Lessons learnt from the EDgE seasonal hindcast experiment

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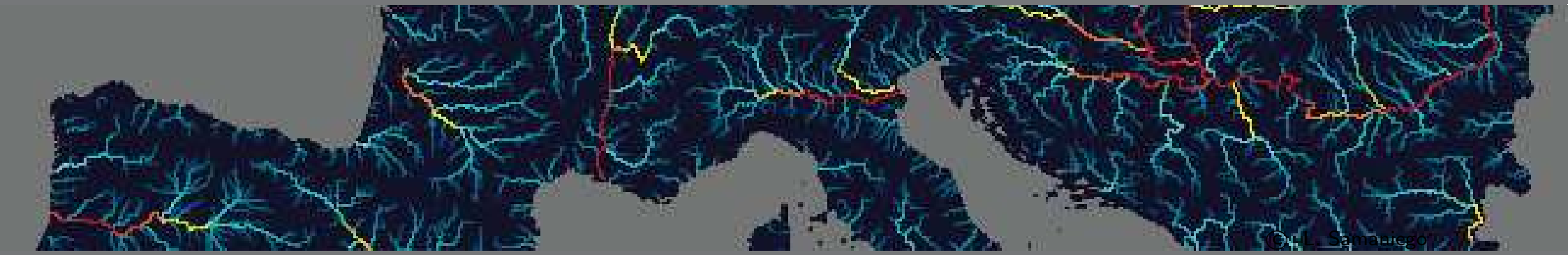
Niko Wanders, Oldrich Rakovec, Justin Sheffield, Eric Wood



2018 HEPEX Workshop

Melbourne, 7th February 2018

PRINCETON UNIVERSITY
Utrecht University
ON BEHALF OF ECMWF FOR THE EUROPEAN COMMISSION
HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Extreme hydrological events

- Socio-economic (health)
- Forest fires (air pollution)
- Water supplies / quality
- Low river flows, low lake/reservoir levels, increase melting
- Agriculture, tourism, infrastructure

...

2002 European Floods
2003 Drought
2010 Heatwave
2017 Drought Iberian Peninsula

...

EDgE project[1]

End-to-end **D**emonstrator for improved decision making in the water sector in **E**urope

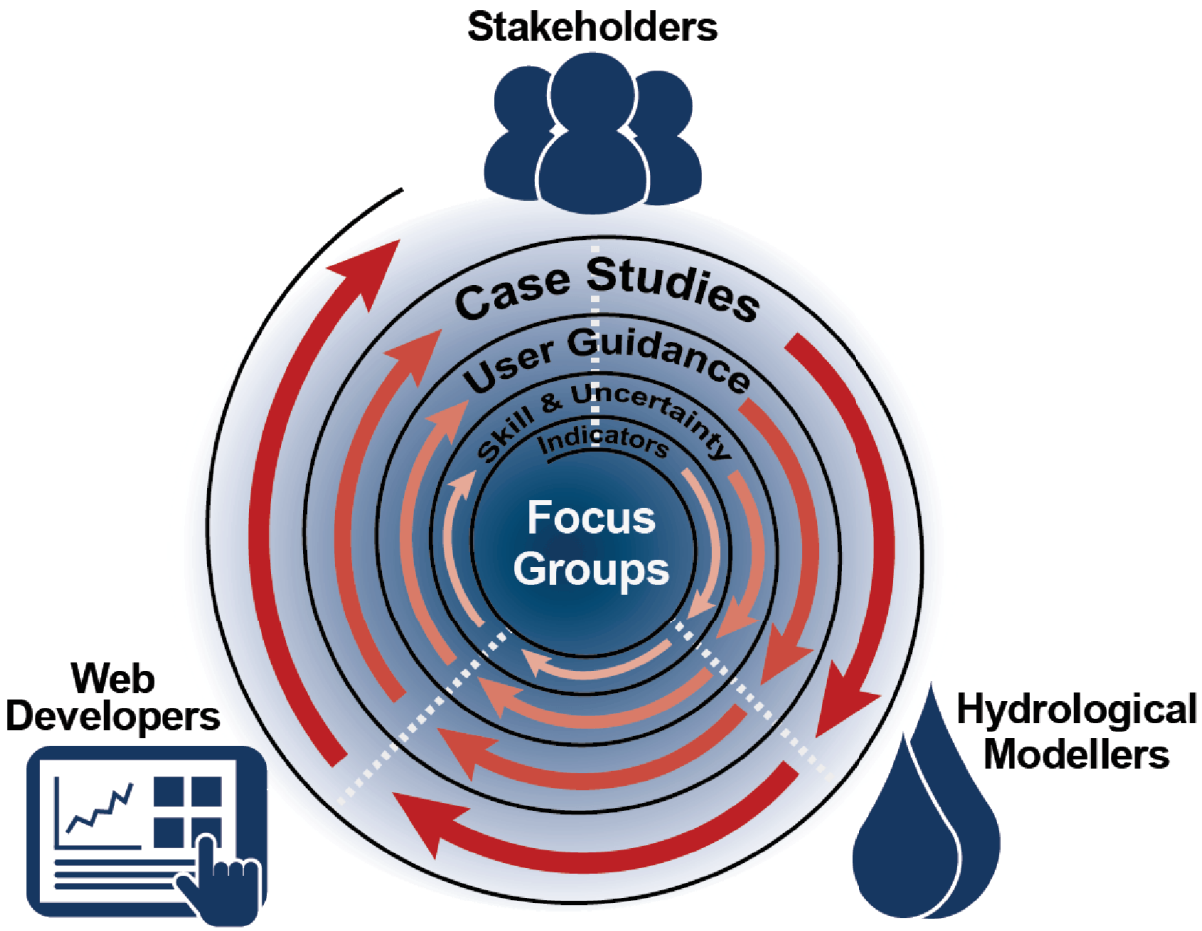
ON BEHALF OF ECMWF
FOR THE EUROPEAN COMMISSION

opernicus
Europe's eyes on Earth

[1] Coordinated by C. Prudhomme, WP Leads: G. Watts, L. Samaniego, M. Fry

EDgE project

- Active stewardship
- User-centric (focus groups, user guidance)
- Active participation from End-Users (co-design)
- Supported by state-of-the-art research
- Support multiple time scales



Thanks to K. Smith

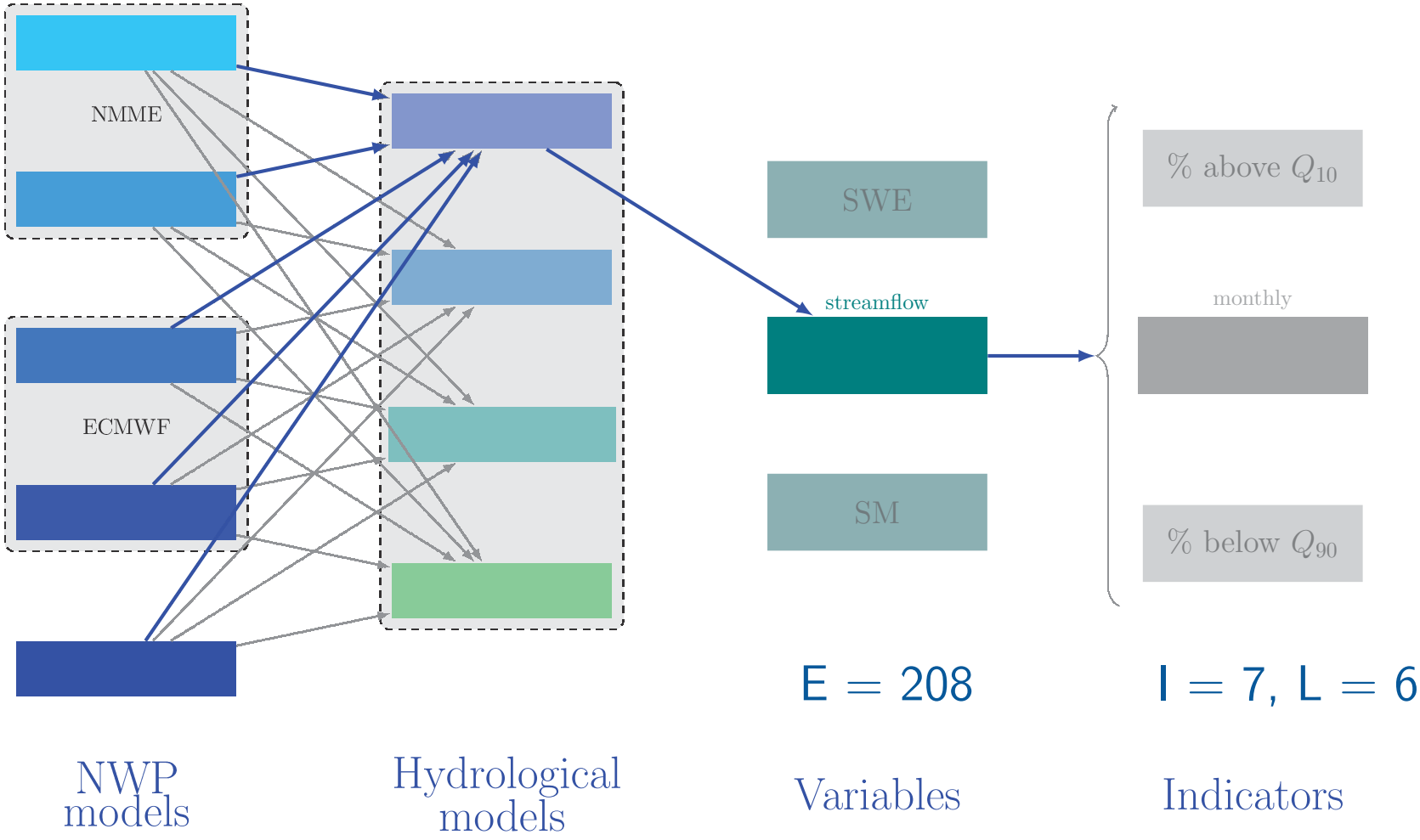
Breaking the barriers...

