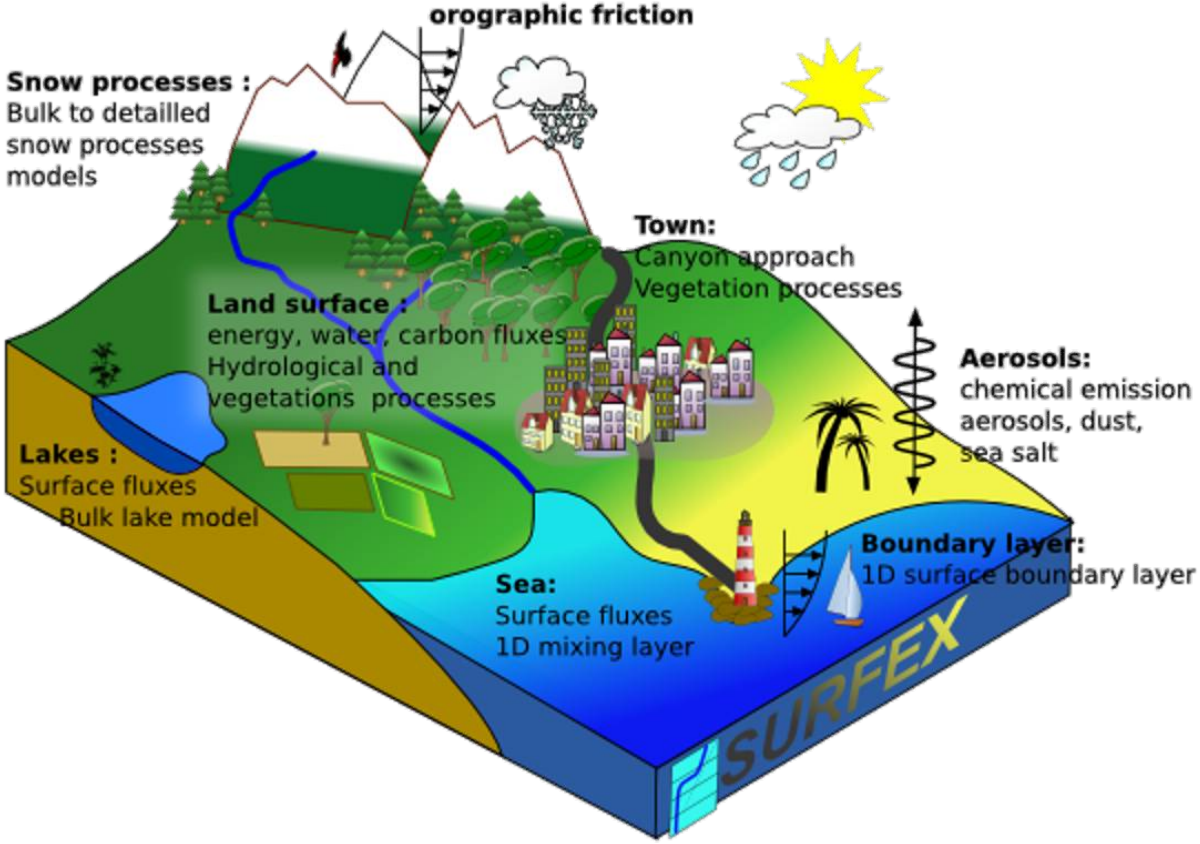
Introduction to SURFEX



Outline

1. Main principles
2. The physical schemes
3. Describe the surface
4. Physiographic data
5. How to run SURFEX in MESONH

SURFEX documentation

Documentation : scientific documentation and user's guide, export versions :

http://www.umr-cnrm.fr/surfex/

A SURFEX course is organized twice a year

Presentation and exercices :

http://www.cnrm.meteo.fr/surfex/spip.php?article423

What is SURFEX ?

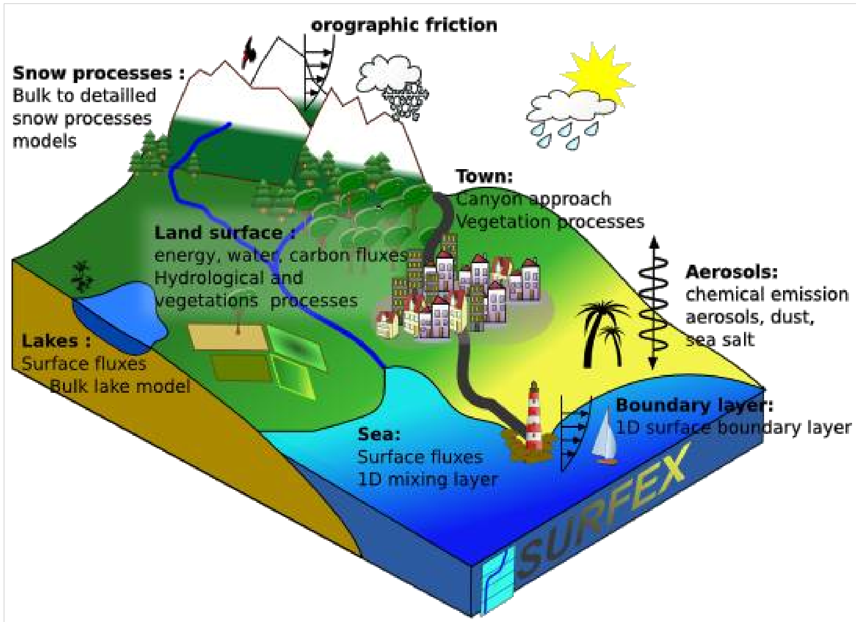
SURFEX = **SURF**face **EX**ternalisée

→ represents the surface processes

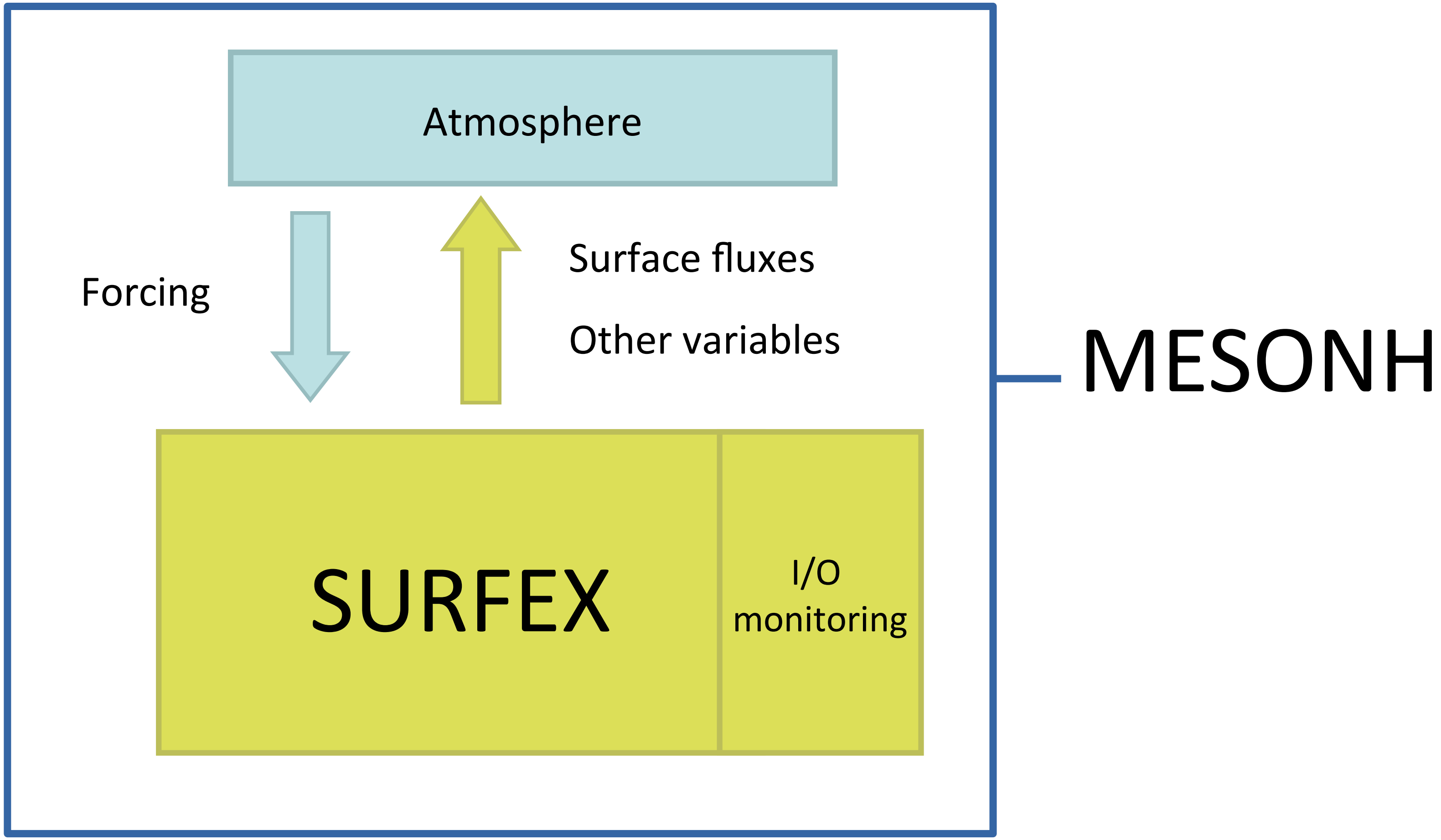
→ « externalized » = the code can be used inside a meteorological or climate model, or in stand alone (offline) mode.

→ modular structure, can include new parameterizations

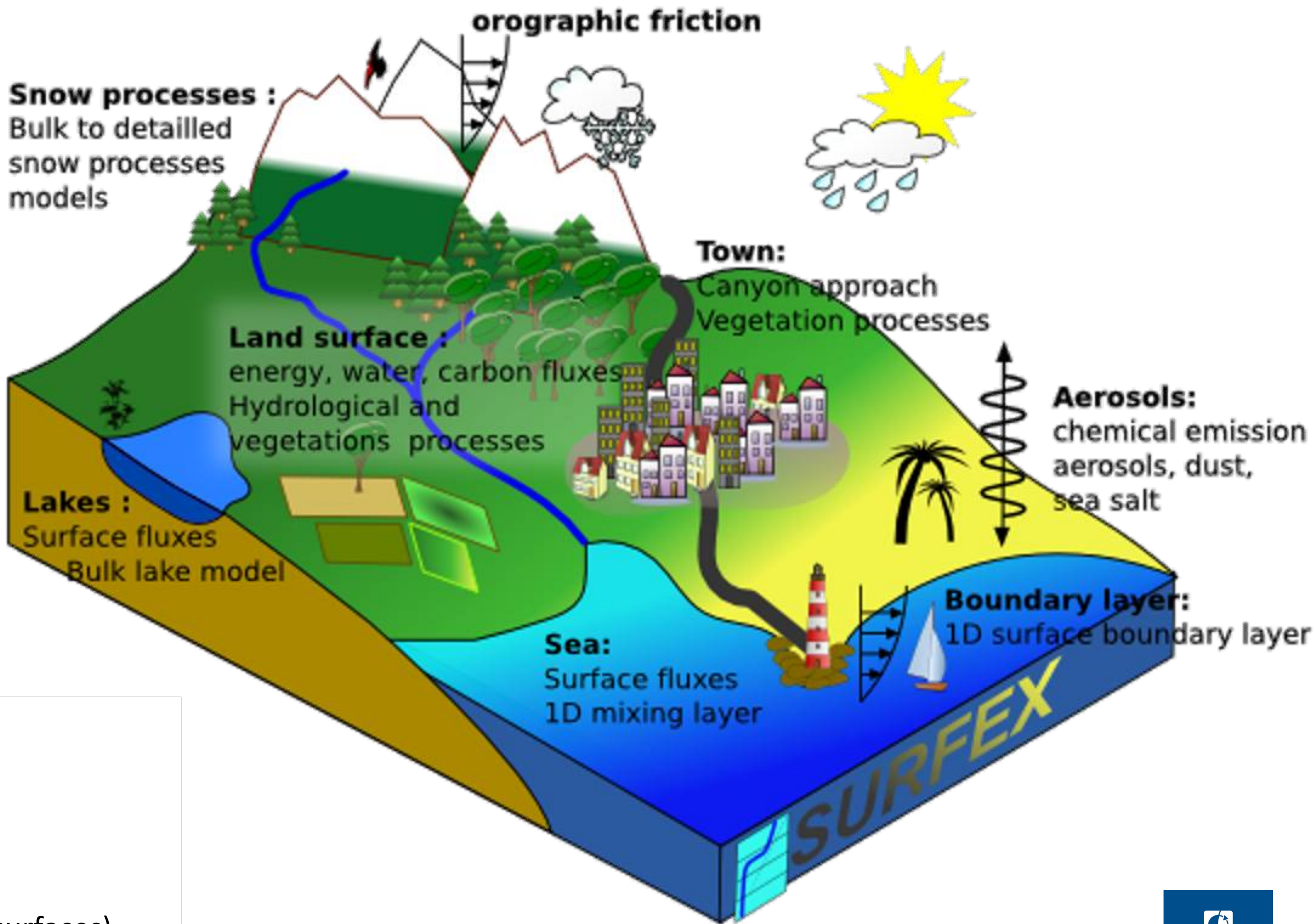
→ the aim is to simulate the fluxes between the surface and the atmosphere: energy, water, carbon, dust, snow, chemical species, ...



Coupling and interfaces



Tiling approach



Four main tiles :

- SEA
- LAKES
- NATURE (natural surfaces)
- TOWN

METEO FRANCE

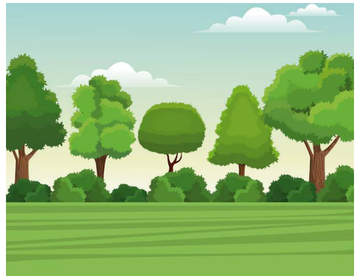
Tiling approach

Tiles aggregation

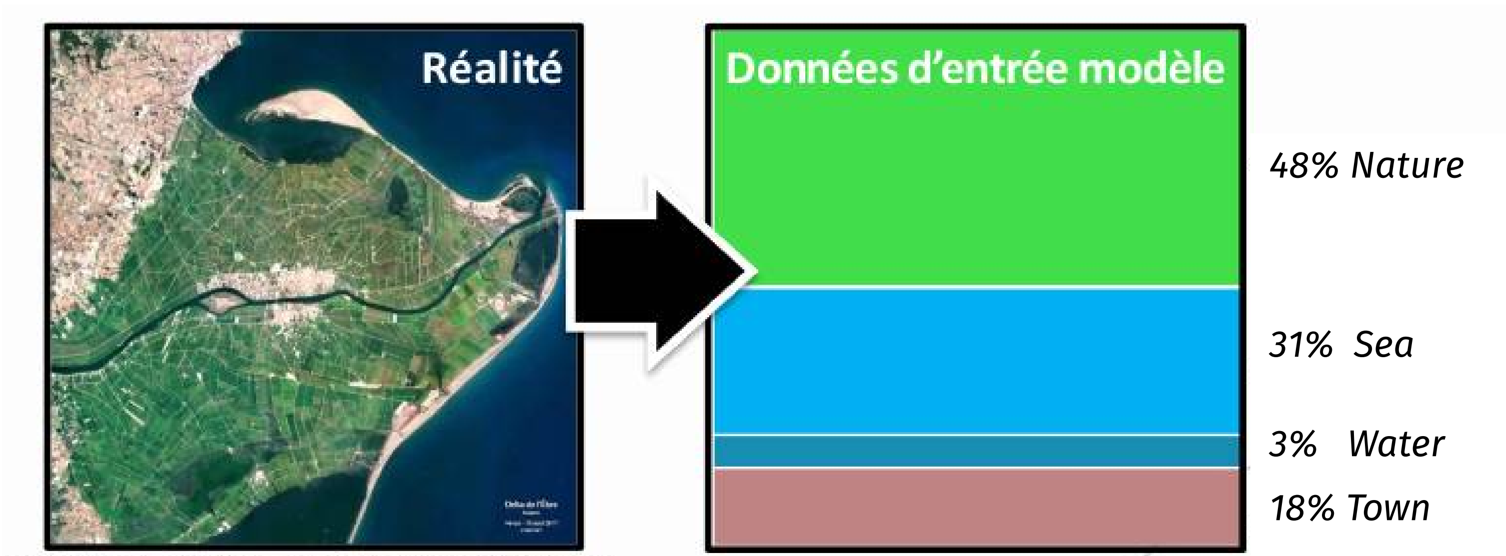
SEA

WATER

NATURE



TOWN

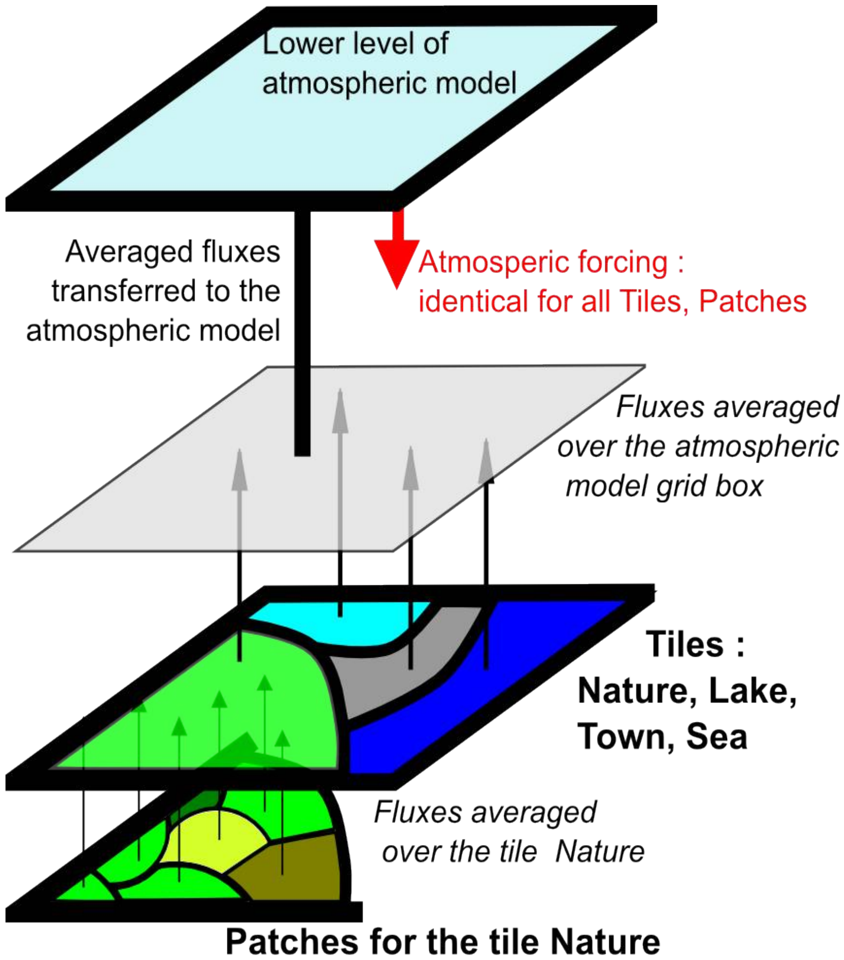


Delta de l'Ebre observé par Venµs
(Copyright CNES 2017)

