Comparing European Streamflow Trends: Observations and Multi-model Simulations

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Motivation
In Europe, an overall appraisal of hydrological changes in recent decades has been hindered by the paucity of readily-available runoff data. European assessments of hydrological change at the continental scale hence often rely on models.

Results
A dipole pattern of positive runoff trends in the North & Northwest and negative runoff trends in the South & East dominates annual runoff and annual high flows. A similar pattern (though less coherent in the Northeast) dominates monthly runoff from Dec.-April. Decreasing trends in the summer months peak in August and dominate summer low flow changes. Observed decreasing trends are underestimated by models. The multi-model mean corresponds better than individual models’ trends to trends in observations. Agreement of the sign of the trend in the eight different models is highest during winter in areas of strong positive precipitation trends and lowest in transition seasons and areas where trend direction changes over short distances. Modelled and observed trends agree least in the Alps and Scandinavia.

Conclusion
European runoff in recent decades showed strong and opposing trends. A multi-model ensemble can increase model reliability, but uncertainty in the transition zones and seasons is high. At the boundary between areas with coherent climatic wetting and drying trends, observed runoff trends can deviate from large-scale climatic trends. Hence, monitoring of transient changes in these critical regions and improved higher-resolution modelling is important for prediction and planning.

Observer’s question
Are the trends in scattered streamflow observations’ representative of a continental pattern of hydrological change?

Data
EWAWATCH observed streamflow from near-natural catchments:
- Catchments 10 - 2 000 km²
- Model grid cells with observations: 293
- The largest catchment was used, where more than one occurred in a single grid cell.

Modeler’s question
Are large-scale model simulations reliable enough to fill the white spaces on the map of observed trends and reveal the regional coherence or variability of hydrological change?

Annual, High, and Low Flow trends 1963-2000:
observed and simulated runoff

Trend Validation
Multi-model mean trend vs observed trend in 293 paired grids:
- Correlation coefficient as a measure for pattern
- Mean absolute error as a measure for magnitude

Methods

Model Ensemble
Uncertainty:
- Trend maps indicating different trend direction in ≥ 2 out of 9 models
- Distribution of trends in observations and simulations from different models