The externalized surface


Sea and ocean


Lakes


Vegetation and soil


Town

Objectives

→ **Simulate Exchanges between surface and atmosphere**

(momentum, heat, water, CO2, chemical species)

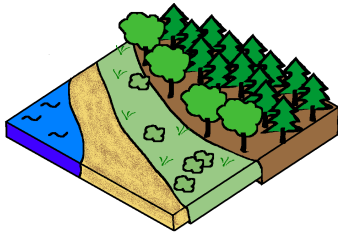
→ **Separate the surface schemes from the atmospheric model**

- allows to use the same surface code for several atmopsheric models

(AROME, MESONH, ALADIN, ARPEGE, off-line runs)

- easy switch between surface schemes and options

→ **Both simple schemes and up-to-date ones,** including:



- imposed fluxes for « ideal » cases
- tiling : 4 surfaces (sea, lakes, town, vegetation) in the grid mesh
- tiling in the vegetation scheme itself : forest, grass, etc… schemes

The physical schemes

Sea and ocean :
prescribed SST, Charnock formula
→ will soon include a better bulk formulation
→ reflexion to implement a 1D oceanic mixing layer

Lakes :
prescribed temperature, Charnock formula

Vegetation and soil : **ISBA**
(Interface Soil Biosphere Atmosphere)

Town : **TEB**
(Town Energy Balance)

ISBA : general

Simulates: exchanges of heat and water, possibly of CO2
soil and vegetation temperature,
soil liquid water, **soil ice, snow**

Coupled with a chemical deposition scheme

Tiling :
1 to 12 patches

Exemples:
1 patch = **classical aggregated scheme**
3 patches = 1 patch bare soils
+ 1 patch low vegetation
+ 1 patch trees
12 patches = flat bare soil + rocks + perm. snow
+ C3, C4 and irrigated crops, C3, C4 and irrigated grass
+ evergreen and deciduous broadleaf trees, needleaf trees

ISBA : physics

Soil options: **Force restore, 2 layers , temp, water, ice**
Force restore, 3 layers , temp, water, ice
Diffusion, N layers , temp, water, ice

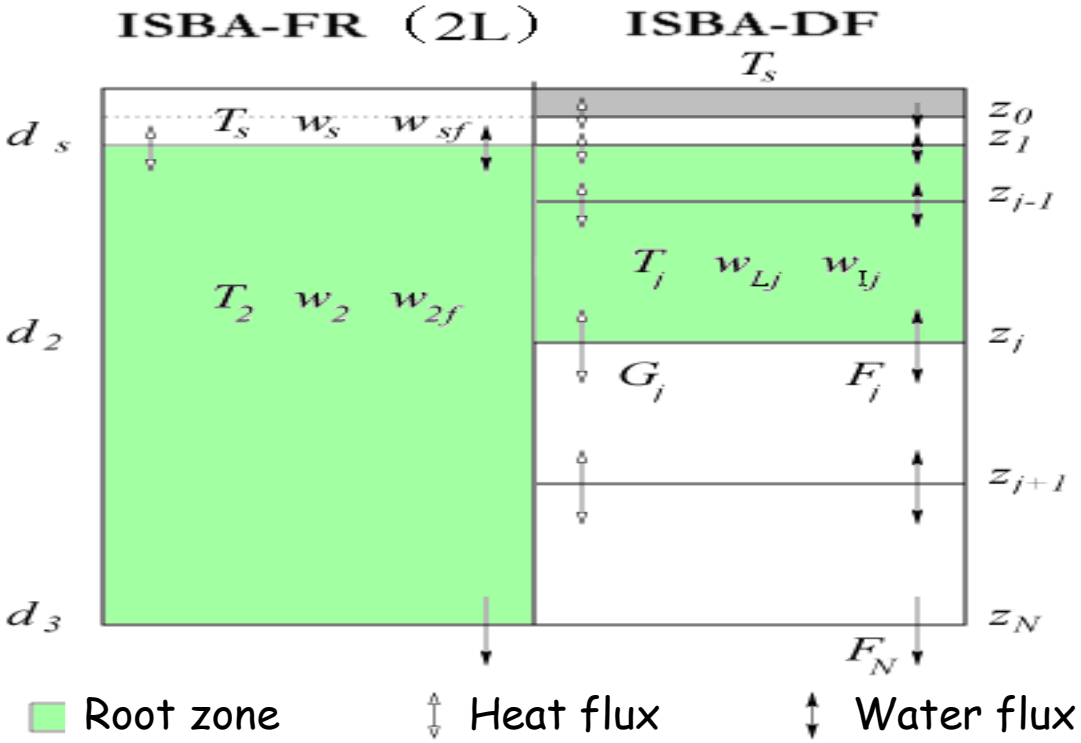
Vegetation options:
Noilhan and Planton 89 (~Jarvis)
AGS (photsynthesis and CO2 exchanges)
AGS and iteractive vegetation

Hydrology options:
no subgrid process
subgrid runoff, subgrid drainage

Snow options:
Douville 95 (**1 layer, varying albedo,** varying density)
Boone and Etchevers 2000
(3 layers, albedo, density, liquid water in snow pack)

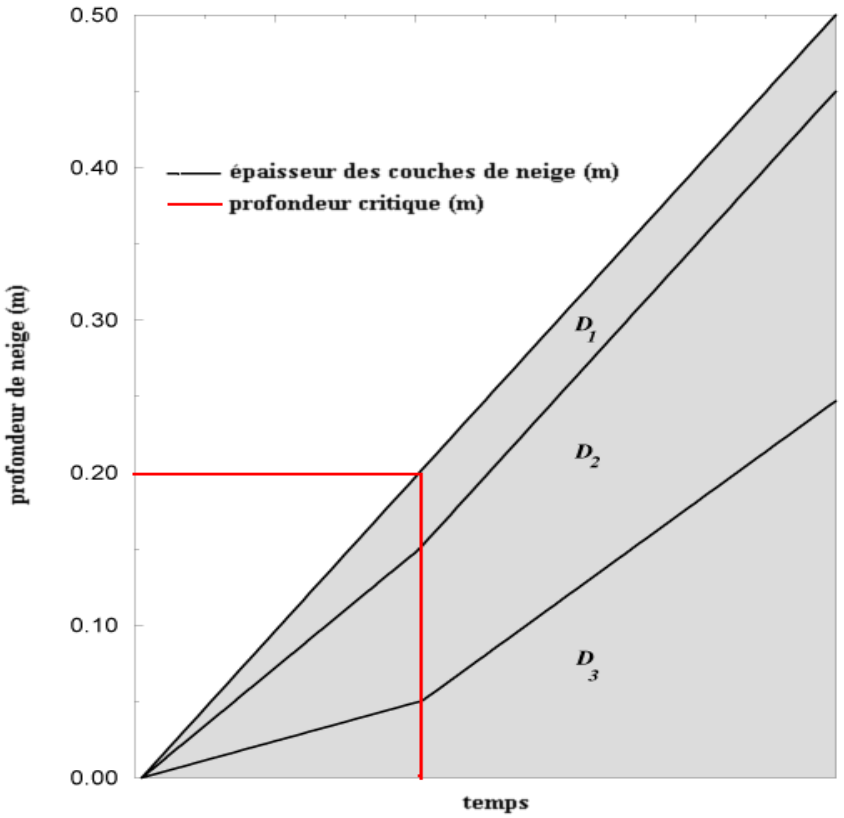
Diffusion version : ISBA-DF

- reference
- keep the same module for surface budgets and vegetation
- diffusion equations for heat and water
- temperature, liquid water, ice in the same layers
- possibility of soil texture profile; vertical root distribution

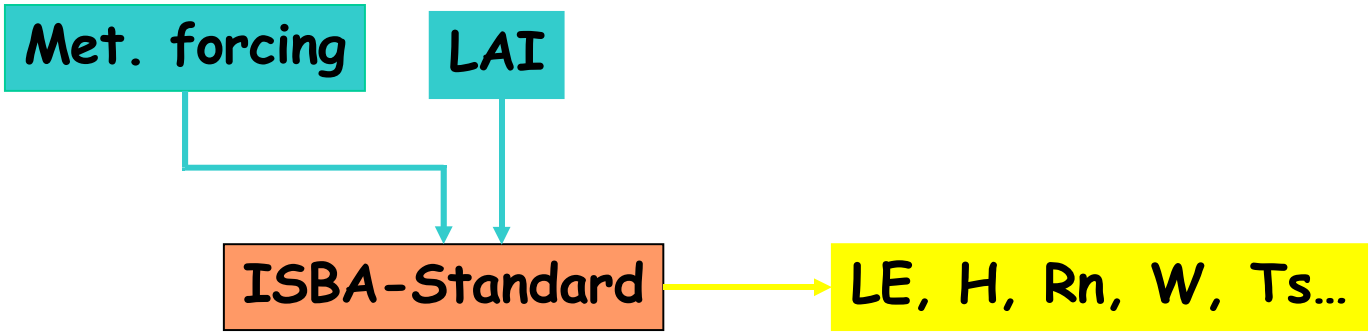


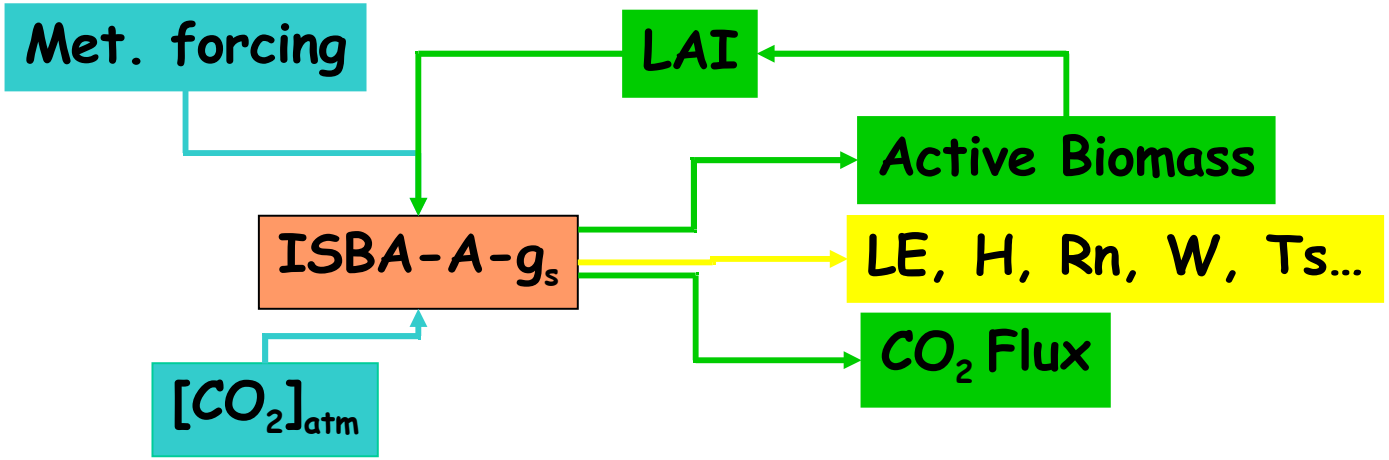
Discretisation verticale de la neige

- 3 variable layers
- resolution of thermal and density gradients in snow pack
- liquid water in snow pack and refreezing
- Heat flux at base of snow pack
- Solar flux transmission through snowpack



