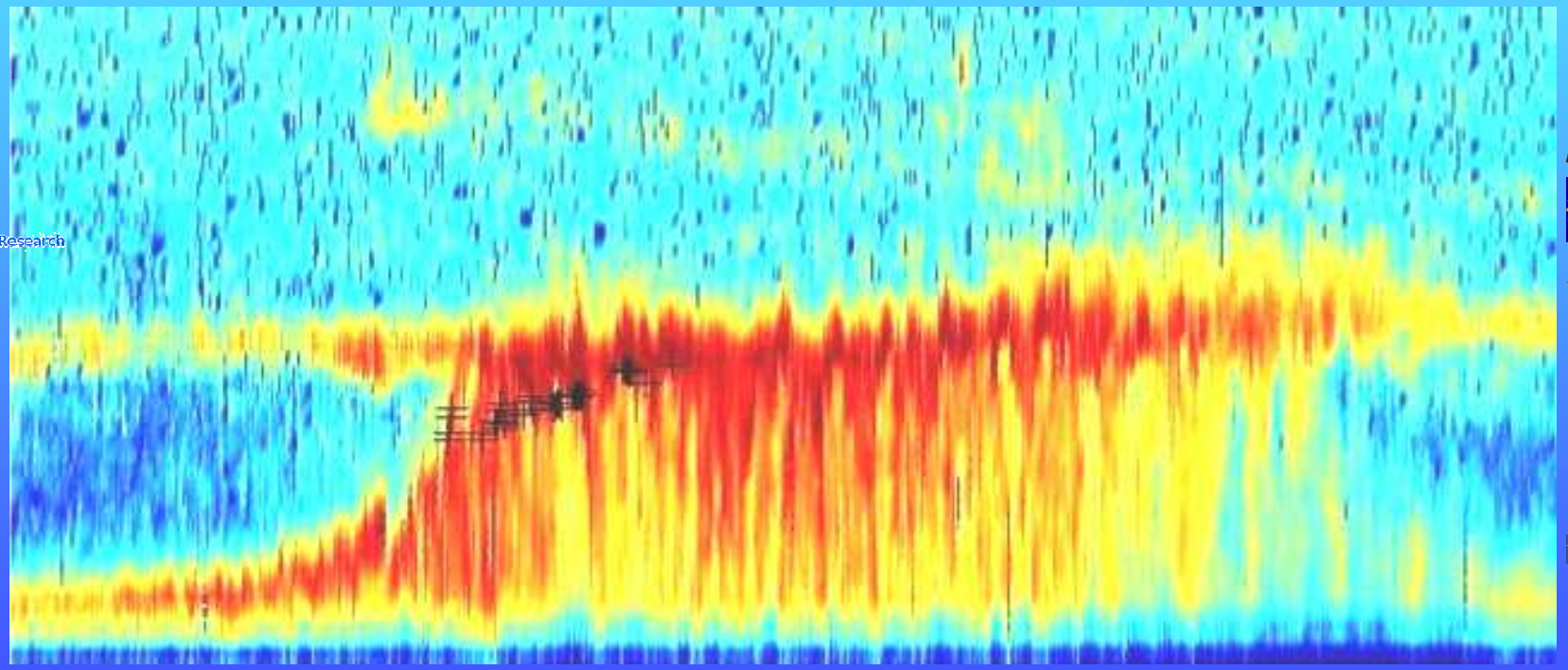
BLLAST

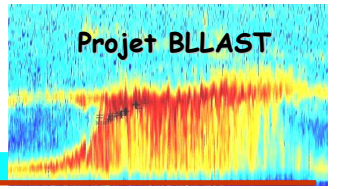
Boundary Layer Late Afternoon and Sunset Turbulence

M. Lothon, Laboratoire d'Aérologie, University of Toulouse, CNRS, FRANCE



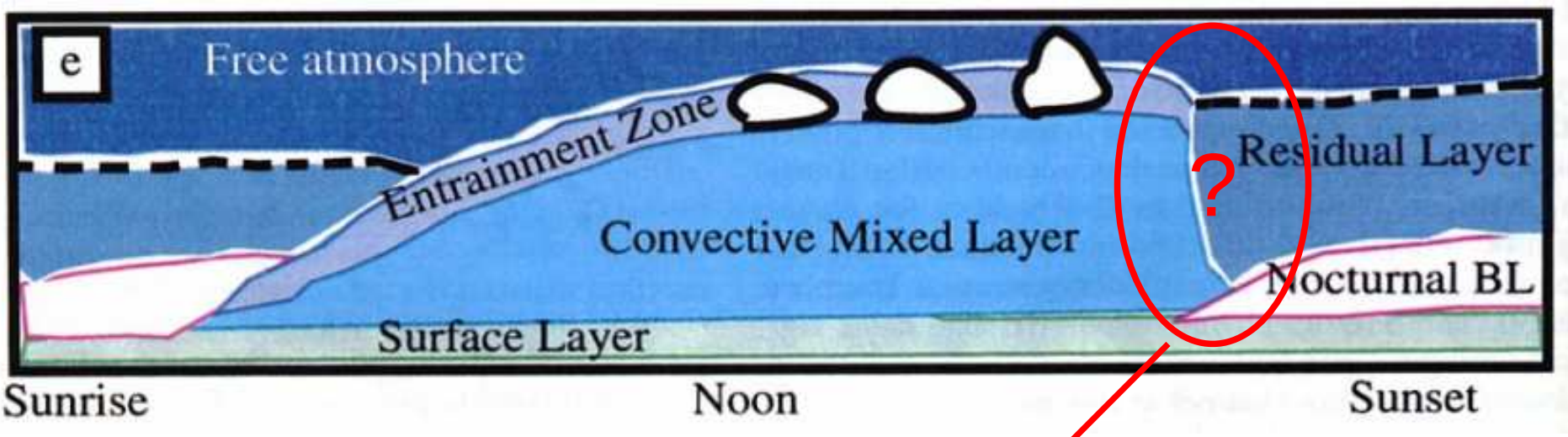
M. Lothon, F. Lohou, P. Durand, F. Couvreux, D. Legain, E. Pardyjak, J. Vila Guerau de A., J. Reuder, D. Pino, P. Augustin, Y. Bezombes, A. van de Boer, J. Cuxart, L. Fleury, B. Gioli, F. Gibert, J. Groebner, O. Hartogensis, A.C. van Kroonenbeerg, S. Martin, G. J. Steeneveld, Y. Seity, C. Yagüe, H. Jonker,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

OUTLINE



- Issue & objectives
- The 2011 Field experiment
- Preliminary results
- Instrumental aspects

Issue



Stull, 1988 - concept

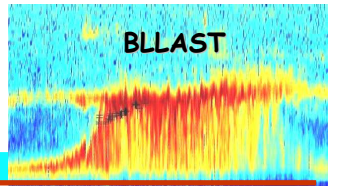
A few numerical studies, scarce observations…

Late afternoon transition:

- **Progressive shut down of the surface heating**
- **Stabilization of the temperature profile close to the surface**
- **Transition from thermal turbulence to dynamical turbulence**

Challenges: *- PBL decaying still not well understood and represented*
- Transitional aspects
- Competition of several weak forcings
- Close to (or beyond) the edge for scaling laws and boundary layer definition

Scientific Questions



Definitions & characterizations

Of the various layers

(surface layer, mixed-layer, residual layer,…)

Understanding

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

Impact

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

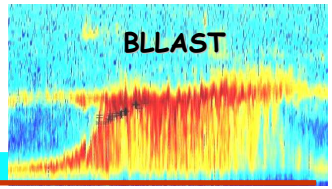
Method: ***Observations & Numerical simulations***

(1D mixed-layer model, LES, Mesoscale, NWP)

The field experiment

Field experiment

14june-8july 2011



Instrumented site of Laboratoire d'Aérologie, Lannemezan

- Instrumented towers
- Tethered and radiosounding balloon
- Aircraft and UAS
- Remote sensing: UHF, sodar, lidar
- Scintillometers

