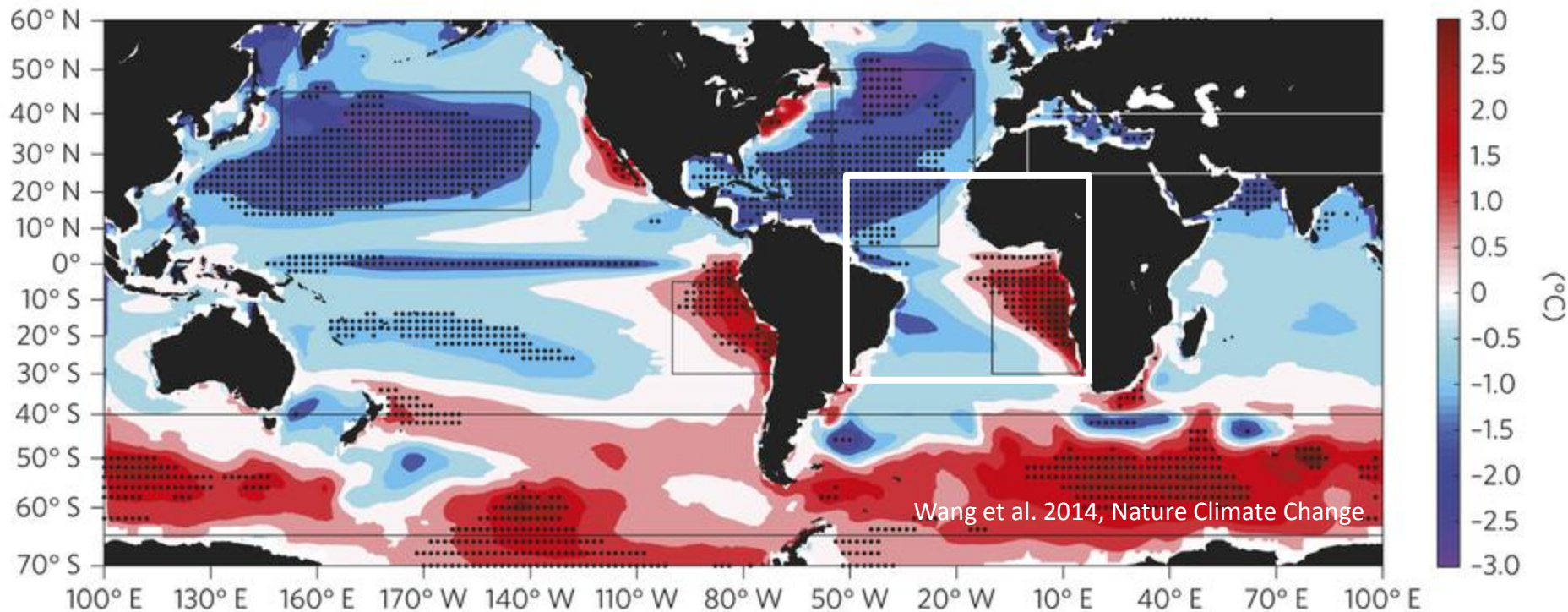


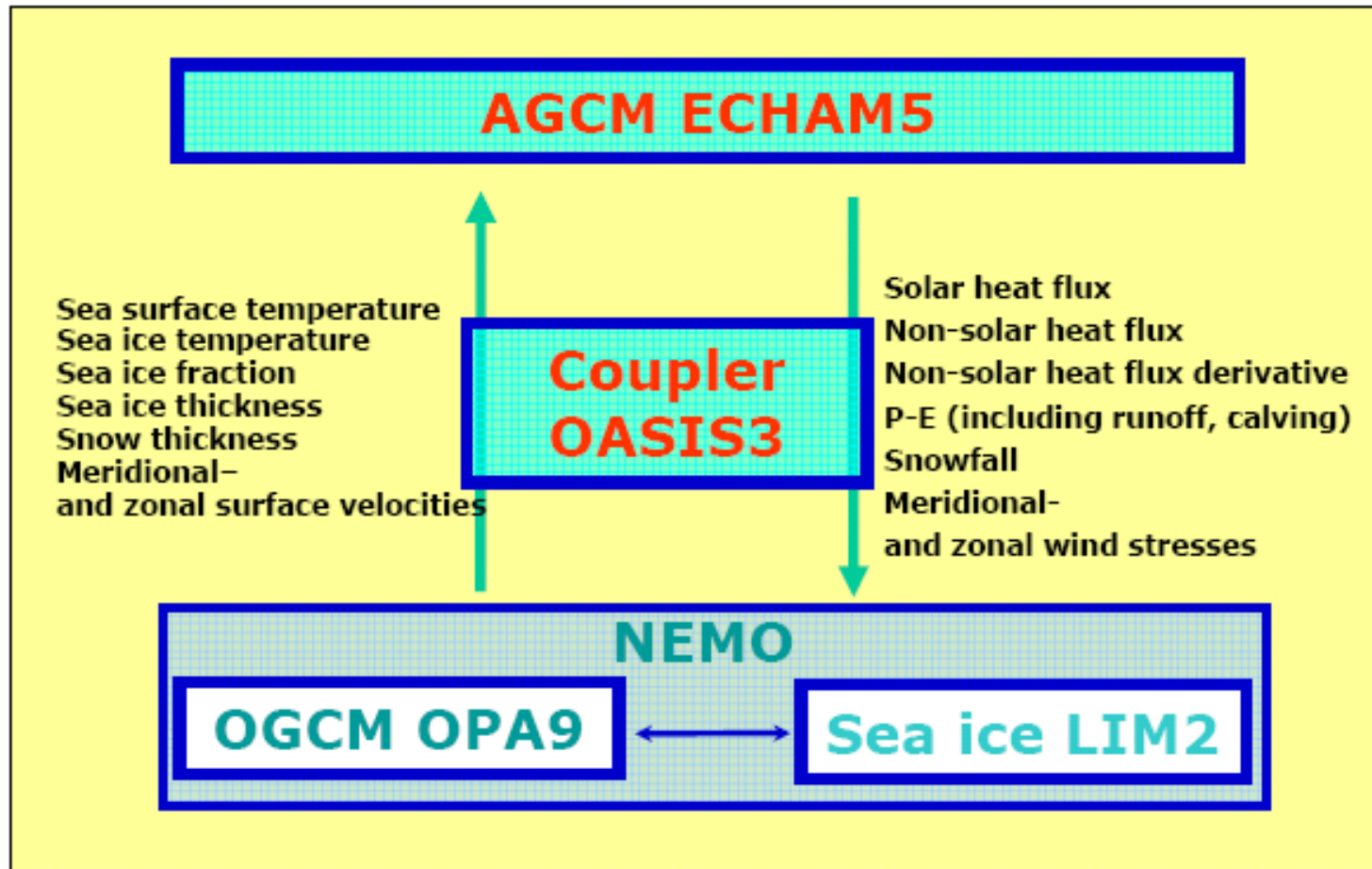
Alleviating Tropical Atlantic Sector Biases in the Kiel Climate Model by Enhancing Horizontal and Vertical Atmosphere Model Resolution: Climatology and Interannual Variability

