FINNISH METEOROLOGICAL INSTITUTE

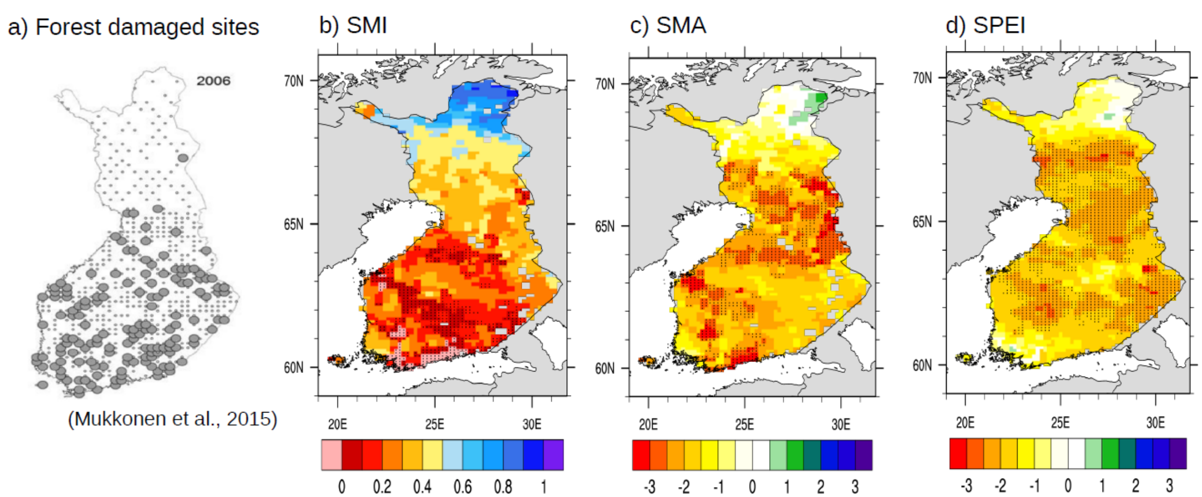
Detecting dry periods in boreal forest zone with JSBACH biosphere model

Y. Gao, T. Markkanen, T. Thum, M. Aurela, A. Lohila, I. Mammarella, S.Hagemann and T. Aalto

- Drought that causes visible damage to trees is occasionally present in boreal forests, as shown by multi-year spatially representative observations

- We compare drought indicators **SPI, SPEI, SMI** and **SMA** in detecting such a severe drought

- We evaluate the LSM **JSBACH** performance in reproducing the drought signals



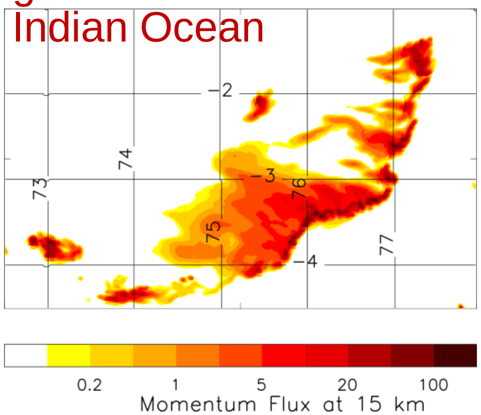
A new empirically derived source parametrization for subgrid scale gravity waves based on precipitation in the Met Office GCM

Andrew C. Bushell, Neal Butchart, Stuart Webster

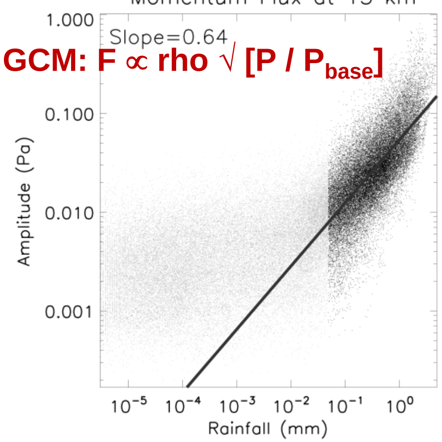
Met Office

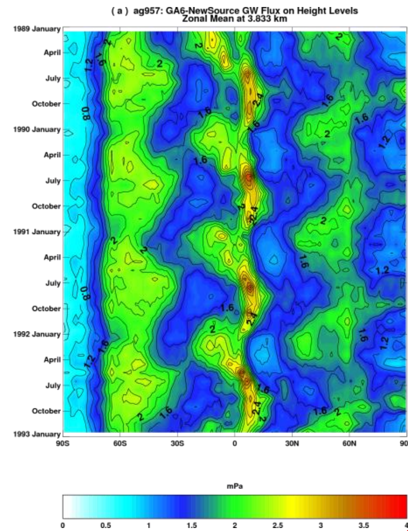
EMBRACE

GW flux derived at GCM gridscale from 2.2km Indian Ocean



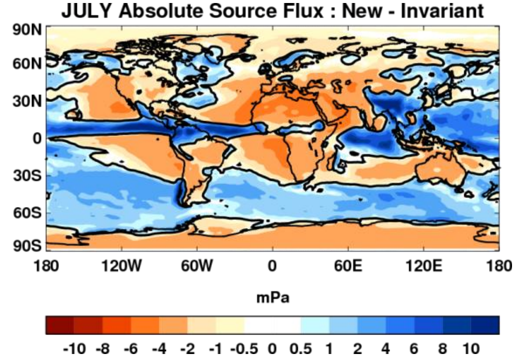
GCM: F ∝ rho √ [P / P_{base}]

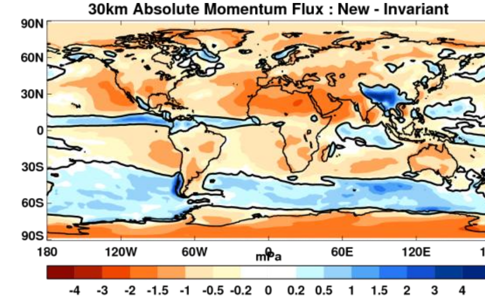




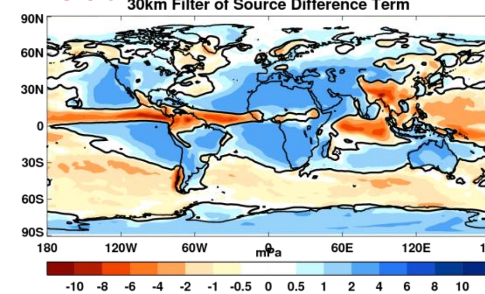
30km difference = dS - f dS + S df

Launch height 3.8km

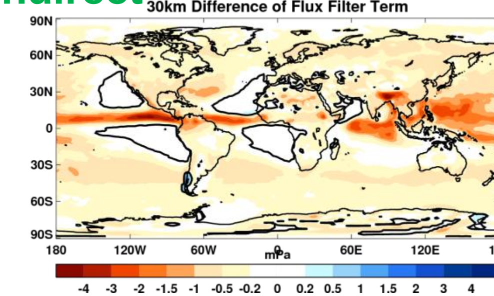




Direct

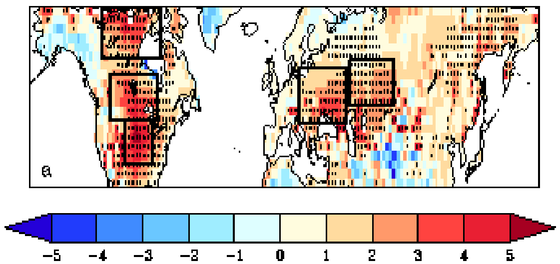


Indirect

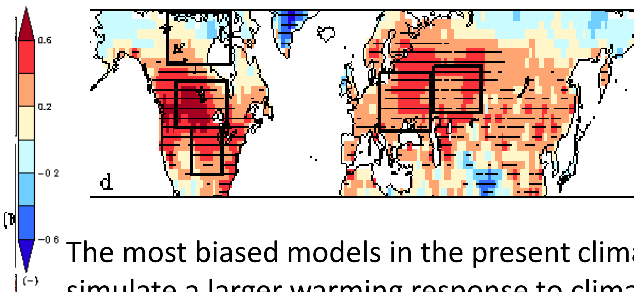


The most biased models CMIP5 in the present climate (summer) simulate a larger warming response to the climate change. The deficiencies identified for the bias are involved in the spread of the summer temperature projection amongst models

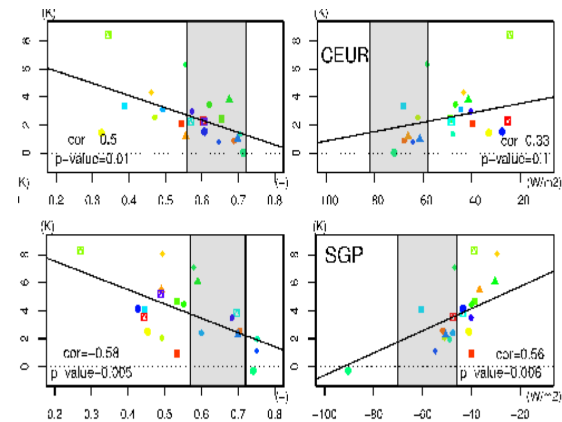
F. Cheruy [(1)], J. L. Dufresne [(1)], F. Hourdin [(1)], A. Ducharne [(2)], C. Rio [(1)] [(1)] **LMD/IPSL-CNRS Paris, France.** [(2)] **METIS/CNRS-Paris**



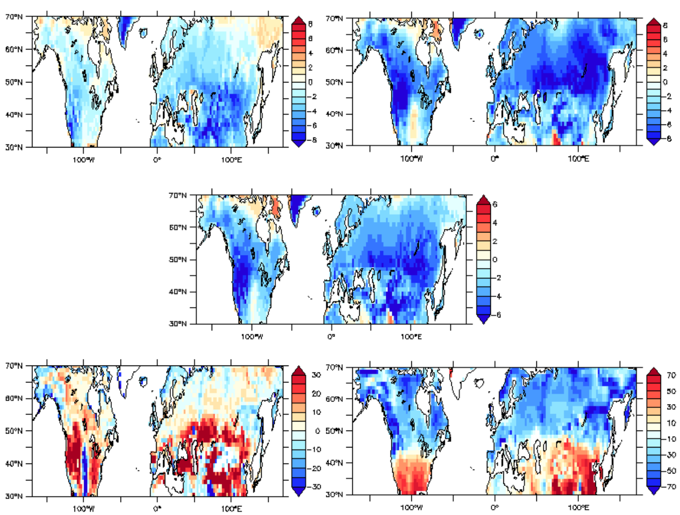
Over land, most state-of-the art climate models contributing to CMIP5 share a strong summer-time warm bias in mid-latitude areas,



The most biased models in the present climate simulate a larger warming response to climate change thus tend to have a higher sensitivity to climate change amplifying it artificially



The most biased models over-estimate solar incoming radiation, because of cloud deficit and have difficulty to sustain evaporation

