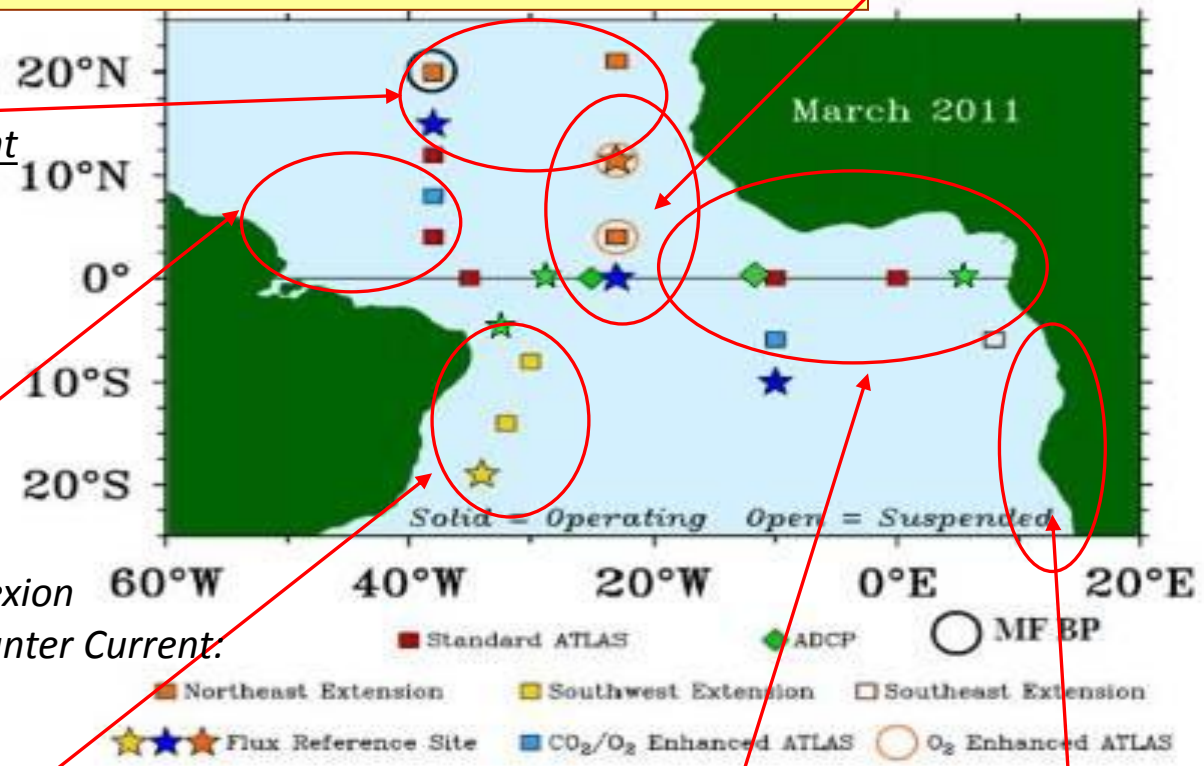
PIRATA: Some Operational Oceanography highlights

F. Hernandez, M. Drévillon, Mercator Ocean team, GODAE OceanView team, CLIVAR/GSOP team

PIRATA areas of interest also key issues for ocean forecasting systems

- *Oxygen Minimum Zone*
- *NECC evolution*

- *Cyclogenesis*
- *North Equatorial Current*



- North Brazil Current retroflexion into the North Equatorial Counter Current.

- *Amazone River influence*

- *North Brazil Current*
- *SEC bifurcation*

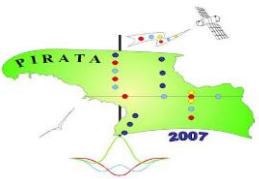
Gulf of Guinea:

- *Cold tongue*
- *Equatorial upwelling*
- *Congo River influence*
- *Coastal upwellings*

Benguela-Angola Front Zone :

- SST bias,

- *SST front migration*
- *Coastal upwellings*



PIRATA and Operational Oceanography

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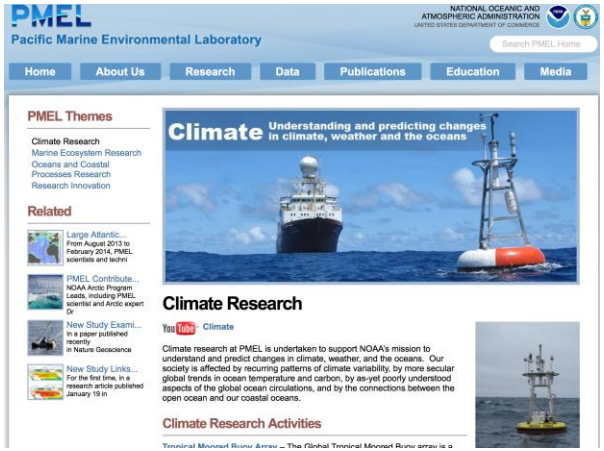
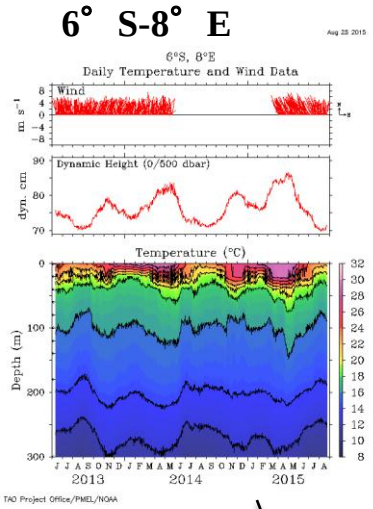
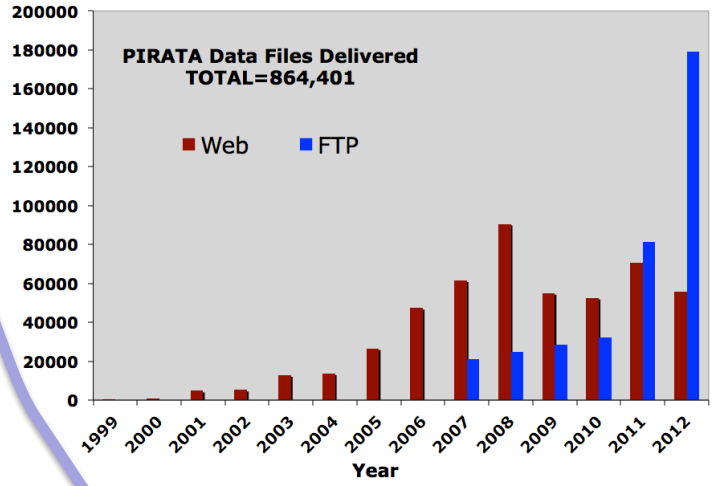
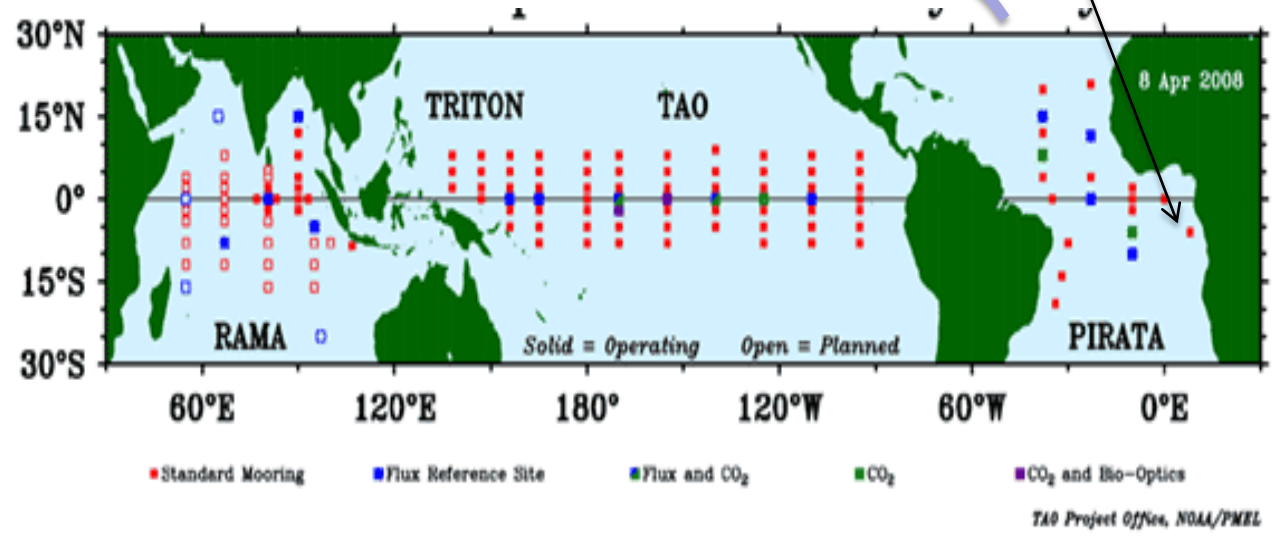
Mercator Ocean
Ocean Forecasters







