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Supplement of

A top-down approach of surface carbonyl sulfide exchange by a Mediterranean oak forest ecosystem in southern France

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Supplementary material

Description of the ICOS-SIRTA atmospheric sampling site and analytical methods used there.

Surveys similar to this study were carried out over the Saclay Plateau in 2014 and 2015 at the ICOS and SIRTA (zone 5) sites (http://www2.cnrs.fr/presse/communique/3481.htm?&theme1=6&debut=16, in French). SIRTA stands for Site Instrumental de Recherche par Télédétection Atmosphérique. It is a French national atmospheric observatory dedicated to cloud, reactive gases and aerosol research and belongs to the European-ACTRIS network. The SIRTA (zone 5) site is separated by about 4 km from the main SIRTA infrastructures (http://sirta.ipsl.polytechnique.fr/sirta.old/index.html, in French). This is a typical sub-urban area where urban infrastructures, main roads, agricultural fields, forests and lawns are found. At the ICOS-SIRTA site, the air inlet is located 7 m above ground level and the instruments located at a distance of ~40 m are connected to the inlet through a 3/8'' Synflex tubing which is permanently flushed. CO_2 atmospheric mixing ratios were measured with a gas chromatograph (HP-6890N from Agilent) with flame ionization detector (Lopez et al., 2012). The two instruments have been coupled and optimized at the LSCE in order to perform semi-continuous measurements of ambient air, as well as flask analysis, and standard calibrations. The ambient air pumped at an elevation of 7 m above ground level is dried using a glass trap in an ethanol bath maintained at -45°C by a cryocooler. Two working standards, with high and low concentrations, are used to calibrate the measurements. They are themselves regularly calibrated against a set of six standards provided by NOAA for consistency with international reference scales (Lopez et al., 2012). Atmospheric CO was analyzed using gas chromatography (PP1 from Peak Performer) equipped with a reduction gas detector (RGD, model PP1, Peak Laboratories) as in Yver et al. (2009). ^{222}Rn is a natural radioactive gas emitted from the ground which is a good tracer of the planetary boundary layer circulation. ^{222}Rn is measured at the ICOS-SIRTA station with the active deposit method, that is, via the radioactive decay of its daughters attached to aerosols (Yver et al., 2009; Belviso et al., 2013). The radon instrument has a random error of 10%.

