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Evaluation of a multi-model seasonal hydrological forecast prototype for the spring flood period in Sweden

By: Kean Foster,

Co-authors: Cintia Uvo, Jonas Olsson, Wei Yang, Johan Södling, Tomas Bosshard and Peter Berg

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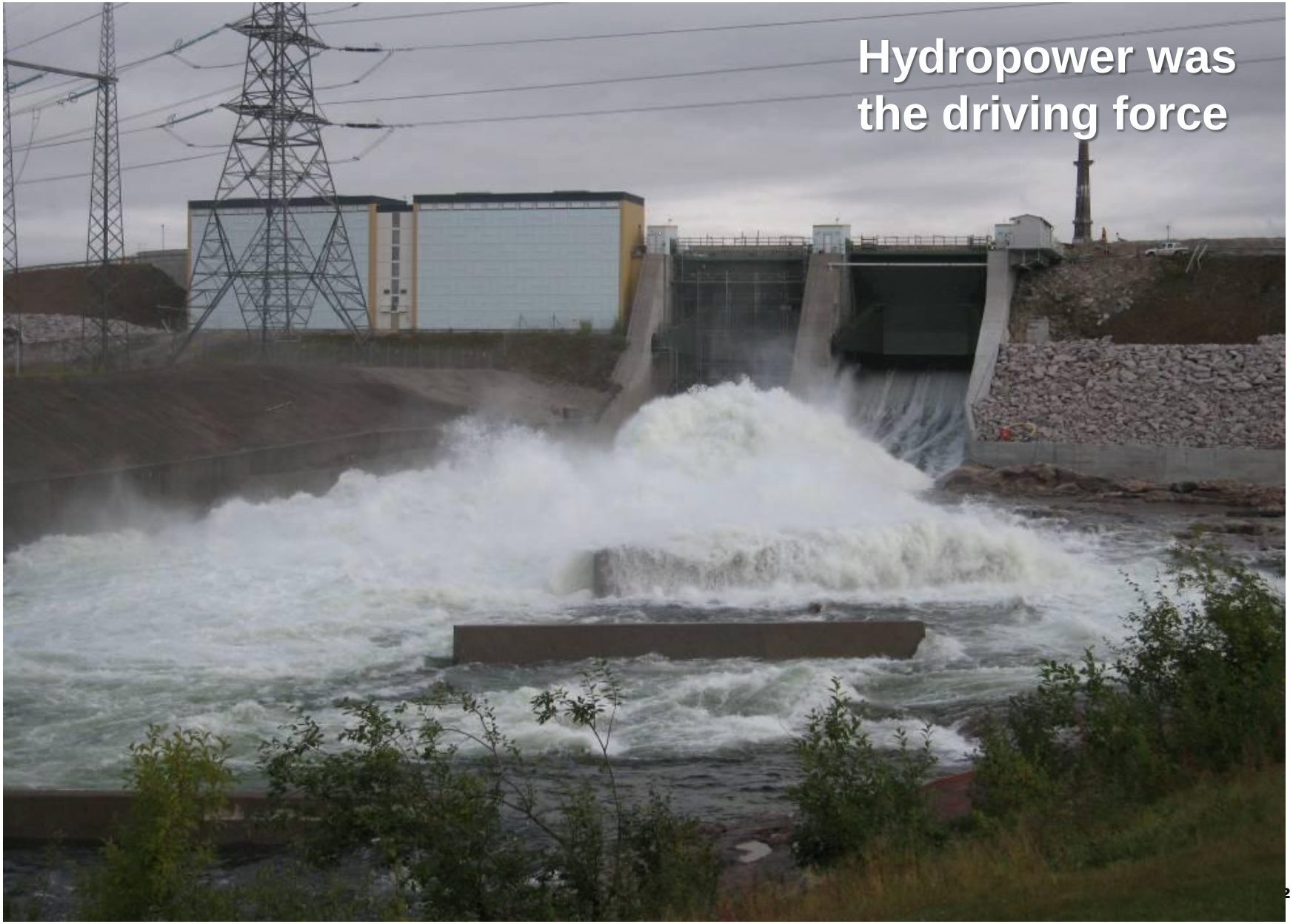

Hydropower was
the driving force

Background - Hydropower in Sweden

- **Sweden is the biggest hydropower producer in the EU and the 10th biggest worldwide (IEA 2012)**

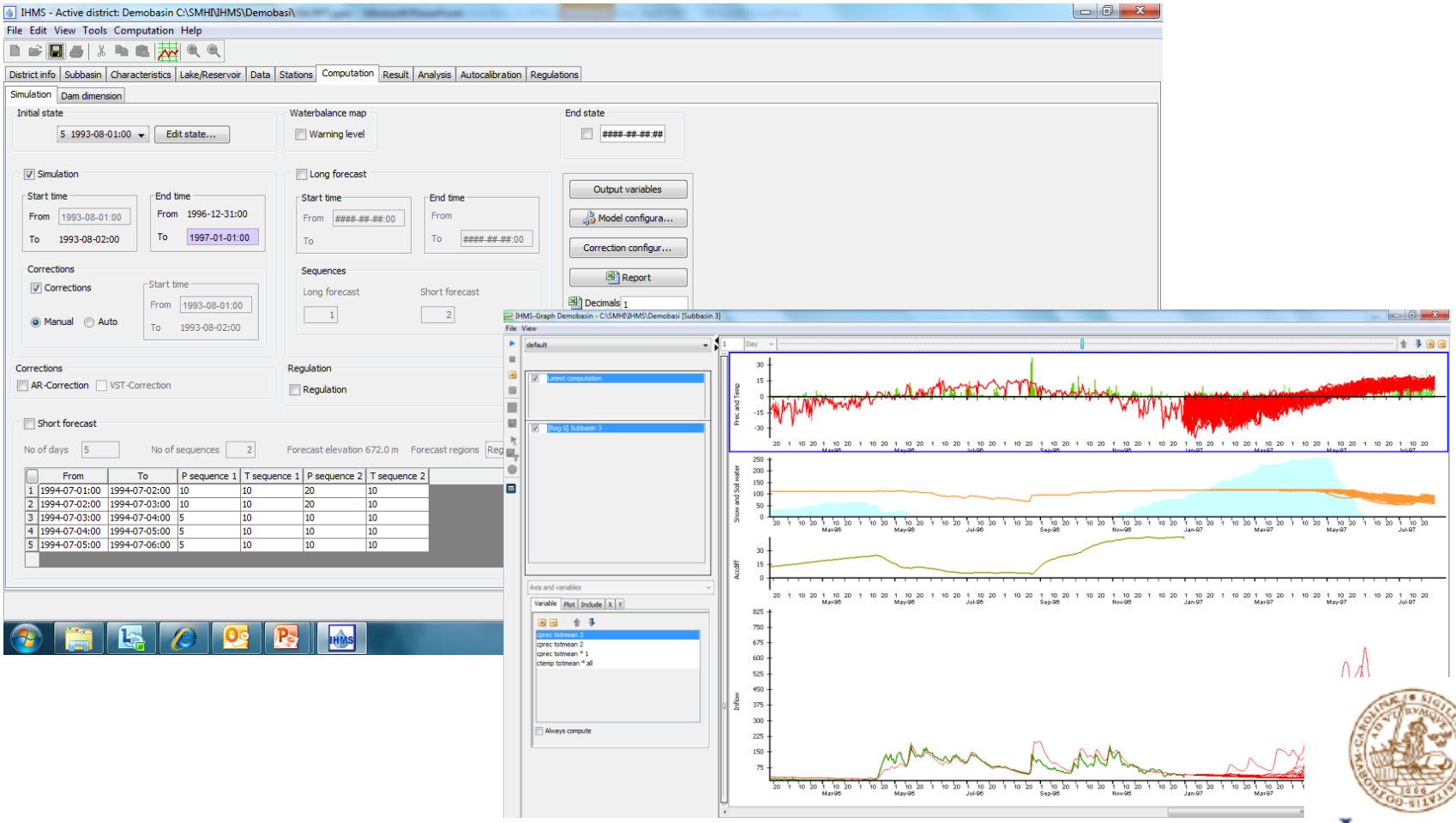
- **Hydroelectric capacity : 16 781 MW**

  - % of total installed capacity : 42.79%
  - % of total renewable capacity : 67.81%

- **Annual production (last 10 years) : 73 TWh**

  - approx. 45% of the country's total consumed electricity

IHMS – Integrated Hydrological Monitoring System



Climatological ensemble:

