IFM-GEOMAR

Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

The Possibility (and Limitation) of Tracing Large Scale T and S Anomalies

Sunke Schmidtko, Jürgen Fischer

Work in Progress

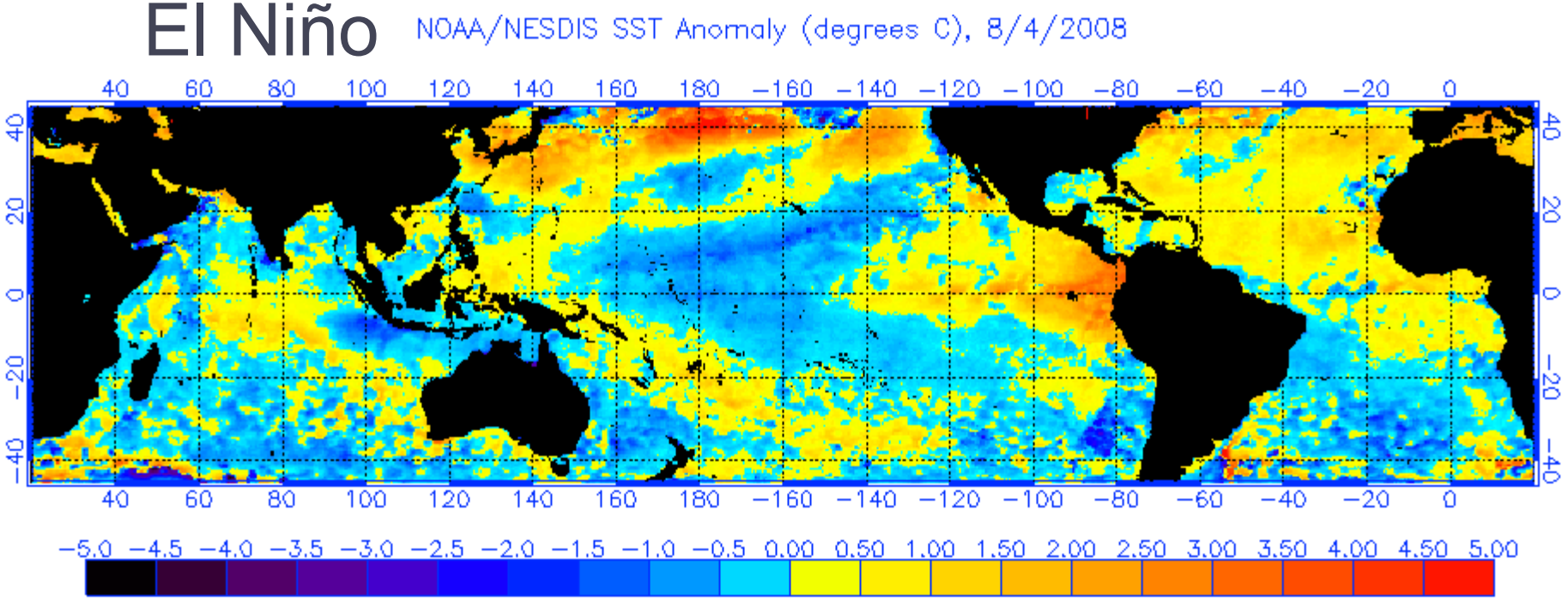
EURO ARGO: A new European Research Infrastructure

General ideas/hints
What is possible?
What is not possible?
What might be done in future?

Tracing Large Scale T and S Anomalies

What are large scale anomalies?

El Niño



Tracing Large Scale T and S Anomalies

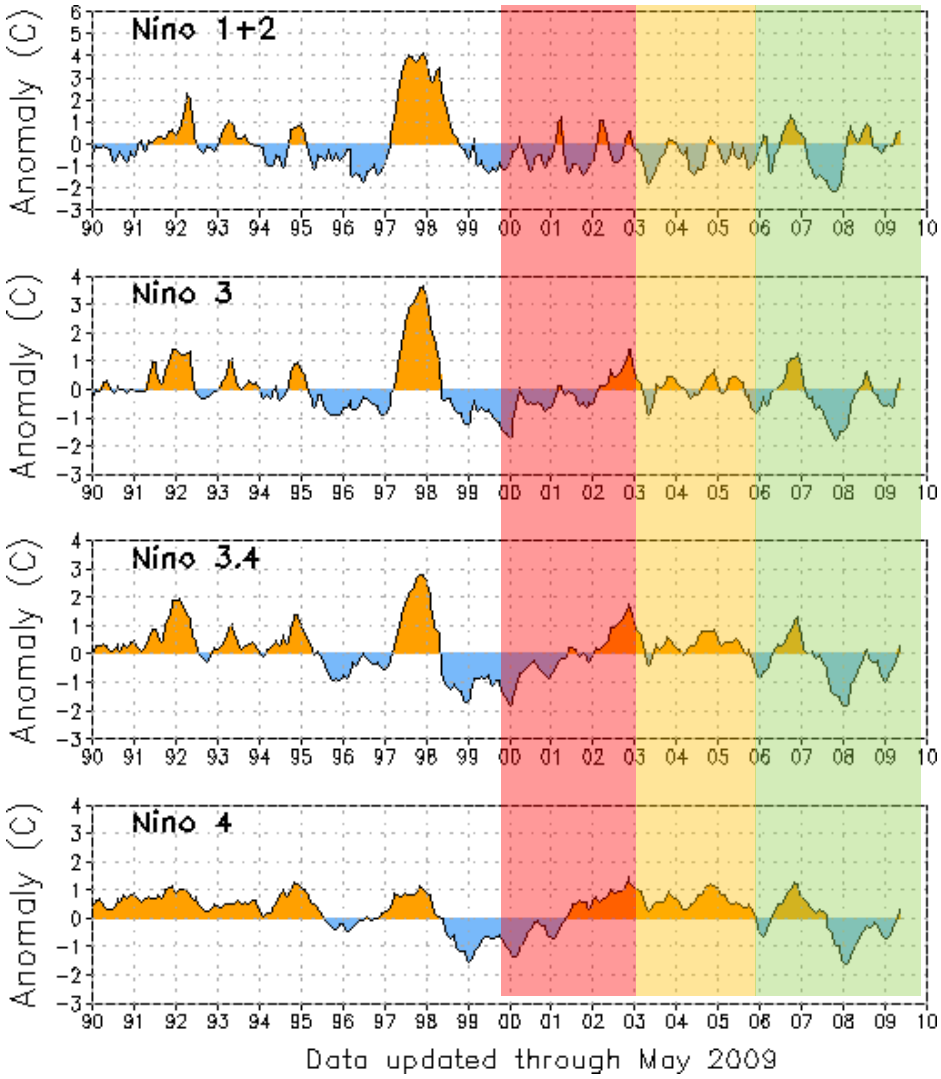
El Niño - SST

Peru

Eq. East Pacific

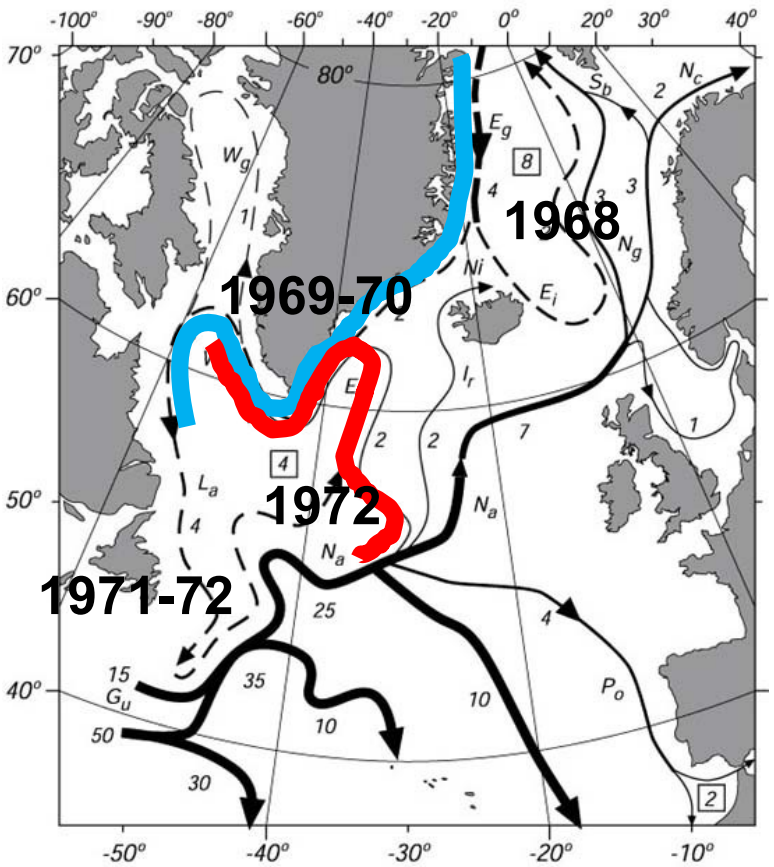
Eq. Pacific

Eq. West Pacific



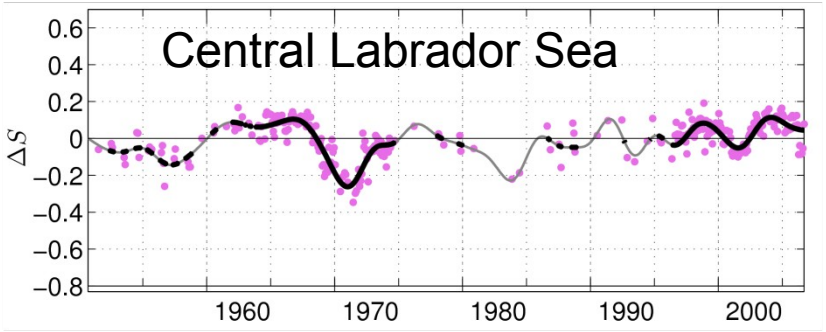
NCEP, Climate Prediction Center (CPC)

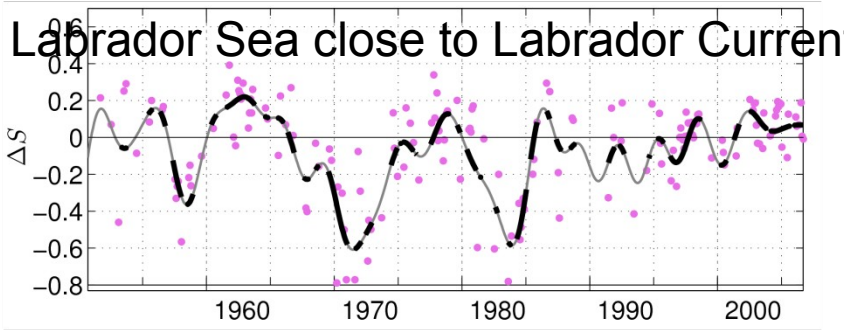
Tracing Large Scale T and S Anomalies



Dickson et al. (1988)/ Dietrich et al. (1980)

GSA 70‘s and beyond





Schmidt and Send (in preparation)

Tracing Large Scale T and S Anomalies

Why only large scale?

What is limitating anomaly tracking?

2007 - 2013

Limitation and Sampling Bias

„3°x3° network would yield a formal error of estimation for near surface temperature of less than 0.5°C”.

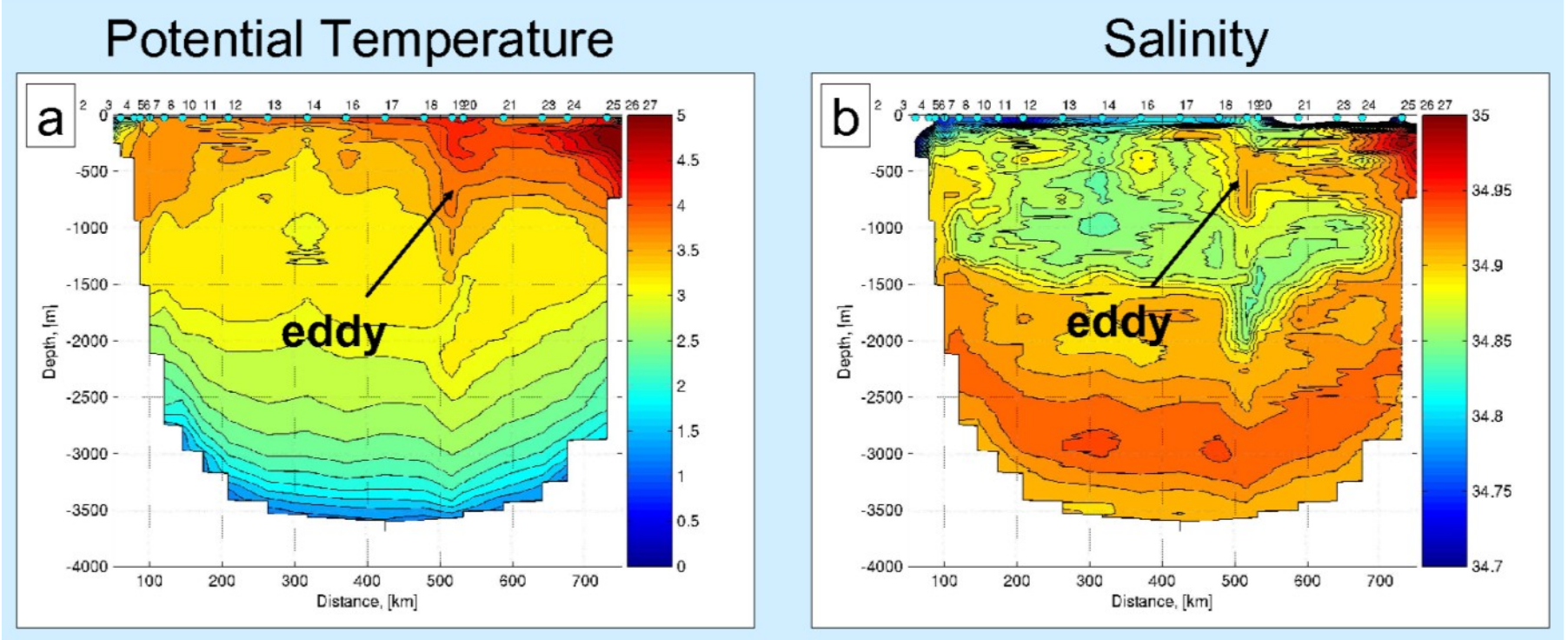
For salinity this would be … ?

- Less accurate data
- More blank data
- False data

Other problems (for more remote areas)!

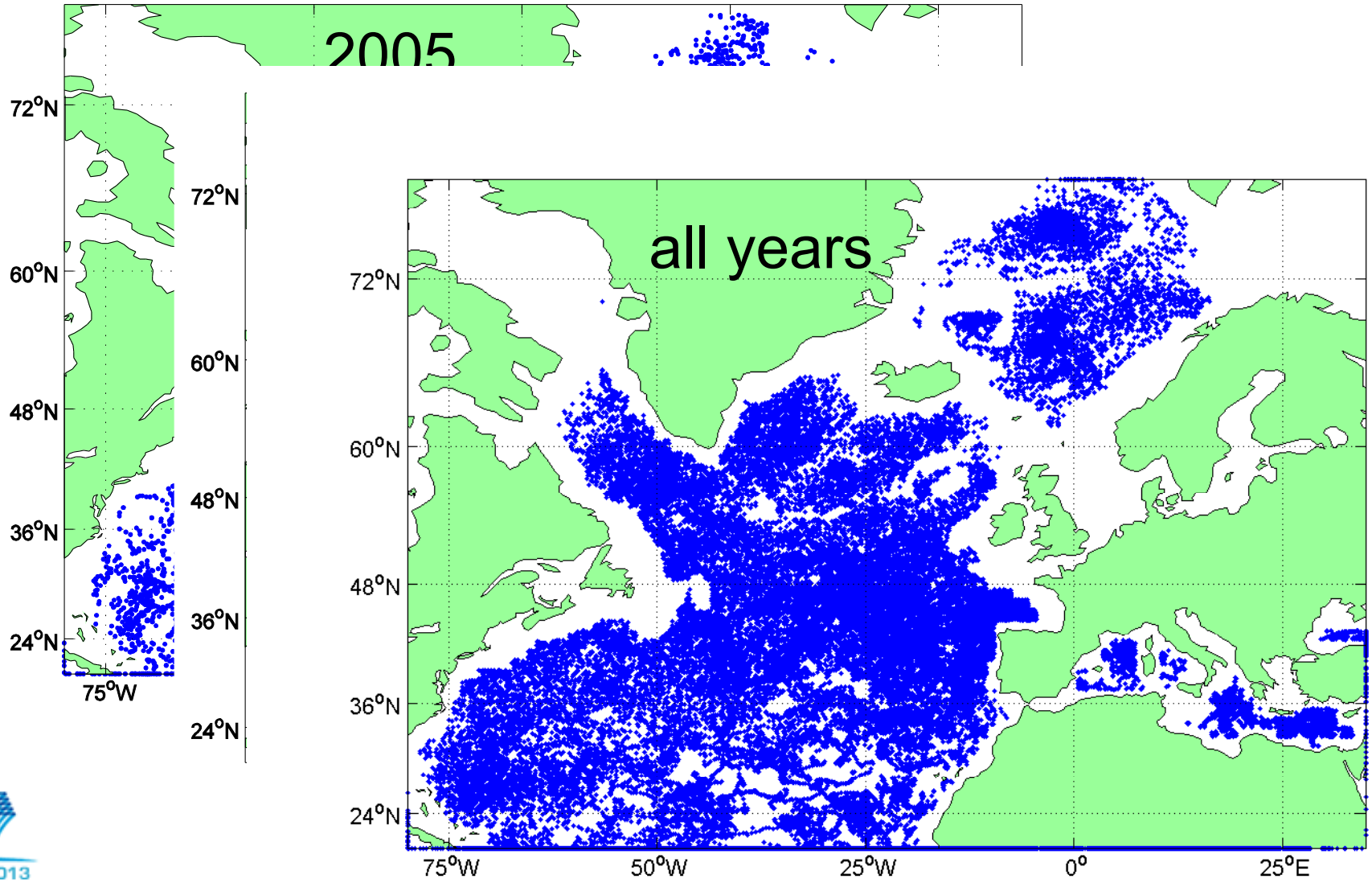
Limitation and Sampling Bias - eddies

Eddy in Labrador Sea T/S Section



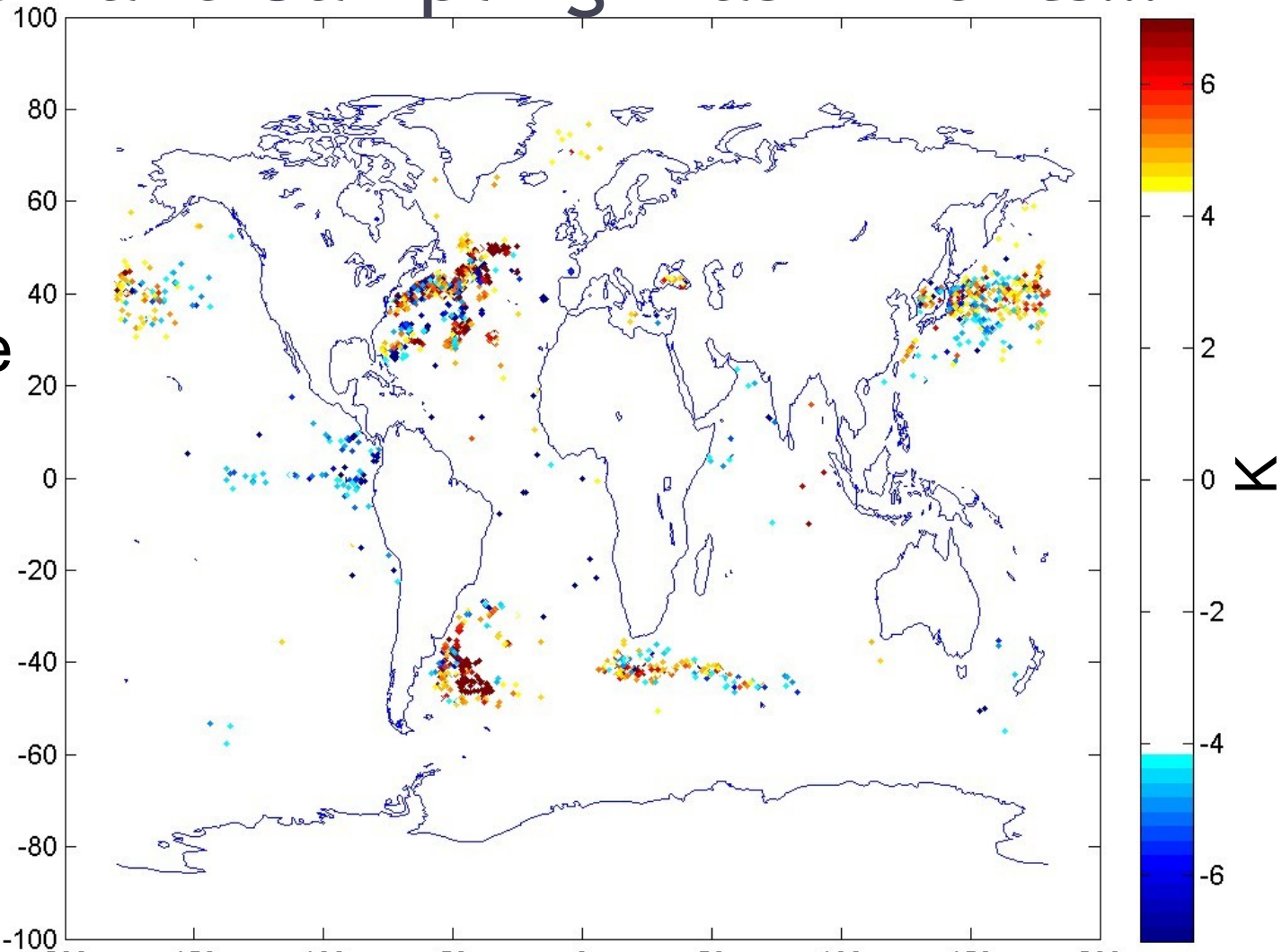
T. Rykova und F. Straneo (2006)

Limitation and Sampling Bias – sills …



Limitation and Sampling Bias – fronts…

Temperature difference to monthly climatology



Limitation and Sampling Bias

- over sampling of eddies and similar features due to scientific significance + trapping of floats within eddies.
- limitation to ocean basins away from shelf boundary currents, thus shelf waters induced anomalies cannot be traced.
- sills shallower than 1000m depth are not sampled (e.g. Denmark Strait, Davis Strait).
- shifting of fronts / representation of fronts in climatologies
- areas that have no “well known” but significant seasonal cycle, thus with only few years of sampling no significant “anomaly mapping” can be performed
- sparse temporal/spatial float data in some regions

Data Used

Argo (JAN 2000 - DEC 2008)

ftp from usgodae/geo/atlantic… (pacific, indian) (OpenDAP turned out to be too slow to use!)

