1
Results

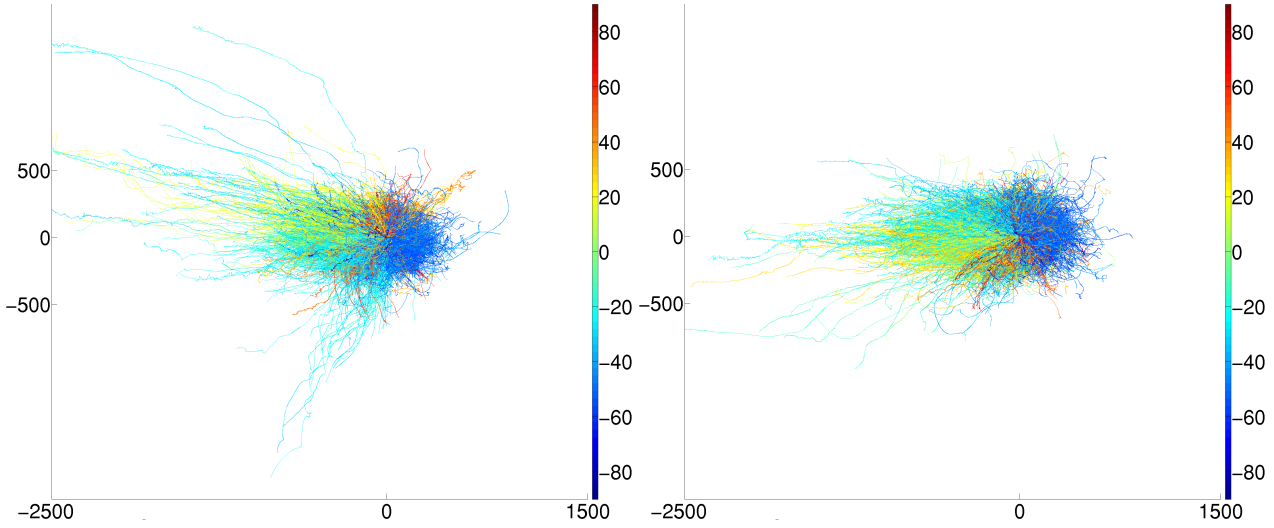


Figure 1.1: Baseline-shifted tracks. Left: anticyclones. Right: cyclones. Color represents *birth*-latitude. Thickness (hardly noticable) represents IQ. Data is from a predecessor run to POP-7day-MII .

[1] depending on the number of cpu's and their frequencies.

Even though all of the computer program's bottle-necks are parllelized in SPMD, an application to more than a decade of high-resoultion SSH data still requires patience (say $\mathcal{O}\left(10^1\right)$ - $\mathcal{O}\left(10^2\right)$ days [1]). The most time-consuming of steps is the numerically arduous part of subjecting each of the vast number of found contours to the filtering procedure as described in **??**. The total number of final analyses was hence limited and it was therefor critical to carefully choose which method/parameters to use in order to maximize the deducible insights from the results. For best comparability of the results with each other it was decided to agree on one complete set of parameters

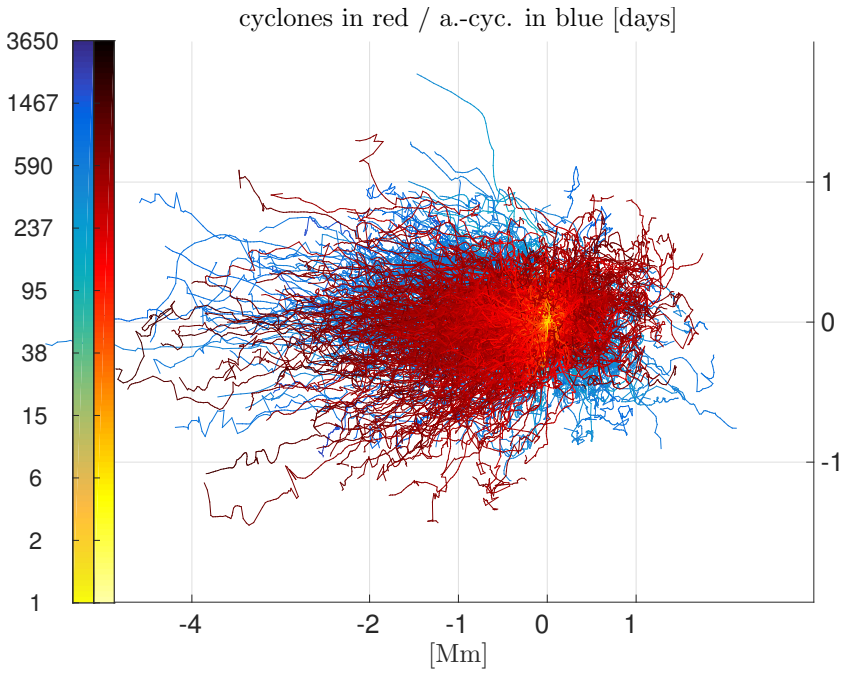


Figure 1.2: Aviso-MI : Baseline-shifted *old* (> 500 d) tracks.

