3.1 Operational SI Climate Forecasting Data Requirements: Timeliness, Distribution, Types, QC

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2nd IQuOD Workshop
June 4, 2014
Silver Spring, MD

Outline

- Operational Constraints
- Caveats
- Ocean Climate Data Assimilation at NCEP
- Performance Metric
- Distribution of Observations
- Impact of Argo
- QC
- Some Current and Future Concerns

Operational Constraints

- Models run daily. Observations must be available in near real-time.
- The servers providing observations must themselves be operational.
- The communications must also be operational. The GTS is preferred for ocean observations.
- Observations should be in preferred formats: BUFR, GRIB, NetCDF.
- All components of an operational system must be supported within the center.

Caveats:

- Delayed mode observations are also valuable for system development, retrospective analyses, hindcasts, validation, and OSE's.
- NCEP has in the past acquired TAO data from a PMEL FTP server, but the use of an FTP server is unlikely to happen again.

Ocean Climate Data Assimilation at NCEP

Global Ocean Data Assimilation System (GODAS)

- MOM3 at 1^ox1^o ($1/3^o$ within 10^o of the equator), 40 levels.
- Originally the ocean component of CFSv1.
- Currently a stand-alone forced by surface fluxes from the NCEP-DOE Reanalysis 2.
- 3DVAR data assimilation system analyzing temperature and salinity.
- XBTs, CTDs, TAO, TRITON, PIRATA, RAMA, Argo, gliders, SST, SSS, SSH (TPX/JSN)

Coupled Forecast System 2 (CFSv2)

- MOM4 at $1/2^o$x$1/2^o$ ($1/4^o$ within 10^o of the equator), 40 levels.
- Ocean component of CFSv2.
- 3DVAR data assimilation system analyzing temperature and salinity.
- XBTs, CTDs, TAO, TRITON, PIRATA, RAMA, Argo, gliders, SST, SSS, SSH (TPX/JSN)

HC300 in Operational Analyses

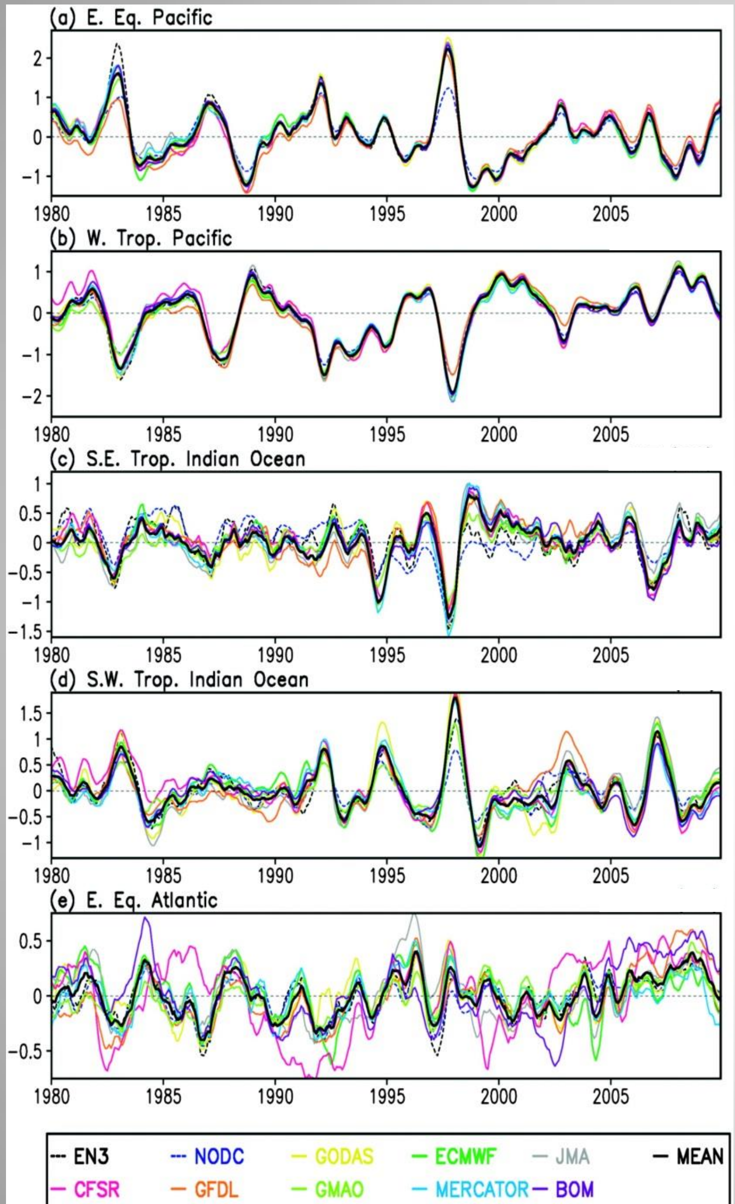
E.Eq.Pac.

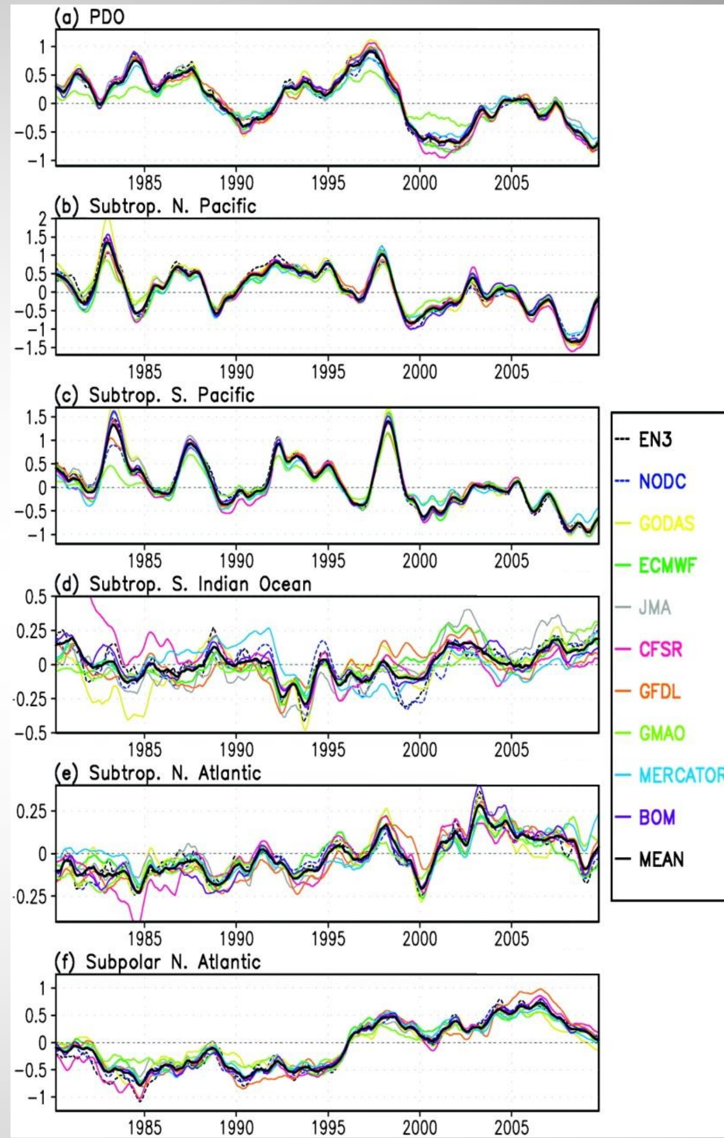
W.Eq.Pac.

