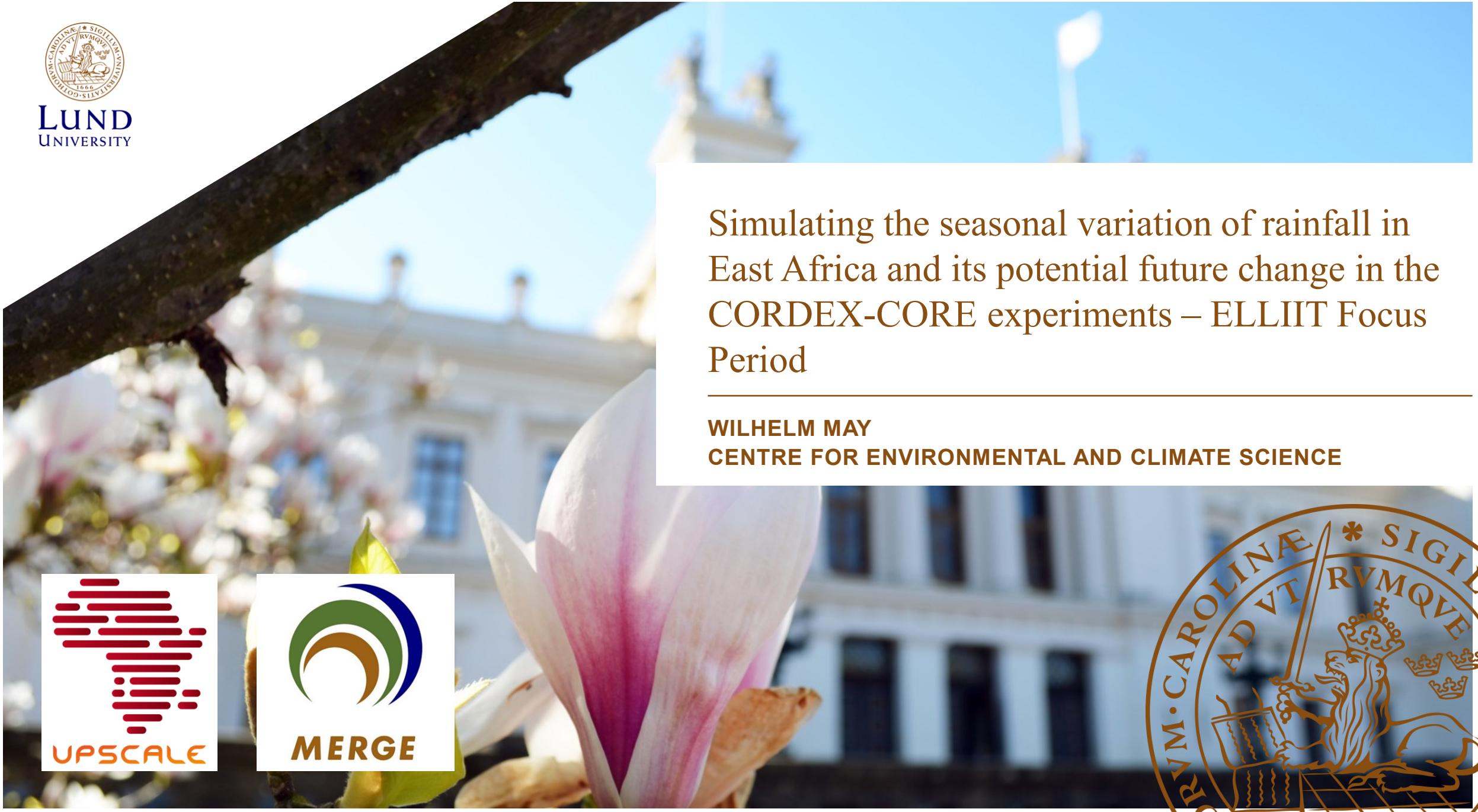

Simulating the seasonal variation of rainfall in East Africa and its potential future change in the CORDEX-CORE experiments – ELLIIT Focus Period

WILHELM MAY
CENTRE FOR ENVIRONMENTAL AND CLIMATE SCIENCE

Smallholder farming in East Africa

Smallholder farming (typically 1-2 ha) accounts for about **75% of the agricultural production** and more than **75% of the employment** in East Africa (in 2010)

Smallholder farming plays a very important role for **food security** in many households

Smallholder farming in East Africa

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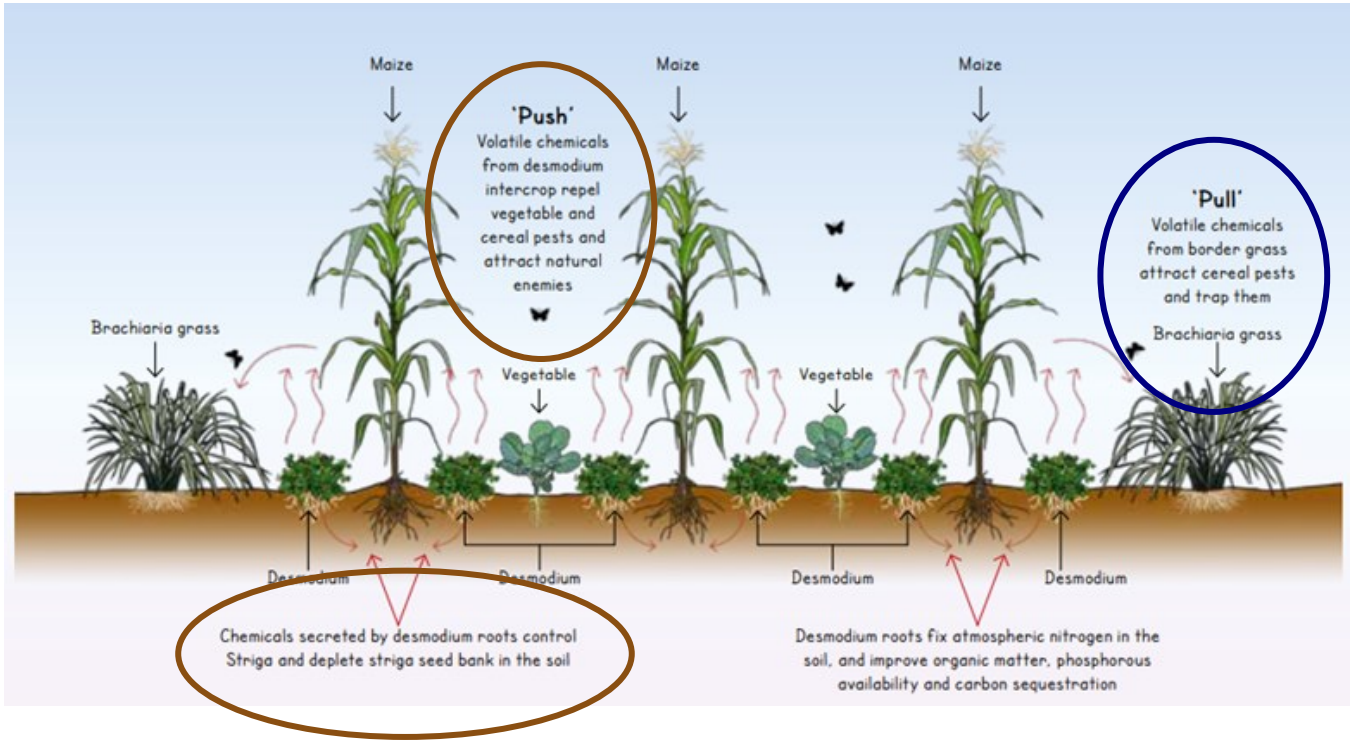
Smallholder farming plays a very important role for **food security** in many households

Smallholder farming in East Africa is **rainfed** and, thus, synchronized with the **rainy seasons**

Smallholder farming is, thus, vulnerable to **climate variability and change**

UPSCALE project

Upscaling the benefits of **Push-Pull Technology** for sustainable agricultural intensification in East Africa

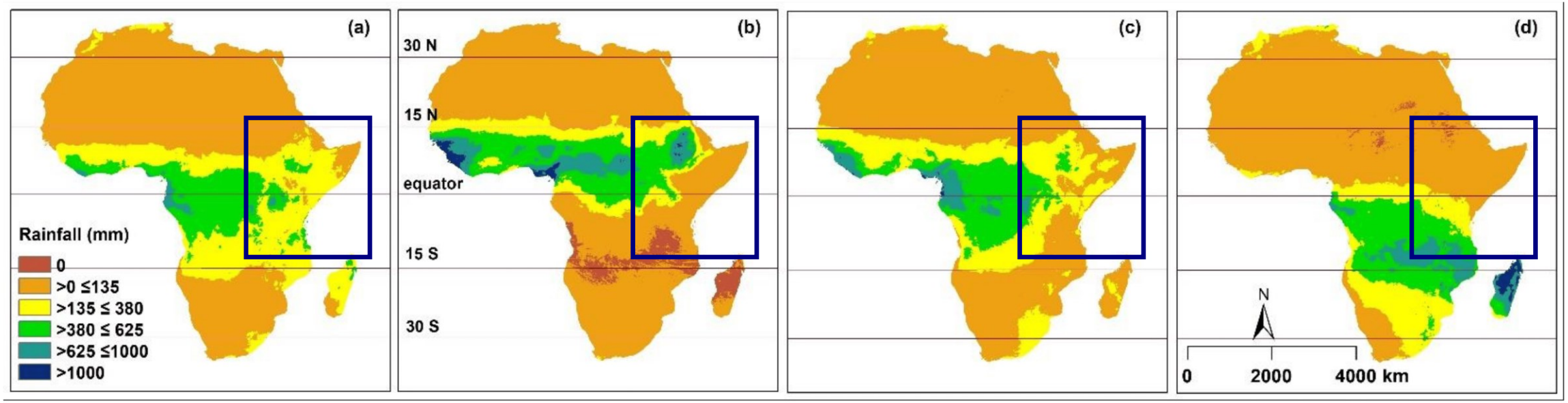


UPSCALE project

Upscaling the benefits of **Push-Pull Technology** for sustainable agricultural intensification in East Africa

… By determining the factors influencing push-pull success across scales, we will enable targeted implementation and prediction of **push-pull effectiveness and resilience under current and future climate conditions.**

Seasonal variation of rainfall



March – April – May

June – July – August

September – October – November

December – January – February

Alahacoon et al (2022)

Characteristics of rainy seasons

For each grid point and data set

1. Compute the **climatological annual cycle** of daily rainfall
2. Perform a **spectral analysis** of the climatological annual cycle
3. Estimate the **contributions** of the first six harmonics **to the variance** associated with the climatological annual cycle
4. Determine the **onset and cessation date(s)** of the rainy seasons(s) for the grid points, where **one of the first two harmonics is dominating**

May et al (1992), Dunning et al (2016)

CORDEX-CORE experiment

CORDEX: COordinated Regional Downscaling EXperiment

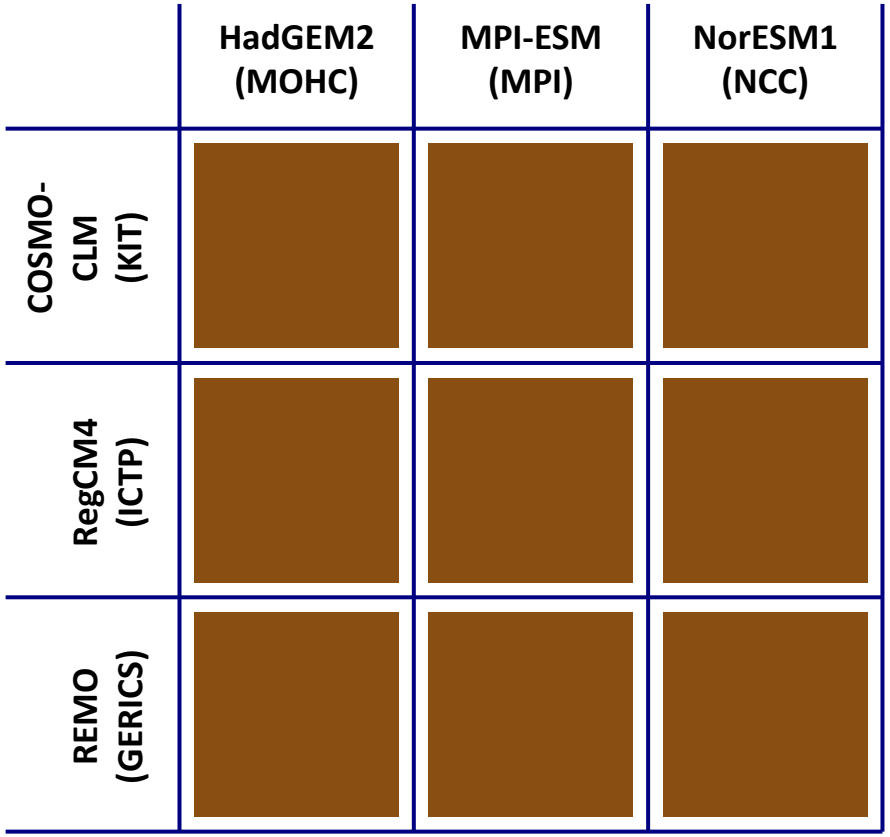
CORE: Coordinated Output for Regional Evaluations

Provides a **homogenous set of projections for 9 domains** at a resolution of ≈25 km

Three Regional Climate Models (RCMs) driven by **three Global Climate Models** (GCMs) for **two climate scenarios**

Giorgi et al (2022)

CORDEX-CORE experiment



Evaluation simulation: driven with ERA-Interim for the observed period

Historical simulations: driven with simulations from the three GCMs for the historical period

Scenario simulations: driven with the two scenario simulations (RCP2.6 and RCP8.5) from the three GCMs for the future period

