Working Group on Numerical Experimentation (some personal reflections)

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Co-chaired 2015-2020 with Ayrton Zadra and Carolyn Reynolds

The role of the Working Group on Numerical Experimentation

Our Mission

WGNE fosters the **development of Earth system ~~atmospheric~~ models** for use in weather prediction and climate studies on **all time scales**, and **diagnosing and resolving shortcomings**.

WCRP Joint Scientific Committee (JSC) → **Research Board**

Commission for Atmospheric Sciences (CAS) → **Research Board**

Sensitivity to model formulation

Diagnostic Strategies & Tools

Systematic Errors

Develop Solutions

Shared Knowledge

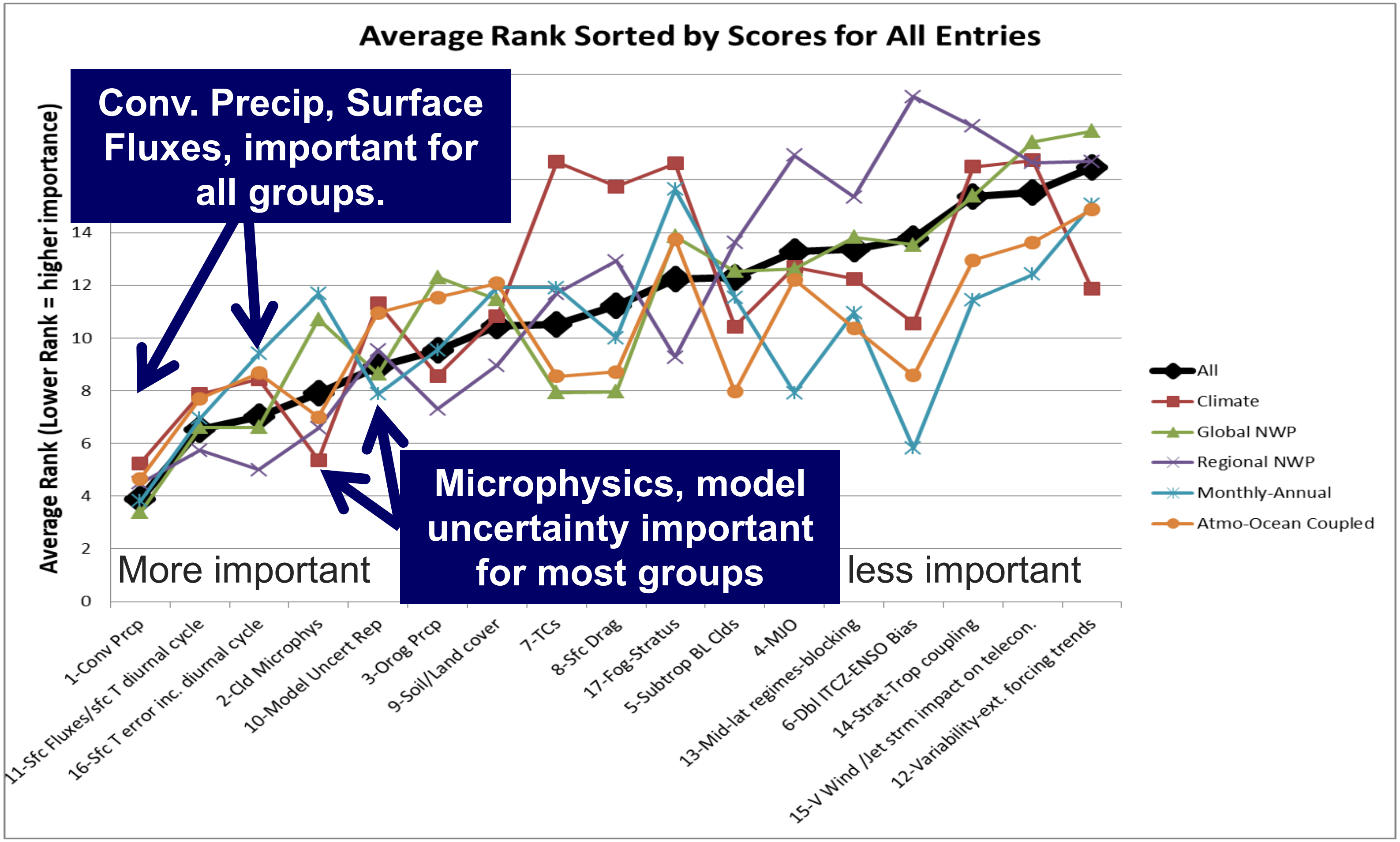
External Groups (GASS…)

WGNE began under GARP in 1967
Re-established under WCRP & CAS in 1985
Moved under Research Board 2020

WGNE has been a **pioneer of seamless work** (e.g. developing the AMIP and Transpose-AMIP methodologies)

