First results from the surface heterogeneity focus area of the Boundary Layer Late Afternoon and Sunset Turbulence (BLLAST) Experiment

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Abstract

The Boundary Layer Late Afternoon and Sunset Turbulence (BLLAST) experiment was conducted from 14 June - 8 July 2011 in Lannemezan, France with the aim of gaining improved understanding of various transitory processes associated with the afternoon boundary layer. A sub-focus area of the BLLAST experiment was dedicated to studying the impact of surface heterogeneity on various aspects of the afternoon transition and decay processes. The three adjacent vegetative surfaces: corn, moor and forest were instrumented with high frequency continuous monitoring surface energy balance and trace-gas flux stations. In addition, during Intensive Observational Periods, measurements of lower frequency typical meteorological variables were acquired using tethered balloon soundings and unmanned aerial vehicle (UAV) vertical profiles and horizontal surveys. Frequent radio soundings, remote sensing and aircraft measurements provided an important context for larger scales processes that interact with local scale heterogeneity. This talk will present the first results from the surface heterogeneity experiment, and will address several areas of inquiry including: variability in timing according the surface energy balance, impact of induced local breezes, variability in turbulence scales, and variability in the transport of heat, momentum, and scalars.

Scientific Questions

- What is the effect of surface heterogeneity on the decay of turbulent momentum and scalar statistics (e.g. variations in roughness, albedo, moisture availability)?
- Can better heat/mass/momentum parameterizations be developed for transitory periods?
- Which flow phenomena (such as front formation and episodic turbulence) are characteristic of the afternoon transitory period?
- How are afternoon transitory processes affected by the influence of large scale forcing?
- What are the factors that affect the collapse of turbulence?
- How does turbulence decay in the Residual Layer?

Field Campaign – Lannemezan, France

Site 1 – Primary observational site at the Centre de Recherches Atmosphériques

Site 2 – Location of the Heterogeneity Experiment

The field site was situated in the south of France on the Lannemezan Plateau between the Pyrenees mountains to the south and plains to the north
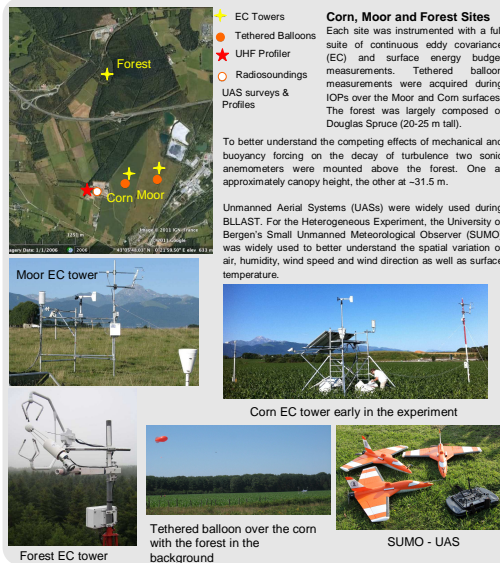
11 IOPs were conducted

International field campaign with participants from Europe and the United States

Wide range of instrumentation to capture afternoon transitory processes (e.g., aircraft, towers, lidars, sodars, radars, radiosoundings, Scintillometry)

More information may be found at: http://bllast.sedoo.fr/campaigns/2011/

Heterogeneous Field Site Description

Corn, Moor and Forest Sites
Each site was instrumented with a full suite of continuous eddy covariance (EC) and surface energy budget measurements. Tethered balloon measurements were acquired during IOPs over the Moor and Corn surfaces. The forest was largely composed of Douglas Spruce (20-25 m tall).

To better understand the competing effects of mechanical and buoyancy forcing on the decay of turbulence two sonic anemometers were mounted above the forest. One at approximately canopy height, the other at ~31.5 m.