Study region – orography

Eritrea

Ethiopia*

Djibouti

Somalia

Kenya*

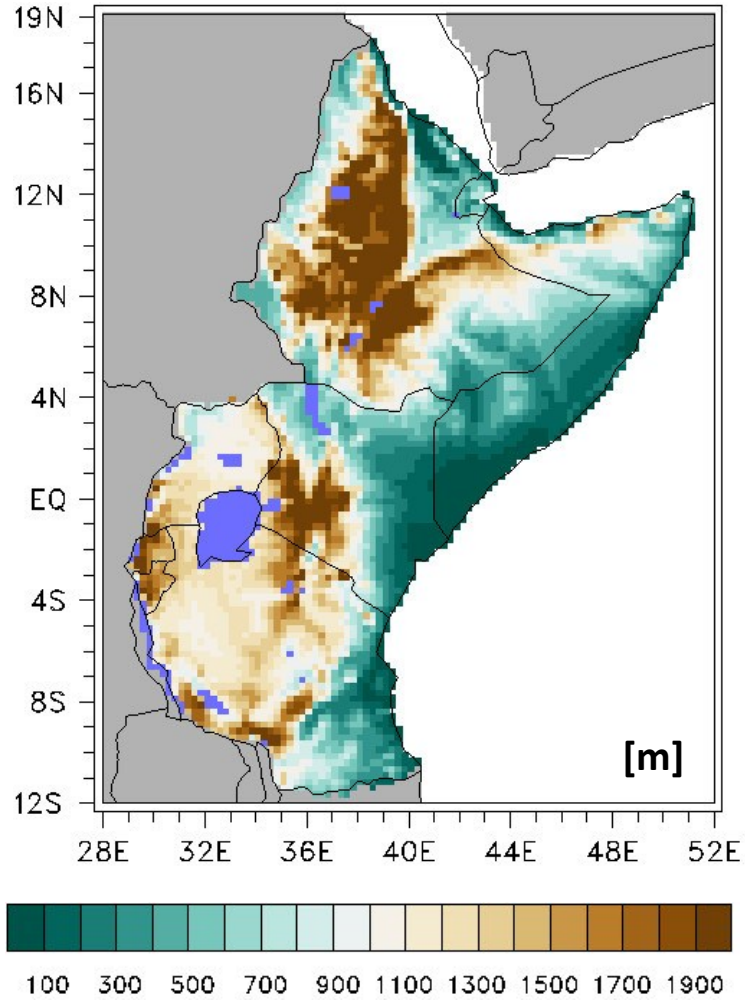
Tanzania*

Uganda*

Rwanda*

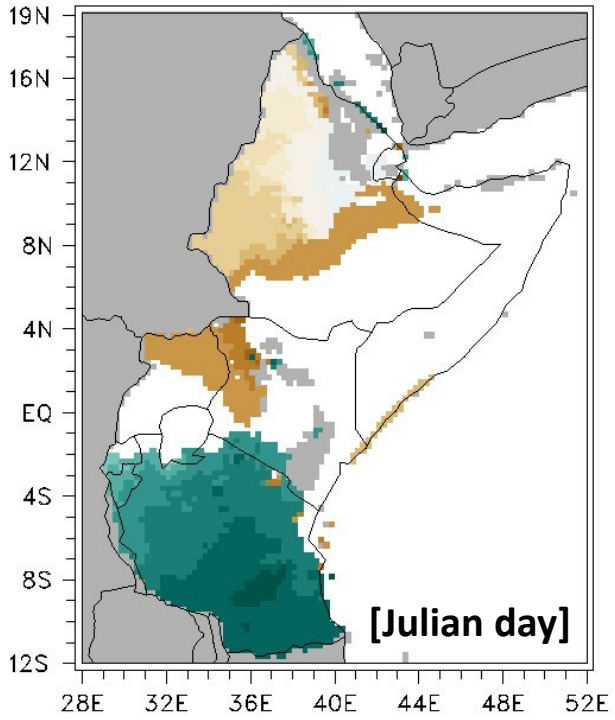
Burundi

*part of UPSCALE

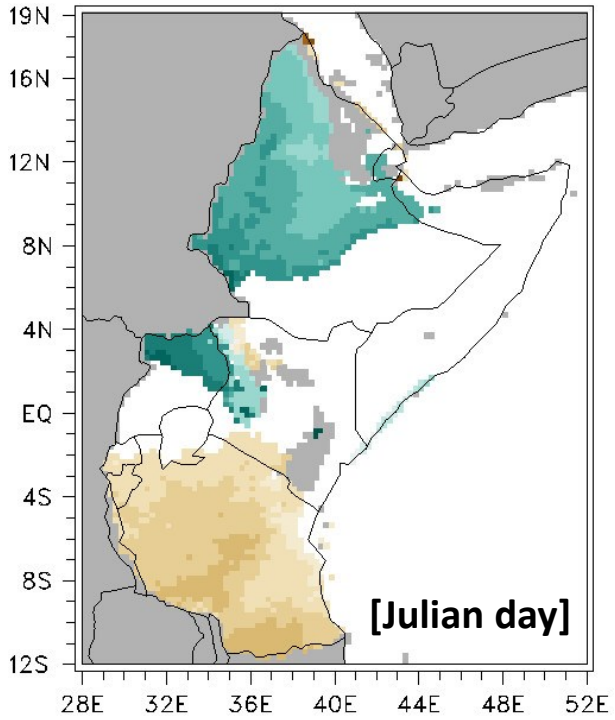


Rainy seasons(s) – observations

Onset



Cessation



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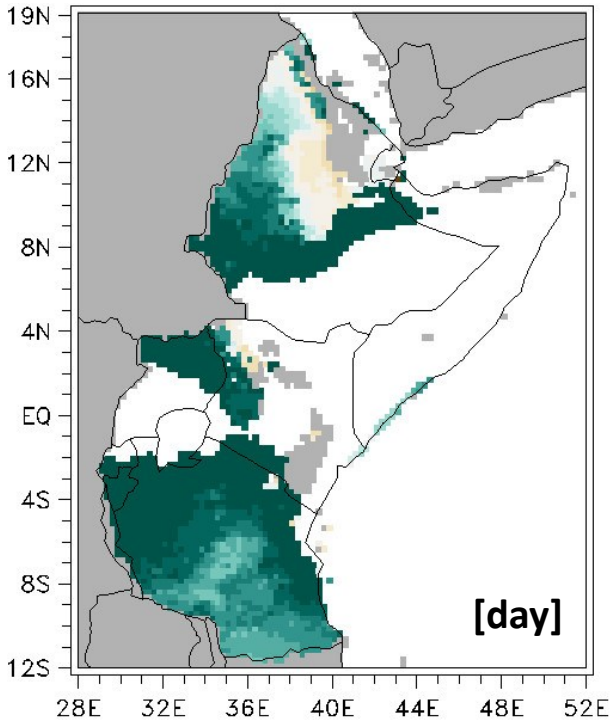
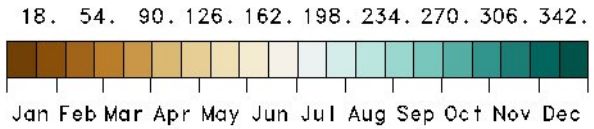
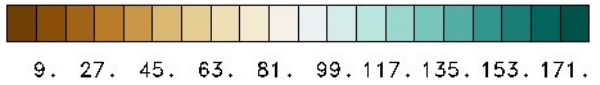


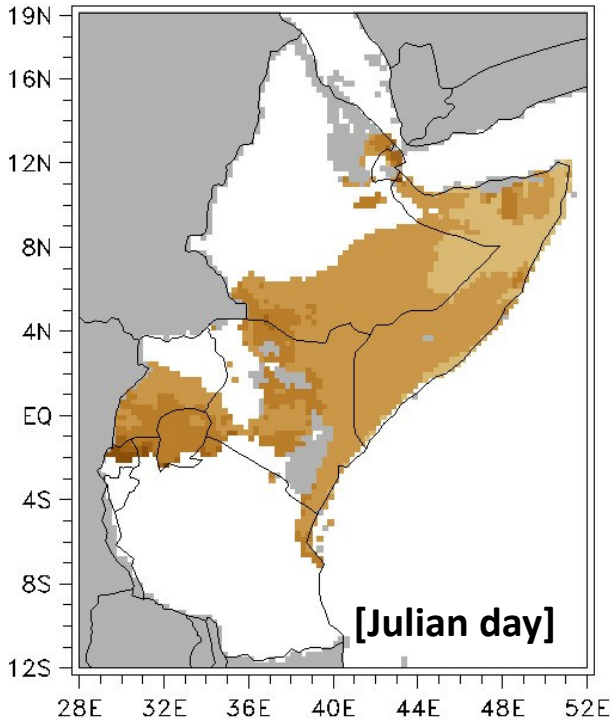




One rainy season

Rainy seasons(s) – observations

Onset



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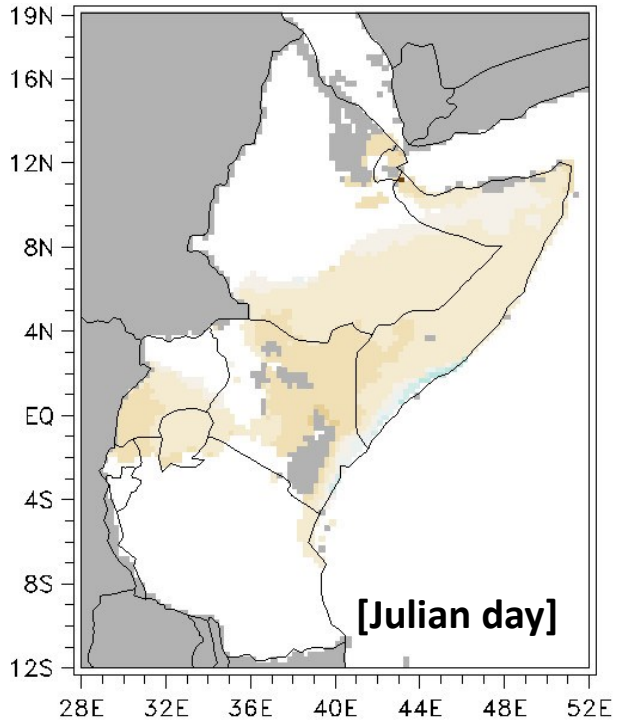

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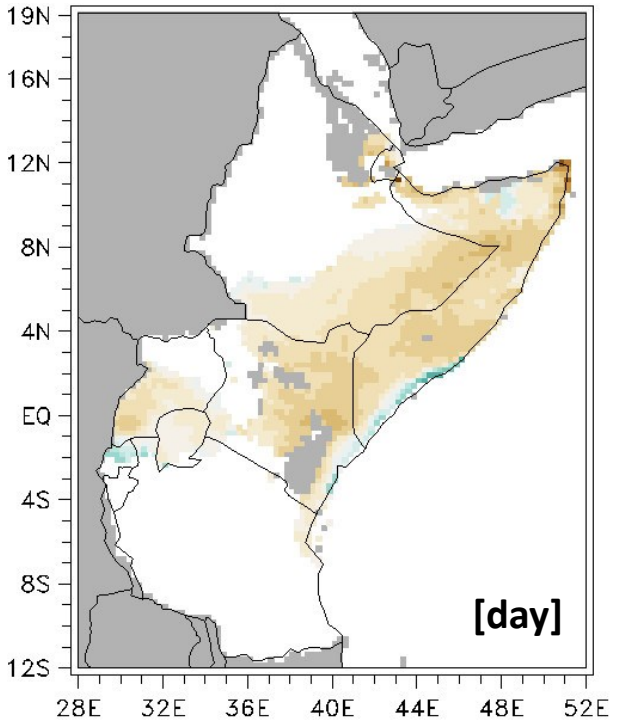
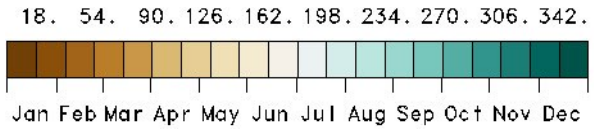
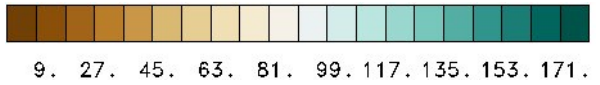


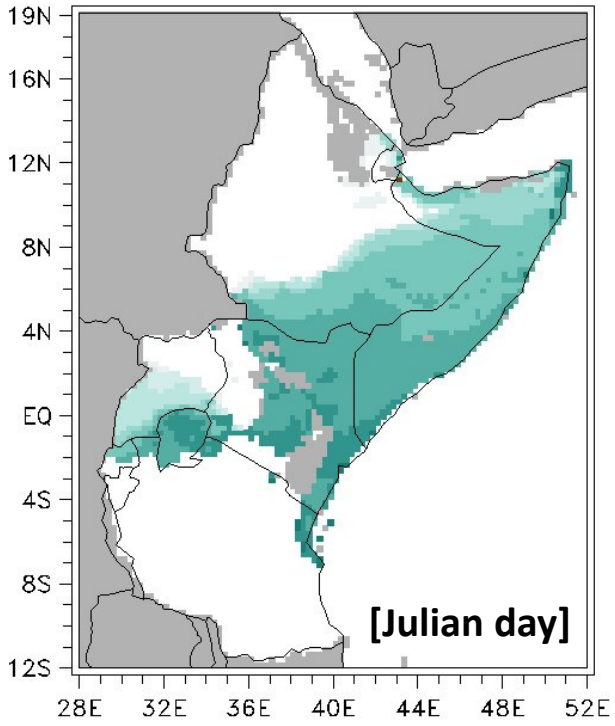




First of two rainy seasons

Rainy seasons(s) – observations

Onset



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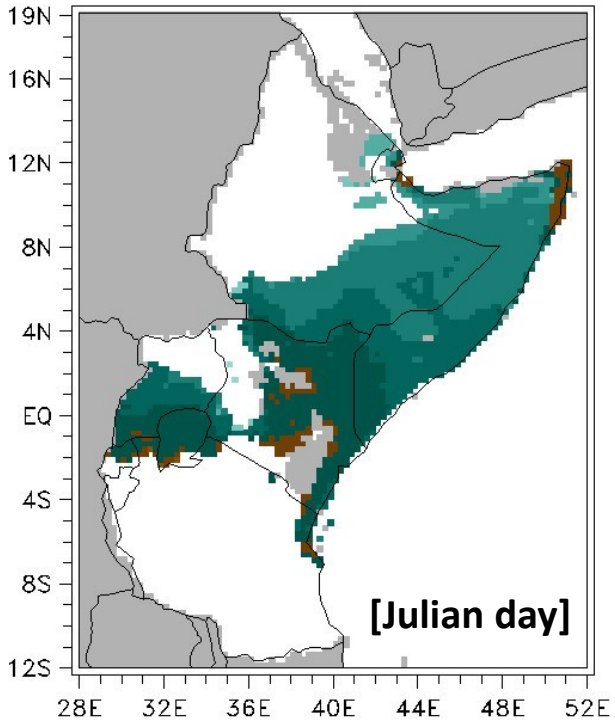