Data interpolated onto depth levels used, - gaussian weighting of all data points less then 10m away. (3m/10m)

Climatology

- SAC-Climatology (Gouretski and Jancke, 1998)
- Monthly values
- 4-D interpolated on position and yearday of each float profile data point used

2007 - 2013

Data Used

Argo (JAN 2000 - DEC 2008)

- QC flags = 1 (better than „probably good“)
- POSITION_QC
- PRES_ADJUSTED > PRES
- TEMP_ADJUSTED > TEMP
- PSAL_ADJUSTED > PSAL

COMPARED

Climatology

- SAC-Climatology (Gouretski and Jancke, 1998)
- Monthly values
- 4-D interpolated on position and yearday of each float profile data point used

2007 - 2013

Data Used

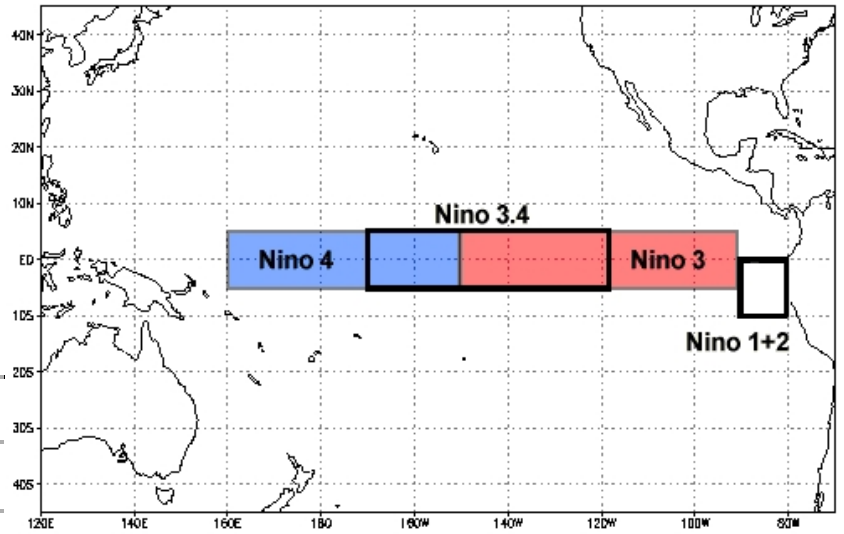
How good is the anomaly data?
Argo – Climatology

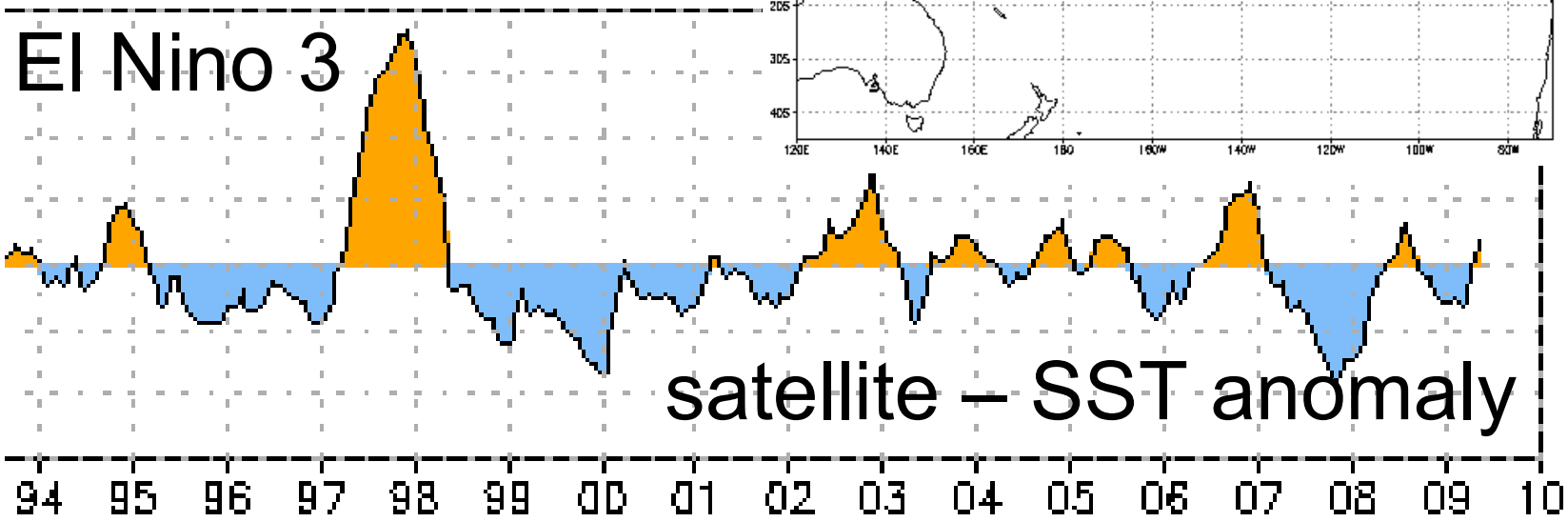
What resolution can be achieved?
What cannot?

Validation of T-anomaly in large areas

How good is the derived anomaly data?

-SST is close to top 20m temperature data.
-SST data is weekly, monthly mean of float data used





NOAA/CDC

2007 - 2013

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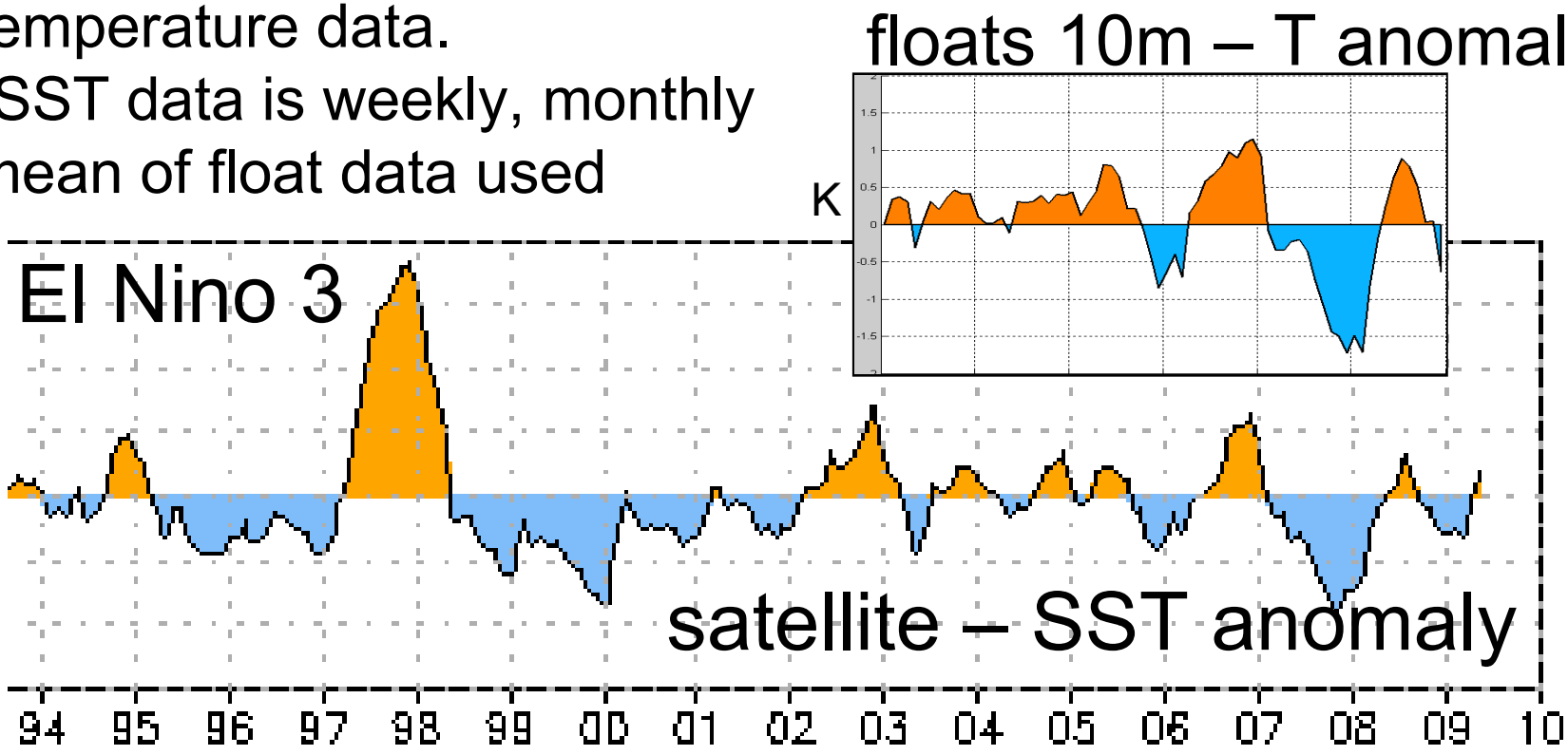
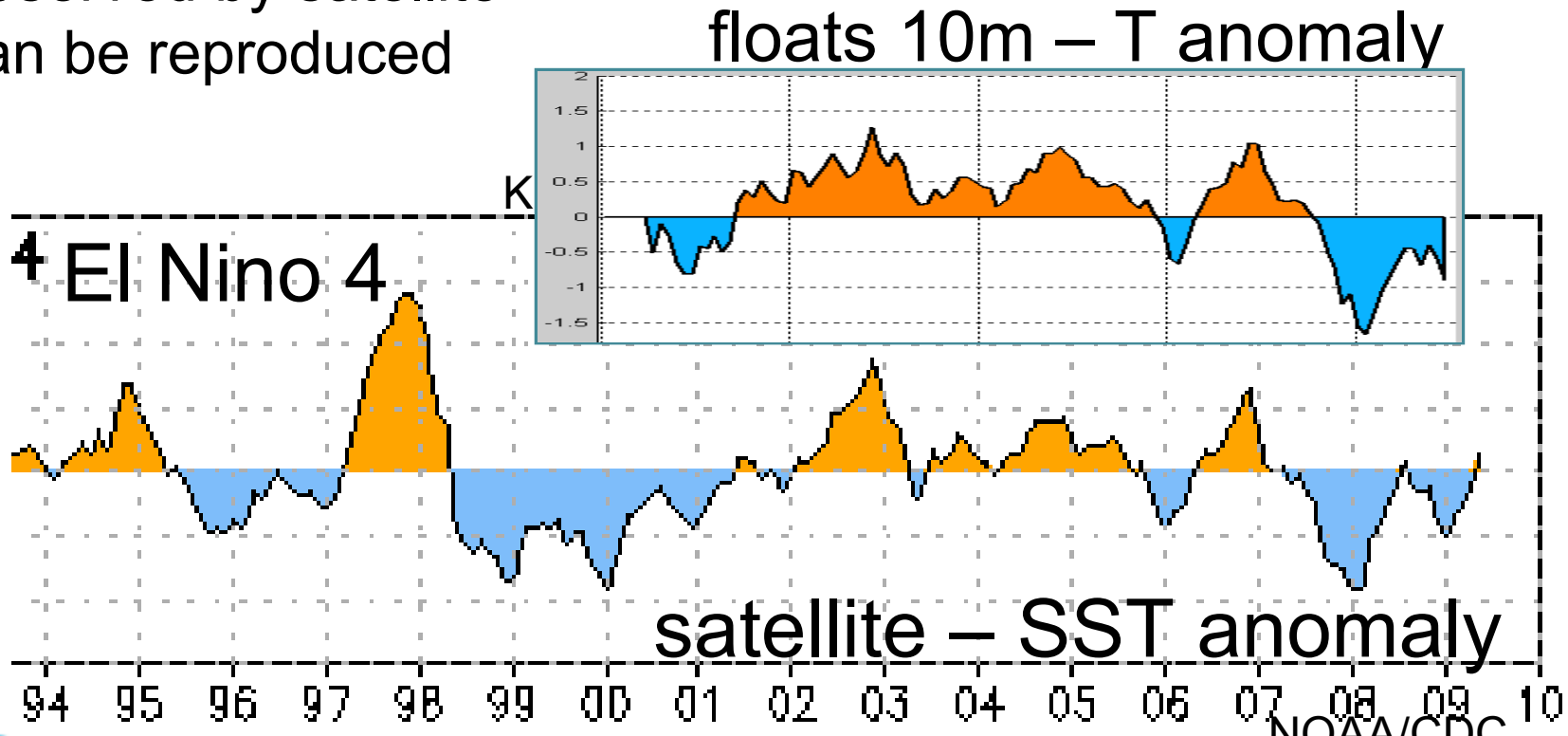


NOAA/CDC

Validation of T-anomaly in large areas

How good is the derived anomaly data?

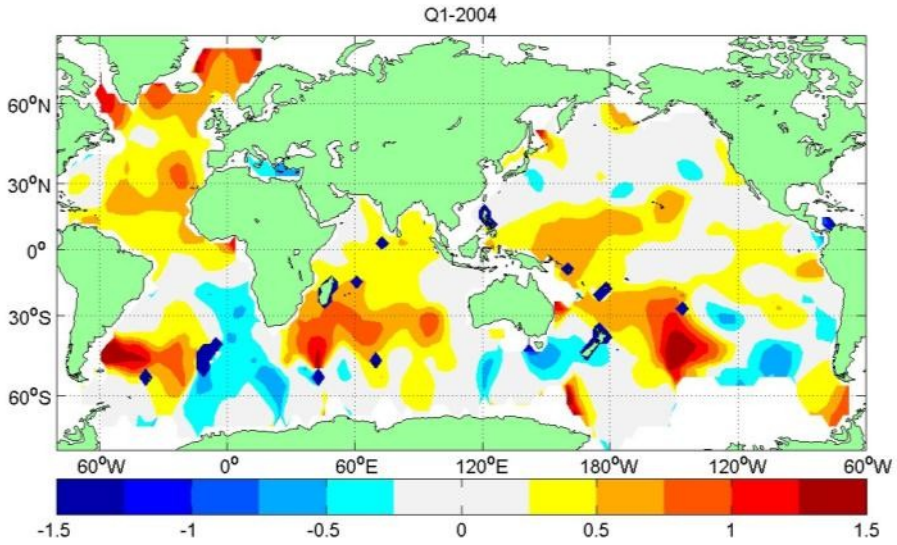
-Large scale SST anomalies observed by satellite can be reproduced

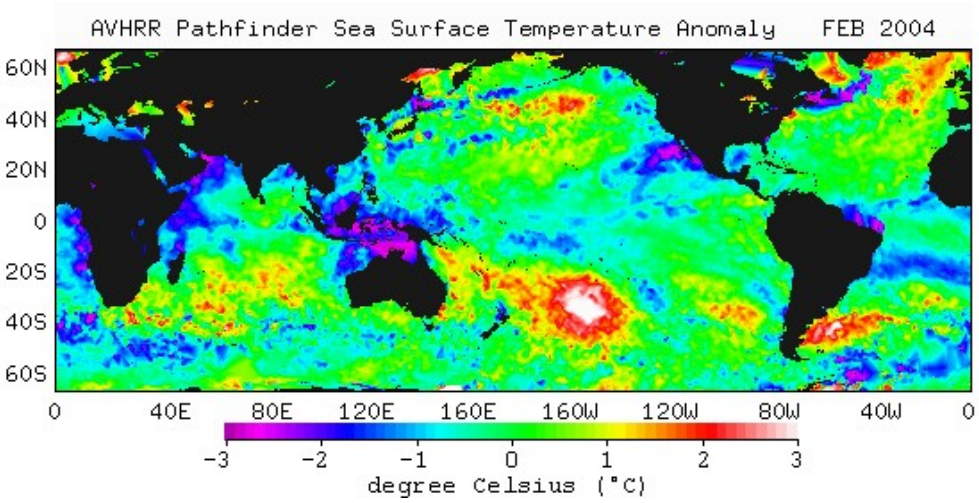


Validation of T-anomaly fields

SURFACE

acceptable quality since 2004 in some areas



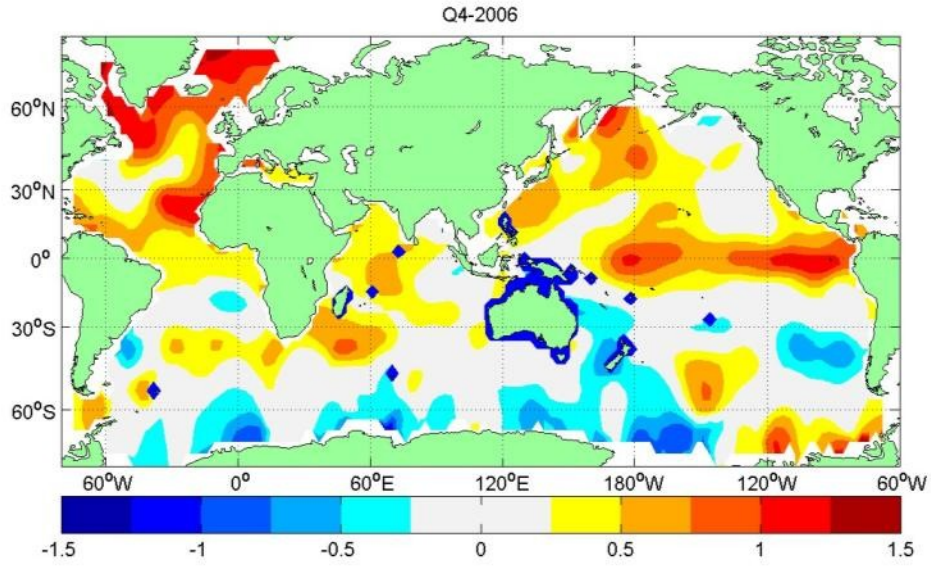


Gaussian weigted 6°x6° (10°x10°)

