GEWEX Global Atmospheric System Studies (GASS)

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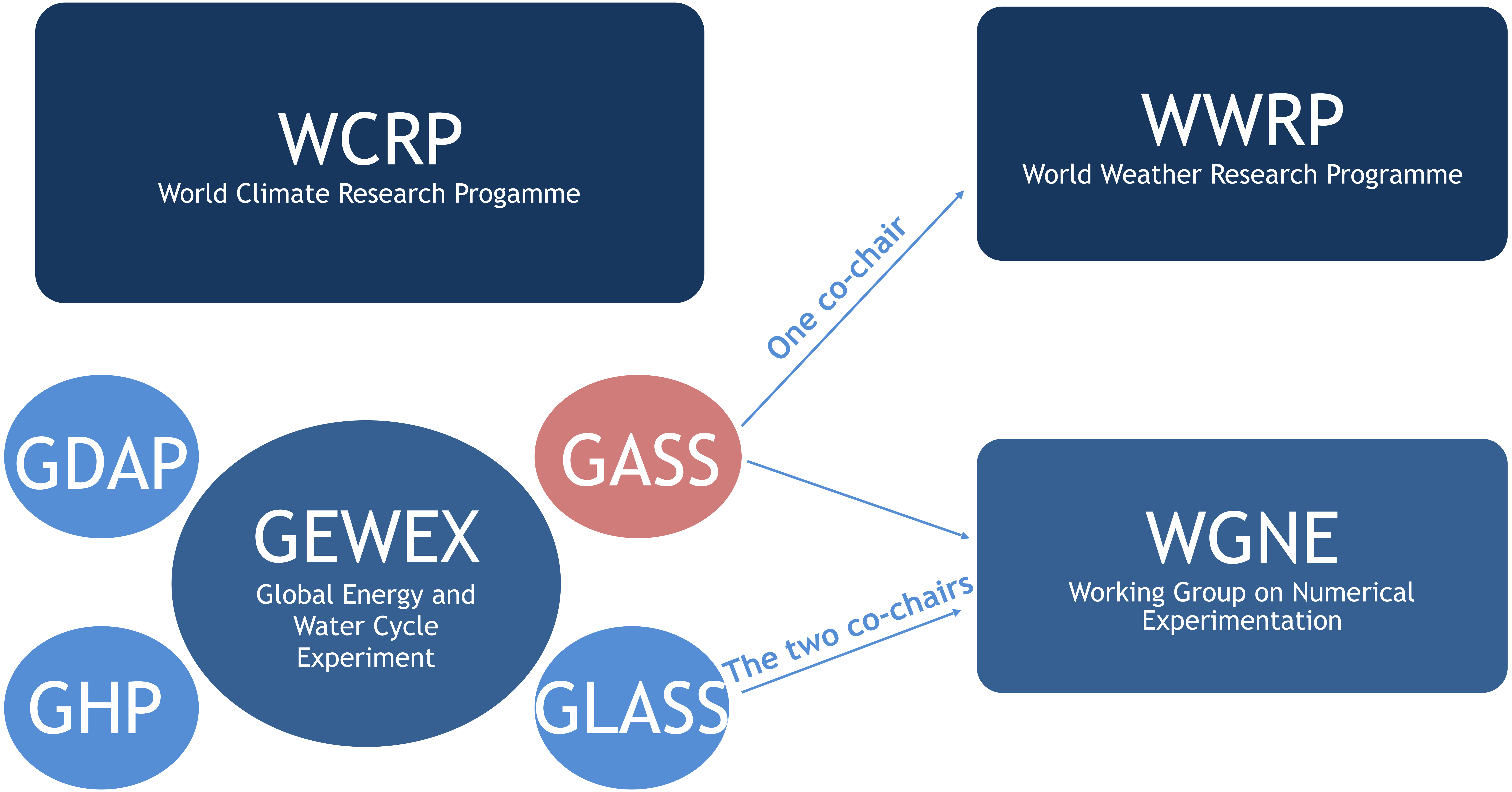
24 - 27 September 2019
WGNE 34
Offenbach, Germany



Goal of GASS: to understand the physical processes and their coupling to atmospheric dynamics

Mission of GASS:

- to develop and improve the representation of the atmosphere in weather and climate models.
- to contribute to the development of atmospheric models.

- Four active projects, two more are close to being launched
    - Surface Drag and Momentum transport
    - Impact of Initialized Land Temperature and Snowpack on S2S
    - Demistify: An LES and NWP Fog Modeling Intercomparison
    - Improving the Simulation of Diurnal and Sub-Diurnal Precipitation over Different Climate Regimes
    - Grey-Zone II
    - Physics-Dynamics coupling

- The projects are strongly related to the top three errors from WGNE Systematic Error Survey Results Summary (2/11/2019, C. Reynolds et al.)

  --- Precipitation diurnal cycle, intensity and frequency
  --- Surface fluxes and temperature diurnal cycle
  --- Cloud microphysics

COnstraining Orographic DRag Effects (COORDE)
Joint with WGNE

Annelize van Niekerk, Irina Sandu

Understanding the effects of resolved and parametrized orographic drag through the ***COORDE***-nation of different modeling groups.

Aims:

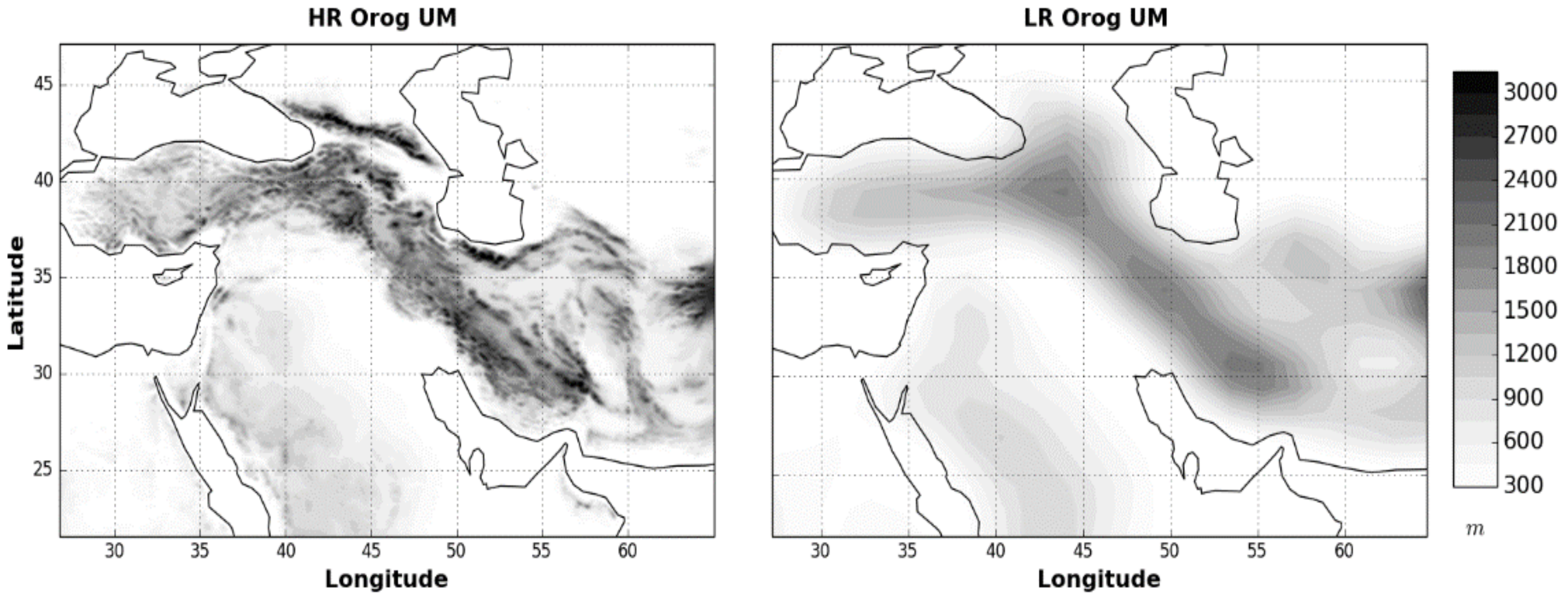
- Expose differences in orographic drag parametrization formulation between models
- Understand impacts of differences in orographic drag parametrizations for modelled circulation
- Use high resolution simulations to quantify drag from small-scale orography, typically unresolved in models used for climate/seasonal projections, in order to evaluate orographic drag parametrizations
- Understand differences in resolved and parametrized orographic drag across models

Protocol: https://osf.io/37bsy/
An article was published in GEWEX News in February 2019 issue