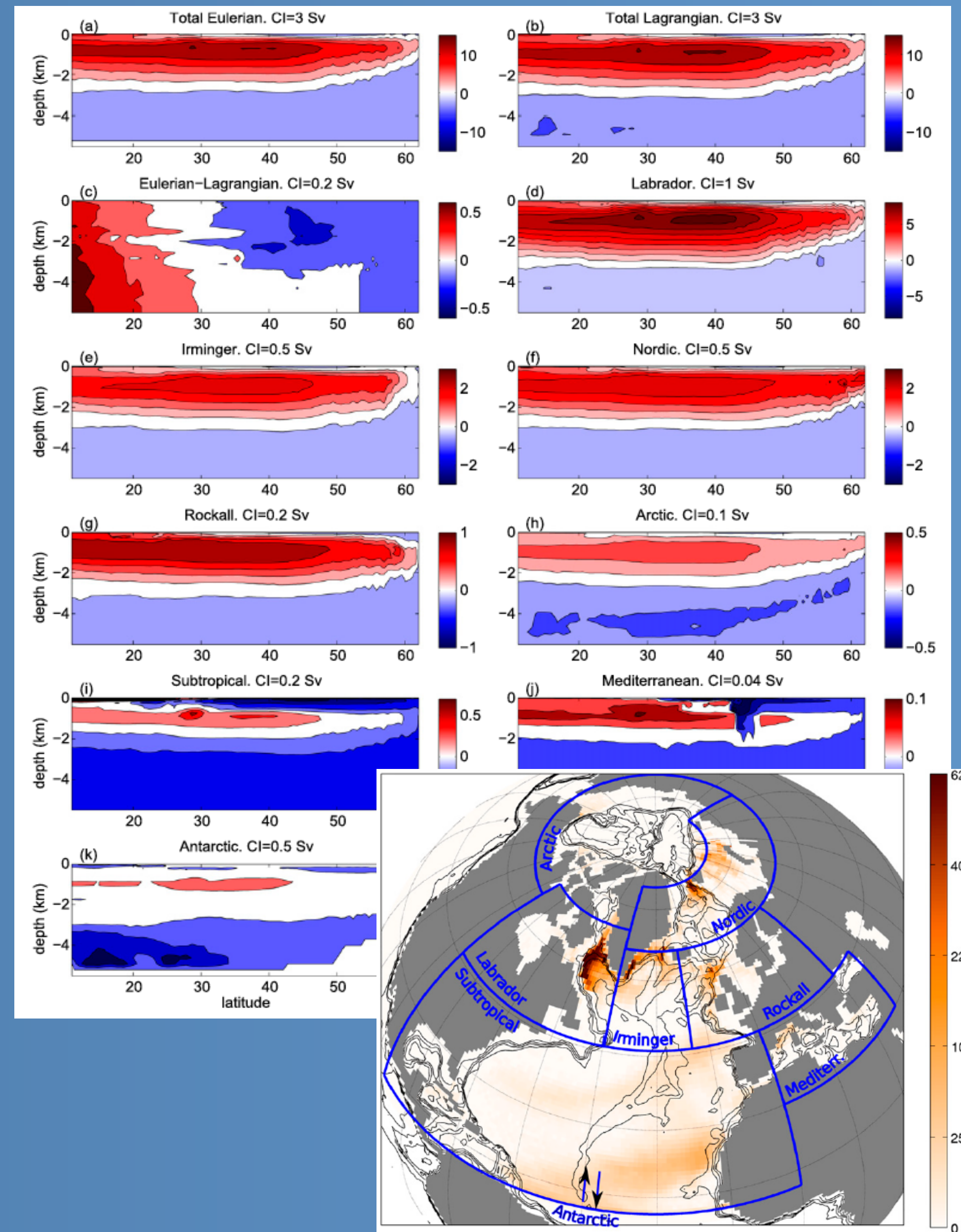


How the models in preparation for CMIP6 are dealing with these deficiencies?

Decomposing the Meridional Overturning Circulation according to its deep water sources

Matthew Thomas, Julie Deshayes, Anne-Marie Treguier, Bruno Blanke, Aurore Voldoire

- We have developed a method based on Lagrangian particles to help make models more easily comparable to observations and to each other.
- Lagrangian particles can be used to reconstruct the time-mean AMOC (top two subpanels).
- Particles are tagged at their last point of subduction from the mixed layer (bottom figure).
- The AMOC is then decomposed (remaining subpanels) according to mixed layer subduction from the different geographical regions (boxes in bottom figure).
- We have used the method to demonstrate that the CNRM model has an ~4 Sv weak AMOC because of too-weak representations of GSR sills overflow and Irminger Sea subduction, as compared to observations (Sarafanov *et al.,* 2012).

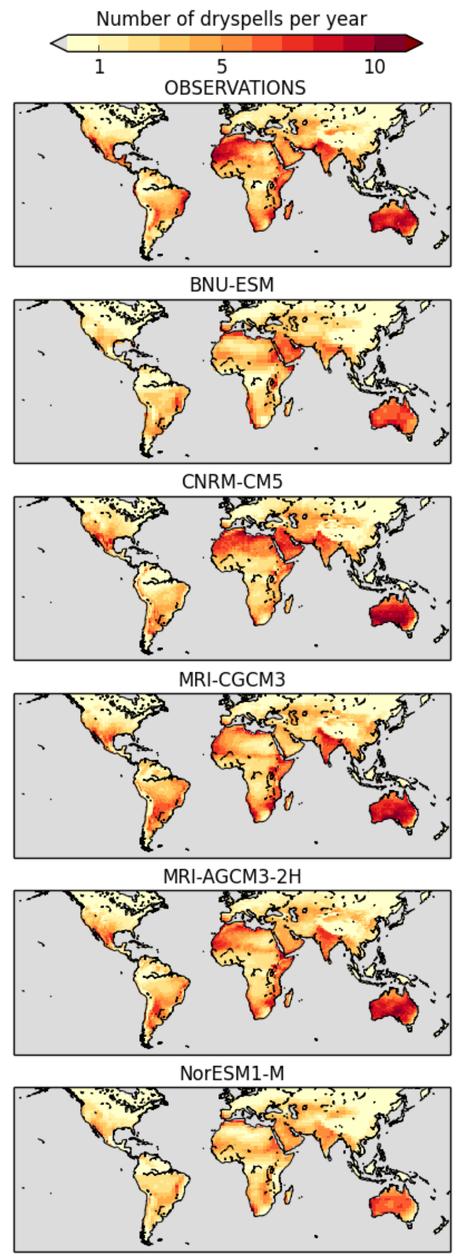


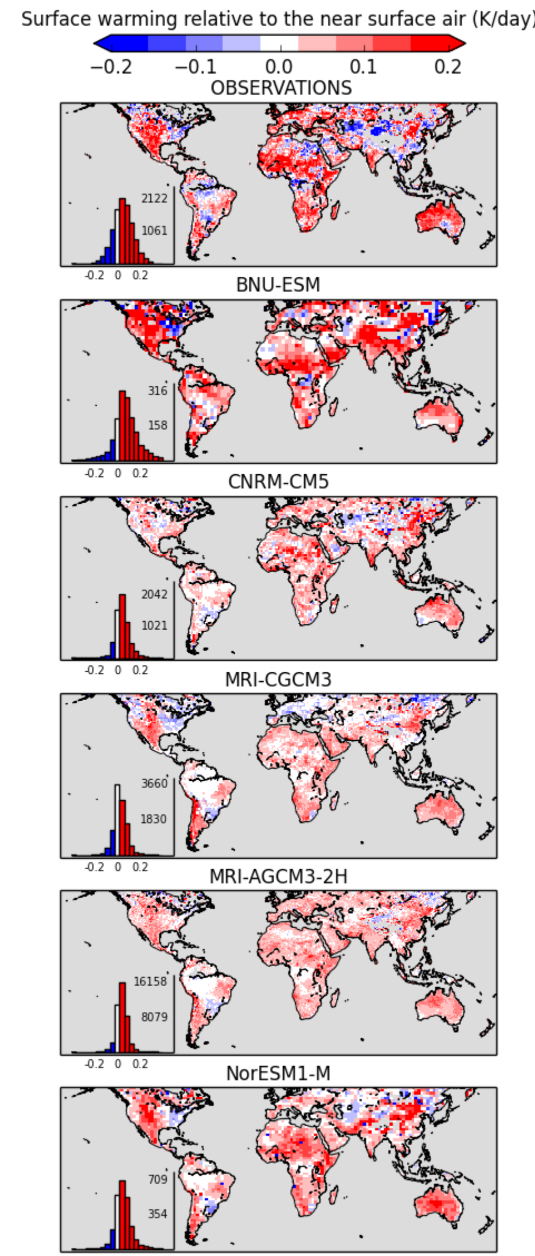
Evaluating soil moisture constraints on land surface fluxes: CMIP5 vs. satellite observations

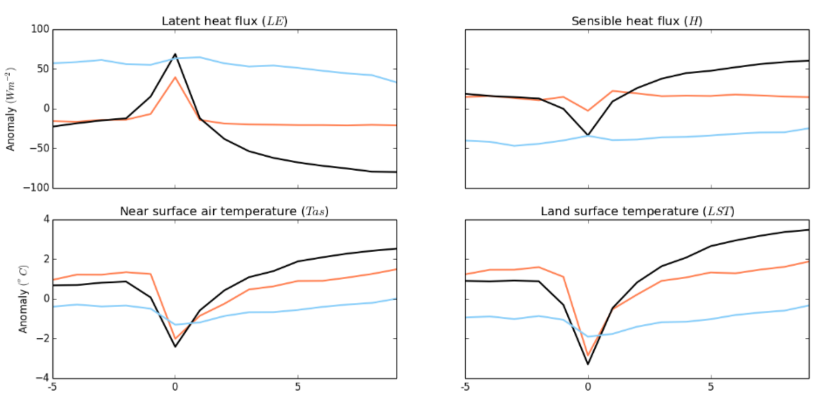
Belen Gallego-Elvira, Christopher M. Taylor, Phil P. Harris, Darren Ghent and Sonja Folwell

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
www.ceh.ac.uk

- Soil moisture regulates the surface energy balance by constraining evapotranspiration
- During dry spells soils can dry out resulting in a reduction of evapotranspiration and an increase of ground and overlying air temperatures
- We use a spatially and temporally aggregated diagnostic to describe the composite response of land surface temperature (LST) during surface dry downs
- The diagnostic is derived from LST day time satellite observations and meteorological reanalyses, and compared to historical climate simulations of six models running the CMIP5 AMIP experiment
- Global Climate Models (GCMs) disagree on where and how strongly the surface energy budget is limited by soil moisture







ASSESSMENT OF MOISTURE TRANSPORT AND CONVERGENCE FIELDS IN CMIP3 AND CMIP5 GLOBAL CLIMATE MODELS IN SOUTH AMERICA

Carla Gulizia * and Inés Camilloni
* gulizia@cima.fcen.uba.ar

MOTIVATION

In a previous study (Gulizia and Camilloni, 2015) we have seen that during austral summer though WCRP/CMIP5 Global Climate Models (GCMs) still underestimate precipitation mainly over southeastern South America, they did so to a lesser extent than those of CMIP3, and the dispersion among the new generation of models was smaller than in the previous one. Overall, models represent austral summer precipitation spatial patterns more adequately than for other seasons.

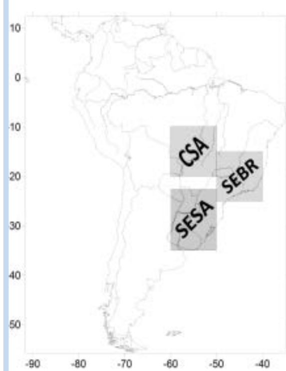
OBJECTIVES

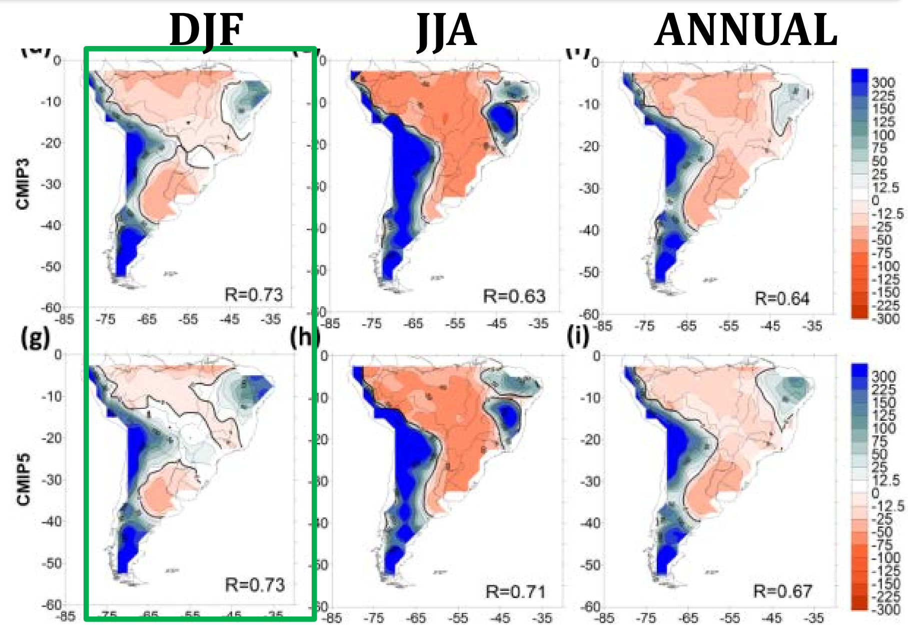
❖ Assess if the improvements found in CMIP5 models to simulate summer precipitation are due to a better representation of moisture transport and convergence over South America.
❖ Evaluate if the deficiencies in simulating precipitation can be at least partially explain by an inadequate representation of the main moisture transport spatial patterns.
❖ Advance in the understanding of the role of summer moisture convergence as a possible mechanism to explain precipitation projections.