Real time daily averages

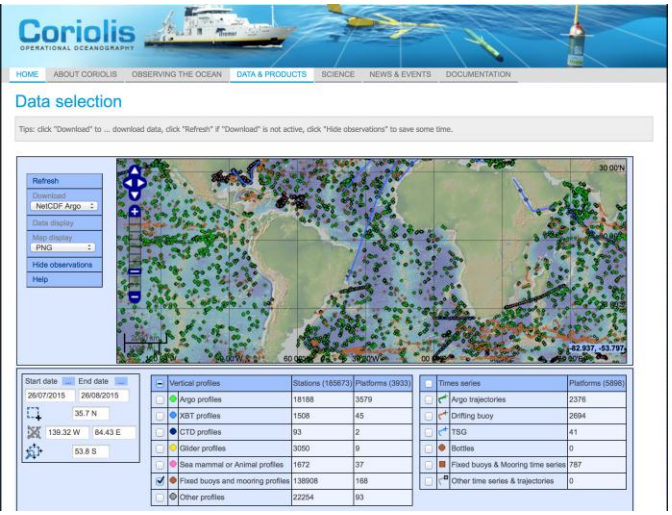


GDAC
Coriolis

Forecast Centres

Forecast Centres

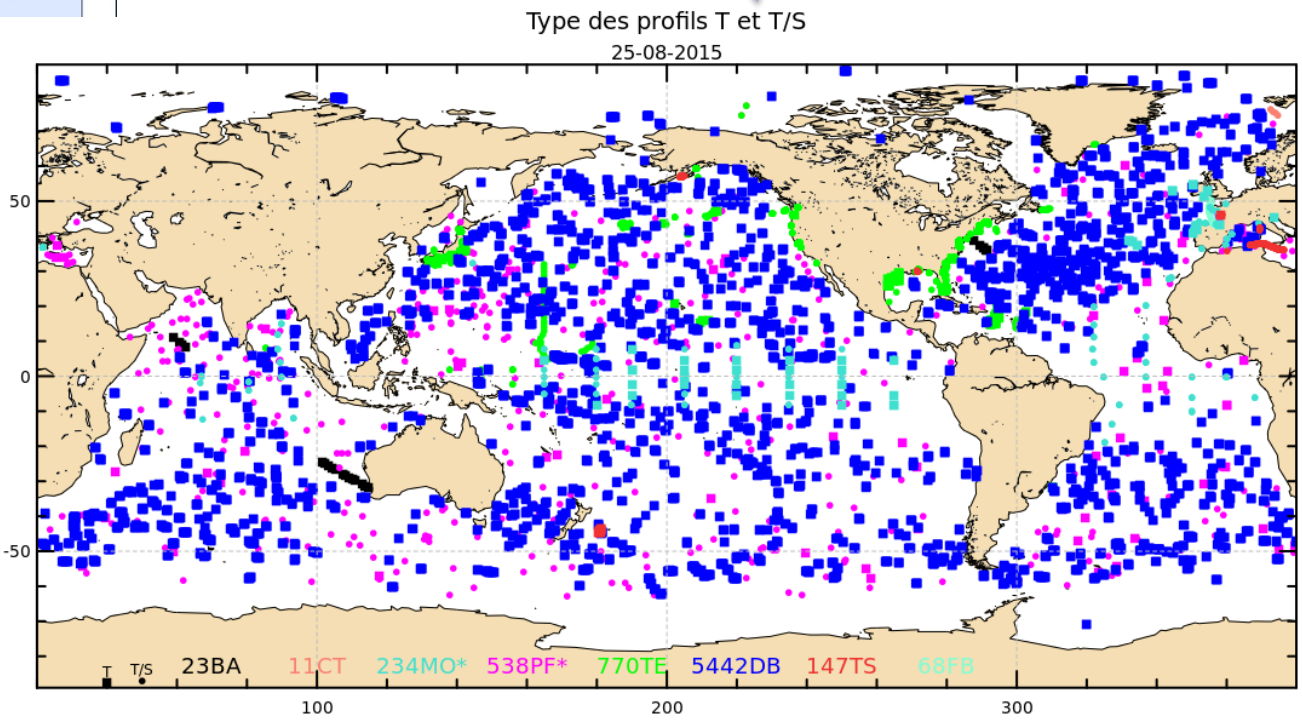
PIRATA and Operational Oceanography



Real time in-situ data collection at Mercator Océan: pre-processsing by type of data

→ Other kind of data from PIRATA cruises also used when available (TSG, XBT, CTD..)

Few daily data in the Tropical Atlantic



PIRATA and Operational Oceanography

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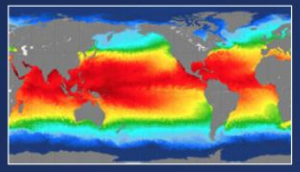
Mercator Ocean
Ocean Forecasters

Mercator Ocean
Ocean Forecasters
Ocean Monitoring and Forecasting

Ocean Forecasts

Provided by the Mercator Ocean Operational Systems.

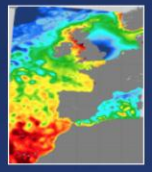
Daily Global Physical Bulletin 1/12°
(PSY4)



- Daily Global Physical Bulletin 1/12°
- Global coverage
- Physical variables
- 1/12° resolution
- Daily updated

Show Bulletin

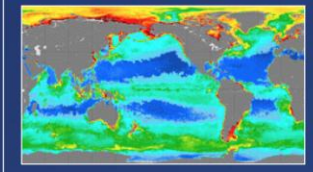
Daily Iberian Biscay Irish Physical Bulletin 1/36° (IBI36)



- Daily Regional Physical Bulletin 1/12°
- Regional coverage (Iberian Biscay Irish)
- Physical variables
- 1/36° resolution
- Daily updated

Show Bulletin

Weekly Global Biogeochemical Bulletin 1/4° (BIOMER)



- Weekly Global Biogeochimical Bulletin 1/4°
- Global coverage
- Biogeochimical variables
- 1/4° resolution
- Weekly updated

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2015 17 AUG

LATEST NEWS FLASH

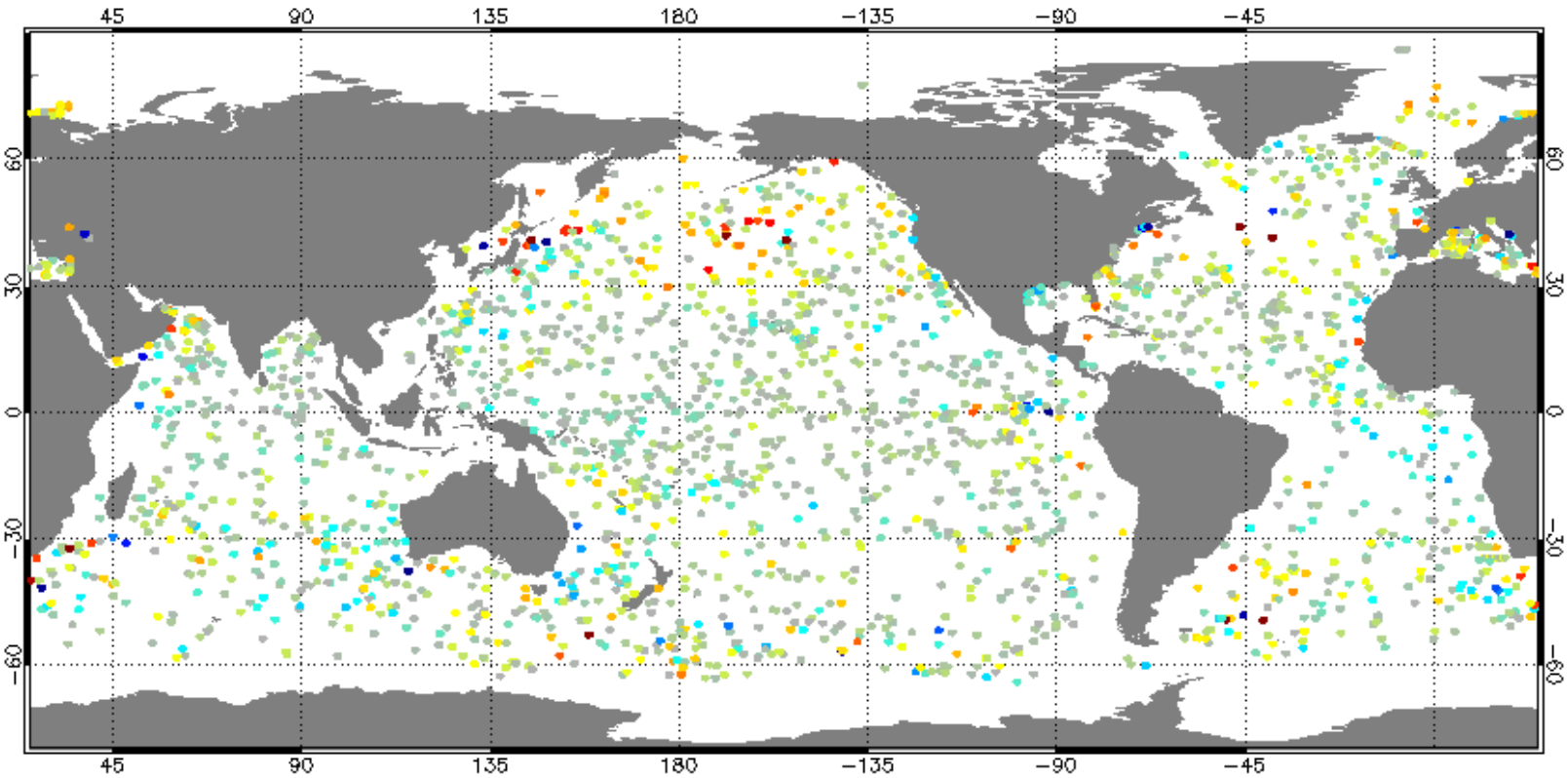
CMEMS:3026
Incident - OCEAN_COLOUR [GLO-ATL-BAL-EUR OC | Degraded] *Resolved*

ALL NEWS FLASH

28 EVENTS AGENDA

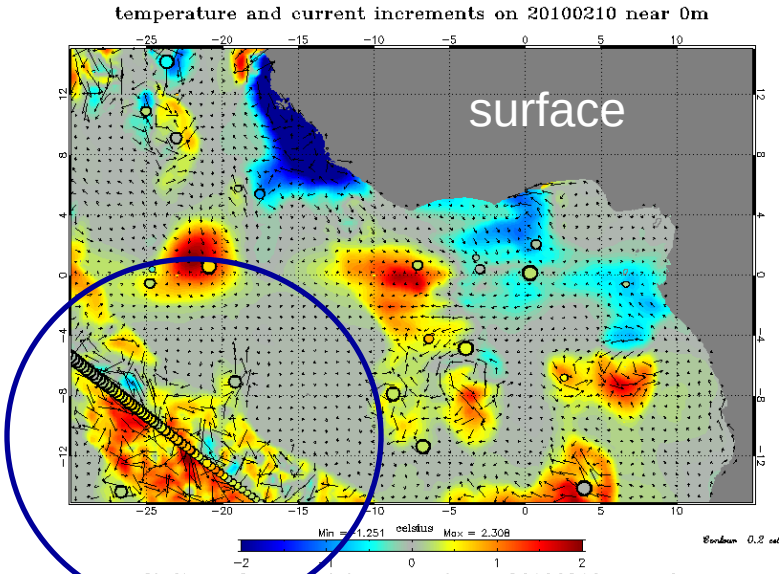
MORE ABOUT THE CMEMS USER UPTAKE PROGRAMME