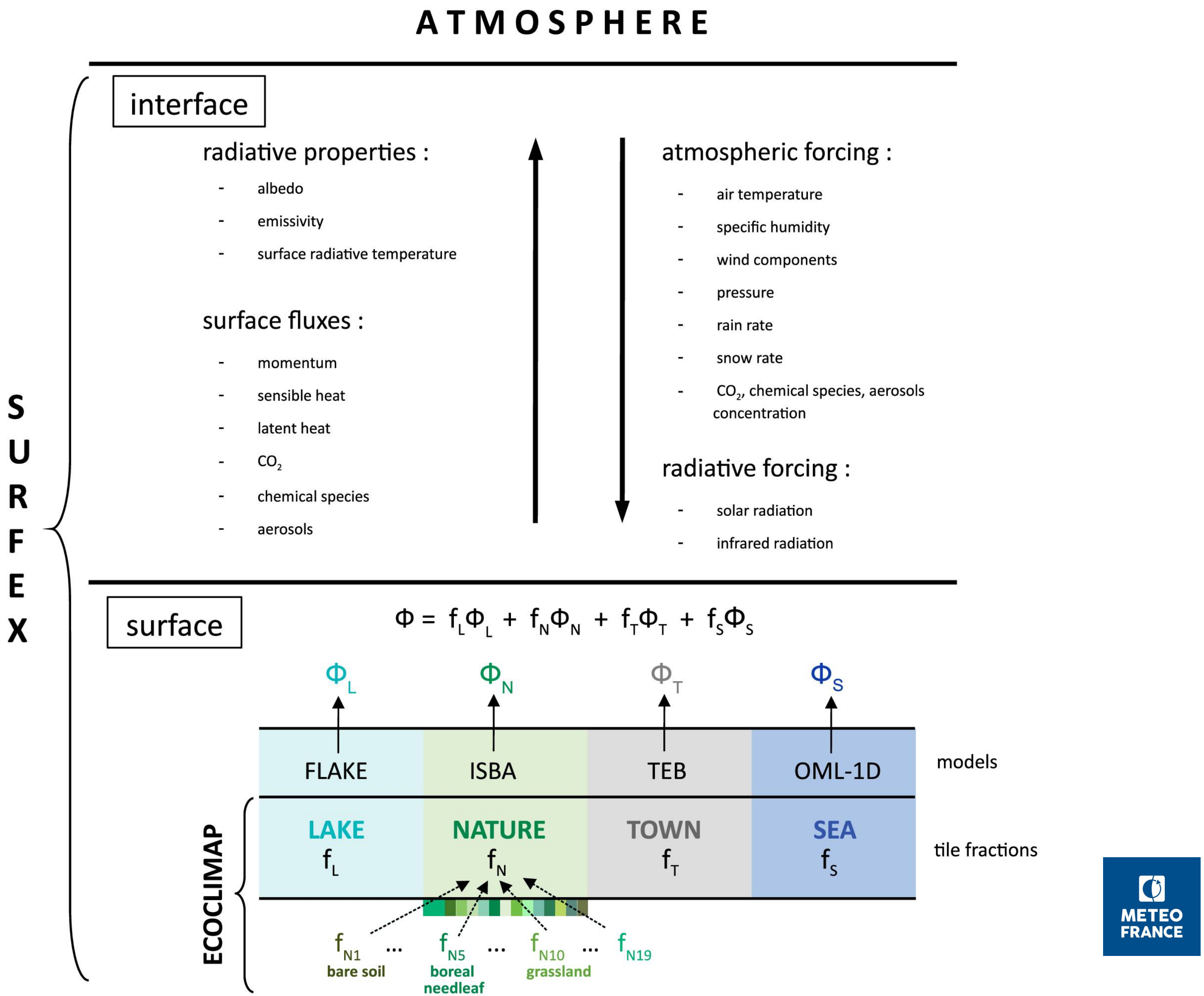
The surface heterogeneity in a grid

<u>Tiling approach :</u>

- Within a grid mesh, the surface is divided into several homogeneous component.
- Each component receives the same atmospheric forcing
- Each component calculates fluxes
- Fluxes are aggregated and returned to the atmosphere
- No horizontal transfert within the surface



Interface with the atmosphere



Outline

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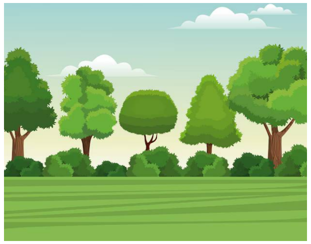
Physical schemes

SEA and OCEANS :

Prescribed SST, Charnock formula
Mondon and Redelsperger
ECUME (multicampaign parametrisation)
1D ocean model

WATER :

Prescribed surface temperatures, Charnock formula
FLake

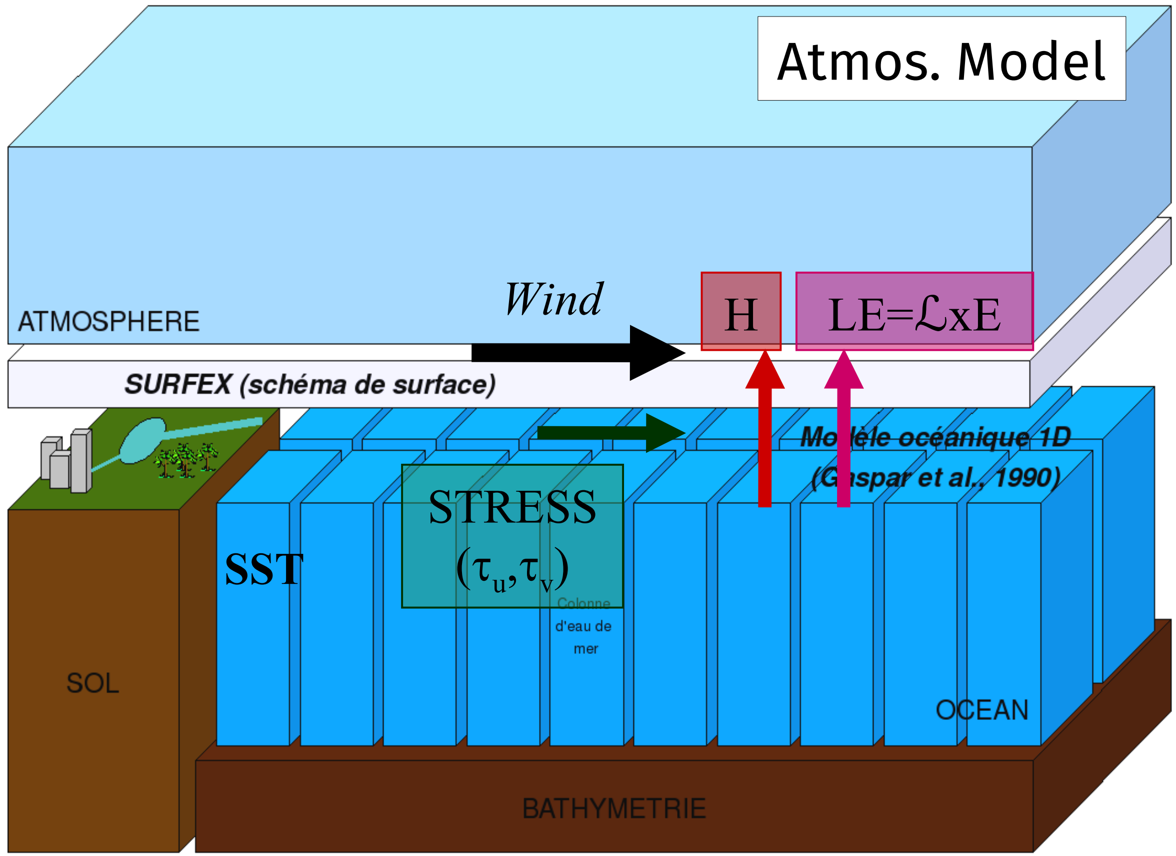


**SOIL/VEGETATION : ** ISBA
(Interaction Soil Biosphere Atmosphere)

TOWN : TEB (Town Energy Balance)
Canyon Approach,
Detailed radiatif scheme
Heat storage in buildings

SEA / OCEAN

- ECUME multi-campaign parametrisation (prescribed SST)
- 1D ocean mixing layer model Gaspar et al., 1990



WATER: FLake model

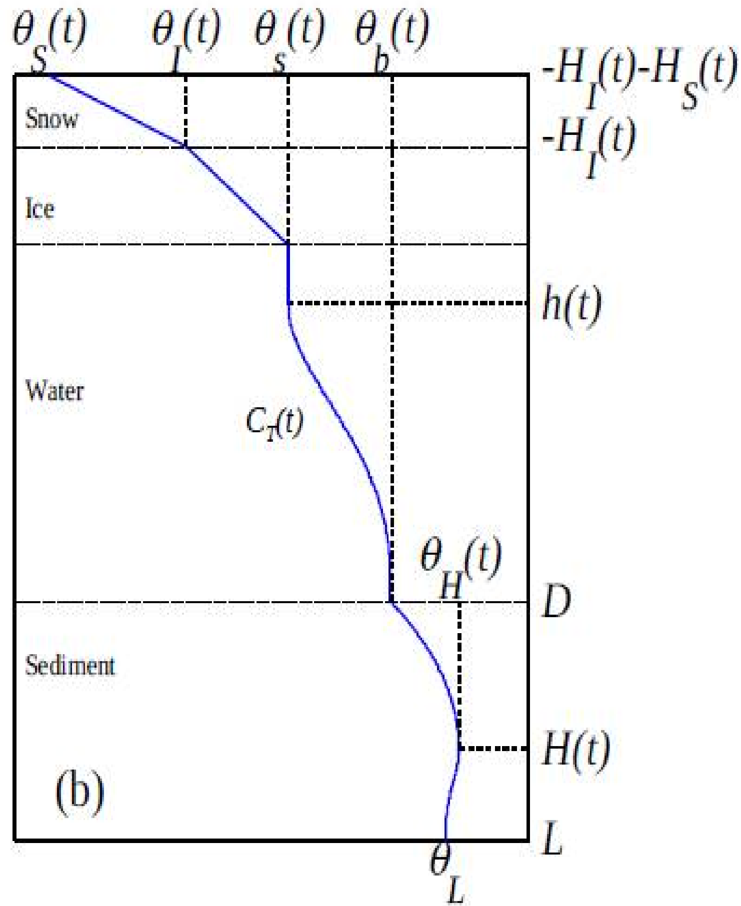
Simple model, based on assumed shape of the temperature profile

Prognostics variables :

- the surface temperature
- the bottom temperature
- the mixed-layer depth
- the depth within bottom sediments penetrated by the thermal wave
- the temperature at that depth

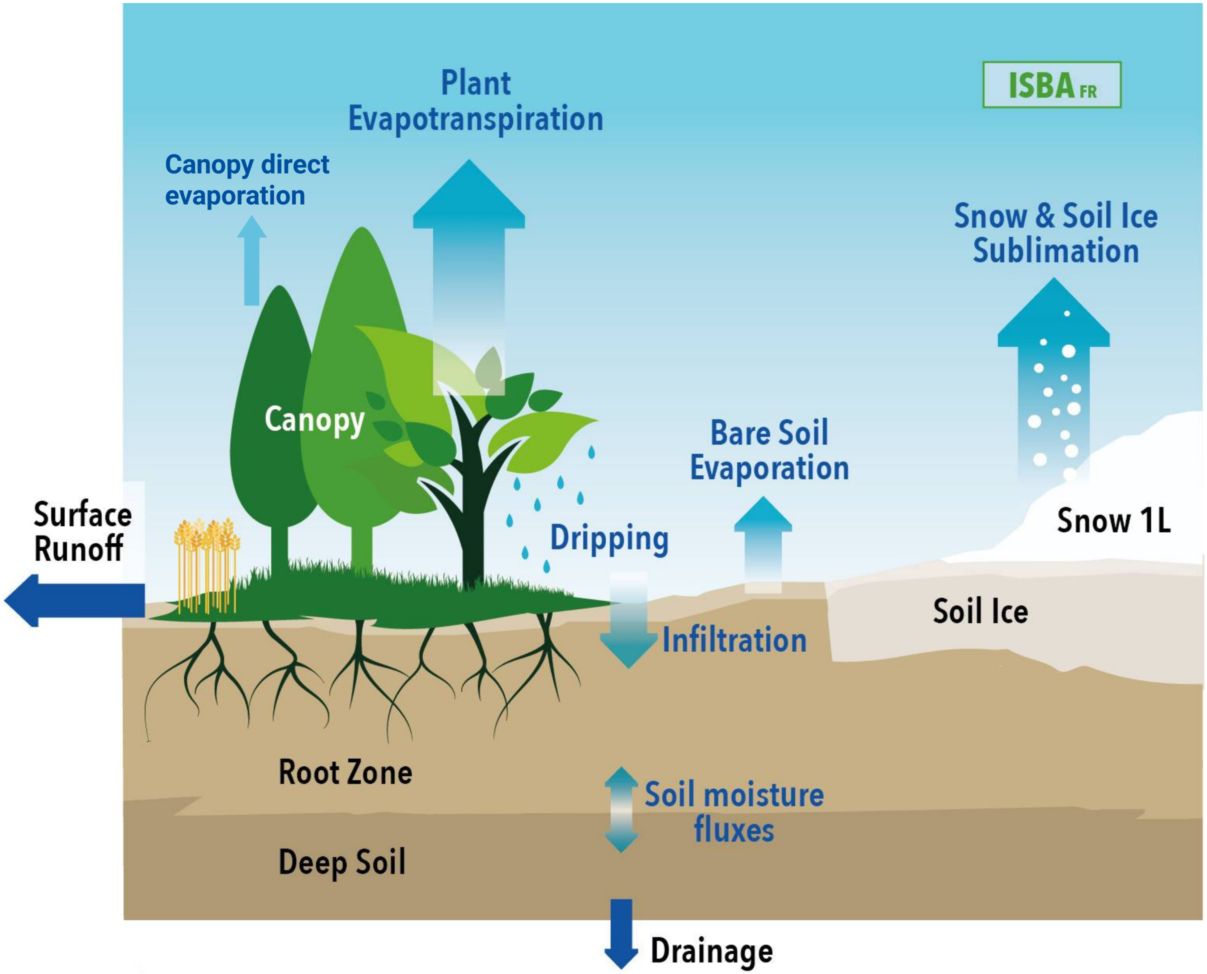
In case of snow/ice :

- the ice depth,
- the temperature at the ice upper surface,
- the snow depth, and the temperature at the snow upper surface.



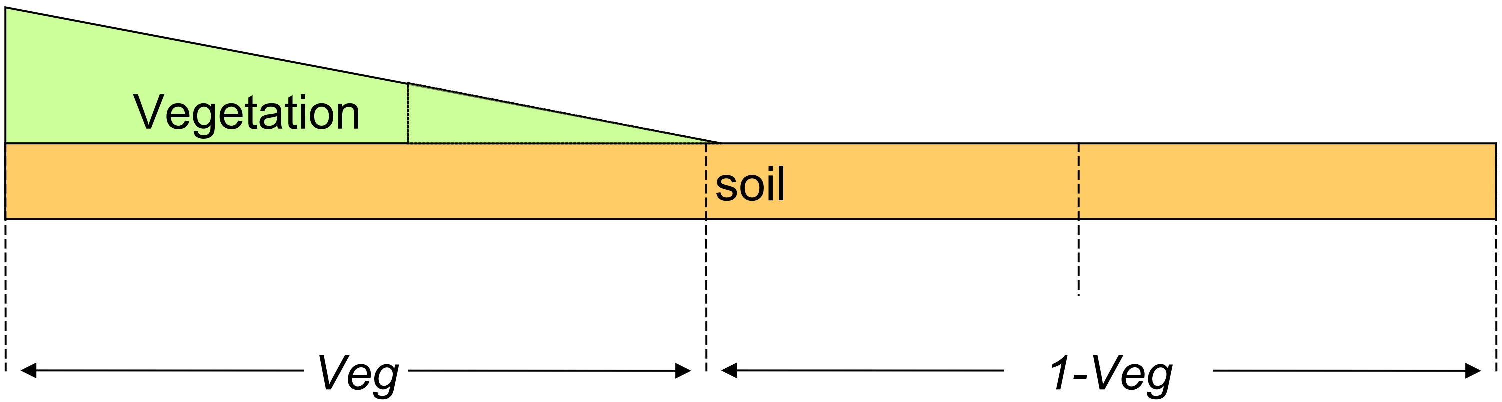
http://www.flake.igb-berlin.de/

NATURE : ISBA

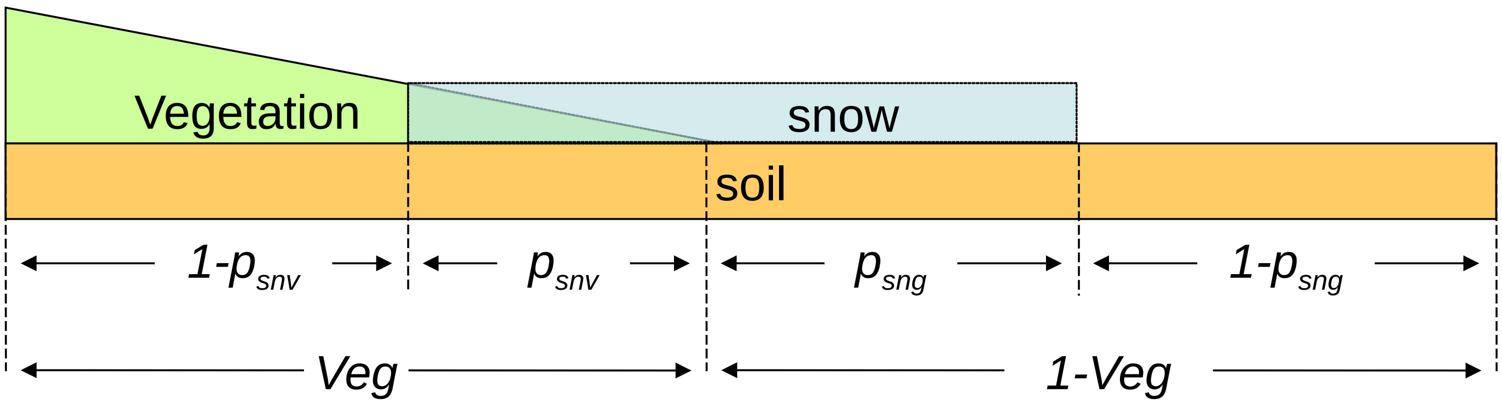


ISBA FR
Plant Evapotranspiration
Canopy direct evaporation
Snow & Soil Ice Sublimation
Canopy
Bare Soil Evaporation
Surface Runoff
Dripping
Snow 1L
Soil Ice
Infiltration
Root Zone
Soil moisture fluxes
Deep Soil
Drainage

