8th IPWG and 5th IWSSM Joint Workshop, Bologna, Italy, 3–7 October 2016

East Africa precipitation variability during recent decades

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Abstract

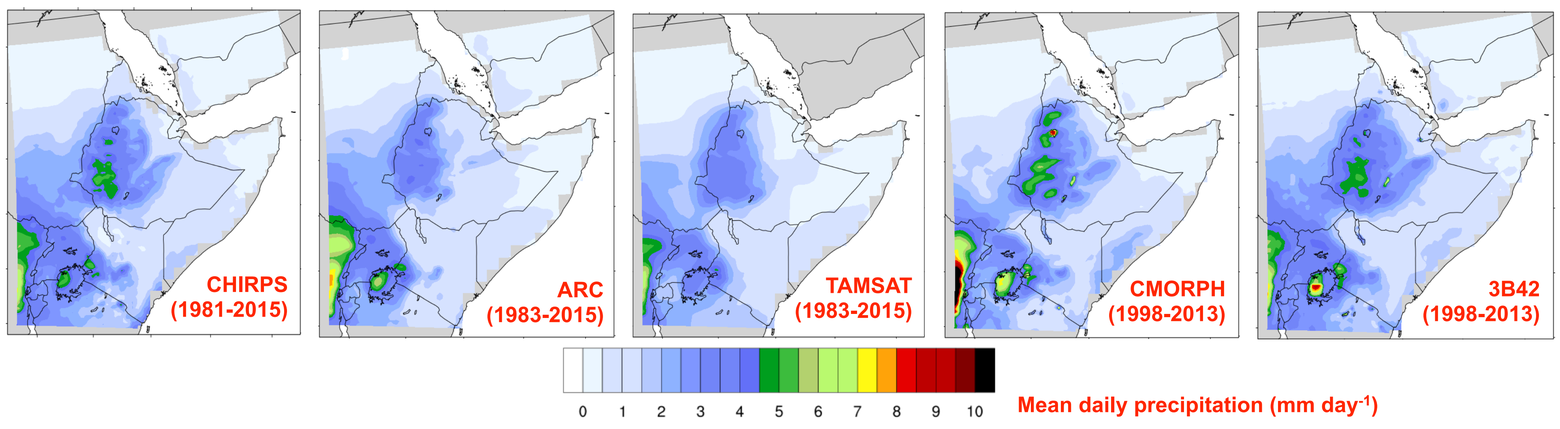
Estimating space-time variability of precipitation is an important task in East Africa, considering the observed increased frequency of extreme events, drought episodes in particular. These events deeply affect the population with implications on agriculture and consequently food security.

Daily accumulated precipitation time series from satellite retrieval algorithms, ARC, CHIRPS, TAMSAT, TMPA-3B42, and CMORPH are exploited to study the spatial and temporal variability of East Africa (EA – 5°S-20°N, 28°E-52°E) precipitation during last decades.

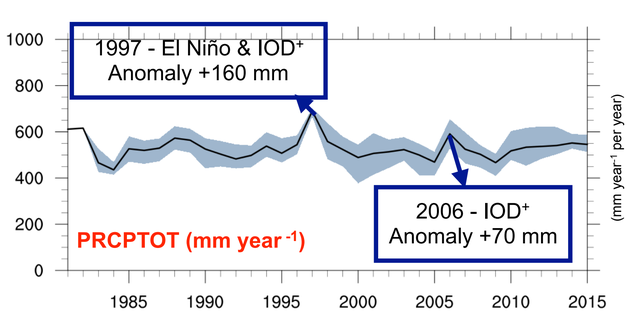
The analysis is carried out by computing the time series of the joint CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI, http://etccdi.pacificclimate.org/index.shtml), e.g. CDD, CWD, SDII, PRCPTOT, and R1, at the yearly and seasonal scales.

