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HYBRID GODAS

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NOAA CLIMATE REANALYSIS TASK FORCE MEETING
SEPTEMBER 23, 2015

OCEAN ASSIMILATION ADVANCEMENTS AT NCEP TO DATE:

- Oceanic Local Ensemble Transform Kalman Filter (Ocean-LETKF) system (Penny et al., 2013)

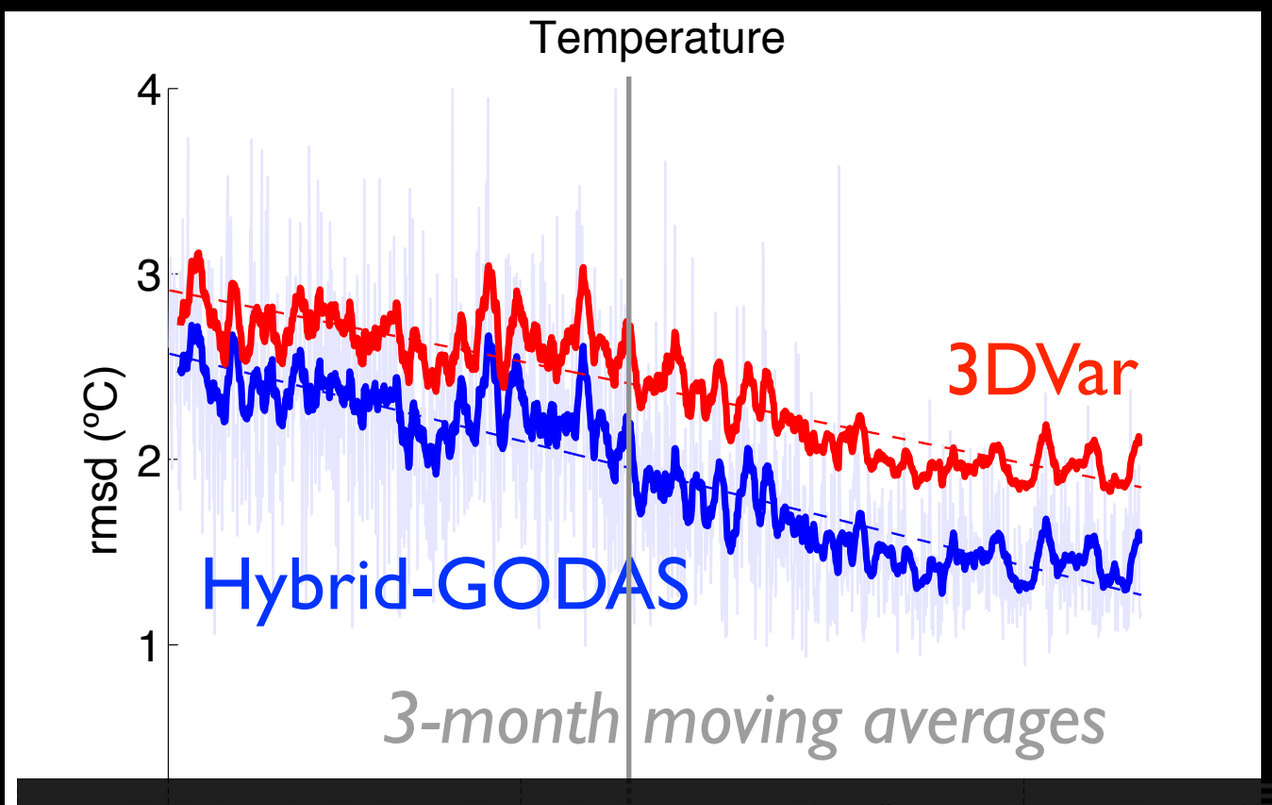
- Hybrid-Gain assimilation method (Penny 2014)

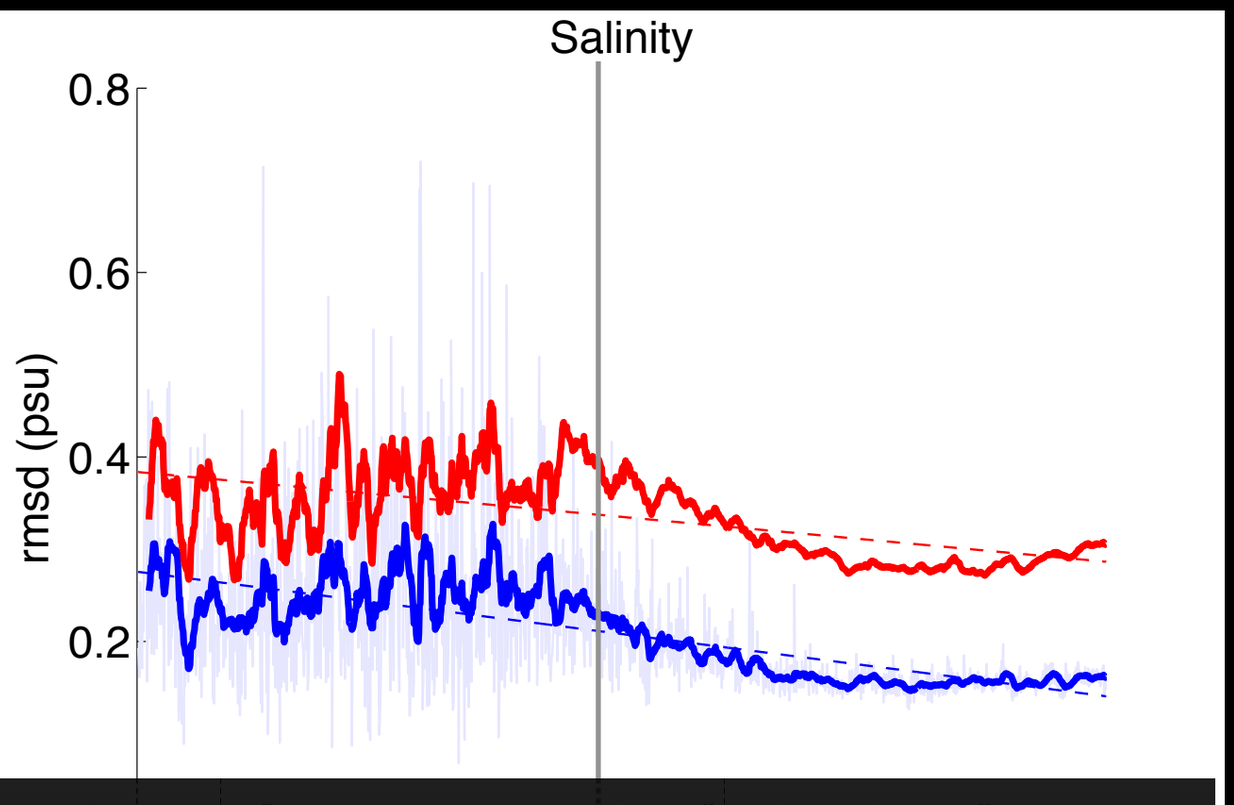
- Hybrid 3DVar/LETKF Global Ocean Data Assimilation System (Hybrid-GODAS) at NCEP (Penny et al., 2015)

- 21-Year Hybrid GODAS Reanalysis (Penny et al., in preparation)

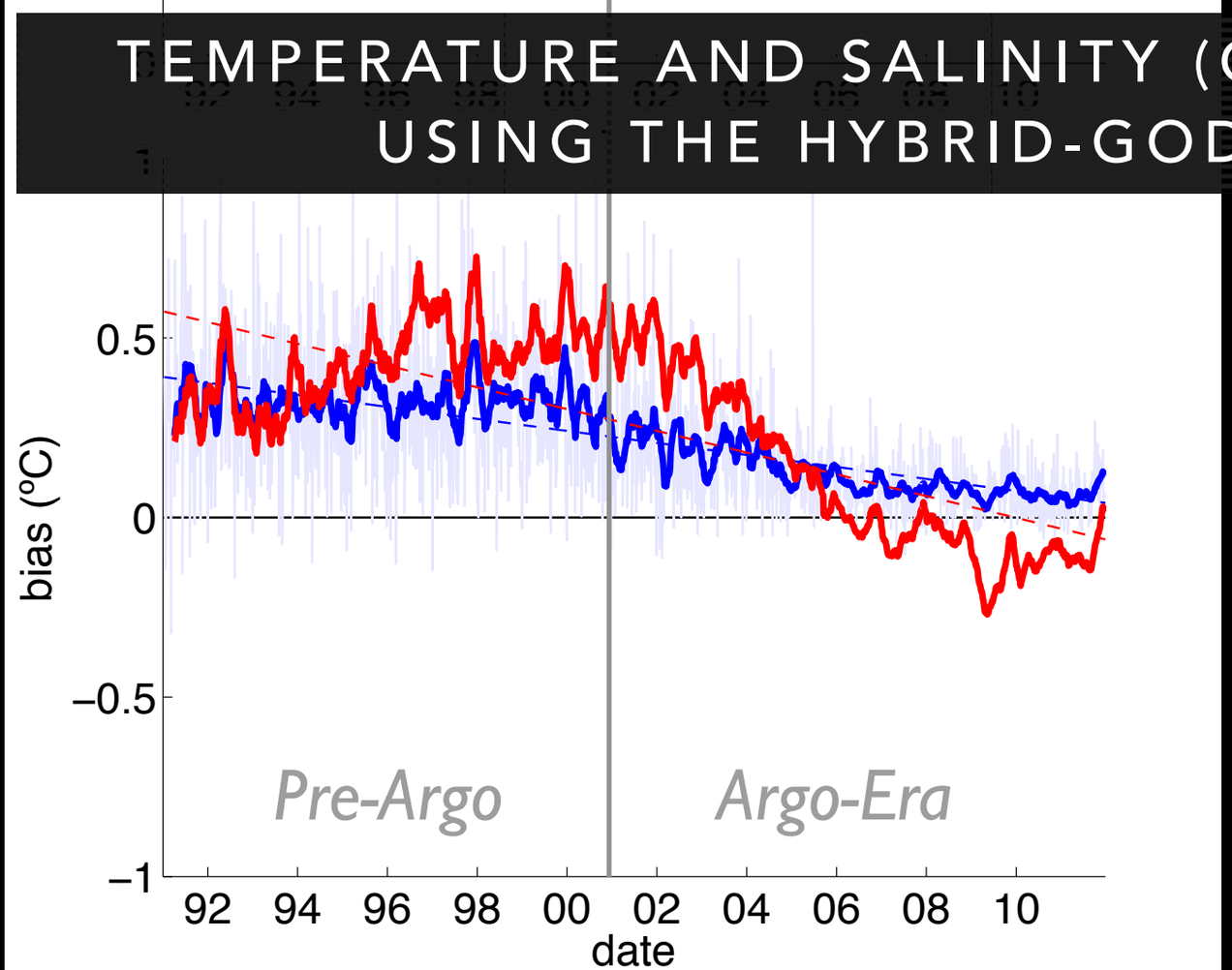
Collaborators: D. Behringer, J. Carton, E. Kalnay, T. Miyoshi, K. Ide, G. Chepurin, Y. Xue