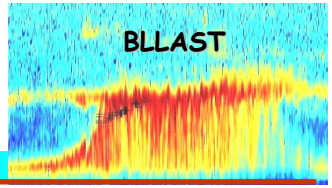
Field experiment

14june-8july 2011

BLLAST Project

Instrumented site of Laboratoire d'Aérologie, Lannemezan, France

Exploration needs



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

- **Surface layer spatial heterogeneity**

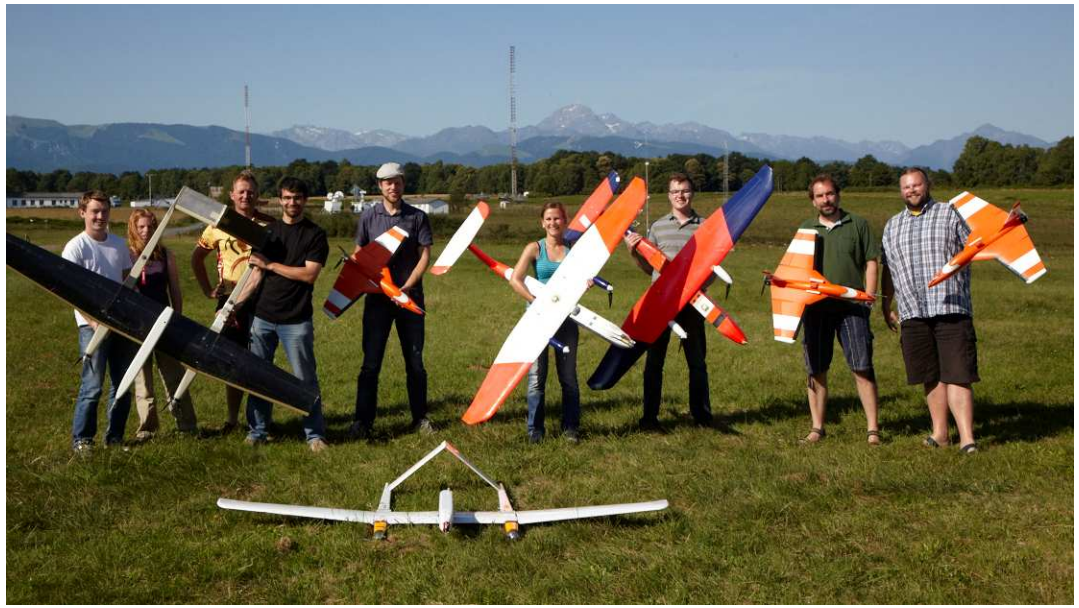
Surface cover heterogeneity, soil moisture, heat storage, energy balance phase shift

