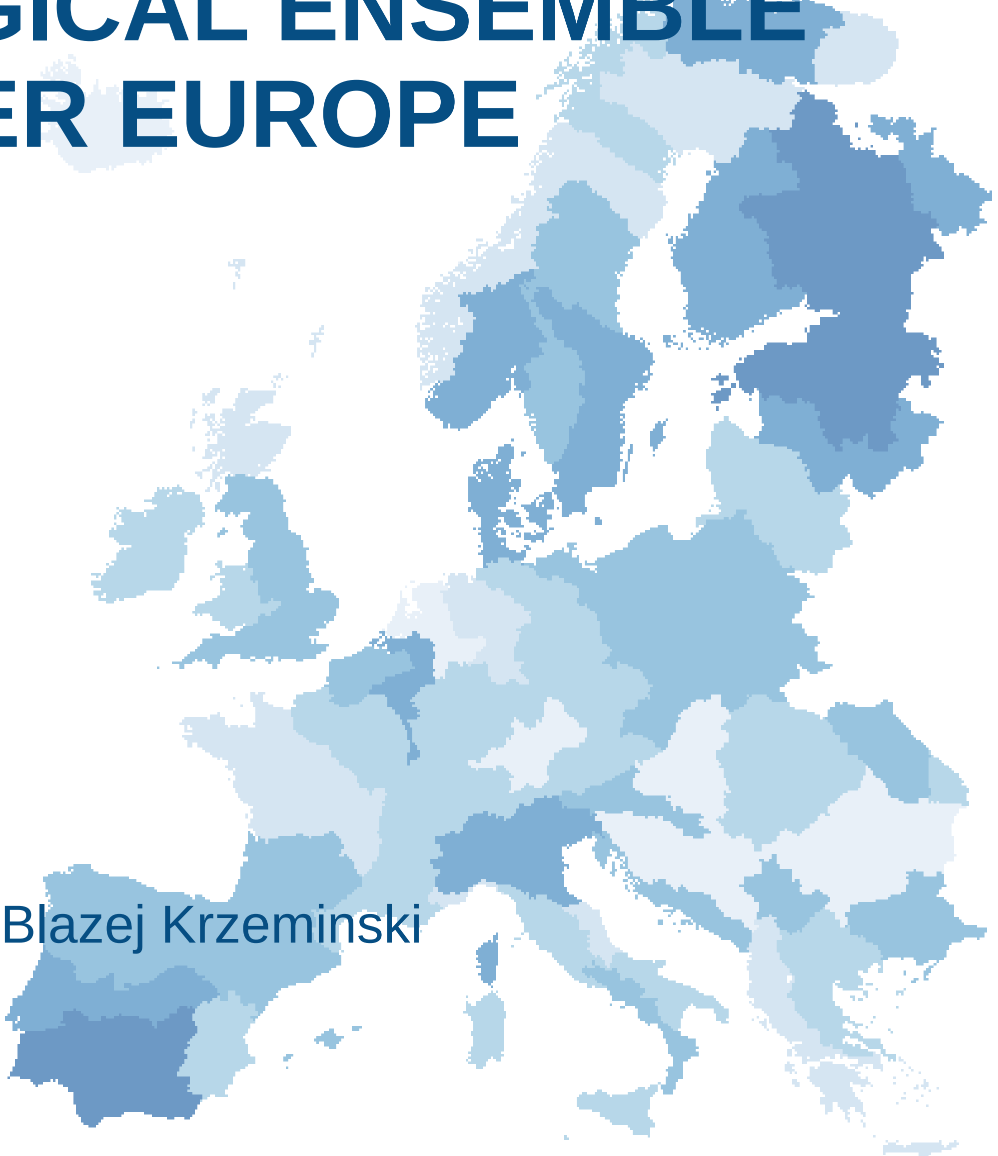
SEASONAL HYDROLOGICAL ENSEMBLE FORECASTS OVER EUROPE



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Copernicus – Europe's eyes on Earth

