Characteristics of risky climate events:

Possible metrics for Kenya and Ethiopia

Outline

- Motivation: recent East African drought
    - Risky events vs extreme events
- Ethiopia: disparate thresholds
- Awash Basin: going beyond rainfall
- Application:
    - New metrics from a climate science lens
    - Incorporating socioeconomic thresholds to map regional and changing risk

Recent drought: Kenya

Kenya's Uhuru Kenyatta declares drought a national disaster

10 February 2017

Share

Kenya's president has declared the drought, which has affected as much as half the country, a national disaster.

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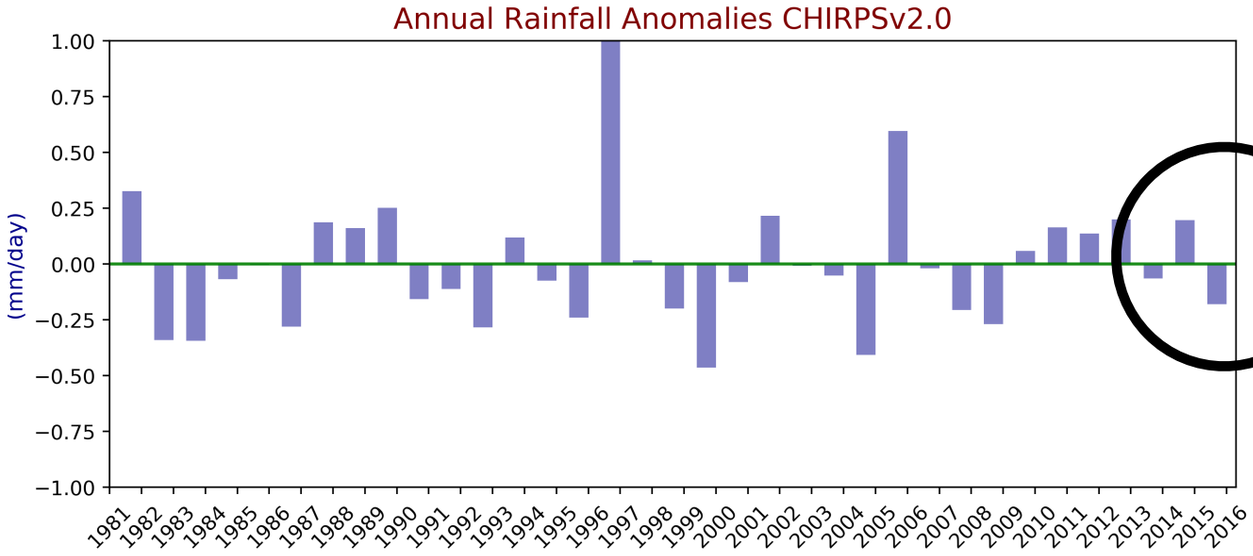
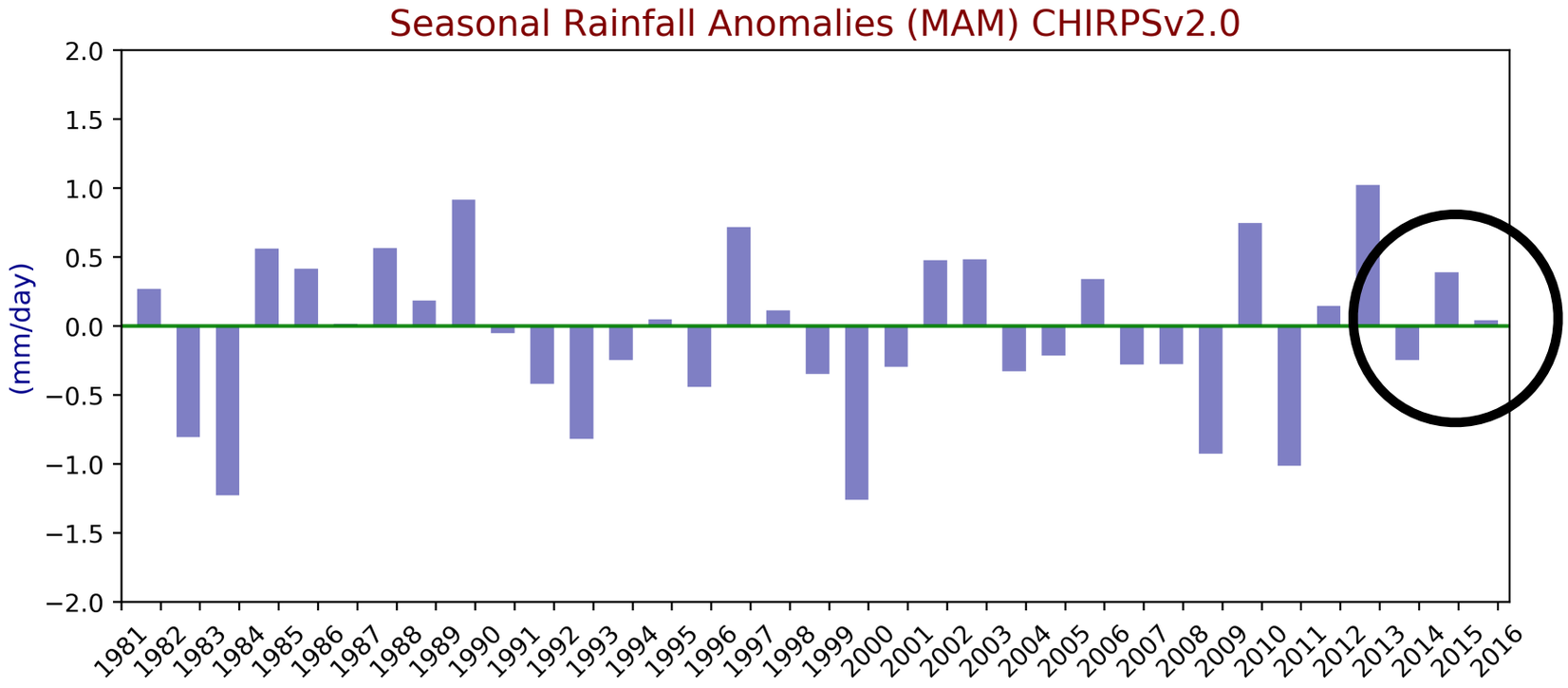
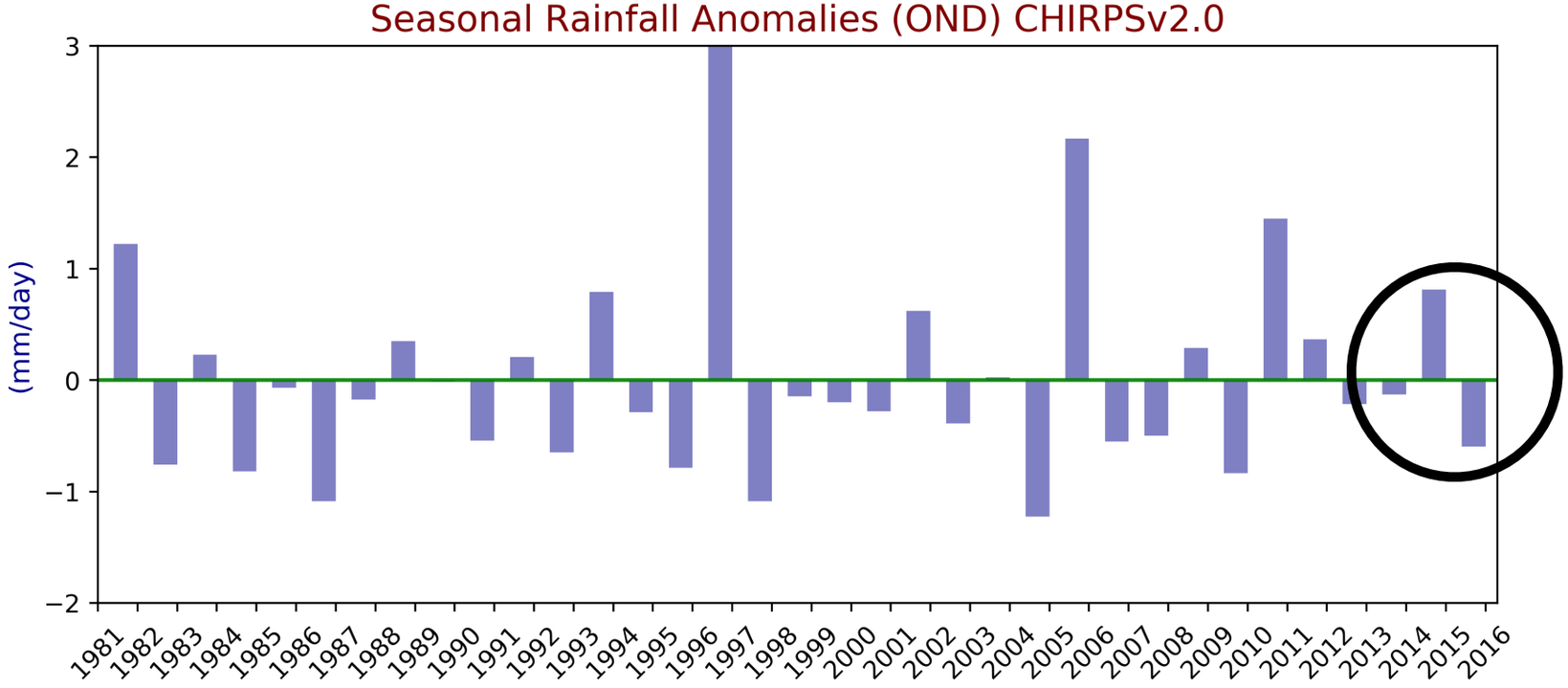


