MODELING ENSO WITH ECHAM6-FESOM

INFLUENCE OF THE OCEAN RESOLUTION

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1. ABSTRACT

- We apply a new global climate model supporting multi-resolution ocean grids with local, isotropic refinements (Sidorenko, Rackow et al., 2014; Rackow et al., 2014a, in preparation)

KEY QUESTIONS:

- ***1)*** *Does high spatial resolution in the tropical ocean (0.25°, Fig.1) improve the Equatorial Pacific simulation?*
- ***2)*** *If so, is the improvement beneficial for ENSO simulations (index statistics, annual cycle representation, and monthly variance)?*

2. OCEAN MODEL SETUPS

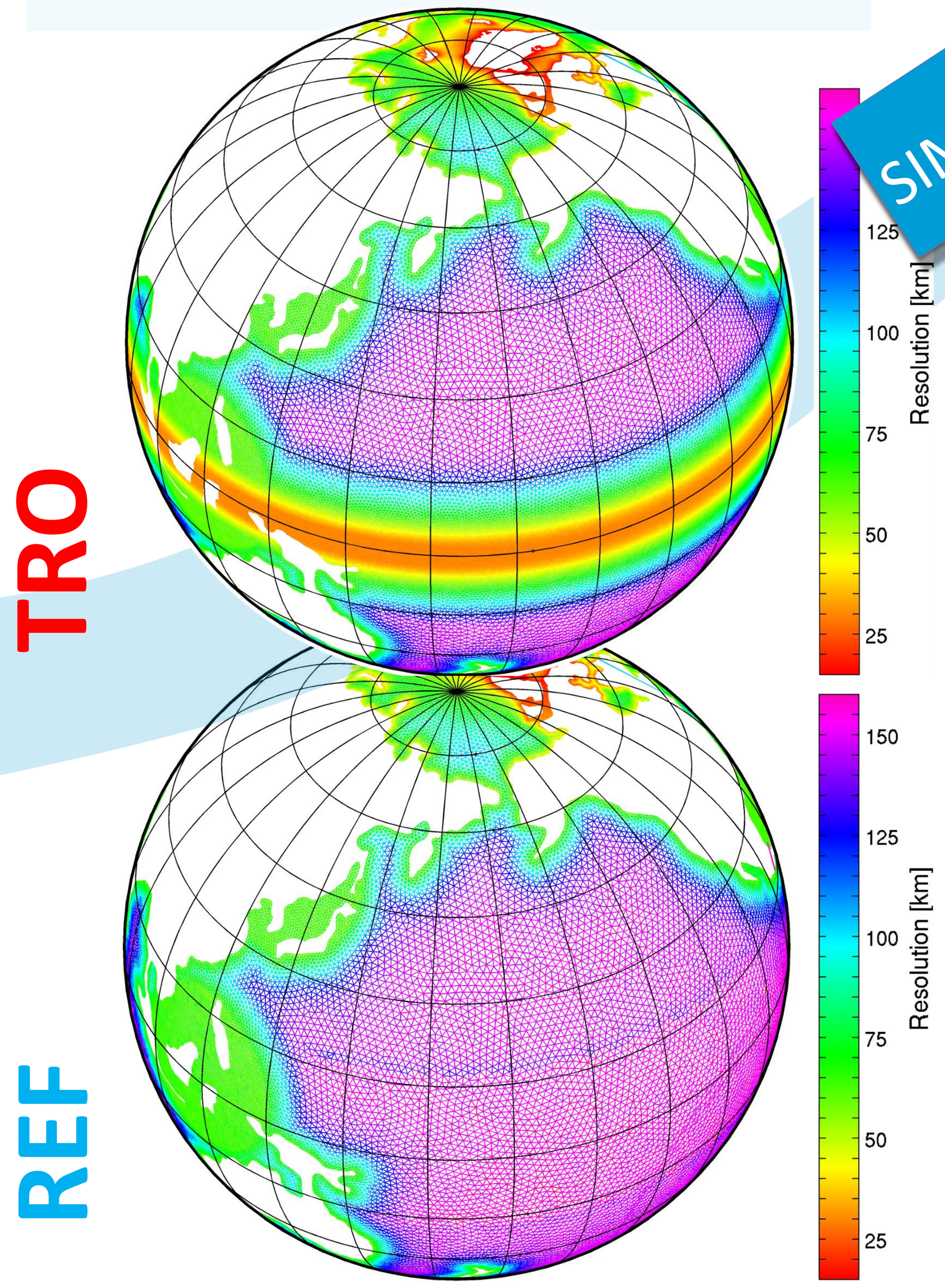
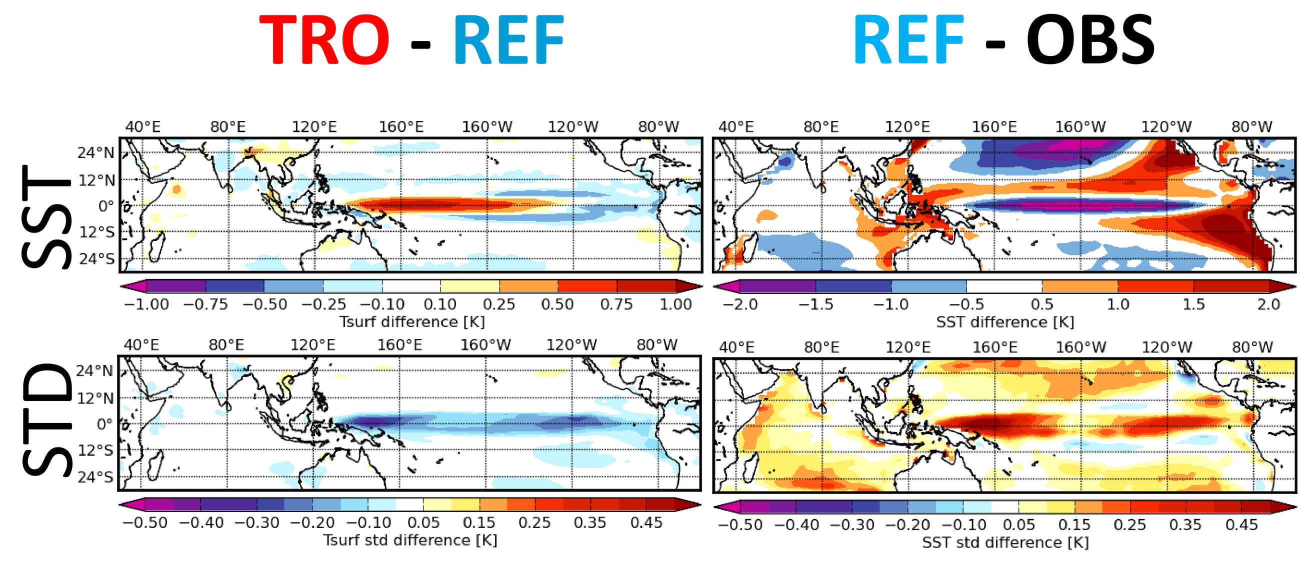


