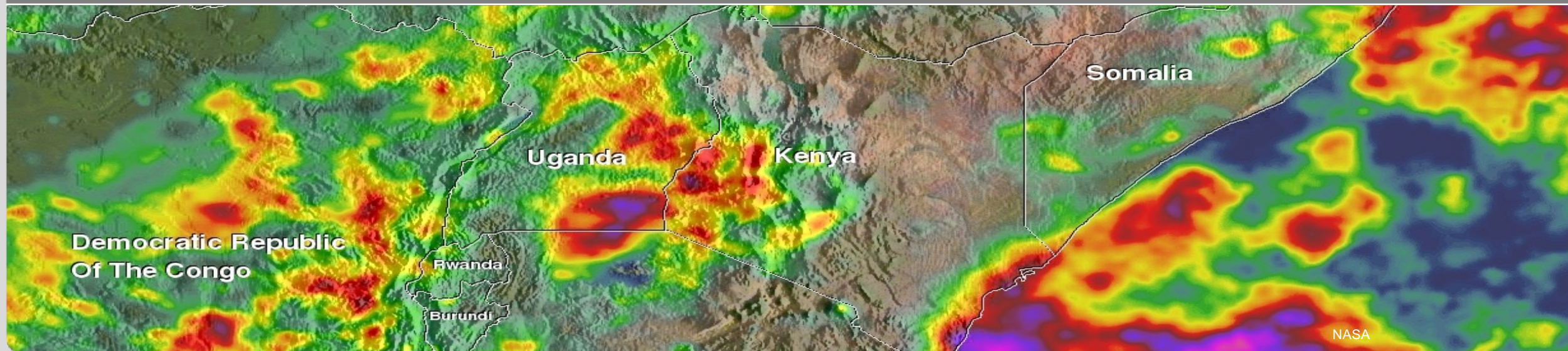


# Predictability of rainfall over Equatorial East Africa from daily to sub-monthly time scale

**Simon Ageet, Andreas H. Fink, Marlon Maranan, Benedikt Schluz and Eva-Maria Walz**

EGU General Assembly, Vienna, Austria 23-27. May 2022



## Uganda floods: At least 16 people dead, Red Cross says

8 December 2019



UGANDA RED CROSS

Red Cross volunteers are assisting with relief and recovery efforts in Uganda

**Flooding in Uganda has claimed at least 16 lives, the Red Cross says, as the region reels from weeks of rain.**

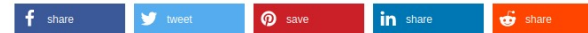
Rescuers have been recovering the bodies of victims swept to their deaths by the flash floods in the western Bundibugyo area, the aid group said.

Source: BBC

- Enormous potential of forecasts to save lives and property over Africa has not been realized (Youds et al. 2021).

## Uganda – at Least 9 Killed in Western Region Flash Floods

25 JANUARY, 2022 BY RICHARD DAVIES IN AFRICA NEWS



At least 9 people have died and more are feared missing after heavy rain caused flash floods and mudslides in Kisoro District in the Western Region of **Uganda**.



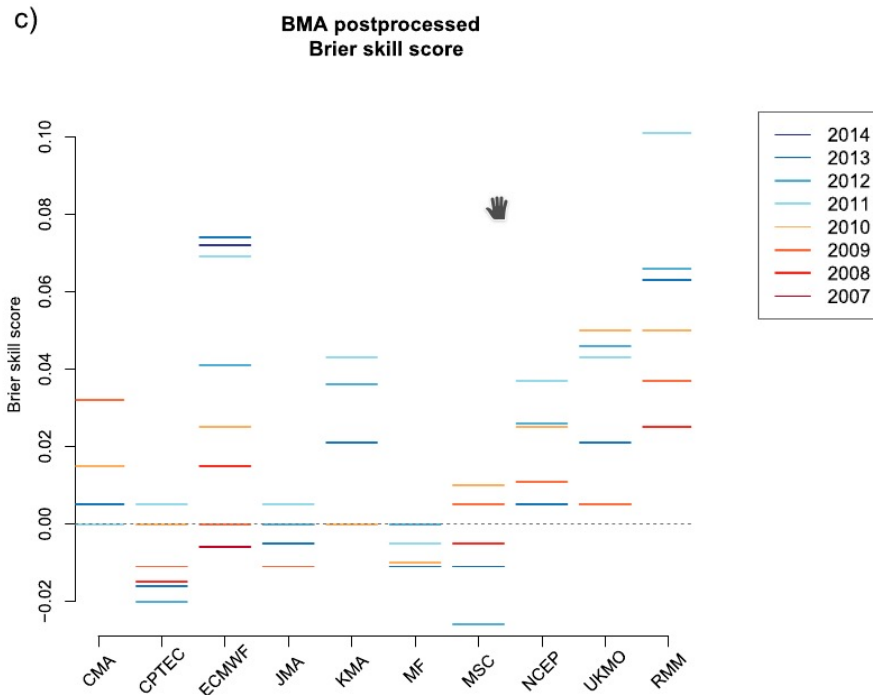
After the floods in Kisoro, Uganda, January 2022. Photo: Uganda Red Cross