SELECTED GCMs

CMIP3	CMIP5
CCCMA-CGCM3.1 (t63)	GFDL-ESM2M
GFDL-CM2.0	HadGEM2-ES
MIROC3.2 (hires)	INMCM4
MRI-CGCM2.3.2	IPSL-CM4
UKMO-HadGEM1	MIROC-ESM

STUDY REGION





$$\text{Relative bias} = \frac{\text{Precipitation}_{GCMs}}{\text{Precipitation}_{CRU}} \times 100 - 100 \qquad (1)$$

Underestimation over the Amazonia and the SEBR sub-region **could not be completely associated with a poor representation of convection** by the GCMs' parameterizations

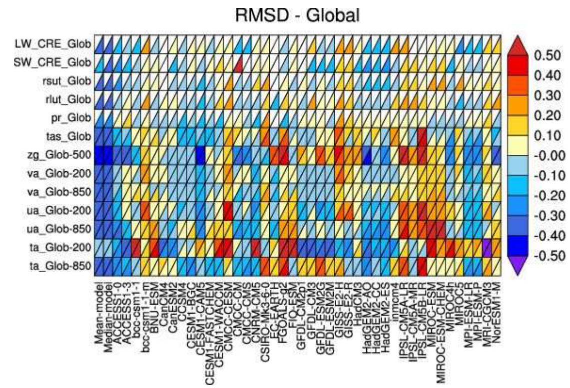
- **lowest relative biases:** found in **summer** when **convection** is **more intense**
- **largest relative biases:** found in **dry season**

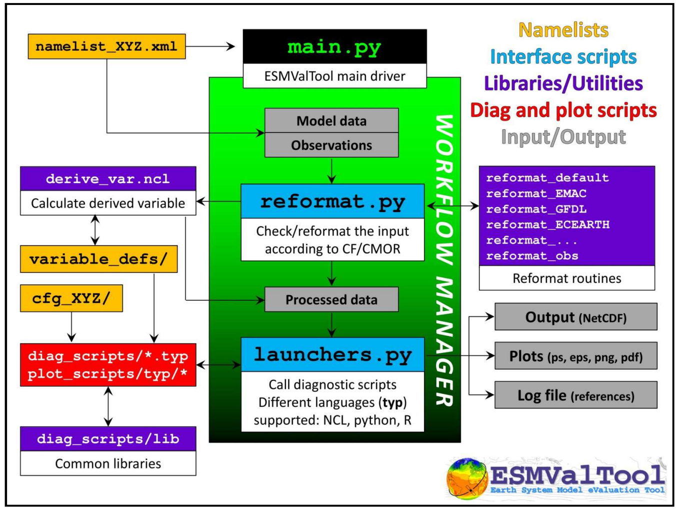
Earth System Model Evaluation Tool (ESMValTool)

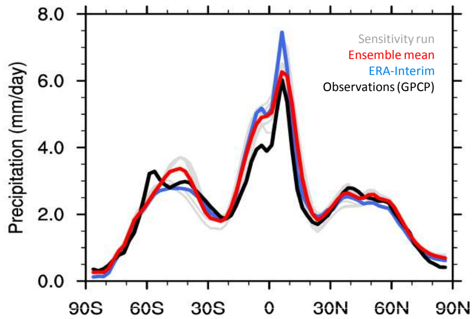
http://www.pa.op.dlr.de/ESMValTool

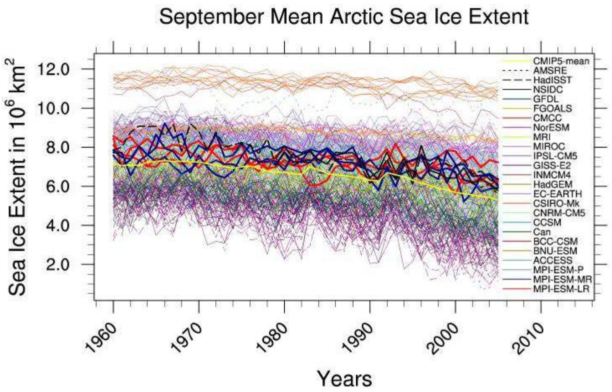
V. Eyring, A. Lauer, M. Righi, M. Evaldsson, S. Wenzel, C. Jones, and ESMValTool Team (EU FP7 EMBRACE project)

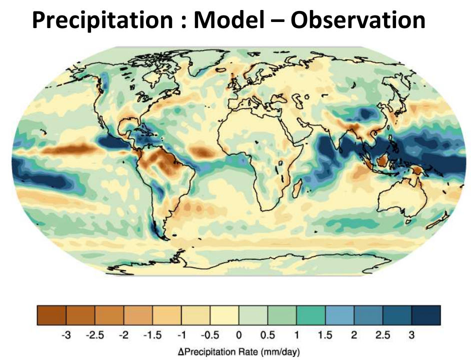
An open community software tool allowing routine and extendable evaluation of ESMs using a range of standardized metrics/diagnostics and quality-controlled observations and reanalyses











Runs directly from CMIP-compliant data.

Targeted for operation from the ESGF

Extensive use planned as a documentation tool for CMIP6 ESMs

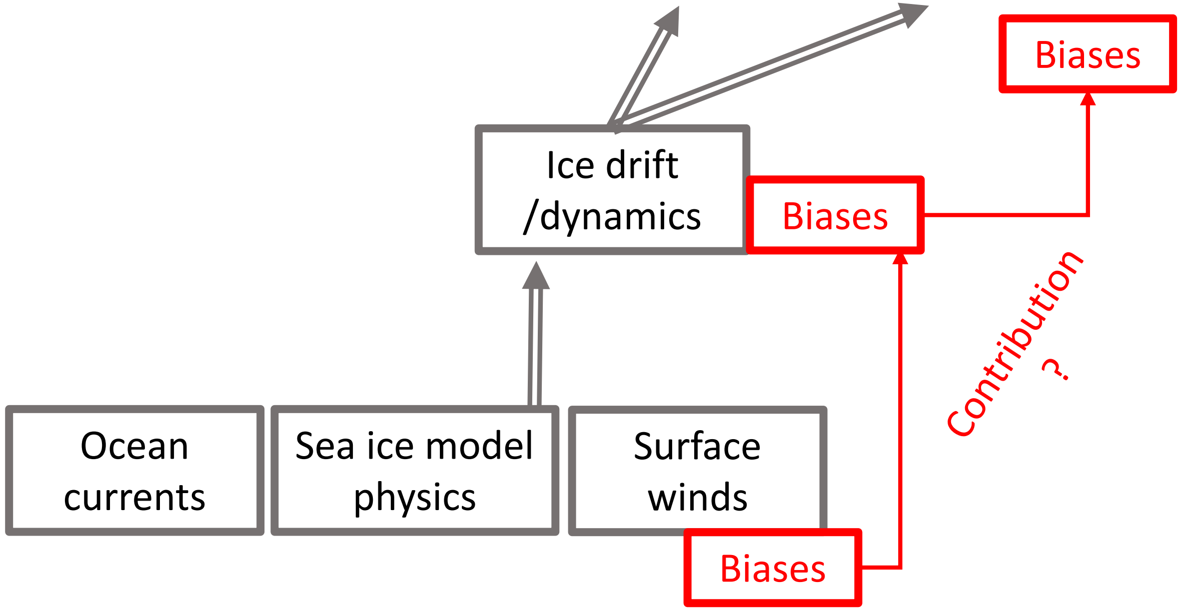
Process-oriented diagnostics in the polar regions. Part 2: Investigating Antarctic sea ice and ocean biases in climate models

Impact of surface wind biases on the Antarctic sea ice concentration budget in climate models

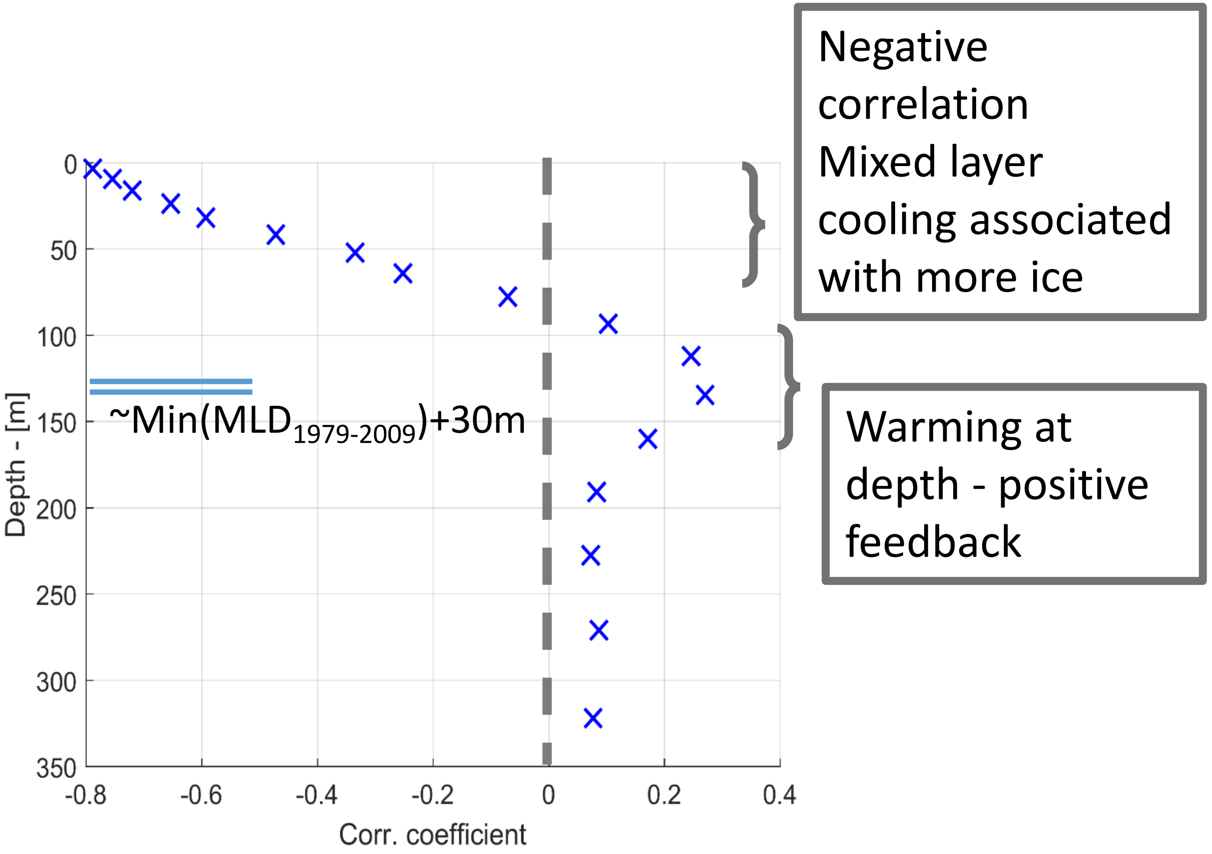
Sea ice concentration budget:

$$A(t_2) - A(t_1) = \int_{t_1}^{t_2} f\,dt - \int_{t_1}^{t_2} \boldsymbol{u}.\nabla A\,dt - \int_{t_1}^{t_2} A\nabla.\boldsymbol{u}\,dt$$