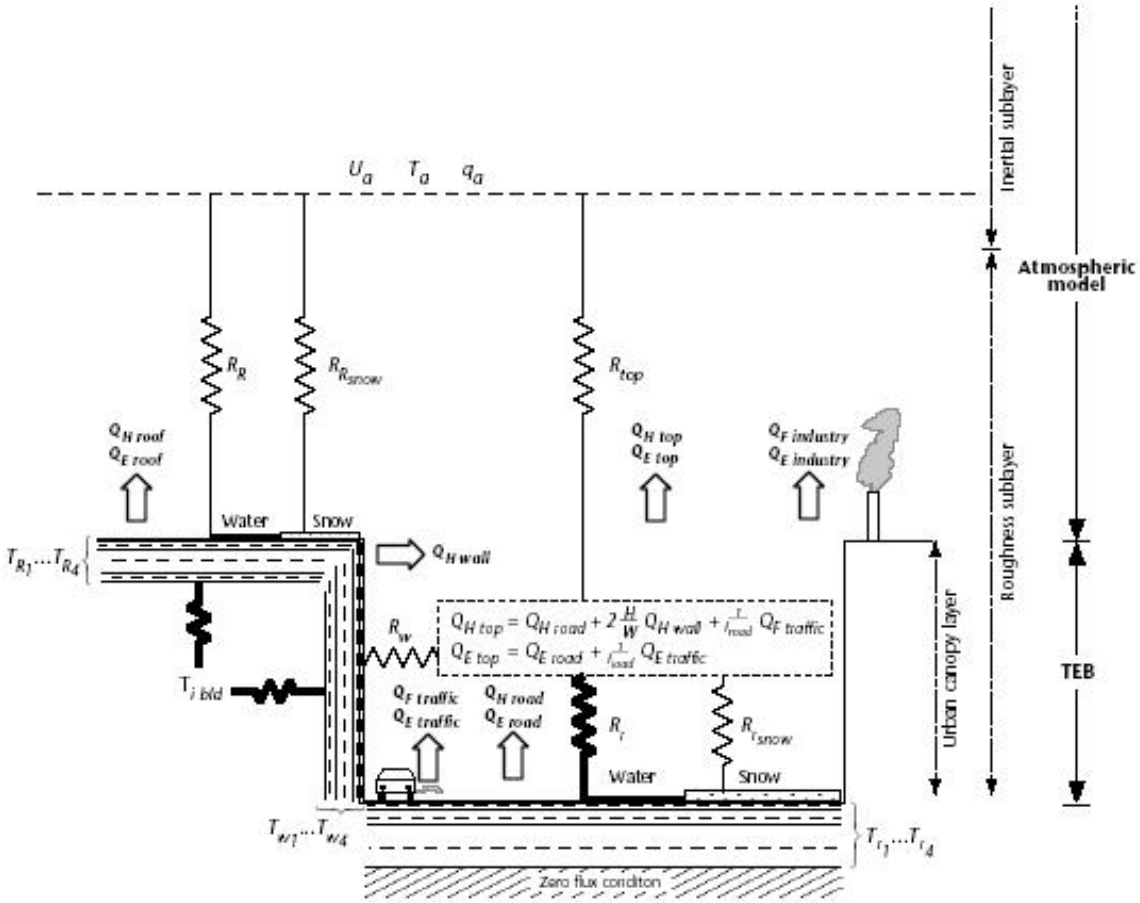
Surface Scheme : ISBA-A-gs





TEB : physics

Masson 2000, Masson et al 2002, Lemonsu et al 2003



- Only 1 road, 1 roof, and 2 *identical* facing walls

→ ONLY ONE WALL SEB

→ Only one wall temp.

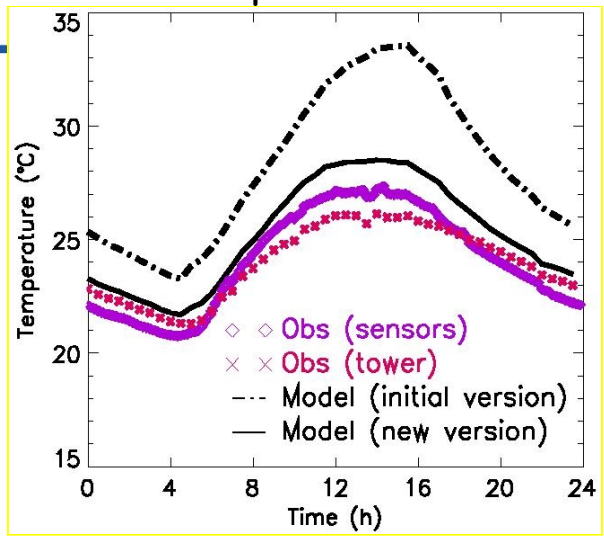
→ Only one road temp.

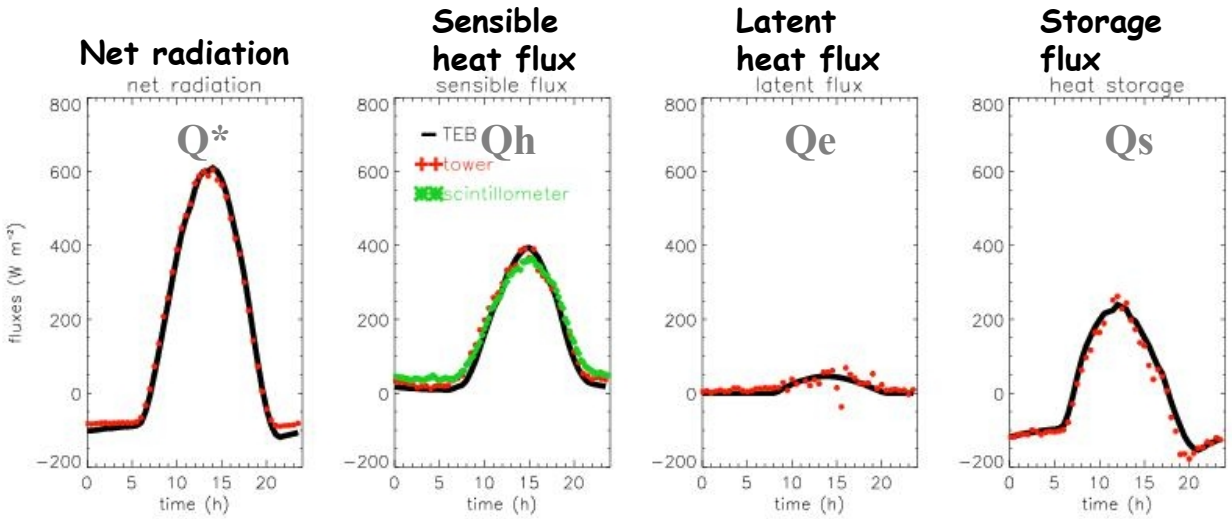
- Rain and snow interception
- Latent heat fluxes
- Heat conduction in the materials
- Anthropogenic fluxes

TEB has been validated on several urban sites:

Mexico City, Vancouver (Masson et al 2002)
Marseilles (Lemonsu et al 2003)

