After (during and before) the Storm:
Comparing SSH Data Systems

[Speaker Zoom video]

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Research Question & Hypothesis

[Speaker Zoom video]

Is there correlation between ECCO data and TG data before, during and after severe storm impact events?

Hypothesis 1: There is a linear relationship between ECCO and TG data during severe storm impact events

Hypothesis 2: There is no linear relationship between ECCO data and TG data during severe storm impact events

STEPS:

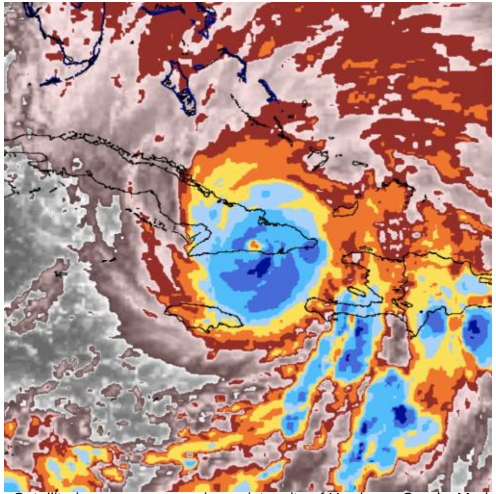
- Identify current network of TGs in our regions of interest (ROI)
- Compare ECCO and TG data recorded:
  - one month of data, one month *prior* to the beginning of extreme weather events
  - during the extreme weather events
  - one month of data, one month *after* the end of the extreme weather events
- Determine the correlation/linear relationship between the ECCO and TG data

Selected Storms

[Speaker Zoom video]