Mojib Latif, Jan Harlass, Wonsun Park, Sebastian Steinig



Harlaß et al. 2015 (GRL), Harlaß et al. 2016 (Climate Dynamics, submitted),
Steinig et al. 2016 (to be submitted)

Influence of AGCM resolution in the Kiel Climate Model (KCM)

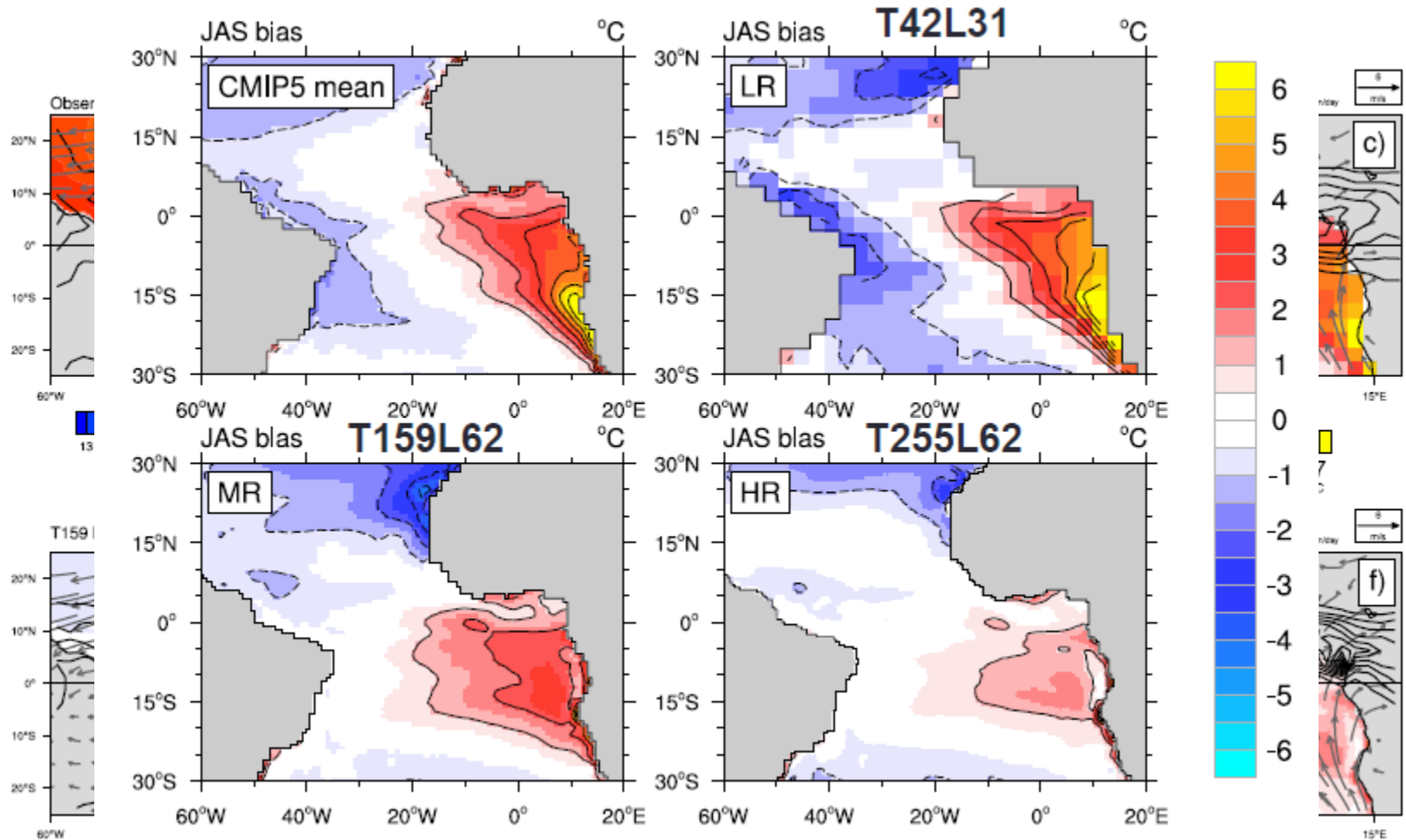


Enhancing AGCM resolution in the KCM, vertical and horizontal

Horizontal Resolution	Grid points Lon × Lat	Vertical Resolution	Acronym Coupled	Acronym Uncoupled
T42, ~2.8°	128 x 64	31	L	L (A)
T159, ~0.75°	480 x 240	31	M	M (A)
T159, ~0.75°	480 x 240	62	M-V	M-V (A)
T255, ~0.5°	768 x 384	62	H-V	-

...but keeping zonal ocean model resolution at 2°

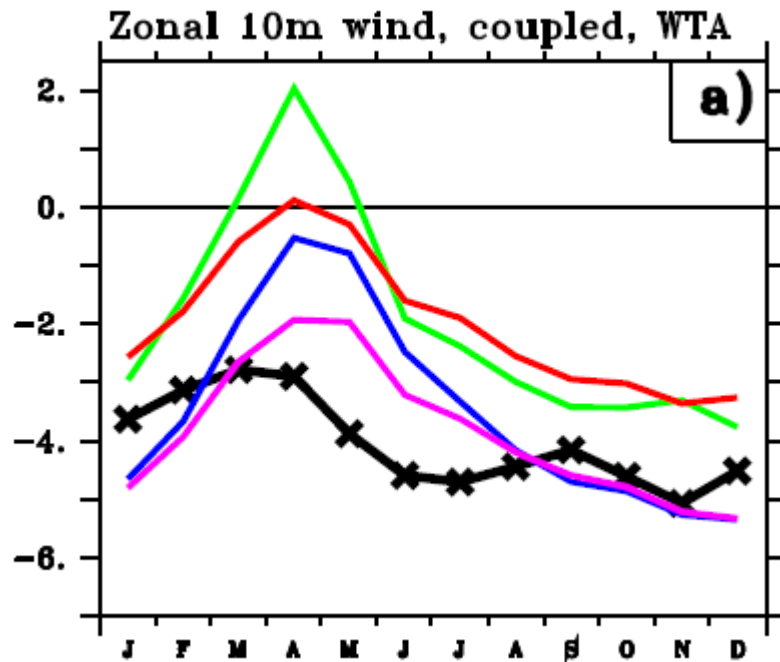
SST bias, mean wind and precipitation (JAS)



