WGNE Aerosol Project: Evaluating the impact of aerosols on the Subseasonal Prediction

Ariane Frassoni*

Angela Benedetti, Andrea Molod, Frederic Vitart,
Georg Grell, Paul Makar, Francois Engelbrecht and many others
***Brazilian National Institute for Space Research,**
Center for Weather Forecasting and Climate Studies
Cacheira Paulista, SP, Brazil
ariane.frassoni@inpe.br

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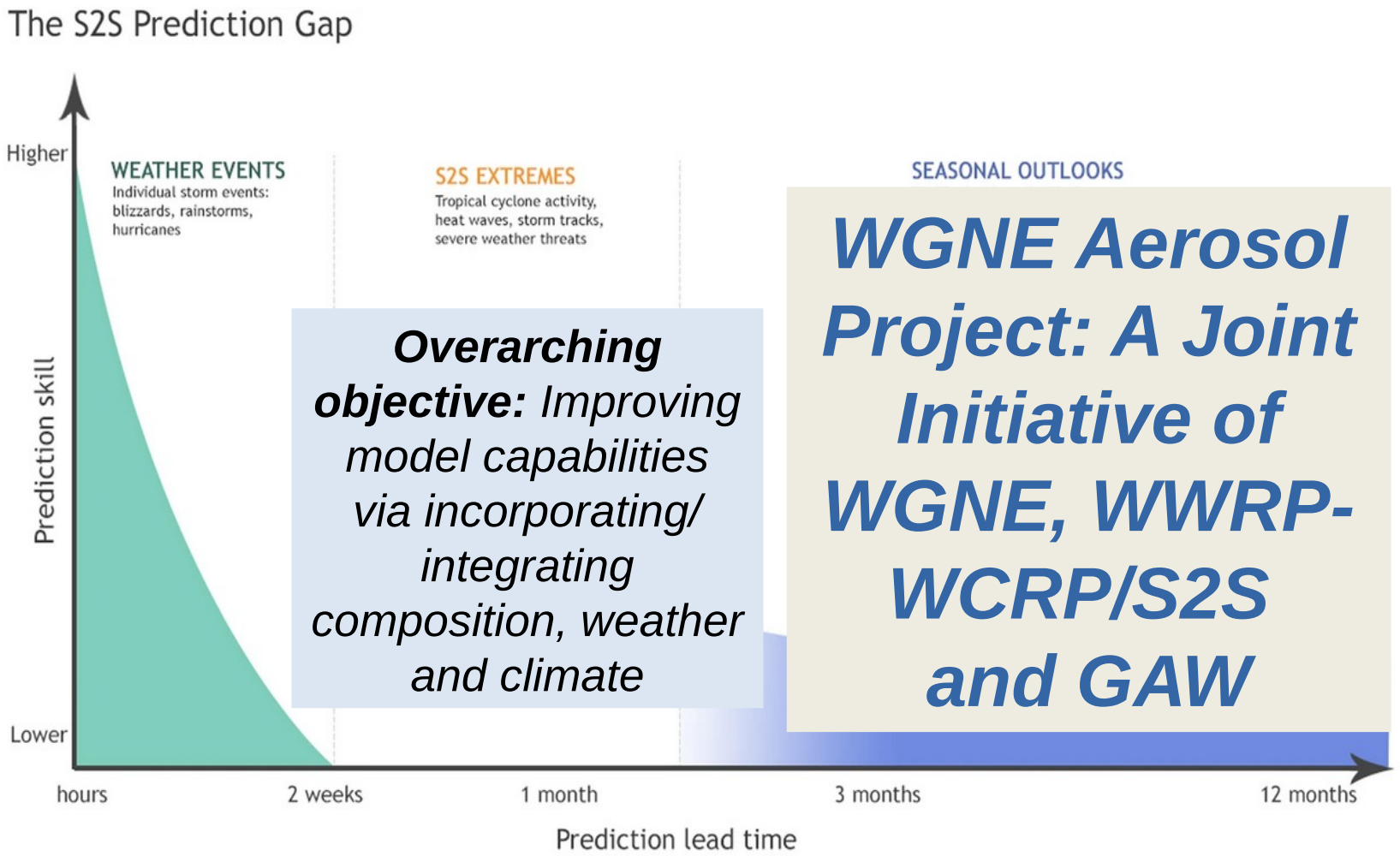
Evaluating the Impact of Aerosols on NWP and Subseasonal Prediction

From: Progress in subseasonal to seasonal prediction through a joint weather and climate community effort



Overarching objective: *Improving model capabilities via incorporating/ integrating composition, weather and climate*

WGNE Aerosol Project: A Joint Initiative of WGNE, WWRP-WCRP/S2S and GAW

Adapted from: iri.columbia.edu/news/qa-subseasonal-prediction-project

Mariotti, A., Ruti, P.M. & Rixen, M. *npj Clim Atmos Sci* **1,** 4 (2018). https://doi.org/10.1038/s41612-018-0014-z

Experiment characteristics

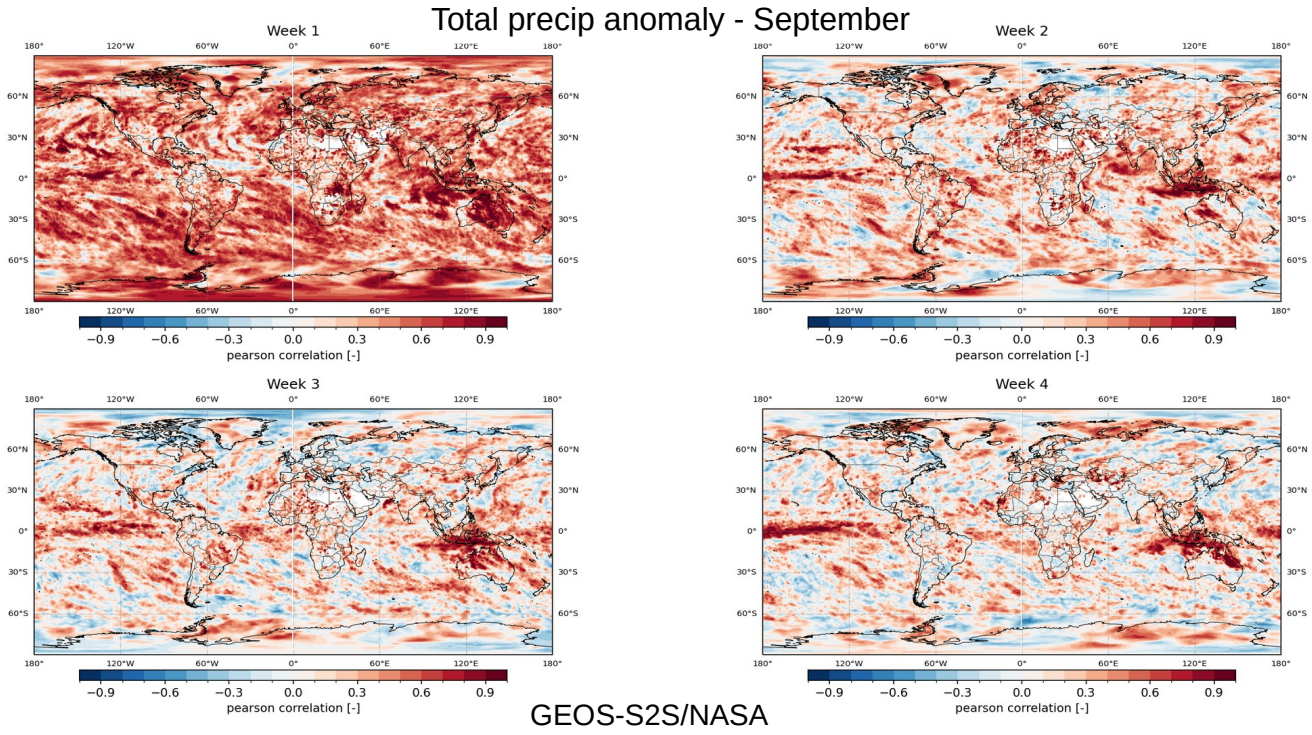
Model	Experiment	Start date	Hindcasts	Ensemble members
GEOS-S2S/NASA	**Climatological aerosols**	**29 Aug 26 Aug**	**2003-2019**	**4**
	Direct + Indirect effect	**29 Aug 26 Aug**	**2003-2019**	**4**
	Direct effect only	29 Aug 26 Aug	2003-2019	4
IFS/ECMWF	Climatological Direct effect only	1st Sep	2003-2018	5
NOAA	**Climatological Direct effect only**	**1st Sep**	**2003-2018**	**5**
KMA	**Direct + indirect effect****	**1th, 9th, 17th, 25th of each month**	**1996-2016**	**10 (5 for stochastic * 2 for time varying)**

**Control run: GloSea6 + offline oxidants chemistry + 5 mode aerosol scheme
Experiment run: GloSea6 + standard troposphere chemistry + 5 mode aerosol scheme

Ongoing work

Computing statistical scores

- correlation between ensemble mean and observations anomalies
- standard deviation ratio
- bias of the ensemble mean
  - 2-meter temperature anomalies
  - precipitation anomalies
  - surface fluxes anomalies
  - surface net downward longwave flux
  - surface net downward shortwave flux
  - AOD
  - Climatic indices



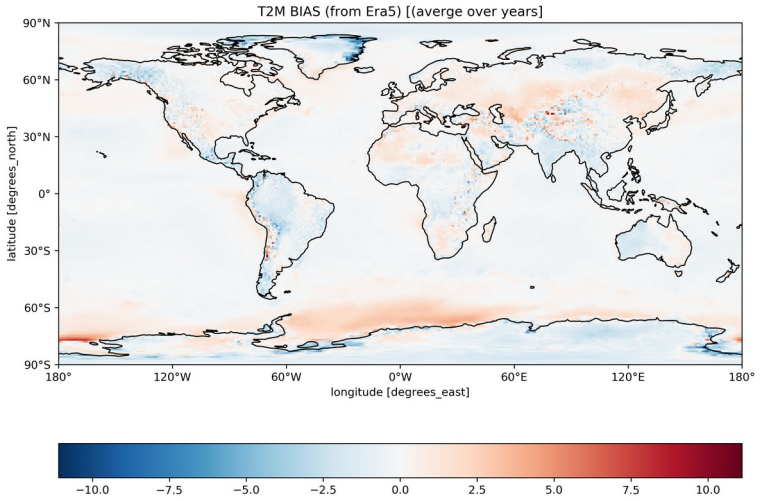
Questions?