ECMWF

EFAS – European Flood Awareness System

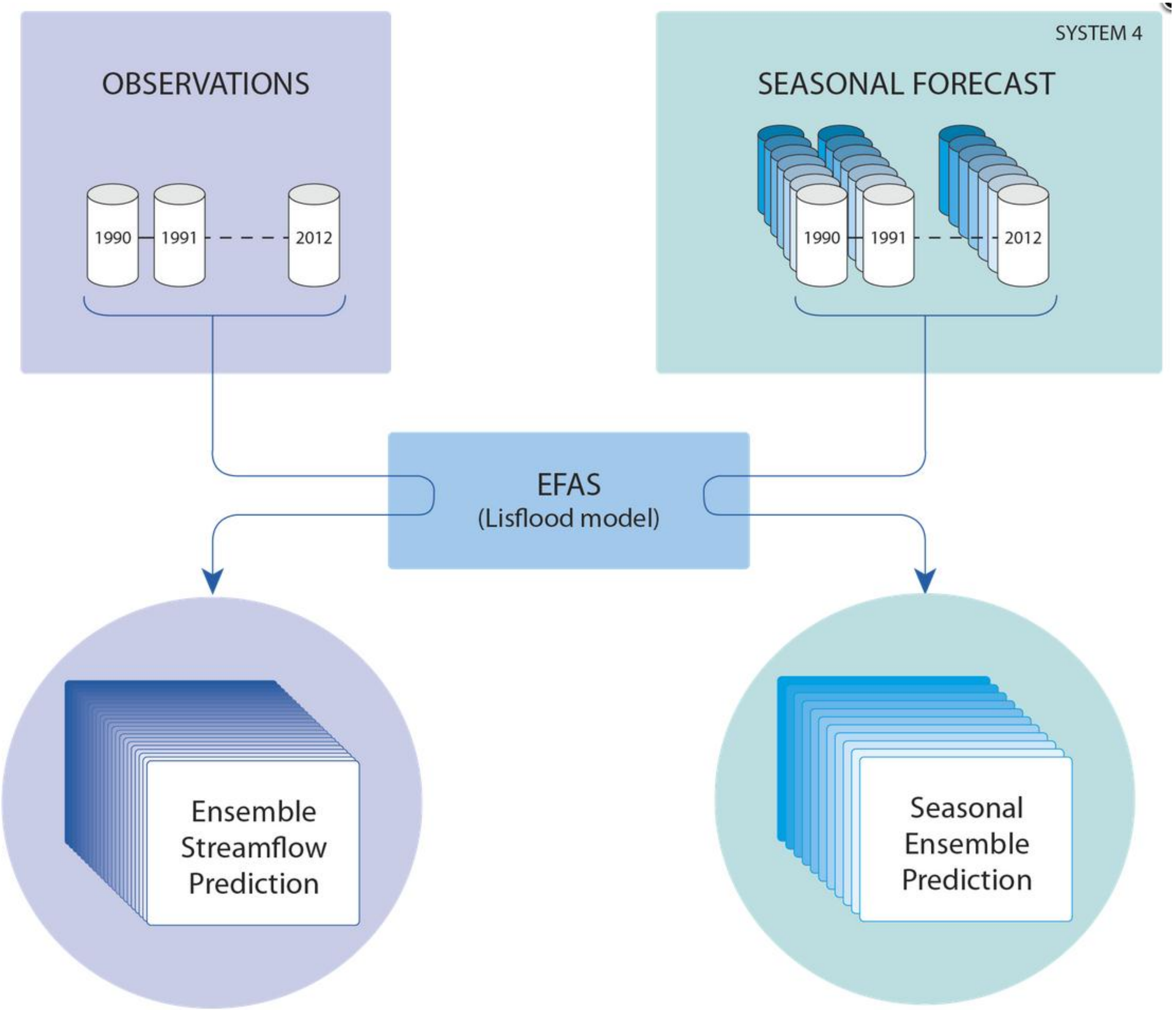
Motivations and aims

- EFAS (European Flood Awareness System): operational system for early flood and flash flood warnings over Europe (up to 15 days lead time)

- Growing incentive for hydrological forecasts at longer lead times:
  - Applications: hydropower management, spring flood prediction, low flows prediction for navigation, agricultural water needs...
  - Increase in NWP skill

- Aims:
  - Produce seasonal streamflow predictions for Europe using ECMWF dynamical seasonal forecasts
  - Provide probabilistic outlooks against model reforecasts for seasonal predictions beyond 15 days

Data



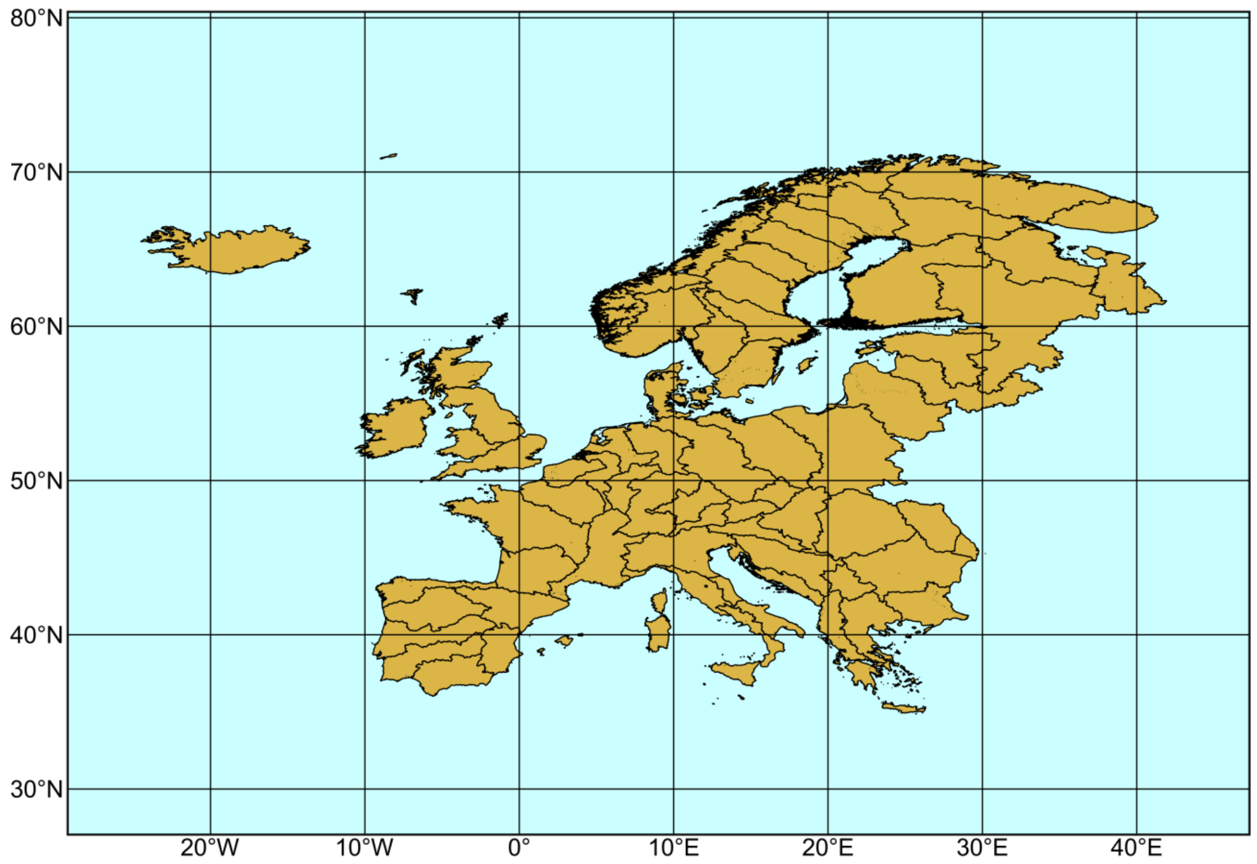
OBSERVATIONS
1990
1991
2012
SYSTEM 4
SEASONAL FORECAST
1990
1991
2012
EFAS
(Lisflood model)
Ensemble Streamflow Prediction
Seasonal Ensemble Prediction

