# Evaluation of GHRSST Products for Studies of Short-TermClimate Variability:

## A Comparison Between **Monthly Averages** of OSTIA and NCDC OI (AMSR+AVHRR) SST Analyses

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Overview:

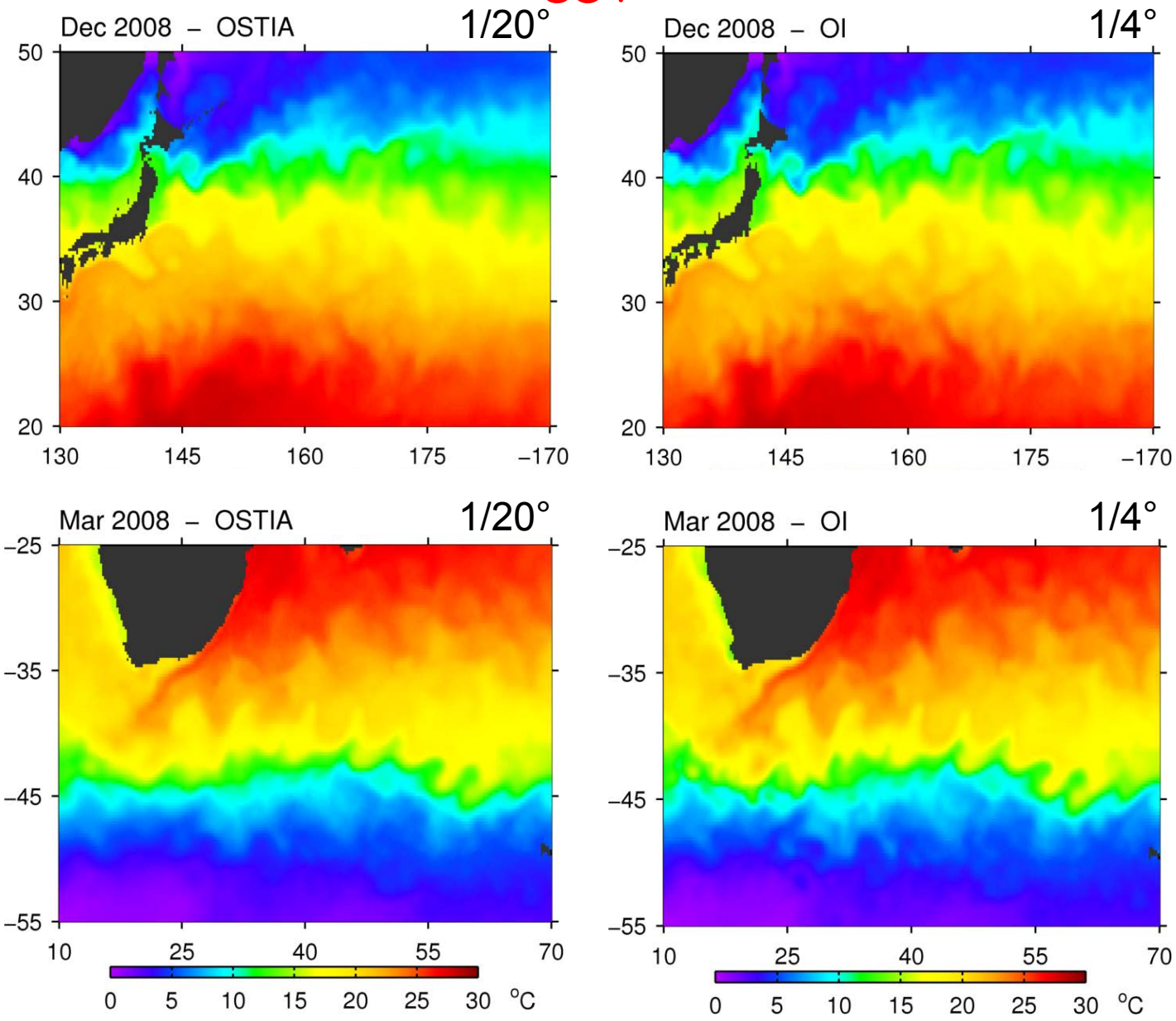
- Spatial resolution
- Estimates of climate indices
  - El Nino
  - Pacific Decadal Oscillation
- Differences between OSTIA and NCDC OI (AMSR+AVHRR)

Spatial Resolution* of the Monthly Averages

*not to be confused with grid resolution

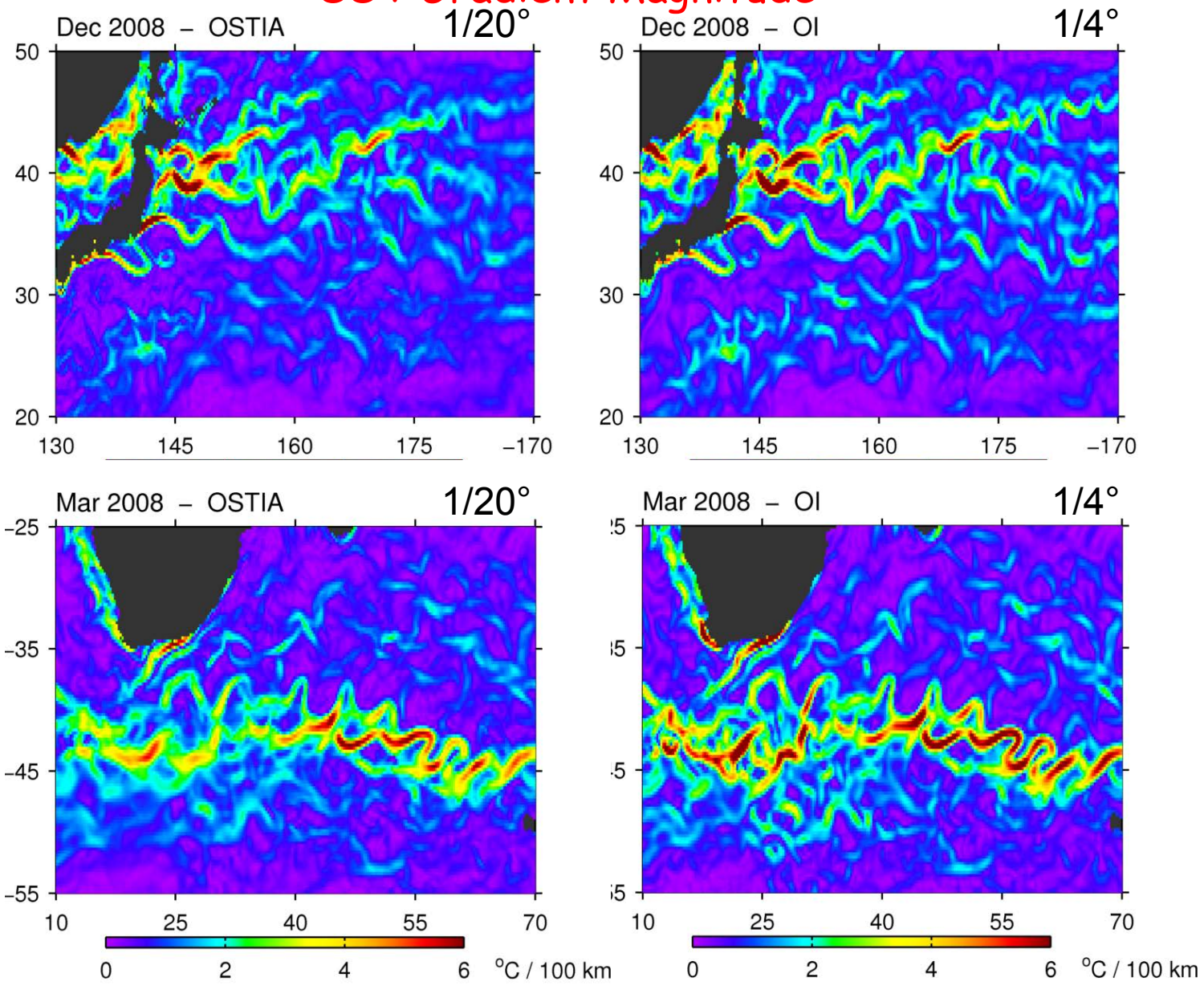
# Example Maps for the Kuroshio Extension and Agulhas Return Current

SST

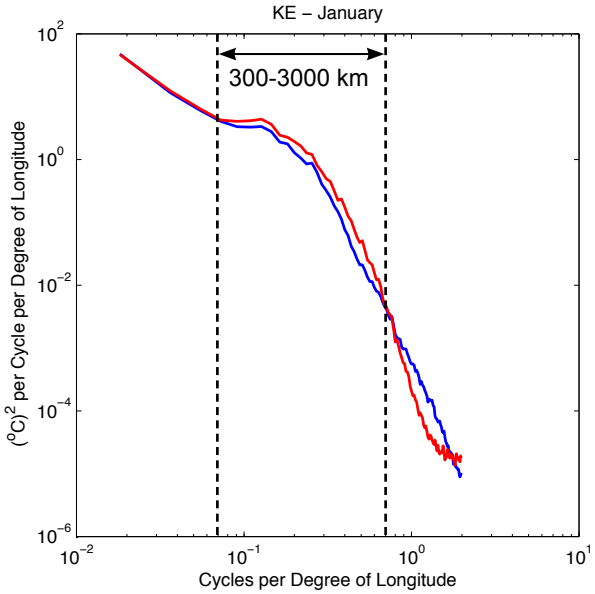


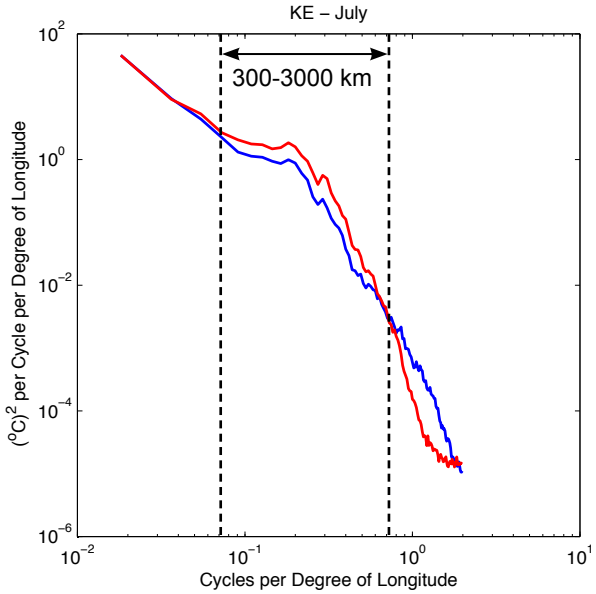
# Example Maps for the Kuroshio Extension and Agulhas Return Current

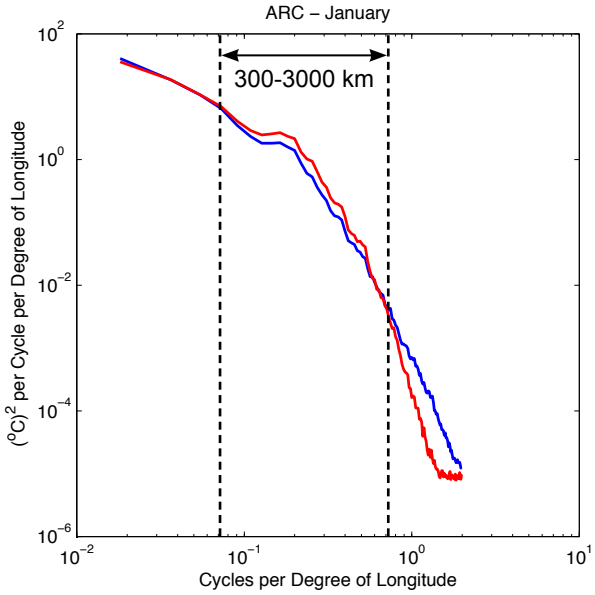
## SST Gradient Magnitude

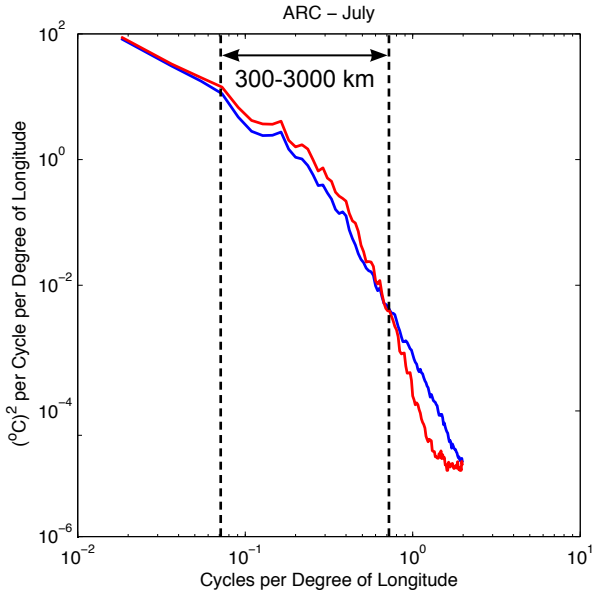


# Example Maps for the Kuroshio Extension and Agulhas Return Current Wavenumber Spectra of Monthly Averaged SST




OSTIA 1/20°

OI 1/4°

Results are very similar to the spectra obtained by Reynolds & Chelton (2010, J. Clim.) from daily fields.

OSTIA has:

- weaker SST signal on wavelength scales of 300-3000 km (feature scales of ~50-500 km)
- stronger SST signal on feature scales < 50 km

This is exactly the range of scales that AMSR and TMI measure best.

