LSGI Research Seminar

-- 2023 Atmospheric and Coastal Observations for Weather Servicing (2023 ACOWS)

Date: ***21 January 2023 (Saturday)***

Time: ***9:00 am - 12:30 pm***

Venue: Z405, Block Z, Hong Kong Polytechnic University (PolyU)

Language: English

Registration: All are welcome and no registration is needed.

Coordinator: Dr. George Liu, Professor at LSGI, PolyU

e-mail: lszzliu@polyu.edu.hk, Tel: 2766 5961

Time	Title	Speaker
9:00 AM to 10:00 AM	***Improve Hurricane Intensity Forecast by Machine Learning of Satellite Data***	**Prof. Hui Su, Global STEM Professor, HKUST**
10:00 AM to 11:00 AM	***Talk I: Low level windshear and turbulence at the Hong Kong International Airport*** ***Talk II: Aircraft reconnaissance by the HKO at the northern part of the South China Sea***	**Mr. P. W. Chan, Assistant Director, Hong Kong Observatory (HKO)**
11:00 AM to 11:30 AM	***Short-term and long-term evolution of precipitable water vapor (PWV) near tropical cyclone centers***	**Mr. Shiwei Yu, PhD student, PolyU**
11:30 AM to 12:00 PM	***Assimilating remote sensing satellite PWV retrievals into WRF model to improve Numerical Weather Prediction (NWP) performance***	**Mr. Yangzhao Gong, PhD student, PolyU**
12:00 PM to 12:30 PM	***Enhancing water vapor measurements from satellite instruments under all weather conditions***	**Mr. Jiafei Xu, PhD student, PolyU**

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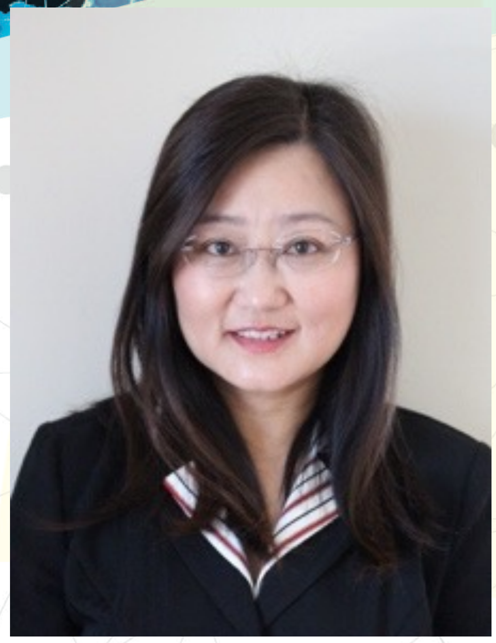
Improve Hurricane Intensity Forecast by Machine Learning of Satellite Data



Date: 21 January 2023 (Saturday)

Time: 9:00 am - 10:00 am

Venue: **Z405**

Language: English

Prof. Hui Su
Global STEM Professor
Department of Civil and Environmental Engineering
The Hong Kong University of Science and Technology
Clear Water Bay, Hong Kong

Biography:

Hui Su is a Global STEM Professor at the Department of Civil and Environmental Engineering, the Hong Kong University of Science and Technology. She received a B.S. in Atmospheric Dynamics from Peking University and a Ph.D. in Atmospheric Sciences from the University of Washington. After receiving her PhD, she worked at UCLA and then at NASA's Jet Propulsion Laboratory (JPL) managed by California Institute of Technology. She was a principal scientist and weather discipline program manager at JPL before joining the HKUST in September 2022. Dr. Su received the JPL Lew Allen Award in 2008 and the Edward Stone Award in 2021. She received NASA Exceptional Scientific Achievement Medal in 2010 and again in 2022. She is an Editor of the Geophysical Research Letter and a fellow of American Meteorological Society. She has published over 120 peer-reviewed articles. Her research interests are primarily in tropical convection and climate change.

