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# Interest of GNSS tomography for nowcasting in the frame of HyMeX

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## GNSS tomography as part of HyMeX

This work is a contribution of the COST Action ES1206 (GNSS4SWEC - <http://gnss4swec.knmi.nl> - Advanced Global Navigation Satellite Systems tropospheric products for monitoring severe weather events and climate) to HyMeX project.



HyMeX (HYdrological cycle in the Mediterranean EXperiment) aims at a better understanding and quantification of the hydrological cycle and related processes in the Mediterranean, notably with emphasis on high-impact weather events ([www.hymex.org](http://www.hymex.org)).

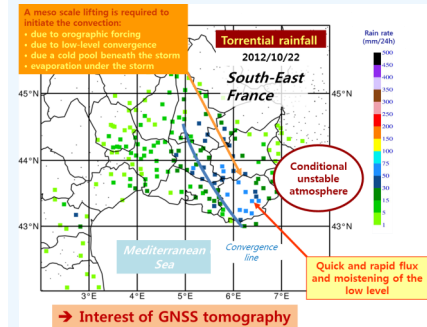


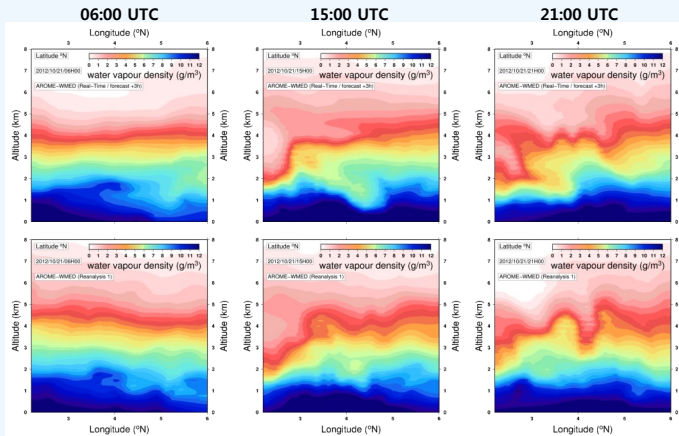
Figure 1: Illustration of triggers initiating convection during high precipitation event (focus on IOP15b). The location of the line of convergence (at 15:00 UTC on 21 October 2012) is shown, as well as the daily rain rate observations.

## Investigations for nowcasting using outputs from AROME-WMED

The sensitivity to a priori model needed to initialise the tomographic retrievals, has been investigated by considering both very-short-term forecasts (e. g. **Real-Time forecasts +3h**) and analyses (and e. g. **Reanalysis 1**) from a high resolution numerical weather prediction system (NWP); i. e. AROME-WMED with a domain covering the western Mediterranean area). Pseudo slant observations have been considered in GNSS tomography to improve the geometrical distribution considered in retrievals (see Brenot et al., 2012, 2014 and poster [EGU2017-7078; X3.186](#)).

AROME-WED  
Real-Time  
forecasts  
+3h

Reanalysis 1



GNSS  
tomography

A priori  
(WMED RT +3h)

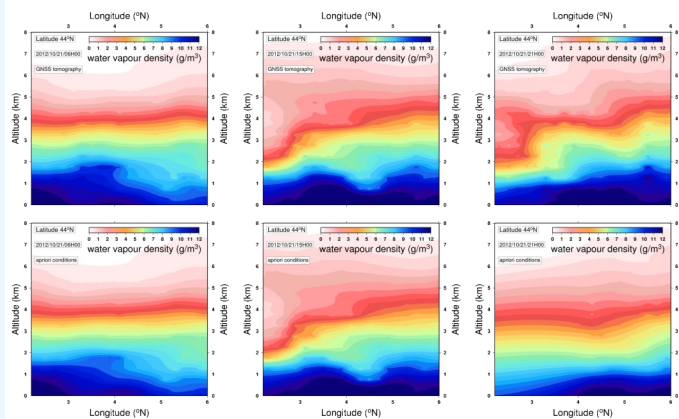


Figure 3: Comparisons of vertical sections of water vapour density established for a fixed latitude of 44°N (2012/10/21).

## Preliminary results of validation by external observations

Validation of tomography retrievals using external observations (GNSS radio-occultation).

