

A stochastic coupling scheme for climate models with high ocean-to-atmosphere resolution ratio

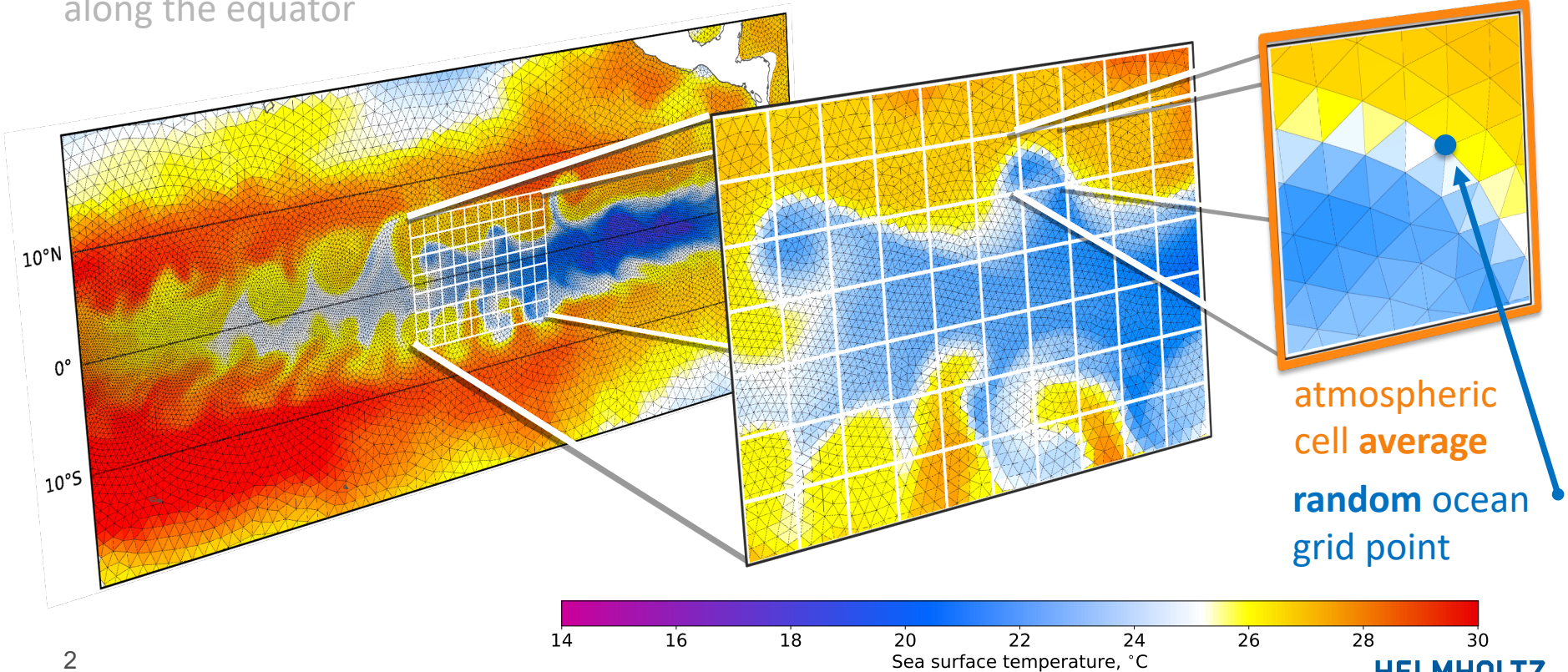
Thomas Rackow and Stephan Juricke
EGU General Assembly 2018