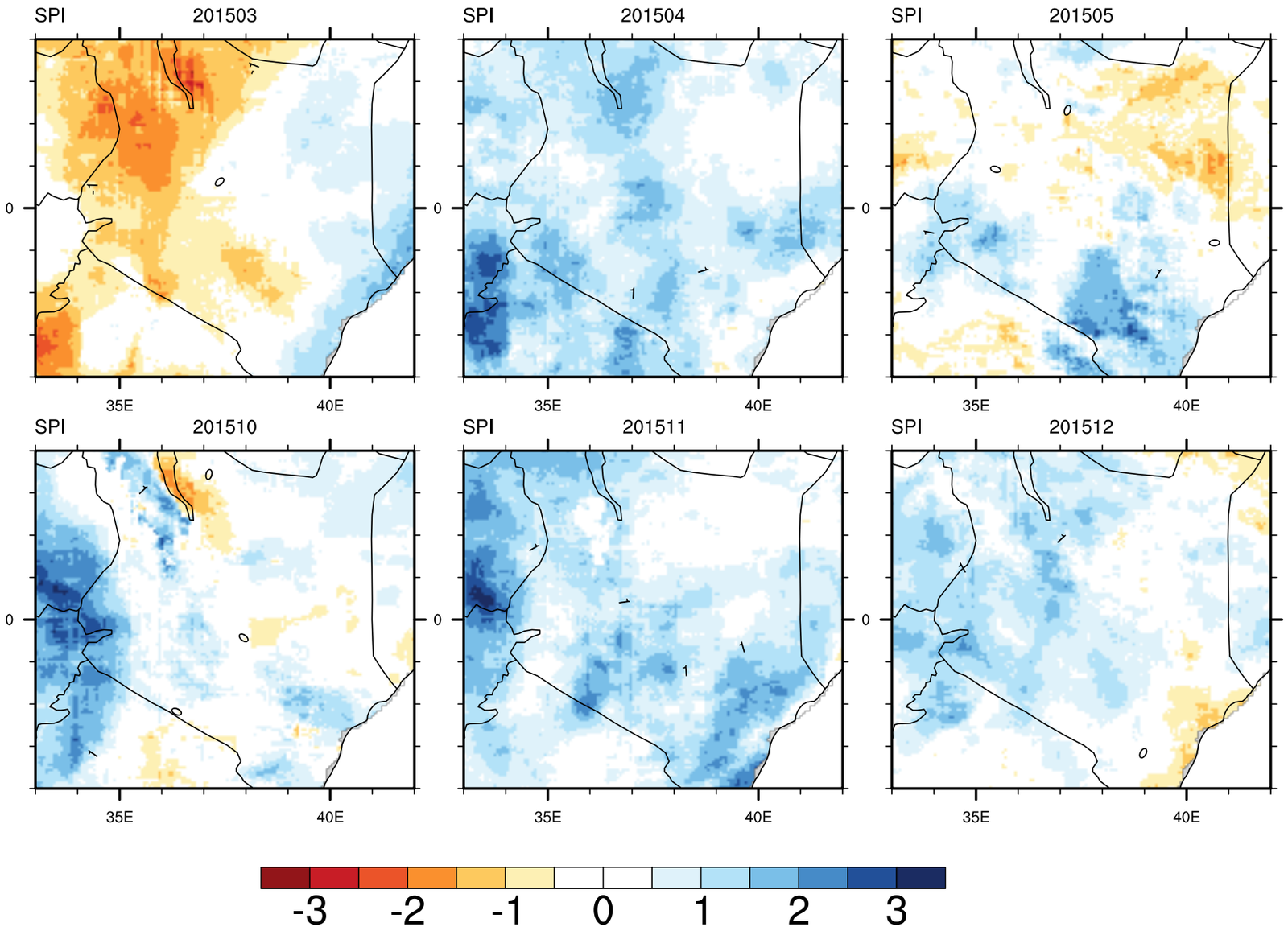
Recent drought: Kenya





Recent drought: Kenya

Standardised Precipitation Index: 2015



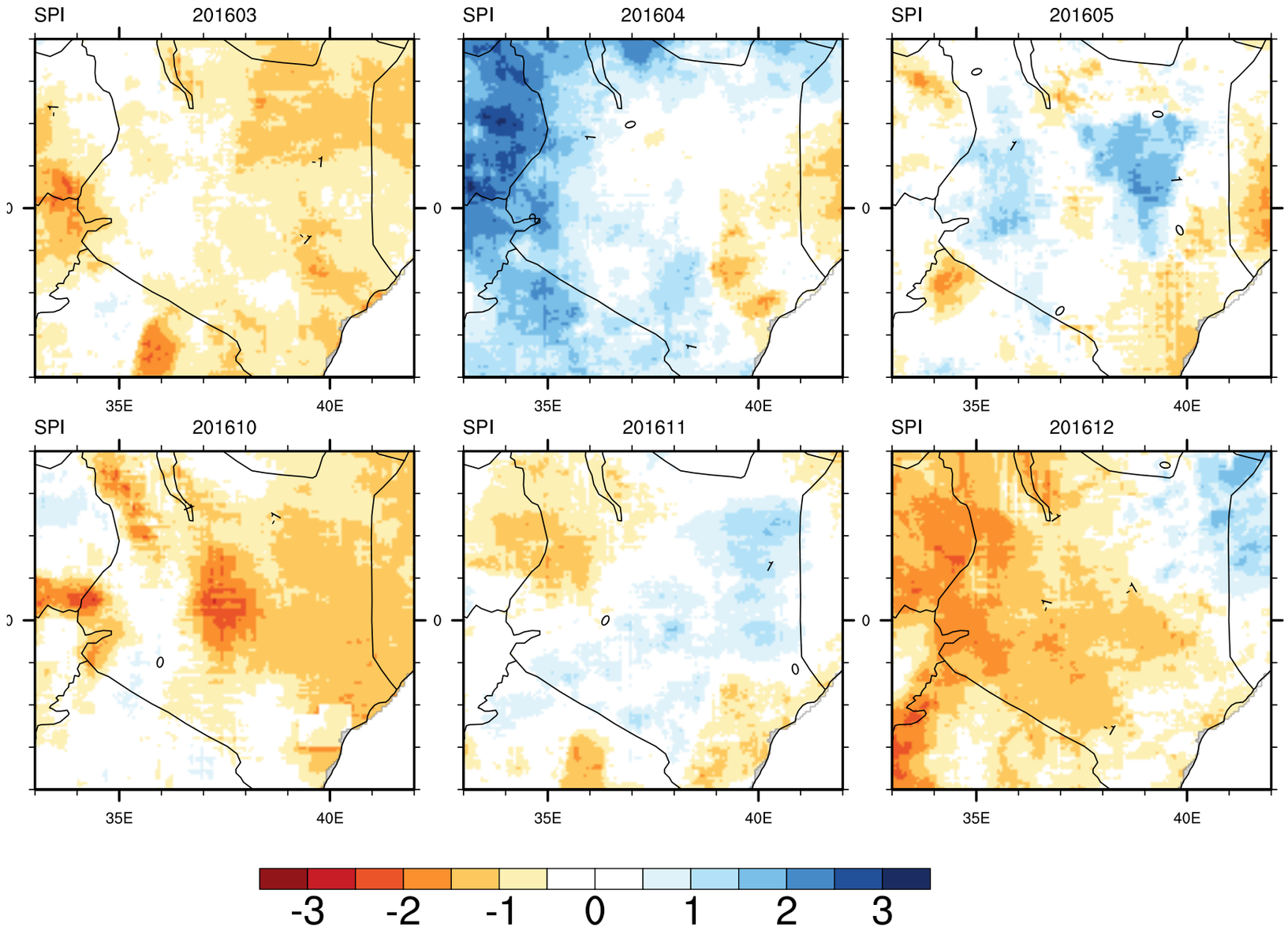
[+,-]2.00 and above/below:
exceptionally [wet,dry]
[+,-]1.60 to 1.99: extremely [wet,dry]
[+,-]1.30 to 1.59: severely [wet,dry]
[+,-]0.80 to 1.29: moderately [wet,dry]
[+,-]0.51 to 0.79: abnormally [wet,dry]
[+,-]0.50: near normal

Chirps 1981-2016 rain rates

- SPI (a measure of abnormal dryness) not extreme in 2015
- March failed in certain key regions
- OND slightly wetter than average in certain areas

Recent drought: Kenya

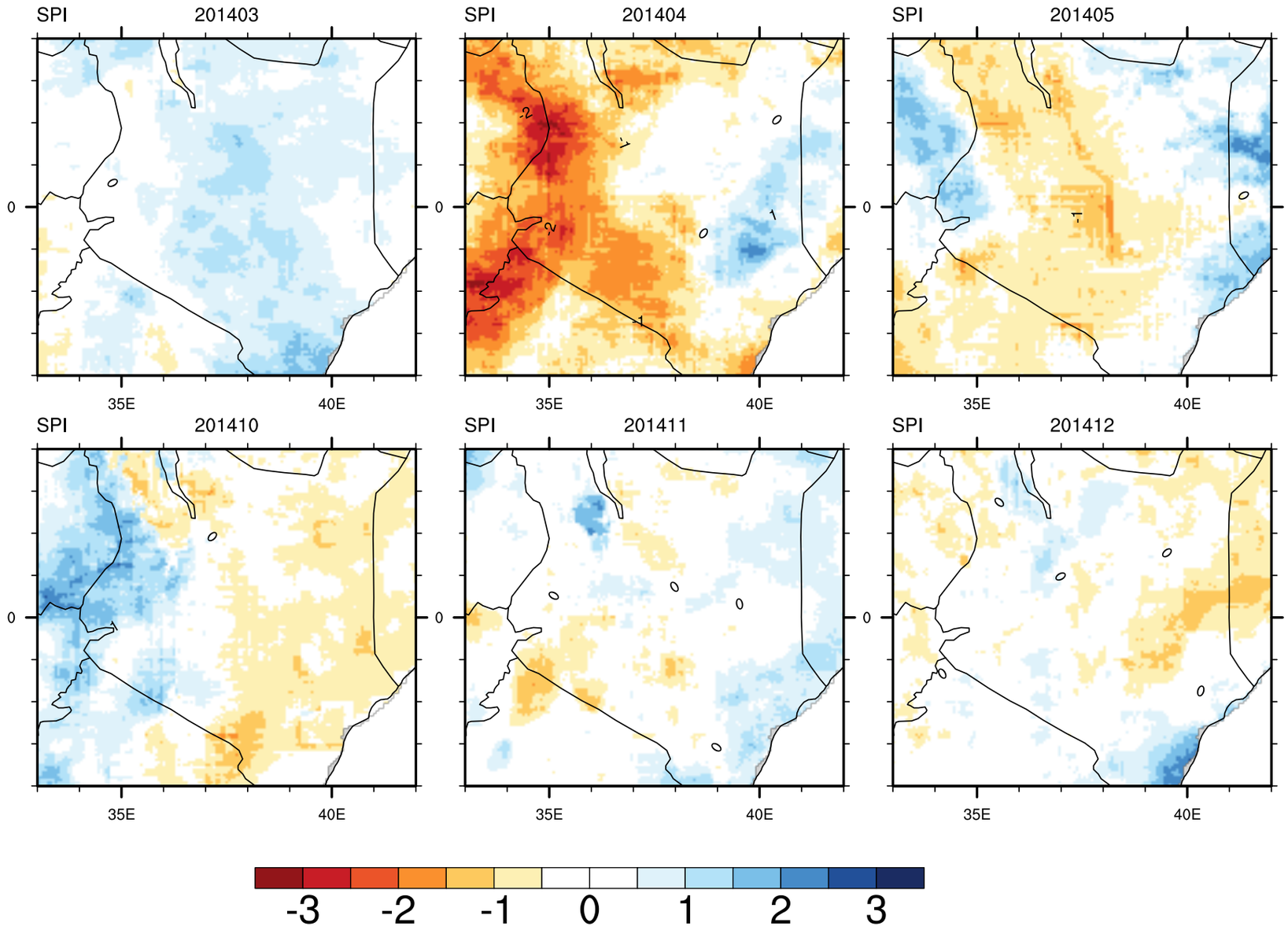
Standardised Precipitation Index: 2016



- March average or dry for certain regions (notably northeast Kenya)
- OND has patches of SPI < -2

