



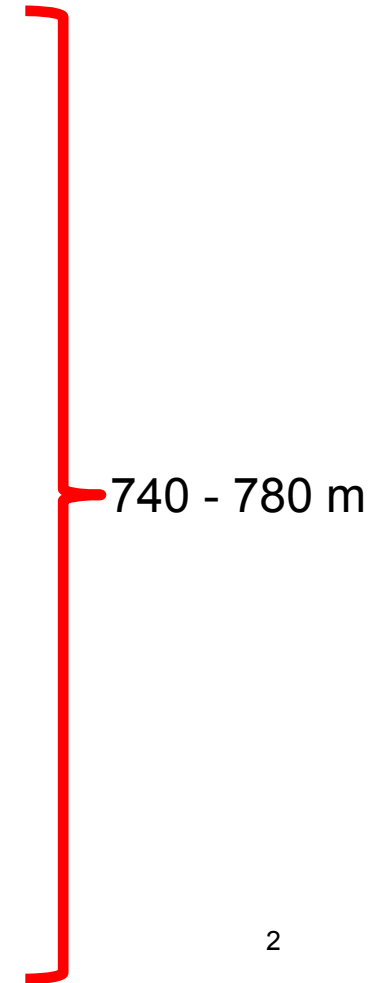
Norway's historical and projected water balance in mm and TWh

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Norwegian Water Resources and Energy Directorate

Hydropower facts (Norway)

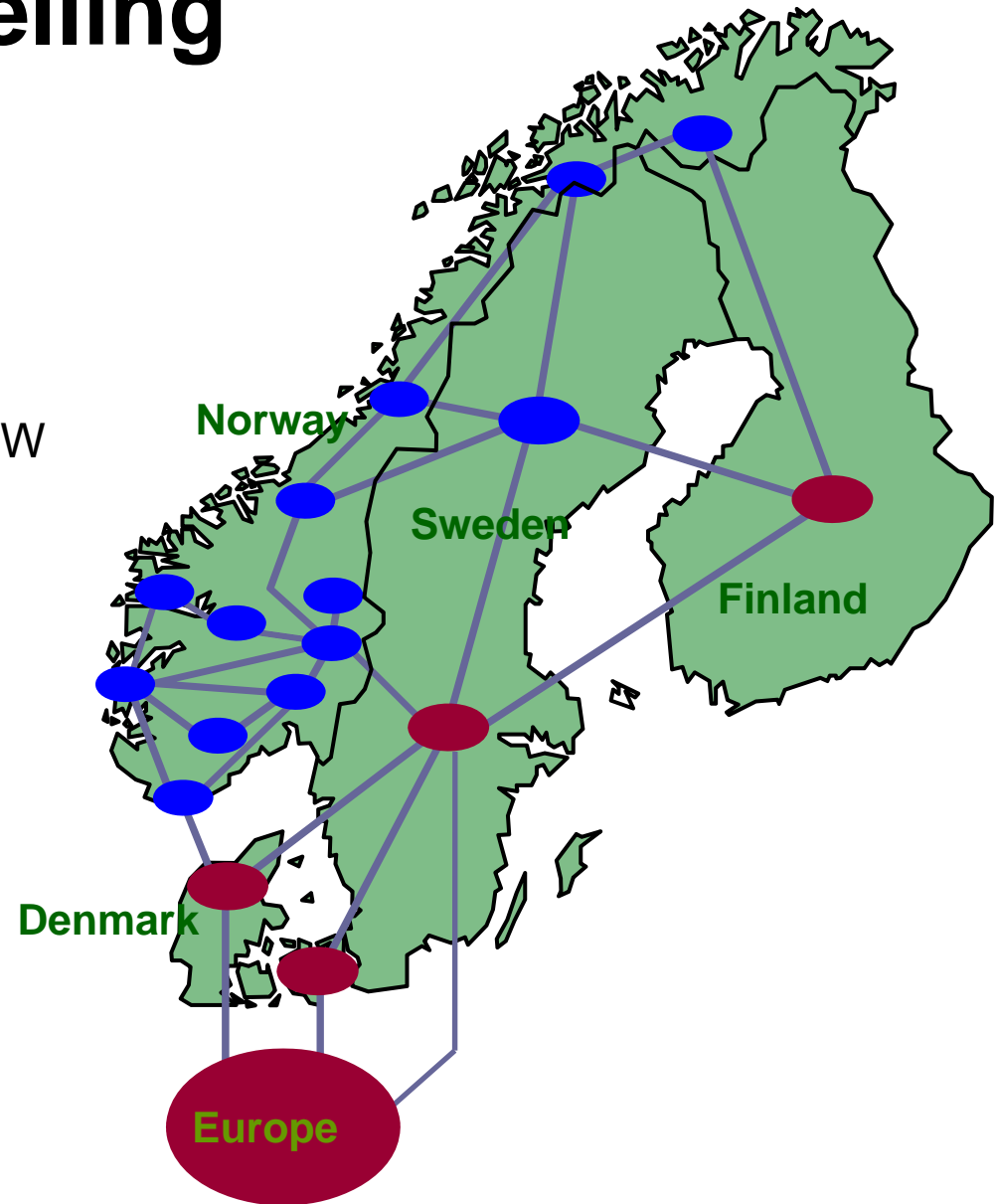
- > 95 percent of electricity production
- 130 TWh year⁻¹
 - Range: 90 to 165 TWh year⁻¹
 - 6th largest hydropower producer in the world (4 %)
- Export and import
 - S, DK, FI, RU, NL
 - (DE, GBR)