Air temperature



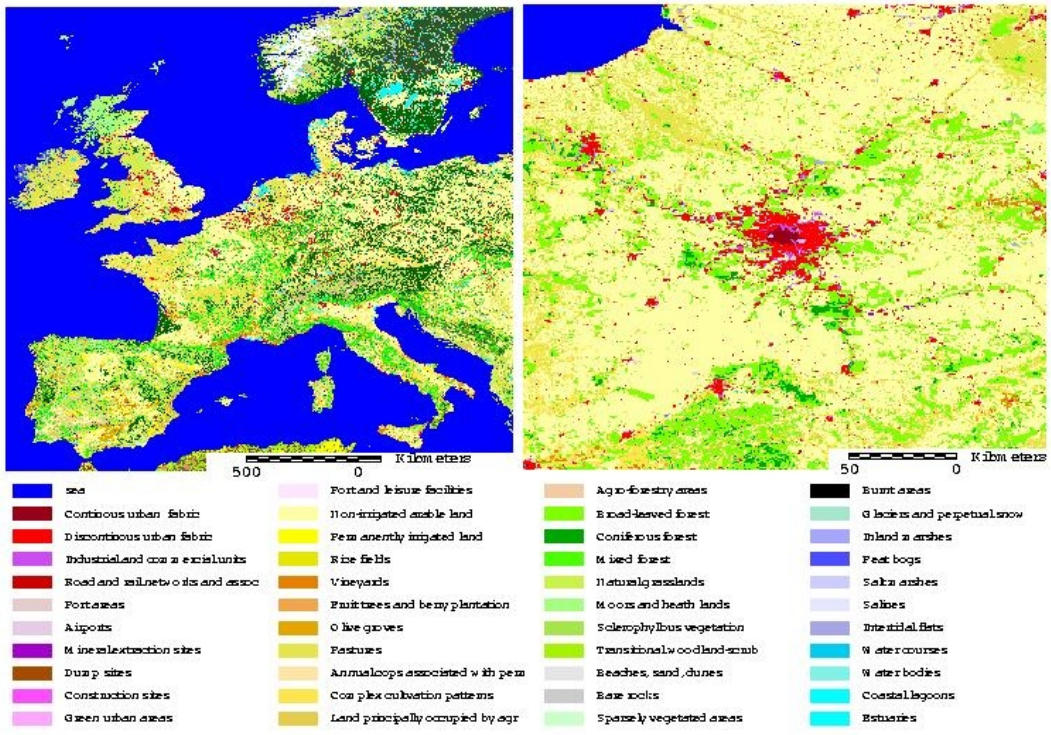


Surface energy budget, observed and simulated

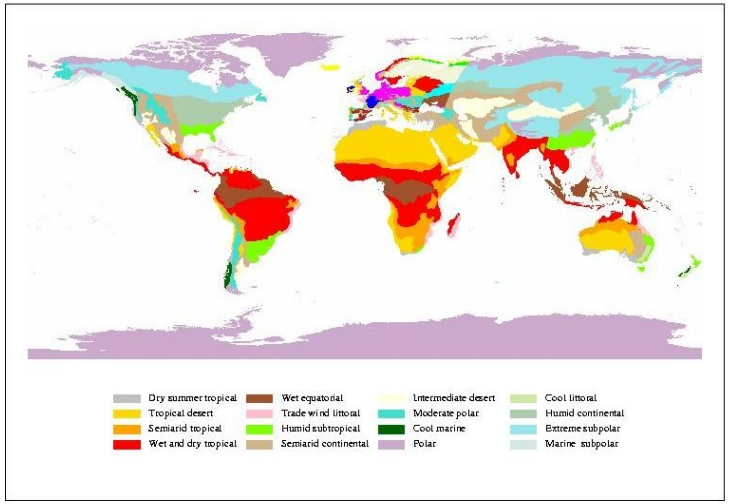
Initialization of physiographic fields

Use of ECOCLIMAP database

- Resolution 1 km
- on the entire globe
- All surface fields necessary to surface schemes
- Take into account the climate variablility from one region to another



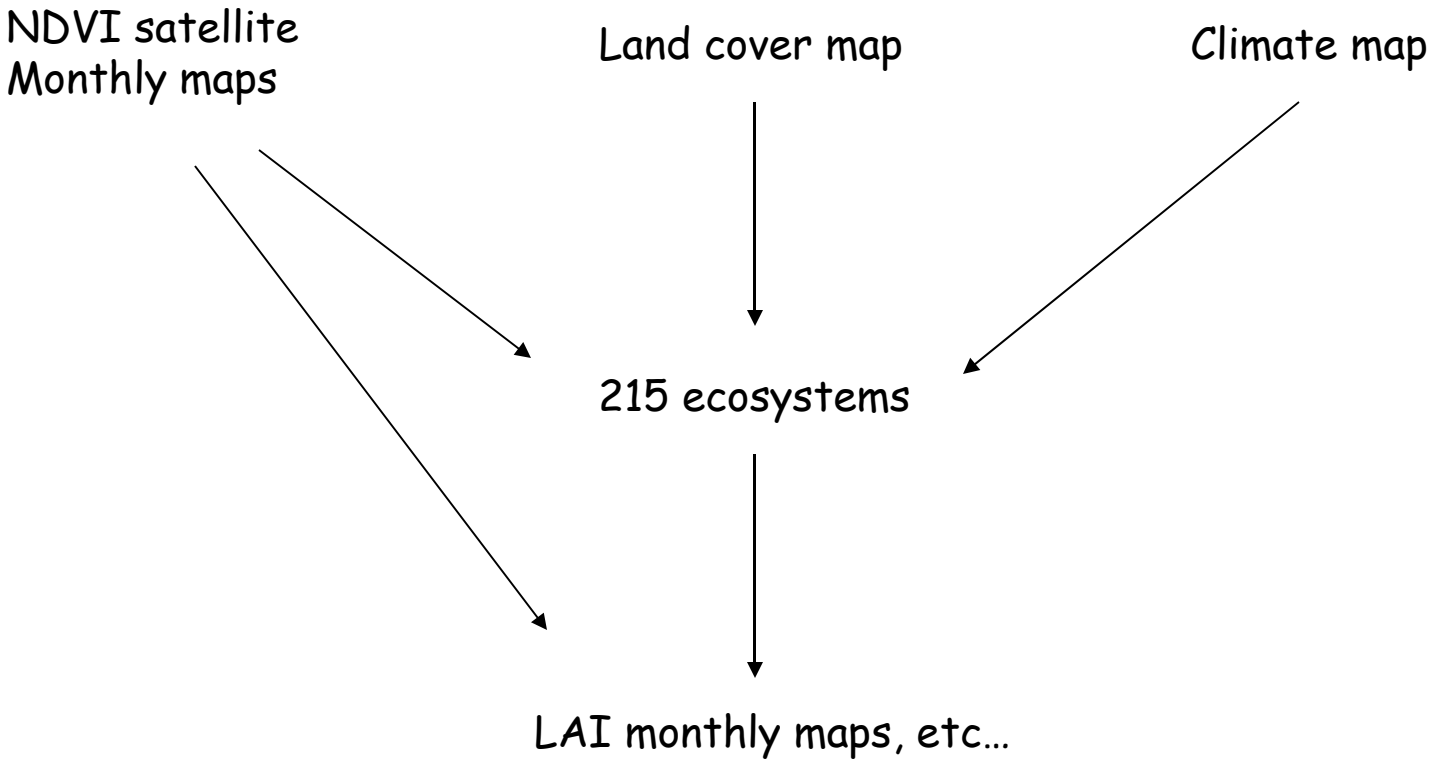
Land cover map



Climate map

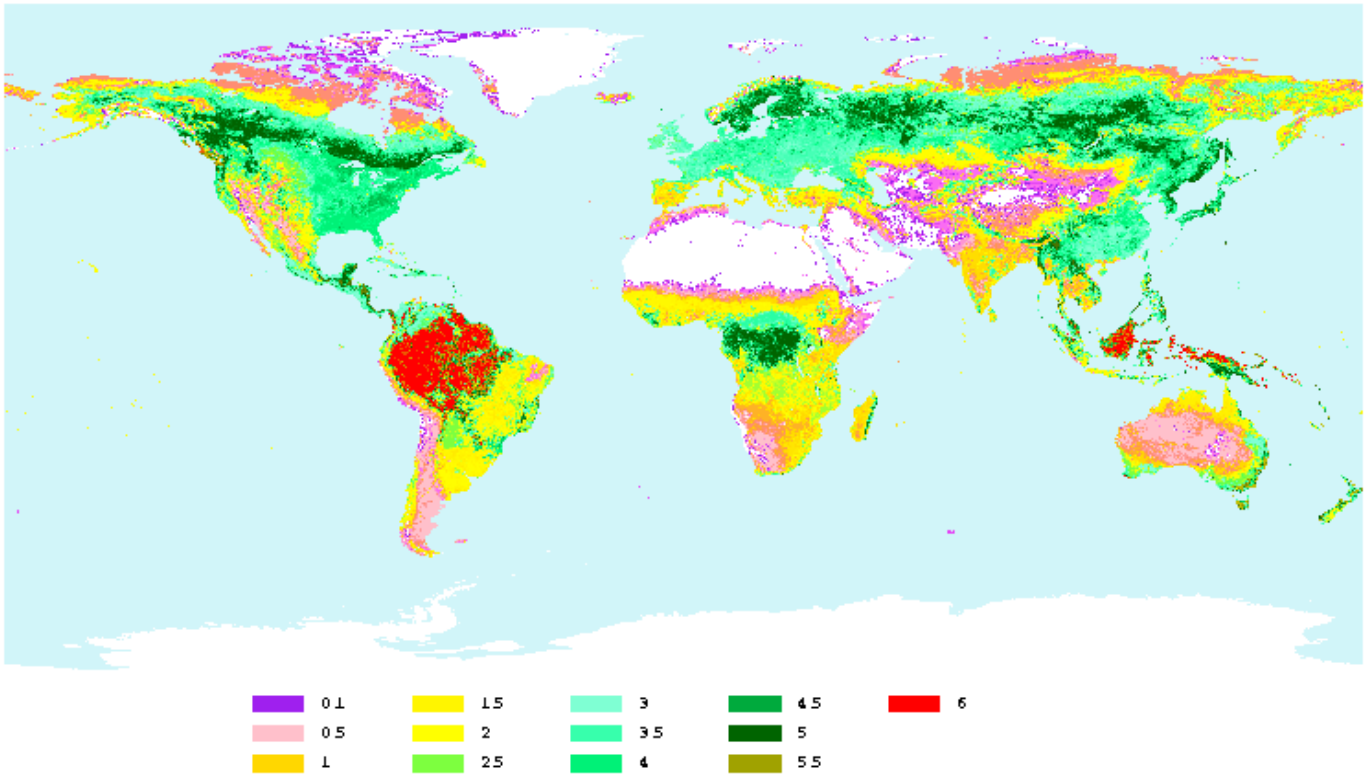
Initialization of physiographic fields

Method to build ECOCLIMAP database :



Initialization of physiographic fields

Maps of LAI from ECOCLIMAP database (Masson et al 2003)



Leaf Area Index in june

The externalized surface algorithm ?

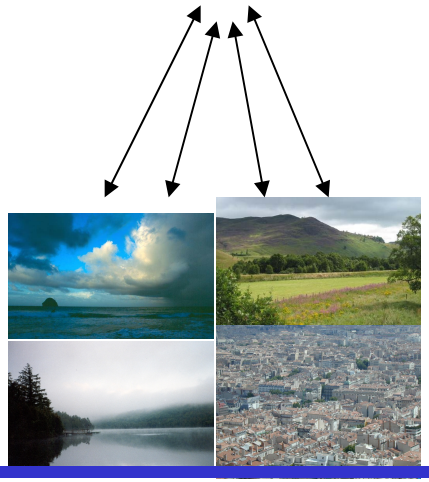
During run, at each timestep

Radiative fluxes
Sun position
Atm. Forcing
Rain, snow fall

Albedo,
Emissivity,
radiative temp.