S.E.Trop. Ind.Ocn.

S.W.Trop. Ind.Ocn.

E.Eq.Atl.





N.Cent. Pac.

Subtrop. N.Pac.

Subtrop. S.Pac.

Subtrop. S.Ind.Ocn.

Subtrop. N.Atl.

Subpolar N.Atl.

Xue et al., J. Clim., 2012

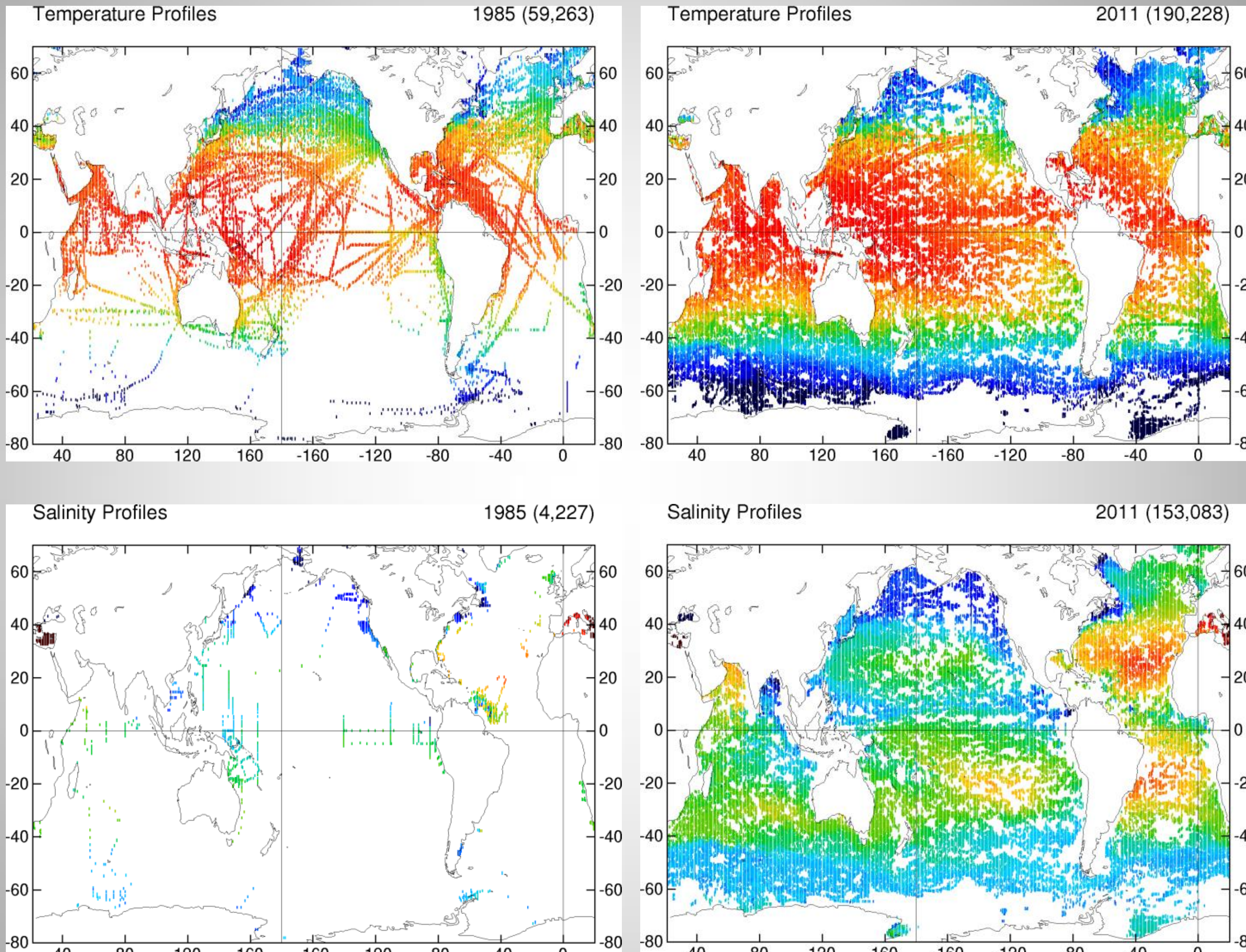
The Distribution of Observations

- For Seasonal-to-Interannual forecasting we clearly want a strong analysis in the tropical Pacific Ocean, but because our forecasts are global we also need a good global analysis.
- Over the years the global observing system has changed dramatically in its geographical distribution and in the depth of the ocean that is sampled.
- Where we formerly relied on a robust array of tropical moored buoys and a network XBT tracks, we now rely on the global Argo array and a moored buoy challenged by budgetary restrictions.

