Combining decadal predictions and near-term projections to obtain reliable information for the upcoming 30-40 years

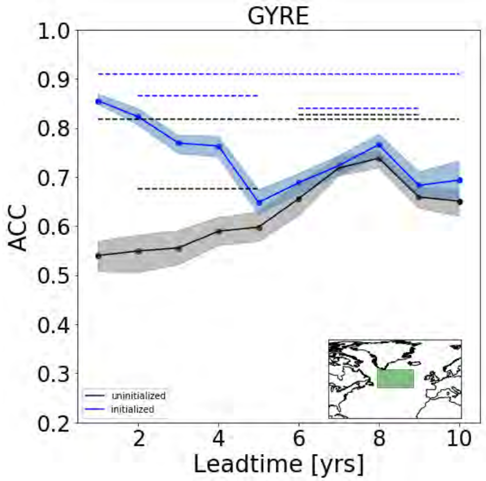
Daniel J. Befort, Christopher H. O'Reilly and Antje Weisheimer

This work aims to analyse the potential for **predicting climate variability over Europe for up to 30-40 years** by using **uninitialized projections as well as initialized (decadal) predictions**

Skill

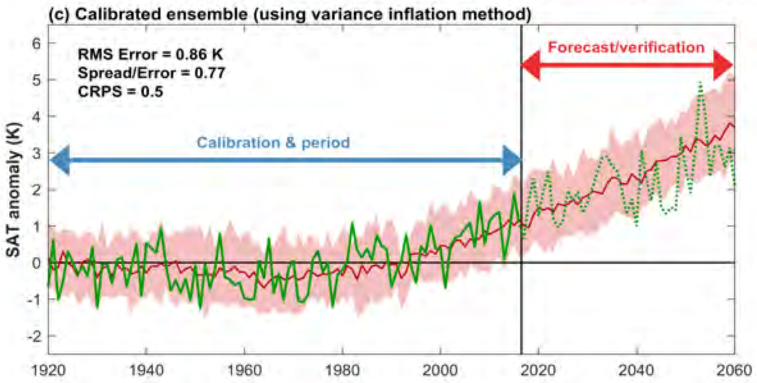
Analyse added value of initialized predictions over uninitialized projections.

- For what regions?
- For what lead times?
- For which variables?



Reliability of Projections

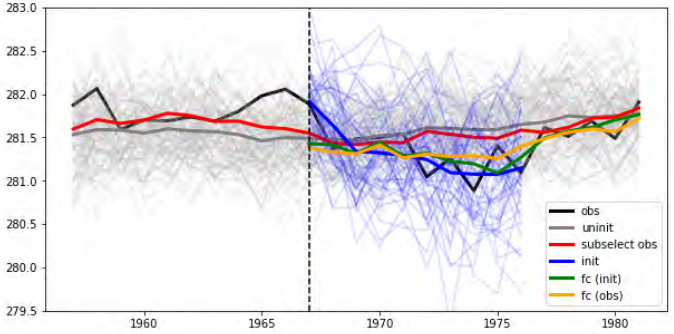
Calibration is needed to obtain reliable projections on 30-40 year time-scales.



Calibration increases reliability of projections over Europe especially for surface temperatures in summer.

Constraining Projections

It is explored in how far constraining projections using decadal predictions increases skill for lead times beyond 10 years.



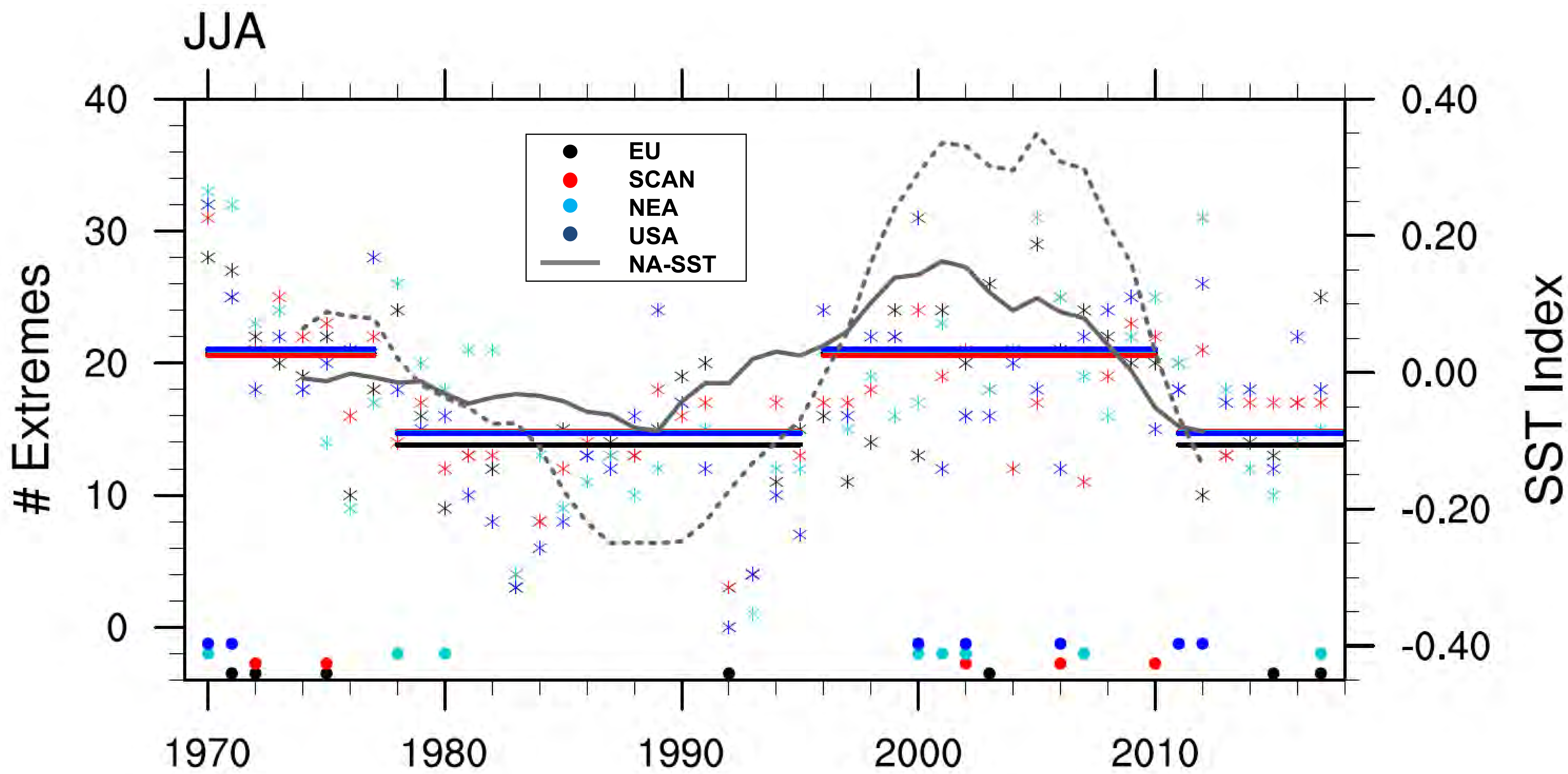
First results suggest that skill for surface temperatures over the North Atlantic is increased lead years 11-13 .

Poster 01, Attendance time: 16:00 to 17:00

Extreme Summer Temperature in the Northern Hemisphere and its Link to the Atlantic Multidecadal Variability in Decadal Hindcasts

Leonard Borchert[1,2], Holger Pohlmann[1], Laura Suárez Gutiérrez[1,3], Nele-Charlotte Neddermann[2,3], Wolfgang A. Müller[1]

[1]: Max Planck Institute for Meteorology, Hamburg, Germany [2]: Institute for Oceanography, CEN, Uni Hamburg, Germany [3]: International Max Planck Research School on Earth System Modeling, Hamburg, Germany



The likelihood of predicting a warm summer temperature extreme in the Northern Hemisphere depends on the phase of North Atlantic SST variability. The Circumglobal Wavetrain connects these extremes to the North Atlantic.

Max-Planck-Institut für Meteorologie

FIND OUT MORE AT POSTER 5-P02

…or contact me directly: leonard.borchert@mpimet.mpg.de

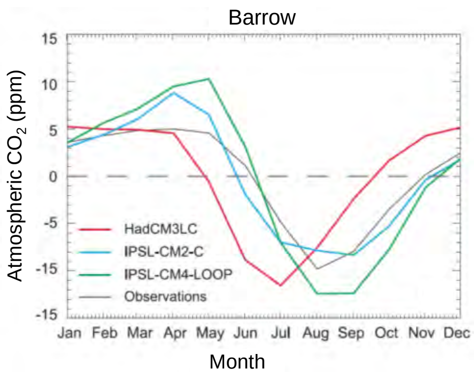
MAX-PLANCK-GESELLSCHAFT

Disentangling the terrestrial, oceanic and anthropogenic contributions to the CO_2 seasonal cycle

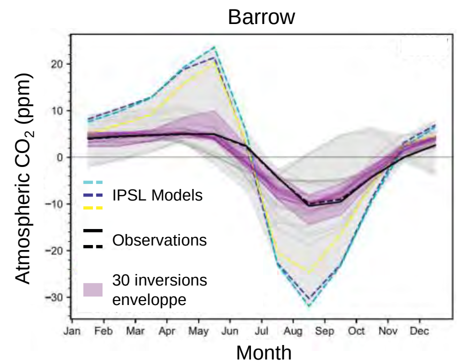
Patricia Cadule[1,2], Philippe Peylin[1], Olivier Boucher[1], and C4MIP participants[2],
1: IPSL Climate Modelling Center; 2: C4MIP (www.c4mip.net)

IPSL's models across the Assessment Reports

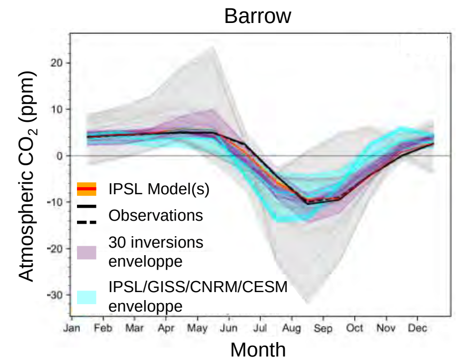
4th AR
correct CO_2, wrong reasons



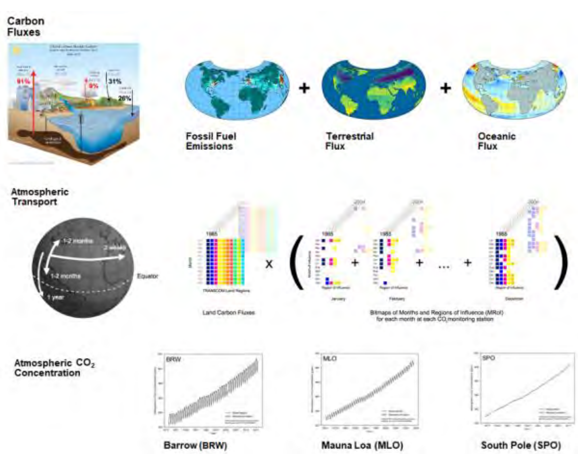
5th AR
incorrect CO_2, several reasons



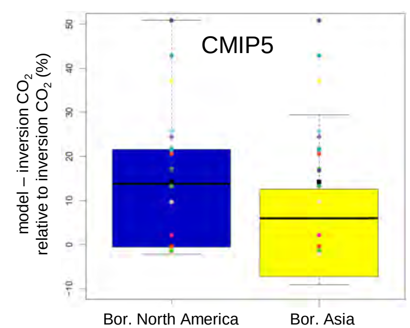
6th AR
correct CO_2, …



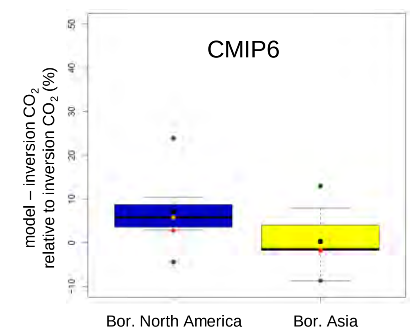
A methodology (and tool chain) …



… for determining whether IPSL (and few other CMIP6) models have met the #ARchallenge of reproducing the CO_2 seasonal cycle for the correct reasons, or not.

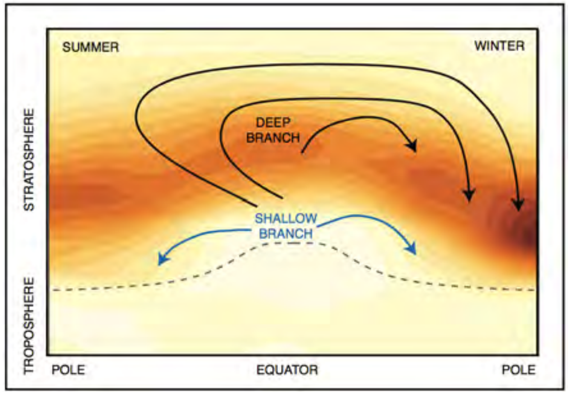


Dispersion of the model minus inversion CO_2 (relatively to inversion global annual value). At Barrow at specific months (JJA) and regions of influence

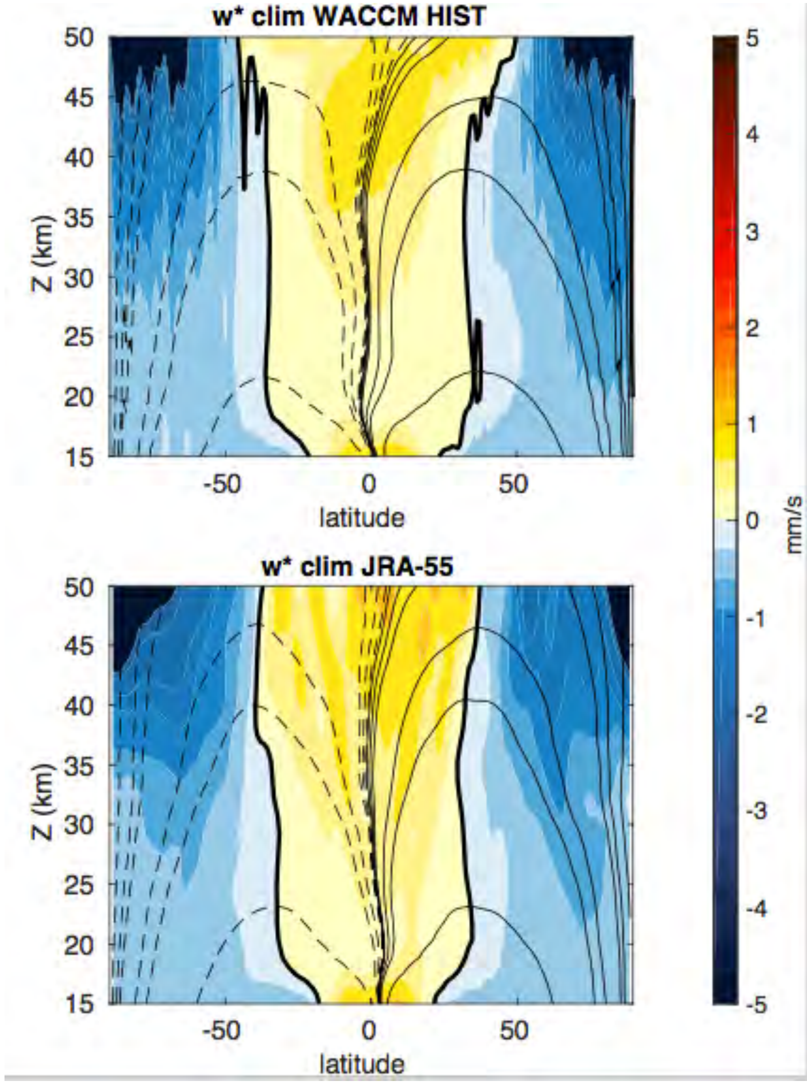


The Brewer Dobson circulation in CMIP6 models
P04. Wed. Session 5.

Natalia Calvo and Marta Abalos. Universidad Complutense de Madrid



(from WMO O3 assessment, 2014)



•We will make use of the CMIP6 models to investigate remaining open questions about the BDC.

