The Eddy Field in the Model and in the Data

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Some extremely preliminary results of two graduate students, Cim Wortham and Ru Chen.

First, a non-eddy comparison (Ru Chen):

sea level is falling

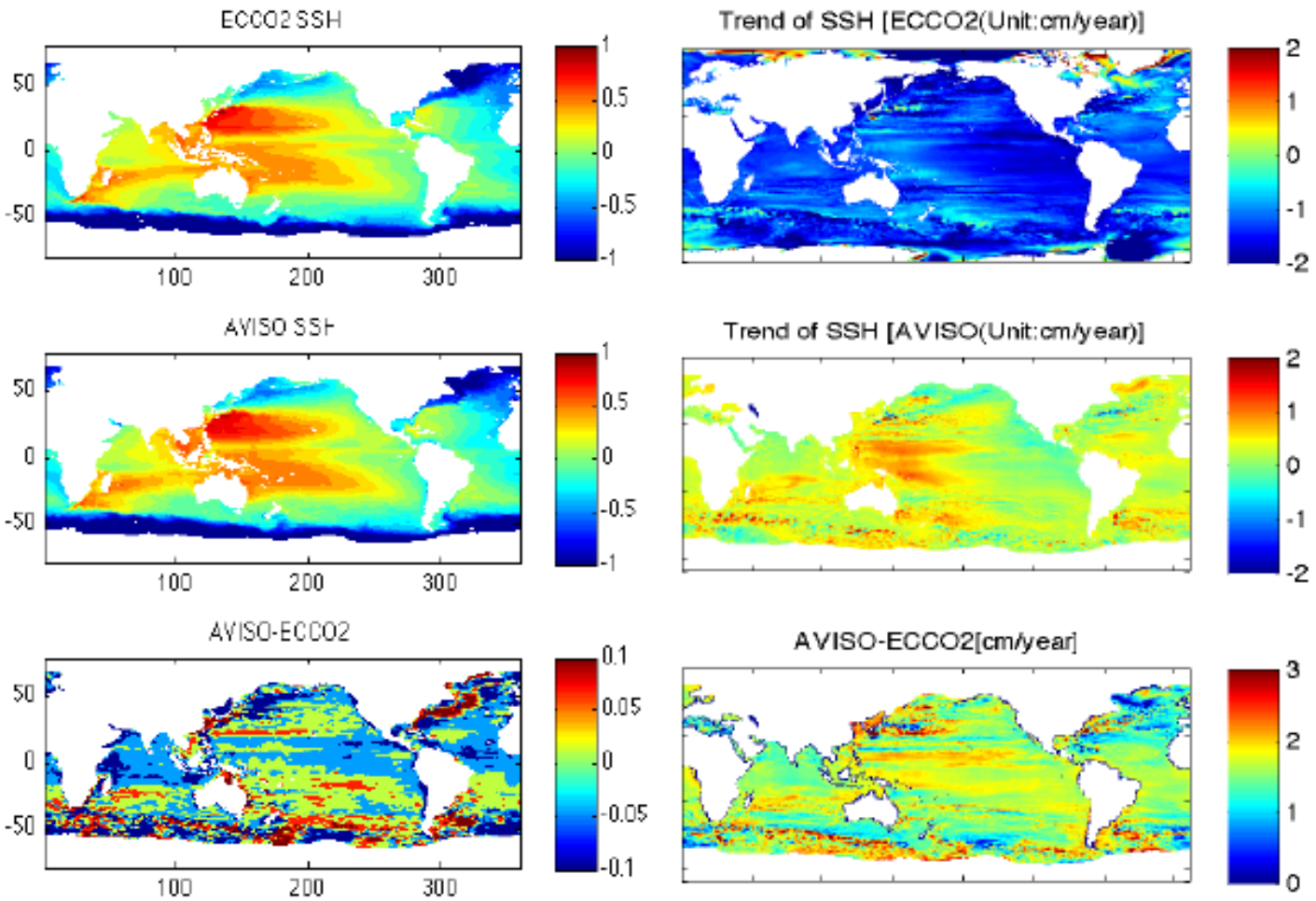


Figure 1: The upper two figures on the left panel show respectively climatological time mean sea surface height (SSH), with global mean removed, from ECCO2 (upper) and AVISO (middle). The bottom figure in the left panel shows the difference between the upper two figures. The right panel shows the trend of modeled (upper) and observed (middle) sea surface anomalies (SLA). The difference of the upper two figures is shown in the lower figure.

salinity is increasing

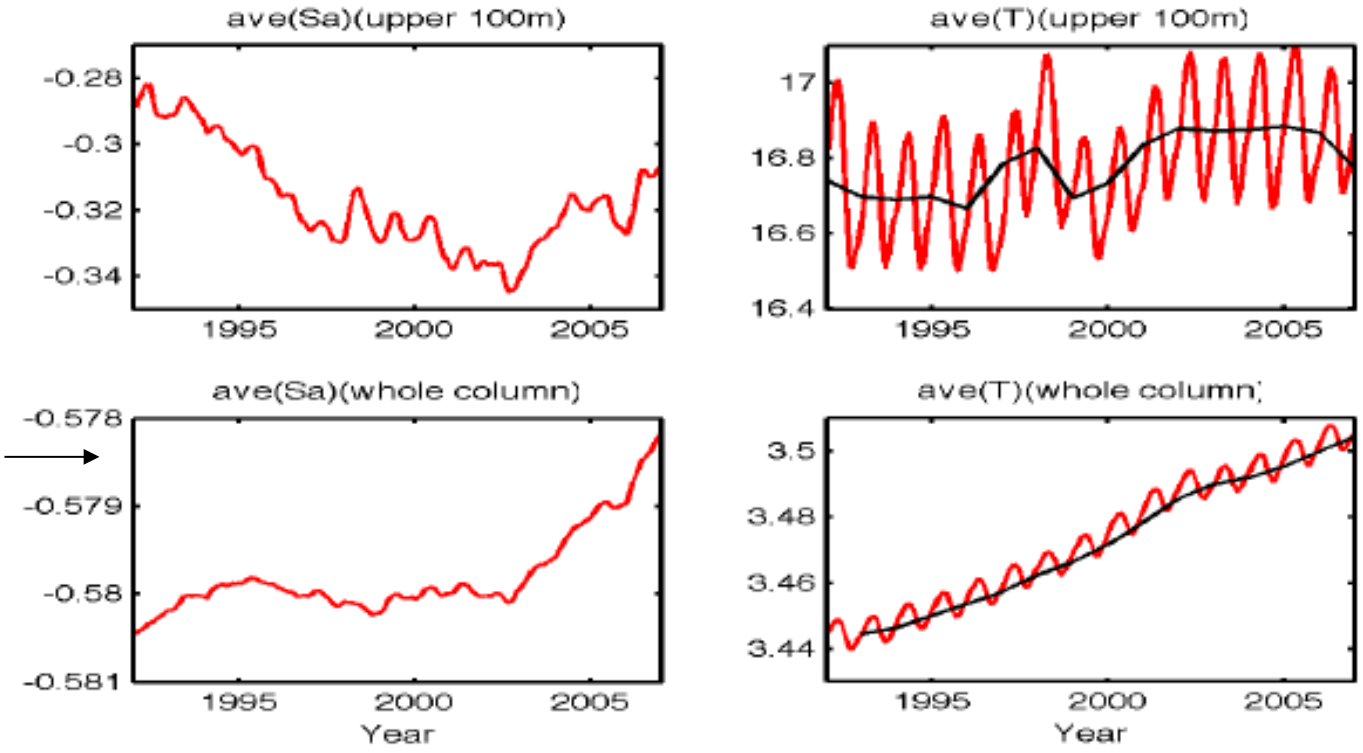


Figure 2: Upper panel: the global averaged salinity anomaly (salinity-35) (left) and temperature (right) in the upper 100m of the ocean. Lower panel: the global averaged salinity anomaly (left) and temperature (right) of the whole water column.The red line shows the monthly time series, and the black curve is the annual time series.

