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Stratospheric Pathway of El Niño-Southern Oscillation in CMIP5 Models

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Recent studies have shown the role of the stratosphere as an intermediary between the ENSO signal in the tropical troposphere and some tropospheric teleconnections in the Northern Hemisphere (NH) winter. An additional type of ENSO, distinct from the traditional Canonical ENSO has also been identified in the last years. It is characterized by sea surface temperature anomalies in the central Pacific and referred as Central Pacific El Niño (CP-ENSO), whereas the Canonical ENSO is referred as the eastern Pacific El Niño (EP-ENSO). While it has been shown that exclusively CP-ENSO has an effect on the SH polar lower stratosphere, it remains unclear whether the effects of CP- and EP-ENSO differ in the NH polar stratosphere.

Up to now, the role of the stratosphere on the ENSO signal has been investigated in atmospheric general circulation models where the sea-surface temperatures were prescribed following observations. We investigate here the NH stratospheric signal of the two distinct types of El Niño events (EP and CP) in a group of atmosphere-ocean coupled models, as those provided by CMIP5. The role of the stratosphere in NH winter tropospheric teleconnections is also explored. Two sets of CMIP5 simulations are considered (preindustrial control and historical experiments) and compared to reanalysis data.

Results show that the comparison of the stratospheric El Niño signal between high-top and low-top models is difficult to assess, as the early winter tropospheric teleconnections are already different in both sets of models. The results obtained for EP in the high-top model ensemble-mean show a robust signal in the NH polar stratosphere with a significant warming about 4 K, which propagates downwards throughout the winter season towards the troposphere, in agreement with observations. During CP events, the anomalous warming is limited to the NH upper polar stratosphere and does not propagate downwards. Thus, CMIP5 high-top models reveal significant differences in the response of the polar stratosphere between EP and CP during winter. The inspection of the upward propagation of the El Niño signal shows an enhancement of wave 1 and weakening of wave 2 for both types of El Niño, although the anomalies occur earlier and are stronger in EP than CP El Niño. The difference in the downward propagation of the El Niño signals is also reflected on tropospheric anomalies during NH winter. Finally, the role of Sudden Stratospheric Warmings on the downward propagation of the El Niño patterns is also evaluated.