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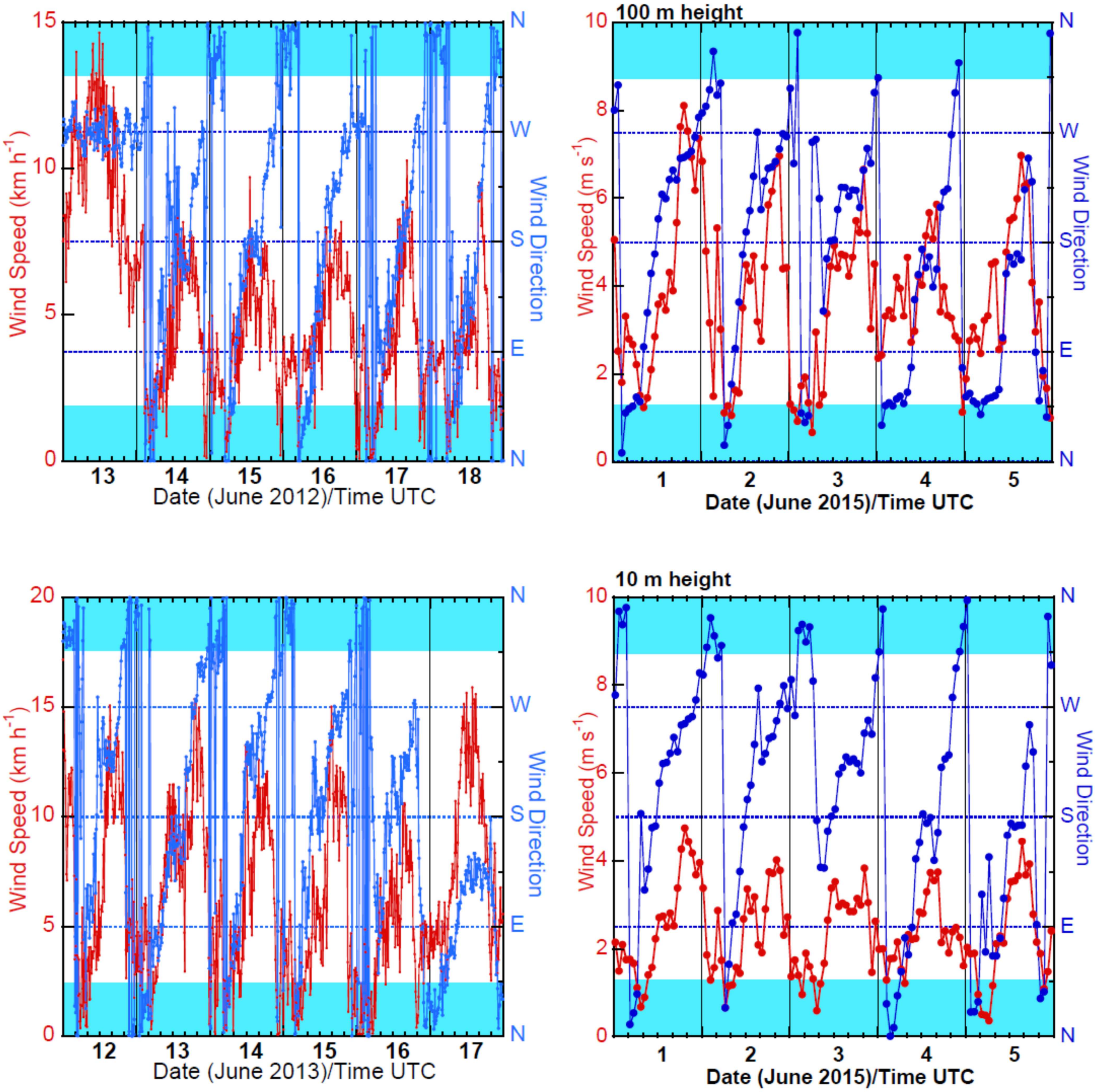


Figure S1: Analyses of wind directions recorded at ground level in June of 2012, 2013 (10 min mean) and 2015 (selected data, hourly mean), and at the top of the ICOS-OHP tall tower (100m agl, June 2015, selected data). This height is intermediate between ground level measurements (this work) and sodar vertical wind profiles (Kalthoff et al., 2015). Winds orientated from the NW-NE sector are highlighted in cyan.

