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**Testing and implementation of the water quality metric for
the 2017 and 2018 reef report cards**

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I. HIERARCHICAL AGGREGATIONS

I.I Theoretical framework

To facilitate the integration of additional input Measures into the report card scores (such as additional Physical or Chemical), or even additional Sub-indicators (such as sediment metals, aquaculture yields etc), we can define a hierarchical structure in which Measures (such as Chlorophyll-a, NOx, sediment aluminum and yield etc) are nested within appropriate Sub-indicators. In turn, these Sub-indicators are nested within Indicators.

By progressively abstracting away the details of the Measures and Sub-indicators, a more focused narrative can be formulated around each level of the hierarchy. For example, when discussing the current state (and trend in state) of the Water Quality Indicator, rather than needing to discuss each individual constituent of Water Quality, high-level Grades are available on which to base high-level interpretations. More detailed explorations are thence revealed as required by exploring the Grades at progressively finer scales of the hierarchy. Moreover, the hierarchical structure offers great redundancy and thus flexibility to add, remove and exchange individual measures.

Similar arguments can be made for a spatial hierarchy in which Sites are nested within Zones which in turn are nested within the Whole GBR.

The purpose of aggregation is to combine together multiple items of data. For Nesp 3.2.5, the report card is informed by a triple hierarchical data structure in which Daily observations are nested within Seasonal and Annual aggregates, Measures are nested within Sub-indicators which are nested in Indicators and Sites are nested within Zones (see Figure 1).

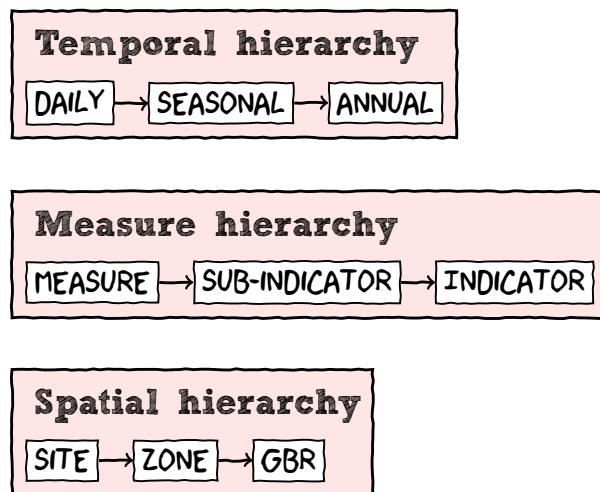


Figure 1: Temporal, measure and spatial aggregation hierarchy

Although the triple hierarchy (temporal, Spatial and Measurement), does offer substantial redundancy and power advantages, it also introduce the complexity of how to combine the hierarchies into a single hierarchical aggregation schedule. Table I (a fabricated example), illustrates this complexity for aggregating across Spatial and Measure scales when data availability differs. This simple example demonstrates how different aggregation schedules can result in different Zone Indicator scores:

- calculating Zone 1 Indicator Score as the average of the Site level Water Quality Scores prioritizes that the Zone 1 Indicator Score should reflect the average of the Water Quality Indicator Scores for the Site. This routine will bias the resulting Zone 1 Water Quality Indicator Score towards Sub-indicators represented in more Sites. The current MMP sampling design is unbalanced (some Zones have more Sites than others and not all Measures are observed in all Sites), and there is no guarantee that the design will be maintained over time. If for example, Chemical Measures were not available for certain Zones, then the Whole GBR Water Quality Indicator Score will be biased towards Water Clarity Sub-indicators.
- calculating Zone 1 Water Quality Indicator Score as the average of the Zone 1 level Sub-indicator Scores prioritizes equal contributions of Sub-indicators to the Indicator Score at the expense of being able to relate Zone 1 Scores to the corresponding Site Scores.

The above becomes even more complex when the temporal dimension is included..

Table 1: Fabricated illustration of the discrepancies between total means (i.e. Zone 1 Indicator Score) generated from row means (Site Sub-indicator Scores) and column means (Zone 1 Sub-indicator Scores).

Site	Sub-indicators		Indicator
	Water Clarity	Nutrients	
1	5	2	3.50
2	6		6.00
3	6	4	5.00
Zone 1	5.67	3.00	X

If X (mean) is calculated from the three row means = 4.83
If X (mean) is calculated from the two column means = 4.33

An additional complication is how the different hierarchies integrate together. Specifically, what level of data should be aggregated first and at what point do the aggregations of one hierarchy feed into other hierarchies. For example, should observations first be aggregated from Daily to Seasonal or Annual, then aggregated from Site level to Zone level and then finally aggregated from Measure to Indicator? Some possible configurations are presented in Figure 2.

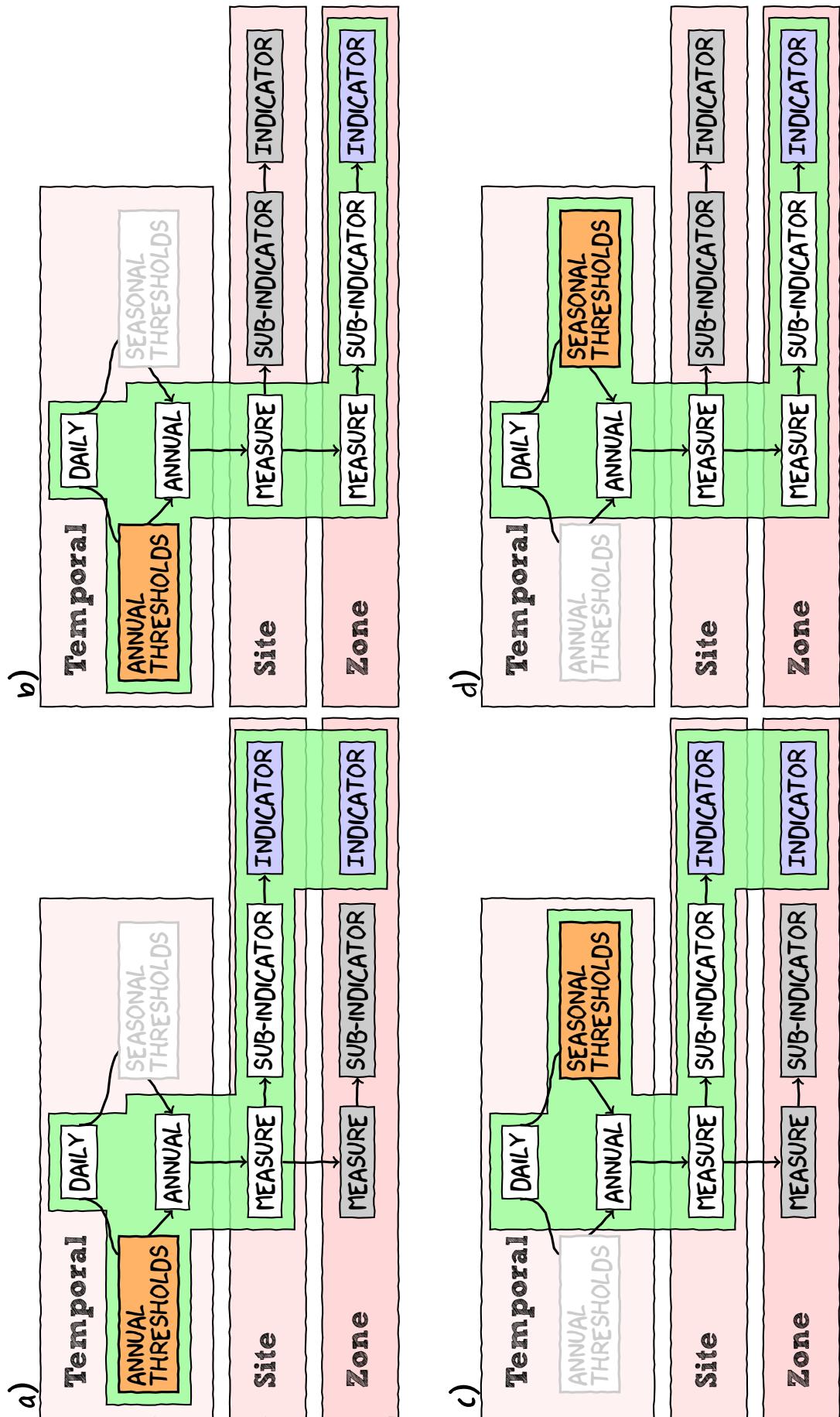


Figure 2: Schematic illustrating four possible aggregation routines through the combination of Temporal (Daily, Seasonal and Annual), Spatial (Site, Zone) and Measure (Measure, Sub-indicator, Indicator) nodes of the triple hierarchical aggregation routine associated with the GBR Report Card. Aggregation directions between nodes are signified by arrows and the main aggregation pathway through the routines is illustrated by the green polygon.

To maximize information retention throughout a series of aggregations, it is preferable to aggregate distributions rather than single properties of those distributions (such as means). The simplest way to perform a hierarchy of aggregations is to interactively calculate the means (or median) of items (means of means etc). At each successive aggregation level only very basic distributional summaries (such as the mean and perhaps standard deviation) are retained, the bulk of upstream information is lost. Alternatively, more complex methods that involve combining data or probability distributions can be effective at aggregating data in a way that propagates rich distributional properties throughout a series of aggregations.

Importantly, if the purpose of aggregation is purely to establish a new point estimate of the combined items, a large variety of methods essentially yield the same outcomes. On the other hand, if the purpose of aggregation is also to propagate a measure of uncertainty or confidence in the point estimate through multiple hierarchical levels of aggregation (as is the case here), then the different methodologies offer differing degrees of flexibility and suitability.

Hierarchical aggregations are essentially a series of steps that sequentially combine distributions (which progressively become more data rich). The resulting distribution formed at each step should thereby reflect the general conditions typified by its parent distributions and by extension, each of the distributions higher up the hierarchy.

Numerous characteristics can be estimated from a distribution including the location (such as mean and median) and scale (such as variance and range). For the current project, the mean and variance were considered the most appropriate¹ distributional descriptions and from these estimates Grades and measures of confidence can be respectively derived. Hence the numerical summaries (mean and variance) at any stage of the hierarchical aggregation are a byproduct rather than the sole property of propagation.

I.I.I Bootstrap aggregation

Although some of the items to be aggregated together might initially comprise only a few values (or even a single value), it is useful to conceptualize them as continuous distributions. For example, when aggregating multiple Measures (such as all Water Quality Chemicals) together to generate a (Site level) Sub-indicator average, each Measure in each Site can be considered a distribution comprising the single Score for that Measure. Aggregation then involves combining together the multiple distributions into a single amalgam (by adding the distributions together, see Figure 3). Similarly, when aggregating at the Indicator level across Site to generate Zone summaries for each Indicator, Site distributions are respectively added together to yield a single distribution per Zone.

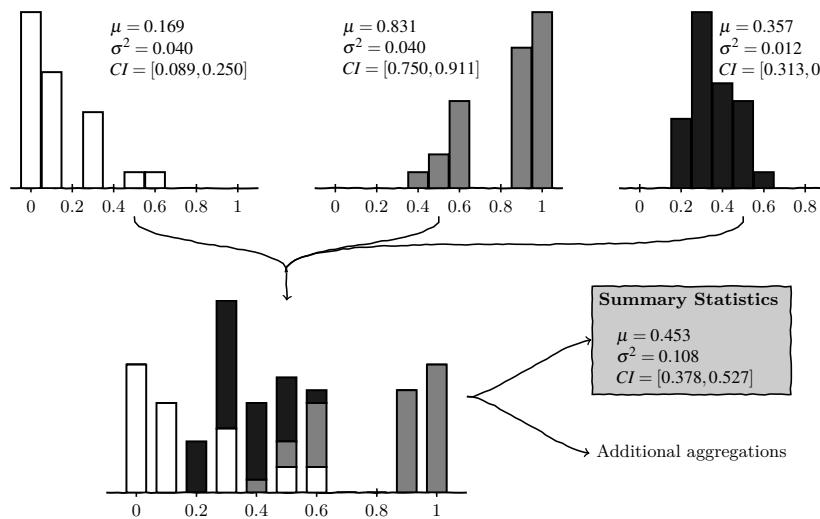


Figure 3: Illustration of Bootstrapped aggregation of three distributions. Simple summary statistics (mean, variance and 95% confidence interval presented for each distribution).

If the distributions being aggregated are all proportional distributions (e.g. density distributions), adding them altogether is trivially simple. However, if, rather than actual distributions, the items to be aggregated are actually just small collections of values (as is the case for many of the discrete Measures here) or even large, yet

¹ The aggregations typically involve some Measures with a small number of unique observations (and thus indices) and thus means and variances provide greater sensitivity than medians and ranges. Moreover, the indexing stage effectively removes outliers and standardizes the scale range thereby reducing the need for robust estimators.

unequally populous collections of values (as could be the case for Continuous Flow Monitoring with missing or suspect observations), then simply aggregating the distributions together will result in amalgams that are weighted according to the size of the collections (larger collections will have more influence). For example, if we were aggregating together three Zones (to yield Whole GBR estimates), one of which comprised twice as many Sites, simple aggregation of distributions would result in a distribution that was more highly influenced by the Zone with the more Sites. Similarly, when aggregating from the level of Sub-indicator to the level of Indicator, the resulting Indicator would be biased towards the Sub-indicator with the most Measures. Whilst this may well be a useful property (e.g. stratified aggregation), it may also be undesirable.

Bootstrapping is a simulation process that involves repeated sampling (in this case with replacement) of a sample set with the aim of generating a bootstrap sample from a distribution. This bootstrap sample can be used to estimate the underlying probability distribution function that generated the data as well as any other summary statistics. Importantly, bootstrapping provides a way to generate distributions that are proportional and thus un-weighted by the original sample sizes thereby facilitating un-weighted aggregation². Bootstrapped distributions can be aggregated (added together) to yield accumulated child distributions that retain the combined properties of both parents (see Figure 3). As a stochastic process, repeated calculations will yield slightly different outcomes. Nevertheless, the more bootstrap samples are collected, the greater the bootstrap distributions will reflect the underlying Score distribution and provided the number of drawn samples is sufficiently large (e.g. 10,000 re-samples), repeated outcomes will converge.

To reiterate, the advantage of bootstrapping data before concatenating (or averaging) versus simply concatenating data from multiple sources together, is to ensure that source data are all of exactly the same sample size (so as to not weight more heavily towards the more populous source(s)³). Bootstrapping also provides a mechanism for propagating all distribution information throughout an aggregation hierarchy and ensures that estimates of variance derived from child distributions are on a consistent scale⁴. The latter point is absolutely critical if variance is going to be used to inform a Confidence Rating system and confidence intervals.

Minimum operator procedures are supported by filtering on the lowest performed indicator prior to bootstrapping. Importantly, the bootstrapping routine simply provides a mechanism to collate all sources together to yield a super distribution. Thereafter, the joint distribution can be summarized in whatever manner is deemed appropriate (arithmetic, geometric, harmonic means, medians, variance, range, quantiles etc). Moreover, different levels of the aggregation can be summarized with different statistics if appropriate.

I.1.2 Beta approximation

Whilst the bootstrap aggregation approach described above does offer a robust way to combine data across scales and sources, for large data sets, it does impose large computational and storage burdens. For such cases (large data such as remote sensing), index distributions can be approximated by beta distributions. The beta distribution is defined on the interval [0,1] and is parameterized by two positive shape parameters (α, β) according to the following:

$$f(x; \alpha, \beta) = \frac{\Gamma(\alpha + \beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1} (1-x)^{\beta-1}$$

A beta function can manifest as many different shapes and as all of these are described by just two shape parameters. Therefore, rather than store all the bootstrapped values for each distribution, we can alternatively approximate each distribution by a beta and store only the defining shape parameters of each distribution. When combining, rather than randomly sample 10,000 stored values of each distribution, we simple resample 10,000 random draws from each beta distribution⁵. The combined distribution can then be approximated by a beta distribution and so on.

I.1.3 Weights

Standard bootstrapping yields equally weighted distributions, however, specific weighting schemes can also be easily applied by bootstrapping in proportion to the weights. For example, to weight one parent twice as high as another, simply collect twice as many re-samples from the first distribution. To ensure that all resulting distributions have the same size (by default 10,000 items), the number of bootstrap samples collected (n) from each of

²technically, all equally weighted rather than un-weighted

³Such weightings should be handled in other ways if at all

⁴Variance is inversely proportional to sample size

⁵Unfortunately there is no closed-form general formula for the sum of multiple independent beta distributions.

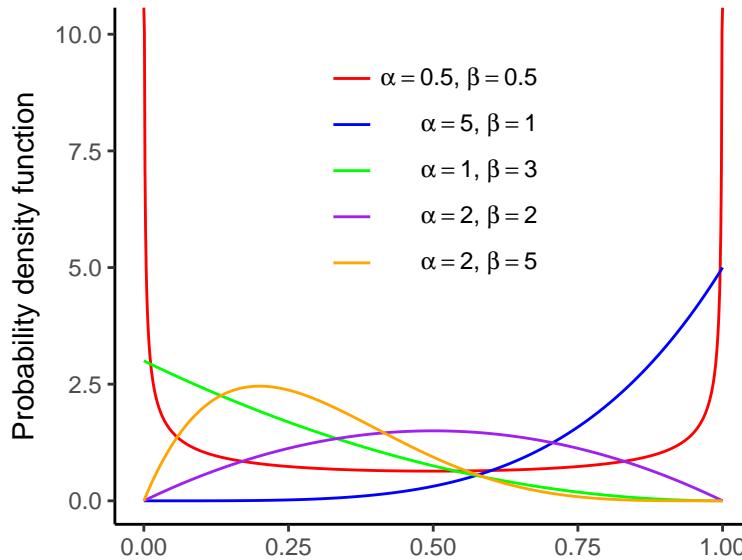


Figure 4: Beta probability densities

the (p) parent distributions (i), given the weights (w_i) is calculated as:

$$n_i = (S / p) \times w_i$$

where S is the target size (10,000) and . indicates the ceiling. Qualitative data (such as ratings) can also be incorporated by enumerating the categories before bootstrapping.

In addition to allowing expert driven weights that govern the contribution of different items during aggregations, it is possible to weight according to relative spatial areas during spatial aggregations. Currently, all Sites are equally weighted when aggregating to Zone level and all Zones equal when aggregating to Whole of GBR level. That means that small Zones have an equal contribution as large Zones despite representing a smaller fraction of the water body. Area based weights could be applied such that Sites and Zones contribute in proportion to relative areas.

Weights are defined by a user editable configuration file that is similar in structure to the Water Quality thresholds file.

I.1.4 Expert interventions

The ability for experts and Report Card managers to intervene (exclude or overwrite) Scores/Grades at any Spatial/Measure scale is essential to maintain the quality of a Report Card in the event of unrepresentative or suspect data. The current system is able to support expert interventions in the form of exclusions and overwrites. For example, after reviewing the QAQC, an expert can elect to exclude one or more Measures (or Subindicators etc) from one or more spatial scales. Such interventions are specified via a user editable configuration files⁶ (csv) that is similar in structure to the Water Quality thresholds file.

The essential component of this configuration file is that it allows a user to specify what Data are to be excluded or replaced. These can be at any of the levels of the Measure hierarchy (Measures, Sub-indications and Indicators) and any level of the Spatial hierarchy (Sites, Zones and Whole GBR). Settings pertaining to levels further along the aggregation hierarchies have precedence. For example, if Chemicals are excluded (or overridden) in a particular Zone, then all Chemical Measures within all Sites will be excluded irrespective of what the settings are for any specific Measure/Site.

I.1.5 Scores and Grades

The double hierarchy Bootstrap aggregation described above, yields **Score** distributions for each Measure-level/Spatial-level combination. The location and scale of each distribution can thus be described by its mean

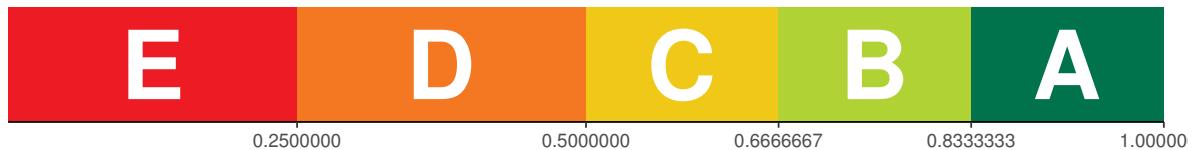
⁶Since aggregation occurs across two hierarchies (the Measure hierarchy and the Spatial hierarchy - see Figures 1 and 2), two configuration files are necessary.

and variance. Mean **Scores** are then converted into a simple five-point alphanumeric **Grade** scale (and associated colors) using a control chart (see Figure 5).

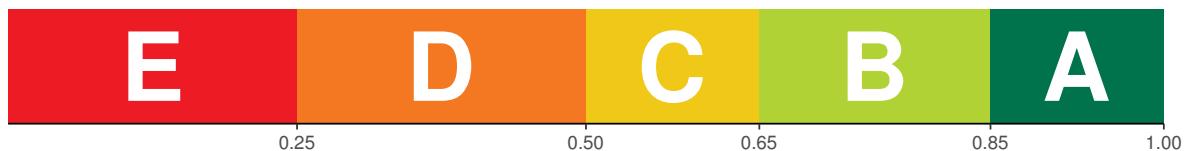
a) Uniform



b) AIMS Marine Monitoring Water Quality and Coral Report Cards



c) Gladstone Healthy Harbour Partnership Environmental Report Card



d) MidCoast Council Waterway and Catchment Report

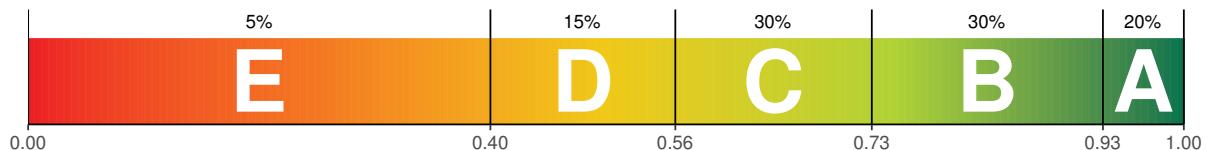


Figure 5: Score to grade conversion control charts. In each case, the scale along the base defines the grade boundaries.

The control charts adopted by the AIMS inshore water quality Marine Monitoring Program (MMP Lønborg et al., 2016) and the Gladstone Healthy Harbour Partnership (Gladstone Healthy Harbour Partnership, 2016) both define two levels (Poor and Very Poor) under the Threshold values and three above (Satisfactory, Good and Very Good). The threshold is purposely placed at the boundary of two grades so as to ease the distinction between 'pass' and 'fail'. The major difference between these two charts is that whereas the AIMS MMP report card control chart partitions the three better than threshold categories, the Gladstone Healthy Harbour Partnership report card control chart employs simpler boundary cutoffs around the 'B' grade (although this does result in arbitrarily unequal category sizes).

By contrast, the MidCoast Council (formally Great Lakes Council) Waterway and Catchment Report (MidCoast Council, 2016) uses grade boundaries based on historical score distribution quantiles associated with definitions of what proportion of total observations (sites) are considered 'Excellent' (A), 'Good' (B), 'Fair' (C), 'Poor' (D) and 'Very Poor' (Fig. 5d). For example, the 'Very Poor' grade was defined as the worst 5% of sites across the entire State of New South Wales and the lowest 5% of sites has a maximum score of 0.4. This approach recognizes the non-linear spread of scores resulting from their particular metrics and attempts to ensure that grades are intuitively interpretable (A grade of A means the site is in Excellent condition). Nevertheless, it does necessitate a of historical data and as well as a very specific and agreed upon set of a priori condition definitions.

In each of the above approaches, grade boundaries are usually determined to some extent by expert panel to ensure that the range of indices represented by each grade classification is congruent with community interpretation of a letter grade report cards. It is far less clear how estimates of uncertainty can be incorporated into such a grading scheme in a manner that will be intuitive to non-technical audiences. That said, statistical uncertainty is just one of many sources of un- certainty that should be captured into a confidence or certainty rating. Hence any expectations of presenting uncertainty in a quantitative manner may well be unrealistic anyway.

In the absence of expert opinion, we have elected to adopt a very simple score-grade control chart in which the score range is simply partitioned into five equal grades (Fig. 5a).

1.1.6 Certainty rating

Incorporating an estimate of scale (variance) into a certainty or confidence rating necessitates re-scaling the estimates into a standard scale. In particular, whereas a scale parameter of high magnitude indicates lower degrees of certainty, for a certainty rating to be useful for end users, larger numbers should probably represent higher degrees of certainty. Thus, the scaling process should also reverse the scale. Furthermore, variance is dependent on the magnitude of the values.

In order to re-scale a scale estimate into a certainty rating, it is necessary to establish the range of values possible for the scale estimate. Whilst the minimum is simple enough (it will typically be 0), determining the maximum is a little more challenging depending on the aggregation algorithm (bootstrapping, Bayesian Network etc). One of the advantages in utilizing proportional distributions (such as is the case for a Bayesian Network or a re-sampled bootstrap distribution) is that the scale parameter for the single worst case scenario can be devised (once the worst case scenario has been determined) independent of sample sizes or weightings. In most situations this is going to be when the distribution comprises equal mass at (and only at) each of the two extremes (for example, values of just 0 and 1).

The measure of confidence rating discussed above is purely an objective metric derived from the variance in the aggregation hierarchy. It is completely naive to issues such as missing data, outliers and Limit of Detection issues - the influences of which on a confidence rating are necessarily subjective. A full Confidence Rating would combine these objective variance component with additional subjective considerations such as climatic and disturbance information, and the perceived influence of missing, Limit of Detection and outlying data. Hence, the statistical scaled statistical variance would form just one component in the Confidence Rating system.

The bootstrap aggregation method provides a mechanism for estimating variance from which to build such an expert considered Confidence Rating system.

Table 2 presents the Water Quality Indicator Scores and associated Grades for each Zone based on three of the grade control chart types described in Figure 5 for the eReefs data indexed using the fsMAMP formulation. Whilst there is some agreement between the different grade types, in general, the Uniform type yields higher grades than either MMP or GHHP.

Table 2: Score and associated Grades based on three different grade control charts (Uniform, MMP and GHHP) for eReefs data indexed via fsMAMP and aggregated to Zone/Indicator level.

Region	Water Body	Water Year	Score	Grade (MMP)	Grade (Uniform)	Grade (GHHP)
Cape York	Open Coastal	2014	0.692	B	B	B
Cape York	Open Coastal	2015	0.741	B	B	B
Cape York	Open Coastal	2016	0.757	B	B	B
Cape York	Midshelf	2014	0.716	B	B	B
Cape York	Midshelf	2015	0.764	B	B	B
Cape York	Midshelf	2016	0.781	B	B	B
Cape York	Offshore	2014	0.825	B	A	B
Cape York	Offshore	2015	0.852	A	A	A
Cape York	Offshore	2016	0.895	A	A	A
Wet Tropics	Open Coastal	2014	0.602	C	B	C
Wet Tropics	Open Coastal	2015	0.668	B	B	B
Wet Tropics	Open Coastal	2016	0.692	B	B	B
Wet Tropics	Midshelf	2014	0.711	B	B	B
Wet Tropics	Midshelf	2015	0.760	B	B	B
Wet Tropics	Midshelf	2016	0.796	B	B	B
Wet Tropics	Offshore	2014	0.819	B	A	B
Wet Tropics	Offshore	2015	0.844	A	A	B
Wet Tropics	Offshore	2016	0.873	A	A	A
Dry Tropics	Open Coastal	2014	0.580	C	C	C
Dry Tropics	Open Coastal	2015	0.624	C	B	C
Dry Tropics	Open Coastal	2016	0.639	C	B	C
Dry Tropics	Midshelf	2014	0.758	B	B	B
Dry Tropics	Midshelf	2015	0.799	B	B	B

..continued from previous page

Region	Water Body	Water Year	Score	Grade (MMP)	Grade (Uniform)	Grade (GHHP)
Dry Tropics	Midshelf	2016	0.821	B	A	B
Dry Tropics	Offshore	2014	0.778	B	B	B
Dry Tropics	Offshore	2015	0.809	B	A	B
Dry Tropics	Offshore	2016	0.829	B	A	B
Mackay Whitsunday	Open Coastal	2014	0.464	D	C	D
Mackay Whitsunday	Open Coastal	2015	0.491	D	C	D
Mackay Whitsunday	Open Coastal	2016	0.505	C	C	C
Mackay Whitsunday	Midshelf	2014	0.568	C	C	C
Mackay Whitsunday	Midshelf	2015	0.607	C	B	C
Mackay Whitsunday	Midshelf	2016	0.602	C	B	C
Mackay Whitsunday	Offshore	2014	0.470	D	C	D
Mackay Whitsunday	Offshore	2015	0.474	D	C	D
Mackay Whitsunday	Offshore	2016	0.475	D	C	D
Fitzroy	Open Coastal	2014	0.377	D	D	D
Fitzroy	Open Coastal	2015	0.382	D	D	D
Fitzroy	Open Coastal	2016	0.442	D	C	D
Fitzroy	Midshelf	2014	0.589	C	C	C
Fitzroy	Midshelf	2015	0.595	C	C	C
Fitzroy	Midshelf	2016	0.631	C	B	C
Fitzroy	Offshore	2014	0.528	C	C	C
Fitzroy	Offshore	2015	0.541	C	C	C
Fitzroy	Offshore	2016	0.571	C	C	C
Burnett Mary	Open Coastal	2014	0.624	C	B	C
Burnett Mary	Open Coastal	2015	0.639	C	B	C
Burnett Mary	Open Coastal	2016	0.653	C	B	B
Burnett Mary	Midshelf	2014	0.646	C	B	C
Burnett Mary	Midshelf	2015	0.675	B	B	B
Burnett Mary	Midshelf	2016	0.745	B	B	B
Burnett Mary	Offshore	2014	0.733	B	B	B
Burnett Mary	Offshore	2015	0.771	B	B	B
Burnett Mary	Offshore	2016	0.848	A	A	B

I.I.7 Confidence intervals

Confidence intervals (CI) represent the intervals in which we have a certain degree of confidence (e.g. 95%) that repeated estimates will fall. Hence the 95% CI of the mean is the range defined by the quantiles representing 95% of repeated estimates of the mean.

To calculate 95% confidence intervals for bootstrap aggregated distributions (e.g. Wet Tropics Open Coastal/Chlorophyll-a distribution), we repeatedly⁷ draw a single sample from each of the constituent distributions (e.g. a single value from the Wet Tropics Open Coastal Chlorophyll-a, Chlorophyll-a and NOx distributions) and from each set of draws, calculate the weighted⁸ mean of the values. The 95% CI is thus calculated as the quantiles ($p=0.025$ and $p=0.975$) of the means.

Confidence intervals are used to represent uncertainty in estimations. For example, 95% confidence intervals associated with a estimated mean roughly express a range of values over which we have the nominated degree of confidence that the true value is likely to lie⁹.

⁷The more repeated draws the closer the distribution of means will converge. For the current project, the number of repeated draws is 10,000.

⁸Weights according to the weights defined for that level of the aggregation hierarchy

⁹From a frequentist perspective, 95% confidence intervals technically indicate that 95% of intervals of the calculated extent will contain the true mean

Uncertainty arises from multiple sources. Firstly, it arises from the accuracies of the measured data and secondly, from the imprecisions introduced by the statistical methodologies for processing and summarizing the data. Hence encapsulating and communicating full uncertainty requires information about both of these sources of uncertainty.

Estimates (such as sample means) are typically calculated from very small (yet ideally representative) samples drawn from a much larger population. In such cases, the statistically derived confidence intervals are used to provide an indication of the range of estimates in which we are confident the true value is likely to lie. That is, they depict the statistical uncertainty that arises from the need to estimate parameters from small amounts of the total possible spatial/temporal domain.

If measurement uncertainty is also known, then it is possible to incorporate and propagate this through the aggregation schedule so as to yield total uncertainty. Measurement uncertainty is very typically very difficult to obtain. Nevertheless, it is usually assumed to be relatively small compared to the statistical uncertainty.

However, in the case of the Satellite and eReefs data, we have a virtual saturation of sample data. That is, with respect to the spatial and temporal extent of the data, we essentially have the entire population. Consequently, the statistical uncertainty is virtually zero. We are not estimating a mean, we are calculating the mean. Hence measurement uncertainty is of elevated importance. Unfortunately, we do not have any information about the measurement uncertainty at a spatial and temporal scale appropriate. As a result, we have elected not to represent uncertainty (as it would only be based on statistical uncertainty which would give the misleading impression of extremely low levels of uncertainty).

I.2 Summary of adopted methodologies

The aggregation schedule can be summarized as:

A. Calculation of Zone level Score and Grades

1. Collect raw data (= *Measures*) at each fixed monitoring Site and compare individual observations to associated *Threshold*
2. Create **indexed** data as an expression of degree of difference with associated *Threshold* values (**fixed capped scaled modified amplitude method**) to yield a *Score* for each *Measure* per sampling location (e.g. Site) (applies to *Measures* in all *Indicators*, Water Quality).
3. Apply any expert opinion interventions (if appropriate - not employed in the current version).
4. Combine *Measure Scores* into Site-level *Sub-indicator Scores* by **averaging** taking into account any weightings, i.e. aggregate into observation-level Sub-indicator Scores. This step involves **Bootstrapping** each input to distributions of 10,000 re-samples (or fewer if weighted), combining distributions and finally Bootstrapping again into a single 10,000 size distribution.
5. Combine *Sub-indicator Scores* into Site-level *Indicator Scores* by **averaging** (bootstrapping), i.e. aggregate into Site-level *Indicator Scores*.
6. Convert Scores into coloured *Grades* (A-E) for visual presentation in report card using a **Uniform** control chart

B. Calculation of Zone level Grades

1. Aggregate Site-level *Measure Scores* from step A.4 into Zone-level *Measure Scores* by **averaging** (bootstrapping incorporating any weights)
2. Aggregate Zone-level *Sub-indicator Scores* into Zone-level *Indicator Scores* by **averaging** (bootstrapping incorporating any weights)
3. Convert Scores into coloured *Grades* (A-E) for visual presentation in report card using a **Uniform** control chart

C. Calculation of Whole GBR Grades

1. Establish spatial weights as proportional Open Coastal Zone geographic areas
2. Aggregate Open Coastal Zone-level *Measure Scores* from step B.1 into Open Coastal GBR-level *Sub-indicator Scores* by **averaging** (bootstrapping incorporating spatial weights)
3. Aggregate Open Coastal GBR-level *Sub-indicator Scores* into Open Coastal GBR-level *Indicator Scores* by **averaging** (bootstrapping)
4. Convert Scores into coloured *Grades* (A-E) for visual presentation in report card using a **Uniform** control chart

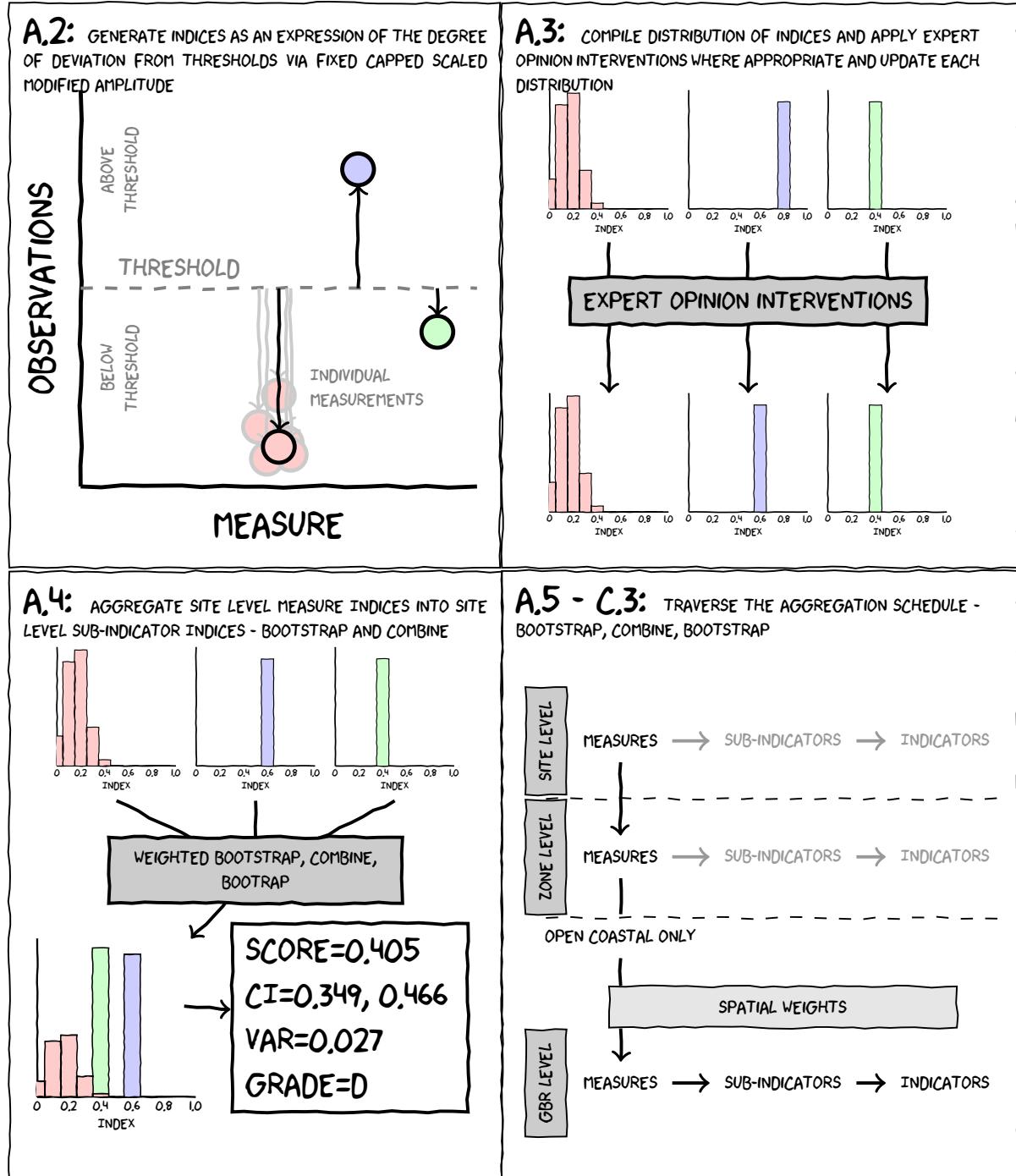
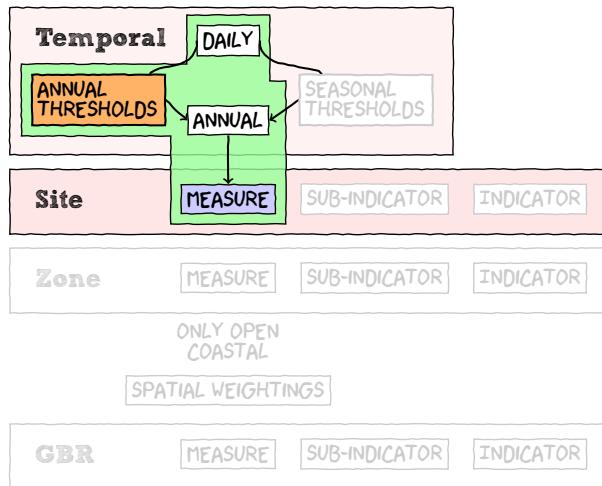


Figure 6: Schematic illustrating the major steps of the GBR Water Quality Report Card. In this fabricated example, there are three Measures (Red, Green and Blue). Each of the Blue and Green Measures are represented by a single discrete observation, whereas the Red Measure is represented by a large collection of observations. Expert option (top right panel) intervened to lower the blue Measure distribution from observed values at 0.8 to 0.6. Bootstrap aggregations (bottom left panel) are used to combine data together proportionally. Aggregation follows a specific pathway through the aggregation hierarchy depicted in the bottom right panel. Great Barrier Reef (GBR) level aggregations utilize Open Coastal data only and aggregations are weighted according to proportional geographic areas of the Zones.

1.3 Aggregation summaries

The ISP have indicated that the Water Quality metric should be based purely on eReefs fsMAMP indexed Chlorophyll-a and Secchi Depth and that the conversion of scores to grades should follow a uniform control chart. Consequently, this section will only present graphical summaries for these metric determinants.

1.3.1 Site/Measure level



1.3.1.1 Site level maps

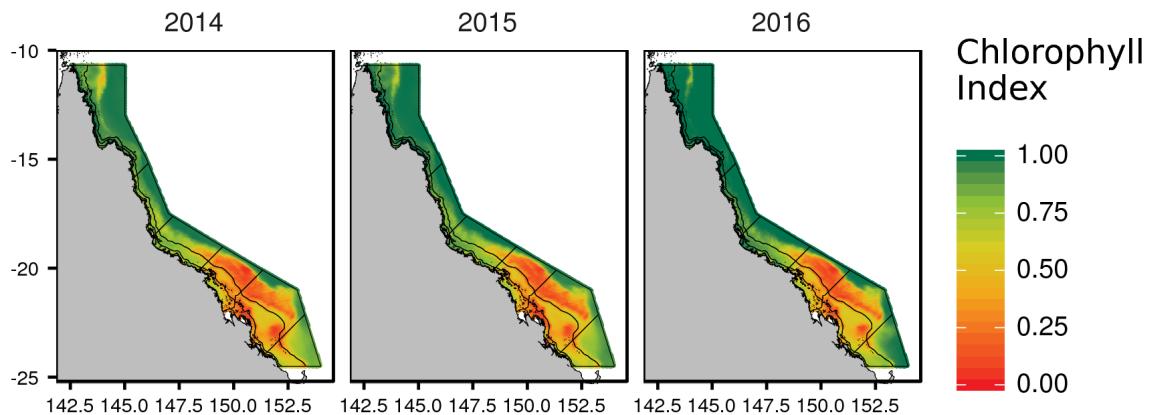


Figure 7: Spatio-temporal patterns in eReefs fsMAMP Chlorophyll-a index grades (Uniform grade type control chart applied).

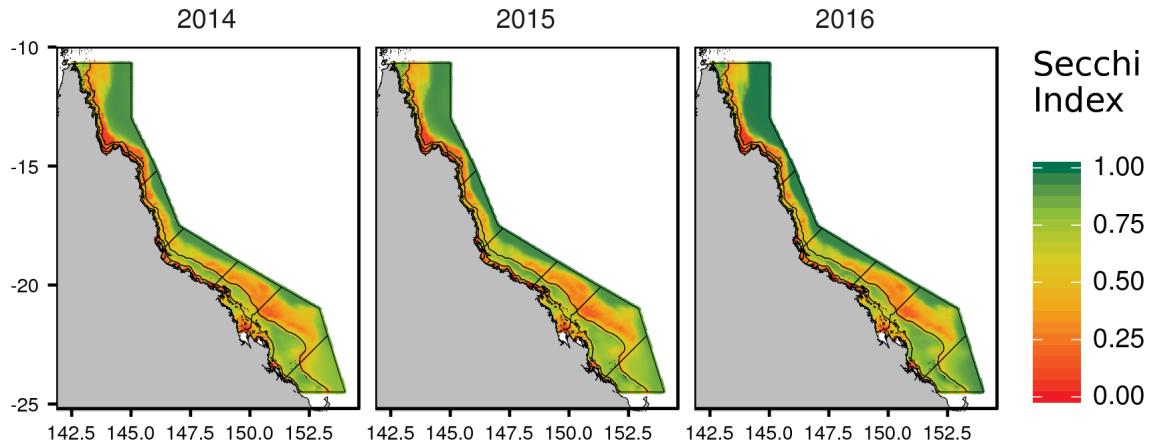
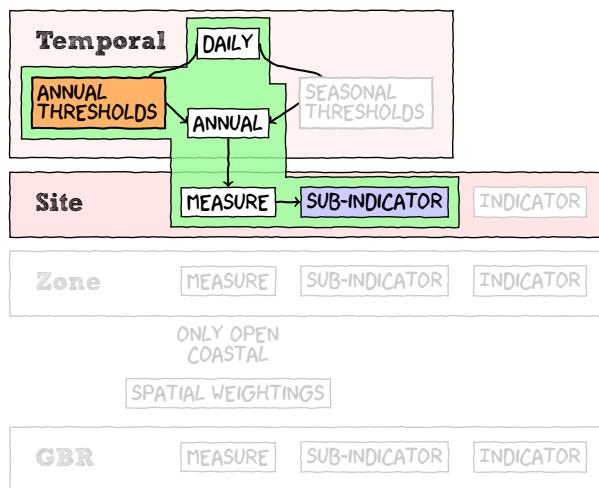


Figure 8: Spatio-temporal patterns in eReefs fsMAMP Secchi Depth index grades (Uniform grade type control chart applied).

I.3.2 Site/Subindicator level



I.3.2.1 Site level maps

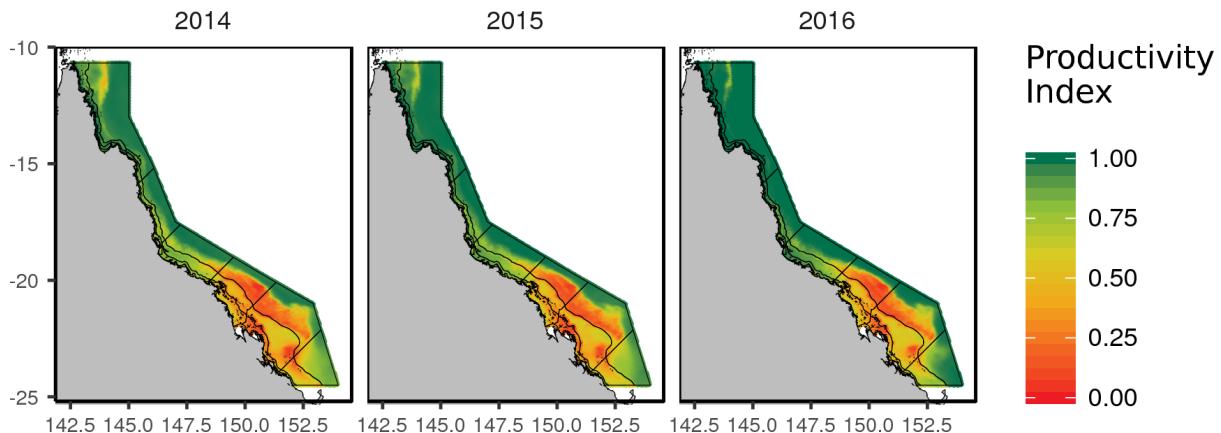


Figure 9: Spatio-temporal patterns in eReefs fsMAMP Productivity index grades (Uniform grade type control chart applied).

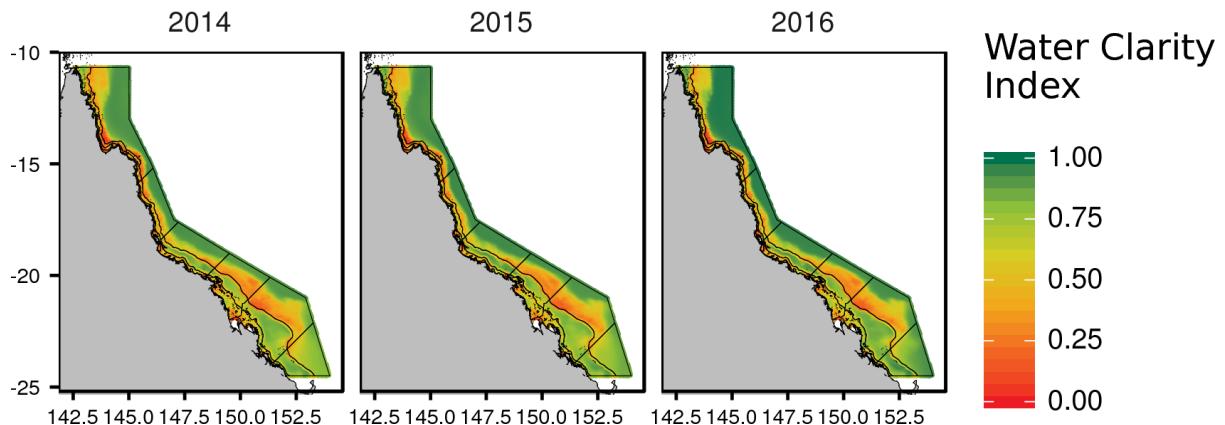
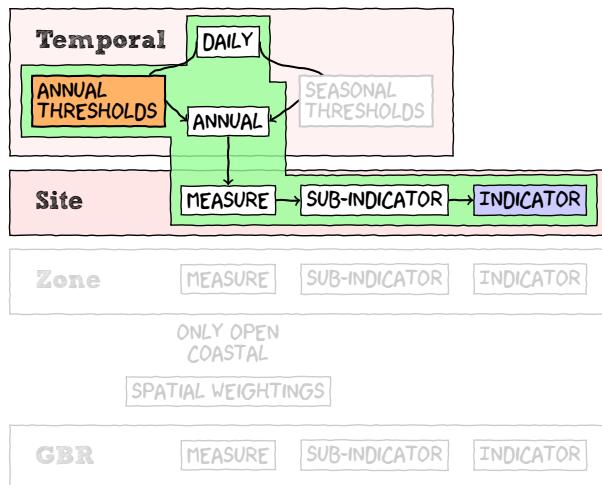


Figure 10: Spatio-temporal patterns in eReefs fsMAMP Water Clarity index grades (Uniform grade type control chart applied).

I.3.3 Site/Indicator level



I.3.3.1 Site level maps

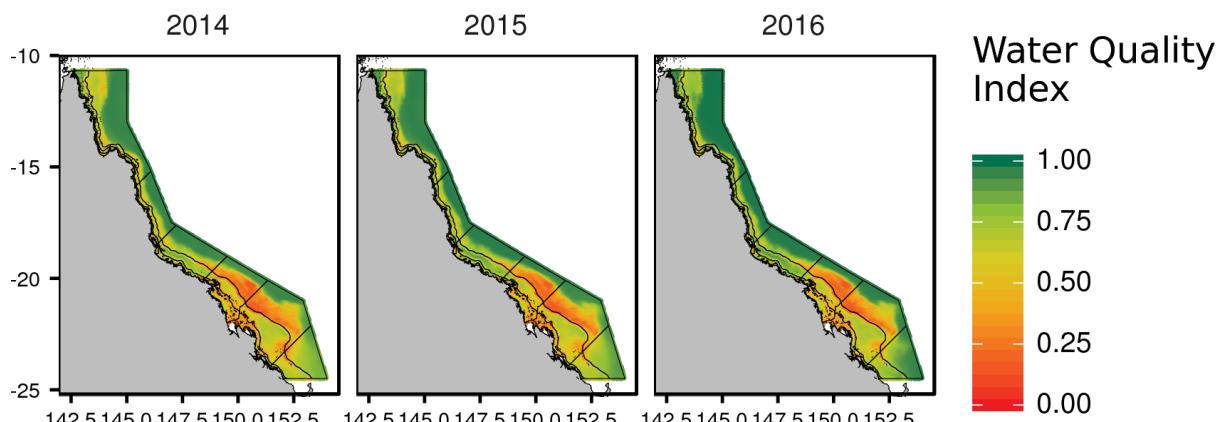
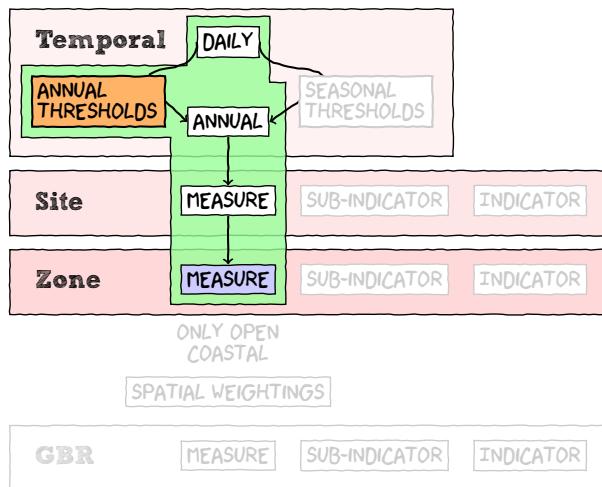


Figure 11: Spatio-temporal patterns in eReefs fsMAMP Water Quality index grades (Uniform grade type control chart applied).

I.3.4 Zone/Measure level



I.3.4.1 Simple time series

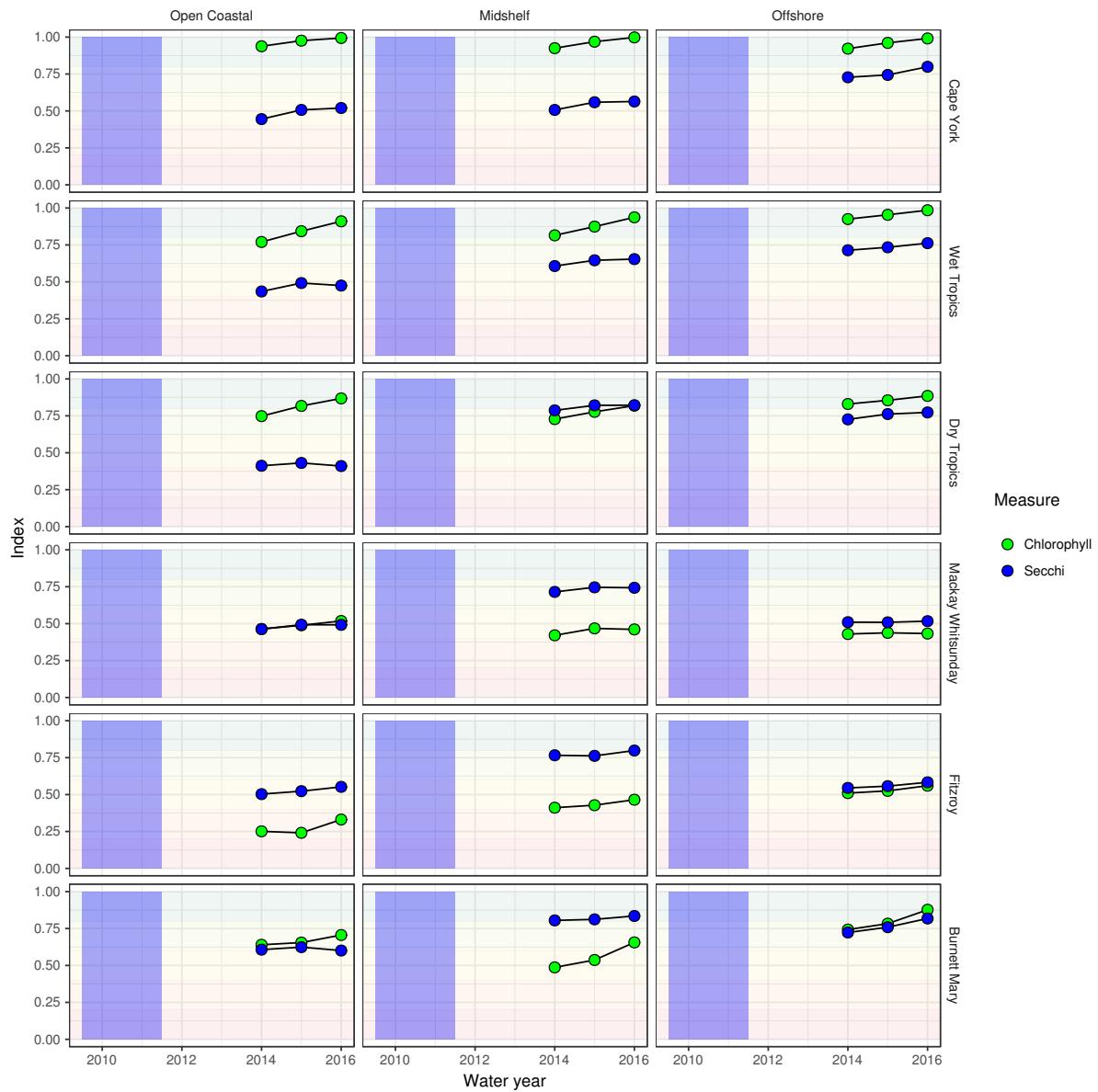


Figure 12: Time series of fsMAMP measures (Chlorophyll-a and Secchi Depth) index scores by zone. The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.3.4.2 Flat map

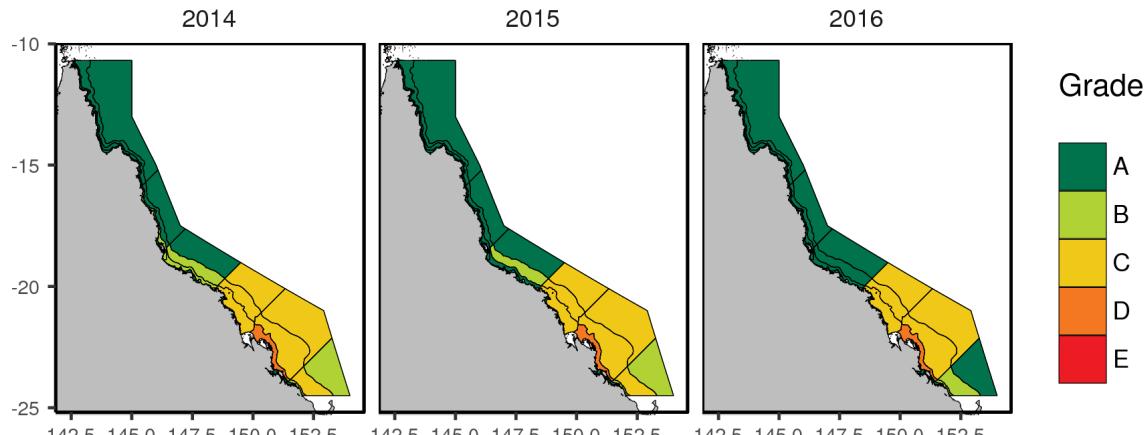


Figure 13: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Chlorophyll-a index grades (Uniform grade type control chart applied).

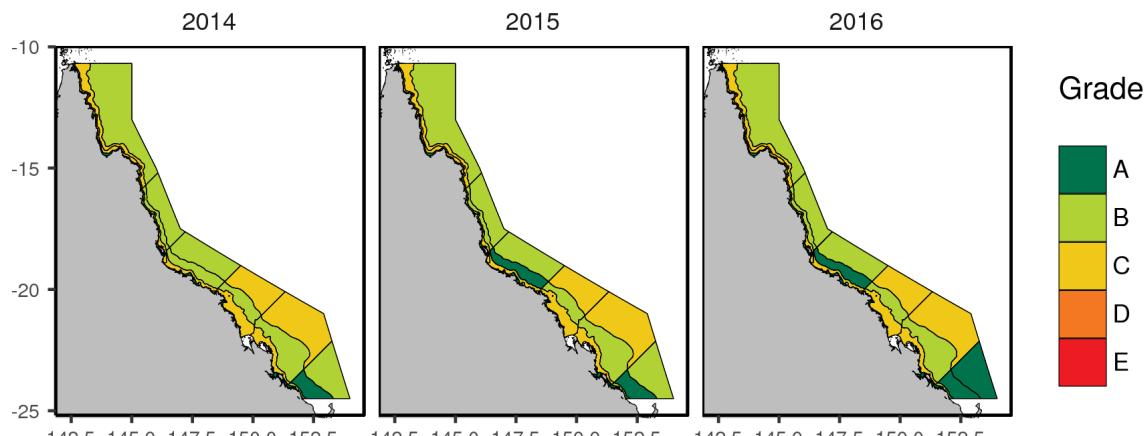


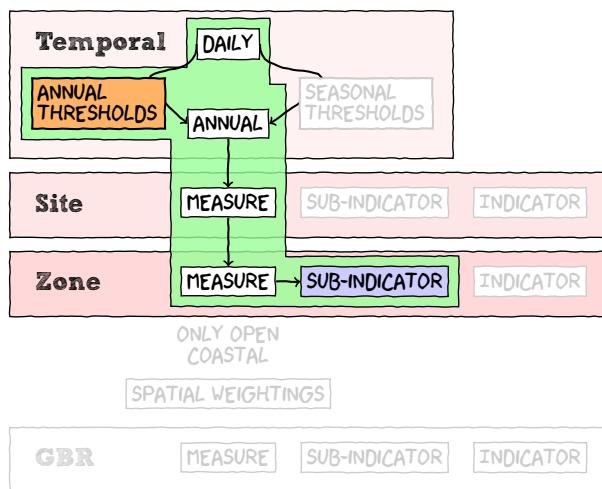
Figure 14: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Secchi Depth index grades (Uniform grade type control chart applied).

I.3.4.3 Mosaic plots level



Figure 15: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Chlorophyll-a index grades (Uniform grade type control chart applied).

1.3.5 Zone/Subindicator



1.3.5.1 Simple time series

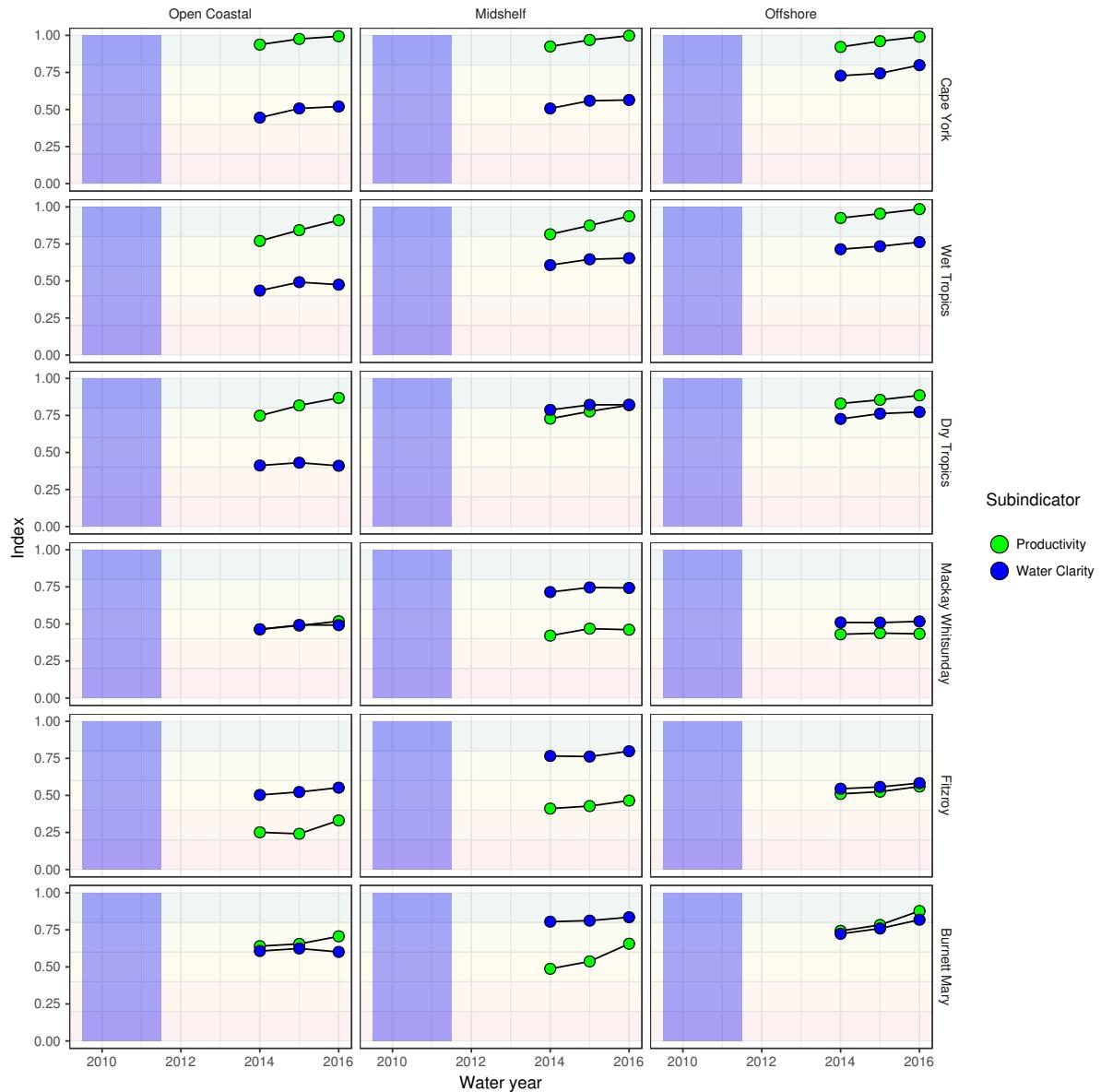


Figure 16: Time series of fsMAMP Productivity and Water Clarity index scores by zone. The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.3.5.2 Flat map

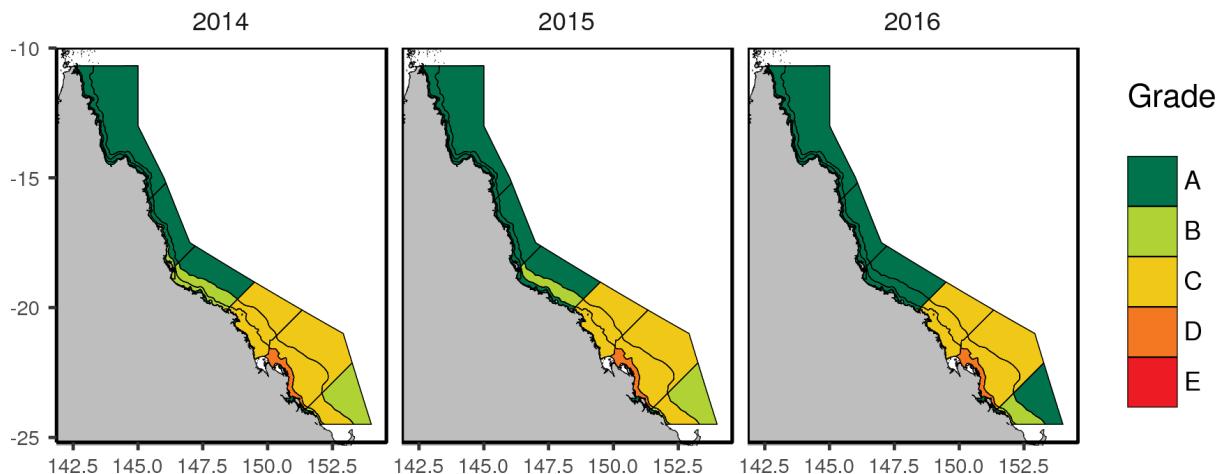


Figure 17: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Productivity index grades (Uniform grade type control chart applied).

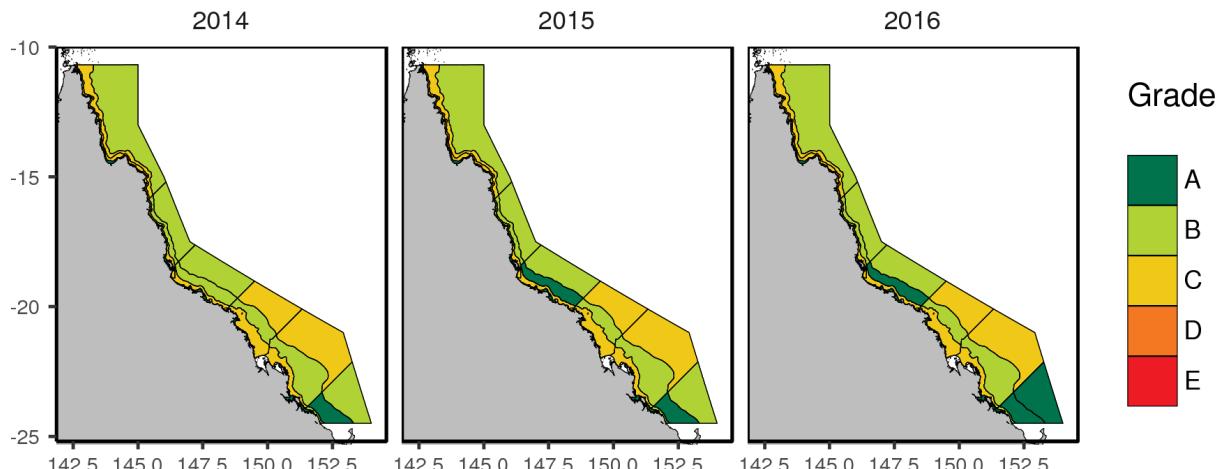


Figure 18: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Water Clarity index grades (Uniform grade type control chart applied).

I.3.5.3 Mosaic plots

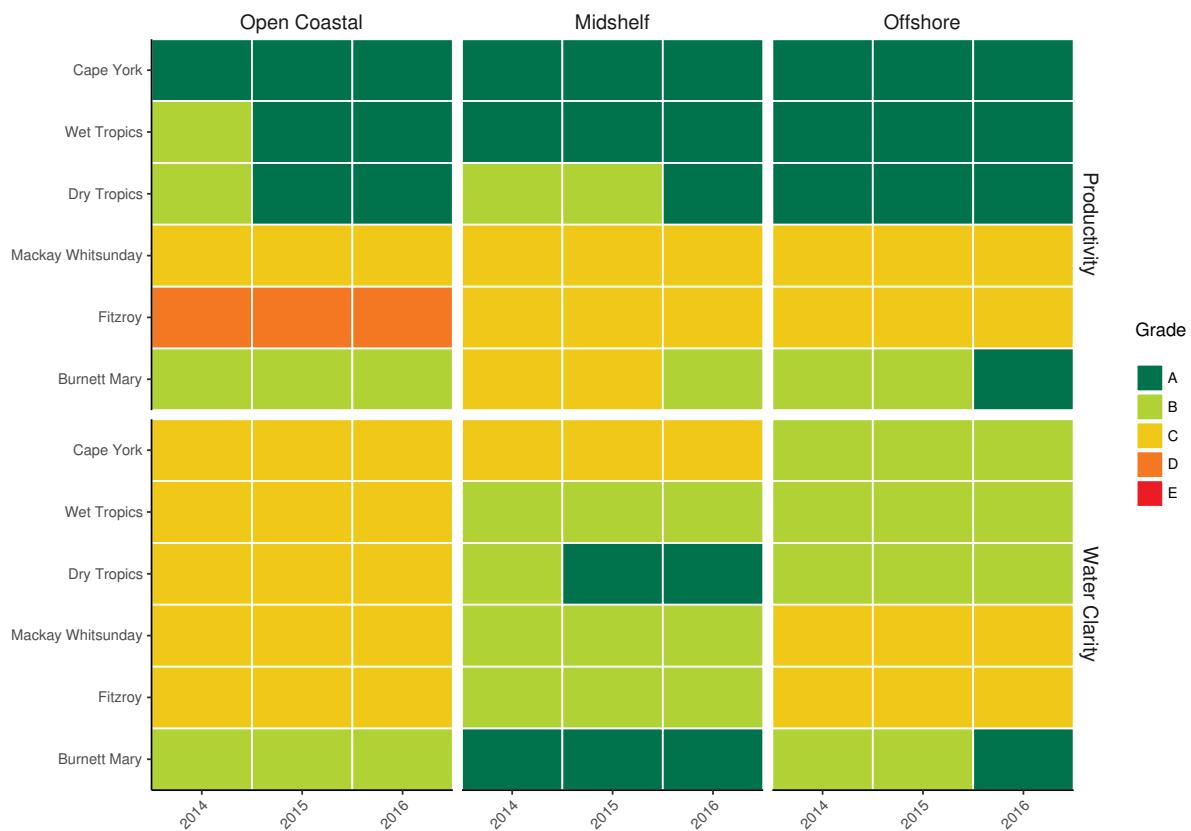
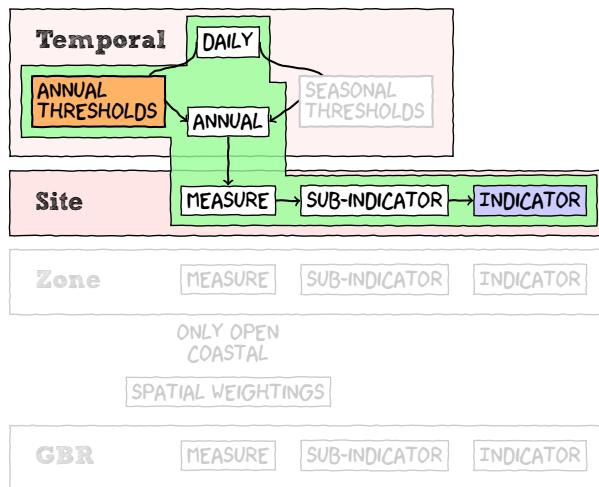


Figure 19: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Subindicator index grades (Uniform grade type control chart applied).