Historical time series

1961, 1962, 1963, 1964, 1965,
1966, 1967, 1968, 1969, 1970,
1971, 1972, 1973, 1974, 1975,
1976, 1977, 1978, 1979, 1980,
1981, 1982, 1983, 1984, 1985,
1986, 1987, 1988, 1989, 1990,
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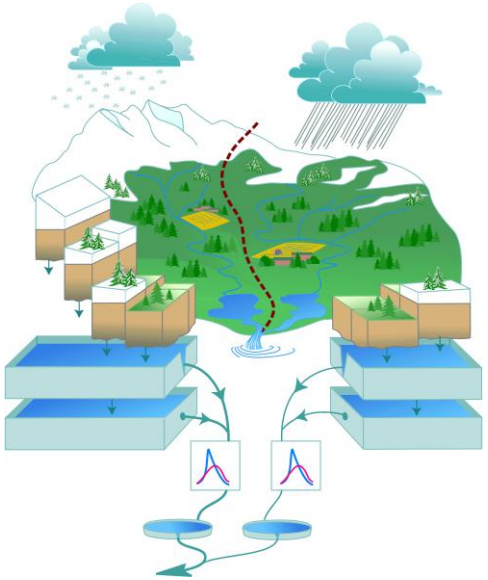
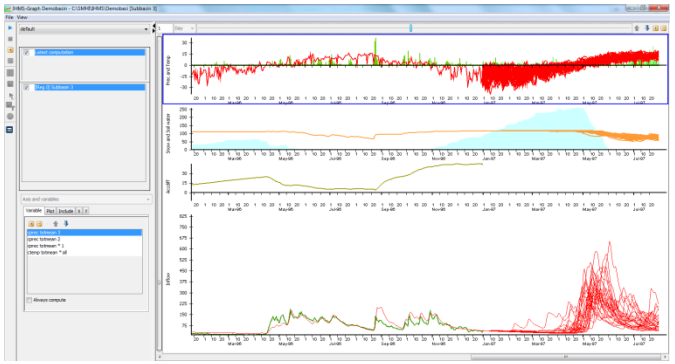
2006, 2007, 2008, 2009, 2010,
2011…

HBV



Forecast



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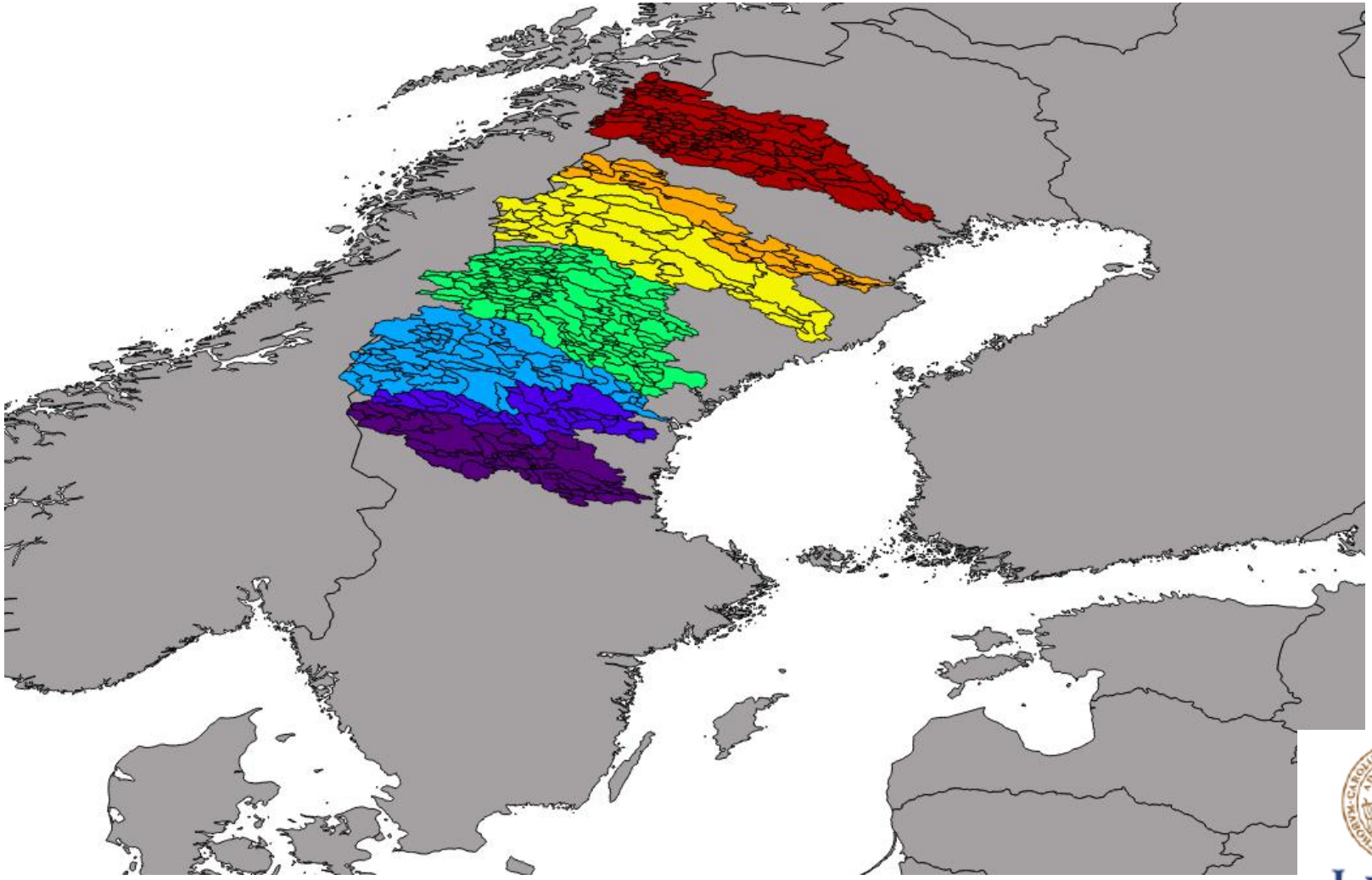
IHMS



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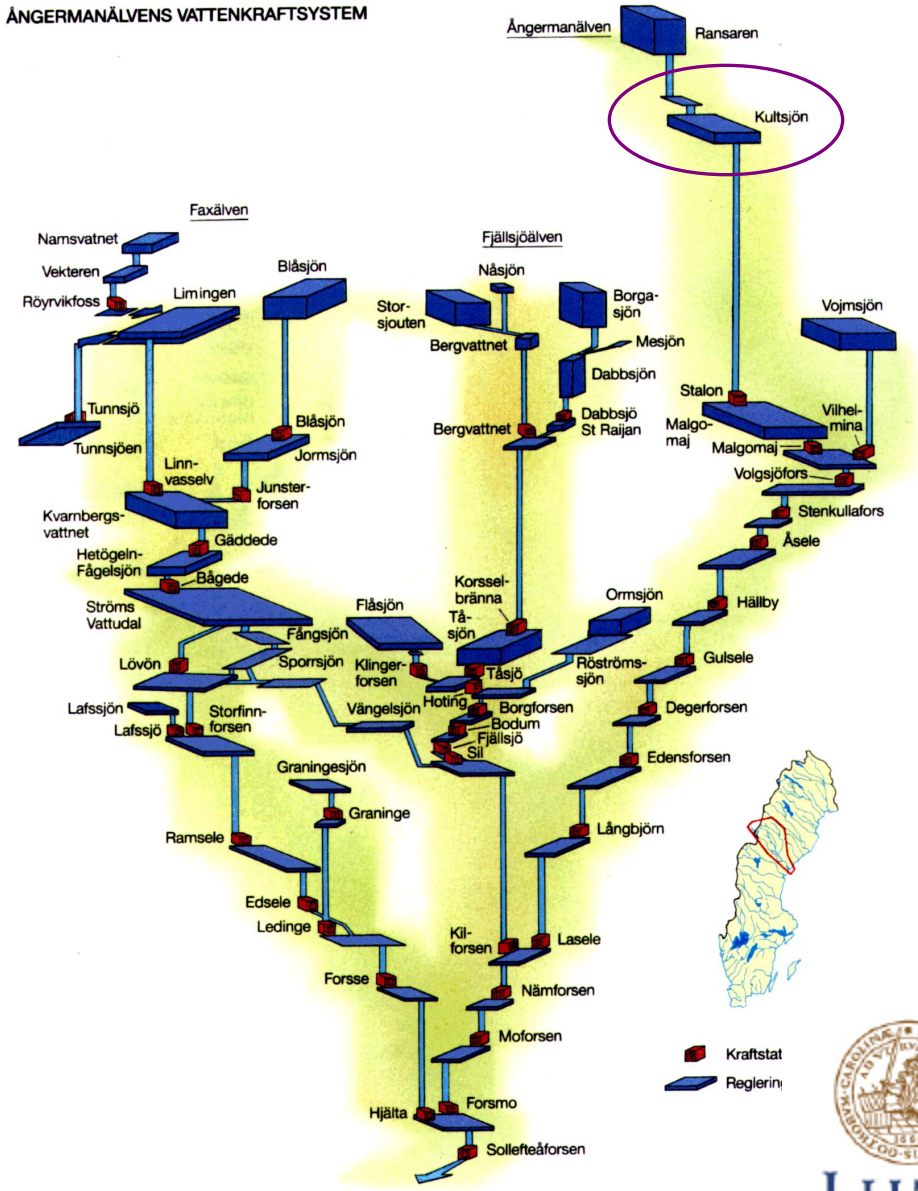
IHMS