WGNE Systematic Errors Workshop

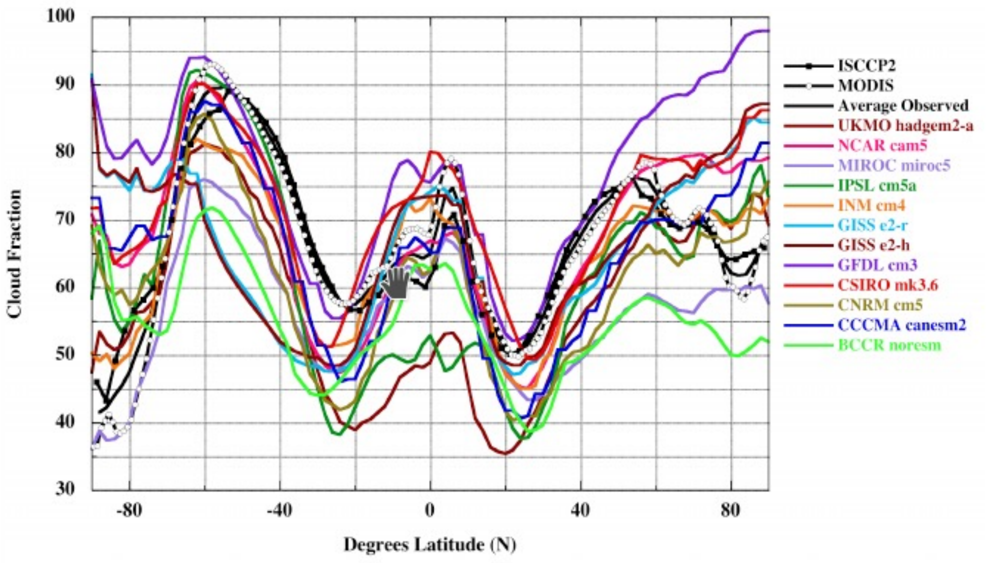
WGNE Systematic Error Priority Survey Results



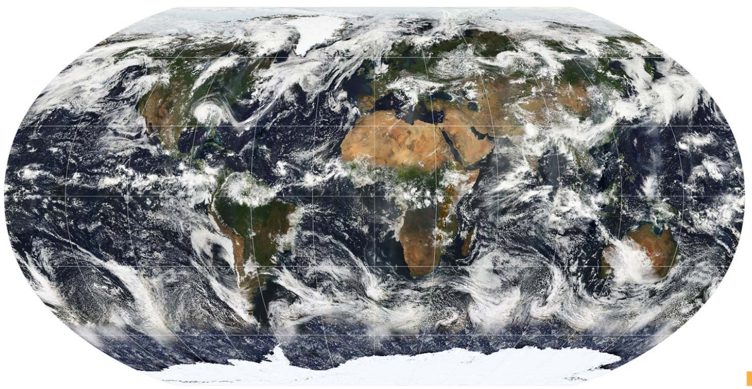
- 14 centers, 35 surveys contributed

Understanding Systematic Model Errors

- Systematic errors often differ between modelling systems, but can sometimes be common.
- Mapping of errors to ESM components is difficult because of complex interactions.
- Model Intercomparison Projects (MIPs) a practical solution: WGNE supports many MIPs



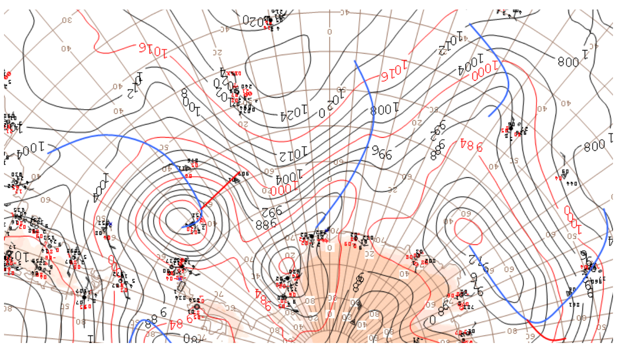
Above: Annual-average global cloud fraction (percent) for A-Train observed MODIS and ISCCP2, and 12 CMIP5 GCM hindcasts (from Frank 2019).