ECMWF

Evaluation strategy

- Scores computed:
  - On weekly catchment discharge averages
  - 1990 - 2013
  - For each season (DJF, MAM, JJA, SON)
  - Lead time: 1 - 8 weeks
  - Against EFAS-WB

- Two main studies



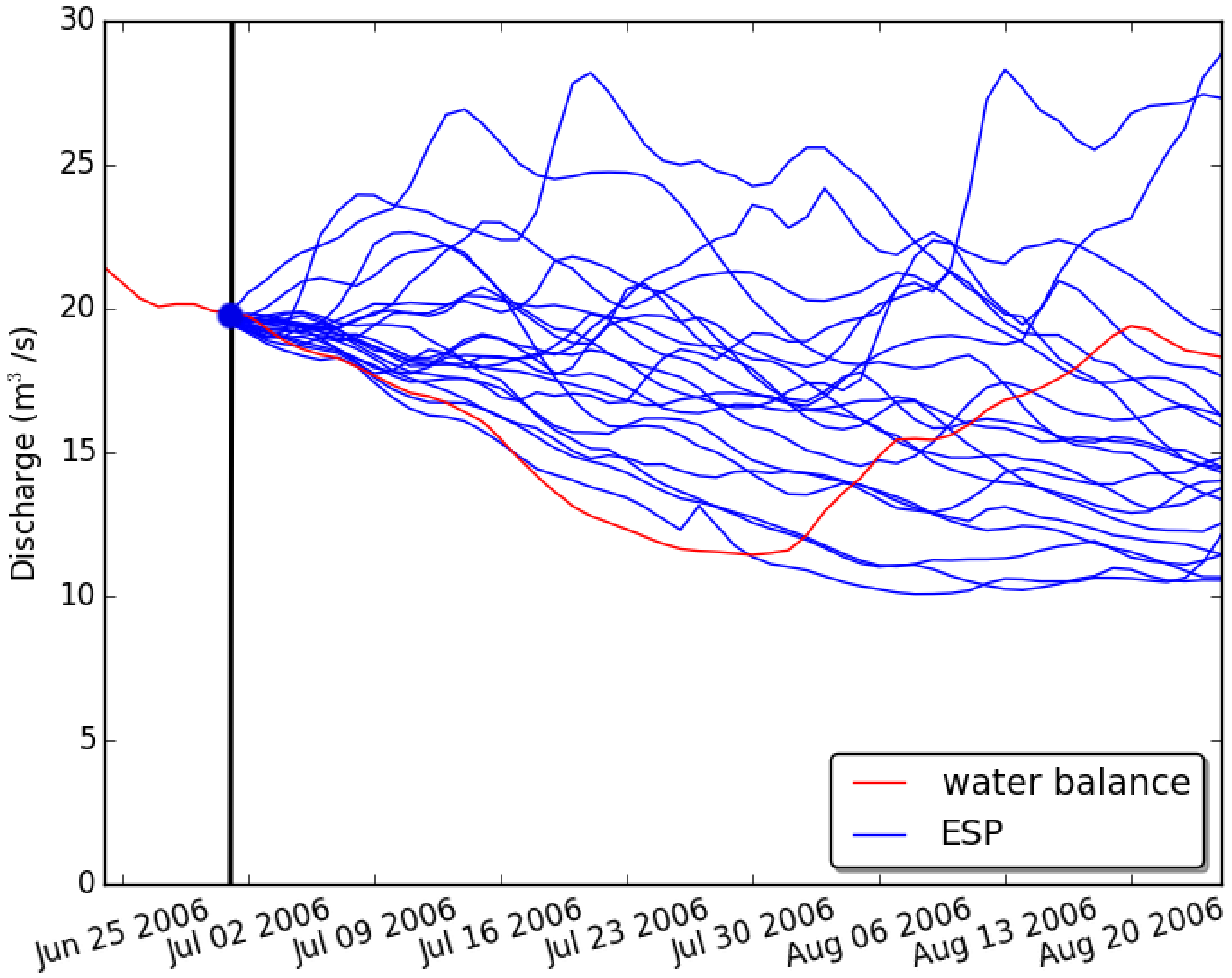
European catchments map used for the analysis (74 catchments)

Evaluation strategy
1) Seasonal predictability over Europe

- **KGE (Gupta et al., 2009):**
  - Correlation + bias + variability
  - Calculated on ensemble mean
- **CRPSS (Hersbach, 2000):** $CRPSS = 1 - \frac{CRPS_{seas.}}{CRPS_{ESP}}$
- **ROC (Mason and Graham, 1999, 2002):**
  - Computed on the 95th and 5th percentiles of model climate (5 bins)

