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Exploitation of ground-based GNSS for Meteorology and Climate studies in Bulgaria/Southeast Europe

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Regional GNSS database at Sofia University (SUADA)

Atmospheric sounding using the Global Navigation Satellite Systems (GNSS) is a well established research field in Europe. At present, GNSS data from more than 1,800 stations are available for model validation and assimilation in state-of-the-art models used for operational numerical weather prediction Centers in Europe. In Bulgaria and Southeast Europe the use of GNSS for atmospheric sounding is currently under development. As a first step the Sofia University Atmospheric Data Archive (SUADA, (http://suada.phys.uni-sofia.bg/)) is developed. SUADA is a regional database and includes:

- GNSS tropospheric products (over 12 000 000 individual observations) and over 55 000 derivatives from:
  - 5 GNSS processing strategies
  - 117 stations for the period 1997-2013
  - temporal resolution 5 min - 6 hours
- Radiosonde IWV data (over 6 000 observations) for station Sofia (1997-2013).
- Surface meteorological observations

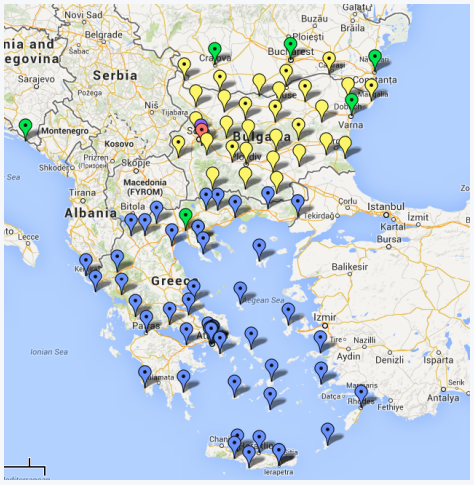

Figure 1. SUADA station location: 1) GNSS (blue, green, yellow and violet) and 2) Radiosonde (red).

SUADA application for long-term variation of IWV during the 2007 heat wave

Heat waves have become a common summer feature in the Southeast Europe. The July 2007 heat wave has the largest geographical extension reaching Bulgaria. The GNSS-IWV from the CODE AC processing for IGS repro2 and Radiosonde-IWV are used to study the 2007 heat wave. In figure 2 top are plotted GNSS-IWV in 2007 (solid line) and 2001-2010 (dashed line). The following features stand out: 1.) IWV decrease in April, 2.) IWV increase in May and 3.) a sharp IWV decrease in July. Clearly seen from figure 2 bottom is that the largest negative IWV anomaly (difference 2007 mean and 2001-2010 mean) is in July about -4 mm from GNSS-IWV (open circles) and -5 mm from RS-IWV (filled circles). There is very good correlation of the anomaly from the two techniques despite the different sampling rate and location. The difference between the GNSS-IWV and RS-IWV anomaly is under 0.5 mm in 7 months, between 0.5 and 1 mm in 2 months and about 1 mm in 3 months.

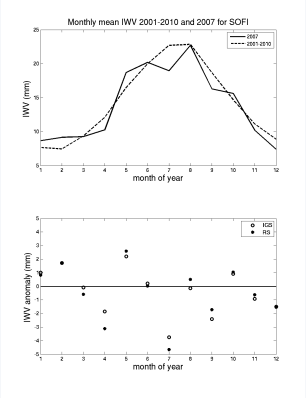

Figure 2: Monthly mean IWV (top) and anomaly (bottom).

SUADA application during 2012 severe weather events in Bulgaria

Two dimensional water vapour maps for Bulgaria are used to study 22 intense precipitation events in 2012. On 26 June a cold front passes over Bulgaria. Advection of dry air mass is well seen from north-west spreading along the Balkan mountain range (figure 3c). The consecutive IWV maps on 26 and 27 June capture well the advancement of the dry air mass. In less than 24 hours the IWV in the north Bulgaria decreased by half from above 35 mm at 0600 UTC (figure 3a) on June 26 to 15-20 mm at 0300 UTC on June 27. On June 27 the advected dry air catches the receding humid air mass resulting to isolated convective cells development with thunderstorms and intense precipitation. Intense rainfall of 74 l/m^2 for six hours is recorded between 0900 and 1500 UTC on June 27 at the Black sea coast. The strong north-south gradient of IWV over the Balkan peninsula is confirmed in the 2D IWV maps derived from the Meteosat data (figure 3h).

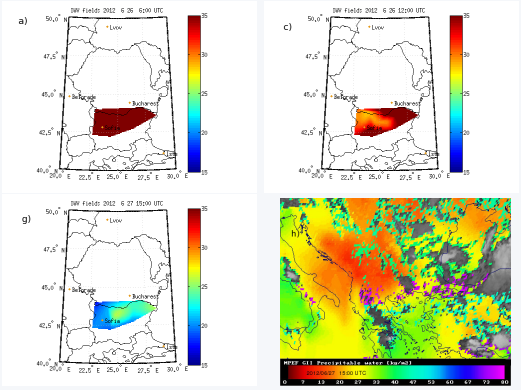

Figure 3. 2D IWV maps from GNSS meteorology and Meteosat on 26-27 June 2012.

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