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How does atmospheric reanalysis reproduce real atmosphere?

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After NOAA/NCEP completed the first atmospheric reanalysis NCEP/NCAR, 20 years passed. For that time, NCEP/DOE, ERA-15, ERA-40, and JRA-25 are processed and widely utilized in various fields in meteorology. Recently, the new generation re-analysis including MERRA, CFSR, ERA-Interim, JRA-55 are also completed and available.

Today, the atmospheric reanalyses are fundamental database for various meteorology studies. Sometimes, they are utilized as same as observation data. Strictly speaking, however, they are hybrid data of observations and model output, and their qualities are widely distributed from high to low. For example, directly assimilated quantities including surface pressure or surface temperature have almost equivalent qualities as observations. On the other hand, radiation fluxes including OLR are the quantities largely reflecting characteristics of the model performance. Therefore, it is important to understand characteristics and application limitation of the elements to intend for when we utilize reanalysis products.

As a second point, we have to take into account a temporary variation of qualities of reanalysis products with change in observing systems. In atmospheric reanalysis, we aim to produce homogenous quality dataset through the target period with the frozen data assimilation system. On the other hand, there are the changes of the observation systems as another factor to affect the quality of the products. For example, meteorological satellites suffer their generation change in several years, and the qualities of satellite data changes every several years. Therefore, if reanalysis system utilizes satellite data, their products are also affected by the generation change of satellites.

As a third point, we have to pay attention to the possibility of discontinuity of the qualities of the products with the connection of the calculation streams. Sometimes there are large discrepancies between real atmosphere climatology and assimilation model climatology depending on the elements, and there may be some discontinuities around connection of calculation streams in such an element. For example, JRA-25 has large discontinuity in stratospheric moisture field around 1990.

There is not doubt that reanalysis products are the GPV data easy to use which reflected observations. Their qualities are depending on the elements, and we have to understand application limitation of these elements in utilization.

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