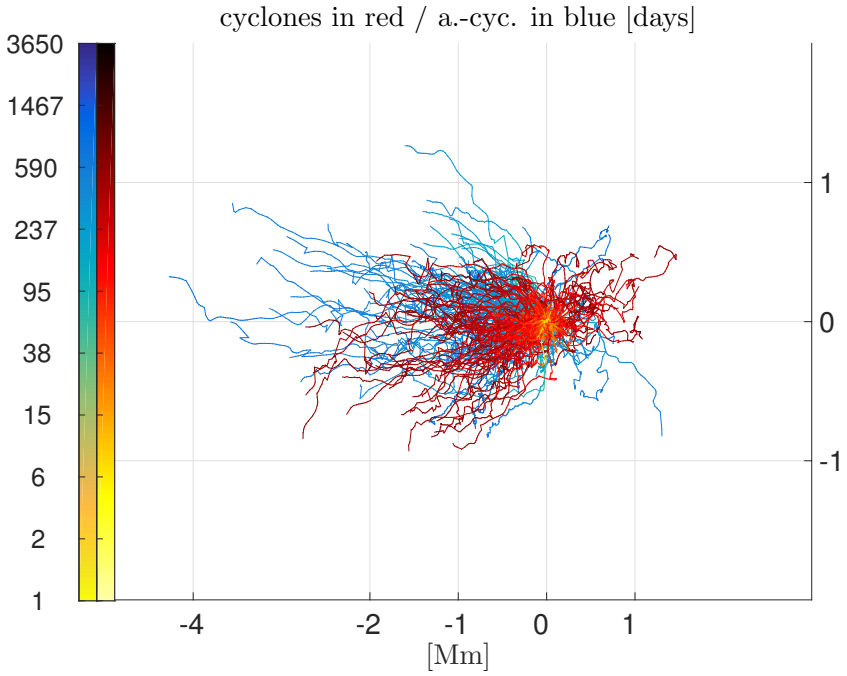


Figure 1.3: Aviso-MII : (same as fig. 1.2)

as a basis (chapter 1), which would then be altered at key parameters.

- The first run is an attempt to reproduce the results from **?**. The SSH-data for this run is therefor that of the Aviso product. This method will be called MI.
- The second run (MII) is equivalent, except that this time the alternative IQ-based shape filtering method as described in **??** and the slightly different tracking-filter as described in **??** are used. MII is then fed with 7-day time-step POP data as well.
- To investigate what role spatial resolution plays, the POP data was remapped to that of the Aviso data and fed to the MI method.
- Finally, to investigate the effects of resolution in time, an MII-2-day-time-step run over POP data was executed. **TODO: popTwoII**
- Start and end dates were fix for all runs as the intersection of availability of both data sets.

time frame	1994/01/05 - 2006/12/27
scope	80°S to 80°N / full zonal.
Aviso geometry	$641x1440$ true Mercator
POP geometry	$2400x3600$ mixed proj.
contour step	0.01 m
thresholds	
max σ/L_R^1	4
min $L_R^1$1	20×10^3 m
min IQ	0.55
min number of data comprising found contour	8
max(abs(Rossby phase speed))	$1\,m\,s^{-1}$
min amplitude	0.01 m

Table 1.1: Fix parameters for all runs.

Box 1: Method MI

The concepts used in this method are mostly based on the description of the algorithm described by **?** and all parameters are set accordingly. Basically MI is a modification of MII (which was completed first), with the aim to try to recreate the results from **?**. It differs from MII in the following:

- **detection**

  As mentioned in **??**, the approach by **?** is to avoid overly elongated objects by demanding:

  - high latitudes

    The maximum distance between any vertices of the contour must not be larger than $400km$ for $|\phi| > 25°$.

  - low latitudes

    The $400km$-threshold increases linearily towards the equator to $1200km$.

- **tracking**

  The other minor difference to MII is in the way the tracking algorithm flags eddy-pairs between time-steps as sufficiently

similar to be considered successful tracking-candidates (see **??**). In this method an eddy B from time-step $k + 1$ is considered as a potential manifestations of an eddy A from time-step k as long as both - the ratio of amplitudes (with regard to the mean of SSH within the found contour) and the ratio of areas (interpolated versions as discussed in TODO ref) fall within a lower and and an upper bound.

Box 2: Method MII

The purpose of this variant is basically to test the conceptually very different idea of the IQ-technique to test the shape of found contours for sufficiently eddy-*typical*. It also uses a slightly different tracking algorithm.

- **detection**

  The IQ-method. See **??** and **??**.

- **tracking**

  Conceptually similar to MI, it is again vertical and horizontal scales that are compared between time-steps. Preferring a single threshold-value over one upper and one lower bound, a parameter ξ was introduced that is the maximum of the two values resulting from the two ratios of amplitude respective σ, where either ratio is -if larger- its reciprocal in order to equally weight a decrease or an increase in respective parameter. In other words: $\xi = \max([\exp|\log R_\alpha| \; ; \; \exp|\log R_\sigma|])$, where R are the ratios. **TODO: this has been explained twice now...**

1.1 *MI - 7 day time-step - Aviso*

The results from the MI-method are special in that they feature many long-lived eddies (see figs. 1.2, 1.4 and 1.6), some of which travelled more than 4000 km west. Tracks were recorded throughout the entire world ocean with the only exeptions being an approximately 20°-wide stripe along the equator. The highest count of unique eddies is along the Antarctic Circumpolar Current [2] with counts of more

[2] abbreviated ACC from here on.

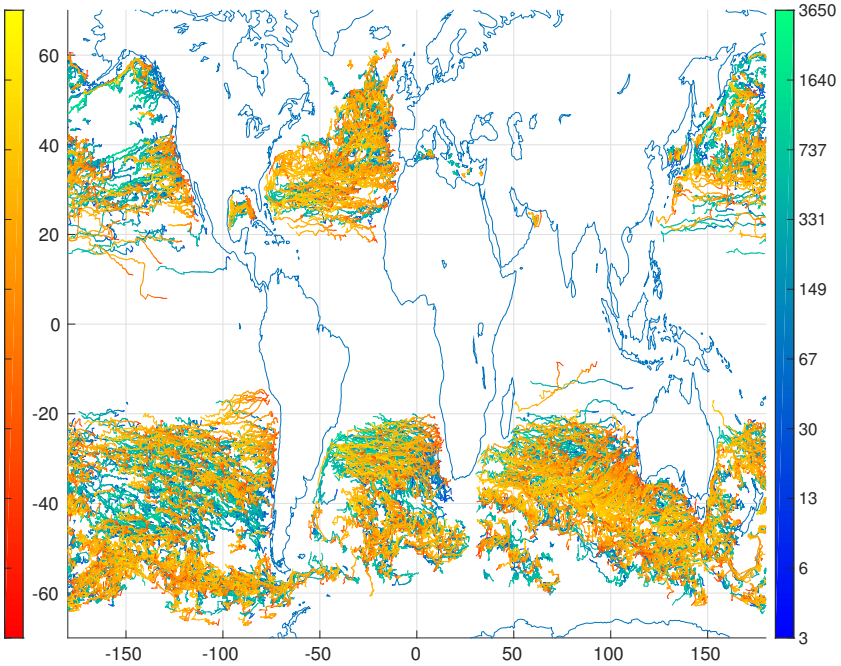


Figure 1.4: MI: cyclones in red. Tracks younger than 1*a* omitted for clarity.