1.3.6 Zone/Indicator level



1.3.6.1 Simple time series

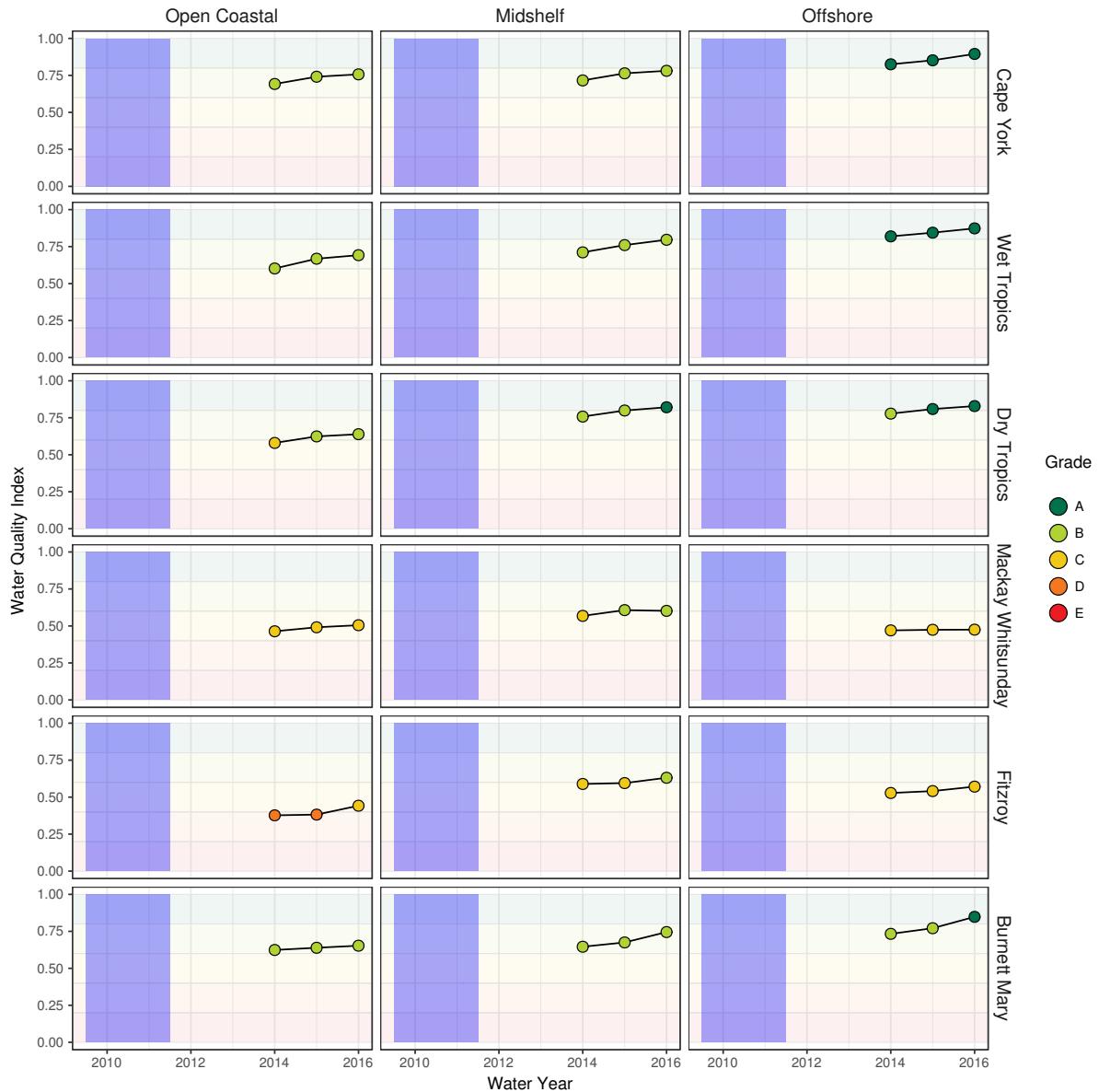


Figure 20: Time series of fsMAMP Water Quality index scores by zone. The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.3.6.2 Flat map

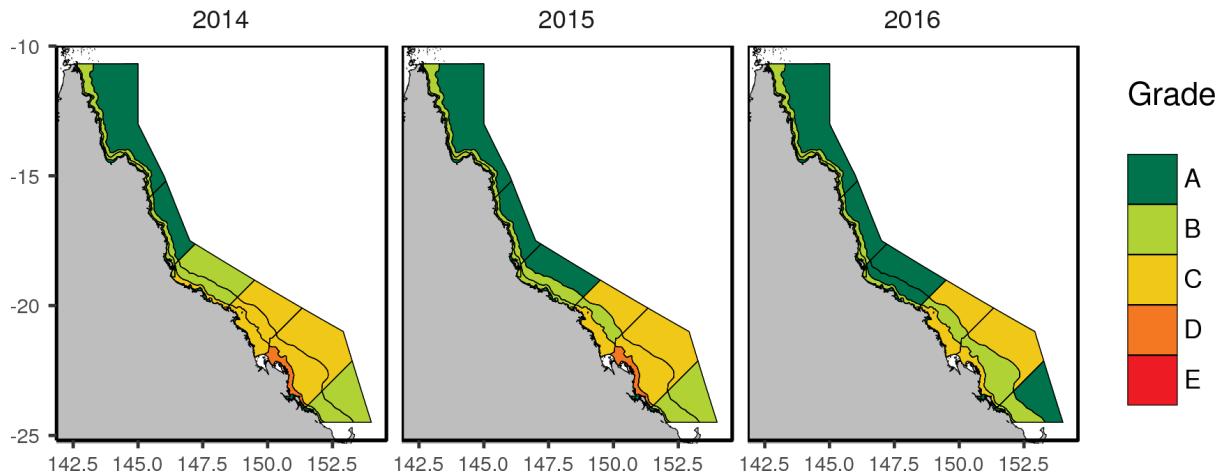


Figure 21: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Productivity index grades (Uniform grade type control chart applied).

I.3.6.3 Mosaic plots

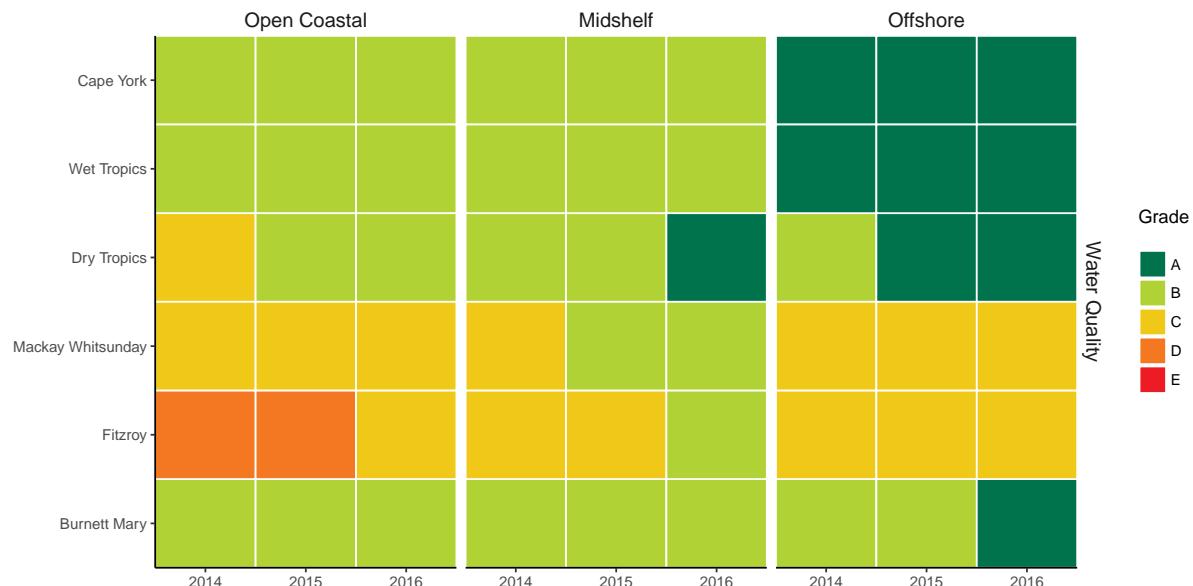
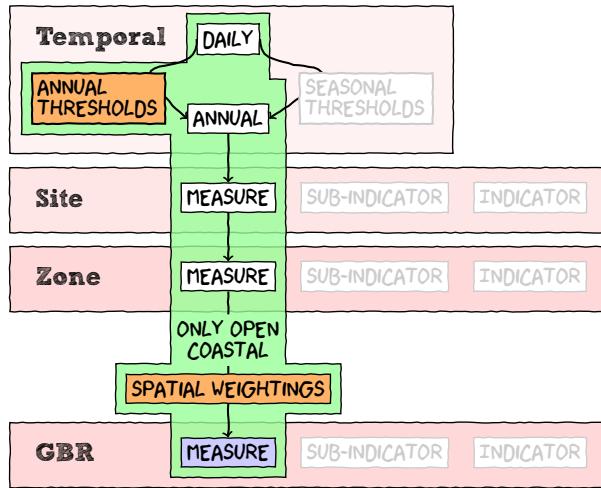


Figure 22: Simplified (Zone mean) eReefs spatio-temporal fsMAMP indicator index grades (Uniform grade type control chart applied).

1.4 Aggregations to water body level

1.4.1 Water body/Measure level



1.4.1.1 Simple time series

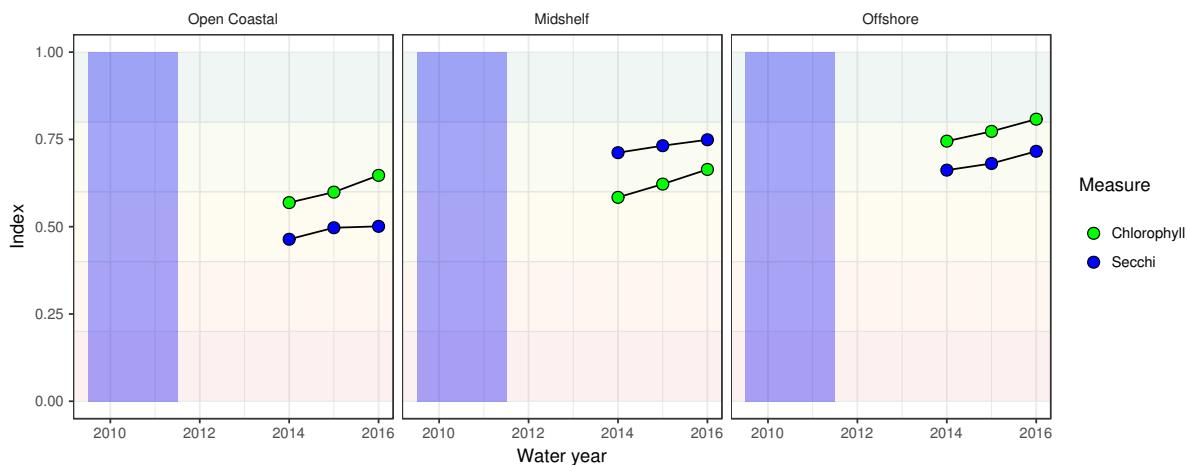


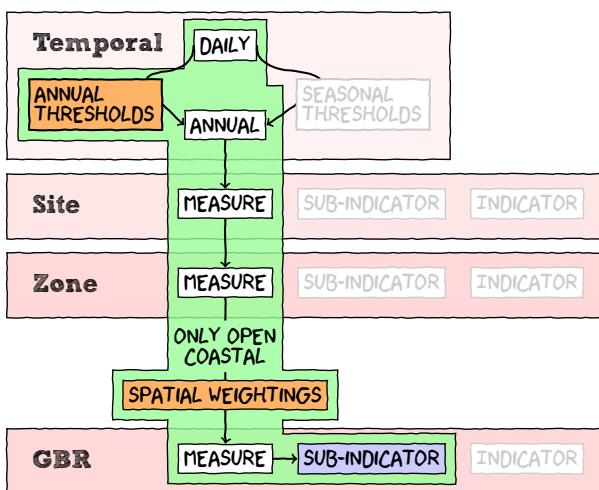
Figure 23: Time series of fsMAMP Measure index scores by water body (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.4.1.2 Mosaic plots



Figure 24: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Measurement index grades (Uniform grade type control chart applied).

I.4.2 Water body/Subindicator level



I.4.2.1 Simple time series

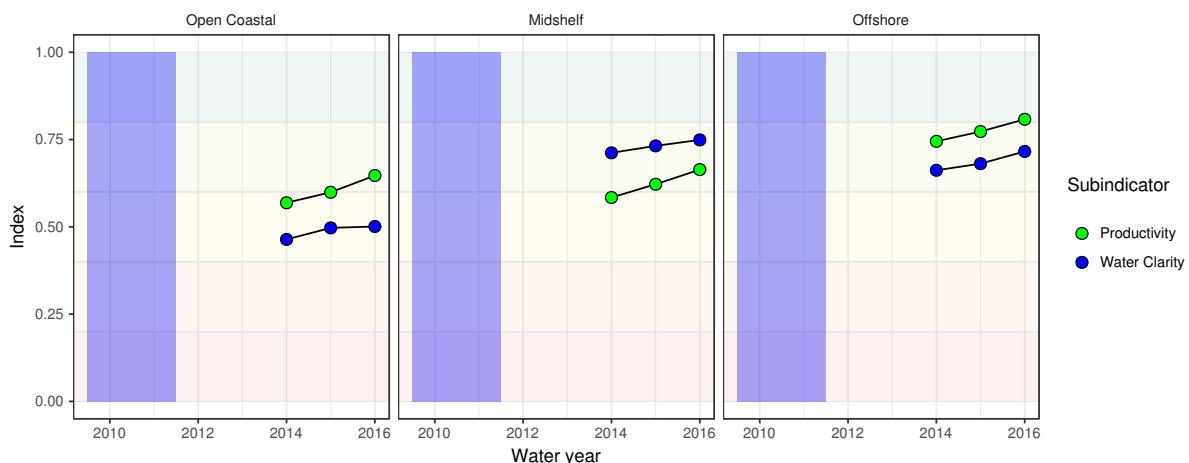


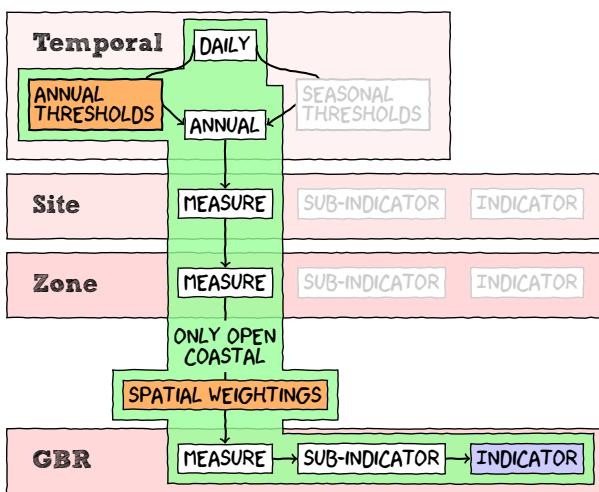
Figure 25: Time series of fsMAMP Subindicator index scores by water body (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

1.4.2.2 Mosaic plots



Figure 26: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Subindicator index grades (Uniform grade type control chart applied).

1.4.3 Water body/Indicator level



1.4.3.1 Simple time series

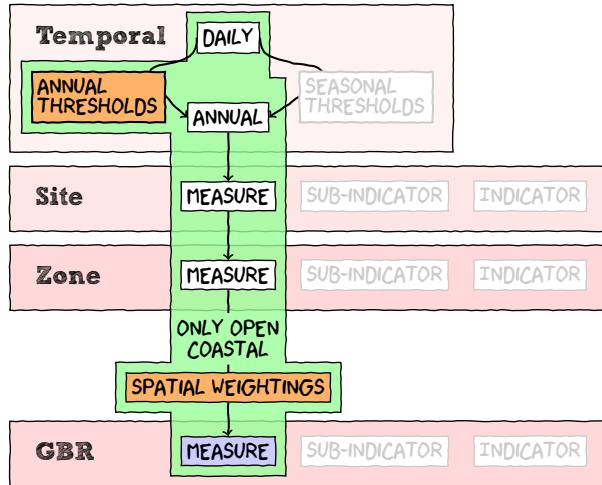
Figure 27: Time series of fsMAMP Indicator index scores by water body (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

1.4.3.2 Mosaic plots

Figure 28: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Indicator index grades (Uniform grade type control chart applied).

I.5 Aggregations to GBR level

I.5.1 GBR/Measure level



I.5.1.1 Simple time series

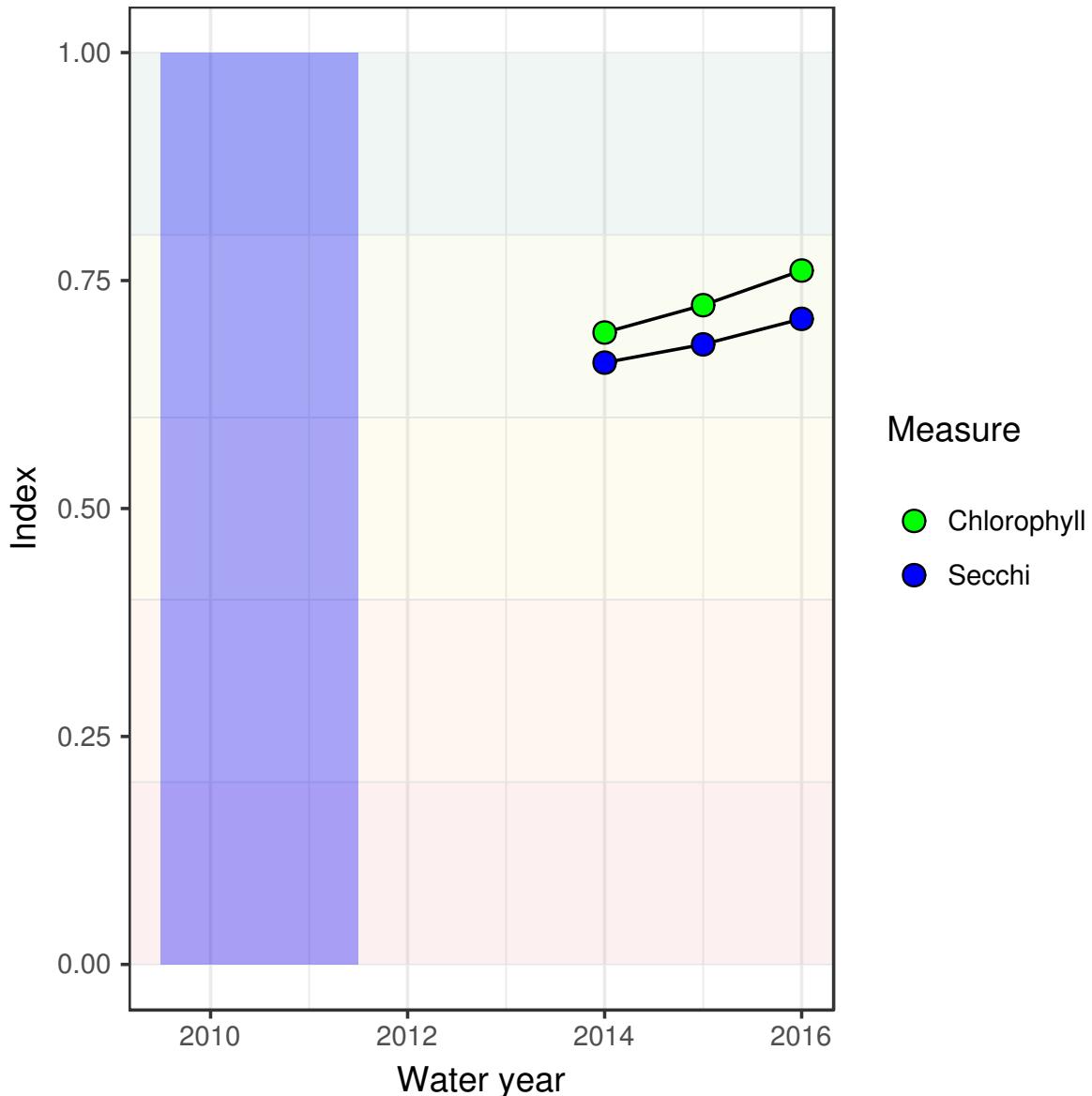


Figure 29: Time series of fsMAMP Measure index scores by GBR (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.5.1.2 Mosaic plots

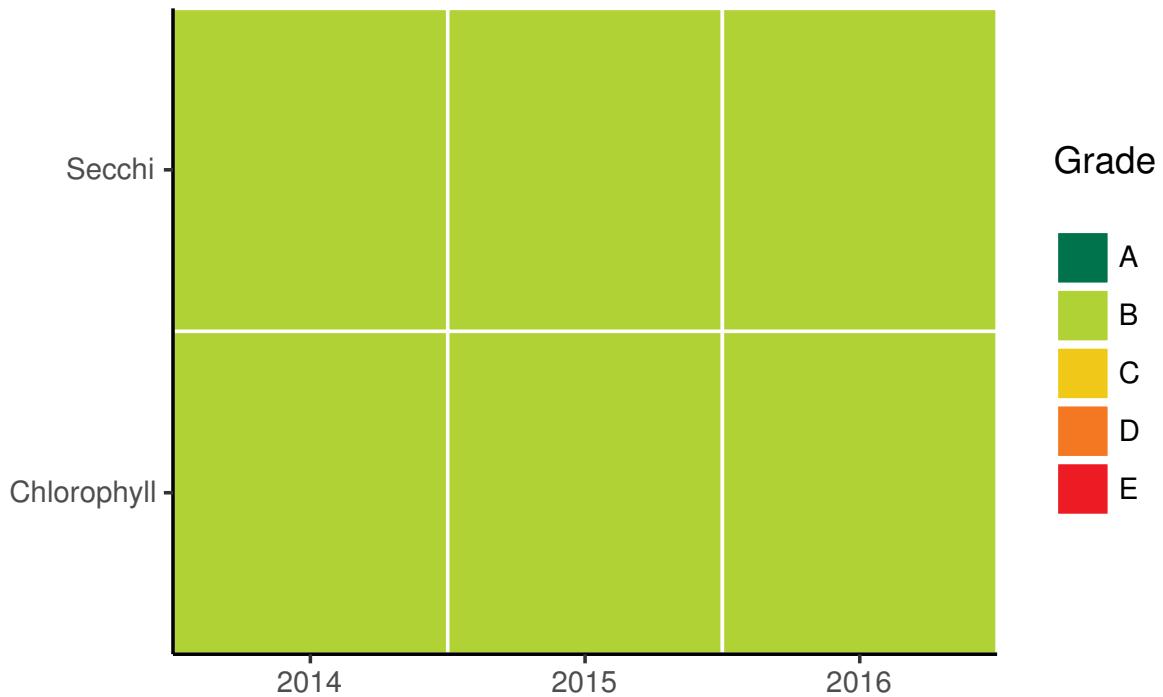
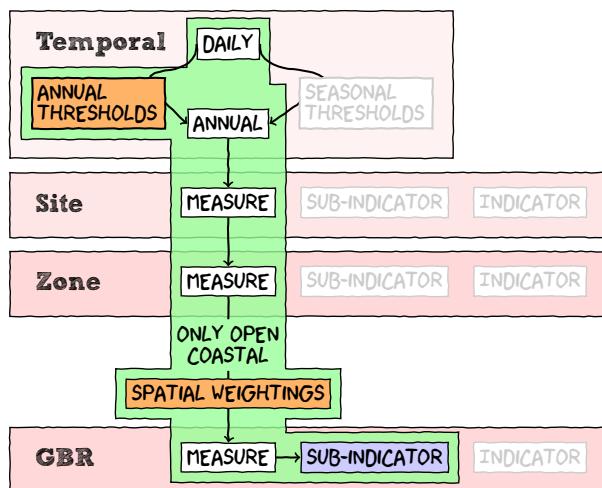


Figure 30: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Measurement index grades (Uniform grade type control chart applied).

I.5.2 GBR/Subindicator level



I.5.2.1 Simple time series

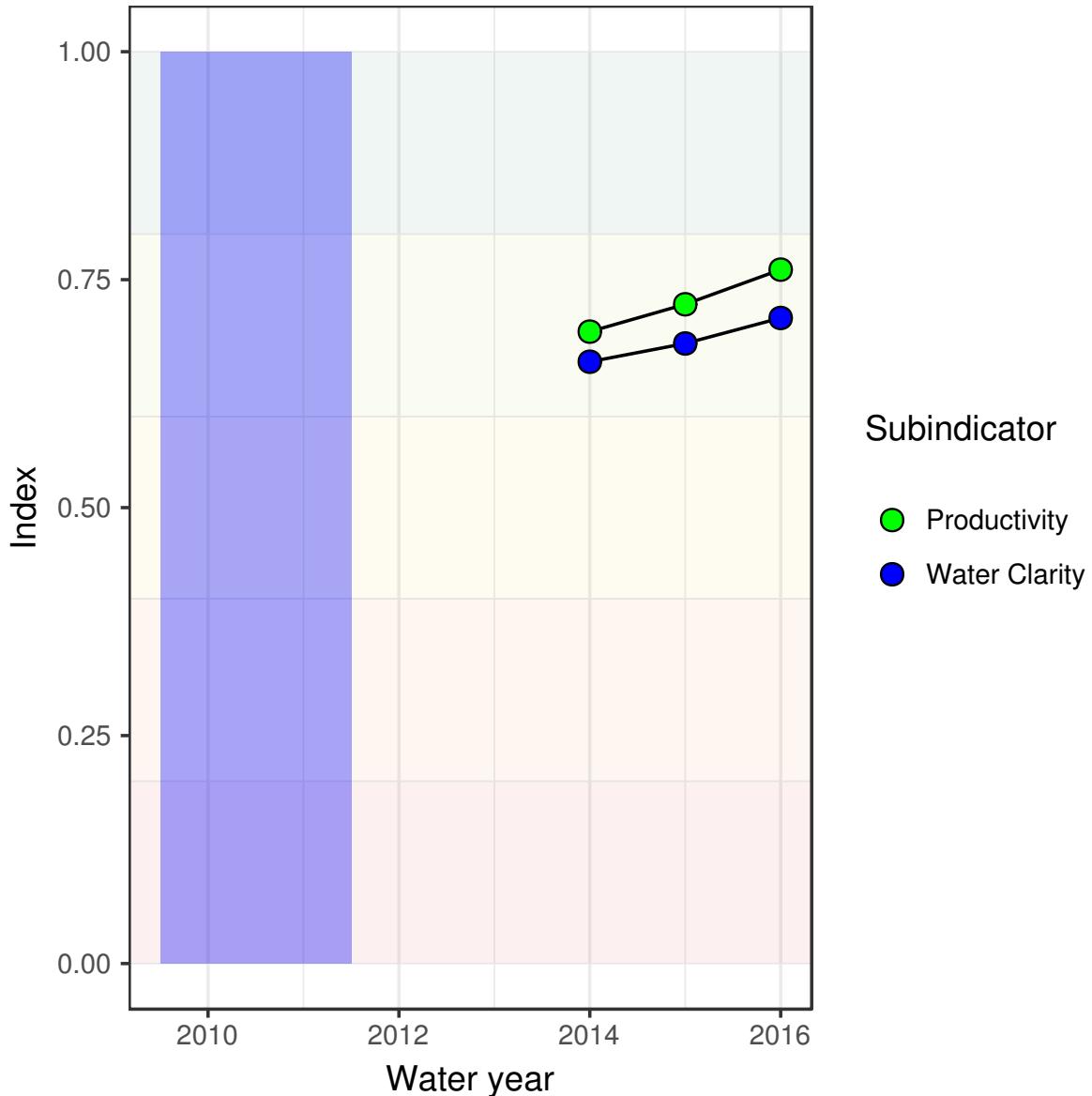


Figure 31: Time series of fsMAMP Subindicator index scores by GBR (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

I.5.2.2 Mosaic plots

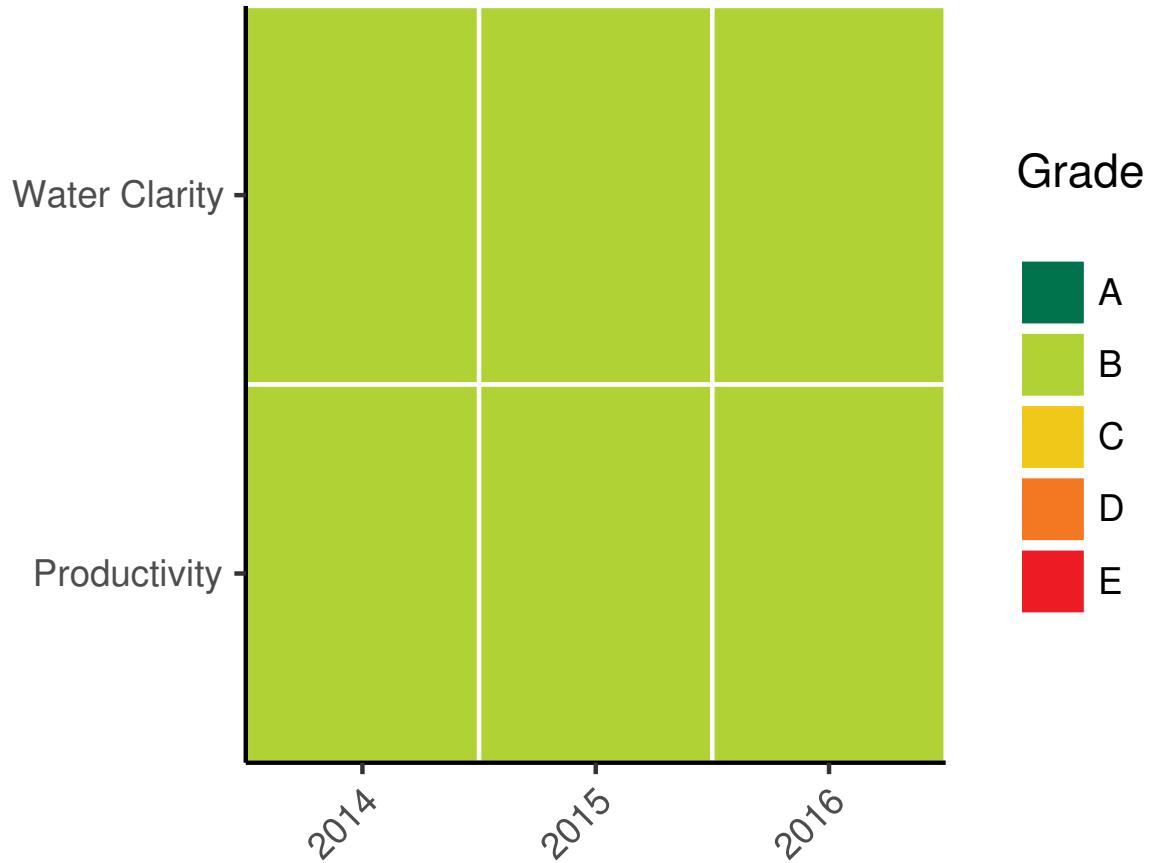
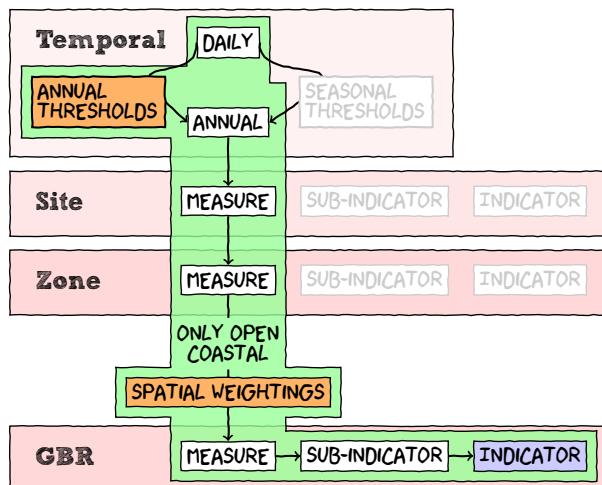


Figure 32: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Subindicator index grades (Uniform grade type control chart applied).

I.5.3 GBR/Indicator level



I.5.3.1 Simple time series

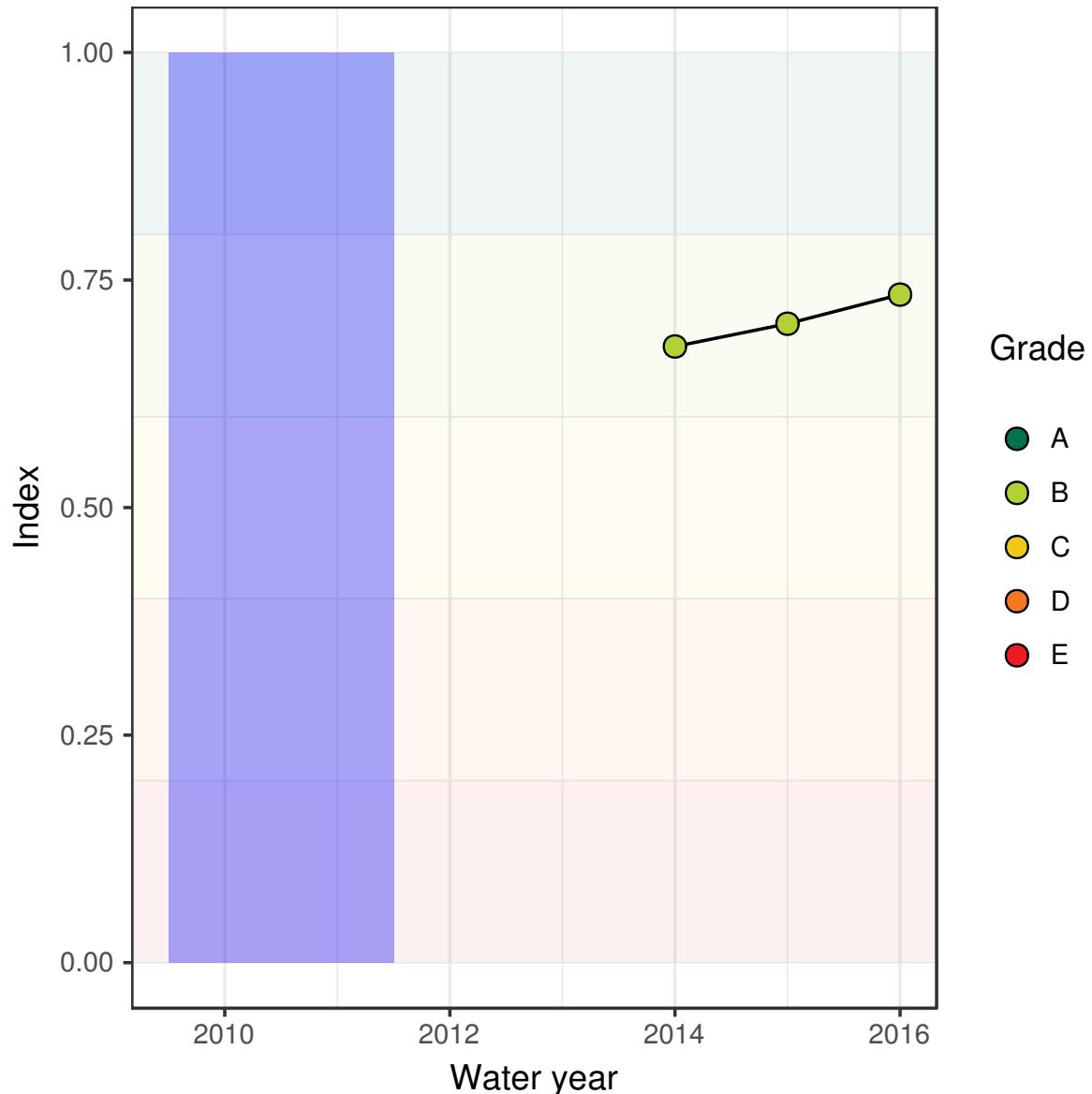


Figure 33: Time series of fsMAMP Indicator index scores by GBR (aggregated over management region weighted by area). The blue vertical bar spans from mid 2009 to mid 2011. Faint colored horizontal bands represent Uniform grade ranges.

1.5.3.2 Mosaic plots

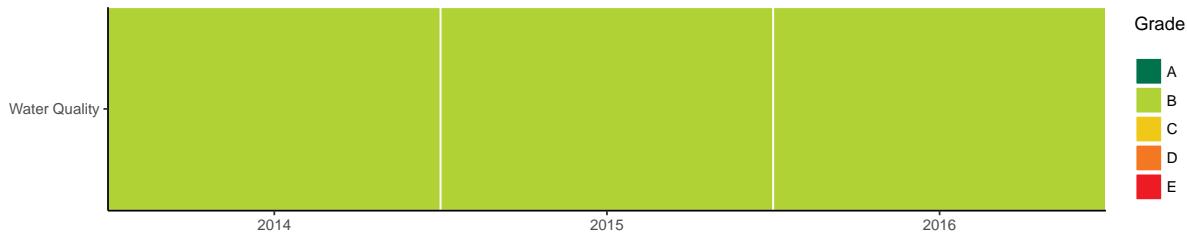


Figure 34: Simplified (Zone mean) eReefs spatio-temporal fsMAMP Indicator index grades (Uniform grade type control chart applied).

I.6 Summary of recommendations

A. Calculation of Zone level Score and Grades

1. Collect raw data (= **Measures**) for Chlorophyll-a and Secchi depth at each fixed monitoring site and compare individual observations to associated threshold/benchmark/reference or set of expectation ranges
2. Create indexed data as an expression of degree of difference (*scaled modified amplitude method*) to yield a **Score** for each **Measure** (Chlorophyll-a and Secchi depth) per sampling location (e.g. Site)
3. Combine **Measure Scores** into **Site-level Sub-indicator** (Productivity and Water Clarity) Scores by averaging
4. Combine **Sub-indicator Scores** into **Site-level Indicator** (Water Quality) Scores by averaging.
5. Convert Scores into coloured **Grades** (A-E) for visual presentation in report card

B. Calculation of Zone level Grades

1. Aggregate **Site-level Measure Scores** from step A.1 into **Zone-level Measure Scores** by averaging.
2. Aggregate **Zone-level Measure Scores** into **Zone-level Subindicator Scores** by averaging.
3. Aggregate **Zone-level Subindicator Scores** into **Zone-level Indicator Scores** by averaging.

C. Calculation of Whole GBR Grades

1. Aggregate **Zone-level Measure Scores** for Open Coastal Regions from step B.1 into **Whole GBR-level Measure Scores** by averaging (incorporating spatial weights).
2. Aggregate **Whole GBR-level Measure Scores** into **Whole GBR-level Subindicator Scores**.
3. Aggregate **Whole GBR-level Subindicator Scores** into **Whole GBR-level Indicator Scores** by averaging.

2. ACKNOWLEDGEMENTS

The model simulations were developed as part of the eReefs project, a public-private collaboration between Australia's leading operational and scientific research agencies, government, and corporate Australia. Atmospherically-corrected MODIS products were sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative."

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Appendices

A. THRESHOLDS

B. EREEFS MODELS

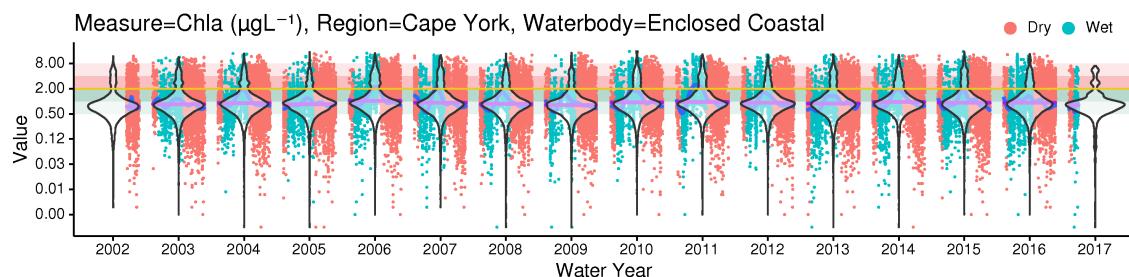
C. EXPLORATORY DATA ANALYSIS

C.I Annual data

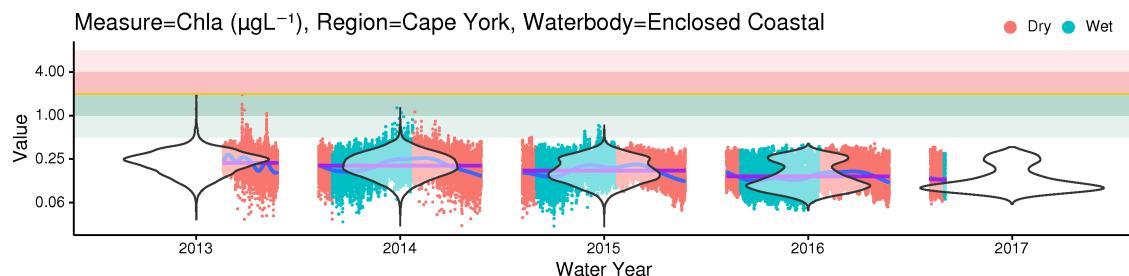
C.I.I Cape York, Enclosed Coastal

C.I.I.I Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

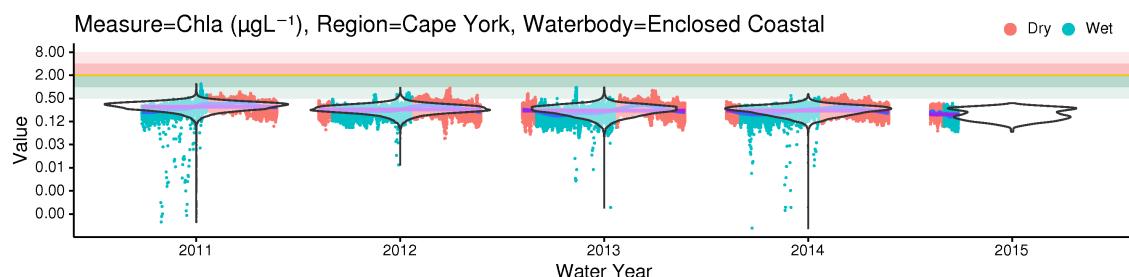
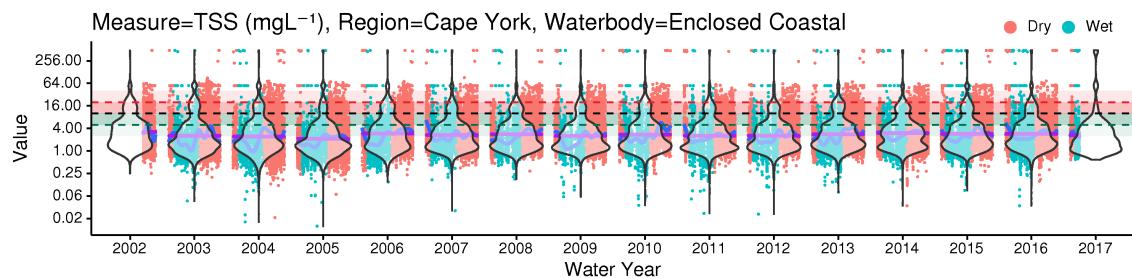


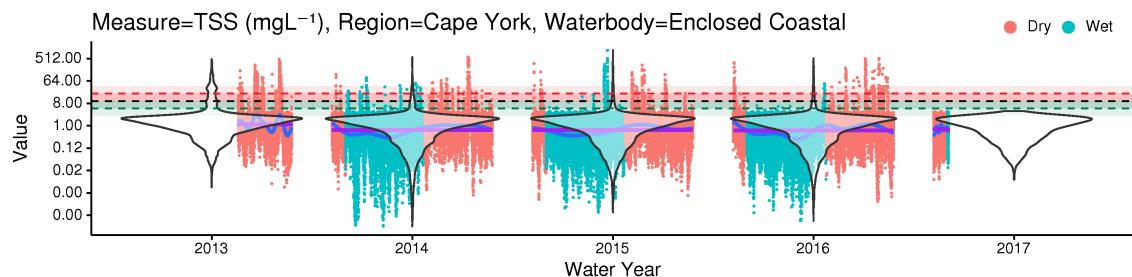
Figure C1: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Cape York Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.I.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

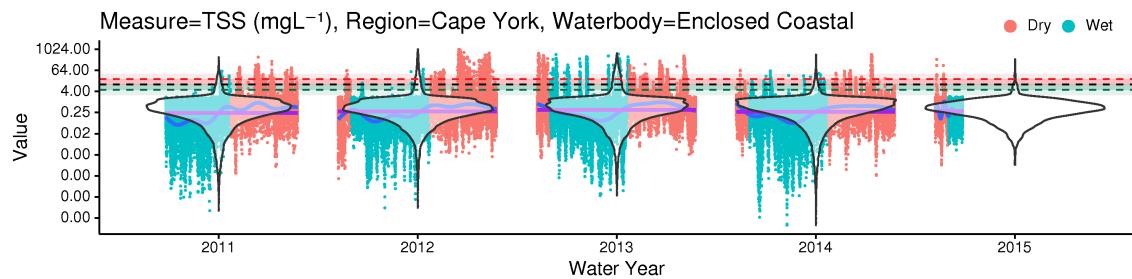
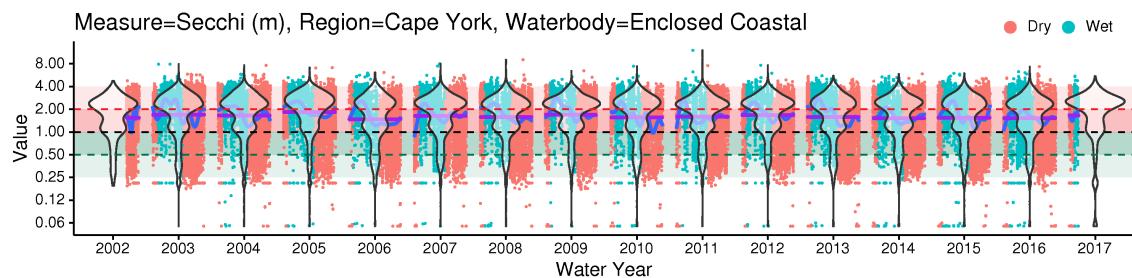


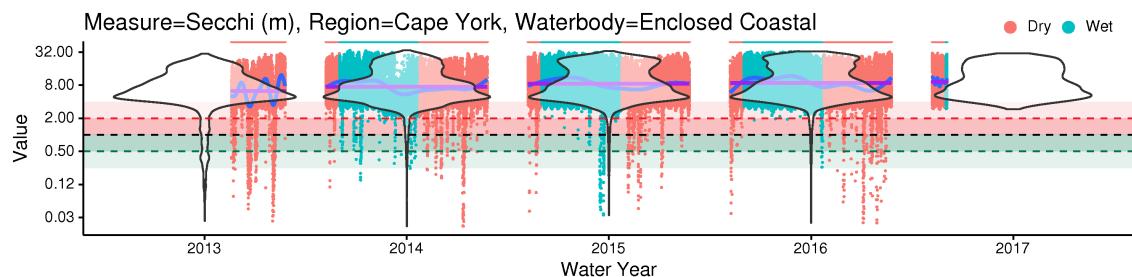
Figure C2: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Cape York Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.1.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

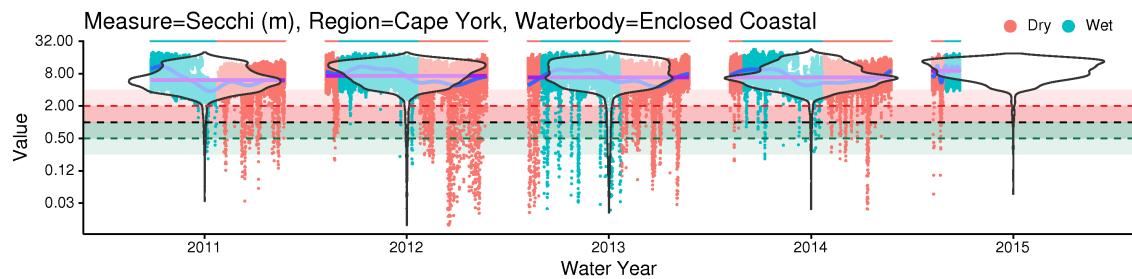
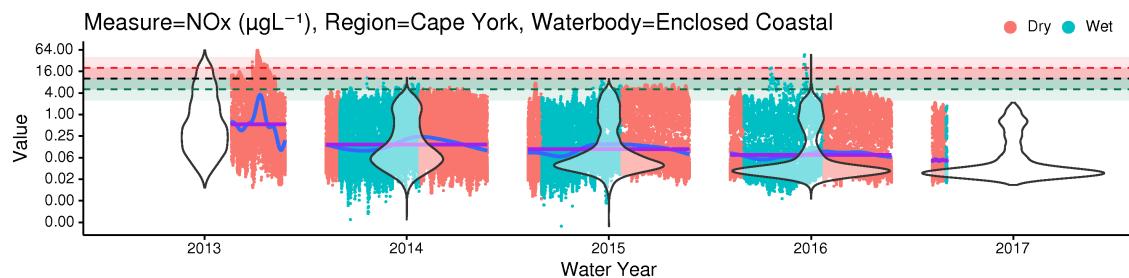


Figure C3: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Cape York Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.I.4 NOx

d) eReefs



e) eReefs926

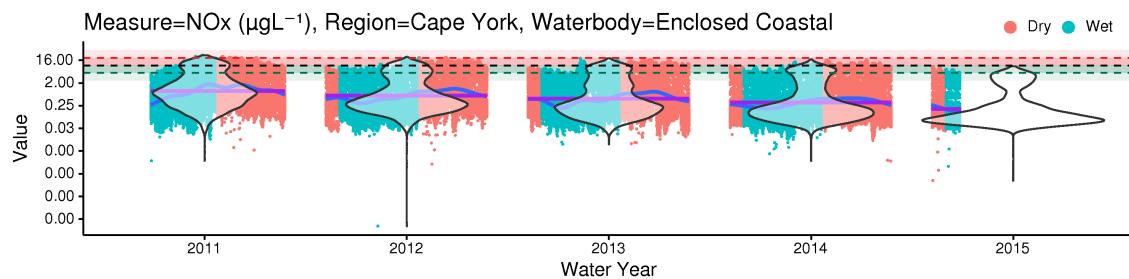
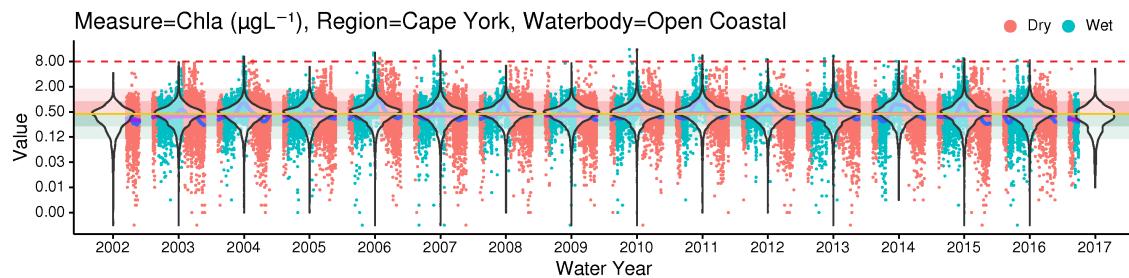


Figure C4: Observed (logarithmic axis with violin plot overlay) NOx data for the Cape York Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

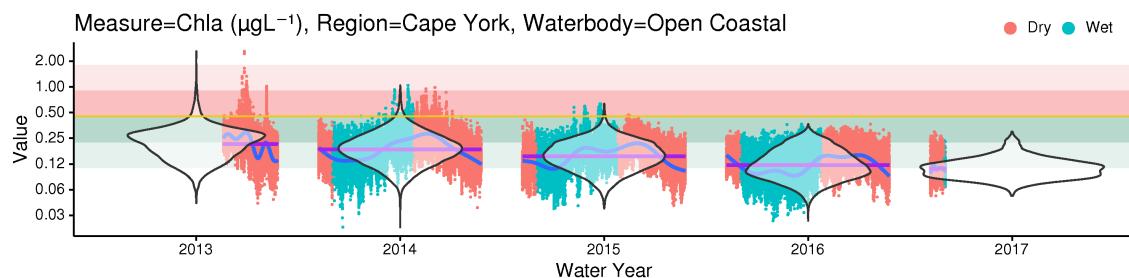
C.I.2 Cape York, Open Coastal

C.I.2.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

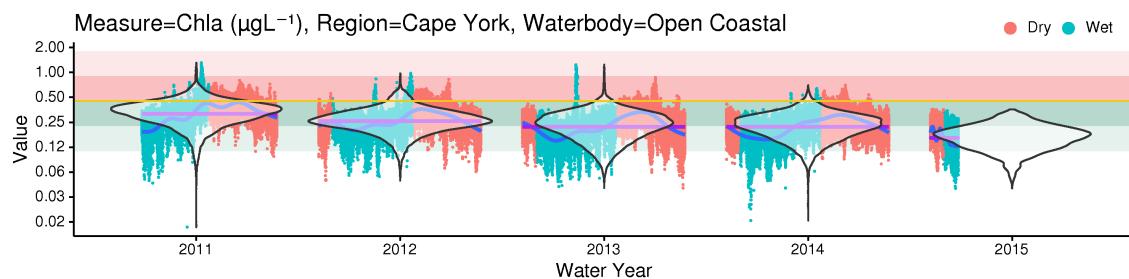
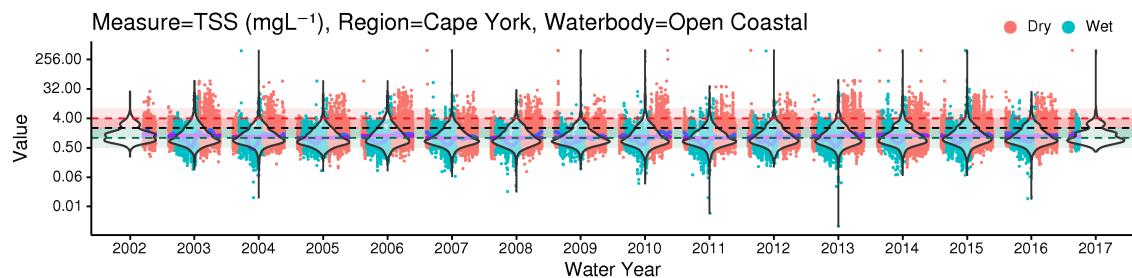


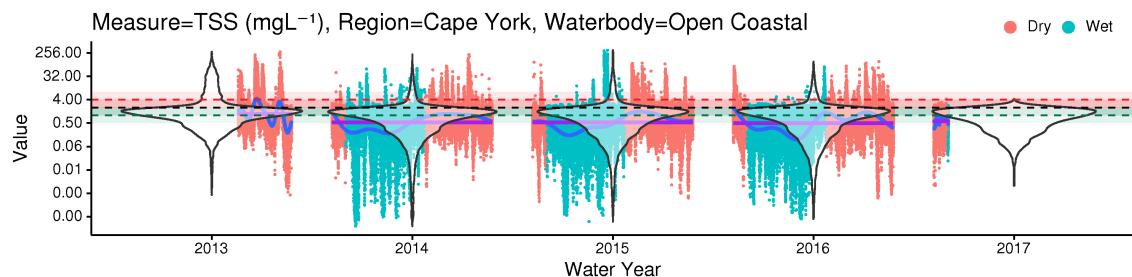
Figure C5: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Cape York Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.1.2.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

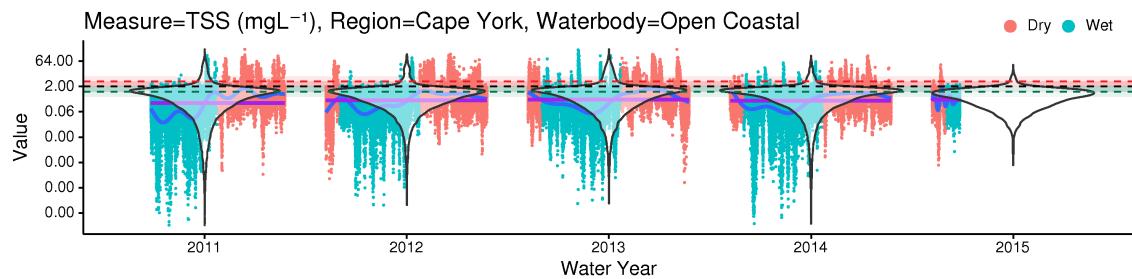
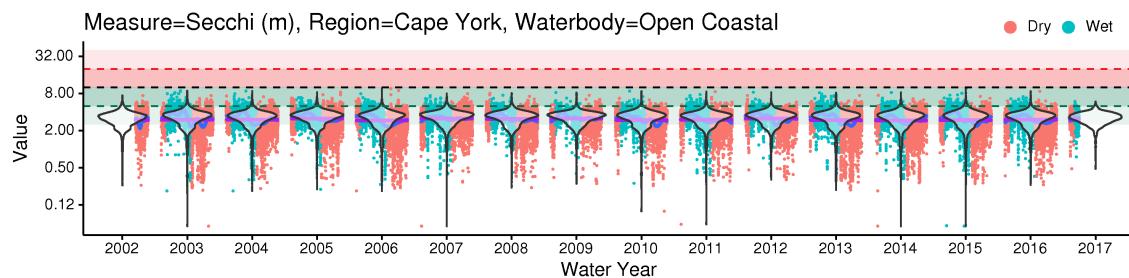


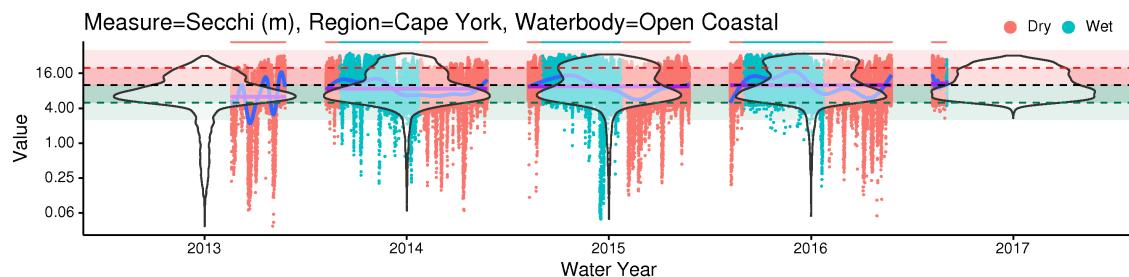
Figure C6: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Cape York Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.1.2.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

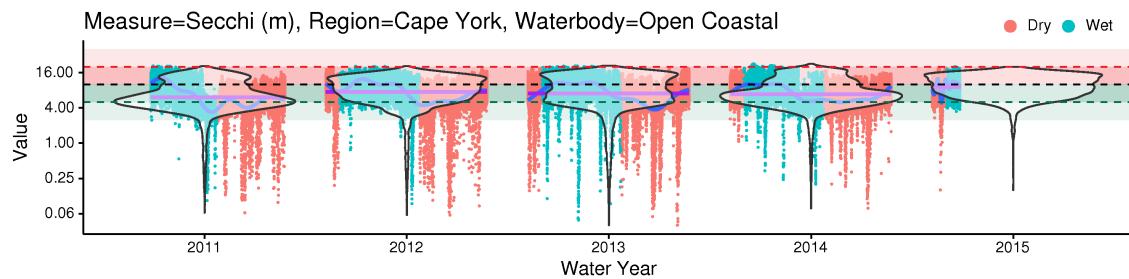
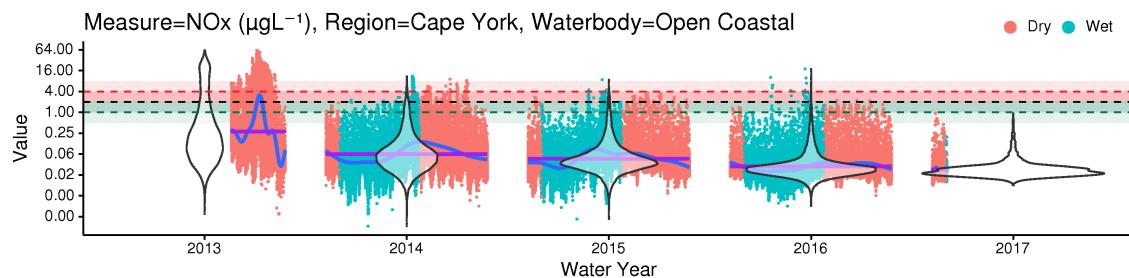


Figure C7: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Cape York Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.2.4 NOx

d) eReefs



e) eReefs926

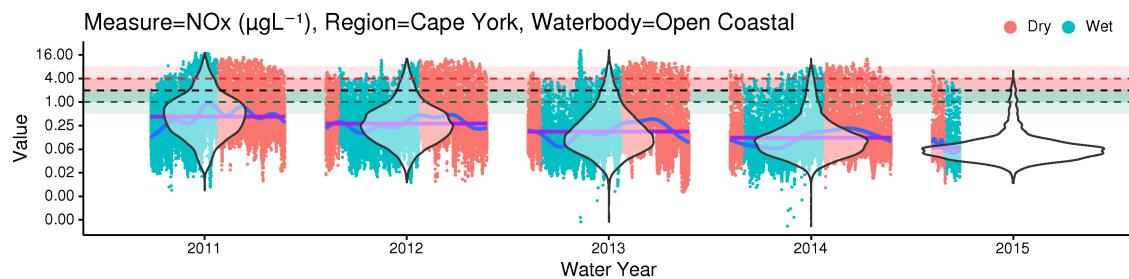
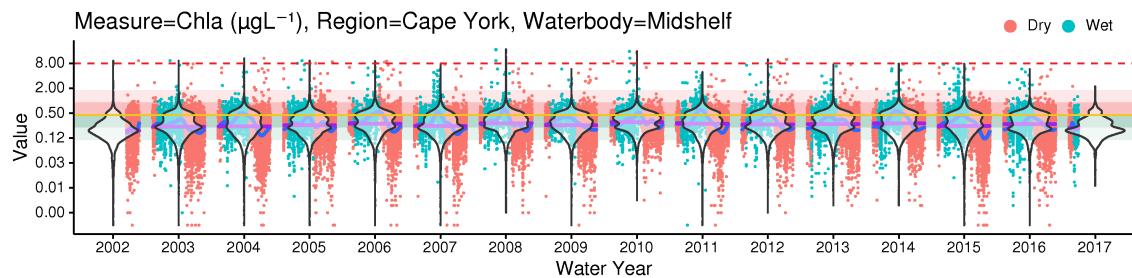


Figure C8: Observed (logarithmic axis with violin plot overlay) NOx data for the Cape York Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

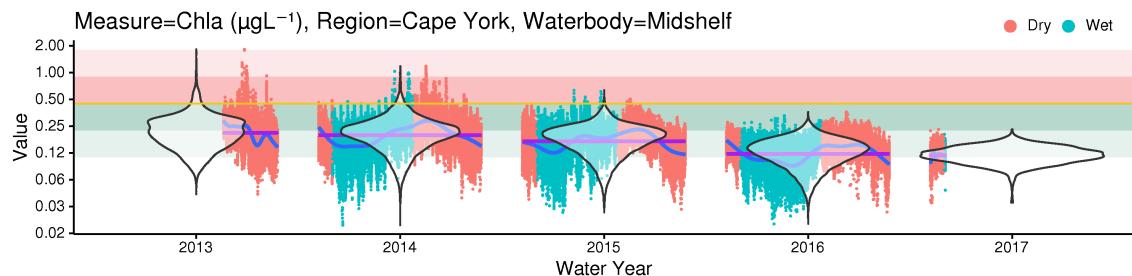
C.I.3 Cape York, Midshelf

C.I.3.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

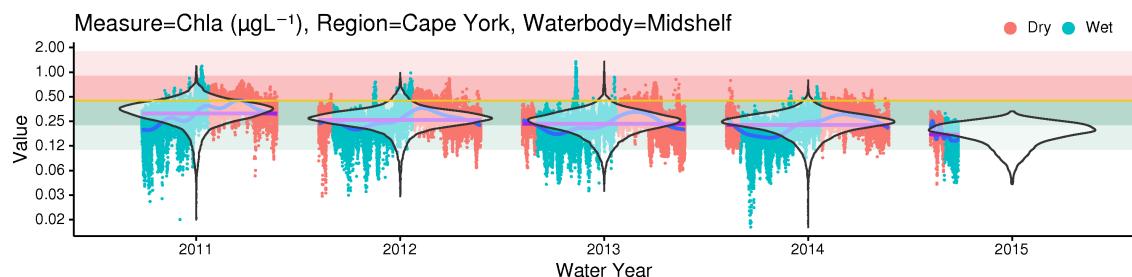
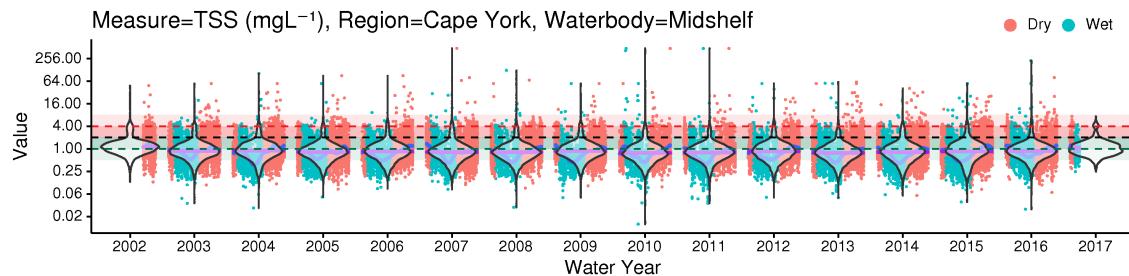


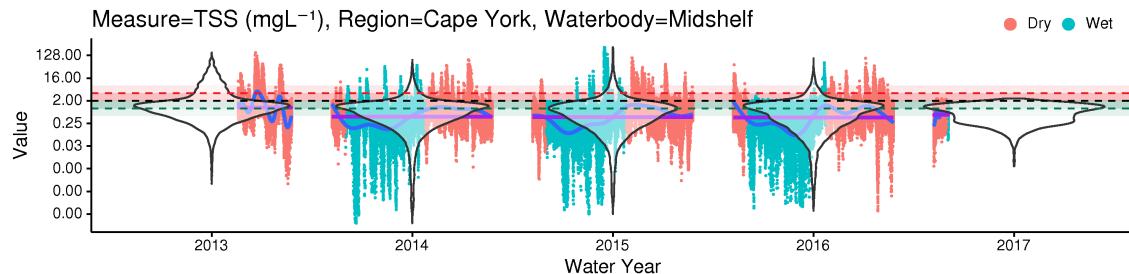
Figure C9: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Cape York Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.1.3.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

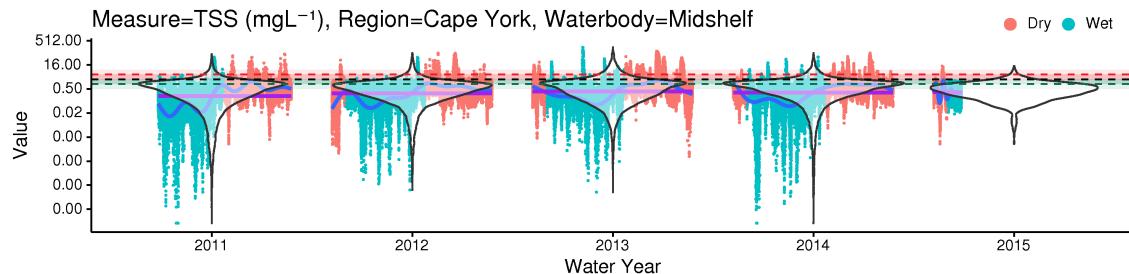
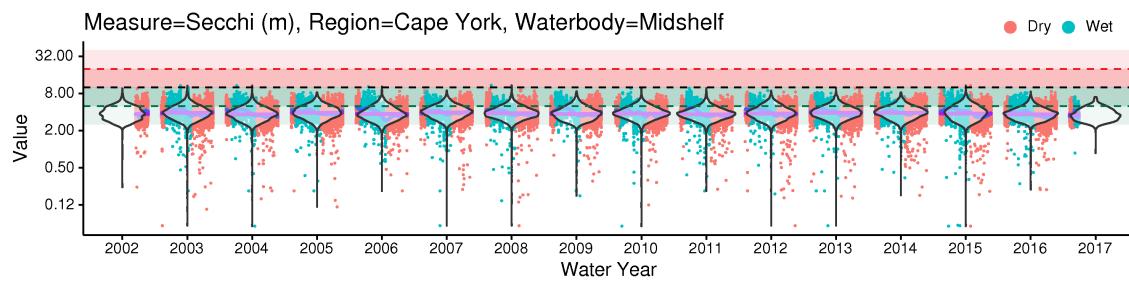


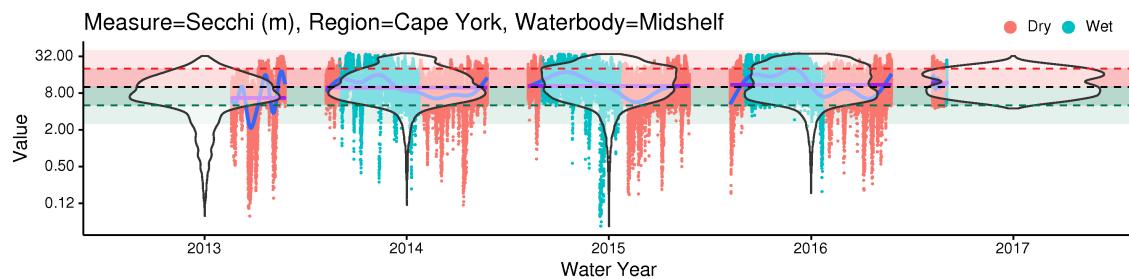
Figure C10: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Cape York Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.3.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

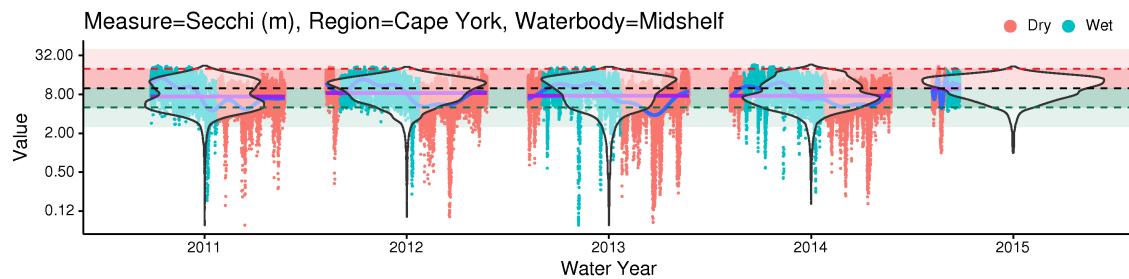
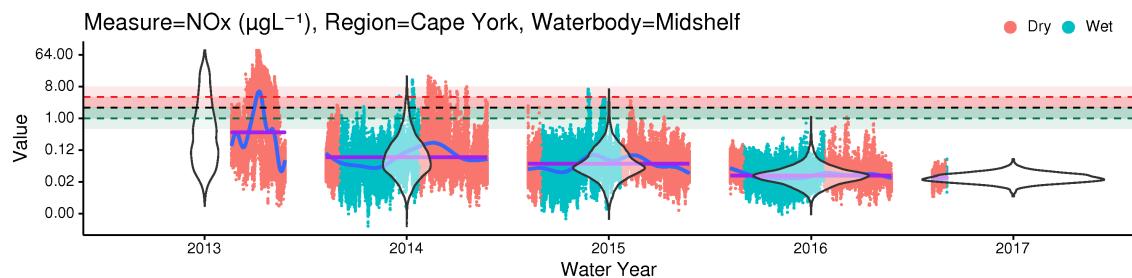


Figure CII: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Cape York Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.3.4 NOx

d) eReefs



e) eReefs926

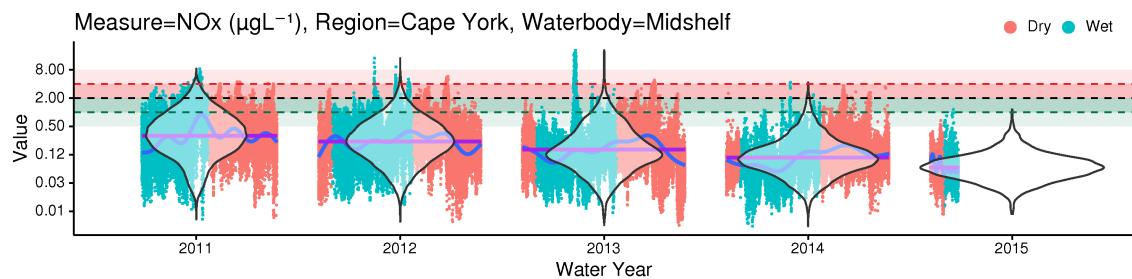
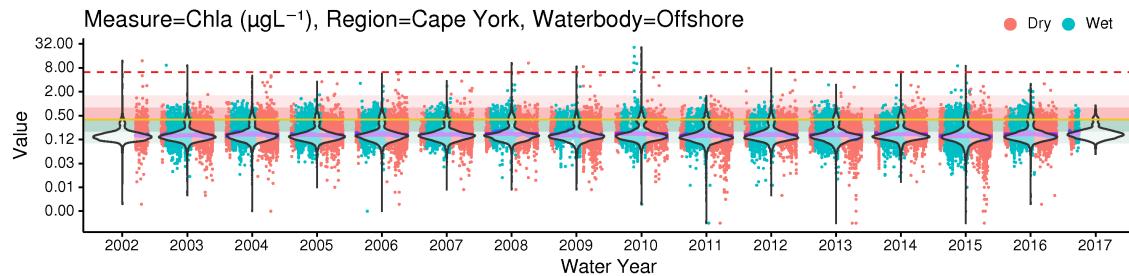


Figure C12: Observed (logarithmic axis with violin plot overlay) NOx data for the Cape York Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

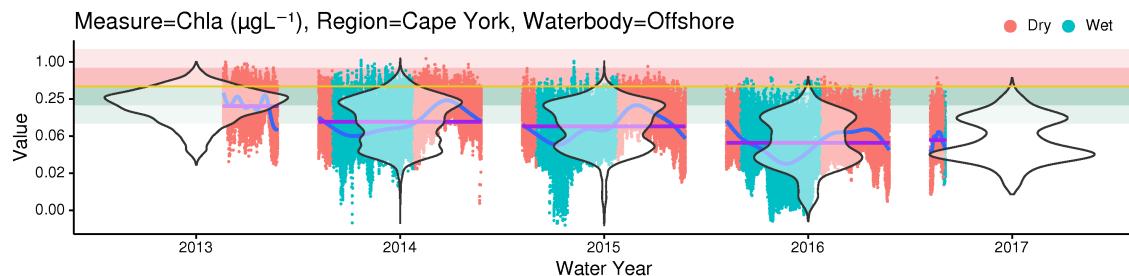
C.I.4 Cape York, Offshore

C.I.4.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

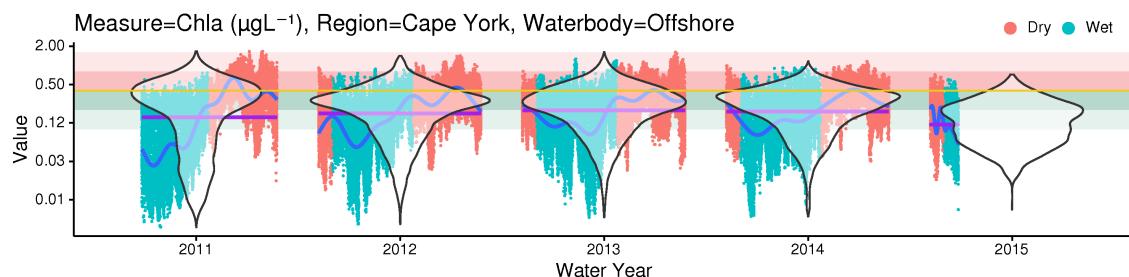
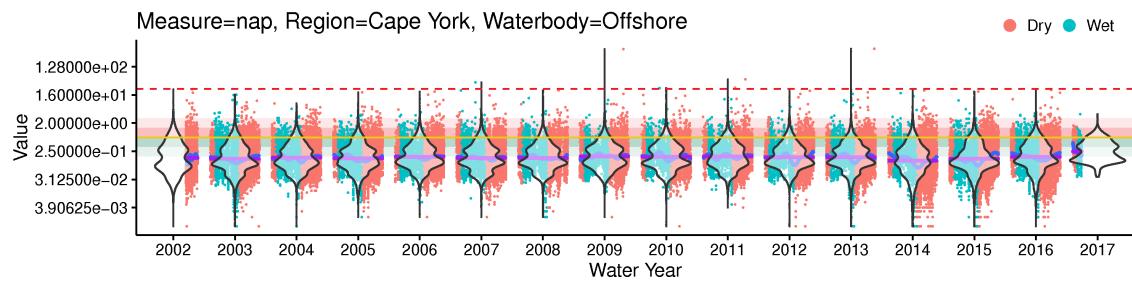


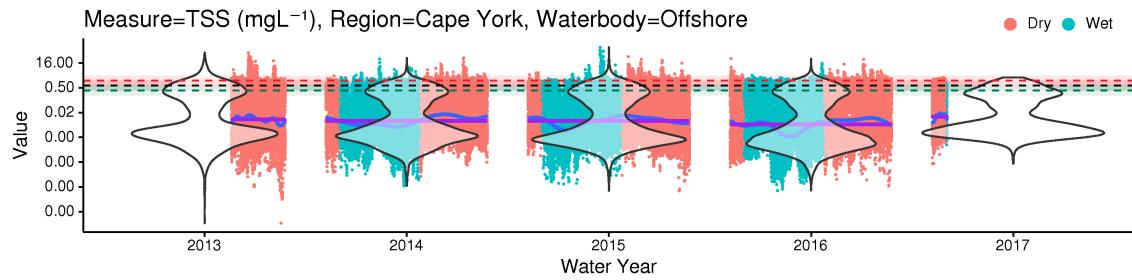
Figure C13: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Cape York Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.4.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

