

# DESTINATION EARTH CLIMATE DT: MODEL EVALUATION

The AQUA Team

## CLIMATE MODEL SIMULATIONS

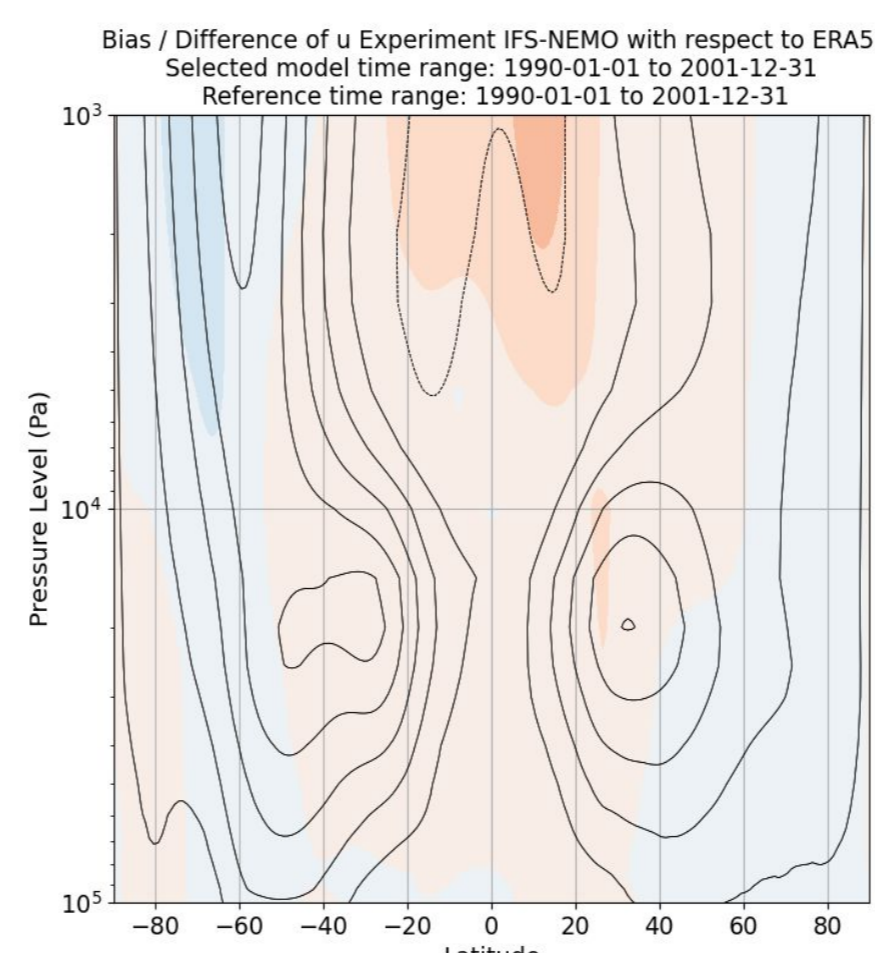
Evaluating climate models is a challenging task, especially considering the **big-data demands** of ClimateDT. Different stakeholders focus on varied aspects: local phenomena, climate sensitivity, temperature trends, or extremes, so that unique answer is hard to deliver.

Such complexity calls for **objective diagnostics combined with human interpretation**. AQUA software helps streamline the process, providing **key metrics** and solving most of the technical issues.

