LOM – Layered Ocean Model Workshop, 2-4 June 2015, Copenhagen

ASSIMILATION OF SEA SURFACE HEIGHT ANOMALIES INTO HYCOM FOR SOUTH ATLANTIC AND OLAM REGIONAL CLIMATE PREDICTION

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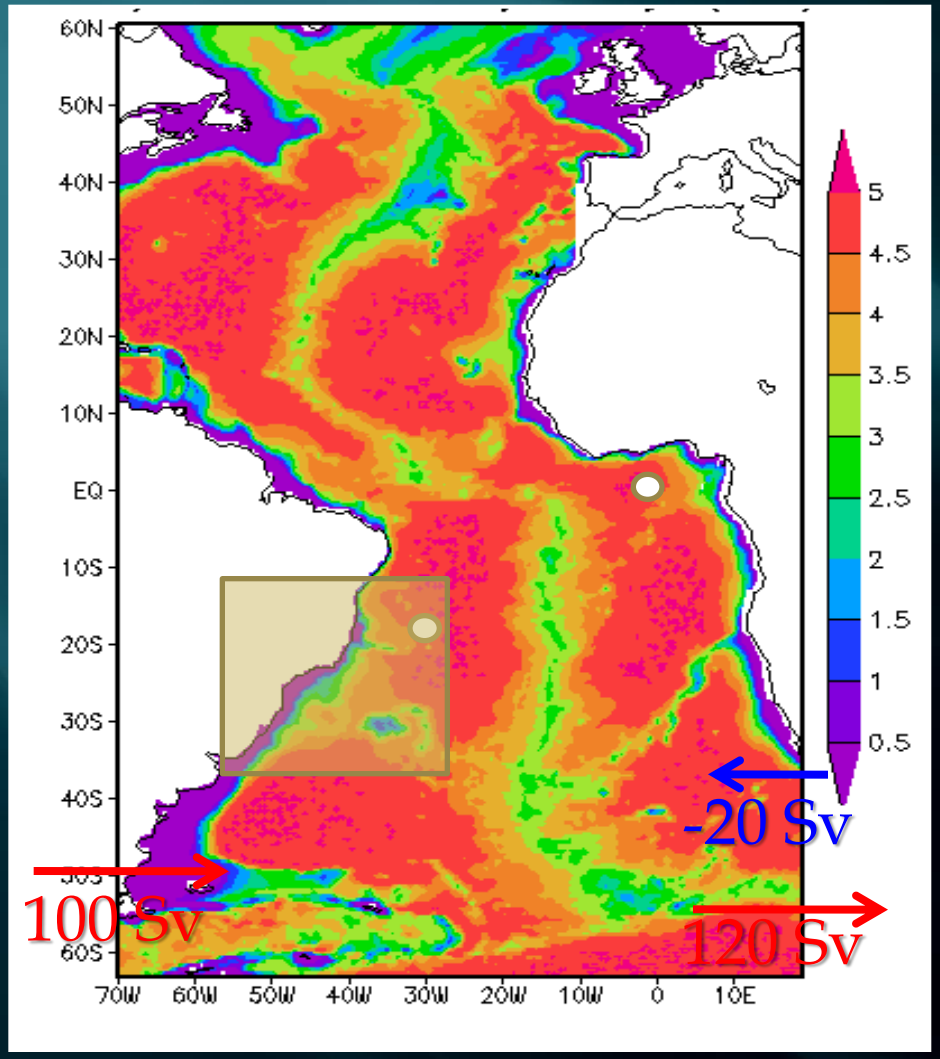
Overview

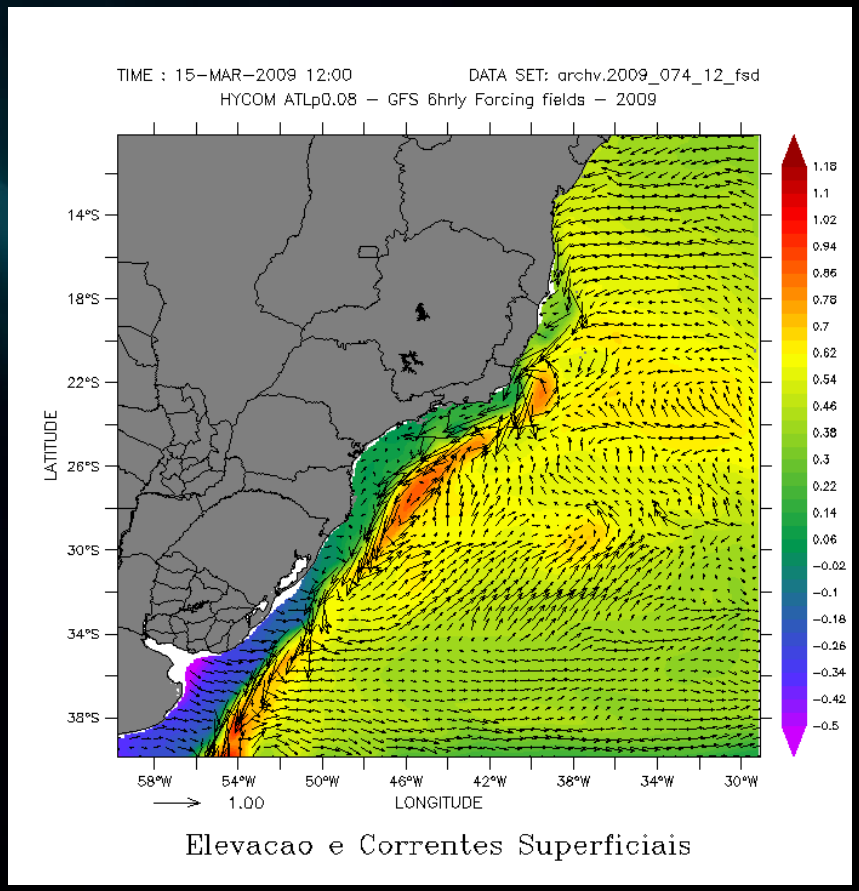
- Historical overview of HYCOM operational for Brazil
- SSH satellite data assimilation
- Ocean-Atmosphere interaction (Mesoscale systems, Regional climate downscaling, Seasonal forecasting, Extreme events)
- HYCOM-OLAM coupling

HYCOM Preliminary operational system – Grid 1/3 (22 levels)

Spin-up COADS 30 years (USP-UFBA)
2007/2008 – NCEP atmospheric forcing



HYCOM Grid nesting
1/12 degree



GFS Atmospheric forcing use on the operational HYCOM Forecasting System

6-hourly GFS (*Global Forecast System*)

Δx = 0.5 degree

7-day forecast

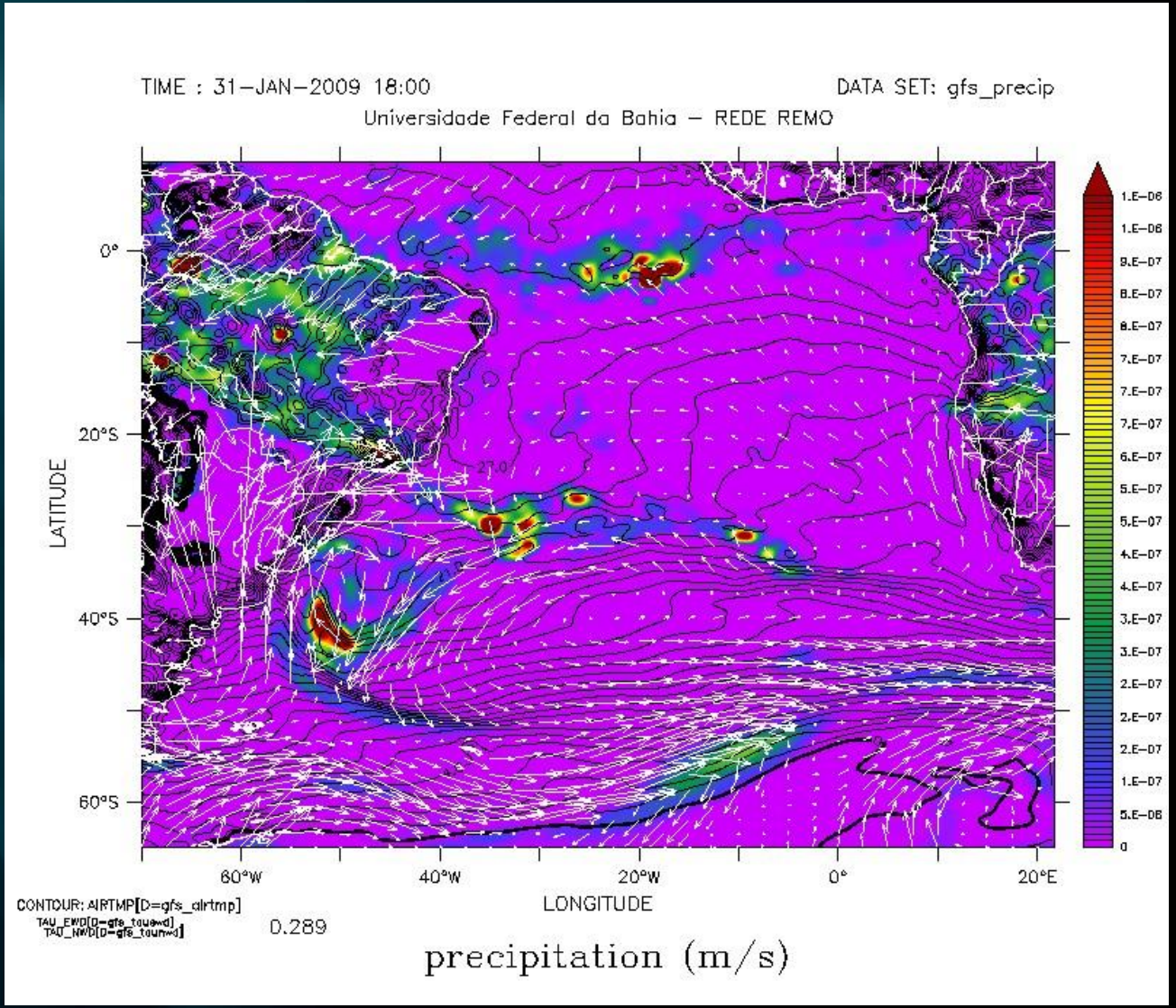
Wind shear;

Temperature;

Precipitation

Humidity

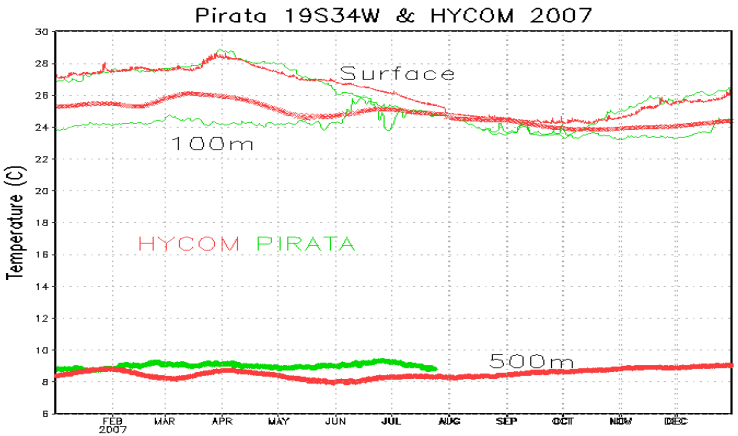
Radiation.