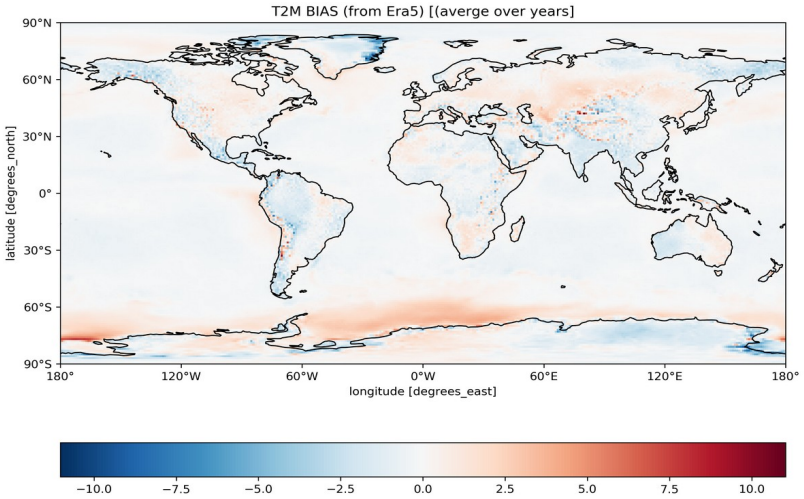
Mean bias

Interactive aerosols

Climatological aerosols

ECMWF





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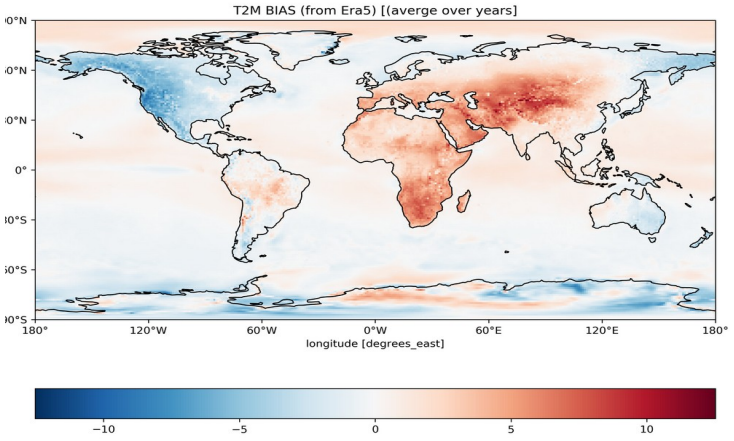
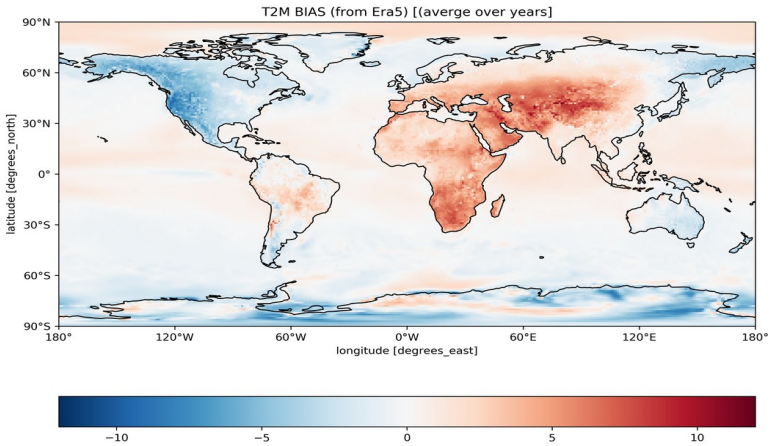
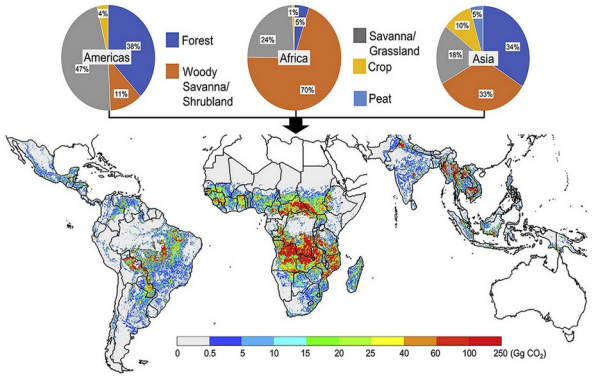






Biomass burning emissions in tropical areas

Shi et al., 2020

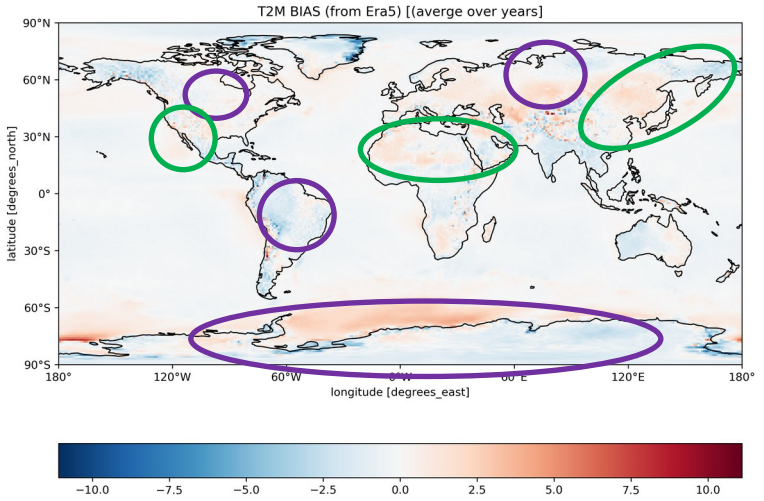
Improvement **Degradation**

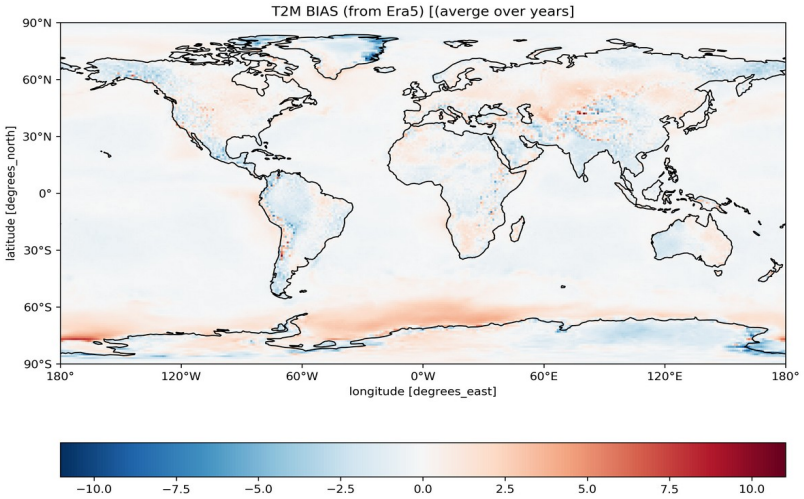
Mean bias

Interactive aerosols

Climatological aerosols

ECMWF





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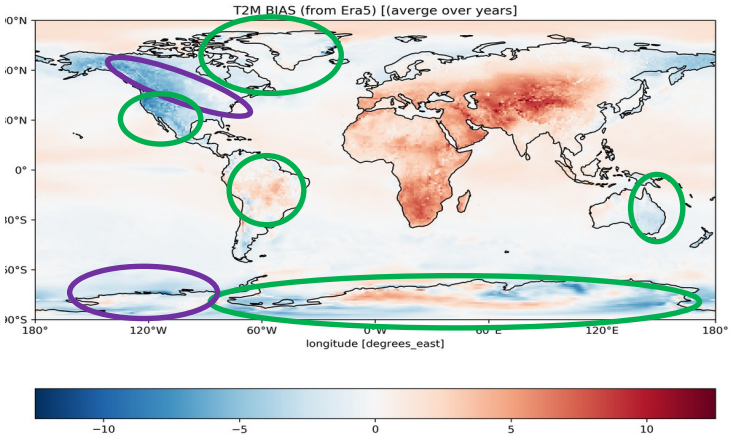
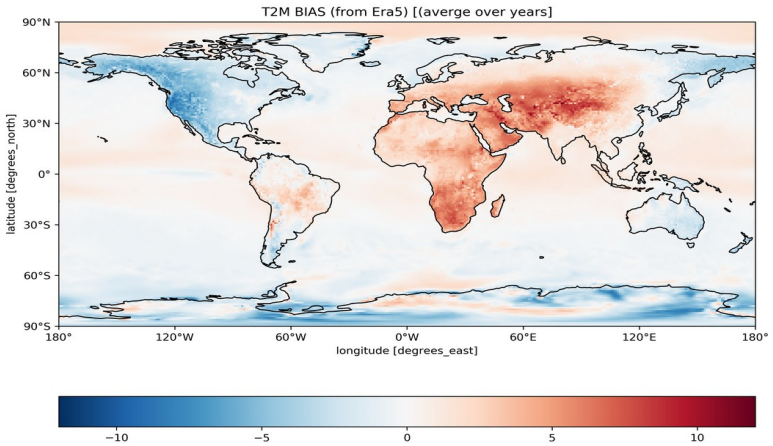
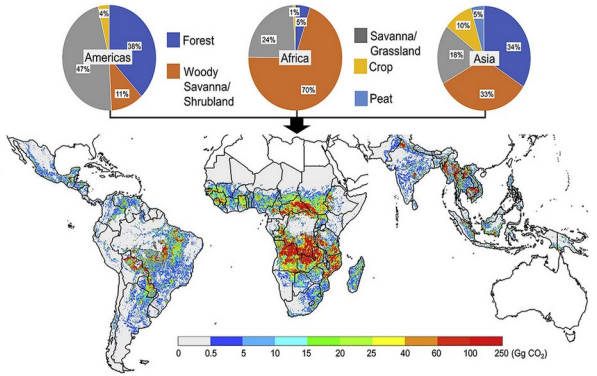






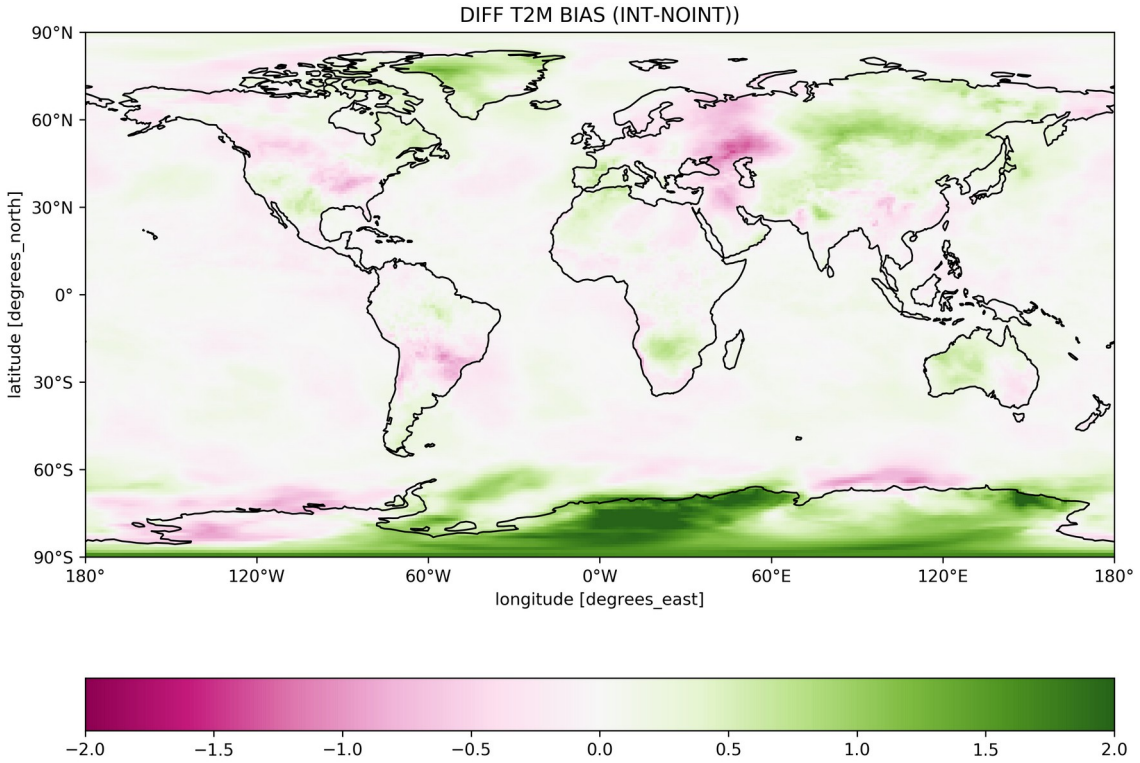
Biomass burning emissions in tropical areas

