

# PlioMIP2 modelling activities at the AWI

## 1. Earth System Model Toolbox

Main tool: Max Planck Institute's Earth System Model (MPI-ESM, e.g. Giorgetta et al., 2013), utilized version is the MPI's version for CMIP6  
 > atmosphere (ECHAM6.3, T63/L49)  
 > ocean (MPI-OM, GR15/L40)  
 > land surface, including dynamic vegetation (JSBACH)  
 > biogeochemistry of the ocean (HAMOCC, no climate feedback)  
 Depending on time frame of PlioMIP2, AWI-CM (ECHAM6/JSBACH with the finite element ocean model FESOM) maybe additionally used.

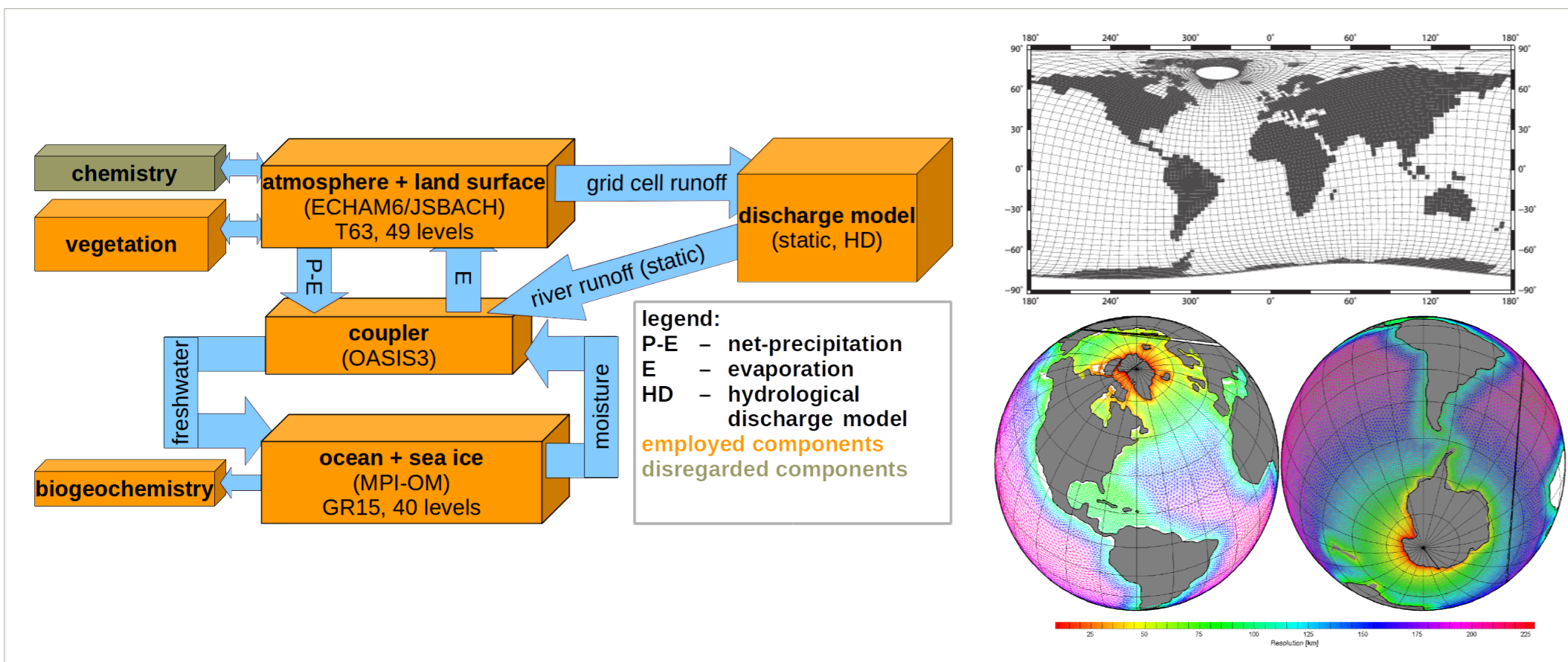


Fig. 1: Model components of the MPI-ESM (left), model grid of MPIOM (right, up) and FESOM (right, below)

## 2. Planned Simulations and expected Time Line

- > CORE simulations (until mid of 2016)
- > Tier 1 simulations (until end of 2016)
- > Tier 2 simulations (until end of 2016)
- > Bering Strait sensitivity study (see topic 5, until end of 2016)

