

Contrasting global and regional climate models over Europe and Africa

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 - RCMs and driving GCMs may project contradicting signals
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First step: identifying regions, seasons and RCM-GCM combinations with contrasting climate change signal between RCMs and their driving GCMs

Euro-CORDEX (March 2019):

- **32 simulations (RCP8.5), 9 RCMs**
 - **7 driving GCMs** (EC-EARTH with 3 and MPI-ESM with 2 members)
 - HadGEM2-ES downscaled by 7 RCMs; EC-EARTH (3 members) downscaled 10 times (5 RCMs)
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Africa-CORDEX:

- **22 simulations (RCP8.5), 8 RCMs**
 - **10 driving GCMs**
 - 9 simulations by SMHI-RCA4 and 5 by GERICS-REMO
-
- Common problem with sparse CORDEX matrices biased to a number of RCMs and/or GCMs
 - Both ensembles are taken as they are

4 categories of what RCMs can show compared to driving GCMs:

- Reduction of GCM signal (same sign)
 - Reduction of GCM signal (opposite sign)
 - Amplification of GCM signal (same sign)
 - **Amplification of GCM signal (opposite sign)**
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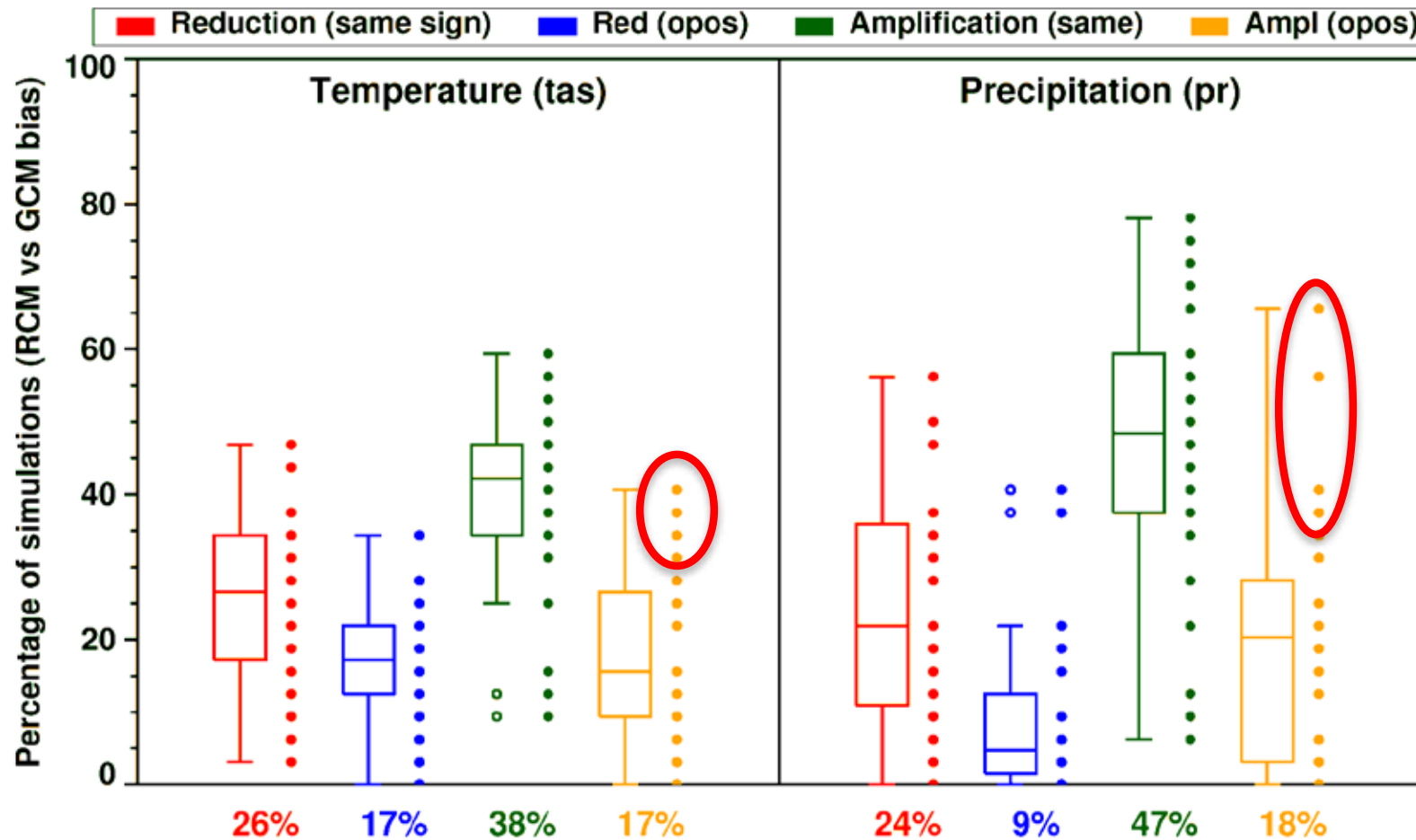
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The same 4 categories are used for classification of **RCM biases** wrt GCM ones