Shi et al., 2020

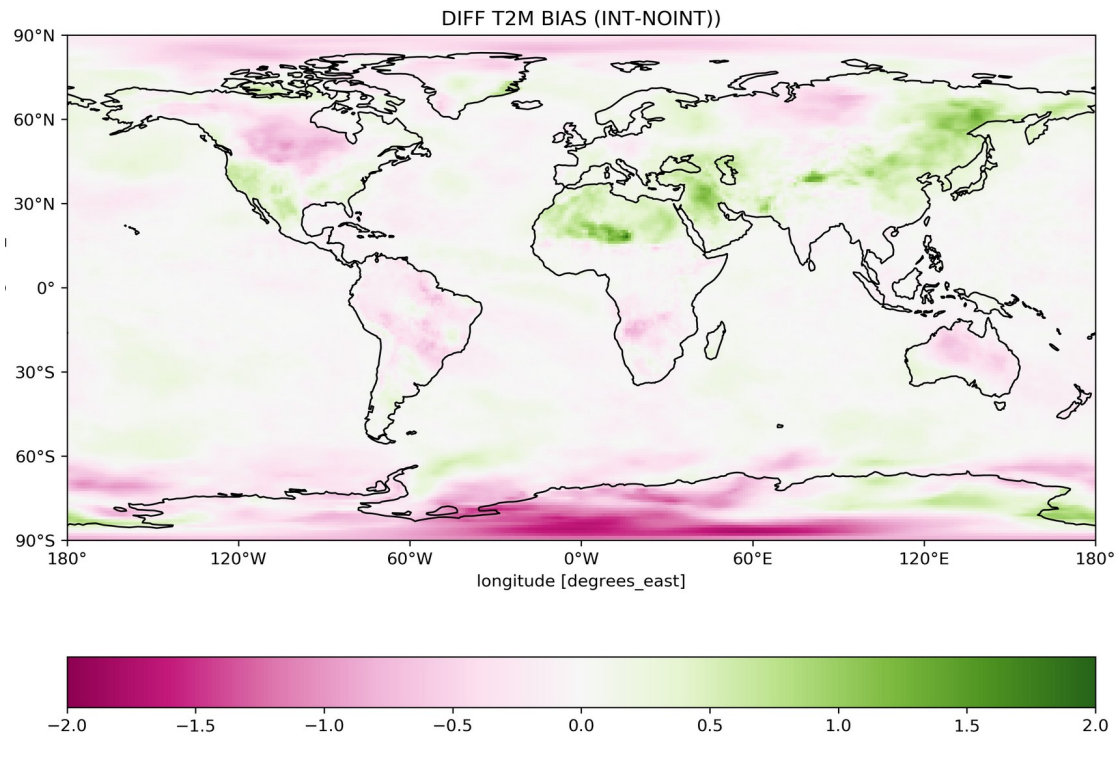
Improvement **Degradation**

Bias differences: INT – NOINT

NASA

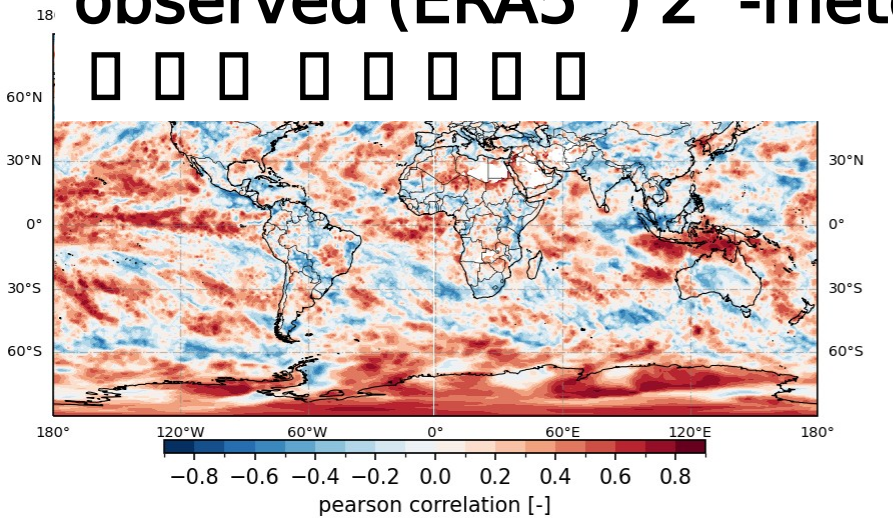


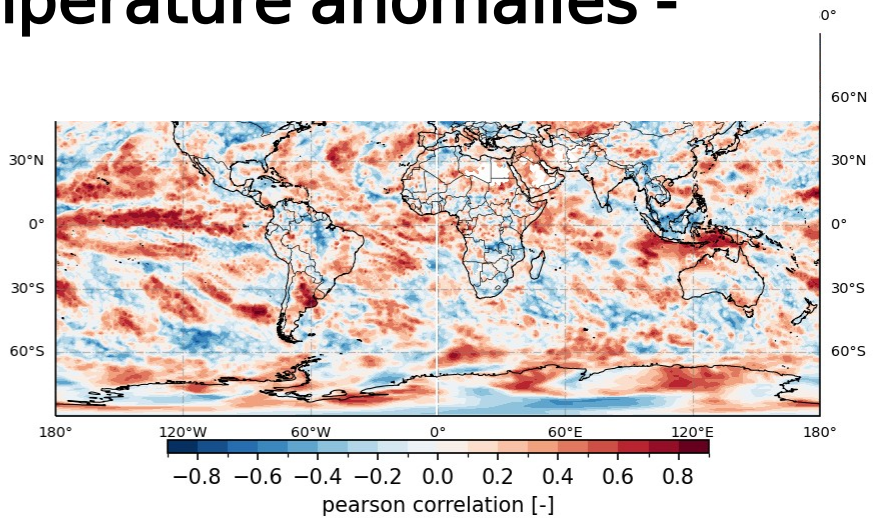
ECMWF



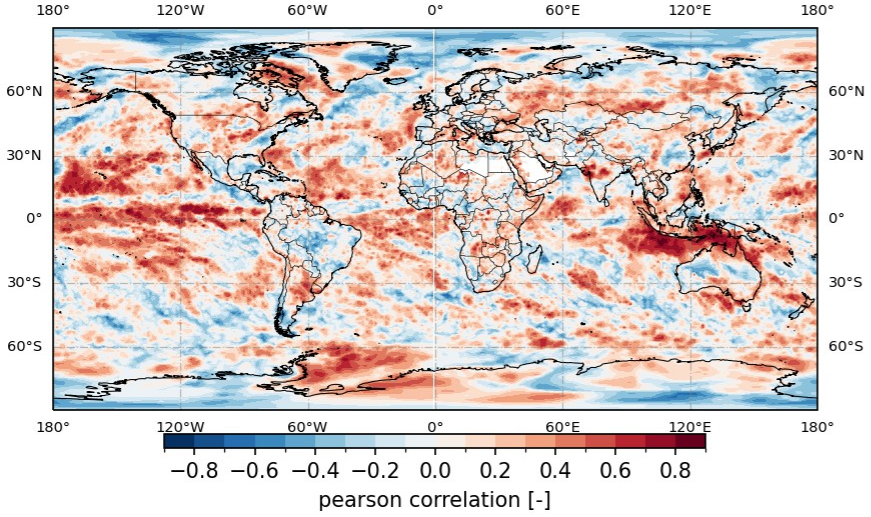
Improvement **Degradation**

Correlation between the ensemble mean of members and observed (ERA5) 2-meter temperature anomalies -





Week 3



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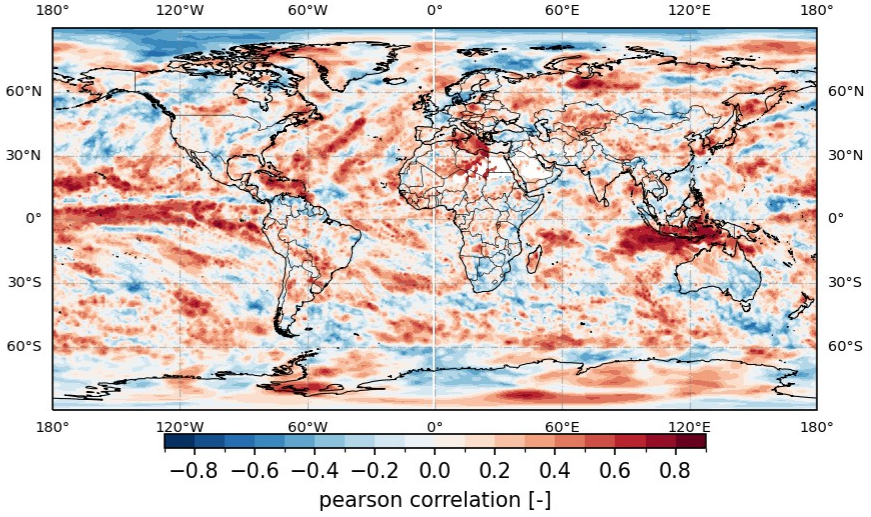
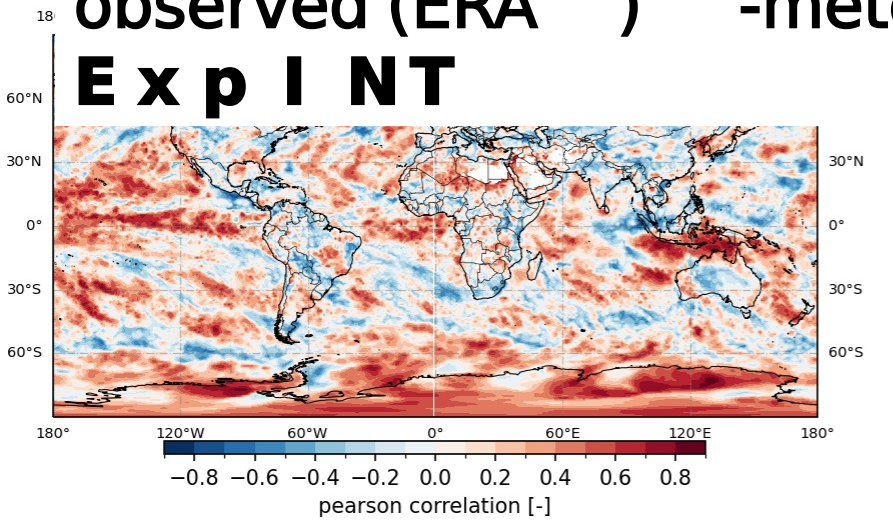
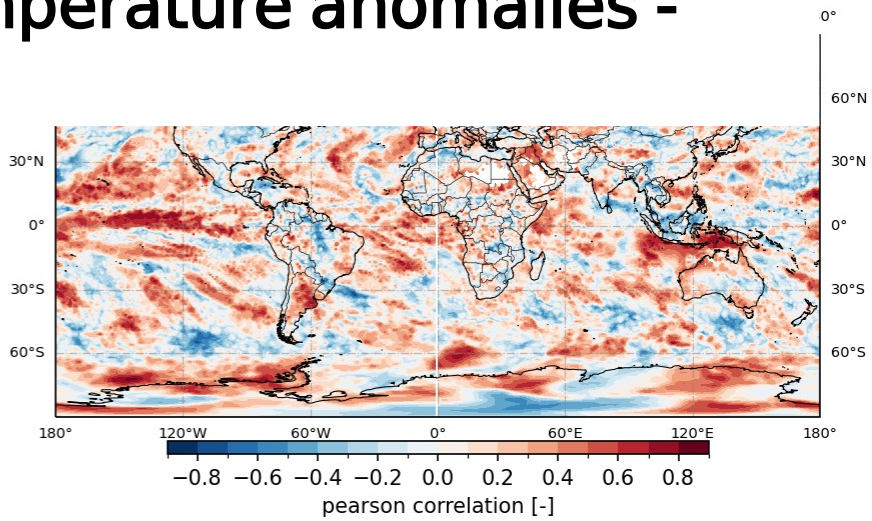


Correlation between the ensemble mean of members and observed (ERA) -meter temperature anomalies - **ExpI NT**





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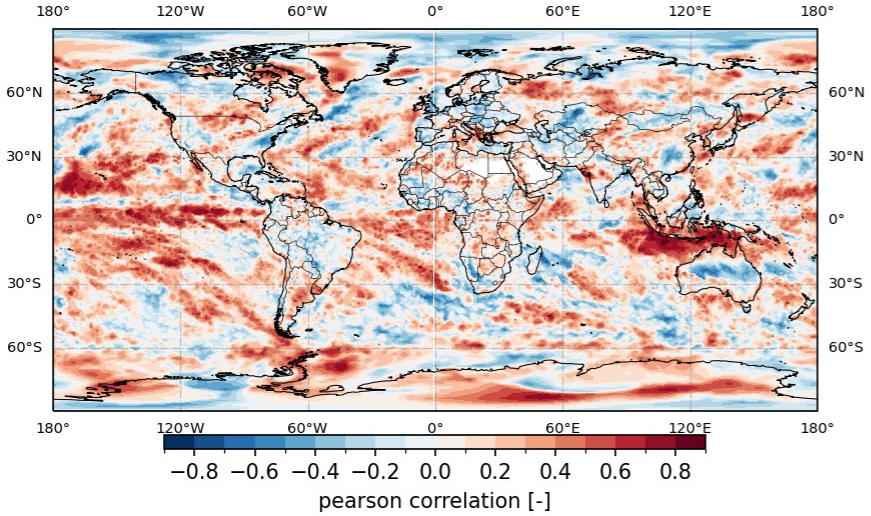