Figure 1: *Ocean grid for setup **TRO** (≈0.25° tropical resolution) compared to **REF** (1°). Outside the tropics, both grids coincide. The atmospheric grid is fixed at T63L47, i.e. 1.85° with 47 levels. Both setups are run for 520 years with constant 1990 greenhouse gas and aerosol concentrations (Sidorenko, Rackow et al., 2014).*

SIMULATES

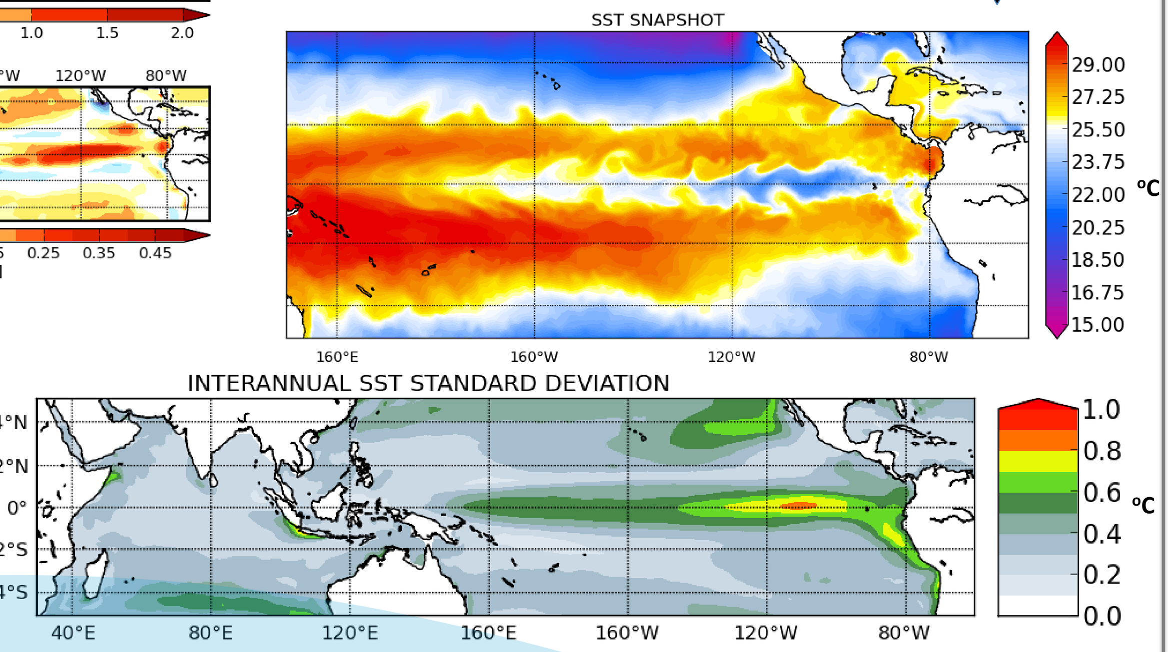