- there are expectations that RCMs should reduce large-scale biases originated in the driving GCMs
- such reduction may occur by different reasons but in general RCMs are supposed to reproduce large-scale GCM climatology

Biases in EUR-11

Bias wrt E-OBS v.17 | 4 seas | 8 regs | 32 CORDEX EUR-11 sim. | 1981-2010



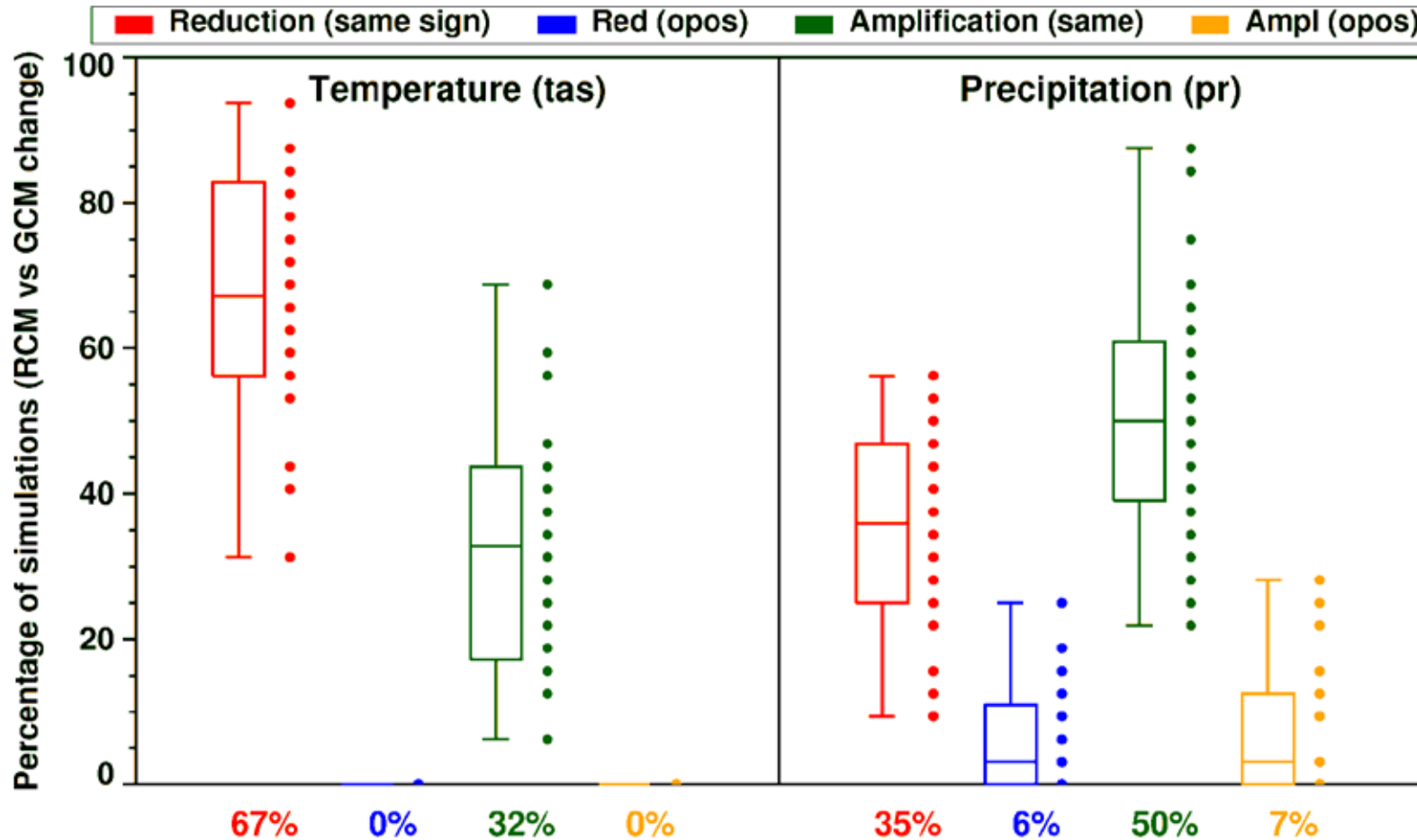
Statistics:
4 seasons
and 8 regions
(PRUDENCE)

one dot is
1 season
1 region
(32 in total)