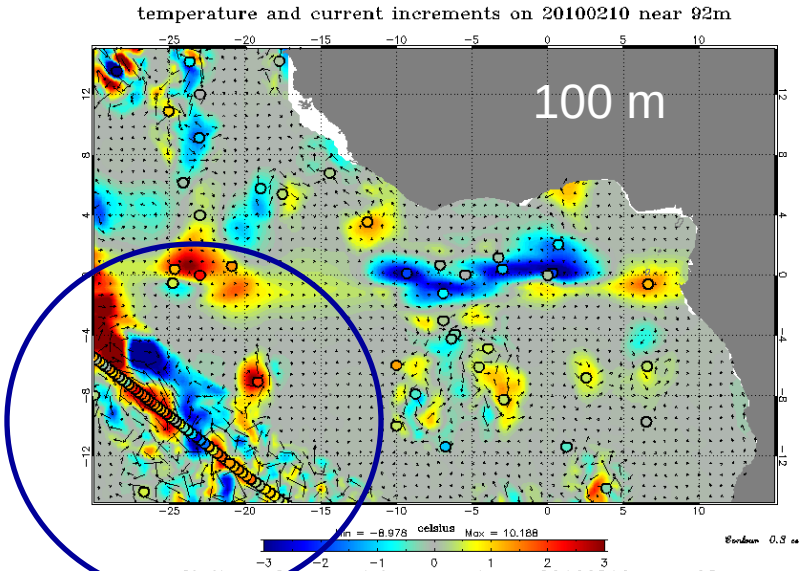
PIRATA and Operational Oceanography

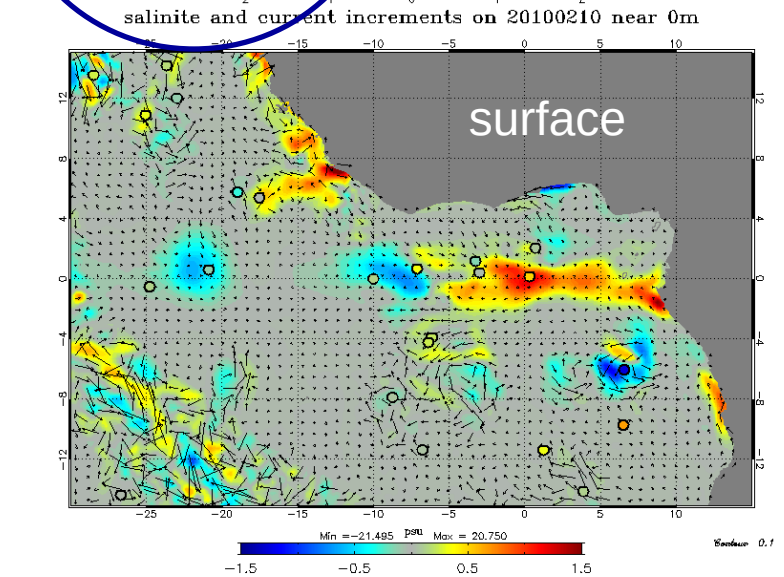


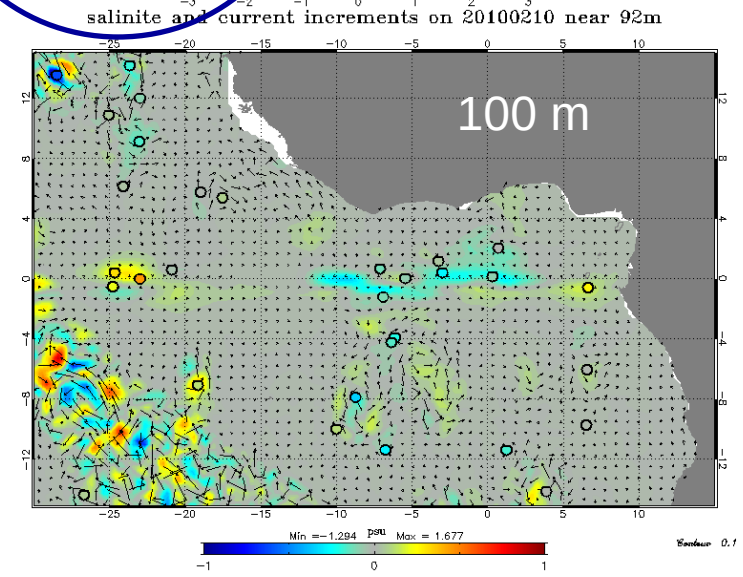
Temperature innovation: misfits between observation and model guess (or forecast)

Assimilation impact of in situ data in the Tropical Atlantic









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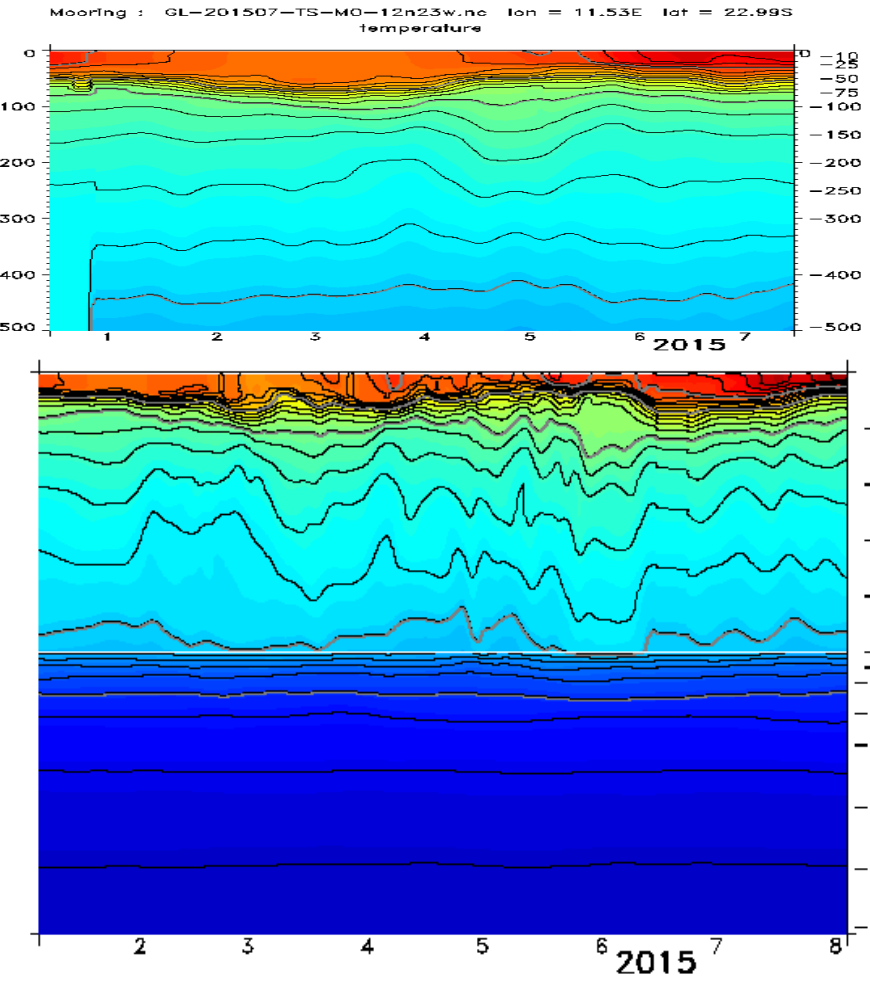
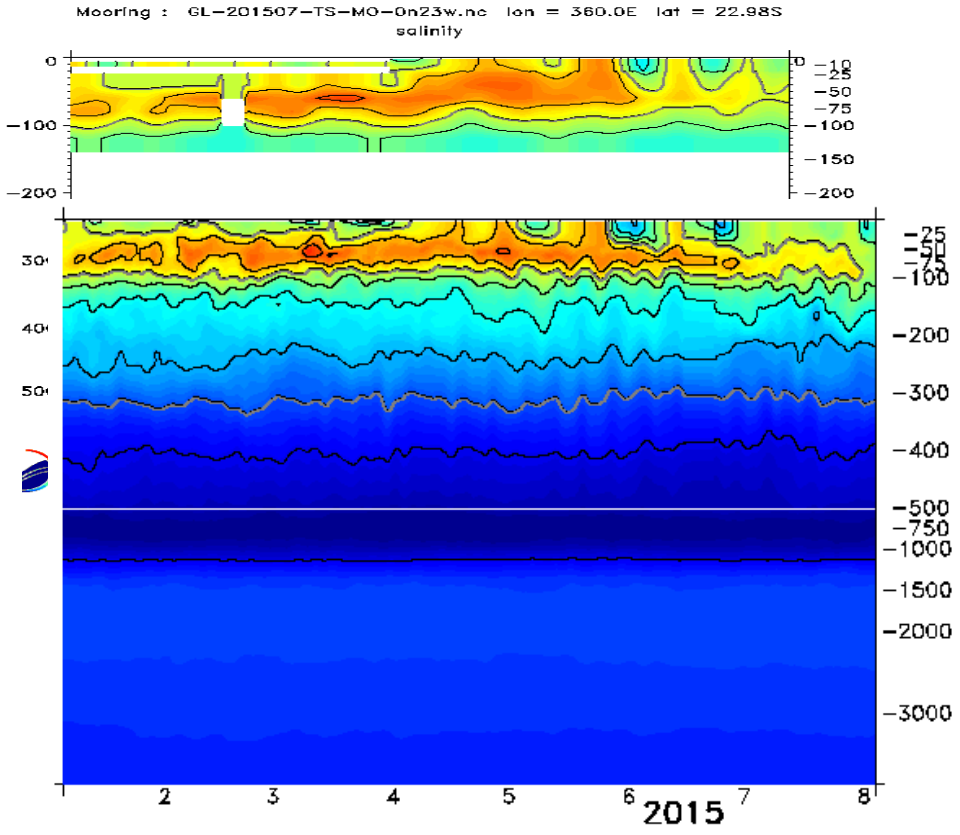
Mercator Ocean Ocean Forecasters

