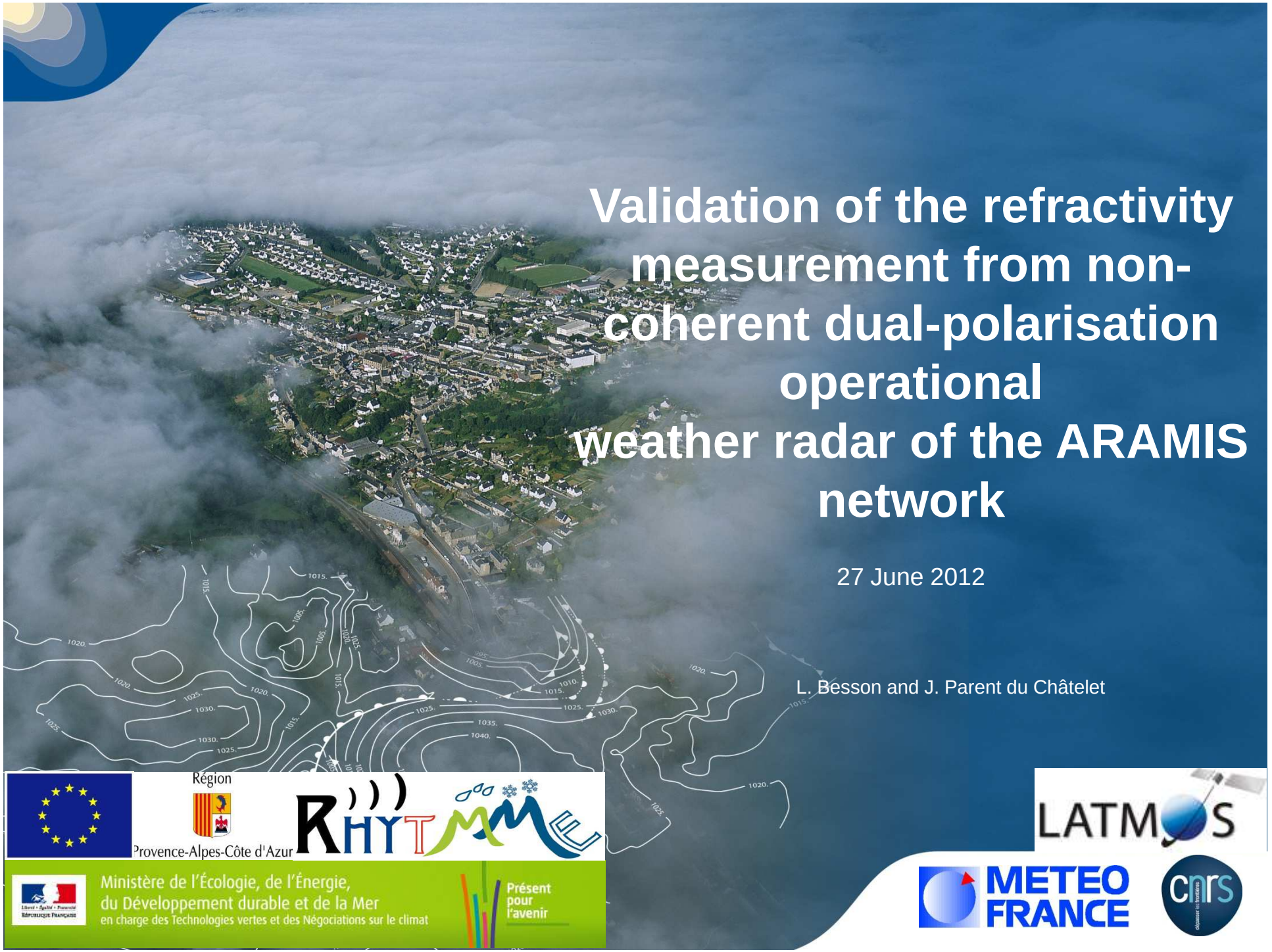

Validation of the refractivity measurement from non-coherent dual-polarisation operational weather radar of the ARAMIS network

