

Multi RCM downscaling of seasonal hindcasts in eastern Africa

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2. Italian National Agency for New Technologies and Energy (**ENEA**, Italy)
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4. University of Lisbon (**UL-IDL**, Portugal)
5. Santander Meteorology Group, Universidad de Cantabria (**UCAN**, Spain)
6. Swedish Meteorological and Hydrological Institute (**SMHI**, Sweden)

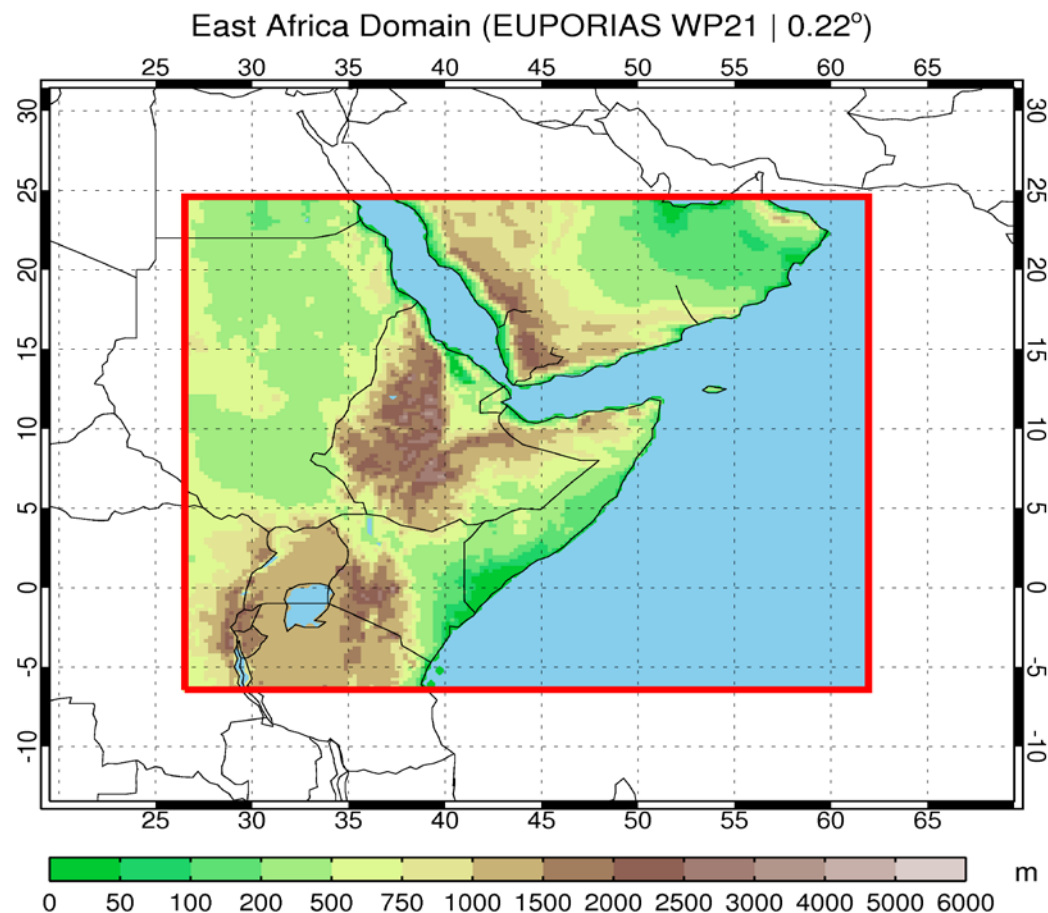
Many thanks to all groups for productive cooperation
during EUPORIAS



Study region

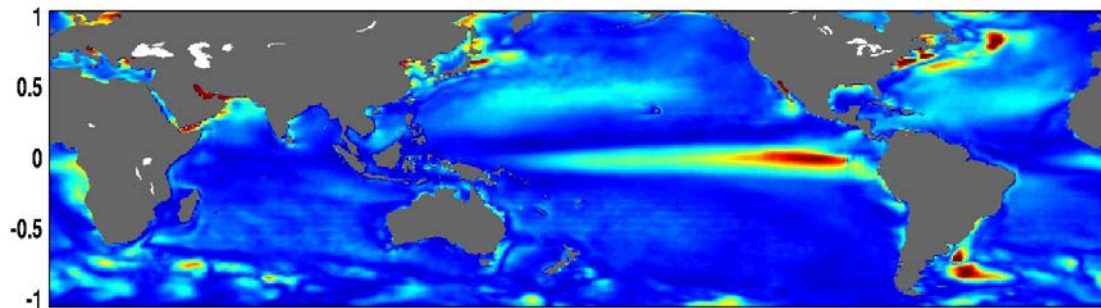
- World Food Programme (WFP): focus is on **summer rainfall in Ethiopia**, downscaling results will be tested in the Livelihoods, Early Assessment and Protection (LEAP) application
- a trade-off between user needs and forecast skill, a stronger seasonal signal in autumn-winter months south of Ethiopia

- 5-month forecasts
- initialised on May 1st
- (May-September)