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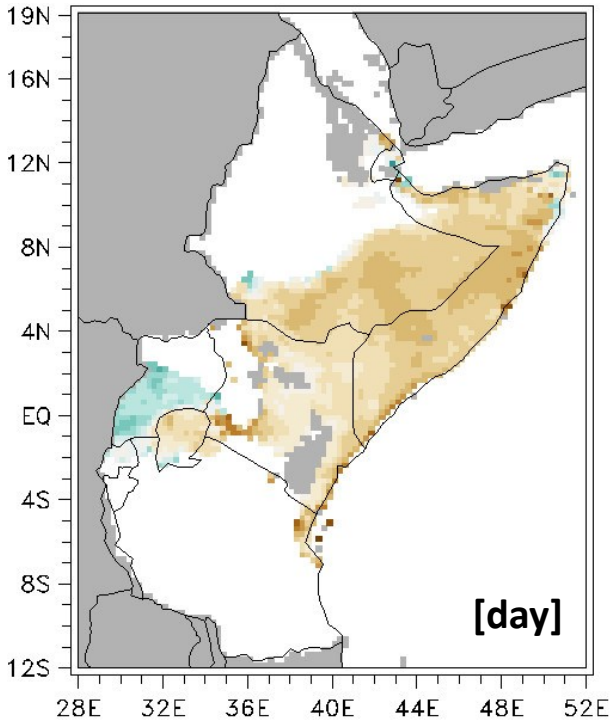
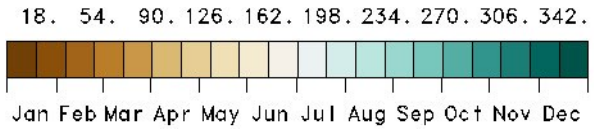
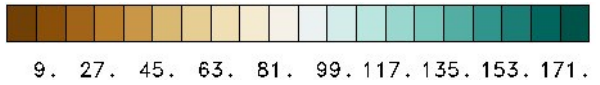


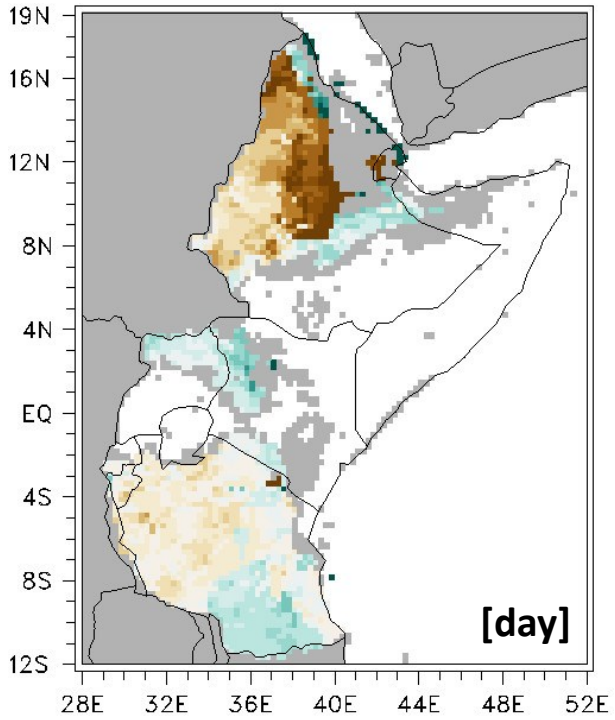




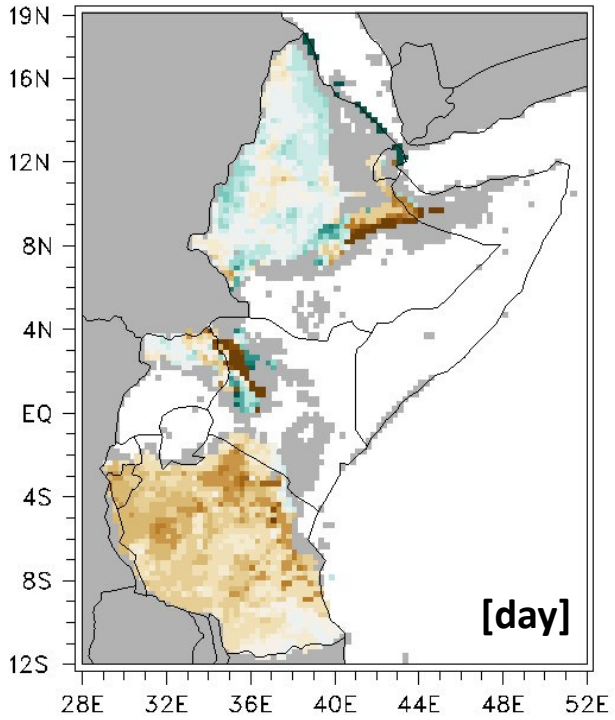
Second of two rainy seasons

Rainy seasons(s) – evaluation simulation vs. observations

Onset



Cessation



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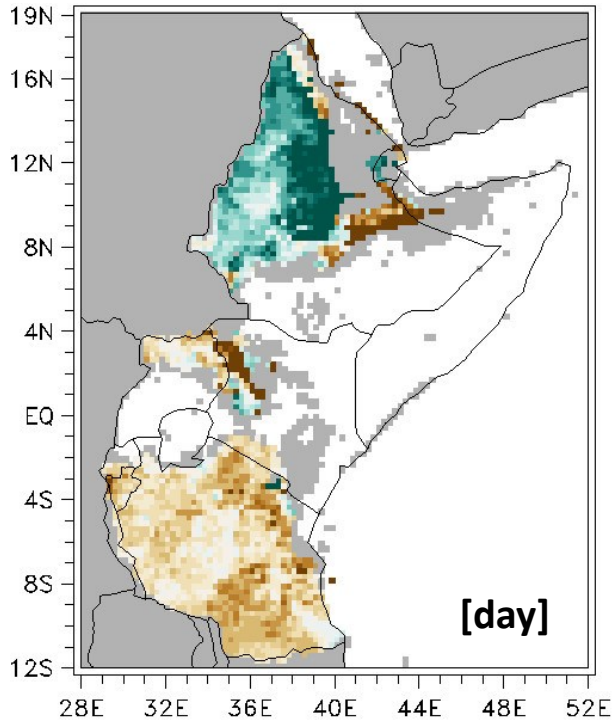
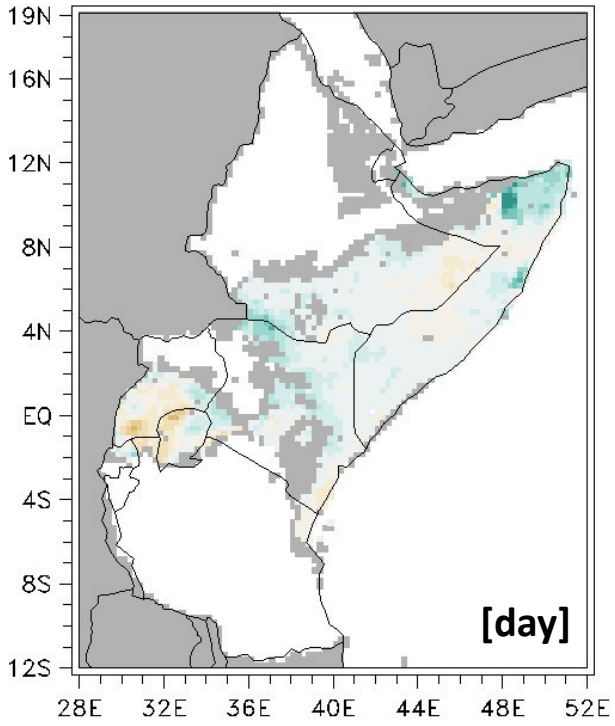


One rainy season

Rainy seasons(s) – evaluation simulation vs. observations

Onset



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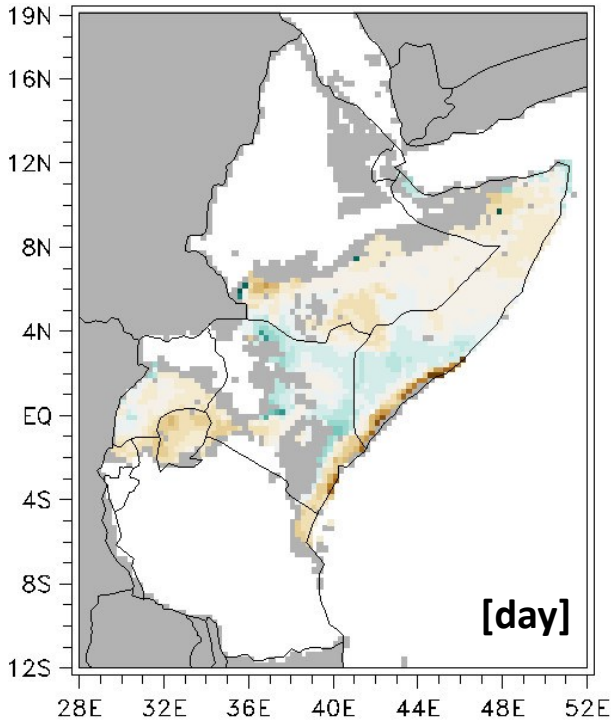

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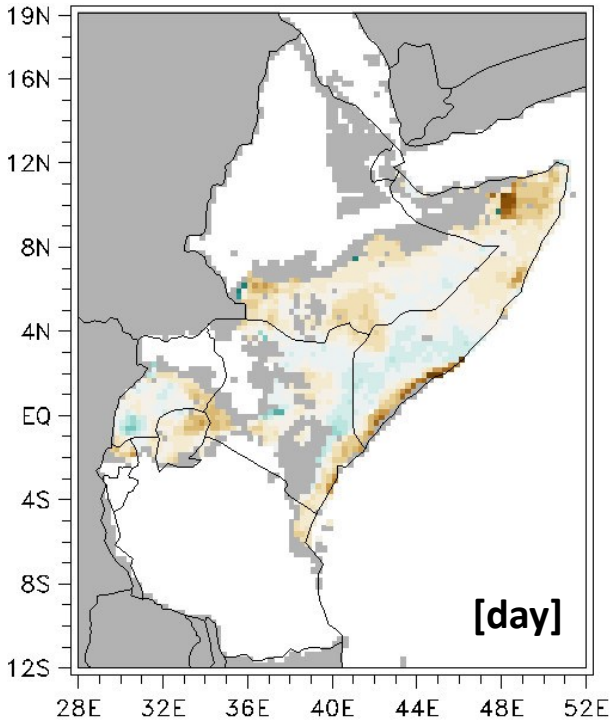
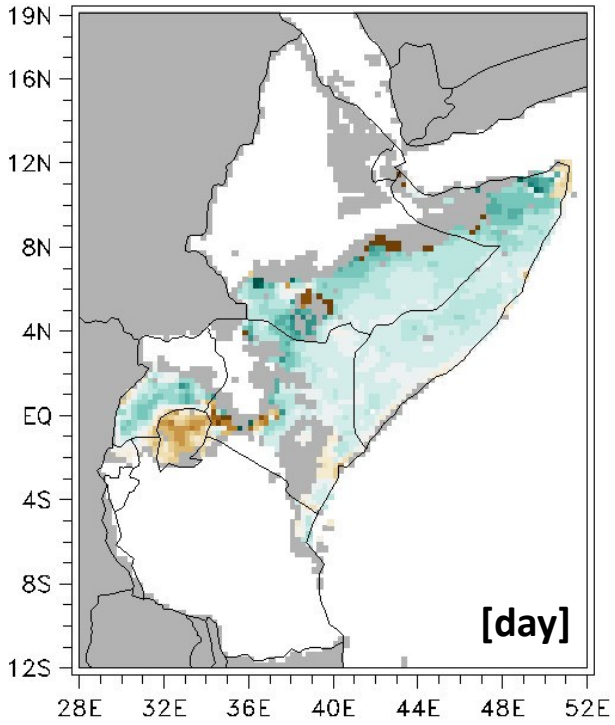


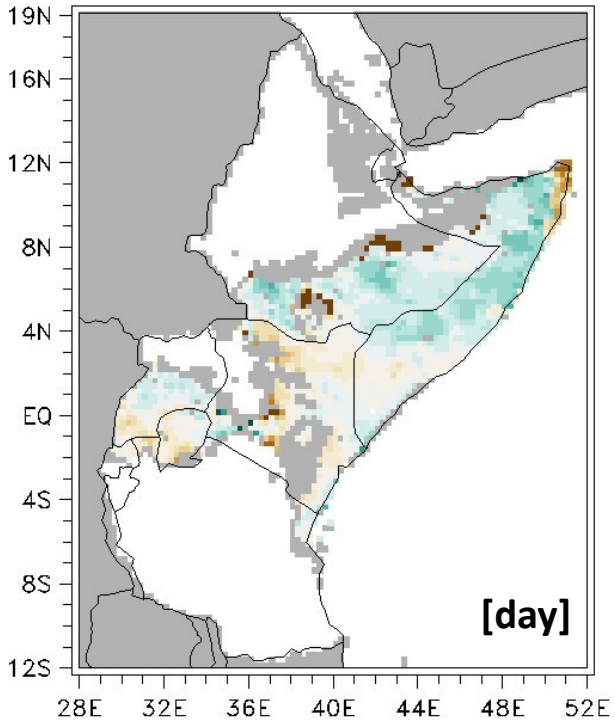
First of two rainy seasons

Rainy seasons(s) – evaluation simulation vs. observations

Onset



Cessation



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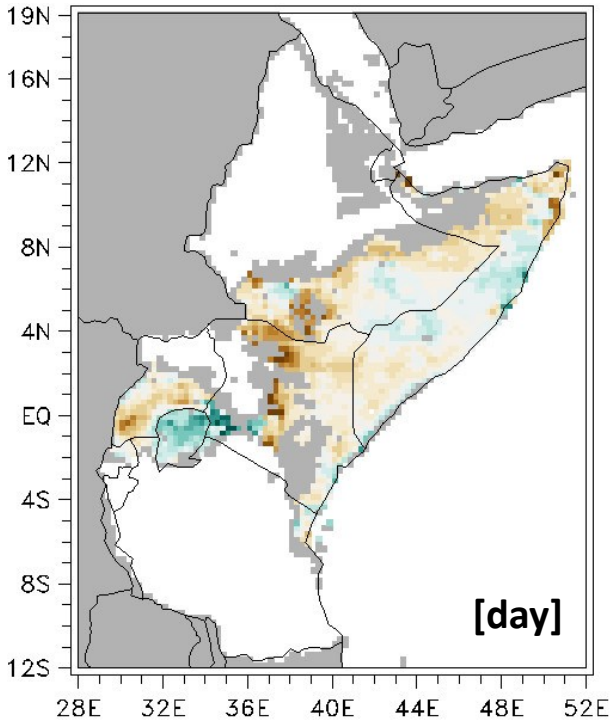
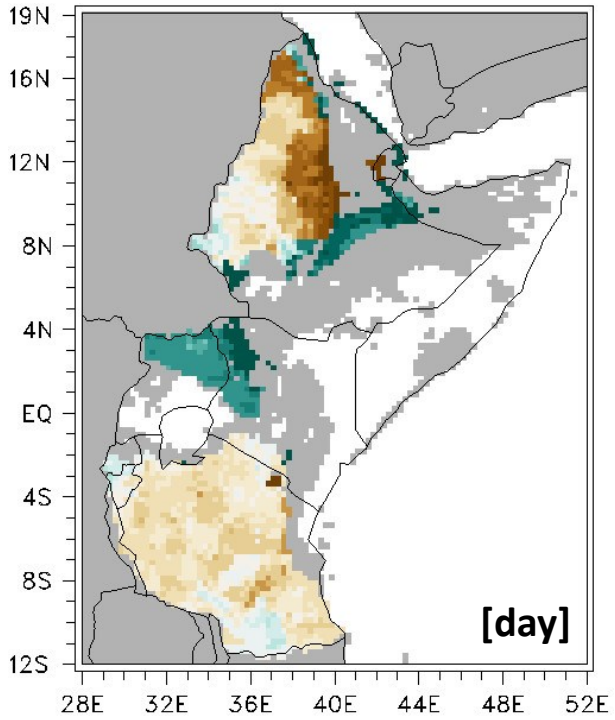