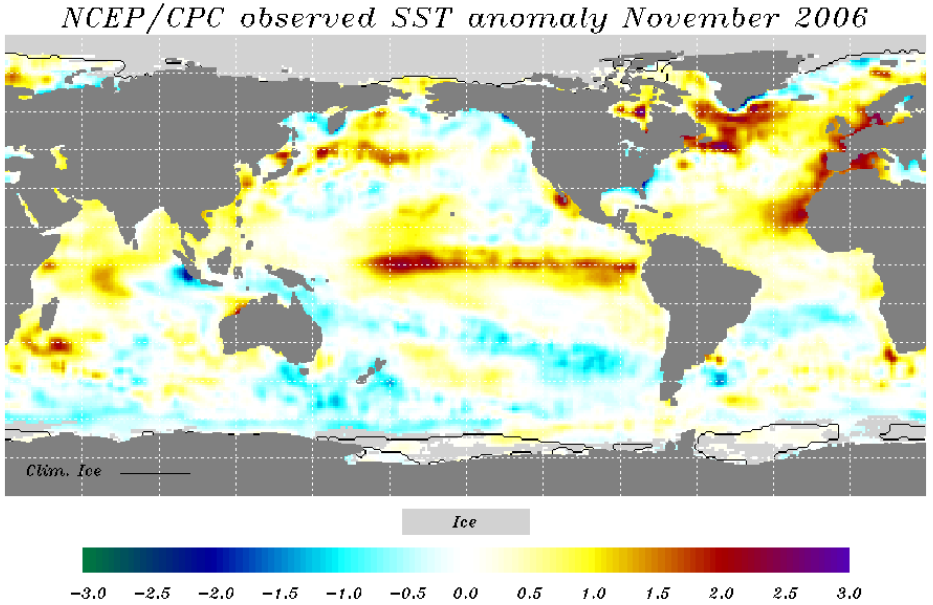
Validation of T-anomaly fields

SURFACE

Good quality since 2006



Gaussian weigted 6°x6° (10°x10°)

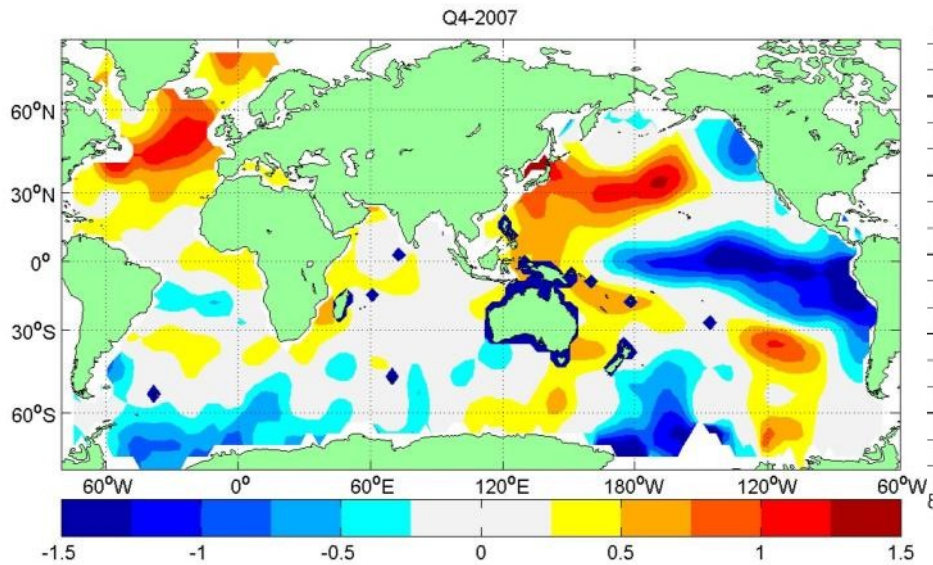


K

Validation of T-anomaly fields

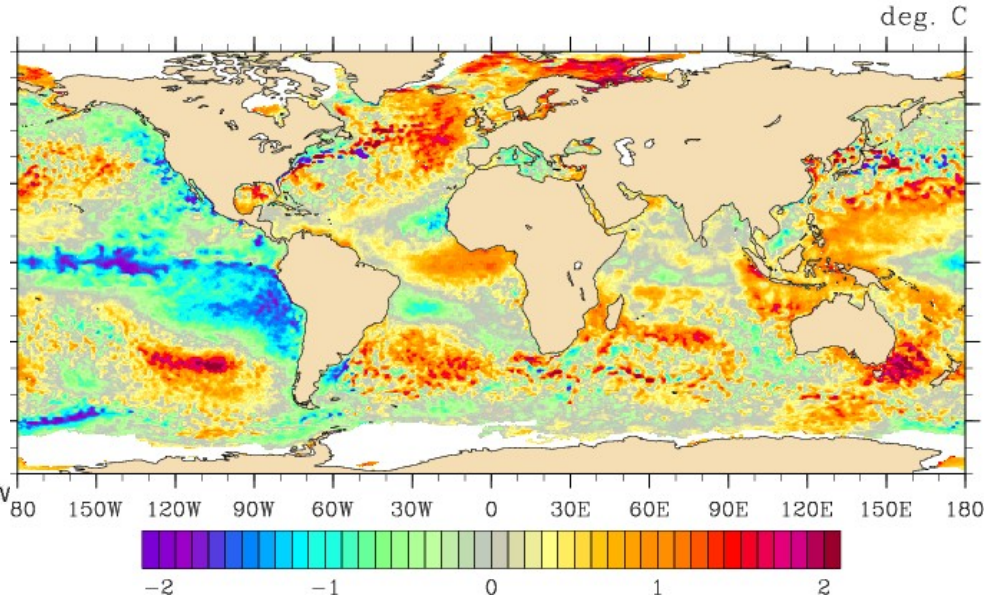
SURFACE

"smaller" features can be found



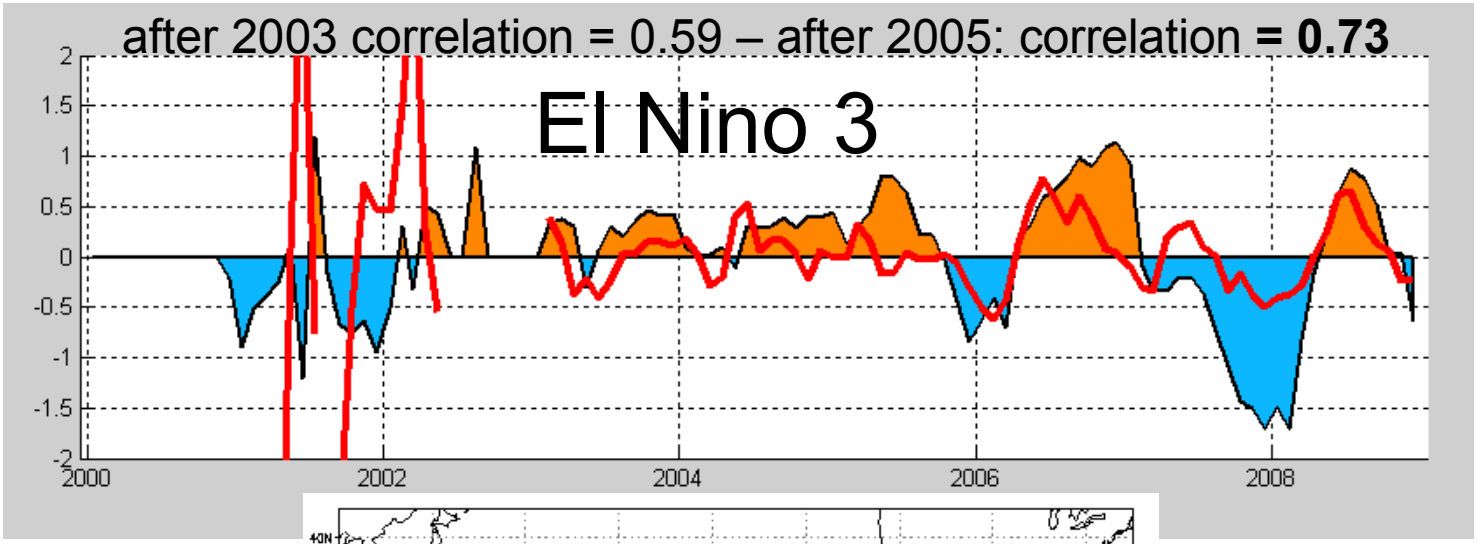
Gaussian weigted 6°x6° (10°x10°)

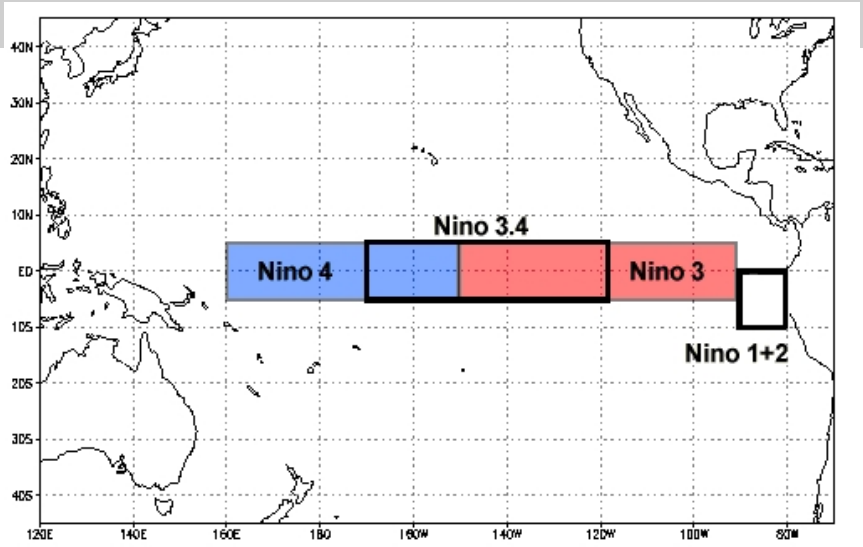
MERSEA



K

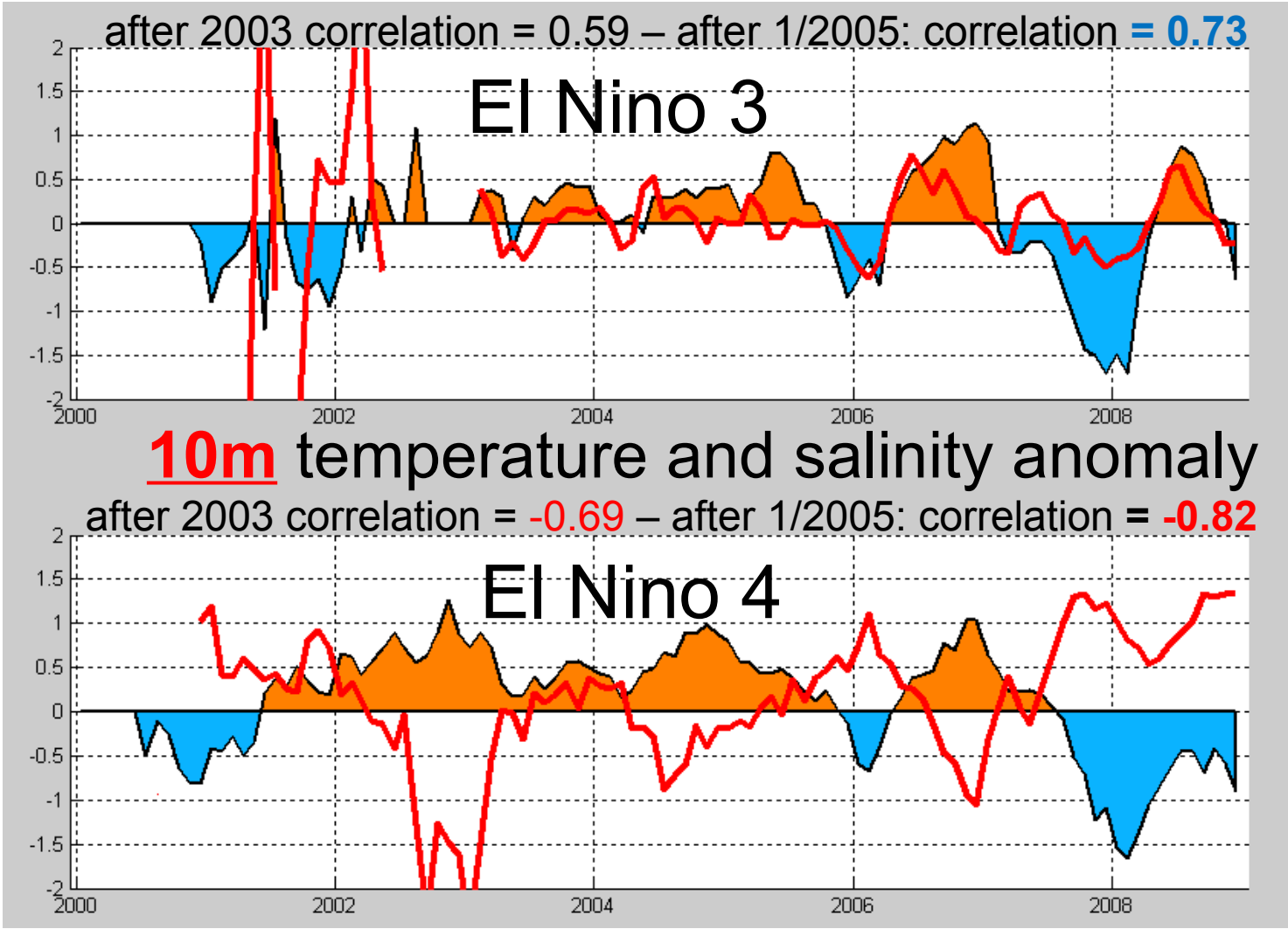
El Nino areas – „salinity anomalies“





S. Schmidtko (in preparation)

El Nino areas – „salinity anomalies“



2007 - 2013

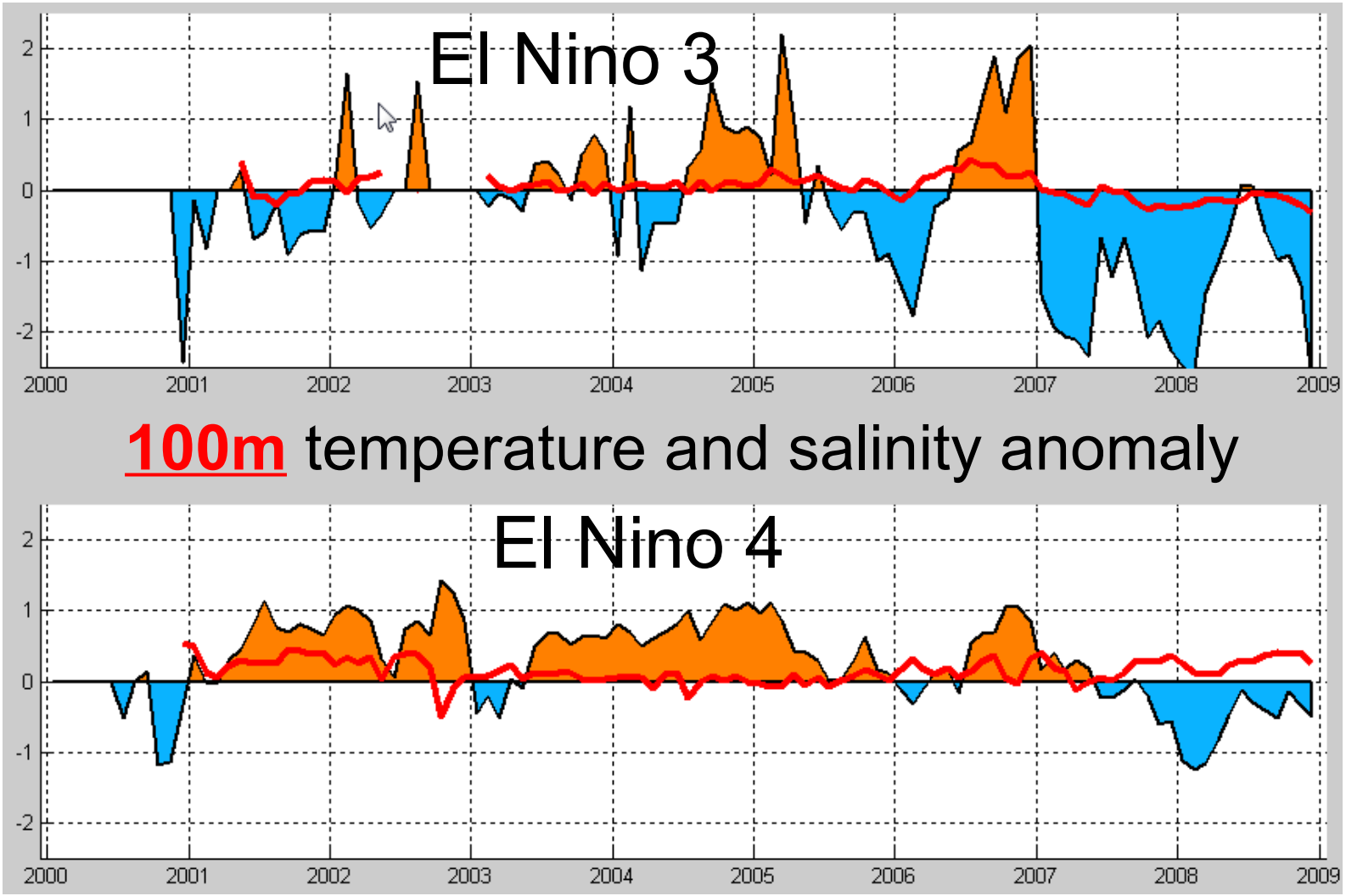
El Nino areas – „salinity anomalies“

- El Nino 3: after 2003 ΔT-ΔS correlation = 0.59 – after 2005: correlation **= 0.73**
- El Nino 4: after 2003 ΔT-ΔS correlation = -0.69 – after 2005: correlation **= -0.82**

What is the reason for this? How deep does it reach?

