



## **Multi-GNSS meteorology: Real-time retrieving of atmospheric parameters from GPS, GLONASS, BeiDou and Galileo observations**

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The rapid development of multi-constellation GNSSs (Global Navigation Satellite Systems, e.g., BeiDou, Galileo, GLONASS, GPS) and the IGS (International GNSS Service) Multi-GNSS Experiment (MGEX) bring great opportunities and challenges for real-time determination of tropospheric zenith total delays (ZTD) and integrated water vapor (IWV) to improve numerical weather prediction (NWP), especially for nowcasting or severe weather event monitoring. The fusion of multiple GNSSs will significantly increase the number of satellites, optimizing the observation geometry. One result is the availability of more tropospheric slant delays, and consequently a more accurate and robust ZTD/IWV monitoring can be expected. This is especially beneficial in areas where satellite signals are blocked, such as urban areas, or in the equatorial latitudes, where the GNSS signals may be disturbed or even lost due to ionospheric scintillations.

In this contribution, we develop a multi-system (BeiDou+Galileo+GLONASS+GPS) processing model to fully exploit all the observations from these systems for the derivation of the real-time ZTD/IWV. A prototype multi-GNSS real-time ZTD/IWV monitoring system is also designed and realized at GFZ and runs in PPP mode for all of the globally distributed MGEX stations. The processing results of the first half year of 2014 are carefully analyzed to assess the quality of the ZTD series derived from different constellations and also evaluate the contribution of multi-GNSS fusion to ZTD/IWV estimates. Furthermore, the Very Long Baseline Interferometry (VLBI) technique is used for independent validation of the GNSS data products to demonstrate the significant benefits from multi-constellation GNSS in terms of both accuracy and reliability.