Motivation

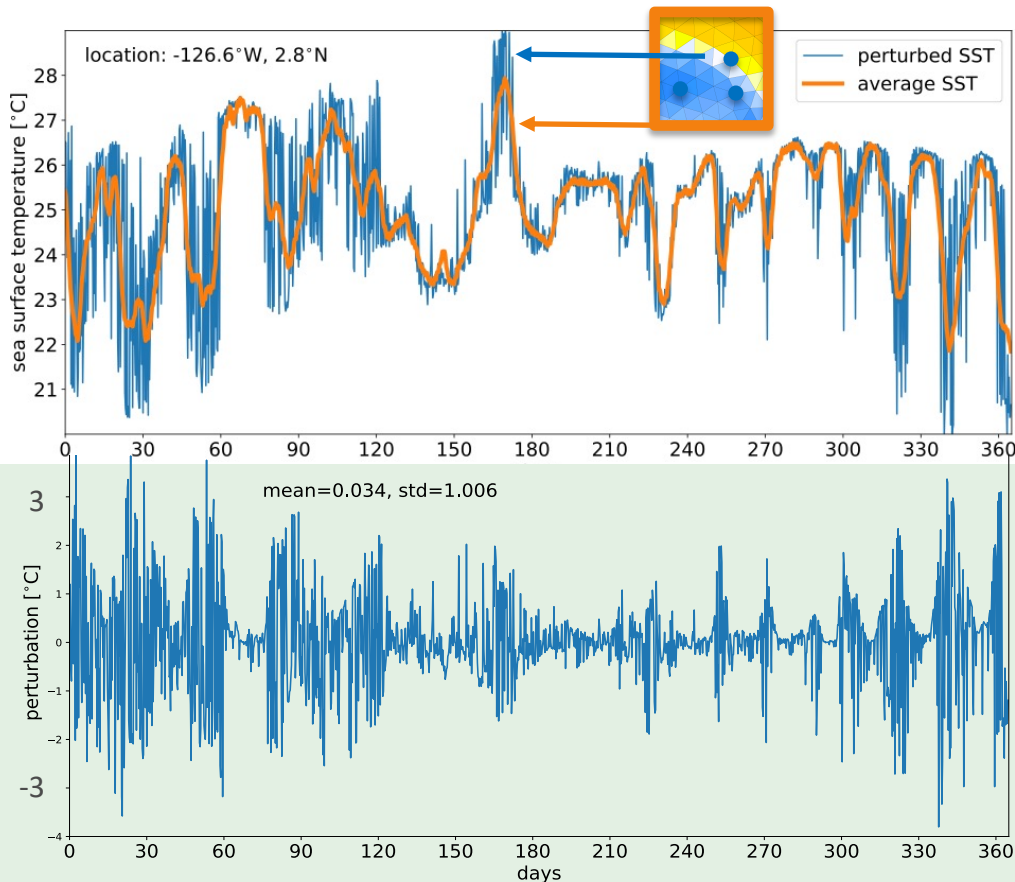
finer than 0.25°
along the equator

60 : 1

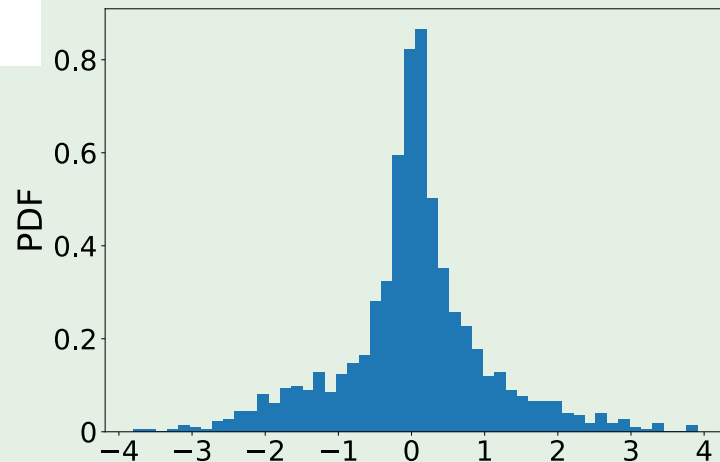
$1.875^\circ \times 1.875^\circ$



Motivation



- Resulting **perturbations** have **zero mean** and **std=1**; *varying over the year*
- More process-oriented approach to stochastic perturbation



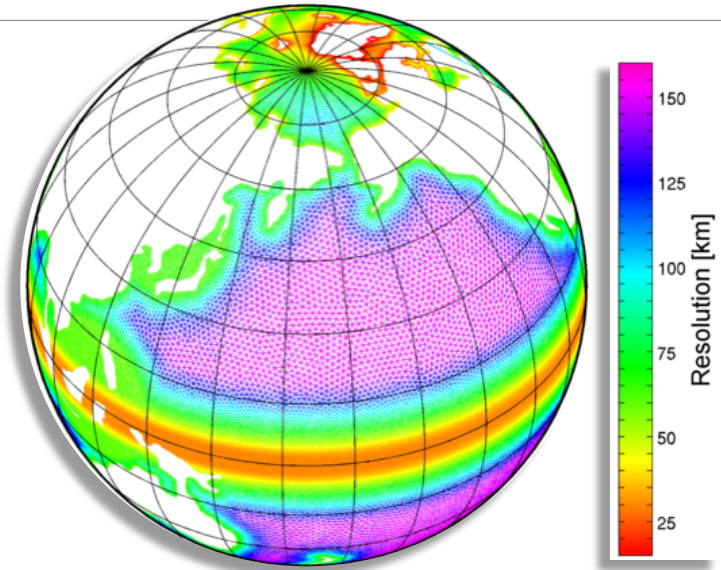
Experimental set-up

- Multi-resolution *AWI Climate Model* (AWI-CM; Rackow et al., 2016; Sidorenko et al., 2015)
- Coupled configuration of the *Finite Element Sea Ice-Ocean Model* (FESOM) and *ECHAM6*
- Refinement in the ocean along the equator, along coastlines, and in the Arctic