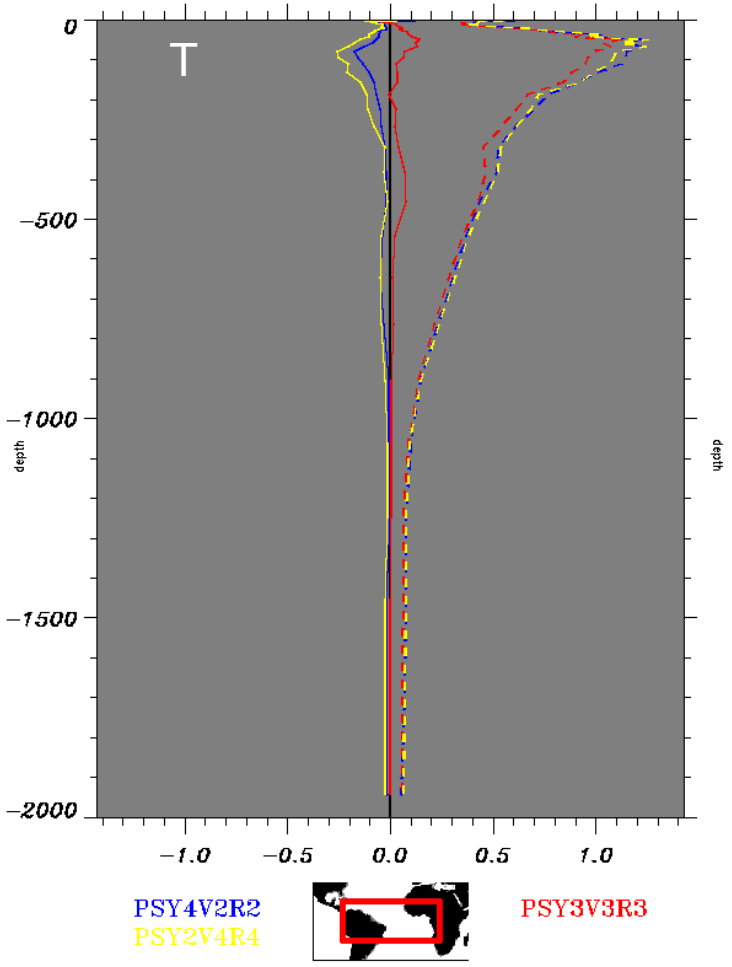
Comparison between Mercator global 1/12° hindcast and PIRATA

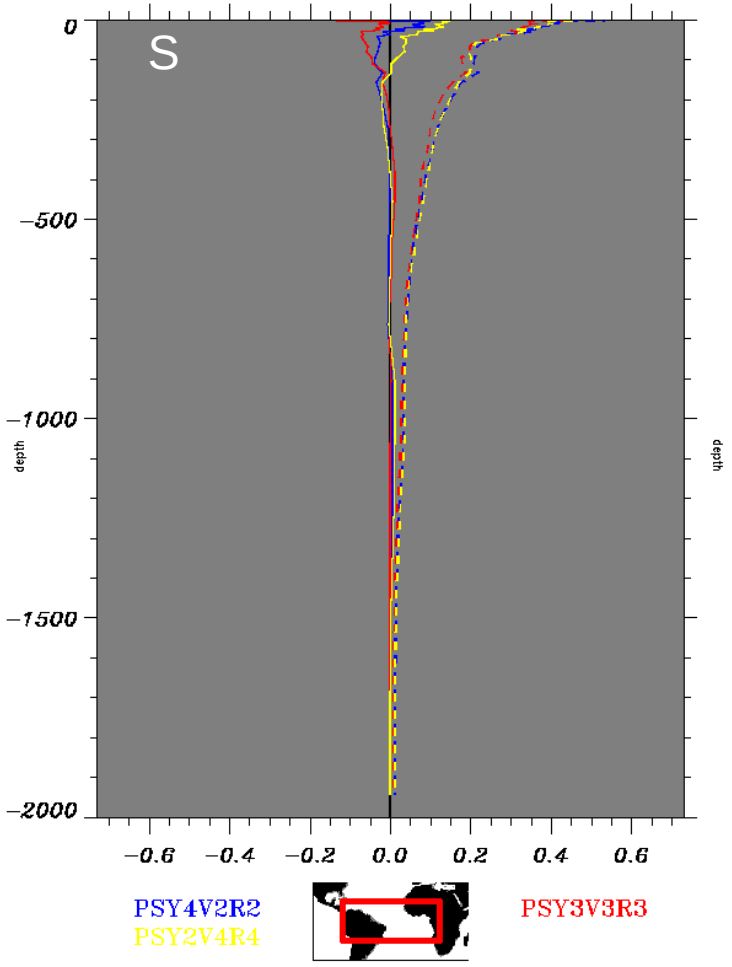




PIRATA and Operational Oceanography

Quarterly systematic operational validation: OND 2014 misfits statistics among Mercator forecasting systems





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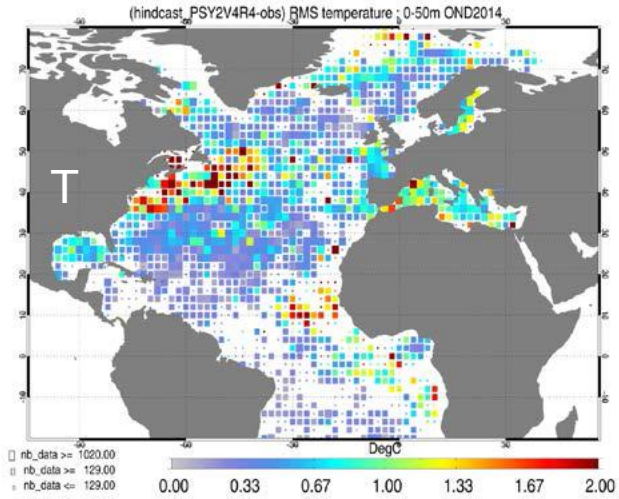
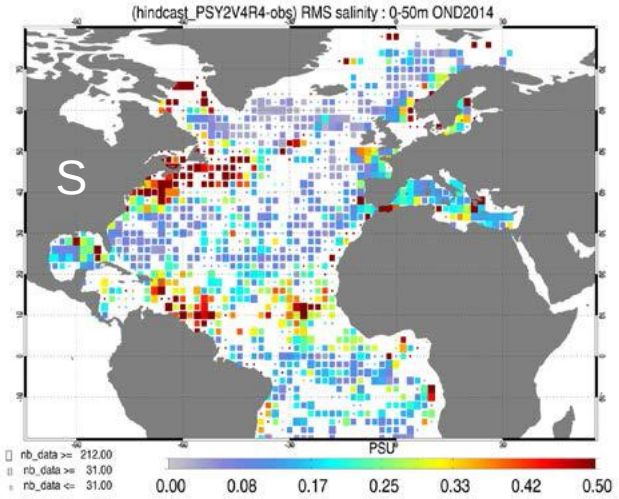
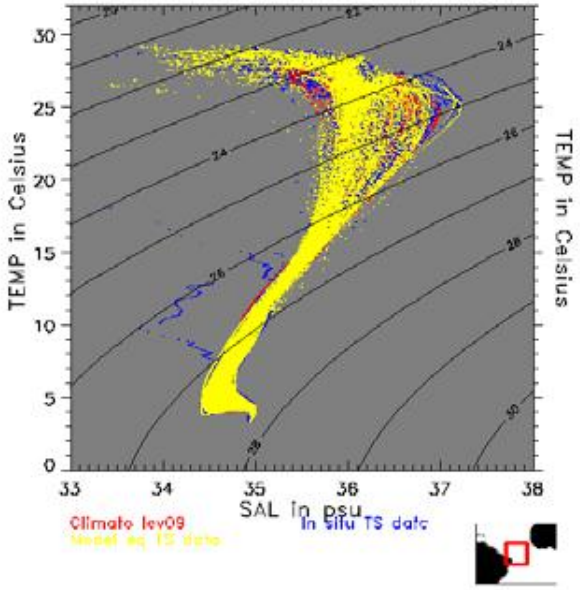
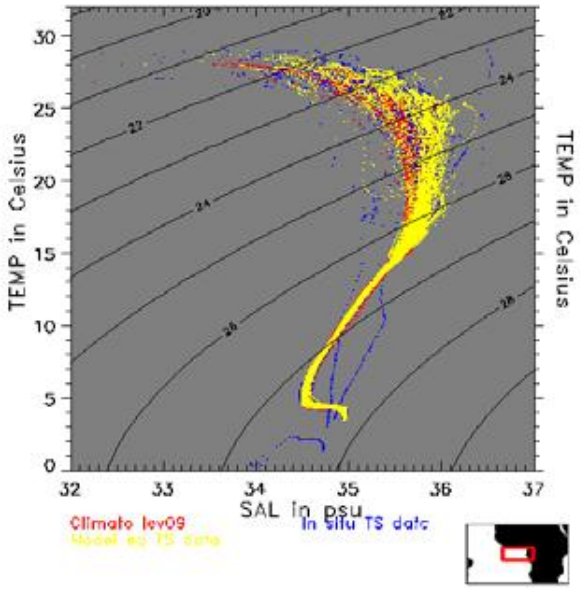


