Seasonal prediction of the austral summer Southern Annular Mode, and investigation of its connection to the Southern Ocean

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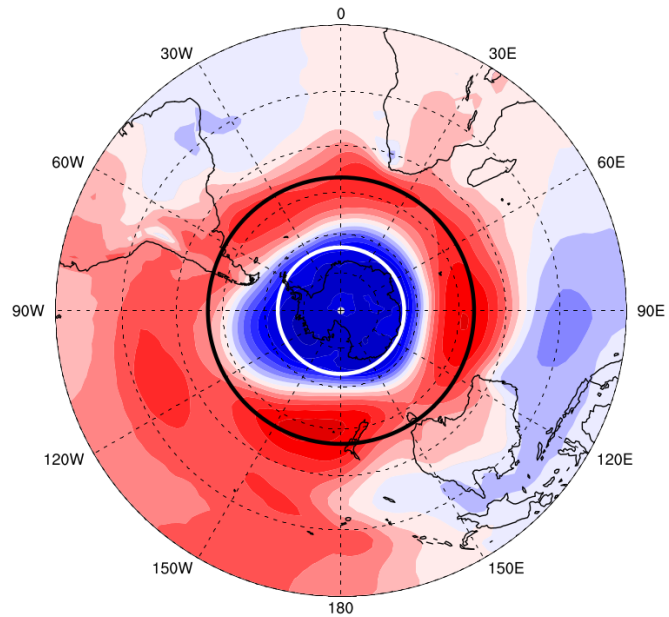

Prediction of the Southern Annular Mode (SAM) in austral summer (DJF) in MPI-ESM

Skill evaluation

- Anomaly correlation coefficient (ACC) between ERA-Interim SAM and ensemble mean SAM of Max-Planck-Institute Earth-System-Model in mixed resolution (MR-30) is
  ACC = 0.31 [0.07 ; 0.56]
  low skill
- Heidke Skill Score (HSS)
  HSS = 0.17 [-0.16 ; 0.49]
  low and not significant at the 5% level

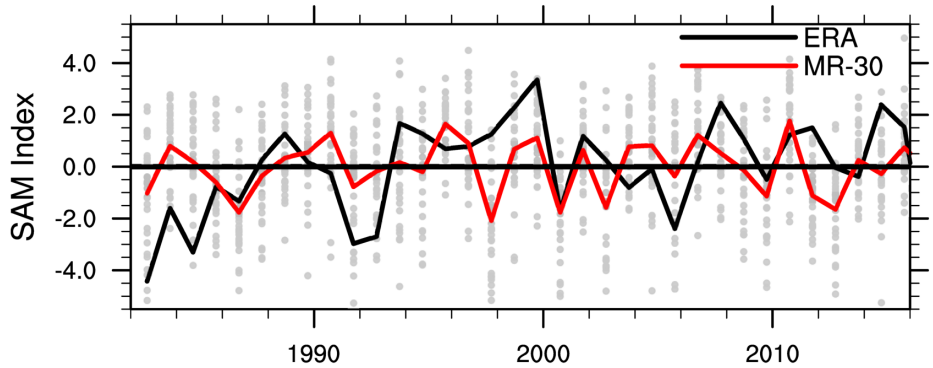

Figure 1: DJF SAM from ERA-Interim (black line) and the ensemble mean SAM from the MPI-ESM (red line). Grey dots represent individual ensemble members of the MPI-ESM.

Atmosphere Ocean connections

- SAM has high correlation to SST in the Southern Ocean in regions where ENSO also impacts the SST
- The Antarctic Dipole (ADP) (black boxes in the Atlantic and Pacific region of the Southern Ocean) are strongly correlated with SAM and ENSO