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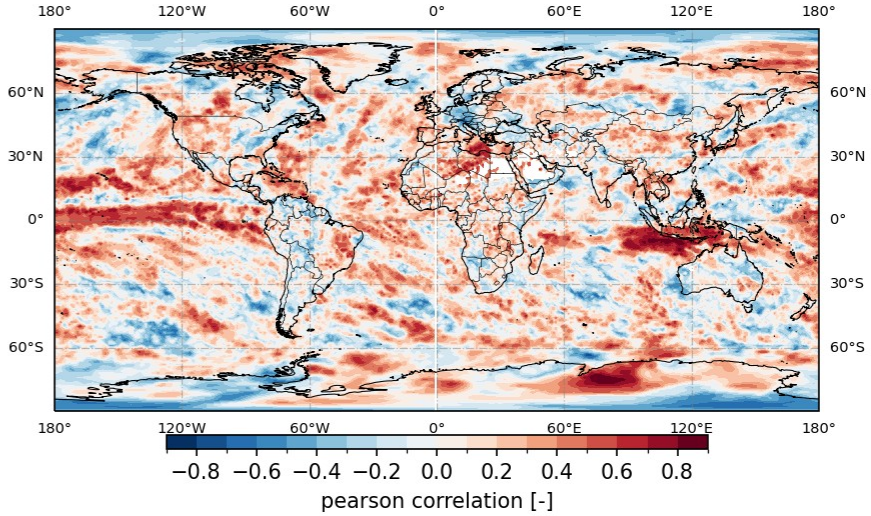
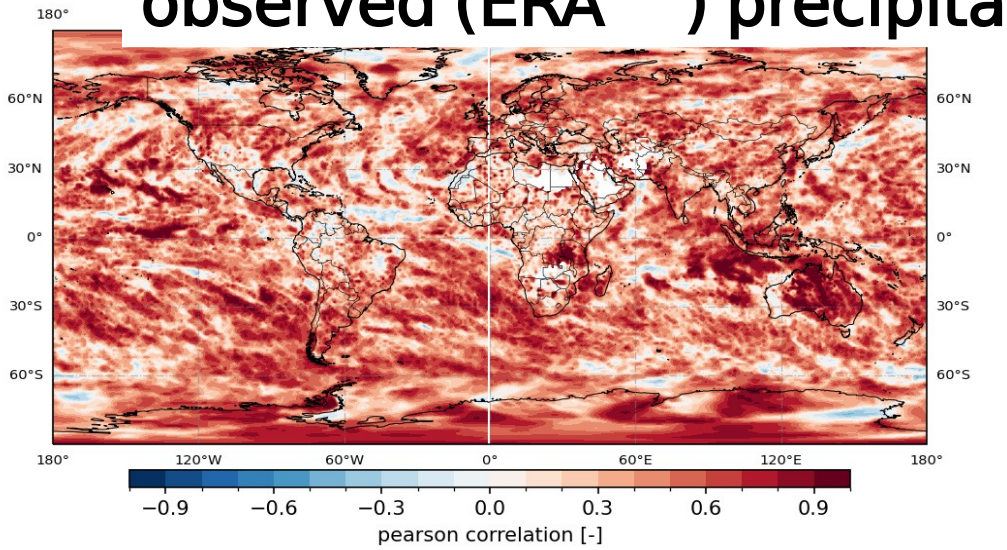
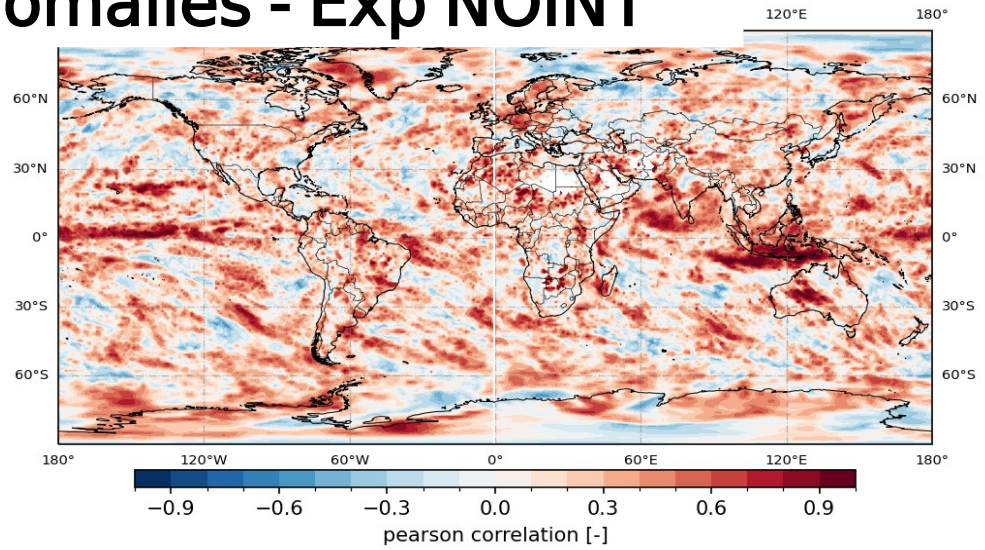


Correlation between the ensemble mean of members and observed (ERA) precipitation anomalies - Exp NOINT





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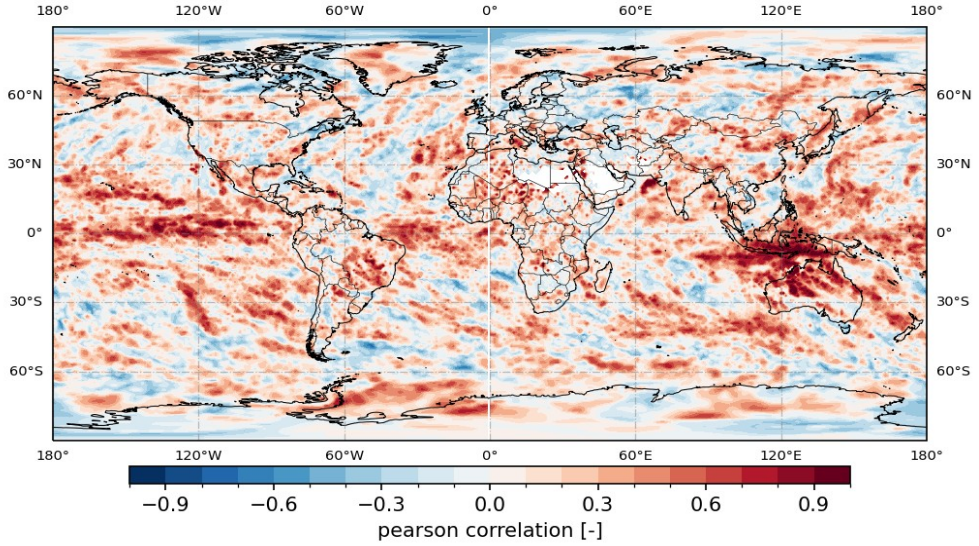

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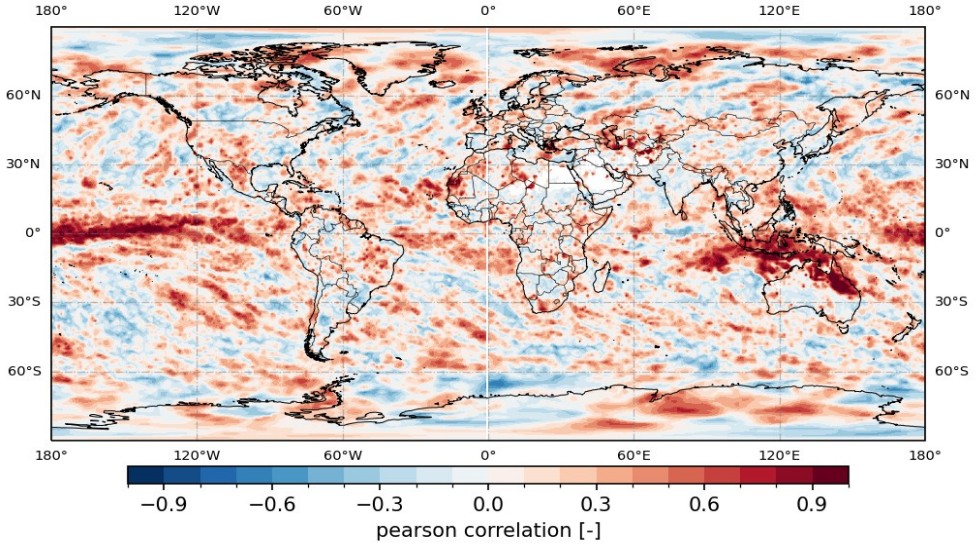
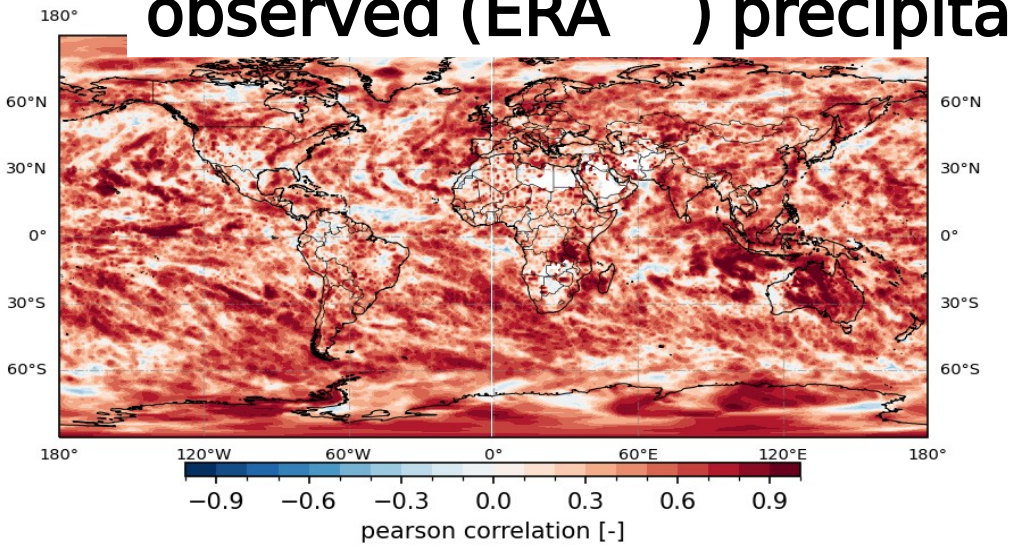
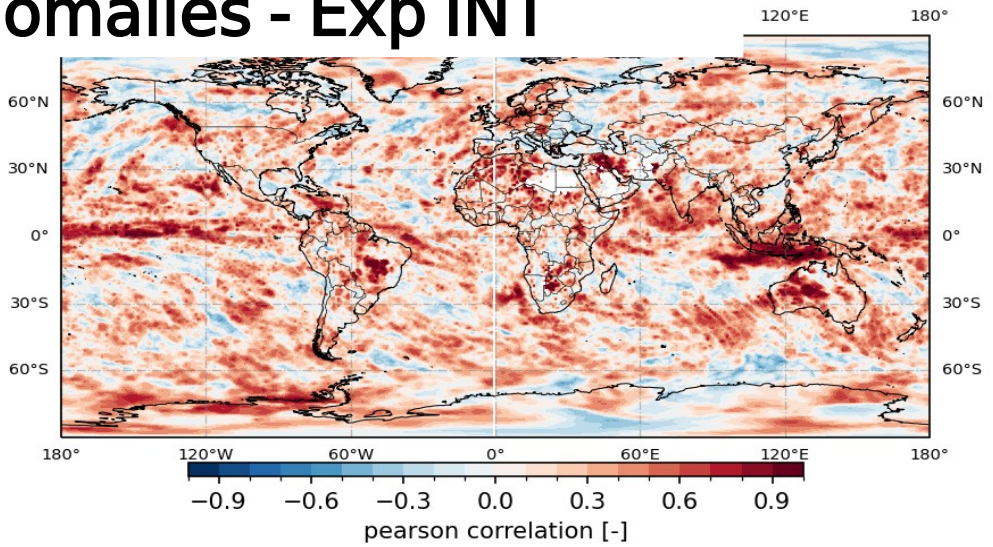


Correlation between the ensemble mean of members and observed (ERA) precipitation anomalies - Exp INT





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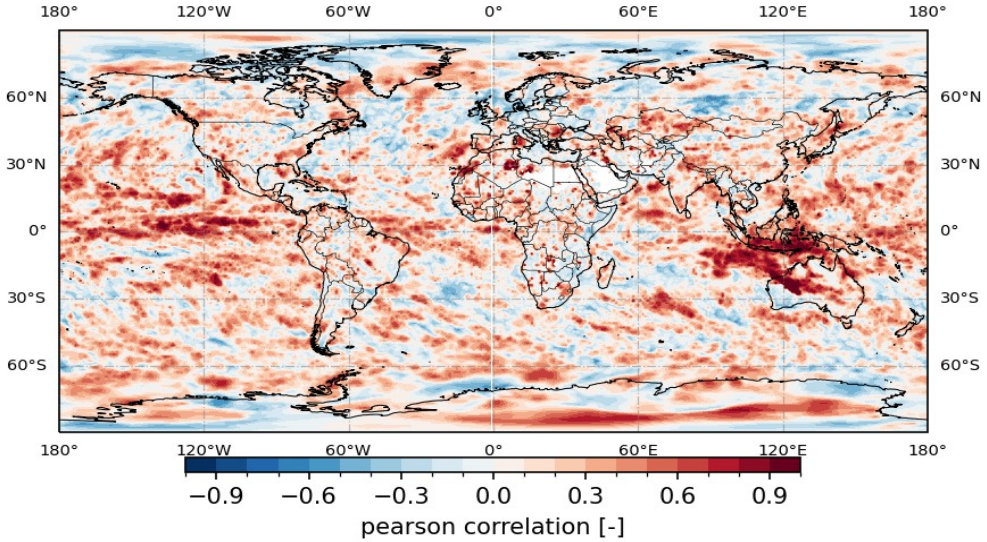