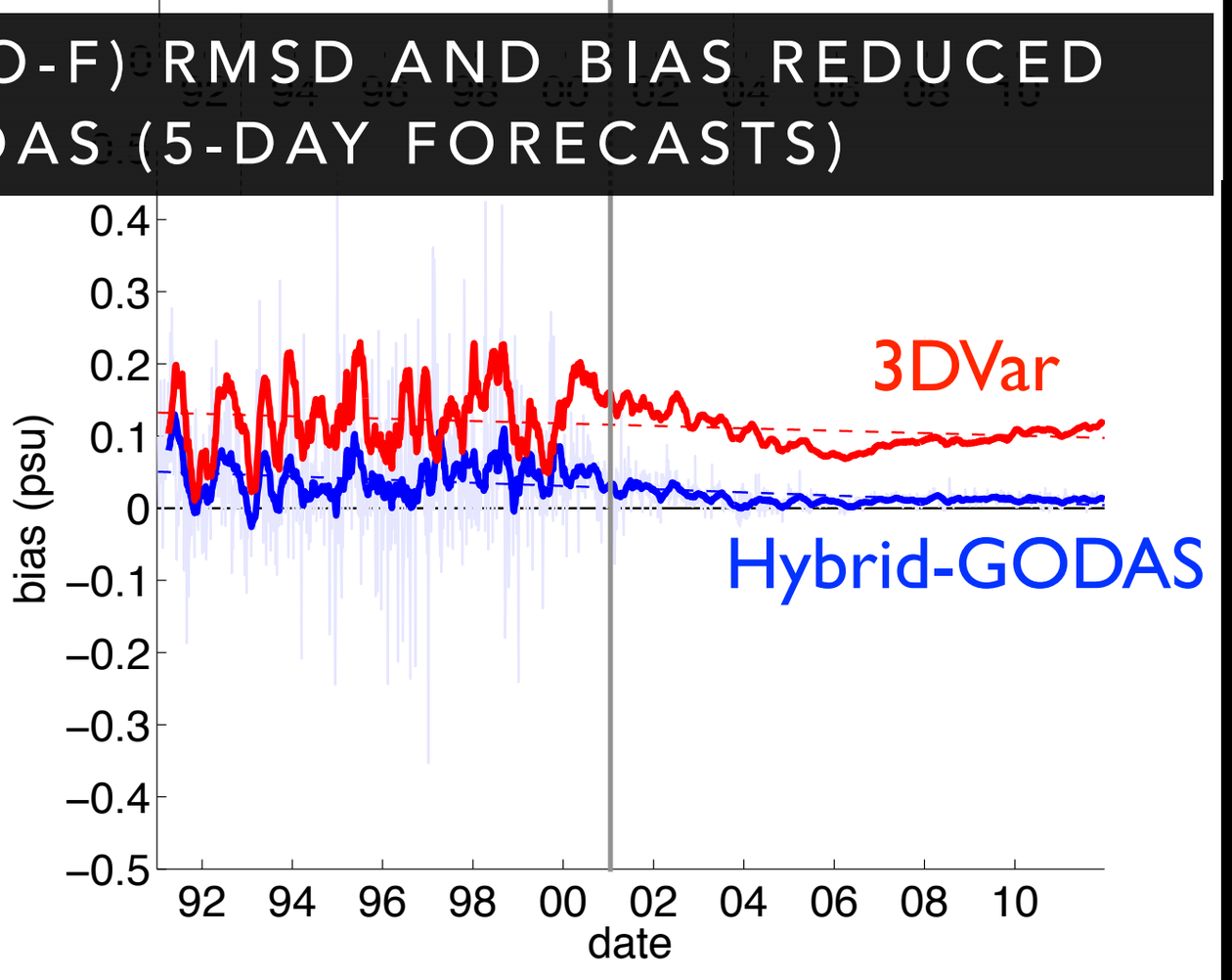
21-YEAR HYBRID-GODAS REANALYSIS





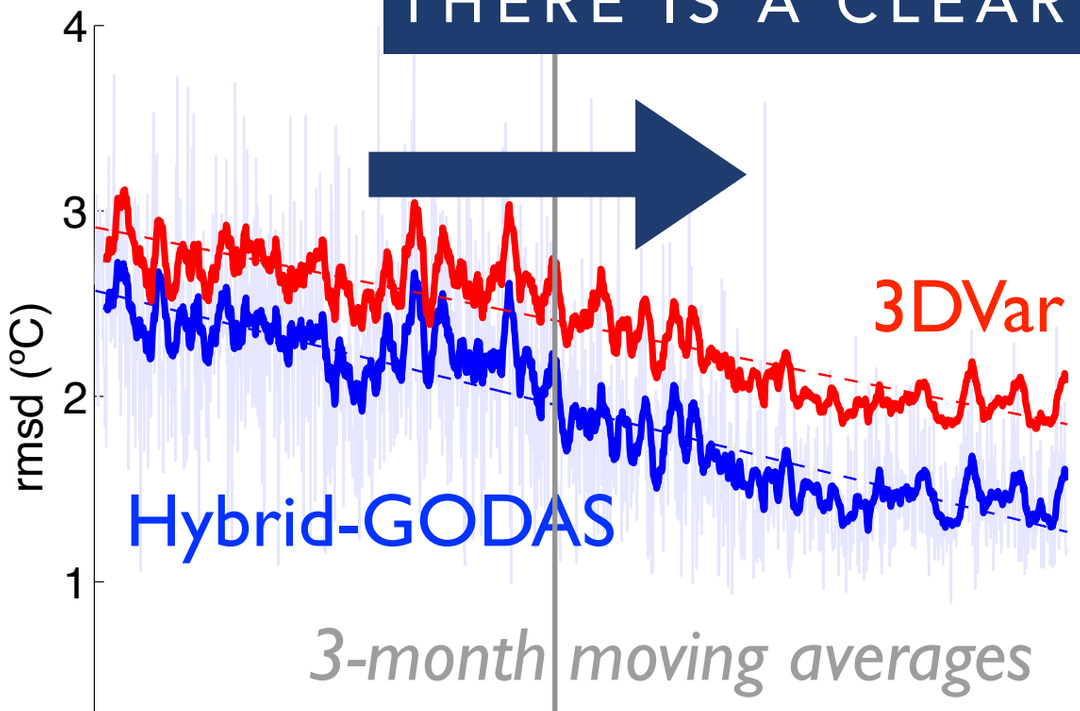
TEMPERATURE AND SALINITY (O-F) RMSD AND BIAS REDUCED USING THE HYBRID-GODAS (5-DAY FORECASTS)

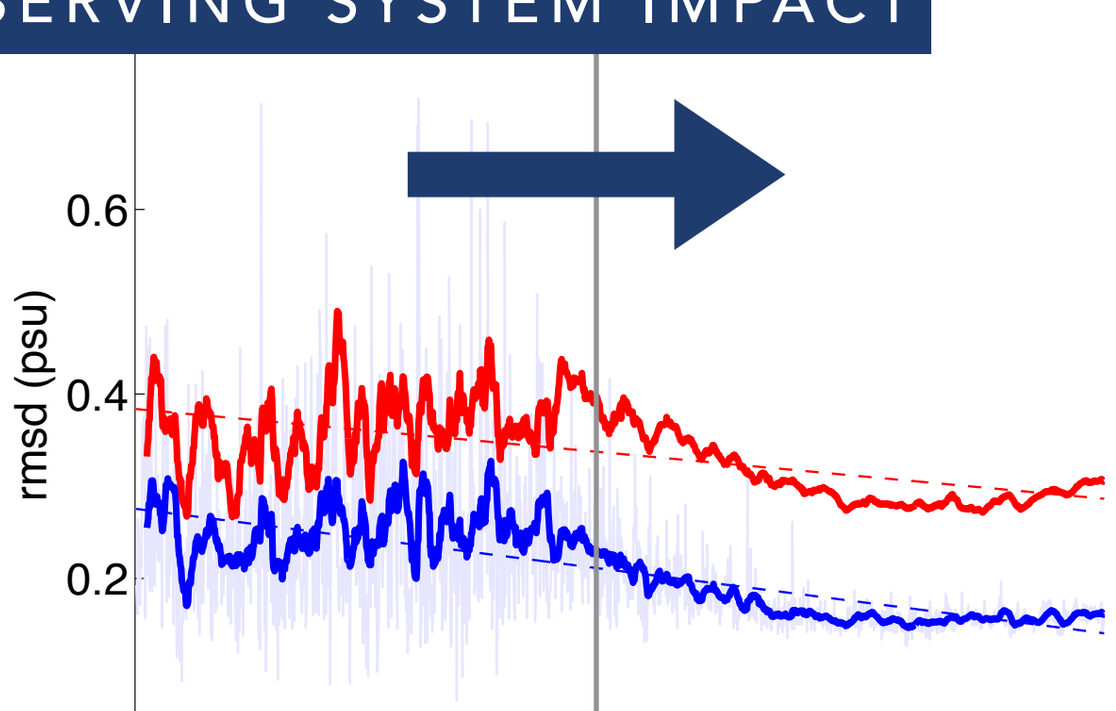




21-YEAR HYBRID-GODAS REANALYSIS

THERE IS A CLEAR OBSERVING SYSTEM IMPACT





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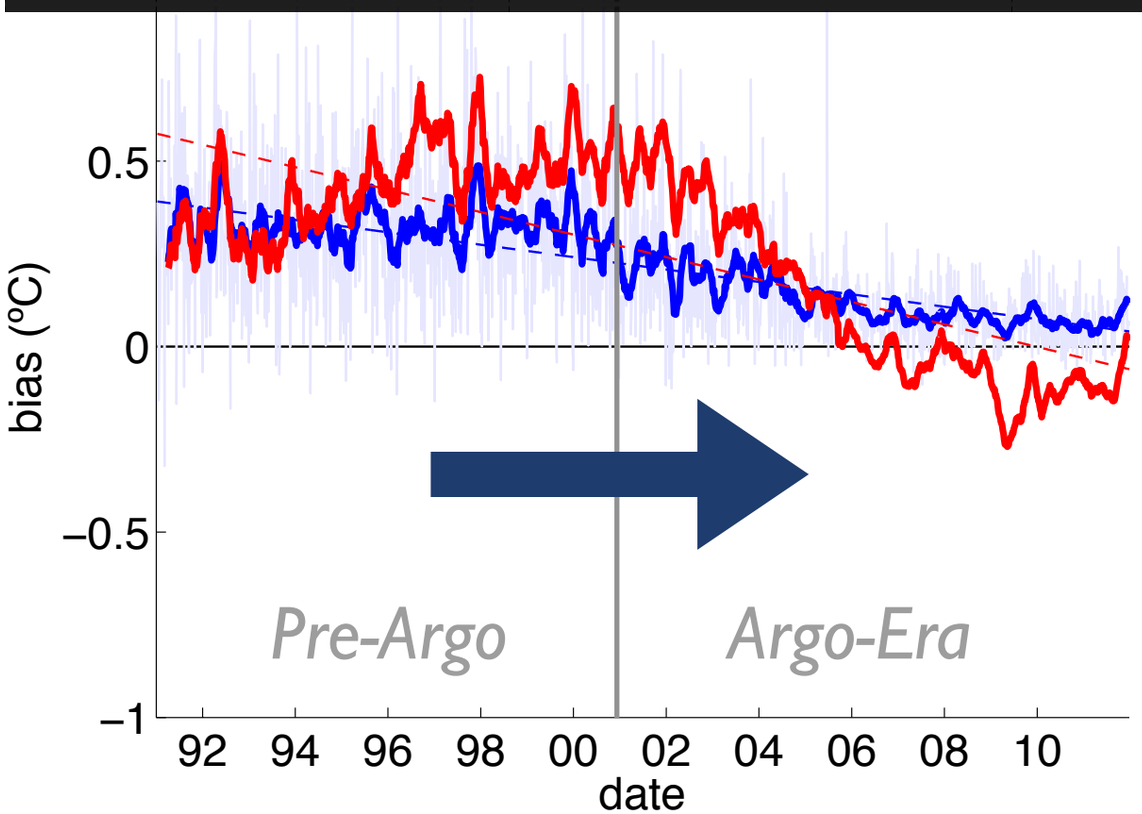
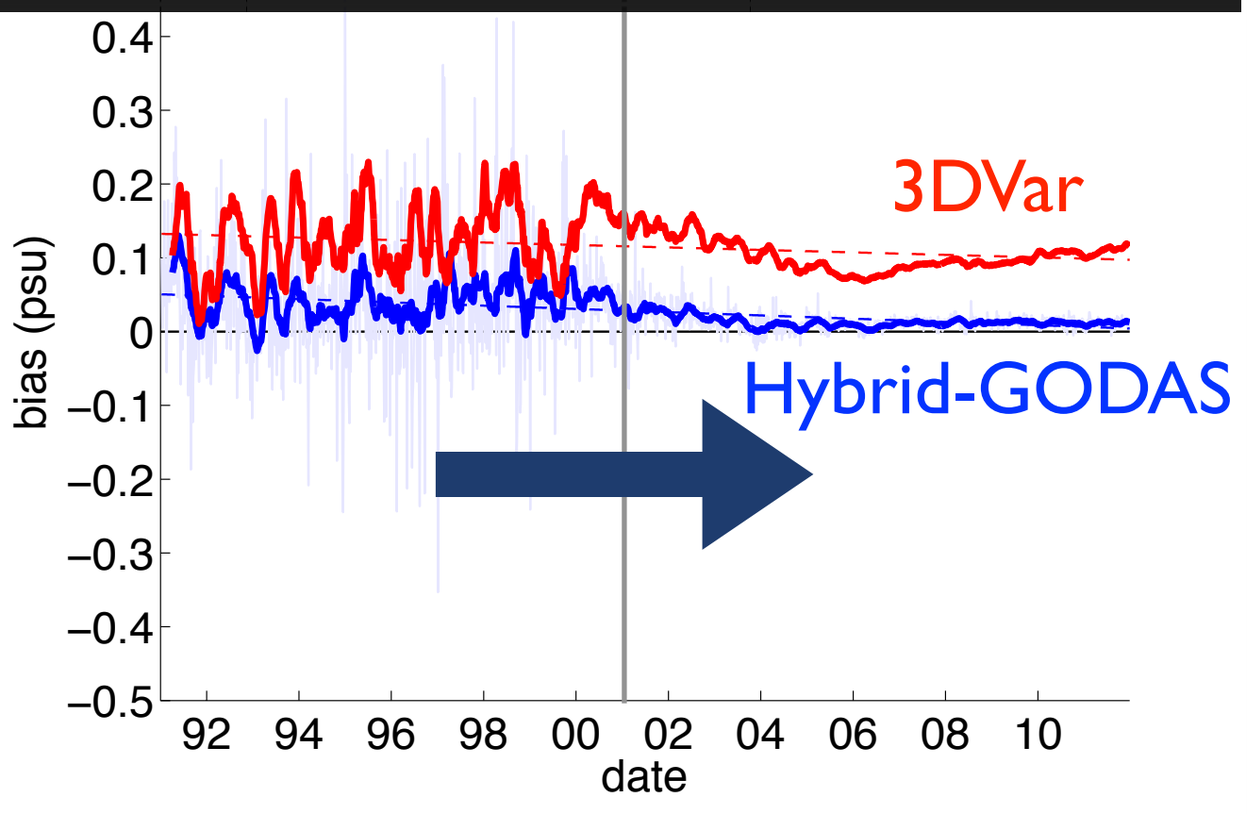
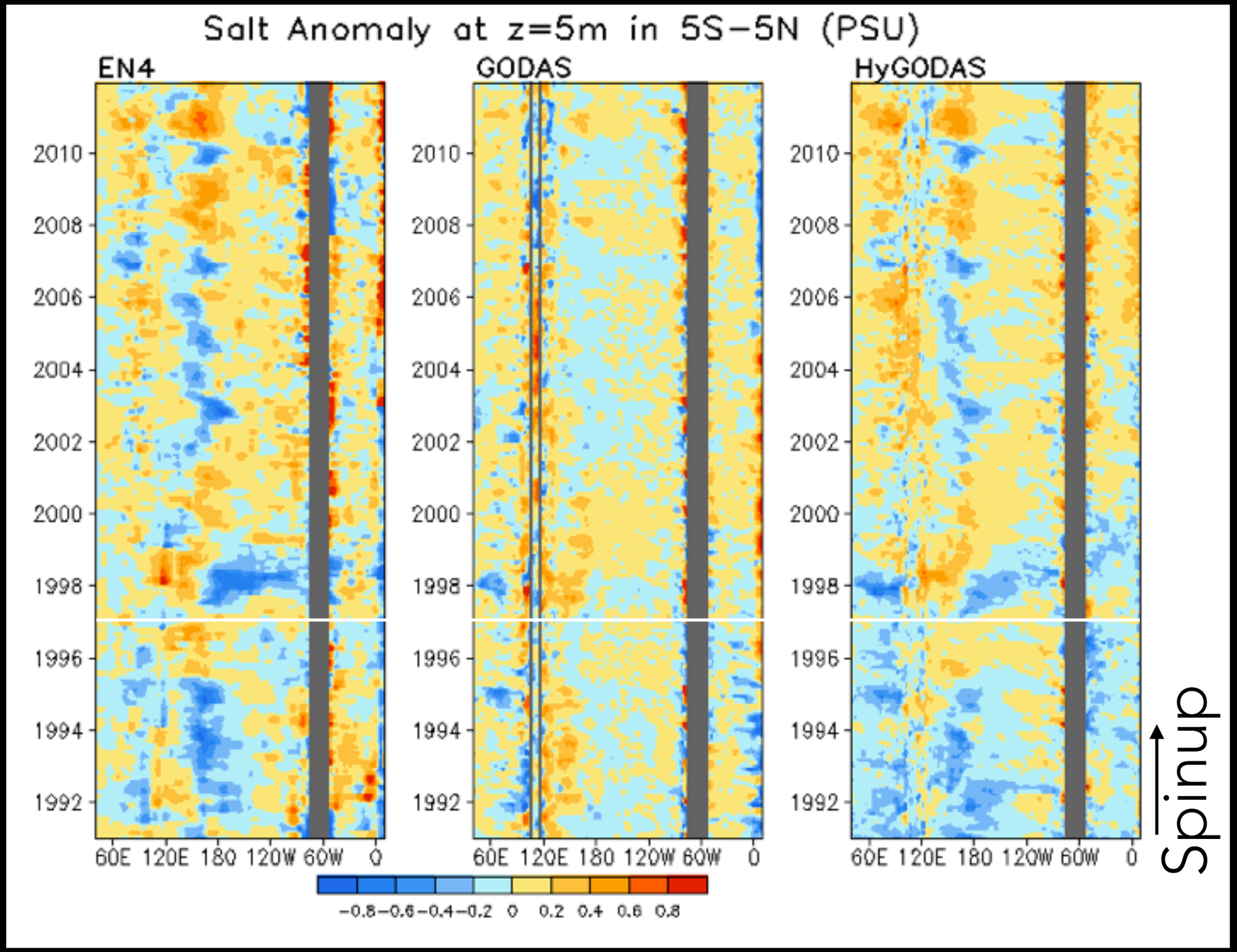