- **2 experiments:**

1) REF: standard **6-hourly** deterministic coupling; 1500yr present-day (1990) control run

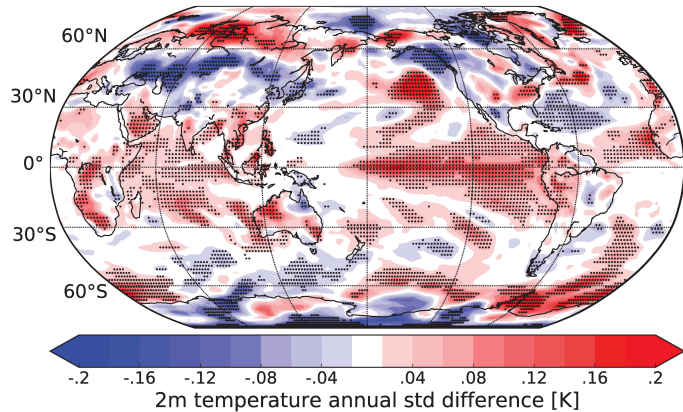
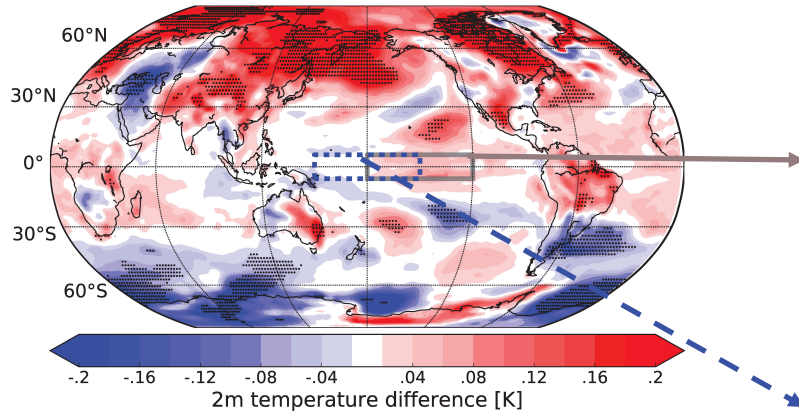
2) STOCH: stochastic coupling; **15** start dates to better sample decadal variability, branching from REF; 15x **9-yr** simulations (**total of 135 years**)



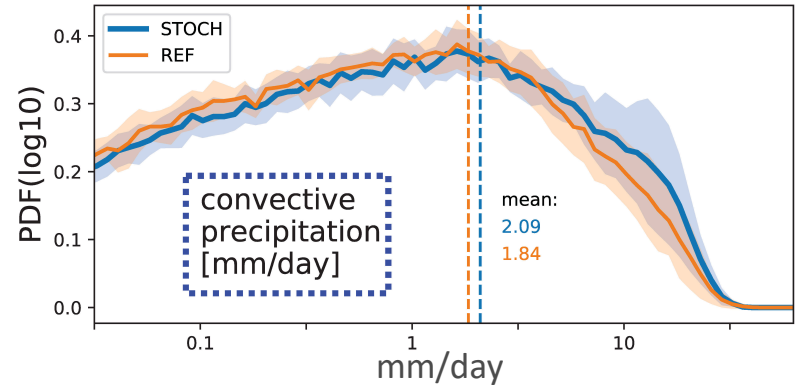
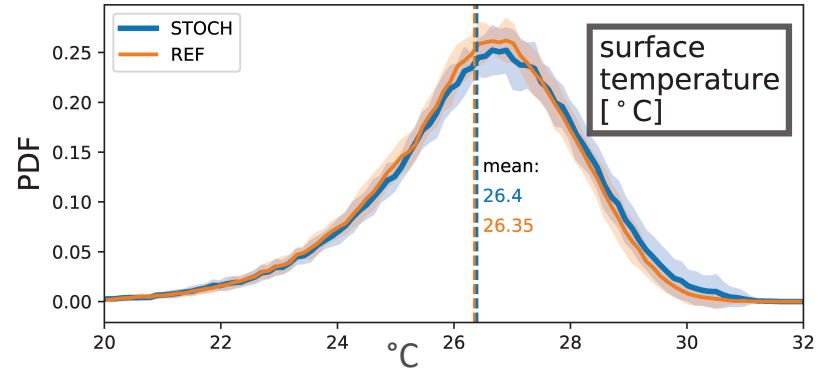
Rackow et al., 2016

