RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

News Article for RISUD Emerging Frontier Area (EFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Prof. George LIU	LSGI
2.	**Name of EFA:**	Environment and Climate Change Observation and Prediction	
3.	**Project Title:**	Augmenting the Extreme Weather Forecasting Capability in the Greater Bay Area through Improving the Accuracy of Satellite-based Atmospheric Water Vapor Remote Sensing Observations using Continent-based and Ocean-based GNSS Calibration	

4. **Final Progress/Achievement**

Successful assimilation of satellite-based Near-Infrared (NIR) water vapor data into Numerical Weather Prediction (NWP) model for a better weather forecasting

Recently, the researchers at the department of Land Surveying and Geo-Informatics (LSGI) in the Hong Kong Polytechnic University, in collaboration with the scientists at the Hong Kong Observatory, have successfully developed the approach to assimilate satellite-based Near-infrared (NIR) water vapor (WV) into Numerical Weather Prediction (NWP) model and improve weather forecasting performance. The direct assimilation of water vapor data, particularly the data at NIR bands, is still a challenge in the meteorological community worldwide. So far, only the U.K. Meteorological Office has successfully assimilated NIR water vapor data into their operational NWP system. It is arguably true that the PolyU is the second one in the world to achieve the same goal at the Lab. One step further than the U.K. Met Office who just used clear-sky data, PolyU researchers utilized all-weather satellite data.

Water vapor, as one of the most important atmospheric parameters and the largest source of greenhouse gases, is a controlling factor in the formation of many weather phenomena. Water vapor is highly variable in time and space. However, high quality water vapor data is very scarce. Observing water vapor from satellite sensors is a most cost-effective approach. The use of satellite water vapor into Numerical Weather Prediction (NWP) model nevertheless is not straightforward. This is particularly true for satellite water vapor observed at Near-infrared (NIR) channels (0.78 μm–2.5 μm). To date, only the U.K. Meteorological Office, a world's leading meteorological service agency, has successfully assimilated NIR satellite water vapor into their daily operational NWP system since May 2022. Different from the work of the U.K. Met Office that uses clear-sky NIR water vapor data only, the researchers at PolyU successfully assimilated all-weather NIR satellite water vapor data. This means that more satellite data can be utilized, which implies that a larger benefit to the NWP performance can be gained.

This work has been published in a paper titled "Assimilating Sentinel-3 All-Sky PWV Retrievals to Improve the WRF Forecasting Performance Over the South China" at the "Journal of Geophysical Research: Atmospheres". The water vapor from two European satellites Sentinel-3A and Sentinel-3B were used to study the weather forecasting the South China region, covering the Greater Bay Area (GBA). Assimilating Sentinel-3 all-sky PWV improved rainfall forecast skill score by 2.4% while the rainfall forecast score was improved by only 1.0% after assimilating clear-sky PWV. The bias of WRF humidity forecasting results could be appreciably corrected and the rainfall spatial pattern could be better captured after assimilation of Sentinel-3 PWV.

This project was funded by the RISUD EFA scheme. The work was carried out at the Micro-Laboratory of Atmospheric Research and Geomatics Engineering (Micro-LARGE) led by the project PI Prof. George Liu with collaboration with scientists from the Hong Kong Observatory. This project demonstrates that Hong Kong researchers are the first one in the world to successfully assimilate all-sky NIR water vapor data into NWP model. With the impact of climate change, reliable weather forecasting becomes more challenging and assimilating as many types of observation data as possible becomes imperative in the meteorological community.

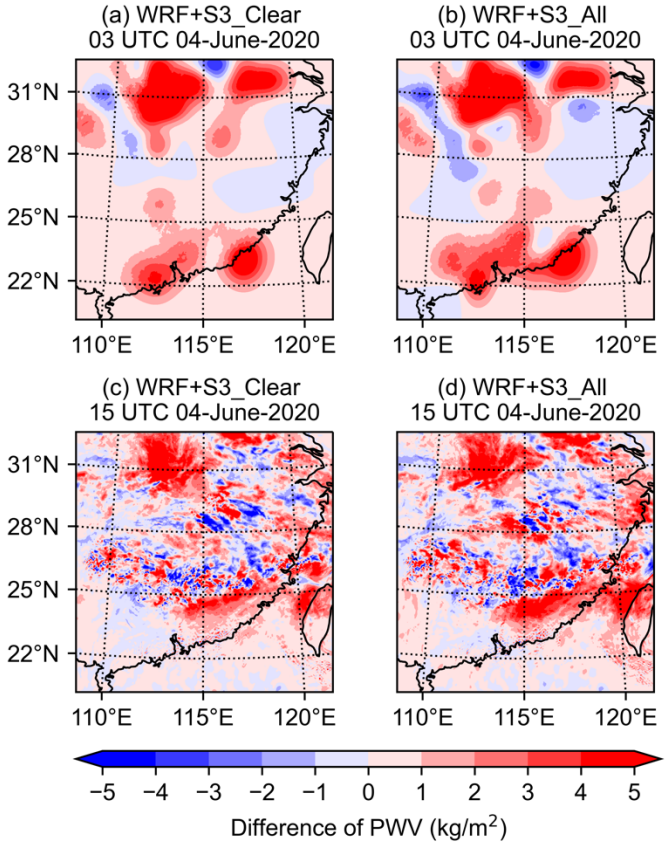

Figure 1 The total moisture changes at 03 UTC (a, b) and 15 UTC (c, d) on 04 June 2020 after the Numerical Weather Prediction (NWP) model WRF assimilates European satellites (Sentinel-3A and Sentinel-3B) moisture data, compared to WRF model without data assimilation. (a) total moisture changes at 03 UTC after data assimilation under clear sky condition; (b) total moisture changes at 03 UTC after data assimilation under all sky conditions; (c) total moisture changes at 15 UTC after data assimilation under clear sky

condition; (d) total moisture changes at 15 UTC after data assimilation under all sky conditions. This figure clearly shows that assimilating Sentinel-3 satellite moisture data generates an increase in moisture over most areas. The increase of moisture in the initial field further generates a wetter forecasting field.