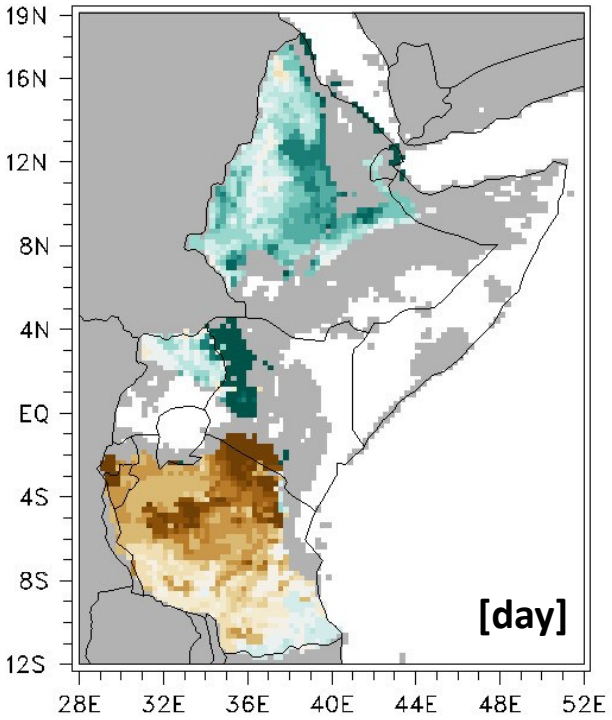
Second of two rainy seasons

Rainy seasons(s) – historical simulation vs. observations

Onset



Cessation



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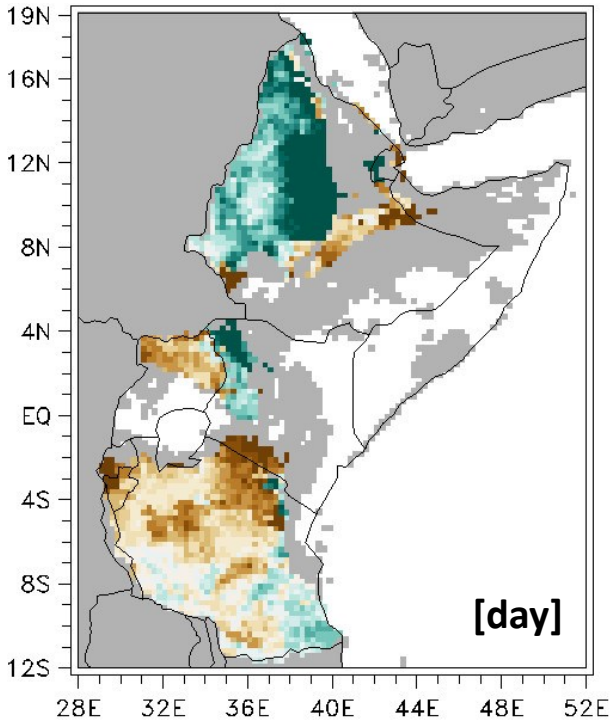
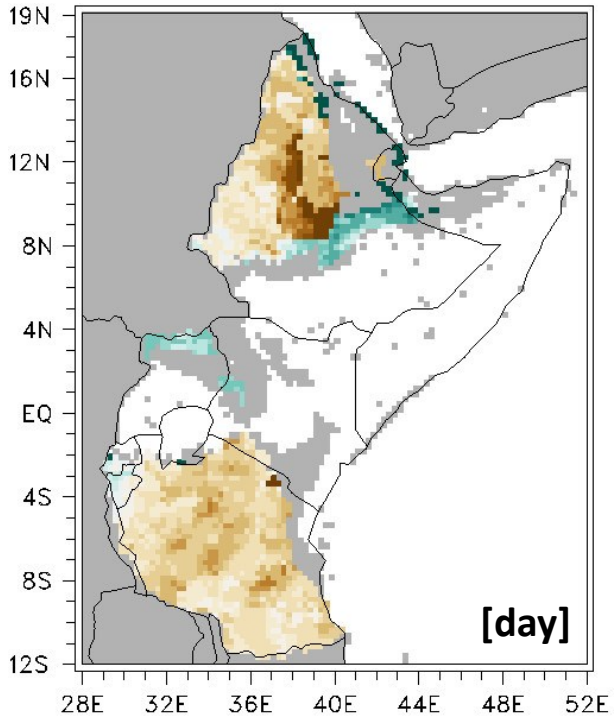


One rainy season
MOHC

Rainy seasons(s) – historical simulation vs. observations

Onset



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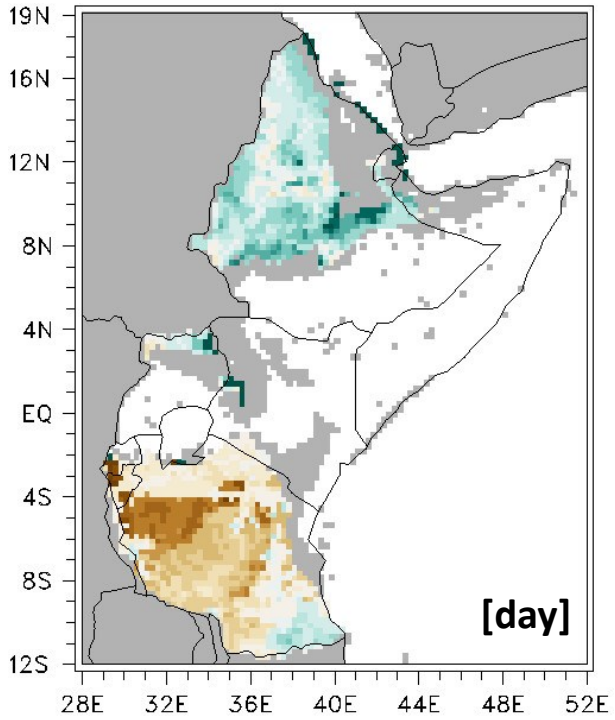

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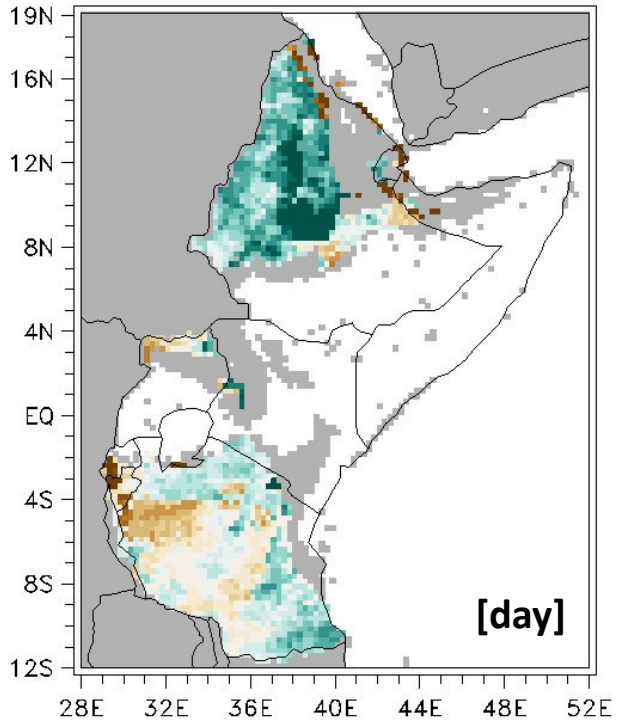
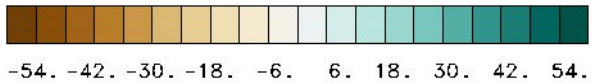
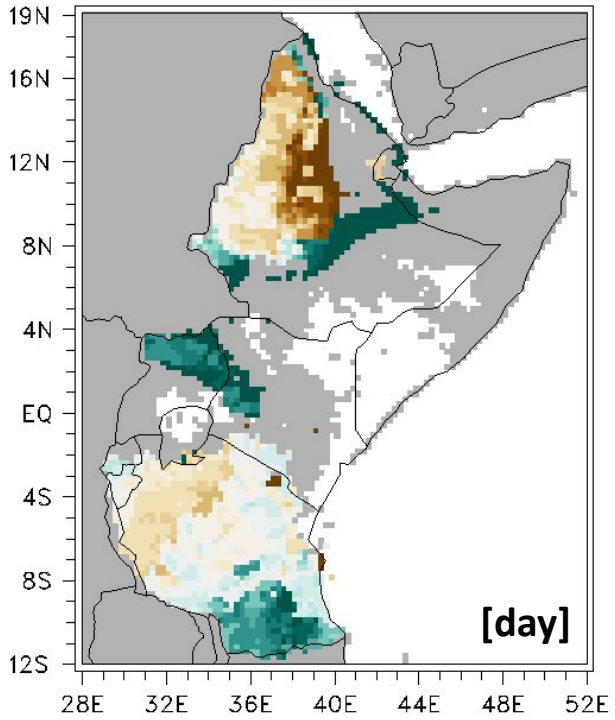




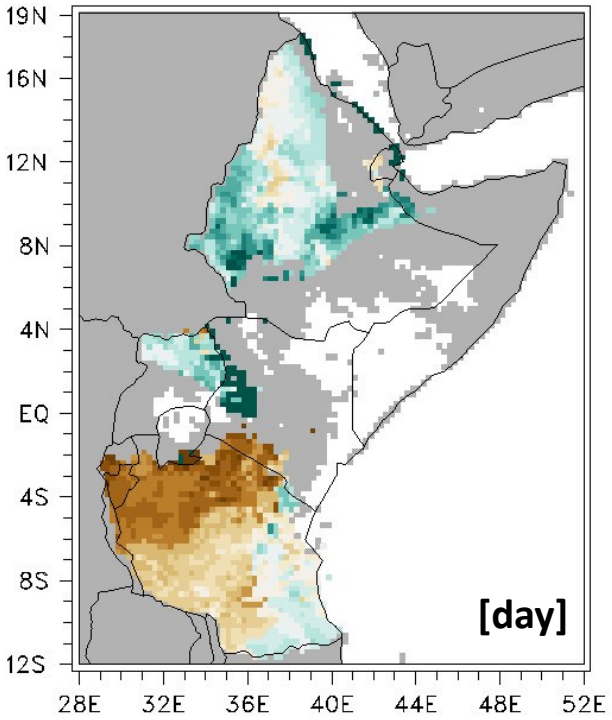
One rainy season
MPI

Rainy seasons(s) – historical simulation vs. observations

Onset



Cessation



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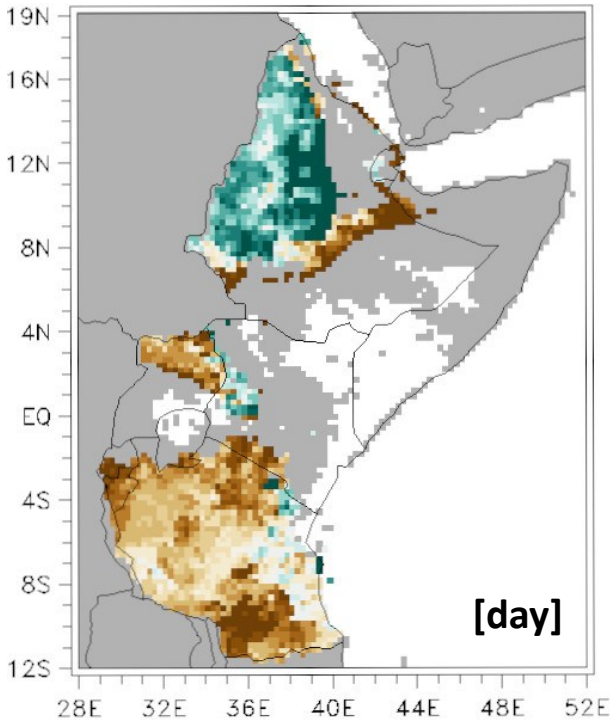
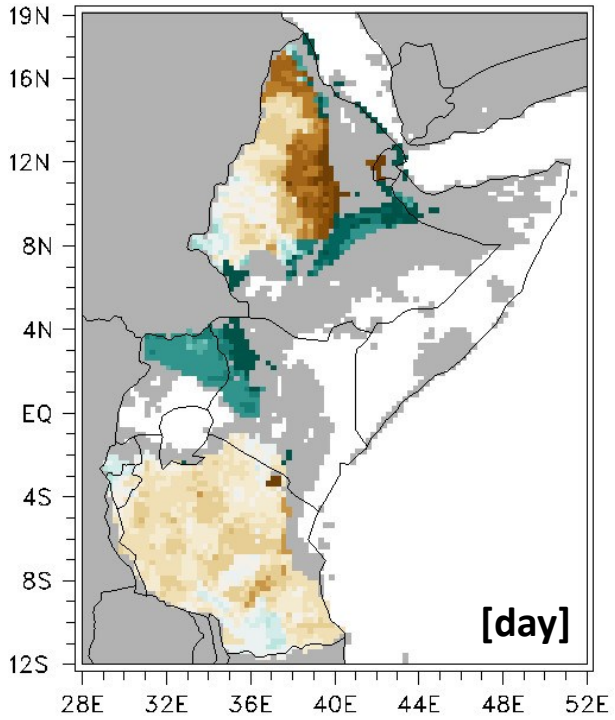


