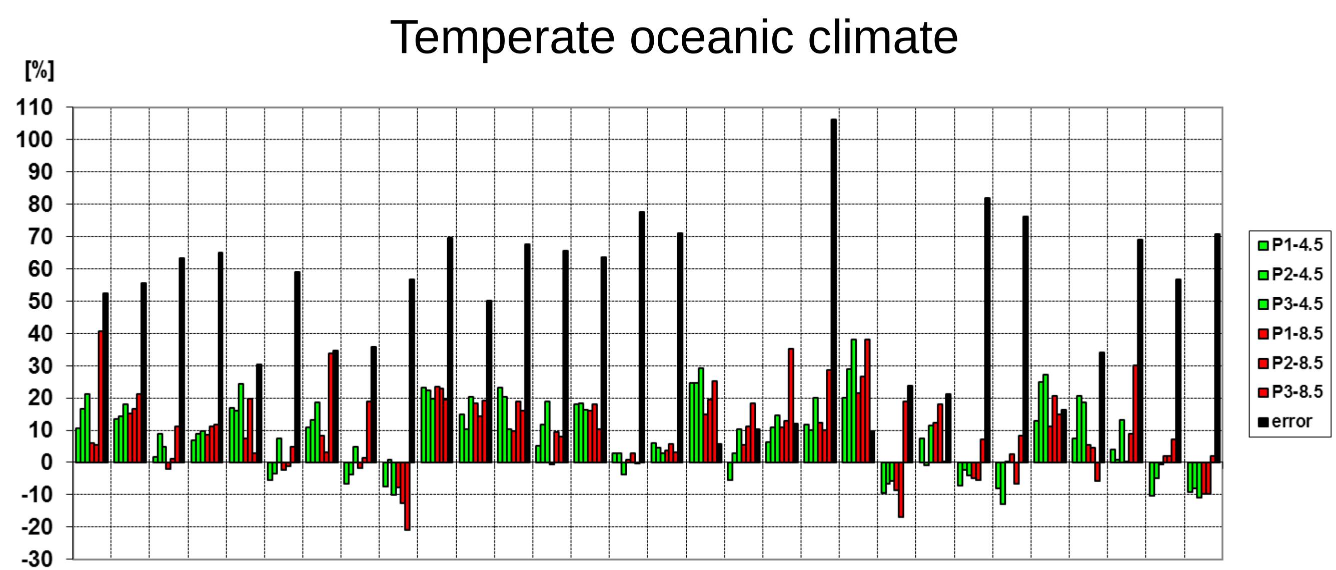
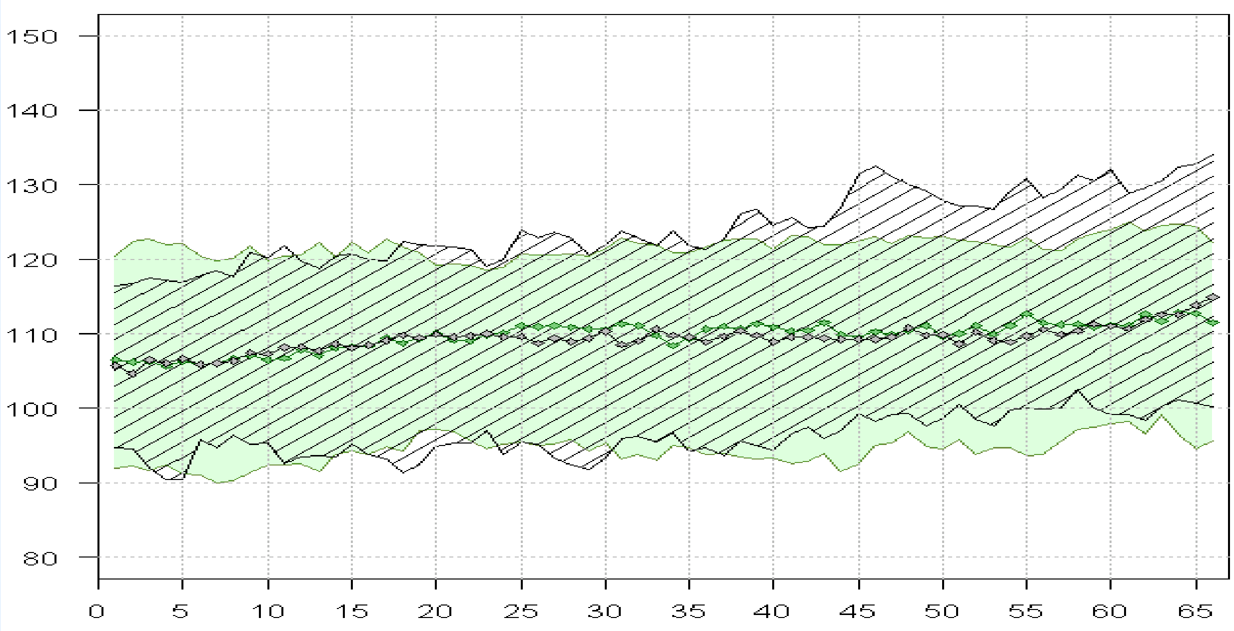
Integrated assessment of CMIP5 simulations in terms of climate classification (Session 3, Poster 1)

Michal Belda, Tomáš Halenka, Jaroslava Kalvová and Eva Holtanová

Charles University in Prague, Faculty of Mathematics and Physics, Department of Atmospheric Physics



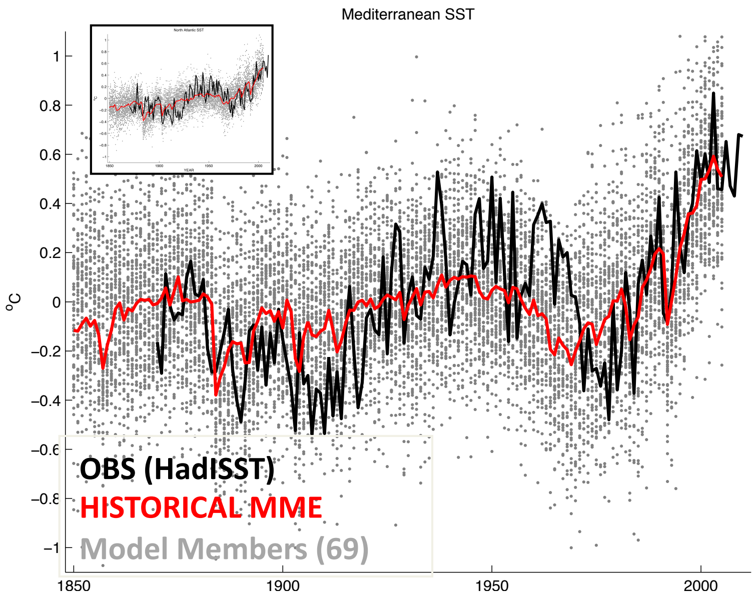


- Validation of CMIP5 model results in representing vegetation zones according to *Köppen-Trewartha climate classification*
- Evaluation of future projections for RCP4.5 and RCP8.5 scenarios
- Evaluation of Euro-CORDEX historical and projection runs forced by CMIP5 models using Köppen-Trewartha climate classification

- Problems capturing rainforest type *Ar*, underestimation of desert type *BW*, overestimation of boreal climate type *E*
- Higher resolution != better representation of climate zones
- Future changes often smaller than model errors
- Ensemble spread quite large

Sources of multi-decadal predictability over the North Atlantic and Mediterranean region: the role of forcings.

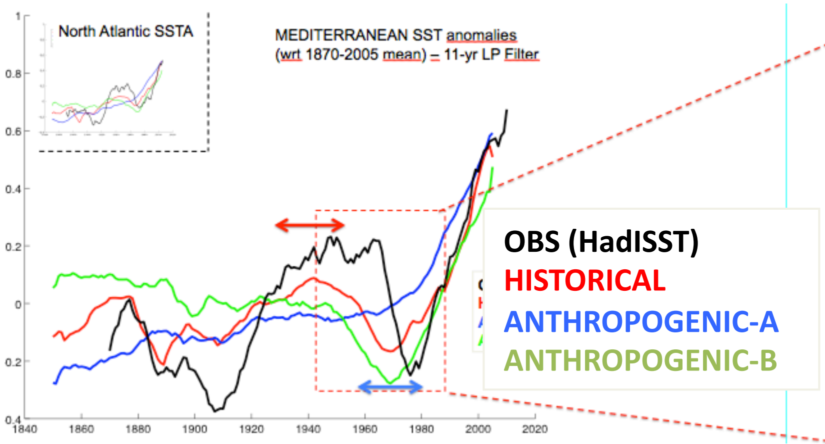
by **Alessio Bellucci (CMCC)**, A. Mariotti (NOAA), S. Gualdi (CMCC, INGV)

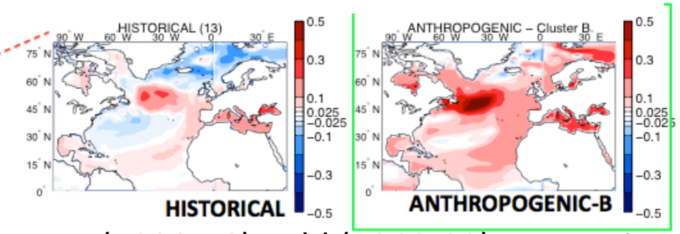


Multi-decadal SST variability in HISTORICAL CMIP5 simulations

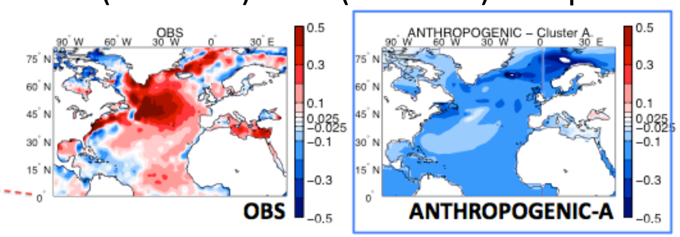
HISTORICAL	HISTMISC Anthropog.	HISTMISC NoAA
NATURAL + ANTHROP.	ANTHROP. only	NATURA+L ANTHROP. NO Ant. Aer.

