SURFEX and EKF surface assimilation at Météo France

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on behalf of **Jean-François Mahfouf, Patrick Lemoigne,** and many other contributors.....

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Outlines of the presentation

1 - SURFEX at Météo-France

- Generalities
- Recent developments
- Plans for future

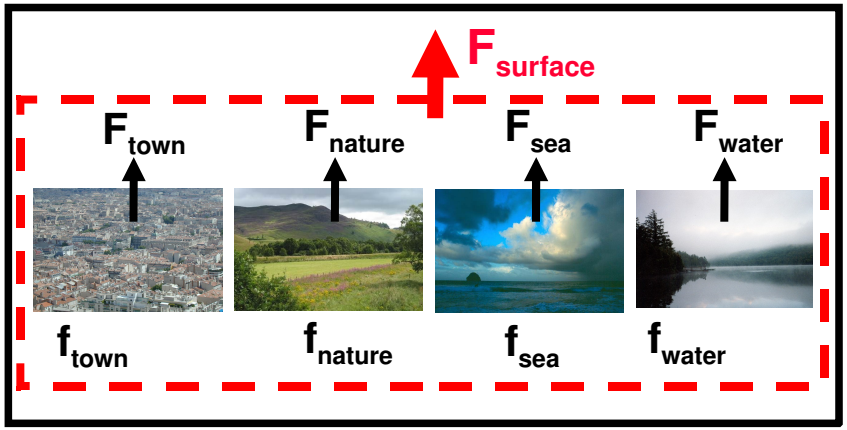
2 - SURFACE assimilation at Météo-France

- On going activities
- Assimilation of ASCAT soil mosture
- Planned developments

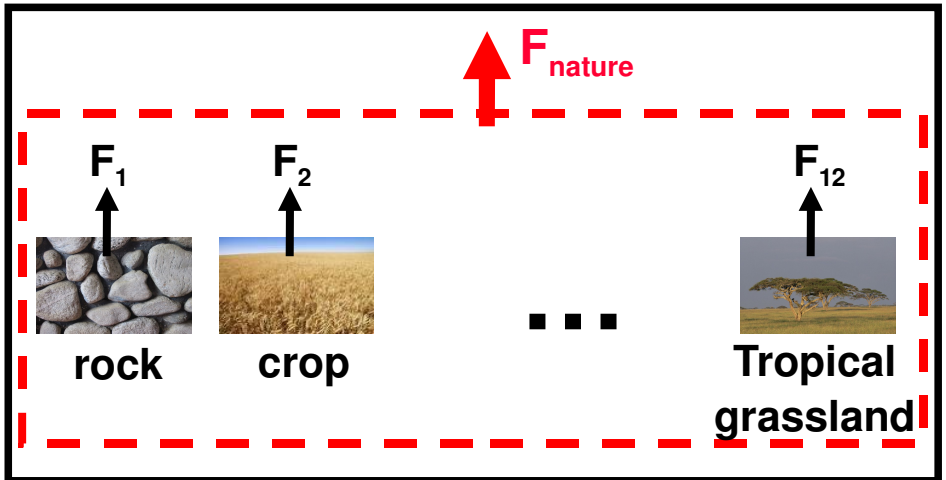
SURFEX generalities

The **SURF**ace **EX**ternalized module has to unify all the work done with surface.

Tiling : surfex is composed of 4 different tiles.



The nature tile can be divided into 12 different patches.



Nature tile and town tile are working with their own model.

Soil and Vegetation	**ISBA**: Interface Soil Biosphere Atmosphere (Noilhan-Planton 1989, Noilhan-Mahfouf 1996)
Sea / ocean	Prescribed temperature or lake model
Town	**TEB**: Town Energy Balance (Masson 2000)
Lake	Prescribed temperature or 1D mixed layer ocen

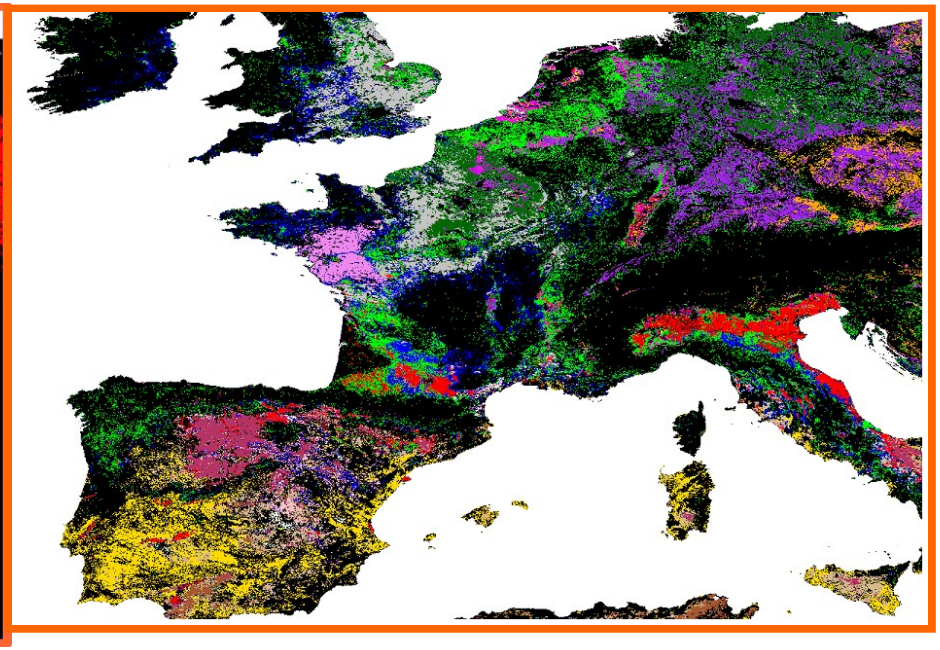
CLS fields can be treated with canopy model inside SURFEX.