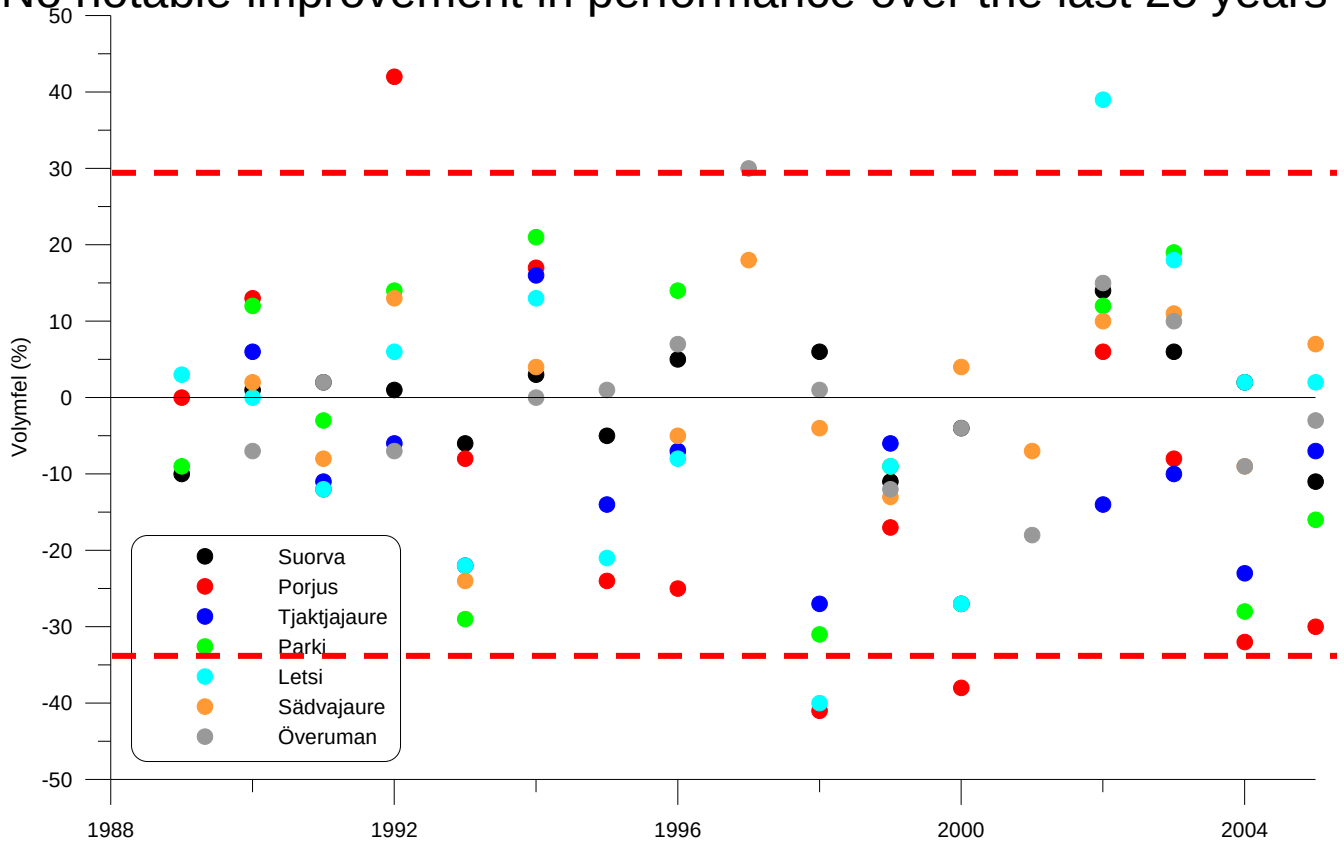
The Ångerman River

The hydropower system of the river Ångermanälven



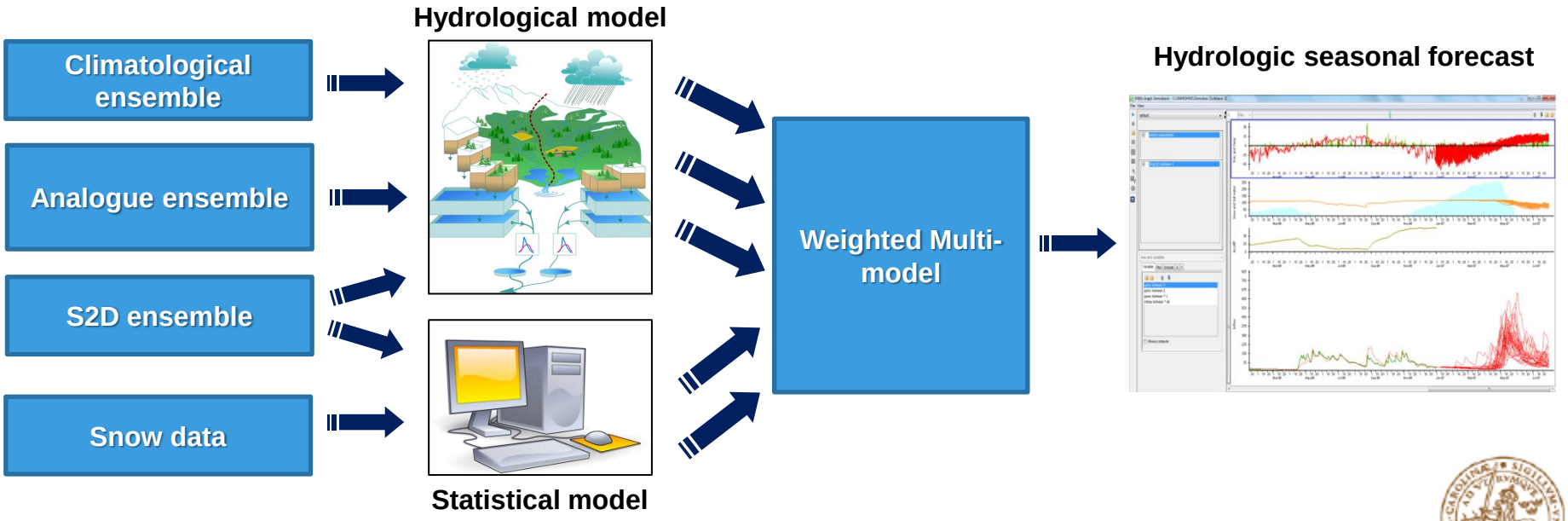
Climatologic ensemble: Limitations

- Climatologic ensemble → Seasonal forecast evolution <u>follows the climatology of the driving data</u>
- No notable improvement in performance over the last 25 years



Arheimer et al. 2010

Schematic of the Multi-model prototype

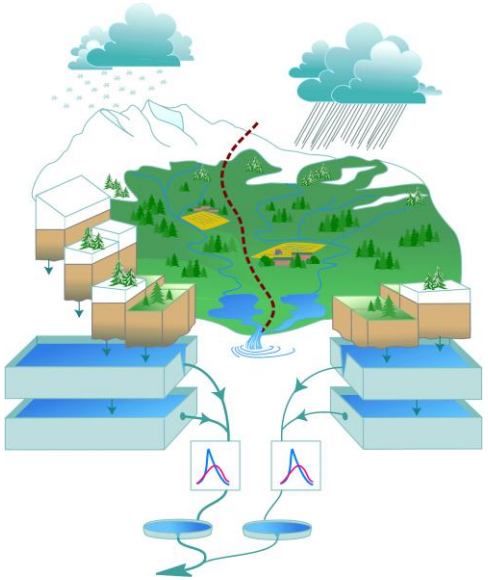


Reduced ensemble:

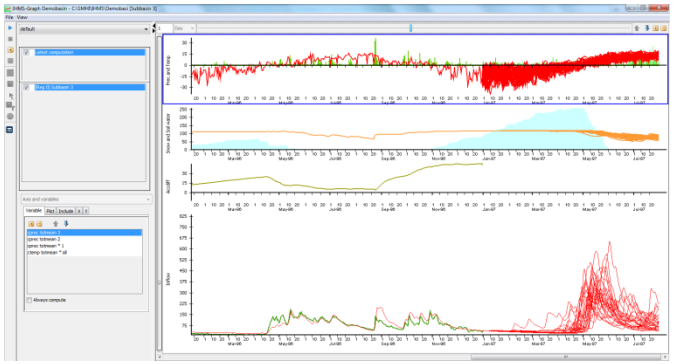
Historical time series

1961, ***1962***, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, ***1973, 1974***, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, ***1987***, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, ***2001***, 2002, 2003, 2004, 2005, 2006, 2007, 2008,***2009, 2010***, 2011…

