Geophysical Research Abstracts
Vol. 15, EGU2013-6454, 2013
EGU General Assembly 2013

GNSS meteorology for severe weather - 1D, 2D and 3D solution

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The variability of water vapour (WV) is strongly correlated with the formation, course and dissipation of the mesoscale convective storm systems, due to the large latent heat transfers in the evaporation/condensation process. Contrary to its importance WV space and time distribution remains under sampled in both domains, especially in sparsely populated countries such as Australia. GPS meteorology currently is a very important data source for meteorology, climatology and forecasting, due to the relatively dense network of receivers, operating in the unified reference frame.

Point observations of troposphere delay (1D), integrated water vapour (1D), as well as maps of these parameters (2D) are highly sensitive to building up of high amount of water vapour in the troposphere, as well as storm passage. The Kalman filter based GNSS tomography is an emerging method of reconstructing dynamically changing wet refractivity fields (3D). All types of ground based GNSS products has solid scientific foundations and are routinely estimated by major GNSS processing centres with high accuracy and low latency (ie. EGVAP AC). The forthcoming challenge of for the analyse of GNSS meteorology estimates (1D, 2D and 3D) is developing a quantifiable method to predict as well as identify location, size and severity of mesoscale convective storm system.

In the course of this research several spatial and temporal filter and indicators have been developed to aid in early detection, prediction and monitoring of severe weather events using all types of GNSS meteorology by-products estimates (1D, 2D and 3D).

This research presents a case study based on the analysis of an extreme convective super cell storm in the Victorian region during March 2010 using GPS tomography. Integrated Perceptible Water readings collected from MOBS stations confirmed high time resolution as well as sensitivity to incoming severe weather. Another, special measure of Refractive Index adopted for GPS tomography wet refractivity profiles, shows excessive values as a response to supercell thunderstorm formation. Finally a 2D cross section mapping the lifecycle of this severe weather event concludes a correlation between the highly dynamic spatial and temporal changes of wet refractivity modelled using 4D GPS tomography with precipitation intensities measured using weather radars.