Understanding differences in the response to composition change as simulated by CCMVal models

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Chemistry climate models (CCMs) have a common conceptual basis. Differences in implementation lead to differences in the stratospheric ozone response to changes in composition and climate. Although evaluation by CCMVal-2 identified strengths and weaknesses of participant models, the evaluation results were not used to discriminate among projections for future ozone evolution, at least in part because the overall diagnostic evaluation did not cleanly relate to the differences in CCM response. Here we use a subset of CCMVal diagnostics and additional analysis to understand the differences in response. In the upper stratosphere, differences in simulated temperature and total odd nitrogen prior to increases in chlorine loading explain the large differences in CCM sensitivity. In the lower atmosphere, there are two principle contributions to differences in CCM sensitivity to chlorine and climate change. First, differences in the lower stratospheric ClO affect simulated sensitivity to chlorine. CCMs with best transport performance match NDACC column HCl measurements at a broad range of latitudes. Other CCMs disagree with observations due to differences in total inorganic chlorine, partitioning between HCl and ClONO2, or both. Differences in ClONO2 are directly related to differences in simulated ClO. Second, although all CCMs predict increased tropical upwelling, the rate of increase varies and contributes to differences in tropical ozone and the 60N-60S column average.