Recent developments inside SURFEX

- Test over CarboEurope domain, CarboFrance project, SIM
- Canopy drag computation improvement
- Ecoclimap II improvement and validation
- Flake Lake model
- Evaluation of SURFEX over Antarctica (DomeC)
- SURFEX maintenance and user support
- Scientific documentation (on going work)

ECOCLIMAP II

forests

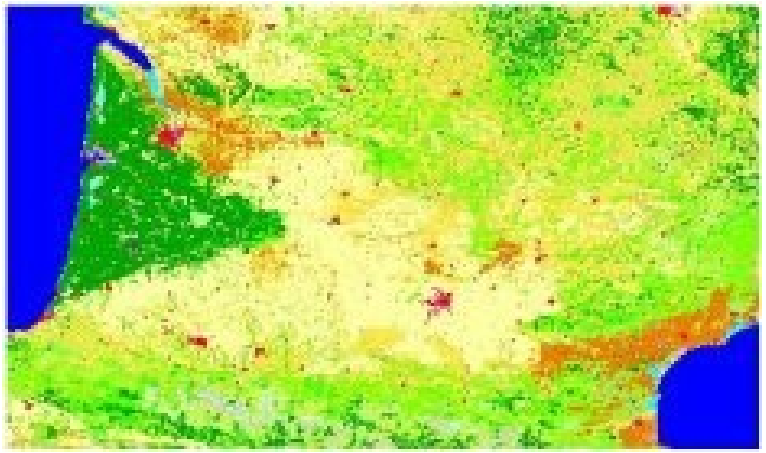


crops

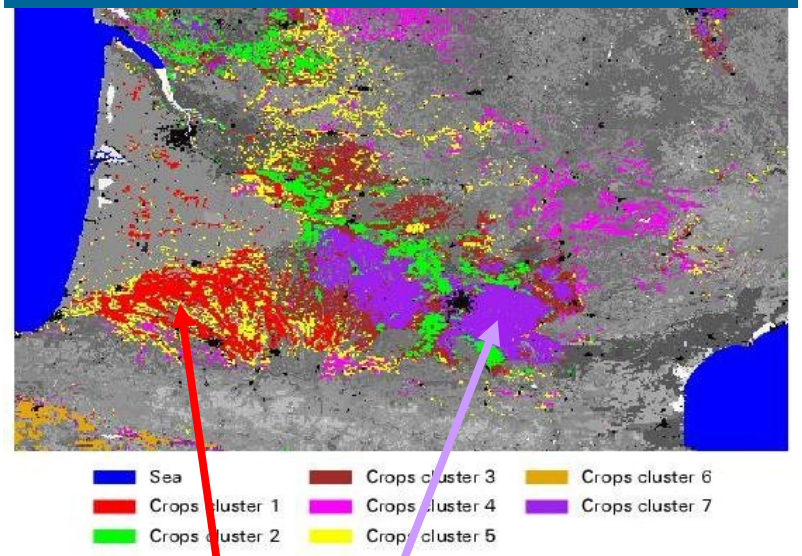
- Ecoclimap II recent improvements :
  - consolidation of database
  - evaluation with different simulations over France
  - development of an African version

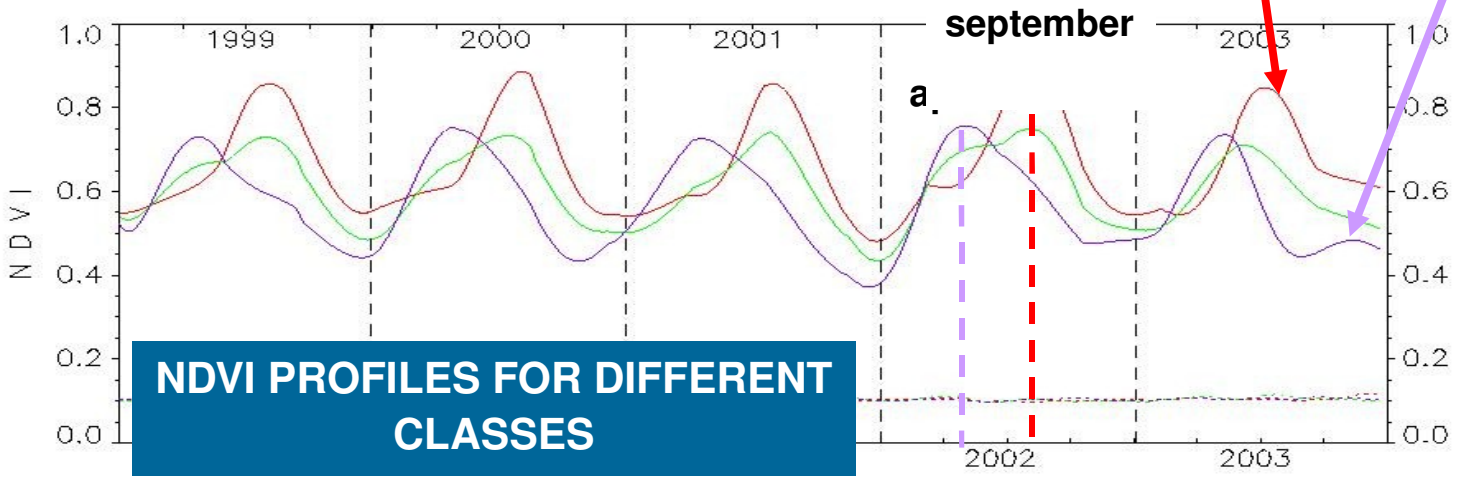
ECOCLIMAP II

Land cover of Corine 2000:
100 m resolution



7 classes for crops





NDVI PROFILES FOR DIFFERENT CLASSES

Summer crops (corn)