The role of anthropogenic forcings on the mid-20C "hiatus"



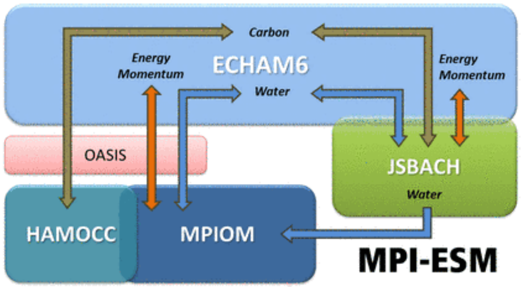


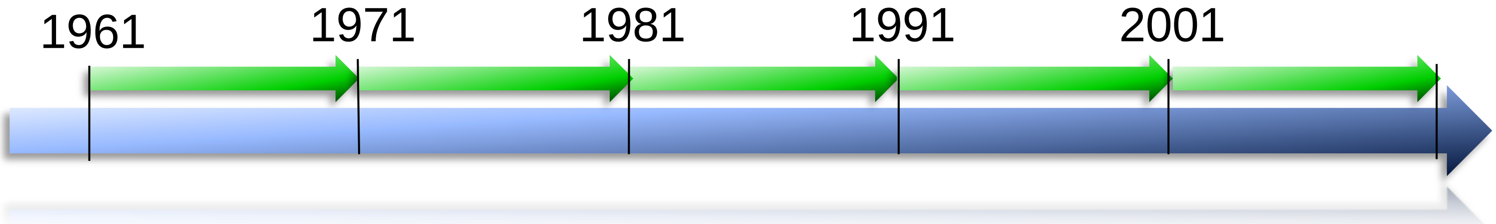
warm(1930-50)-cold (1960-80) composites

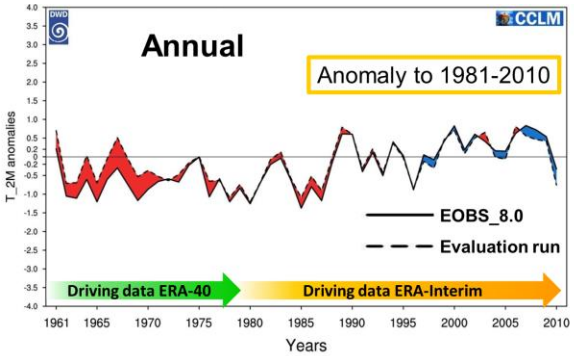


Towards a limited-area climate ensemble prediction system for decadal forecasts

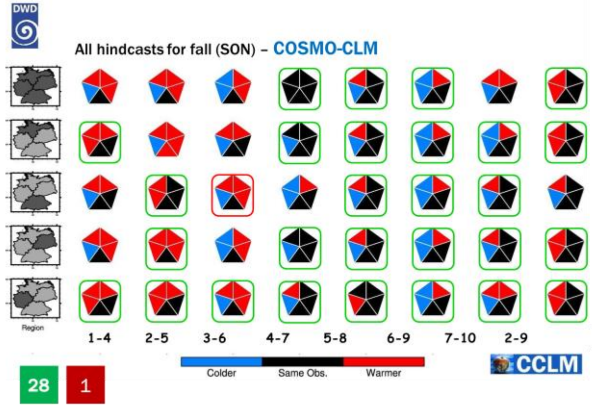
On global and regional scale





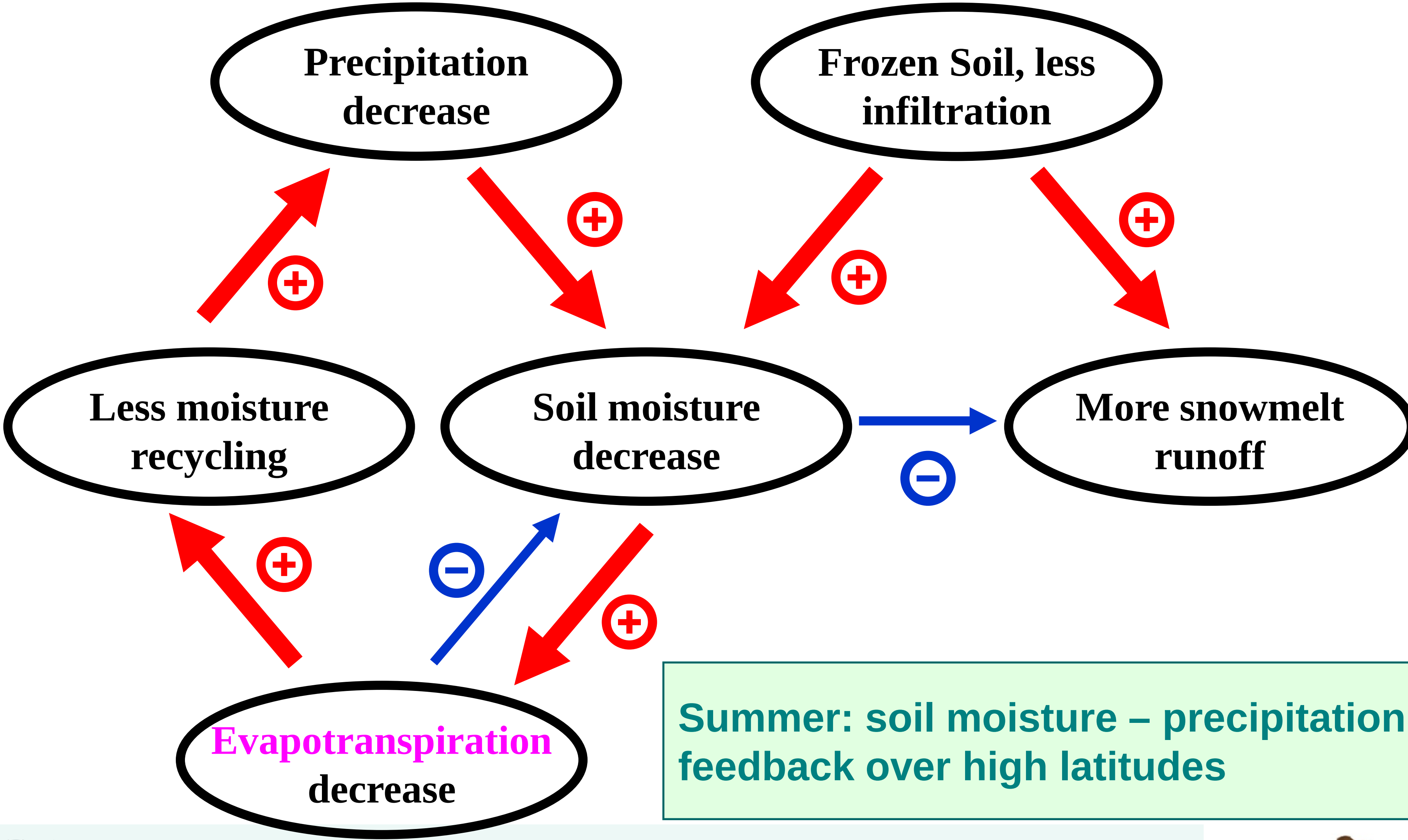


MiKlip
FONA
Mittelfristige Klimaprognosen
BMBF



Impact of permafrost relevant processes on hydrological change using MPI-ESM

Stefan Hagemann, Tanja Blome, Christian Beer and Altug Ekici



Summer: soil moisture – precipitation feedback over high latitudes

Climate indicators of the pace of change using CMIP5 projections

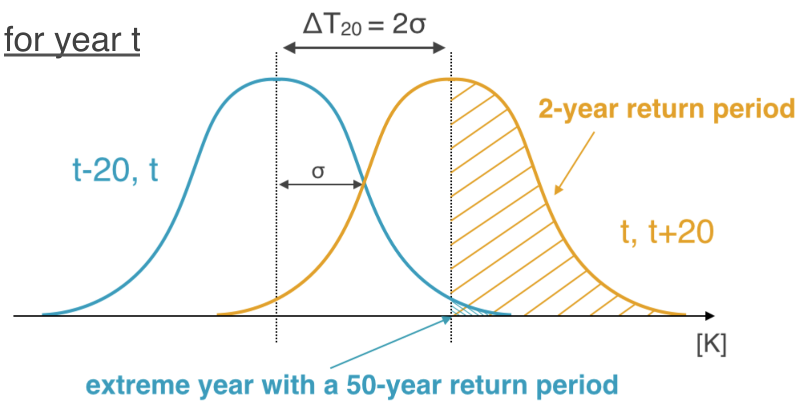
Yann Chavaillaz[1]*, Sylvie Joussaume*[1]*, Sandrine Bony*[2]*, Pascale Braconnot*[1] *and Robert Vautard*[1]

Main idea

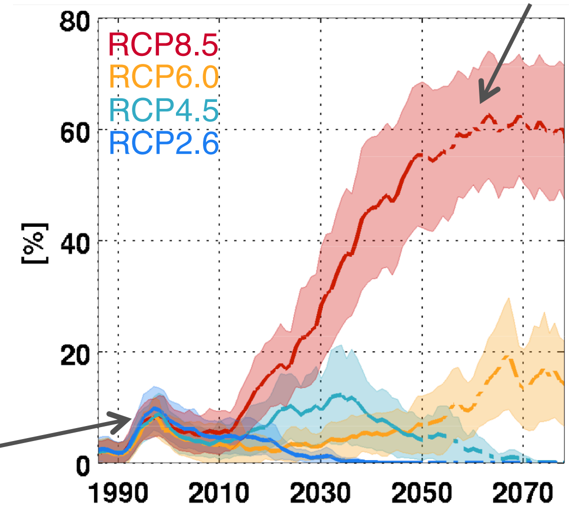
Statistics of temperature and precipitation with a running baseline of 20 years with 18 GCMs