High ocean-to-atmosphere resolution ratio in the eq. Pacific

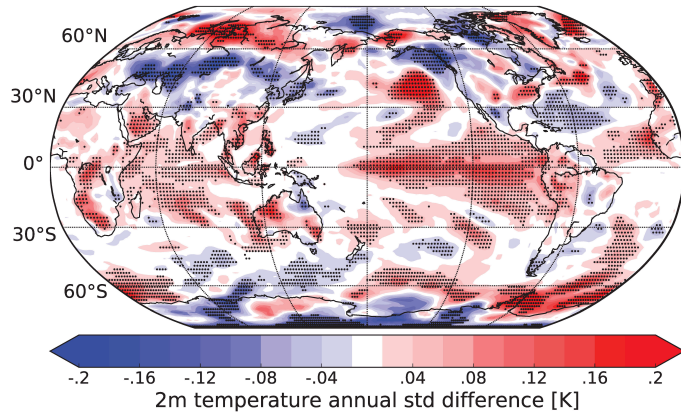
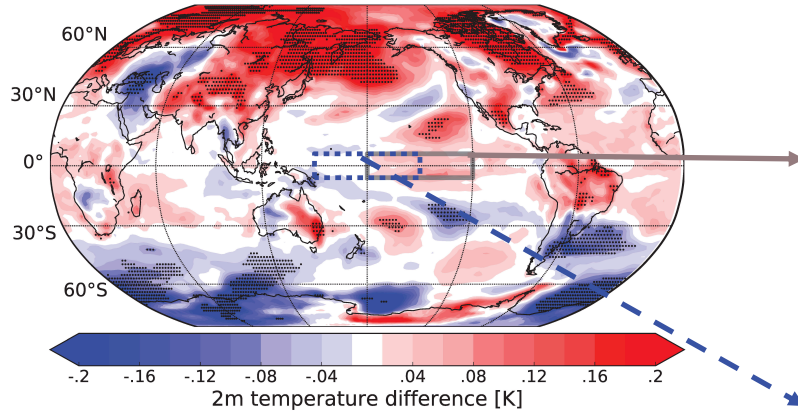
STOCH – REF



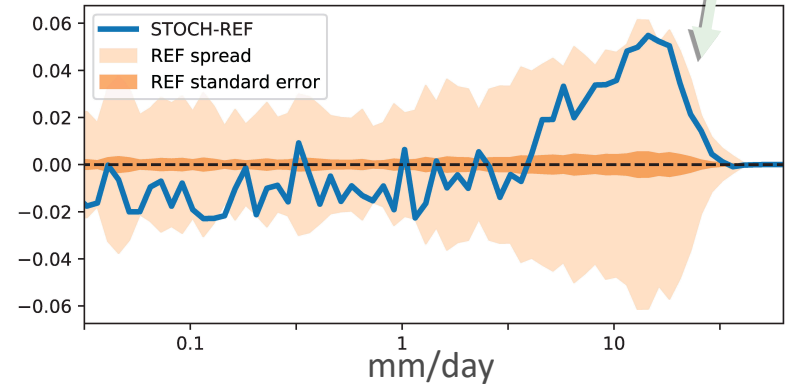
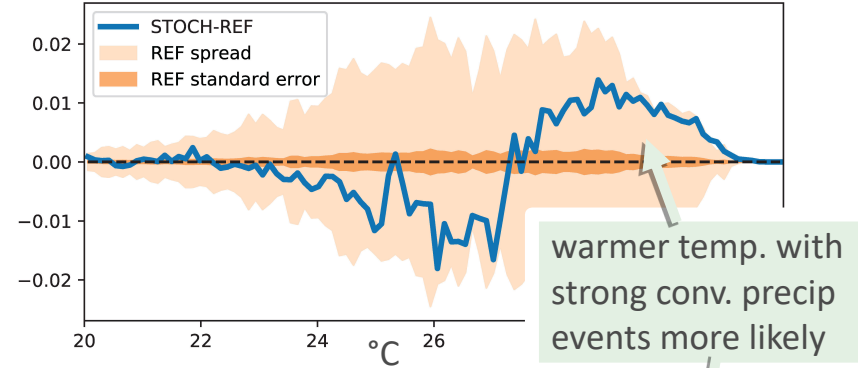
PDFs in tropical boxes