One rainy season

NCC

Rainy seasons(s) – historical simulation vs. observations

MOHC



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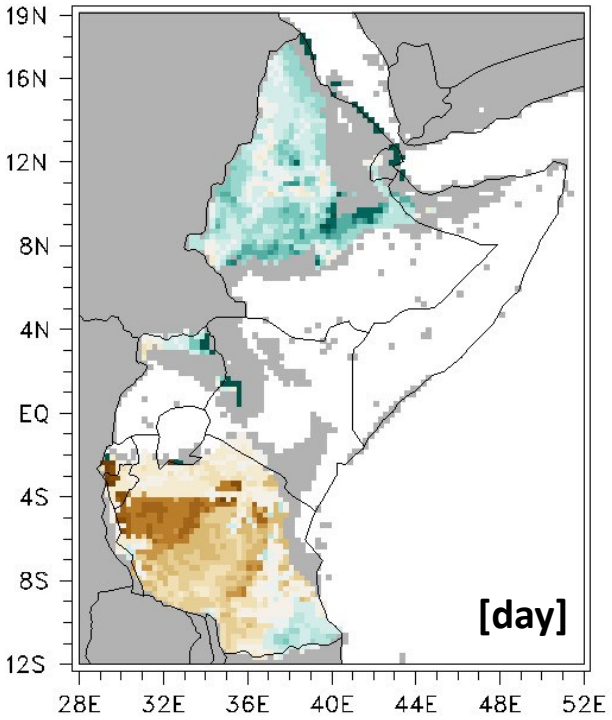

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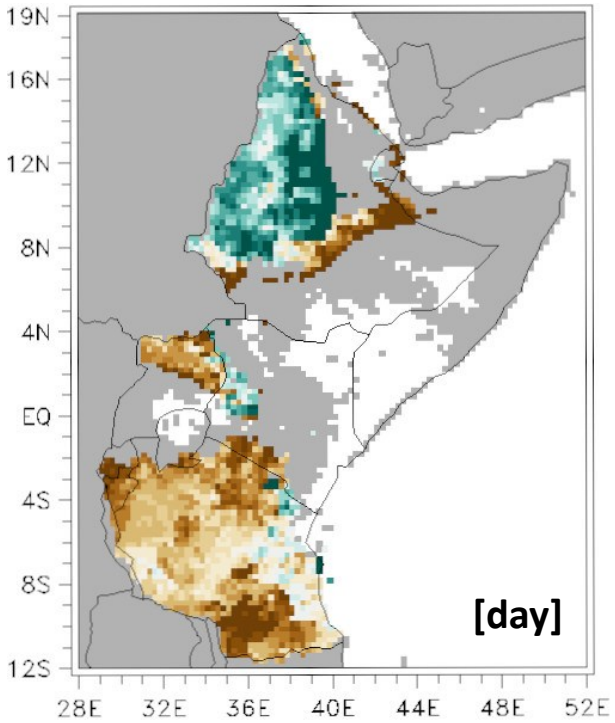
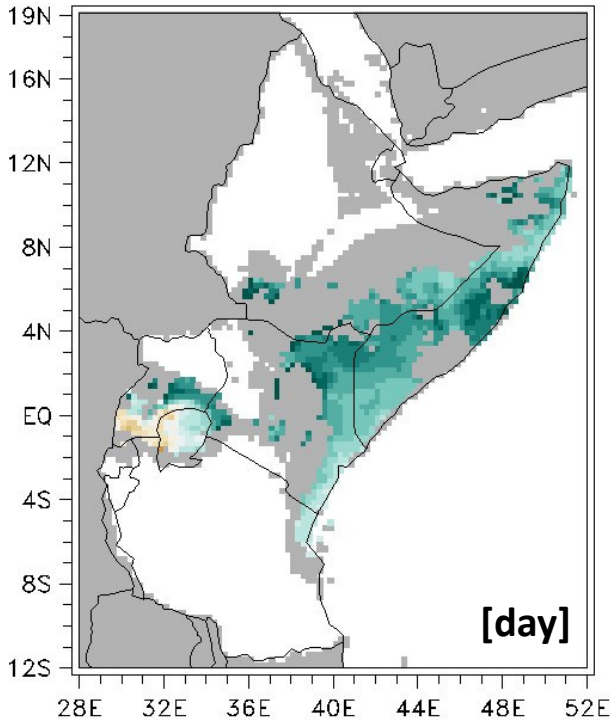


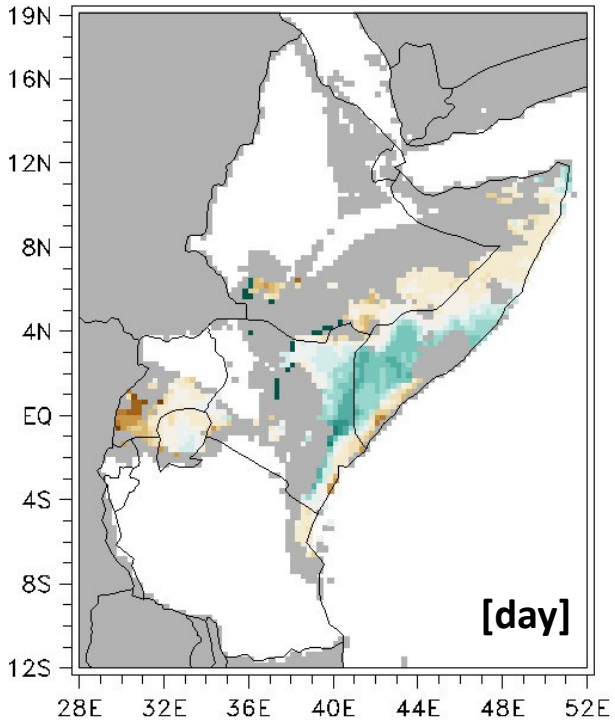
Length of one rainy season

Rainy seasons(s) – historical simulation vs. observations

Onset



Cessation



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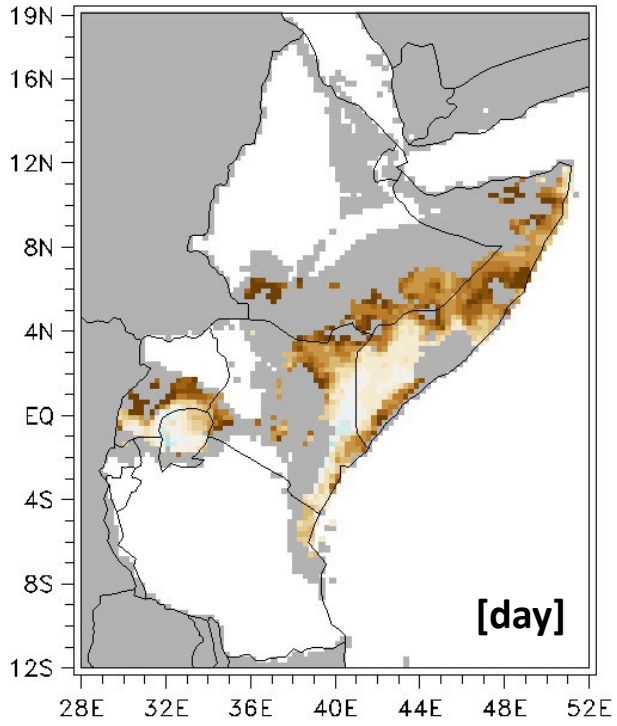
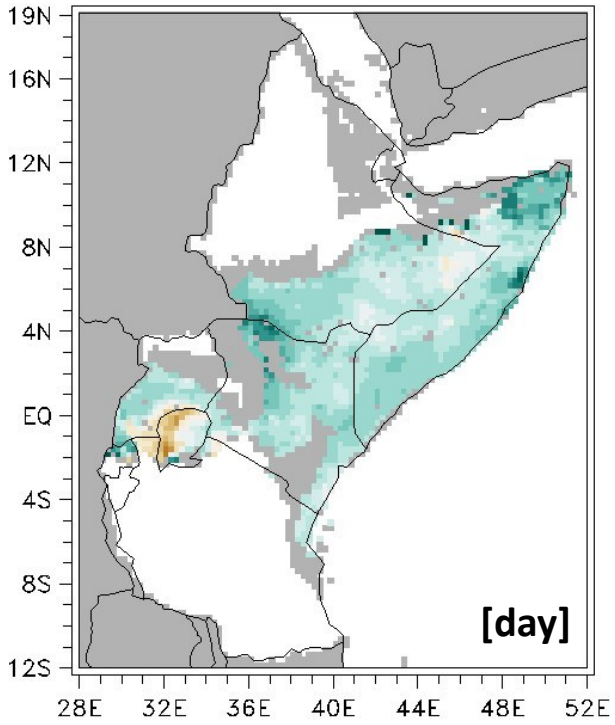


First of two rainy seasons
MOHC

Rainy seasons(s) – historical simulation vs. observations

Onset



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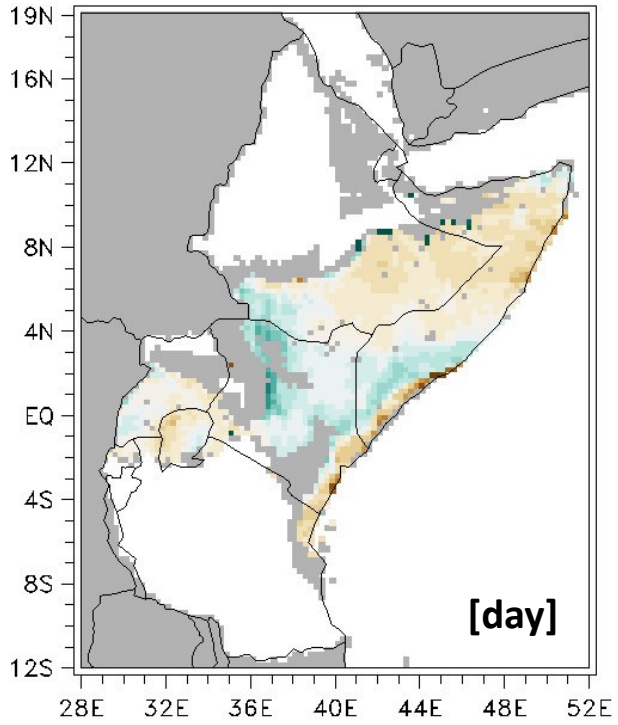

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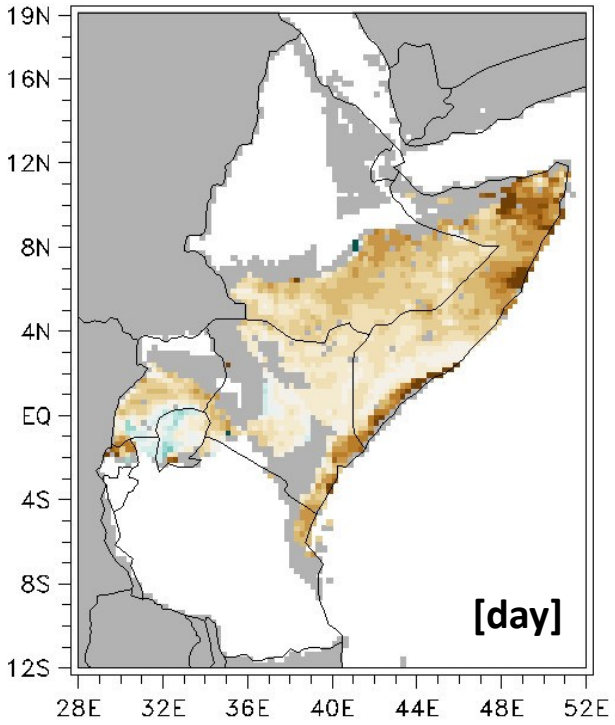
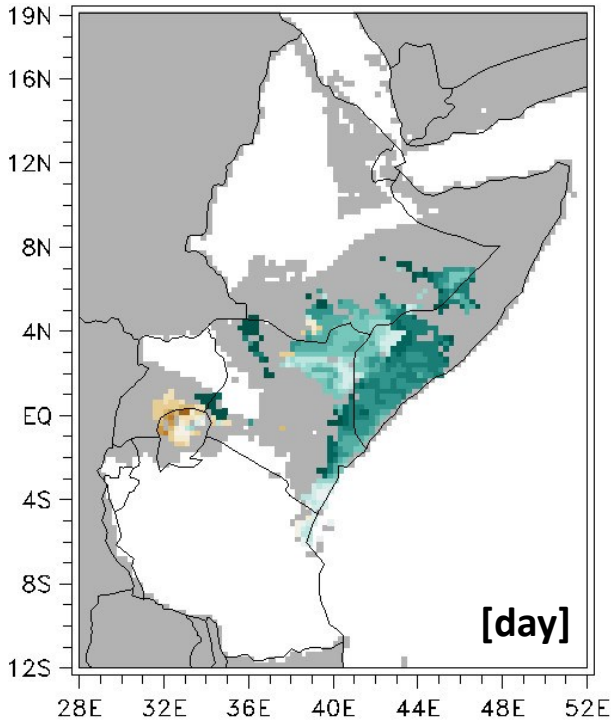


First of two rainy seasons
MPI

Rainy seasons(s) – historical simulation vs. observations

Onset



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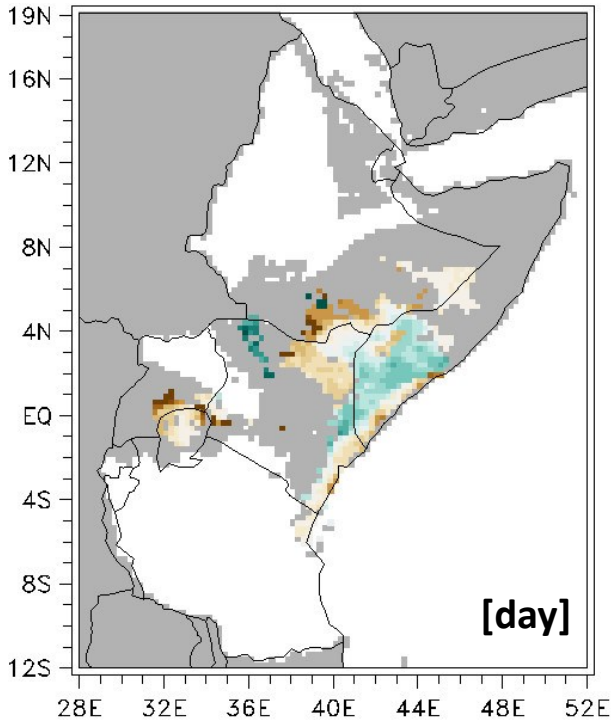

