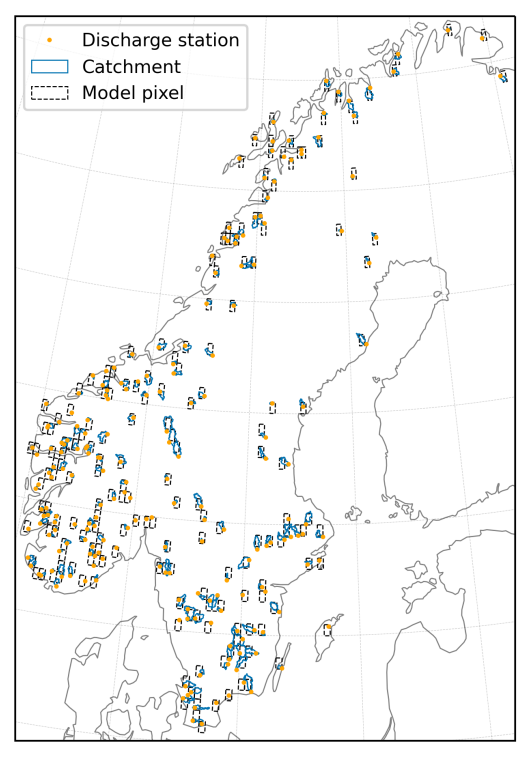
Community Land Model v5 runoff evaluation in small near-natural catchments in Fennoscandia

UiO : Department of Geosciences
University of Oslo

Gelati E., Yilmaz Y., Bakke S. J., Tallaksen L. M.

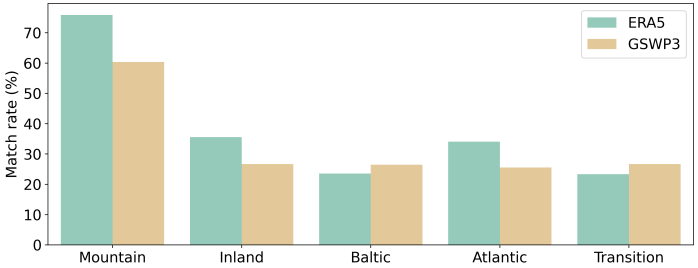
Experimental design

- Forcing: GWSP3, ERA5 (2001-2014)
- Spatial resolution: 0.25° lat/lon
- Model grid-cell runoff evaluated on 214 catchments (area < 10^3 km^2)