edge.climate.copernicus.eu

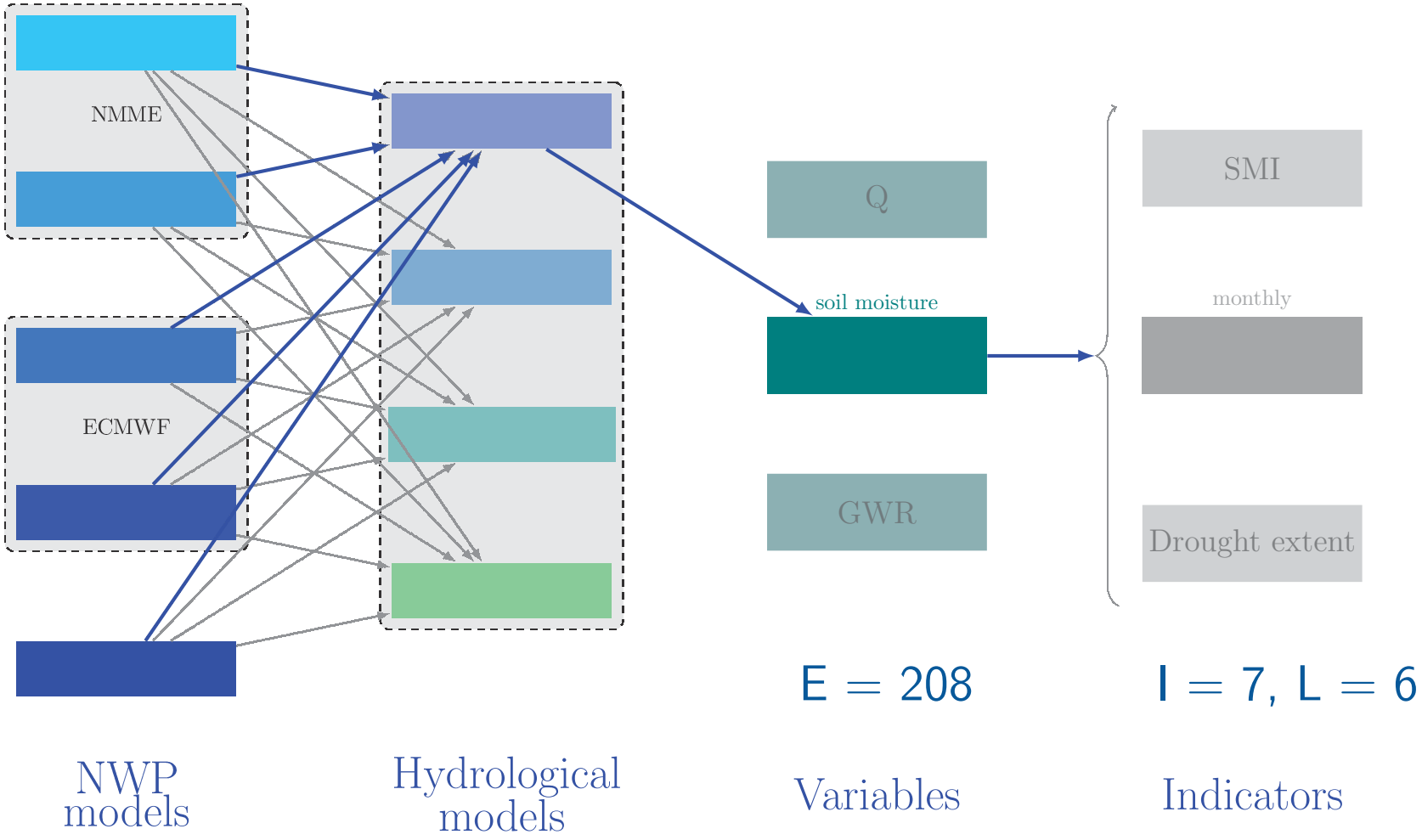
Features

- Consistent land-surface properties
  CORINE Land use data (30 m)
  ISRIC Soil Inf. System (1 km)
  EU-DEM (100 m)
- Unique network and routing scheme (mRM)
- Consistent forcings (bias correction, downscaling)
- Seamless parameterization (mHM)
  Samaniego et. al. HESS, 2017
- Computational effort & storage
- **Resolution 5×5 km^2**

SeFo modeling chain



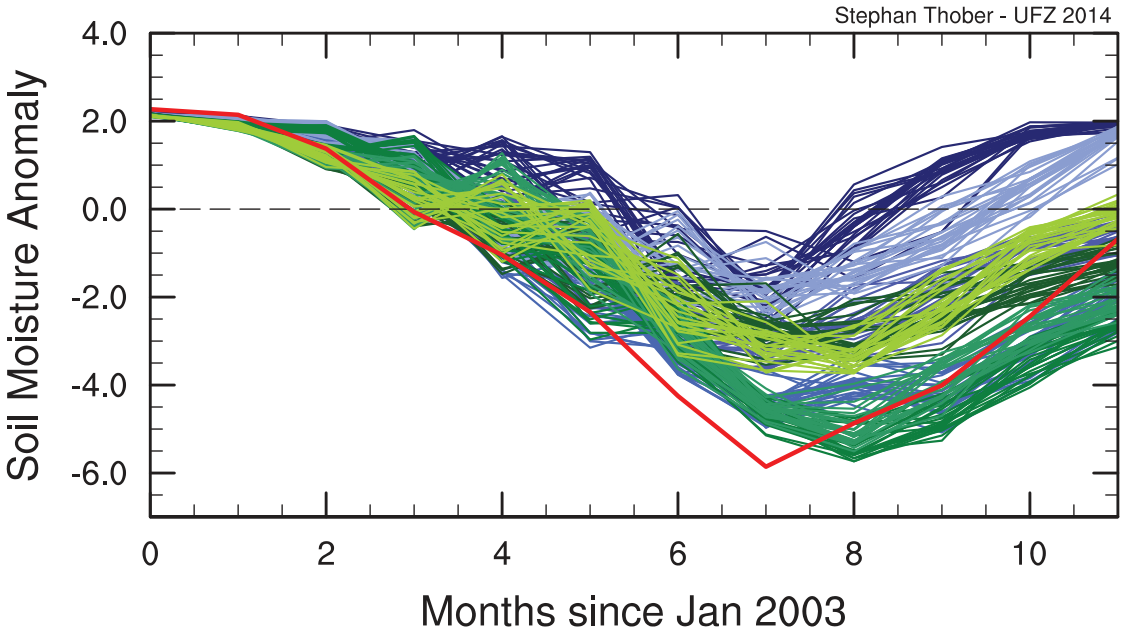
SeFo modeling chain



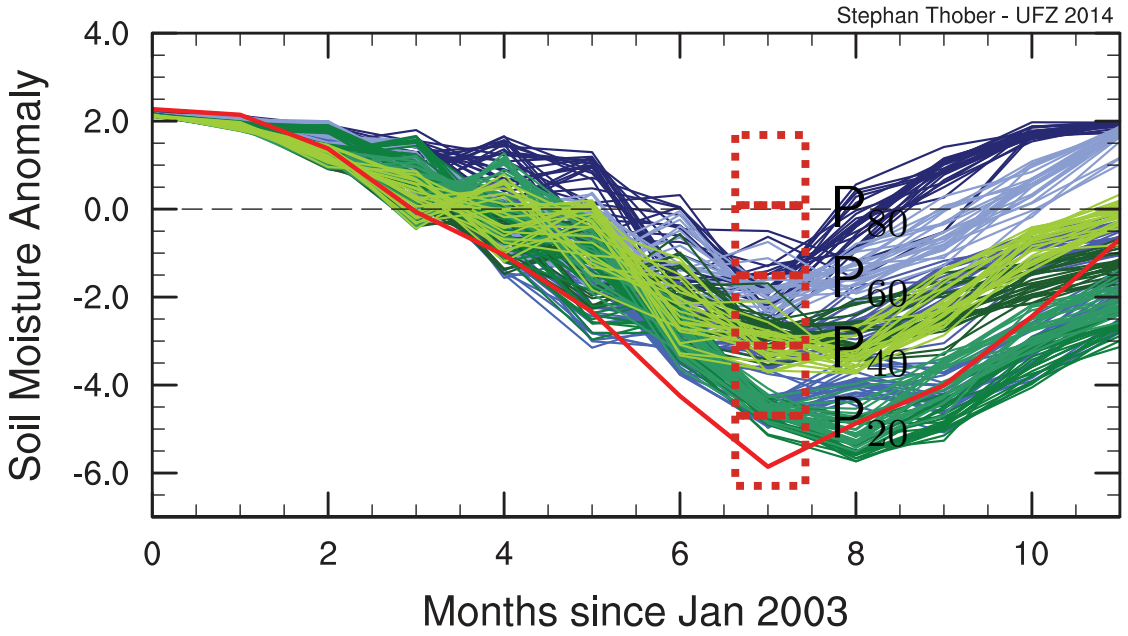
Research questions

- Does the hydrological model structure have an impact on the seasonal hydrological forecasting skill under different hydro-climatic conditions?
- Are the skill metrics regionally differentiated?
- Which is the skill from the EDgE SeFo modeling chain? How does it comparable with ESP?
- What would be better: more HMs or more GCMs?
- Does the seamless parameterization have a positive effect on skill/efficiency?