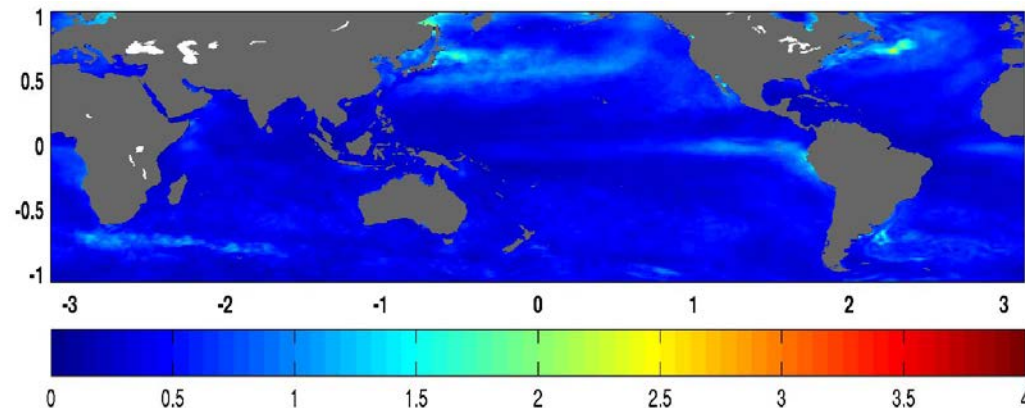
Global forecast

- ECMWF System 4: not all model levels and not for all members
- Re-run the S4 hindcast by the atmosphere only EC-EARTH (bias corrected S4 SST, S4 initial cond.; model levels for RCMs)
- EC-EARTH is based on the IFS code and can be run at the same horizontal (T255) and vertical resolution (91 levels) as S4
- EC-EARTH hindcast: 1991-2012, 15 members, May-September:



**S4 SST bias: July
3-month lead
time**

**Bias-corrected
S4 SST**





RCM and ESD

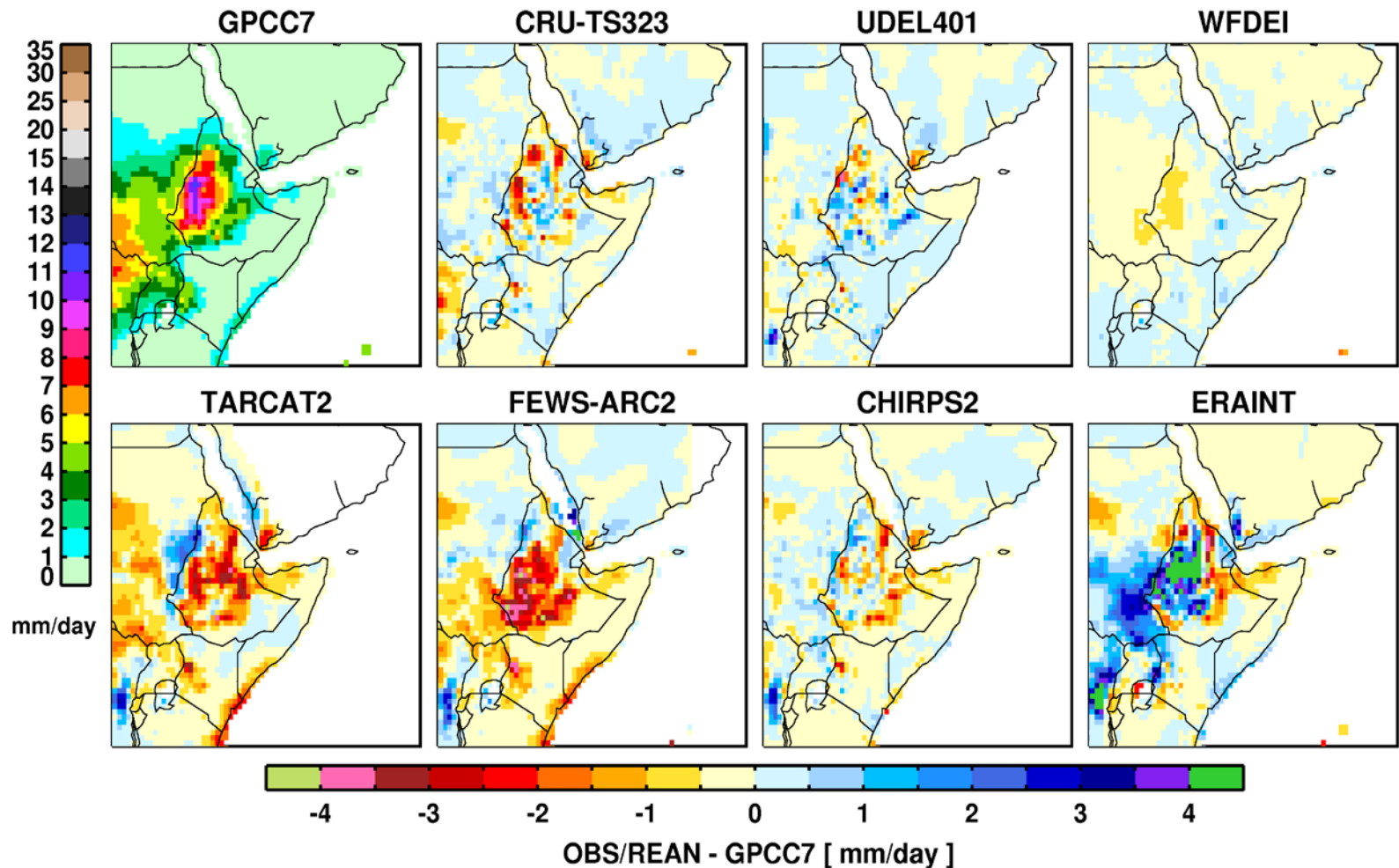
	Partner – RCM or ESD	Experiment	Resolution
RCM	DWD-CCLM4-8-21	EC-EARTH full hindcast	25 km
	ENEA-RegCM-4-3	EC-EARTH subset	25 km
	SMHI-RCA4	EC-EARTH full hindcast	25 km
	UCAN-WRF341G	EC-EARTH subset	25 km
	UL-IDL-WRF360D	EC-EARTH subset	25 km
	MOHC-HadGEM3-RA	GloSea5	12 km
ESD	UCAN-4NN	EC-EARTH and S4 full hindcast	50 km
	UCAN-15PC	EC-EARTH and S4 full hindcast	50 km

- Two streams of EC-EARTH - full hindcast and a subset: all 15 members for 2 wet (2006, 2007) and two dry (2002, 2009) years; first 3 members for 1991-2012 to establish the hindcast climatology
- Common file format, variables etc. (based on CORDEX)