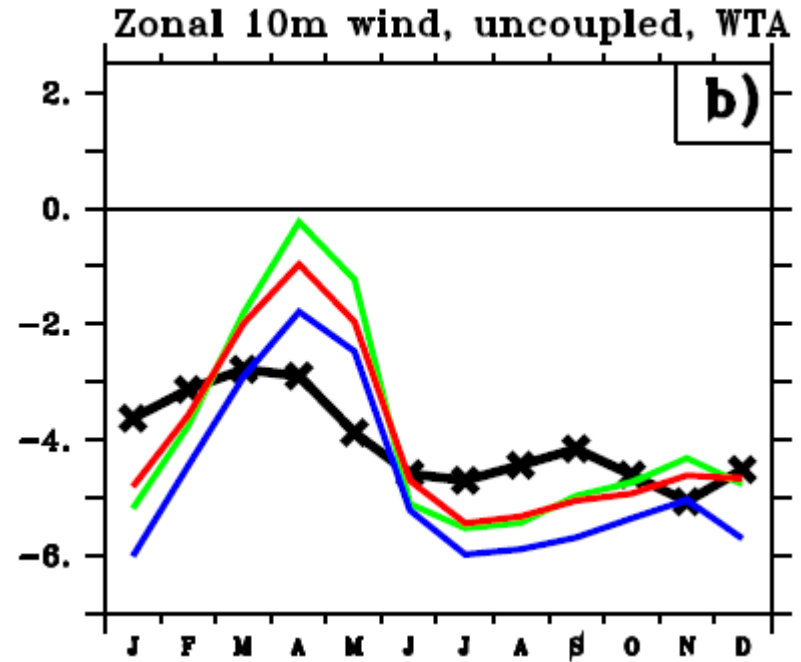
Harlaß et al. 2016

The equatorial westerly surface wind bias to a large extent originates in the AGCM

coupled KCM versions



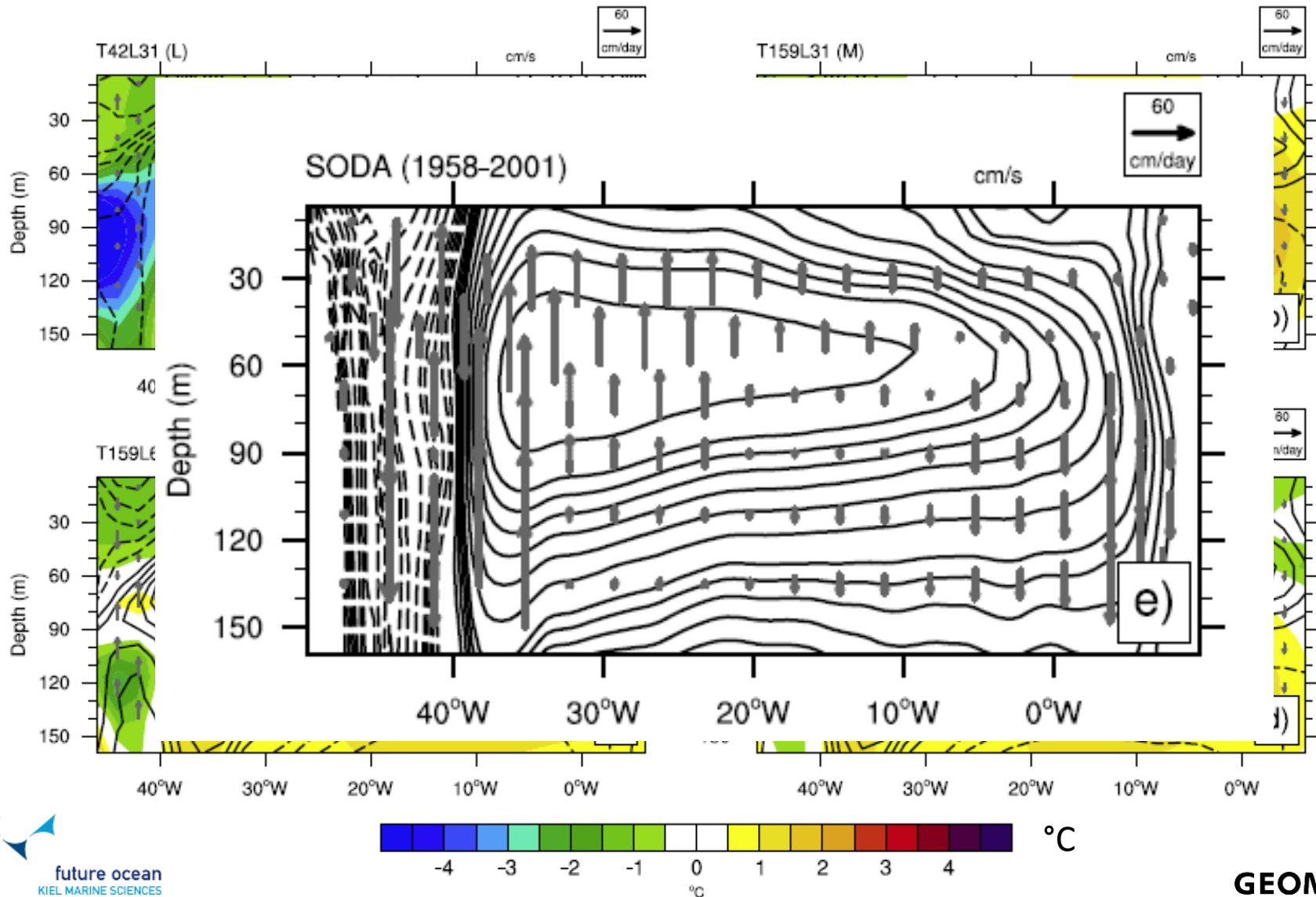
uncoupled AGCM versions



T42L31 (L/L(A)) T159L31 (M/M(A)) T159L62 (M-V/M-V(A)) T255L62 (H-V) Obs(-x-)