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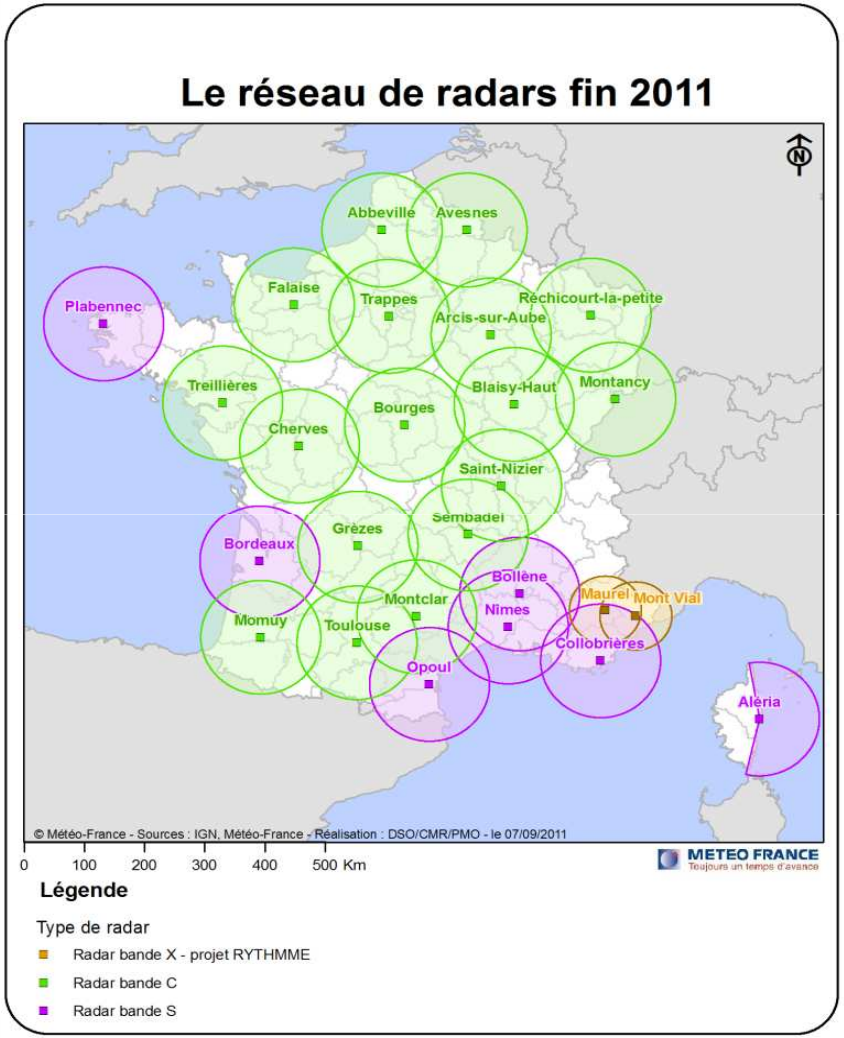
Background

The densification of operational radar network measurement could achieve to map refractivity

Refractivity potentially provides information about pressure, temperature, and humidity in the lower layers of the atmosphere within a few tens of kilometers around the radar.

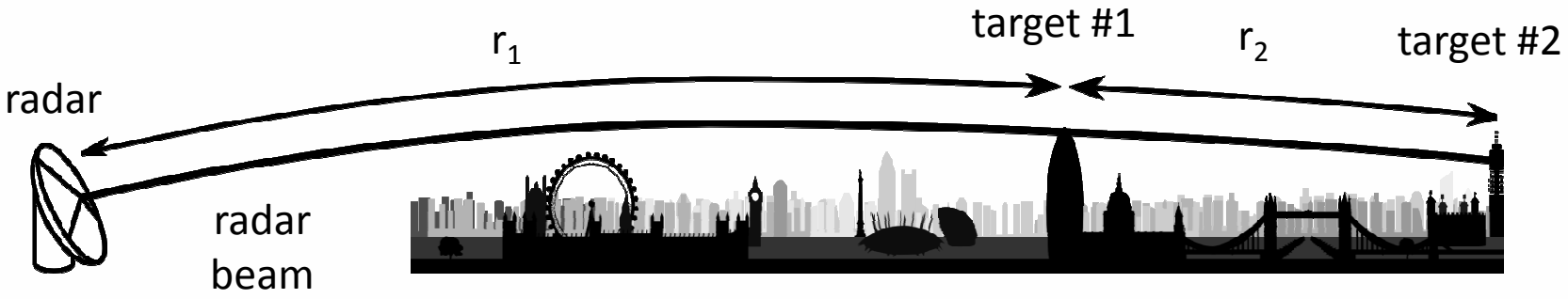
This technique is thus of great meteorological interest, both for numerical weather prediction and process studies



Outline

1. Principle
2. Validation of the Fabry algorithm adapted to magnetron transmitter
3. Way to improve the refractivity measurement
4. Conclusions and perspectives

1. Principle of refractivity measurement by weather radar



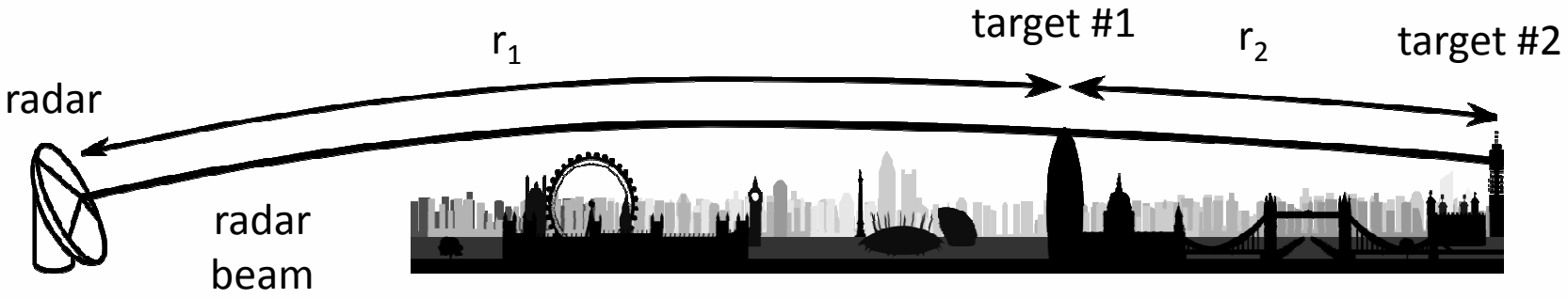
For Coherent transmitter

Phase change $\Delta\varphi$ between radar and target or 2 targets (Fabry et al. 1997):

$$\delta\Delta\varphi = \frac{4\pi f r 10^{-6}}{c}\delta\langle N\rangle$$

f: radar frequency
r: r_1 or r_2
c: speed of light in vacuum
$\langle N\rangle$: refractivity averaged over ray path