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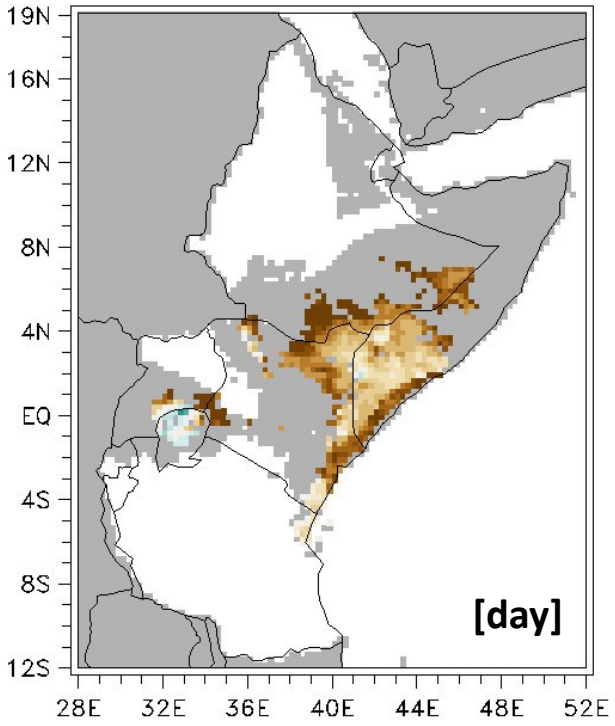
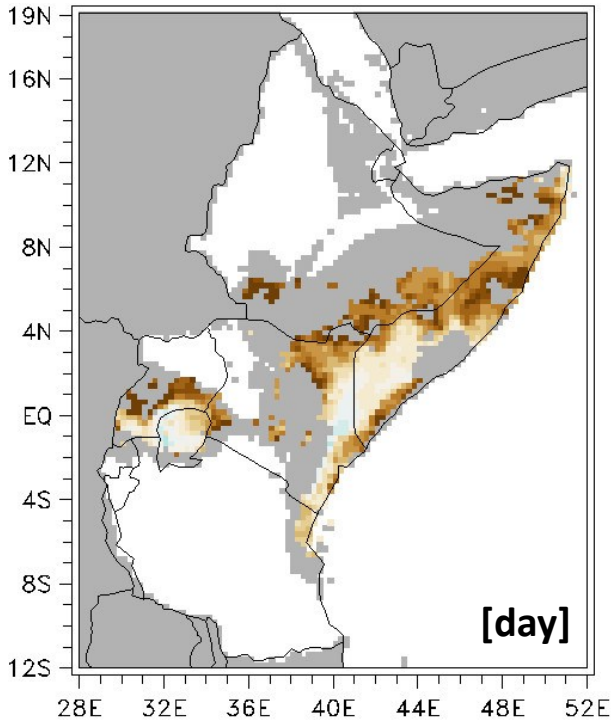


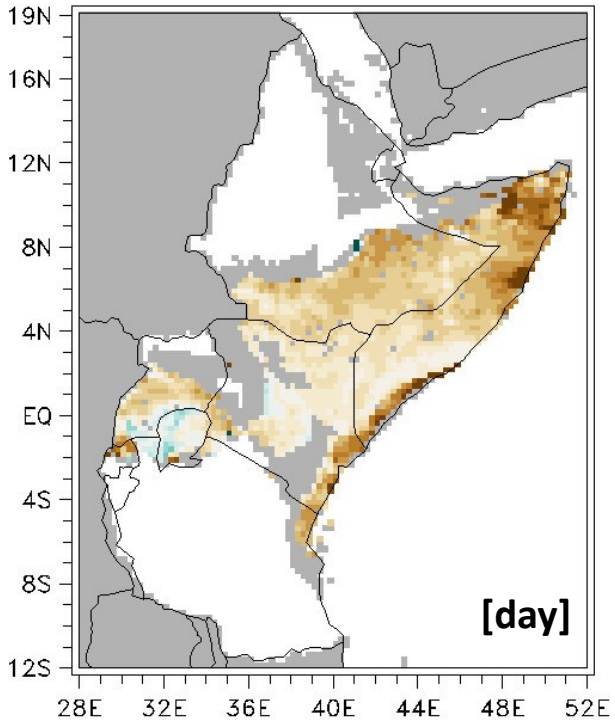
First of two rainy seasons
NCC

Rainy seasons(s) – historical simulation vs. observations

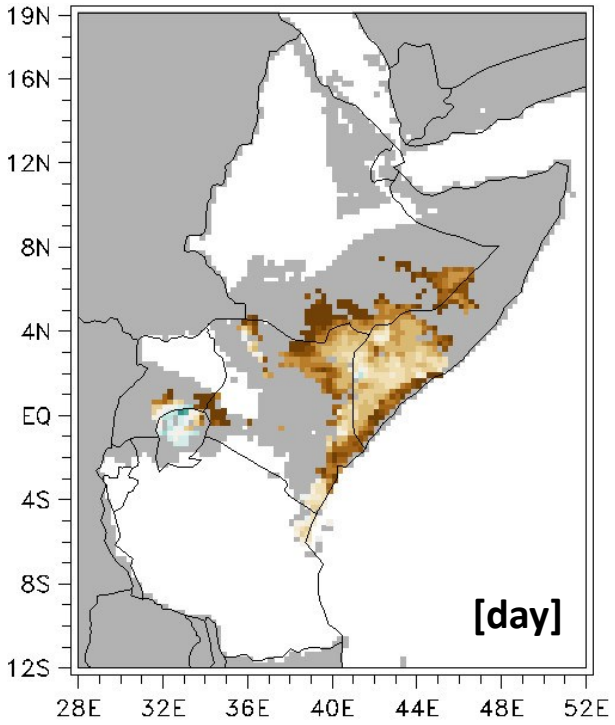
MOHC



MPI



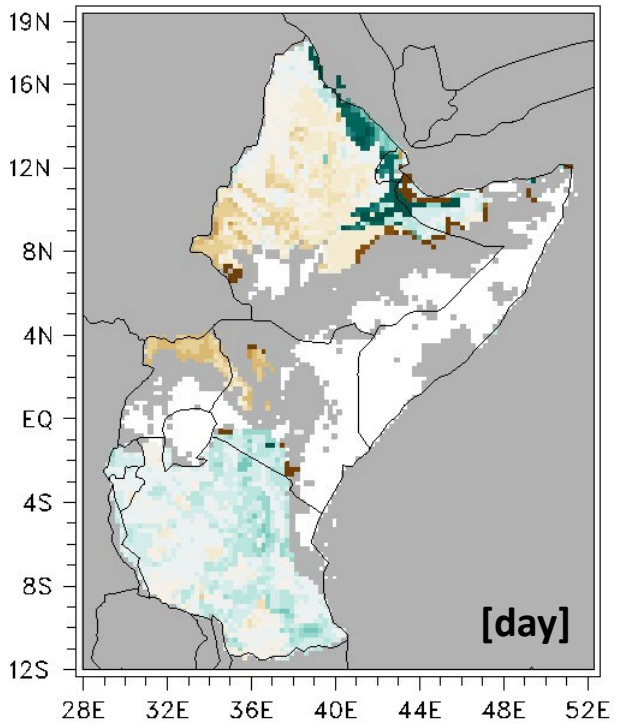
NCC



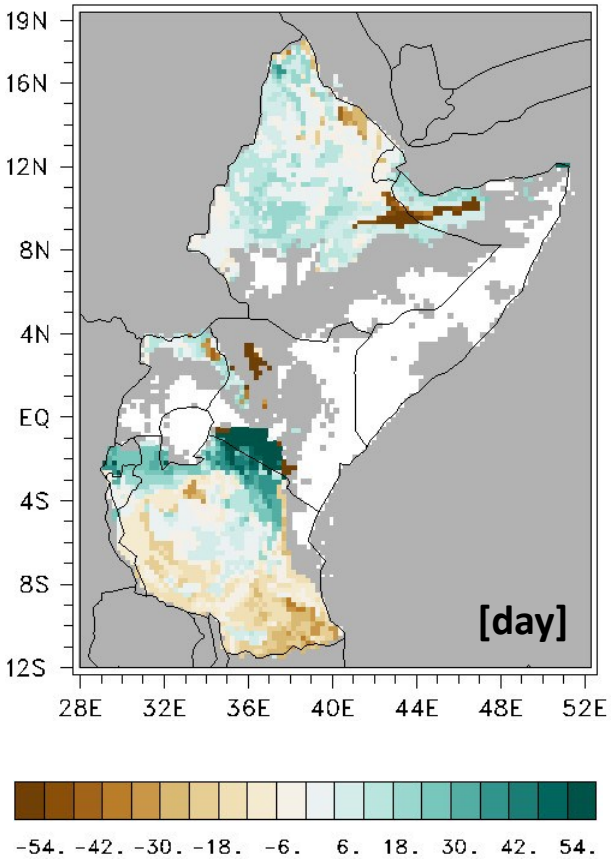
Length of the first of two rainy seasons

Rainy seasons(s) – future changes

Onset



Cessation



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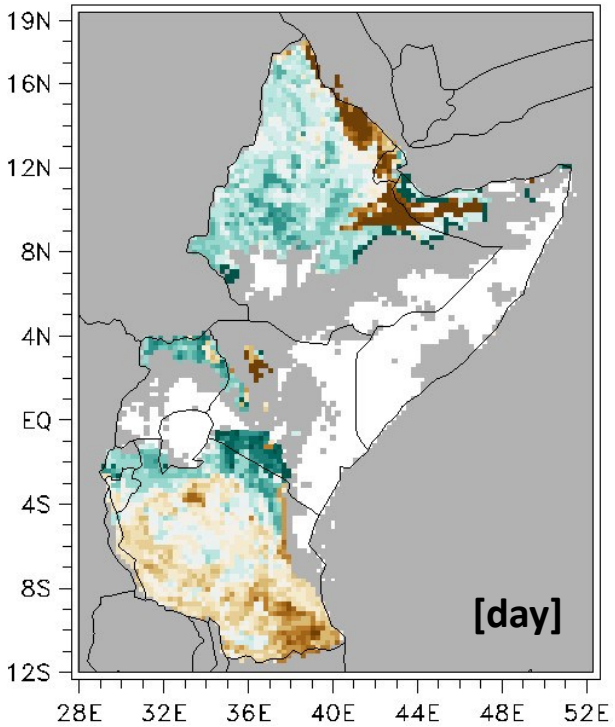
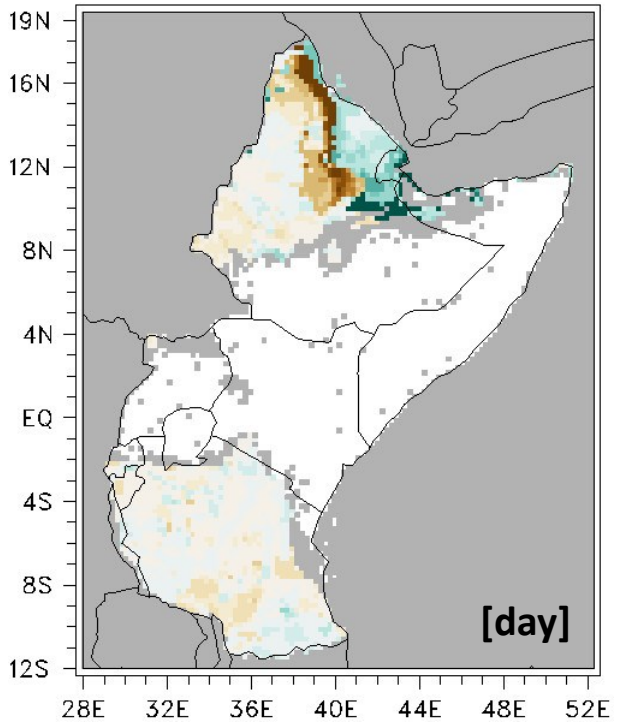


One rainy season

MOHC

Rainy seasons(s) – future changes

Onset



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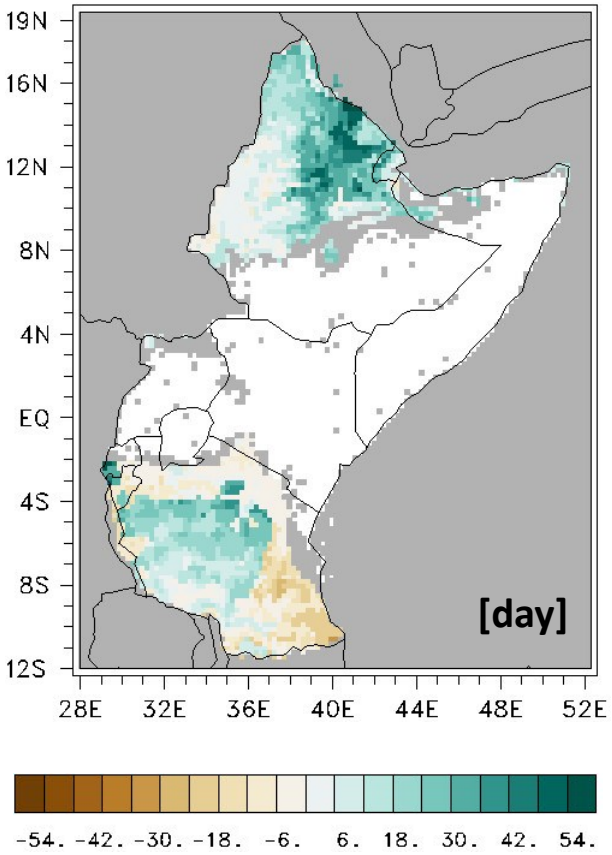