Removing the spatial mean:

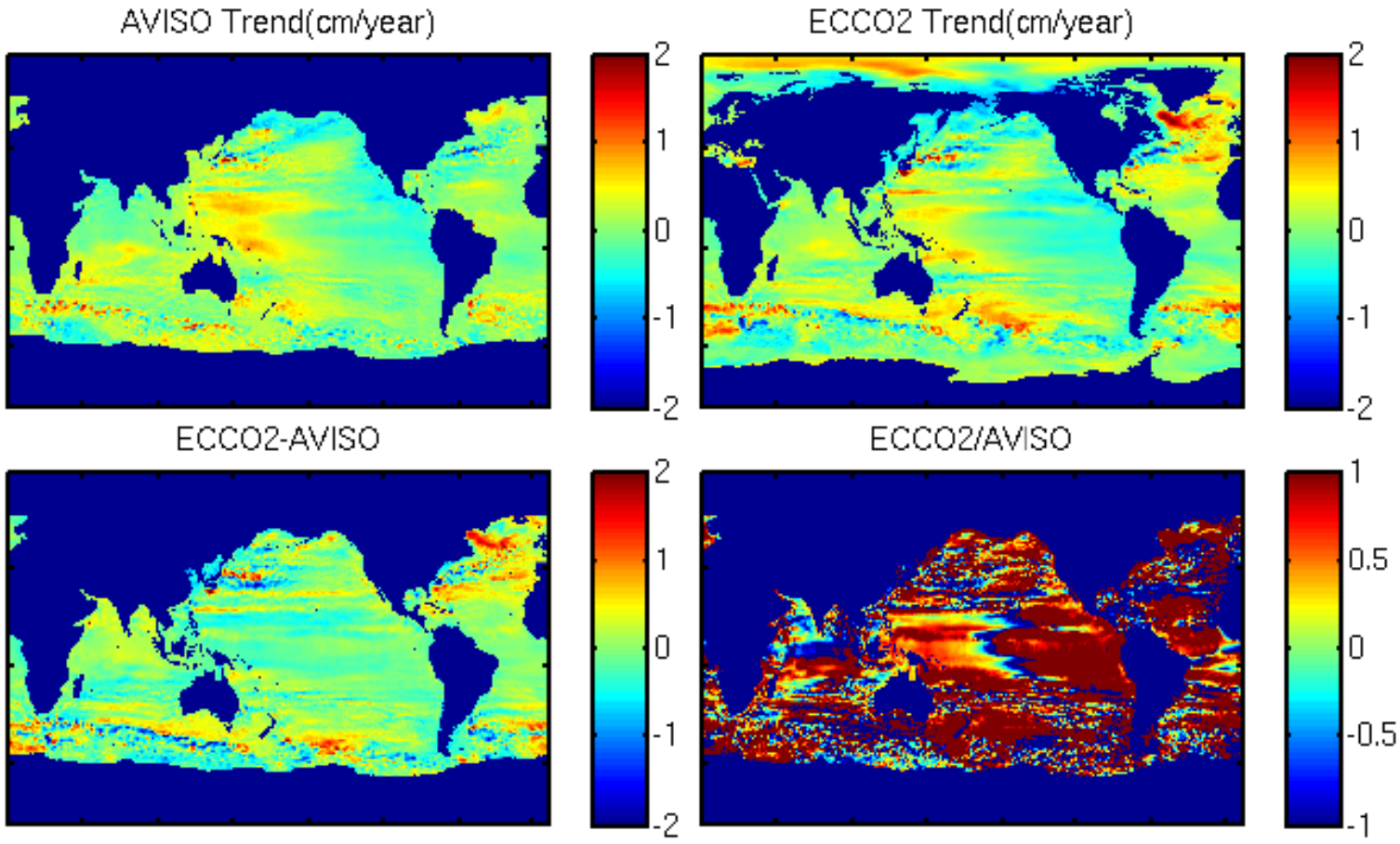


Figure 3: Upper panel: the trend of the corrected SLA from observation (left) and the ECCO2 model (right). Lower panel: the difference (left) and the ratio (right) between observed trend and modeled trend of corrected SLA. The unit of the trend in this figure is cm/year.

Variances of sea level variability.

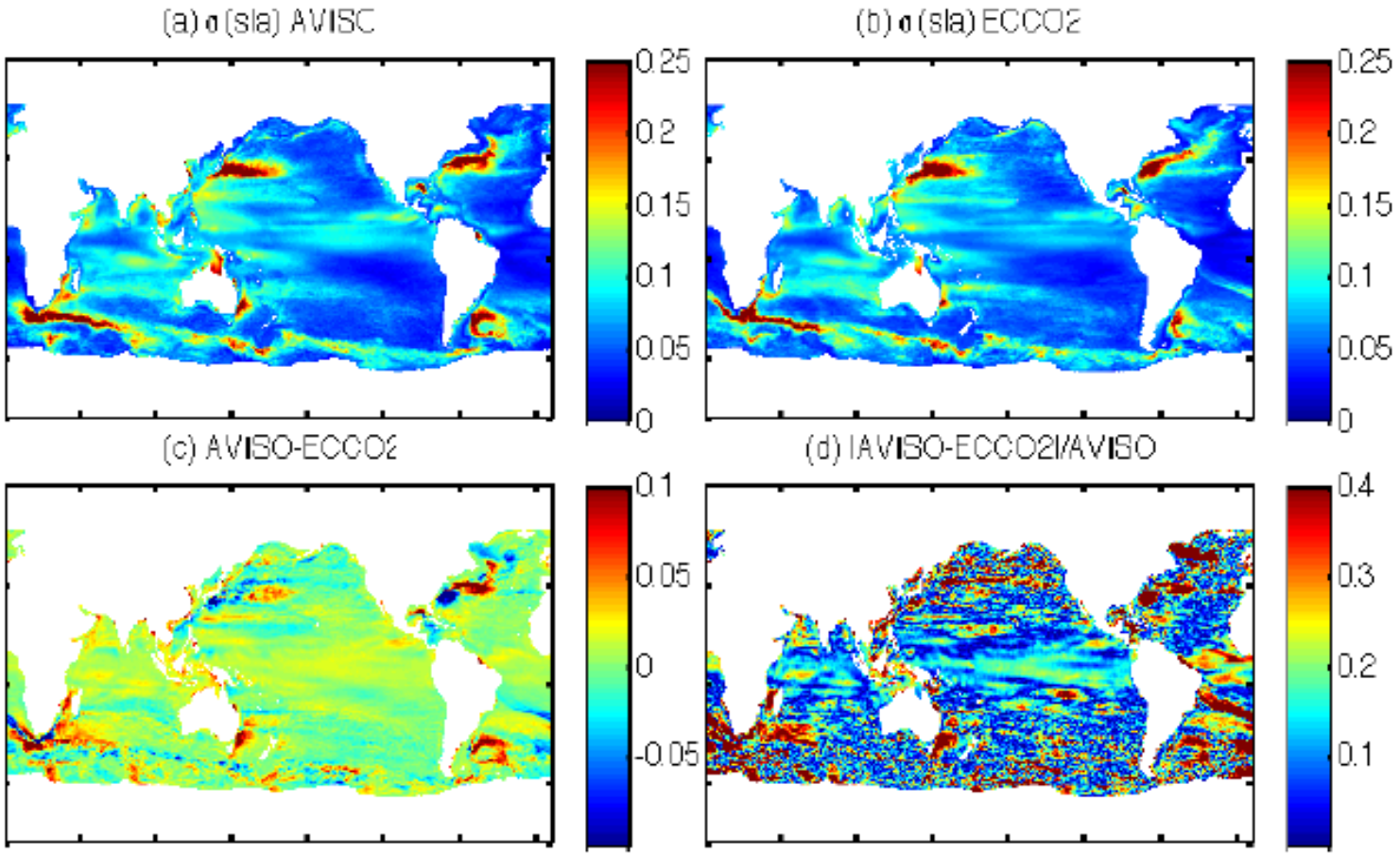


Figure 4: Upper panel: the temporal standard deviation of the corrected SLA of AVISO (left) and ECCO2 (right). Lower panel: the absolute difference (left) and the relative difference (right) between the observed and modeled standard deviation.