Momentum fluxes
Heat flux
Water vapor flux
CO2 flux
Chemical fluxes

Surface run

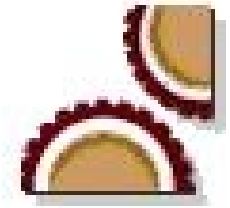


Atmospheric model

surface

The externalized surface algorithm

Initialization of Physiographic fields



Initialization of Variables fields

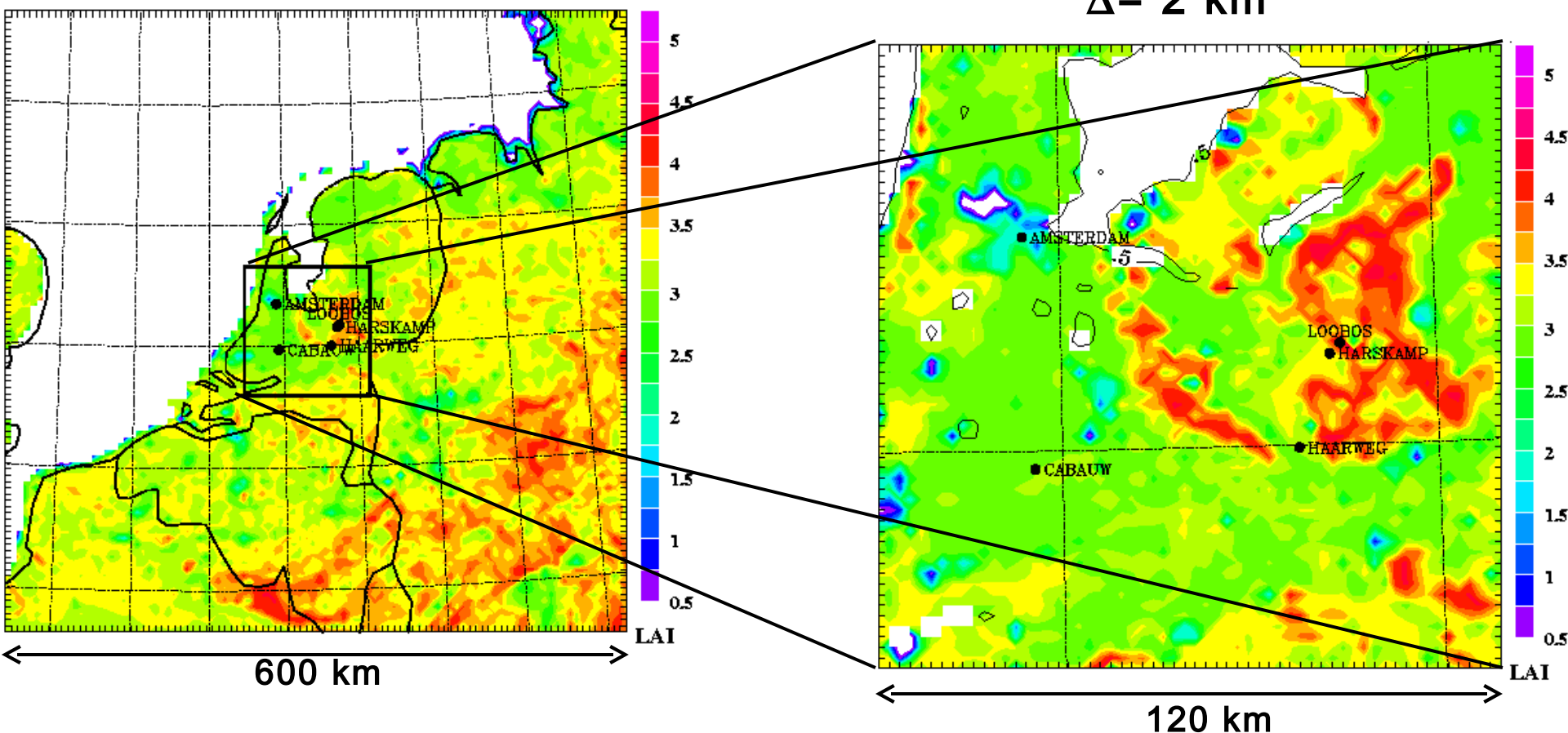
Run

Diagnostics

Initialization of physiographic fields

PGD : <u>preparation of physiographic fields at any scale</u>
(including subgrid orographic fields from 30' Gtopo30 data)

Example of LAI produced by externalized PGD over Netherlands



Initialization of prognostic fields

ECMWF

ARPEGE

ALADIN

MESONH

MOCAGE

Prescribed fields

<u>Initialization of:</u>

SST

Water temperature

Soil temperature profile
Water and soil ice profiles
Leaf interception reservoir
Snow mantel characteristics

Wall, roof, road temp. profiles
Water and snow reservoirs

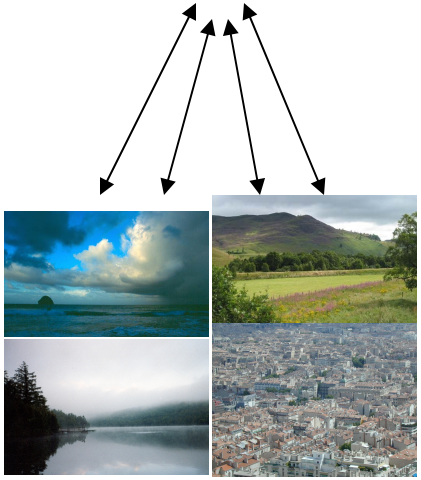
Run

Before first time step

Type of input file
Sun position

Albedo,
Emissivity,
radiative temp.

Surface Initialisation



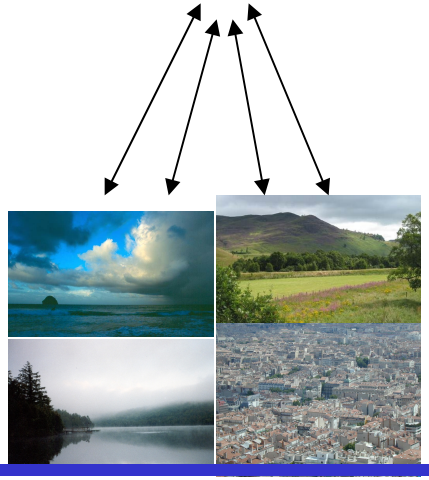
During run, at each timestep

Radiative fluxes
Sun position
Atm. Forcing
Rain, snow fall

Albedo,
Emissivity,
radiative temp.

Momentum fluxes
Heat flux
Water vapor flux
CO2 flux
Chemical fluxes

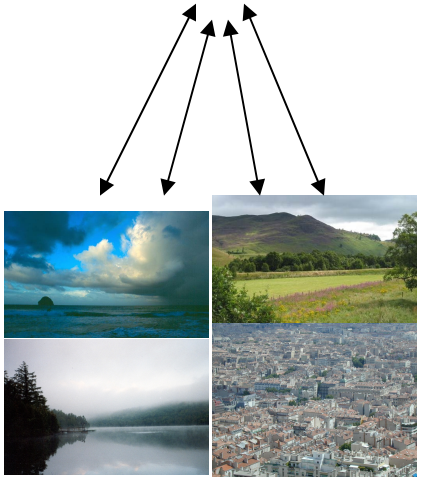
Surface run



Output files

Type of output file

Surface writing



Atmospheric model

surface

Diagnostics

- 2m temperature and humidity
- 10m wind
- energy budgets
- water budgets
- all physiographic fields from Ecoclimap

And this for:

- the whole surface (aggregated diagnostics)
- each type of surface (sea, lakes, vegetation, town)
- each patch in case of several patches in ISBA

One example of use of externalized surface

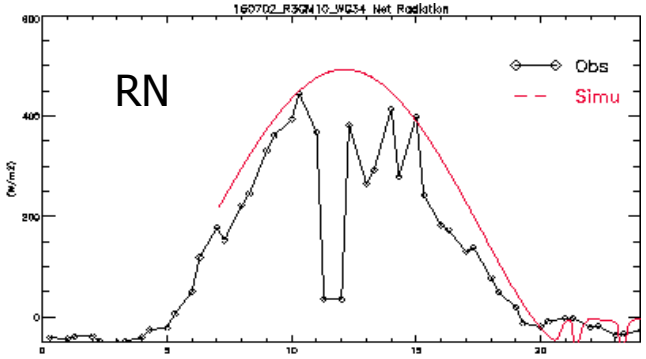
Meso-NH 1D run

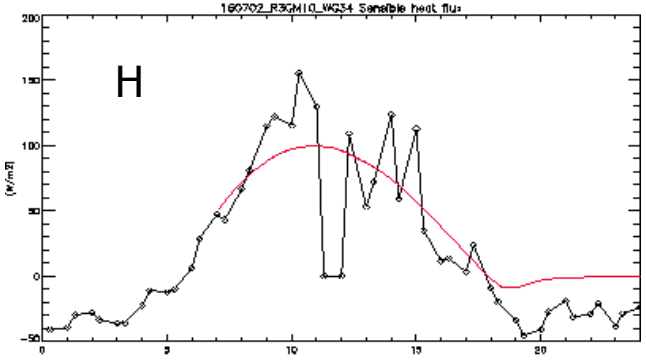
<u>CABAUW (grassland) : 16.07.2002</u>

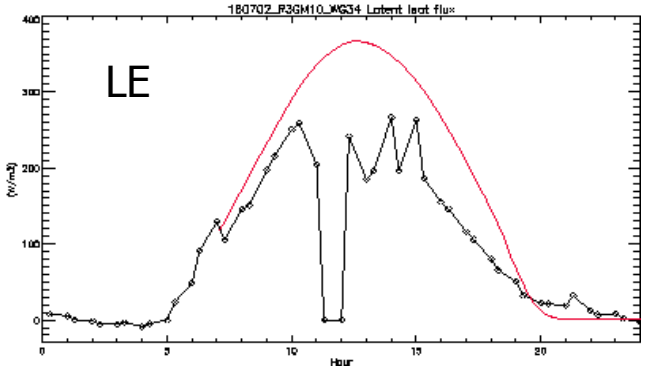
Initialisation at 6H :

