

# Combining remote-sensing instruments at work during the COPS Campaign in order to provide vertical profiles of temperature, humidity and wind

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## Introduction

In the prospect of a possible discontinuance of the Nancy meteorological synoptic station, due to human costs and technological evolution, a survey conducted by forecasters has stressed the need to maintain high-resolution measurements of temperature, humidity and wind in the region, at least up to 4 km height.

Consequently, a locally-managed project at the Strasbourg regional centre of Météo-France has been launched in order to study the capabilities offered by a combination of ground-based remote-sensing instruments as an alternative to radio soundings. In these validation studies radio soundings have been used as reference.

The COPS Campaign was considered a good opportunity due to the large network of such instruments implemented in the nearby region of Alsace and Black Forest during summer 2007.

## Instruments used for this study

- V supersite (July 2007):
  - UHF radar (CNRM)
  - Sodar (CNRM)
  - Raman lidar (IGN-SA)
  - Radio soundings )
- R supersite (for instrument combination study):
  - UHF radar (Manchester university): 13/06-07/08
  - Radiometer (Salford university) : 13/06-15/08
  - Radio soundings : 05-20/06, 01-15/07 (IOP)
- R, H and M supersites (for Radiometer evaluation)
  - 3 Radiometers (Salford University, AMF)
  - Radio soundings
- GPS receiver network at all sites

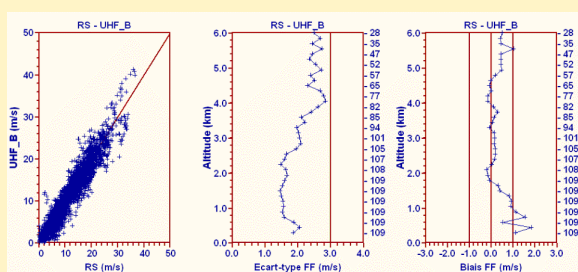
## Wind : V supersite

### UHF & SODAR compared with RS

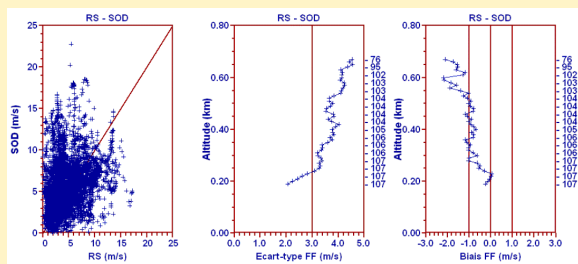
UHF radar are already known to give accurate information on wind force and direction. However the measurement is disturbed in the first hundred meters, due to ground echoes.

At these lower levels, sodar could be used as complementary information.

However, comparisons of both instruments for the same periods show that accordance in common altitudes is often very good, but at certain times very large discrepancies may occur, indicating that care should be taken when trying to combine the data of each of these instruments.

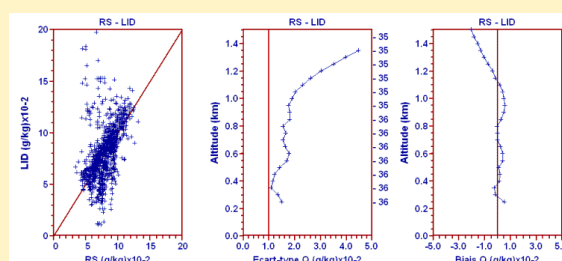


V supersite UHF compared to RS ; July 2007



V supersite sodar compared to RS ; July 2007

## Humidity: V supersite lidar compared with RS



LIDAR data of V site were compared to radio soundings over the month of July.

Accuracy of LIDAR data is good in the first 1000 meters, but quickly worsens above this height.

However, sensibility to rain and day light conditions may strongly limit its operational use.

## Statistical study of temperature and humidity vertical profile obtained by radiometer for operational use by weather forecasters

The main objective of the study was to assess capabilities of various remote-sensing instruments to provide vertical information on wind, temperature and humidity to weather forecasters in operational conditions.

Considering the results obtained by combining UHF with radiometer for humidity retrieval method, we decided to focus on the quality of temperature and humidity profile obtained with radiometer. Post-treated radiometer temperature and humidity profiles of R, H, M supersites were compared to radio soundings (T: temperature, Td: dew point calculated from temperature and relative humidity data).

The statistics show a quite good accordance for T profile, which has to be confirmed in temperature inversion situation.

Direct comparisons of single profiles with radio soundings confirm considerable smoothing of vertical variation by radiometer.

A similar behaviour was found for the three studied radiometers.