Source: floodlist

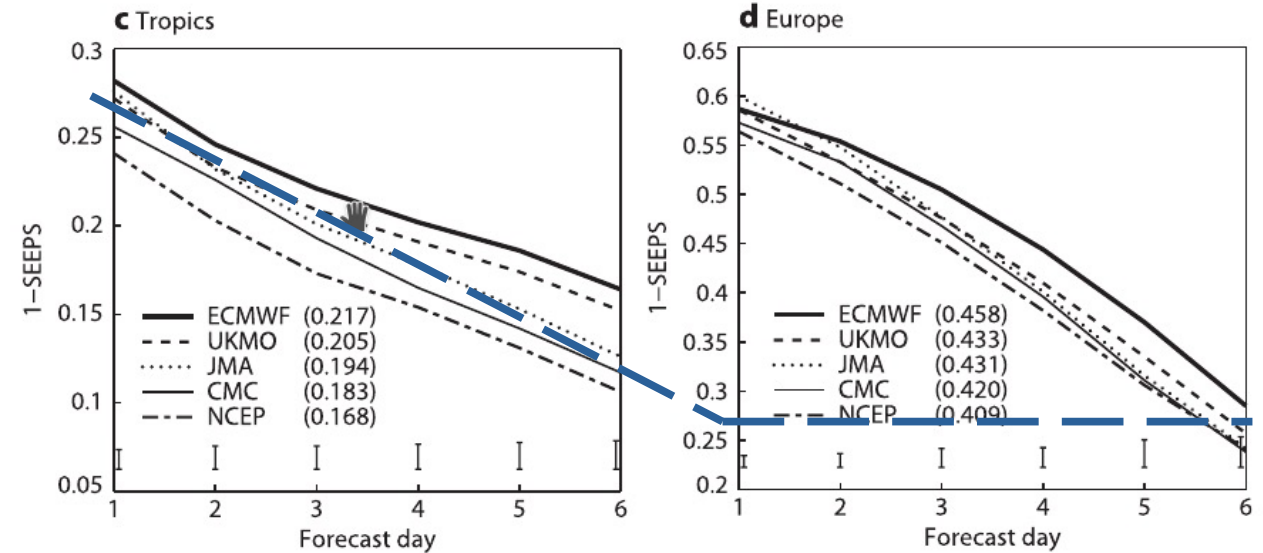


# Motivation

- In the tropics, forecasts are very poor (e.g., Vogel et al. 2018, Haiden et al. 2012).
- But the poor skill should not be generalized as it can be spatial-temporally variable (e.g., Vogel et al. 2020, de Andrade et al. 2021).