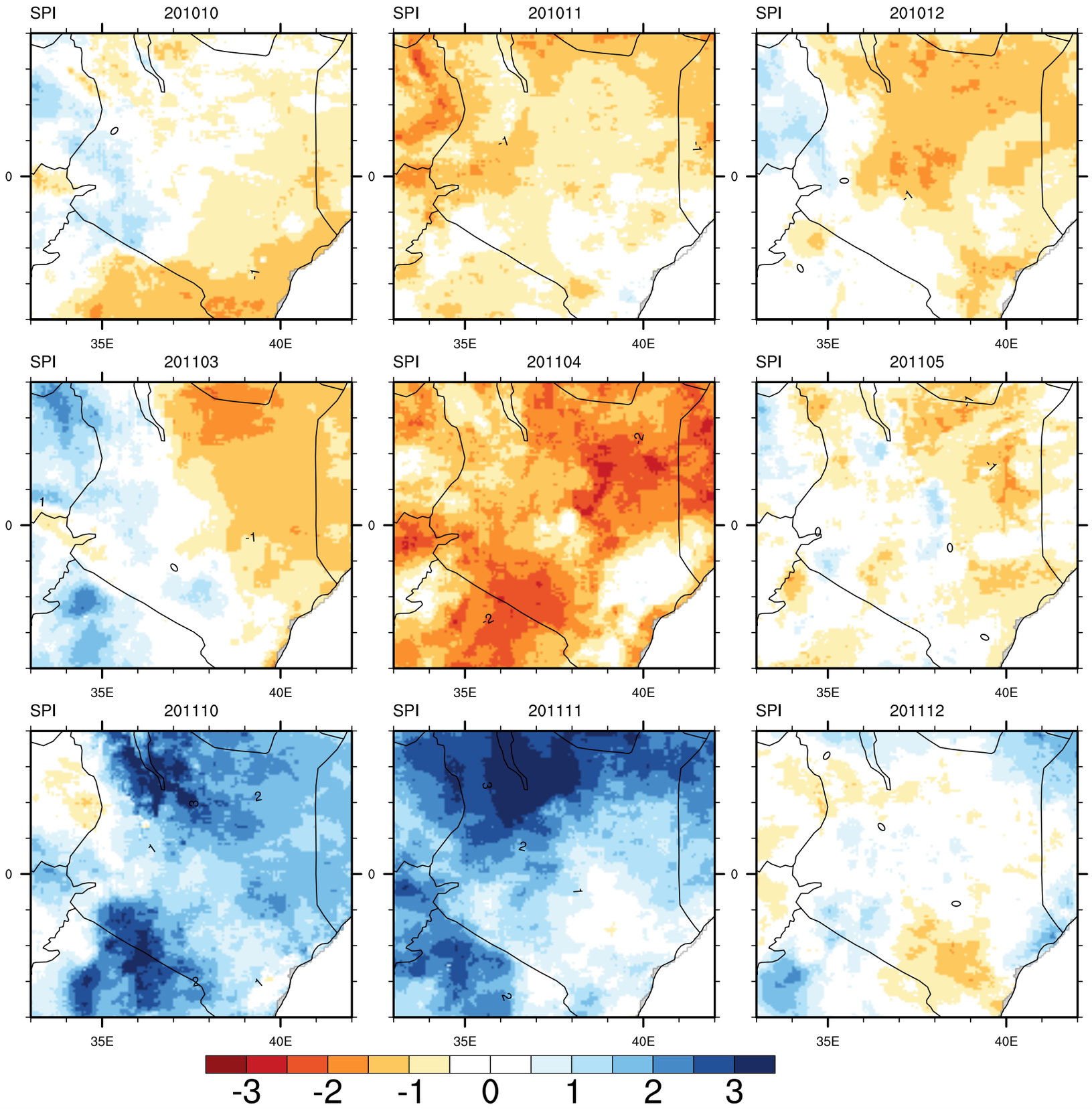
Recent drought: Kenya

Standardised Precipitation Index: 2014



- Looking back further to 2014:
  - Not particularly wet, with areas that are extremely dry in April
  - Potentially a “failed” rainy season in these areas

Recent drought: Kenya



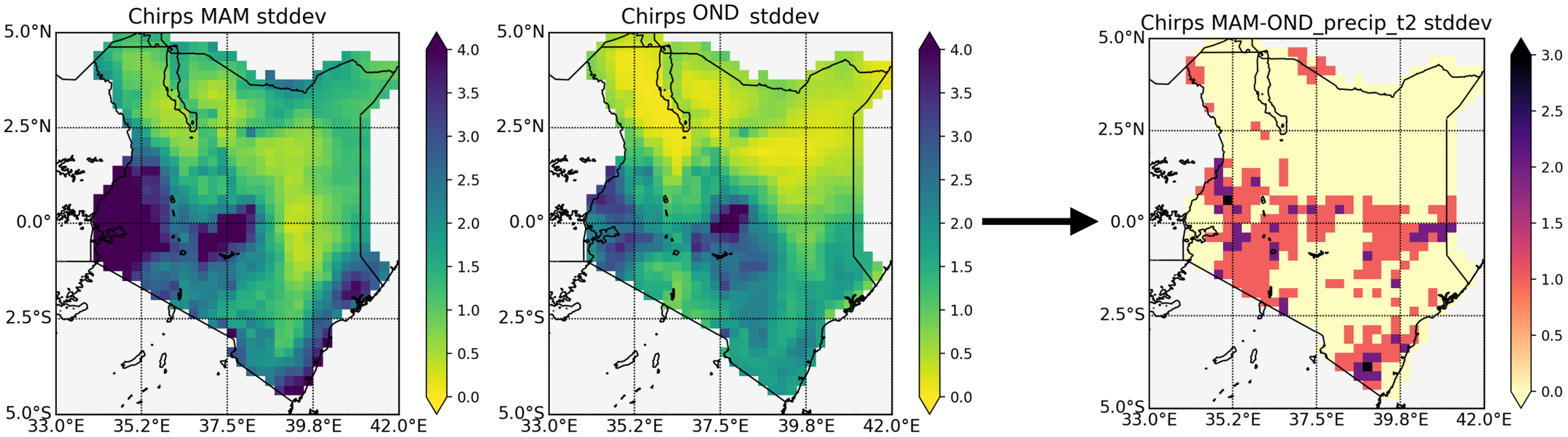
- Maps of SPI for 2014-2016 don't look as extreme in magnitude or spatial extent compared to an event like 2010/2011
- Not extreme in the short term but prolonged
- Particular areas may be less resilient

Recent drought: Kenya

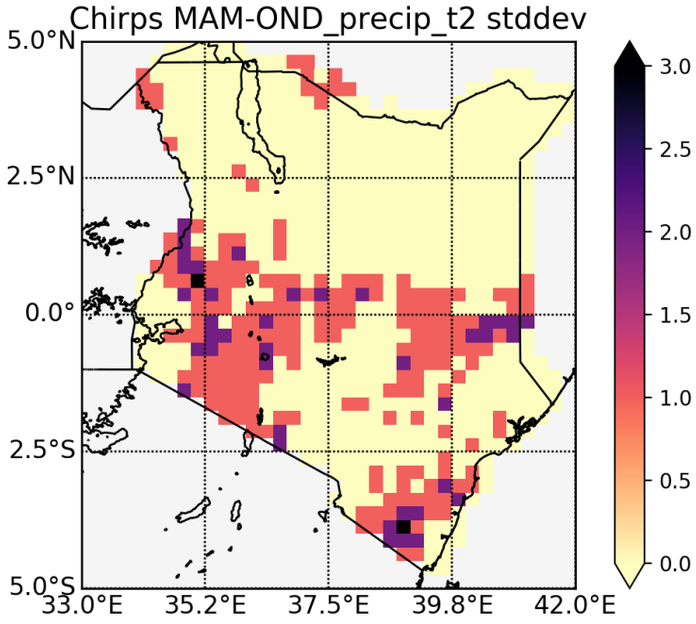
- Successive but not extreme dry events may be just as damaging as extreme events that are less persistent
- Average rainfall is not a good gauge of risk events:
  - Spatial heterogeneity may be important
  - What regions are prone to particular events?
  - What are the thresholds that should be used in different areas?
- Need to better understand how low rain amounts affect different areas at different times of the year:
  - Is March rainfall particularly important, and how often does it fail?

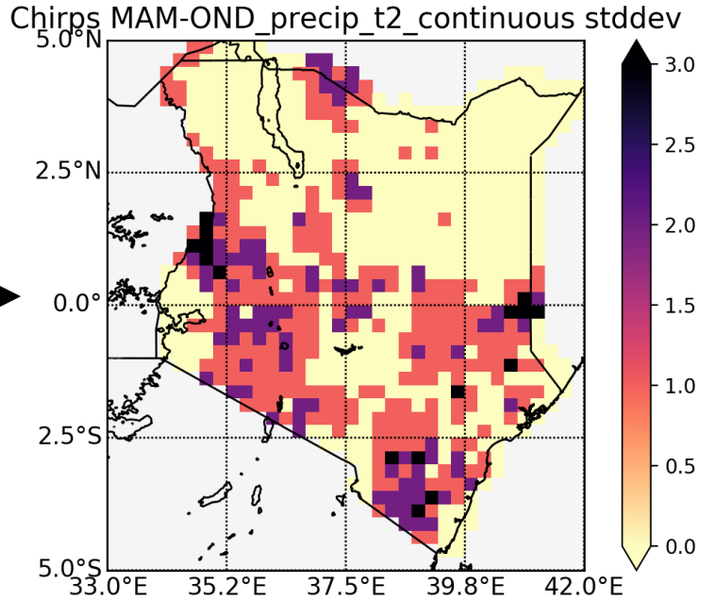
Kenya: consecutive dry rainy seasons

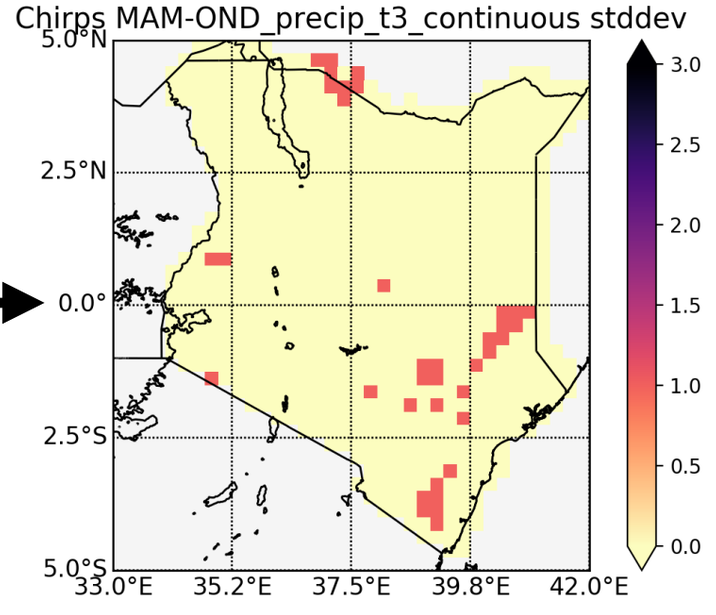
- Using the Chirps v2.0 merged satellite gauge rainfall (mm/day rain rates)
- Set a threshold for each grid point (average, one standard deviation over the average, percentiles, or a given value)
- Flag every time this threshold is crossed (above or below) at each grid point over time for given the given season(s) or month(s)
- Set a repeat threshold and count how often the threshold has been crossed consecutively
- Example: How many times is a dry MAM followed by a dry OND in the same year with the threshold of one standard deviation below the average?