NATURE : ISBA



NATURE : ISBA



Snow fraction : $p_{sn} = p_{snv} + p_{sng}$

Albedo : $\alpha_{total} = (1-p_{snv})\,\alpha_{veg} + p_{sn}\,\alpha_{snow} + (1-p_{sng})\,\alpha_{soil}$

Emissivity : $\varepsilon_{total} = (1-p_{snv})\,\varepsilon_{veg} + p_{sn}\,\varepsilon_{snow} + (1-p_{sng})\,\varepsilon_{soil}$

NATURE : ISBA
Main parameters

Primary parameters	**Secondary parameters**
Soil	
Clay fraction (X_{clay})	
Sand fraction (Y_{sand})	
	Saturation (or porosity) (W_{sat})
	Field capacity (W_{fc})
	Wilting point (W_{wilt})
Vegetation	
Type of cover	
	Minimal surface resistance (R_{smin})
	Leaf area index (LAI)
	Roughness lenght for momentum and heat z_0 and z_{0h}
	Fraction of vegetation (veg)
Both	
Soil depth (d_i) i =1,2,...	
Albedo (α)	
Emissivity(β)	

NATURE : ISBA

main physical options

ISBA	Soil	
	Vegetation	
	Hydrology	
	Snow	

METEO FRANCE

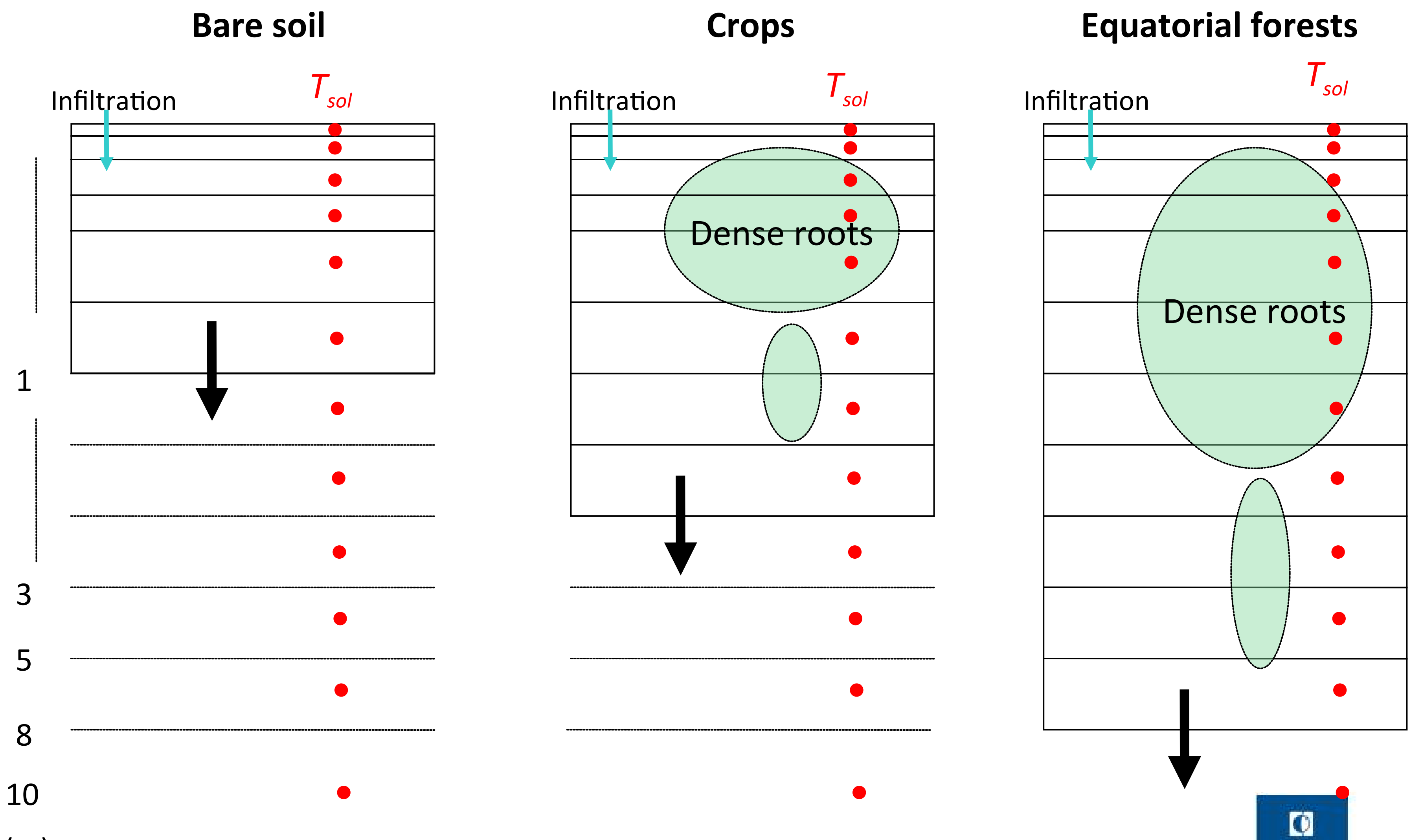
NATURE : ISBA
main physical options

ISBA	Soil	Force restore : 2 temperatures 2 or 3 layers for water, icing Diffusion : multilayer (temperature, water, icing)	CISBA='2-L' or '3-L' CISBA='DIF'
	Vegetation		
	Hydrology		
	Snow		

NATURE : ISBA
main physical options for soil

Option Namelist : CISBA	**Temperature profile**	**Hydrology profile**
2-L	Ts : surface temperature T2 : deep temperature	Surface layer (1cm) Root zone
3L (by default)	Ts : surface temperature T2 : deep temperature	Surface layer (1cm) Root zone Sub-root zone
DIF	N temperature	N soil layers (default = 14 layers) root zone depends on vegetation (Richard's equations)

NATURE : ISBA
main physical options for soil - DIF



Source : B. Decharme, CNRM

NATURE : ISBA
main physical options

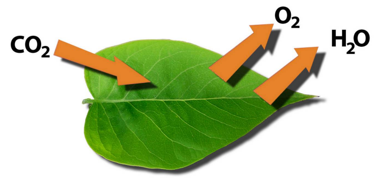
ISBA	Soil	Force restore : 2 temperatures 2 or 3 layers for water, icing Diffusion : multilayer (temperature, water, icing)	
	Vegetation	Noilhan et Planton 89 (~Jarvis) A-gs (photosynthesis and CO_2 fluxes) A-gs and interactive vegetation Slow carbon processes (wood and roots)	CPHOTO='NON' CPHOTO='AST' CPHOTO='NIT' CPHOTO='NCB'
	Hydrology		
	Snow		

NATURE : ISBA

main physical options for vegetation

Evapotranspiration

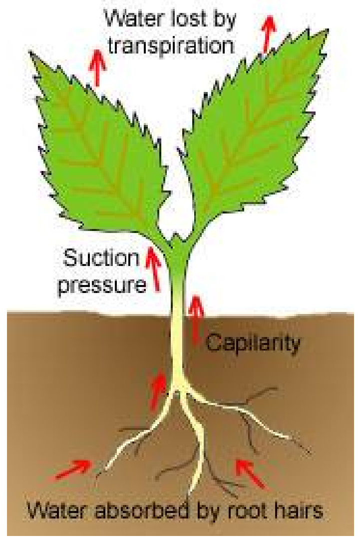
$$E_{tr} = \rho_a \left(1 - \delta\right) \frac{\left[q_{sat}\left(T_s\right) - q_a\right]}{R_a + \boxed{R_c}}$$



Simple (Jarvis) option : NO explicit photosynthesis

In reality: Canopy resistance includes many processes: soil water extraction (root resistance, profile/depth, stress), photosynthesis (vapor pressure deficit, light/shading, CO_2 concentration, T, base resistance…)

→ I**SBA-Ags options**



METEO FRANCE

NATURE : ISBA
main physical options

<table>
<tr><td rowspan="4">ISBA</td><td>Soil</td><td>Force restore : 2 temperatures
2 or 3 layers for water, icing
Diffusion : multilayer (temperature, water, icing)</td></tr>
<tr><td>Vegetation</td><td>Noilhan et Planton 89 (~Jarvis)
A-gs (photosynthesis and CO2 fluxes)
A-gs and interactive vegetation
Slow carbon processes (wood and roots)</td></tr>
<tr><td>Hydrology</td><td>No subgrid process
Subgrid surface runoff
Subgrid drainage
Flooding and coupling with TRIP</td></tr>
<tr><td>Snow</td><td></td></tr>
</table>

NATURE : ISBA

main physical options

ISBA	Soil	Force restore : 2 temperatures 2 or 3 layers for water, icing Diffusion : multilayer (temperature, water, icing)
	Vegetation	Noilhan et Planton 89 (~Jarvis) A-gs (photosynthesis and CO_2 fluxes) A-gs and interactive vegetation Slow carbon processes (wood and roots)
	Hydrology	No subgrid process Subgrid surface runoff Subgrid drainage Flooding and coupling with TRIP
	Snow	1 layer, albedo, density variable (ARP/Climat, Douville 95) 1 layer, albedo, density variable (ARP/ALD, Bazile) Multilayer (3, or…) albedo, density, liquid water content (Boone and Etchevers 2000)

METEO FRANCE

NATURE : ISBA

the snow models

EBA	1 reservoir, 2 prognostic variables (Wn, albédo) model : ARPEGE/PN, ALADIN/PN (Bazile)
D95 (default)	1 reservoir, 3 prognostic variables (Wn, albedo, density) (climate model, AROME, offline) (Douville, 1995)
3-L	ISBA-ES (explicit snow) multi-layer, 4 prognostic variables offline (chaîne SIM, …) and climate applications, 12 layers (Boone and Etchevers 2001 ; Decharme et al., 2016)
CRO	CROCUS/SURFEX : multilayer model based on ISBA-ES and the snow model CROCUS (description of snow grains, increased number of layers) (Brun et al., 1992, Vionnet et al., 2012)

METEO FRANCE

NATURE : ISBA
the snow models

CRO	CROCUS/SURFEX : multilayer model based on ISBA-ES and the the snow model CROCUS (description of snow grains, increased number of layers) (Brun et al., 1992, Vionnet et al., 2012)

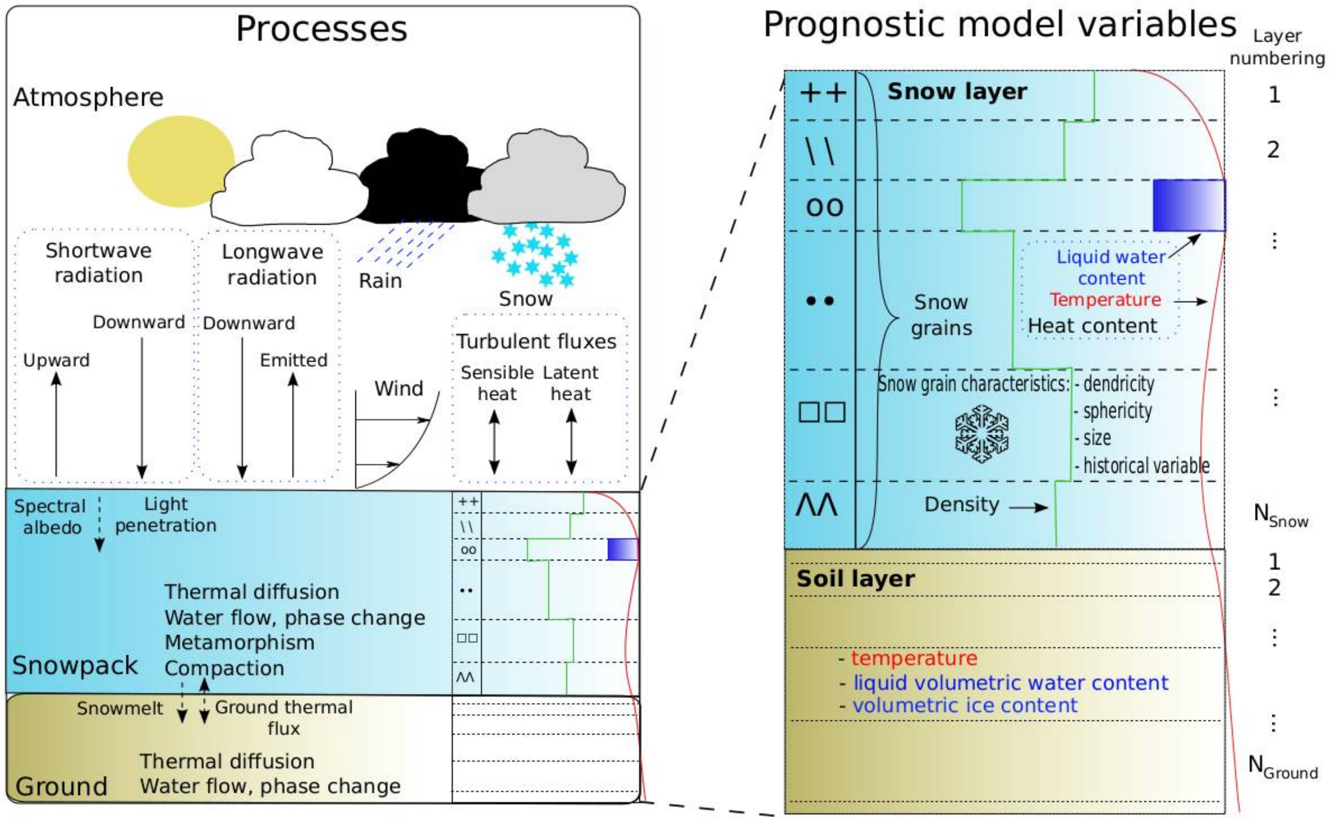


Fig. 1. Main physical processes and model variables.

Vionnet et al. 2012

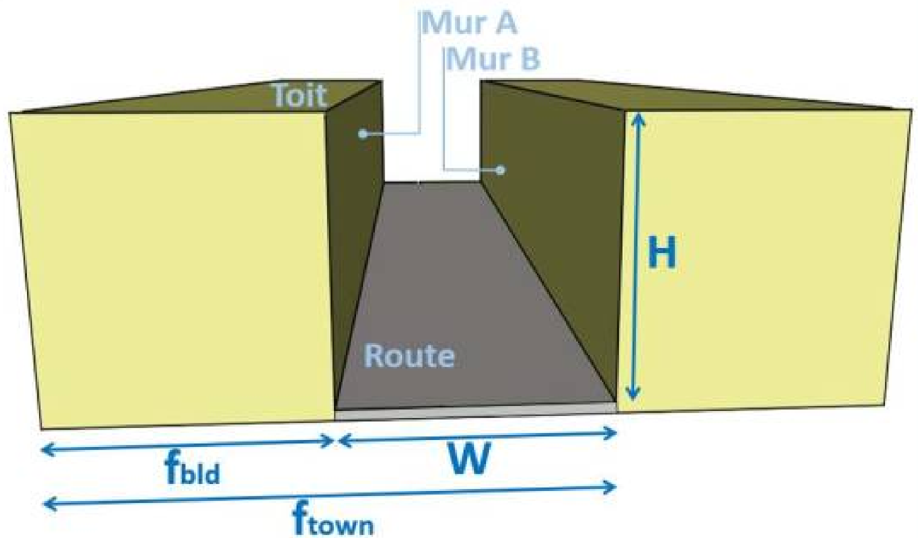
Description of the TEB model

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

The buidings aren't explicitely solved

The roads are represent by an **average urban canyon**

(concept of Oke 1982)



Radiative balance

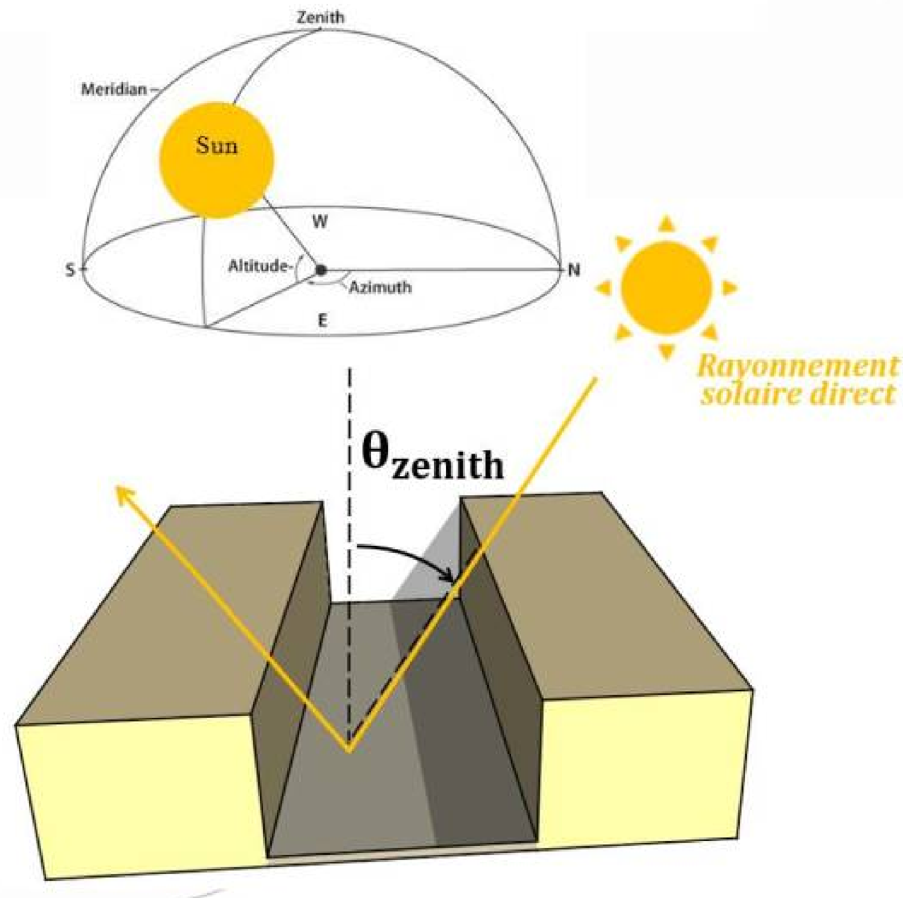
- A radiative balance is calculated for each surface (road, roof, walls), taking into account :
  - **The solar direct radiation** (directional) got by the surface
    = geometric calculation of shadowing effects functions of the shape and the orientaion of the canyon, and of the position of the sun

$$S^{\Downarrow}_{road} = S^{\Downarrow}\left[1 - \frac{\frac{H}{W}\tan\theta_{zenith}}{\left|\sin\theta_{azimuth} - \sin\theta_{canyon}\right|}\right]$$

