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Vertical propagation of the ENSO signal to the middle atmosphere: a comparison among WACCM and MAECHAM5 GCMs and ERA-40 reanalysis

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The vertical propagation of the ENSO signal in atmospheric temperatures has been analyzed in the reanalysis dataset ERA-40 and two GCMs: WACCM and MAECHAM5. These two models resolve well enough the middle atmosphere and make it possible to isolate the ENSO signal from other sources of variability, which facilitates its study. Monthly-mean data have been used for the period 1979-1999 and composite differences (El Niño-La Niña) have been computed and analyzed.

Our results show an overall agreement among the three data sets. The ENSO signal propagates to the middle atmosphere by means of Rossby waves; significant anomalies are observed up to around 40-50 km. An analysis of the zonal mean zonal winds reveals their strong influence on the ENSO propagation , which is more effective in the Northern Hemsiphere at 40º and 50ºN. Further, zonal mean temperature anomalies are observed in the middle atmosphere in tropical and polar latitudes in the boreal NH. Our analysis reveals that, during an El Niño event, the vertical wave propagation, the negative divergence of EP flux and, as a result, the stratospheric branch of the residual mean meridional circulation, are enhanced. This generates the zonal pattern of ENSO-related temperature anomalies in low and polar latitudes.

The comparison between the models highlights that WACCM shows the more effective vertical wave propagation into the middle atmosphere and the largest differences between the NH and SH propagation, while the residual circulation anomalies during extreme ENSO events in MAECHAM5 are less intense in strength and duration. The comparison between the three data sources further suggests that ENSO operates

independently of other sources of variability at middle latitudes and in the tropical lower stratosphere. Above 20 km, ENSO anomalies are observed in the tropics only when the isolated ENSO signal is studied but not in the reanalysis, probably due to the influence of other sources of variability.