One of the main findings:

Fraction of population exposed to 2σ-shifts in 20 years for the annual temperature



6 billions, i.e. 61%



significant gap between RCP8.5 and others

currently, **8%** of the population exposed

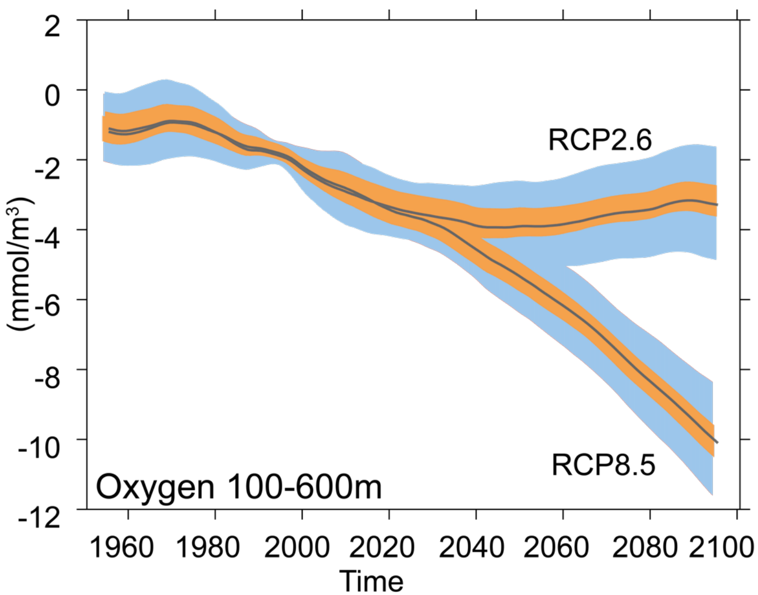
Also on the poster: doubling of the warming rate, intensification of the drying and moistening rates, expansion and stabilization of precipitation rate patterns, etc.

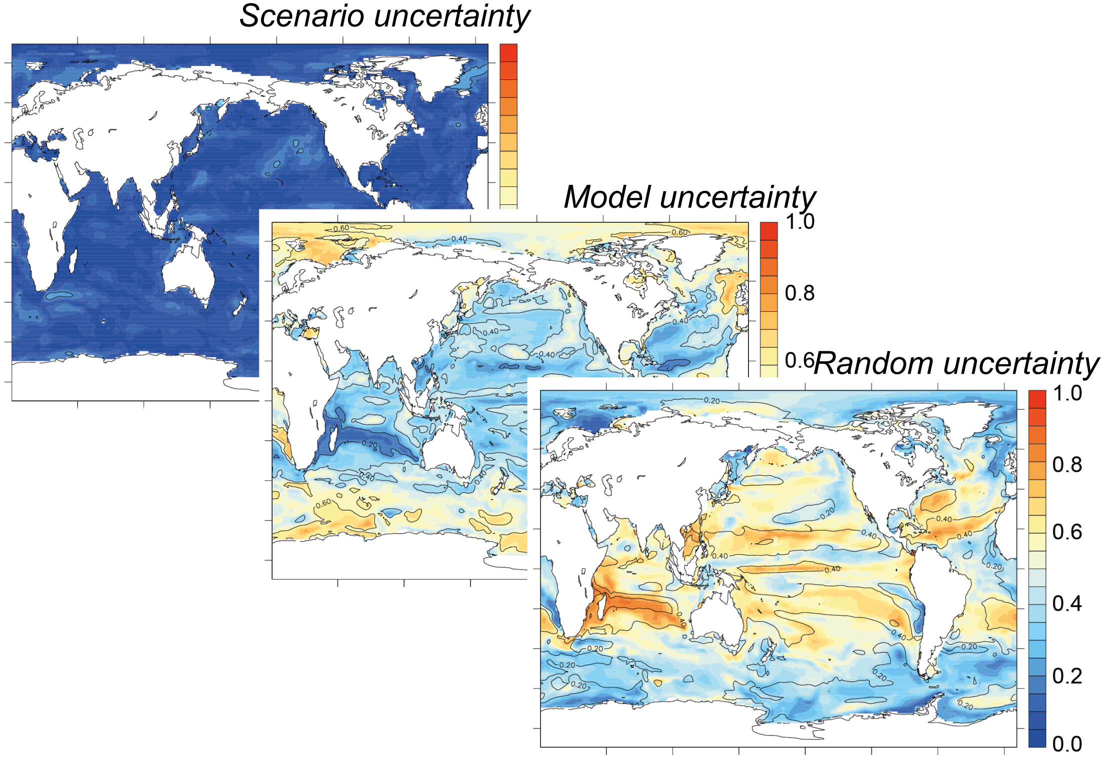
[1]LSCE-IPSL, Gif-sur-Yvette, France
[2]LMD-IPSL, Paris, France

Sources of uncertainties in projections of potential marine ecosystem stressors

T. L. Frölicher, K. B. Rodgers, C. Stock, W. W. L. Cheung

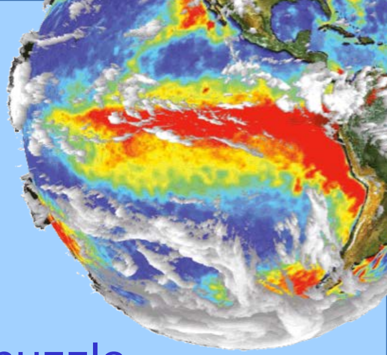
- Marine ecosystems are increasingly stressed by human-induced changes
- Ocean acidification, ocean warming, ocean deoxygenation and changes in primary production are of greatest concern
- Future projections of these marine ecosystem stressors are inherently uncertain
  → uncertainty assessment is needed!



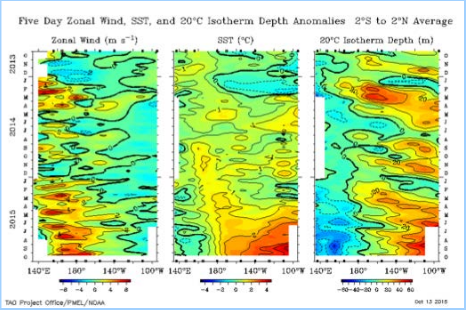


ENSO and tropical Pacific metrics for CMIP6

Eric Guilyardi (IPSL & NCAS/Climate) and Andrew Wittenberg (GFDL)
On behalf of the CLIVAR Reseach Focus “ENSO in a changing climate”

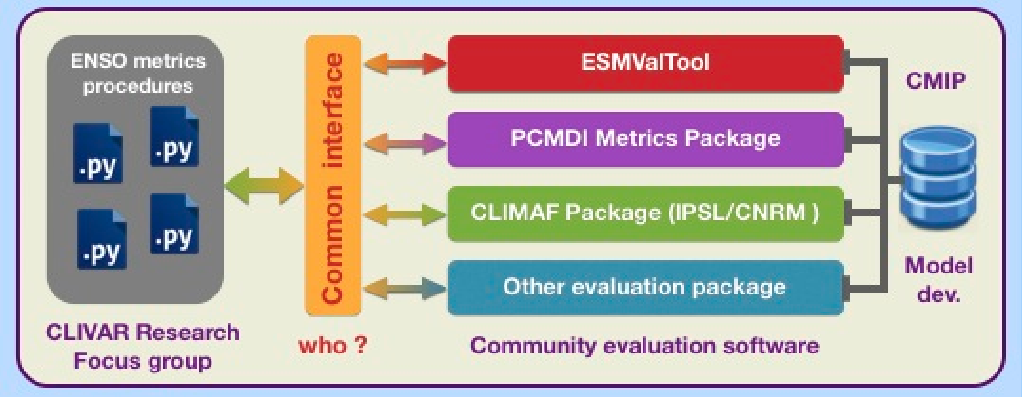


- Despite 30 years of progress, ENSO continues to surprise us and challenge our assumptions - It remains a major unsolved climate puzzle
- It is the “elephant in the room” for regional impacts of climate change
- ENSO research very active field
  - diversity of events, extremes, role of atmosphere,…



Coupled GCMs are choice tools to understand ENSO

- ENSO simulation and prediction still suffer from long standing biases
- Little improvement from CMIP3 to CMIP5
- Beyond performance metrics, process-based metrics are required during model development phase
- Poster provides examples of the such metrics and how to develop their use in the community



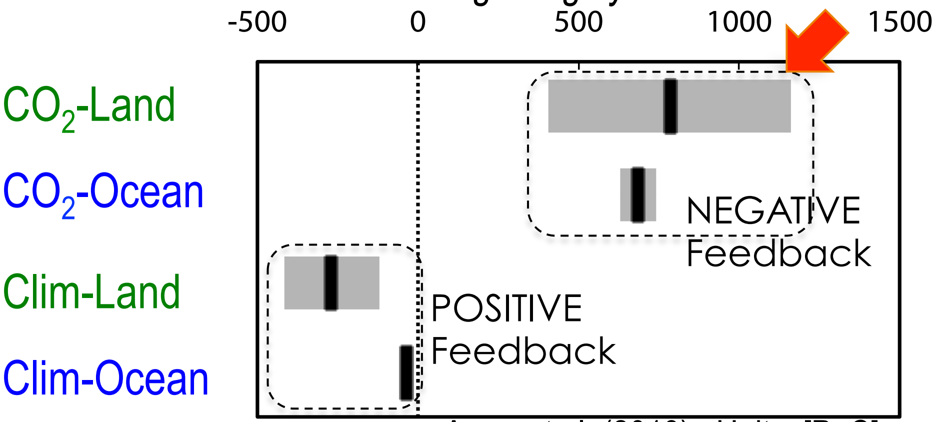
CLIVAR

Carbon Cycle Feedback of Land Ecosystems in Response to Atmospheric CO_2 Increase