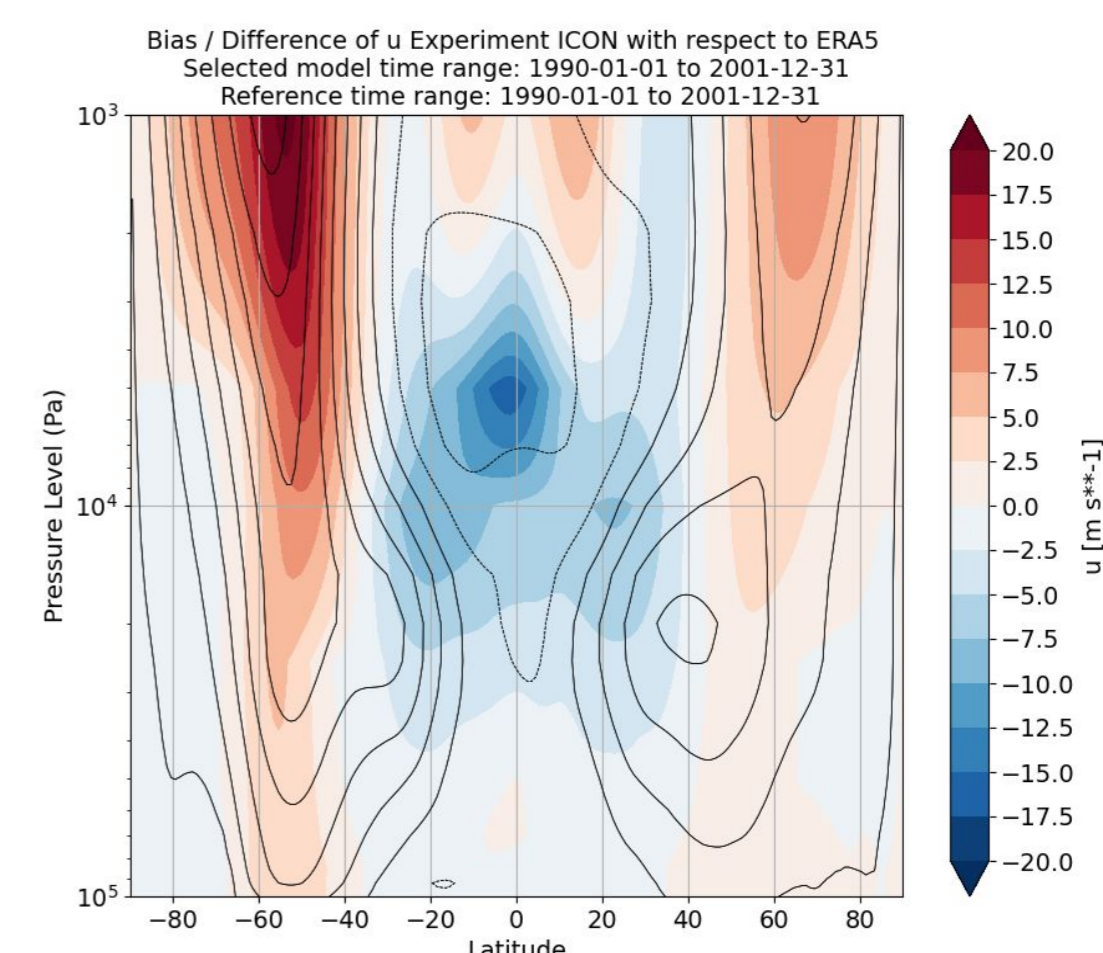
Experiment	Years	Atm Resolution	Oce Resolution
<b>ICON</b> historical-1990	1990-2015 (running to 2020)	10 km	5 km
SSP3-7.0	2020-2035 (running to 2040)	5 km	5 km

Experiment	Years	Atm Resolution	Oce Resolution
<b>IFS-NEMO</b> historical-1990	1990-2002	10 km	1/12 degree
SSP3-7.0	2020-2040	5 km	1/12 degree

## WIND PROFILES



**IFS-NEMO zonal wind** vertical structure of the atmosphere is fairly good with moderate bias in the stratosphere (disclaimer: comparison against ERA5)



**ICON** has some issues in the **pressure level structure** in Southern Hemisphere, with overly strong upper-layer westerly jet stream