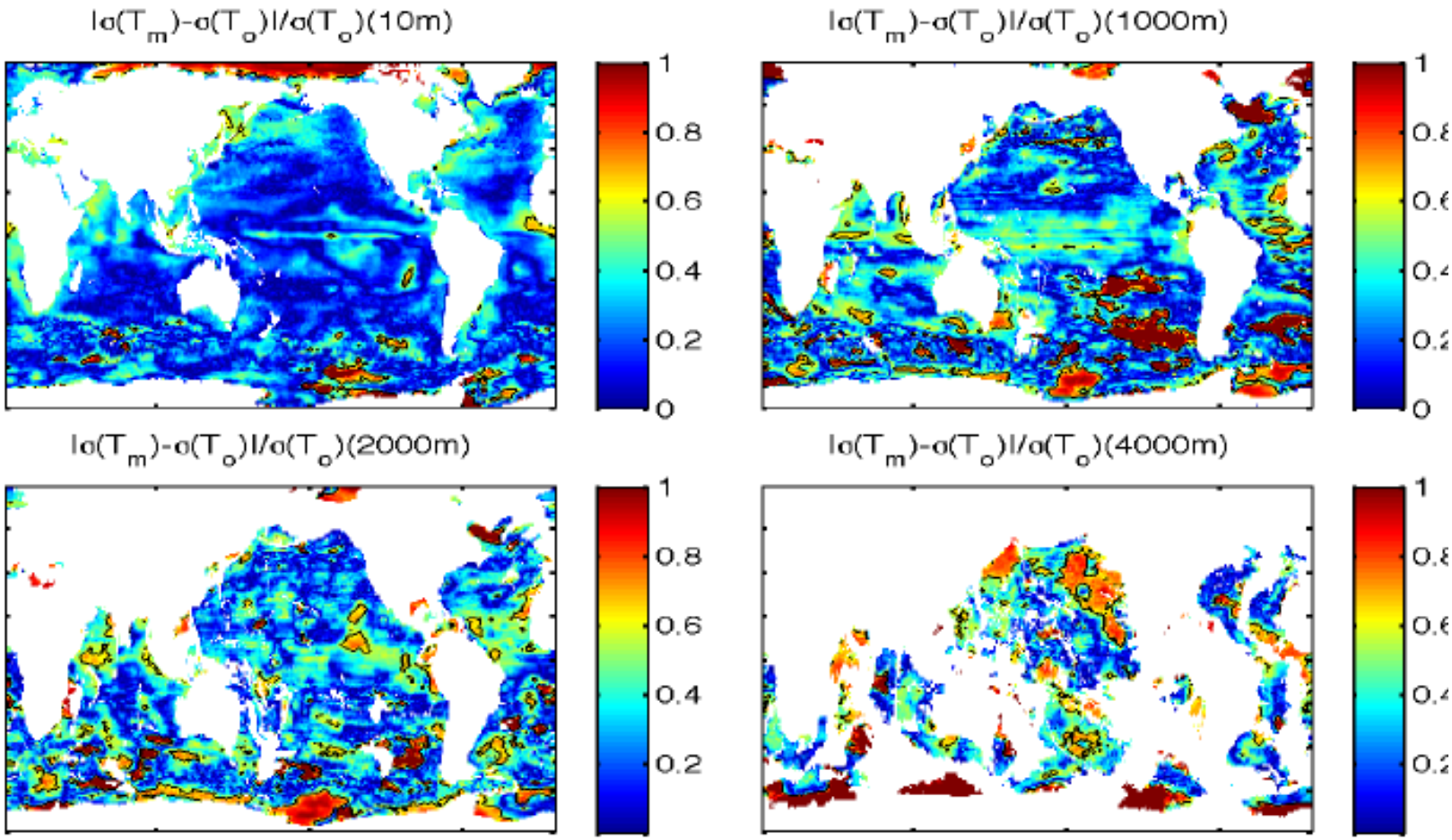


Figure 7: The relative difference between the observed and modeled temperature temporal standard deviation at 10m (upper left), 1000m (upper right), 2000m (lower left) and 4000m (lower right). The black line is the contour with the value 0.6.