•We will study climatology and trends
•Focus on the deep branch (wave forcing)
•Mean age of air, two-way mixing
•Comparison with observations and reanalysis

Section 5, P05

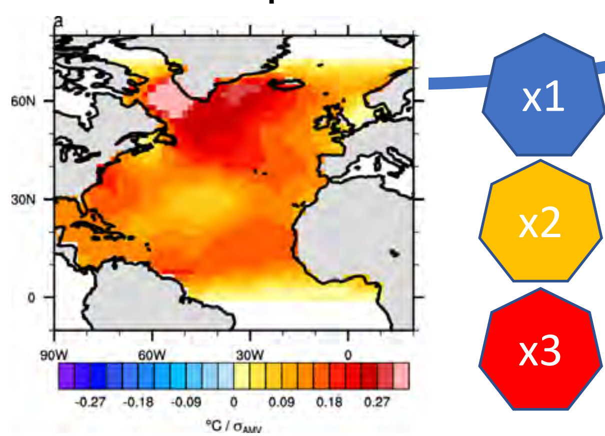
Ch. CASSOU, S. QASMI and J. BOE

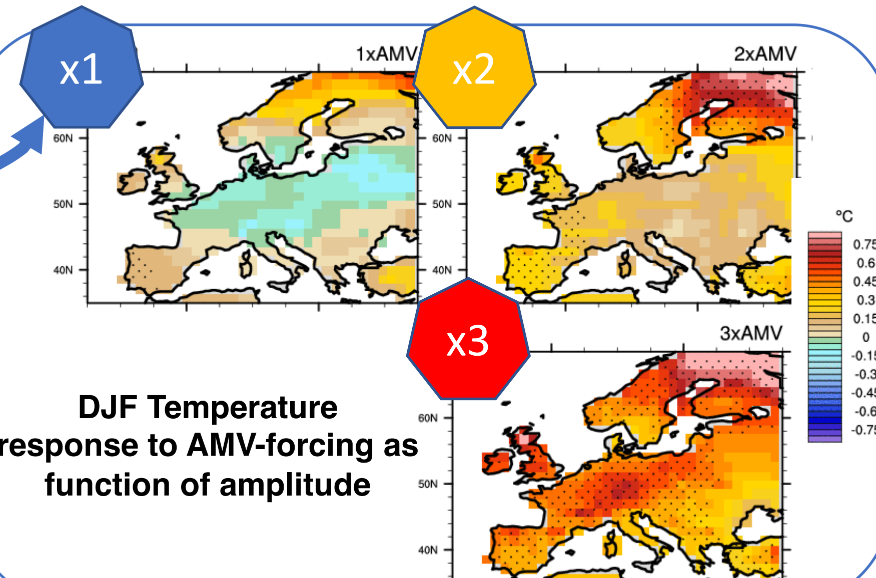
CERFACS

Centre National de la Recherche Scientifique

Processes linking the intensity of the Atlantic Multidecadal Variability (AMV) to the climate impacts over Europe as assessed from CMIP6/DCPP-C pacemaker experiments

40-member ensemble of 10-yr simulations where North Atlantic is restored to SST anomalies representative of AMV





DJF Temperature response to AMV-forcing as function of amplitude

<u>Take home message:</u>

Strong sensitivity of the model response to the intensity of the AMV-SST forcing (e.g. sign shift between 1std-AMV and 2std or 3std AMV for temperature in winter) explained by:

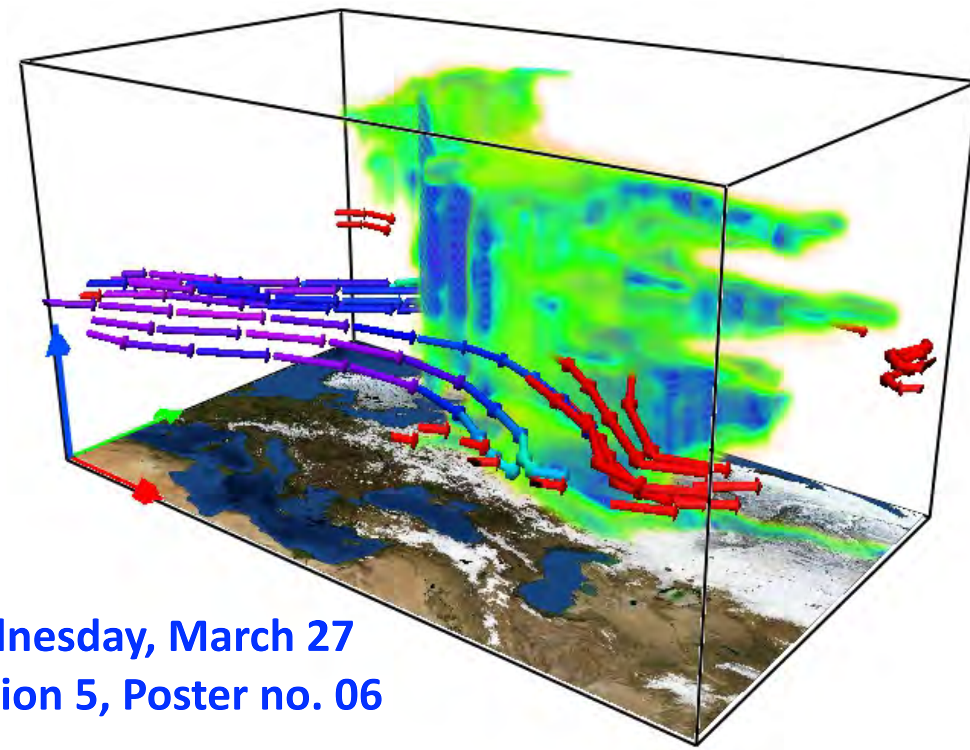
- Competition between AMV-forced dynamical and thermodynamical response
- Competition between AMV-forced Tropical (Rossby wave) versus Extratropical (polar amplification) influence

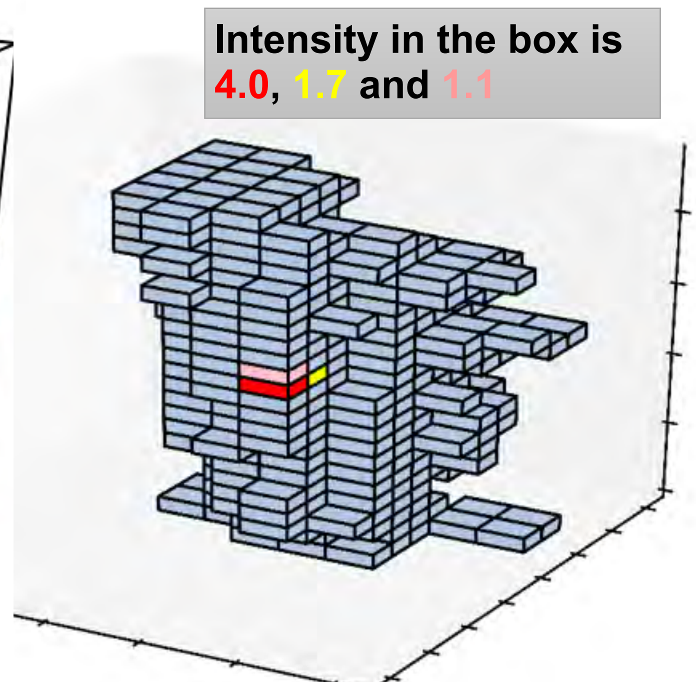
→ A process-oriented framework to understand inter-model diversity in CMIP6 dcppC exp.

Heat Wave Extremes from Event Prospectives: Observation, Simulation, and Attribution

Cheng-Ta Chen and Shih-How Lo
National Taiwan Normal University, Department of Earth Sciences, Taipei, Taiwan

Objectively tracking the spatial and temporal evolution of extreme events from observation and model simulation



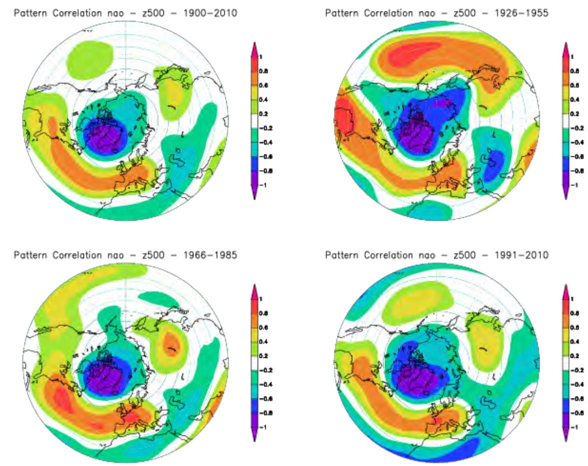


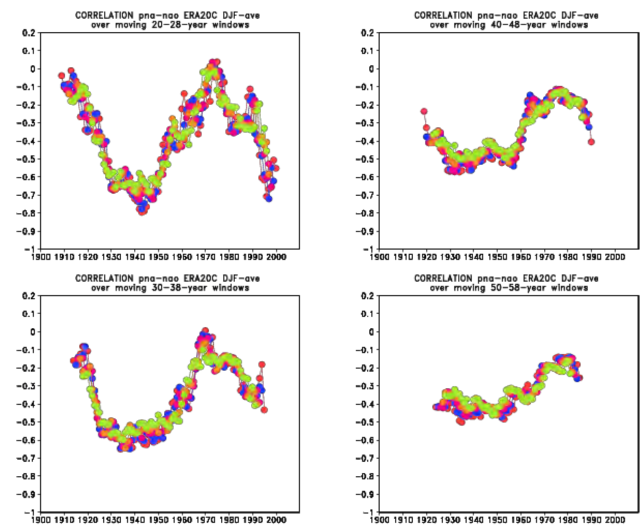
Wednesday, March 27
Session 5, Poster no. 06

Decadal variability in weather regimes and teleconnections in reanalysis datasets and climate simulations.

Susanna Corti (ISAC-CNR)

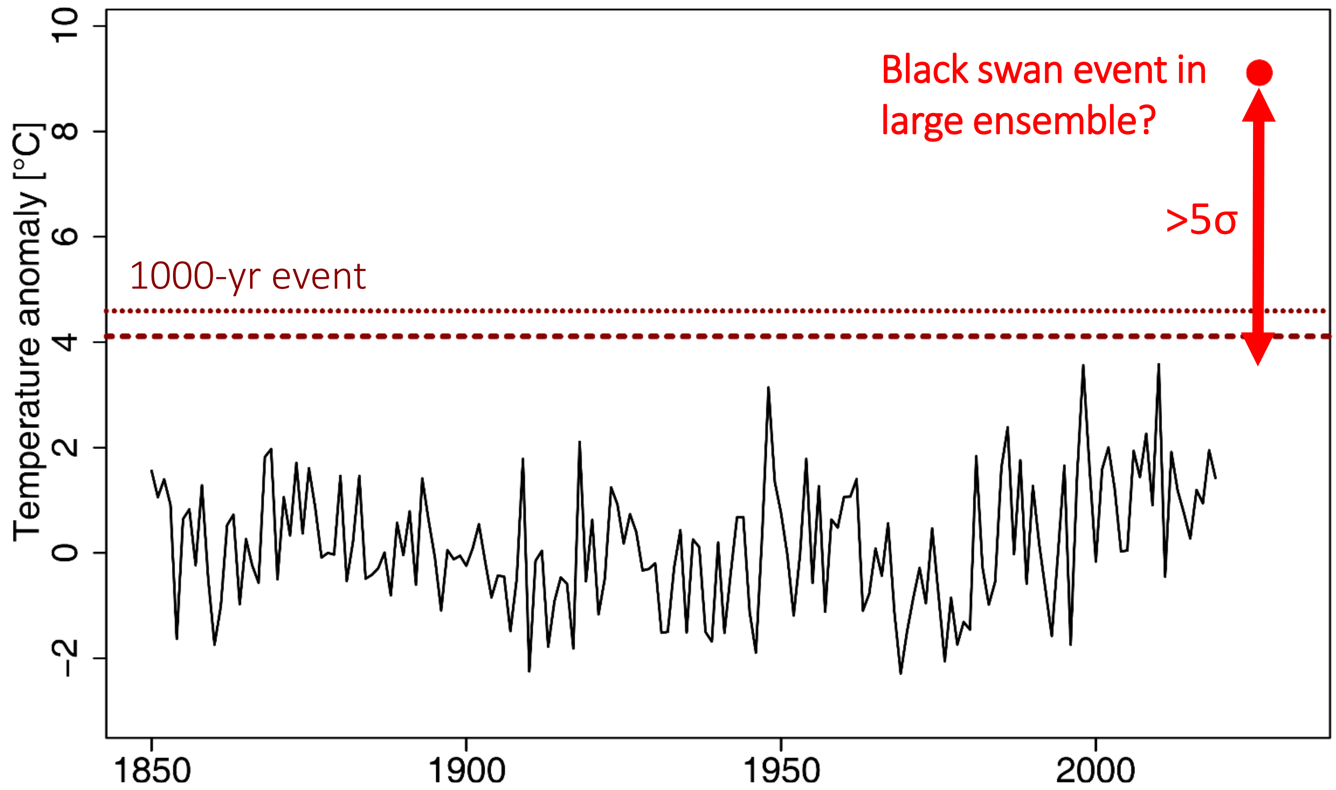
- ✓ PNA and NAO relationships has a decadal variability which seems related to both internal and forced variability. A positive PNA and negative NAO combined pattern (reminiscent of the Arctic Oscillation) was more prominent in the 20-year period centred in the 40s. While in the 20-year period centred in the 70s a more local NAO pattern is found.
- ✓ The relationship with the SSTs consistently presents a NAO-Niña positive connection in the early 20-year periods and no signal in the later period.
- ✓ In the last 40 years NAO is more related to the hemispheric pattern which is more consistent with a positive-positive PNA-NAO relationship. This hemispheric pattern is reminiscent of the COWL (Cold Ocean Warm Land) pattern which is consistent with both SST's (positive AMO and PDO) and climate change radiative forcing.





Do we underestimate today's risk of extremes?

Erich Fischer
ETH Zurich, Switzerland



Annual max. 7-day temperature anomaly in Central N America in 84-member NCAR-CESM ensemble

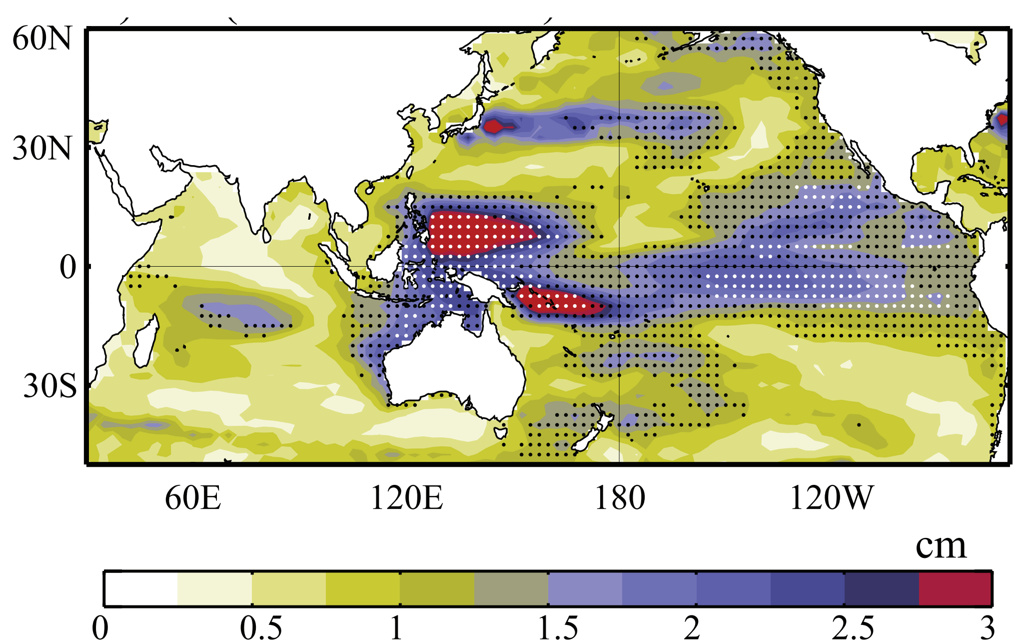
Large ensembles and CMIP5 models simulate «record-shattering» extremes
Are they plausible? Does their probability change?