- **Radiation divergence**

- **Advection, large scale subsidence, baroclinicity**

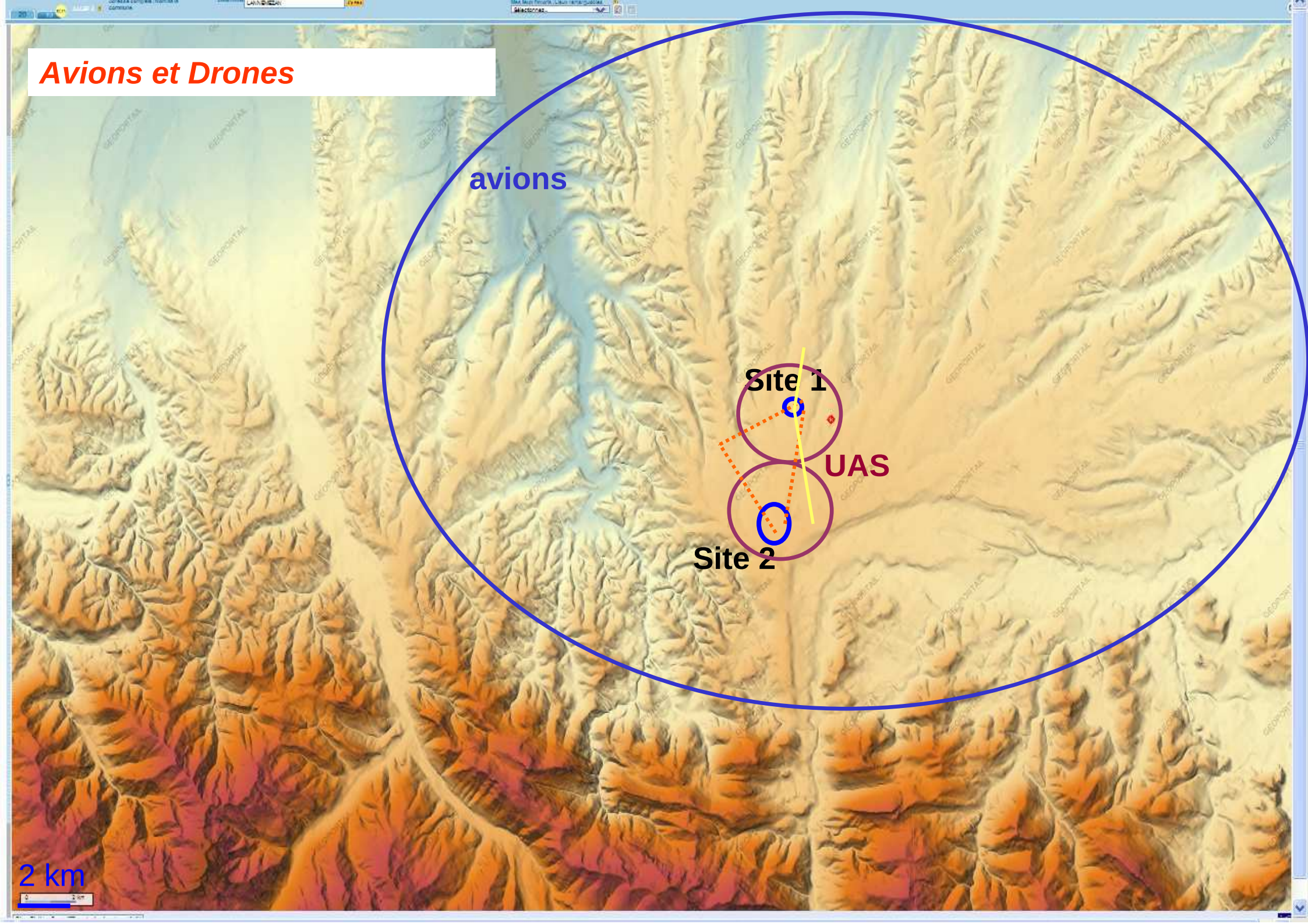
- **Gravity waves**

Manned and unmanned airplanes

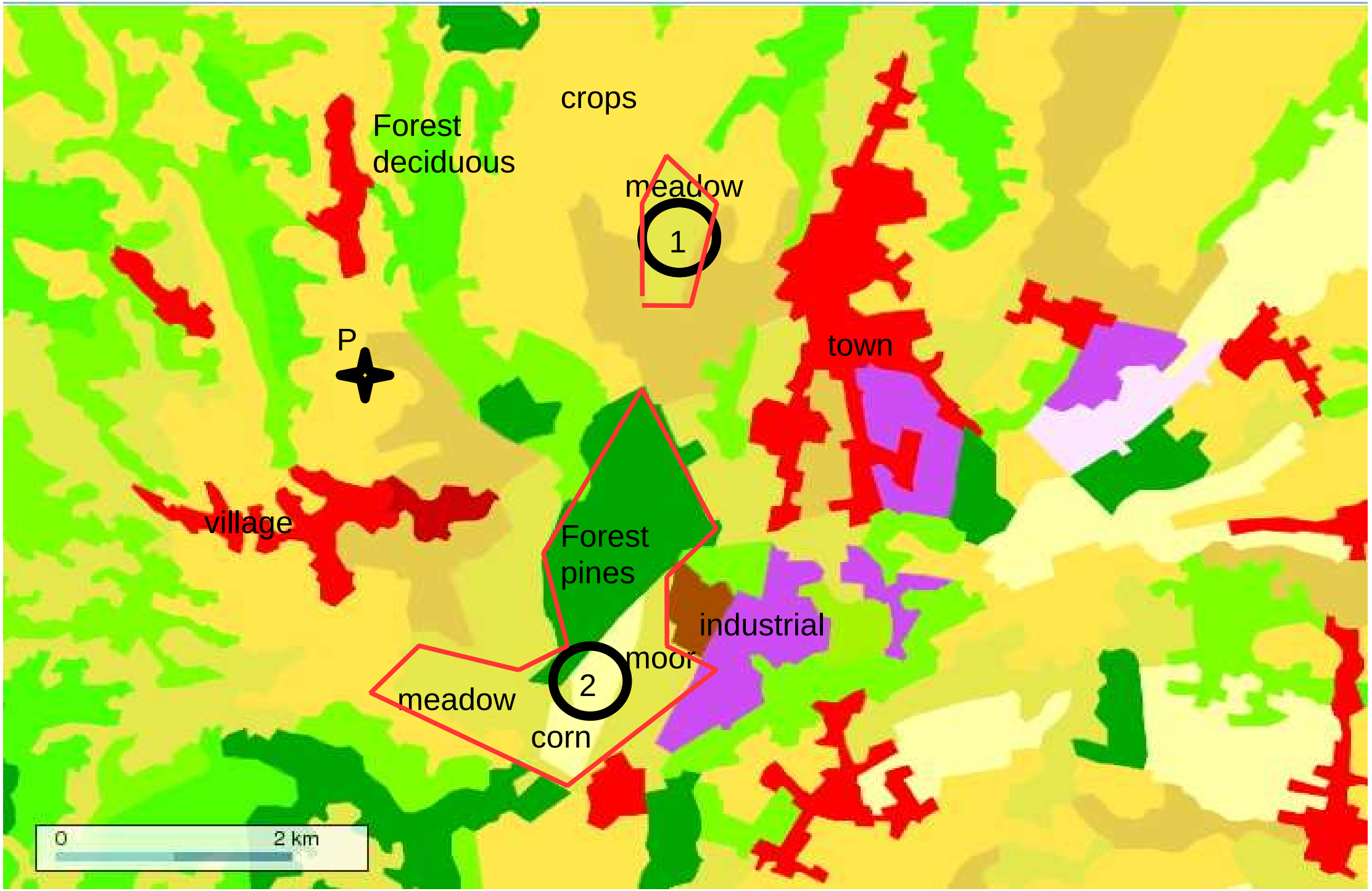


Photos: P. Dumas/Look-at-Science/BLLAST

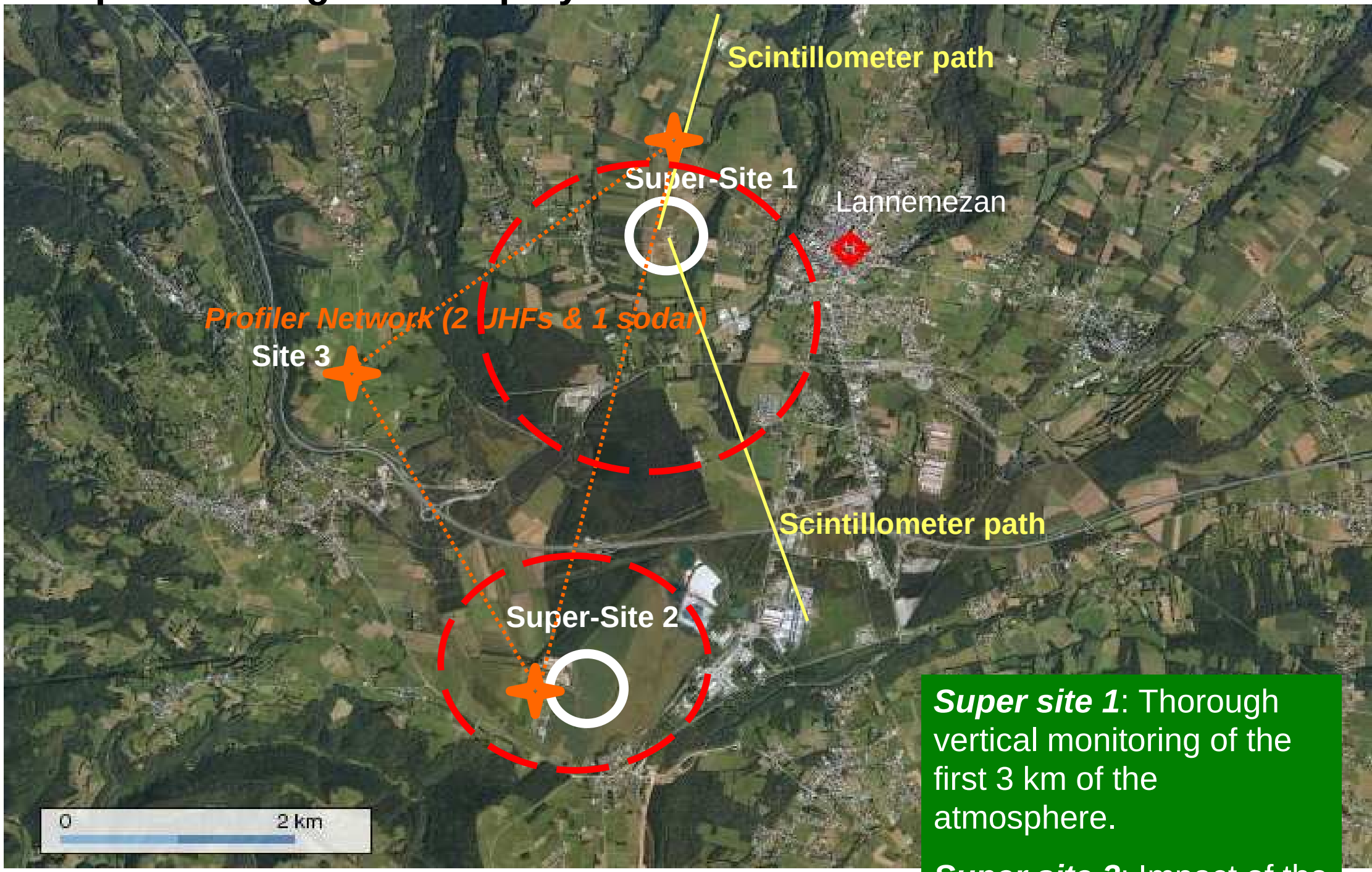
Avions et Drones



Land-use


crops
Forest
deciduous
meadow
1
P
town
village
Forest
pines
industrial
moor
2
meadow
corn
0
2 km

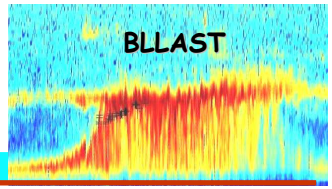
Experimental ground deployment



Super site 1: Thorough vertical monitoring of the first 3 km of the atmosphere.