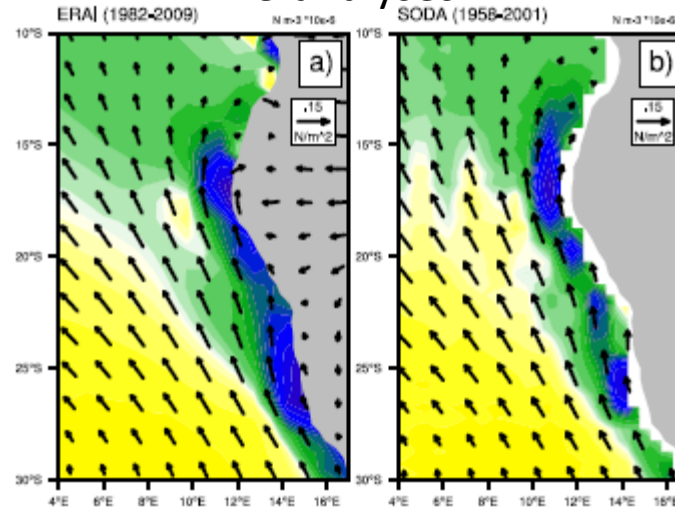
The westerly wind bias already is present in the uncoupled AGCM and is due to too little downward and equatorward transport of easterly momentum

Ocean temperature biases and circulation along the equator (MAM)

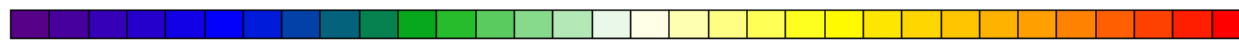
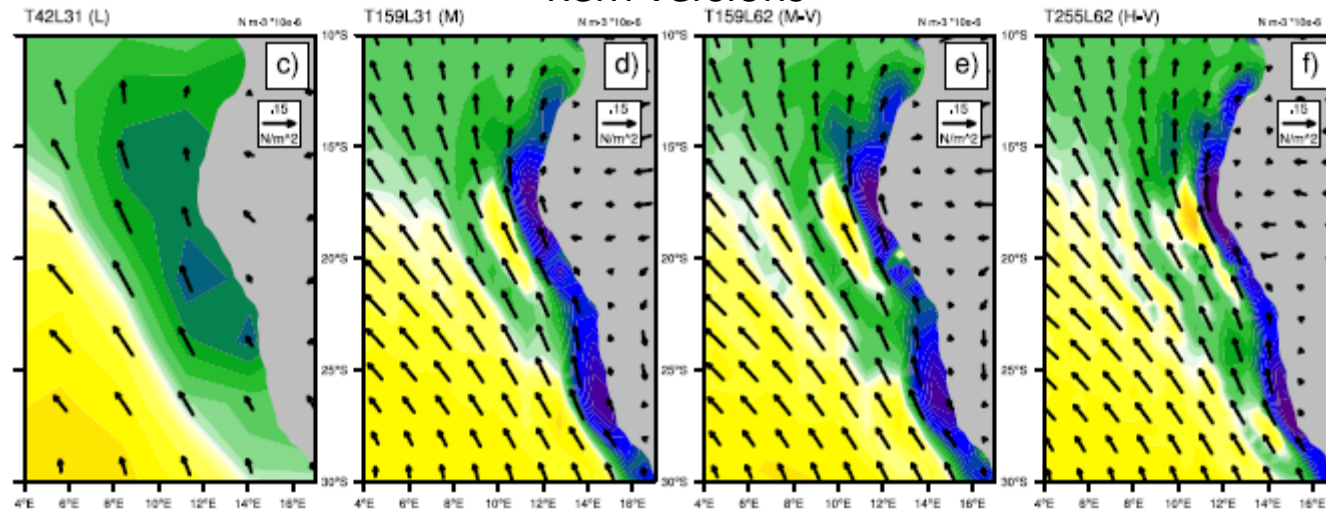


Wind stress and its curl in the southeast (JAS)

Re-analyses

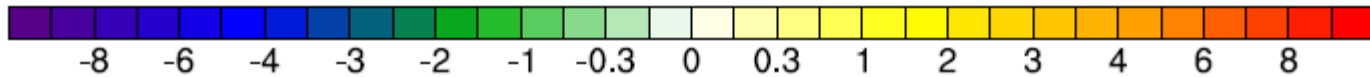
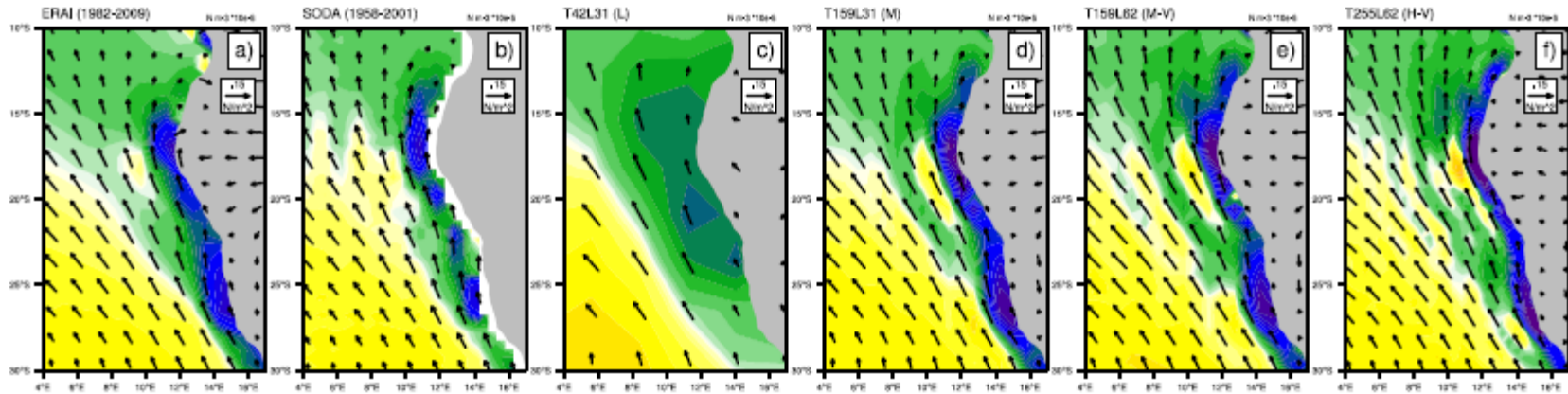