Annual Distribution of Observed Profiles

Temperature

Salinity

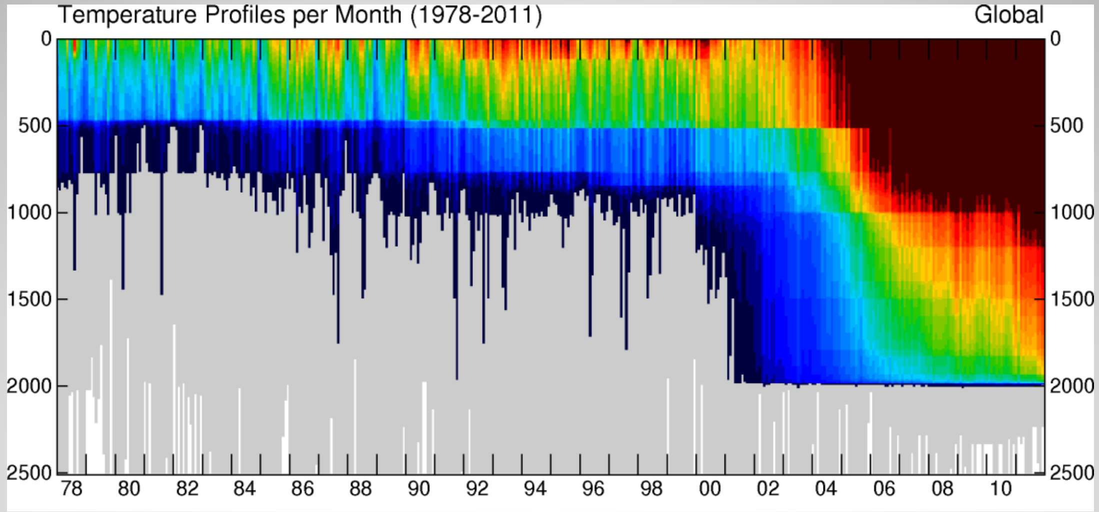


1985

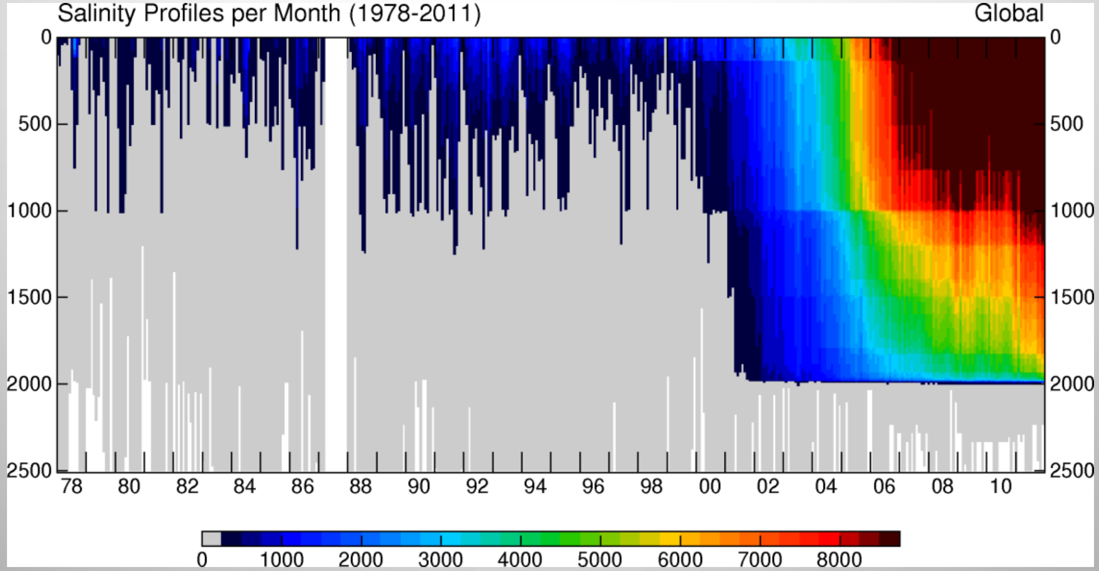
2011

Vertical Distribution of Global Profile Observations per Month 1978-2011

Temperature



Salinity



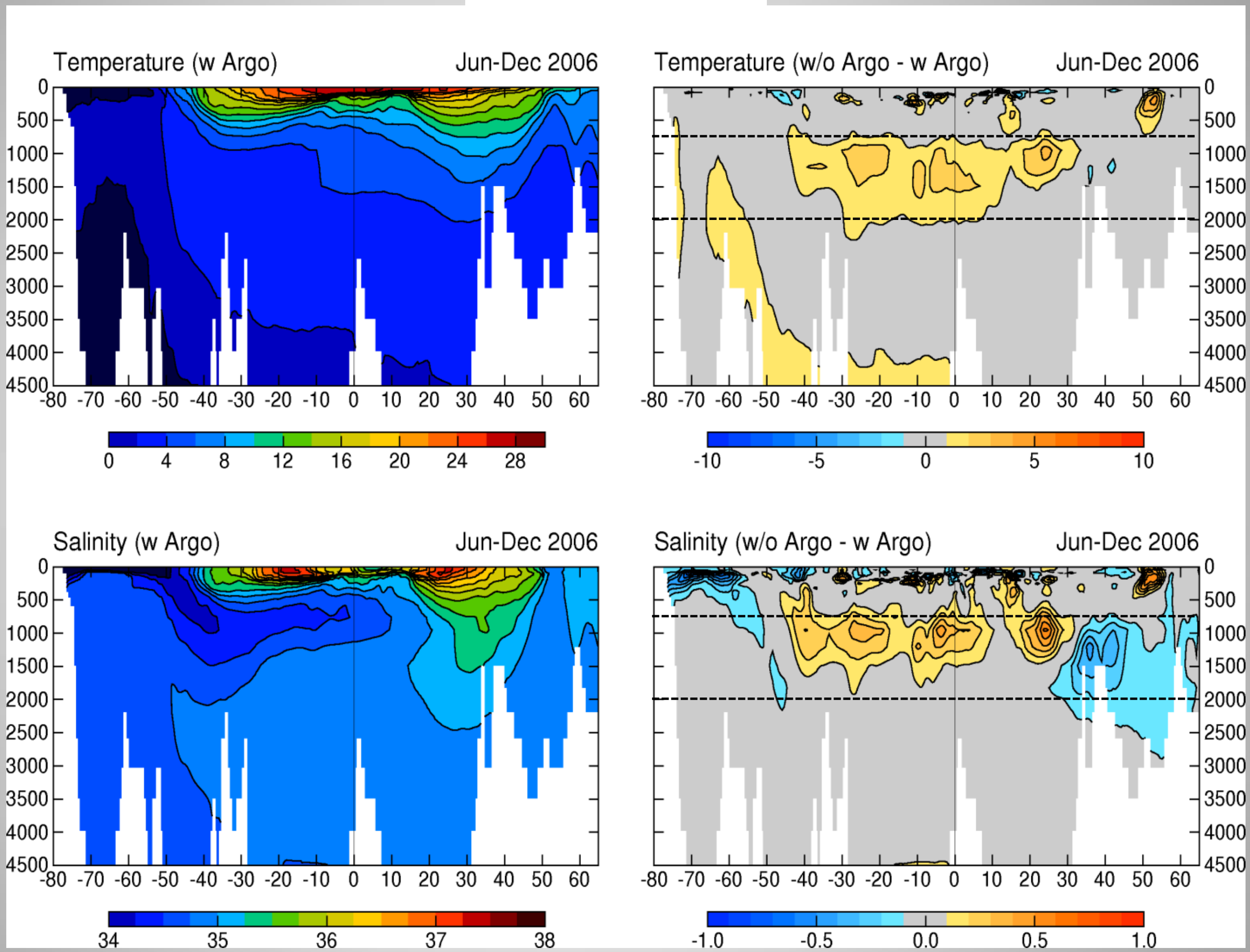
The Impact of Argo

- A deeper data assimilation.
- Argo Salinity vs Synthetic Salinity

Atlantic 30°W Section Jun-Dec 2006

Temperature

Salinity