Winter crops (wheat)

mixed crops

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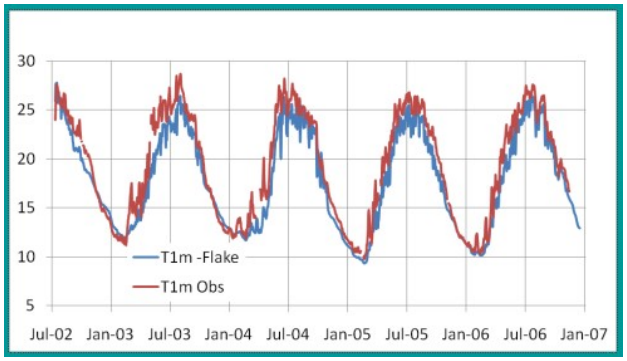
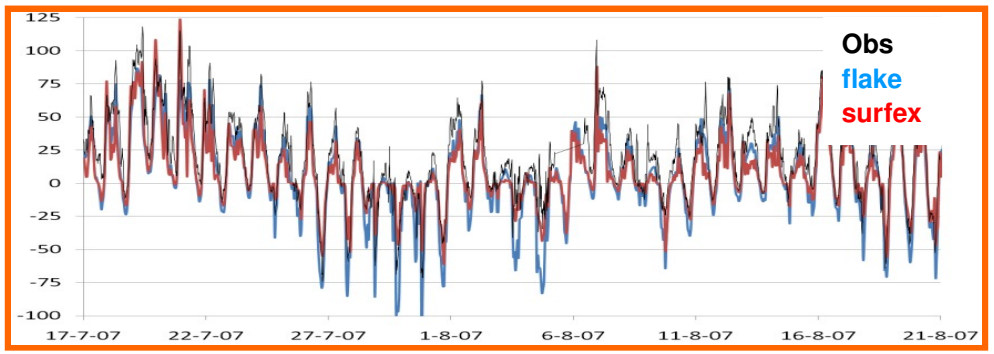
Evaluation of Lake model Flake

(From Rui Salgado)

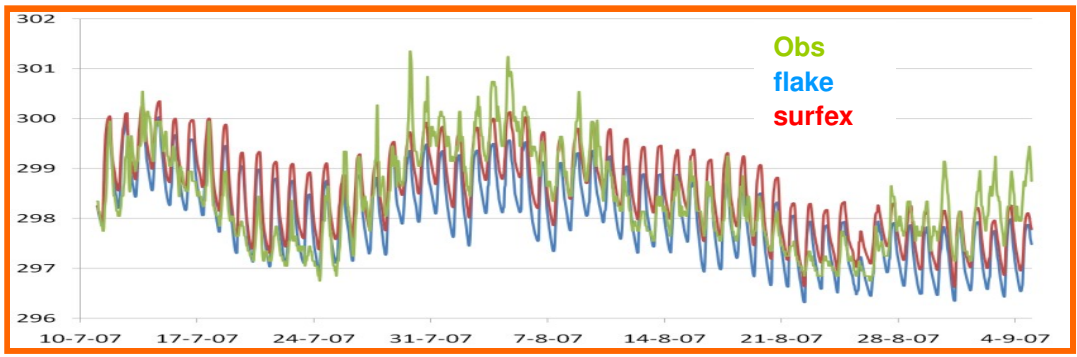
Measurements and validation of FLake over Alqueva lake



Integration of Flake within SURFEX



Sensible heat flux



Surface temperature

Evaluation of Flake last summer in a 3D run coupled with meso-NH -> not analyzed yet.

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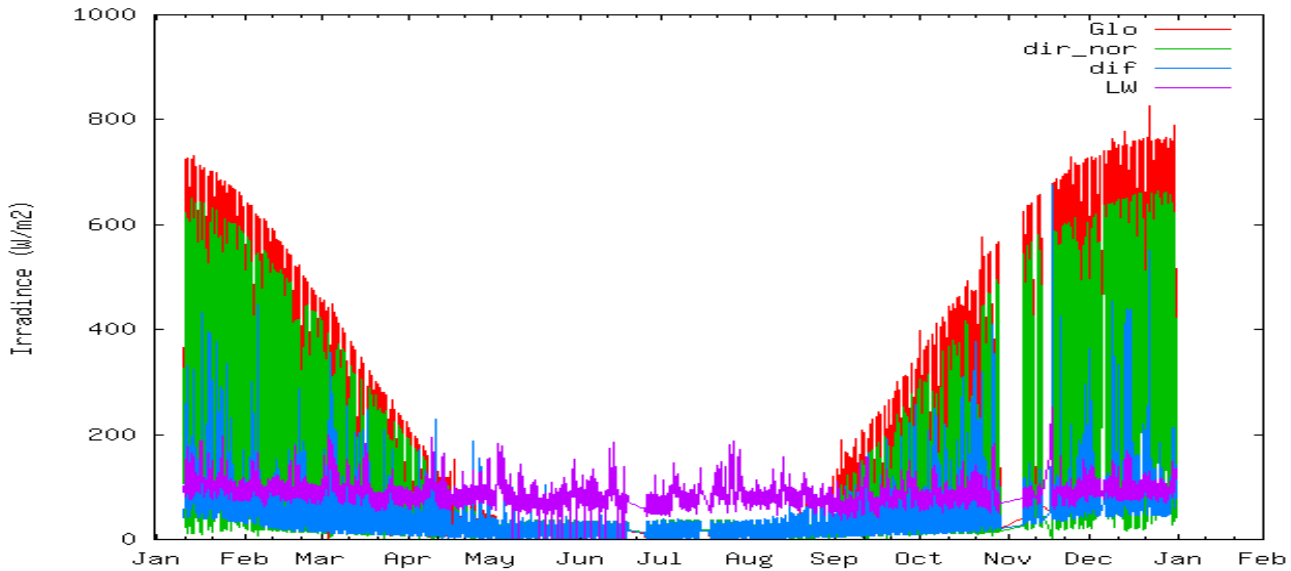
Modelling over Antarctica

