

An eddy-resolving ocean reanalysis using the 1/12° global HYbrid Coordinate Ocean Model (HYCOM) and the Navy Coupled Ocean Data Assimilation (NCODA) scheme

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HYCOM/NCODA Ocean Reanalysis

- Of those ocean reanalyses listed on <http://reanalysis.org>, only a few have eddy-permitting resolution and none are capable of fully resolving oceanic mesoscale features (eddies and current meanders) across the globe
- This project addresses the need for a long time period **eddy-resolving** ocean reanalysis
- Funded by the DoD Modeling and Simulation Coordination Office (M&S CO)
- Goal to the sponsor: provide physically consistent environmental scenarios for planning, wargaming and scenarios to support the warfighter
- Numerous other applications and research opportunities

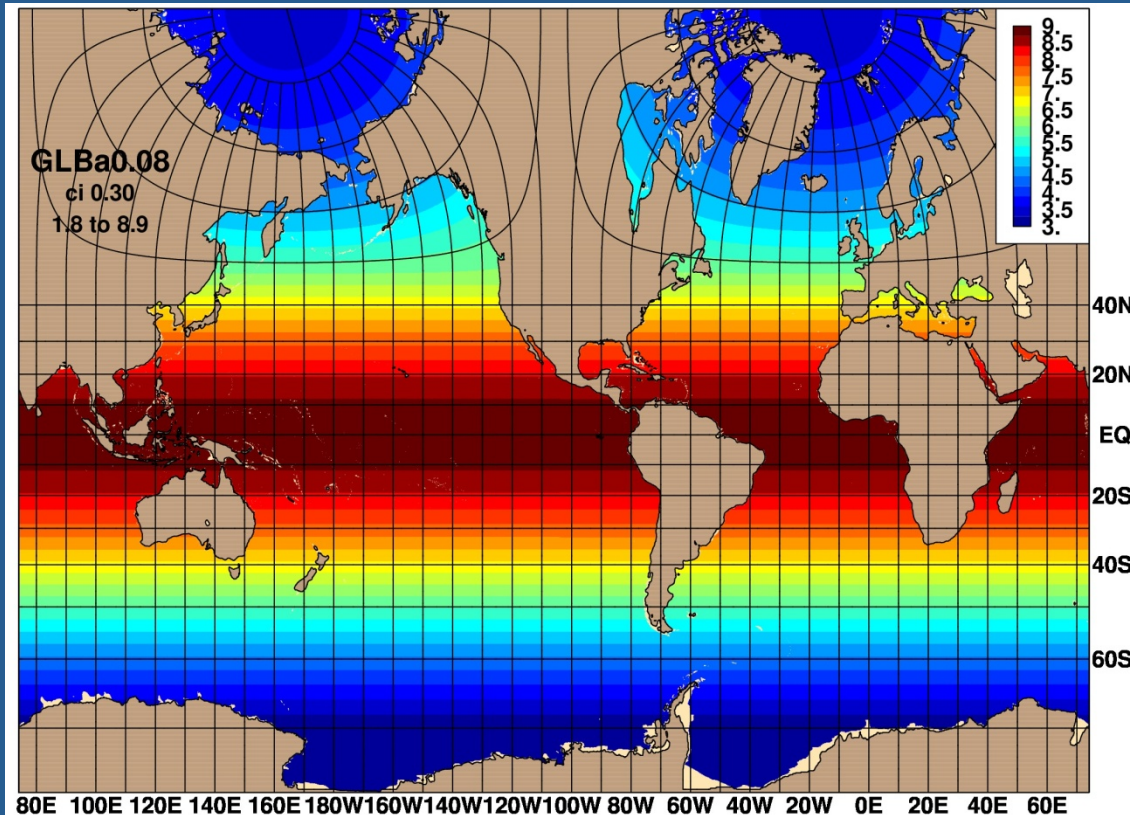
HYbrid Coordinate Ocean Model

Tri-pole latitudinal grid resolution (km)

