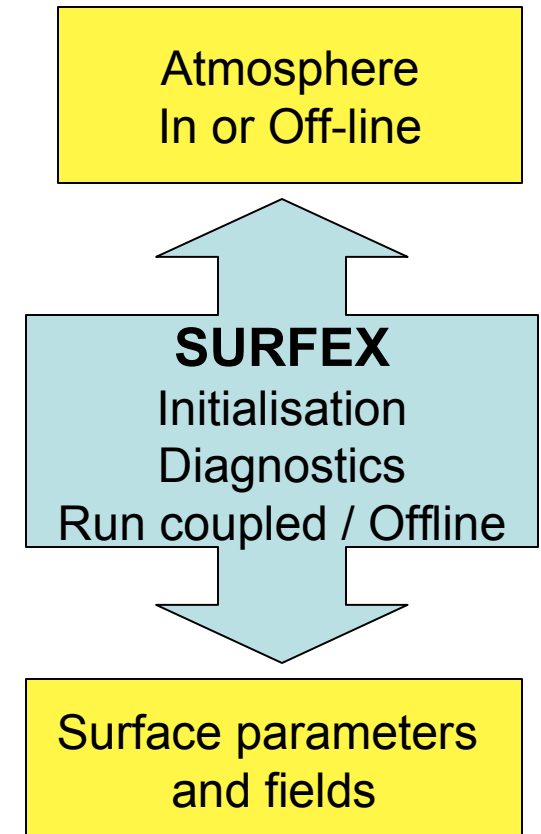# SURFEX : recent scientific developments and plans

Eric Martin, Patrick Le Moigne, Sophie Belamari, Andrey Bogatchev, François Bouyssel, Aurore Brut, Jean-Christophe Calvet, Sylvie Donier, Véronique Ducrocq, Stéphanie Faroux, Hervé Giordani, Gwenaëlle Hello, Luksa Kraljevic, Pierre Lacarrère, Cindy Lebeaupin Joachim Munoz Sabater, Joël Noilhan, A. Pirani, Jean-Louis Roujean, Claire Sarrat, Yann Seity…

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Summary

- The SURFEX presentations :
  - Scientific aspects (this presentation)
  - Coupling SURFEX and ALADIN (Luksa Krlajevic)
  - Technical aspects (Gwenaelle Hello)

- **Plan :**
  - The SURFEX parametrisations (short)
  - New parametrisations and research work on advanced parametrisations
    - Sea fluxes
    - A-gs (CO_2 fluxes and interactive LAI)
  - ECOCLIMAP
  - Assimilation / analysis (few words)
  - Plans for the future

Atmosphere
In or Off-line

SURFEX
Initialisation
Diagnostics
Run coupled / Offline

Surface parameters
and fields

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The Physical schemes

Sea and ocean :
prescribed SST, Charnock formula,
Mondon and Redelperger formulation
Multi campaign fluxes formulations
(thanks to CNRM/MEMO and MICADO teams)

NEW

Lakes :
prescribed temperature, Charnock formula

Vegetation and soil : ISBA
(Interface Soil Biosphere Atmosphere)

Town : TEB (Town Energy Balance)
Canyon approach,
detailed radiation scheme (trapping – shadow effect)
heat storage in buildings

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ISBA physical options

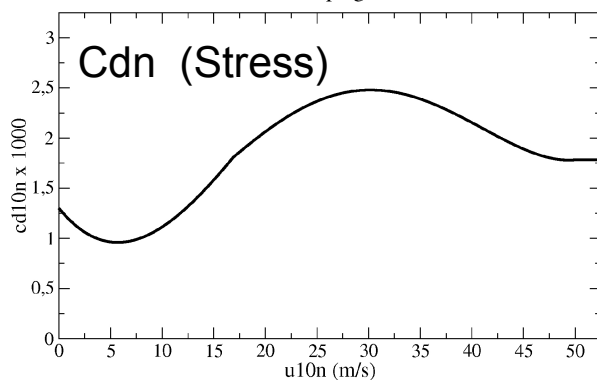| ISBA		
	Soil	Force restore, 2 layers , temp, water, ice Force restore, 3 layers , temp, water, ice Diffusion, N layers , temp, water, ice
	Vegetation	Noilhan and Planton 89 (~Jarvis) A-gs (photsynthesis and CO2 exchanges) A-gs and interactive vegetation
	Hydrology	no subgrid process subgrid runoff subgrid drainage
	Snow	1 layer, varying albedo, varying density (Douville 95) 3 layers, albedo, density, liquid water in snow pack (Boone and Etchevers 2000) *operational ARPEGE/ALADIN scheme* *(thanks to Andrey !)* ⬅ **NEW**

Parametrisation of sea fluxes

- Provided by the MEMO team at CNRM

- Based on the TOGA-COARE code (Fairall et al., 1996).

- Calibrated using 5 recent experiments under various conditions POMME, FETCH, SEMAPHORE, CATCH, EQUALANT99

- Iterative determination of exchange coefficients (including also gustiness, precipitation correction)
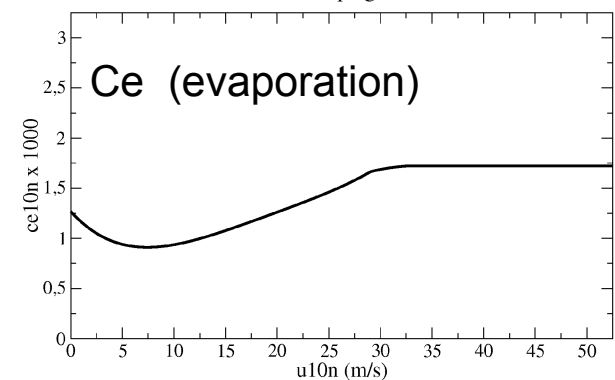
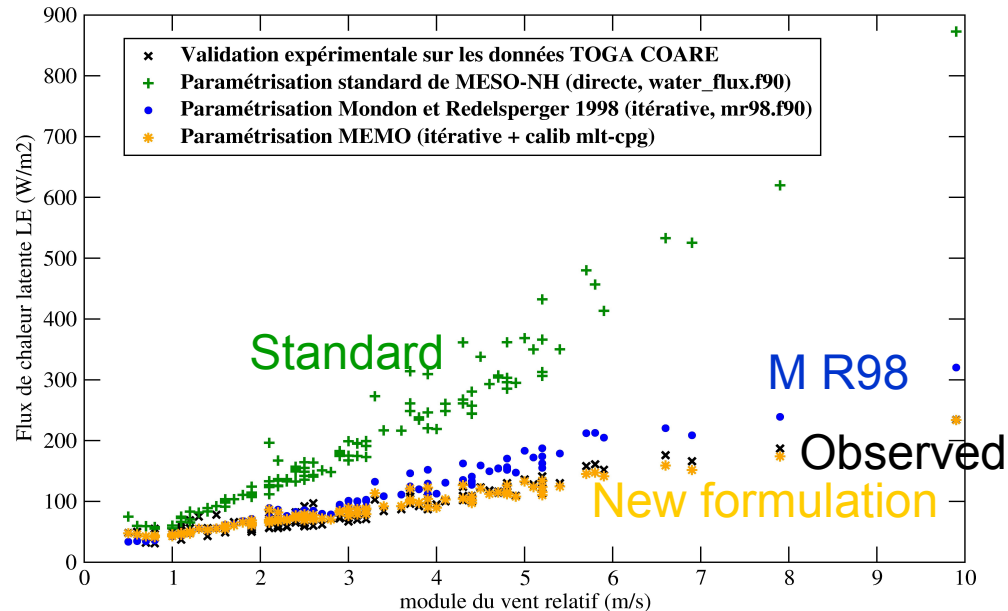cd10n multi-campaigns calibration   ch10n multi-campaigns calibration   ce10n multi-campaigns calibration
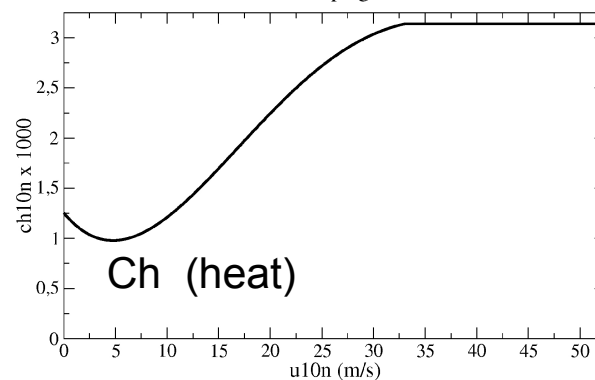
Cdn (Stress)   Ch (heat)   Ce (evaporation)

