Multi-model forecast quality assessment of CMIP6 decadal predictions

Carlos Delgado-Torres[1], Markus G. Donat[1,2], Nube Gonzalez-Reviriego[1], Louis-Philippe Caron[1,3], Panos J. Athanasiadis[4], Pierre-Antoine Bretonnière[1], Nick J. Dunstone[5], An-Chi Ho[1], Dario Nicolì[4], Klaus Pankatz[6], Andreas Paxian[6], Núria Pérez-Zanón[1], Margarida Samsó Cabré[1], Balakrishnan Solaraju-Murali[1], Albert Soret[1], Francisco J. Doblas-Reyes[1,2]

[1]Barcelona Supercomputing Center (BSC), Barcelona, Spain
[2]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain
[3]Ouranos, 550 Sherbrooke St W, Montreal, QC, Canada
[4]Centro Euro-Mediterraneo sui Cambiamenti Climatici, Bologna, Italy
[5]Met Office Hadley Centre, FitzRoy Road, Exeter, EX1 3PB, UK
[6]Business Area of Climate and Environment, Deutscher Wetterdienst, Offenbach (Main), Germany

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

This presentation participates in OSPP
Outstanding Student Poster & PICO Contest

EGU General Assembly 2022

Vienna, May 2022

European Climate Prediction system
H2020 grant 776613

