

# Eastern Tropical Oceans Synthesis (ETOS) Working Group

Simon de Szoeke

Paquita Zuidema

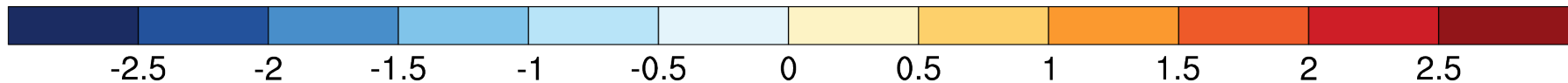
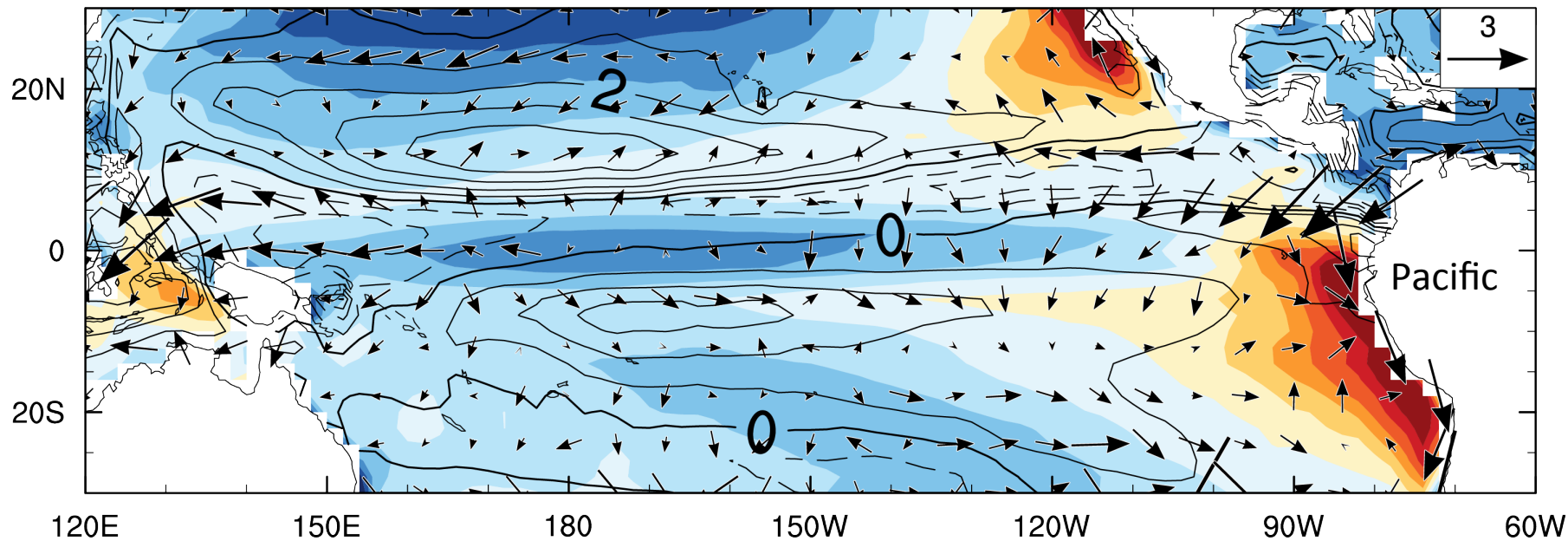
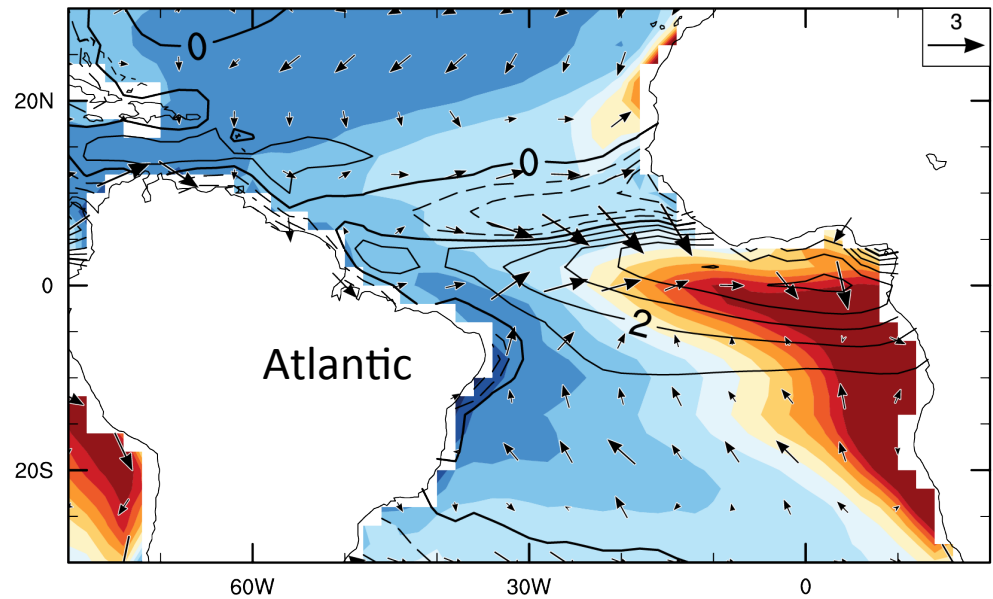
Robert Wood

Roberto Mechoso

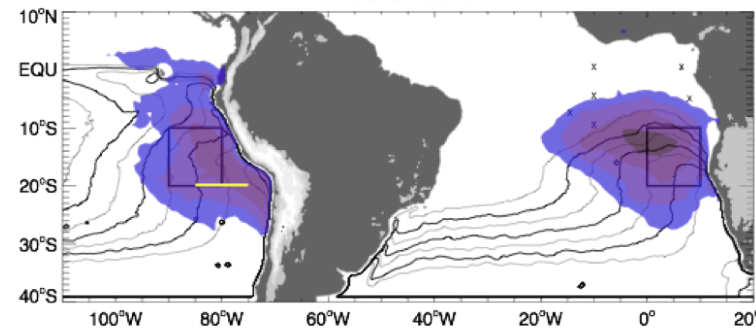
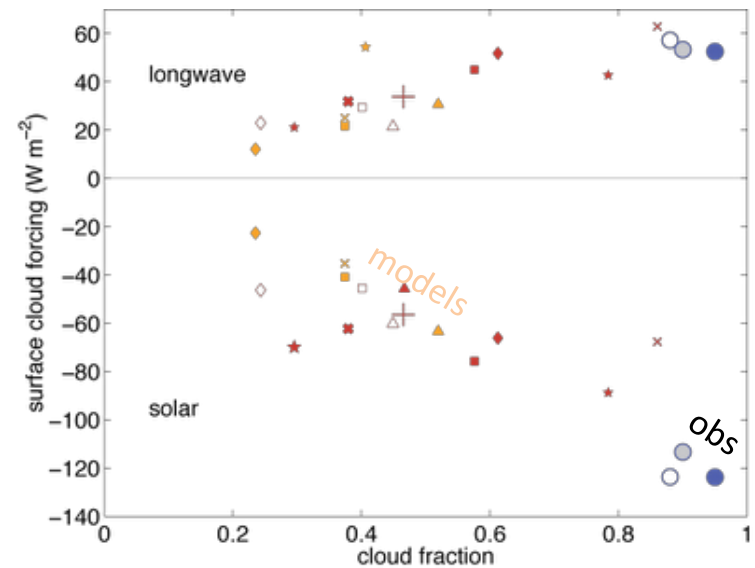
# Atlantic & Pacific CMIP3 errors

SST (shading)  
sfc. winds (vectors)  
precip (contours)