Exchange coefficients as a function of wind speed
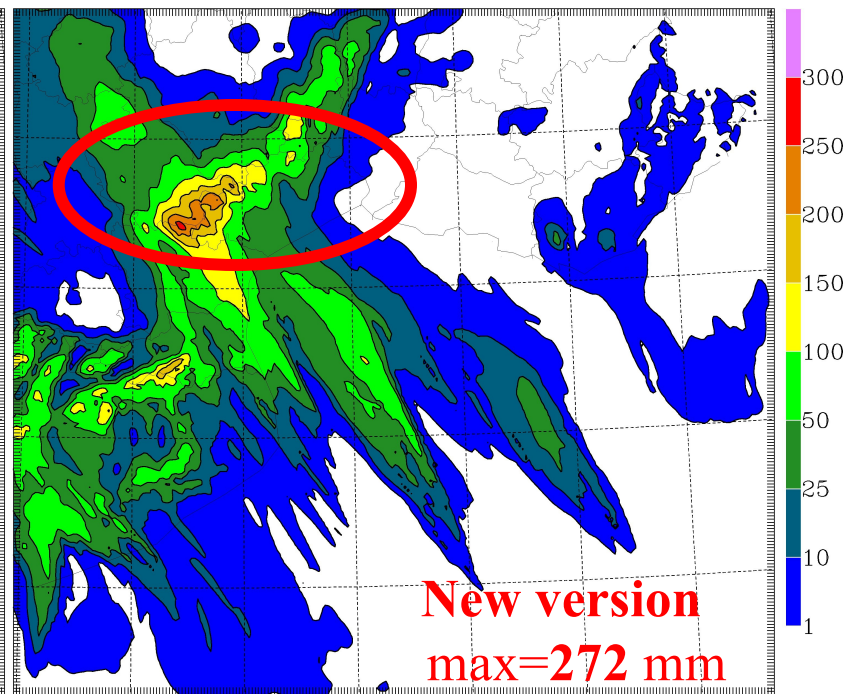
Impact of the new parametrisation

Latent heat flux
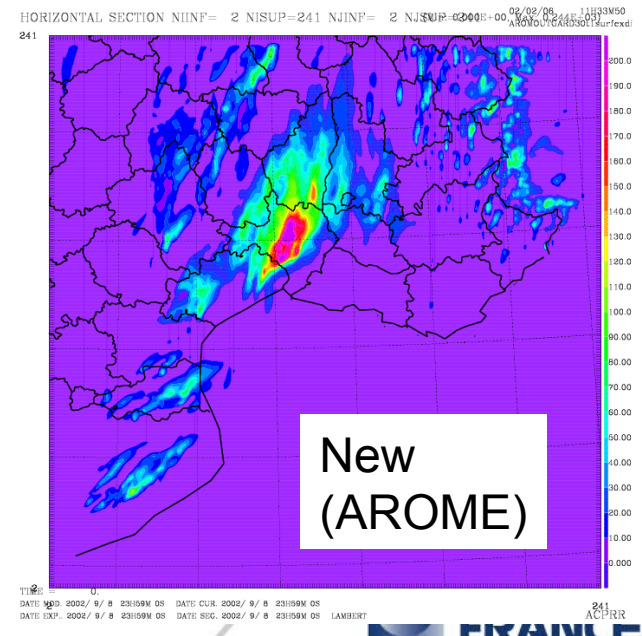
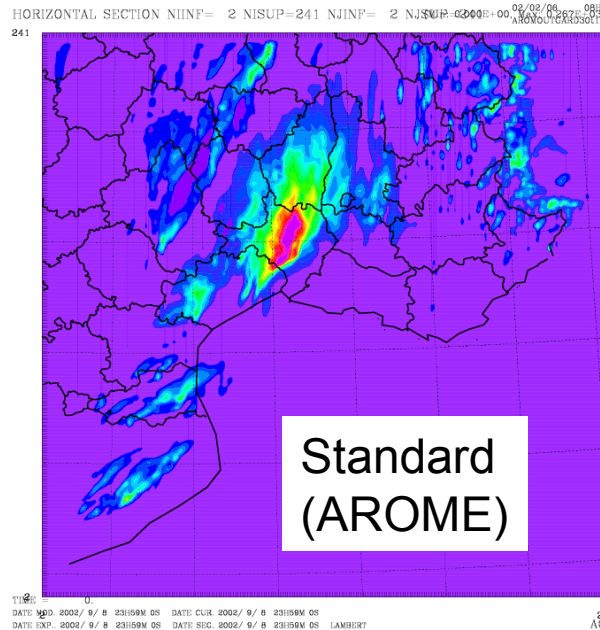Flux de chaleur latente au dessus de la mer
données TOGA COARE

- **×** Validation expérimentale sur les données TOGA COARE
- **+** Paramétrisation standard de MESO-NH (directe, water_flux.f90)
- **•** Paramétrisation Mondon et Redelsperger 1998 (itérative, mr98.f90)
- **✳** Paramétrisation MEMO (itérative + calib mlt-cpg)

Flux de chaleur latente LE (W/m2)

module du vent relatif (m/s)