STOCH – REF

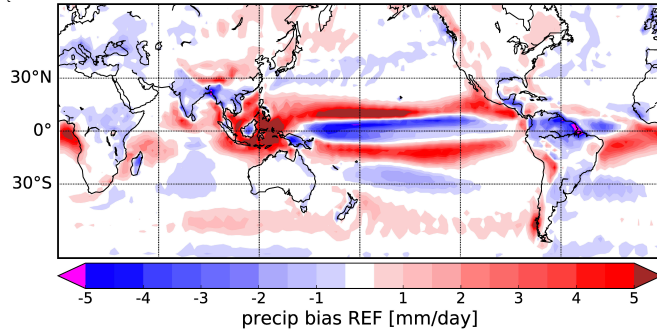


PDFs in tropical boxes

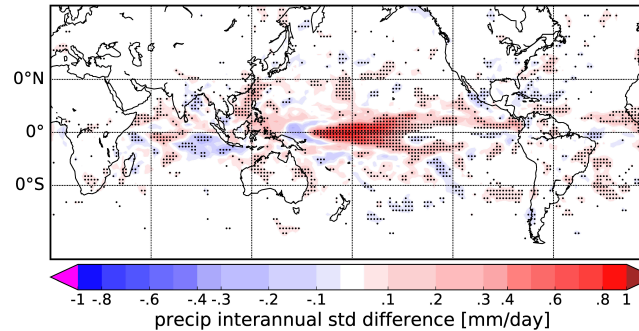
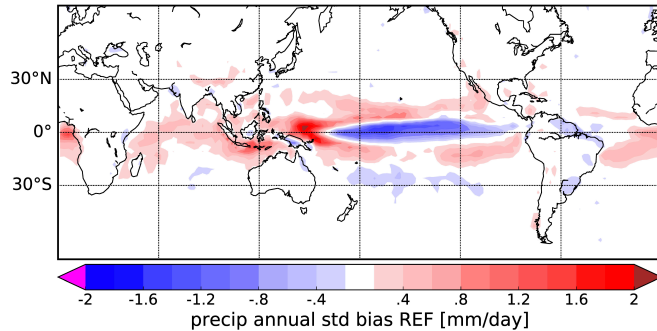
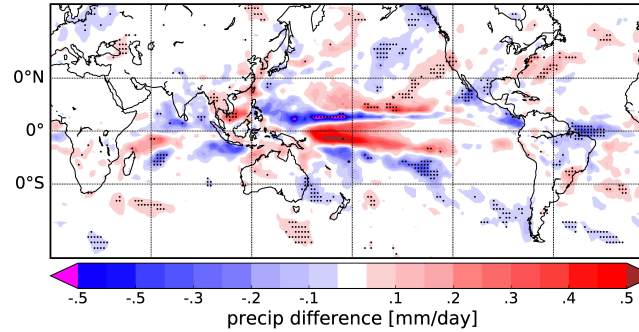


Results: precip bias and change

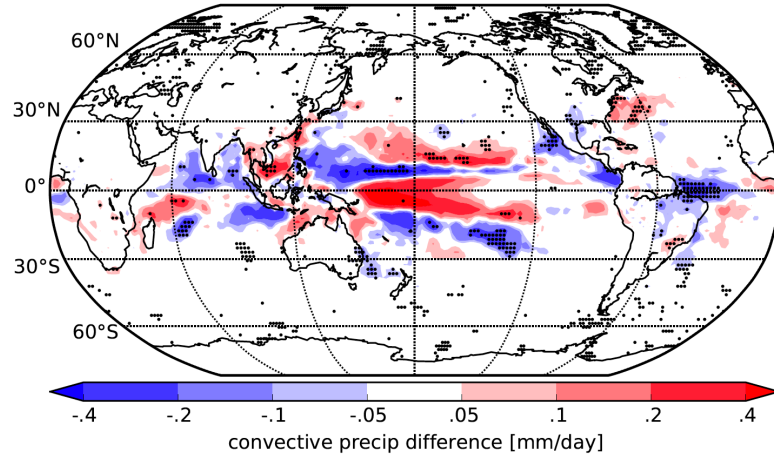
REF – GPCP (1981-2016)