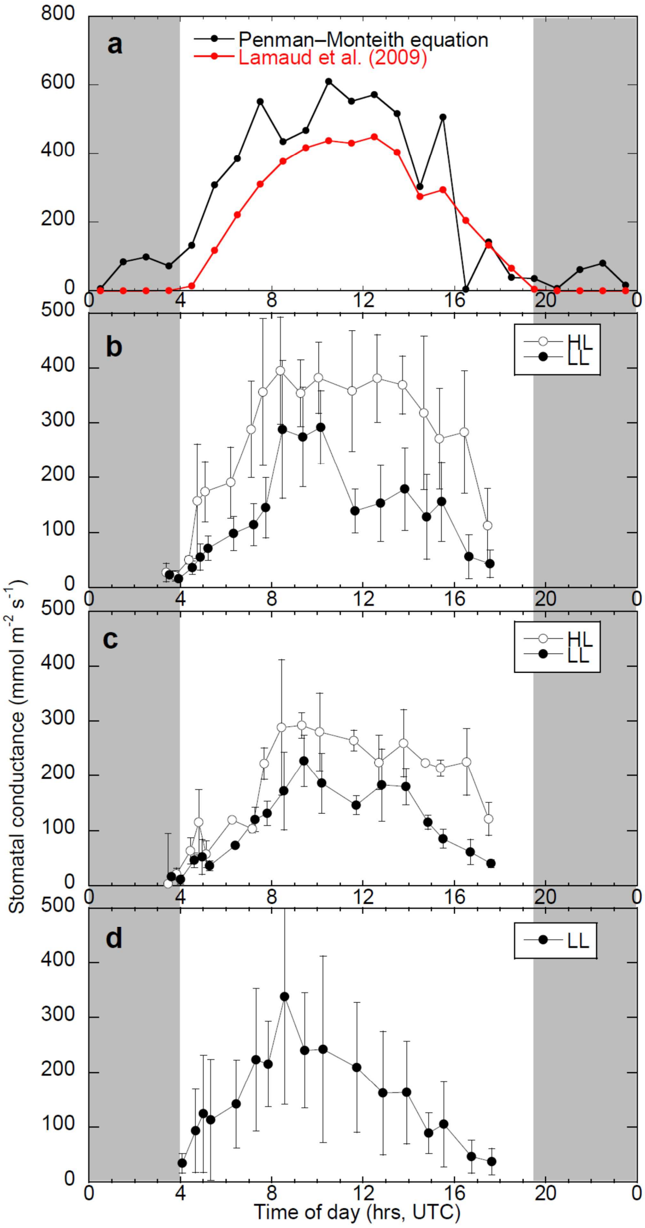


Figure S2: Stomatal conductance to water vapour (a) calculated using the Penman-Monteith equation or the Lamaud et al. (2009) approach (shown as diurnal averages over the May 29 to June 3 period) or (b, c, d) measured 06/16/2013 using a transit-time porometer in the sun and shade crowns of (b) 6 oak, (c) 3 maple trees, accessible by the scaffolding, and (d) 3 smokebushe plants in the undergrowth on the O3HP field site. HL and LL stand for High Light (sun crowns) and Low Light (shade crown, leaf area index around 1.5-2.0) conditions. Note that nighttime measurements of stomatal conductance of the smokebush in the undergrowth typically took very long (20 s - 70 s transit time) to complete, and were considered to be too low as to be correctly predicted by this method. The time scale is UTC time and the grey vertical bands correspond to the night time.

