

PIRATA: Some Operational Oceanography highlights

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

PIRATA areas of interest also key issues for ocean forecasting systems

- Cyclogenesis
- North Equatorial Current

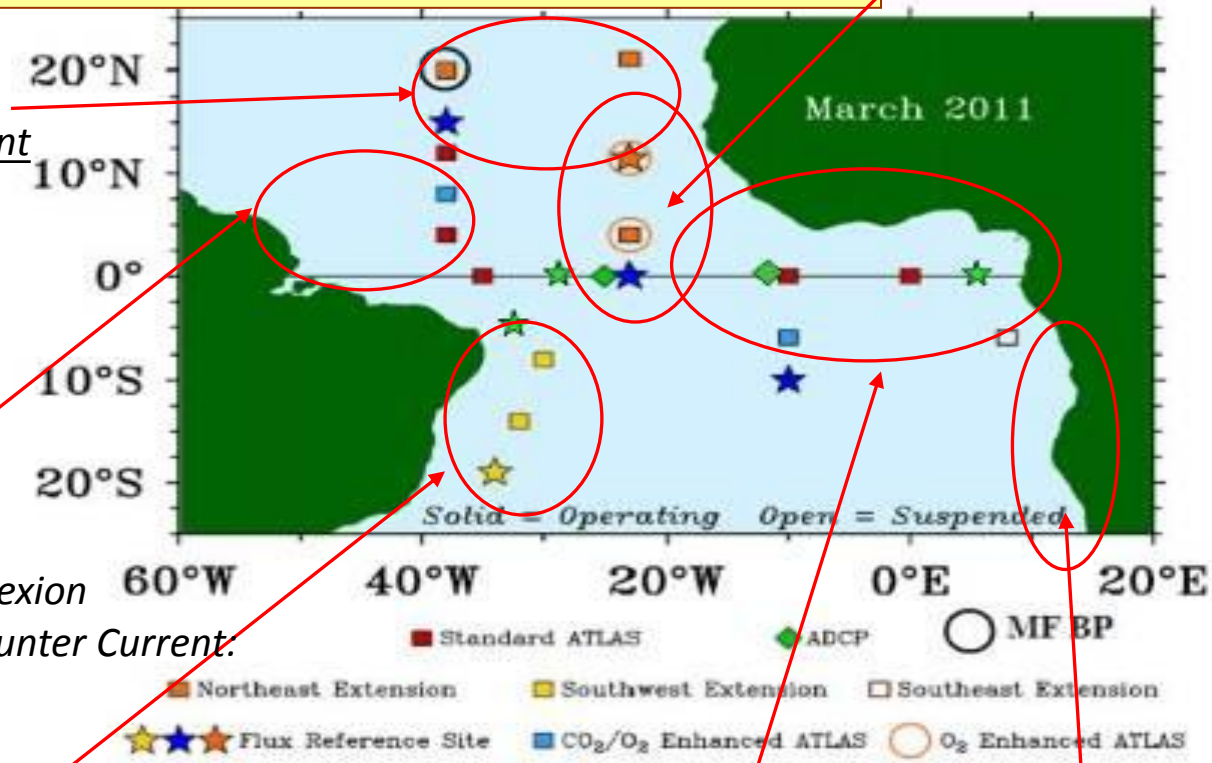
- Oxygen Minimum Zone
- NECC evolution

- North Brazil Current retroflexion into the North Equatorial Counter Current:
- Amazon 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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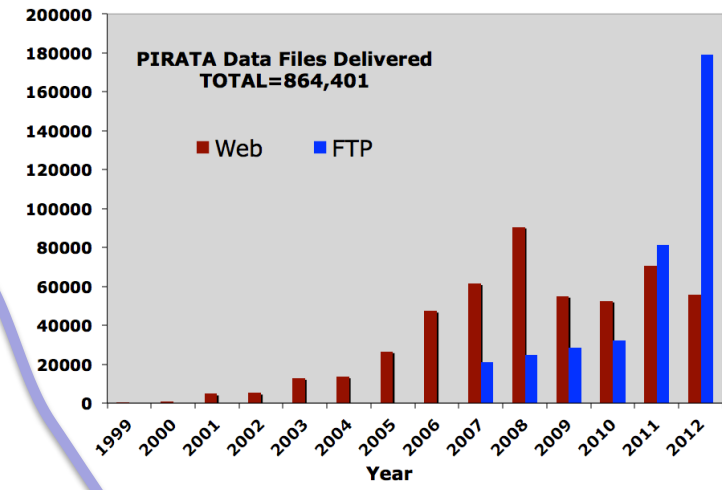
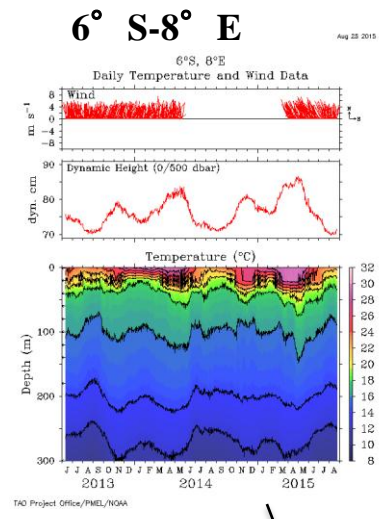
- Large Atlantic... From August 2013 to February 2014, PMEL scientists and staff...
- PMEL Contribute NOAA Arctic Program Leads, including PMEL scientist and Arctic expert Dr. [Name] in a paper published recently in Nature Geoscience
- New Study Links... For the first time, in a research article published January 19 in [Journal]

Climate Research

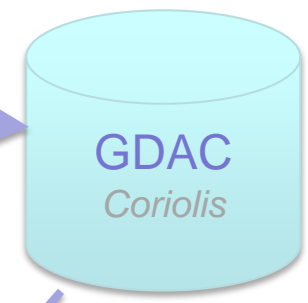
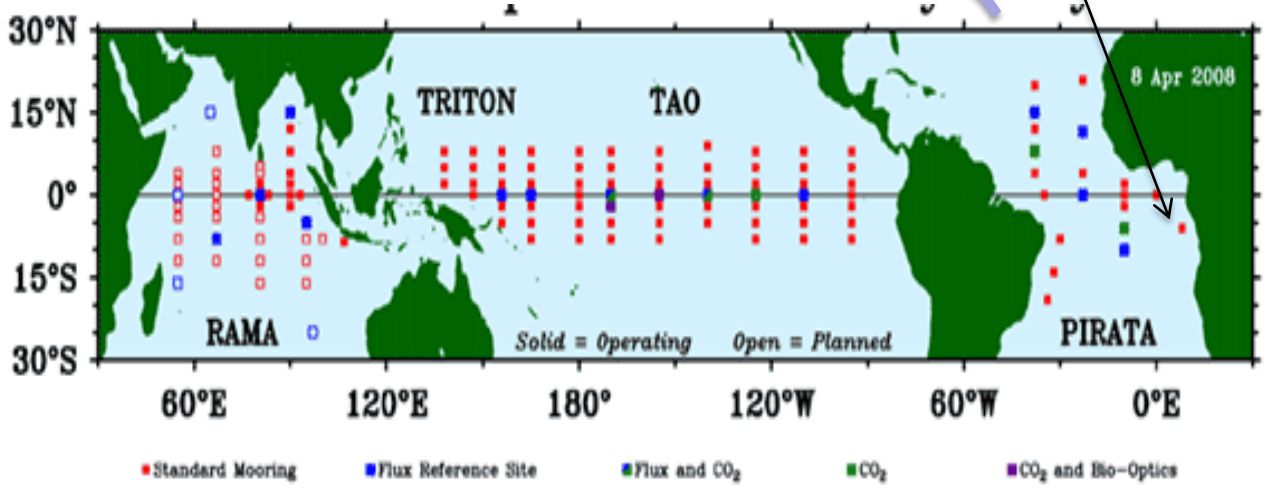
Climate research at PMEL is undertaken to support NOAA's mission to understand and predict changes in climate, weather, and the oceans. Our society is affected by recurring patterns of climate variability, by more secular global trends in ocean temperature and carbon, by as-yet poorly understood aspects of the global ocean circulation, and by the connections between the open ocean and our coastal oceans.

Climate Research Activities

Tropical Moored Buoy Array - The Global Tropical Moored Buoy Array is a



Real time daily averages





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Coriolis
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Data selection

Tip: click "Download" to ... download data, click "Refresh" if "Download" is not active, click "Hide observations" to save some time.