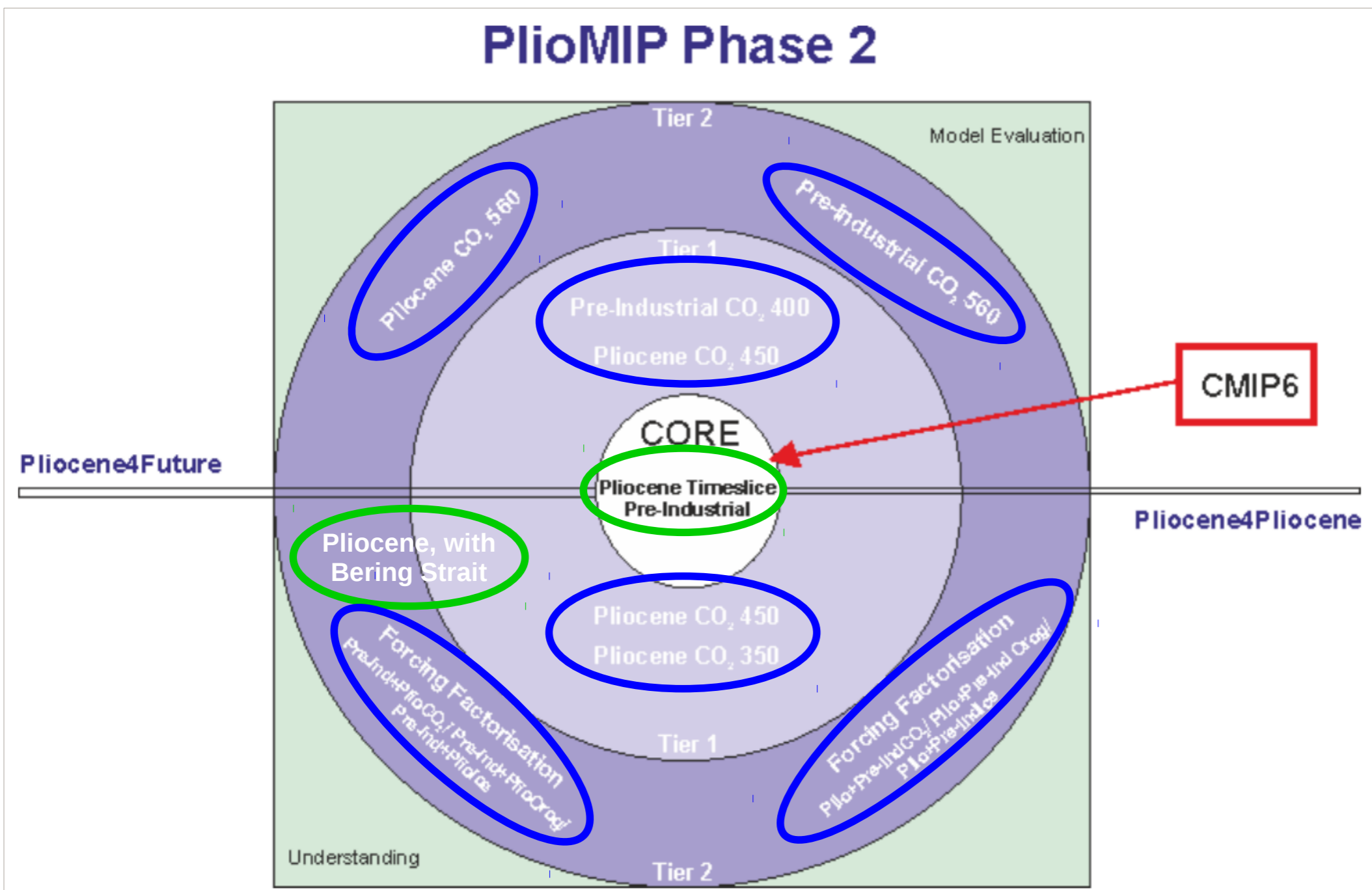


Fig. 2: Simulations that are planned in the framework of PlioMIP2; green: computational resources available; blue: conducted depending on the availability of computational resources; modified after Haywood et al. (2015).

## 3. Modelling Methodology

Pliocene setup implemented based on enhanced PRISM4 data, following Haywood et al. (2015), cf. Stepanek and Lohmann (in prep.):  
 > palaeogeography  
 • bathymetry, topography, and lakes via anomaly  
 • ice sheets and land sea mask via absolute reconstructed value  
 • present day rivers with adjustments to Pliocene topography  
 • soils: mapping scheme based on pre-industrial MPI-ESM setup  
 > vegetation dynamically simulated, including feedbacks  
 > ocean-biogeochemistry computed for diagnostics (no feedbacks)

## 4. Current Status

- > nearly all boundary conditions of the land surface are prepared
- > current focus: setup of ocean bathymetry and A-O coupling
- > switch from COSMOS to MPI-ESM (to be used in PlioMIP2)