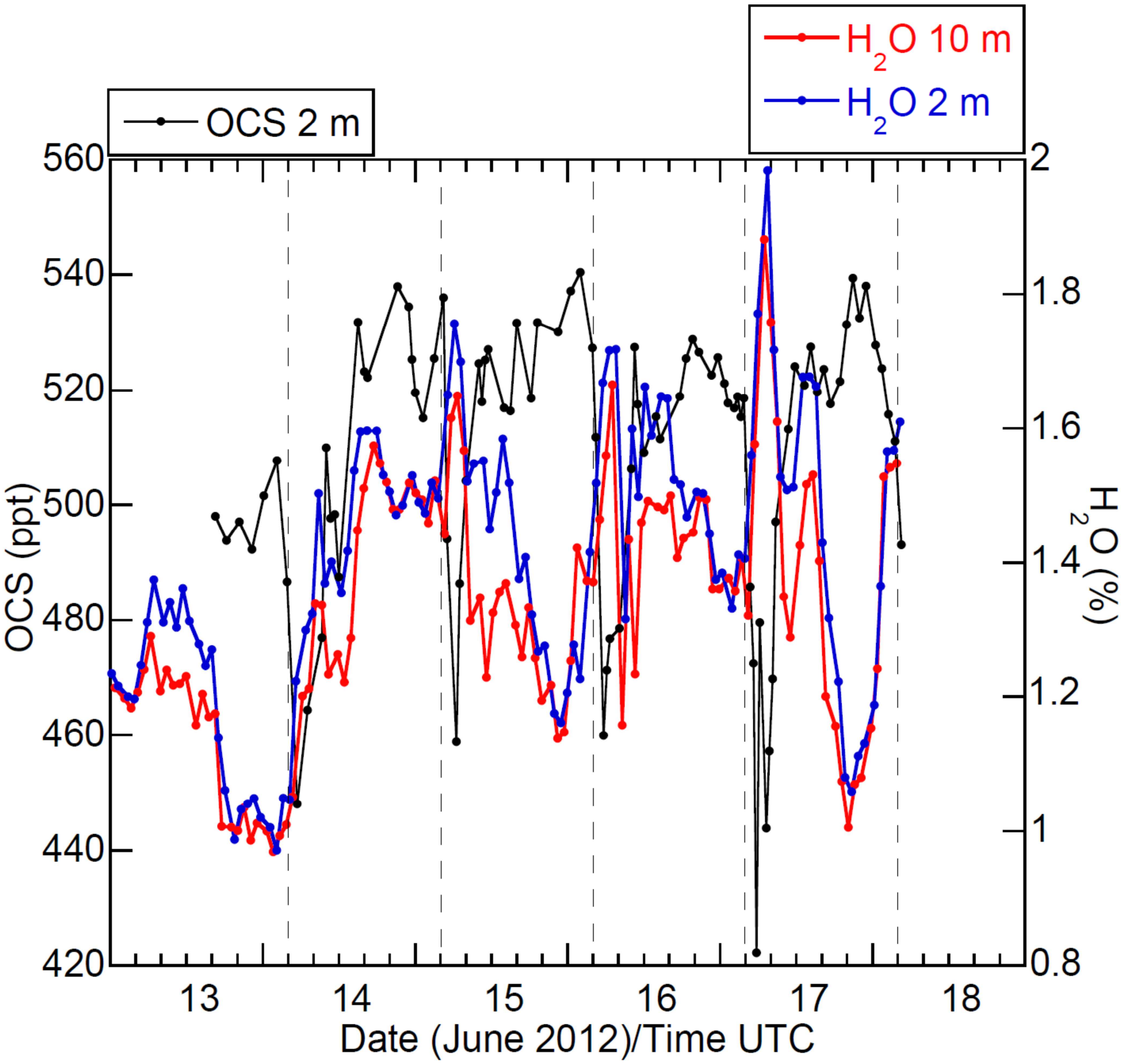
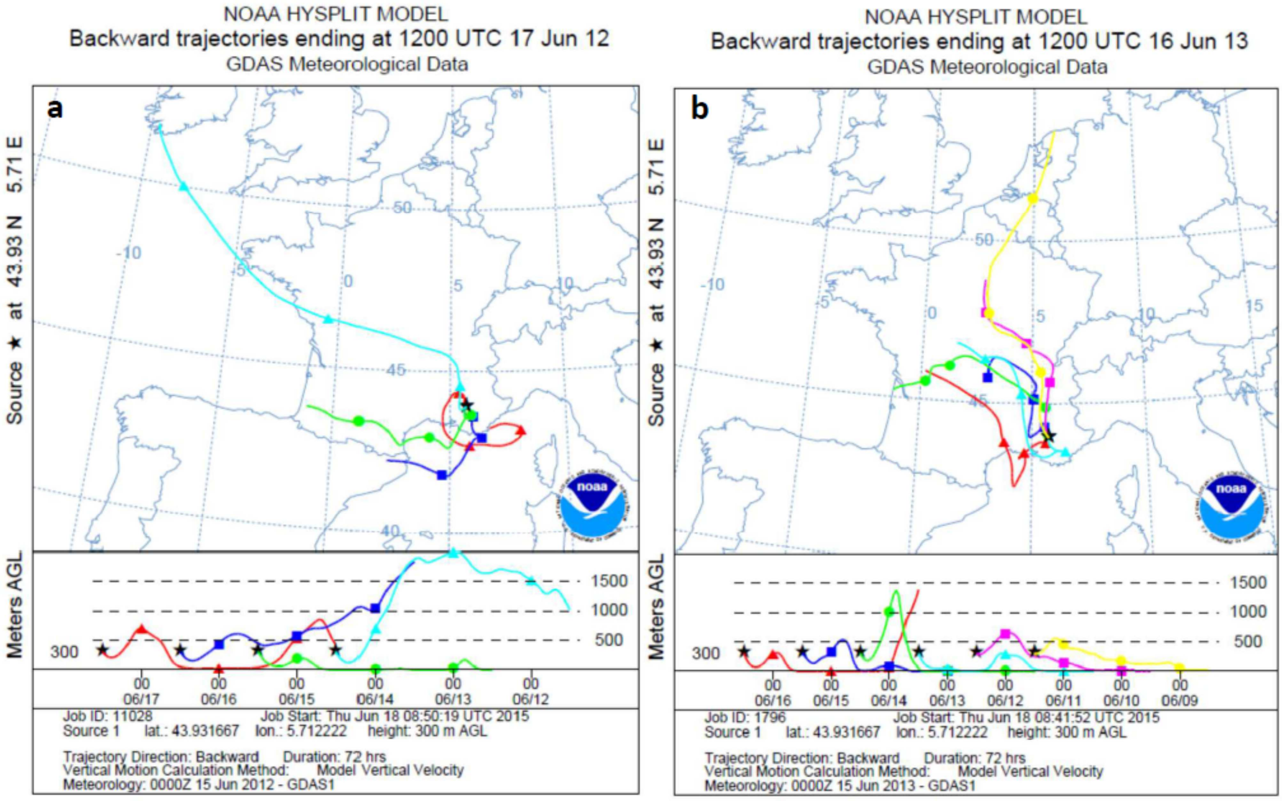