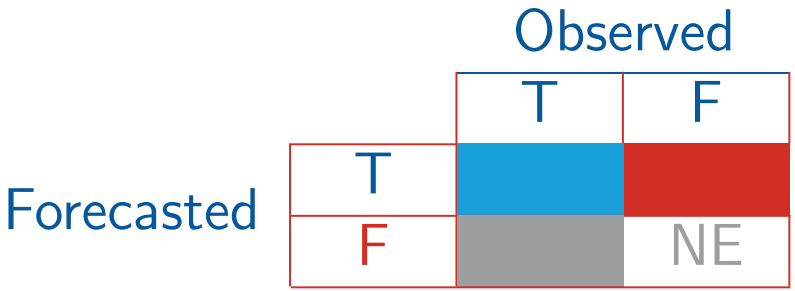
Skill metrics



Skill metrics



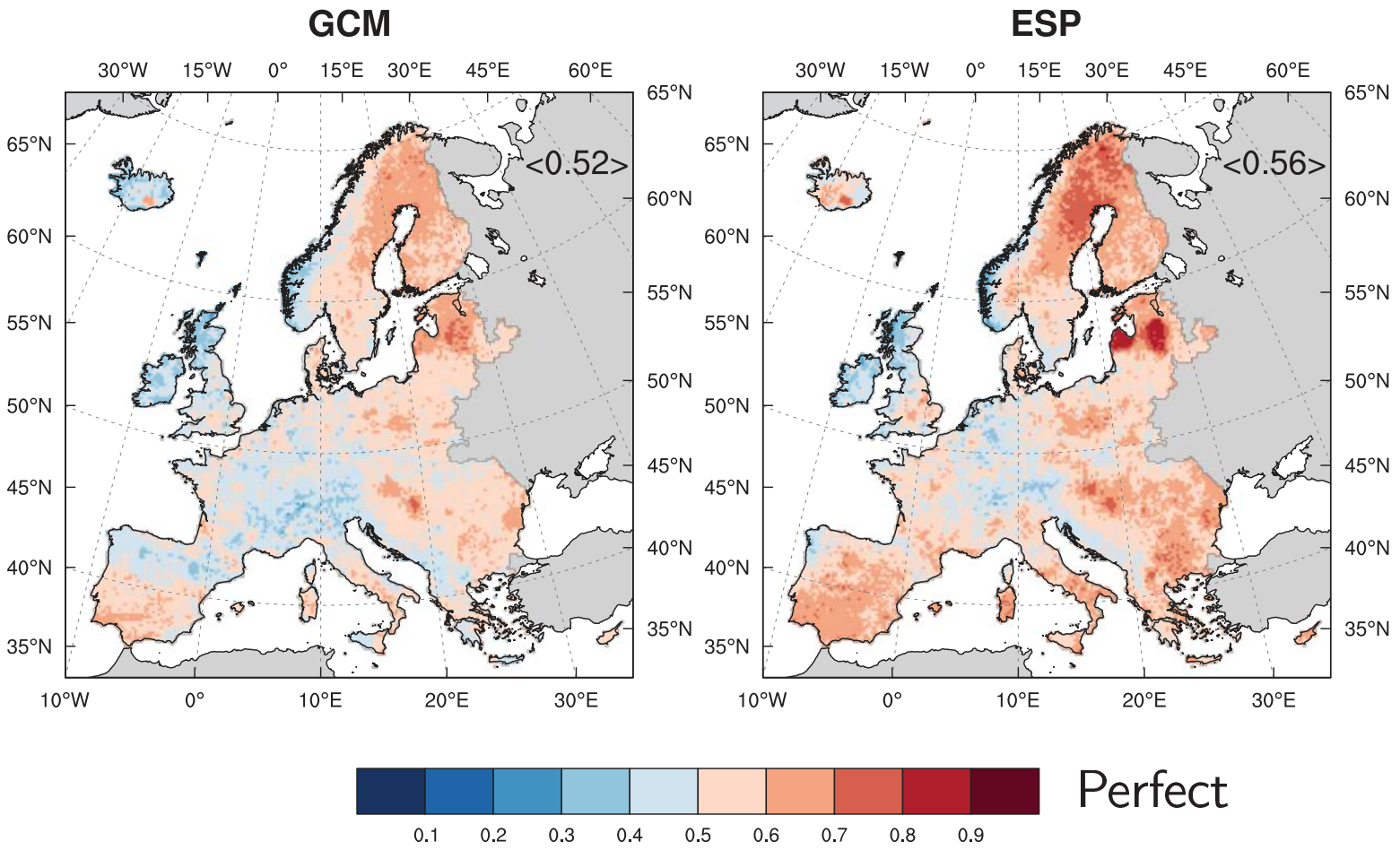
- SM-probabilistic-quintile-distribution
- Cut-offs: monthly P_{20},$P_{40}P_{60}P_{80}$, ref.: E-OBS
- Metrics

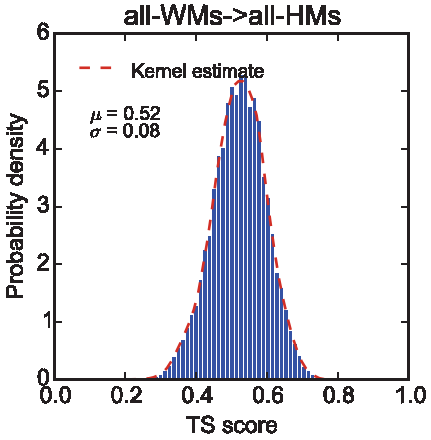


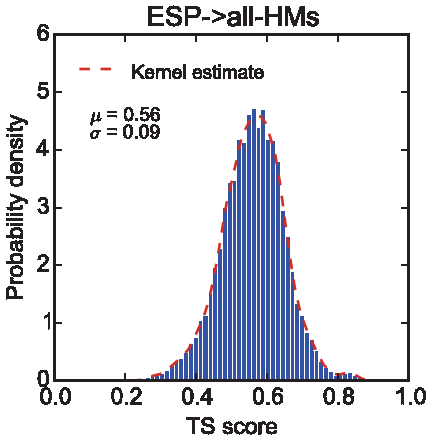
$$\mathrm{FAR} = \frac{F}{H+F} \quad \mathrm{POD} = \frac{H}{H+M} \quad \mathrm{TS} = \frac{H}{H+F+M} \quad \mathrm{BS} = \frac{1}{n}\sum_k^n (\hat{p}_k - p_k)^2$$