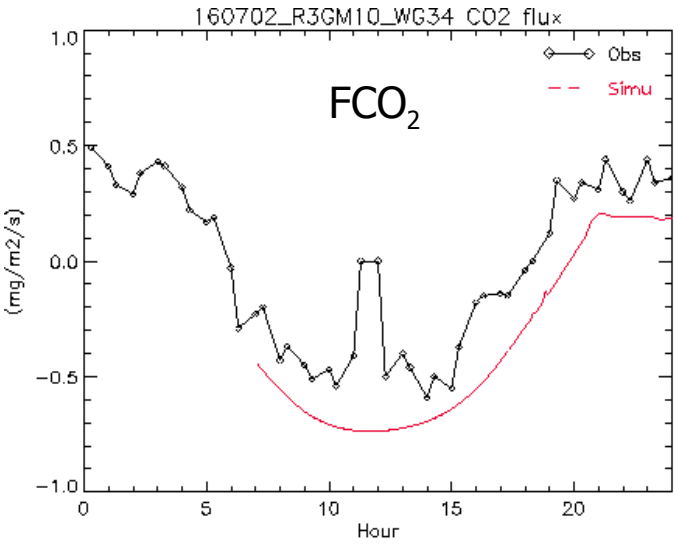
✖ *CO2* :
- 0-200m Cabauw tower data
- 200-2000m : aircraft data
- above 2000 m : constant profile

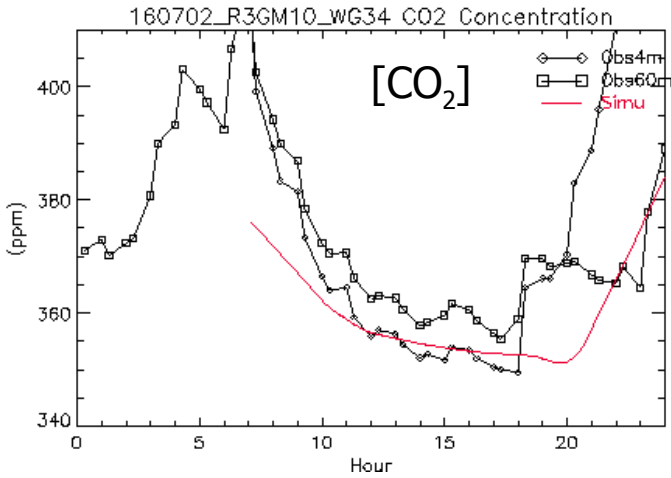
✖ Other parameters :
- 0-2000 m aircraft profile
- above 2000 m : constant gradient



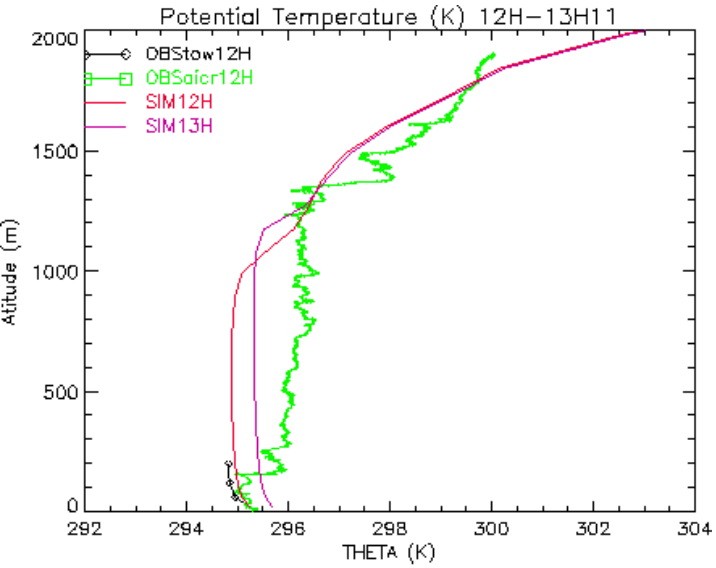


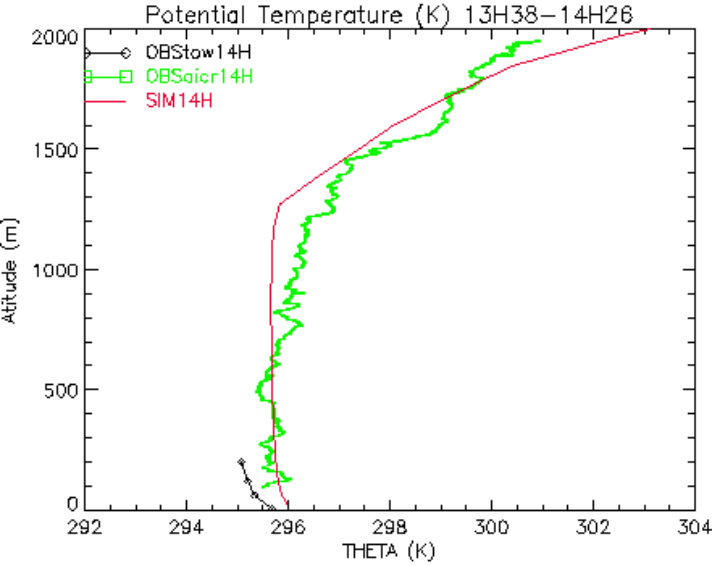




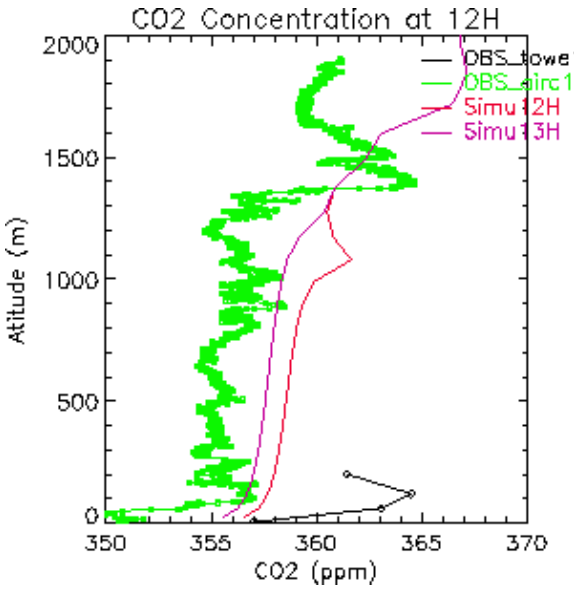


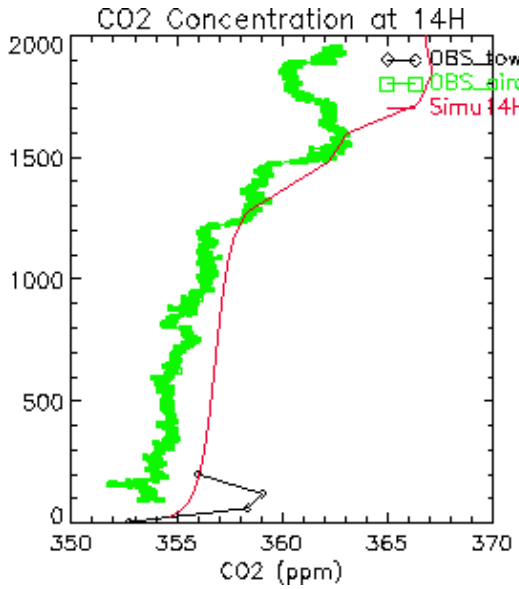
One example of use of externalized surface





Meso-NH 1D run





<u>Results for CABAUW :</u>
<u>16.07.2002</u>

Comparison of vertical profiles
Of potential temperature and CO2

Conclusion and perspectives

- Externalized surface is implemented :
  - in AROME
  - in MESO-NH
  - offline

- Exactly the same code
  → portability
  → easy to implement physical evolutions in all atmospheric models

- <u>What needs to be done</u> :

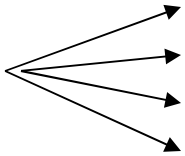
  - Assimilation :
    - of surface fields
    - of operationnal 2m obs. in atmospheric assimilation
  - Improvement of sea and lake schemes
  - building of an extensive database of validation cases
  - …

How to use the same code in different universes?

- File types (MESO-Nh, netcdf, Ascii, ALADIN?)

- All reading (writing) orders from the surface are given by the same routine
-This routine, READ_SURF, chooses the correct reading routine:

READ_SURF (**file type**, field)



READ_SURF for Arome file (field)
READ_SURF for MesoNH file (field)
READ_SURF for netcdf file (field)
READ_SURF for Ascii file (field)

- Parallelization

Parallelisation is done when fields are read or written

How to use the same code in different universes?

• File types (MESO-Nh, netcdf, Ascii, ALADIN?)

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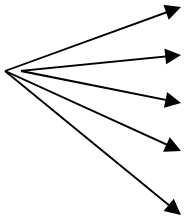


READ_SURF for Arome file (field)
READ_SURF for MesoNH file (field)
READ_SURF for netcdf file (field)
READ_SURF for Ascii file (field)
etc…

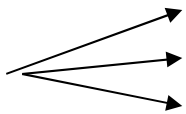
• Parallelization

Parallelisation is done when fields are read or written

• Different grids :

- grid type characteristics is stored in a pointer
- everytime the grid is needed, then a generic routine is called:

LAT (**grid type**, grid info, lat)