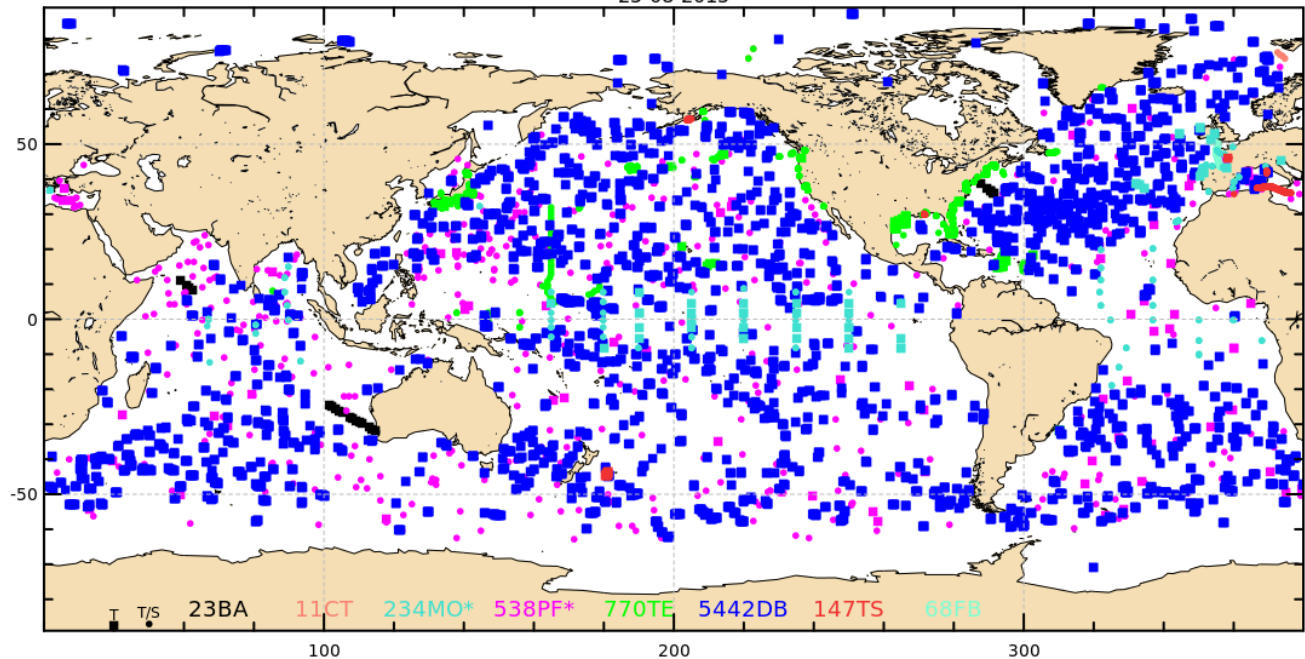
Refresh
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Data display
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Vertical profiles	Stations (185673)	Platforms (3533)	Times series	Platforms (5896)
<input type="checkbox"/> Argo profiles	18188	3579	<input type="checkbox"/> Argo trajectories	2376
<input type="checkbox"/> XBT profiles	1508	45	<input type="checkbox"/> Drifting buoy	2694
<input type="checkbox"/> CTD profiles	93	2	<input type="checkbox"/> TSG	41
<input type="checkbox"/> Glider profiles	3050	9	<input type="checkbox"/> Bubbles	0
<input type="checkbox"/> Sea mammal or Animal profiles	1672	37	<input type="checkbox"/> Fixed buoys & Mooring time series	787
<input checked="" type="checkbox"/> Fixed buoys and mooring profiles	138908	168	<input type="checkbox"/> Other time series & trajectories	0
<input type="checkbox"/> Other profiles	22254	93		

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

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

Type des profils T et T/S
25-08-2015



Few daily data in the
Tropical Atlantic



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Ocean Monitoring and Forecasting

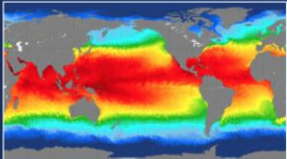


Ocean Forecasts

Provided by the [Mercator Ocean Operational Systems](#).

Daily Global Physical Bulletin 1/12°

(PSY4)

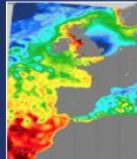


- Daily Global Physical Bulletin 1/12°
- Global coverage
- Physical variables
- 1/12° resolution
- Daily updated

Show Bulletin

Daily Iberian Biscay Irish Physical Bulletin 1/36°

(IBI36)

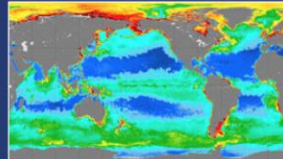


- Daily Regional Physical Bulletin 1/12°
- Regional coverage (Iberian Biscay Irish)
- Physical variables
- 1/36° resolution
- Daily updated

Show Bulletin

Weekly Global Biogeochemical Bulletin 1/4°

(BIOMER)



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

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LATEST NEWS FLASH

CMEMS:3026

Incident - OCEAN_COLOUR (GLO-ATL-BAL-EUR OC) Degraded! Resolved

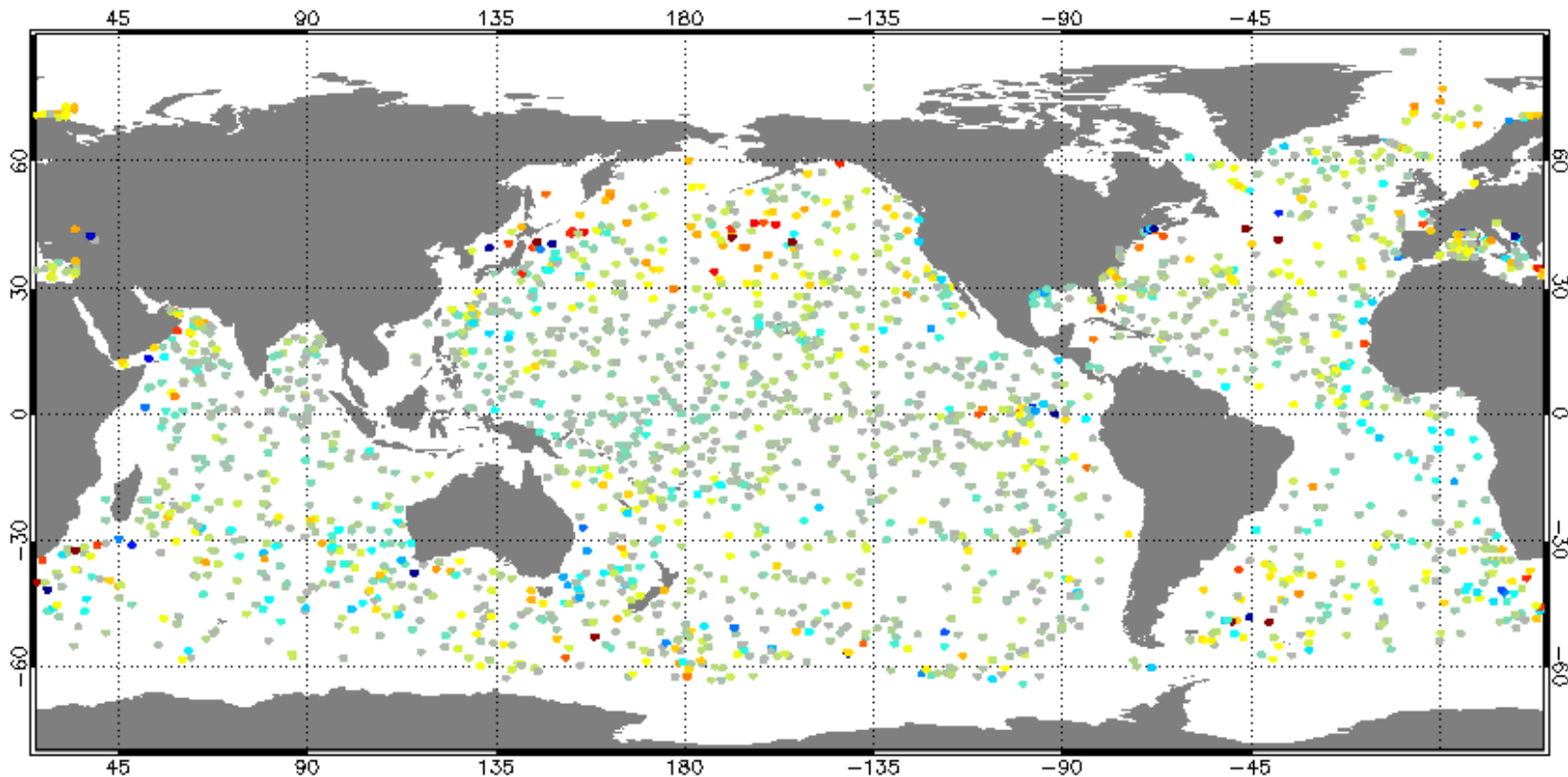
2015
17
AUG

ALL NEWS FLASH

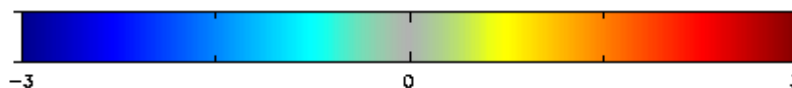


PIRATA and Operational Oceanography

guess temperature innovation : SOFATINO on 19-08-2015 near 0m



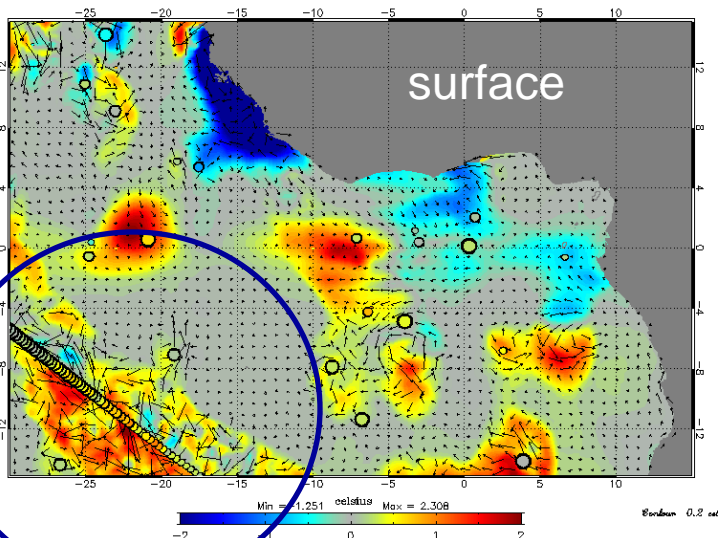
Temperature innovation: misfits between observation and model guess (or forecast)