- no systematic reduction of GCM biases
- more cases with amplification (especially with the same sign)
- a few season-region pairs where about 40-60% of the simulations show an amplification of GCM biases with the opposite sign

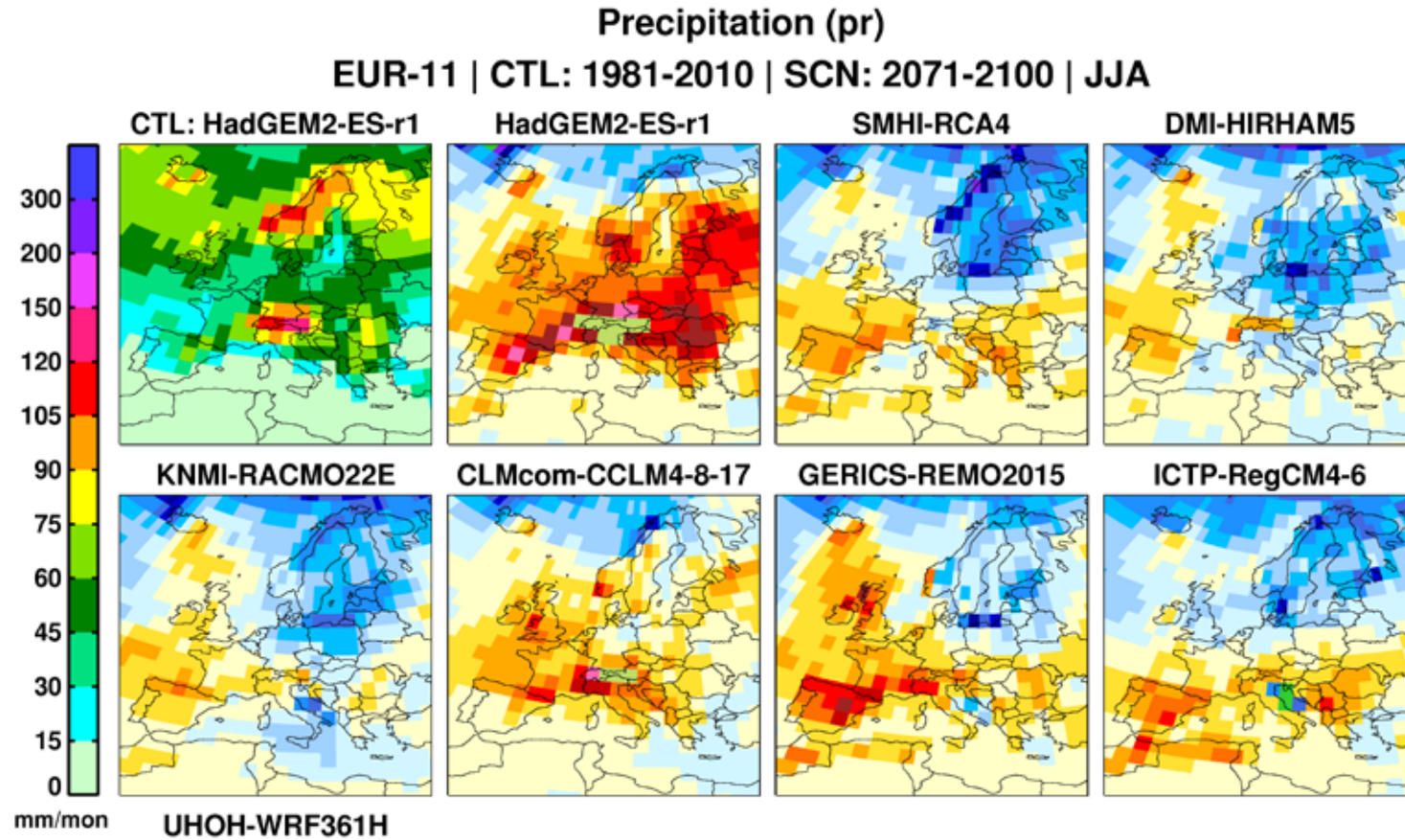
Climate change in EUR-11

Delta | 4 seas | 8 regs | 32 CORDEX EUR-11 sim. | CTL: 1981-2010 | SCN: 2071_2100