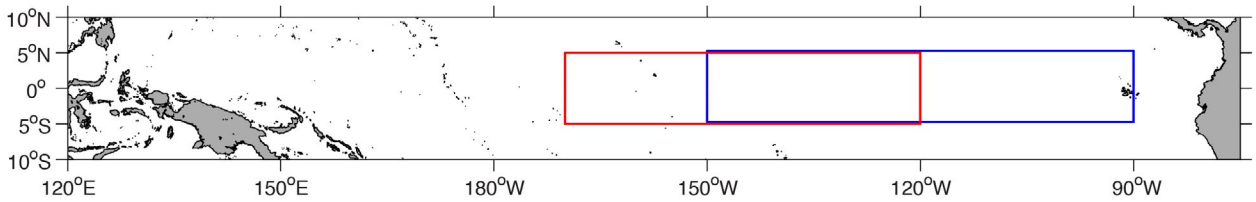
Perhaps OSTIA is not weighting the microwave data high enough???

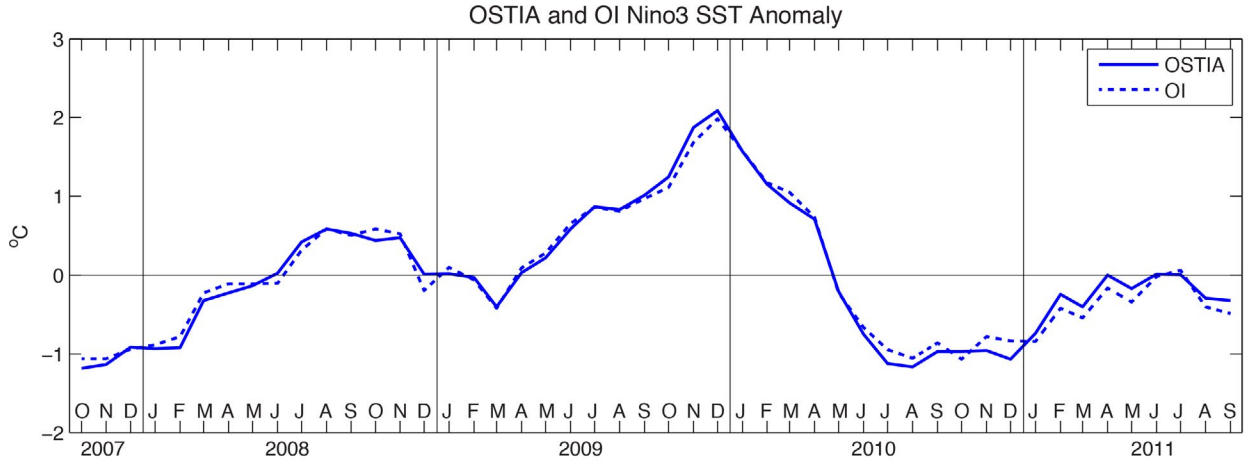
## Estimates of Climate Indices from Anomaly SST*

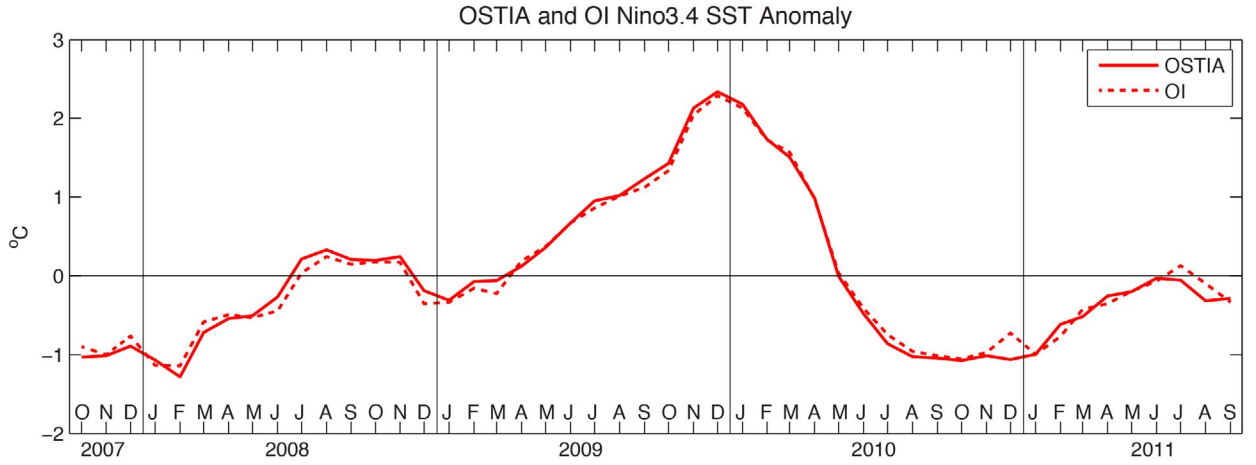
- El Nino
- North Pacific EOFs (the PDO)
- Global EOFs

*Anomalies are defined to be deviations from the seasonal cycle.

# Nino3 and Nino3.4 Indices of the El Nino/Southern Oscillation



# North Pacific EOFs 1-4 of Monthly Anomaly SST

## OSTIA

EOF #1
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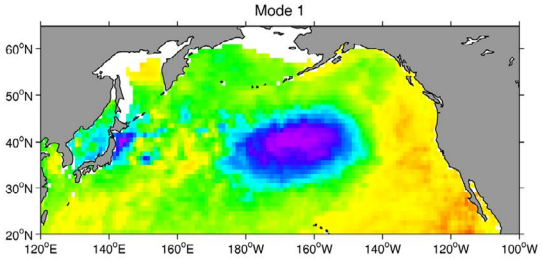


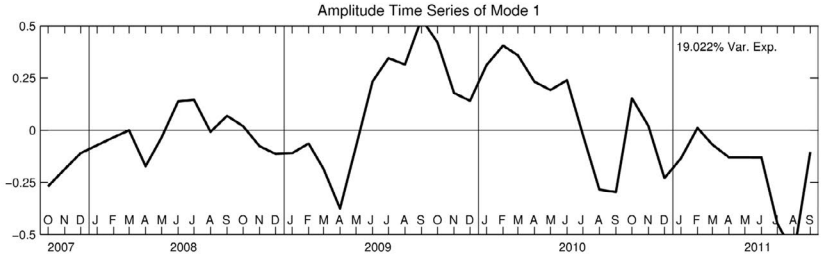


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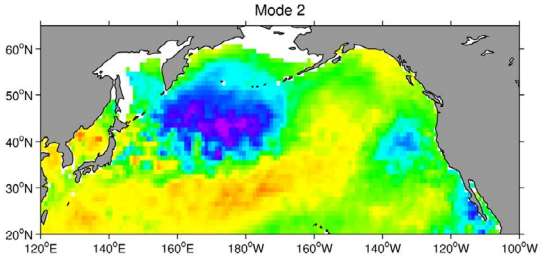


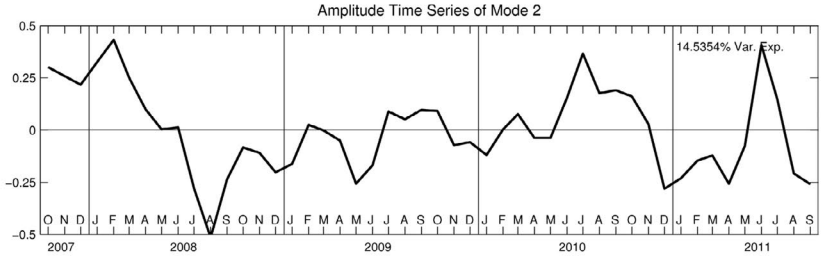


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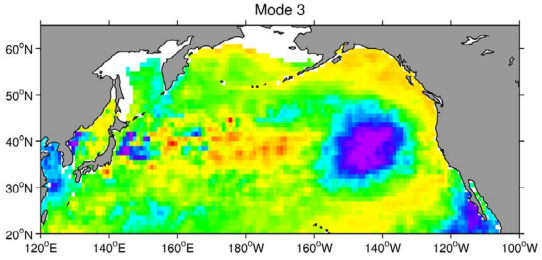


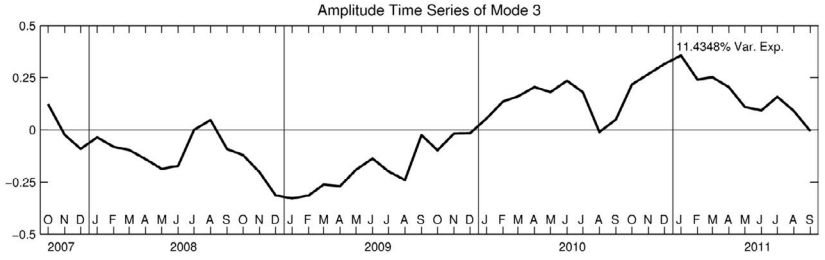


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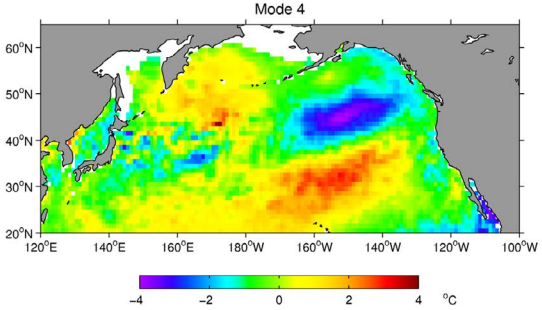
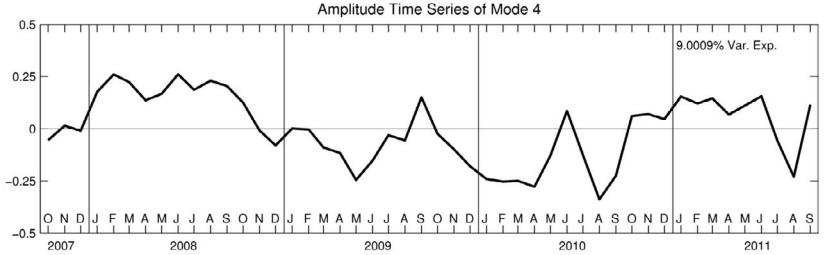
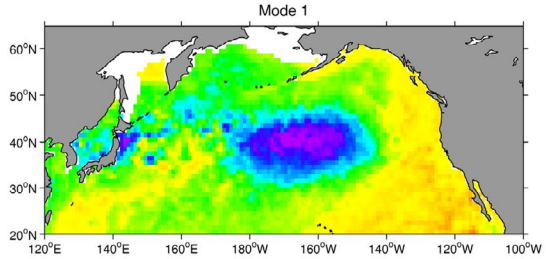


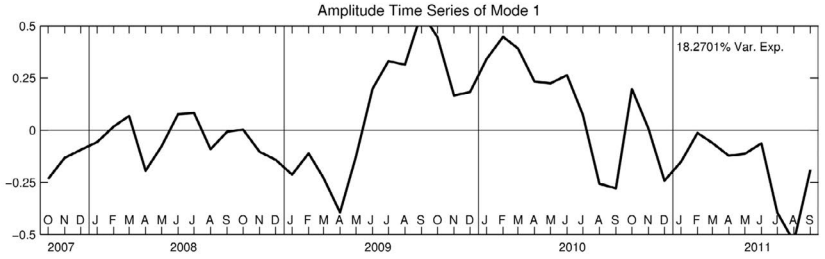



# North Pacific EOFs 1-4 of Monthly Anomaly SST

OI

EOF #1
18%

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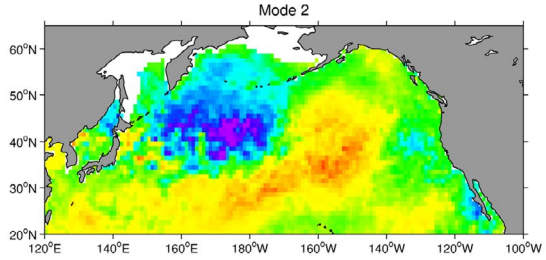


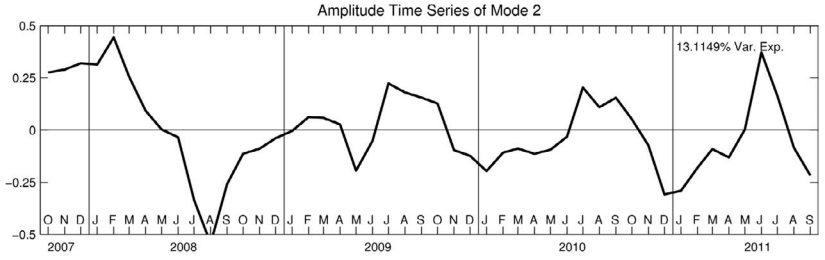


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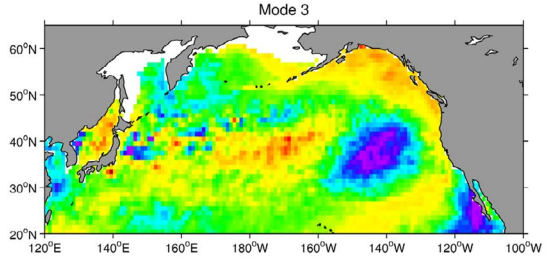


