20th Century Variability and Trends in the SAM from Reconstructions, Observations, and the IPCC AR4 Models

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The Southern Hemisphere Annular Mode (SAM) is examined from reconstructions, observed indices, and simulations from 17 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) models from 1865- 2005. Comparisons reveal the models often have a weaker meridional pressure gradient, and they do not fully simulate periods of strong low-frequency natural variability within the reconstructions during the 1930s and 1960s.

The various seasonal indices are examined to understand the relative roles of forced and natural fluctuations. The models capture the recent (1957-2005) positive SAM trends in austral summer and autumn, with ozone driving summer trends; the relative forcing of the autumn trends is uncertain. The models also produce significant spring trends during this period not seen in observations, suggesting the models are too sensitive to the forcing in spring and/or are not resolving internal climate processes that dampen SAM trends. The majority of models produce significant positive 100-yr trends in the SAM (1905-2005) in all seasons, yet long-term trends are not present outside of austral summer in the reconstructions. In a historical perspective, the recent 30-year trend in summer is the strongest in the last 140 years, while in autumn negative trends after 1930 are actually stronger than the recent positive trend. These large natural fluctuations and inter-model differences make attributing the recent autumn trends especially difficult. Similarly, the disparate model and observationally-based spring trends warrant further study, and cast doubt onto the reliability of future SAM projections in this season.