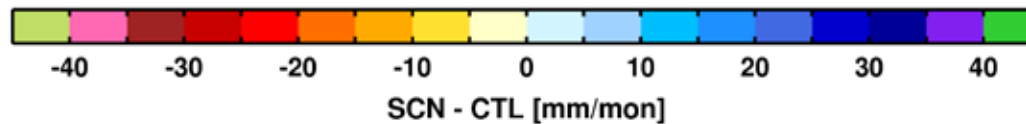
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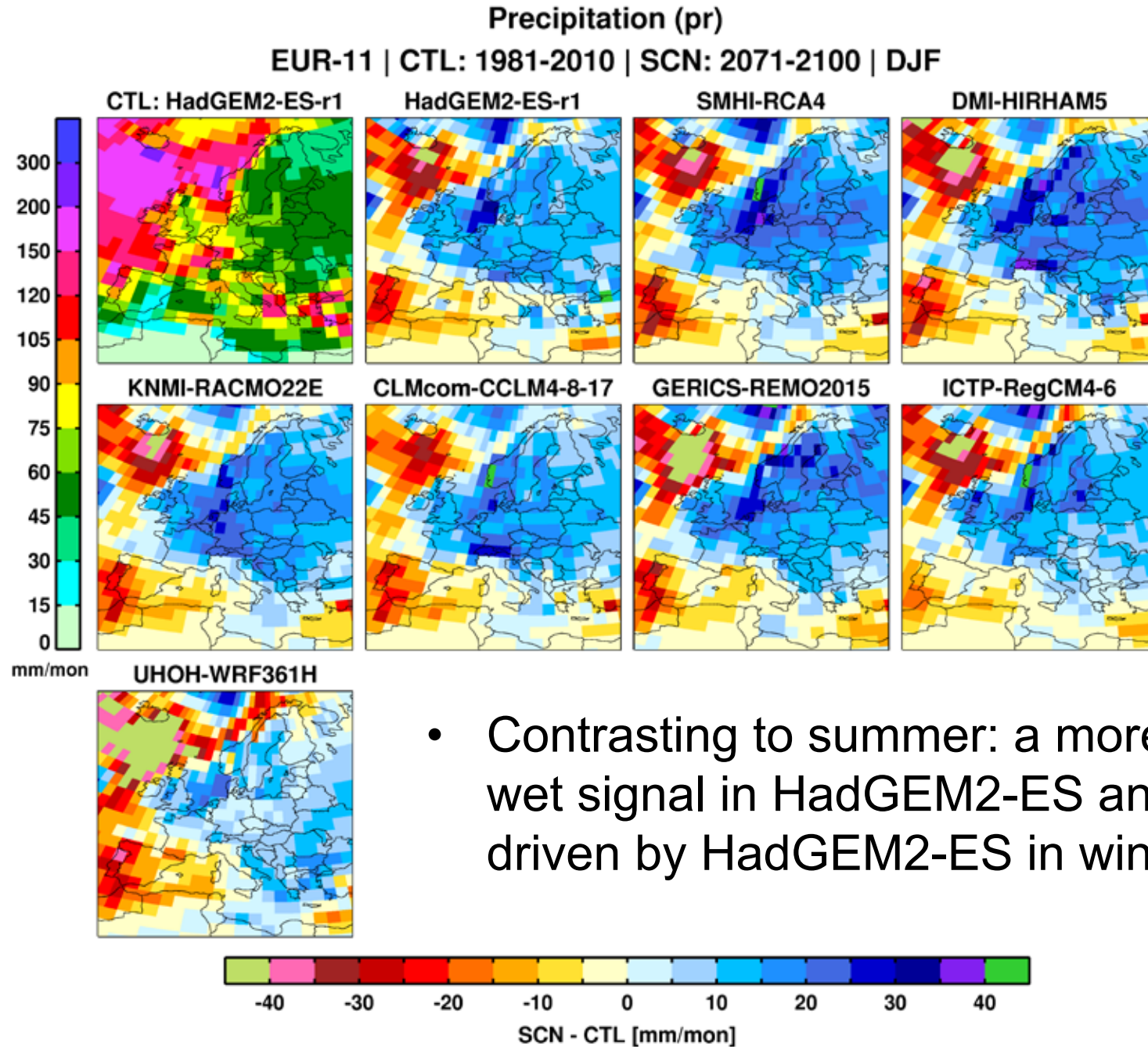
- Temperature: more cases when RCMs reduce GCM signal
- Precipitation: more cases when RCMs amplify GCM signal
- a number of cases with reduction/amplification (opos sign)