Figure S3: Time series of ambient mixing ratios of OCS (GC data) and water vapor (Picarro data) within (2 m) and above the canopy (10 m, only for water vapor). The time scale is UTC and the dashed lines indicate the sunrise.



<u>Figure S4</u>. 3 days back trajectories, calculated by the NOAA HYSPLIT MODEL, ending at the O3HP site at 12:00 UTC, 300 m above ground level. (a) June 2012, (b) June 2013.

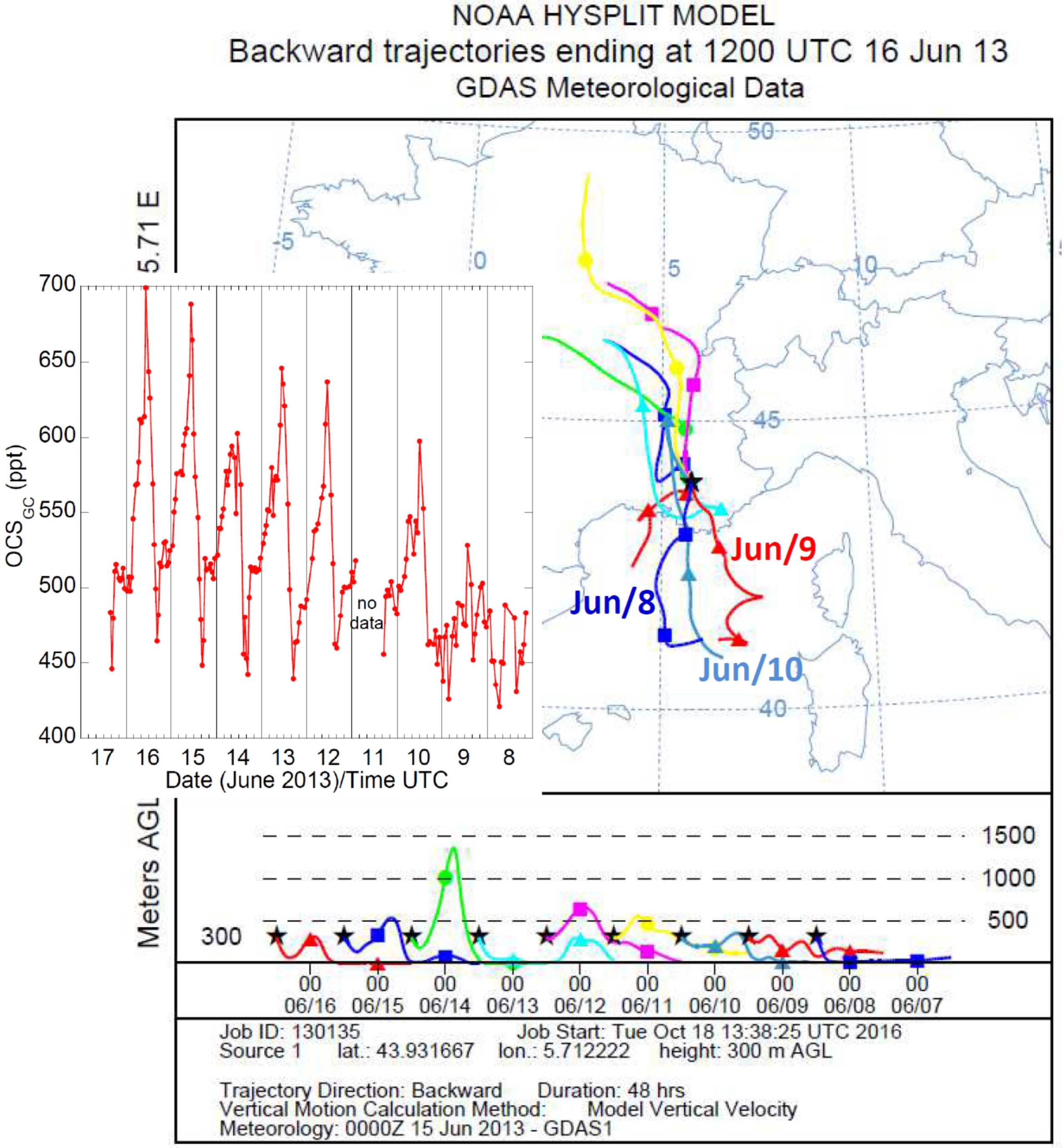


Figure S5: Full OCS records in June 2013 and corresponding back trajectories of 48h duration to better visualize the movement of air masses over the Mediterranean Sea and France. Note that the x-axis is reversed and that there is gap in the time series due to GC maintenance and calibration on Jun/11. The Jun/10 back trajectory shows that the air mass travelled from the Mediterranean Sea up to 45°N, then moved backwards to reach the OHP site. This may explain why the maximum OCS level on that day is not as high as later in the week.