Thermal variance is generally low in the model

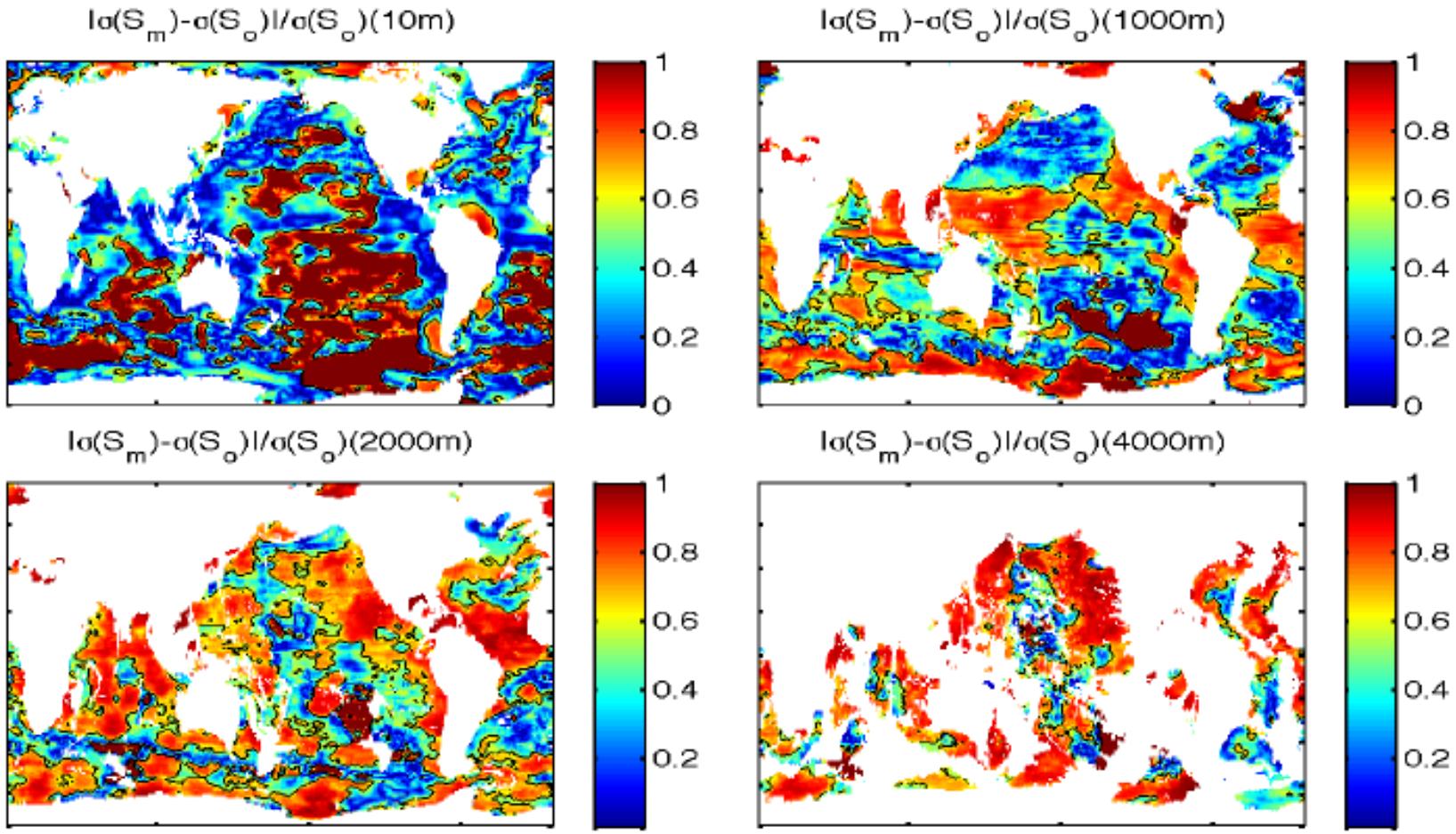


Figure 8: The same as Figure 7, but for salinity.

Salinity variance is generally low in the model

SST

Difference of the time means

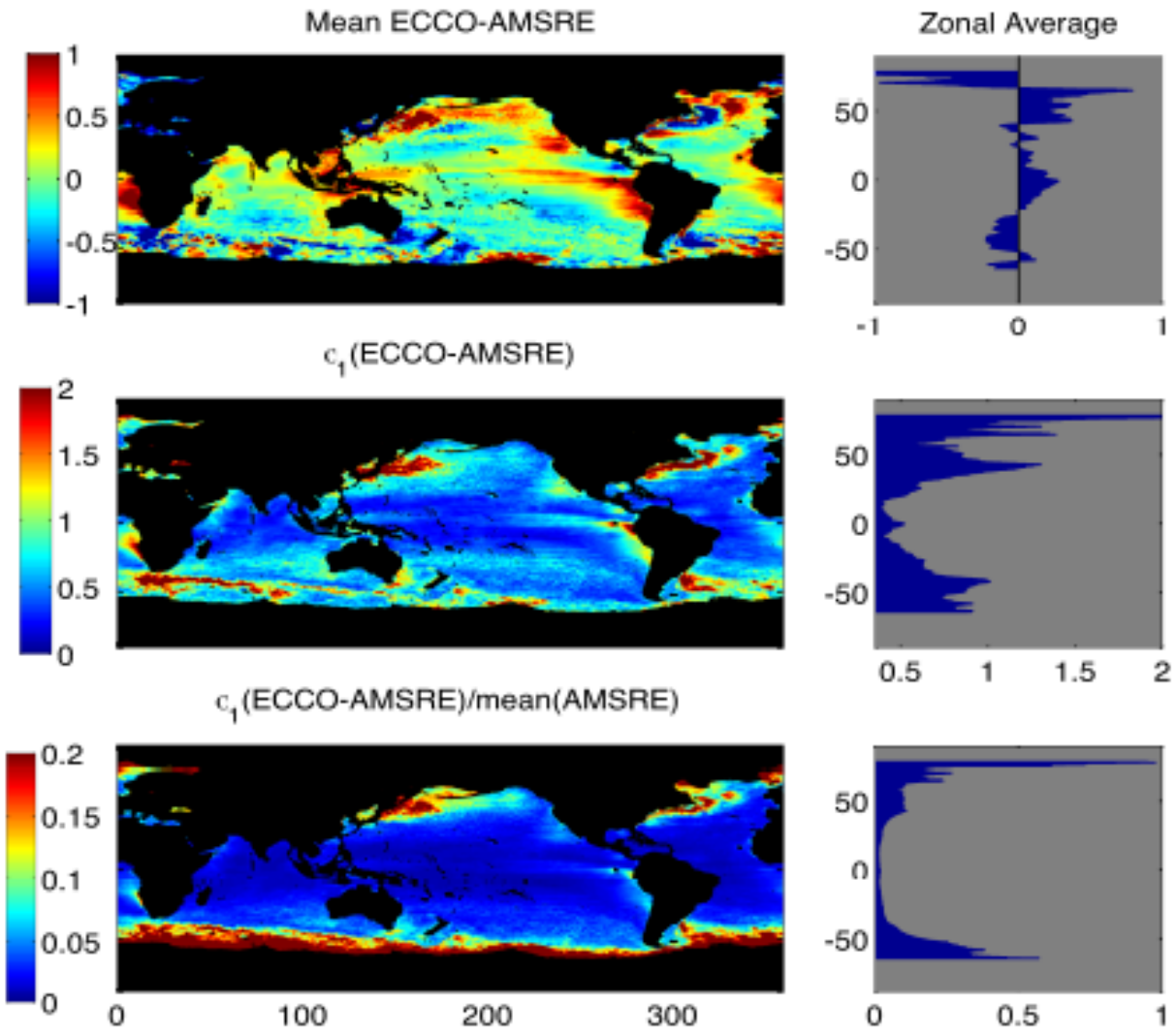
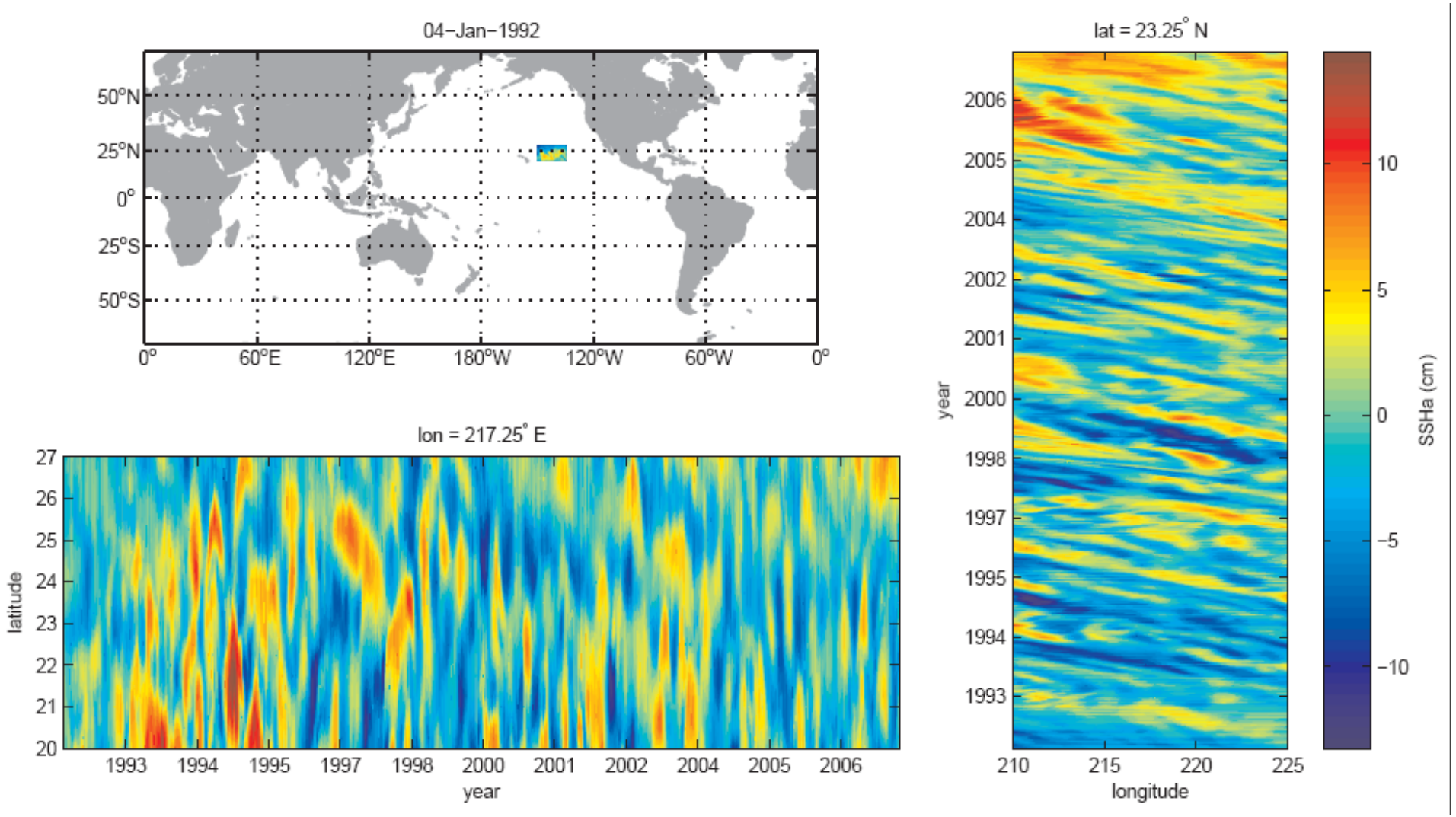