RCMs are aggregated to 2x2deg grid

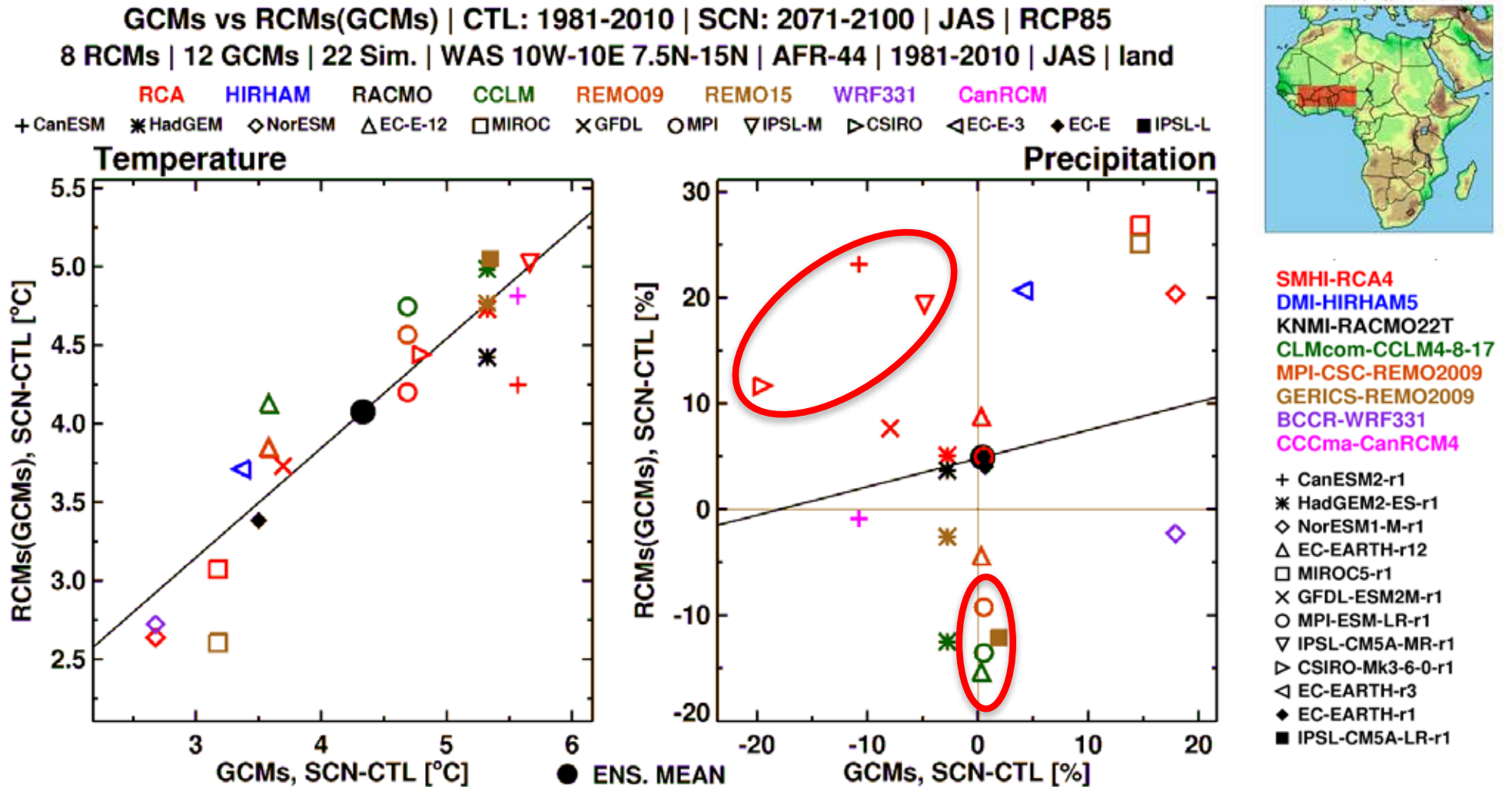
- a large-scale drying signal in HadGEM2-ES
- a well-known dipole pattern in RCMs driven by HadGEM2-ES





