AIFS-S2S:
A data-driven model for sub-seasonal forecasts

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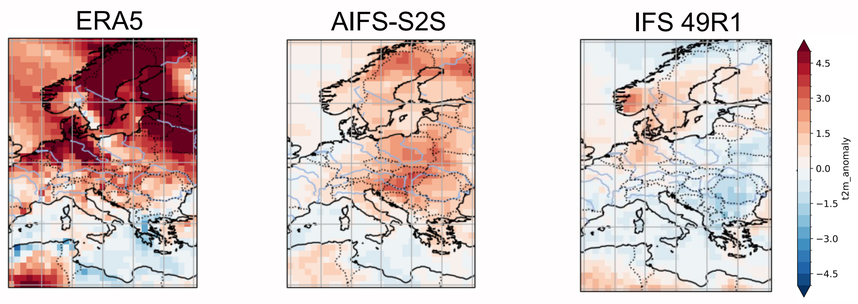
I. Motivation

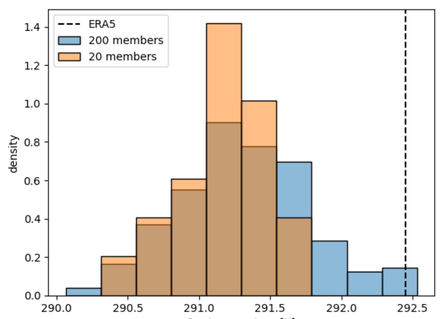
Sub-seasonal forecasts (2-6 weeks) are modulated by slower-evolving parts of the earth system but are hampered by uncertain initial conditions and model biases. We adapt the AIFS-CRPS [1] for sub-seasonal forecasts by:

- Longer time-step -> 24h
- Including sub-seasonal predictors -> stratosphere
- Longer and different rollout fine-tuning

II. European heatwave 2018

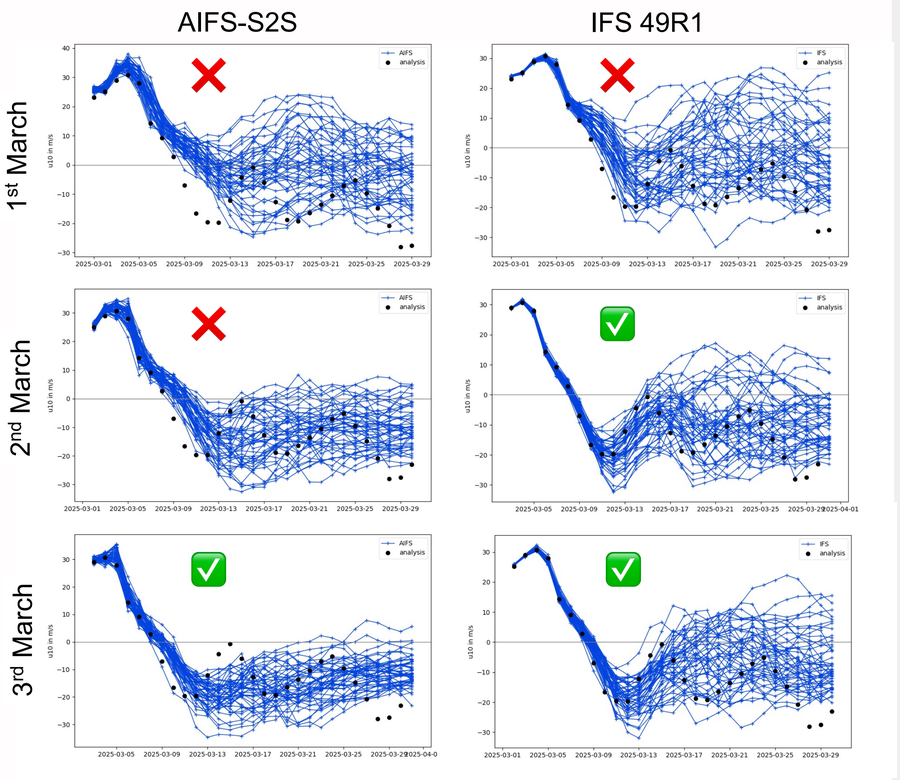


T2M anomalies of 27 July 2018. The 20-day forecasts show the ensemble mean forecasts wrt. model climatology.



