RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

News Article for RISUD Emerging Frontier Area (EFA) Scheme

		Name	Department
1.	**Principal Investigator**:	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. **First Year Progress/Achievement**

In the context of global warming and climate change, more and more extreme weather events are being experienced globally. As the coastal city in the tropics, Hong Kong, as well as the Greater Bay Area, experiences more frequent typhoons and typhoons are expected to occur in an even higher frequency in the future. The study and prediction of the extreme weather events particularly typhoons are significant for Hong Kong and the entire GBA.

It has been identified that atmospheric water vapor is one of the most poorly observed meteorological parameters in the weather service. Water vapor, the most abundant greenhouse gas in the atmosphere (more than the carbon dioxide CO2), has an important role in the formation of many weather events, including rainstorm and typhoon. This project aims to enhance the atmospheric water vapor observations in the Hong Kong and GBA, which can be used to help weather prediction.

We make water vapor observation using both ground-based and space-based approaches. In the ground-based approach, we mainly use global navigation satellite systems (GNSS) to make water vapor measurement. In the space-based approach, we mainly use remote sensing satellites to make water vapor measurement. In this project, we develop an algorithm to improve the accuracy of water vapor data from remote sensing satellite by using GNSS water vapor data. Our test results show that we can improve the accuracy of remote sensing satellite’s data by 15.26% to 22.48%, depending on the processing methods and the satellite data. We are the first researchers that take advantage of ground-based water vapor to enhance the accuracy of remote sensing satellite water vapor data.

In order to make more ground-based water vapor observations, we think of utilizing the high speed train (HST) as an observation platform on which GNSS receivers are installed. This fast-moving platform is expected to collect atmosphere observations using GNSS with a very high spatial resolution. However we find that the HST window glass is a major obstacle to block GNSS signals. A field experiment was conducted to compare and analyze the quality of GNSS signals with and without the impacts of HST window glass. Based on our comprehensive comparison and analysis, we found that HST window glass can cause significant GNSS signal degradation and even loss of GNSS signals.

In addition, we have made water vapor observations on the vast oceanic region based on altimetry satellite data. The Jason-3 altimetry satellite has been used for this purpose. The quality of the Jason-3 water vapor data have been evaluated using coastal GNSS data and radiosonde data. The combination of oceanic water vapor and continental water vapor will provide valuable meteorological data source for the weather forecasting services such as the numerical weather prediction (NWP) at the Hong Kong Observatory. Hong Kong Observatory is one of the research partners of this project.

Hong Kong and the GBA are frequently impacted by typhoon. It is highly desired to predict and monitor the progress and development of a typhoon event. In this study, we analyzed atmospheric water vapor under three super typhoon events in Hong Kong in 2013-2014. We found that the typhoons approached Hong Kong, water vapor in the upper troposphere (1.6-8.5 km in altitude) was influenced most significantly. In the lower troposphere under 1.6 km, there was little fluctuation. We have measured the water vapor temporal and spatial increase rates in the upper troposphere (1.6-8.5 km in altitude) during the typhoon events. We found that the temporal increase rates were about 12.710 mm/day to 24.272 mm/day and that spatial increase rates were about 0.031 mm/km to 0.037 mm/km as typhoon approached Hong Kong from a distance about 800 km away.

The typhoon has significant impact on the civil engineering structures such as the wind turbines in the coastal region. We have studied the typhoon-induced vibration responses of offshore wind turbines under the impact of different stages of typhoon. Research results demonstrate that the multi-stage typhoon-induced effects can influence significantly the value of peak factor, the extremum of wind-induced force, and vibration responses of large wind turbines.