An assessment of the skill, sources of predictability and the climatological biases within sub-seasonal precipitation hindcasts over Africa

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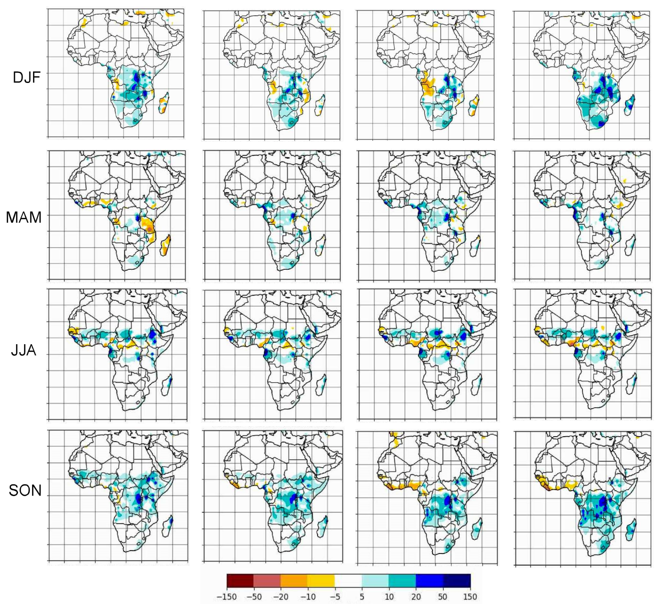
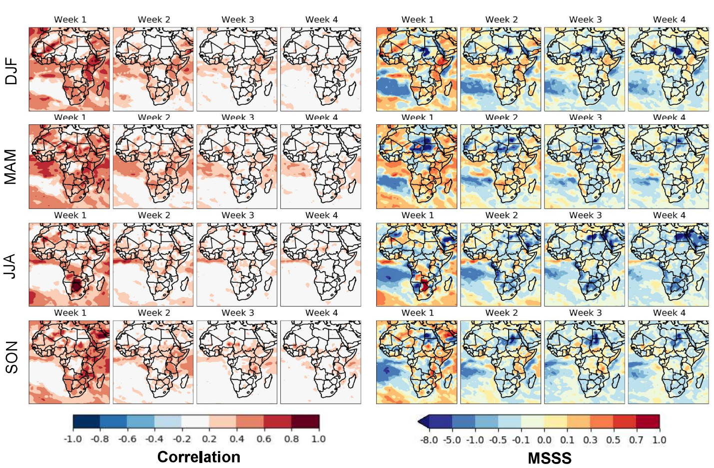
1. Weekly Climatological Biases



The weekly climatological biases (mm/week) show the Week 1 [5-11 days], Week 2 [12-18 days], Week 3 [19-25 days] and Week 4 [25-32 days] comparison between the ECMWF hindcast climatology and the CHIRPS climatology (1997-2017). One start date per month with the above lead times was used to calculate the hindcast climatology. Increasing lead time appears to show consistent patterns, with some intensification. Larger systematic biases are seen during the boreal autumn and winter, particularly over the Democratic Republic of the Congo, Kenya and Ethiopia.

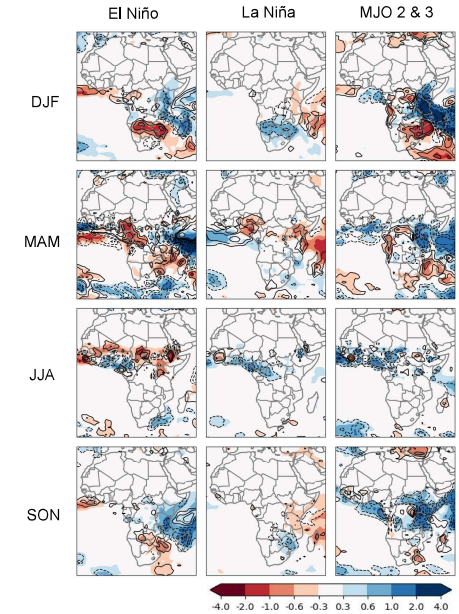
2. Deterministic Verification



The correlation between the ECMWF hindcast and GPCP anomalies (1999-2010) show a large decrease after week 1 during all seasons, with more gradual reduction from week 2 to week 4. Higher correlations over East and West Africa indicate better hindcast quality over these regions. Generally, positive skill is shown over much of Africa in week 1, with some areas persisting positive correlations, although progressively declined, during subsequent weeks, specifically as seen over East Africa.