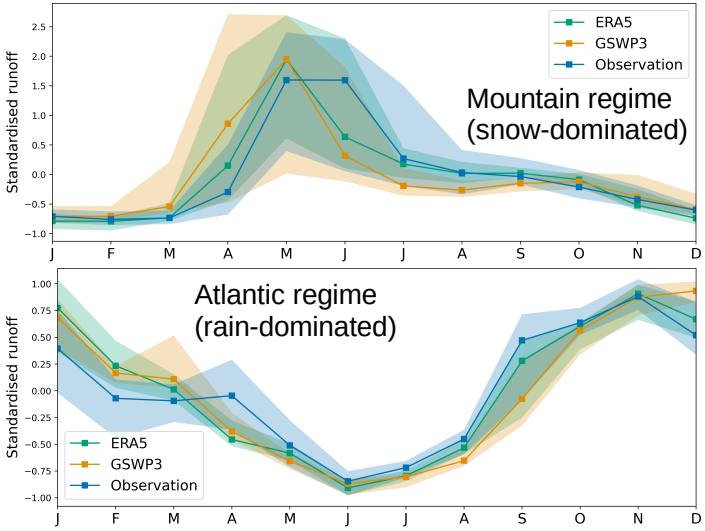


Runoff climatologic regimes

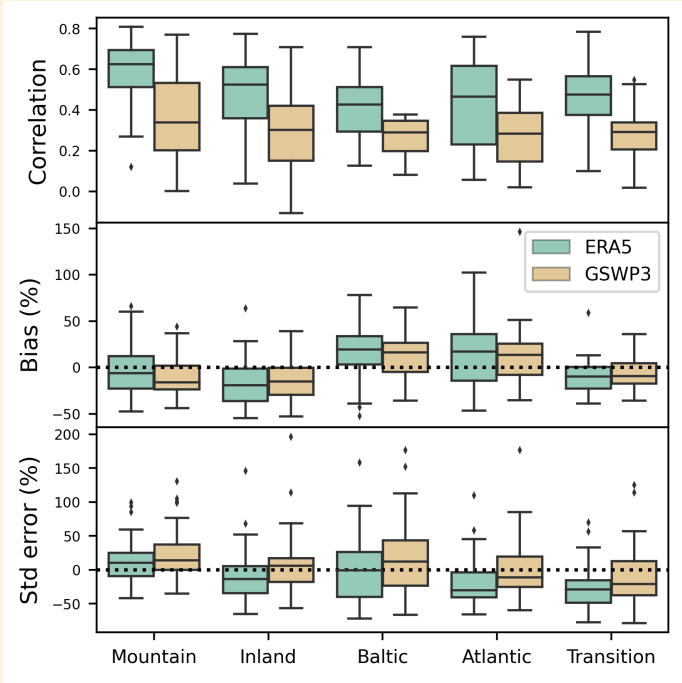
Model match rates of observed runoff regimes



Standardised monthly runoff in matching catchments (median and 10-90 percentile range)



Daily runoff statistics



Conclusions

- ERA5 performs better than GSWP3 in terms of runoff regimes and time correlation, not bias or st.dev. error.
- Next step: test other forcing datasets to assess effects of atmospheric data uncertainty.

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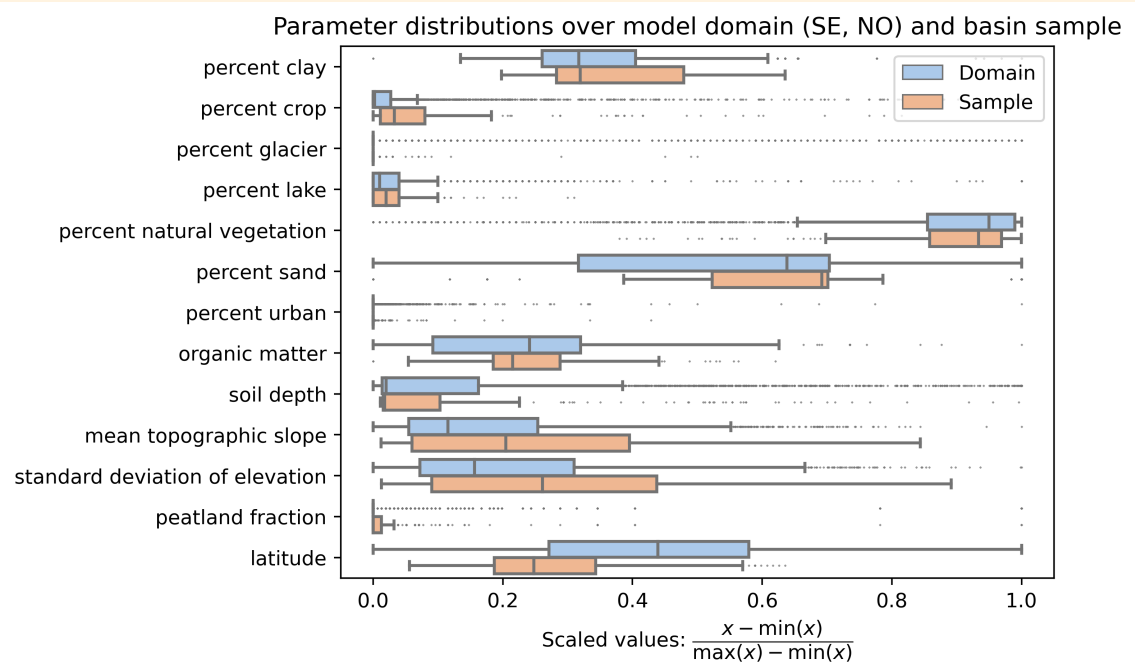
Representativeness of selected grid-cells