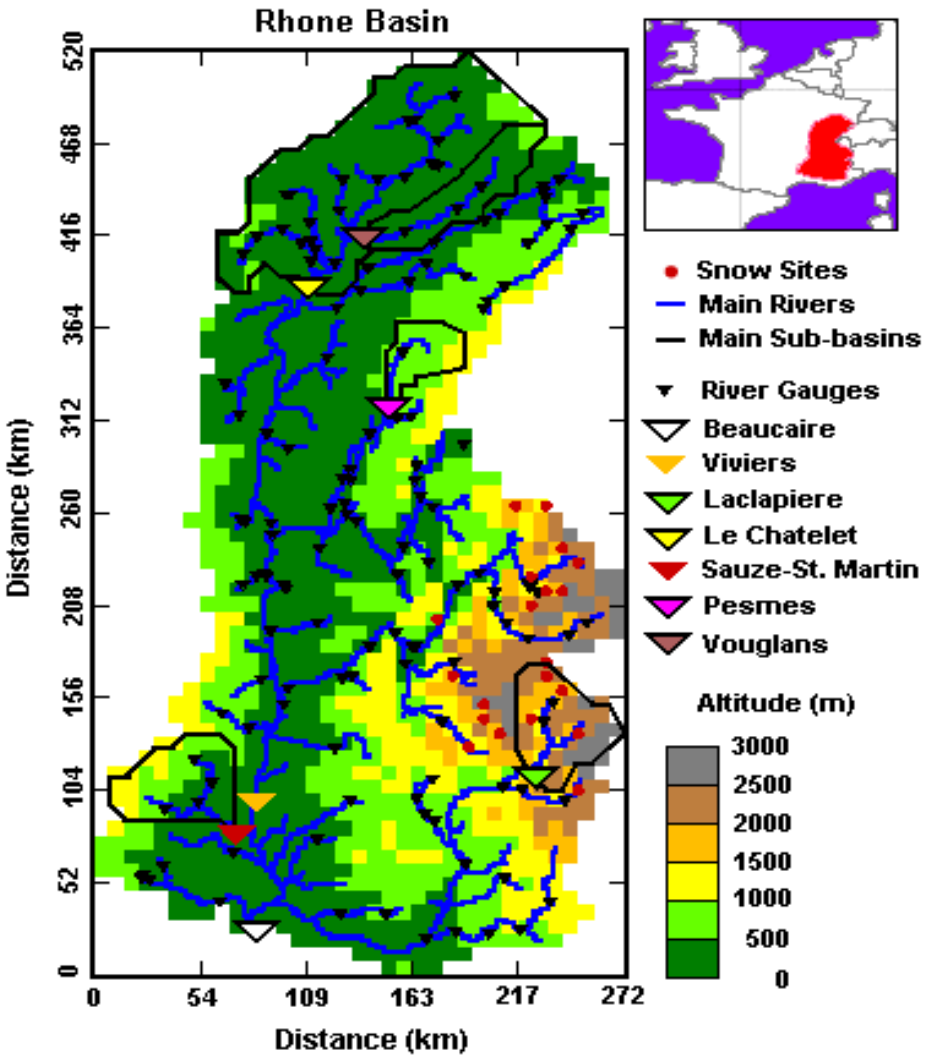
LAT for projection grid (grid info, lat)
LAT for regular latlon (grid info, lat)
etc…

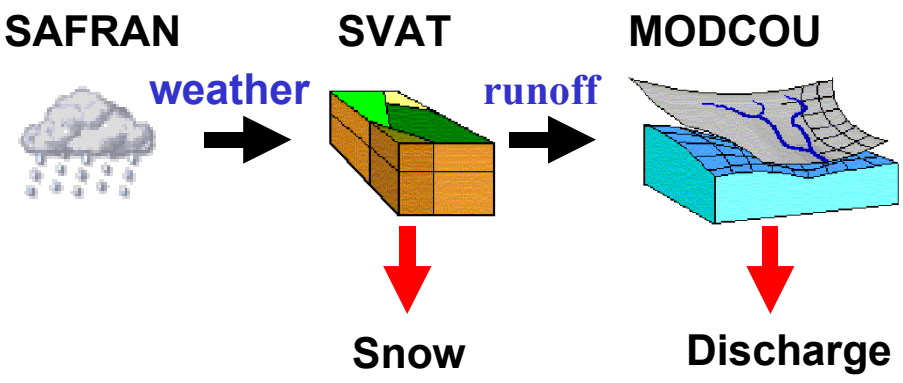
Rhone-AGG

Rhone AGGregation experiment

Objectives:

- Projet: GEWEX Rhône: GLASS, GSWP2
- International Inter-comparison Project 15 (+ 3 ELDAS) SVATs
- 3 year simulation (1986-1989) of regional-scale water and energy budgets (ELDAS)
- Evaluation of snow and discharge simulations (ELDAS)
- Impact of changing spatial scale on the simulations

