Recent variability and trends in Antarctic snow accumulation from Polar MM5 simulations

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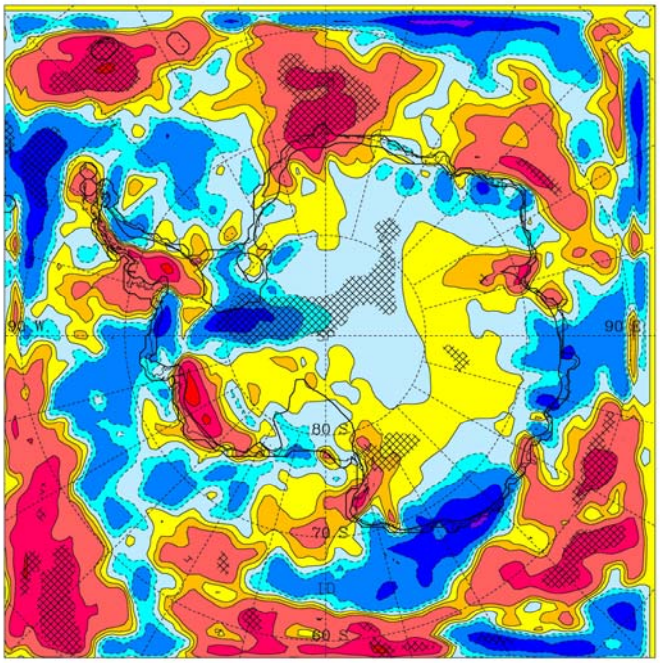
Polar MM5, a mesoscale atmospheric model optimized for use over polar ice sheets, is employed to simulate Antarctic accumulation in recent decades. Two sets of simulations, each with different initial and boundary conditions, have been run for the ~24-y period from January 1979-August 2002. The initial and boundary conditions for the two sets of runs are provided respectively by the (1) European Centre for Medium-Range Weather Forecasts 40-year Reanalysis (ERA-40), and (2) National Centers for Environmental Prediction – Department of Energy Reanalysis II (NCEP-II). This approach has been used so that uncertainty can be assessed by comparing the two resulting data sets.

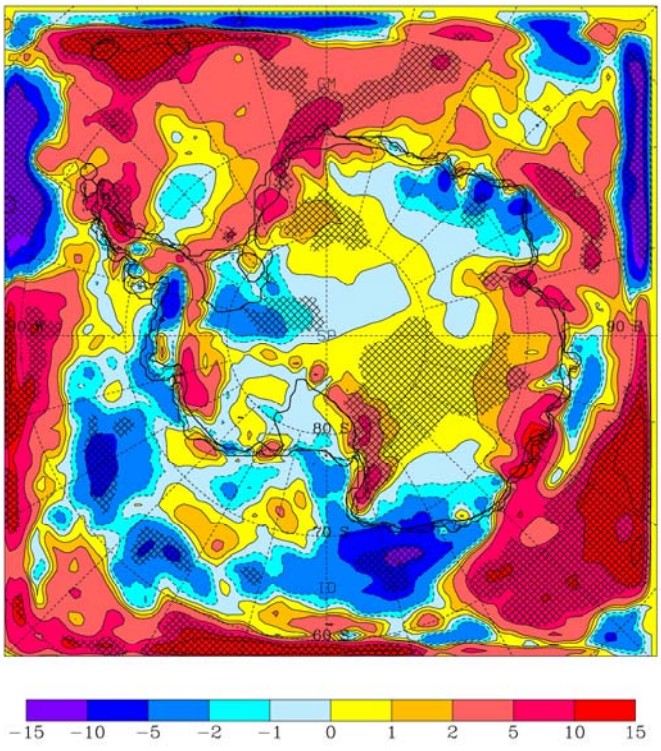
There is broad agreement between the two data sets for the annual precipitation trends for the 17-y period spanning 1985-2001 (Fig. 1). This period is chosen, rather than the entire 1979-2001 period, because agreement between the simulations for the longer period is not as good. The reason for this may be related to adjustments in the ERA-40 assimilation system after the onset of the modern satellite era and prior to the mid-1980s. The trends shown in Fig. 1 generally agree with ice core and snow stake accumulation records at various locations around the continent (not shown). The similarity between the trends for the two runs, as well as their agreement with observations, lends confidence that the trends are robust.

Areas of strong upward and downward trends are apparent in Fig. 1. Statistically significant (at the 90% confidence interval) upward trends are occurring near the Antarctic Peninsula, in the ocean regions north of the coastline at ~0^{o} E and between 105^{o}-150^{o} E, and in the Transantarctic Mountains in Victoria Land. Statistically significant downward trends are occurring just inland of the Ronne-Filchner Ice Shelf. Strong downward trends are also indicated in coastal regions of East Antarctica in both simulations, although these are, for the most part, not statistically significant. Averaged over the continent, the trends in Fig. 1 are small in both simulations, and not statistically significant, suggesting that the role of Antarctica in mitigating sea-level rise in recent years may not be as large as reported by other authors.

Our results indicate that there is an enormous amount of spatial and temporal variability in the Antarctic surface mass balance. The annual variability and trends over Antarctica tend to be the small residual of larger seasonal variability and trends (not shown) that are related to recent climate change.



a) PMM5 E40 Annual Trends



b) PMM5 NN2 Annual Trends

Fig. 1. Annual trends (mm y^{-2}) for 1985-2001 derived from a linear fit through each grid point for the (a) PMM5 E40 and (b) PMM5 NN2 runs. Hatching indicates the trend is significant from zero at the 90% confidence interval.