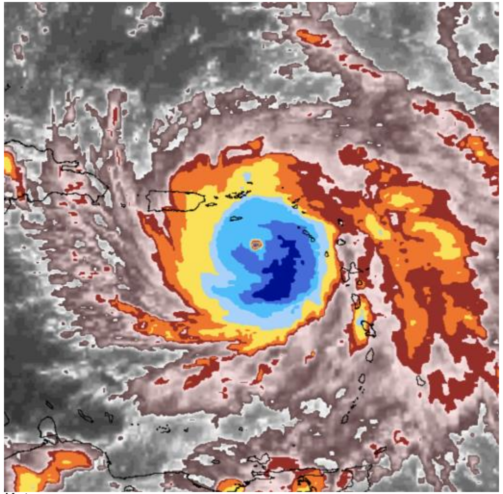
Hurricane Sandy New Jersey

Full Moon-Spring Tide
Landfall 30/10/2012 00Z



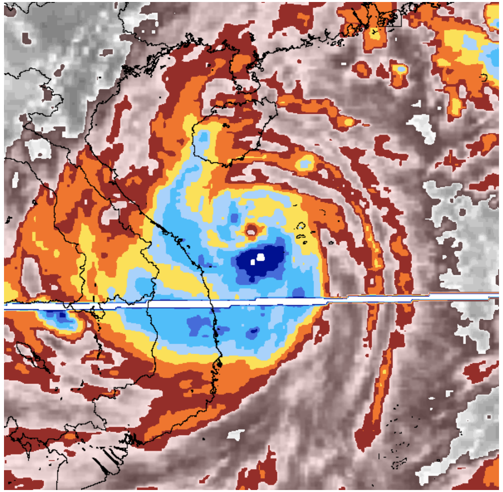
Hurricane Maria, PR and Caribbean

- New Moon-Spring Tide
- Landfall 20/9/2017 10Z



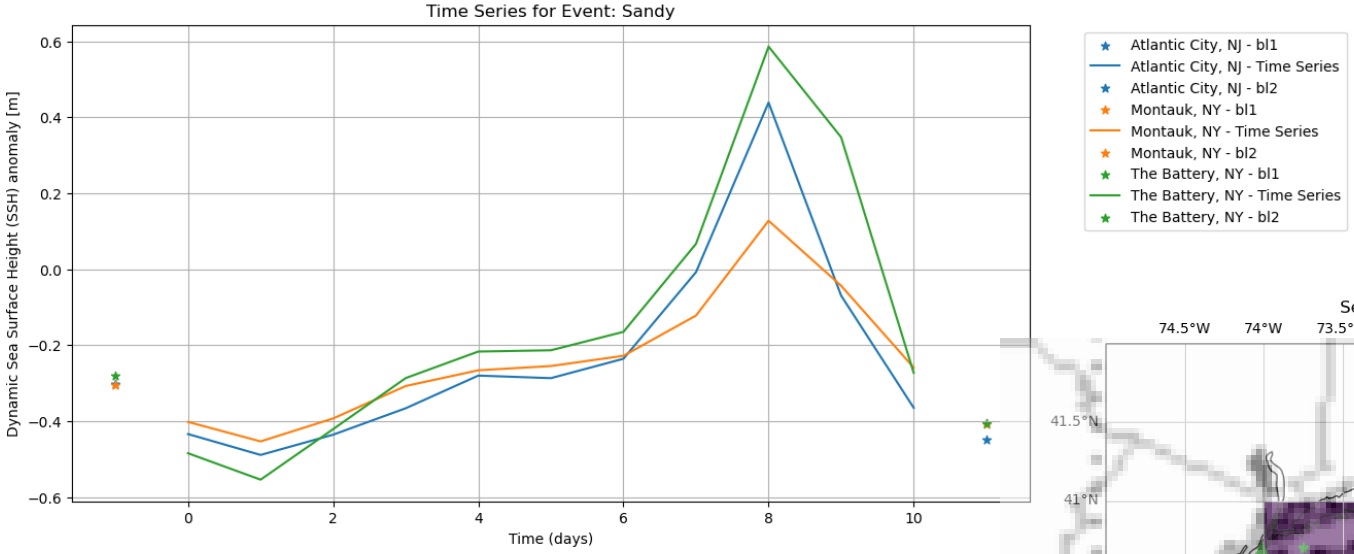
Typhoon Ketsana, Philippines and Vietnam

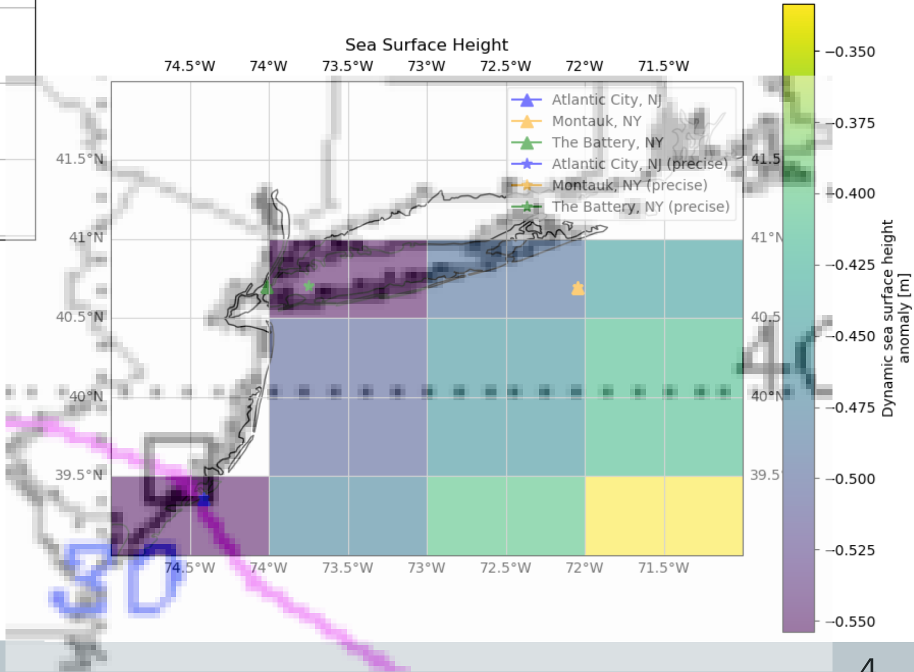
- Half moon waxing-Neap Tide
- Landfall 26/09/2009, 29/09/2009



Satellite imagery near maximum intensity of Hurricane Sandy, Maria, and Typhoon Ketsana
from Knapp, K. R., H. J. Diamond, J. P. Kossin, M. C. Kruk, C. J. Schreck, 2018: International Best Track Archive for Climate Stewardship (IBTrACS) Project, Version 4. [2012296N14283]. NOAA National Centers for Environmental Information.
doi:10.25921/82ty-9e16 [27/7/2023]

