SPARC Workshop SHARP2016

Atmospheric long-term changes in the Southern Hemisphere simulated by CMIP5 models

Gloria Rea[1], Dr. Chiara Cagnazzo[1], Dr. Angelo Riccio[2], Dr. Federico Fierli[1], Dr. Francesco Cairo[1]

[1] Institute of Atmospheric Sciences and Climate, ISAC-CNR

[2] Department of Environmental Sciences, "Parthenope" University of Naples

gloria.rea@artov.isac.cnr.it

Southern Hemisphere (SH) climate variations in the past 30 years result to be strongly driven by ozone long-term changes in the austral spring-summer season. Since the 1970s the stratospheric ozone reduction and its strong depletion over Antarctica has led to a long-term cooling of the stratosphere that seasonally superimposes to the GHG cooling. The polar lower stratospheric cooling has contributed, together with the GHGs-induced upper tropospheric warming at tropical latitudes, to enhance the meridional temperature gradient delaying the polar vortex breaking and propagating down to the troposphere accelerating and poleward shifting the mid-latitude tropospheric jet, and projecting onto the positive phase of the Southern Annular Mode (SAM). This work attempts to demonstrate that a limited representation of stratospheric processes in the Coupled Intercomparison Project Phase 5 (CMIP5) models leads to a bias in the representation of simulated SH stratospheric and tropospheric long-term changes as well as in simulated sea level pressure patterns of the SAM. More in detail, we pay attention to the importance of the stratospheric chemistry-dynamics coupling represented in climate models. We show that only models with a proper representation of both dynamical and chemical stratospheric processes succeed in capturing more realistic SH summertime lower stratospheric cooling in the past and the following changes in the tropospheric circulation and in their projections onto the SAM index. Indeed, models not including an interactive stratospheric chemistry and dynamics underestimate the SH long-term changes found in ERA 40 and ERA Interim reanalysis.

Implications for future changes including two different scenarios for GHGs increase and ozone recovery are also analyzed. Specifically, we verify if the relationships between lower stratospheric trends and tropospheric/surface changes, discussed for the historical simulations, are also found in two different RCPs scenarios.