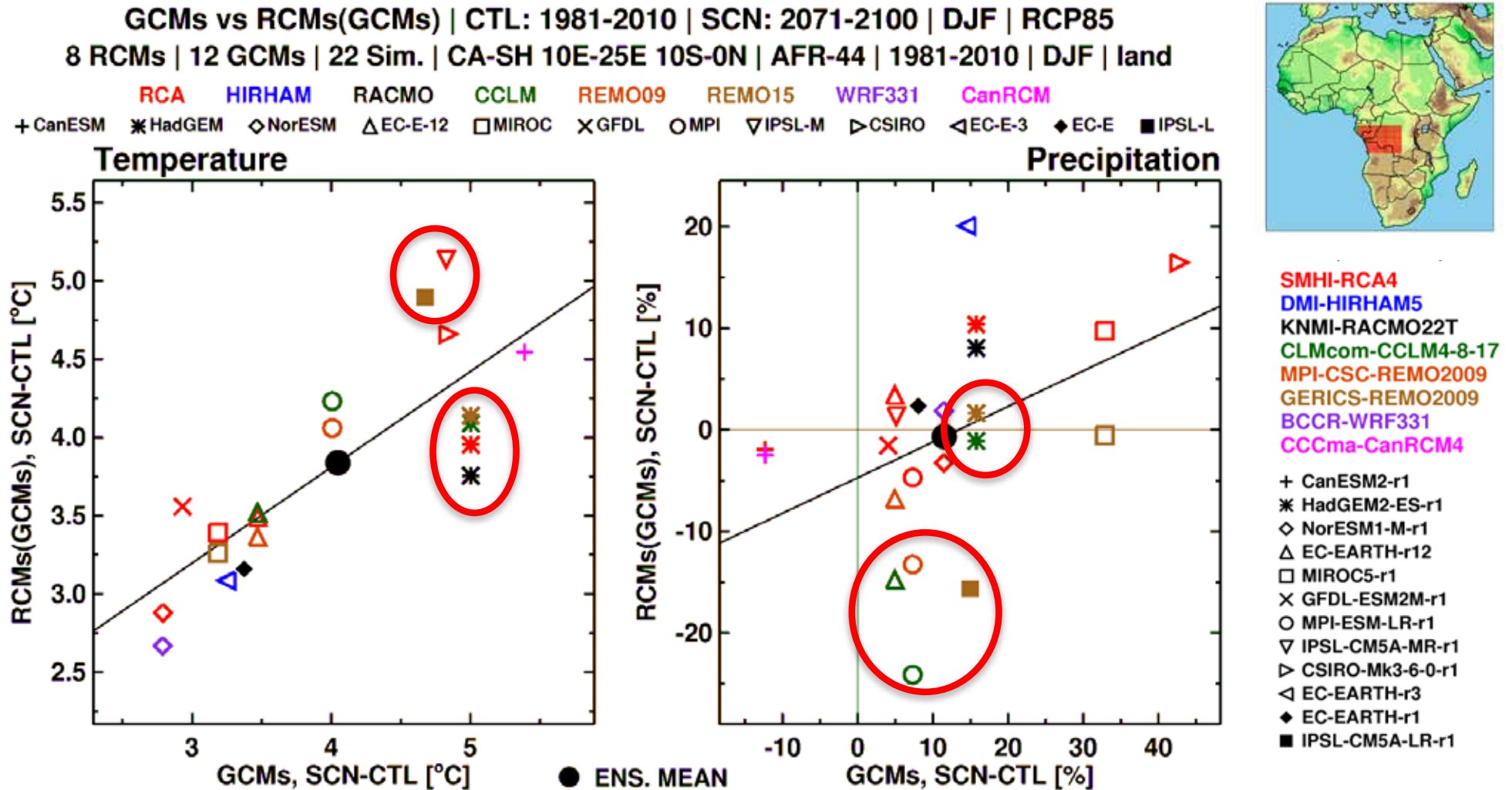
- Contrasting to summer: a more consistent wet signal in HadGEM2-ES and RCMs driven by HadGEM2-ES in winter

