5.077 An atmospheric definition of the equator and its implications for atmospheric chemistry and climate.

Presenting Author:
Christopher Holmes, Florida State University, cdholmes@fsu.edu

Co-Authors:
Michael Prather, University of California, Irvine

Abstract:

Earth's northern hemisphere contains higher concentrations of many greenhouse gases and air pollutants than the southern hemisphere due to human activity and the partial isolation of the atmosphere's northern and southern hemispheres. While sharp composition gradients have been observed in the tropics for decades, the boundary between the atmospheric hemispheres has not been rigorously defined. After showing that the intertropical convergence zone (ITCZ) and other past definitions are not adequate, we suggest defining the atmospheric equator as the boundary where air originates equally from the northern and southern extra-tropics. We use a 3-D atmospheric transport model to identify the location and spatio-temporal structure of the atmospheric equator. This definition coincides with observed concentration gradients and the mean position of the ITCZ, when it is well developed over the oceans, and also works in regions where the ITCZ is ill defined. On average the southern hemisphere is larger, with large seasonal and synoptic variability. The asymmetry of the atmospheric hemispheres affects how simple mass balance models are constructed and evaluated against observations. For example, erroneously assuming equal hemisphere sizes overestimates the rate of interhemispheric transport implied by SF_6 observations. We also show that tropospheric OH concentrations and CH_4 loss rates in 3-D chemistry models are substantially different when averaged over atmospheric vs. geographic hemispheres. Methyl chloroform observations imply that CH_4 loss in the southern atmospheric hemisphere is equal to or faster than in the north, but for decades models have predicted much faster CH_4 loss in the northern hemisphere. Diagnosing the models consistently with the observational constraints at the atmospheric equator reveals that modeled north-south differences of CH_4 loss are actually consistent with observations within their uncertainties. This result supports our ability to simulate a key atmospheric oxidant, tropospheric OH, and its consequences for air quality and climate.