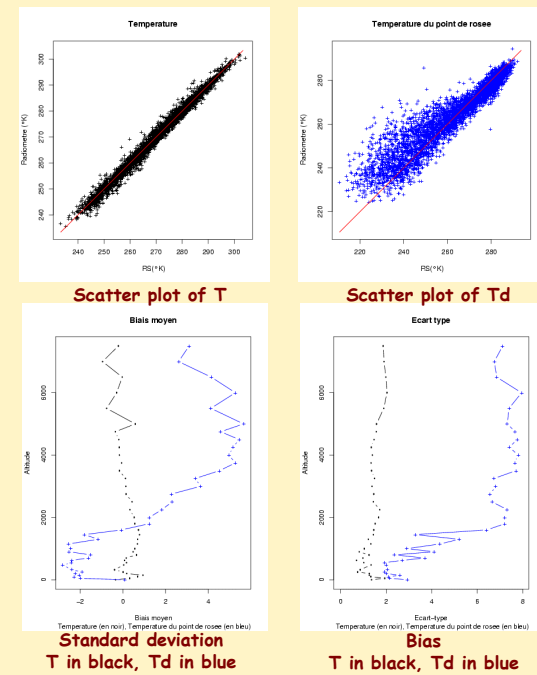
With large bias and standard deviation, humidity profile retrieved from radiometer are considered not usable.

## Statistical validation of humidity retrieval method using UHF with radiometer (RM)

UHF radar data of V and R sites have been post-treated in order to retrieve additive data from spectral signal : signal-to-noise ratio, noise and signal width.

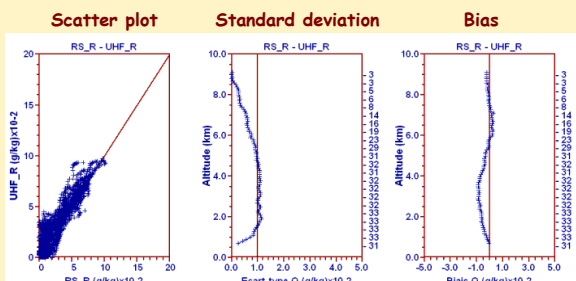
These data have been used to retrieve humidity information with the supply of temperature profile and humidity reference obtained by other remote-sensing instruments. Three algorithms were tested : Tsuda, Gossard and Tatarskii.

Theoretical applicability of these methods was first tested using radio sounding profiles, supposed to be perfect.

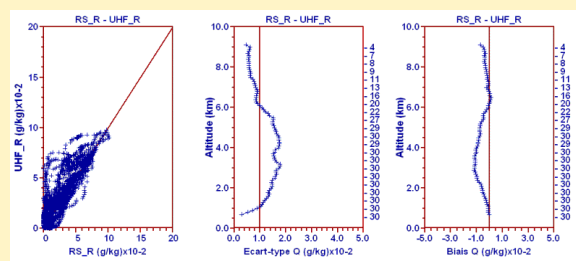


Profiles obtained with the supply of other information were then tested, using radiometer temperature profile, and GPS total humidity as references.

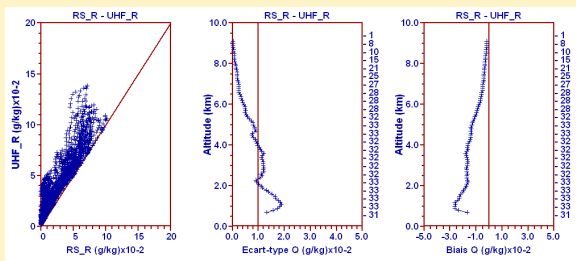
Not surprisingly, the quality of the retrieved profiles gets worse each time we introduce new measurement errors in the method.



T reference RS, Qt Reference RS, Comparison with RS, June/July 2007



T reference RM, Qt Reference RS, Comparison with RS, June/July 2007



T reference RM, Qt Reference GPS, Comparison with RS, June/July 2007

## Conclusion

- Good prospects to observe accurate wind profiles combining UHF profiler and sodar.
- Mixed results with the humidity measurements :
  - Good results with lidar, but not always available data.
  - Need to improve the humidity retrieval with UHF radar:
    - Better integration of GPS.
    - Radiometer data quality ?
- Radiometers :
  - Quite good accuracy in validated temperature data
  - Some gaps in the temperature profile observations
  - Humidity profile may not be exploited by forecasters
- To this time, none of the studied combinations has given a definite answer in terms of accurate temperature and humidity profiles.
- With the completion of the data base, more results are expected to evaluate the practical capabilities of integrated ground-based remote-sensing instruments.



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