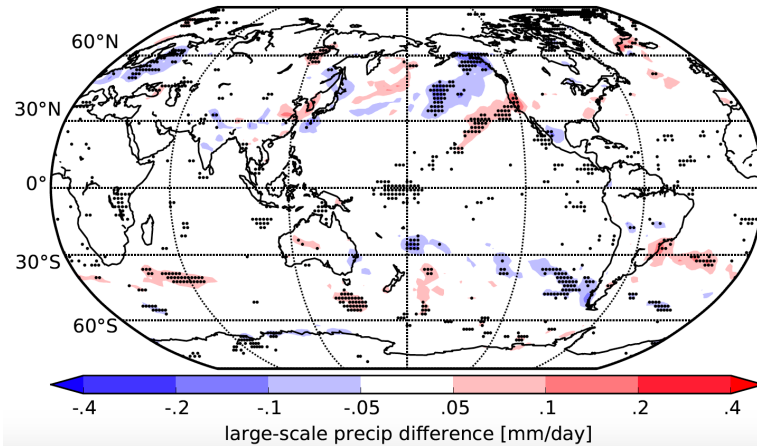
STOCH – REF



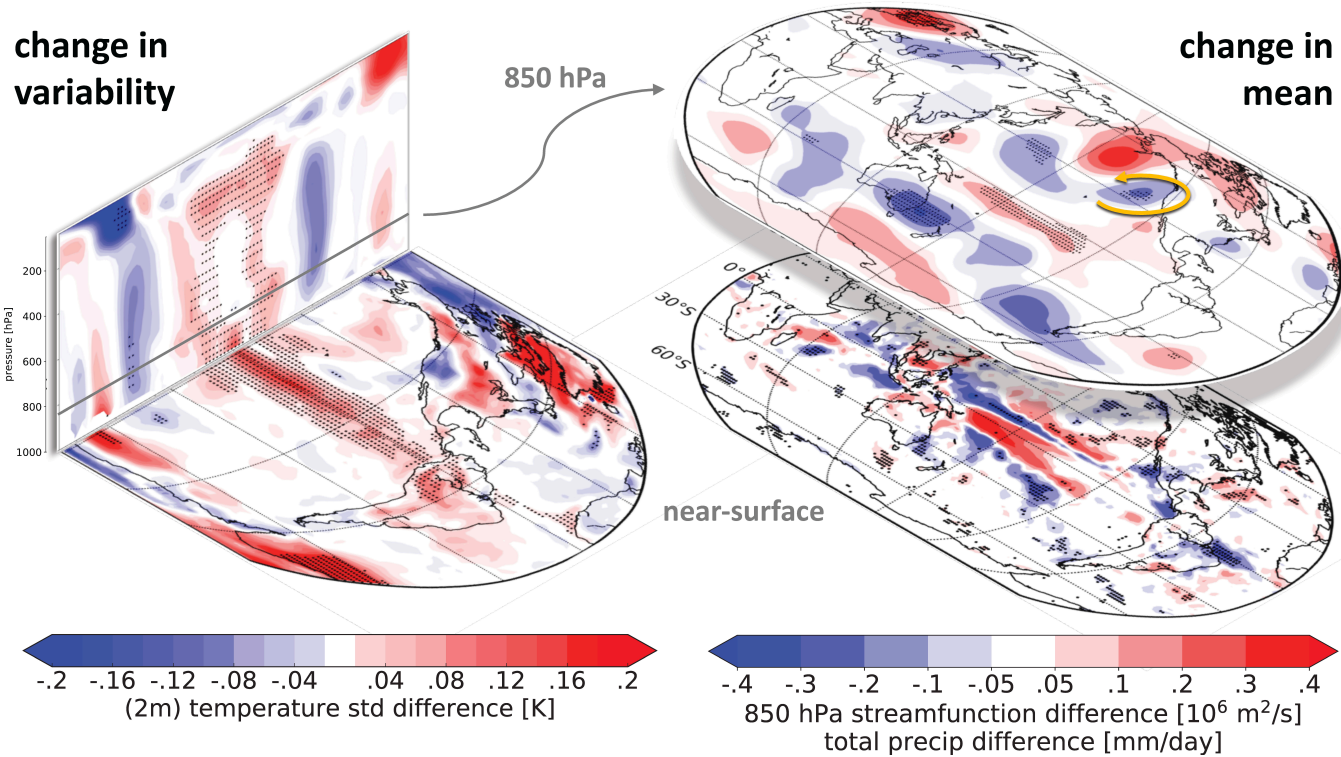
- Change (STOCH-REF) resembles bias pattern, but with different sign
-> **major improvement** by 10% (mean) and up to 50% (interannual variability)



- precip changes (STOCH-REF) are mainly due to convective precipitation changes
- large-scale precipitation changes of smaller amplitude in extratropics



Summary of mechanism

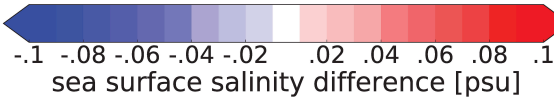
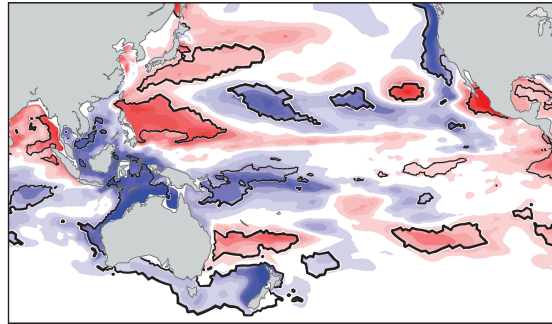
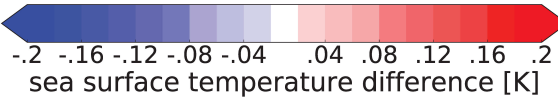
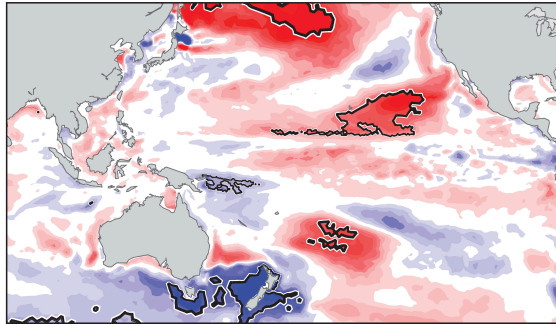