Middle East

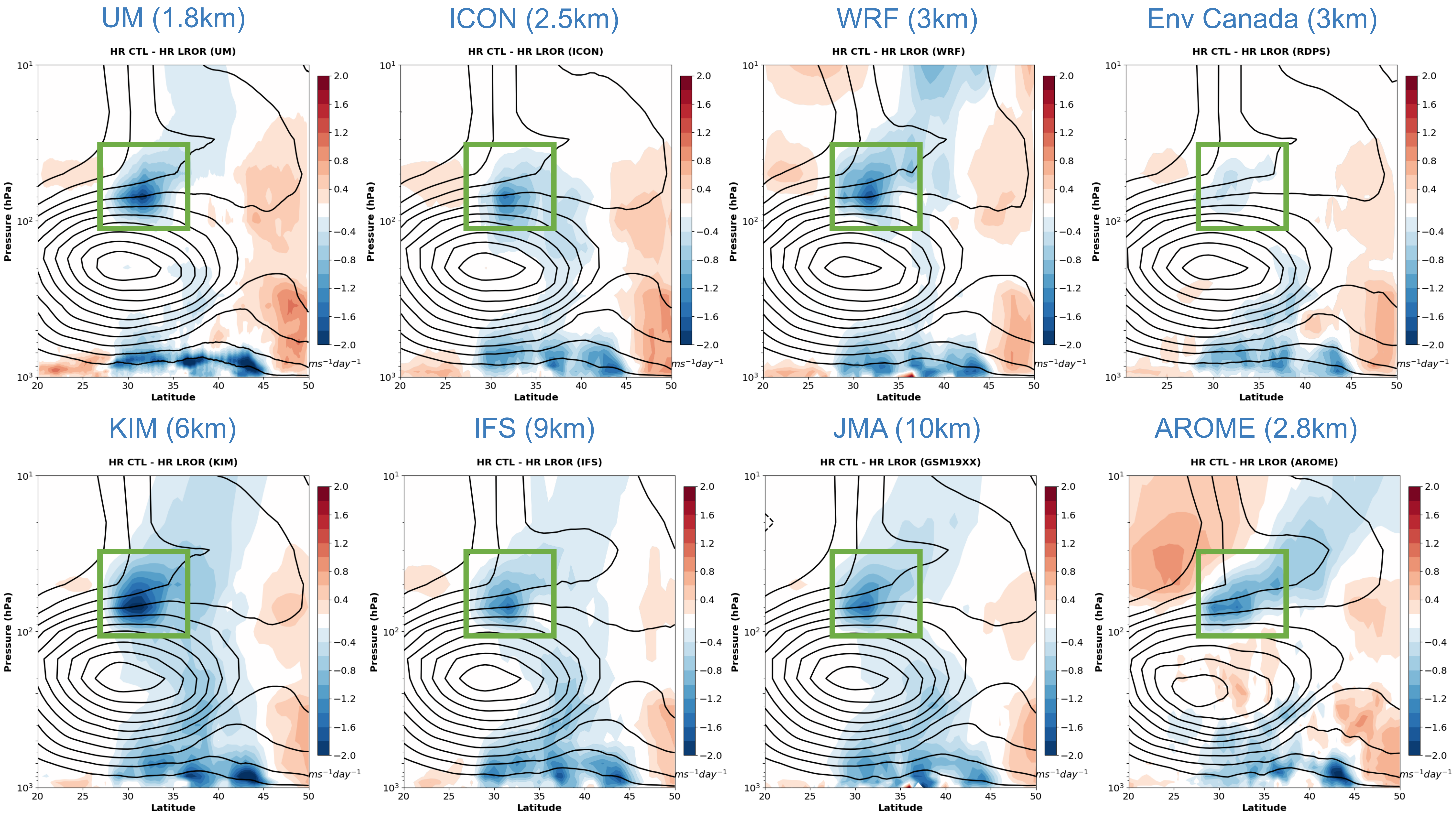
High resolution orography

Low resolution orography



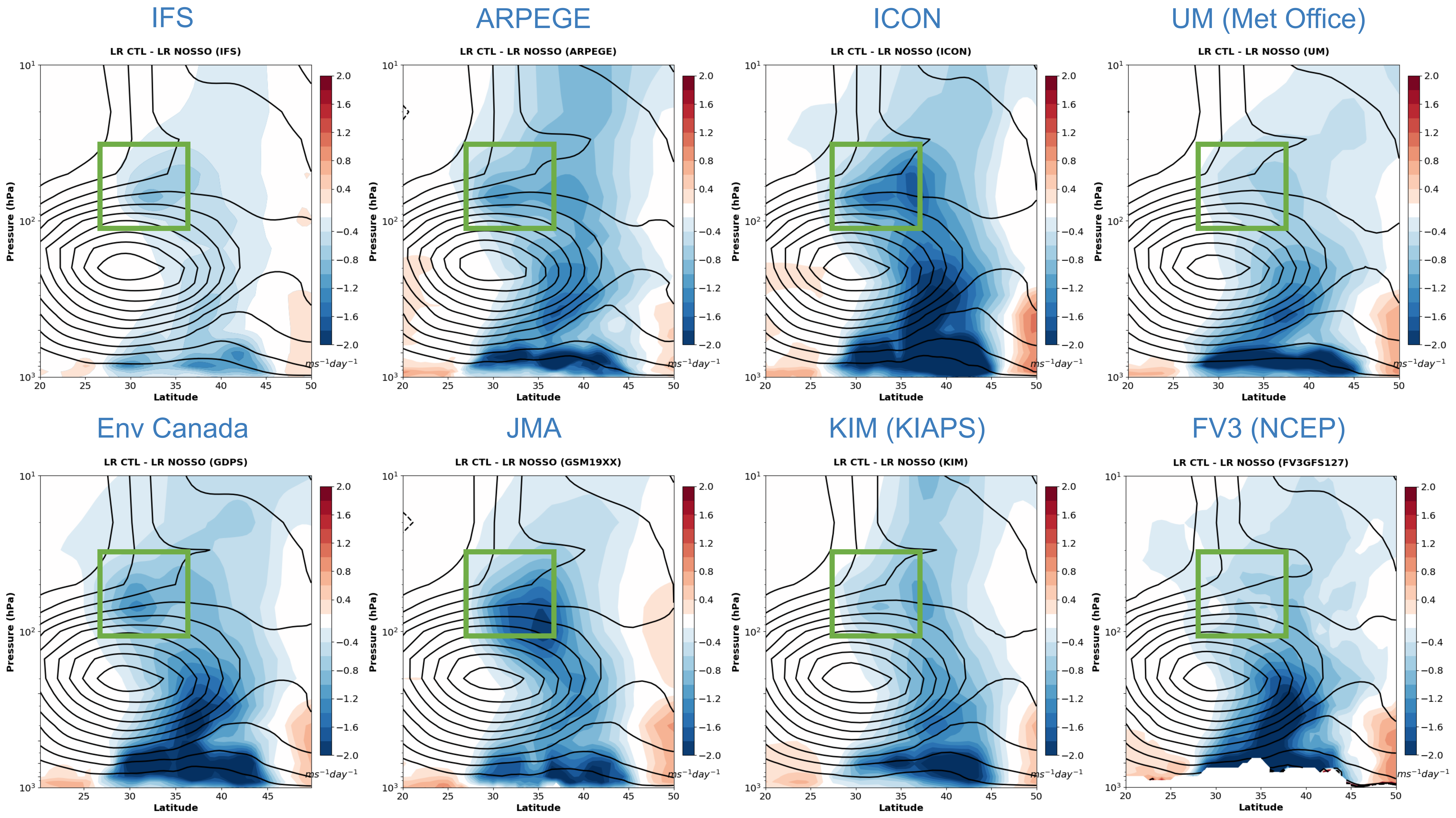
Impact of resolved orographic drag (Δx=1.8-10km)

Plots show impact on the zonal winds after 24 hours, longitudinally averaged over region