KCM versions

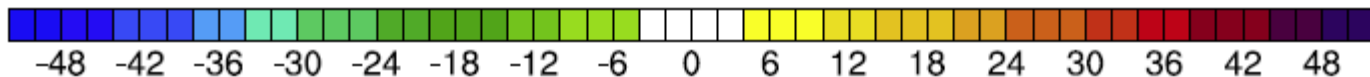
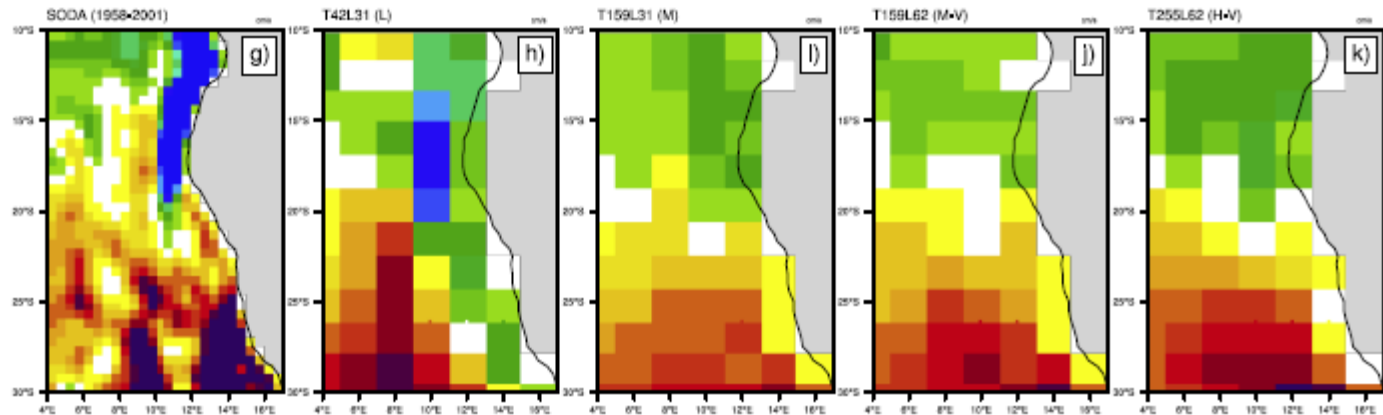


JAS mean wind stress (vectors, N/m^2) and curl ($N/m^3 \times 10^6$)

Meridional ocean currents (JAS)

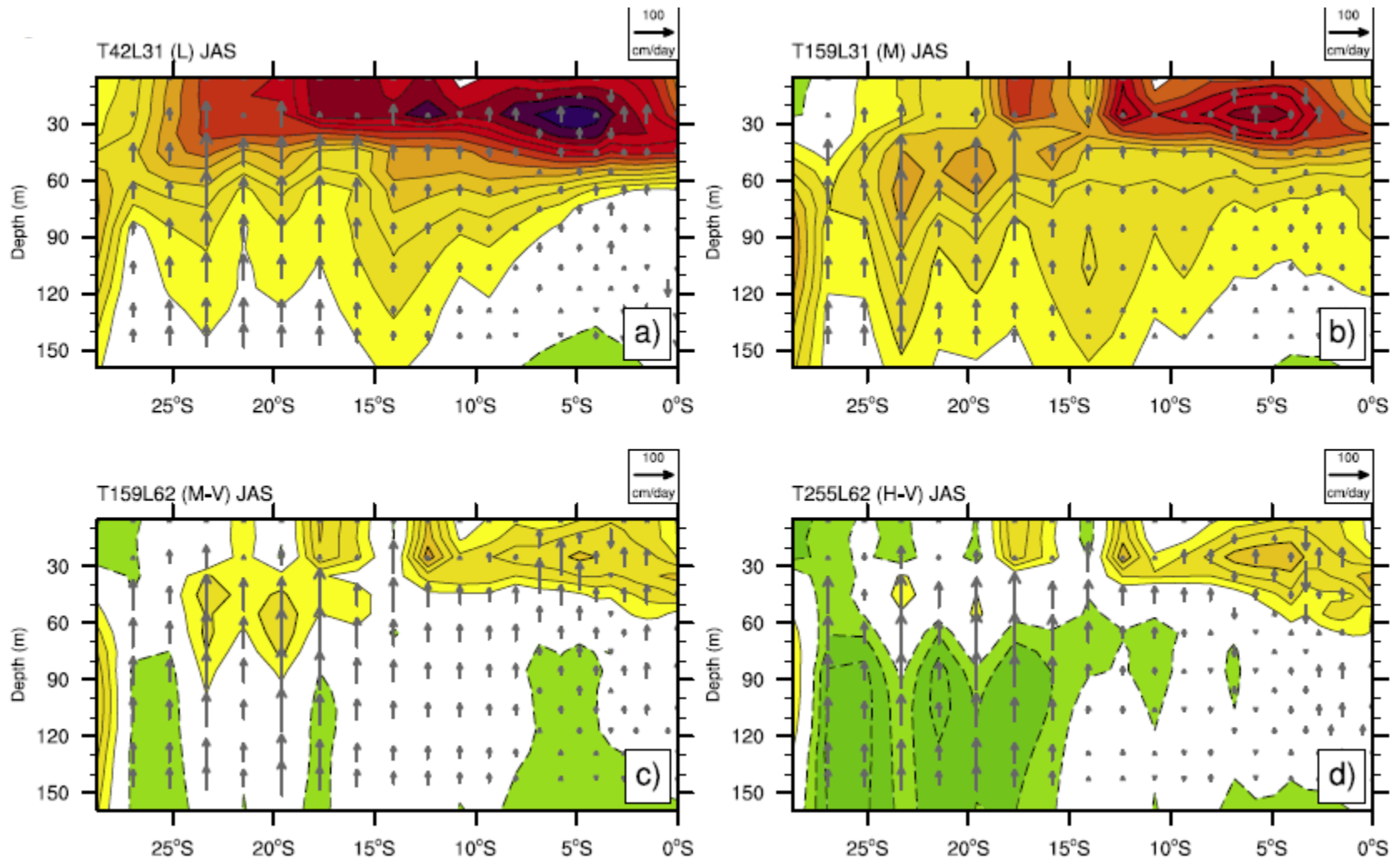


JAS mean wind stress (vectors, N/m^2) and curl ($\text{N/m}^3 \times 10^6$)



depth integrated meridional currents (cm/s, 15-216 m)