Climate Change Service
climate.copernicus.eu
ECMWF/COPERNICUS/2019/C3S_34c_DWD

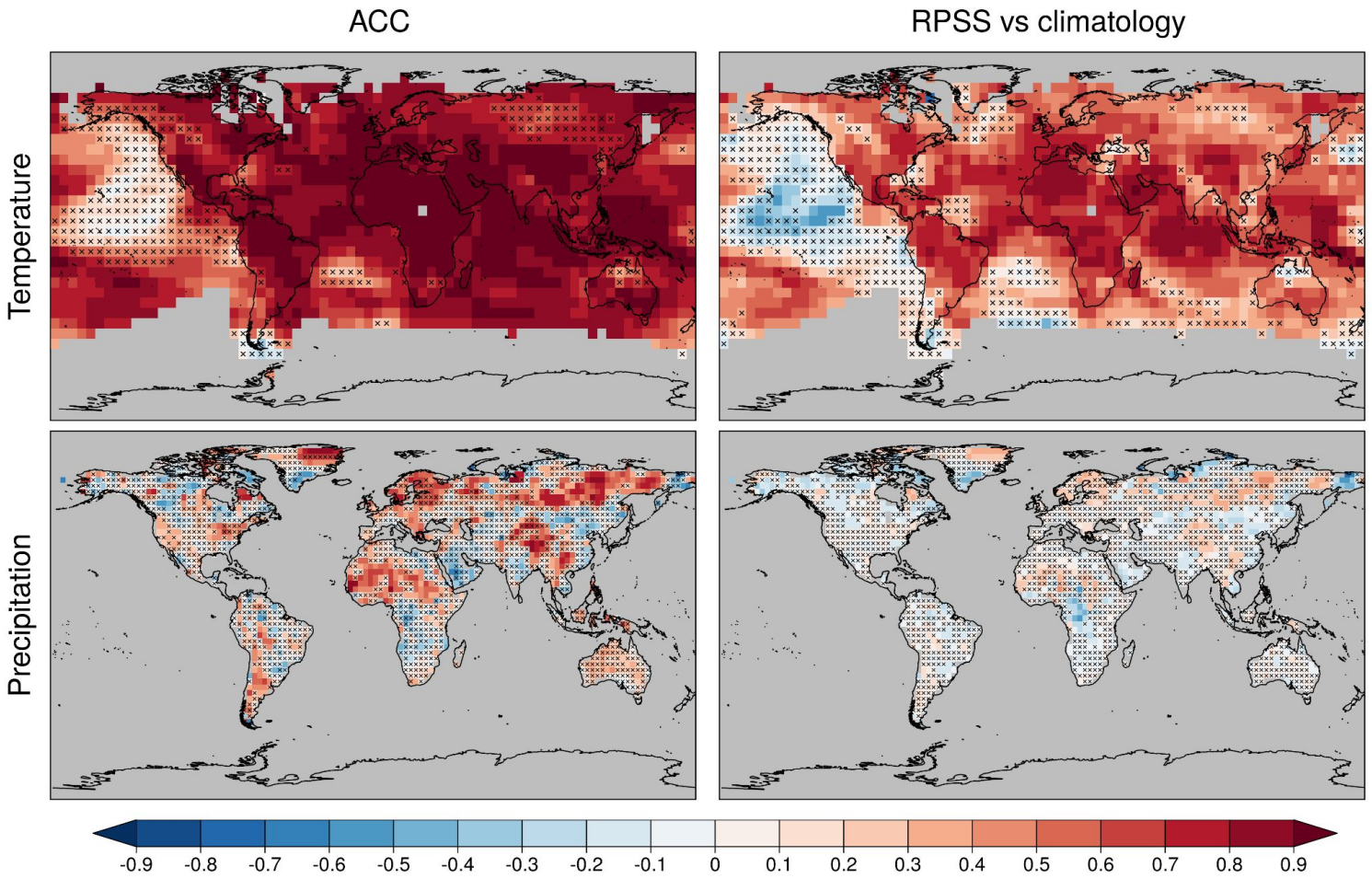
Data and methods

- **Evaluation period**: 1961-2014 (start dates 1960-2009)
- **Forecast period**: years 1-5
- **Reference period**: 1981-2010
- **Variables**: temperature and precipitation
- **Indices**: AMV index and GSAT anomalies
- **Evaluation metrics**:
  - Deterministic forecasts: ACC and Residual ACC
  - Probabilistic forecasts: RPSS for 3 categories
- **Reference forecasts:**
  - Climatological forecast
  - Individual forecast systems
  - Historical forcing simulations

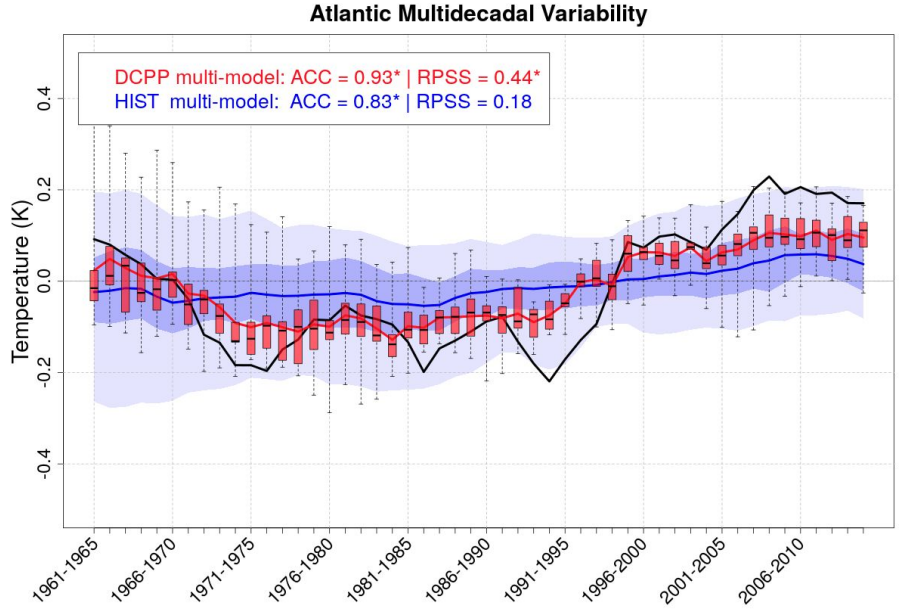
Forecast system	DCPP-A members	Historical members	Initialisation month
BCC-CSM2-MR	8	3	January
CanESM5	20	40	January
CESM1-1-CAM5-CMIP5	40	40	November
CMCC-CM2-SR5	10	1	November
EC-Earth3-i1	10	10	November
EC-Earth3-i2	5	-	November
HadGEM3-GC3.1-MM	10	4	November
IPSL-CM6A-LR	10	32	January
MIROC6	10	10	November
MPI-ESM1.2-HR	10	10	November
MPI-ESM1.2-LR	16	10	November
MRI-ESM2-0	10	5	November
NorCPM1	10	30	October
	169 members	**195 members**	