S. Schmidtko (in preparation)

El Nino areas – „salinity anomalies“



100m temperature and salinity anomaly

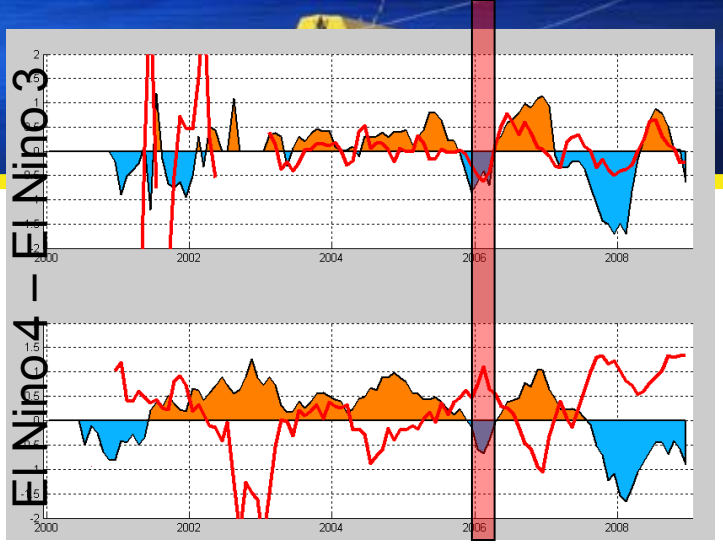
S. Schmidtko (in preparation)

El Nino areas – „salinity anomalies“

- El Nino 3: after 2003 ΔT-ΔS correlation = 0.59 – after 2005: correlation **= 0.73**
- El Nino 4: after 2003 ΔT-ΔS correlation = -0.69 – after 2005: correlation **= -0.82**

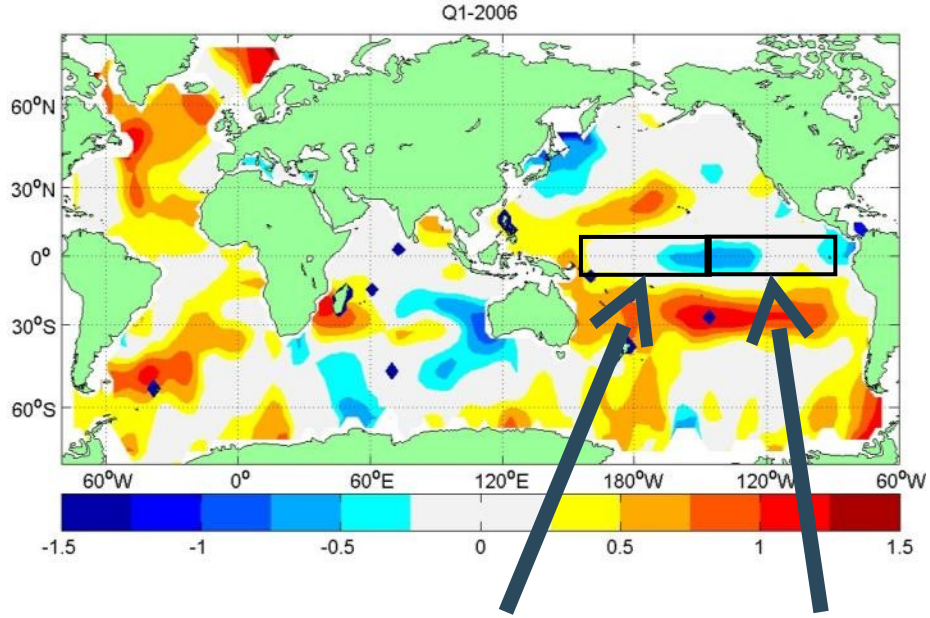
At and below 100m the salinity anomaly is reduced by a factor of four.

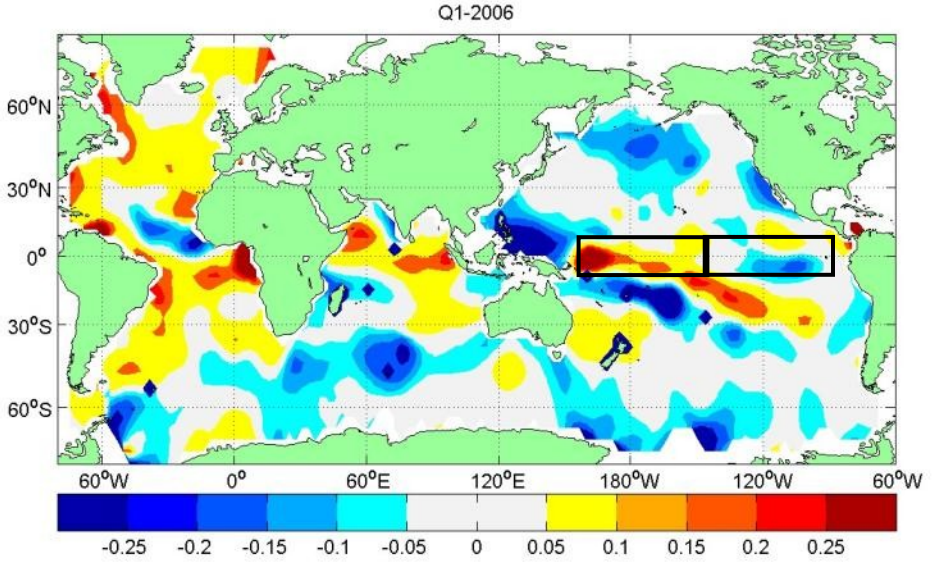
Salinity anomaly is mainly found at surface.