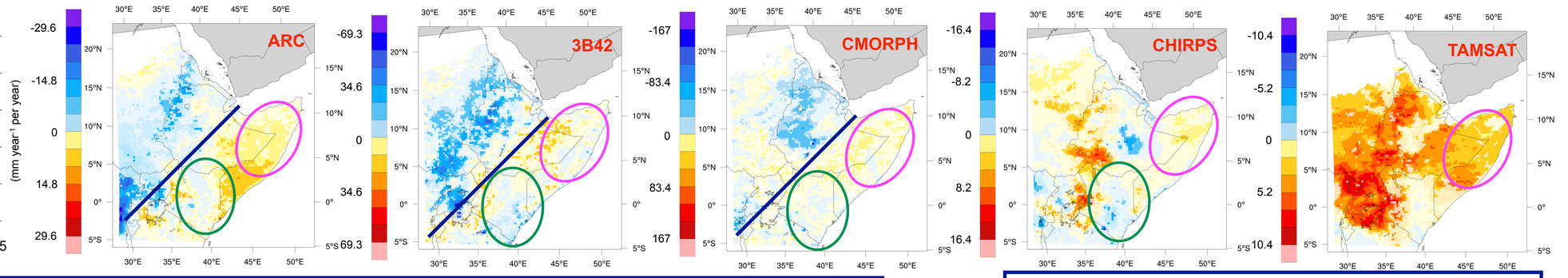
The purpose is to identify the occurrence of extreme events (droughts and floods), and extract precipitation spatial patterns of variation by trend analysis (Mann-Kendall technique).

Prior to the analysis satellite time series are checked for the possible presence of inhomogeneities due to variations in rain gauge density and/or in the satellite retrieval algorithms.



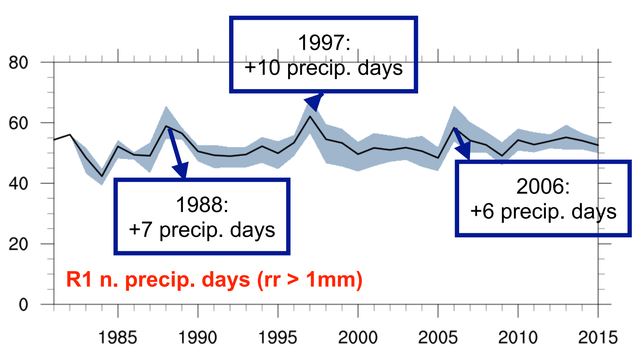
ANNUAL PRECIPITATION VARIABILITY

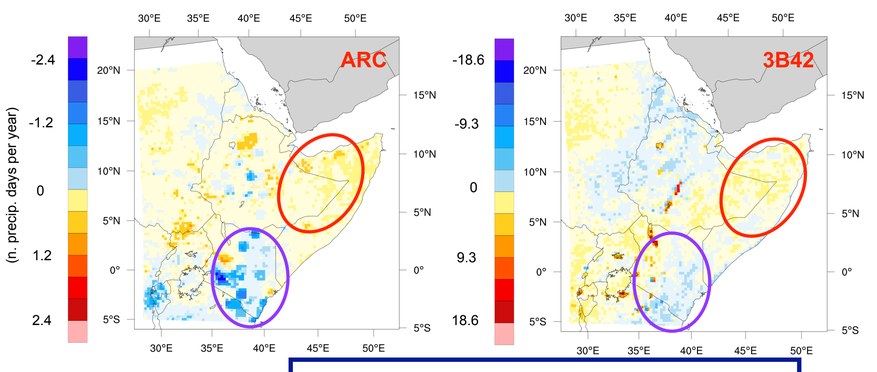




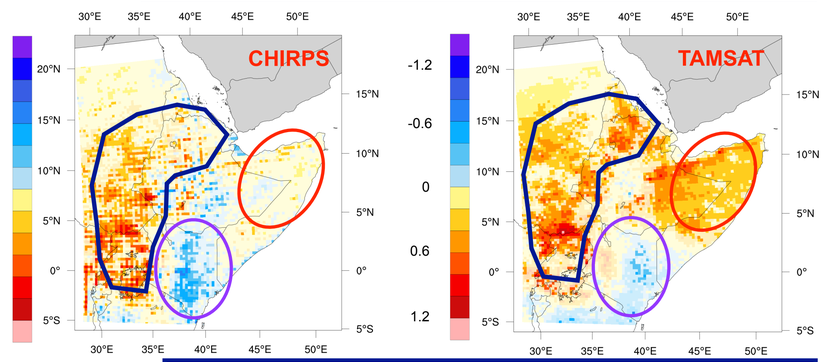
ARC, 3B42, and CMORPH have a similar spatial pattern of PRCPTOT trend: annual precipitation decreases in western Ethiopia and Uganda and increases over eastern Ethiopia and Somalia. This pattern is not shared with CHIRPS and TAMSAT. **Areas with confidence level > 95% in trend analysis are depicted in full colors.**

All satellite products show a positive trend over Northern Somalia (encircled in magenta); weakly negative trends over Kenya are evident in ARC, 3B42, CMORPH, and CHIRPS data (encircled in green).



