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The role of model calibration and verification techniques for sub-seasonal weather regime forecast skill

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Introduction | The sub-seasonal forecast challenge





ECMWF Strategy 2016 – 2025

«... By developing a seamless approach, we also aim to predict largescale patterns and regime transitions up to four weeks ahead...»

Ferranti et al., 2018, QJRMS

Introduction | Research questions



- How should we calibrate a sub-seasonal forecast to optimize forecast skill for weather regimes (WRs)?
- How should we verify and rate sub-seasonal WR forecasts? What should and can we expect from a sub-seasonal model?

Data | Sub-seasonal NWP model



- ECMWF IFS reforecasts (S2S project database) (Vitart et al., 2017, <u>BAMS</u>)
- Reforecast period: 1997 2017, init. from ERA-Interim every ~2 days → 4080 in total
- 11 ensemble members (10 perturbed, 1 control)
- Daily output





Methods | Weather regime implementation



Cluster mean Z500 anomalies of 7 year-round WRs

(Grams et al., 2017, NCLIM)

WR index in ensemble forecast

(Michele & Rivière, 2011, JAS)

b Zonal regime

d Atlantic ridge

f Scandinavian blocking

h All Regimes

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WR life cycle in ensemble forecast

(Grams et al., 2020, ECMWF Newsletter)

100

f mem.] 80

freq. [% of 60 40

МB cumulative 20

0104 00





Atlantic trough | Zonal | Scandinavian trough | Atlantic ridge | European blocking | Scandinavian blocking | Greenland blocking | No

0114 00

0124_00

0203 00

0213_00

Methods | Weather regime verification





Results | Year-round BSS for all WRs





Büeler et al., in preparation

Results | Year-round BSS for individual WRs





Büeler et al., in preparation



How to calibrate a WR forecast





Results | Year-round life cycle frequency biases





Results | Seasonal life cycle frequency biases





Results | Seasonal life cycle frequency biases





Results | Standard forecast calibration





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Results | Flow-dependent forecast calibration





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Results | Year-round life cycle frequency biases





Results | Seasonal life cycle frequency biases











Results | Year-round BSS of calibrated forecast











How to verify a WR forecast



Results | Evaluated lead-time window







Results | BSS with running attribution over obs.





Results | BSS with running mean / attribution over both







0124_0

Results | BSS with running mean / attribution over both



Conclusions | Calibration and verification





- Forecast calibration is particularly relevant for sub-seasonal WR forecast skill in spring, summer, and autumn, but less so in winter
- How exactly the forecast is calibrated does not really matter



- Improving sub-seasonal WR forecast skill may also require changing the forecast question: "What is the probability that a specific WR will appear once within a certain period in the future?"
- This goes along with modifying the lead time window both in the forecast and observational space (see also e.g., Zhu et al., 2014, MVR).

Space (see also, e.g., Zhu et al., 2014, MWR)



Thank you!



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