Source: Vogel et al. 2018



Source: Haiden et al. 2012

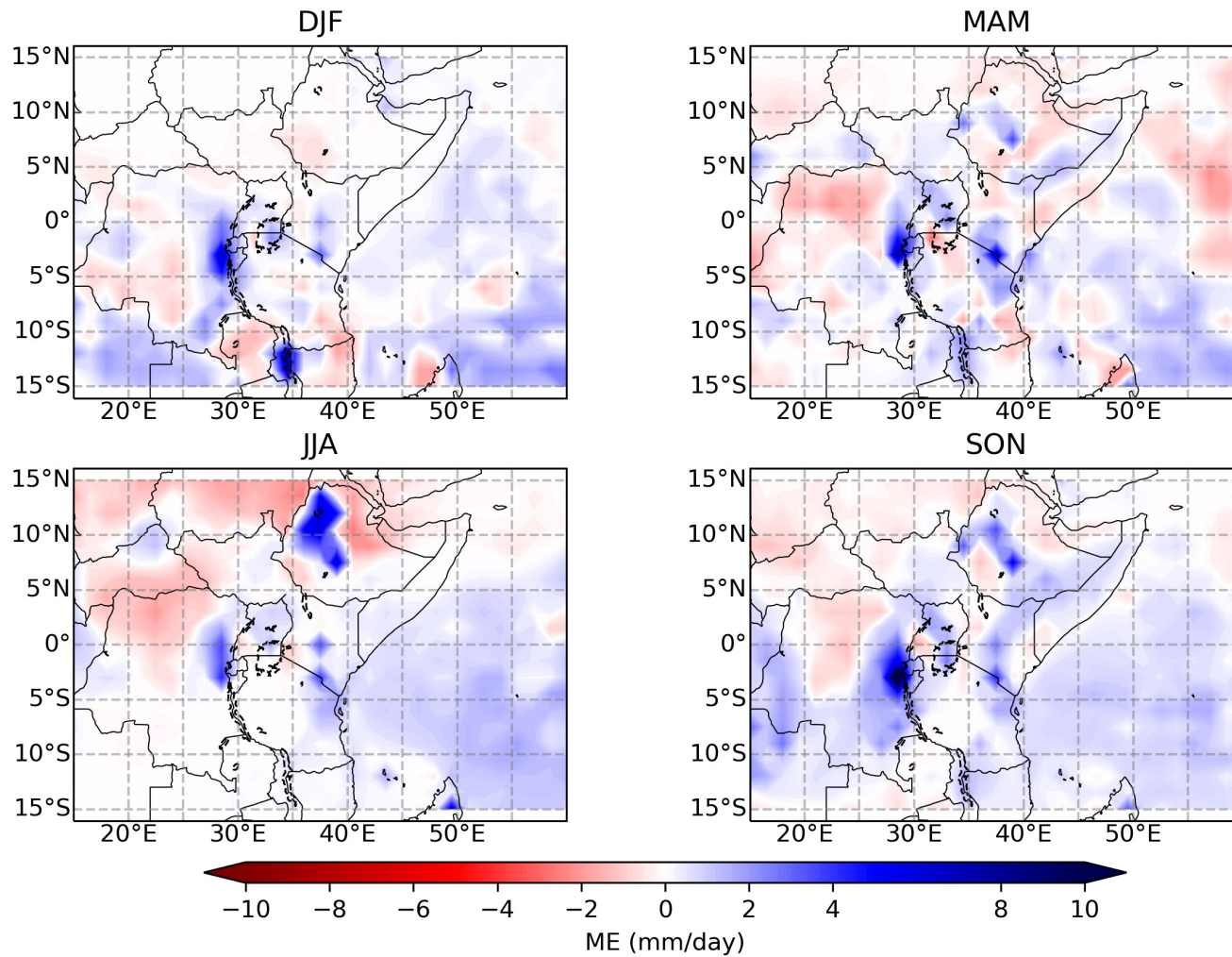
# Research questions

- **What is the skill of multi-model ensemble reforecasts of rainfall over EEA on lead times of 1–15 days?**
- Can tropical wave activity be forecast in wind and cold cloud fields in Uganda at lead times from one to three weeks?
- Does the large-scale wave or other synoptic forcing temporarily improve the skill of ensemble rainfall forecasts at lead times from one to three weeks?

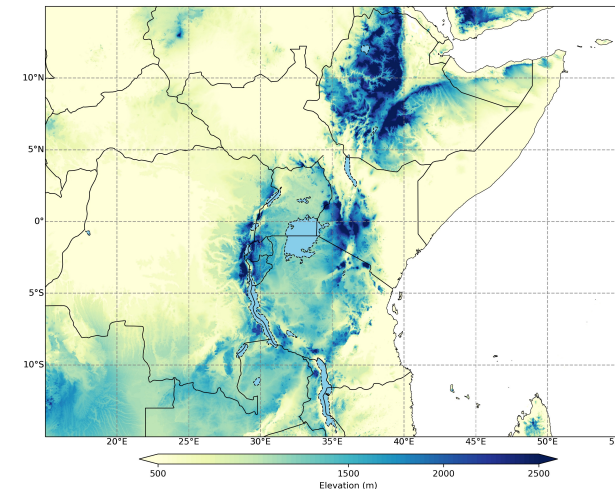
- Observations: **IMERG** – the best performing product at short lead times (Ageet et al. 2022), MSWEP and **gauges**.
- ECMWF reforecasts from the S2S archive: initialized twice a week, lead time up to 45 days, spatial (temporal) resolution of  $1.5^\circ$  (6-hourly), 2020 version of forecast used (2000–2018).
- BS (BSS) and CRPS (CRPSS) – detecting rainy days and accumulation (Rainy day:  $>0.2$  mm).
- Reference forecast: observations-based extended probabilistic climatology (EPC; Vogel et al. 2020, Walz et al. 2021).
- ROC and AUC – discrimination.
- Reliability diagrams – calibration.
- Post-processing: Isotonic distributional regression (IDR; Henzi et al. 2021).

