Advances in describing recent Antarctic climate variability

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Several observationally-based Antarctic temperature datasets are compared for the past ~45 years and found to be in good agreement at annual and seasonal timescales. These datasets, which are representative of the entire continent, are useful for assessing global climate model (GCM) simulations of Antarctic near-surface temperature during the 20th century, and thus the reliability of 21st century Antarctic climate scenarios. Five 20th century GCM ensembles run in support of the Intergovernmental Panel on Climate Change Fourth Assessment Report are evaluated. It is found that they overestimate annual Antarctic near-surface temperature trends by a factor of 2-to-3 during the 20th century, and by more than 5 times during the latter half of the century. The overly-vigorous Antarctic temperature increases in the GCMs appear to be due to an increase in total column water vapor that enhances the downward longwave radiation incident at the surface. The relationship between Antarctic temperature changes and the Southern Hemisphere Annular Mode, the primary mode of Antarctic atmospheric variability, is of secondary importance in the GCMs.

Snowfall variability in the GCMs is compared to a recently published 5-decade record of Antarctic snowfall variability. The GCM snowfall compares reasonably to the observations, for which there are generally upward trends. However most of the GCM runs end in the late 1990s, when the snowfall sharply decreases, so it is uncertain whether the models would have captured this fluctuation. Promisingly, the GCMs are able to accurately simulate the observed sensitivity of Antarctic snowfall to near-surface temperature of about 5-6 % K-1, suggesting that if Antarctic near-surface temperature does increase by about 2-3.5 K by the end of the 21st century as the GCMs predict, snowfall will increase by about 10-20%. Properly simulating Antarctic temperature in GCMs is thus critical for understanding how Antarctic snowfall will change, and consequently affect sea level rise.