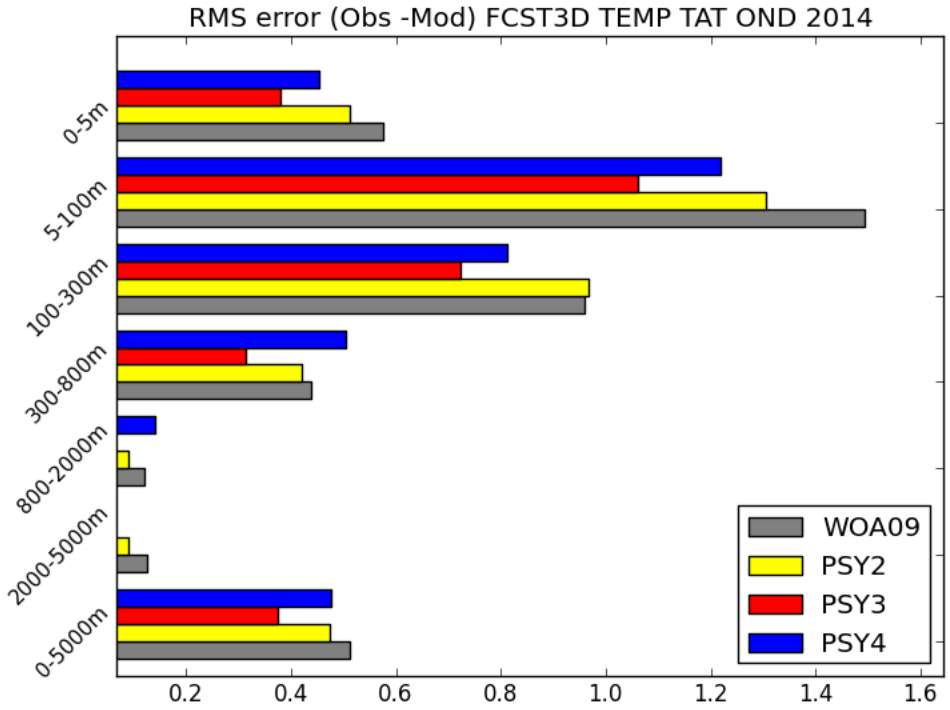


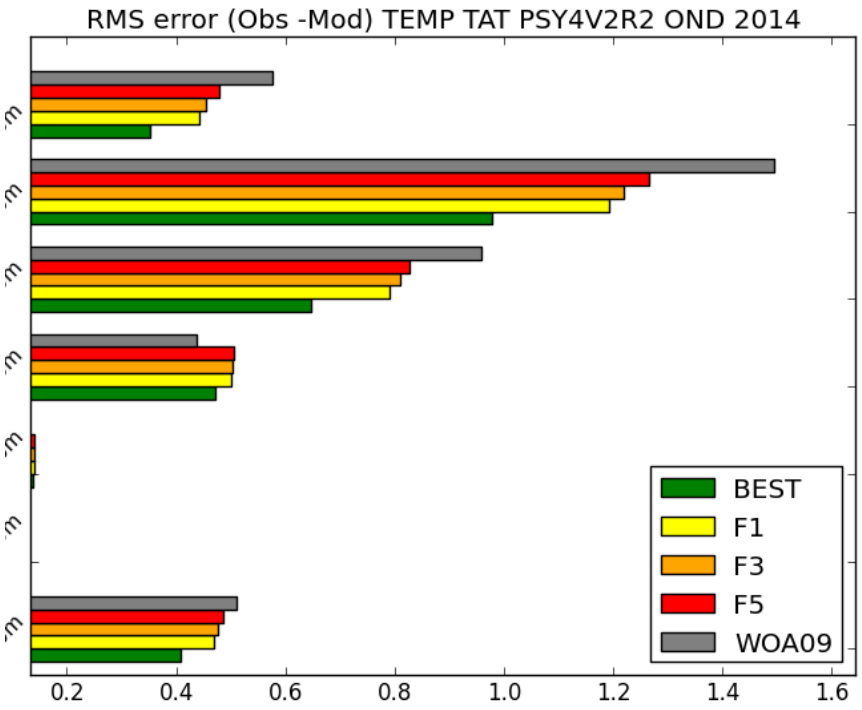




PIRATA and Operational Oceanography

Forecasting skill monitoring by comparison to in-situ data





PIRATA tropical moorings and impact on reanalyses and ocean estimation

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Mercator Ocean
Ocean Forecasters

- GDAC (Coriolis…) database are regularly qualified to propose dedicated dataset for assimilation on ocean reanalysis: EN3, CORA3.4 …..

- The ocean reanalysis community (mostly ocean and climate/seasonal forecast centres) is regularly providing improved ocean reanalysis: most are eddy-permitting over the altimetric era

- In the framework of CLIVAR/GSOP and GODAE OceanView an Intercomparison exercice has been carried out recently: ORA-IP results under publication in Clim. Dyn.

- In operational mode, ocean estimation is carried on, and synthetized at NCEP

PIRATA tropical moorings and impact on reanalyses and ocean estimation

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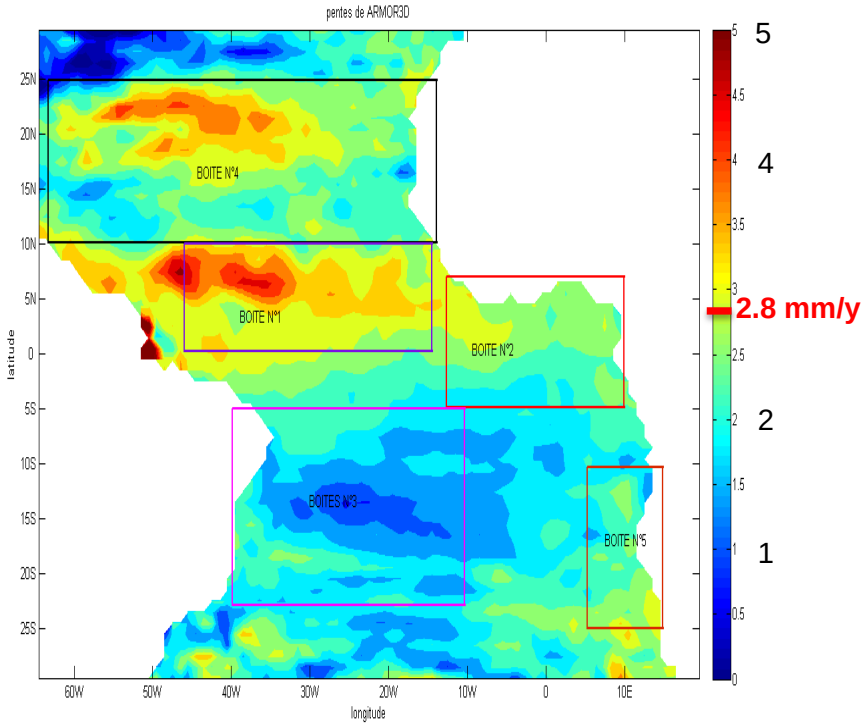
Mercator Ocean
Ocean Forecasters

Product	Institution	Configuration	Control method	Reference
ARMOR3D	CLS	1/3° product (T/S)	OI (T/S/SST)	Guinehut et al (2012) & Mulet et al (2012)
CFSR	NOAA NCEP	1/2° MOM4 coupled	3DVAR (T)	
C-GLORS05V3	CMCC	1/2° NEMO3.2	3DVAR (SLA/T/S/SST/Ice)	Storto et al (2011)
ECCO-NRT	JPL/NASA	1° MITgcm	KF-KS (SLA/T)	Marshall et al (1997) & Fukumuri (2002)
ECCO-v4	MIT/AER/JPL	0.4-1° MITgcm	4DVAR (SLA/SSH/T/S/SST)	Marshall et al (1997) & Wunsch and Heimbach (2013)
EN3 v2a	UK Met Office	1° product (T/S)	OI (T/S)	Ingleby and Huddleston (2007)
GECCO2	Hambourg University	1x1/3° MITgcm	4DVAR (SLA/T/S/SST)	
ECDA	GFDL/NOAA	1/3° MOM4 coupled	EnKF (T/S/SST)	Zhang et al (2007) & Chang et al (2013)
GloSea5	UK Met Office	1/4° NEMO3.2	3DVAR (SLA/T/S/SST/ice)	
MERRA Ocean	GSFC/NASA/GMAO	1/2° MOM4	EnOI (SLA/T/S/SST/ice)	
GODAS	NOAA NCEP	1°x1/3° MOM3	3DVAR (SLA/T)	
G2V3	Mercator Océan	1/4° NEMO3.1	KF+3DVAR (SLA/T/S/SST/ice)	
K7-ODA	JAMSTEC/RIGC	1° MOM3	4DVAR (SLA/T/S/SST)	
K7-CDA	JAMSTEC/DrC	1° MOM3 coupled	4DVAR (SLA/SST)	
LEGOS	LEGOS	1/4° product (SL)	OI+EOF (SLA/SSH)	Meyssignac et al (2012)
NODC	NODC/NOAA	1° product (T/S)	OI (T/S)	Levitus et al (2012)
PEODAS	BOM	1°x2° MOM2	EnKF (T/S/SST)	Yin et al (2011)
ORAS4	ECMWF	1° NEMO3	3DVAR (SLA/T/S/SST)	Balmaseda et al (2013) & Mogensen et al (2012)
MOVE-C	MRI/JMA	0.3-1° MRI.COM2 coupled	3DVAR (SLA/T/S/SST)	Fuji et al (2009)
MOVE-G2	MRI/JMA	0.3°-1° MRI.COM3	3DVAR (SLA/T/S/SST)	Toyoda et al (2013)
MOVE-CORE	MRI/JMA	0.3°-1° MRI.COM3	3DVAR (T/S)	Tsujino et al (2011) & Danabasoglu et al (2013)
SODA	University of Maryland and Texas A&M University	0.4x1/4° POP2.1	OI (T/S/SST)	Carton and Giese (2008)
UR025.4	University of Reading	1/4° NEMO3.2	OI (SLA/T/S/SST)	Haines et al (2012)
SLCCI	ESA	1/4° product (SL)	OI (SLA)	