## Results – Bias

Mean daily error(fcst. - obs.) - Day1



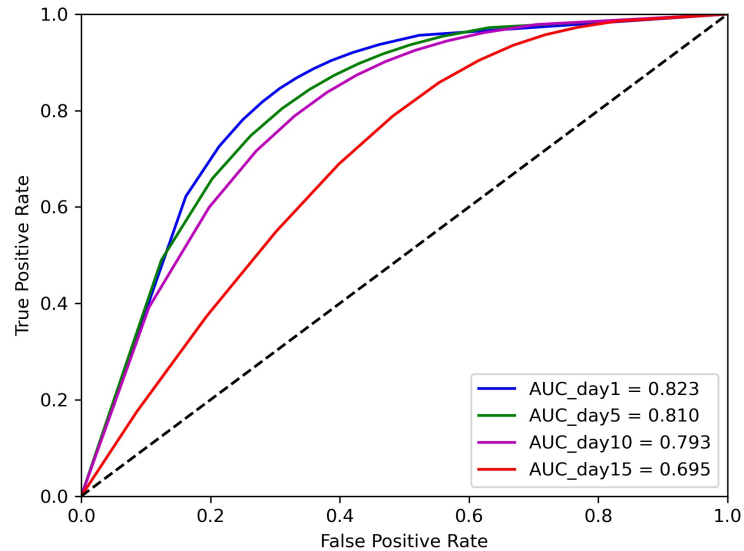
- Bias vary from season to season and place to place.
- Generally low error (-2–2mm/day), except at the high-altitude regions, where there is pronounced overestimation – partly be due to inaccuracies in the observations (SREs struggles with warm rain).



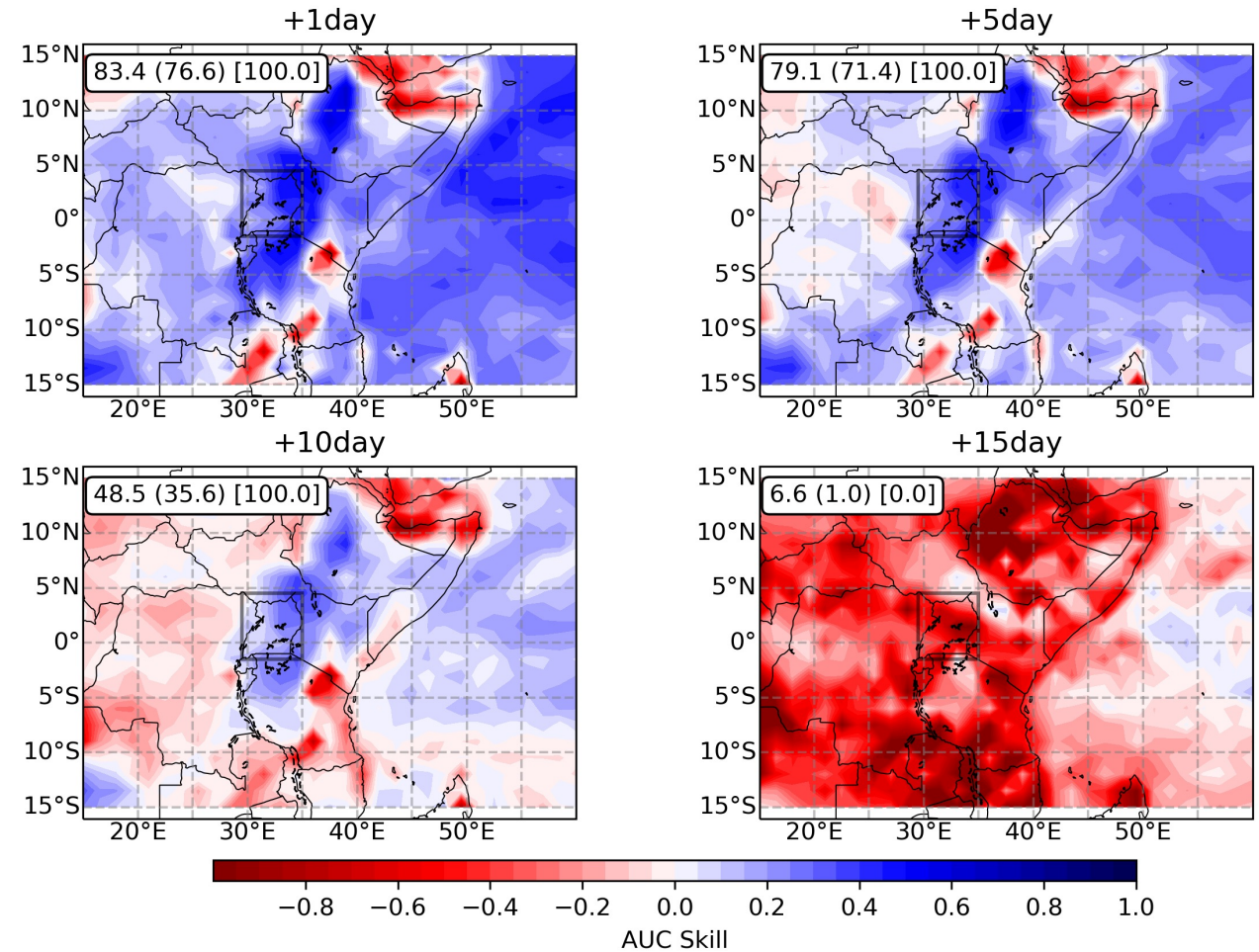
*Topography of the study area showing. The high-altitude areas generally correspond with the high positive bias in the bias plots.*