3. IMPROVEMENTS DUE TO HIGHER RESOLUTION IN THE OCEAN



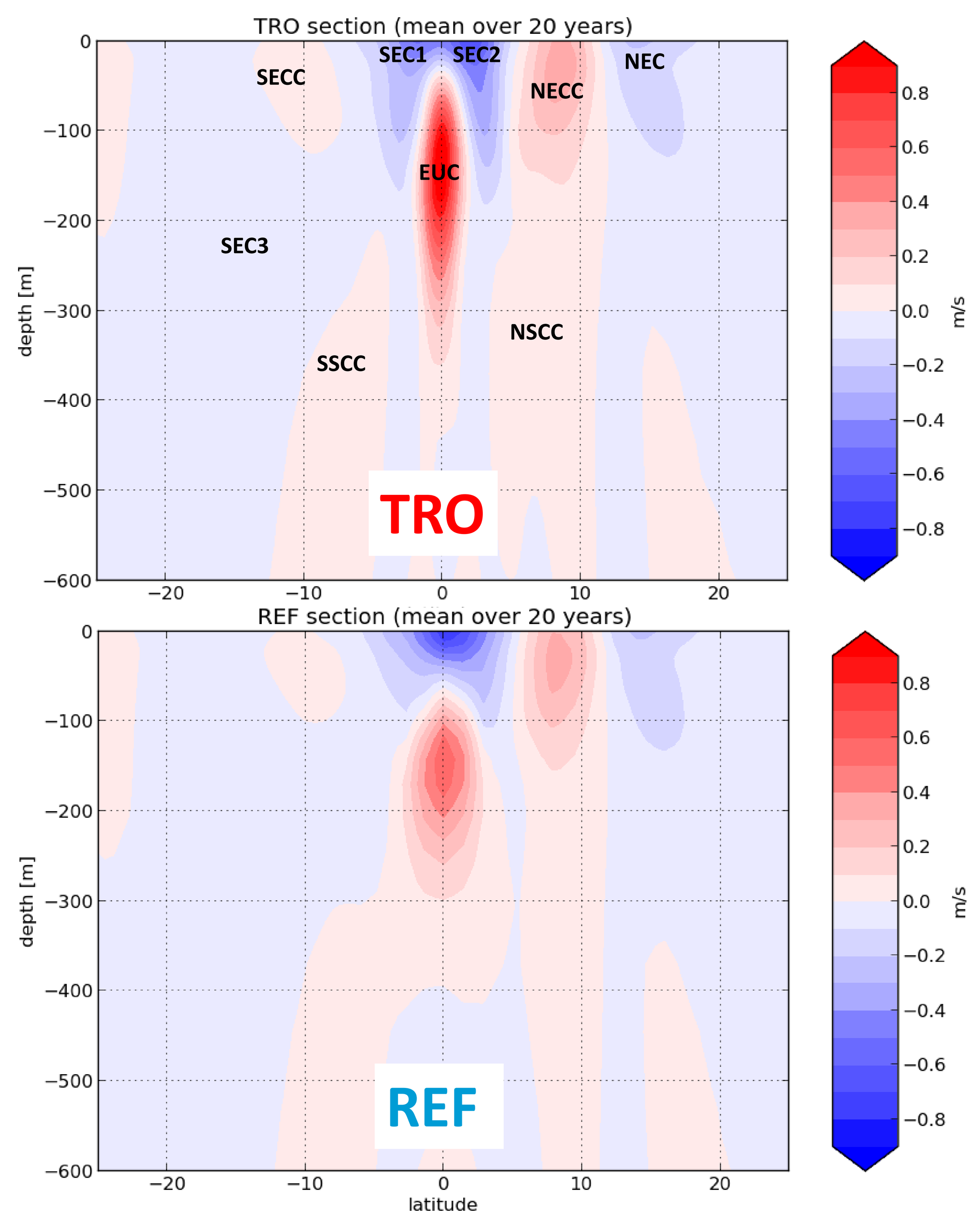
▲ ***Figure 2***: *Differences (**TRO - REF** and **REF - OBS**) concerning annual mean sea surface temperature (SST, **top panel**) and interannual SST standard deviation (STD, **bottom panel**). **OBS** is referring to HadISST (Rayner et al., 2003).*