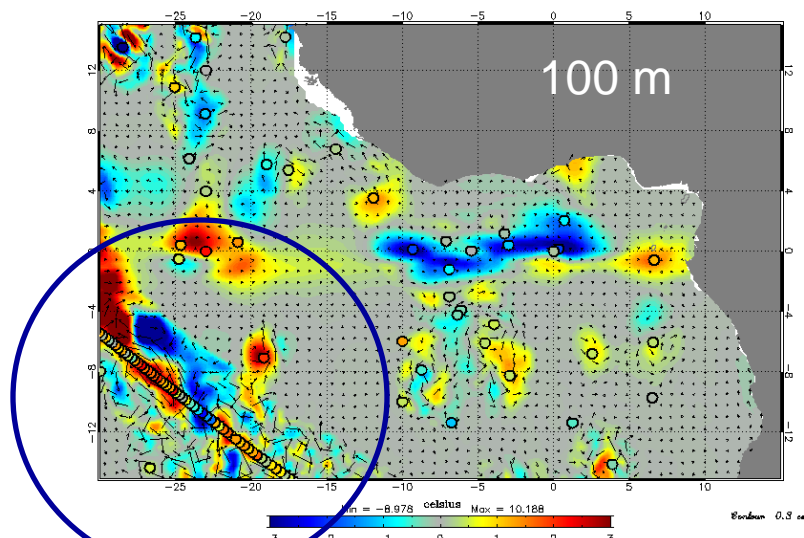


Assimilation impact of in situ data in the Tropical Atlantic

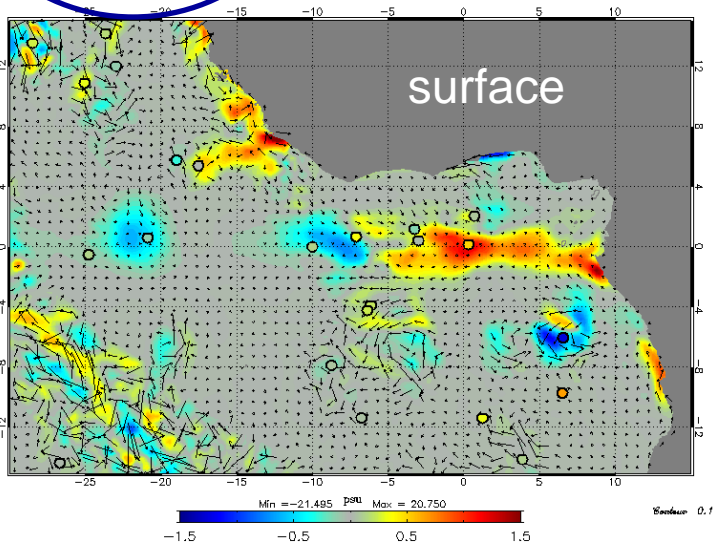
temperature and current increments on 20100210 near 0m



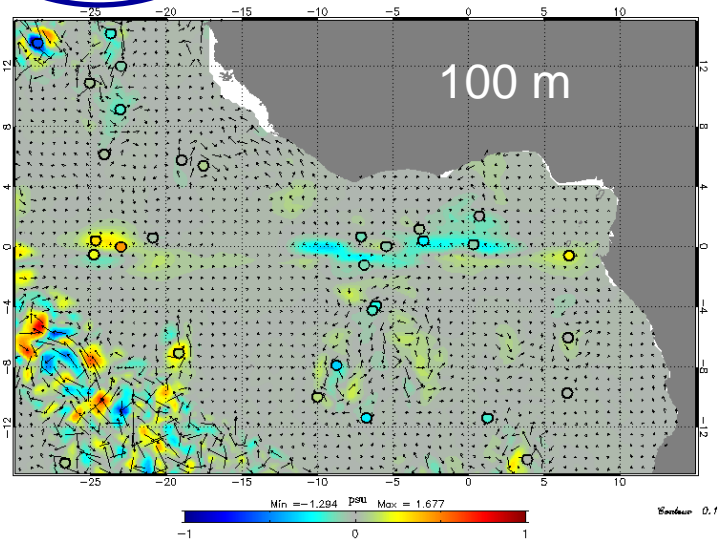
temperature and current increments on 20100210 near 92m



salinity and current increments on 20100210 near 0m



salinity and current increments on 20100210 near 92m

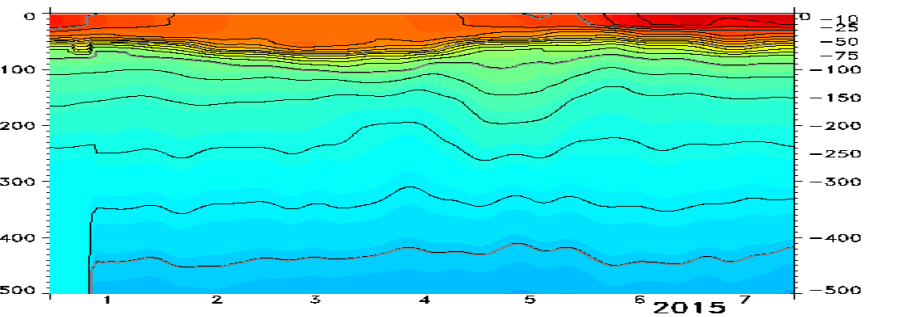




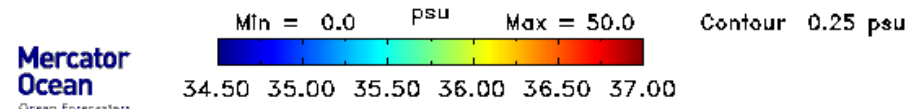
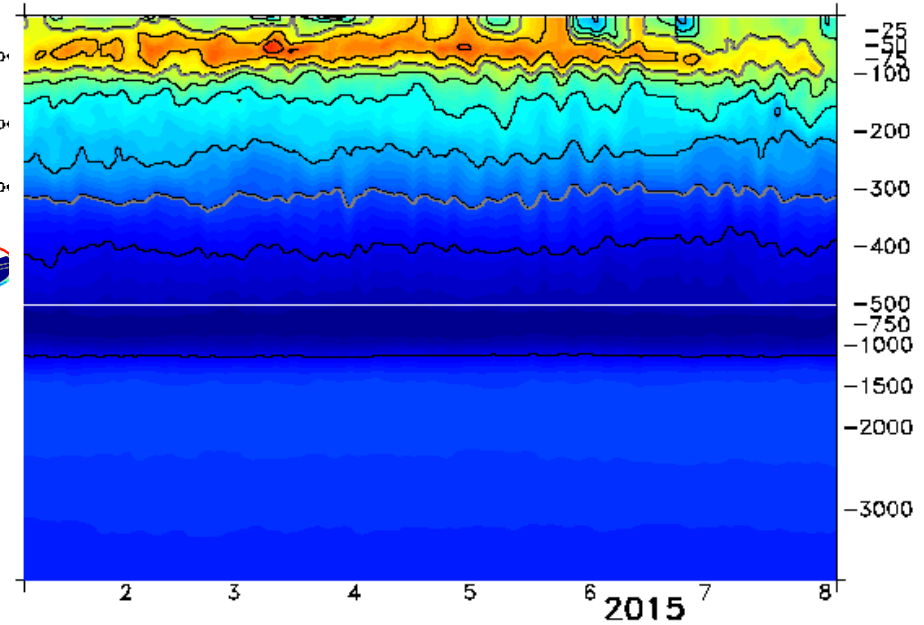
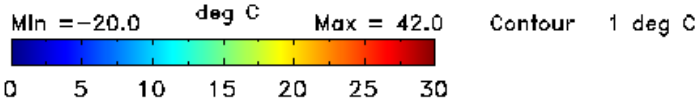
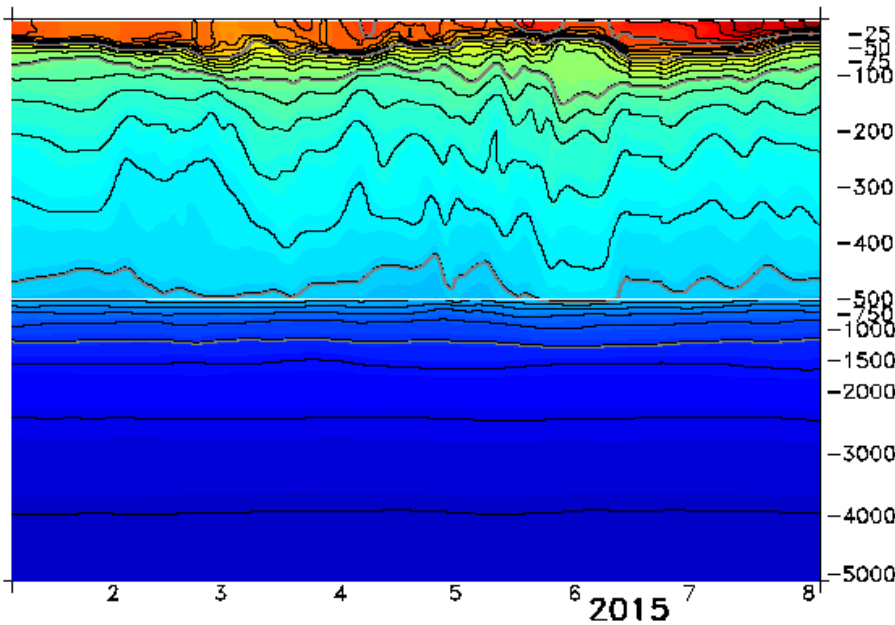
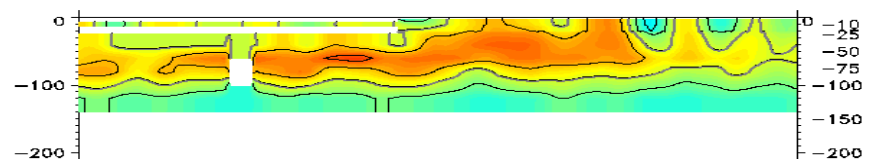
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Comparison between Mercator global 1/12° hindcast and PIRATA