Natural decadal sea-level variability in the Indian Ocean: Lessons from CMIP models

A.G. Nidheesh[1], M. Lengaigne[2], J. Vialard[2], T. Izumo[2,3], A.S. Unnikrishnan[3], R. Krishnan[1]

[1]Indian Institute of Tropical Meteorology (IITM), Pune, India
[2]LOCEAN-IPSL, Sorbonne Univ. (UPMC, Univ Paris 06)-CNRS-IRD-MNHN, Paris, France
[3]CSIR-National Institute of Oceanography, Goa, India

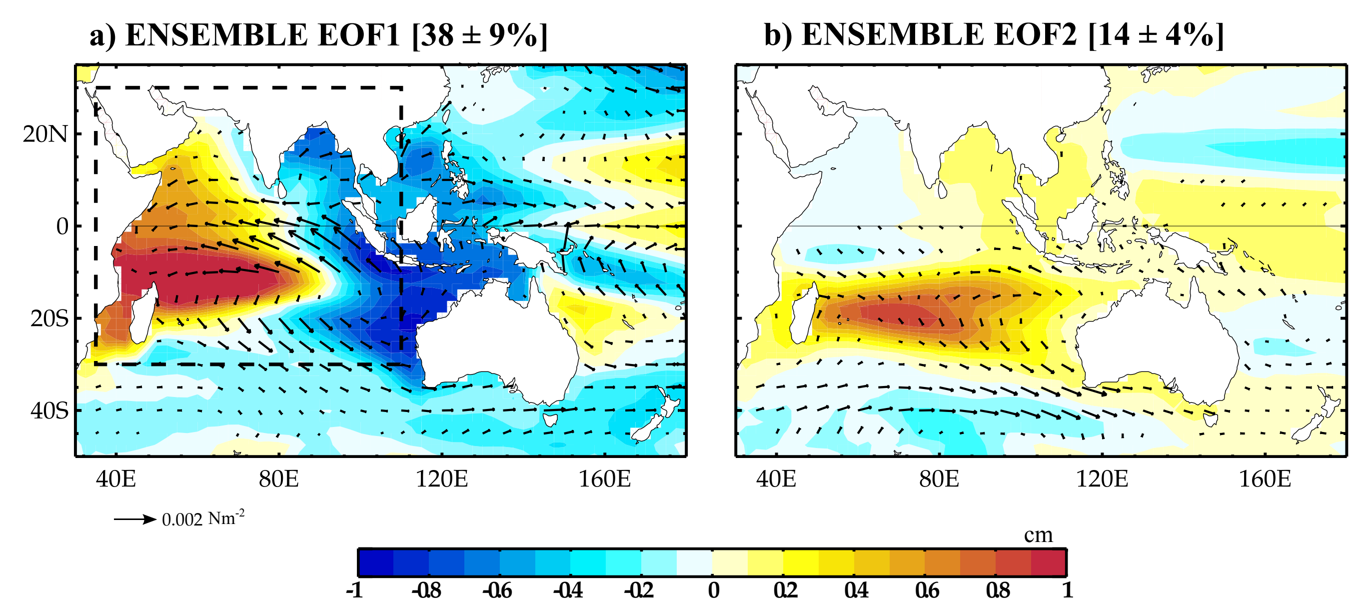
Standard deviation of Ensemble mean decadal SLA & **inter-product agreement**



- Least OBS-coverage in the 60's and 70's
- Inconsistent decadal variability in OBS-based sea-level products (Nidheesh et al. 2017).

Indian Ocean decadal sea-level variability: A grey area!

Two consistent modes of decadal SLA in CMIP

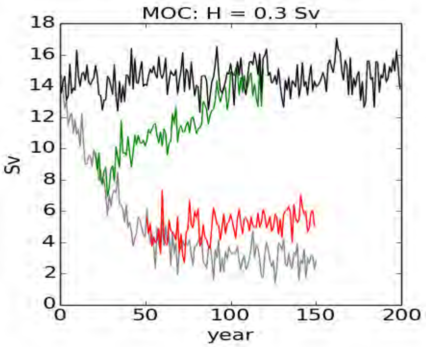


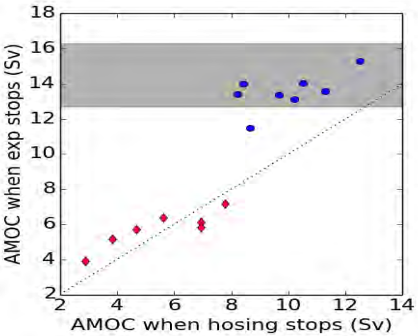
- Related to decadal IOD and Mascarene High.
- Physical mechanisms are discussed.

P09

AMOC hysteresis in a pre-CMIP6 GCM and a proposal for comparing AMOC feedbacks.

Laura Jackson and Richard Wood, Met Office Hadley Centre, UK





We apply hosing to the North Atlantic in a pre-CMIP6 GCM (HadGEM-GC2) in a suite of experiments

When hosing is finished, the AMOC recovers in some but not in those where the AMOC has been weakened more strongly (see Figure)

The AMOC remains in a weak state for at least 180 years in one experiment – this is a quasi-stable weak state.

We explore what determines the threshold and the recovery/non-recovery

This paper (and other studies) motivate the question of whether AMOC non-recovery is found in other recent GCMs. Also we want to understand which feedbacks dominate and why across models.

MIP proposal

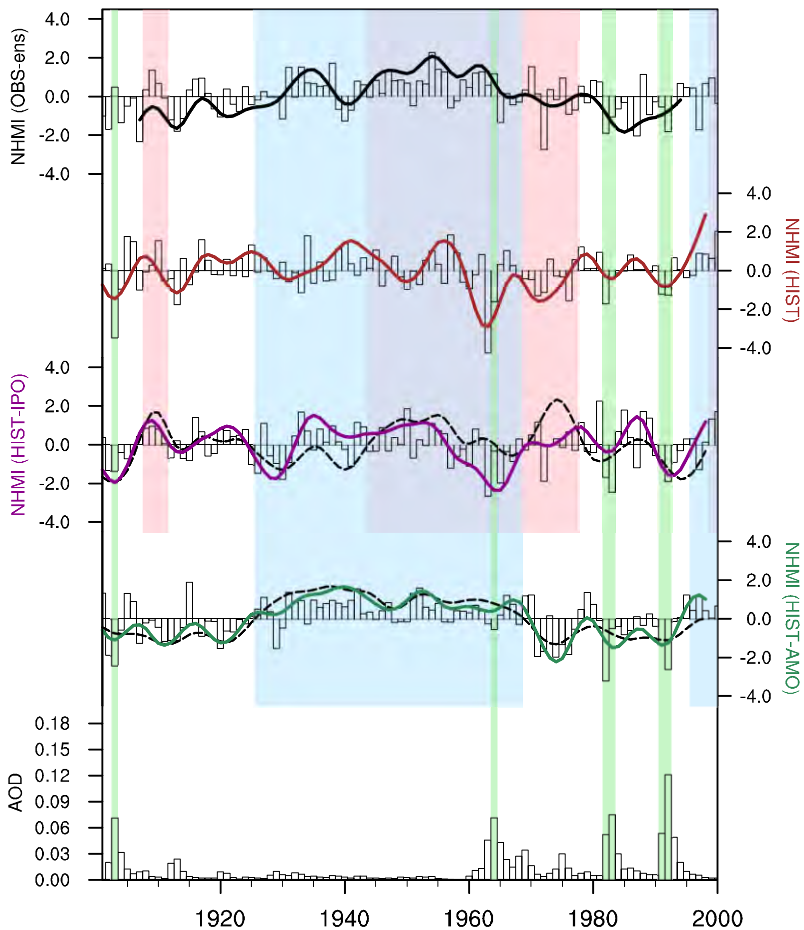
Objective: Understand the signs and strengths of feedbacks on the AMOC and how this relates to AMOC hysteresis

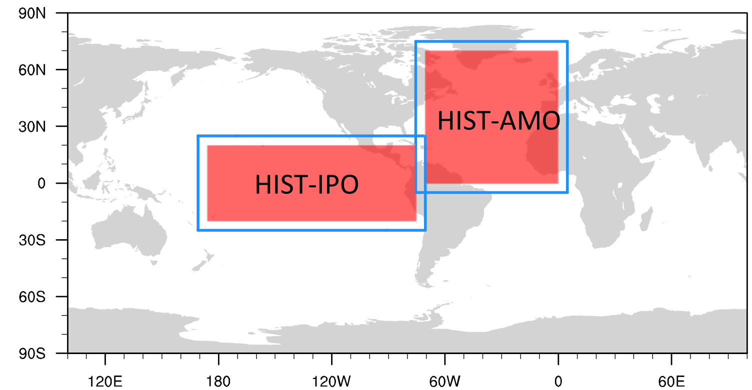
Method: Conduct a small number of experiments applying hosing to the North Atlantic for a limited time. See poster for more details, though some aspects are still open for discussion.

Global monsoon response to sea surface temperature during the 20th century

Jie Jiang (jiangj@lasg.iap.ac.cn), Tianjun Zhou

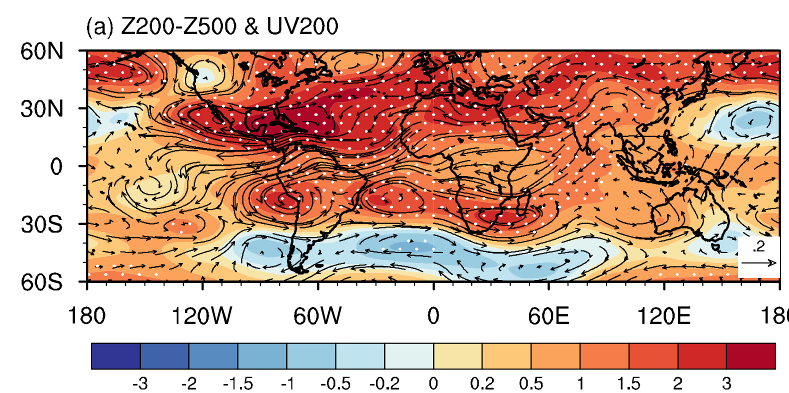
■ **NHMI**: Northern Hemisphere monsoon index
1901-1955 ↑ 1956-1990 ↓





■ The interdecadal variations of NHMI in observation can be reproduced by HIST-AMO

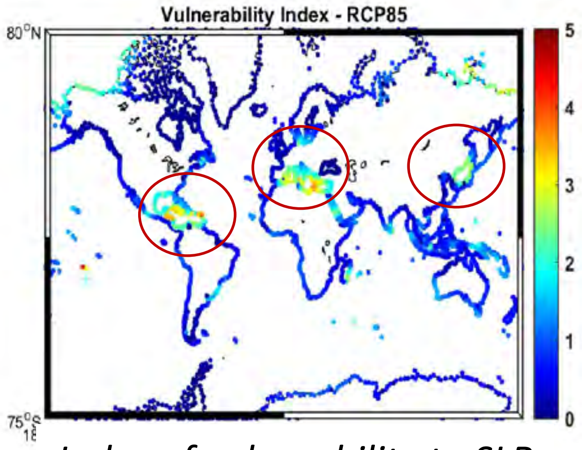
■ Warming in the North Atlantic→ tropospheric warming → monsoon circulation→monsoon precipitation



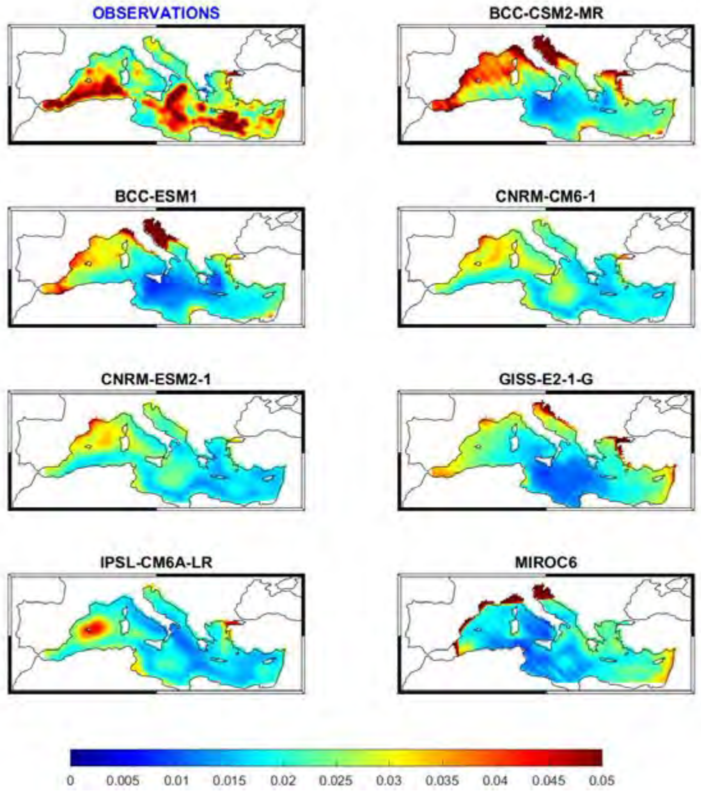
Sea level variability in marginal seas from CMIP simulations. Strengths, weaknesses and ways to solve them.

Gabriel Jordà
gabriel.jorda@ieo.es

Sea level variability in marginal seas is challenging as local (small scale) processes can dominate over large scale variations. At the same time, marginal seas are considered the most vulnerable to sea level rise.



Index of vulnerability to SLR



Comparison of monthly STD of sea level from observations and 7 CMIP6 simulations

In the Mediterranean Sea, under RCP8.5, the dynamical effects can account for up to ±15 cm difference in the sea level rise with respect to the global average.

Half of the dynamical effects come from the evolution in the North Atlantic and half from the local dynamics.

Can CMIP simulations reproduce reasonably well those effects?

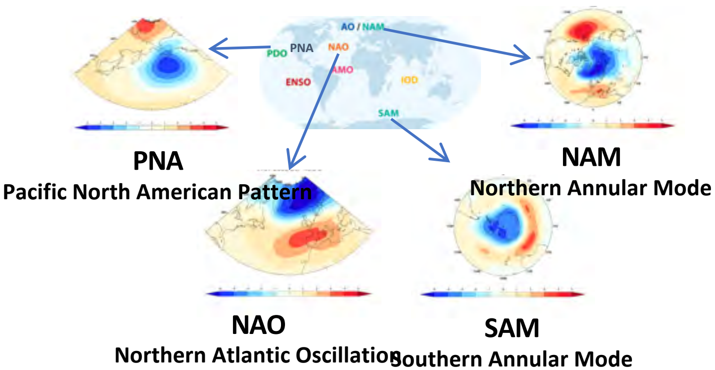
Poster 5 P13

Quantifying the Agreement Between Observed and Simulated Extratropical Modes of Interannual Variability

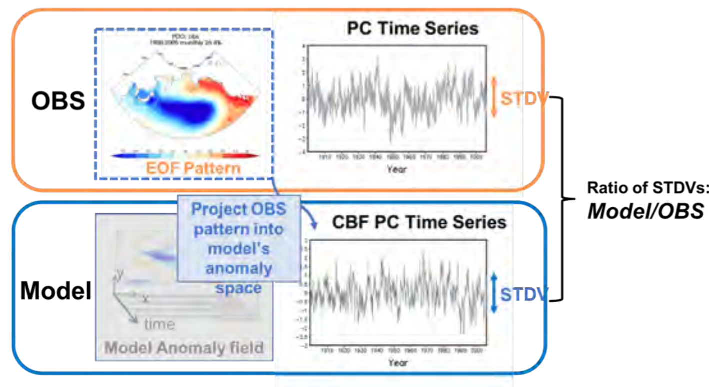
Jiwoo Lee, Kenneth Sperber, Peter J. Gleckler, Celine Bonfils, Karl Taylor

Program for Climate Model Diagnosis and Intercomparison (PCMDI), Lawrence Livermore National Laboratory, USA

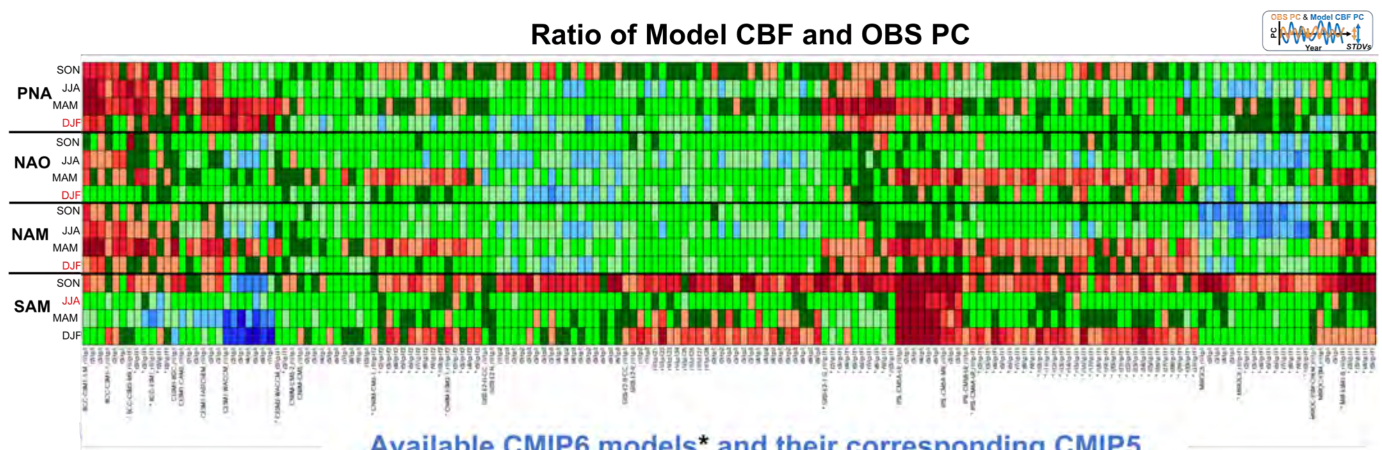
Extra-tropical Modes of Variability



Defining Metrics using Common Basis Function (CBF)