- Collaboration with Astrophysics Laboratory of Arcetri in Florence:E. Masciadri et F. Lascaux. Improved optical turbulence.
- Objectives:
  - At the start, user support on meso-NH regarding surface aspects
  - Improvements of the current system to better simulate Ts
  - Characterize the PBL in Antarctica et simulate improved surface fluxes

Downward radiation fluxes

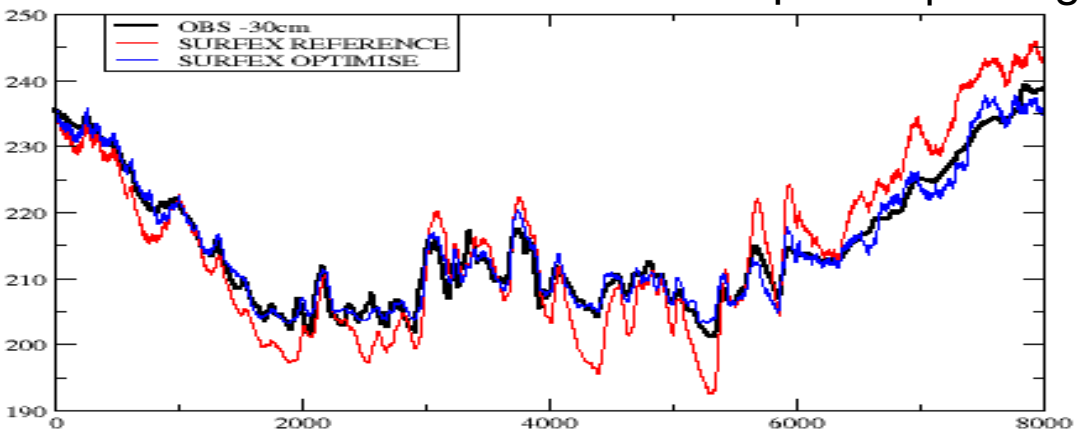


Modelling over Antarctica

- Method:
  - Simplified description of the surface at DomeC: isba-2L over frozen soil
    - No water exchanges
    - Modified thermal conductivity – low density ice
    - Include a restore term towards a climatological Tc in the deep soil temperature equation T_2

$$\frac{\partial T_2}{\partial t} = \frac{1}{\tau}(T_s - T_2) + \frac{1}{\gamma\tau}(T_c - T_2)$$

  - Calibration of Tc and of the time constant γ for improving T_2:



T2 isba compared to obs at 30cm

Dome C

- Recent development : analysis of measured data of 2005-2006 at Dome C, offline simulations realized

SURFEX scheme inside ALADIN LAM-model

Evaluation of SURFEX in forecast experiments with new options in ALADIN (same as the ones used in AROME except TEB and CANOPY for the time being):

- ECOCLIMAP II

- ISBA-3L

- Snow scheme (Douville, 1995)

- Frozen soil scheme (Boone et al, 2000)

Encouraging results, but two problems :

- T2m overestimation at 12 UTC points the need of a surface analysis

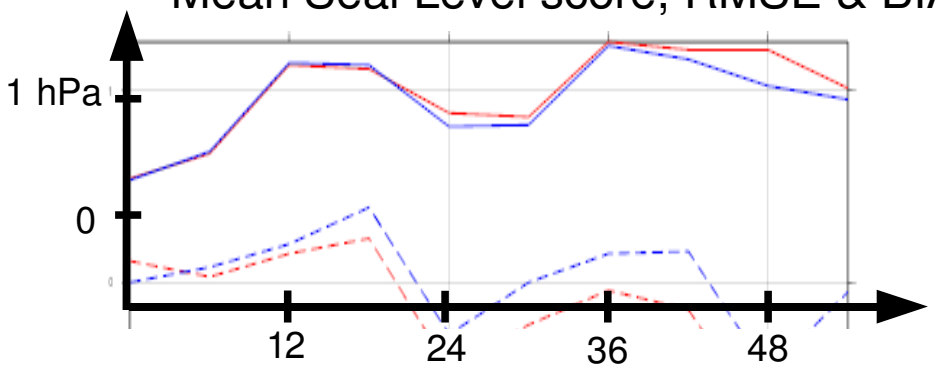
- problem with frozen soil parameterization in winter (perhaps also a problem of initialization or the need of tunings in Boone et al. parameterization)