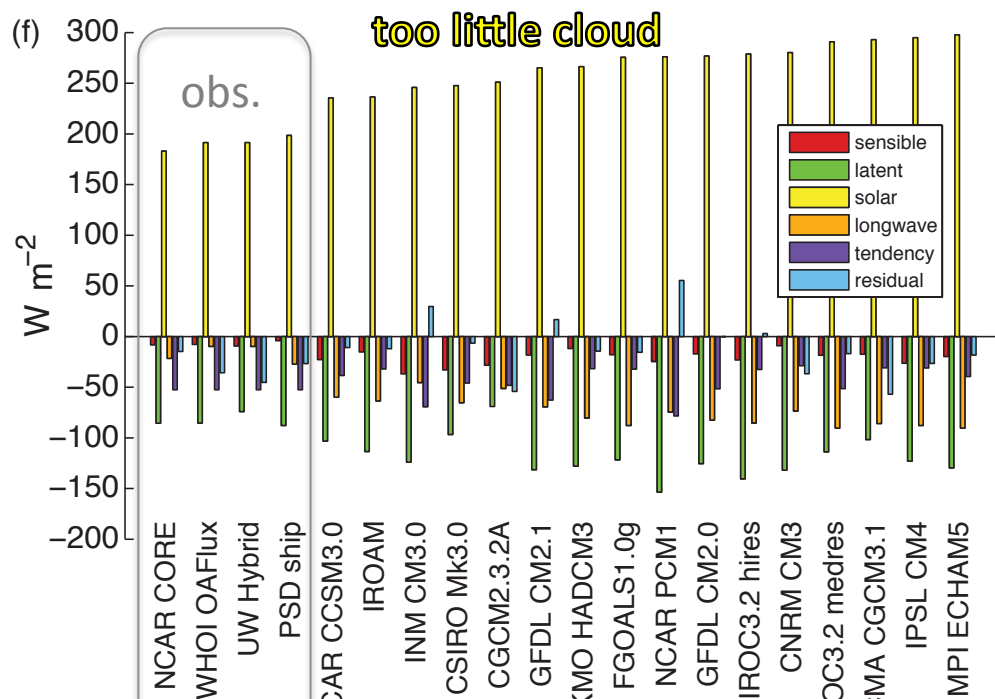
*Ingo Richter, 2011*



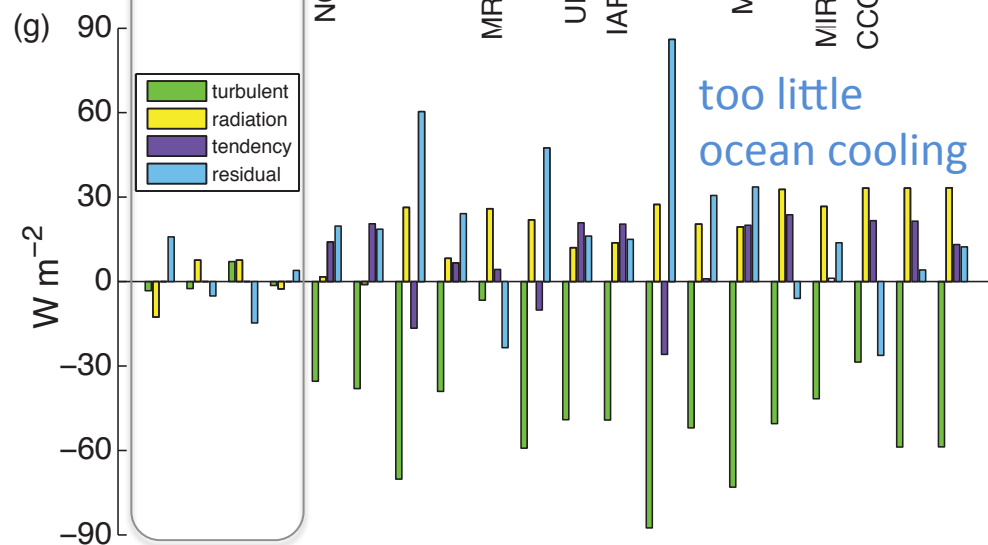
- We have considerably improved our understanding of the coupled Pacific Ocean-Atmosphere system since the 1990s.
  - ENSO, TAO and *Stratus* buoys, *EPIC2001*, *PACS*, *VOCALS2008*
  - Model errors reduced
- Outstanding Pacific errors:
  - Too little cloud fraction
  - Too little cooling by ocean eddies and mixing



