Long-Term Trends and Variability in the Tropospheric Circulation over Antarctica

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Many model and observational analyses have documented the dynamical response of the stratosphere over Antarctica in recent decades to ozone depletion in the Austral spring, confirming a springtime stratospheric enhancement of what is now often referred to as the Antarctic Oscillation (AAO) or Southern Annular Mode (SAM). It has also been suggested that ozone depletion and/or greenhouse warming may contribute to the enhancement of the AAO/SAM in the stratosphere and troposphere [Shindell, et al., *Nature*, *392*, 589-592, 1998]. However, observational analyses of the tropospheric response to ozone depletion and/or global warming have been more difficult: Neff, *J. Geophys. Res.*, *104*, 27,217-27,251 [1999] found a delay in dynamical springtime over the interior of Antarctica that could be linked to the ozone-induced delay in the breakup of the stratospheric winter vortex. Thompson and Solomon, *Science*, *296*, 895-899 [2002], in an analysis of sounding data from coastal areas for the period 1969-1998, found negative trends in geopotential heights at 500 hPa and 30 hPa during the early austral summer and again in the fall. Marshall, *J. Clim*., 16, 4134-4143 [2003], on the other hand, showed only minor annual trends in the troposphere using longer time series (1960-1999). Furthermore, many past analyses used upper-air data weighted heavily toward the Indian Ocean side of the Antarctic continent. In fact, Marshall's results suggested positive trends in 500 and 300 hPa heights at Halley station in contrast to results from those Antarctic stations lying in the eastern hemisphere. In order to examine tropospheric trends over Antarctica for a longer period and for geographical consistency, we have been able to extend records at both McMurdo and Amundsen-Scott stations to provide a very complete record from 1957 to the present. In our analyses we have found (1) an asymmetry in trends between West and East Antarctica, (2) the largest significance in trends during the Austral spring over West Antarctic (positive) and the Austral Fall over east coastal Antarctica (negative), (3) strong decadal variability that makes trend detection somewhat suspect, and (4) good agreement with other indices derived from surface station analysis (Figure 1).

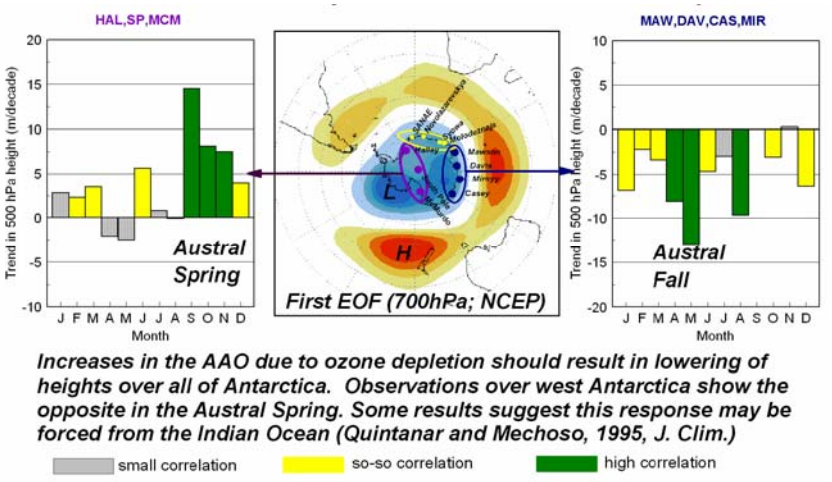

Figure 1. 500 hpa trends by month over Antarctica (1957-2005): In the western hemisphere, the trends are positive in the Austral Spring whereas in the eastern hemisphere, the trends are significantly negative in the Austral Fall.