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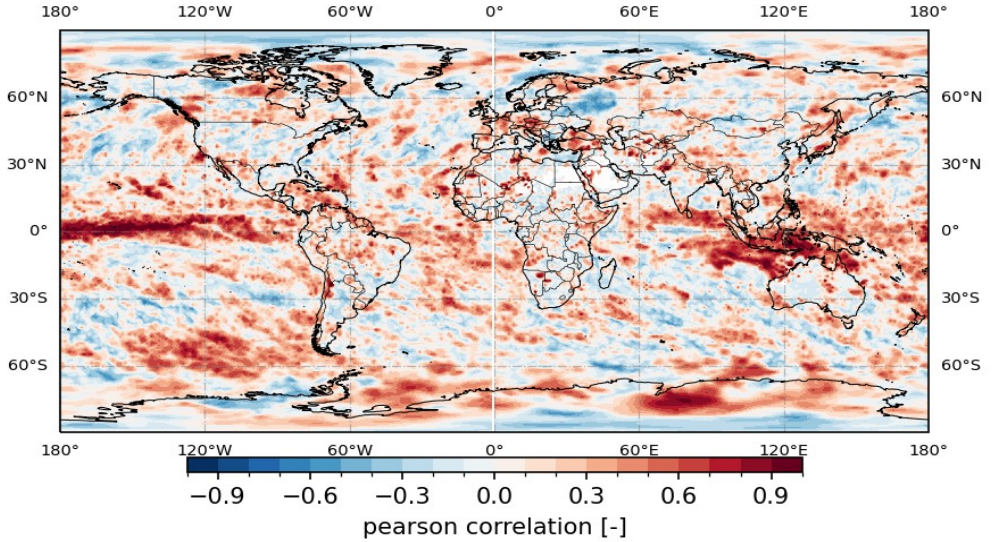
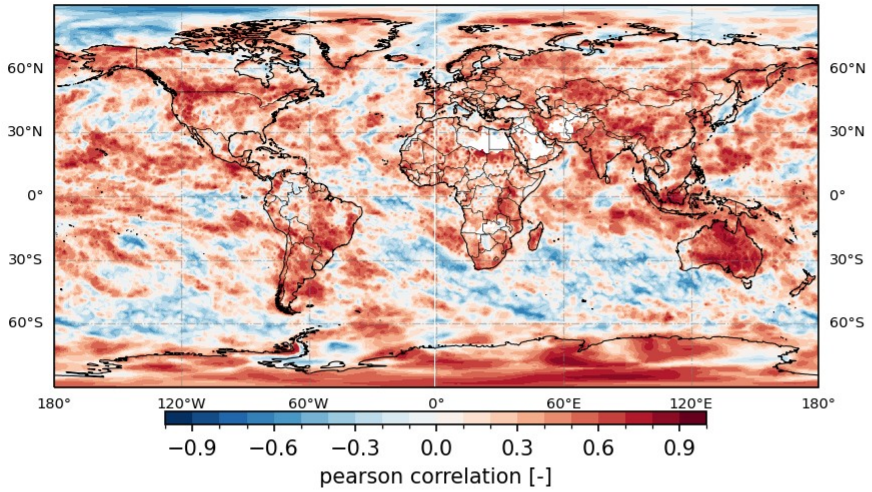
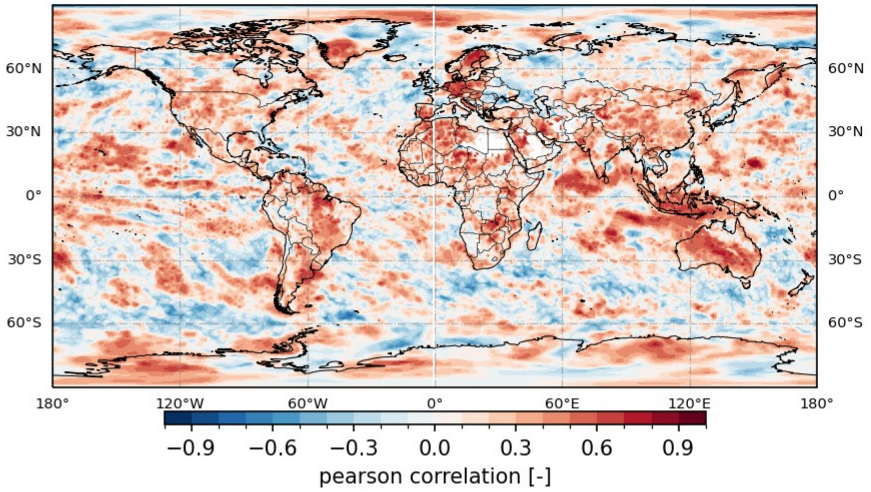


Correlation between the ensemble mean of members and observed (ERA) surface net downward longwave flux anomalies - **E x p N O I N T**





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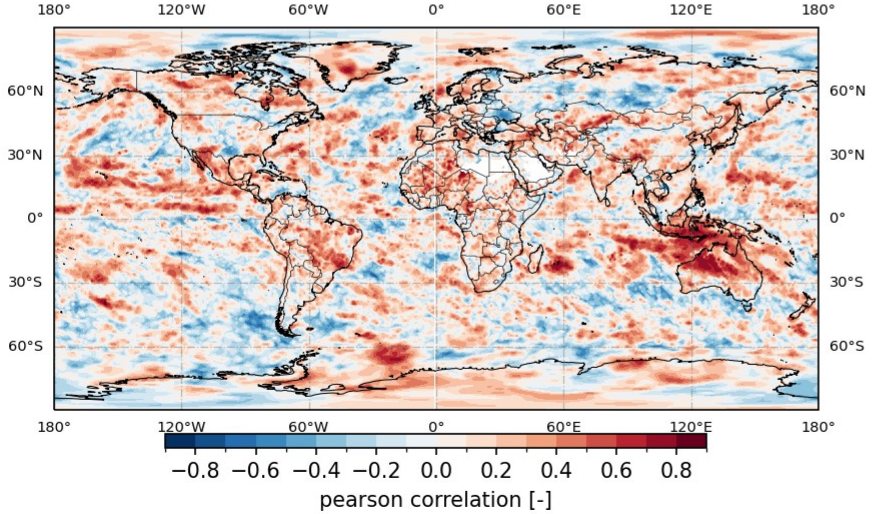
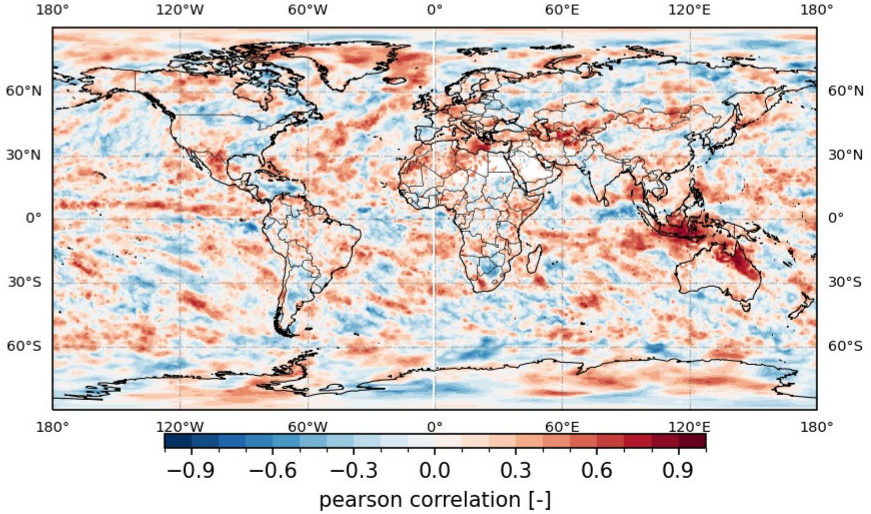
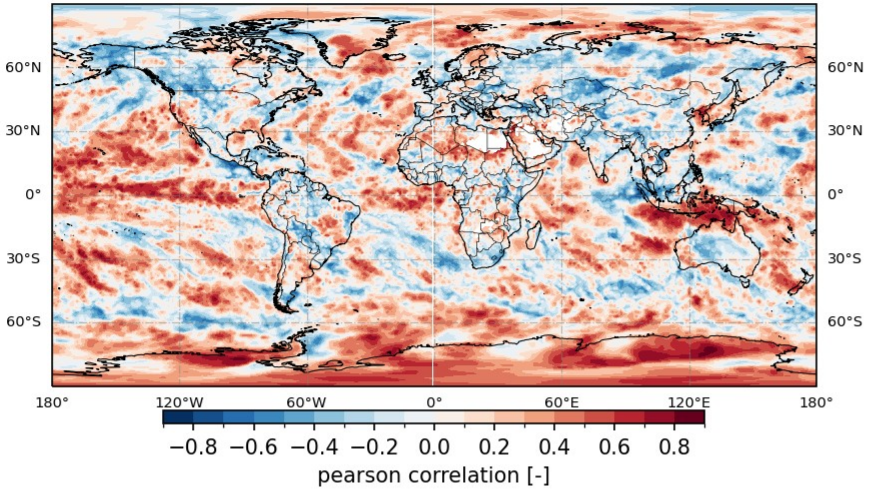
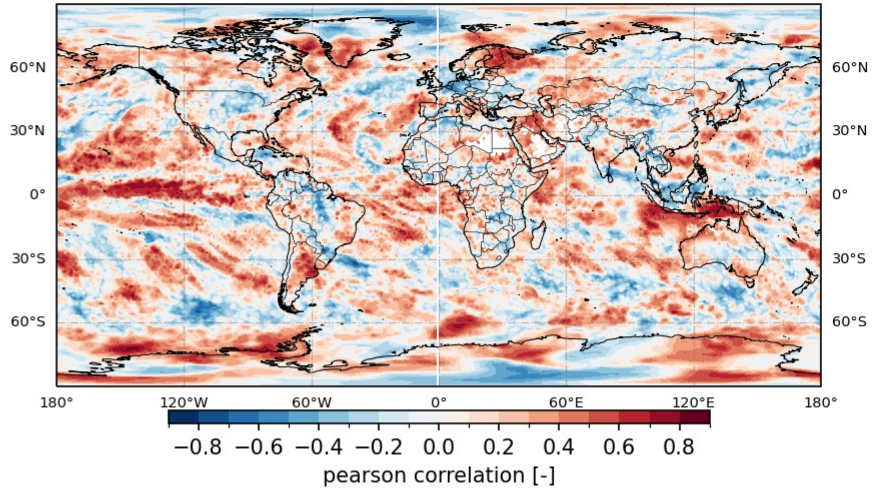


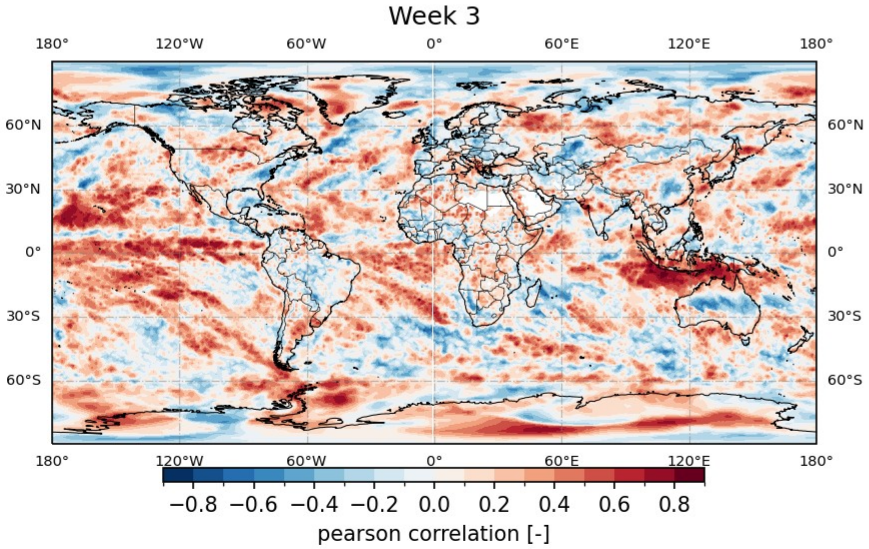
Week 4

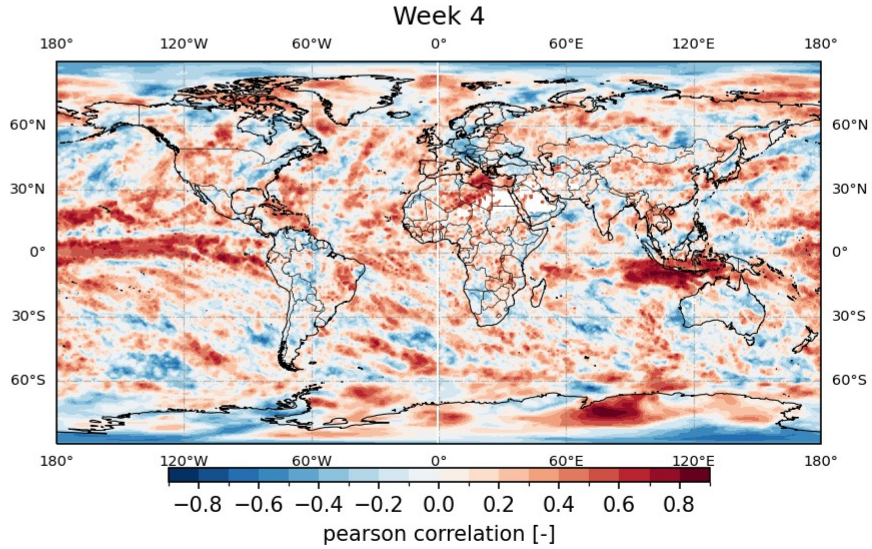


Correlation between the ensemble mean of members and observed (ERA) surface net downward longwave flux anomalies - **E x p I NT**