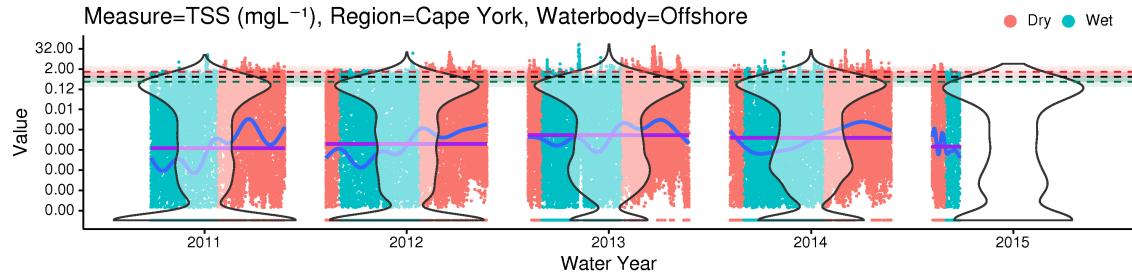
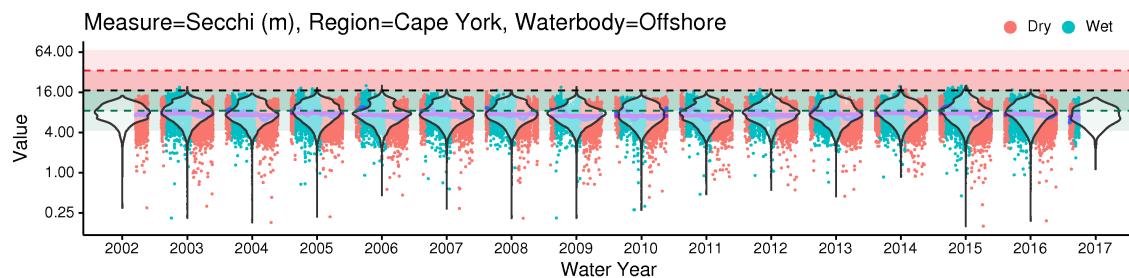


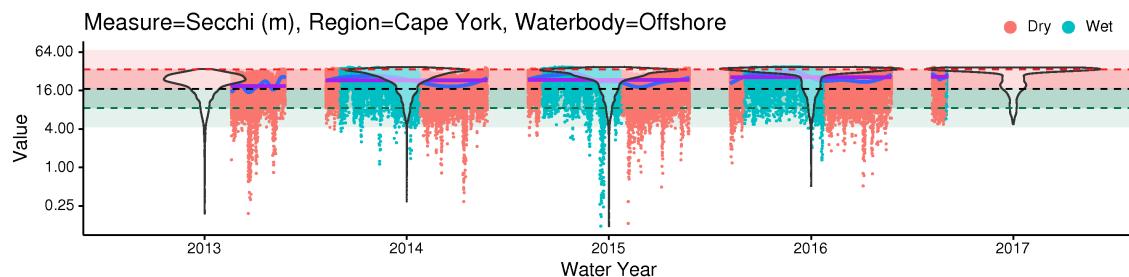
Figure C14: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Cape York Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.4.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

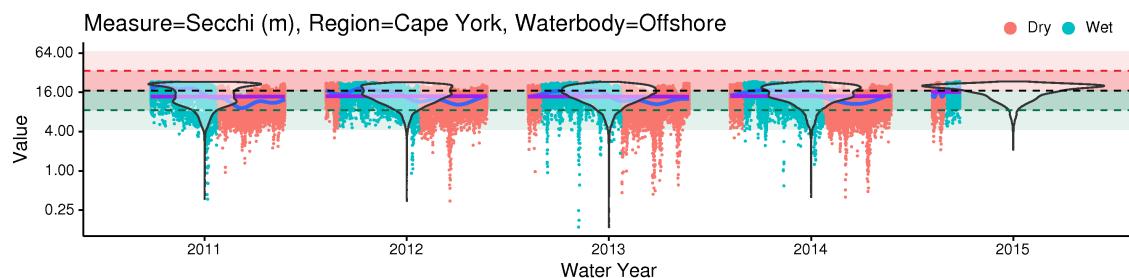
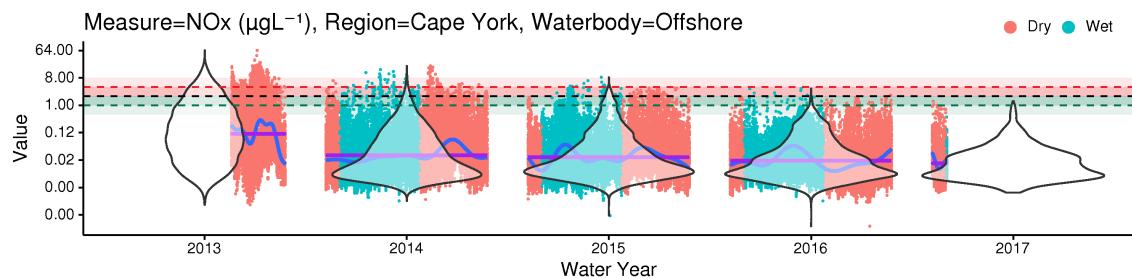


Figure C15: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Cape York Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.4.4 NOx

d) eReefs



e) eReefs926

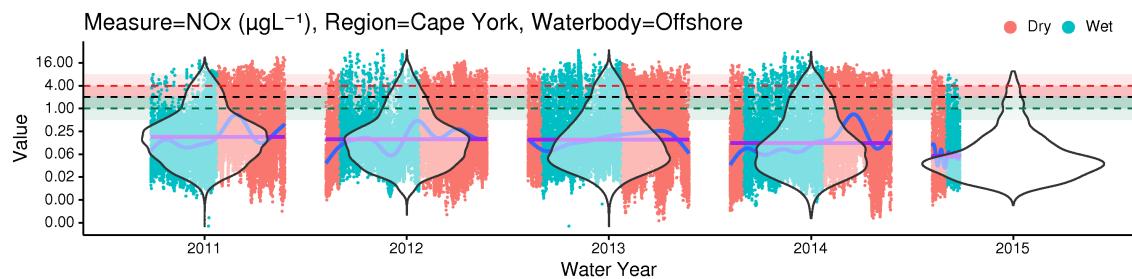
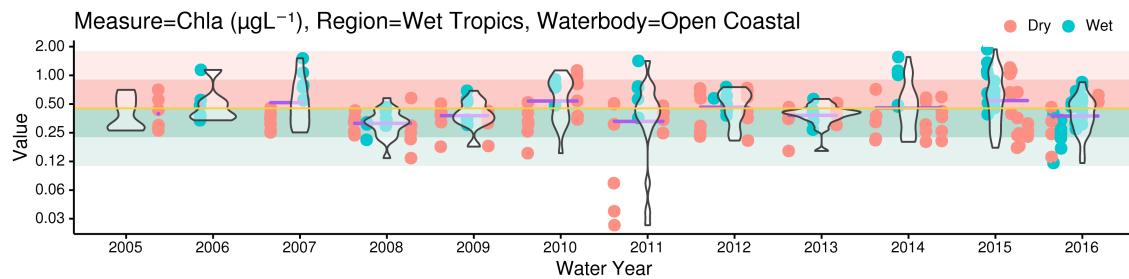


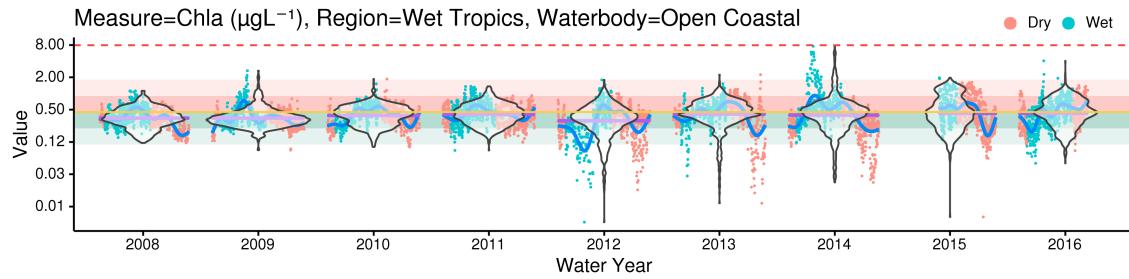
Figure C16: Observed (logarithmic axis with violin plot overlay) NOx data for the Cape York Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.5 Wet Tropics, Enclosed Coastal*C.I.5.1 Chlorophyll*

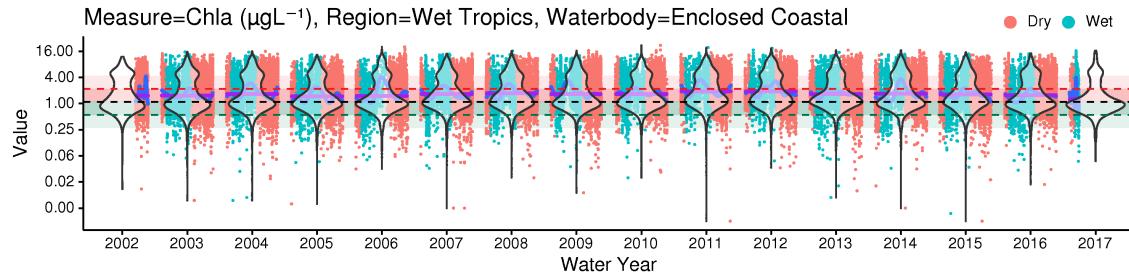
a) AIMS insitu



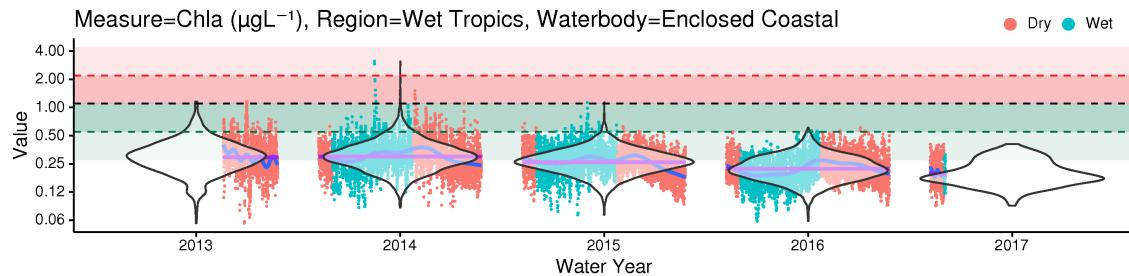
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

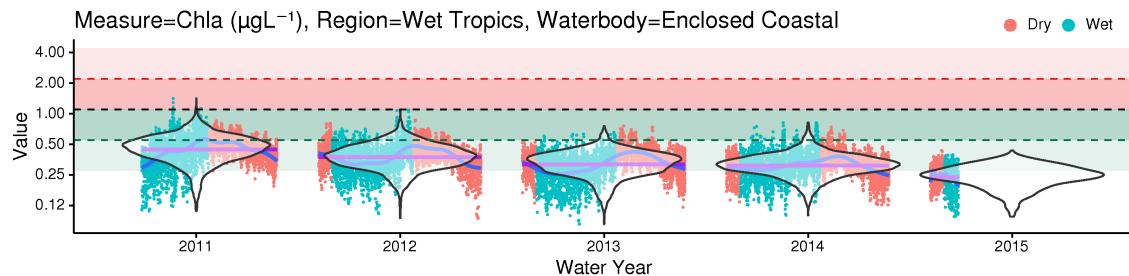
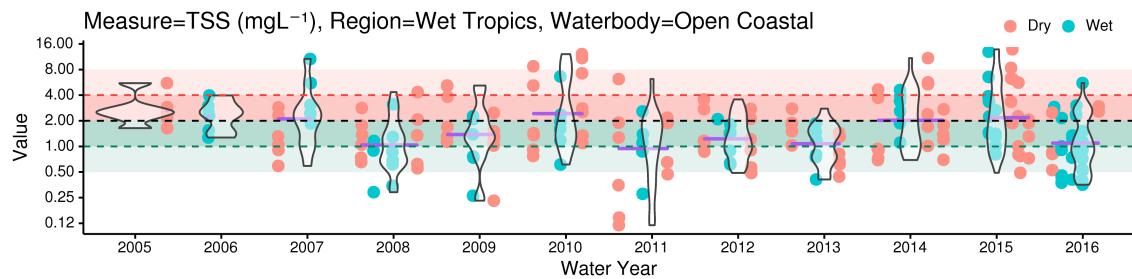


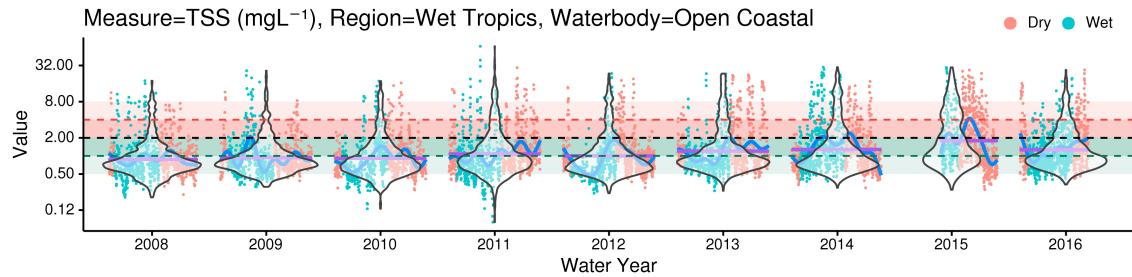
Figure C17: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Wet Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.5.2 Total Suspended Solids

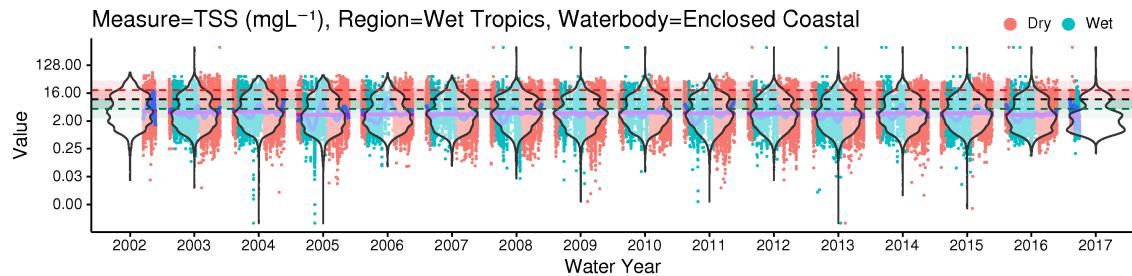
a) AIMS insitu



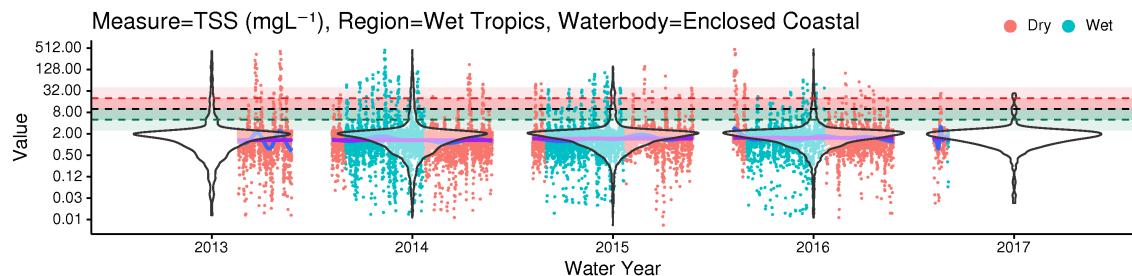
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

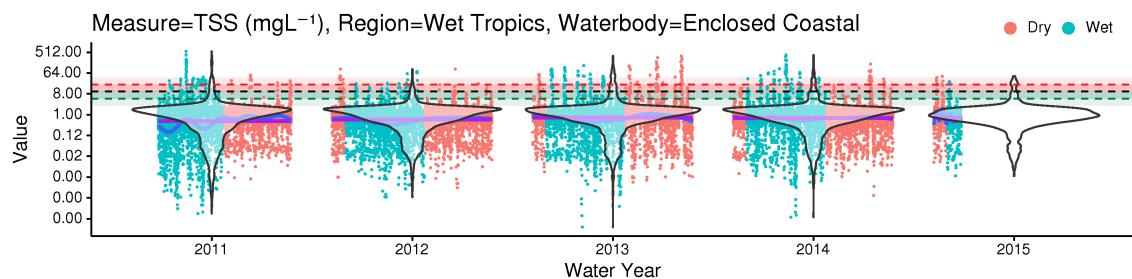
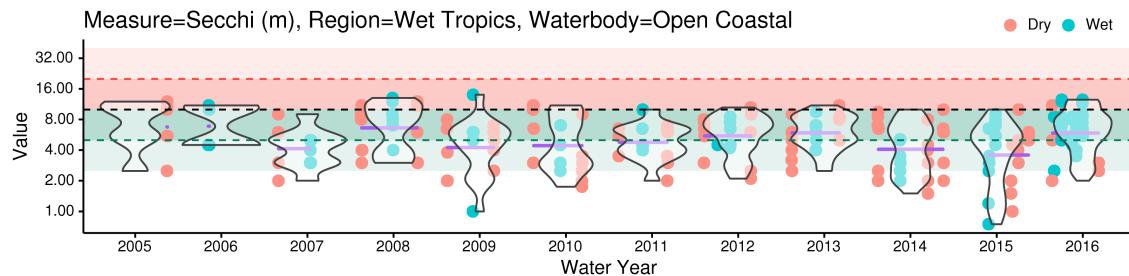


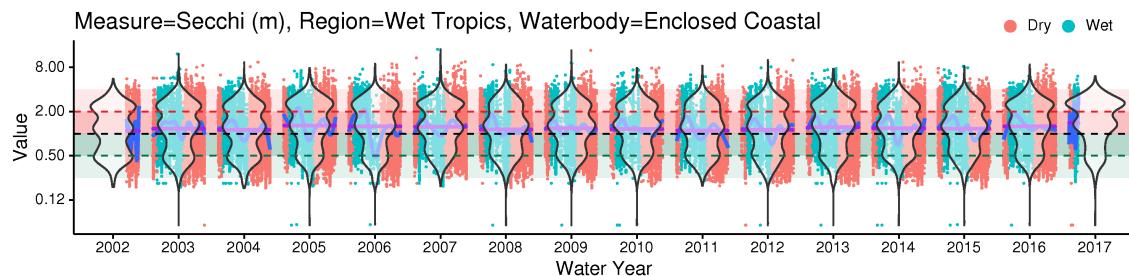
Figure C18: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Wet Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.1.5.3 Secchi Depth

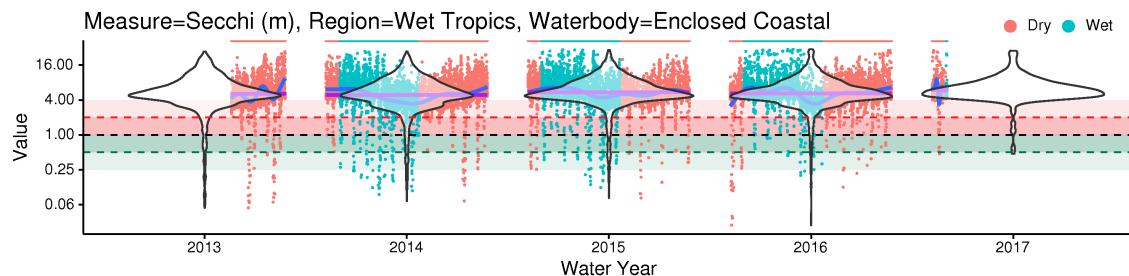
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

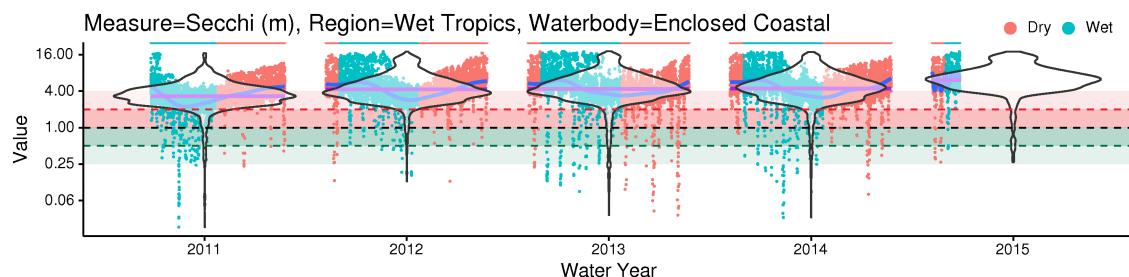
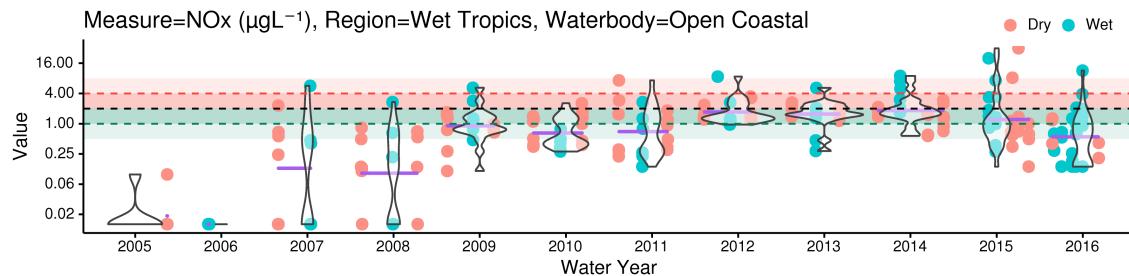


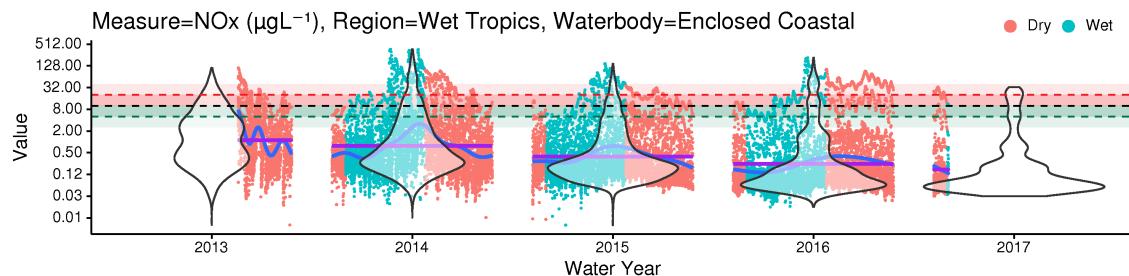
Figure C19: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Wet Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.5.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

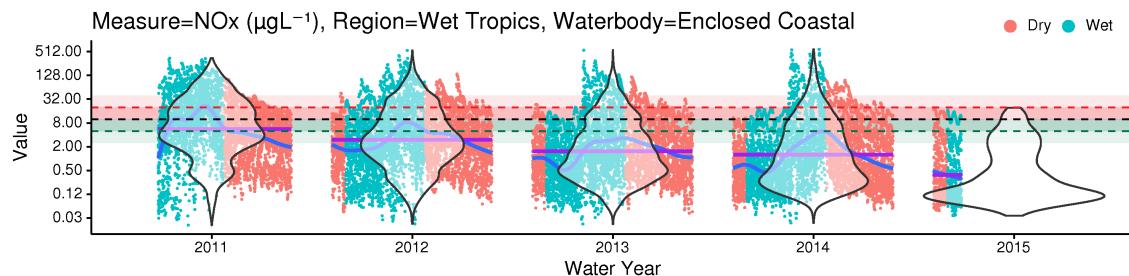
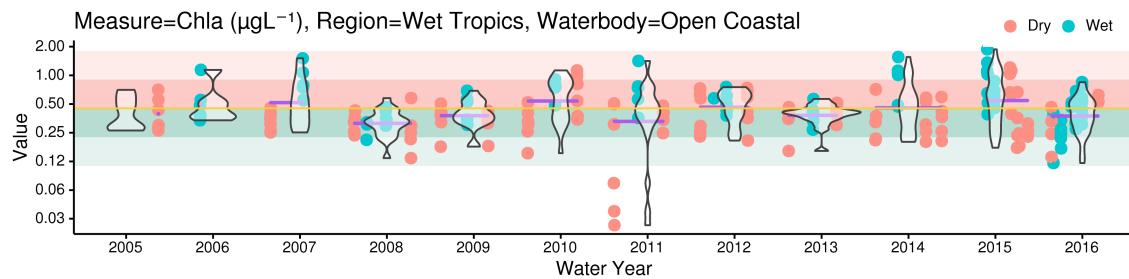


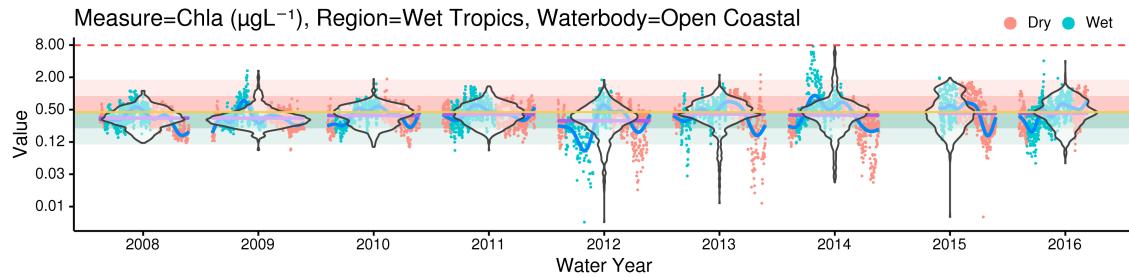
Figure C20: Observed (logarithmic axis with violin plot overlay) NOx data for the Wet Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.6 Wet Tropics, Open Coastal*C.I.6.1 Chlorophyll*

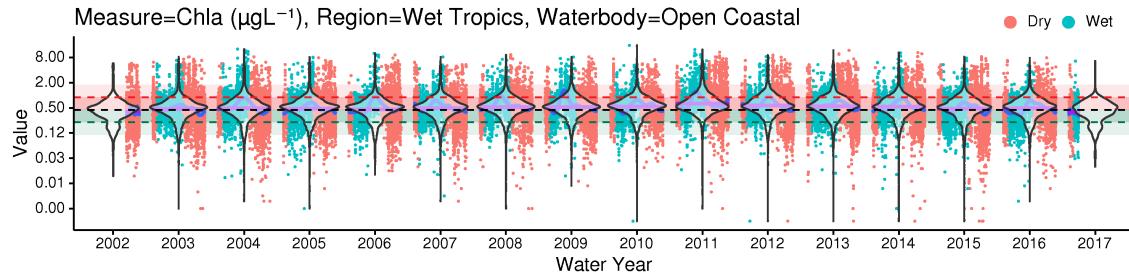
a) AIMS insitu



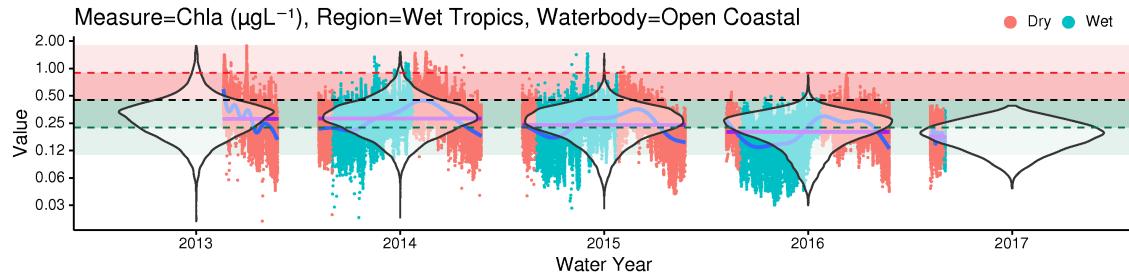
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

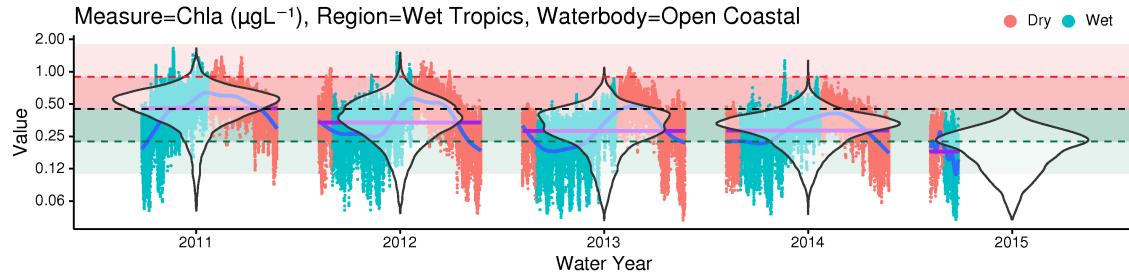
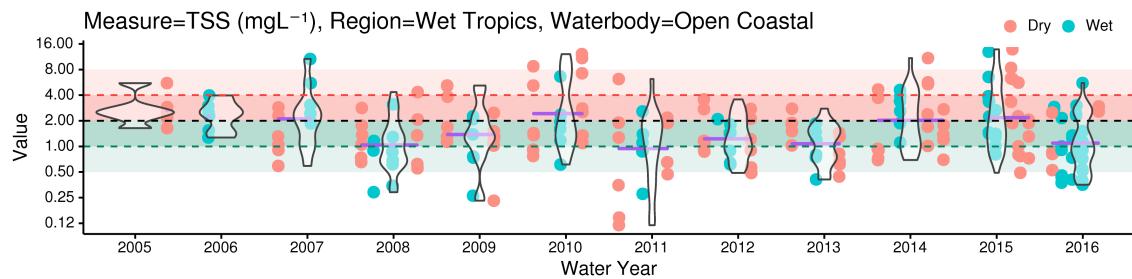


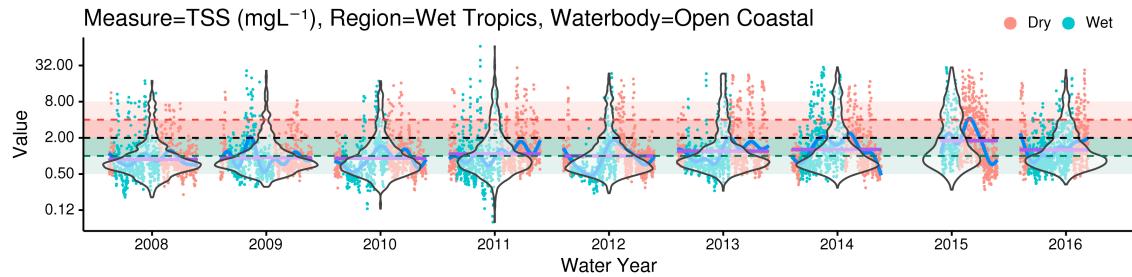
Figure C21: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Wet Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.6.2 Total Suspended Solids

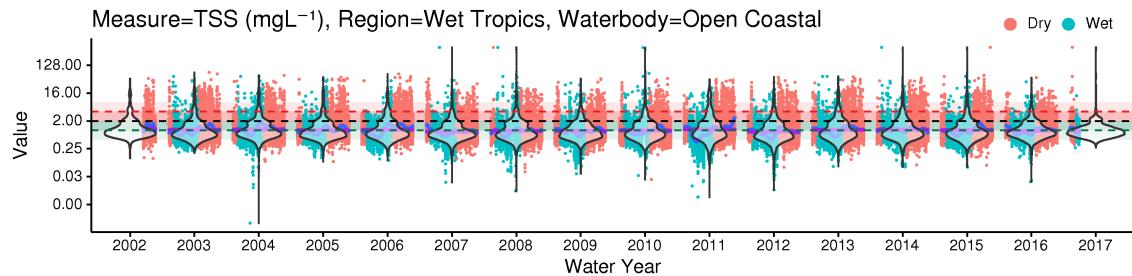
a) AIMS insitu



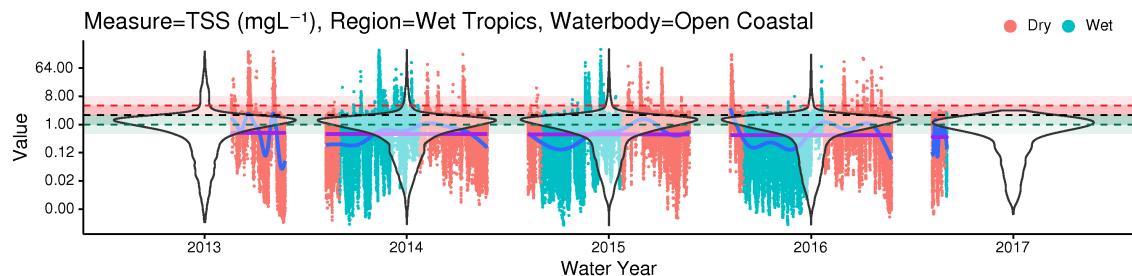
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

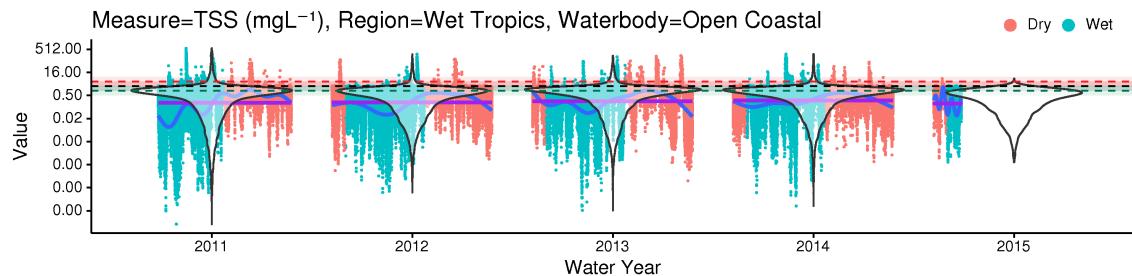
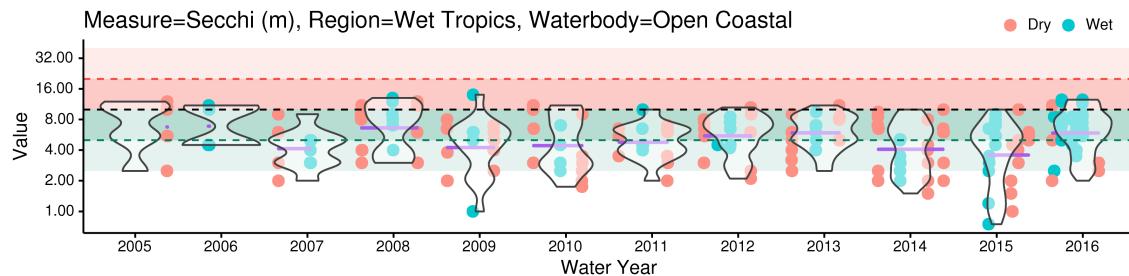


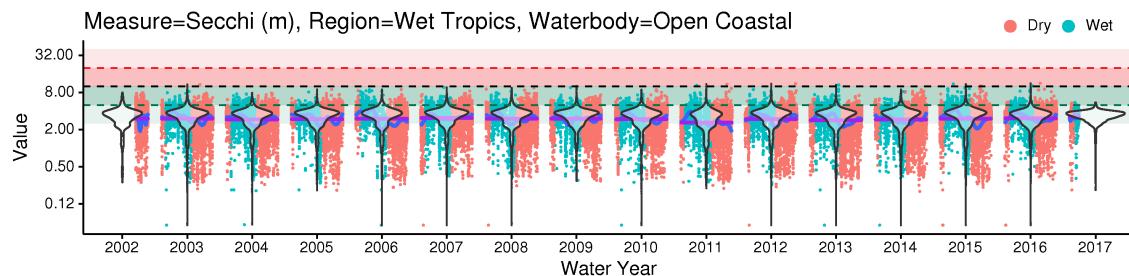
Figure C22: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Wet Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.6.3 Secchi Depth

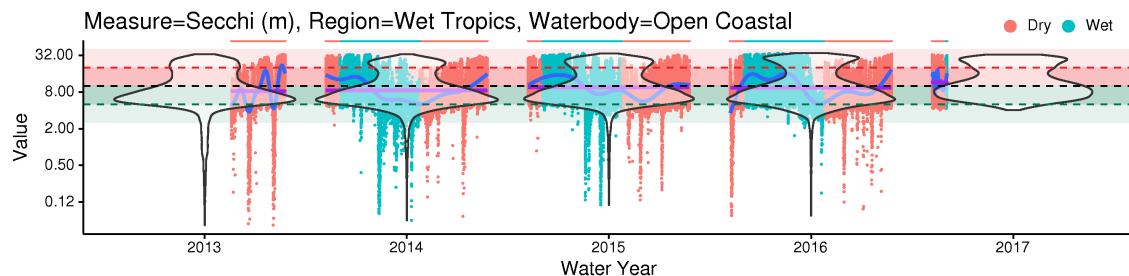
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

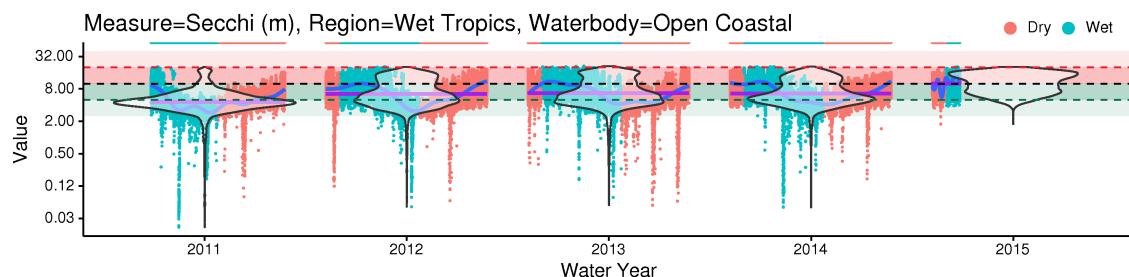
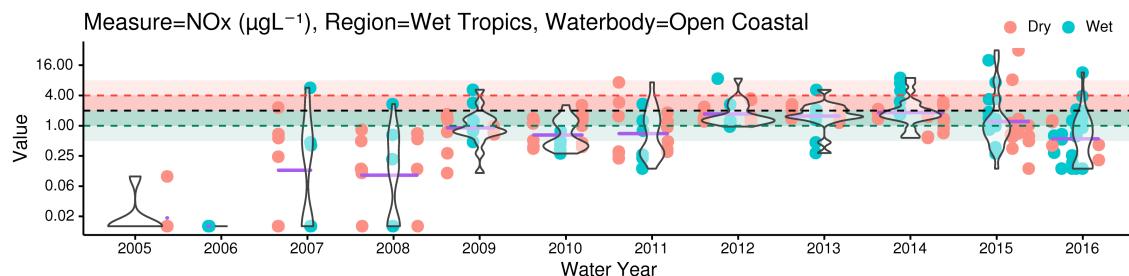


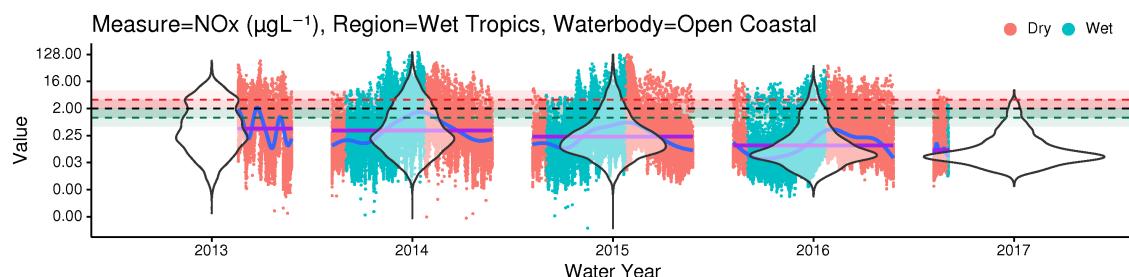
Figure C23: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Wet Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.6.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

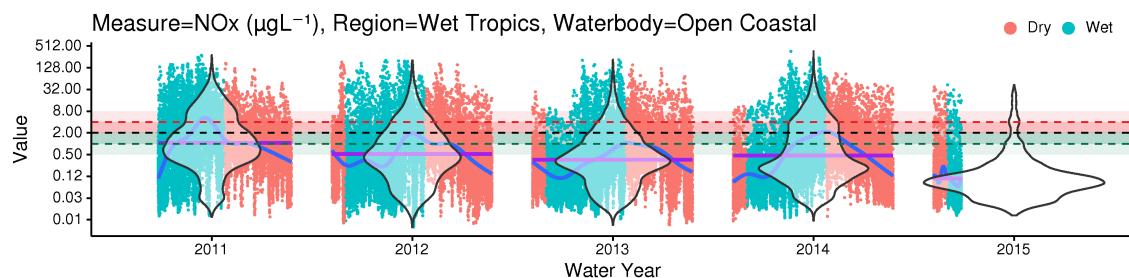
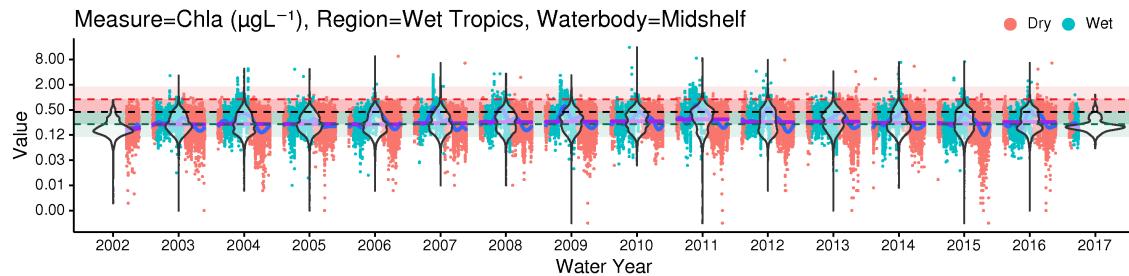


Figure C24: Observed (logarithmic axis with violin plot overlay) NOx data for the Wet Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

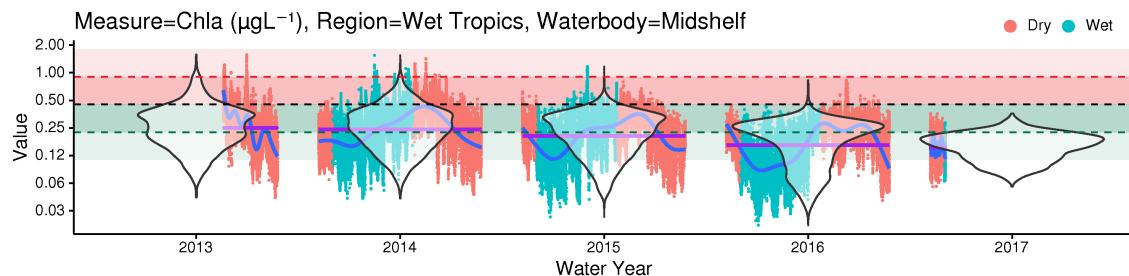
C.I.7 Wet Tropics, Midshelf

C.I.7.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

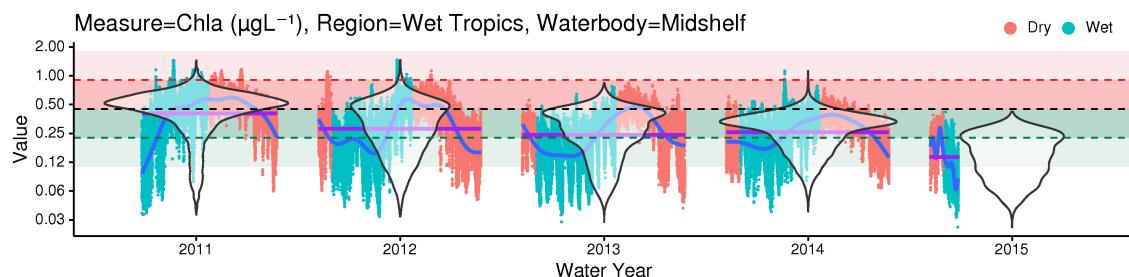
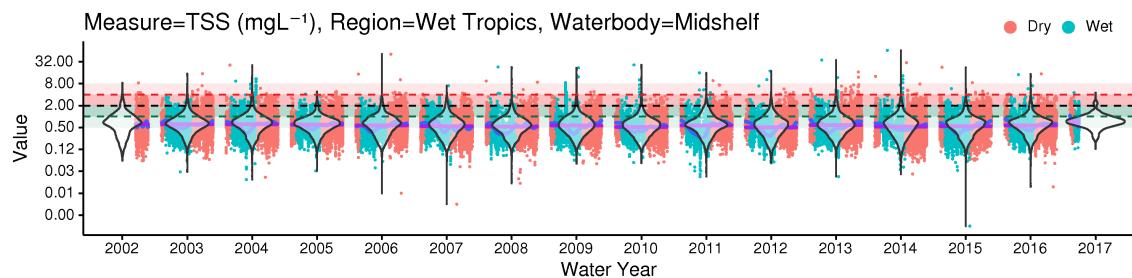


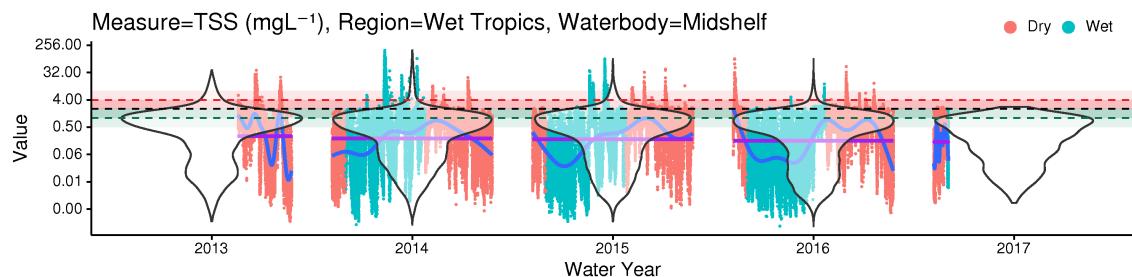
Figure C25: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Wet Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.1.7.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

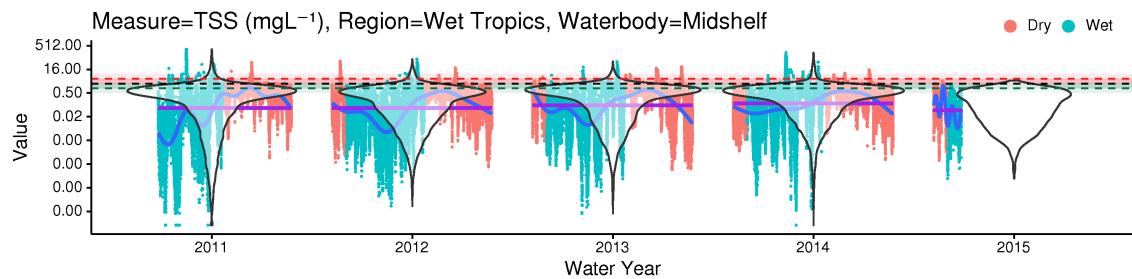
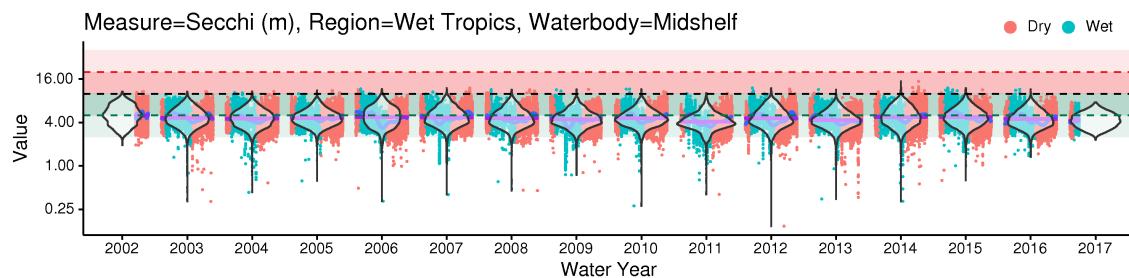


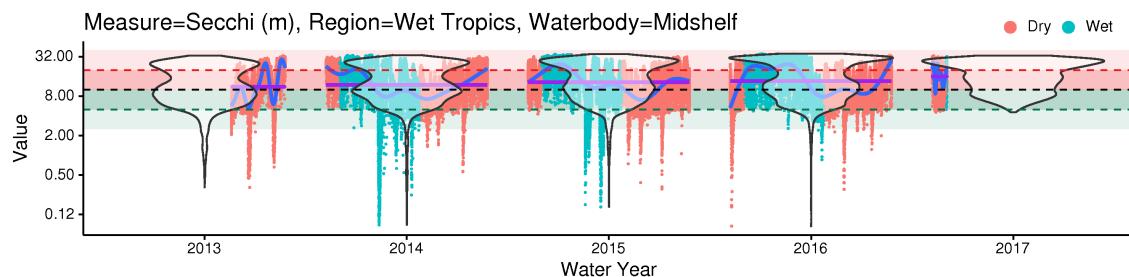
Figure C26: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Wet Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.7.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

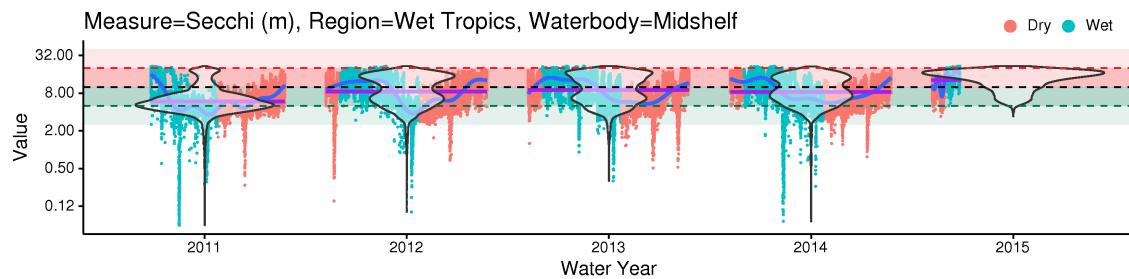
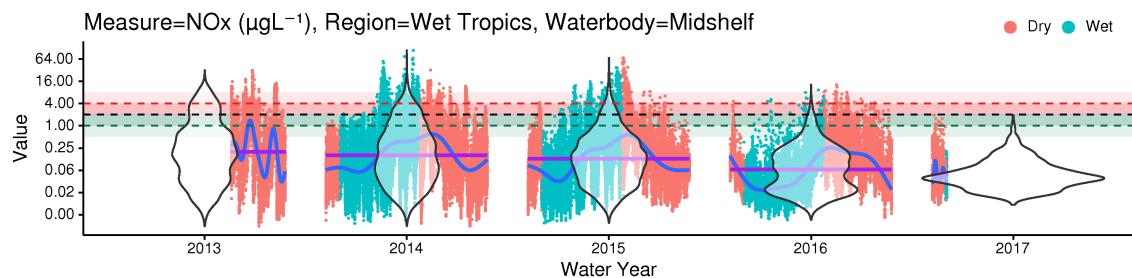


Figure C27: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Wet Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.7.4 NOx

d) eReefs



e) eReefs926

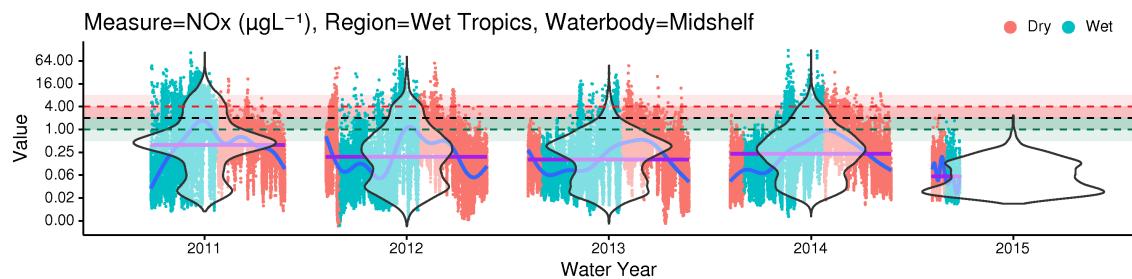
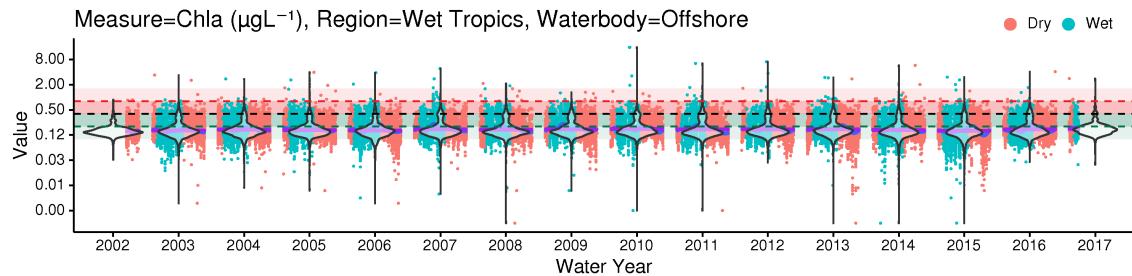


Figure C28: Observed (logarithmic axis with violin plot overlay) NOx data for the Wet Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

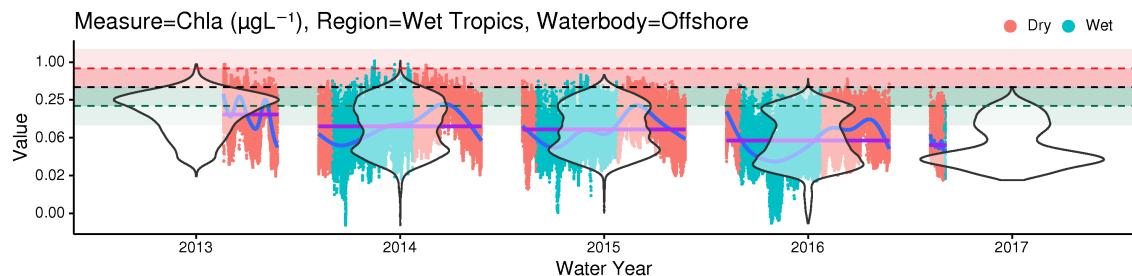
C.I.8 Wet Tropics, Offshore

C.I.8.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

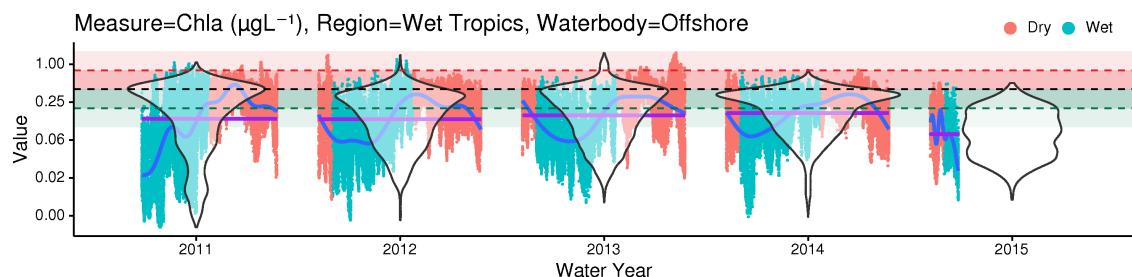
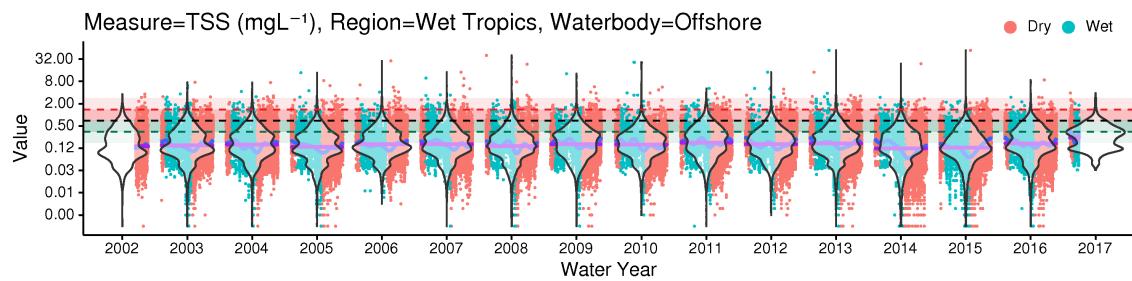


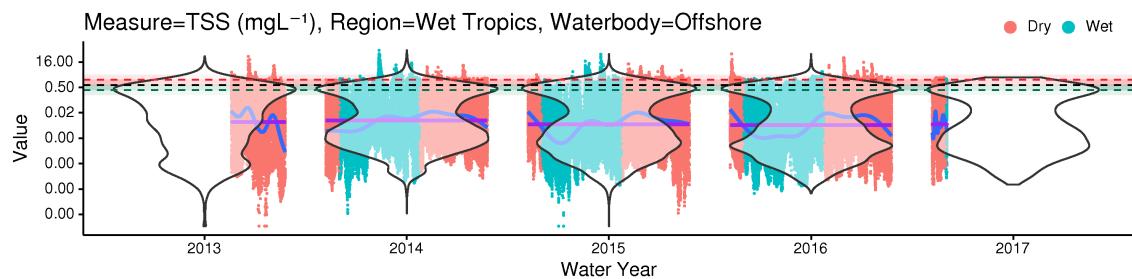
Figure C29: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Wet Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.8.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

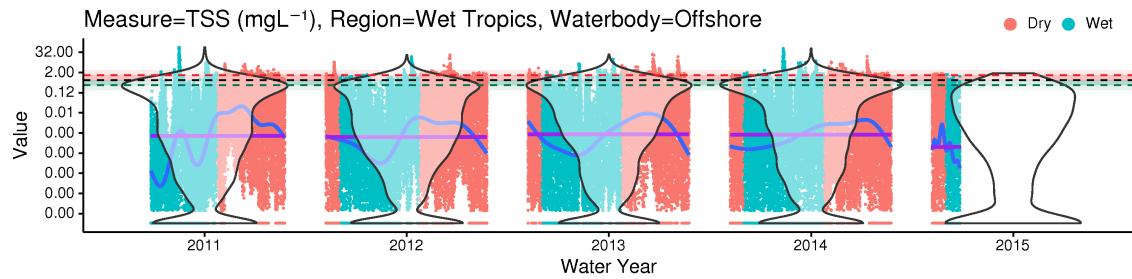
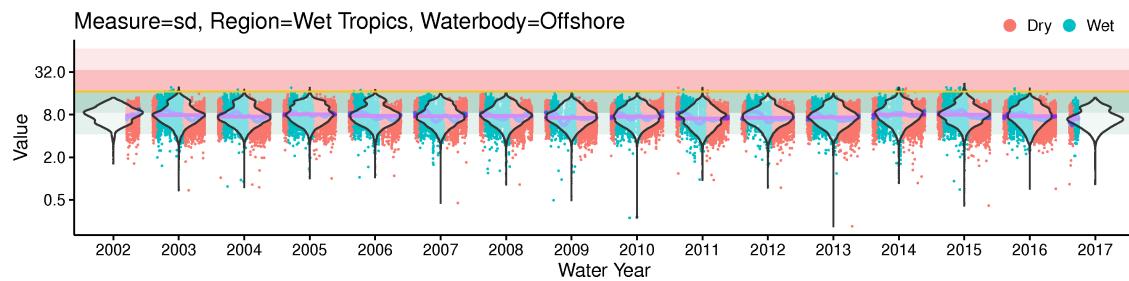


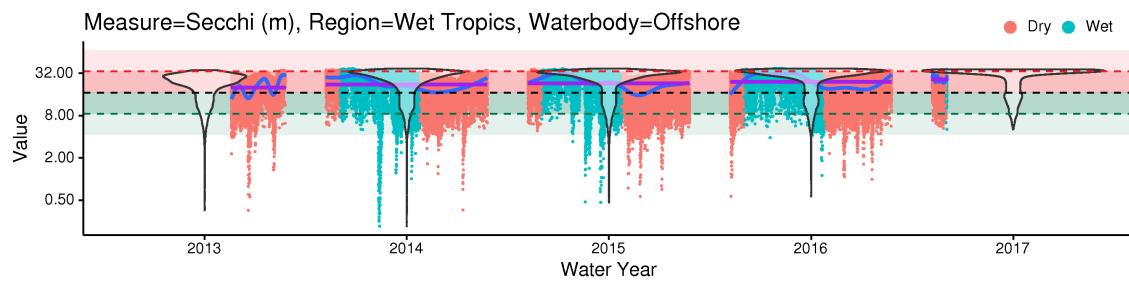
Figure C30: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Wet Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.8.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

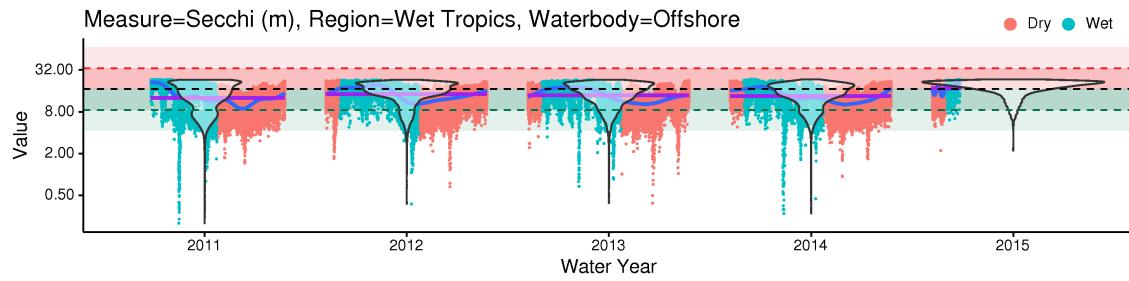
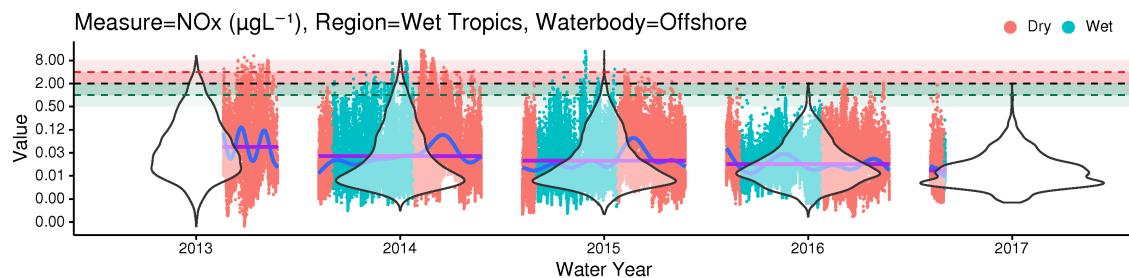


Figure C3I: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Wet Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.8.4 NOx

d) eReefs



e) eReefs926

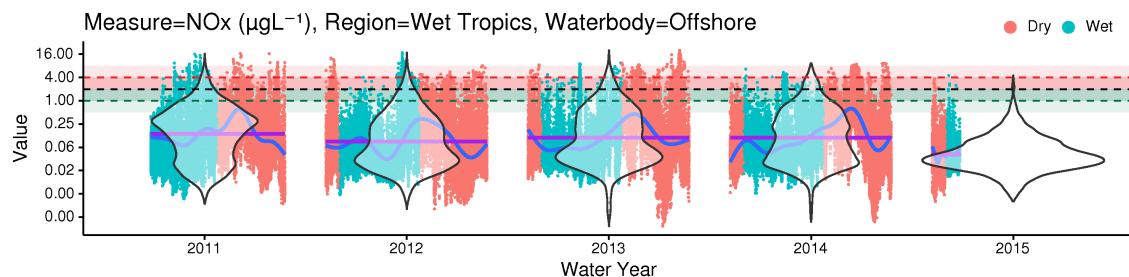
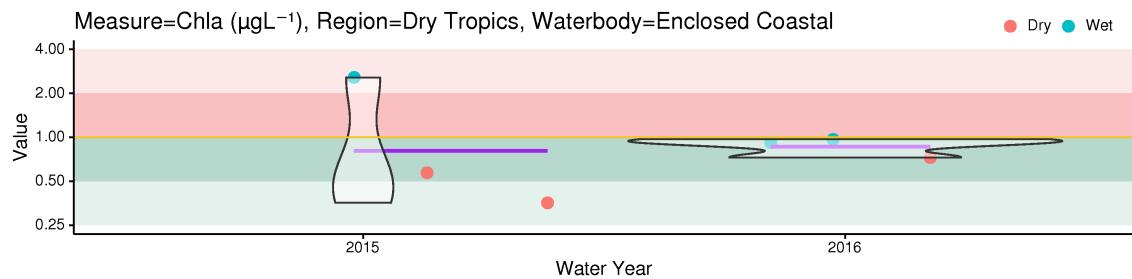


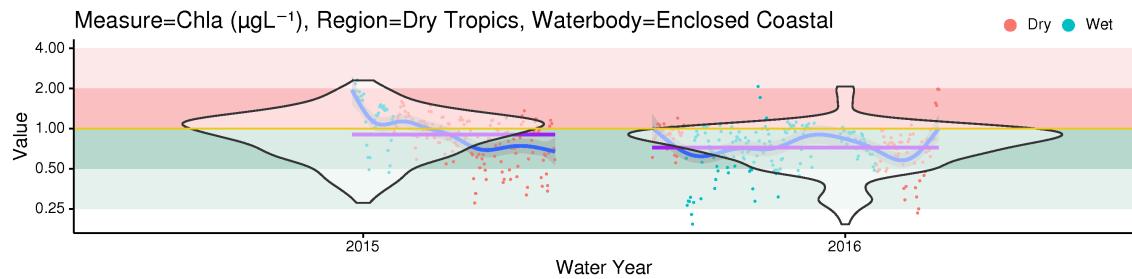
Figure C32: Observed (logarithmic axis with violin plot overlay) NOx data for the Wet Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.9 Dry Tropics, Enclosed Coastal*C.I.9.1 Chlorophyll*

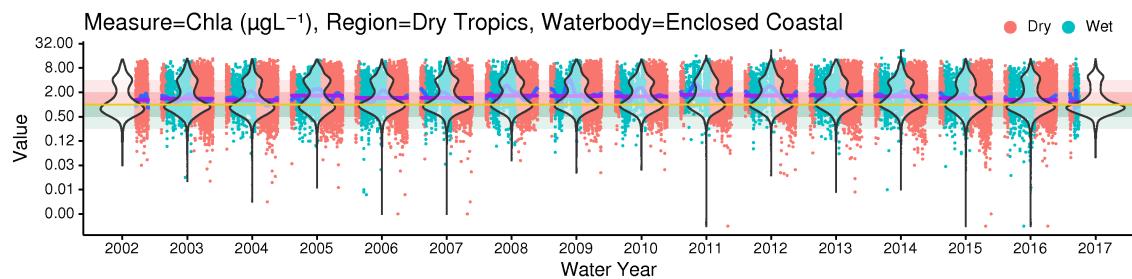
a) AIMS insitu



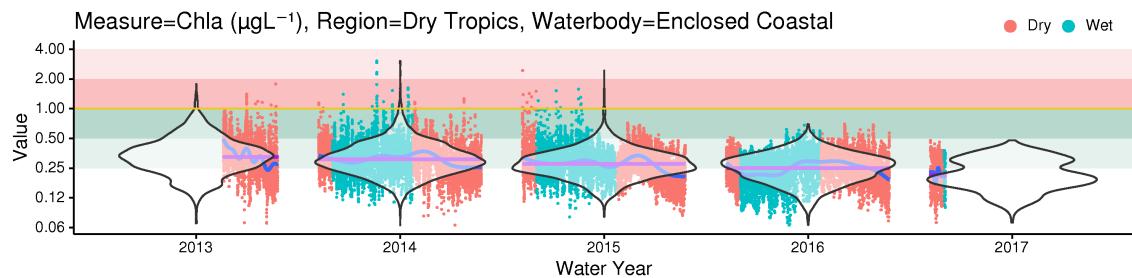
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

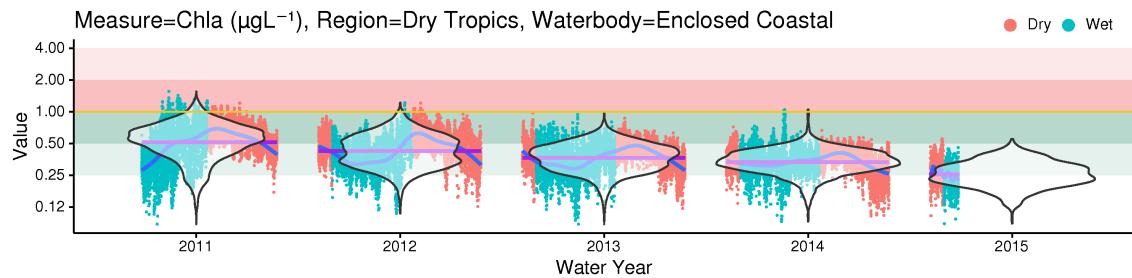
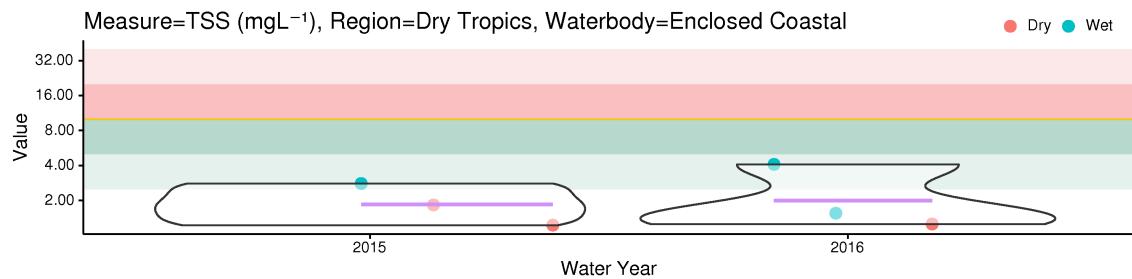


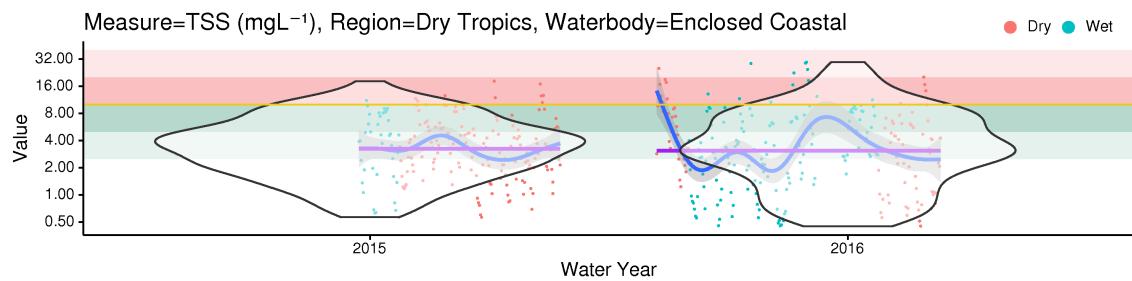
Figure C33: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Dry Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.9.2 Total Suspended Solids

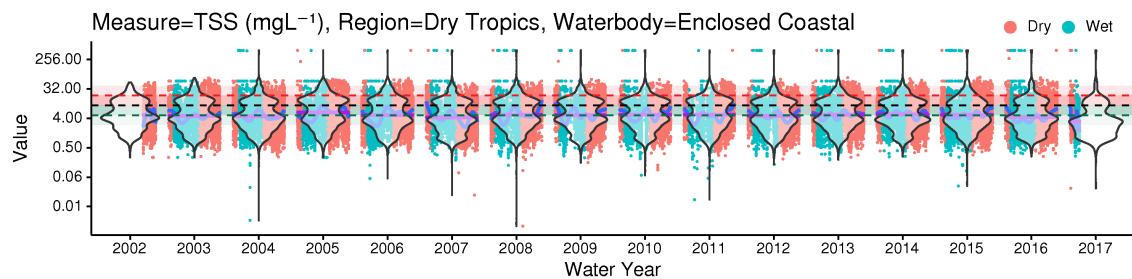
a) AIMS insitu



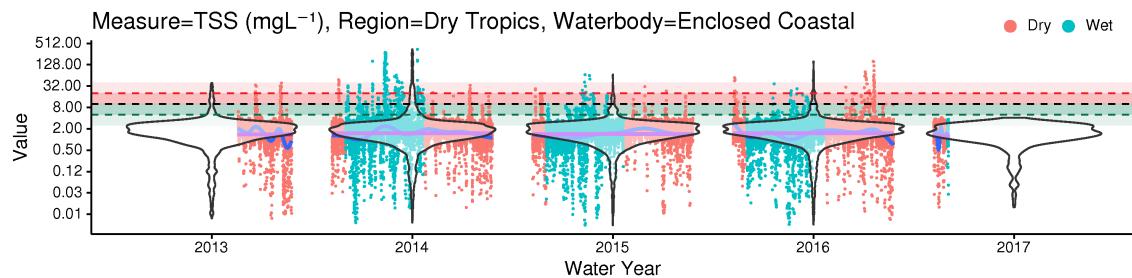
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

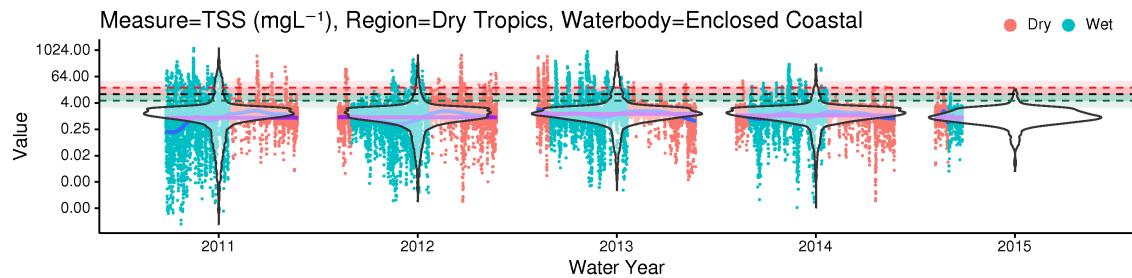
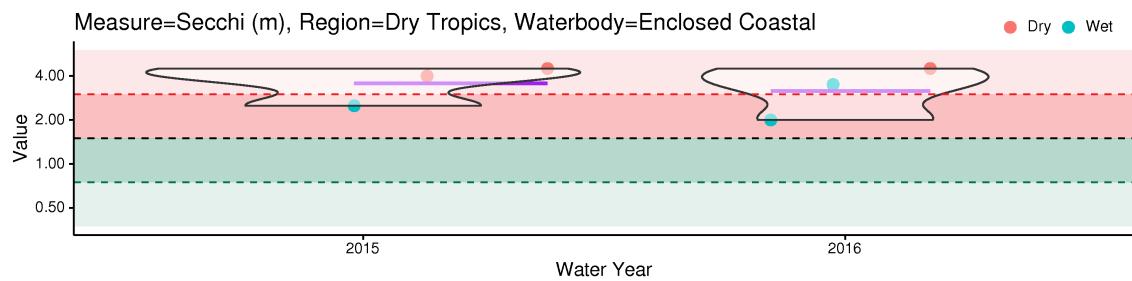