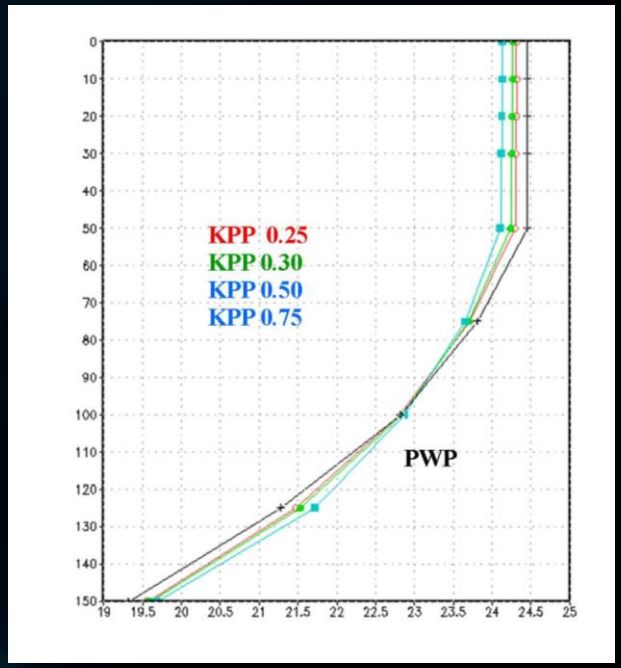


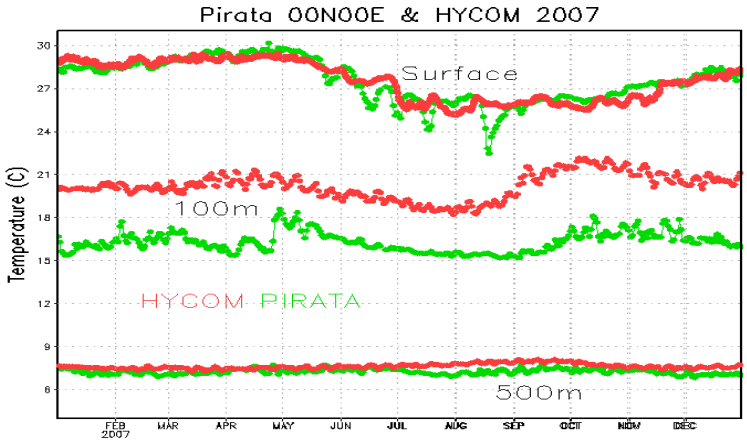
HYCOM Model evaluation & tests

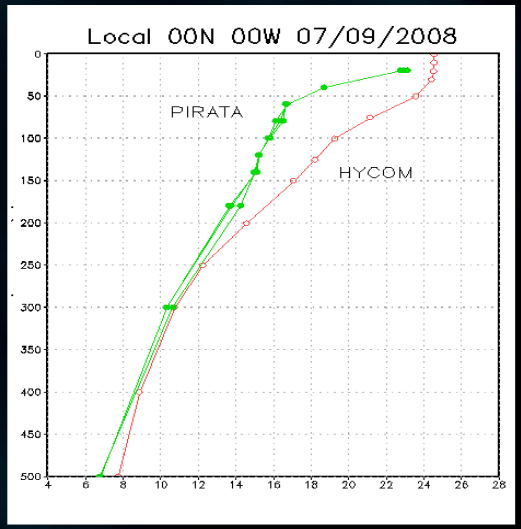
Several tests were performed to evaluate the KPP parametrization.

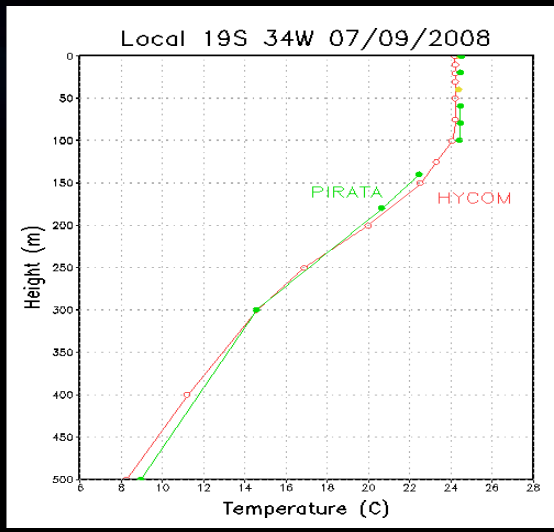
Temperature was warmer than observations (e.g. 100m) at Pirata profile sites.







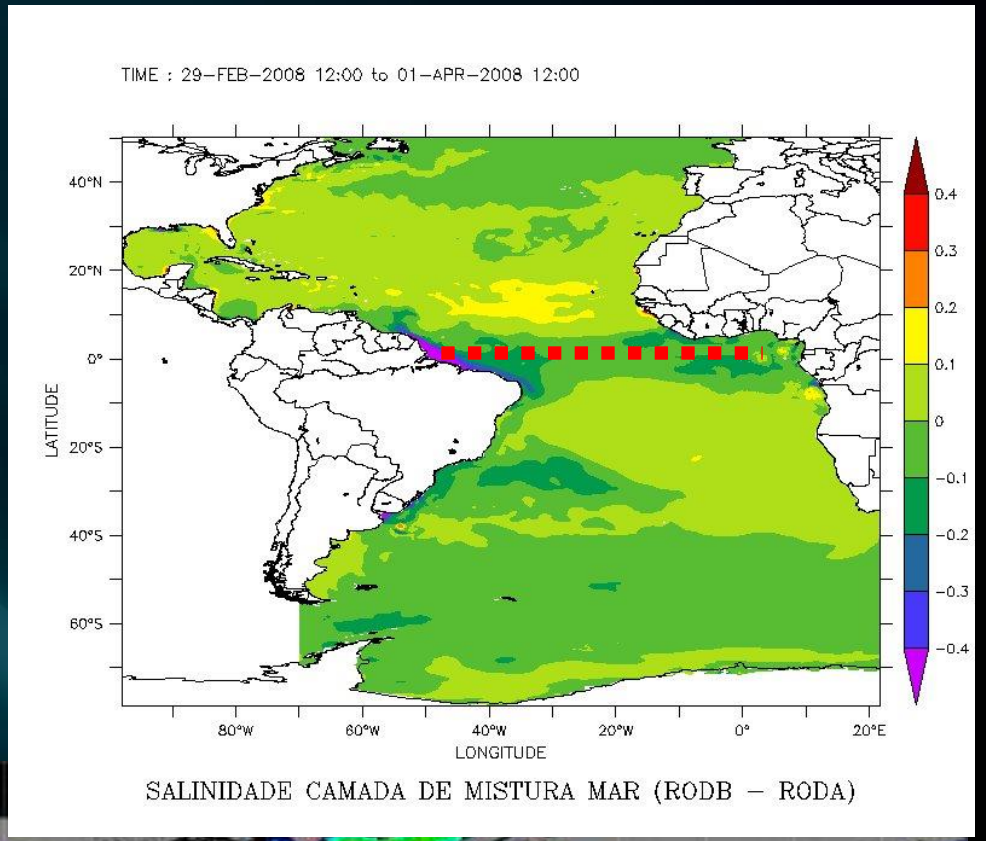


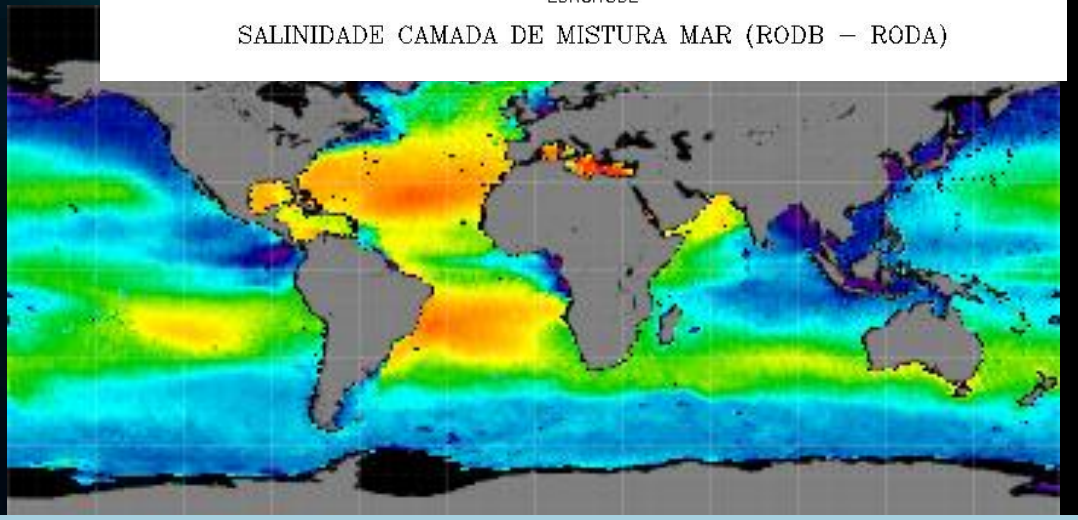


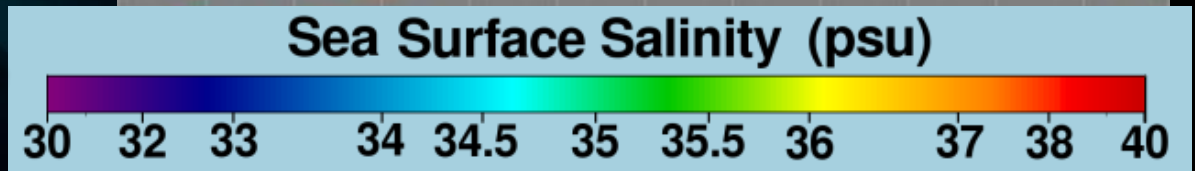
HYCOM
Sensitivity tests for the precipitation impacts on the salinity.

