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Advancing climate studies in the Asia-Pacific region with the next generation GNSS and an innovative radio occultation technique

Y. Kuleshov (1,2), E. Fu (1,2), K. Zhang (2), D. Silcock (2), A. G. Pavelyev (3,2)

(1) Bureau of Meteorology, Melbourne, Australia, (2) School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Australia, (3) Kotelnikov Institute of Radio Engineering and Electronics of the Russian Academy of Sciences, Fryazino, Moscow region, Russia

The global positioning system (GPS) radio occultation (RO) technique has demonstrated great potential for climate monitoring. Since the first GPS RO mission GPS/MET launched in 1995, dozens of satellites have successfully produced quality atmospheric profiles. CHAMP and FORMOSAT-3/COSMIC RO missions proved to be very useful for long-term climate studies. The next generation FORMOSAT-7/COSMIC-2 RO mission will be the first capable of receiving signals not only from GPS satellites but also other Global Navigation Satellite Systems (GNSS). Due to the increased number of GNSS satellites utilized, higher spatial and temporal resolution of atmospheric observation can be achieved using the same number of RO satellites. Moreover, multiple GNSS mean more frequencies available for the data retrieval process and higher quality of the data products can be expected.

Regional climate studies will gain benefits from the increased quantity and quality of RO atmospheric profiles. The National Climate Centre at the Australian Bureau of Meteorology, as a leading climate research agency in Southern Hemisphere, has utilized GPS RO data in various studies for the Asia-Pacific region and will continue to use the improved observations for a broader range of applications. A simulation study is carried out to examine the impact (benefit) of the next generation RO mission for the climate studies in the Asia-Pacific region. The number and distribution of RO events from FORMOSAT-7/COSMIC-2 with multiple GNSS (i.e. GPS, Glonass, Galileo Beidou and QZSS) are modelled. The results show that the number of daily RO retrievals in the Asia-Pacific region will increase from a few hundreds to over three thousands due to the use of multiple GNSS. A several demonstrating studies are carried out based on the future available RO atmospheric data.

An innovative analytical technique based on the relationships among the derivatives of the phase, eikonal and Doppler frequency over time and the intensity of GPS transmitted radio waves through the Earth' atmosphere has also been developed. This technique is applied to the identification and location of the plasma layers in the lower ionosphere by use of GPS RO data. This is highly important for determination of the location of the vertical wind shear and the direction of internal wave propagation in the lower ionosphere, and possibly in the atmosphere. Application of this innovative technique, particularly in combination with the next generation GNSS RO data, could advance climate research, for example, our understanding of tropical cyclone genesis and development in the Asia-Pacific region.