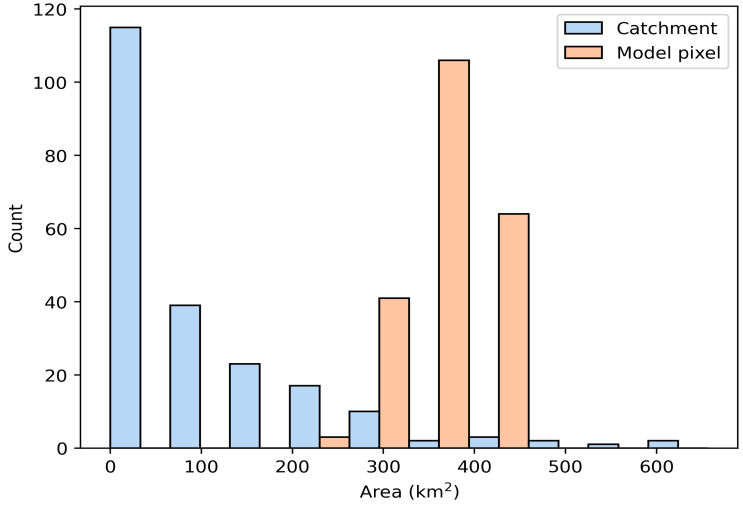


Slightly over-represented:

- Low latitudes
- Shallow soils
- Rugged terrains

Catchment and grid-cell areas

(model pixel area decreases with latitude)



Areas:

- catchments << model grid-cells
- mismatches apparently not correlated to poorer model performance

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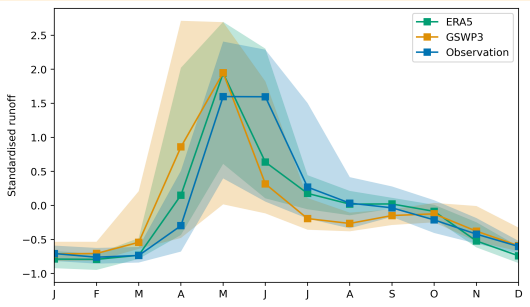
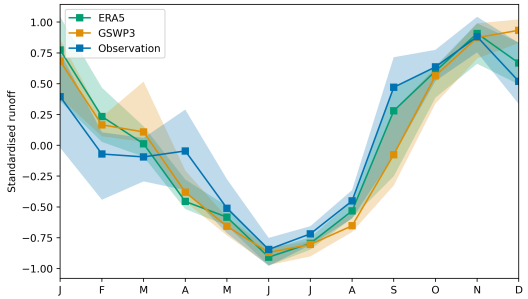
Runoff regimes*

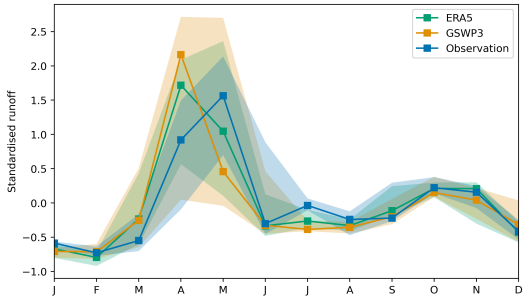
Mountain
- Winter min: snow accumulation.
- Spring-summer max: snowmelt.

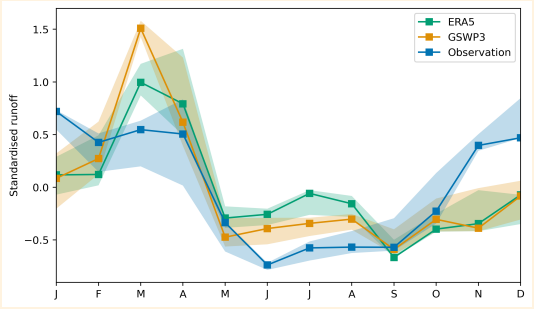




Atlantic
- Summer min: high evapotranspiration, low precipitation.
- Autumn-winter max: rainfall.