SURFEX scheme inside ALADIN LAM-model

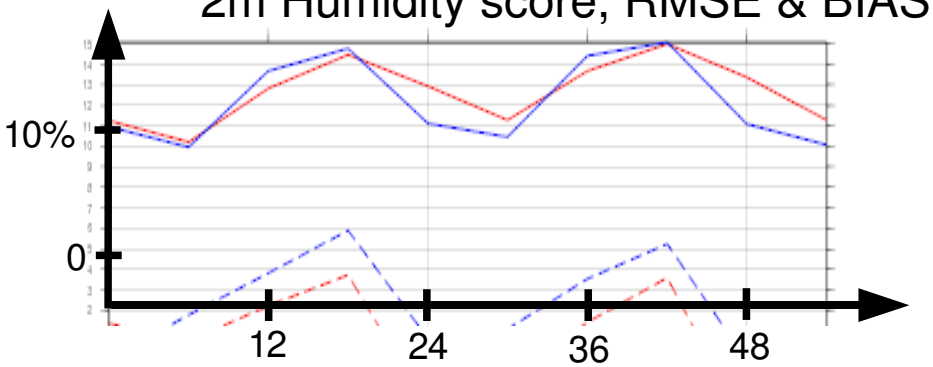
ALADIN-SURFEX

ALADIN-ISBA

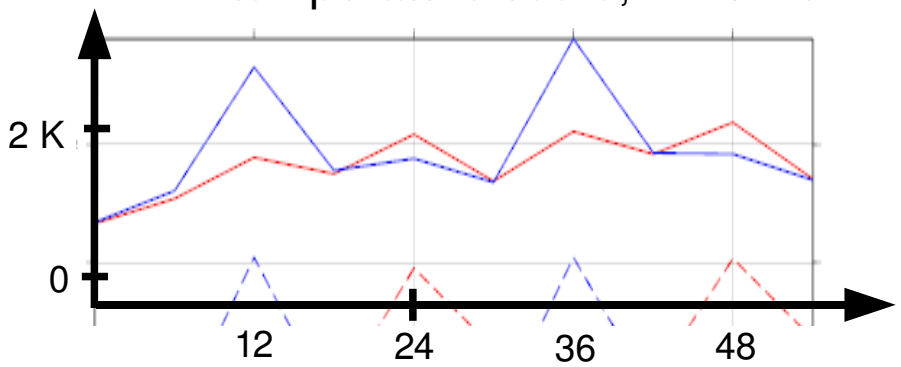
Mean Seal Level score, RMSE & BIAS



2m Humidity score, RMSE & BIAS



2m temperature score, RMSE & BIAS



A general improvement is observed for screen level parameters (mainly due to new ecoclimap database)

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SURFEX future plans 2010

- Snow scheme Isba-ES : adduction of some new functionalities from Crocus snow scheme.
- Implementation of Ecoclimap II over Africa
- Lake model :
  - work with the Thau lake
  - New 3D lake simulations
- improve the representation of lake inside ECOCLIMAP, define a global map and lake depth (one year scientific visit of E. Kourzeneva at Météo-France from October 2009)
- Add a vegetation part inside TEB town model (because isba is treating urban vegetation)
- Surfex parallelization problems; collaboration with GMAP and CERFACS
- Double surface energy balance (snow/forest infteraction), collaboration with HIRLAM/CESBIO, could start at the end of 2009
- Use of LandSAF surface albedo and snow cover in ALADIN : three month scientific visit of J. Cedilnik (LACE) in 2010
- Discussions on a strategy for the implementation of a sea-ice model in SURFEX (HIRLAM/ALADIN) – implication of the Météo-France climate modelling group (GMGEC)

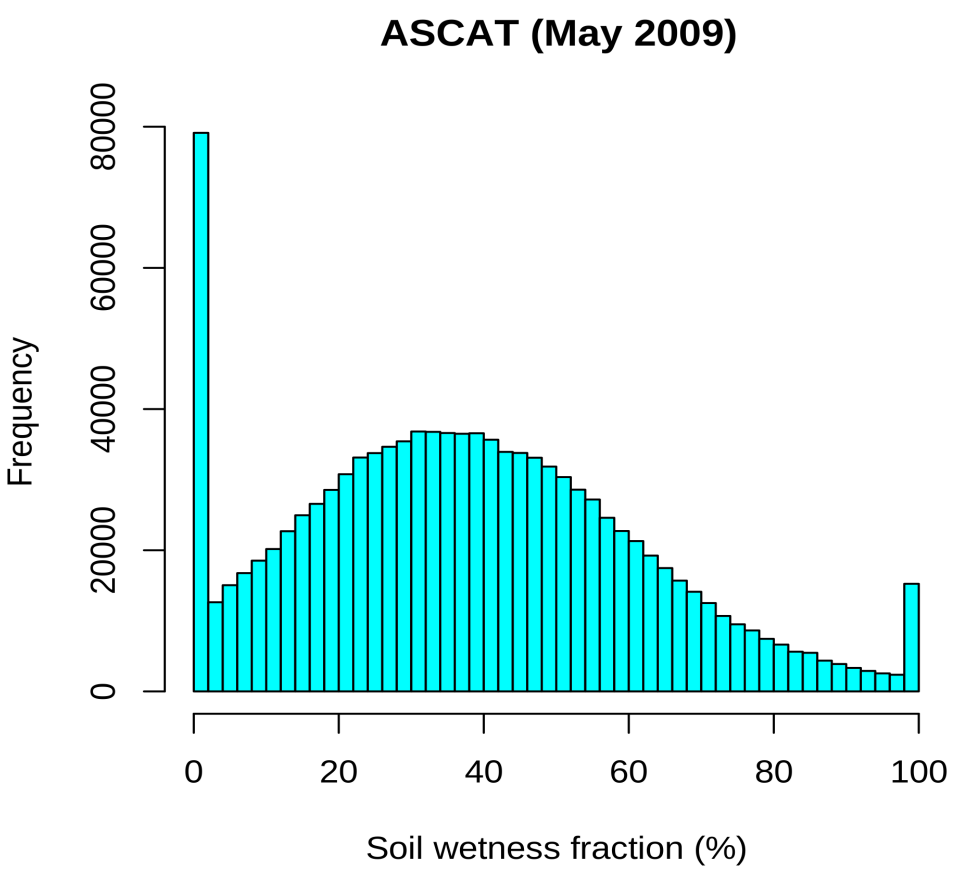
Soil analysis within SURFEX – ongoing activities