Evaluation strategy

2) Meteorological forcings (MF) versus initial conditions (IC)



Evaluation strategy

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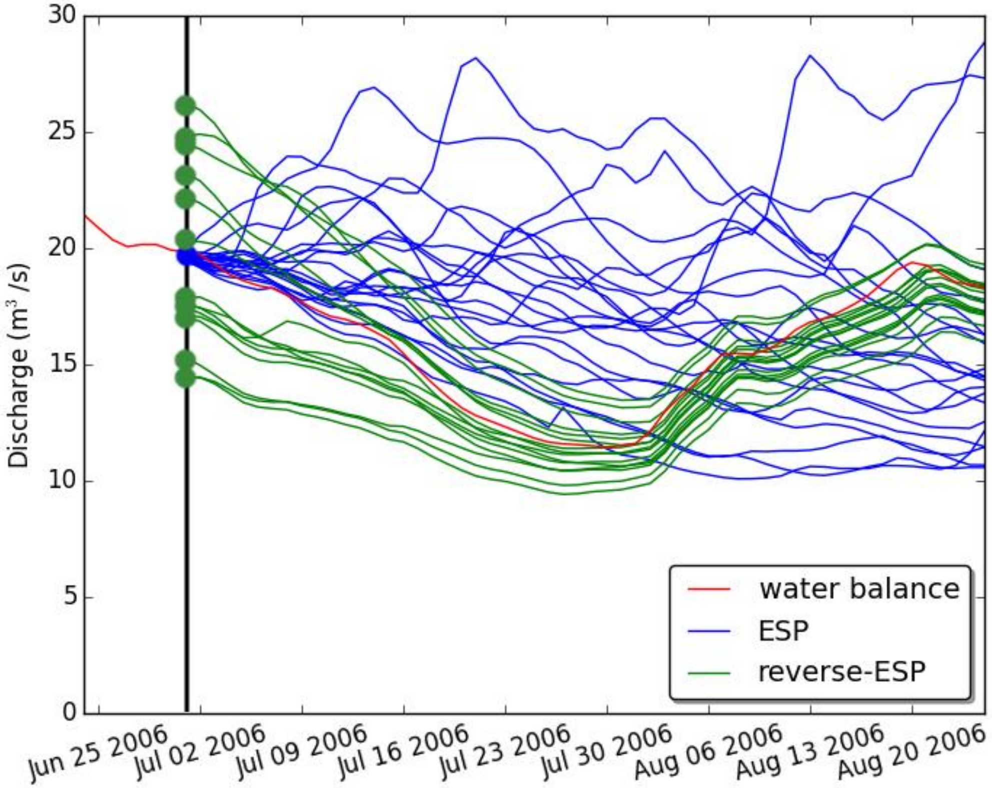
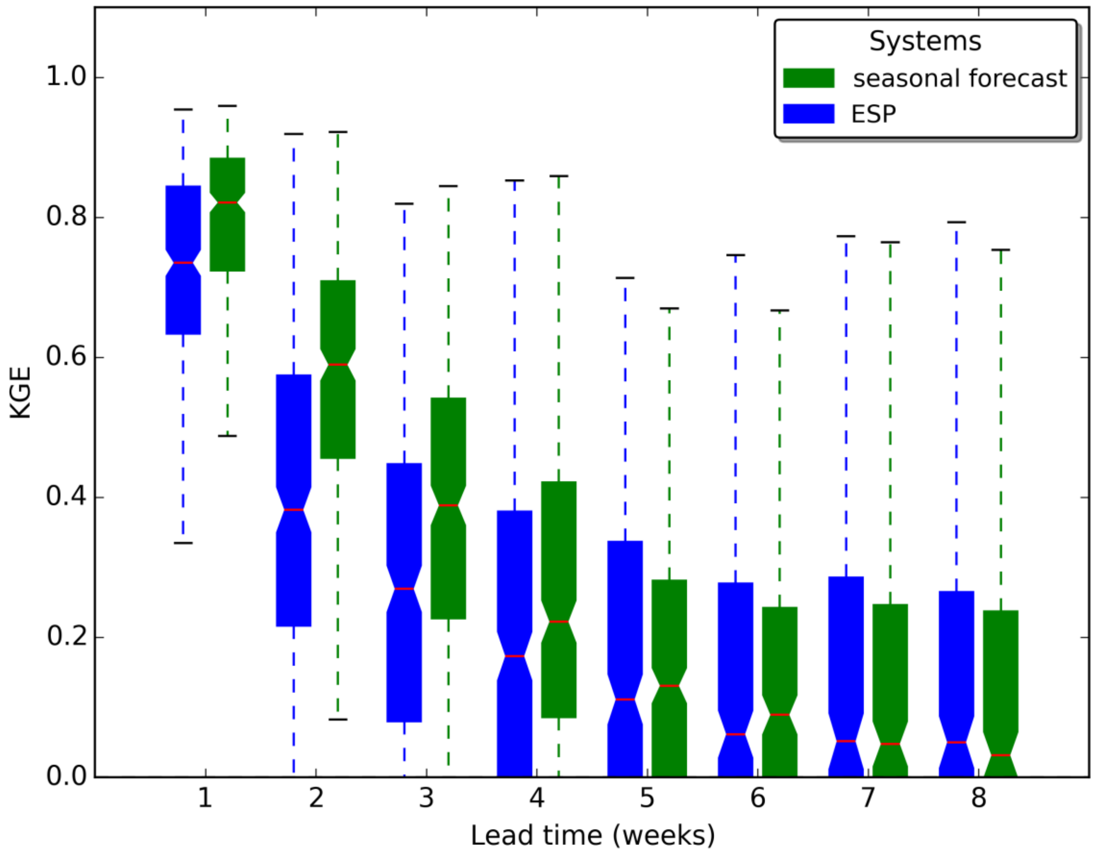