1. Adaptation to non-coherent transmitter



For non-coherent transmitters (as magnetron), special care has to be paid to frequency changes

(Parent du Châtelet et al 2007, Parent du Châtelet and Boudjabi 2008, Parent du Châtelet et al in revision)

Local Oscillator Term

$$\Delta\varphi(\tau_{sam2},t,t_{ref})-\Delta\varphi(\tau_{sam1},t,t_{ref})=-2\pi\left[\begin{array}{c}+\left[f_{LO}(t)-f_{LO}(t_{ref})\right]\left[\tau_{sam2}-\tau_{sam1}\right]\\-\left[f(t)-f(t_{ref})\right]\left[\Delta\tau_2-\Delta\tau_1\right]\\+\left[f(t_{ref})10^{-6}(r_2-r_1)\left(N(r,t)-N(r,t_{ref})\right)\right]\end{array}\right]$$

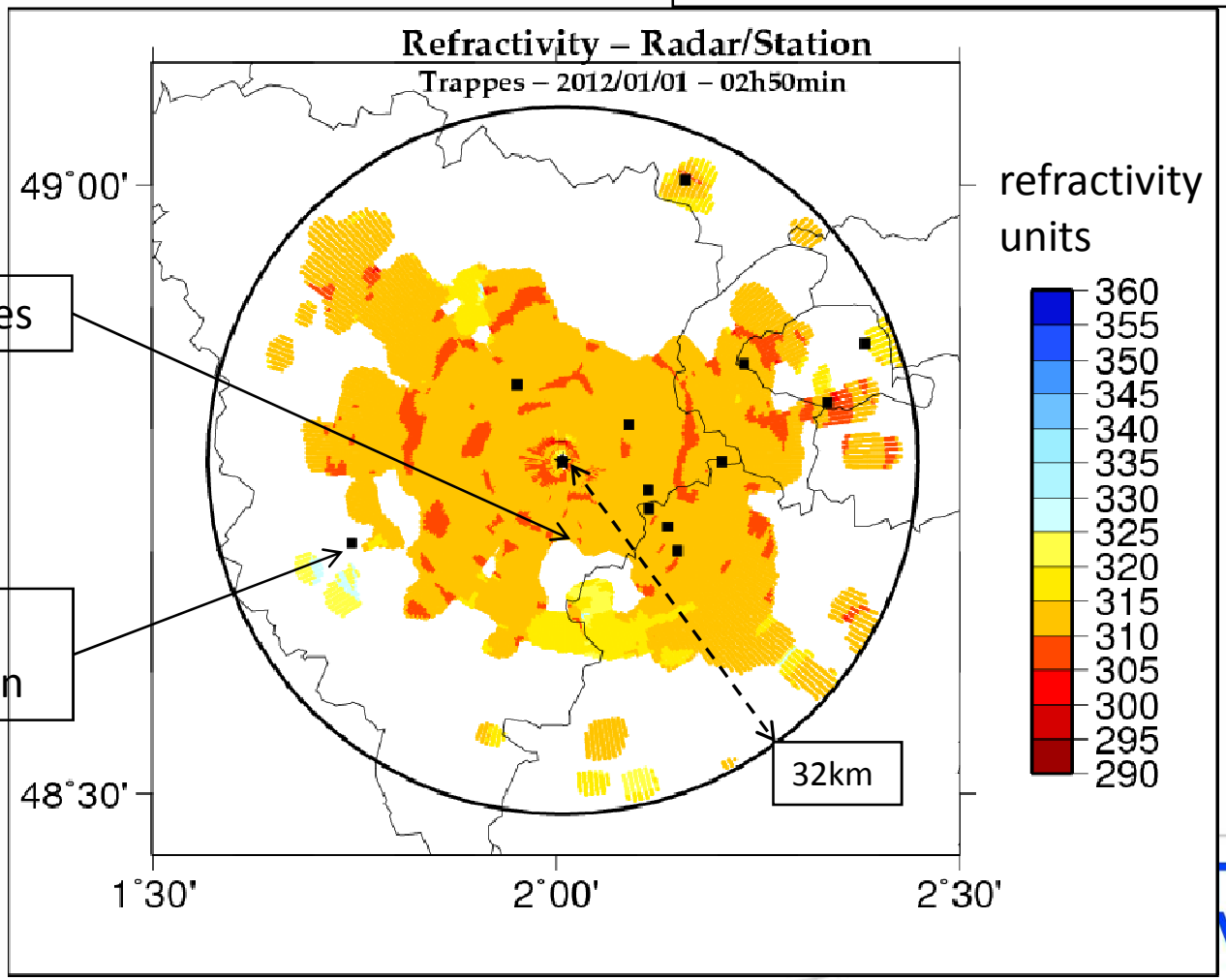
Residual Term

Refractivity Term

2. Validation of the Refractivity measurement

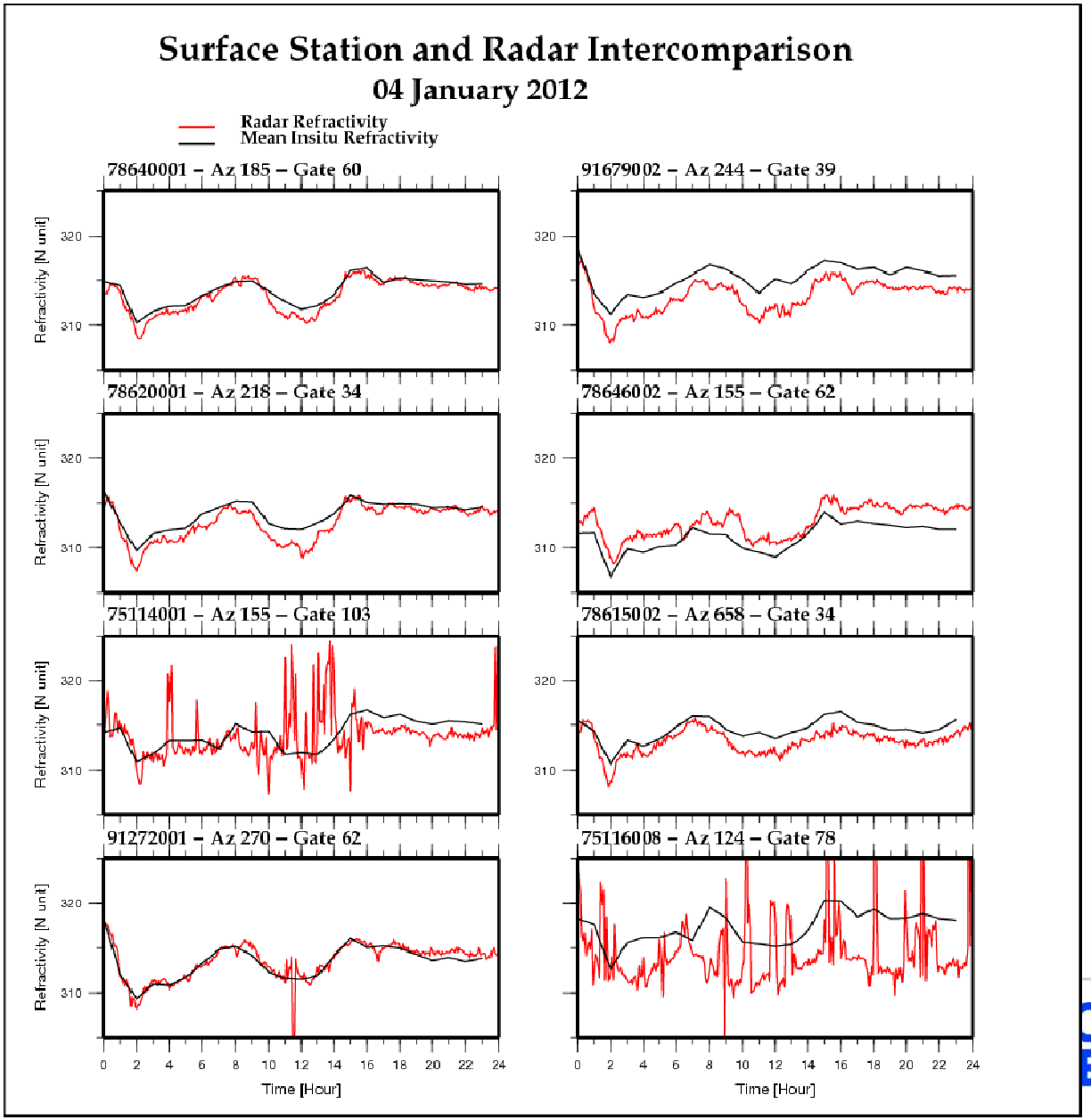
Fabry's Algorithm adapted to magnetron

Radar of Trappes
C-Band, doppler, dual-polarisation
Data available from 1 to 26 January 2012
12 Automatic Weather Stations