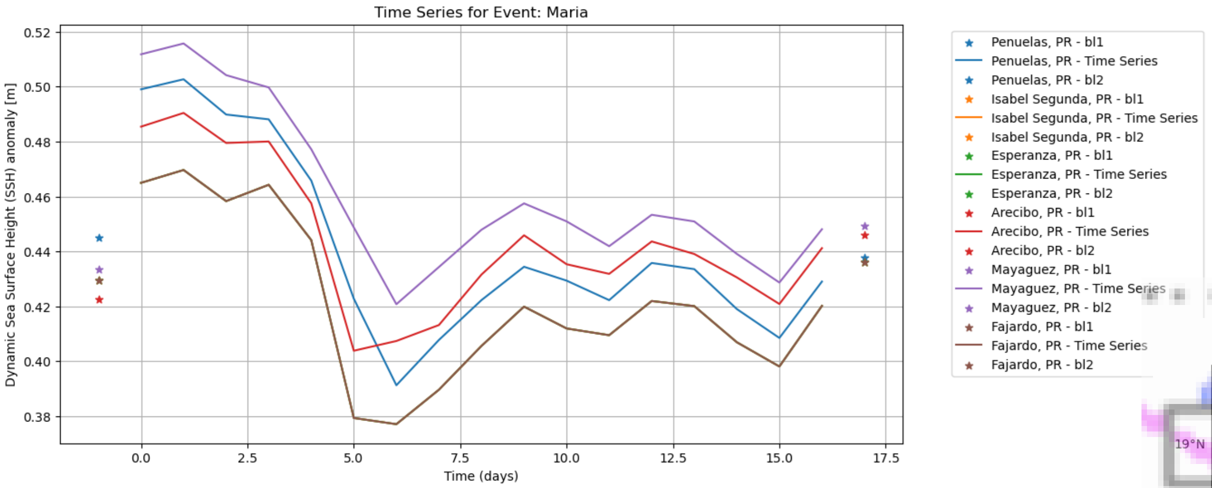
Hurricane Sandy

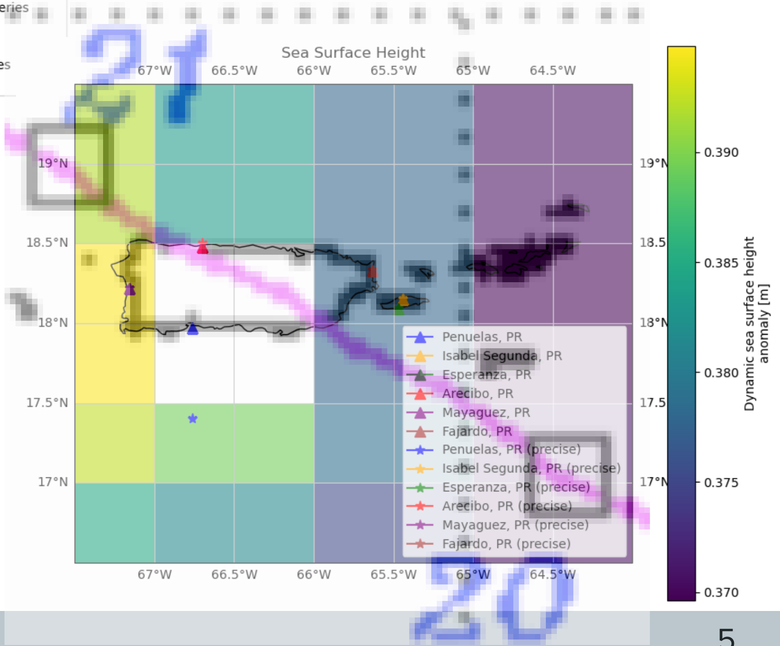




[Speaker Zoom video]