## PERFORMANCE INDICES (PI)

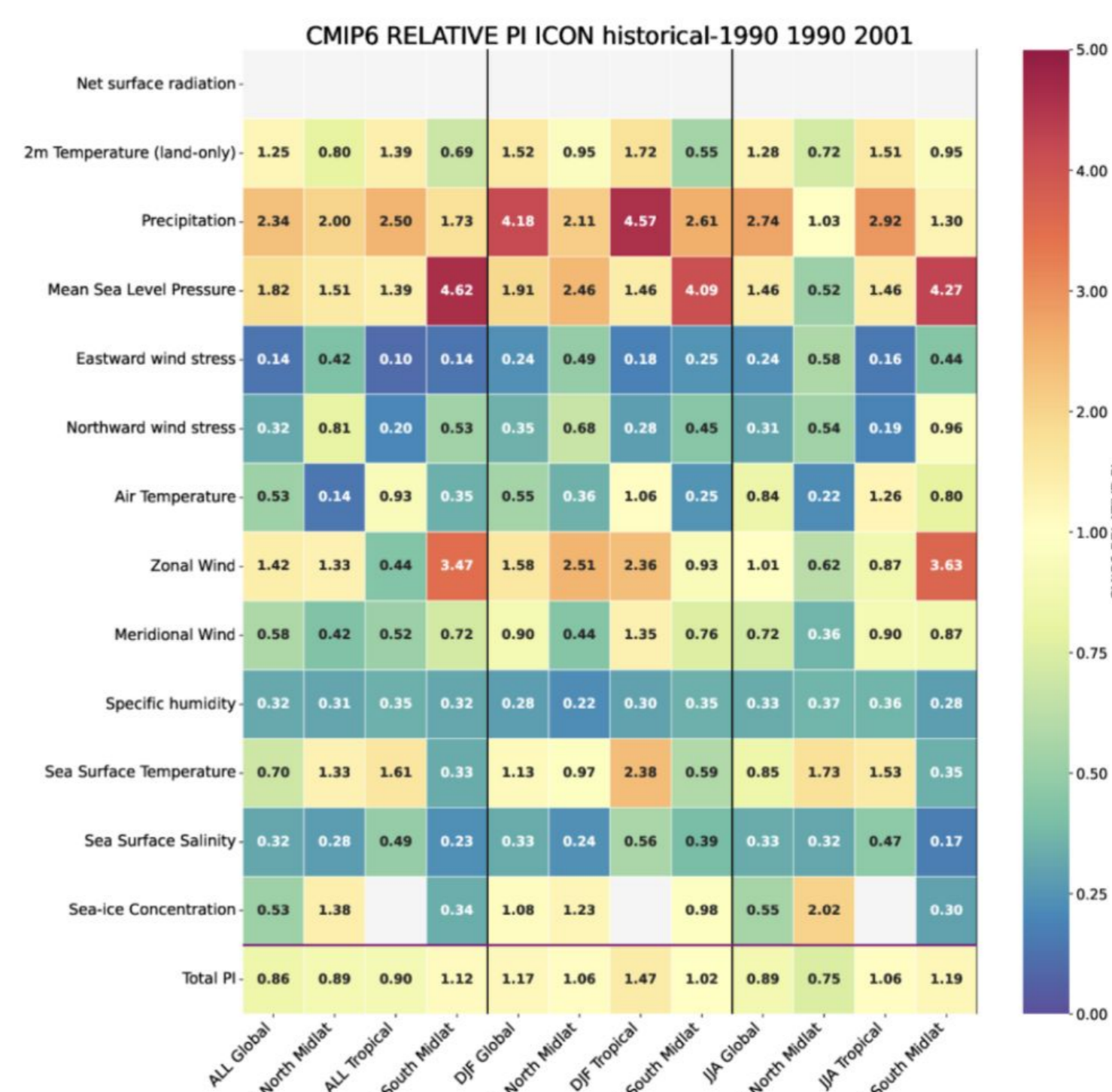
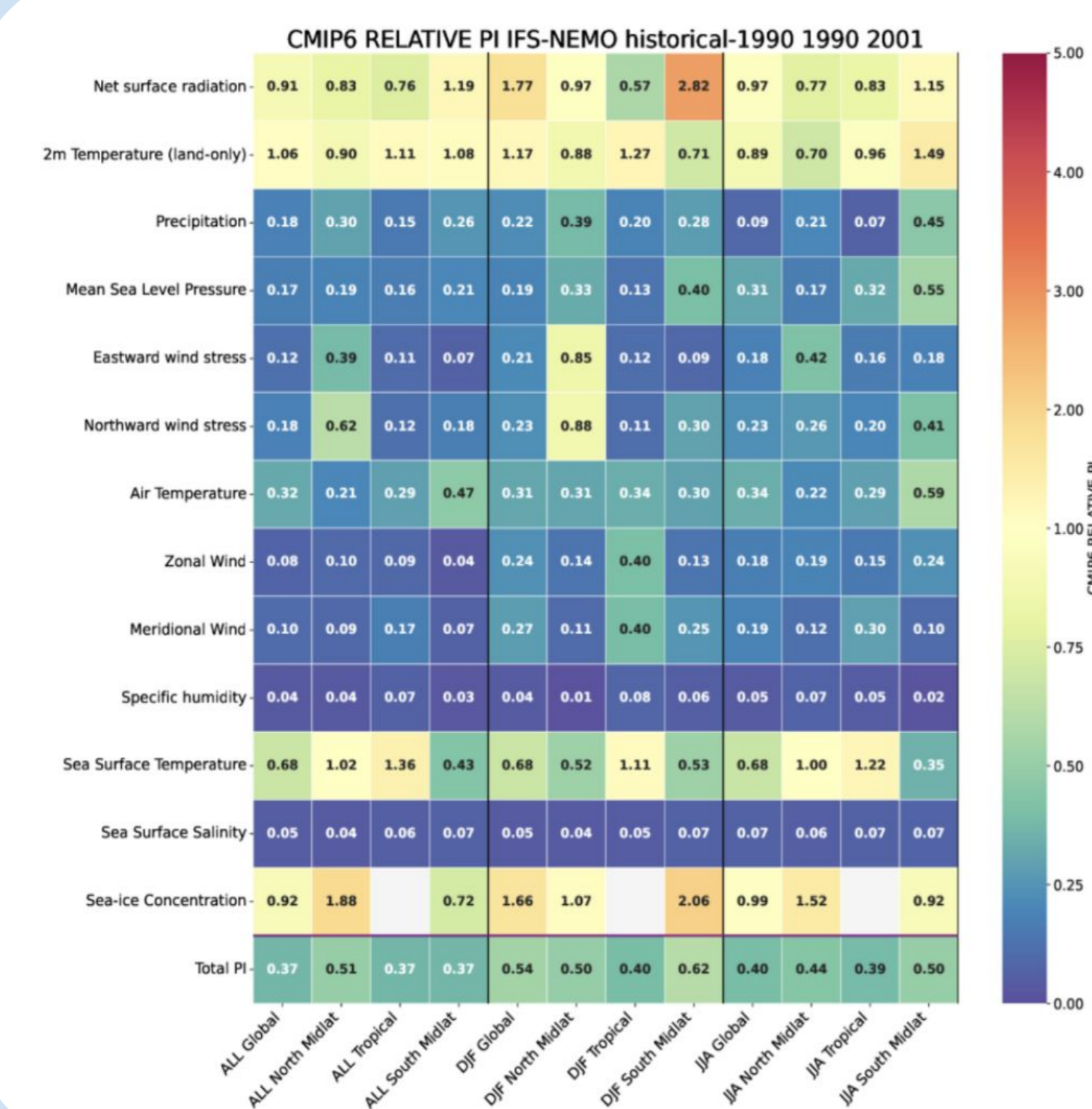
Reichler and Kim (2008) Performance Indices are a **compact metric to evaluate the model mean climate**.