Flørli

Hydropower modelling

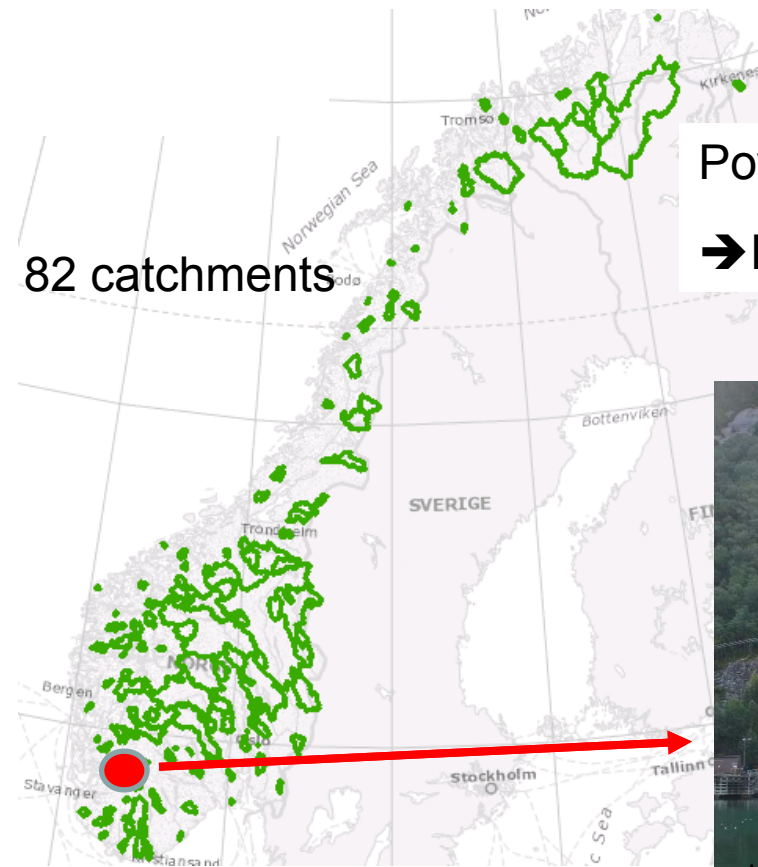
- Multi-area Power-market Simulator (EMPS)
 - 700 hydro power stations >1 MW
 - > 1000 reservoirs
 - Tunnels, intakes
 - Demand



Hydropower

Needed: Computational efficient short and long-term energy forecasts/projections