2. Validation of the Refractivity measurement

Reference time:
01/01/2012



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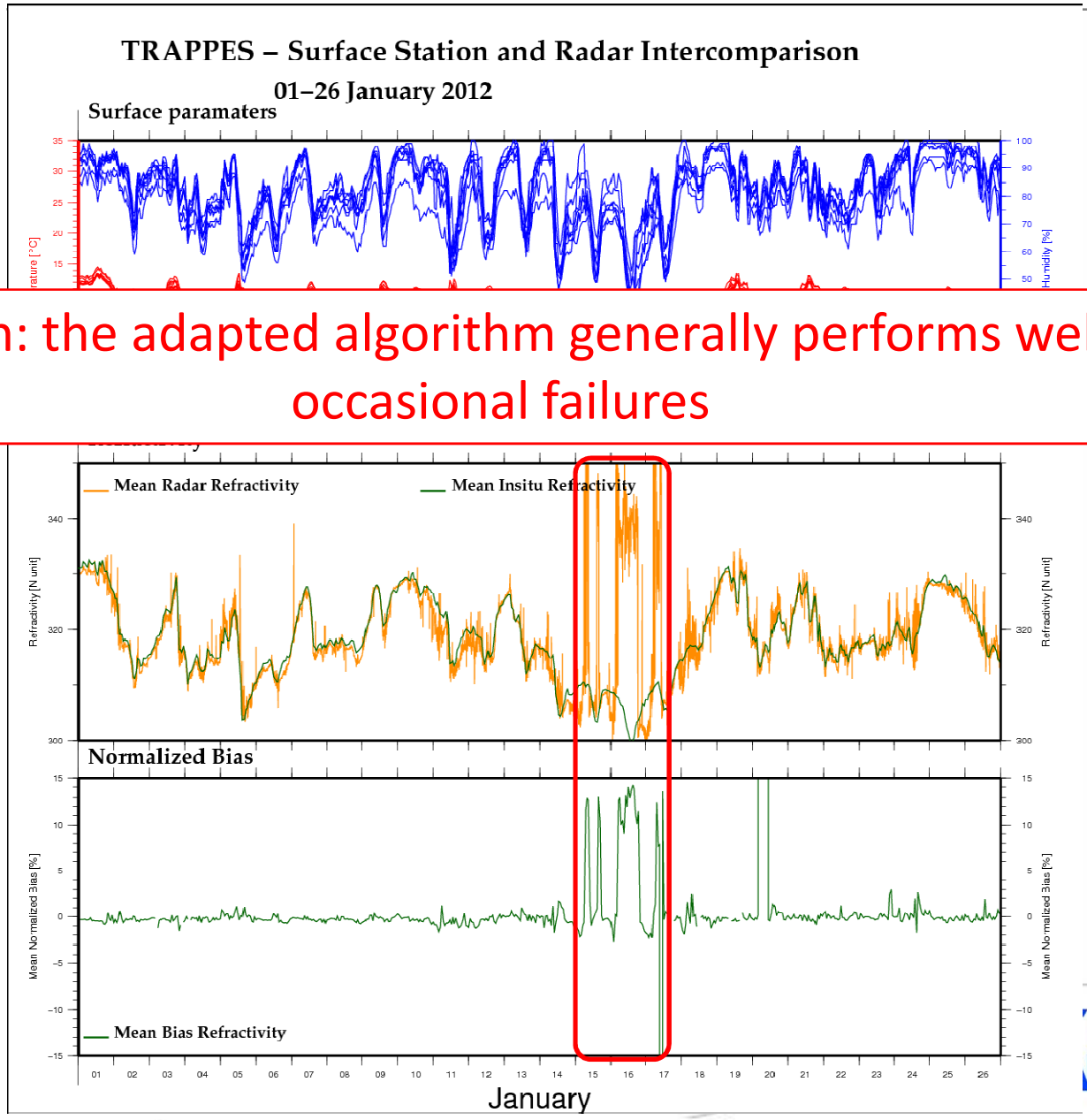
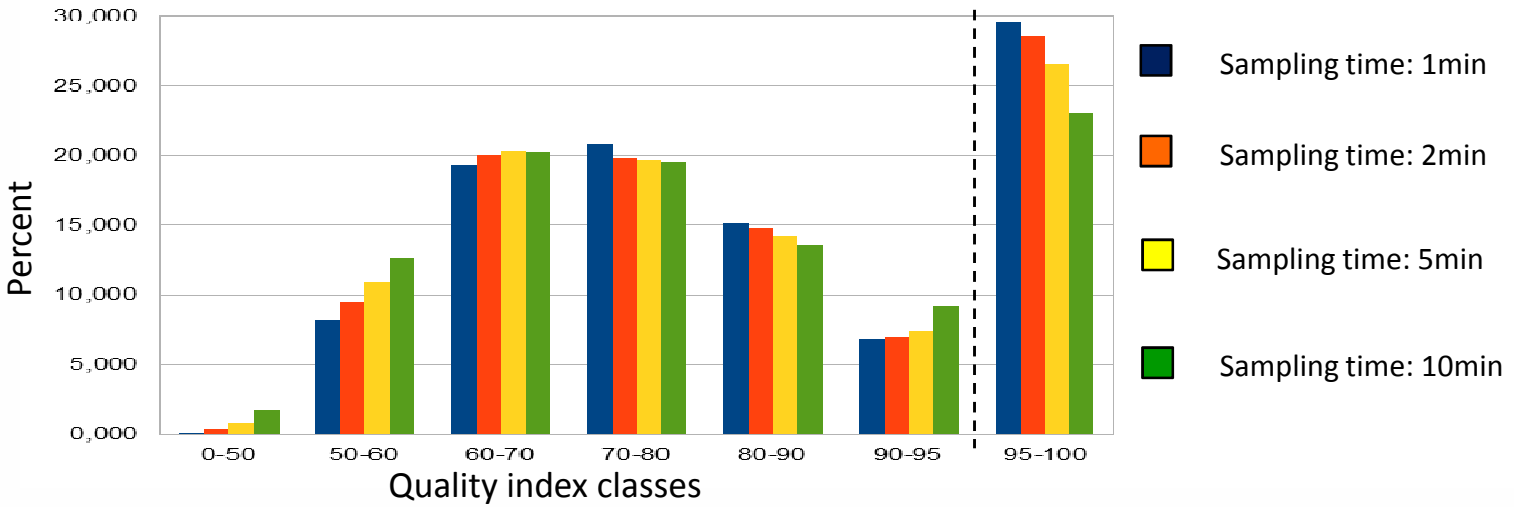