Ice conc. change **Freezing** **Advection** **Divergence**



A new ocean – sea ice diagnostic for the Southern Ocean in climate models

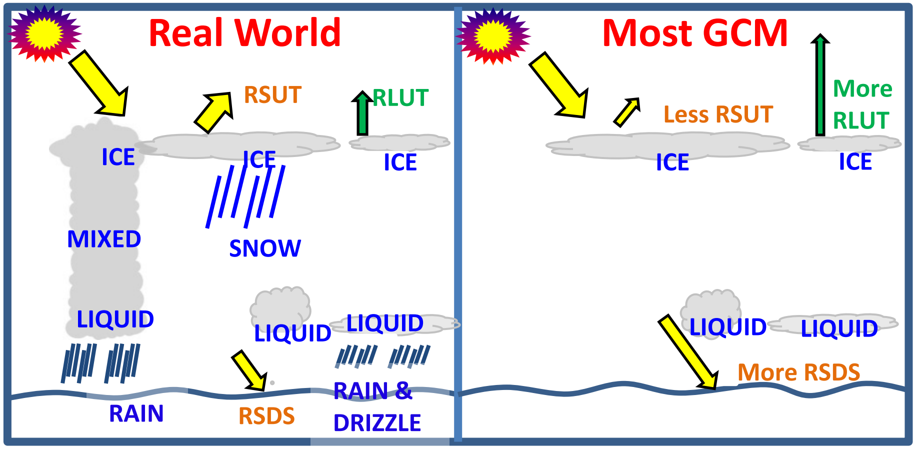


Correlation between ice concentration trends and ocean temperature trends as a function of depth over the period 1979-2009, in a simulation from the NEMO-LIM3 ocean-sea ice model

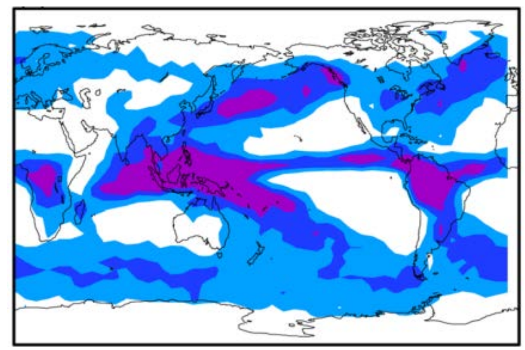
Impact of Snow-Radiation Interaction on Systematic Biases of Large-scale Circulations in CMIP3/CMIP5 Simulations

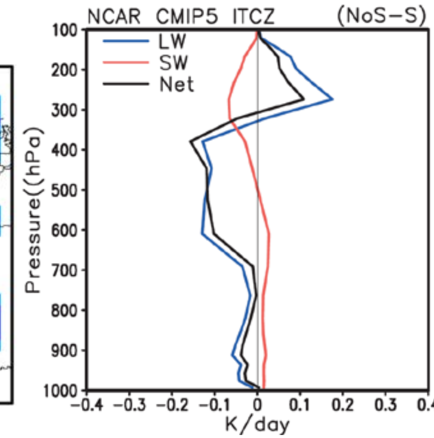
Wei-Liang Lee, *Academia Sinica, Taiwan*

Jui-Lin Frank Li, Duane Waliser, J. David Neelin, and Huang-Hsiung Hsu

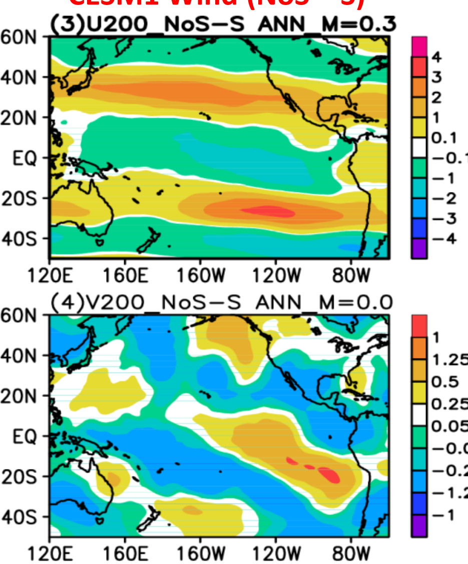


CMIP5 IWP bias

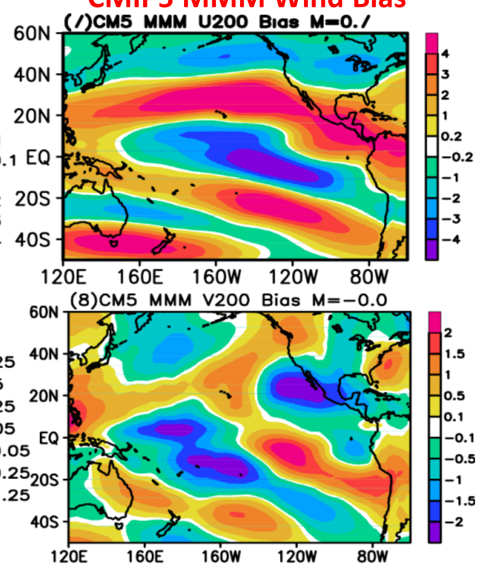




CESM1 Wind (NoS – S)



CMIP5 MMM Wind Bias



Key Issue:

Radiative effects of Precipitating hydrometeors are missing in all CMIP3 and most of CMIP5 GCMs.

Study Approach:

Turning off snow-radiation interaction in NCAR CESM1/CAM5

Result:

1. There are too much solar flux at surface and too much OLR at TOA over convective zones.
2. Convective zones become more unstable.
3. Hadley circulation is enhanced, causing too strong subtropical jet streams.
4. Discrepancies in radiative and dynamic fields between sensitivity tests are similar to systematic biases in CMIP5 multi-model means.

NOAA Model Diagnostics Task Force

Connecting the external research community with NOAA labs and operational centers

MAPP
Modeling, Analysis, Predictions, and Projections

Mission

The Model Diagnostics Task force, organized by the NOAA Modeling, Analysis, Predictions, and Projections program, aims to develop, coordinate, and implement process-based model evaluation metrics in modeling center metrics packages. The Task Force will leverage ongoing efforts at the modeling centers toward advancing model evaluation and development capabilities through an initial effort focused on NOAA's GFDL and NCAR. The Task Force will coordinate with ongoing efforts such as the WCRP/WGCM Metrics Panel, PCMDI's UV-CDAT effort, and the EMBRACE ESMValTool project.

Performance Metrics
The whether
↓
Process-Oriented Diagnostics
The why

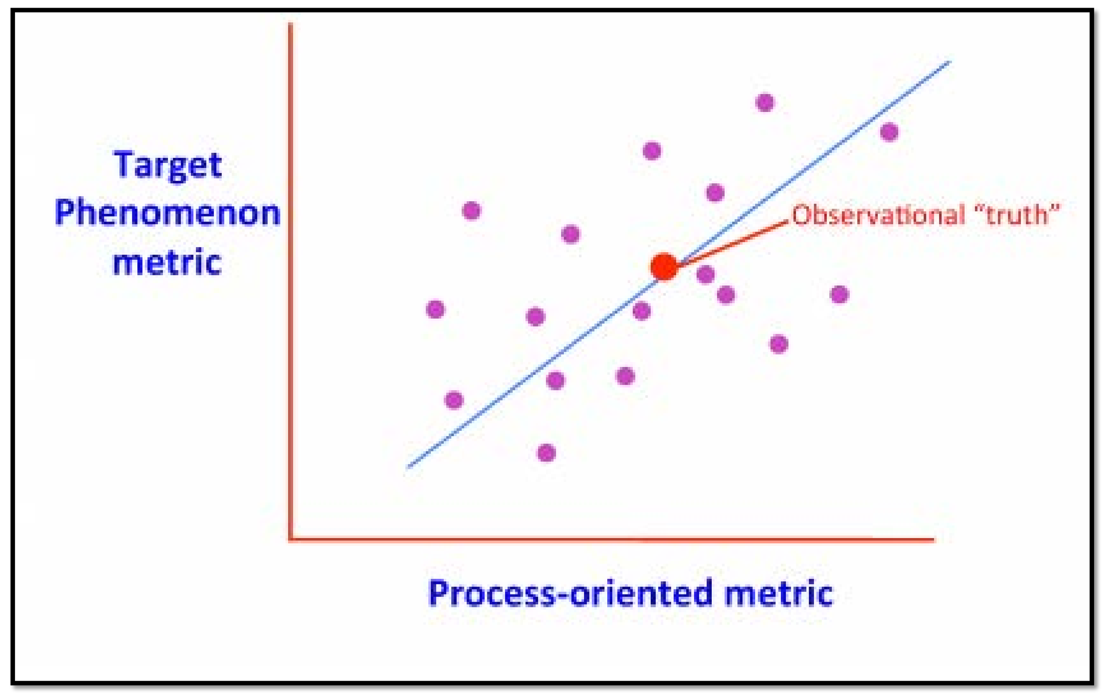
The task force initiated its activities in October 2015 and will have a duration of three years.

Assessing processes in climate and Earth system models is essential for understanding model biases, identifying model error origins, and developing next-generation models.

Background

The Task Force consists of researchers whose projects were successfully evaluated as part of the FY15 competition, "Process-oriented evaluation of climate and Earth system models and derived projections," held by NOAA's Modeling, Analysis, Predictions, and Projections (MAPP) program.

The FY15 competition was motivated by:
- **Community interest in moving beyond performance-oriented metrics toward process-oriented metrics**
- **Current efforts to develop next-generation climate and Earth system models**
- **Evolving plans for the Coupled Model Intercomparison Project (CMIP)**
- **A need to link model development and evaluation efforts across modeling centers.**



The Task Force will enhance communication between investigators, and build an integrative process-oriented metrics framework serving NOAA and other modeling centers. This activity represents a partnership between a number of universities, federal agencies, and activities.

Leadership

Lead: Eric Maloney (Colorado State University)
Co-lead: Yi Ming (GFDL)
Co-lead: Andrew Gettelman (NCAR)
Co-lead: Aiguo Dai (University at Albany)

MAPP management oversees the activities of the Task Force working with the Leads.

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

GFDL Geophysical Fluid Dynamics Laboratory

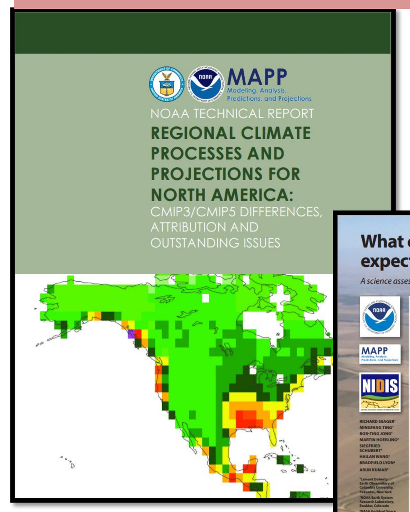
Task Force Concept

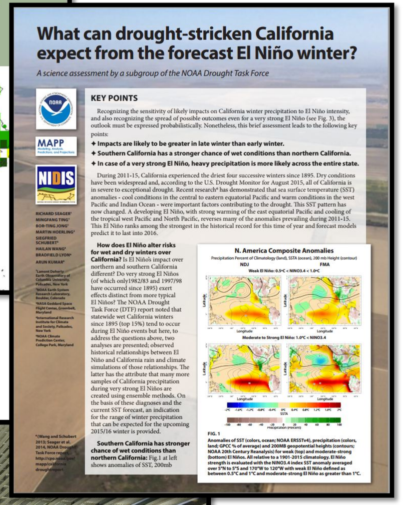
The MAPP program Task Forces target high-priority research areas where rapid progress is needed to advance MAPP program, NOAA, and National objectives. The Task Forces provide a working-level opportunity for MAPP-funded researchers already engaged in projects with synergistic goals to communicate and coordinate.