Solution: Hydrological modelling only (inflow)



Power production = 290 GWh year⁻¹

→ Inflow energy (GWh) = Runoff(mm)*2.5 GWhmm⁻¹

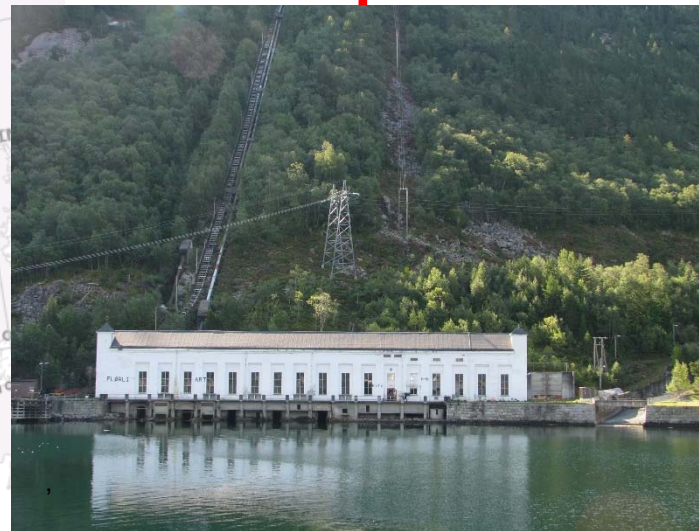
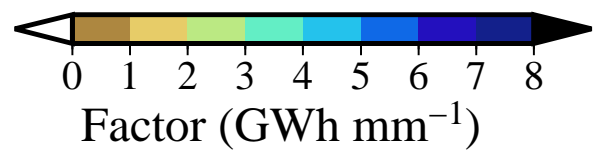
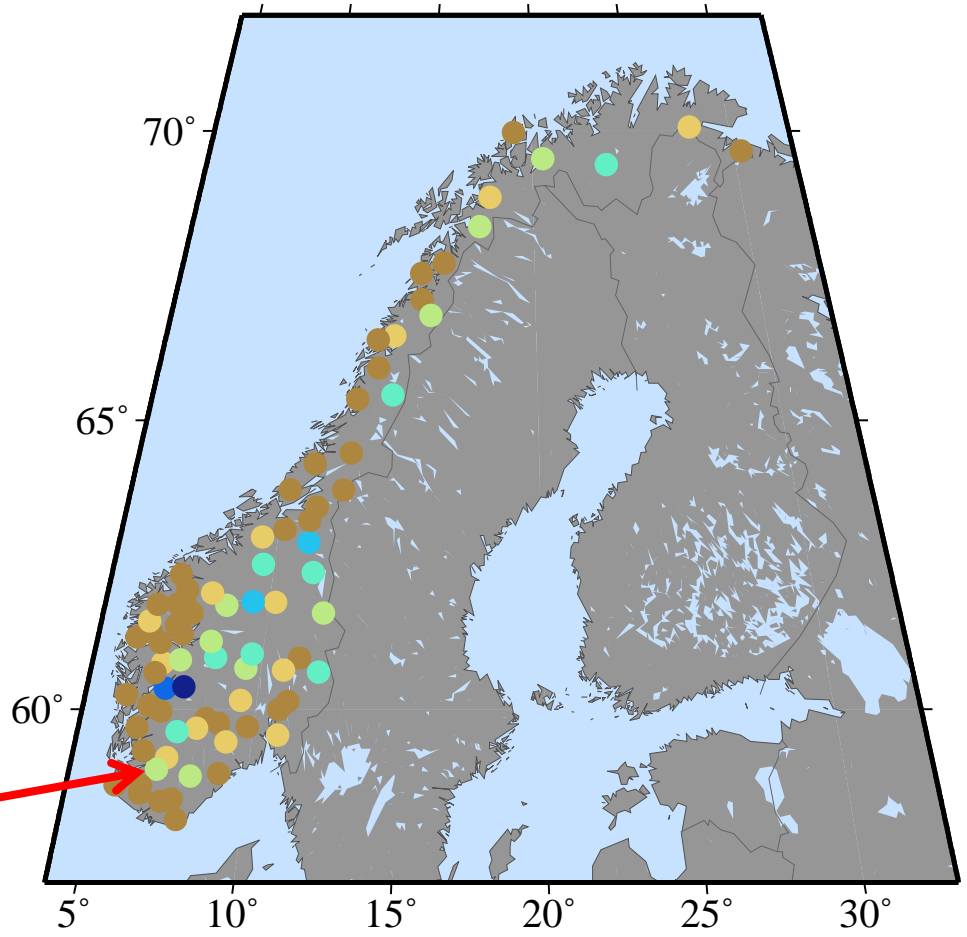
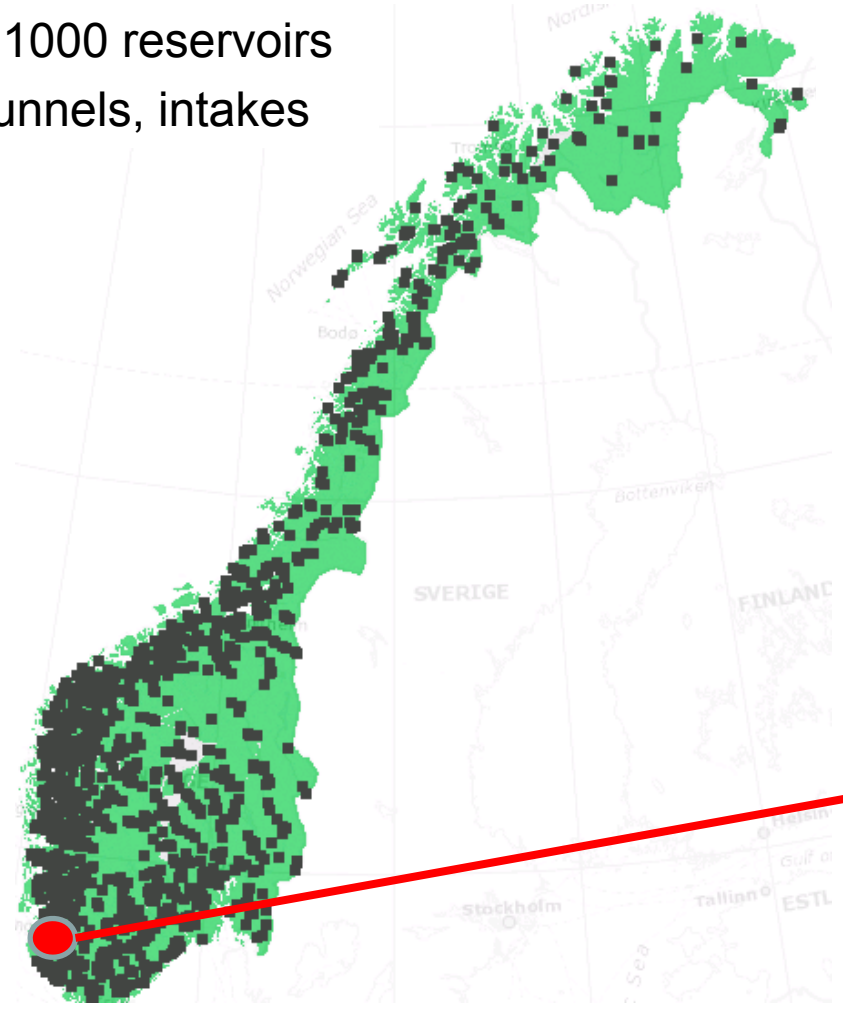