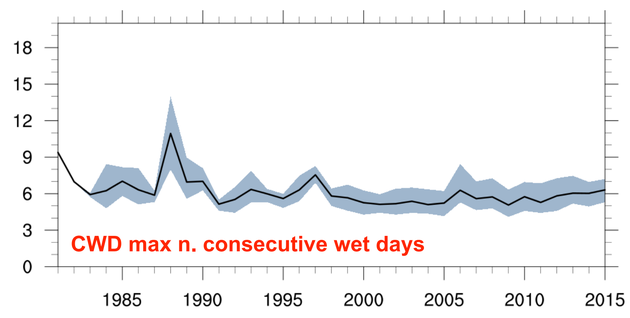


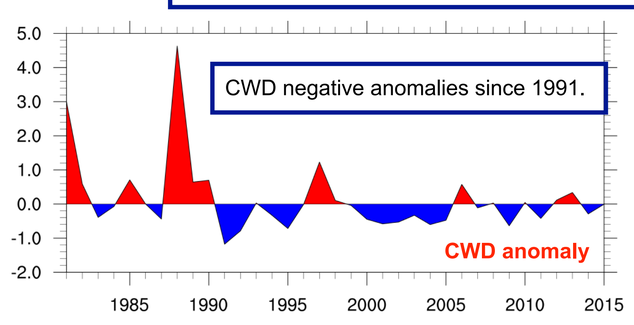
Negative trends over Kenya (violet circles) and positive over northern Somalia (red circles).

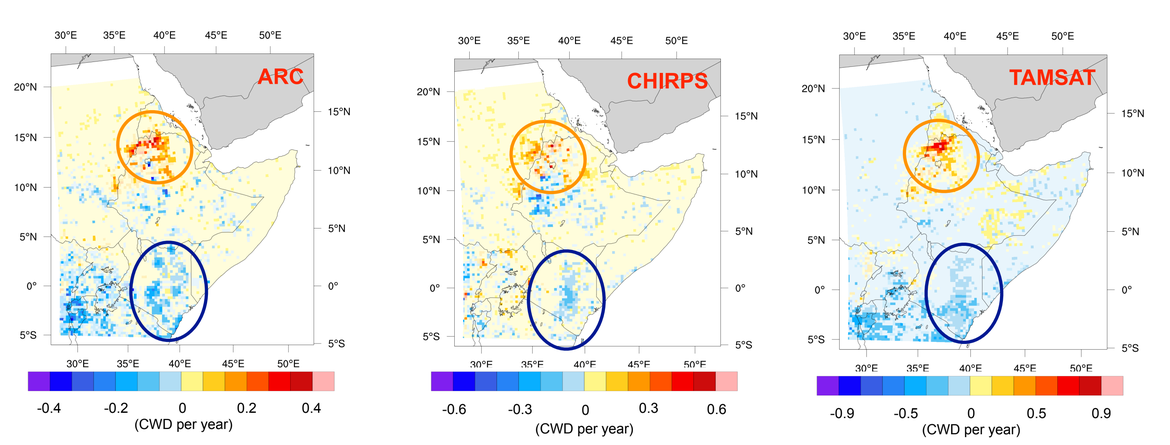


CHIRPS and TAMSAT have a similar spatial pattern of R1 trend.

Scarce significance of the CWD trends. ARC, 3B42, CMORPH, and CHIRPS exhibit similar spatial patterns unlike TAMSAT.







