

# High resolution GPS tomography during COPS: Overview and perspectives

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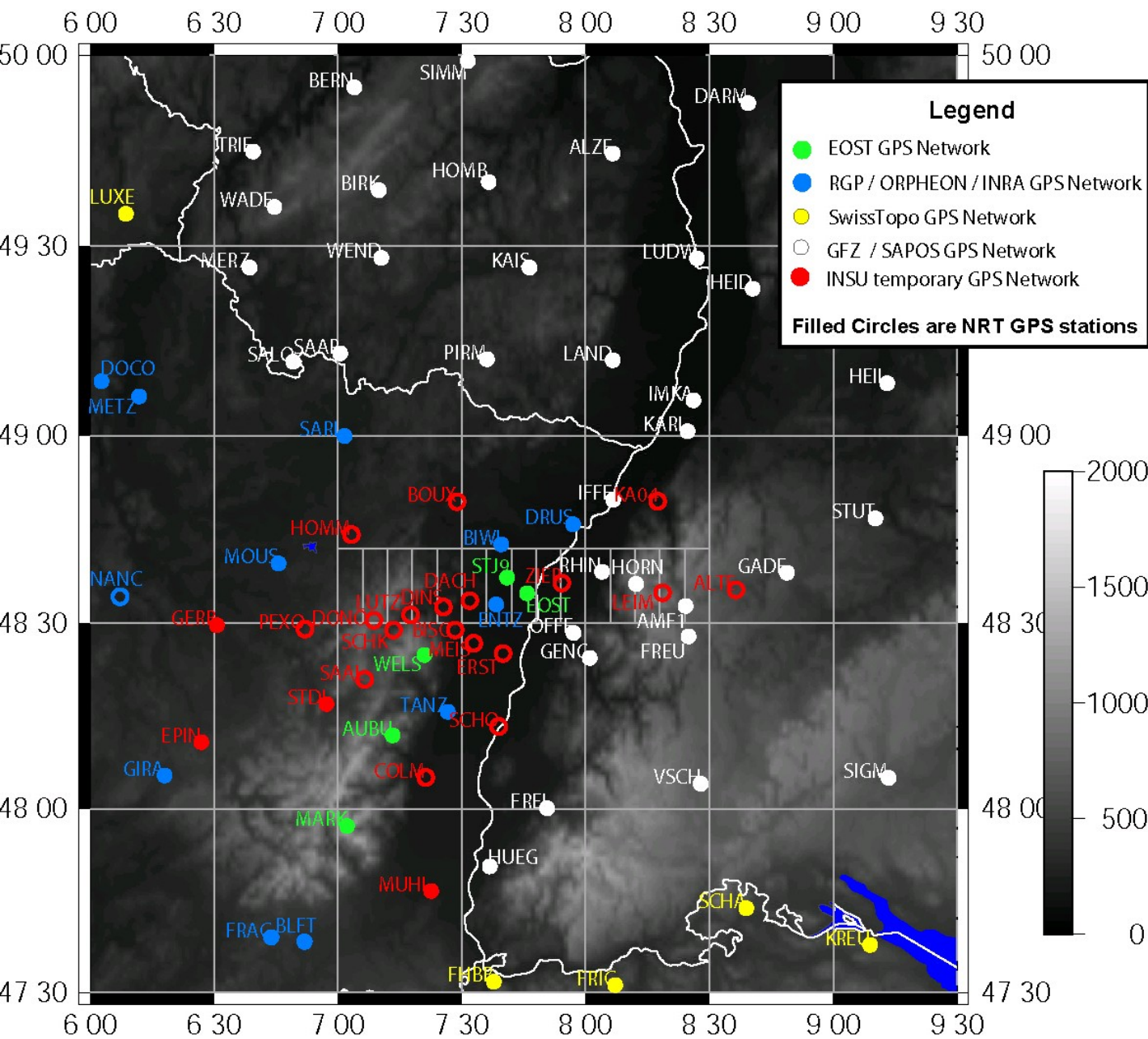
# Why GPS water vapour measurements ?

1- Additional all weather capable dataset with good temporal sampling for CI case studies (Samiro Khodayar Poster).

2- Impact of GPS data assimilation in numerical modeling: need to determine the best GPS network configuration for future operational QPF (Olivier Caumont presentation).