H/W	Aspect ratio of the canyon
θ_{can}	Angle of orientation of the canyon
θ_{zenith}	Zenithal angle
$\theta_{azimuth}$	Azimutal angle

$$S^{\Downarrow}_{wall\ A} = S^{\Downarrow}\left[1 - S^{\Downarrow}_{road}\right]\frac{W}{H}$$ *(in the sun)*

$$S^{\Downarrow}_{wall\ B} = 0$$ *(in the shadow)*



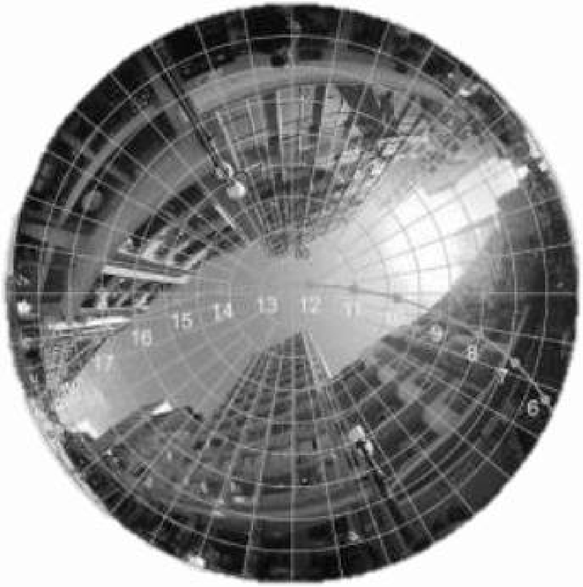
Radiative balance

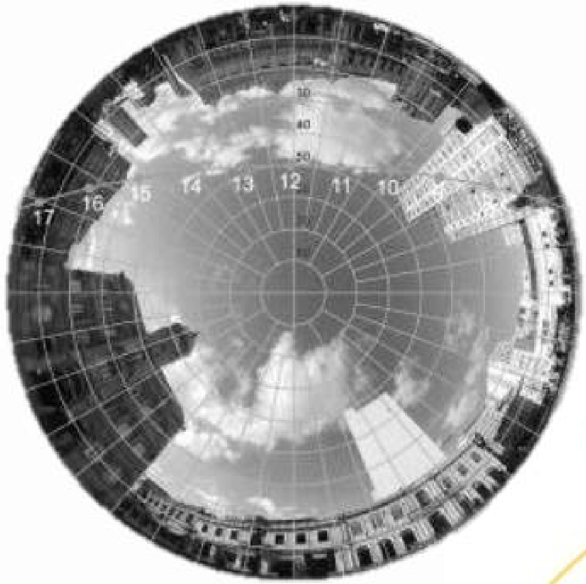
- A radiative balance is calculated for each surface (road, roof, walls), taking into account :
  - **The diffusive solar radiation** (isotrope) got by the surface
    = *geometric calculation based on the sky view factor of the surface*

$$S^{\downarrow}_{road} = \Psi_{road}\, S^{\downarrow}$$
$$S^{\downarrow}_{wall} = \Psi_{wall}\, S^{\downarrow}$$

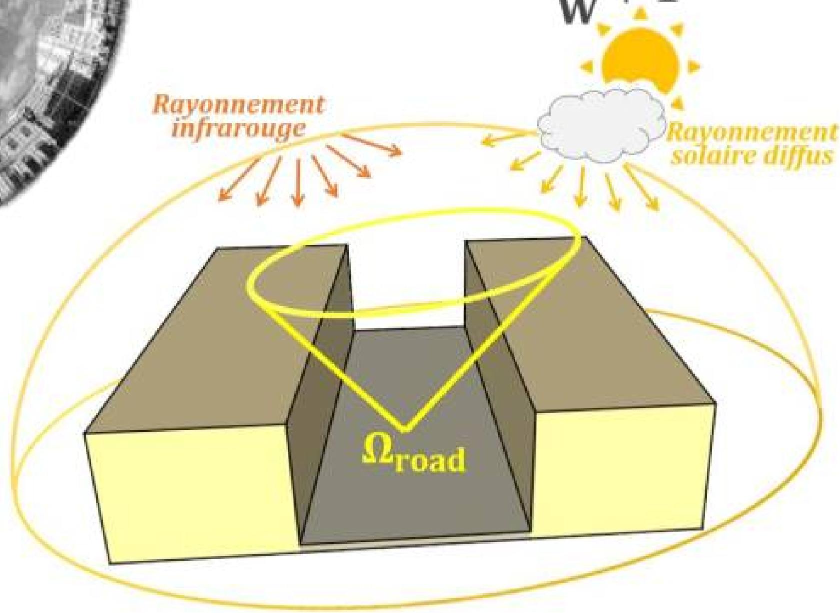
$$\Psi_{road} = \sqrt{\left(\frac{H}{W}\right)^2 + 1} - \frac{H}{W}$$

$$\Psi_{wall} = \frac{1}{2}\,\frac{\frac{H}{W} + 1 - \sqrt{\left(\frac{H}{W}\right)^2 + 1}}{\frac{H}{W} + 1}$$





The sky view factor Ψ is the fraction of the canopy of heaven seen from an observation point (here the center of the surface) according the narrowness of the canyon for a flat surface without obstacles



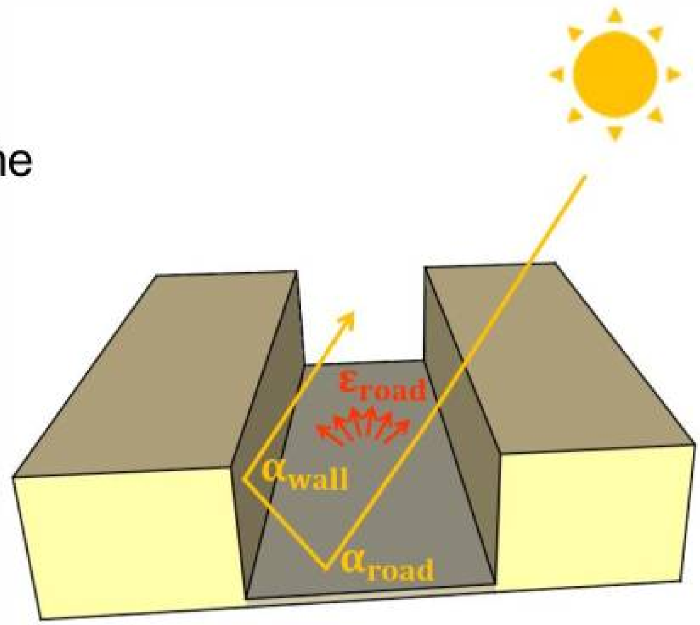
Radiative balance

- A radiative balance is calculated for each surface (road, roof, walls), taking into account :
  - **Inter-reflections between the surfaces**

    = calculation based on the shape factors between the surfaces and the radiative properties (albedo, emissivity)

    → at each reflection, a part of the energy is absorbed by the surface

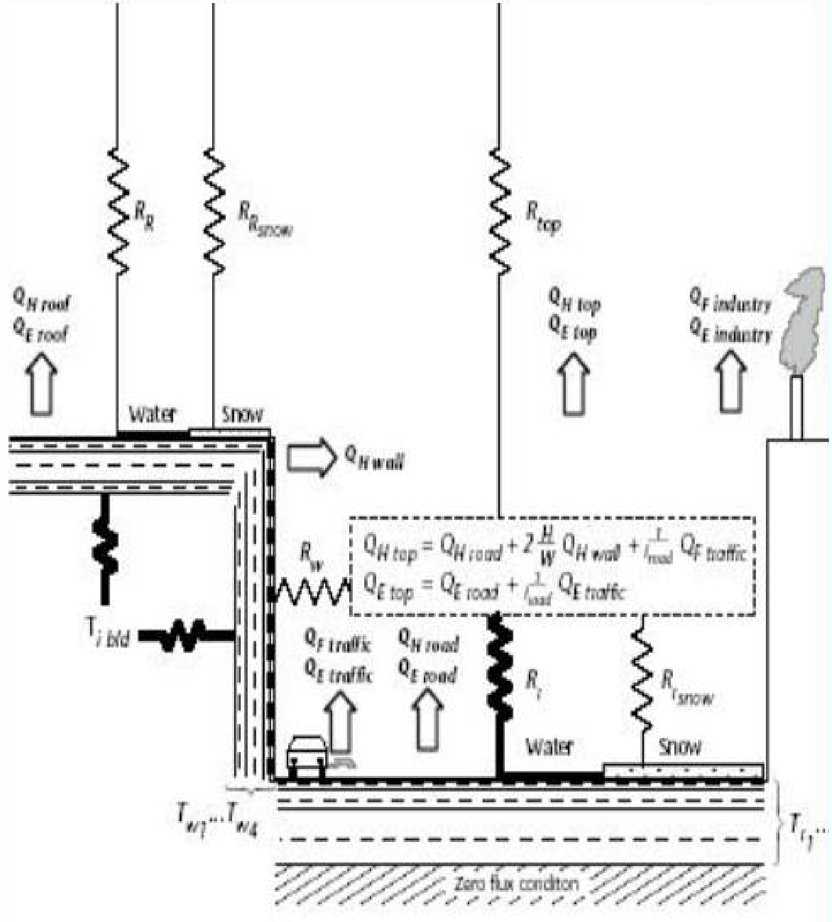
  - **REM :** the surface emissions take part in the radiative balance for the infrared radiation (functions of the surface temperatures)



Temperatures of the urban surfaces

For each urban surface, the **equation of evolution of the temperature** is solved

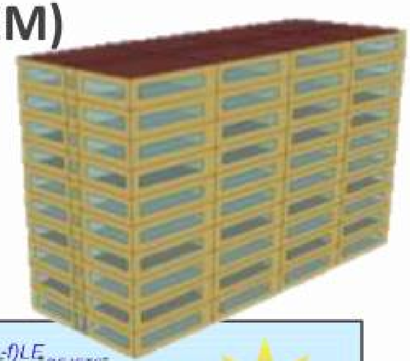
- The temperature of the first layer (fine) is assimilated to the surface temperature
- The equation of evolution depends on the energy balance for the surface layer
- It depends on the conduction of the heat for the other layers of materials
- Limit conditions for the last layer (in the deep soil for the road and in the buildings for the walls and the roofs)



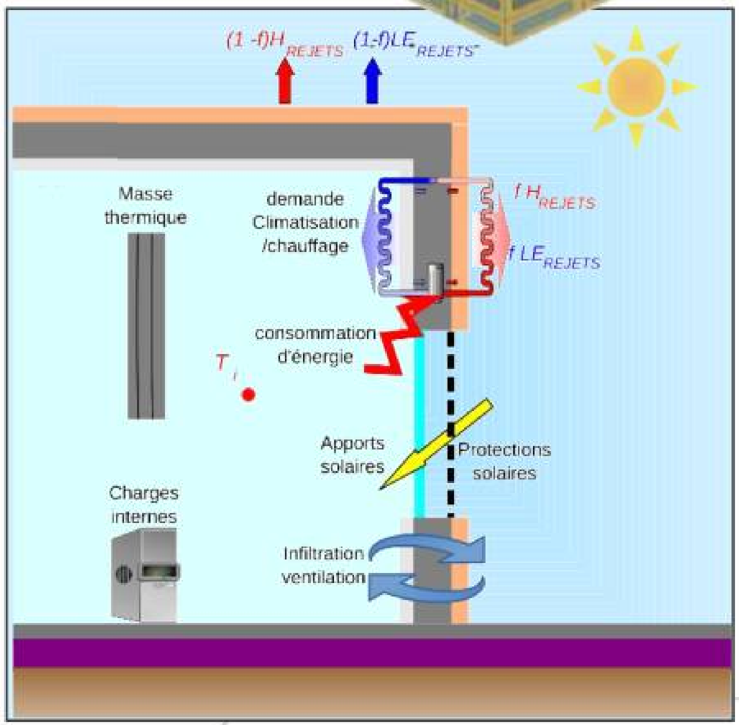
Source : Masson BLM 2000

Energetics of the building

The TEB model today includes the **Building Energy Model (BEM)** that solved the energy balance inside the building



- It's inspired by more sophisticated building energetics models like Energy Plus
- The inside of the building is represented as a **unique thermal** area, ie without taking into account the splits between floors and apartments
- It defines a **unique thermal mass** that represent the thermal inertia of the materials inside the buildings (floors, dividing walls)
- It speficies a **fraction of window surfaces** for the Il spécifie une **fraction de surfaces vitrées** pour les facades



Source : Pigeon et Bueno 2012

Urban vegetation and underground

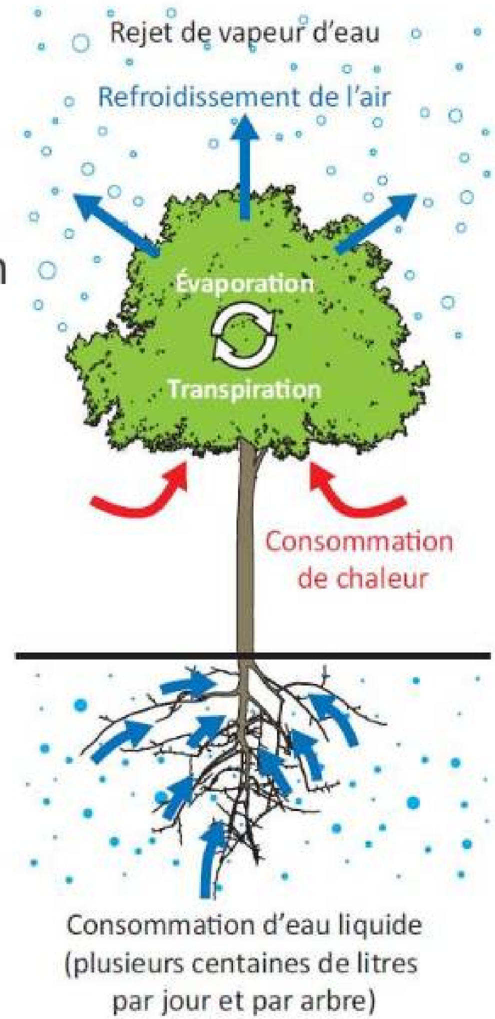
The most recent versions of the model represent

1. The full soil vegetation and the street trees
2. The green roofs
3. The urban underground and the hydrology
4. The watering systems

Urban vegetation and underground

These developements allow to model :

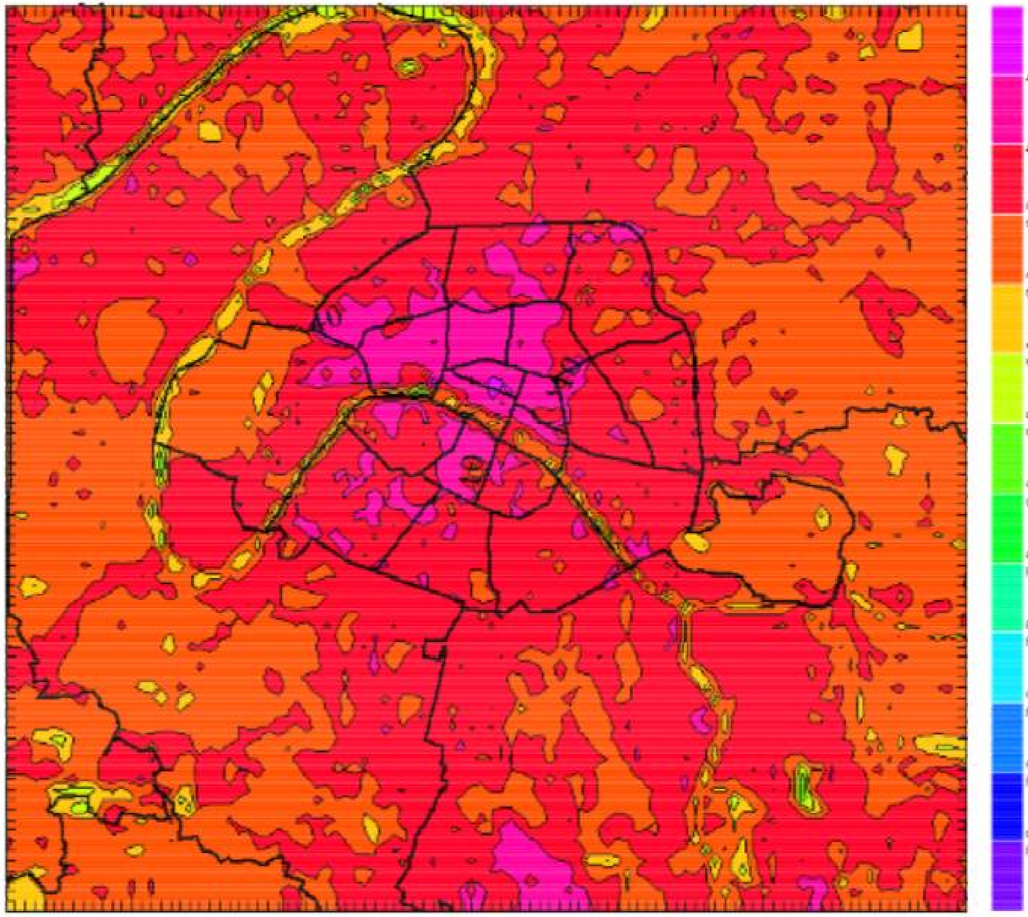
- **Interactions** built/vegetation/soil/atmosphere
- **Cooling power** of the vegetation by evapotranspiration
- **Shadowing** and attenuation of the radiation
- **Thermal isolation** of the buildings
- **Fluxes** surface/soil/network
- Evolution of the **water contents of soils**



Source : APUR

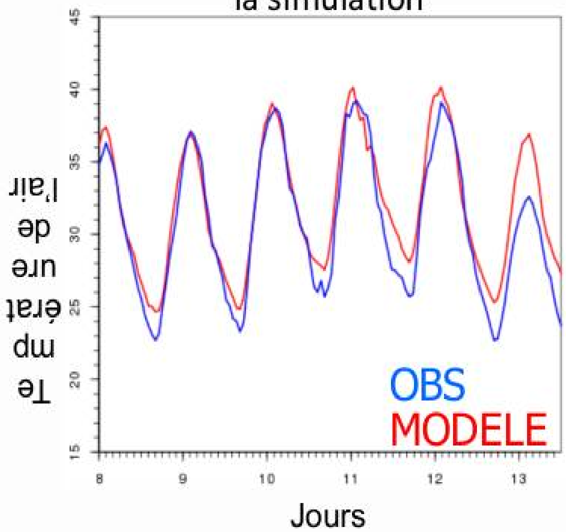
Examples of applications

Simulation of the 2003 heatwave on the Parisian region
with TEB / Meso-NH at 250 m resolution



T2m on the parisian region
during the 2003 heatwave
(spatial resolution = 250m)