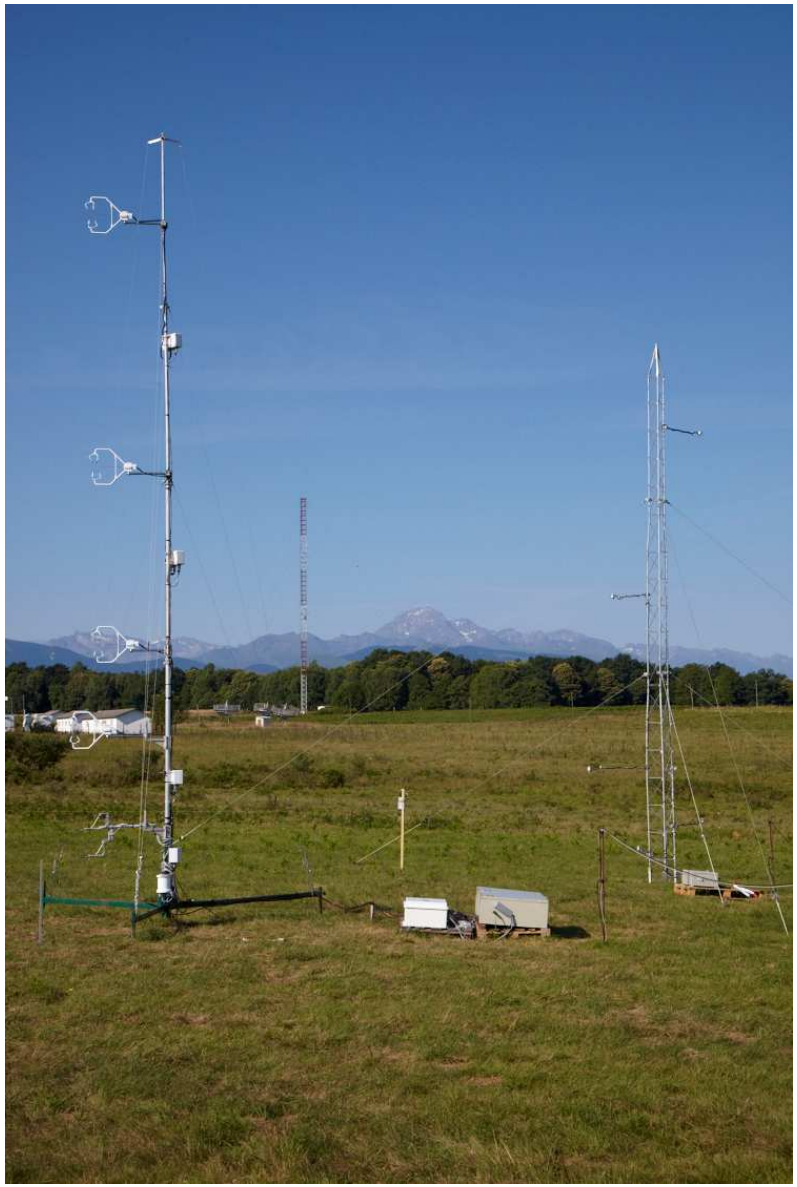
Super site 2: Impact of the

Field experiment



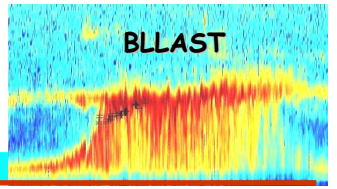
Instrumented towers

"Edge site", Hartogensis, van de Boer et al, MAQ, Univ. Wageningen



"Divergence & skin flow sites", Pardyjak & Alexander, Univ. Utah
Hartogensis, et al, MAQ, Univ. Wageningen

Summary table of the IOPs



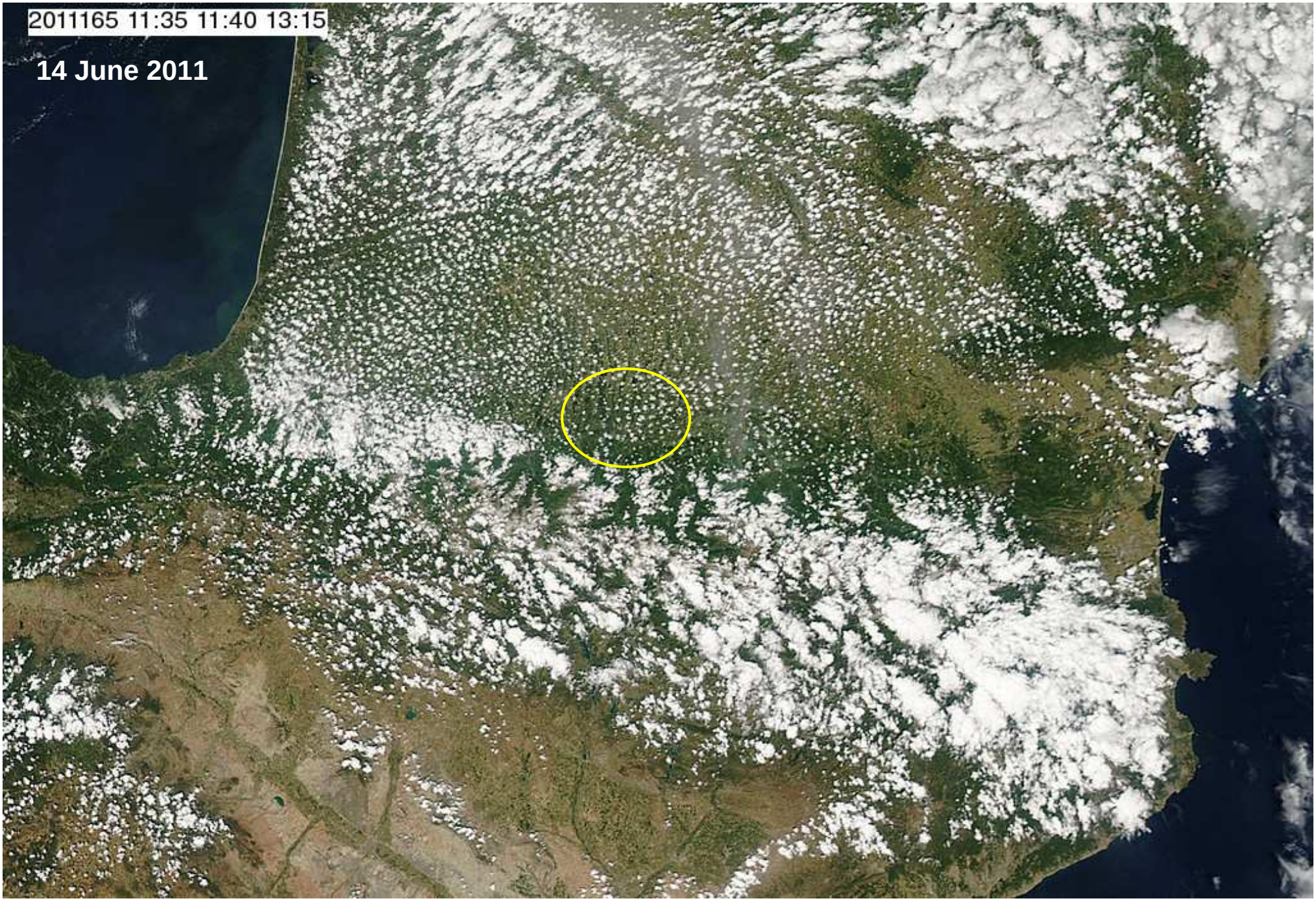
		AIRCRAFT				SUMO UAS			RADIOSOUNDINGS		
		Sky Arrow		Piper Aztec		PROF	SURV	TURB	Site 1	Site 2	Site 3
IOP 00	14/06/11	2 FL	2h				1	2	8	1	
IOP 01	15/06/11	2 FL	4h	2FL	3,0h		2	19	7	6	
IOP 02	19/06/11	2 FL	4h	2FL	3,9h	12	13	3	4	8	
IOP 03	20/06/11	3 FL	5h	2FL	4,2h	11	10	2	4	7	
IOP 04	24/06/11	2 FL	4h			10	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**	

Tethered balloon in site 1 (turbulence probe): ~**80** hours total
Tethered balloons in site 2 : ~**50** hours total for each

M2AV UAS: **9** test flights
15 science flights in second period

IOP 0-1 : Post-front conditions – north-westerly flow
IOP 2-3 : No significant synoptic surface pressure gradient – heat wave
IOP 4-7 : Drying surface episode with easterly flow over the area
IOP 8-10 : Drying surface episode with synoptic NE at low level
IOP 11 : Weak north synoptic wind – plain-mountain breeze regime

