Text: Details of the method of comparison - Information how different fields are represented in AIRS and model data sets.

Figure: "Temperature bias for individual models" - Vertical structure of difference in zonal averaged temperature compared to AIRS for all models used in this study, ensemble mean of the models, and the two reanalysis data sets (ERA-40 and NCEP)

Figure: "Specific humidity bias for individual models" - Vertical structure of difference in zonal averaged specific humidity compared to AIRS for all models used in this study, ensemble mean of the models, and the two reanalysis data sets (ERA-40 and NCEP).
Details of the methodology of comparison
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For model output and reanalyses, we use temperature and humidity (both specific and relative) values reported at standard pressure levels (1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, and 100 hPa). These data represent the value corresponding to that particular pressure level.

In AIRS data, temperature values are also provided at standard pressure levels similar to model and reanalysis values, however the water vapor mass mixing ratios (MMR) are not. In AIRS the MMR is provided as a layer mean quantity, i.e., the reported value at a level is the mean value of the atmospheric layer above this level. For example, MMR at 1000 hPa is the mean of MMR of the layer between 1000 and 925 hPa. For comparison, we convert MMR to specific humidity (q) using the formula, q = MMR / (1 + MMR). The layer mean MMR (or $q_S$) in AIRS data are calculated assuming the logarithm of MMR varies linearly with logarithm of pressure. This assumption allows us to calculate layer mean q from model and reanalysis data by 'simply' taking mean of logarithm of q at adjacent levels and then exponentiating it. As the highest level at which models report $q_S$ is 100 hPa, the mean layer values from models go only up to 150 hPa.

Relative humidity in AIRS data is computed by taking ratio of MMR and saturation mass mixing ratio (SMMR), where as explained above, MMR is a layer mean quantity, but SMMR is calculated using retrieved air temperature profile which is a level quantity and therefore SMMR is also a level quantity. Thus taking ratio of layer mean value to level value would thus produce a dry bias in RH values because level SMMR will be larger than layer SMMR due to a positive lapse rate in the troposphere. This results in erroneously large differences in the AIRS RH product relative to both reanalyses and model simulations and greatly complicates any evaluation of humidity using AIRS RH retrievals.

AIRS data is available from {http://disc.sci.gsfc.nasa.gov/data/datapool/AIRS/}. A detailed description of these models can be found online at http://www-pcmdi.llnl.gov/ipcc/model_documentation/ipcc_model_documentation.php.