Grid ¼
NCEP reanalysis forcing

March 2008





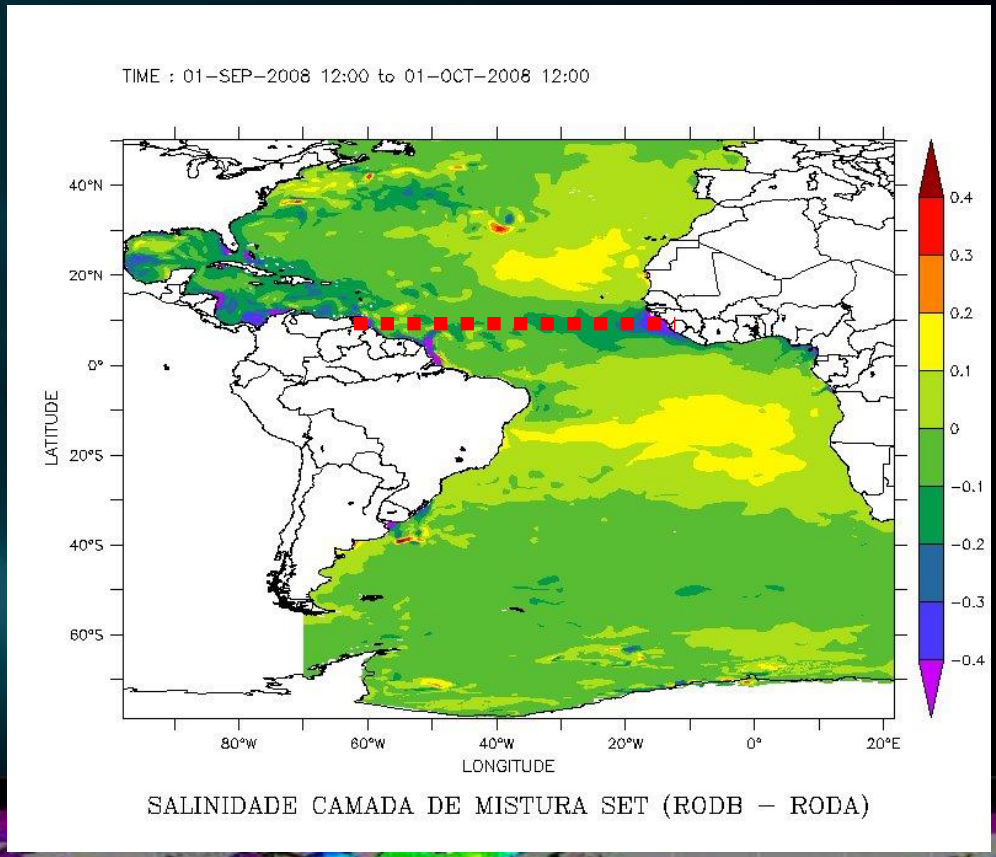


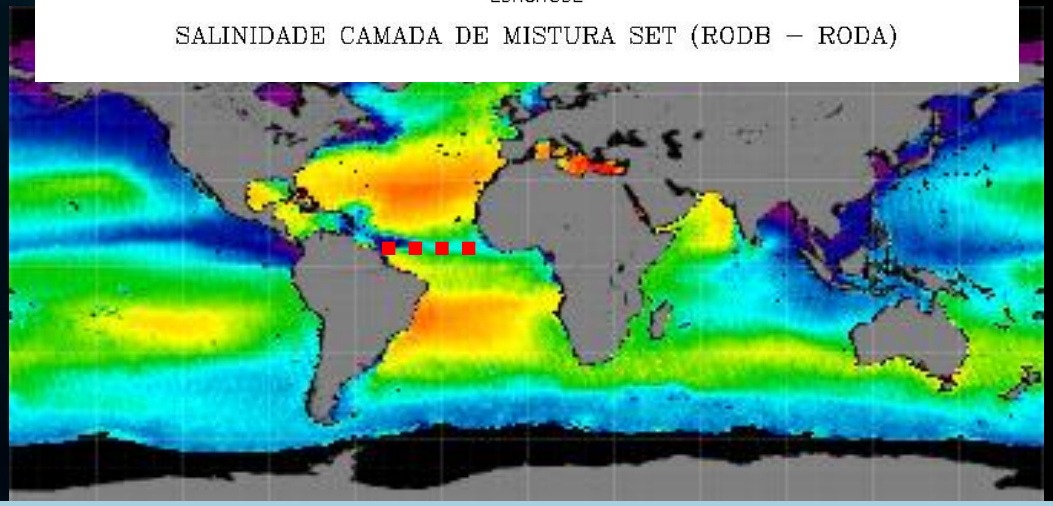
Aquarius Satellite Climatology

HYCOM
Sensitivity tests for the precipitation impacts on the salinity.

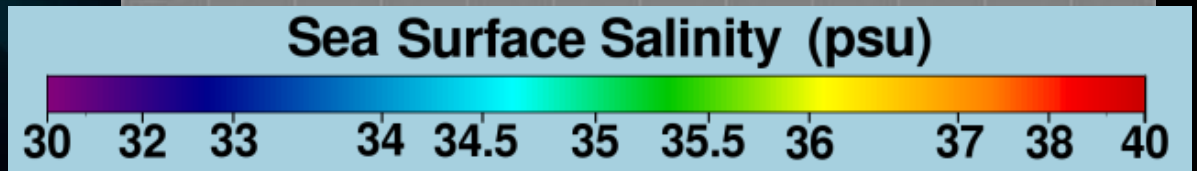
Grid ¼
NCEP reanalysis forcing

September 2008



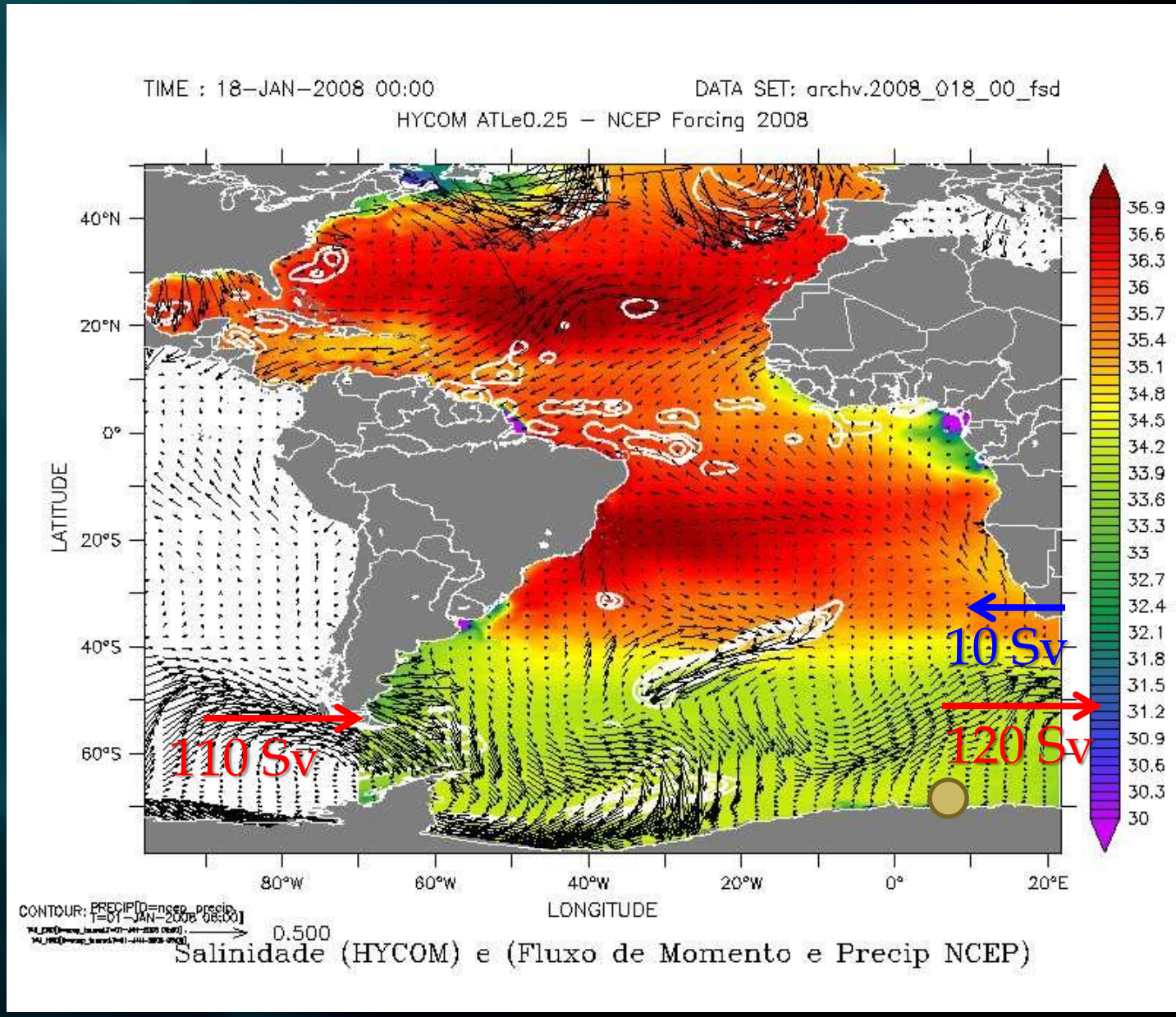


Aquarius Satellite Climatology



HYCOM New grid for Atlantic Ocean

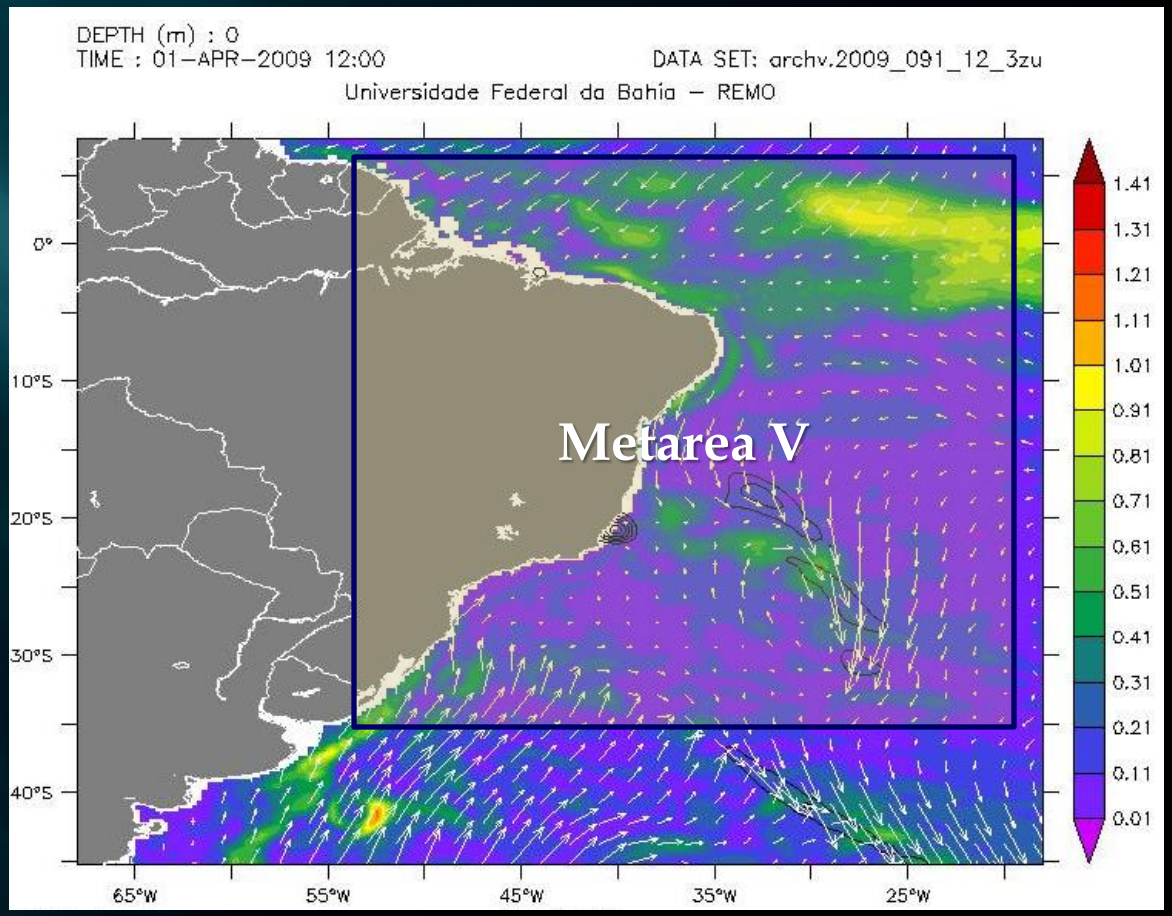
- Spin-up
- COADS
- NCEP: 2008, June-2009



HYCOM 1st operational tests started on 1st September 2008

HYCOM New 1/12 nested grid / Nave Metaarea5

- Implementation of the 1/12 grid;
- The domains is slight larger than the Navy Metaarea V;
- Try do avoid the confluence between the Brazil current with the Malvinas current.



HYCOM SSH assimilation

Jason-1 Jason-2; Filtering; Optimal Interpolation
7-day Window; Cooper & Haines
1st July -31st Dec. 2009

Jason 3 (July 2015) !!!