Photo: Kalev Kevad

Hydropower: mm to TWh

- > 700 hydro power stations >1 MW
- > 1000 reservoirs
- Tunnels, intakes



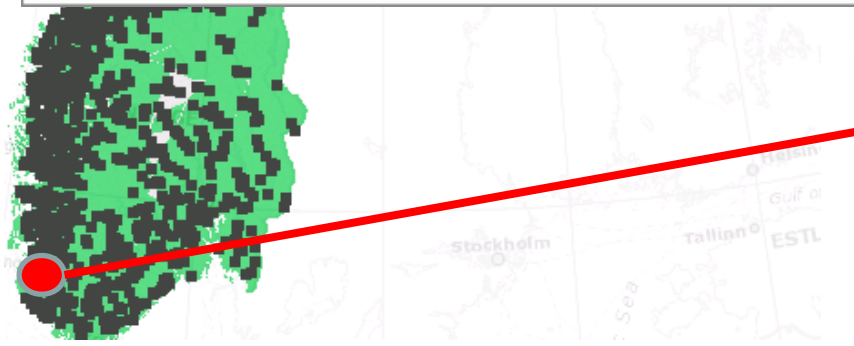
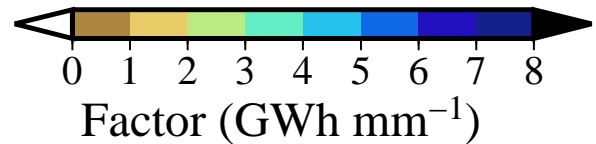
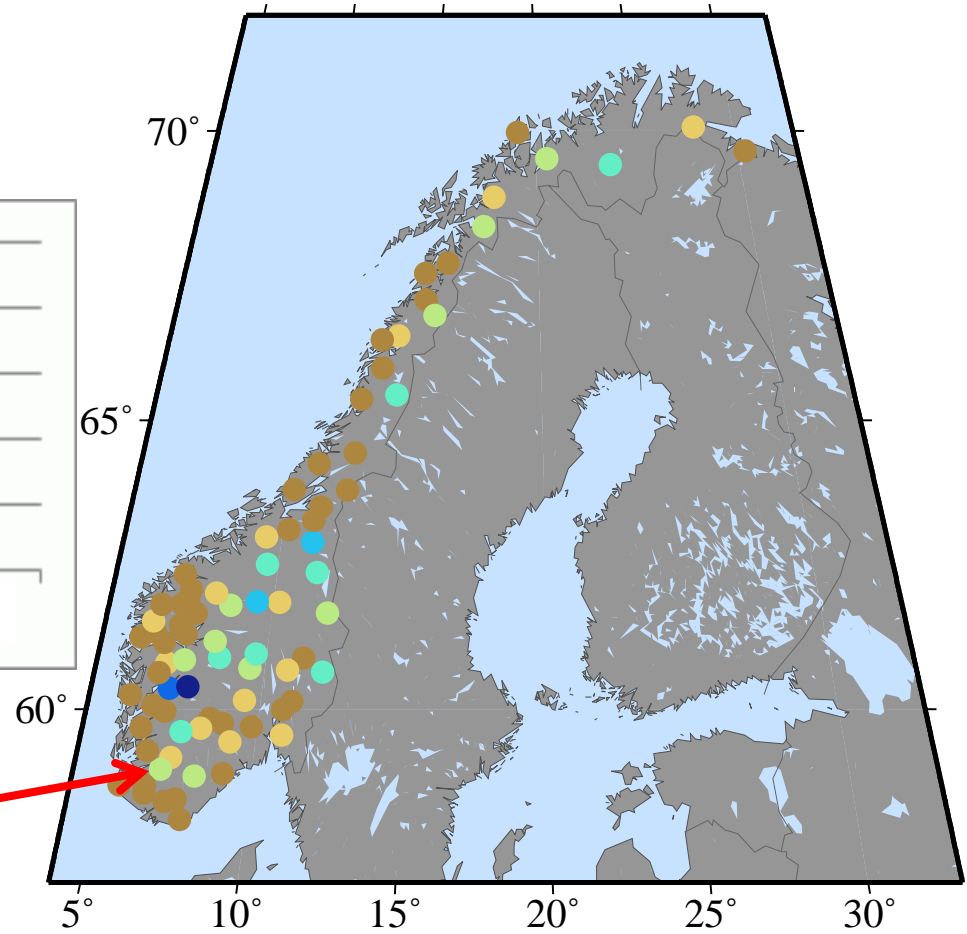
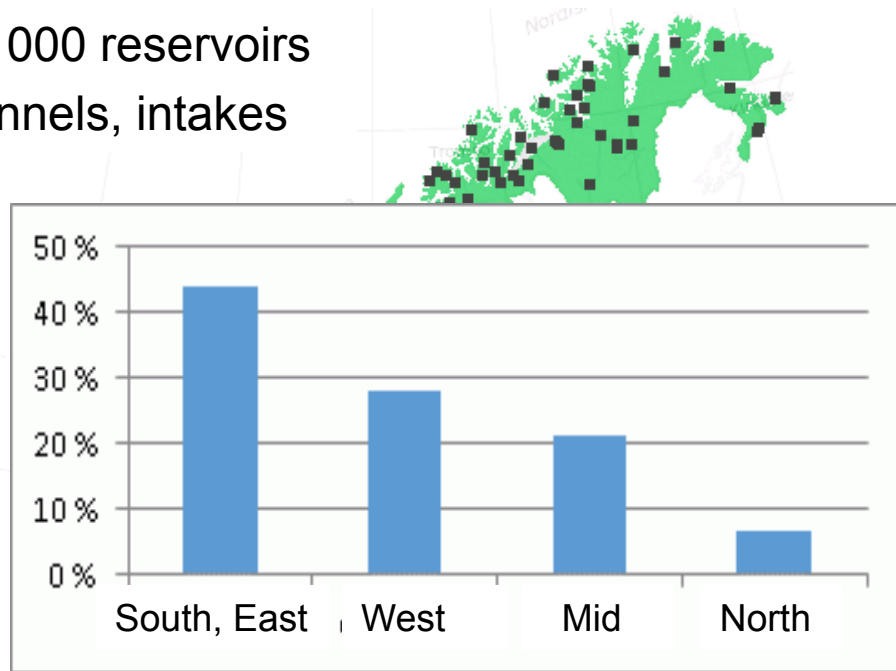
Norwegian Water Resource