Metrics Results:

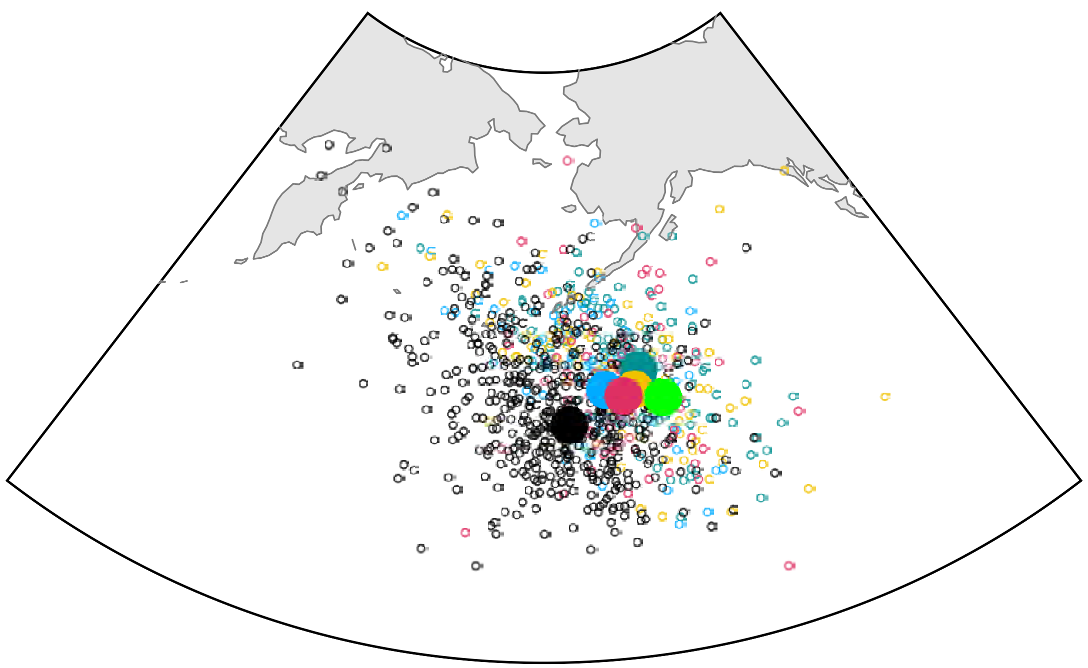


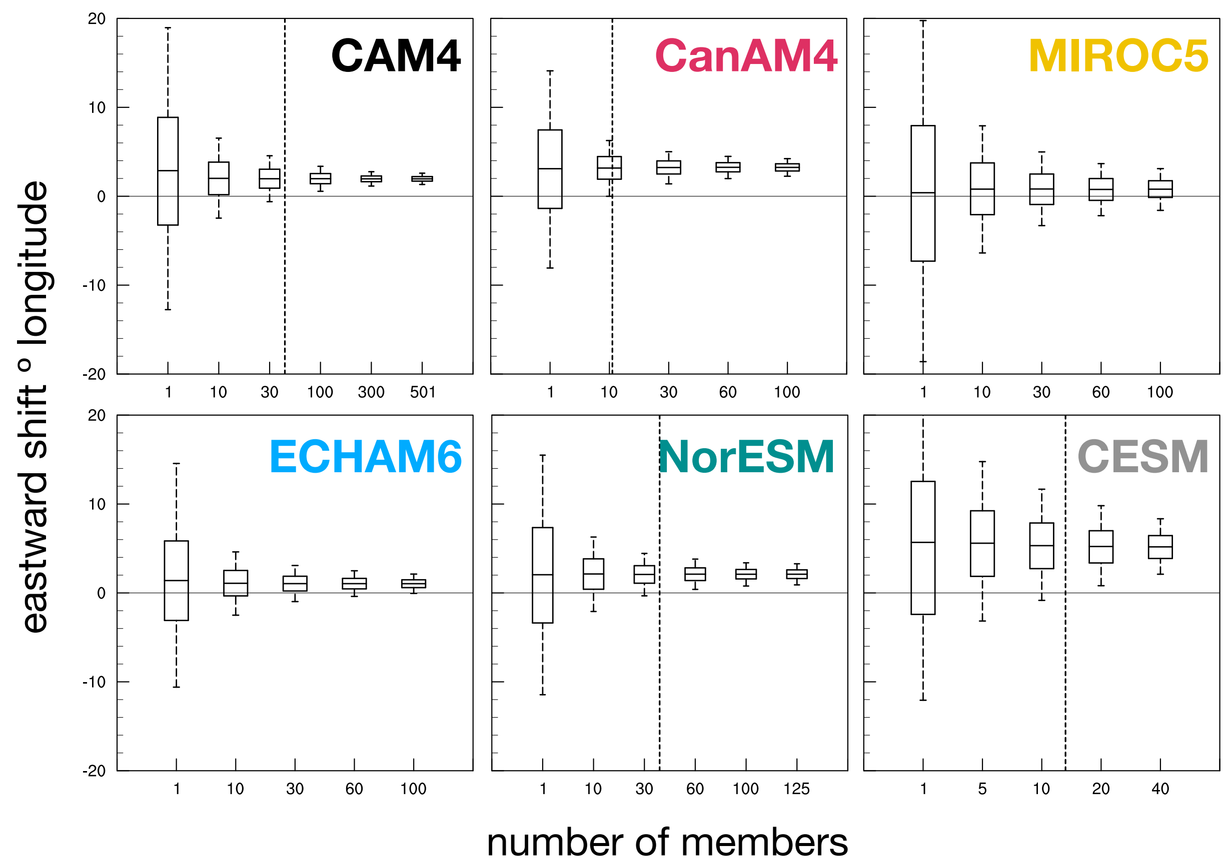
Investigating the ENSO teleconnection response to global warming using a multi-model large-ensemble experiment

Clio Michel[1,2], Camille Li[1,2], Isla R. Simpson[3], Ingo Bethke[1,4,2], Martin P. King[4,2], Stefan Sobolowski[4,2]
[1]University of Bergen, [2]Bjerknes Centre for Climate Research, [3]NCAR, [4]NORCE
contact: clio.michel@uib.no

BJERKNES CENTRE for Climate Research

model/ensemble spread in location of North Pacific SLP centre





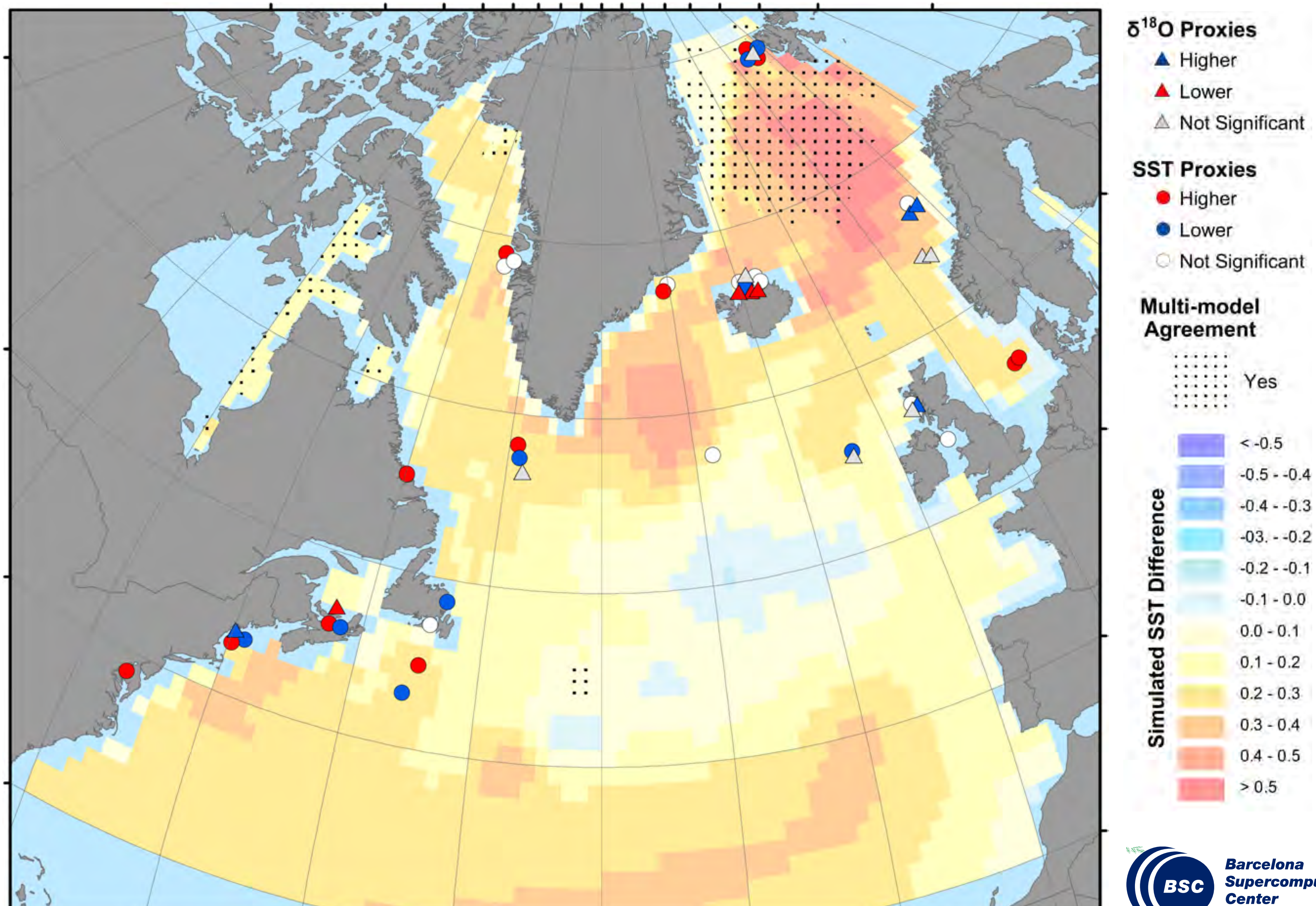
1 consistent northeastward shift of the North Pacific centre of action with global warming in the HAPPI "very large" ensemble

2 *but* forced signal is small compared to internal variability - significant shift in 3/5 model ensembles but requires at least 50 ENSO events

Variability in the northern North Atlantic and Arctic oceans in the past millennium: A review of CMIP5/PMIP3 efforts

SST anomaly Industrial (1850–2005) vs. Preindustrial (850–1849)

- Shading: multimodel ensemble mean (13 x CESM, 1 x IPSL-CM5A-LR, 3 x MPI-ESM-P)
- Polygons: state-of-the-art collection of high-resolution SST proxies



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

P18 A multi-model comparison of the ocean contributions to multidecadal variability in the North Atlantic

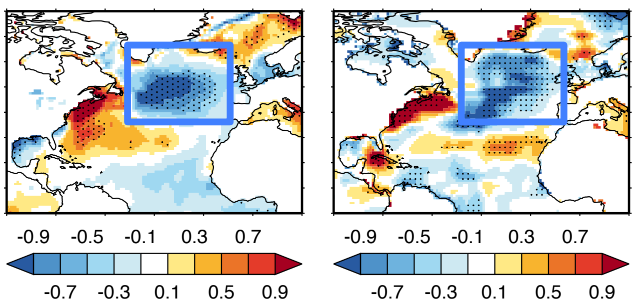
P. Ortega

University of Reading · National Centre for Atmospheric Science (Natural Environment Research Council) · National Oceanography Centre Southampton (University of Southampton and Natural Environment Research Council) · Met Office · NCAR (National Center for Atmospheric Research)

I. Context and Motivation

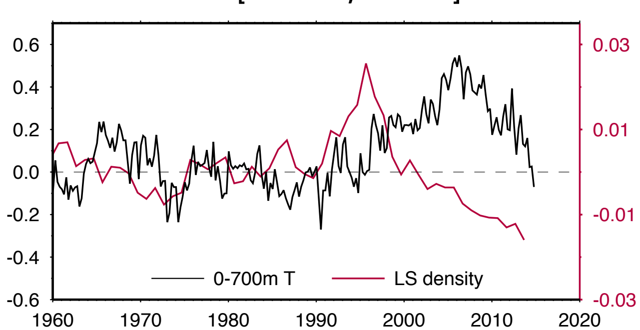
Robson et al (2016)

SST trends (2005-2014) T700 trends (2005-2014)



A Labrador Sea density (LSD) decline preceded the occurrence of the recent cold blob in the North Atlantic

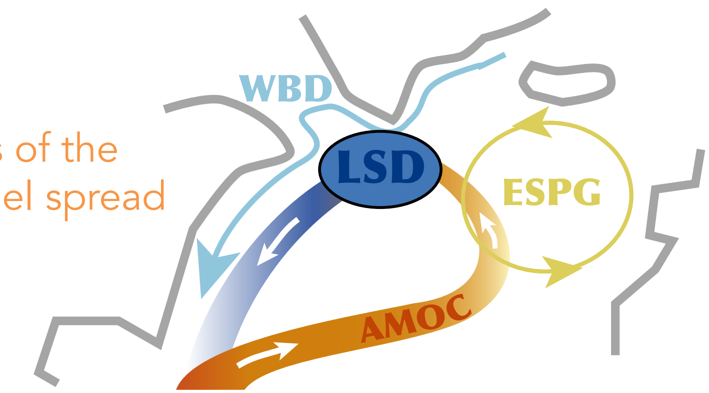
T700 [50-10W;35-65N]



II. Questions Addressed

Consistency of the LSD relationships across an ensemble of climate models

Causes of the inter-model spread



Latitudinal coherence of AMOC changes

III. Experimental Setup

Analysis of a set of Preindustrial Control Experiments:

HadGEM3-GC2	310 years, 1/4° ORCA Grid
HiGEM3	340 years, 1/3° ORCA Grid
CMIP5 ensemble	19 experiments (Lower Resolution)

ENSO and PDO modulation of Sudden Stratospheric Warmings: a multi-model study

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

UNIVERSITAT DE BARCELONA

Froila M. Palmeiro[1], Javier Garcia-Serrano[1,2]

[1]Barcelona Supercomputing Center (BSC), Barcelona, Spain

[2]Group of Meteorology, Universitat de Barcelona, Barcelona, Spain

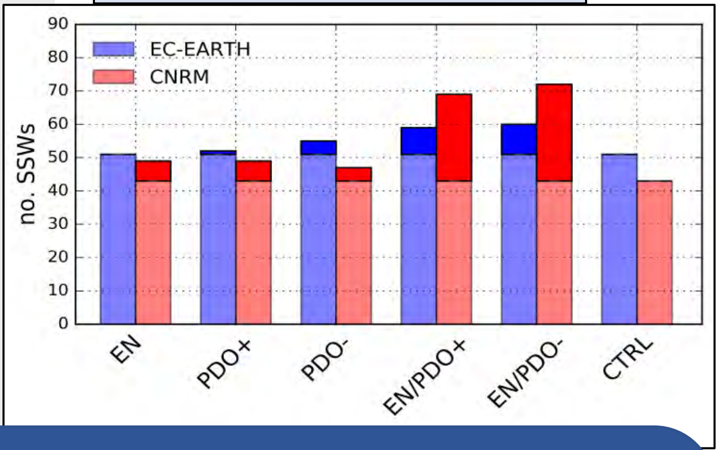
(froila.palmeiro@bsc.es)

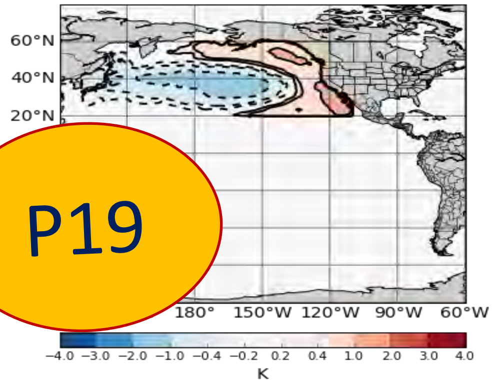
European Research Area for Climate Services

MEDSCOPE
MEDiterranean Services Chain based On climate PrEdictions

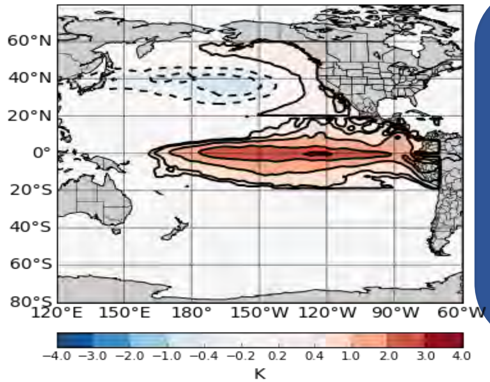
- Is there an effect on SSW occurrence from ENSO/PDO?
- How does the vortex respond to ENSO/PDO?
- Does ENSO/PDO modulate wave injection from the troposphere to the stratosphere?
- Could a strong PDO alone have an impact on SSW frequency?