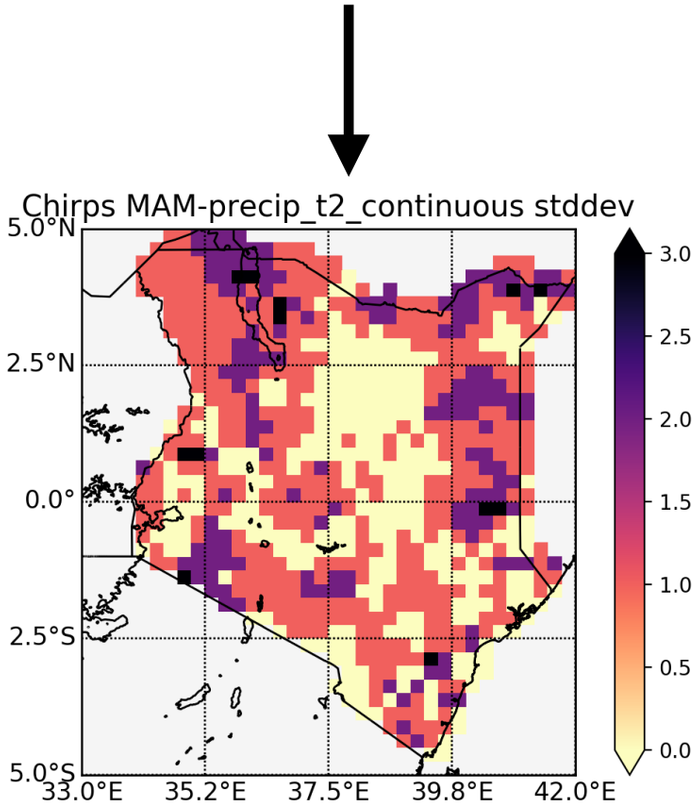


Kenya: consecutive dry rainy seasons



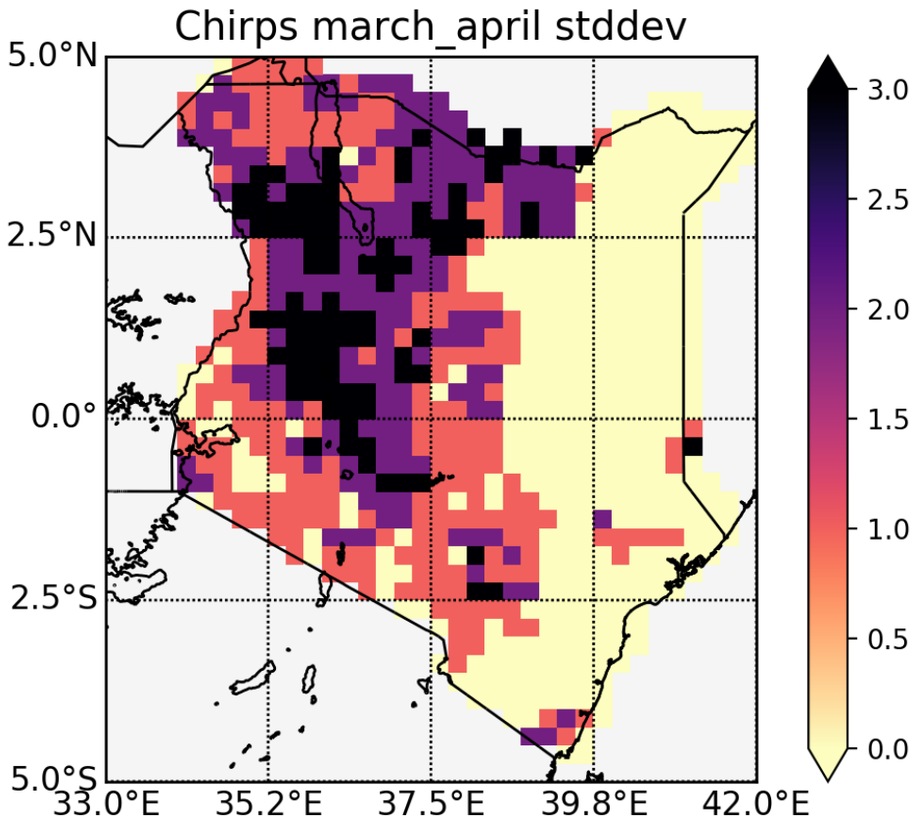


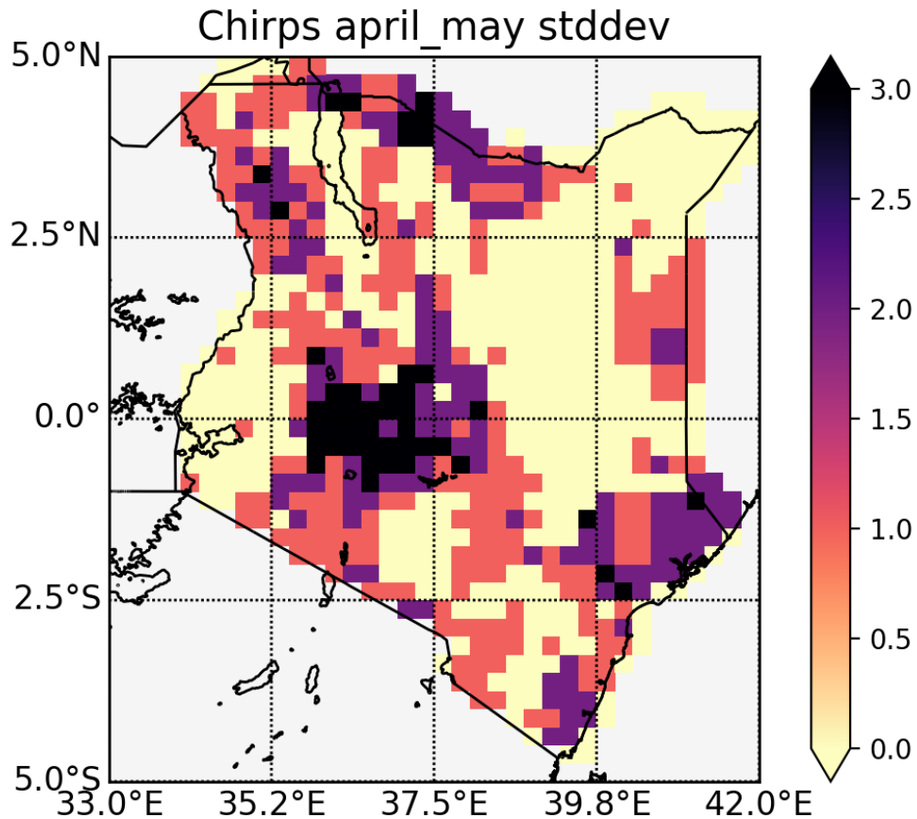




- A dry MAM followed by a dry OND is primarily a southern Kenyan phenomenon
- When the seasonal ordering isn't a criteria more area is covered
- More than two consecutive seasons isn't very common with this threshold
- If OND isn't a major rainy season does a dry OND matter as much?
  - Successive dry MAM seasons have been experienced across Kenya

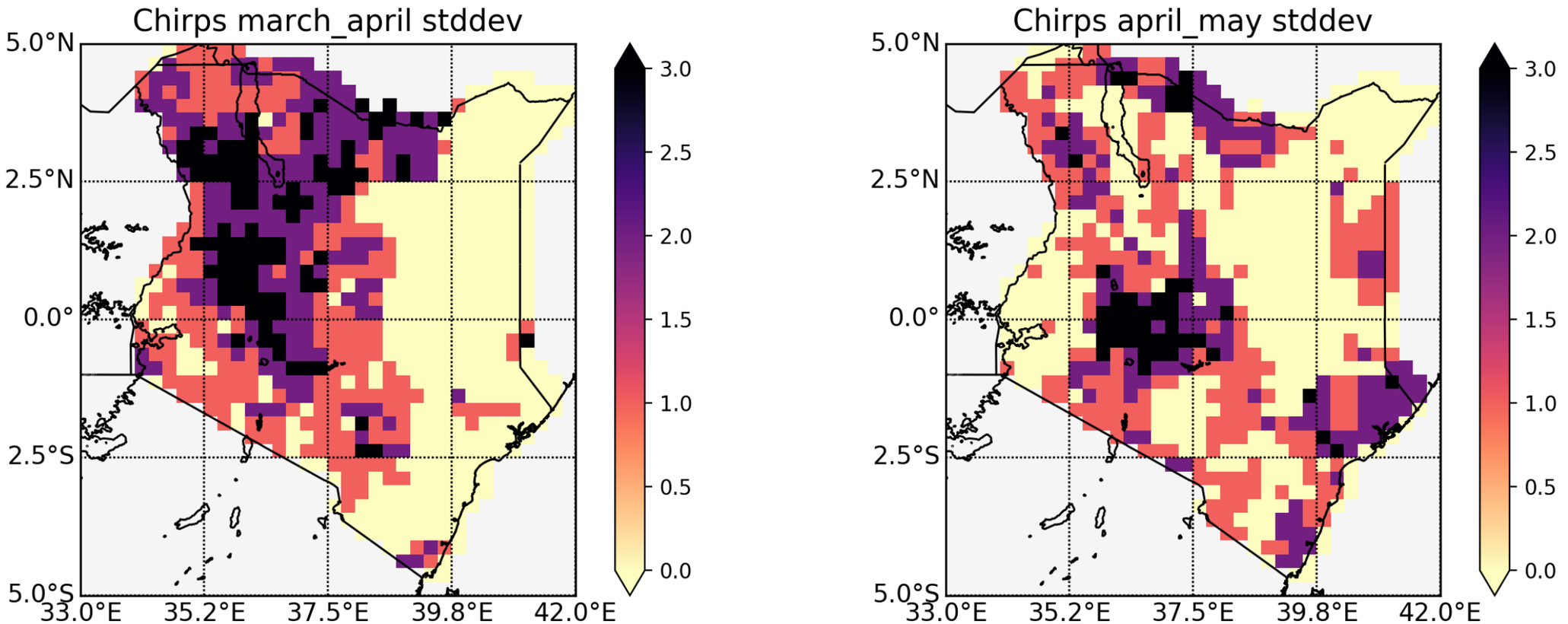
Kenya: short rainy seasons





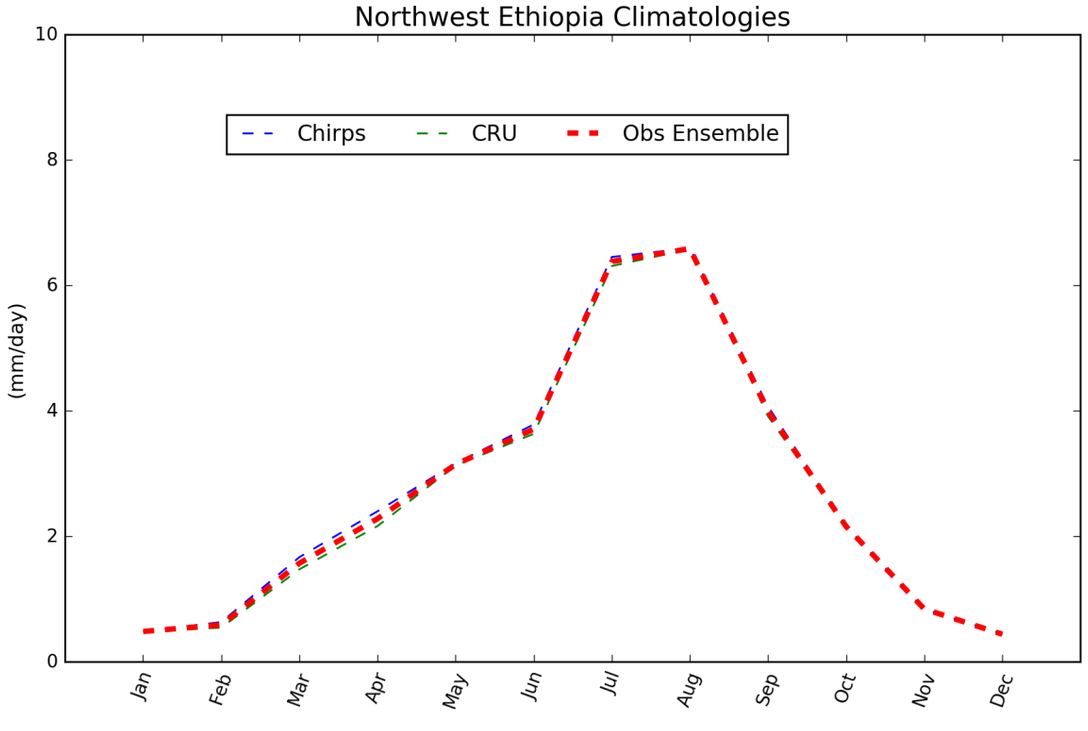
- We know that dry MAM, and consecutive dry MAM seasons are widespread
  - What are the characteristics of these dry seasons: do they start late, or end early?