Standard · M R98 · Observed · New formulation

**Latent heat flux :
comparison with TOGA-COARE**

- Improvement of the standard parametrisation

- Tests on some recent extreme events Méso-NH and AROME
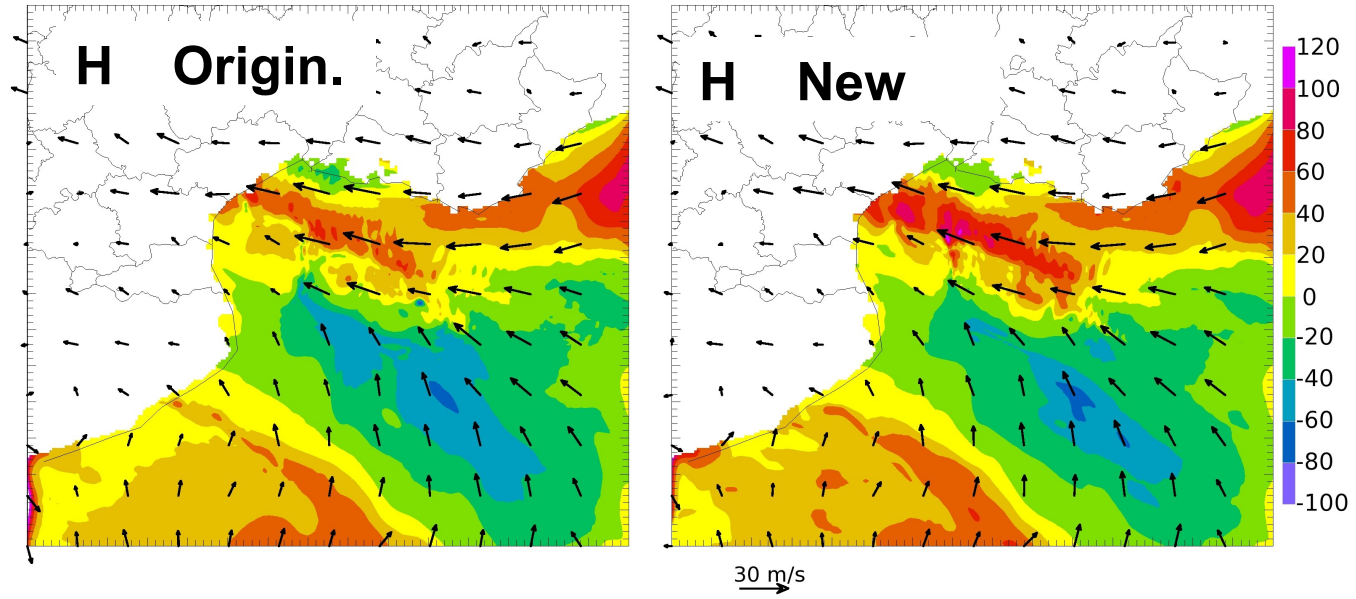 - Aude (1999)
  - Gard (2002)
  - Gard (2005)

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Standard
max=**296** mm

New version
max=**272** mm
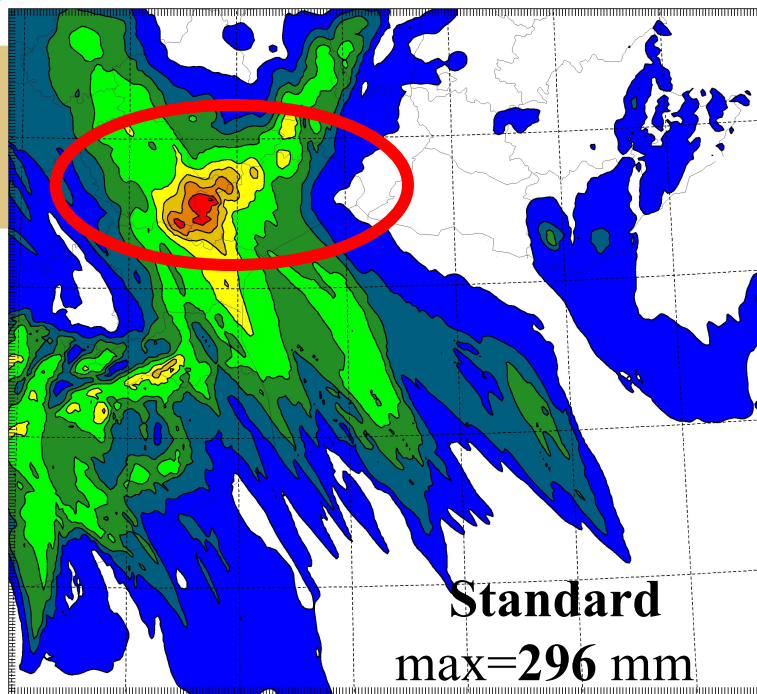
- Aude 1999
  (Méso-NH)
  Large changes

- Gard 2005
  (AROME and
  Méso-NH)
  small changes
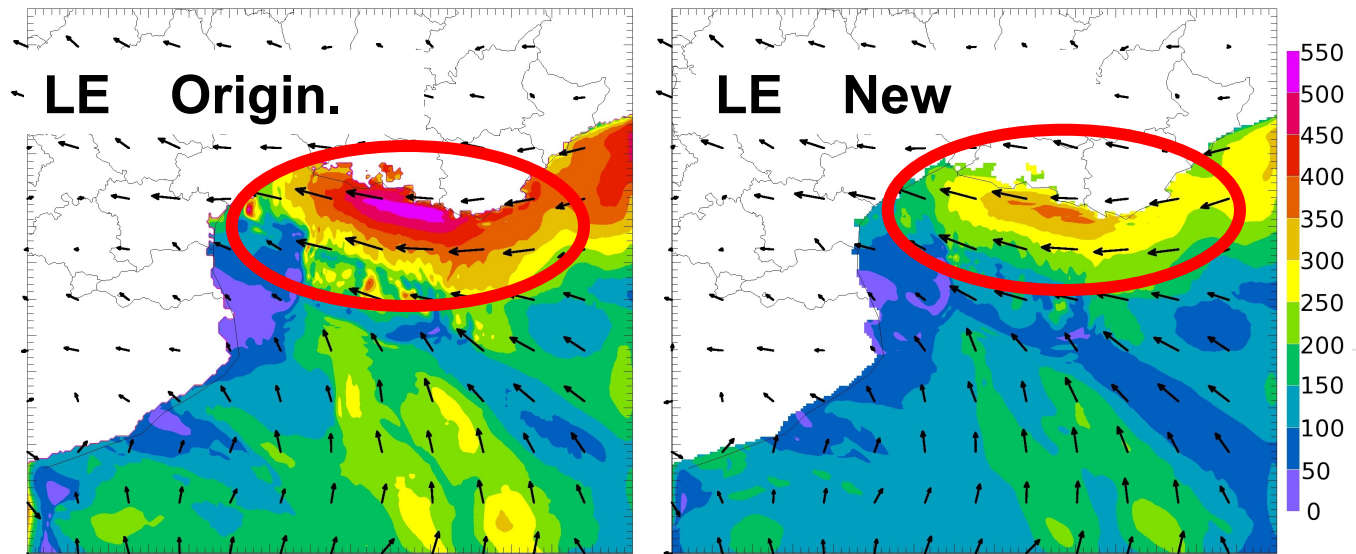
Standard
(AROME)

New
(AROME)
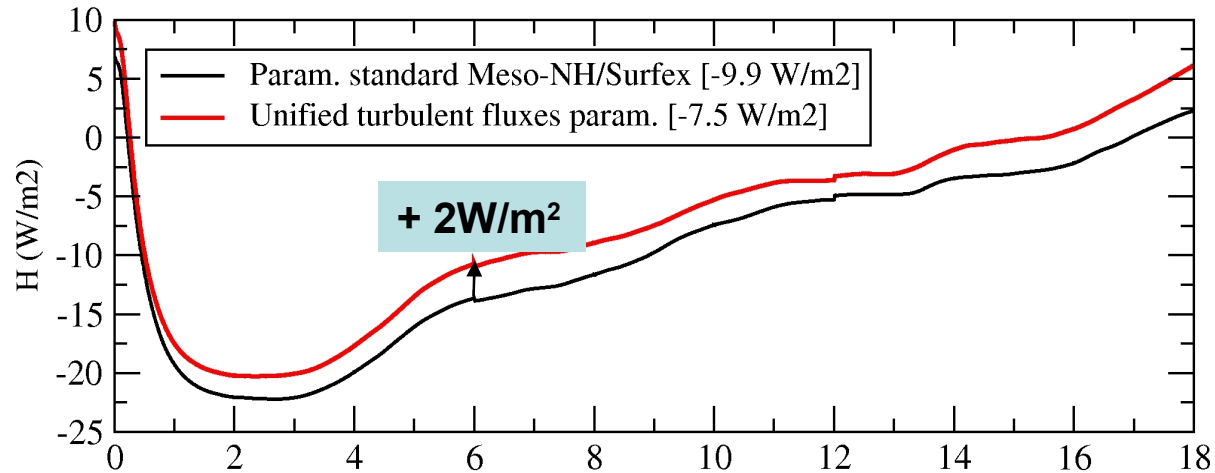
Aude 1999 : Sensible and latent heat fluxes