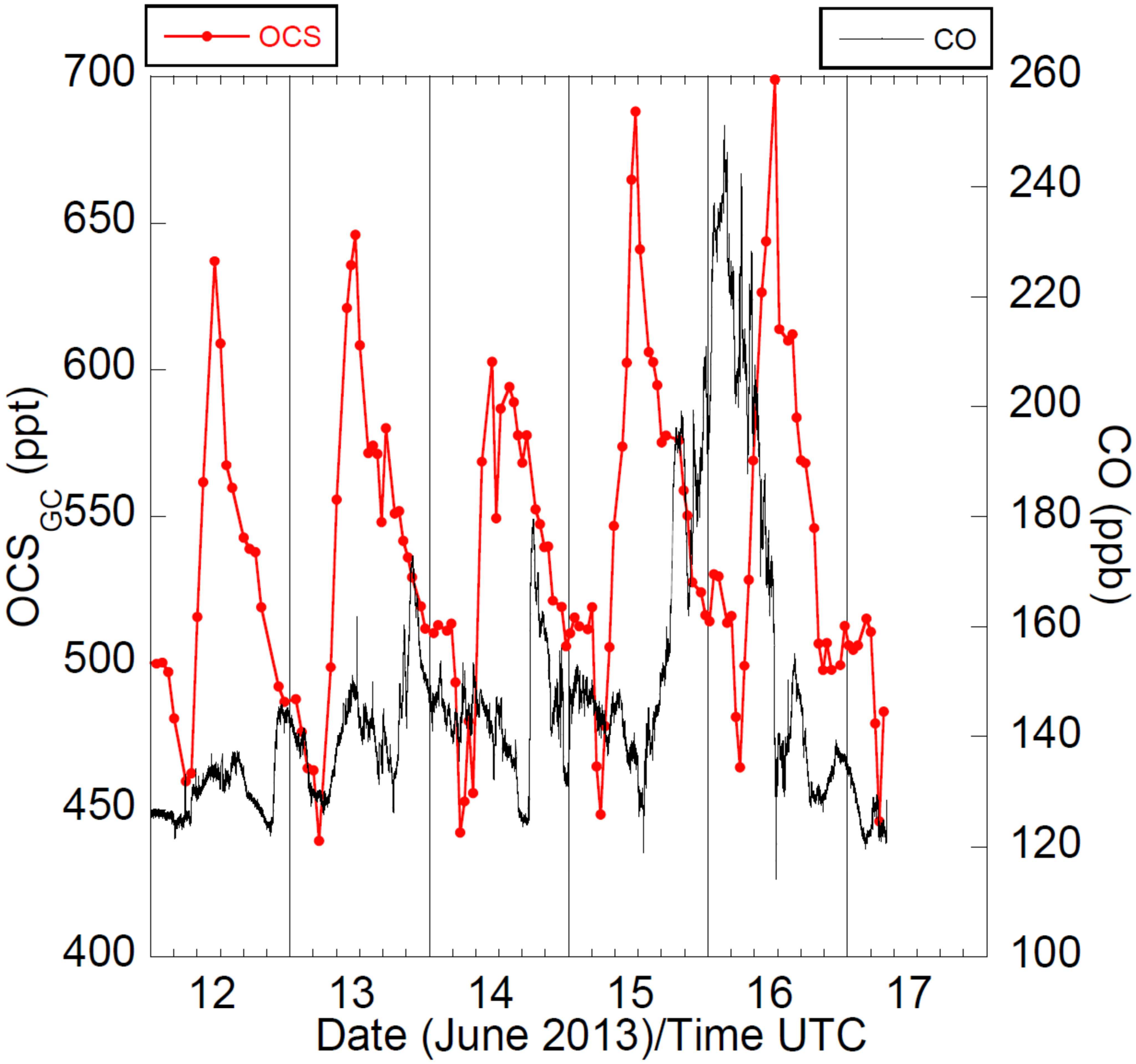


Figure S6: Time series of ambient mixing ratios of OCS (GC data) and CO (LGR uncalibrated data) within the canopy (2 m).

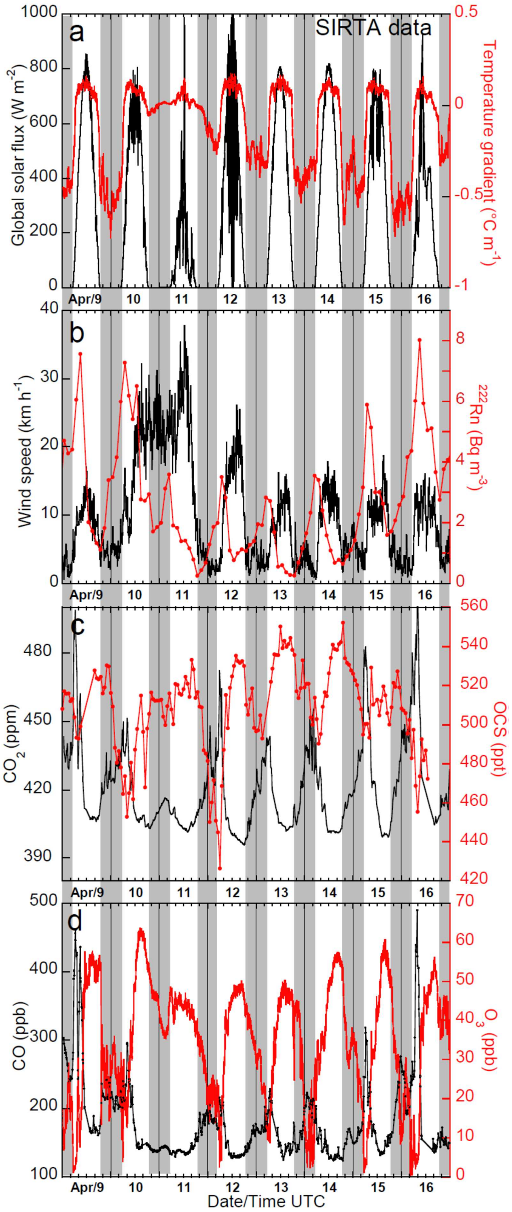


Figure S7. Time series of ambient mixing ratios of OCS, CO_2, CO and O_3 in a suburban area of the Paris region (Saclay Plateau, ICOS site, April 2015; c,d) at 7 m height above ground level (a.g.l.), respectively, in relation to incoming global radiation and thermal stratification a.g.l. ($\Delta T/\Delta H$ in °C m^{-1}; a) and wind speed (b). Note that global radiation and temperature vertical gradients in the Saclay area (a) were recorded at the SIRTA site located about 4 km East of the ICOS sampling site (data downloaded from http://sirta.ipsl.polytechnique.fr/sirta/data/data_search/). The same OCS and O_3 analyzers were used to monitor the diurnal variations of those compounds at the O3HP and ICOS-SIRTA sampling sites. The ICOS-SIRTA time series is meant to illustrate the atmospheric signature during periods of low atmospheric turbulence of strong OCS and O_3 deposition events. Periods of low atmospheric turbulence were evaluated using ^{222}Rn accumulations (b). The time scale is UTC time and the grey vertical bands correspond to the night time. Analytical methods are described in the main text and in the supplementary material.