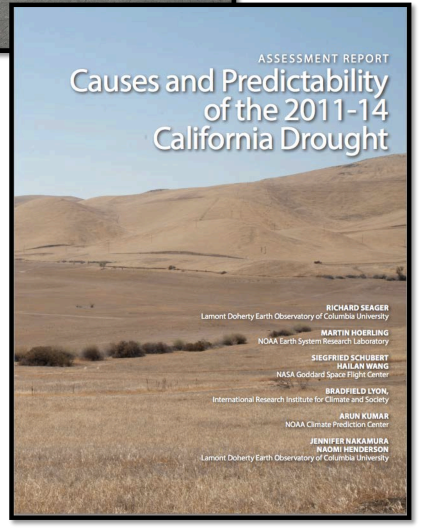
The activities of each Task Force target objectives beyond the scope of each individual project that require a community approach. Objectives are defined based on drivers of relevance to the Task Force research area, the expertise of the researchers, the scope of funded research projects, and the time span of the Task Force.

Other MAPP Task Forces:
- **Drought Task Force**
- **Climate Model Development Task Force**
- **Climate Reanalysis Task Force**

Past Task Force Highlights







Projects and Participants

Development of a framework for process-oriented diagnosis of global models
PI: Eric Maloney (Colorado State University); **Co-PIs:** Yi Ming (NOAA GFDL), Andrew Gettelman (NCAR), David Neelin (UCLA)

Evaluation of warm cloud microphysical processes in global climate models with multi-sensor satellite observations
PI: Kentaroh Suzuki (University of Tokyo); **Co-PIs:** Jean-Christophe Golaz (NOAA GFDL), Huan Guo (NOAA GFDL), Peter Bogenschutz (NCAR)

Process oriented diagnostics of tropical cyclones in climate models
PI: Suzana Camargo (Columbia University); **Co-PIs:** Adam Sobel (Columbia University), Daehyun Kim (University of Washington), Anthony D. Del Genio (NASA GISS)

Metrics for general circulation model biases in extratropical cyclone clouds and precipitation: evaluating their skill and identifying processes to be improved
PI: James Booth (City University of New York, City College); **Co-PIs:** Catherine Naud (Columbia University, Zhengzhao Luo (City University of New York, City College), Jean-Christophe Golaz (NOAA GFDL)

Development of process-oriented metrics for ENSO-induced teleconnection over North America and U.S. affiliated pacific islands in climate models
PI: Hariharasubramanian Annamalai (University of Hawaii), **Co-PI:** Arun Kumar (NOAA CPC)

Process oriented metrics of land-surface-atmospheric interactions for diagnosing coupled model simulations of land surface hydro-meteorological extremes
PI: Justin Sheffield (Princeton University)

Process-oriented diagnosis and metrics development for the Madden-Julian Oscillation based on climate simulations
PI: Xianan Jiang (UCLA); **Co-PIs:** Eric Maloney (Colorado State University), Ming Zhao (NOAA GFDL), Shian-Jiann Lin (NOAA GFDL)

Diurnal metrics for evaluating GFDL and other climate models
PI: Aiguo Dai (University at Albany); **Co-PIs:** Jean-Christophe Golaz (NOAA GFDL), Junhong Wang (University at Albany), Ming Zhao (NOAA GFDL)

Evaluation and diagnosis of the Atlantic Meridional Overturning circulation 3D structure in climate models
PI: Xiaobiao Xu (Florida State University); **Co-PIs:** Eric Chassignet (Florida State University), Molly Baringer (NOAA AOML), Shenfu Dong (NOAA AOML)

Influence of diabatic heating profiles on monsoon circulations

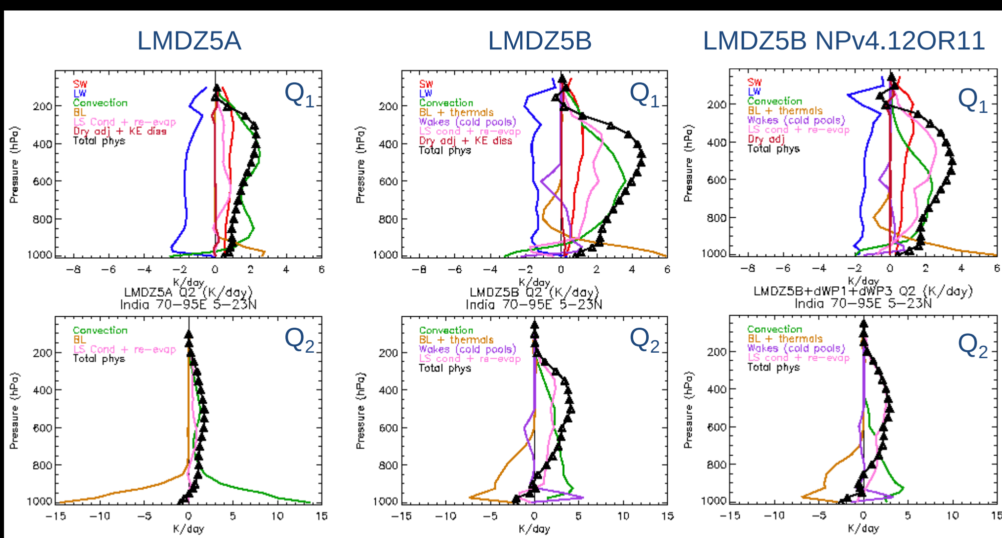
Met Office Hadley Centre

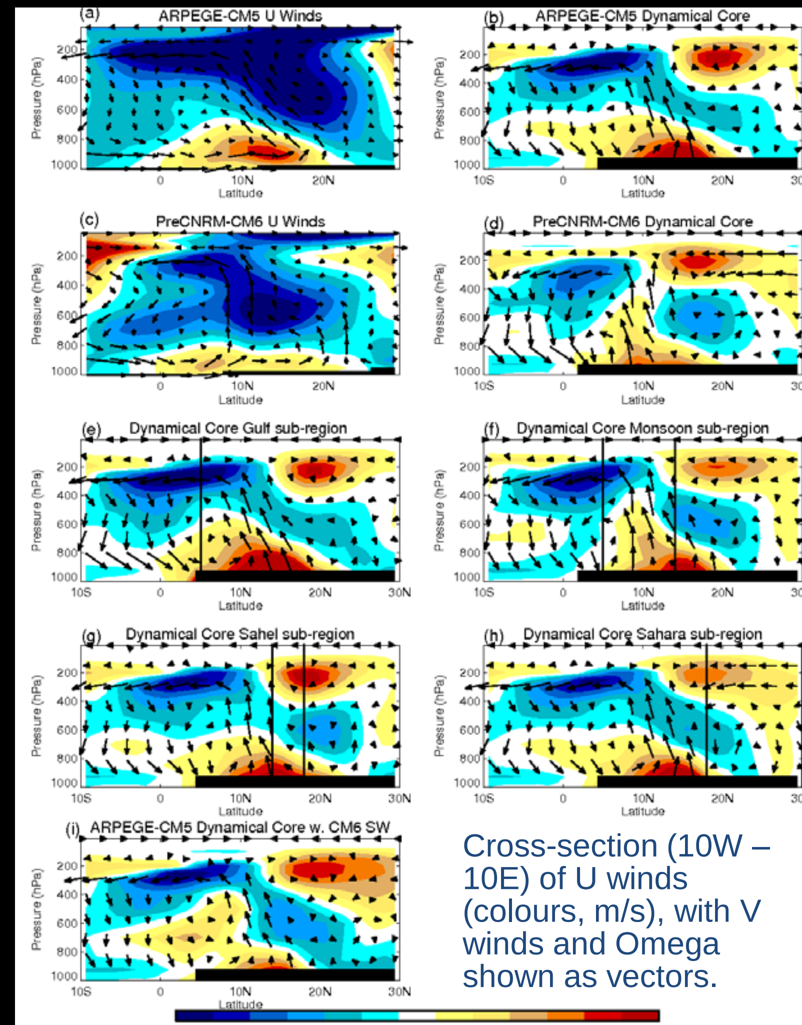
Gill Martin, Rob Chadwick, Catherine Rio, Romain Roehrig, Mihaela Caian, Philippe Peyrille, Francis Codron, Gilles Bellon, D. Emmanuel Poan, Jean-Philippe Lafore

Models struggle to represent the characteristics of monsoon systems. On-going model development has resulted in some significant changes to these characteristics in some model families, but only modest effects in others.

Radiative heating is important in influencing the dynamical monsoon flow and the strength and position of the African Easterly Jet.

Changes in diabatic heating in the Sahara, Sahel and monsoon regions all appear to affect the monsoon flow, while changes in the Gulf of Guinea region appear to have a compensating effect.





Cross-section (10W – 10E) of U winds (colours, m/s), with V winds and Omega shown as vectors.

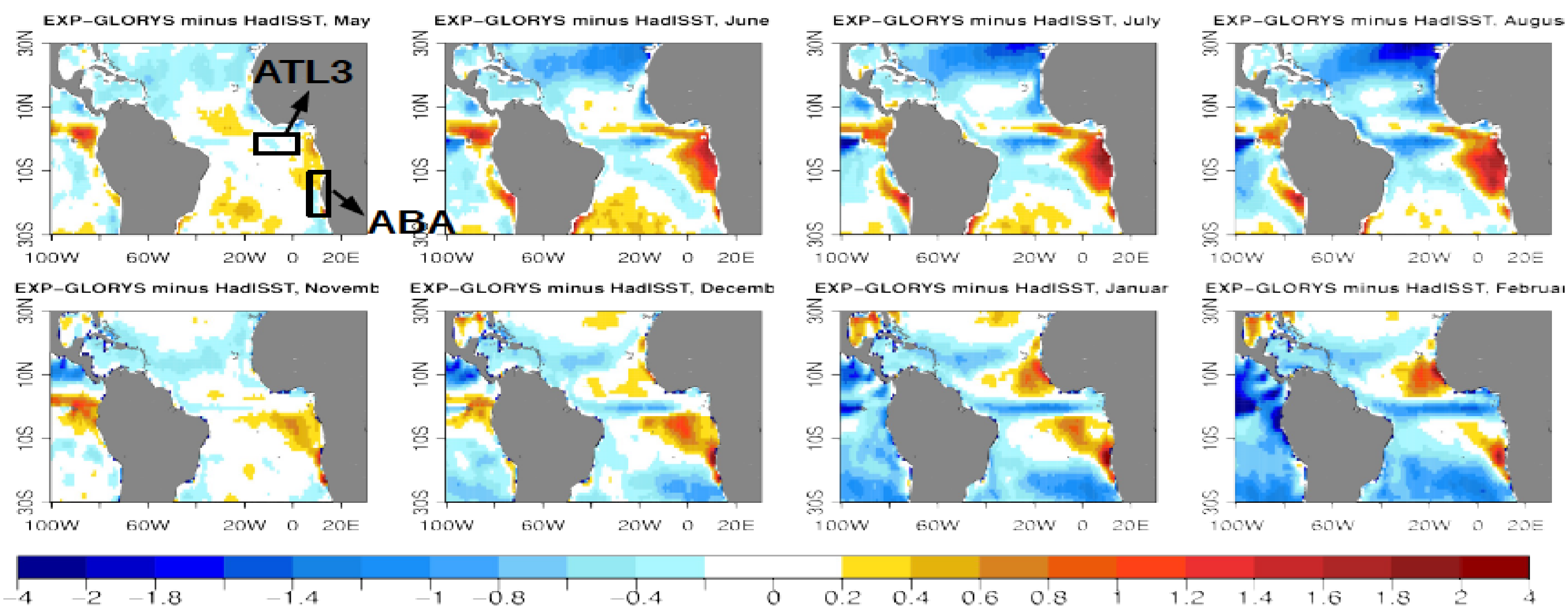
Impact of the initialization with different ocean reanalysis on the forecast bias

Eleftheria Exarchou, Chloé Prodhomme, Virginie Guemas, Francisco Doblas-Reyes

We use seasonal forecasts performed with EC-Earth3.0.1, in order to investigate:

→ Possible mechanisms of error growth in the Tropical Atlantic

→ The impact of initialization with different ocean reanalysis (ORAS4 vs GLORYS) on the forecast bias



eleftheria.exarchou@ic3.cat

Constraining hydrological and carbon cycle parameters in JSBACH with micrometeorological flux measurements (S 1.14)

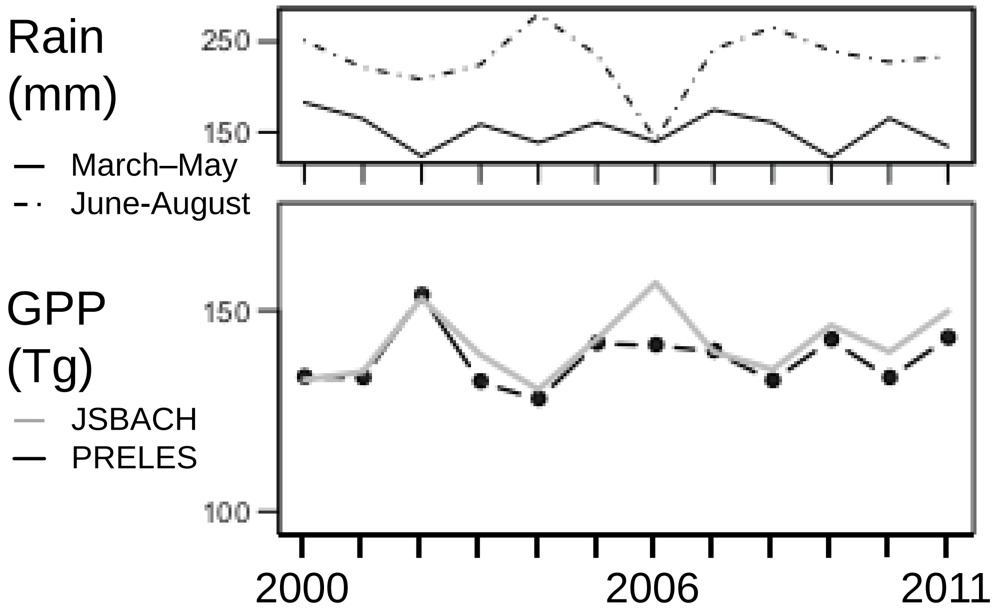


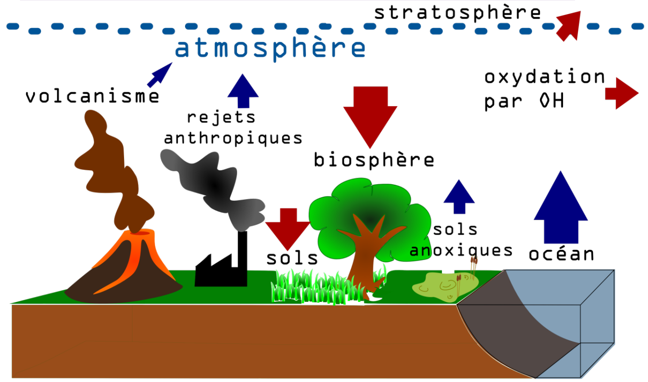
Fig 1: Peltoniemi et al. 2015. BER 20: 196–212. Consistent estimates of gross primary production of Finnish forests – comparison of estimates of two process models.

- Insuffficient response to water limitation
- Seasonal tuning to capture site-level characteristics
- Dense temporal resolution for optimization runs
- See poster for results

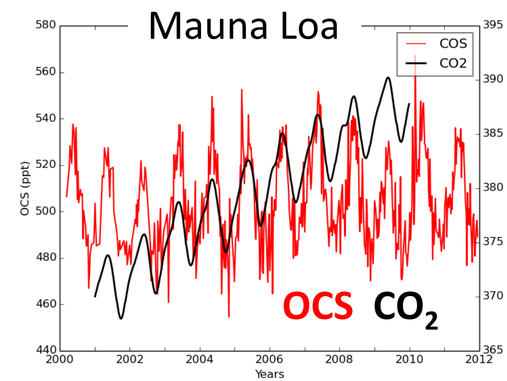
Atmospheric [OCS], [CO_2] and Satellite Fluorescence : Multiple constraints on model GPP

(P. Peylin, N. MacBean, P. Cadule, T. Launois, S. Belviso, V. Bastrikov, L Guanter, P Köhler)

OCS cycle



CO_2 & OCS atmospheric budgets

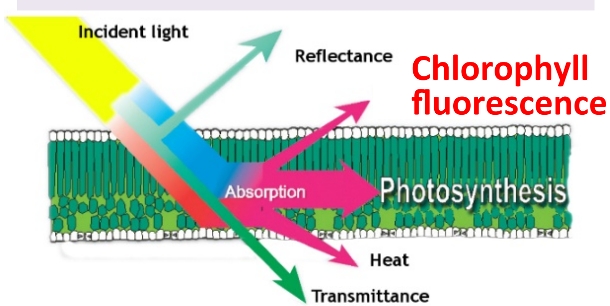


OCS absorption during Photosynthesis

F_{OCS} = K . GPP [OCS]/[CO2]

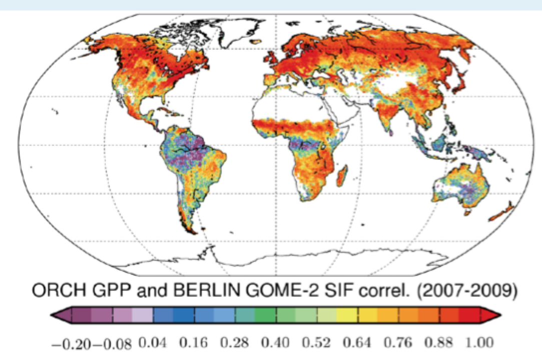
Multiple constraints (OCS, CO_2ampli, SIF) on GPP seasonal variations (ex CMIP5)

Solar Induced Fluorescence (from satellite)



SIF as a potential proxy for GPP

GOME2_SIF – ORCHIDEE_GPP: Correlation (0.8)

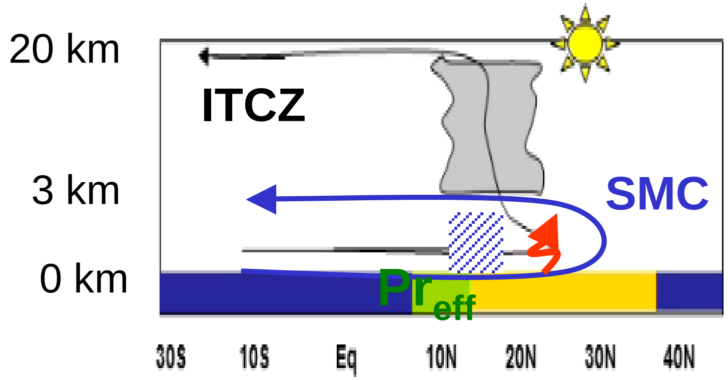


Analysis of the West African monsoon annual cycle using a two-dimensional model: Some key factors contributing to the rainband displacement

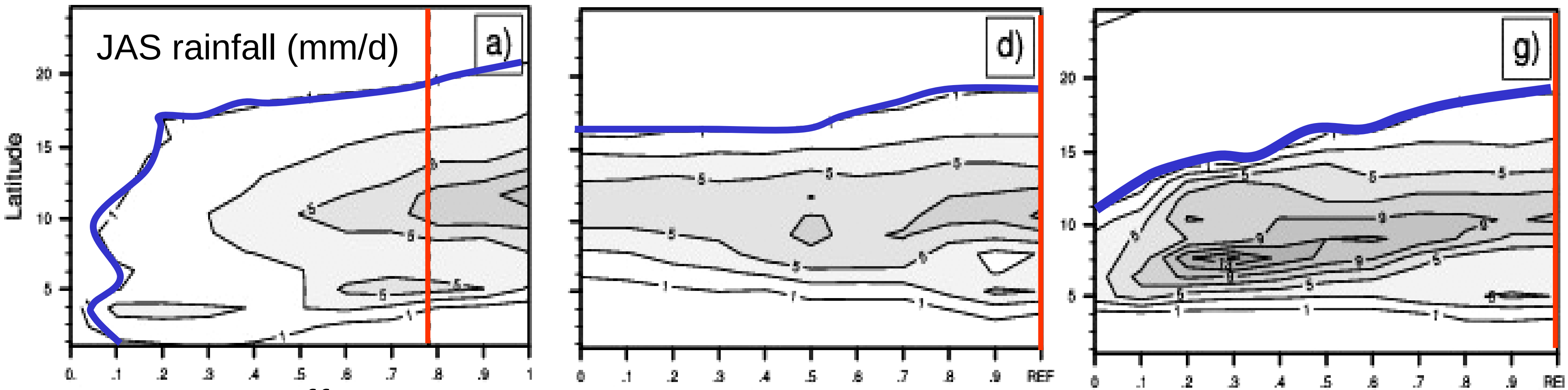
P. Peyrillé, J.-P. Lafore, A. Boone
CNRM-GAME, Toulouse, France

- **The West African monsoon annual cycle is still well simulated by CMIP5 climate models**
- **2D meridional-vertical numerical model: simple and flexible framework with a complete physical package**

➔ The role of water recycling, precipitation efficiency and advection by the circulation associated with the Saharan Heat Low is key to shape the summer rainband



➔ Sensivity experiments explore the obtained equilibria



Precipitation efficiencty

Water recycling

Advection by the SMC

Coupling between convection and large-scale circulation in cloud-resolving and single-column models

C. L. Daleu, S. J. Woolnough, R. S. Plant, D. Raymond, S. Sessions,A. Sobel, S. Wang, A. Cheng, M. Herman, G. Bellon, **P. Peyrille**, F. Ferry, P. Siebesma, B. van Ulft

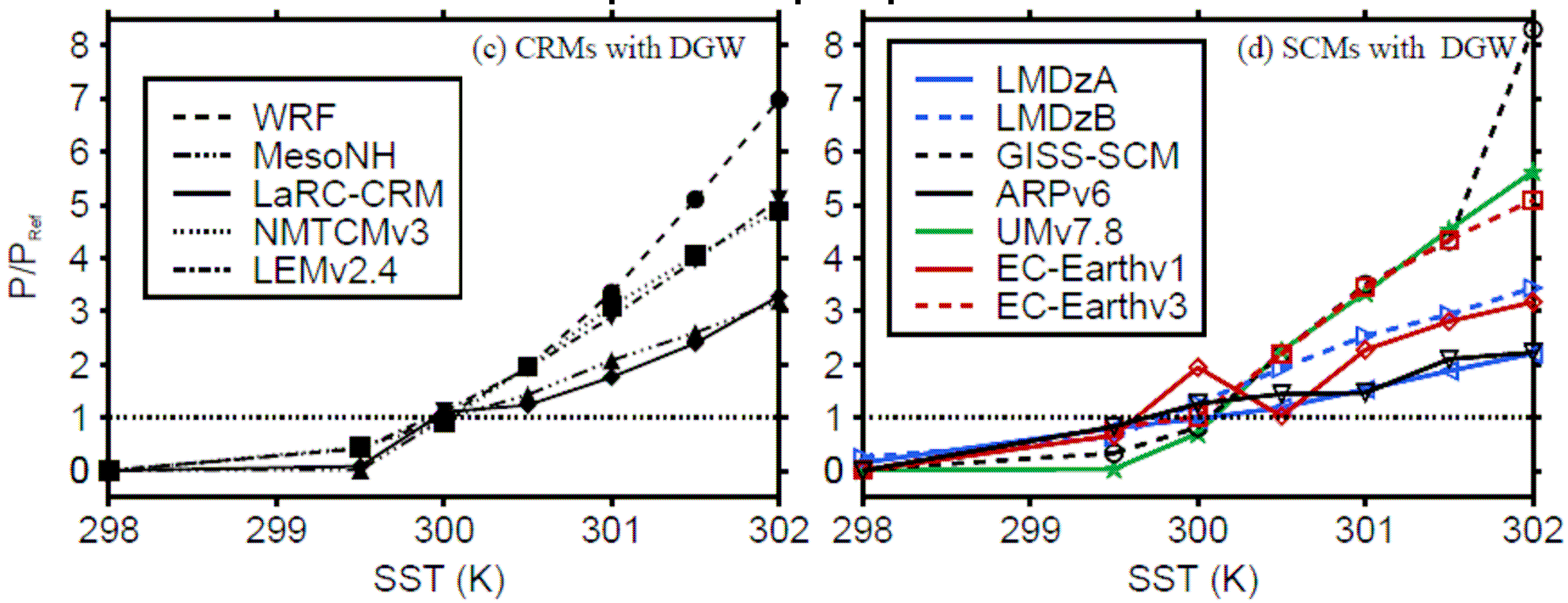
Within GASS-WTG: a simple configuration has been set-up to analyze the interaction between convection and the large-scale atmospheric circulation:

-**Test of methodology: Weak Temperature Gradient (WTG) v.s. Damped Gravity Wave (DGW)**

➔ **ω velocity is render interactive instead of prescribed**

-**Test of GCM-1D models by comparing with Cloud Resolving Models (CRM) in a warm pool experiment**

Ratio of the stationary-state precipitation with parameterized-circulation (DGW) to the radiative-convective equilibrium precipitation for SST = 300 K :



-**DGW produces smoother profiles and appears preferable;**

-**GCM-1D models have improved since CMIP5. Some of them are now in the CRM ballpark.**

Atmospheric long-term changes in the Southern Hemisphere simulated by CMIP5 models

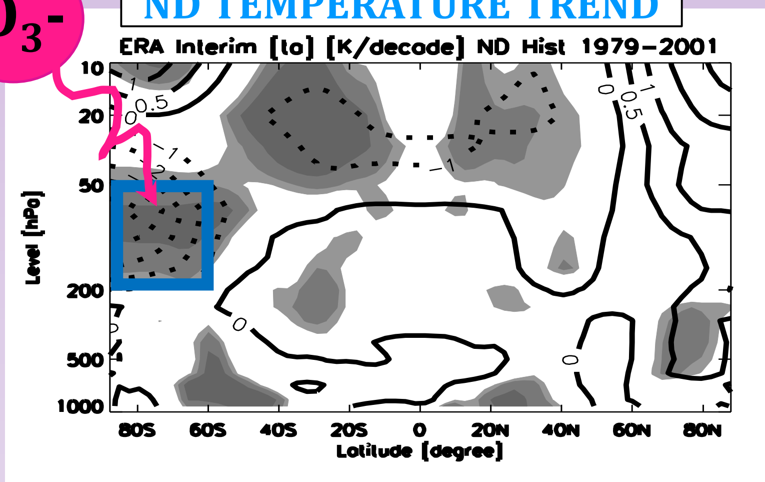
Gloria Rea[1,2], Chiara Cagnazzo[2], Angelo Riccio[1], Federico Fierli[2] and Francesco Cairo[2]

[1]Department of Environmental Sciences, "Parthenope" University of Naples, Naples, Italy;
[2]Institute of Atmospheric Sciences and Climate, ISAC-CNR, Rome, Italy.

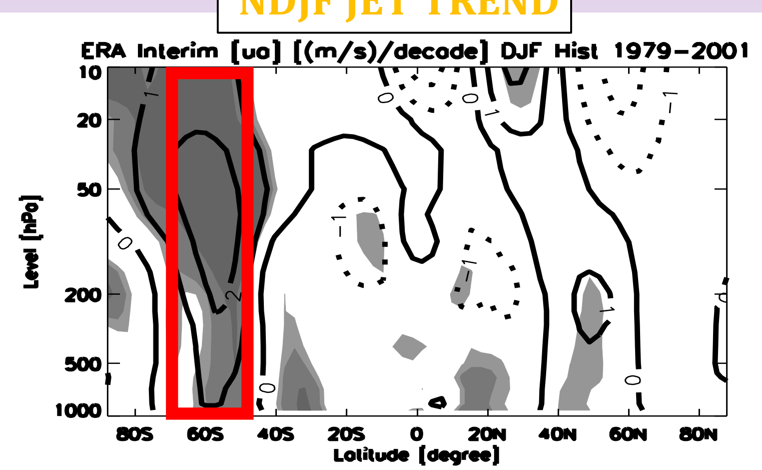
1979-2001

O_3-

ND TEMPERATURE TREND



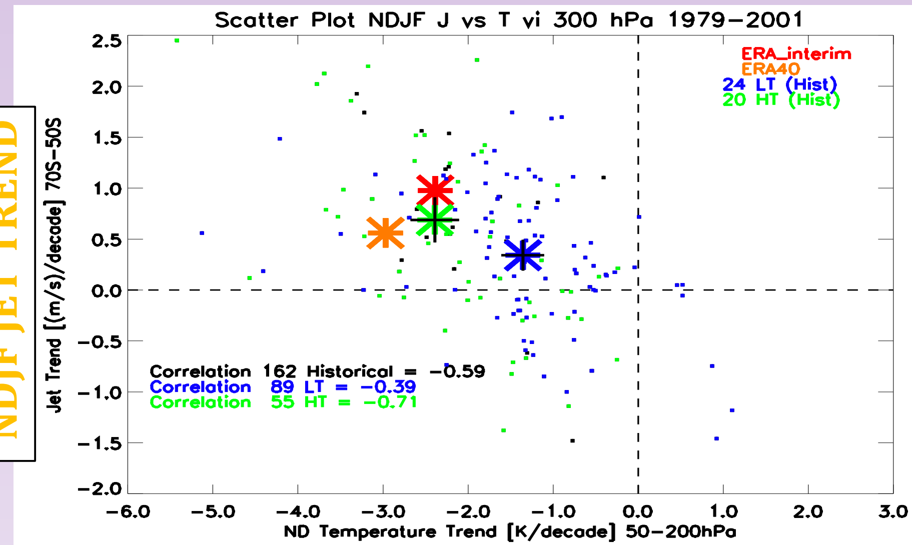
NDJF JET TREND



LT MODELS
HT MODELS
HISTORICAL CMIP5 MODELS

+ ERA40 & ERA INTERIM

NDJF JET TREND



ND TEMPERATURE TREND

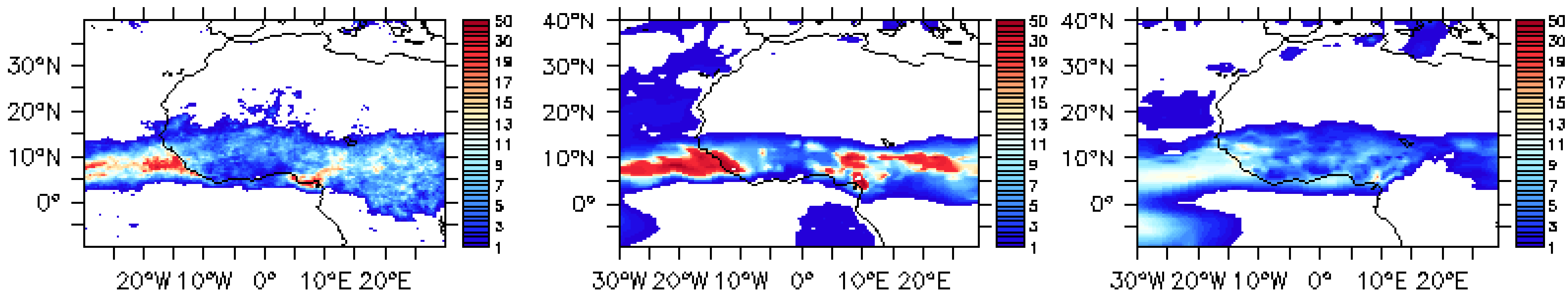
- **HT-LT distinction maintains in SAM + trends at the surface**
- **RCPs scenarios…**

Improvement of the representation of boundary-layer, convection and clouds in the LMDZ general circulation model: Impact on tropical climate simulation

C. Rio, F. Hourdin, J.-Y. Grandpeix, M. Bonazzola, N. Rochetin, A. Jam, F. Cheruy, A. Idelkadi, I. Musat, M.-P. Lefebvre, L. Fairhead

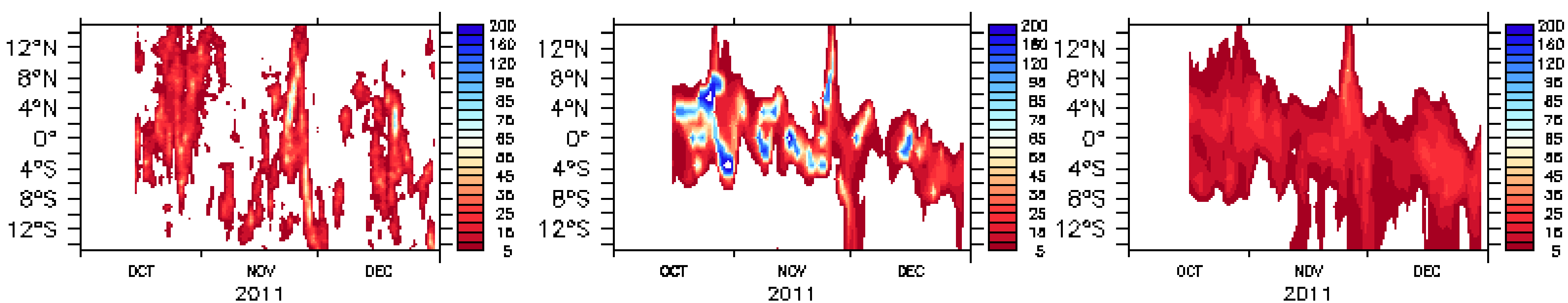
Laboratoire de Météorologie Dynamique, CNRS/IPSL, Paris, France

Mean precipitation over West-Africa in July 2006



TRMM LMDZ5B PRE-LMDZ6

Mean precipitation over Indian Ocean during Cindy-Dynamo (oct-dec 2011)



TRMM LMDZ5B → PRE-LMDZ6

??

Accounting for observational uncertainties in the evaluation of low latitude turbulent air-sea fluxes simulated in CMIP5 models

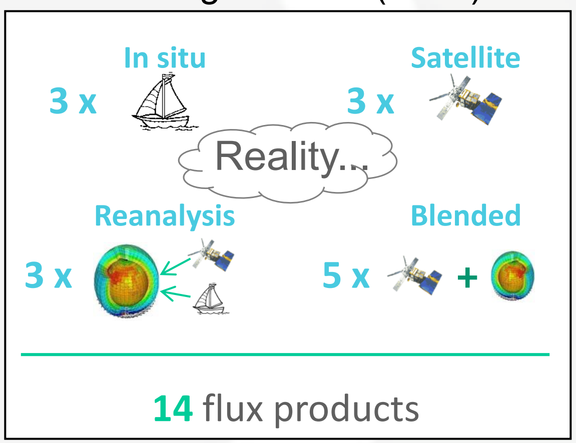
Jérôme Servonnat, Alina Gainusa-Bogdan, Pascale Braconnot