Curvi-linear
grid: north
of 47°N

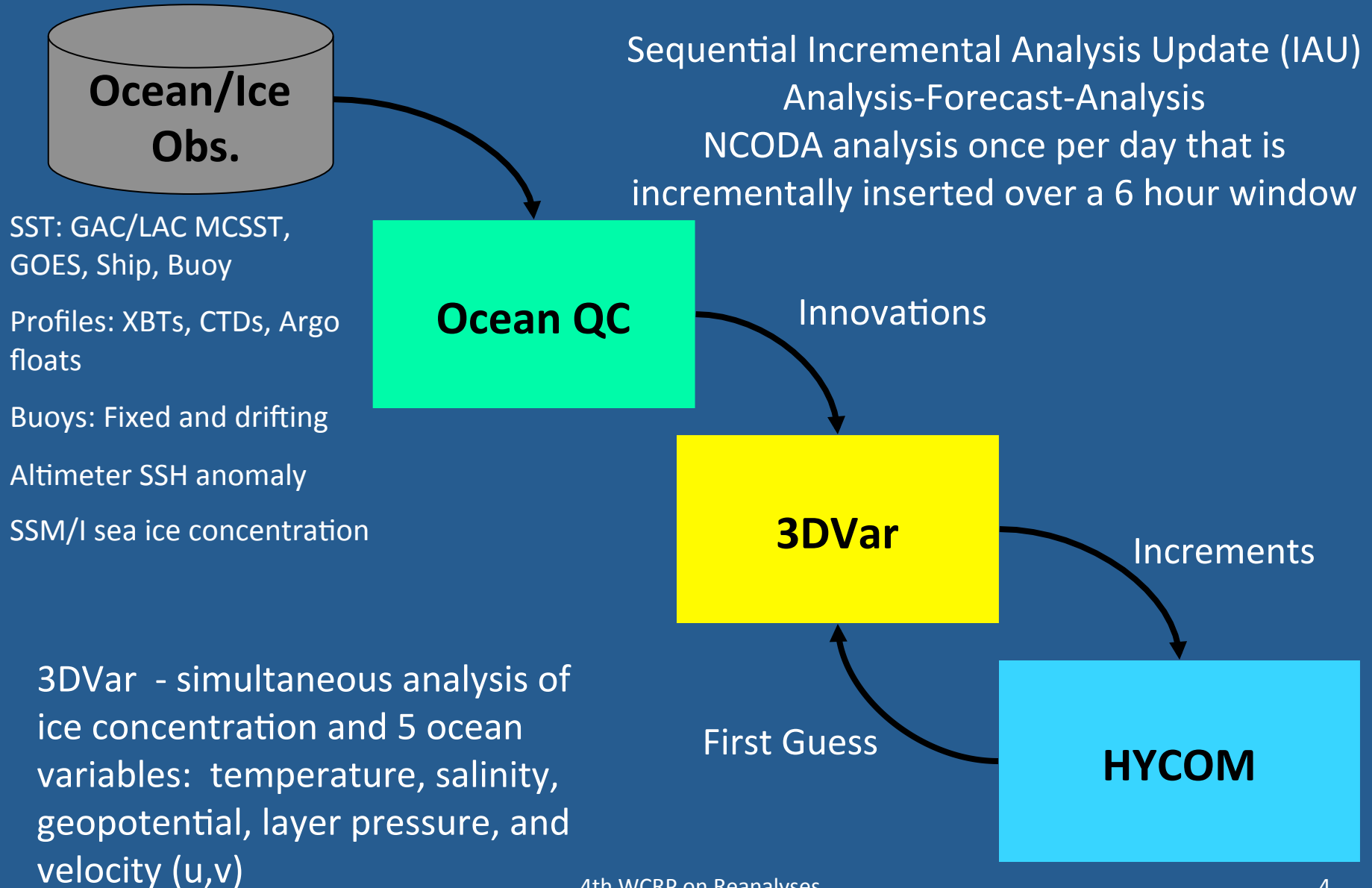
Mercator
projection:
66°S to
47°N

Uniform
cylindrical:
south of
66°S



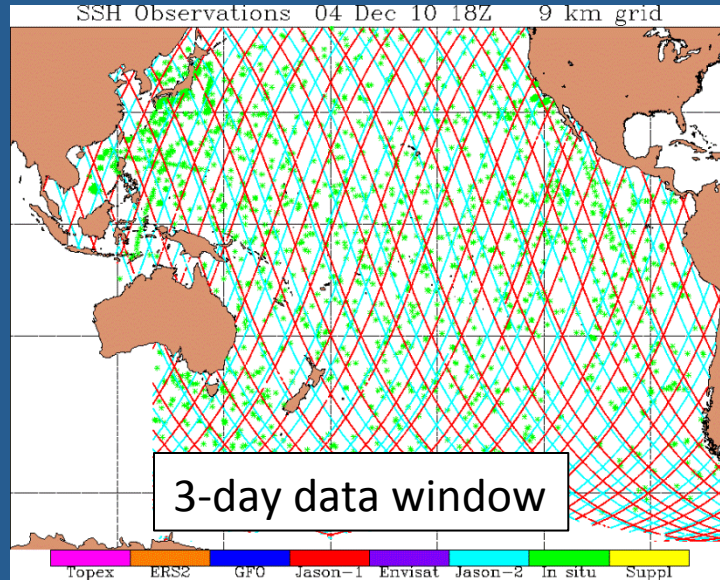
- 32 hybrid coordinate surfaces, thermobaricity, σ_2^*
- K-Profile Parameterization (KPP) mixed layer model
- Monthly river runoff
- Surface salinity relaxation to U.S. Navy GDEM4 climatology
- Thermodynamic “energy loan” ice model