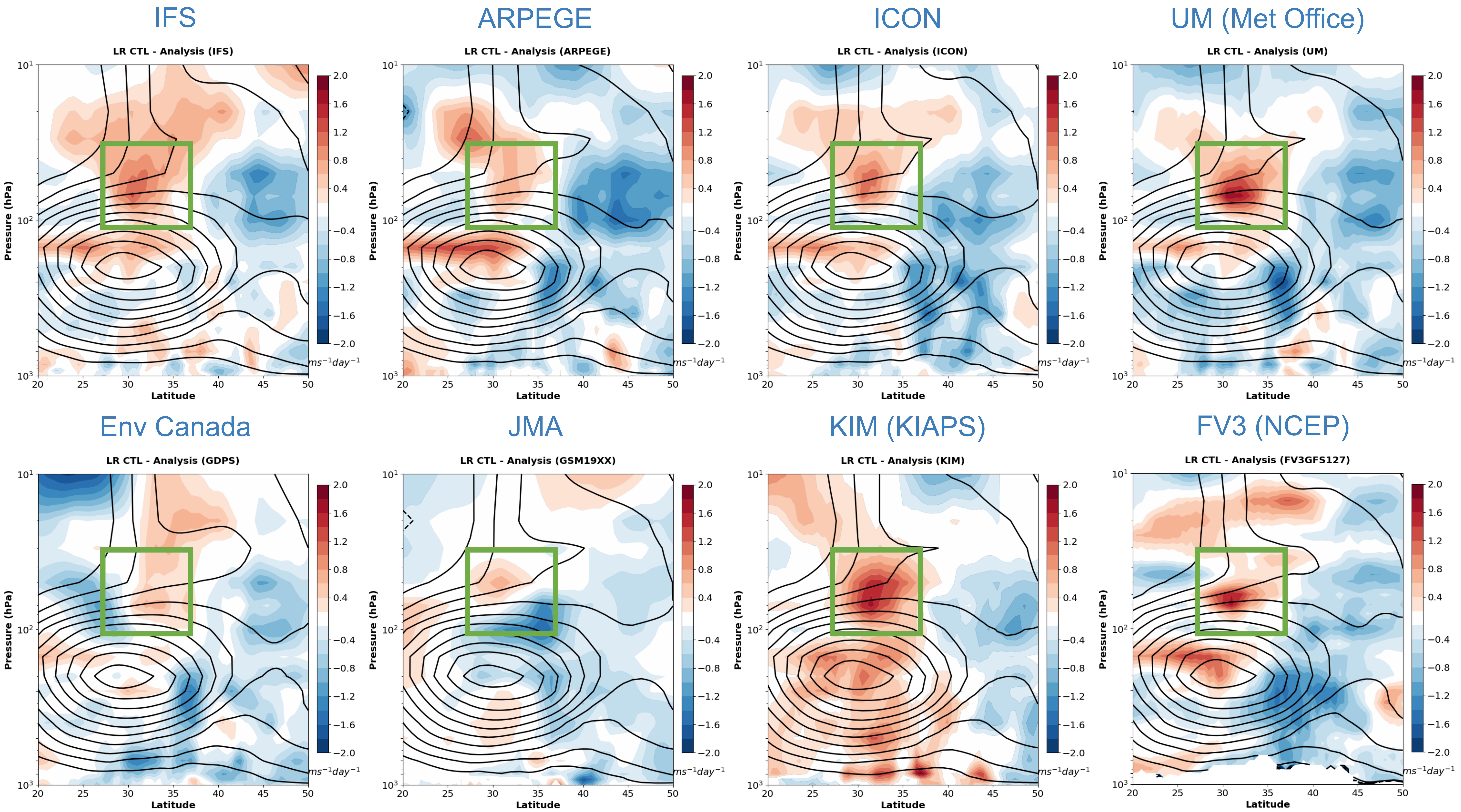
Impact of parametrized orographic drag (Δx=80-150km)

Plots show impact on the zonal winds after 24 hours, longitudinally averaged over Middle East



Model U error relative to analysis at T+24 (Δx=80-150km)

Plots show drift on the zonal winds after 24 hours, longitudinally averaged over Middle East



COORDE key points

- The **impact of the resolved orographic drag is quite similar** across the models, although the magnitude does differ. This gives us faith in using models to constrain parametrizations.
- The **parametrized orographic drag impact is quite diverse** across the models, with both the magnitude of the low level drag varying greatly and the vertical distribution of the gravity wave drag being very different.
- There is quite a robust signal of **insufficient/misplaced, gravity wave drag in the lower stratosphere** in most models.

COORDE Next Steps

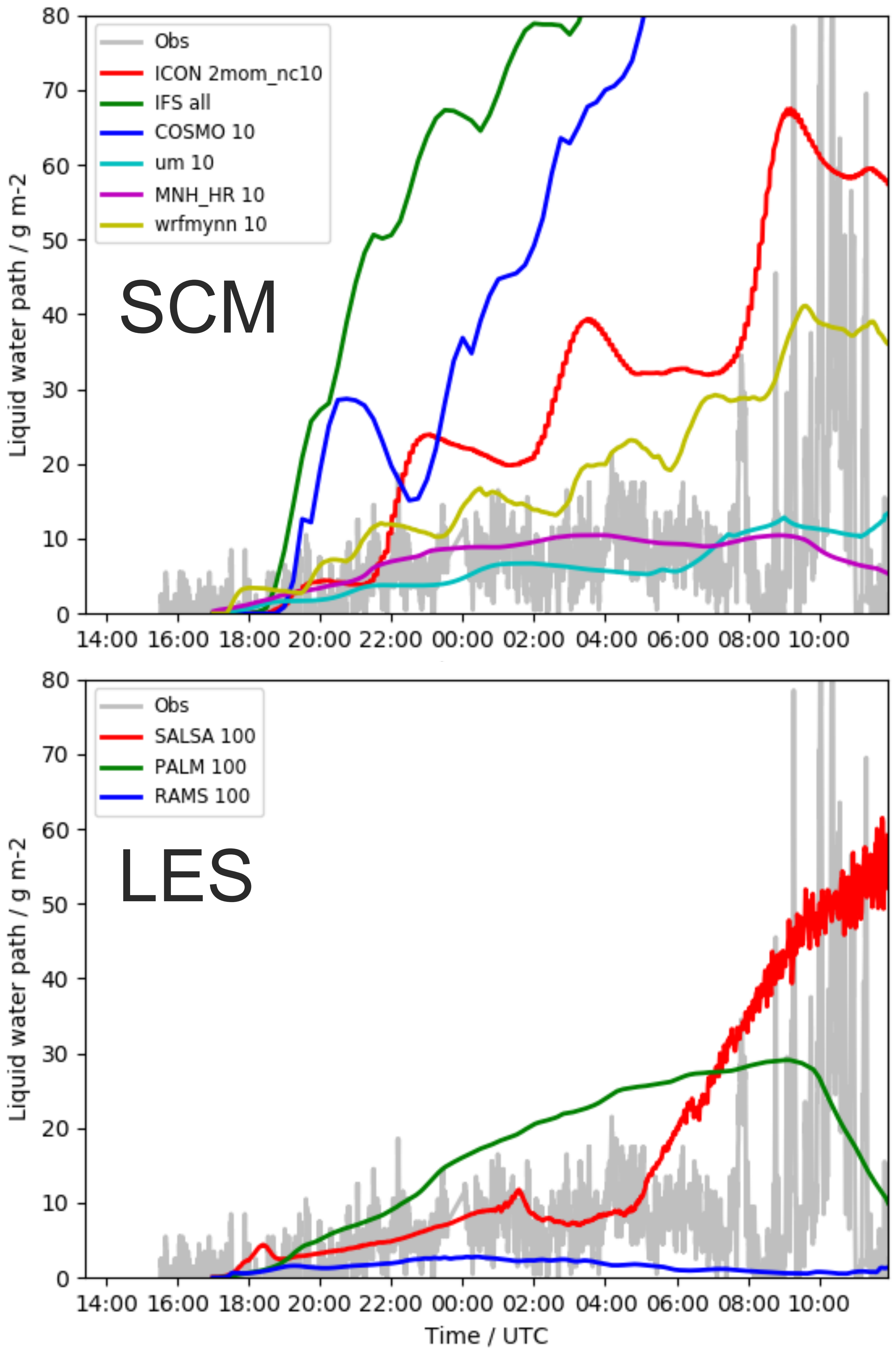
- Use experiments with increased drag to evaluate the compensation between parametrized drag and model dynamics (experiments already done, analysis pending)
- Look at parametrized drag at resolutions relevant for seasonal/long range forecasting (i.e. ~30km)

Demistify: an LES and NWP fog modelling intercomparison

Ian Boutle

- Most operational NWP centres will list errors in fog forecasting amongst their top model problems, with the requirement for improvement considered high-priority.
- Aviation is the key customer driving this
- ~40% of all delays (~50% of weather relayed delays) at busy airports due to low visibility events
- Very expensive + lots of grumpy passengers
- With accurate forecasts, can plan ahead to mitigate the effects
- Key questions:
  - How well can models simulate the development of radiation fog?
  - What are the key processes governing the development of radiation fog, i.e. aerosol, cloud microphysics, radiation, turbulence, dew deposition, ...?
  - What level of complexity is required from NWP models to adequately simulate these processes?
  - What role does land-surface interaction play in the development of radiation fog?