IMPACT of ENSO/PDO on SSW occurrence





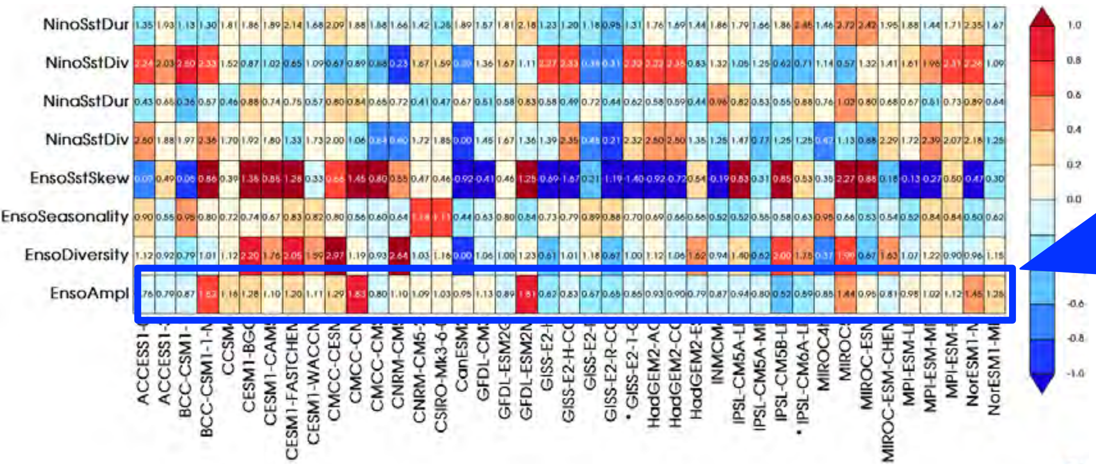
P19

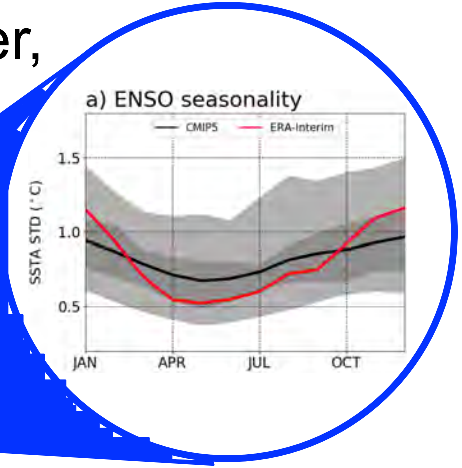


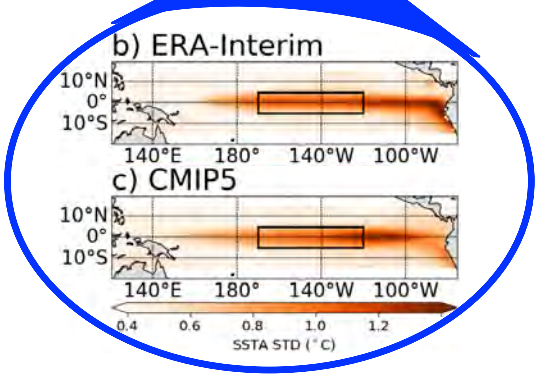
Assessment of the Northern stratospheric variability in EC-EARTH and CNRM

ENSO evaluation in CMIP models

5P20 – Planton, Guilyardi, Lee, Gleckler, Wittenberg, Power, Mcgregor







- Working on consensus ENSO metrics:
  - performance, teleconnection, processes
- Package developed for several software infrastructures
- Publication expected for the AR6

Atlantic Multidecadal Variability and North Atlantic storm track

P. Ruggieri A. Bellucci, D. Nicolì, P. Athanasiadis, P. Davini, G. Gastineau, J. Grieger, B. Harvey, D. Hodson, C. O'Reilly, B. Rodriguez de Fonseca, Y. Ruprich-Robert, E. Sanchez-Gomez, D. Smith, R. Sutton, S. Wild.

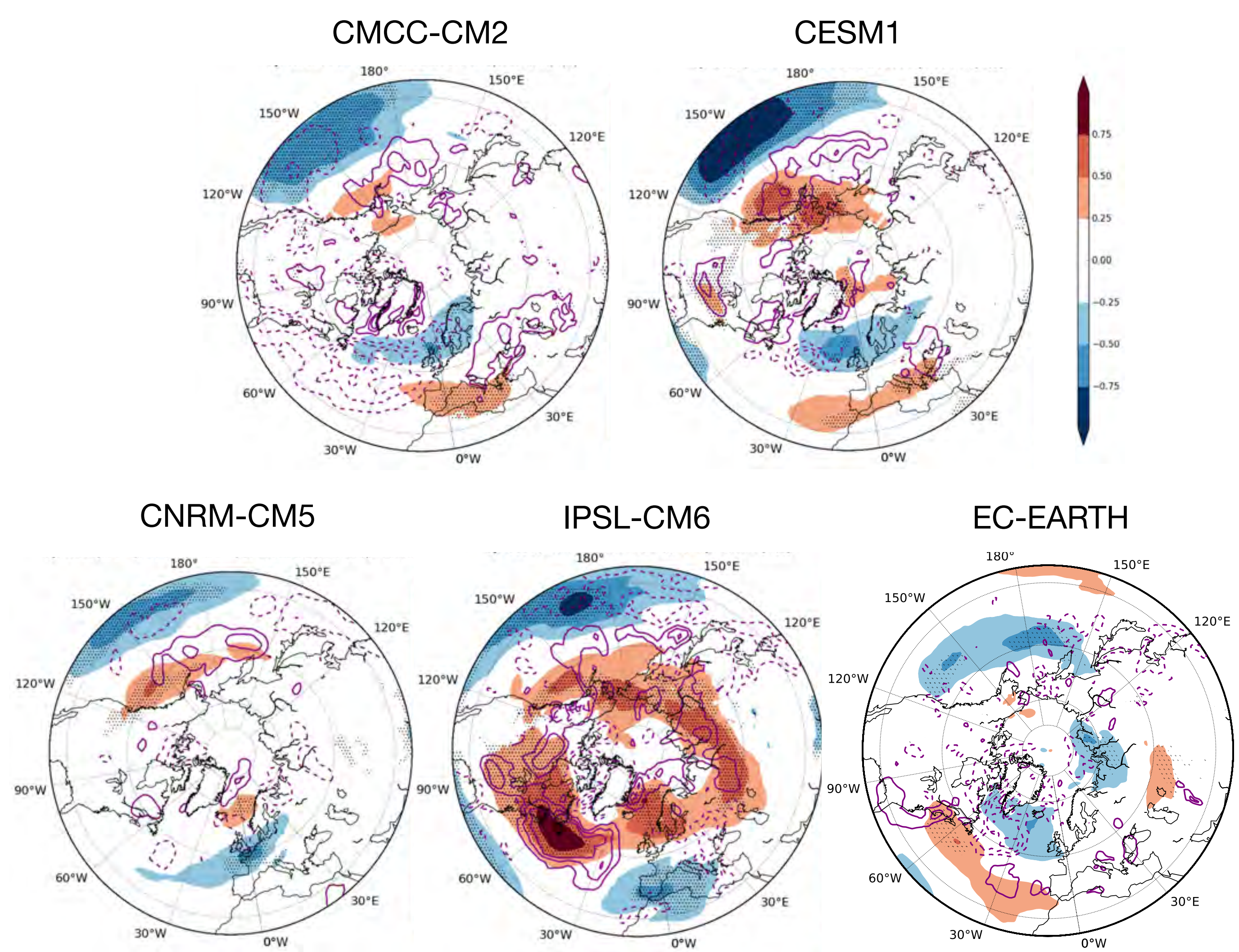
We present an assessment of the influence of AMV on the Atlantic storm track via a coordinated analysis of available idealised simulations.
We use a homogeneous set of ensemble simulations (DCPP and PRIMAVERA) where the state of the Atlantic surface is relaxed towards the phases of the AMV

Most models show a substantial reduction of meridional eddy heat flux in the high baroclinicity region of the North Atlantic.

Come see the poster for more !

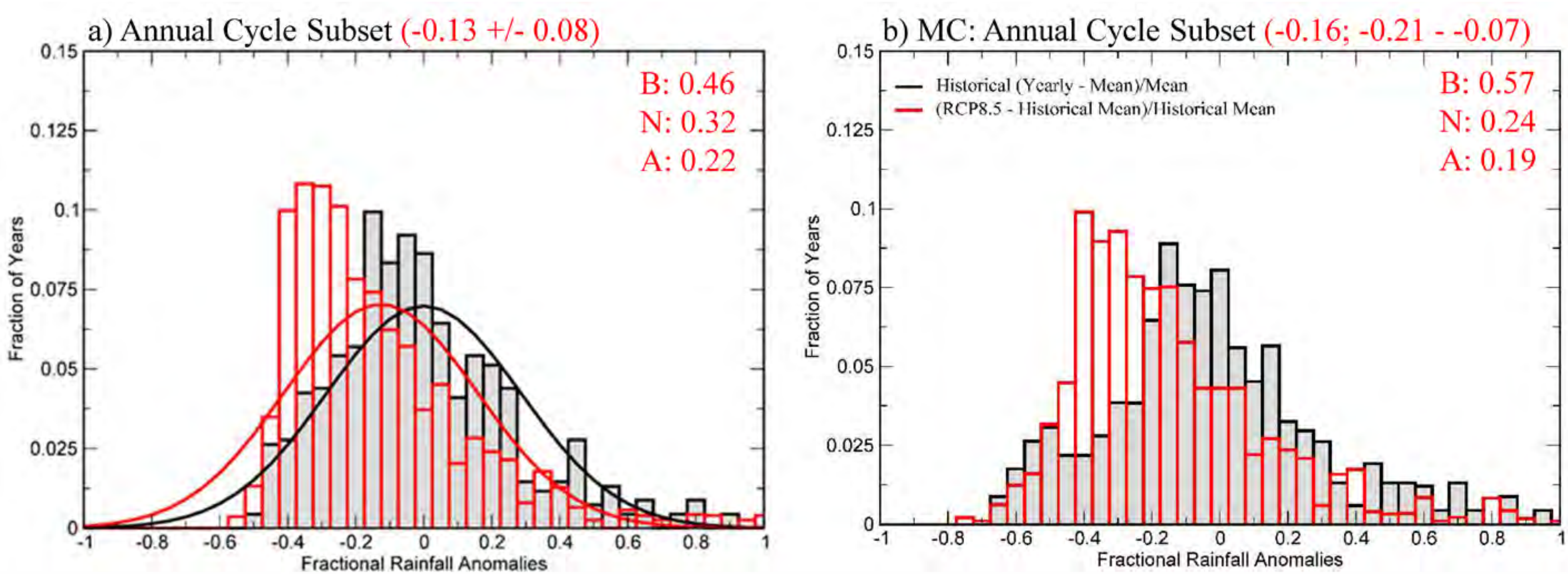
WEDNESDAY
SESSION 5
POSTER 21

U850 (Shading m/s) and V`T`850 (contours, .25 K m/s) DJF AMV+ minus AMV-



Session 5, Poster 22: CMIP5: A Monte Carlo Assessment of Changes in Summertime Precipitation Characteristics Under RCP8.5-Sensitivity to Annual Cycle Fidelity, Overconfidence, and Gaussianity (Sperber, Annamalai, Pallotta)

- CMIP5 Pentad precipitation (33 models: Historical, 1961-1999: 82 members, 3198 years; RCP8.5: 2061-2100: 70 members, 2797 years)
- Despite the non-Gaussian distributions
  - The Gaussian approach and Monte Carlo non-parametric Mann-Whitney U-test results have similar 99% confidence intervals. As such, Gaussian confidence intervals are a reasonable proxy for assessing the lower- and upper-bounds of the projected change
  - The tercile perturbations under the Gaussian assumption are more conservative than the empirical non-parametric perturbations
- Sub-selecting on annual cycle skill has a greater impact on the projections than sub-selecting for overconfidence

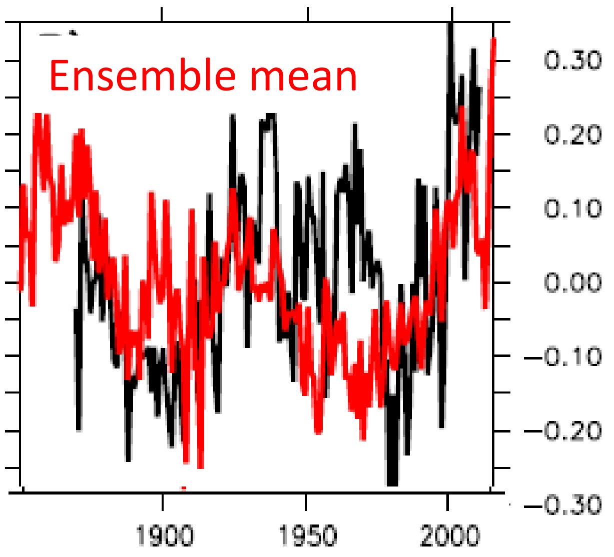


Atlantic Multidecadal Variability in pre-CMIP6 Historical Simulations

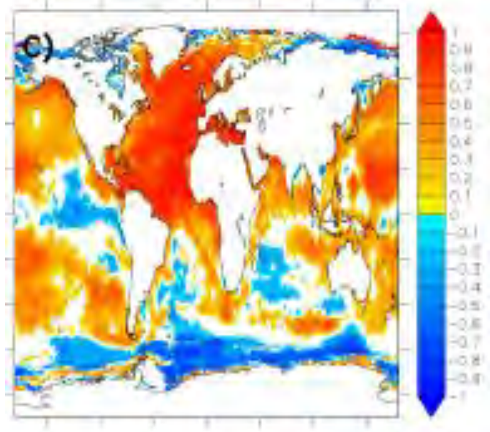
Dan Hodson[1], Jon Robson[1], Ben Booth[2], **Rowan Sutton**[1]

1: NCAS, University of Reading, UK
2 : Met Office, FitzRoy Road, Exeter, UK

AMV Index



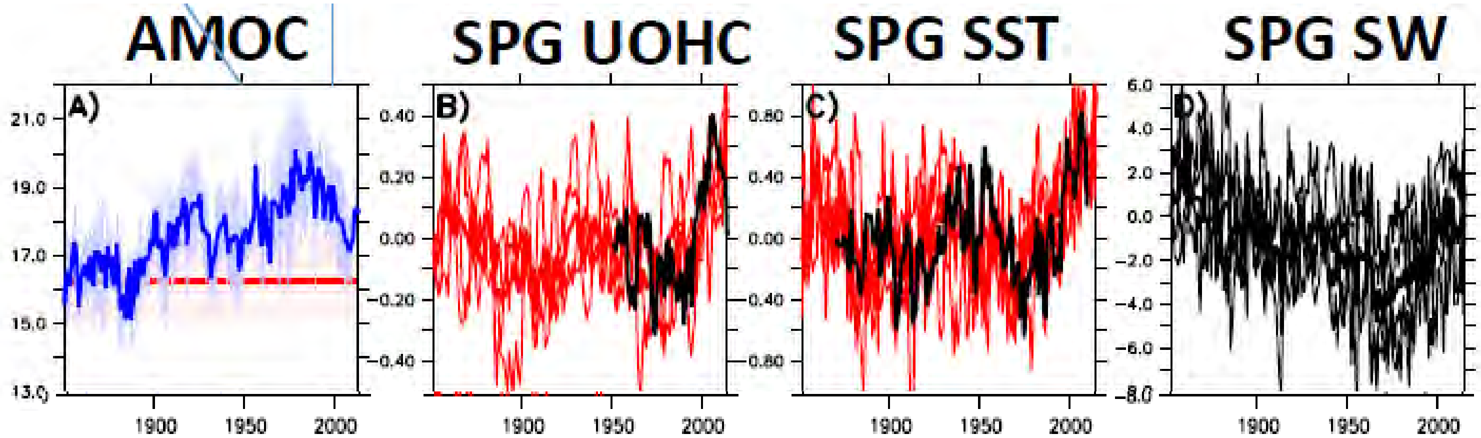
Observed AMV correlation pattern



Key AMV questions:

- Internal variability or a response to external forcings?
- What are the roles of:
  - AMOC?
  - Anthropogenic Aerosols?

