Abstract

Water vapour is fundamental to the climate system, as the most significant greenhouse gas and a key driver of many atmospheric processes. At the inception of this thesis, there existed no truly global and homogenised surface humidity dataset with which to assess recent changes or compare with climate model output. HadCRUH, the result of this thesis, provides a homogenised quality-controlled near-global 5 ^{o} by 5 ^{o} gridded monthly mean anomaly dataset in surface specific humidity and relative humidity from 1973 to 2003. It consists of data from both land and marine observations, and is geographically quasi-complete over the region 60 °N to 40 °S.

HadCRUH specific humidity is found to correlate strongly with global temperature records from the HadCRUT3 dataset. Statistically significant increases in specific humidity are widespread, with a global mean trend of 0.07 g kg^{-1} $10yr^{-1}$ (given reported temperature trends, the expected specific humidity trend at a constant relative humidity of 70 % is ~0.08g kg^{-1} $10yr^{-1}$). Trends are strongest in the Tropics and Northern Hemisphere Summer, regions of higher ambient temperature and thus consistent with the Clausius-Clapeyron relation. Relative humidity trends are statistically indistinguishable from zero on the largest spatial and temporal scales, but can be significant at smaller scales.

A strong positive bias is present in marine humidity data prior to 1982, most likely relating to a known change in observing practice for dewpoint temperature at this time. Thus, trends in both specific and relative humidity are likely to be underestimated over the oceans.

The Northern Hemisphere specific humidity signal is detectable above HadCM3 climate model expectations of natural variability. The HadCM3 anthropogenic forcings only ensemble provides a far better explanation than the natural forcings ensemble across a range of space scales pointing to a primarily anthropogenic origin of recently observed changes.