HBV

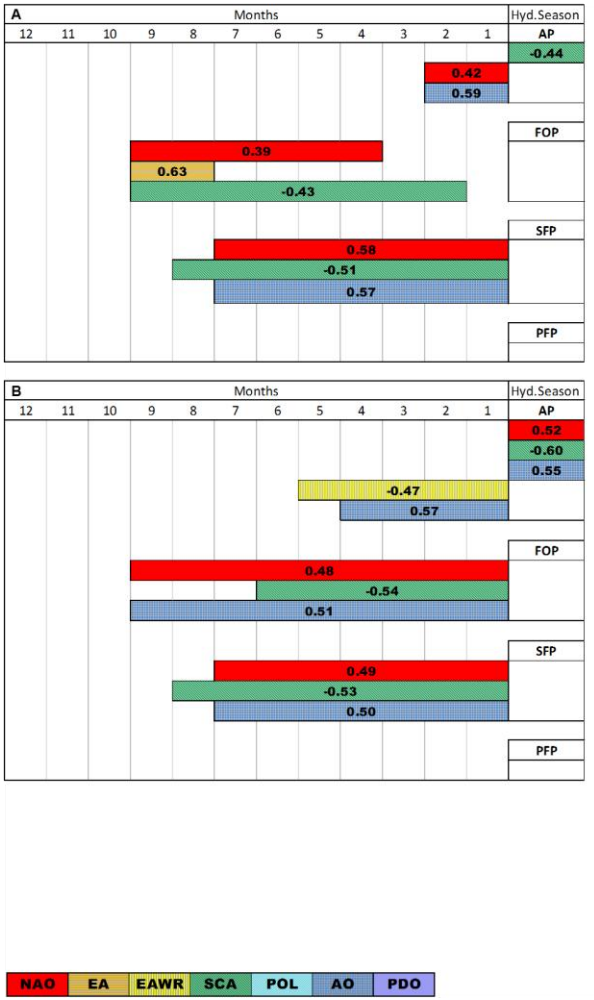


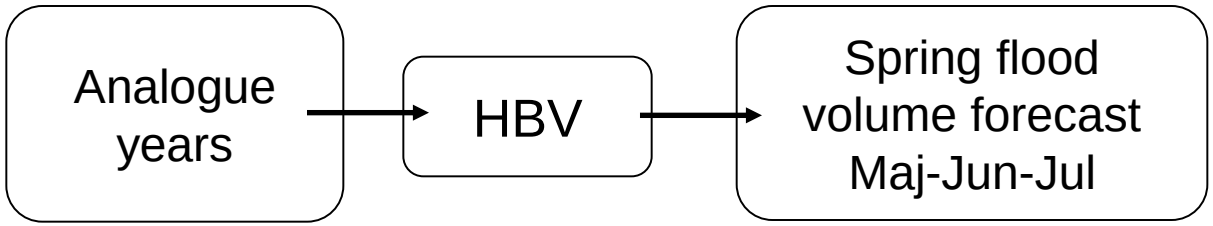
Forecast



Reduced ensemble: TCI method

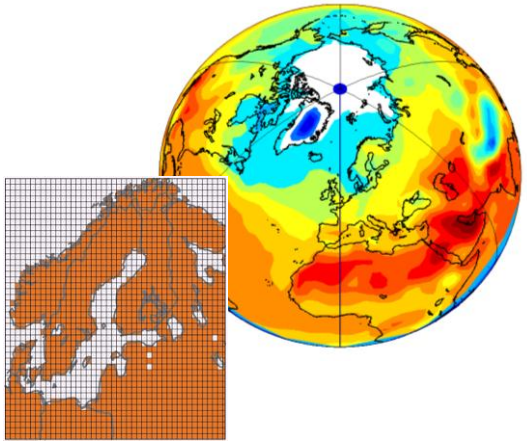
- Teleconnection Climate Indices
  - NAO
  - AO
  - SCAND
- Select all years with comparable TCI combinations
- Run HBV with reduced ensemble





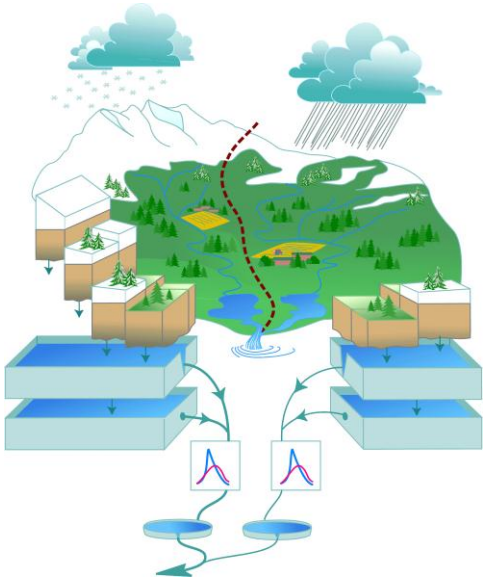
Seasonal NWP based forecast:

NWP

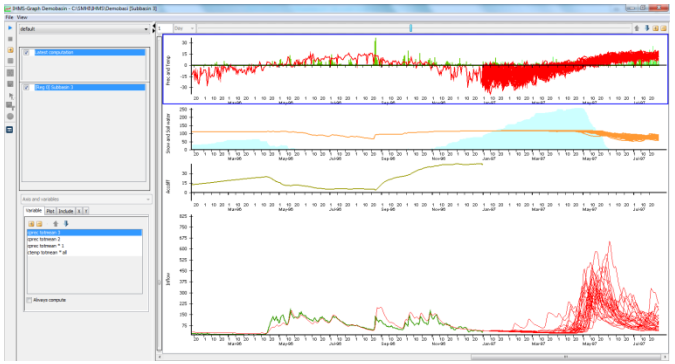


~100 km

HBV

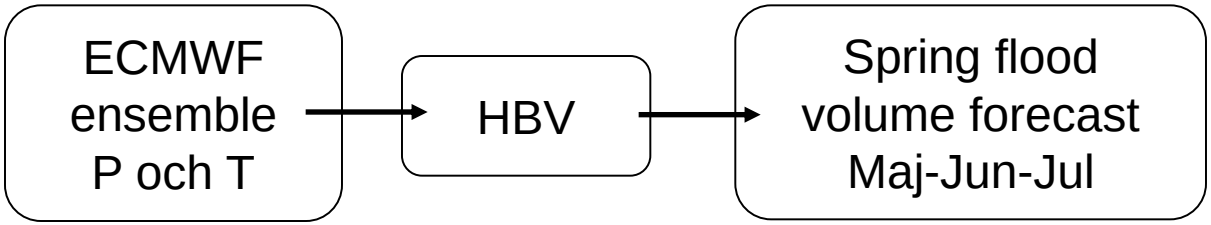


Forecast



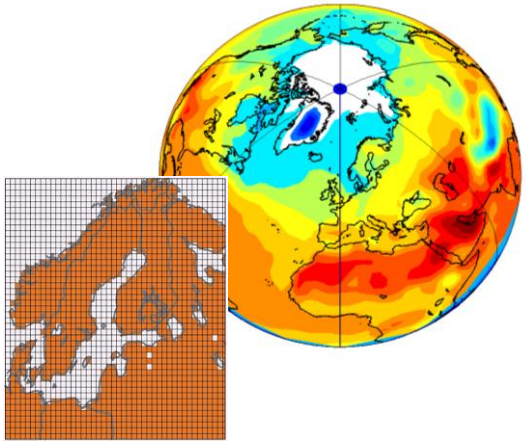
ECMWF forecasts in HBV: method

- ECMWF seasonal forecasts
  - 51 ensemble members
  - Daily P and T → Bias correction and remapping to HBV grid format
- Run HBV with ECMWF ensemble