Hydropower: mm to TWh

> 700 hydro power stations >1 MW

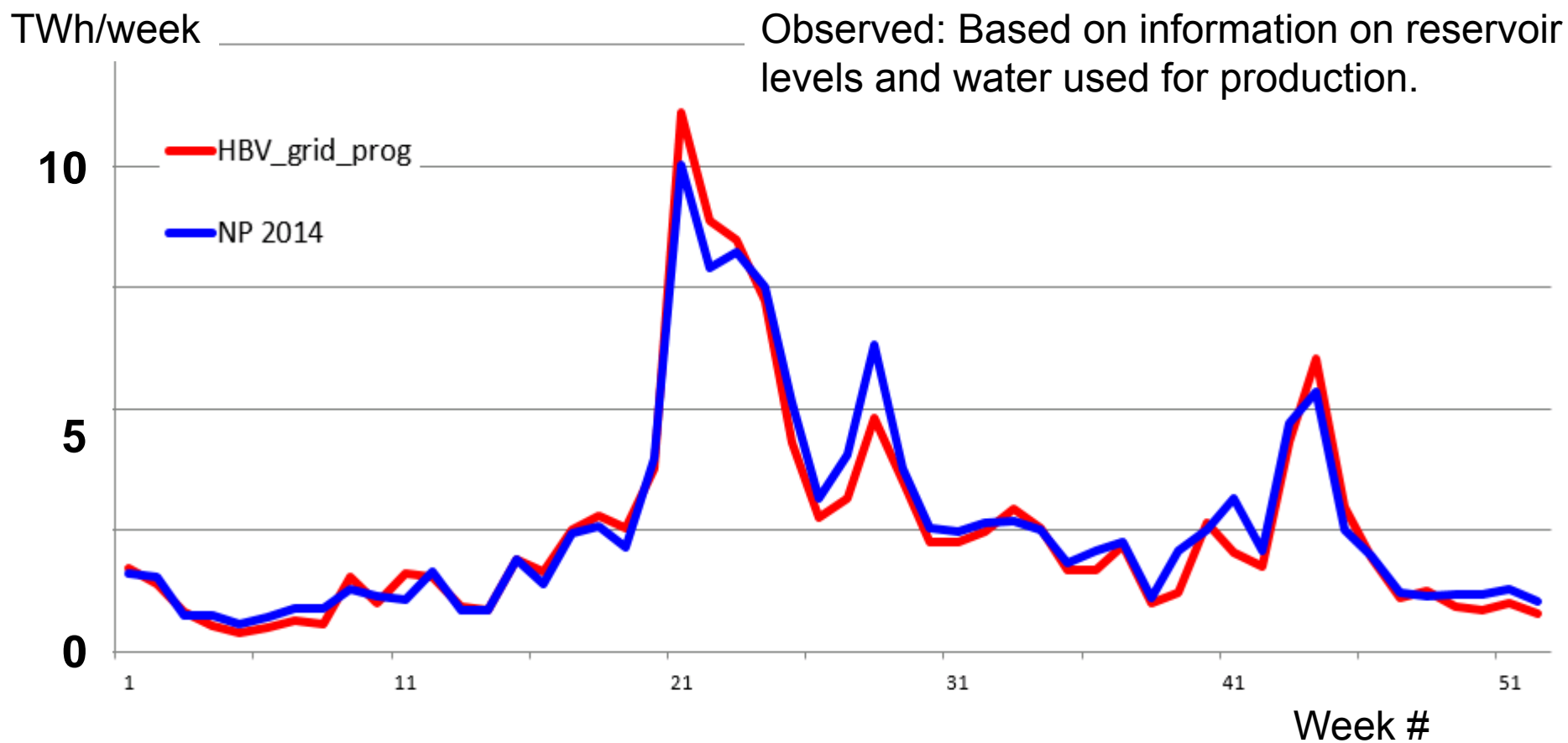
> 1000 reservoirs

Tunnels, intakes



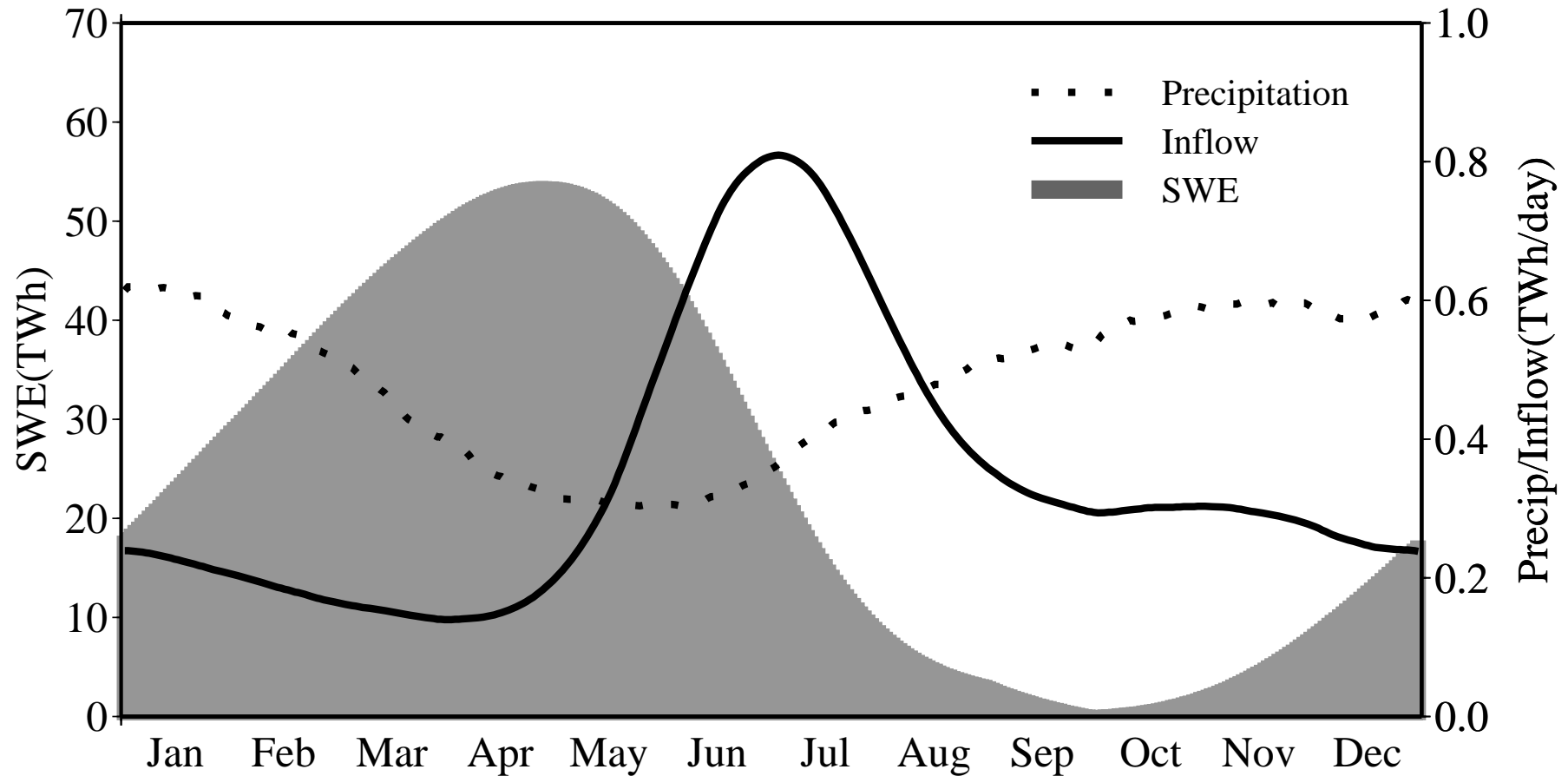
Norwegian Water Resource

Observed and forecasted inflow energy in 2014 (TWh/week)