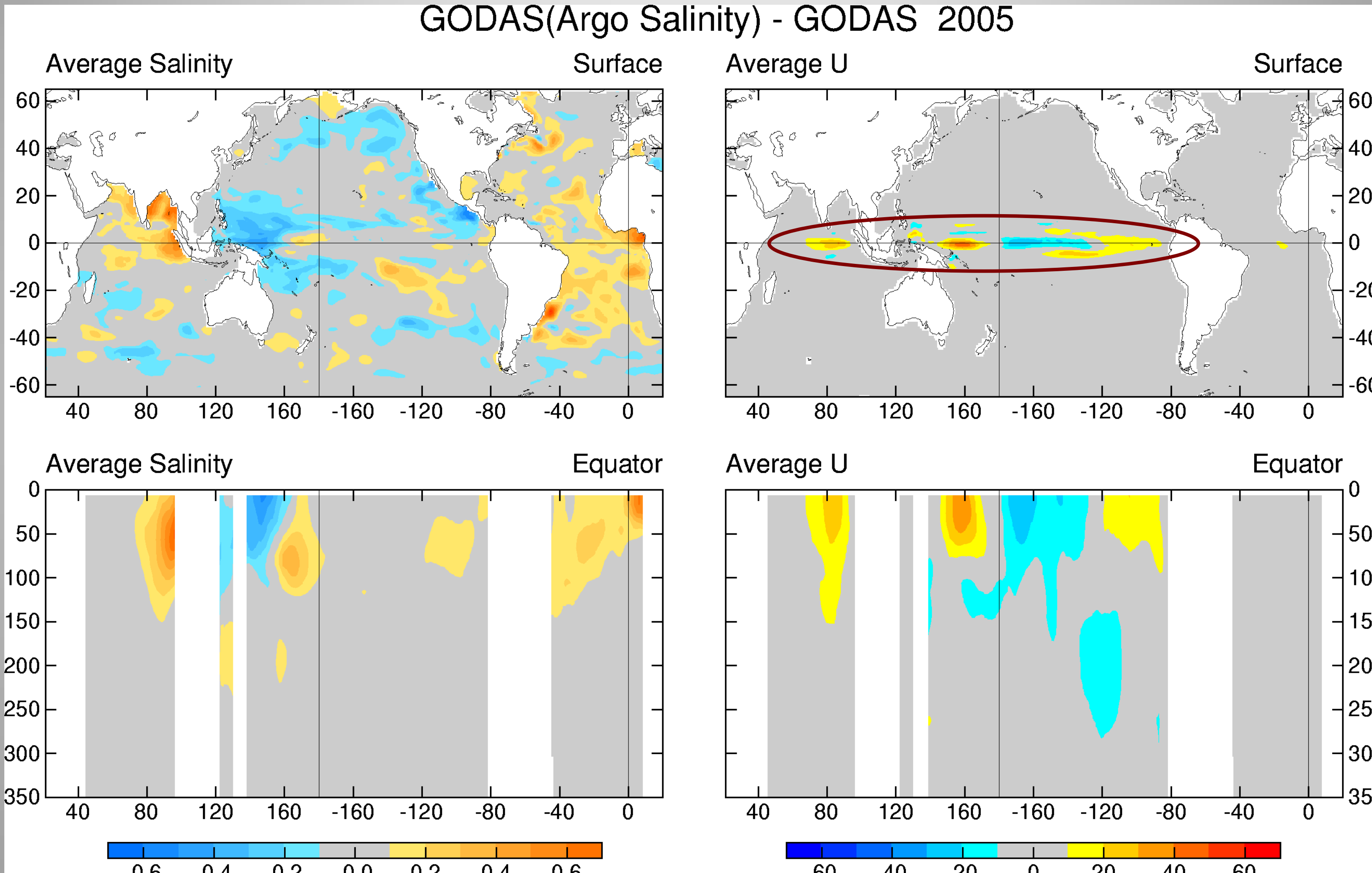
GODAS w. Argo
(w. bias corr.)

GODAS
w/o Argo - w. Argo

Assimilating Argo observations alters GODAS salinity by as much as 0.5 psu over broad regions.

Argo Salinity vs Synthetic Salinity

Along with the salinity changes there are changes of up to 0.3m/sec in the mean zonal equatorial currents.



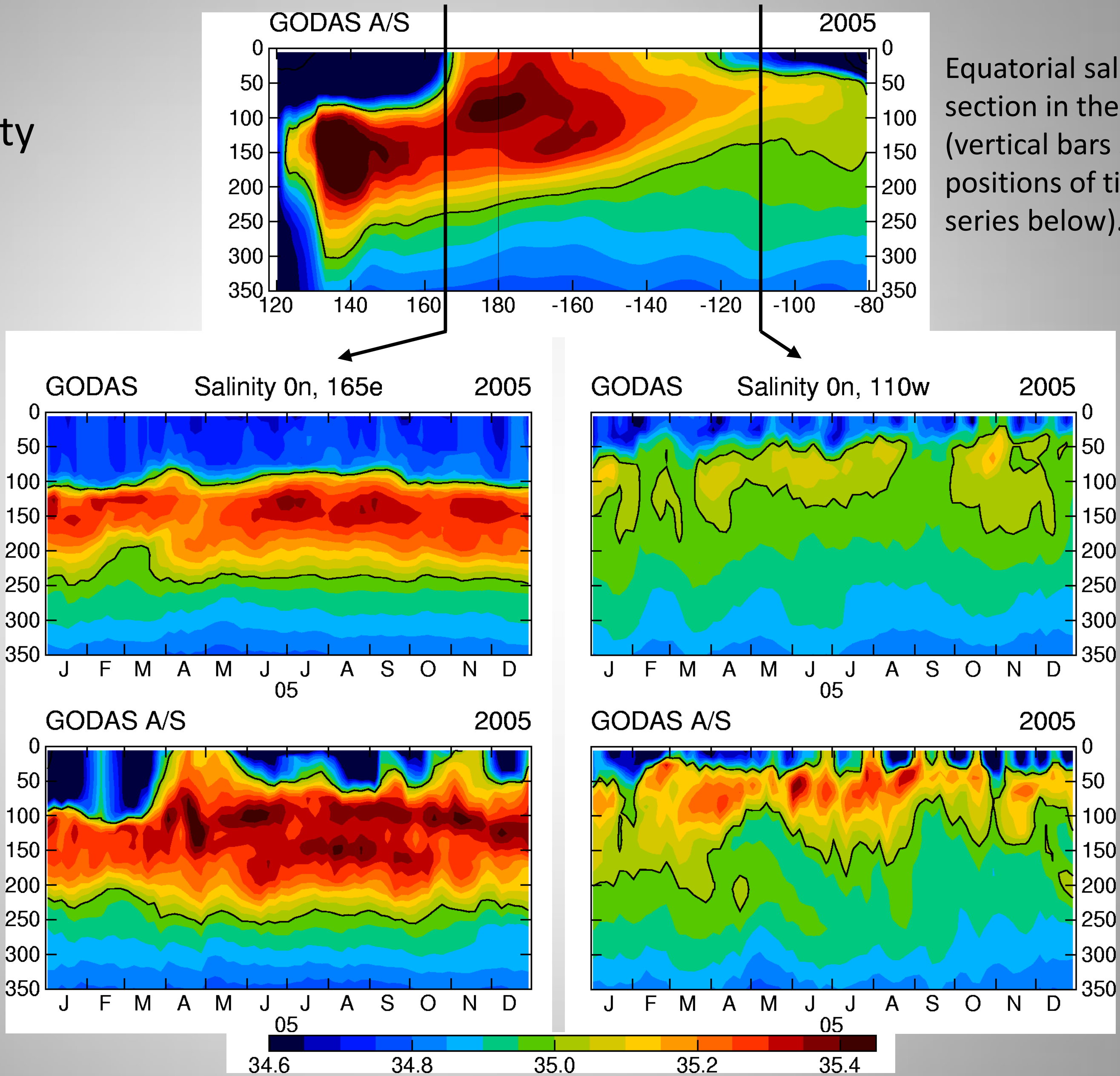
Changes in both S and U are largely confined in and above the thermocline.