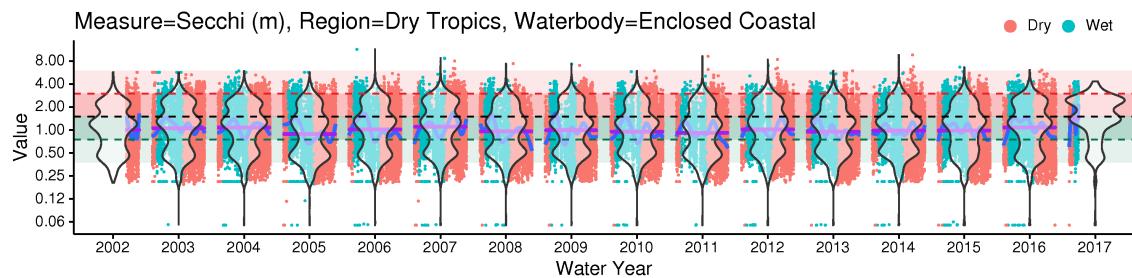
Figure C34: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Dry Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.9.3 Secchi Depth

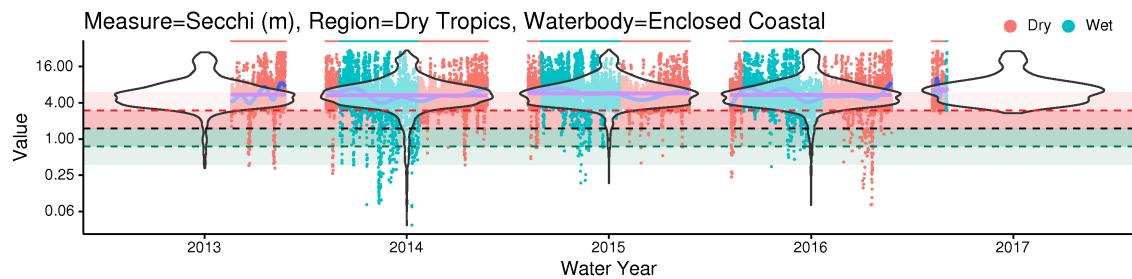
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

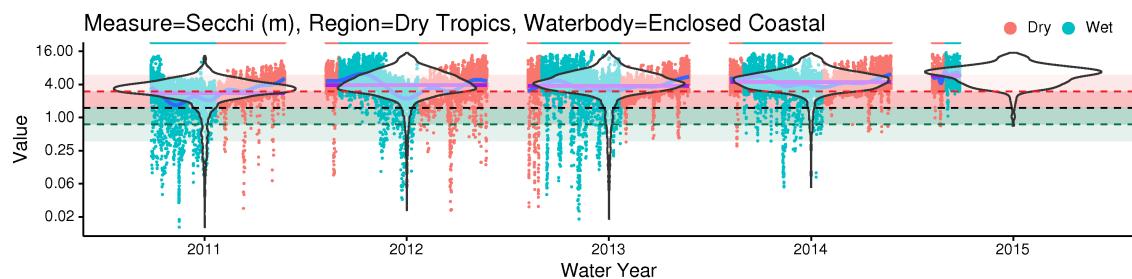
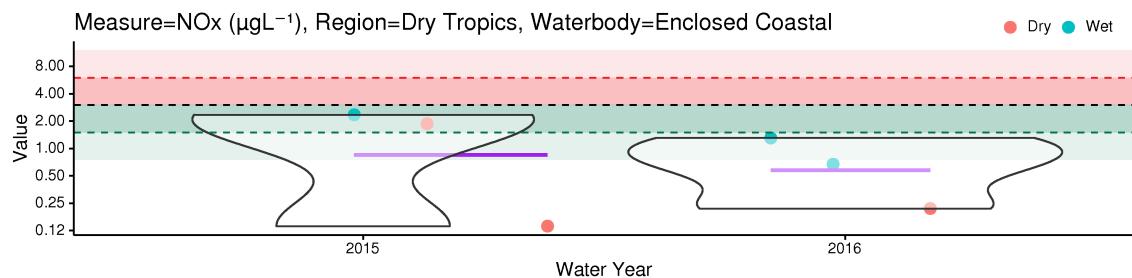


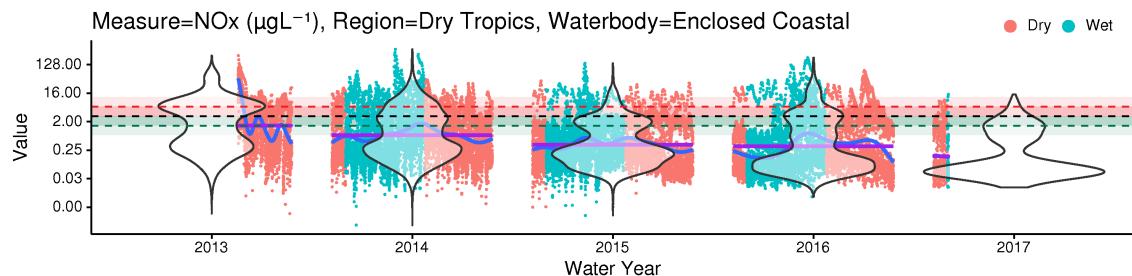
Figure C35: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Dry Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.9.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

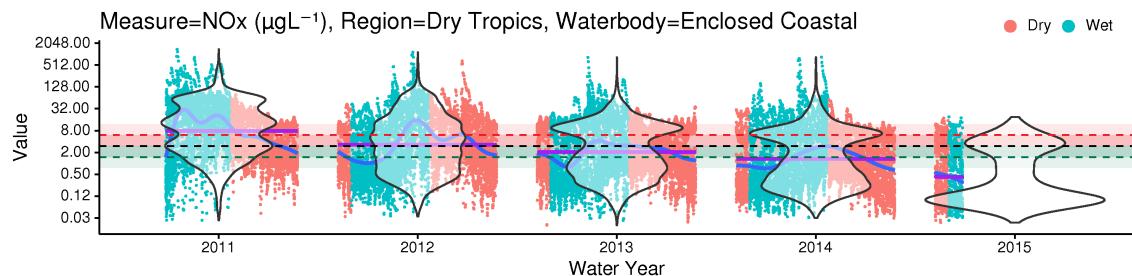
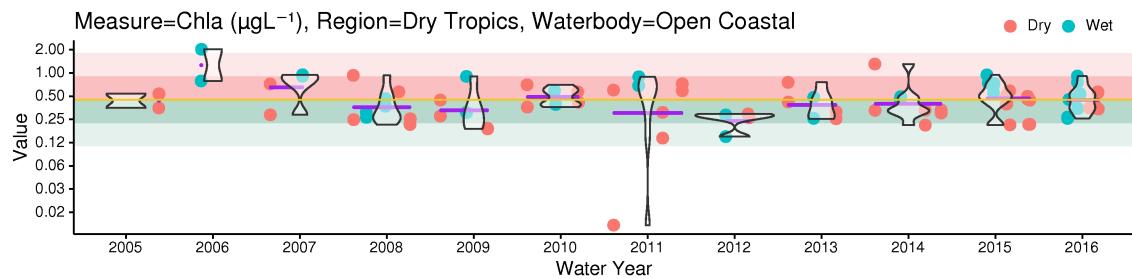


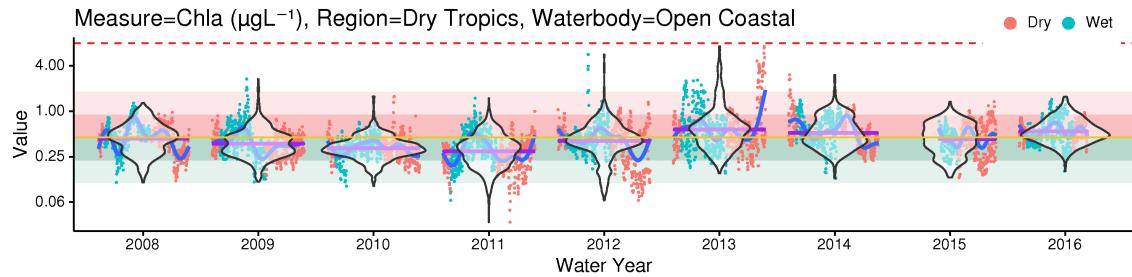
Figure C36: Observed (logarithmic axis with violin plot overlay) NOx data for the Dry Tropics Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.10 Dry Tropics, Open Coastal*C.I.10.1 Chlorophyll*

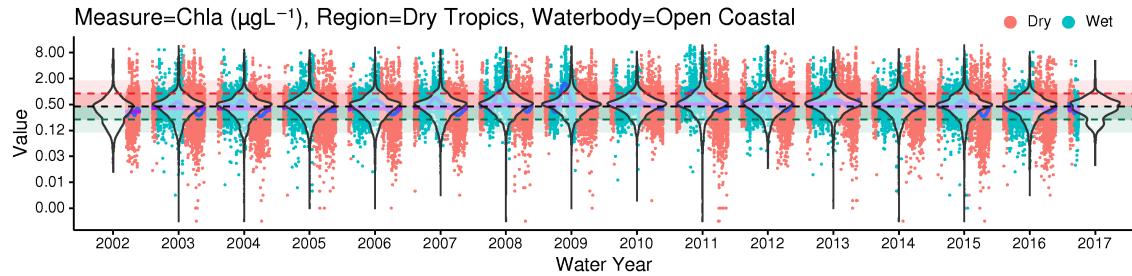
a) AIMS insitu



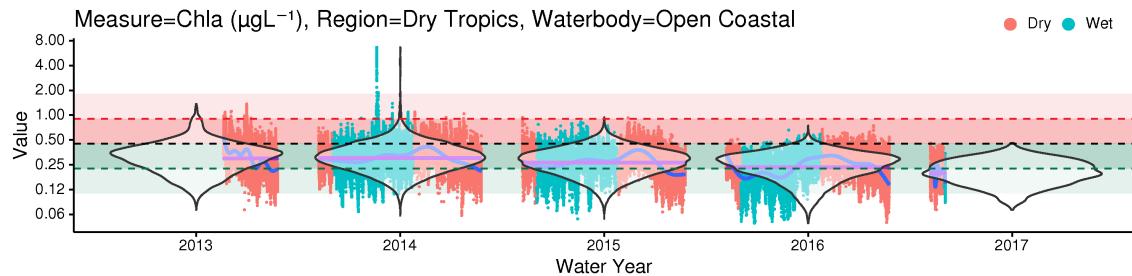
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

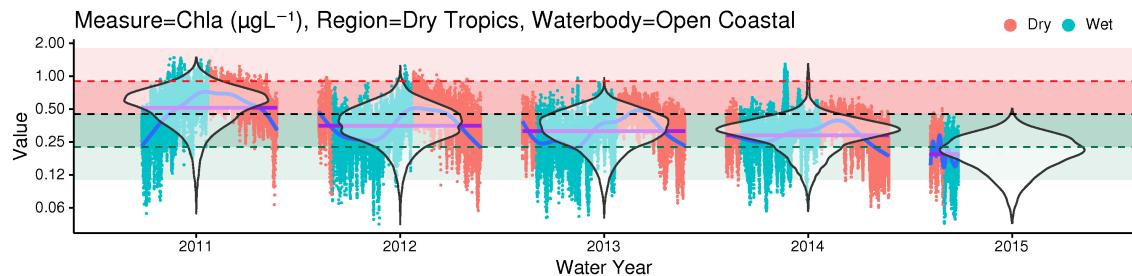
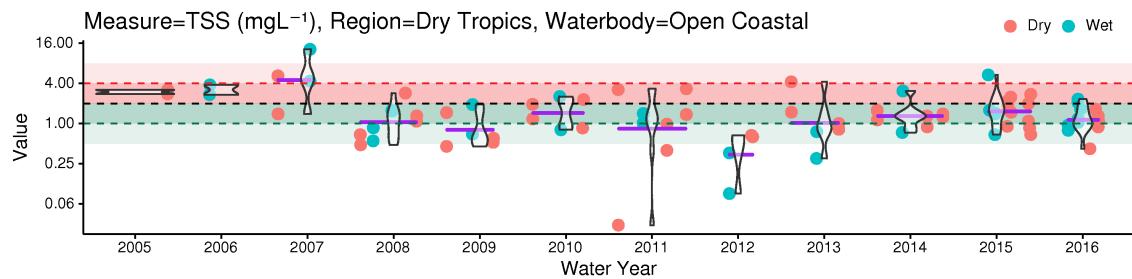


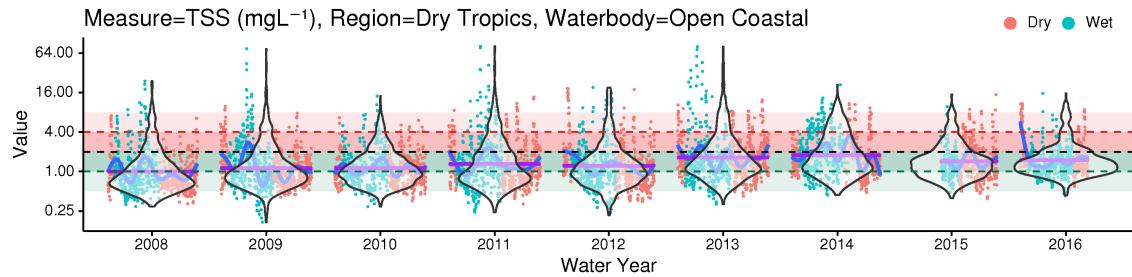
Figure C37: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Dry Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.10.2 Total Suspended Solids

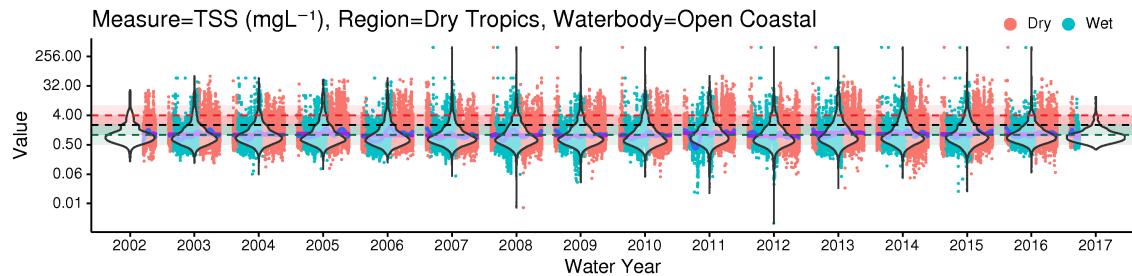
a) AIMS insitu



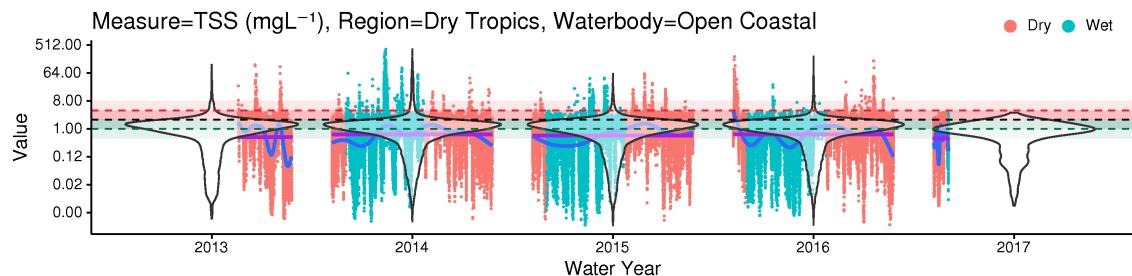
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

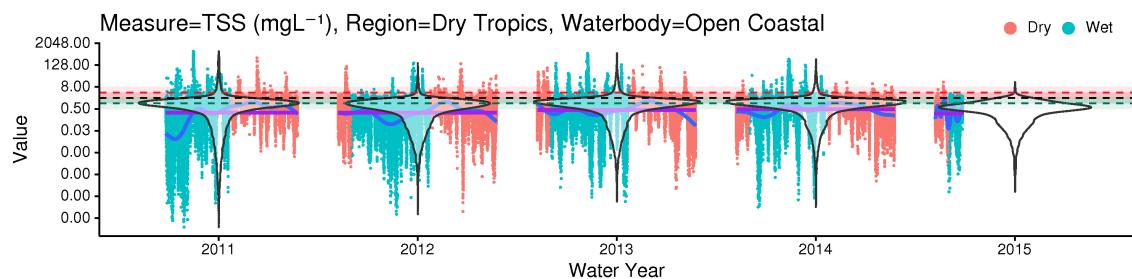
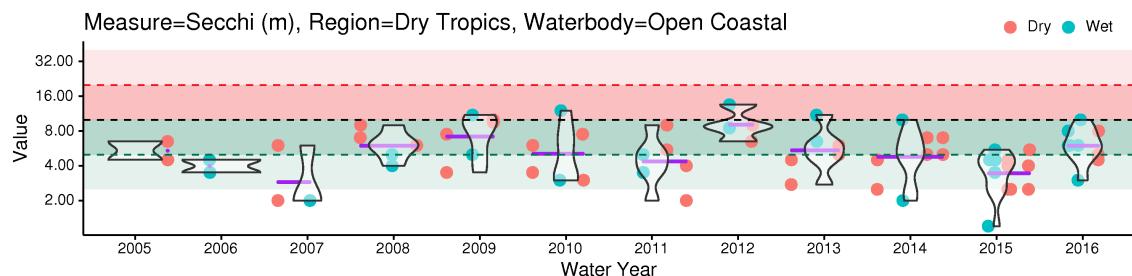


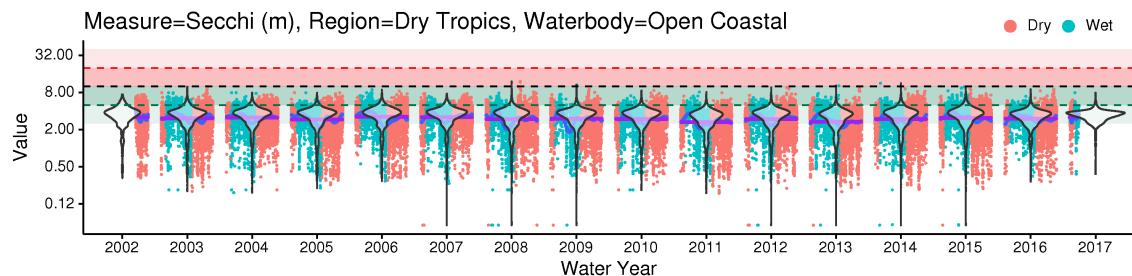
Figure C38: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Dry Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.10.3 Secchi Depth

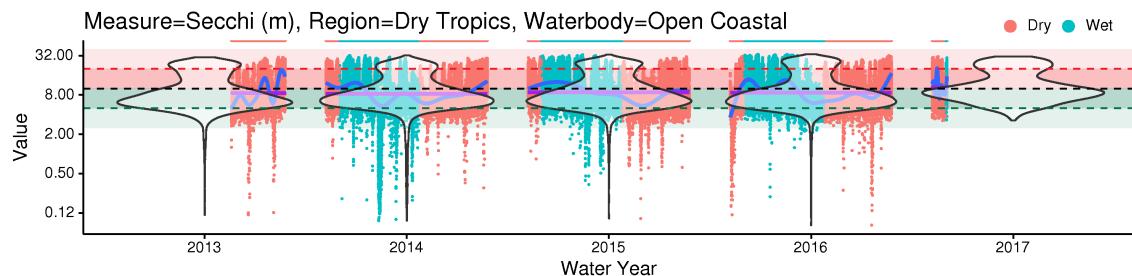
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

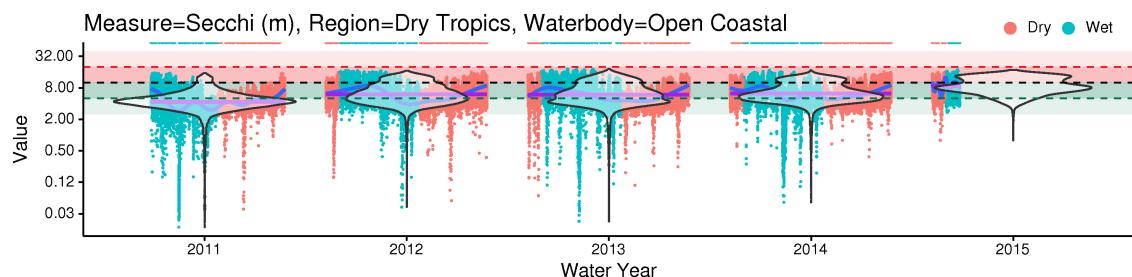
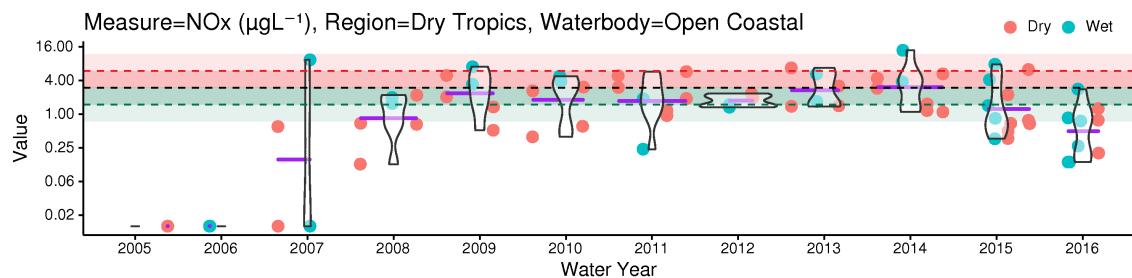


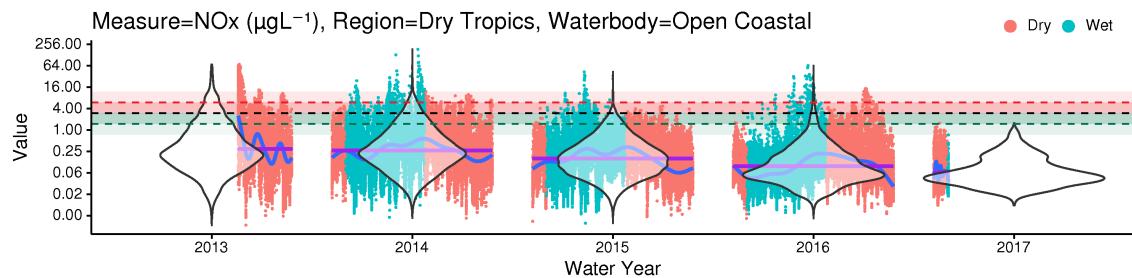
Figure C39: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Dry Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.10.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

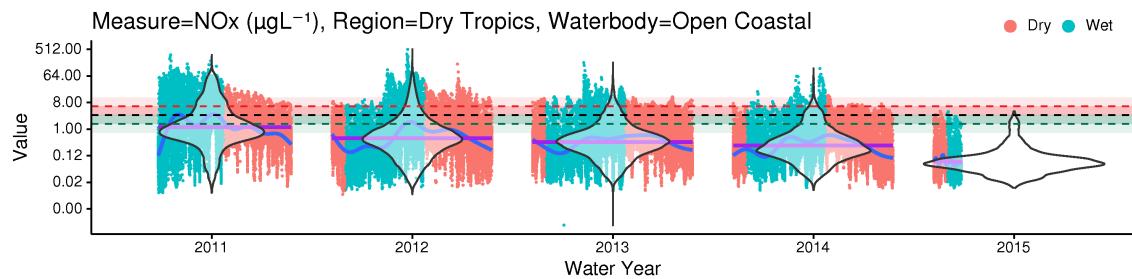
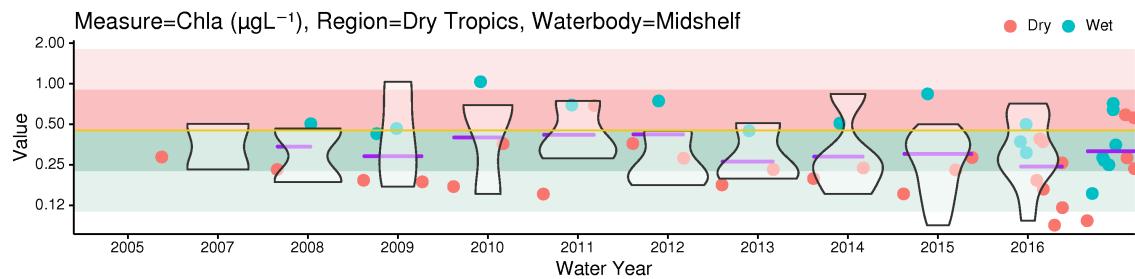


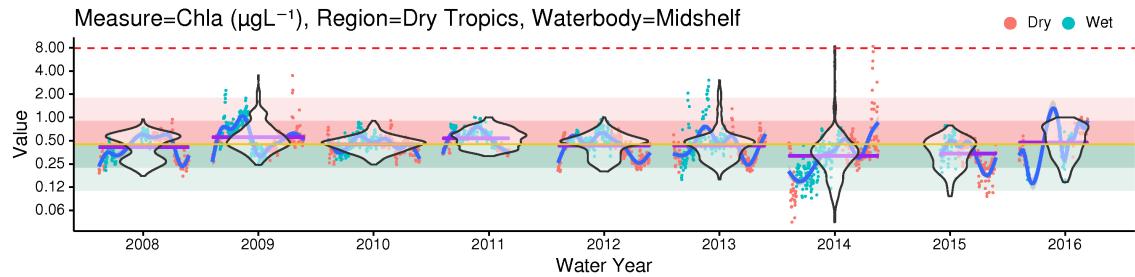
Figure C40: Observed (logarithmic axis with violin plot overlay) NOx data for the Dry Tropics Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.II Dry Tropics, Midshelf*C.I.II.I Chlorophyll*

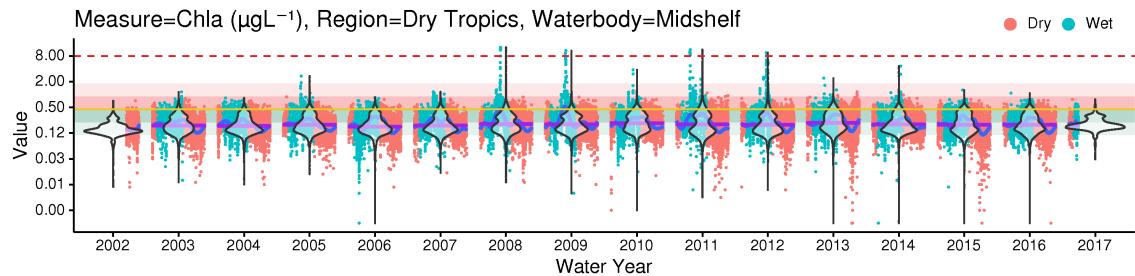
a) AIMS insitu



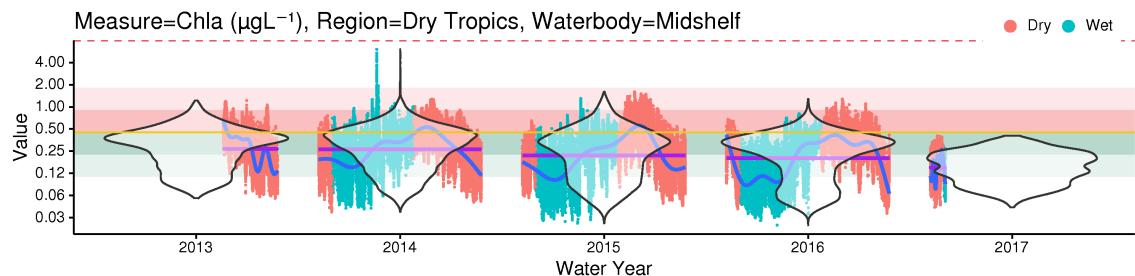
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

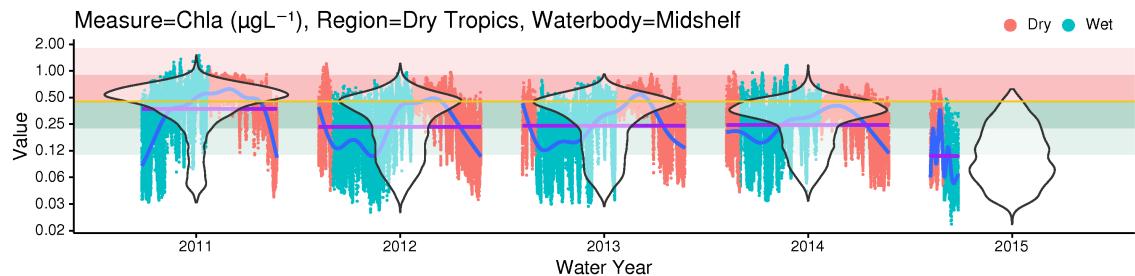
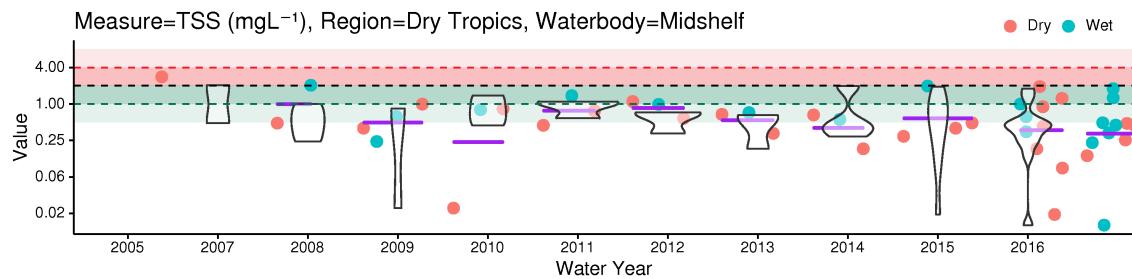


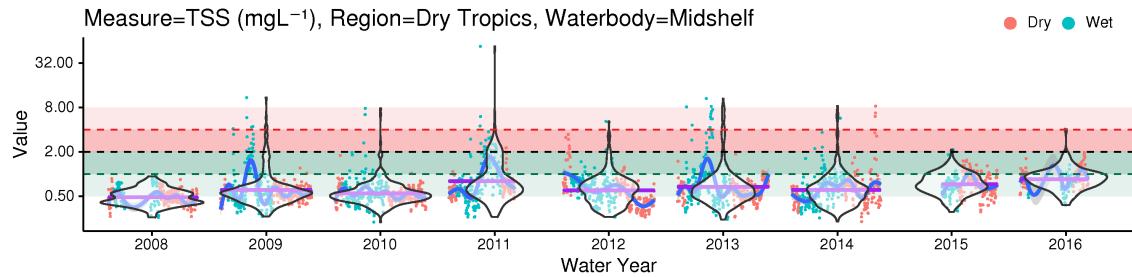
Figure C41: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Dry Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.II.2 Total Suspended Solids

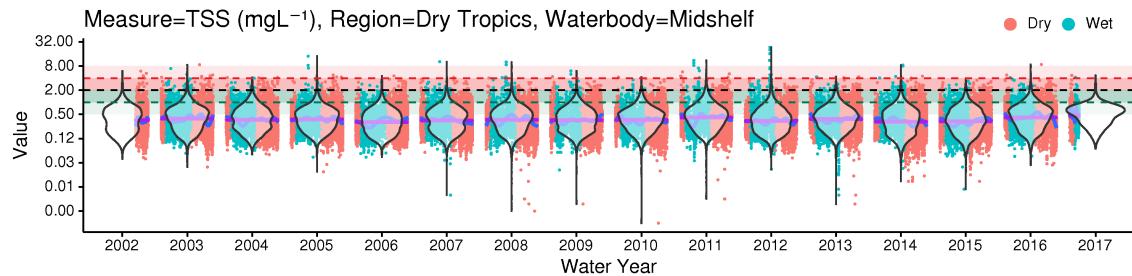
a) AIMS insitu



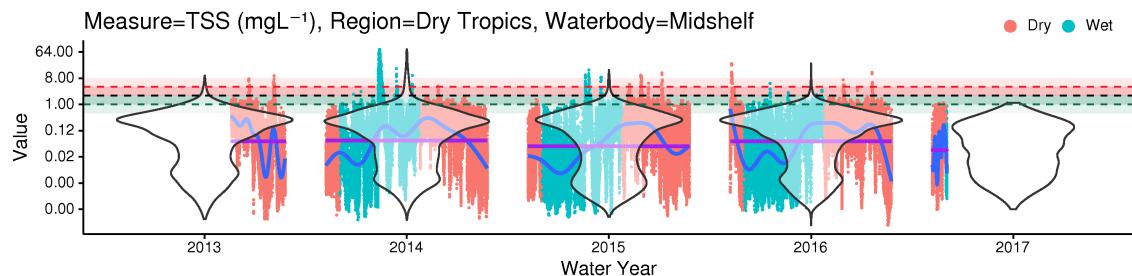
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

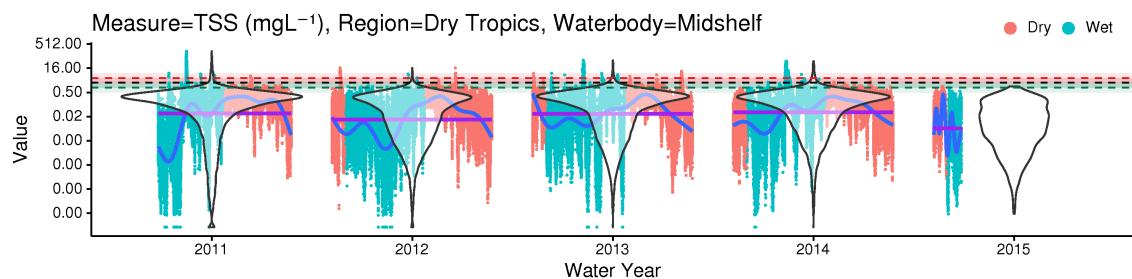
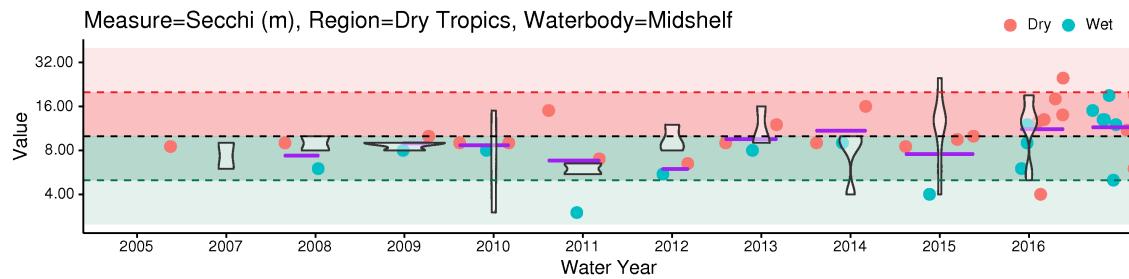


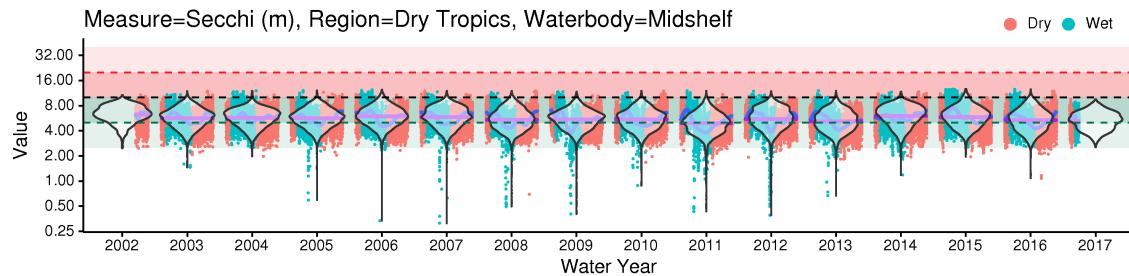
Figure C42: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Dry Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.II.3 Secchi Depth

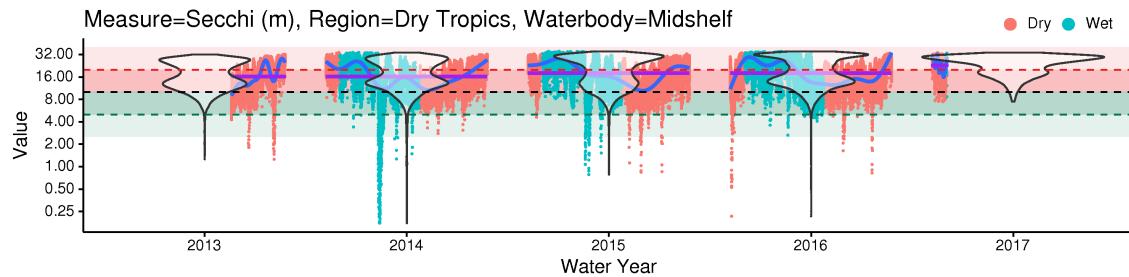
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

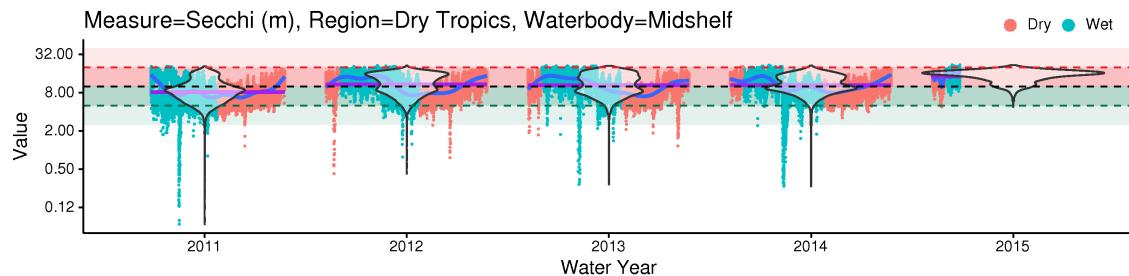
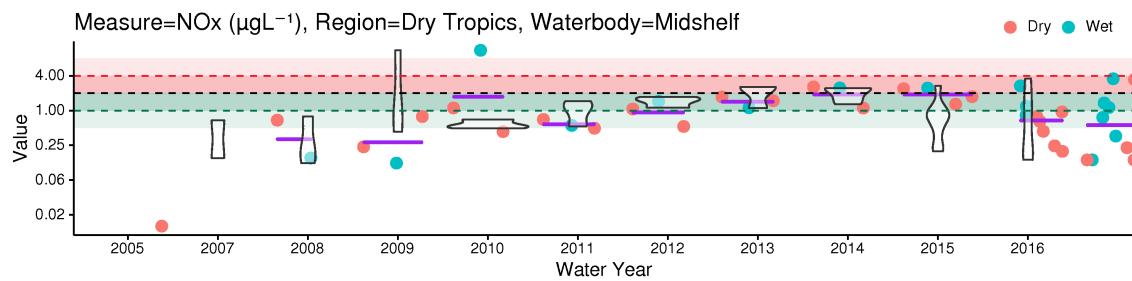


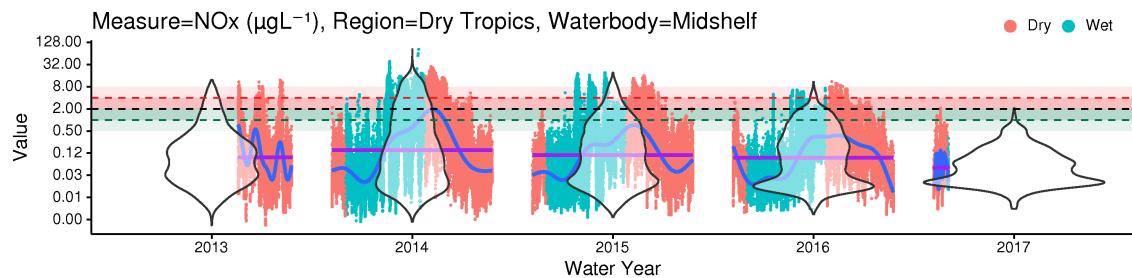
Figure C43: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Dry Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.II.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

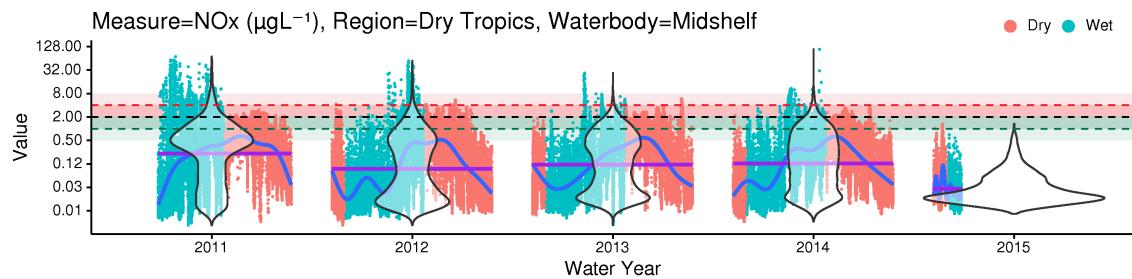
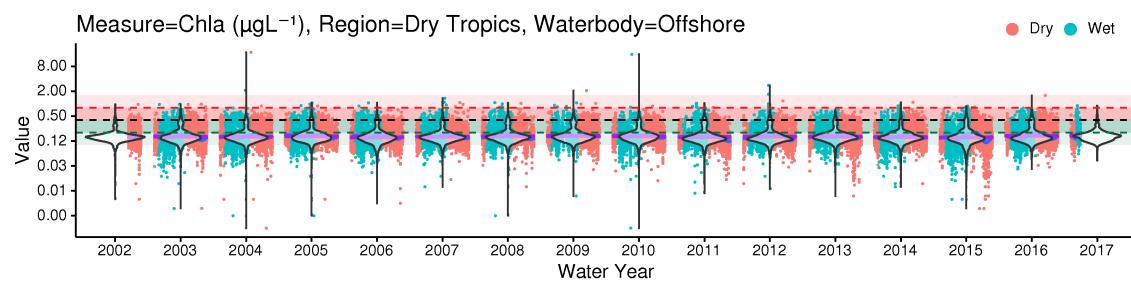


Figure C44: Observed (logarithmic axis with violin plot overlay) NOx data for the Dry Tropics Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

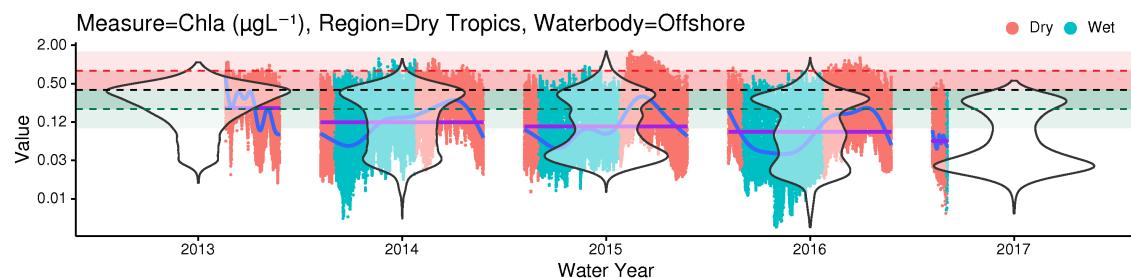
C.I.12 Dry Tropics, Offshore

C.I.12.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

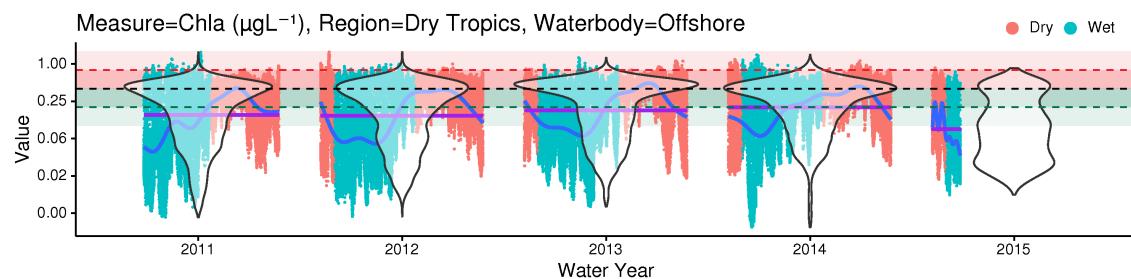
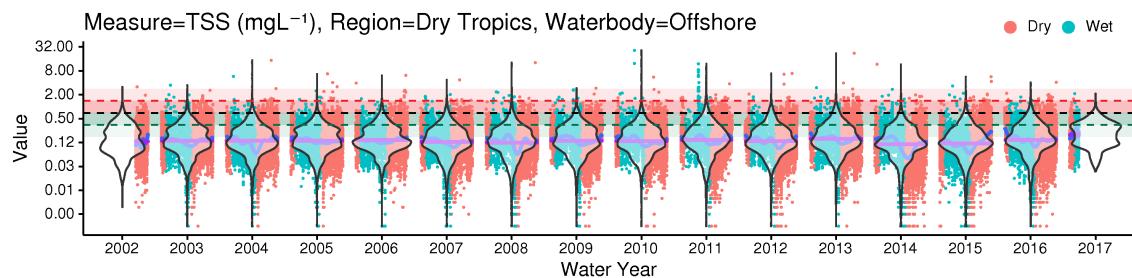


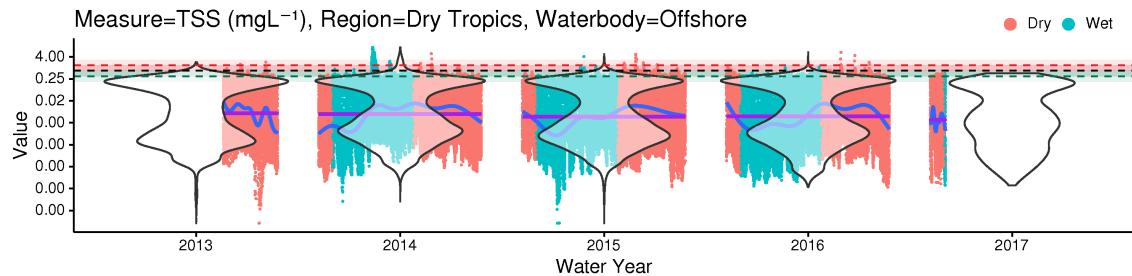
Figure C45: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Dry Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.12.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

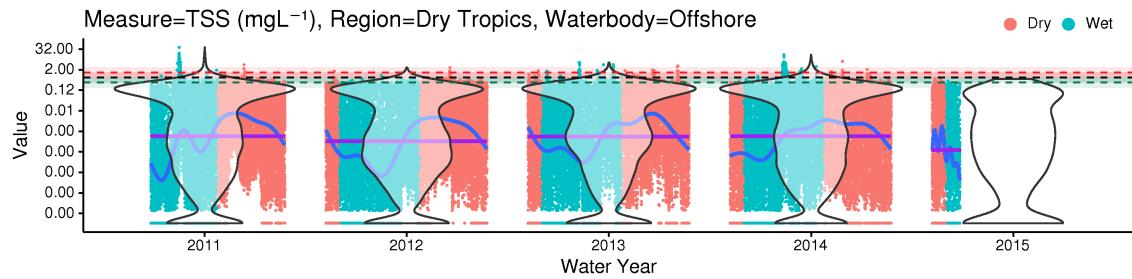
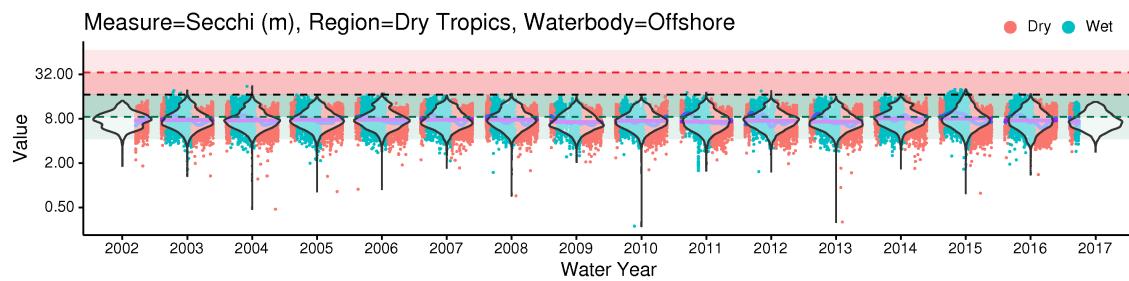


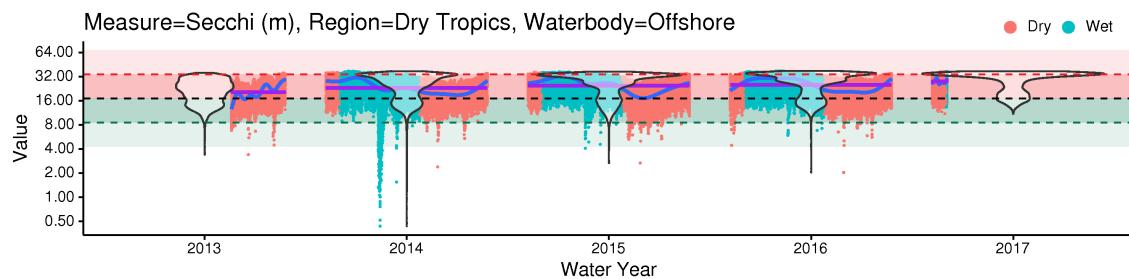
Figure C46: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Dry Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.12.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

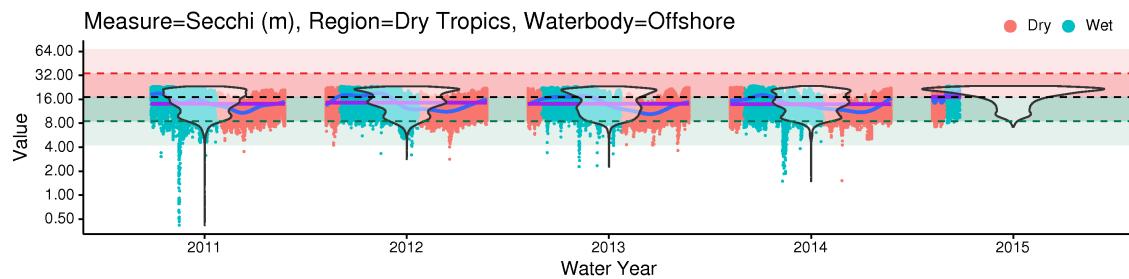
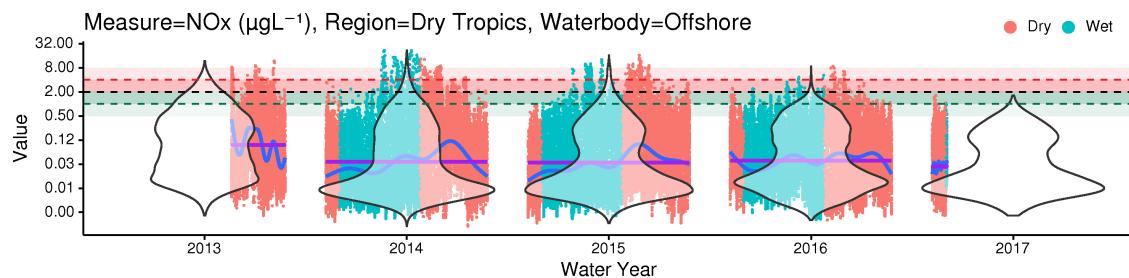


Figure C47: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Dry Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.12.4 NOx

d) eReefs



e) eReefs926

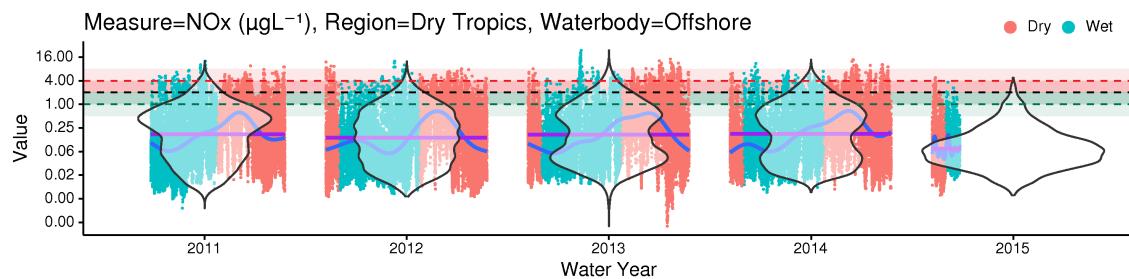
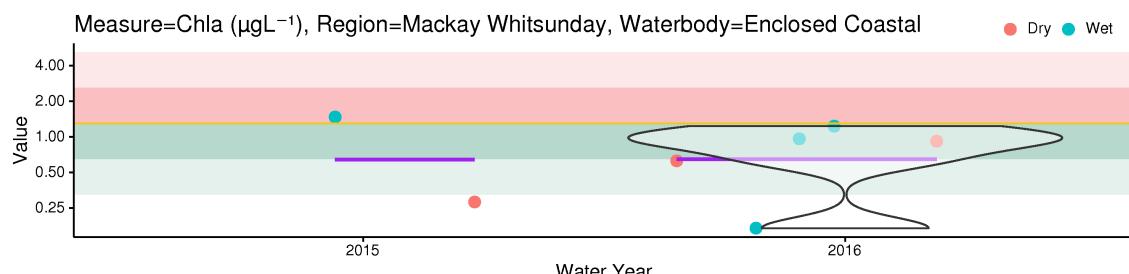


Figure C48: Observed (logarithmic axis with violin plot overlay) NOx data for the Dry Tropics Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

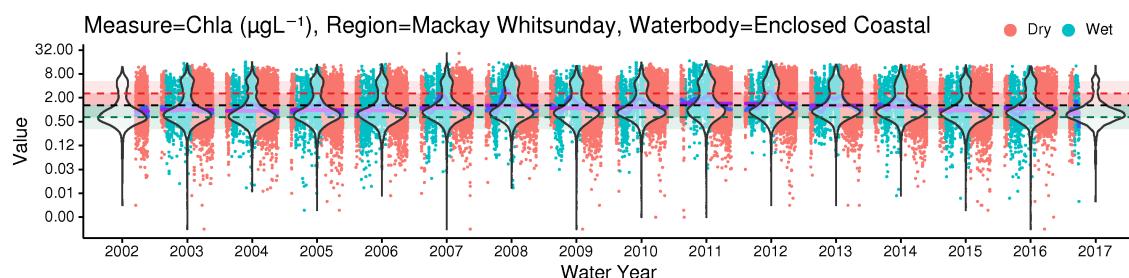
C.I.13 Mackay Whitsunday, Enclosed Coastal

C.I.13.1 Chlorophyll

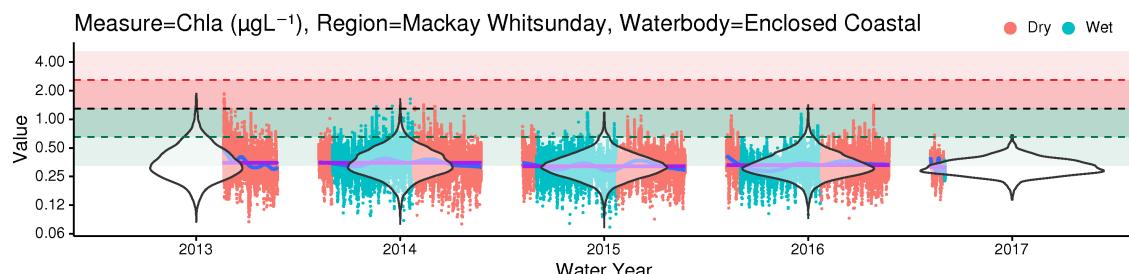
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

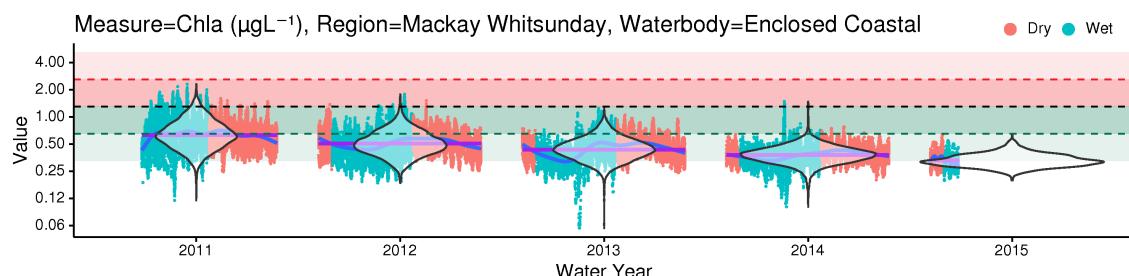
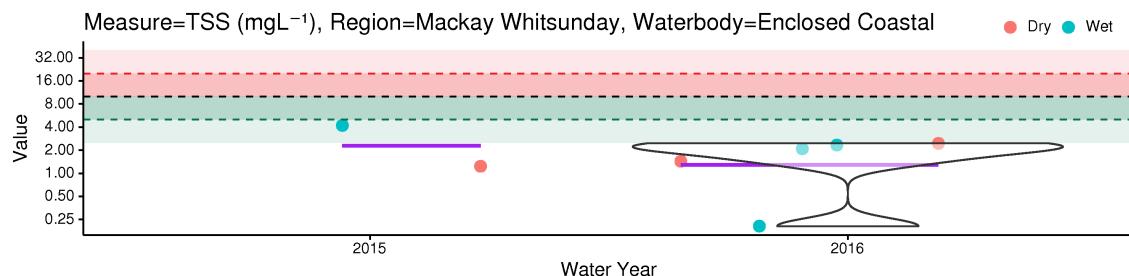


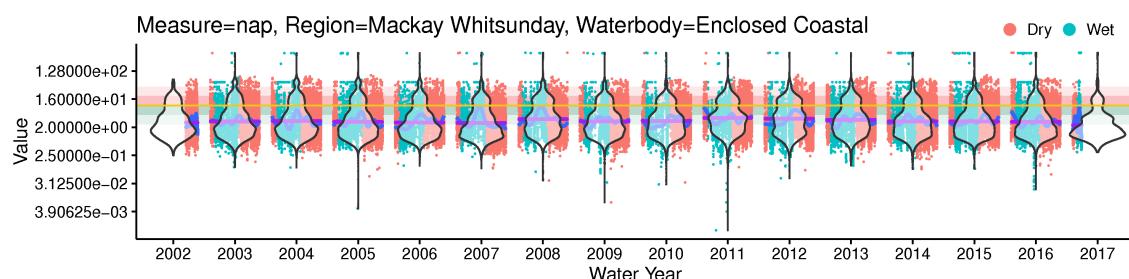
Figure C49: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Mackay Whitsunday Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.13.2 Total Suspended Solids

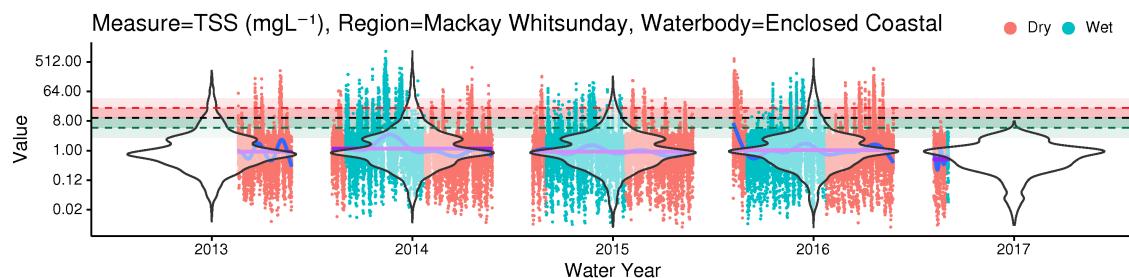
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

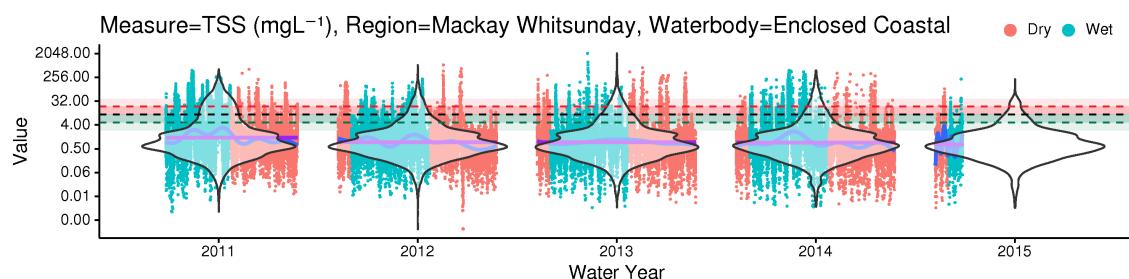
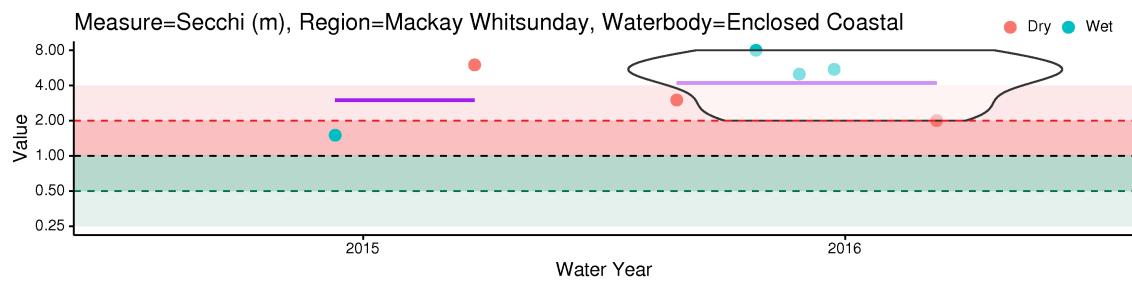


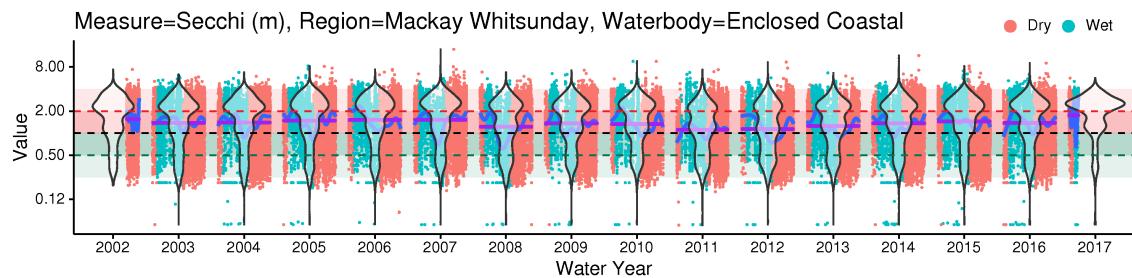
Figure C50: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Mackay Whitsunday Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.13.3 Secchi Depth

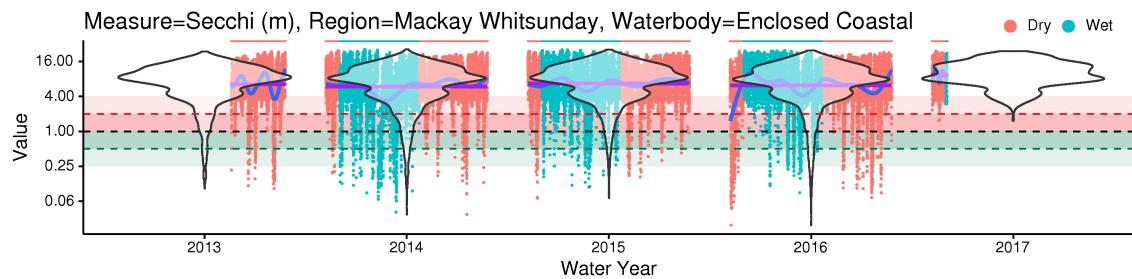
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

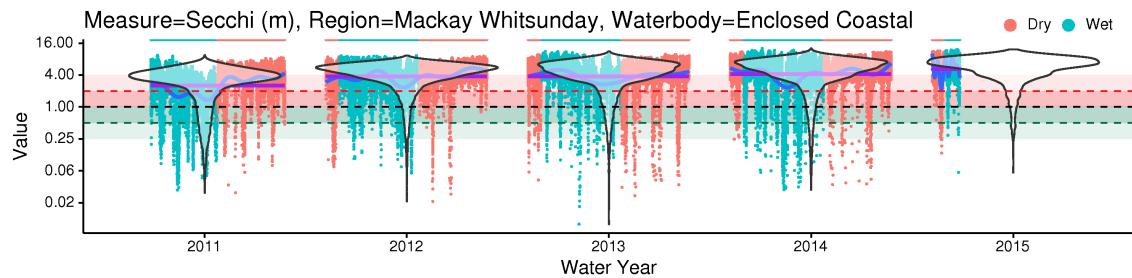
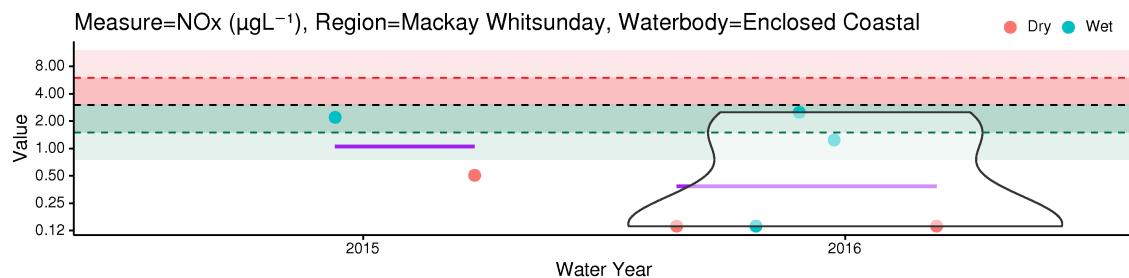


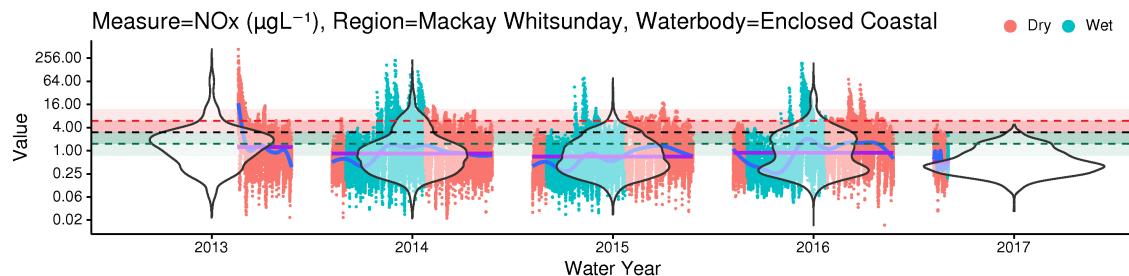
Figure C51: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Mackay Whitsunday Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.13.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

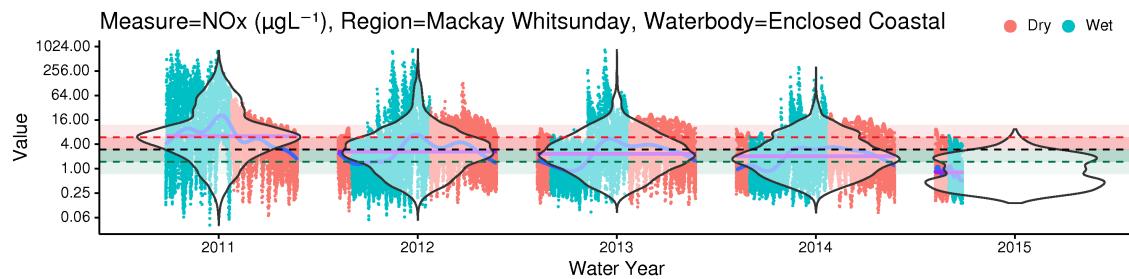
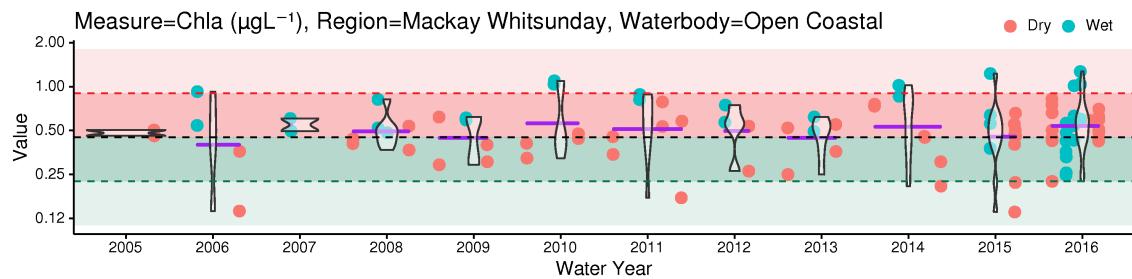


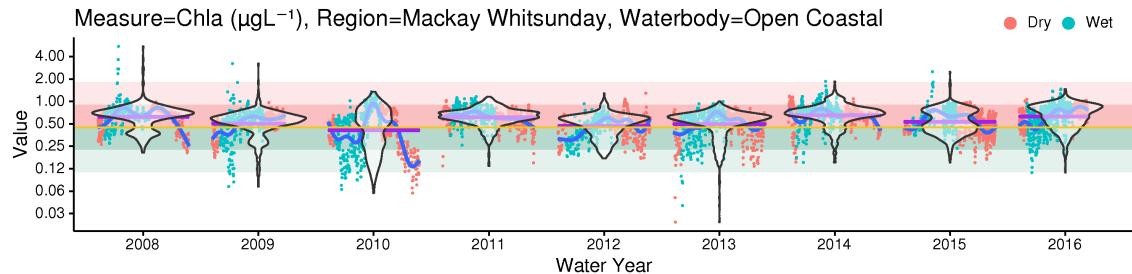
Figure C52: Observed (logarithmic axis with violin plot overlay) NOx data for the Mackay Whitsunday Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.14 Mackay Whitsunday, Open Coastal*C.I.14.1 Chlorophyll*

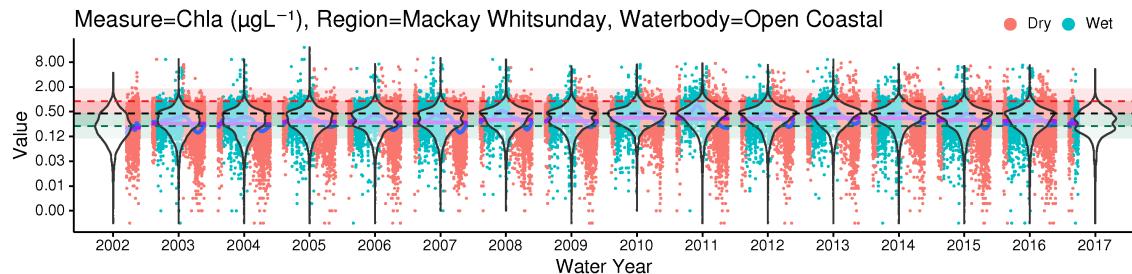
a) AIMS insitu



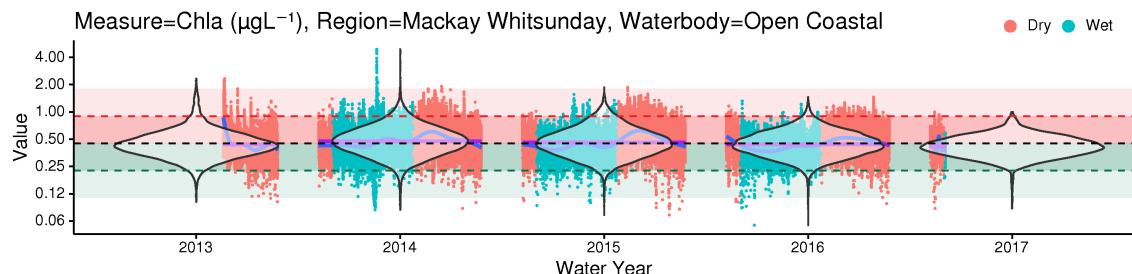
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

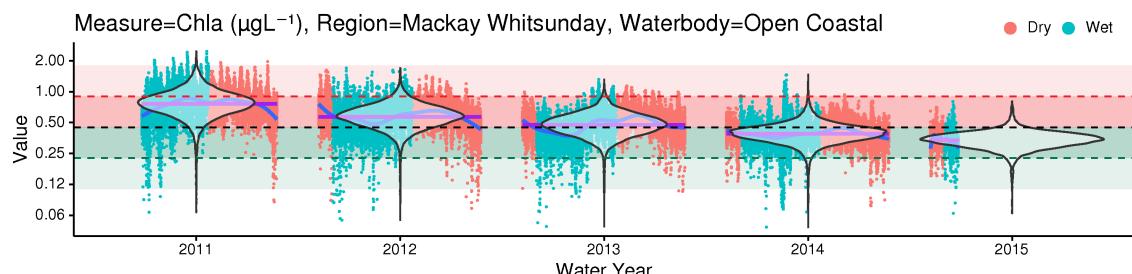
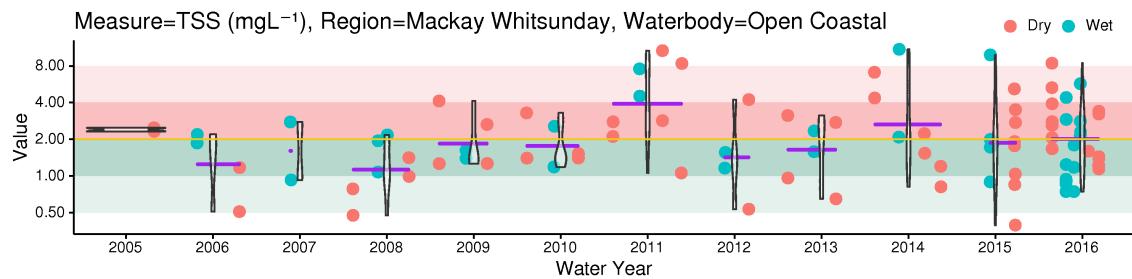


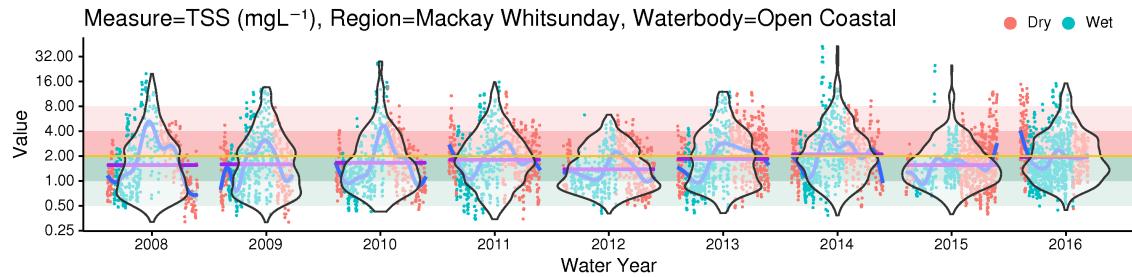
Figure C53: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Mackay Whitsunday Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.14.2 Total Suspended Solids

