SEASONAL HYDROLOGICAL ENSEMBLE FORECASTS OVER EUROPE

Louise Arnal

louise.arnal@ecmwf.int

Fredrik Wetterhall, Florian Pappenberger and Blazej Krzeminski
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
- SEASONAL FORECAST
- 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):
  \[ CRPSS = 1 - \frac{CRPSE_{seas}}{CRPSE_{ESP}} \]

• 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

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

- **Reverse-ESP**: 15 resampled years of initial conditions and ‘perfect’ meteorological forcing data (Wood and Lettenmaier, 2008)

- MF lead the uncertainty over the IC $\rightarrow$ 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
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
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
Take-home messages

- 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 2\textsuperscript{nd} - 8\textsuperscript{th} 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

Operational release: First quarter of 2016

Louise Arnal - louise.arnal@ecmwf.int