Ensemble all GCMs → all-HMs

TS: Lead time 1 months

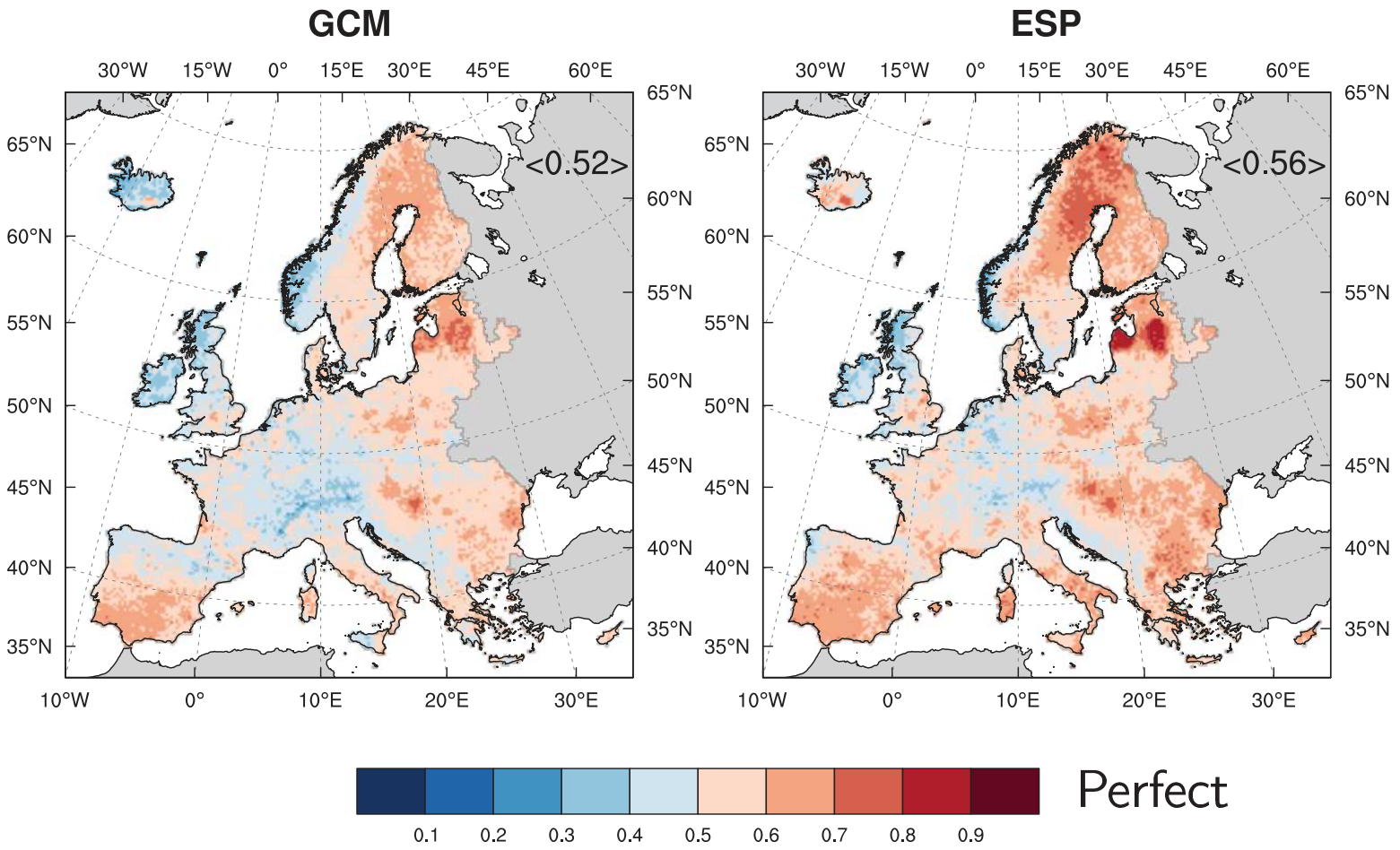


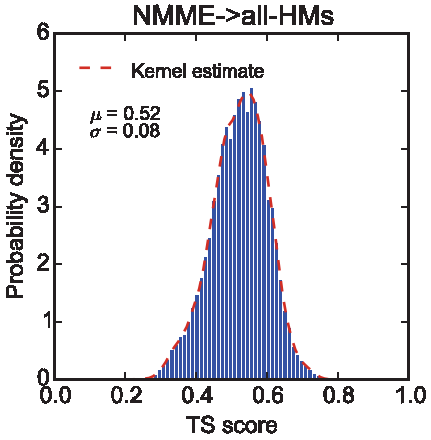


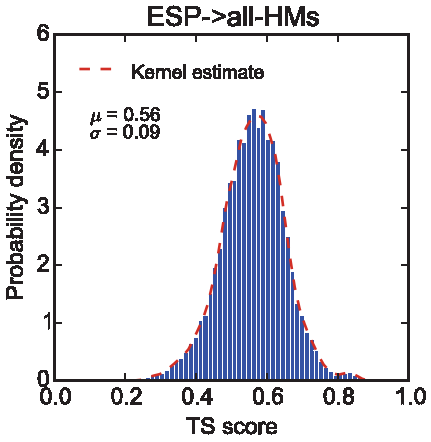


Ensemble CanCM4 & GFDL (FLOR) → all-HMs

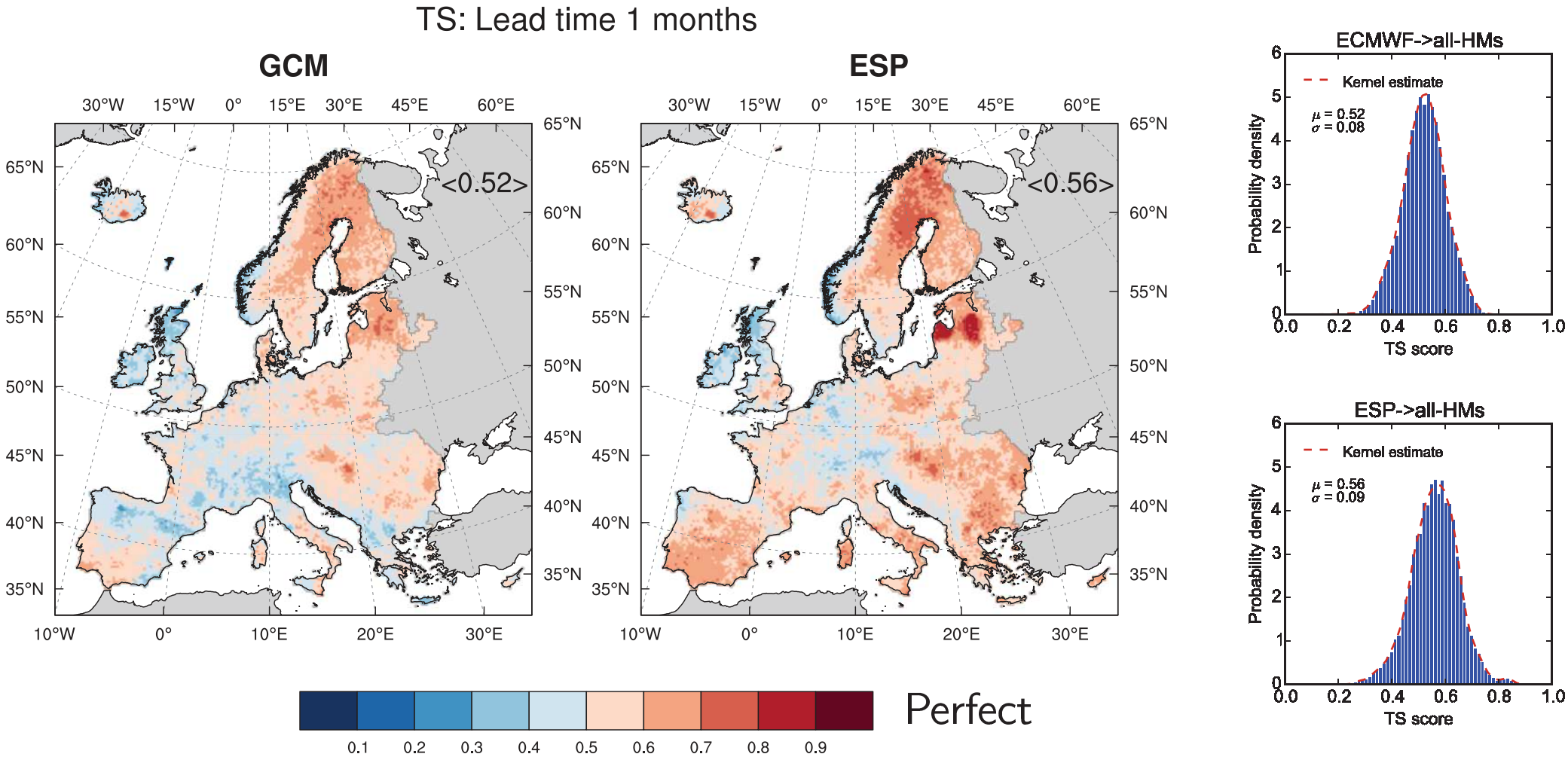
TS: Lead time 1 months



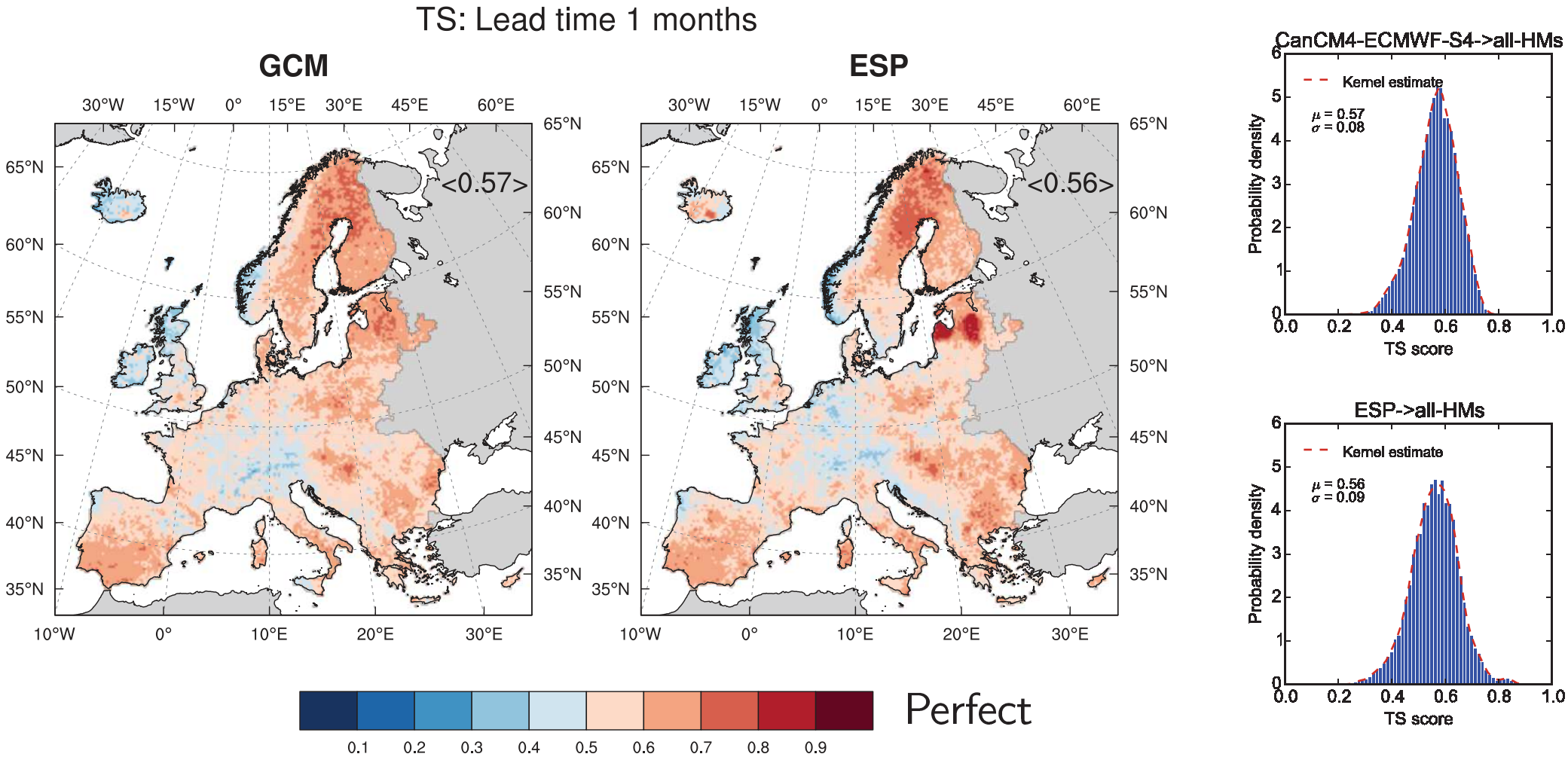




Ensemble ECMWF-S4 & MétéoFrance-5 → all HMs

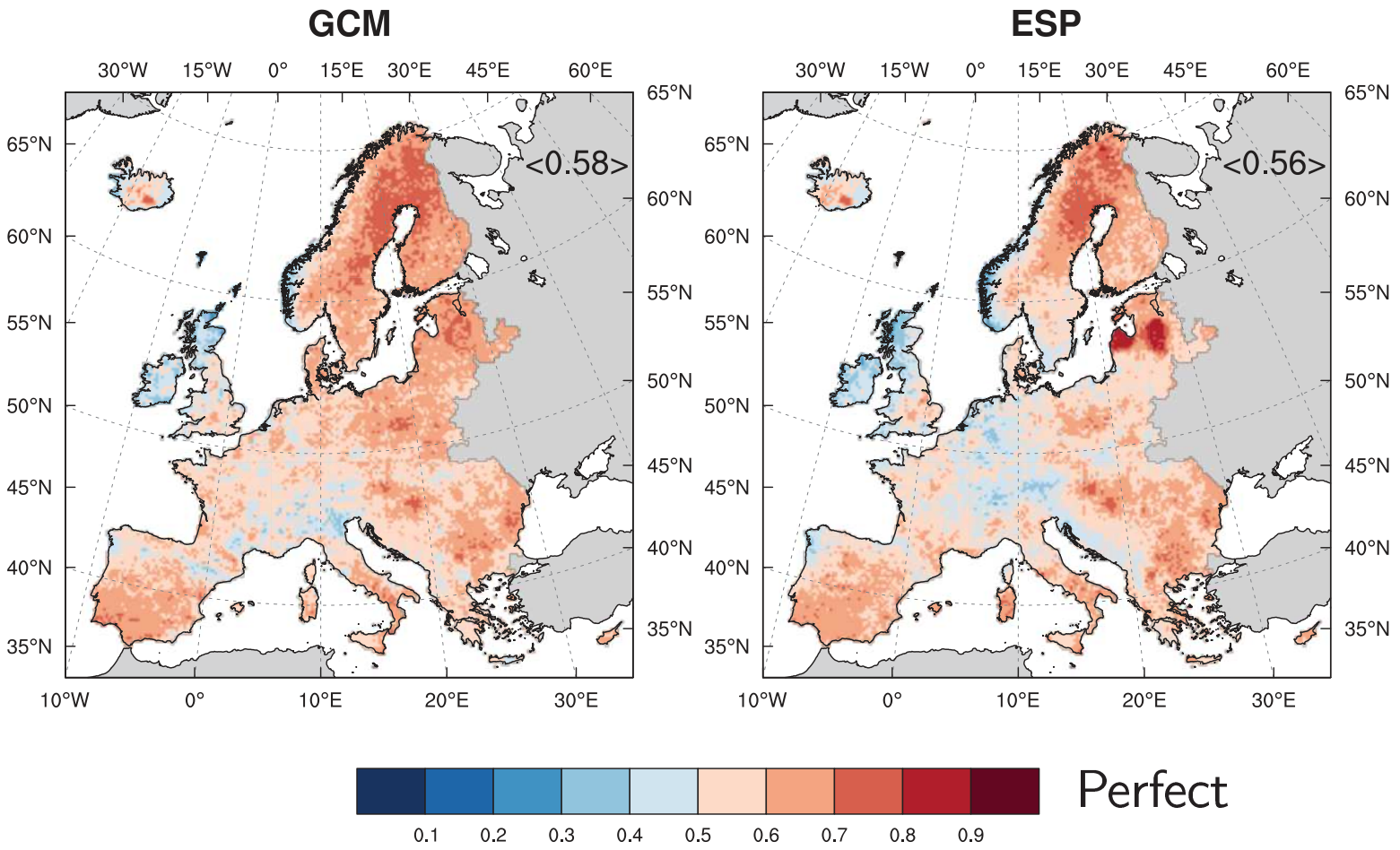


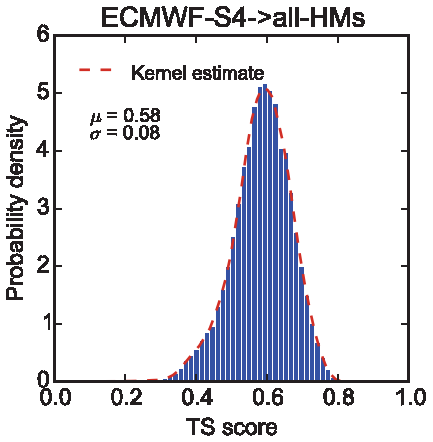