- **Reverse-ESP:** 15 resampled years of initial conditions and ‘perfect’ meteorological forcing data (Wood and Lettenmaier, 2008)
- MF lead the uncertainty over the IC → variance ESP > variance rESP

Results
1) Seasonal predictability over Europe

- Decreasing accuracy with lead time
- On average still some accuracy until 8 weeks
- Increasing geographical disparities with lead time
- Seasonal more accurate than ESP on average until 4 weeks
- Increasing gap during 2nd week between seasonal and ESP

KGE for all seasons combined

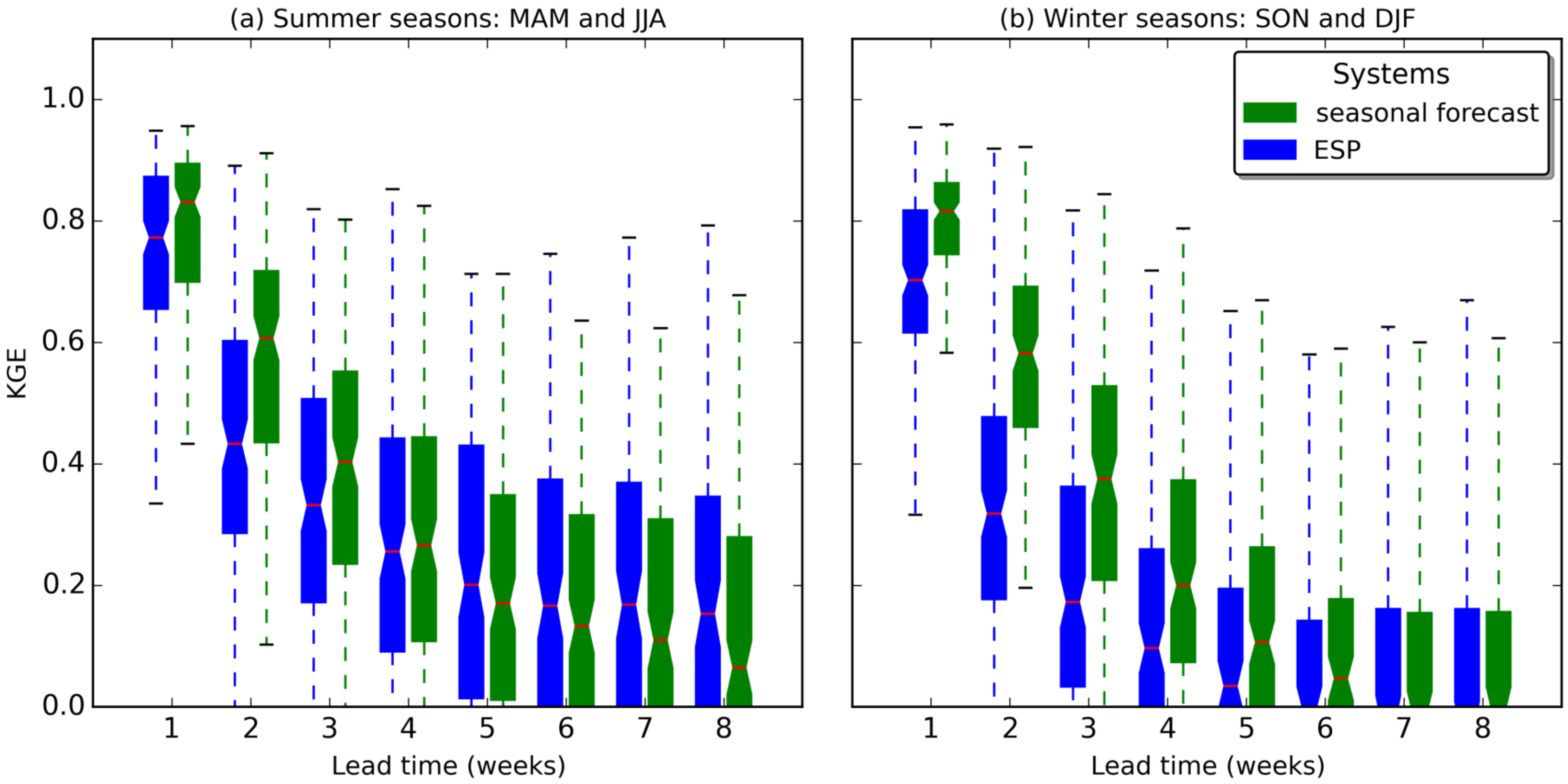


ECMWF

Results