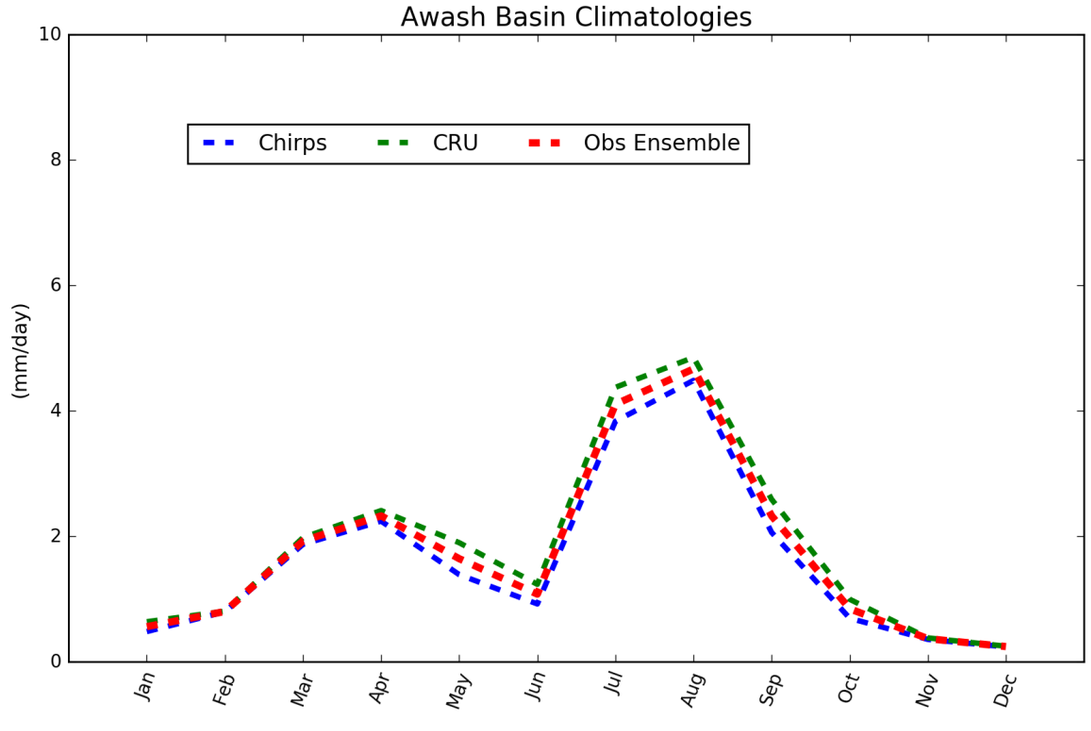
Kenya: short rainy seasons

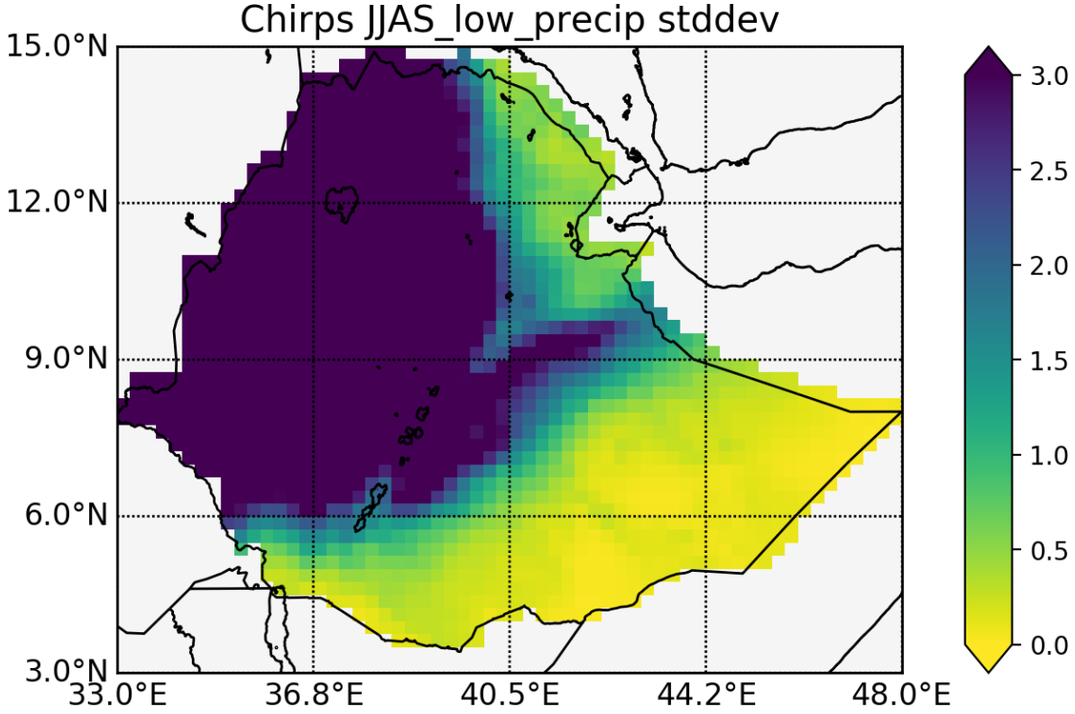


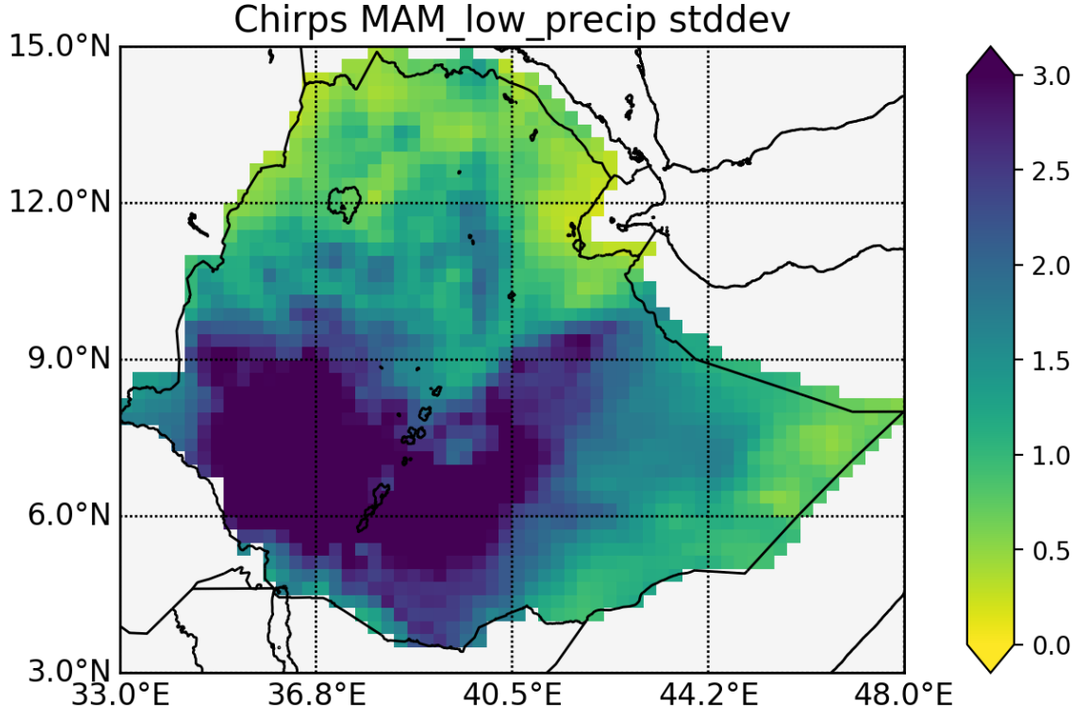
- Different regions are subject to different types of successive or prolonged events
- Using arbitrary thresholds can provide useful insight for understanding regional climate variability
  - Breaking up the MAM long rains to understand the main drivers in different parts of the season -> may also be useful to extend to a larger region
- Need to experiment with better thresholds…

Ethiopia: what threshold?









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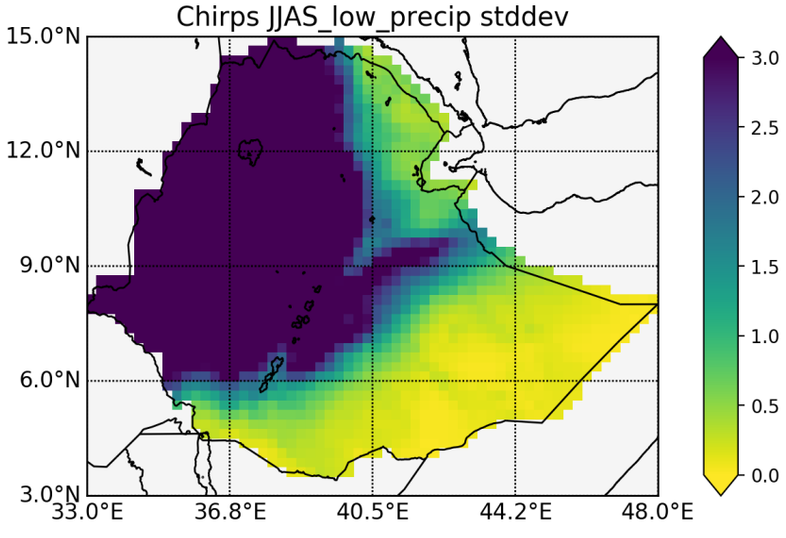
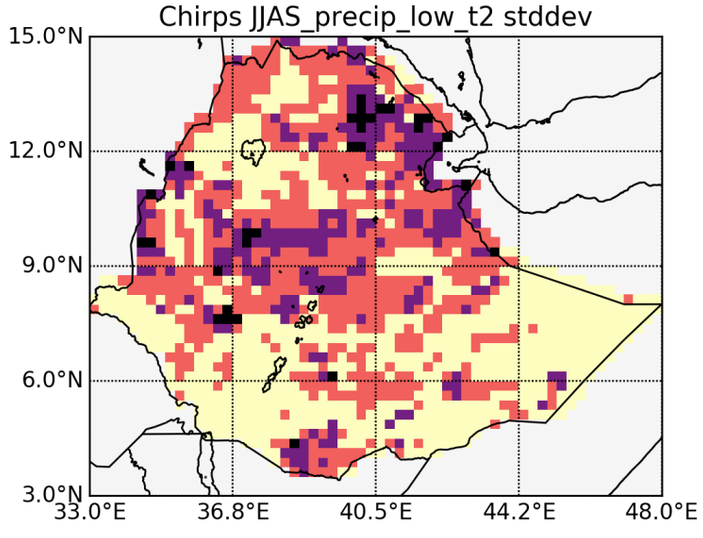
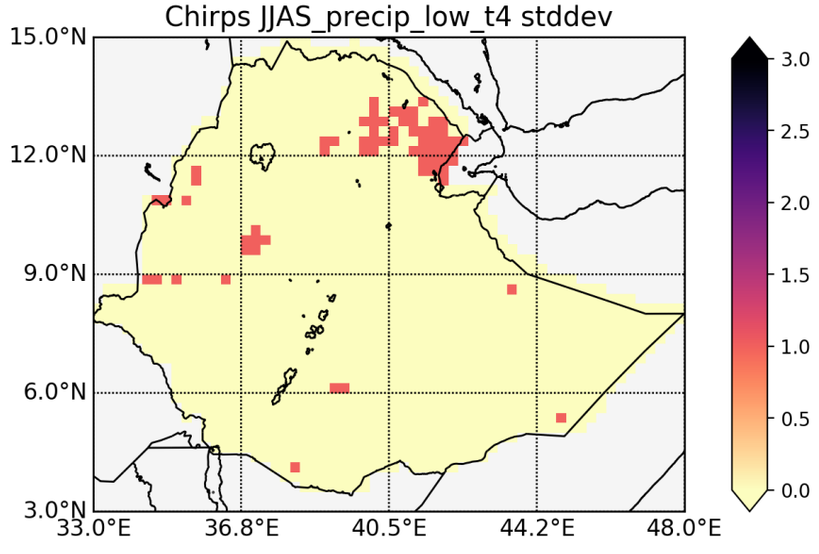
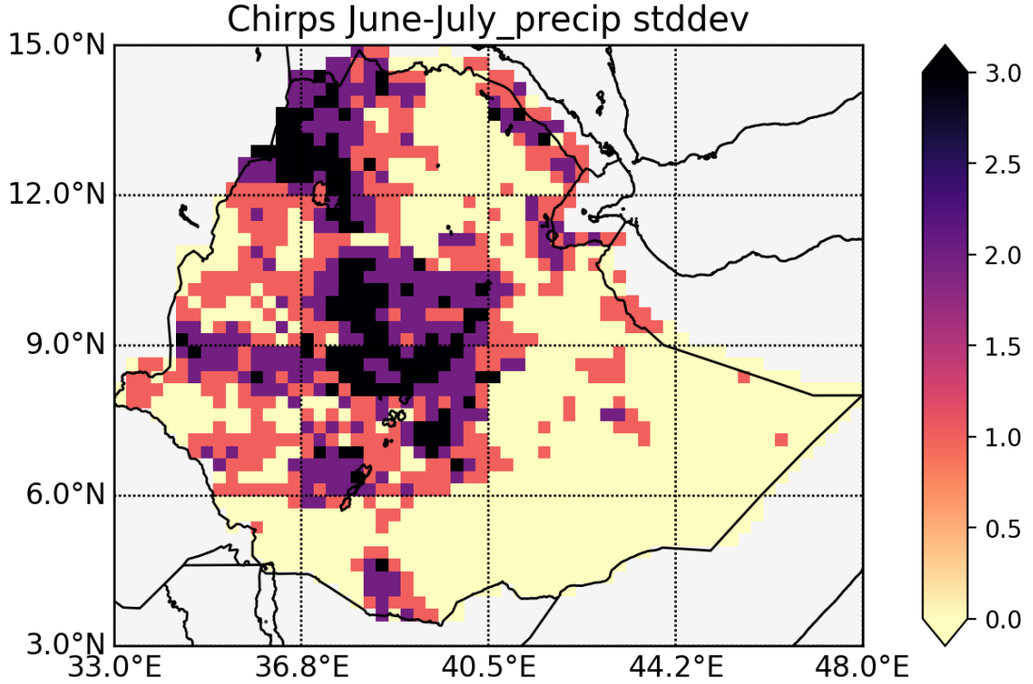