heat budget



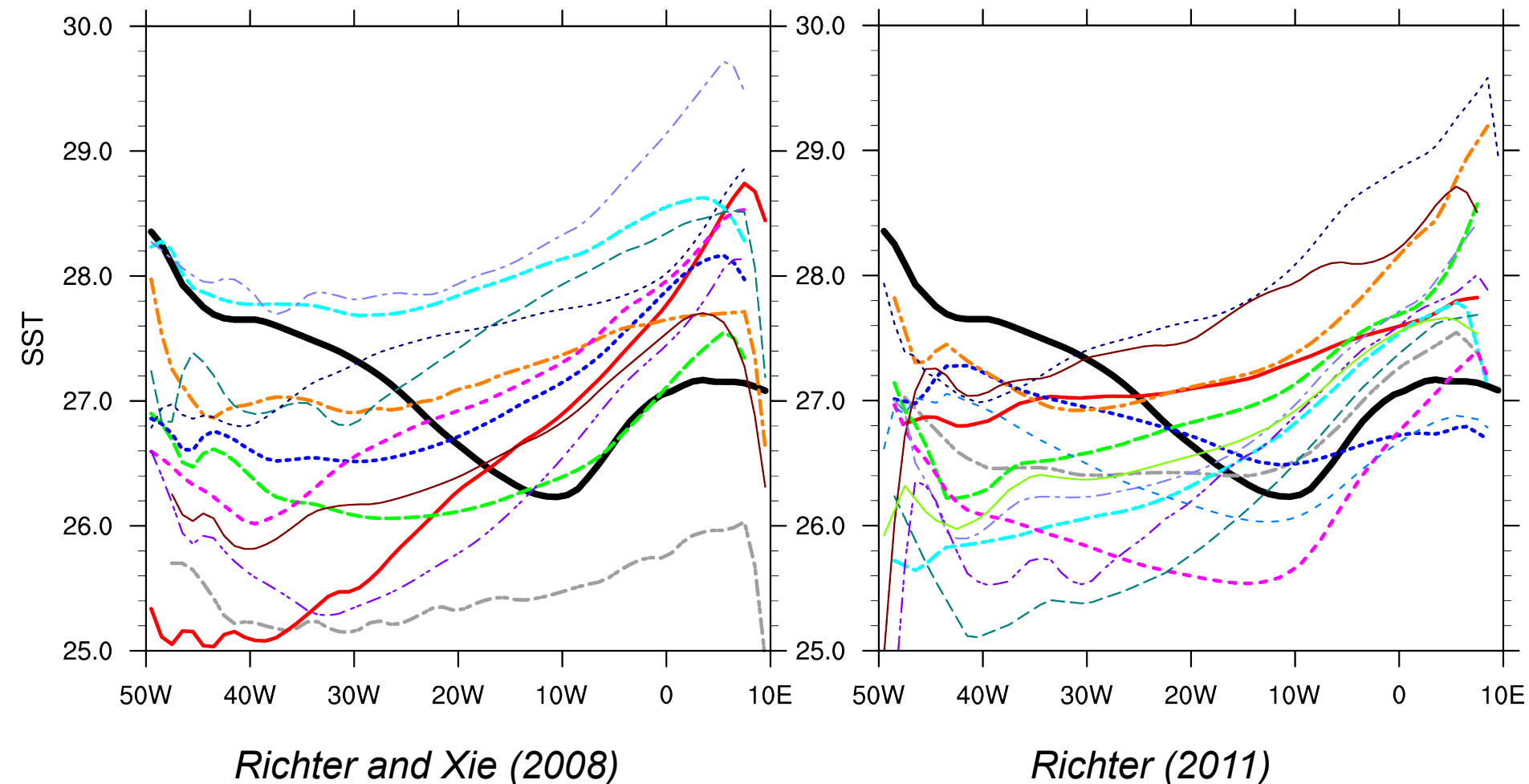
errors



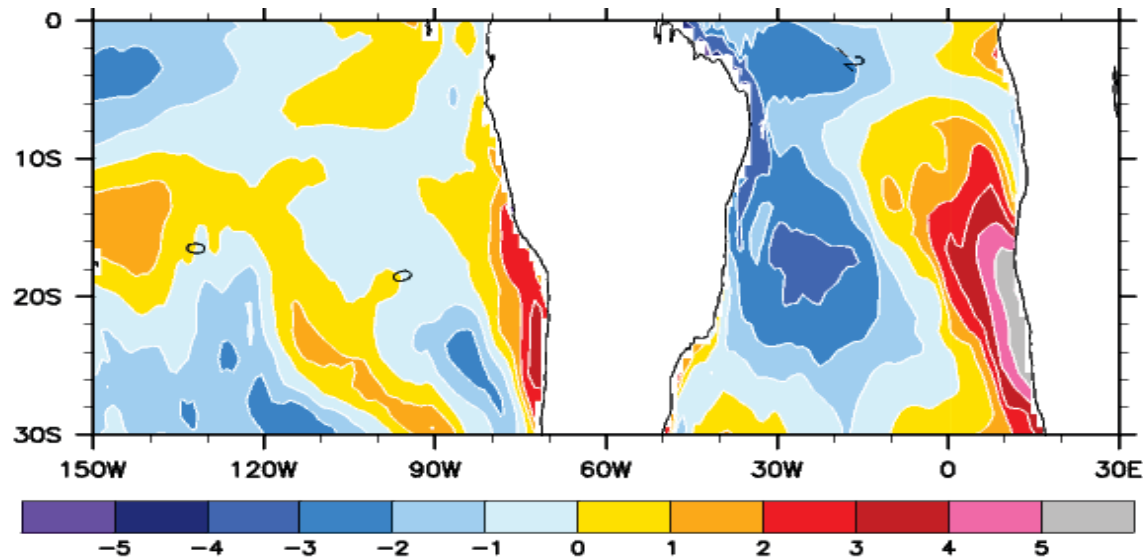
# Persistent errors in Atlantic Ocean: Annual mean SST along the equator

CMIP3

CMIP5



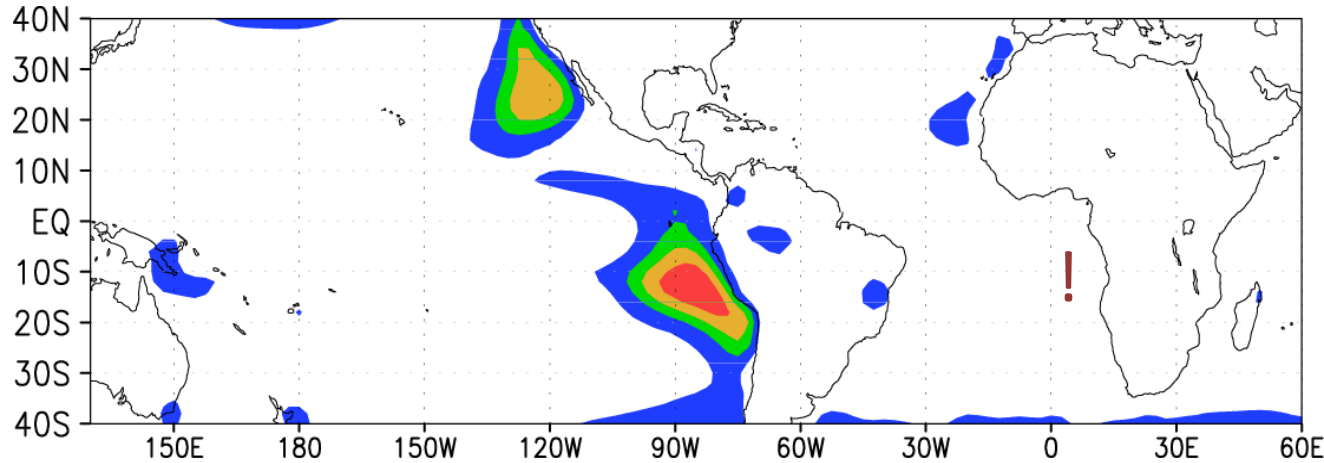
# Annual mean SST errors by an uncoupled OGCM



SST errors (K) in a 50-year simulation by the MIT Ocean model forced with surface fluxes from the NCEP Reanalysis. Note the big differences between the southeastern Atlantic and Pacific. Despite the “perfect forcing” of the ocean, biases are different in the Atlantic and Pacific. OGCM resolution is 1degx1/3deg in tropics.

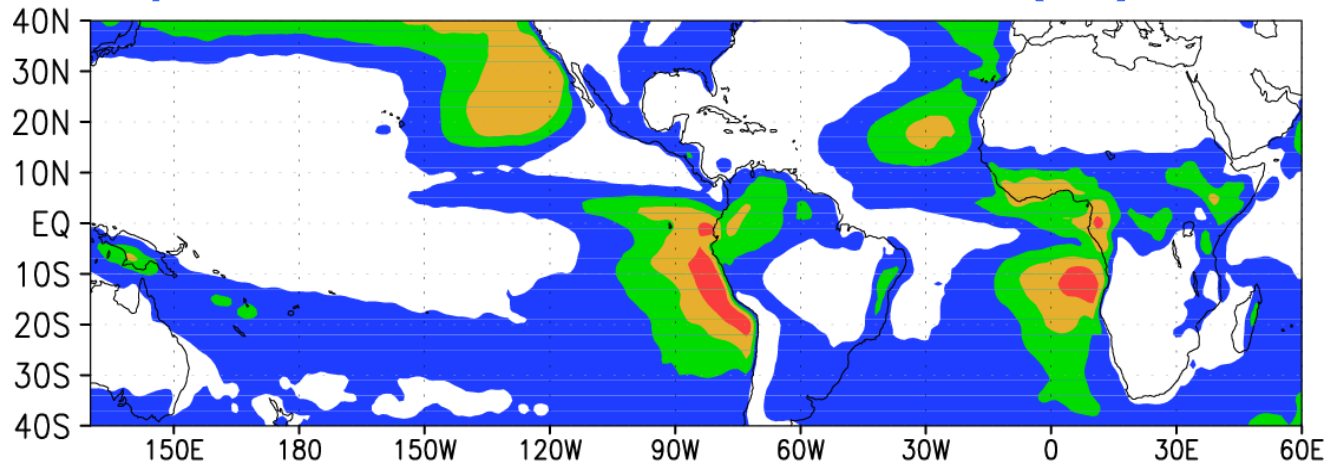
(The OGCM runs were performed by C. R. Mechoso and T. Losada from the U. Complutense, Madrid, Spain.)