Ensemble CanCM4 & ECMWF-S4 → all-HMs

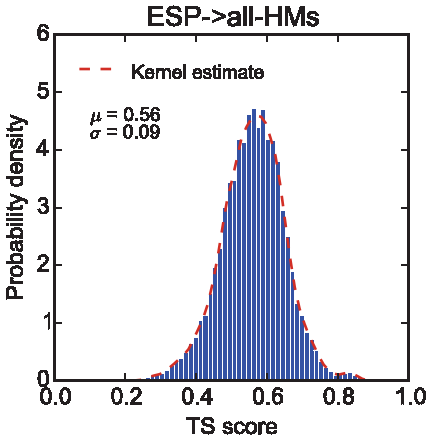


Ensemble ECMWF-S4 → all HMs

TS: Lead time 1 months

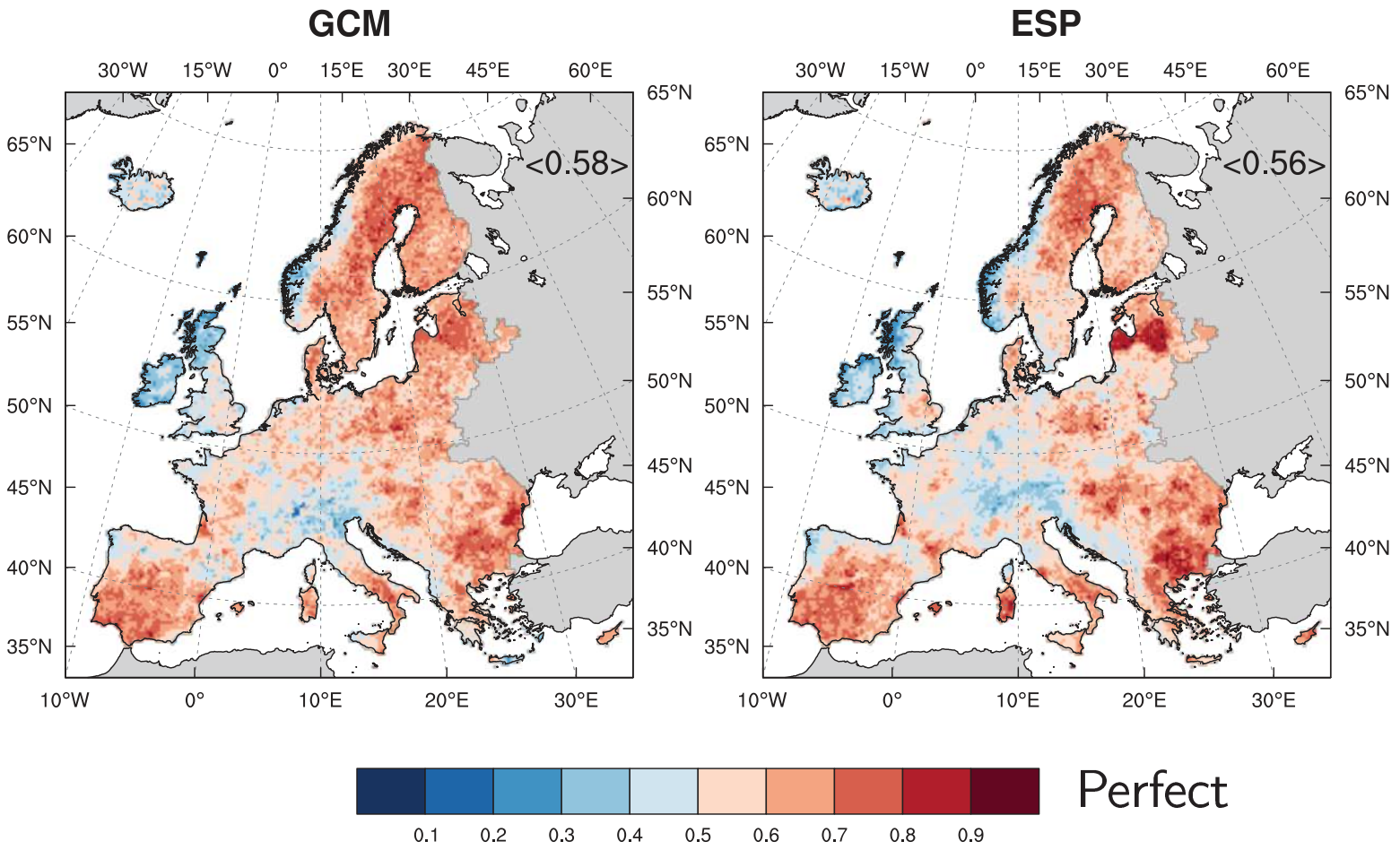


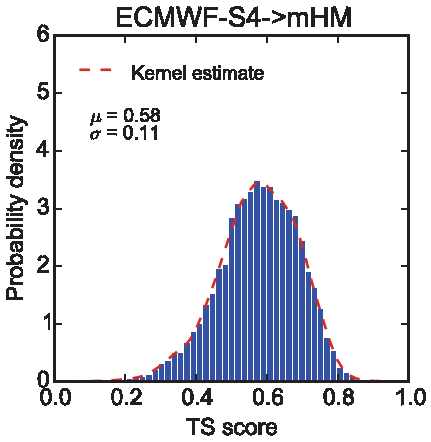


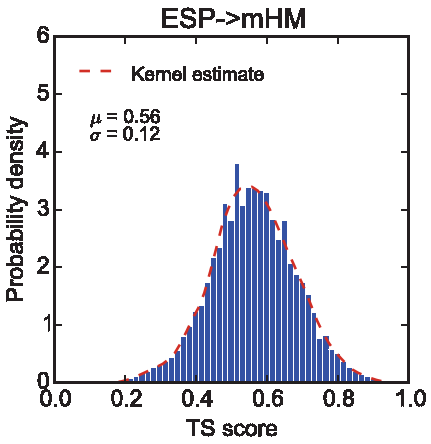


Ensemble ECMWF-S4 → mHM

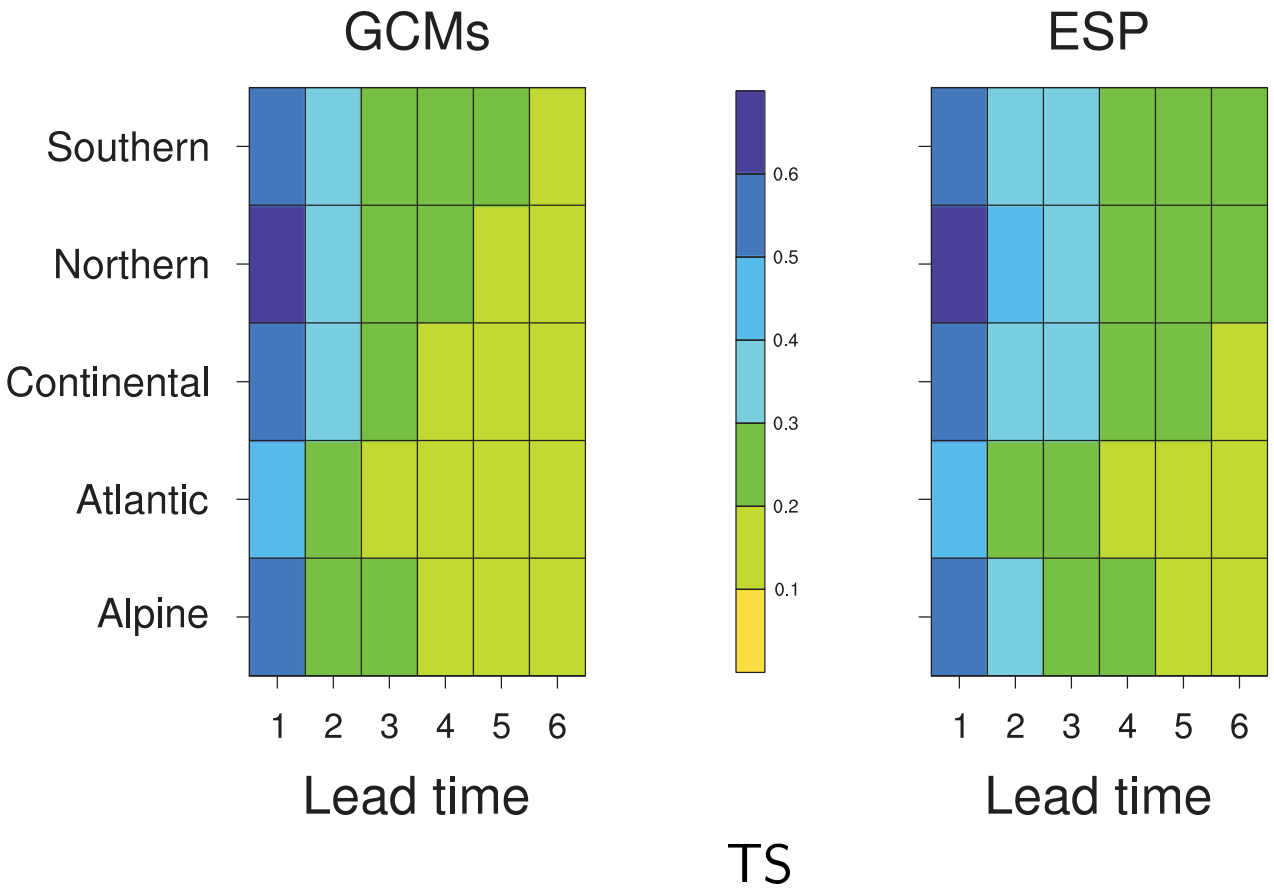
TS: Lead time 1 months

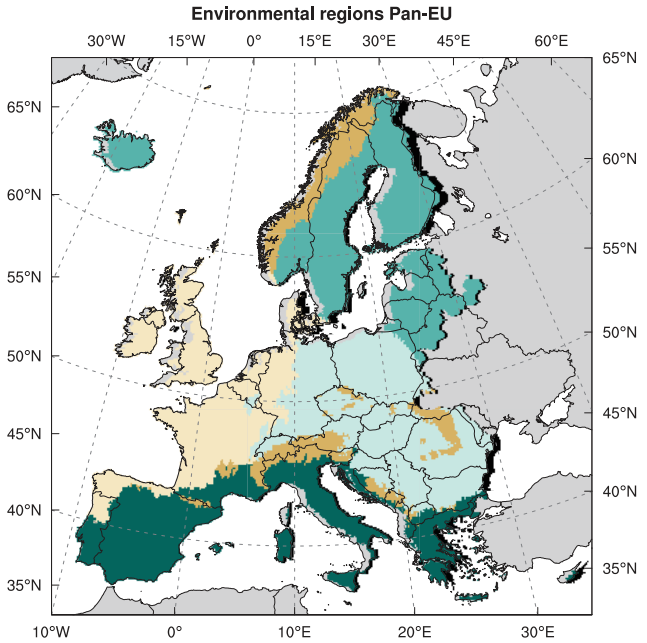






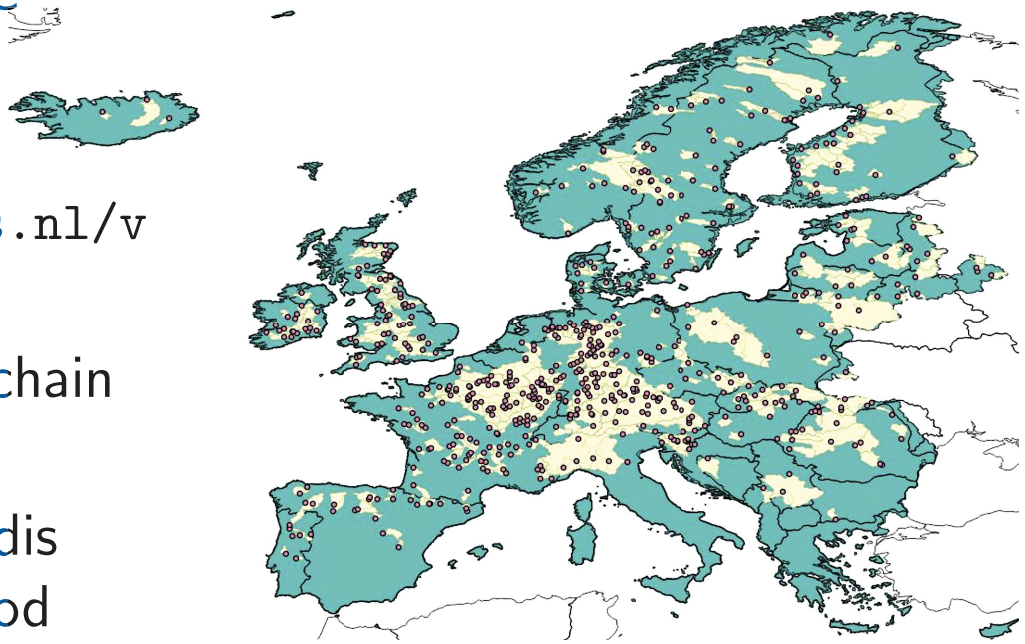
Ensemble skill metrics over Pan-EU regions





SeFo model inter-comparison

Models	EDgE	Noah-MP, mHM, PCR-GLOBWB, VIC
	SWICCA	EHYPE
	EFAS	LISFLOOD
Protocol	`http://dl-ng005.xtr.deltares.nl/view/358/`	
Goal	Impacts of model structure and chain settings	
Participants	S. Harrigan (CEH), I. Pechlivanidis (SMHI), N. Wanders & Eric Wood (UP), L. Arnal & C. Prudhomme (ECMWF), R. Kumar O. Rakovec, L. Samaniego, S. Thober (UFZ)	