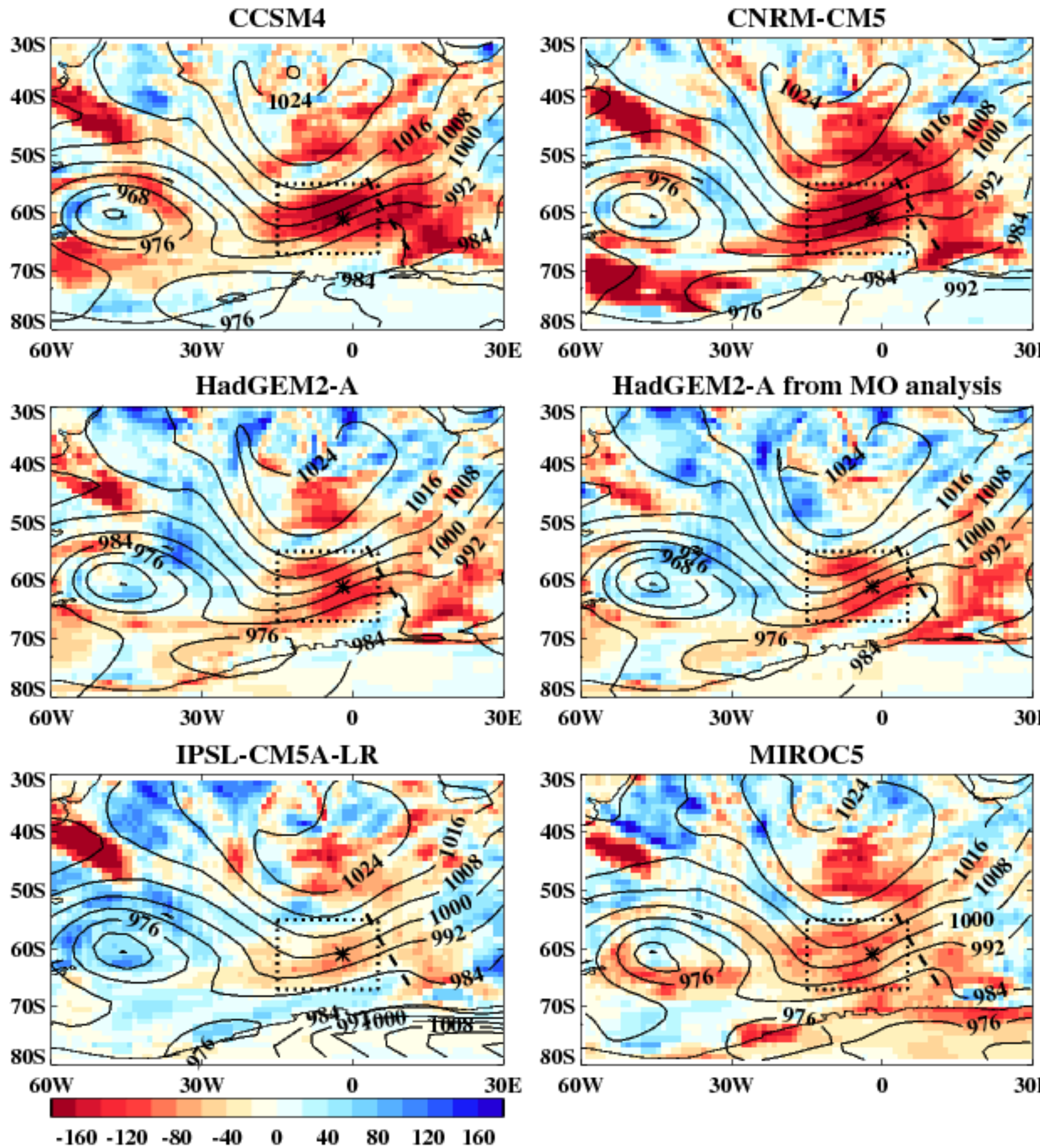


Left: Composite satellite estimate of global cloud cover on 11 July 2005, primarily from MODIS sensor (from NASA GISS).

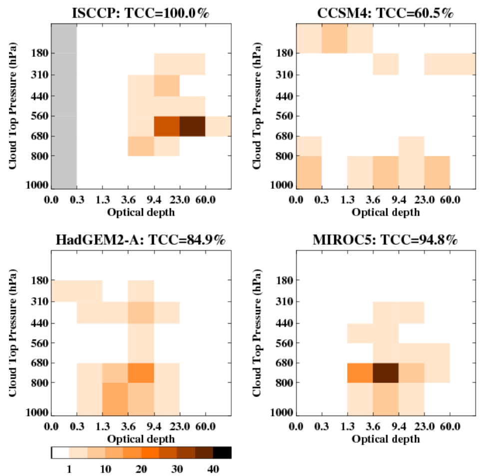
Transpose-AMIP: Running climate models in 'weather forecasting mode'