0-20m

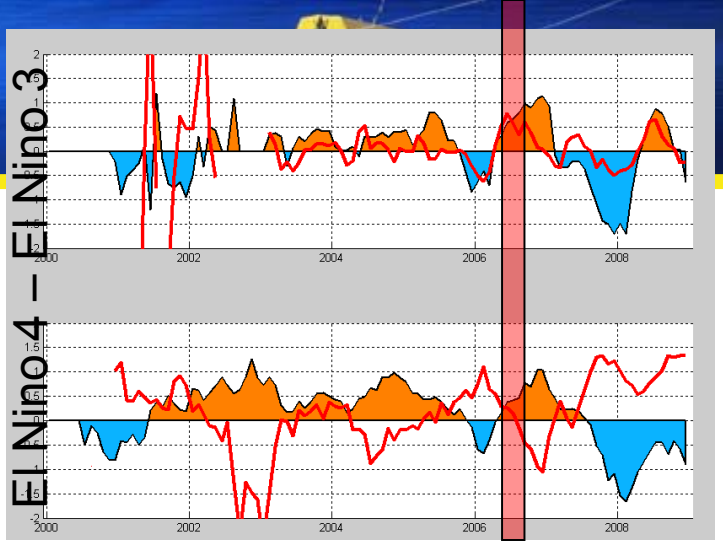
Temperature anomaly – Salinity anomaly





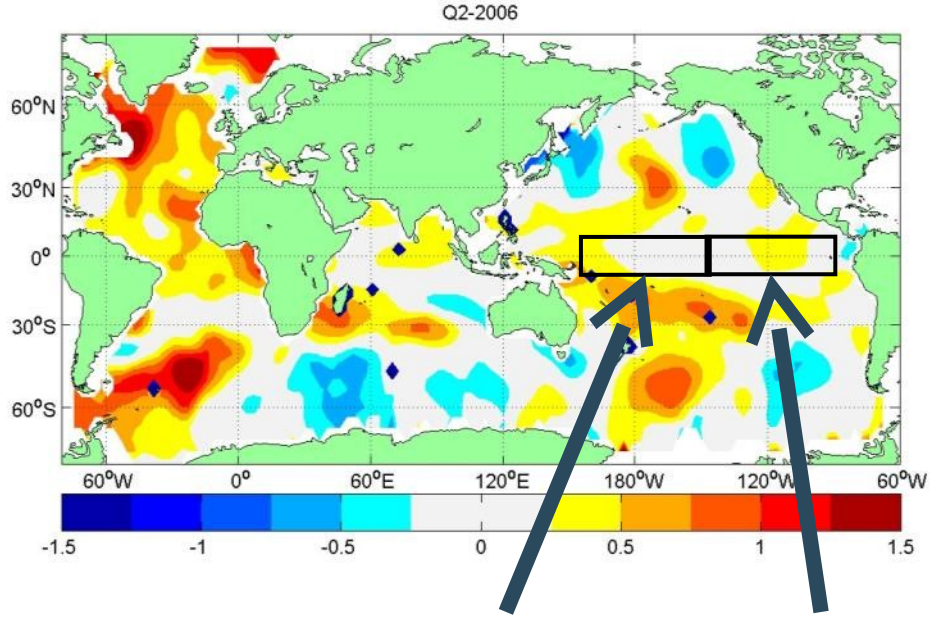
El Nino 4 El Nino3

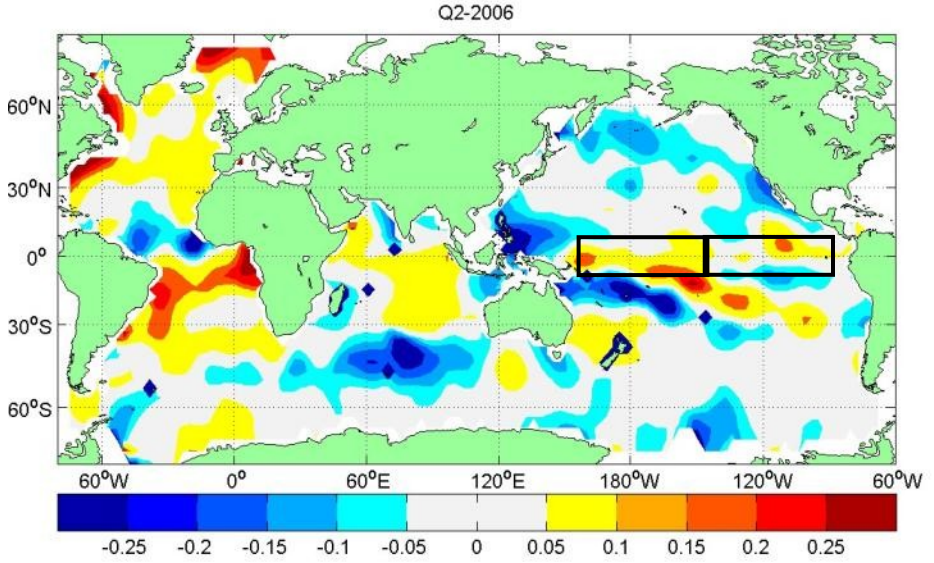
2007 - 2013



0-20m

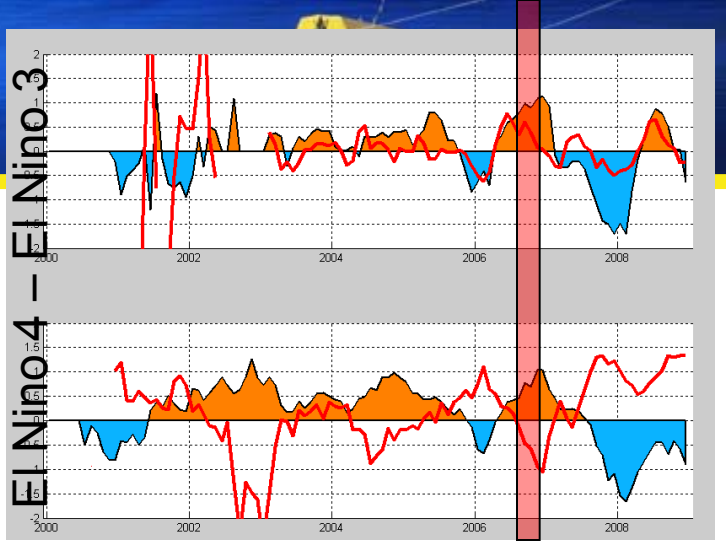
Temperature anomaly – Salinity anomaly





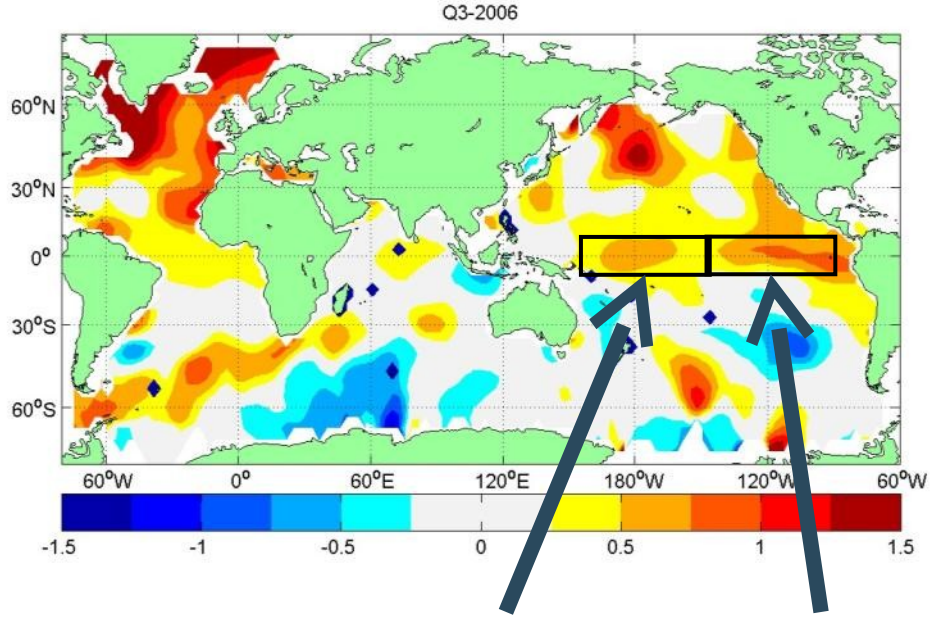
El Nino 4 El Nino3

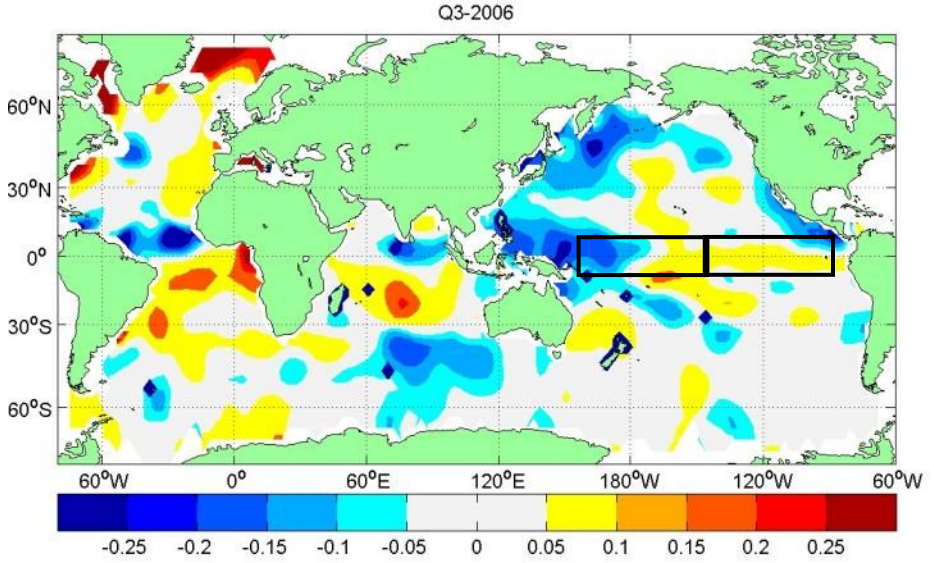
2007 - 2013



0-20m

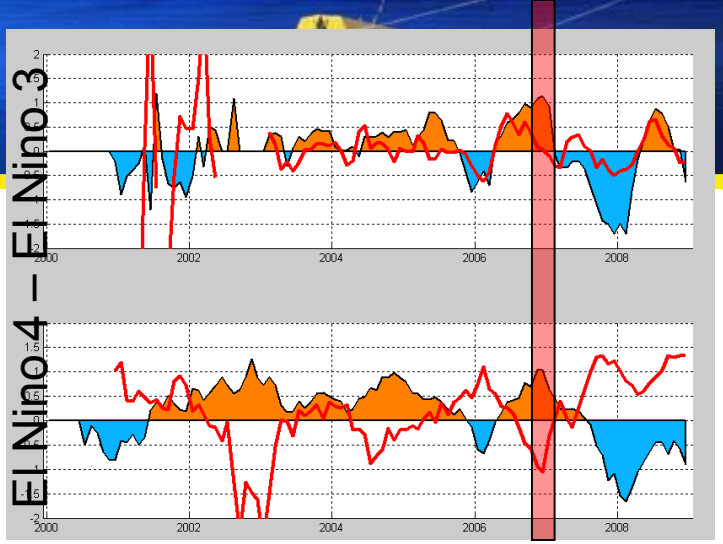
Temperature anomaly – Salinity anomaly





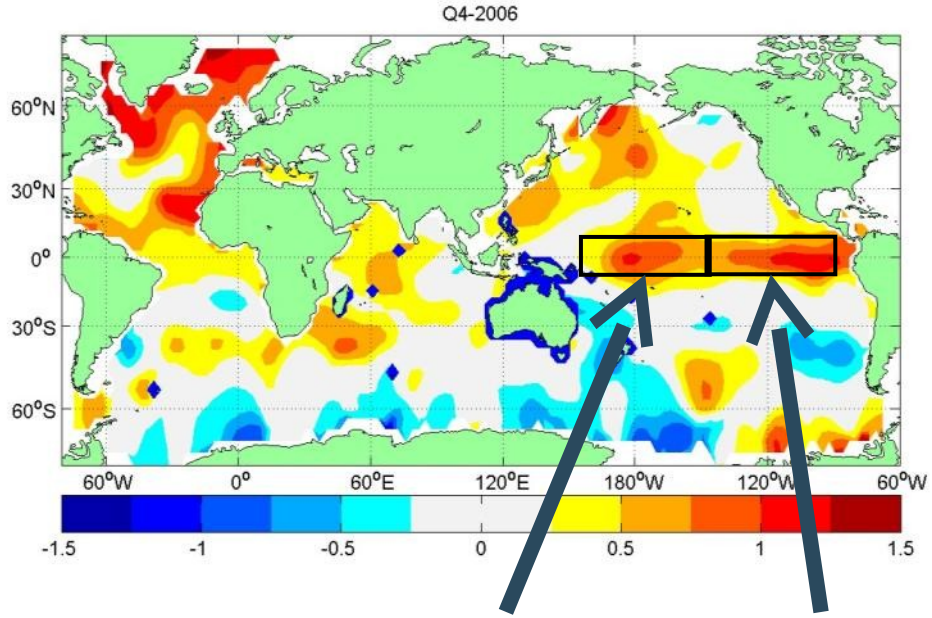
El Nino 4 El Nino3

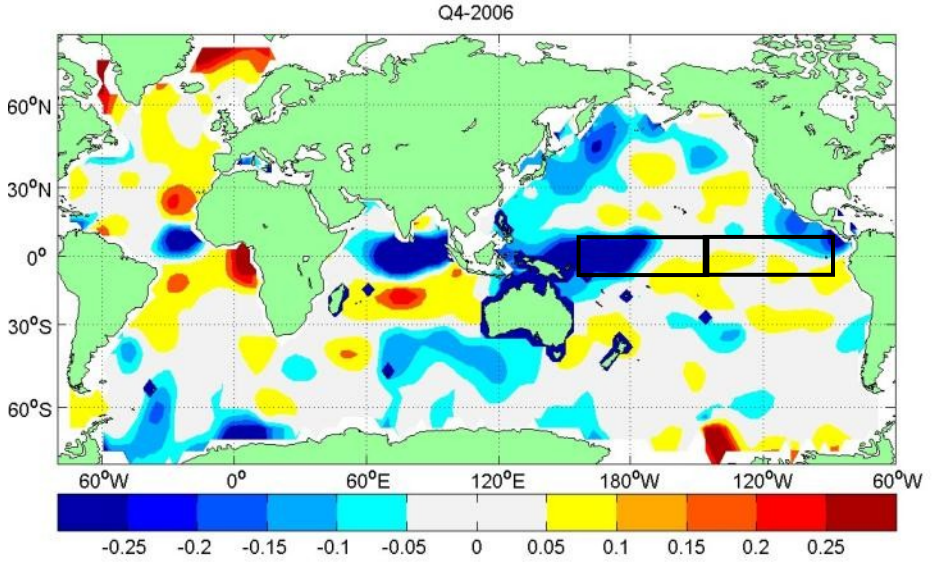
2007 - 2013



0-20m

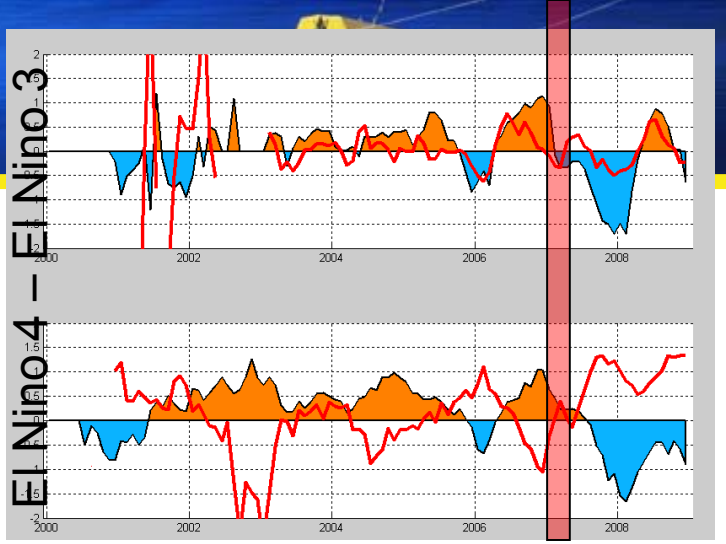
Temperature anomaly – Salinity anomaly





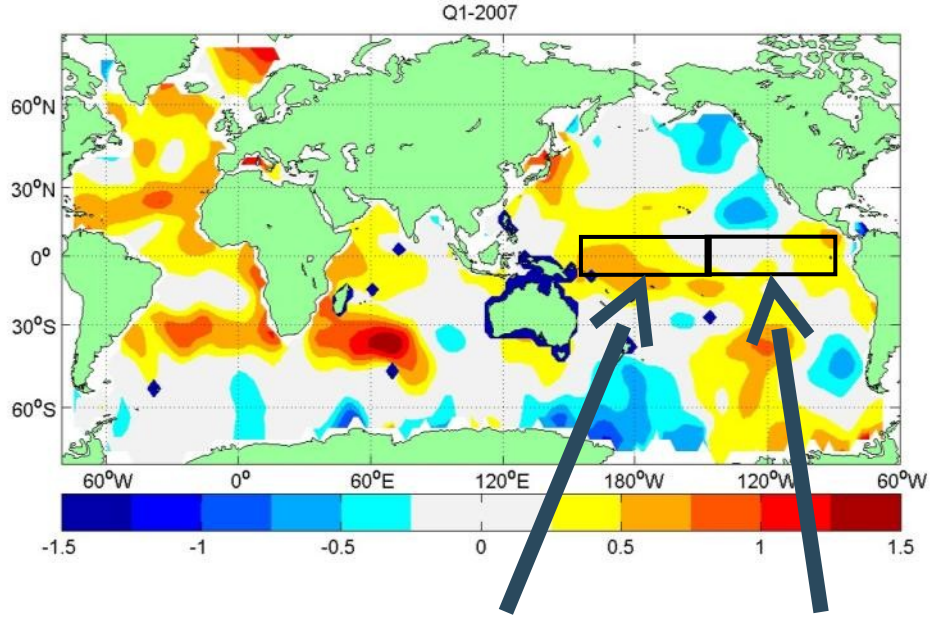
El Nino 4 El Nino3

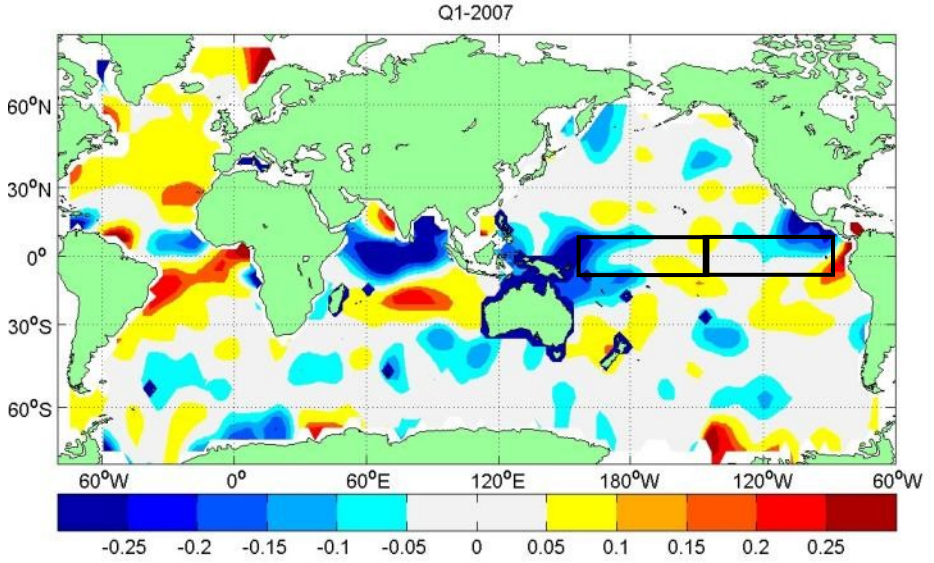
2007 - 2013



0-20m

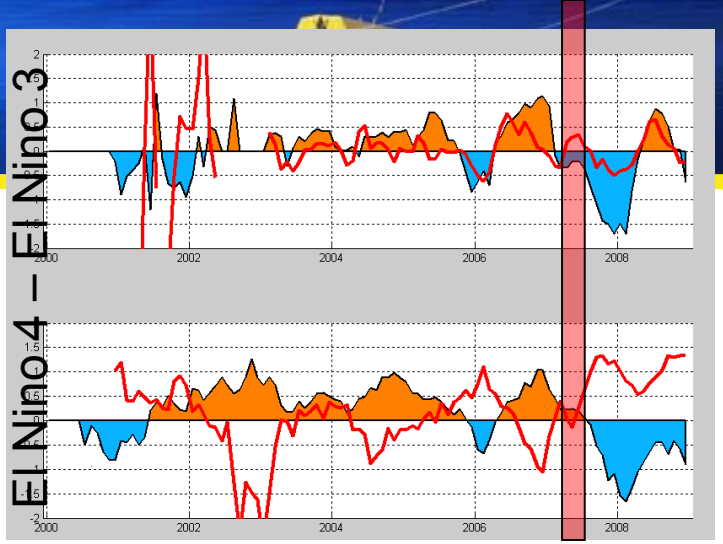
Temperature anomaly – Salinity anomaly





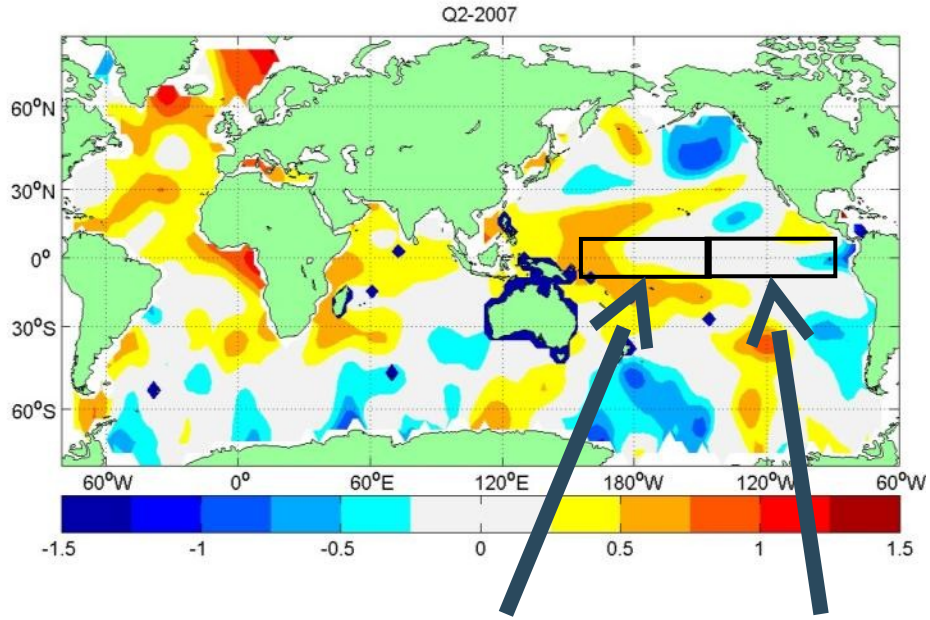
El Nino 4 El Nino3

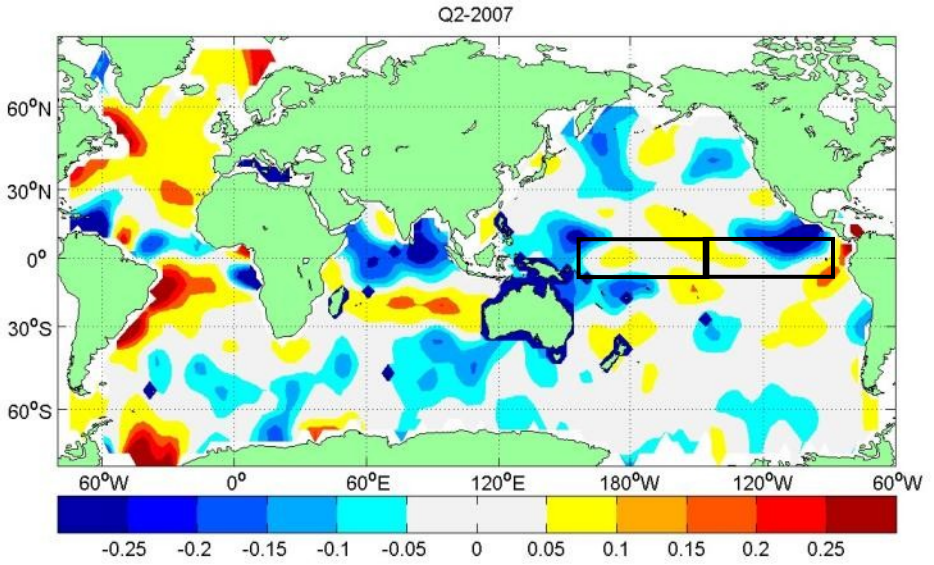
2007 - 2013



0-20m

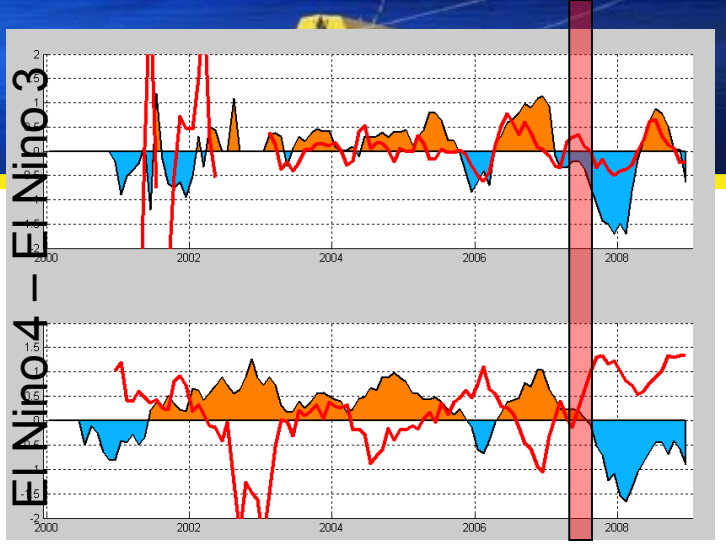
Temperature anomaly – Salinity anomaly