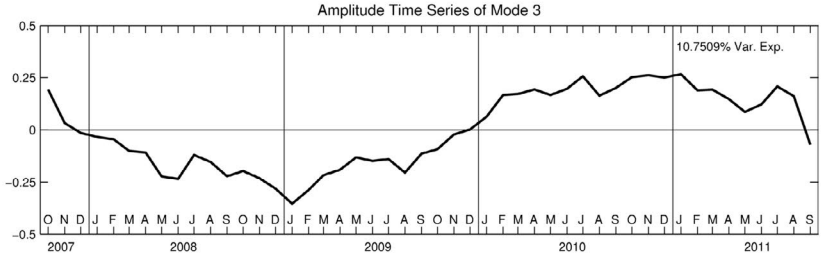


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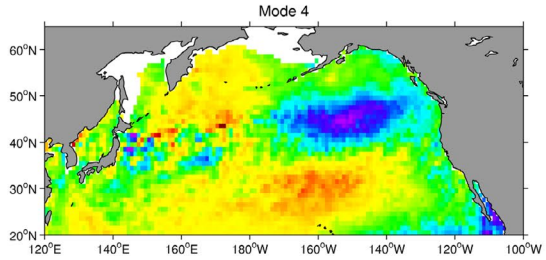
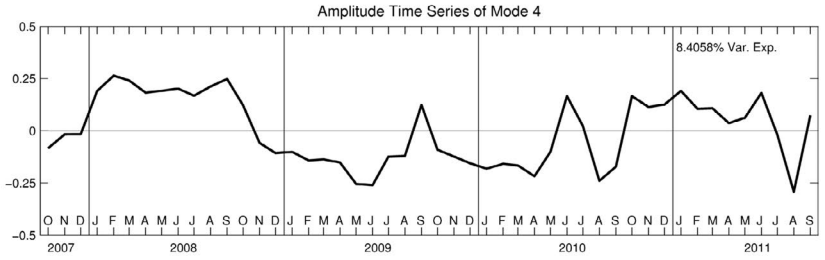
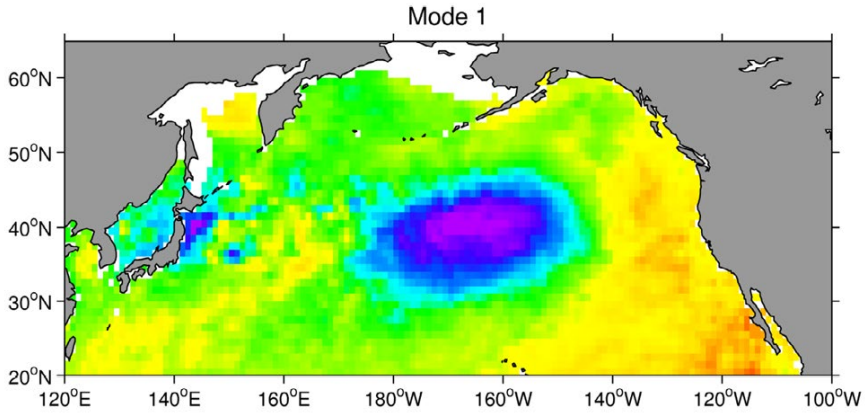


# OSTIA EOF #1

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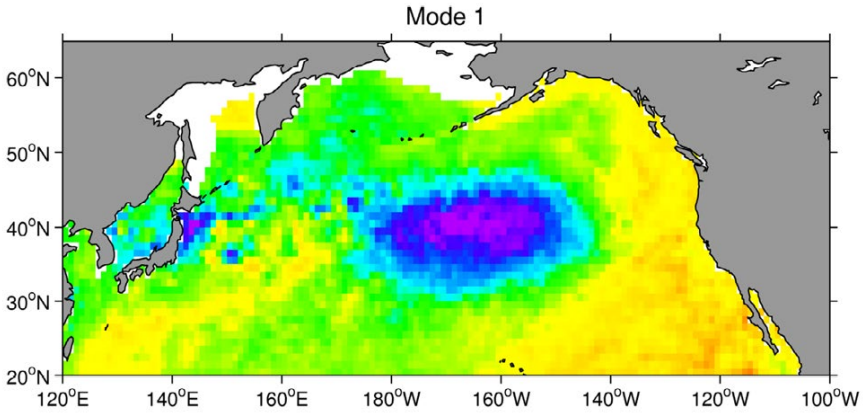
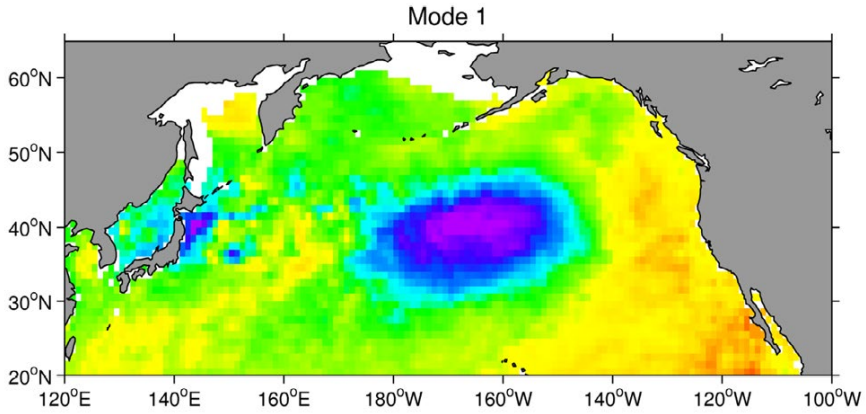
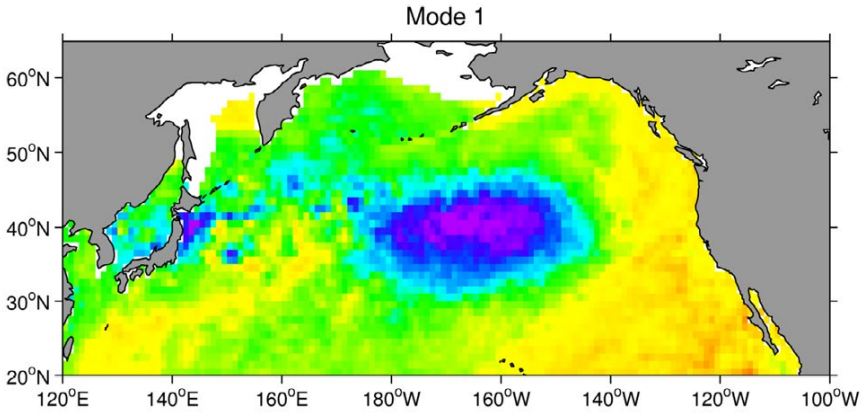


## OSTIA EOF #1



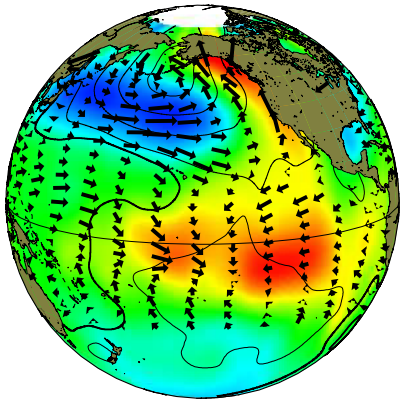

## OI EOF #1

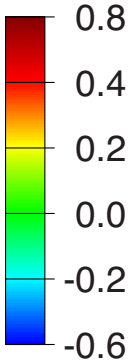



# The "Official" North Pacific Pattern of the Pacific Decadal Oscillation

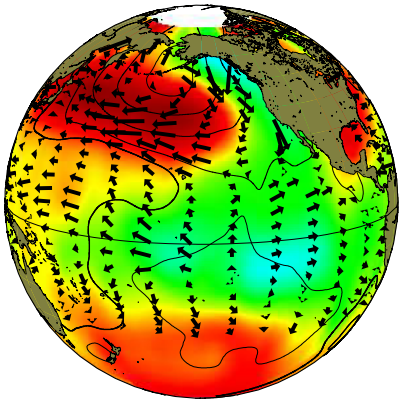
*The PDO Index is defined to be the amplitude time series (or principle component) of the most energetic empirical orthogonal function (EOF) of SST north of 20°N in the North Pacific Ocean.*

Positive (warm) phase






Negative (cold) phase



*Color is the 1st EOF of SST in its positive (warm) and negative (cold) phases.*

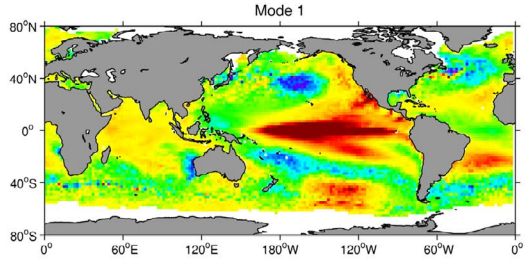
*Contours are sea-level pressure regressed on the PDO index.*

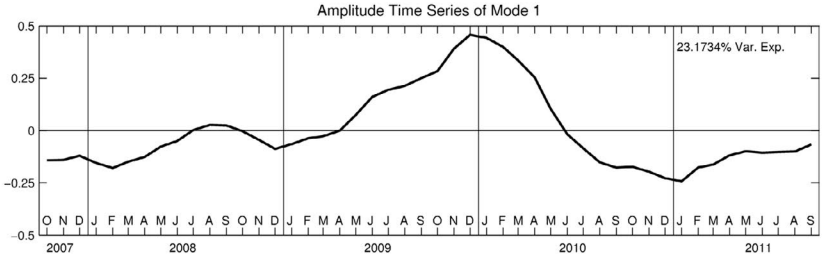
*Vectors are the surface wind stress regressed on the PDO index.*

# Global EOFs 1-4 of Monthly Anomaly SST

## OSTIA

EOF #1
23%

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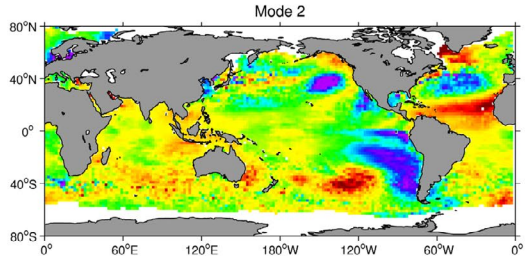


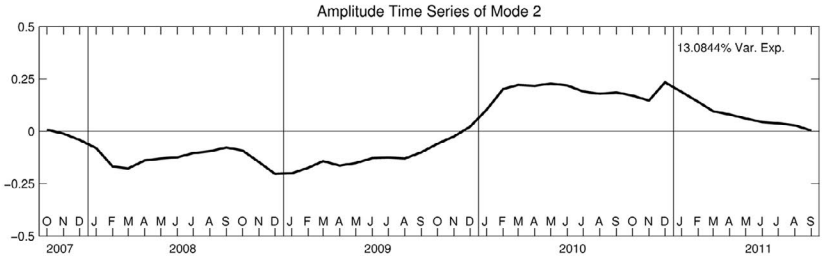


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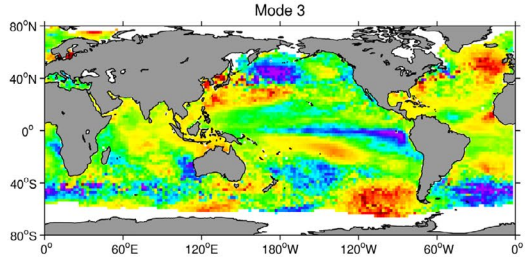


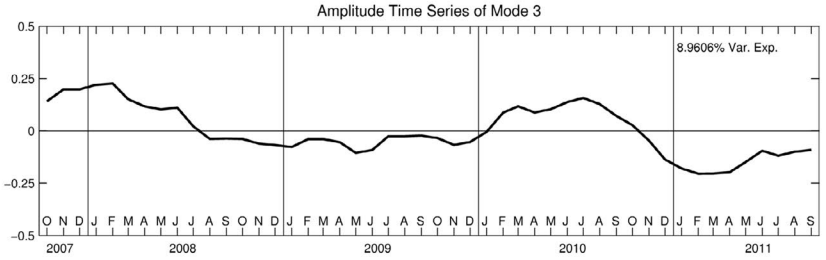


EOF #4
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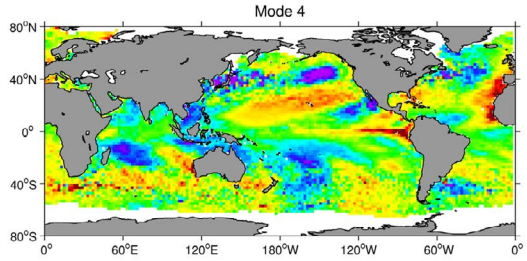
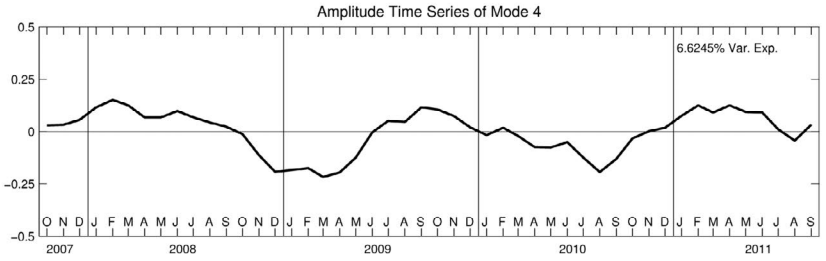
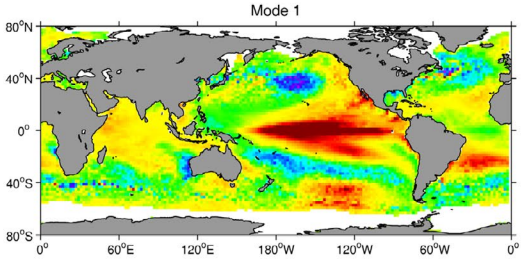