Climate change in West Africa

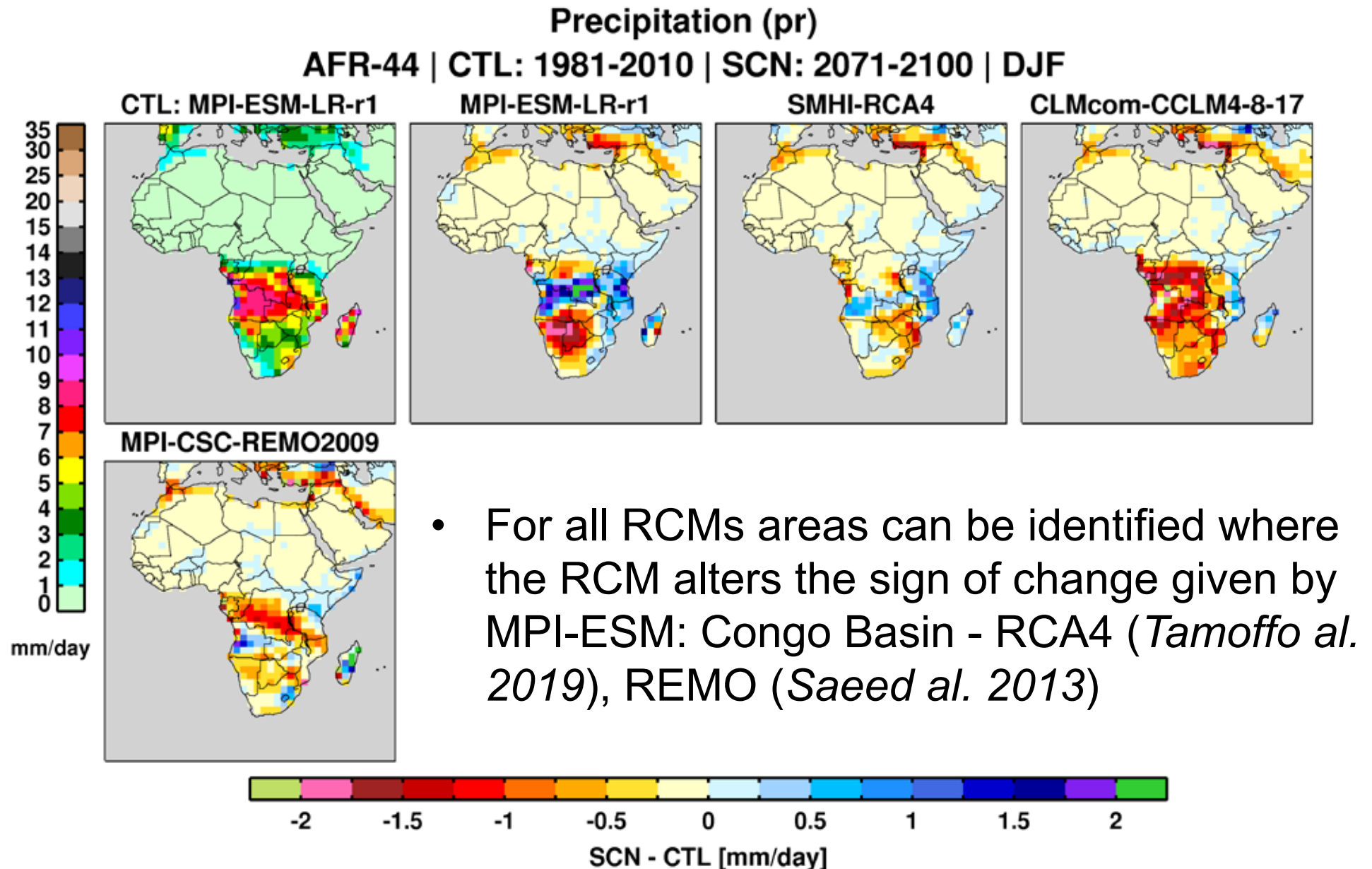


- in general consistent signal for temperature
- many contrasting RCM-GCM pairs for precipitation
- west Africa is a region with strong land-atmosphere coupling