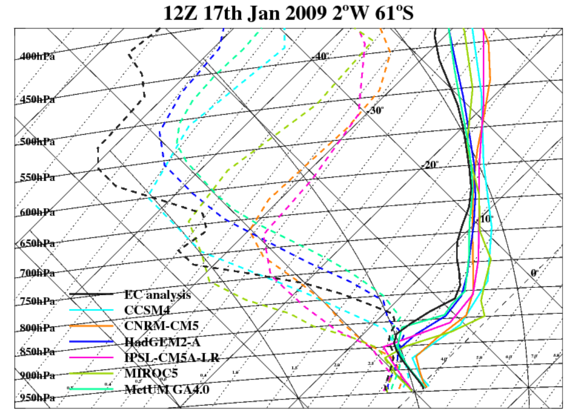
T+30 bias in RSW against CERES-FF



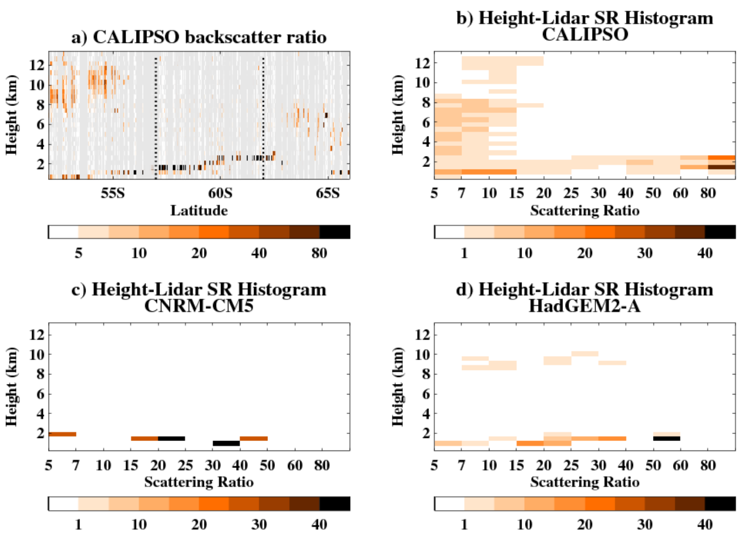


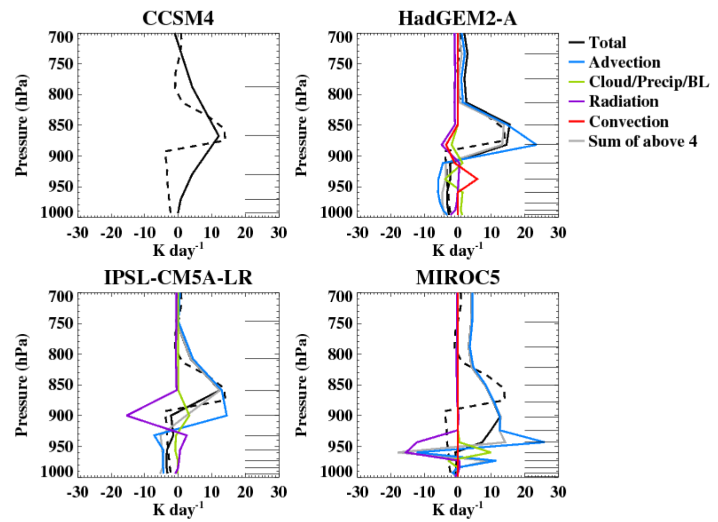
Transpose-AMIP



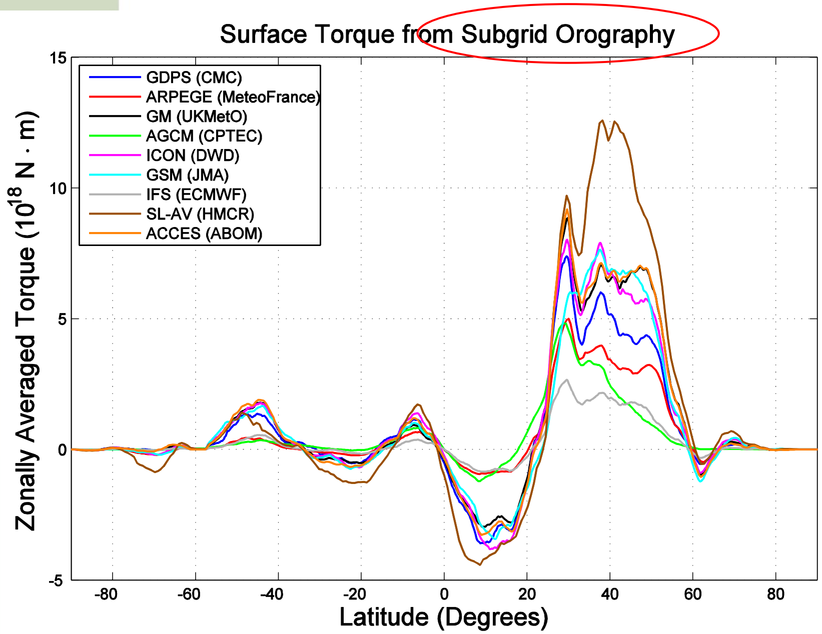


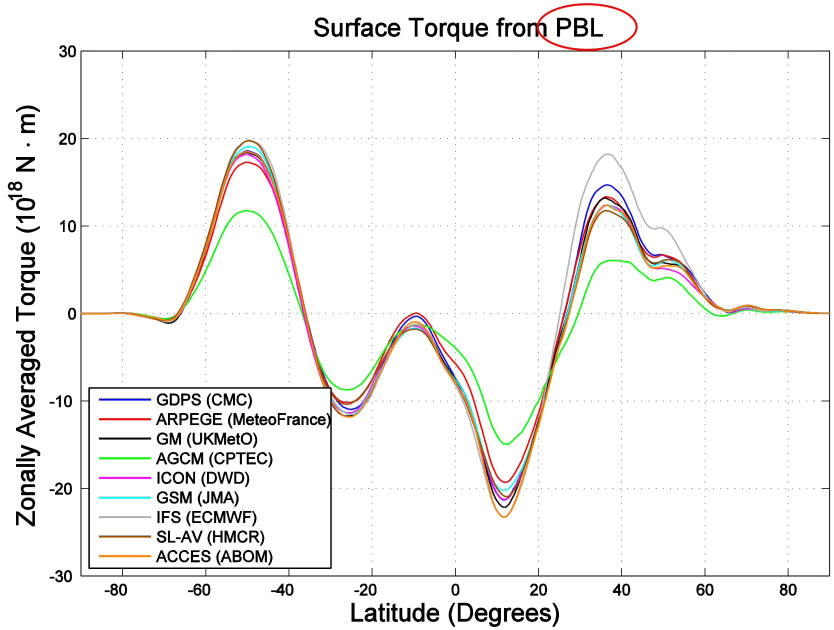
Use of novel diagnostics to understand the cause of the bias