- *The Pacific cold tongue bias does not extend as far to the West with high resolution. Thus warm pool SSTs are higher by up to 1 K.*
- *The erroneous warm pool local maximum in STD (present in **REF**) is absent in **TRO** (see Fig.3).*

Figure 3: ***(Top panel)*** *SST snapshot for **TRO** showing resolved Tropical Instability Waves (TIW).* ***(Bottom panel)*** *Improved interannual SST standard deviation in **TRO**.* ▼



▼ ***Figure 4***: *Meridional section of zonal velocities [m/s] at 155 °W (20yr mean). The Eq. Undercurrent (EUC) is stronger in **TRO** (> 0.9 m/s core speed) compared to **REF** (0.5 - 0.6 m/s). **TRO**: Two distinguishable branches of South Eq. Current (SEC1 & SEC2) emerge.*



LEADS TO

4. SPECTRA AND STATISTICS OF NIÑO INDICES

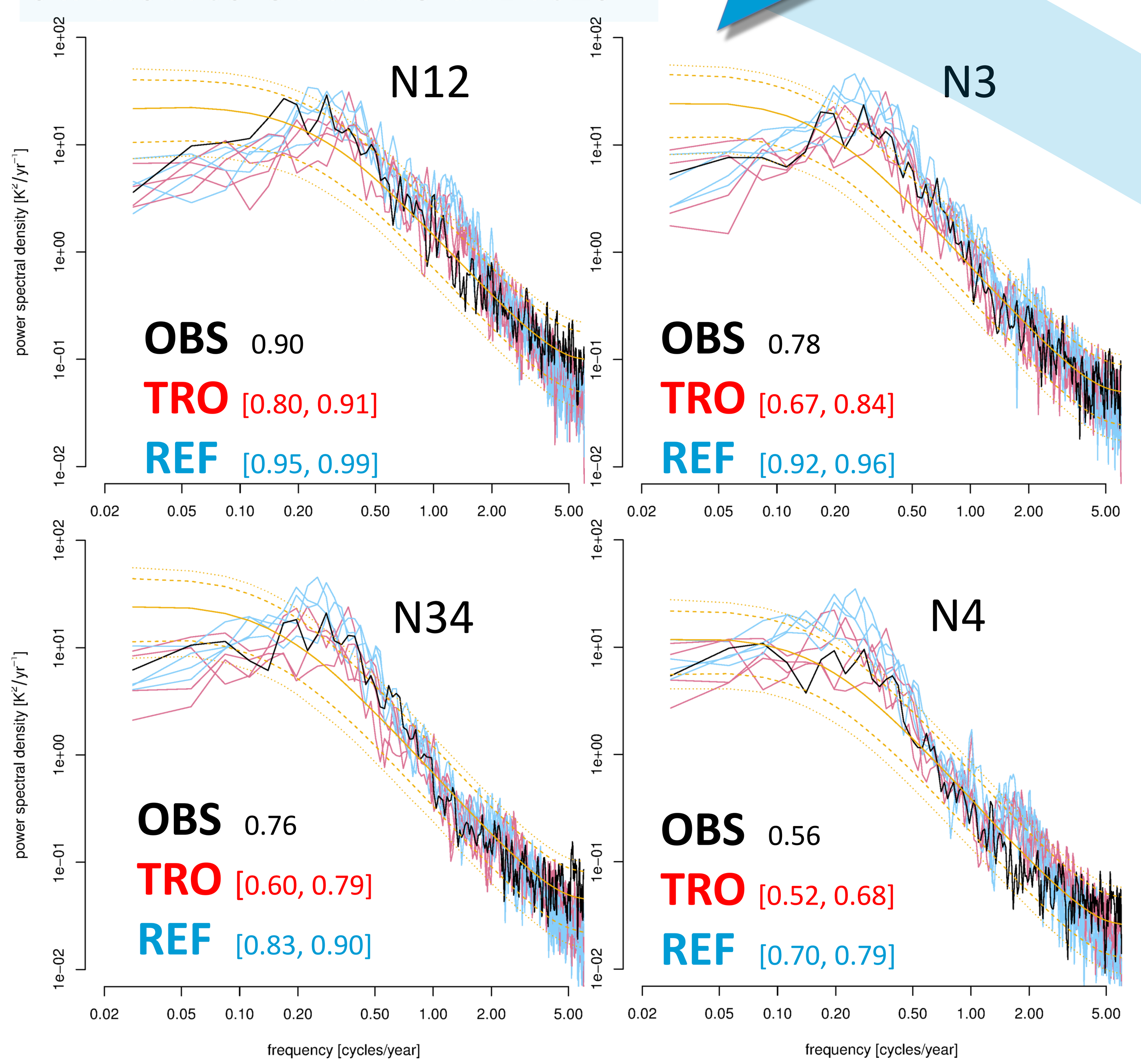
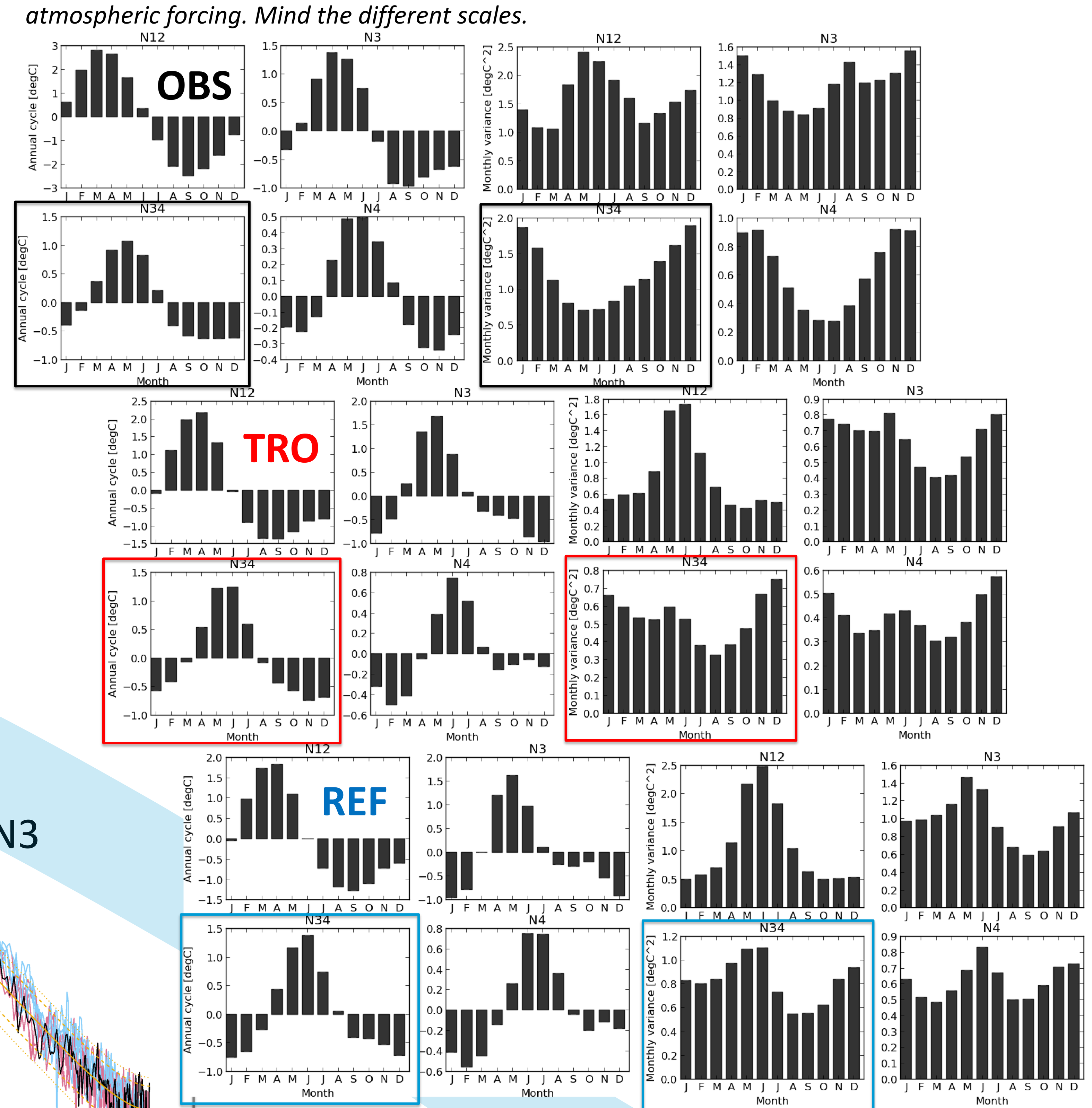