Conclusion: the adapted algorithm generally performs well, with occasional failures

3. Way to improve the refractivity

The Quality index is the percent of time where $\left|\delta\Delta\varphi_{\delta}\right| \leq 90°$

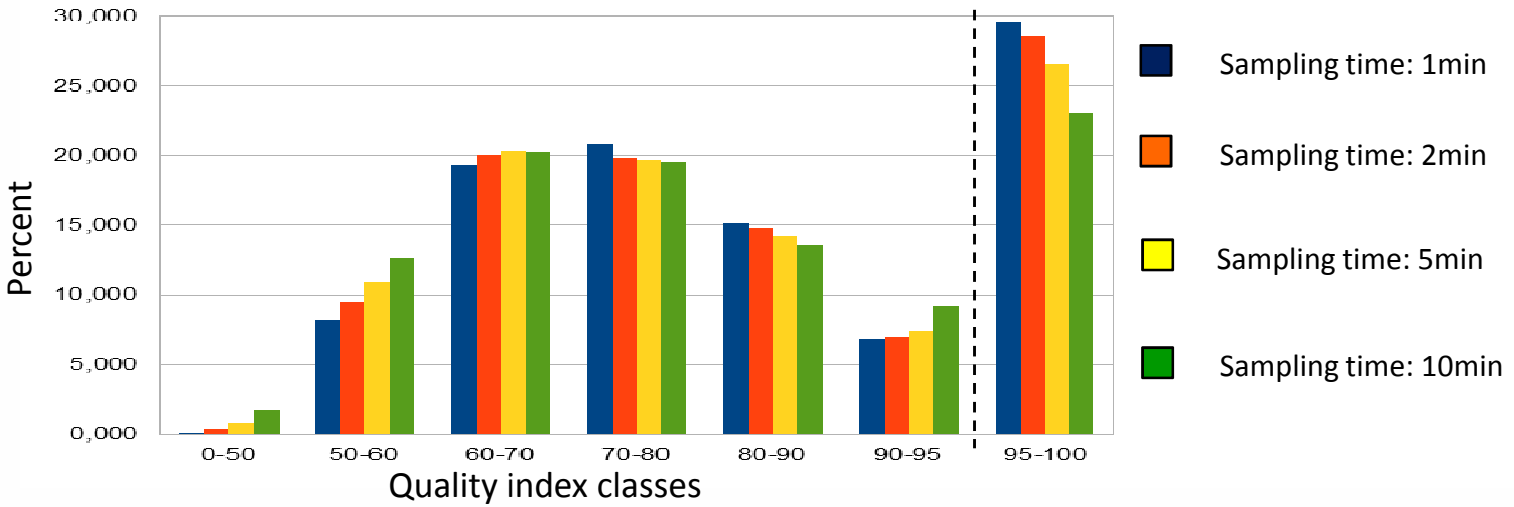


2 ways of research :

- Reduce the time between two measurements:
  - Increase the antenna speed;
  - Use additional elevation angles;
- Improve the retrieval quality of the ground target:
  - Decrease the pulse width;
  - Use the dual-polarisation.

3. Way to improve the refractivity

The Quality index is the percent of time where $|\delta\Delta\varphi_{dp}| \leq 90°$



2 ways of research :

- Reduce the time between two measurements:
  - Increase the antenna speed;
  - **Use additional elevation angles;**
- Improve the retrieval quality of the ground target:
  - Decrease the pulse width;
  - **Use the dual-polarisation**.

