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## Past, Present and Future in Reanalysis

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It is going to pass 20 years since ECMWF performed ERA-15 reanalysis. During this 20 years, many re-analyses were produced also in USA and Japan, and now we can obtain the ensemble mean of re-analyses. In these situations, it has been recognized that the qualities of re-analysis products must be not comparable with observation data, and that verification of their error evaluation is necessary. Of course, it is unchanged that a re-analysis product is the essential database in various research fields including meteorology and oceanography. Important is to understand the application limit in the re-analysis products, and to utilize them within the application limits. This is also recognized by re-analysis producing groups themselves, and they are trying to evaluate quality of re-analyses with AMIP type experiments specialized re-analyses for specific purposes and so on. As examples of such efforts, I like to introduce AMIP type experiment or specialized re-analysis using long history observations planned at MRI. The AMIP experiment is performed to understand model climatology. As a specialized re-analysis, we are planning one for climate change research. In conventional re-analyses in which all available observations are utilized, resultant analysis fields are suffered from history of observations especially from satellite data, and their quality depend on time. Therefore, it is difficult to separate natural variability and artificial variability by observation history. In the re-analysis we planning, only long history data such as surface or upper air observations are utilized to suppress artificial variability in circulation fields. We will be able to finally extract signals of climate change with such re-analysis.

As a second point, we can point out re-analyses for specific serious phenomena. It is not only interest in meteorological research but also important in various decision making, to reproduce the qualitative meteorological fields of a past serious affair, and to discuss detailed circumstance and predictability of the weather phenomena. We at MRI performed re-analysis and re-forecast of Isewan Typhoon, because 2009 was the 50th anniversary of Isewan Typhoon. We can precisely predict storm tidal surge in Nagoya port comparable with observations, using current forecast model and data assimilation system of JMA. We can also show pseudo weather radar images and pseudo meteorological satellite images of Isewan Typhoon that were not available in those days yet. On the other hand, ECMWF carried out the D-day reanalysis in which the Normandy landing operation was carried out, and showed possible prediction of the weather in the day (June 6, 1944) with 3-day lead time, using current forecast model and data assimilation system of ECMWF. Of course, more than 50 years ago, the numerical forecast model and data assimilation system were not available and people cannot know qualitative weather situation in that time. In the present, we can reproduce circulation fields and detailed weather in that time if we use the state-of-the-art technology and definite observations. If even observation data are saved about the other serious affairs, a similar re-analysis and re-forecast experiments are possible. If observations for such affairs are discovered, we like to try again quantitative reproduction of the weather condition. These trials will be expected to contribute future development of meteorology.

Keywords: Data Assimilation, Reanalysis, Reforecast, Database for climate change research, Data Integration