Influence of atmospheric processes on gravity – At what scales?

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Atmospheric processes influence high-precision gravity measurements over a broad range of frequencies. Besides air pressure, the knowledge of the vertical distribution of water in the atmosphere is essential to ensure reliable results. However, it is rather unknown at what temporal and spatial scale does this parameter influence the gravity signal. Is it adequate to provide a rather rough mean value on a larger scale or do we need highest possible resolution in both temporal and spatial scales?

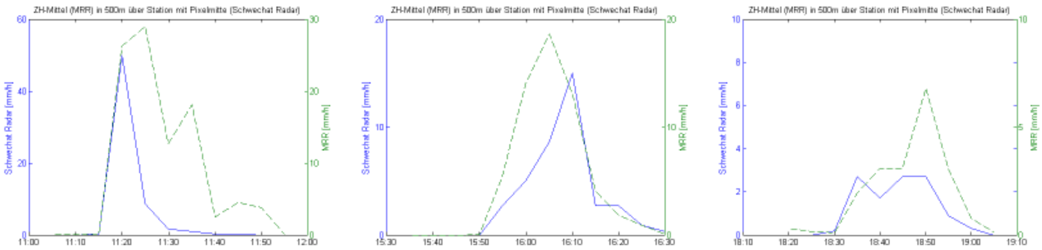

Figure 1: Rain rates (mm/h) for the lowest 1000m height interval for WRX (blue) and MRR (green). Left: Type A: 27 Mai 2011 11h00-12h00 UTC , centre: Typ B: 3 Juni 2011 15h30-16h30 UTC and right: Typ C: 27 Mai 2011; 18h00-19h10 UTC. Note the different scaling of the axes.

Water in the atmosphere in terms of vertical integrated liquid water content (VIL) causes short-term variations in the gravity signal. The correction of these disturbances is crucial to get meaningful geodynamic results (Meurers, et al., 2011). VIL is determined from two different data sources measuring at different scales. Data from the dual Doppler weather radar (WRX) in Schwechat are compared to data from the vertical-pointing micro rain radar (MRR) positioned at the Conrad Observatory (COBS). The direct line from the WRX to the observatory is about 60 km. VIL can be extracted from both data sources but on very different scales. One WRX data point represents a mean value for a cube of 1x1x1km every 3 and 5min. By contrast one MRR data point represents a mean value for a height interval of 100m and 30sec mean.

In a first step MRR data are upscaled to allow for a comparison of the two data sources. One has to note that the scanned volume of the MRR represents less than 1 per mille of the WRX volume.

The WRX suffers from the fact that strong convective cells in the direct line between Schwechat and the COBS dampen the radar beam and result in an underestimation of the precipitation amount above the COBS. Depending on the propagation direction (along the direct line) of the precipitation systems three characteristic weather regimes can be identified (Fig. 1). Type A: Weather systems moving from southwest to northeast. WRX underestimates precipitation on the later stage of the weather system. Type B: Weather systems moving from northeast to southwest: WRX underestimates precipitation at the beginning of the event. Type C: Stratiform precipitation events. Both measurement systems perform equal. An example for a Type B event is given in Fig. 2).

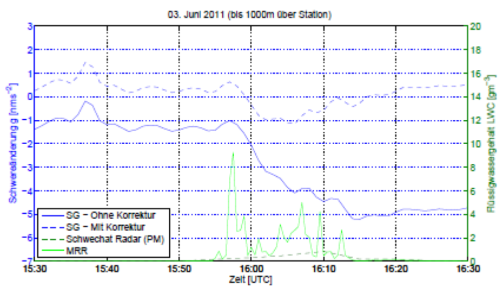

Figure 2: Type B event:
Non-corrected (blue-solid) and rain corrected (blue-dashed) gravity signal.
Liquid water content measured by MRR (green-solid) and WRX (green dashed).

References:

Meurers B., Dorninger M., Blaumoser N. (2011) Atmospheric signals in the SG gravity record at Conrad Observatory, Austria. Geophys Res Abstr, 13, 12747.

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