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Uncertainties and assessments of chemistry-climate models of the stratosphere

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Abstract. In recent years a number of chemistry-climate models have been developed with an emphasis on the stratosphere. Such models cover a wide range of time scales of integration and vary considerably in complexity. The results of specific diagnostics are here analysed to examine the differences amongst individual models and observations, to assess the consistency of model predictions, with a particular focus on polar ozone. For example, many models indicate a significant cold bias in high latitudes, the "cold pole problem", particularly in the southern hemisphere during winter and spring. This is related to wave propagation from the troposphere which can be improved by improving model horizontal resolution and with the use of non-orographic gravity wave drag. As a result of the widely differing modelled polar temperatures, different amounts of polar stratospheric clouds are simulated which in turn result in varying ozone values in the models.

The results are also compared to determine the possible future behaviour of ozone, with an emphasis on the polar regions and mid-latitudes. All models predict eventual ozone recovery, but give a range of results concerning its timing and extent. Differences in the simulation of gravity waves and planetary waves as well as model resolution are likely major sources of uncertainty for this issue. In the Antarctic, the ozone hole has probably reached almost its deepest although the vertical and horizontal extent of depletion may increase slightly further over the next few years. According to the model results, Antarctic ozone recovery could begin any year within the range 2001 to 2008.

The limited number of models which have been integrated sufficiently far indicate that full recovery of ozone to 1980 levels may not occur in the

Antarctic until about the year 2050. For the Arctic, most models indicate that small ozone losses may continue for a few more years and that recovery could begin any year within the range 2004 to 2019. The start of ozone recovery in the Arctic is therefore expected to appear later than in the Antarctic.

Further, interannual variability will tend to mask the signal for longer than in the Antarctic, delaying still further the date at which ozone recovery may be said to have started. Because of this inherent variability of the system, the decadal evolution of Arctic ozone will not necessarily be a direct response to external forcing.

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