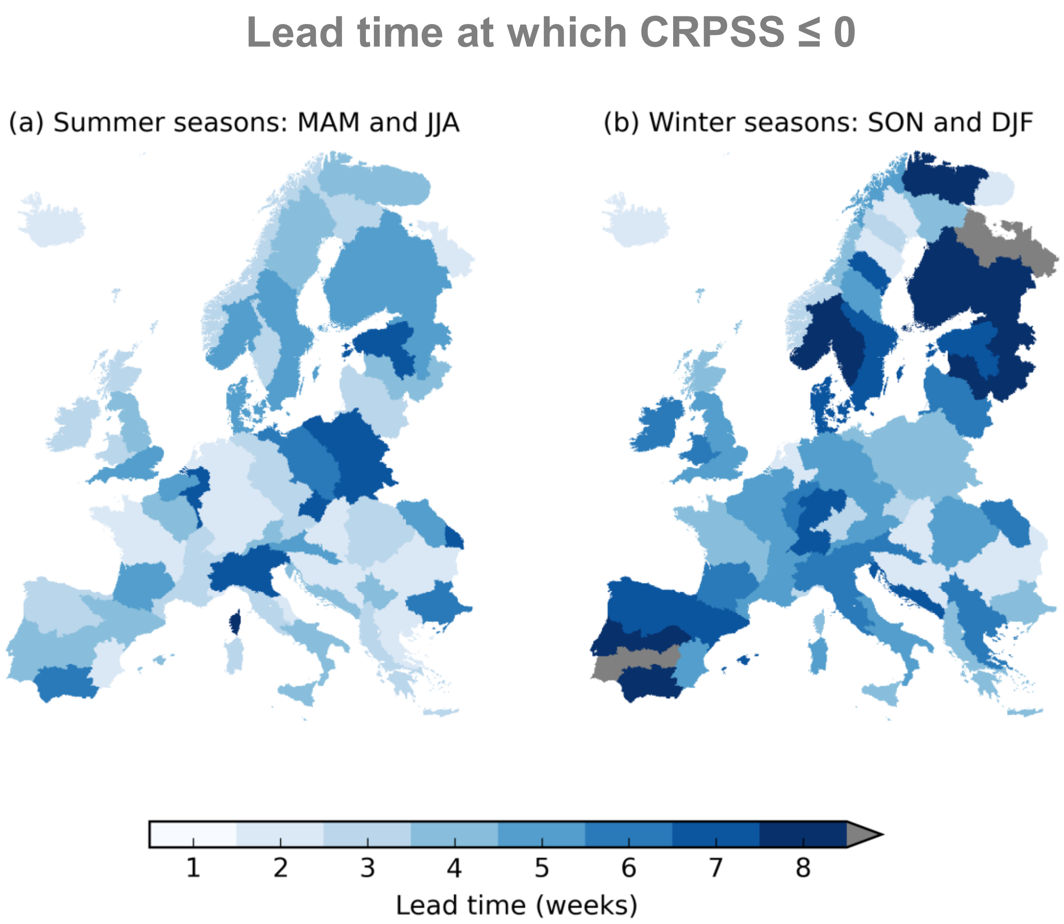
1) Seasonal predictability over Europe

- Higher predictability in summer
- Gain of using seasonal forecast increases in winter for lead times 1 to 4 weeks



Results

1) Seasonal predictability over Europe



- Seasonal shows highest gain in predictability in winter:
  - Iberian Peninsula
  - Scandinavia (Baltic Sea)
- In summer predictability largest for:
  - Scandinavia (Baltic Sea)
  - Around Mediterranean Sea
  - South of North Sea

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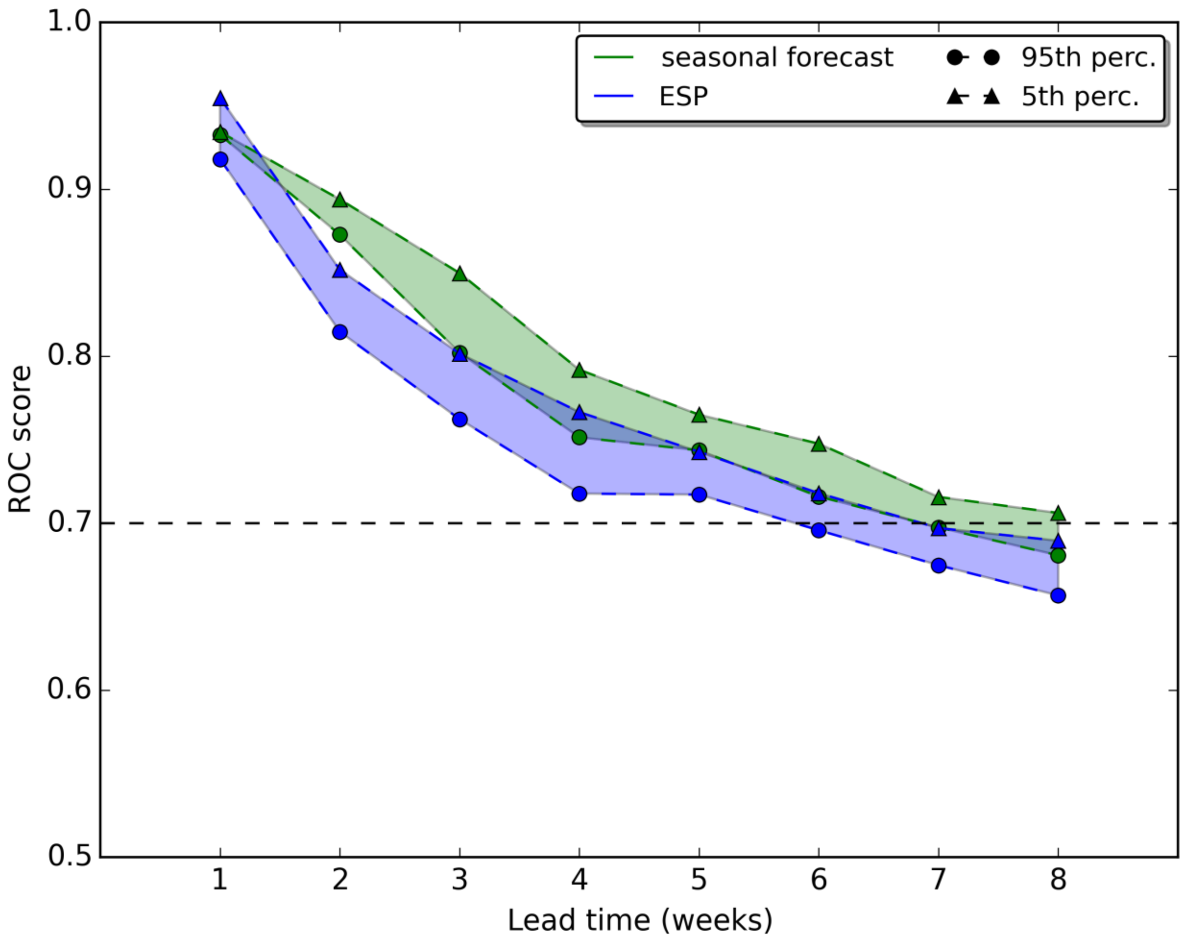
Results
1) Seasonal predictability over Europe