Évaluation systématique de
la simulation



Source : Projet CLIM2 – Météo France, CLIMESPACE, CNAM

Describe the surface

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Describe the surface

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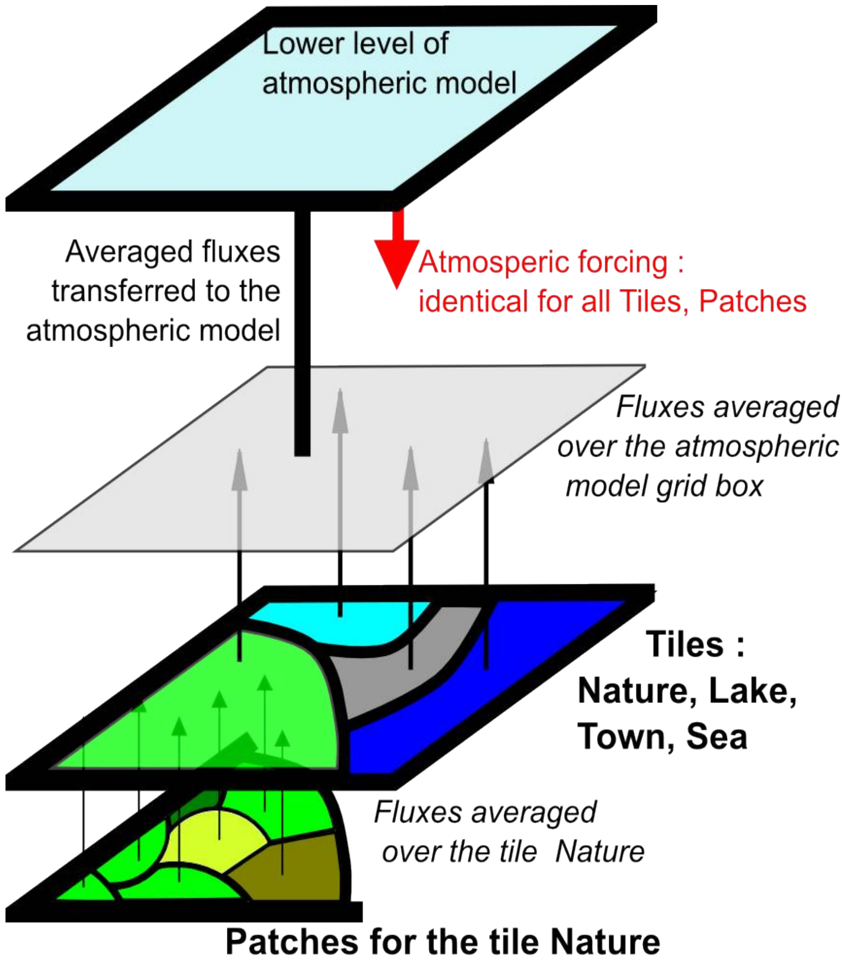


Describe the surface

The surface needs several types of parameters :

- Orography
- Type of the surface (tile)
- Type of vegetation for « NATURE »
- ISBA : Albedo, leaf area index, soil texture, height of trees, ...
- FLAKE : lake depth, extinction coefficient …
- SEA : Bathymetry (if 1D ocean model activated)
- - …

Solutions :

- Use of existent physiographic maps
- Use your own data
- Prescribe the model uniform parameters using a namelist.

METEO FRANCE

Describe the surface

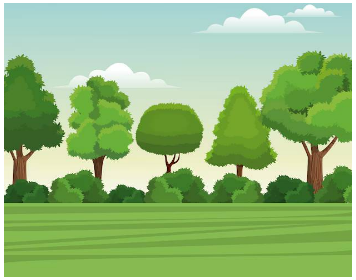
The tiles in SUFEX

The surface is divide into 4 main tiles, which are treated by different models.

SEA

WATER

NATURE



TOWN

Describe the surface

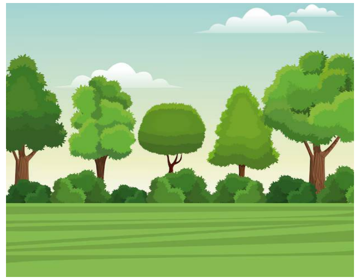
The tiles in SUFEX

The surface is divide into 4 main tiles, which are treated by different models.

SEA

WATER

NATURE



TOWN

The tile NATURE is divided into 19 natural functional types
(20 types with ECOCLIMAP-SG)

NO (no vegetation)	**C4** (summer crops)	**BOGR** (boreal grassland)
ROCK (bare rock)	**IRR** (irrigated crops)	**SHRB** (shrub)
SNOW (permanent snow and ice)	**GRAS** (grassland)	**TEBE** (temperate broadleaf evergreen)
TEBD (temperate boradleaf deciduous)	**TROG** (tropical grassland)	**TENE** (temperate needleleaf evergreen)
BONE (boreal needleleaf evergreen)	**PARK** (peat bogs, parks, gardens)	**BOBD** (boreal broadleaf deciduous)
TRBE (tropical broadleaf evergreen)	**TRBD** (tropical broadleaf deciduous)	**BOND** (boreal needleleaf deciduous)
C3 (winter crops)		

Describe the surface

Concept of patch

Concept of PATCH

- The user is not constraint to consider each vegetation type separately of the others, he can work with a number of patches between 1 (19 types aggregated) and 19 (19 types separated).
- A patch is consequently a merge of several vegetation types.
- If the number of patches is lower than 19, values of surface parameters are calculated no longer by vegetation type but by patch, following an aggregation process lying on the composition of patchs in terms of vegetation types.

Describe the surface

Concept of patch

Number of patches chosen by user

Type of vegetation

	19	12	11	10	9	8	7	6	5	4	3	2	1
NO	1	1	1	1	1	1	1	1	1	1	1	1	1
ROCK	2	2	2	1	1	1	1	1	1	1	1	1	1
SNOW	3	3	3	2	2	2	2	1	1	1	1	1	1
C3	7	7	7	6	5	4	4	3	3	3	3	1	1
C4	8	8	8	7	6	5	4	3	3	3	3	1	1
GRASS	10	10	10	9	8	7	6	5	5	3	3	1	1
BOGR	18	10	10	9	8	7	6	5	5	3	3	1	1
TROG	11	11	10	9	8	7	6	5	5	3	3	1	1
IRR	9	9	9	8	7	6	5	4	4	4	3	1	1
PARK	12	12	11	10	9	8	7	6	4	4	3	1	1
TEBD	4	4	4	3	3	3	3	2	2	2	2	2	1
TRBD	13	4	4	3	3	3	3	2	2	2	2	2	1
TEBE	14	4	4	3	3	3	3	2	2	2	2	2	1
BOBD	16	4	4	3	3	3	3	2	2	2	2	2	1
SHRB	19	4	4	3	3	3	3	2	2	2	2	2	1
TRBE	6	6	6	5	3	3	3	2	2	2	2	2	1
BONE	5	5	5	4	4	3	3	2	2	2	2	2	1
TENE	15	5	5	4	4	3	3	2	2	2	2	2	1
BOND	17	5	5	4	4	3	3	2	2	2	2	2	1

Describe the surface

Concept of patch

NPATCH=1 -> aggregated parameters for all types of vegetation

Number of patches chosen by user

	19	12	11	10	9	8	7	6	5	4	3	2	1
NO	1	1	1	1	1	1	1	1	1	1	1	1	1
ROCK	2	2	2	1	1	1	1	1	1	1	1	1	1
SNOW	3	3	3	2	2	2	2	1	1	1	1	1	1
C3	7	7	7	6	5	4	4	3	3	3	3	1	1
C4	8	8	8	7	6	5	4	3	3	3	3	1	1
GRASS	10	10	10	9	8	7	6	5	5	3	3	1	1
BOGR	18	10	10	9	8	7	6	5	5	3	3	1	1
TROG	11	11	10	9	8	7	6	5	5	3	3	1	1
IRR	9	9	9	8	7	6	5	4	4	4	3	1	1
PARK	12	12	11	10	9	8	7	6	4	4	3	1	1
TEBD	4	4	4	3	3	3	3	2	2	2	2	2	1
TRBD	13	4	4	3	3	3	3	2	2	2	2	2	1
TEBE	14	4	4	3	3	3	3	2	2	2	2	2	1
BOBD	16	4	4	3	3	3	3	2	2	2	2	2	1
SHRB	19	4	4	3	3	3	3	2	2	2	2	2	1
TRBE	6	6	6	5	3	3	3	2	2	2	2	2	1
BONE	5	5	5	4	4	3	3	2	2	2	2	2	1
TENE	15	5	5	4	4	3	3	2	2	2	2	2	1
BOND	17	5	5	4	4	3	3	2	2	2	2	2	1

Type of vegetation

Describe the surface

Concept of patch

NPATCH=3 -> no vegetation / low vegetation / high vegetation

Number of patches chosen by user

Type of vegetation

	19	12	11	10	9	8	7	6	5	4	3	2	1
NO	1	1	1	1	1	1	1	1	1	1	1	1	1
ROCK	2	2	2	1	1	1	1	1	1	1	1	1	1
SNOW	3	3	3	2	2	2	2	1	1	1	1	1	1
C3	7	7	7	6	5	4	4	3	3	3	3	1	1
C4	8	8	8	7	6	5	4	3	3	3	3	1	1
GRASS	10	10	10	9	8	7	6	5	5	3	3	1	1
BOGR	18	10	10	9	8	7	6	5	5	3	3	1	1
TROG	11	11	10	9	8	7	6	5	5	3	3	1	1
IRR	9	9	9	8	7	6	5	4	4	4	3	1	1
PARK	12	12	11	10	9	8	7	6	4	4	3	1	1
TEBD	4	4	4	3	3	3	3	2	2	2	2	2	1
TRBD	13	4	4	3	3	3	3	2	2	2	2	2	1
TEBE	14	4	4	3	3	3	3	2	2	2	2	2	1
BOBD	16	4	4	3	3	3	3	2	2	2	2	2	1
SHRB	19	4	4	3	3	3	3	2	2	2	2	2	1
TRBE	6	6	6	5	3	3	3	2	2	2	2	2	1
BONE	5	5	5	4	4	3	3	2	2	2	2	2	1
TENE	15	5	5	4	4	3	3	2	2	2	2	2	1
BOND	17	5	5	4	4	3	3	2	2	2	2	2	1

Describe the surface

Concept of patch

NPATCH=19 -> separate energy budgets for all vegetation types

Number of patches chosen by user

Type of vegetation	19	12	11	10	9	8	7	6	5	4	3	2	1
NO	1	1	1	1	1	1	1	1	1	1	1	1	1
ROCK	2	2	2	1	1	1	1	1	1	1	1	1	1
SNOW	3	3	3	2	2	2	2	1	1	1	1	1	1
C3	7	7	7	6	5	4	4	3	3	3	3	1	1
C4	8	8	8	7	6	5	4	3	3	3	3	1	1
GRASS	10	10	10	9	8	7	6	5	5	3	3	1	1
BOGR	18	10	10	9	8	7	6	5	5	3	3	1	1
TROG	11	11	10	9	8	7	6	5	5	3	3	1	1
IRR	9	9	9	8	7	6	5	4	4	4	3	1	1
PARK	12	12	11	10	9	8	7	6	4	4	3	1	1
TEBD	4	4	4	3	3	3	3	2	2	2	2	2	1
TRBD	13	4	4	3	3	3	3	2	2	2	2	2	1
TEBE	14	4	4	3	3	3	3	2	2	2	2	2	1
BOBD	16	4	4	3	3	3	3	2	2	2	2	2	1
SHRB	19	4	4	3	3	3	3	2	2	2	2	2	1
TRBE	6	6	6	5	3	3	3	2	2	2	2	2	1
BONE	5	5	5	4	4	3	3	2	2	2	2	2	1
TENE	15	5	5	4	4	3	3	2	2	2	2	2	1
BOND	17	5	5	4	4	3	3	2	2	2	2	2	1

Outline

1. Main principles
2. The physical schemes
3. Describe the surface
4. Physiographic data
5. How to run SURFEX in MESONH

Physiographic data

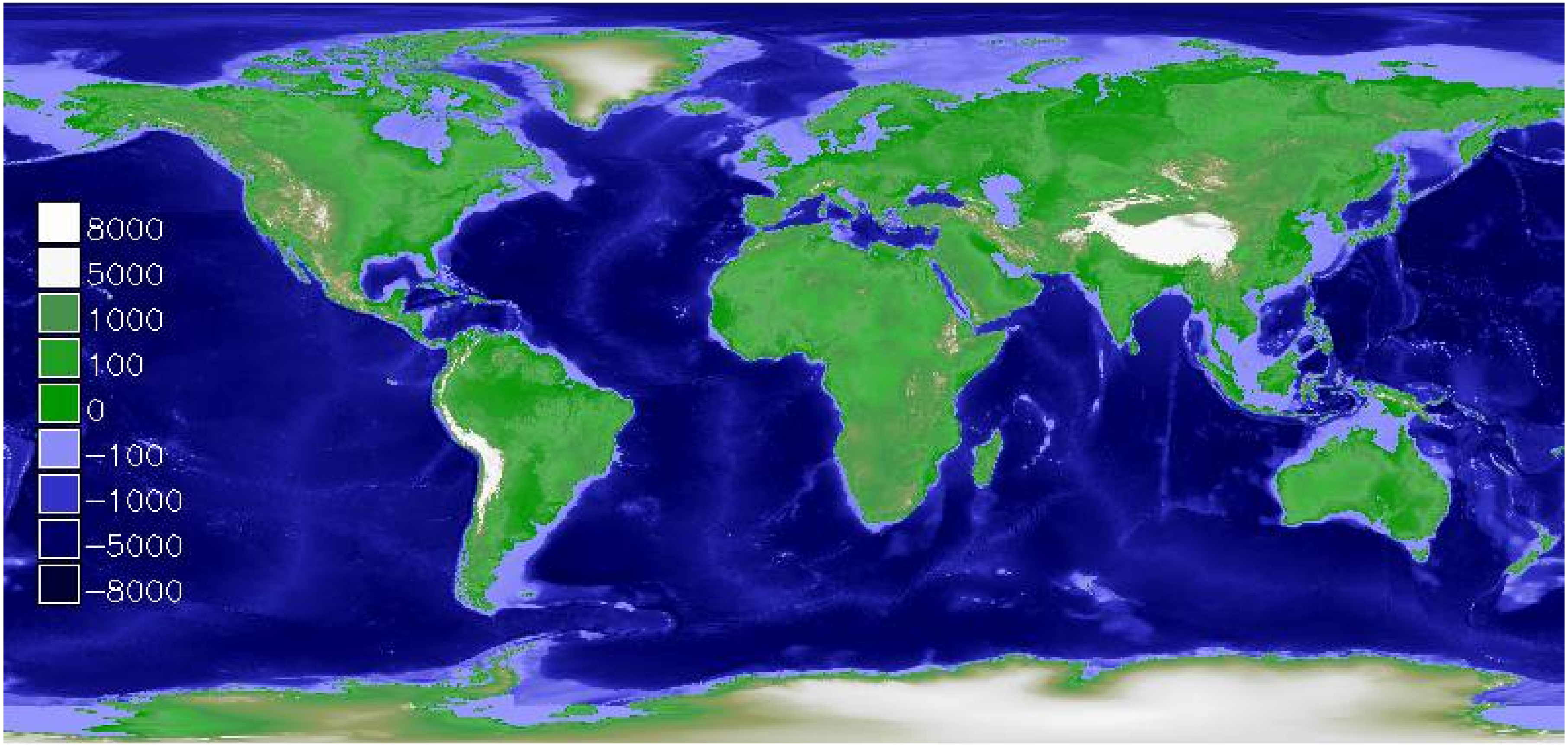
Can be downloaded on the SURFEX website : Home > Physiographic maps

http://www.umr-cnrm.fr/surfex/spip.php?rubrique14

Physiographic data

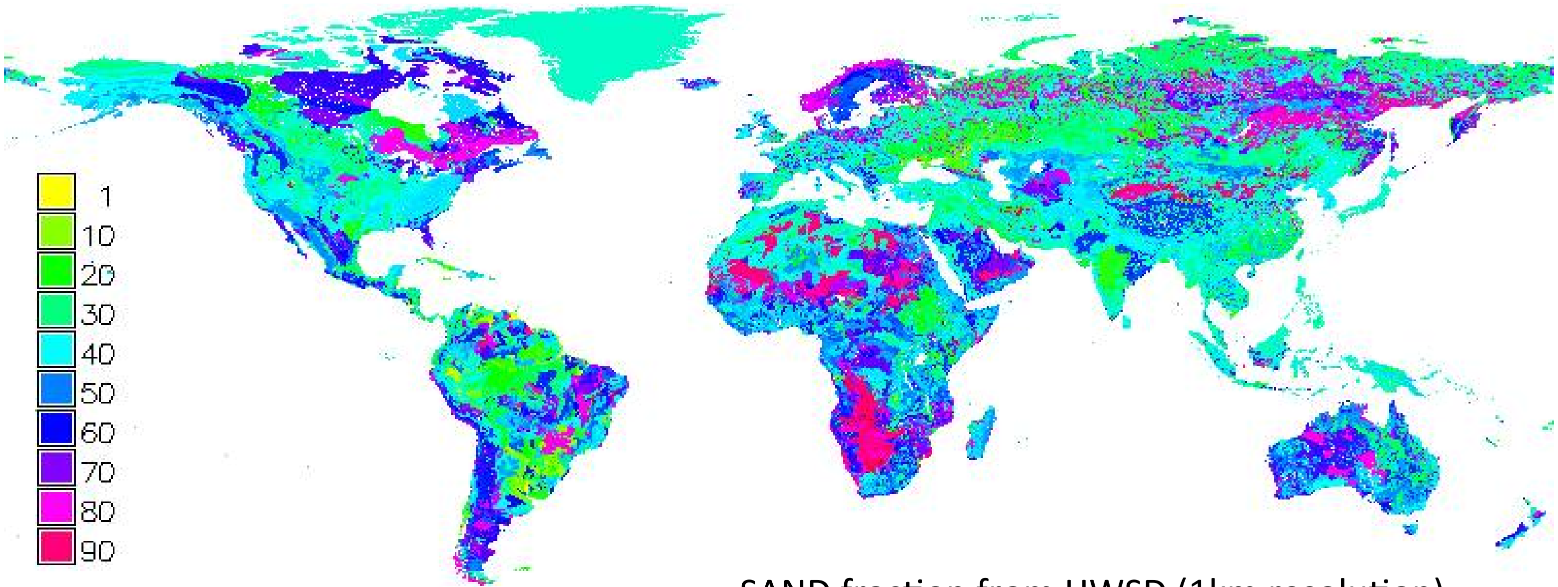
Can be downloaded on the SURFEX website : Home > Physiographic maps
http://www.umr-cnrm.fr/surfex/spip.php?rubrique14

- BATHYMETRY :etopo2 from NOAA (4km resolution)