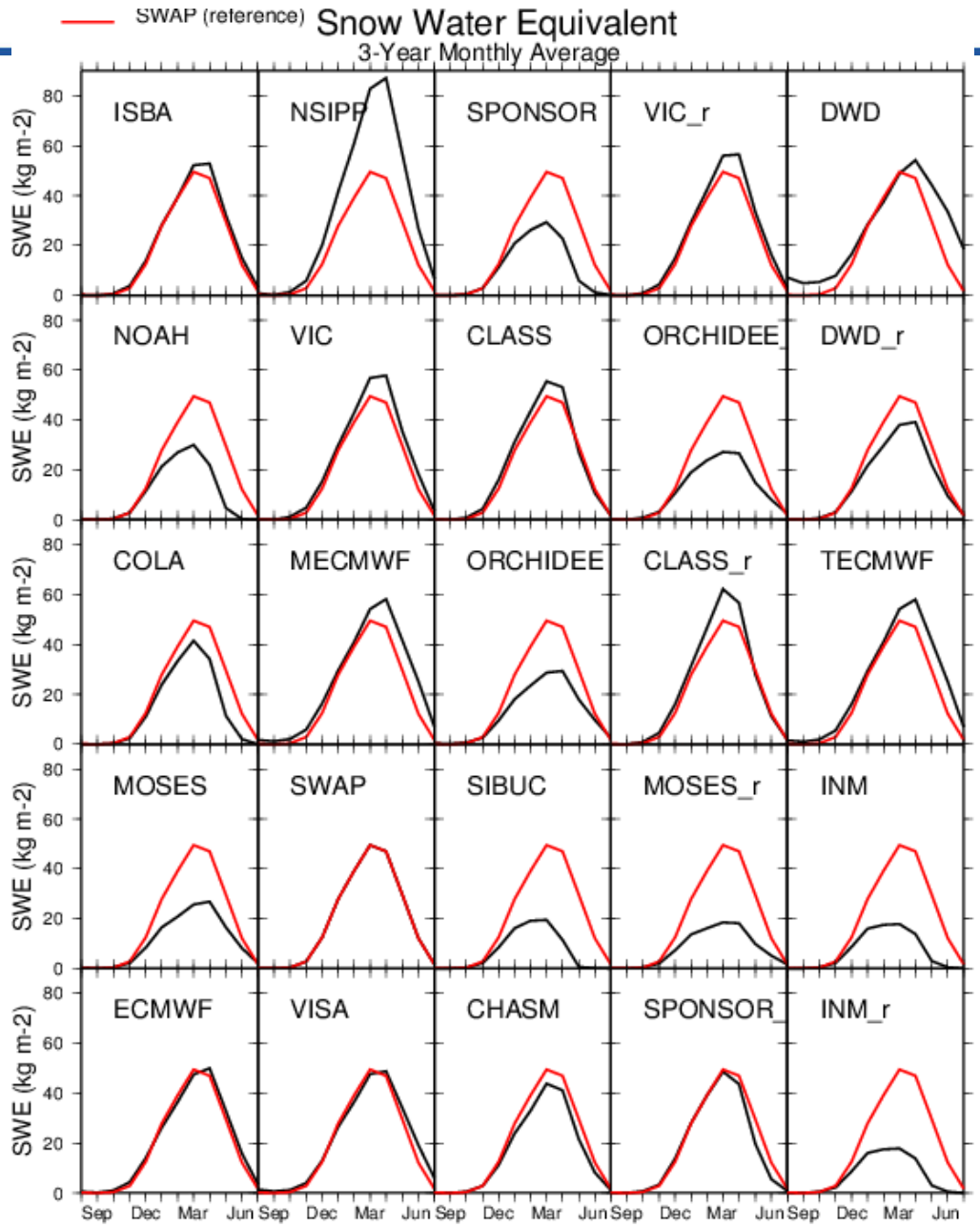




Evaluation using observations

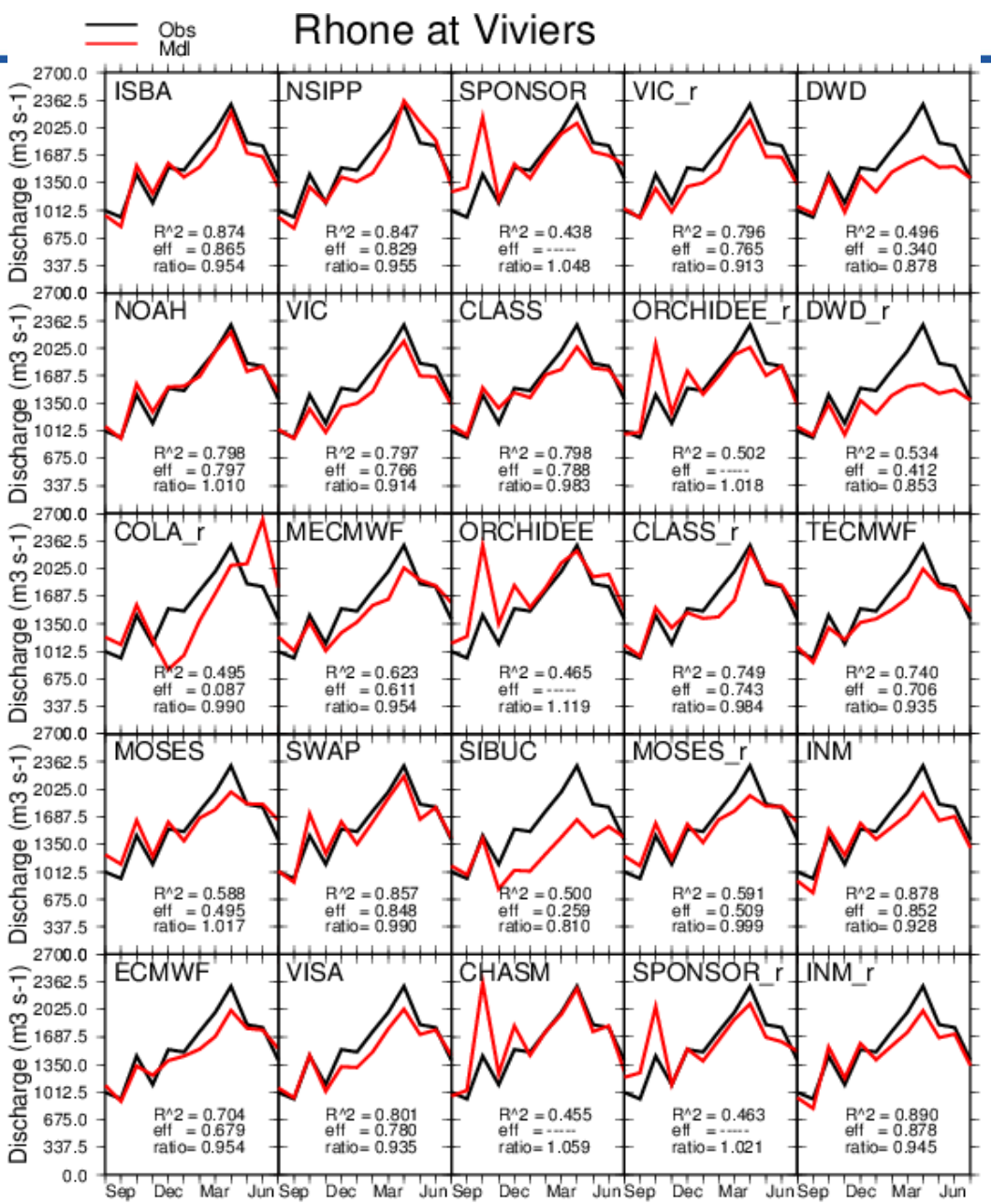
Rhone-AGG

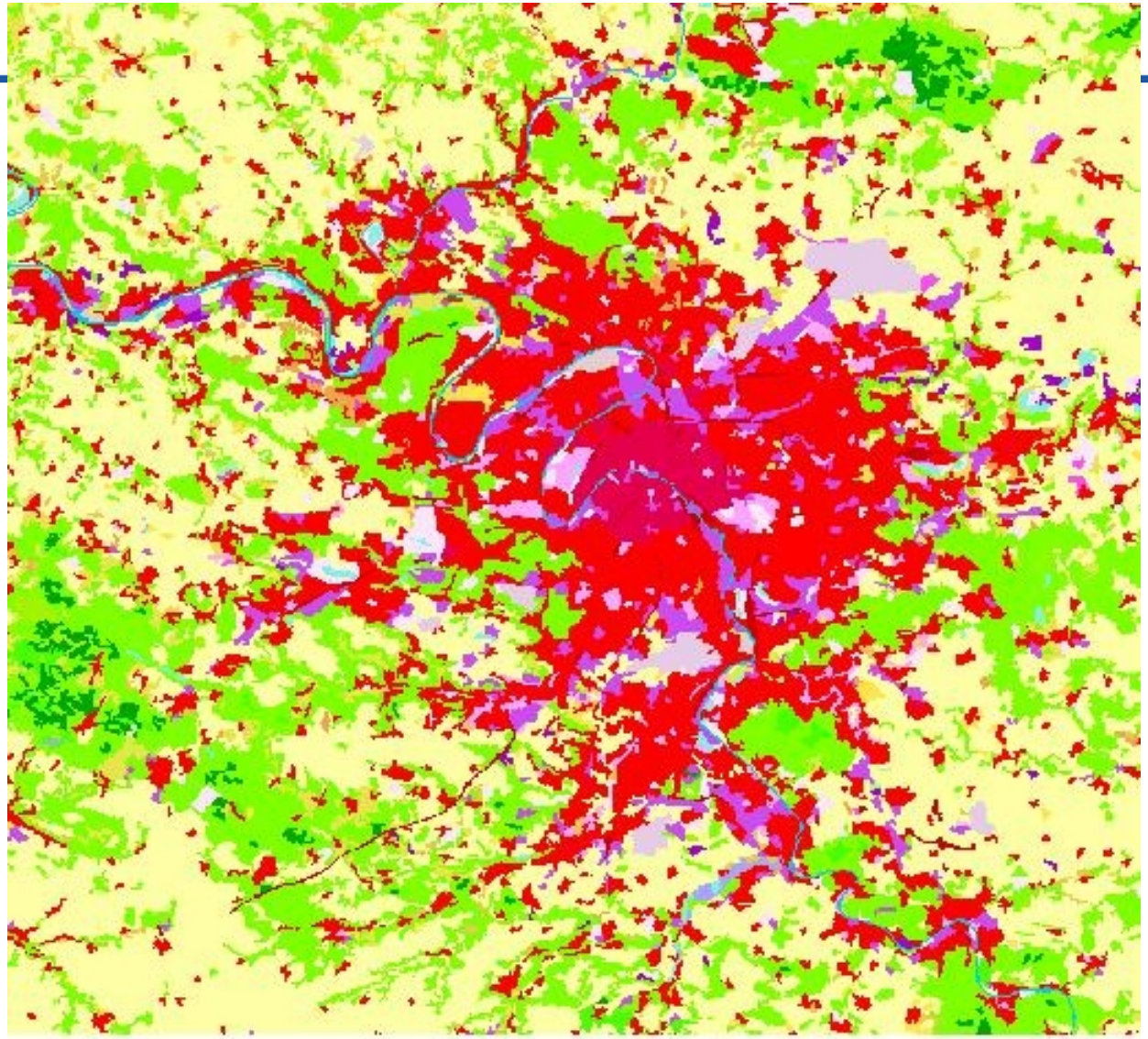
Rhone AGGregation experiment



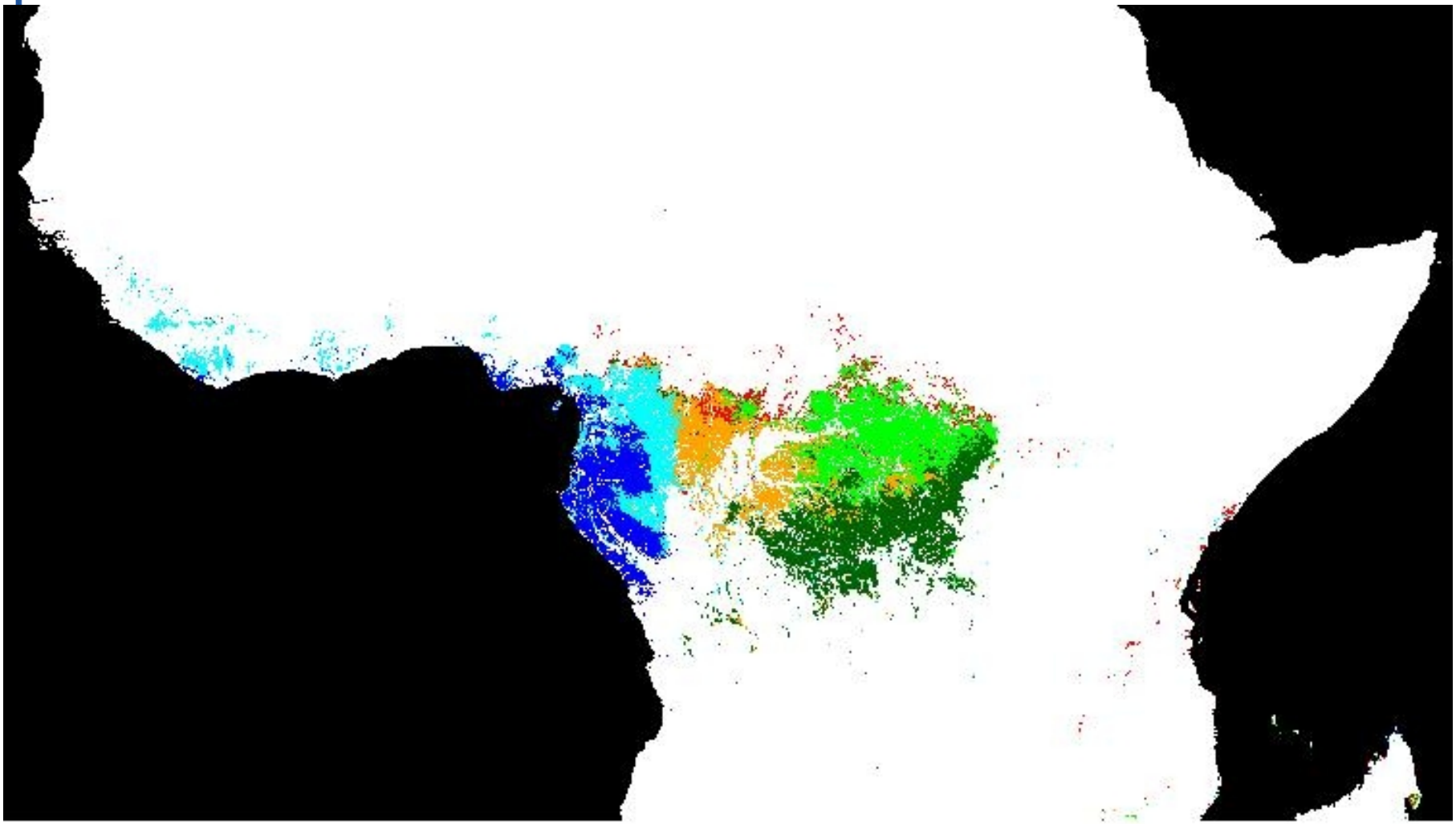
Rhone-AGG

Rhone AGGregation experiment



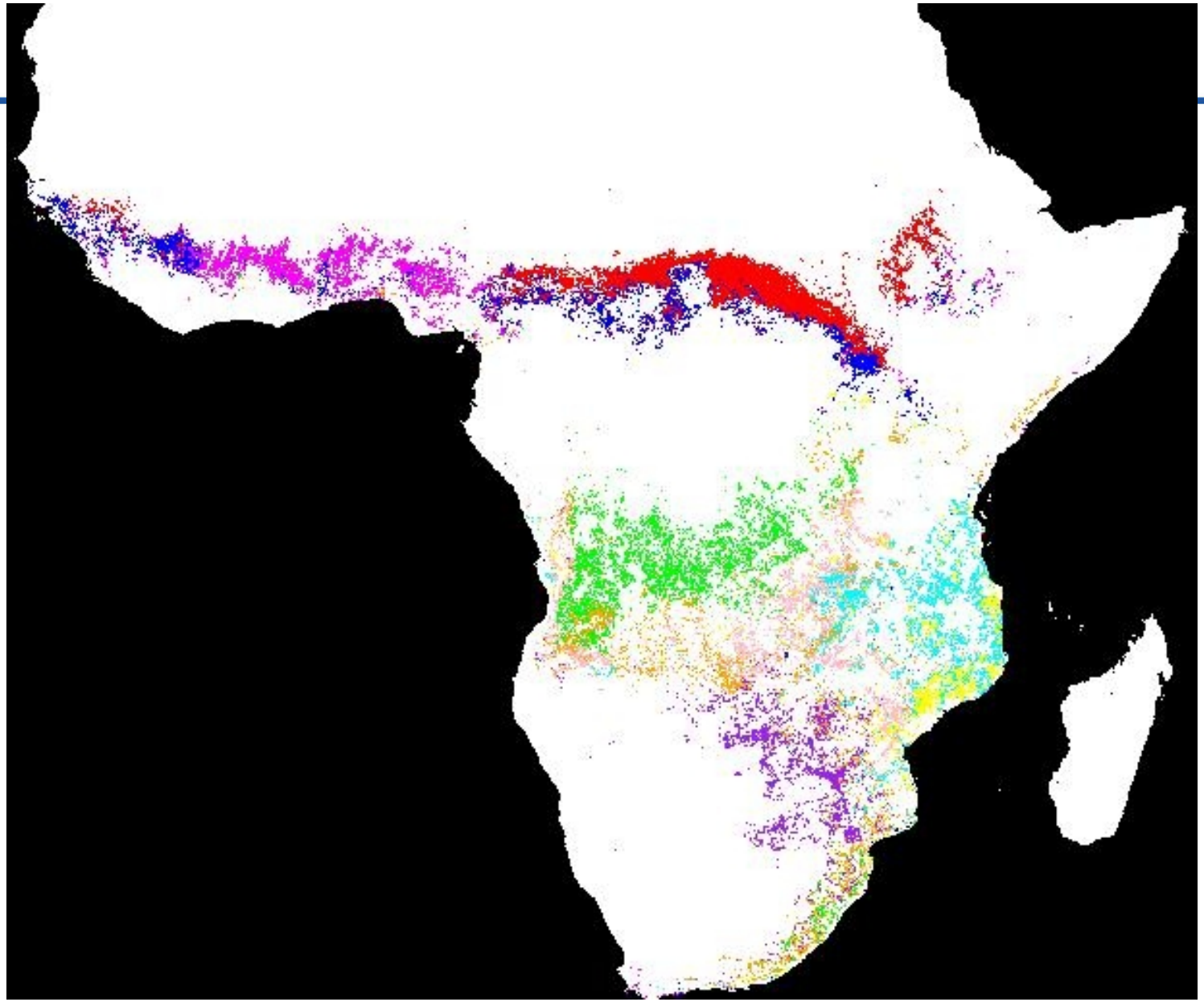


CORINE 2000 raster 100m de résolution
(Source IFEN)