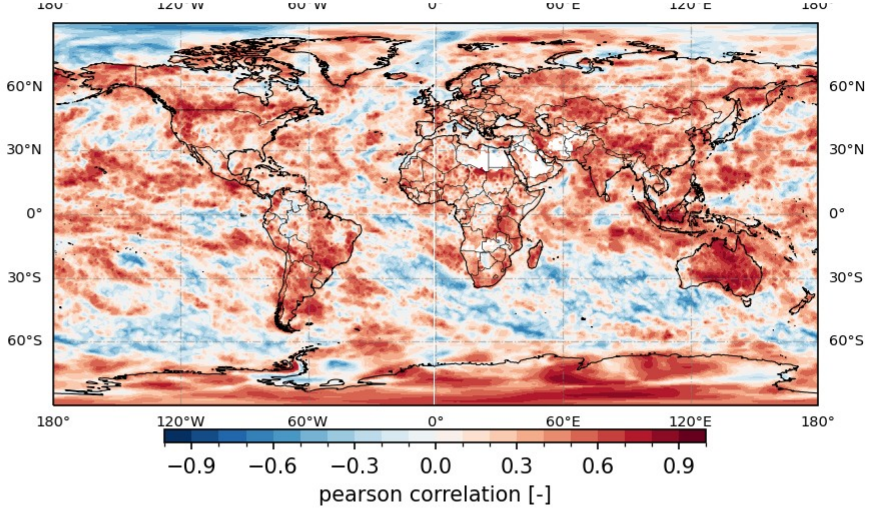


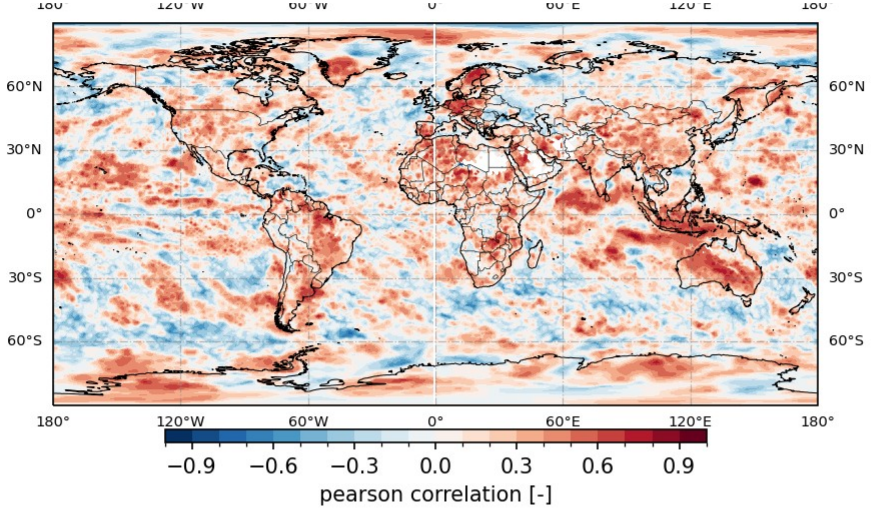


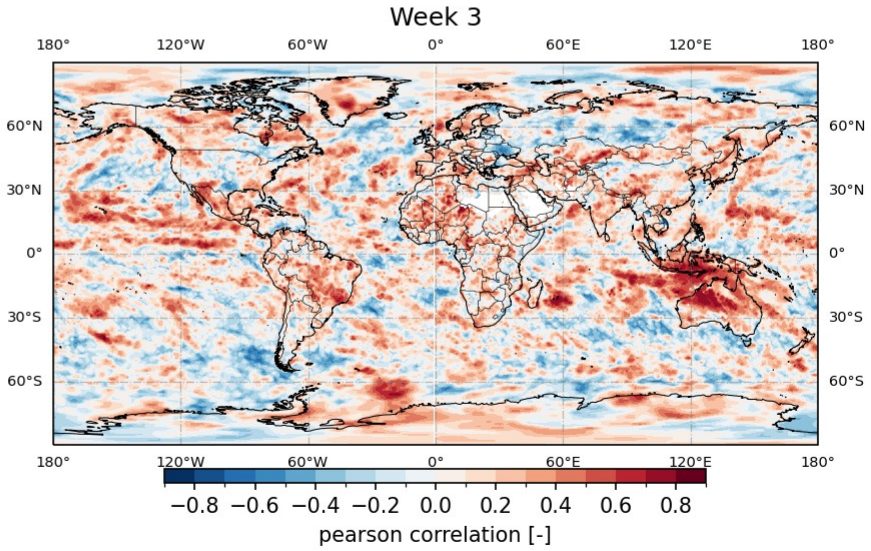


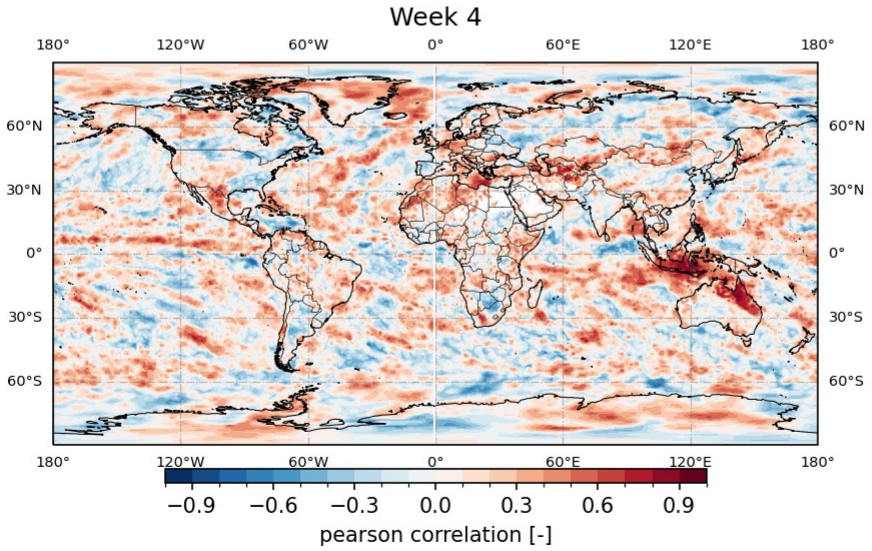


Correlation between the ensemble mean of members and observed (ERA) surface net downward shortwave flux anomalies - **E x p N O I N T**

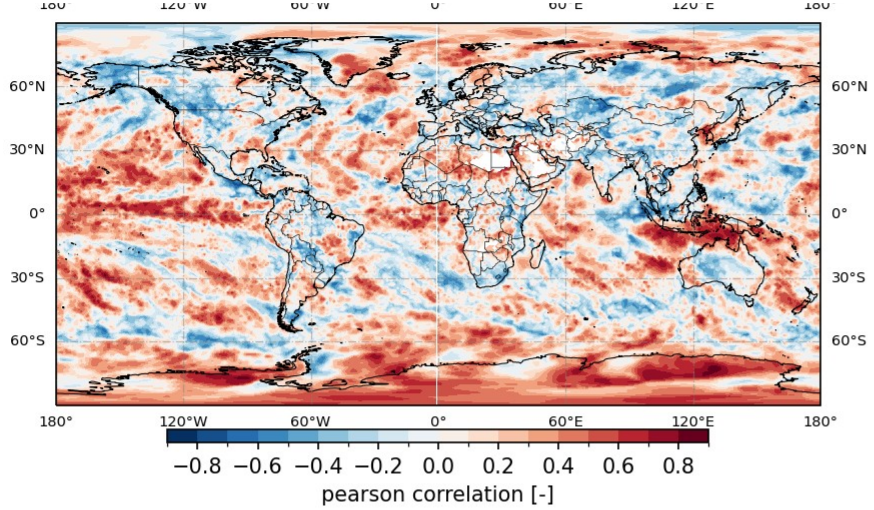


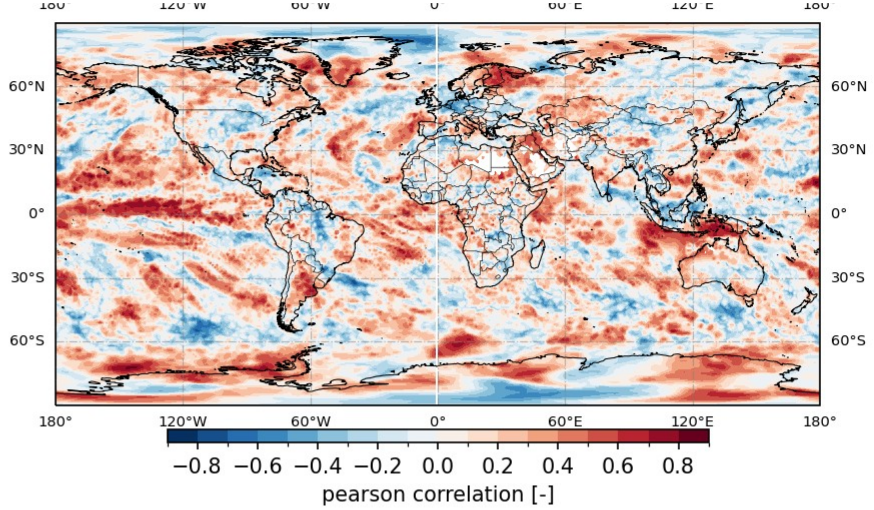


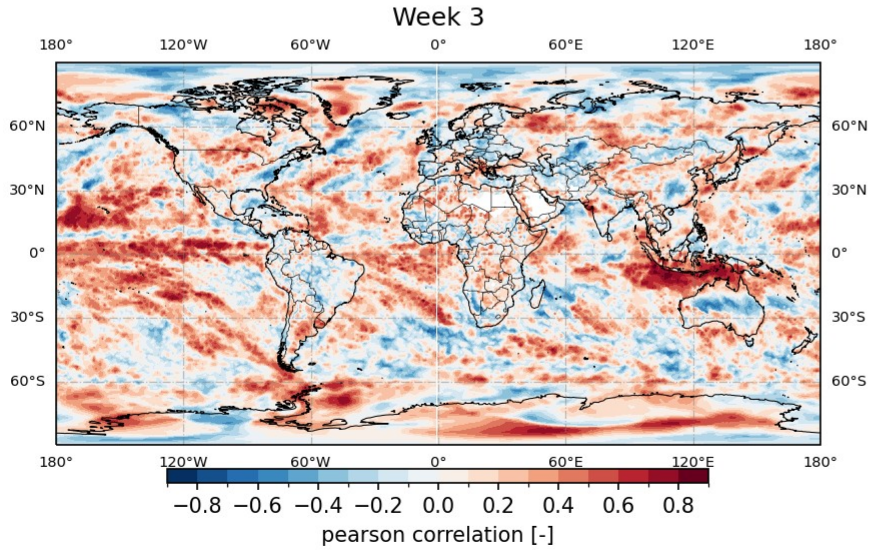


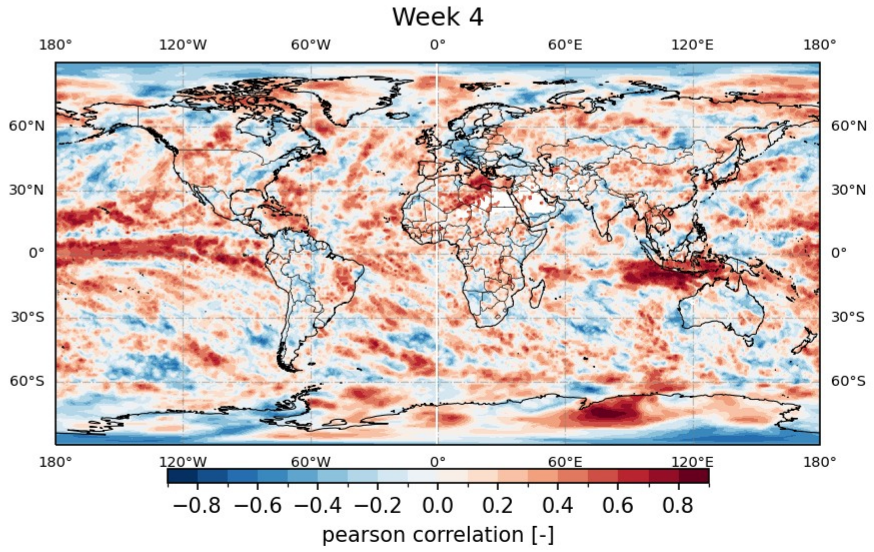


Correlation between the ensemble mean of members and observed (ERA) surface net downward shortwave flux anomalies - **E x p I NT**