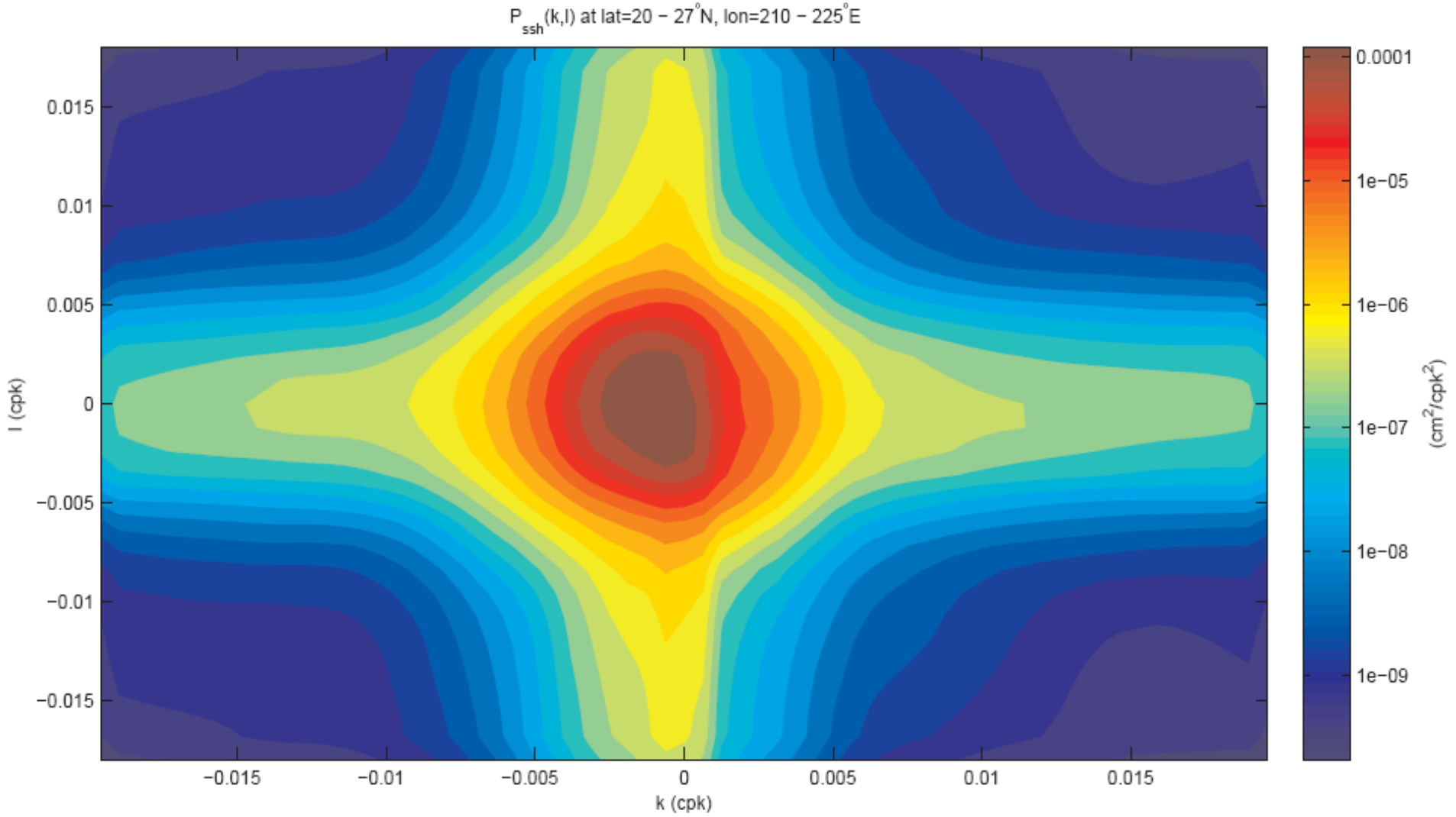
Figure 9: Top left: the climatological (temporal) mean of the difference between ECCO2 SST and AMSRE SST; Middle left: σ_1 of the difference between modeled and observed SST (σ_1 is defined in the text). Bottom left: the ratio between σ_1 and the climatological mean of AMSRE SST. The figures on the right are the zonal average of the data displayed on the left.

Consider now some spectral comparisons (Cimarron Wortham)

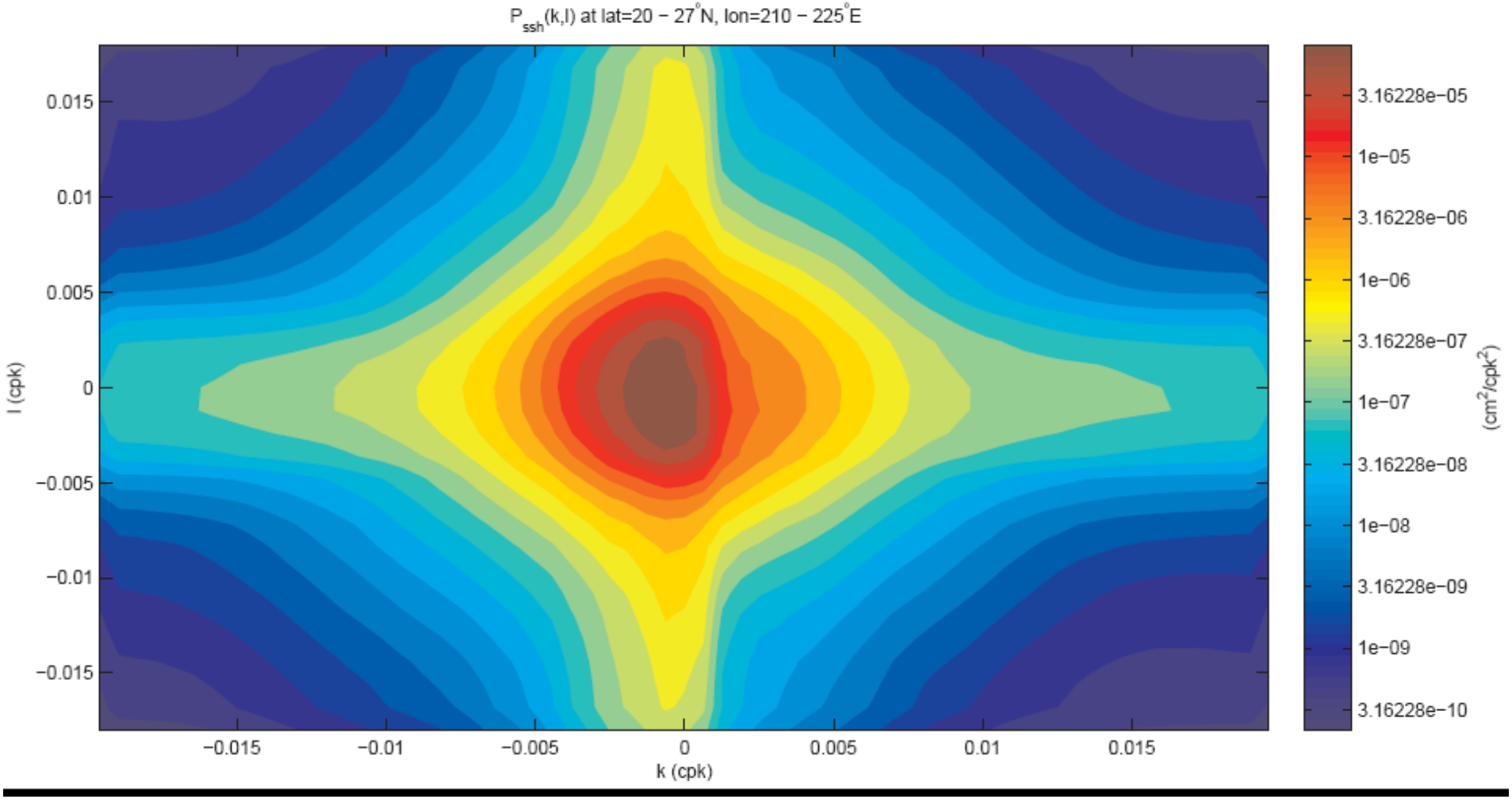
Model results, time-latitude and time-longitude