Mooring : GL-201507-TS-MO-12n23w.nc lon = 11.53E lat = 22.99S
temperature



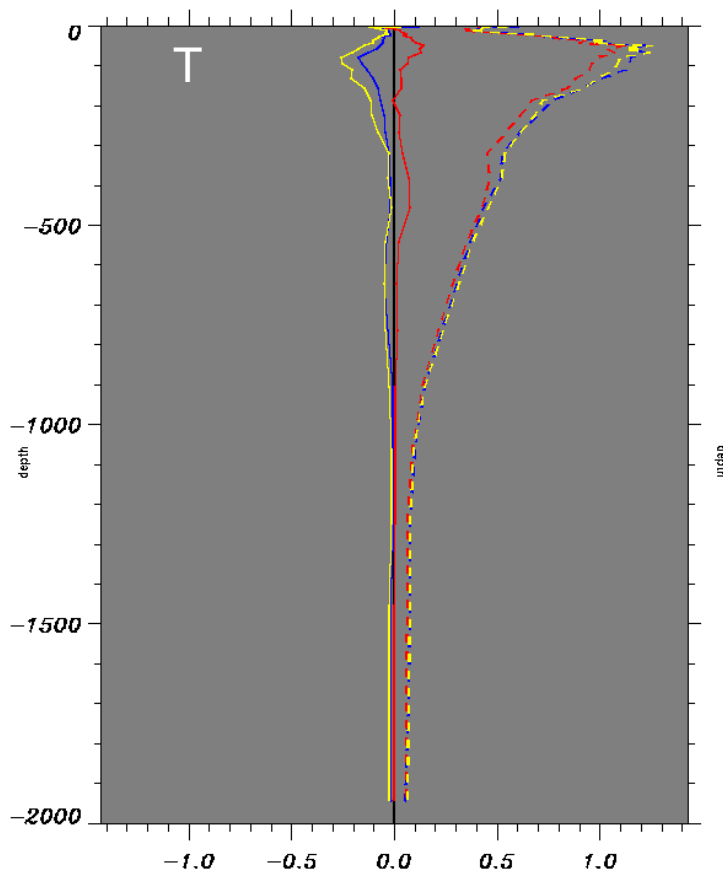
Mooring : GL-201507-TS-MO-0n23w.nc lon = 360.0E lat = 22.98S
salinity





PIRATA and Operational Oceanography

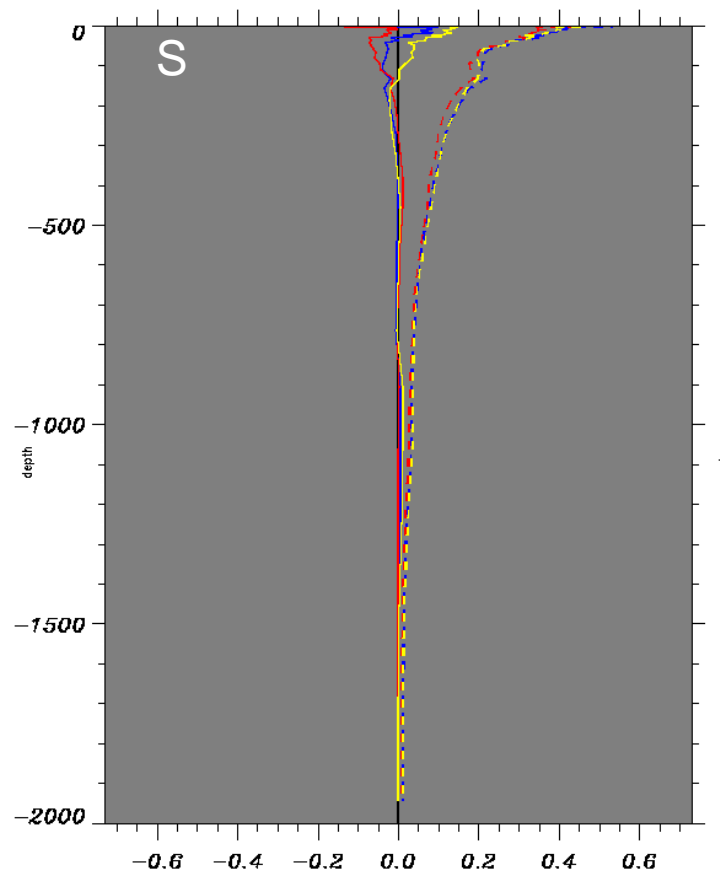
Quarterly systematic operational validation: OND 2014 misfits statistics among Mercator forecasting systems



PSY4V2R2
PSY2V4R4



PSY3V3R3



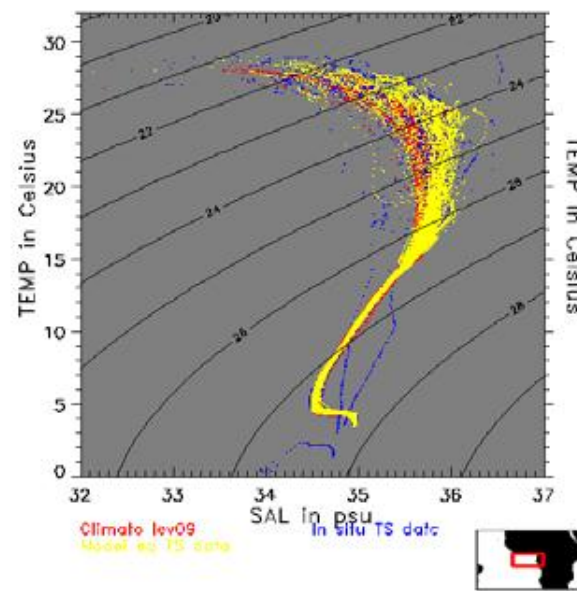
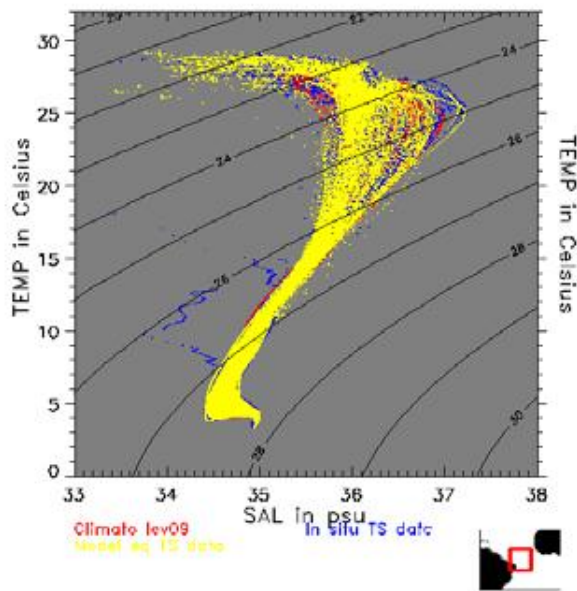
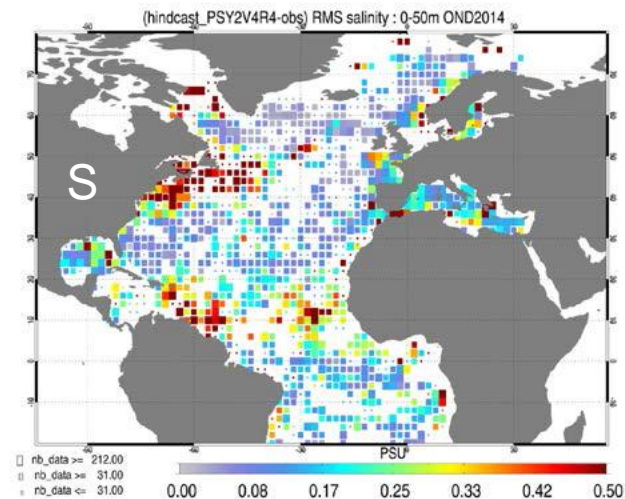
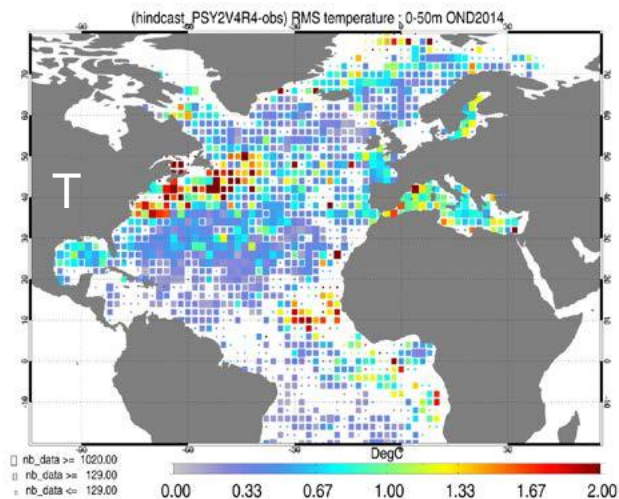
PSY4V2R2
PSY2V4R4