Argo Salinity vs Synthetic Salinity

Equatorial salinity section in the Pacific (vertical bars show positions of time-series below).

Synthetic Salinity

Argo Salinity

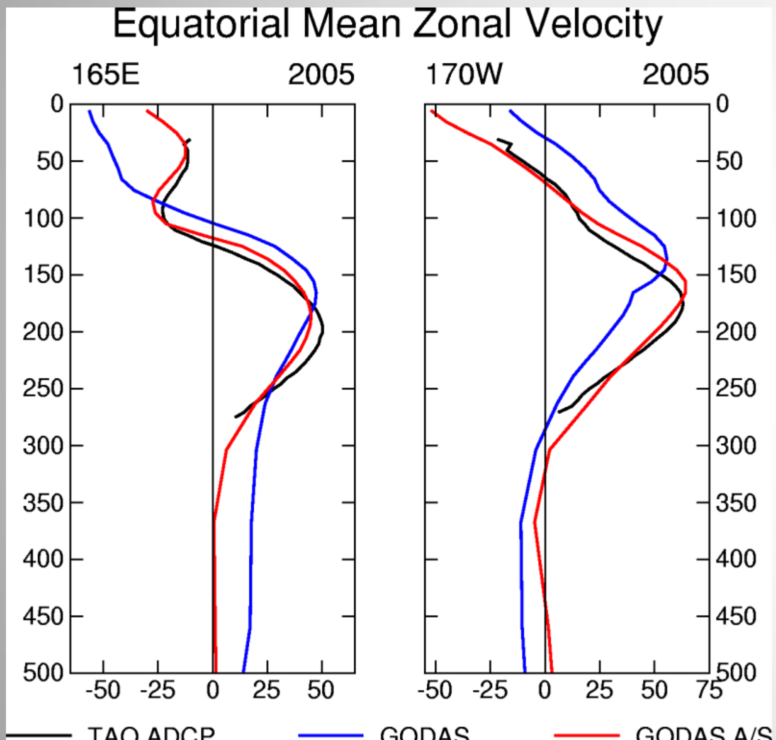


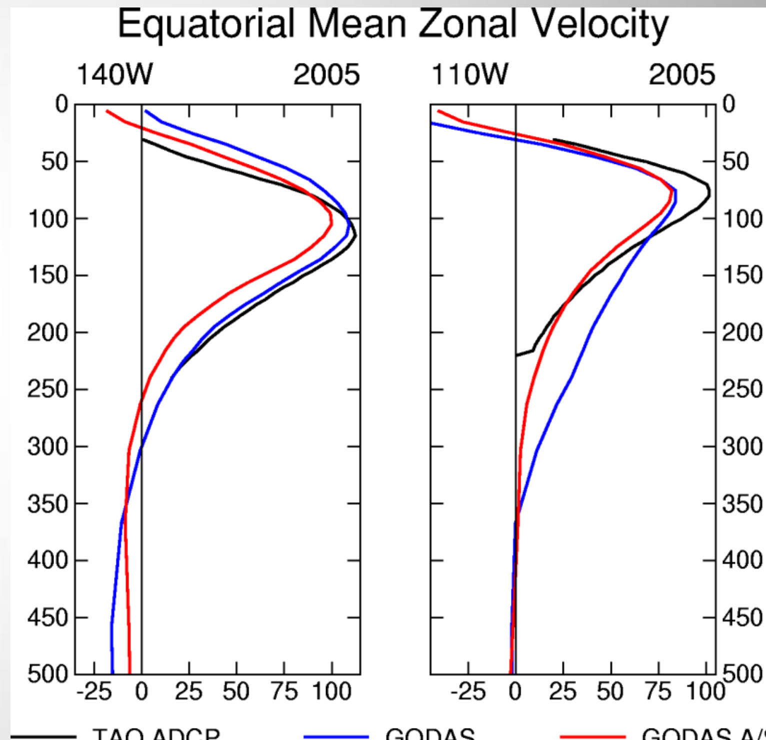
Argo Salinity vs Synthetic Salinity

In the west, assimilating Argo salinity corrects the bias at the surface and the depth of the undercurrent core and captures the complex structure at 165°E.

Comparison with independent ADCP currents.

In the east, assimilating Argo salinity reduces the bias at the surface and sharpens the profile below the thermocline at 110°W.