- increased temp. *variability* extends well into free troposphere
- *mean* circulation and conv. precip changes
- Rossby wave train leading to large-scale precip changes

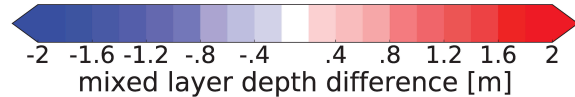
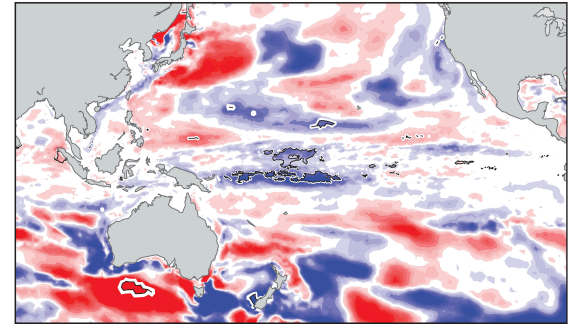
- **While the SST perturbations act on short time scales (6-hourly coupling), we identified a large impact not only on inter-annual variability, but also on the mean state**
 1. higher probability of strong convective precipitation events along the eq.
 2. *double ITCZ bias* is partly reduced (10% for mean), variability up to 50% in tropical Central and East Pacific
 3. further impacts on ocean and sea-ice (not shown)
- The coupling scheme is easily transferable to other models; currently implementing the coupling scheme into the OASIS3-MCT coupler (Valcke, 2015)
- **More details in: Rackow and Juricke, *A stochastic coupling scheme for climate models with high ocean-to-atmosphere resolution ratio*, under review in JAMES**