Climate change in Central Africa

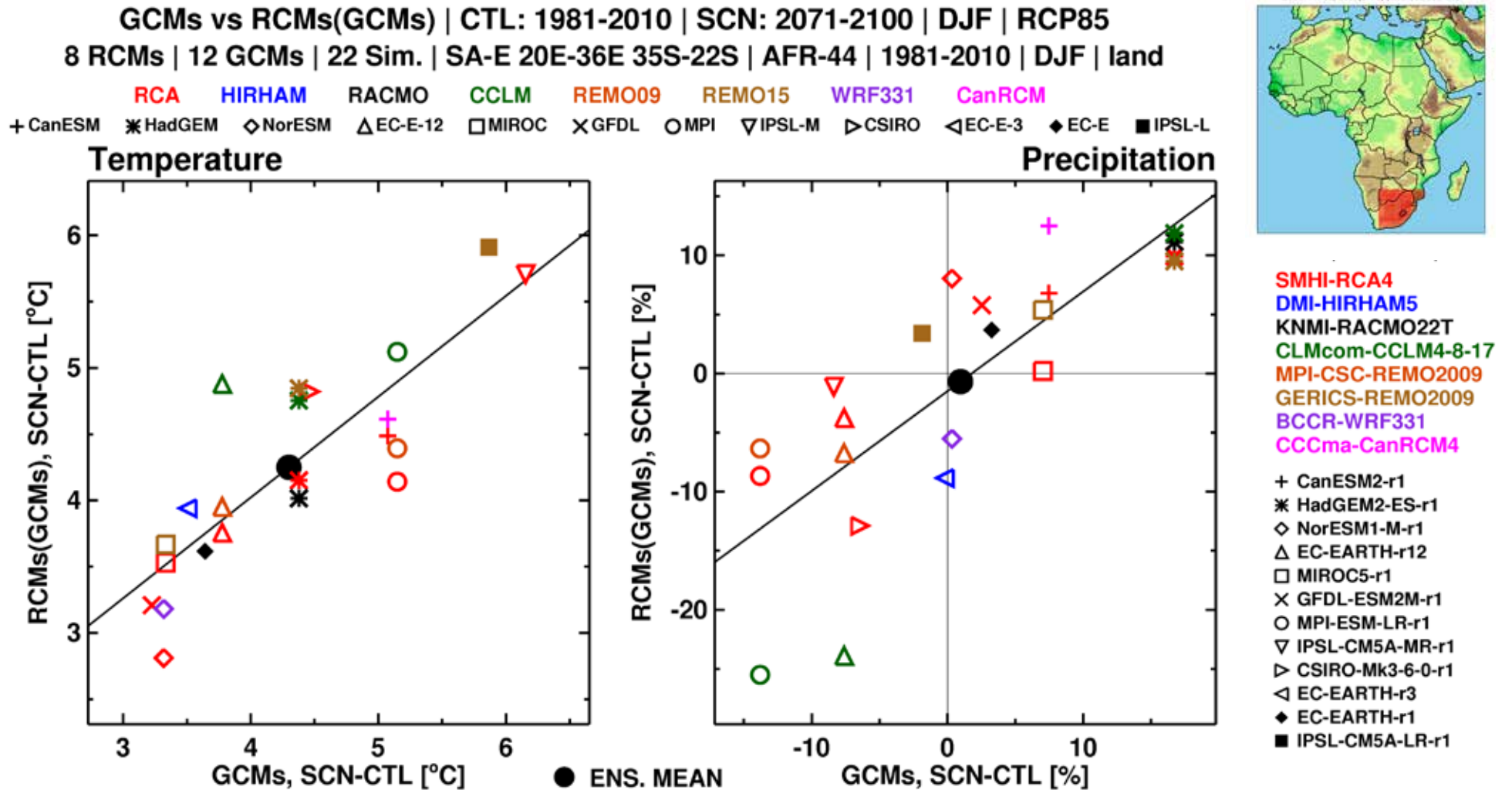


- in general consistent signal for temperature, although some strong amplification and reduction
- GCMs project wetter conditions while many RCMs project no change or drier conditions (e.g. Mba et al. ERL, 2018)



- regional moisture budget is necessary for understanding

Climate change in southern Africa



- In general consistent projected changes in precipitation between RCMs and their driving GCMs
- Pinto et al. 2019 found RCM/GCM differences at local scale

- A systematic analysis of seasonal mean large-scale climate change signal between RCMs and GCMs (Europe/Africa)
- In both Europe and Africa there a number of cases with strong regional reduction or amplification of GCM warming by RCMs
- In Europe projected change in precipitation is, in general, consistent between RCMs and GCMs with exceptions in a few seasons and regions when 40-60% of the RCM simulations contradict the driving GCMs
- In Africa there are many cases with contradicting signal in precipitation between the RCMs and GCMs (the tropics)

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- there is a need for a careful evaluation and analysis of both GCM and RCM ensembles (essential for Climate Services)
 - excluding GCMs and using only RCMs, can significantly change the message on future regional climate change