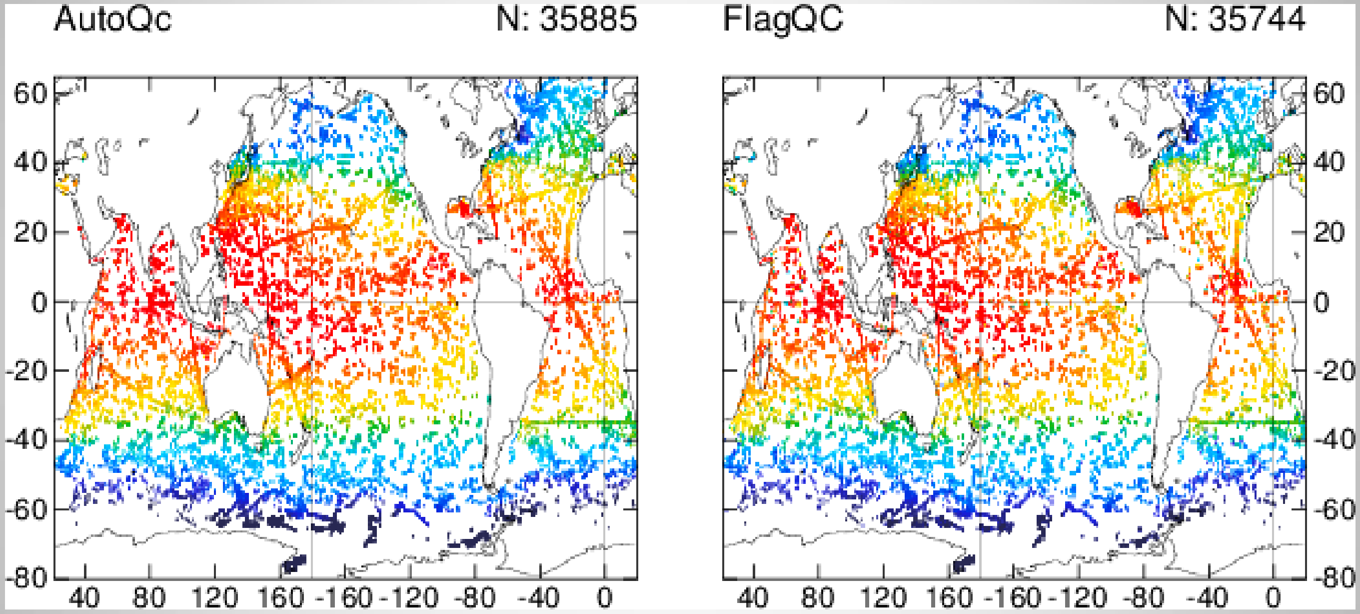




ADCP GODAS-S/S GODAS-A/S

Quality Control

Auto QC vs 'flagged' QC

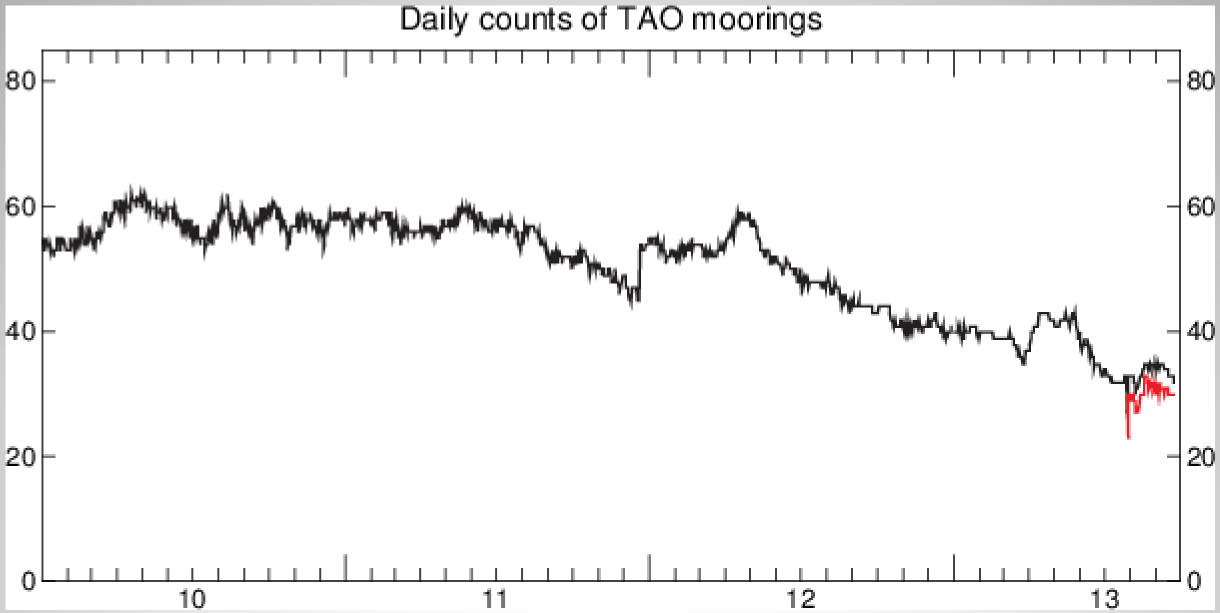


May-June 2010 profiles and QC flags from the GODAE sever.

The use of real-time observations, the need for in-house system support, and 'frozen' systems weigh heavily in favor of maintaining our own auto QC.

Some Current and Future Concerns

- The decline(?) of the tropical moored arrays.
- Completing the Argo global array; maintaining the existing Argo array.
- NCEP is committed to the goal of a seamless suite of environmental models spanning scales from synoptic to climate.
- Going beyond SI forecasting: other forecast and monitoring products (e.g. hurricane tracking, AMOC, sea ice, geochemistry)
- There will be a need to expand on the Argo capability, develop new systems.



The number of TAO/TRITON moorings reporting daily 2010-2013.

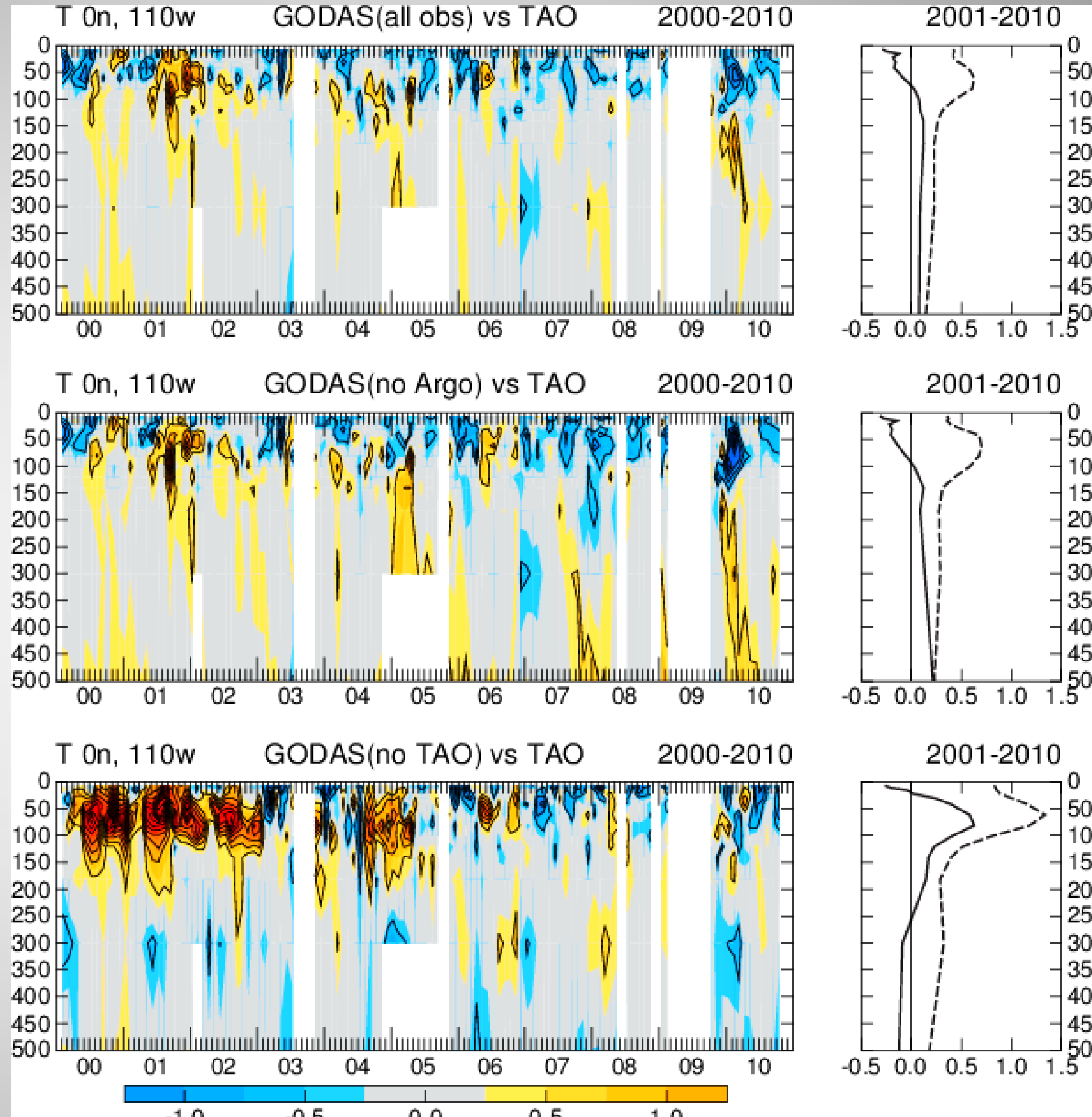
The black line is data acquired from the GODAE server at a 10-day delay; the red line indicates data acquired from GTS in real time.

