



Systematic Attribution of Secular Southern Hemispheric Circulation Trends

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A critical question in the global warming debate concerns the causes of the secular trends of the Southern Hemisphere (SH) atmospheric circulation over the recent decades. Secular trends have been identified in the frequency of occurrence of circulation regimes, namely the positive phase of the Southern Annular Mode (SAM) and blocking. Previous investigations of the causes of these secular trends have either been purely model based, have not included observational forcing data or have mixed external forcing with indices of internal climate variability. Here we systematically attribute the secular trends using a non-stationary clustering method and both NCEP/NCAR re-analysis and observational forcing data. While most previous studies emphasized the importance of stratospheric Ozone depletion in causing SH circulation trends, we show here that both greenhouse gas emissions and Ozone depletion have contributed almost equally to these secular trends in the frequency of occurrence. This suggests that the recovery of the ozone hole might delay the signal of global warming less strongly than previously thought.