The Antarctic Oscillation from Global Reanalyses

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The Antarctic Oscillation or Southern (Hemisphere) Annular Mode is the dominant mode of the Southern Hemisphere extratropical circulation, and influences precipitation regimes. The Antarctic Oscillation (hereafter AAO) is typically associated with the atmospheric pressure seesawing between mid and high latitudes. Similarly to the Artic Oscillation, AAO has zonally symmetric structure or annular pattern. The AAO positive (negative) phase indicates negative (positive) pressure anomalies at high latitudes and positive (negative) pressure anomalies in middle latitudes. This results in intensification (weakening) of the circumpolar circulation.

More often, studies have discussed the phase changes of AAO as an additional factor on the Southern Hemisphere climate variability. Nevertheless, there have been relatively few studies addressing the AAO phase change impact on precipitation variability over South America. It has been reported that positive (negative) AAO phase reduces (intensifies) precipitation over southeastern South America, and modulates ENSO’s influence on that region especially during springtime. During the austral summer, the inter-annual tropical activity intensification (reduction) has been associated with AAO negative (positive) phase, as well as the corresponding variability in the positioning of the subtropical upper-level jet.

Several studies have proposed methods to identify AAO from meteorological fields. Here, a general formulation from the initial work of Gong and Wang provides the basis for the Antarctic Oscillation Index (AAOI) calculation from four reanalysis sources: the National Centers for Environmental Prediction (NCEP) – National Center for Atmospheric Research (NCAR) Reanalysis (R1), the NCEP-Department Of Energy (DOE) (R2), the NCEP Climate Forecast System Reanalysis (CFSR), and the European Centre for Medium-Range Weather Forecasts (ECMWF) 40-yr Reanalysis (ERA-40). The AAOI was then defined as the difference between the zonal sea-level pressure anomalies at 40°S and 65°S.

In this study, the AAOI obtained from each of the reanalysis sea-level pressure monthly means from 1981 to 2010 (except for ERA-40, available only through 2002) behaves accordingly to the series of the same index calculated from observations that are based on station data near 40°S and 65°S (the Marshall-AAO Index). Except for a few isolated periods, the reanalysis time series closely follow the observed index, especially when a 12-month moving average is applied to the index values, practically causing the curves to overlap. It is very likely that those episodes with same tendencies, but with different magnitudes, are due to problems in obtaining characteristic data, considering only a relatively small number of station points over such a large area.

The AAOI time series calculated from the NCEP CFSR provides good examples that demonstrate the reliability of the AAOIs obtained from the global reanalyses, such as: 1) the well captured signal changes between 1988-1990; 2) the negative AAOI trend from 1990 through 1992; and 3) the persistence of a positive AAOI between 1998-2000.

Due to the lack of consistency between the reanalyses at the high southern latitudes prior 1979, and because of the hydrological imbalance perceived in the reanalysis fields at the initial integration steps, all analyses before the year of 1981 were waived in this study.

The AAOI series from the ECMWF ERA Interim and the National Aeronautics and Space Administration (NASA) Modern Era Retrospective-Analysis for Research and Applications (MERRA) will be also compared to the Marshall-AAO Index. Correlation between the AAO phases with precipitation patterns that affect water supplies for densely cultivated areas at the southern Brazil will be also analyzed, taking into account the AAO seasonal mean index.

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