Historical simulations

WCRP CMIP5 — World Climate Research Programme

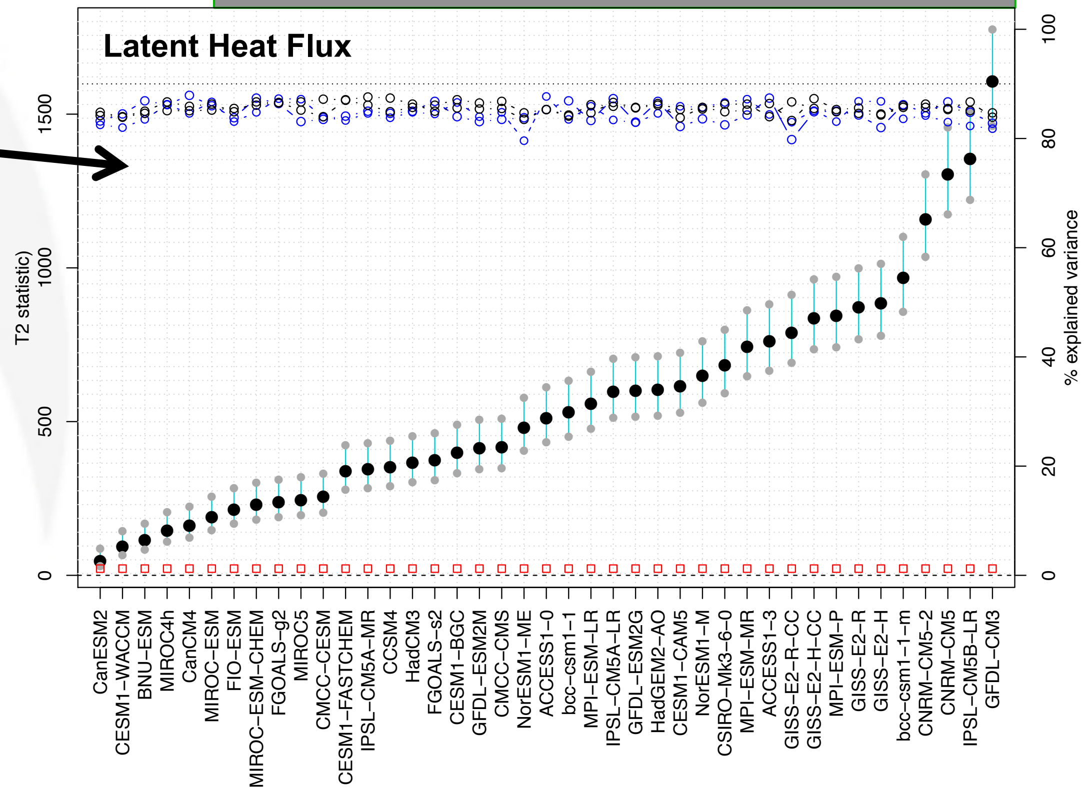
$$T^2 = (\overrightarrow{X_m} - \overrightarrow{X_{REF}})^T S^{-1} (\overrightarrow{X_m} - \overrightarrow{X_{REF}})$$

Gainusa-Bogdan et al (2015)



From A. Gainusa-Bogdan's PhD defense

A metric for the spatio-temporal evaluation of the climatological annual cycle



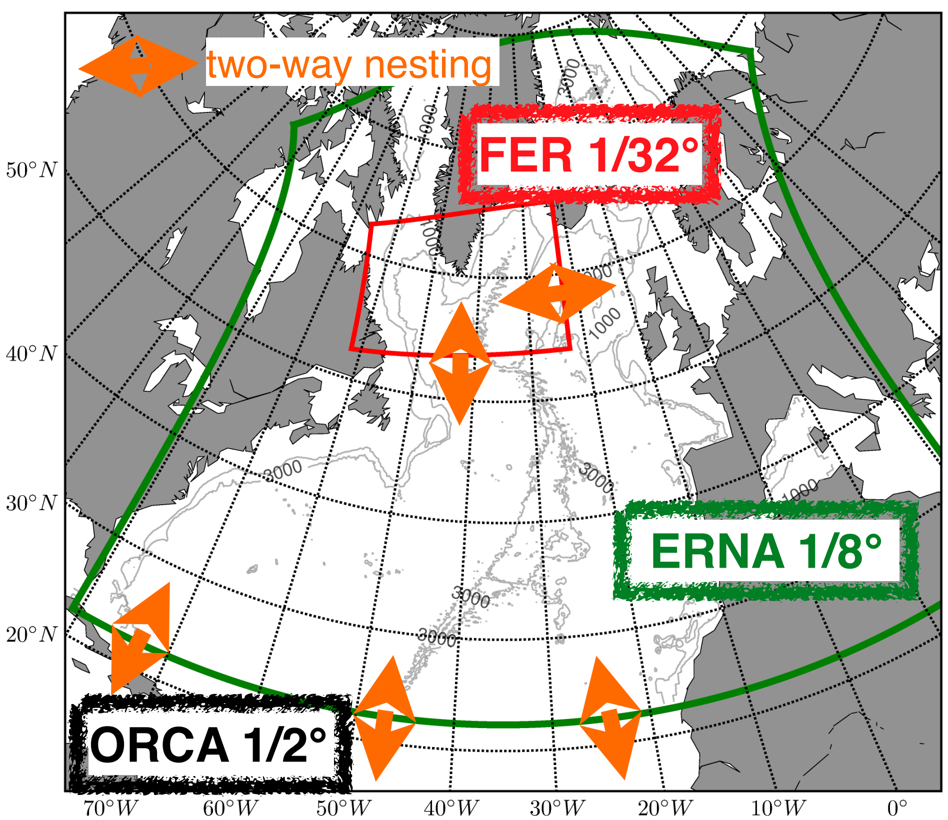
Explicitly resolved vs parameterized mesoscale processes in the Labrador Sea: impact on the AMOC

Talandier Claude[1], Deshayes Julie[2], Capet Xavier[2], Treguier Anne-Marie[1]
[1] Laboratoire de Physique des Océans (LPO-UMR CNRS/IFREMER/UBO/IRD Brest - FRANCE)
[2] Laboratoire d'Océanographie et du Climat: Experimentation et Analyse Numérique (LOCEAN- UMR CNRS/UPMC/IRD/Museum Paris - FRANCE)

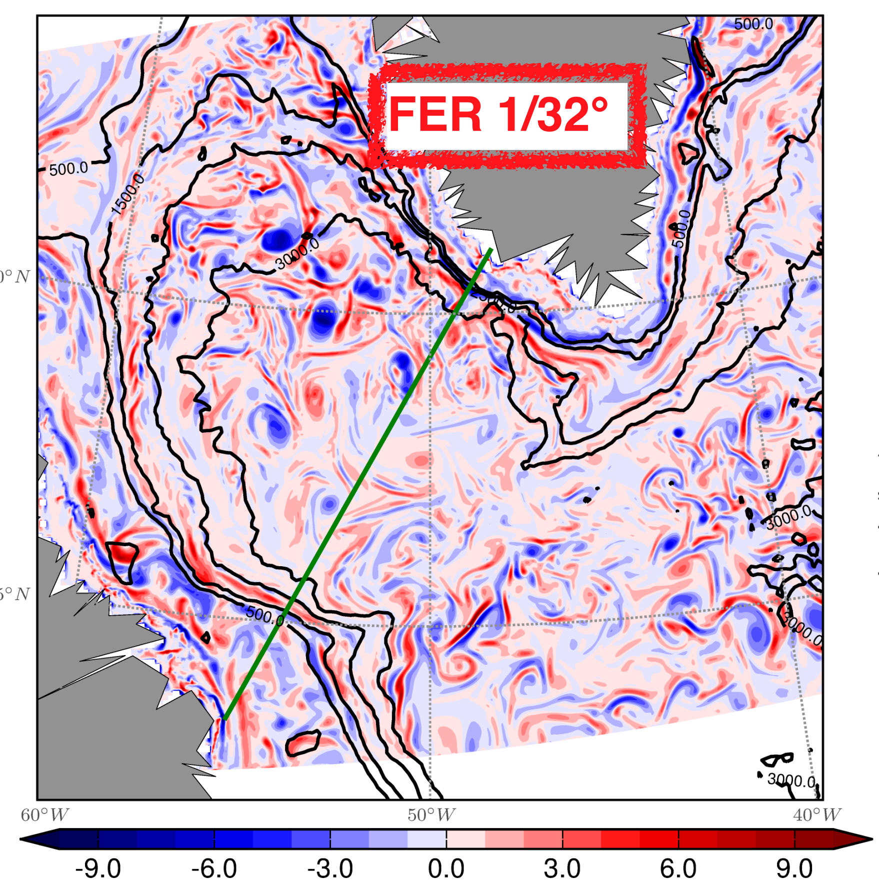
Key words

AMOC, DWBC, Convection, Mesoscale processes, dynamical regimes

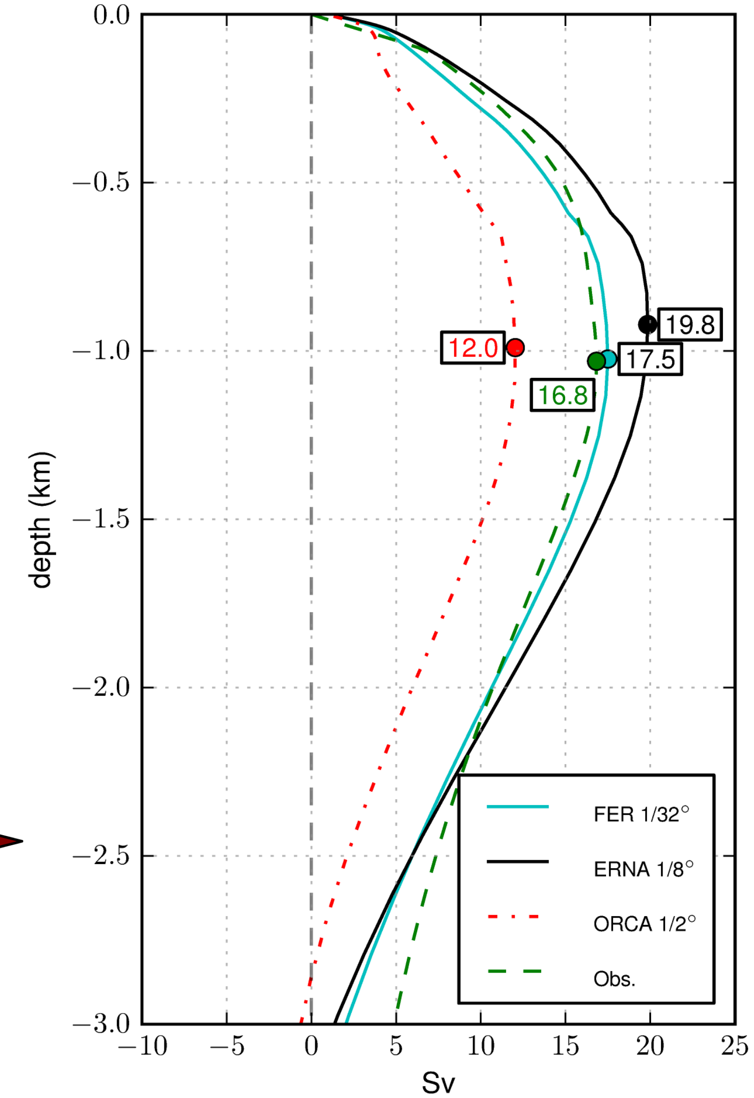
3 numerical configurations



Relative vorticity snapshot



Mean AMOC-Z at 26.5°N



Poster # 21

Disentangling atmospheric biases in the Tropical Atlantic region

C. Frauen, R. Roehrig, A. Voldoire
CNRM-GAME, Toulouse, France

Motivation

- Equatorial Atlantic SST biases are related to surface wind biases in spring (Richter et al., 2014) in CMIP models
- Even in AMIP mode, surface winds are not simulated accurately enough to drive the ocean models (Voldoire et al., 2013)

Aim

Explore the source of the wind biases

Method

As Wind and precipitation biases settle within a few days in Transpose-AMIP simulation

- Assess the conformity of the biases in AMIP and Transpose-AMIP mode
- Use of a simplified momentum budget analysis
- Perform sensitivity experiments to study the role of the diabatic heating profile

From global to regional and back again: Improved resolution for ocean biogeochemistry in CMIP6

A. Yool, J. Palmieri, E.E. Popova, A.C. Coward, A.G. Nurser and the UKESM1 team

- CMIP5 used ~1° ("medium" → "low") resolution, but CMIP6 will use ~0.25° ("high" → "medium") resolution
- Improves mesoscale features; extra realism will help: **Arctic**; **Boundary currents**; **Upwelling**; and **Mixing**
- But cost means most runs will be low-res with a few high-res runs
- Determining traceability (physical and BGC) from low-to-high will add value to low-res from high-res
- Related is where improvements come from: better resolution or better representation of underlying processes
- Where CMIP6 models support increased resolution there is an opportunity for exploration of these (and other) topics