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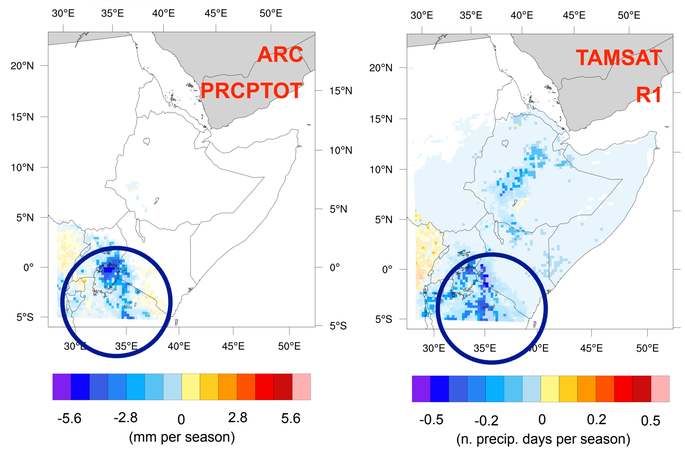
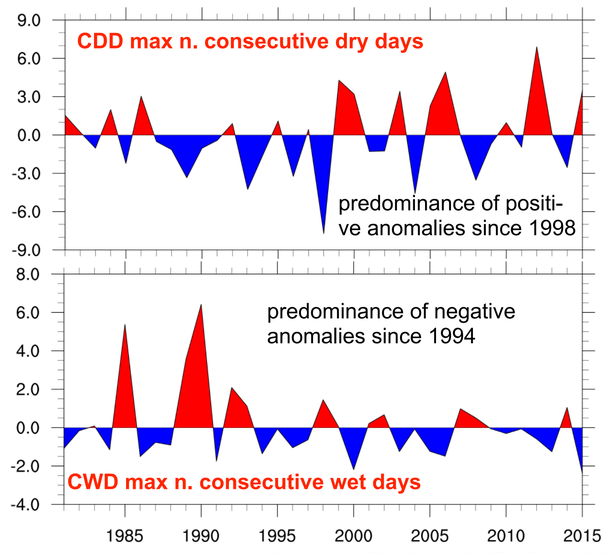
JF

Significant precipitation only over Tanzania with PRCPTOT∈[100, 240] mm and CDD∈[10, 30] days.

Precipitation tends to decrease over northern Tanzania.



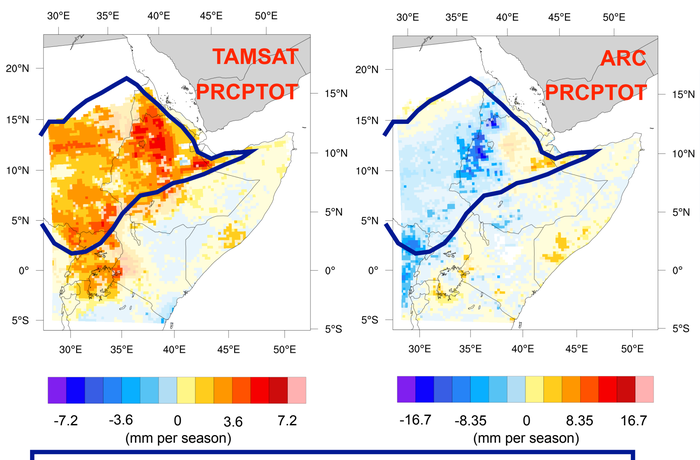


All the data sets show similar trends for PRCPTOT and R1 over northern Tanzania.

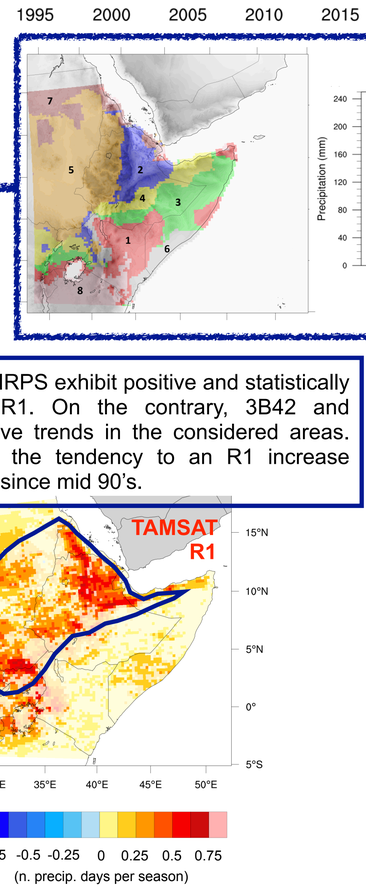
JJAS

Precipitating areas are concentrated over north-western EA (clusters 5, 2, and 4) with CDD from [12, 30] days (cluster 5) to [30, 55] days (cluster 4).

Absence of trend spatial patterns shared among satellite products.

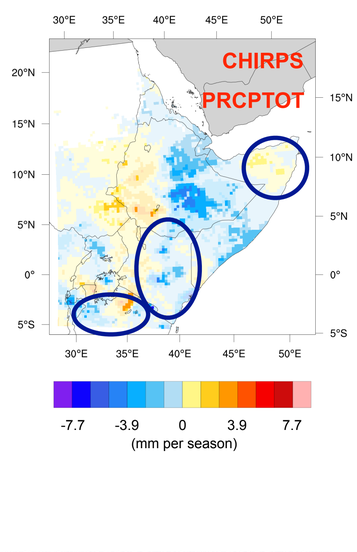


The PRCPTOT trend maps resemble those of the same parameter at annual scale, thus TAMSAT and CHIRPS provide positive PRPCTOT trends over the precipitating areas, whereas 3B42, CMORPH and ARC present negative trends. PRCPTOT anomalies do not provide a clear signal.