Abstract:

Tropical cyclone (TC) intensity change, especially rapid intensification (RI), has been a forecast challenge for years. The Statistical Hurricane Intensity Prediction Scheme (SHIPS) as one of the most skillful operational RI forecast guidance tools employed at the USA National Hurricane Center (NHC) has an average probability of detection (POD) lower than 40% and false alarm ratio (FAR) higher than 60% for RI detection in North Atlantic (Kaplan et al., 2015), highlighting the urgent need of improving RI forecast skill. We built a machine learning model for RI probability forecast using historical data and achieved substantial improvement in POD in the Atlantic basin (Su et al., 2020). Moreover, we found that inner-core precipitation rate derived from merged satellite products varies systematically with TC intensity and intensification rate, with stronger rainfall corresponding to stronger storms and higher intensification rate. Adding the azimuthally averaged inner-core precipitation rate as a predictor in the machine learning model yields additional improvements. Recently, we have examined the impacts of spatial and temporal variability of TC precipitation and ocean surface salinity in RI forecast and achieved further improvements with varying magnitudes in different ocean basins.

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- **Talk I: Low level windshear and turbulence at the Hong Kong International Airport**
- **Talk II: Aircraft reconnaissance by the HKO at the northern part of the South China Sea**

Date: 21 January 2023 (Saturday)

Time: 10:00 am - 11:00 am

Venue: **Z405**

Language: English

Mr. Pak Wai Chan
Assistant Director
The Hong Kong Observatory

Biography:

Mr. P.W. Chan is an Assistant Director of the Hong Kong Observatory responsible for weather forecasting and warning services for the public. Before that position, Mr. Chan has been working at the Hong Kong International Airport for over 20 years, with research and operational efforts in airport meteorological instrumentation, low level windshear and turbulence alerting, and high resolution numerical weather prediction. He is a visiting professor of a number of universities in mainland China and an adjunct associate professor of the University of Hong Kong. He is a fellow of the Royal Meteorological Society and a Chartered Meteorologist. He has published more than 270 papers in SCI journals, with a significant portion of the papers focusing on the applications at the airport. He is a vice chair of the Expert Team of Upper Air Measurement at World Meteorological Organization and a chair of a working group of International Civil Aviation Organization in Asian region.

Abstract for talk I:

Low level windshear and turbulence could be hazardous to the departing and arriving aircraft at the airport. At the Hong Kong International Airport, the major kind of windshear is due to terrain disruption of the airflow. This report focuses on the effort of the Hong Kong Observatory in the monitoring and prediction of low level windshear and turbulence. Since the windshear mostly occurs in clear air conditions, the Observatory introduced the world's first Light Detection And Ranging (LIDAR) system to the airport in 2002 for operational alerting purpose. The LIDAR reveals many interesting features of wind changes at the airport, including mountain wake flow, mountain wave, tiny vortices, etc. The predictability of such features is also studied by running Weather Research and Forecasting (WRF) model at large eddy simulation model with a spatial resolution down to 40 m. Some recent results of the modelling of windshear features as well as turbulence intensity would be covered in the talk.

Abstract for talk II:

The Hong Kong Observatory has been cooperating with Government Flying Service to conduct reconnaissance flight into tropical cyclones over the northern part of the South China Sea. The talk would cover the history of the flights and samples of the data collected. In particular, the dropsonde flights provide useful information about the evolution of the tropical cyclones. Future developments would also be discussed.

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土地測量及地理資訊學系

LSGI Research Seminar – 2023 ACOWS

Short-term and long-term evolution of precipitable water vapor (PWV) near tropical cyclone centers

Date: 21 January 2023 (Saturday)

Time: 11:00 am - 11:30 am

Venue: **Z405**

Language: English

Mr. Shiwei Yu

Ph.D. Student

Department of Land Surveying and Geo-Informatics

The Hong Kong Polytechnic University

Biography:

Mr. Shiwei Yu currently is a Ph.D. student at the Department of Land Surveying and Geo-Informatics (LSGI), the Hong Kong Polytechnic University, Hong Kong, China. He completed his PhD oral examination in November 2022. He received his B.S. and M.S. degrees in Surveying Engineering from China University of Mining & Technology, Beijing, China, in 2013 and 2016, respectively. His research interests include GNSS data processing, GNSS meteorology, and atmospheric dynamics due to extreme weather, e.g. tropical cyclone.