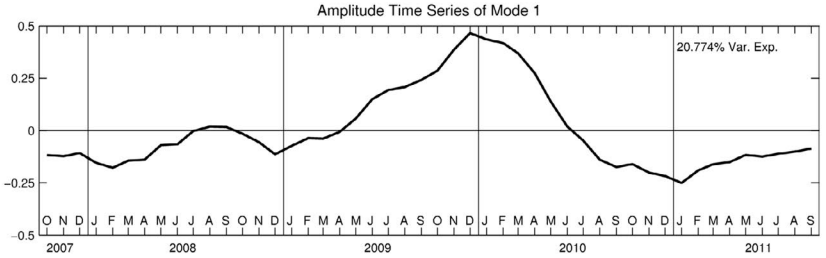



# Global EOFs 1-4 of Monthly Anomaly SST

OI

EOF #1
21%

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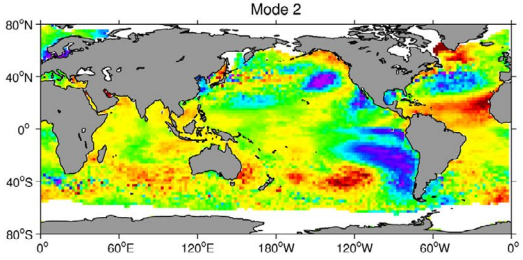


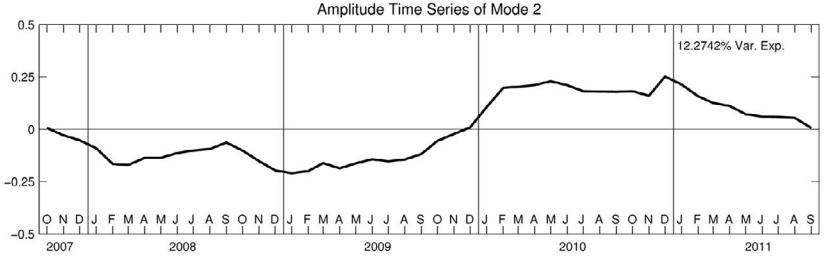


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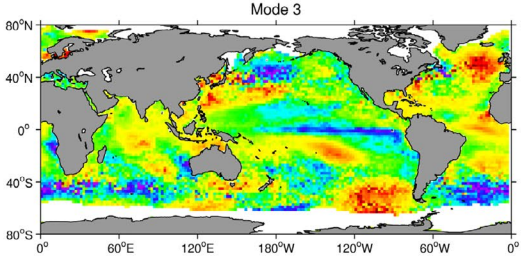


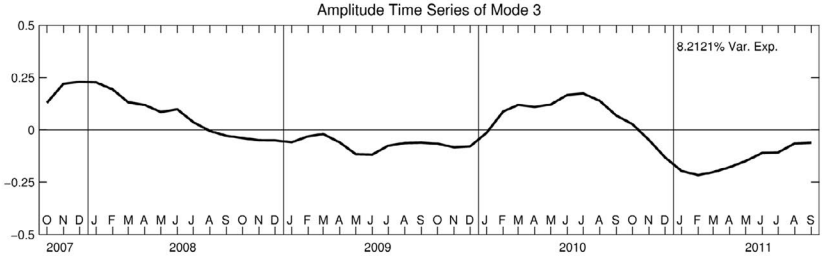


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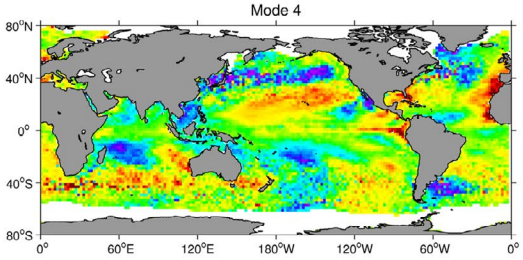
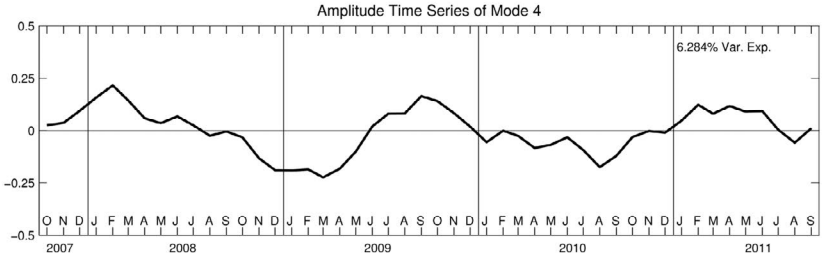
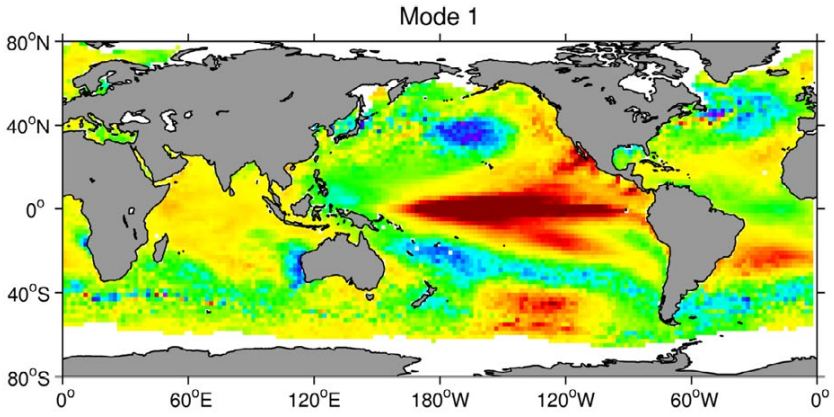
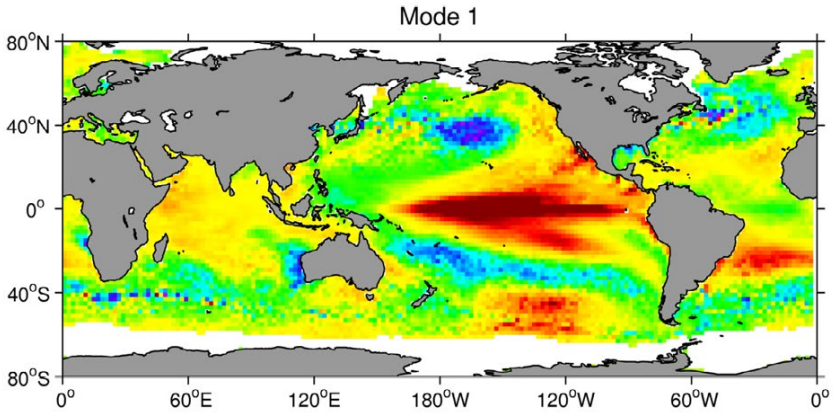