## July mean Scu fraction (%): UCLA AGCM



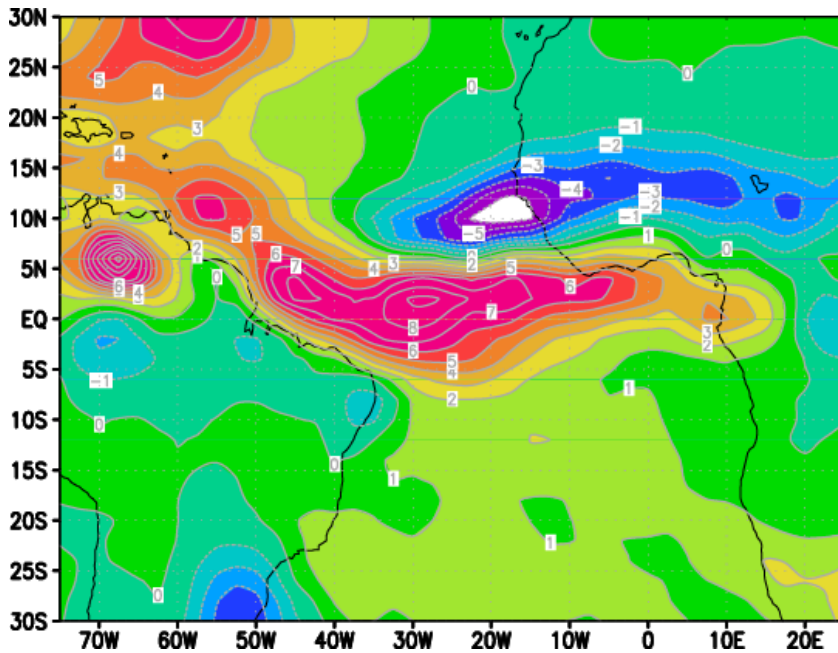
Successful simulation in SEP; almost no Scu in SEA. SEP and SEA are different!

## July mean warm cloud fraction (%): MODIS

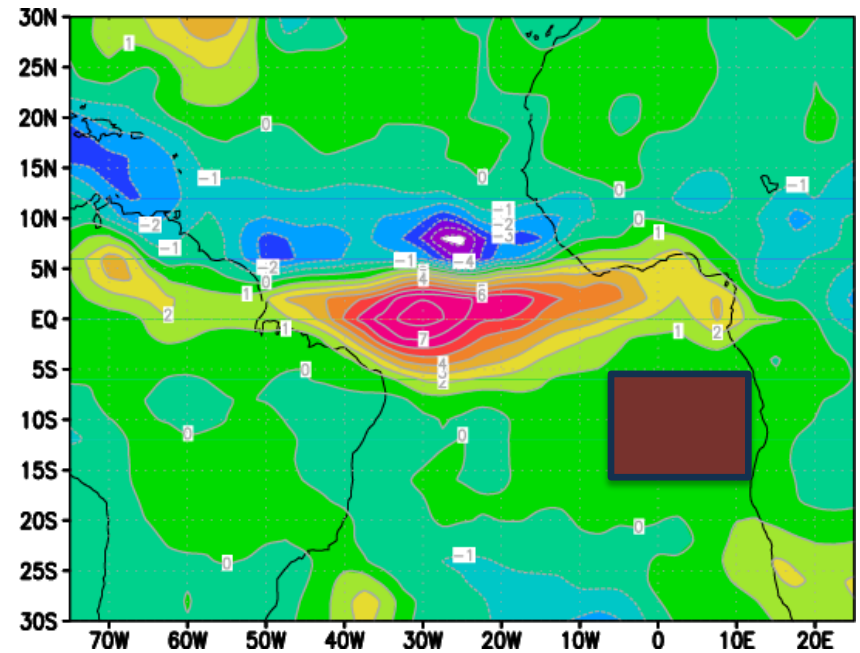


# Angola stratiform cloud reduces July mean rainfall biases (mm/day)

## Control



## Control - Experiment

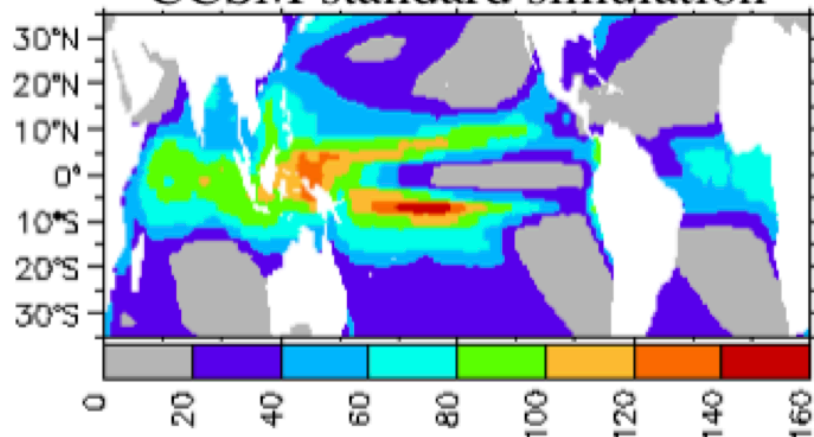


Artificially enhancing  $S_c$  in the Brown Square results in significantly decreased rainfall south of 5°N:  $S_c$  also matter in the southeastern Atlantic albeit their impact is weaker than in the southeastern Pacific



# UPSCALING EFFECTS FROM SUBTROPICAL EASTERN BOUNDARY OCEANS

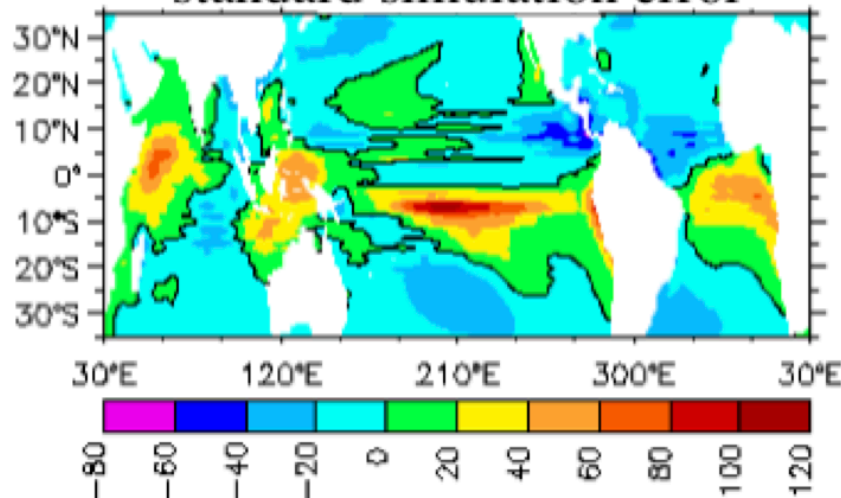
CCSM standard simulation



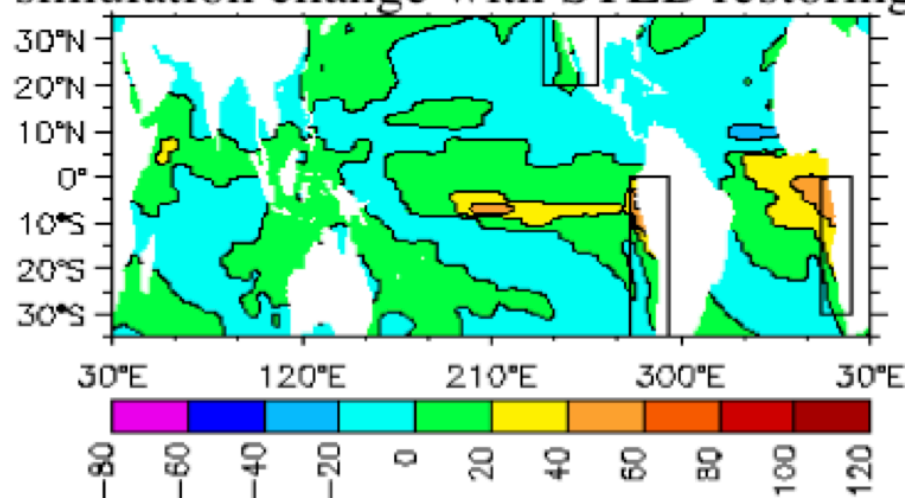
Mean precipitation [ $\text{mg}/\text{m}^2/\text{s}$ ] in coupled model and its change with restoring of T & S in upper subtropical Eastern Boundary regions in N. & S. Pacific and S. Atlantic.