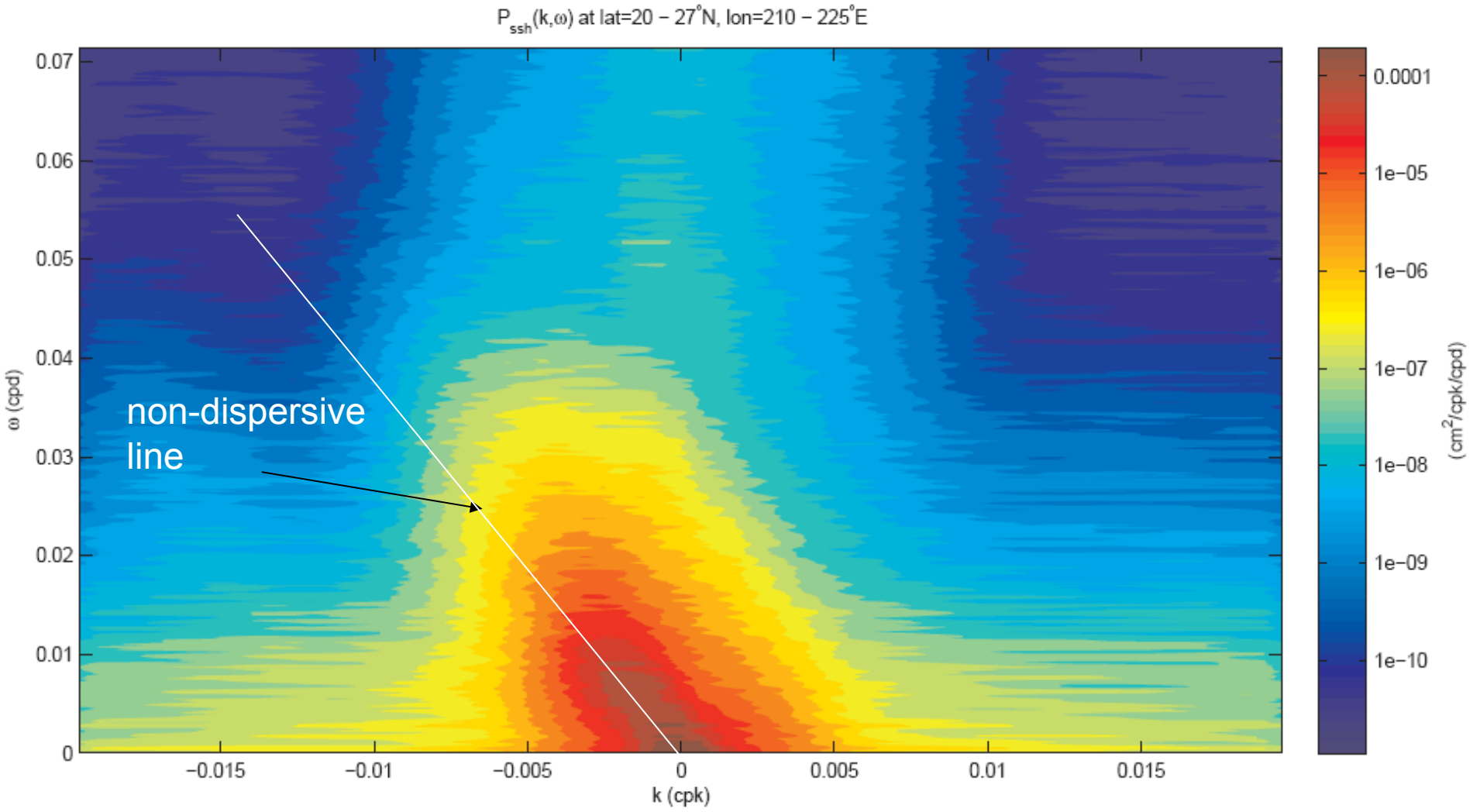
k,l spectrum from AVISO



k,l spectrum ECCO2 CS510 cube84 run, 6-hour averages

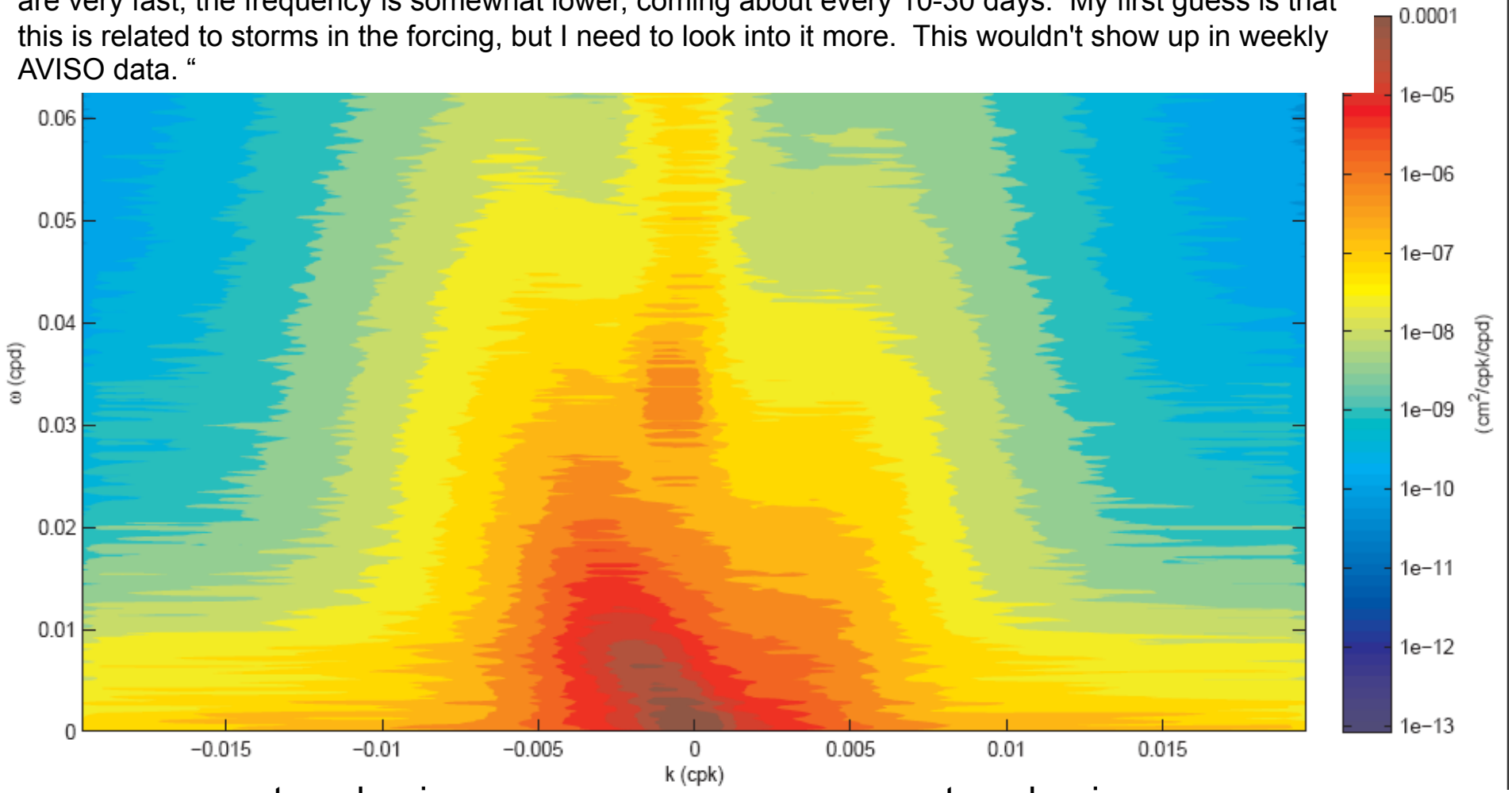


frequency/zonal wavenumber spectrum, AVISO



frequency/zonal wavenumber spectrum ECCO2

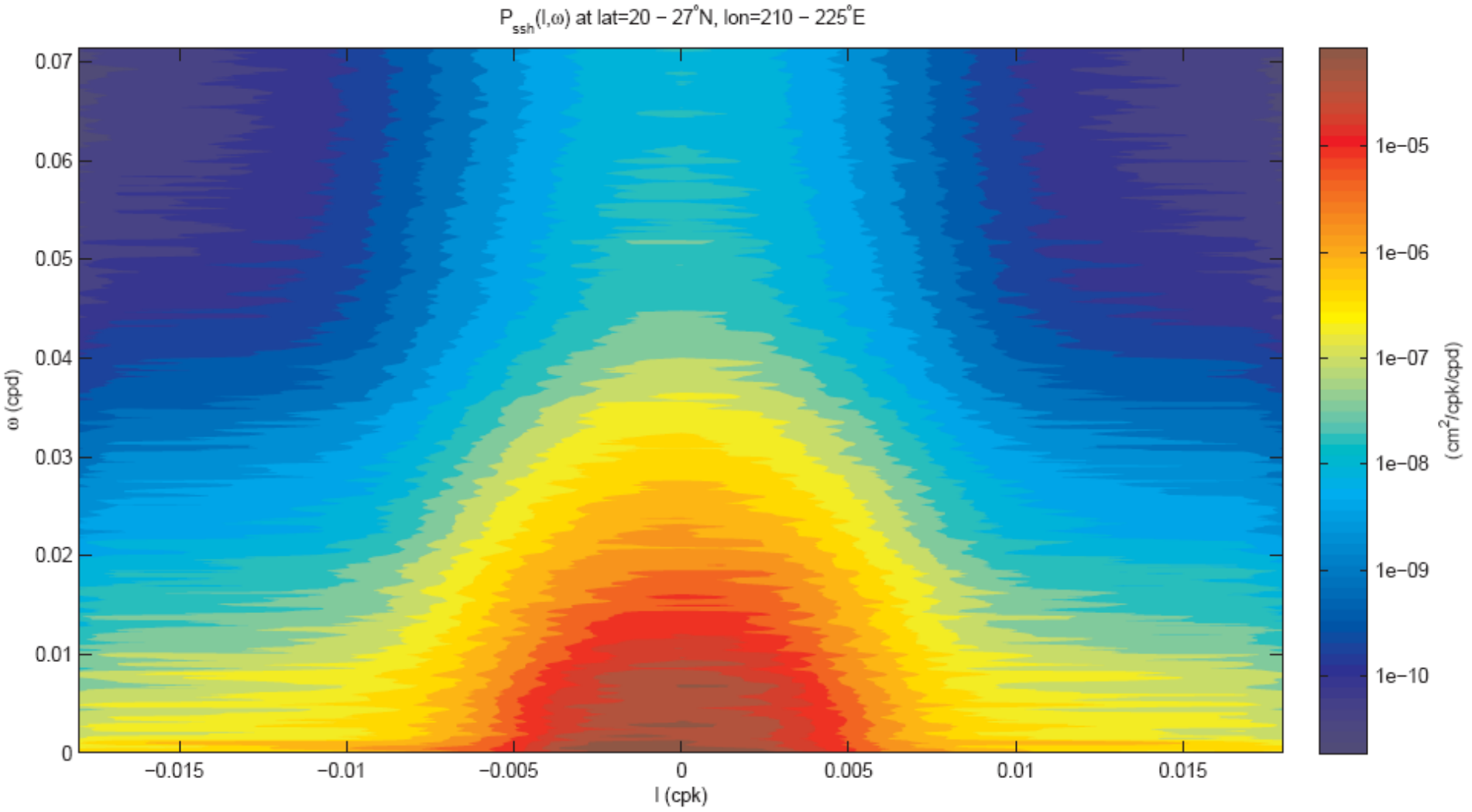
“This does show the nondispersive line with a slope consistent with that in the AVISO data. The two main differences are (1) the amplitudes are significantly lower in the ECCO2 spectrum and (2) there appears to be excess energy around k=0 in the ECCO2 spectrum relative to AVISO. The spatial mean has been removed, so this isn't due to the drift in SSH after 2002. Zooming in on the longitude-time plot shows a "streakiness" that does not appear in the AVISO data, that actually appears to be very fast propagating anomalies, that cross the region (15deg) from east to west in a matter of days. While they are very fast, the frequency is somewhat lower, coming about every 10-30 days. My first guess is that this is related to storms in the forcing, but I need to look into it more. This wouldn't show up in weekly AVISO data. “