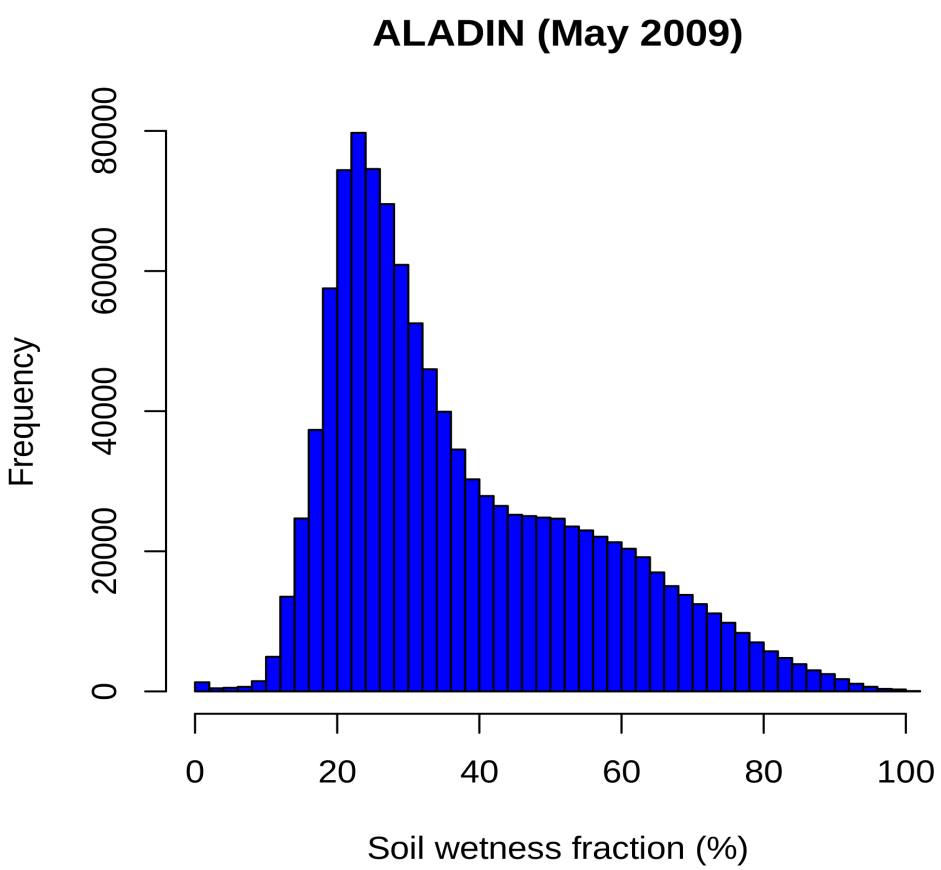
- Optimum Interpolation available in 3D-Var with ALADIN/SURFEX (under evaluation) – to be adapted for AROME
- Simplified EKF developed for the assimilation of ASCAT soil moisture in ALADIN 3D-Var
- SURFEX EKF extended for a joint assimilation of LAI and soil moisture (GEOLAND2 project)
- Evaluation of the Jacobians from CANOPY for the assimilation of screen-level observations
- Developments on the inclusion of improved precipitation forcing in the SURFEX EKF

Assimilation of ASCAT soil moisture in ALADIN

- 3D-Var ALADIN/France + SURFEX
- Period : May 2009
  - Use of a simplified SURFEX EKF : Analytical formulation of the Jacobians of the ISBA scheme
  - ASCAT superficial soil moisture at 12.5 km resolution provided by EUMETSAT – data screening using quality flags – bias correction scheme using CDF matching technique – error specifications from statistics of innovations
  - Experiments : **CTRL** (no soil analysis), **EXP** (soil analysis from ASCAT), **OPER** (soil analysis from screen-level observations)

Soil wetness index histograms





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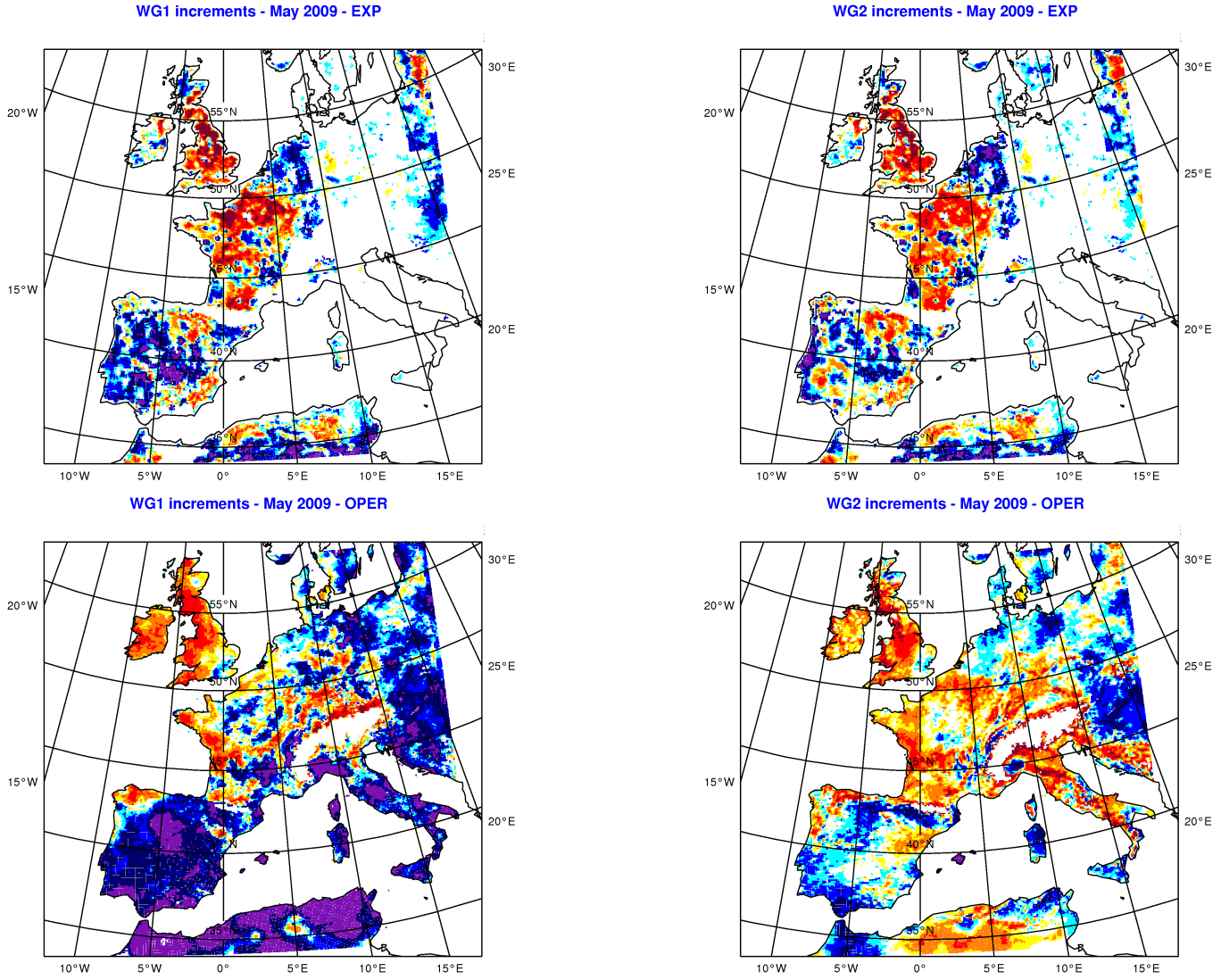
Monthly soil moisture increments (mm)