**3- Synergy between the GPS tomography and the profiling instruments (RS, LIDAR,IASI)**

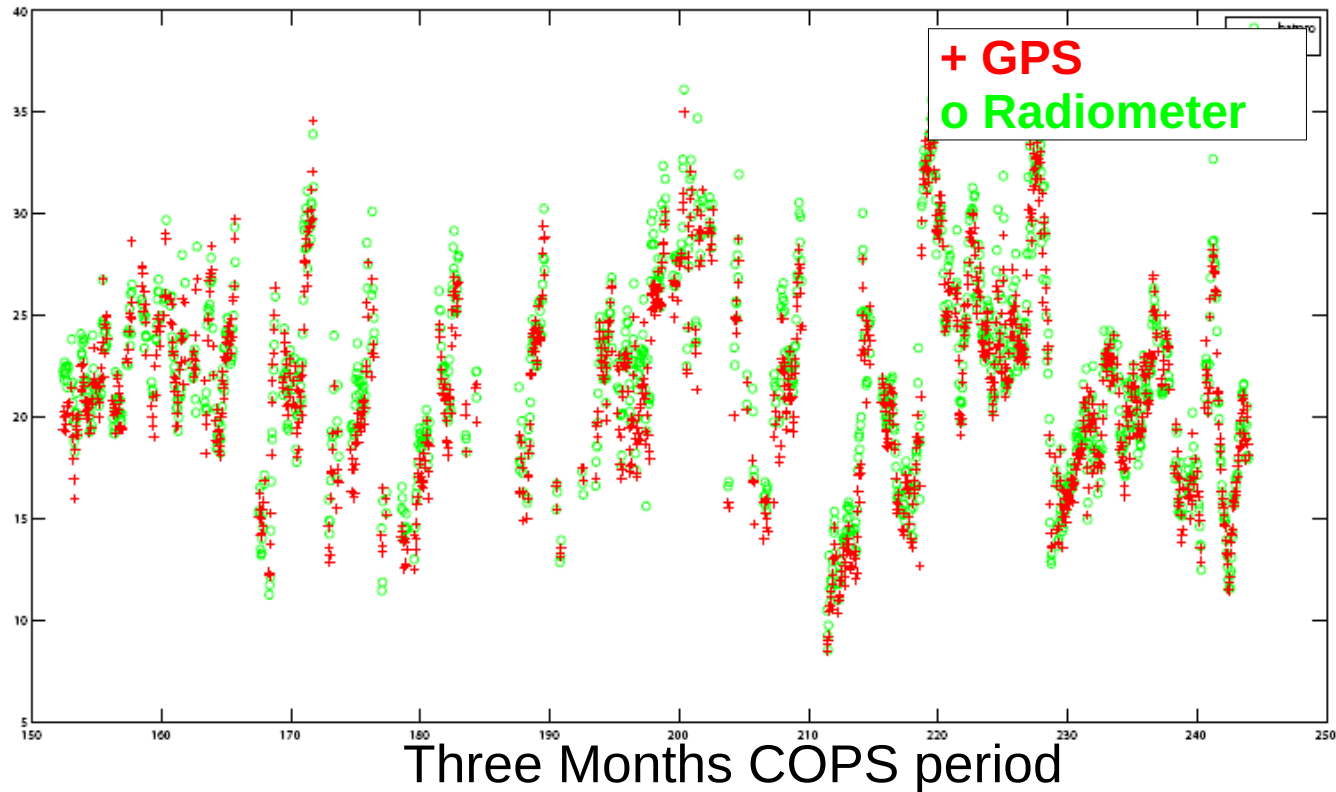
# The COPS GPS Network



## Things done:

- 25 GPS (20 Fr. et 5 All.) installed during COPS
- ~80 GPS on a large COPS area
- A regional network (50 km)
- A E-W dense profil (10 km)
- 3 months of continuous measurements
- About 15 people participated to the field experiment
- All the ZTD data processed and available
- IWW, SWV and tomography available: please ask for