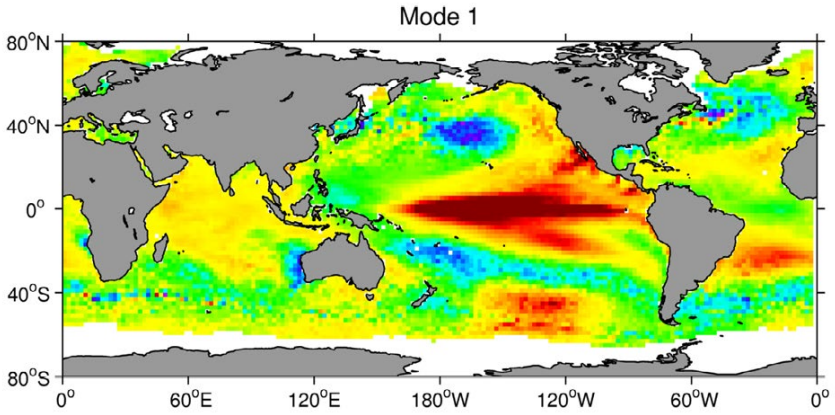

# OSTIA EOF #1



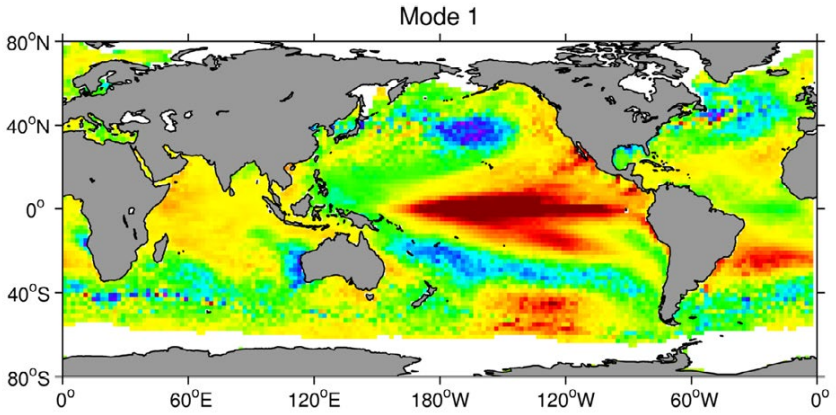

# OI EOF #1



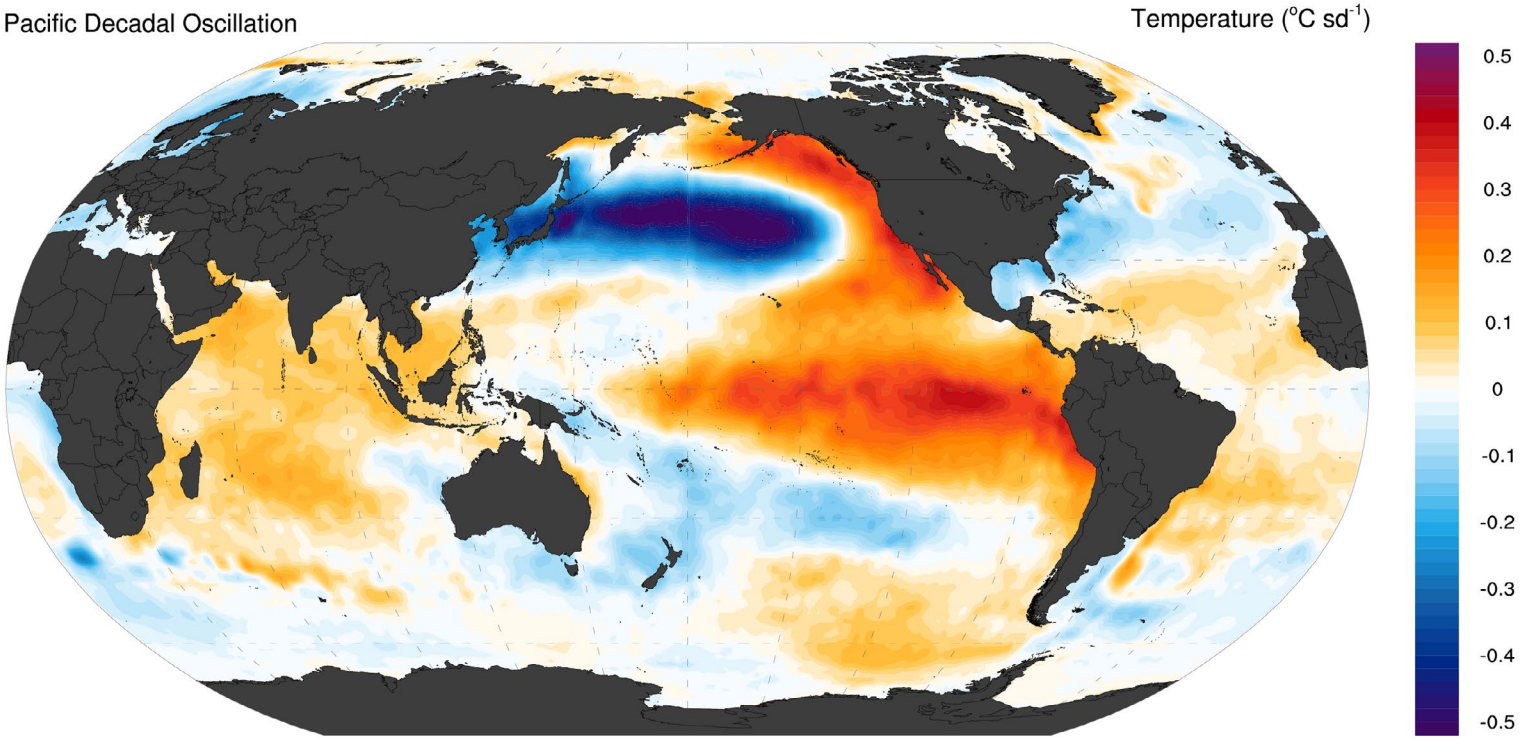
## OSTIA EOF #1




## OI EOF #1

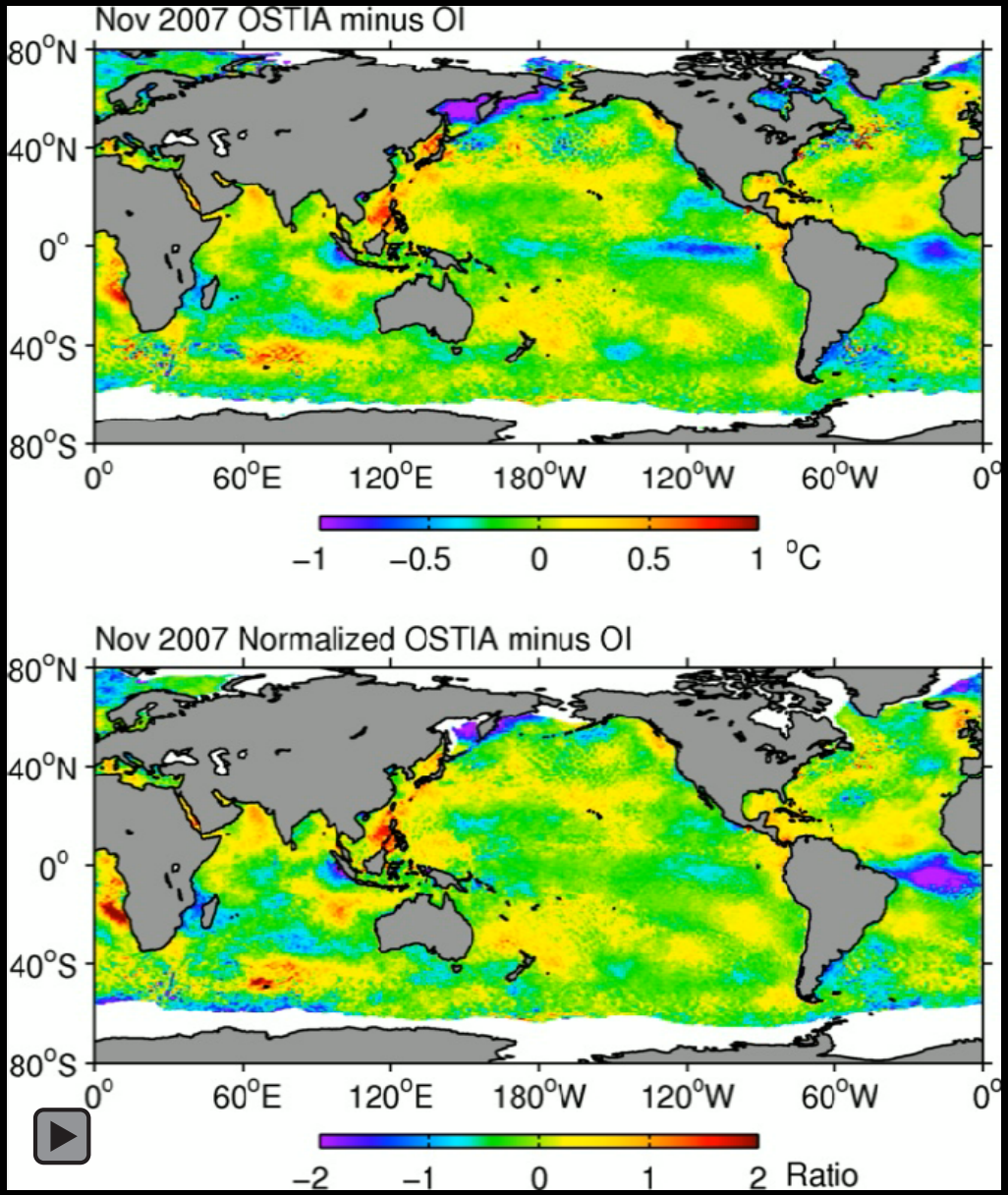



## The "Official" Global Pattern of the Pacific Decadal Oscillation

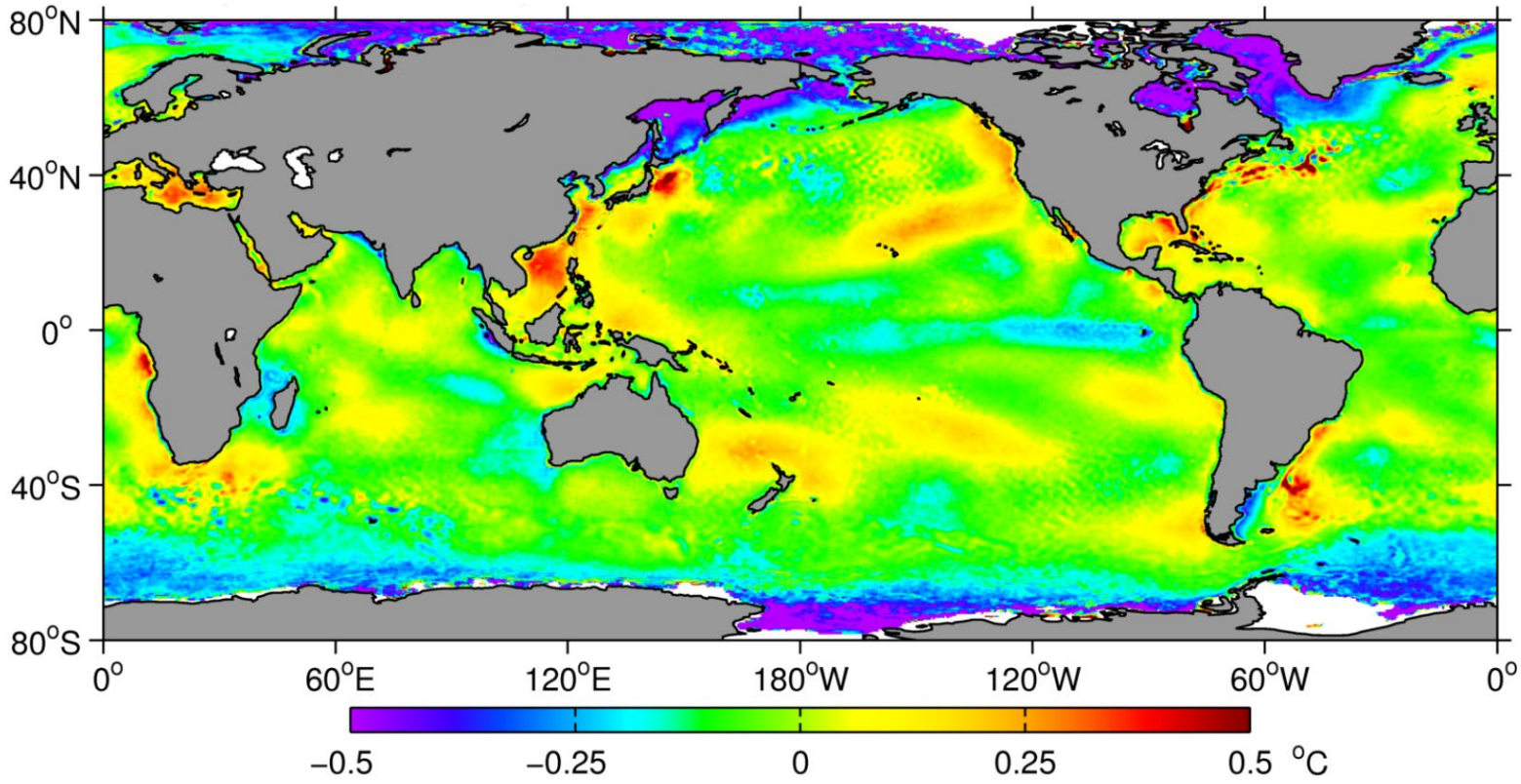


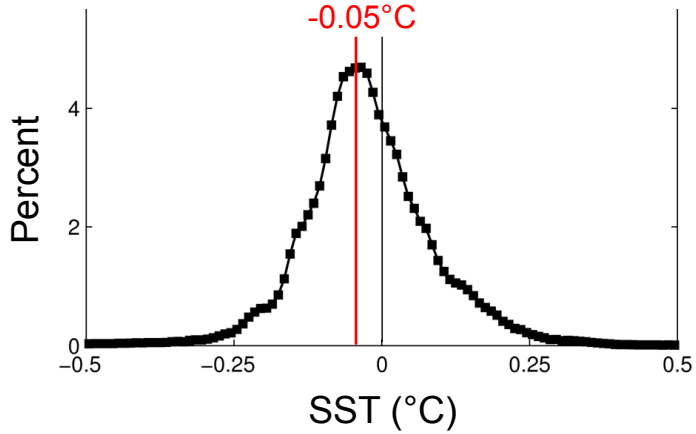
# Differences Between Monthly Averages of OSTIA and OI

# Global Animation of SST Differences, OSTIA minus OI
## (Monthly Averages)



# Mean Value of the Monthly Averaged Differences OSTIA minus OI

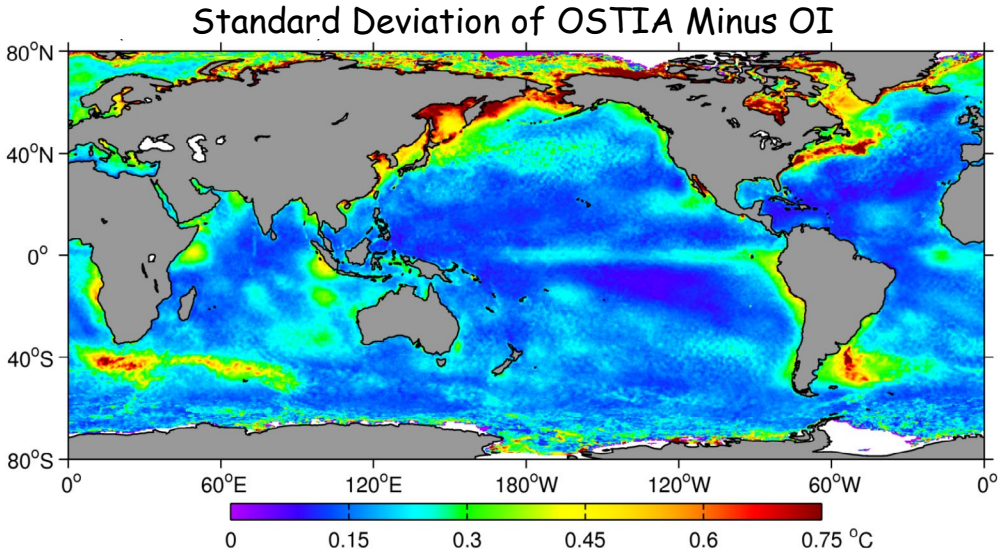


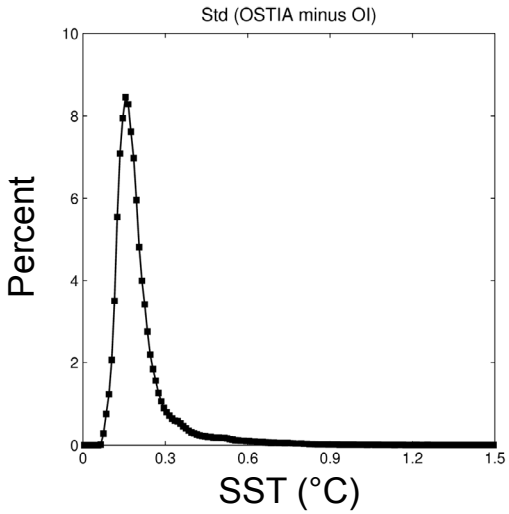



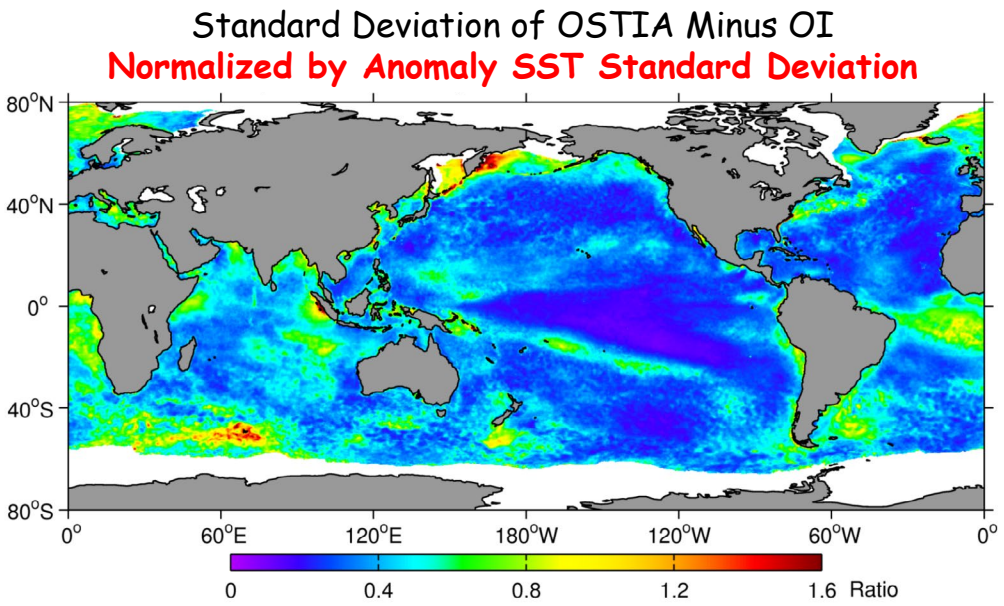

The mode of the distribution is about -0.05 °C (OSTIA colder than OI).

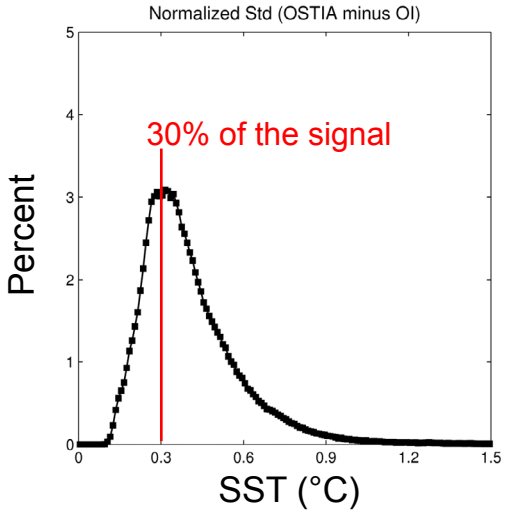
Is this the value expected for the difference between foundation and skin temperature?