Meteorological conditions



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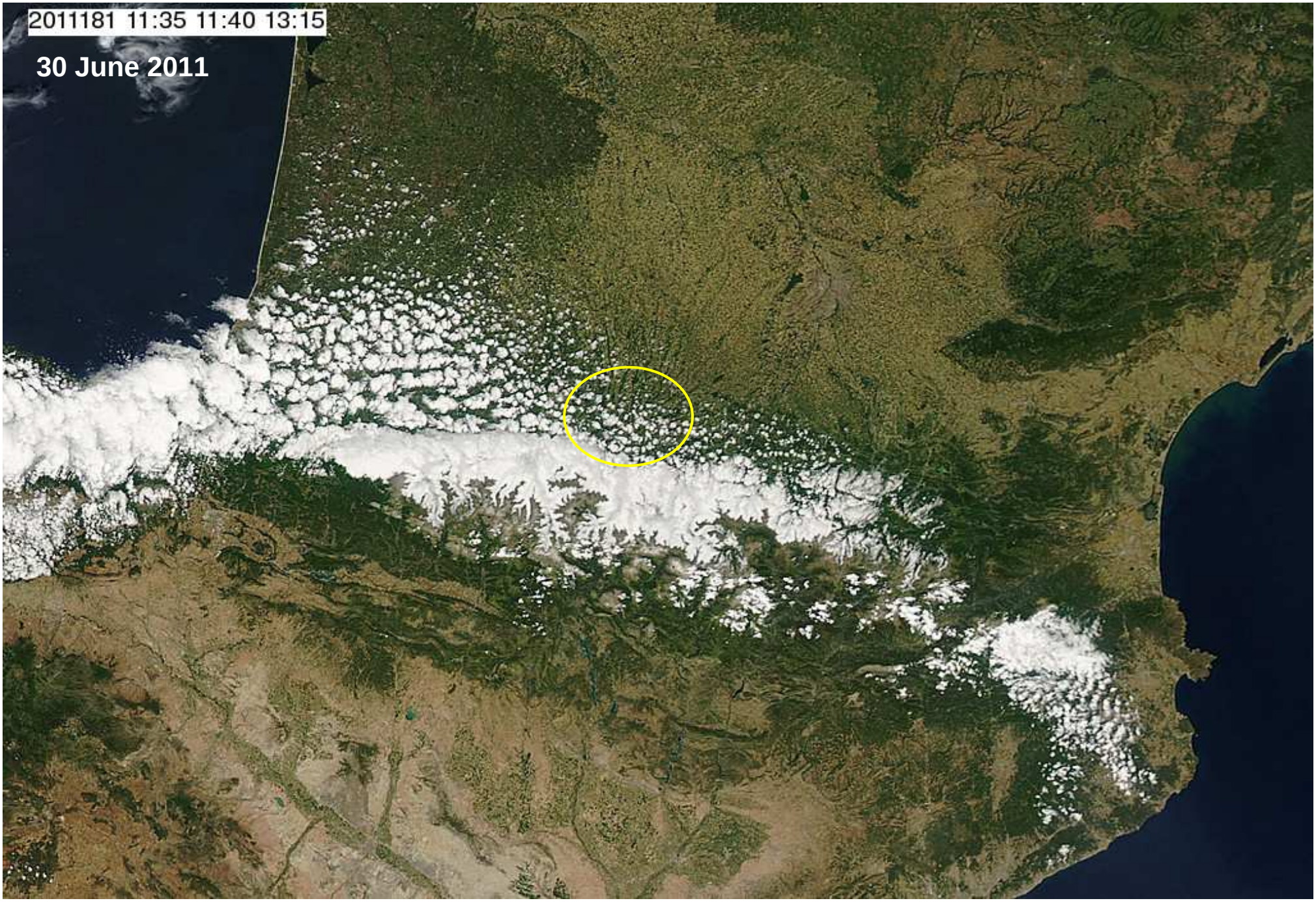

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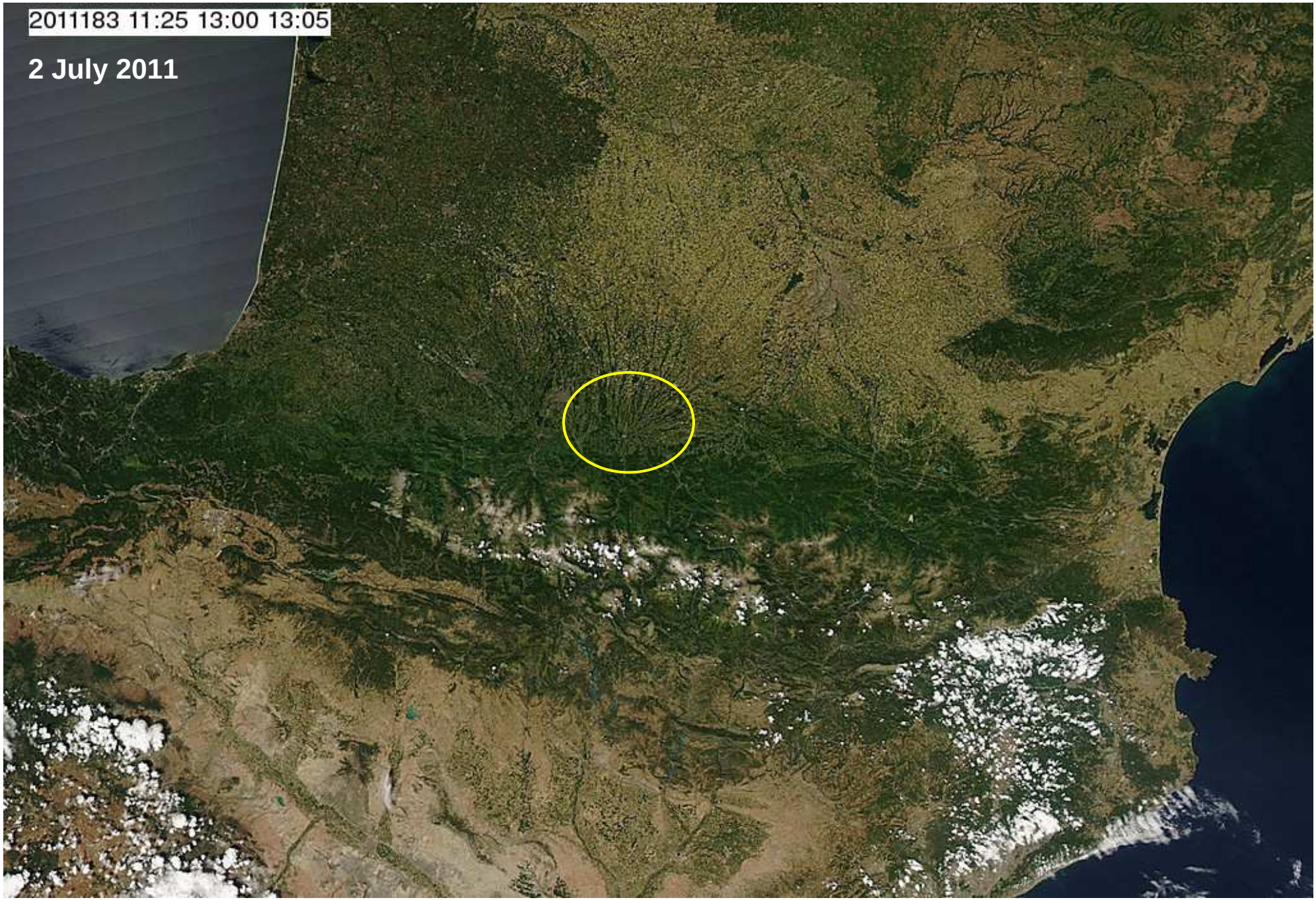
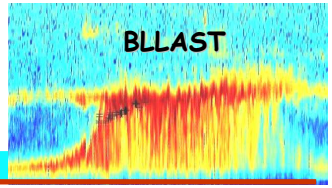


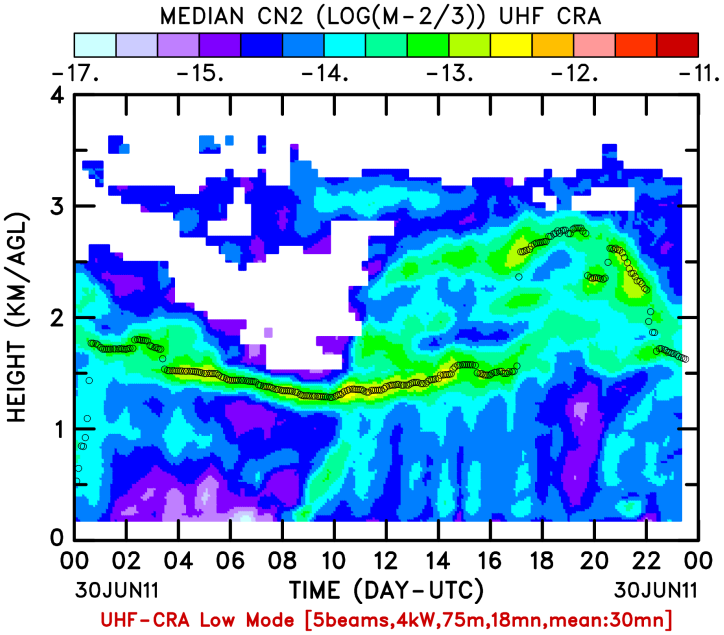
Preliminary results

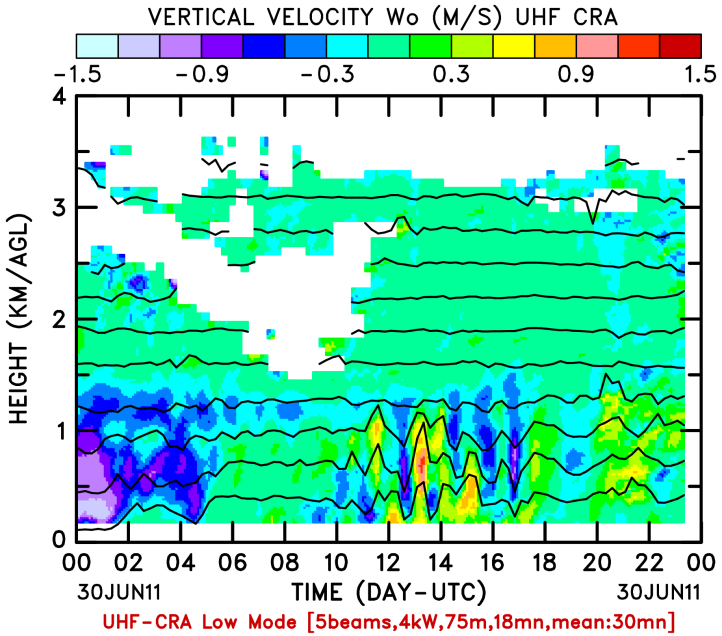
Examples of observations – Vertical structure