- 10 models submitted – 6 SCM and 4 LES (more still expected & welcome)
- Analysis ongoing:
  - Significant variation between models
  - No more consistency for LES than SCMs, suggesting microphysics & radiation as key causes (not turbulence)
- Aim draft report by November
- Project then likely on hiatus for 1 year unless an alternative lead can be found



Impact of initialized land temperature and snowpack on S2S prediction (LS4P)

Yongkang Xue

Project Goals

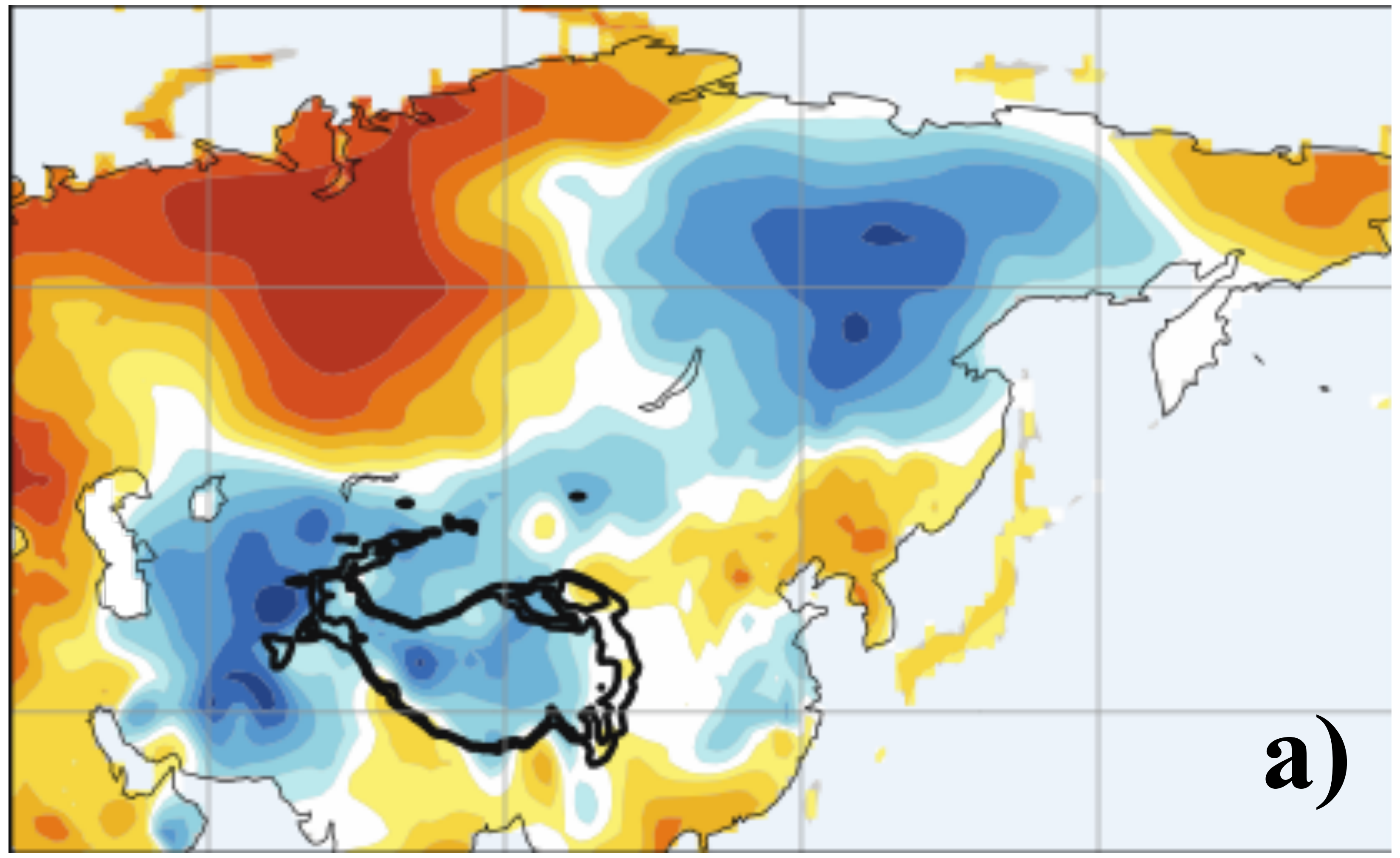
- What is the impact of the initialization of large scale land surface temperature (LST)/ subsurface temperature (SUBT), mainly in high elevation regions, and the aerosol in snow, in climate models on the S2S prediction over different downstream regions?

- What is the relative role and uncertainties in these land processes versus in SST in S2S prediction? How do they synergistically enhance the S2S predictability?

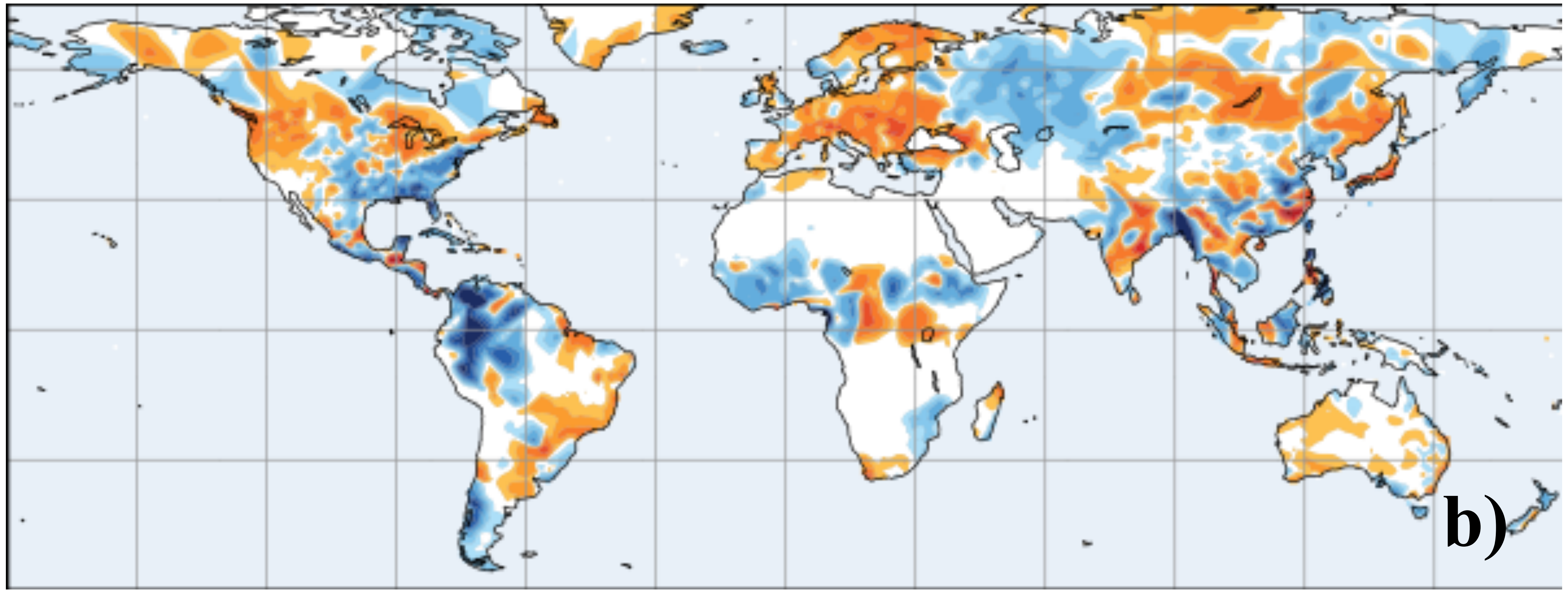
Recent studies support the concept that the high elevation land surface temperature/ subsurface temperature (LST/SUBT) in the Third Pole region (TP) has a substantial remote predictive capability for precipitation at S2S time-scales.

Comparison between observed anomalies and 20 LS4P Models ensemble mean BIAS

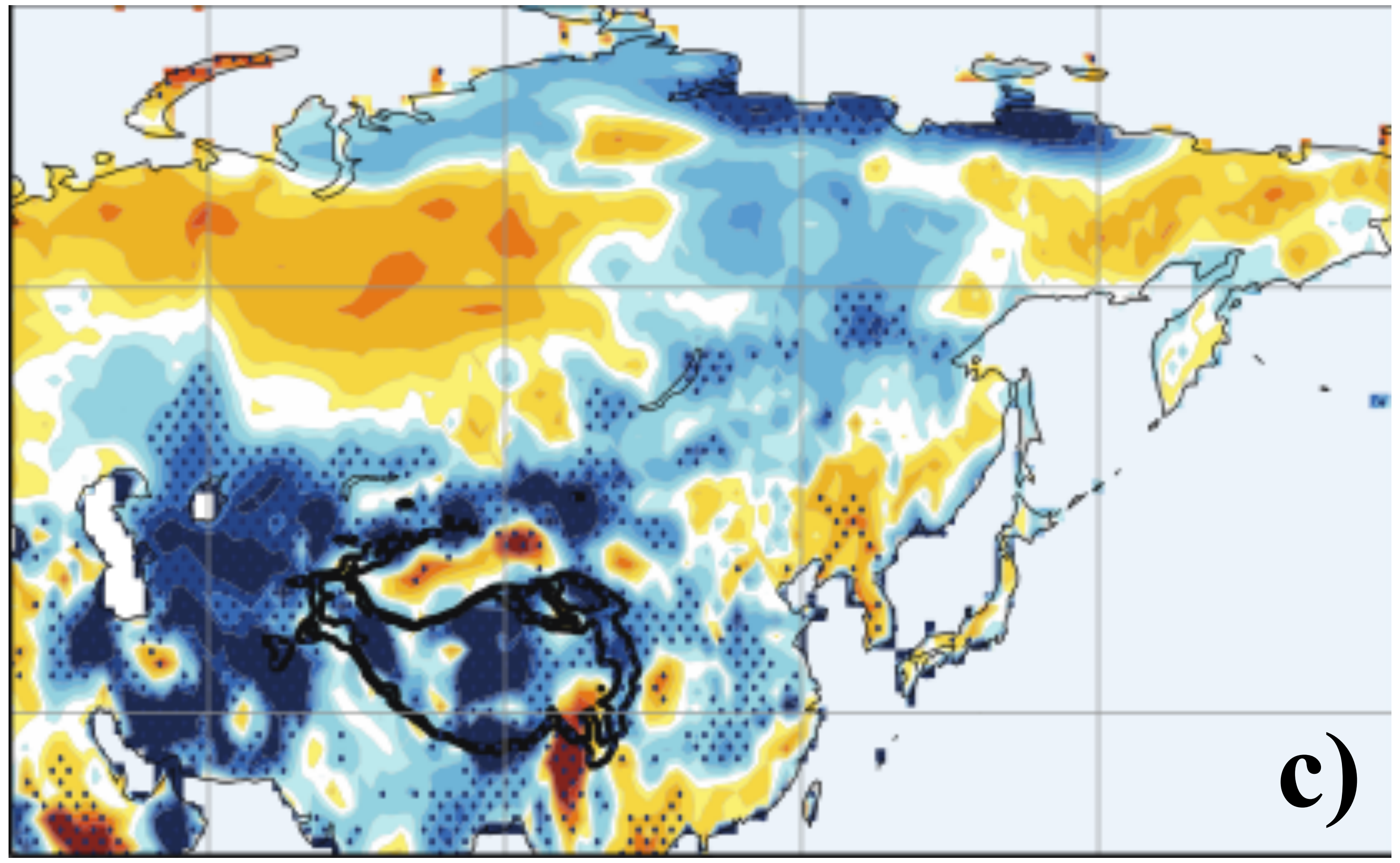
Observed May 2003 T-2m anomalies (˚C)