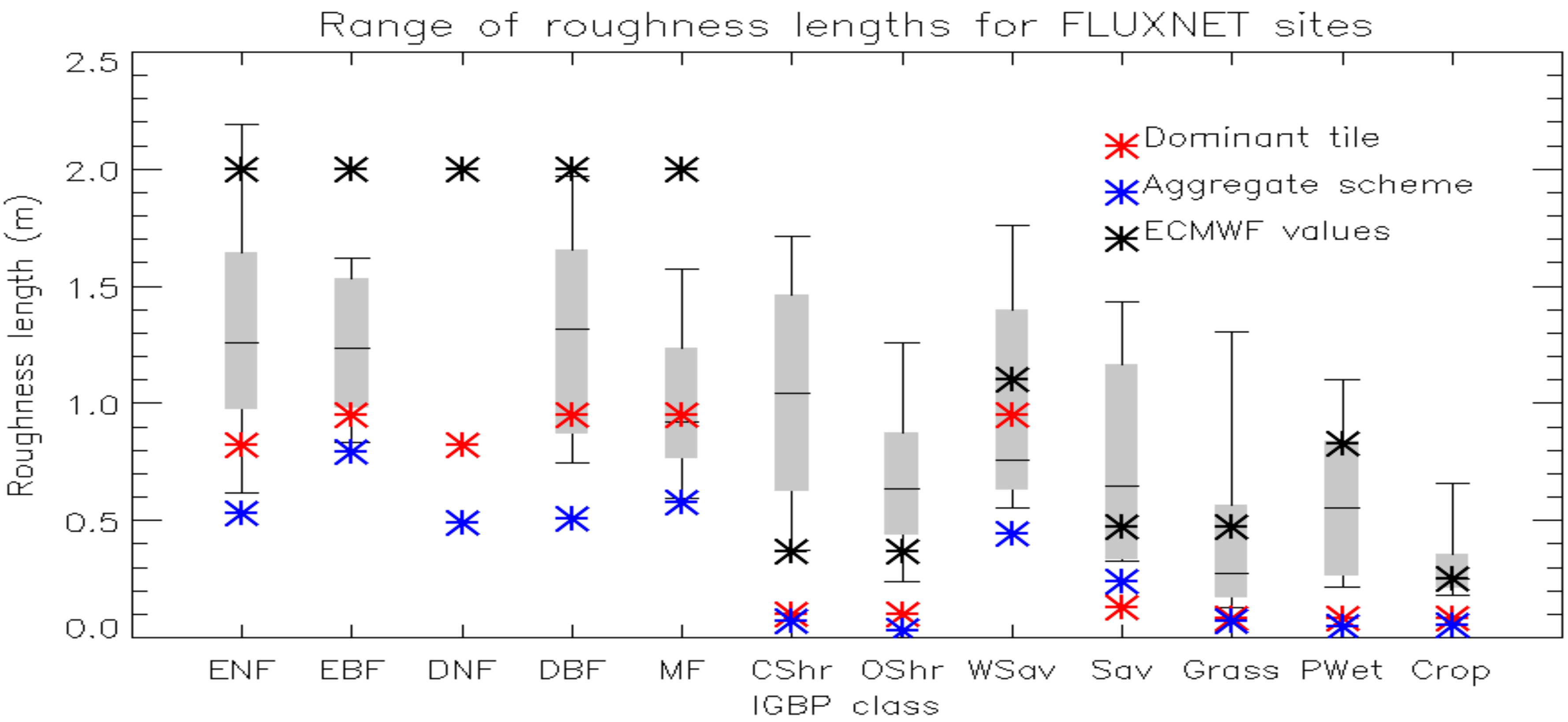
WGNE Drag Project (Ayrton Zadra)





Partitioning of drag varies between models

Martin Best



Trees Shrubs Grasslands

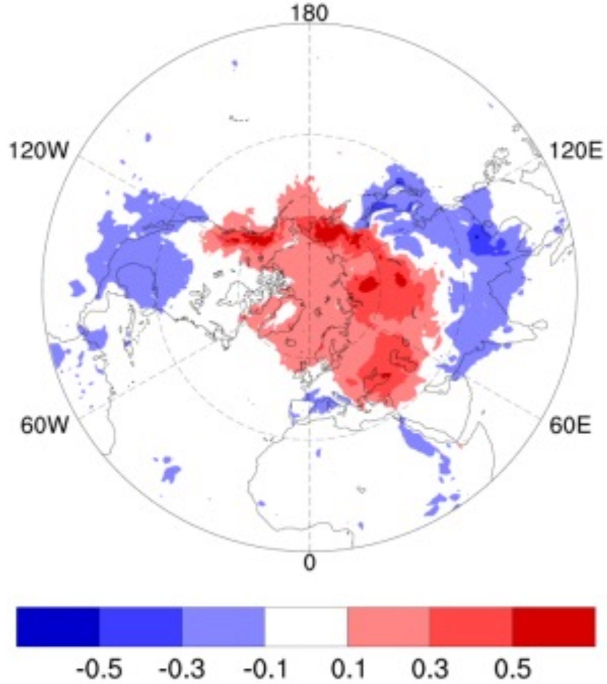
Met Office

c/o Irina Sandu (ECMWF)