Unmanned Aerial Systems (UASs) were widely used during BLLAST. For the Heterogeneous Experiment, the University of Bergen's Small Unmanned Meteorological Observer (SUMO) was widely used to better understand the spatial variation of air, humidity, wind speed and wind direction as well as surface temperature.

Moor EC tower

Corn EC tower early in the experiment

Forest EC tower

Tethered balloon over the corn with the forest in the background

SUMO - UAS

Results

Preliminary Data Analysis
The following preliminary results are from IOP #7, 27 June 2011. The CRA (Centre de Recherches Atmosphériques) soundings shown below were released from Site 1 (~4.5 km north of the Corn and Moor towers) The sounding system is a SR2K2-P from MODEM Company, used with M2K2-DC sondes.
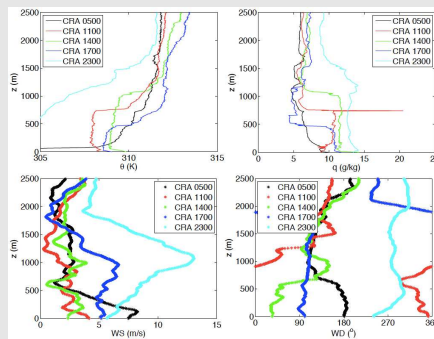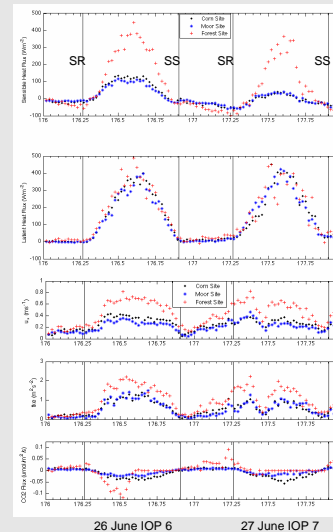

Results

Tethered Balloon Comparison
The following altitude corrected profiles illustrate the subtle differences between various boundary layer parameters above both sites. Both sites were quite moist with small mid-day Bowen ratios less than ~ 0.25.
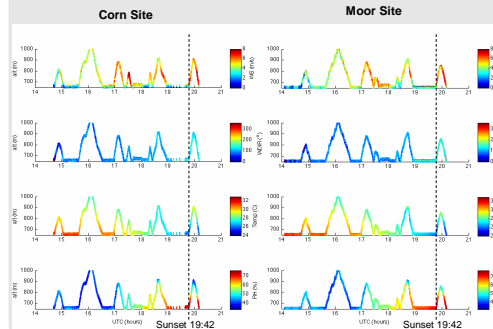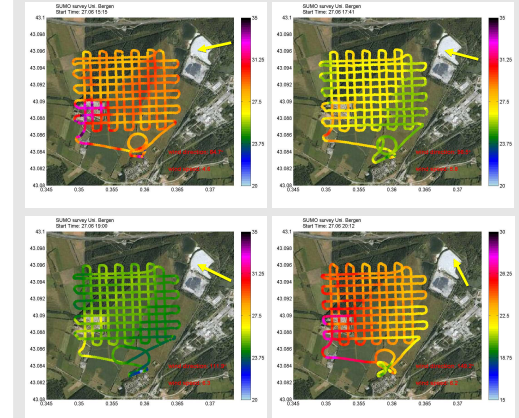

Turbulent Flux Variability

Results

Unmanned Aerial System – SUMO Aerial Surveys
Surface Temperature Measurements
The radiometric surface temperature clearly illustrates the microstructure of the temperature over the different surface types. Surveys were flown at 70 m above ground level.

Summary Observation Points
For the IOP 7 considered:

- Large differences in sensible heat fluxes between the forest and the other two sites
- Similar latent heat fluxes at all sites
- Absolute rate of tke (turbulent kinetic energy) decay is greatest over the forest site
- The moist layer that develops during transition is slightly thicker over the Moor
- Although the surface temperatures over the Moor site are substantially cooler than the Corn site, the balloon temperatures above the surface are very similar

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