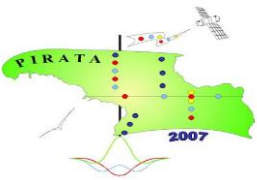


PSY3V3R3



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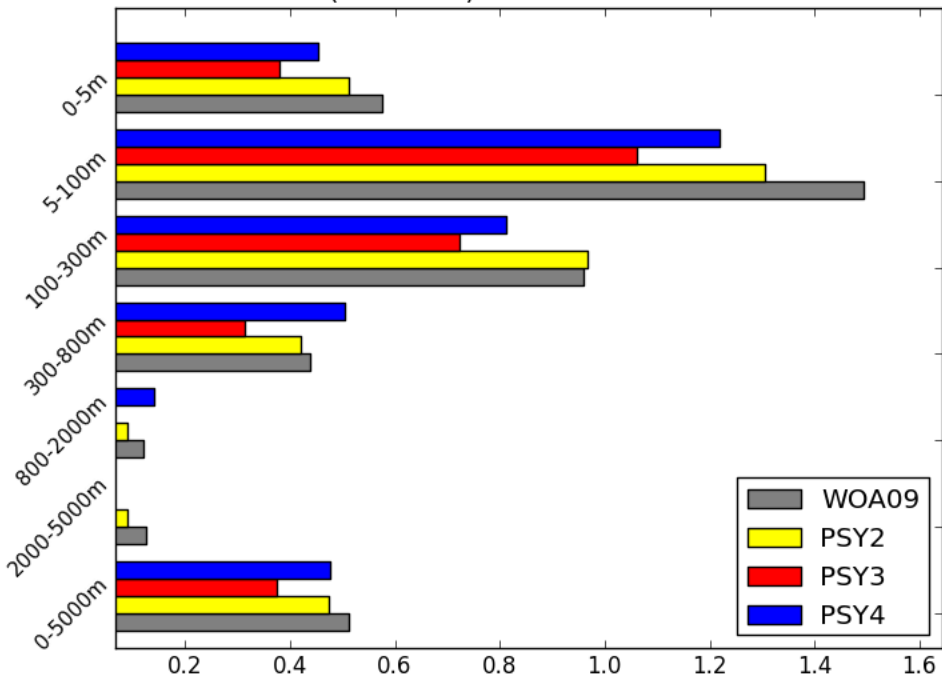




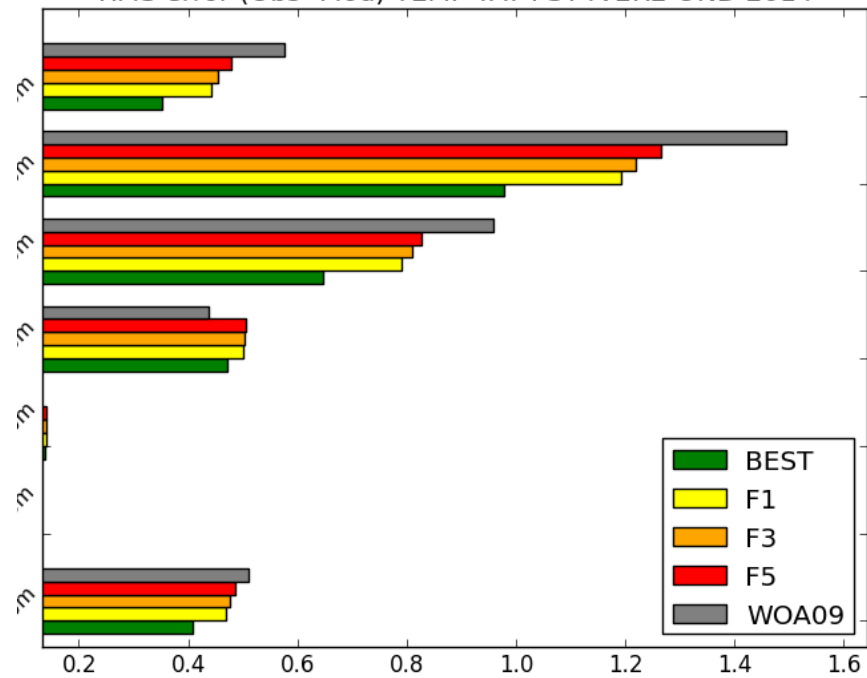
PIRATA and Operational Oceanography

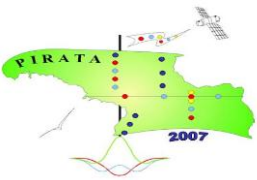
Forecasting skill monitoring by comparison to in-situ data

RMS error (Obs -Mod) FCST3D TEMP TAT OND 2014



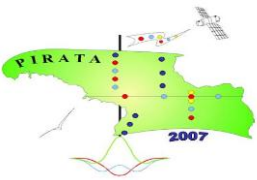
RMS error (Obs -Mod) TEMP TAT PSY4V2R2 OND 2014





PIRATA tropical moorings and impact on reanalyses and ocean estimation

- 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 exercise has been carried out recently: ORA-IP results under publication in Clim. Dyn.
- In operational mode, ocean estimation is carried on, and synthesized at NCEP



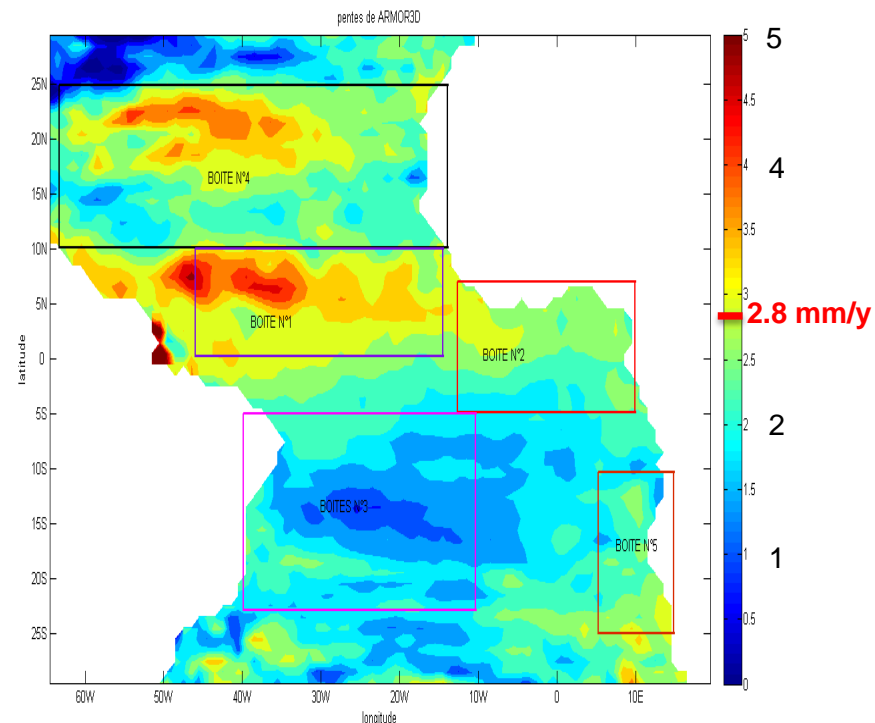
PIRATA tropical moorings and impact on reanalyses and ocean estimation