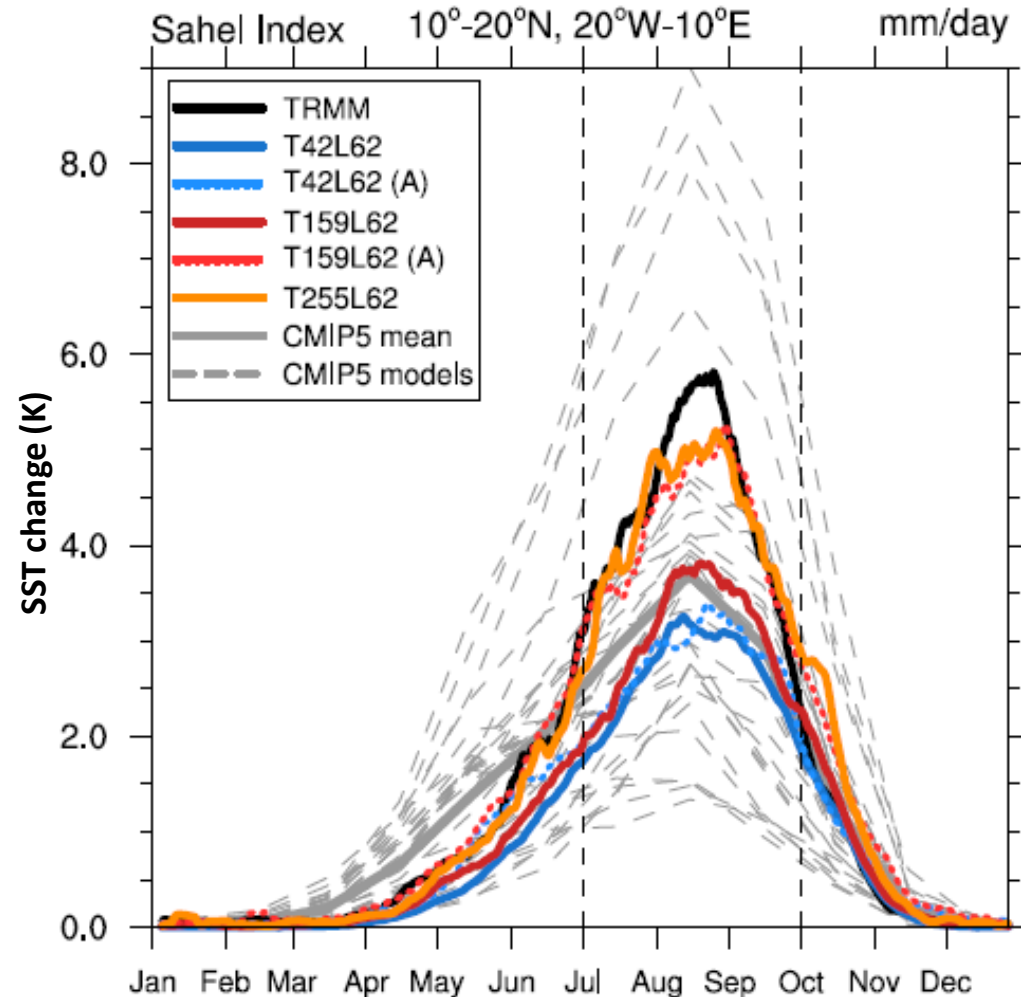
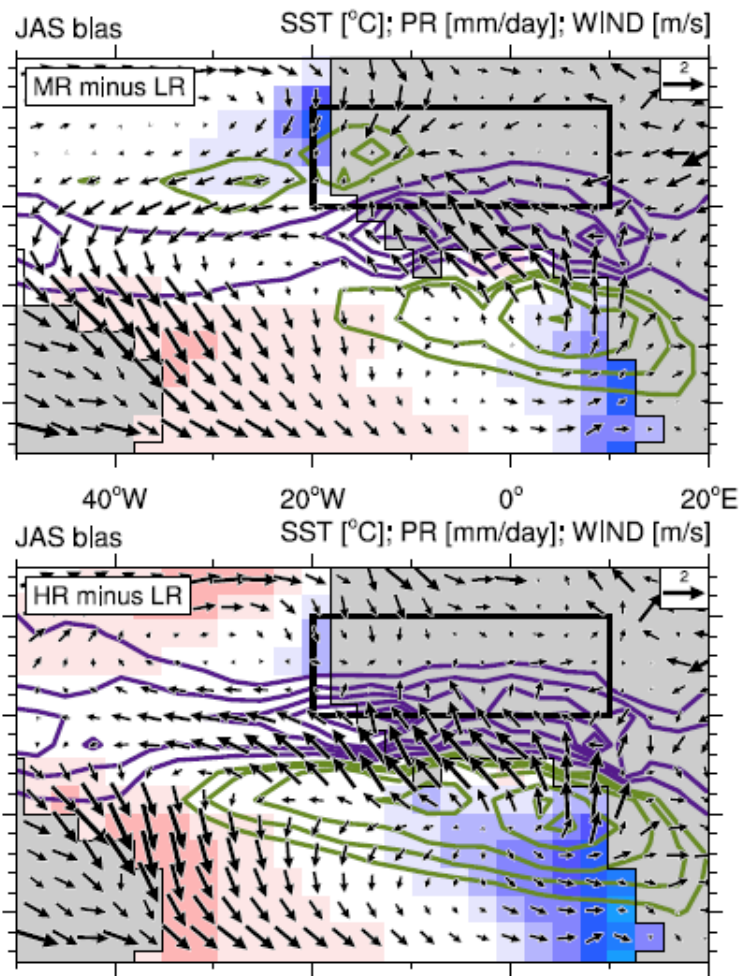
Meridional bias structure near the coast (JAS)