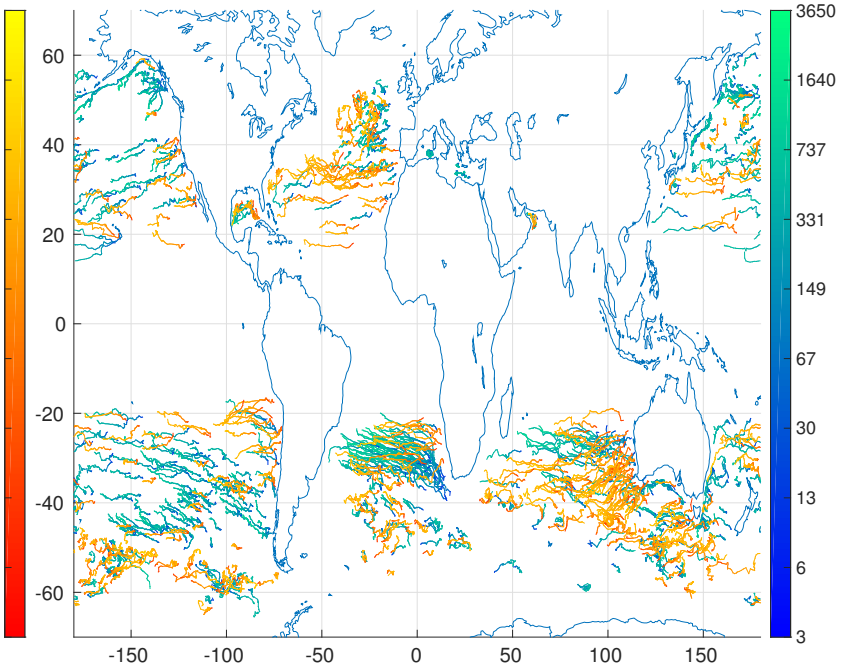


Figure 1.5: MII: (see fig. 1.4)

than 60 individual eddy-visits per $1° \times 1°$-cell. Further eddy-rich regions are the western North-Atlantic throughout the Gulf-Stream and North-Atlantic Current, *Mozambique eddies* (**?**) at 20° South along the Mozambique coast, along the Agulhas Current and south of the Cup of Good Hope at $\sim 40°$, along the coasts of Brazil, Chile and all along the Eastern, Southern and Western coasts of Australia (see fig. 1.8).

EDDIES APPEAR AND DISAPPEAR throughout the world ocean. For long-lived solid eddies there is a tendency to emerge along western coasts (see **??**).

THE SCALE σ of tracked eddies is similar to that in **?**, yet generally smaller in high latitudes and slightly larger in low latitudes (see **??**). It is larger than the first-mode baroclinic Rossby Radius by factor of at least 2 and its meridional profile appears to be separable into two different regimes; one apparently linear profile in low latitudes and a steeper one equator-wards of $\sim |15°|$. Regionally, locations of high mesoscale activity appear to correlate with smaller eddy-scales (see fig. 1.10).

THE EASTWARD ZONAL DRIFT SPEEDS are slightly slower than the first-mode baroclinic Rossby-Wave phase-speed and agree well with the results from **?**. Propagation is generally west-wards except for regions of sufficiently strong eastward advection as in the ACC and North Atlantic Current (see fig. 1.11 and **??**).

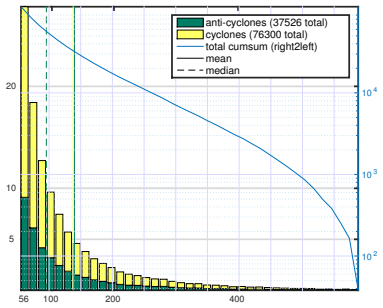


Figure 1.6: Aviso-MI : Final age distribution. x-axis: [days], Left y-axis: [1000]

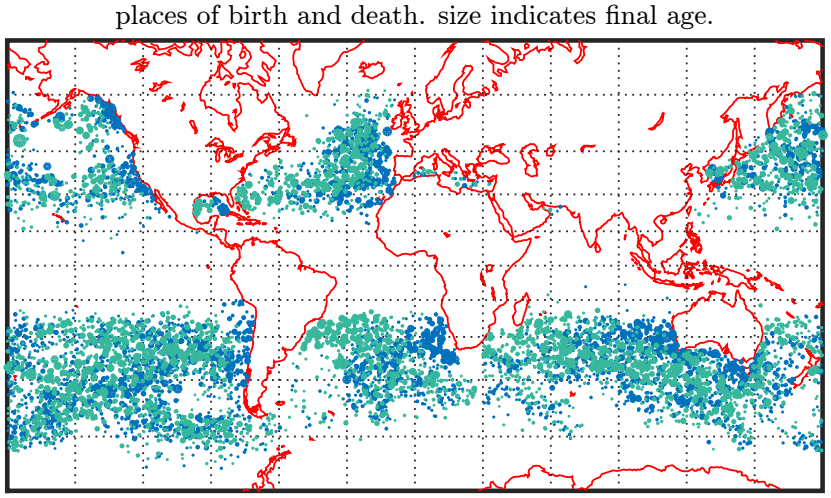


Figure 1.7: Aviso-MI : Births are in blue and deaths in green. Size of dots scales to age squared. Only showing tracks older than one year.