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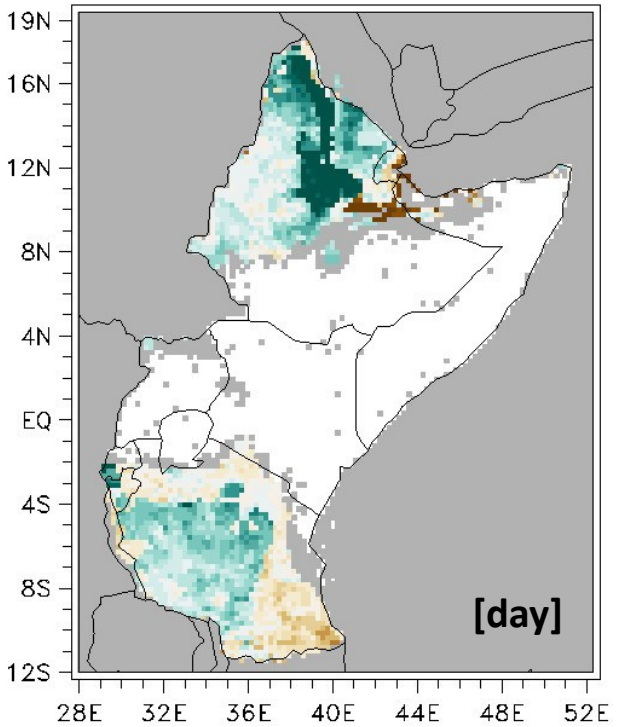
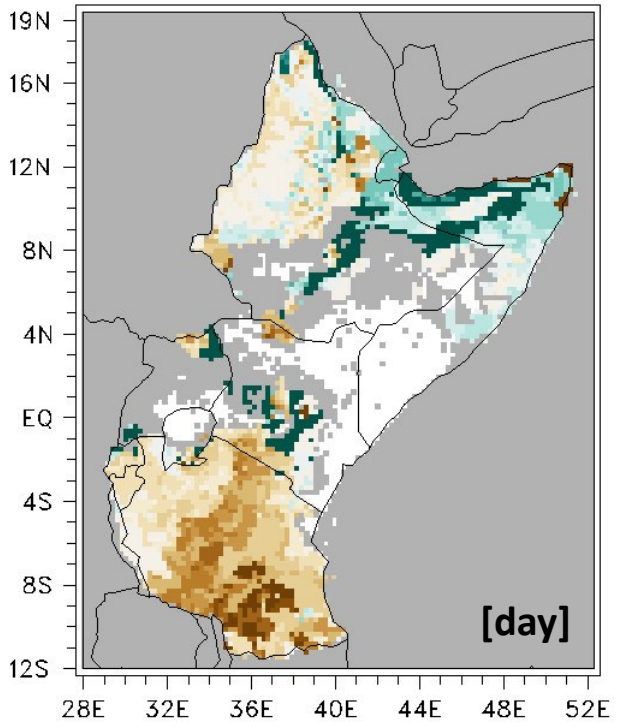


One rainy season

MPI

Rainy seasons(s) – future changes

Onset



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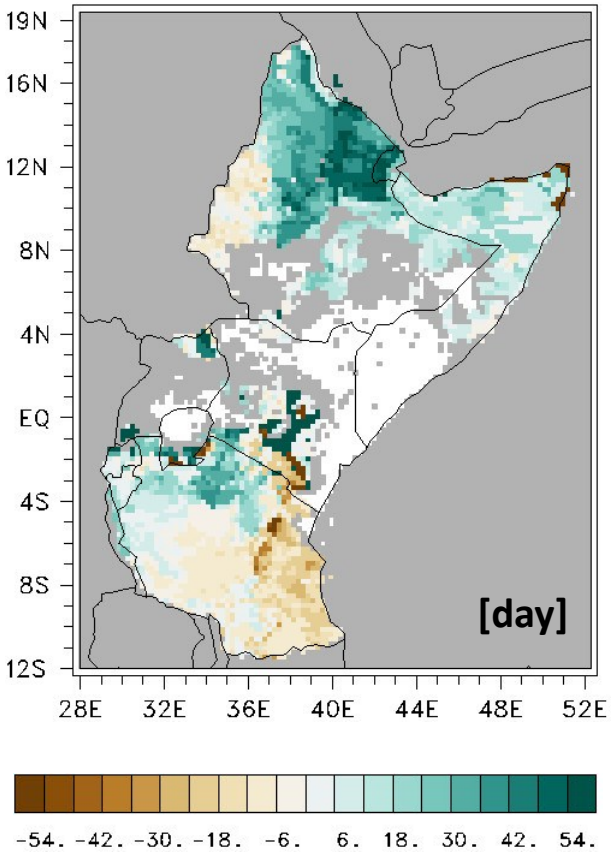

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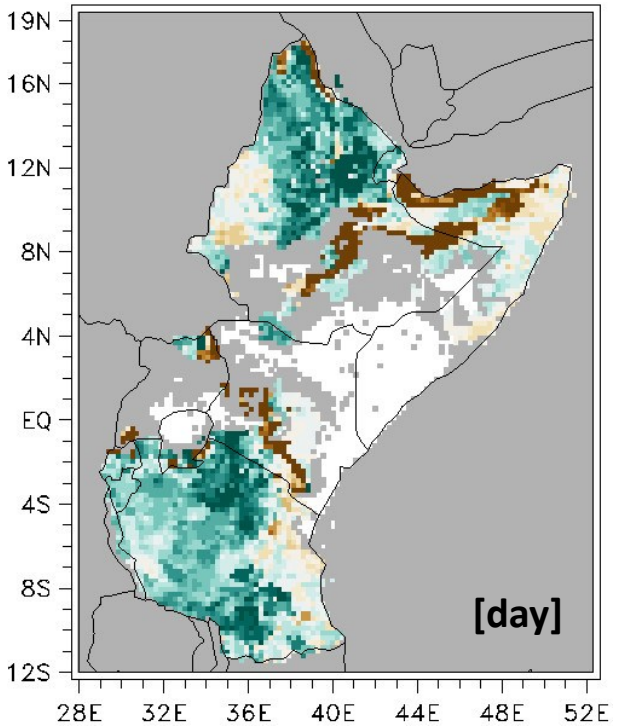
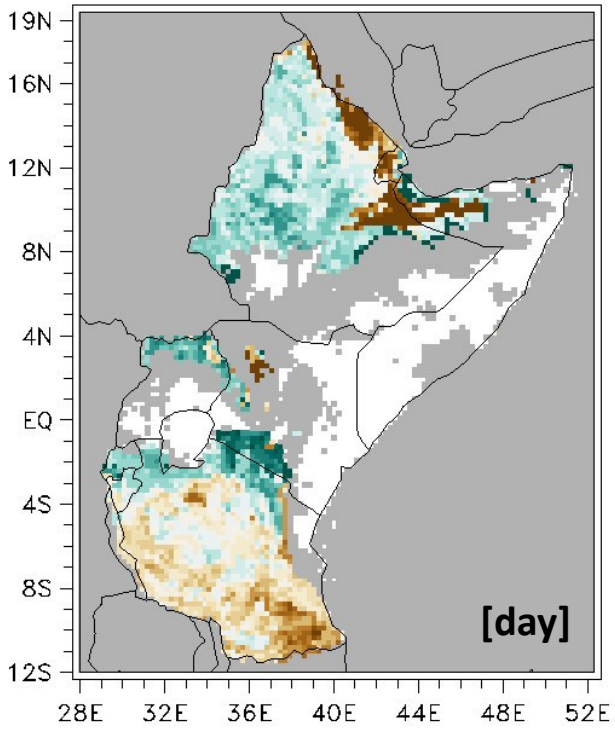


One rainy season

NCC

Rainy seasons(s) – future changes

MOHC



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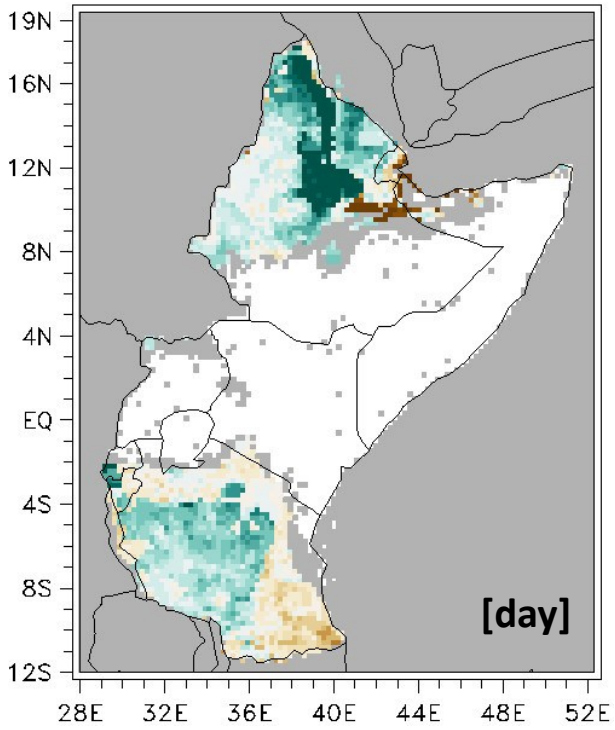

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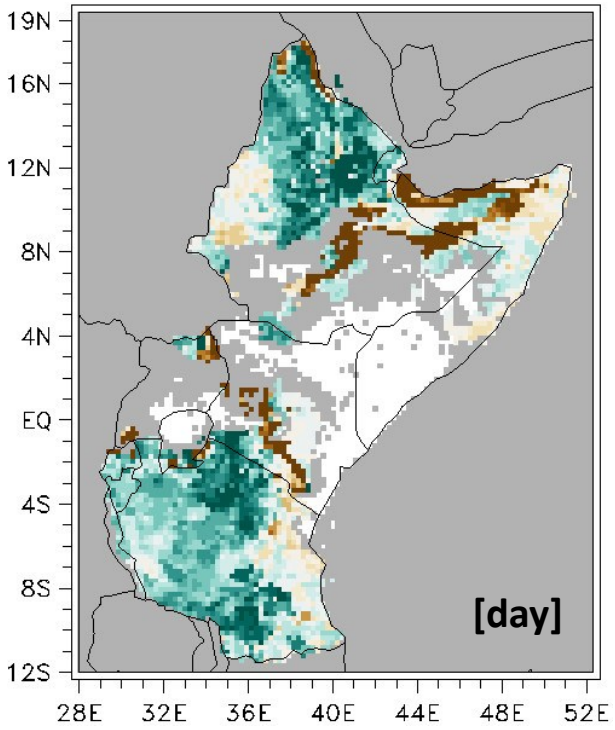
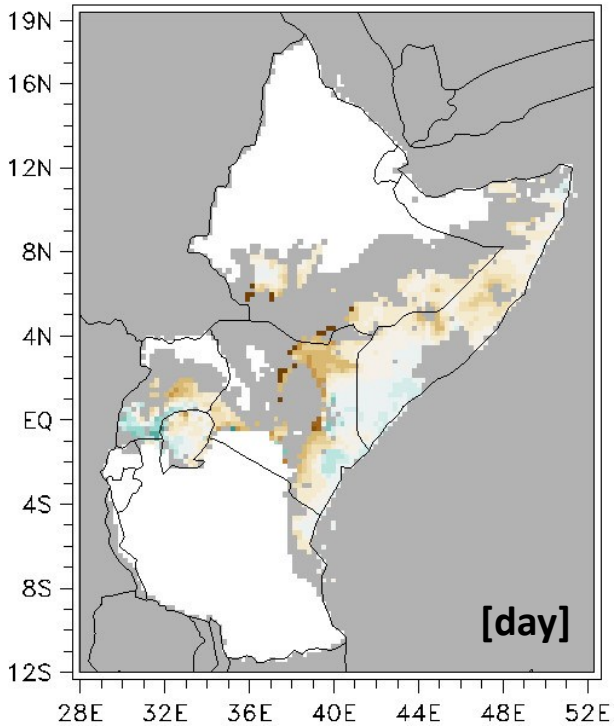


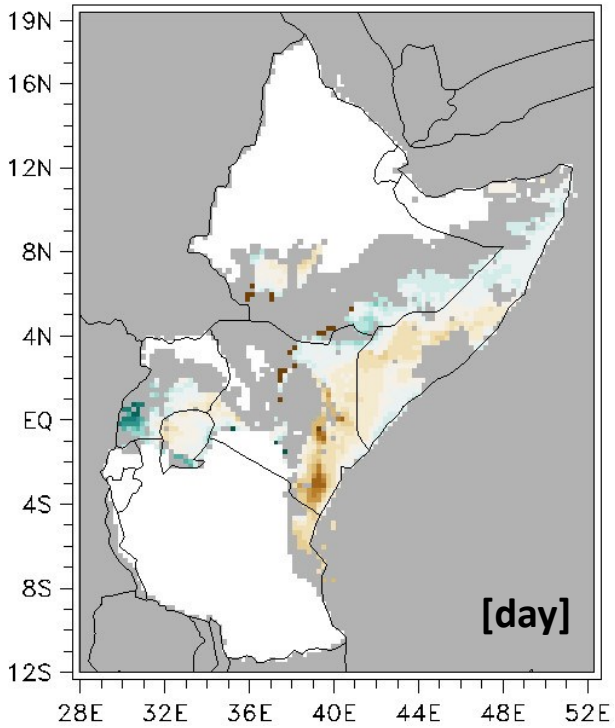
Length of one rainy season

Rainy seasons(s) – future changes

Onset



Cessation



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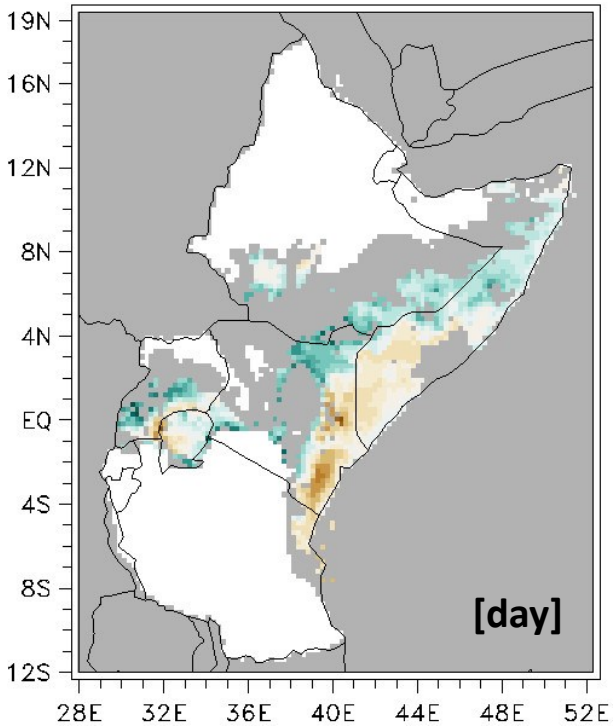
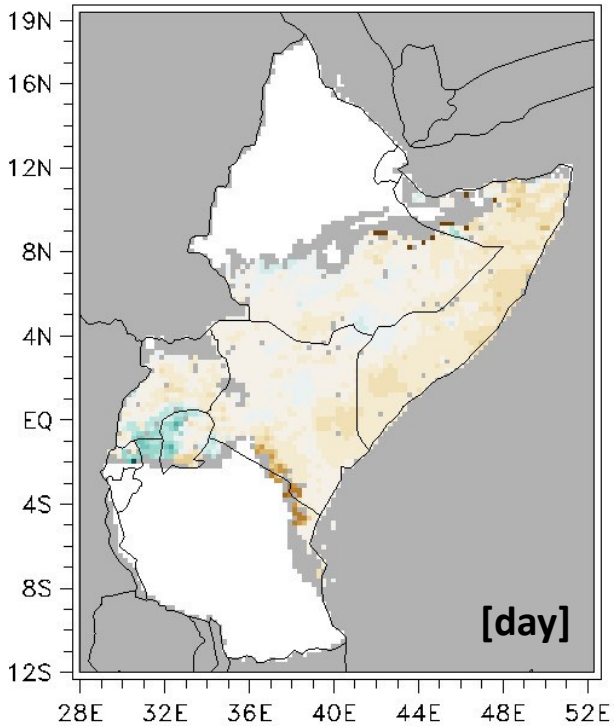