Physiographic data

- <u>SOIL TEXTURE</u> (CLAY and SAND fractions): Global
  - FAO at 10km resolution
  - HWSD at 1km resolution + Maps of topsoil and subsoil organic carbon
  - SOILGRIDS at ~300m resolution

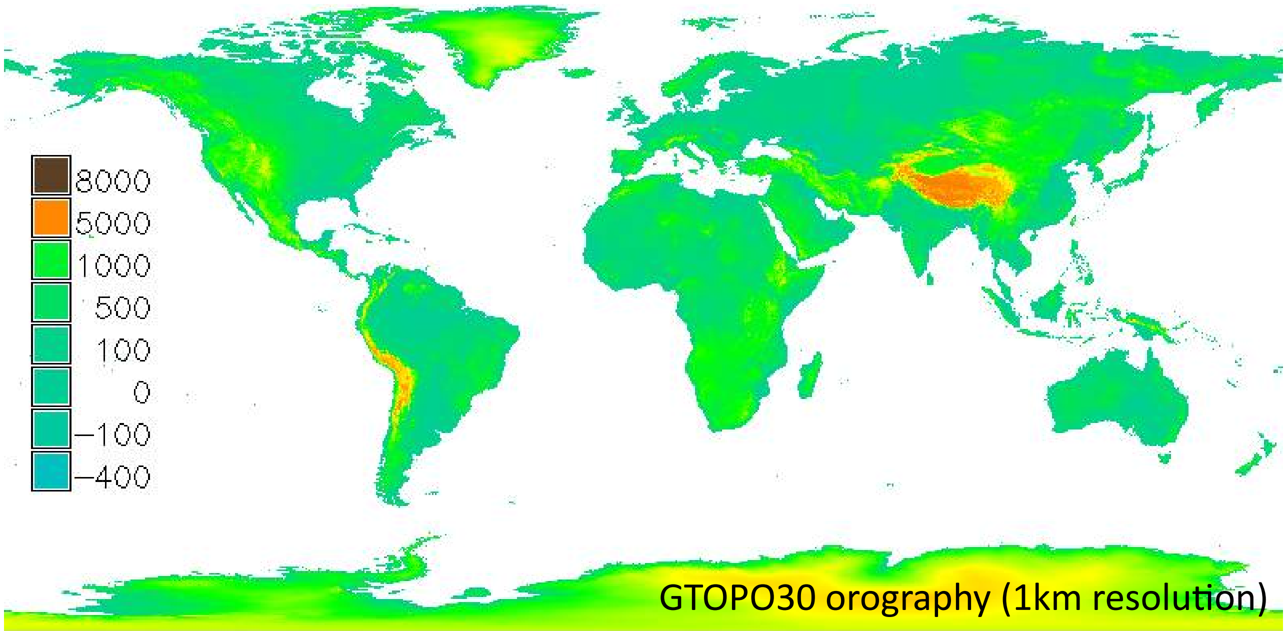


SAND fraction from HWSD (1km resolution)

Physiographic data

- TOPOGRAPHY:
  - GTOPO30, global, from USGS at 1km resolution
  - GMTED2010 (1km and 250m resolution)
  - srtm250 at 250m resolution
  - srtm90 at 90m resolution / srtm60 at 60m resolution over France

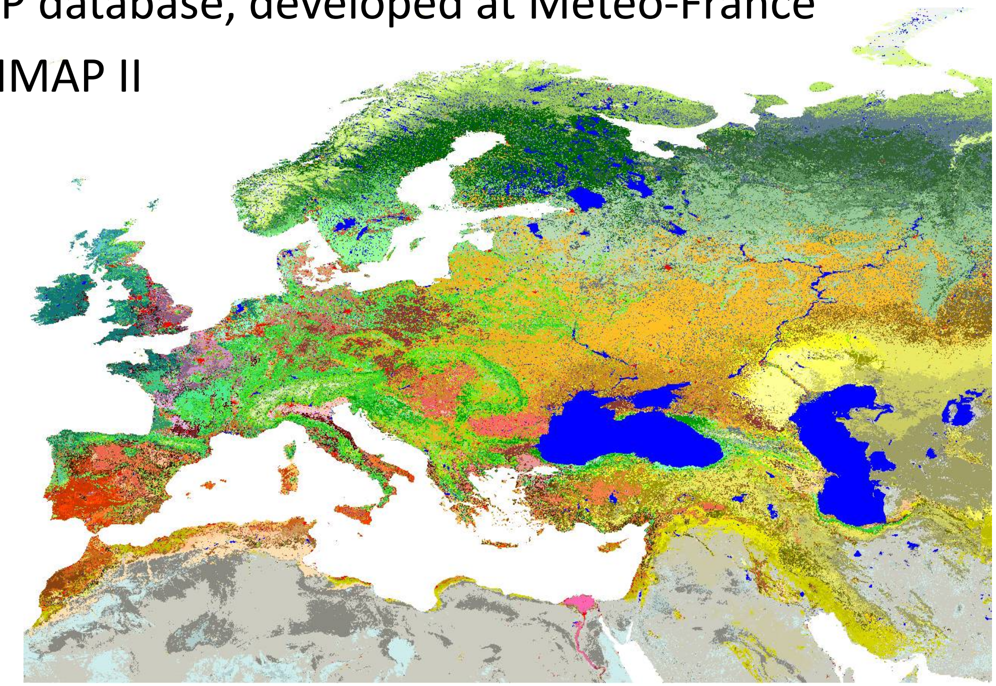
- TOPOGRAPHIC INDEX: HYDRO1K, derived from GTOPO30.



GTOPO30 orography (1km resolution)

Physiographic data

- <u>LAND COVER </u>: ECOCLIMAP database, developed at Météo-France
  - ECOCLIMAP I & ECOCLIMAP II
  - ECOCLIMAP-SG



- <u>LAKE DEPTH</u>: a 1km global database (from E. Kourzeneva)

  + 2 other versions where lake depth is collocated with 2 versions of ECOCLIMAP

Physiographic data
ECOCLIMAP

- ECOCLIMAP is the CNRM home-made global database of land covers.

- It describes the types of surface covering the whole Earth and associated land surface parameters (1km resolution)

- 1 cover = 1 area of homogeneous ecosystem

- Three versions of ECOCLIMAP
  - ECOCLIMAP-I 255 covers
  - ECOCLIMAP-II (update of ECOCLIMAP-I) +273 covers over Europe
  - ECOCLIMAP Second Generation (ECOCLIMAP-SG)

Can be downloaded on the SURFEX website

https://www.umr-cnrm.fr/surfex/spip.php?article136

(ECOCLIMAP-I see *Masson et al. 2003*, ECOCLIMAP-II *Faroux et al. 2013*)

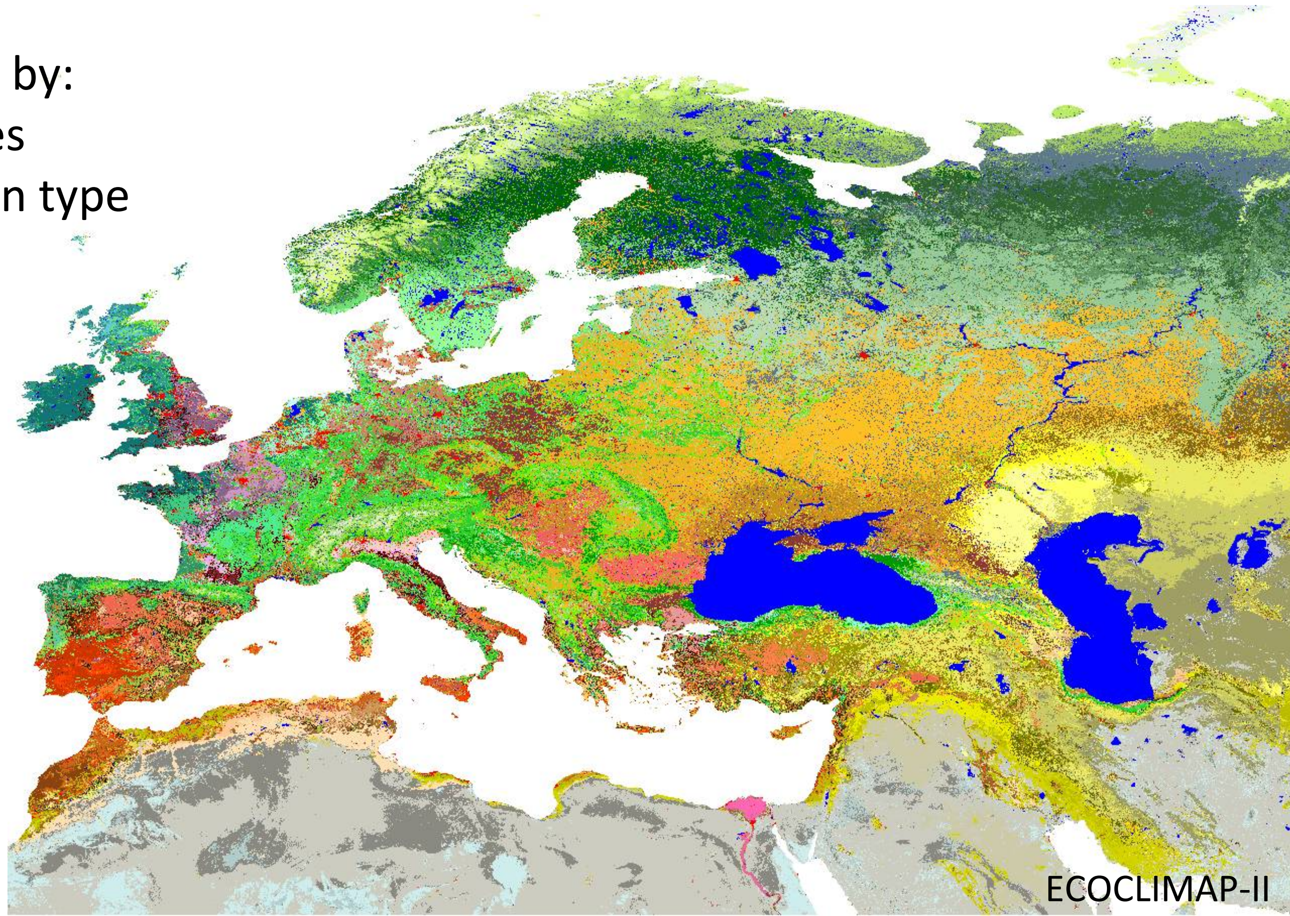
METEO FRANCE

Physiographic data
ECOCLIMAP I and II - covers

A cover is an area of homogeneous ecosystem.

On the ECOCLIMAP map, a cover is a set of pixels, where the surface cover is considered as homogeneous.

A cover is characterized by:
- a fraction of the 4 tiles
- fractions of vegetation type



Physiographic data

ECOCLIMAP I and II - covers

A cover is characterized by:

- a fraction of the 4 tiles SEA, WATER, TOWN, NATURE
- if the tile NATURE is present, fractions for each of the 19 vegetation types

VEGETATION TYPES					
1	NO	No vegetation - Bare soil	11	TROG	Tropical grassland
2	ROCK	Bare rock	12	PARK	Peat bogs, parks and garden (irrigated grass)
3	SNOW	Permanent snow and ice	13	TRBD	Tropical broadleaf deciduous
4	TEBD	Temperate broadleaf cold-deciduous	14	TEBE	Temperate broadleaf evergreen
5	BONE	Boreal needleleaf evergreen	15	TENE	Temperate needleleaf evergreen
6	TRBE	tropical broadleaf evergreen	16	BOBD	Boreal broadleaf cold-deciduous
7	C3	Winter crops	17	BOND	Boreal needleleaf cold-deciduous
8	C4	Summer crops	18	BOGR	Boreal grass
9	IRR	Irrigated crops	19	SHRB	Shrub
10	GRAS	Grassland			

Physiographic data

ECOCLIMAP I and II - covers

COVER	NAME	TILE				19 VEGETATION TYPES					
		SEA	WATER	TOWN	NATURE	NO	...	TEBD	...	...	PARK
02	Lakes	0	1	0	0	-	-				

Physiographic data

ECOCLIMAP I and II - covers

COVER	NAME	TILE				19 VEGETATION TYPES					
		SEA	WATER	TOWN	NATURE	NO	...	TEBD	...	...	PARK
02	Lakes	0	1	0	0	-	-				
04	Bare land	0	0	0	1	1					

- NO : no vegetation
- TEBD : temperature broadleaf decidous
- PARK : irrigated grass

Physiographic data

ECOCLIMAP I and II - covers

COVER	NAME	TILE				19 VEGETATION TYPES					
		SEA	WATER	TOWN	NATURE	NO	...	TEBD	BONE	...	PARK
02	Lakes	0	1	0	0	-	-				
04	Bare land	0	0	0	1	1					
160	Urban Parks	0	0	0.1	0.9			0.5			0.5

- NO : no vegetation
- TEBD : temperature broadleaf decidous
- PARK : irrigated grass

METEO FRANCE

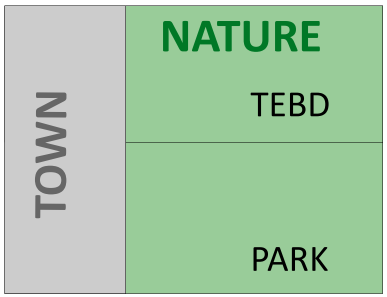
Physiographic data

ECOCLIMAP I and II - covers

COVER	NAME	TILE				19 VEGETATION TYPES					
		SEA	WATER	TOWN	NATURE	NO	...	TEBD	BONE	...	PARK
02	Lakes	0	1	0	0	-	-				
04	Bare land	0	0	0	1	1					
160	Urban Parks	0	0	0.1	0.9			0.5			0.5

- NO : no vegetation
- TEBD : temperature broadleaf decidous
- PARK : irrigated grass

COVER 160 : URBAN PARKS



- 10% TOWN
- 0.9x0.5 = 45% TEBD
- 0.9x0.5 = 45% PARK

Physiographic data

ECOCLIMAP I and II - files

Global map with covers

- Different versions available on the SURFEX website.
- 1pixel = 1 cover number

ECOCLIMAP_*.dir is **BINARY** and contains the rough grid of covers numbers.

ECOCLIMAP_*.hdr is **ASCII** and contains the metadata for the upper binary file.

Use with MESONH :

The description of all ECOCLIMAP covers for version I and version II is contained in several *.F90 routines (default_lai_eco1.F90, default_alb_eco1.F90, default_data_cover.F90, ...)

Physiographic data

ECOCLIMAP I and II - files

- the fraction of the 4 tiles SEA,WATER,TOWN, NATURE
- the fraction for each of the 19 vegtypes (if NATURE present)
- Land surface parameters depending on tiles and vegetation types

  - Mean ALB_SOIL_NIR (*soil albedo in Near InfraRed*)
  - Mean ALB_SOIL_VIS (*soil albedo in VISible*)

For each **vegtype** with not null fraction:

- 3 soil depths (root, soil, ice)
- Height of trees (if vegtype for tree)
- Mean ALB_VEG_NIR and ALB_VEG_VIS (36 10-days period)
- LAI (Leaf Area Index) 36 10-days period

  LAI : 1 year for ecoclimap1 - 1992, 5 years for ecoclimap2 – 2002->2006)

Physiographic data

ECOCLIMAP I and II - files

▸ For **TOWN** (if not null fraction):

- Z0, BldHgt, WOHor, Bld frac, Garden frac
- Alb & Emis for Roof, Road, Wall
- Hc, Tc, D for each layer of Roof, Road, Wall
  - H & LE for Traffic and Industry

▸ Some parameters are calculated from other ones:

- VEG (fraction of vegetation) from LAI and vegtype
- Z0 (roughness length) from LAI, H_TREE and vegtype
- EMIS (emissivity) from VEG and vegtype

Like LAI, these parameters deduced from LAI are 10-day defined.

Physiographic data

ECOCLIMAP I and II – example COVER 160

```
COVER 160
 FRACTION   Town Nature  Water    Sea
    160   0.10   0.90   0.00   0.00
 FRACTION    No   Rock   Snow   Tebd   Bone   Trbe    C3    C4    Irr   Gras   Trog   Park   Trbd   Tebe   Tene   Bobd   Bond   Bogr   Shrb
    160   0.00   0.00   0.00   0.50   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.50   0.00   0.00   0.00   0.00   0.00   0.00   0.00
 mean ALB_SOIL_NIR (36 10-day periods)
           Jan              Feb              Mar              Apr
    160  0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000
           May              Jun              Jul              Aug
    160  0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000
           Sep              Oct              Nov              Dec
    160  0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000 0.2000
 mean ALB_SOIL_VIS (36 10-day periods)
           Jan              Feb              Mar              Apr
    160  0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
           May              Jun              Jul              Aug
    160  0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
           Sep              Oct              Nov              Dec
    160  0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
VEGTYPE   Tebd
      DEPTH   Root   Soil    Ice
    160   Tebd   2.00   3.00   1.60
       LAI  YEAR 1992 (36 10-day periods)
            Jan       Feb       Mar       Apr
    160   Tebd 1.0 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.8 1.9 2.1 2.4
            May       Jun       Jul       Aug
    160   Tebd 2.6 2.9 2.9 3.0 3.0 2.9 2.9 2.8 2.8 2.8 2.8 2.7
            Sep       Oct       Nov       Dec
    160   Tebd 2.7 2.6 2.5 2.3 2.2 2.0 1.8 1.6 1.4 1.3 1.1 1.1
  |   HT|
    160   Tebd  5.
```

Physiographic data

ECOCLIMAP I and II – example COVER 160

mean ALB_VEG_NIR (36 10-day periods)

Jan Feb Mar Apr
160 Tebd 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500
May Jun Jul Aug
160 Tebd 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500
Sep Oct Nov Dec
160 Tebd 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500 0.2500

mean ALB_VEG_VIS (36 10-day periods)

Jan Feb Mar Apr
160 Tebd 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500
May Jun Jul Aug
160 Tebd 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500
Sep Oct Nov Dec
160 Tebd 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500 0.0500

VEGTYPE Park

DEPTH Root Soil Ice
160 Park 1.50 2.00 1.20

LAI YEAR 1992 (36 10-day periods)

Jan Feb Mar Apr
160 Park 1.0 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.8 1.9 2.1 2.4
May Jun Jul Aug
160 Park 2.6 2.9 2.9 3.0 3.0 2.9 2.9 2.8 2.8 2.8 2.8 2.7
Sep Oct Nov Dec
160 Park 2.7 2.6 2.5 2.3 2.2 2.0 1.8 1.6 1.4 1.3 1.1 1.1

mean ALB_VEG_NIR (36 10-day periods)

Jan Feb Mar Apr
160 Park 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000
May Jun Jul Aug
160 Park 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000
Sep Oct Nov Dec
160 Park 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000 0.3000

METEO FRANCE

Physiographic data

ECOCLIMAP I and II – example COVER 160

```
mean ALB_VEG_VIS (36 10-day periods)
              Jan              Feb              Mar              Apr
   160  Park 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
              May              Jun              Jul              Aug
   160  Park 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
              Sep              Oct              Nov              Dec
   160  Park 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000 0.1000
  TOWN     Z0 BldHgt  WOHor    Bld Garden
   160  0.50     5.   0.10   0.10   0.00
  TOWN  AlbRf  AlbRd  AlbWl EmisRf EmisRd EmisWl
   160  0.15   0.08   0.25   0.90   0.94   0.85
  TOWN Hc_Roof1 Hc_Roof2 Hc_Roof3 Hc_Road1 Hc_Road2 Hc_Road3 Hc_Wall1 Hc_Wall2 Hc_Wall3
   160 2.11E+06 2.80E+05 2.90E+05 1.94E+06 1.28E+06 1.28E+06 1.55E+06 1.55E+06 2.90E+05
  TOWN Tc_Rf1 Tc_Rf2 Tc_Rf3 Tc_Rd1 Tc_Rd2 Tc_Rd3 Tc_Wl1 Tc_Wl2 Tc_Wl3
   160 1.5100 0.0800 0.0500 0.7454 0.2513 0.2513 0.9338 0.9338 0.0500
  TOWN  D_Rf1  D_Rf2  D_Rf3  D_Rd1  D_Rd2  D_Rd3  D_Wl1  D_Wl2  D_Wl3
   160  0.050  0.400  0.100  0.050  0.100  1.000  0.020  0.125  0.050
  TOWN  H_Trf Le_Trf  H_Ind Le_Ind
   160     0.     0.     0.     0.
```

Physiographic data
ECOCLIMAP-SG

Land cover : a global map at 300m-resolution, with 33 covers only. Cover = vegtype (pixels are pure at 300m-resolution). Based on ESA-CCI LCC.