Ensemble simulations at two resolutions

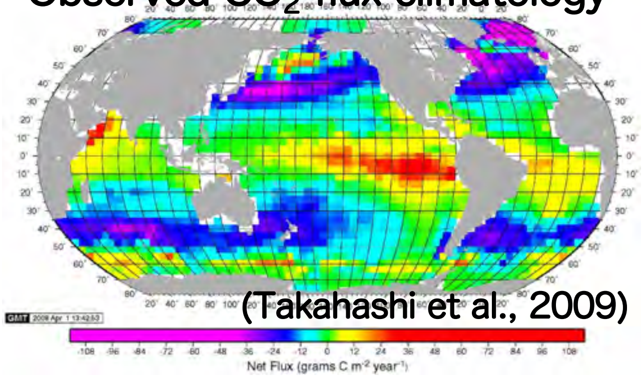


P24 Tropical air-sea CO_2 flux variations in two ESMs with an ocean DA system

Tatebe, H.[1], M. Watanabe[1], H. Koyama[1], T. Hajima[1], M. Watanabe[2], & M. Kawamiya[1]
1: JAMSTEC, 2: AORI, U. Tokyo

TOUGOU Integrated Research Program for Advancing Climate Models

Observed CO_2 flux climatology



(Takahashi et al., 2009)

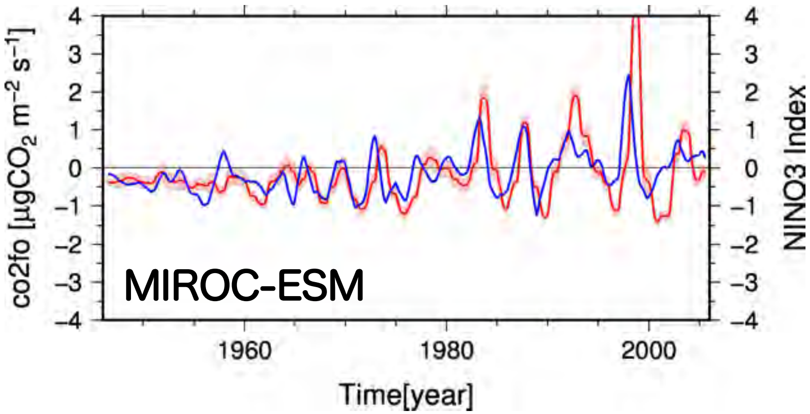
- ✓ Global air-sea CO_2 flux dominated by the tropical Pacific
- ✓ During El-Nino occurs, anomalous CO_2 uptake

■ Importance of ENSO and associated ocean/land ecosystem variations for global carbon predictions

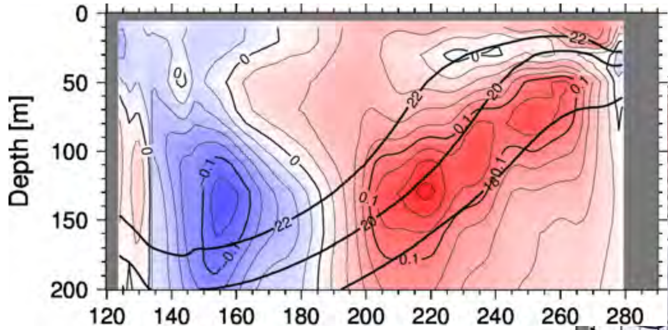
Two ESMs: MIROC-ES2L & MIROC-ESM with anomaly DA of ocean T/S

- ✓ Anti-correlation between NINO3-SST and CO_2 flux in the pi-control runs of both models, but NOT in MIROC-ESM with DA.

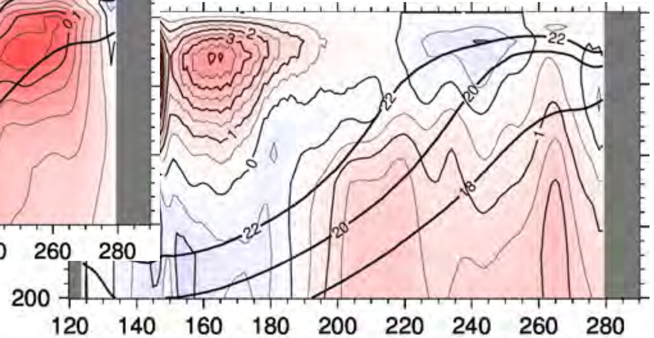
Timeseries of NINO3-SST and CO_2 flux



T increment anomaly along Eq.



W anomaly along Eq.



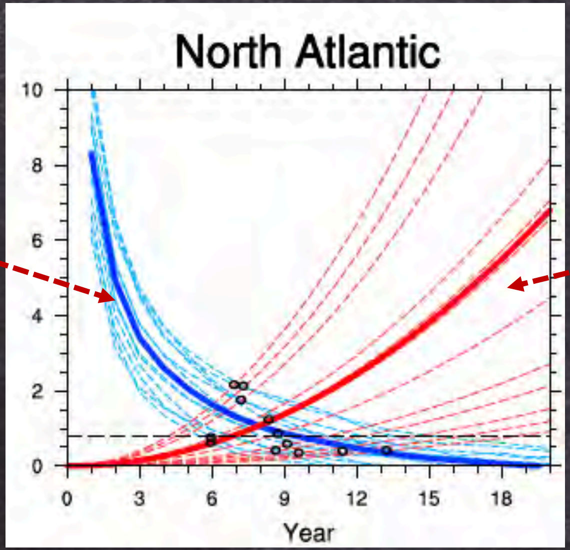
□ Spurious upward transport of rich-DIC subsurface water → CO_2 release

Impacts of Initialization on the CMIP6 Decadal Prediction Experiments

Haiyan Teng (hteng@ucar.edu), NCAR, USA

PROS: Initial-value predictability

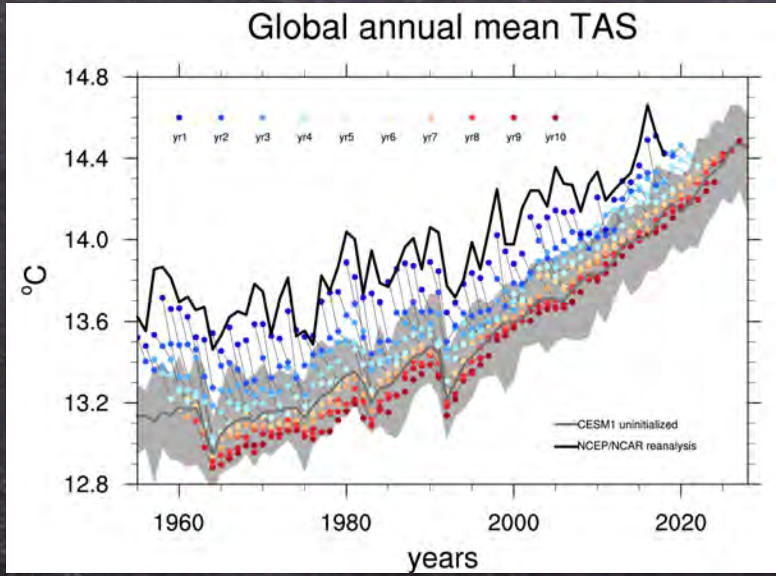
Initial-value predictability



Forced predictability

We'll update Teng and Branstator (2012)

CONS: Model drift/initialization shock



How does bias/drift behavior change with climate change?

Uncertainties in Historical Changes and Future Projections of Drought simulated by CMIP models

Tianbao Zhao (zhaotb@tea.ac.cn)

Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS), Beijing, China

Aiguo Dai

University at Albany, SUNY

Objective

Historical records of precipitation, streamflow and calculated drought indices all show considerable drying since 1950 over many land areas (e.g., Dai et al. 2004; van der Schrier et al. 2007, 20011, 2013; Dai 2011a, 2013a). However, large uncertainties exist in precipitation and other meteorological forcing datasets, as well as in the drought index calculations, that could lead to different estimates of the drying trend (e.g., Sheffield et al. 2012; van der Schrier et al. 2013; Trenberth et al. 2014). In this study, we will further examine the uncertainties in estimating historical drying trends and the key factors that may have contributed to the different. In addition, we will also compare the drought changes projected by the CMIP3 and CMIP5 models, as few studies have made such a detailed comparison.

Data and method

The Penman-Monteith PET (an important term in the PDSI model), were used in all versions of the sc_PDSI_pm corresponding to a different precipitation (P) dataset, including:

- ✓ the merged precipitation data from Dai et al. (1997) for 1850-1947, Chen et al. (2002) for 1948-1978, and GPCP v2.2 (Huffman et al. 2009) for 1979-present (referred to as DaiP);
- ✓ GPCC V6 for 1901-2010 (Schneider et al. 2011);
- ✓ CRU TS 3.10.01 for 1901-2009 (Harris et al. 2014);
- ✓ CRU TS 3.21 (for update to 2012) for 1901-2012 or TS 3.22 (for update to 2014) for 1901-2013,
- ✓ University of Delaware precipitation data set v3.01 for 1900-2010 (referred to as WilP).

Model sc_PDSI_pm was first calculated using the output from each of the 12 CMIP3 models (Dai 2013a) and 14 CMIP5 models (Zhao and Dai 2015, and then the sc_PDSI_pm values for individual models were simply averaged over the models to create the multi-model ensemble mean for the CMIP3 and CMIP5 models.

Model center	CMIP3	CMIP5
Bjerknes Centre for Climate Research, Norway	BCCR-BCM2.0	
Canadian Centre for Climate Modelling and Analysis, Canada	CGCM3.1	CanESM2
Canadian Centre for Climate Modelling and Analysis, Canada	CGCM3.1-t63	
National Center for Atmospheric Research (NCAR), USA		CCSM4
Centre National de Recherches Meteorologiques/Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique, France	CNRM-CM3	CNRM-CM5
Commonwealth Scientific and Industrial Research Organisation in collaboration with the Queensland Climate Change Centre of Excellence, Australia	CSIRO-MK3.5	CSIRO-MK3-6-0
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences	FGOALSg1.0	
NASA Goddard Institute for Space Studies, USA	GISS-AMO	GISS-E2-R
Met Office Hadley Centre, UK		HadGEM2-CC
Met Office Hadley Centre, UK		HadGEM2-ES
Institute for Numerical Mathematics, Russia	INM-CM3.0	INM-CM4
Institute Pierre-Simon Laplace, France	IPSL-CM4	IPSL-CM5A-LR
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute, and National Institute for Environmental Studies, Japan	MIROC3.2 Medres	MIROC-ESM-CHEM
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute, and National Institute for Environmental Studies, Japan	MIROC3.2Hires	MIROC-ESM
Meteorological Research Institute		MIROC5
Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute, and National Institute for Environmental Studies, Japan	MRI-CGCM2	MRI-CGCM3
Max Planck Institute for Meteorology (MPI-M)		MPI-ESM-LR

Results

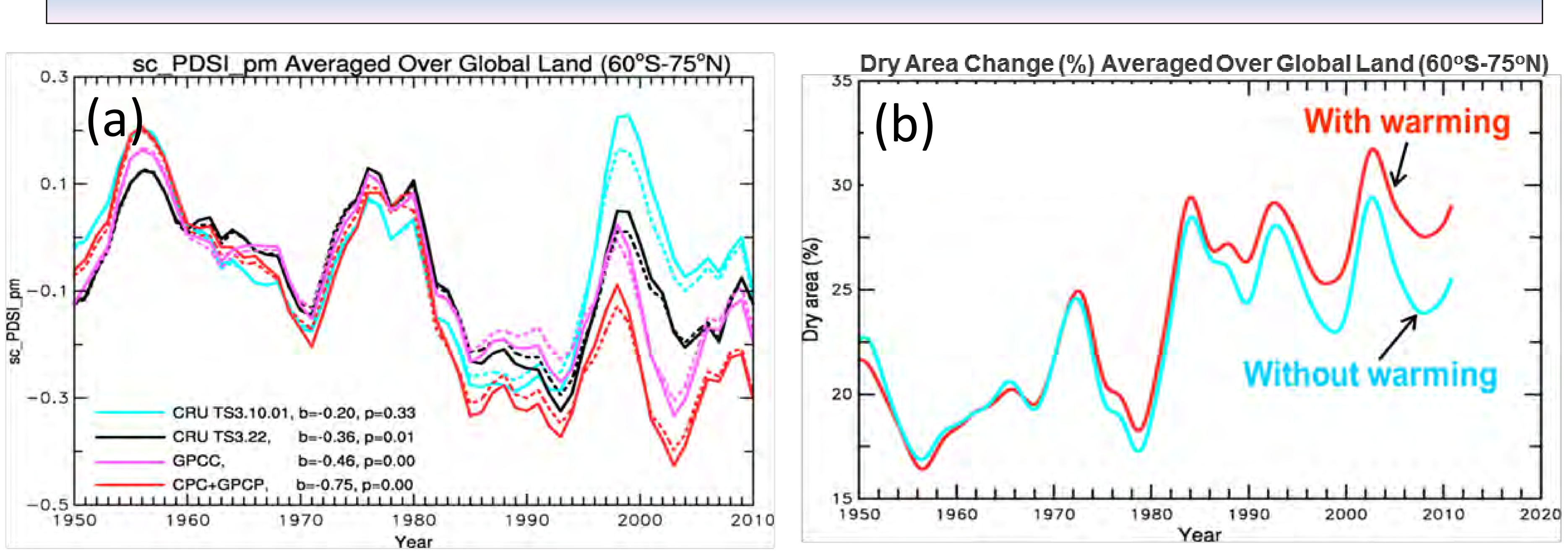


Figure 1. (a) Globally (60°S-75oN) averaged and 5-year smoothed sc_PDSI_pm time series from 1950 to 2010 calculated using the same meteorological forcing data (from CRU TS 3.22) except for precipitation, which was from CRU TS3.10.01 (blue), CRU TS3.22 (black), GPCC V6 (pink), and CPC + GPCP (red). In **(a)** the solid lines are for the case using 1950–1979 as the calibration period while the dashed lines are derived using 1950–2008 as the calibration period. **(b)** percentage dry areas from 1950 to 2014 calculated using the DaiP precipitation data and other meteorological forcing data. In **(b)** the red lines are for the case where all changes in the forcing data are included, while the blue lines are for the case where surface air temperature and vapor pressure were kept constant but all other changes are included.