# Results - Discrimination ability

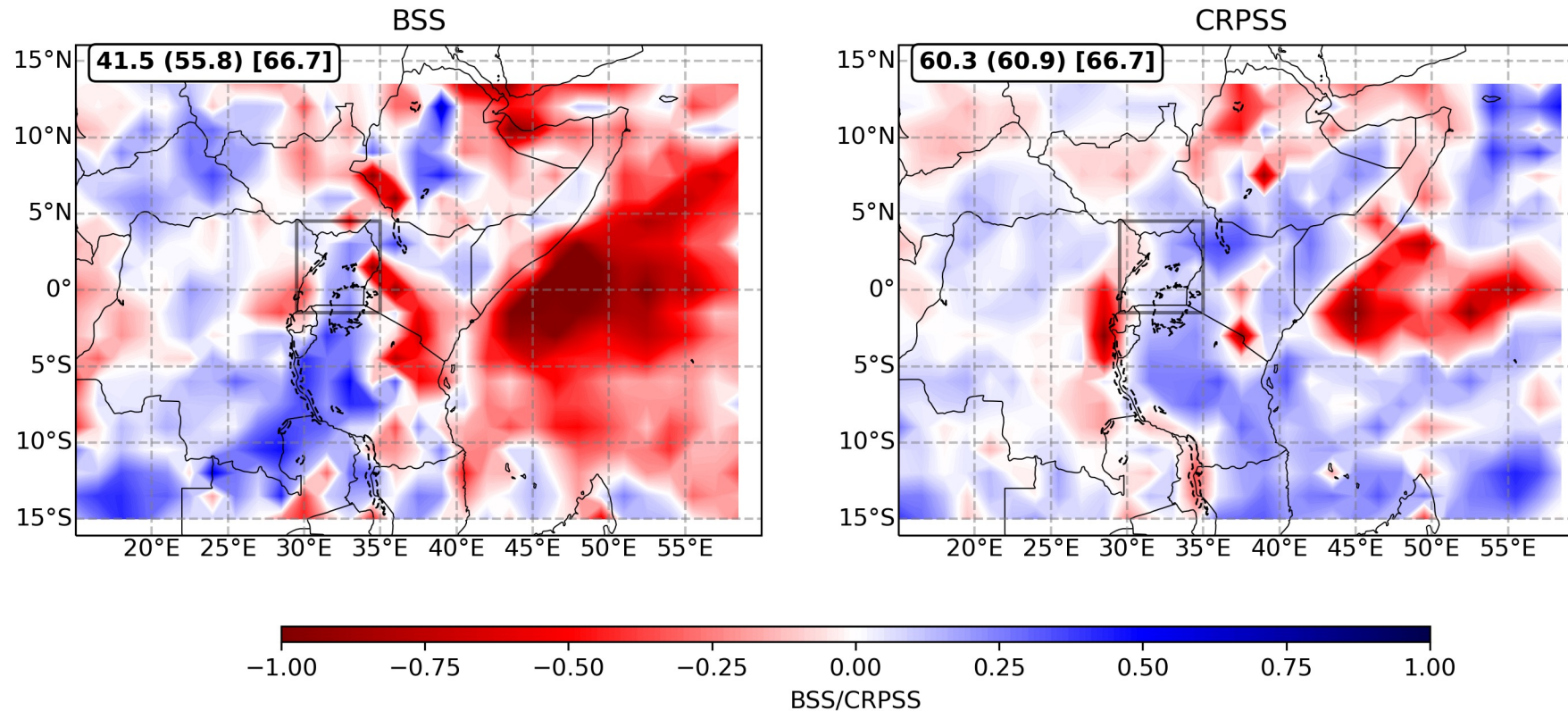


- Model tends to correctly discrimination between events and non-events, up to day 10 for some areas.
- High altitude areas have negative skill.