$$PI = \frac{\sum (\text{Model climatology} - \text{observational climatology})}{\text{Observation variance}}$$

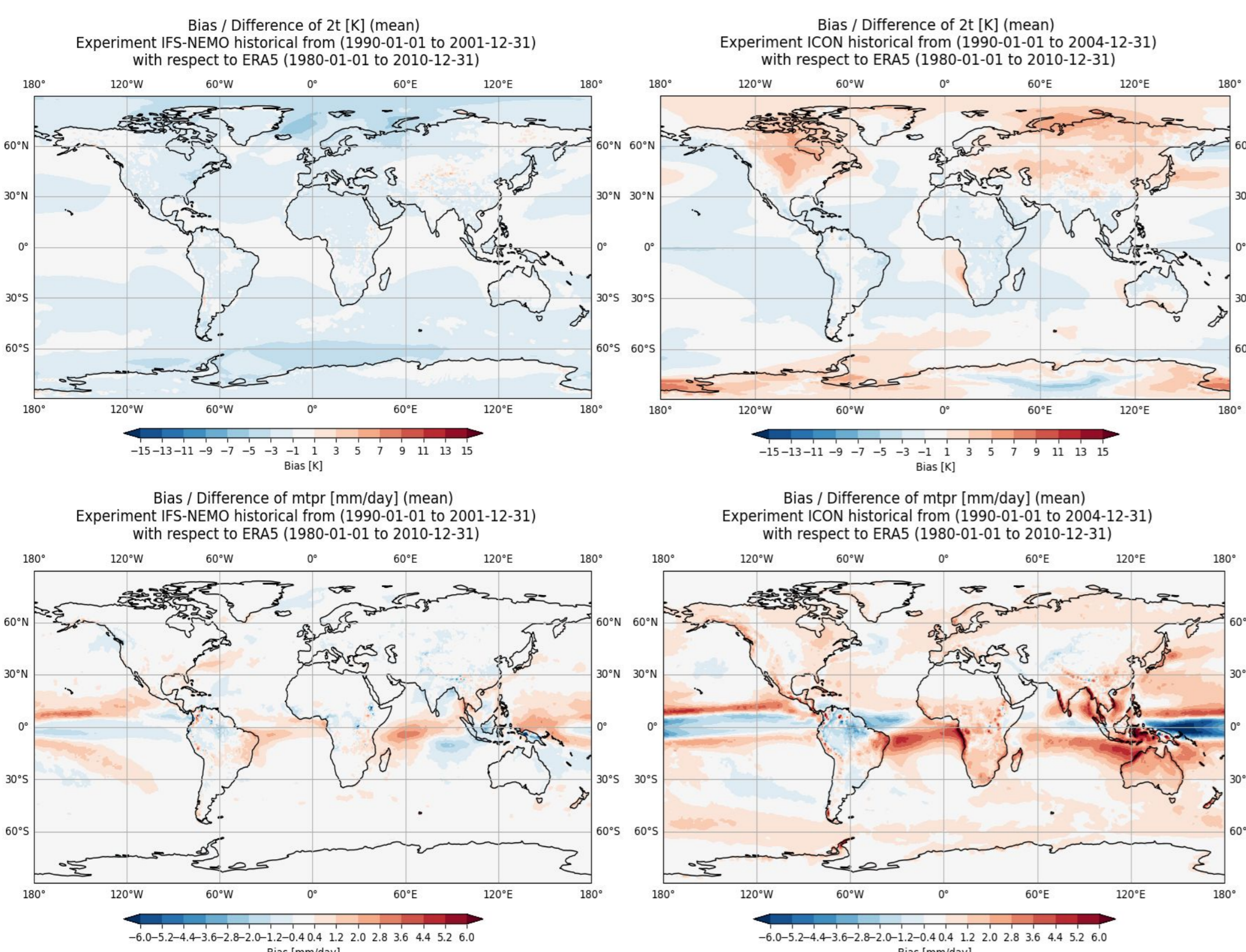
They can be **normalized** toward an "average" value which in our case is **CMIP6 model multi model mean**