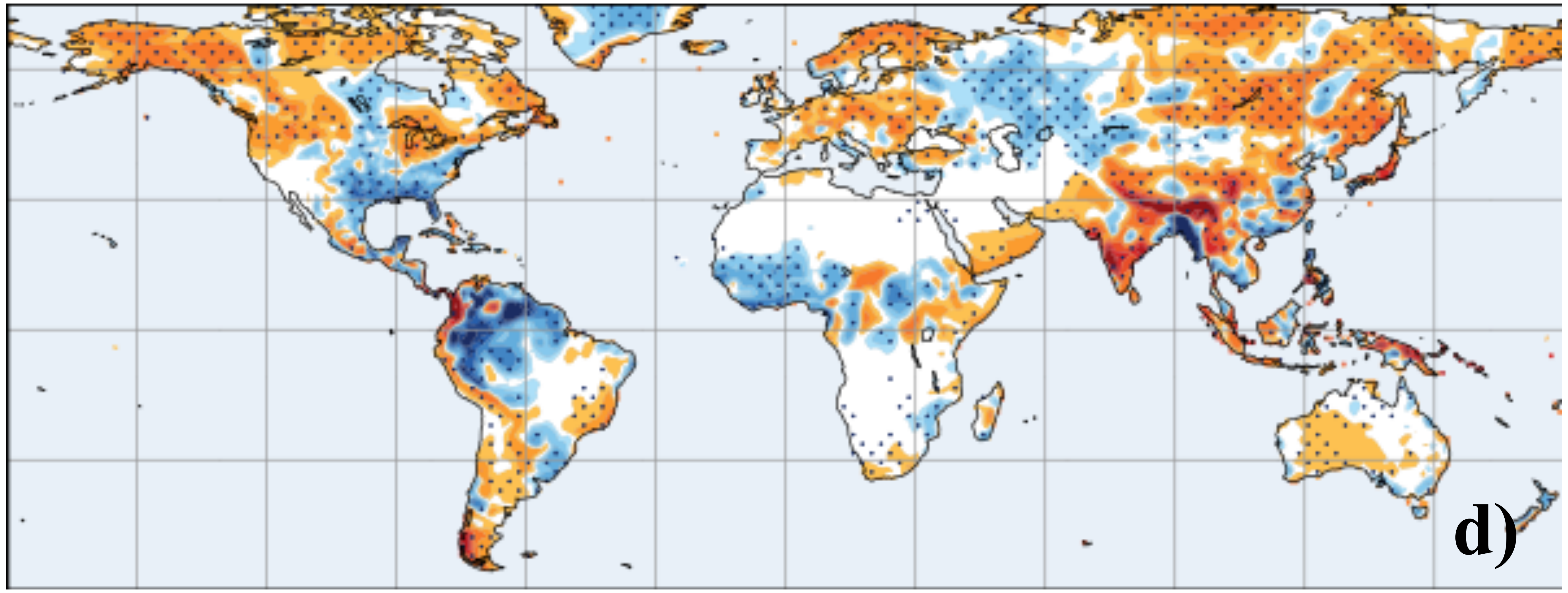
Observed June 2003 Precipitation anomalies (mm/day)