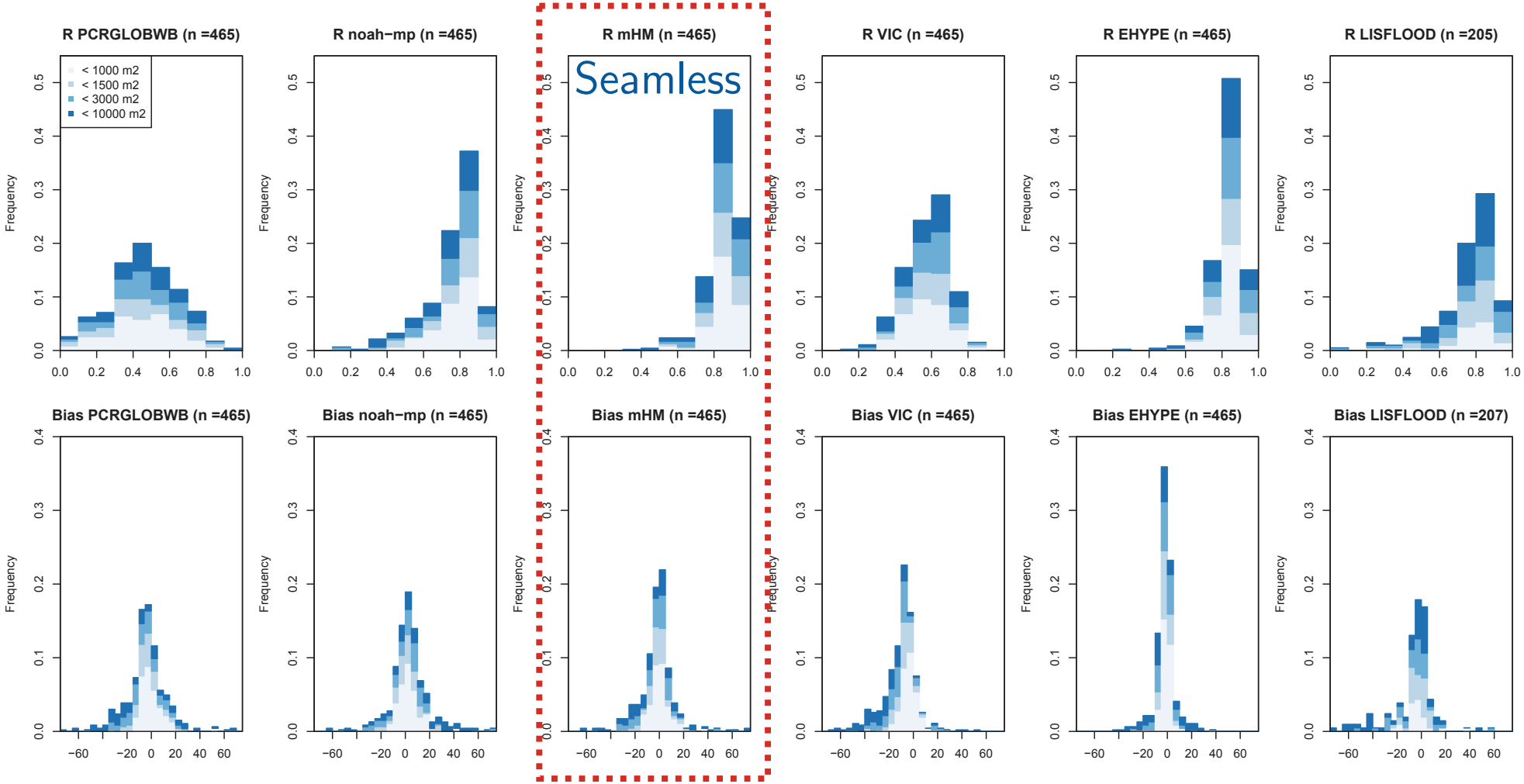


Model performance with streamflow observations

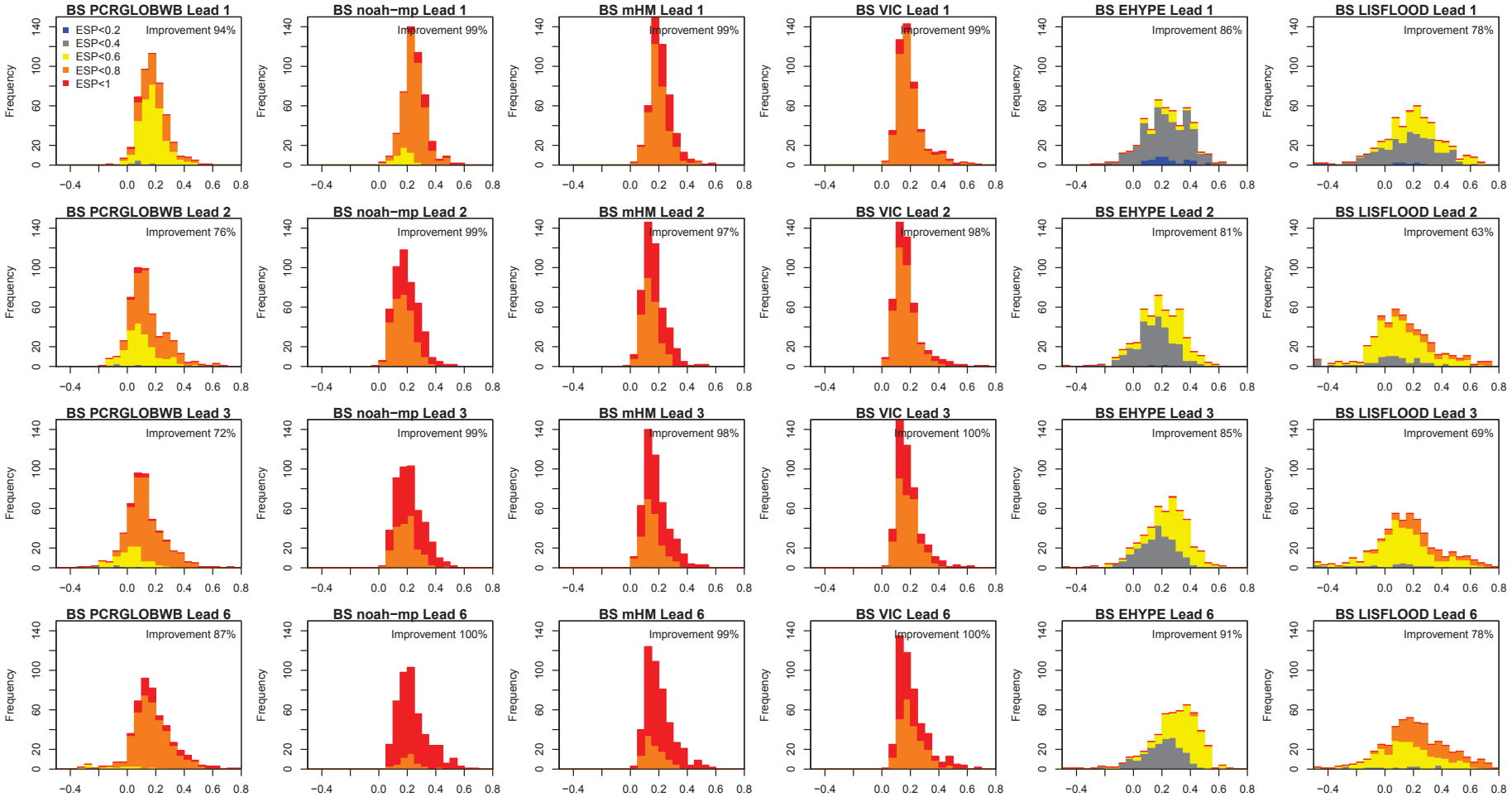
Metric \ Model	PCR-GLOBWB	Noah-MP	mHM	VIC

Metric \ Model	E-HYPE	LISFLOOD

Distributions of r, bias



Improvement in the Brier scores (BSS)



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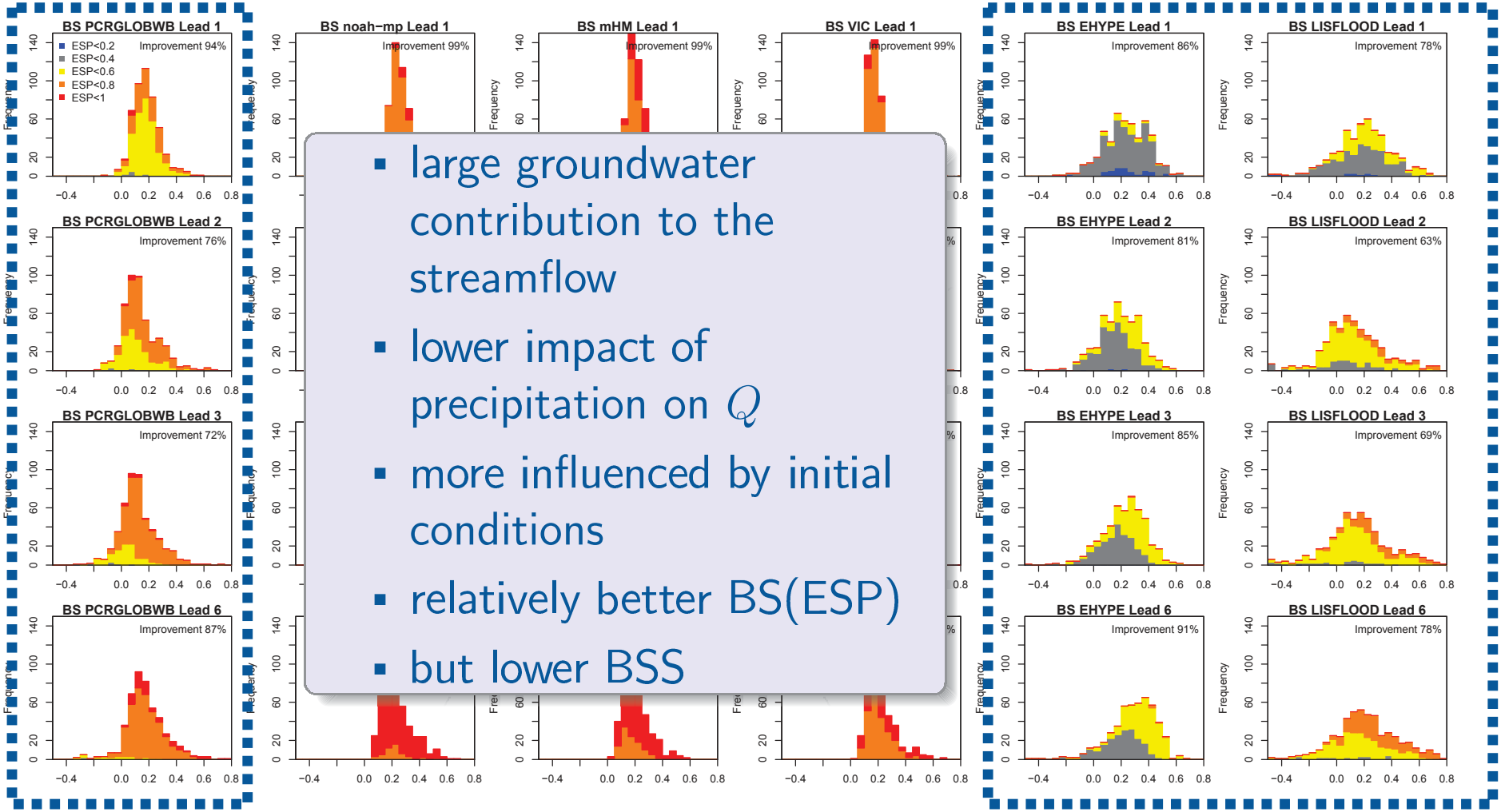
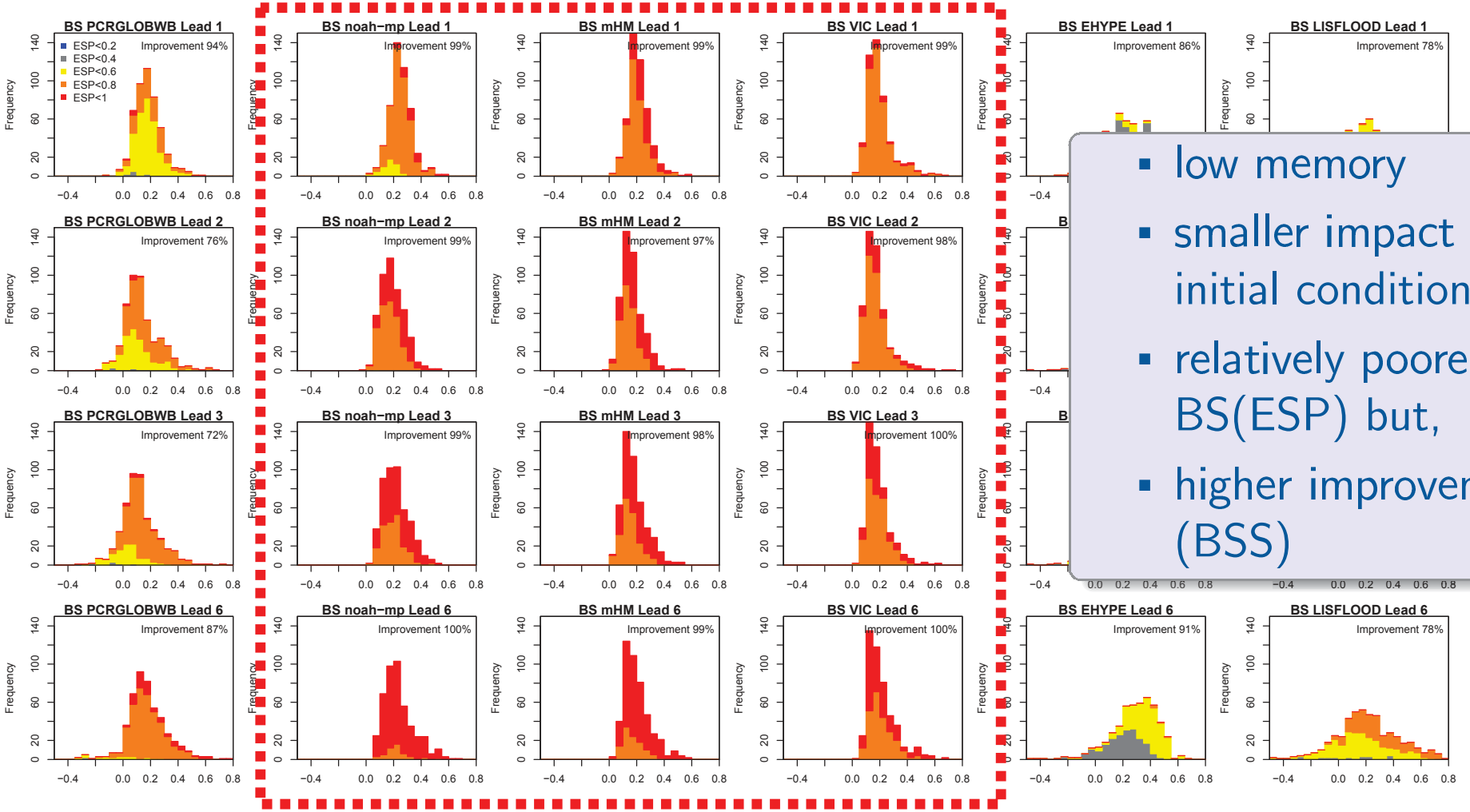