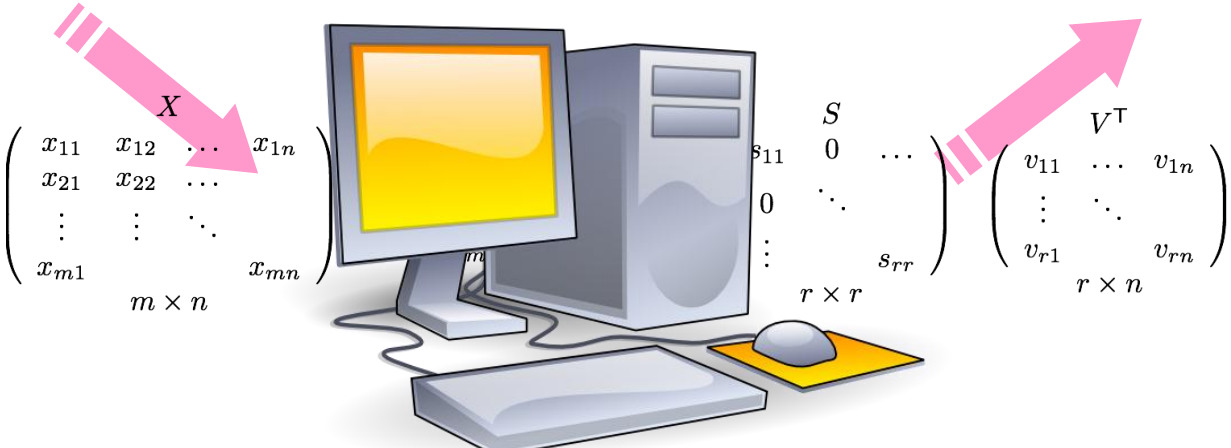
Statistical downscaling:

NWP

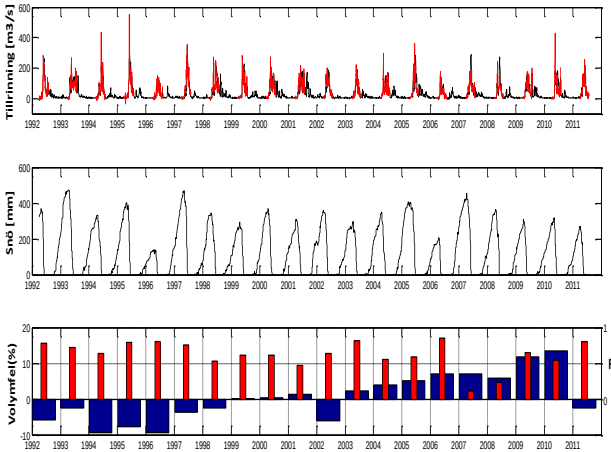


~100 km

SVD



Forecast



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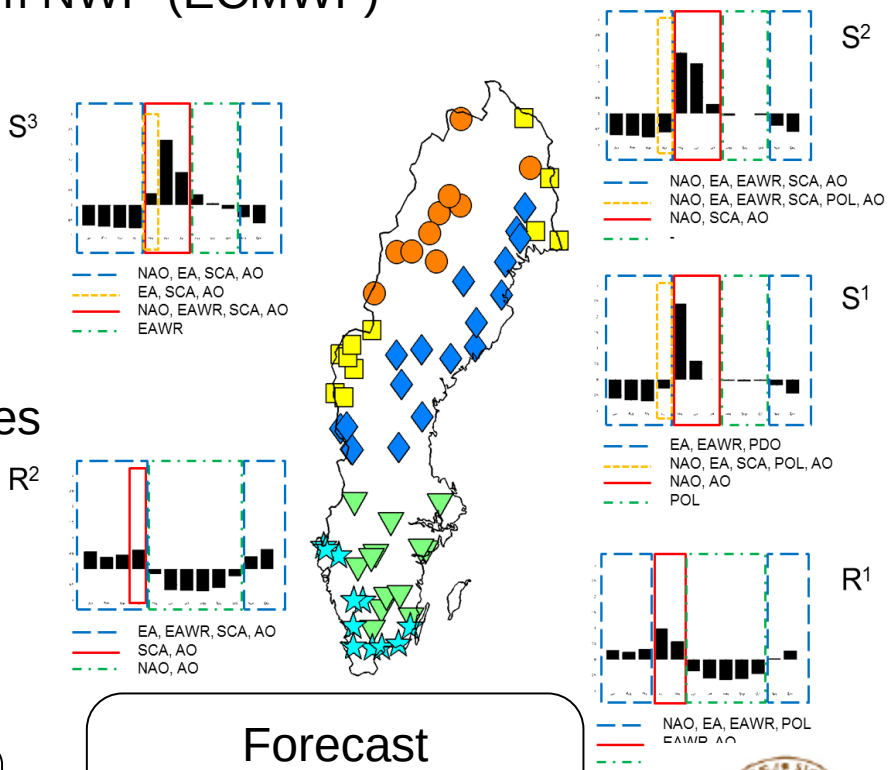
Statistical downscaling: method

- Atmospheric variables predictors from NWP (ECMWF)
  - Pressure field variables
  - Temperature/radiation variables
  - Moisture variables
- Observed Seasonal dischage volumes



In December
GCM forecast
Jan-Feb-Mar

→ SVD →

Forecast
spring flood volume
May-Jun-Jul

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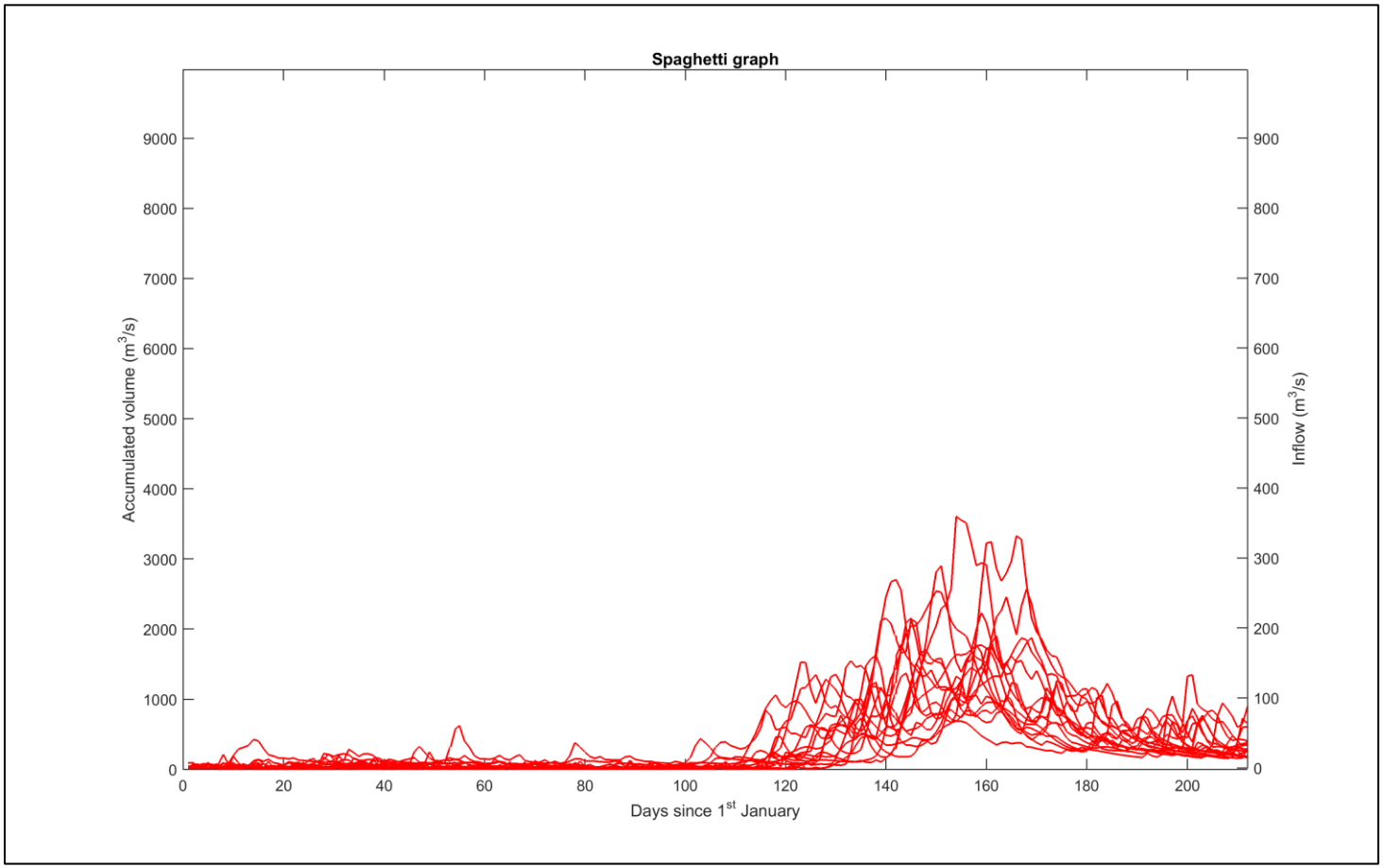
Multi-model Forecast example:



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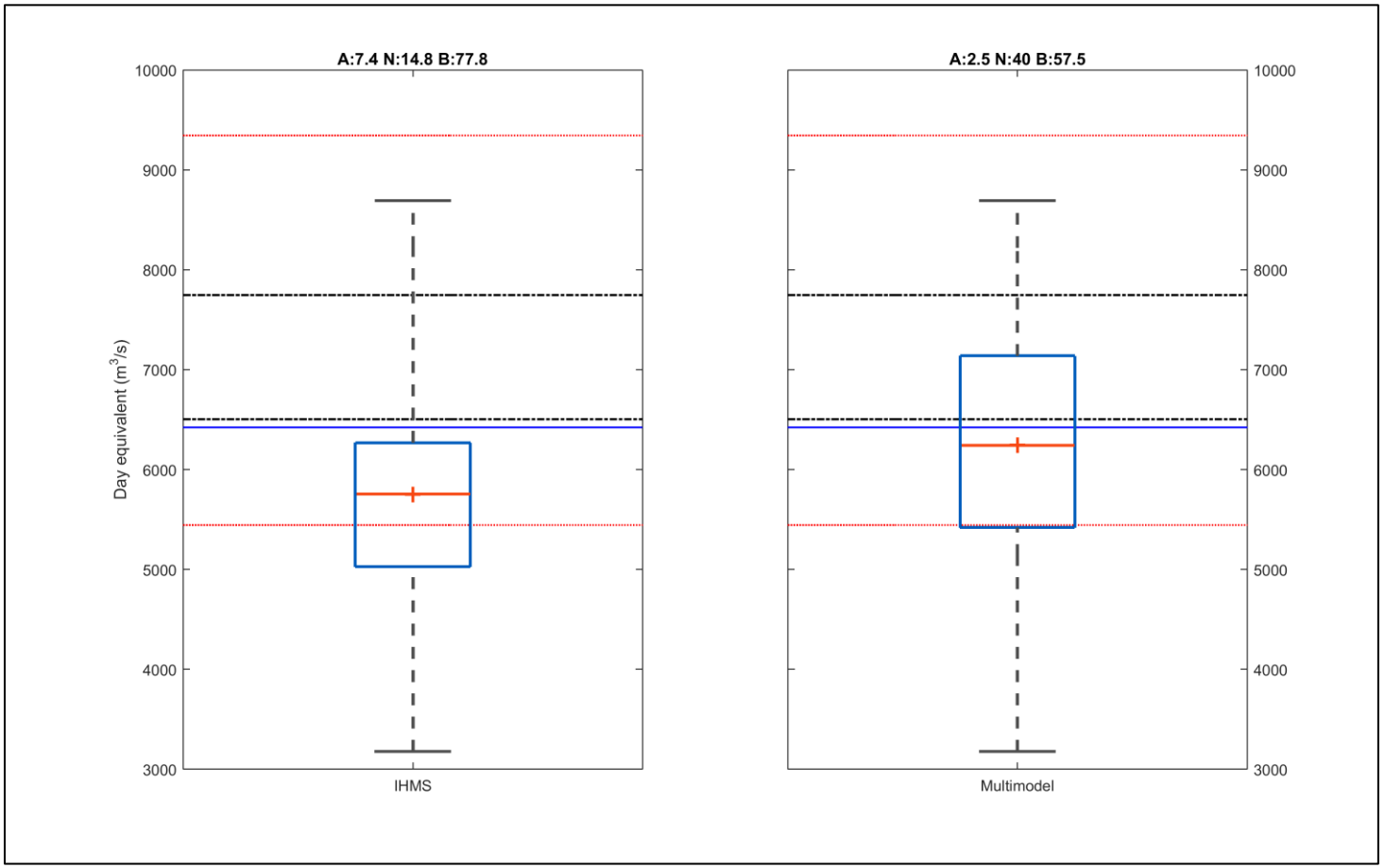

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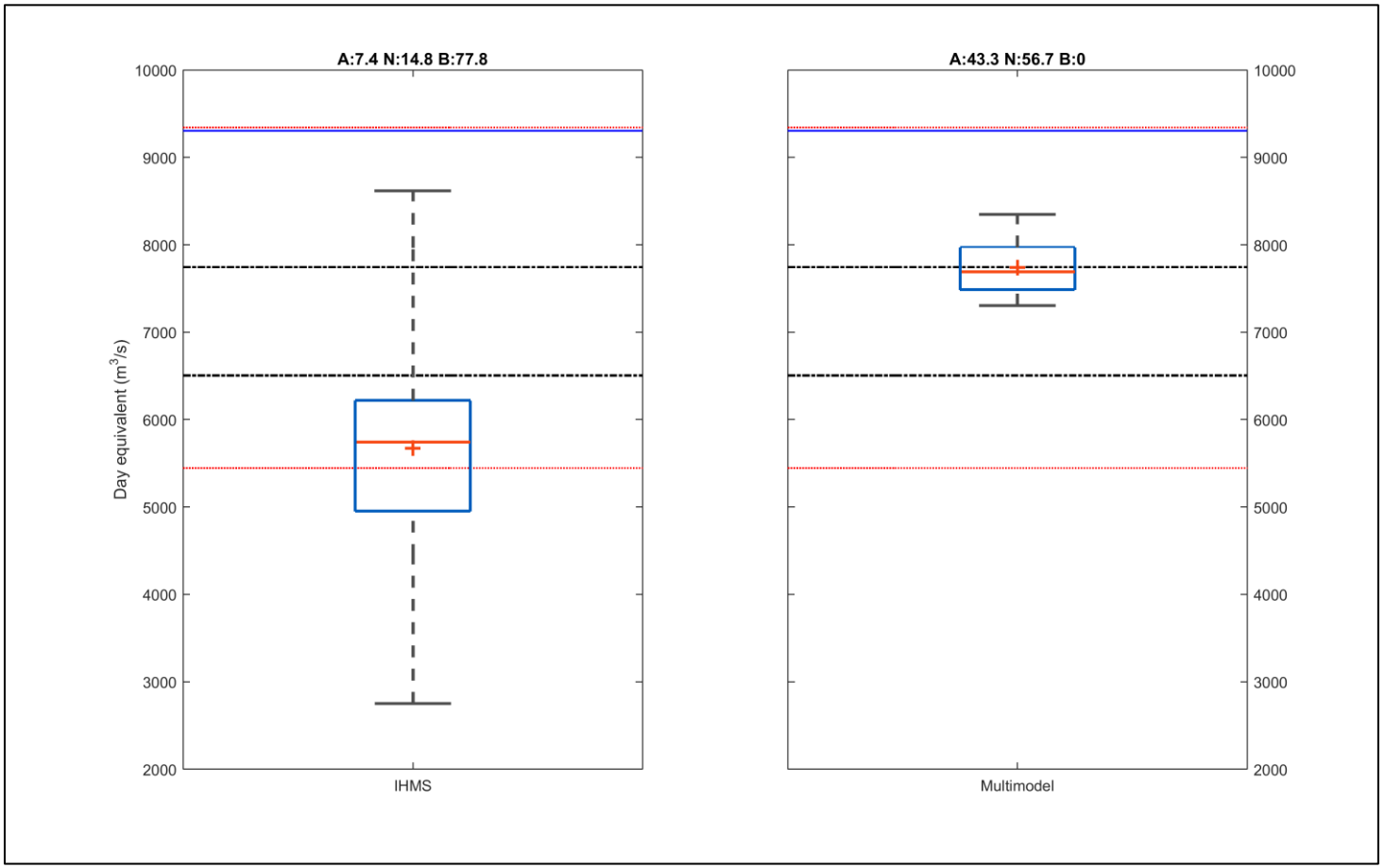
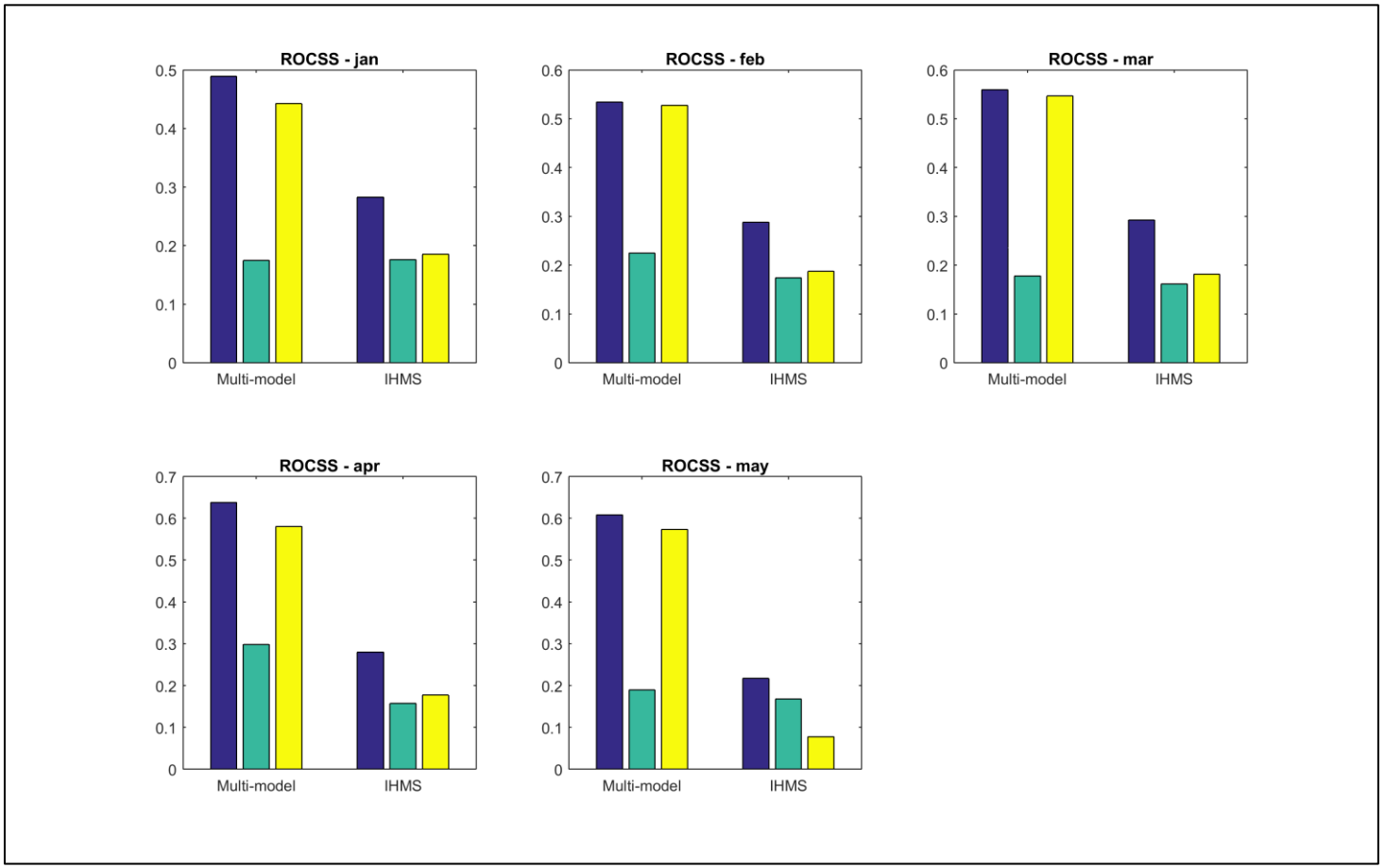