Primary parameters : not included anymore in the code. Now given in namelist NAM_DATA_ISBA (LAI, ground depths, height of trees, visible and near infrared soil and vegetation albedos)

→ can be uniform values
→ from input maps (from satelite data for example)

First version available :

- 1 map of land cover
- 36 maps of LAI, 36*4 maps of albedo, 1 map of height of trees
  → larger than ECOCLIMAP (> 500Go)
  → will be updated with new versions of the ESA-CCI map.

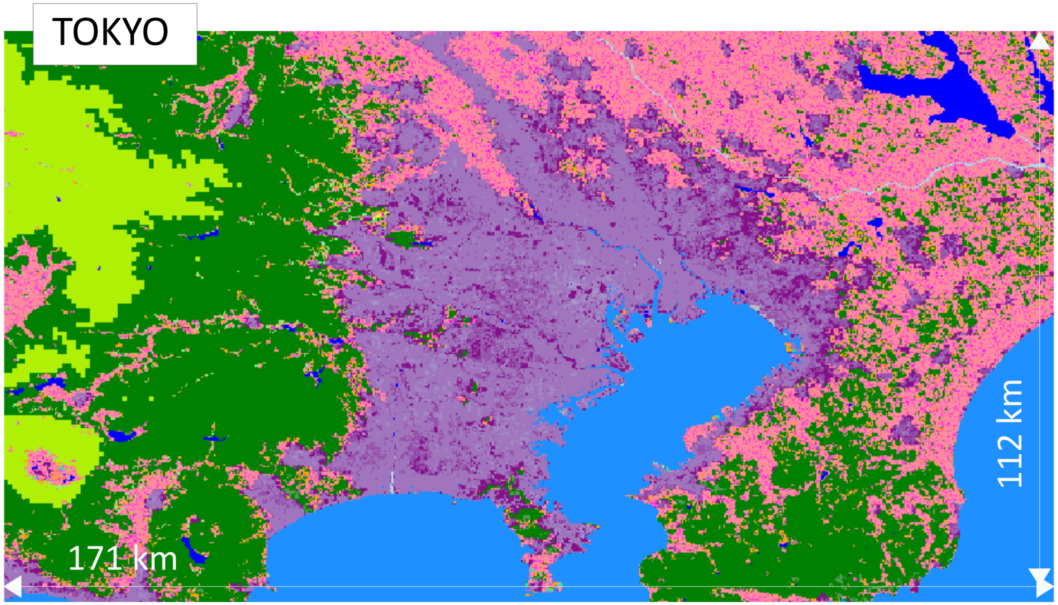
http://www.umr-cnrm.fr/surfex/spip.php?article405
https://opensource.umr-cnrm.fr/projects/ecoclimap-sg/wiki

METEO FRANCE

Physiographic data
ECOCLIMAP-SG

33 covers

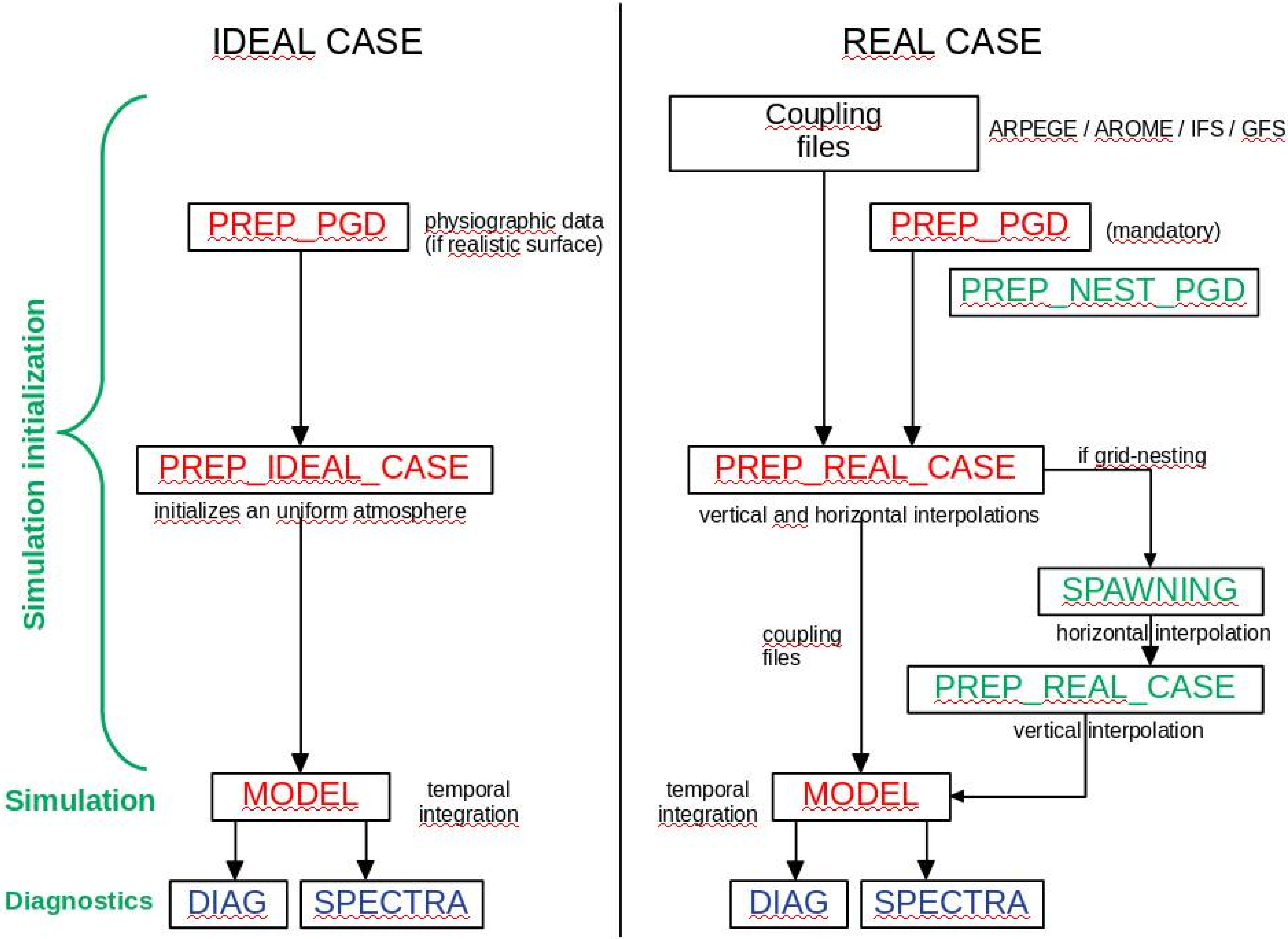
3 WATER	1	Sea and oceans
	2	Lakes
	3	Rivers
20 NATURE	4	Bare soil
	5	Bare rock
	6	Permanent snow
	7	Boreal broadleaf deciduous
	8	Temperate broadleaf deciduous
	9	Tropical broadleaf deciduous
	10	Temperate broadleaf evergreen
	11	Tropical broadleaf evergreen
	12	Boreal needleleaf evergreen
	13	Temperate needleleaf evergreen
	14	Boreal needleleaf deciduous
	15	Shrubs
	16	Boreal grassland
	17	Temperate grassland
	18	Tropical grassland
	19	Winter C3 crops
	20	Summer C3 crops
	21	C4 crops
	22	Tree cover, flooded
	23	Shrub or herbaceous, flooded
10 URBAN	24	urban LCZ1: compact high-rise
	25	urban LCZ2: compact midrise
	26	urban LCZ3: compact low-rise
	27	urban LCZ4: open high-rise
	28	urban LCZ5: open midrise
	29	urban LCZ6: open low-rise
	30	urban LCZ7: lightweight low-rise
	31	urban LCZ8: large low-rise
	32	urban LCZ9: sparsely built
	33	urban LCZ10: heavy industry



METEO FRANCE

Outline

1. Main principles
2. The physical schemes
3. Describing the surface
4. Physiographic data
5. How to run SURFEX in MESONH
   - PGD and PREP_IDEAL
   - PREP
   - RUN


IDEAL CASE
REAL CASE
Simulation initialization
Simulation
Diagnostics
PREP_PGD
physiographic data
(if realistic surface)
PREP_IDEAL_CASE
initializes an uniform atmosphere
MODEL
temporal
integration
DIAG
SPECTRA
Coupling
files
ARPEGE / AROME / IFS / GFS
PREP_PGD
(mandatory)
PREP_NEST_PGD
PREP_REAL_CASE
if grid-nesting
vertical and horizontal interpolations
SPAWNING
horizontal interpolation
coupling
files
PREP_REAL_CASE
vertical interpolation
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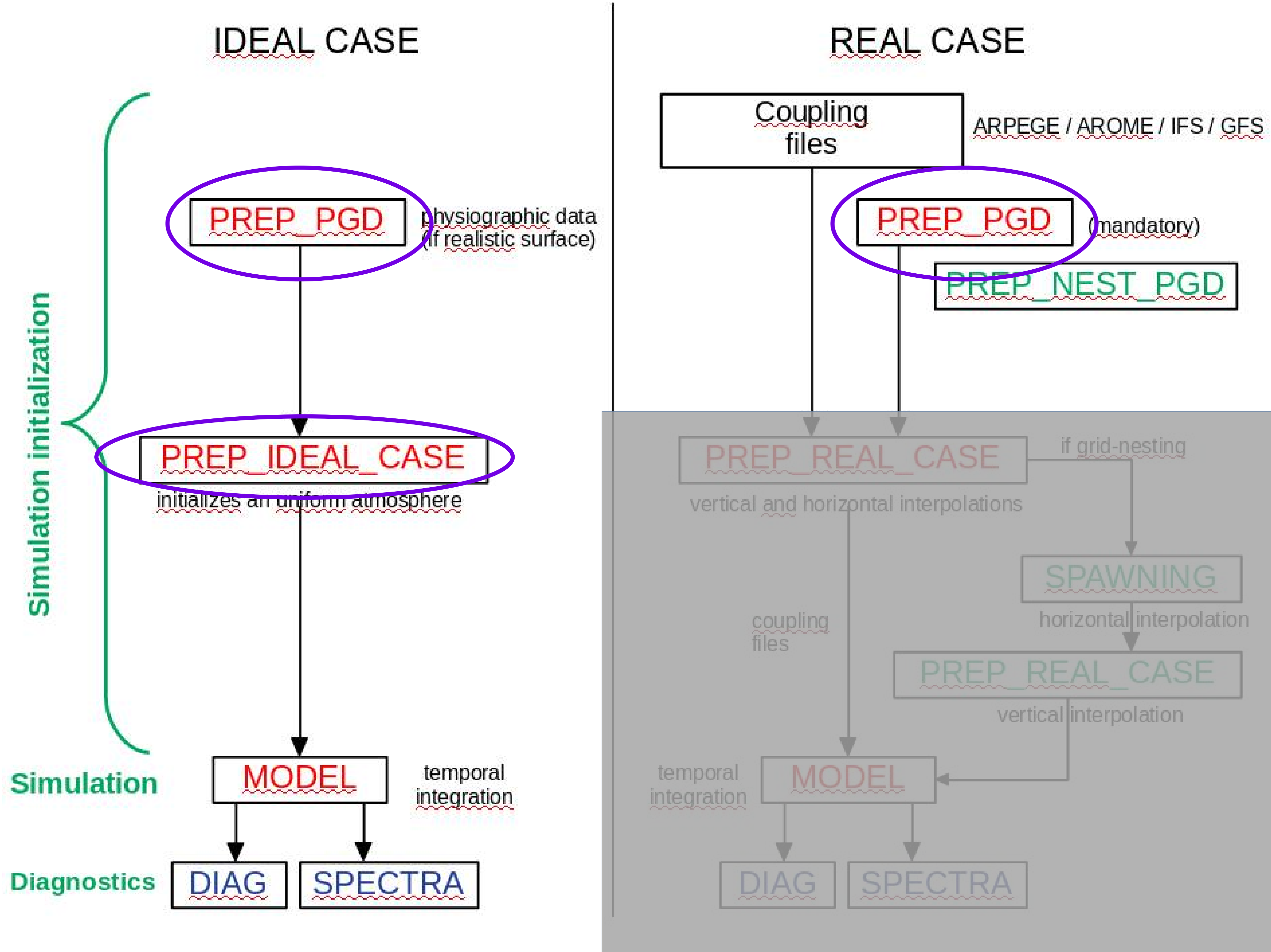
DIAG
SPECTRA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How to run SURFEX in MESONH

PGD step

PGD = Physio**G**raphic **D**ata

- orography, land cover, clay & sand fractions, bathymetry

  + data for specific Surfex options
- constant fields
- need to be fixed for each grid point of the experiment

PGD step

The first step when you run SURFEX

- you choose the surface schemes
- you choose and define the grid for the surface
- physiographic fields are defined, averaged and interpolated on this grid

→ All is defined in PRE_PGDn.nam (or partly in PRE_IDEA1.nam)

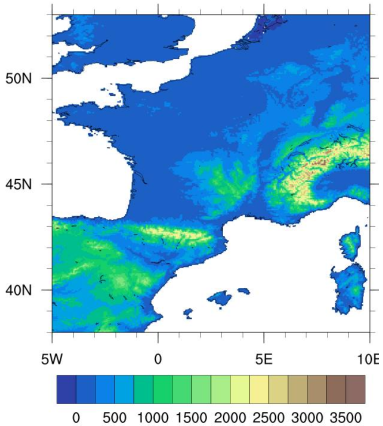
METEO FRANCE

How to run SURFEX in MESONH

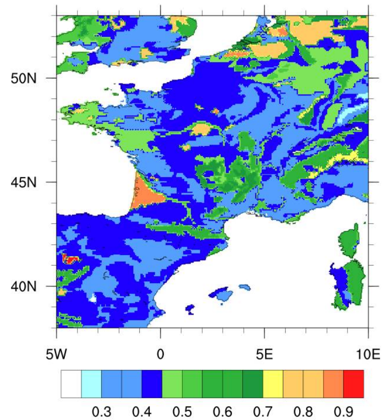
PGD step

<u>Examples of variables written in PGD file</u>

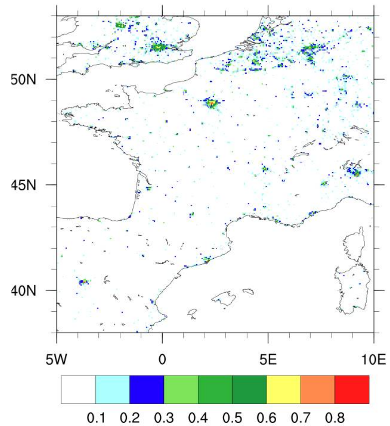
- DIM_FULL total number of points
- DIM_NATURE / DIM_SEA / DIM_TOWN / DIM_WATER : number of points for each tile
- SEA / NATURE / TOWN / WATER : scheme chosen for each tile
- GRID_TYPE/ XLON / XLAT / LONMIN/ LONMAX / … : grid information



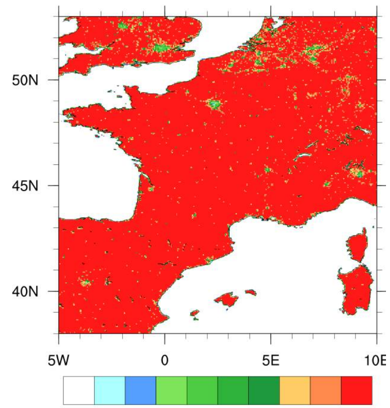
ZS : orography



SAND : sand fraction



FRAC_TOWN : fraction of town for each grid point



FRAC_NATURE : fraction of nature for each grid point

- COVER131 : fraction of cover 131 for each grid point.
- COVER137

…

Namelists and options at PGD/PRE_IDEAL step

general schemes

To define the four schemes that will be used, one for each type of surface (SEA, NATURE, TOWN, WATER).

&NAM_PGD_SCHEMES

CNATURE = « NONE / FLUX / TSZ0 / ISBA »

CSEA = « NONE / FLUX / SEAFLX »

CWATER = « NONE / FLUX / WATFLX / FLAKE »

CTOWN = « NONE / FLUX / TEB »

LGARDEN = F

Namelists and options at PGD step

grid

- This namelist defines the grid type, specified or from an existing surface file

&NAM_PGD_GRID

CGRID = « CONF PROJ / CARTESIAN / ~~LONLAT REG~~ / ~~LONLATVAL~~ / ~~IGN~~ »:

type of grid. (IGN = lambert, CONF PROJ = mercator).

- Other specific namelists to define parameters according to the grid type.