# GPS processing validation: IWV



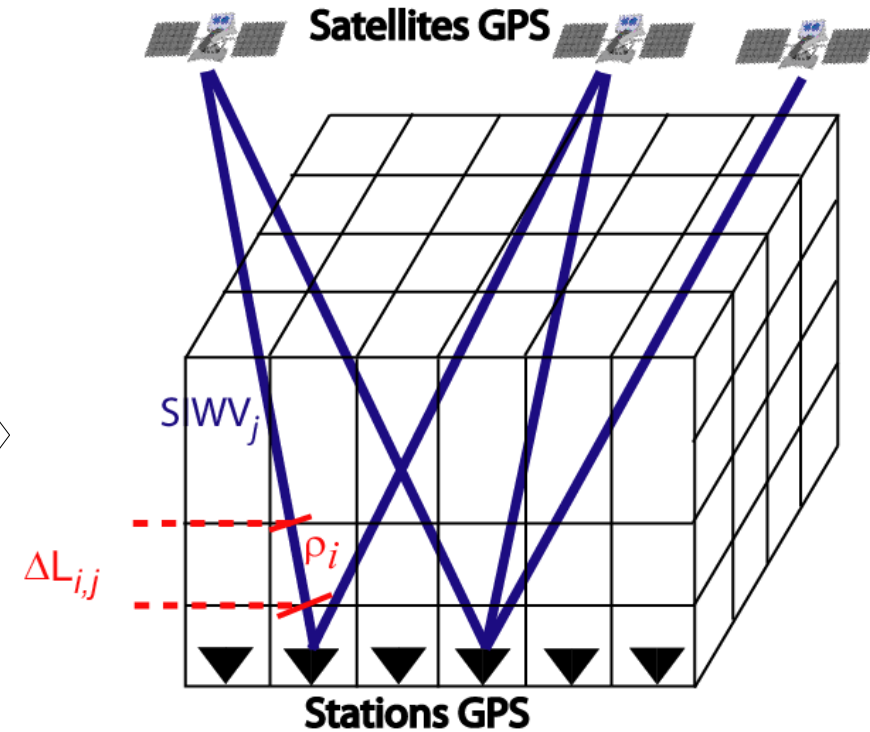
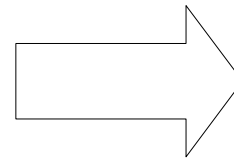
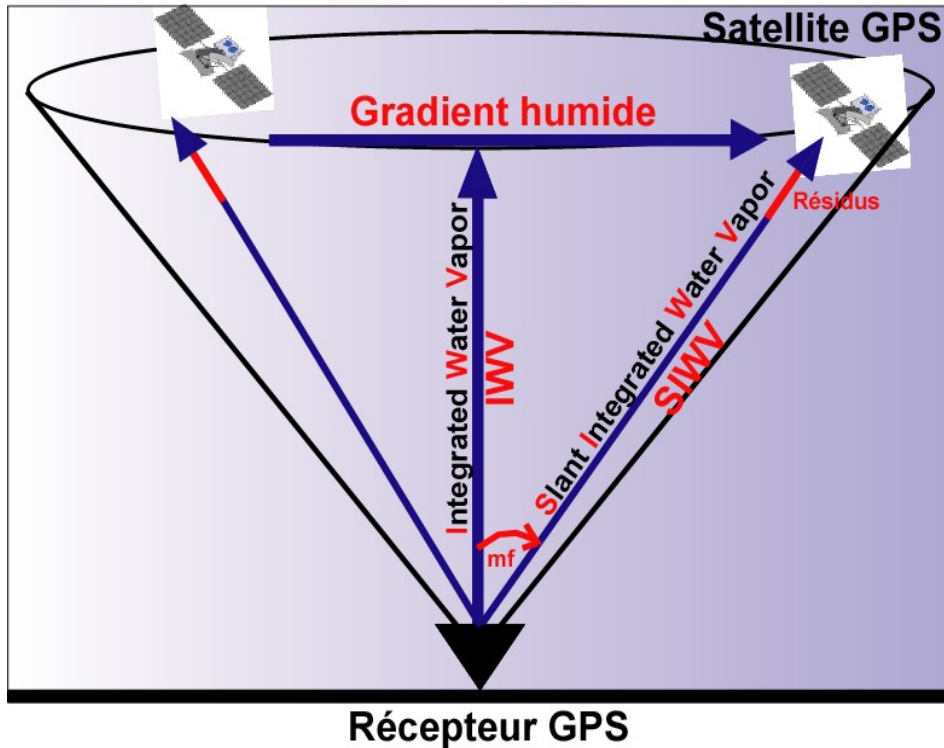
Bias GPS / Radiometer: 0.56 kg/m<sup>2</sup> at supersite M (AMF)

RMSE GPS / Radiometer: 1.14 kg/m<sup>2</sup> at supersite M (AMF)

Bias GPS / RS: 1.35 kg/m<sup>2</sup> at supersite V (Poster of P. Bosser)

RMSE GPS / RS: 1.24 kg/m<sup>2</sup> at supersite V (Poster of P. Bosser)

# GPS tomography principles



In fact, additional **vertically resolved measurements needed (RS)**

-> Tomography is the combination of all water vapor measurements to retrieve the 4D water vapor field

# Previous tomography studies

First attempt of GPS tomography during **ESCOMPTE** in south France (Marseille):

- **very dense** GPS network (5 km) but **small extend** (25km<sup>2</sup>) and no CI case

Second attempt during **IHOP**:

- Very good CI cases, **mesoscale** GPS network but **sparse** (40 km)

Champollion et al., QJRMS, 2008, accepted.