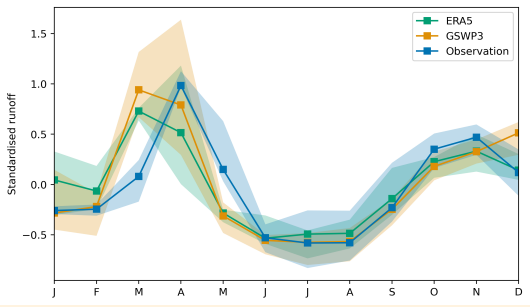
Inland
- Winter min: snow accumulation.
- Spring-summer max: snowmelt.
- Autumn wet period: rainfall.





Transition
Intermediate between Inland, Baltic and Atlantic, grouping unclassified catchments.

Baltic
- Summer min: high evapotranspiration, low precipitation.
- Spring max: snowmelt.
- Autumn wet period: rainfall.



*Regime definitions by Bakke et al. (2020), adapted from Gottschalk et al. (1979).

Bakke, S. J., Ionita, M., and Tallaksen, L. M.: The 2018 northern European hydrological drought and its drivers in a historical perspective, Hydrol. Earth Syst. Sci., 24, 5621–5653, https://doi.org/10.5194/hess-24-5621-2020, 2020.

Gottschalk, L., Jensen, J. L., Lundquist, D., Solantie, R., and Tollan, A.: Hydrologic Regions in the Nordic Countries. Hydrology Research, 10(5), 273–286, https://doi.org/10.2166/nh.1979.0010, 1979.

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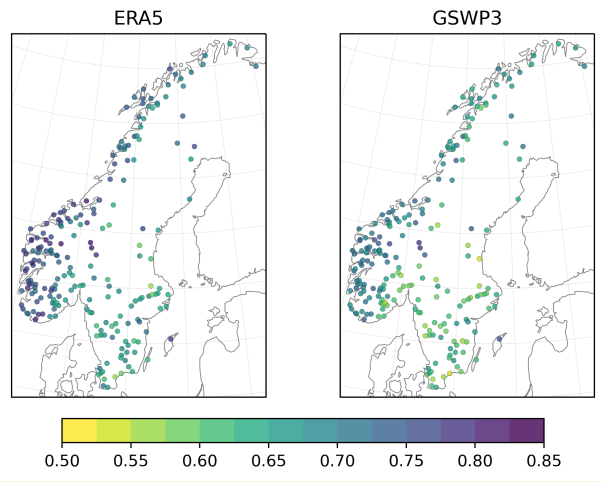
Daily runoff and precipitation correlation with reference datasets

Atmospheric data statistics are computed by comparing forcing with the 2 km Nordic Gridded Climate Dataset (Norwegian Meteorological Institute)

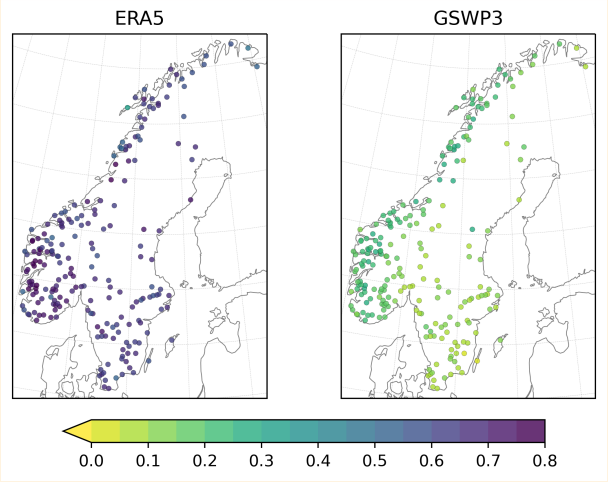
Precipitation occurrence agreement:

fraction of days with the same occurrence value (dry/wet) in both datasets

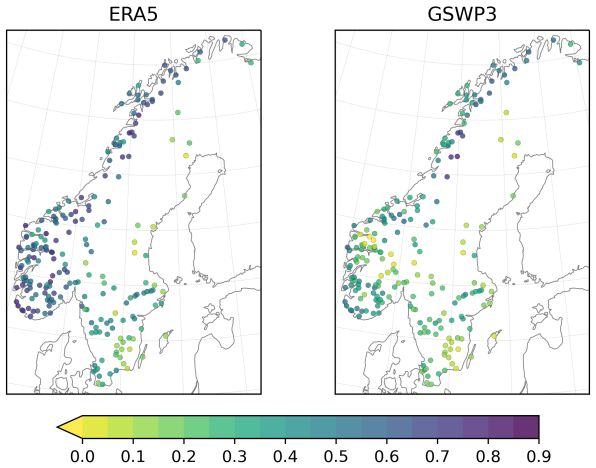


Precipitation amount correlation:

excluding days without precipitation



Correlation of simulated runoff and observed discharge



GSWP3: lower correlation for both runoff and precipitation amount.

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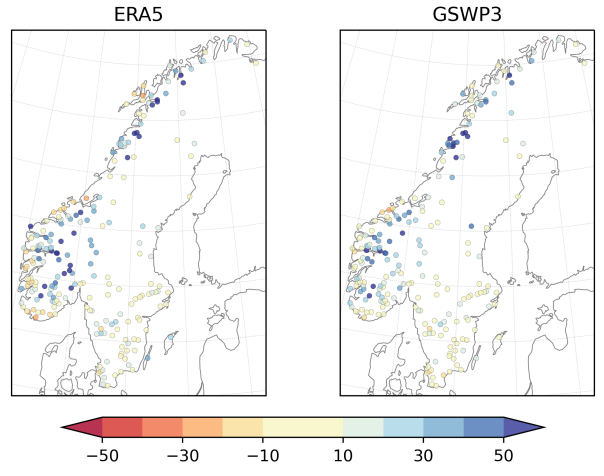
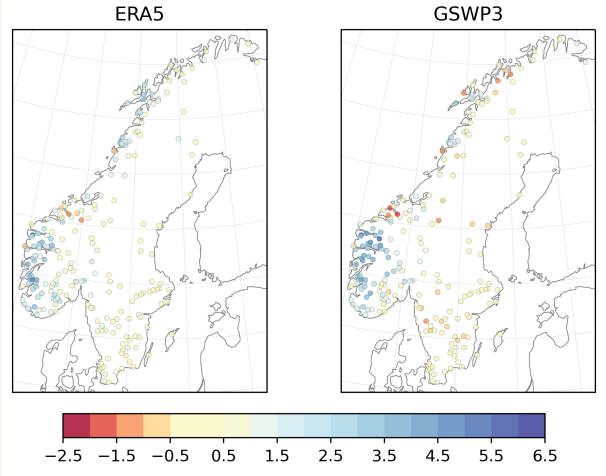
Daily runoff, precipitation and temperature bias with respect to reference datasets

Precipitation bias (%)



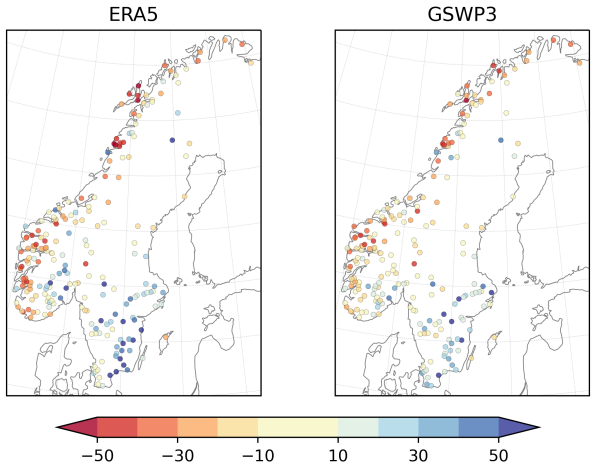
- Positive bias in Norway and along Scandinavian Mountains
- ERA5, GSWP3: similar patterns

Temperature bias (°C)



- Positive bias in western Norway
- GSWP3: slightly larger absolute values

Bias (%) of simulated runoff compared to observed discharge



- Positive bias in southern Sweden and south-eastern Norway
- Negative bias in western, central and northern Norway
- ERA5: slightly larger absolute values