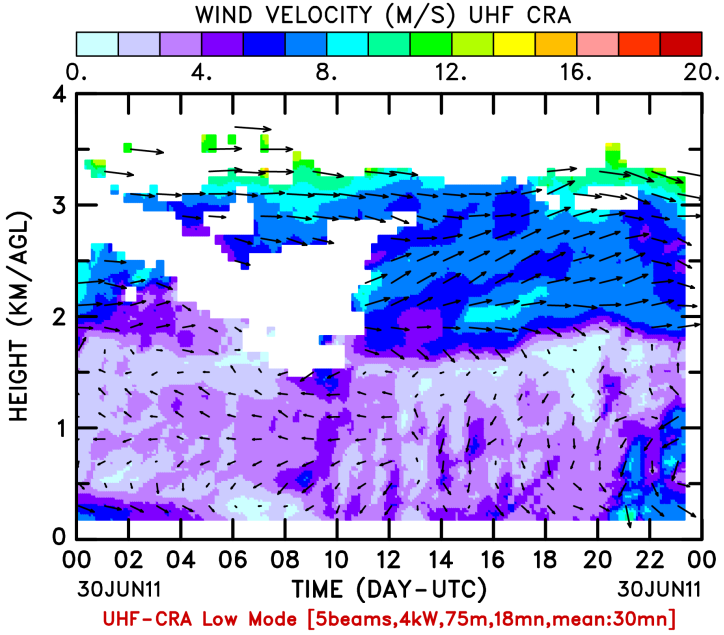


UHF wind profiler measurements

30 June 2011

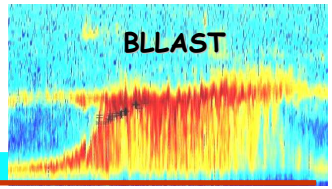




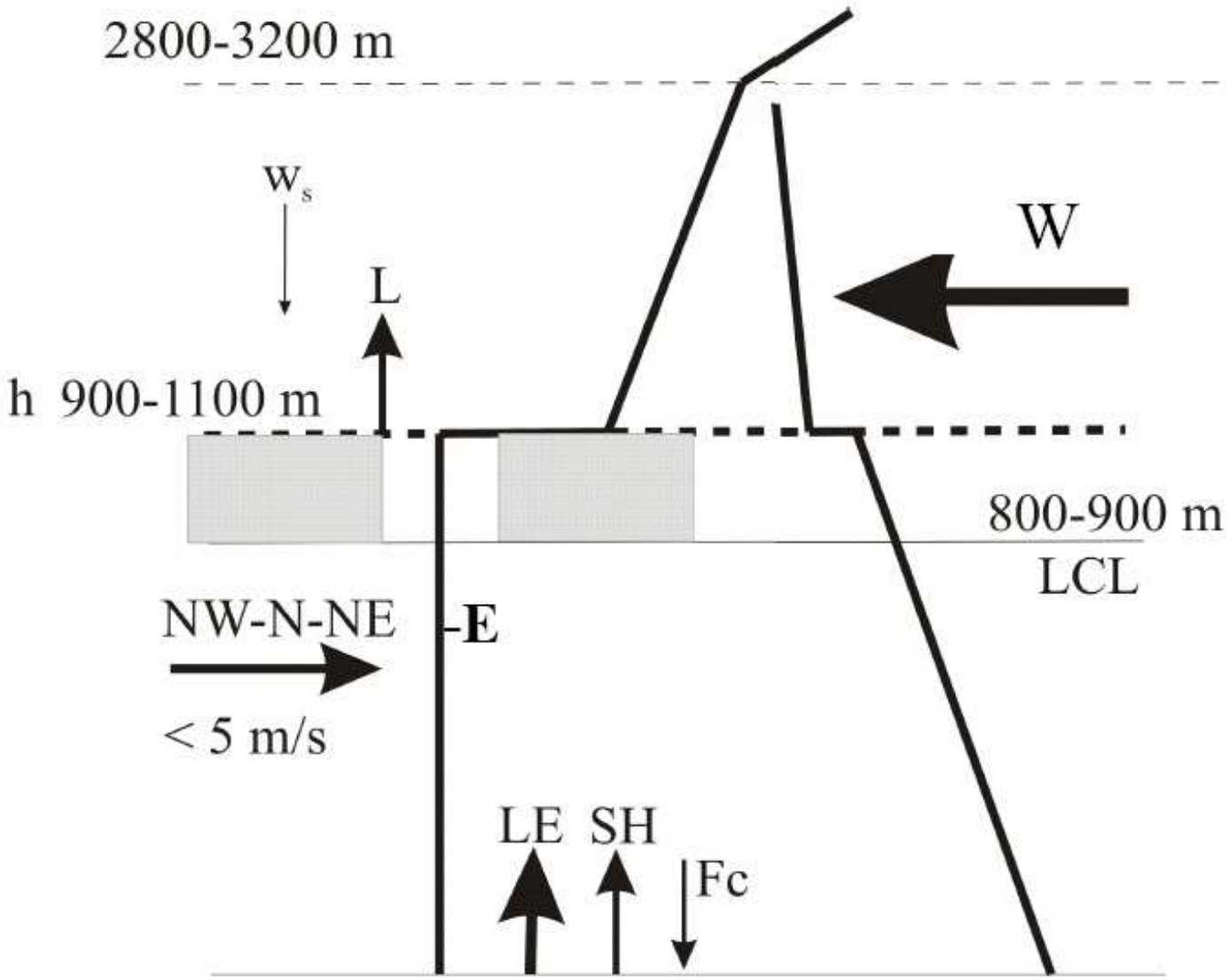


Saïd and Campistron, Laboratoire d'Aérologie, Univ. Toulouse

Examples of observations – Vertical structure