westward-going

eastward-going

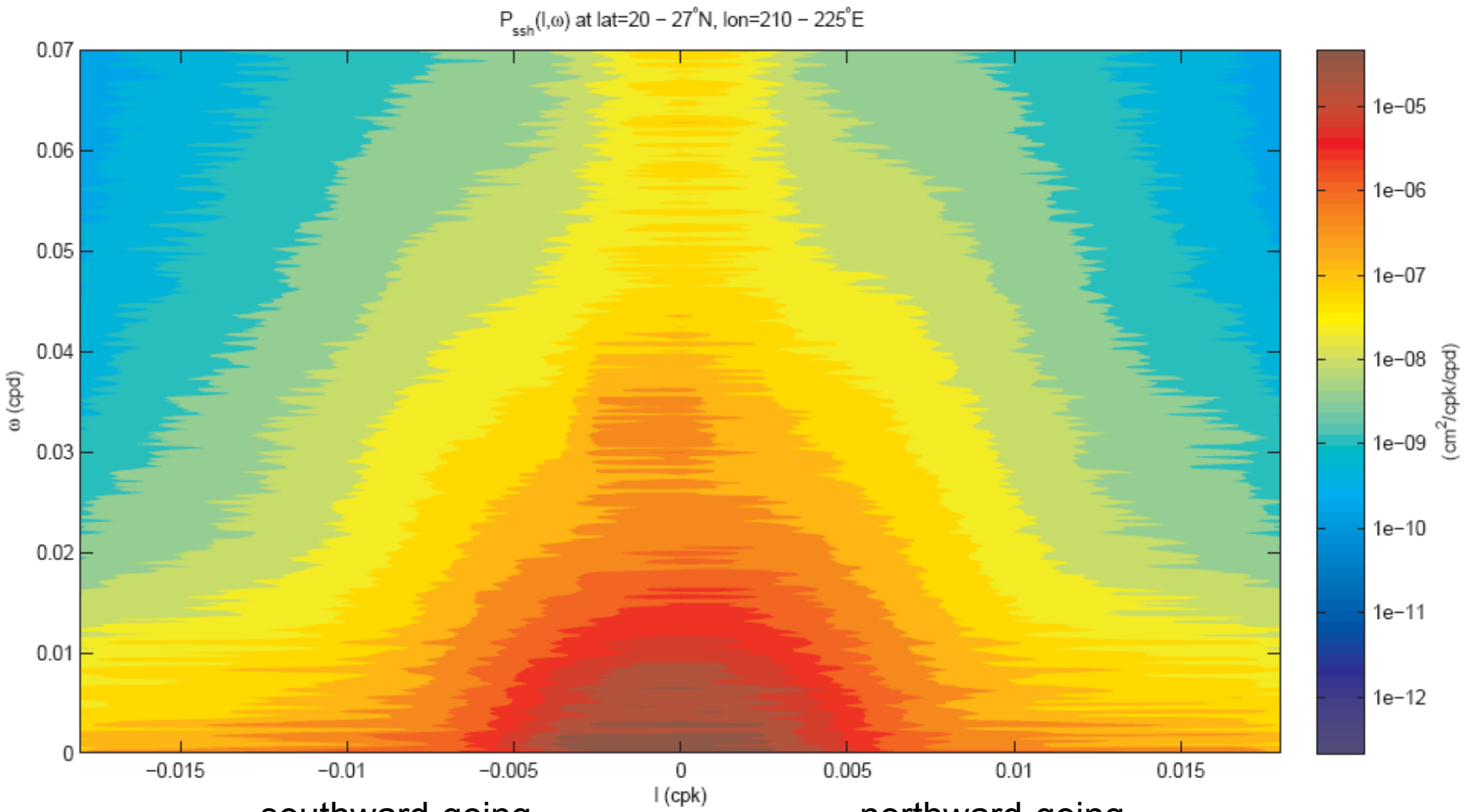
Meridional wavenumber/frequency spectrum AVISO



southward-going

northward-going

Meridional wavenumber/frequency spectrum ECCO2



southward-going

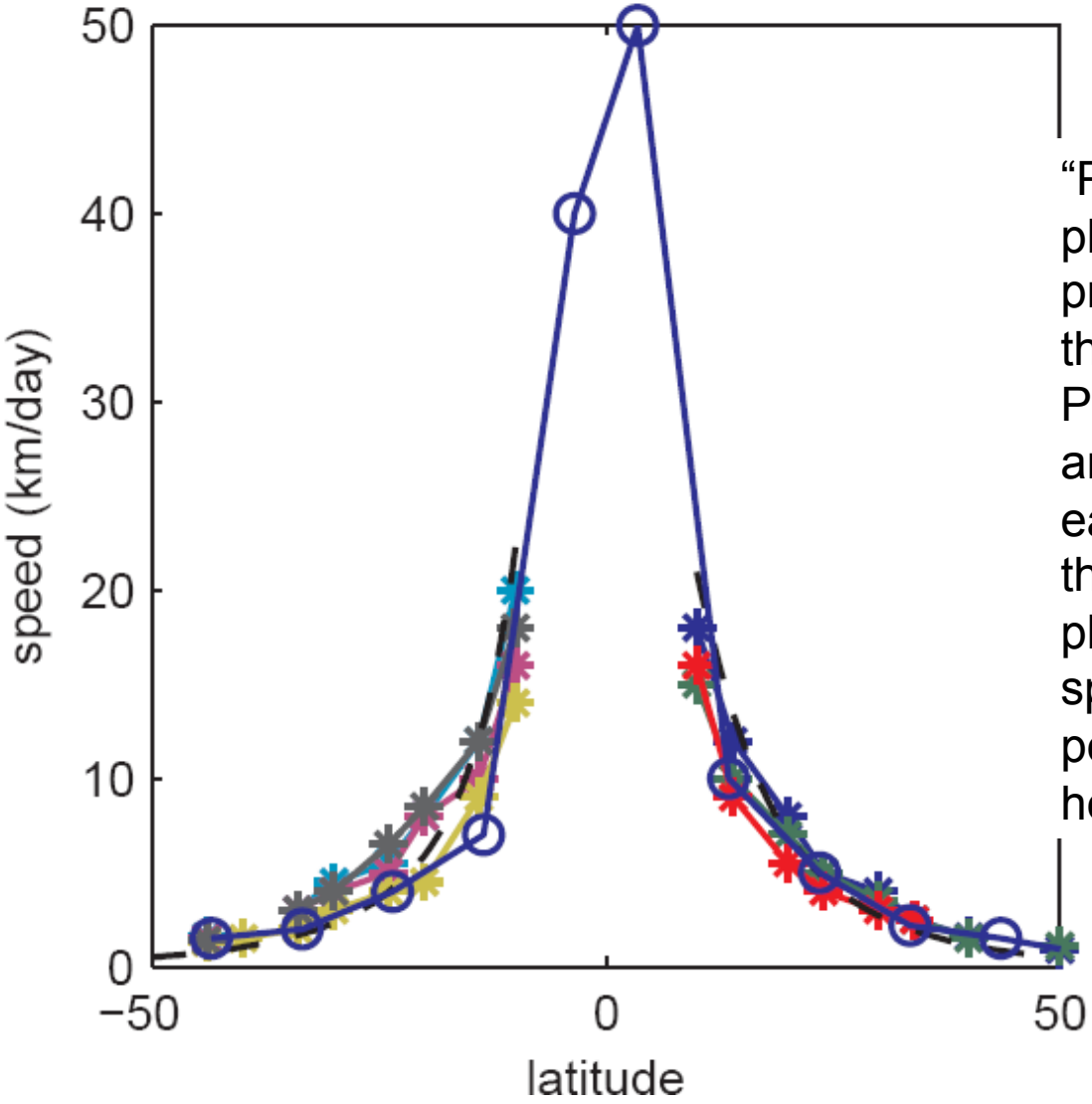
northward-going

“AVISO mean variance with spatial mean removed: 23.9 cm2
ECCO2 mean variance with spatial mean removed: 16.7 cm2
So (aside from the drift in ECCO2 after 2002) the SSH variance is significantly higher in the AVISO observations. “

Note that the AVISO product is significantly smoothed (over about a 300km radius) and so is already an underestimate of the total variance.

Phase speed comparison: slope of the non-dispersive line versus the theoretical value.

•different longitudes in the model
•dashed basic textbook theory



"Phase speed compares the dominant phase speed for westward propagating anomalies (the slope of the nondispersive line) from TOPEX/ POSEIDON observations in several areas to ECCO2 results for the eastern Pacific and the basic textbook theory long baroclinic Rossby wave phase speed. The ECCO2 phase speeds are comparable, though perhaps a little low in the southern hemisphere."

Should be able to understand the nature of the nondispersive line.