Forcing the IFS with MetUM SSO

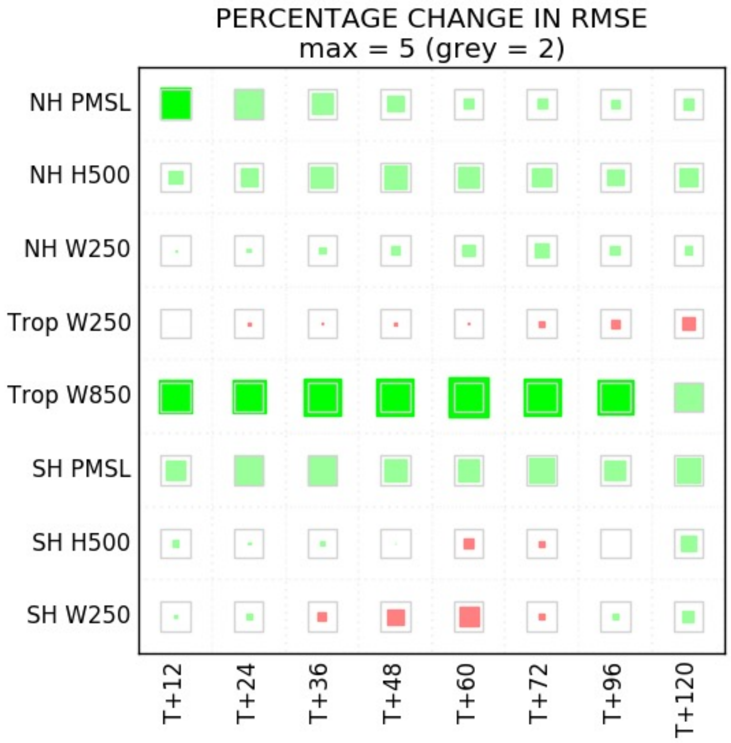
Impact on NH PMSL (hPa) IFS-UMsso minus IFS

Using UM subgrid fields in IFS re-creates the polar high pressure bias. Implies the subgrid orography fields are part of the issue.

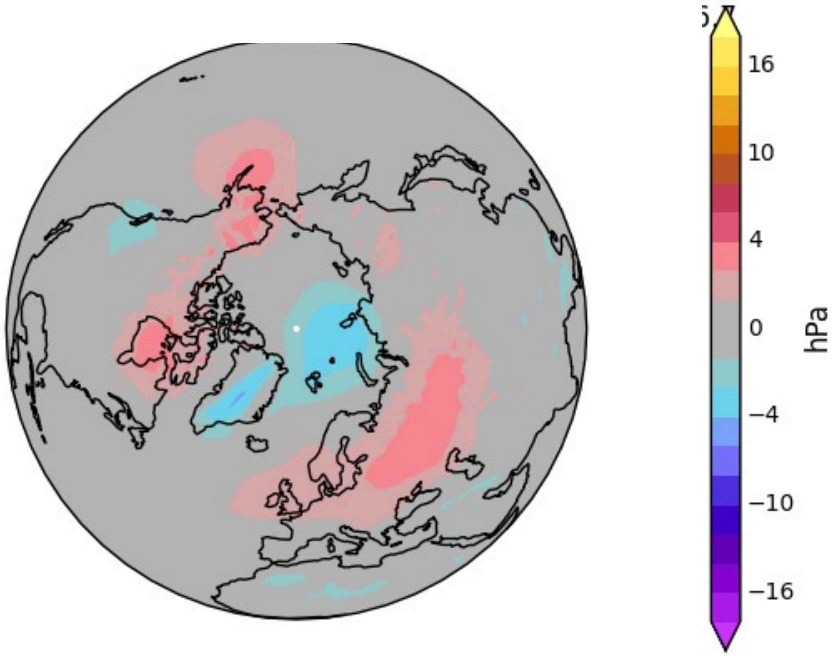


Performance of full package
(land surface + orographic drag changes)