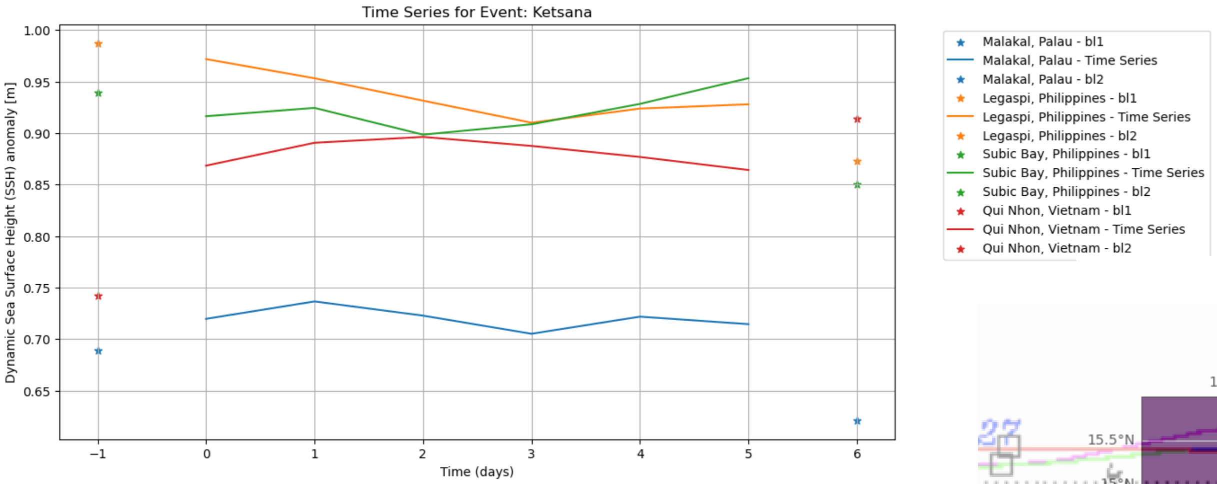
Hurricane Maria

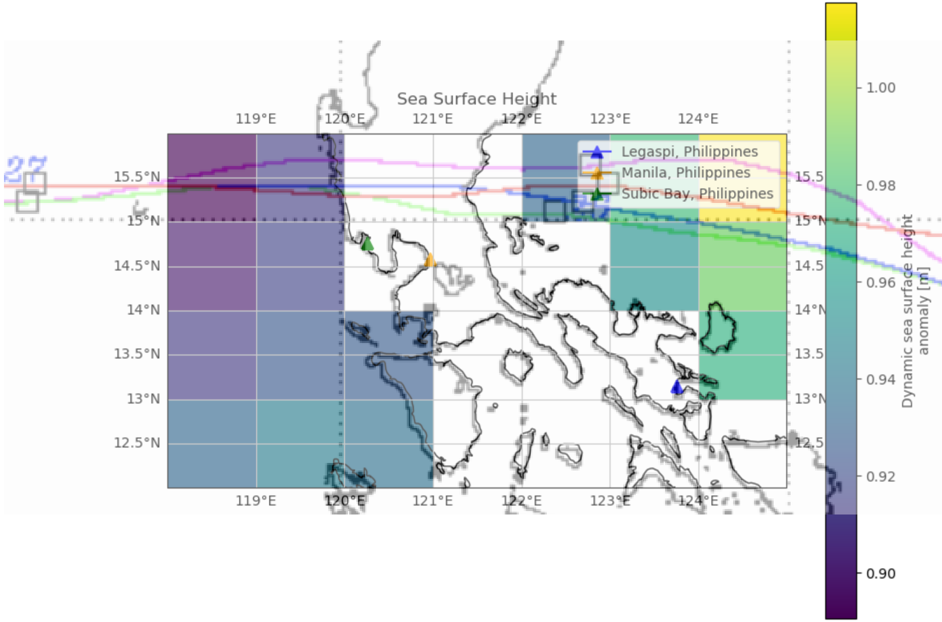




[Speaker Zoom video]

