

20th Century Forcing of the Antarctic Atmosphere

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Ice cores provide us with a window through which past atmospheric conditions can be viewed. The addition of seven new ice cores to the US ITASE collection, which now totals 23 fully analyzed cores, allows past atmospheric conditions for the last 200+ years to be contrasted and compared at near continental-scale.

Examination of the data reveals that non-sea-salt-calcium (nssCa) concentrations have been rising since ~1850 AD over much of West Antarctica. Correlations between ice core nssCa concentrations and Southern Hemisphere 850 mb zonal winds (from 1948-2000) suggest a strong link between the strength of the polar westerlies and dust transport into West Antarctica (Yan et al., 2005). The strength of these correlations gives us confidence in using nssCa as a proxy for zonal wind strength around Antarctica. Increased nssCa concentrations in central and coastal West Antarctica imply intensification of Antarctic polar westerlies starting around 1850 and increasing up to the present day. These observations also suggest that the recent increasing trend of the Southern Annular Mode (SAM) toward a more positive state (Thompson and Solomon, 2002) is actually part of a process that began as early as 1850.

A Holocene climate record from Siple Dome reveals that the polar westerlies have not been this intense for several millennia. The last time Antarctic polar westerlies were as strong as today West Antarctica had just experienced a rapid cooling event and was starting to warm slowly. The present day situation is occurring in a starkly contrasting setting where West Antarctic atmospheric temperatures are higher than they have been at any other time during the Holocene (AGCS., in press). The present day intensification of the SAM is likely a direct result of natural and anthropogenic forcings (Thompson and Solomon, 2002; Marshall et al., 2004), the latter composed primarily of greenhouse gas increases and ozone depletion. As greenhouse gas emissions are set to push global temperatures even higher in the near future we should expect to observe further increases in the state of the SAM. The question of whether or not the westerlies will collapse abruptly as following the last such intensification is critical to the future of Antarctic and Southern Ocean climate change.

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