# Standard Deviation and Normalized Standard Deviation of the Differences OSTIA minus OI



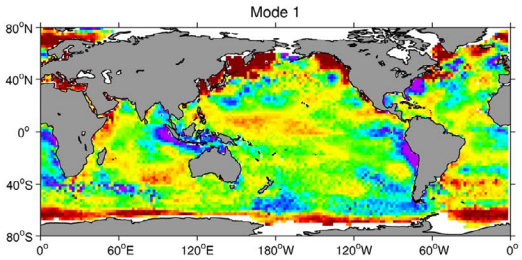



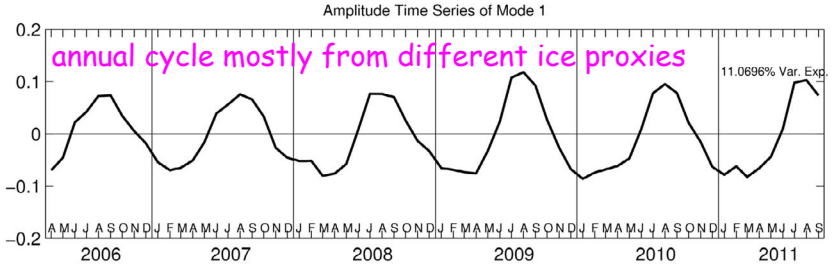



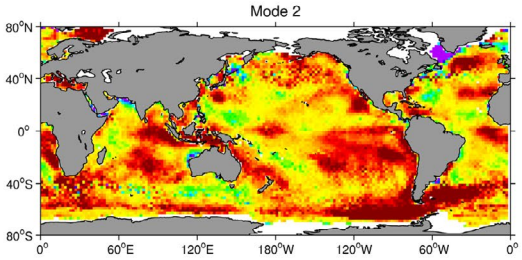
# Global EOFs 1-4 of the Monthly Averaged Differences OSTIA Minus OI
## (mean not removed at each grid point)

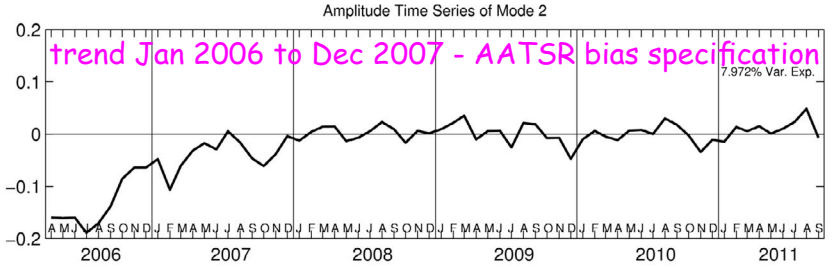
EOF #1
11%



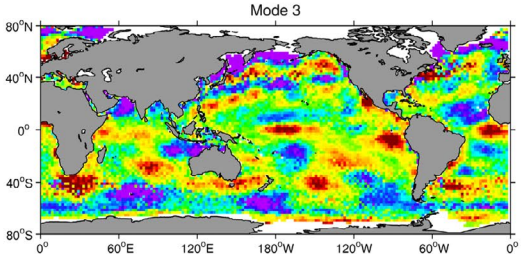



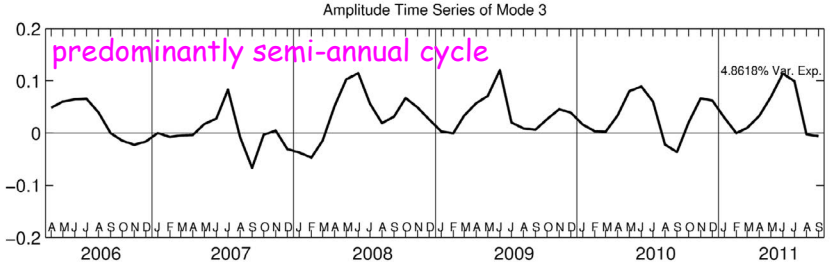

EOF #2
8%



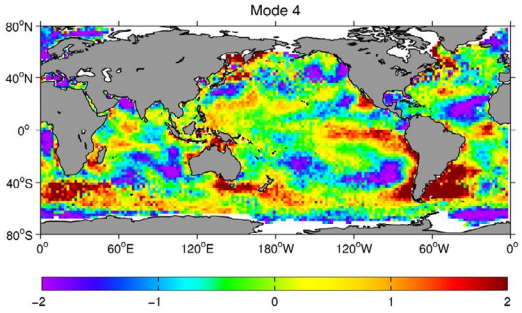



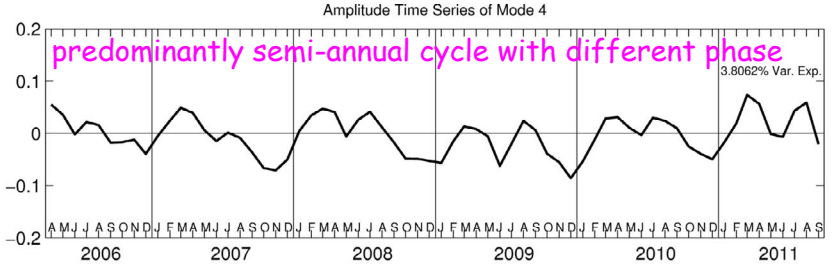

EOF #3
5%



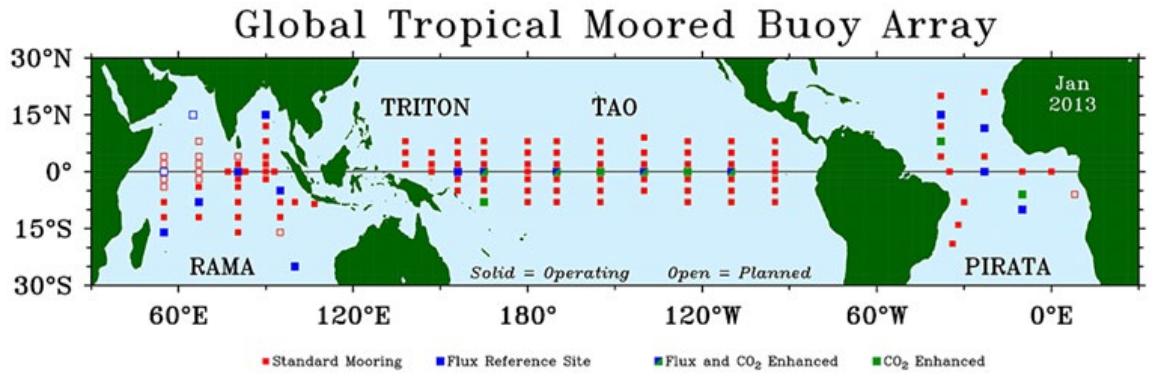




EOF #4
4%

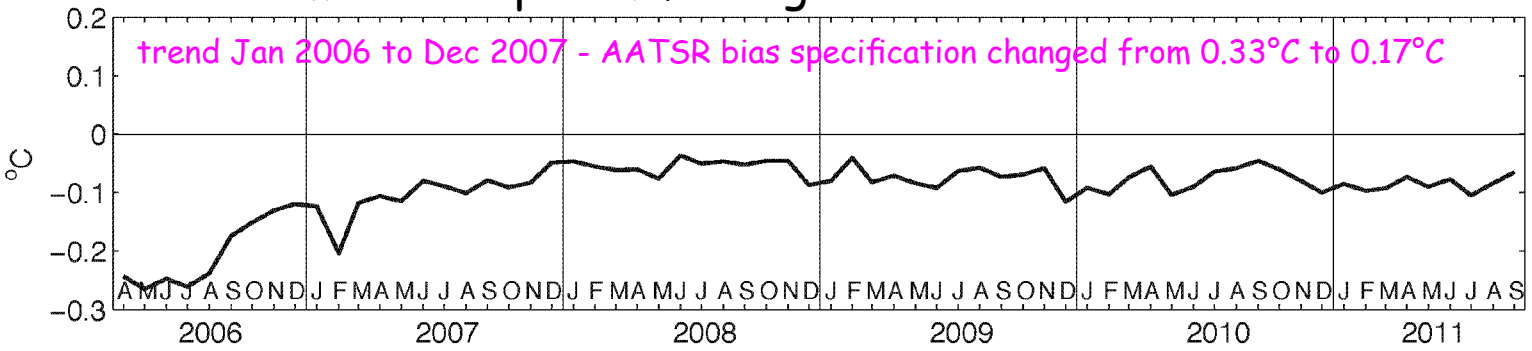


# Overall Average of the Differences Between Monthly Averages of the Tropical Mooring SST and OSTIA and OI SST

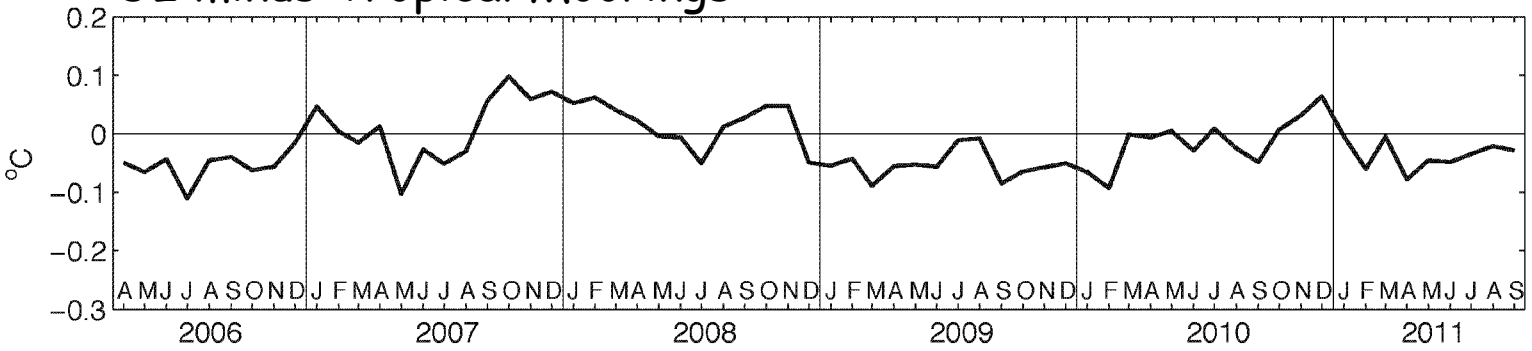



## OSTIA minus Tropical Moorings

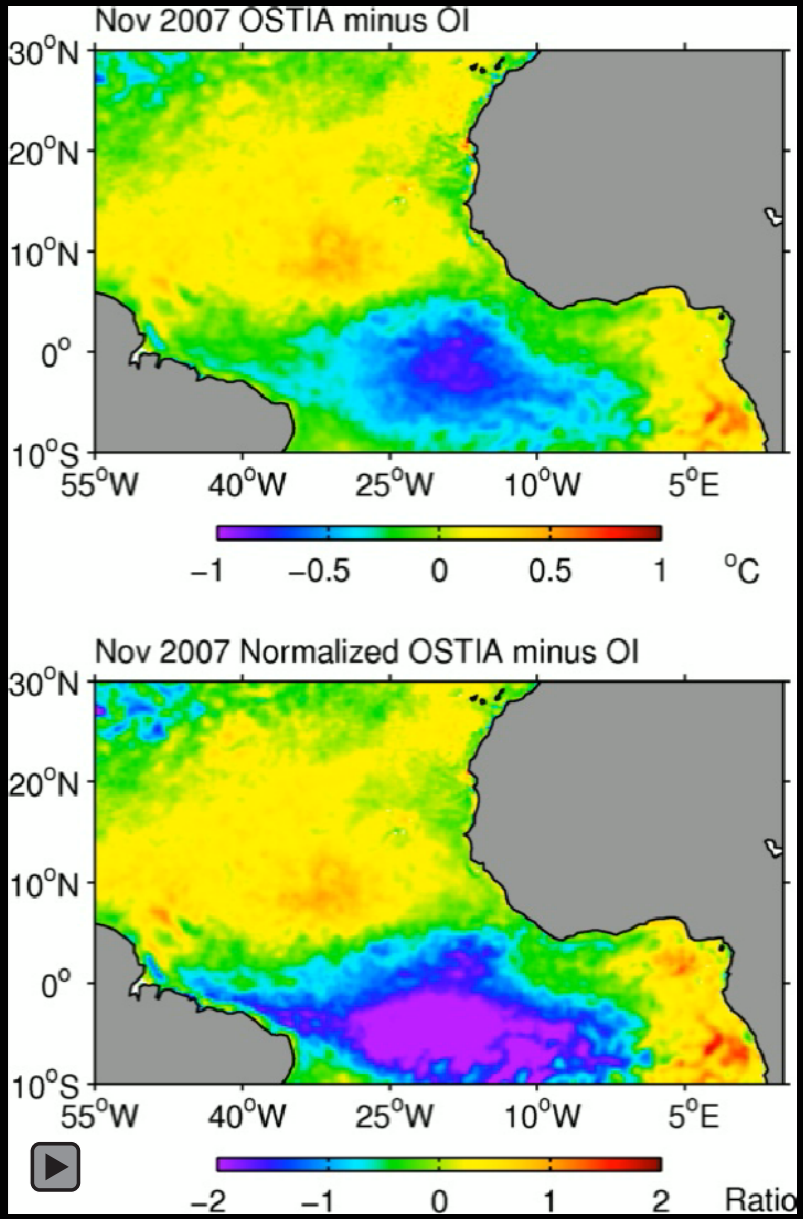



?