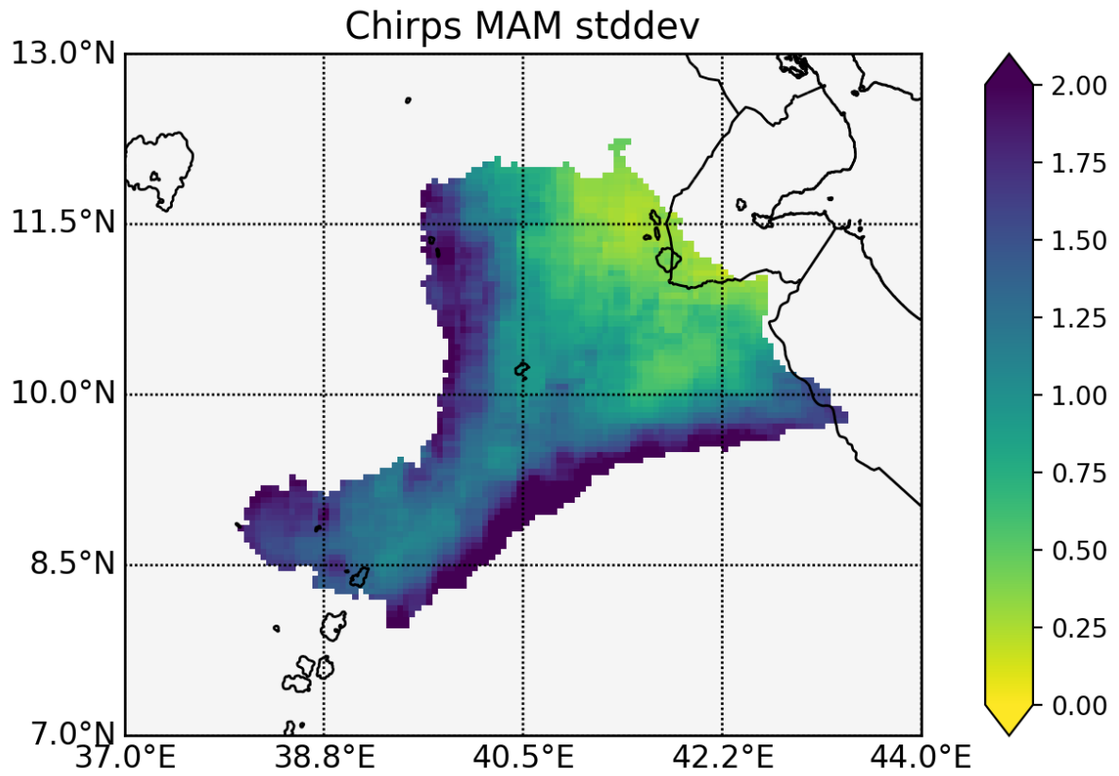


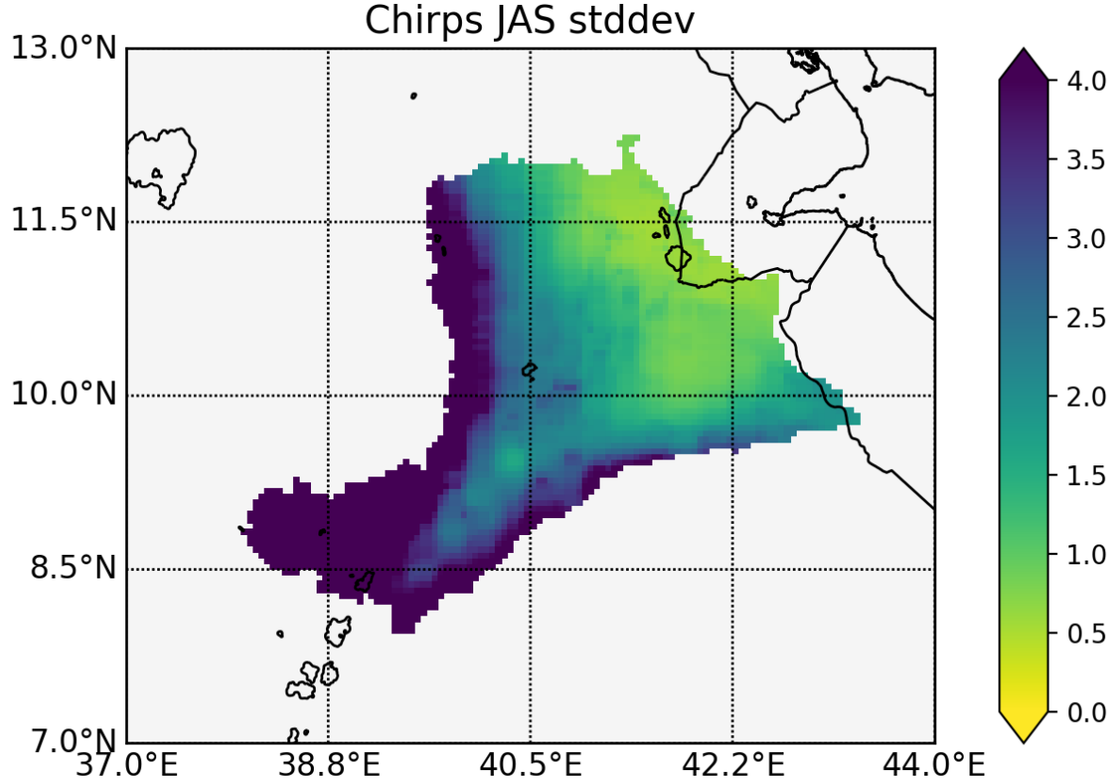


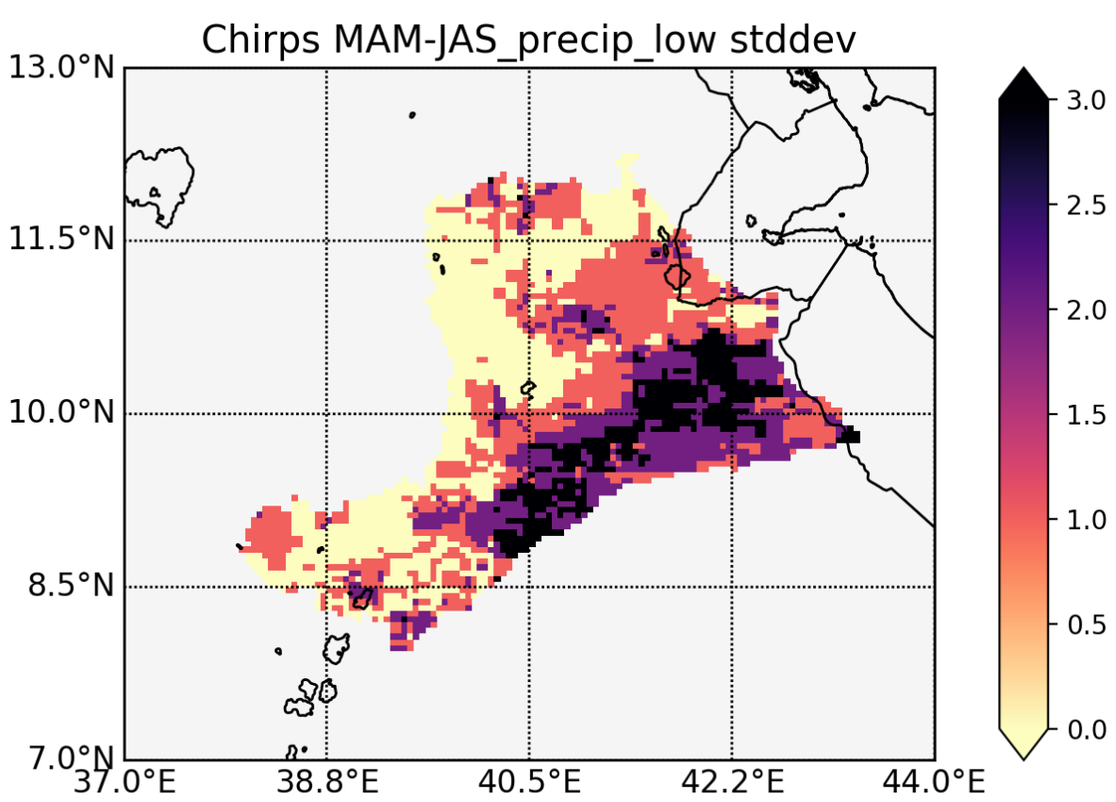
- Given the low value of JJAS threshold in some reasons, looking for events in very dry seasons may not be very meaningful
  - June is one of the driest months in the Awash basin, but does still register dry consecutive June and July events