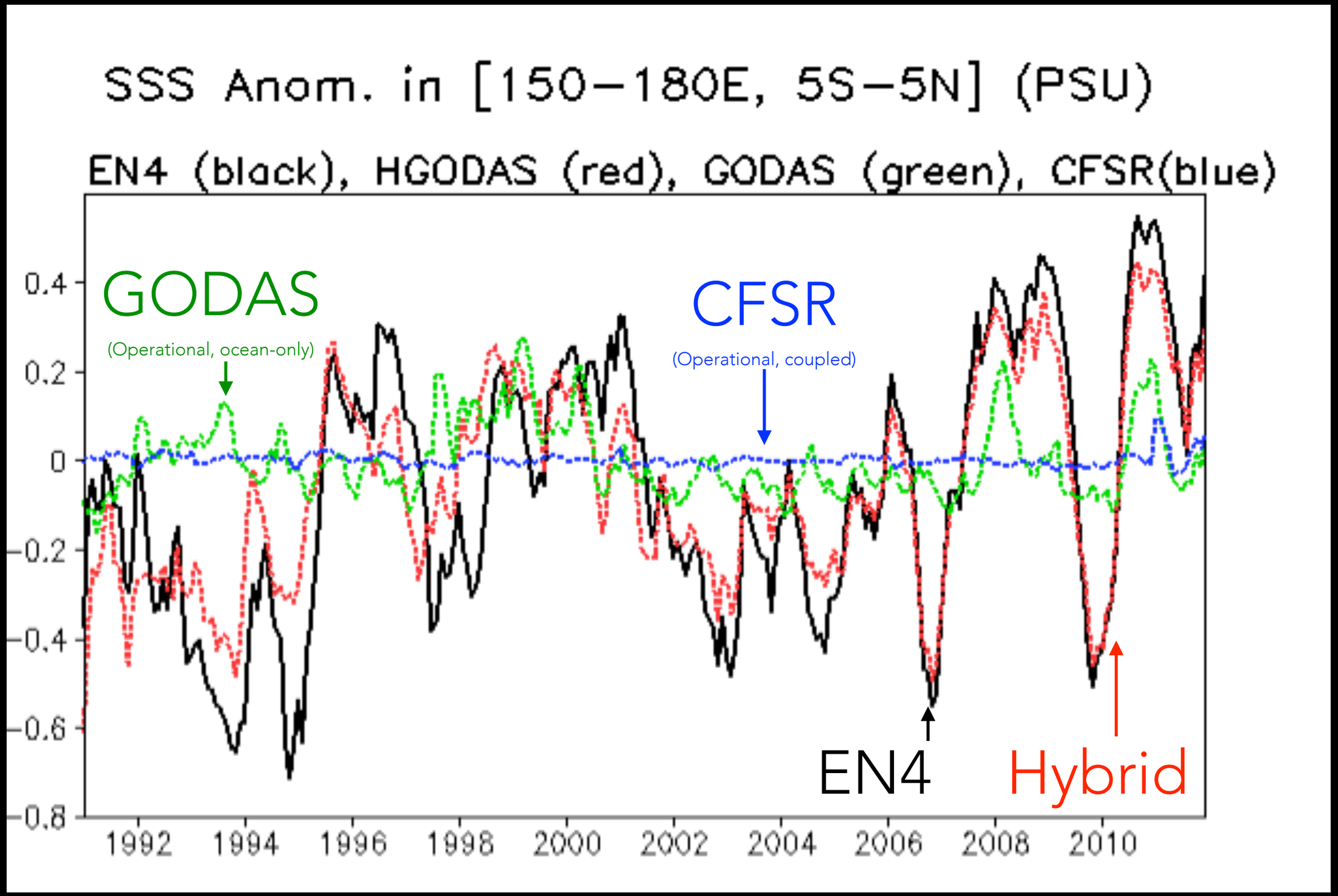


NEAR SURFACE SALINITY

Seasonal variability of the SSS is improved.



NEAR SURFACE SALINITY



*Acoustic Dopler Current Profilers

EQUATORIAL PACIFIC ADCP*

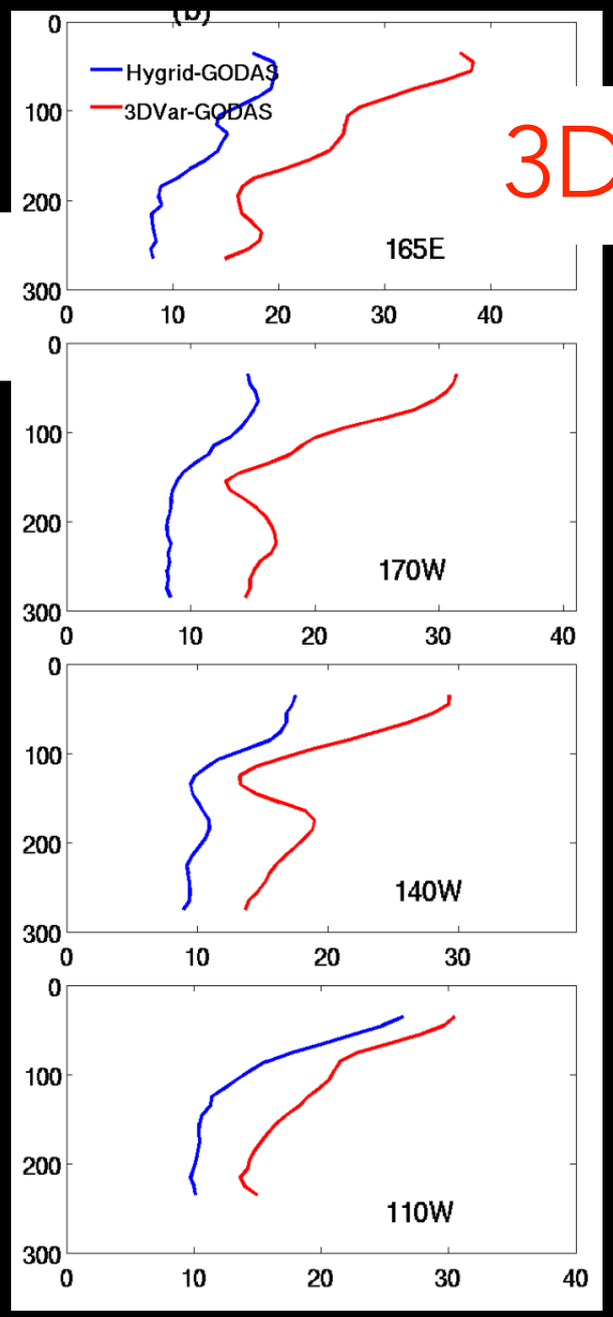
RMSD (cm/s)

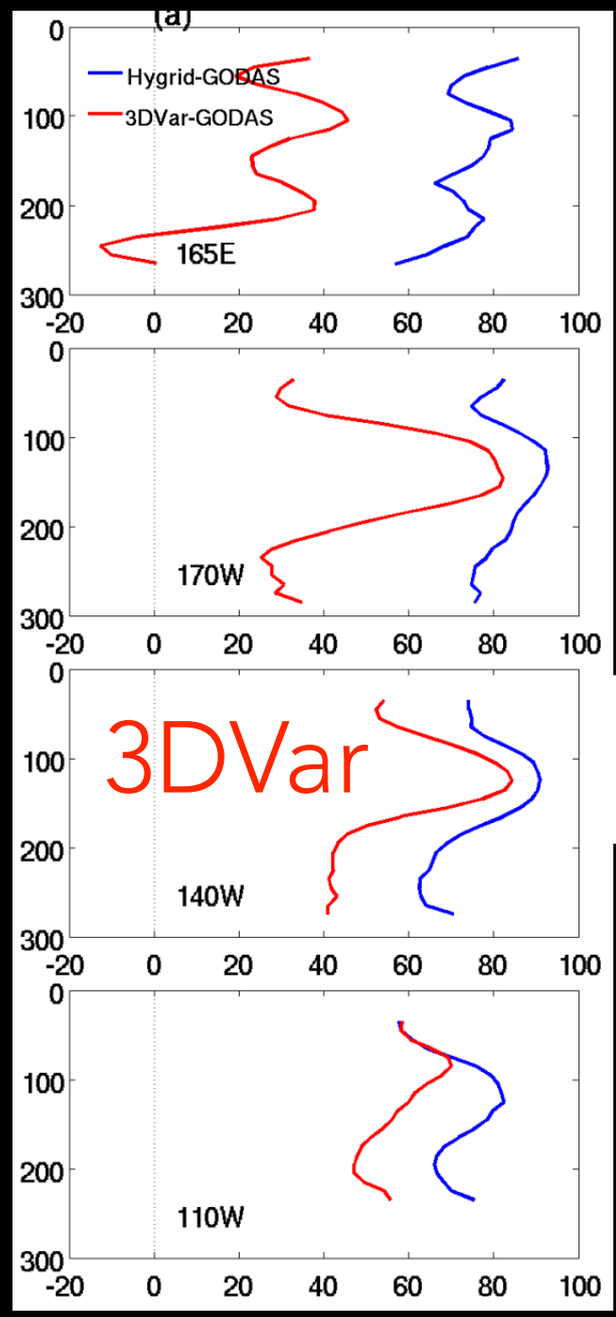
Anomaly Correlation

Hybrid

3DVar

Hybrid-GODAS updates velocity field, 3DVar-GODAS does not.