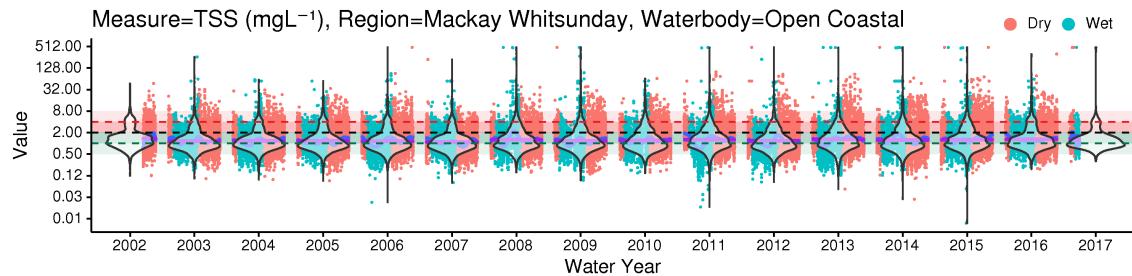
a) AIMS insitu



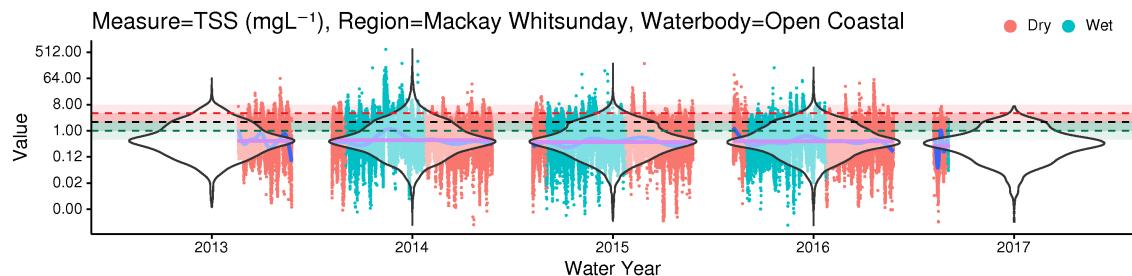
b) AIMS FLNTU



c) Satellite



d) eReefs



e) eReefs926

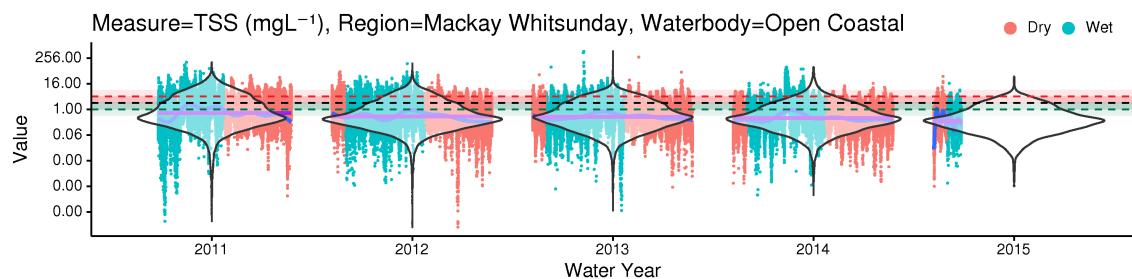
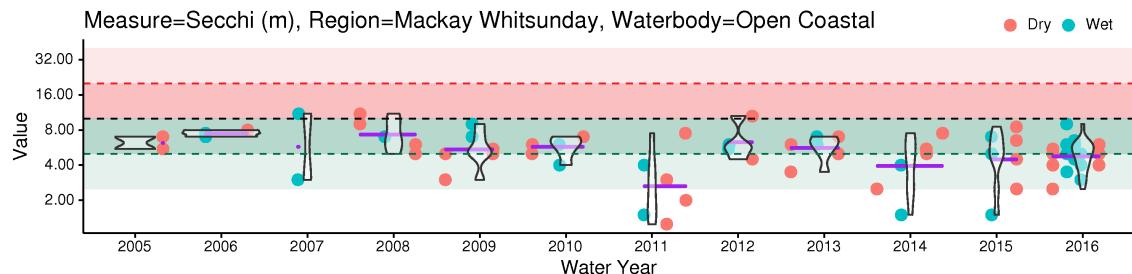


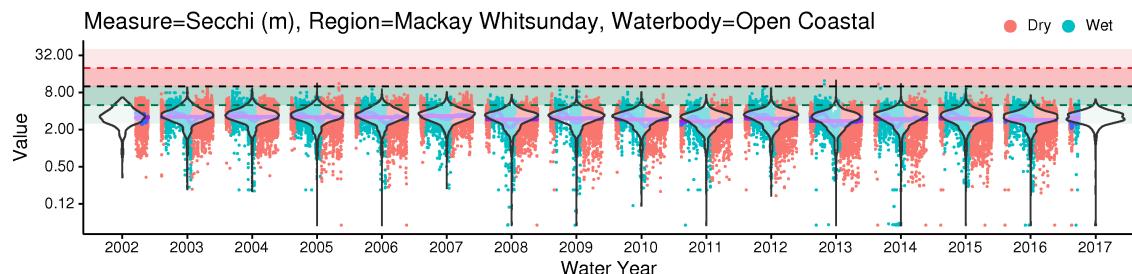
Figure C54: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Mackay Whitsunday Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.14.3 Secchi Depth

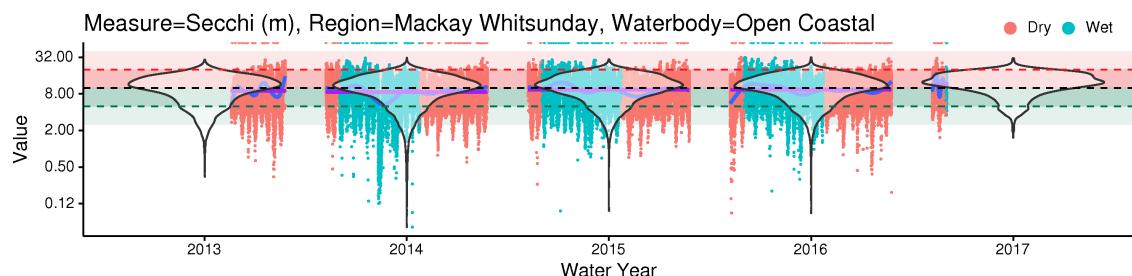
a) AIMS insitu



c) Satellite



d) eReefs



e) eReefs926

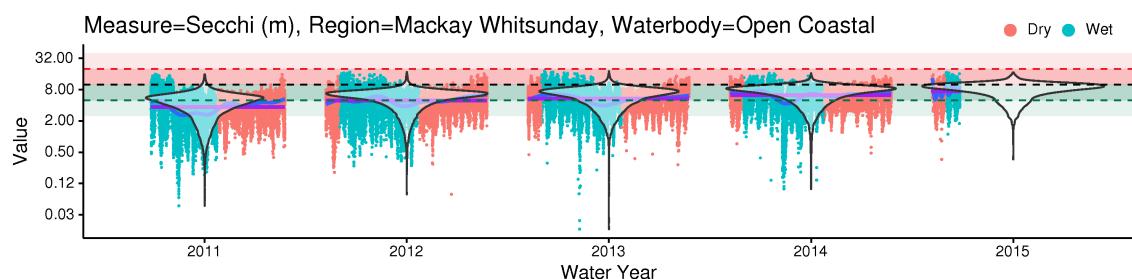
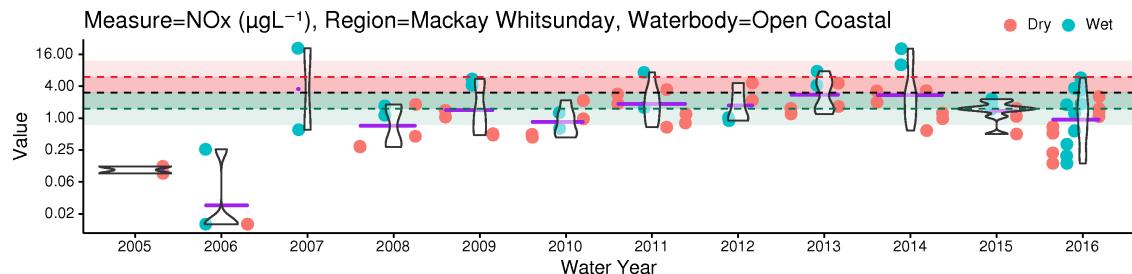


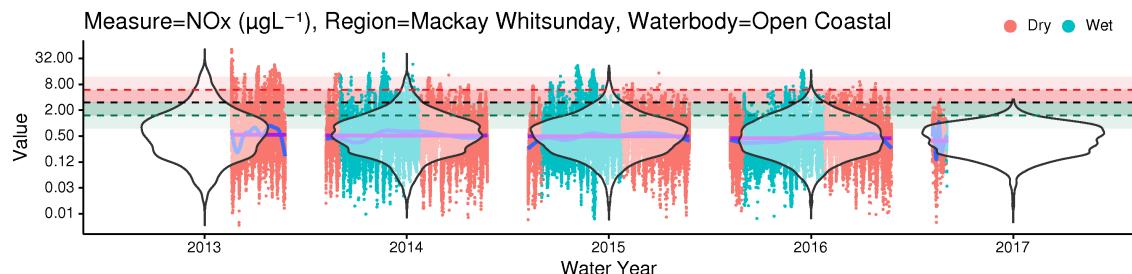
Figure C55: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Mackay Whitsunday Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.14.4 NOx

a) AIMS insitu



d) eReefs



e) eReefs926

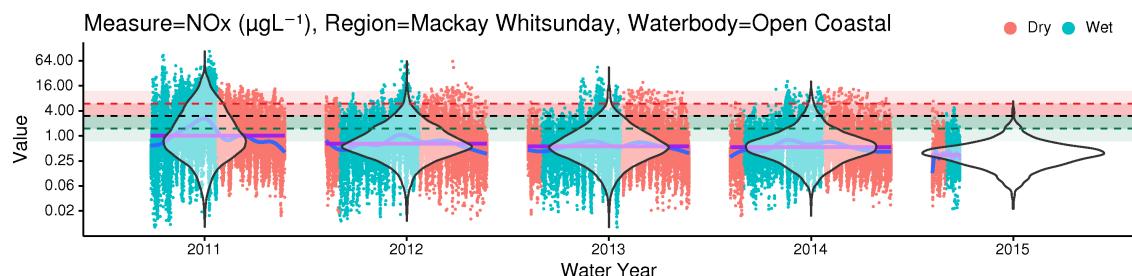
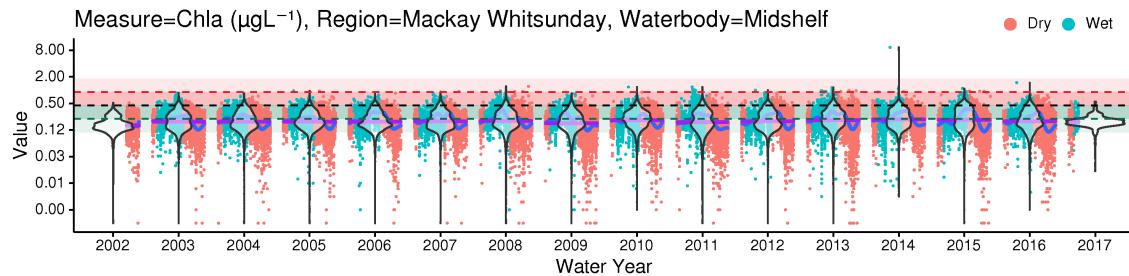


Figure C56: Observed (logarithmic axis with violin plot overlay) NOx data for the Mackay Whitsunday Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

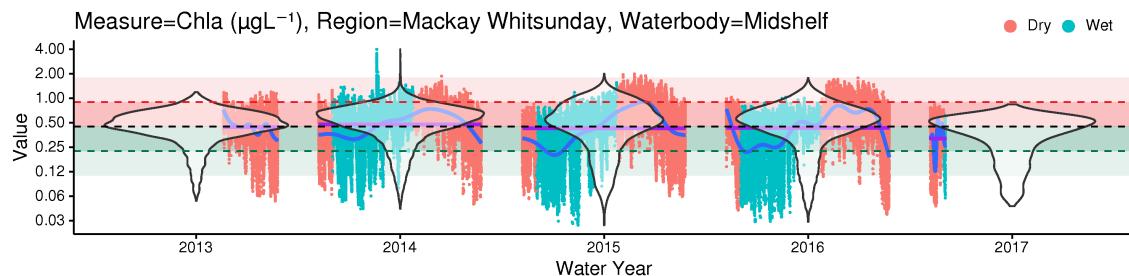
C.I.15 Mackay Whitsunday, Midshelf

C.I.15.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

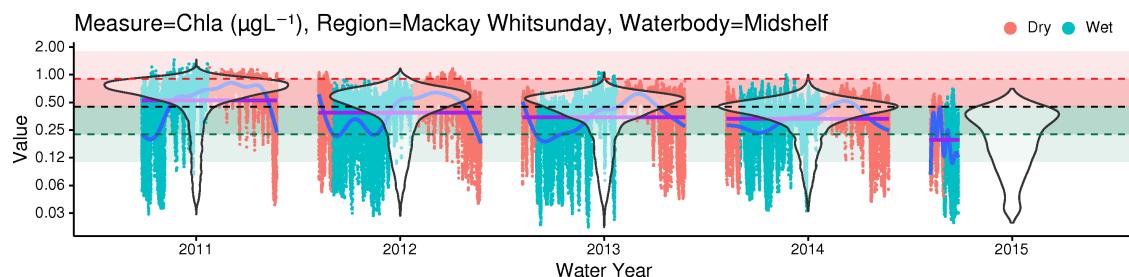
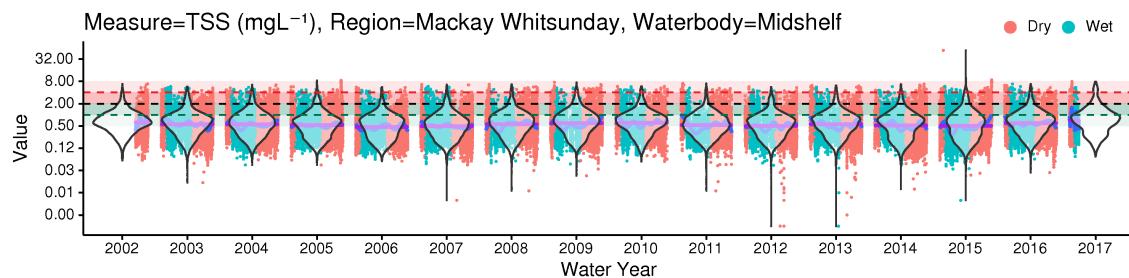


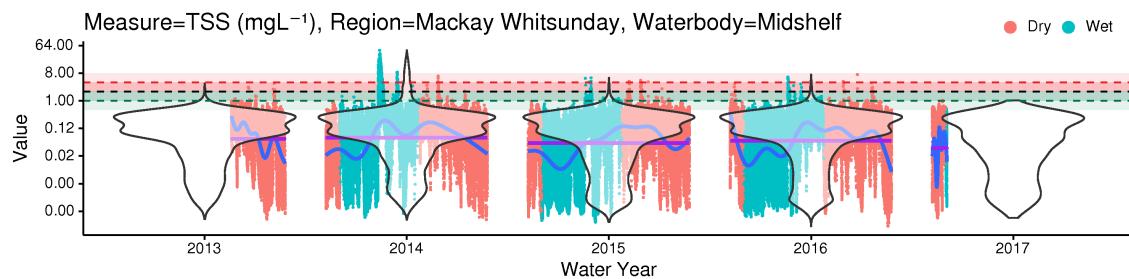
Figure C57: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Mackay Whitsunday Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.15.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

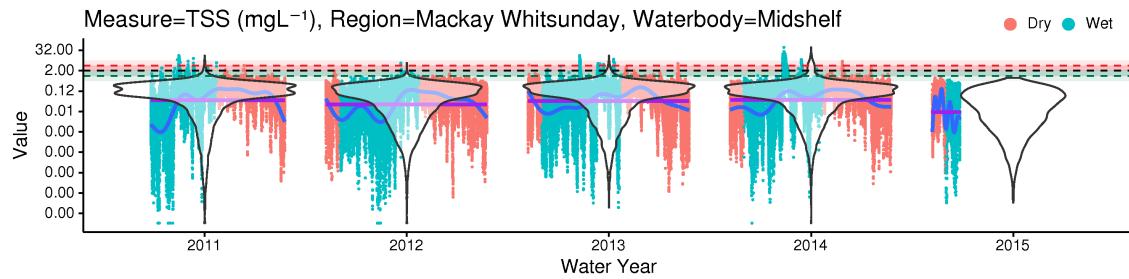
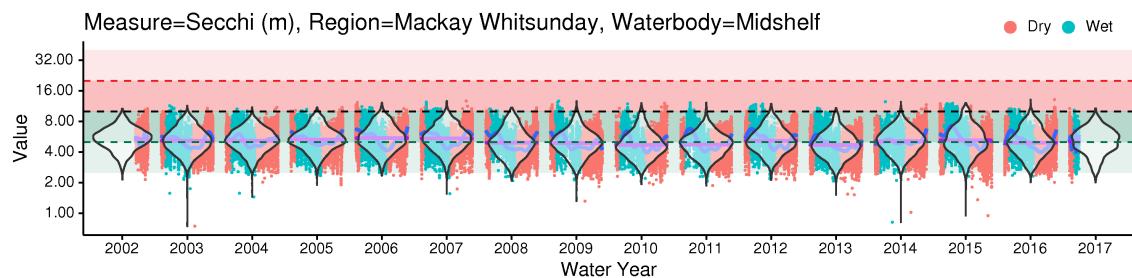


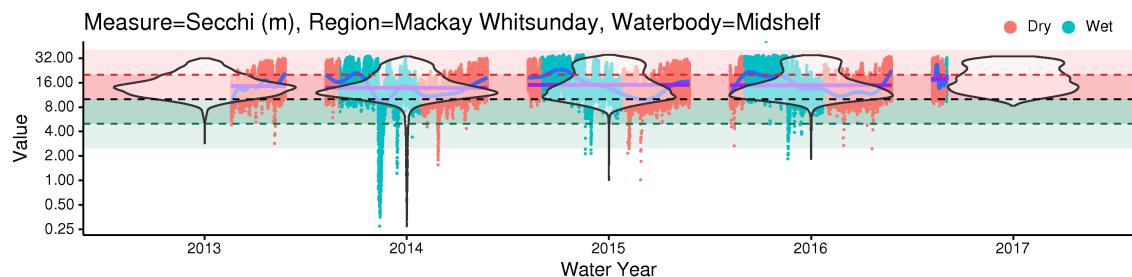
Figure C58: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Mackay Whitsunday Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.15.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

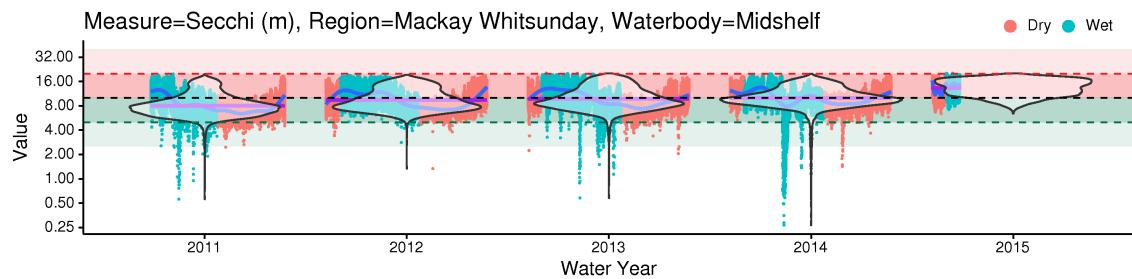
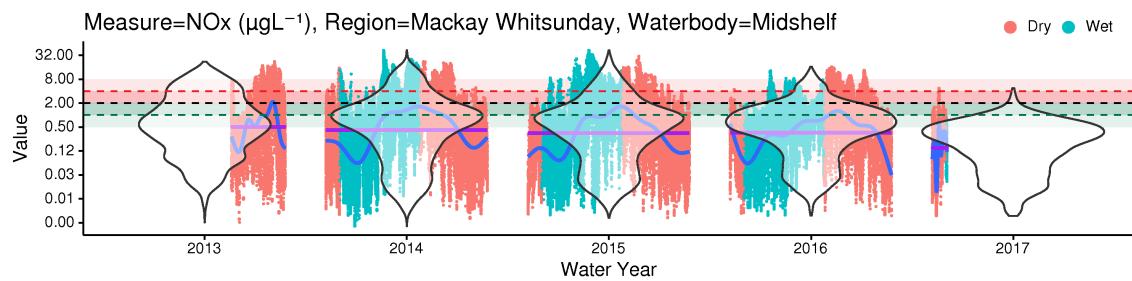


Figure C59: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Mackay Whitsunday Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.15.4 NOx

d) eReefs



e) eReefs926

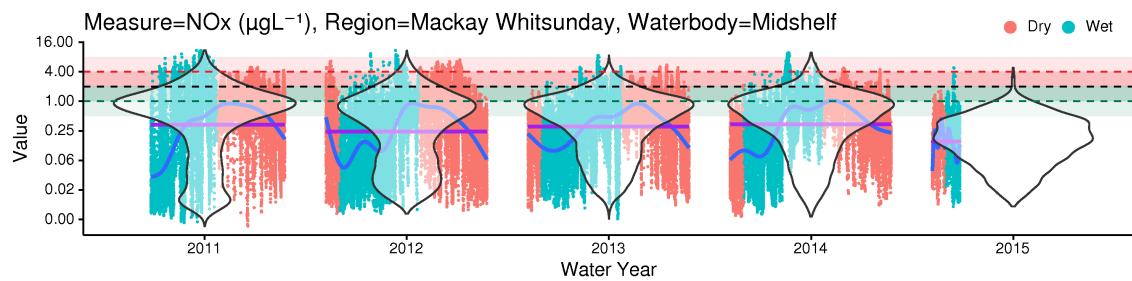
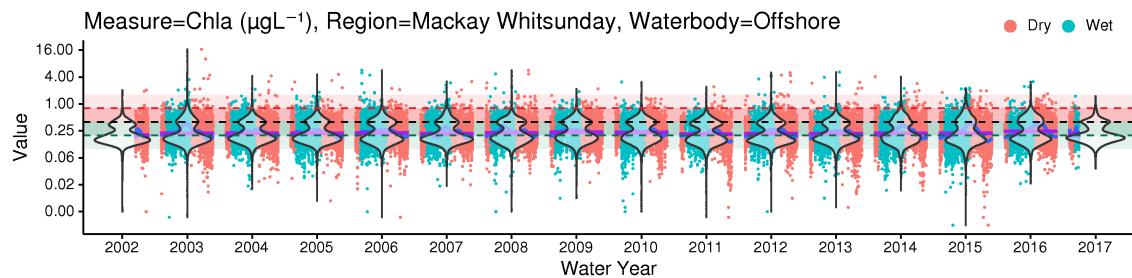


Figure C60: Observed (logarithmic axis with violin plot overlay) NOx data for the Mackay Whitsunday Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

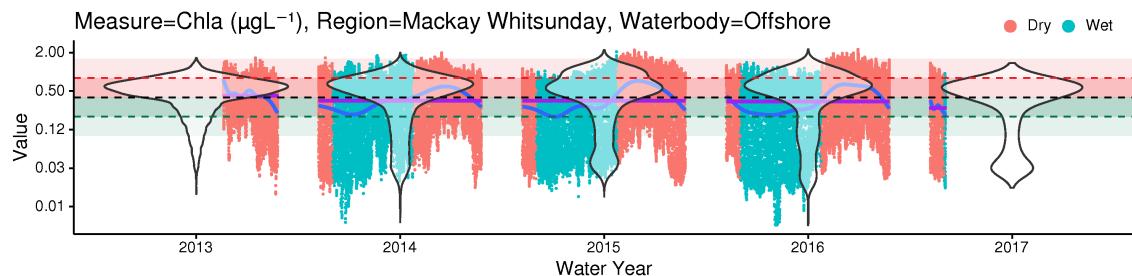
C.I.16 Mackay Whitsunday, Offshore

C.I.16.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

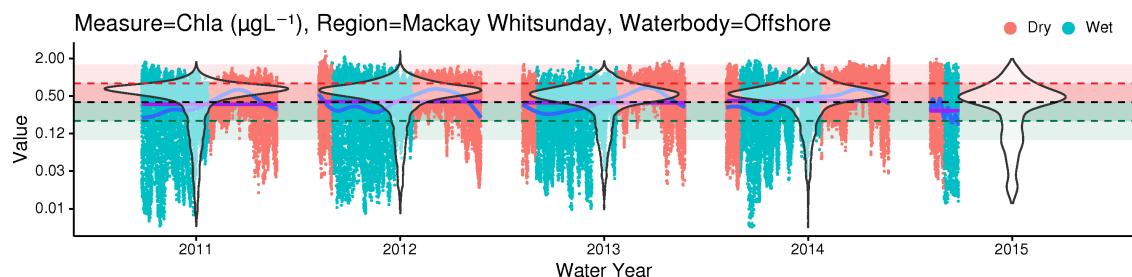
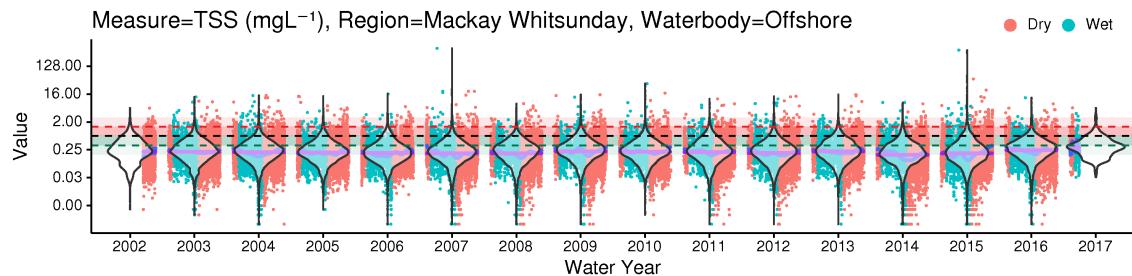


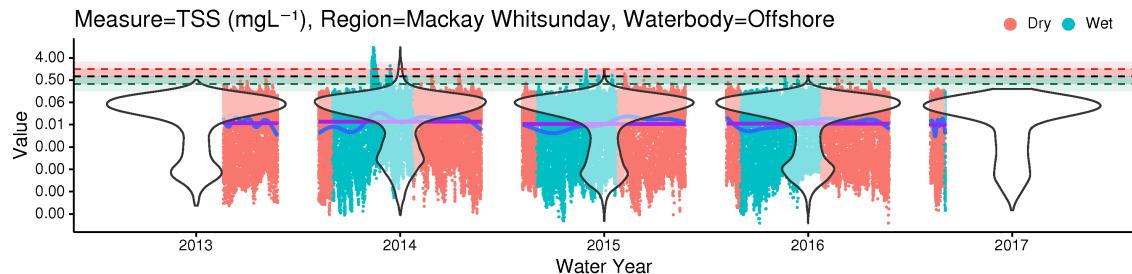
Figure C61: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Mackay Whitsunday Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.16.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

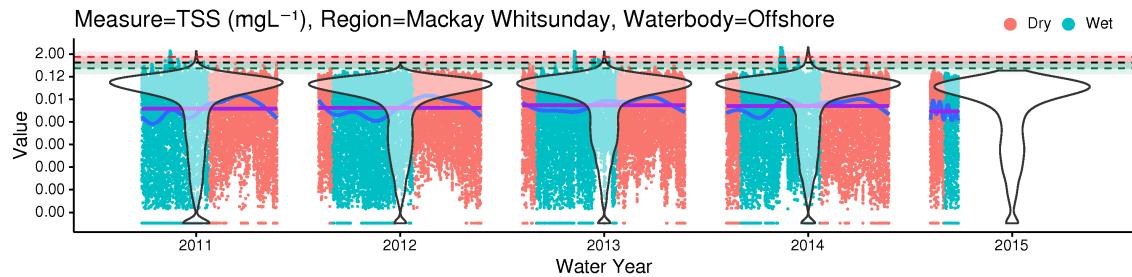
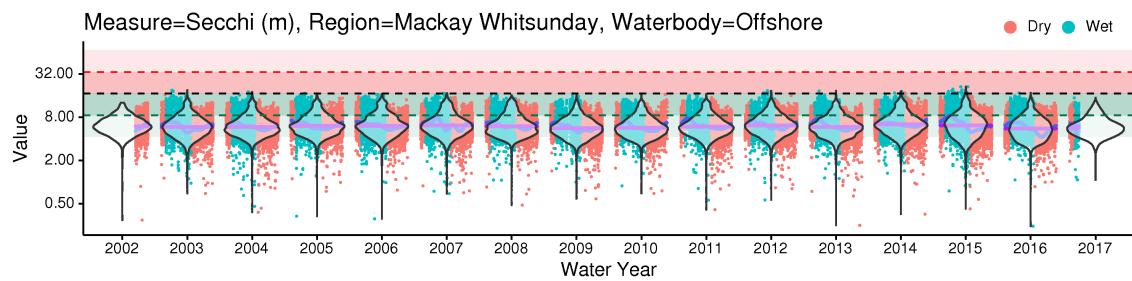


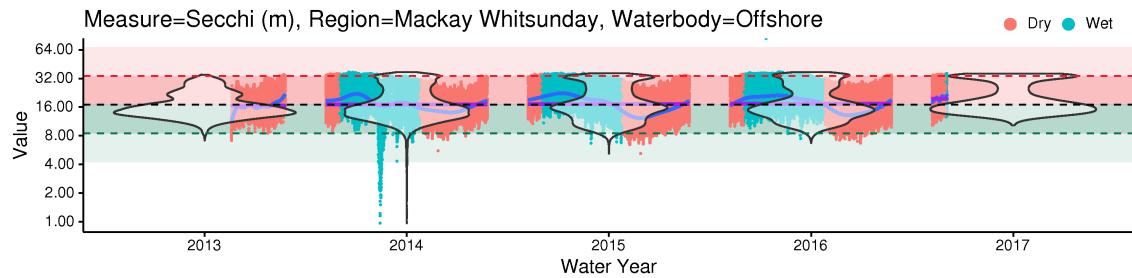
Figure C62: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Mackay Whitsunday Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.16.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

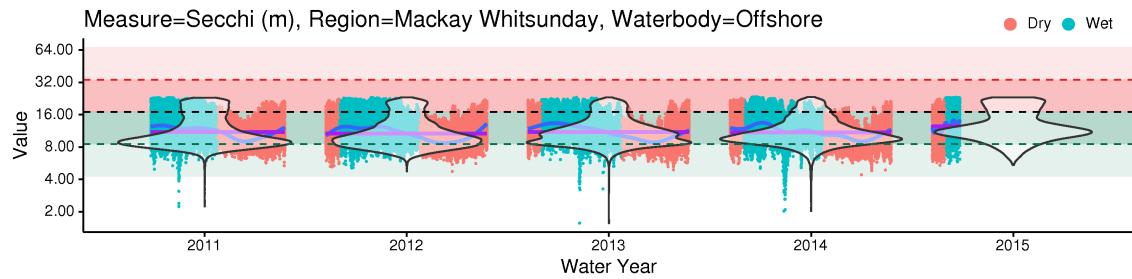
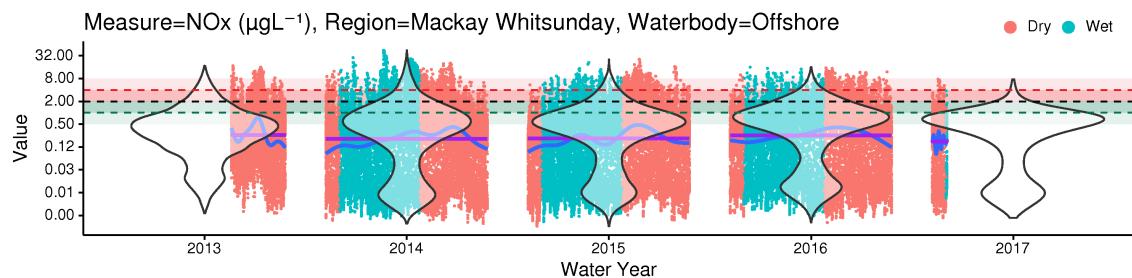


Figure C63: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Mackay Whitsunday Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.16.4 NOx

d) eReefs



e) eReefs926

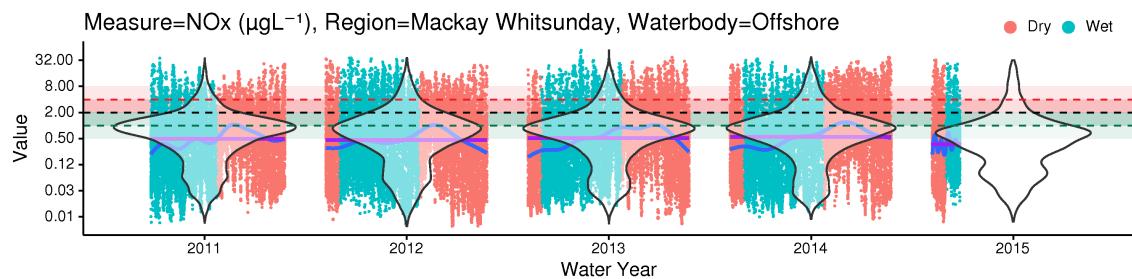
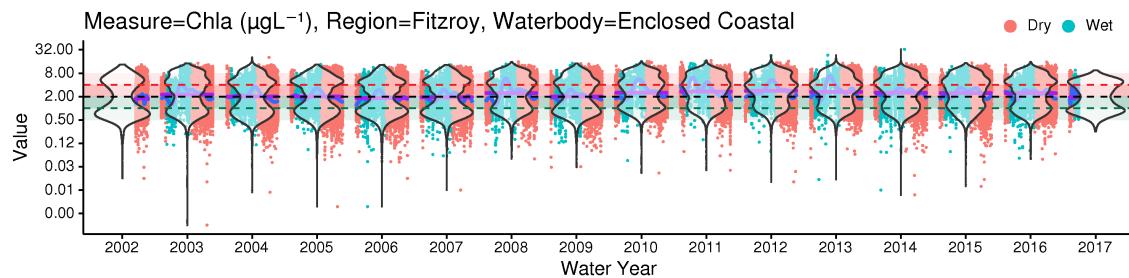


Figure C64: Observed (logarithmic axis with violin plot overlay) NOx data for the Mackay Whitsunday Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

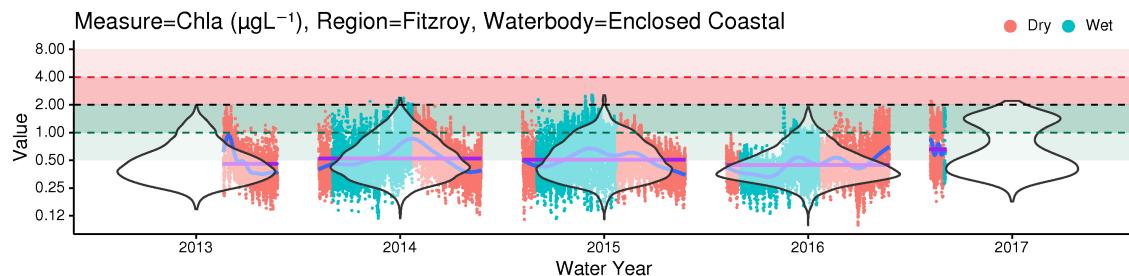
C.I.17 Fitzroy, Enclosed Coastal

C.I.17.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

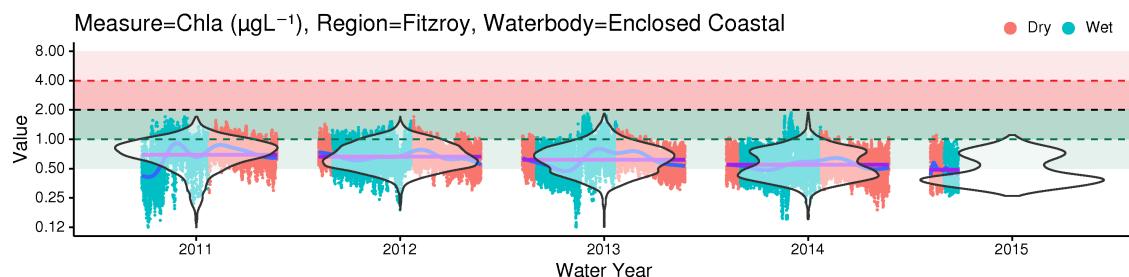
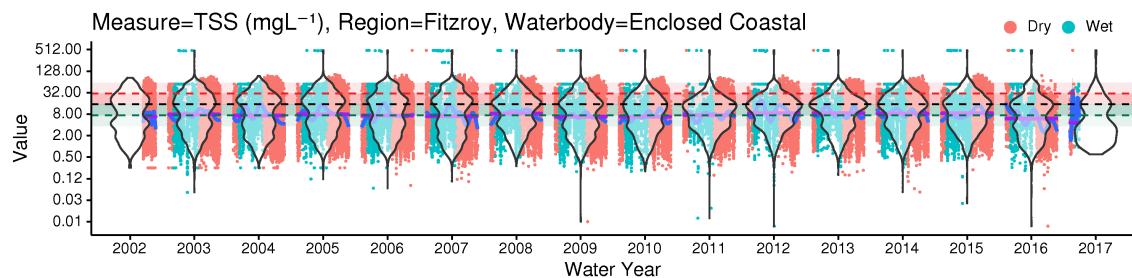


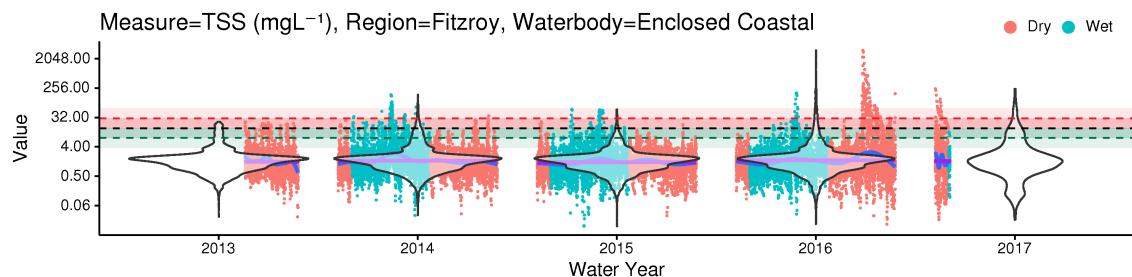
Figure C65: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Fitzroy Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.17.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

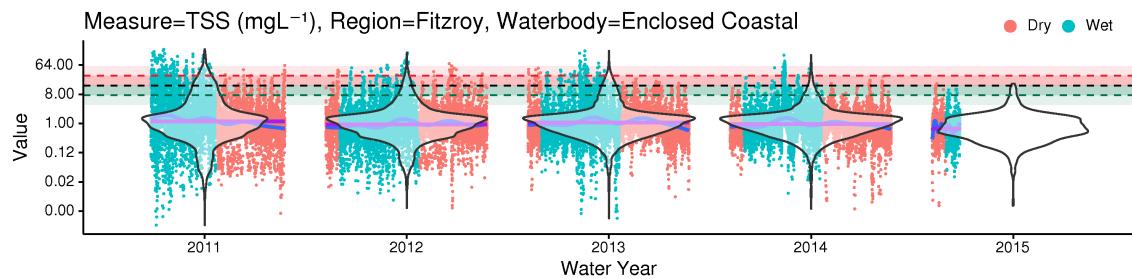
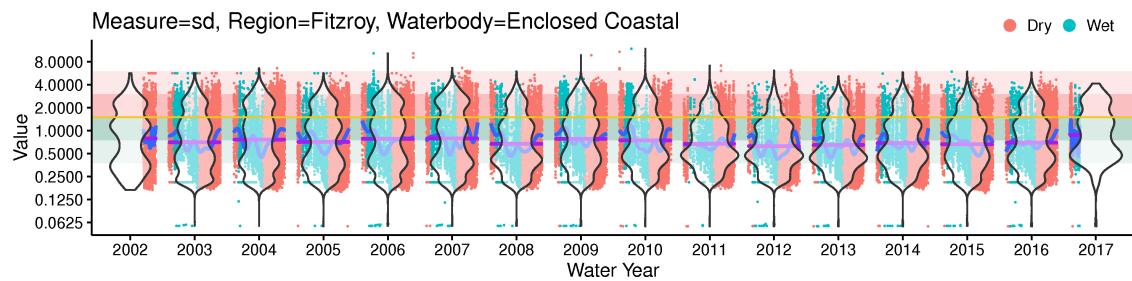


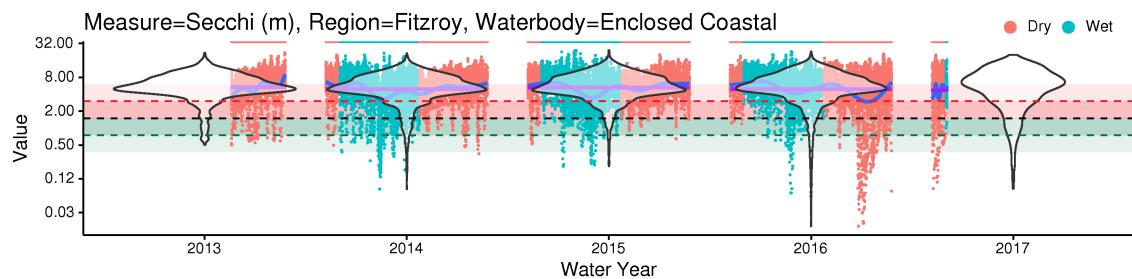
Figure C66: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Fitzroy Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.17.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

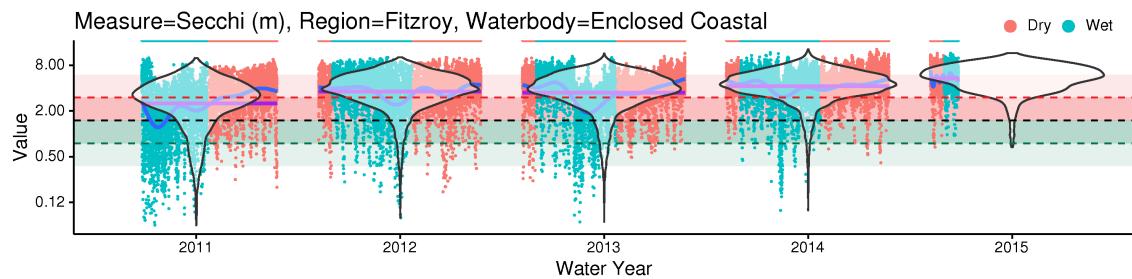
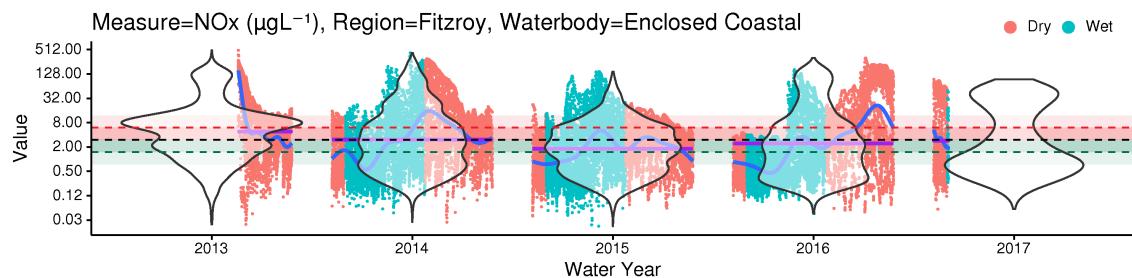


Figure C67: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Fitzroy Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.17.4 NOx

d) eReefs



e) eReefs926

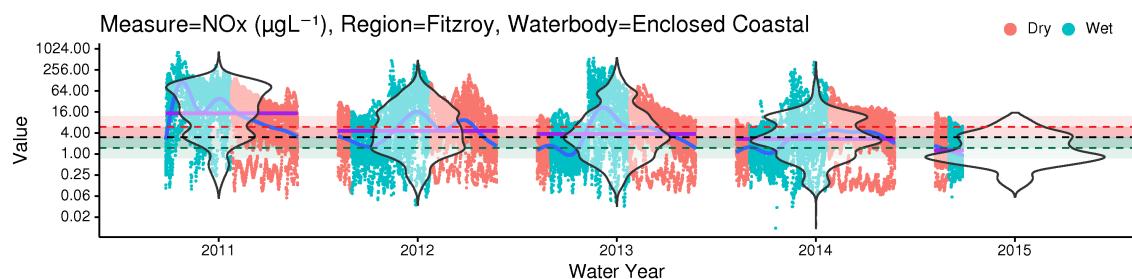
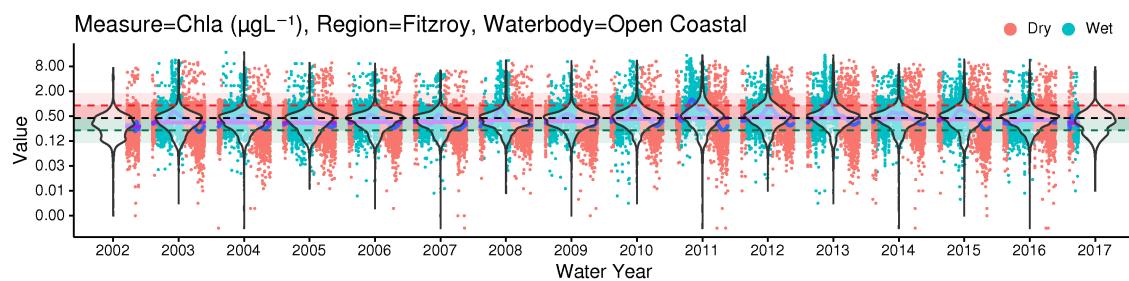


Figure C68: Observed (logarithmic axis with violin plot overlay) NOx data for the Fitzroy Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

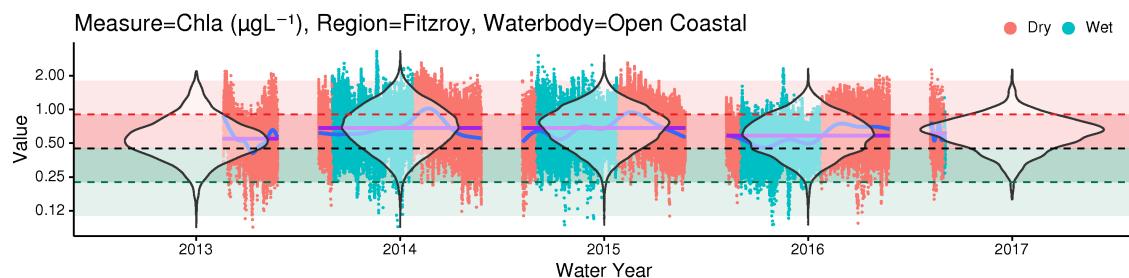
C.I.18 Fitzroy, Open Coastal

C.I.18.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

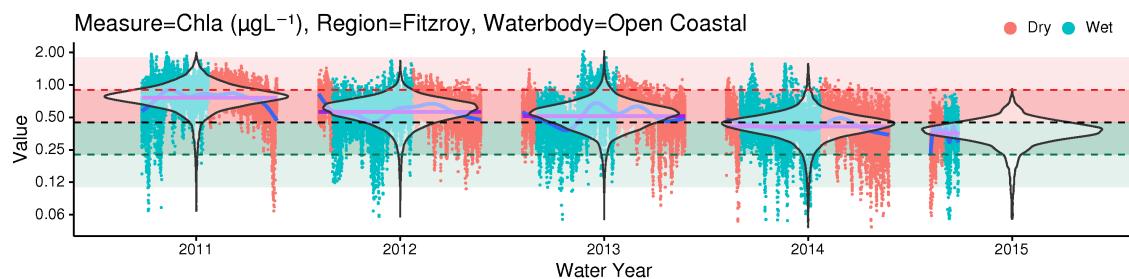
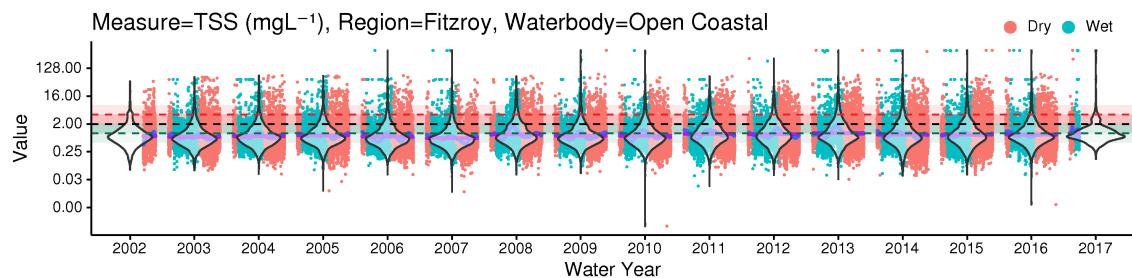


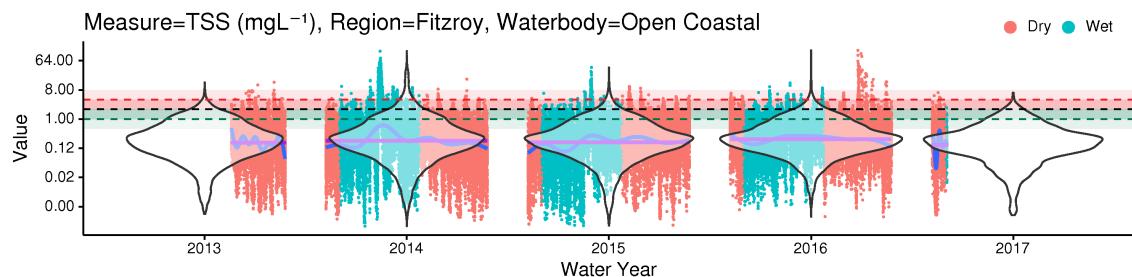
Figure C69: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Fitzroy Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.18.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

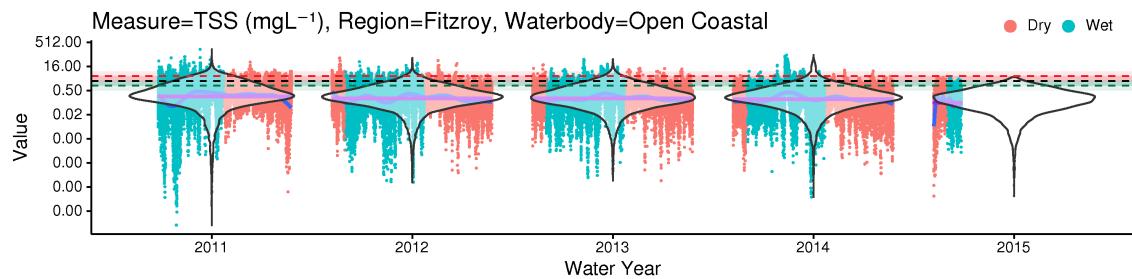
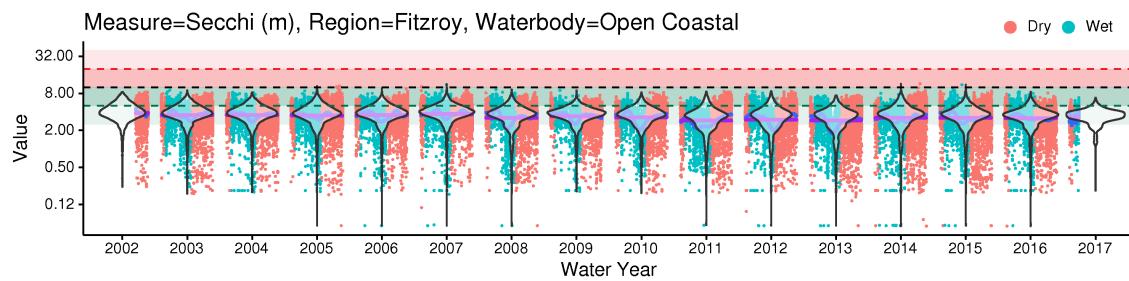


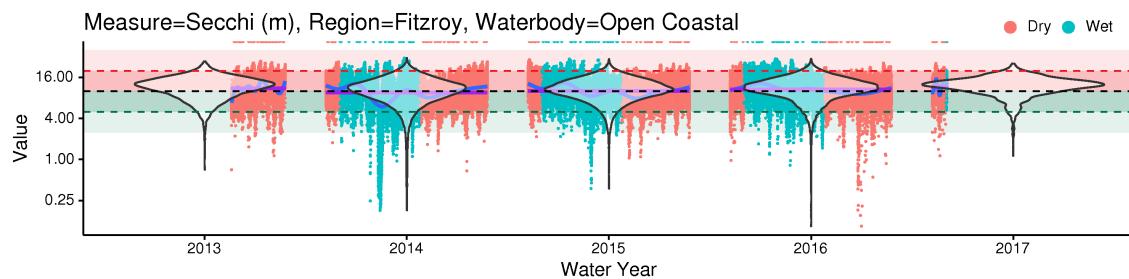
Figure C70: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Fitzroy Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.18.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

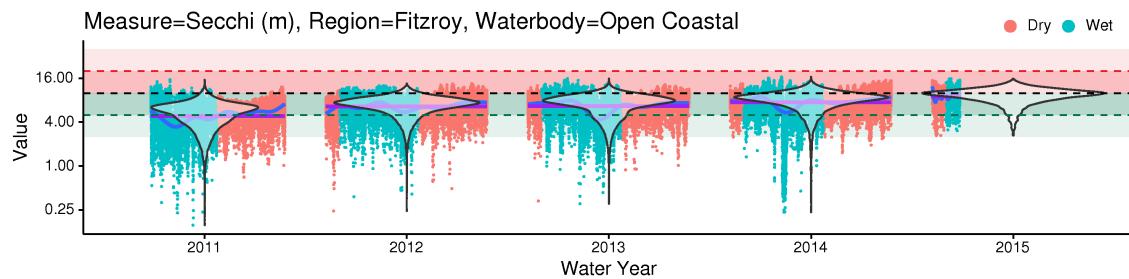
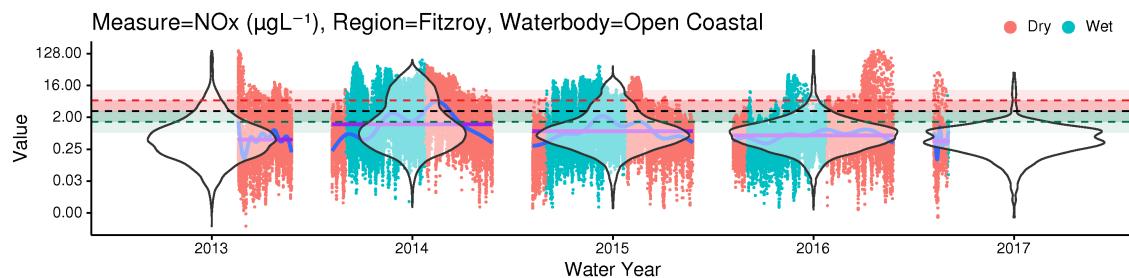


Figure C7I: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Fitzroy Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.18.4 NOx

d) eReefs



e) eReefs926

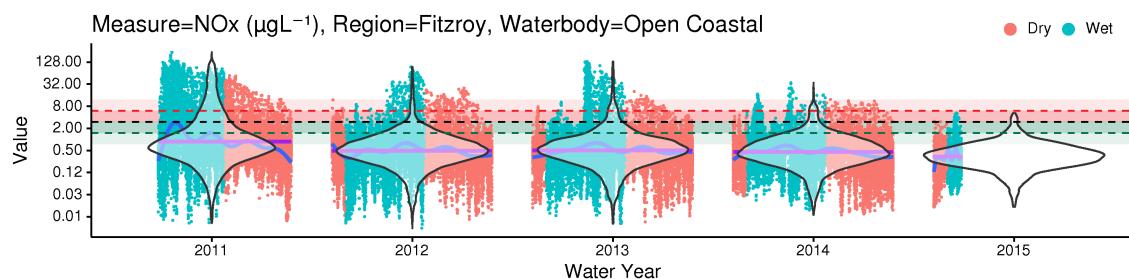


Figure C72: Observed (logarithmic axis with violin plot overlay) NOx data for the Fitzroy Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

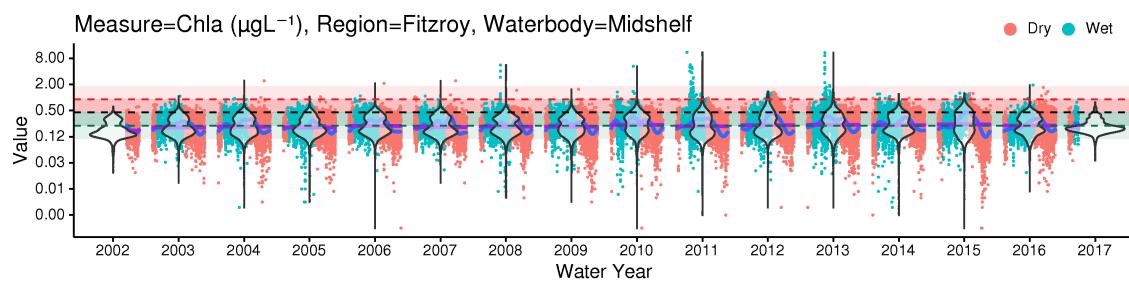
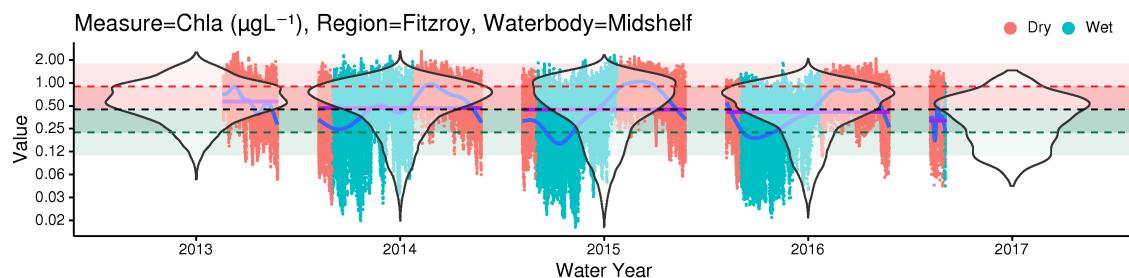
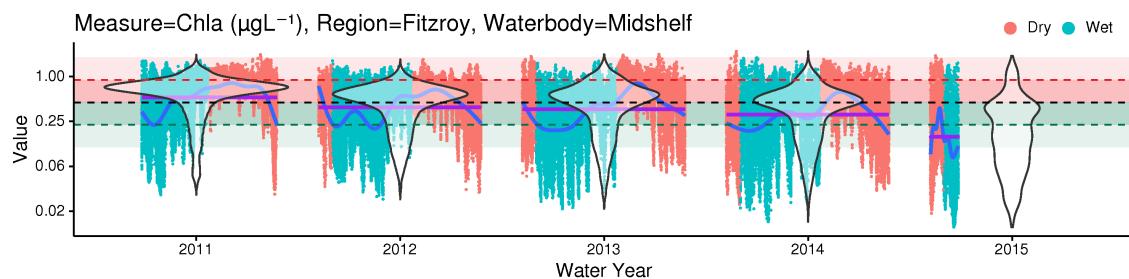
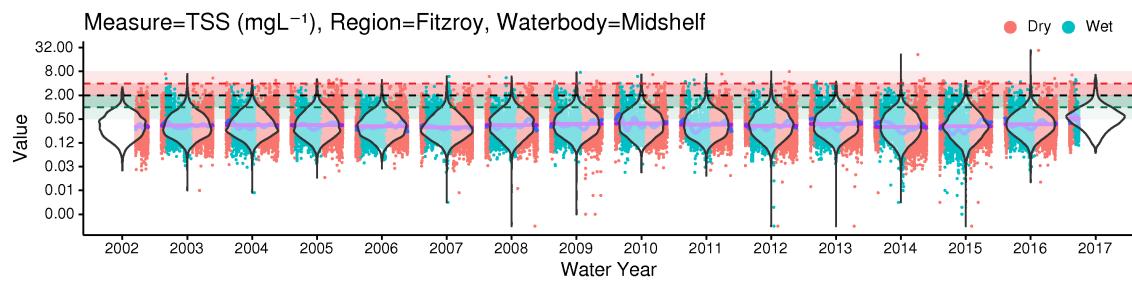
C.I.19 Fitzroy, Midshelf**C.I.19.1 Chlorophyll****c) Satellite****d) eReefs****e) eReefs926**

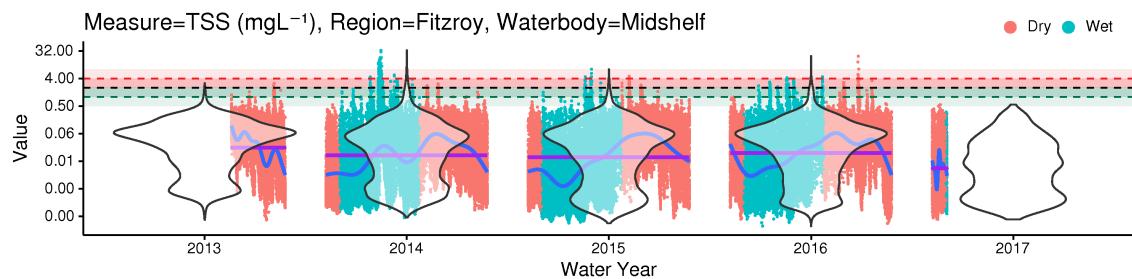
Figure C73: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Fitzroy Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.19.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

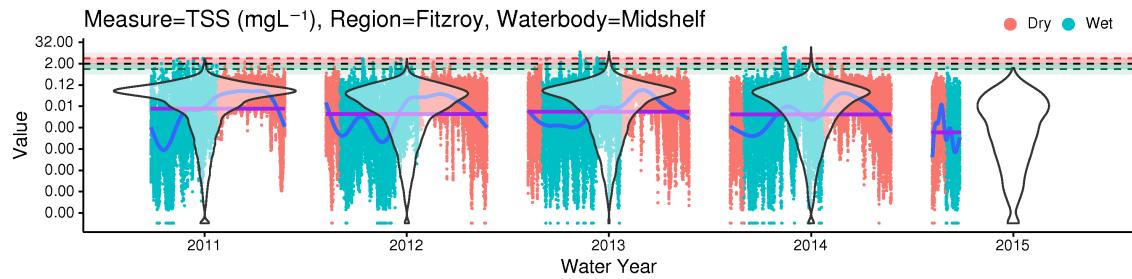
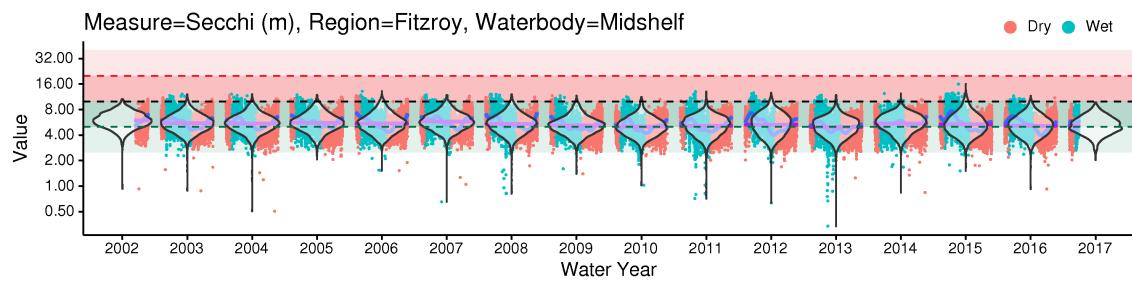


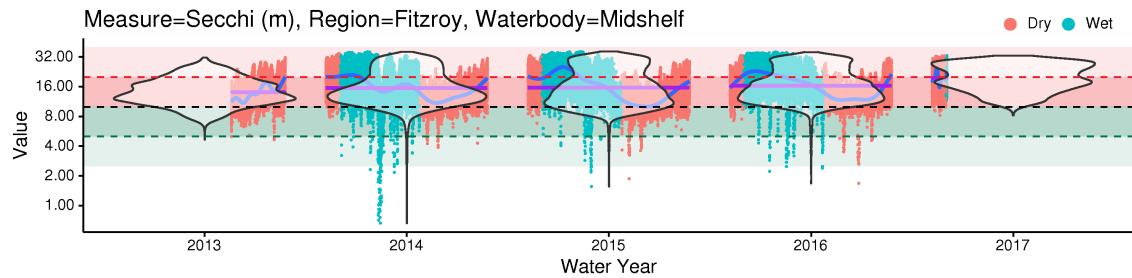
Figure C74: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Fitzroy Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.19.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

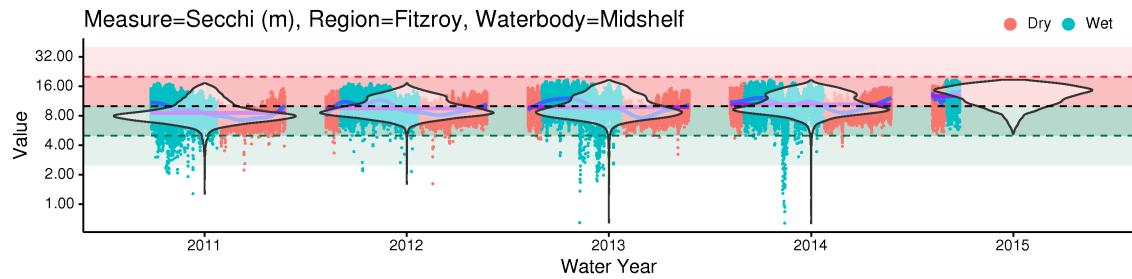
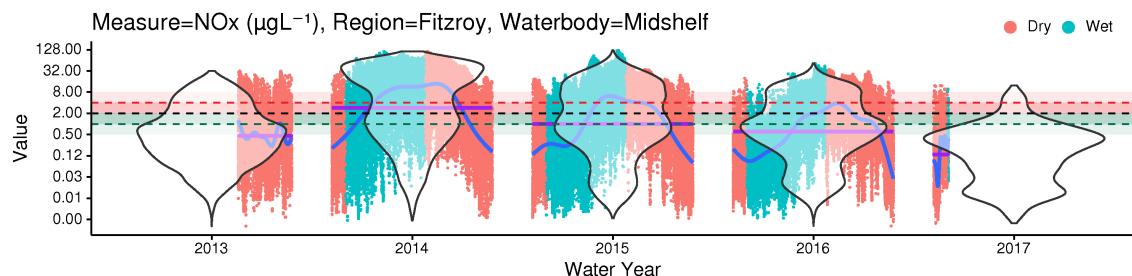


Figure C75: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Fitzroy Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.19.4 NOx

d) eReefs



e) eReefs926

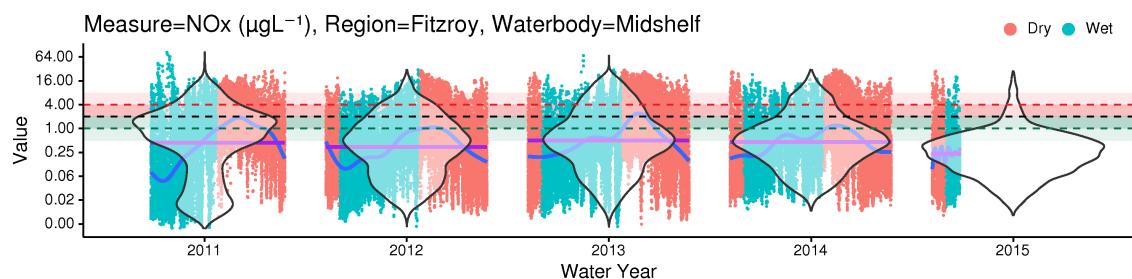
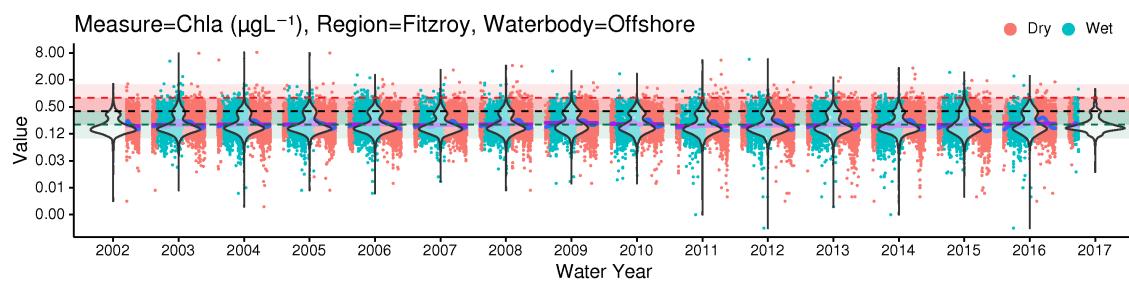


Figure C76: Observed (logarithmic axis with violin plot overlay) NOx data for the Fitzroy Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

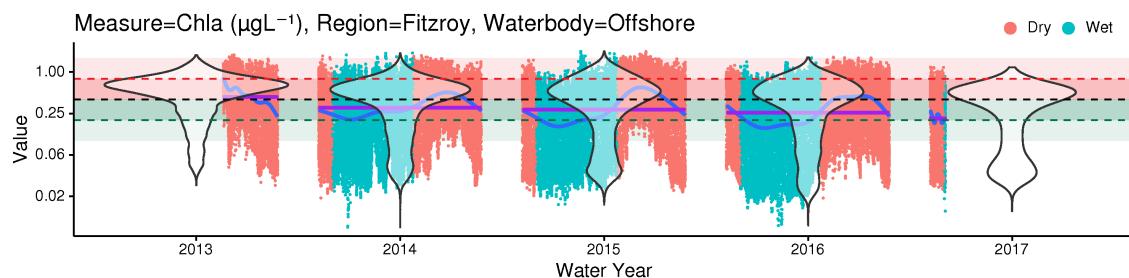
C.I.20 Fitzroy, Offshore

C.I.20.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

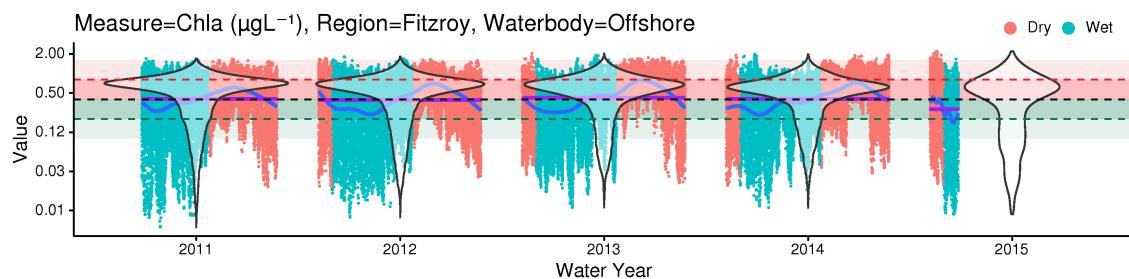
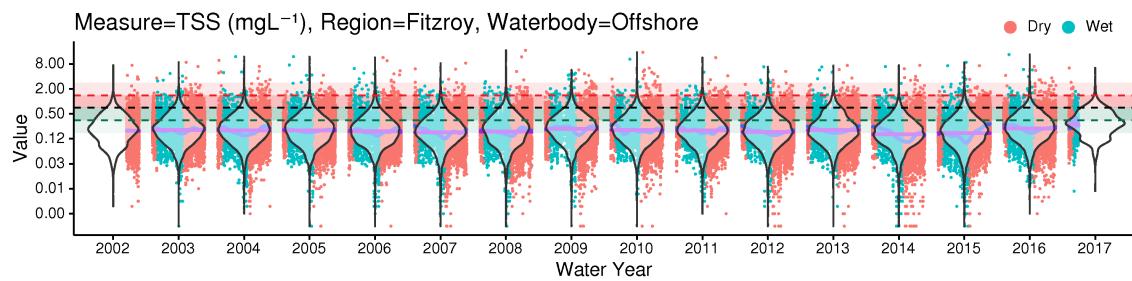


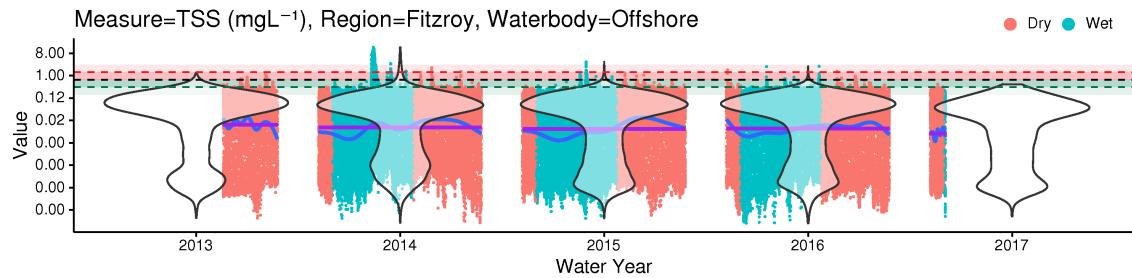
Figure C77: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Fitzroy Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.20.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

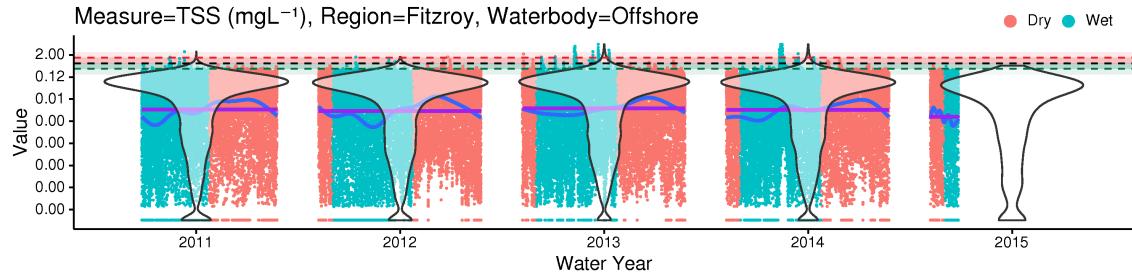
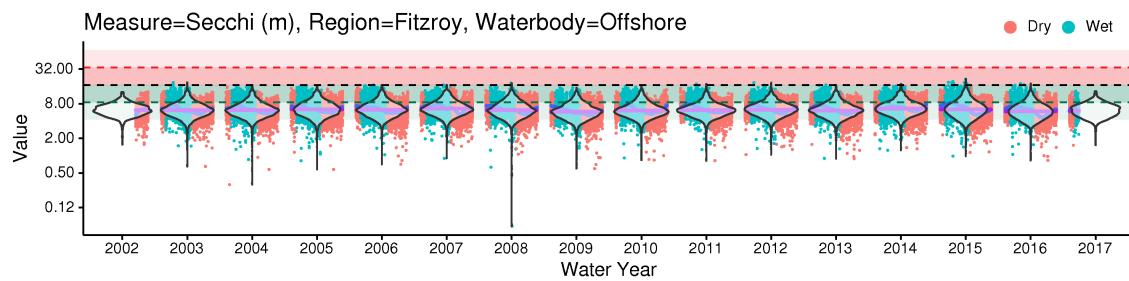