Awash Basin: rainfall







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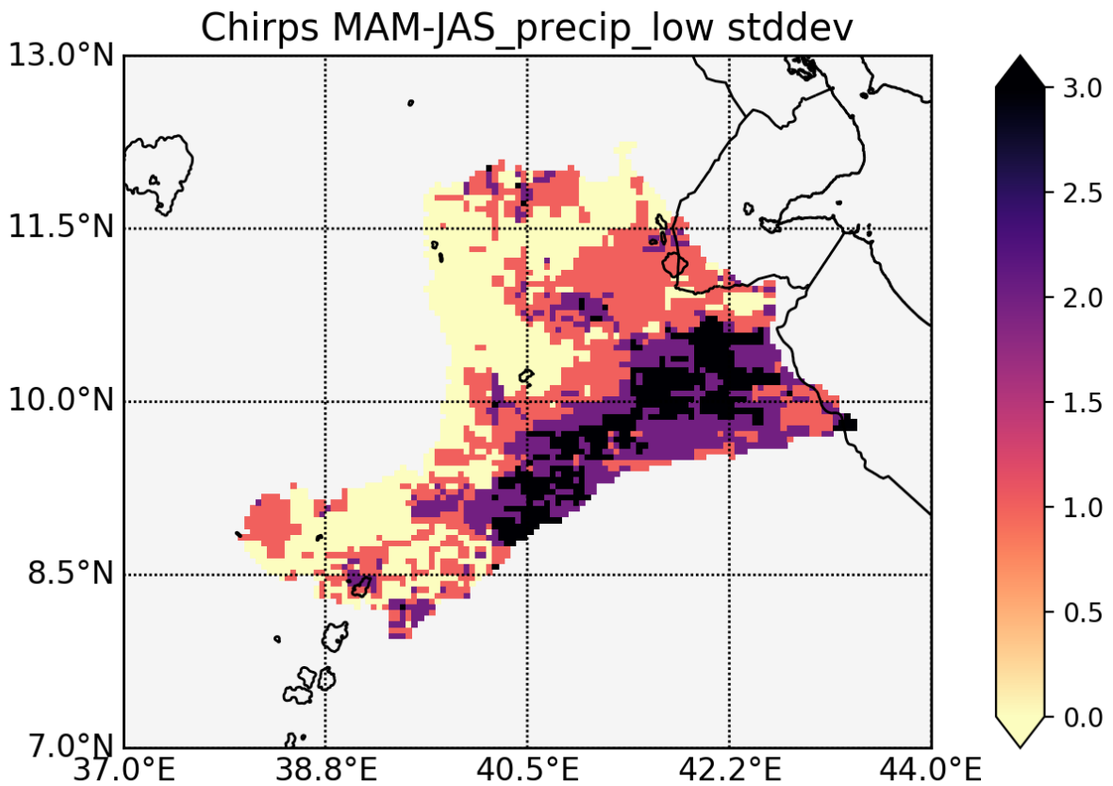
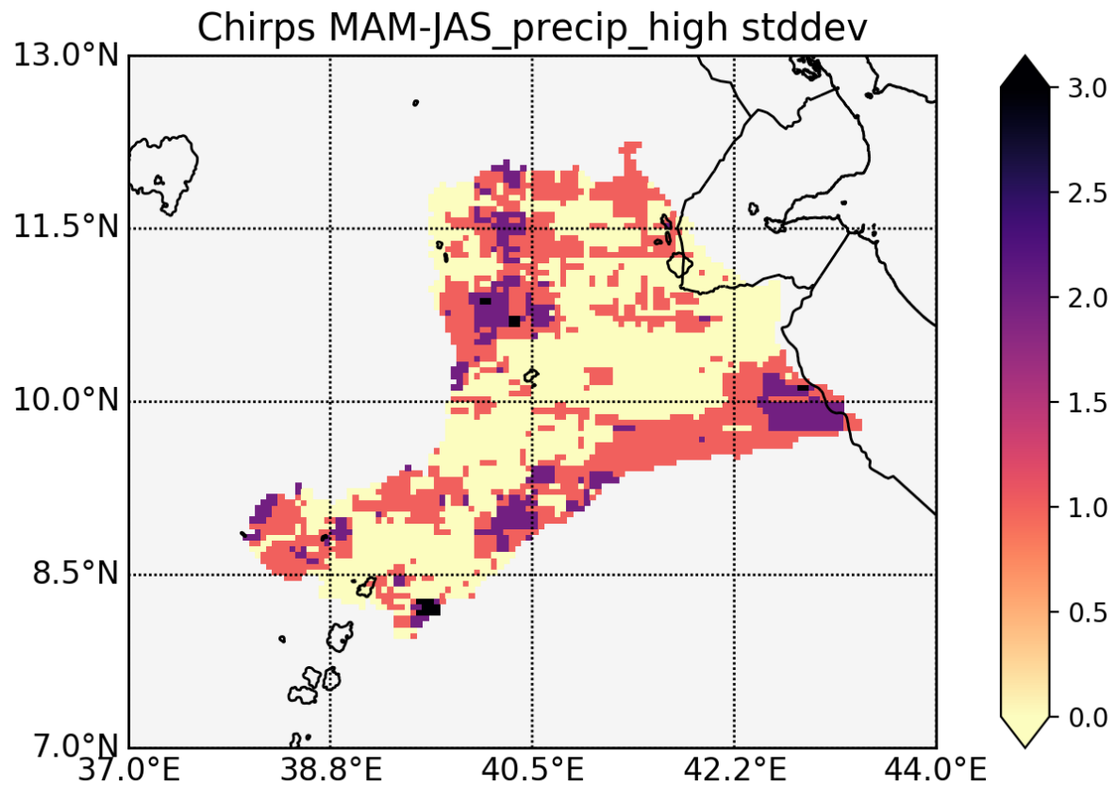
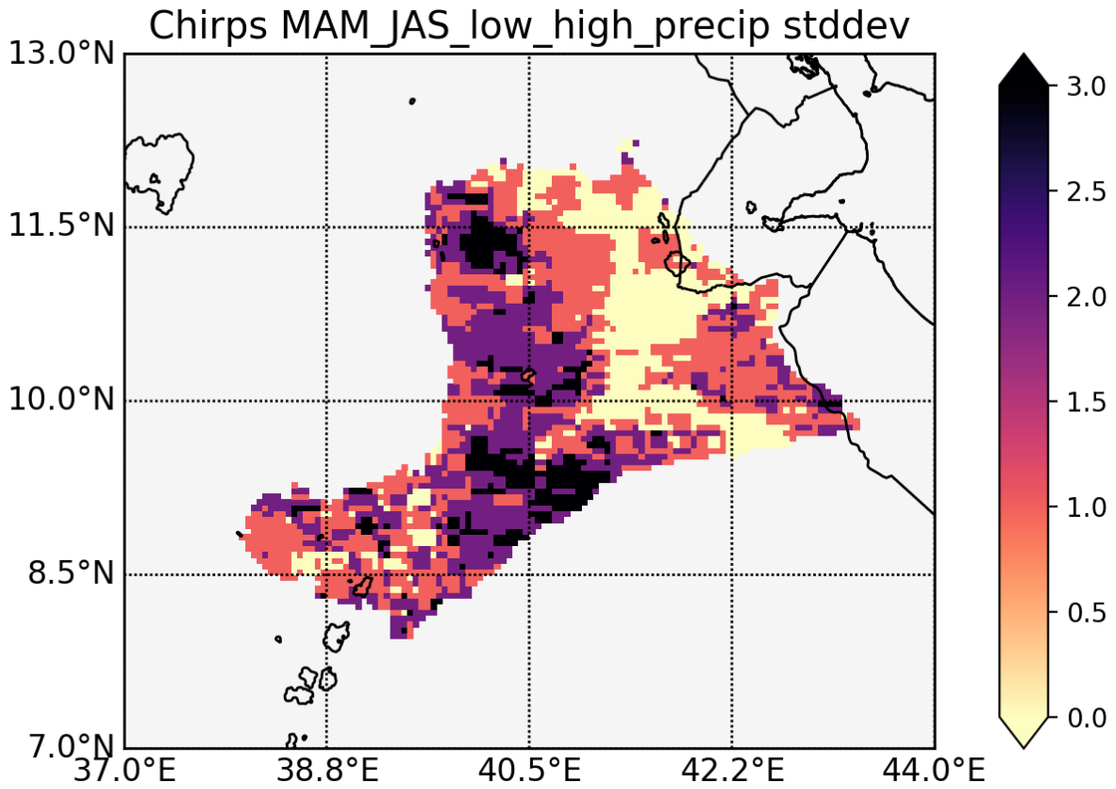
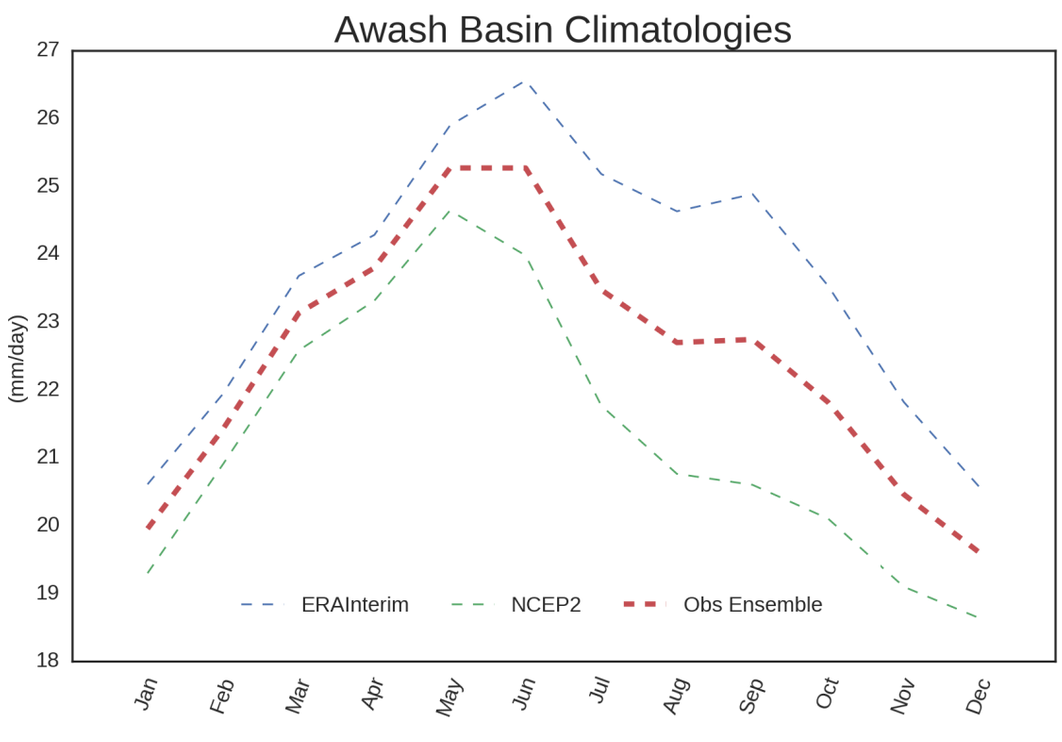
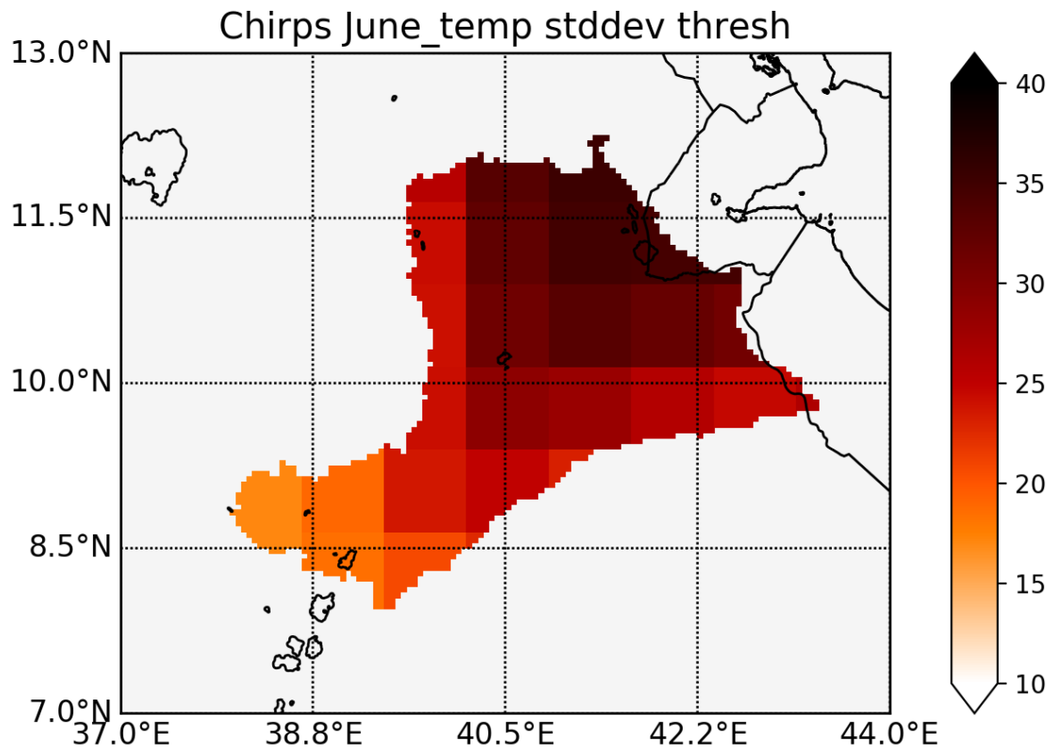