4° longitude averages



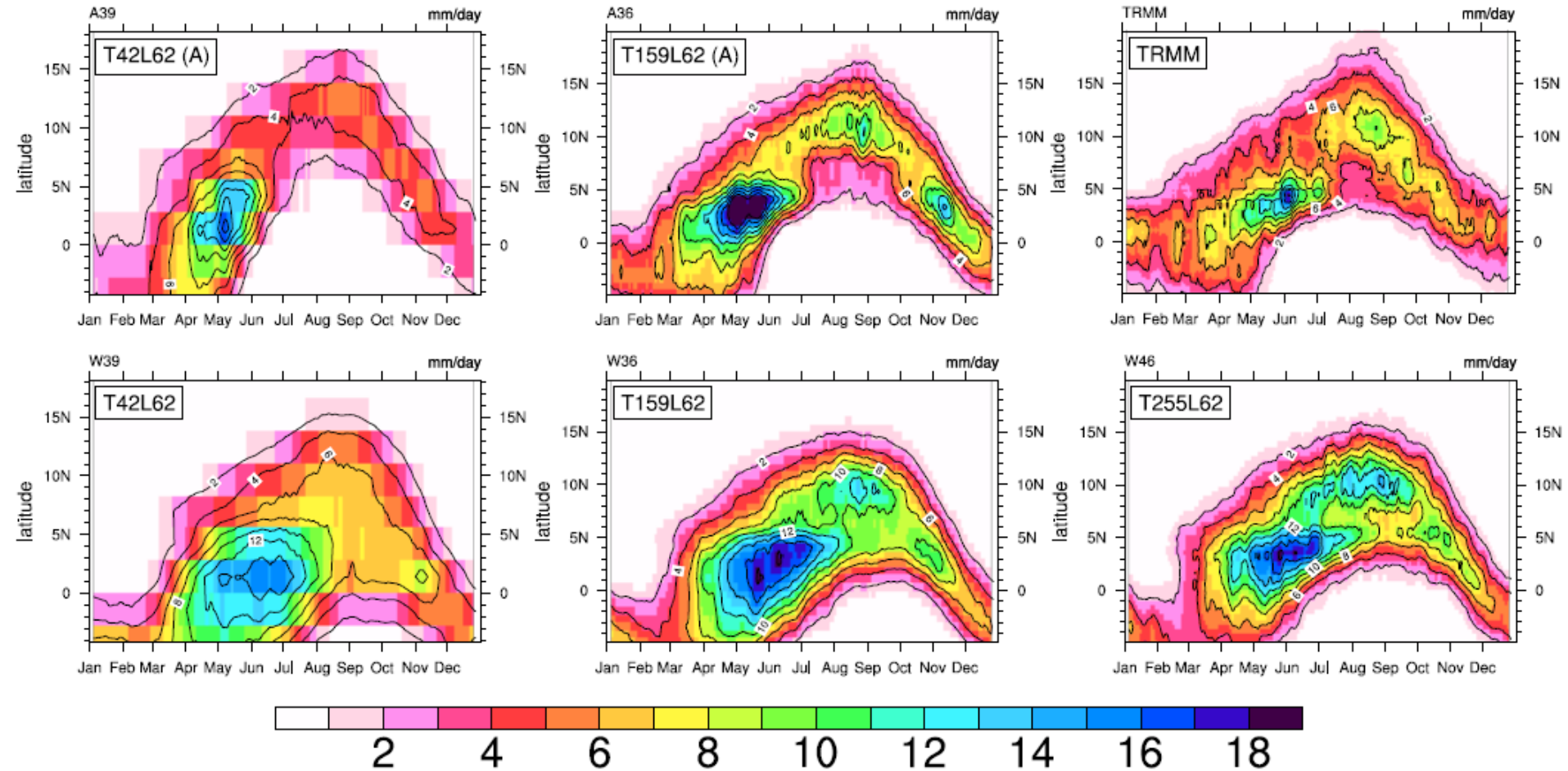
Differences in SST, precipitation and 925 hPa winds (JAS)



HR (T255-L62), MR (T159-L62), LR (T42-L62)