- Sensible
  (few changes)

- Latent
  (high impact)

Aude 1999 : gobal impact on surface fluxes

AUDE CASE

Sensible heat flux over sea surface

Param. standard Meso-NH/Surfex [-9.9 W/m2]
Unified turbulent fluxes param. [-7.5 W/m2]

+ 2W/m²

Latent heat flux over sea surface

Param. standard Meso-NH/Surfex [207.9 W/m2]
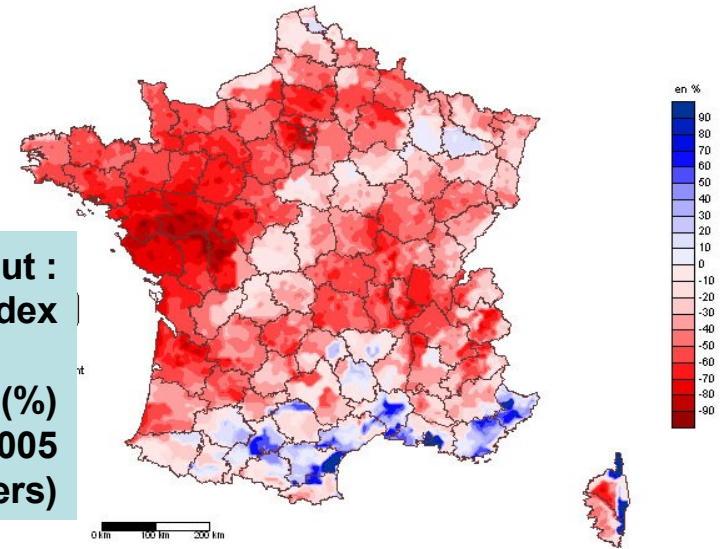Unified turbulent fluxes param.[145.7 W/m2]

- 60 W/m²

hours of simulation
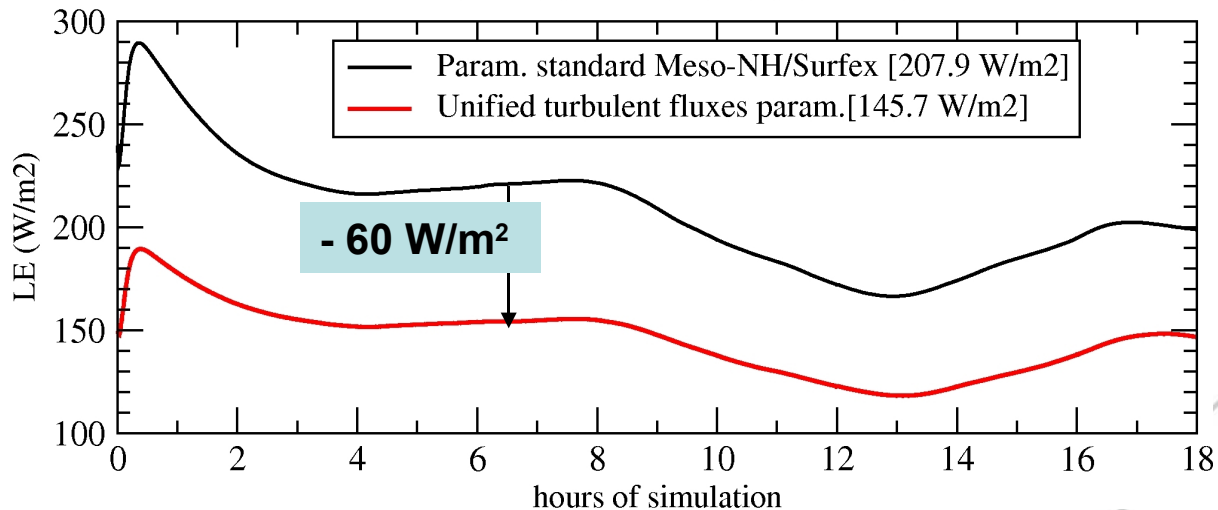
Research on Carbon fluxes, LAI, Biomass and soil wetness

- An already operational chain for soil wetness monitoring and hydrological applications (Safran-Isba-Modcou)

SIM output :
Soil wetness index

Deviation from mean (%)
1 October 2005
ISBA standard (3 layers)

- ***Objectives :***
Test the A-gs and interactive LAI options of SURFEX in order to improve surface fluxes for monitoring and hydrological applications. Propose a model for the simulation of ***regional carbon fluxes***.

- Assimilation of LAI and soil wetness at local scale
- 2xD offline runs, compare LAI simulated and observed
- Regional campaign : run coupled with the atmosphere
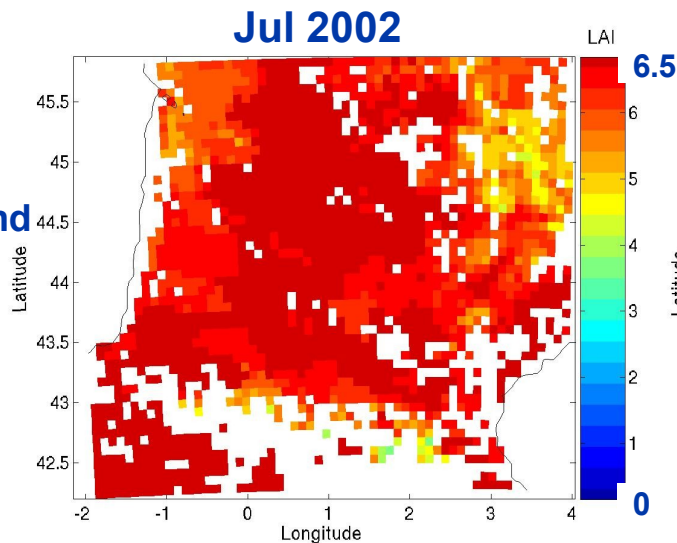
Local results, SMOSREX site