Tomohiro HAJIMA, Kaoru TACHIIRI, Akihiko ITO, Michio KAWAMIYA

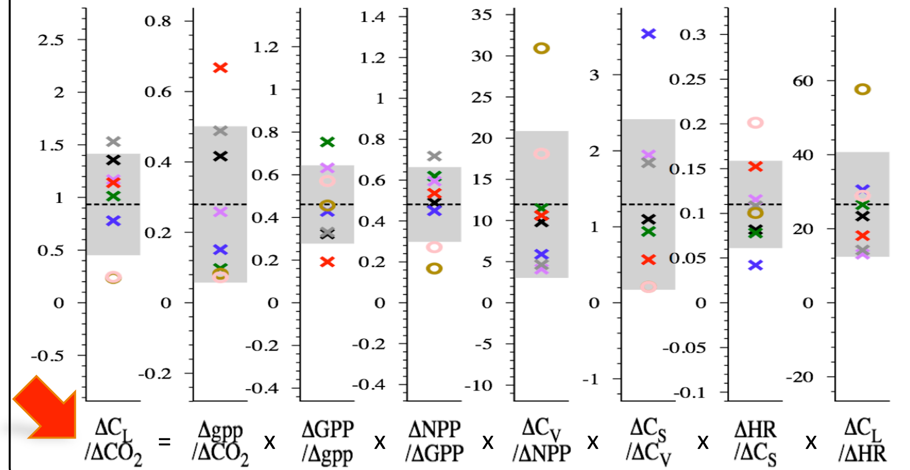
1. Target: *Land carbon cycle response to CO_2 in ESMs*

→Strong & highly uncertain feedback



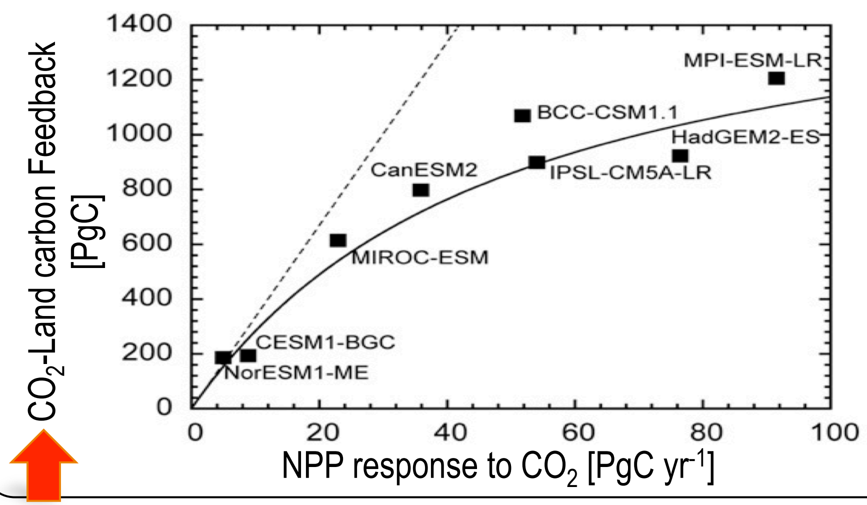
Arora et al. (2013), Units: [PgC]

2. Analysis: *Decomposing the feedback into factors, etc*



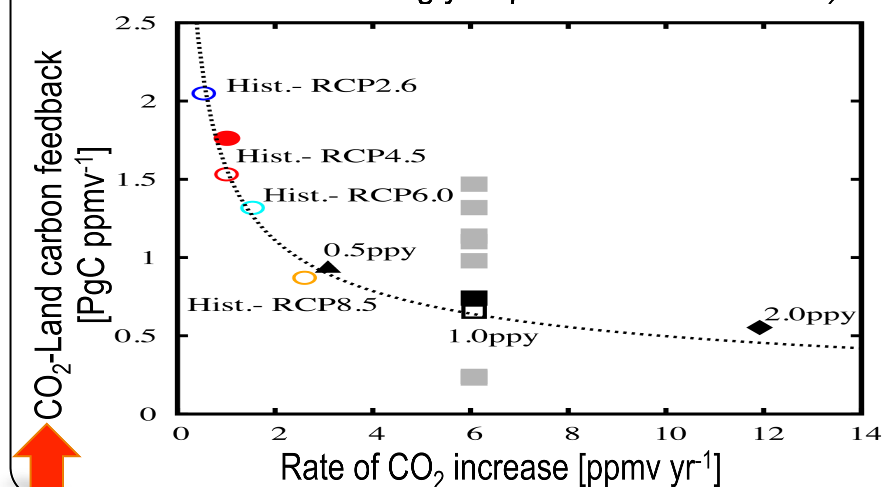
3. A Key result:

NPP determines the total CO_2-land carbon feedback in an ESM



4. Another feature:

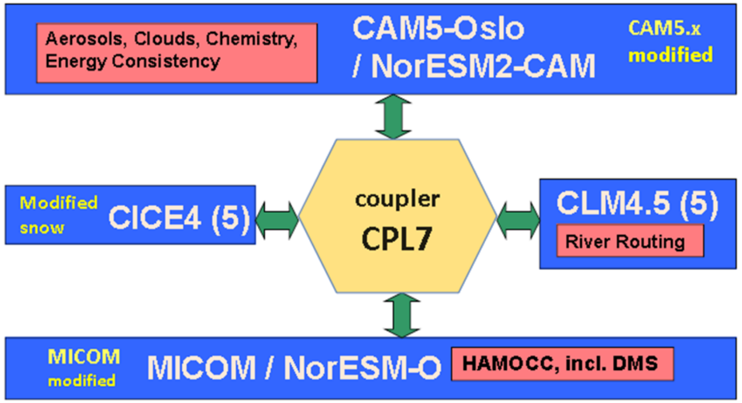
The feedback strongly depends on rate of CO_2 inc.



Refs: Hajima et al. (2014) J. Clim; Arora et al. (2013) J. Clim.

Improving the Norwegian Earth System Model (NorESM) for CMIP6

Trond Iversen, MET Norway



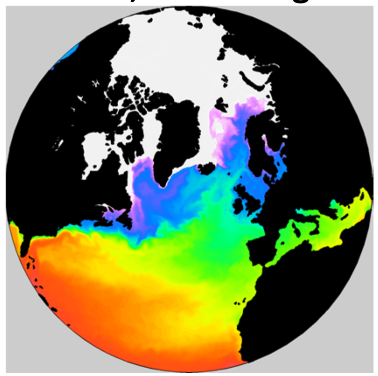
NorESM belongs to a "family" of models based on the (NCAR) Community ESMs, where:

- **The ocean model** is replaced with an iso-pycnic co-ordinate version developed from MICOM;
- **Ocean bio-geochemistry** is based on HAMOCC (Hamburg Ocean Carbon Cycle Model);
- Own modules for **aerosol life-cycling, physics**, and interactions with **cloud microphysics** (CAM-Oslo);
- Adjusted processing of sea-ice and **snow on sea-ice**.

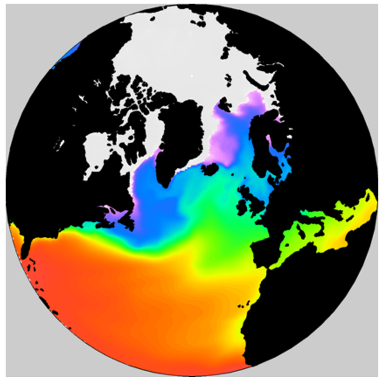
Six possible configurations of NorESM2 for CMIP6.

NorESM2_		_MH	_HH	_MM	_LM	_LME	_LMEC
RESOLUTION	Atmosphere - Land	M: 0.9x1.25 deg.	H: 0.23x0.31 deg.	M: 0.9x1.25 deg.	L: 1.9x2.5 deg.	L: 1.9x2.5 deg.;	L: 1.9x2.5 deg.
	Ocean - Sea-Ice	H: nominal 0.25 deg.	H: nominal 0.25 deg.	M: nominal 1 deg.	M: nominal 1 deg.	M: nominal 1 deg.	M: nominal 1 deg.
PROCESSES	Greenhouse Gases (GHG)	Concentration-driven	Concentration-driven	Concentration-driven	Concentration-driven	E: Emission-driven	E: Emission-driven
	Aerosols	Emission-driven, Complex physics	Emission-driven, *Possibly:* Simplif. physics	Emission-driven, Complex physics	Emission-driven, Complex physics	Emission-driven, Complex physics	Emission-driven, Complex physics
	Atmosph. Chemistry	Simplified;	Simplified;	Simplified;	Simplified;	Simplified	C: Complex
	Ocean Bio-GeoChem.	OFF	OFF	OFF	OFF	E: ON	E: ON
CMIP-DECK & CMIP6 Historic		ALL	Only AMIP	OPTIONAL: ALL if _MH fails	AMIP, PreInd, Historic	ALL except AMIP	Only AMIP
MIPs		•AerChemMIP •CFMIP •RFMIP •DAMIP •OMIP •ScenarioMIP •SIMIP	HighResMIP	OPTIONAL. If _MH fails: •AerChemMIP •CFMIP •RFMIP •DAMIP •OMIP •ScenarioMIP •SIMIP	•AerChemMIP •CFMIP •DAMIP •DCPP •LS3MIP(?) •LUMIP •OMIP •PMIP •RFMIP •ScenarioMIP •VolMIP •SIMIP	•C4MIP •LUMIP(?) •GeoMIP(?) •OMIP(?)	•AerChemMIP •VolMIP

Sst & ice, d=0.25deg



Sst & ice, d=1deg



Complementing Thermosteric Sea-Level Rise Estimates

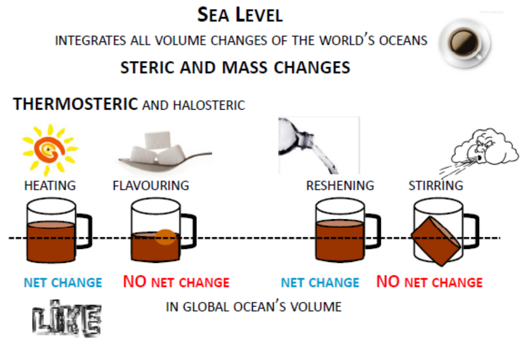
by Katja Lorbacher[1], Alexander Nauels[1] and Malte Meinshausen[1,2]