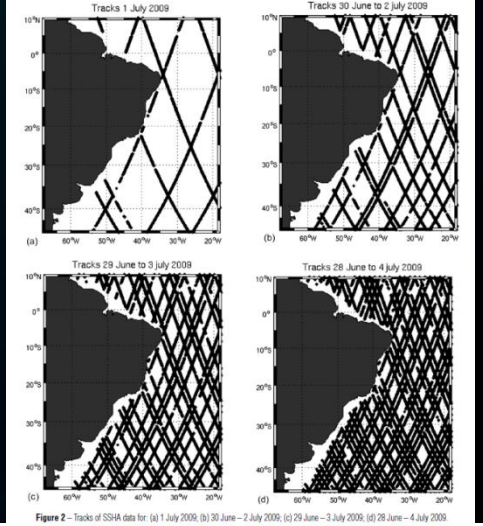
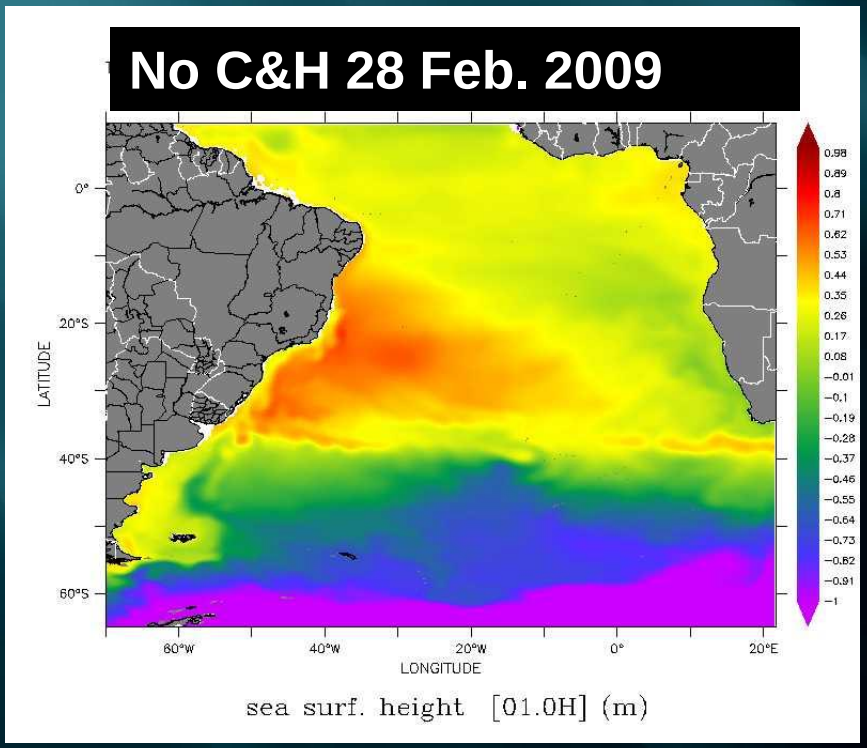
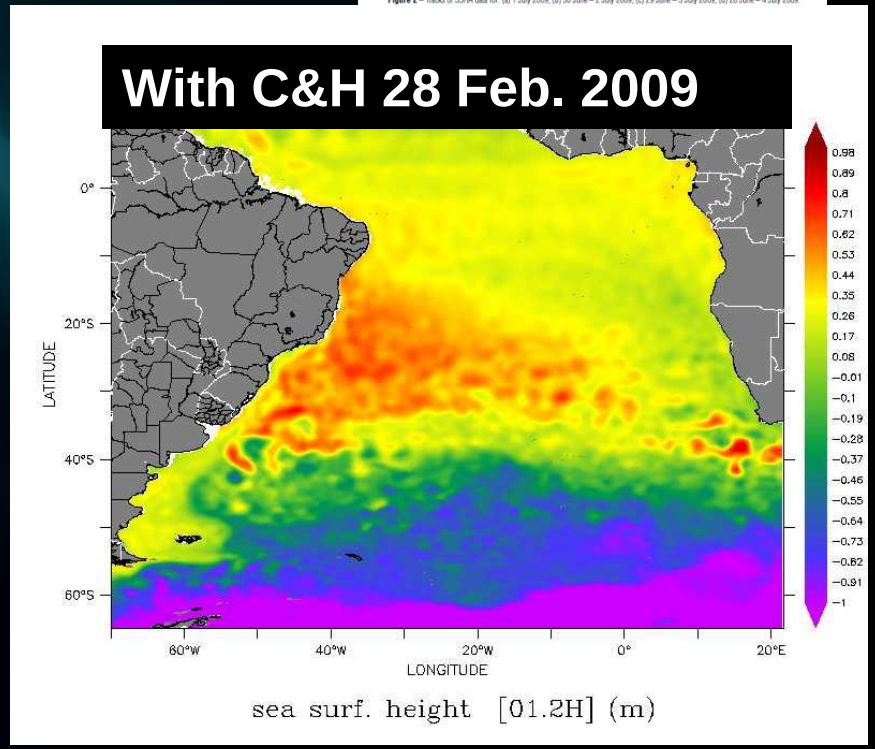


Figure 2 – Tracks of SSHA data for: (a) 1 July 2009; (b) 30 June – 2 July 2009; (c) 29 June – 3 July 2009; (d) 28 June – 4 July 2009.





ASSIMILATION OF SEA SURFACE HEIGHT ANOMALIES INTO HYCOM WITH AN OPTIMAL INTERPOLATION SCHEME OVER THE ATLANTIC OCEAN METAREA V
Tanajura, Costa, Ramos-da-Silva, Ruggiero & Daher, RBGEF, 2013

HYCOM SSH assimilation

Vertical cross section show that the assimilation improved the presence of the Brazilian current near the surface.

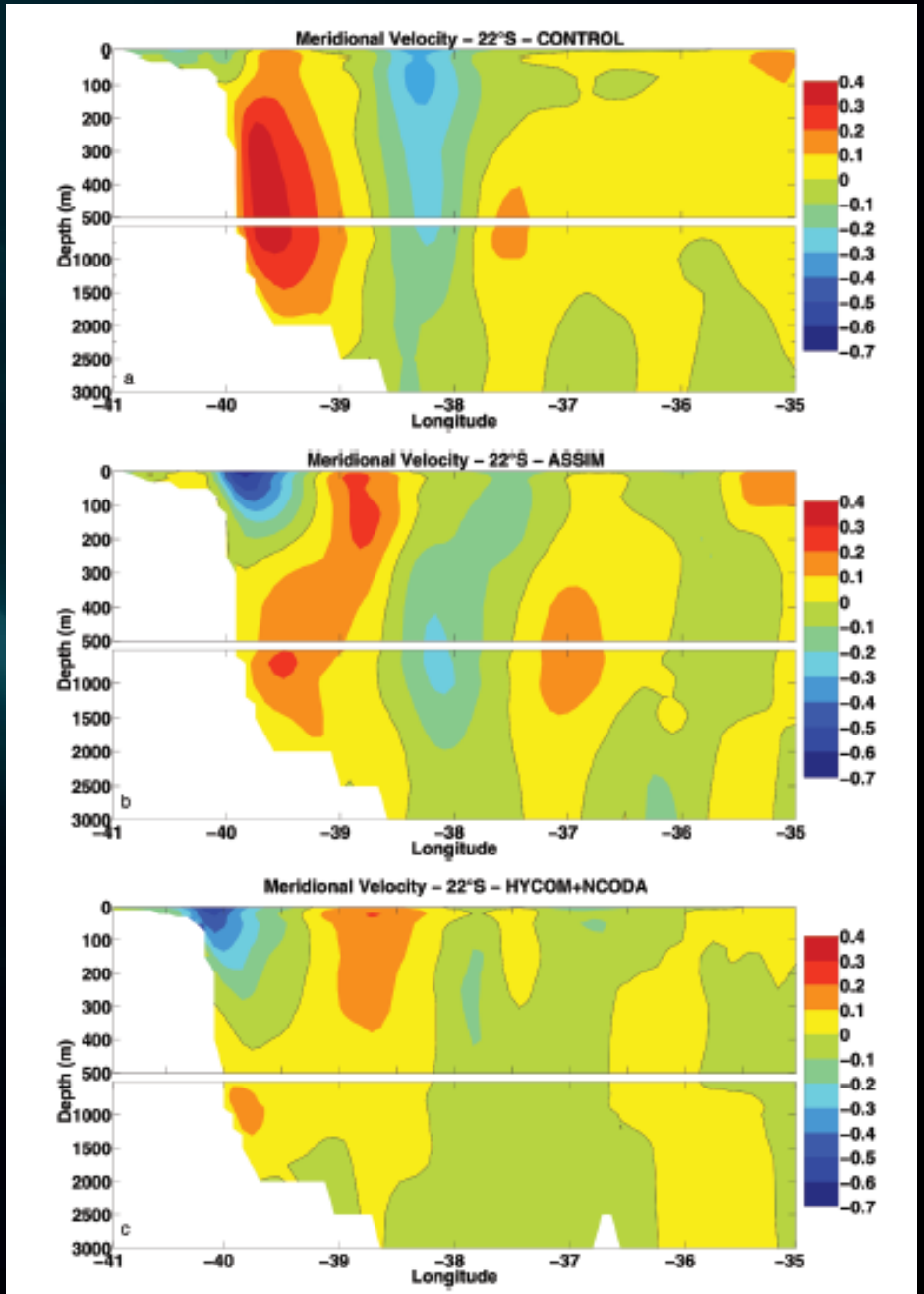


Figure 8 – Vertical cross section of the monthly mean meridional velocity (m/s) for December 2009 at 22°S according to (a) the control run; (b) the assimilation run; and (c) the HYCOM+NCODA.

Tanajura, Costa, Ramos-da-Silva, Ruggiero & Daher, RBGEF, 2013

HYCOM SSH assimilation

RMSE as compared to AVISO

- The control run has higher error (e.g. Amazon & south);
- The assimilation processes decreases the errors;
- Improvements on the latitude of the Bifurcation of the South Equatorial Current.

Tanajura, Costa, Ramos-da-Silva, Ruggiero & Daher, RBGEF, 2013

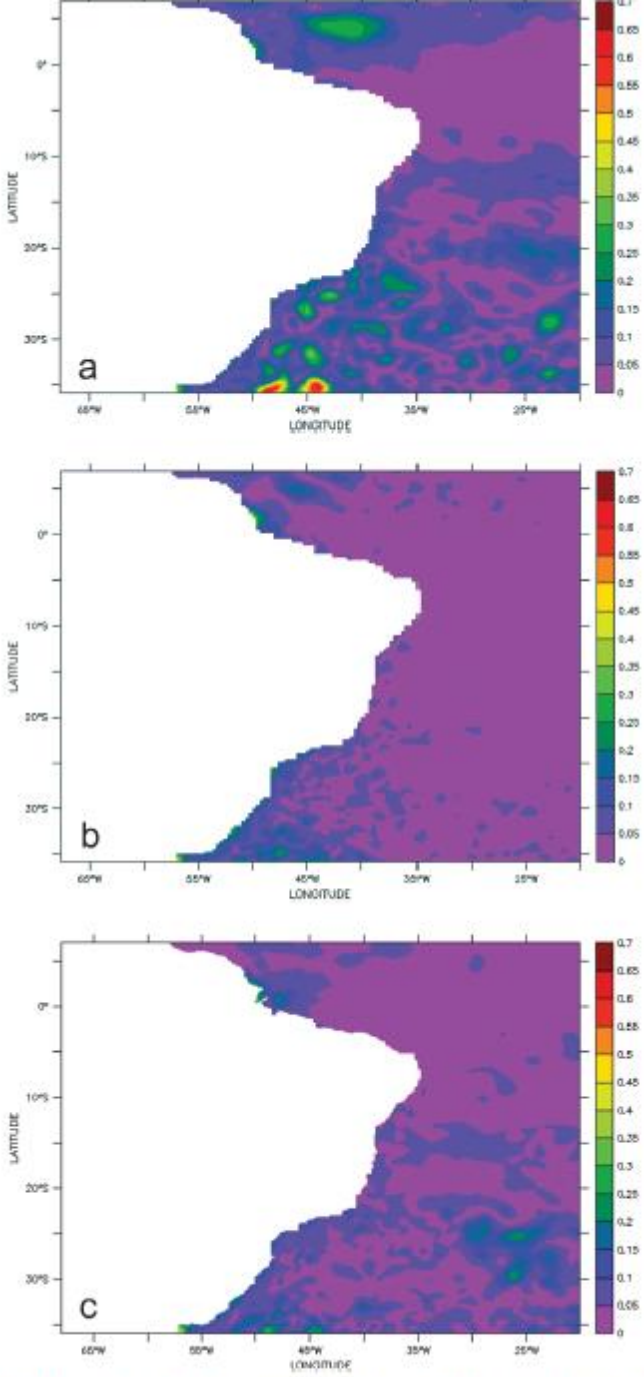


Figure 6 – Centered RMSE of the SSHA anomaly (m) with respect to AVISO for December 2009 for (a) the control run; (b) the assimilation run and (c) the HYCOM+NCODA analysis.