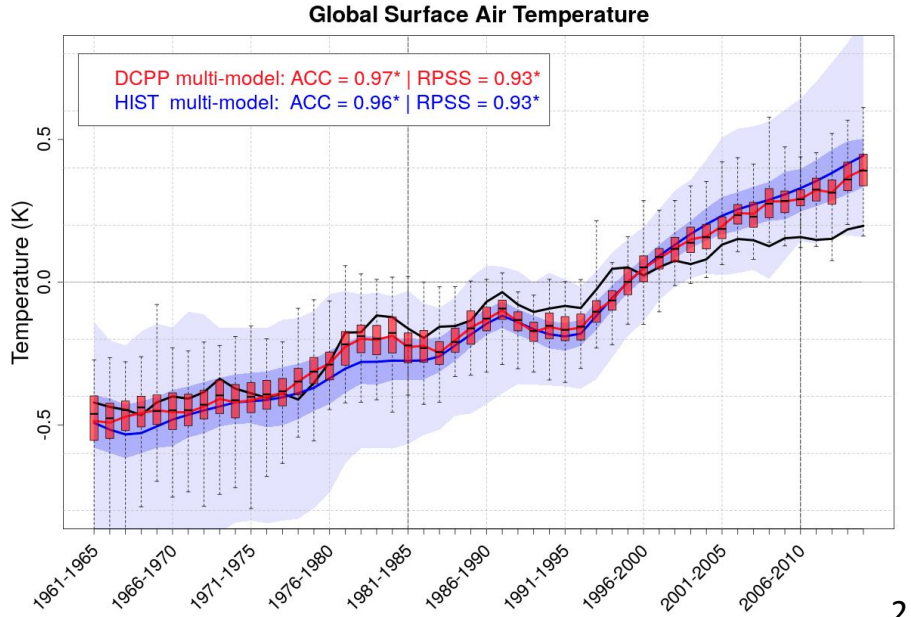
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

DCPP multi-model skill



Multi-model **worse** than climatology ← | →Multi-model **better** than climatology