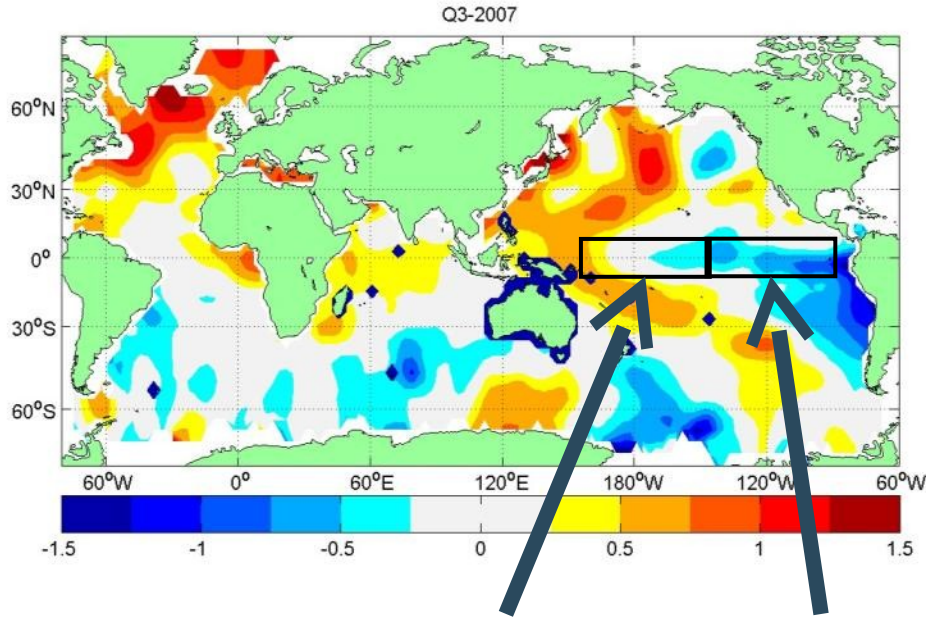
El Nino 4 El Nino3

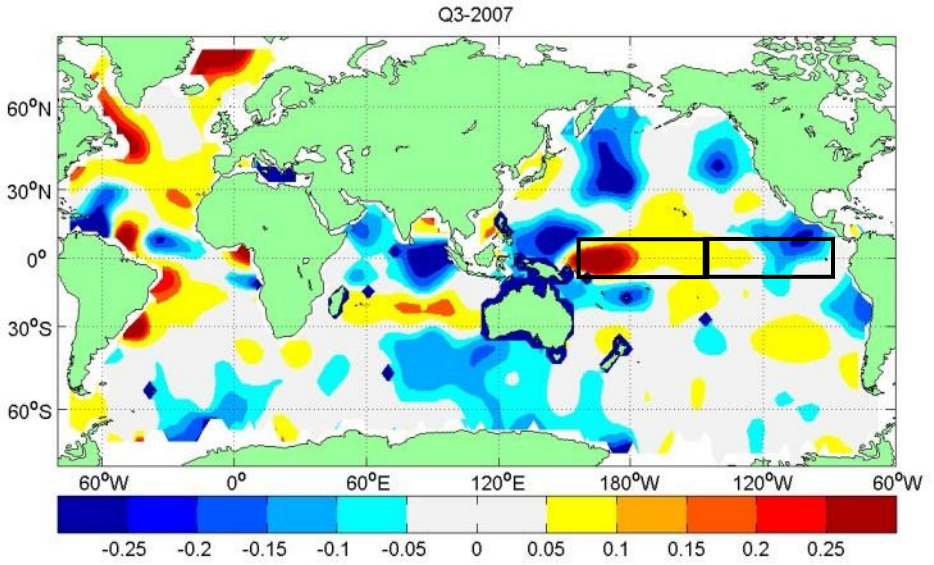
2007 - 2013



0-20m

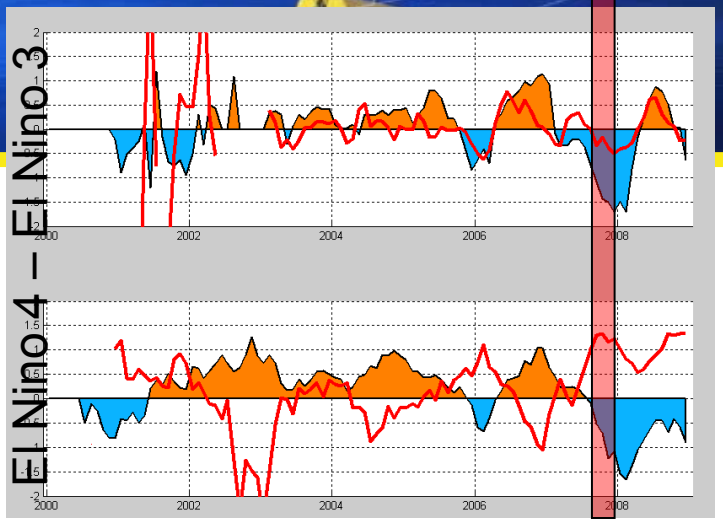
Temperature anomaly – Salinity anomaly





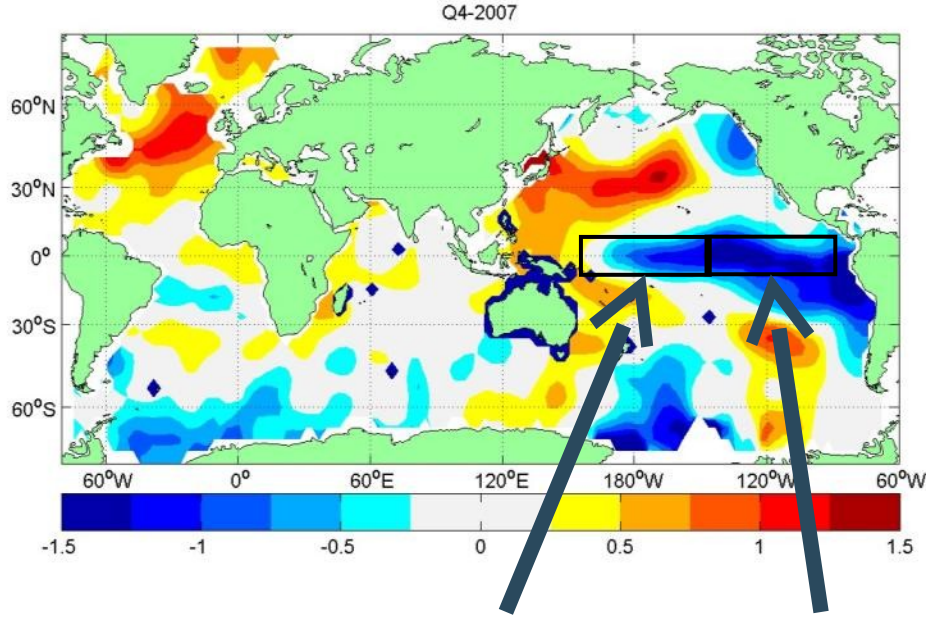
El Nino 4 El Nino3

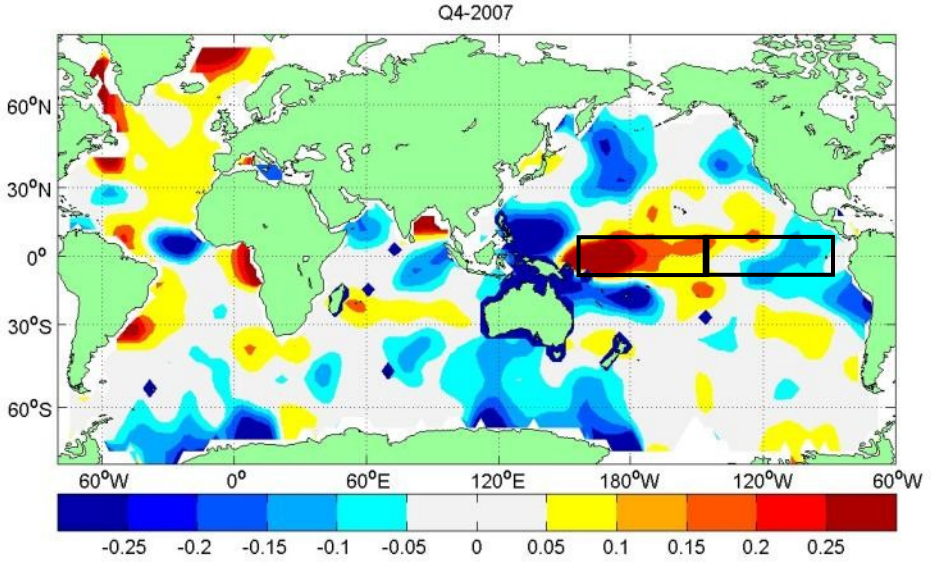
2007 - 2013



0-20m

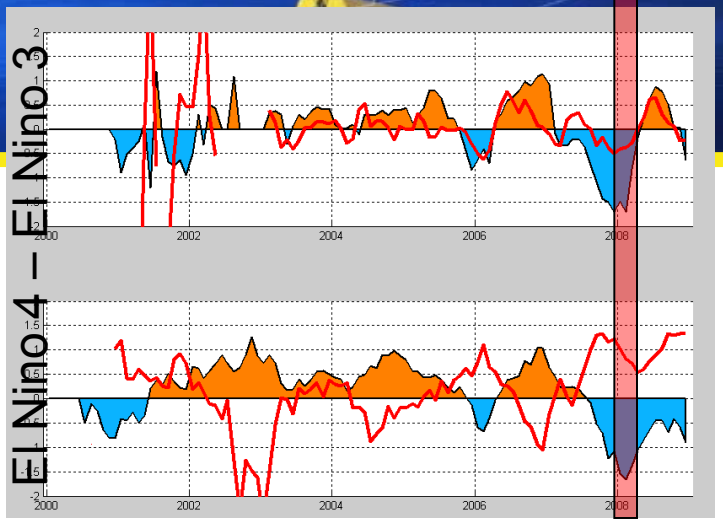
Temperature anomaly – Salinity anomaly





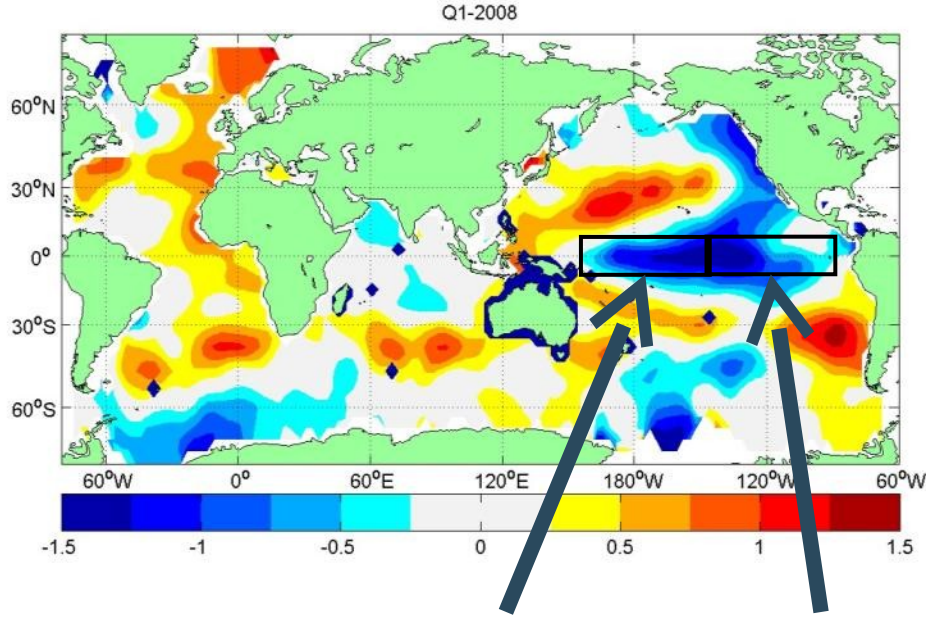
El Nino 4 El Nino3

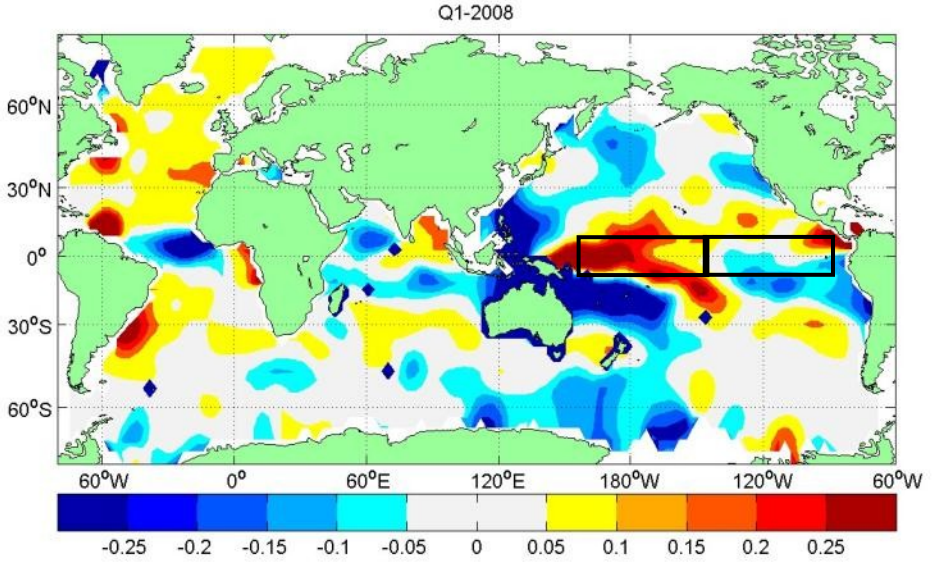
2007 - 2013



0-20m

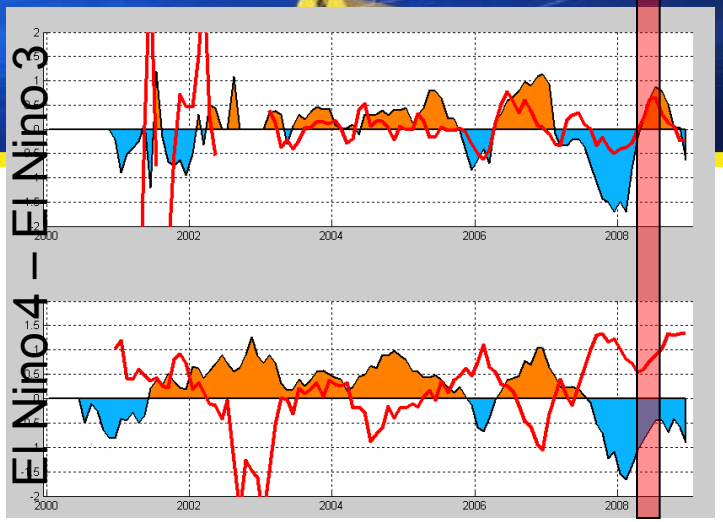
Temperature anomaly – Salinity anomaly





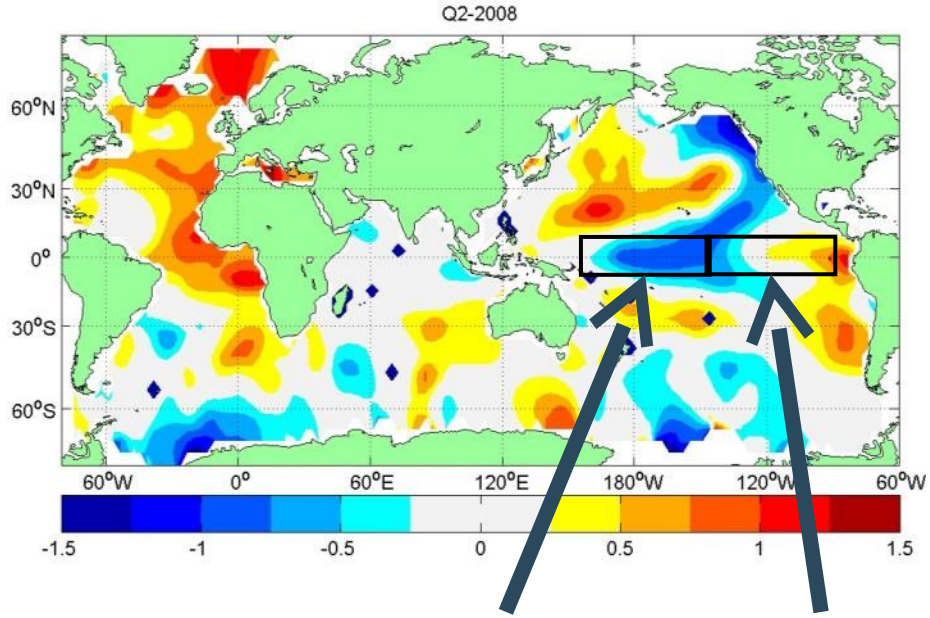
El Nino 4 El Nino3

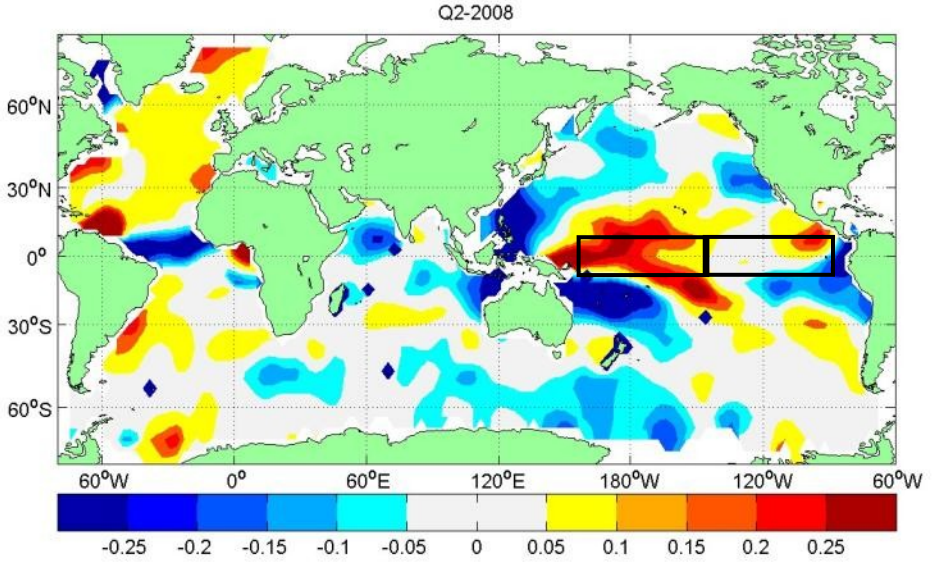
2007 - 2013



0-20m

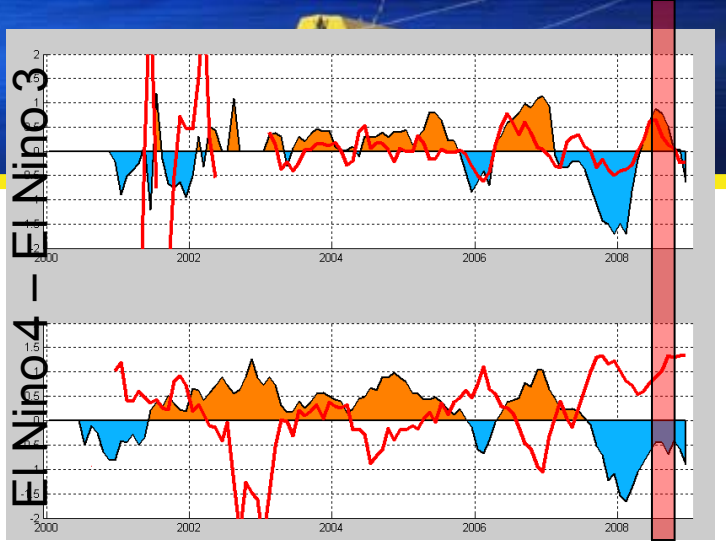
Temperature anomaly – Salinity anomaly





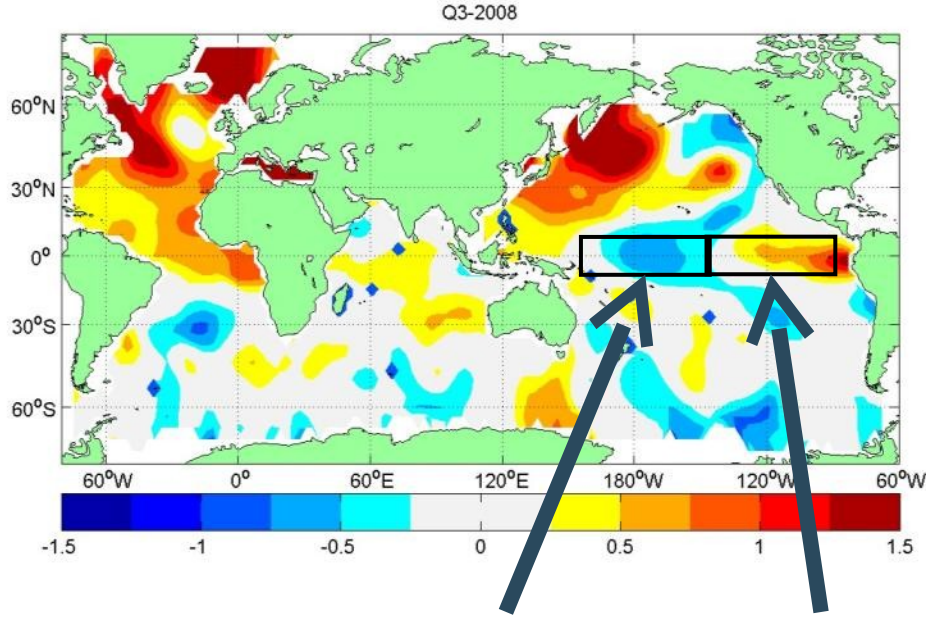
El Nino 4 El Nino3

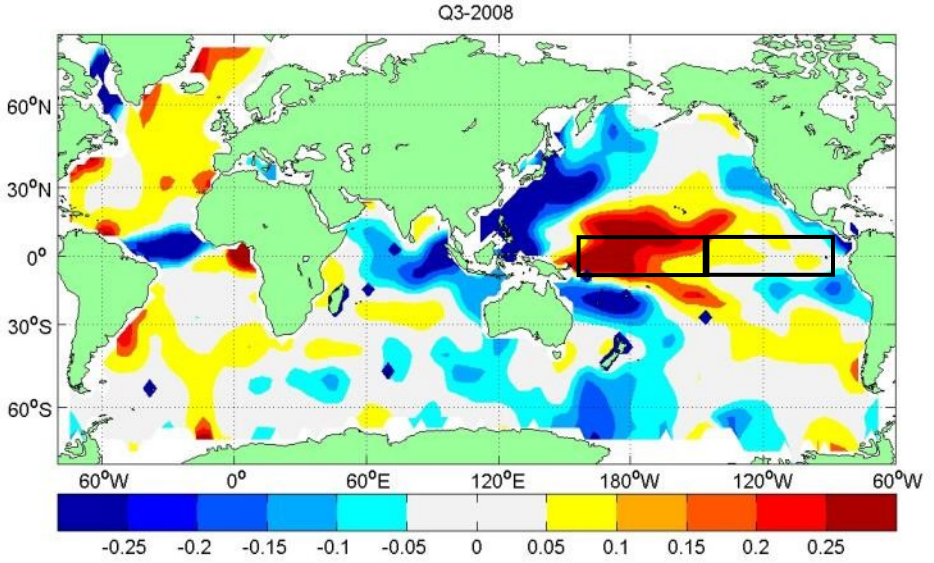
2007 - 2013



0-20m

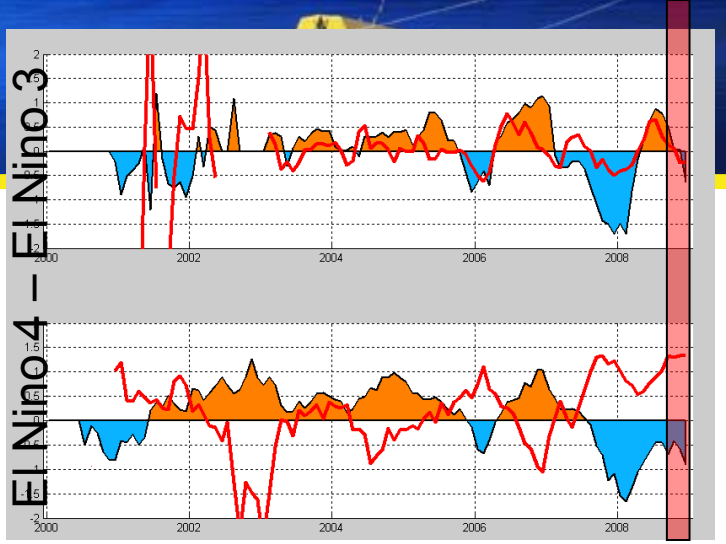
Temperature anomaly – Salinity anomaly





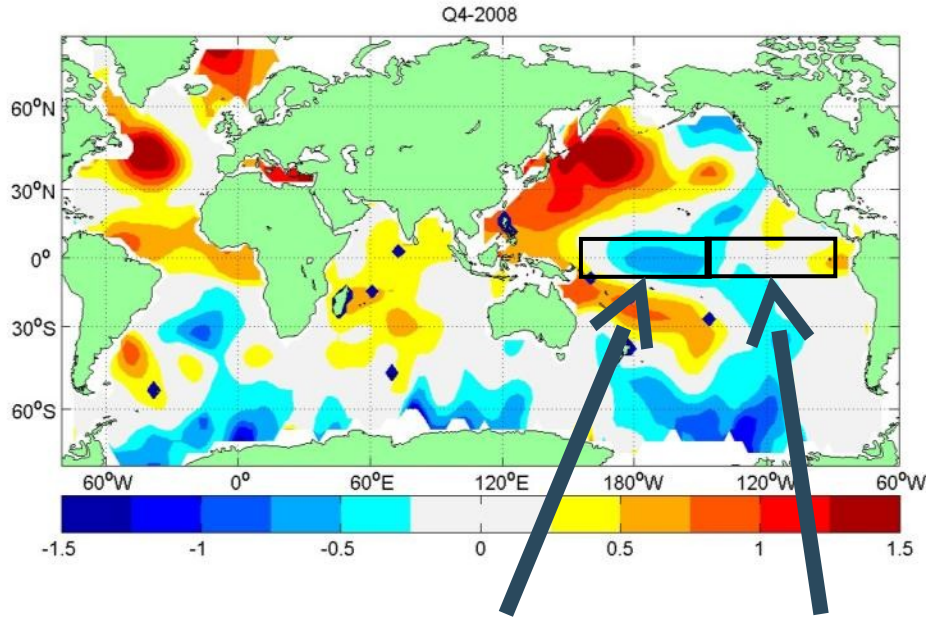
El Nino 4 El Nino3