## OI minus Tropical Moorings



# Tropical Atlantic Animation of SST Differences, OSTIA minus OI (Monthly Averages)



# Conclusions from Analysis of Monthly Averages of OSTIA and OI (AMSR+AVHRR)

## Spatial resolution

- SST signals in OSTIA are stronger at feature scales < 50 km, but weaker at feature scales of 50-500 km.
- Perhaps OSTIA is not weighting the microwave data high enough?

## Differences between OSTIA and OI

- The differences are larger than I would expect for monthly averages.
- Standard deviations σ approach ~1°C in the western boundary current extensions and are commonly 30-80% of the anomaly SST signal in the open ocean.
- However, σ is not a comprehensive metric since differences of ~1°C with scales of ~1000 km and persistence of 1-3 months occur randomly in space and time throughout the ocean.

## Reasons for the differences

- We have not been able to determine the reasons for most of the differences.
- Exceptions include: different SST proxies for ice; cold bias from Jan 2006 to Dec 2007 in AATSR used for calibration in the OSTIA analysis; possible aerosol and/or cloud errors in the tropical Atlantic.

## Despite the differences, OSTIA and OI yield very similar climate indices, though slightly noisier for OI.

# Overviews of OSTIA and NCDC OI

## OSTIA

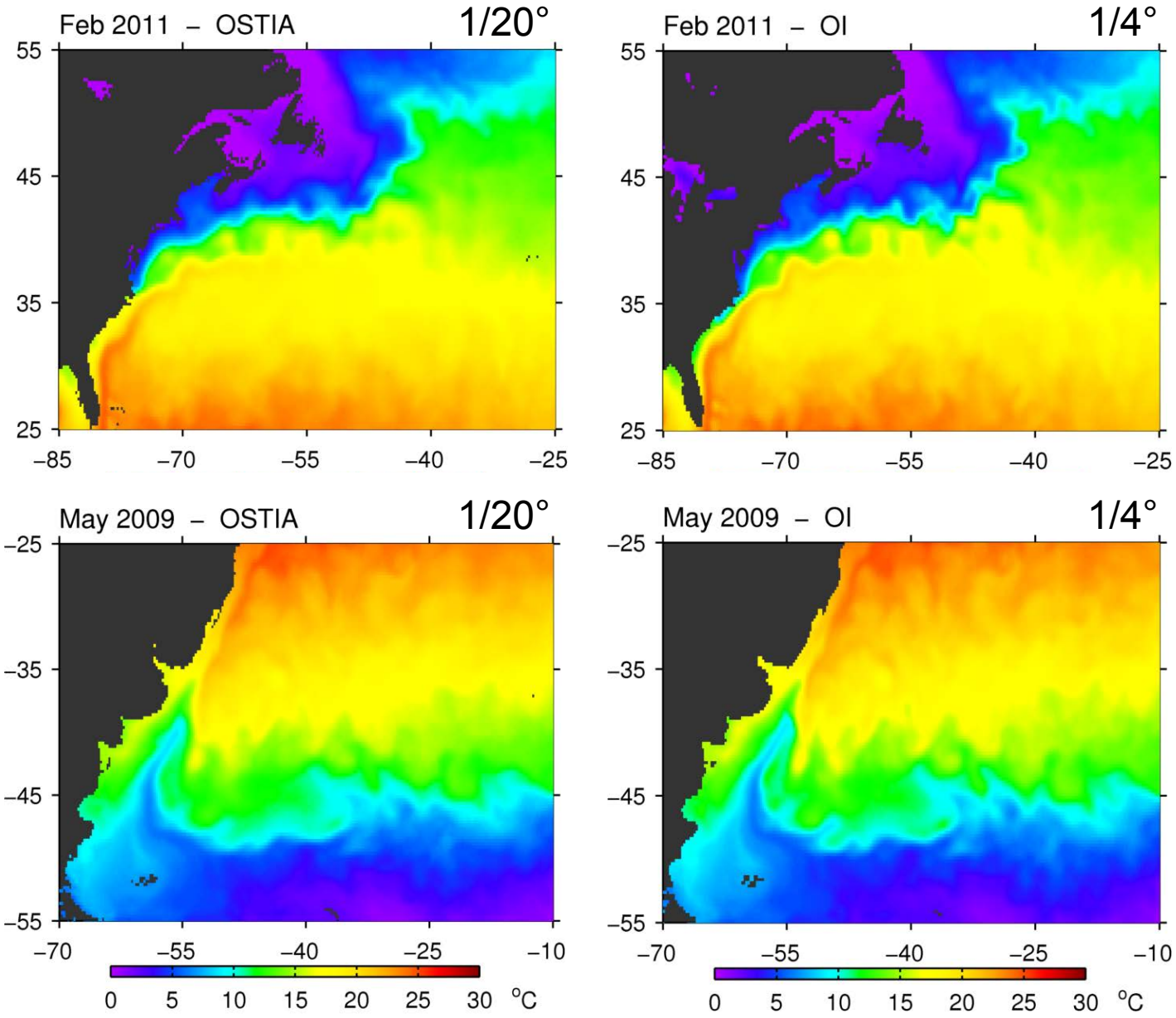
- Daily analyses of foundation SST
- 1/20° grid resolution
- Data sources:
  - AATSR used as reference for bias adjustment (until April 2012)
  - AVHRR (only 1 instrument)
  - SEVIRI
  - TMI
  - AMSR-E (until October 2011)
  - METOP AVHRR (since April 2008)
  - IASI and GOES-E (since Nov 2011)
  - In situ ship and buoy data for large-scale bias correction
- Proxy SST in ice-covered regions based on sea ice concentration
- Daytime data in winds < 6m/s are excluded to reduce skin SST effects on estimates of foundation SST

## NCDC OI (AMSR+AVHRR)

- Daily analyses of skin SST
- 1/4° grid resolution
- Data sources:
  - Navy Operational AVHRR since January 2007 (2 instruments). (Switched from Pathfinder because of negative bias in cloudy regions)
  - AMSR-E (until October 2011)
  - In situ ship and buoy data for large-scale bias correction
- Proxy SST in ice-covered regions based on sea ice concentration
- No attempt to correct to foundation temperature

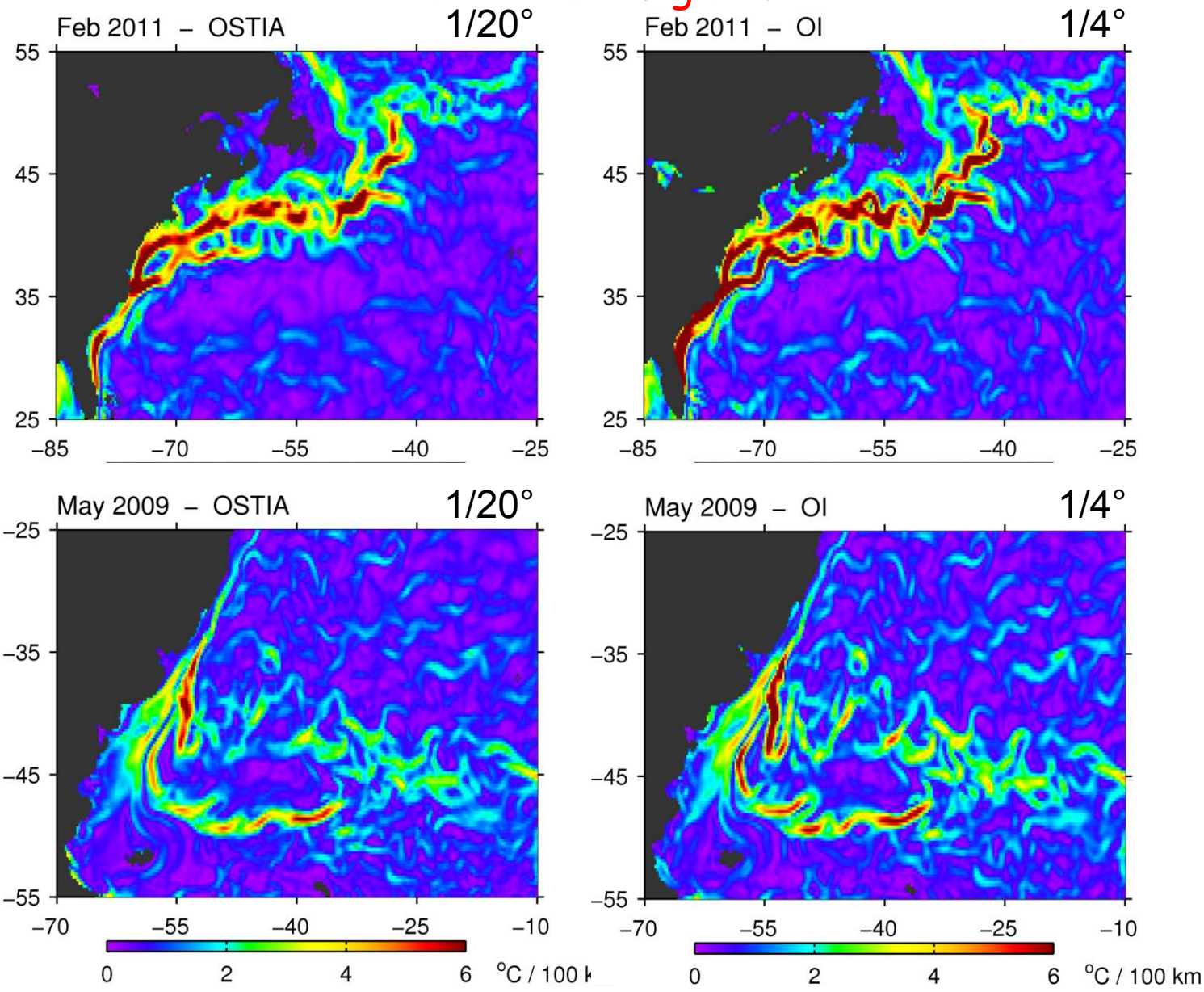
# Example Maps for the Gulf Stream and Southwest Atlantic

SST



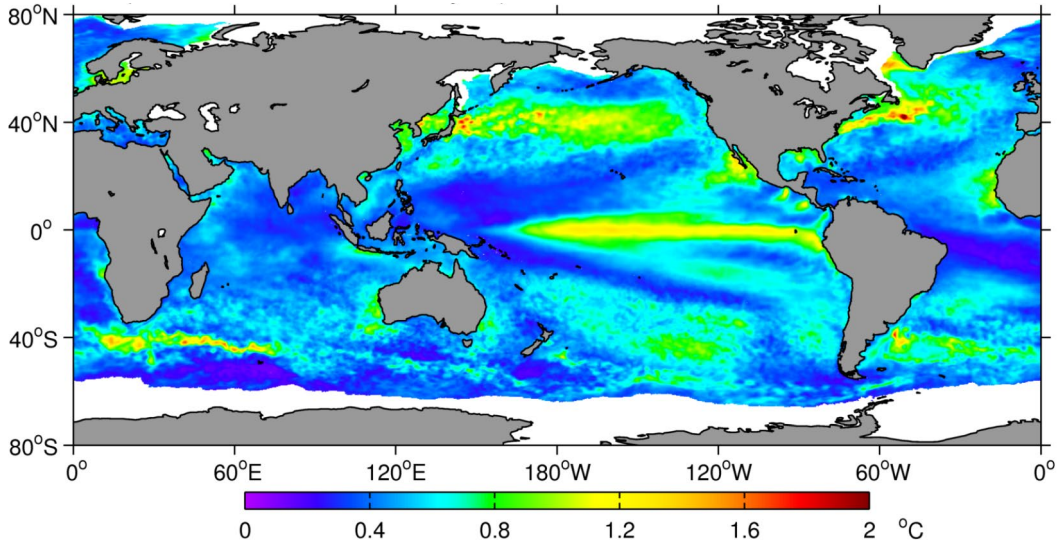
# Example Maps for the Gulf Stream and Southwest Atlantic