# Results - Skill of raw forecasts

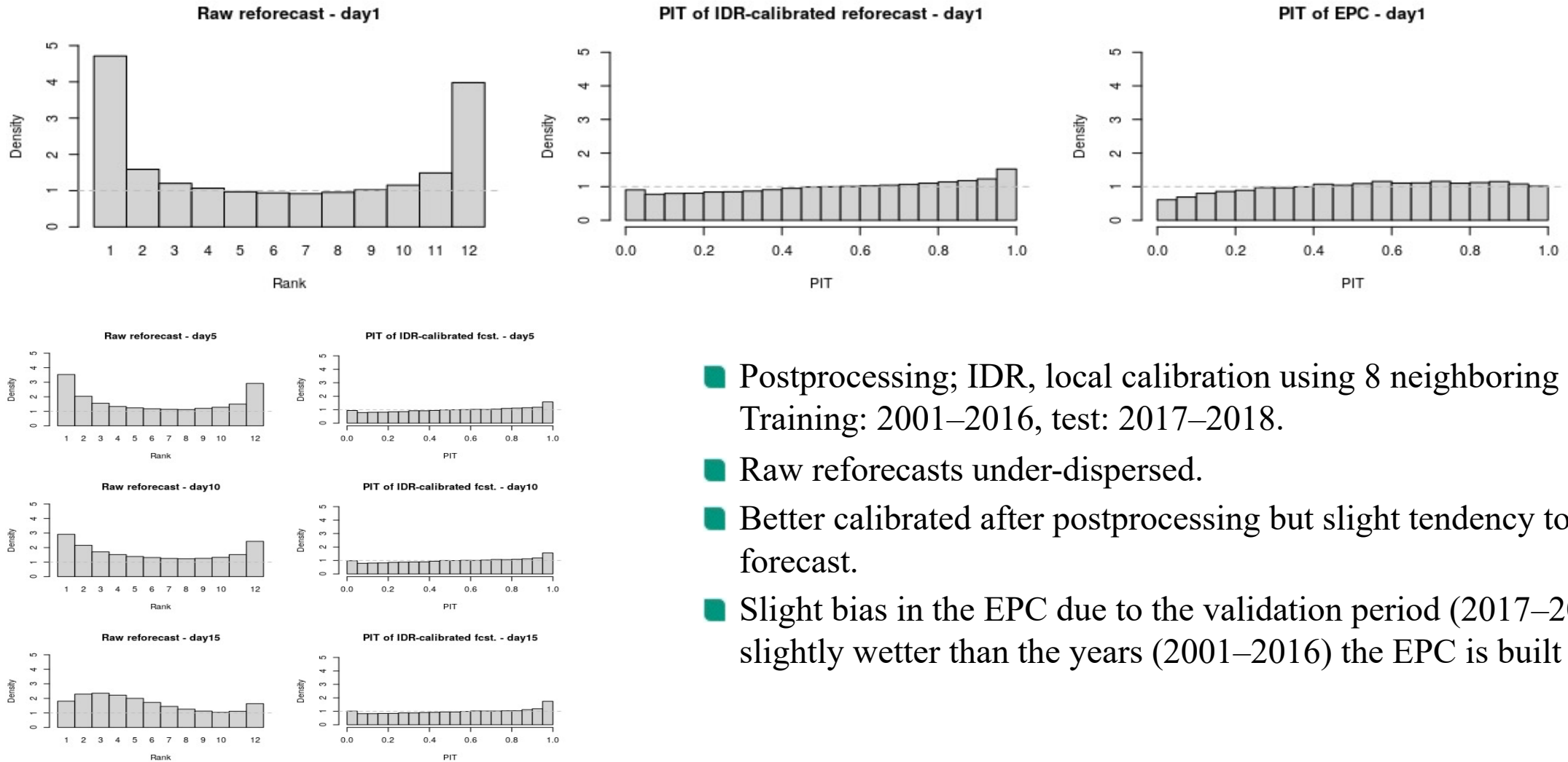
Skill of raw reforecasts - day1 (2017-2018)



