QOS2016-69, 2016
Quadrennial Ozone Symposium of the International Ozone Commission

Another Approach to the Brewer-Dobson Circulation: The Direct Inversion of the Continuity Equation

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The analysis of the mean age of stratospheric air is often used to diagnose the Brewer-Dobson circulation. The main problems of this approach are (a) that the age spectrum must be known to convert measured tracer mixing ratios into age of air, (b) decomposition of tracers can distort the results, and (c) any discrepancy between measured and modeled age distributions cannot directly be associated with a specific latitude, altitude, or time. To solve these problems, we propose to directly invert the two-dimensional continuity equation to obtain from global tracer measurements information on the advection vectors and mixing coefficients. This is, besides sequential or variational data assimilation or inverse modelling of sources, another independent category of inverse techniques. We have applied this method to MIPAS measurements of CFC-12, SF_6, CH_4 and N_2O. The resulting 2-dimensional field of advection vectors covers 90°S to 90°N and 10-70 km altitude. The spatial sampling is 4° in latitude, 5 km in altitude, and the time resolution of the current tests is one month. Results reproduce the expected atmospheric features like major warmings, overturning mesospheric circulation, mesospheric intrusions, the tropical pipe, as well as the upper and lower branch of the Brewer-Dobson circulation. Furthermore, the results are roughly consistent with measurements of the mean age of stratospheric air, which all gives confidence in this novel method. We propose to use resulting advection vectors and mixing coefficients as a model diagnostic to get more specific information about discrepancies between models and measurements than one would get with the analysis of the mean age of stratospheric air. Both the method and results will be presented.