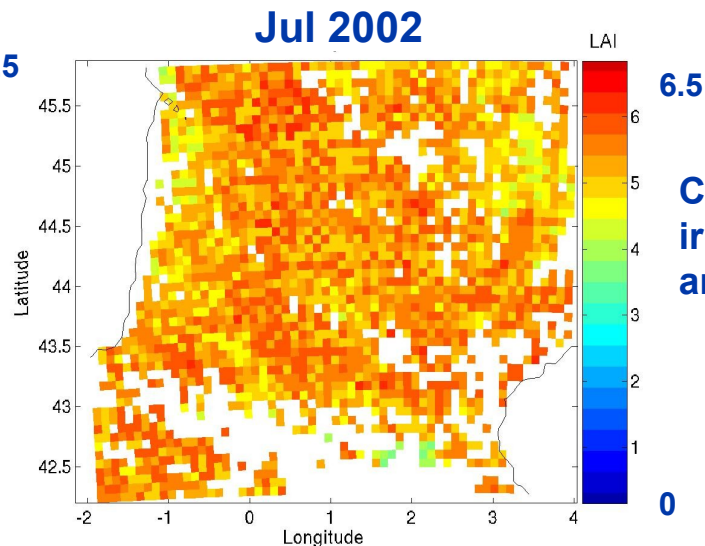- Test of various assimilation techniques, coupling Biomass and soil wetness.
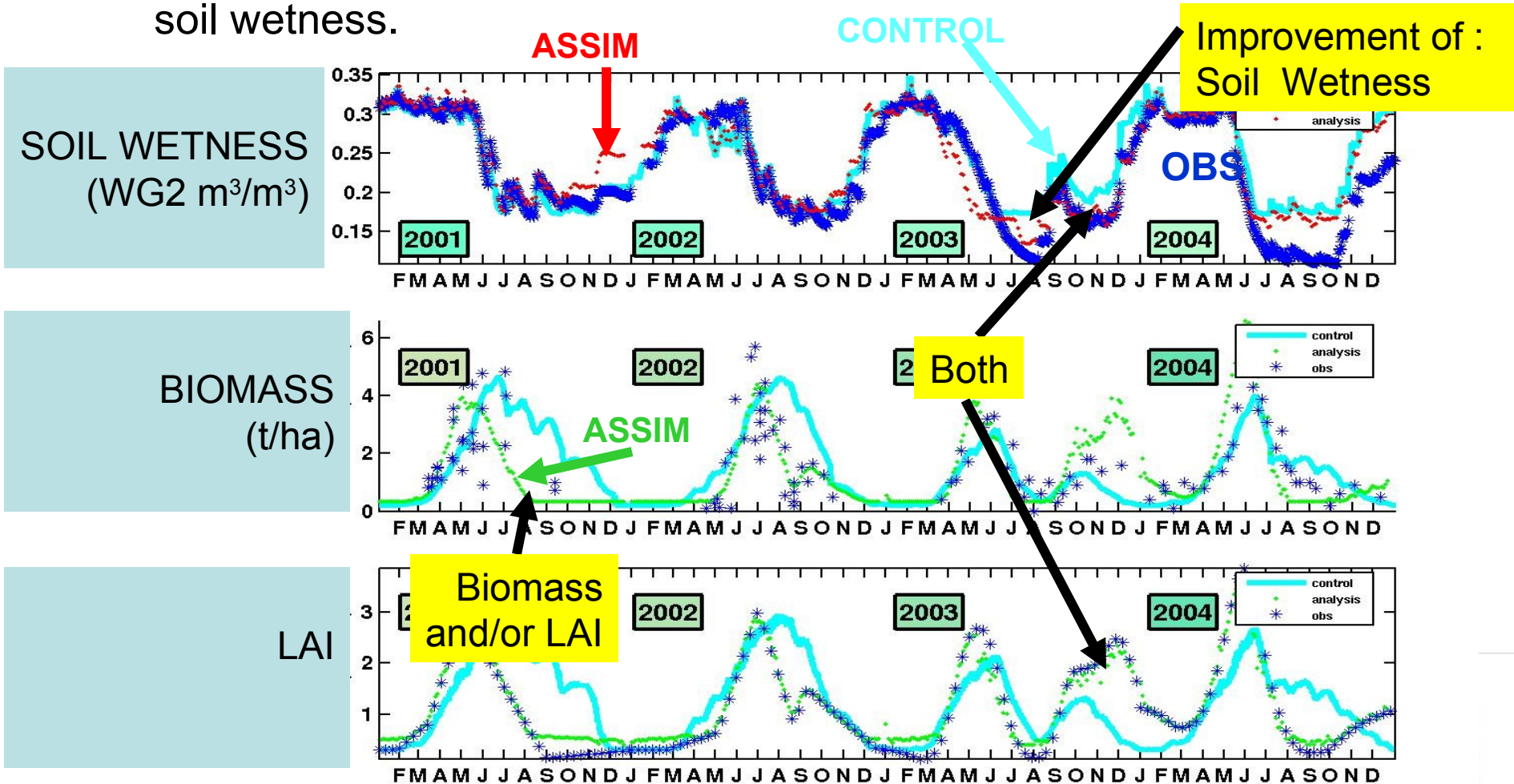
Regional results
(Force mode only)

- **Needed :**
  - inclusion of realistic sowing date
  - Irrigation parametrisation

Impact of irrigation and sowing :
high impact on LAI

Comparison of LAI with satellite data (may 2001)