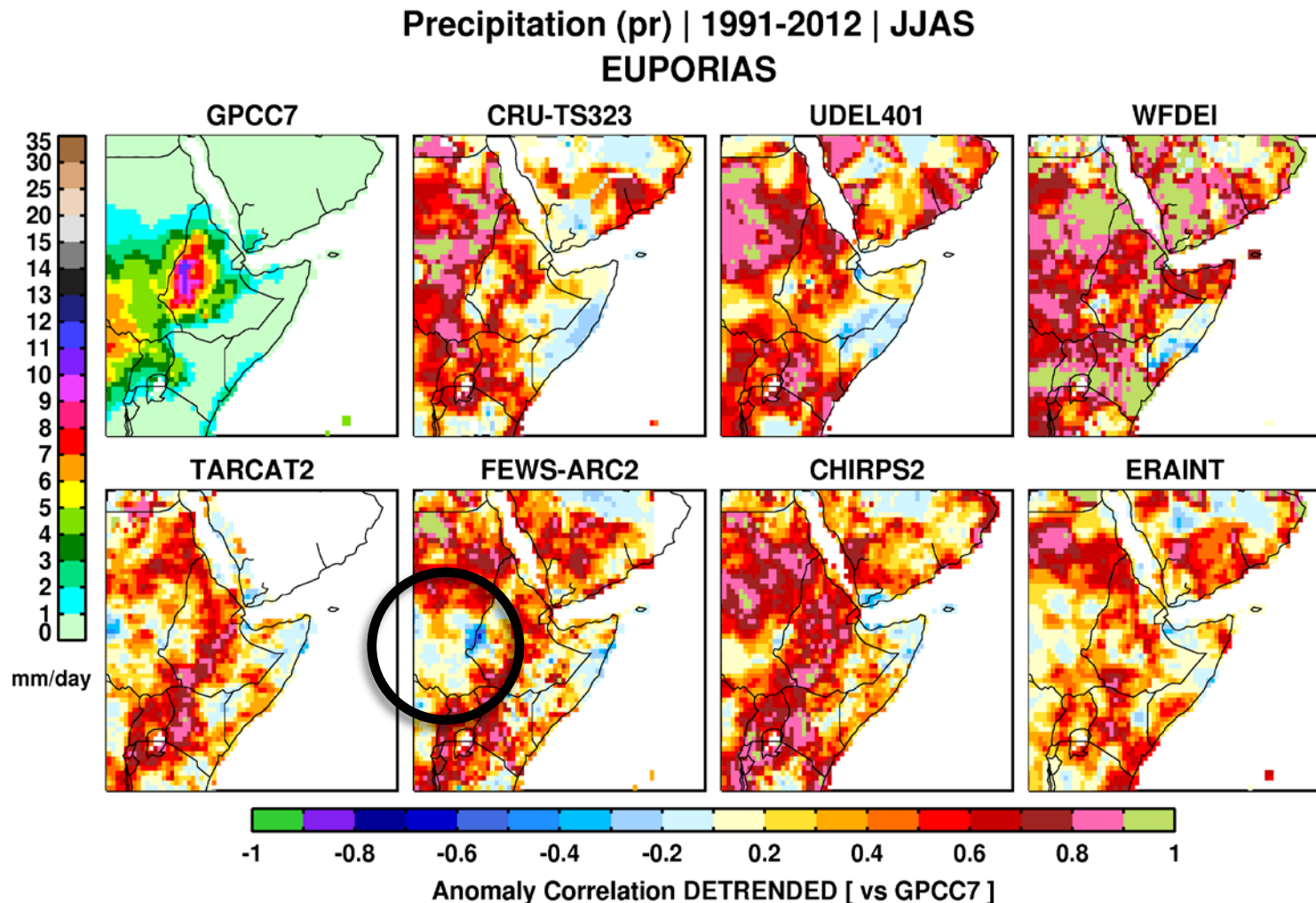
Observational uncertainties: climatology

Observations (GPCC7, CRU-TS323, UDEL401, TARCAT2, FEWS-ARC2, CHIRPS2), ERA-Interim and WFDEI

Precipitation (pr) | 1991-2012 | JJAS
EUPORIAS



Observations: interannual variability

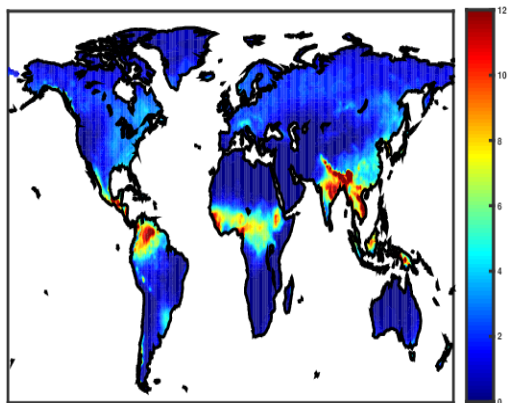


no correlation over western Ethiopia and southern Sudan
(climatologically wet region in JJAS) for TARCAT, ARC2 and in less
degree in CRU, UDEL and CHIRPS.