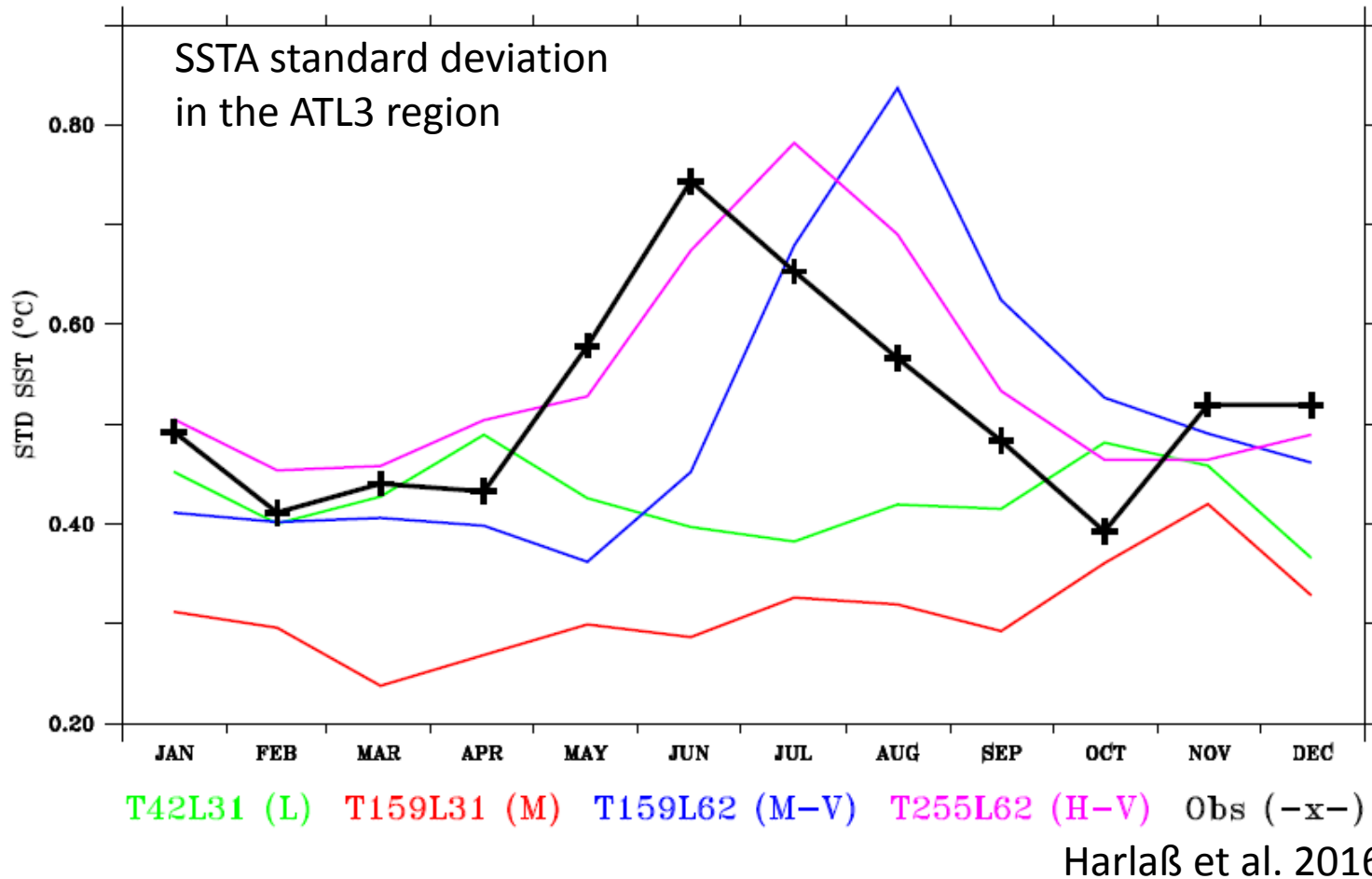
Steinig et al. 2016

Seasonal cycle of precipitation (10°W-10°E)



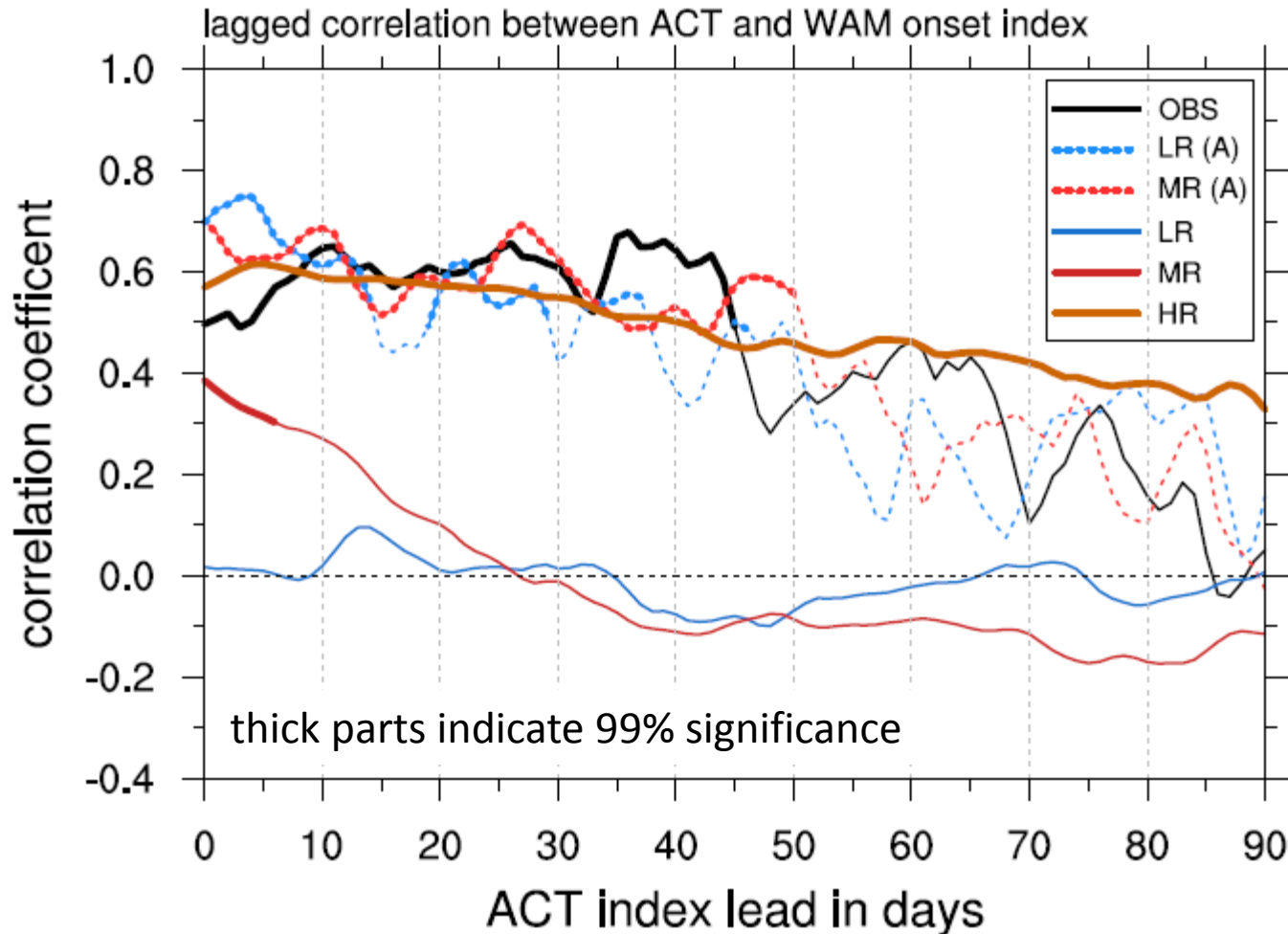
Steinig et al. 2016

Interannual variability and seasonal phase locking



enhancing atmosphere model resolution continuously improves interannual variability and its seasonal phase locking

Atlantic cold tongue index and WAM onset



ACT region: (30°W-12°E; 5°S-5°N, Caniaux et al., 2011)

WAM onset: Fontaine and Louvet (2006) and Vellinga et al. (2013), 10-day running mean was applied

Summary

- Enhancing atmosphere model resolution in the KCM strongly reduces biases in tropical Atlantic sector SST, wind and precipitation
- Biases mostly originate in the atmosphere models and are not due to coupling
- Both horizontal and vertical atmosphere model resolution are important
- Simulation of interannual SST variability also benefits from reducing wind biases, specifically with regard to the seasonal phase locking
- The improved SST simulation also enhances simulation of Sahel rainfall (increased meridional moisture transport onto the continent) and its predictability potential