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

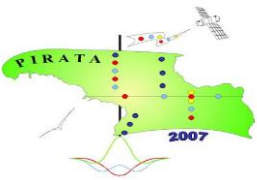


Tropical Atlantic Sea Level

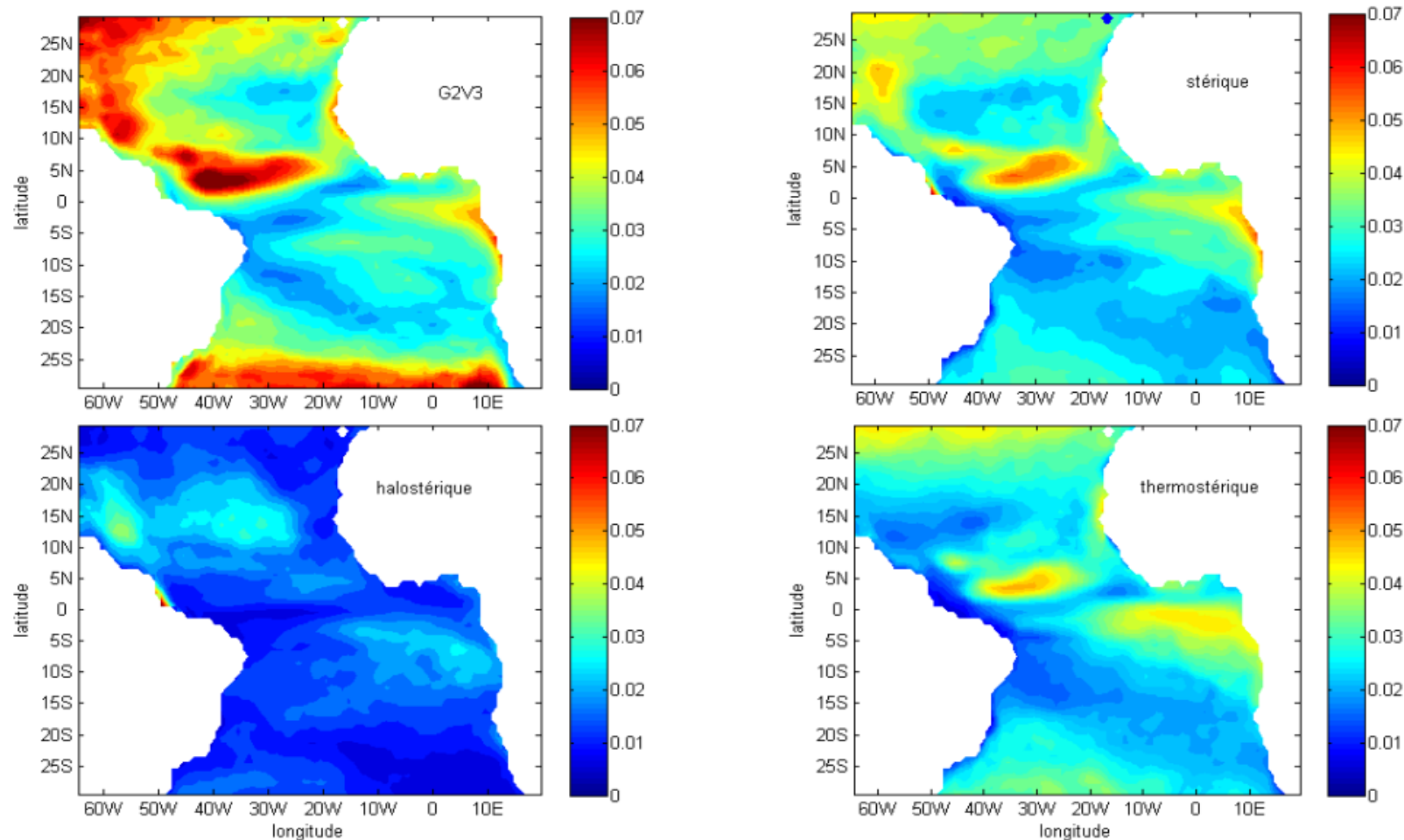
- Sea level trend assessment
- Definition of averaging boxes with consistent signals (SL index)
- Analysis of the seasonal and interannual variability
- Assessment against SL observed products / Tide Gauges
- **Assessment of the ensemble average**