1/ Australian-German Climate and Energy College, 700 Swanston Street, University of Melbourne, Parkville 3010, Victoria, Australia
2/ The Potsdam Institute for Climate Impact Research, Telegrafenberg A26, 14412 Potsdam, Germany

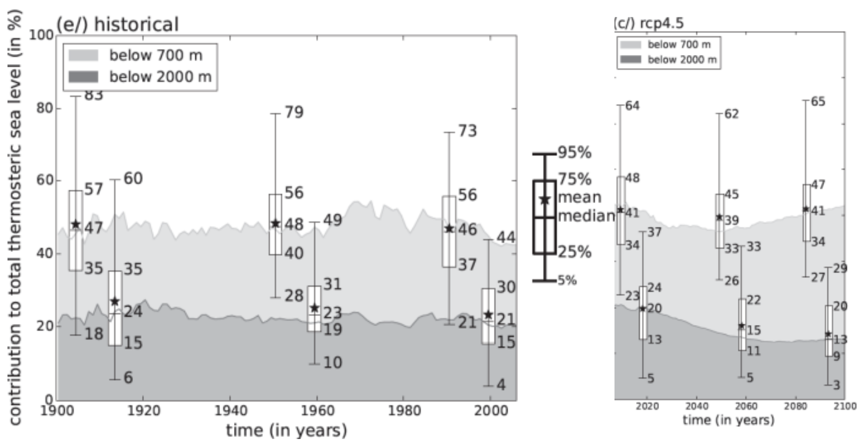
Motivation

1) Thermosteric sea level rise (thSLR) defines the expansion of seawater caused by the world's oceans warming. Over the last 50 years, thSLR accounts for 40% of global sea level rise.
2) Down to the present day, observed thSLR estimates are sparse and primarily available for the upper ocean layers down to 700 m.
3) Only a part of the available climate model data is sufficiently diagnosed to complete our quantitative understanding of thSLR.

Schematic of Sea Level Components



Model median percentage contribution to global mean thSLR for the entire water column from depths below 700 m (light grey) and below 2000 m (dark grey) for seven scenarios.



Methods and Models

1) Complementing CMIP5 thSLR Data Set
Calculation of the simulated thermal expansion over the entire ocean grid for CMIP5 models resulting in an extension of the available set of thSLR diagnostics (*zostoga*) from CMIP5 and depth-dependent time series.
2) Complementing Observations
Analysis of those model results in order to complement upper ocean layer observations.
3) Enable Surrogate Techniques for long-term thSLR Projections
Investigation of hemispheric averages and global averages of calibrated thSLR mimicking CMIP5 estimates to enable the development of surrogate techniques to project thSLR using vertical temperature profile and ocean heat uptake time series.

Atlantic Multidecadal Variability in a multi-model ensemble of CMIP5 simulations:

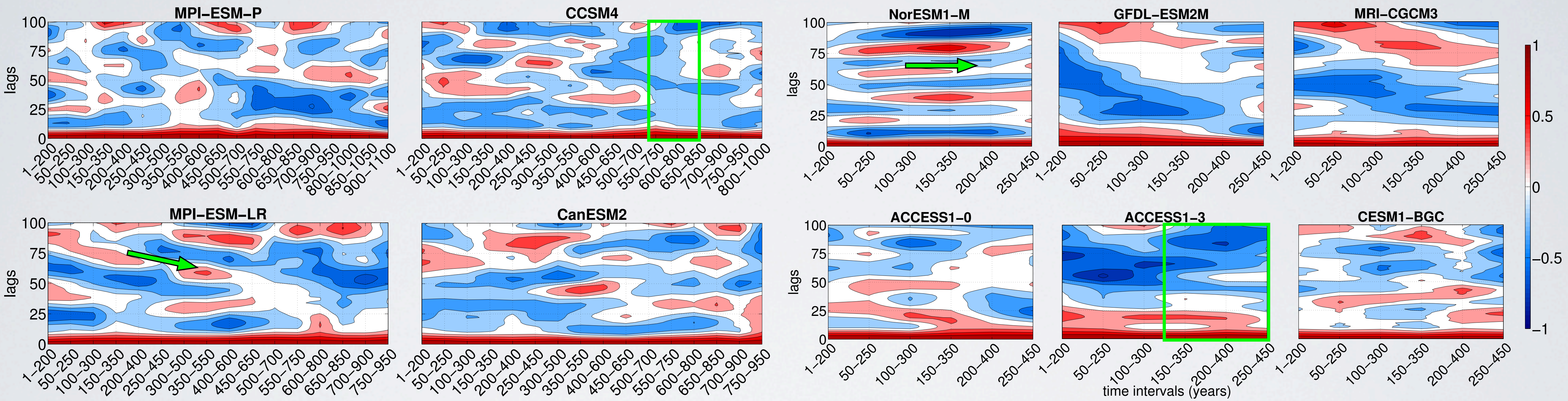
an assessment of its spectral characteristics and its non-stationary behaviour

Irene Mavilia (1,2), Alessio Bellucci (1), Panos Athanasiadis (1), Silvio Gualdi (1,3), Rym Msadek (4), Yohan Ruprich-Robert (4)

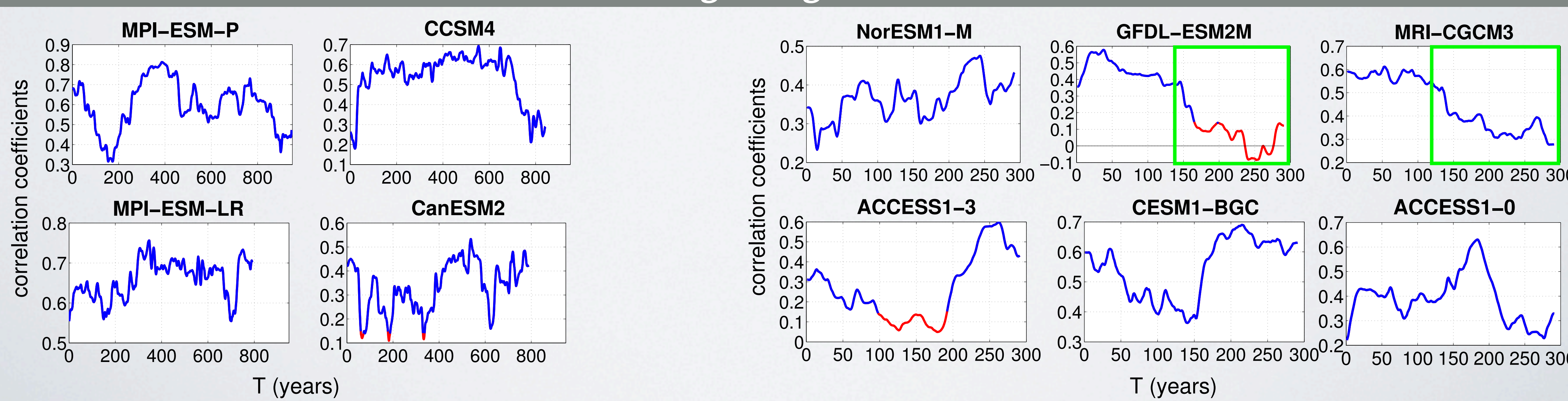
(1) Euro-Mediterranean Center on Climate Change (CMCC), Bologna, Italy (irene.mavilia@cmcc.it), (2) Ca' Foscari University, Venice, Italy,

(3) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy, (4) NOAA/Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey.

Evidence of AMV non-stationarity: *AMV autocorrelation for moving and overlapping 200-year-long time windows*

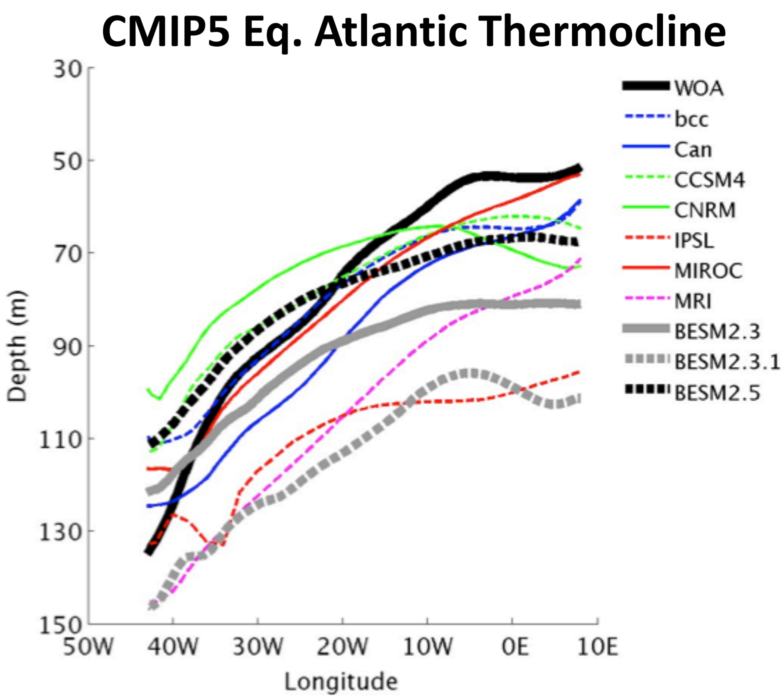


AMV/AMOC correlation undergoes significant fluctuations with time



Equatorial Atlantic Ocean dynamics in a coupled ocean-atmosphere model simulation

Paulo Nobre, E. Giarolla, L. Siqueira, M. Bottino, M. Malagutti, V. Capistrano
National Institute for Space Research – INPE - Brazil



- The development of the Brazilian earth system model (BESM) is a cooperative effort in Brazil, documented in Nobre et al. (2013).
- Bottino and Nobre (2015) investigated the cloud cover scheme, resulting in an improved version of the model;
- Giarolla et al. (2015) compared the ocean features over the equatorial Atlantic, simulated by BESM and seven other CMIP5 models.