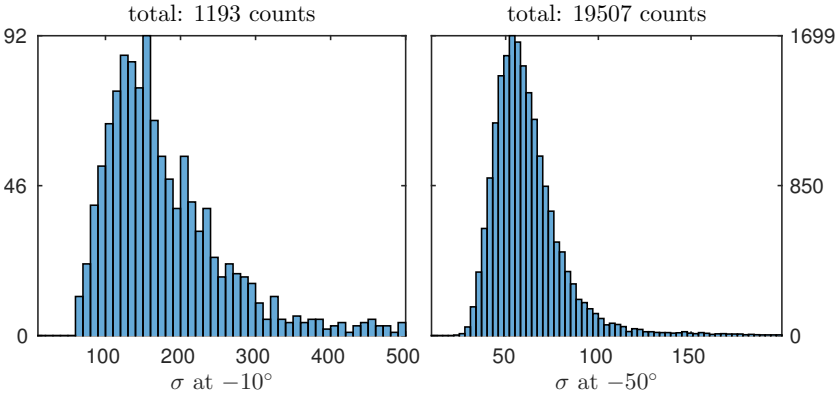


Figure 1.9: Aviso-MI : σ [km]

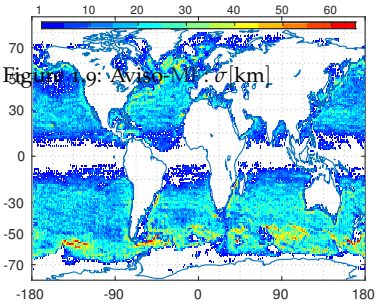


Figure 1.8: Aviso-MI : Total count of individual eddies per 1 degree square.

1.2 *MII - 7 day time-step - Aviso*

The IQ-based method results in approximately the same total amount of tracks as the MI-method used in section 1.1 (see figs. 1.6 and 1.12). The difference is that tracks here are generally much shorter, meaning that less eddies are detected at any given point in time.

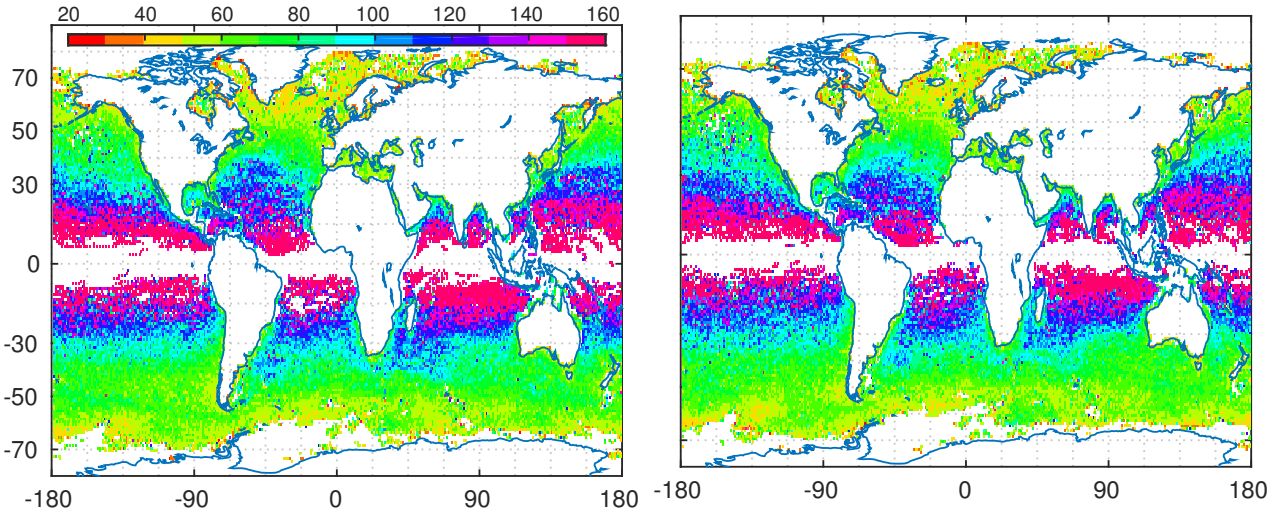


Figure 1.10: Aviso-MI : σ[km]

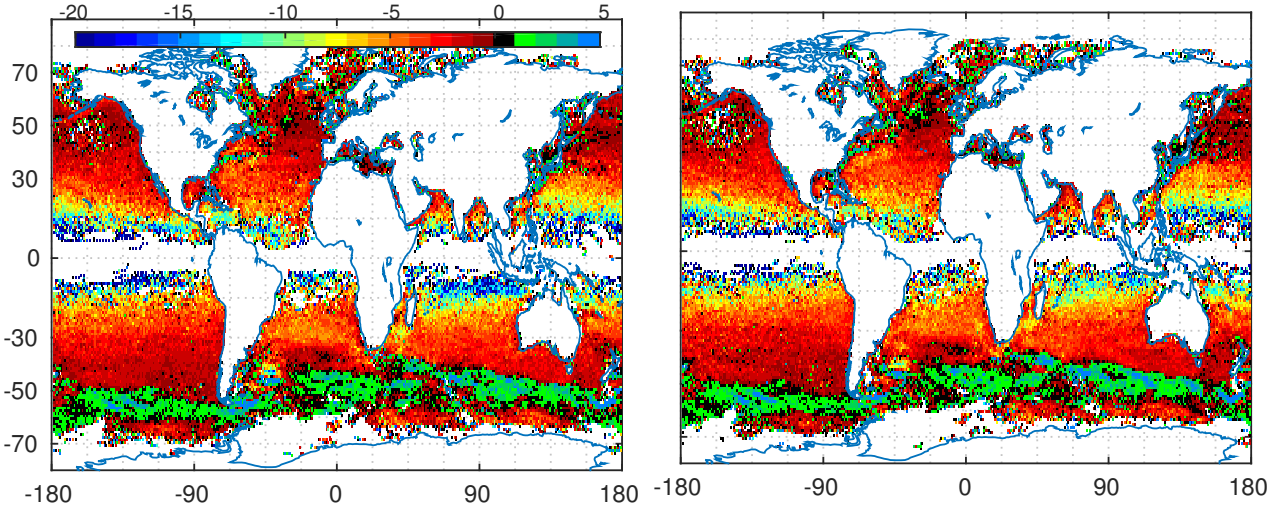
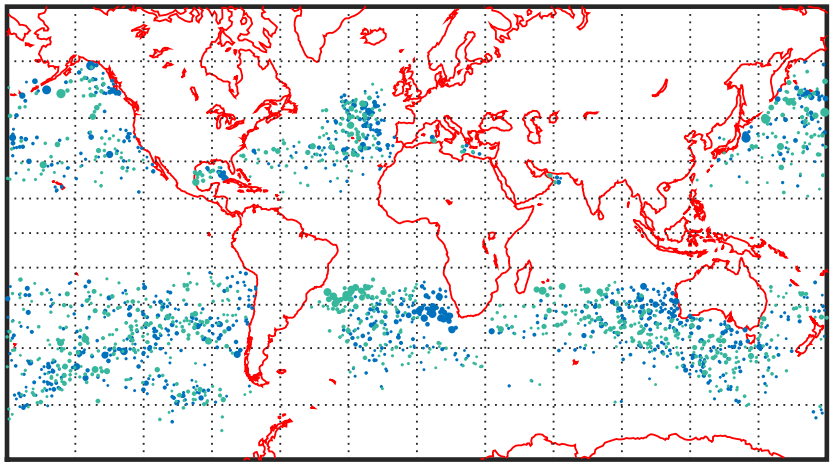


