Variations in Cn2 measured by LAS scintillometery over the city of Nantes during the FluxSAP 2010 measurement campaign

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Introduction In the framework of a large French research program investigating sustainable development of cities (ANR 'Villes Durables'), one project, VegDUD, proposed the exploration of the role of the vegetation in the urban environment. Within this project an intensive experimental campaign, know as FluxSAP, was planned, involving remote sensing and surface flux measurements (further details can be found on http://www.irstv.fr/). The aim of FluxSAP is to improve our characterisation of fluxes over a city, with Nantes in the north-west of France chosen as model.

Experimental setup The measurement stage of the FluxSAP 'volet' was undertaken during the month of May 2010. As part of the set-up 5 Large Aperture Scintillometers (LAS) were installed over a peri-urban part of the city in firstly, a triangular formation (3 LAS) with path-lengths between 1.3 and 2.4 kms, secondly a LAS crossing through the triangular formation (pathlength 3.5 kms) and thirdly a fifth LAS was used to double up one of the paths on the triangular formation to be sure of the repeatability of the reflective index structure parameter (Cn2) measurement by the LAS (see table 1 & Figure 2). Over 3 weeks of common data are available from the LAS to study the Cn2 and sensible heat flux (H) variability.

Figure 1 Scintillometers during FluxSAP

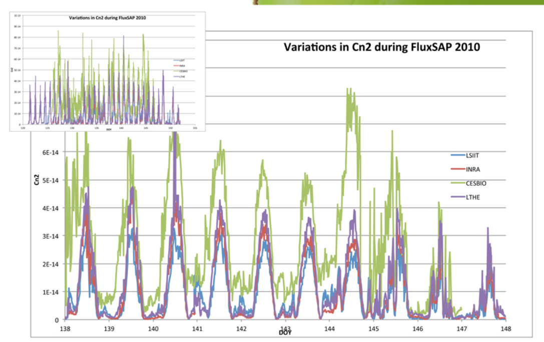

Figure 4 Cn2 for the different scintillometer paths

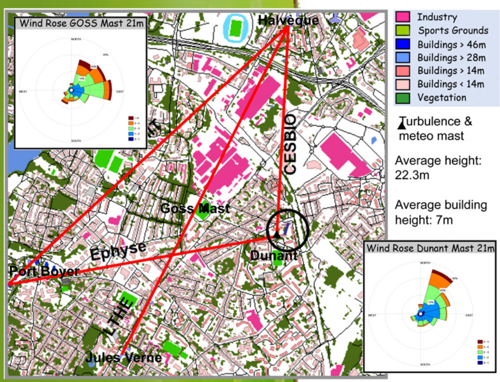

Figure 2 Building distribution in the city of Nantes

Path	Distance (m)
Dunant – Port Boyer*	1770
Port Boyer - Halvèque	2470
Dunant - Halvèque	1310
Halvèque – Jules Verne	2490
* 2 receivers	

Table 1 Scintillometer paths

Method Cn2 is directly measured by the LAS via the received amplitude fluctuations from the infrared source (σ_{xiR}). Temperature structure parameter (Ct2) can be determined from Cn2 using a few meteorological variables and thereafter sensible heat flux (H) by exploiting similarity theory (Figure 3).