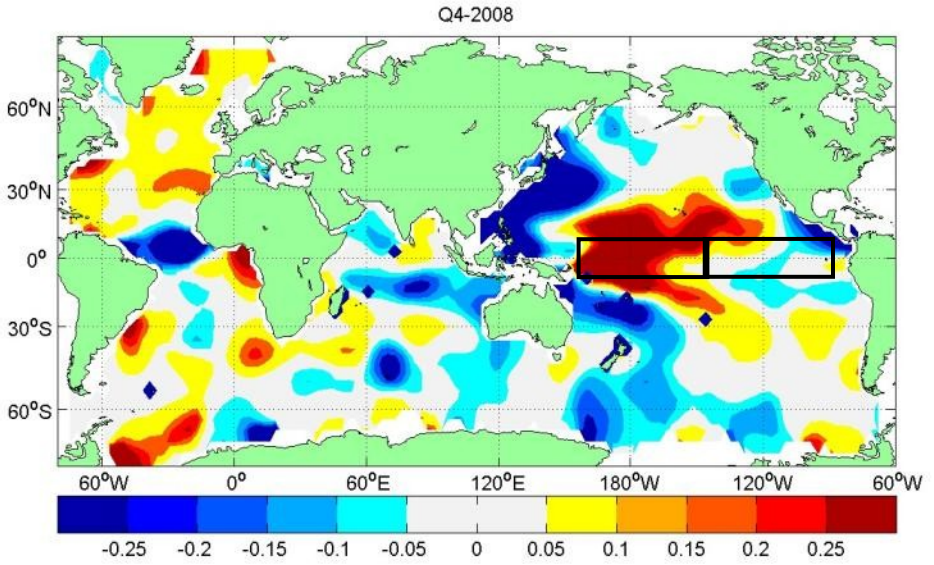
2007 - 2013



0-20m

Temperature anomaly – Salinity anomaly

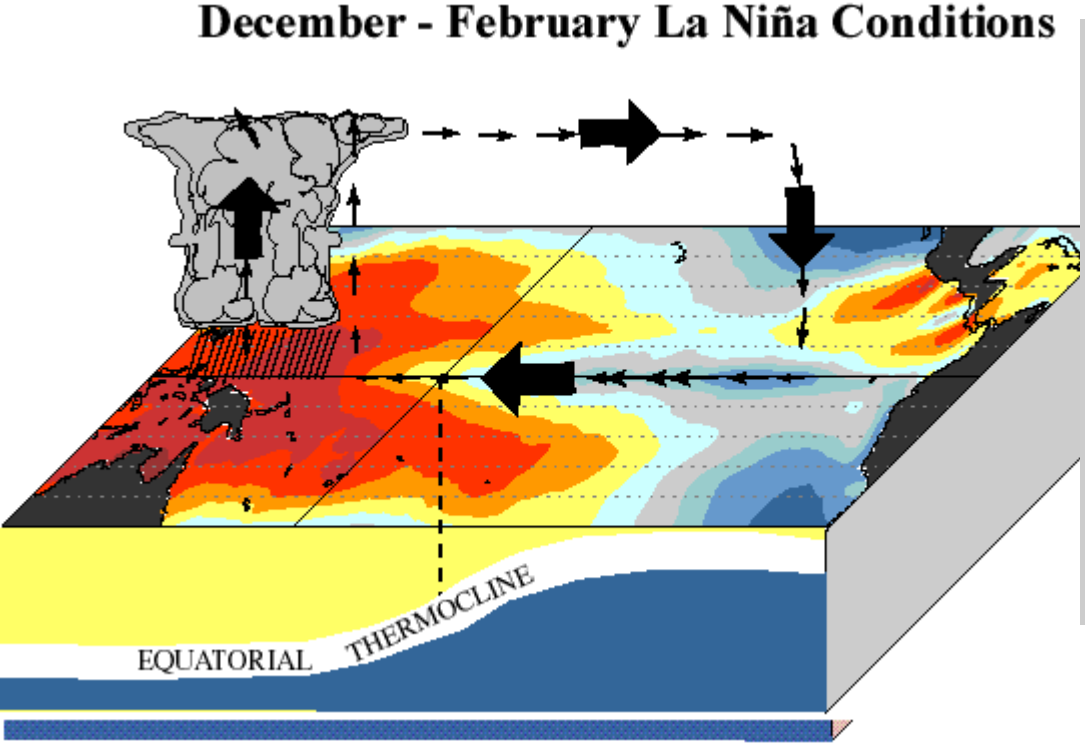


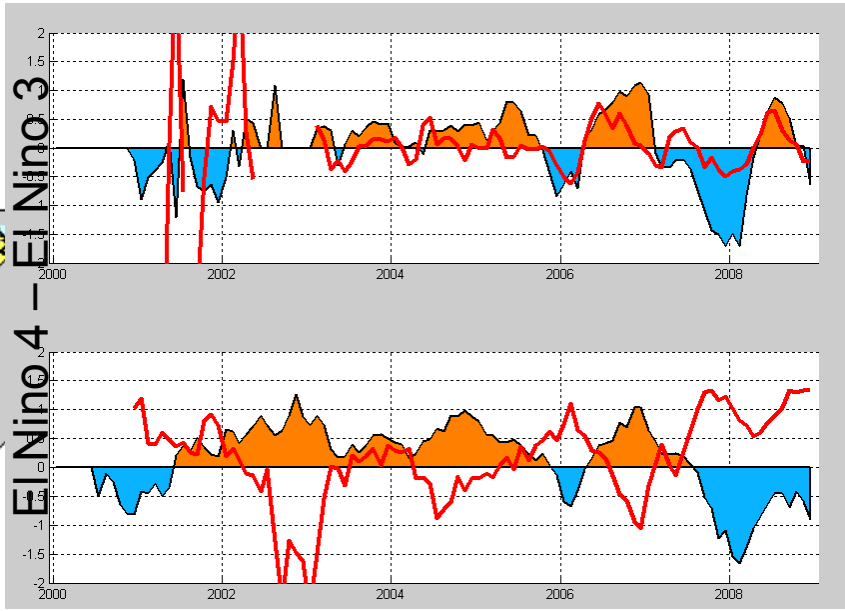


El Nino 4 El Nino3

2007 - 2013

El Nino areas – „salinity anomalies“





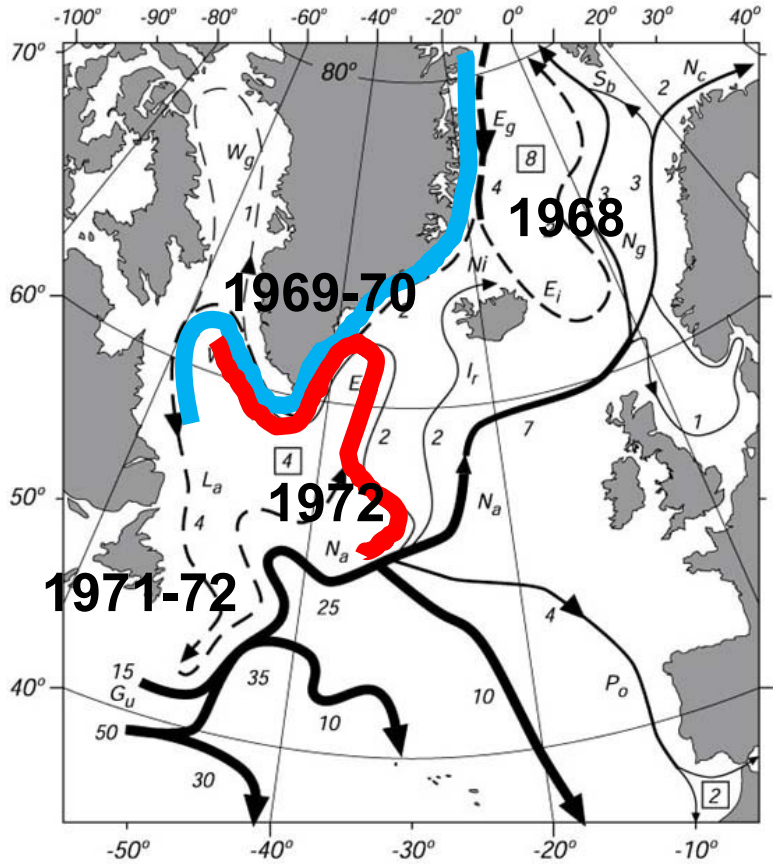
Probably: Walker Circulation Feedbacks

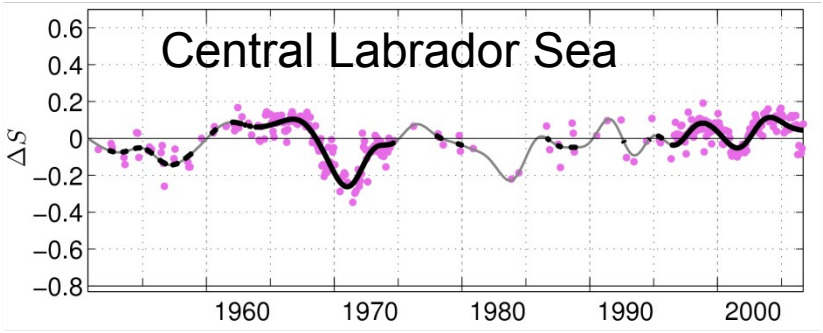
Equatorial Pacific anomalies

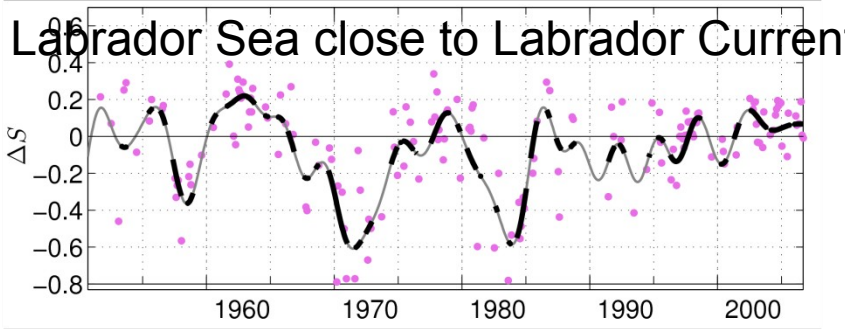
- Near surface anomaly
- Likely an atmospheric feedback loop along the equator
(La Nina precipitation patterns)

Small Outlook
- Impacts of salinity anomaly are verified.
- Fate of anomaly isopycnaly traced

Labrador Salinity anomalies

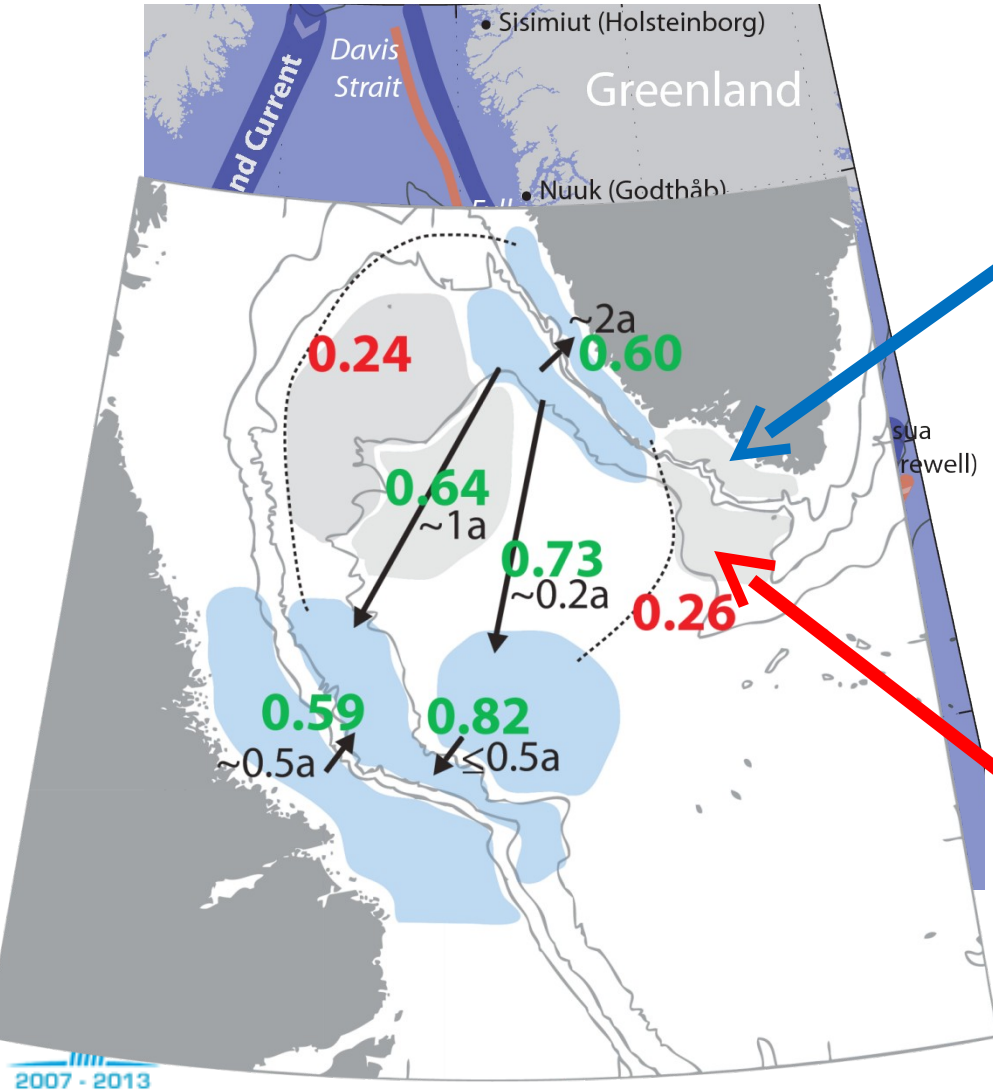


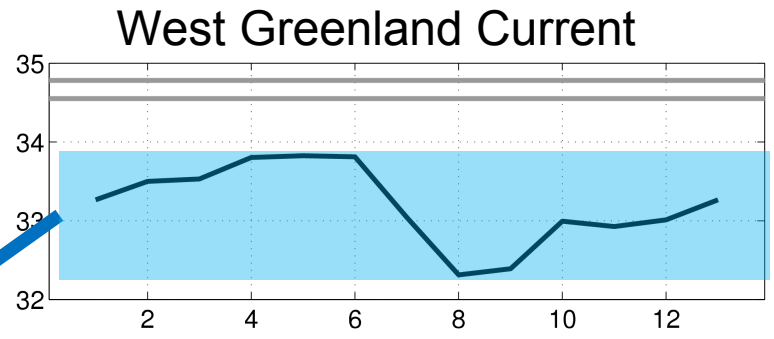




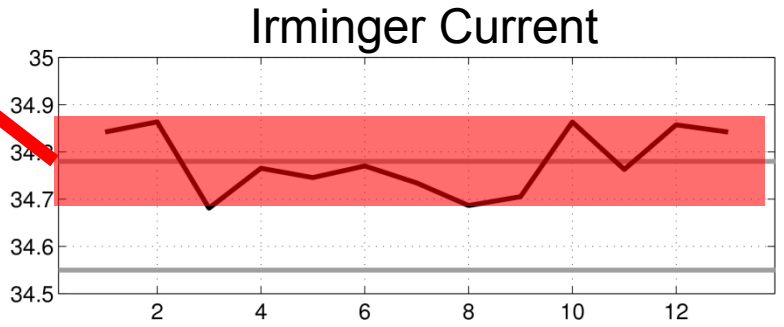
Dickson et al. (1988)/ Dietrich et al. (1980)

Labrador Salinity anomalies

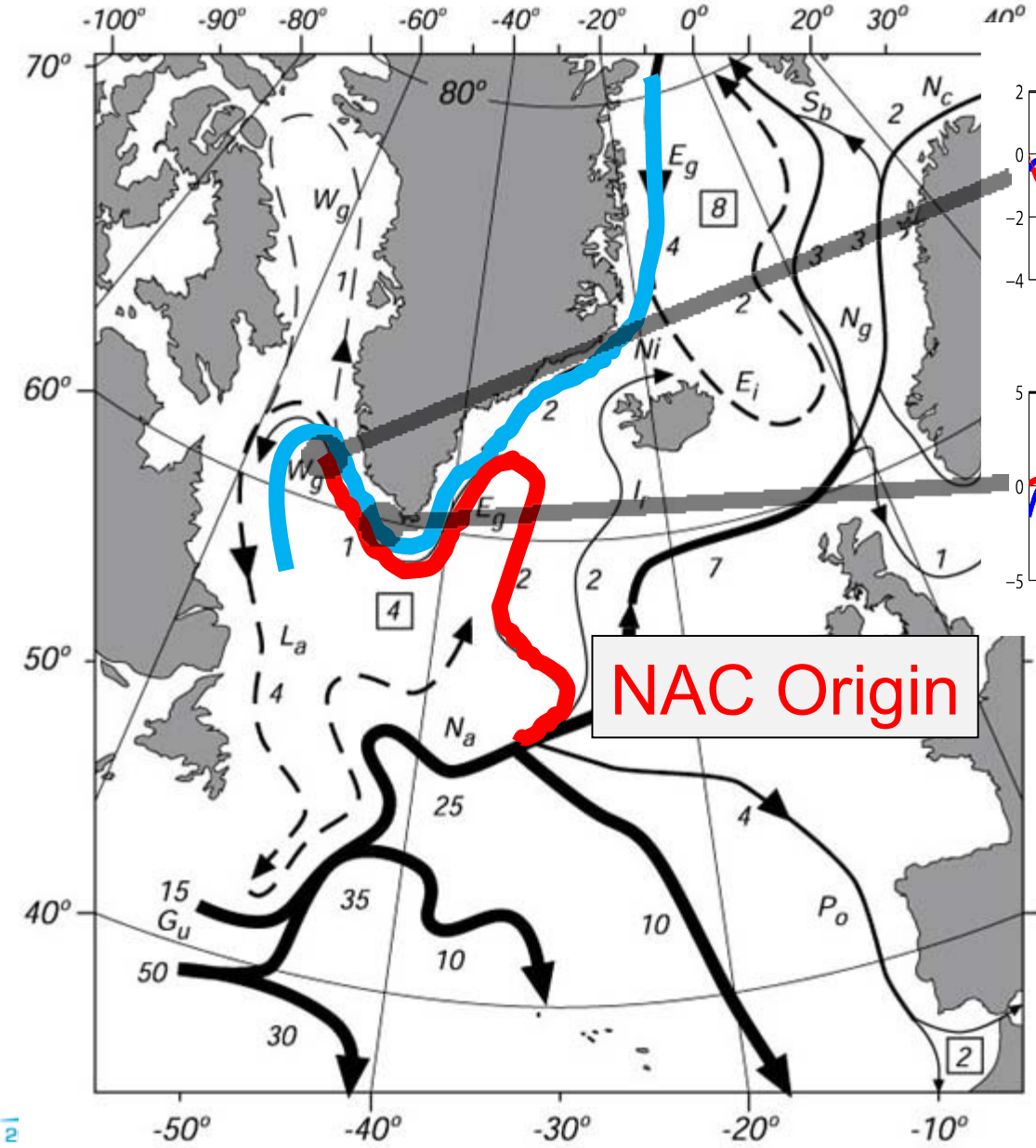




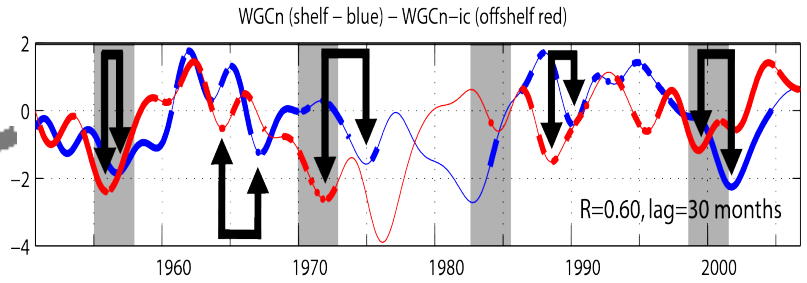
Seasonal Cycles

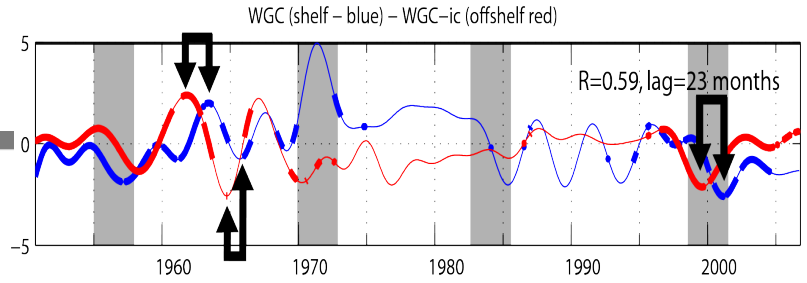


2007 - 2013

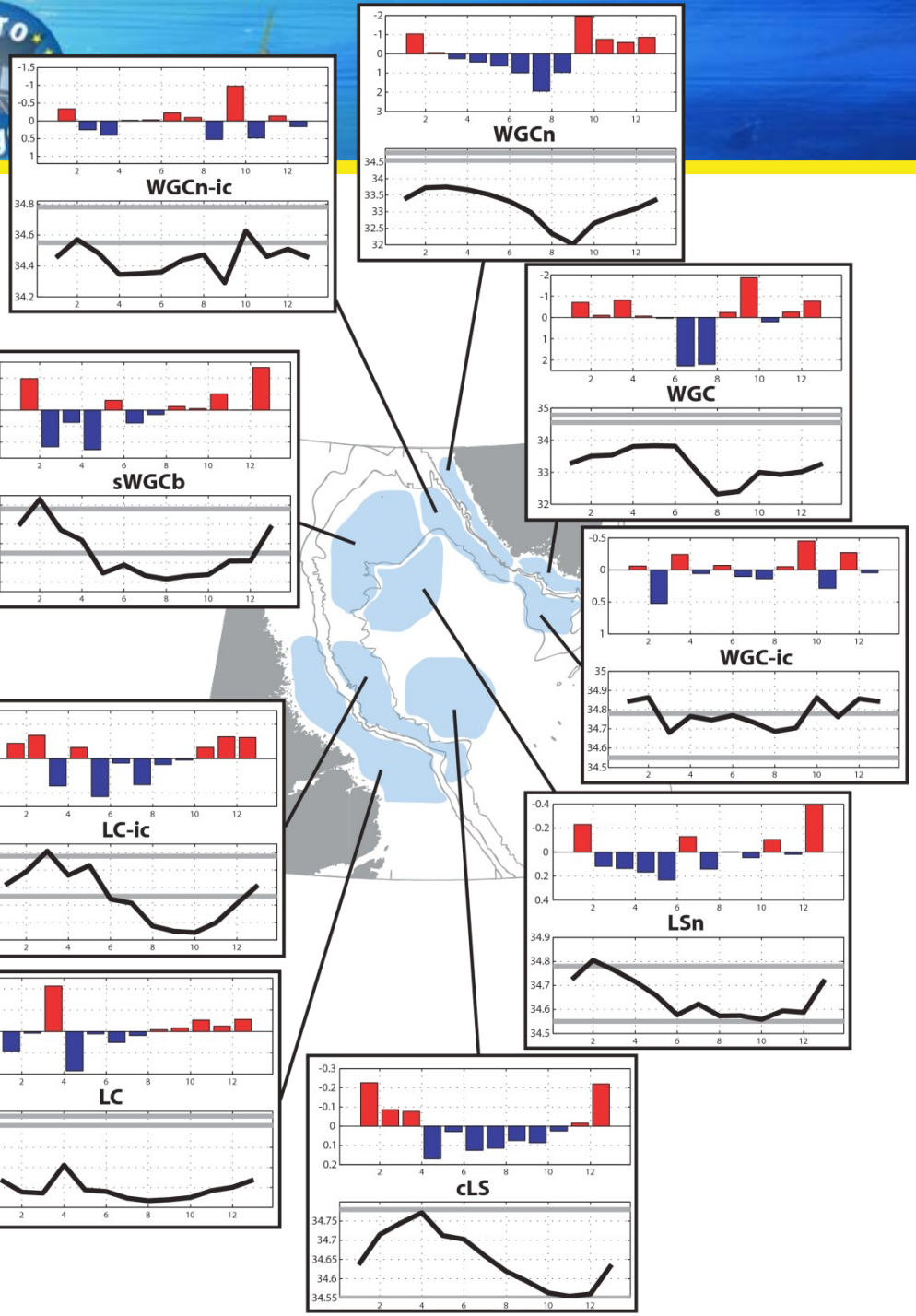


NAC Origin





Anomalies at source traceable?