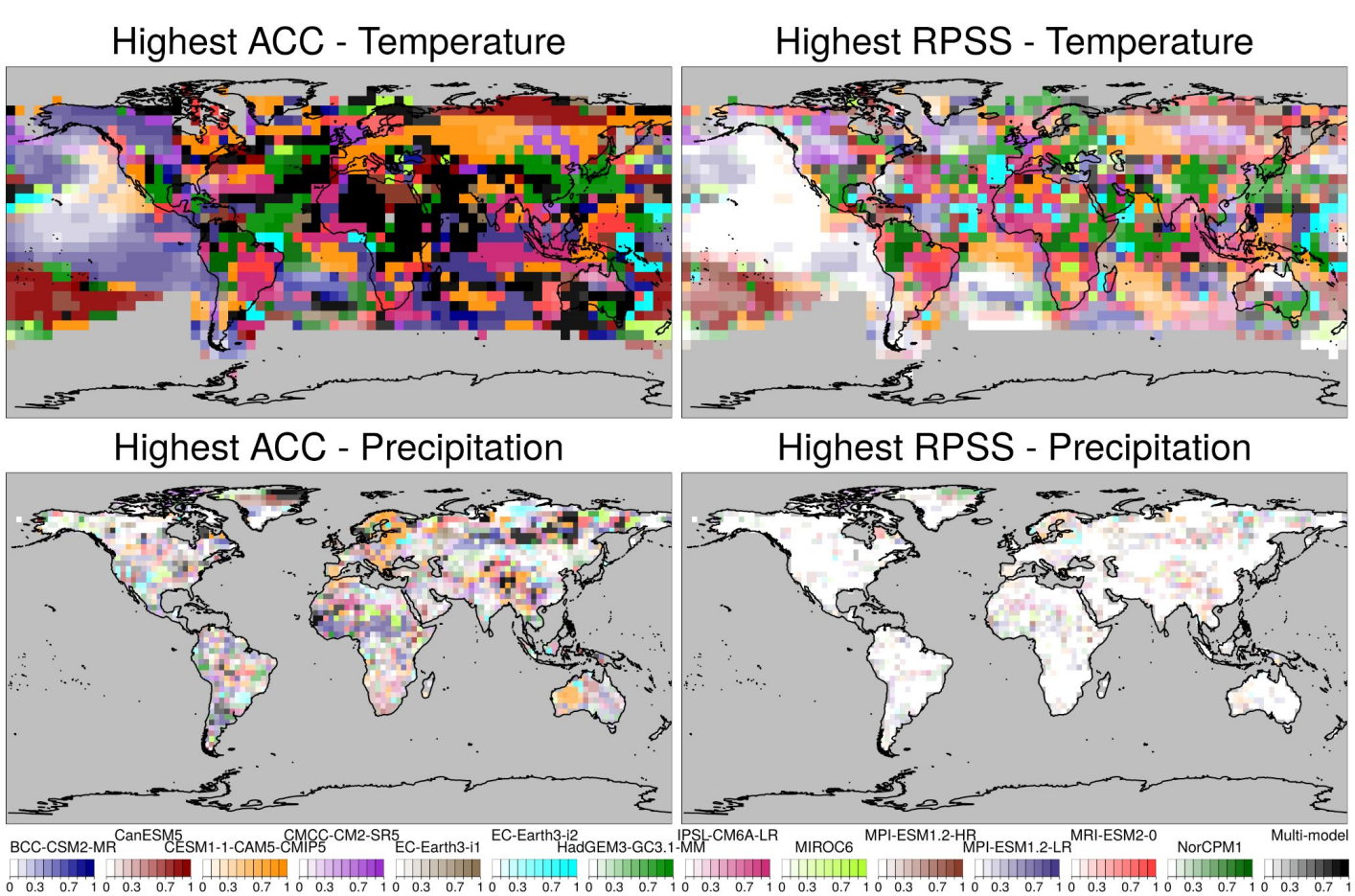


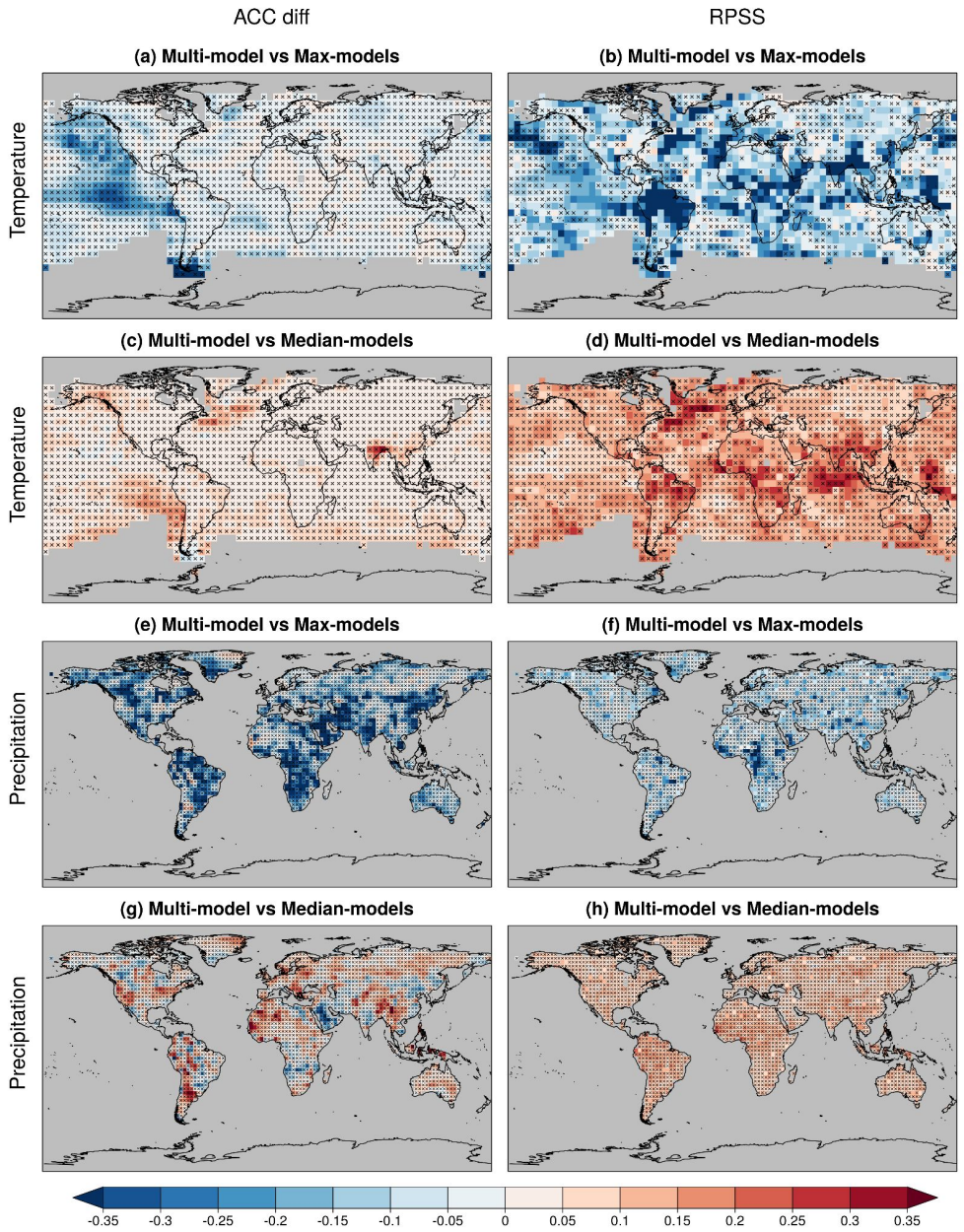


Barcelona Supercomputing Center
Centro Nacional de Supercomputación

DCPP multi-model: **169 members** from **13 forecast systems**

Multi-model vs individual forecast systems

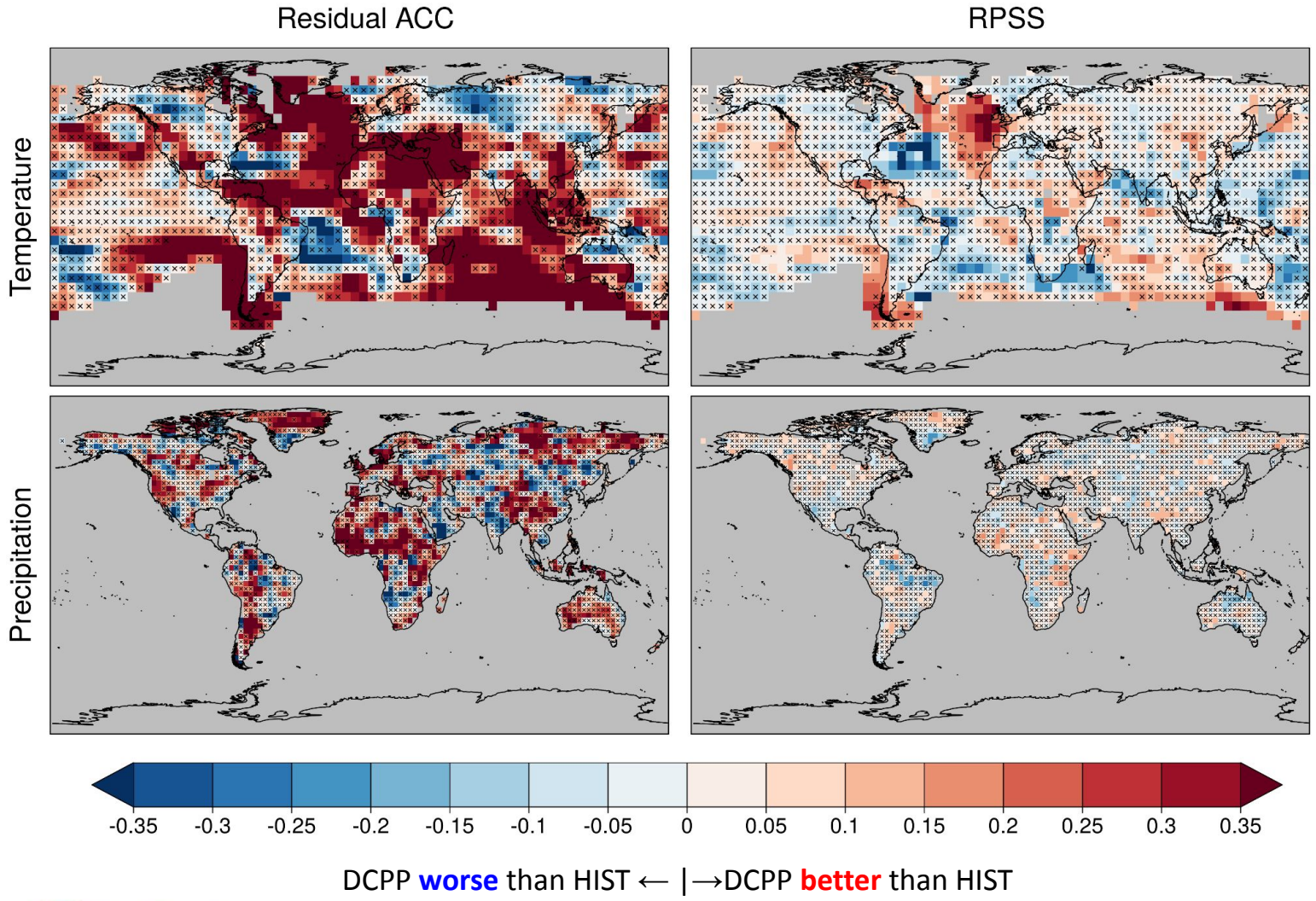




- Multi-model generally **worse** than the best forecast system
- Multi-model generally **better** than the 50% of the forecast systems

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Impact of initialisation



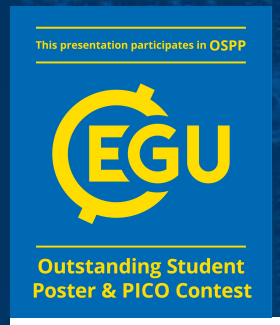
Index	Residual ACC	RPSS
AMV	0.75*	0.32*
GSAT	0.45*	-0.06

- DCPP multi-model ensemble: **169 members**
- HIST multi-model ensemble: **195 members**

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Conclusions