Figure 5: *Power spectral densities [K^2/yr^{-1}] for different Niño indices in **TRO**, **REF** and **HadISST** (1970 to 2012). The 520 model years have been subsampled resulting in 4 realisations for **REF** and **TRO**. 1%, 5%, 50%, 95%, and 99% quantiles of 10,000 HadISST-fitted AR1-process PSDs are depicted. Insets show (range in) standard dev. of **TRO**, **REF**, and **HadISST**.*

5. ANNUAL CYCLE / MONTHLY VARIANCE

Figure 6: *Annual cycles **(left)** and monthly variances **(right)** of SST in different Nino boxes for **OBS**, **TRO**, and **REF**. Plots from an uncoupled ocean simulation, run with CORE2 forcing (Large and Yeager, 2009), are referred to as **OBS** since SSTs are largely constrained by the atmospheric forcing. Mind the different scales.*



6. SUMMARY AND CONCLUSIONS

- ***1)*** *Due to improved equatorial currents (Fig.4) in **TRO**, warm pool SST bias is reduced by 1 K; STD bias is reduced by up to 0.4 K (Fig.2) compared to **REF**; TIWs are better resolved in **TRO** (Fig.3)*
- ***2)*** *ENSO statistics tend to improve with **TRO** (insets in Fig.5)*
- *N34 annual cycle: Equally good in **TRO** and **REF**. N34 monthly variance: **TRO** shows reduced local maximum in AMJ compared to **REF** and has a global maximum in NDJF (colored boxes in Fig.6)*
- ***OUTLOOK:*** *Investigate ENSO - annual cycle interaction (Rackow et al., 2014b, in preparation)*

References

- Sidorenko, D., **Rackow, T.**, et al. (2014) Towards multi-resolution climate modeling with ECHAM6-FESOM. Part I: Model formulation and mean climate. Climate Dynamics, under revision
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- **Rackow, T.**, Timmermann, A., Jung, T. (2014b) ENSO-annual cycle interactions in ECHAM6-FESOM. In preparation.
- Large, W. G., and Yeager, S. G. (2009) The global climatology of an interannually varying air-sea flux data set. Clim. Dyn. 33 (2-3), 341-364.
- Rayner, N. A.; Parker, D. E.; Horton, E. B.; Folland, C. K.; Alexander, L. V.; Rowell, D. P.; Kent, E. C.; Kaplan, A. (2003) Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century. J. Geophys. Res. 108, No. D14, 4407 10.1029/2002JD002670

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