Evaluation of multi-reanalysis products with in situ observations over the Tibetan Plateau

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Tibetan Plateau (TP) is the highest plateau on earth and has the most complex topography. The importance of TP on the weather and climate variations has been demonstrated in numerous studies. TP is the heat source in summer and it plays an important role in the Asian monsoon establishment and maintenance. The atmosphere-land interaction over TP significantly influences the thermal and dynamic circulation globally. Therefore, understanding the water and energy interaction between land and overlying atmosphere would greatly help to understand the weather and climate change over both TP and surround areas. Due to the complex topography, severe weather, and environmental condition, it is very difficult to obtain in-situ measured meteorology variables, especially for long-term over larger areas. Existing observation is too sparse for the representation of large areas, especially over the eastern TP where the elevation is generally higher than 4500m. The global reanalysis products provide high resolution and continuous variables, which could be used as a surrogate over TP. However, the reanalysis products could contain uncertainties from various sources which are inherent in the reanalysis processes. Thus, it is necessary to evaluate and compare various reanalysis products with available in-situ observations before they are used to represent meteorological states over TP.

In this study, six reanalysis products (i.e., MERRA, NCEP/NCAR-1, CFSR, ERA-40, ERA-Interim, and GLDAS) are evaluated using in situ measurements at 63 weather stations over the TP from the Chinese Meteorological Administration (CMA) for 1992-2001 and at nine stations from field campaigns from the Coordinated Enhanced Observing Period (CEOP)/ Asia-Australia Monsoon Project (CAMP/Tibet) for 2002-2004. The measurement variables include daily and monthly precipitation and air temperature at all CMA and CAMP/Tibet stations as well as radiation (downward and upward shortwave/longwave), wind speed, humidity, and surface pressure at CAMP stations. Four statistical quantities (correlation coefficient, ratio of standard deviations, standard deviation of difference, and bias) are computed and a ranking approach is also utilized to quantify the relative performance of reanalyses with respect to each variable and each statistical quantity. Compared with measurements at the 63 CMA stations, ERA-Interim has the best performance of variations in both daily and monthly air temperature, while MERRA has the highest correlations with observation. GLDAS has the best overall performance in both daily and monthly precipitation because it is primarily based on the merged precipitation product from surface measurements and satellite remote sensing, while ERA-40 and MERRA have the highest correlation coefficient for daily and monthly precipitation, respectively. Compared with measurements at

the nine CAMP stations, CFSR shows the best overall performance, followed by GLDAS, although the best ranking scores are different for different variables. It is also found that NCEP/NCAR-1 reanalysis shows the least representation compared with observation over both CMA and CAMP data. Since no reanalysis product is superior to others in all variables at both daily and monthly time scales, various reanalysis products should be combined for the study of weather and climate over the TP.

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