Abstract:

A tropical cyclone (TC) is a strong cyclonical-rotating system generated in tropical ocean regions. It is also a destructive nature hazard characterized by powerful winds, heavy rainfalls, and magnitude thunderstorms. Annually, the global financial losses due to TC events were around US$ 26 billion, and the casualty toll was estimated to approximate 8,000 worldwide. Close monitoring for TC events is in urgent need, particularly in the context of global climate changes. In our study, we emphasize the evolution properties of precipitable water vapor (PWV) during the TC phase. PWV is a vital driven energy in the TC genesis and evolution. Based on the GNSS technology, the PWV evolution can be easily observed, and the TC-induced signature in PWV can be well captured. Taking the Super Typhoon Hato in 2017 for example, we found PWV increased rapidly to the peak when the TC was at a distance of around 500-700 km from the landfall area. In the course of landfall, the PWV variation featured a period of 2-5 hours, which was consistent with the time which it took for the rainband to pass by the landfall area.

Furthermore, we investigated the TC-surrounding PWV retrieved from the altimetry satellites during 367 TC events over the western Pacific Ocean between 2008 and 2020. The findings suggest that the TC-surrounding PWV features a north-leaning (south-leaning) property in the western North Pacific (western South Pacific) ocean basin. Due to the global warming, the sea surface temperature is increasing at a rate of 0.05ºC per year in the western Pacific Ocean. Consequently, much more water vapor is concentrated into the TC center, which sequentially leads to the outstretching PWV area and the flattening PWV spatial gradient.

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Assimilating remote sensing satellite PWV retrievals into WRF model to improve Numerical Weather Prediction (NWP) performance

Date: 21 January 2023 (Saturday)

Time: 11:30 am - 12:00 pm

Venue: **Z405**

Language: English

Mr. Yangzhao Gong

Ph.D. student

Department of Land Surveying and Geo-Informatics

The Hong Kong Polytechnic University

Biography:

Mr. Yangzhao Gong just started his fifth year of Ph.D. program in January 2023 at the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Kowloon, Hong Kong. He received the B.Sc. degree in Surveying Engineering from Xi'an University of Science and Technology, Xi'an, China, in 2015, the M.Sc. degree in geodesy from Central South University, Hunan, China, in 2018. His current research interests include numerical weather prediction, data assimilation, Global Navigation Satellite System (GNSS) atmosphere monitoring, and GNSS precise point positioning.

Abstract:

Various remote sensing satellites provide a huge amount of water vapor data that can be assimilated into the Numerical Weather Prediction (NWP) model to improve the weather forecasting performance. To investigate the benefits of water vapor data assimilation for different satellites, we have assimilated water vapor observations from three satellites-based instruments, i.e., Sentinel-3 Ocean and Land Colour Instrument (OLCI), Fengyun-4A (FY-4A) Advanced Geostationary Radiation Imager (AGRI), and the Moderate Resolution Imaging Spectroradiometer (MODIS) over the South China into the Weather Research and Forecasting (WRF) model. The impact of assimilation of both satellite raw (uncalibrated) PWV and calibrated PWV has been tested in dry period (February and March 2020) and wet period (June and July 2020). The PWV was calibrated using the Back Propagation Neural Network (BPNN) algorithm with the assistance of Precipitable Water Vapor (PWV) derived from Global Navigation Satellite System (GNSS).

The impact of assimilating PWV from various satellites has been assessed by multiple reference datasets such as GNSS-derived PWV, radiosonde profiles, and rainfall observations from surface meteorological stations.