Figure 1.11: Aviso-MI : zonal translational speed [cm/s]

THE SCALE σ is now smaller than that from **?** for all latitudes in zonal-mean as well as median.

WESTWARD DRIFT SPEEDS are almost identical to those in section 1.1.

places of birth and death. size indicates final age.



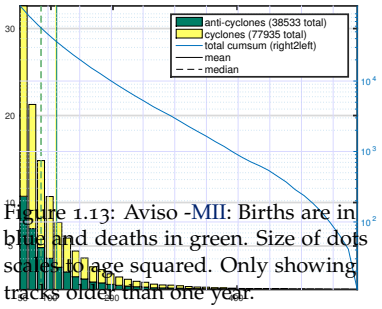


Figure 1.13: Aviso -MII: Births are in blue and deaths in green. Size of dots scales to age squared. Only showing tracks older than one year.

Figure 1.12: Aviso -MII: Final age distribtion. x-axis: [days], Left y-axis: [1000]

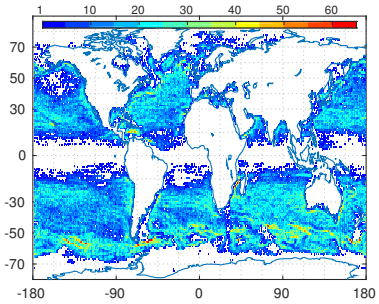


Figure 1.14: Aviso -MII: Total count of individual eddies per 1 degree square.

1.3 *MII - 7 day time-step - POP*

THE MODEL DATA delivers slightly more total tracks with a similar 2-fold dominance of cyclones over anti-cyclones (compare figs. 1.12 and 1.17). Similar to Aviso-MII , very long tracks are fewer than via Aviso-MI [3]. The regional pattern looks somewhat similar to the satellite patterns in terms of which regions feature the strongest eddy activity, with the exception of an unrealistic abundance of eddies right along the Antarctic coast where no eddies were detected for the satellite data likely due to sea ice and/or the inherent lack of polar data due to the satellites' orbit-inclinations.

THE more important difference between model- and satellite regional distributions is that the model results indicate significantly less eddy activity away from regions of strong SSH gradients, in the open ocean away from coasts and strong currents. The algorithm also detects hardly any eddy tracks in tropical regions (see **??**).

[3] Aviso-MI features 3000 tracks that are older than 400 days, while both MIImethods have only $\sim$ 1000 of such.

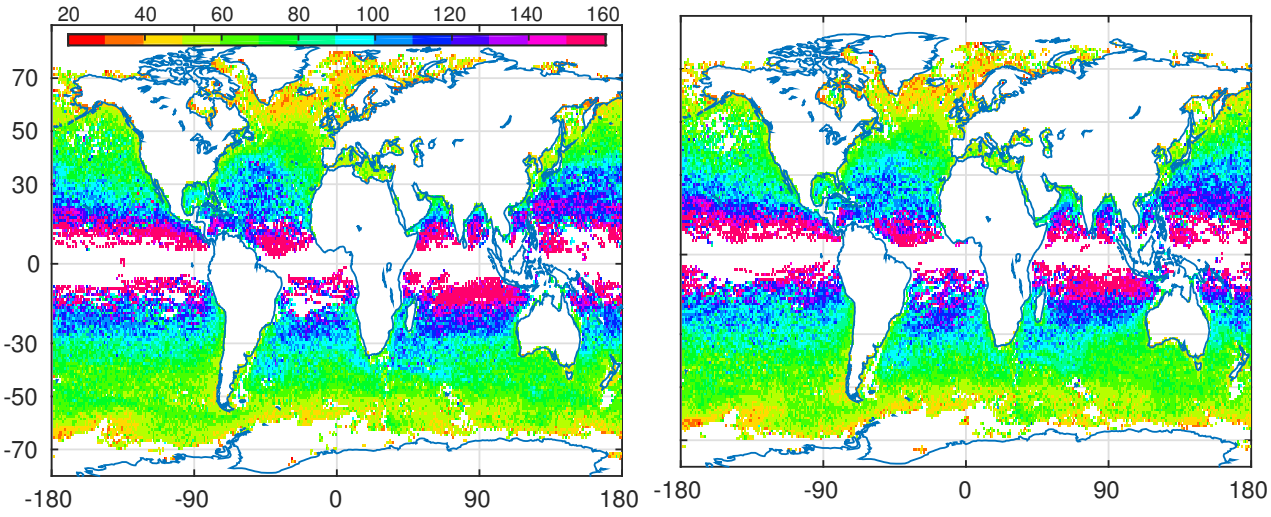


Figure 1.15: Aviso -MII: σ[km]