Navy Coupled Ocean Data Assimilation

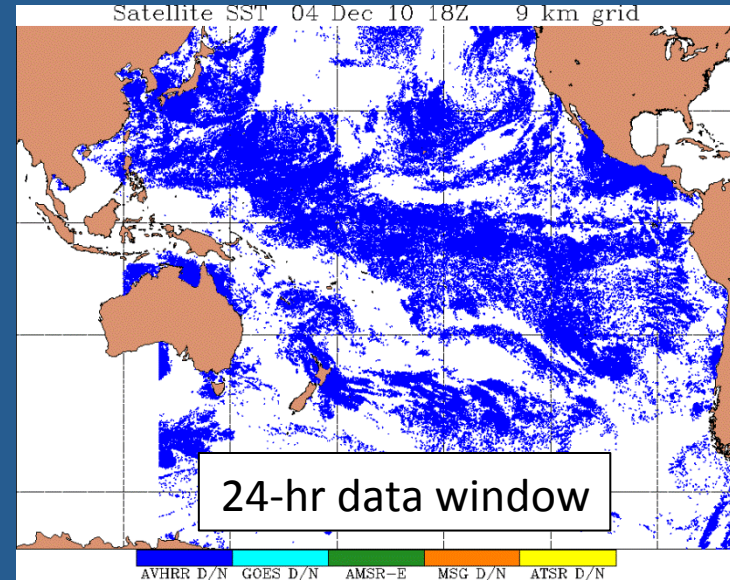


Observations to be Assimilated via NCOA

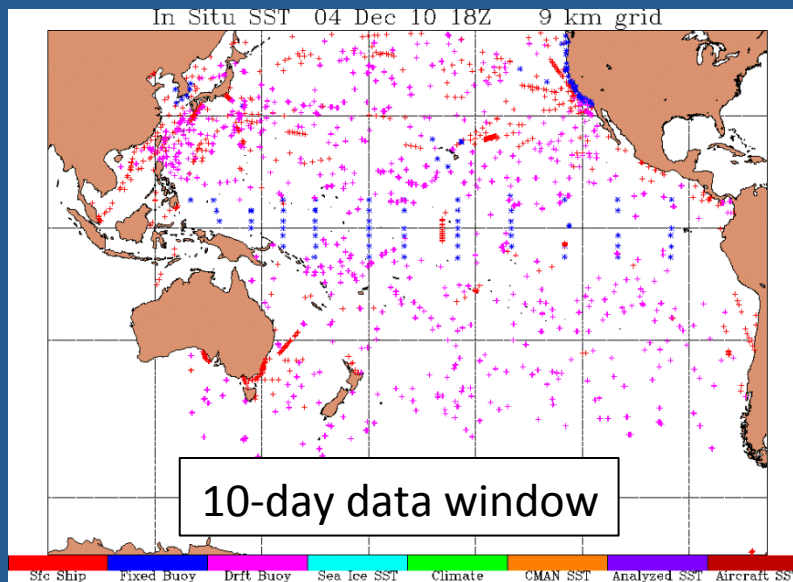
SSH Observations



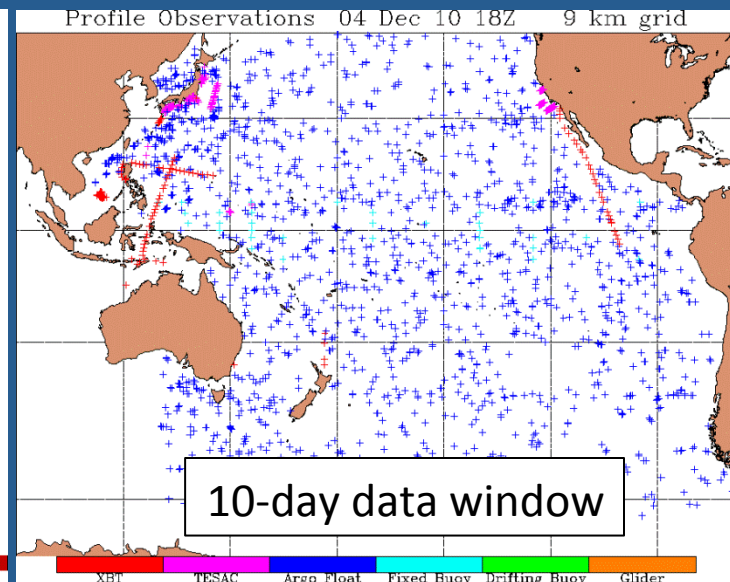
SST Observations



In-situ SST



Profile Observations