3DVar

Hybrid

← Improvement

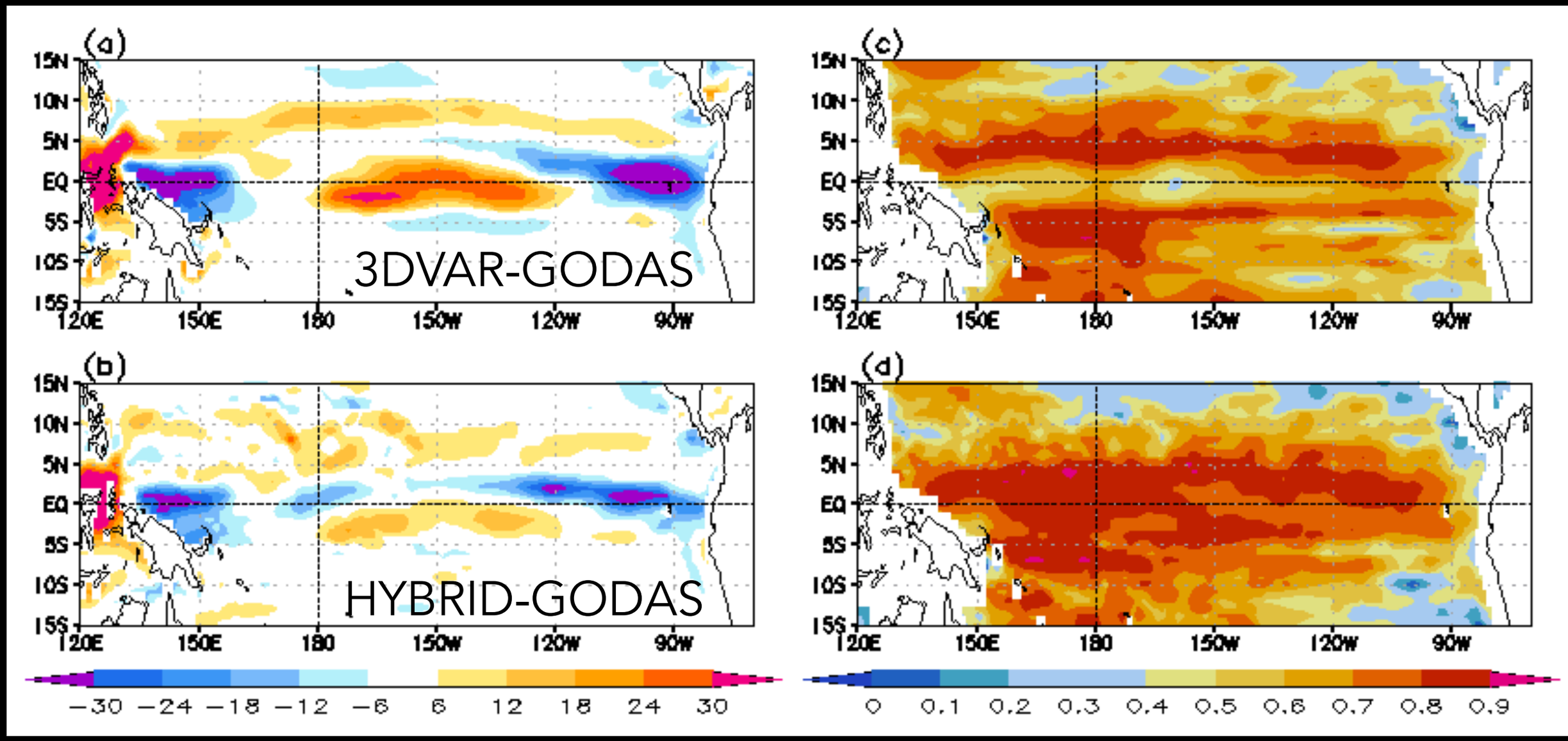
Improvement →

NEAR SURFACE OCEAN CURRENTS

Comparison to OSCAR* currents (~0-30m) from 1995-2011

Mean zonal current differences (cm/s)

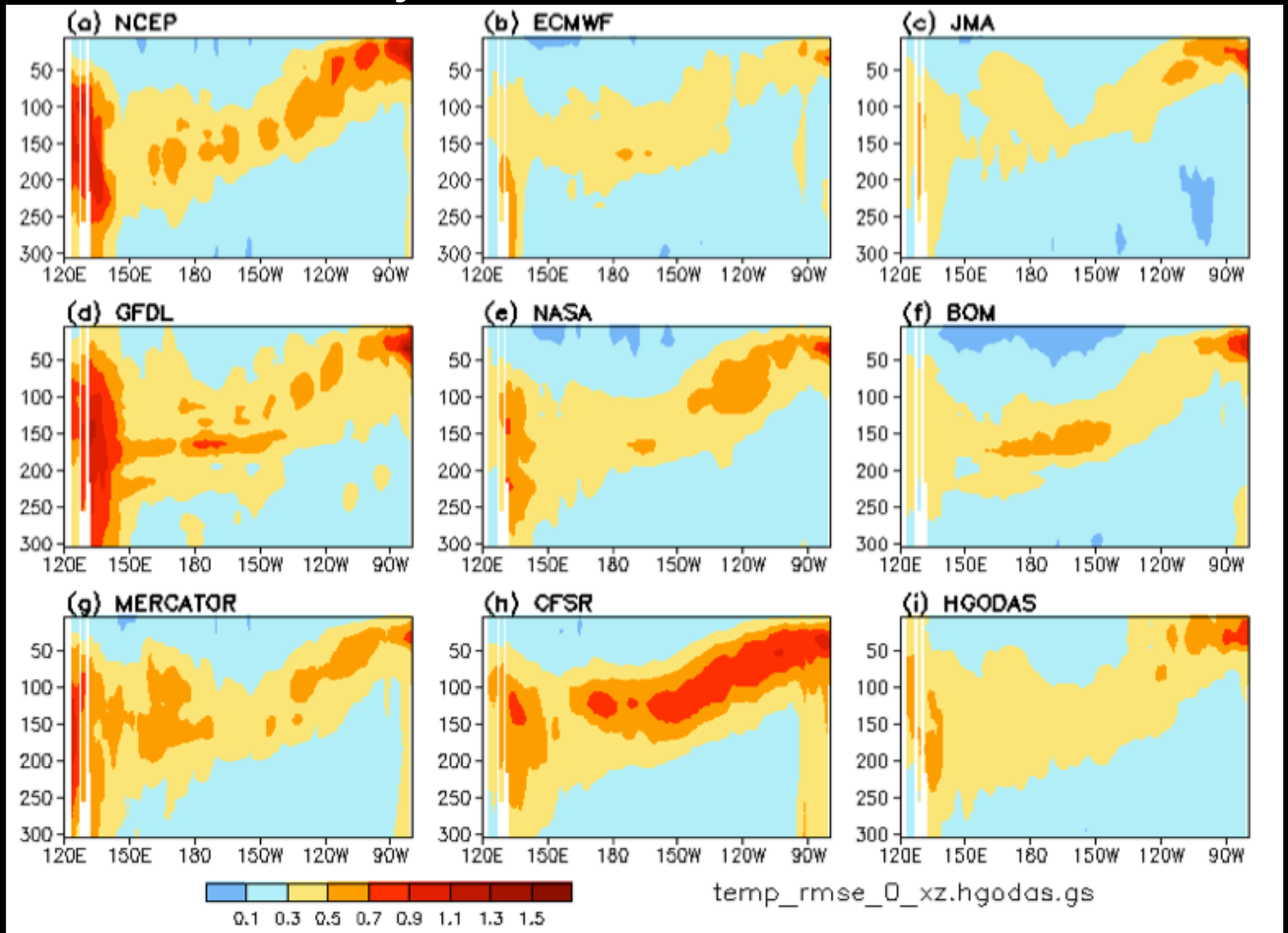
Anomaly Correlation



*OSCAR currents derived from satellite altimeter and scatterometer data

INTERNATIONAL COMPARISON

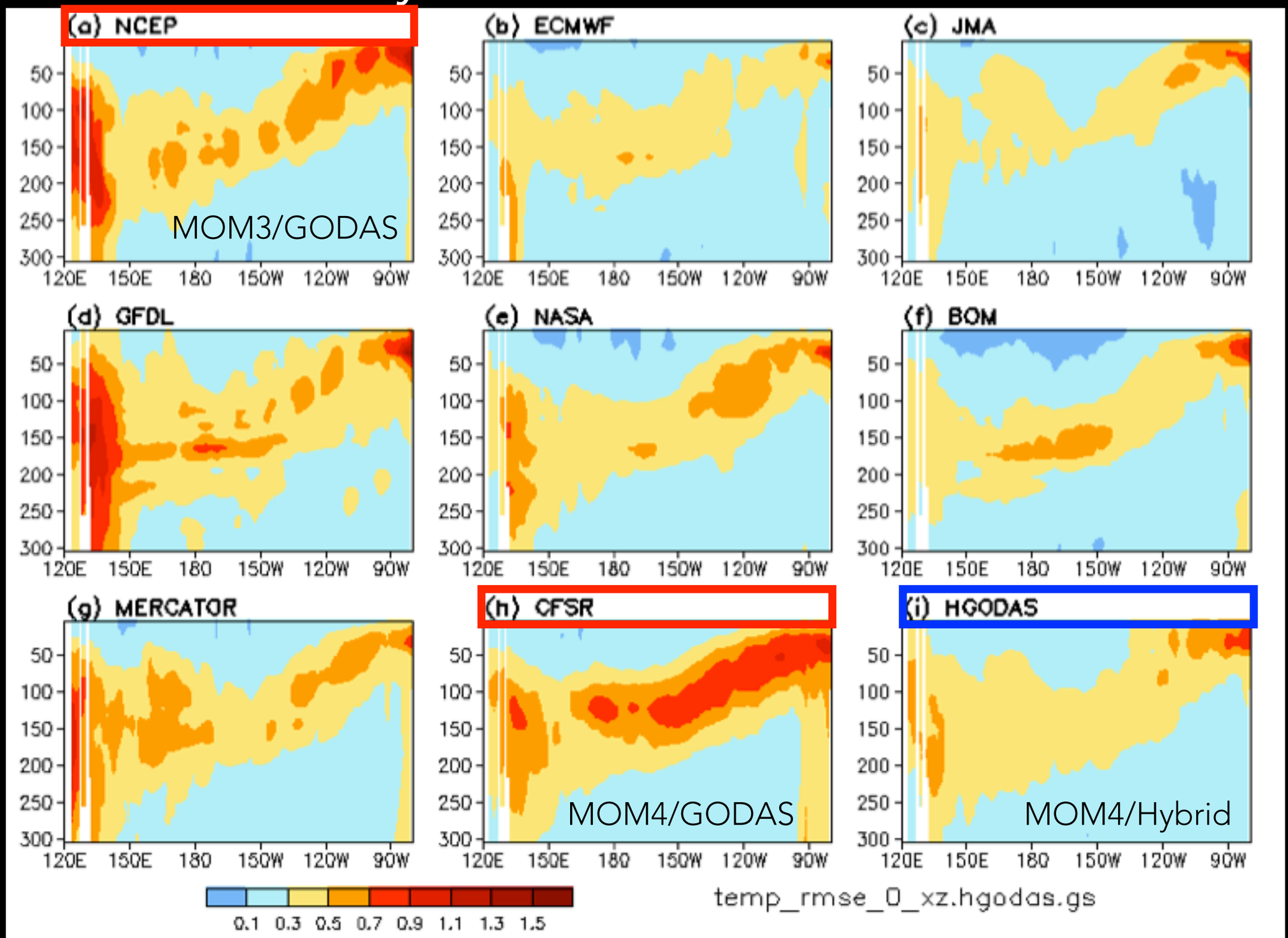
RMSD of anomaly correlations versus ensemble mean