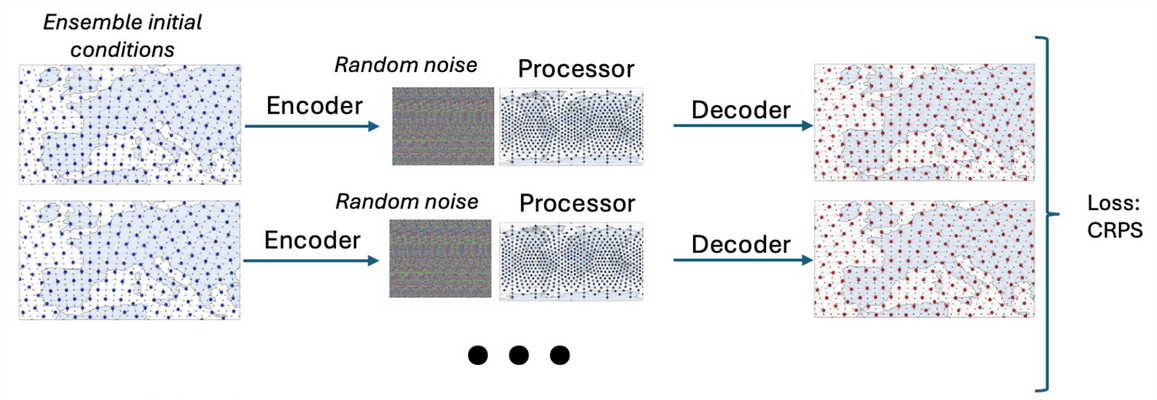
Only the 200 ensemble member forecast of the AIFS-S2S include the observed intensity of the European heatwave in July 2018. The distribution shows week 3 forecasts initialized at 10.07.2018.

III. SSW of 09/10 March 2025



Successful prediction (ensemble median of u10 < 0) 8 days ahead by IFS, 7 days ahead by AIFS-CRPS

IV. Methods



We use the AIFS-CRPS architecture [1] that creates ensemble members by conditioning the processor on randomly sampled noise in each step. The loss over the members is computed by the almost fair CRPS:

$$\text{afCRPS} := \alpha\,\text{fCRPS} + (1-\alpha)\,\text{CRPS}$$

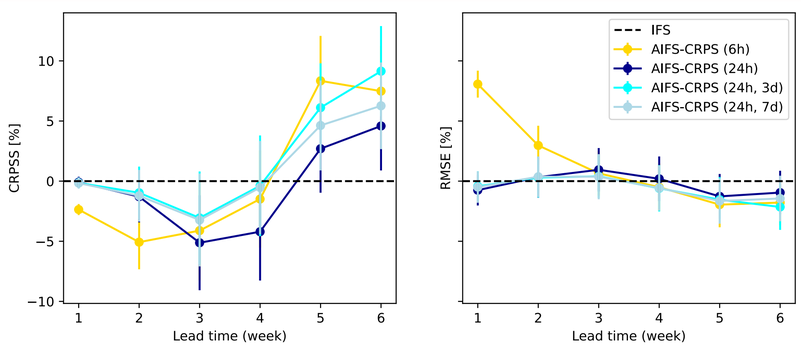
Training:

- Variables of AIFS0.2.1 [2] + stratosphere
- Period: 1979 - 2017
- 4 ensemble members

Evaluation:

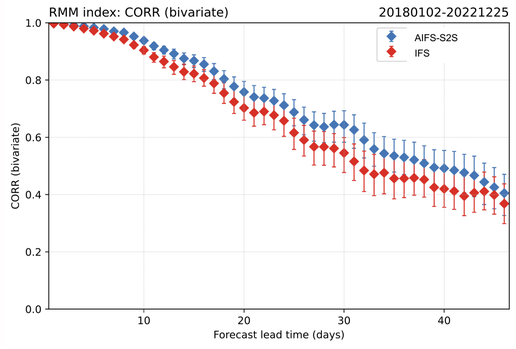
- Period: 2018-2023
- Weekly initialized reforecasts
- 8 ensemble members from ERA5 EDA

V. Scores



Mean CRPSS and RMSE of t850 in the Northern Hemisphere:

- 24h time-steps decreases performance in medium-range but shows improvements for week 3 + 4 compared to the 6h model
- The impact of rollout-finetuning is not obvious for the S2S timescale.



Correlation coefficient of of a wind-only equivalent of the real-time multivariate MJO index calculated from zonal winds at 200 hPa and 850 hPa [1].

- ~10% improvement of correlation coefficient in week 3-5 in comparison to the IFS.

V. CONCLUSION

1. AIFS-S2S show significant improvement of biases and MJO prediction wrt. IFS
2. Including stratospheric levels < 50hpa has little impact on surface variables but allows SSW predictions
3. While larger time-step improve S2S forecasts, the impact of rollout-finetuning is not clear.

References:

[1] Lang et al., AIFS-CRPS: Ensemble forecasting using a model trained with a loss function based on the Continuous Ranked Probability Score, arXiv:2412.15832

[2] Lang et al., AIFS - ECMWF's data-driven forecasting system, arXiv:2406.01465

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github.com/ecmwf/anemoi-core