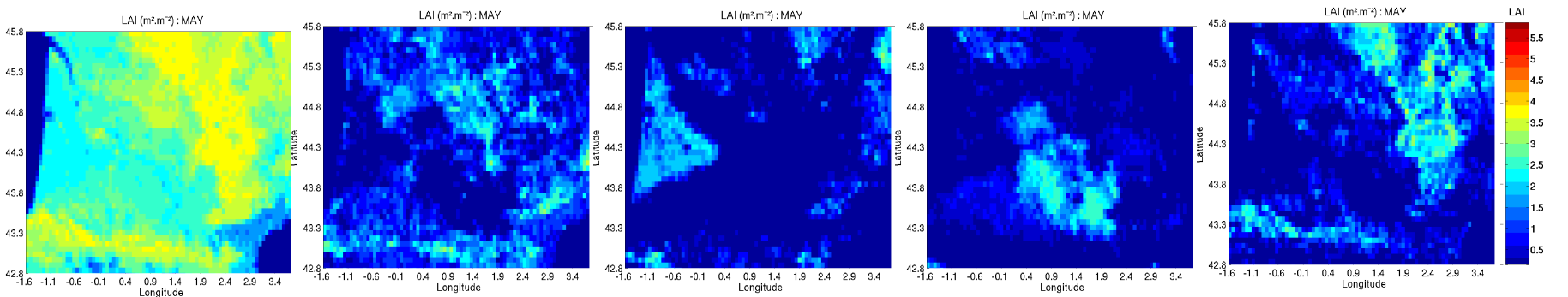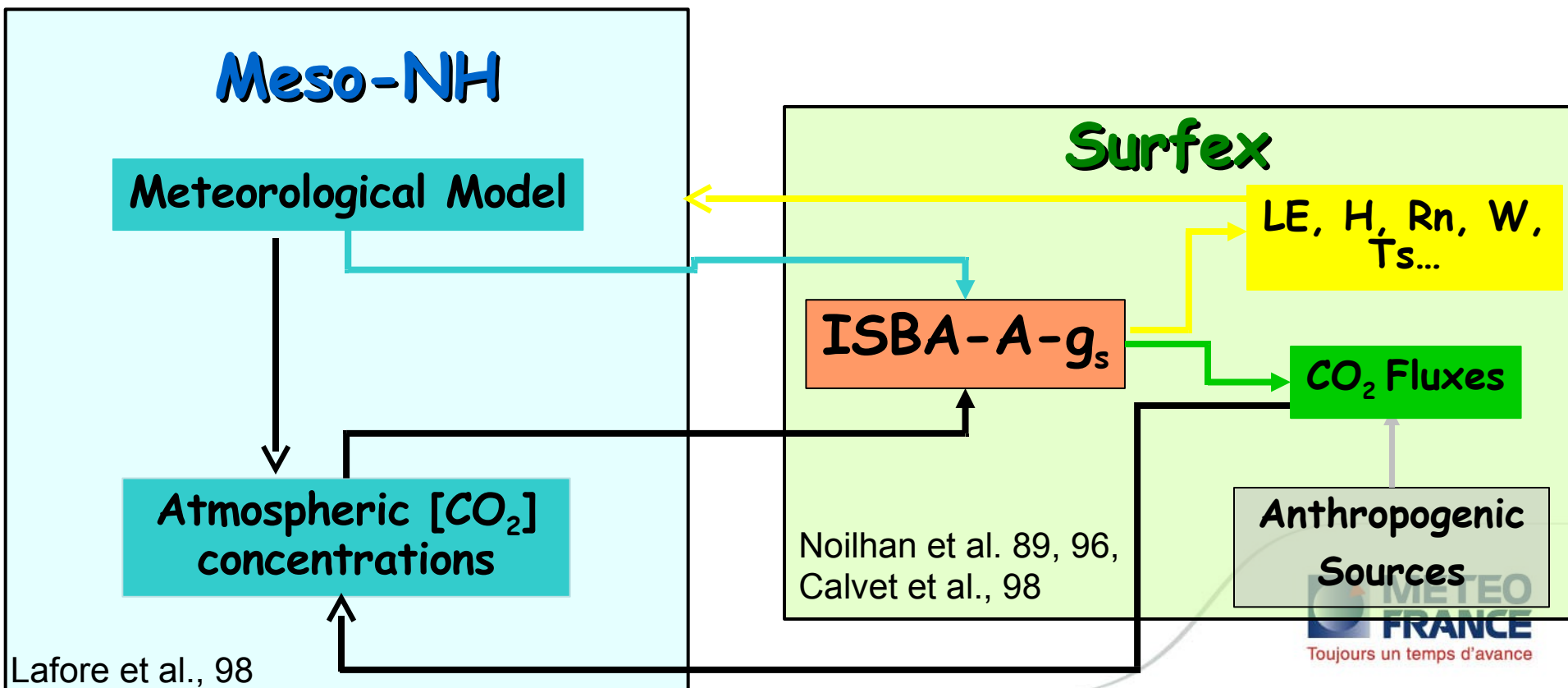| TOTAL	Deciduous	Coniferous	C3 crops	Grassland
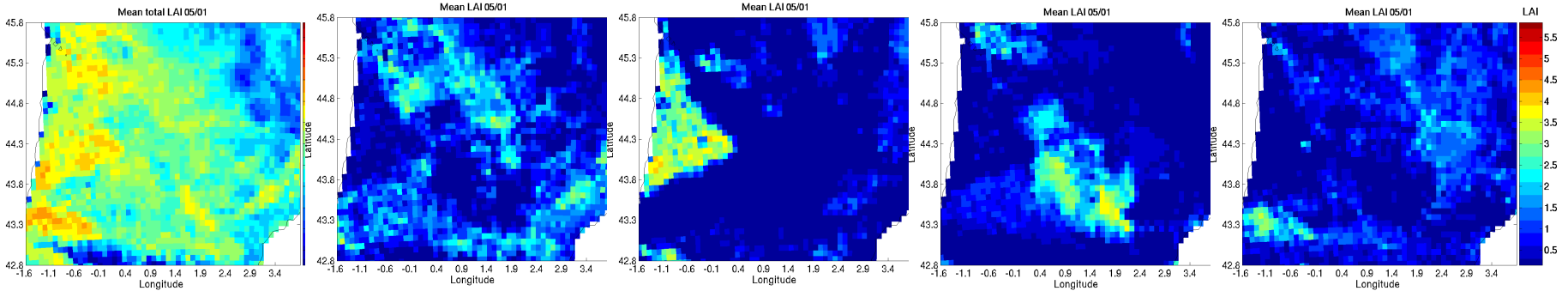
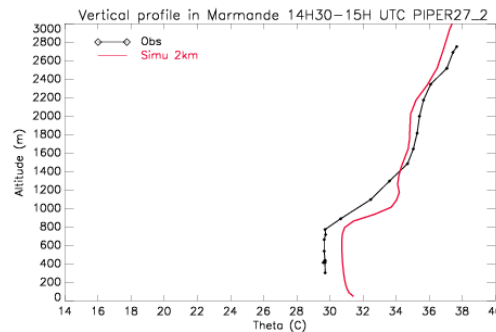**SURFEX - ISBA-A-gs**

MODIS satellite– CNRM method (J.-L. Roujean)

> Recalibration of ISBA-A-gs for coniferous and Grassland needed

METEO FRANCE
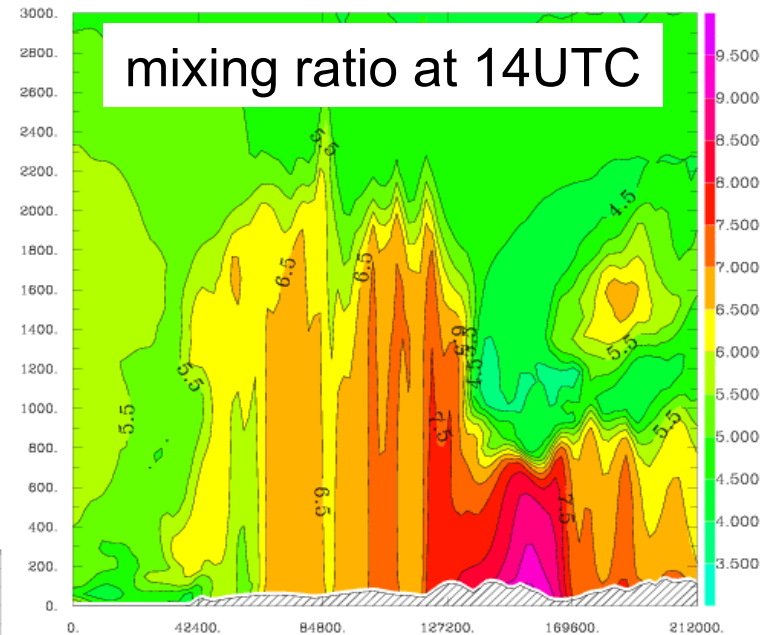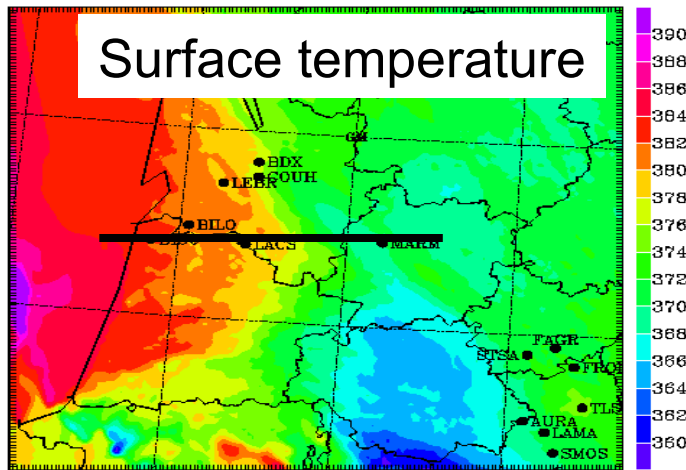Toujours un temps d'avance

CarboEurope : Atmospheric CO2 modelling using the Meso-NH model

- **CarboEurope** : physical basis for monitoring of Carbon fluxes
- Online coupling with the surface scheme ISBA-A-gs :
- Validation of CO2 and other surface fluxes and the boundary layer

Meso-NH

Meteorological Model

Atmospheric [CO_2] concentrations

Surfex

ISBA-A-g$_s$

LE, H, Rn, W, Ts…

CO_2 Fluxes

Anthropogenic Sources

Noilhan et al. 89, 96, Calvet et al., 98

Lafore et al., 98

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CarboEurope :
May – 27 2005 Boundary layer heterogeneity