## 5. Does a closed Bering Strait (BS) resolve the model – proxy data discrepancy inferred from PlioMIP?

- > mismatch between reconstruction (Fig. 3a) and simulation (Fig. 3b)
- > particularly pronounced discord in North Atlantic Ocean (Fig. 3b)
- > closing BS in COSMOS Pliocene experiment 2 increases meridional flow (Fig. 4) and partly resolves the mismatch (Fig. 5, 6)

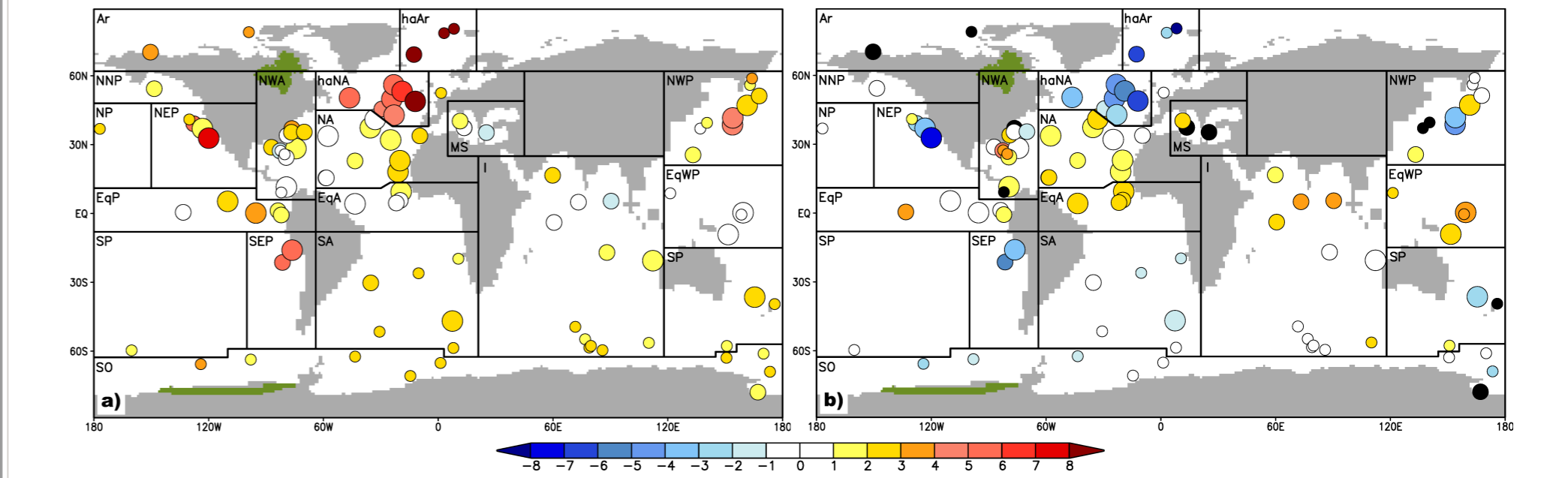


Fig. 3: PRISM3 mid-Pliocene sea surface temperature (SST) anomaly (a, in °C, after Dowsett et al., 2013), and difference between COSMOS Pliocene experiment 2, PlioMIP and PRISM3 (b, in °C).