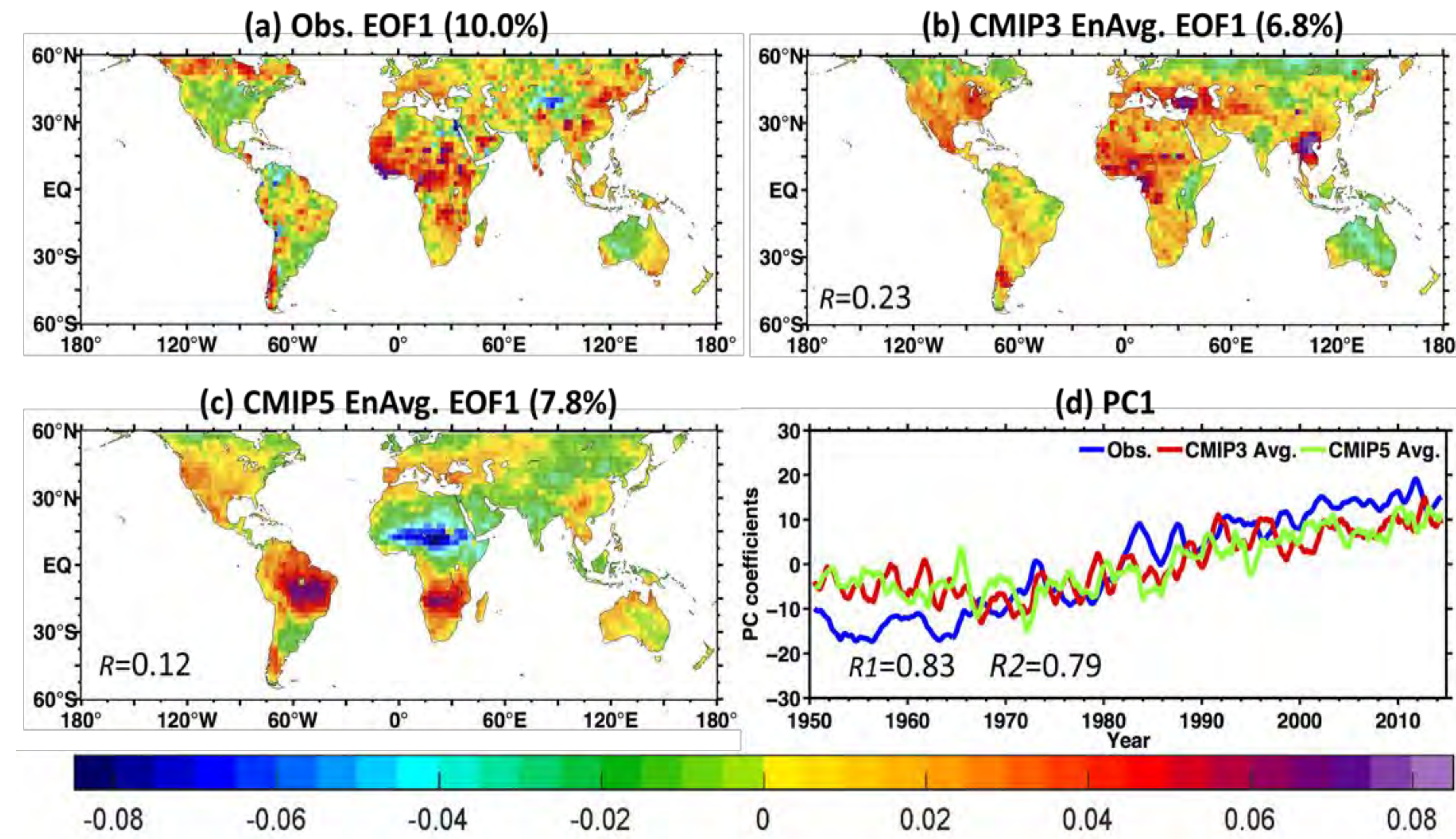


Figure 2. The leading EOF of monthly sc_PDSI_pm anomalies from 1950 to 2014 for **(a)** observation-based estimates, **(b)** CMIP3 ensemble mean, **(c)** CMIP5 ensemble mean, and **(d)** their corresponding PC time series. The explained percentage of the total variance is also shown on top of **(a)–(c)**. The pattern correlation (R) of the CMIP3 and CMIP5 EOF with (a) is also shown in (b-c). In (d), the PC correlations between the observation and the CMIP3 (R1) or CMIP5 ensemble (R2) is also shown.

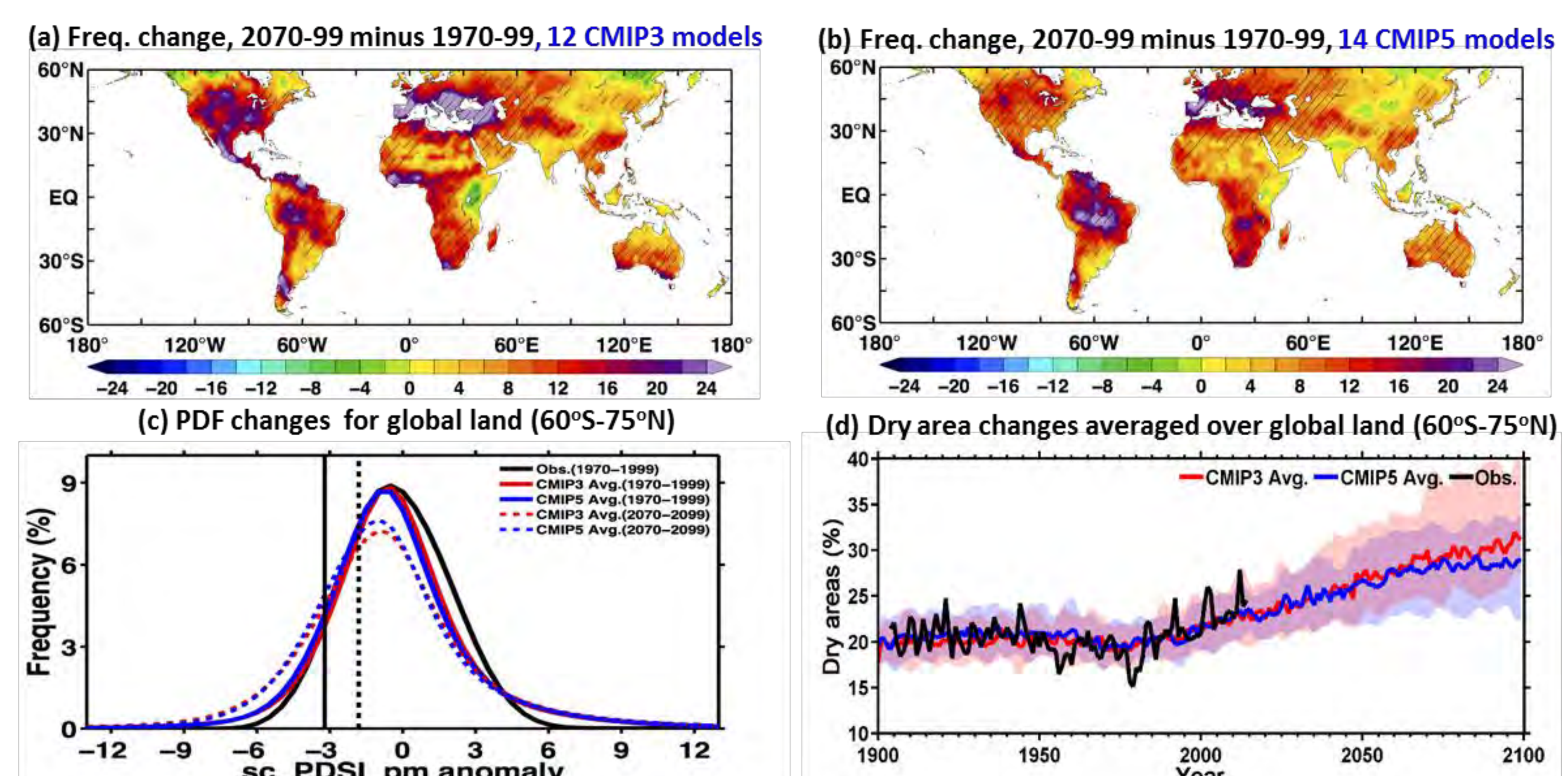


Figure 3. Frequency changes of drought from 1970-1999 to 2070–2099 (below the percentile of the 1970–1999 period based on monthly sc_PDSI_pm anomalies) from **(a)** 12 CMIP3 models and **(b)** 14 CMIP5 models; **(c)** the PDFs of the monthly sc_PDSI_pm for all the grid boxes over the global (60°S-60°N); **(d)** dry areas change of global land below the 20th percentile of the 1970–1999 period.

Conclusion

- ✓ Substantial uncertainties arise in the calculated PDSI_pm due to different choices of forcing data (especially for precipitation and solar radiation) and the calibration period; the GPCC V6 and GPCP v2.2 are likely to be more reliable than other (including CRU) datasets for estimating global land precipitation changes for the period since the 1990s.
- ✓ Updated records of precipitation, streamflow and the calculated sc_PDSI_pm show consistent spatial patterns of drying during 1950-2012 over most land areas; while the "little drying“ conclusion by Sheffield et al. (2012) solely based on their calculated PDSI_pm is likely influenced by spurious changes in their precipitation.
- ✓ Long-term changes in global and hemispheric drought areas and mean sc_PDSI_pm from 1900-2014 are consistent with the CMIP3 and CMIP5 model-simulated response to GHGs and other external forcing, while the short-term variations are within the model-simulated spread of internal variability.
- ✓ Both the CMIP3 and CMIP5 models project continued increases (by 50-200% in a relative sense) in the 21st century in global agricultural drought frequency and area even under low-moderate emissions scenarios, resulting from a decrease in the mean and flattening of the probability distribution functions (PDFs) of the sc_PDSI_pm.

- Dai, A., and T. Zhao, 2017: Uncertainties in historical changes and future projections of drought. Part I: Estimates of historical drought changes. *Climatic Change*, doi:10.1007/s10584-016-1705-2.
- Zhao, T., and A. Dai, 2017: Uncertainties in historical changes and future projections of drought. Part II: Model simulated historical and future drought changes. *Climatic Change*, doi:10.1007/s10584-016-1742-x.

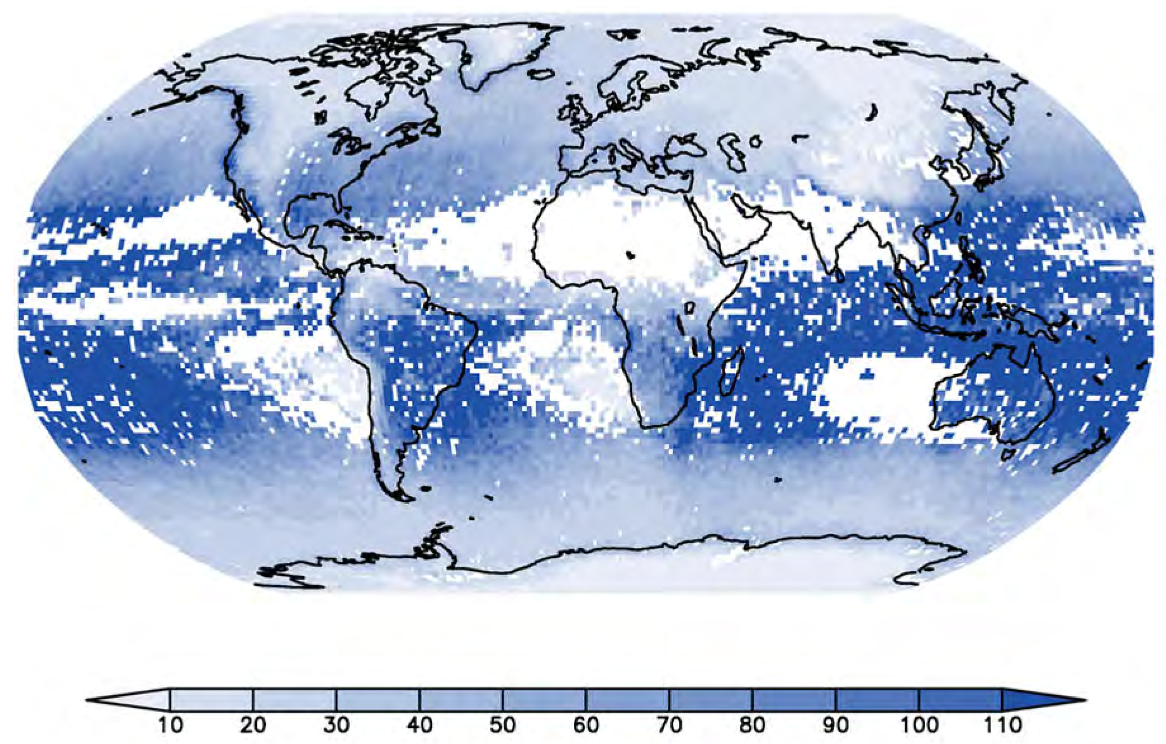
European Commission

Evaluating climate model simulated extremes

Andrea Toreti

European Commission, Joint Research Centre (JRC), Ispra, Italy

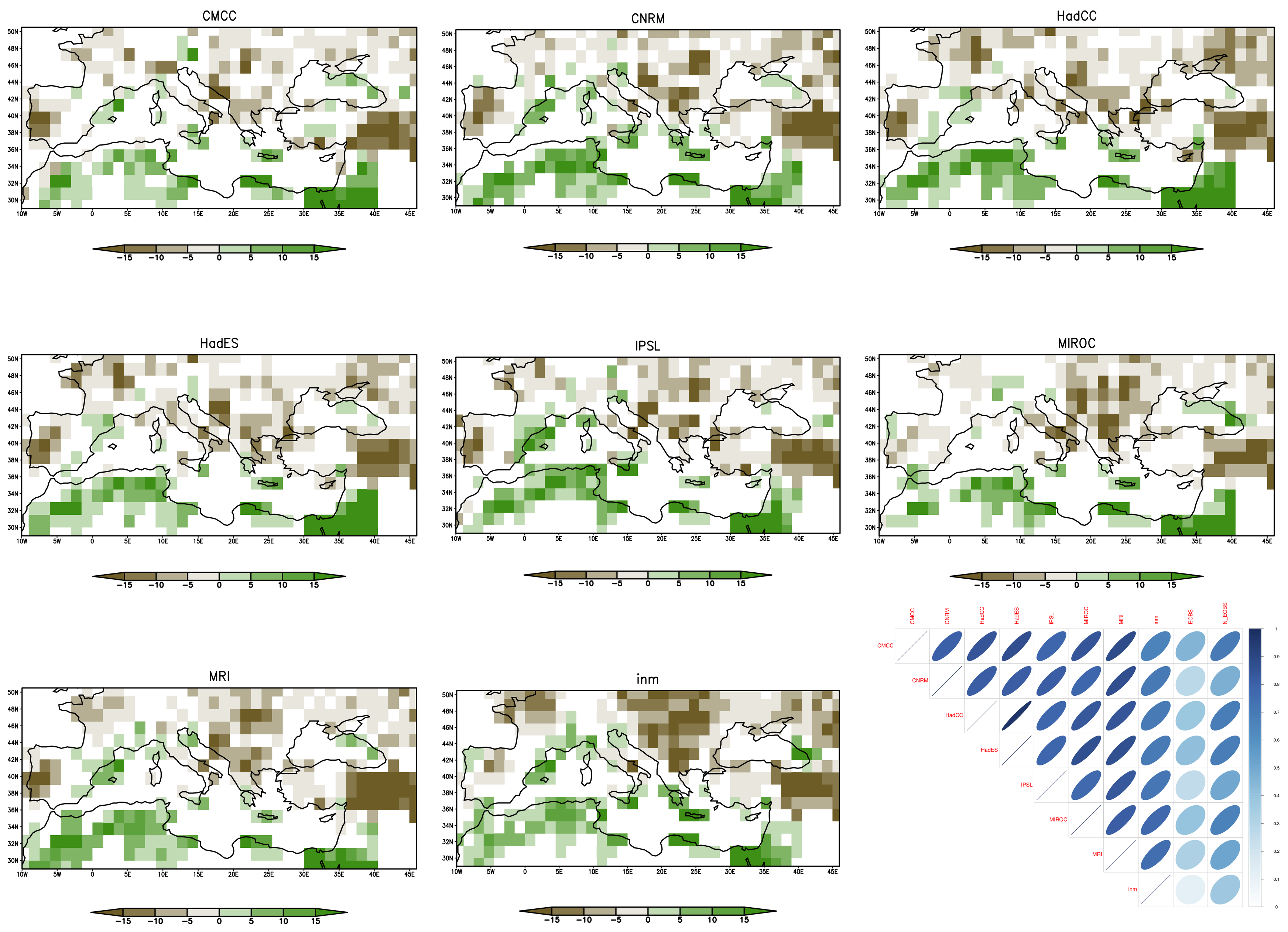
Climate extremes heavily affect all key socio-economic sectors causing losses, damages and fatalities. Understanding their dynamics and their projected changes is of upmost importance. Tailored statistical methods need to be developed and applied to evaluate model simulations



Estimated 50-year return levels of winter daily precipitation. Ensemble of 8 GCMs from CMIP5, 1966-2005. Source: Toreti et al., 2013.