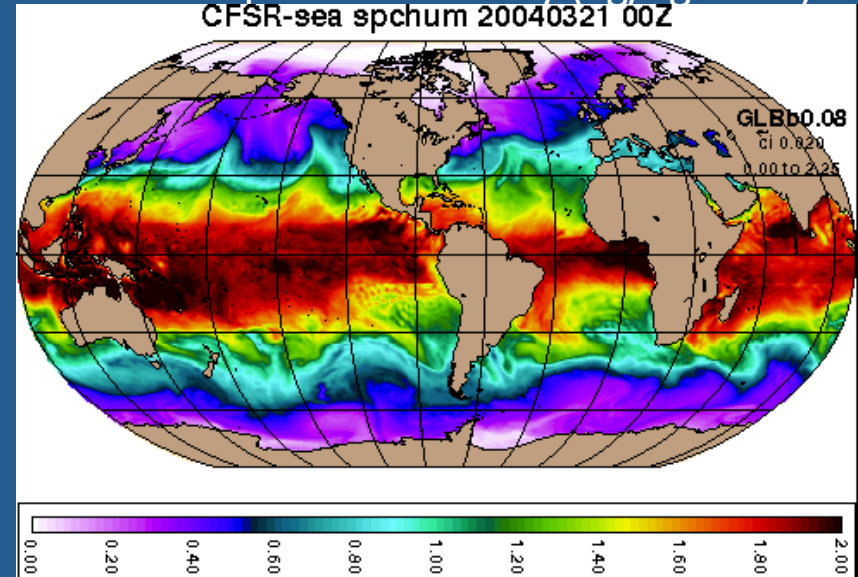


Atmospheric Forcing

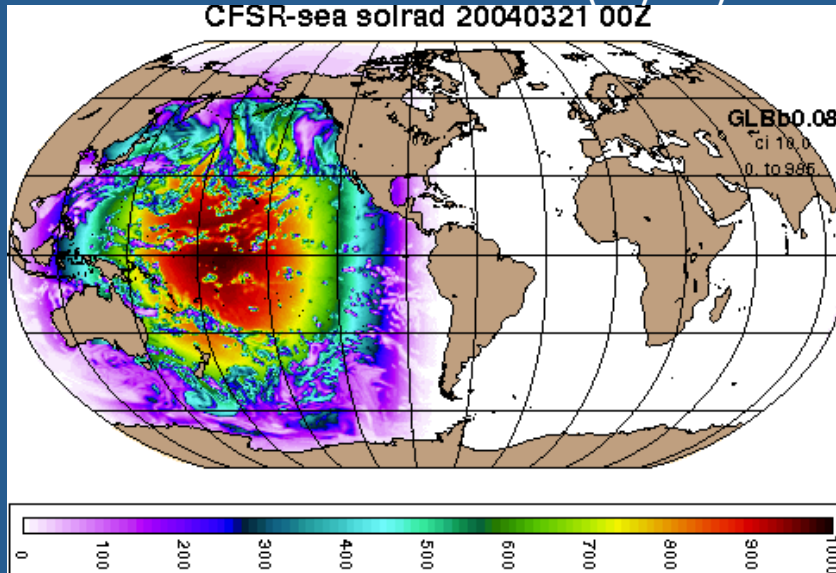
NCEP Climate Forecast System Reanalysis (CFSR)

- Time frame: 1993-2009 (altimeter period)
- Horizontal resolution: 0.3125° gaussian
- Temporal resolution: 1-hourly