**PI < 1**: the model is doing a good job compared to average CMIP6 models

**PI > 1**: the models is doing worse than the average of CMIP6 models



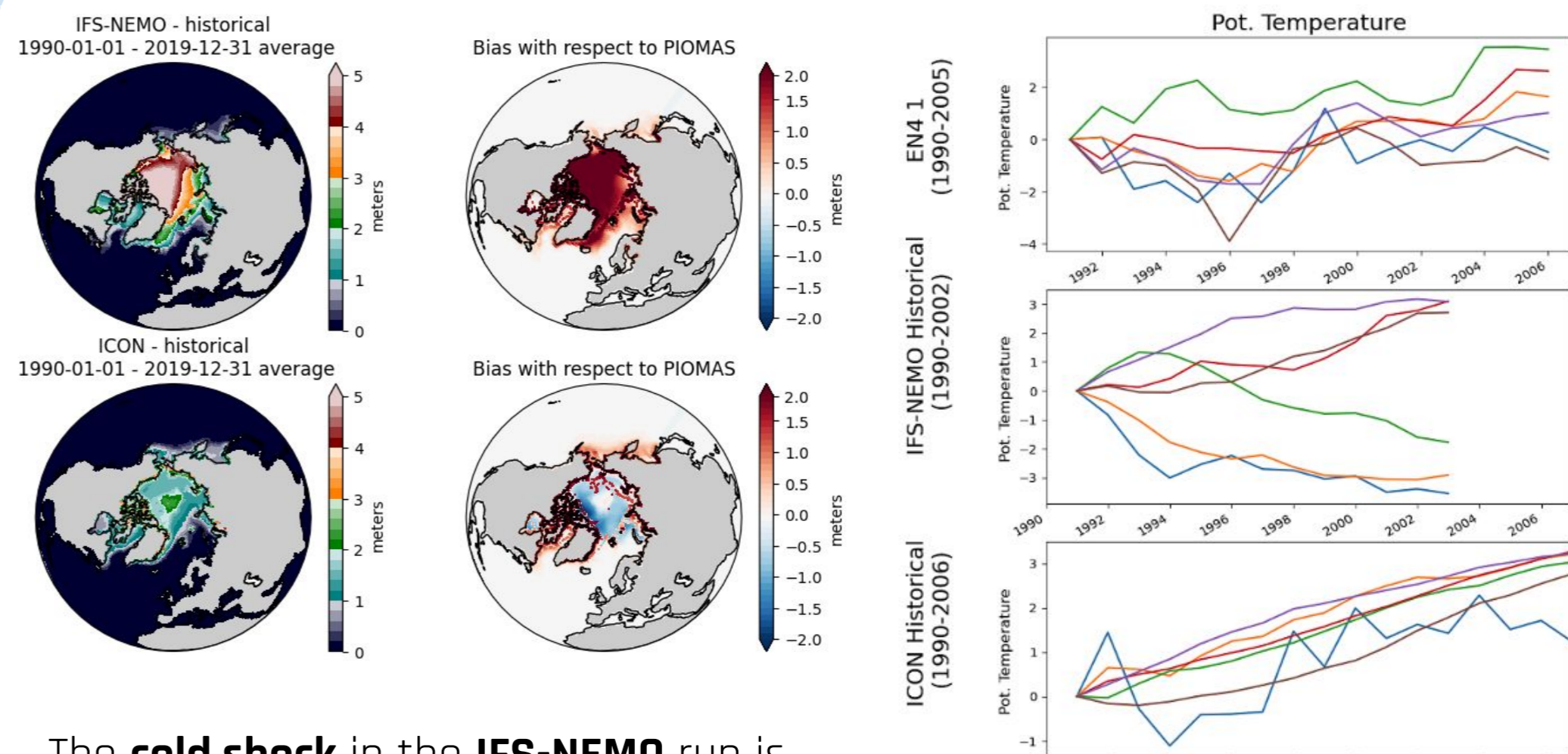
## TEMPERATURE AND PRECIPITATION



**IFS-NEMO** shows a larger negative temperature bias in polar regions, associated with to overestimated sea ice. Precipitation is well represented.

**ICON** shows a positive temperature bias at high latitudes and over NH continents, with precipitation overestimated in the Indian and Atlantic oceans, along with traces of a double ITCZ.

## STATE OF THE OCEAN



The **cold shock** in the **IFS-NEMO** run is due to a negative drift in surface and mid-ocean temperature, likely because the **oceanic model is not in equilibrium**. This results in **excess sea ice** in the Northern Hemisphere.

**ICON** conversely shows a clear **warming of all oceanic layers** as in observations, but this is likely **overestimated** suggesting a too large climate sensitivity

## Positive aspects

- **Very good mean climate** despite global surface temperature bias in IFS-NEMO
- High level of details in atmospheric and oceanic circulation in both models especially in IFS-NEMO
- On average both ICON and IFS-NEMO performance indices **better** than the **average of CMIP6** output

## Things to be improved

- Too **cold 2m-temperature** in historical and lack of warming in scenario likely due to suboptimal tuning (IFS-NEMO)
- Excessive precipitation in tropical areas (ICON)
- Wrong pressure patterns in Southern Hemisphere (ICON)
- **Preliminary tests after careful tuning on IFS-NEMO reduced the cold temperature bias for Phase 2**

## Contact us:

[silvia.caprioli@polito.it](mailto:silvia.caprioli@polito.it), [p.davini@isac.cnr.it](mailto:p.davini@isac.cnr.it)

[github.com/DestinE-Climate-DT/AQUA](https://github.com/DestinE-Climate-DT/AQUA) (code will be open source soon)