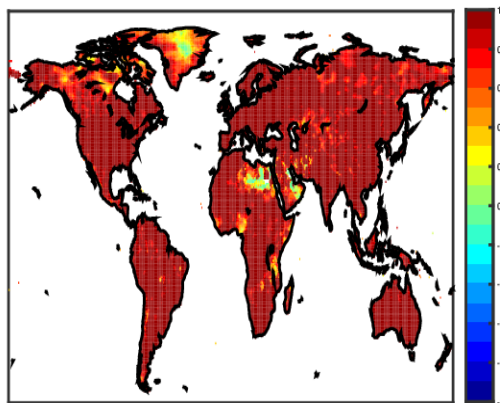


Global hindcasts: S4 and EC-EARTH

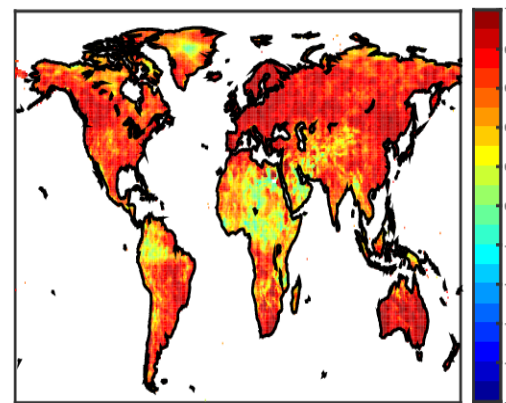
GPCC7



WFDEI

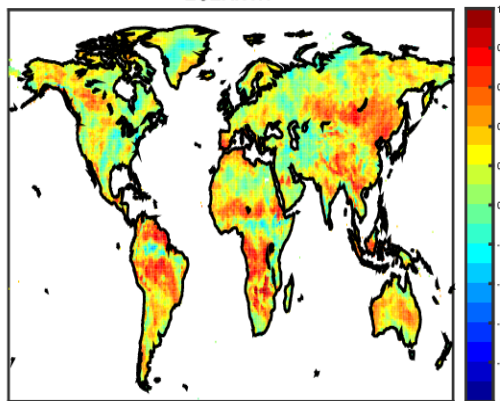


ERA-Interim

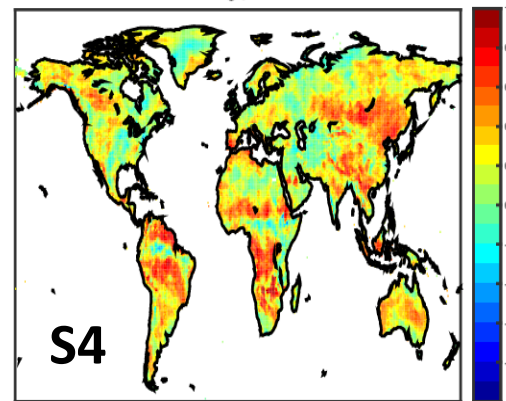


Anomaly correlation
between GPCC7 and
other datasets, JJAS,
1991-2012

EC-EARTH



S4



EC-EARTH

Interannual variability of precipitation is partly reproduced in S4 and EC-EARTH only over some regions (e.g. the Sahel, South Asia, and South America).

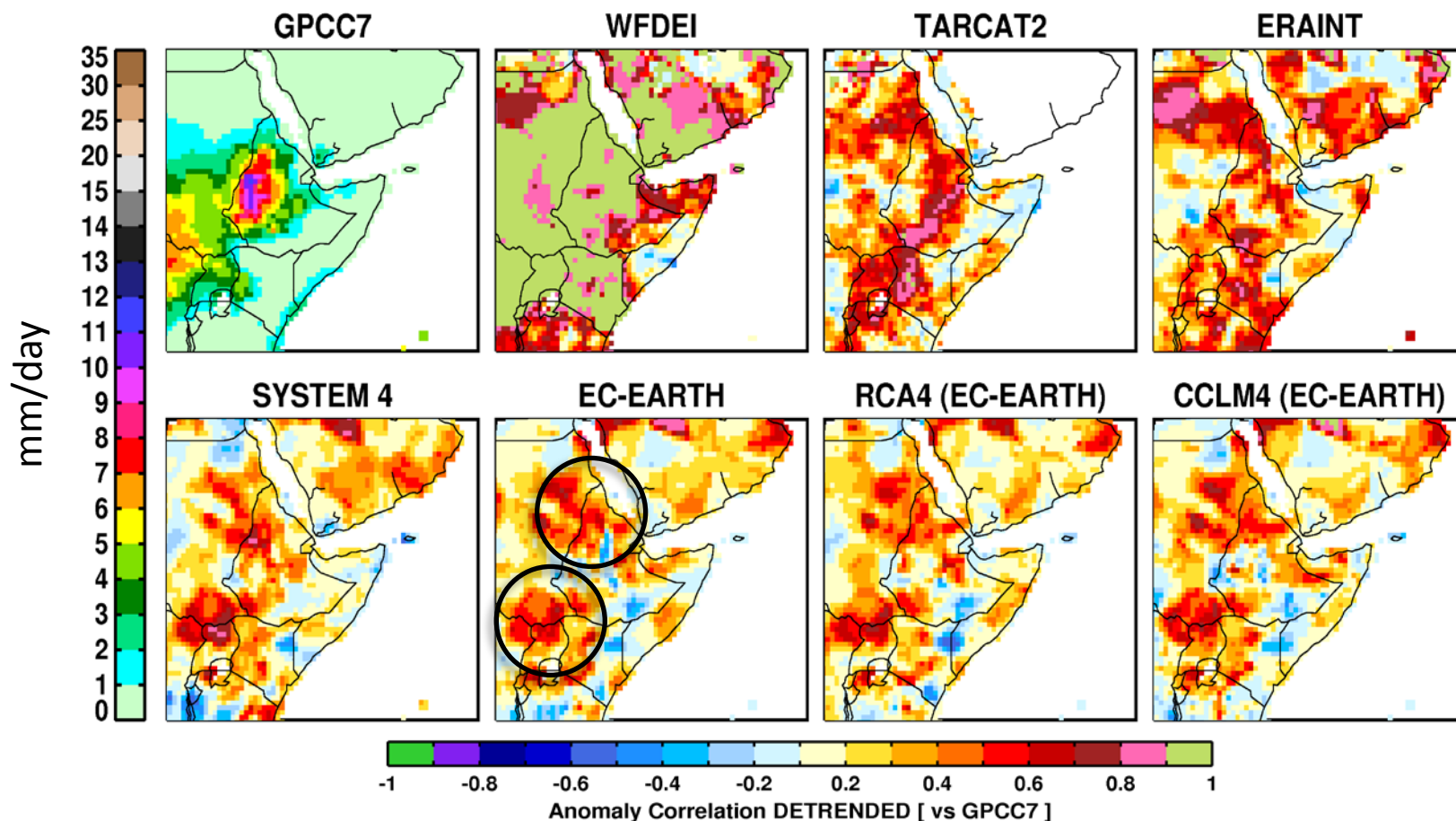
- spatial pattern of ACC is almost the same: S4 and EC-EARTH