- Decreasing skill with lead time, but still skilful until about 6 weeks

- Seasonal and ESP show similar ROC score for week 1, then seasonal's ROC scores higher

- Large decrease in skill for ESP between 1 and 2 weeks

- Both systems more skilful to resolve low flows than high flows



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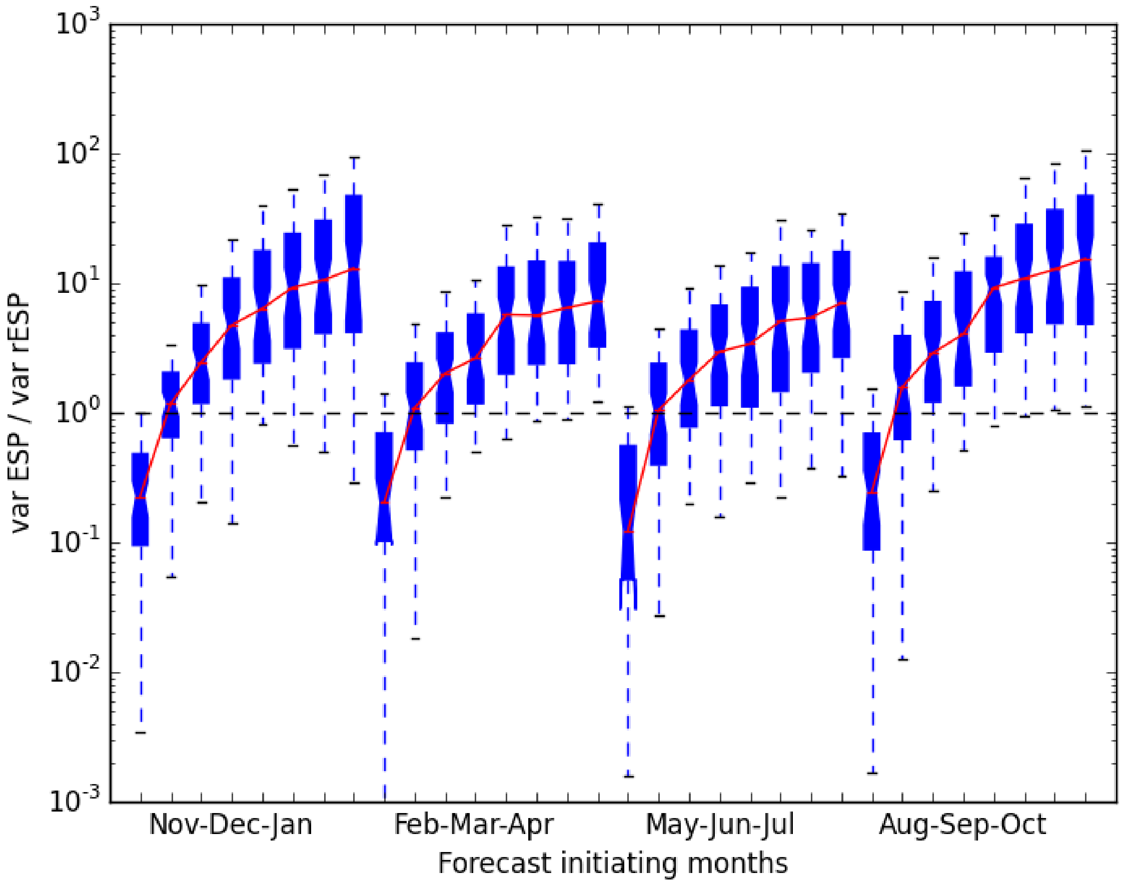
Results