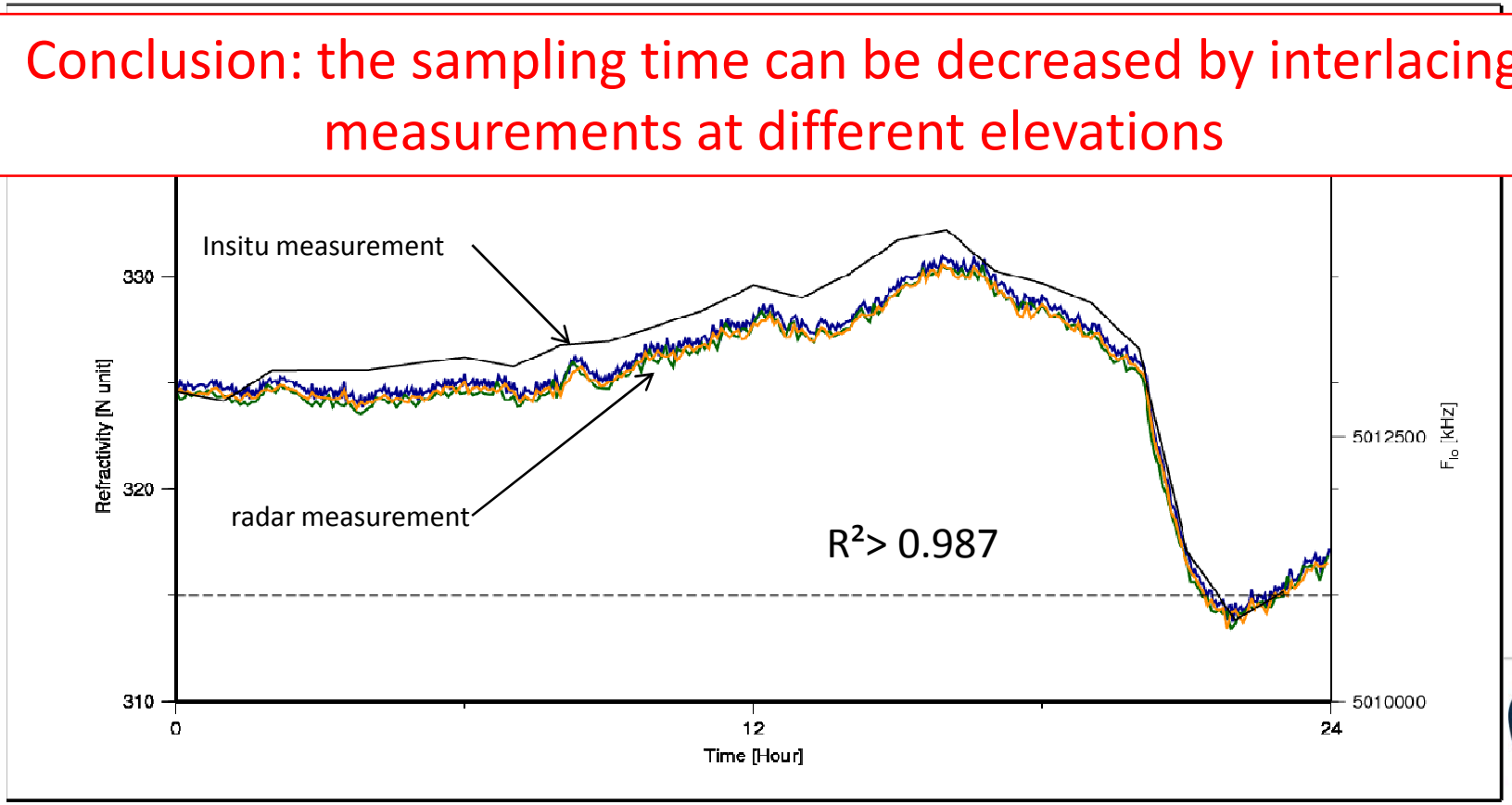
3. Way to improve the refractivity

Two elevation angles

Three refractivity calculated:

- 0.4° elevation only,
- 0.8° elevation only,
- 0.4 and 0.8° elevations.

Conclusion: the sampling time can be decreased by interlacing measurements at different elevations