HYCOM SSH

With the SSH assimilation in about 3 months the model is able to reconstruct the SSH

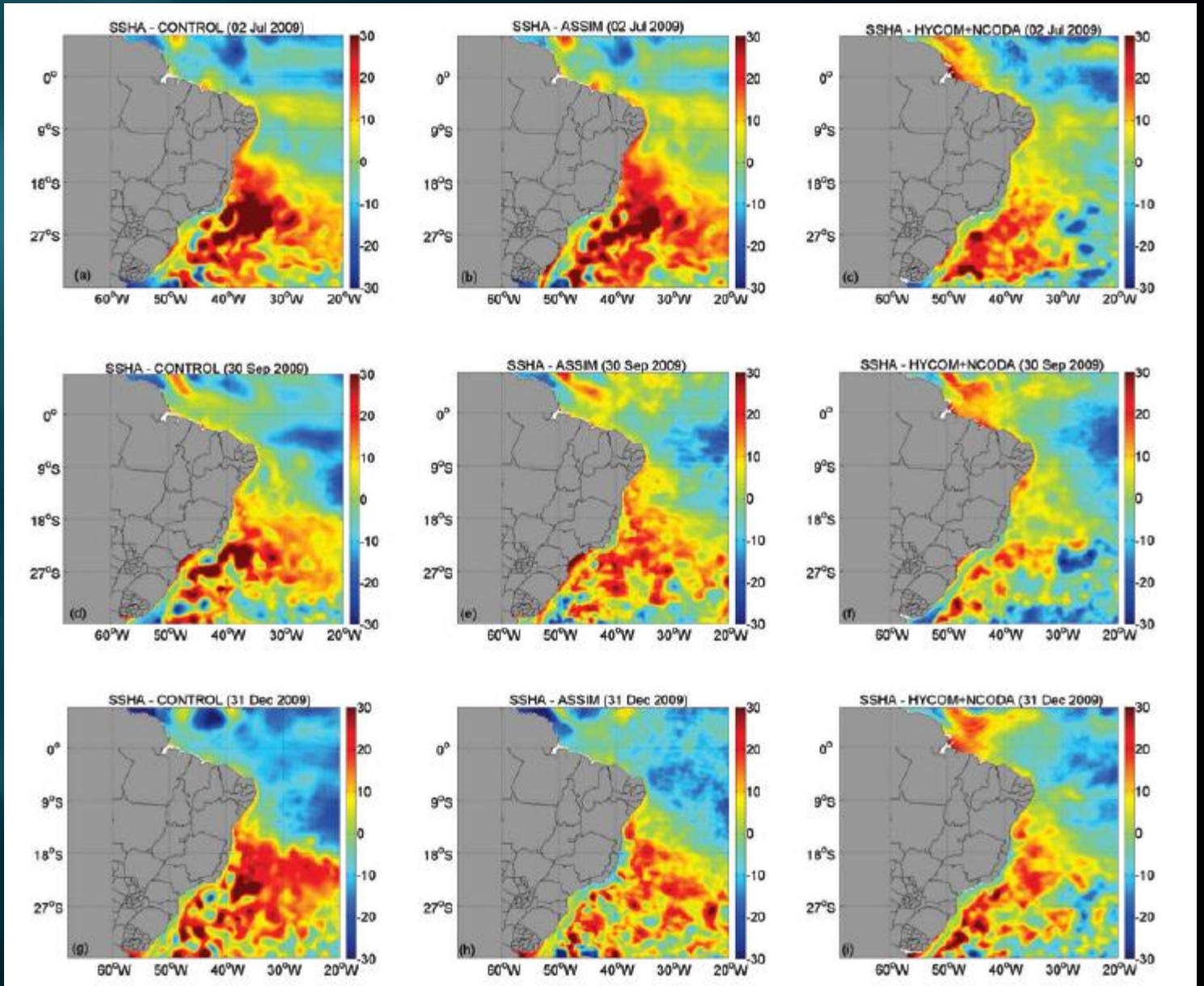
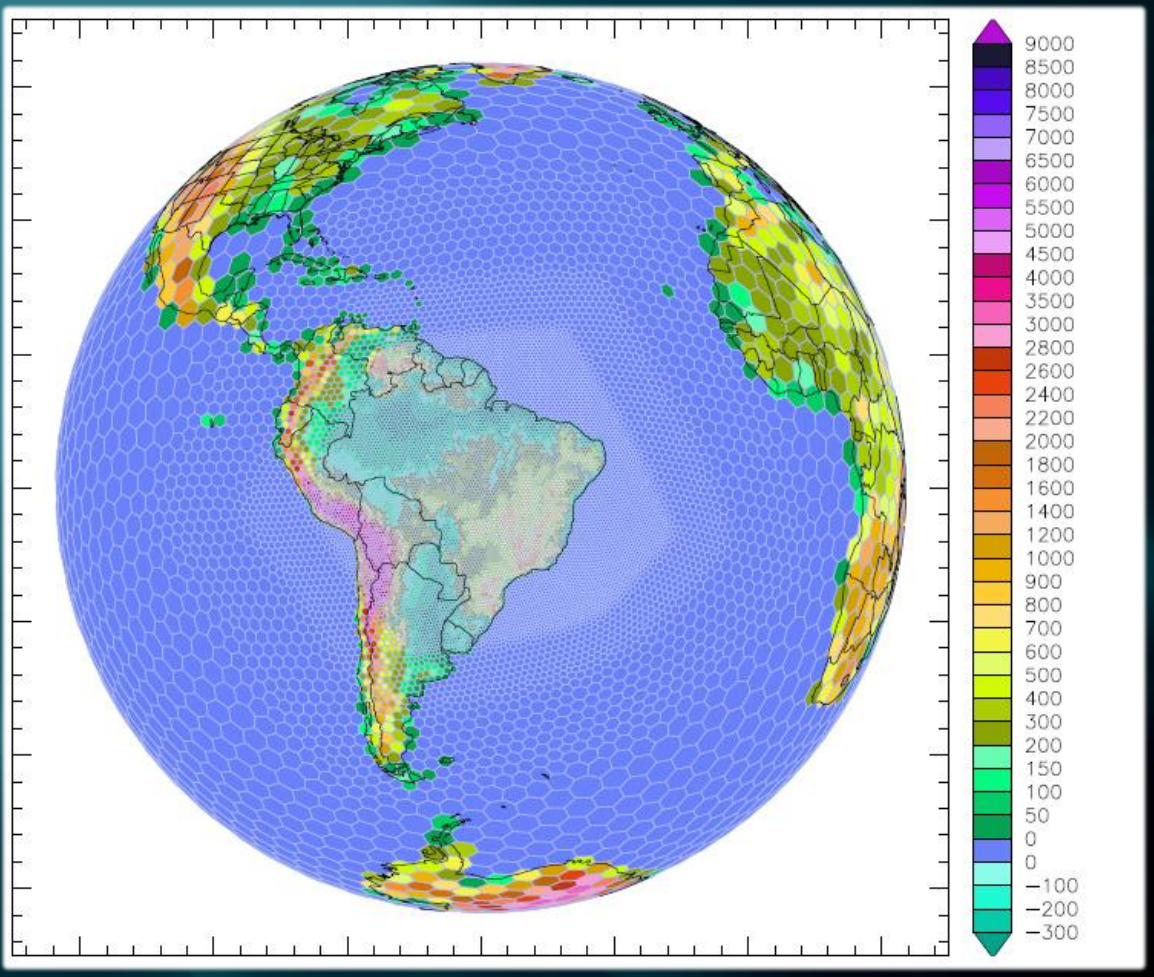


Figure 5 – SSHA (cm) anomalies with respect to area average on July 2 (first row), 30 September 30 (second row) and December 31, 2009 (third row) produced by the control run (first column), the assimilation run (second column) and the HYCOM+NCODA analysis (third column).