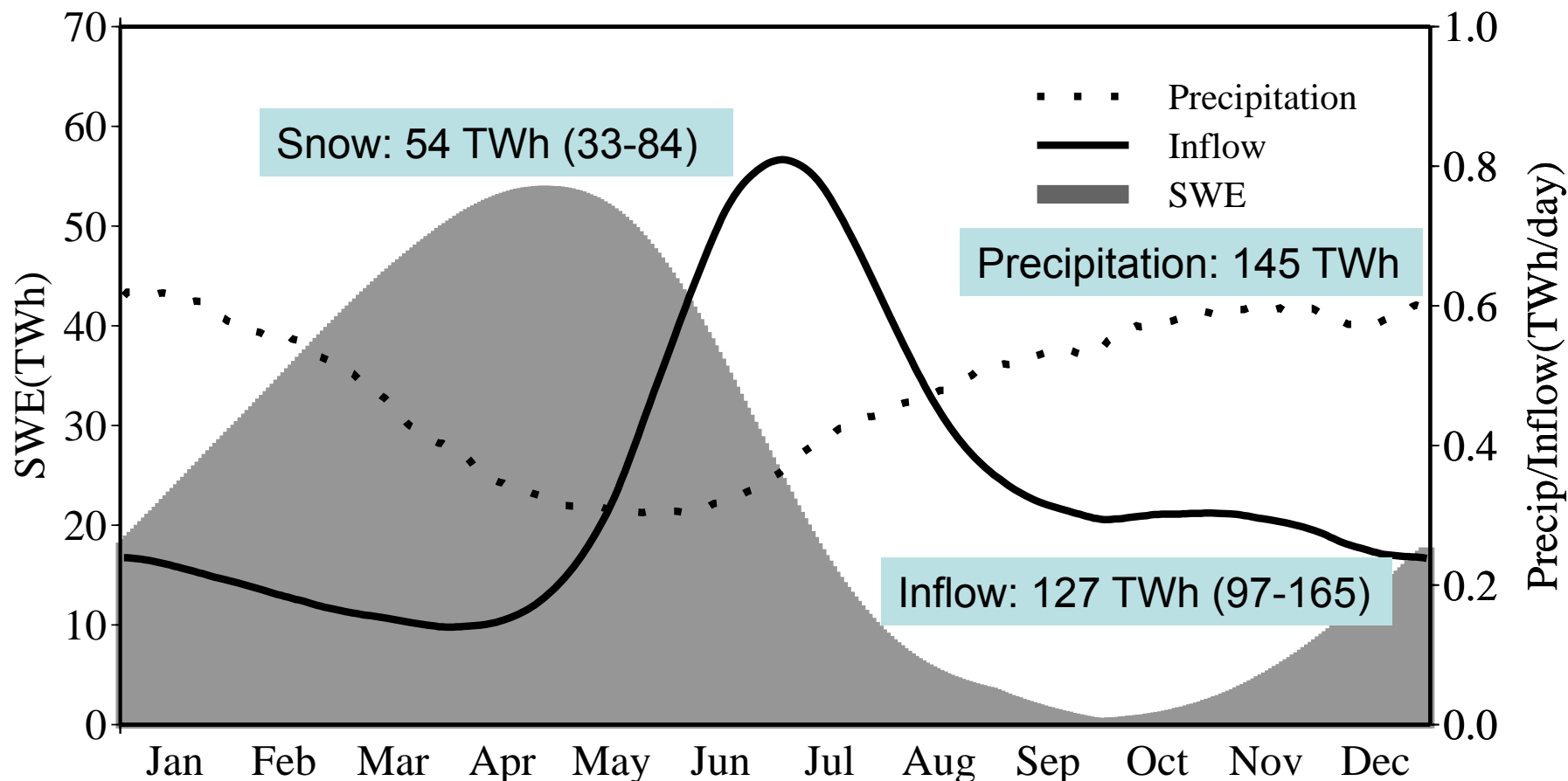
Historical water balance: 1971-2000

Mean inflow energy: 127 TWh year⁻¹



Historical water balance: 1971-2000

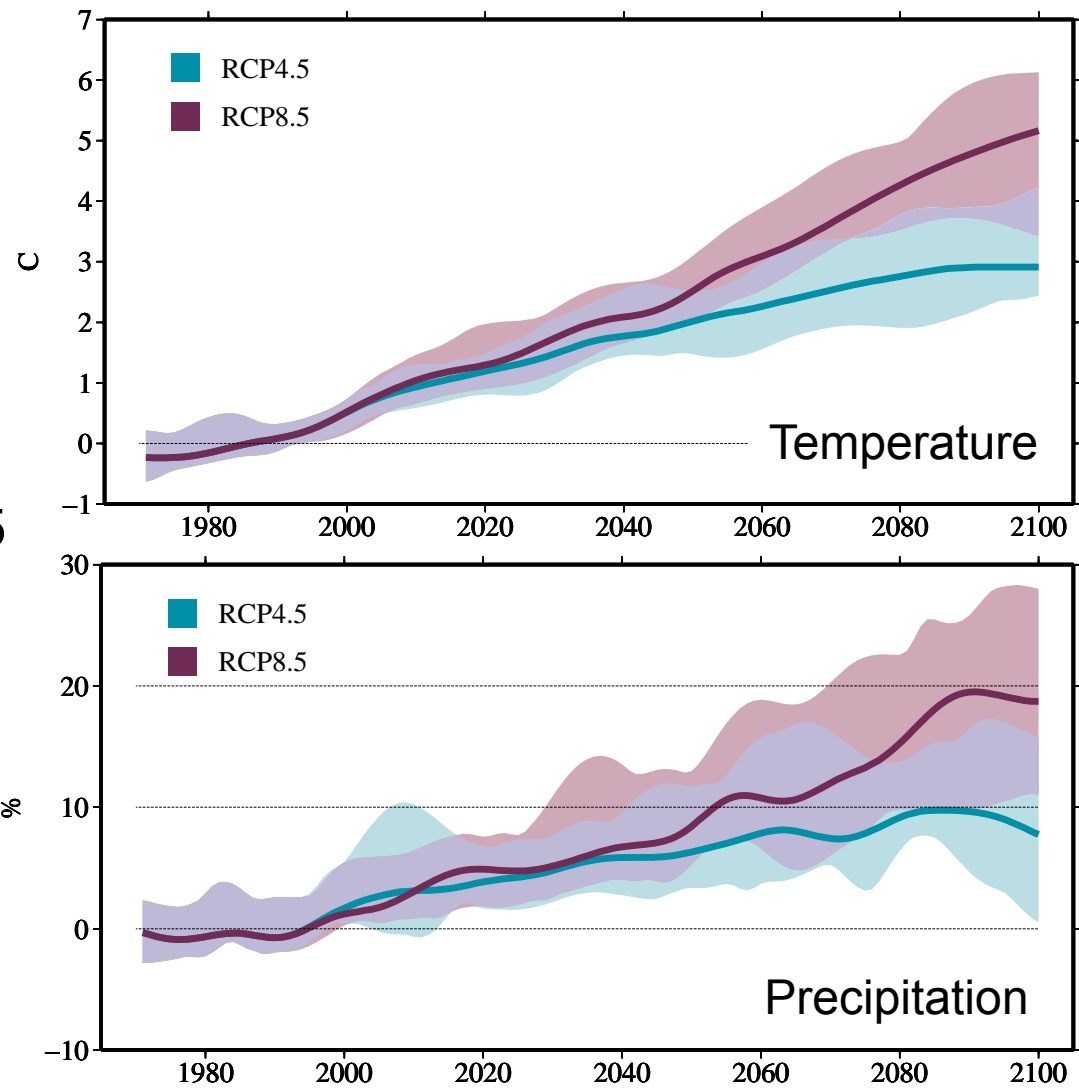
Mean inflow energy: 127 TWh year⁻¹



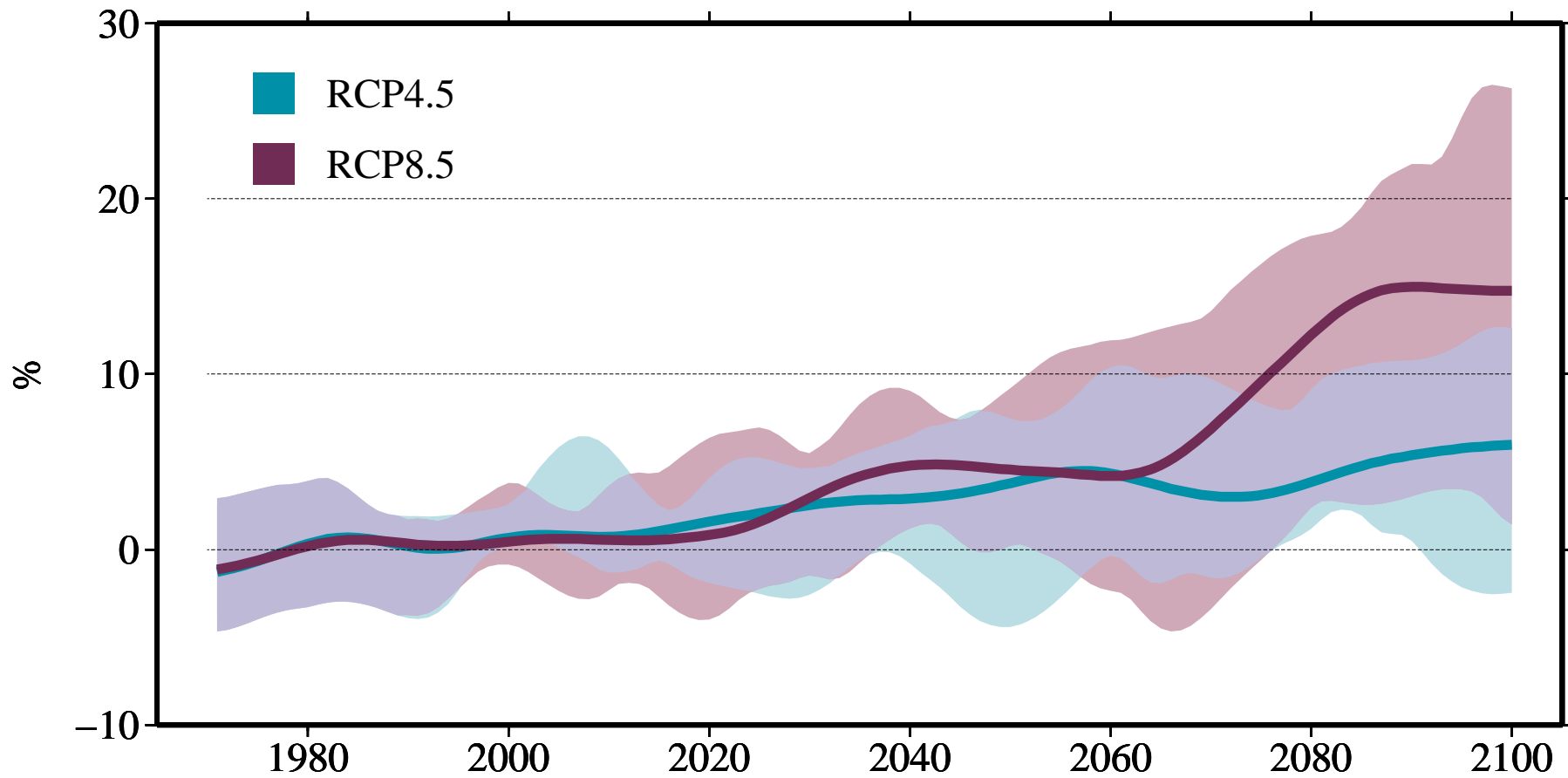
