Boundary Layer Late Afternoon and Sunset Turbulence: the BLLAST 2011 experiment

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## International participants

<table>
<thead>
<tr>
<th>Country</th>
<th>Institutions</th>
<th>Activities</th>
</tr>
</thead>
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<tr>
<td><strong>France</strong></td>
<td>LA, CNRM, IPSL/LMD, LPCA SAFIRE</td>
<td>Tethered balloon, UHF profiler, aircraft meas. Balloons, towers, <strong>modelling (ARPEGE, AROME)</strong> Aerosol and Doppler Lidar. Sodar Aircraft (Piper Aztec)</td>
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<tr>
<td><strong>Germany</strong></td>
<td>Univ. Tübingen, Univ. Braunschweig, Univ. Bonn</td>
<td>UAS - MASC UAS - M²AV Soundings</td>
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<td><strong>The Netherlands</strong></td>
<td>Univ. Wageningen, Univ. Delft</td>
<td><strong>Modelling (LES, WRF)</strong>, eddy covariance and scintillometer <strong>Modelling (LES-DNS)</strong></td>
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<tr>
<td><strong>Spain</strong></td>
<td>BarcelonaTech (UPC), Univ. Baleares, Univ. Comp. Madrid</td>
<td><strong>Modelling (MXL, LES, WRF)</strong> Eddy covariance, <strong>modelling (MesoNH)</strong> Microbarometers</td>
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<td><strong>Italy</strong></td>
<td>IBIMET</td>
<td>Aircraft (Sky Arrow)</td>
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<td><strong>UK</strong></td>
<td>Univ. Exeter</td>
<td><strong>Modelling (LES)</strong></td>
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<td><strong>USA</strong></td>
<td>Univ. Utah, UC Davis, UC San Diego, NCAR &amp; NOAA</td>
<td>Tethered balloon, tower, Raman Lidar Soundings IR camera Expertise, <strong>Modelling (WRF)</strong></td>
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<tr>
<td><strong>Norway</strong></td>
<td>Univ. Bergen</td>
<td>UAS – SUMO, <strong>modelling (WRF)</strong></td>
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OUTLINE

• Issue & objectives
• The 2011 field experiment
• Preliminary results
Late afternoon transition:

• Progressive shut down of the surface heating
• Stabilization of the temperature profile close to the surface
• Transition from thermal turbulence to mechanical turbulence

Few numerical studies, scarce observations, less than 20 published papers

• PBL decaying still not well understood and represented
• Transitional aspects
• Competition of several weak forcings
• Close to (or beyond) the edge for scaling laws
Scientific Questions

**Definition & characterization**
- Understanding of the various layers (surface layer, mixed-layer, residual layer)

**Understanding**
- The evolution of turbulence intensity & scales
- The role of the various PBL processes (entrainment, dynamical turbulence, convection, advection, radiation, ...)
- The role of surface heterogeneity

**Impact**
- Transport of trace gases and water vapour
- Representation of the diurnal cycle by mesoscale models
- Evaluation of the forecast models

**Methodology:** *Observations* & *numerical simulations* (mixed-layer model, LES, Mesoscale, NWP)
The 2011 field experiment
Field experiment 14 June-8 July 2011

Instrumented site of Laboratoire d’Aérologie, Lannemezan, France
Exploration needs

• PBL Vertical structure
  multi-layering, shear, entrainment, stability

• Surface layer spatial heterogeneity
  Surface cover heterogeneity, soil moisture, heat storage, energy balance

• Radiation divergence

• Advection, large scale subsidence, baroclinicity

• Gravity waves
Field experiment 14 June-8 July 2011

Supersite 1 (Vertical structure of the BL):
- Up to 9 hourly RS launched from 12 UTC (during IOPs)
- Tethered balloon with turbulence measurements
- 60 m tower with turbulence measurement at 3 levels
- 10 m tower: sonic anemometers at 6 levels
- Sodar, UHF, VHF, MWR, ceilometer
- Backscatter and Doppler lidars
- 3 microbarometers, 8 thermocouples, soil
- Four 2 m masts with EC instruments

Supersite 2 (Surface heterogeneity):
- EC over 3 different surfaces: corn, moor, forest (30 m tower)
- 2 tethered balloons
- Backscatter lidar

3 scintillometers: 30 m, 3 and 4 km
Two airplanes and several UAS simultaneously performing horizontal legs and vertical profiles (first campaign)
Aircraft flight tracks
Preliminary results

• Vertical structure: RS, LIDAR
• Surface heterogeneity: UAS
• TKE decay: surface, aircraft, LIDAR, UAS
Vertical structure: 1\textsuperscript{st} July 2011

- Residual layer, rapid growth of the BL
- Westerly winds aloft
- NE-SW during day-night in the mixed layer
- Differential shear
- Subsidence
Surface heterogeneity: 27\textsuperscript{th} June 2011

- Forest
- Corn
- Moor

1 km

SUMO flying at SS2

Reuder, Jonassen and Lindenberg (Univ. Bergen)
2 m and aircraft: TKE decay 1\textsuperscript{st} July 2011

Piper Aztec (points):
Four legs at each height

- magenta = 0.95 zi
- red = 0.7 zi
- blue = 0.45 zi
- black = 0.25 zi

F. Lohou, M. Lothon, P. Durand (Laboratoire d'Aérologie), E. Pardyjak (U Utah)
Doppler LIDAR: TKE decay 2\textsuperscript{nd} July 2011

$z_i=1100 \text{ m}$

$w^*=1.44 \text{ m/s}$

$t^*=0.21 \text{ h}$

$t_0=13 \text{ UTC}$

$\rightarrow$ Larger TKE in the middle of the CBL than at the bottom

\textit{F. Gibert (LMD), L. Thobois (Leosphere), Y. Bezombes (LA), A. Dabas (MeteoFrance)}
UAS (M²AV): TKE decay 2nd July 2011

- TKE/m of single flightleg
- Time of sunset

G. Lohman, S. Martin, A. Lampert (TUB)
BLLAST related studies at EGU2012:

Poster session this afternoon: **XY671, XY672, XY673**

Additional information: quick looks, other instruments, model results at:

http://bllast.sedoo.fr
Thank you for your attention!