- DCPP multi-model skill
  - Generally high for temperature, particularly over land regions
  - Lower for precipitation (limited to regions over Central Africa, Europe, and Asia)
- Multi-model vs forecast systems
  - The best system generally provides the highest skill for a particular location, variable and forecast period
    - Highest forecast quality for a particular climate service
  - The multi-model provides higher skill than, at least, the 50% of the systems
    - More straightforward operational forecast generation
  - More real-time predictions would allow selecting the best forecast system or multi-model (sub)ensemble for each specific region, variable and forecast period
- DCPP vs HIST multi-models
  - Added value of initialisation over some ocean and land regions for temperature and precipitation
  - Added value for AMV and GSAT



EGU General Assembly 2022

Vienna, May 2022

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

European Climate Prediction system

H2020 grant 776613

Climate Change Service
climate.copernicus.eu

ECMWF/COPERNICUS/2019/C3S_34c_DWD

Thank you!

Delgado-Torres, C., Donat, M. G., Gonzalez-Reviriego, N., Caron, L.-P., Athanasiadis, P. J., Bretonnière, P.-A., Dunstone, N., Ho, A.-C., Nicolì, D., Pankatz, K., Paxian, A., Pérez-Zanón, N., Samsó Cabré, M., Solaraju-Murali, B., Soret, A., and Doblas-Reyes, F. J. (2022). Multi-model forecast quality assessment of CMIP6 decadal predictions. Journal of Climate. https://doi.org/10.1175/JCLI-D-21-0811.1

carlos.delgado@bsc.es