Thanks to Yan Xue

INTERNATIONAL COMPARISON

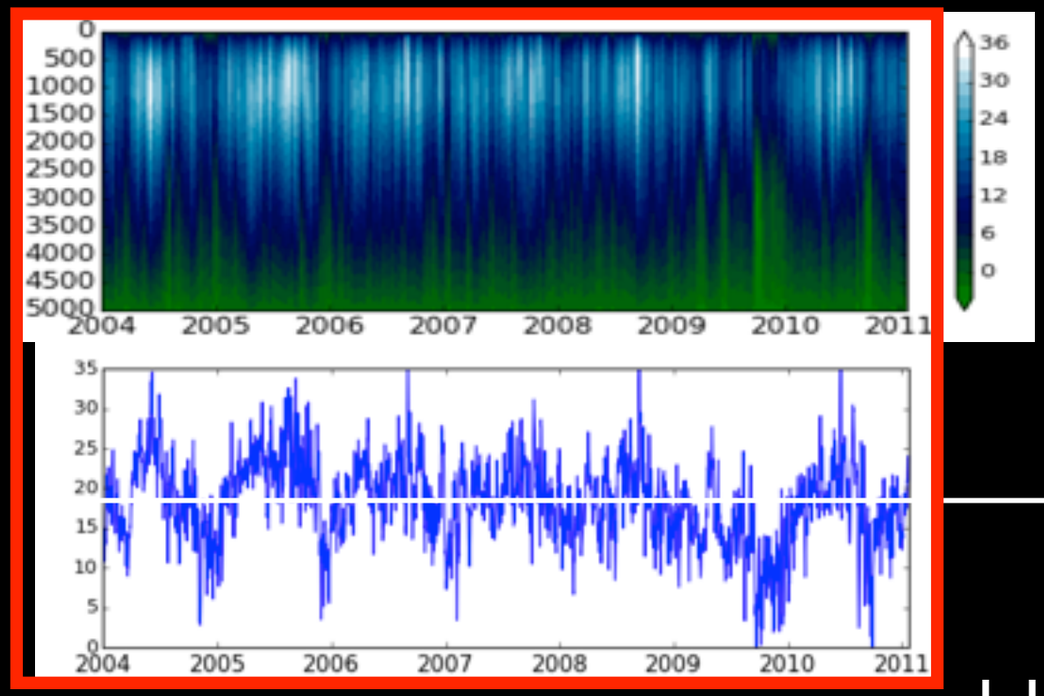
RMSD of anomaly correlations versus ensemble mean



Thanks to Yan Xue

26.5°N, NORTH ATLANTIC

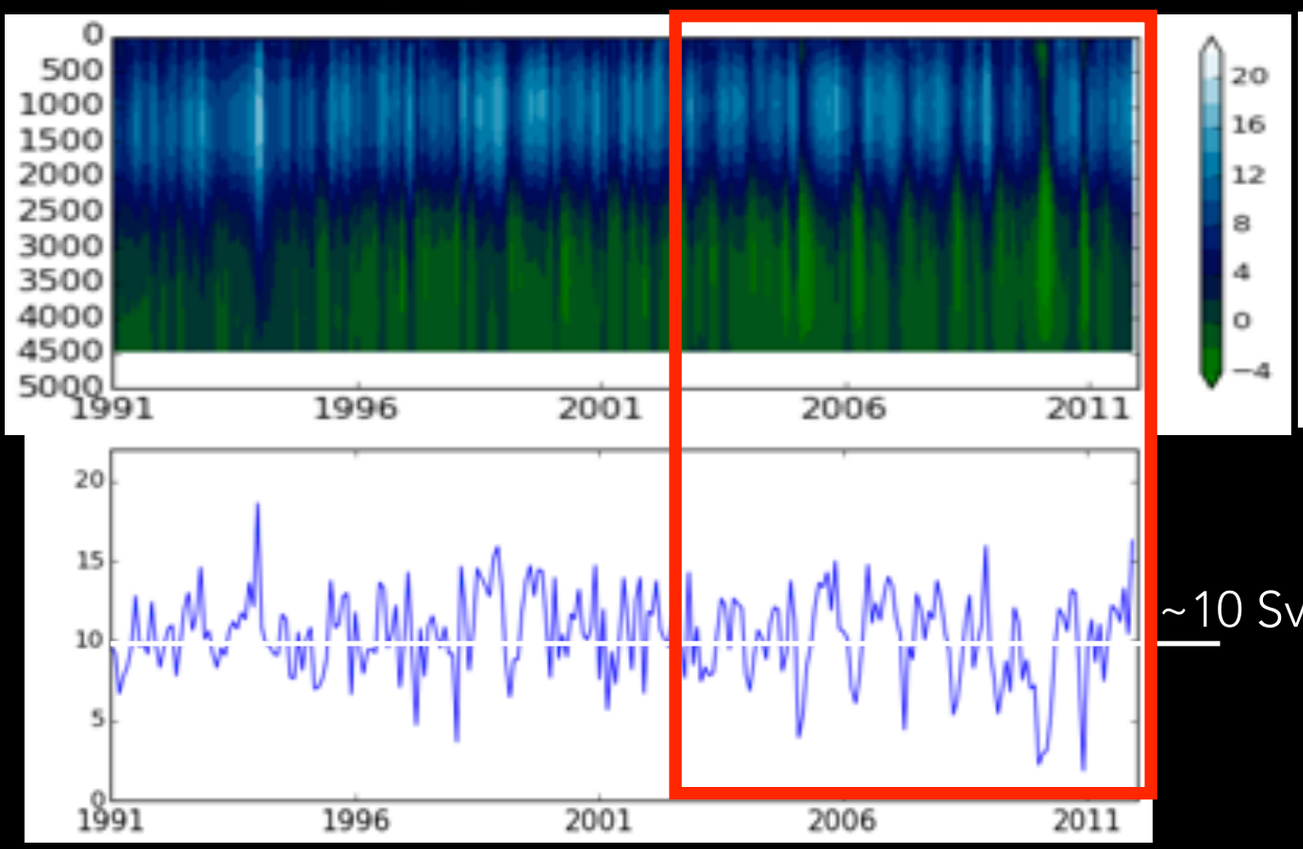
Seasonal cycle captured well in both. The hybrid spins up volume throughflow towards observed levels.



RAPID/MOCHA Array (Observed)

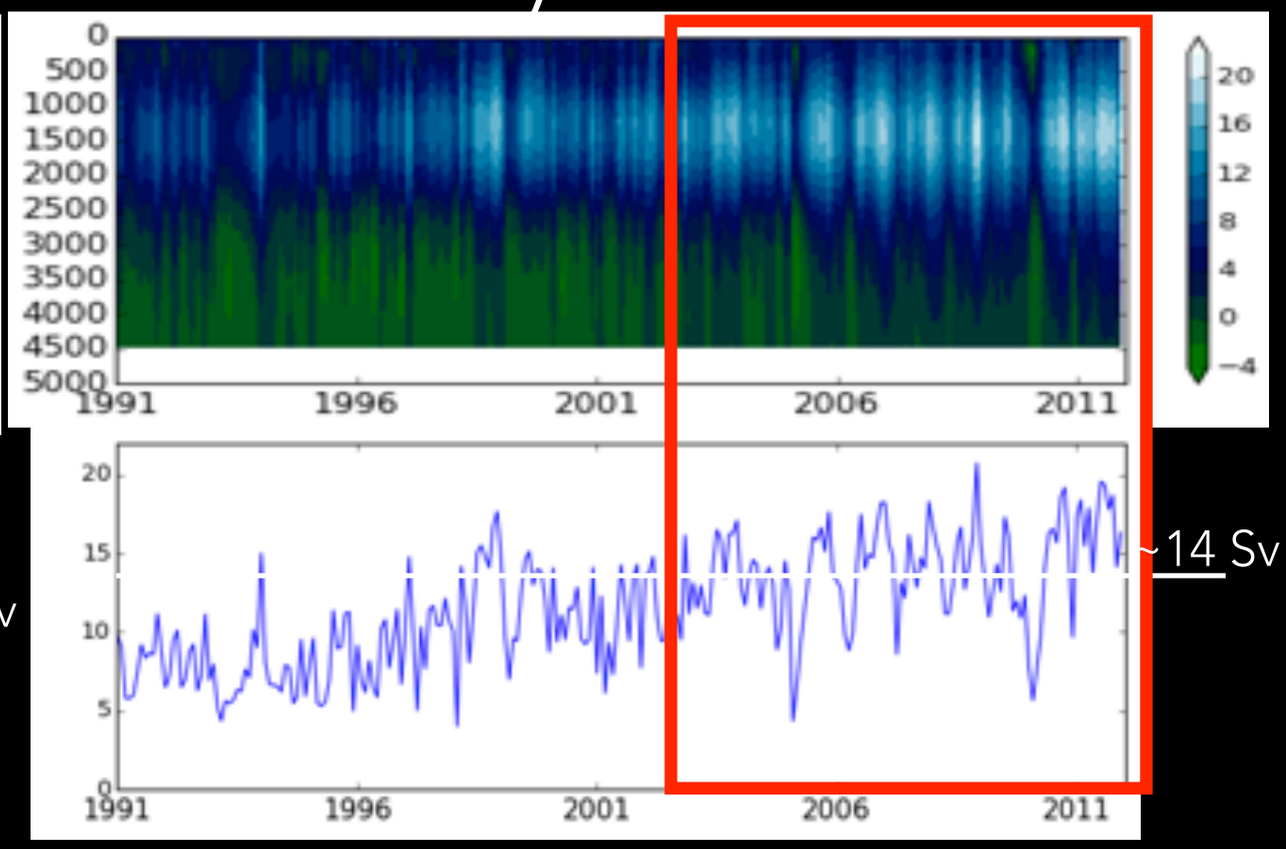
~18 SV

3DVar-GODAS



~10 Sv

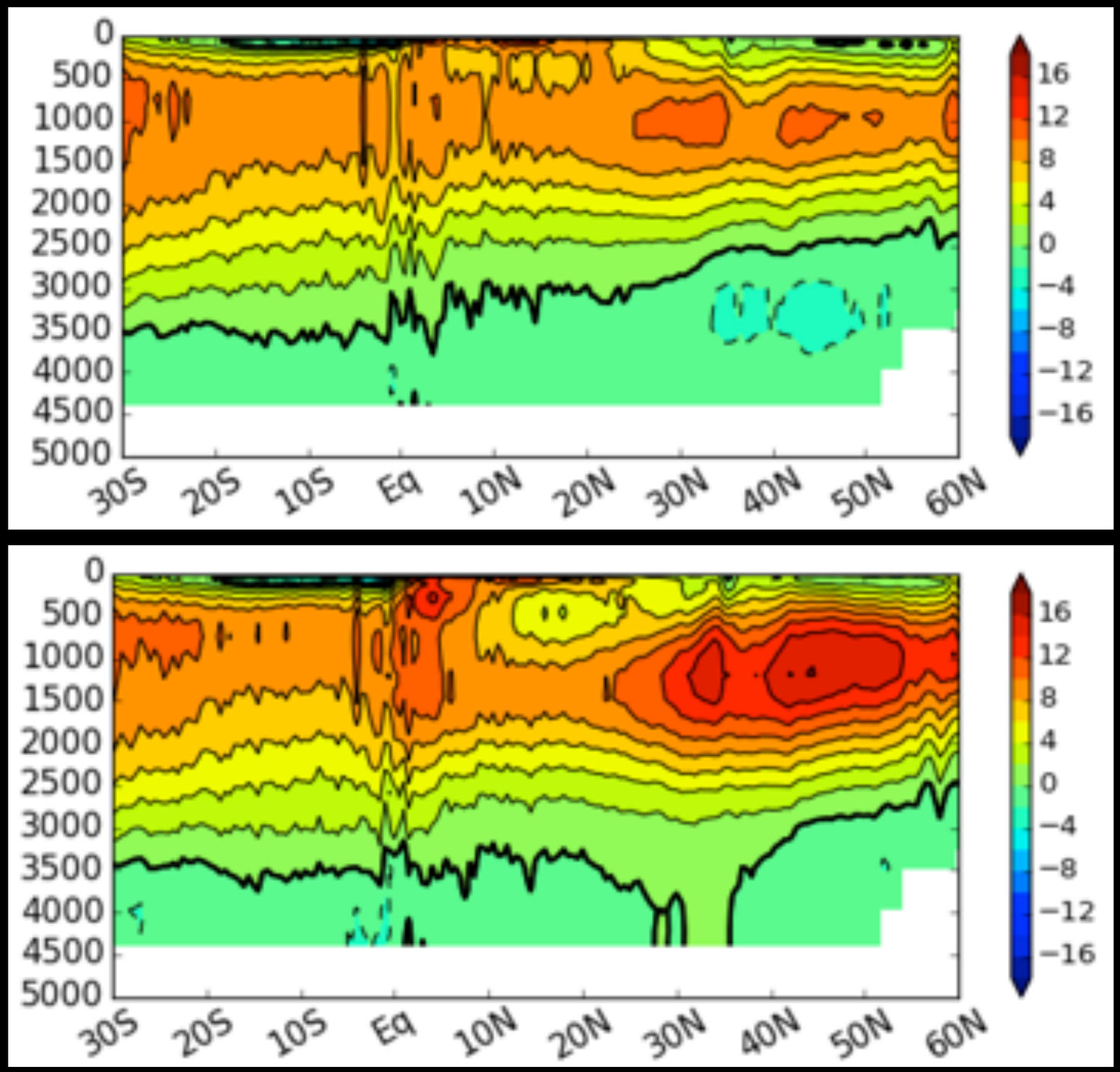
Hybrid-GODAS



~14 Sv

AMOC (1991-2011)

