Project: **1333**

Project title: **ASPECT**

Principal investigator: **Wolfgang Mueller**

Report period: **2024-01-01 to 2024-10-31**

1. Project overview

ASPECT is an EU Horizon Europe project aiming for the setup and demonstration of a seamless climate information (SCI) system with a time horizon up to 30yr, accompanied by underpinning research and utilisation of climate information for sectoral applications ('middle-ground level'1). The goal is to improve existing climate prediction systems and merge their outputs across timescales together with climate projections to unify a SCI as a standard for sectoral decision-making. The focus is on European climate information but also to look more widely where there is a policy interest (e.g., disaster preparedness) and in regions of European interest. A strong link is maintained into an exploit learning from the WCRP lighthouse activities on explaining and predicting earth system change.

2. Achievements

We have completed the historical-like simulations with the climate model MPI-ESM-LR for the large ensemble single forcing model intercomparison project (LESFMIP; Smith et al. 2022). The following historical-like 30 members ensemble simulations are completed: greenhouse gases-only (GHG-only), total-ozone-only (O3-only), anthropogenic aerosols-only (Aer-only), volcanic aerosols-only (Volc-only), solar-only (Sol-only), land use-only (Lu-only) and natural forcing-only (Nat-only). As a first step, we compare the global mean surface air temperature of the single forcing simulations with historical simulations (Olonscheck et al. 2023) over the period 1850-2014.

The surface air temperature difference between the last 20 years (i.e.1995-2014) and the first 20 years (i.e. 1850-1869) of the simulation period is in most regions positive in the historical, GHG-only and the O3-only (and to a lesser extent the Sol-only) experiments except in the region of the subpolar gyre in the North Atlantic referred to the *"warming hole"* (Qasim 2023). In the Aer-only, Volc-only and Nat-only experiments, the situation is vice-versa with a cooling in most regions except in the North Atlantic (Fig. 1).

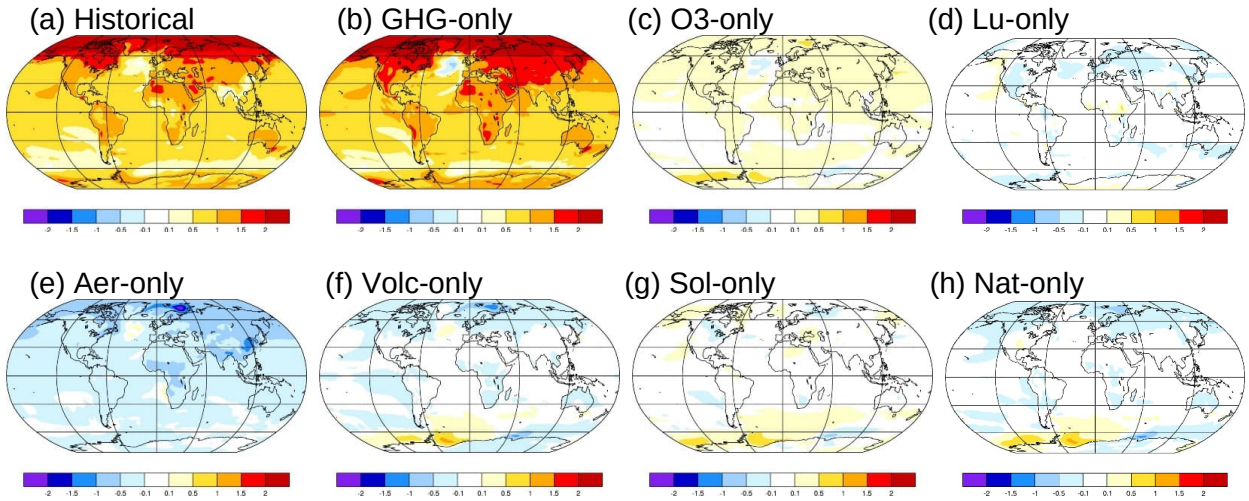

Fig. 1: *Surface air temperature difference (K): last 20 years minus first 20 years (i.e. 1995-2014 minus 1850-1869) of the (a) historical, (b) GHG-only, (c) ozone-only, (d) land use-only, (e) anthropogenic aerosols-only, (f) volcanic aerosols-only, (g) solar-only and (h) natural forcing-only simulations.*

Key of the mechanism is a shift in position of the North Atlantic Current further to the east advecting less heat to the central North Atlantic. As a consequence of the relatively cool central North Atlantic, a positive precipitation-minus-evaporation flux leads to a reduction in surface salinity and density in the central and eastern North Atlantic that weakens oceanic convection mainly in the Irminger Sea. The Atlantic meridional overturning circulation strength, that has been affected over the past century by the strong global warming in the polar regions and the freshwater input from the melting sea and land ice, is decreased by this mechanism further and underlines the anthropogenic influence on ocean circulation systems and impacts (Pohlmann et al. 2024).

3. Data Lifecycle

Central aim of ASPECT is the publication of the data in the Earth System Grid Foundation (ESGF). The historical-like sensitivity simulations performed in this project (hist-GHG, hist-aer, hist-sol, hist-totalO3, hist-volc, hist-nat) have been converted into the CMOR data format and uploaded onto the ESGF server at the DKRZ. Additionally, hist-lu simulations are available via the WDCC of DKRZ.

Müller, W., et al., 2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-GHG. doi:10.22033/ESGF/CMIP6.15022
Müller, W., et al., 2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-aer. doi:10.22033/ESGF/CMIP6.15024
Müller, W., et al., 2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-sol. doi:10.22033/ESGF/CMIP6.15030
Müller, W., et al., 2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-totalO3. doi:10.22033/ESGF/CMIP6.15032
Müller, W., et al.,2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-volc. doi:10.22033/ESGF/CMIP6.15033
Müller, W., et al., 2019: MPI-M MPI-ESM1.2-LR model output prepared for CMIP6 DAMIP hist-nat. doi:10.22033/ESGF/CMIP6.15028
Pohlmann, H., S. Brune, 2024: CMIP6_supplemental DAMIP MPI-ESM1-2-LR. World Data Center for Climate (WDCC) at DKRZ. https://doi.org/10.26050/WDCC/C6s_5275364

References

Olonscheck D, Suarez-Gutierrez L, Milinski S, Beobid-Arsuaga G, Baehr J, Fröb F (2023) The new Max Planck Institute grand ensemble with CMIP6 forcing and high-frequency model output. Journal of Advances in Modeling Earth Systems, 15, e2023MS003790. https://doi.org/10.1029/2023MS003790

Pohlmann H, Brune S, Müller W (2024) North Atlantic climate trends in single-forcing large ensemble simulations with MPI-ESM-LR. To be submitted to Climate Dynamics.

Qasim S (2023) Past and future response of the North Atlantic warming hole to anthropogenic forcing. Earth Syst Dynam 14:685-695. https://doi.org/10.5194/esd-14-685-2023

Smith DM, Gillett NP, Simpson IR, Athanasiadis PJ, Baehr J, Bethke I, Bilge TA, Bonnet R, Boucher O, Findell KL, Gastineau G, Gualdi S, Hermanson L, Leung LR, Mignot J, Müller WA, Osprey S, Otterå OH, Persad GG, Scaife AA, Schmidt GA, Shiogama H, Sutton RT, Swingedouw D, Yang S, Zhou T, Ziehn T (2022) Attribution of multi-annual to decadal changes in the climate system: The Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP). Front Clim 4:955414, https://doi.org/10.3389/fclim.2022.955414