Model Ensemble mean May 2003 T-2m Bias

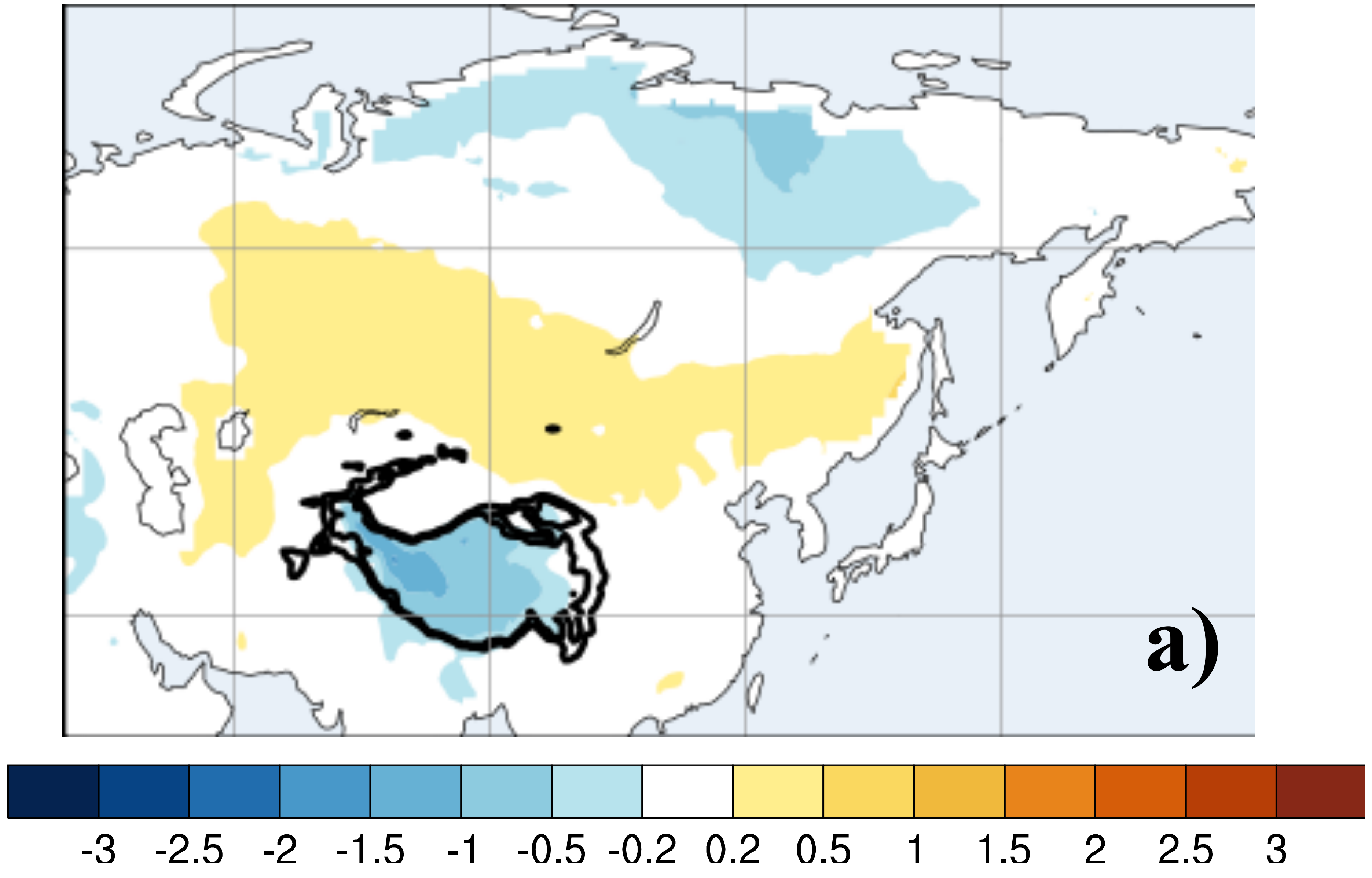


Model ensemble mean June 2003 PRE Bias

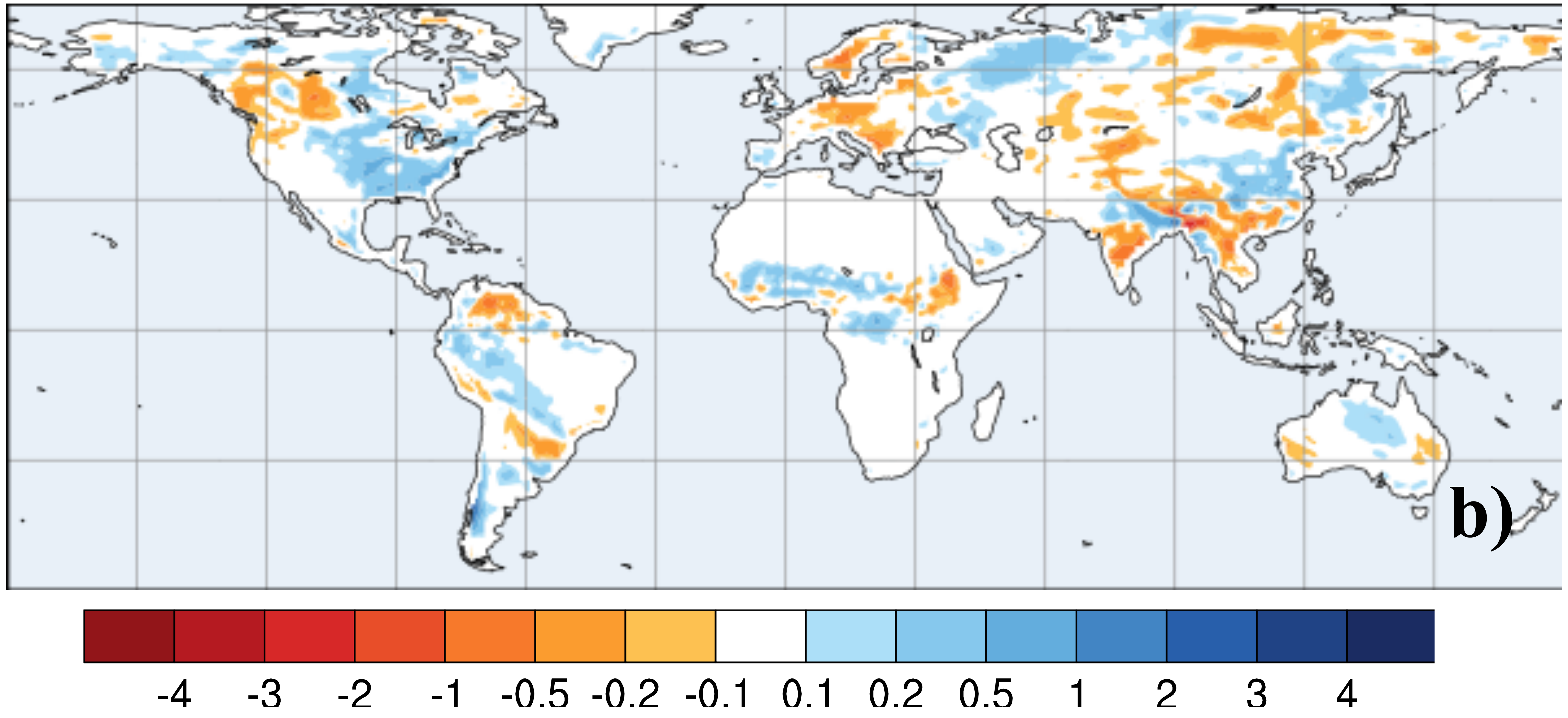


Eight LS4P model-simulated ensemble mean May 2003 T-2m anomaly and June 2003 precipitation anomaly

Simulated May 2003 T-2m anomalies (˚C)



Simulated June 2003 Precipitation anomalies (mm/day)

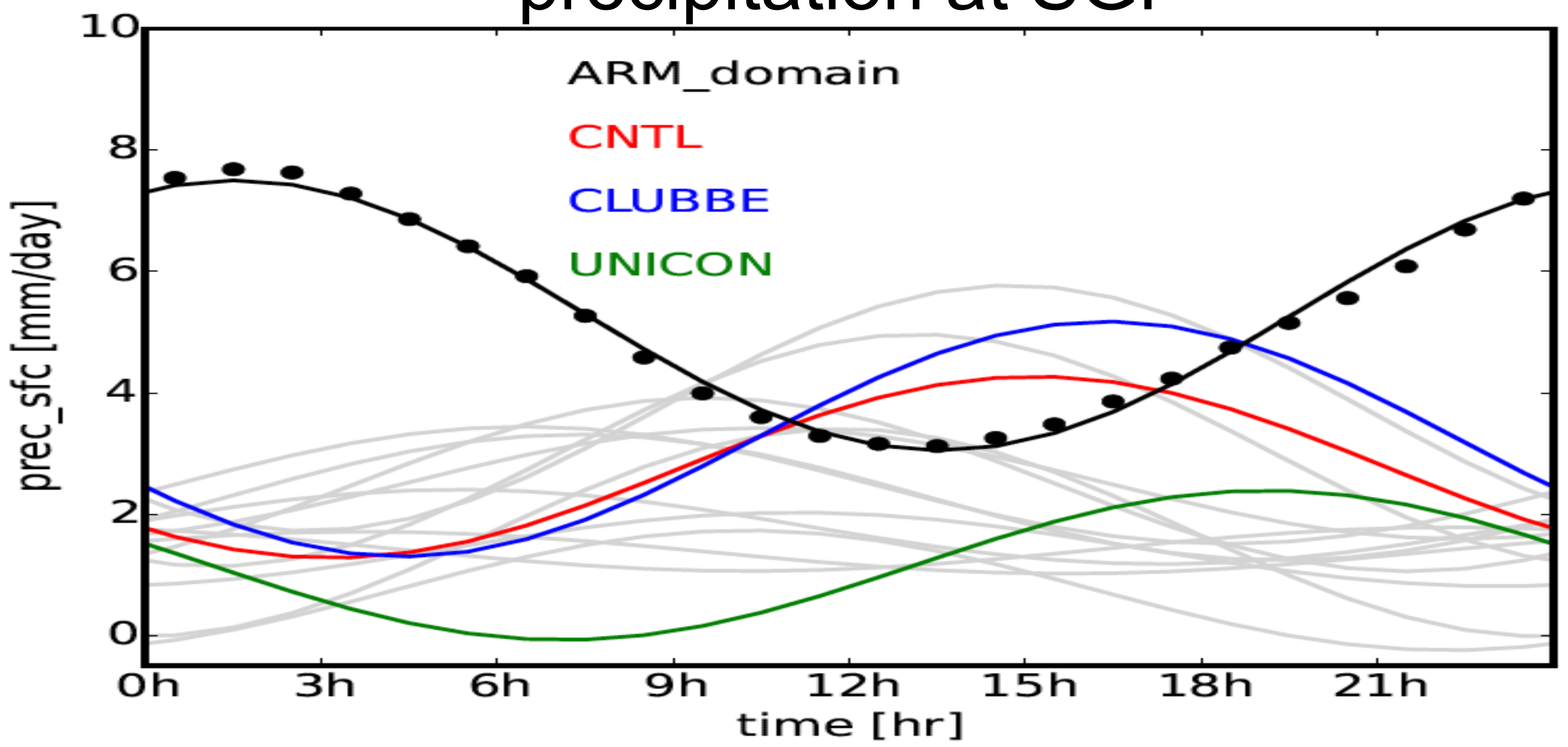


Improving the simulation of the diurnal and sub-diurnal precipitation over different climate regimes

Shaocheng Xie

- **Interaction between convection and water vapor**
  - *Which processes are most essential and how can these be improved in weather and climate models?*
- **Nocturnal convection over land**
  - *What is the role of convective memory (advection), elevated convection initiation, nighttime low-level jet, radiative cooling from cloud tops?*
- **Diurnal cycle of convection over ocean**:
  - *What is the role of the "direct radiation–convection interaction" (or lapse-rate) mechanism on diurnal cycle of convection over ocean?*
  - *What is the role of the "dynamic cloudy–clear differential radiation" mechanism?*
- **Convection transition**
  - *What controls the transition from shallow to deep convection? Free tropospheric humidity or boundary layer inhomogeneity?*

Missing summertime nocturnal precipitation at SGP



Approach

- **A hierarchy modeling approach**
  - *SCMs, CRMs, LESs, Regional Models, Convection Permitting models, and GCMs*
- **Case studies vs. statistical studies**
  - *Major field campaigns (PECAN, GOAmazon)*
  - *Multi-year simulations*
- **Short-range hindcasts vs. climate simulations**
  - *The Transpose-AMIP or CAPT approach with models initialized with NWP analysis*
  - *Free AMIP type of runs*
- **Observational studies and modeling tests**
- **Process oriented diagnosis**
  - *Convection onset diagnosis*