NAM_CONF_PROJ

NAM_CONF_PROJ_GRID

NAM_CARTESIAN

…

Namelists and options at PGD step
grid

Example with CONF PROJ grid type:

```
&NAM_CONF_PROJ       XLAT0 = 45.,
                     XLON0 = -0.5,
                     XRPK = -0.5 /

&NAM_CONF_PROJ_GRID  XLATCEN = 45.,  latitude of the center of the domain (°)
                     XLONCEN = -0.5,
                     NIMAX = 15,   number of surface points of the grid in x-direction
                     NJMAX = 15,
                     XDX = 1250,  mesh size along x-direction (m)
                     XDY = 1250 /
```

Namelists and options at PGD/PRE_IDEAL step
grid

Consequences of grid type and resolution on ECOCLIMAP: spatial aggregation of parameters

4 types of averaging surface parameters (weights according to fractions present in grid points):

- **ARITHMETIC**: value in one grid point = sum of weighted data / sum of weights → *main parameters*

- **INVERSE**: value in one grid point = sum of weights / sum of weighted (1 / values) → *RSMIN & CV*

- **INVERSE OF SQUARE LOGARITHM** : base data used is 1 / (ln (dz / data)**2. → *Z0*

- **MAJORITY**: value in one grid point = value of the most present data in the gridpoint. → *dates for seeding and reaping*

Namelists and options at PGD step
ECOCLIMAP I and II

NAM_FRAC : This namelist defines if ECOCLIMAP will be used or not.

```
&NAM_FRAC                LECOCLIMAP   = T,
  /
```

NAM_COVER : this namelist gives the information to compute the surface cover fractions when ECOCLIMAP is used

```
&NAM_COVER        YCOVER= « ECOCLIMAP_I_GLOBAL »,
                  YCOVERFILETYPE = « DIRECT»
/
```

Type "DIRECT" means that the file YCOVER is composed of 2 files:

-**ECOCLIMAP_I_GLOBAL.*dir*** is **BINARY** and contains the rough grid of covers numbers.

-**ECOCLIMAP_I_GLOBAL.*hdr*** is **ASCII** and contains metadata for the upper binary file.

Need to be linked in the run directory

Remark on albedo

To use albedos from the *.bin ECOCLIMAP files (more precise and evolving in time), and not those from ini_data_param.F90 (very rough), you need to activate, in NAM_ISBA, CALBEDO = « CM13 » during the run SURFEX.

```
&NAM_ISBA          CALBEDO= « CM13 »,
/
```

Namelists and options at PGD step
ECOCLIMAP-SG

NAM_FRAC : activate the namelist key LECOSG

```
&NAM_FRAC                LECOCLIMAP   = T,
                         LECOSG       = T
      /
```

NAM_COVER : indicate the ECOCLIMAP-SG land cover map

```
&NAM_COVER          YCOVER= « ecosg_final_map »,
                    YCOVERFILETYPE = « DIRECT»
/
```

NAM_DATA_ISBA : you will need to update your namelist NAM_DATA_ISBA with the names of the files you use for the primary parameters

Namelists and options at PGD step

ECOCLIMAP-SG

```
&NAM_DATA_ISBA      CFNAM_LAI(1,1) = 'LAI_0105_c'
                    CFTYP_LAI(1,1) = 'DIRTYP'
                    CFNAM_LAI(1,2) = 'LAI_0115_c'
                    CFTYP_LAI(1,2) = 'DIRTYP'
                    CFNAM_LAI(1,3) = 'LAI_0115_c'
                    CFTYP_LAI(1,3) = 'DIRTYP'
                    . . .
                    CFNAM_ALBNIR_VEG(1,1) = 'ANV_DESAG_0105_c'
                    CFTYP_ALBNIR_VEG(1,1) = 'DIRTYP'
                    CFNAM_ALBNIR_VEG(1,2) = 'ANV_DESAG_0115_c'
                    CFTYP_ALBNIR_VEG(1,2) = 'DIRTYP'
                    . . .
                    CFNAM_H_TREE(1) = 'new_ht_c'
                    CFTYP_H_TREE(1) = 'DIRTYP'
                    . . .
/
```

Namelist example on : https://opensource.umr-cnrm.fr/projects/ecoclimap-sg/wiki

Namelists and options at PGD step
an alternative to ECOCLIMAP

It is possible to not use ECOCLIMAP, or to use it partially, only for some variables.

NAM_FRAC : This namelist defines if ECOCLIMAP will be used or not.
It's also where the fractions of the 4 main types of surfaces or tiles are given if ECOCLIMAP is not used to define them.

```
&NAM_FRAC                LECOCLIMAP   = F,
                         XUNIF_SEA    = 0.,
                         XUNIF_WATER  = 0.,
                         XUNIF_TOWN   = 0.,
                         XUNIF_NATURE = 1.
/
```

NAM_DATA_… (ISBA, TEB, BEM, TEB_GARDEN, TEB_GREENROOF, SEAFLUX, FLAKE) : Allows the user to replace one, several, or all ECOCLIMAP parameters by its own data.

For detailed descriptions, cf namelists documentation in user's guide on surfex website. http://www.umr-cnrm.fr/surfex/spip.php?rubrique10

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Namelists and options at PGD step

ECOCLIMAP

&NAM_PGD_ARRANGE_COVER

LWATER_TO_NATURE = F : *to replace water (not lakes) by nature*

LTOWN_TO_ROCK = F : *to replace town by rock.*

/

&NAM_COVER

XRM_COVER = 1.E-6 : *limit in fraction value to remove a cover from a grid point. For each point, all fractions of ecosystems that are below XRM_COVER are removed*

XRM_COAST = 1.: *idem for land part in a coastal grid point.*

XRM_LAKE = 0.: *idem for lake in a land grid point.*

XRM_SEA = 0.: *idem for sea in a land grid point.*

/

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Namelists and options at PGD step

additional data to ECOCLIMAP

&NAM_ZS

XUNIF_ZS=100 : uniform prescribed value of orography (m)

or

YZS : orography data file name (gtopo30, srtm_europe...)

YZSFILETYPE : type of orography data file

&NAM_ZS_FILTER

NZSFILTER : nb of iterations for a global spatial filter

LHSLOP : flag to use a local filter for steep slopes

XHSLOP : local filtering slope threshold

```
&NAM_ZS        XUNIF_ZS=500.,
/
```

uniform value of orography imposed on all points (real,meters)

```
&NAM_ZS        YZS='gtopo30',
               YZSFILETYPE='DIRECT'
/
```

An orography file is used

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Namelists and options at PGD step
additional data to ECOCLIMAP

&NAM_ISBA

XUNIF_CLAY=0.33 : uniform prescribed value of clay fraction

or

YCLAY : clay fraction data file name

YCLAYFILETYPE : type of clay data file

Same for :

- SAND fraction in NAM_ISBA
- others (subgrid runoff and drainage, organic carbon top/sub soil, permafrost distribution, pH and soil fertilization rate)

Namelists and options at PGD step
ISBA

ISBA physical options known and needed at PGD step

&NAM_ISBA

CISBA = « 2-L / 3-L / DIF »: type of soil discretization and physics in ISBA : force restore method with 2 or 3 layers or diffusive scheme.

NGROUND_LAYER : 2, 3, or any for DIF.

XSOILGRID : depths for the vertical grid in diffusive scheme (ideal 14 depths by default)

NPATCH = 1 … 12 : number of patchs for which ISBA will separately run.

CPHOTO = « NON / AST / NIT / NCB » : type of photosynthesis physics

CPEDO_FUNCTION = « CH78 / CO84 / CP88 / WO99 »: pedo-transfert function.

LTR_ML = F : to activate radiative transfert calculation (only if cphoto/=NON)

Namelists and options at PGD step
TEB

TEB physical options known and needed at PGD step

&NAM_TEB

NTEB_PATCH = 1 : TEB patches are associated to road orientations defined at PREP step.

CBEM = « DEF / BEM »: building energy model

LAUTOSIZE = F: to activate autosize calculation

CHEAT_COIL = « IDEAL / FINCAP »: type of heating coil (BEM)

CCOOL_COIL = « IDEAL / DXCOIL »: type of cooling coil (BEM)

NROAD_LAYER = 5 : number of layers in roads

NROOF_LAYER = 5 : idem in roofs

NWALL_LAYER = 5 : idem in walls

NFLOOR_LAYER = 5 : idem in floors (BEM)

LGREENROOF = F : to activate the greenroof ISBA modelization

LHYDRO = F : urban hydrology (not implemented yet)

LSOLAR_PANEL = F : to activate solar panels representation.

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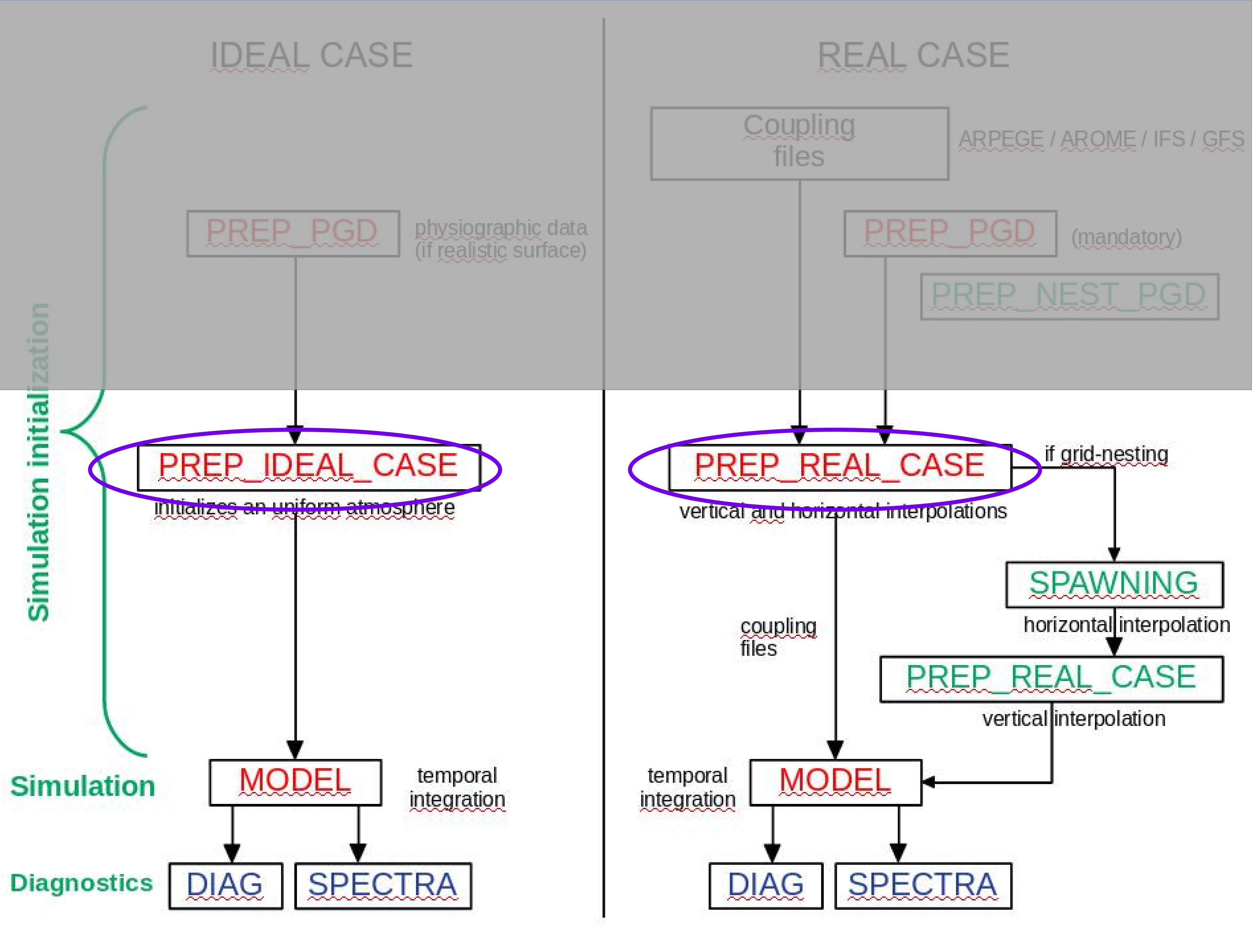
IDEAL CASE
REAL CASE
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PREP_PGD
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temporal integration
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DIAG
SPECTRA
DIAG
SPECTRA

PREP SURFEX (IDEAL / REAL)

- **REAL** : initialization of prognostic variables (depends on schemes activated)

&NAM_PREP_SURF_ATM

CFILE : surface analysis file

CFILETYPE : MESONH / GRIB / ~~LFI~~ / ASCII

CFILEPGD : pgd file related to the surface analysis

CFILEPGDTYPE : MESONH / GRIB / ~~LFI~~ / ASCII

Prognostic variables for all tiles from the same file indicated in NAM_PREP_SURF_ATM

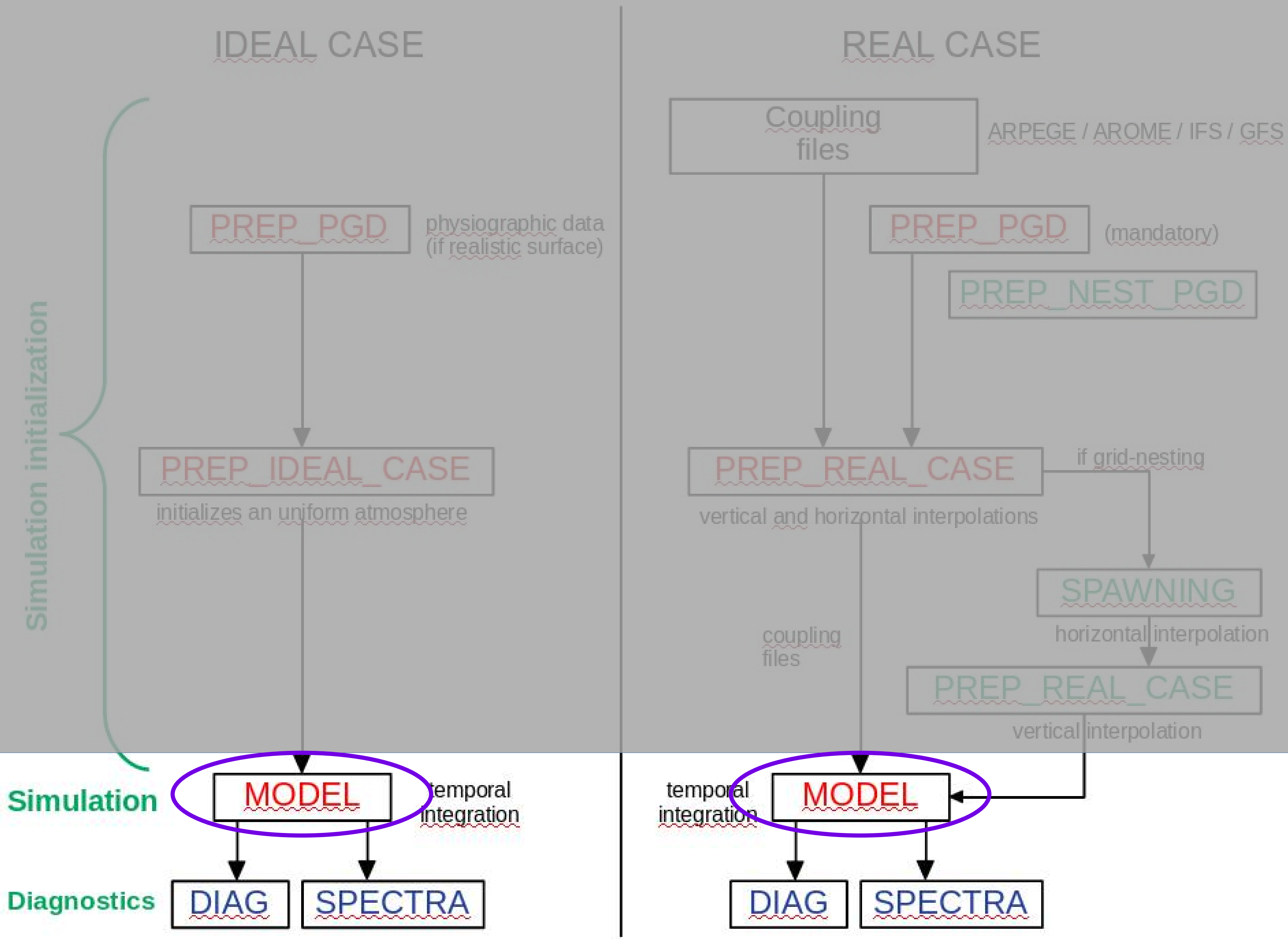
PREP SURFEX (IDEAL / REAL)

- **IDEAL**: initialization of prognostic variables (depends on schemes activated) with uniform values

NAM_PREP_SEAFLUX
NAM_PREP_WATFLUX
NAM_PREP_FLAKE
NAM_PREP_ISBA
NAM_PREP_ISBA_SNOW
NAM_PREP_ISBA_CARBON
NAM_PREP_TEB
NAM_PREP_TEB_SNOW
NAM_PREP_TEB_GARDEN
NAM_PREP_GARDEN_SNOW

→ Idealized profiles/uniform values only if NAM_PREP_SURF_ATM not used

```
&NAM_PREP_ISBA       XHUG_SURF = 0.,
                     XHUG_ROOT = 0.,
                     XHUG_DEEP = 0.,
                     XTG_SURF  = 291.45,
                     XTG_ROOT  = 291.45,
                     XTG_DEEP  = 291.45,
/
&NAM_PREP_TEB        XTDEEP_TEB = 290.15
                     XTI_BLD = 295.45
                     XTS_ROAD= 291.45
                     XTS_ROOF= 291.45
                     XTS_WALL= 291.45
                     XWS_ROAD= 0.
                     XWS_ROOF= 0.
/
```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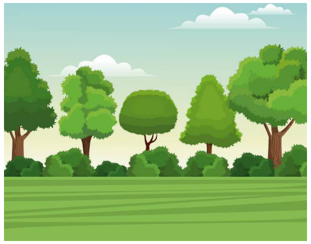
Namelists and options at RUN step

Specific options for each schemes

&NAM_SEAFLUXn

&NAM_FLAKEn
&NAM_WATFLUXn



&NAM_ISBAn

&NAM_TEBn

Namelists and options at RUN step

Idealized surface (forced)

&NAM_IDEAL_FLUX

NFORCF : number of surface forcing instants for fluxes
NFORCT : number of surface forcing instants for radiative temperature

XTIMEF : times of forcing for fluxes (from beginning of run)
XTIMET : times of forcing for temperature (from beginning of run)

XSFTH: data heat surface flux (W/m^2)
CSFTQ: Unit for the evaporation flux ($kg/m^2/s$) or (W/m^2)
XSFTQ: data water vapor surface flux

CUSTARTYPE: 'Z0 ' / 'USTAR'
XUSTAR: hourly data of friction (m^2/s^2)
XZ0: roughness length
XALB: albedo
XEMIS:emissivity
XTSRAD: radiative temperature

Namelists and options at RUN step

To save fields of surface parameters in the output files

&NAM_DIAG_SURF_ATMn

LFRAC = T : to write the fractions of tiles (SEA, WATER, NATURE, TOWN)

&NAM_DIAG_ISBAn

LPGD = T: to write the natural physiographic parameters fields

&NAM_DIAG_TEBn

LPGD = T : to write the urban physiographic parameters fields

&NAM_DIAG_OCEANn

LPGD = T : to write the sea physiographic parameters fields

&NAM_DIAG_FLAKEn

LPGD = T : to write the lake physiographic parameters fields

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