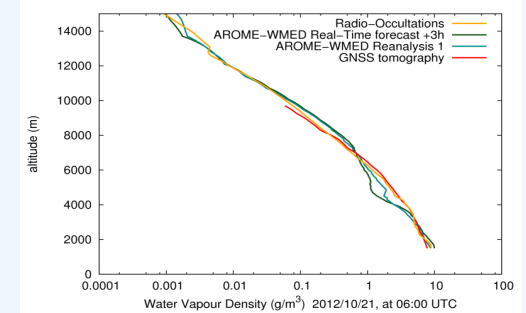


Figure 4: Profiles of water vapour from radio-occultations, AROME-WED and GNSS tomography.

## Conclusions and future works

This study illustrates the use of Real-Time forecasts (+ 3hours) from AROME-WMED to initialise GNSS tomography products (e. g. during IOP15b of SOP1 with a case of heavy rain in southeaster France), showing a good potential for an operational use, with improvement of the understanding of the meteorological situation (nowcasting scenario).

Retrievals of water vapour density, wet and total refractivity from GNSS tomography are available for 23 days of Autumn 2012, covering 6 Intensive Observation Periods (IOPs). The potential of GNSS tomography for these IOPs still need to be investigated.

A preliminary result of validation of GNSS tomography by radio-occultation (RO) is presented showing a better agreement between RO and GNSS than between RO and AROME-WMED. The next step of validation is to consider other data available during these IOPs, like ground-based Raman lidar, airborne Liandré II lidar, radiosondes and other radio-occultations profiles, to obtain statistical results between observations and NWP.

## References

**Brenot et al.**: Humidity 3D field comparisons between GNSS tomography, IASI satellite observations and ALARO model, *Geophys. Res. Abstr.*, 14, EGU2012-4285, 2012.

**Brenot et al.**: A GPS network for tropospheric tomography in the framework of the Mediterranean hydrometeorological observatory Cévennes-Vivarais (southeastern France), *Atmos. Meas. Tech.*, 7, 553-578, doi:10.5194/amt-7-553-2014, 2014.

**Ducrocq et al.**, HyMeX-SOP1: The Field Campaign Dedicated to Heavy Precipitation and Flash Flooding in the Northwestern Mediterranean, *Bulletin of the American Meteorological Society*, American Meteorological Society, 95 (7), pp.1083-1100, <http://dx.doi.org/10.1175/BAMS-D-12-00244.1>, 2014.

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We thank the European Commission for supporting our meeting and this work in the frame of GNSS4SWEC COST action.



The 1<sup>st</sup> HyMeX Special Observation Period (SOP1; Ducrocq et al., 2014) took place in autumn 2012. Six Intensive Observation Periods (IOP) have been achieved with respect to severe weather. This study focusses on IOP15b (21-22 October), investigating the interest of GNSS tomography for nowcasting (retrievals of water vapour density, wet and total refractivity, with a resolution of 10 km horizontally and 0.5 km vertically).

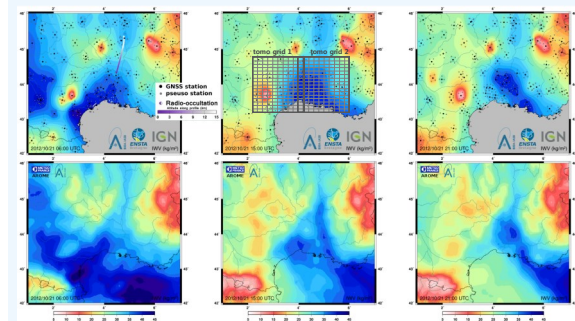


Figure 2: IWV images from GNSS and from AROME-WED-A1 on 21 Oct. 2012 at 06:00, 15:00, 21:00 UTC.

AROME-WMED (horizontal resolution of 2.5 km) uses a 3DVAR data assimilation system in a rapid update cycle with analyses performed every 3 hours. Its domain covers the western Mediterranean area and additional observations available during HyMeX field campaigns are assimilated. This system was used in real-time (AROME-WMED-RT) to guide the deployment of research observing systems during SOP1 and IOP15b. A first reanalysis (AROME-WMED-R1) was performed with an improved forecast model (including more data not assimilated in RT).