Timelines

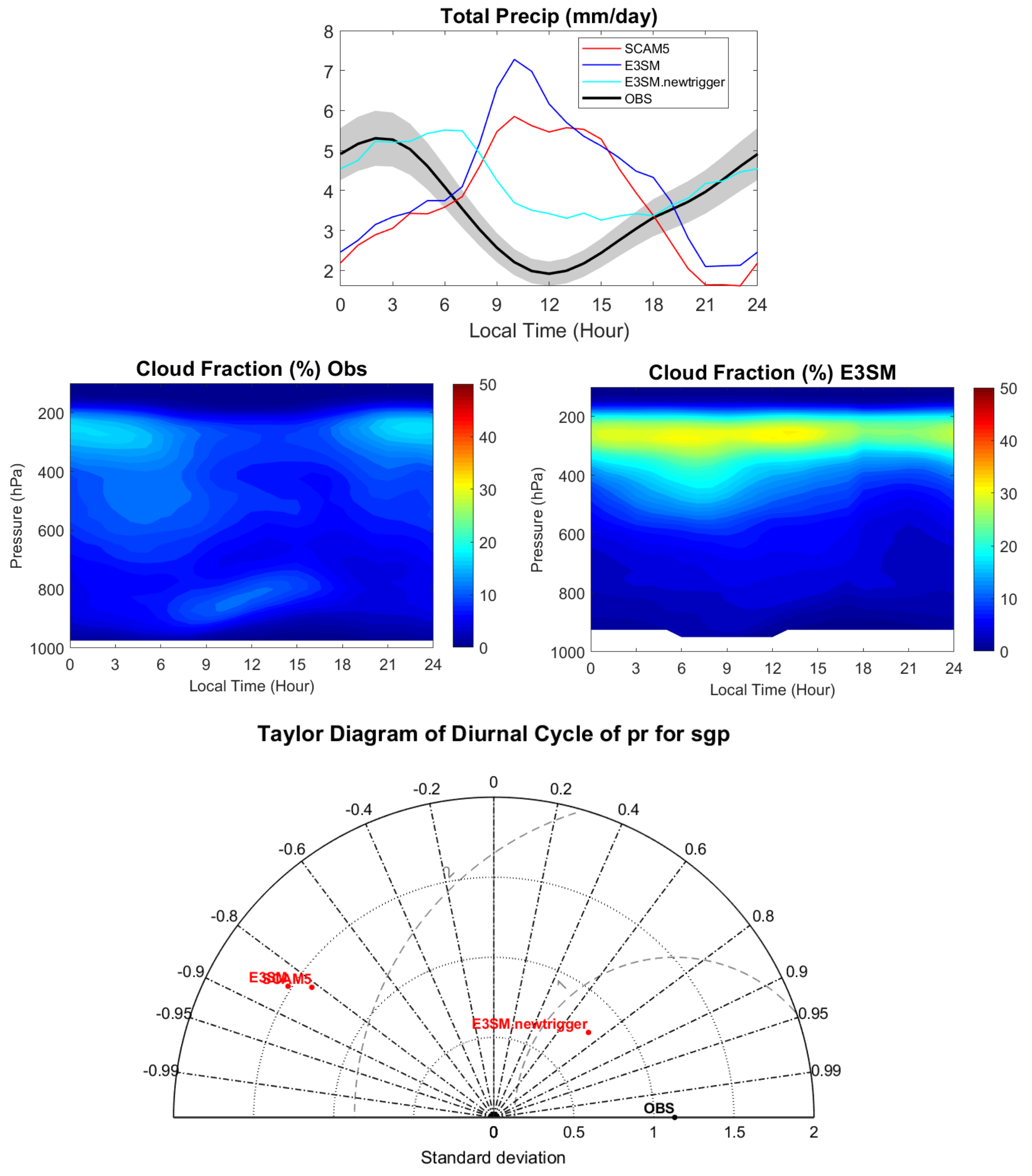
- March 1, 2019: Finalize experiment documents for the project to start
- 31 October, 2019: Deadline for data submission participants
- 28 February, 2020: Model data processed and shared with the group; initial analysis done.
- 30 April, 2020: Ideas and plans for papers developed
- 31 August, 2020: First draft of the inter-comparison papers
- 31 October, 2020: manuscripts submitted

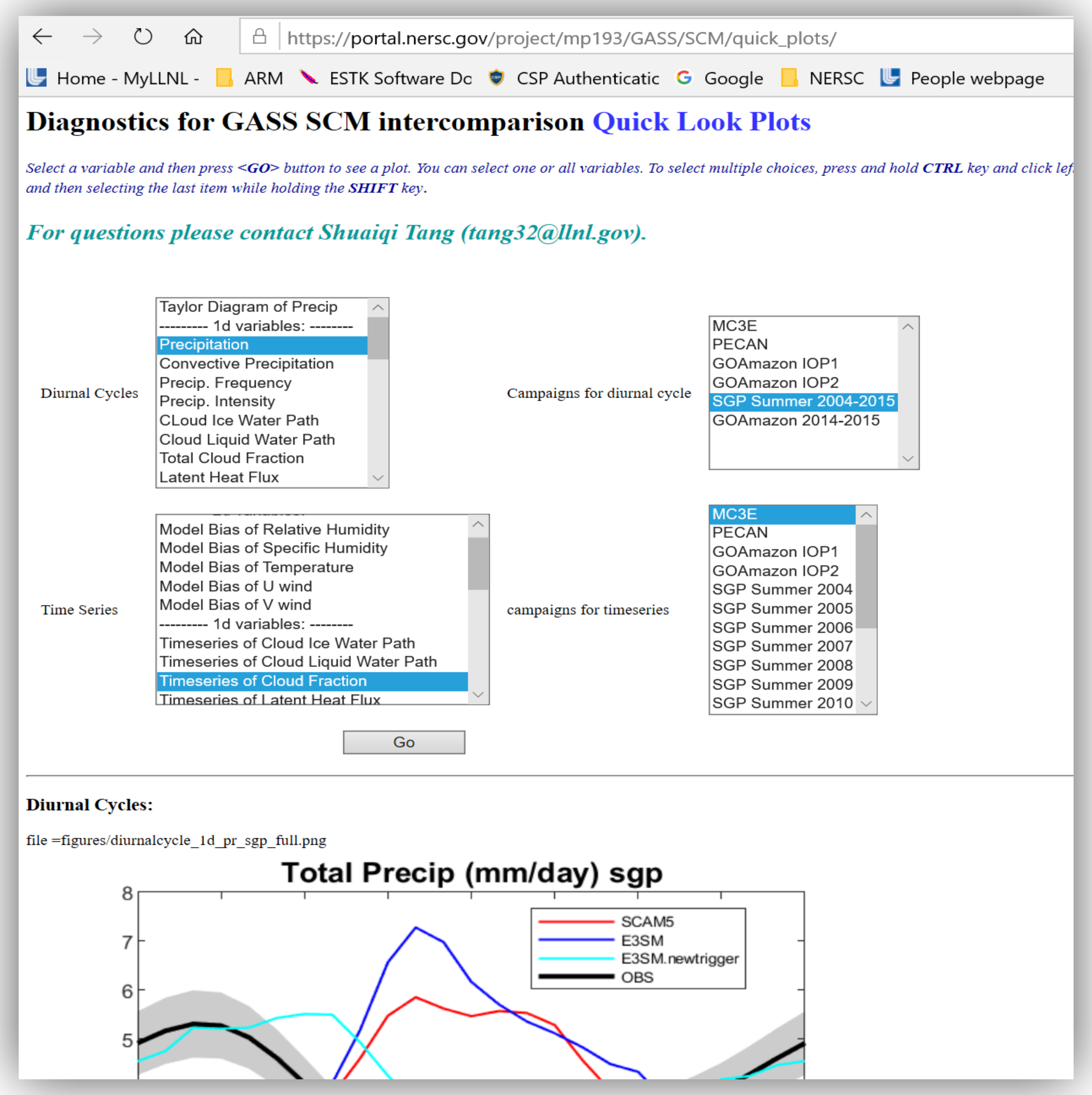
Note: The progress for the GCM part of the study is delayed and its timelines will be adjusted accordingly.

Initial diagnostic plots and the interface

Shuaiqi Tang (LLNL)
Shaocheng Xie (LLNL)

SGP (2004-2015 MJJA)





Second phase of the "Grey Zone" project based on the EUREC4A and phase III of the GATE field campaigns – joint with WGNE
Scale-awareness, stochasticity and convective organization

Jan/Feb 2020
Investigate how shallow cumulus clouds respond to changes in their large scale environment

First test are being made, experiment definition after campaign.
Contact: Rachel Horner
rachel.honnert@meteo.fr

Aug/Sep1974
Scale interactions between convective and the large-scale atmospheric circulation

Contact: Lorenzo Tomassini
lorenzo.tomassini@metoffice.gov.uk

Second phase of the "Grey Zone" project, time line:

EUREC[4]A-GreyZone (shallow convection)

July 2019 | October 2019 | February 2020 | June 2020 | October 2020

Consolidate group of people who intend to contribute/testing

field campaign
case selection

Discuss pieces of analysis
Who takes the lead?