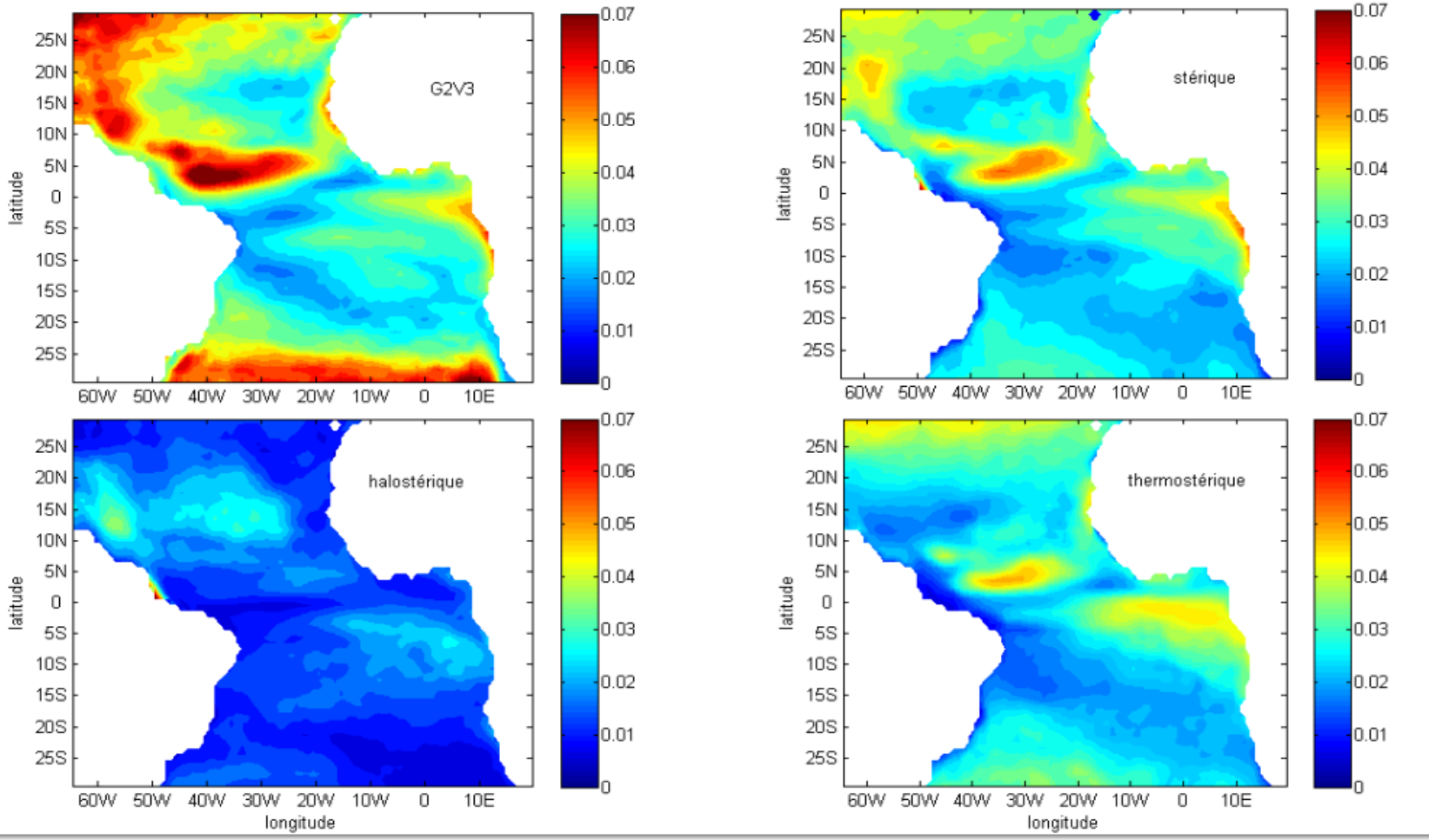
Tropical Atlantic Sea Level

- Sea level trend assessment
- Definition of averaging boxes with consistent signals (SL index)
- Analysis of the seasonal and interannual variability
- Assessment against SL observed products / Tide Gauges
- **Assessment of the ensemble average**



Sea Level Trend (mm/year) from ARMOR3D (AVISO)