First of two rainy seasons
MOHC

Rainy seasons(s) – future changes

Onset



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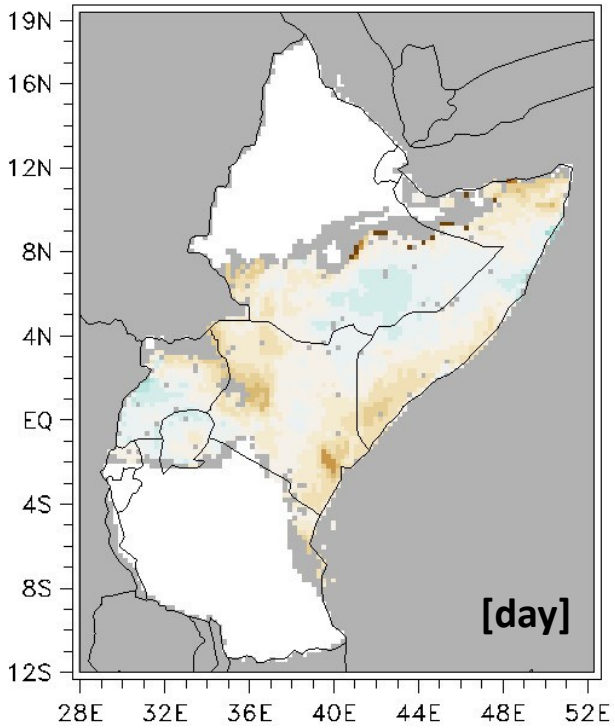

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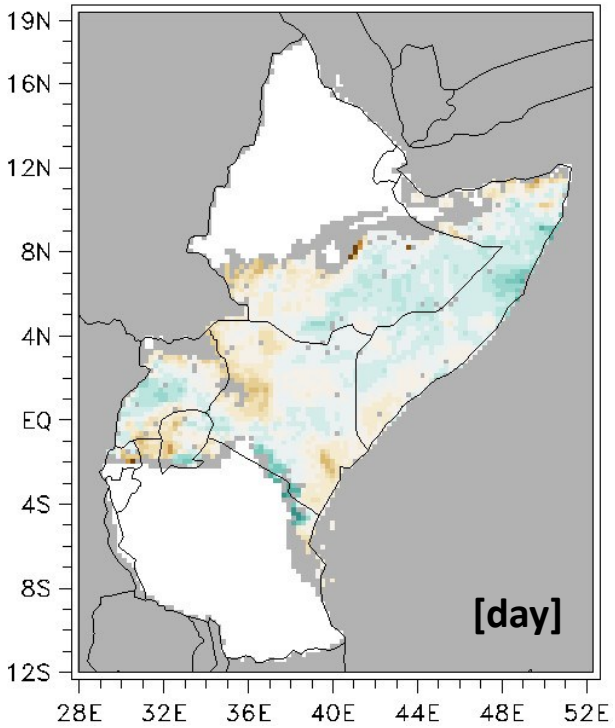
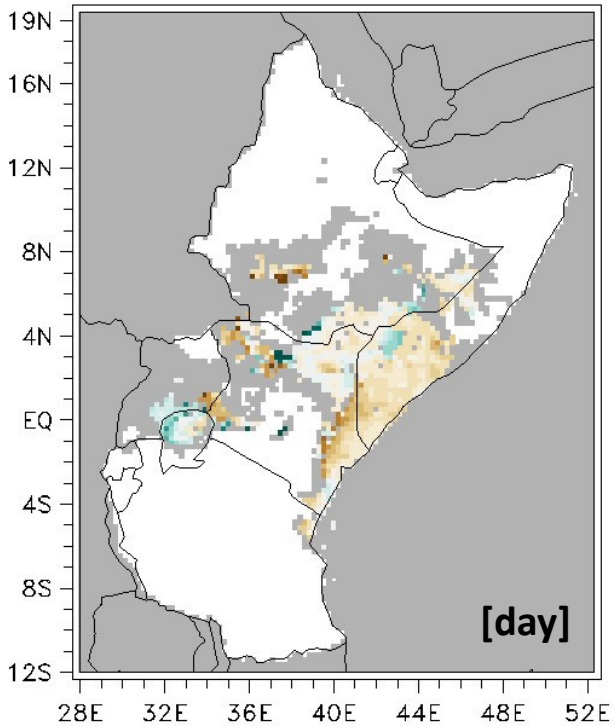


First of two rainy seasons
MPI

Rainy seasons(s) – future changes

Onset



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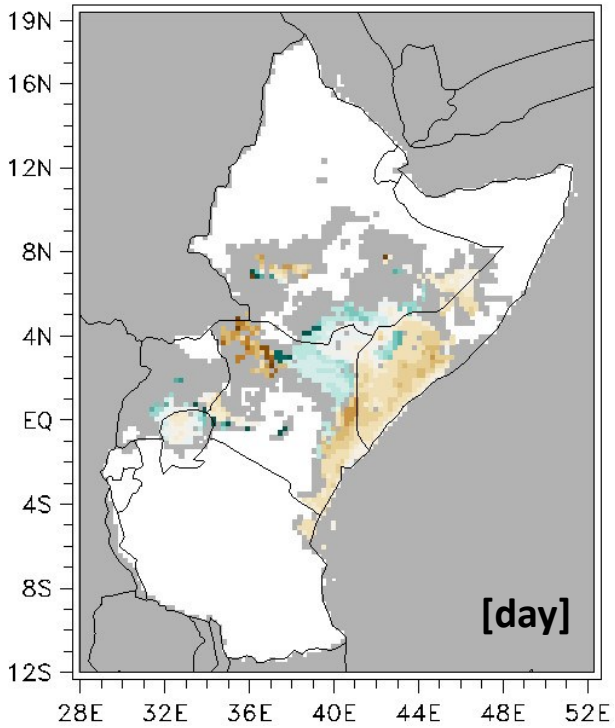

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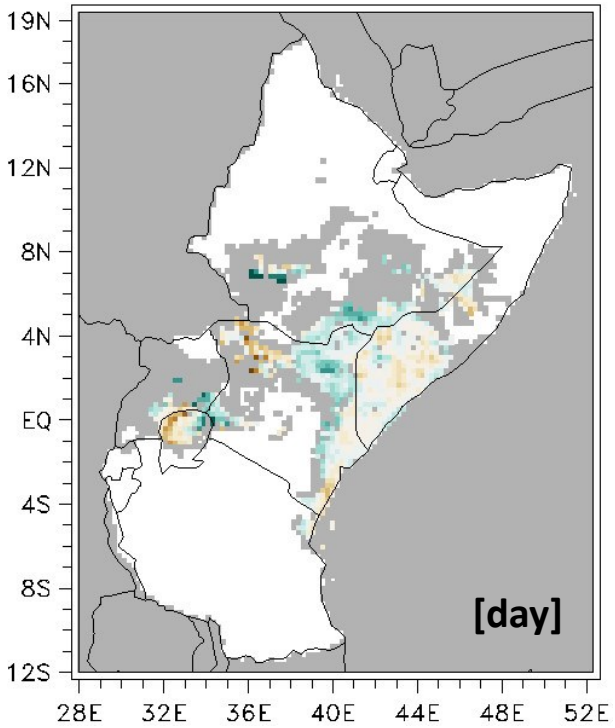
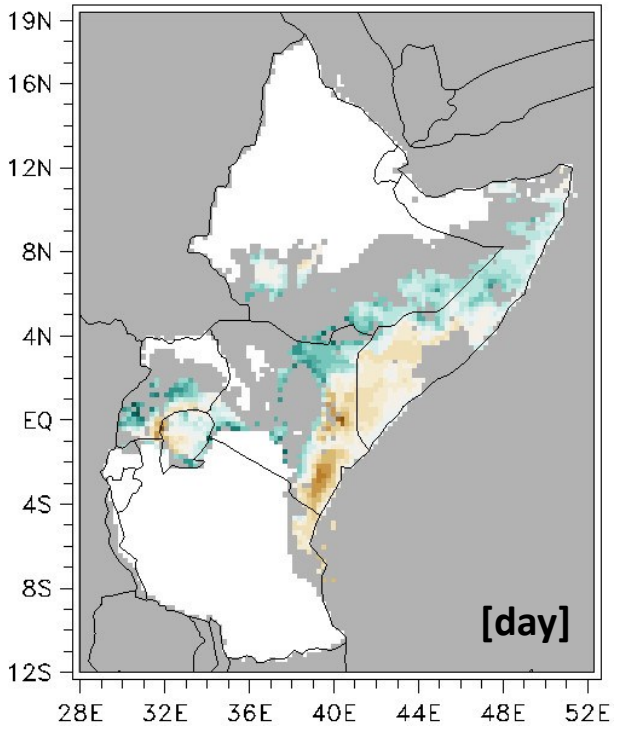


First of two rainy seasons

NCC

Rainy seasons(s) – future changes

MOHC



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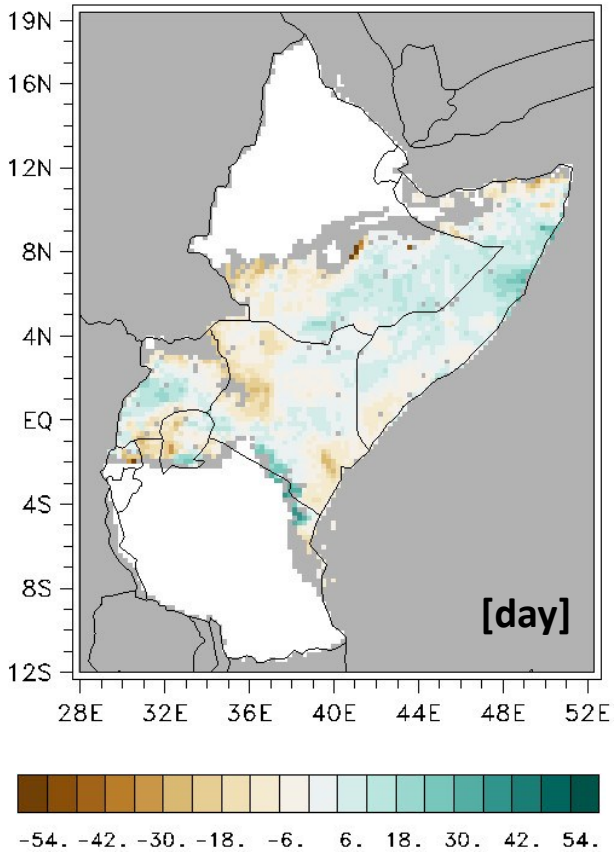

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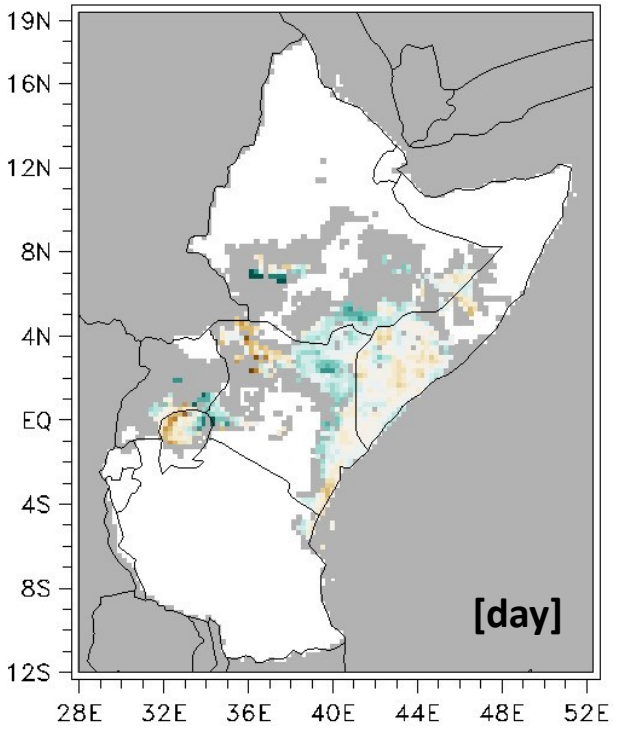

Length of the first of two rainy seasons

Conclusions

- All three selected RCMs simulate the seasonal variation of rainfall in East Africa realistically when forded with ERA-Interim
- All three RCMs show some regional deviations from observations specific to each RCM
- For all three RCMs the characteristics of the three driving GCMs govern the representation of the dominating rainy seasons in the RCMs, with one GCM giving much more realistic simulations for the regions with two rainy seasons
- The future climate changes simulated by the three driving GCMs govern the future changes of the dominating rainy seasons simulated by the three RCMs, resulting in a large uncertainty of the projected climatic changes

And what about Machine Learning?

Advancing bias correction of climate model output

- What is feasible; can biases in the timing of the rainy seasons be corrected based on the coupling to certain features of the large-scale circulation (that the GCM may not represent properly)?
- What is a valid way to go; would such a correction also be valid for a different climate state, and would such a correction constrain the simulation too much?

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