- Inputs:
 - Bulk-derived wind stress
 - Wind speed
 - Radiative fluxes
 - Thermal fluxes
 - Precipitation

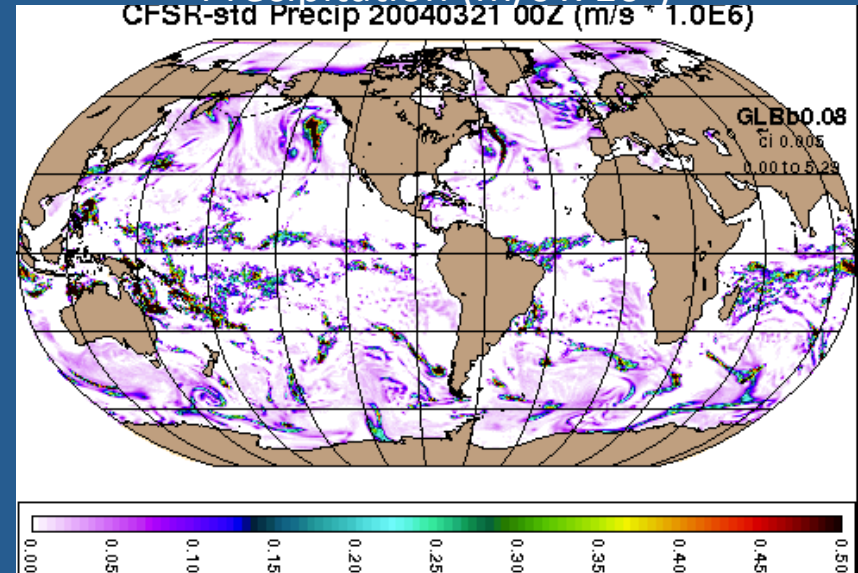
Surface Specific Humidity ($\text{kg/kg} \times 10^2$)



Net Surface Shortwave (W/m^2)



Precipitation ($\text{m/s} \times 10^6$)