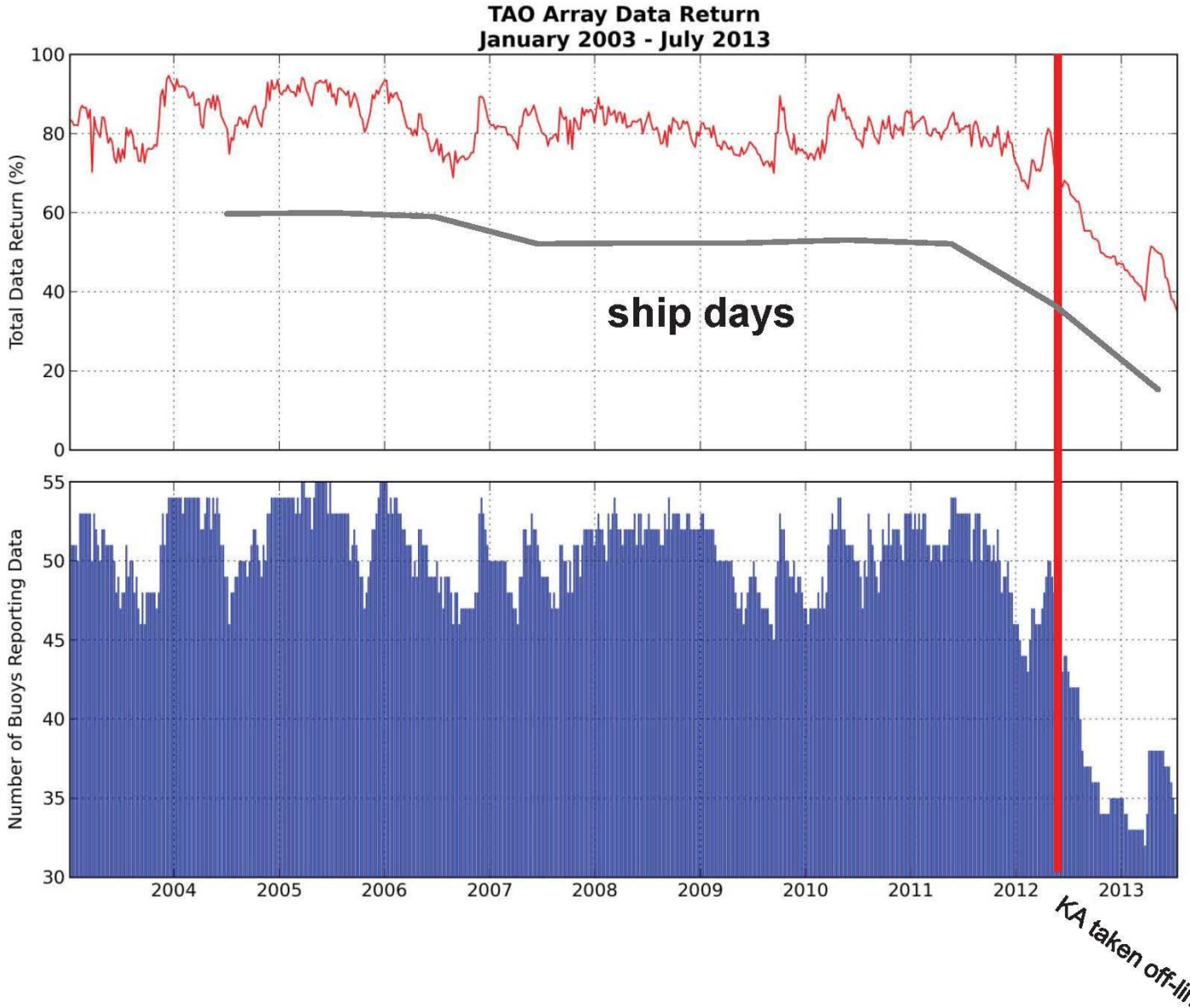
Contribution of steric signals to SL

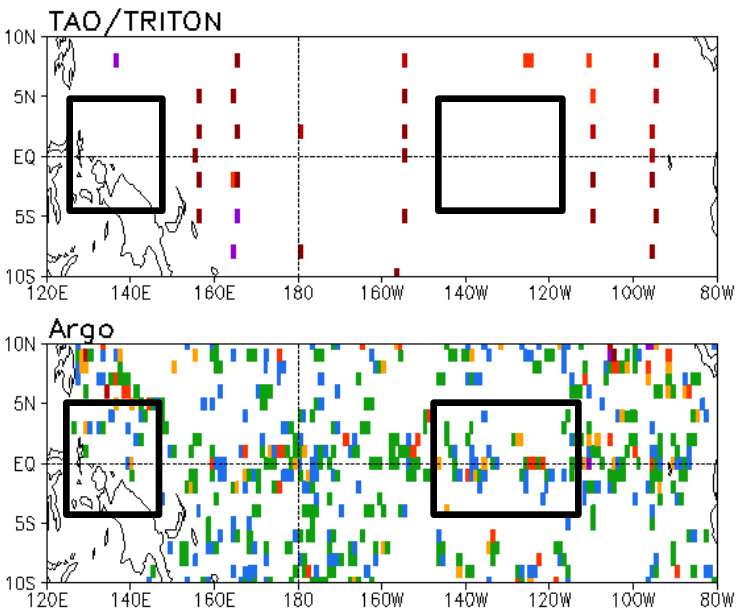


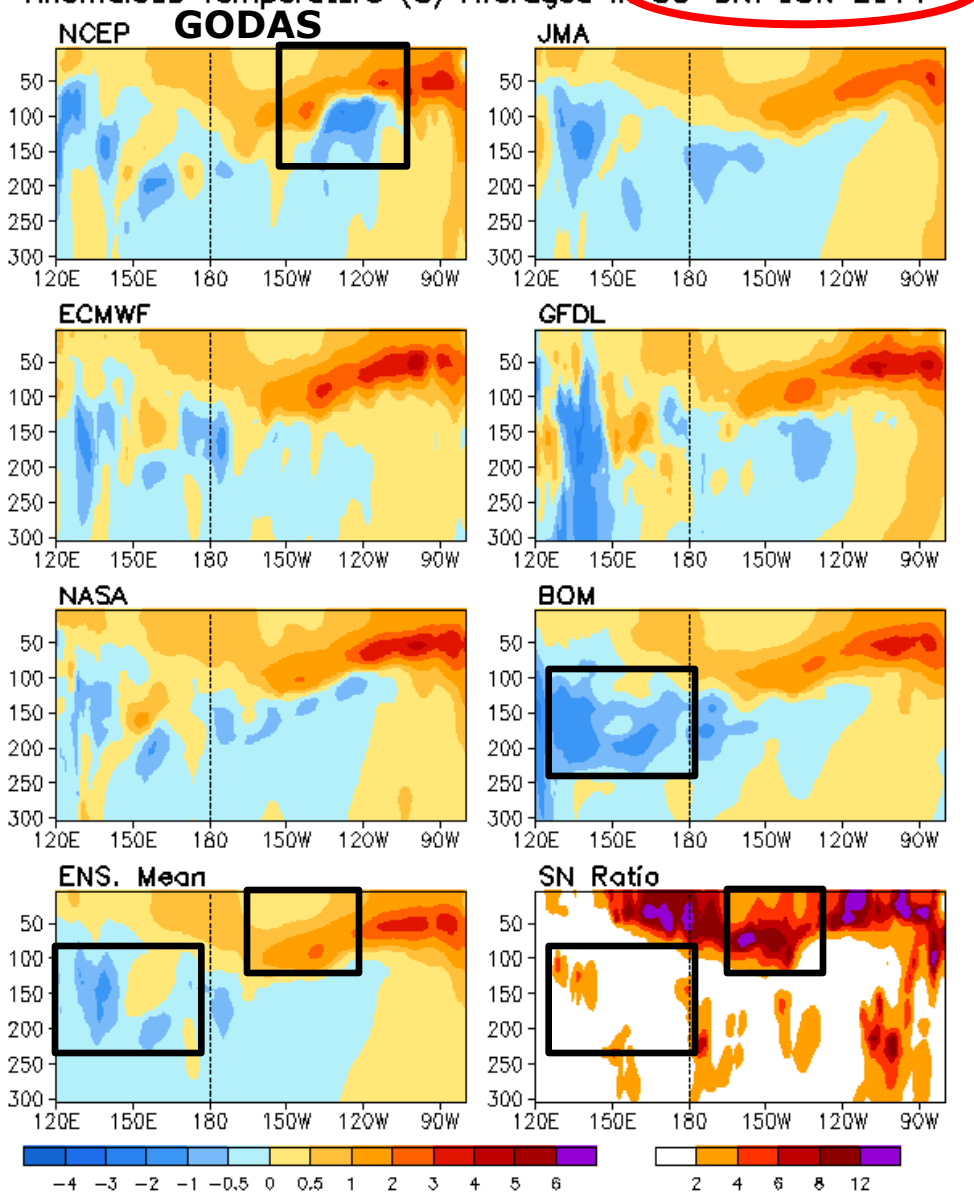
Variability of interannual signals: 0-100m steric vs sea level

Climate Observation Division

Historical TAO reporting + ship resourcing





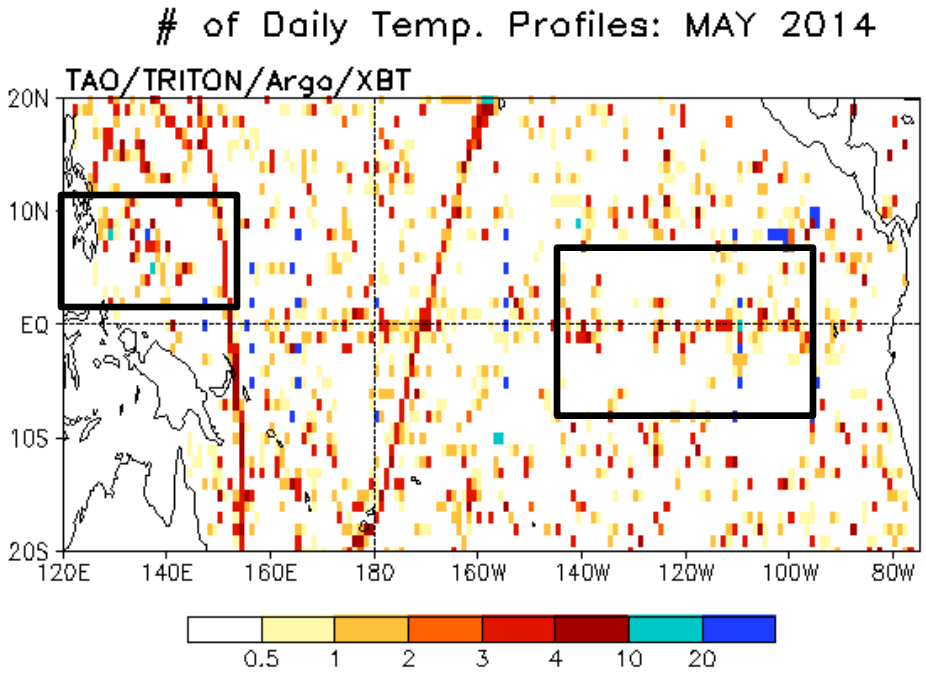


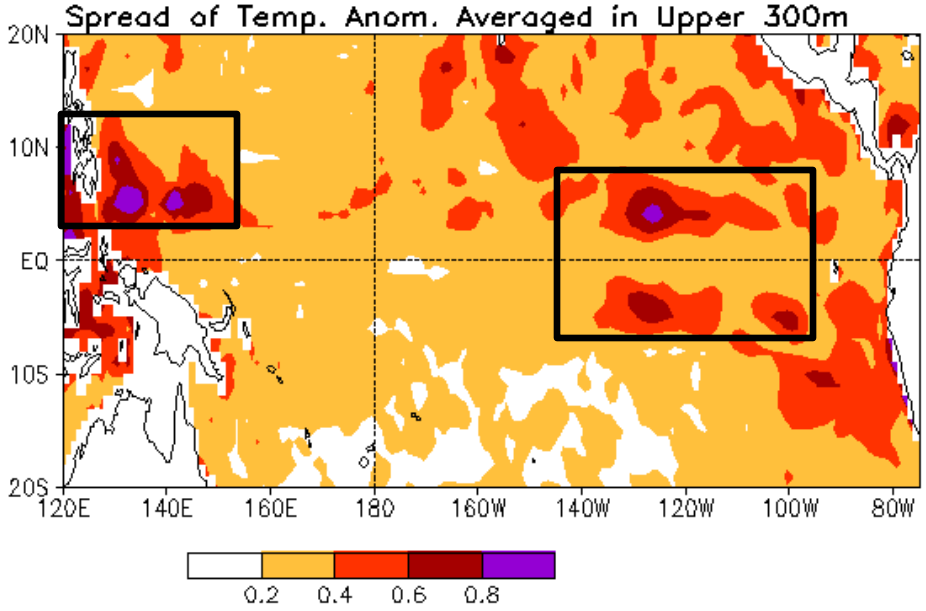
-The ensemble mean (ensemble spread) can be used to measure signal (noise).

- The signal-to-noise (SN) ratio is relatively low in the western (central-eastern) Pacific where negative (positive) anomalies presented.

- The low signal-to-noise ratio may be partially attributed to the sparse observations in those regions.