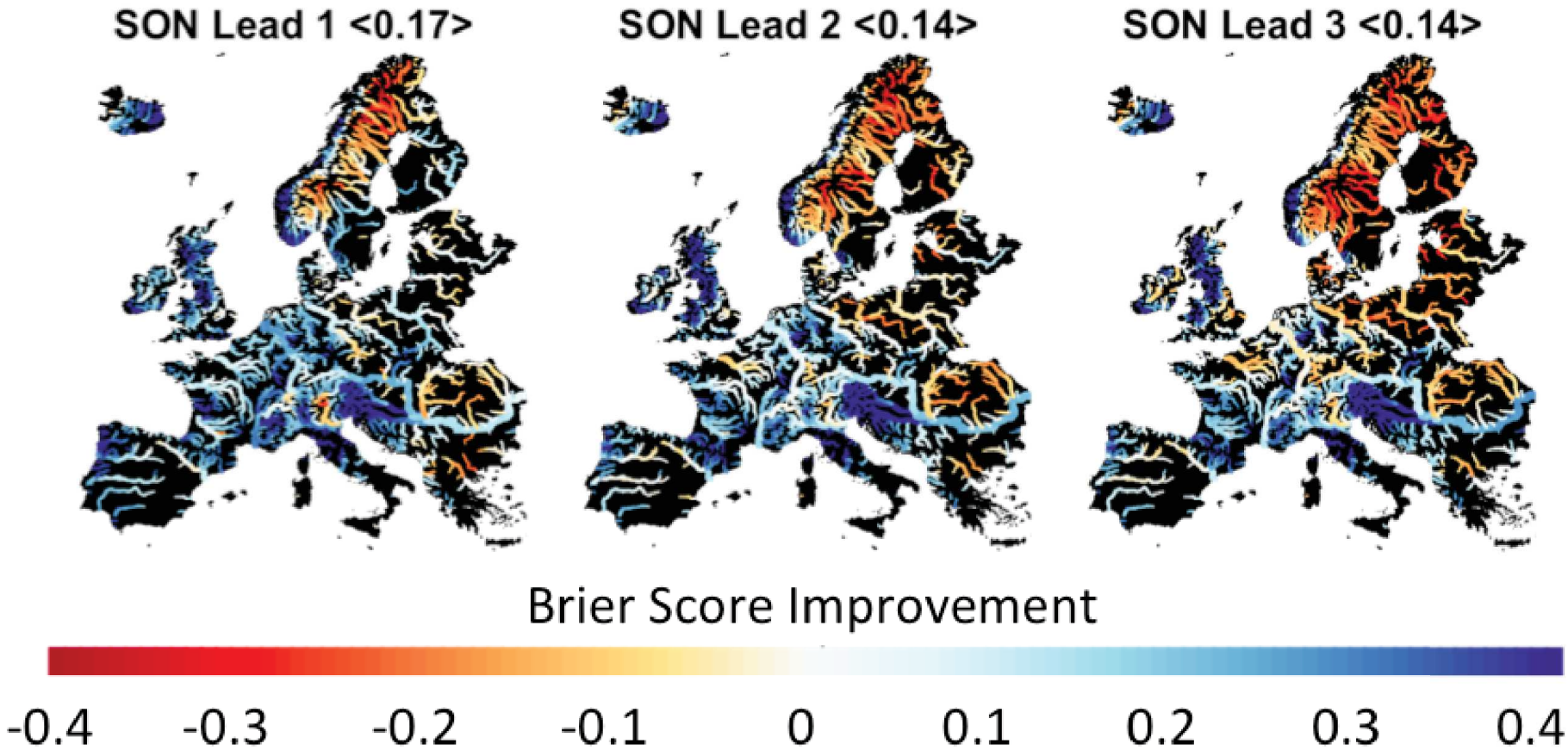
- large groundwater contribution to the streamflow
- lower impact of precipitation on Q
- more influenced by initial conditions
- relatively better BS(ESP)
- but lower BSS

Improvement in the Brier scores (BSS)



- low memory
- smaller impact from initial conditions
- relatively poorer BS(ESP) but,
- higher improvements (BSS)

Improvement in the Brier skill (BSS): GCMs vs. ESP



Conclusions

1. First pan-European, multi-model hydrological seasonal forecasting system, using an ensemble (52) of dynamical forecasts, climatological benchmark forecasts (15) and 4 hydrologic/land-surface models.
2. Large differences among the benchmark skill of the hydrological models, caused by the model's dependency on the initial hydrological conditions.
3. The dynamical model forecasts outperform the climatological benchmark for large parts of Europe, with the largest improvements are found for western and central Europe.
4. The use of multi-model forecasting systems should be the new default for operational seasonal forecasts, but results in a significant computational effort.
5. The extensive runs from EDgE can be used to better understand the sources of uncertainty.

Thank you

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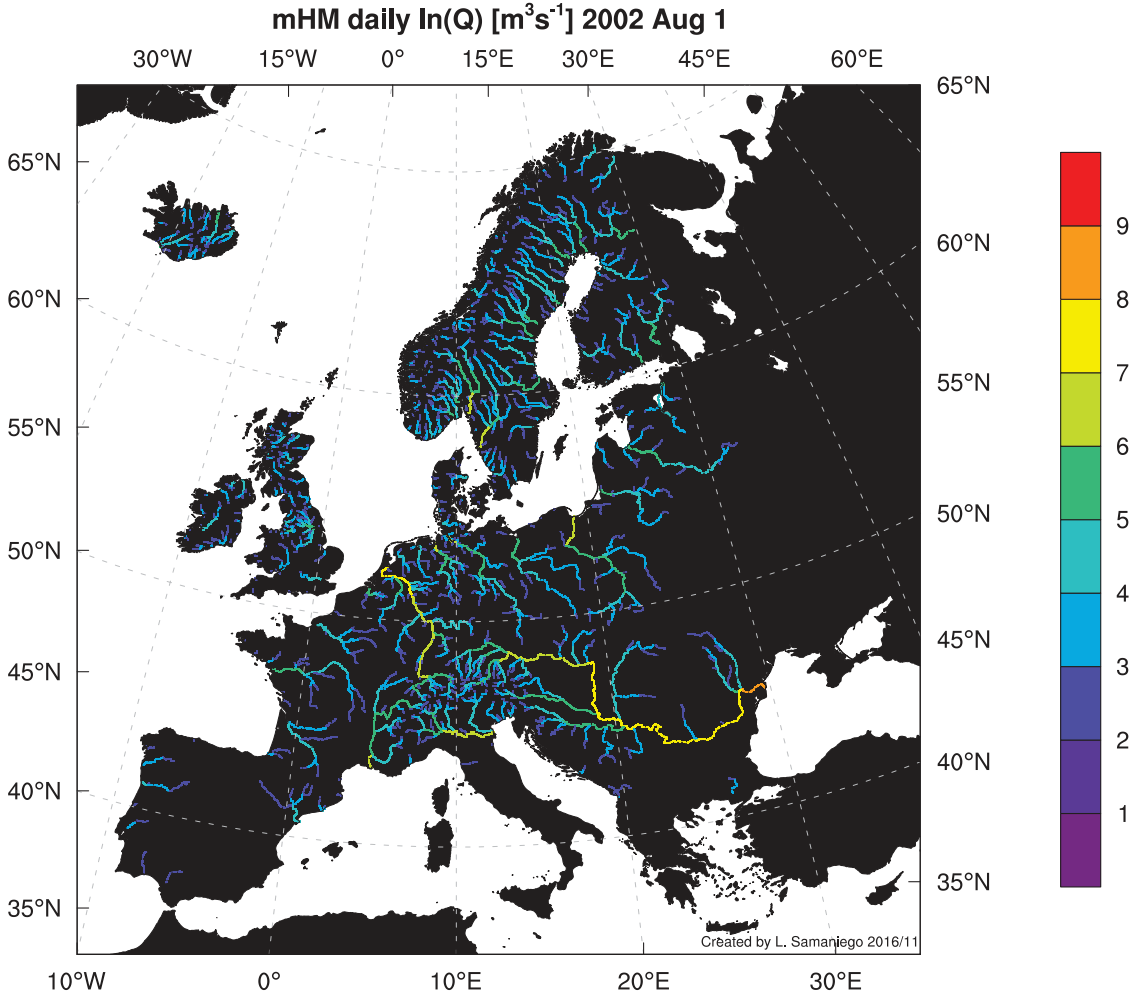
FOR THE EUROPEAN COMMISSION

Questions?



2002 European floods