Time-series of GODAS temperature minus observed TAO temperature at 110^{o}W

All profiles assimilated

Only TAO profiles assimilated

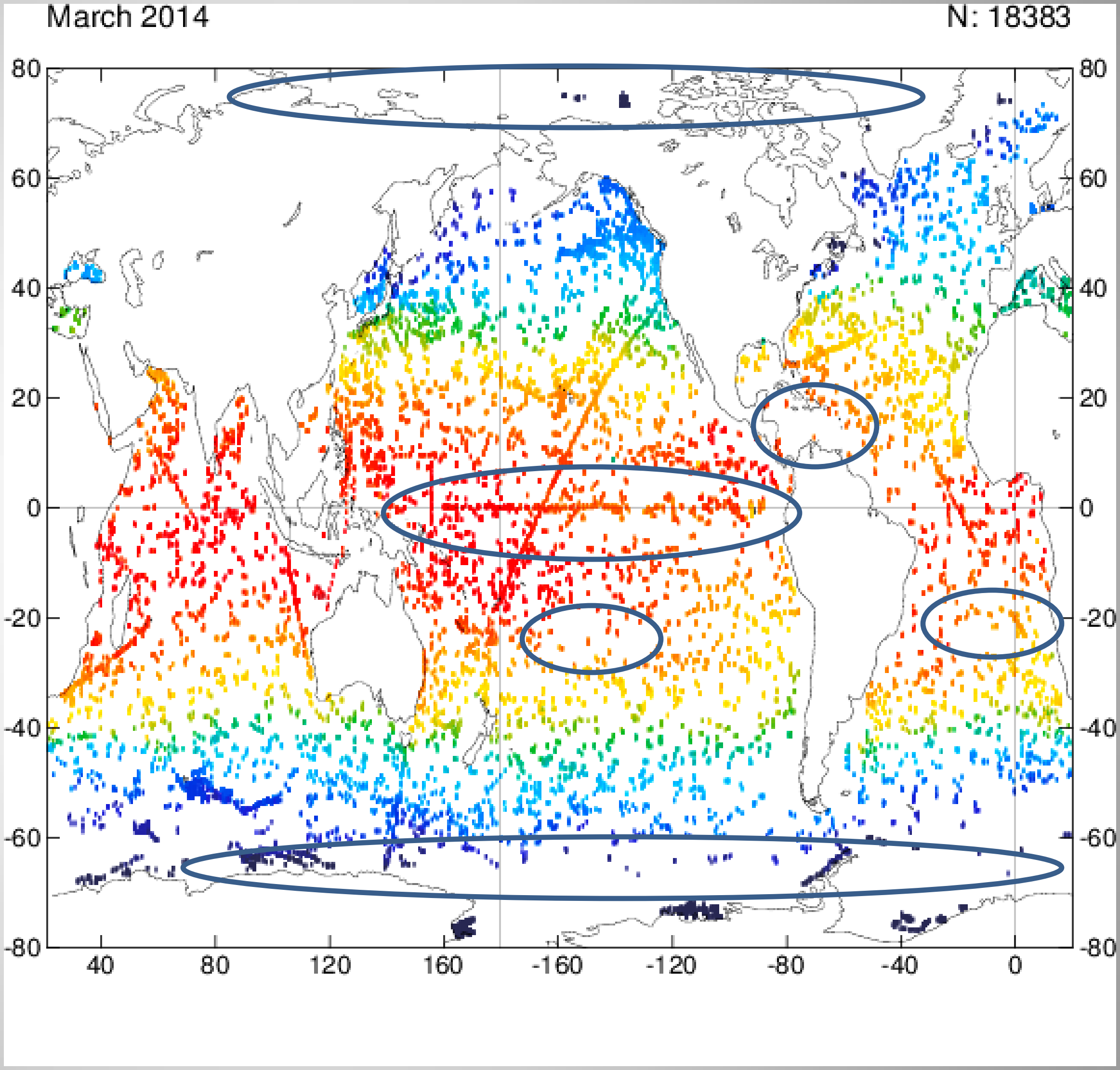
Only Argo profiles assimilated



Beginning in 2006 as the number of Argo profiles increases, the error in GODAS decreases sharply. The same effect is seen at 95^{o}W and to a lesser extent at 125^{o}W but it is not seen farther to the west.

Maintaining/Augmenting the Observing System

- Populating high latitudes.
- Reseeding mid-latitude gaps.
- Coping with equatorial divergence.
- Populating marginal seas.