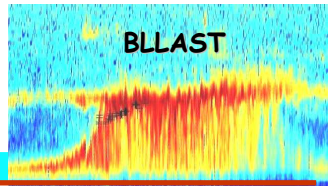


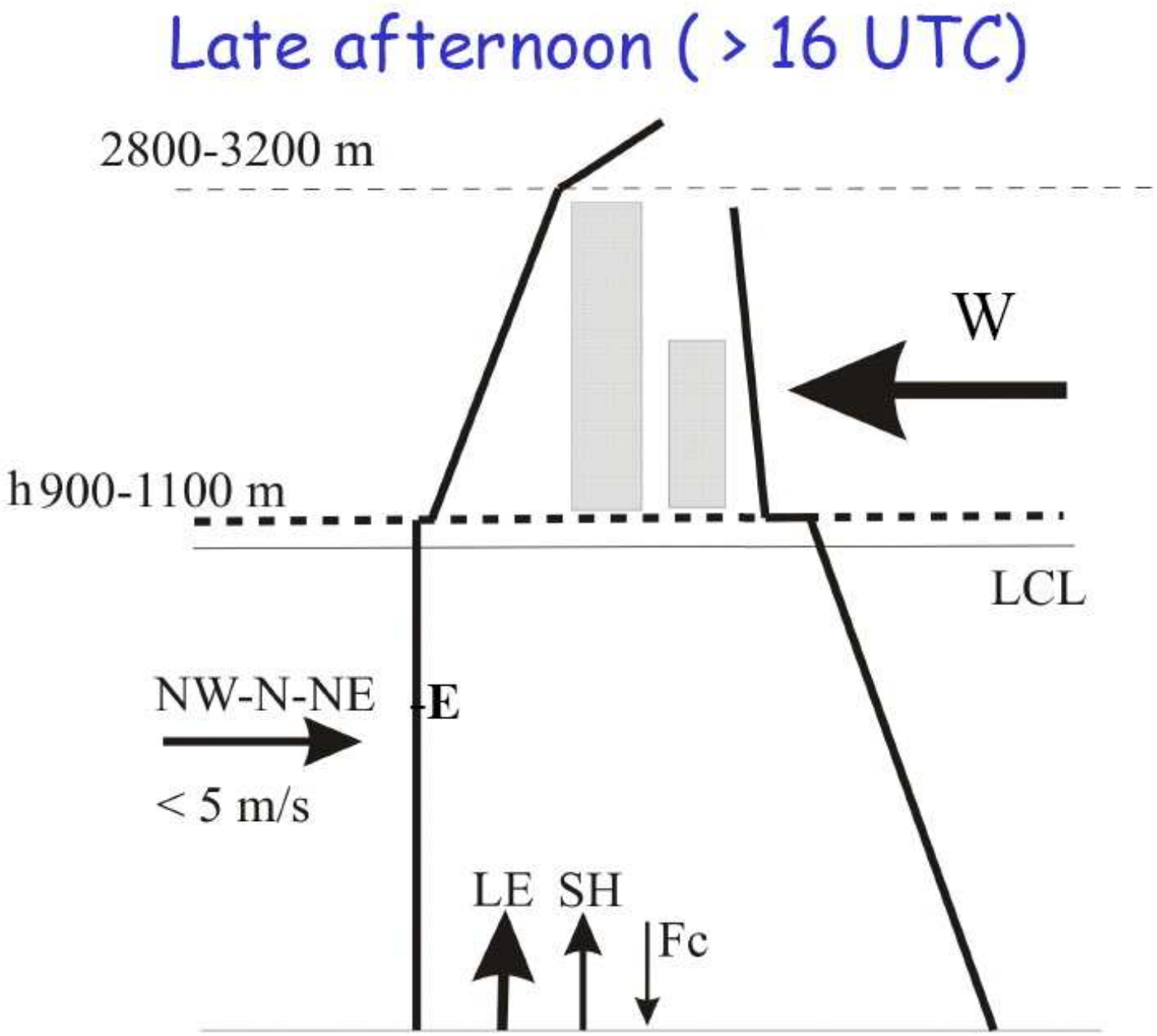
Early afternoon (< 16 UTC)



Vila Guerau de Arellano, Univ. Wageningen

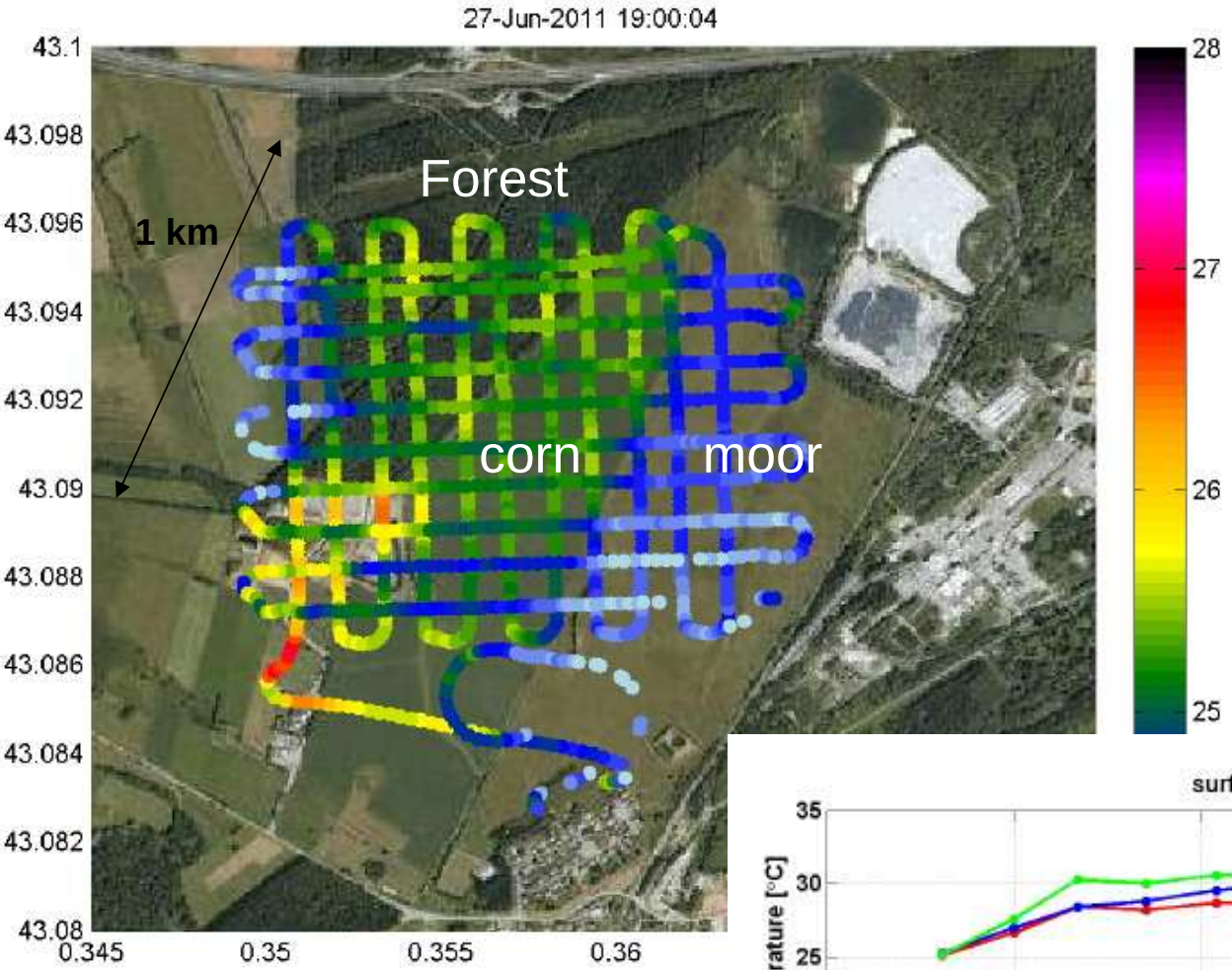
Examples of observations – Vertical structure