Tanajura, Costa, Ramos-da-Silva, Ruggiero & Daher, RBGEF, 2013

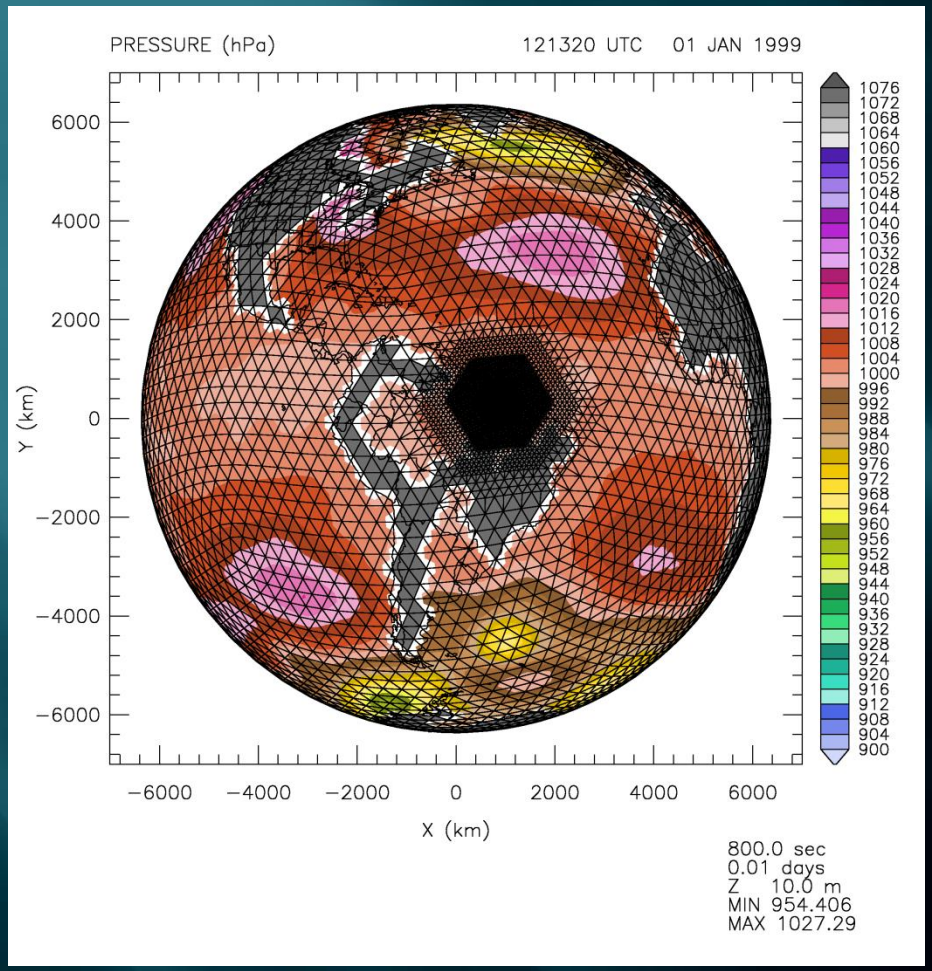
OLAM – Ocean Land Atmosphere Model

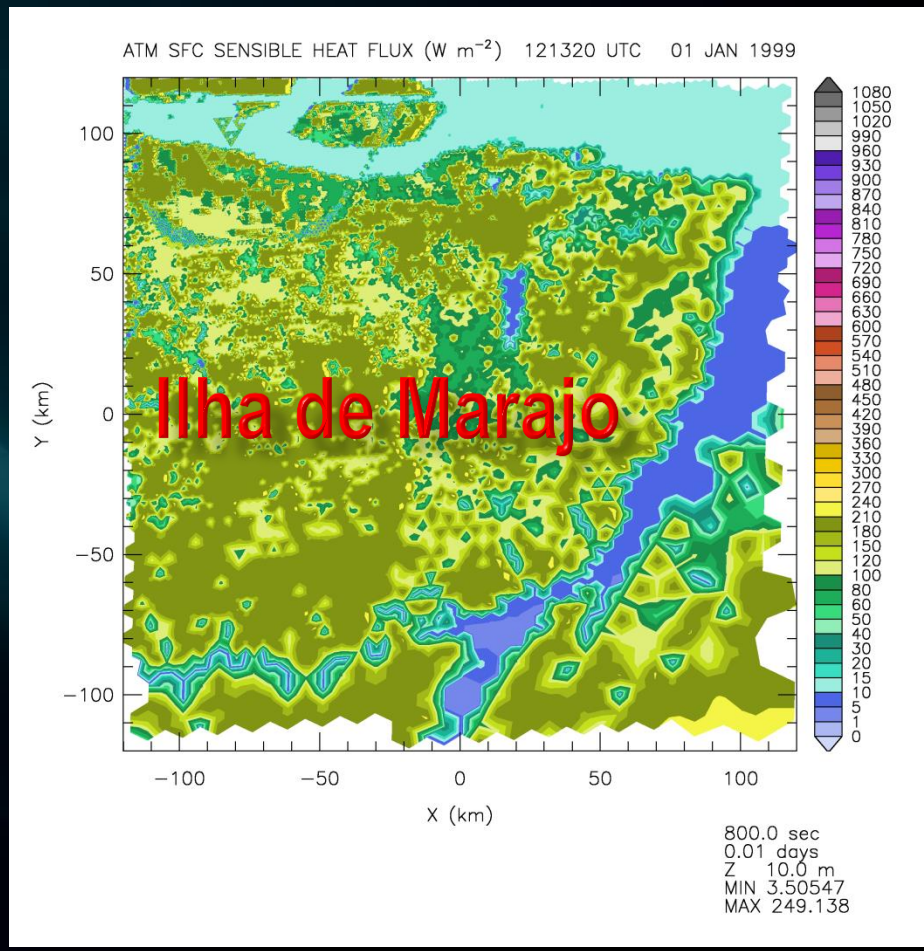


Topography, grid structure and grid refinement.

* OLAM – is an evolution of the regional RAMS model.
* It is capable now to represent the global domain with a regional grid refinement (Walko & Avissar, 2008).
* The grids can have triangular or hexagonal grid cells.
* Vertical shaved coordinate.
* It uses the **finite volume** approach to integrate the Navier-Stokes equations.

OLAM 10 Grades (G10 400 m)



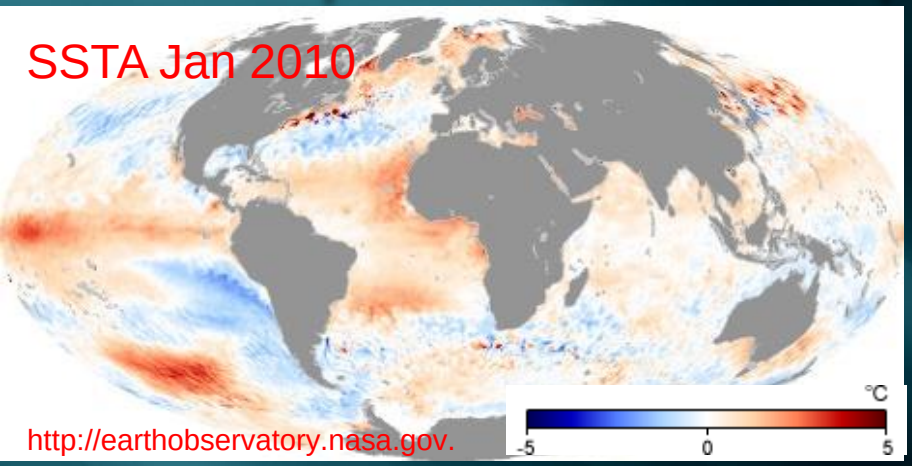


~ 200km 100km 50km 25km 12.5 6.3 3.1 1.6 800m 400 m

OLAM - Regional seasonal predictability for El Nino & La Nina conditions

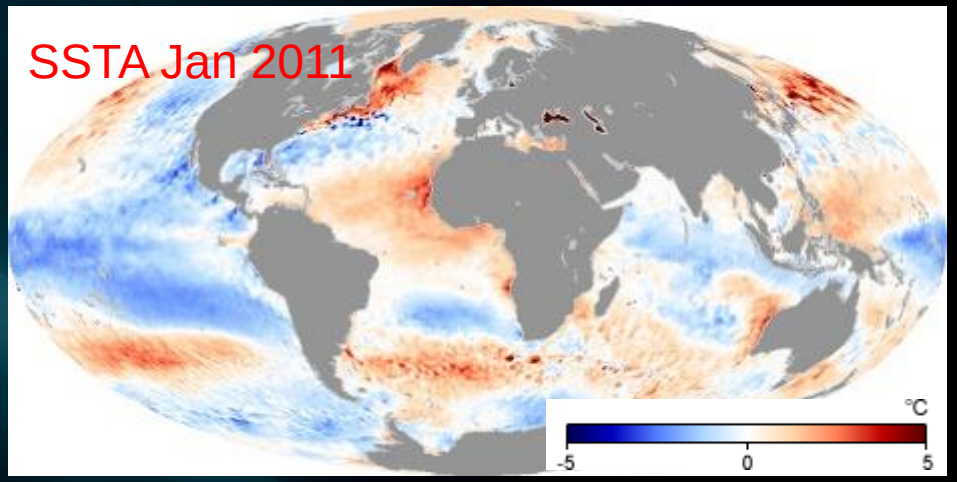
OBS: If we get the right oceanic forecast, can we predict well the precipitation regime?

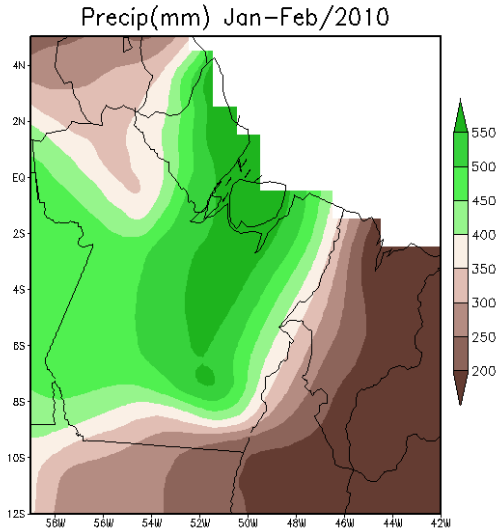
SSTA Jan 2010



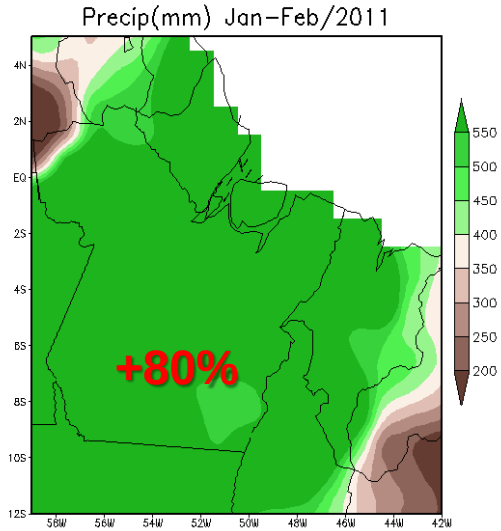
http://earthobservatory.nasa.gov.

