Evaluation of a long-term hindcast simulation with COSMO-CLM² over Antarctica

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Project website

1. Motivation

- Few RCM simulations available over Antarctica.
- Limited number of RCMs adapted for Antarctic conditions.
- Large uncertainties in projections.
- Urge for more model(s) (simulations) is high (CORDEX & IPCC).
- Direct impact on sea level rise and coastal areas.

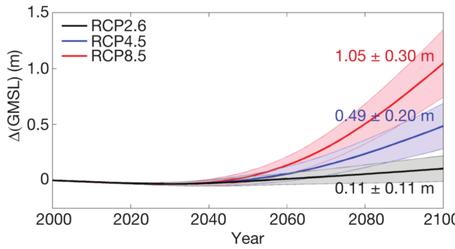

Fig. 1: Large ensemble model analyses of future Antarctic contributions to global mean sea level for different RCPs. Solid lines are ensemble means, and the shaded areas show the standard deviation (1σ) of the ensemble members (DeConto and Pollard, 2016).

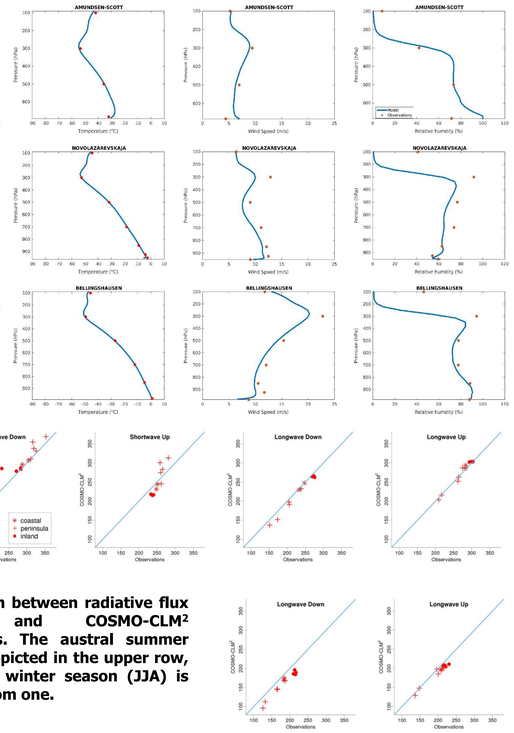

Fig. 4: Average radiosounding profiles (red dots) and vertical COSMO-CLM² model profiles (blue line) for the austral summer season (DJF) of temperature (column 1), wind speed (column 2) and relative humidity (column 3). Three stations are displayed located inland (upper), at the coast (middle) and the Antarctic peninsula (lower).

Fig. 5: Comparison between radiative flux measurements and COSMO-CLM² simulation results. The austral summer season (DJF) is depicted in the upper row, while the austral winter season (JJA) is shown in the bottom one.

3. Model evaluation

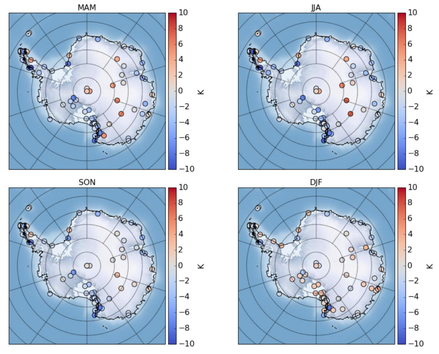

Fig. 6: Temperature bias between seasonally averaged ground-based observations and the corresponding pixel in the COSMO-CLM² simulation.

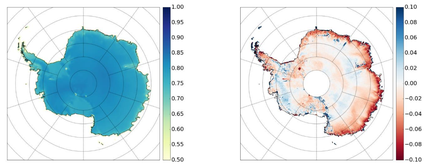

Fig. 7: Albedo climatology during austral summer (DJF) in COSMO-CLM² (left) and the absolute difference with the MODIS white sky albedo climatology.

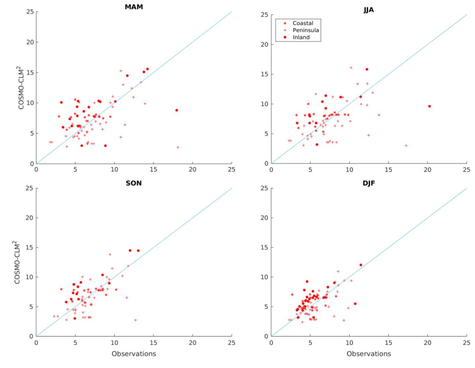

Fig. 8: Scatterplot of seasonally averaged ground-based wind speed observations (m/s) compared to the corresponding pixel in the COSMO-CLM² simulation.

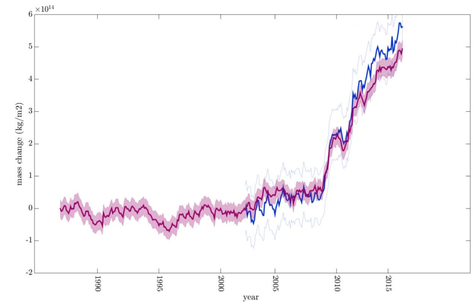

Fig. 9: Comparison of the mass change derived from GRACE altimetry (purple) and the change in SMB from the COSMO-CLM² simulation (blue). The COSMO-CLM² SMB is converted to mass anomaly to the reference period 1979-2011. The envelope represents uncertainties on GRACE and COSMO-CLM².

2. Model description

COSMO-CLM5.0:
- Spatial domain covering the whole ice sheet (conform the CORDEX Antarctica domain).
- ERA-Interim as initial and boundary conditions (Dee et al., 2011).
- Spatial resolution: 0.22x0.22.
- Time span: 1987-2016 (excluding 4 years of spin-up).

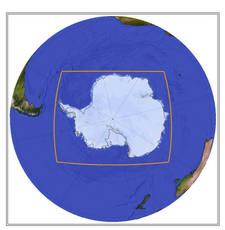

Fig. 2: CORDEX Antarctica domain.

Physical adjustments:
- Coupling to the Community Land Model for better snow pack representation (Oleson and Lawrence, 2013).
- Improvements for perennial snow cover representation (van Kampenhout et al., 2017).
- Lowering of the roughness length of snow to depict correct katabatic wind forcing (Smeets and van den Broeke, 2008).
- Reduction of the minimum turbulent diffusion coefficients for stable boundary layer representation (Cerenzia et al., 2014).
- Spectral nudging at the top of the atmosphere (van de Berg and Medley, 2016).
- Implementation of the two-moment scheme for better representation of the surface mass balance (Seifert and Beheng, 2006) including lowering aerosol content and rapid ice conversion.

Observational database

- Long-term ground-based observations (> 10 years) of wind speed and temperature (103 sites), 11 sites with humidity and radiative flux measurement.
- Long-term radiosounding information (> 10 years; 12 sites).
- MODIS albedo product.
- SMB reconstructions from stake measurements, ice cores and GRACE.

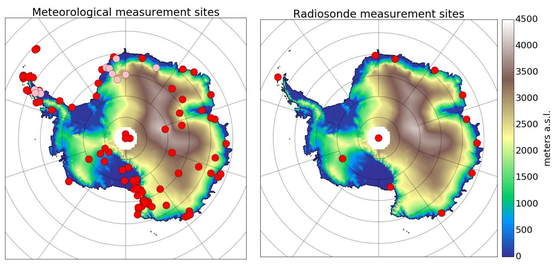

Fig. 3: Spatial extent of ground-based (left) and radiosounding observations (right). Pink dots show the availability of humidity and radiative flux measurements.

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