EGU23-9910, updated on 16 Jun 2023
https://doi.org/10.5194/egusphere-egu23-9910
EGU General Assembly 2023

Tropospheric tomography – integration of ground- and space-based GNSS observations

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On the way transmitter-receiver, the Global Navigation Satellite Systems (GNSS) signal is attenuated and delayed by the presence of water vapor. This information serves as the input to the GNSS tomography - a robust technique in water vapor estimation concerning its amount and distribution in the troposphere.

GNSS rays pass through the tomographic grid built over a dense network of ground-based GNSS stations. Due to the constant movement of the GNSS satellites influencing their elevation angle and visibility, the measurement geometry varies in time. The model elements are either over or under-determined during the chosen time span within the area of interest; hence, the system of observation equations is mixed-determined.

However, to enhance the tomographic solution, the model can be supplied with additional data, e.g., from the radio occultation (RO). The RO technique provides the space-based signal delay between the low Earth orbit (LEO) and GNSS satellites. Products obtained from the RO measurements consist of bending angles and vertical dry- and wet-atmosphere data.

In this study, we analyze the COSMIC-1 radio occultation events in the tomographic domain located in the Netherlands in February 2018. The observation system in the ATom GNSS software was extended with the space-based wet refractivity profiles (level 2 data). We compare the obtained 3D wet refractivity field to the GNSS ground-based-only tomographic solution and the radiosonde measurements. The drawbacks and potential development of the applied solution are also discussed.