Similar increase throughout Atlantic

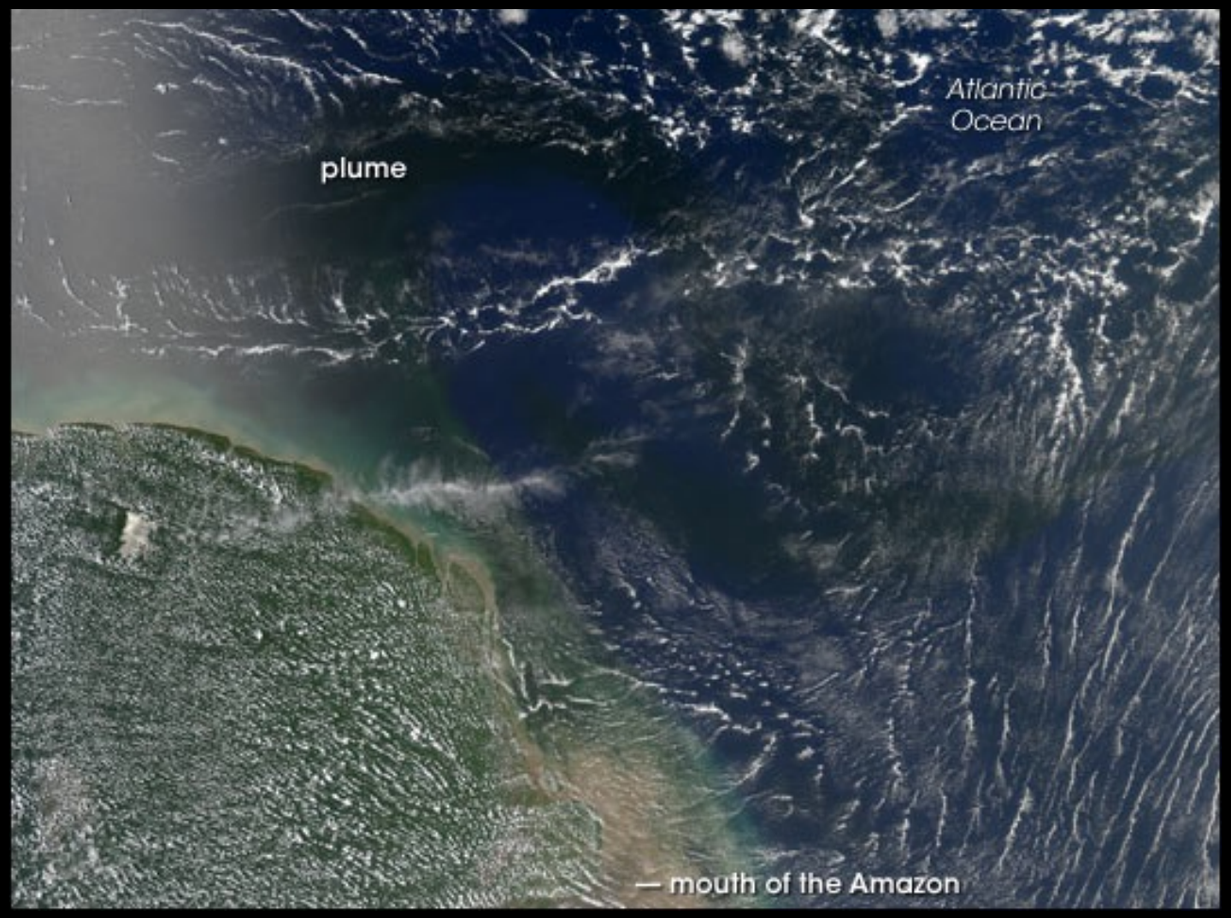


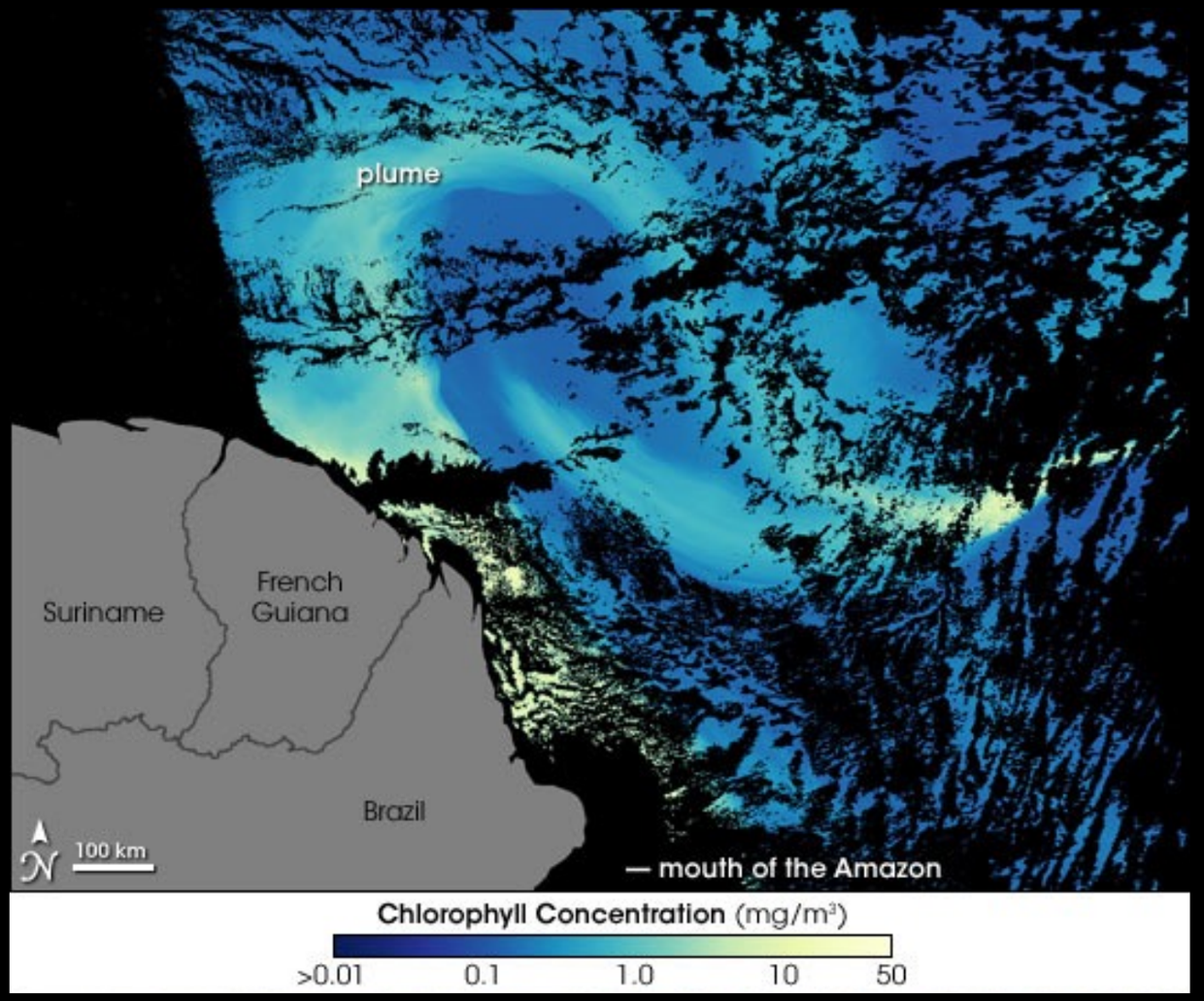
3DVar-GODAS

Hybrid-GODAS

EQUATORIAL ATLANTIC

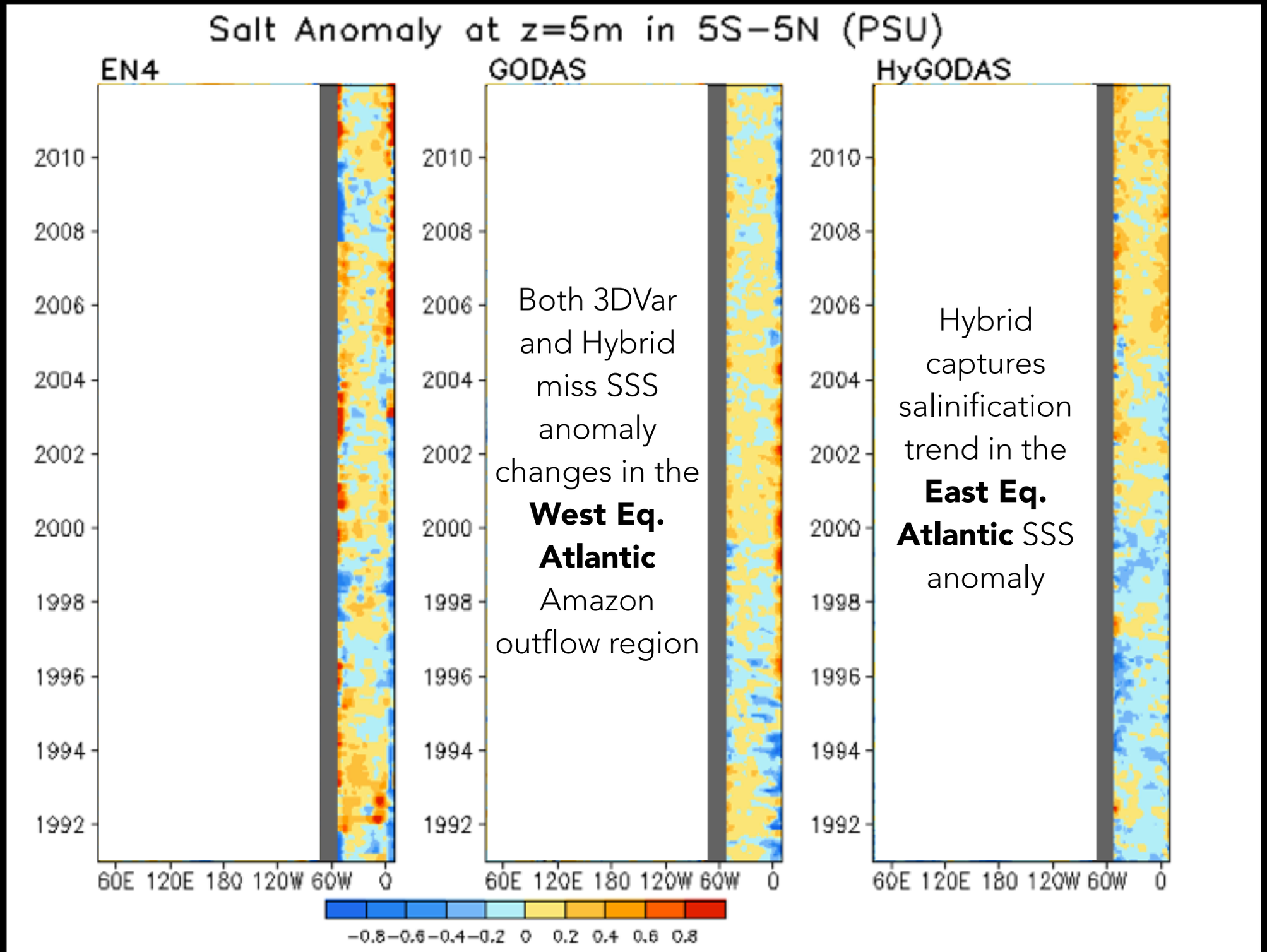
AMAZON OUTFLOW PLUME



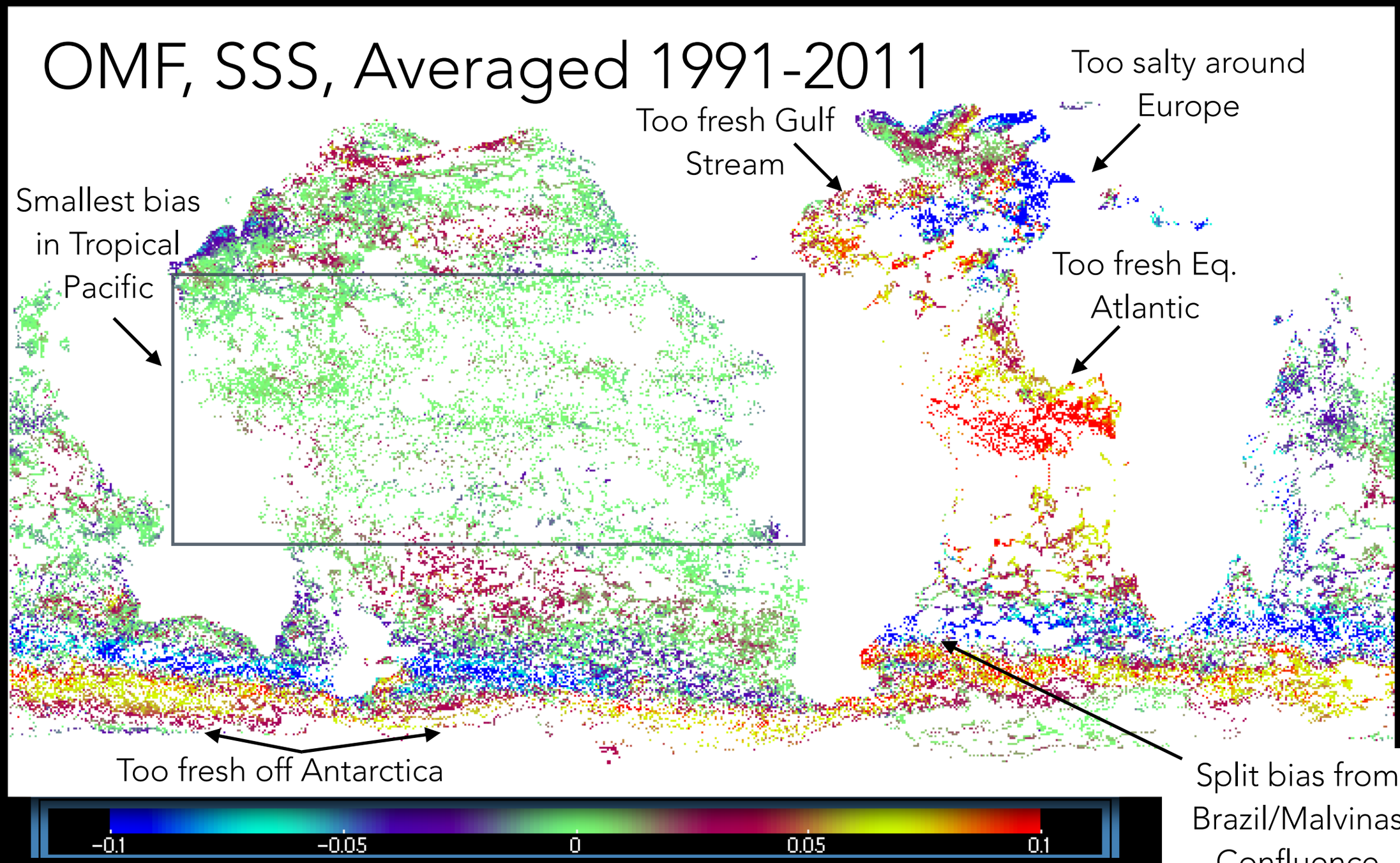


http://earthobservatory.nasa.gov/IOTD/view.php?id=7021

NEAR SURFACE SALINITY

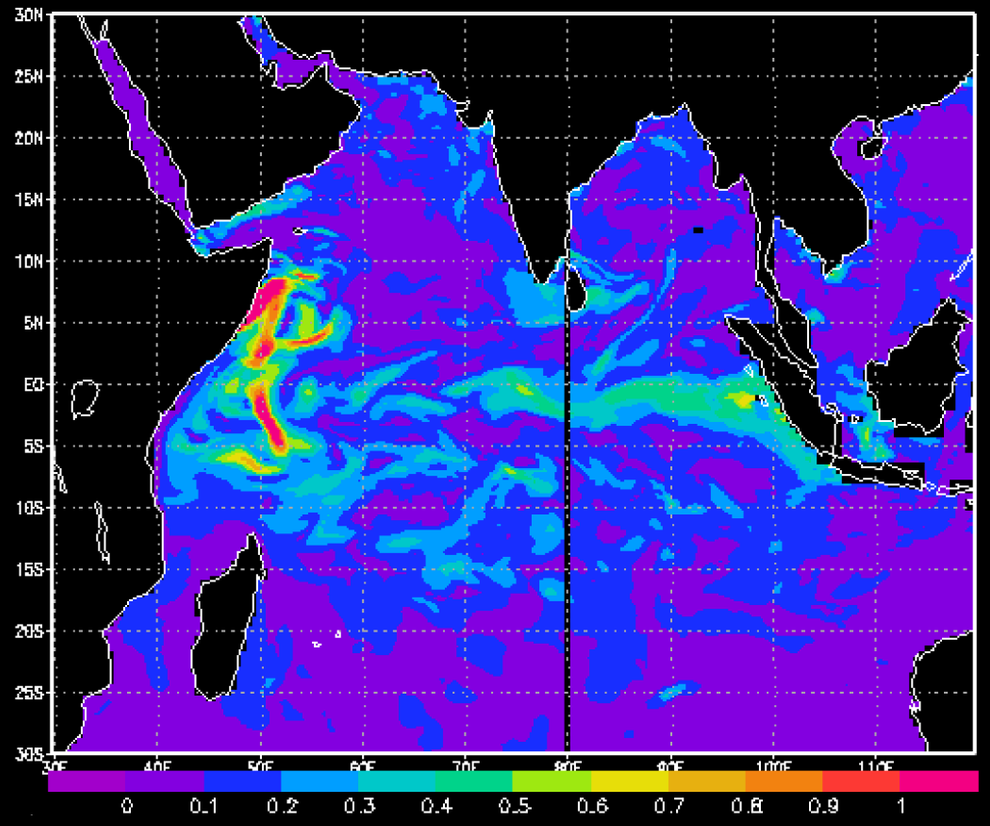