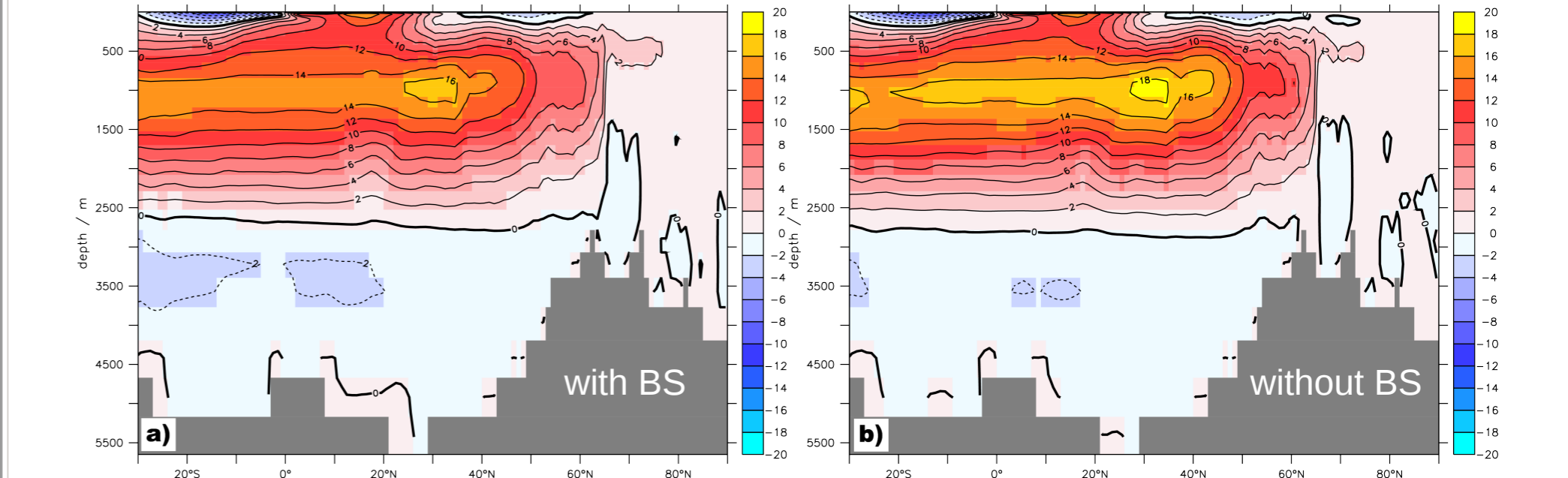


Fig. 4: Meridional volume transport in the Atlantic Ocean (AMOC, Sv) for COSMOS Pliocene experiment 2 of PlioMIP (a), the same setup without Bering Strait (b); Pliocene AMOC in b) increased by 10.7%.

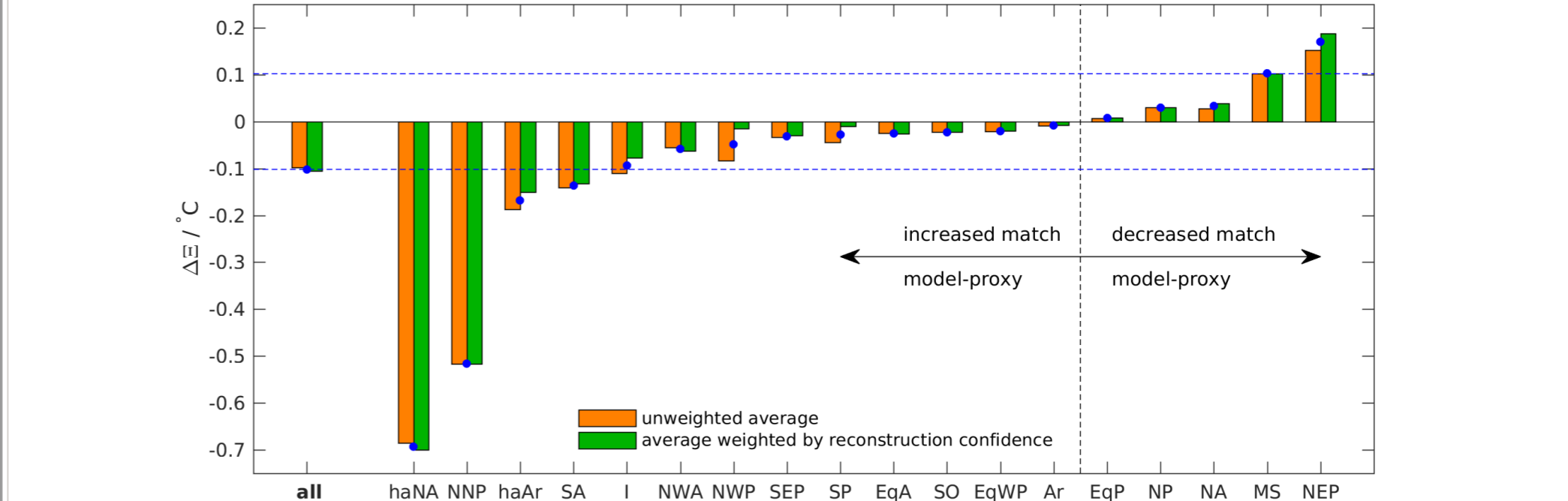


Fig. 5: Change in root mean square deviation  $\Xi$  between mid-Pliocene SST in COSMOS and PRISM3 due to closure of the Bering Strait for various ocean regions (cf. Fig. 1).