TAMSAT, ARC, and CHIRPS exhibit positive and statistically significant trends of R1. On the contrary, 3B42 and CMORPH show negative trends in the considered areas. R1 anomalies confirm the tendency to an R1 increase through positive values since mid 90's.

CHIRPS, ARC, and TAMSAT confirm a positive and significant trend over coastal Somalia and Kenya.
Negative trends are found over central Kenya (only CHIRPS has significant trends).
Positive trends characterize Tanzania but without significance.

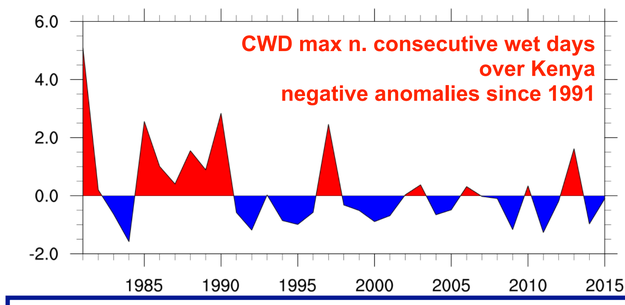


MAM

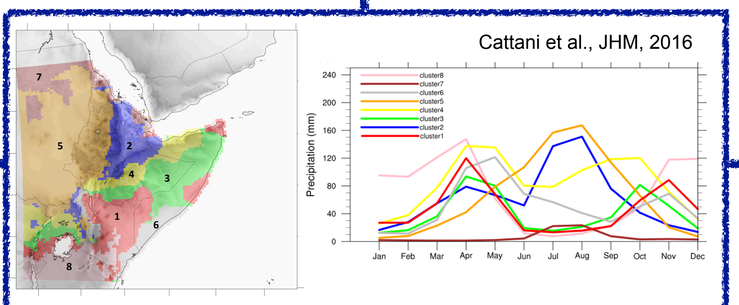
MAM is the precipitation season of the south-east part of the EA (clusters 1, 2, 3, 4, 6, and 8) with PRCPTOT ∈[200, 400] mm for cluster 8, PRCPTOT ∈[100, 300] mm for the other clusters.

No significative trends, only some indications about a decrease of precipitation over Kenya and northern Tanzania, and an increase over north-eastern Somalia.

The negative trends over Kenya and Tanzania and the positive one over Somalia are evident also in the other datasets although without significance.



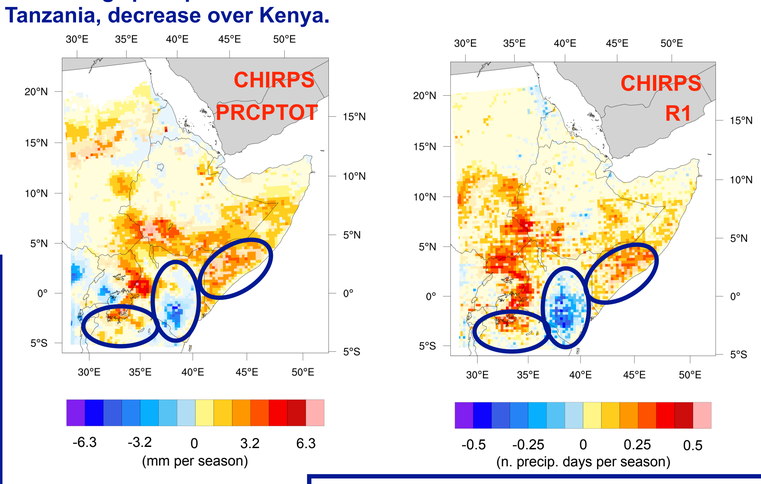
The trend analysis did not point out any significant trend of CWD, nevertheless negative anomalies are present since 90's over Kenya and the other areas of South-east EA. The same behaviour can be found in the R1 anomalies.



OND

OND precipitation characterize the region including southern coastal Somalia, central Kenya, and northern Tanzania (clusters 6, 1, and 8), where CDDs range between [20, 40] days (clusters 1, and 8) and [15, 30] for cluster 8.

Increasing precipitation over coastal Somalia and northern Tanzania, decrease over Kenya.



The trends found for PRCPTOT in CHIRPS, ARC, and TAMSAT data sets are confirmed also for R1.