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



Contribution of steric signals to SL

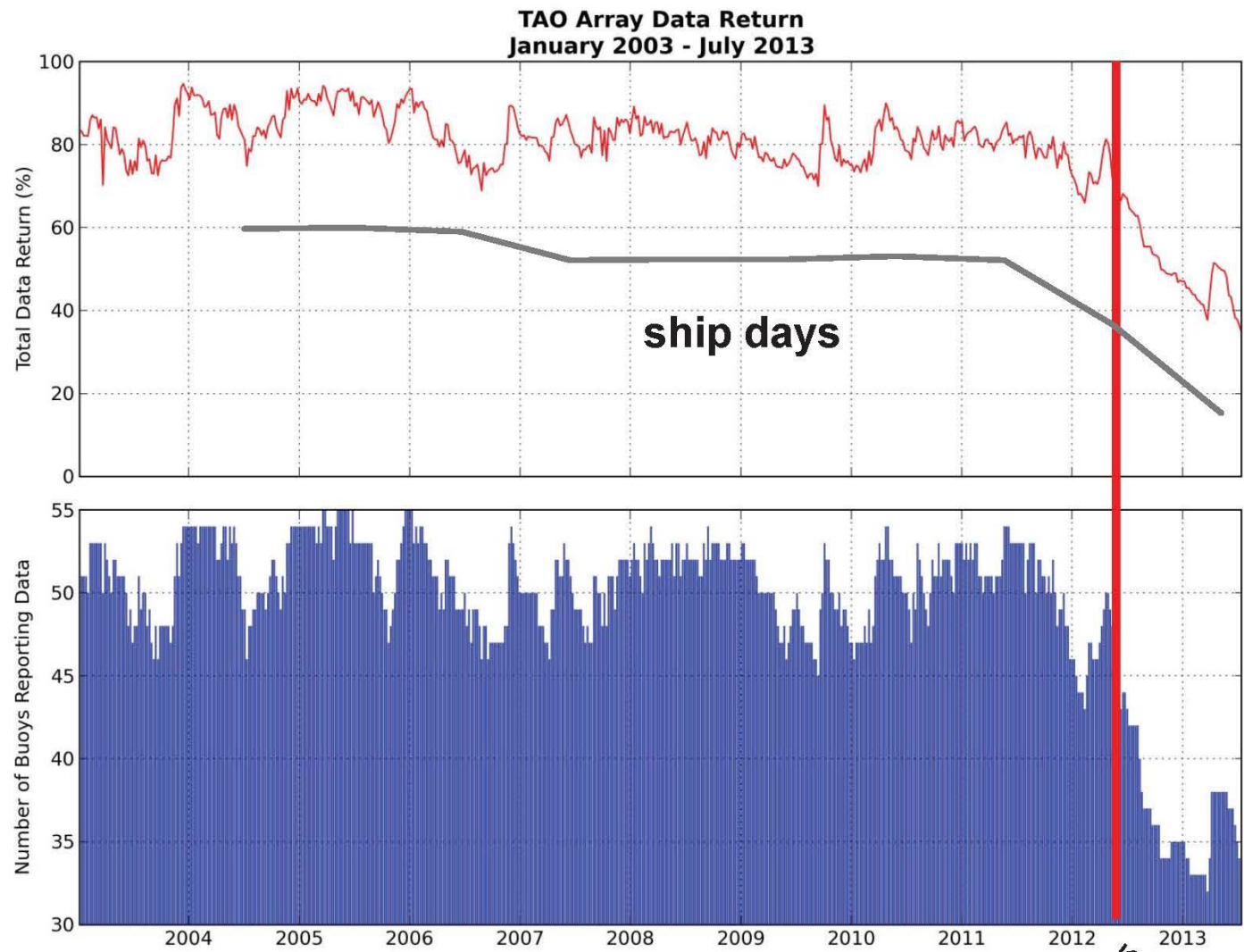


Variability of interannual signals: 0-100m steric vs sea level



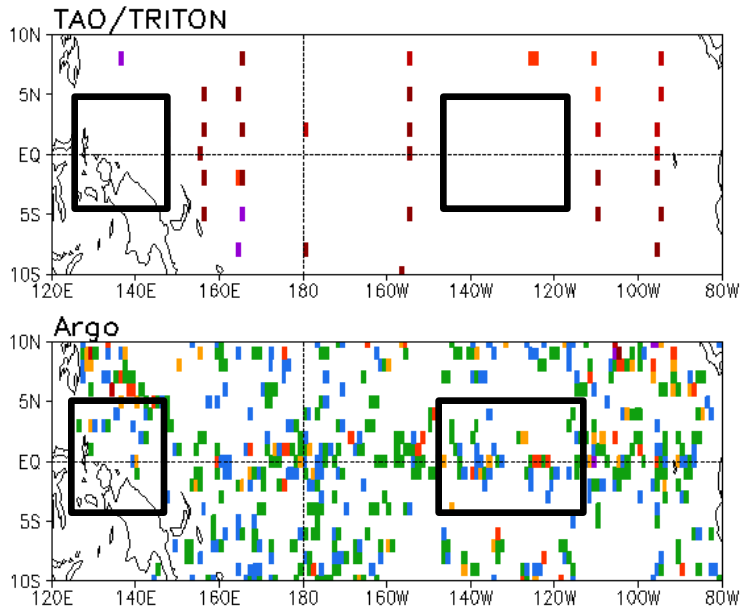
Climate Observation Division

Historical TAO reporting + ship resourcing



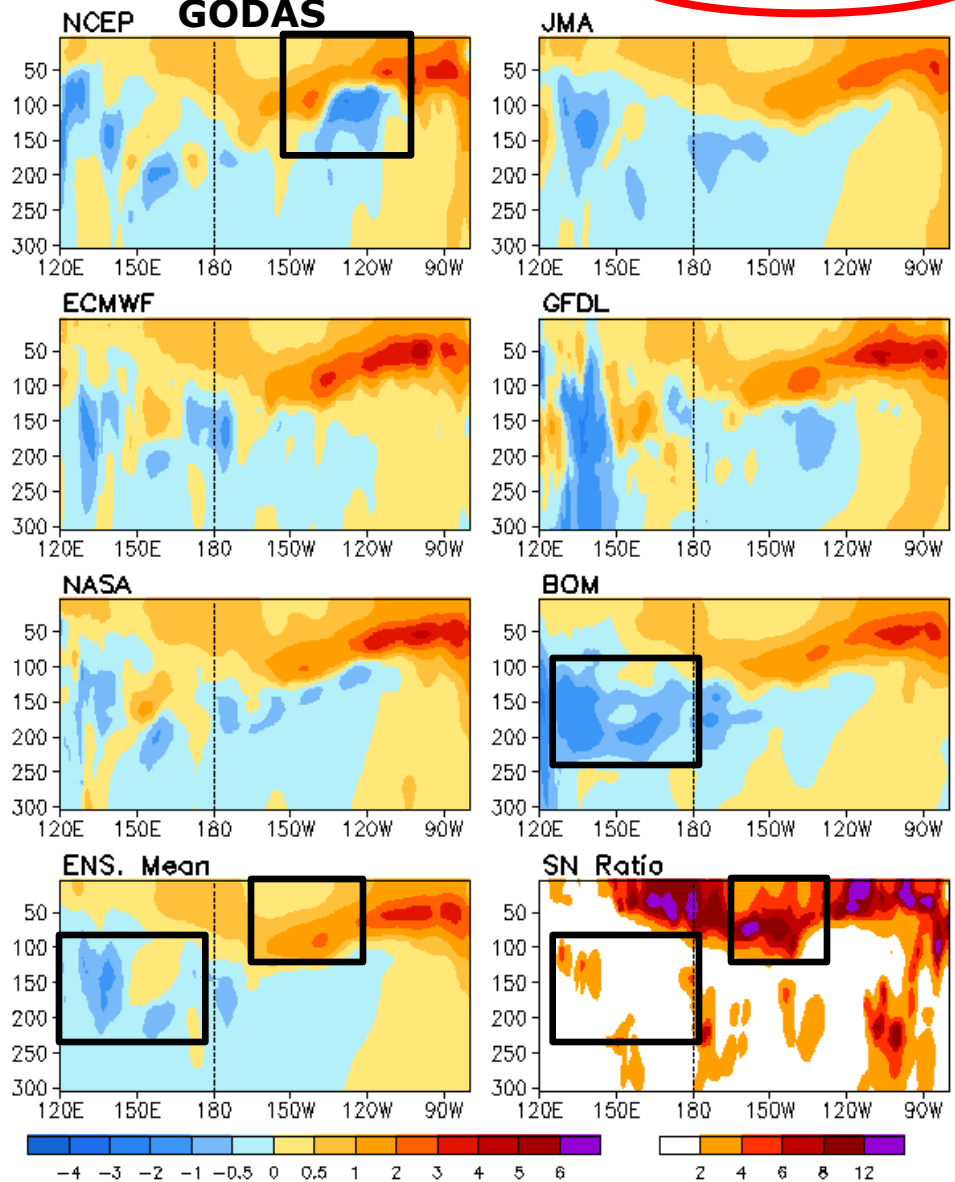
KA taken off-line

of Daily Temp. Profiles in JUN 2014

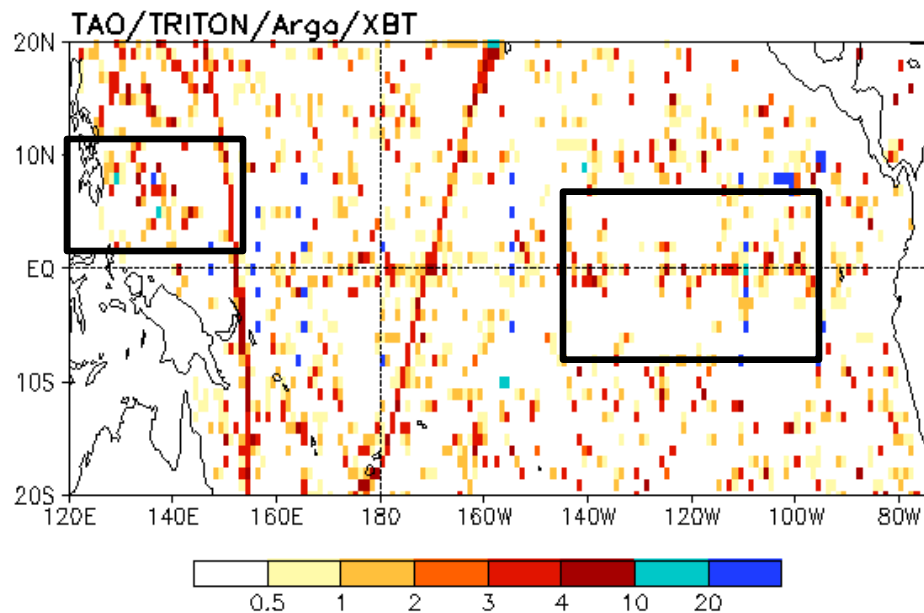


- The ensemble mean (ensemble spread) can be used to measure signal (noise).
- The signal-to-noise (SN) ratio is relatively low in the western (central-eastern) Pacific where negative (positive) anomalies presented.
- The low signal-to-noise ratio may be partially attributed to the sparse observations in those regions.

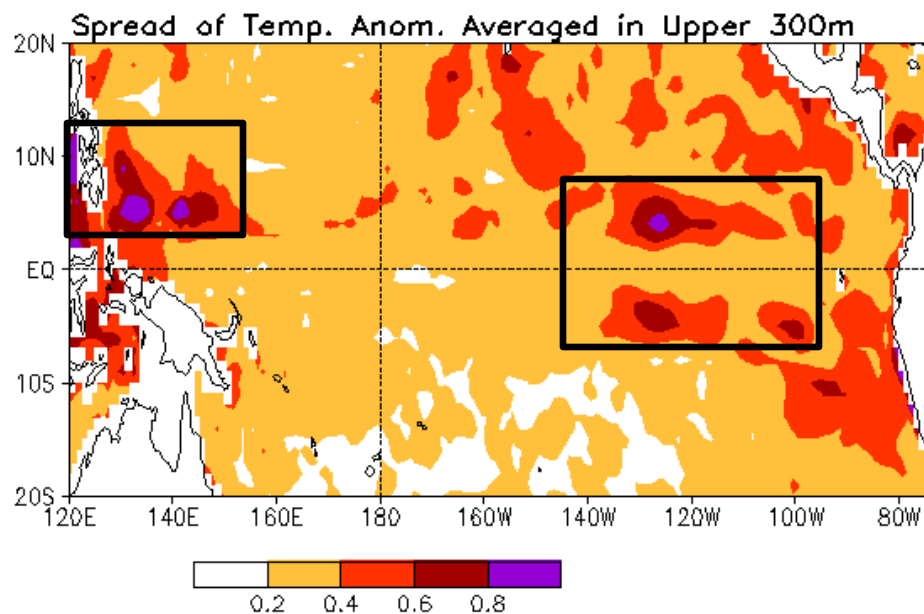
Anomalous Temperature (C) Averaged in 5S-5N: JUN 2014



