The afternoon-evening transition : presentation of the BLLAST field campaign and a first evaluation of NWP models

F. Couvreux, M.Lothon, F. Lohou, E. Bazile, Y. Seity, B. Szintai,F. Guichard, D. Legain and the BLLAST team

BLLAST OBJECTIVES:

- to understand the evolution of **the intensity and scales of the turbulence,** and, to determine the role of **different processes** (PBL entrainment, mesoscale circulations…)
- to identify **the role of surface heterogeneity** in this transition
- to evaluate the ability of NWP in reproducing **this afternoon-evening transition**

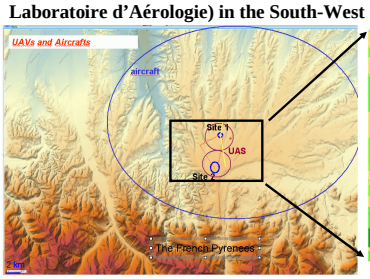
Issues:

- Only **few numerical studies** and **very few observations**
- **Close to/Beyond the edge of scaling laws** and boundary layer definitions
- Importance of **Transitional** aspects
- Competition of **various weak forcings** (advection, subsidence, radiation,..)

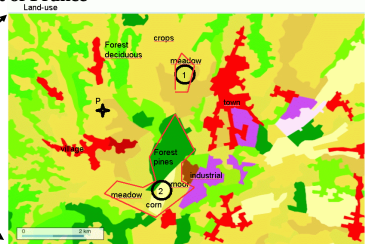
I/ The field campaign :

From 14 June to 8 July 2011

On the **Instrumented site of Lannemezan, (Centre de Recherche Atmosphérique, Laboratoire d'Aérologie) in the South-West of France**



Location of the different sites and zone of exploration of Unmanned Aerial Systems (UAS) and aircraft.



Land-use around site 1 and site 2

The exploration needs and associated instruments:

Vertical structure of the PBL:

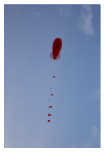
-radiosoundings standard and frequent (2 balloons in order to get back the sonde, retrieval rate =80%, 65 soundings with 20 probes)

-UHF, doppler and aerosol lidars, telemeters, sodar, radiometers

- Meteorological tower -> 65m
- UAS profiles

Turbulence measurements:

-Aicrafts
- UAS
- tethered balloon with a turbulent probe



Surface Layer Heterogeneities:

-2 Tethered balloons with sondes at similar heights over two large vegetated patches (meadow and corn)

- Meteorological and Flux stations over these two patches and a forest patch
- Soil temperature and moisture measurements

Radiation divergence:

-radiative tower -> 10 m

-skin flow mast

New instrumental devices tested during this campaign are indicated in red

A total of 12 IOPs :

Covering **different synoptic conditions**: heat-wave, North-Westerly flow, Easterly flow, North-Easterly flow and North flow

Clear sky or cumulus (post-frontal situations)

		AIRCRAFT				SUMO UAS			RADIOSOUNDINGS		
		Sky Arrow		Piper Aztec		PROF	SURV	TURB	Site 1	Site 2	Site 3
IOP 00	14/06/11	2 FL	2h				1	2	8	1	
IOP 01	15/06/11	2 FL	4h	2FL	3,0h		2	19	7	6	
IOP 02	19/06/11	2 FL	4h	2FL	3,9h	12	13	3	4	8	
IOP 03	20/06/11	3 FL	5h	2FL	4,2h	11	10	2	4	7	
IOP 04	24/06/11	2 FL	4h			10	2		4		
IOP 05	25/06/11	3 FL	4h	3FL	5,2h	11	6	2	4	8	
IOP 06	26/06/11	2 FL	4h	2FL	4,1h	11	8	4	6	6	1
IOP 07	27/06/11			2 FL	2,0h	12	12	11	6	2	2
IOP 08	30/06/11			2 FL	4,5h	12	5		3		
IOP 09	01/07/11			2 FL	4,5h	6	5		7	8	
IOP 10	02/07/11			2 FL	3,6h	9	3		6	8	
IOP 11	05/07/11			3 FL	5,9h	13	1		8	8	3
TOTAL			27		41	107	68	43	67	62	6
TOTAL			68 h				218 FL			135 RS	

Summary table of IOPs with details of aircraft, UAV and radiosoundings operations

The BLLAST Team:

M. Lothon, F. Lohou, P. Durand, F. Couvreux, D. Legain, E. Pardyjak, J. Vila Guerau de A., J. Reuder, D. Pino, P. Augustin, Y. Bezombes, A. van de Boer, J. Cuxart, L. Fleury, B. Gioli, F. Gibert, J. Groebner, O. Hartogensis, A. von Kroonenbeerg, S. Martin, G. J. Steeneveld, Y. Seity, C. Yagüe, H. Jonker, W. Angevine, D. Lenschow, Z. Sorbjan, S. Derrien, C. Darbieu