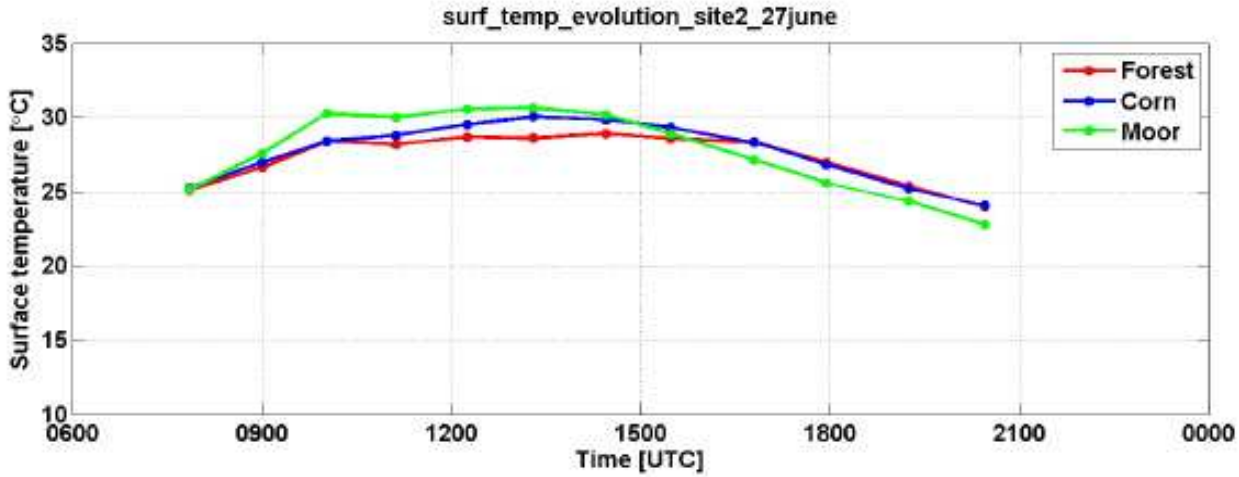


Vila Guerau de Arellano, Univ. Wageningen

Examples of observations – Surface heterogeneity



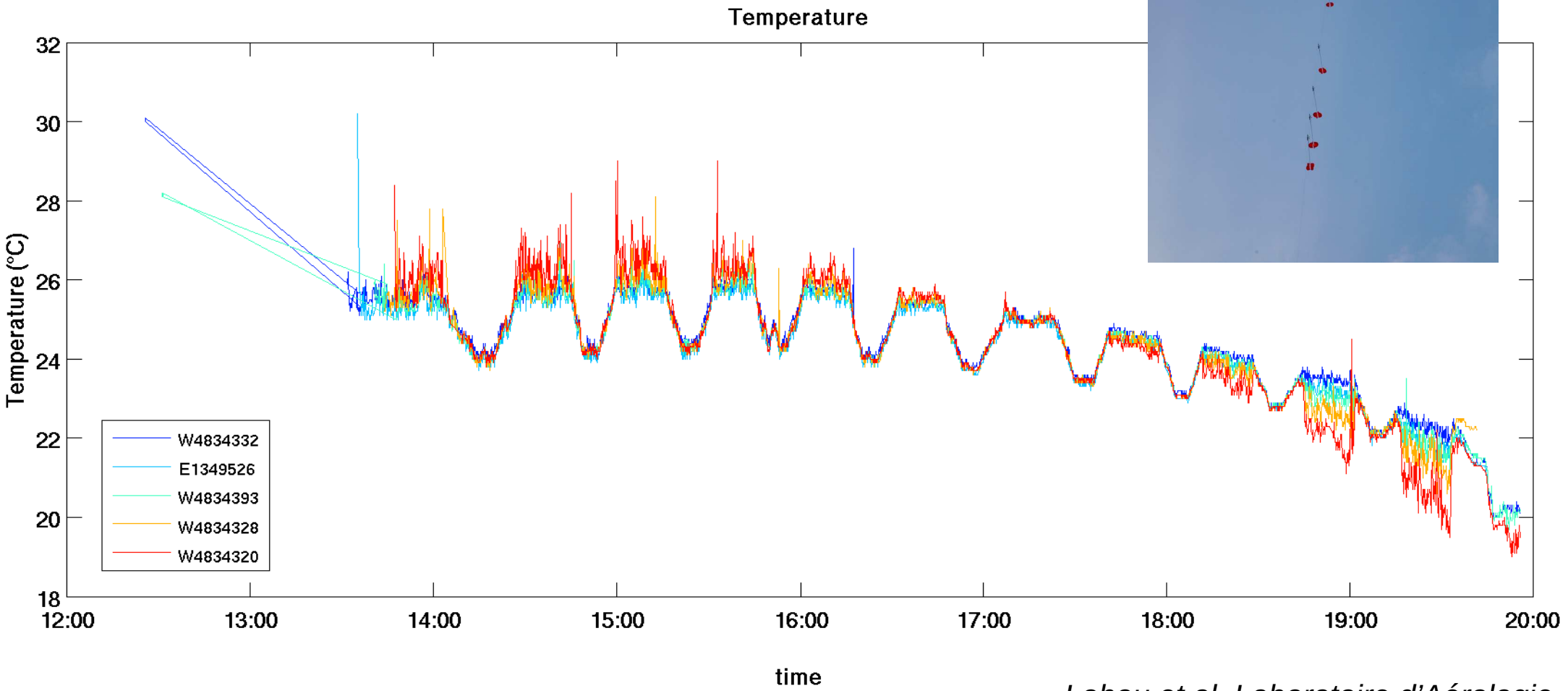
SUMO UAS



Reuder, Jonassen and Lindenberg, Univ. Bergen

Examples of observations:

The transition as seen by the tethered balloon measurements



Lohou et al, Laboratoire d'Aérologie
Pardyjak et al, Univ of Utah

Testing new instrumental devices

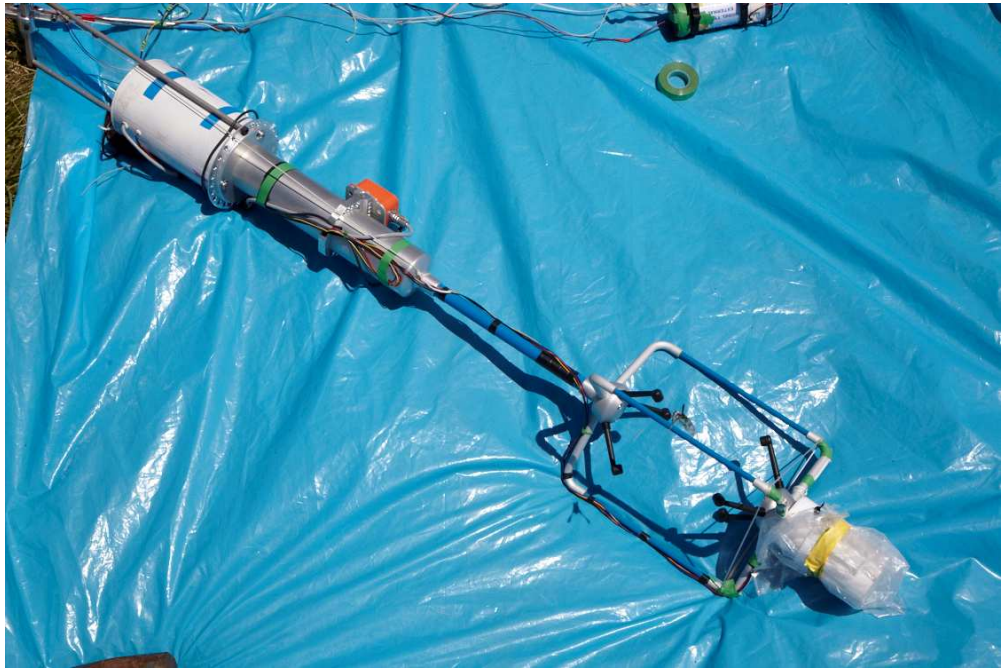
High Frequency Radiosounding system

- Frequent soundings of the low troposphere
- Allows the re-use of the probe
  Retrieval rate of 80%,
  65 soundings made with 20 probes

Legain et al, Météo-France

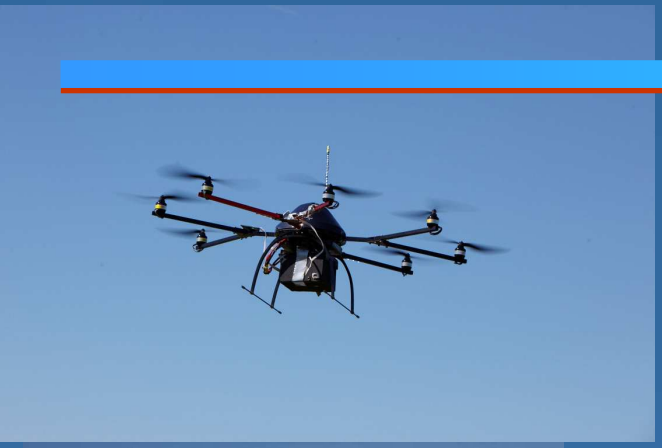
Tethered-ballon Turbulence probe

- Miniaturized INS for motion correction
- Airborne sonic
- Usual TTS for reference
  ~ 60 hours of observations



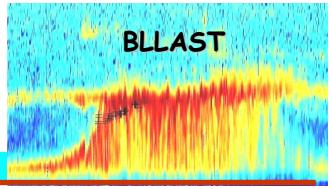
Legain et al, Météo-France

Multiple UAS experiment



- Validation of sensors, platforms, strategies
- Process study with combined manned and unmanned aircrafts

Reuder et al, COST action



Coming: Post-field workshop 6-7 February 2012
Summary of our observations
Organisation of our work

http://bllast.sedoo.fr

Thank you for your attention!