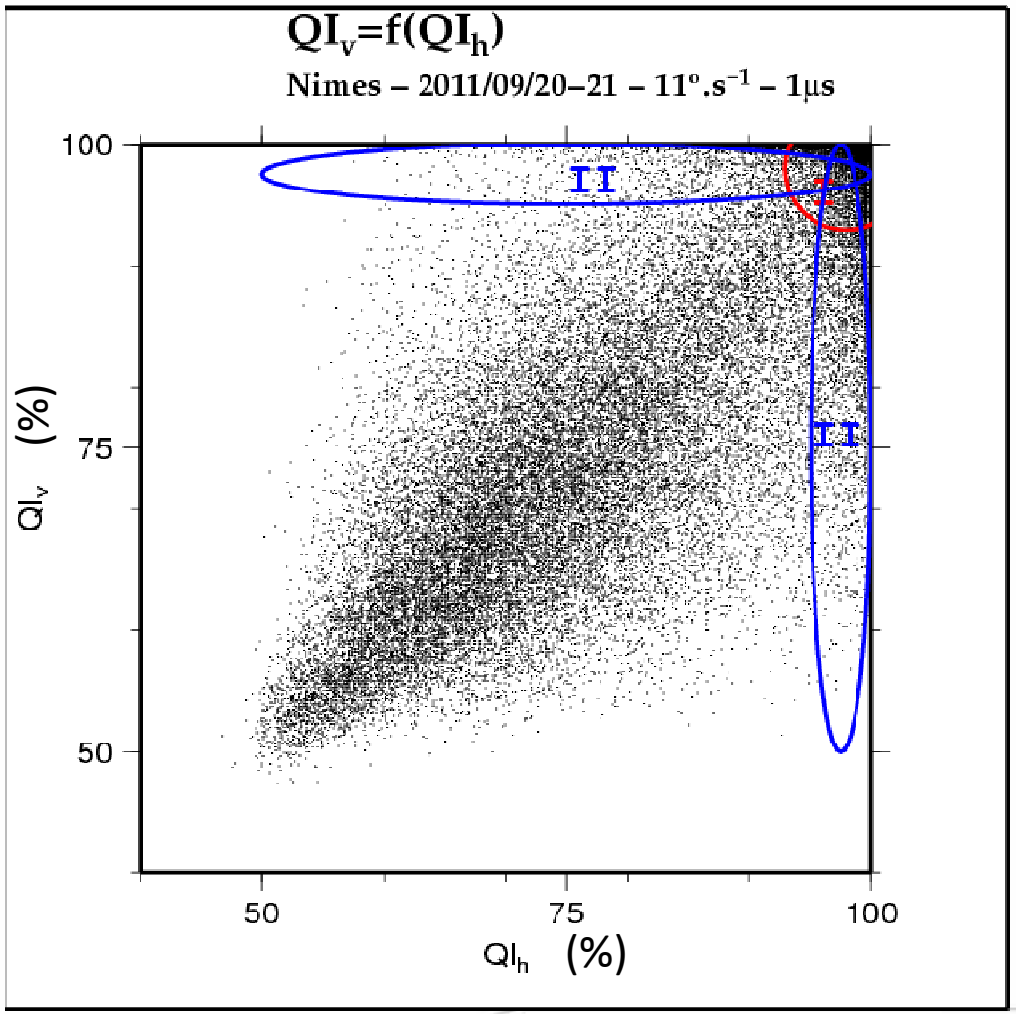


3. Way to improve the refractivity

Dual-Polarisation

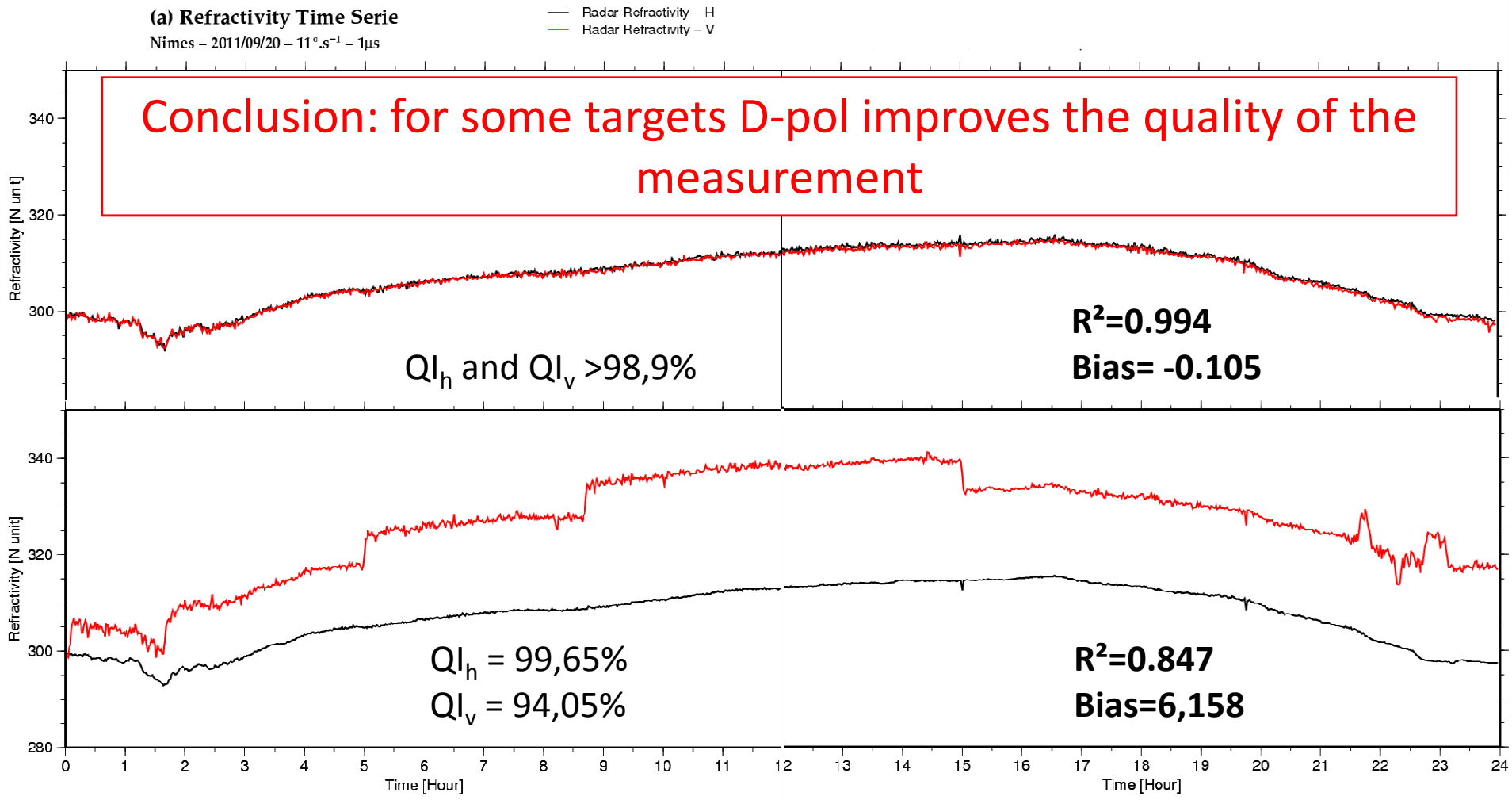
The Quality Index could be classified in two groups:

- similar for the two polarisations (Red area) ➔ no added value of D-pol
- better on one of the two polarisations (blue are) ➔ added value of D-pol



3. Way to improve the refractivity

Dual-Polarisation



Conclusions and perspectives

Refractivity measurement with non-coherent weather radar is possible

Regardless of the transmitter type, improvement of the refractivity measurement through:

- Use of upper elevations
- Use of D-pol

Future works

- Extension to S- and X-band,
- Assess the robustness of the QI,
- Future real-time deployment in September 2012 for HyMeX (http://sop.hymex.org).


END