SSTA Jan 2011

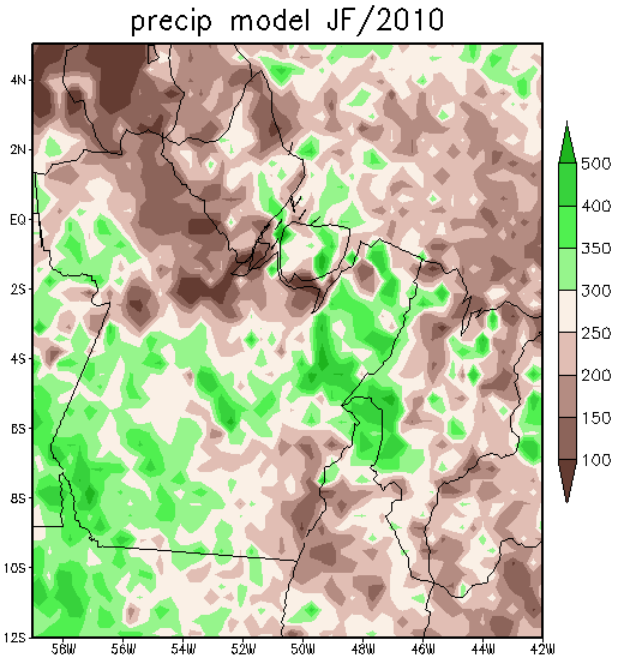


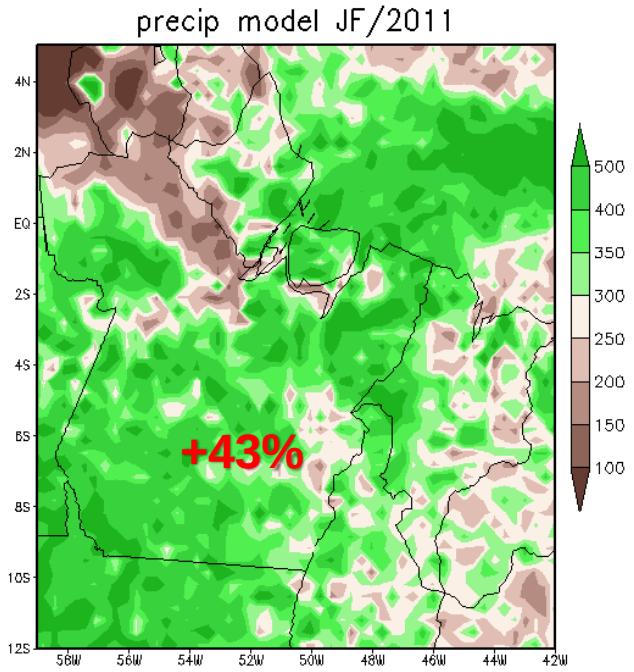


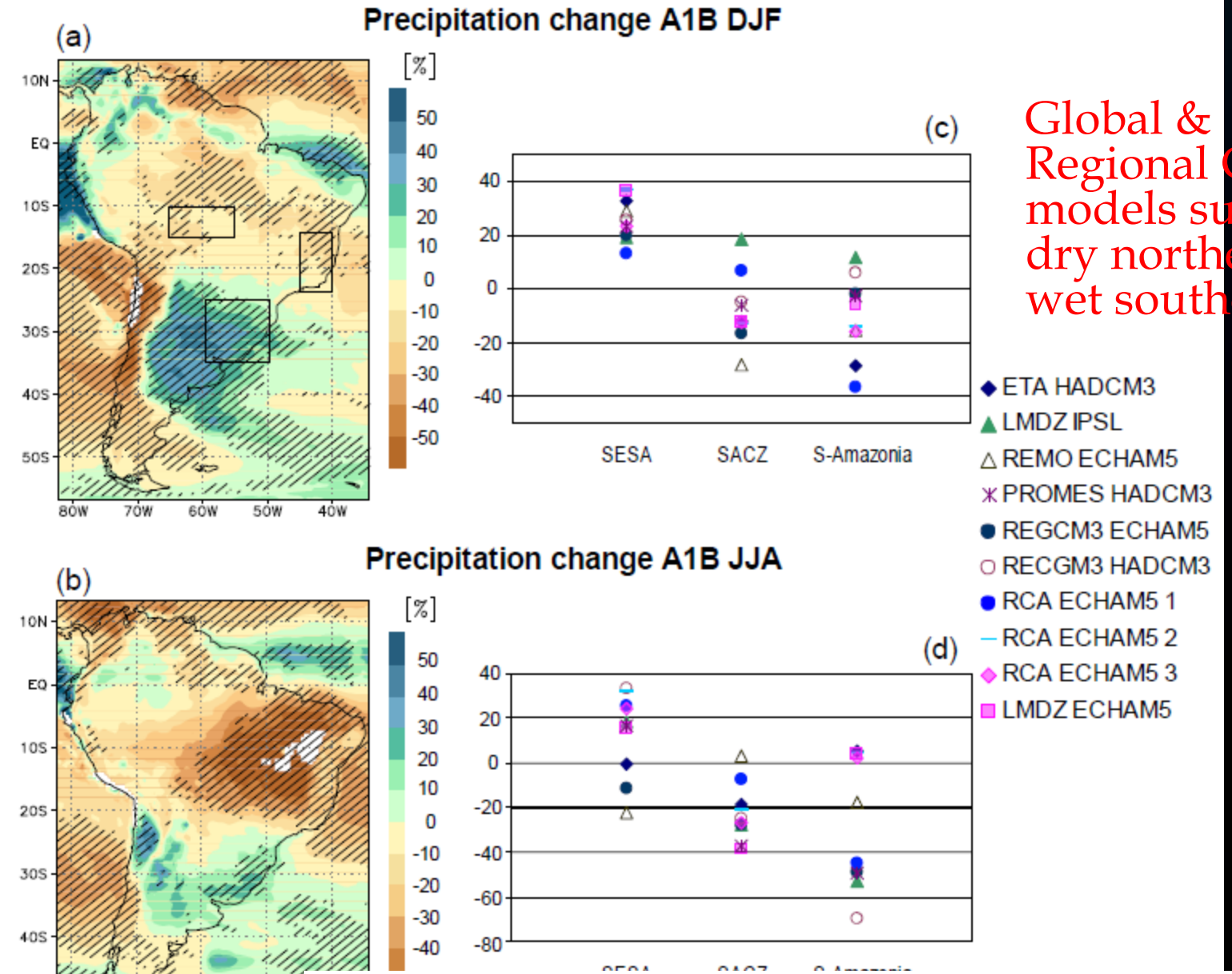
GPCP observations show 80% more precipitation in 2011 than 2010



OLAM Numerical experiments: Jan-Feb 2010 & Jan-feb 2011
Grids: global Δx= 250 km; refinement 125 km, 64 km, 32 km.
weekly SST from NOAA-OI upgraded during the run.
The model results show an increase (43%) on precipitation for 2011 as compared with 2010.
OLAM is able to predict dry/wet condition (precipitation) in case the SST is well forecasted.



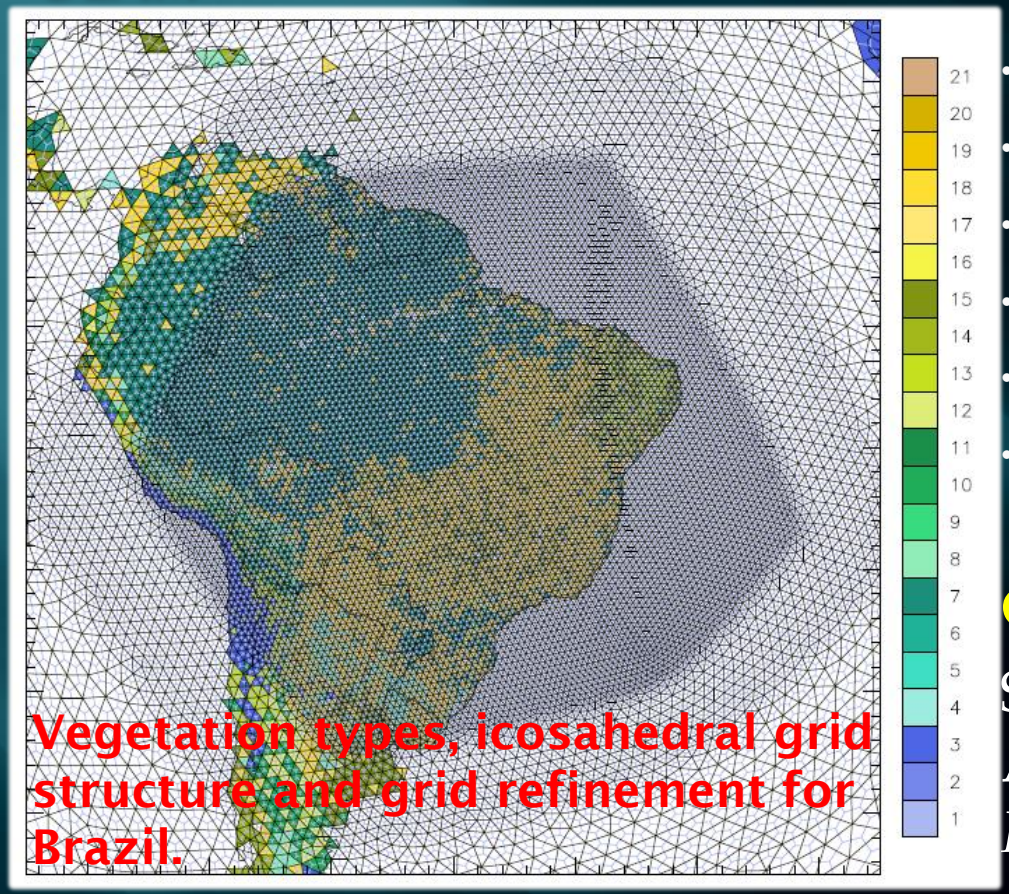




Global & Regional Climate models suggest a dry northeast and wet southeast.

Figure 14.21: (a) DJF and (b) JJA relative precipitation change in 2071–2100 with respect to 1961–1990 in the A1B scenario from an ensemble of 10 RCMs participating in the CLARIS-LPB Project. Hatching denotes areas where 8 out of 10 RCMs agree in the sign of the relative change. (c) DJF and (d) JJA dispersion among regional model projections of precipitation changes averaged over land grid points in South Eastern South America, SESA (35°S–25°S, 60°W–50°W), South Atlantic Convergence Zone, SACZ (25°S–15°S, 45°W–40°W) and Southern Amazonia (15°S–10°S, 65°W–55°W), indicated by the boxes in (a).

ASSESSING THE IMPACTS OF GLOBAL OCEAN WARMING ON CLIMATE OVER BRAZIL WITH THE OLAM



Vegetation types, icosahedral grid structure and grid refinement for Brazil.

RENATO RAMOS DA SILVA, R. HAAS (UFSC) ROBERT L. WALKO (RSMAS - U OF MIAMI); & DARREN DREWRY (JPL, PASADENA, CA).
AGU FALL MEETING, 2013

OLAM model experiment design

- **Global coarse cells 250 km**
- **Regional cells 32 km**
- **45 vertical levels up to ~ 34 km**
- **Initial conditions NCEP/NCAR**
- **No nudging necessary**
- **Full microphysics**
- **Time step = 30 seconds**

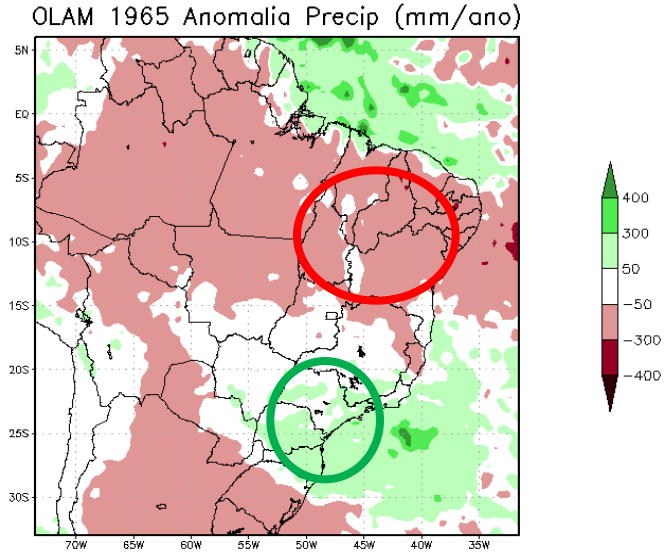
Climatological Run (1960-1990)

SST boundary conditions from **AMIP** (*Atmospheric Modeling Intercomparison Project*)

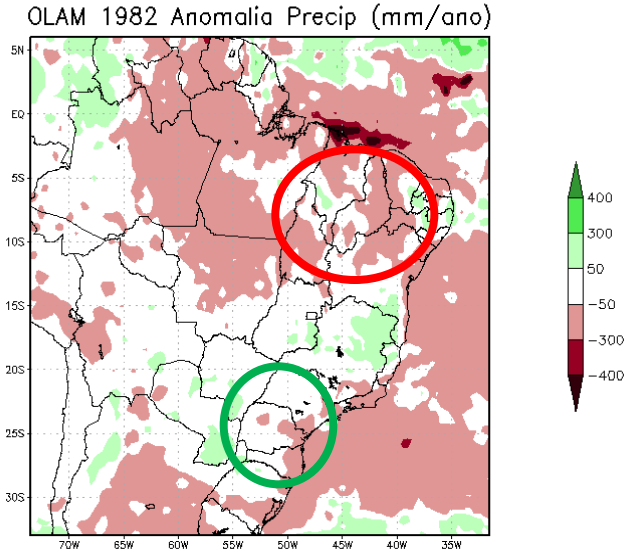
XXI Century Run (2010-2100)

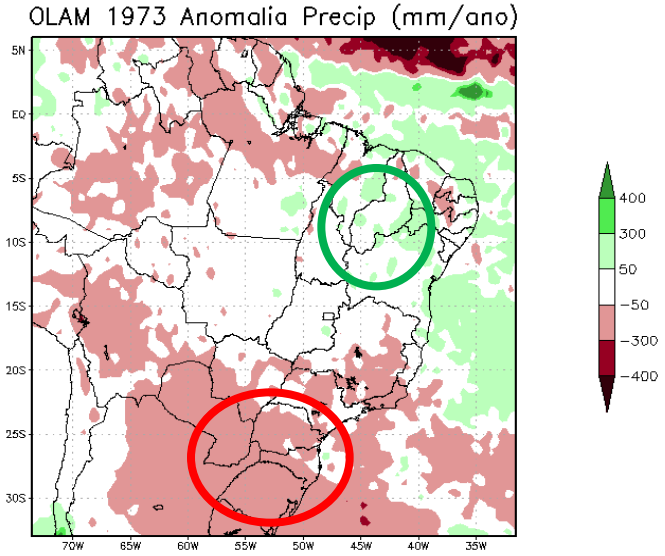
SST boundary conditions from Hadley Centre Model (A1B)

OLAM was able to capture the El Niño & La Niña variability impacts on rainfall in the South America.