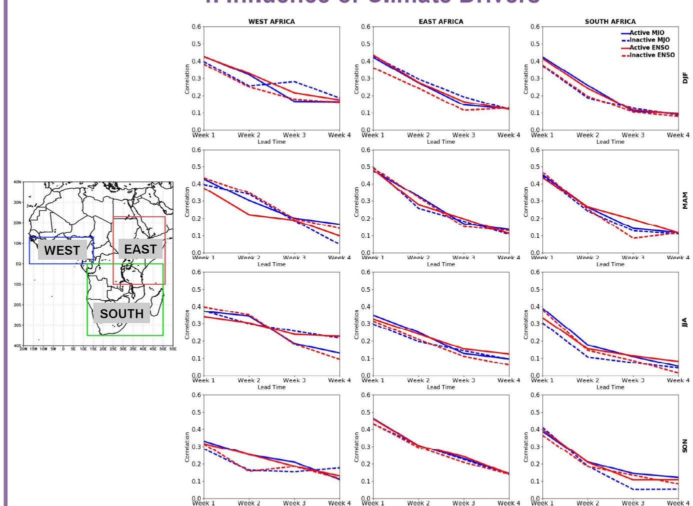
The accuracy of the hindcasts relative to a reference climatology for the ECMWF model are measured through Mean Square Skill Score (MSSS) for DJF, MAM, JJA and SON (1999-2010). Large errors are shown after the first week during all seasons. Errors are smaller over East Africa. The spatial patterns of the MSSS are broadly similar to those seen in the correlation maps, with high MSSS and high correlation during week 1 across Mali and Algeria in DJF, over Botswana in JJA, and over the Greater Horn of Africa during much of the year.

3. Climate Driver Modulation of Rainfall



The climate driver composites and biases show the influence of the El Niño, La Niña and MJO phases on the precipitation anomalies of the region. The biases are comprised 5 to 32 days forecasts for all forecast start dates during the season (1998-2014). Phases 2 and 3 (Phases 6 and 7 show a reversed signal) of the MJO show a dry bias centred over Tanzania during boreal winter. A wet bias is shown over West Africa during boreal spring and summer for El Nino and MJO phases 4 and 5 (Phases 8 and 1 show a reversed signal). Overall, MJO and ENSO rainfall signals are underestimated over most regions. The colours show the GPCP composites. The contours show the Biases with positive values solid and negative values dashed. The contours are: -4, -2, -1, -0.6, -0.3, 0.3, 0.6, 1, 2, 4 mm/week.

4. Influence of Climate Drivers



The influence of climate drivers is shown by zonal average correlation over 3 African regions between the ECMWF hindcast and GPCP anomalies based on MJO and ENSO states on start dates during DJF, MAM, JJA and SON (1998-2014). African regions are displayed in the figure to the left.

5. Summary

We evaluate the skill of sub-seasonal forecasts of weekly precipitation from ECMWF hindcasts using 20 years of data from starts in 2017 to 2018, with satellite and gauge based precipitation estimates from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) and the Global Precipitation Climatology Project (GPCP).

1) Wet biases dominate the ECMWF comparison with CHIRPS, particularly during the boreal autumn and winter.

2) There is high positive correlation between ECMWF and observed rainfall at week 1, however the MSSS shows large errors after the first week. The correlation scores are higher during week 1 and drop as lead time increases, maintaining reasonable skill over West and East tropical Africa, particularly during transition seasons.

3) Phases 2-3 of the MJO show a dry bias centred over Tanzania during boreal winter. Wet bias is shown over West Africa during boreal spring and summer for El Nino and MJO phases 4-5. MJO and ENSO rainfall signals are underestimated over most African regions.

4) ENSO and MJO phase dependent analysis shows the influence of these particular climate drivers on forecast quality over selected African regions. Despite errors in the teleconnections, skill is high during ENSO years, possibly related to the strong seasonal drivers. The impact of MJO is variable, with greater skill in West Africa during SON but lower skill in JJA, associated with the large biases in JJA.

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