Assessing the reliability of estimated extremes

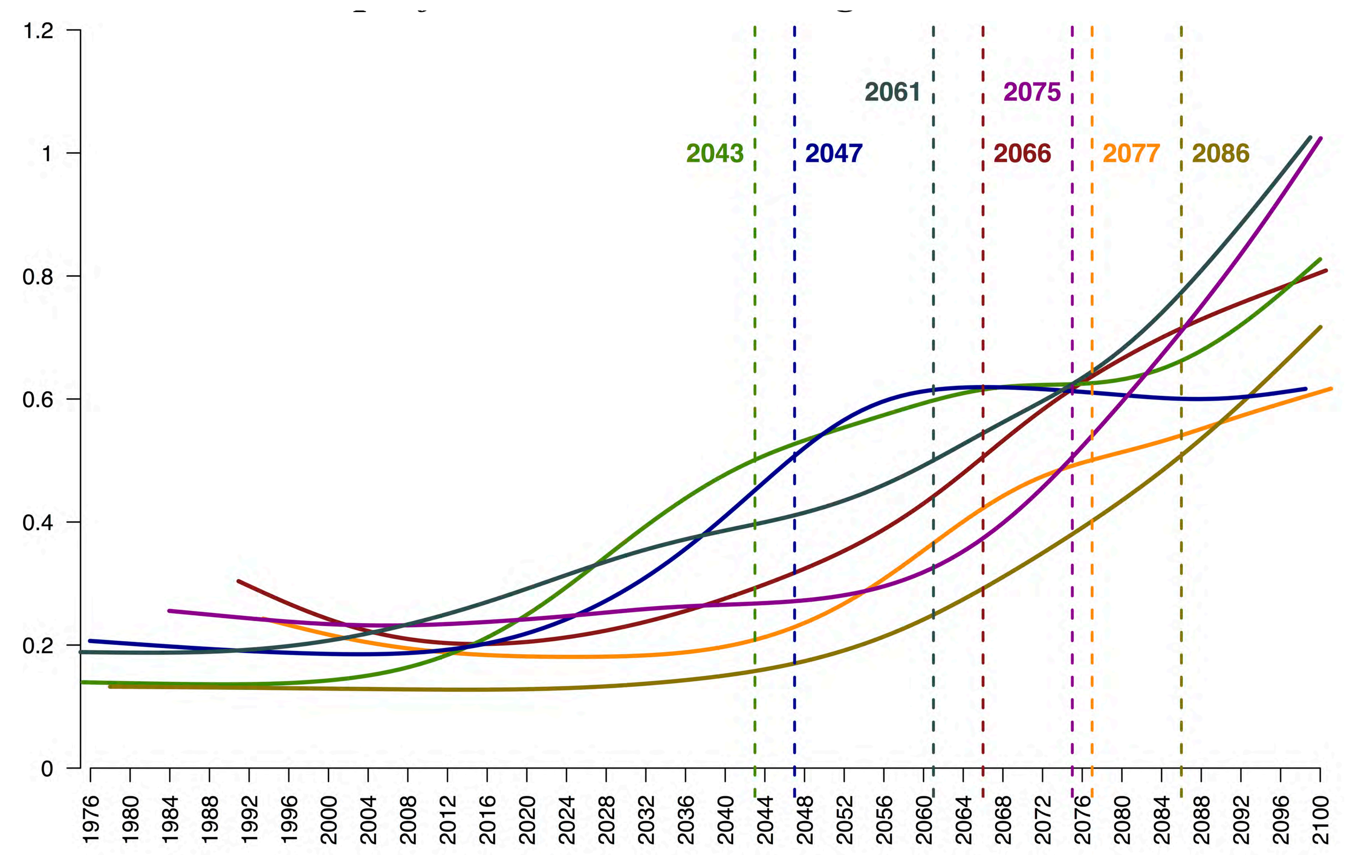
Extremes can be characterised and analysed by using tools derived within the Extreme Value Theory, Daily exceedances (w.r.t. a high threshold) can be modelled by using the Generalised Pareto Distribution. The goodness-of-fit can be assessed by applying a Modified Anderson-Darling Statistic combined with a bootstrap procedure (Babu and Toreti, 2016; Toreti et al., 2013)



Bottom-Left Panel: Spearman-based correlation matrix of scale parameters estimated for 8 CMIP5 GCMs and E-OBS in the period 1966-2005. Main panel: Rescaled-tail comparison w.r.t E-OBS. Colours are associated with the values of the 2-sample modified Anderson-Darling statistic with the sign given by the estimated KLD-divergence. Blank areas are associated with non-significant values. Source: Toreti and Naveau (2015).

Evaluating model simulations w.r.t. observations and assessing projected changes

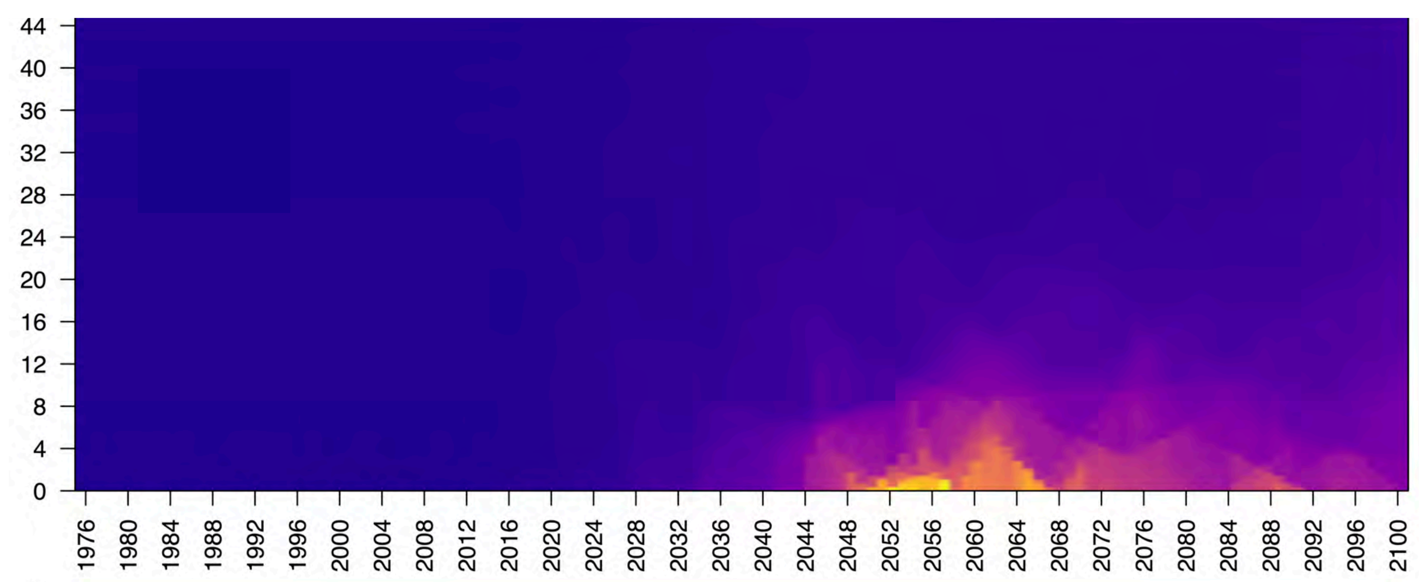
Complex projected changes in extremes and/or different representation of extremes w.r.t. observations can be identified by using a non-parametric approach based on modified 2-sample Anderson-Darlin statistic and direct divergence applied to rescaled tails. The comparison of the estimated scaling factors can give also important insight into the representation of climate extremes and information on their changes (Toreti and Naveau, 2015).



Estimated frequency of occurrence of 2018-like drought events in Central Europe. HELIX model simulations . Source: Toreti et al. 2019

Characterising the spatio-temporal occurrence of extremes

Point process theory can be applied to characterise the spatio-temporal evolution of climate extremes and also for concurrent climate events. The spatio-temporal intensity function can be estimated with a resample-smoothed Voronoi estimator (Toreti et al., 2019; Moradi et al., 2019). While concurrent climate extremes (in both space and time) can be analysed by using multi-type point processes with no dependence and homogeneity assumptions (Toreti, Cronie and Zampieri, 2019).



Estimated spatio-temporal frequency of extreme drought events in Central Europe. HELIX model simulations . Source: Toreti et al. 2019.

References

- *Babu GJ, Toreti A. 2016. A goodness-of-fit test for heavy tailed distributions with unknown parameters and its application to simulated precipitation extremes in the Euro-Mediterranean region. Journal of Statistical Planning and Inference 174, 11–19.*
- *Toreti A et al. 2013. Projections of global changes in precipitation extremes from CMIP5 models. Geophysical Research Letters, 40, 4887–4892.*
- *Toreti A, Naveau P. 2015. On the evaluation of climate model simulated precipitation extremes. Environmental Research Letters 10, 014012.*
- *Toreti A et al. 2019. The exceptional 2018 European water seesaw calls for action on adaptation. Earth's Future, in review.*
- *Moradi MM et al. 2019. Resample-smoothing of voronoi intensity estimators. Statistics and Computing. doi: 10.1007/s11222-018-09850-0.*
- *Toreti A, Cronie O, and Zampieri M. 2019. Concurrent climate extremes in the key wheat producing regions of the world. Scientific Report, in press.*

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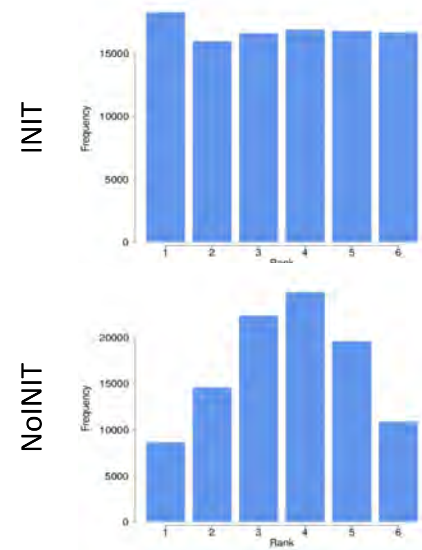
Impact of initialisation on the reliability of decadal predictions

D. Verfaillie et al., Session 5, Poster 28

Compare initialised decadal predictions (**INIT**) and non-initialised projections (**NoINIT**)

Here: in terms of **reliability**
= agreement between predicted probabilities & observed relative frequencies of an event

Precip over Europe, EC-Earth, f. year 1



Verfaillie et al., in prep.

Model setup:
- Multi-model, INIT and NoINIT, same ensemble size
- 1961-2005, forecast year 1 and forecast years 1 to 5

Analysis:
- rank histograms & reliability diagrams
- different variables and indices (GMT, AMV index)

Decadal Climate Prediction with EC-Earth at BSC

Poster 5 - P29

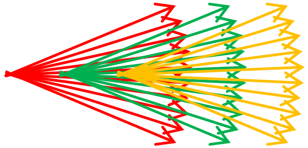
*Simon **WILD**, Roberto **BILBAO**, J Acosta Navarro, AE Amaral Ramos, PA Bretonniere, LP Caron, M Castrillo, R Cruz-Garcia, FJ Doblas-Reyes, MG Donat, E Exarchou, P Echevarria, E Moreno-Chamarro, P Ortega, Y Ruprich-Robert, V Sicardi, E Tourigny, D Verfaillie*

DCPP - A

NEMO only reconstruction:

1958 2017

Ocean and Ice Initial Conditions



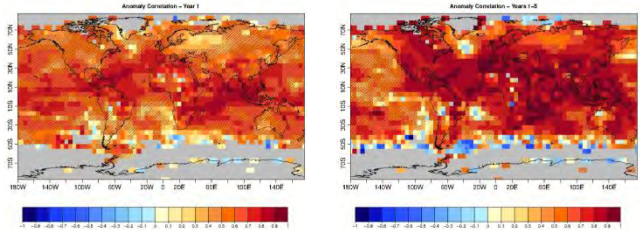
10 EC-Earth Hindcasts

1960...... yearly 2017

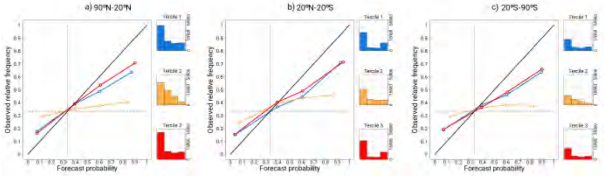
ECMWF Reanalyses (3D T-Pert.)

Currently being produced

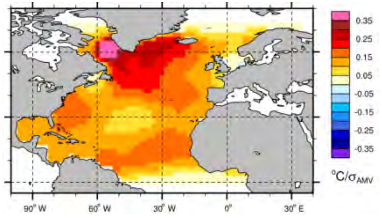
Skill:



Reliability:



Role of the AMV:



Ongoing analyses

Danish Meteorological Institute

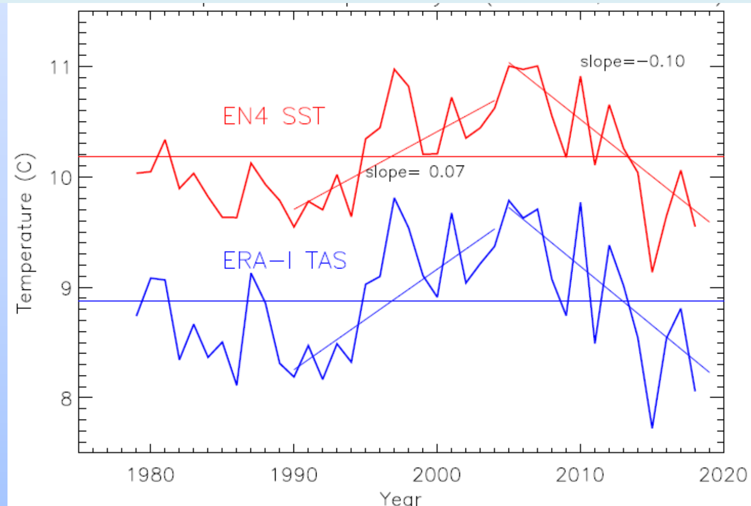
The recent abrupt cooling over North Atlantic: A forced signal or natural variability?

Shuting Yang[1], Sybren Drijfhout[2,3], Jenny V. Mecking[3] and Bo Christiansen[1]

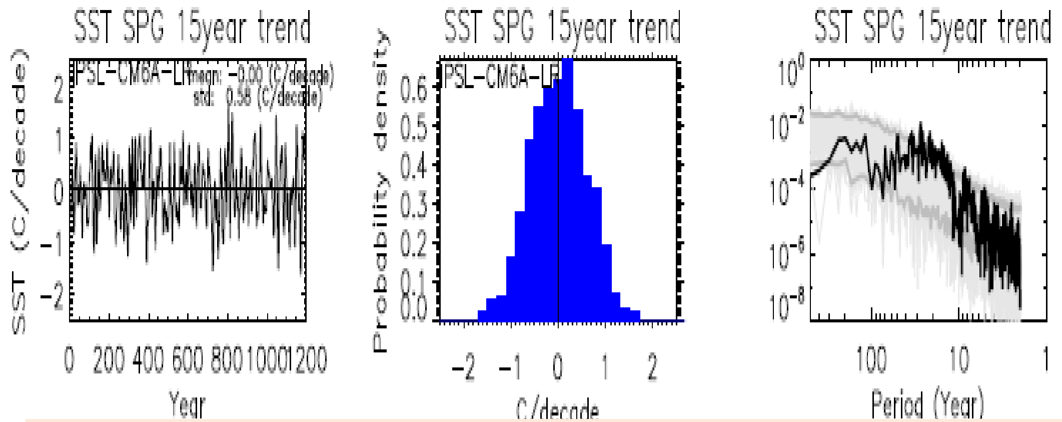
[1] Danish Meteorological Institute [2] Royal Netherlands Meteorological Institute [3] Univ. of Southampton, UK

The recent abrupt cooling trend in the North Atlantic subpolar gyre region and the large decadal variability in obs.

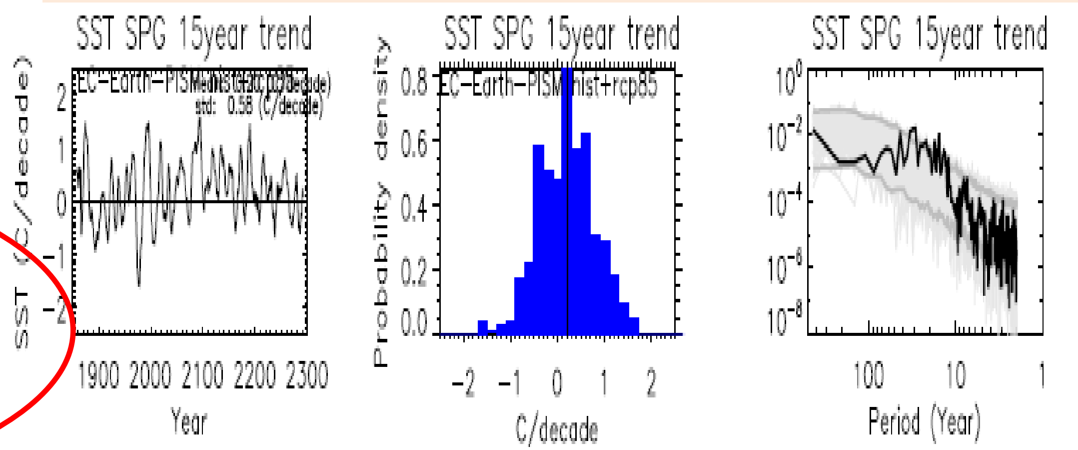
Mean temp. over subpolar gyre (40-15°W, 50-60°N)



Analysis of 15-year trend in piControl



Analysis of 15-year trend in Historical+RCP8.5



Warming and cooling trends of ~15 years occur frequently and alternatively in both **unforced** and **climate change** experiments