- This work refers to Giarolla et al. (2015), also including in the comparisons the most recent BESM version, BESM2.5. Analyses are based in the last 30 years of 100-yr long simulations.

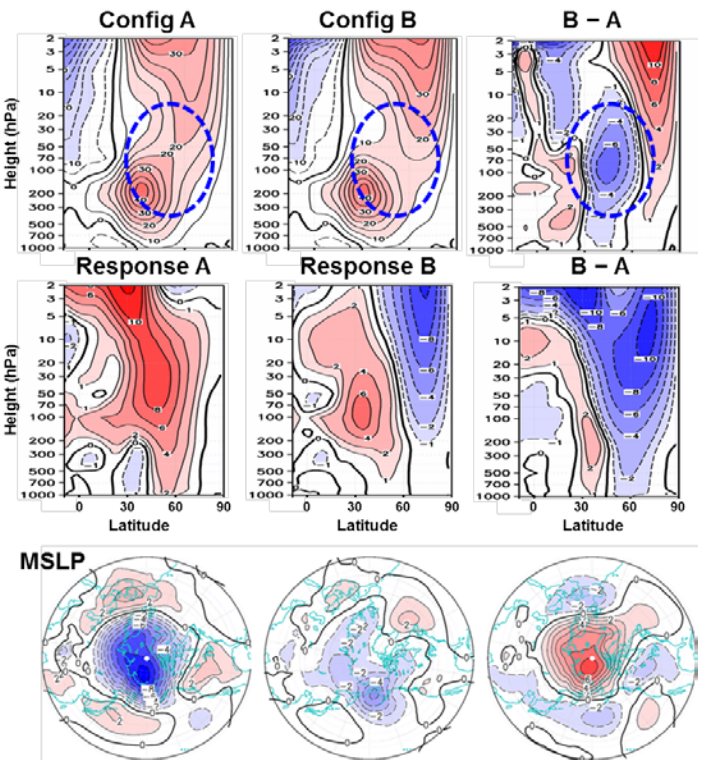
BESM Brazilian Earth System Model
FAPESP MUDANÇAS CLIMÁTICAS
INCT PARA MUDANÇAS CLIMÁTICAS
REDE CLIMA
INPE
Ministério da Ciência, Tecnologia e Inovação
GOVERNO FEDERAL BRASIL PÁTRIA EDUCADORA

Reducing Uncertainty in Future Projections of the Northern Annular Mode

- Future projections of the NAM remain highly uncertain (Miller et al. 2006, Manzini et al. 2014)
  ⇒ large uncertainty in regional climate change (<u>model formulation</u>, <u>well-resolved stratosphere</u>?)

- Sigmond and Scinocca (2010; SS10): Sensitivity of the NAM response to GHG is primarily due to differences in the initial <u>climatological winds</u> upon which GHG forcing is applied in each model.

models with <u>stronger/weaker</u> climatological NH wintertime winds in a critical region of the lower stratosphere tend to have a more <u>positive/neutral</u> NAM response to increased GHG forcing



- SS10 have identified a planetary-wave mechanism to explain this sensitivity

- Recent analysis of the NAM response in CMIP3 and CMIP5 climate change simulations (Manzini et al. 2014) has provided support for the SS10 mechanism

⇒

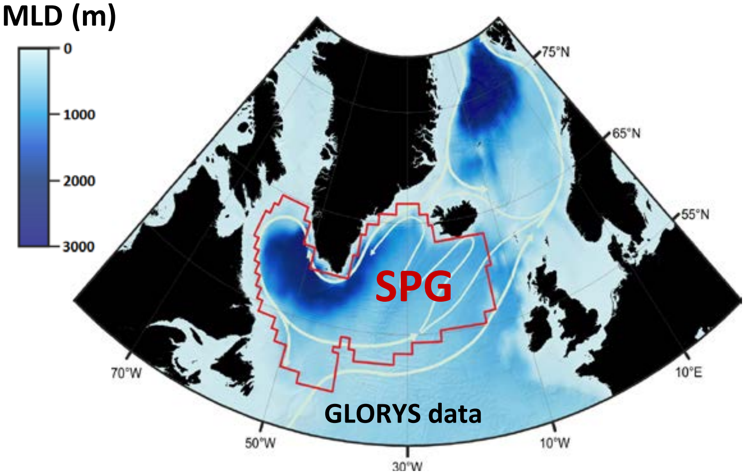
<u>Uncertainty</u> in regional climate change associated with the NAM response <u>can be reduced</u> in CMIP6 <u>if present-day wind biases are reduced</u> in the critical region of the NH wintertime lower stratosphere.

John Scinocca, CCCma

Rapid cooling in the North Atlantic: a real eventuality or a sporadic model propensity?

Giovanni Sgubin, Didier Swingedouw and Sybren Drijfhout

SST response in the **SPG** ➡ CMIP5 simulations



- **3 main patterns** of the SST response
- 3 different climatic impacts
- SST response depends on the **present-day density stratification** in the SPG

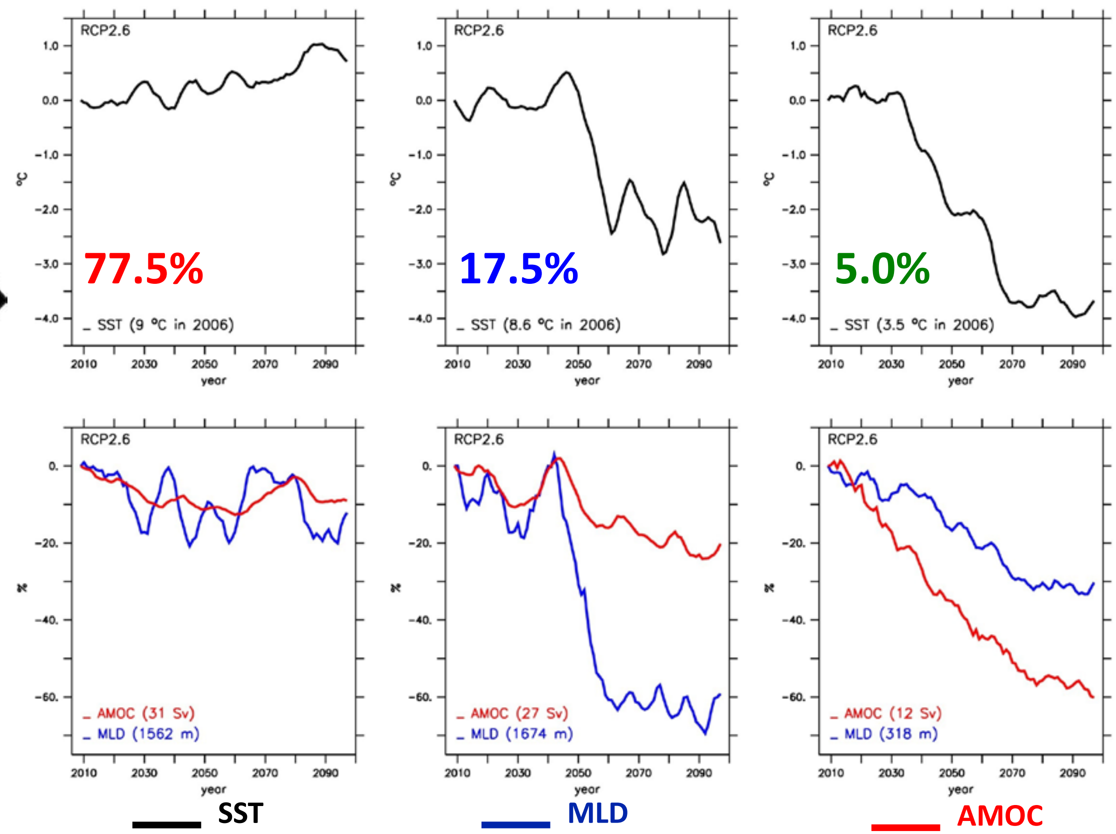
⬇

Models *vs* observation-based data

Model Skill Score

Subset ranking	Average skill score
1. SPG convection collapse	0.90
2. no abrupt	0.54
3. AMOC disruption	0.39

no abrupt | **SPG convection collapse** | **AMOC disruption**



CMIP5 models are biased towards too stratified SPG

CMIP5 models underestimate the risk of a local convection collapse in the SPG

Do we need coupled models to simulate anthropogenic climate change?

Jie He and Brian Soden
University of Miami

Atmospheric models may be better tools for predicting anthropogenic climate change over land because:

- Coupling is not necessary to simulate ACC
- Coupling degrades mean climate state
- Atmospheric models have better climatologies
- Land is insensitive to pattern of SST changes
- Range of climate sensitivity unchanged in 40 years

Suggests a greater application of AGCMs or flux-adjusted CGCMs in CMIP6 for improving regional projections over land.