Most of the pictures are from Patrick Dumas @ Look at Science / BLLAST

II/ First evaluation of Numerical Weather Prediction Models:

Models:

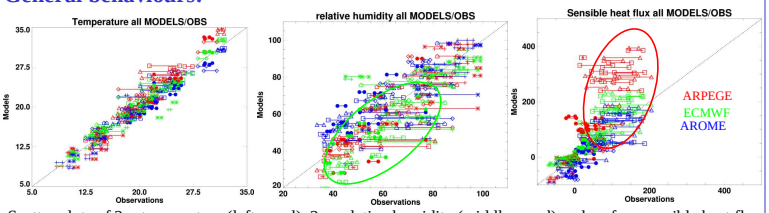
AROME: 2.5km resolution, no deep convection scheme but still shallow convection scheme (Seity et al., 2011)
ARPEGE: 10 km resolution
ECMWF ~15km resolution

Observations:

Radiosondes: Radiosoundings were launched at site 1 (MODEM or GRAW) or site 2 (VAISALA) at different times during the day

Radiative fluxes, turbulent fluxes and near surface atmospheric variables: observed at the 60m tower at site 1 and the corn and moor sites at site 2

General behaviours:



Scatter plots of 2m-temperature (left panel), 2m-relative humidity (middle panel) and surface sensible heat flux for ARPEGE(red), AROME (blue) and ECMWF (green) models as a function of observations

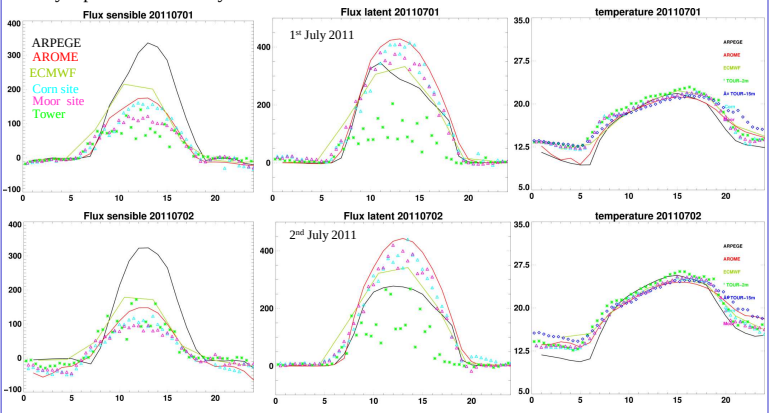
In general, ARPEGE tends to produce a too large sensible heat flux, cold temperature slightly too cold and warm temperature slightly too warm as also shown below.

ECMWF has a dry bias in term of relative humidity near the surface. It also tends to produce slightly too large boundary-layer height during the day.

A focus on 1st and 2nd of July: clear sky days:

During these two days, clear skies were observed and simulated.

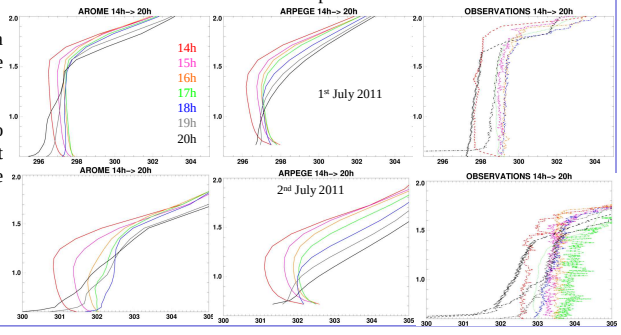
The synoptic flow is mainly from North-West.



ARPEGE tends to be too cold at night but the afternoon transition present a more realistic evolution than AROME that has a too slow decrease of temperature at this time.

ARPEGE has a strong subsidence not observed.

AROME tends to correctly represent the transition in the low levels



CONCLUSION:

A large dataset has been gathered to document the afternoon-evening transition with different instrumental techniques with a total of 12 IOPs covering different synoptic conditions.

Some systematic biases in the NWP models exist with a general better behaviour for the high resolution model.

References:

BLLAST web site : http://bllast.sedoo.fr

Lothon, M., and D. H. Lenschow, 2010, Studying the afternoon transition of the planetary boundary layer, Eos Trans. AGU, 91(29), 253-254

Seity Y., P. Brousseau, S. Malardel, G. Hello, P. Bénard, F. Bouttier, C. Lac and V. Masson:, The AROME-France Convective-Scale Operational Model, Mon. Wea. Rev, 139,976-991