And **COPS** ?

- Both mesoscale (40 km) and local (10km) GPS Network
- Good CI cases
- Ground-based and airborne LIDAR data for validation

**The main questions:**

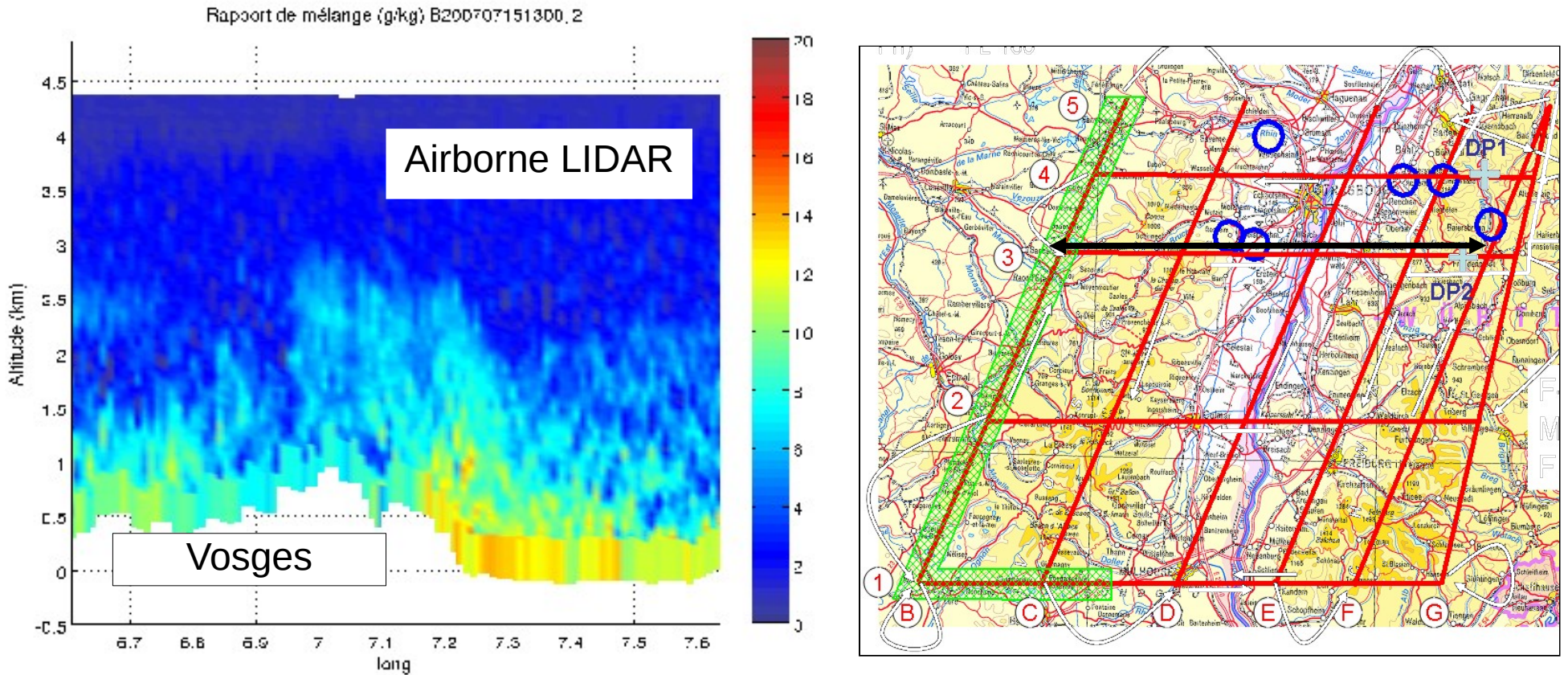
- What kind of water vapour heterogeneities GPS tomography can retrieve ?
- As radiosoundings measurements must be used in the GPS tomography,

When and Where?