Multi-Model Forecast validation stats:



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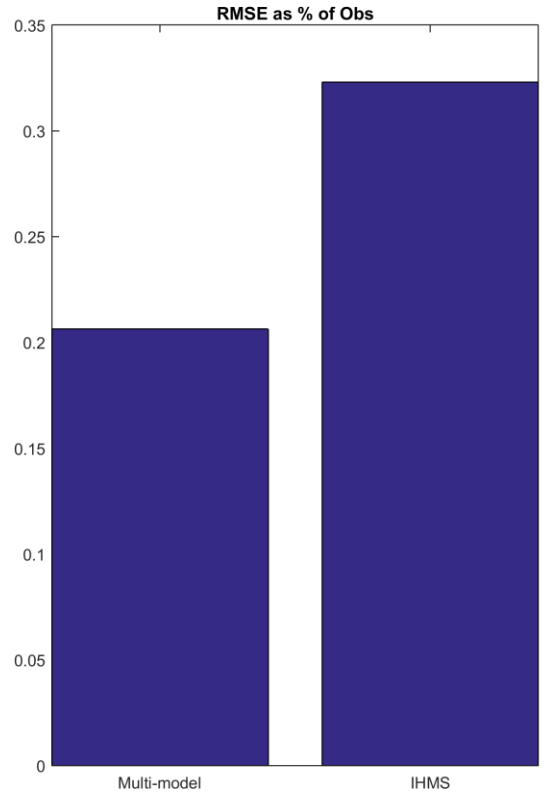

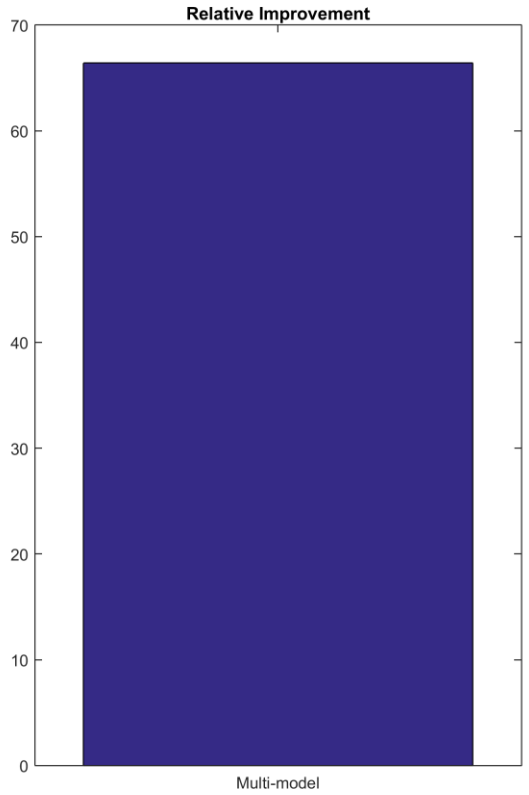

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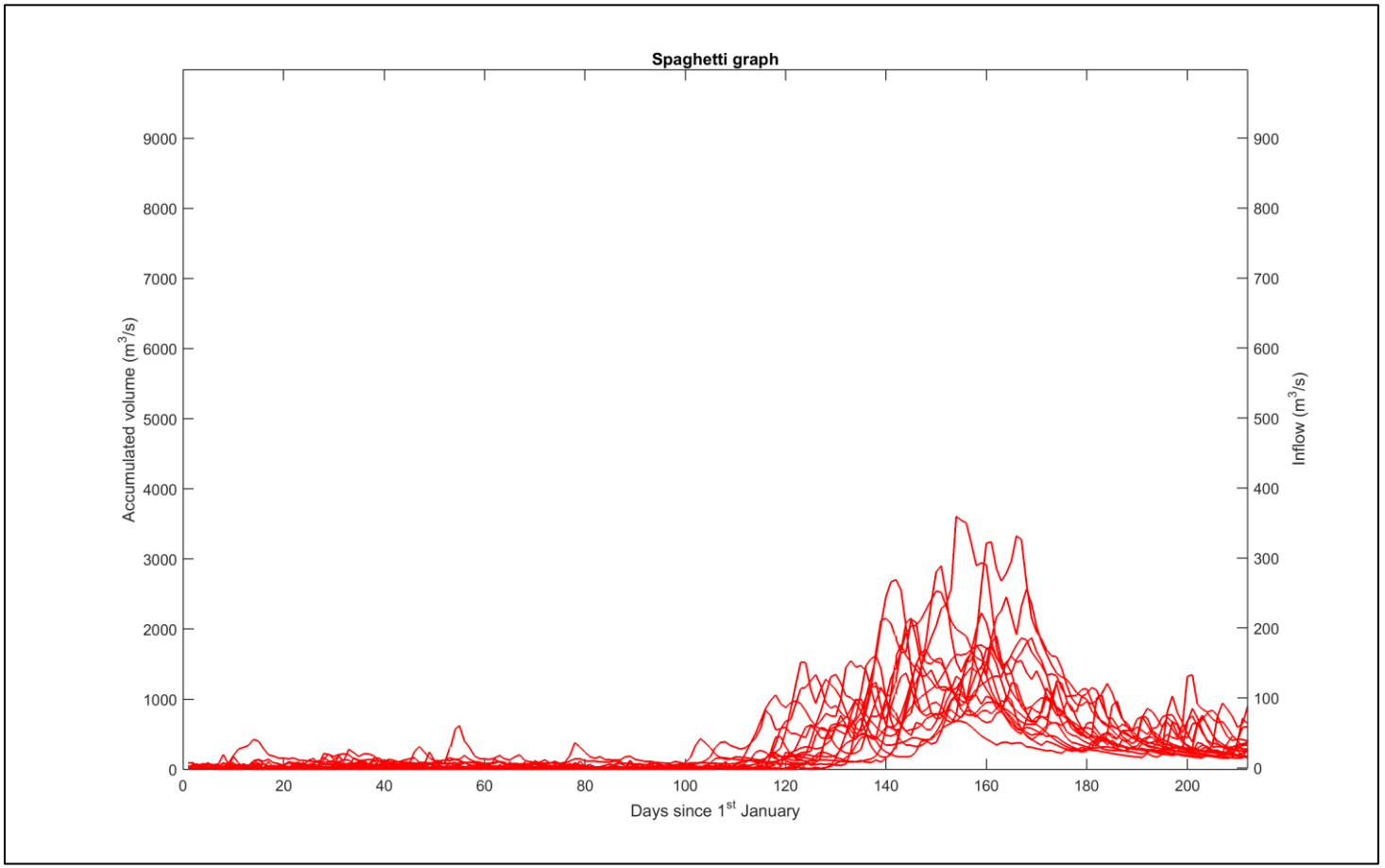