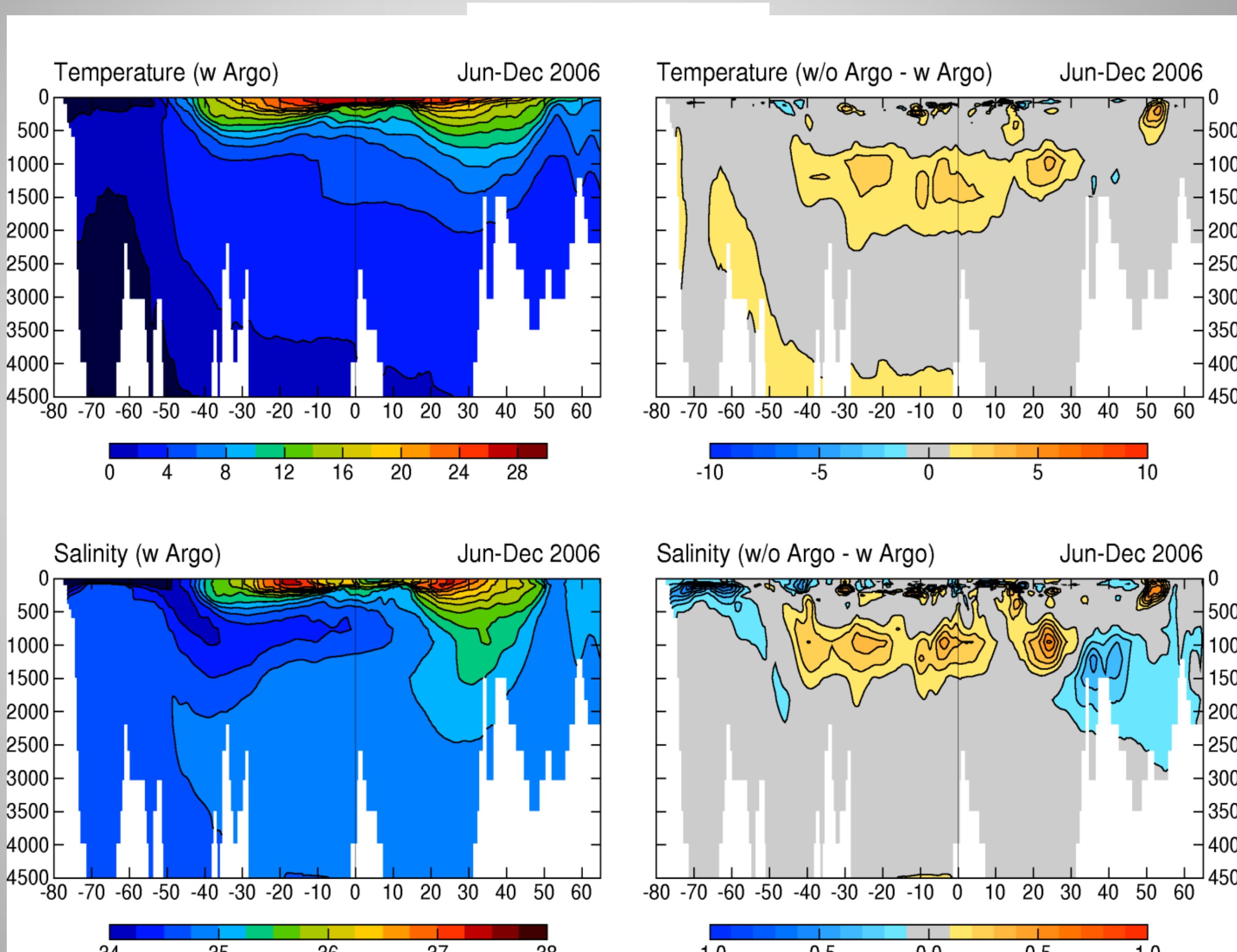


An experiment to see whether Argo has an impact on the AMOC in GODAS

Atlantic 30^{o}W Section Jun-Dec 2006

Temperature

Salinity

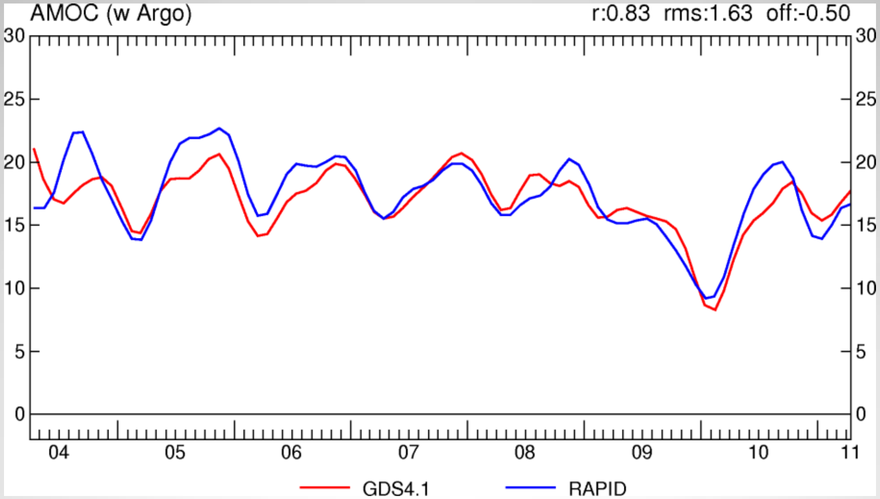


GODAS w. Argo
(w. bias corr.)

GODAS
w/o Argo - w. Argo

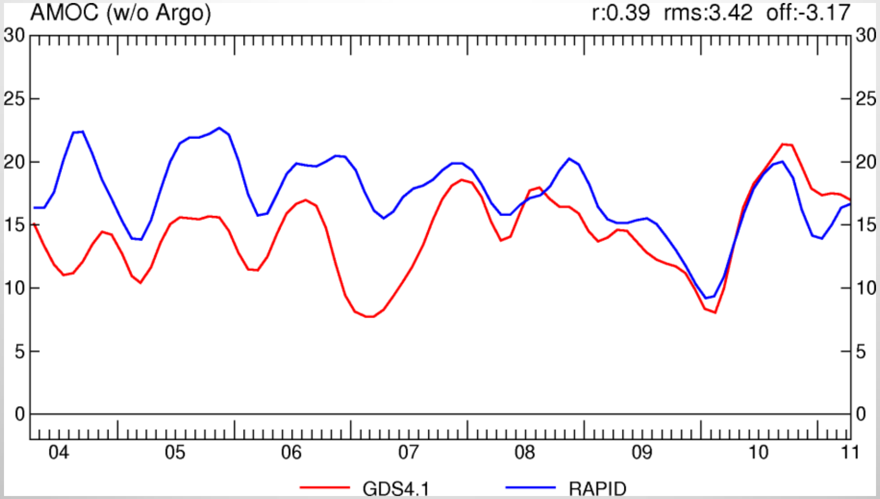
Atlantic Overturning Transport (Sv)

GODAS (red)
30-35°N
w. Argo



Rapid (blue)
26.5°N

GODAS (red)
30-35°N
w/o Argo



Final Remarks

- Seasonal to Interannual forecasting and monitoring rely heavily on the global observing system.
- That reliance will increase as we move toward the goal of a seamless environmental modeling system.
- Budgetary constraints will always remain; observing systems must be intelligently designed and the case for their existence intelligently argued.

The End