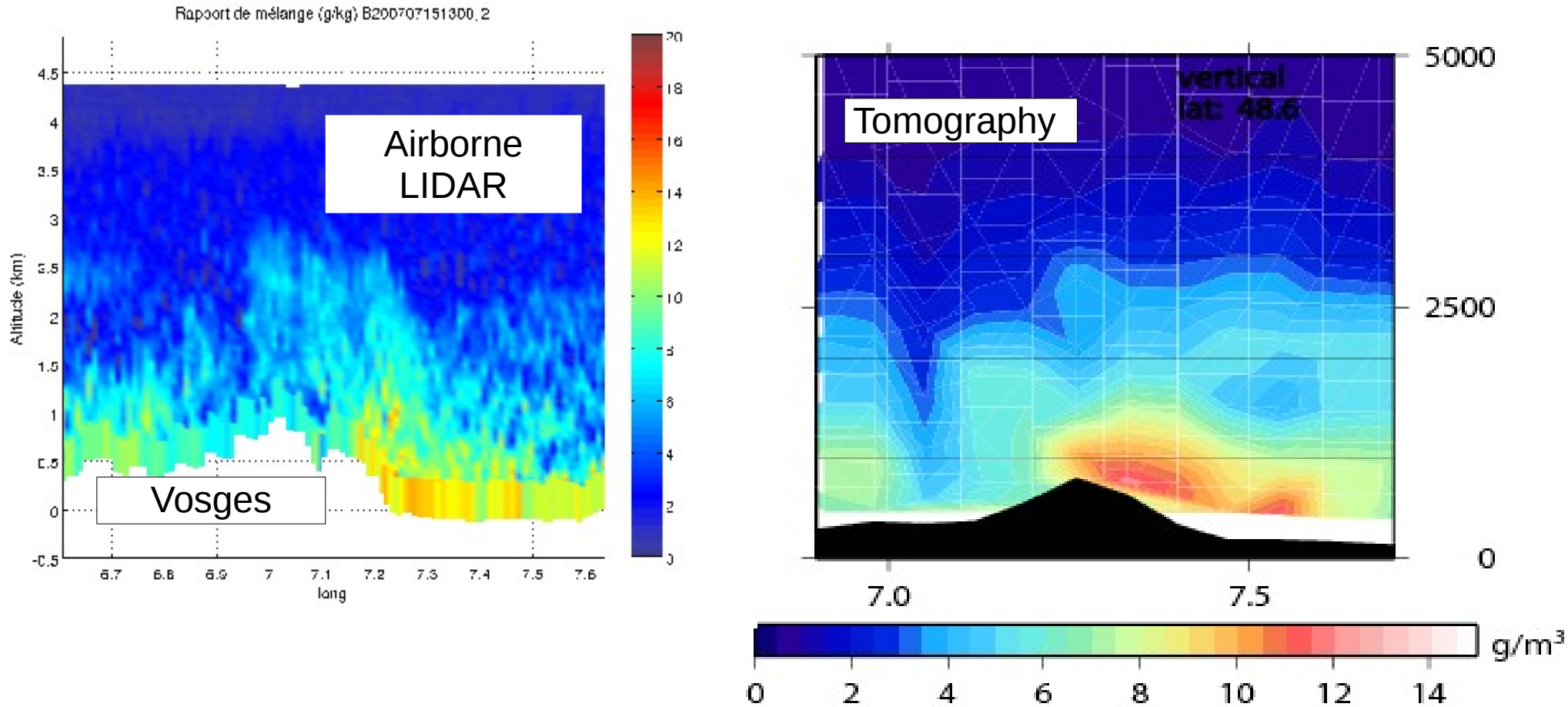
# Horizontal and vertical water vapour heterogeneities: Mountain slopes winds (1)



Airborne LIDAR measurements over the Vosges mountains  
(15/07:1300UTC)