Surface temperature

mixing ratio at 14UTC
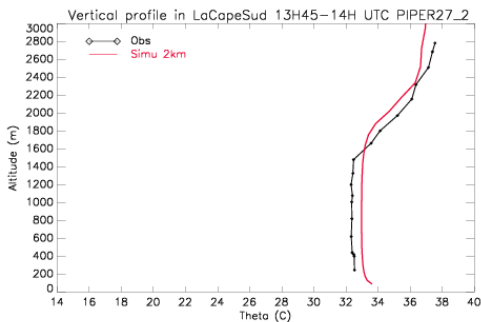
OCEAN   FOREST   AGRICUL.
        AREA   AREA

CarboEurope :
CO2 concentration in the boundary layer

Anthropogenic CO2 emissions 12H

- The CO2 concentration in the boundary layer depends on
  - The « meteorological » boundary layer (including advection)
  - The respiration and assimilation of plants
  - Anthropogenic sources
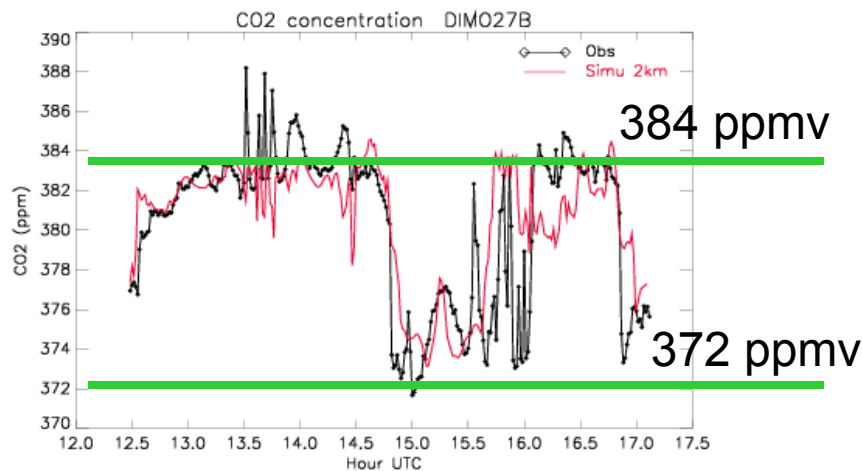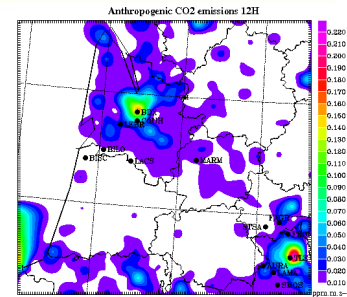
DIMONA 27B TRAJECTORY : MAY–27 12–17UTC
on simulated CO2 concentrations (ppm) at 14H

CO2 concentration DIMO27B

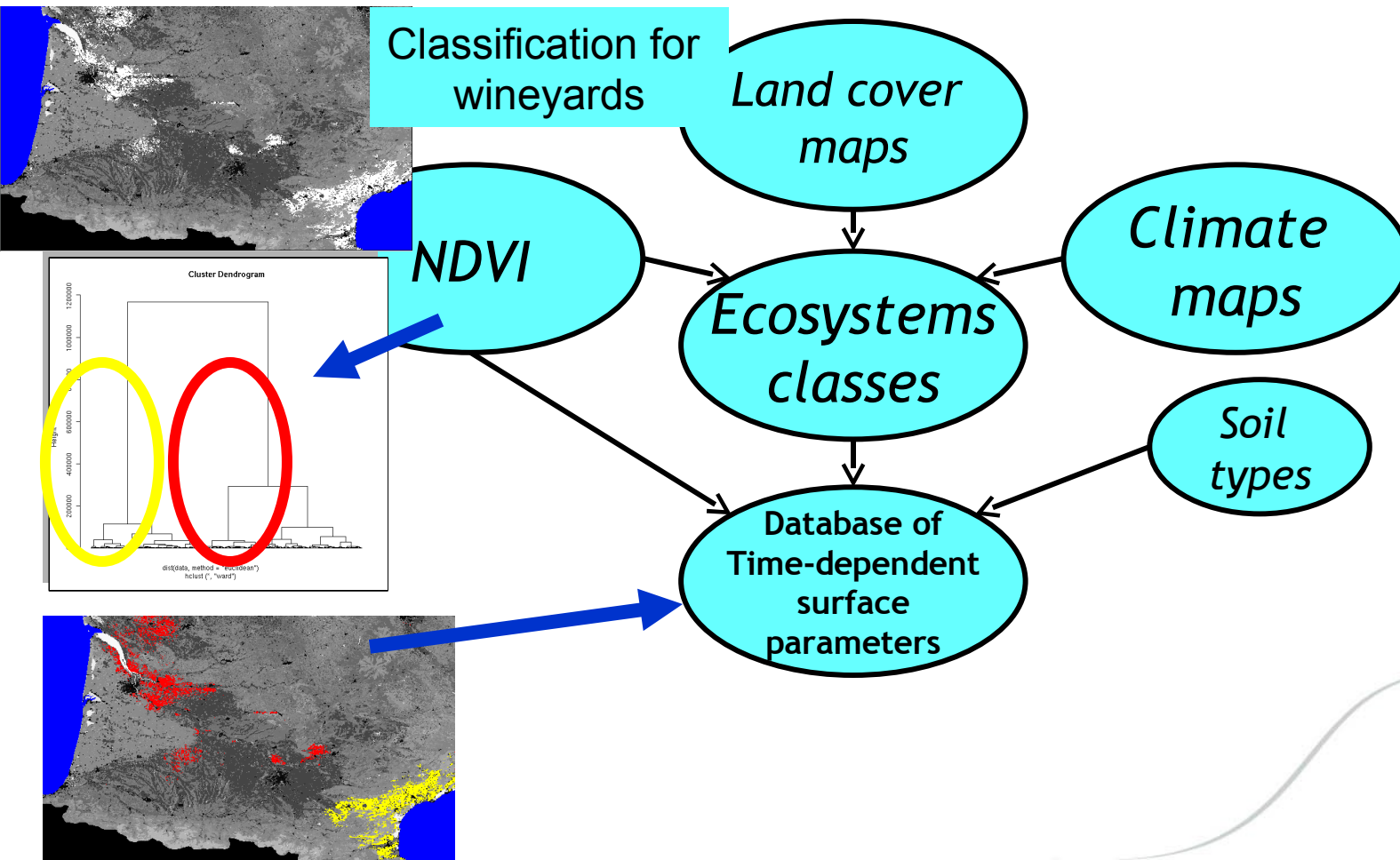384 ppmv

372 ppmv

CO2 concentration at 14H
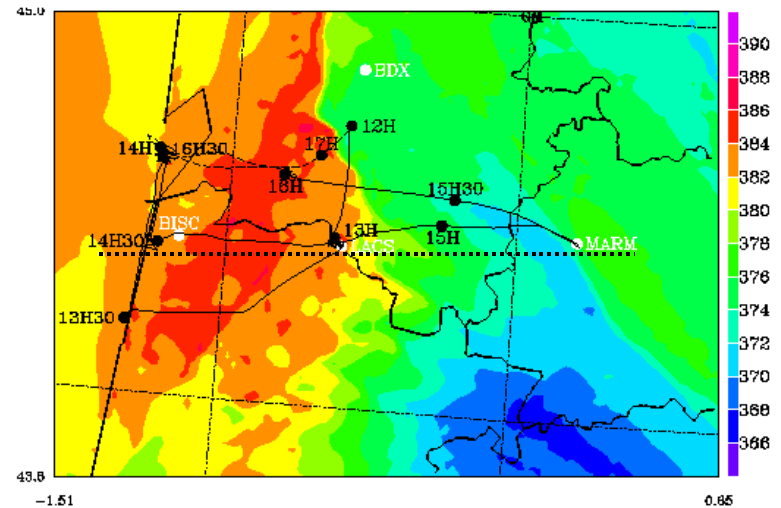
CO2 concentration along the plane trajectory