Increasing potential to biomass burning over Sumatra, Indonesia induced by anthropogenic tropical warming

R. Kartika Lestari[1], M. Watanabe[1], Y. Imada[2], H. Shiogama[3], R. D. Field[4] , T. Takemura[5] & M. Kimoto[1]

[1]Atmosphere and Ocean Research Institute, the University of Tokyo; [2]Meteorological Research Institute; [3]National Institute for Environmental Studies; [4]Columbia University; [5]Kyushu University

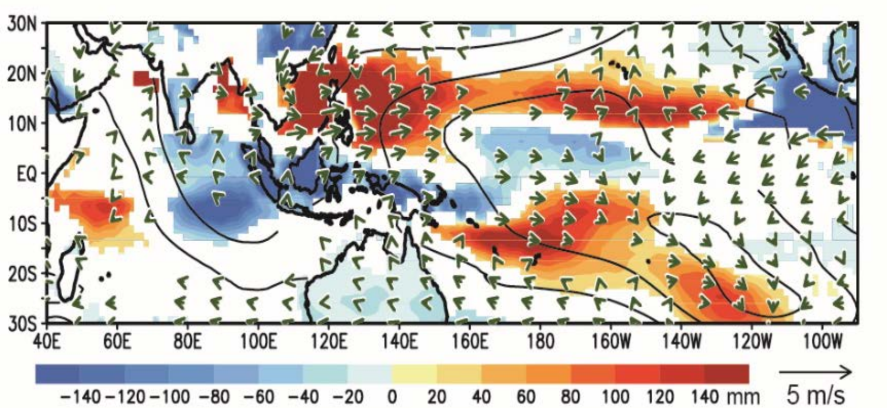
Drought events

exacerbate

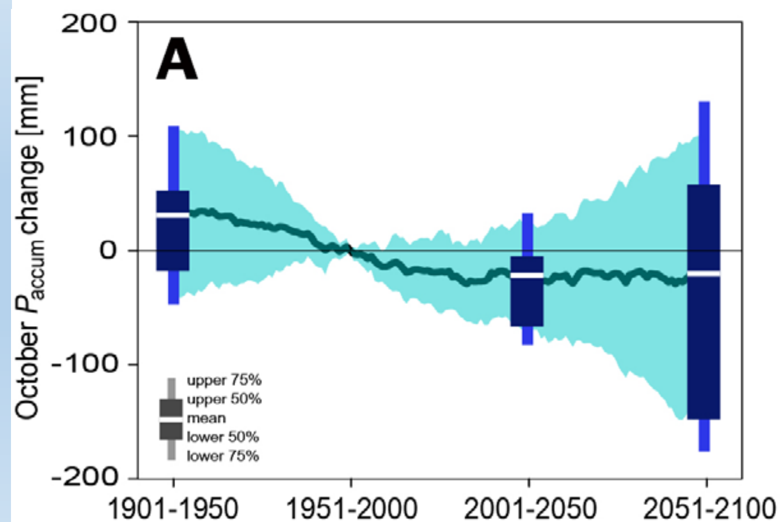
Forest fires

See you
at the poster session

Difference in 5mon-accumulated precipitation (shaded) in 1979–2008. (*With minus without anthropogenic warming*)



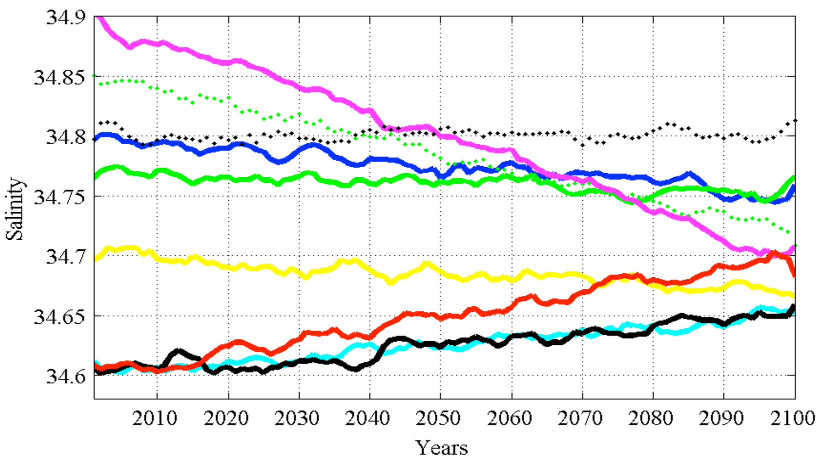
Change in 5mon-accumulated precipitation mean in October. Base period: 1951 – 2000

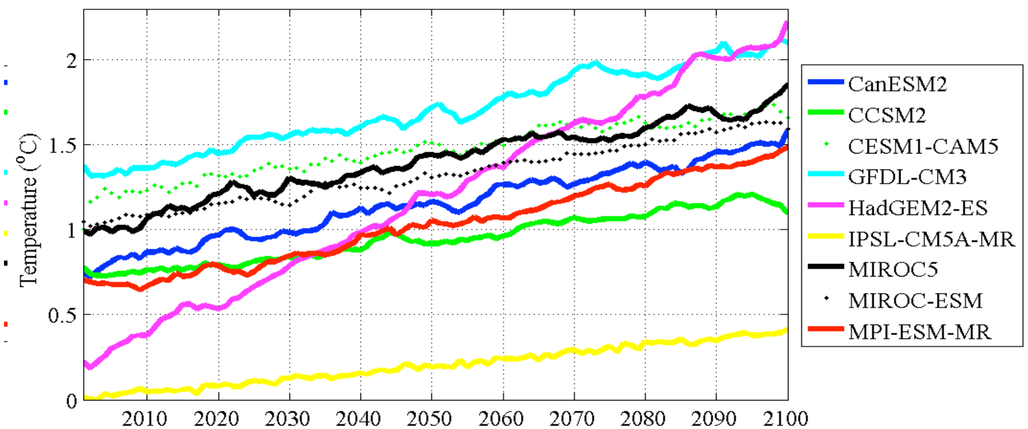


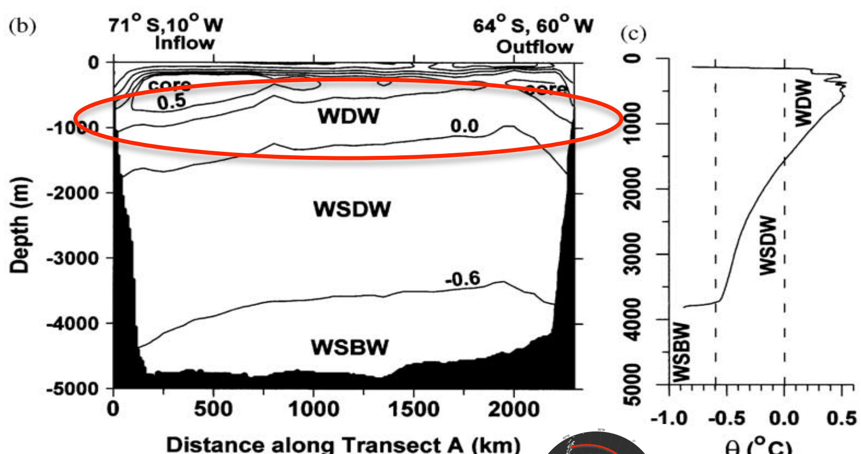
Changes In The Weddell Sea Warm Deep Water In Cmip5 Models - From The 20th Into The 21st C