(Large & Danabasoglu, 2006)

standard simulation error



simulation change with STEB restoring



# Short history

VOCALS project in the **Eastern Tropical Pacific** identifies ocean eddy-mixing as a leading hypothesis for closing the upper-ocean heat budget. Specific processes remain difficult to quantify in observations and models.

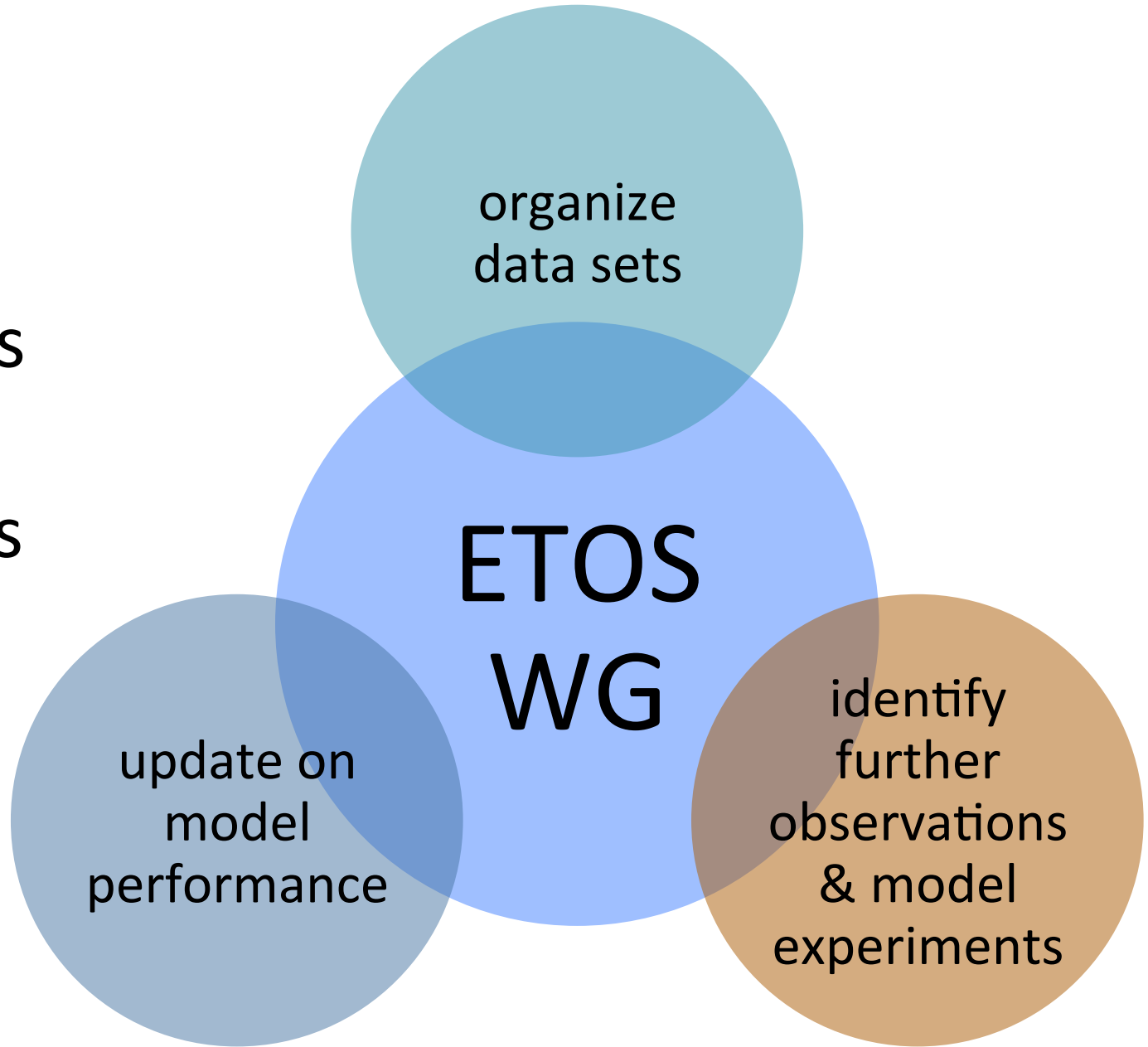
**Atlantic Tropical Biases** Workshop (Miami spring 2011) identified multiple potential hypotheses reflecting coupled processes among ocean, land, and atmosphere.

At suggestion of US CLIVAR SSC, 2 proposed WGs combined into a single Eastern Tropical Oceans Synthesis (ETOS) WG.

## ETOS Working Group Membership

|  |                                       |
|--|---------------------------------------|
| <a href="#">Simon de Szoeke</a> , co-chair | Oregon State University               |
| <a href="#">Roberto Mechoso</a> , co-chair | UCLA                                  |
| <a href="#">Rob Wood</a> , co-chair        | University of Washington              |
| <a href="#">Paquita Zuidema</a> , co-chair | University of Miami                   |
| <a href="#">Michela Biasutti</a>           | Columbia University/LDEO              |
| <a href="#">Peter Brandt</a>               | GEOMAR, Kiel, Germany                 |
| <a href="#">Ping Chang</a>                 | Texas A&M University                  |
| <a href="#">Amy Clement</a>                | University of Miami                   |
| <a href="#">Takeshi Doi</a>                | NOAA/GFDL                             |
| <a href="#">Tom Farrar</a>                 | WHOI                                  |
| <a href="#">Carmen Grados</a>              | IMARPE, Peru                          |
| <a href="#">Ben Kirtman</a>                | University of Miami                   |
| <a href="#">Alban Lazar</a>                | Sorbonne University/IPSL, France      |
| <a href="#">Brian Medeiros</a>             | NCAR                                  |
| <a href="#">Pierrick Penven</a>            | IRD, France                           |
| <a href="#">Chris Reason</a>               | University of Cape Town, South Africa |
| <a href="#">Ingo Richter</a>               | University of Hawaii/IPRC             |
| <a href="#">Mathieu Rouault</a>            | University of Cape Town, South Africa |
| <a href="#">Irina Sandu</a>                | ECMWF                                 |
| <a href="#">Ed Schneider</a>               | George Mason University/COLA          |
| <a href="#">Laurent Terray</a>             | CEFACS, France                        |

Eastern  
Tropical  
Oceans  
Synthesis  
WG  
functions



# Proposed Goals

## a. Organize datasets

WG website with value added products/cultivated plots

## b. Coordinate model performance assessments

- Do CMIP5 model/observation comparisons behave similarly and change similarly from CMIP3 to CMIP5?
- Are model improvements in the Pacific correlated to those in the Atlantic?
- What observations/model metrics are most useful? e.g. *PIRATA line, Klein/Hartmann box averages, Ascension Island.*

## c. What further observations/model experiments are needed?

# Ongoing Activities

- teleconferences
- dedicated websites:
  - Google site (members contribute content)
  - US CLIVAR web site (public, moderated)  
<http://www.usclivar.org/working-groups/etos>
- publications list
  - user-contributed, subdivided by basin
- develop metrics

