A comparison of Brewer-Dobson Circulations in Reanalysis

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Brewer-Dobson circulation is of great interest to many scientists, which conducts mean-meridional transports of air mass, heat and minor constituents in the stratosphere. The actual mean circulations are analyzed from the JRA-25, the NCEP/NCAR and the ERA-40 in terms of mass-weighted isentropic zonal means (MIM analysis), averaging over December, January and February from 1980 to 2002. Among analyses, the mass streamfunctions are significantly different from each other especially near the tropopause in the lower latitudes. . Let us look at the mass streamfunctions at 100 hPa which indicate the strength of B-D circulations in each latitude. The differences among reanalyses are quite large in the tropics compared with those in the extratropics.

Recently, increasing interest is in the effects of climate change on the Brewer-Dobson circulation. However, the actual trends of the mass streamfunctions at 100 hPa can hardly be estimated from the reanalyses, because of large diversity among them. On the other hand, inter-annual variability of the mass streamfunctions at 100 hPa is to some degree, correlated with each other. The reason may be that wave-mean flow interactions due to resolvable waves are presented well in the reanalyze and drive mean-meridional circulations in data-assimilation cycle.

In the reanalyses, the stratospheric mean-vertical velocity is very noisy compared with the GCM runs. In the stratosphere, observation data are mostly temperature derived from satellite observations. Temperature data may cause dynamical imbalances and induce strong vertical motions through excitations of gravity mode. In an experiment of adding an zonal mean temperature increment, they are shown to generate large vertical motions after 6 hour integration. In order to eliminate dynamical imbalances from analyses, we need to develop advanced data-assimilation schemes and/or to reduce biases of the retrieved data and of GCM used in the data assimilation.