- *Results evaluated by the GNSS-derived PWV show that assimilating Sentinel-3 PWV improves the PWV forecasting accuracy by 5.6% for the dry period (February 2020) and 5.0% for the wet period (July 2020); assimilating FY-4A PWV improves the PWV forecasting accuracy by 7.5% for the dry period (February 2020); assimilating MODIS PWV improves the PWV forecasting accuracy by up to 13.7% for the dry period (February 2020) and 8.9% for the wet period (July 2020).*
- *Results evaluated by the radiosonde data show that assimilating Sentinel-3 PWV can improve humidity, i.e., water vapor mixing ratio, forecasting accuracy by up to 8.0%; assimilation of MODIS gains 10.4% humidity forecasting accuracy improvement at altitude 2 to 3 km and 8.3% of temperature forecasting accuracy improvement at altitude 4 to 5 km. Assimilating either Sentinel-3 PWV or MODIS PWV can considerably reduce the mean bias of WRF humidity over the wet period.*
- *Evaluated by the surface rainfall observations, assimilation of Sentinel-3 PWV improves rainfall forecasting success rate from 69.4% to 71.1%; assimilation of MODIS PWV improves the rainfall forecasting success rate from 70.9% to 71.5%.*

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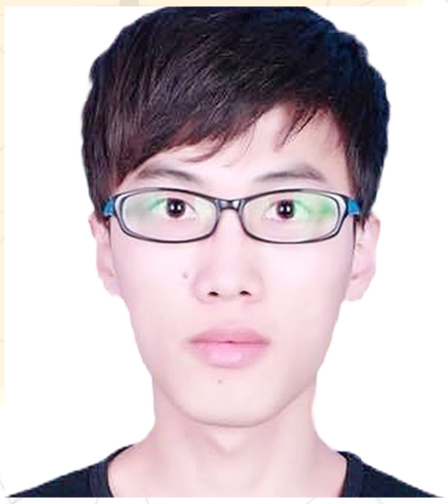
Enhancing water vapor measurements from satellite instruments under all weather conditions



Date: 21 January 2023 (Saturday)

Time: 12:00 pm - 12:30 pm

Venue: **Z405**

Language: English

Mr. Jiafei Xu

PhD Student

Department of Land Surveying and Geo-Informatics

The Hong Kong Polytechnic University

Biography:

Mr. Jiafei Xu is a third-year Ph.D. student in the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University. He received the B.Sc. degree in Remote Sensing Science and Technology from Shandong Agricultural University, Tai'an, China, in 2015, and the M.Sc. degree in Geomatics Engineering from Aerospace Information Research Institute, Chinese Academy of Sciences, Beijing, China, in 2019. His current research interests include the algorithm development for water vapor retrieval from multiple satellite-borne instruments as well as the algorithm validation for multiple satellite-sensed water vapor products. He has published a number of peer-reviewed journal papers in association with satellite water vapor observations, including IEEE Transactions on Geoscience and Remote Sensing, International Journal of Applied Earth Observation and Geoinformation, IEEE Geoscience and Remote Sensing Letters, and IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. In addition, his several manuscripts are being peer-reviewed, including IEEE Transactions on Geoscience and Remote Sensing, Quarterly Journal of the Royal Meteorological Society, and Geophysical Research Letters.

Abstract:

High-quality satellite remotely sensed water vapor observations present a vital role in Earth's weather and climate. Yet satellite-derived water vapor estimates observed under cloudy sky conditions show a much poorer observation performance compared to those measured under clear sky conditions. In addition to the cloud influence, the performance of satellite-sensed water vapor measurements is also inferior to that of ground-based and reanalysis-based water vapor data records. To date, no study has been reported on enhancing satellite water vapor retrieval accuracy under all-weather conditions. Previous research improved satellite water vapor observations only under clear sky conditions. In our research, we develop several algorithms for the first time to enhance the measurement performance of multiple satellite water vapor data records under all weather conditions. The result indicates that new resulting water vapor data records significantly outperform the official water vapor estimates from satellite instruments, in terms of improved R^2, smaller root-mean-square error (RMSE), and reduced mean bias. The new water vapor estimates under all-weather conditions even have a better observation performance than official satellite confident-clear water vapor data records, indicating the effectiveness of the algorithms. Our research can reduce the RMSE of all-weather water vapor estimates by over 50%. The enhanced satellite-observed water vapor data records could play a very important role in weather forecasting, climate monitoring, and many other applications.

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