- Positive skill over most areas, especially over land.
- Poor skill over ocean, coastal areas and high mountains – *although could be due to model misrepresenting process in these regions, the errors in the observations partly play a role.*



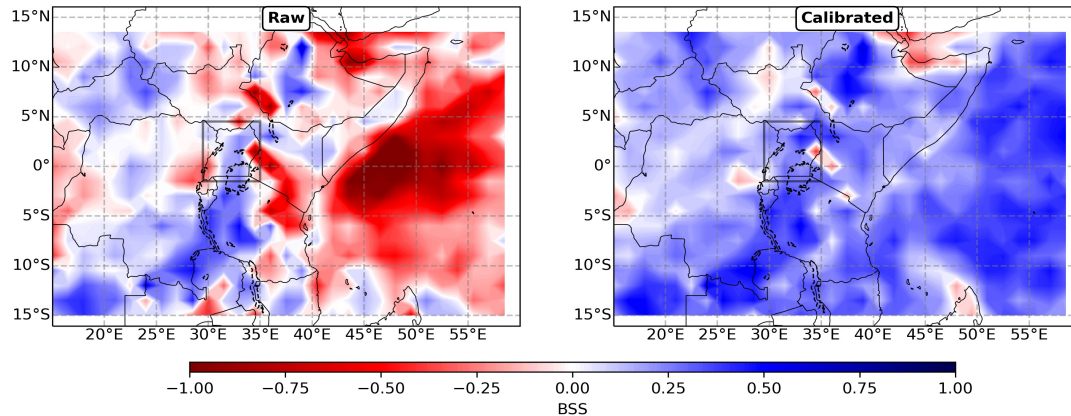
# Results - PIT histograms



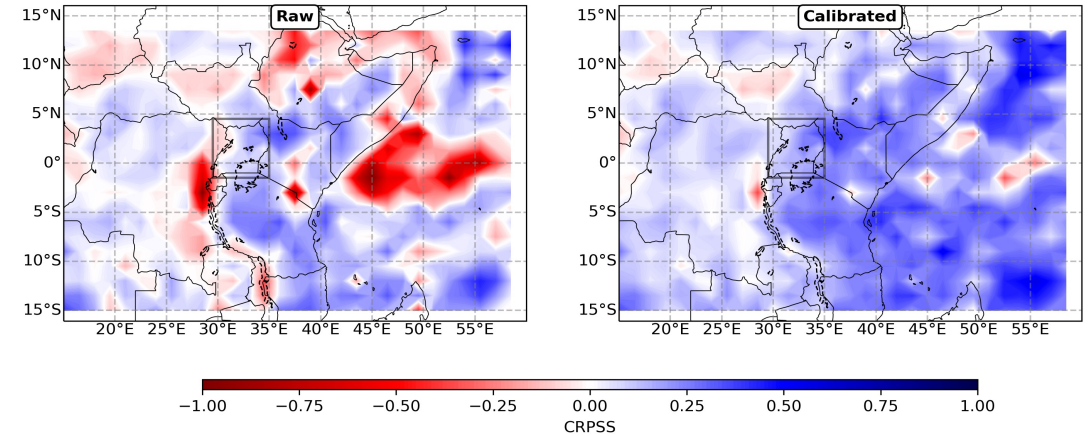
- Postprocessing; IDR, local calibration using 8 neighboring grids, Training: 2001–2016, test: 2017–2018.
- Raw reforecasts under-dispersed.
- Better calibrated after postprocessing but slight tendency to under-forecast.
- Slight bias in the EPC due to the validation period (2017–2018) being slightly wetter than the years (2001–2016) the EPC is built on.