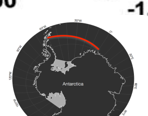
I. Wainer & M. Tonelli

10 Cmip-5 models
Use OMP for WDW







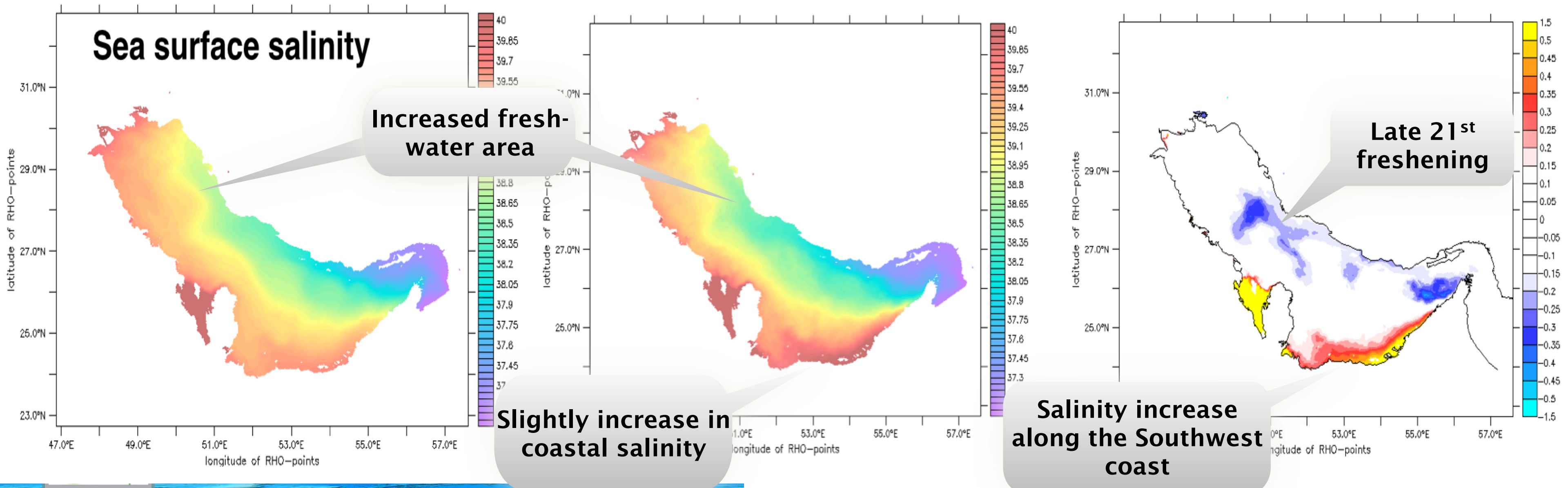


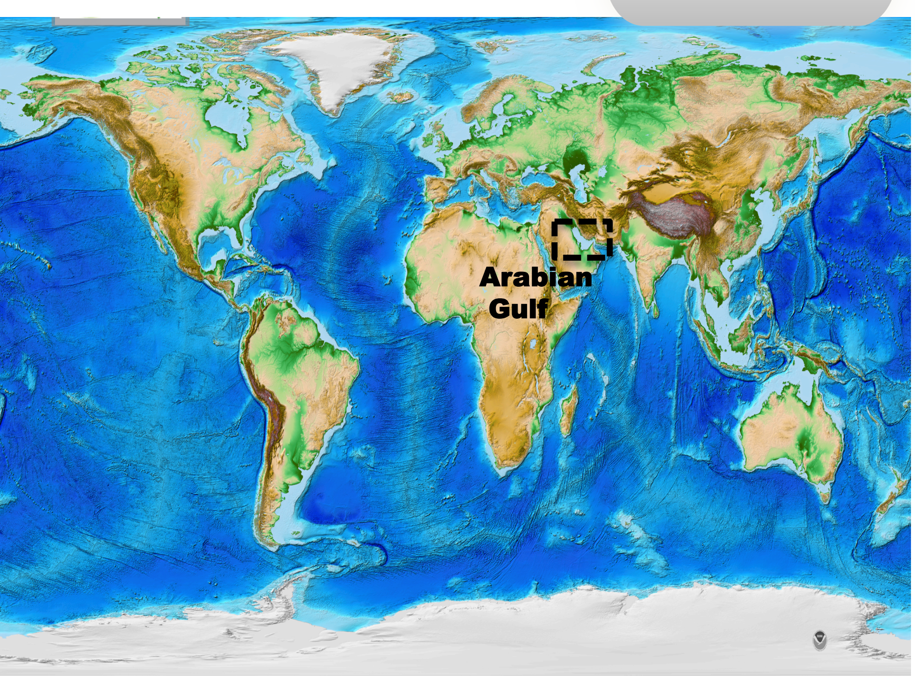
Robertson et al. 2002

Results show freshening and warming of WDW for most models *(although their physical representation of the water mass distri- bution in the Weddell Sea is remarkably different.)*

The shallowing trend is consistent in all models (core depth can differ from 100 to 1000 m among models).

Ocean Downscaling of CMIP5 1990-2100 climate projections for the Arabian Gulf





How to translate the large-scale climate information from an Earth System Model (MPI) into regional/local ocean changes. Arabian Gulf as a case study because of its very high salinity.

Evaluation of seasonal and decadal predictions on regional and global scale

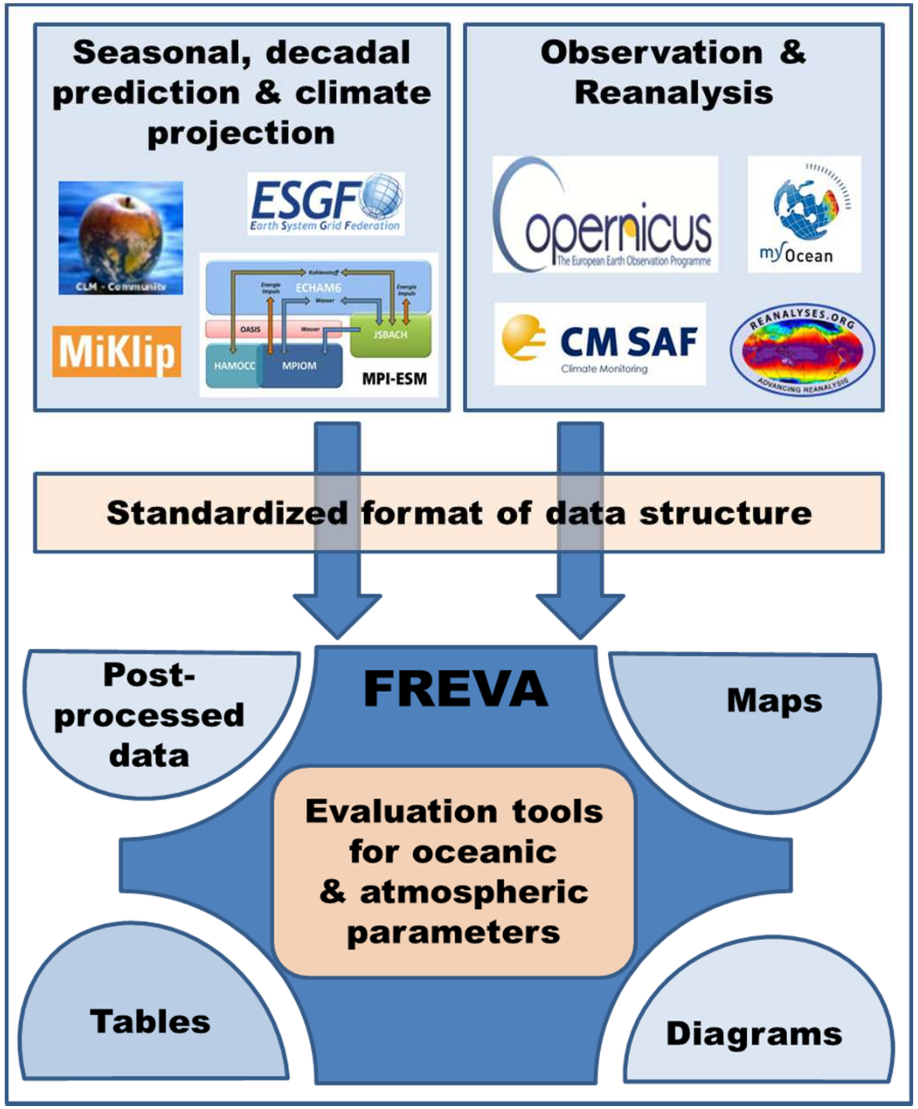
FREVA

(www-miklip.dkrz.de)

Freie University Evaluation System

In context of

German research project for decadal predictions



In context of

Successful implementation of FREVA at DWD:

- Further developments for seasonal prediction
- Integration of observations and reanalysis for ocean parameters, especially satellite products

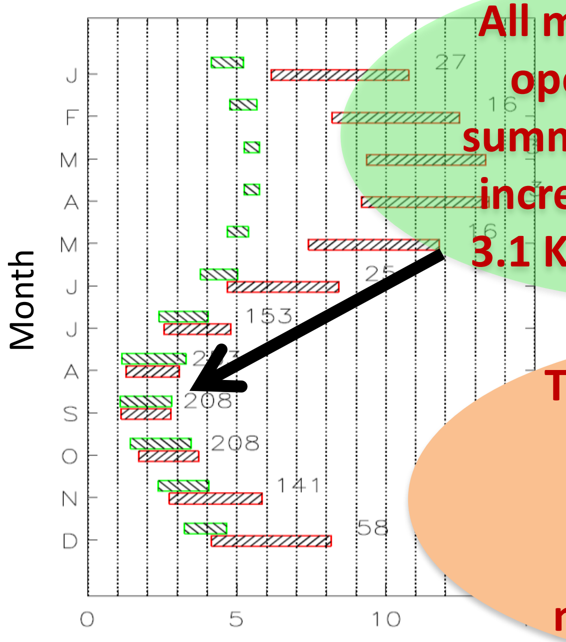
Understanding the Source of Uncertainty in Arctic Sea Ice Projections in CMIP5 – Toward Unanimous Projections

Shuting Yang, Perter L. Langen, Peter Thejll and Jens H. Christensen
Danish Meteorological Institute (DMI), Denmark

Research questions:

- Given the large spread in models, how to obtain reliable projections for the future Arctic sea ice evolution using climate model experiments?
- What is the condition for open-water Arctic Ocean?

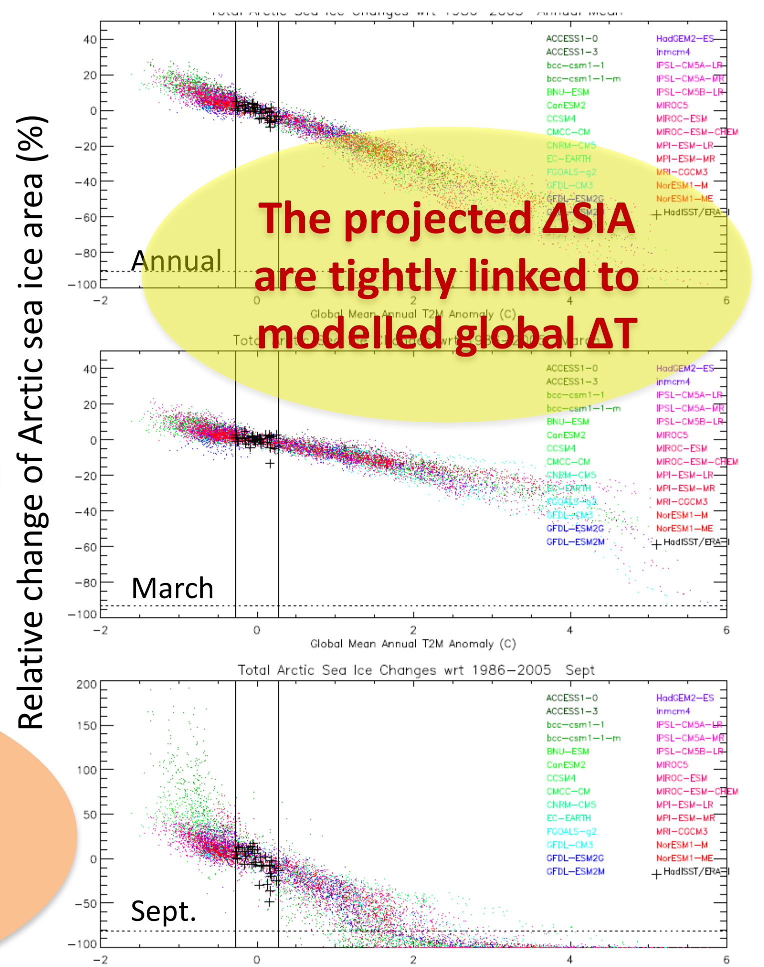
Projected global SAT changes for open-water Arctic Ocean wrt 1986-2005



All models project an open-water Arctic summer when global T increases about 1.3 – 3.1 K wrt. present day

The over all change of Arctic sea ice area follows the global T change in a similar manner in all models

Total Arctic sea ice changes vs. global SAT



The projected ΔSIA are tightly linked to modelled global ΔT