Scientists assess reliability of multiple precipitable water vapor datasets in Central Asia

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Careful evaluation and selection of datasets for scientific research are essential, particularly for poorly observed regions such as Central Asia.

The ERA5, the new generation reanalysis of European Centre for Medium-Range Weather Forecasts (ECMWF), is the most reliable in revealing the spatiotemporal characteristics of precipitable water vapor (PWV) in Central Asia, compared with other reanalysis datasets, according to a recent study published in *Earth and Space Science*.

The study specifically focuses on Central Asia, a vast, semi-arid to arid region, as it has been suffering severe water shortages in the recent half century, impacting the sustainable development of society. As a basic component of the water cycle, atmospheric water vapor plays an important role in the climate system and water resources. Understanding the spatiotemporal variations of atmospheric water vapor is essential for the understanding of the water cycle and management of water resources.

"Station observations are limited in Central Asia due to the sparse spatial distributions and the inhomogeneities of observations," said Jie Jiang of the Institute of Atmospheric Physics of the Chinese Academy of Sciences, the paper's first author. "Satellite products and reanalysis datasets are useful complements of in situ observations. However, the reliability and accuracy of these datasets in Central Asia remain unclear."

Scientists evaluated multiple satellite and reanalysis PWV datasets against radiosonde observations in Central Asia. The evaluation showed that two major satellite products, namely, Atmospheric Infrared Sounder-only (AIRS-only) and Atmospheric Infrared Sounder/Advanced Microwave Sounding Unit (AIRS/AMSU), can reasonably capture the climatological distributions, annual cycle and monthly variations of PWV. Among the eight current state-of-the-art reanalysis datasets, including ECMWF interim reanalysis (ERAIM), the fifth generation ECMWF atmospheric reanalysis (ERA5), National Centers for Environmental Prediction (NCEP)1, NCEP2, Climate Forecast System

Reanalysis (CFSR), 55-year modern Japanese Reanalysis Project (JRA55), Modern Era Retrospective Analysis for Research and Applications (MERRA), and MERRA version 2 (MERRA2), ERA5 and MERRA2 have better performance in both climatological characteristics and interannual variations, while NCEP1 and NCEP2 perform worse as these products has not assimilated either AIRS or AMSU data.

"There is no 'best' reanalysis dataset, as different datasets have their own strengths and weaknesses in different aspects," commented Prof. Tianjun Zhou, corresponding author on the paper and senior scientist at the Institute of Atmospheric Physics in the Chinese Academy of Sciences. Thus, they further constructed a skill-weighted ensemble mean of the reanalysis datasets, based on the different performances of individual datasets. "It is expected to be more reliable in revealing the climatological spatial patterns of PWV, compared with the simple ensemble mean and individual datasets," Zhou added.

The team further studied the physical processes dominating the PWV variations in Central Asia. They found the year-to-year variations in PWV are largely modulated by the local water cycle, followed by the remote forcing from North Atlantic

"This work provides valuable information for future research on water cycle in Central Asia. The use of skill weighting is a new attempt in merging different reanalysis datasets, as the method is generally more often used in multimodel studies," Zhou said.

More information: Jie Jiang et al, Evaluation of Satellite and Reanalysis Precipitable Water Vapor Data Sets Against Radiosonde Observations in Central Asia, *Earth and Space Science* (2019). DOI: 10.1029/2019EA000654