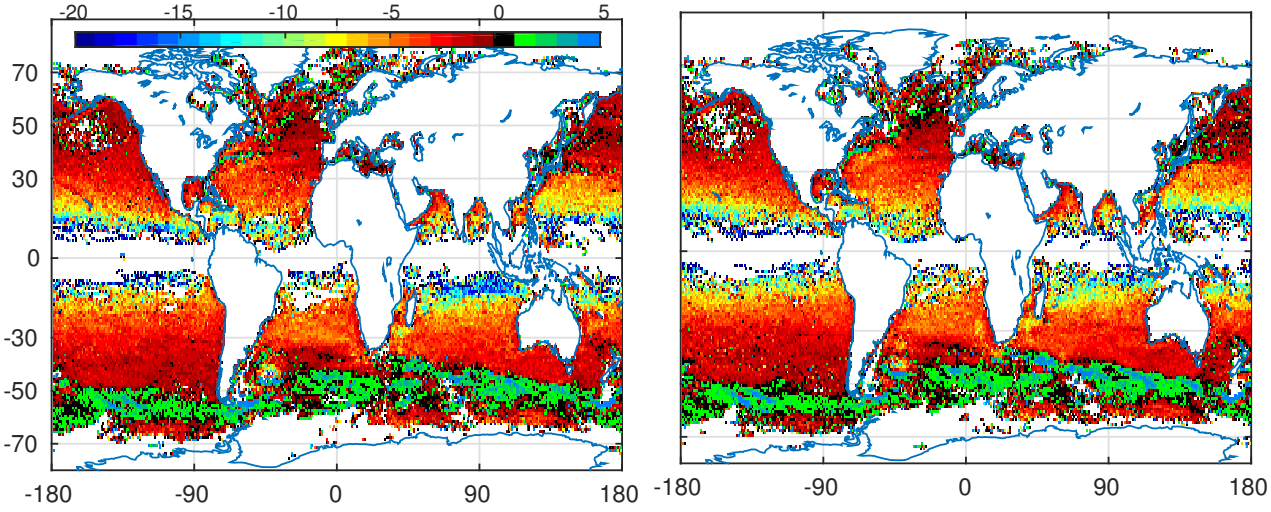
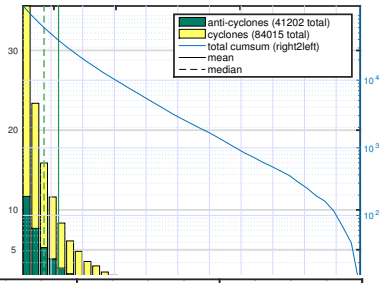


Figure 1.16: Aviso -MII: zonal translational speed [cm/s]

The scale σ is generally smaller for the model-data-based analysis than for any satellite-based analyses, especially so in high latitudes.

Westward drift speeds look regionally similar to those from satellite data (figs. 1.16 and 1.20). In the zonal mean their magnitude is below those from satellite (see fig. 1.24).



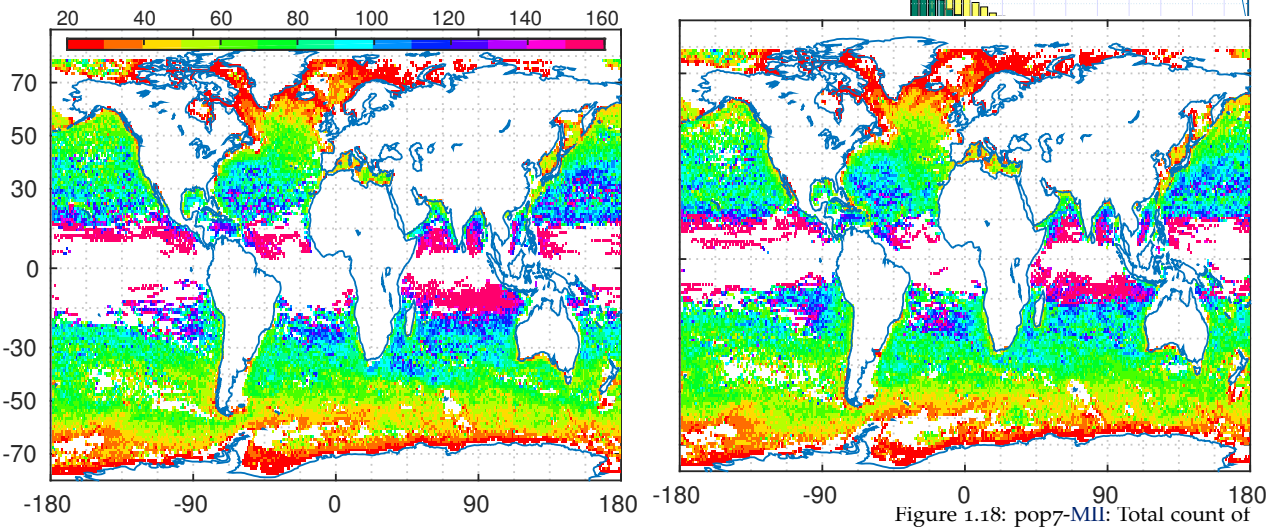


Figure 1.18: pop7-MII: Total count of individual eddies per 1 degree square.