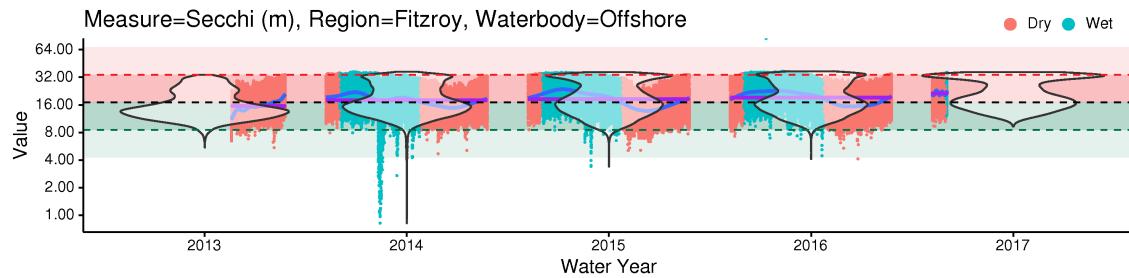
Figure C78: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Fitzroy Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.20.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

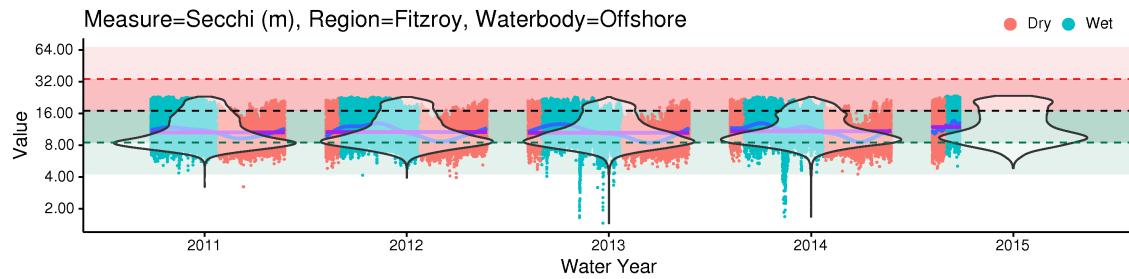
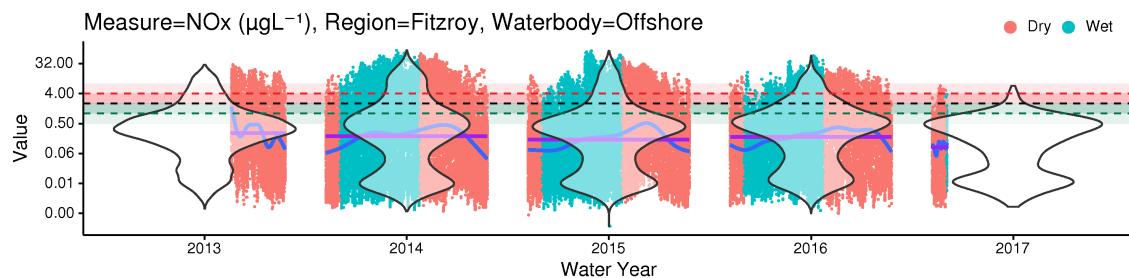


Figure C79: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Fitzroy Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.20.4 NOx

d) eReefs



e) eReefs926

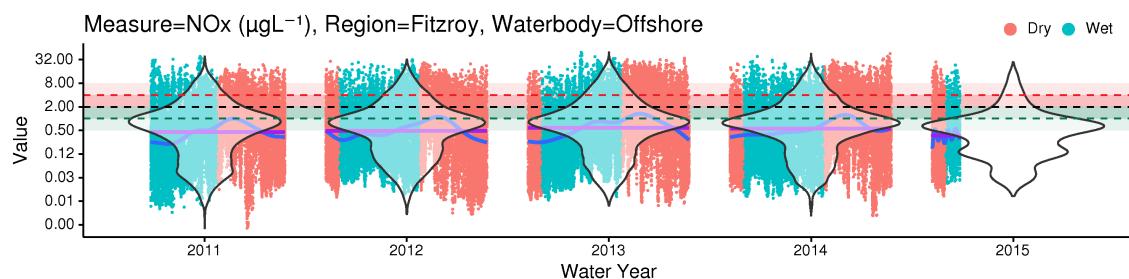
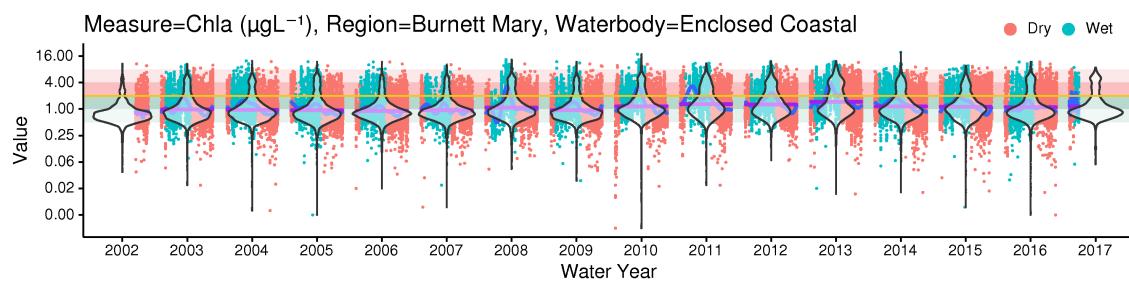


Figure C80: Observed (logarithmic axis with violin plot overlay) NOx data for the Fitzroy Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

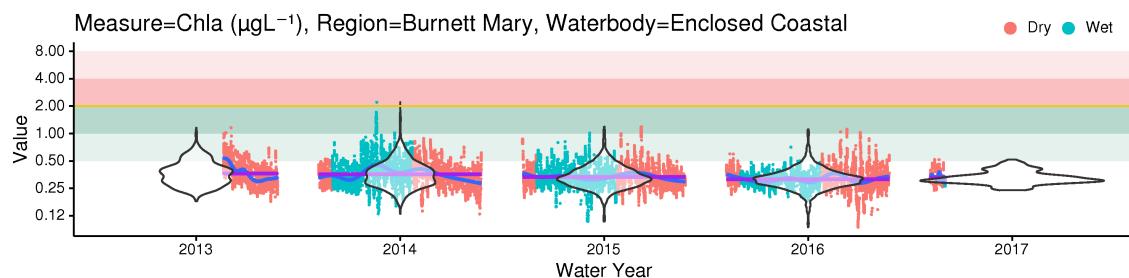
C.I.21 Burnett Mary, Enclosed Coastal

C.I.21.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

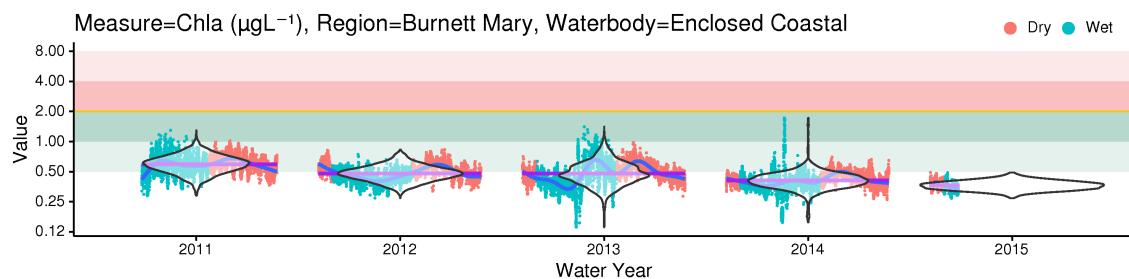
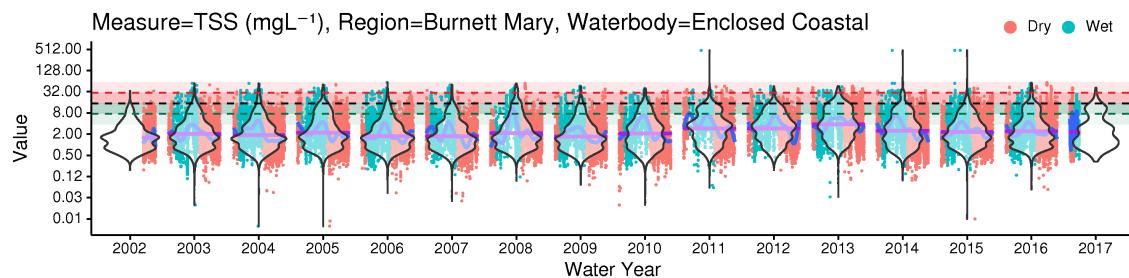


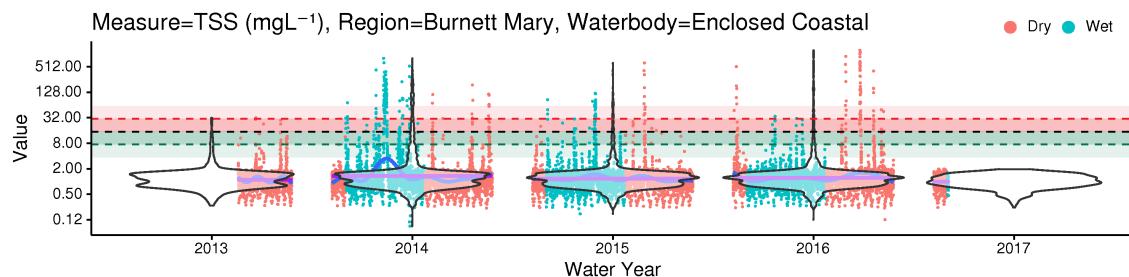
Figure C8I: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Burnett Mary Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.2I.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

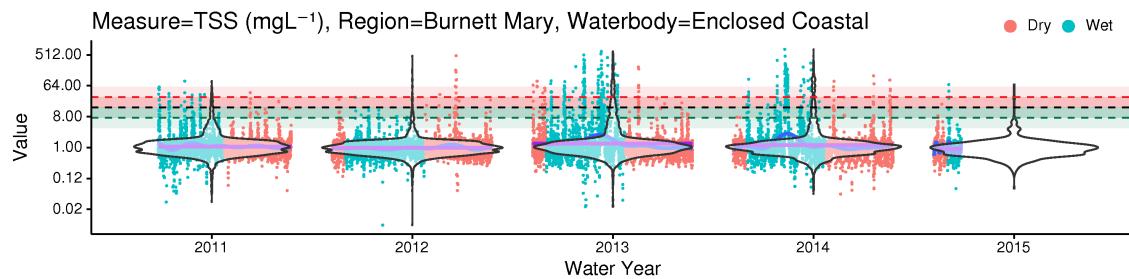
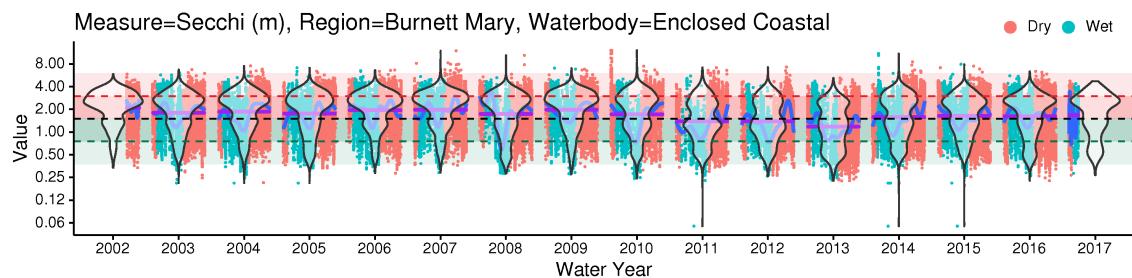


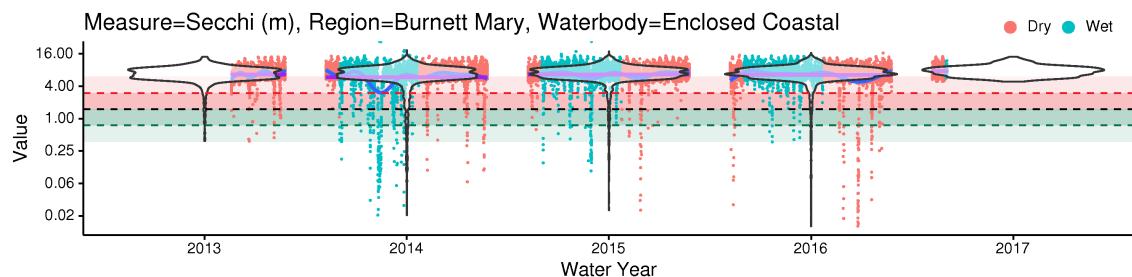
Figure C82: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Burnett Mary Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.21.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

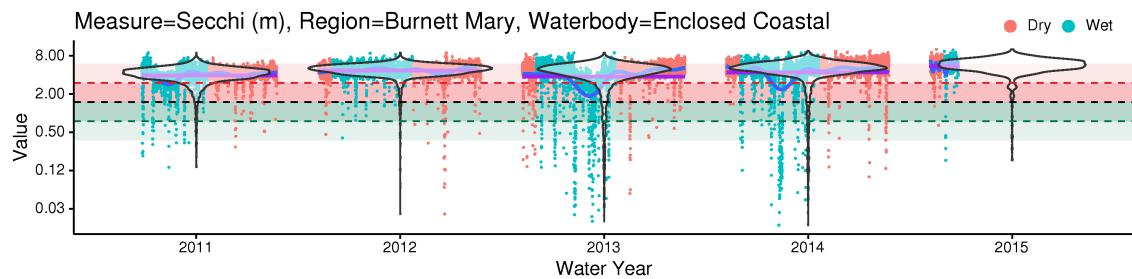
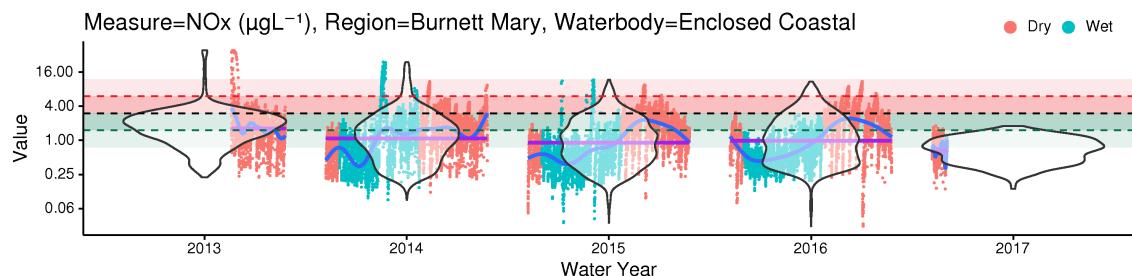


Figure C83: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Burnett Mary Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.2I.4 NOx

d) eReefs



e) eReefs926

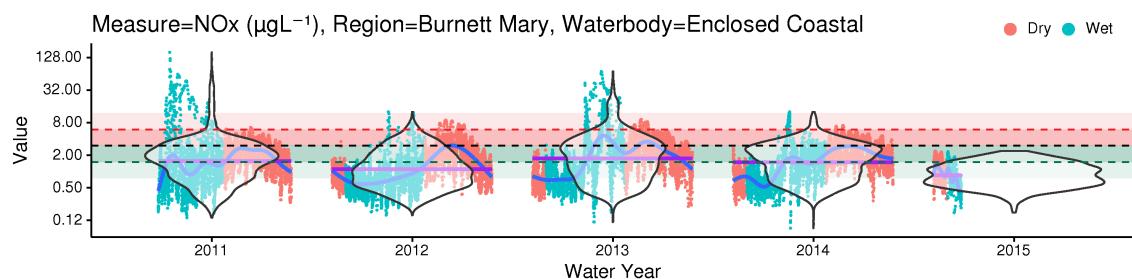
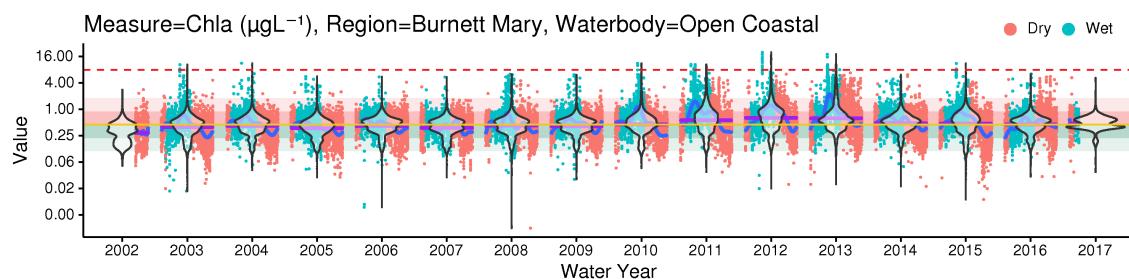


Figure C84: Observed (logarithmic axis with violin plot overlay) NOx data for the Burnett Mary Enclosed Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

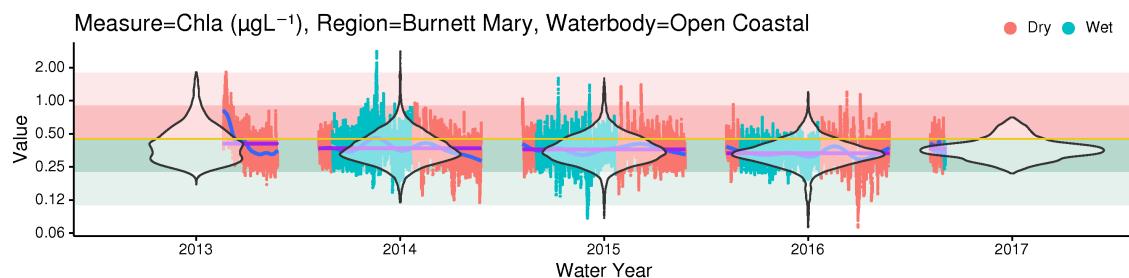
C.I.22 Burnett Mary, Open Coastal

C.I.22.1 Chlorophyll

c) Satellite



d) eReefs



e) eReefs926

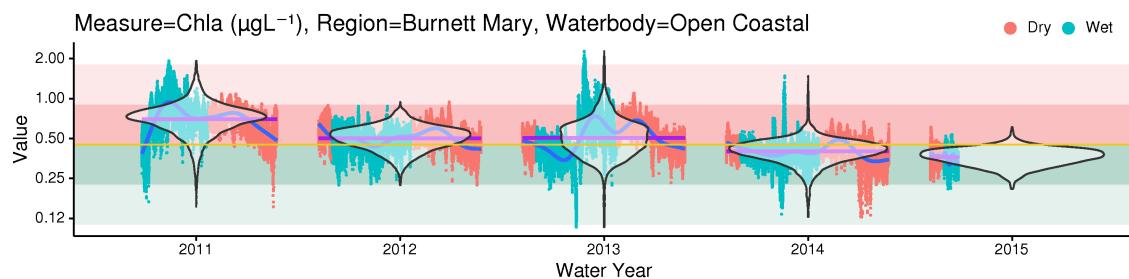
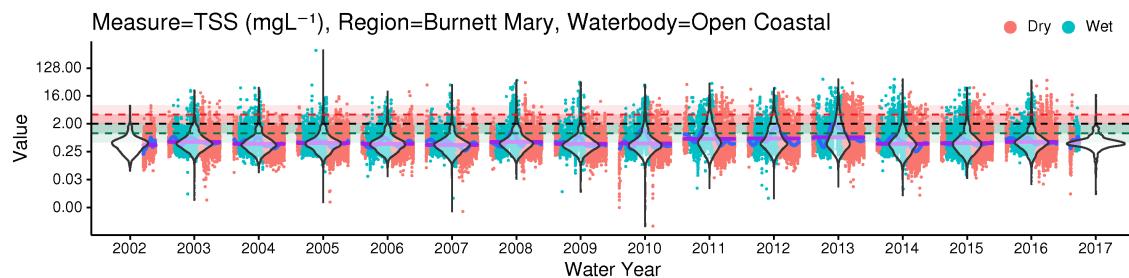


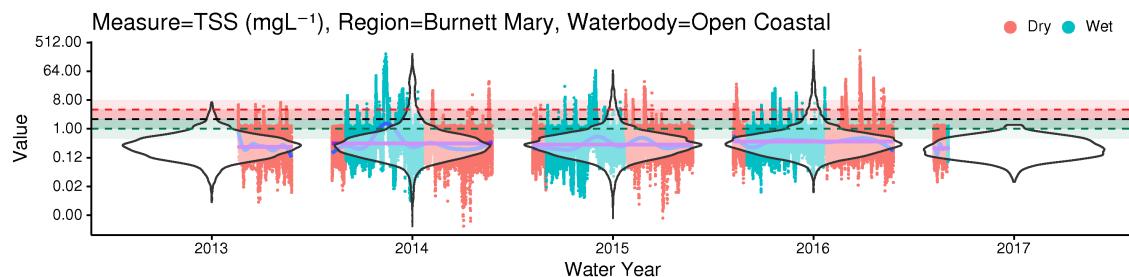
Figure C85: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Burnett Mary Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.22.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

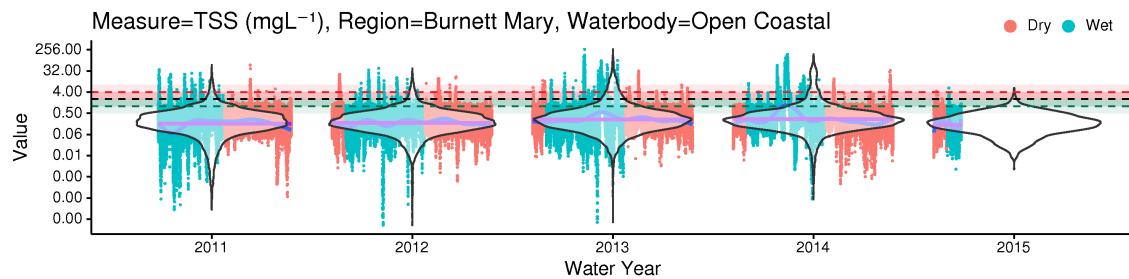
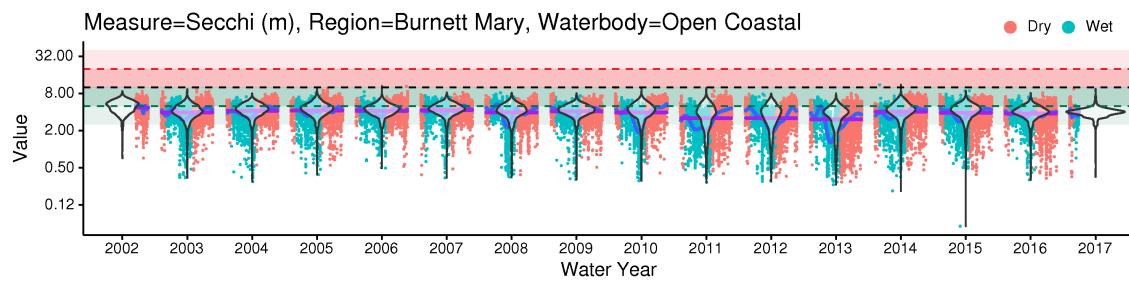


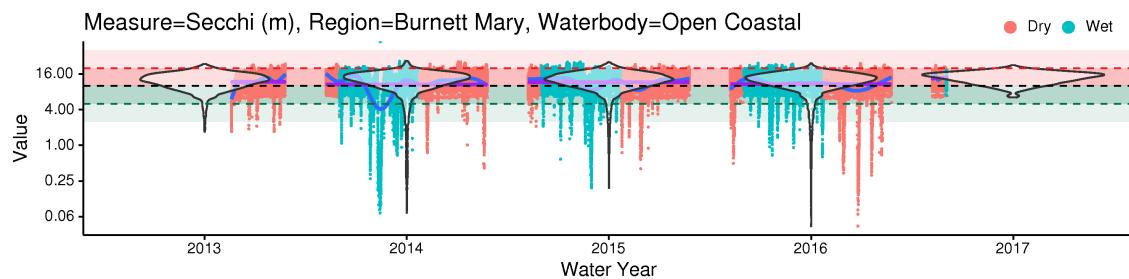
Figure C86: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Burnett Mary Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.22.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

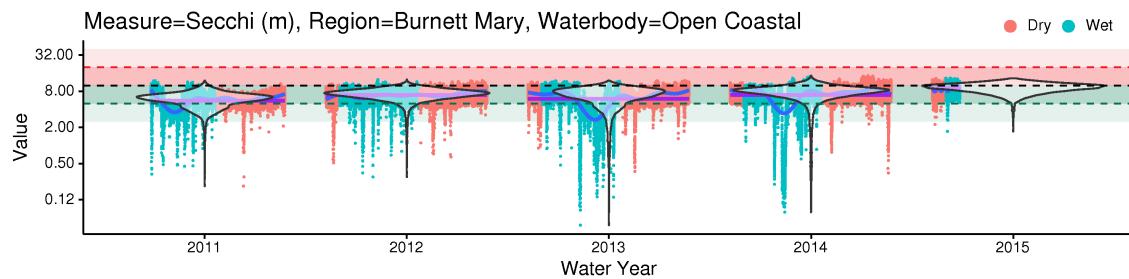
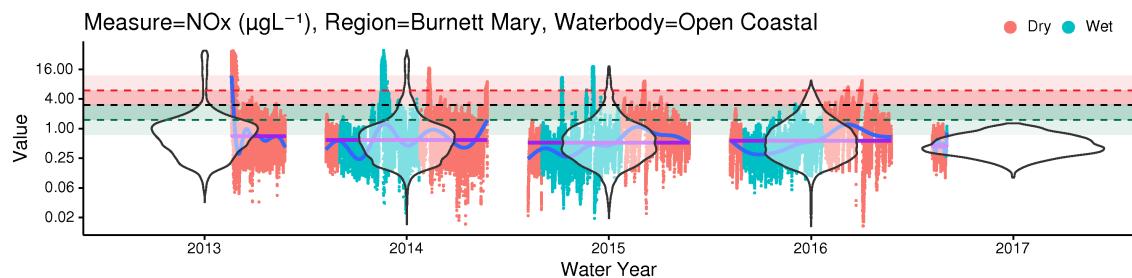


Figure C87: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Burnett Mary Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.22.4 NOx

d) eReefs



e) eReefs926

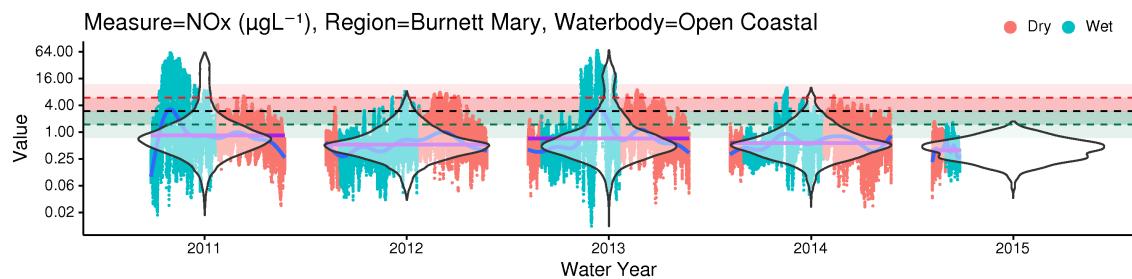
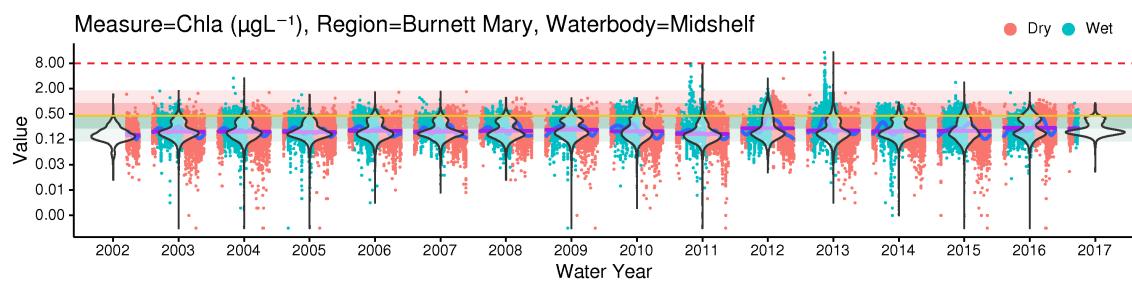


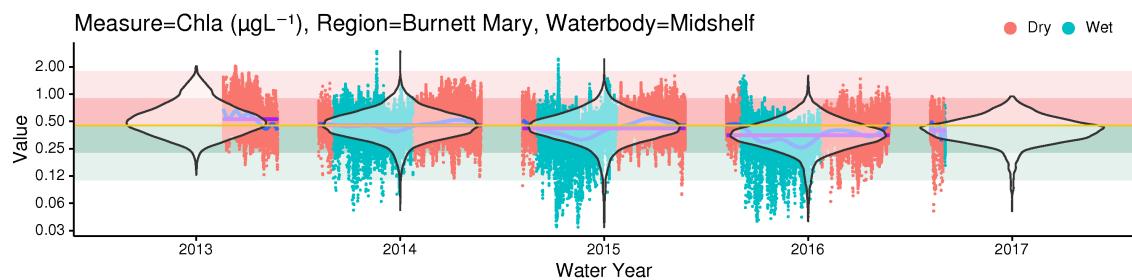
Figure C88: Observed (logarithmic axis with violin plot overlay) NOx data for the Burnett Mary Open Coastal Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.23 Burnett Mary, Midshelf*C.I.23.1 Chlorophyll*

c) Satellite



d) eReefs



e) eReefs926

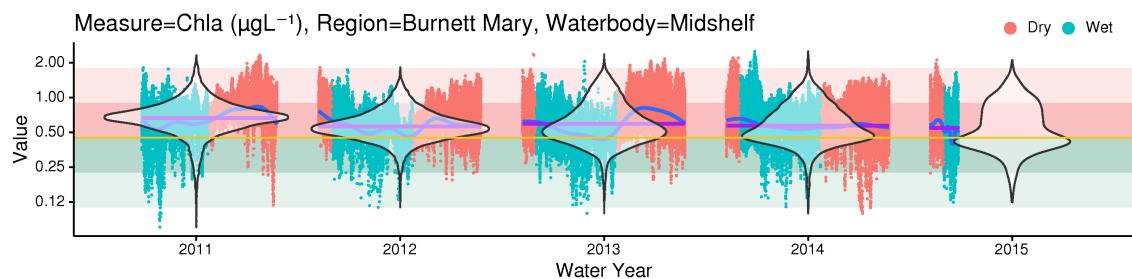
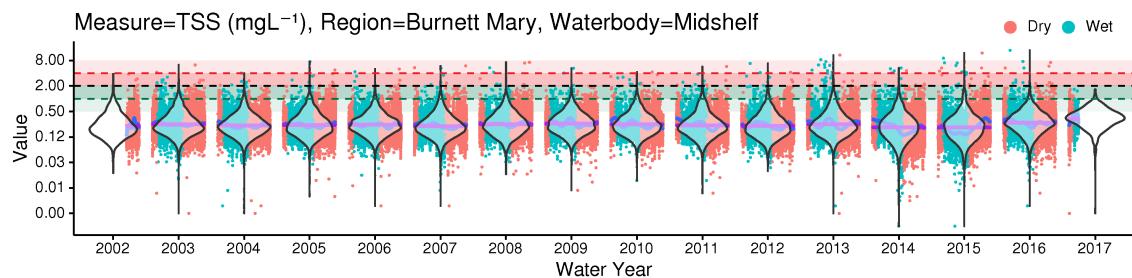


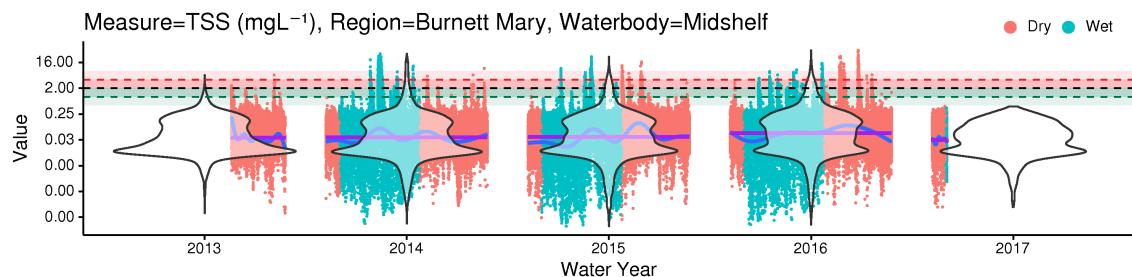
Figure C89: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Burnett Mary Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.23.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

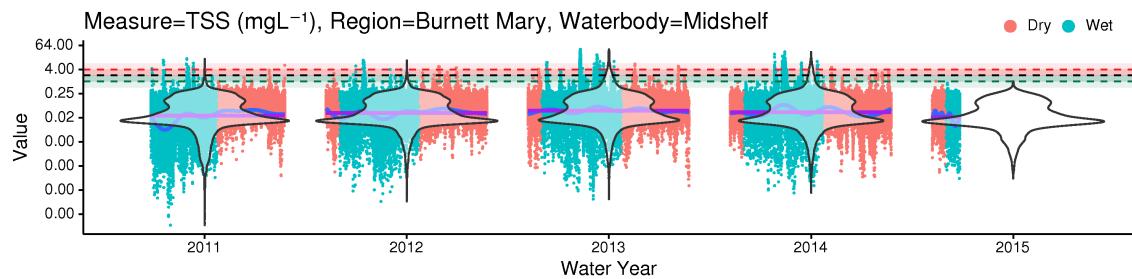
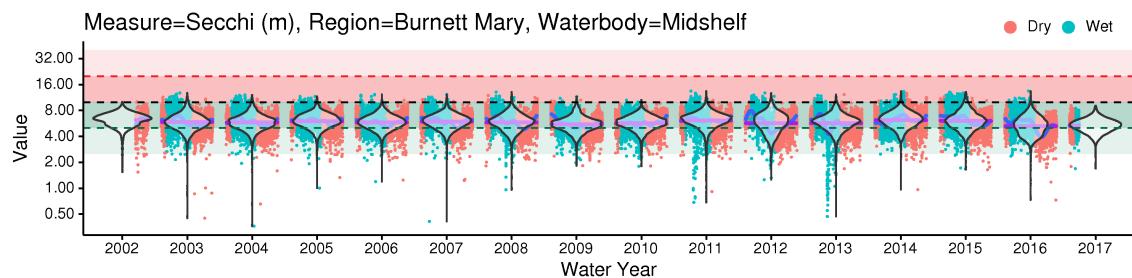


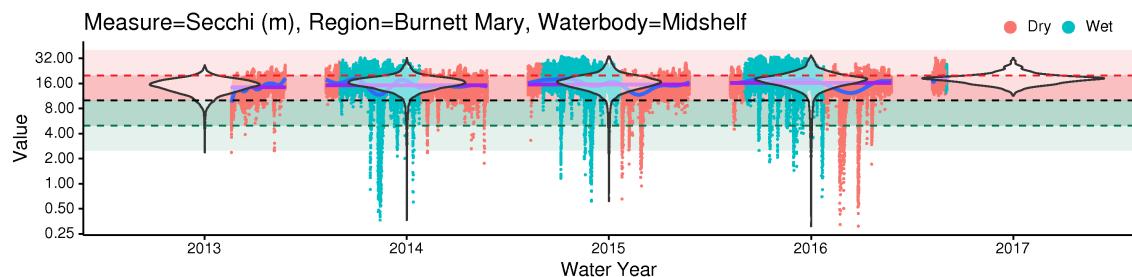
Figure C90: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Burnett Mary Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.23.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

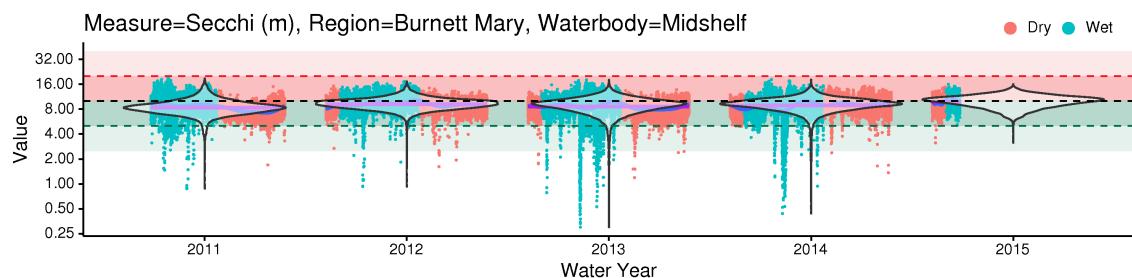
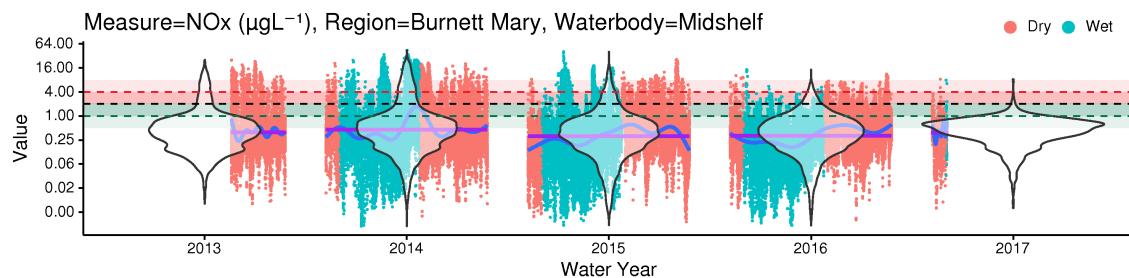


Figure C9I: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Burnett Mary Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.23.4 NOx

d) eReefs



e) eReefs926

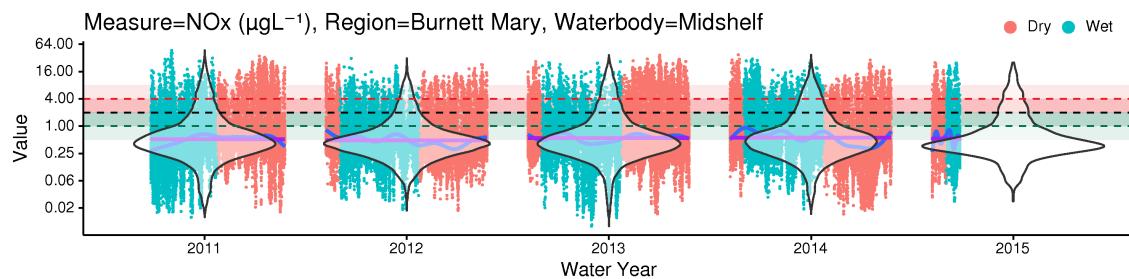


Figure C92: Observed (logarithmic axis with violin plot overlay) NOx data for the Burnett Mary Midshelf Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

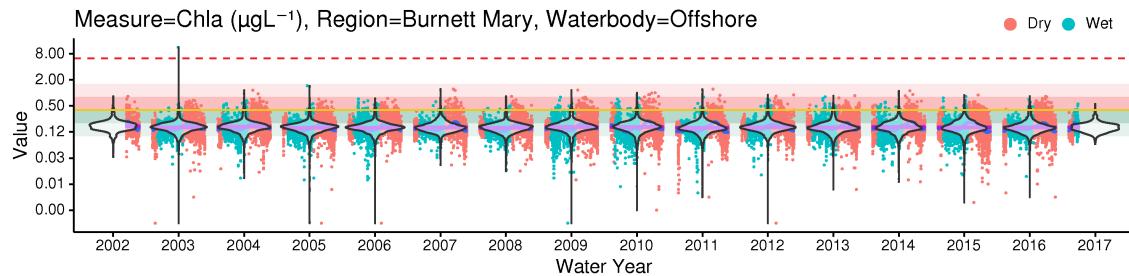
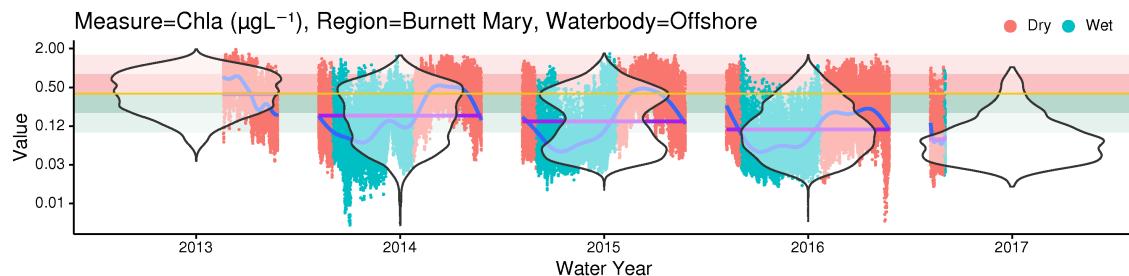
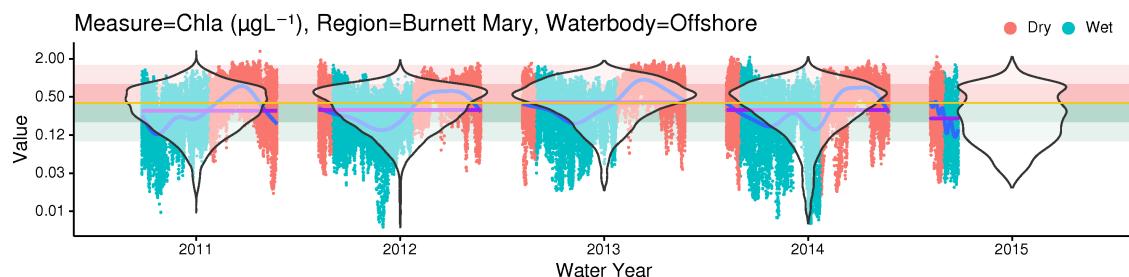
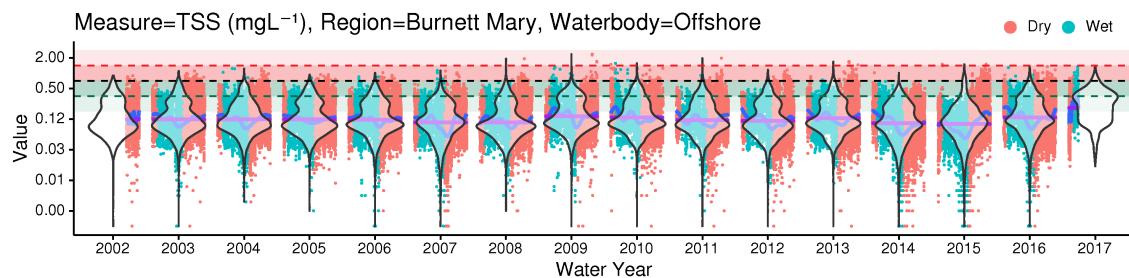
C.I.24 Burnett Mary, Offshore**C.I.24.1 Chlorophyll****c) Satellite****d) eReefs****e) eReefs926**

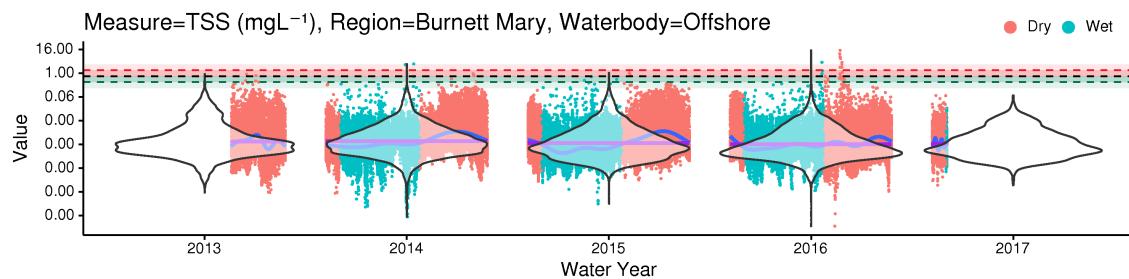
Figure C93: Observed (logarithmic axis with violin plot overlay) Chlorophyll-a data for the Burnett Mary Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.24.2 Total Suspended Solids

c) Satellite



d) eReefs



e) eReefs926

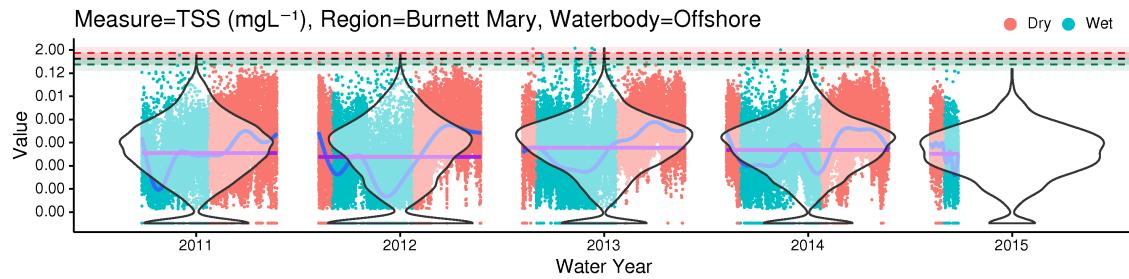
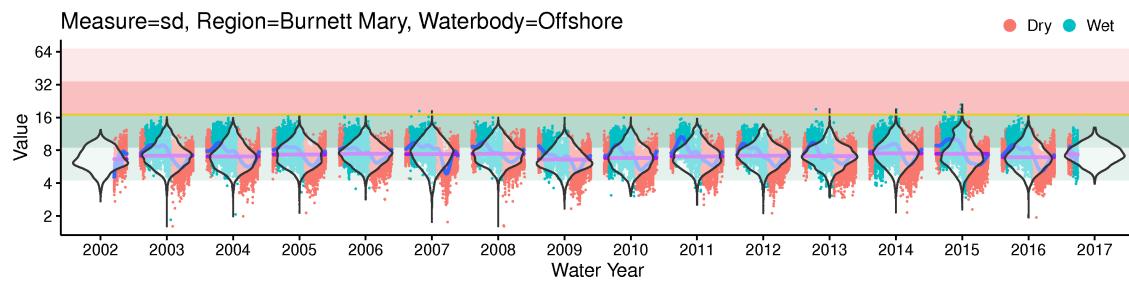


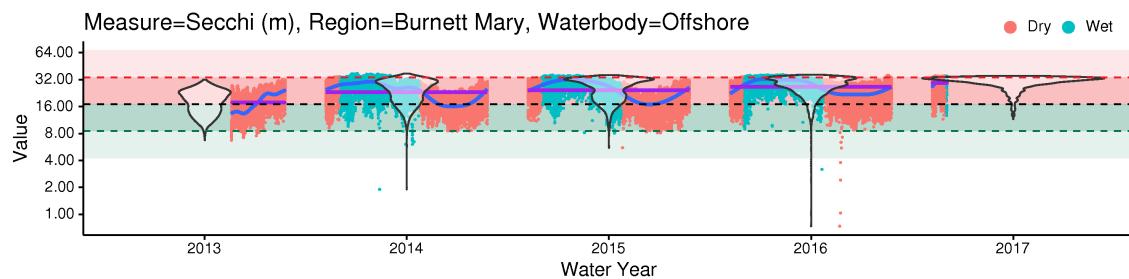
Figure C94: Observed (logarithmic axis with violin plot overlay) Total Suspended Solids data for the Burnett Mary Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.I.24.3 Secchi Depth

c) Satellite



d) eReefs



e) eReefs926

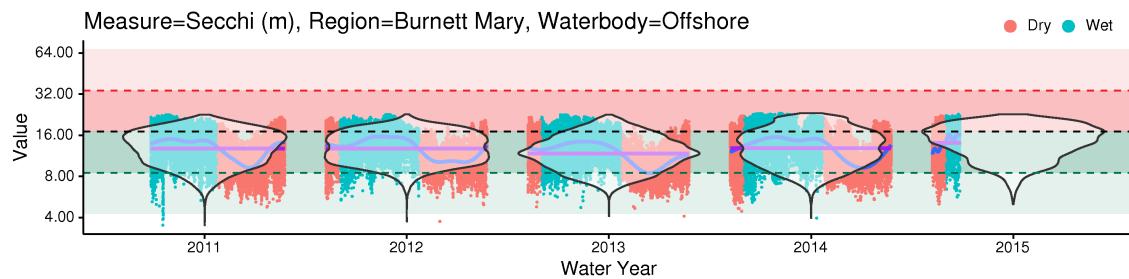
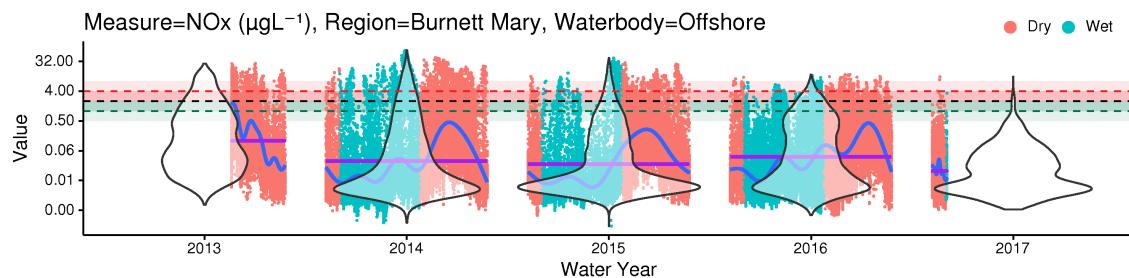


Figure C95: Observed (logarithmic axis with violin plot overlay) Secchi Depth data for the Burnett Mary Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $\times 4/4$; 30% shade: $\times 2/2$) above and below threshold respectively.

C.I.24.4 NOx

d) eReefs



e) eReefs926

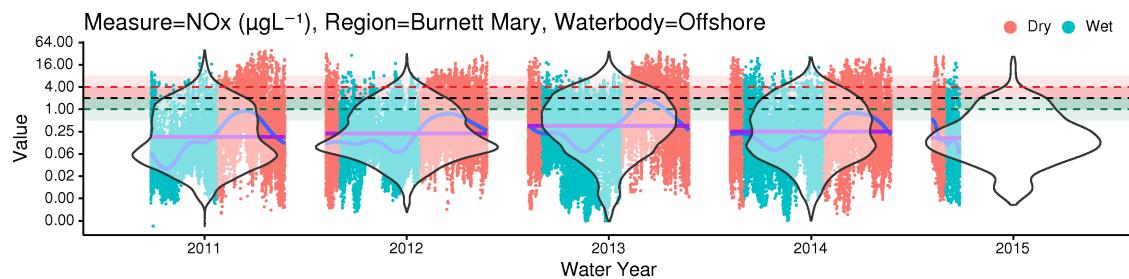


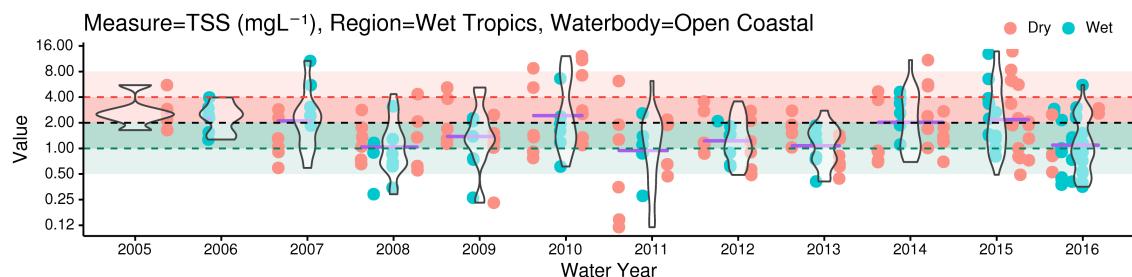
Figure C96: Observed (logarithmic axis with violin plot overlay) NOx data for the Burnett Mary Offshore Zone from a) AIMS insitu, b) AIMS FLNTU, c) Satellite, d) eReefs and e) eReefs926. Observations are ordered over time and colored conditional on season as Wet (blue symbols) and Dry (red symbols). Blue smoother represents Generalized Additive Mixed Model within a water year and purple line represents average within the water year. Horizontal red, black and green dashed lines denote the twice threshold, threshold and half threshold values respectively. Red and green background shading indicates the range (10% shade: $x4/4$; 30% shade: $x2/2$) above and below threshold respectively.

C.2 Indices

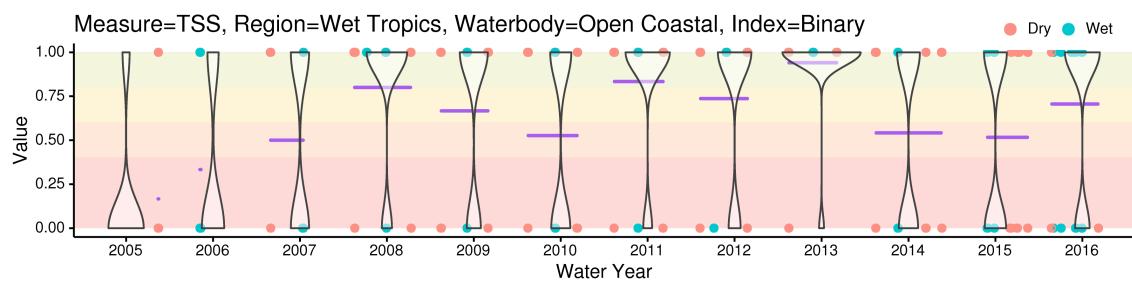
C.2.1 Wet Tropics Open Coastal

C.2.1.1 Total Suspended Solids

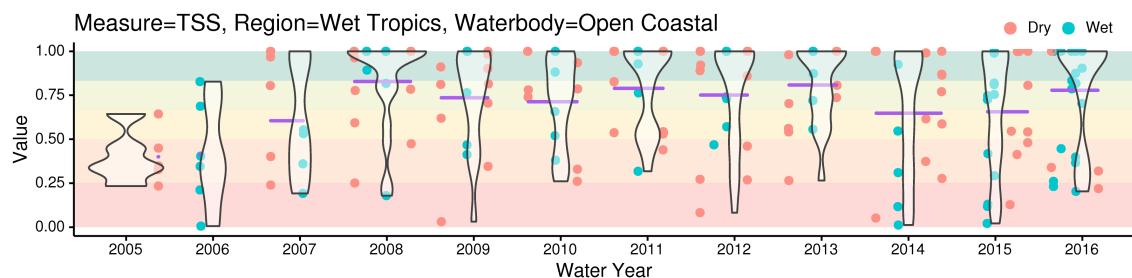
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

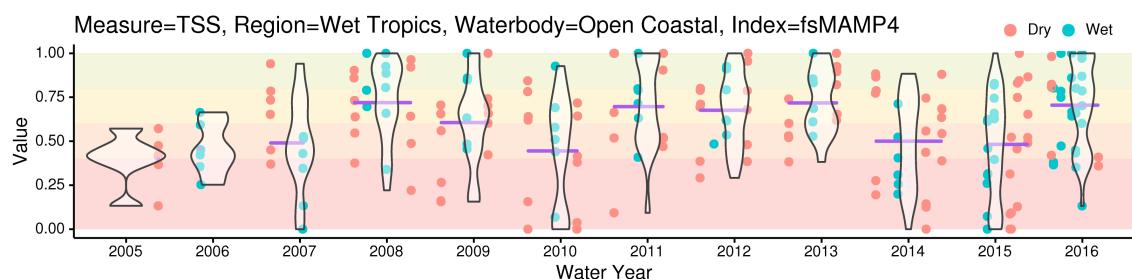


Figure C97: Temporal distribution of AIMS insitu Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

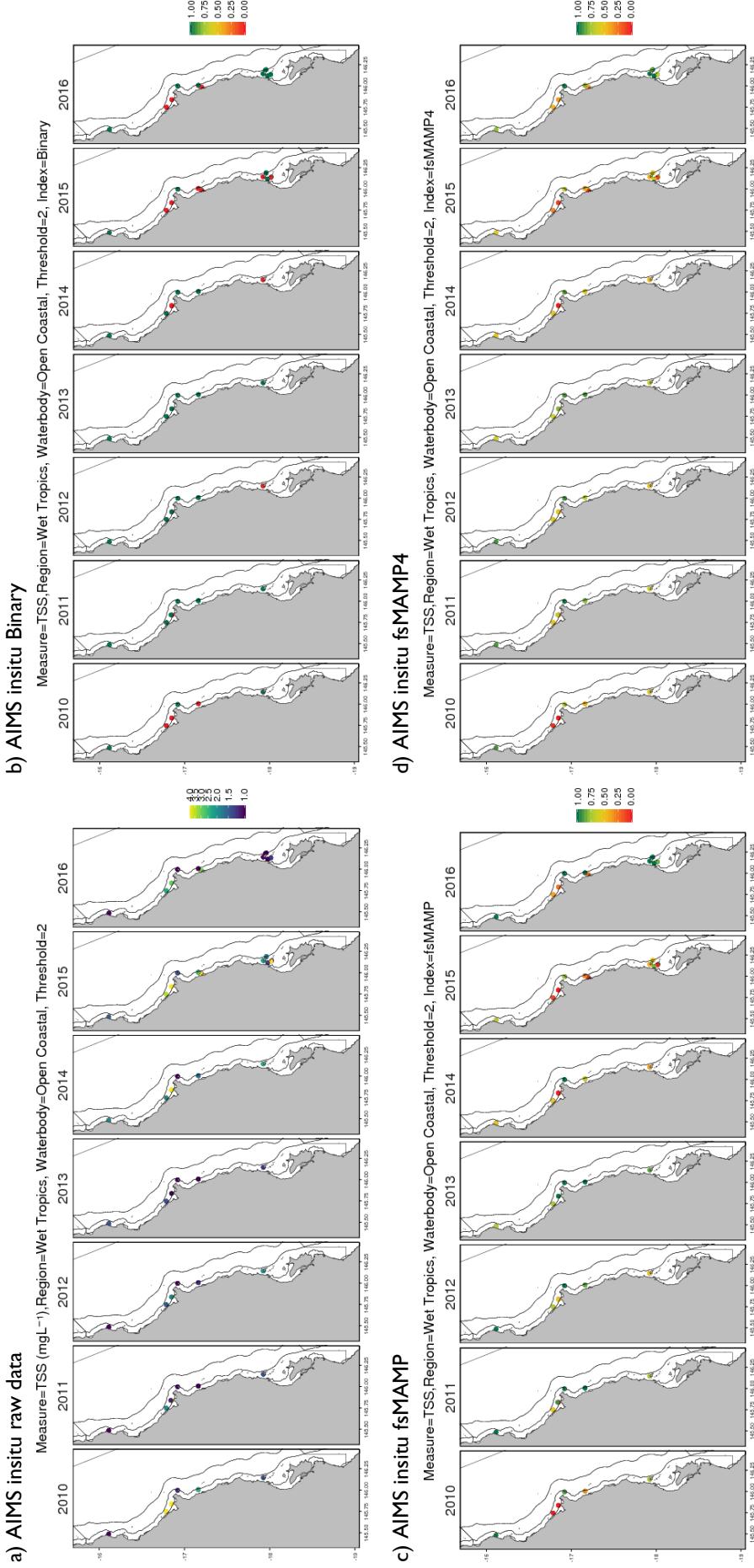
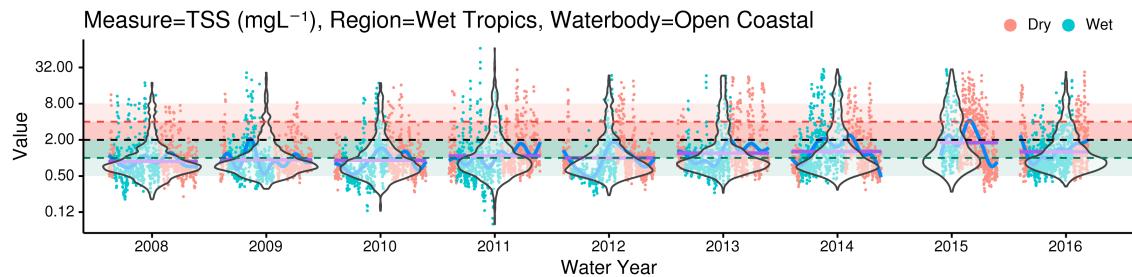
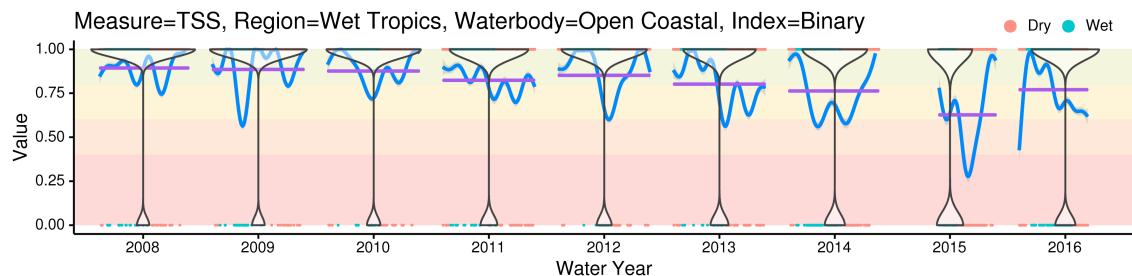


Figure C98: Spatial distribution of AIMS in situ Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

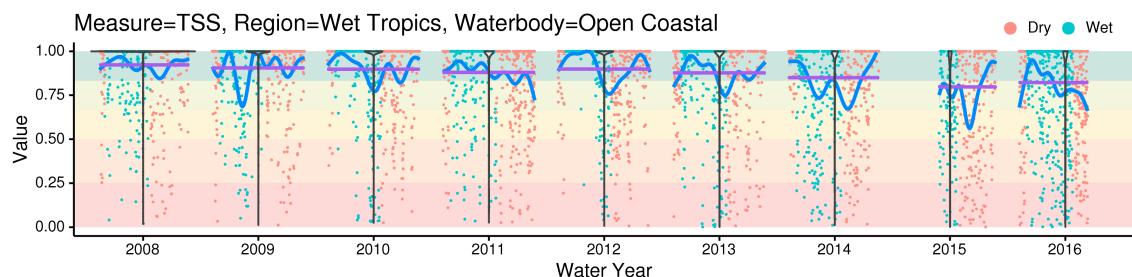
a) AIMS FLNTU raw site means



b) AIMS FLNTU site mean Binary



c) AIMS FLNTU site mean fsMAMP



d) AIMS FLNTU site mean fsMAMP4

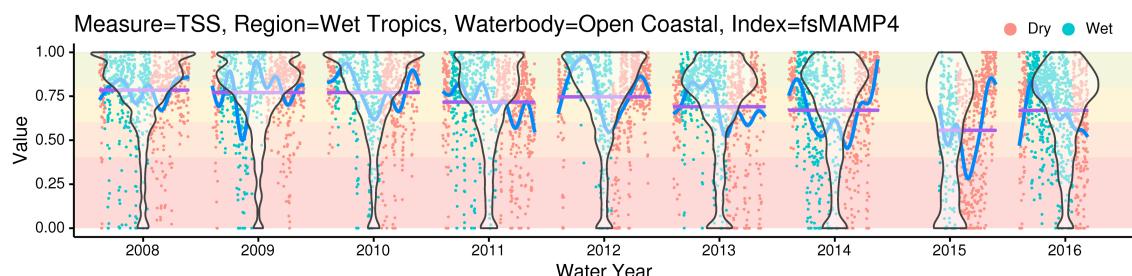
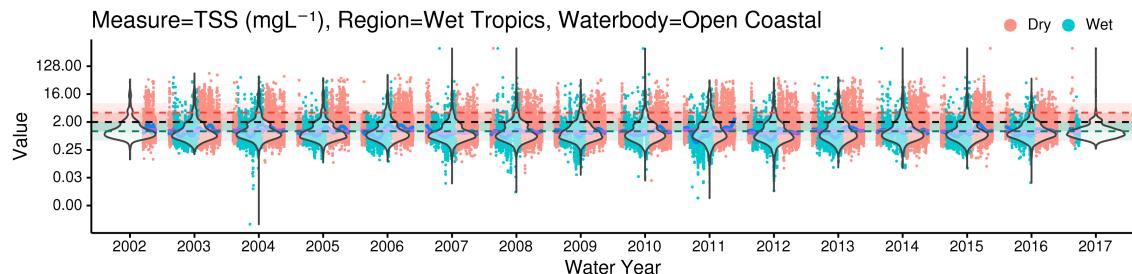
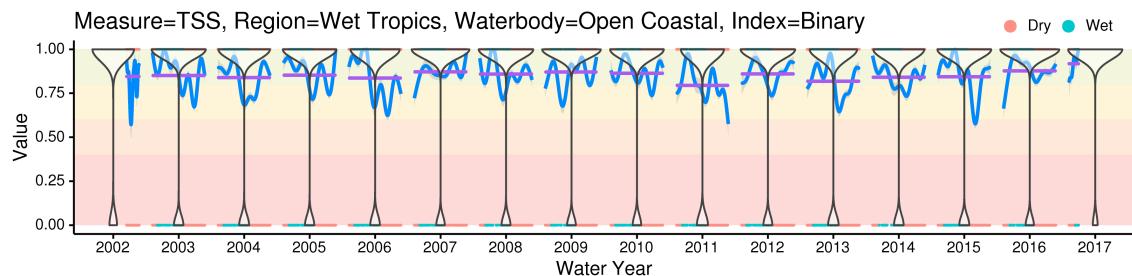


Figure C99: Temporal distribution of AIMS FLNTU Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

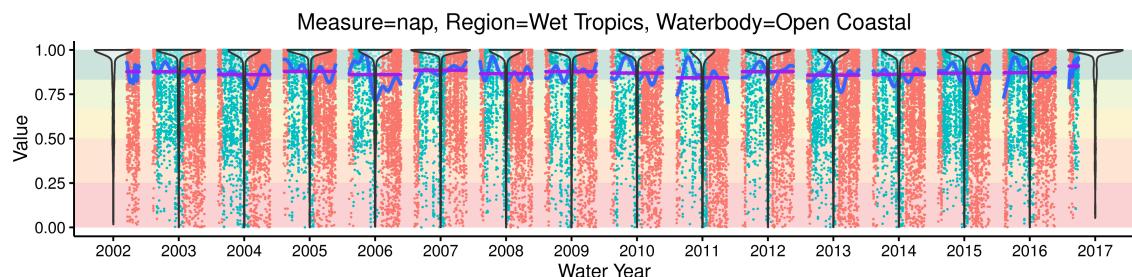
a) Satellite raw site means



b) Satellite site mean Binary



c) Satellite site mean fsMAMP



d) Satellite site mean fsMAMP4

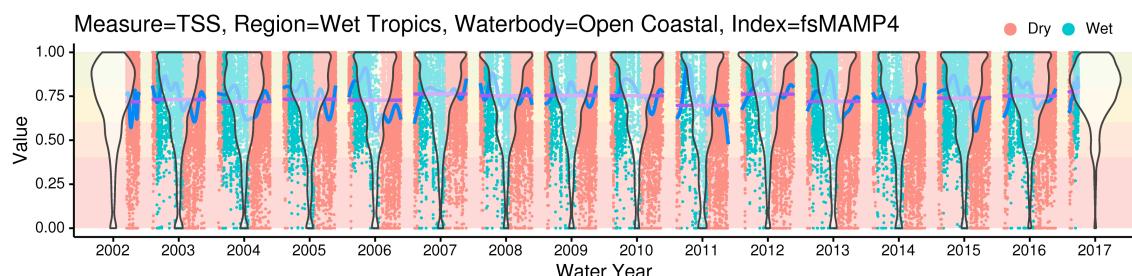


Figure C100: Temporal distribution of Satellite Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

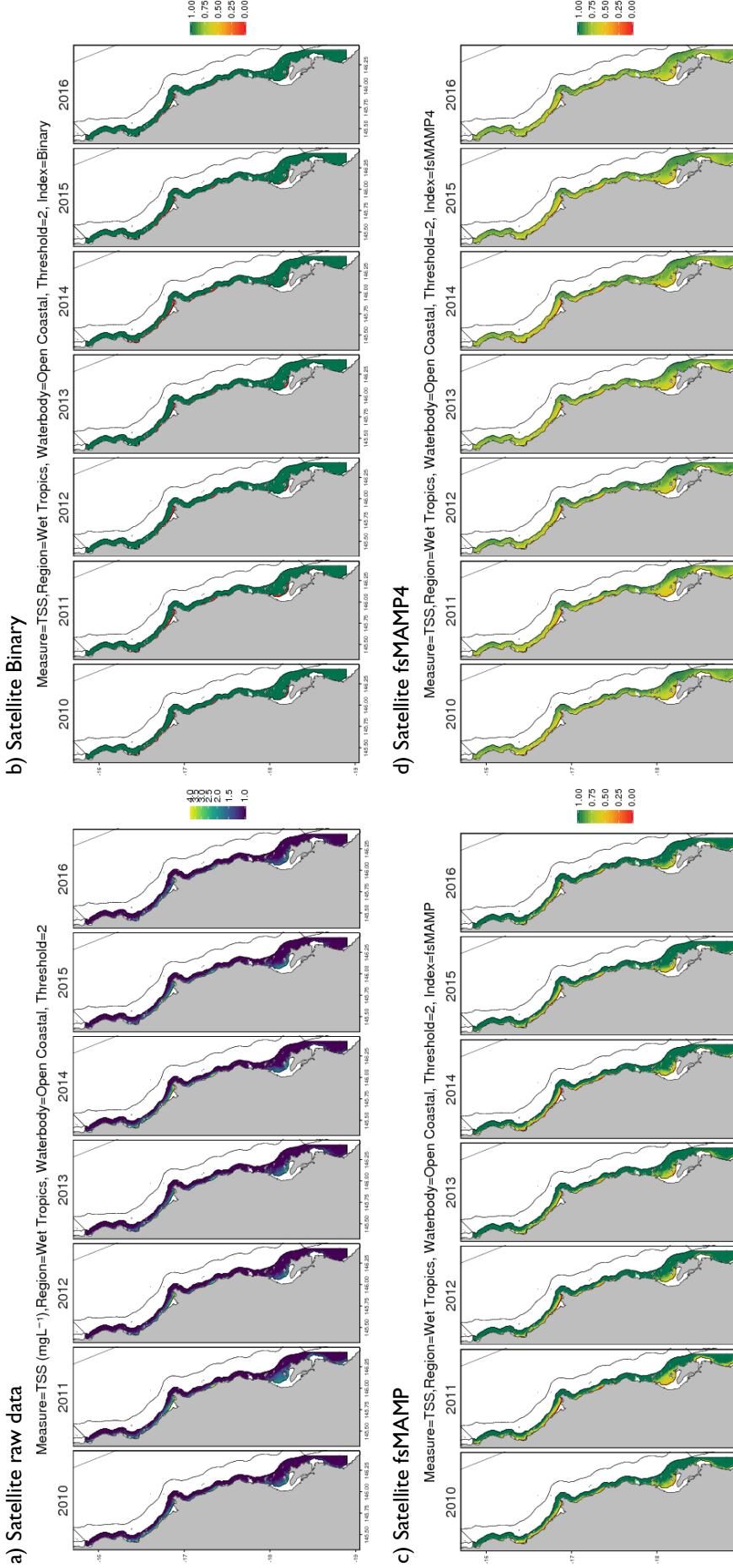
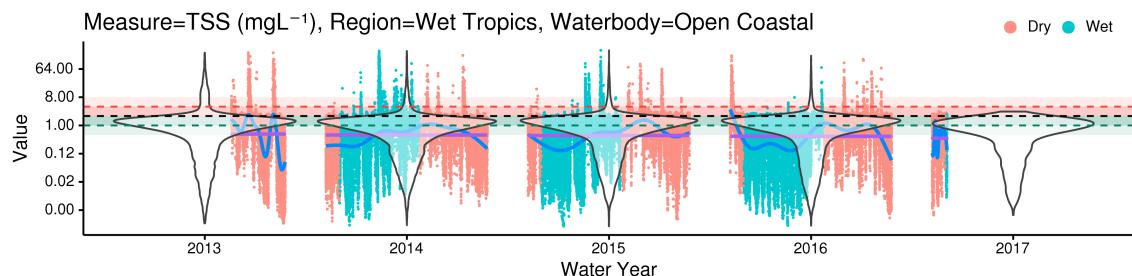
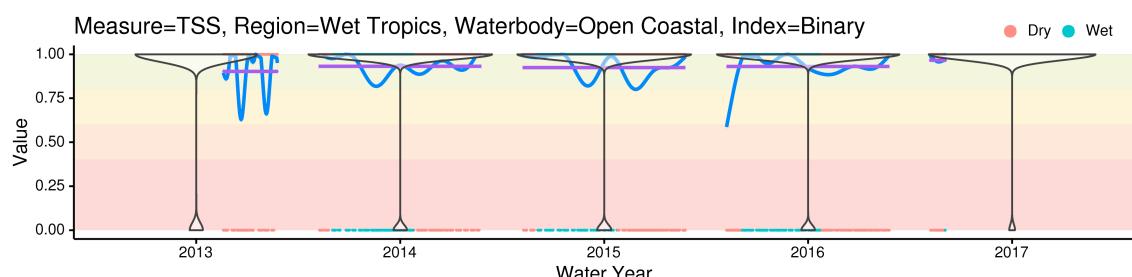


Figure C10: Spatial distribution of Satellite Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and I (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

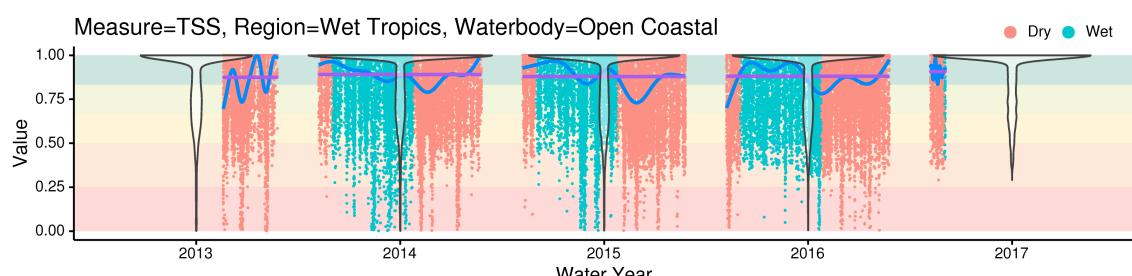
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

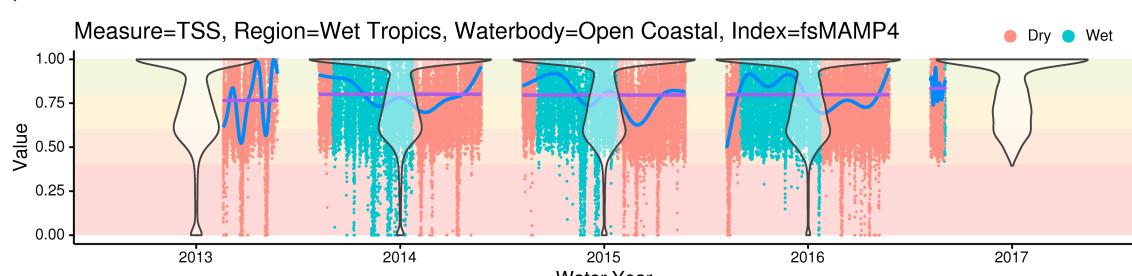


Figure C102: Temporal distribution of eReefs Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