EXP

OPER



WG1

WG2

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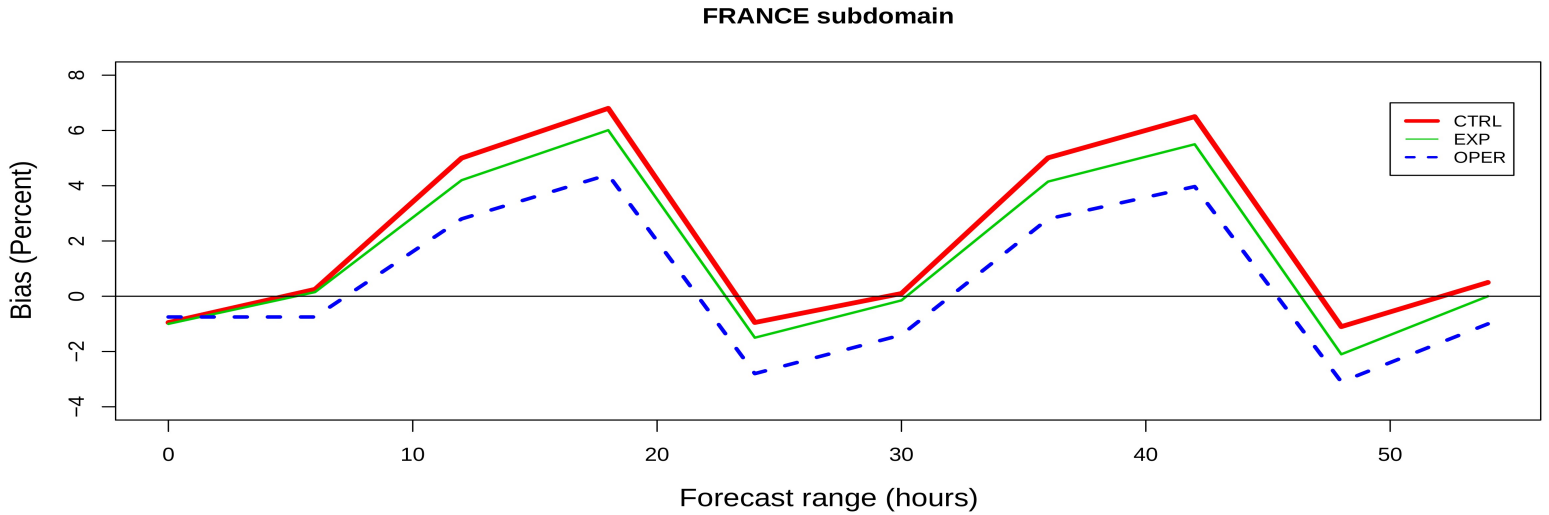
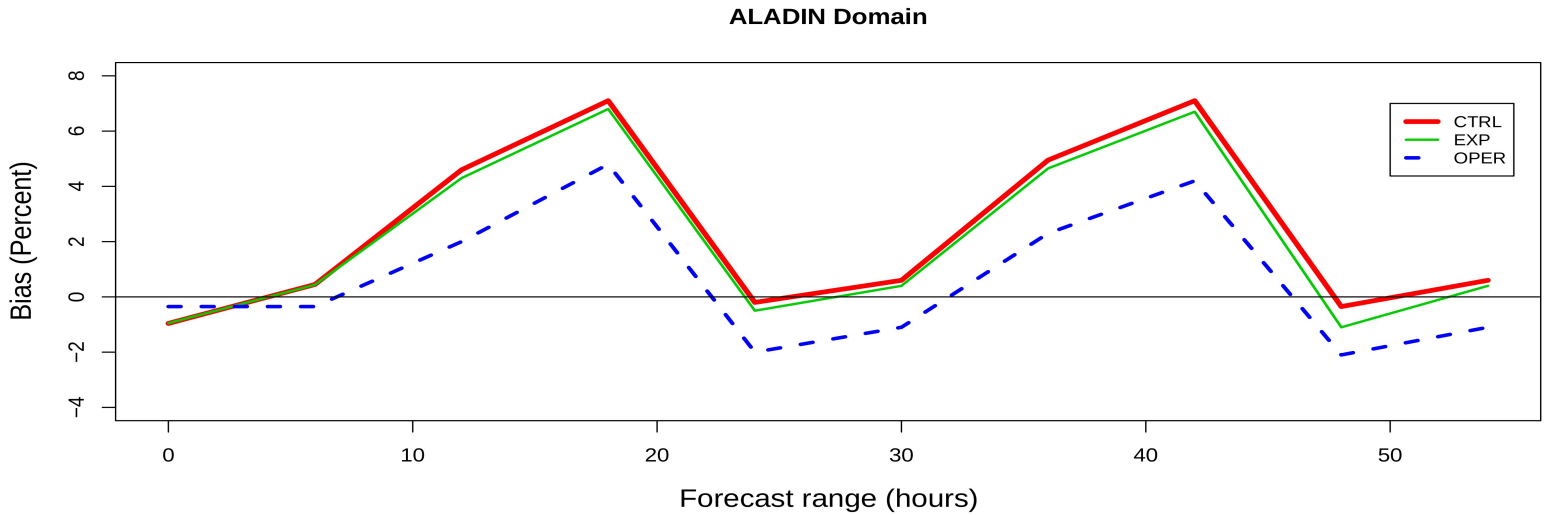
Forecast error (bias) in RH2m