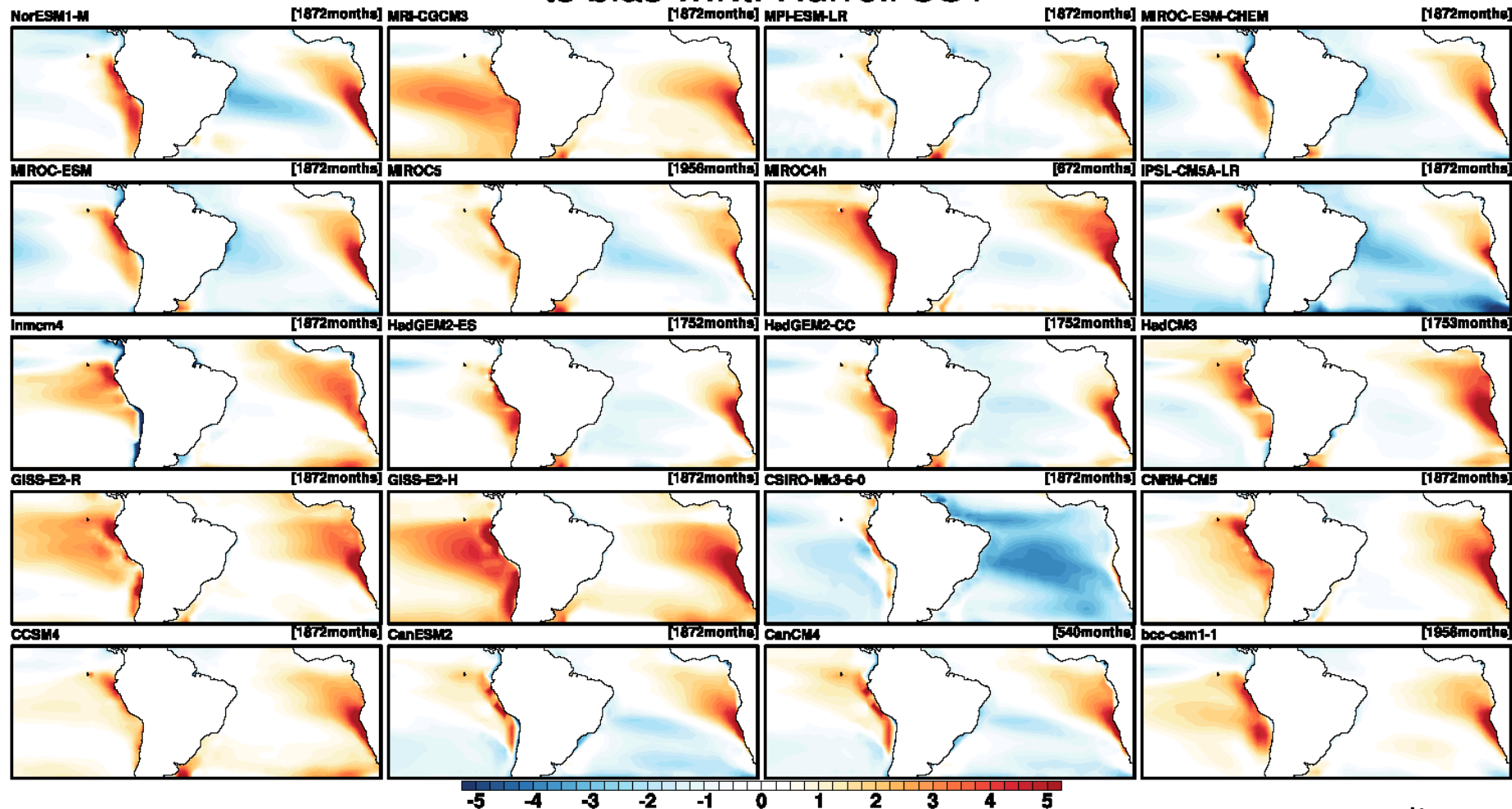
# Regional Climate in the Eastern Tropical Oceans: What Processes Determine Sea Surface Temperature?

*Coupled climate models show persistent SST biases in the eastern tropical oceans even as the models improve in other respects. This session solicits presentations on the processes—atmospheric, oceanic, and those influenced by land—that ultimately affect the sea surface temperature distribution. This encompasses both local (e.g., oceanic upwelling, low-latitude stratocumulus clouds) and remote (e.g., monsoons) influences; modeling analysis and observational studies of equal interest.*

abstracts due August 8

# ETOS web site user-contributed analysis documents CMIP5 SST errors

## CMIP5 historical ts bias w.r.t. Hurrell SST





# User-contributed publications list started

## Relevant Publications

Doi, T., G. A. Vecchi, A. J. Rosati, and T. L. Delworth, 2012: Biases in the Atlantic ITCZ in seasonal-interannual variations for a coarse and a high resolution coupled climate model. *J. Climate*, 10.1175/jcli-d-11-00360.1.

Gottelman, A., J. E. Kay, and K. M. Shell: The Evolution of Climate Sensitivity and Climate Feedbacks in the Community Atmosphere Model. *J. Climate*, 25, 1453-1469, 10.1175/jcli-d-11-00197.1.

Hu, Z.-Z., B. Huang, Y.-T. Hou, W. Wang, F. Yang, C. Stan, and E. K. Schneider, 2011: Sensitivity of Tropical Climate to Low-Level Clouds in the NCEP Climate Forecast System. *Climate Dyn.*, 36, 1795-1811. DOI 10.1007/s00382-010-0797-z.

Kay, J. E., and Coauthors: Exposing global cloud biases in the Community Atmosphere Model (CAM) using satellite observations and their corresponding instrument simulators. *J. Climate*, 10.1175/jcli-d-11-00469.1.

Medeiros, B., D. L. Williamson, C. c. Hannay, and J. G. Olson: Southeast Pacific stratocumulus in the Community Atmosphere Model. *J. Climate*, 10.1175/jcli-d-11-00503.1.

Semyon A. Grodsky, James A. Carton, Sumant Nigam, Yuko M. Okumura, Tropical Atlantic Biases in CCSM4. *J. of Climate*.

## Relevant Publications (Pacific)

Wittenberg, A. T., A. Rosati, N.-C. Lau, and J. J. Ploshay, 2005: GFDL's CM2 Global Coupled Climate Models, Part 3: Tropical Pacific Climate and ENSO. *J. Climate*.

G. Danabasoglu, W. G. Large, J. J. Tribbia, P. R. Gent, B. P. Briegleb, and J. C. McWilliams, 2005 : Diurnal Ocean-Atmosphere Coupling. *J. Climate*, submitted.

Deser, C., A. Capotondi, R. Saravanan, and A. Phillips, 2005:Tropical Pacific and Atlantic Climate Variability in CCSM3. *J. Climate*.

Large, W. G. and G. Danabasoglu, 2005: Attribution and Impacts of Upper Ocean Biases in CCSM3. *J. Climate*.

# Discussion

- What lessons learned in the Pacific can be applied to Atlantic model errors?
- Are CMIP5 errors similar to CMIP3?
  - Yes, mostly.
  - Improvement from modeling centers that prioritized reducing eastern ocean errors (e.g. NCAR)
- Are Atlantic errors similar to Pacific?
- What metrics/observations are most useful?
  - PIRATA moorings
  - Klein & Hartmann (1993) regional averages
  - MODIS decade (2002-2012)

# Products

- Gather relevant publications
- Catalog best-practices and unanswered questions
- Collect and generate hypotheses for Atlantic model errors and processes
- Define metrics for model evaluation
- Provide guidance for proposing highest-value new measurements
- Spark relevant science activity
  - Organizing AGU 2012 session & WG meeting
- Compile contributions on web site
- Publish condensed review article

# ETOS WG Membership

*Peter Brandt* PIRATA PI (Max-Planck Institute)

*Ping Chang* high-resolution ocean modeling  
(Texas A&M)

*Michela Biasutti* Atlantic climate (Lamont-  
Doherty)

*Amy Clement* long-term climate (U Miami)

*Simon de Szoeke* south-east Pacific expert  
(Oregon State U.)