Evapotranspiration: 18 TWh. In addition, about 14 TWh in flood losses, environm. flow

Projections: T and P

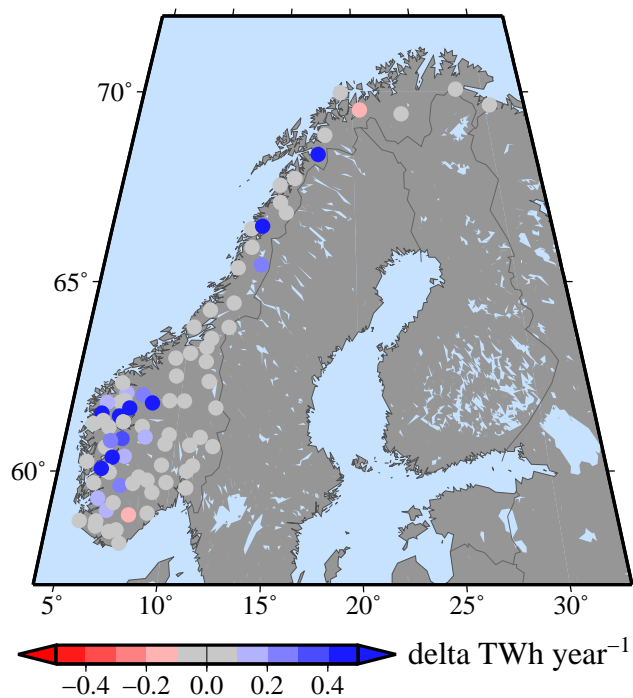
- Norway on average
- Euro-Cordex
 - 10 GCM-RCMs
 - RCP4.5 and RCP8.5
 - 0.11 deg (12.5 km)
- Bias adjusted, 1 km²%