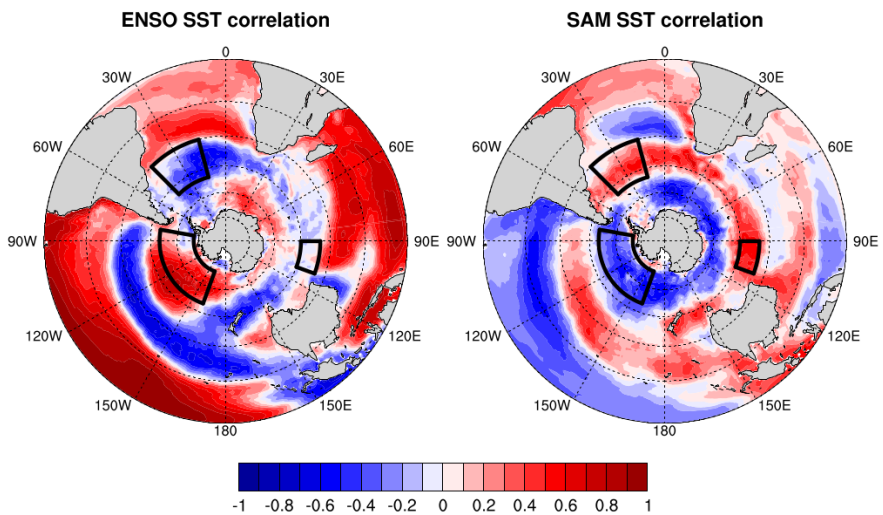

Figure 2: DJF correlation of ENSO SST (left) and SAM SST (right).

Selecting a subset of ensemble members can increase the prediction skill of the SAM

Selection scheme

- Case 1: SST anomaly Atlantic region **not equal** SST anomaly Pacific region → ensemble members selected **depending on their relation to the ADP**
- Case 2: SST anomaly Atlantic region **equal** SST anomaly Pacific region → SST anomaly Atlantic region **equal** SST anomaly Indian Ocean region → ensemble members selected **depending on their relation to Atlantic region**
- Case 3: SST anomaly is **not opposite sign** in Atlantic and Pacific region **AND not of same sign** in Atlantic and Indian Ocean region → ensemble members are selected **depending on their relation to ensemble mean SAM**

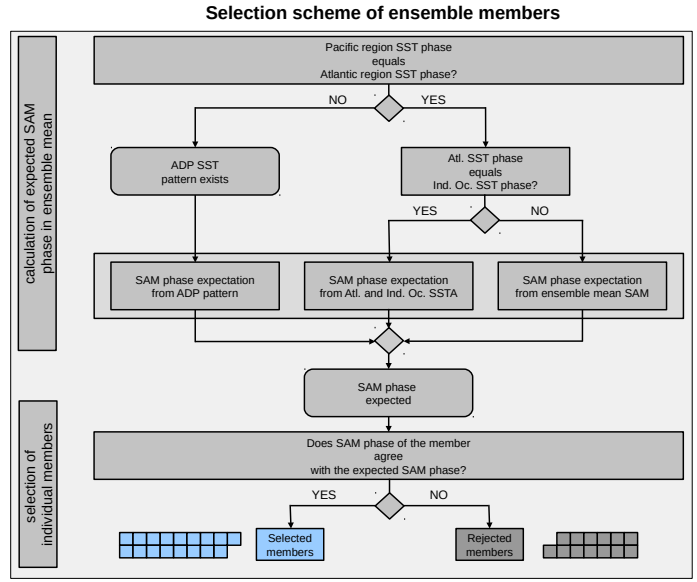

Figure 3: Mechanism to select a subset of ensemble members.

Resulting prediction skill

- Prediction skill from the mean of selected ensemble members (MR-Sub) and ERA-Interim
  ACC = 0.50 [0.30 ; 0.71]
  increased skill
- The Heidke Skill Score
  HSS = 0.35 [0.06 ; 0.69]
  increased skill, significant at the 5% level

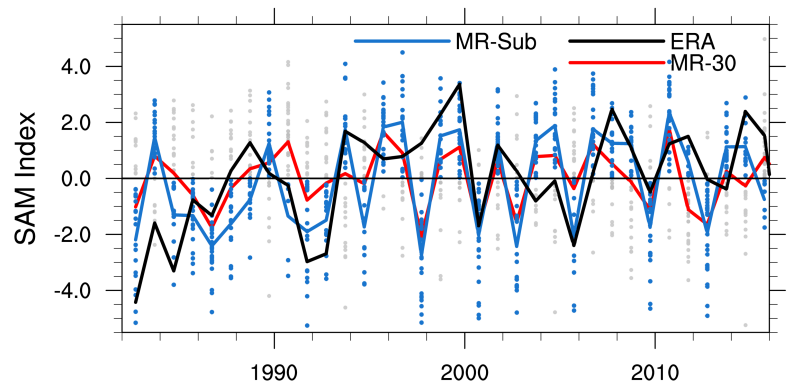

Figure 4: DJF SAM from ERA-Interim (black line), the ensemble mean SAM from the MPI-ESM (red line), and the mean of selected members (MR-Sub) (blue line). Grey dots represent not selected ensemble members and blue dots are selected members.