Anomaly correlation: full hindcast

Precipitation (pr) | 1991-2010 | JJAS | 15 members

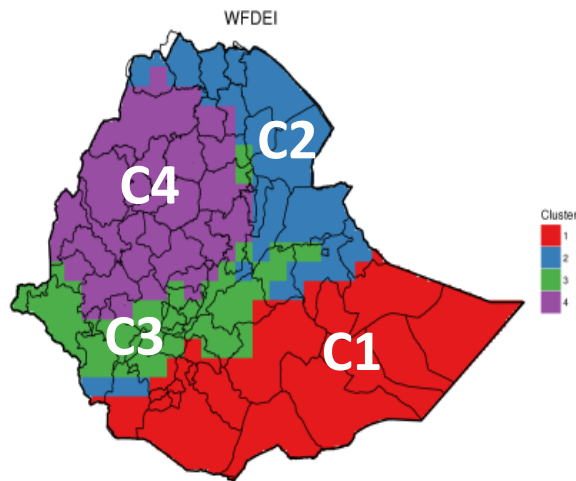
Initialisation: May 1st | lead time: 2-5 months | EUPORIAS



- there is a signal in S4 and EC-EARTH: northern Ethiopia and northeast Sudan and southern Sudan - northern Uganda
- reproduced by RCA4 and CCLM;

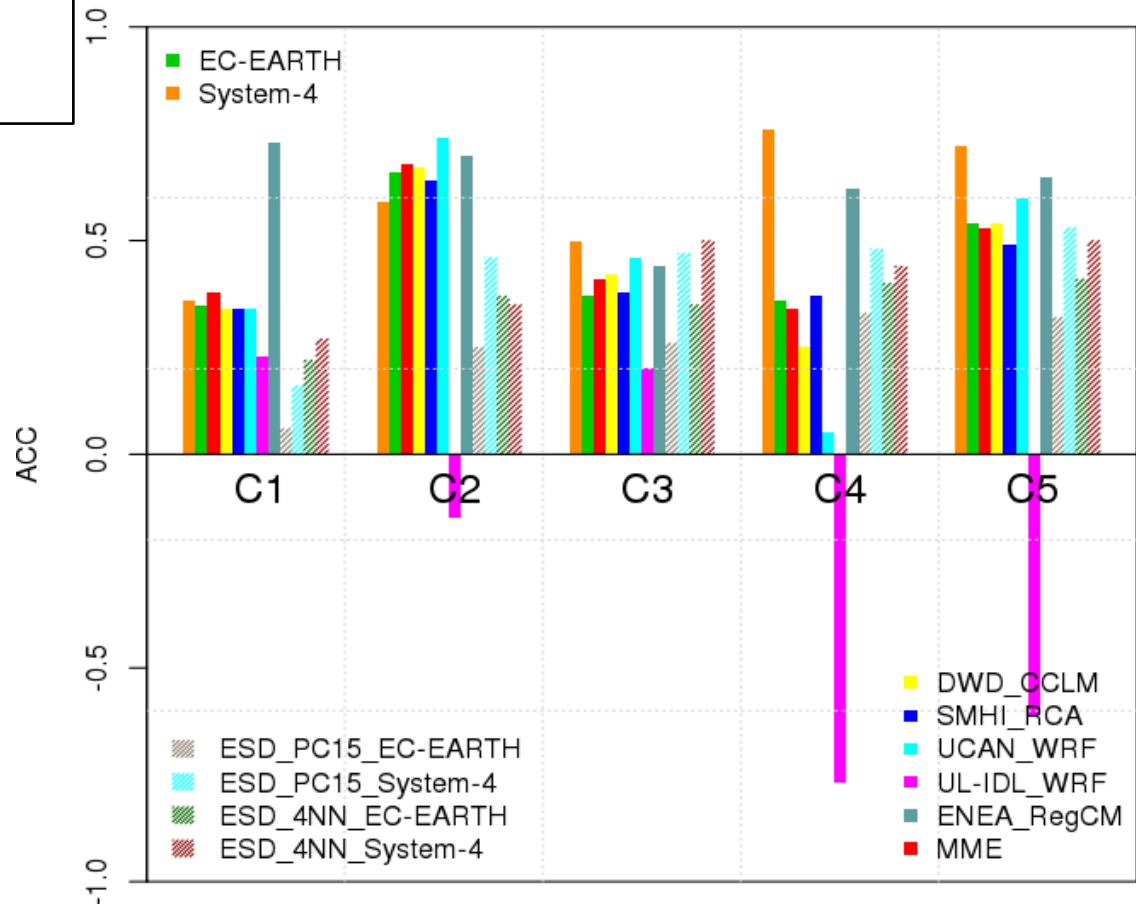
Sub-regions in Ethiopia: anomaly correlation

Clusters based on WFDEI rainfall
(annual cycle)



