

# GPS Tomography and Remote Sensing Techniques for Water Vapor Determination in the ESCOMPTE Campaign

## Abstract

The ESCOMPTE field campaign (Expérience sur Site pour COntreindre les Modèles de Pollution atmosphérique et de Transport d'Emissions) was carried out in the region of Marseille (France) in June 2001. It aimed at studying summer pollution in industrialized areas and its impact on the complex processes in the atmosphere. Several techniques were deployed to provide independent data sets for validation purposes.

Water vapor is the most variable parameter of the major constituents in the atmosphere and it has a strong effect on the refraction of the signals emitted by GPS satellites. For geodetic applications, it is mandatory, to determine the water vapor and its variation with a high accuracy.

The comparison of the integrated precipitable water vapor retrieved by GPS, microwave radiometer, solar spectrometer and radiosondes shows a good agreement. A tomographic approach is used to determine the spatial distribution of water vapor in the troposphere. The comparison with radiosonde data shows the success of this method.

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## Outline

In the framework of the ESCOMPTE field campaign, GPS, microwave radiometer, solar spectrometer, and radiosondes were deployed to determine the integral amount as well as the spatial distribution of tropospheric water vapor during three weeks.

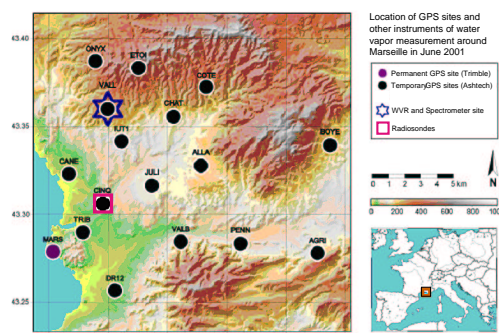


Fig. 1: GPS network and sites of further instruments in the ESCOMPTE field campaign.

## Integral amount of water vapor

The integrated precipitable water vapor (IPWV) is retrieved by four methods:

- GPS data are used to estimate the IPWV with the post-processing software GAMIT.
- The Water Vapor Radiometer (WVR) measures the radiation intensity emitted by  $H_2O$  molecules due to thermal excitation at the 22.235 GHz spectral line.
- The solar spectrometer SAMOS measures the amount of absorption of the solar radiation traversing the atmosphere due to water molecules.
- Radiosondes provide meteorological profiles for IPWV retrieval.

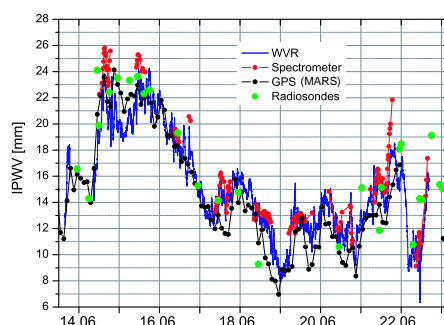


Fig. 2: Comparison of IPWV including radiosonde data from Nîmes and Aix-les-Milles.

During the measurement period of nine days, a significant variation of the IPWV between 7 and 26 mm is observed. A generally good agreement of the different techniques is visible.

## GPS Tomography

In the tomographic approach, the vertical resolution of refractivity in the troposphere is elucidated. The software package AWATOS is based on the assimilation of double differenced GPS observations to calculate the refractivity in a voxel model applying a least squares adjustment.

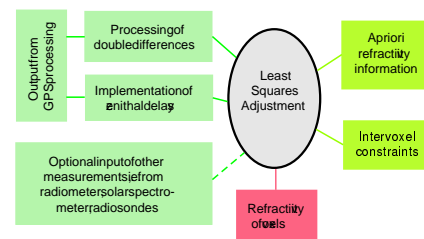


Fig. 3: Flow chart of the software package AWATOS.

Because of the limited number of GPS satellites and receivers, the network geometry is partially under-determined and, therefore, additional constraints have to be introduced in the adjustment system.

Refractivity profiles are obtained with a high temporal resolution and at any location within the area of the GPS receivers.

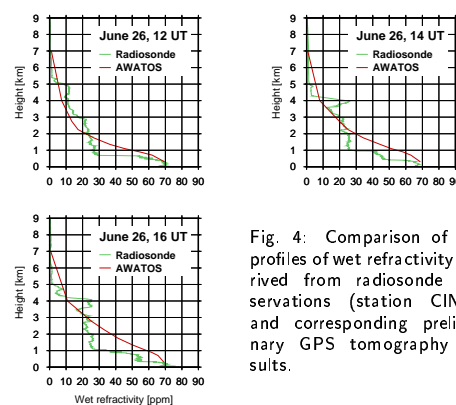


Fig. 4: Comparison of the profiles of wet refractivity derived from radiosonde observations (station CINQ) and corresponding preliminary GPS tomography results.

The preliminary tomographic results fit quite well to the corresponding radiosonde profiles. Due to the intervocal constraints, irregularities in the refractivity profiles are smoothed out.

## Conclusions

The data collected during the ESCOMPTE field campaign is useful to analyze the performance of tropospheric water vapor sensing techniques. The determination of IPWV showed a high accuracy. The tomographic approach allows the extraction of time dependent 3D refractivity fields. Further investigations are currently in progress to improve the reliability of AWATOS.

## References

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