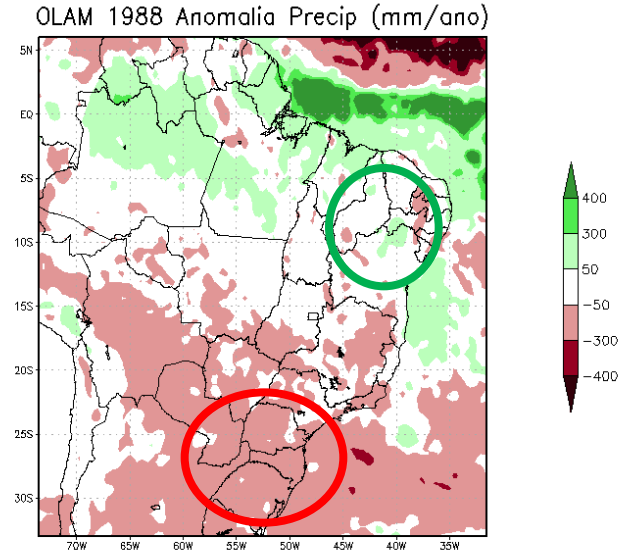


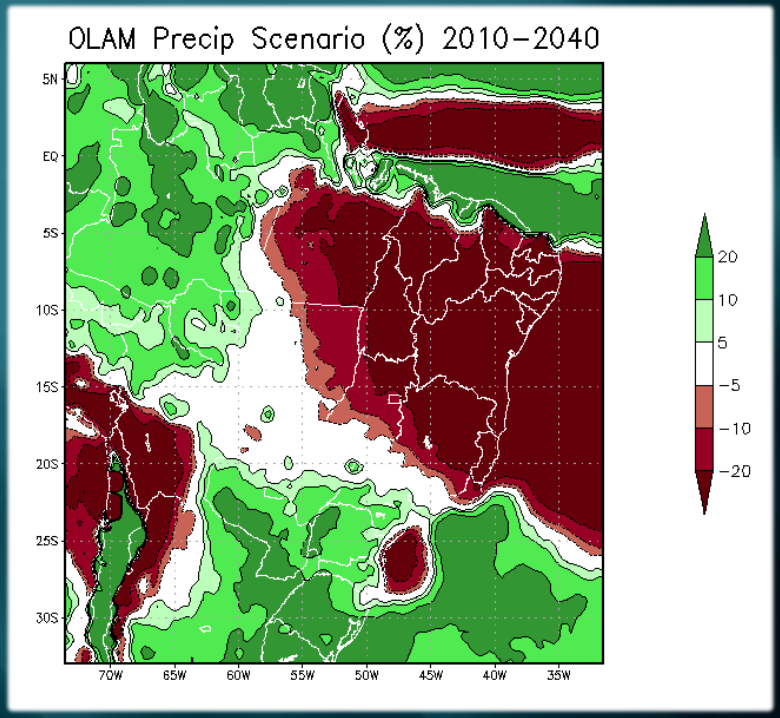
EL NIÑO
1965, 1982





LA NIÑA
1973, 1988

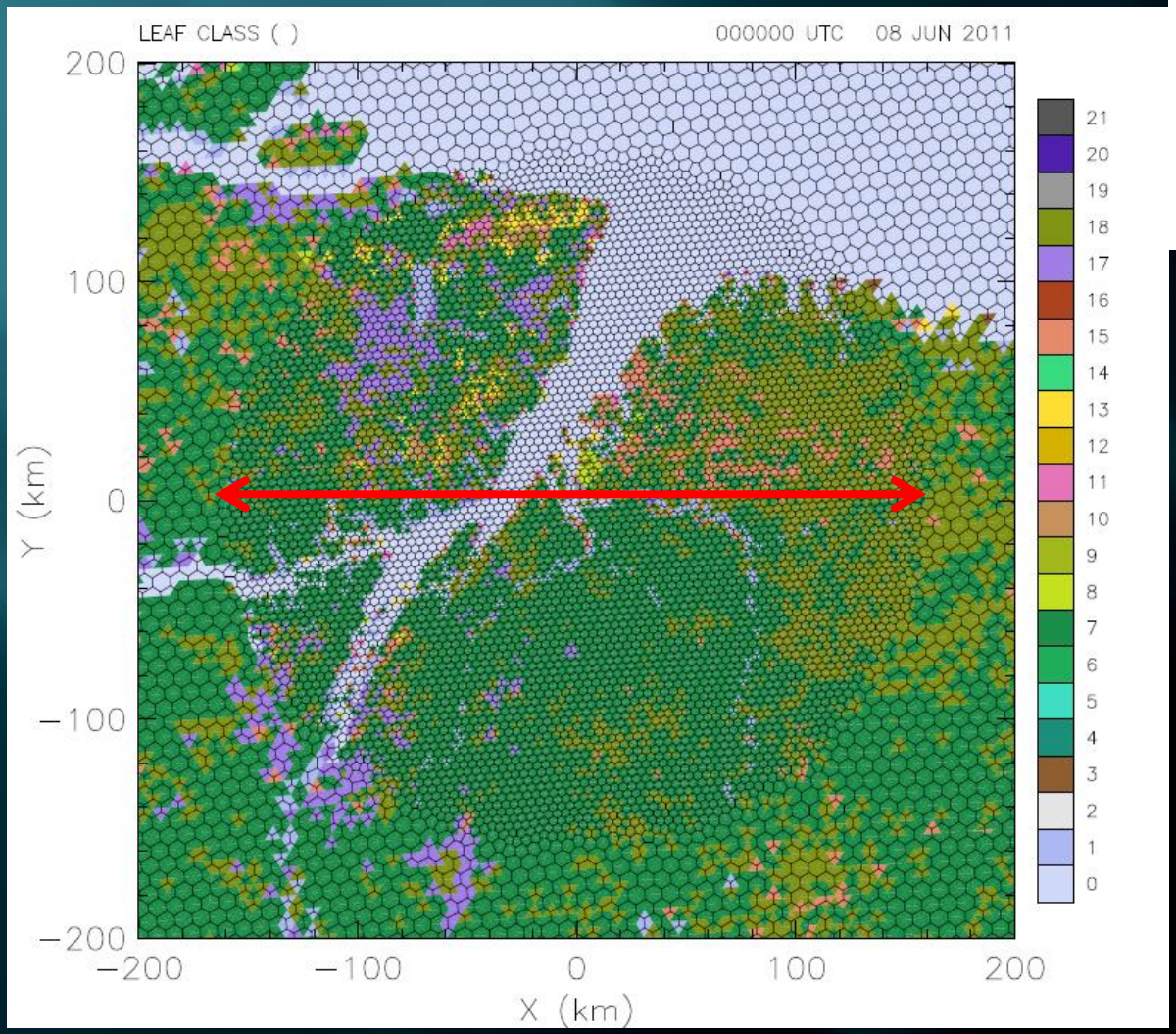


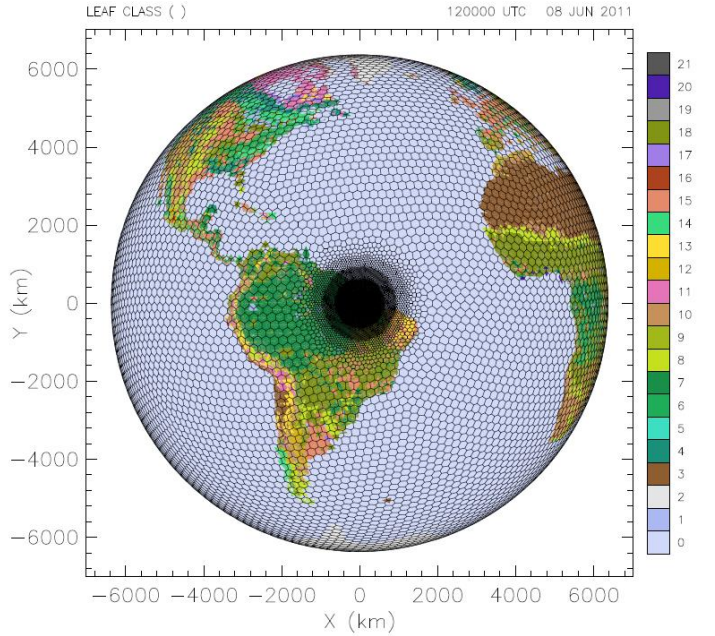


The **OLAM precipitation scenarios** for 2010-2040 suggest a decrease in precipitation over northeast Brazil, increase in some coastal areas in the north, west of the Amazon and south of South America. Near the Equator it seems that we may have a broader ITCZ. These results are comparable with the Global & regional climate models.

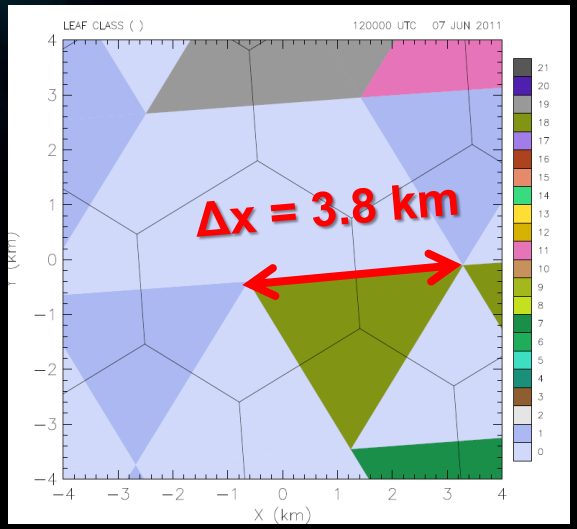
However, we can have a more detailed approach on the estimating the potential changes.

OLAM application to the Amazon river mouth region





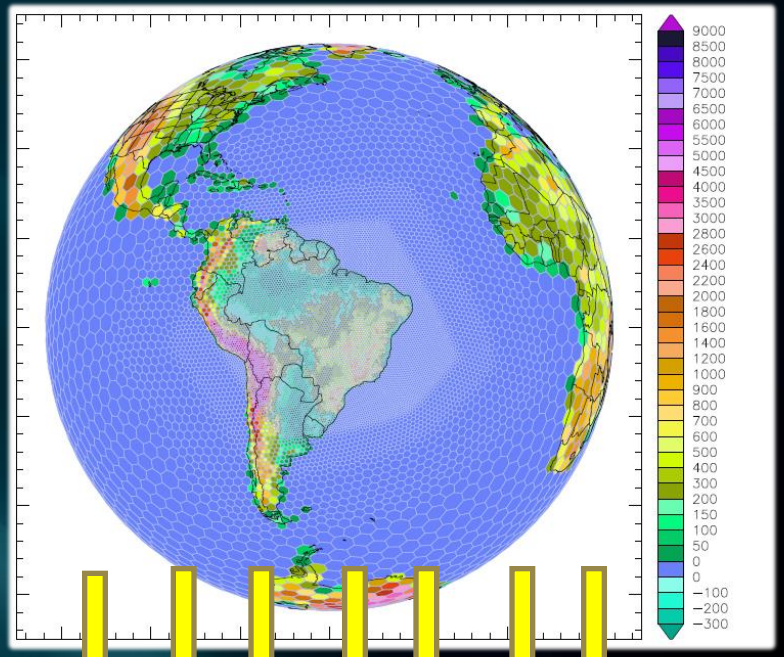
- 45 vertical levels up to ~ 34 km
- Initial conditions NCEP/NCAR
- SST weekly fields (NOAA)
- Time step = 5 seconds



HYCOM-OLAM coupling project (2015-2016)

Coupler = MCT
(Argone Nat Lab)

Global HYCOM
Global OLAM



Winds Stress
Temperature
Moisture
Precipitation
Radiation
hourly

MCT - coupler

HYCOM

SST
daily

Tak = Thanks = Obrigado: renato.ramos@ufsc.br

The Workshop Organizers

Brian Arbic	University of Michigan
Rainer Bleck	NASA / GISS
Eric Chassignet	Florida State University
Robert Hallberg	NOAA / GFDL Princeton University
Patrick Hogan	Naval Research Laboratory
Mohamed Iskandarani	RSMAS / University of Miami
James Richman	Naval Research Laboratory
Laurent Bertino	Nansen Environmental and Remote Sensing Center
Till Rasmussen	Danish Meteorological Institute