## SST Gradient Magnitude

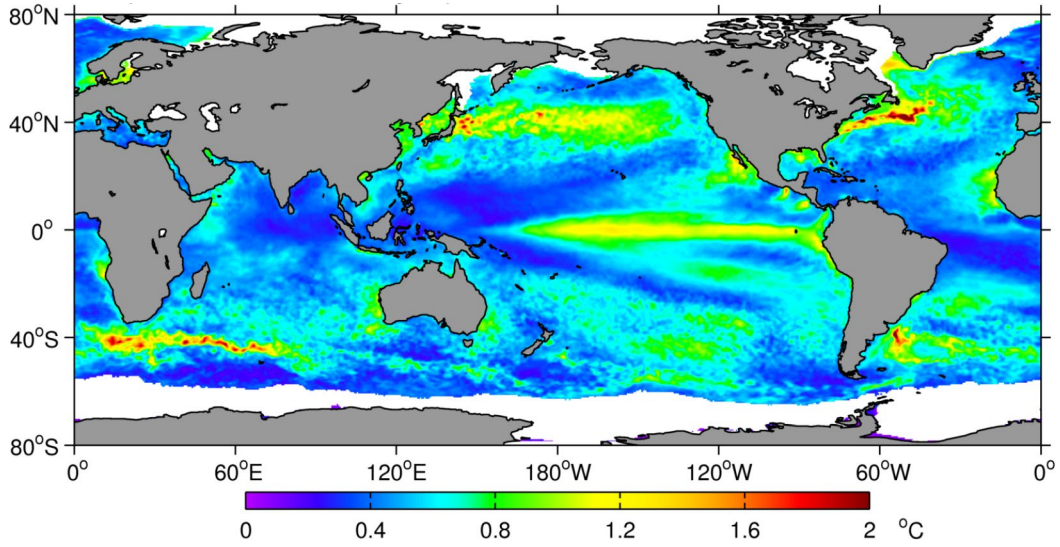


# Standard Deviations of Monthly Averaged SST Anomalies

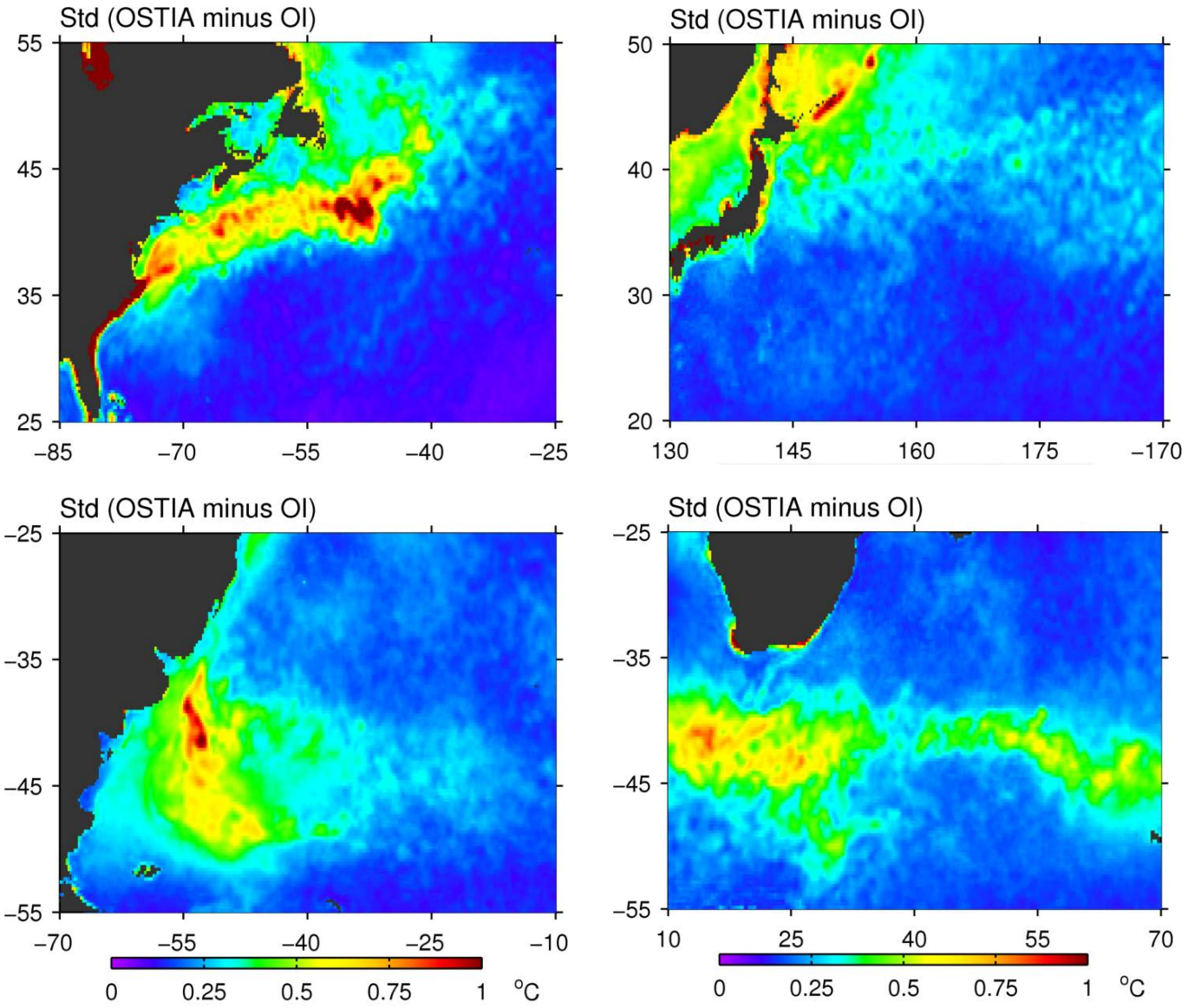
Standard Deviation of OSTIA SST Anomalies




Standard Deviation of OI SST Anomalies

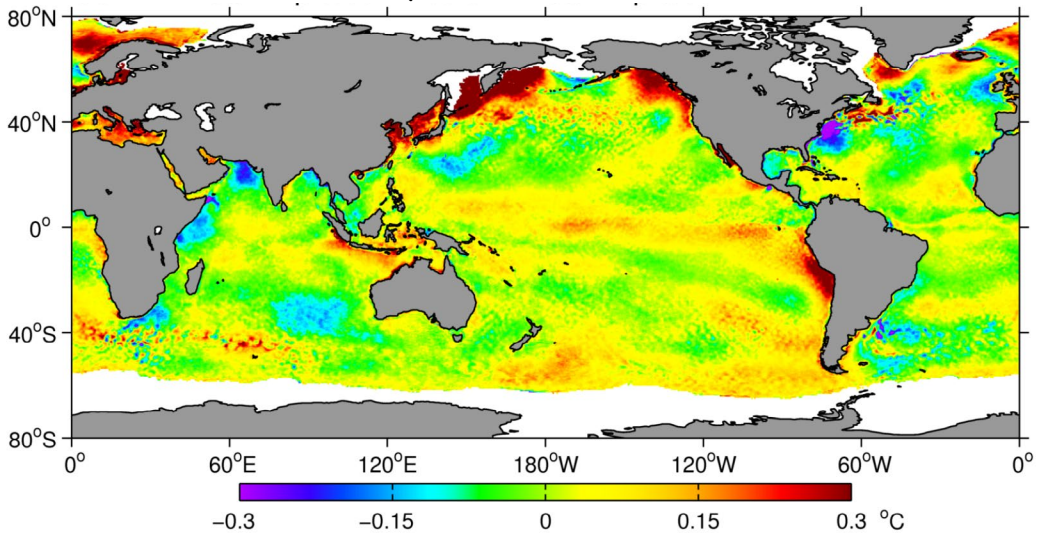


# Standard Deviations of the Differences OSTIA minus OI for the Gulf Stream, Kuroshio Extension, SW Atlantic and Agulhas Return Current

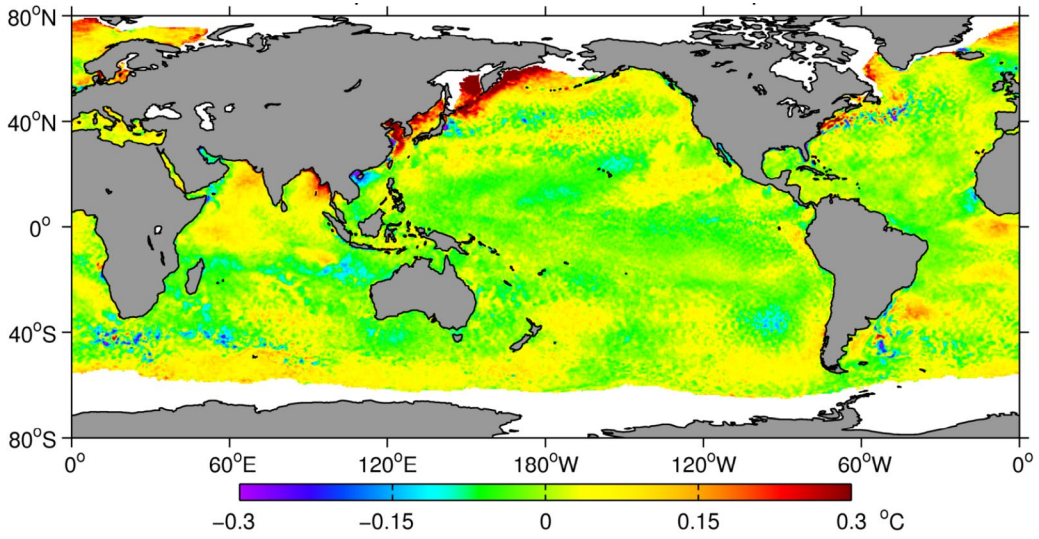


# Amplitudes of Annual and Semiannual Variability of the Monthly Averaged Differences OSTIA Minus OI and Standard Deviation of the Residuals

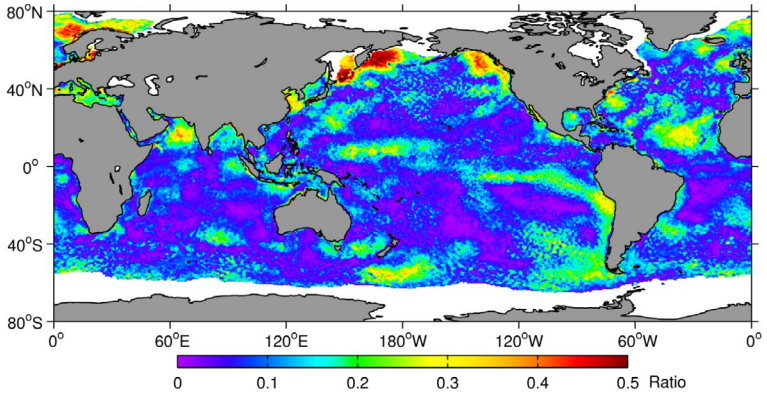
Annual Cycle of OSTIA Minus OI




Semiannual Cycle of OSTIA Minus OI

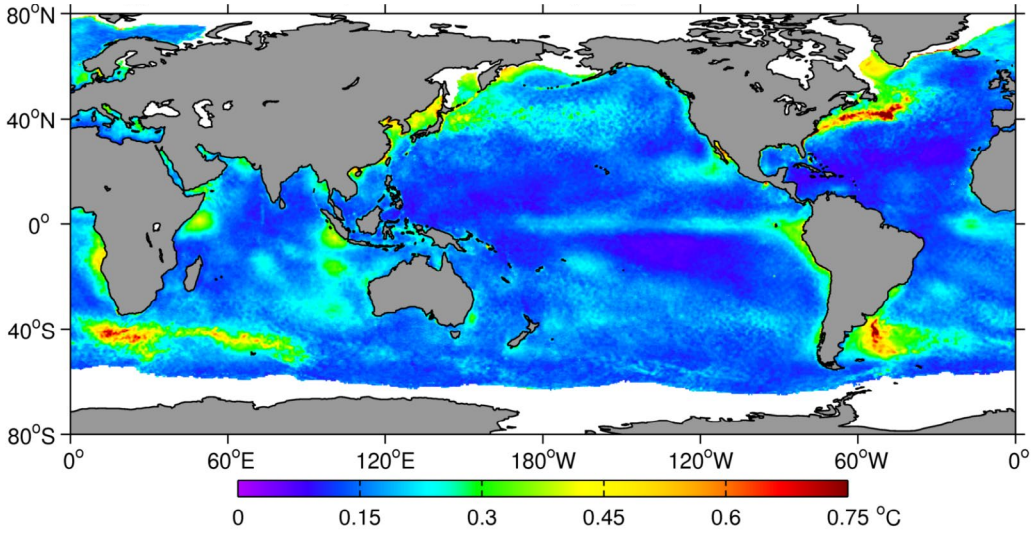



Fraction of Standard Deviation of the Differences that is Seasonal (Annual plus Semiannual)

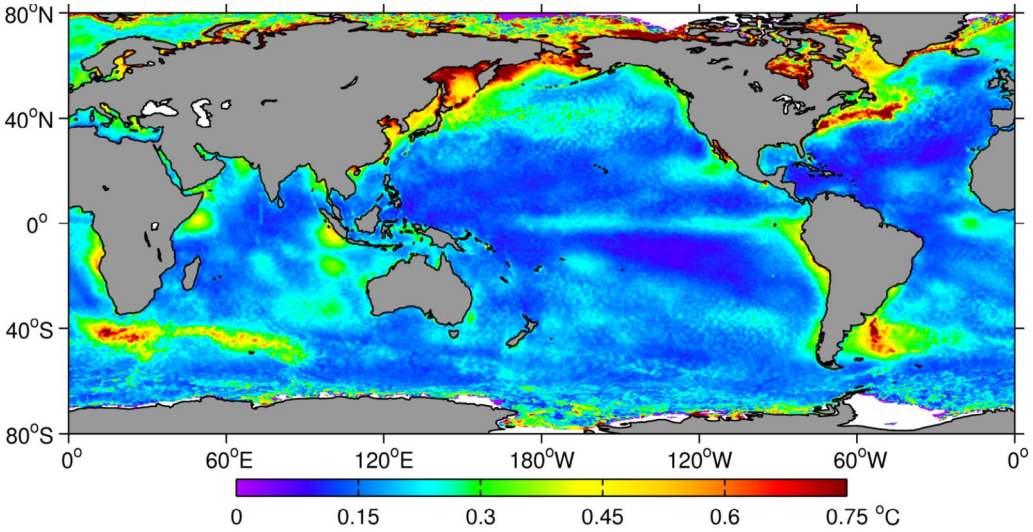


# Standard Deviations of the Total and Nonseasonal Monthly Averaged Differences OSTIA Minus OI

Standard Deviation of **Nonseasonal** OSTIA Minus OI




Standard Deviation of **Total** OSTIA Minus OI




Fraction of Standard Deviation of the Differences that is Nonseasonal