primarily to strengthening circumpolar westerly winds, referred to as the Southern Annular Mode. Modelling studies suggest that the upward trend in the Southern Annular Mode is due partly to human activities, including increases in greenhouse gases and the depletion of ozone high above Antarctica (the 'ozone hole'). Others argue that internal climate variability linked to the tropics also has a first-order role in driving the variability of the Southern Annular Mode. Whether the Southern Annular Mode will continue to strengthen in forthcoming decades is still unknown because the relative importance of each of these factors, and how they could change, is uncertain. However, an attribution of the causality of polar climate variability is critical for understanding how the ice sheets will evolve in the twenty-first century.

Gillett and colleagues have analysed the results from several models used in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report[10] to examine the mechanisms underlying the observed polar climate changes. Their work demonstrates convincingly what previous studies have suggested — that humans have indeed contributed to warming in both the Arctic and Antarctic regions. The work by Gillett and colleagues is unique in comparison with previous studies that have assessed polar climate variability with the help of global climate models, because it focuses only on the grid points where observational temperature records exist, rather than on the entire Arctic and Antarctic regions.

By this restriction, the group is able to perform an 'apples with apples' comparison of model simulations and polar near-surface temperature records during the twentieth century. Their analysis implies that the models can simulate trends better than previous studies had suggested. Gillett and colleagues were also able to isolate the factors controlling the observed temperature variability. Model simulations that used only natural forcing were unable to recreate the temperature records: observed twentieth-century temperature increases in the Antarctic and Arctic regions could be simulated only when the impacts of industrial greenhouse gas emissions and stratospheric ozone depletion were included in the models.

Because the authors focus only on the grid points for which there are observations, caution must be used in extrapolating the results to the entire polar regions. This is especially true for much of the vast interior of Antarctica, for which there are few observations, and for which other studies suggest that no statistically significant temperature changes exist[6]. Indeed, the distribution of observational records along the coastal margins, and especially on the rapidly warming Antarctic Peninsula, may be biased towards a limited region of Antarctica for which warming has been more pronounced. Gillett and colleagues argue that Antarctic warming would be more widespread if the influence of the Southern Annular Mode trends on temperatures were removed from the signal. In contrast, some of the IPCC models may simulate too much warming over the data-sparse interior of Antarctica[11].

The results of Gillett and colleagues show that efforts to improve polar simulations in the IPCC models are starting to pay off. Their confirmation that humans are contributing to polar changes adds urgency to continuing efforts to simulate more realistic changes in these environments. The coupling of ice sheet processes to the climatic changes in the next generation of global climate models will be an especially important step towards constraining the potentially nonlinear anthropogenic contribution of thinning polar ice sheets to global sea level rise.

Published online: 30 October 2008.

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CLIMATE SCIENCE

The other greenhouse effect

Corrected online: 7 December 2008

Greenhouse agriculture has undergone a massive expansion in southeastern Spain in recent years in order to provide regions of Europe that receive less natural sunlight with fruit and vegetables. In fact, the extremely dry landscape of Almeria, once a backdrop to numerous 'spaghetti westerns', is now home to the world's largest collection of greenhouses.

This horticultural explosion, which has overidden the semi-arid pasture that characterized the region, has had its own regional climatic impact: Pablo Campra of the University of Almeria, Spain and colleagues (*J. Geophys. Res.* **113,** D18109; 2008) found that greenhouses in the coastal regions of Almeria bounce significantly more radiation back into the atmosphere compared with the vegetation in neighbouring communities. The increase in surface reflectance is greatest in summer, when farmers whitewash their greenhouses to stop the plants getting too much sun.

ALEX BRACKE

In an effort to determine the climatic significance of this agricultural development, the team trawled through satellite records of surface reflectivity and regional temperature records. They calculated the net change in solar radiation absorbed due to this particular land-use change, and estimated a reduction by an enormous 19.8 Wm^{-2}, much higher than earlier computations of the radiative effects associated with a variety of land-use changes.

Apparently as a result of this increase in surface reflectivity, the local temperature fell by 0.3 °C per decade between 1983 and 2006 — whereas the rest of Spain warmed by 0.5 °C per decade over the same period. The development of greenhouse farming in southeastern Spain therefore seems to have generated a microclimate that has provided local relief from global warming.

Anna Armstrong

Climate Science: The other greenhouse effect

ANNA ARMSTRONG

Nature Geoscience **1,** 729 (2008)

In the final paragraph of the above News & Views piece, the rate of heating was erroneously given as being per year; it should have read per decade. This has been corrected on the HTML and PDF versions.