Awash Basin: beyond rainfall





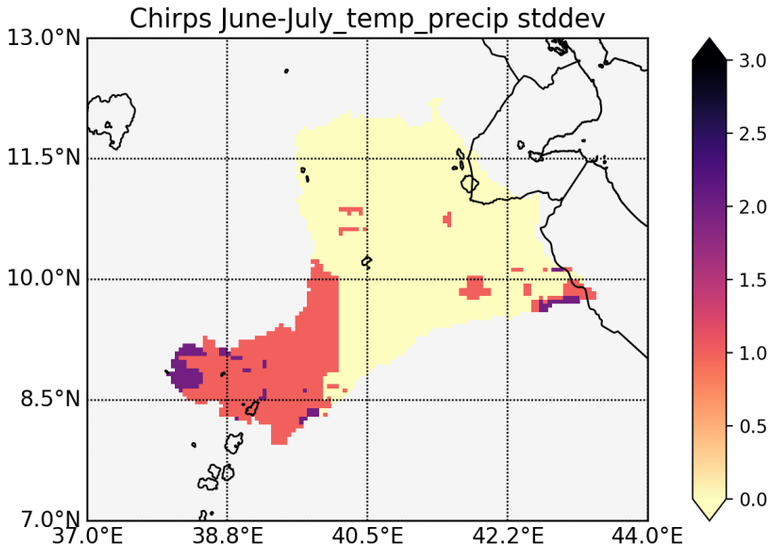
- Adding temperature to the mix
  - Kenya: SPI only takes into account precipitation and can only measure meteorological drought, but drought also depends on evapotranspiration and temperature
  - Awash: June has very low rainfall - the break between the two rainy seasons - but is one of the hottest months of the year

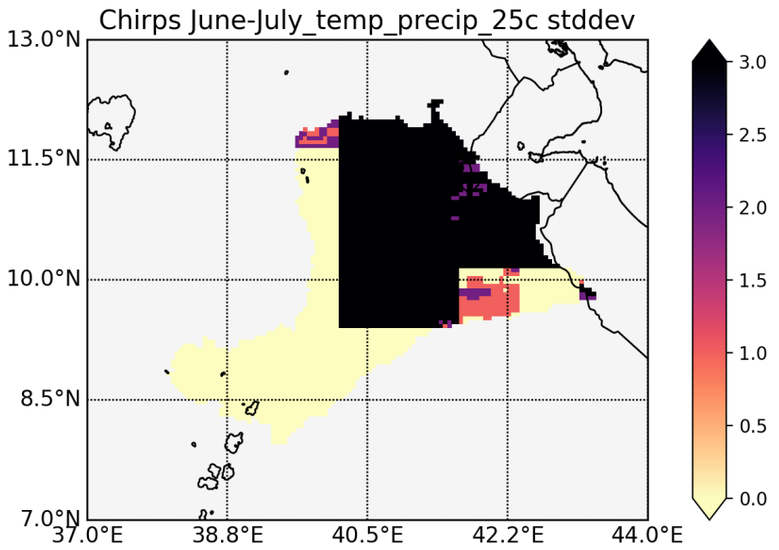
Awash Basin: beyond rainfall

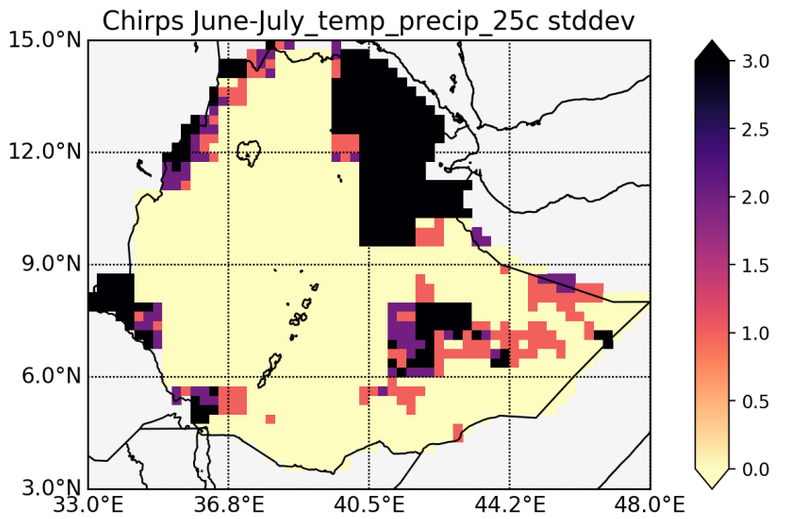
- We can apply the same statistical thresholds as before (standard deviation etc.)
- A warm June followed by a dry July

- But if we knew something about what a good temperature threshold would be (wilting temperature)
- June with an average 25C temperature followed by a dry July

- For all of Ethiopia:
  - This is a map that will likely change
- This would be an interesting kind of threshold to look at with different climate scenarios because it is constant and physically meaningful







"Coffee Farming and Climate Change in Ethiopia: Impacts, Forecasts, Resilience and Opportunities" KEW,ECFF (2017)

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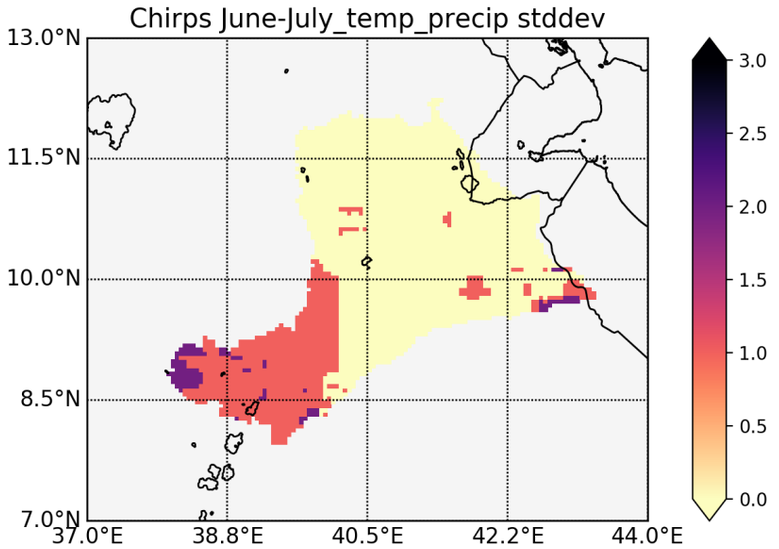

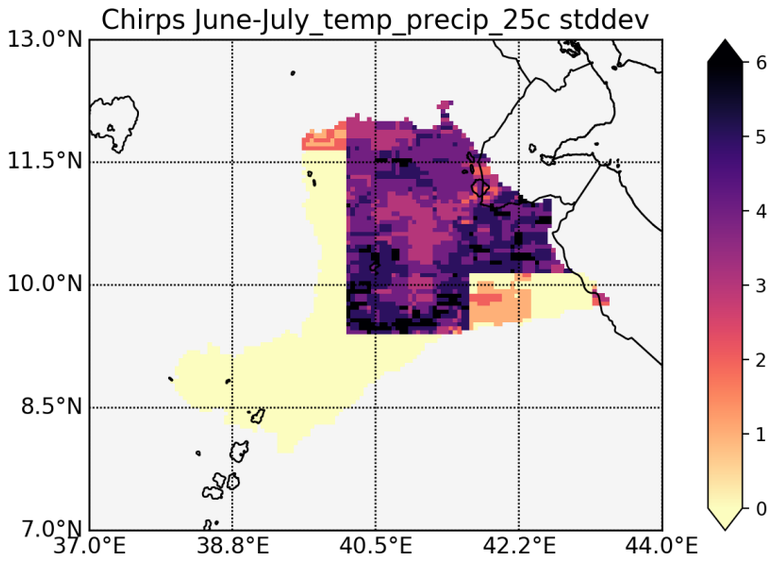

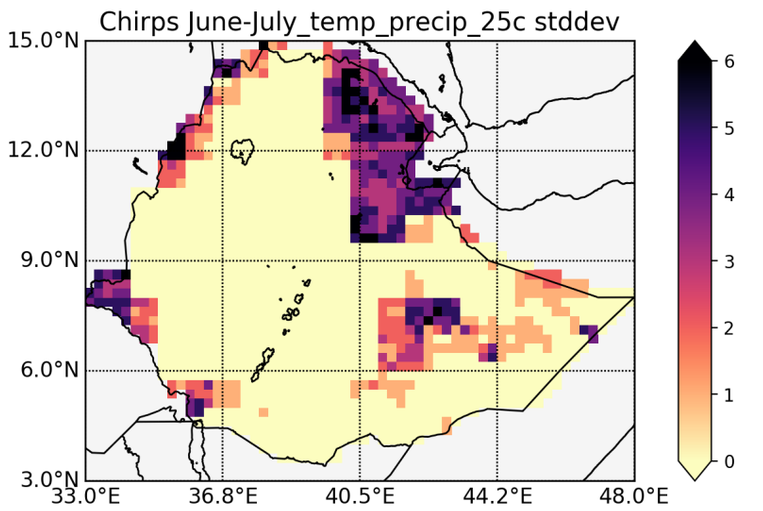

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Summary

- Risky events aren’t always extreme: prolonged dry periods maybe just as detrimental
- Spatial patterns of rainfall need to be taken into account
    - OND rainfall in Turkana is low - successive dry MAM events maybe most critical
- Looking at ways in which the rain season can fail might help to uncover large scale controls on rainfall
- Thresholds related to industry/agricultural needs yield much different event distributions than statistical thresholds (still require context specific thresholds)
    - Catherine and Feyera’s work!
- Can apply these to future projections to assess geographic changes in risk of certain types of events
    - Challenges: selection of models, resolution of available models