change in upper-ocean mean state

surface

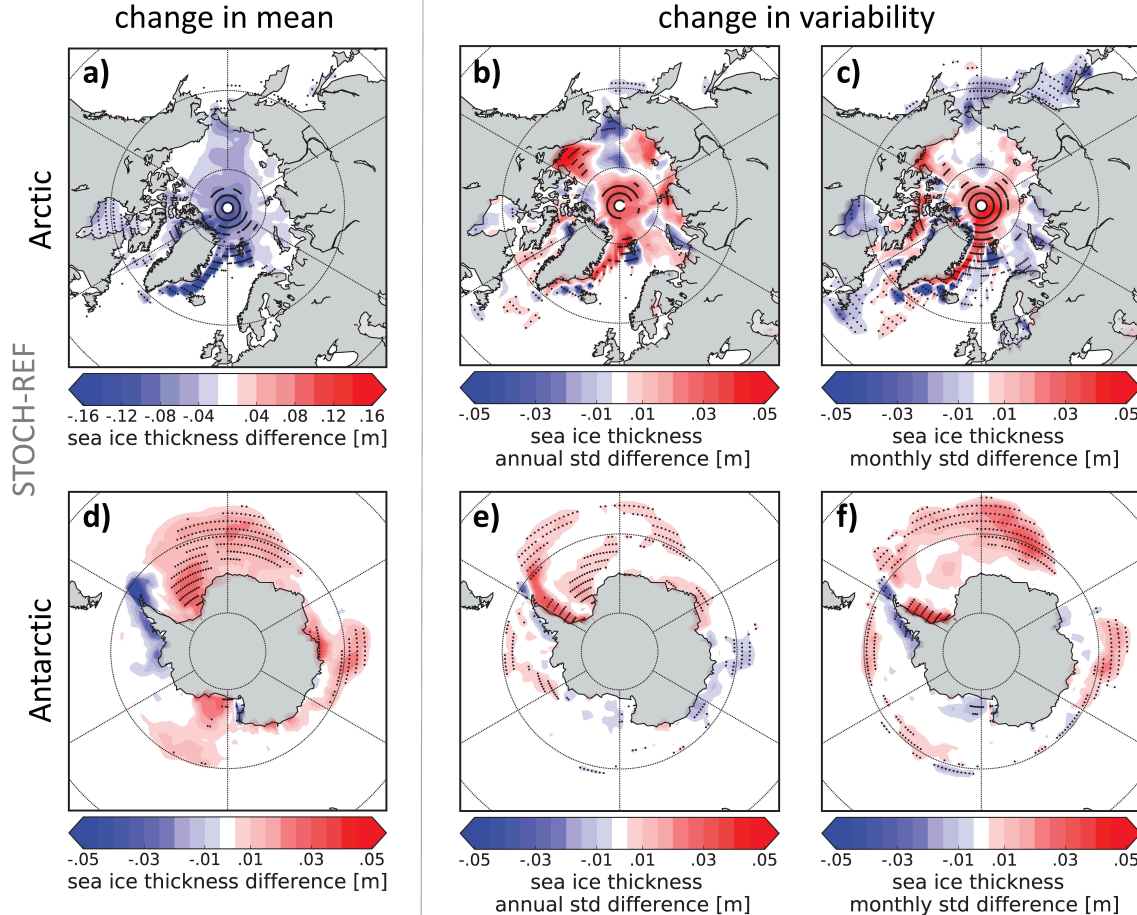


subsurface



- Upper ocean salinity changes respond directly to precipitation changes; fresher surface leads to shallower MLD

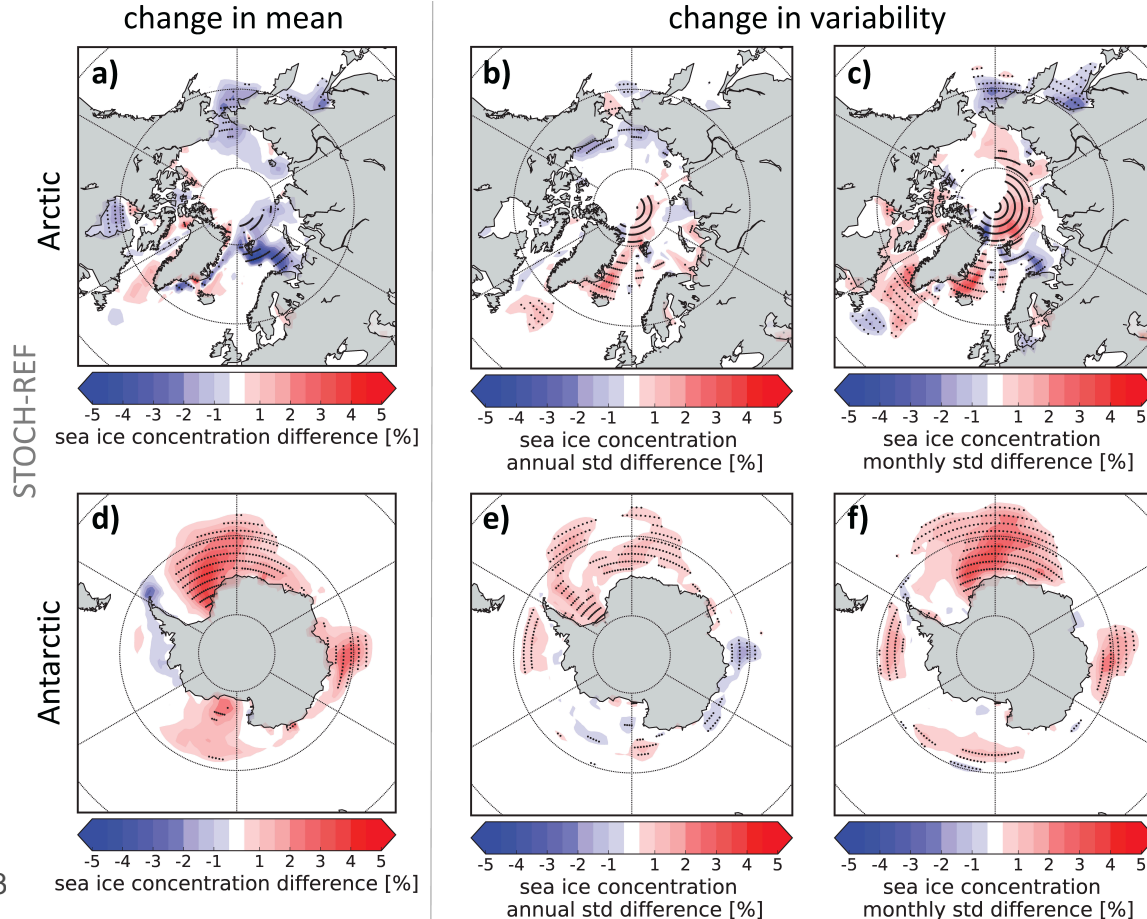
Appendix: sea ice changes



- Method **decreases** sea ice thickness (and concentration) in the **Arctic**
- Method **increases** sea ice thickness (and concentration) in the **Antarctic**

- **Increased** variability at both poles

Appendix: sea ice concentration changes



- Method **decreases** sea ice concentration in the **Arctic**
- Method **increases** sea ice concentration in the **Antarctic**
- **Increased** variability at both poles