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Southern Hemisphere long-term changes simulated by CMIP5 models

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Previous studies have demonstrated that ozone depletion is the main forcing of Southern Hemisphere (SH) long-term changes, specifically the late spring ozone depletion leads to the strengthening of westerly winds in the stratosphere with a later transition to easterlies, a poleward displacement and a strengthening of the mid-latitude jet with an expansion of Hadley cell in the troposphere and a projection of these long-term changes onto a high-index polarity of the Southern Annular Mode (SAM) at the surface. SH changes are due to both well-mixed greenhouse gases (GHGs) increase and ozone depletion but ozone seasonality suggests its prevalent role in SH climate change. At surface, mid-latitude westerlies drive the Antarctic Circumpolar Current influencing the ocean meridional overturning and likely sea ice extent. Therefore, as recent model and observational studies indicate, changes in wind pattern can cause changes in the oceanic circulation as well as in air-sea carbon fluxes in the Southern Ocean. Recently, it has also been proposed that a limited representation of stratospheric processes in models could lead to a bias in the representation of simulated tropospheric long-term changes and air-sea carbon fluxes. However, not all aspects of SH response can be explained by changes in the mid-latitude jet in response to stratospheric ozone and GHGs increase. The response of the oceanic circulation and Antarctic sea ice is indeed still under debate.
In this study a multi-model analysis is conducted-by putting together output data derived from different model simulations participating to the Coupled Model Intercomparison Project-phase 5 (CMIP5), with the aim of understanding how models represent long-term atmospheric and surface climate changes in the historical simulations. The analysis focuses on the representation of the stratosphere-troposphere coupling, the SAM and Antarctic sea ice at surface.
Implications for future changes including projected increase of GHGs and ozone recovery are also discussed.