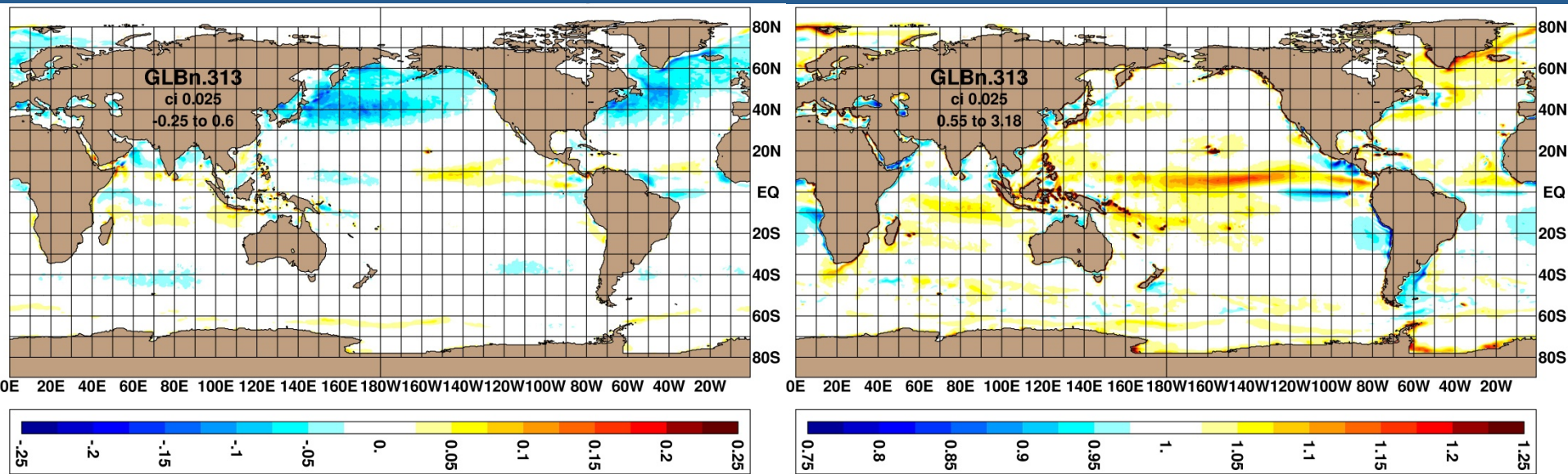


Modifications to CFSR Wind Forcing

QuikSCAT Scaling

Offset

Bias



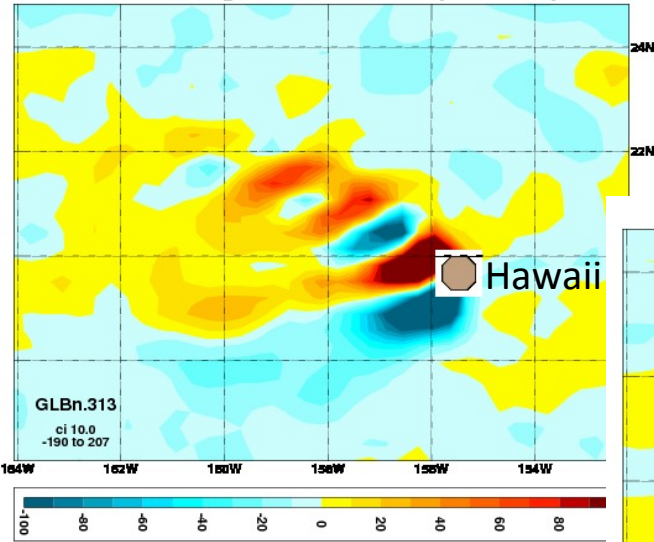
Based on a regression analysis from 11 years (1999-2009) of monthly contemporaneous CFSR and QuikSCAT wind speed data