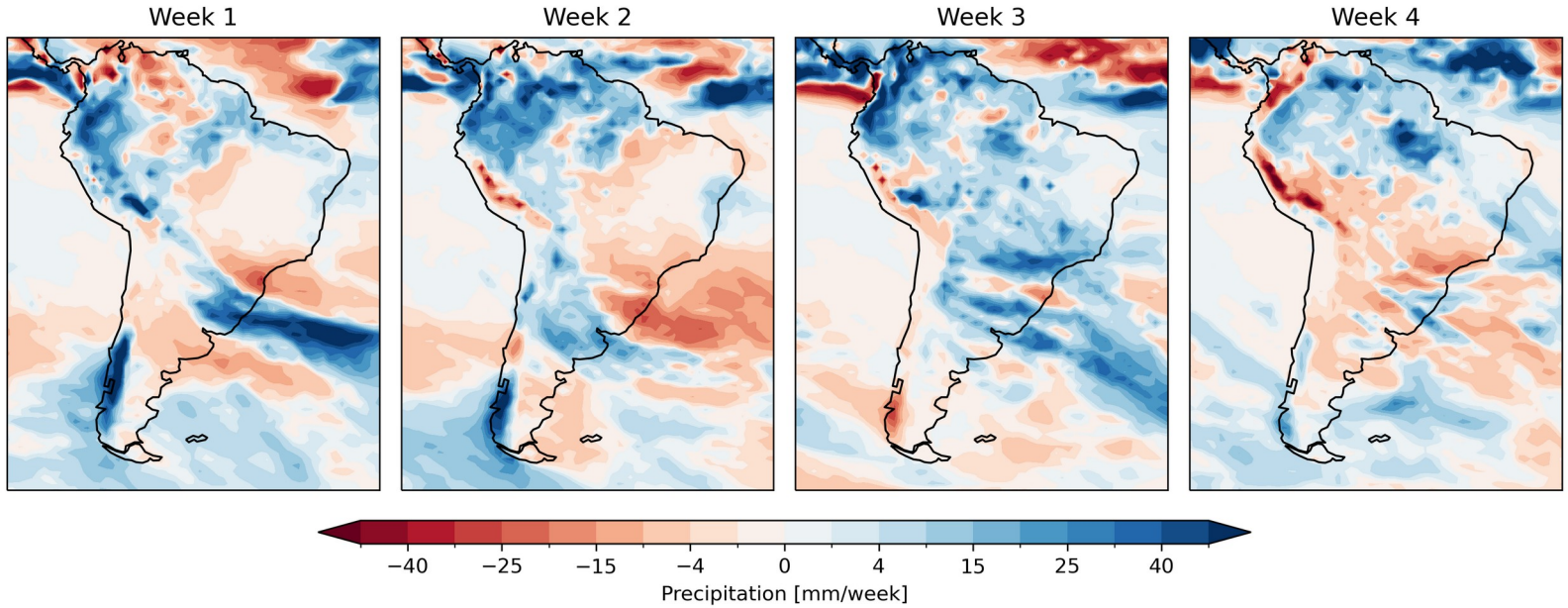




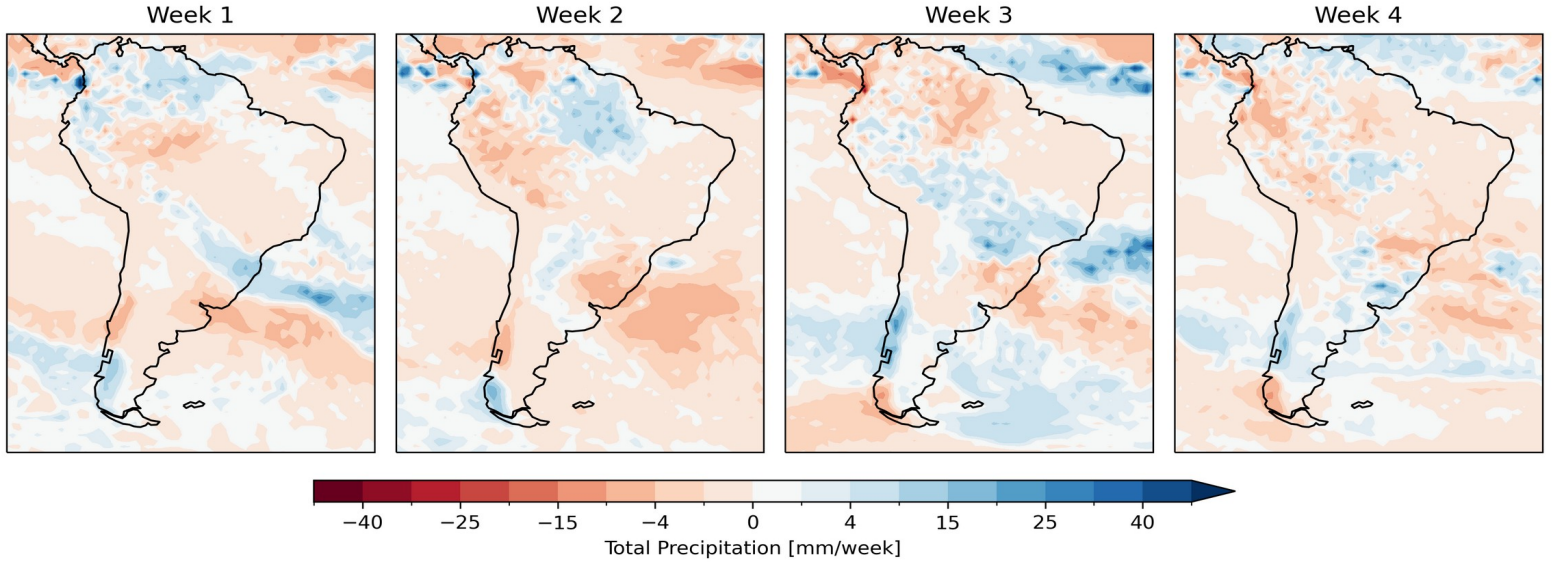


Precipitation anomaly - September 2018 - Exp NOINT

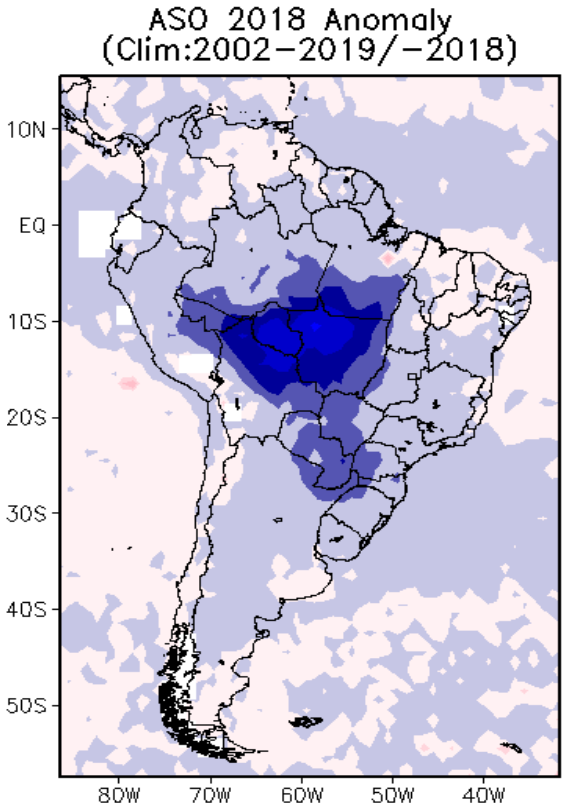
NASA



ERA5

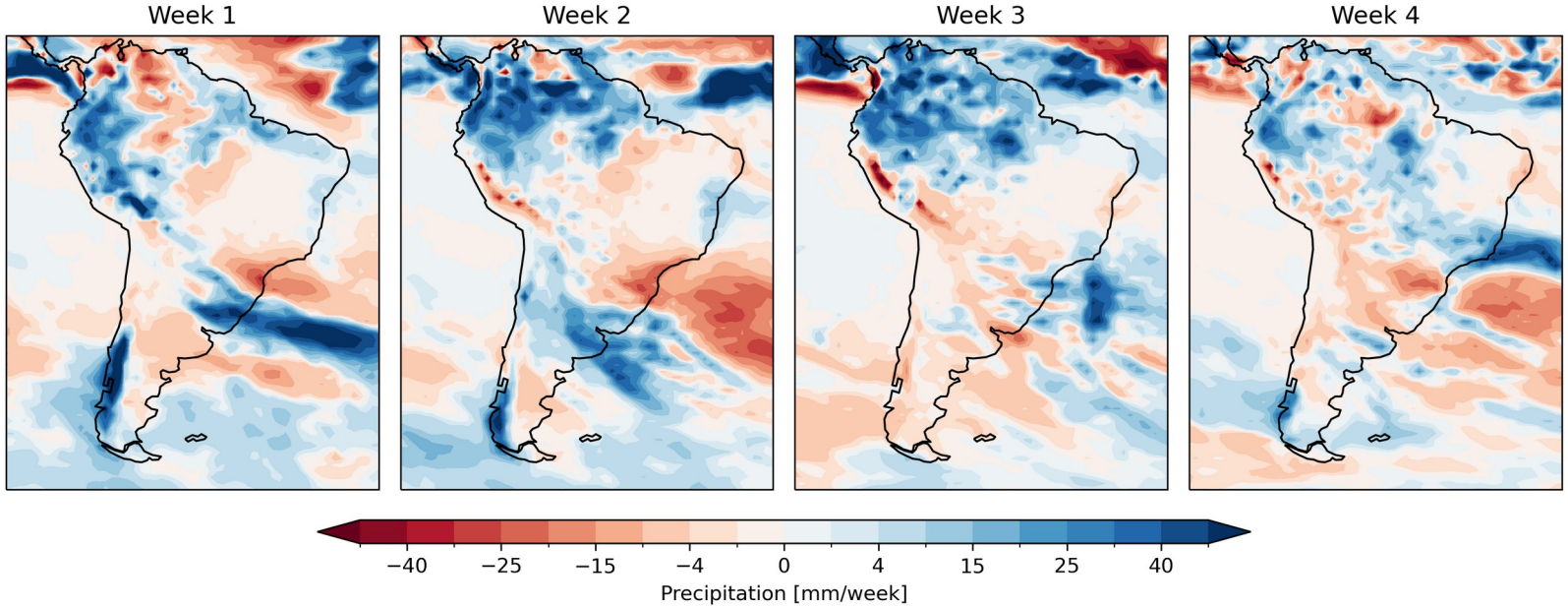


MODIS/NASA AOD Anomaly

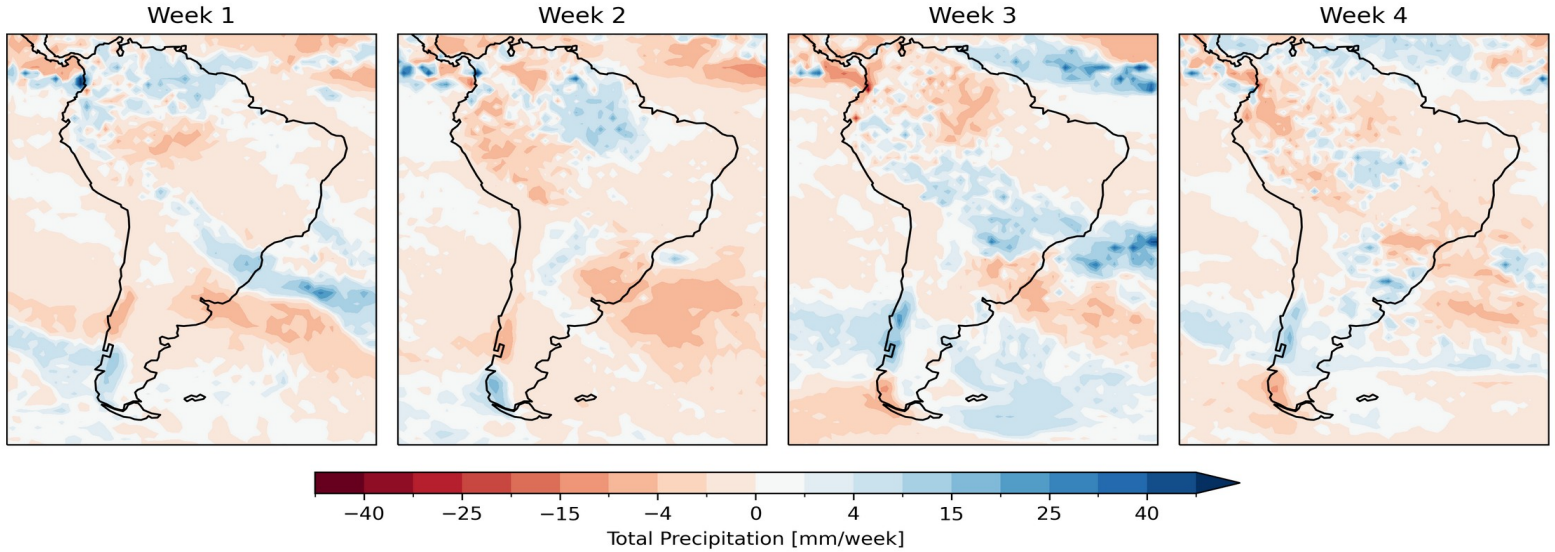


Precipitation anomaly - September 2018 - Exp INT

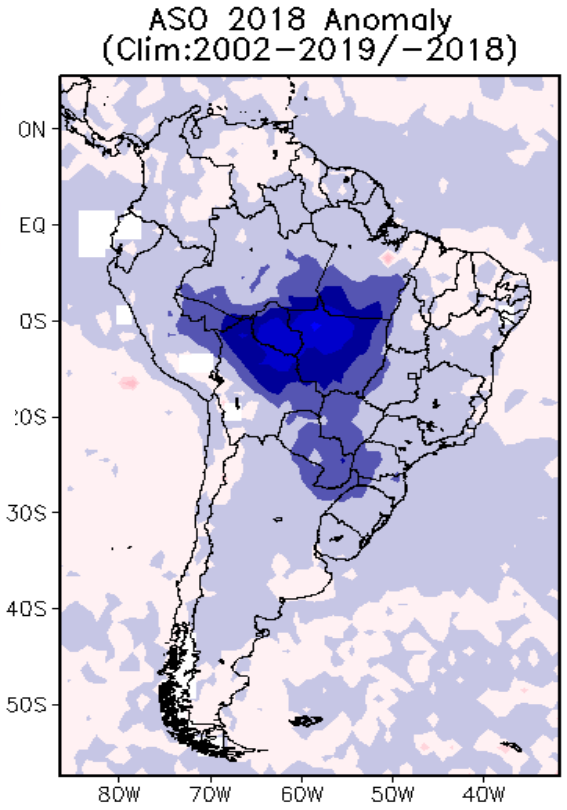
NASA



ERA5



MODIS/NASA AOD Anomaly



Conclusions

Aerosol-radiation interaction is, in general, well represented by NWP and climate models

Subseasonal experiments show improved skill for near surface meteorological variables

Impressive increase in correlation for surface net downward shortwave and longwave fluxes anomalies over oceans, especially for weeks 3-4

Improvement in precipitation and temperatures (not shown), especially for weeks 3-4

Aerosol-cloud interaction is a key process to be modeled in longer timescales

The WGNE Aerosol project:

Evaluating the impact of aerosols on Numerical Weather and Subseasonal Prediction

For more information visit:

https://wgne.net/activities/on-going-activities/