MODEL BIAS*, DIAGNOSED

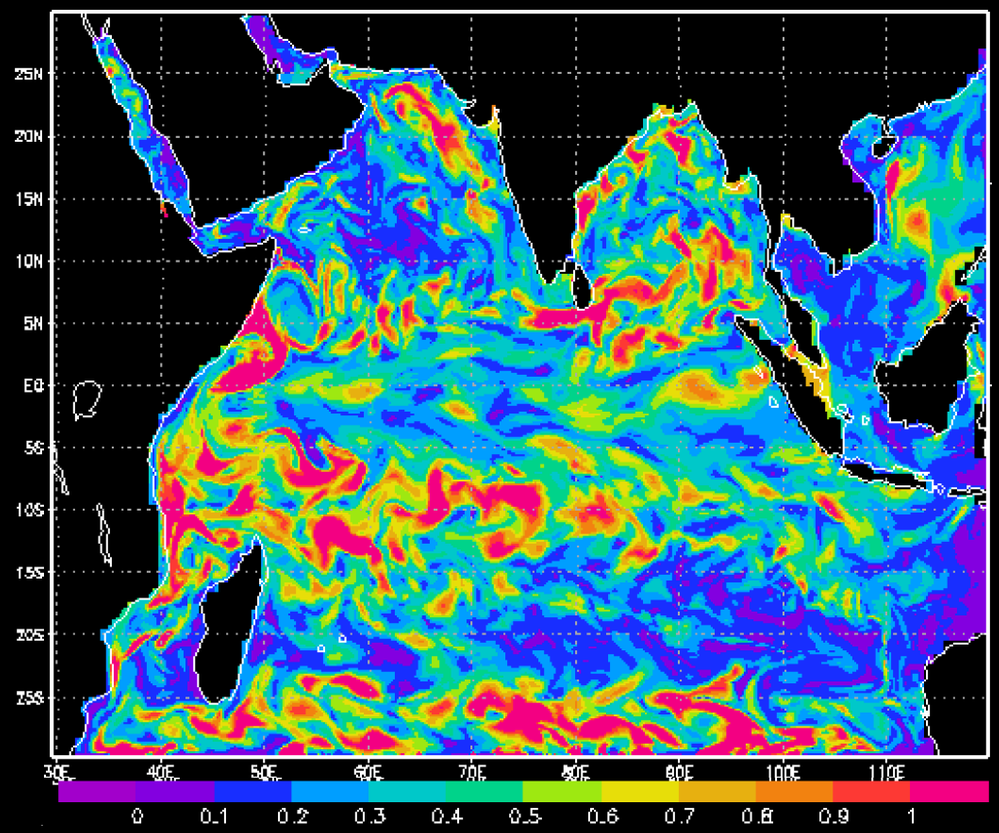


(*Model Bias = OGCM + Forcing)

ENSEMBLE SPREAD



1/2°x1/2° with refinement to 1/4° latitude at the equator (CFS GODAS resolution)



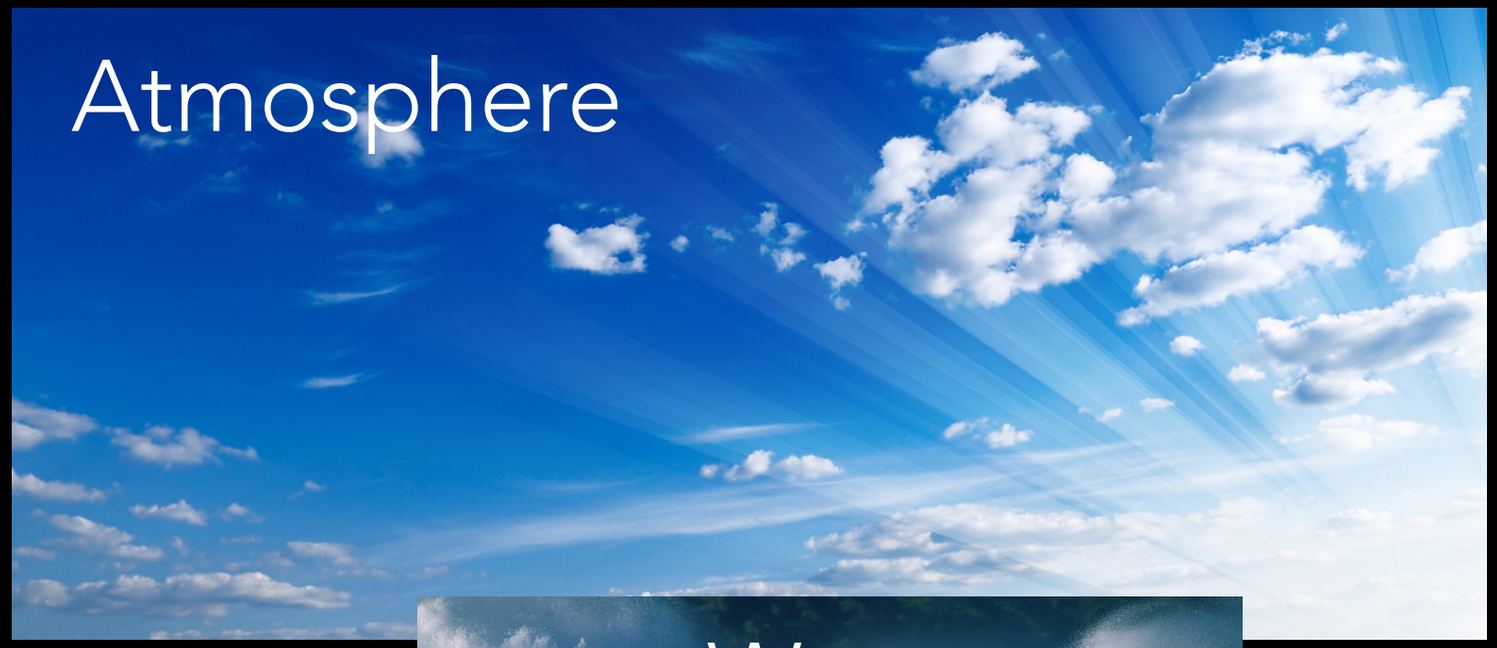
1/4°x1/4° with increased vertical resolution near the surface

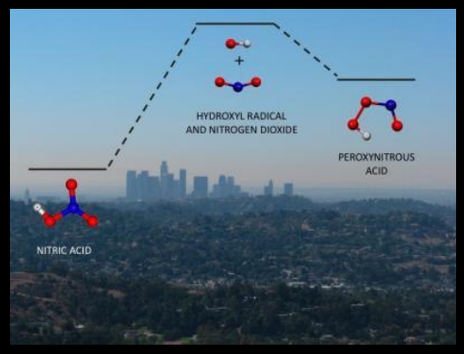
Both with MOM4p1, from collaborator Hasibur Rahaman (INCOIS)