Figure 1.19: pop7-MII: σ[km]

1.4 *MII - 7 day time-step - POP remapped to Aviso geometry*

The model data

The scale σ

Westward drift speeds

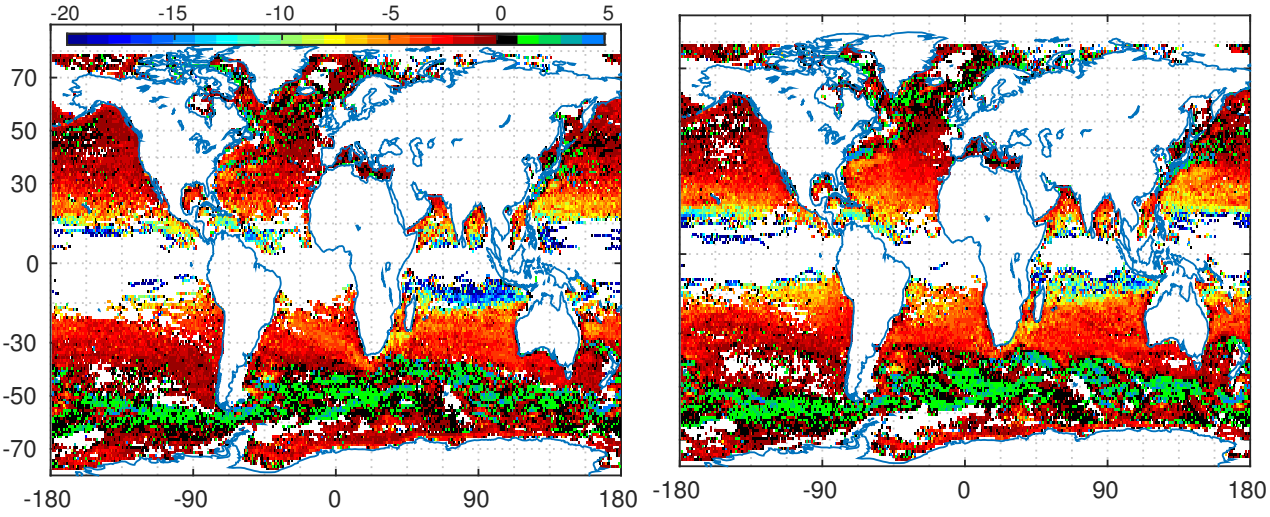


Figure 1.20: pop7-MII: zonal translational speed [cm/s]

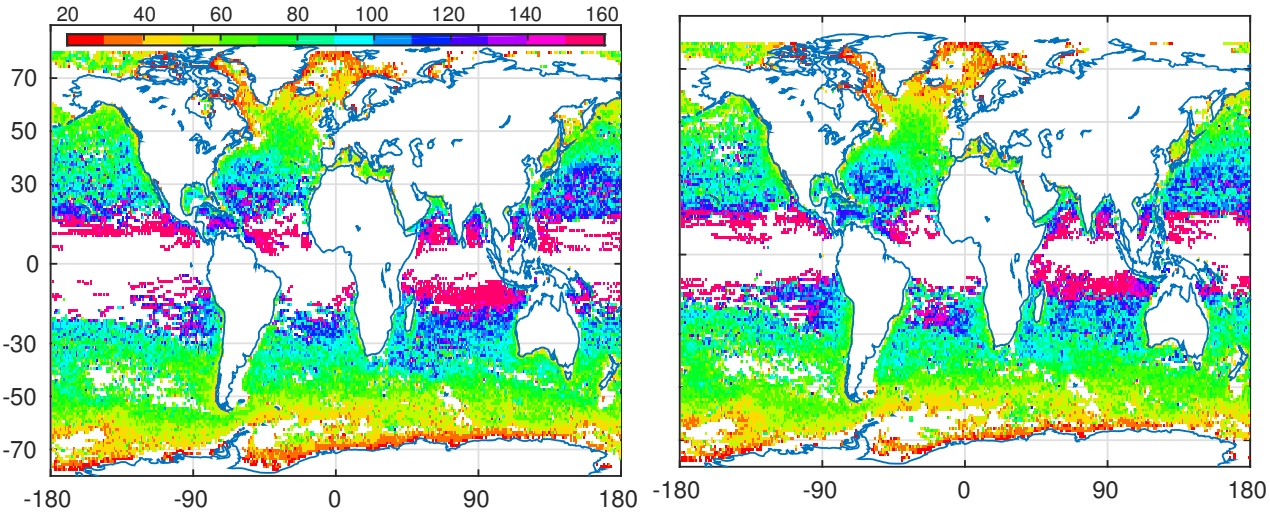


Figure 1.21: pop2aviso-MII: σ[km]

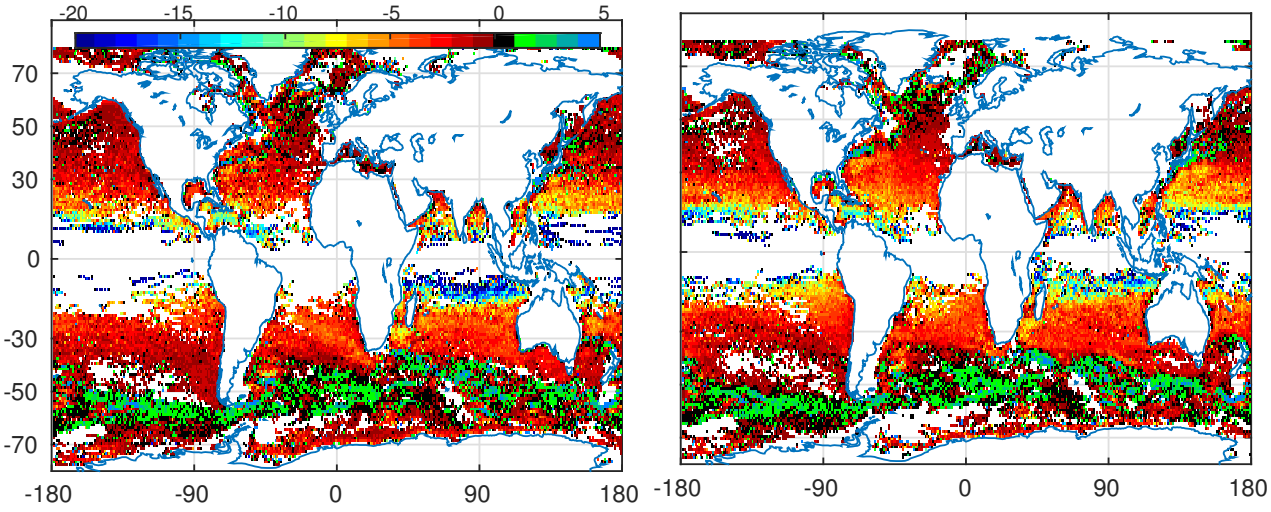


Figure 1.22: pop2aviso-MII: zonal translational speed [cm/s]