Labrador Sea Salinity Cycles

Very different seasonal cycles within a „small“ area

2007 - 2013

100m salinity anomaly NAtl.

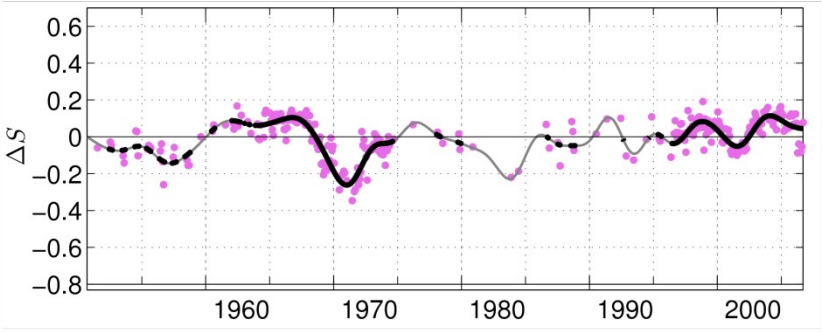
300m salinity anomaly NAtl.

North Atlantic Anomalies

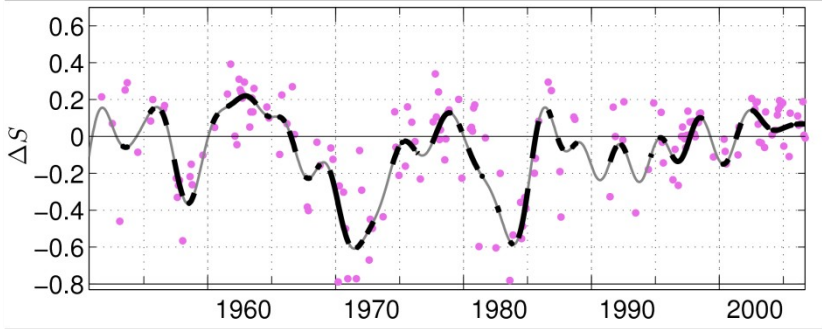
Cannot be tracked straight foreward.

Has there been any surface anomaly propagating on the last years?

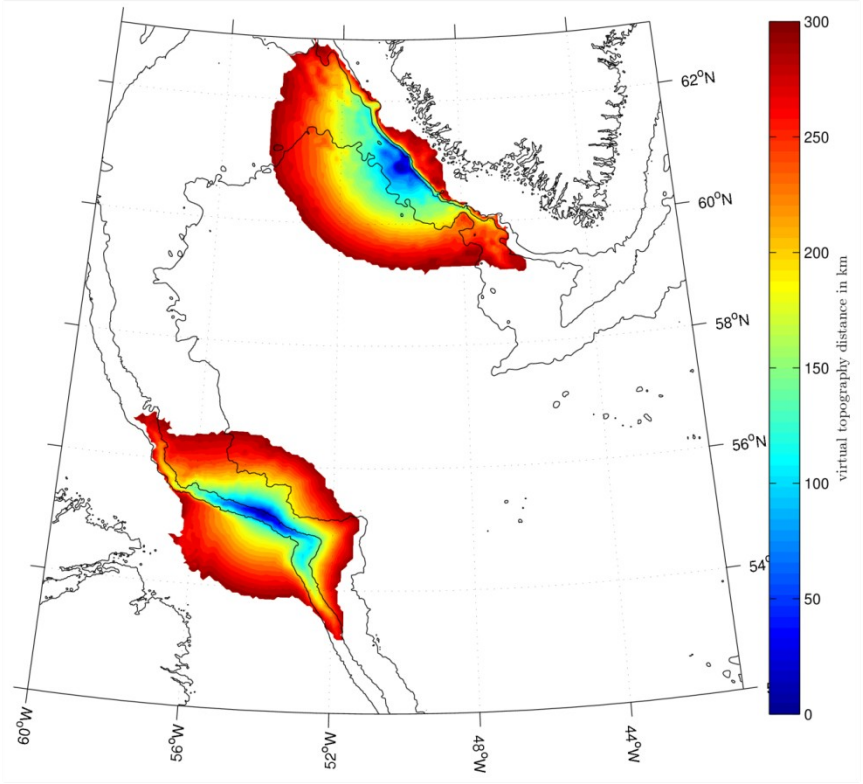
Central Labrador Sea



Labrador Sea close to Labrador Current



Increase possibilities by
-f/H interpolation NOT 5x5° or similar



Improvements

Was there just NO anomaly in those years?

Increase possibilities by

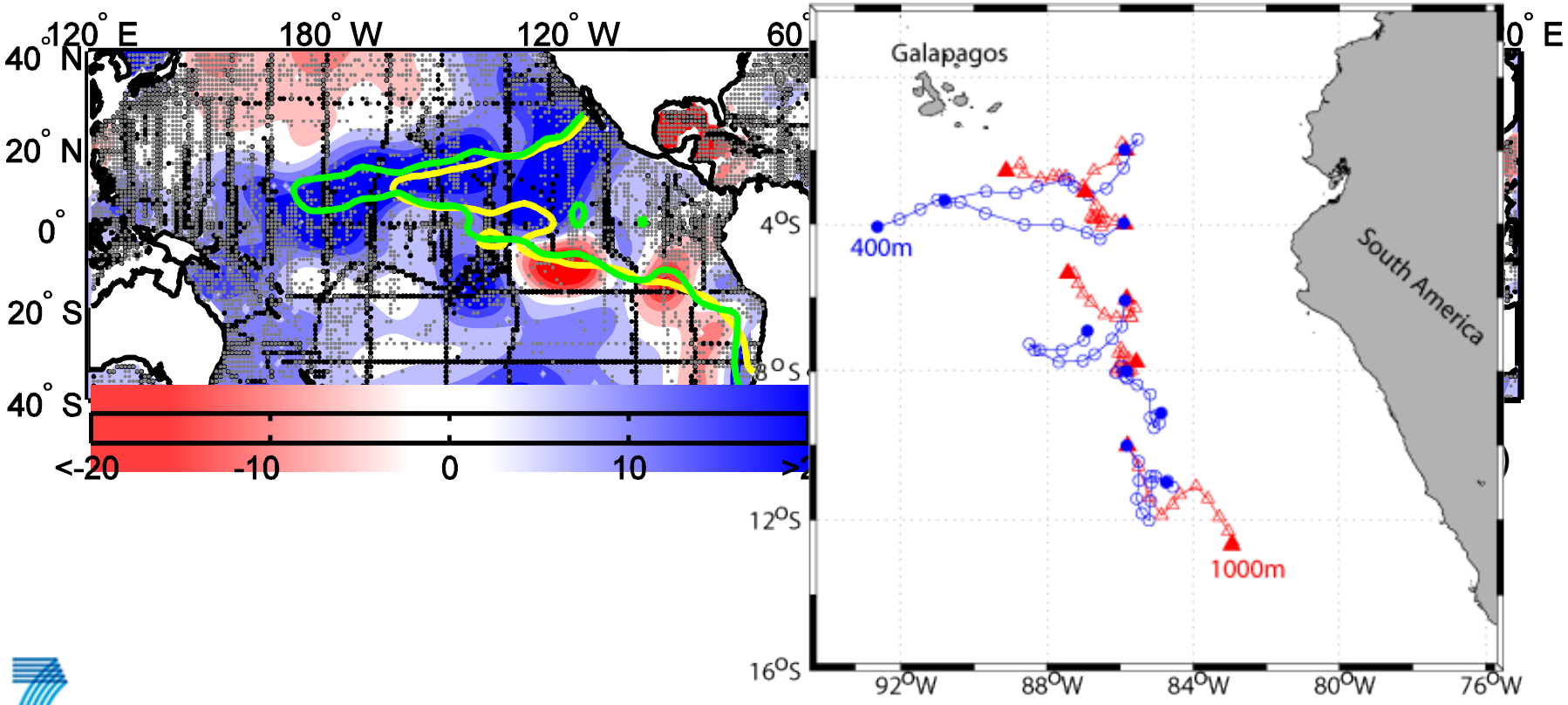
- isopycnal not isobaric analysis
- f/H interpolation NOT 5x5° or similar
- streamfunction weighted interpolation (leads to an extreme shortage of floats in some areas)
- better climatology needed, regional covariance fields?

Float deployment not 3x3 but related to ocean variability. (Fronts, Seasonal Cycle, Convection, Streamfunction)

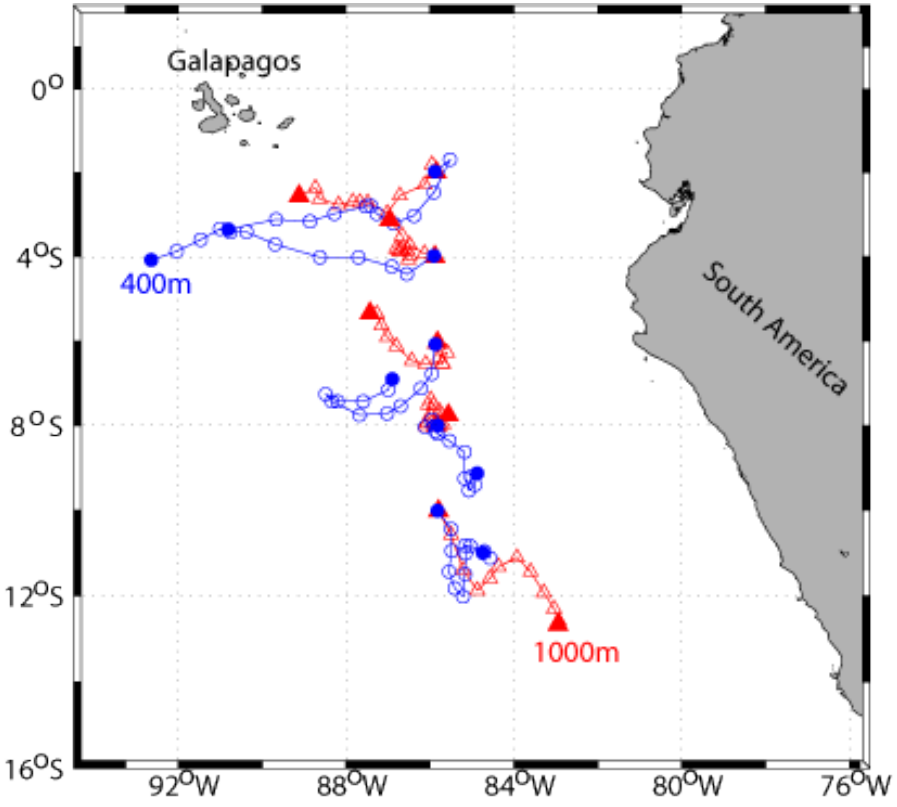
2007 - 2013

Future Work

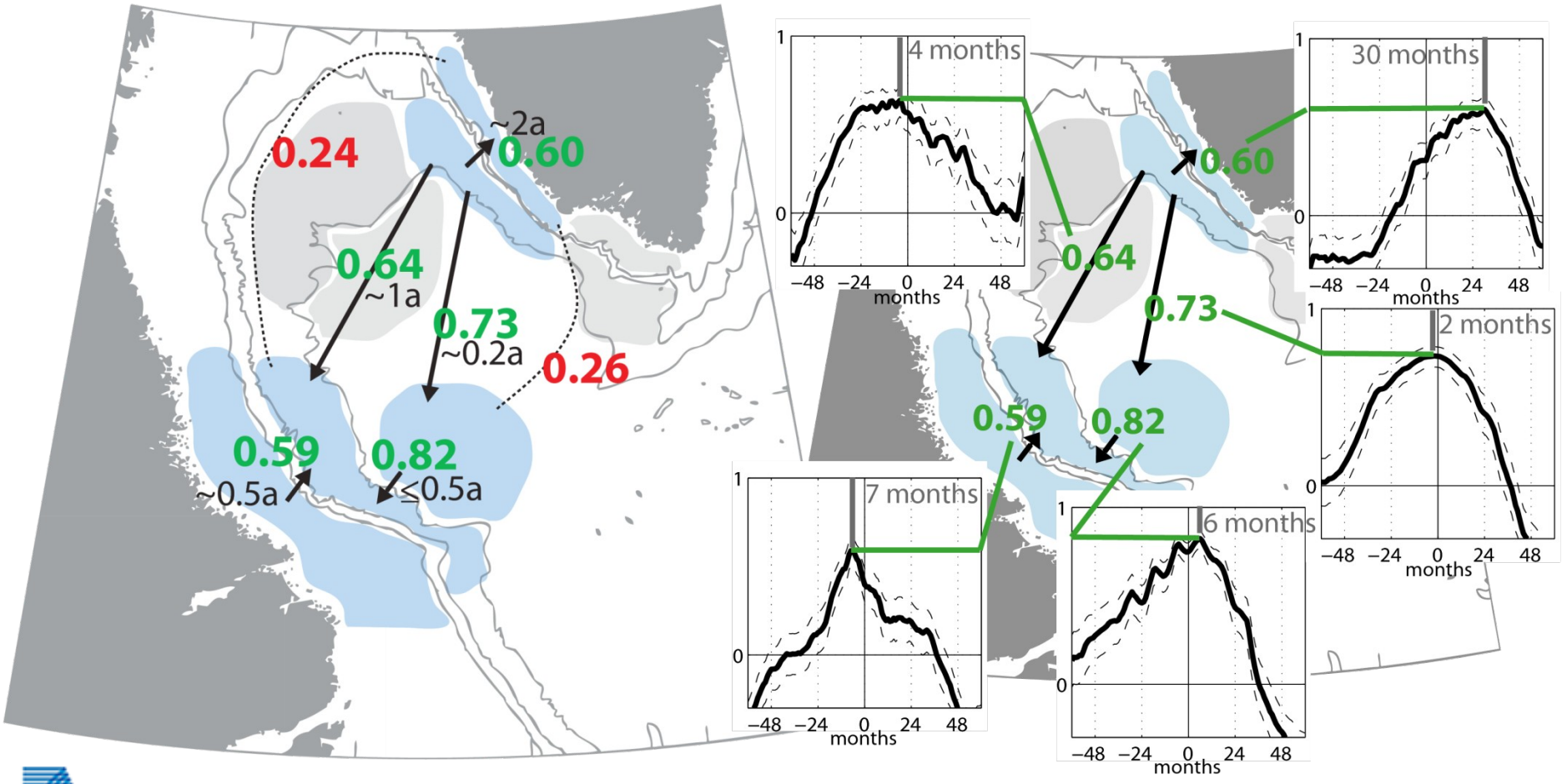
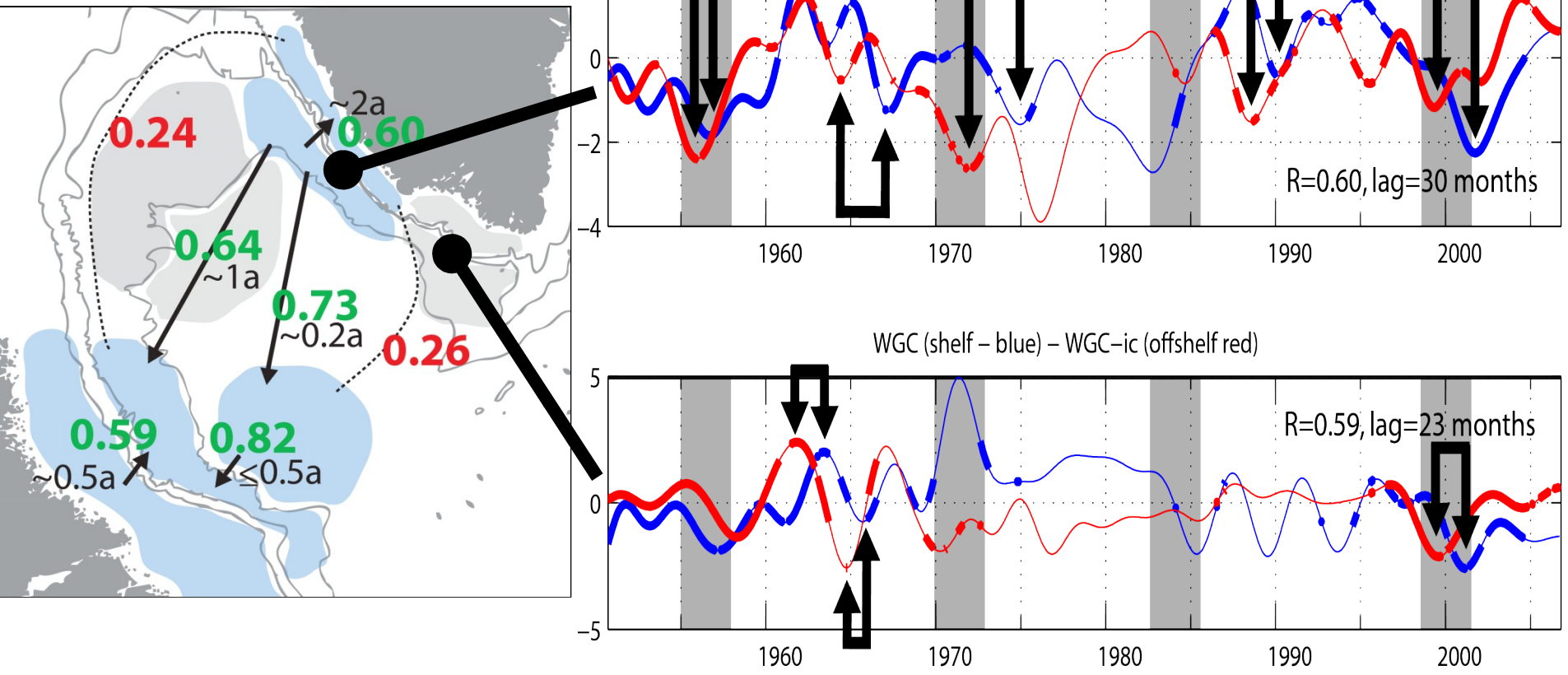
200m Dissolved Oxygen Change 1960-1975 to 1990-2007



10 APEX floats with Aanderaa oxygen optodes
400m and 1000m drift depth



Labrador Salinity anomalies



Labrador Salinity anomalies