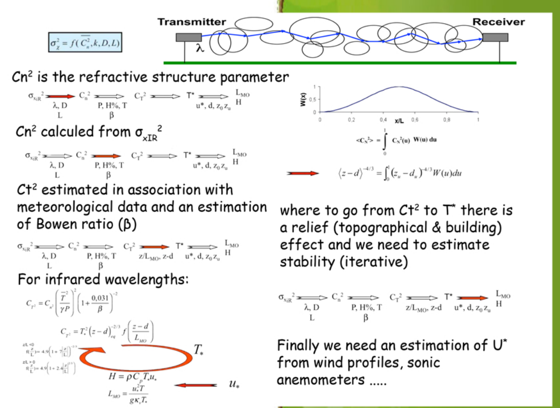

Figure 3 Scintillometry flux estimation

Scintillometer optical paths over the city of Nantes

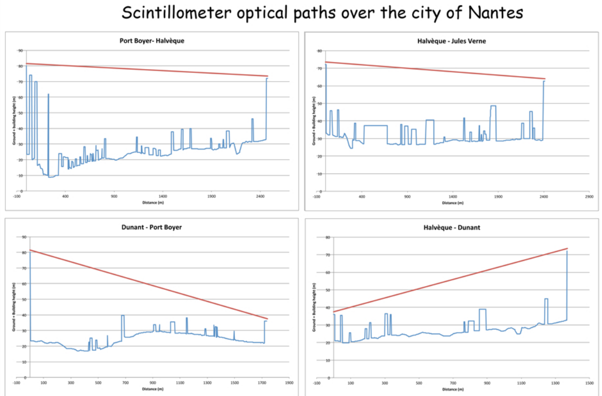

Figure 5 Relief profiles

Results Figure 4 presents Cn2 for the 4 scintillometer paths (note the doubled path, not present here, was identical providing measurement confidence). The whole measurement campaign is shown in the top left with a zoom on a 10 day period. One can clearly see differences between the measurement paths, where on some days there are more in agreement. In order to better understand these observed differences it is necessary to account for relief differences between the scintillometers. Figure 5 presents a simple, first, extraction along each scintillometer path of ground level and building height from a topographical database.These relief profiles are integrated into Figure 6, which presents H estimations.

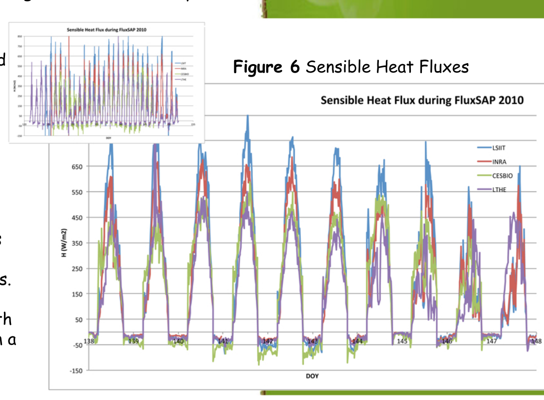

Figure 6 Sensible Heat Fluxes

Results (cont) It can be seen that despite this initial attempt to estimate the relief there is a large variation of the flux between the different paths. This variation for example of the CESBIO scintillo-meter indicates lower fluxes on days 138-140 and higher fluxes on days 144-146 compared to the LTHE scntillometer. Figure 7 provides wind direction information which indicates quite different directions for the 2 before mentioned examples.

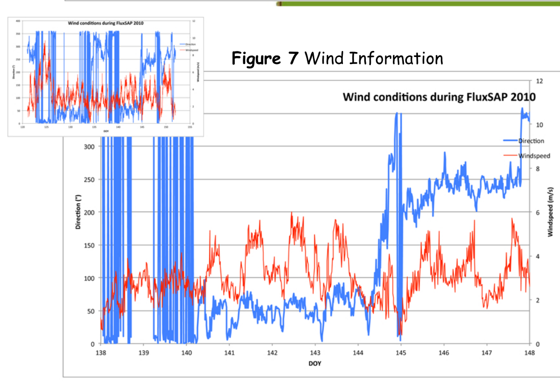

Figure 7 Wind Information

Conclusion The spatial variability of Cn2 is an important question in our analyses of the scintillometry FluxSAP data as we want to be able to improve our understanding of sensible heat flux variability. Our initial results indicate a rather large variability in a rather small area (< 5 km2), despite a first attempt to eliminate relief effects. Observations suggest an influence from wind direction, which probably indicates a 'footprint' factor. This 'factor' may have a triple impact: 1 the relief influence is directional, 2 given the building distribution (Figure 2) there is indeed flux variability and 3 the vegetation distribution may have a influence on the fluxes. To conclude a 'footprint'/relief study has to be done in order to determine the true flux variability.