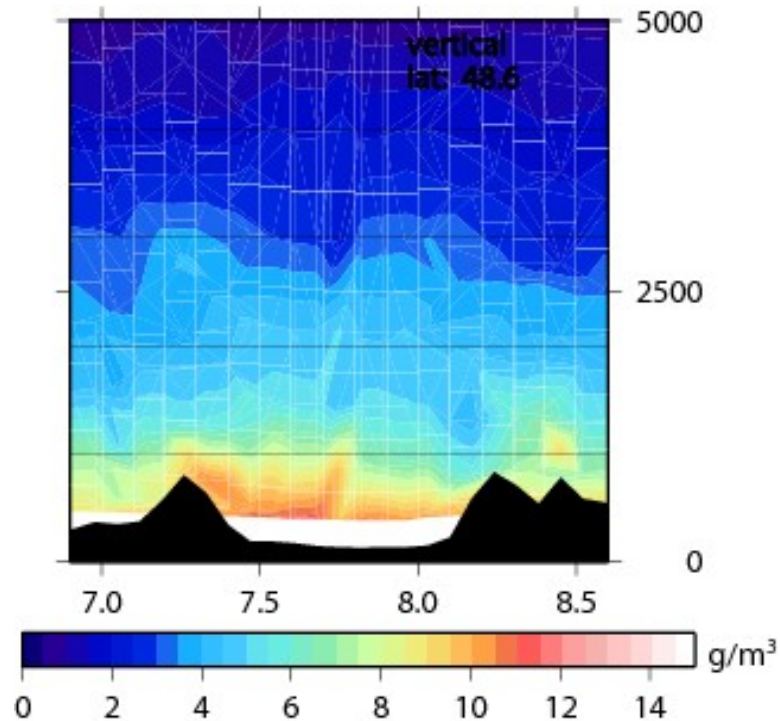
# Horizontal and vertical water vapour heterogeneities: Mountain slopes winds (2)



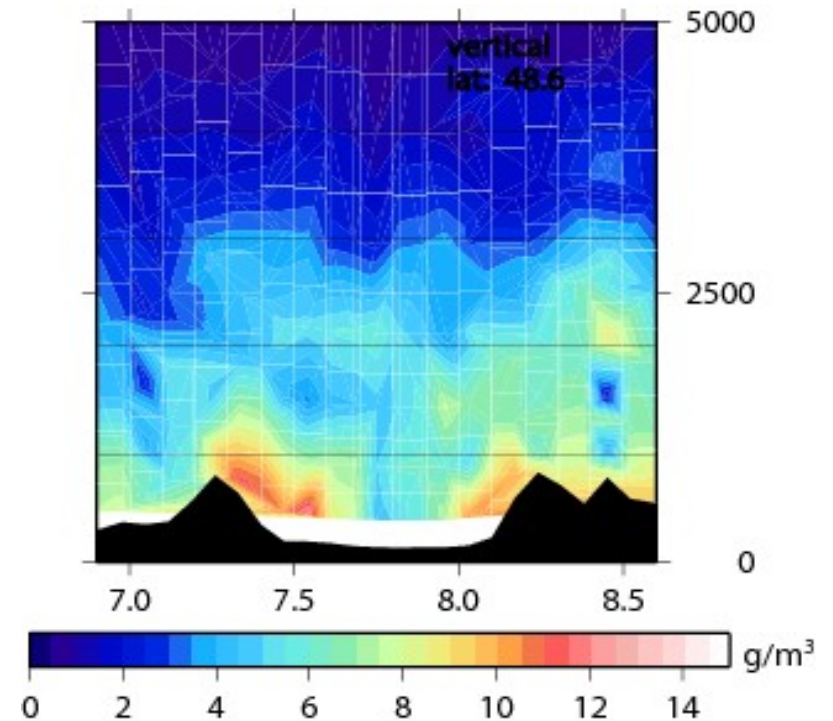
! Different units !