-> Shift toward 1/4°x1/4° global MOM6 with 2m resolution near SFC

CLIMATE FORECAST SYSTEM V3

Atmosphere





Aerosol

Land

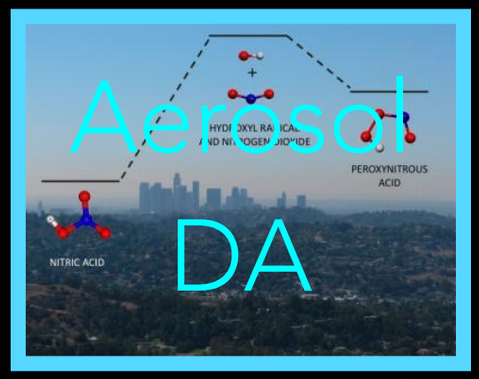
Wave

Sea Ice

Ocean

Current CFSv3
components

WEAKLY COUPLED DATA ASSIMILATION



Aerosol

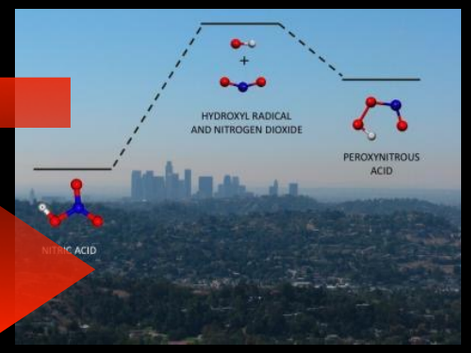
Land

Sea Ice

Current CFSv3 components

COUPLING ONLY ON FORECAST

Atmosphere



Aerosol

Land

Wave

Ocean

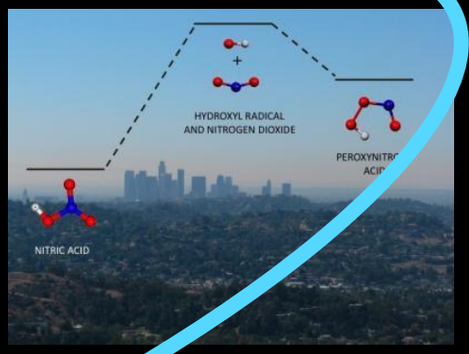
Sea Ice

Current CFSv3 components

STRONGLY COUPLED DATA ASSIMILATION

Atmosphere

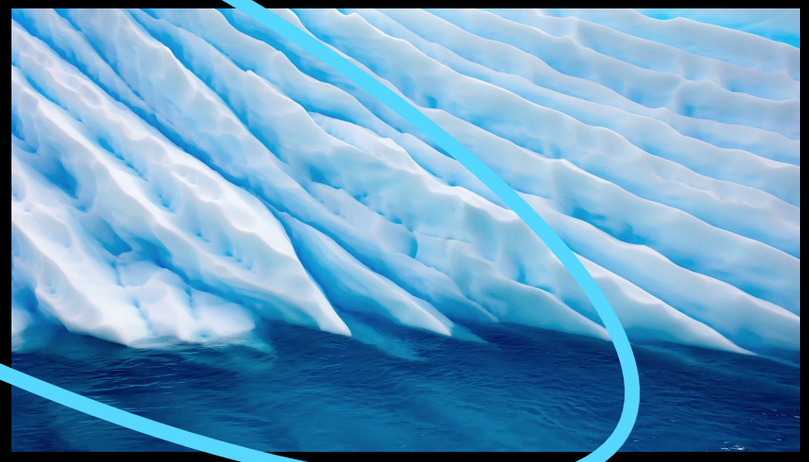
EACH DOMAIN IS INFLUENCED BY OBSERVATION INNOVATIONS FROM ALL OTHER DOMAINS



Aerosol

Land

Wave DA



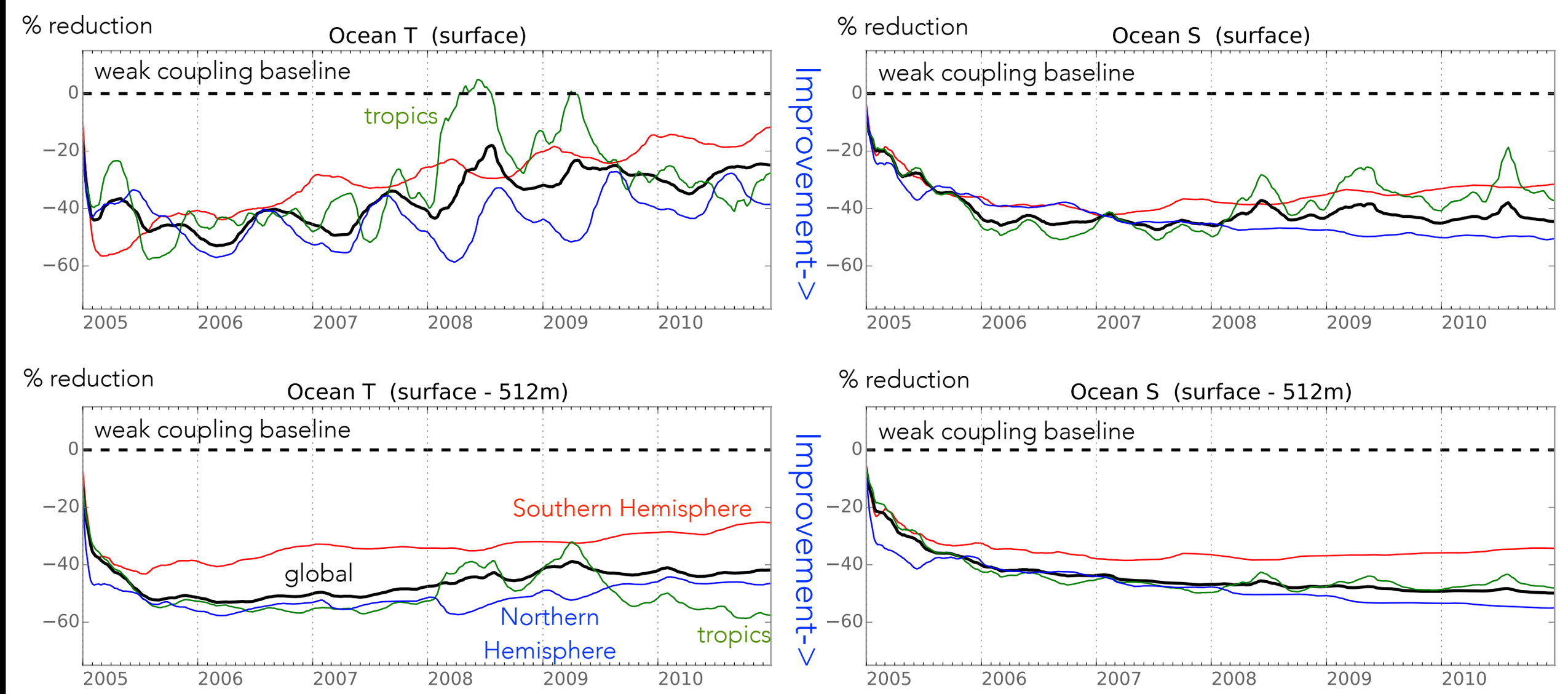
Ocean

Sea Ice

Current CFSv3 components

STRONGLY COUPLED DA REDUCES ERRORS (vs. weakly coupled DA)

For example, assimilating only atmospheric observations leads to significant improvements in ocean:



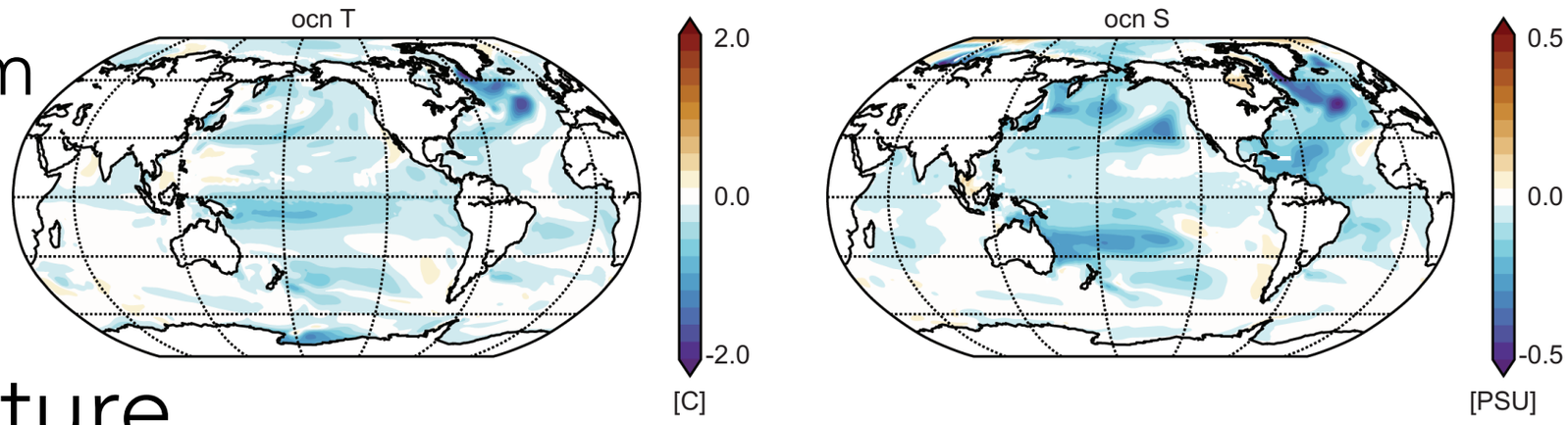
(Note: Observing System Simulation Experiments (OSSEs), not real data)

Sluka, T., S.G. Penny, E. Kalnay, T. Miyoshi, 2015: Using Strongly Coupled Ensemble Data Assimilation to Assimilate Atmospheric Observations into the Ocean. Submitted to GRL.

STRONGLY COUPLED DA REDUCES ERRORS (vs. weakly coupled DA)

Again, assimilating only atmospheric observations:

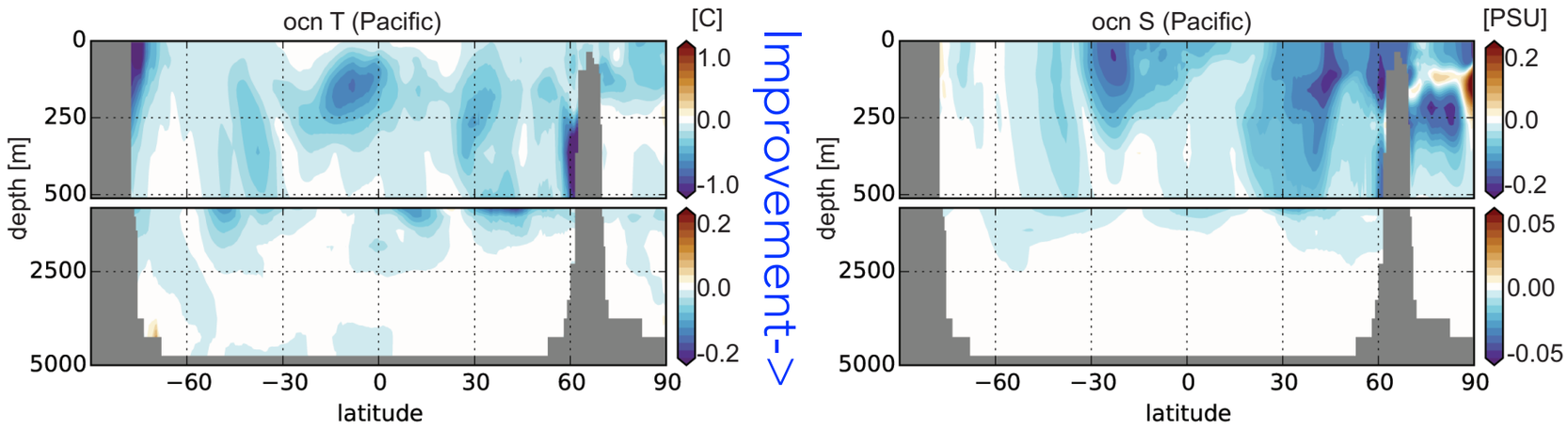
Upper 500m



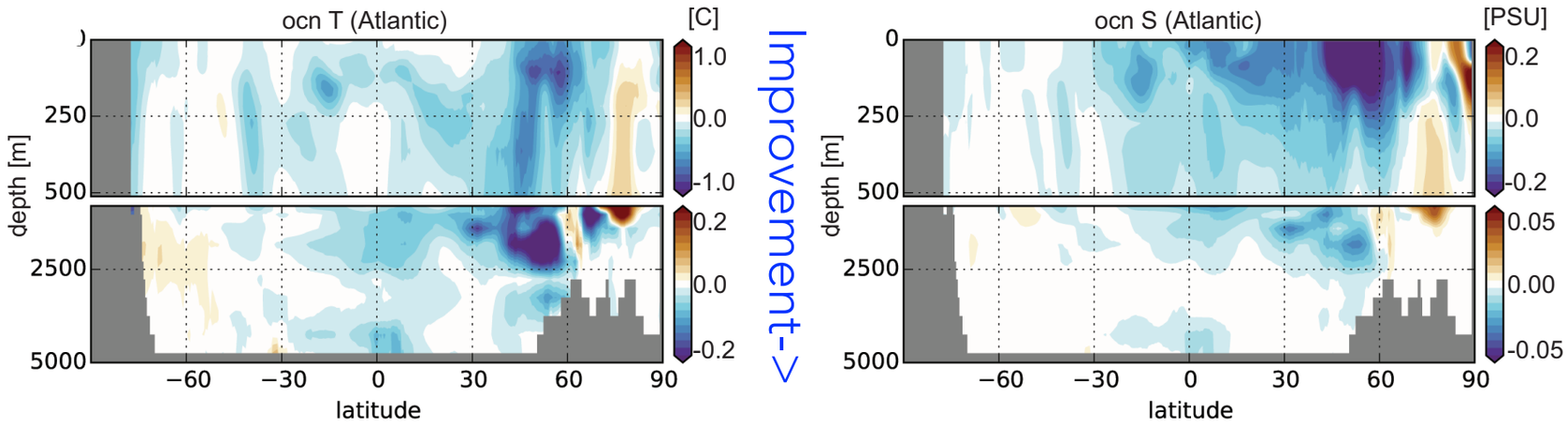
Temperature

Salinity

Pacific



Atlantic



Real-data experiments with the CFSv2 will come next.

NEXT STEPS

- Upgrade to GFDL MOM6 ocean model (1/4°x1/4°, 75 vertical layers with 2m surface layers) (NGGPS/R2O) {complete, pending testing}

- New observational data in the Hybrid-GODAS (satellite data, surface drifters, atmospheric data) (NGGPS/R2O) {in progress}

- Transitioning Hybrid-GODAS to operations

- Implementing Strongly Coupled DA in CFSv2 (India Monsoon Mission) and prototype CFSv3.

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