Increased prediction skill of other variables

- Compared to the **full ensemble mean (MR-30)** the **selection of members (MR-Sub)** shows an **increased prediction skill** of variables that are closely connected to the SAM.
- Increased prediction (in MR-Sub) for Z500 at the latitudes **where the SAM is defined** (40°S and 65°S) $\Longrightarrow$
- Increased prediction skill (in MR-Sub) for zonal wind **at the latitude of the westerly jet** $\Longrightarrow$
- Slight increase of prediction skill (in MR-Sub) over some **regions of Antarctica** $\Longrightarrow$
- Overall **better representation** of the SAM and connected variables in MR-Sub compared to MR-30 in the **mid- to high-latitudes** $\rightarrow$ **selection increases prediction skill**

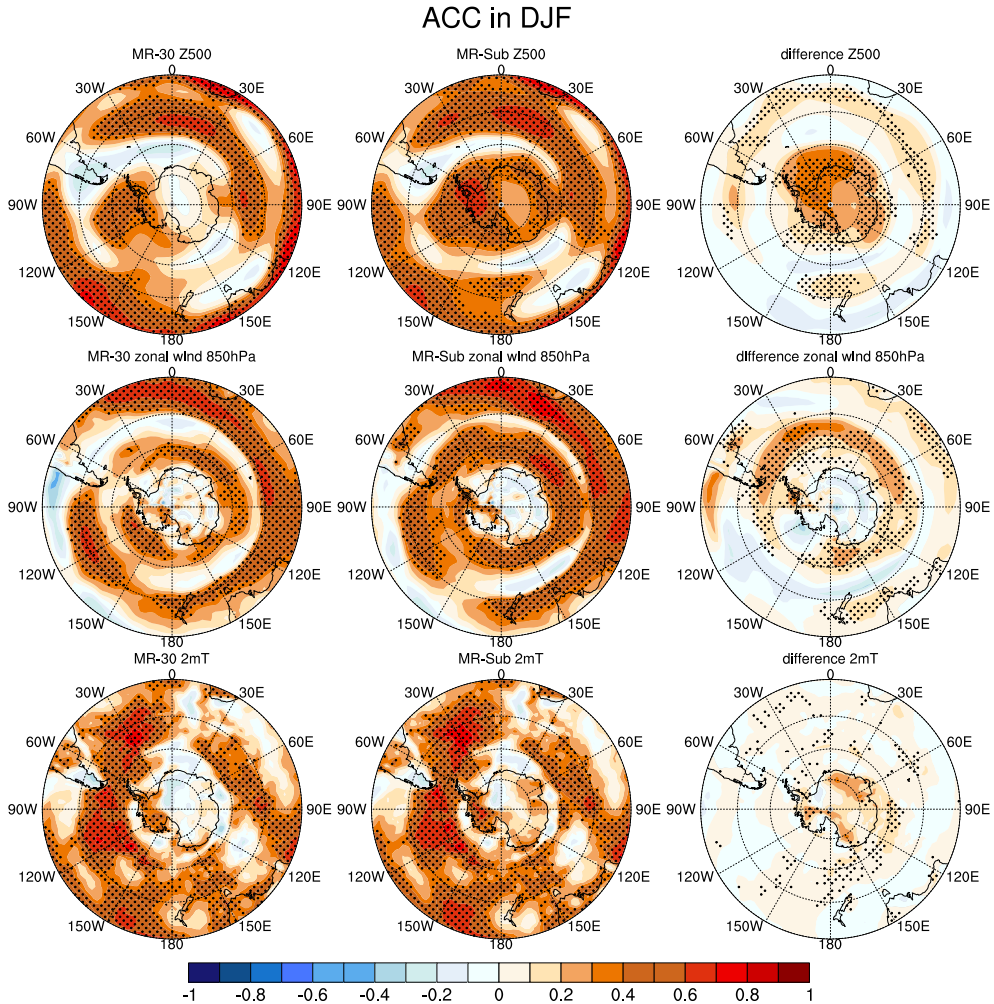

Figure 5: ACC of Z500 (first row), zonal wind at 850hPa (middle row), and 2m temperature (bottom row) for the full ensemble (left column), selection (middle), and difference (middle - left) (right column). Dotted areas are significant at 5%.