Typhoon Ketsana

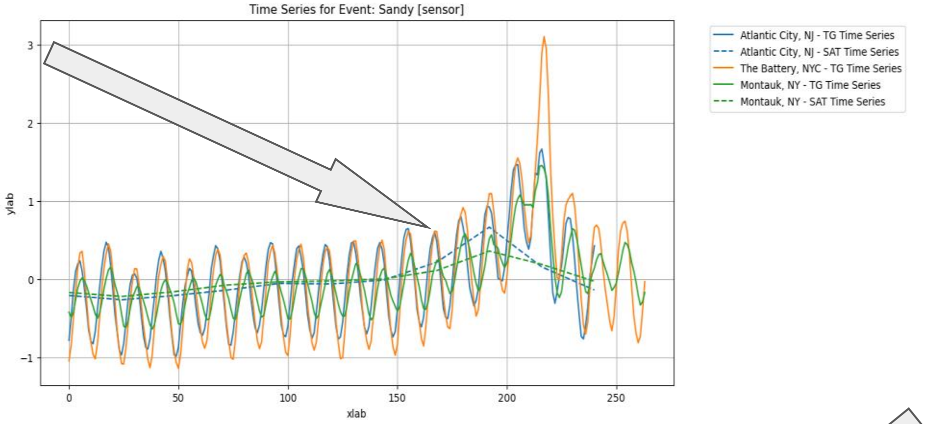




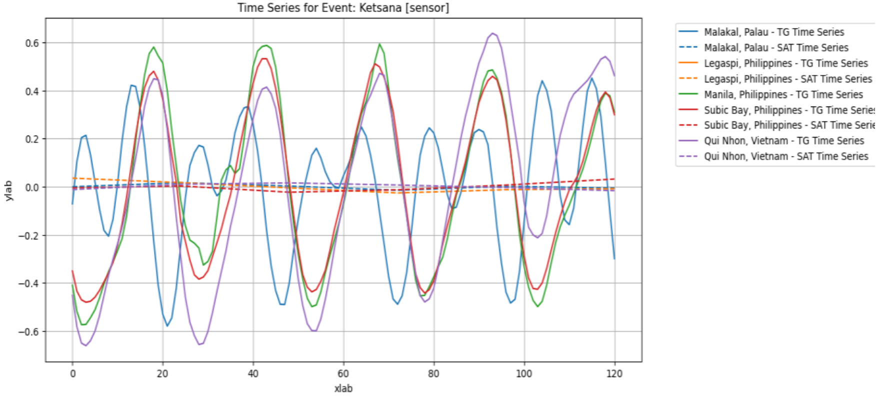
[Speaker Zoom video]

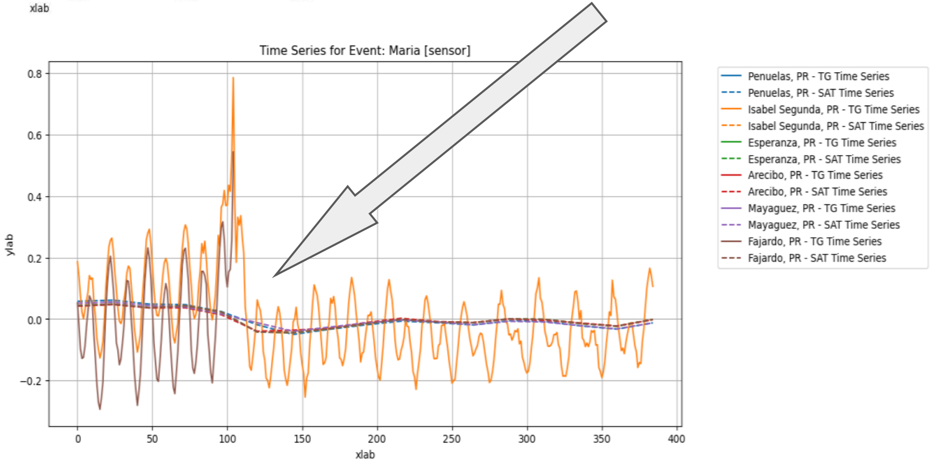
Normalized time series

ECCO & TG



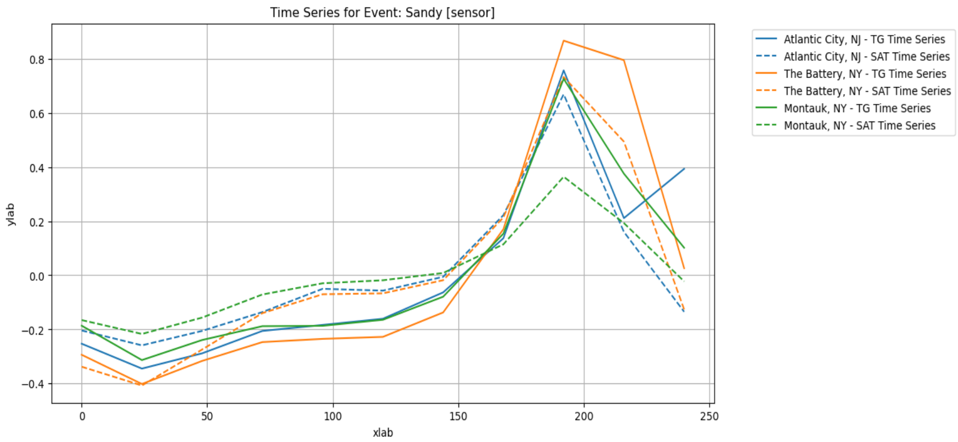
[Speaker Zoom video]