NWP verification

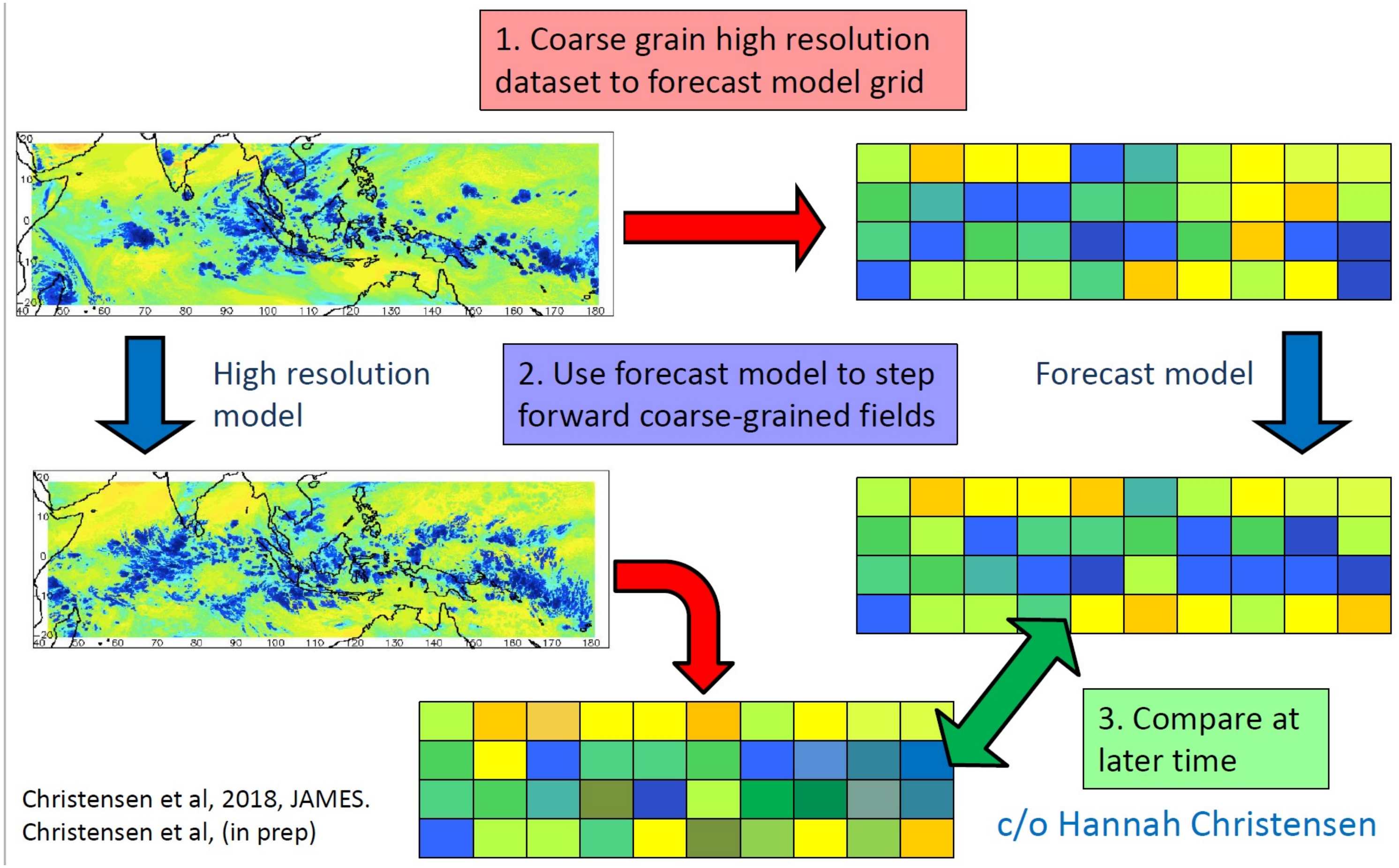


Change in mean PMSL bias



Joint projects

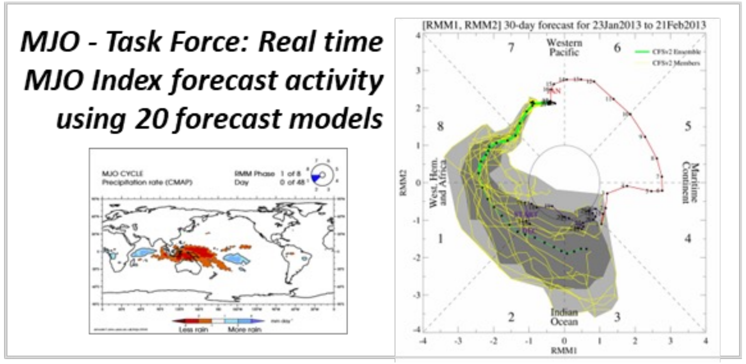
PDEF-WGNE Coarse-Graining Experiment



Protocol written and kick-off meeting held

Working with GASS and GLASS

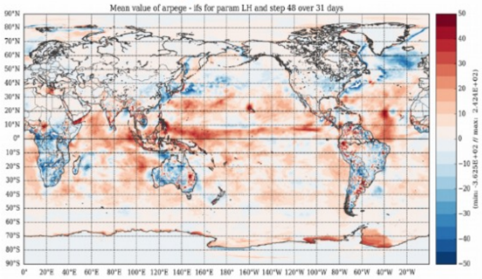
MJO Task Force (Joint with GASS)



Focusing on propagation over MC (levering YMC) and teleconnections

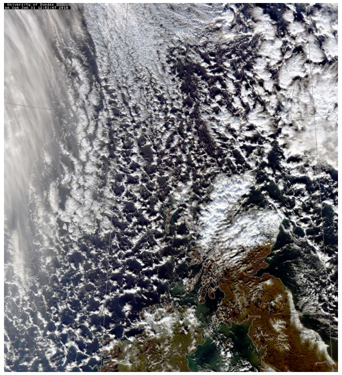
Surface Flux Intercomparison (Joint with GLASS)

ARPEGE – IFS Differences in Latent Heat Flux



Grey Zone (Joint with GASS)

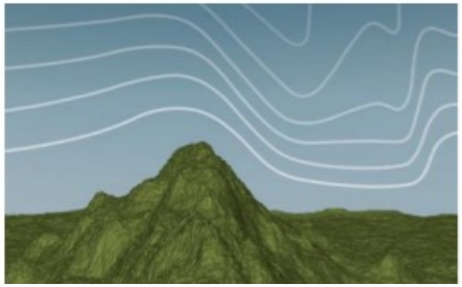
Gain insight into model behavior in grey zone and provide guidance for scale-aware parameterizations



GASS-WGNE Grey Zone II (leverage EUREC4A) white paper (Tomassini et al.)