of Daily Temp. Profiles: MAY 2014



Influences of ocean observations on spread among ocean reanalyses



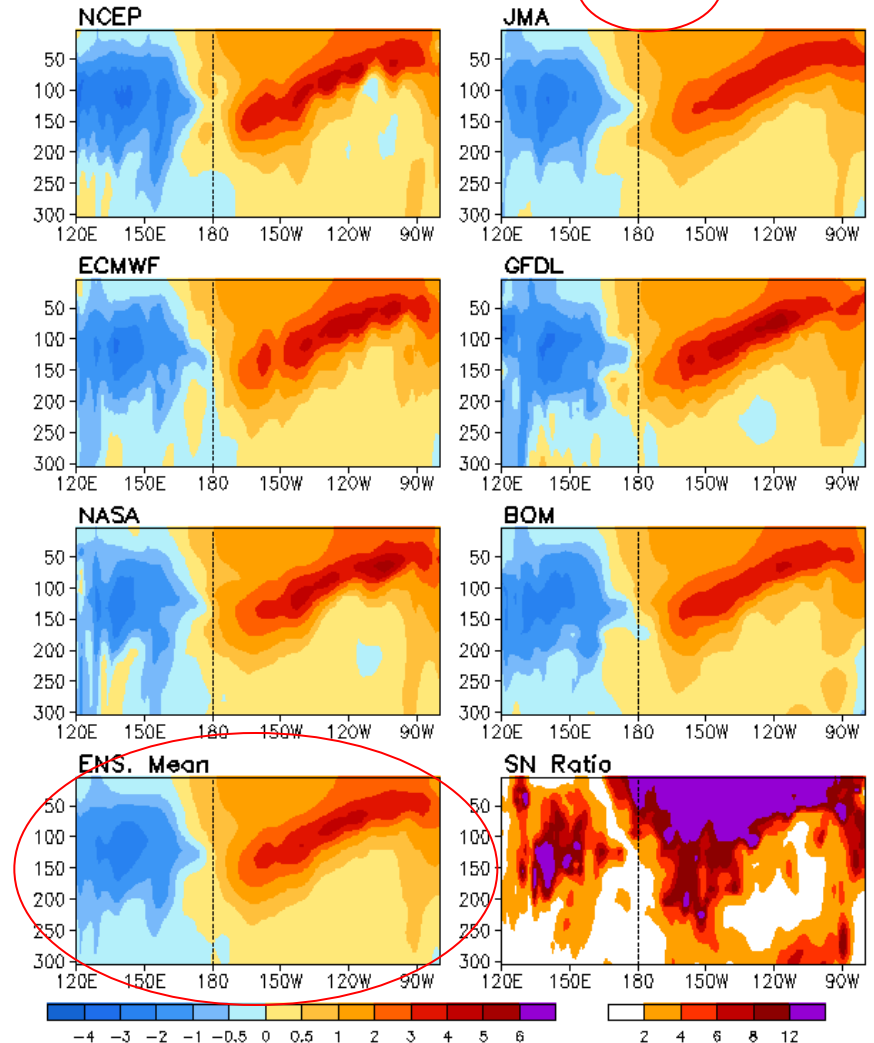
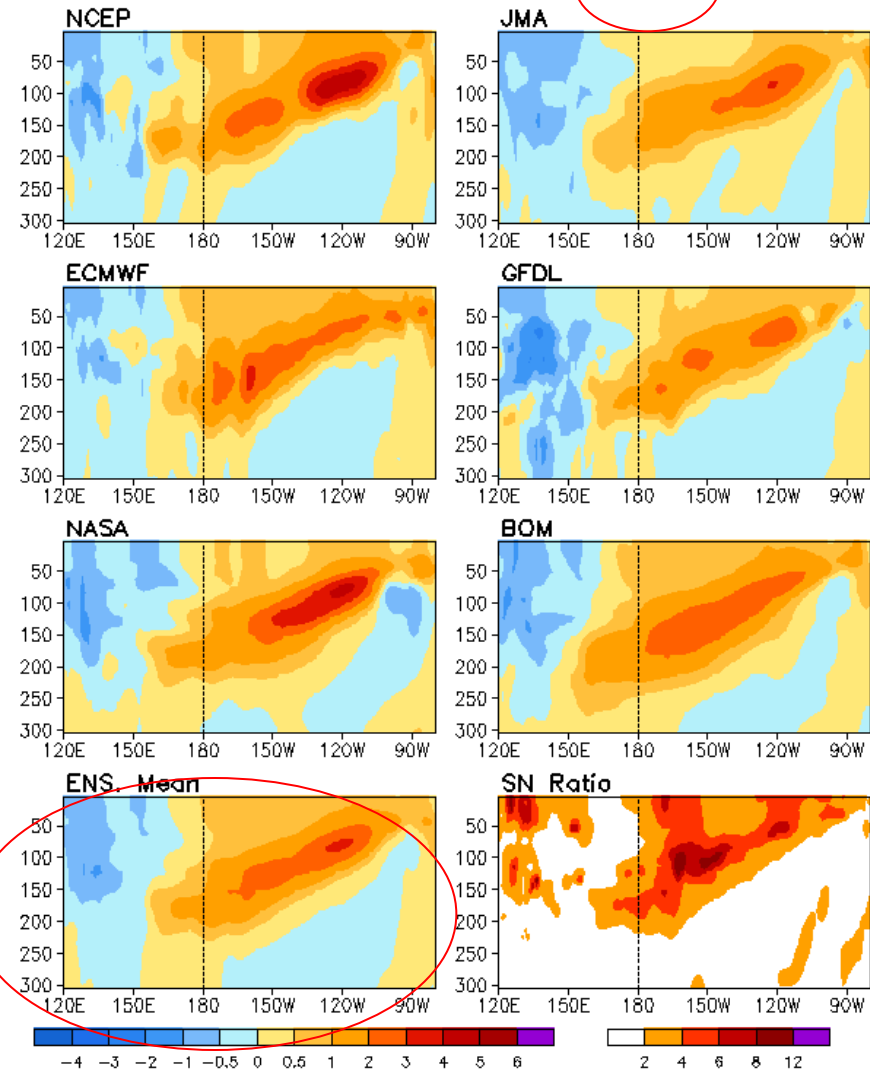
Real-Time Multiple Ocean Reanalyses Intercomparison

Jul 1982

Jul 2015

Anomalous Temperature (C) Averaged in 5S-5N: JUL 1982

Anomalous Temperature (C) Averaged in 5S-5N: JUL 2015

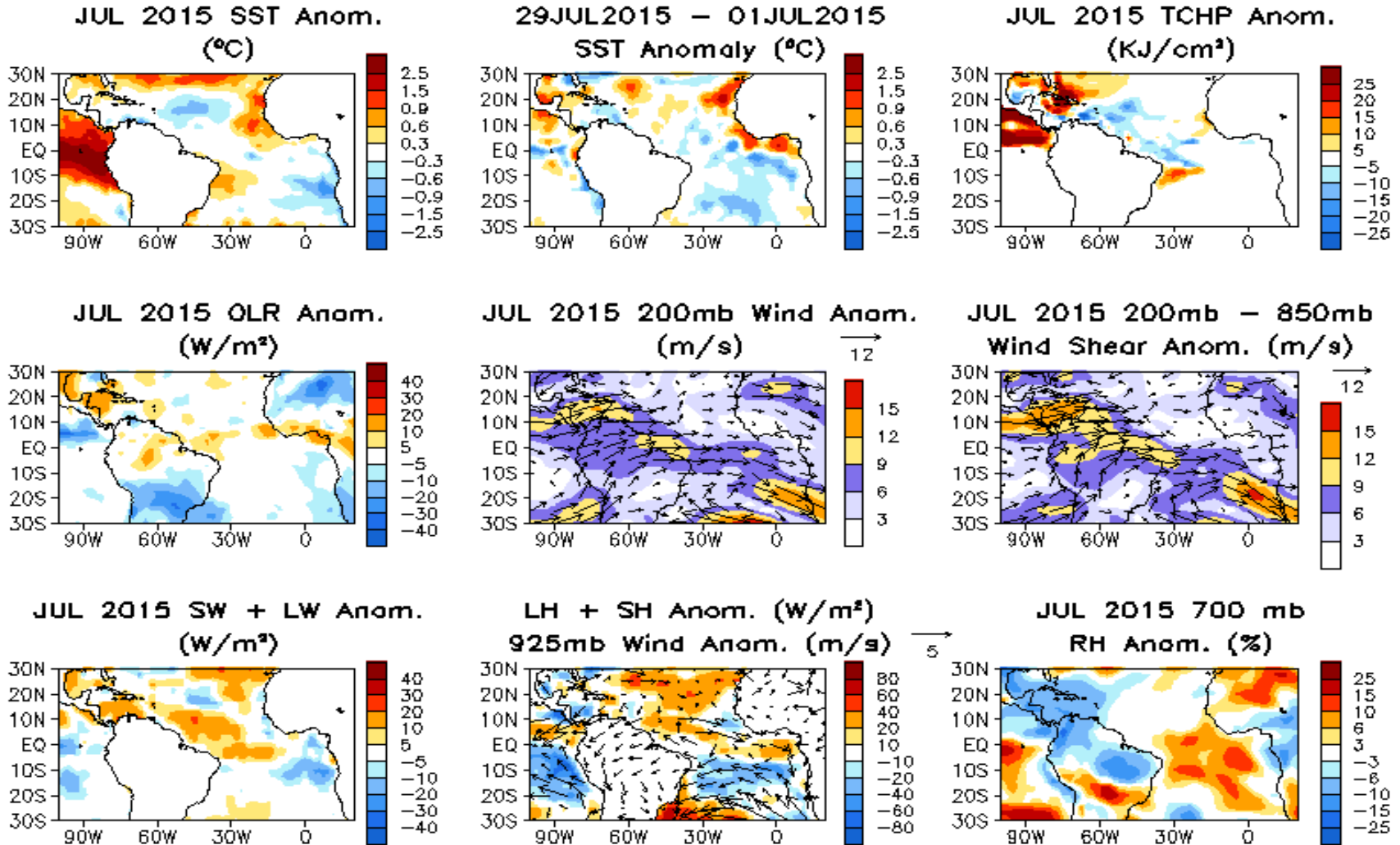


Courtesy of Yan Xue

(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 ($\geq 1.5^\circ$ 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

- 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