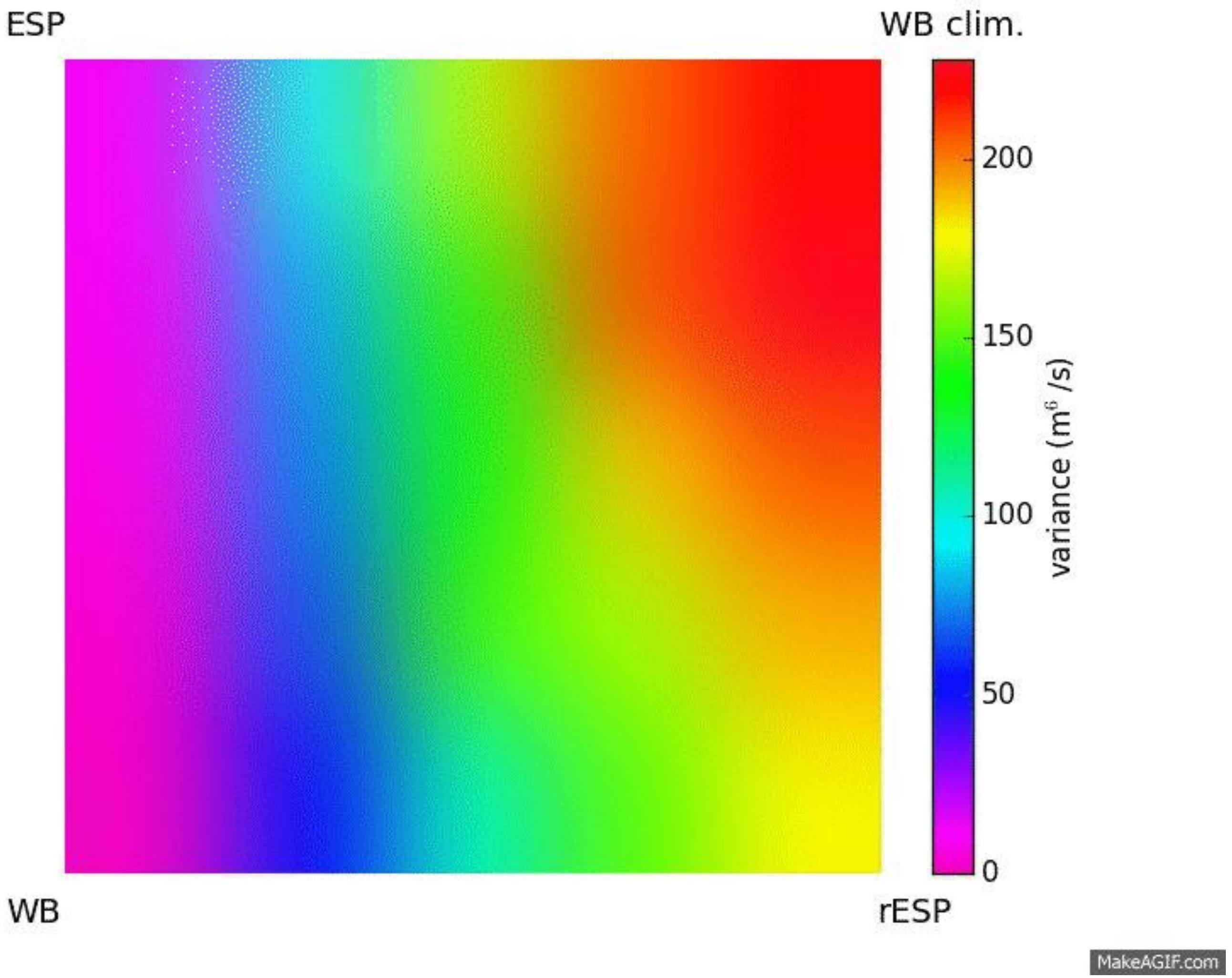
2) Meteorological forcings (MF) versus initial conditions (IC)

- Var ESP > var rESP on average at 2 weeks lead time for Europe
- Evolution of increasing contribution of MF, relative to IC, to forecast errors reflected in state of the seasons transitions (wet or dry)



Ongoing work

- Monthly aggregations
- More work on the reverse-ESP



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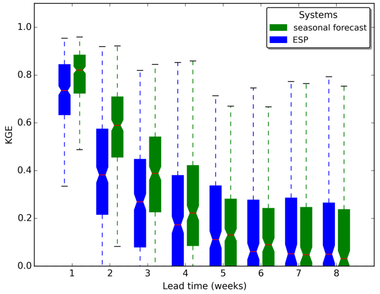
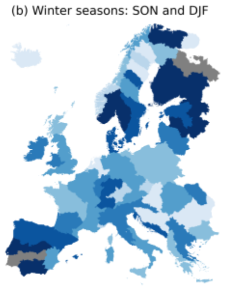
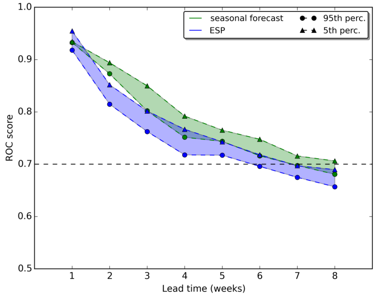
Take-home messages

Operational release: First quarter of 2016

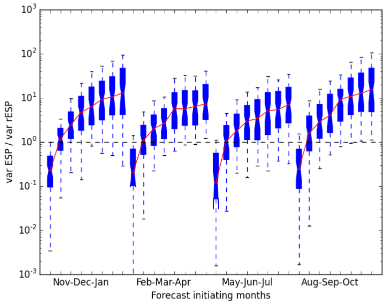




- ✓ Overall gain of using seasonal forecasts from 1 – 4 weeks lead time
  - ✓ Especially in winter: Iberian Peninsula and Scandinavia (Baltic Sea)



- ✓ Seasonal more skilful to resolve low and high flows from the 2nd - 8th week lead time
  - ✓ Lower flows more skilfully resolved than upper flows



- ✓ MF leads uncertainty over IC from 2 weeks of lead time on (average for Europe)
  - ✓ Seasonal transitions between hydrological states (wet, dry) crucial in this process