Courtesy of Yan Xue



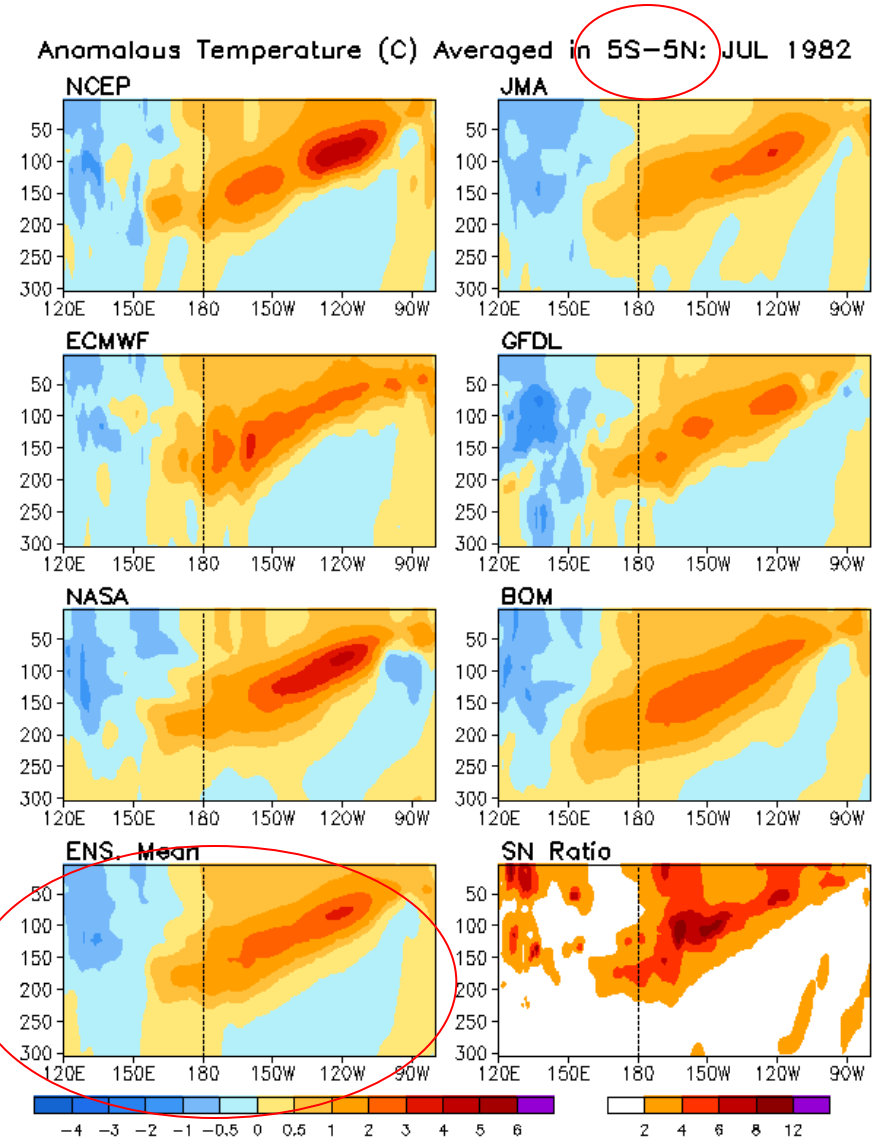


Influences of ocean observations on spread among ocean reanalyses

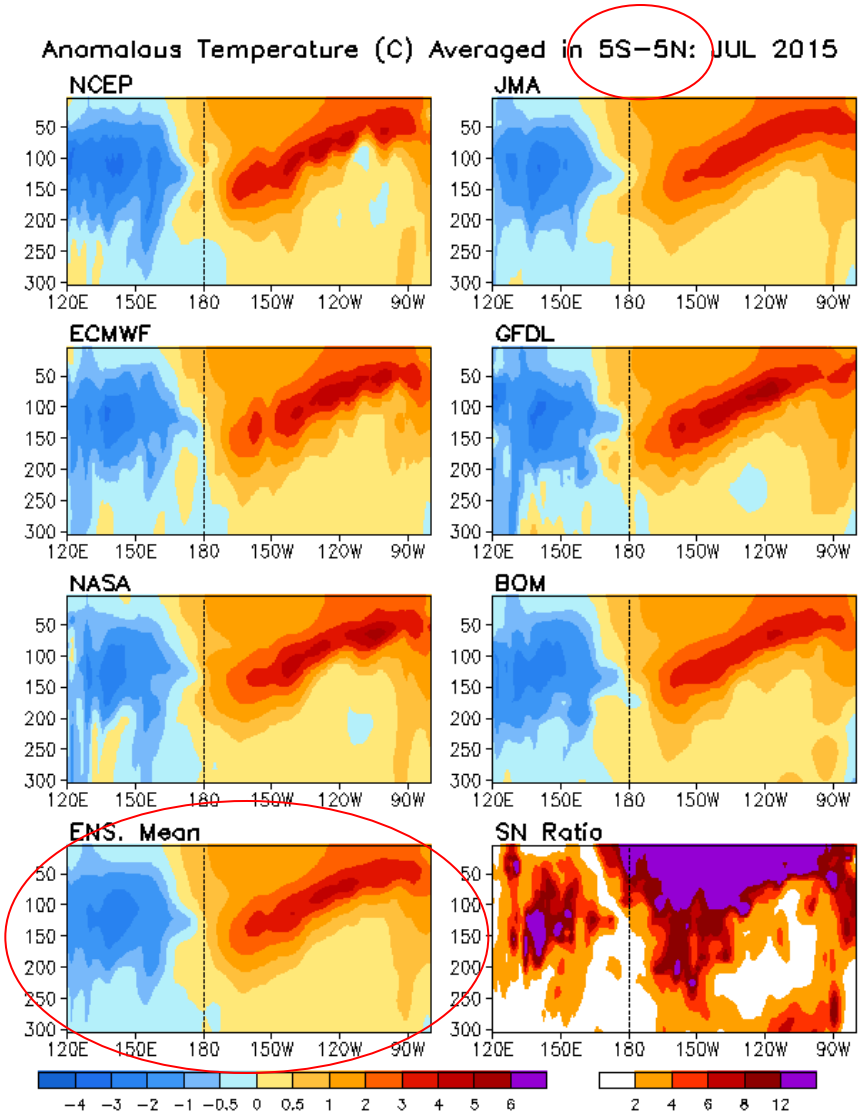
Courtesy of Yan Xue

Real-Time Multiple Ocean Reanalyses Intercomparison

Jul 1982



Jul 2015

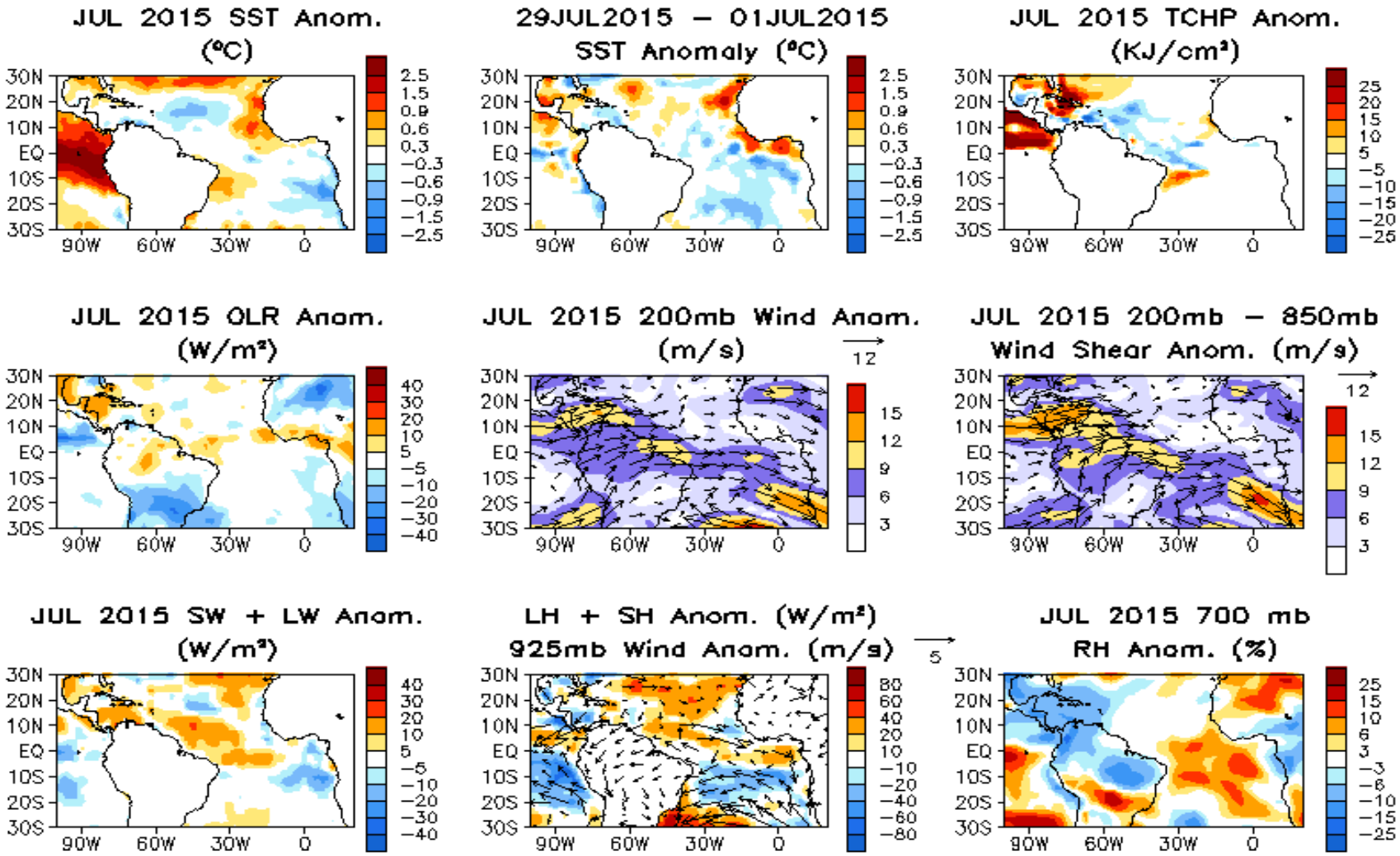


Courtesy of Yan Xue

(http://origin.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html)

Tropical Atlantic:

SST Anom., SST Anom. Tend., TCHP OLR, Sfc Flx, 925-mb/200-mb Winds and RH



- **Negative SSTA and TCHP continued in the hurricane Main Development Region (MDR) .**
- **Above-normal vertical wind shear was observed in MDR in July 2015.**

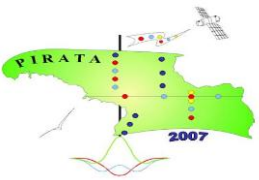
Courtesy of Yan Xue

July 2015 Ocean synthesis overview at NCEP

- **Pacific Ocean**
  - **El Niño conditions strengthened in July 2015 and the Nino34 index (+1.6° C) exceeded the threshold for a strong El Niño (>=1.5° C).**
  - **Most model predictions called for a strong El Niño through the Northern Hemisphere fall-winter 2015.**
  - **Upper ocean warming associated with the "Blob" has persisted since winter 2013/2014.**
  - **Positive PDO phase strengthened, with the PDO index increased from +0.7 to +1.5 in July.**

- **Indian Ocean**
  - **Positive SSTAs dominated the whole Indian Ocean.**

- **Atlantic Ocean**
  - **NAO switched to negative phase with NAOI = -3.1 in July.**
  - **NOAA's updated hurricane outlook called for 90% chance of below-normal Atlantic hurricane season.**



Concluding remarks

Institut de recherche pour le développement

Mercator Ocean
Ocean Forecasters

- PIRATA mooring data are used in real time by most ocean and seasonal forecast centres
- Tropical Atlantic is not correctly covered (Argo) and PIRATA offers the main source of T/S information at depth
- PIRATA data are key data to assess ocean forecast skill on daily basis

- At depth, ocean reanalyses T/S reliability depends strongly on PIRATA data: a lack of ship servicing like in the Tropical Pacific would impact more ocean estimates in the Atlantic (less Argo profiles)

- Ocean estimation monitoring are now in place in several operational centres, and international collaboration is now in place