Modifications to CFSR Wind Forcing

Wind Stress Curl – August 2009

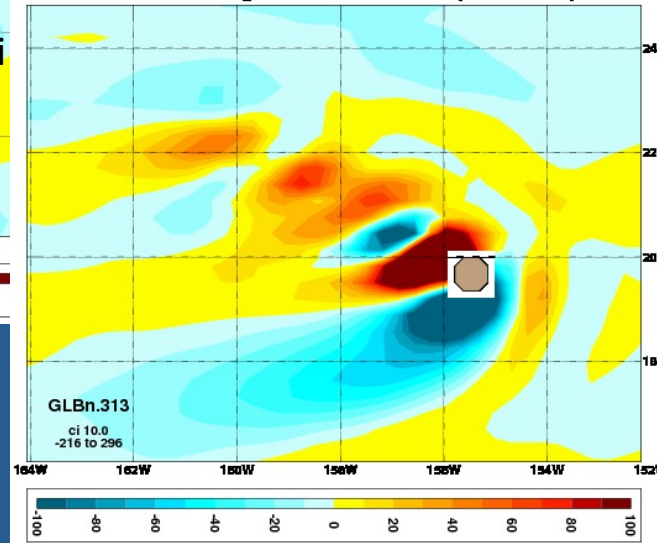
QuikSCAT

QScat-std August 2009 Wind Curl (10^8 Pa/m)



CFSR after correction

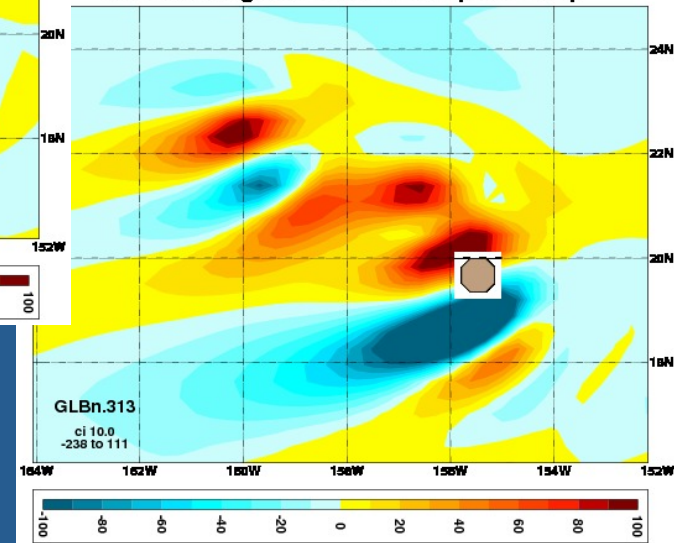
CFSR-sec2 August 2009 Wind Curl (10^8 Pa/m)



More realistic curl over Hawaii after QuikSCAT correction

CFSR before correction

CFSR-sea August 2009 Wind Curl (10^8 Pa/m)



Wind stress curl plotted over Hawaii on the 0.3125° CFSR grid

Pre Spin-up Simulations

- 1-layer barotropic linear $1/16^\circ$ Navy Layered Ocean Model simulation using the CFSR climatology to determine the 1st order Sverdrup response to the wind forcing
- 0.72° and 0.24° global HYCOM (non-assimilative) using the 1993-2009 CFSR climatology
 - Compared these against existing simulations forced with different atmospheric products and found no gross errors in ocean model response

Spin-up and Reanalysis Simulations

- Spin-up 1/12° **non-assimilative** global HYCOM with CFSR climatology (12 model years) - **done**
- Extend climatological spin-up with 1993-2009 1-hourly CFSR forcing using 1/12° **non-assimilative** global HYCOM – **done**
- Extend climatological spin-up with Oct 1992-2009 1-hourly CFSR forcing using 1/12° **assimilative** HYCOM/NCODA – **started**
 - Begin in Oct 1992, allow 3 month adjustment period