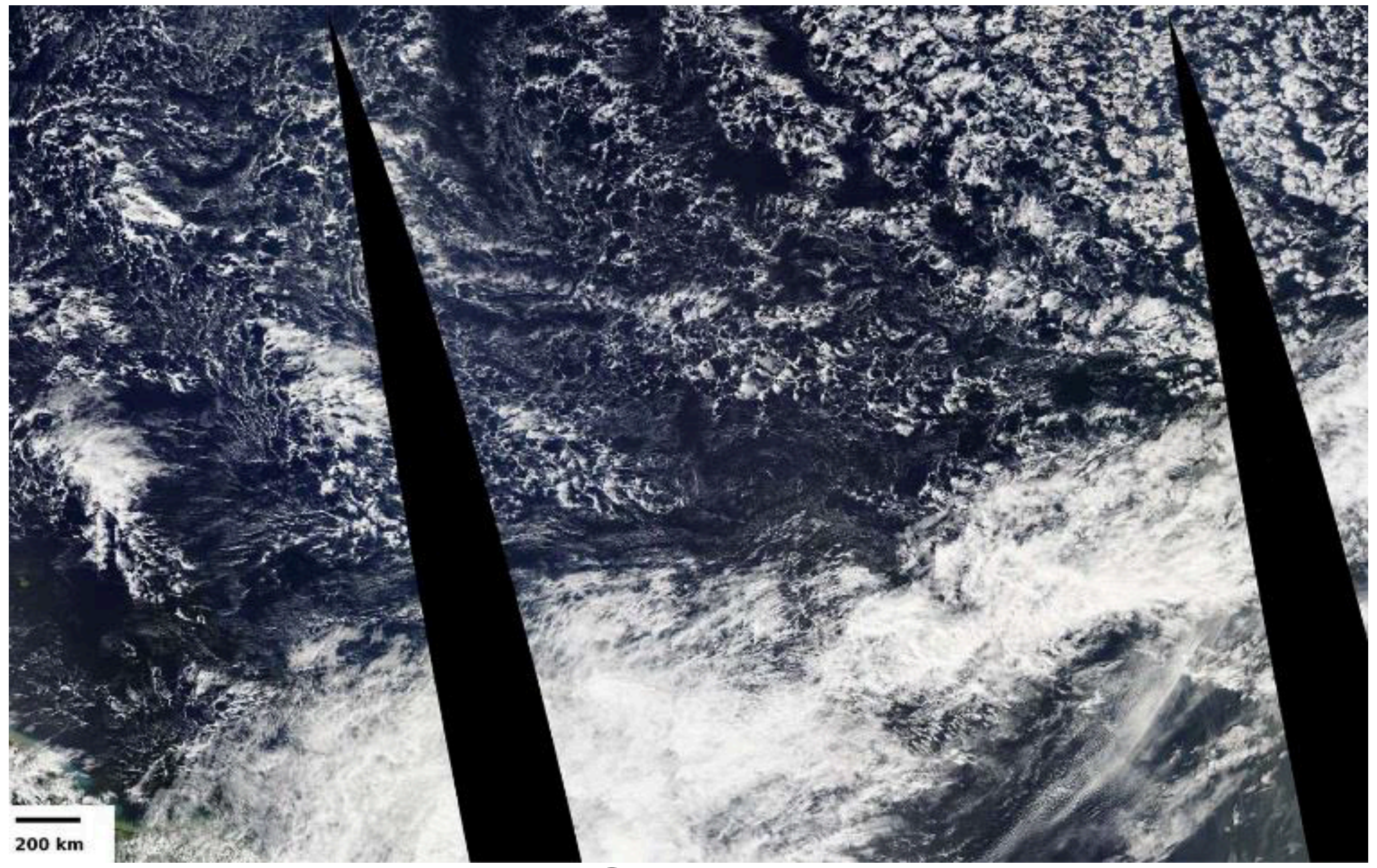
Discuss and define output diagnostics

Discuss sensitivity experiments with groups

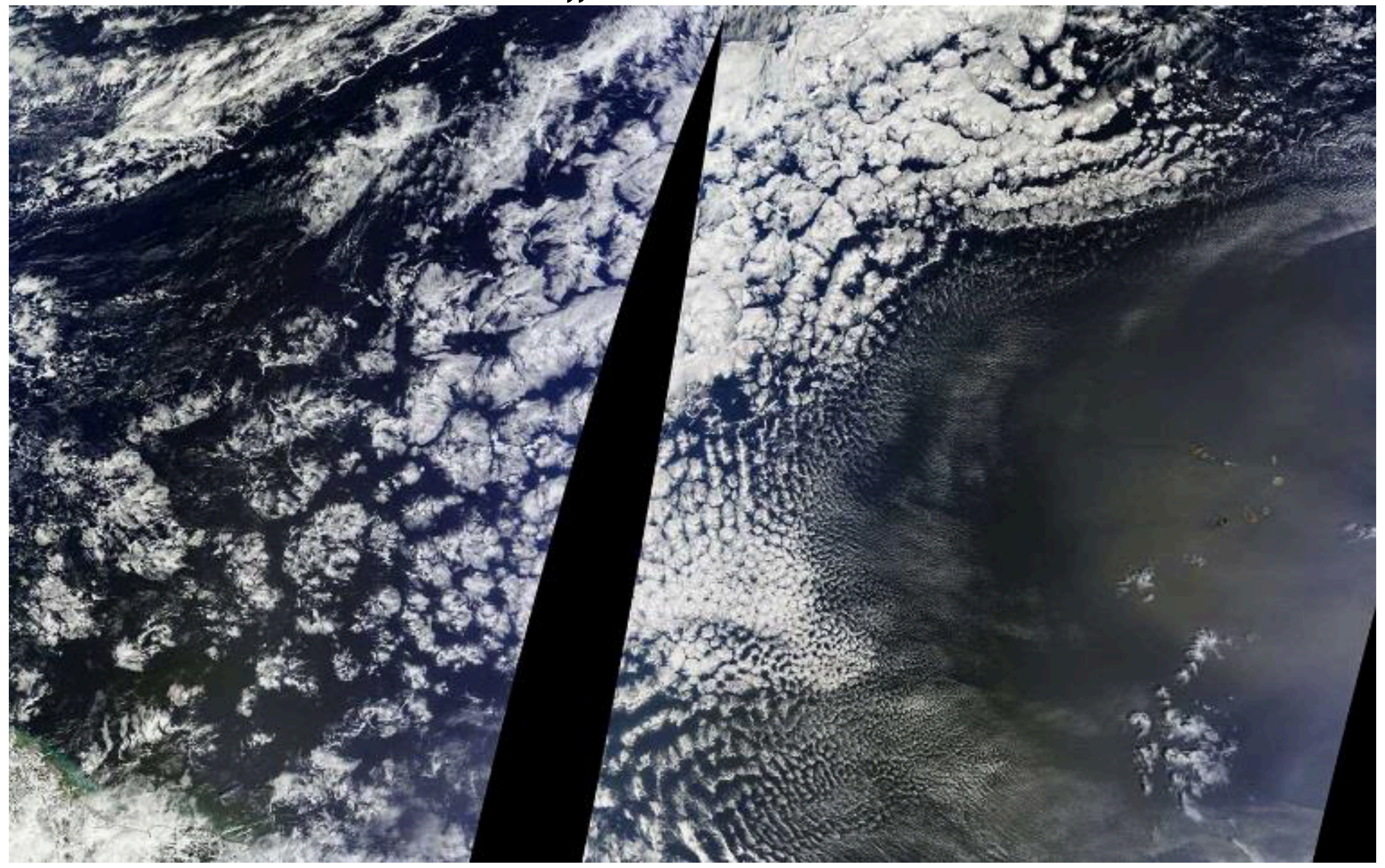
Collect/process observations

Start model experiments

Modis



„Gravel“



„Flower“

Direction of future GASS projects

Potential Gaps:

- Dynamics-physics coupling (White Paper prepared)
- Stable boundary layer (follow-up on GABLS3/4); e.g. around the MOSAiC campaign over the Arctic– under discussion
  -- Papers on GABLS4 are still on progress, with three papers (SCM, Land model, LES) under preparation.
- Joint effort on the surface flux project of WGNE along with other programs
- Radiation: circulation coupling; interaction between radiation and clouds
- High Impact and Extreme Weather: role of convective scale models; ensembles; relevant challenges for model development
- Machine learning?
- Processes relevant for polar prediction: mixed-phase clouds, coupling to the surface

Direction of future GASS projects

Partnerships:

WGNE: **Joint** “Drag” and “Grey-Zone” projects; **future**: atmospheric model bias reduction (?) surface flux project?

WWRP: Directly involved in “S2S”, “Grey-Zone”, and other projects

WWRP/WCRP S2S Project: the GASS GS4P project cooperated with S2S in the development of the white paper and implementation

ACPC: One mechanism is through the GEWEX Aerosol Precipitation (GAP) initiative

CFMIP: CFMIP and GASS collaborated on the CGILS project (CFMIP-GASS Intercomparison of LES and SCMs); Discussion ongoing on a potential joint project

Thanks!