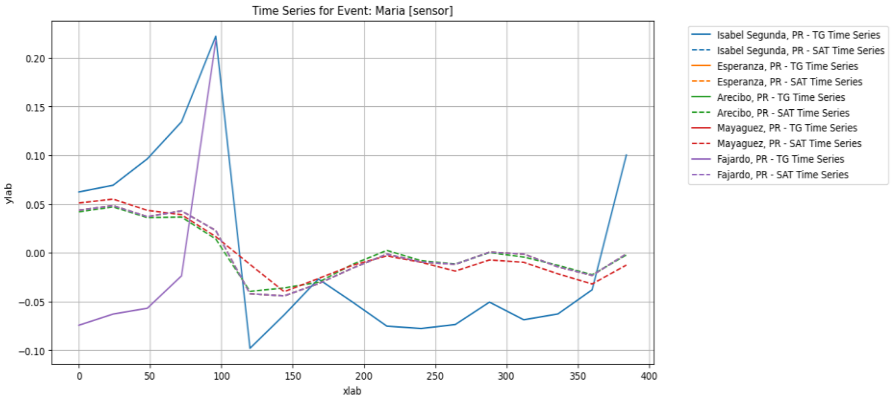


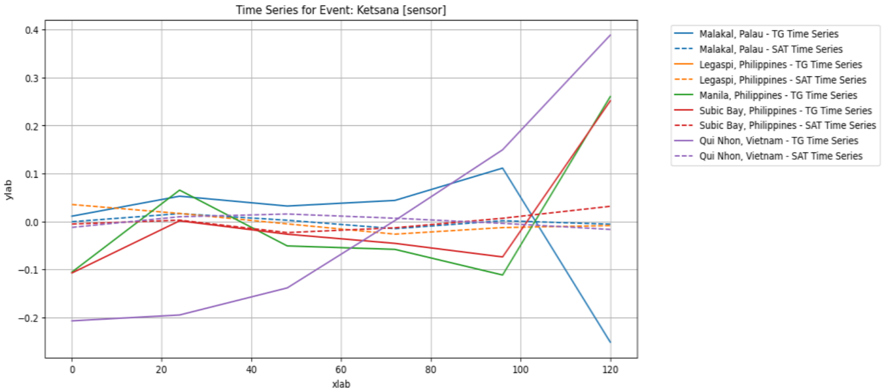
Normalized time series

ECCO & TG
(resampled)



[Speaker Zoom video]



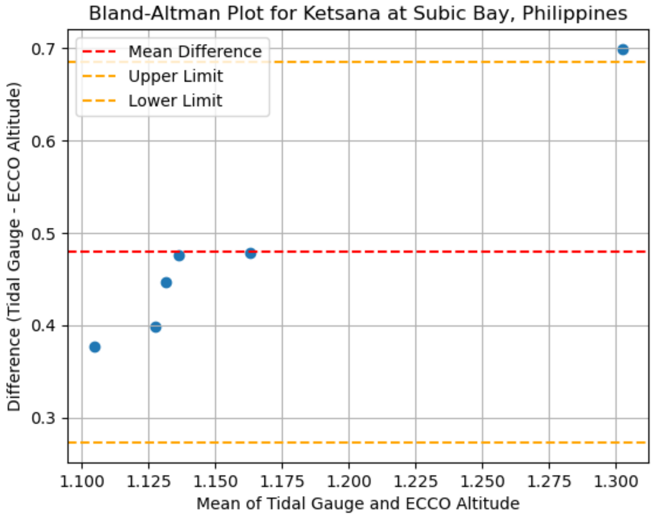


Correlation Analysis

[Speaker Zoom video]

- Methods
    - Pearson correlation (assesses linear relationship)
    - Bland-Altman analysis for testing the agreement of two observation procedure