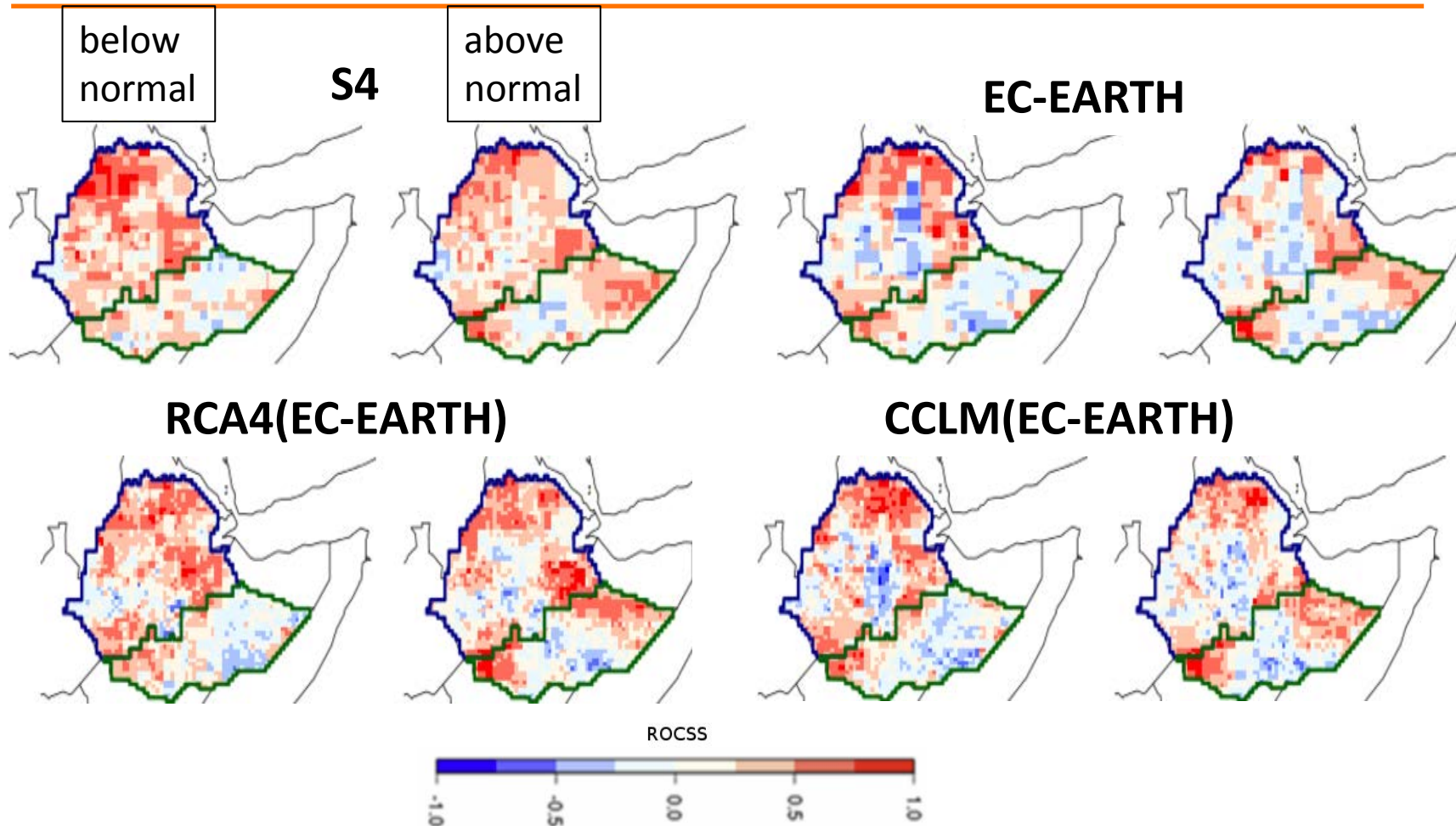
$C5 = C2 + C3 + C4$
(summer precipitation)

- Hindcast subset (only 3 members)



- C2: S4, EC-EARTH and almost all RCMs show the signal
- C4 and C5: EC-EARTH loses a part of the S4 signal (RCA4 and CCLM are similar)
- RegCM shows a stronger signal (C1); one of WRF shows negative correlation