# Results - Postprocessed reforecasts

Brier skill scores - day15



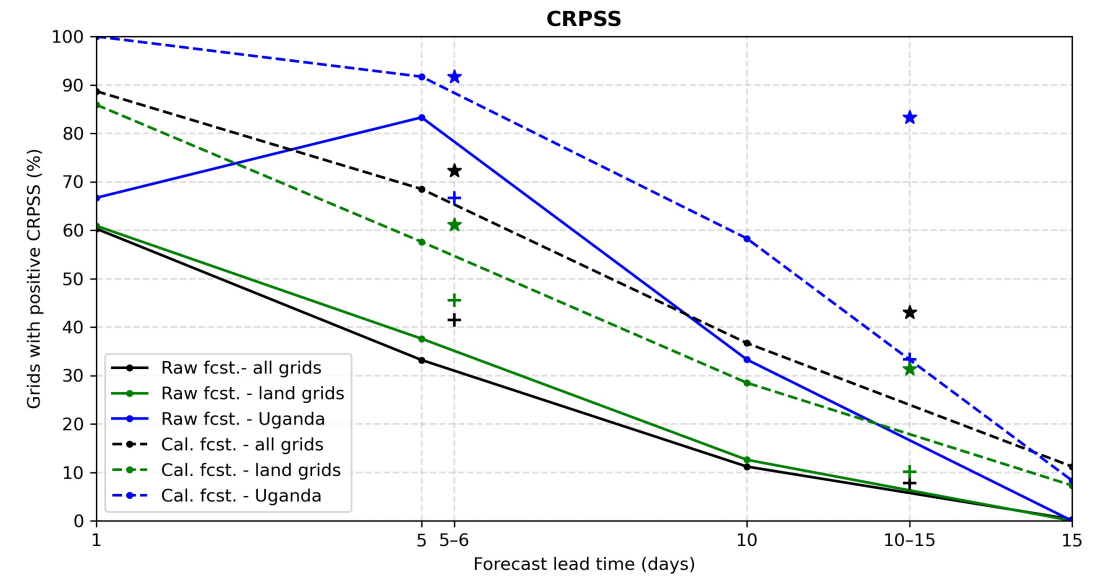
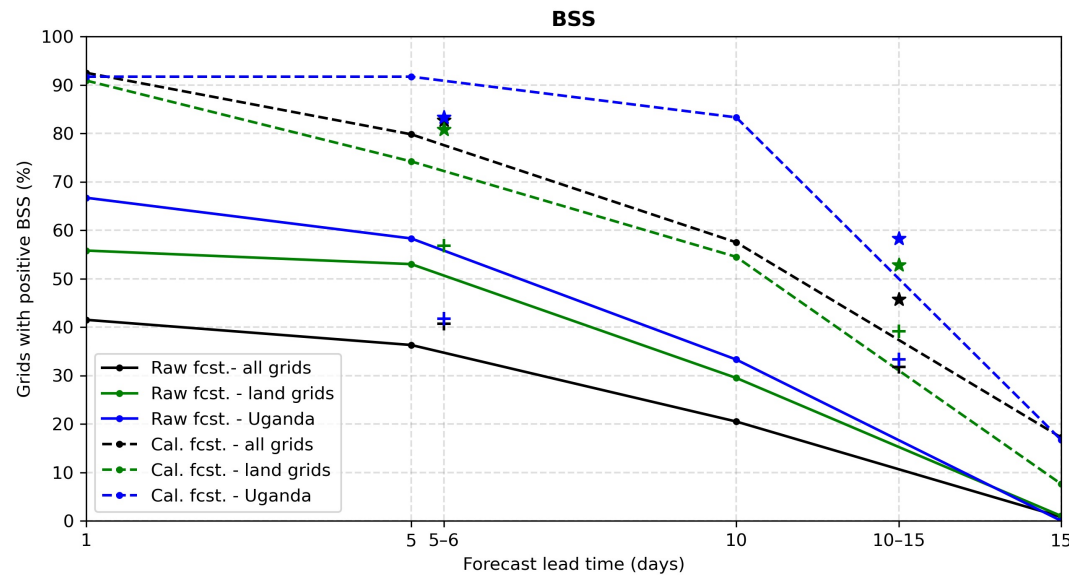
CRPS - day1



Percentage of grids with positive skill (%)

Domain	Full domain		Land-only		Uganda	
Reforecast	Raw	Cal.	Raw	Cal.	Raw	Cal.
BSS	41.5	92.5	55.8	90.9	66.7	91.7
CRPS	60.3	88.7	60.9	85.9	66.7	100.0

# Results – Skills summary



- Better skill after postprocessing – miscalibration significantly reduced.
- Skill degrades with lead time.
- Better skill for larger aggregation – *reduction in errors due to mismatches and the fact that forecasting single peaks in the short aggregation may be more difficult compared to consecutive peaks in longer the aggregations.*



## Summary

- The raw reforecasts are potentially skillful, although the skill depends on location and decreases with lead time.
- Longer temporal accumulation (e.g., 48hrs) increases the skill
- Calibrating the forecasts significantly reduces the bias.

## Next steps

- How skillful are the forecasts in predicting tropical waves.
- How is the skill affected by tropical waves and other synoptic scale phenomenon (e.g., IOD, ENSO and Congo air mass).