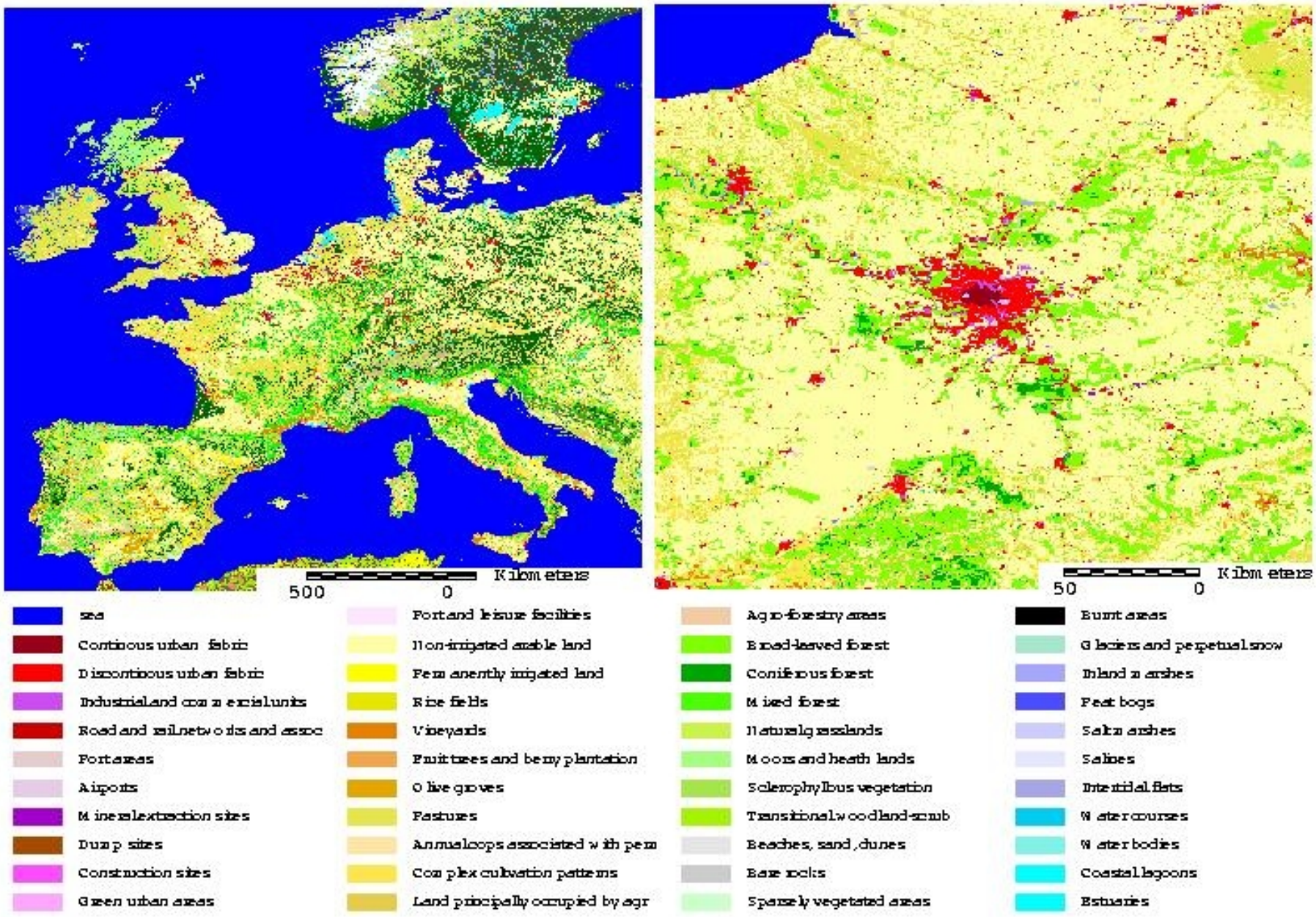


Sous-classes de la classe d'occupation des sols "evergreen forest"

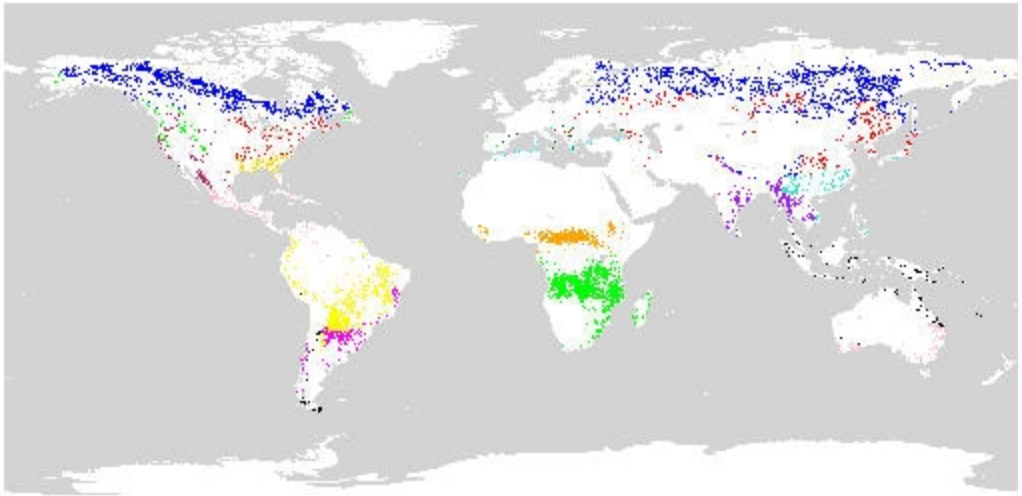
CNRM/GMME
J-L CHAMPEAUX



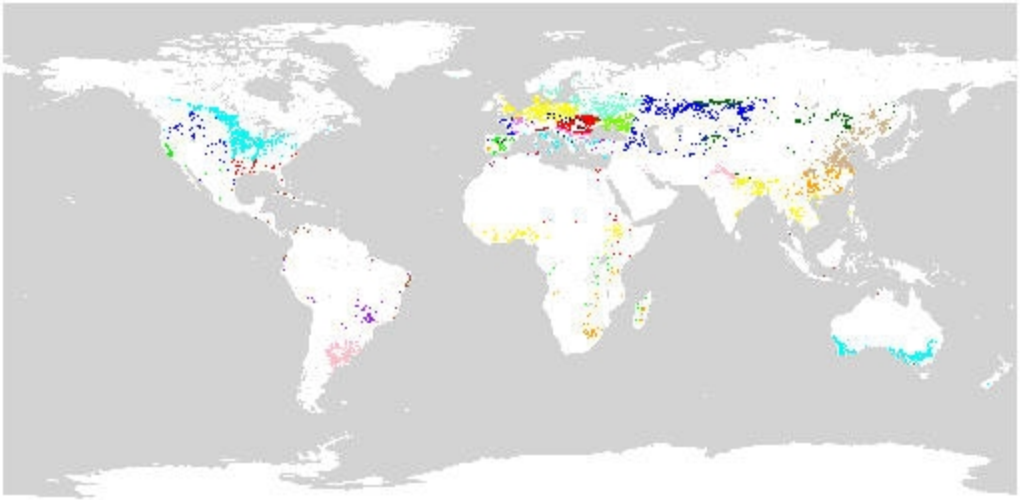
Classe Deciduous Woodland (GLC2000)



Corine Land cover (1990)sur l'Europe à 250m de résolution



Les différents types de woodland



Les différents types de cultures