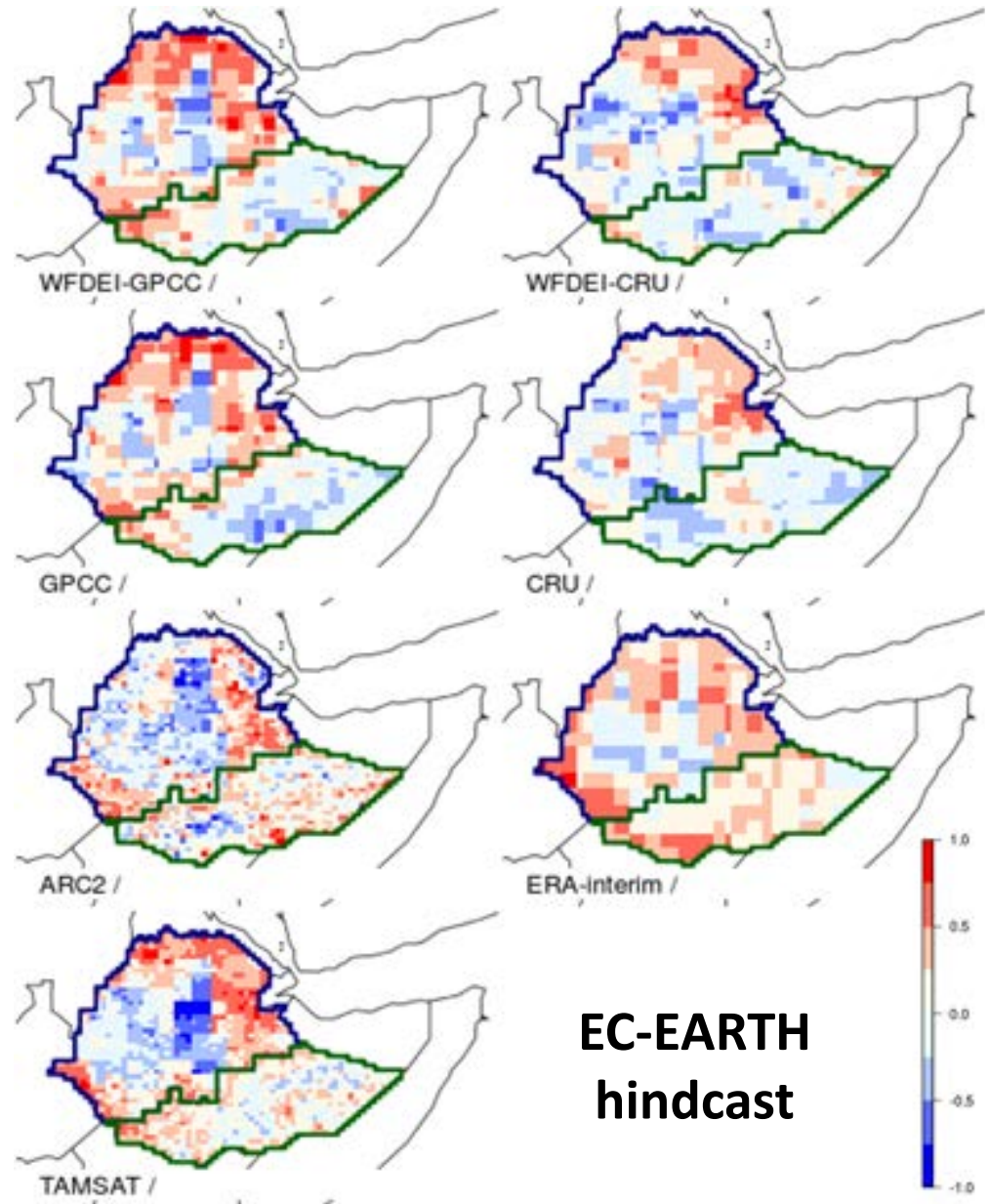
ROCSS: full hindcast



- EC-EARTH shows lower ROCSS compared to S4
- RCA4 and CCLM capture the EC-EARTH signal
- highest ROCSS over north and northeast Ethiopia

ROCSS: observational uncertainties

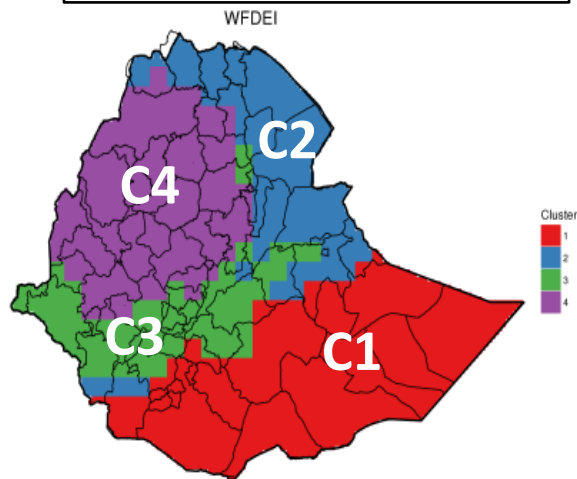
- Taking different observational datasets for verification gives different results