**Very similar pattern in tomography and lidar:**  
both east-west and vertical water vapour variations

# Horizontal and vertical water vapour heterogeneities: Mountain slopes winds (3)

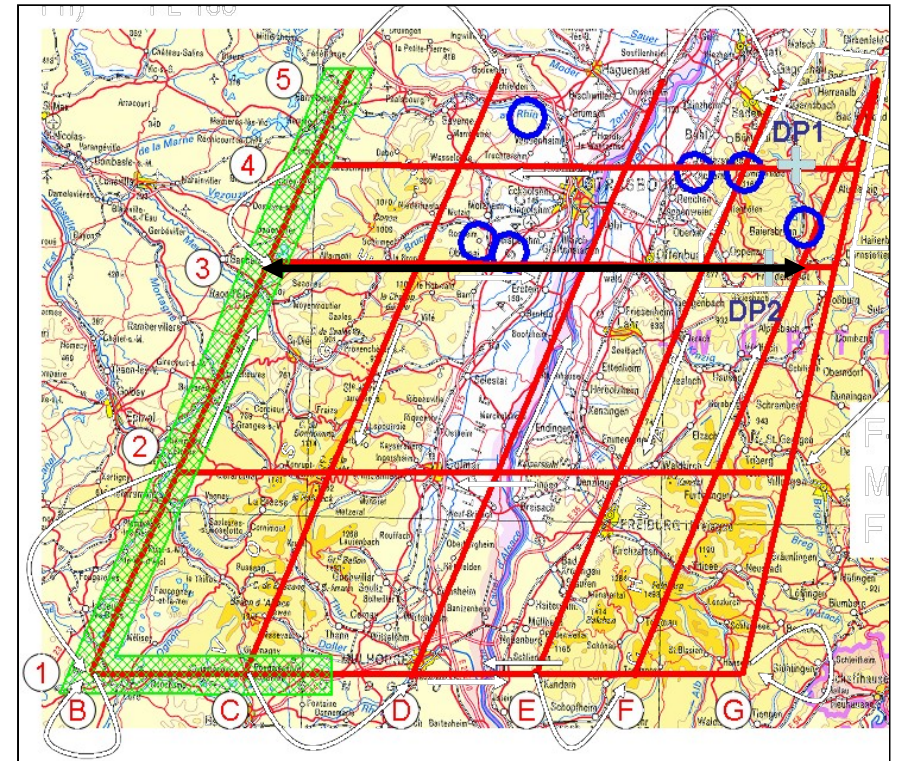
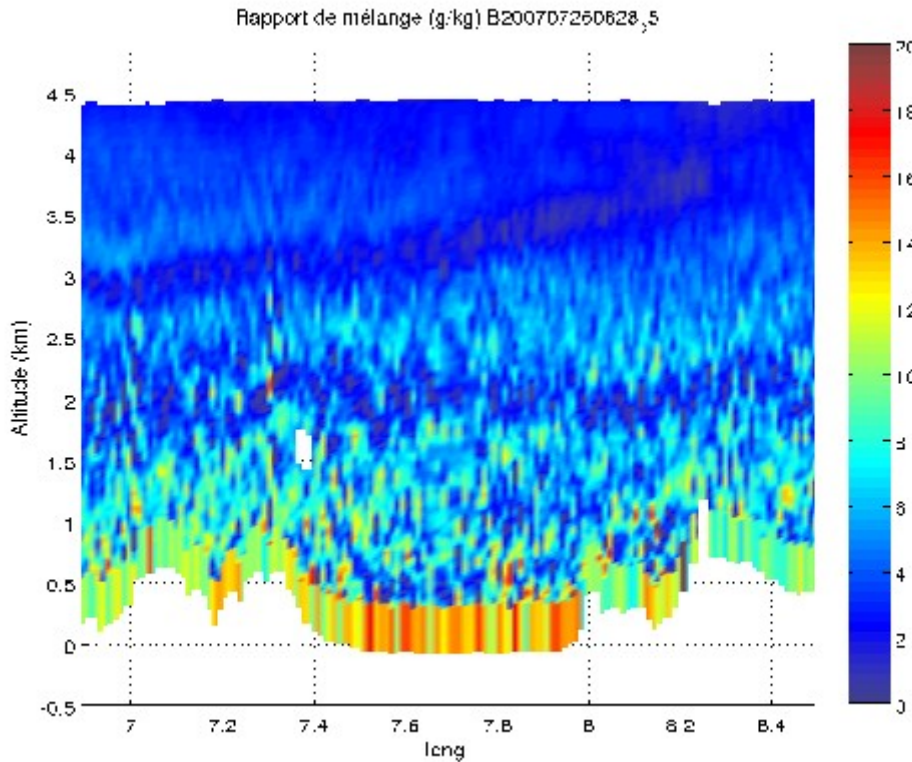


At 0600 UTC the 15 June,  
Start of slopes winds in the Vosges



At 1300 UTC the 15 June,  
- Slopes winds still more active in  
the Vosges  
- No more water vapour in the  
Rhine Valley