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ECOCLIMAP principles

- ECOCLIMAP is a database of ecosystems and time-dependent surface parameters for SVAT models

ECOCLIMAP : history

Version	Land cover maps	NDVI sources	Time step	Grid Resolution
V1	UMD (1km)	NOAA/ AVHRR	Monthly	1 km
V2	GCL2000 Corine 2000	SPOT/VGT	10 days	1km (global) 250 m (Europe)
V3 (Europe)	Corine2000 Next Corine?	SPOT/VGT 1999-2004	10 days	100 m (Europe)
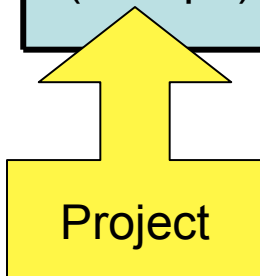
Project

V3 :
Improved cluster classifications
Import experience from **CarboEurope** project
for S-W France (e. g. crops)

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Future plans for ECOCLIMAP

1. Build a « extended France » database
2. Test in offline (Safran-Isba-Modcou) and in NWP context
3. Build the European database
4. Other continents *(Plan still open : alternate : go directly to Europe)*
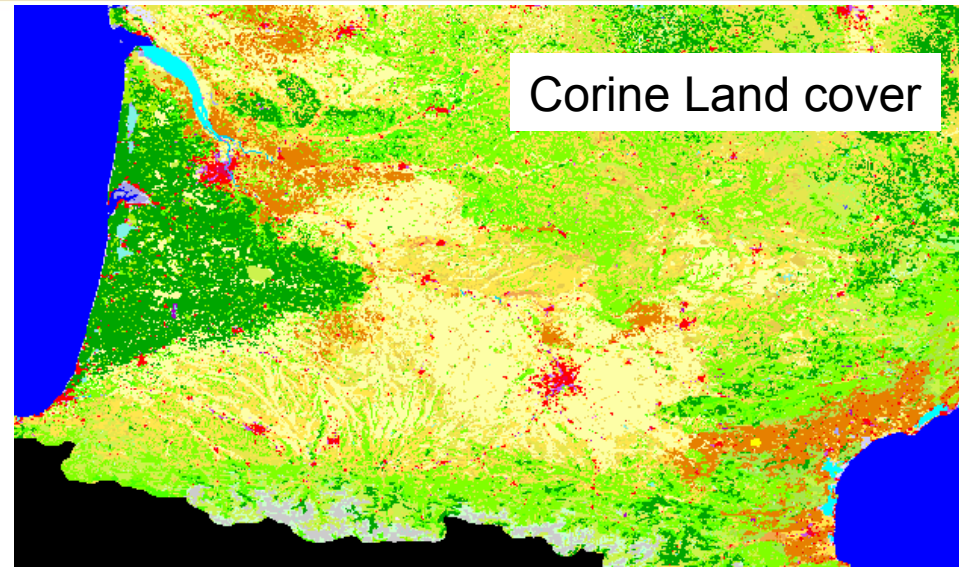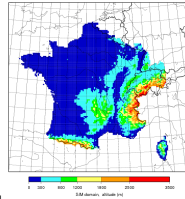
Work by Stéphanie Faroux

For Europe : help from teams specialized in surface parameters needed or national databases to ensure the best quality for surface parameters

Stephanie.Faroux@meteo.fr

Corine Land cover

ECOCLIMAP V3 « Carbo Europe » prototype
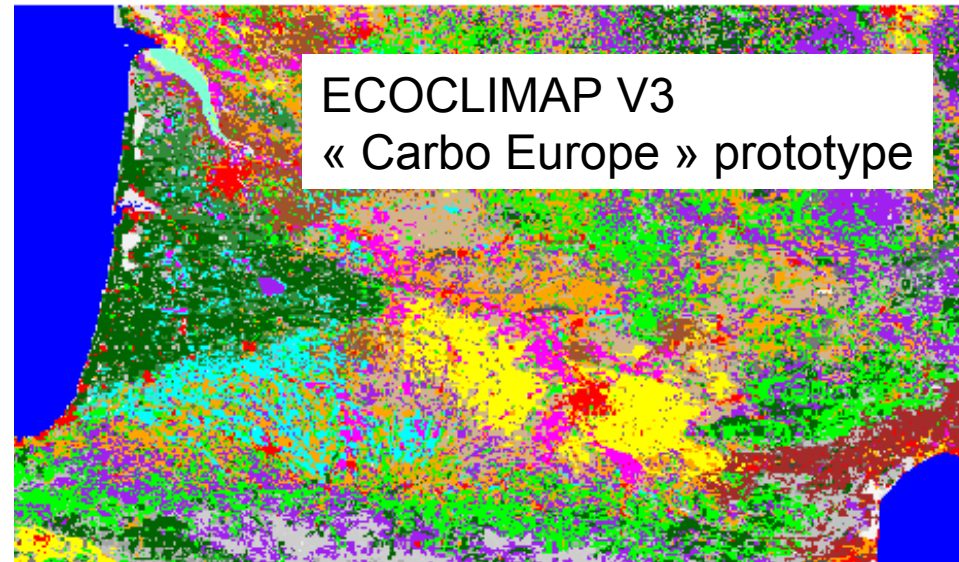
Assimilation /analyses

- **A still very open question !**

- **Some plans at Météo-France :**

- **Soil moisture analysis**
  - Transfer the existing ARPEGE soil moisture analysis to SURFEX/CANARI
  - relaxation to ARPEGE SWI
  - Test the introduction of a relaxation term to Offline simulations (SIM for France)

$$\Delta W = f(\alpha \Delta T2m + \beta \Delta HU2m) + g(\Delta\ SWI_{SIM}) + h(\Delta\ SWI_{ARPEGE})$$

- **Sea surface temperature**
  - Transfer the existing ARPEGE analysis
    - Ships+Buoys / SSMI (sea ice) / SST from NCEP(0.5x0.5)
  - Improve the analysis
    - New NCEP data (0.125x0.125)
    - Data from SAF-Ocean (AVHRR 2-3 km)
- **Snow ?** (previous works on ALADIN-F and ALADIN-BG)

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Conclusions

- **Recent improvements**
  - Sea fluxes
  - Operational ARPEGE/ALADIN snow
    to ensure compatibility of present surface parametrisation and SURFEX
- **ECOCLIMAP**
  - V3 : fine mesh surface database
  - Plans still in discussion, help needed to ensure good quality over Europe !
- **Assimilation /analysis**
  - Short term plans are beeing built by now
  - Long term plans via A-gs (LAI-CO2), research in Offline mode now
- **SURFEX plans**
  - On-going research on A-gs (>> Offline and assimilation)
  - Oceanic mixing layer (MEMO-MICADO)
  - Hydrology : redistribution of soil wetness within a catchment, improvement of ISBA drainage
  - TEB improvement (air profile within the canyon) – Rafiq Hamdi (BE)
  - Introduction of snow drift processes (with LGGE, Hubert Gallée)

➤ *Last 3 points to be discussed in the common HIRLAM-ALADIN surface plan*

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