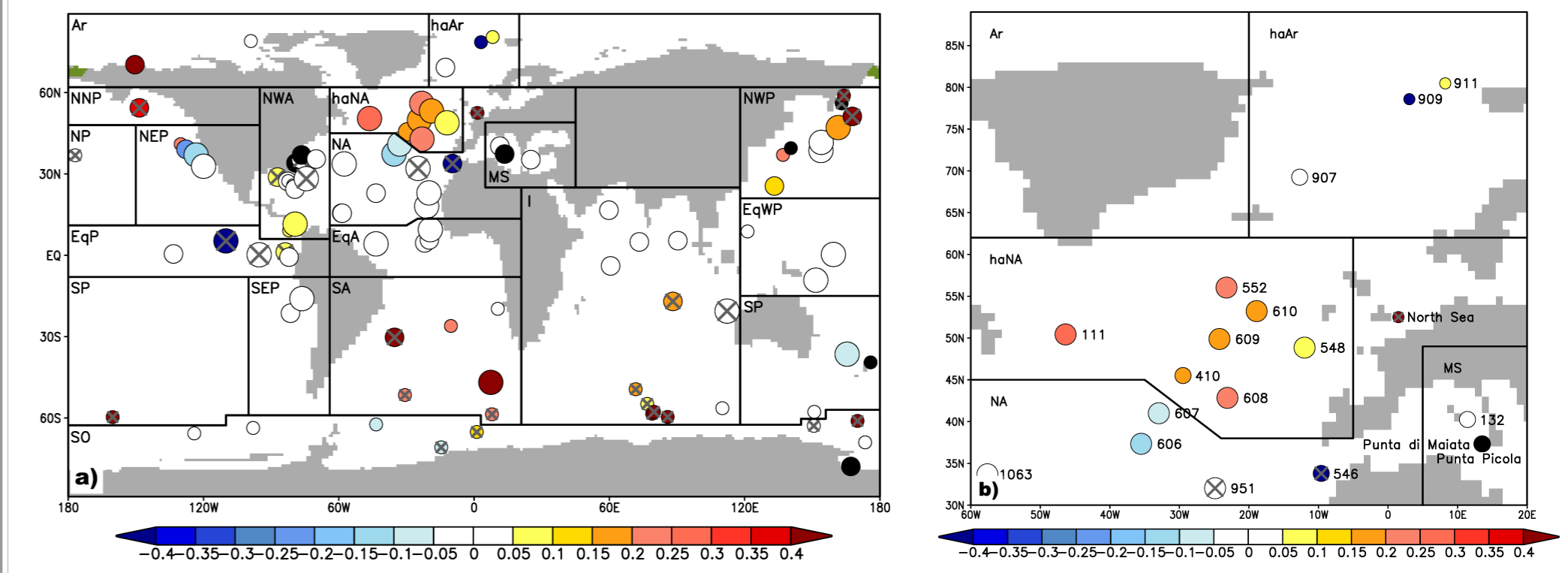


Fig. 6: Reduction (fractional) of the mid-Pliocene mismatch for a closed Bering Strait, global (a), and around North Atlantic Ocean (b).  
 → closed Bering Strait mitigates model-reconstruction mismatch  
 → need to test model-dependency of this effect in PlioMIP2  
 → contribution of sensitivity studies with other models very welcome

References: Giorgetta, M. A., et al. (2013). Climate and carbon cycle changes from 1850 to 2100 in MPI-ESM simulations for the Coupled Model Intercomparison Project phase 5. J. Adv. Model. Earth Syst., 5, 572–597, doi:10.1002/jame.20038. Haywood, A. M., Dowsett, H. J., Dolan, A. M., Rowley, D., Abe-Ouchi, A., Otto-Bliessen, B., Chandler, M. A., Hunter, S. J., Lunt, D. J., Pound, M., and Salzmann, U.: Pliocene Model Intercomparison (PlioMIP) Phase 2: scientific objectives and experimental design, Clim. Past Discuss., 11, 4003–4038, doi:10.5194/cpd-11-4003-2015, 2015. Stepanek, C., and Lohmann, G.: PlioMIP2 climate simulations performed with MPI-ESM, in preparation for the PlioMIP2 special issue of Climate of the Past. Dowsett, H. J., Foley, K. M., Stoll, D. K., Chandler, M. A., Sohl, L. E., Bentsen, M., Otto-Bliessen, B. L., Bragg, F. J., Chan, W.-L., Contoux, C., Dolan, A. M., Haywood, A. M., Jonas, J. A., Jost, A., Kamae, Y., Lohmann, G., Lunt, D. J., Nisancioglu, K. H., Abe-Ouchi, A., Ramstein, G., Riesselman, C. R., Robinson, M. M., Rosenbloom, N. A., Salzmann, U., Stepanek, C., Strother, S. L., Ueda, H., Yan, Q., and Zhang, Z.: Sea Surface Temperature of the mid-Pliocene Ocean: A Data-Model Comparison, Sci. Rep., 3, 2013, doi:10.1038/srep02013, 2013.