	Event	Location	Pearons Statistic	Pvalue	Min TG	Max TG	Min SAT	Max SAT	Percent_usable
0	Sandy	Atlantic City, NJ	-0.830777	0.001537	-0.344750	0.757125	-0.011458	0.011458	100.0
1	Sandy	The Battery, NY	-0.742462	0.008869	-0.401583	0.866917	-0.014469	0.014469	100.0
2	Sandy	Montauk, NY	-0.753133	0.007456	-0.313288	0.725920	-0.010682	0.010682	100.0
3	Maria	Isabel Segunda, PR	-0.461112	0.062467	-0.097939	0.222228	-0.001560	0.001560	100.0
4	Maria	Esperanza, PR	TOO SHORT	TOO SHORT	NaN	NaN	-0.001560	0.001560	0.0
5	Maria	Arecibo, PR	TOO SHORT	TOO SHORT	NaN	NaN	-0.001668	0.001668	0.0
6	Maria	Mayaguez, PR	TOO SHORT	TOO SHORT	NaN	NaN	-0.001315	0.001315	0.0
7	Maria	Fajardo, PR	0.800279	0.103875	-0.074278	0.217527	-0.000390	0.000390	100.0
8	Ketsana	Malakal, Palau	-0.471233	0.345471	-0.251410	0.111299	-0.001758	0.001758	100.0
9	Ketsana	Legaspi, Philippines	TOO SHORT	TOO SHORT	NaN	NaN	-0.001937	0.001937	0.0
10	Ketsana	Manila, Philippines	TOO SHORT	TOO SHORT	-0.111479	0.260396	NaN	NaN	0.0
11	Ketsana	Subic Bay, Philippines	0.642657	0.168726	-0.107208	0.251458	-0.000841	0.000841	100.0
12	Ketsana	Qui Nhon, Vietnam	0.94912	0.003817	-0.206937	0.388438	-0.002310	0.002310	100.0



Conclusions

[Speaker Zoom video]

- The visualizations of the data resampled to the same time steps ***appear*** to show a linear relationship (e.g; TG data increases over the same time steps as the ECCO data from that same location). Statistical analysis of correlation values, however, do not agree. We ***think*** this is due to a methodological error in the analysis which we would hope to address with more time.

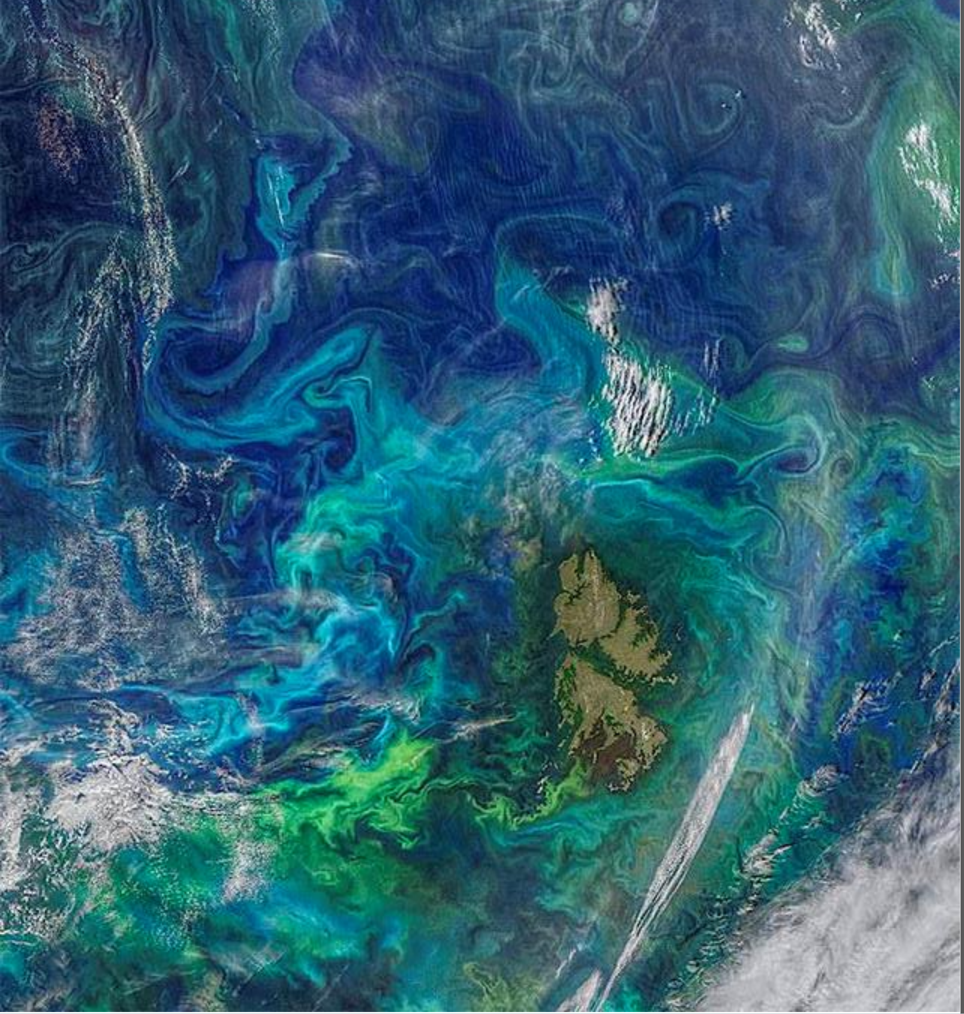
- Bland-Altman analyses show that for higher sea level values, the level of disagreement between TG and ECCO data increases. This suggests that extreme events like storms contribute to greater differences in the measured values of sea level between data systems.