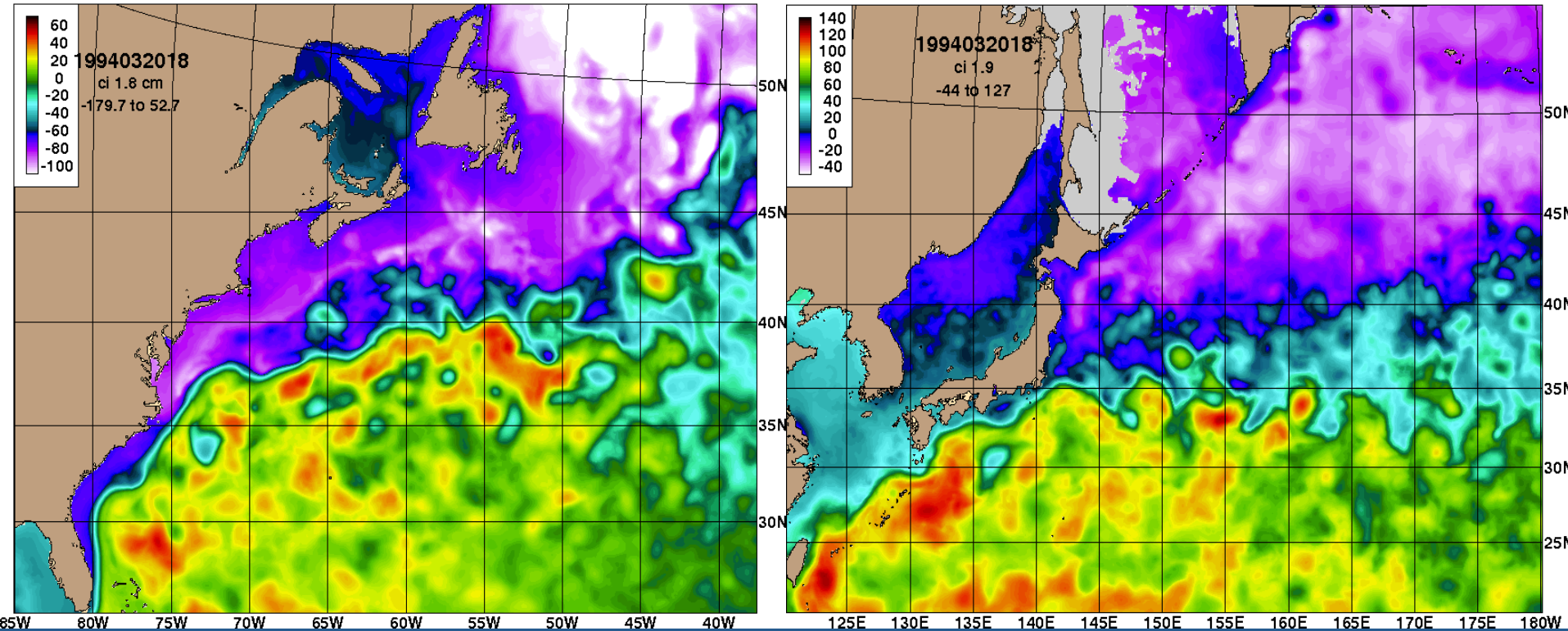
Preliminary Results

SSH animation: Gulf Stream and Kuroshio

Month-long animation: 21 March – 20 April 1994

sea surf. height Mar 21, 1994 00Z [12.3H]

SSH Mar 21, 1994 00Z 12.3



TOPEX/POSEIDON only altimeter flying at this time

Gray area = sea ice

Computational Requirements

- Computer time via the DoD High Performance Computing Modernization Office
- Currently integrating the ocean reanalysis on the Navy DoD Supercomputing Resource Center (DSRC) IBM Power 6
- Using 949 processors
 - Integrate ~10 model days every 24 hrs of wall time
 - 17 year reanalysis will take ~1³/₄ years to complete

Output and Storage

- HYCOM 3D native grid archive files (compressed):
 - Single hour: ~7 Gb
 - Saving 3-hourly output:
 - ~20 Tb / model year
 - ~340 Tb for the entire reanalysis
- HYCOM 3D constant $.08^\circ$ grid ($\pm 80^\circ$ lat) netCDF files remapped to 40 z-levels (compressed):
 - Single hour: ~1.2 Gb
 - Saving 3-hourly output:
 - ~3.5 Tb / model year
 - ~59 Tb for the entire reanalysis
- Subset of the output to be placed on the hycom.org data server
 - Still to be determined