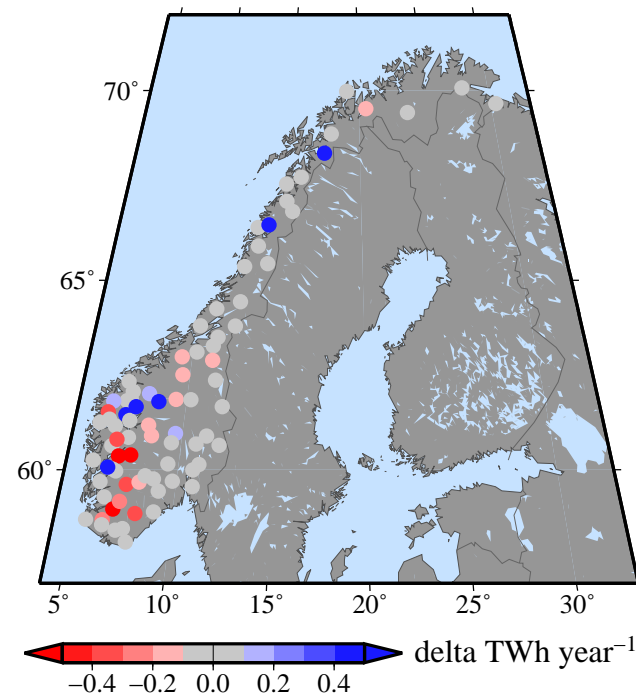
Projections: Inflow energy



Projections: 2071-2100 cp 1971-2000



CNRM-CCLM (RCP4.5): +7.5 TWh

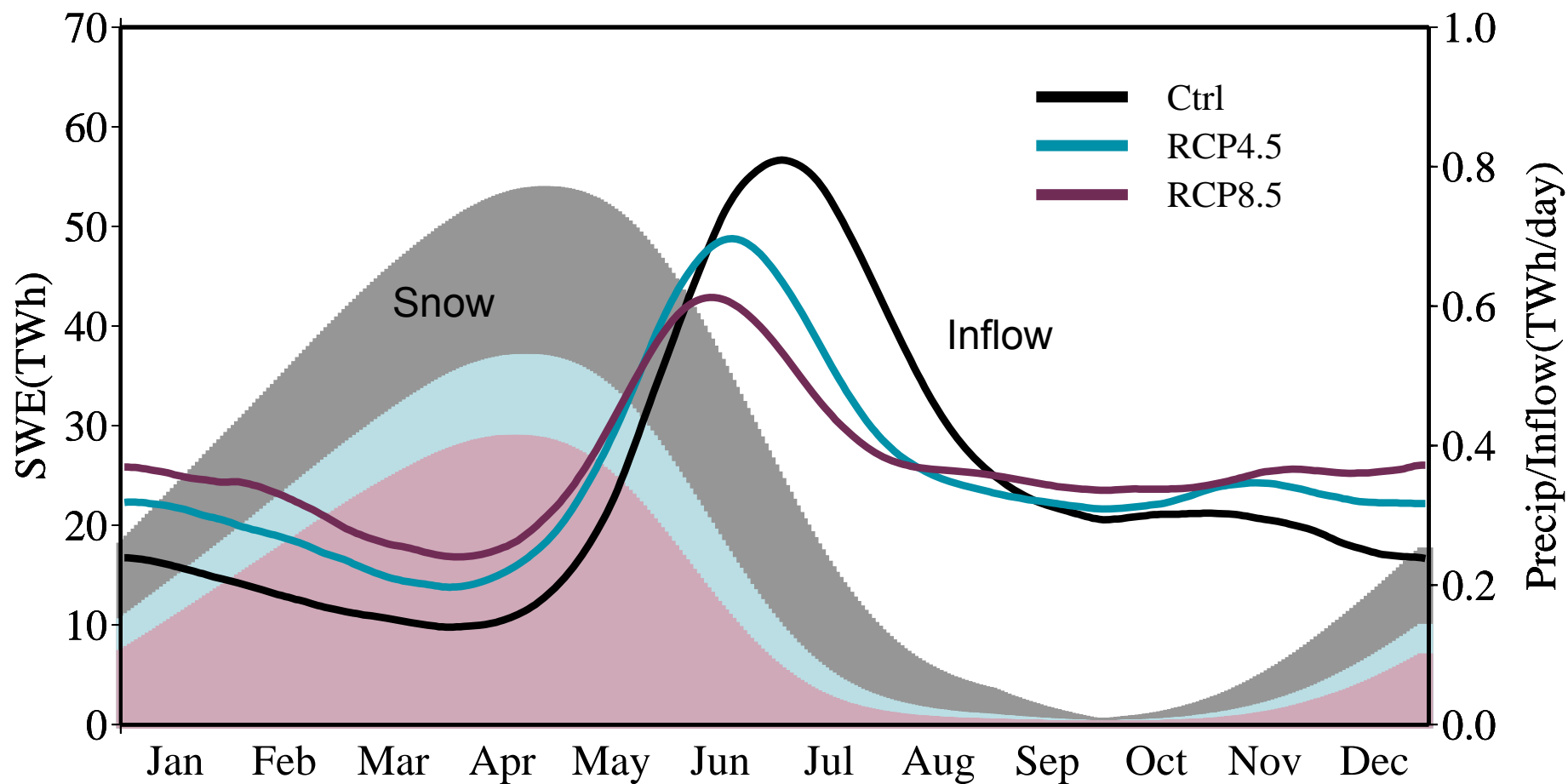


EC-EARTH-CCLM (RCP4.5): -1 TWh

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Water balance elements, TWh

Mean results, 1971-2000 and 2071-2100



Concluding remarks

- Slight increase in TWh
- Inflow: Flattened seasonality
- Future land use
- Climate and energy policies
- Technology