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Summary of planned developments

- Snow analysis in CANARI : scientific visit in Toulouse (October 2009)
- Inclusion of an EnKF in SURFEX by NILU (Norway) – to be compared with the EKF
- Collaboration between Météo-France and ZAMG on the assimilation of ASCAT soil moisture in ALADIN with the SURFEX EKF (started in April 2009)

Practical informations

- Documentation and training :
  - External web site available : http://www.cnrm.meteo.fr/surfex/
  - SURFEX scientific documentation (P. Le Moigne) : Note de Centre GMME No 87, 211 pp.
  - Internal reports – useful links (e.g. ECOCLIMAP)
  - First SURFEX training course : Météo-France (Toulouse) – 14/16 October 2009 - lectures + practical exercises (37 participants)

Thank you for your attention....

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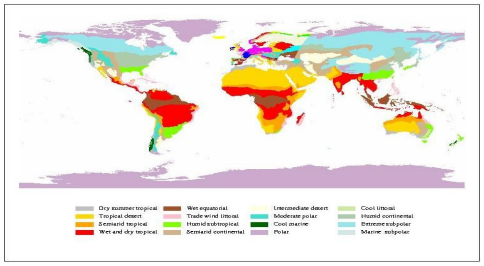
Generalities about SURFEX

•At Météo-France, surface models were formely based on the ISBA land model, a force-restore model developped to provide boundary conditions to atmospheric models and make evolve ground temperature and water.
•Each ISBA version linked with each atmospheric model diverged with time, making the importat of code developed by another team difficult
•After the strategic decision in Meteo-France to develop a meso-scale model at 2.5km of resolution, it was also decided to develop an externalized surface module for every model : SURFEX
•The **SURF**ace **EX**ternalized module had to unify all the work done so far concerning surface at CNRM
•Main objective : having the same surface parameterization in every model, to benefit from every development made with surface

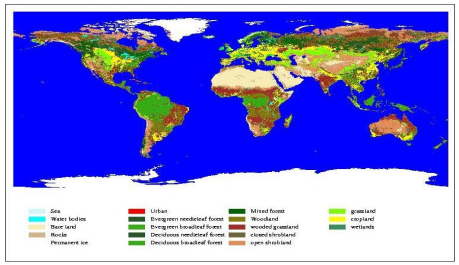
Data initialization

Climate map



Koeppe et de Lond

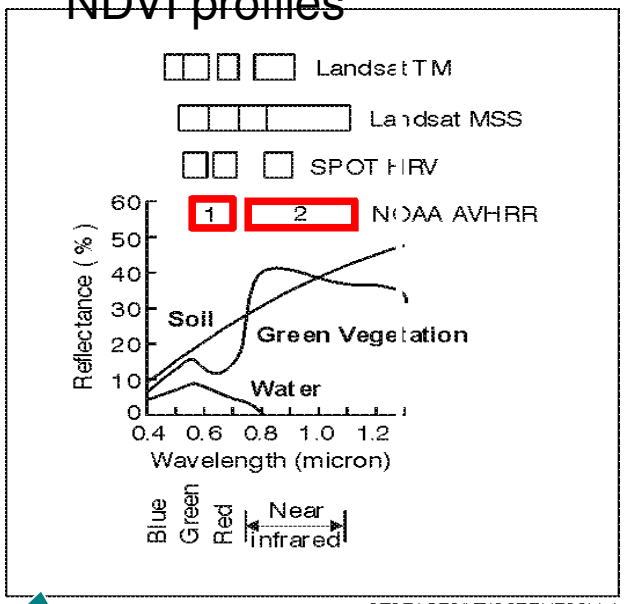
Land cover maps



University of Maryland
1km: 15 classes

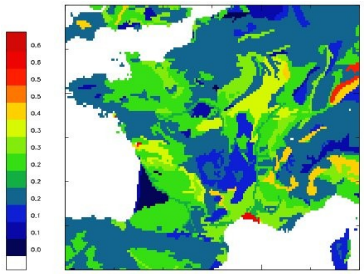
Corine land cover
« 250m »: 44 cl.

NDVI profiles

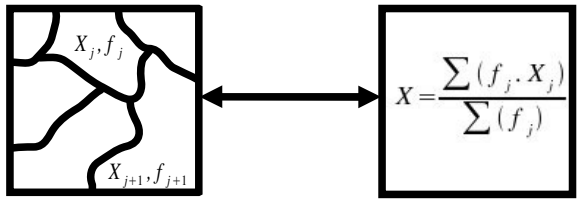


215 ecosystems over the globe

Texture: **FAO**



Agreggation



DATABASE AND SURFACE PARAMETERS

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