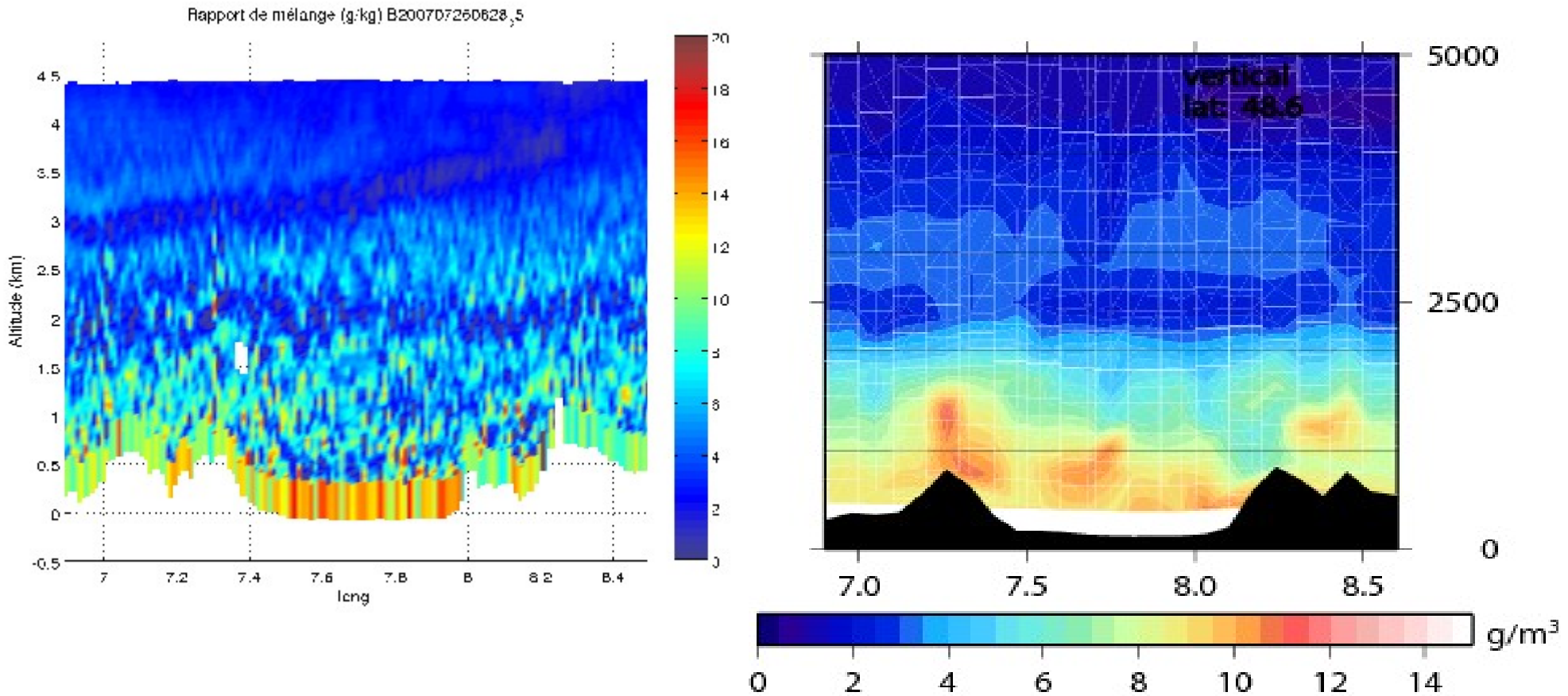
# Vertical heterogeneities only: dry layer (lids)



Airborne LIDAR measurements over the Vosges mountains and the Black forest  
(26/07:0800UTC)



# Vertical heterogeneities only: dry layer (lids)



! Different units !

**similar pattern in tomography and lidar:**  
but only one dry layer retrieved by the tomography

# Conclusion and future work

## Processing

- Process the all COPS period (three months)

## Quantitative Validation

- Extensive validation of the GPS data processing (all radiometers and RS available, GFZ processing)
- Statistical GPS tomography validation: Ground-based LIDAR
- Cases validation: airborne LIDAR

## Cases studies

- Mountain slopes dynamic -> influence on the water vapour field and CI (both Vosges Mountain and Black Forest)
- Dry layer dynamic during COPS: impact on CI
- Convergence lines -> influence on the water vapour field and CI

## Methodology studies

- Best GPS / RS network for tomography and assimilation -> towards HYMEX SOP



# Thanks to:

- GPS INSU division
- Secretaries of SA and IPGS
- Field participants (Diana, Sophie, Myrto, Phillipe, Joel, Pascal, Cécile, Caroline, Bernard, ...).
- GPS data providers: Orphéon, RGP, GFZ, Engref Nancy, SwissTopo
- Meteorological surface data providers: Météo-France, SwissMeteo, DWD
- GM and GA for free GPS rent, IPGS for technical help.