1.5 *MII - 2 day time-step - POP*

TODO: run is finished. Results will be looked at / interpreted next week

1.5.1 *TODO: net U*

TODO:

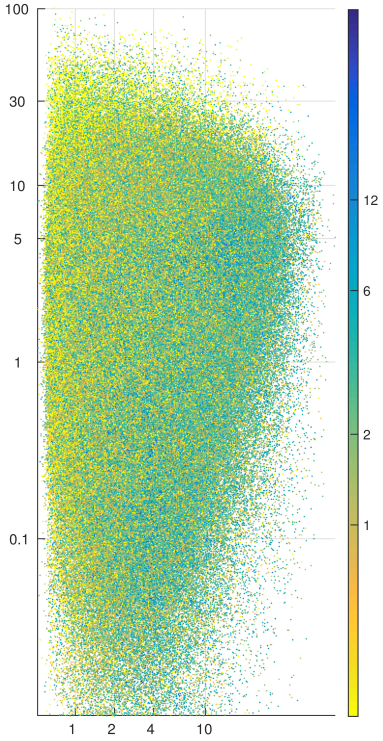


Figure 1.23: pop2aviso-MII: Small amplitude correlates with a short life and a broad translational speed spectrum. y-axis: translational speed $[cm/s]$, x-axis: amplitude $[cm]$, color: age [months] **TODO: use this as argument for 2cm contour step in pop2II**

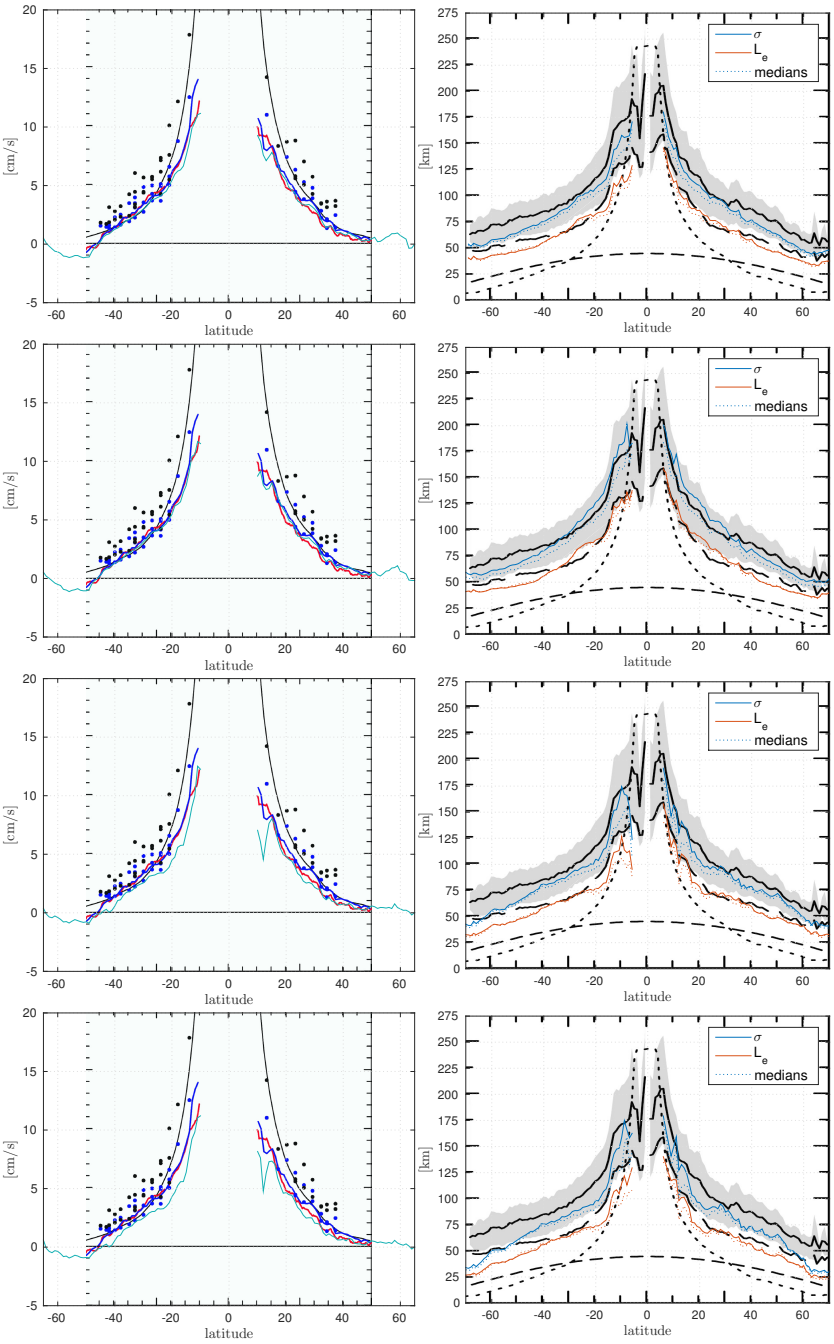


Figure 1.24: Left: Zonal-mean drift speed (cyan) fit to Fig 22 of (**?**) (Background). Right: σ and L_e fit to Fig. 12 of their paper. Dotted lines are medians instead of means. 1st row: Aviso-MII , 2nd row: Aviso-MI , 3rd row: pop2avi-MII , 4th row: POP-7day-MII . Note that for the very high latitudes ($> |60°|$) the contrast between model and satellite data is further intensified by the lack of satellite data (see figs. 1.15 and 1.19) in those regions (sea-ice / orbit inclinations). For a depiction without this effect see **??**.

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