*Takeshi Doi* coupled model developer (IPRC)

*Tom Farrar* ocean eddy observationalist (WHOI)

*Maria Grados* near-coastal ocean circulation  
(IMARPE, Peru)

*Alban Lazar* near-coastal Atlantic expert (French  
institute in Guinea)

*Ben Kirtman* coupled model developer (U  
Miami)

*Roberto Mechoso* coupled climate modeler

*Brian Medeiros* boundary layer cloud analyst  
(NCAR)

*Chris Reason* physical oceanographer,  
observationalist (Cape Town South Africa)

*Ingo Richter* Atlantic coupled climate expert

*Matthieu Rouault* Benguela current  
observationalist (Cape Town, South Africa)

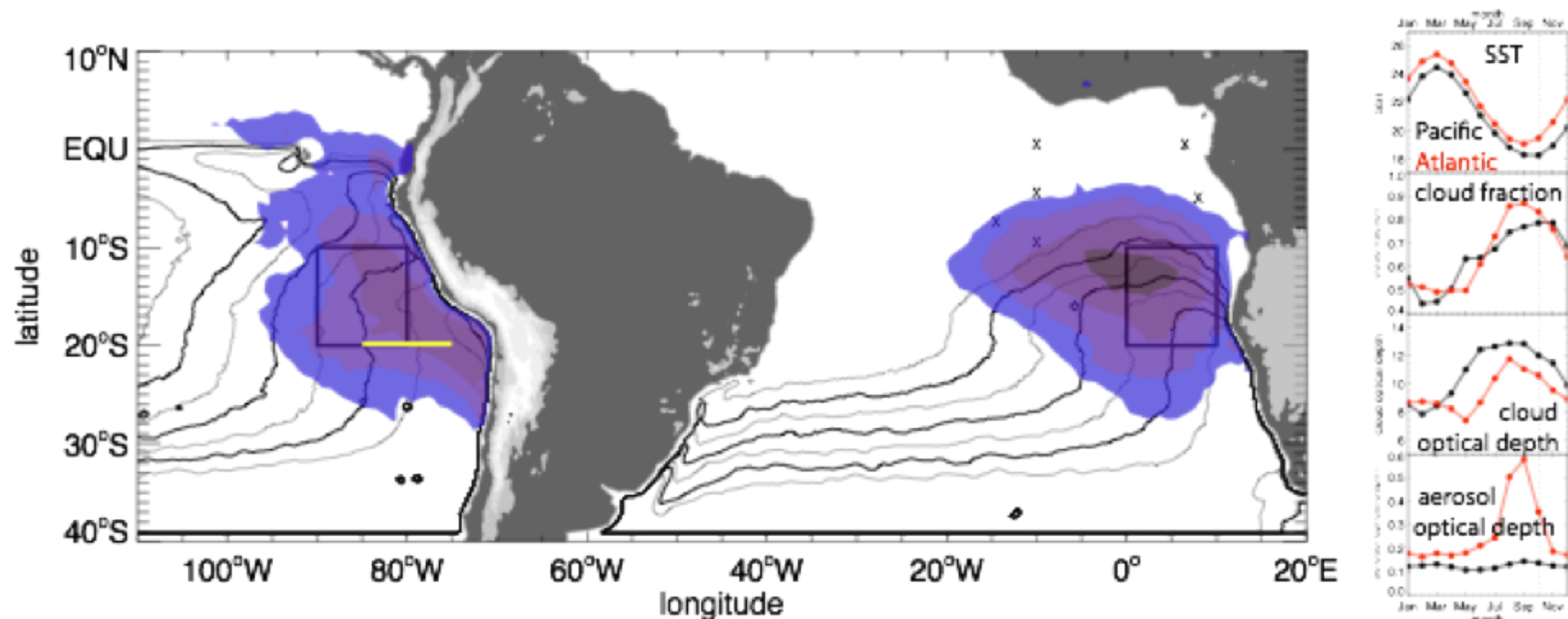
*Irina Sandu* atmospheric boundary layer model  
developer (ECMWF)

*Ed Schneider* coupled ocean-atmosphere  
modeler (COLA)

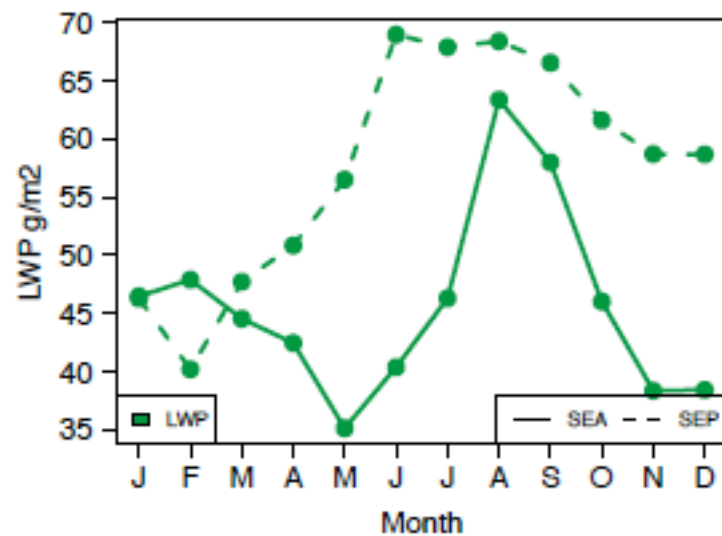
*Laurent Terray* coupled ocean-atmosphere  
modeler (COLA)

*Rob Wood* cloud microphysical processes expert  
(U of Washington)

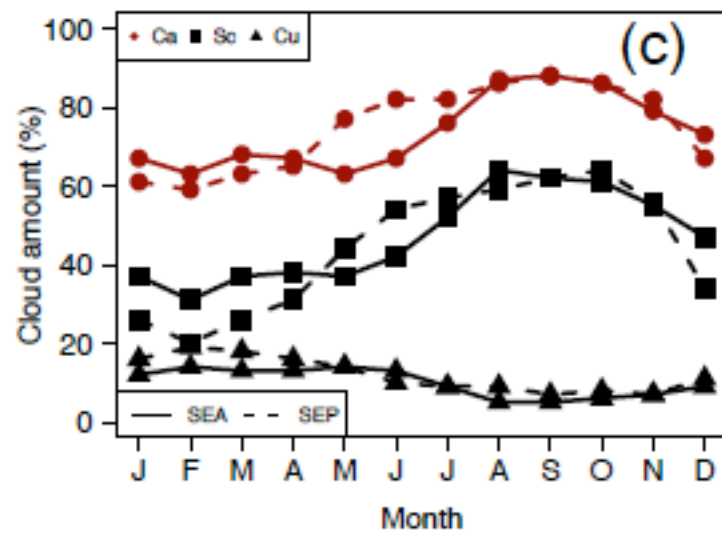
*Paquita Zuidema* cloudy boundary layer  
observationalist (U of Miami)



October-mean 17C-23C sea surface temperature climatology (2002-2010, TMI, black contour lines, 18-20-22C lines boldened), 2002-2009 MODIS Terra mean cloud fraction (blue-purple shading spans 60-100% cloud cover). 'X' mark PIRATA buoys, Sao Tome island (0N, 6.5E), and San Ascension island (8S, 14.5W). Boxes indicate stratocumulus deck locations used within Klein and Hartmann (KH; 1993), yellow line along 20S, 75-85W corresponds to VOCALS/cruise enhanced sampling. Land topography indicated in 1 km height increments. Right four panels depict mean annual cycles in SST, cloud fraction, cloud and aerosol optical depth for the KH boxes, with a dashed line marking October and red and black lines indicating the southeast Atlantic and Pacific respectively.