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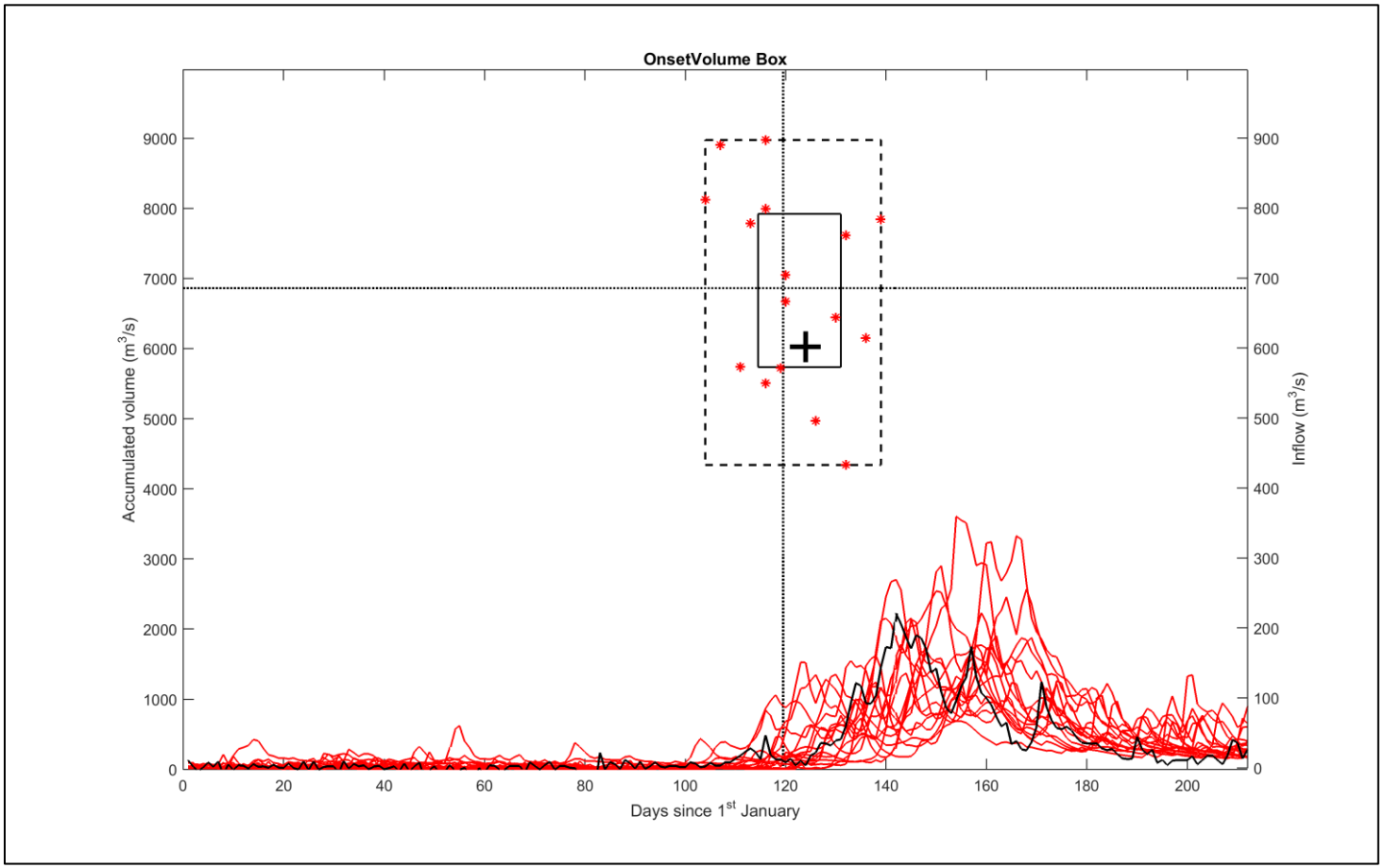

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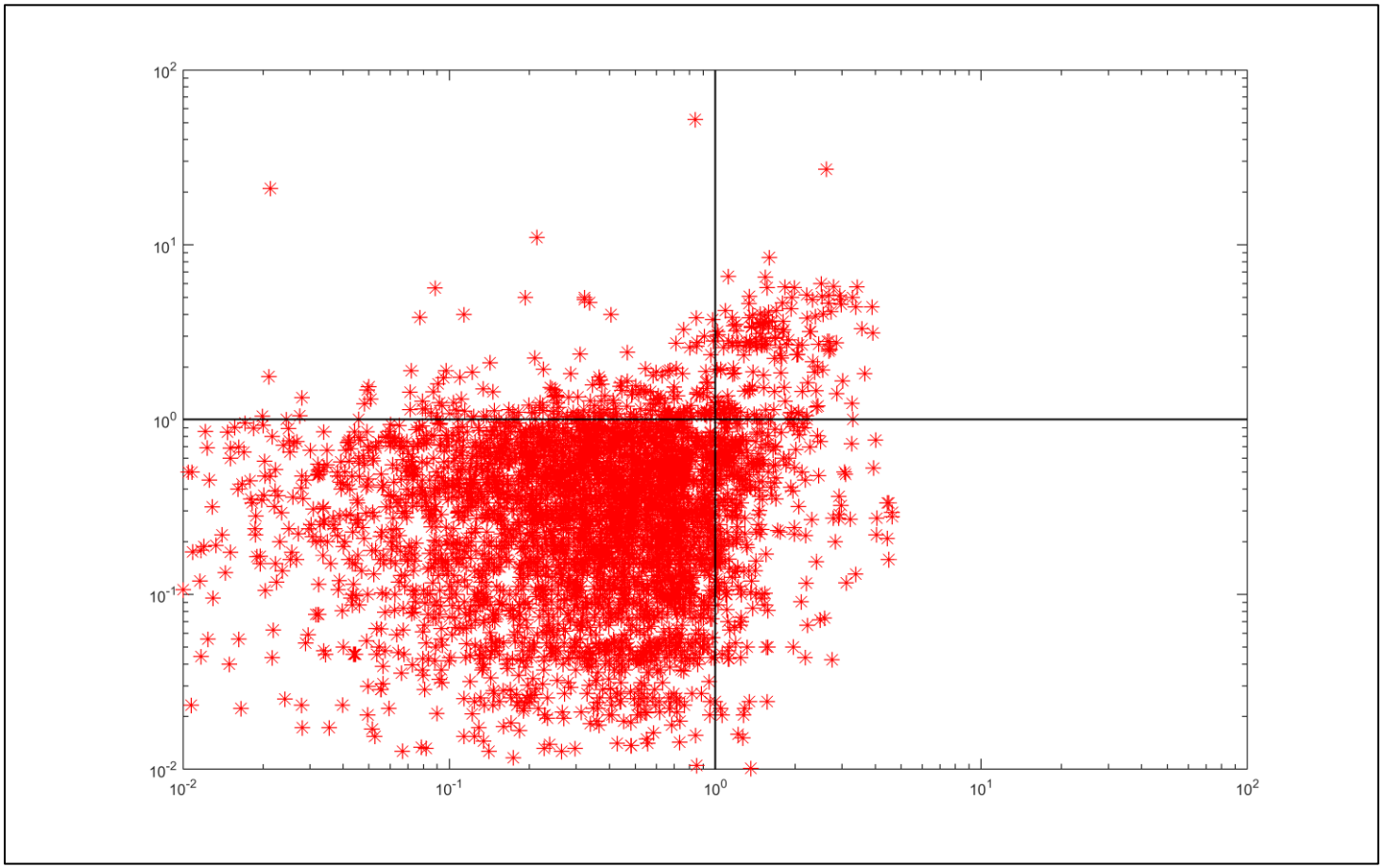
Forecast example: Initialised 1Jan



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Conclusions

- Climatological spring flood forecasts are difficult to beat.
- For single basins and forecast dates, a reduction of the forecast error by up to 30%.
- The Multi-model shows more skill at forecasting anomalies and is able to reduce the forecasted volume error by 10% points on average.

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