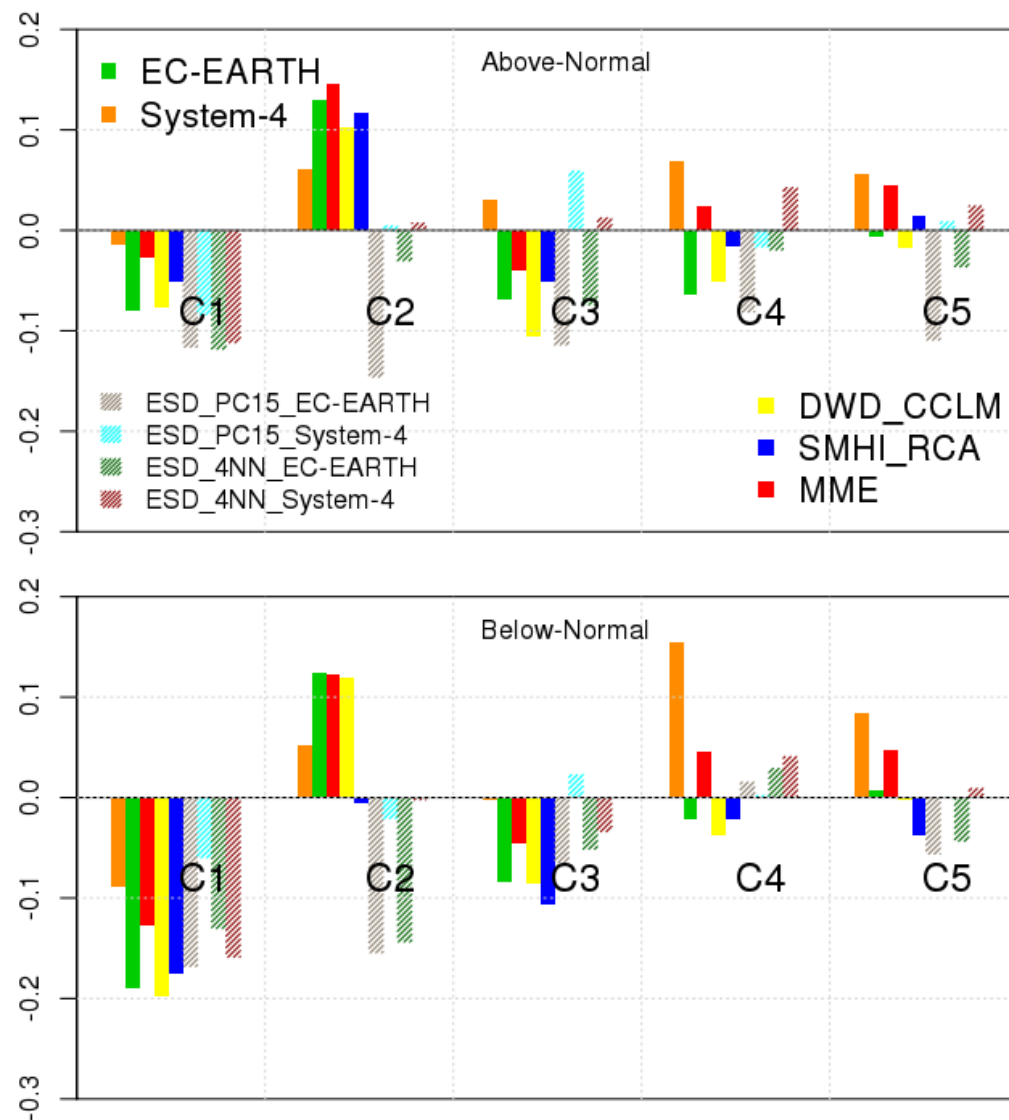


Fair Brier Skill Score: full hindcast

$C5 = C2 + C3 + C4$
(summer precipitation)



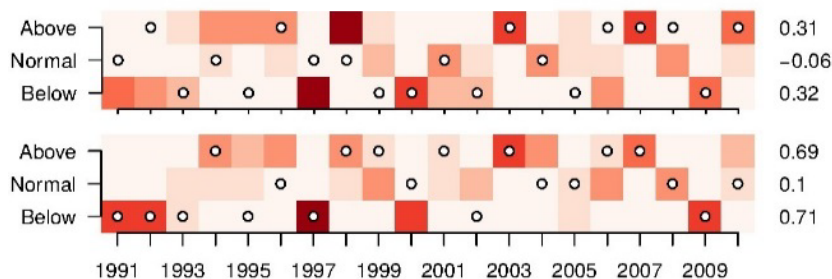
- C1: no skill (dry)
- C2: skill in all datasets
- C3-C5: some skill in S4 and RCM ensemble



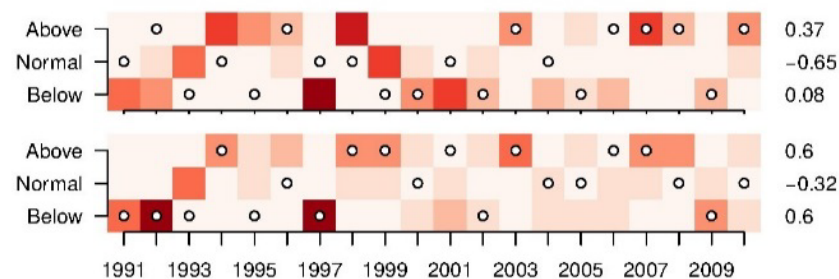


Downscaled full hindcasts: ROCSS

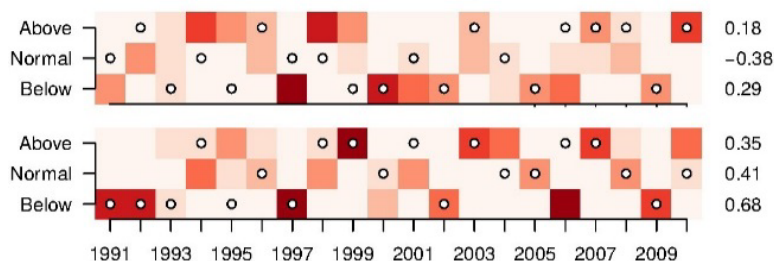
EC-EARTH



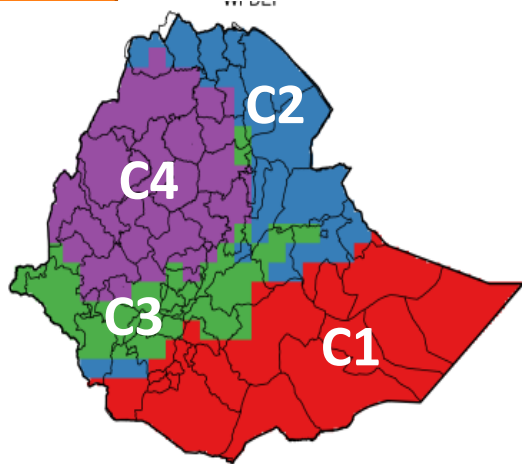
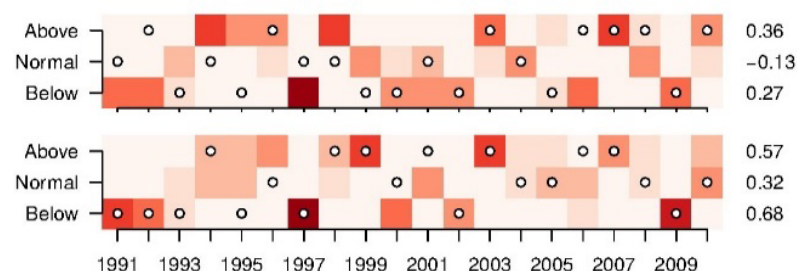
S4



RCA4(EC-EARTH)



CCLM(EC-EARTH)



1997/2002/2009 (dry) and 2007 (wet)
are reproduced but 2006



Focus on summer rainfall in Ethiopia

- RCMs are able to capture the seasonal signal from their driving GCM (EC-EARTH)
- Prediction skill comes from large scale
- RCMs show no clear added value (if the added value is a higher predictive skill in the RCM hindcast)
- All models can predict dry (1997, 2002 and 2009) and wet (2007) years over the Ethiopian Highlands but wet 2006
- Large observational uncertainties can potentially prevent us from accurate verification of hindcasts in East Africa
- using a subset of the full ensemble doesn't provide much information (limited use)
- conclusions are only for Ethiopia in the June-September season and cannot be generalised for other regions and seasons