https://wgne.net/wp-content/uploads/ / /
WGNE_S2S_GAW_Aer_122020.pdf

Extra slides


Thanks!
BB in Amazon

Importance of aerosols for S2S predictability

May-June 2003-2015

11 ensemble members

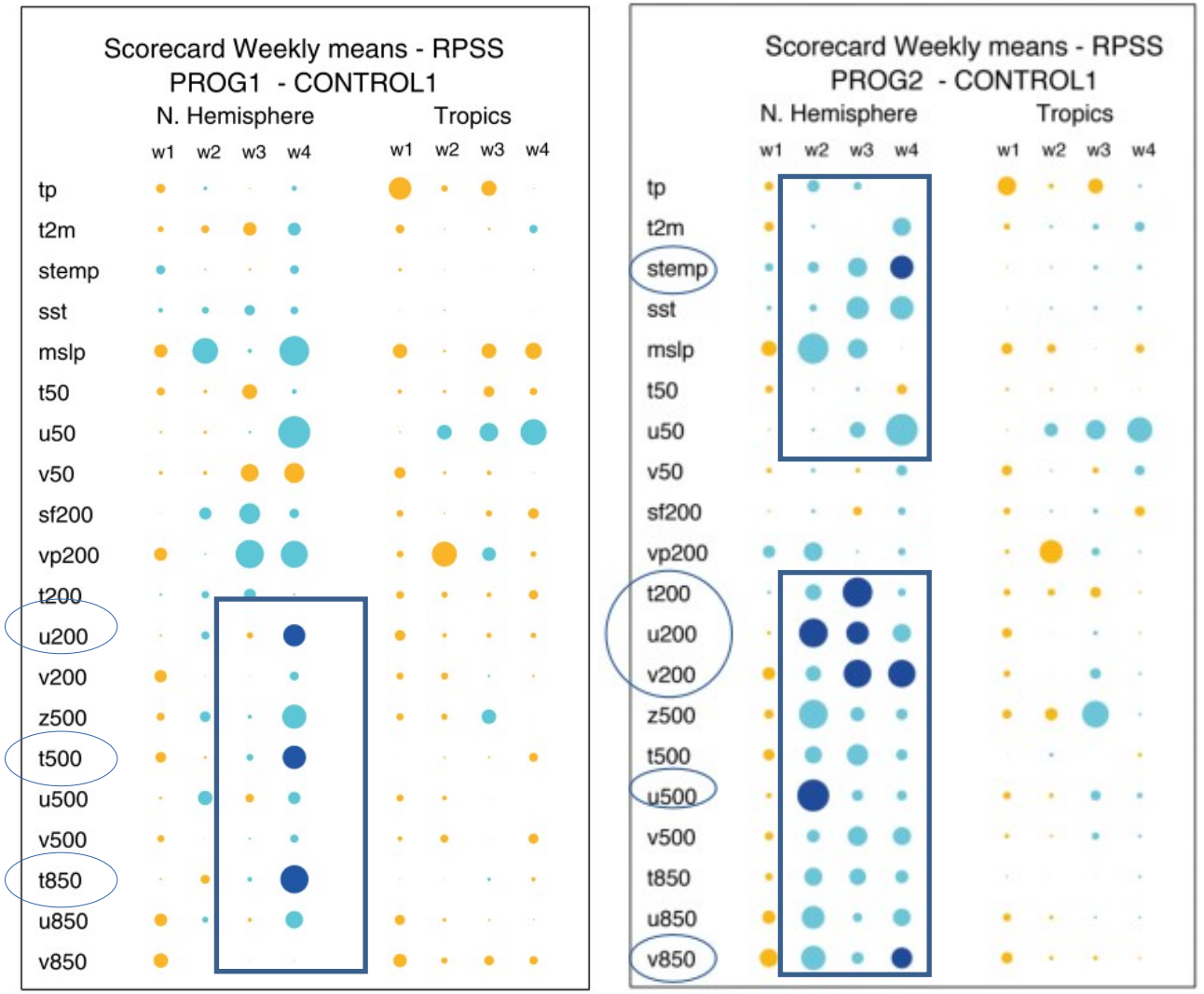
4 experiments:

→ Two different climatologies

→ Prognostic aerosols initialized using the time-varying CAMSira

→ Prognostic aerosols initialized using a fixed climatology (based on a CAMS experiments without data assimilation) –PROG2

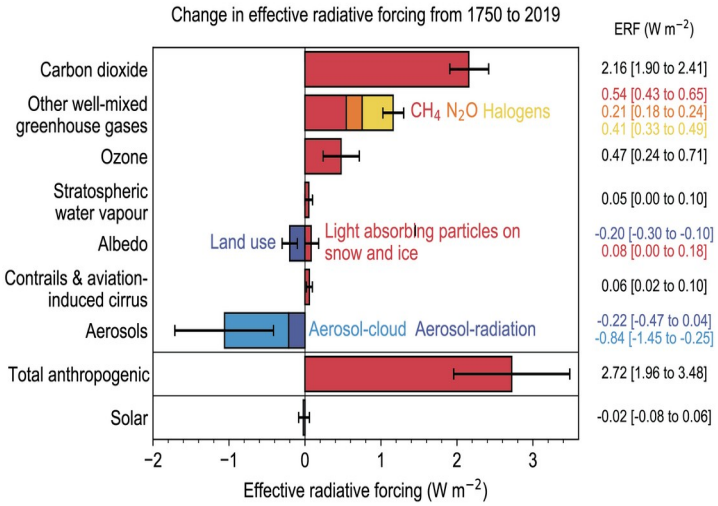
Only direct effect was considered

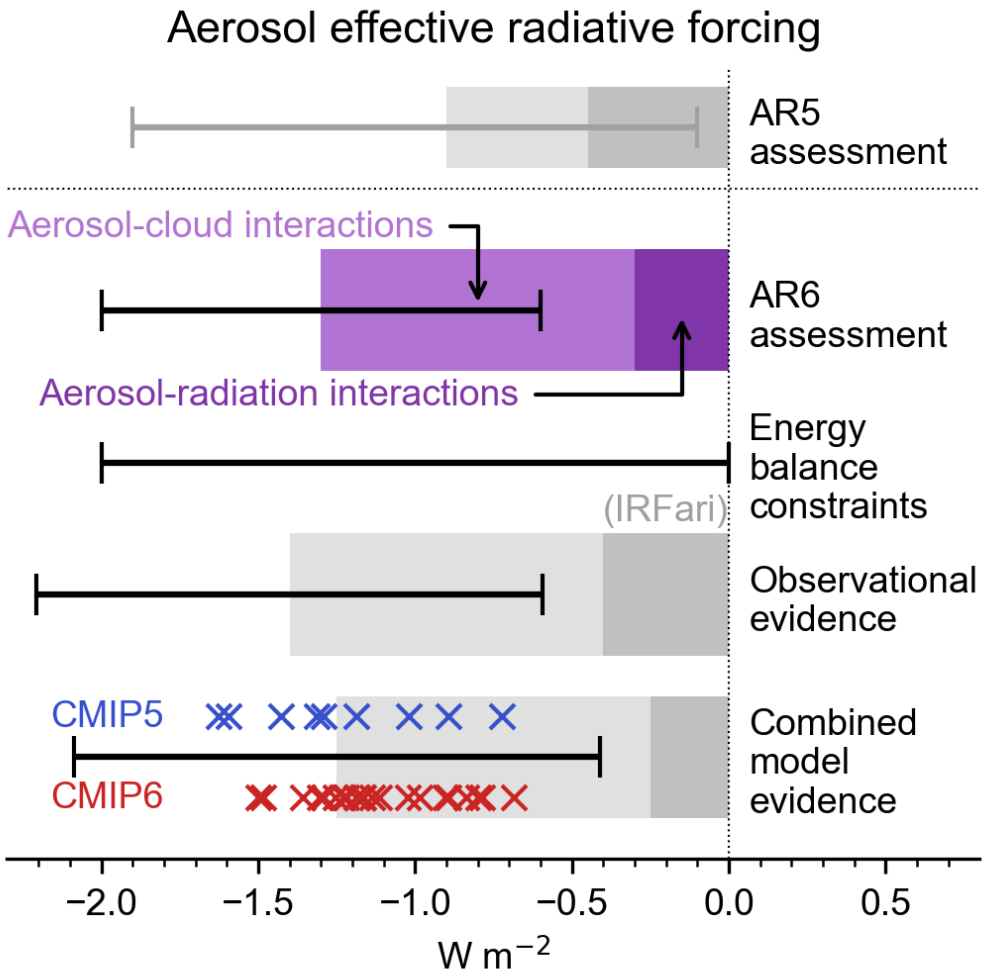


Benedetti and Vitart (2018, MWR)

Effective radiative forcing

Increased confidence in the quantification of changes in the ERF
-> improved observational records and closure of the sea level





ERF:
allows rapid adjustments to perturbations, for all variables except for global mean surface temperature or ocean temperature and sea ice cover

ERF**aci** (aer-cloud interactions) contributes most (75–80%) to the total aerosol effect (high confidence)

Forster and co-authors, AR6 IPCC 2021