TWP (g/m²)



Cloud amount (%)

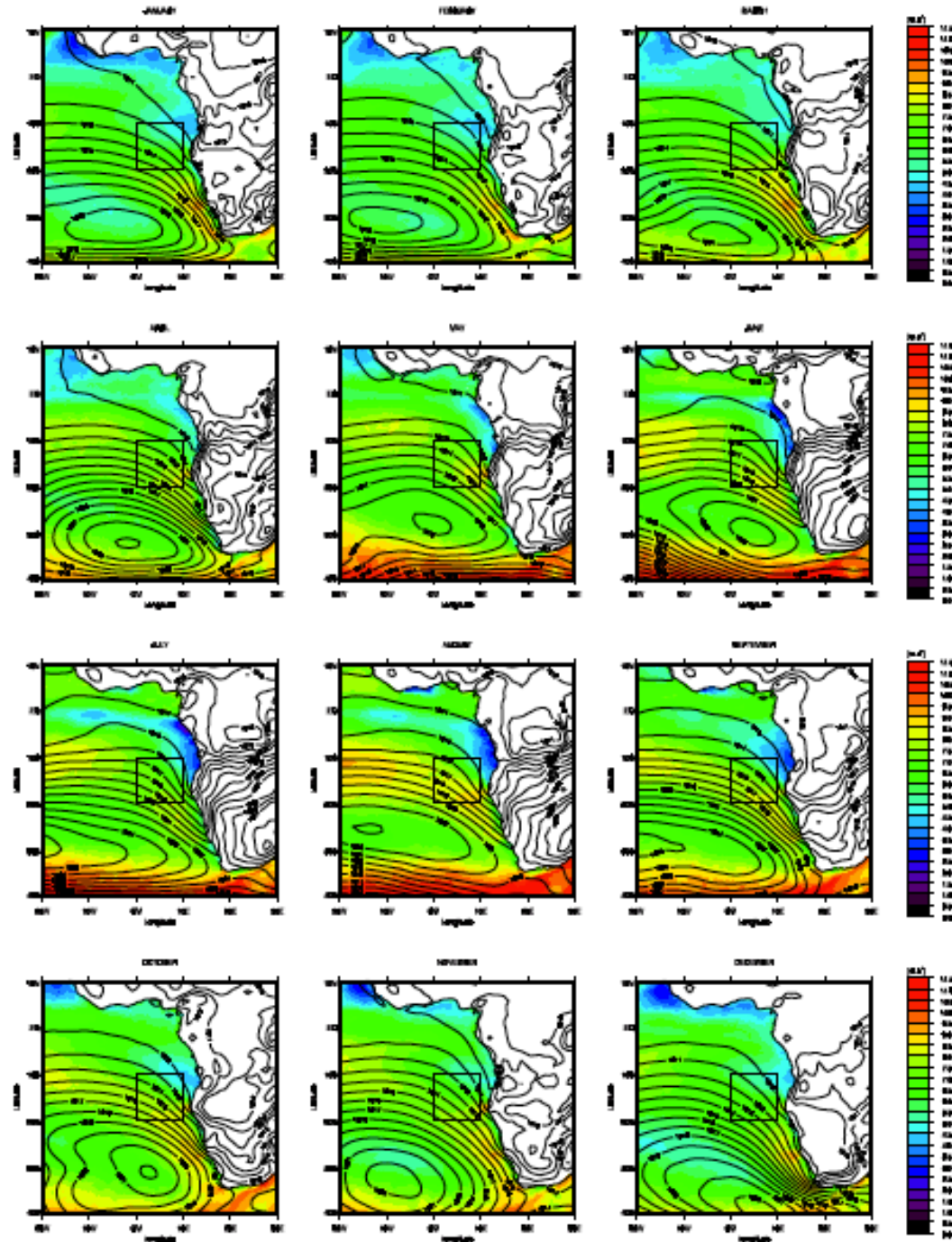


FIG. B.1 – ECMWF-ERA Interim MSLP (hPa) and QuikSCAT wind speed ( $\text{m.s}^{-1}$ ).

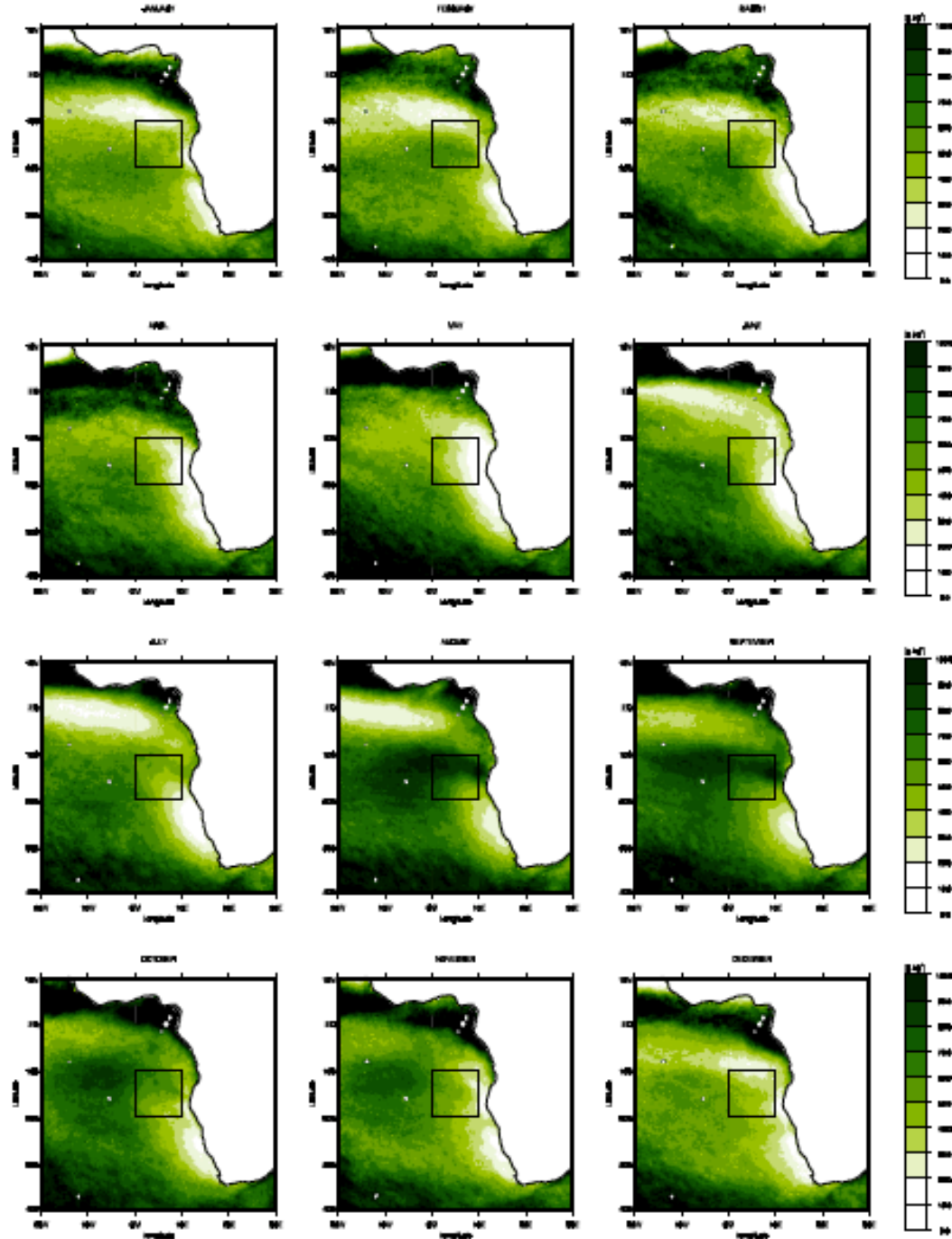


FIG. B.3 – Aqua AMSR-E LWP ( $\text{g.m}^{-2}$ ).