There are pros and cons to analyzing storm events with both data sources.

- Tidal gauges
  - Benefit: Unmatched temporal resolution (as fine as just several minutes) can be especially useful for picking up small changes in RSL due to tides without any interpolation
  - Downfall: Major storms can damage tidal gauges and render them useless during important times
- Satellite (ECCO)
  - Benefit: Not susceptible to damage in the middle of an event
  - Downfall: Cannot necessarily capture short time scales which take tides into account

Lots of room for future work

- Due to limited project time, we were restricted to data we could quickly access
- The ECCO data that we could access offers daily data
  - This means either coarsening or interpolation in required to fairly correlate tidal gauge with satellite data
  - More time could allow us to access satellite data at a finer temporal resolution



[Speaker Zoom video]

Additional Information (beyond the presentation)

ECCO

[Speaker Zoom video]

ECCO stands for "Estimating the Circulation and Climate of the Ocean." It is a project that uses satellite observations, in-water instruments, and computer models to create a detailed picture of the global ocean circulation. This information is used to study ocean currents, heat transport, and other aspects of ocean climate.

[Speaker Zoom video]

How does ECCO work?

ECCO uses a combination of data assimilation and modeling to create its estimates of ocean circulation. Data assimilation is the process of combining observations with model predictions to improve the accuracy of the model. ECCO uses data from a variety of sources, including satellite altimetry, ocean buoys, and Argo floats.

The models used in ECCO are complex computer programs that simulate the physical processes that govern ocean circulation. These models are run on supercomputers and can take weeks or months to complete a single run.

[Speaker Zoom video]

What are the benefits of ECCO?

ECCO provides a wealth of information about the global ocean circulation. This information is used to study a variety of oceanographic and climate phenomena, including:

- The El Niño-Southern Oscillation (ENSO)
- The Gulf Stream
- The thermohaline circulation
- Ocean acidification

[Speaker Zoom video]

What are the limitations of ECCO?

ECCO is a complex project and there are some limitations to its accuracy. One limitation is that ECCO relies on data from a variety of sources, and the quality of this data can vary. Another limitation is that ECCO's models are simplified representations of the real ocean, and they cannot capture all of the complexity of ocean circulation.

[Speaker Zoom video]

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[Speaker Zoom video]

Tide Gauge Data

Tide gauge data is a valuable source of information about sea level changes. This data can be used to track long-term trends in sea level, as well as to monitor short-term changes that may be caused by storms, earthquakes, or other events..

Tide gauge data is typically available in two formats:

- **Raw data:** Raw data is the original data collected by the tide gauge. This data can be used to calculate the water level, as well as to identify any errors or anomalies in the data.
- **Processed data:** Processed data is the raw data that has been cleaned and corrected for errors. This data is typically used for scientific analysis and modeling

Bibliography

[Speaker Zoom video]

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