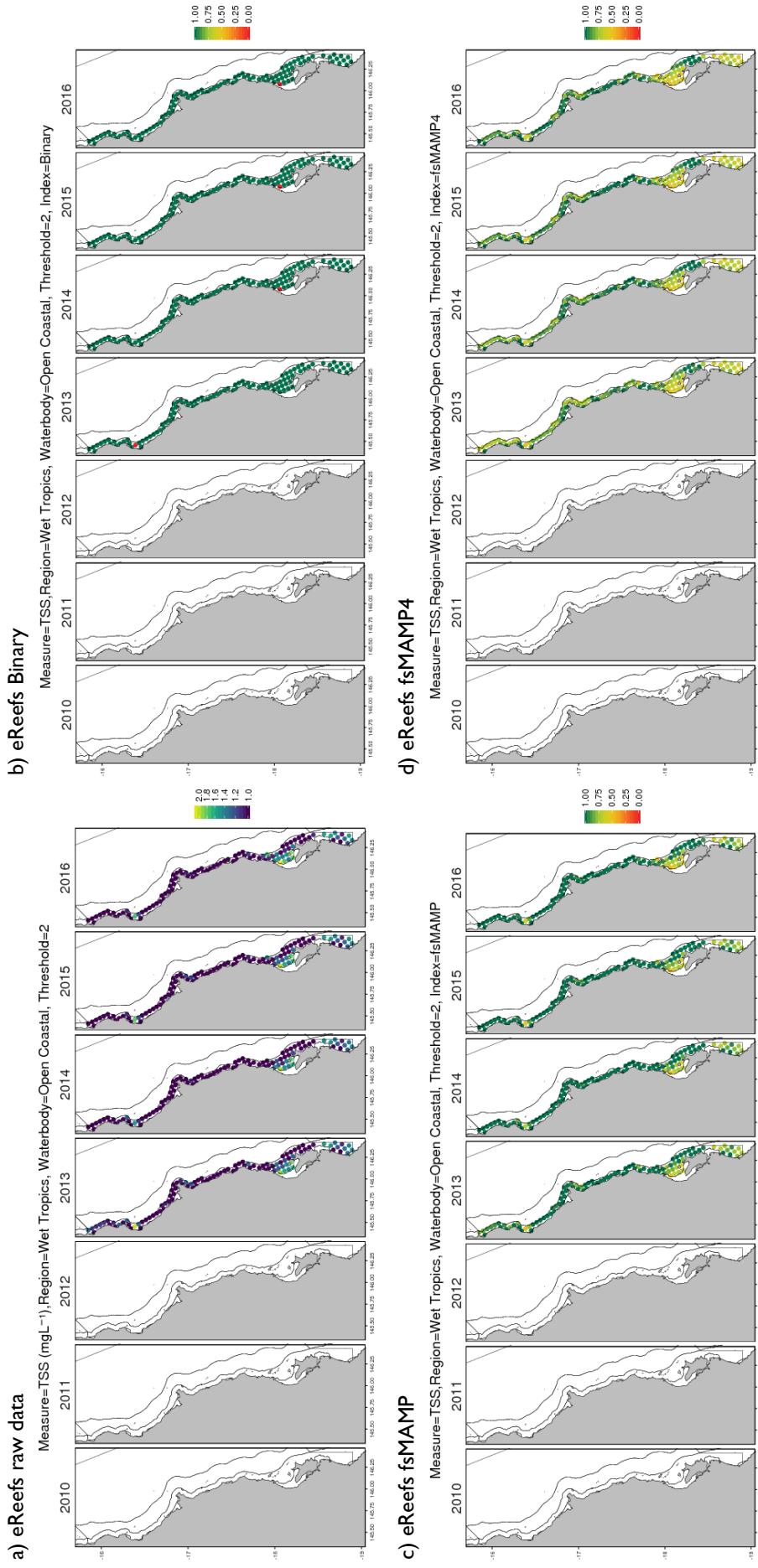
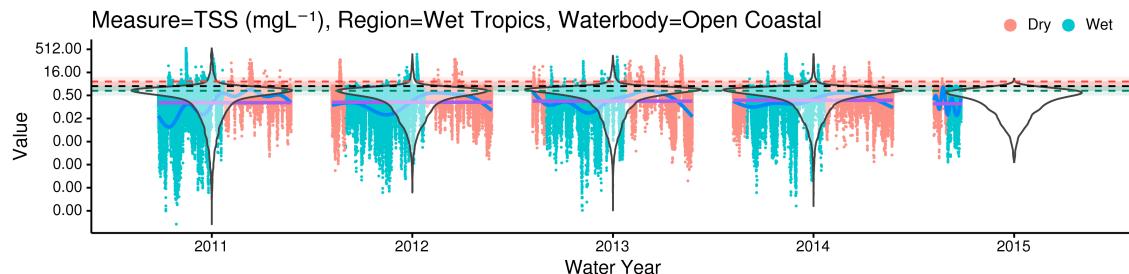
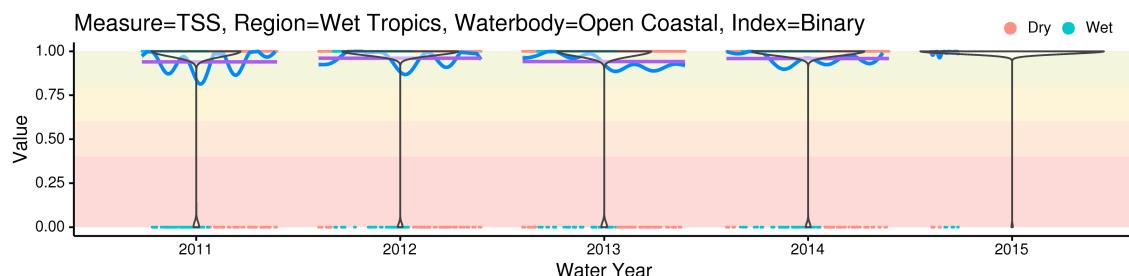


Figure C103: Spatial distribution of eReefs Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

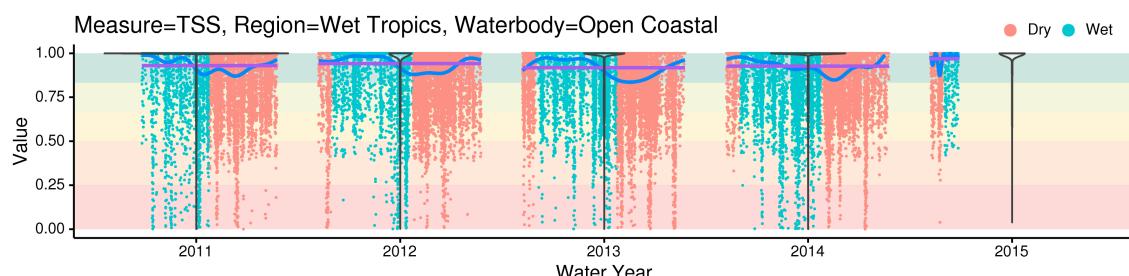
a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP



d) eReefs926 site mean fsMAMP4

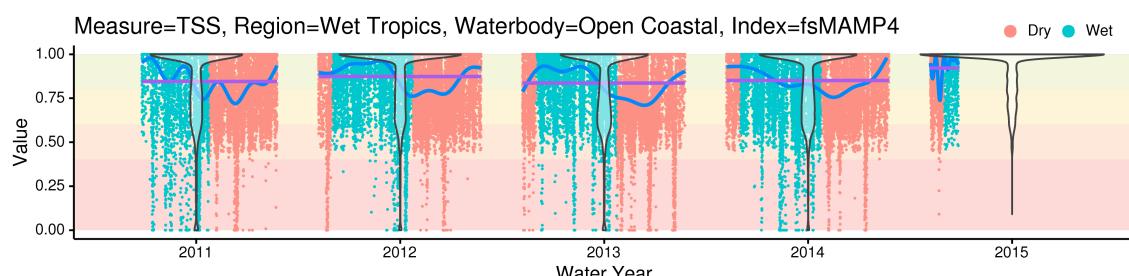


Figure C104: Temporal distribution of eReefs926 Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

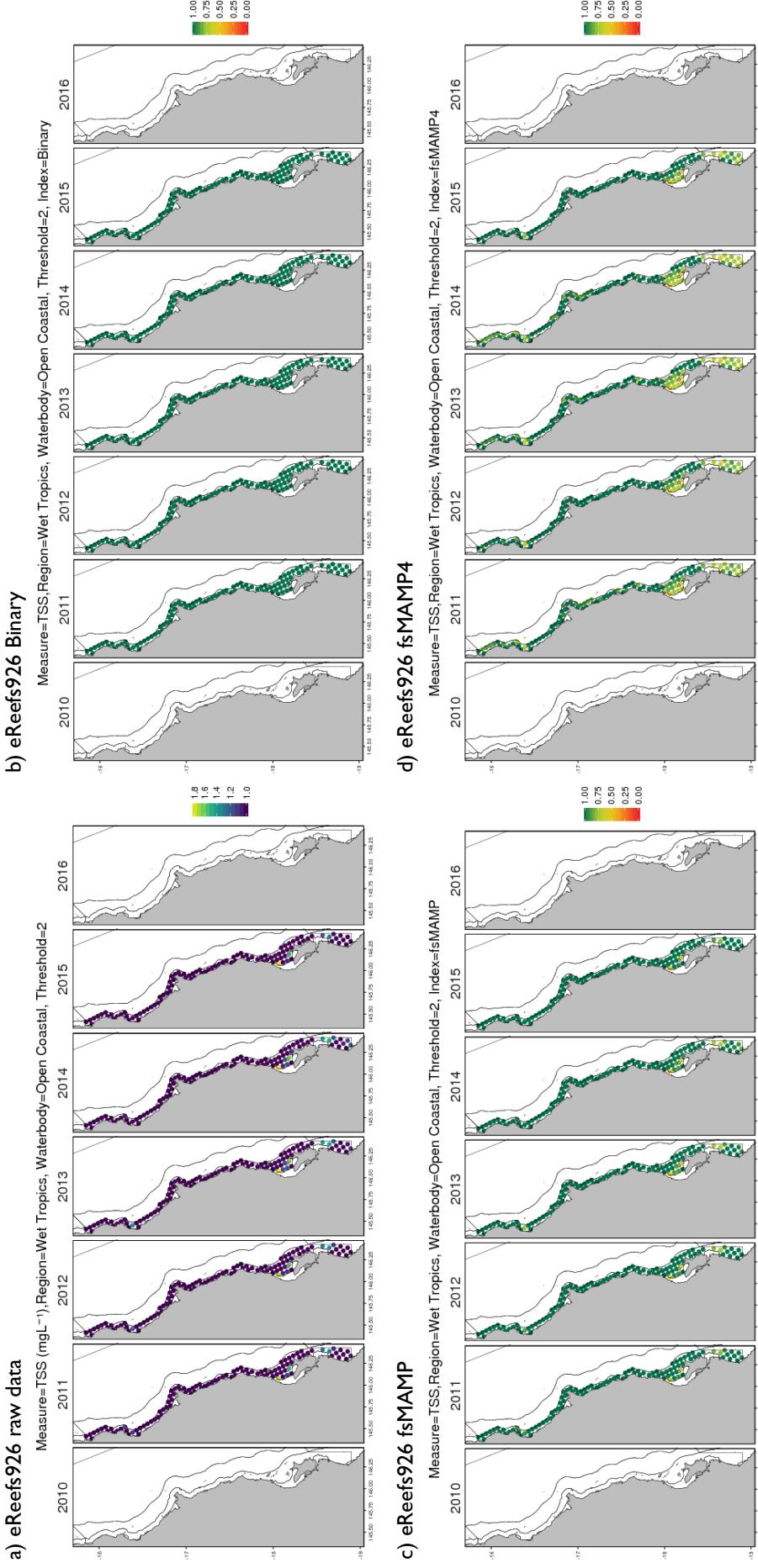
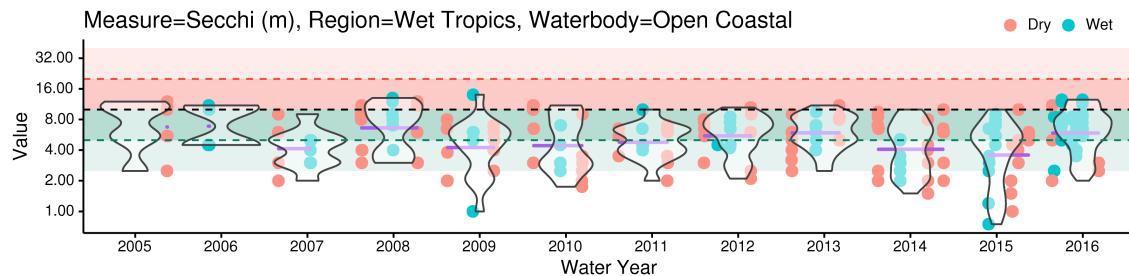


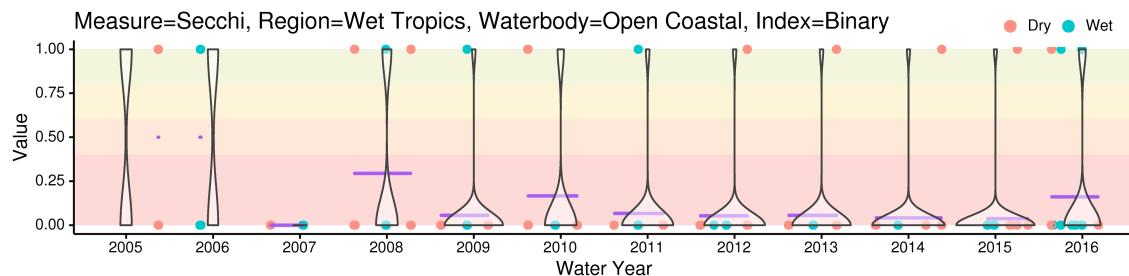
Figure C105: Spatial distribution of eReefs926 Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

C.2.1.2 Secchi Depth

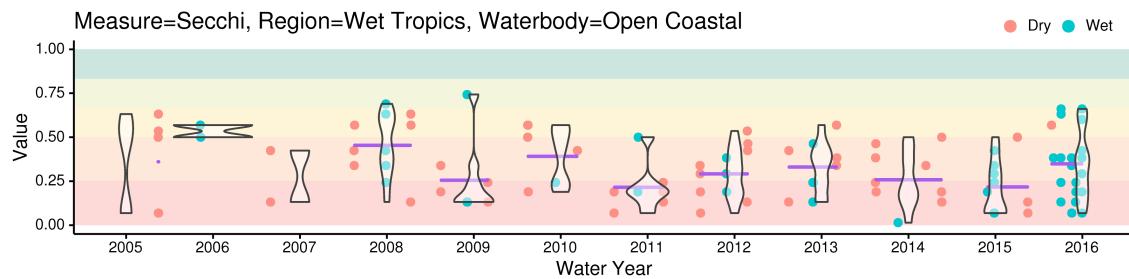
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

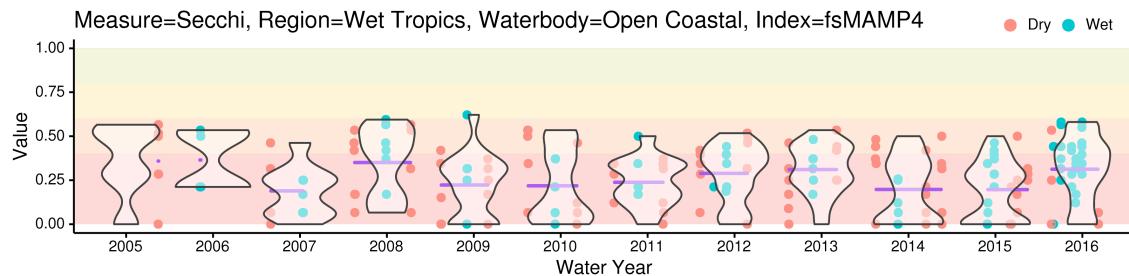


Figure C106: Temporal distribution of AIMS insitu Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (5% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

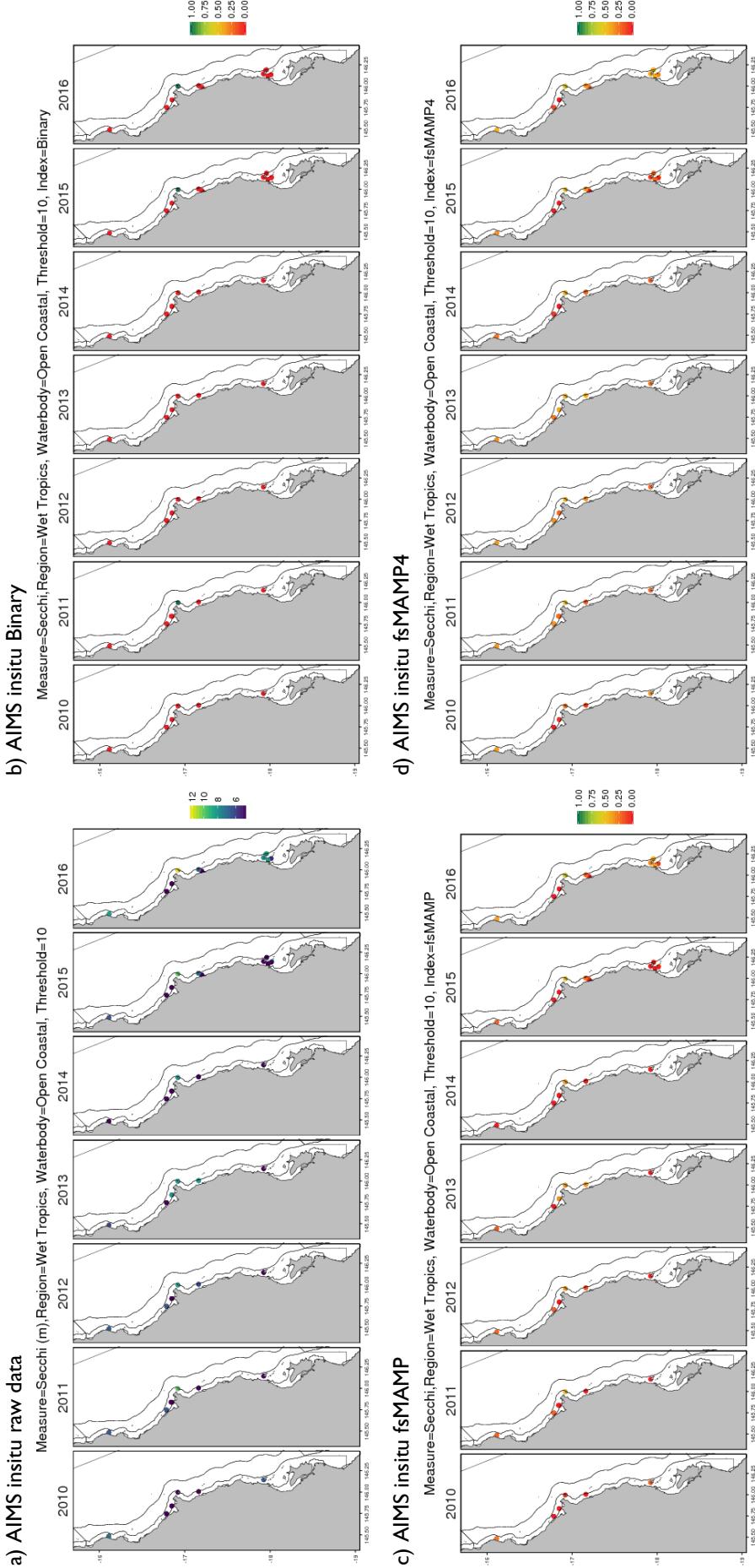
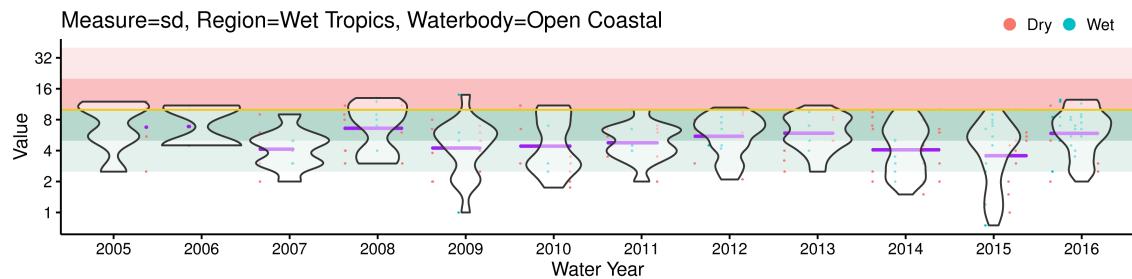


Figure C107: Spatial distribution of AIMS *in situ* Secchi Depth a) samples and associated b) Binary, c) fSMAWP and d) fSMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and I (green) and 0 (red) for Binary, fSMAWP and fSMAMP4.

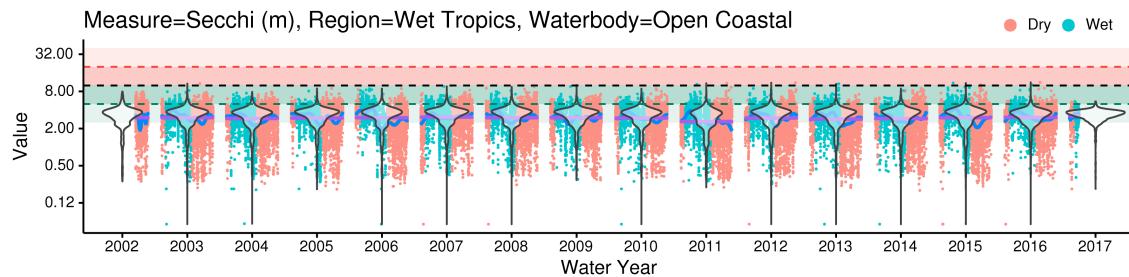
a) AIMS FLNTU raw site means



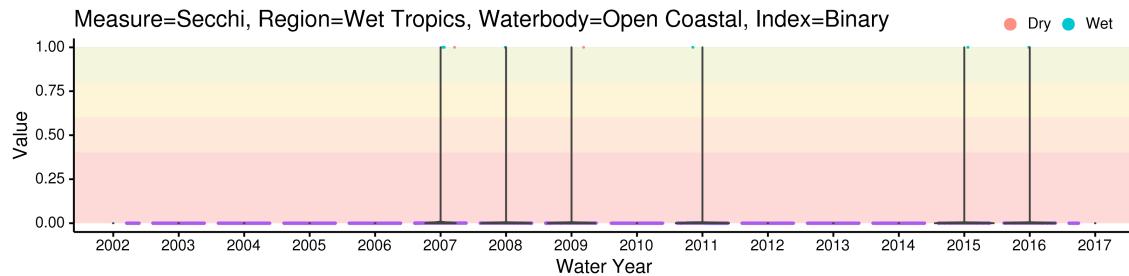
b) AIMS FLNTU site mean Binary

c) AIMS FLNTU site mean fsMAMP

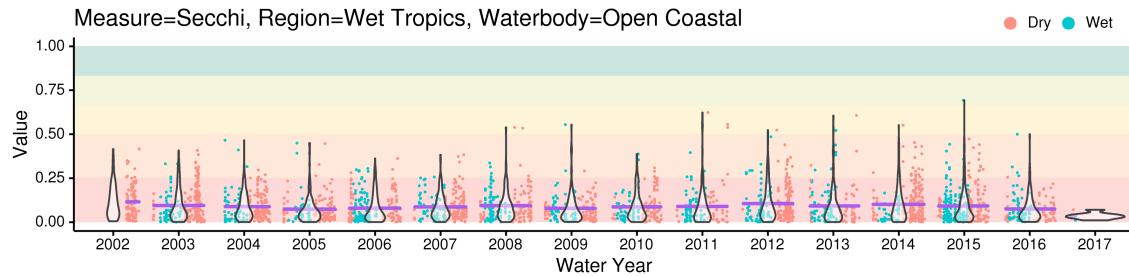
a) Satellite raw site means



b) Satellite site mean Binary



c) Satellite site mean fsMAMP



d) Satellite site mean fsMAMP4

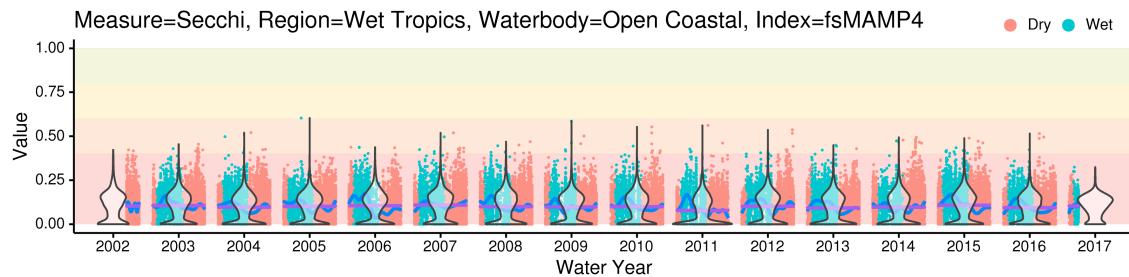


Figure C109: Temporal distribution of Satellite Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

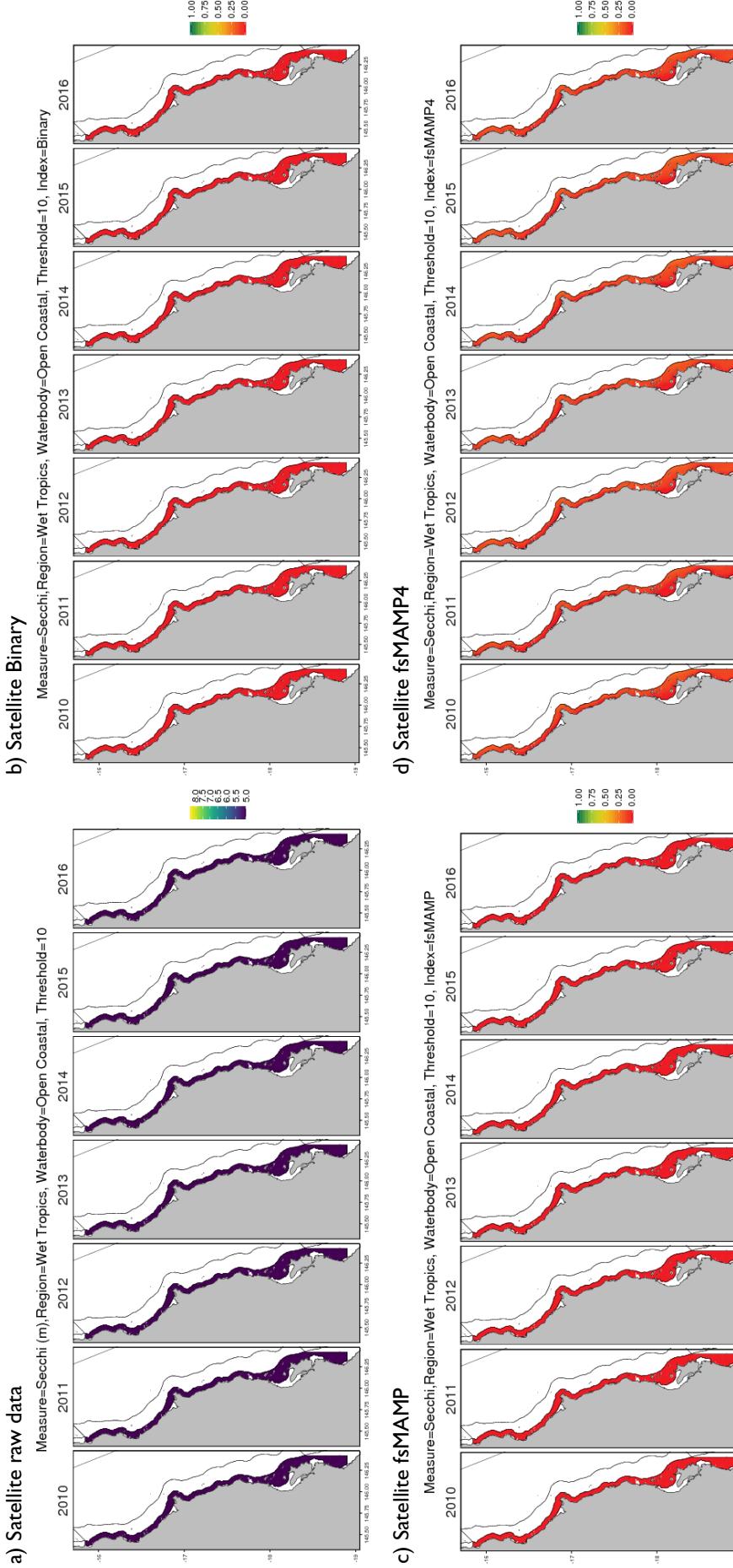
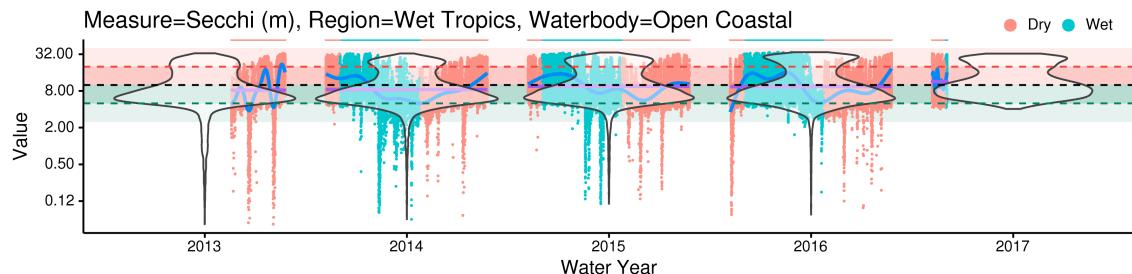
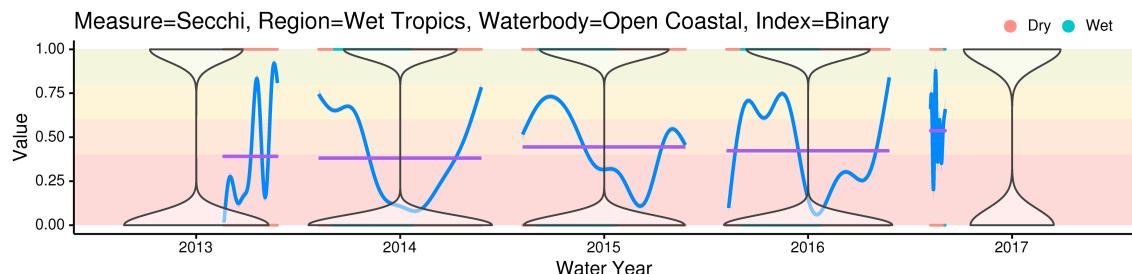


Figure C10: Spatial distribution of Satellite Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

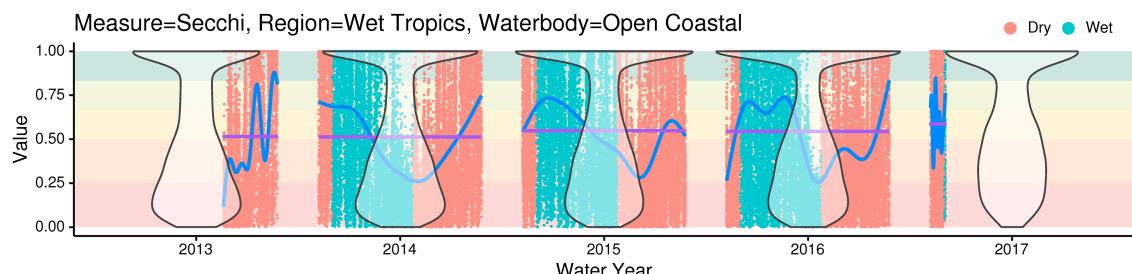
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

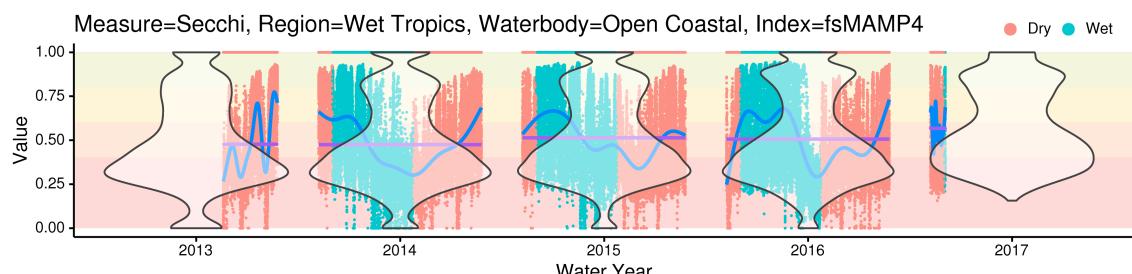


Figure C111: Temporal distribution of eReefs Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

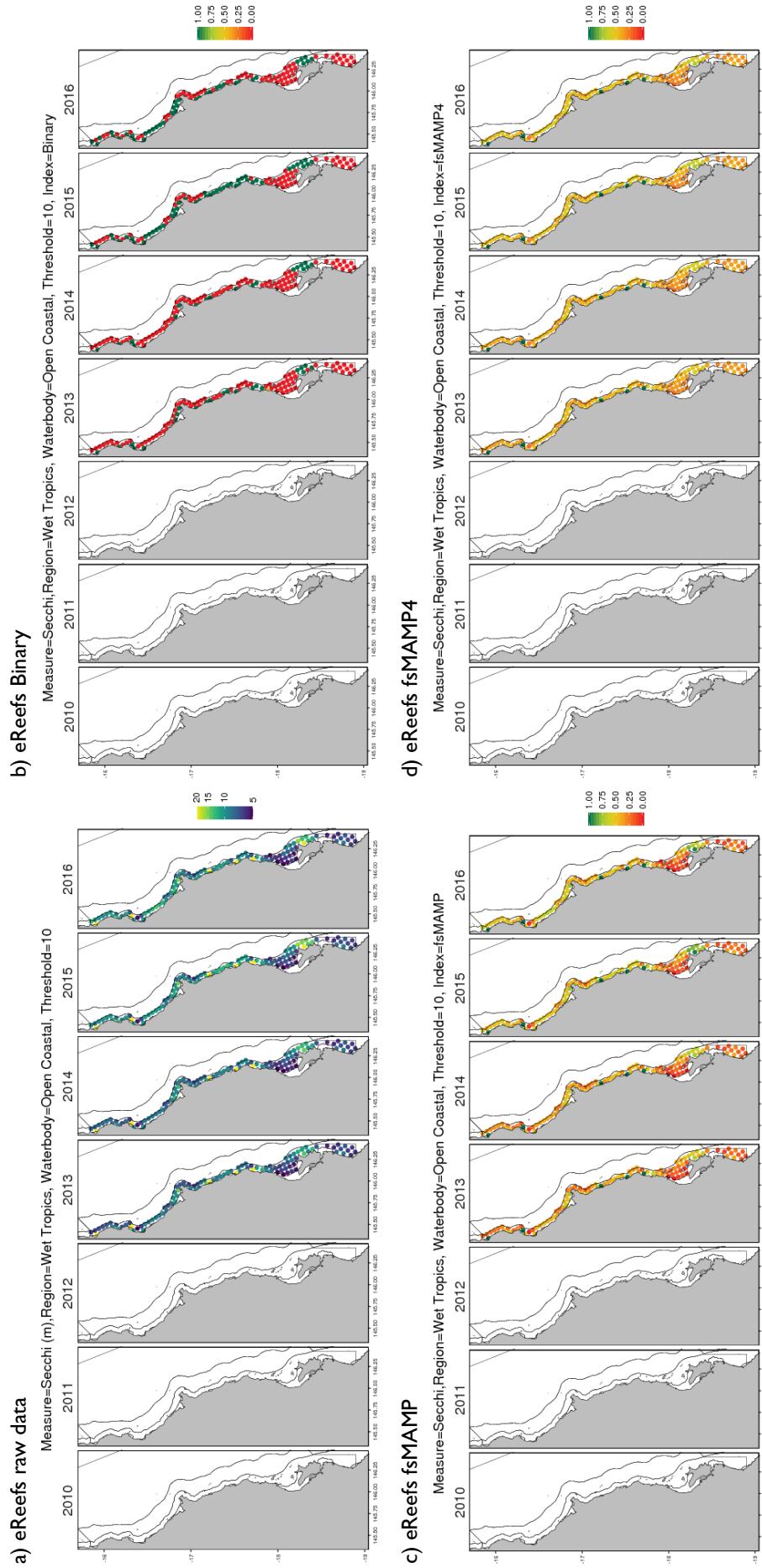
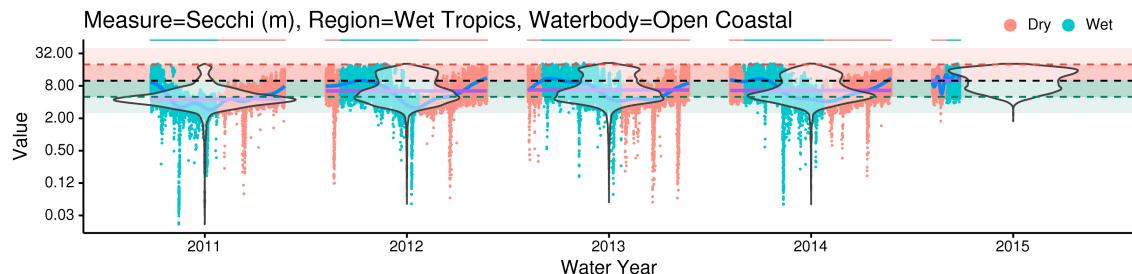
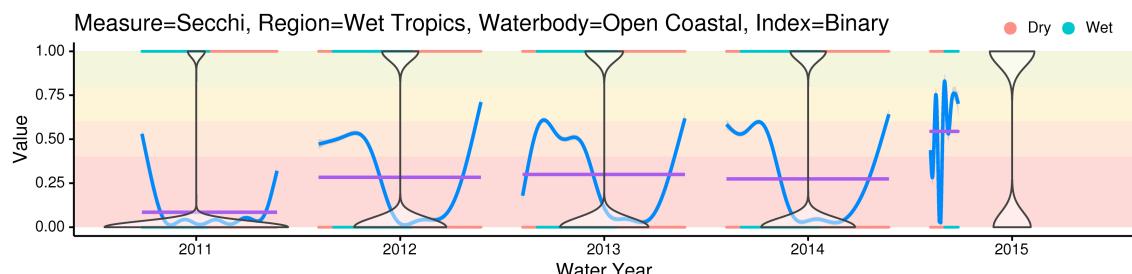


Figure C1/2: Spatial distribution of eReefs Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

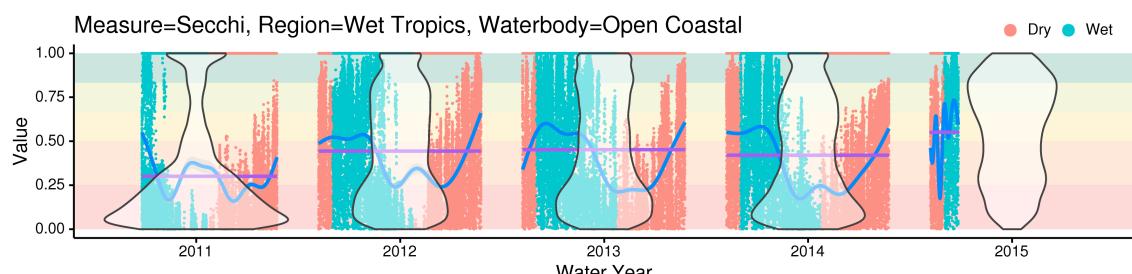
a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP



d) eReefs926 site mean fsMAMP4

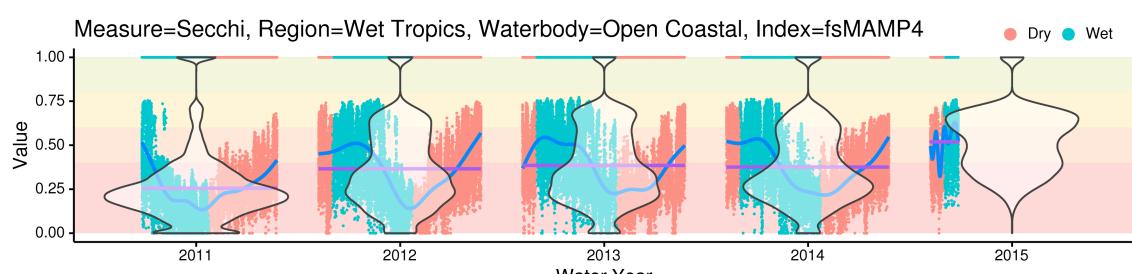


Figure C113: Temporal distribution of eReefs926 Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

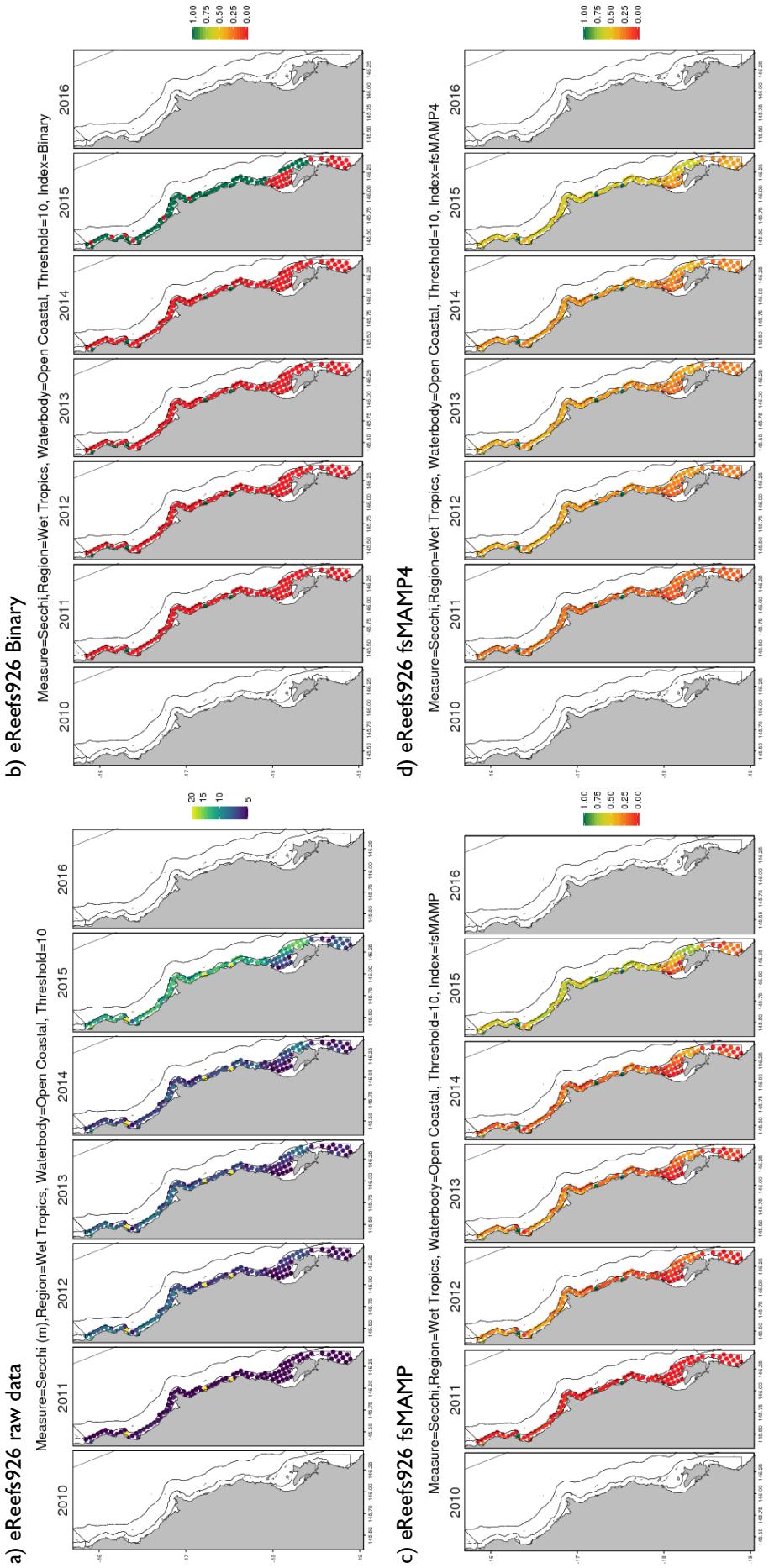
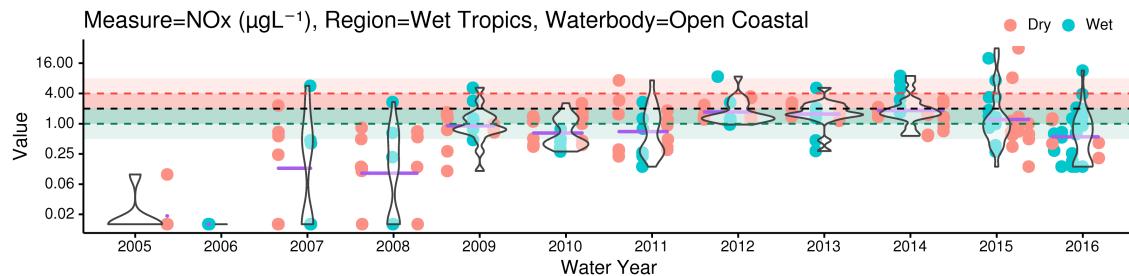


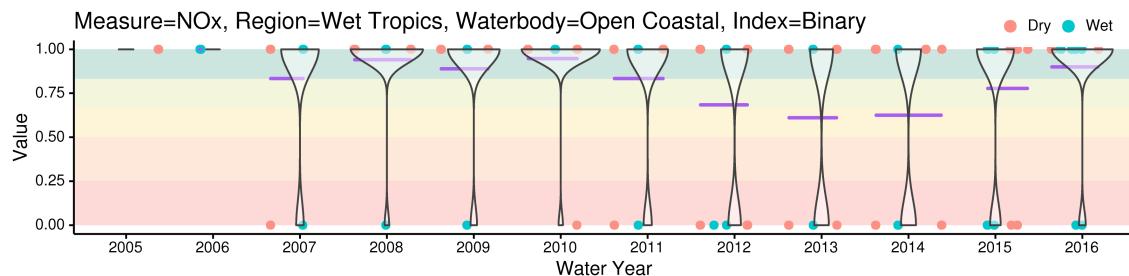
Figure C14: Spatial distribution of eReefs926 Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

C.2.1.3 NO_x, Wet Tropics Open Coastal

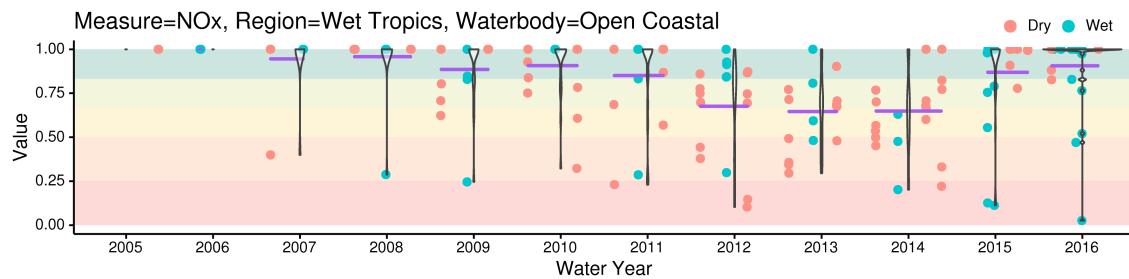
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

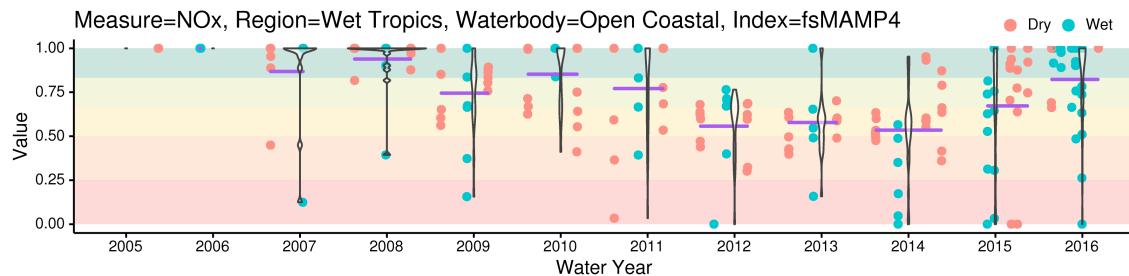


Figure C115: Temporal distribution of AIMS insitu NO_x a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

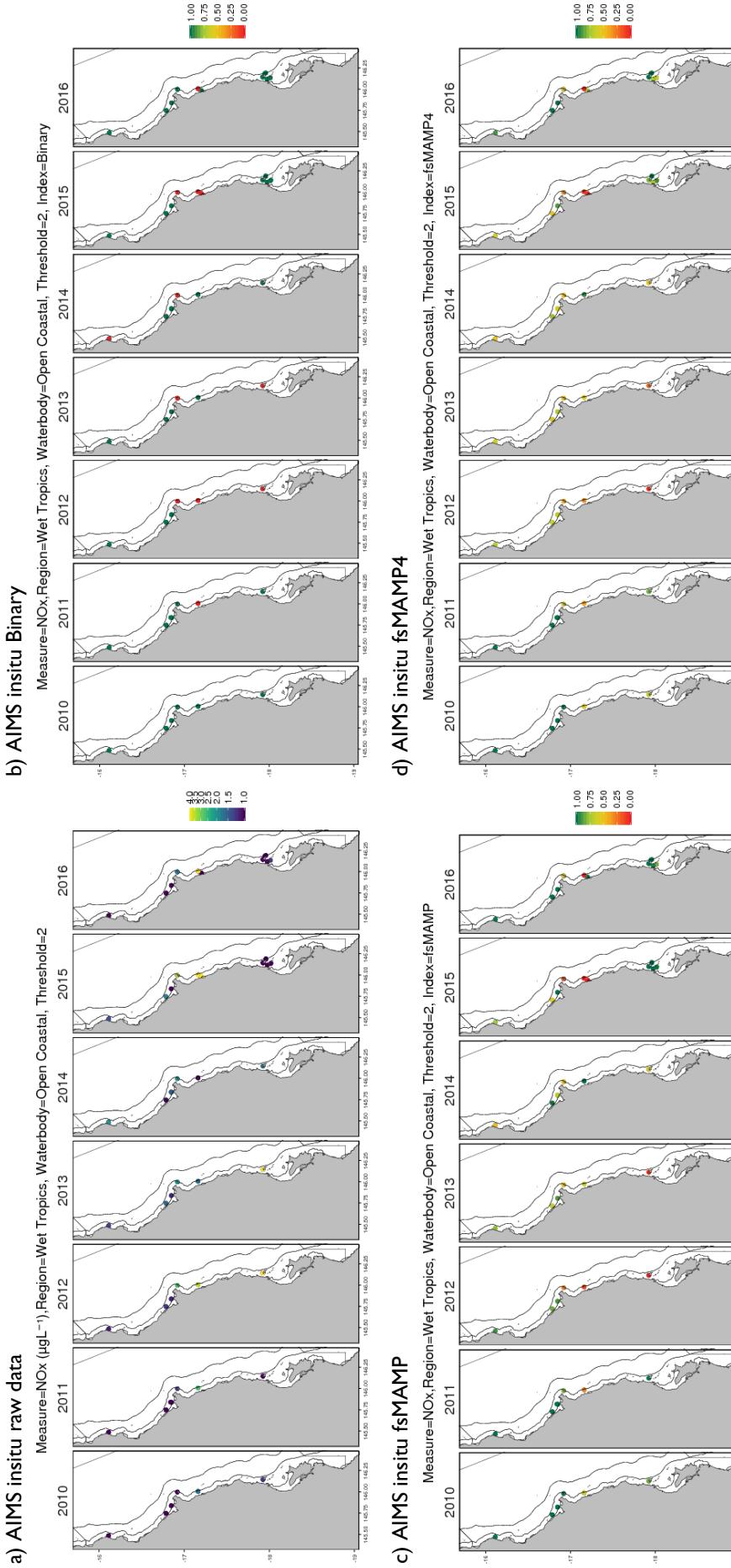
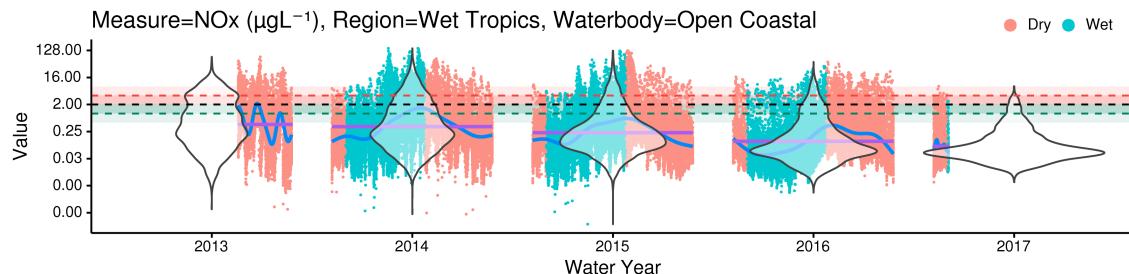
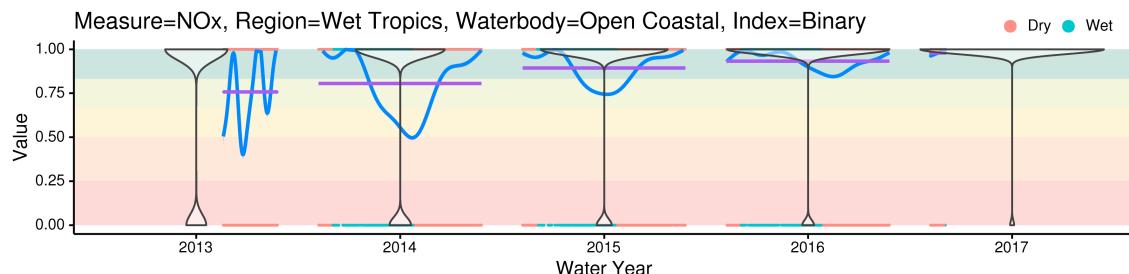


Figure C116: Spatial distribution of AIMS in situ NOx samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

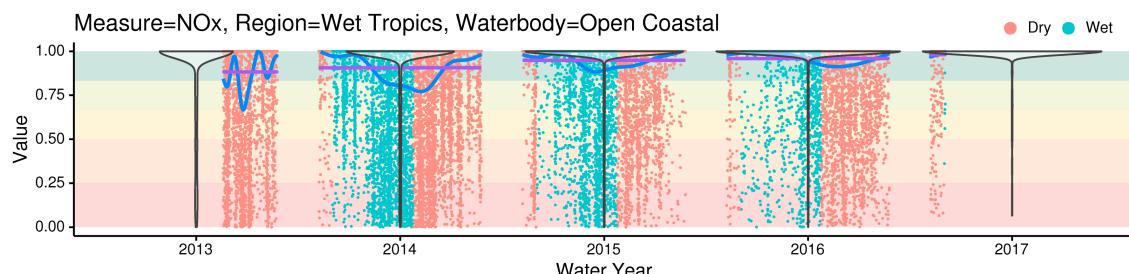
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

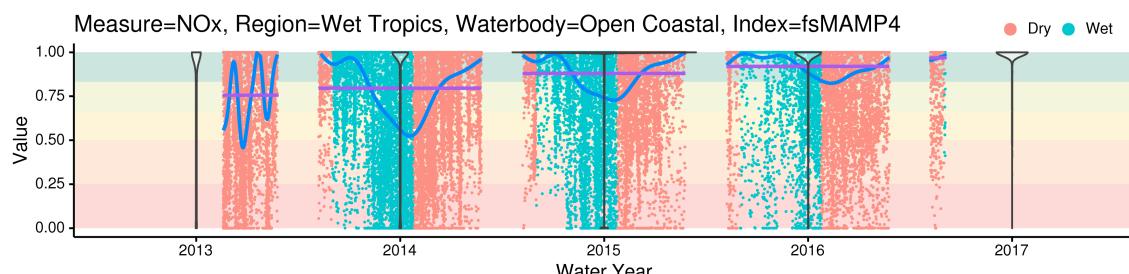


Figure C117: Temporal distribution of eReefs NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

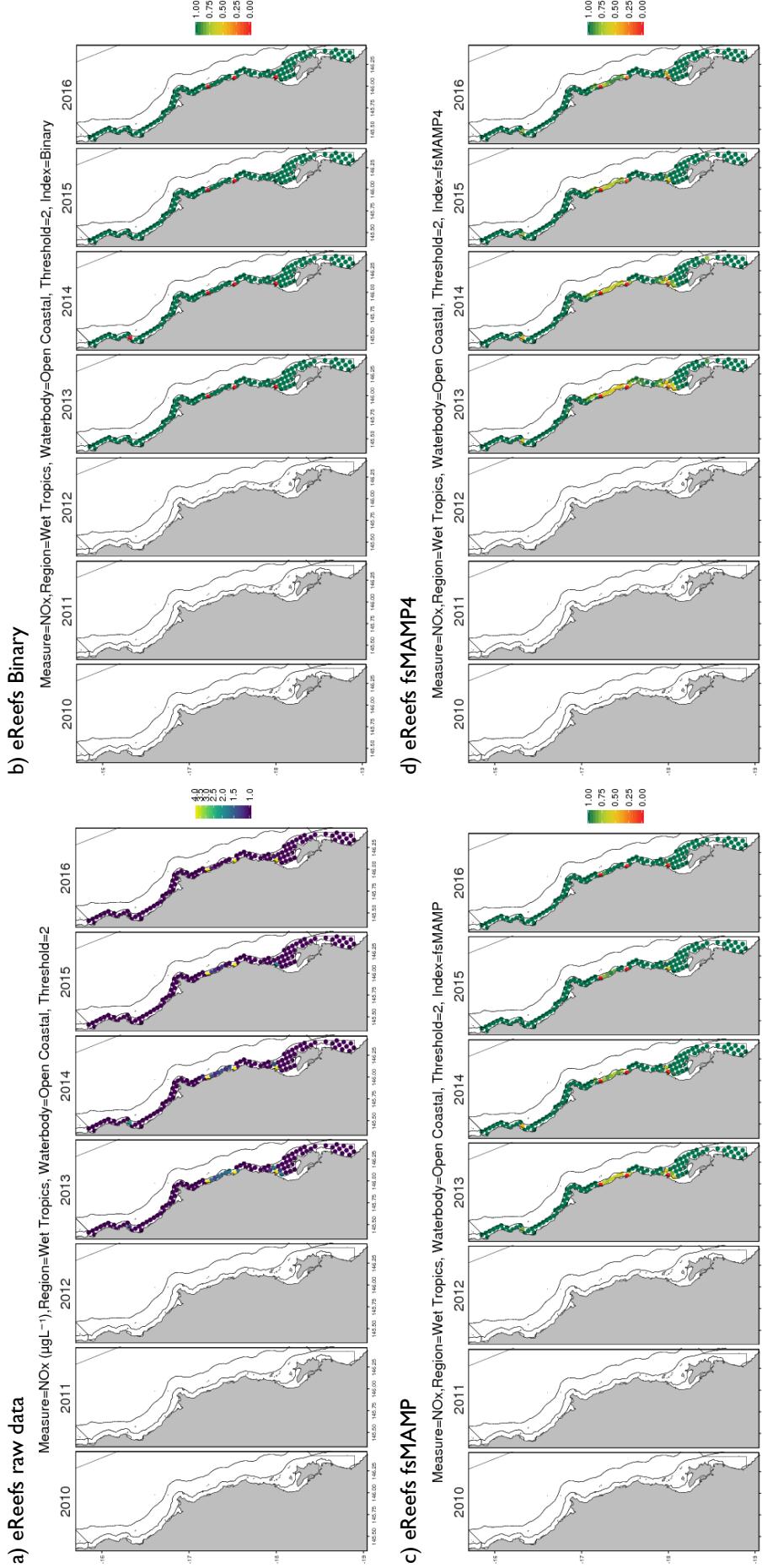
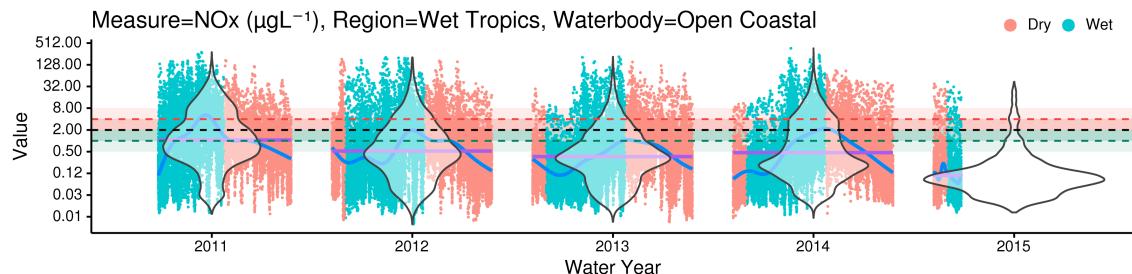
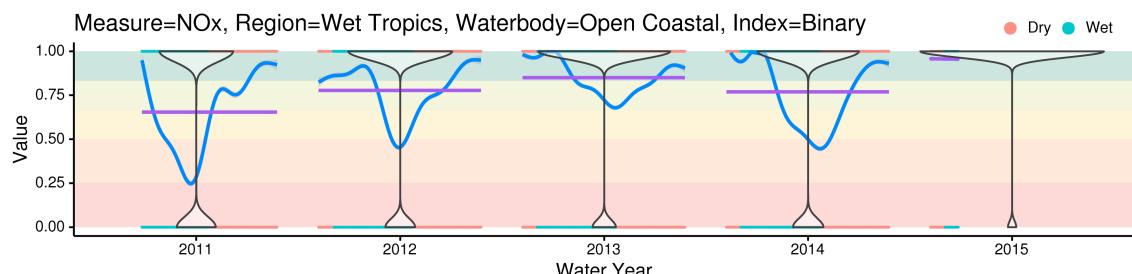


Figure C18: Spatial distribution of eReefs NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

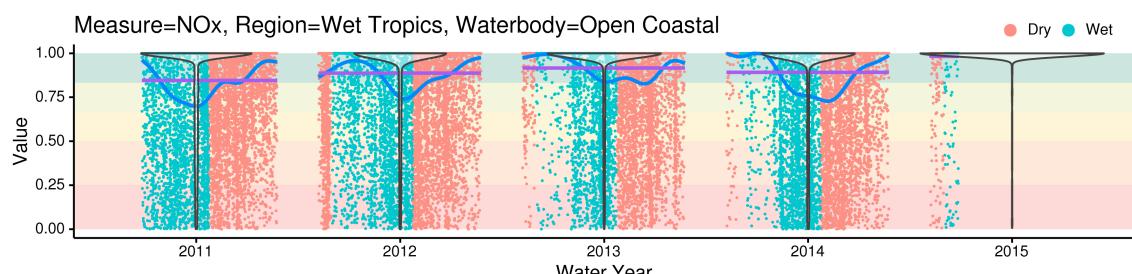
a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP



d) eReefs926 site mean fsMAMP4

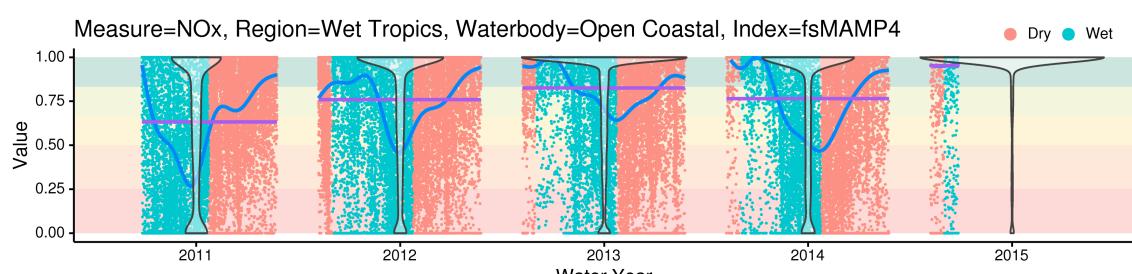


Figure C119: Temporal distribution of eReefs926 NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

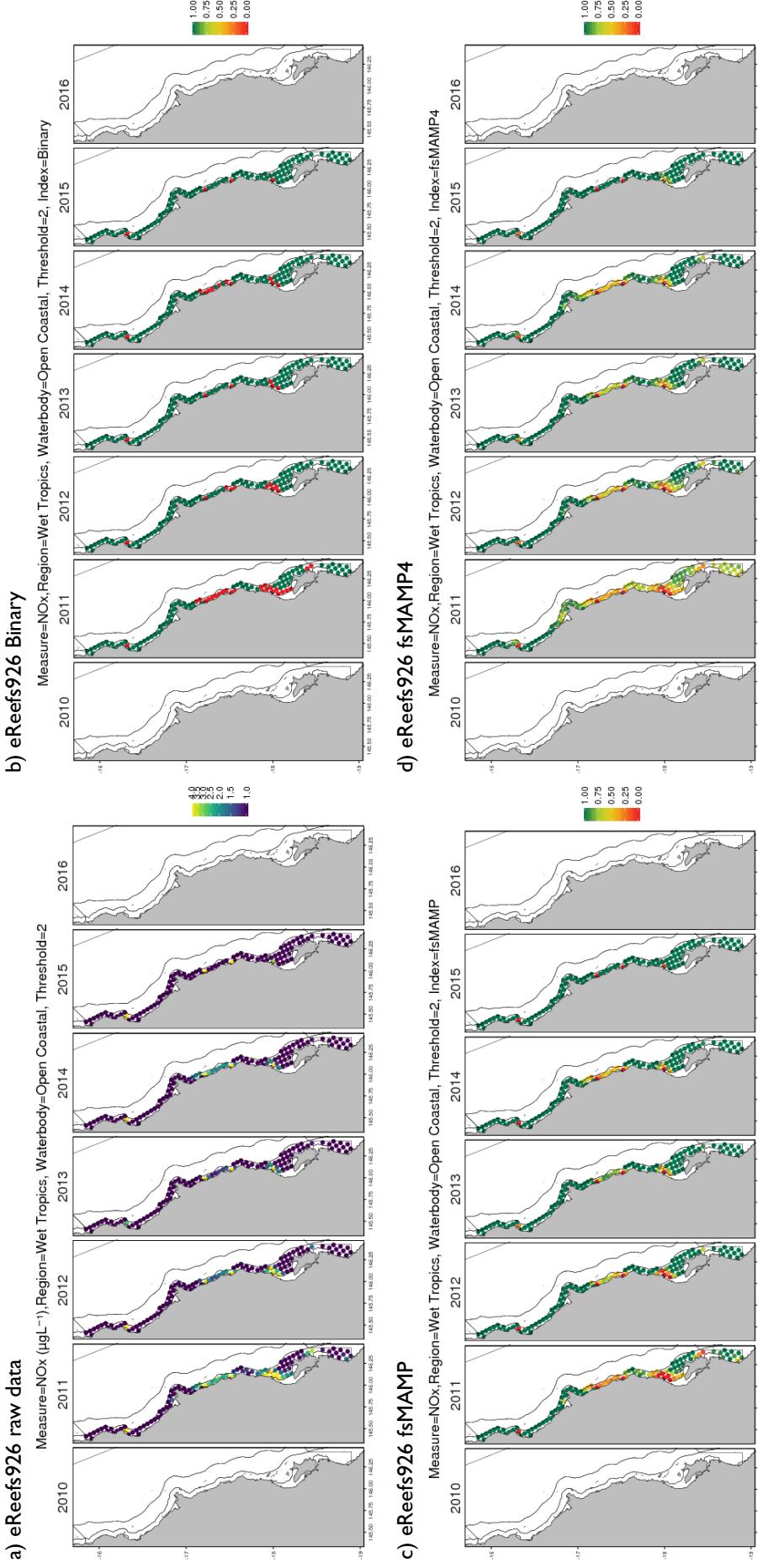
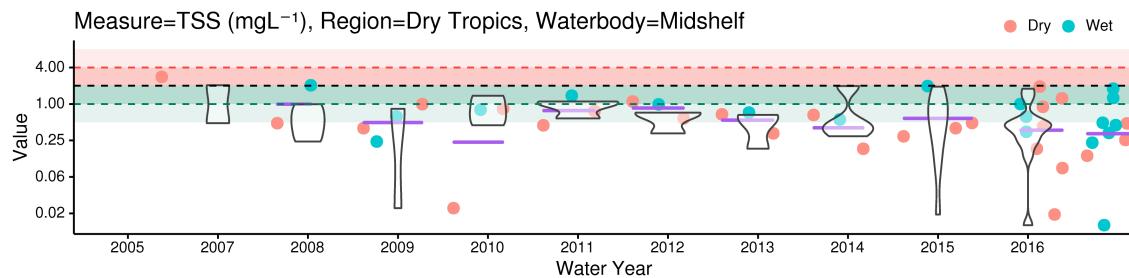


Figure C.20: Spatial distribution of eReefs926 NO_x a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and I (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

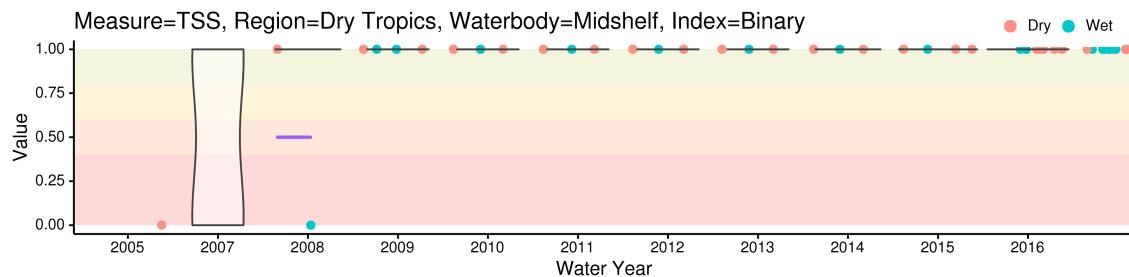
C.2.2 Dry Tropics Midshelf

C.2.2.1 Total Suspended Solids, Dry Tropics Midshelf

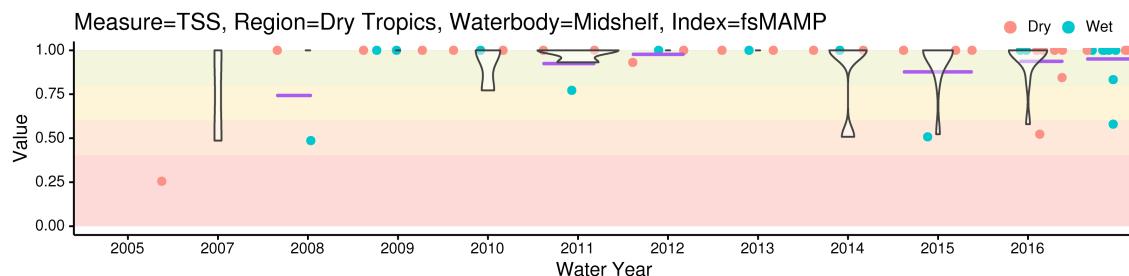
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

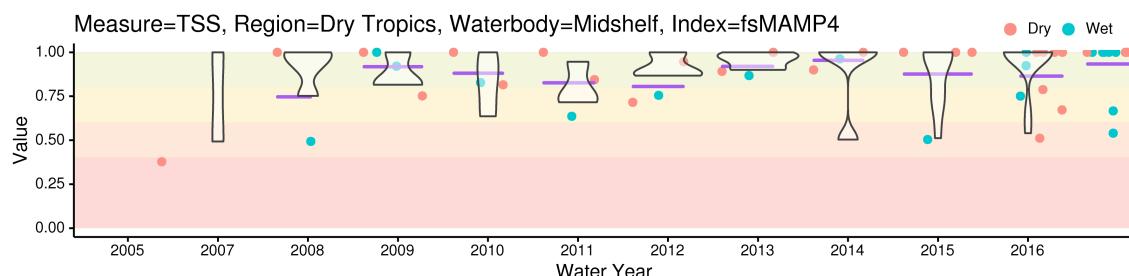
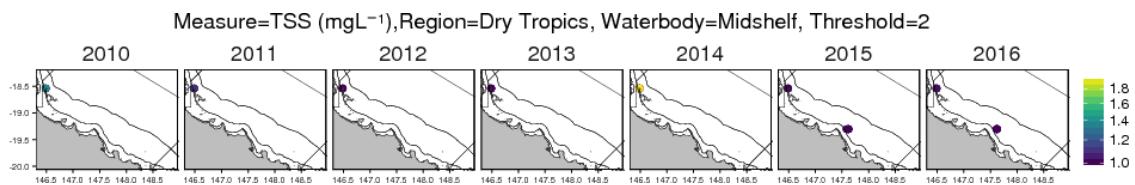
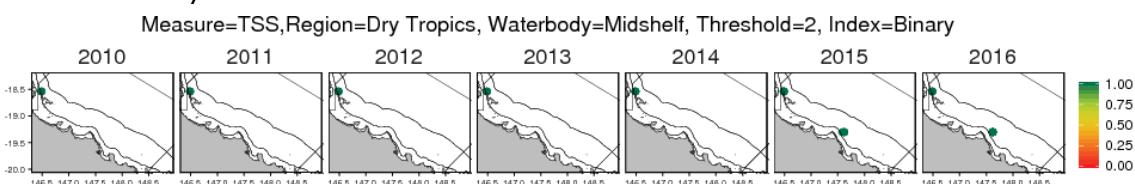


Figure C121: Temporal distribution of AIMS insitu Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

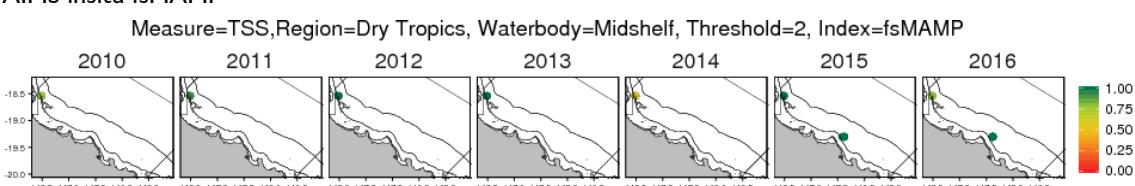
a) AIMS insitu raw data



b) AIMS insitu Binary



c) AIMS insitu fsMAMP



d) AIMS insitu fsMAMP4

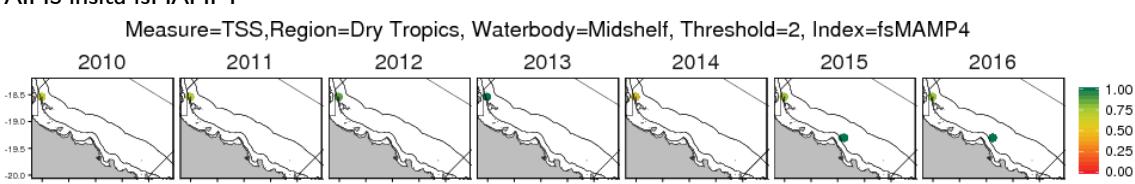
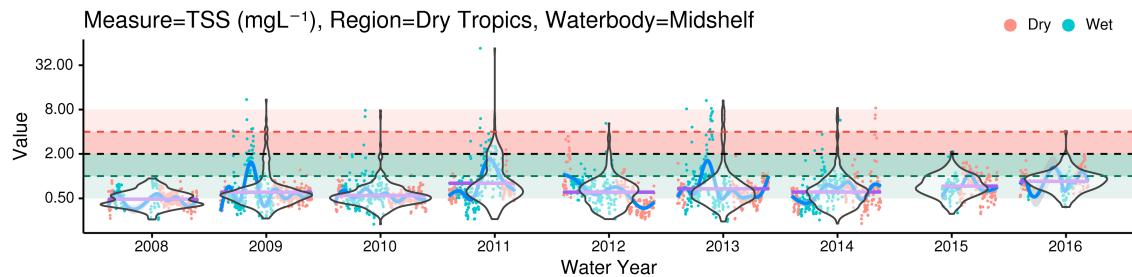
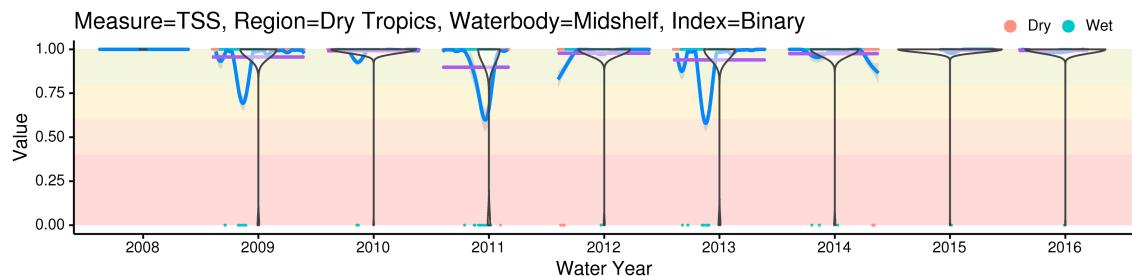