COORDE Drag Project (Joint with GASS)

Investigating drag processes and their links to large-scale circulation



Evolving into GASS-WGNE momentum project (Sandu et al.), complementary to SPARC effort

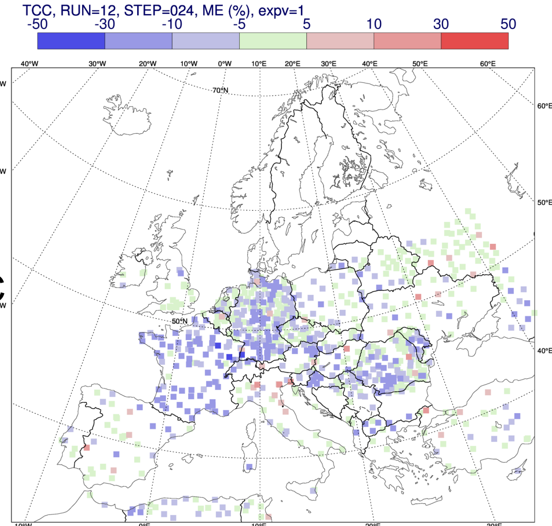
Verification

Process-oriented Verification White Paper (requested by WGNE) Joint Working Group for Forecast Verification Research,

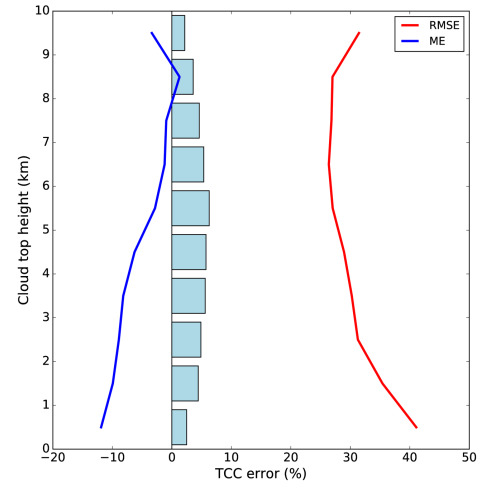
Conditional verification: TCC error stratification by cloud top height:

Negative cloud bias mainly associated with tops <5km

Large contribution to negative TCC bias comes from low clouds



Example of combined use of sfc. obs. (TCC from SYNOP), and cloud top height (from satellite) to gain insight

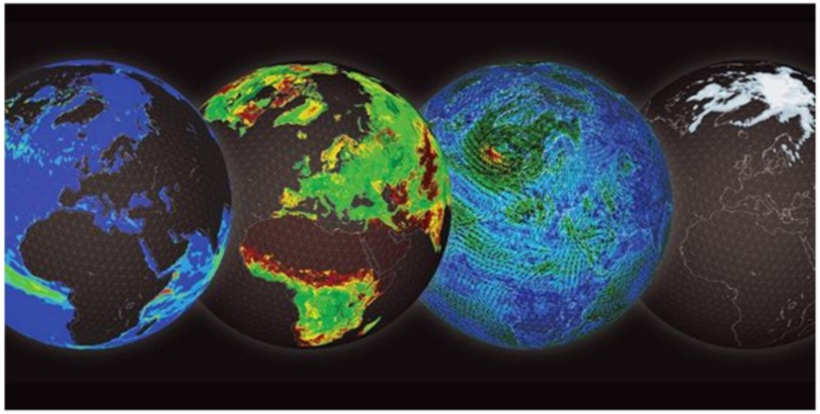


Thomas Haiden (ECMWF)

Horizon scanning modelling disruptors

Exascale Awareness: Assessment of trends and scalability of atmosphere and ocean models

- Use of manycore CPUs possibly combined with accelerators such as GPUs
- Arrival of open instruction set architectures (FPGA, ARM, RISC-V, …)
- Exascale race driven by a concern for the energy footprint and physical distances between processors (e.g. low-power processors, memory hierarchies, liquid cooling, etc)
- Machine learning, both driving specific processor development (eg. Google TensorFlow) and application development (e.g. physical parametrizations, feature detection in satellite observations)
- Cloud computing and storage (e.g. access to HPC from anywhere, simpler install in embedded virtual environments, data processing near large meteorological archives, etc)



Machine learning/AI for model development:

Evaluate community progress and plans for AI/ML applications.

- Emulation of existing parametrizations.
- New parametrizations through obs/LES emulation.
- Emulation of whole GCM's.

Reflections

- Becoming co-chair was a significant step-up in terms of work, but very worthwhile.
- WMO has a **lot** of groups and an extensive structure. A sign of WGNE's strength is the number of groups it interacts with but that takes time.
- WGNE is at its best when it is doing. Try not to become a talking shop. All members need to participate.
- WGNE is well respected due to the expertise of its members and ability to highlight important disruptors which affect modelling (and adapt to these)
- WGNE has set me up with an amazing network of international contacts and I made many friends.
- I was extremely lucky to have two excellent co-chairs.