Figure C122: Spatial distribution of AIMS in situ Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

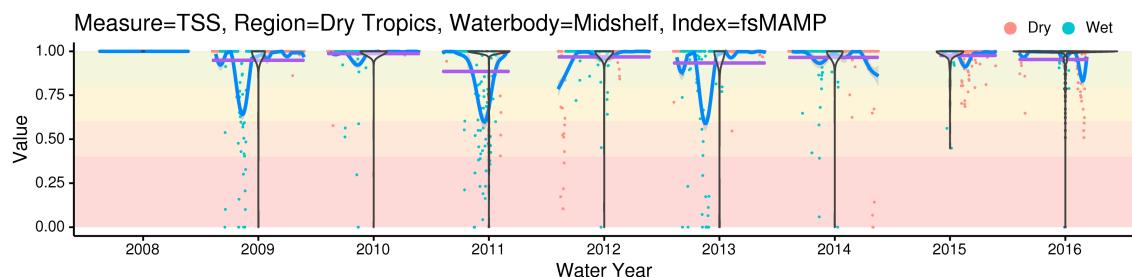
a) AIMS FLNTU raw site means



b) AIMS FLNTU site mean Binary



c) AIMS FLNTU site mean fsMAMP



d) AIMS FLNTU site mean fsMAMP4

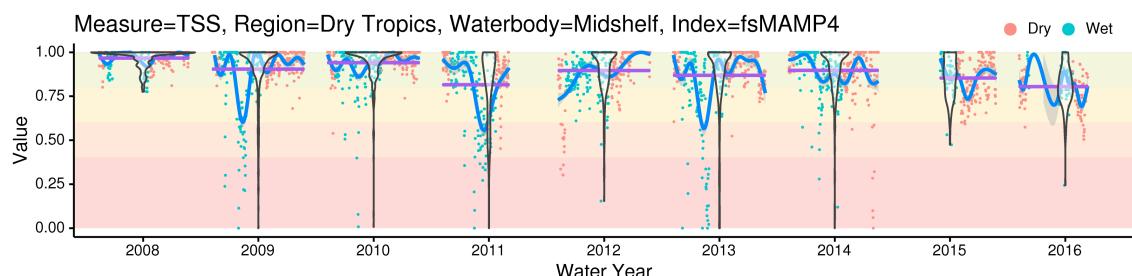
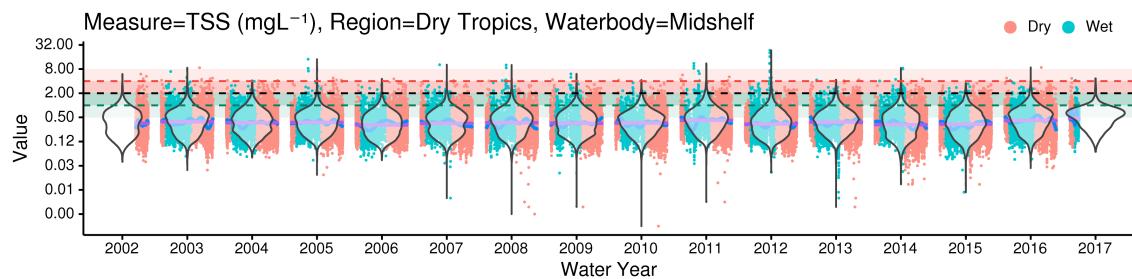
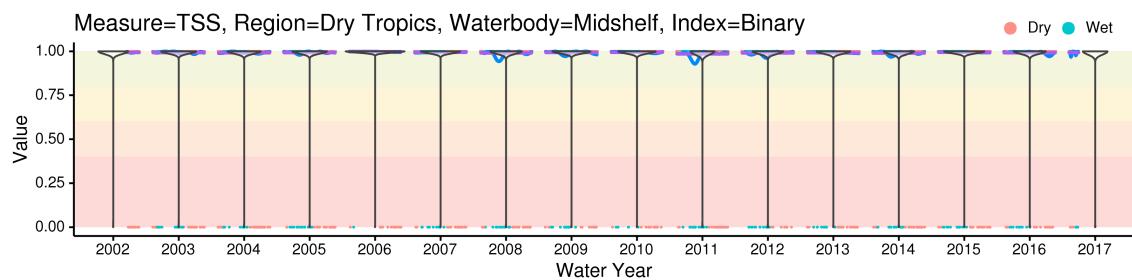


Figure C123: Temporal distribution of AIMS FLNTU Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

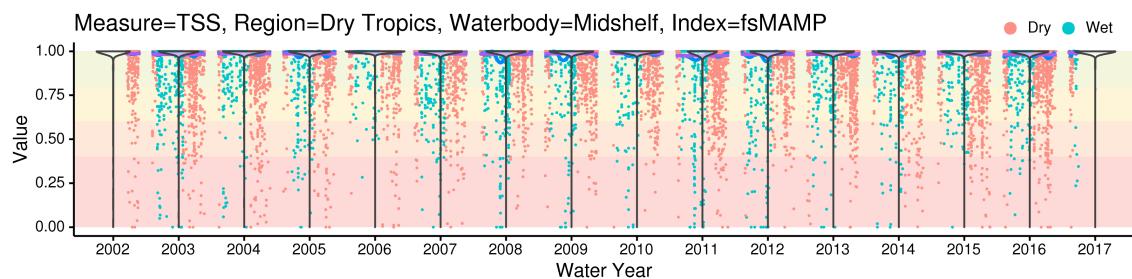
a) Satellite raw site means



b) Satellite site mean Binary



c) Satellite site mean fsMAMP



d) Satellite site mean fsMAMP4

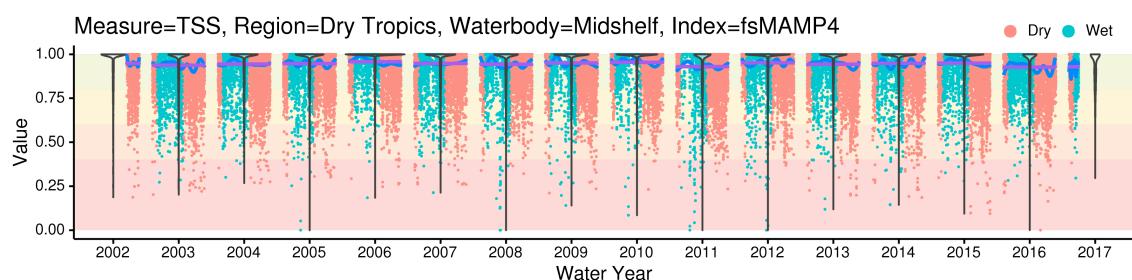
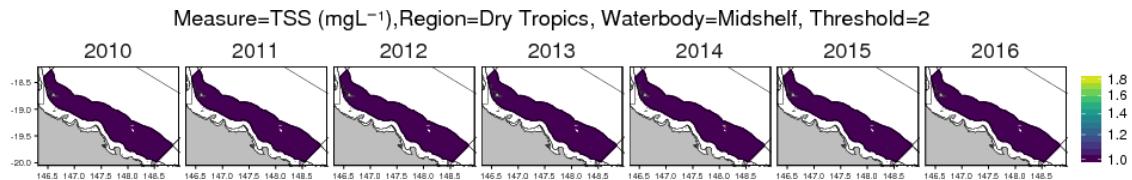
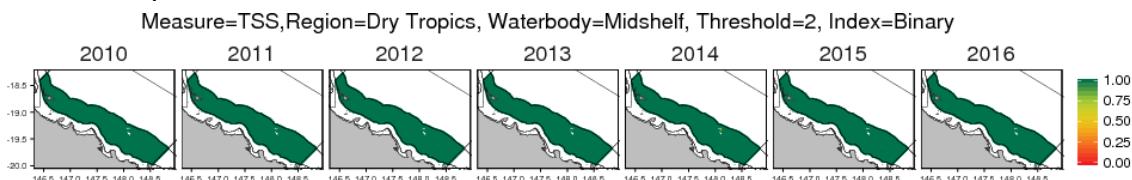


Figure C124: Temporal distribution of Satellite Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

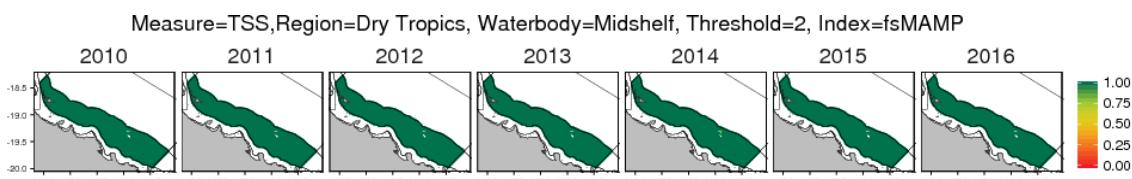
a) Satellite raw data



b) Satellite Binary



c) Satellite fsMAMP



d) Satellite fsMAMP4

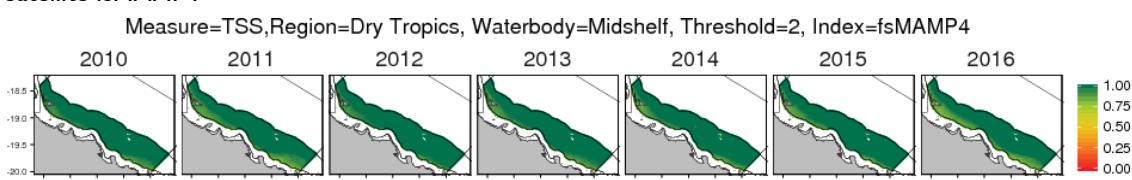
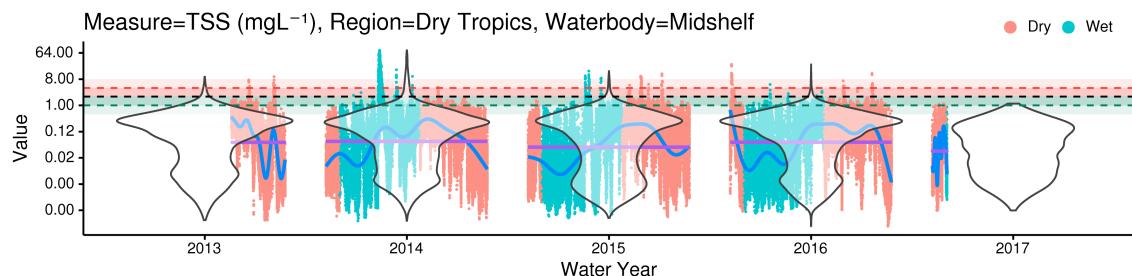
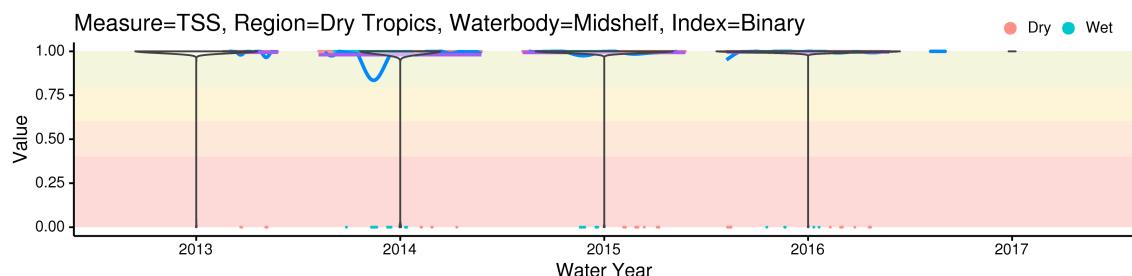


Figure C125: Spatial distribution of Satellite Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

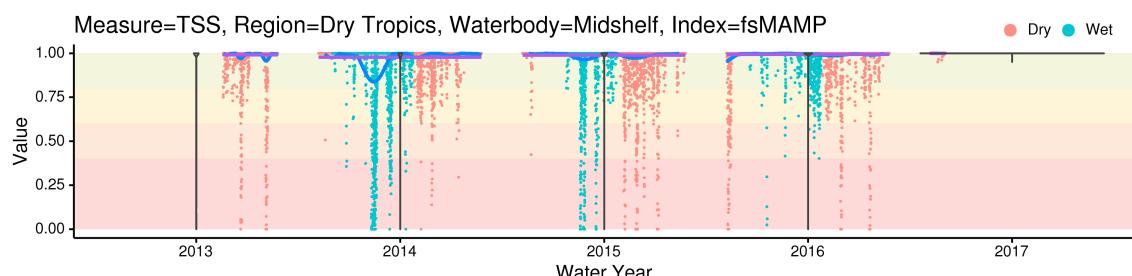
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

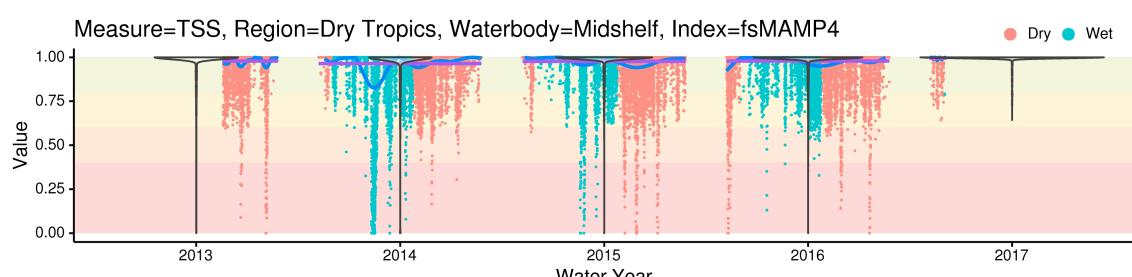
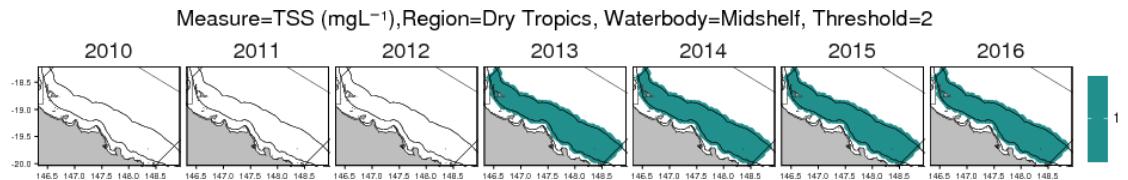
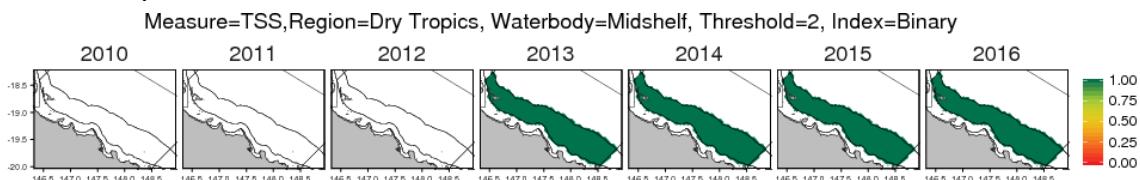


Figure C126: Temporal distribution of eReefs Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

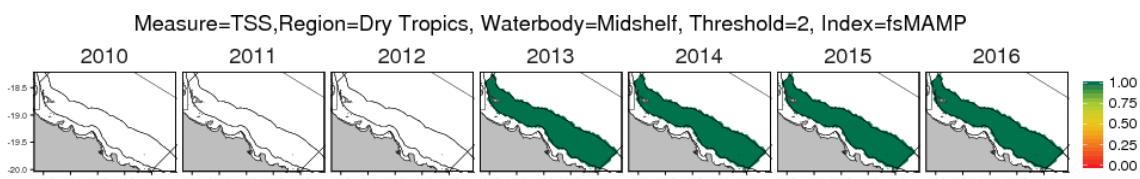
a) eReefs raw data



b) eReefs Binary



c) eReefs fsMAMP



d) eReefs fsMAMP4

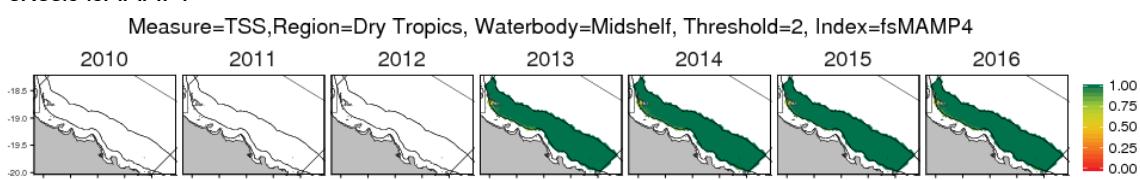
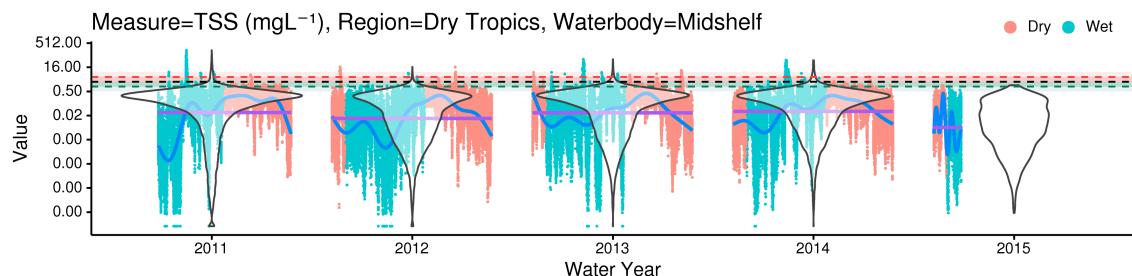
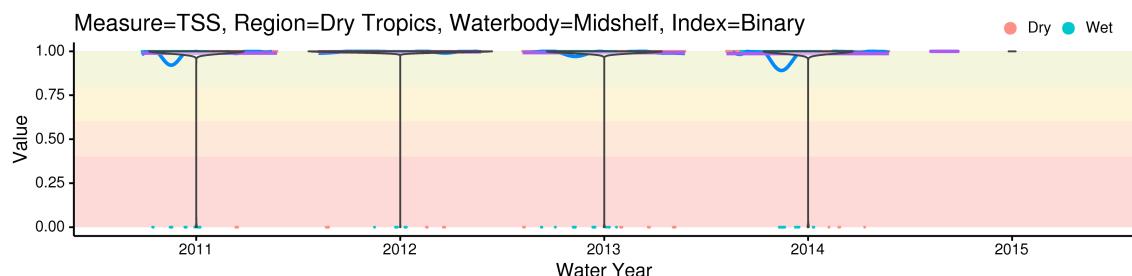


Figure C127: Spatial distribution of eReefs Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

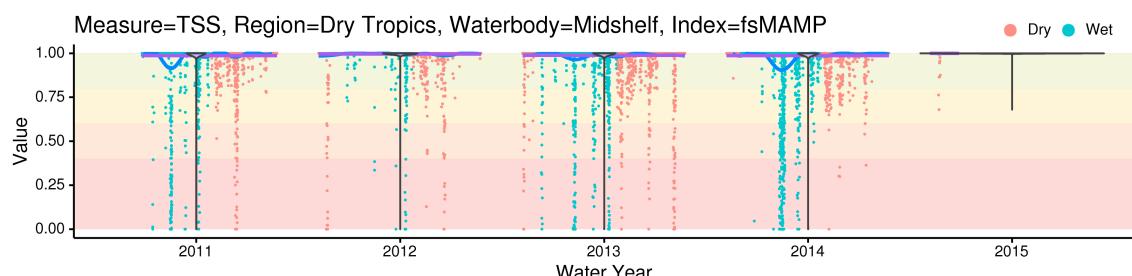
a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP



d) eReefs926 site mean fsMAMP4

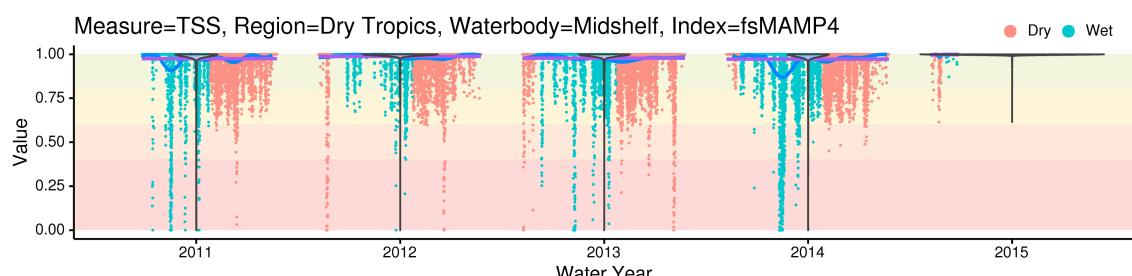


Figure C128: Temporal distribution of eReefs926 Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

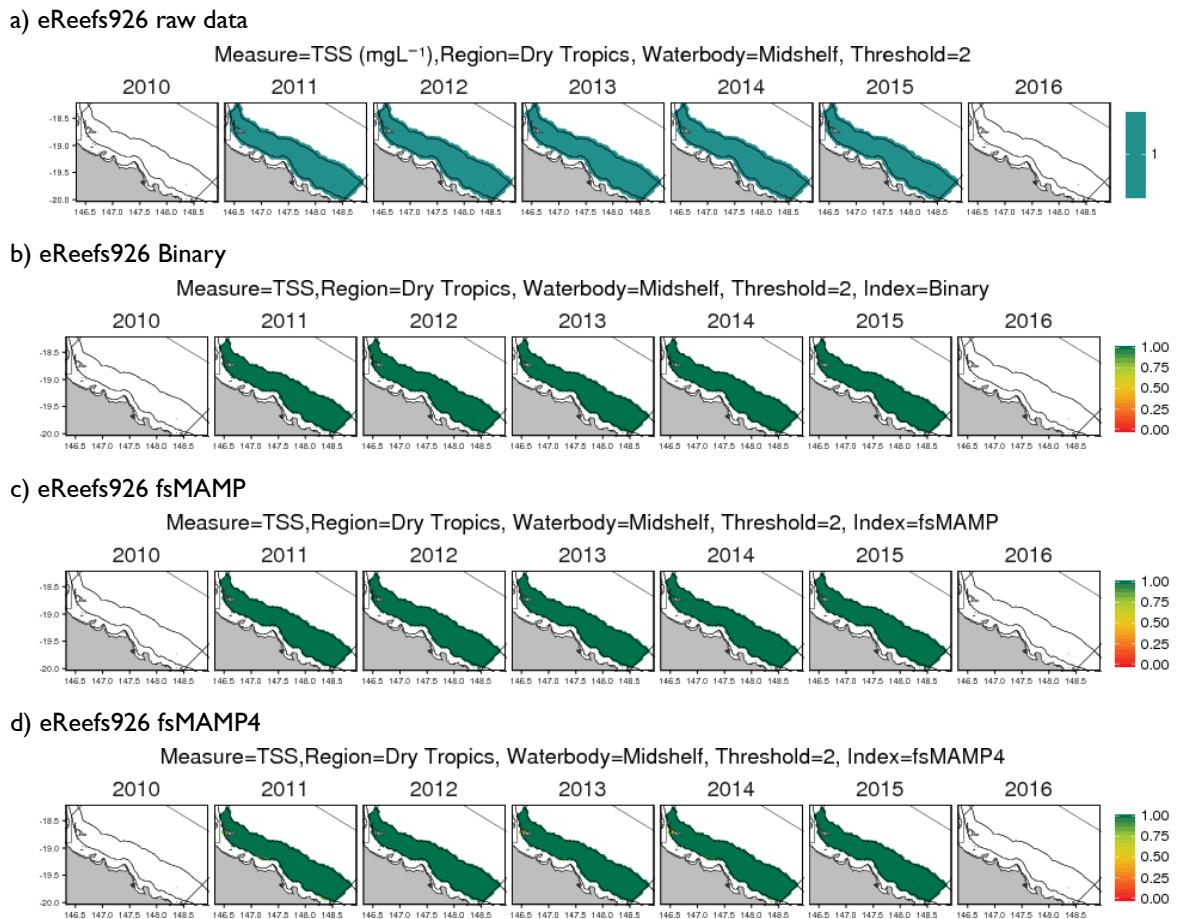
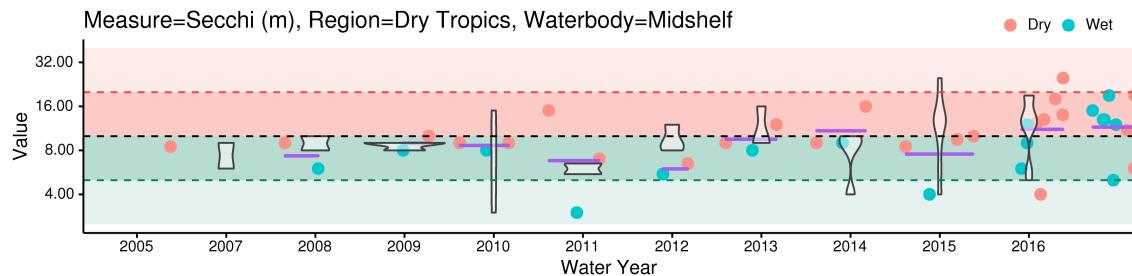


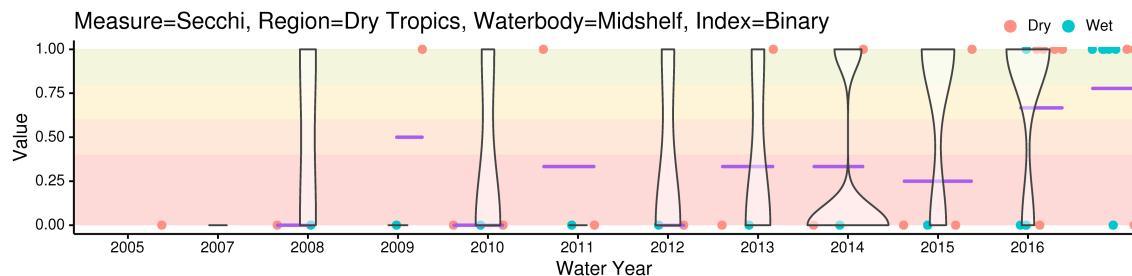
Figure C129: Spatial distribution of eReefs926 Total Suspended Solids a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

C.2.2.2 Secchi Depth, Dry Tropics Midshelf

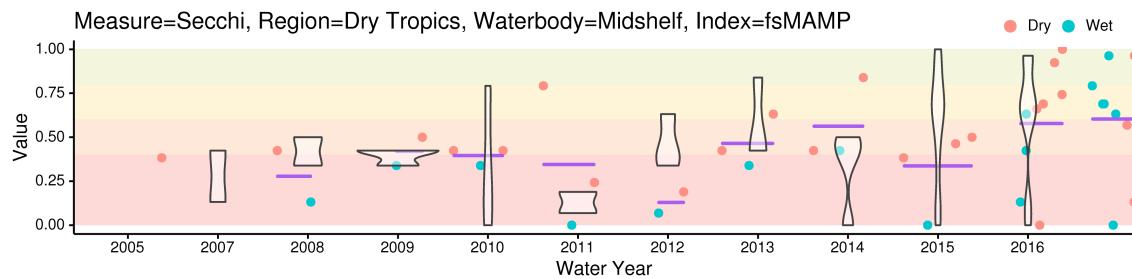
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

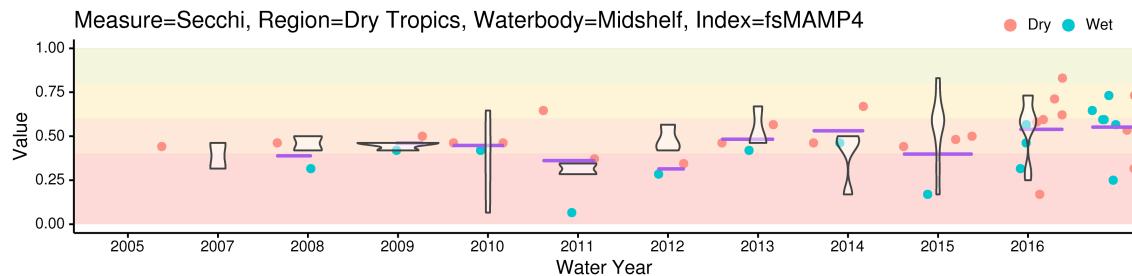
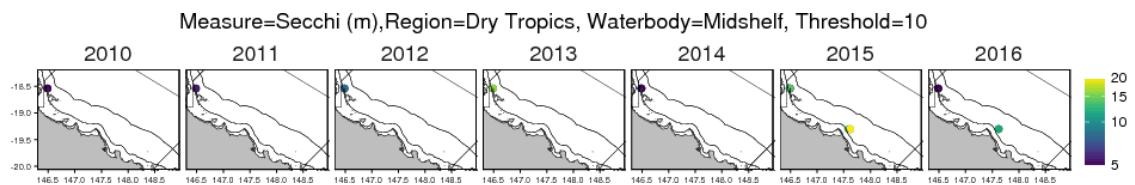
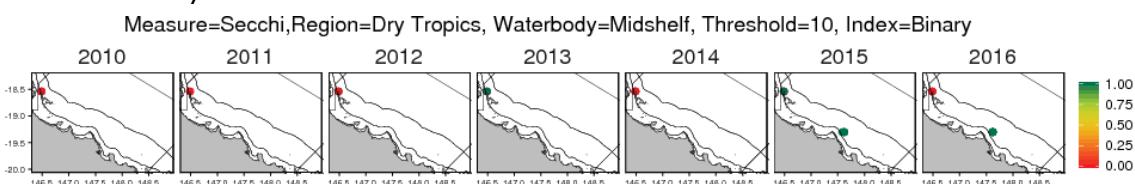


Figure C130: Temporal distribution of AIMS insitu Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

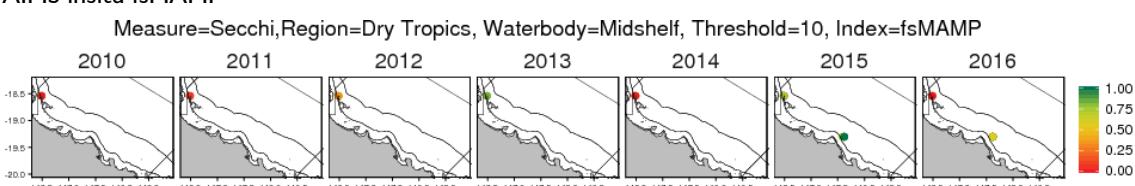
a) AIMS insitu raw data



b) AIMS insitu Binary



c) AIMS insitu fsMAMP



d) AIMS insitu fsMAMP4

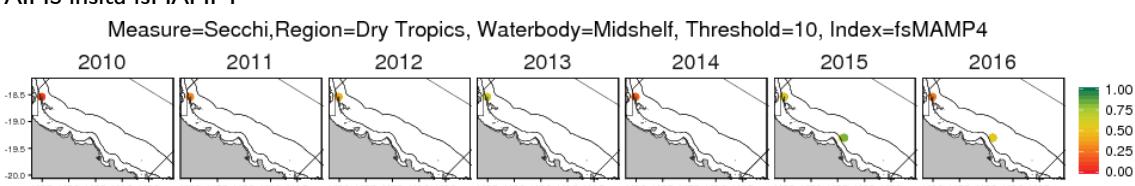
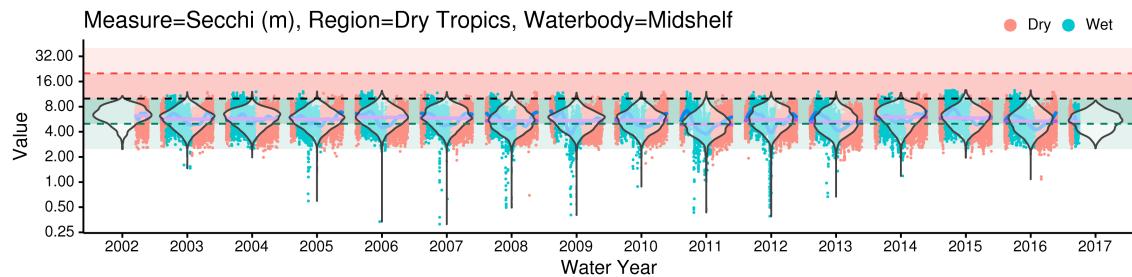
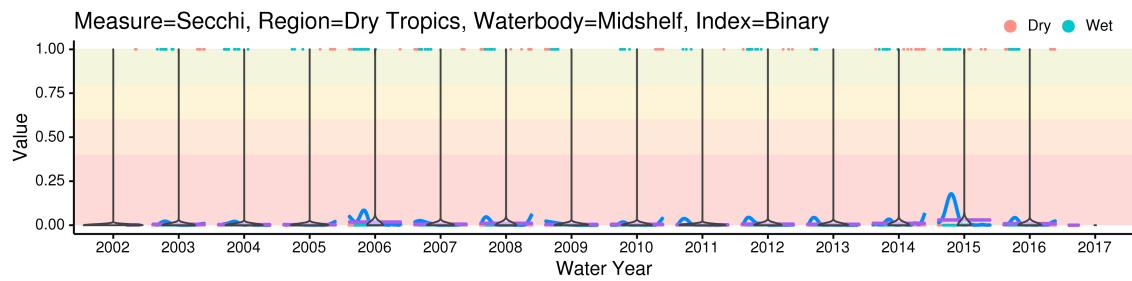


Figure C131: Spatial distribution of AIMS in situ Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

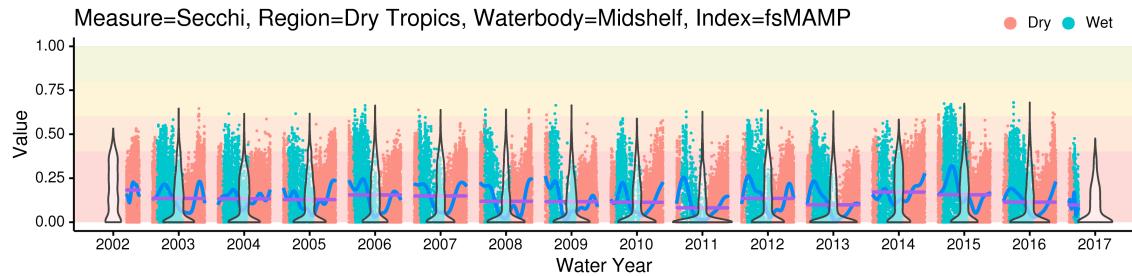
a) Satellite raw site means



b) Satellite site mean Binary



c) Satellite site mean fsMAMP



d) Satellite site mean fsMAMP4

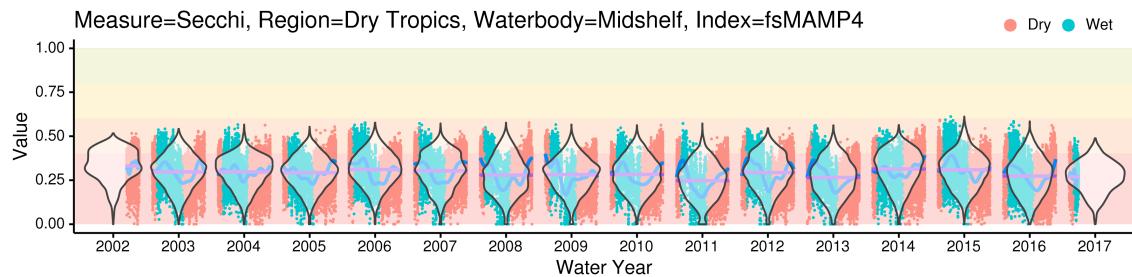
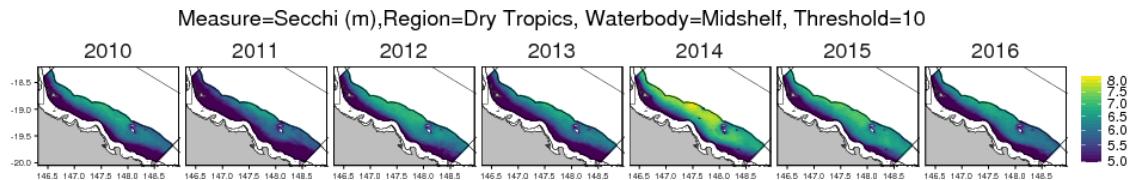
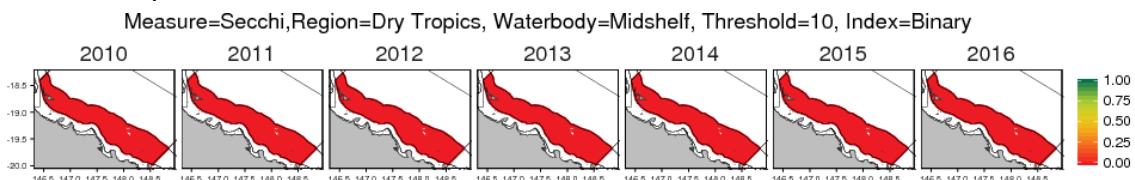


Figure C132: Temporal distribution of Satellite Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

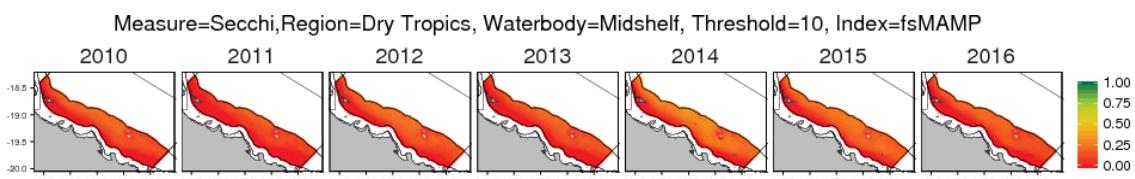
a) Satellite raw data



b) Satellite Binary



c) Satellite fsMAMP



d) Satellite fsMAMP4

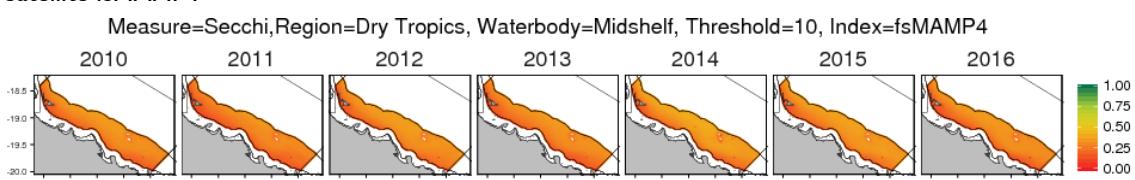
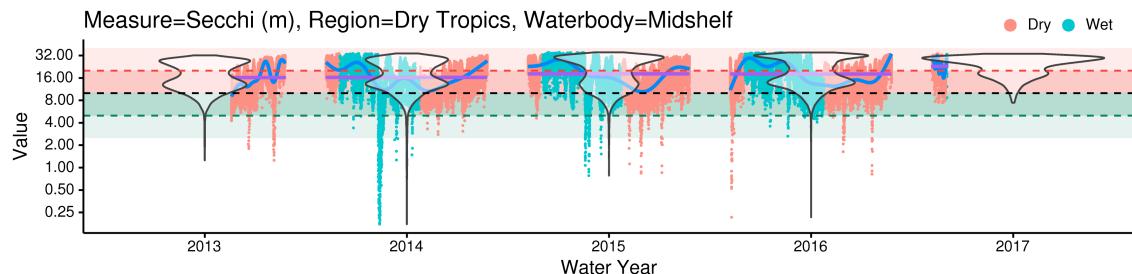
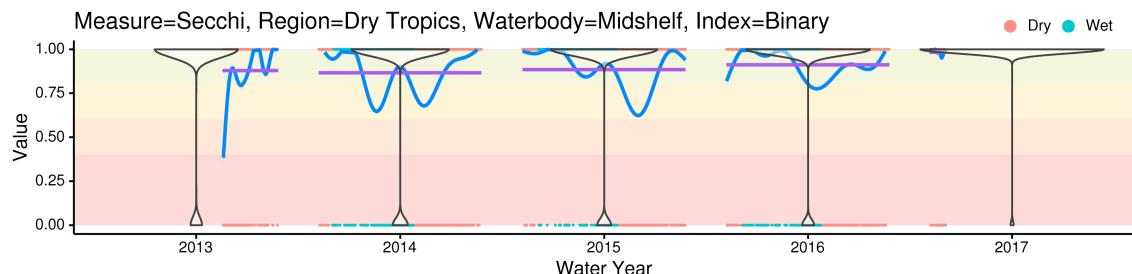


Figure C133: Spatial distribution of Satellite Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

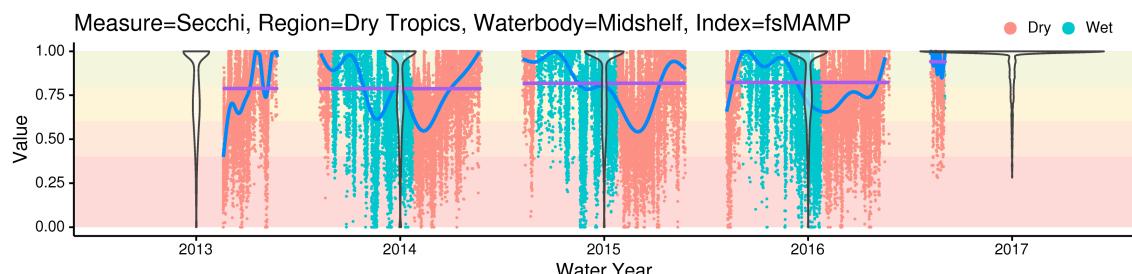
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

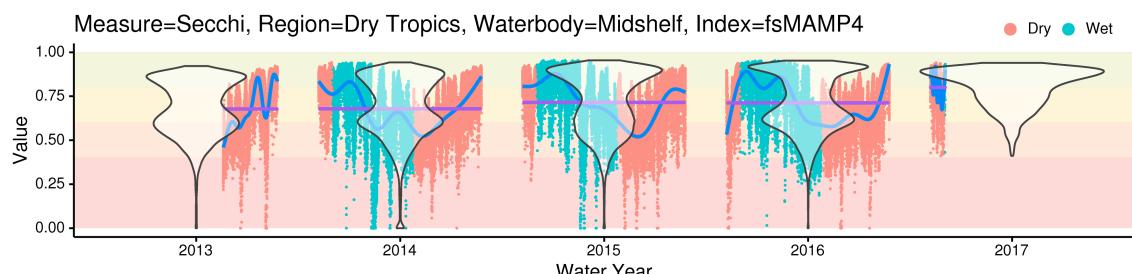
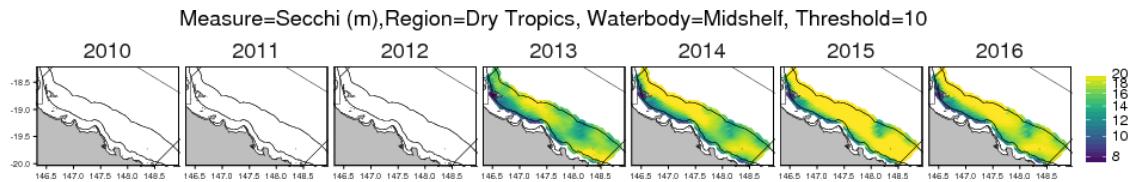
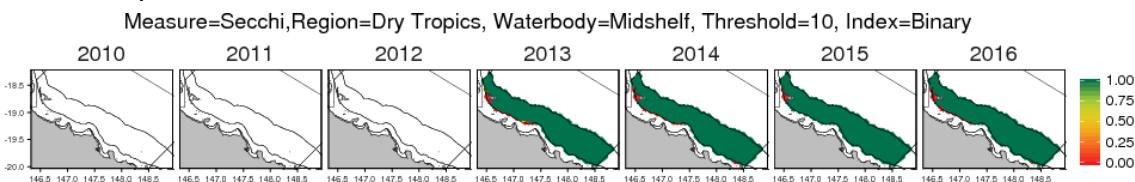


Figure C134: Temporal distribution of eReefs Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

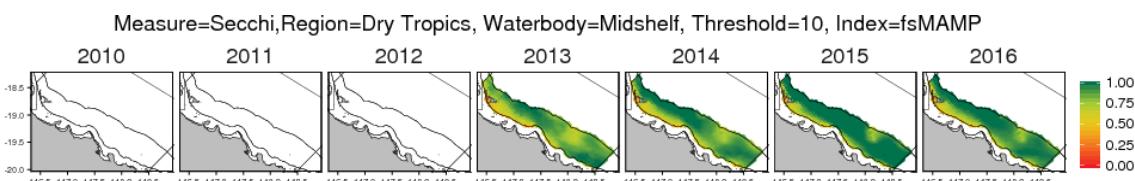
a) eReefs raw data



b) eReefs Binary



c) eReefs fsMAMP



d) eReefs fsMAMP4

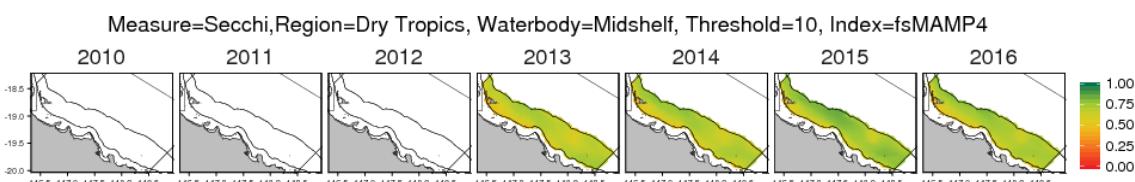
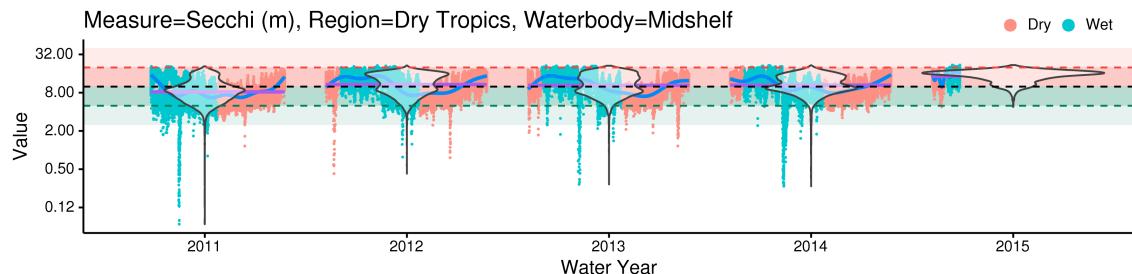
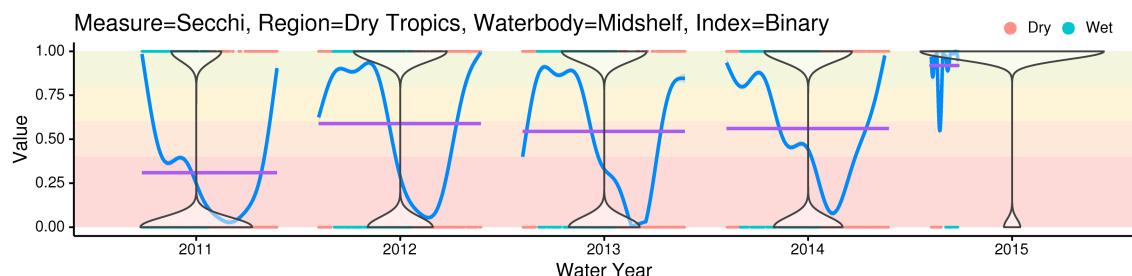


Figure C135: Spatial distribution of eReefs Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

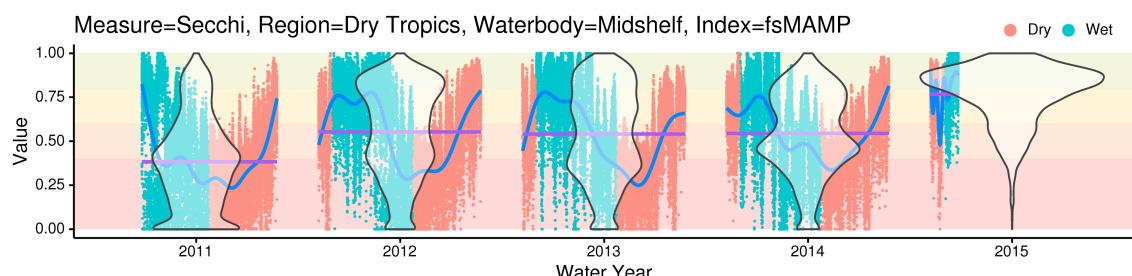
a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP



d) eReefs926 site mean fsMAMP4

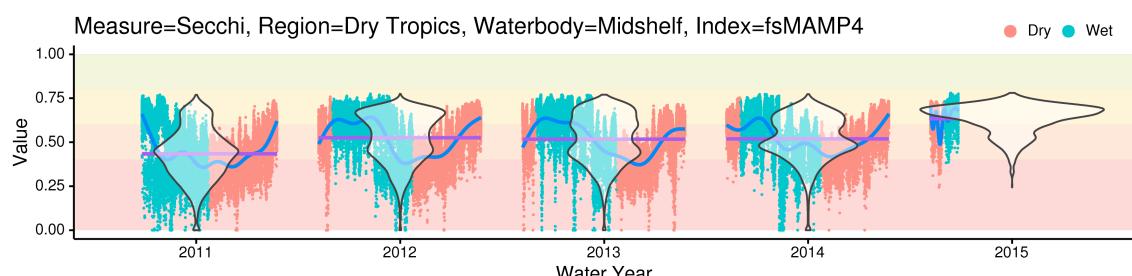
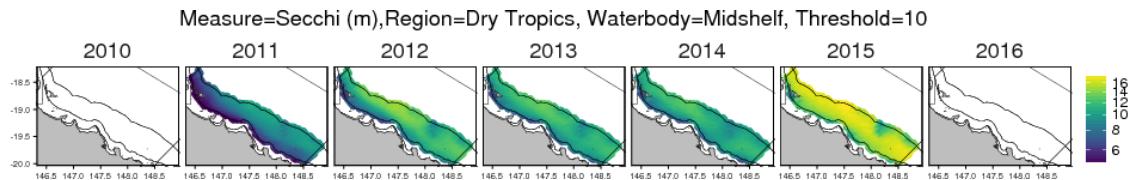
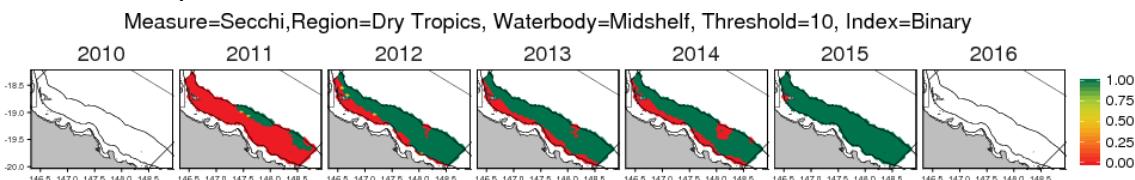


Figure C136: Temporal distribution of eReefs926 Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

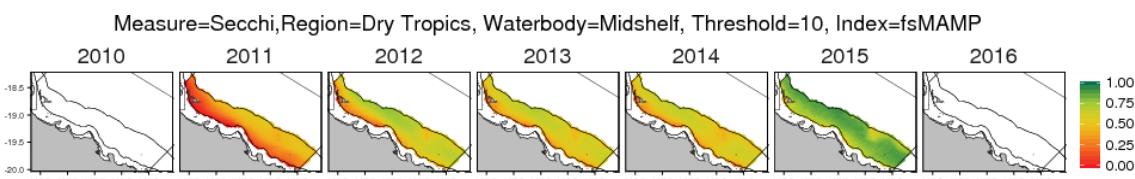
a) eReefs926 raw data



b) eReefs926 Binary



c) eReefs926 fsMAMP



d) eReefs926 fsMAMP4

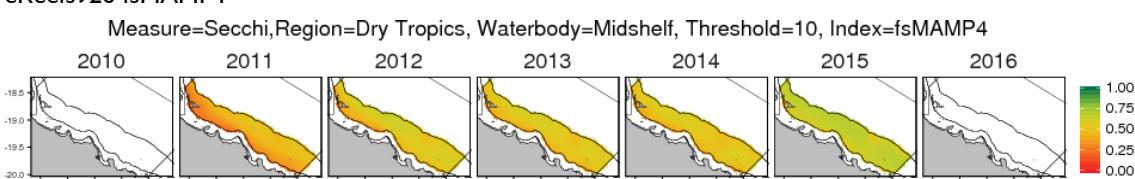
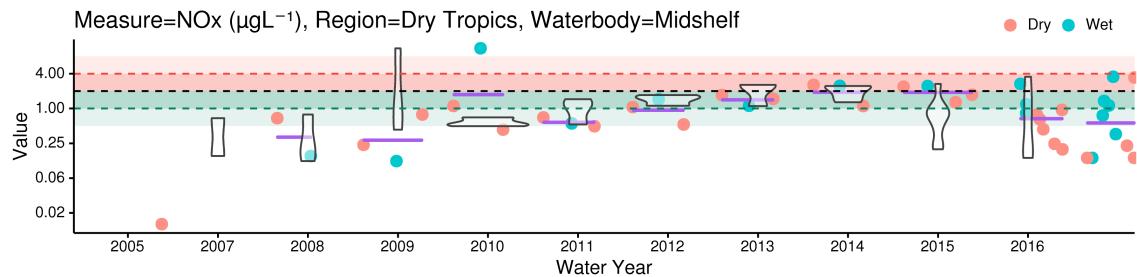


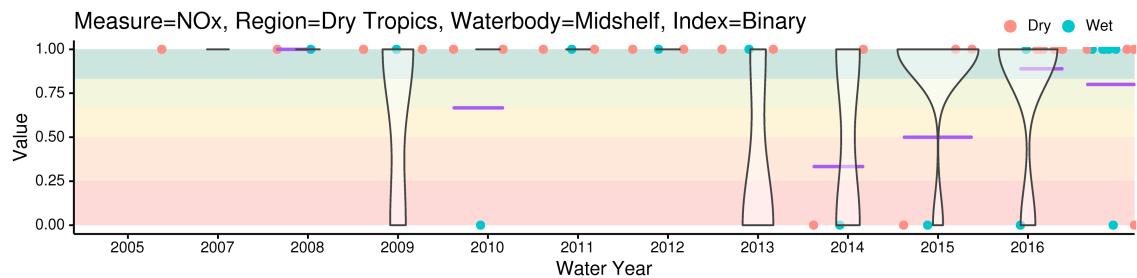
Figure C137: Spatial distribution of eReefs926 Secchi Depth a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

C.2.2.3 NOx, Dry Tropics Midshelf

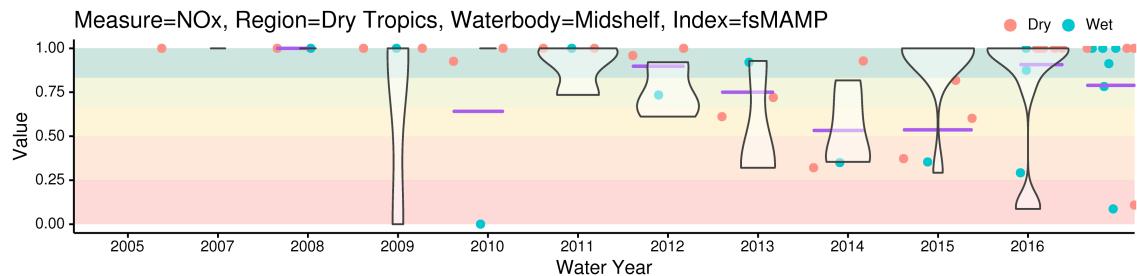
a) AIMS insitu site means



b) AIMS insitu site mean Binary



c) AIMS insitu site mean fsMAMP



d) AIMS insitu site mean fsMAMP4

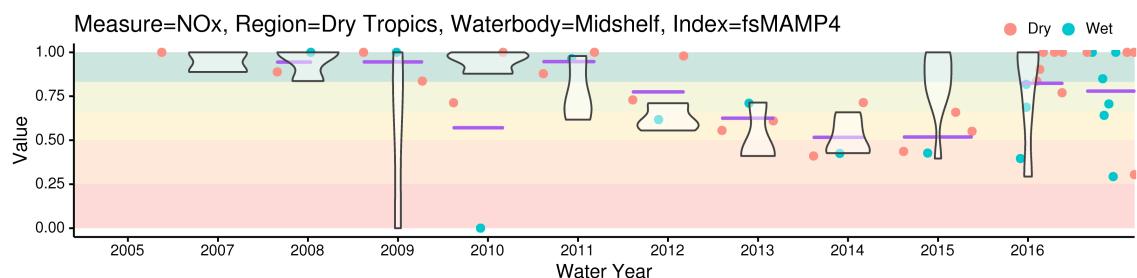
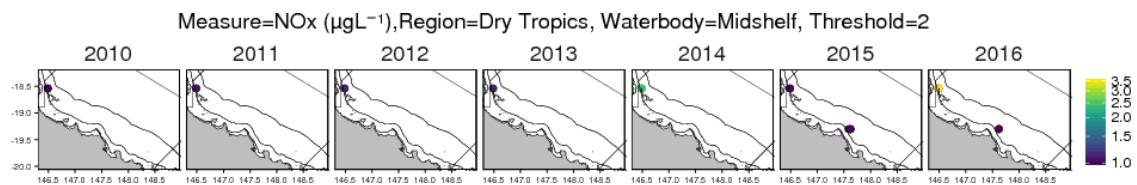
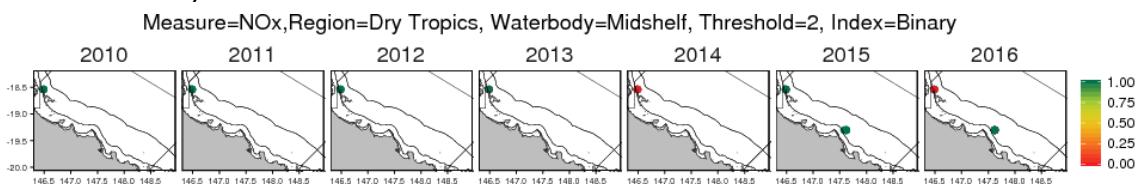


Figure C138: Temporal distribution of AIMS insitu NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

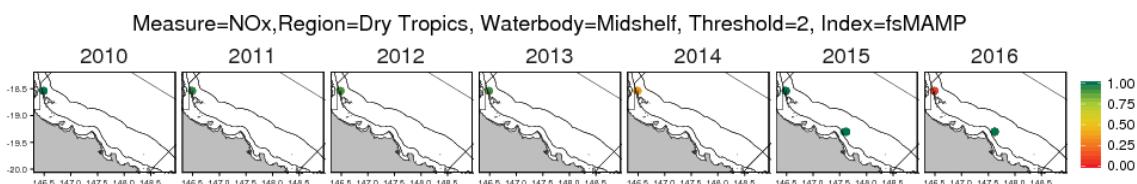
a) AIMS insitu raw data



b) AIMS insitu Binary



c) AIMS insitu fsMAMP



d) AIMS insitu fsMAMP4

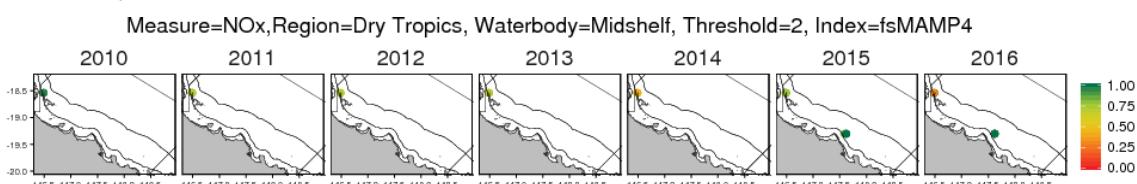
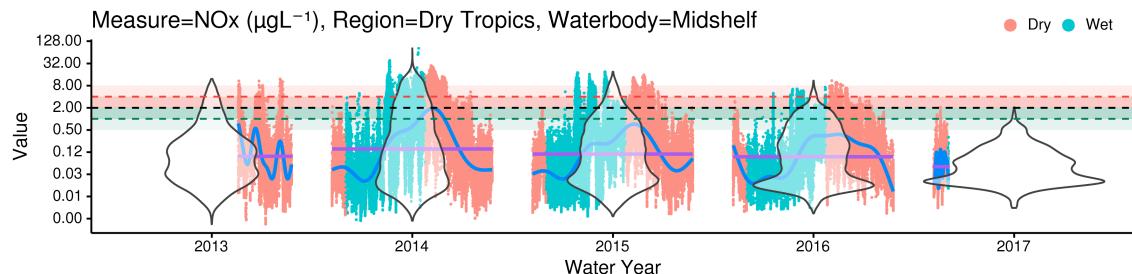
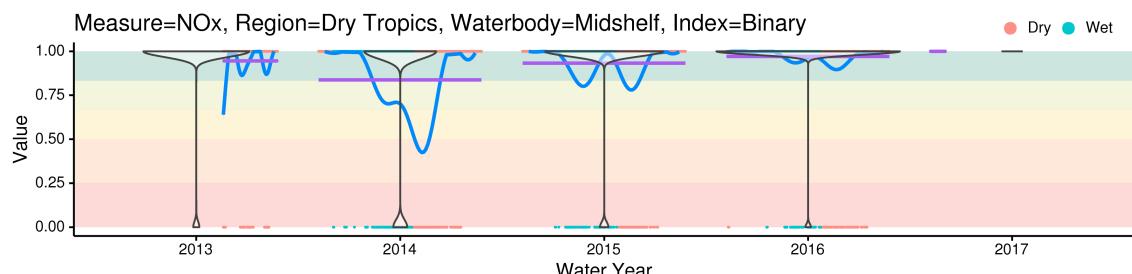


Figure C139: Spatial distribution of AIMS in situ NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Dry Tropics Midshelf zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

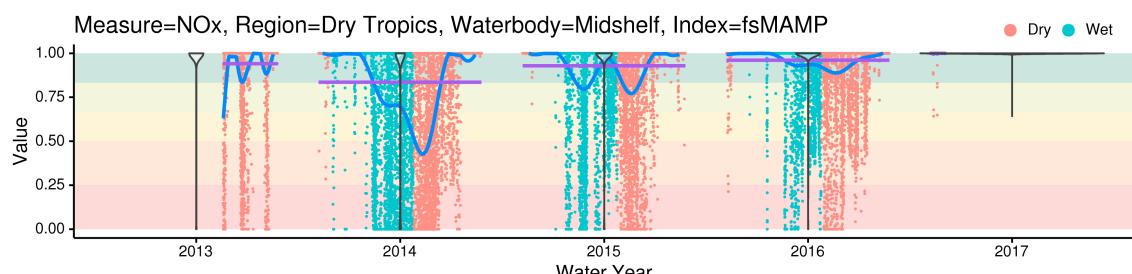
a) eReefs raw site means



b) eReefs site mean Binary



c) eReefs site mean fsMAMP



d) eReefs site mean fsMAMP4

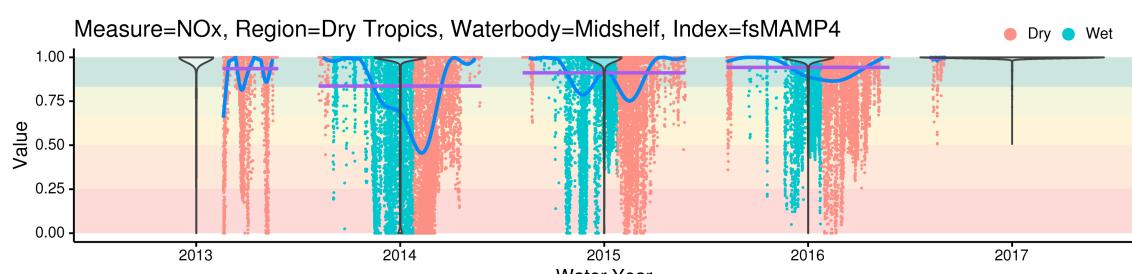
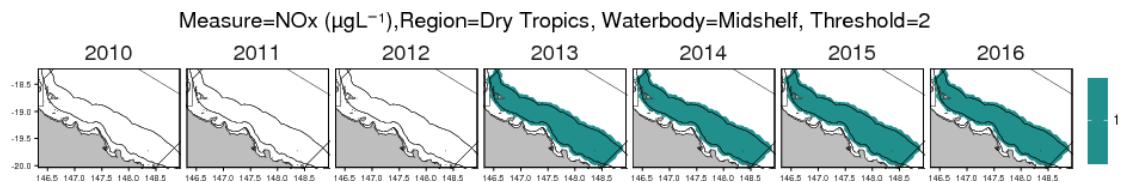
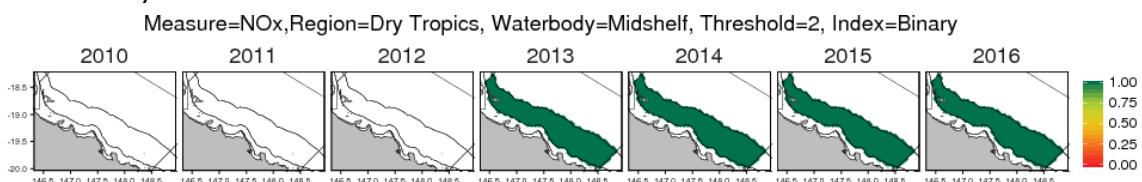


Figure C140: Temporal distribution of eReefs NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

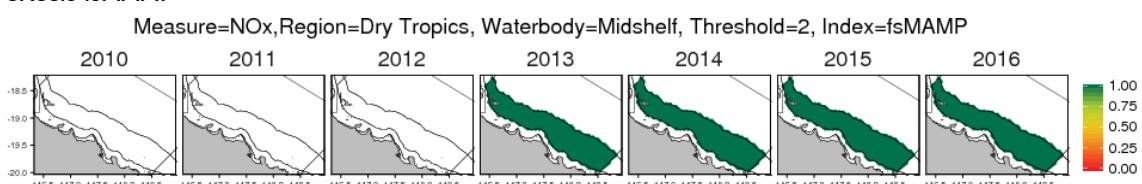
a) eReefs raw data



b) eReefs Binary



c) eReefs fsMAMP



d) eReefs fsMAMP4

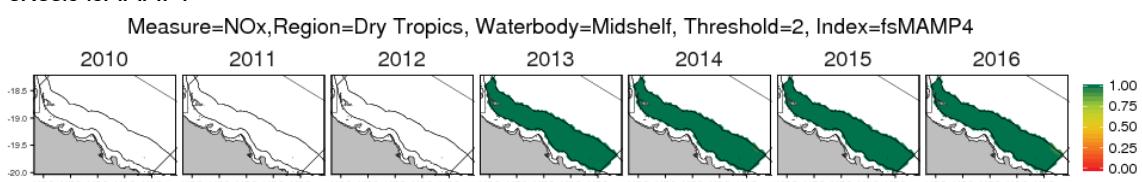
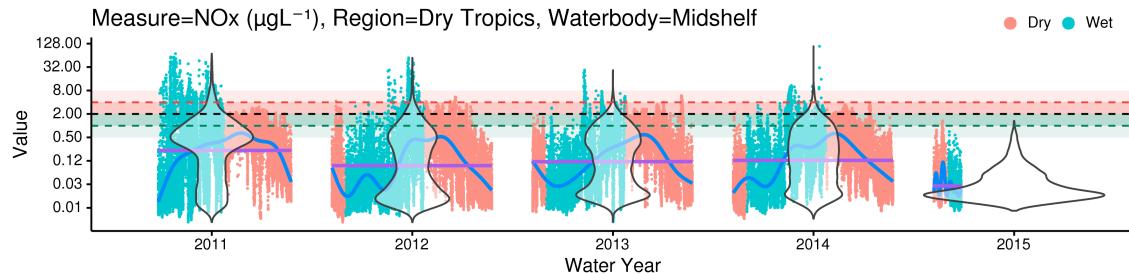
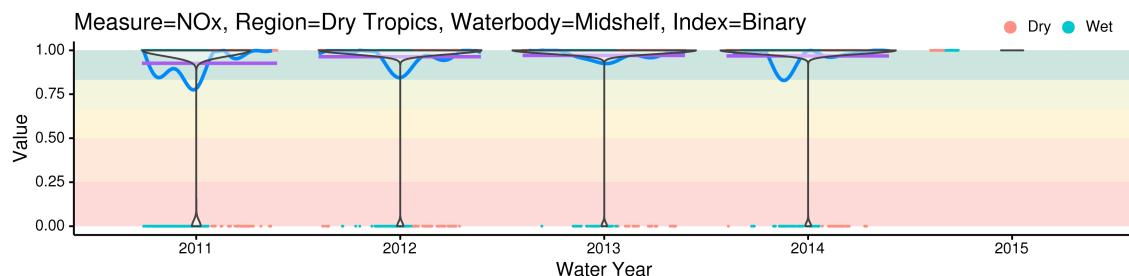


Figure C141: Spatial distribution of eReefs NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Dry Tropics Midshelf zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.

a) eReefs926 raw site means



b) eReefs926 site mean Binary



c) eReefs926 site mean fsMAMP

d) eReefs926 site mean fsMAMP4

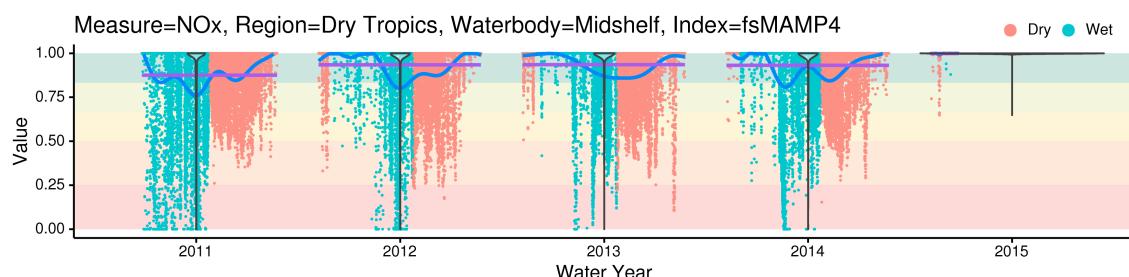
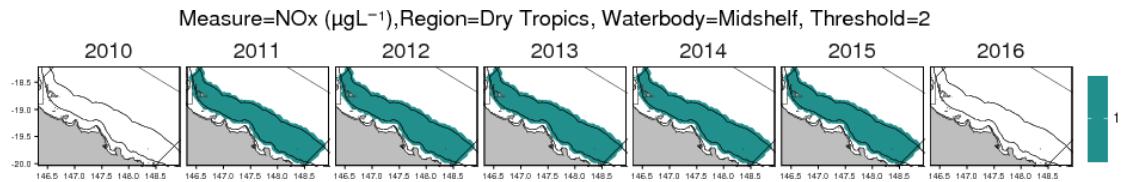
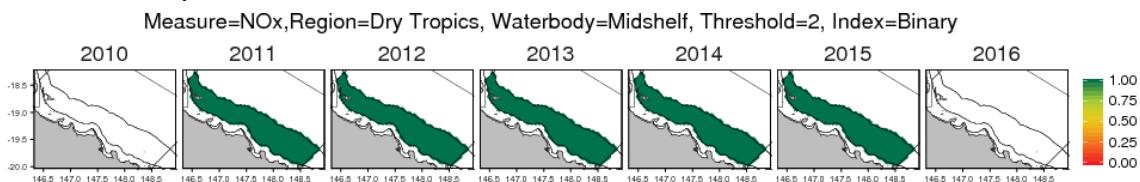


Figure C142: Temporal distribution of eReefs926 NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Wet Tropics Open Coastal zone. Red and Blue symbols represent samples collected in Dry and Wet seasons respectively. Green and red shaded banding on a) respectively represent half and twice threshold value (50% shading) and one-fourth and four times threshold value (30% shading). Traffic-light banding on b-d) indicates simple 5-level color scheme. Purple lines represent annual means.

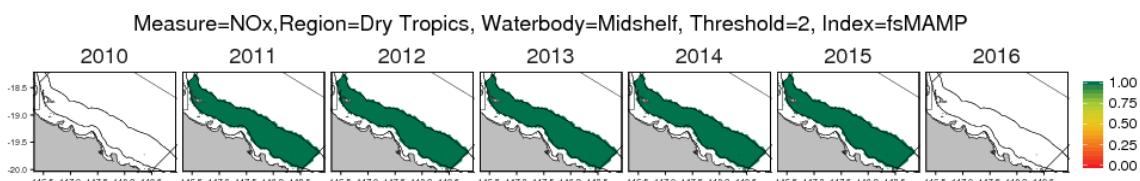
a) eReefs926 raw data



b) eReefs926 Binary



c) eReefs926 fsMAMP



d) eReefs926 fsMAMP4

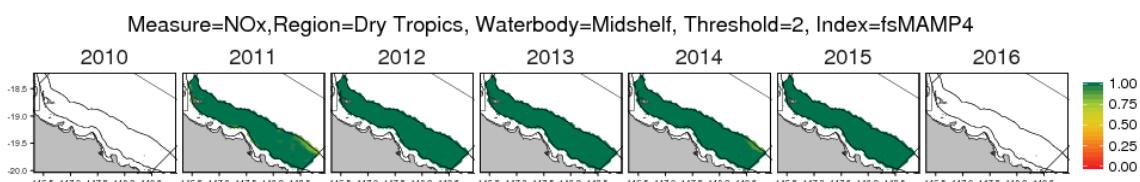


Figure C143: Spatial distribution of eReefs926 NOx a) samples and associated b) Binary, c) fsMAMP and d) fsMAMP4 index formulations for the Dry Tropics Midshelf zone. Color bars scaled to half (green) and twice (red) threshold value for raw data and 1 (green) and 0 (red) for Binary, fsMAMP and fsMAMP4.