Soil and land cover characteristics

Plan

- Database: soil characteristics, land cover, vegetation, albedo, etc ...
- How do we transform the initial data to the model fields ?
- Impact of the database on the forecast.

Database

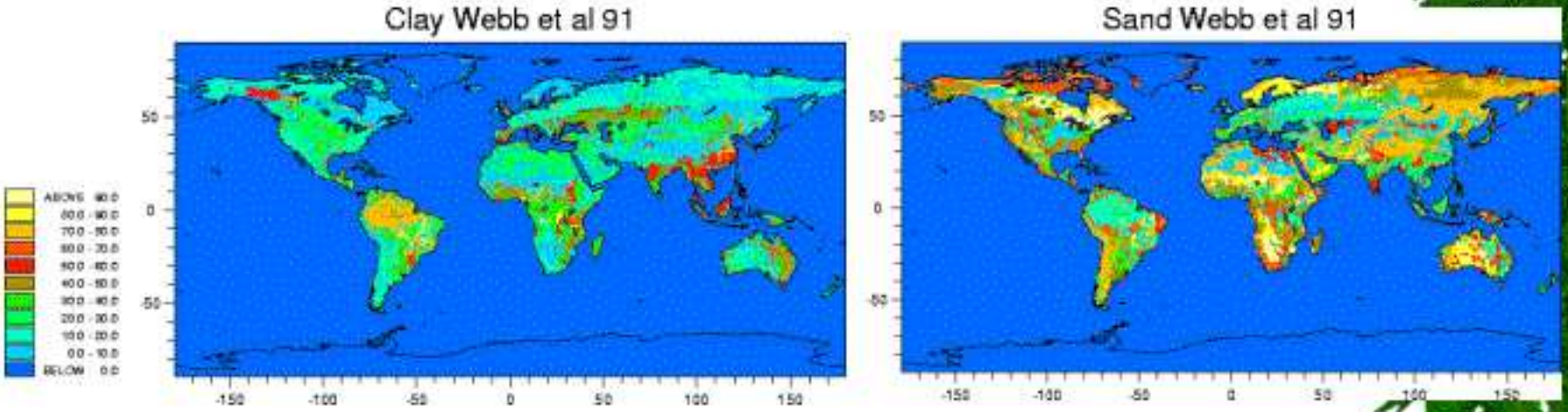
- According to the surface scheme (ISBA or ECMWF), the number of required parameters can vary noticeably.
- Some parameters are constant in time like the sand and the clay fractions, the type of vegetation (no interactive vegetation-human scheme) and the soil depth.
- In the ECMWF scheme the Leaf Area Index (LAI), the minimum stomatal resistance, soil characteristics, surface emissivity are also constant in time and uniform in space !
- For ISBA we need:

  -the soil characteristics: sand, clay, depth (d_p)

  -fields used to describe the vegetation: vegetation fraction, LAI, minimum surface resistance and main land cover type (sea, land-ice, lake, low and high vegetation). The vegetation databases contribute to modify the soil depth, the albedo and the roughness length (z_0) via d_r, z_{0v} and α_v.

Database

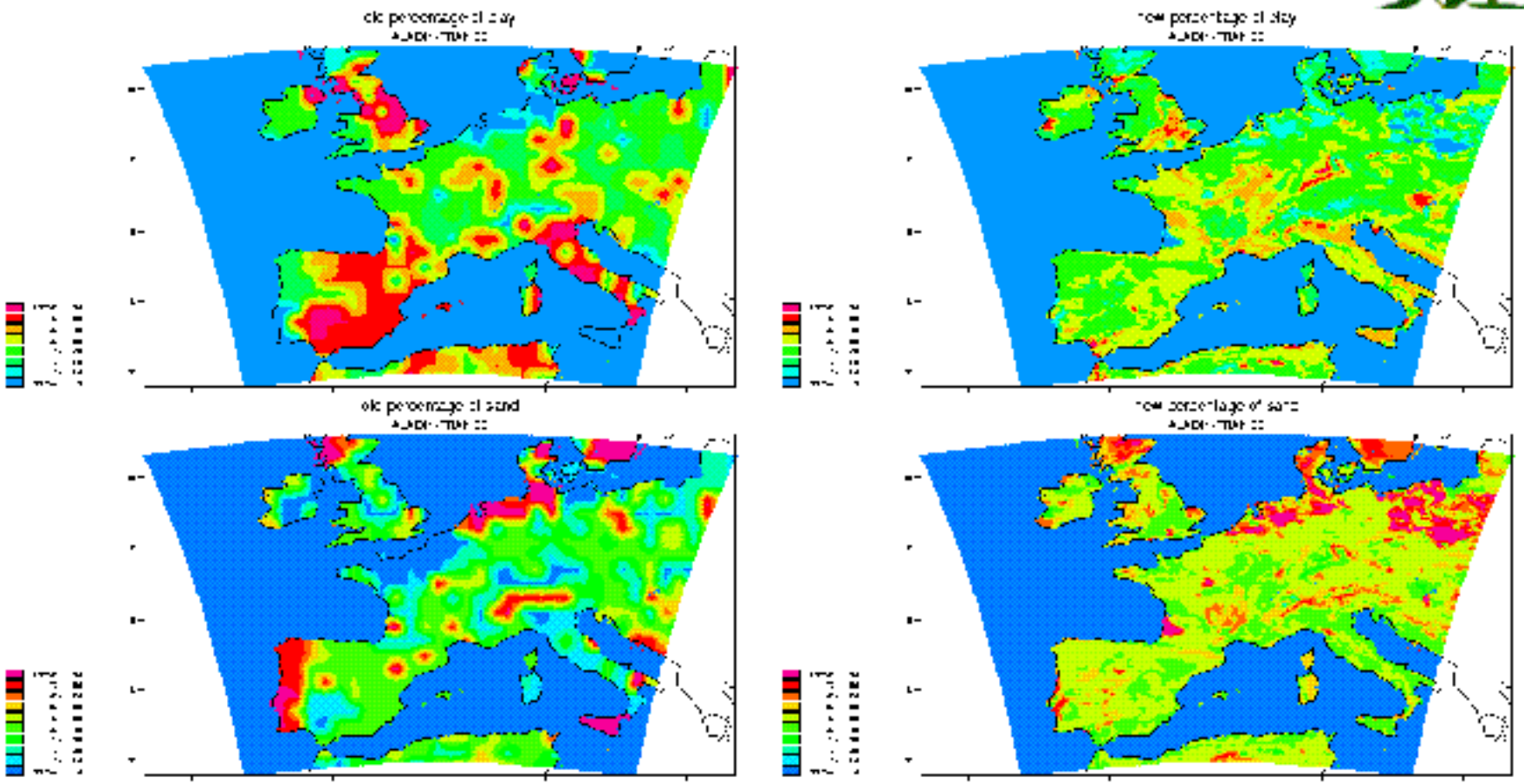
- The soil texture is derived from Webb et al. (1991) and the hydrological soil depth from Sellers et al. (1996). The resolution is 1° for both datasets.



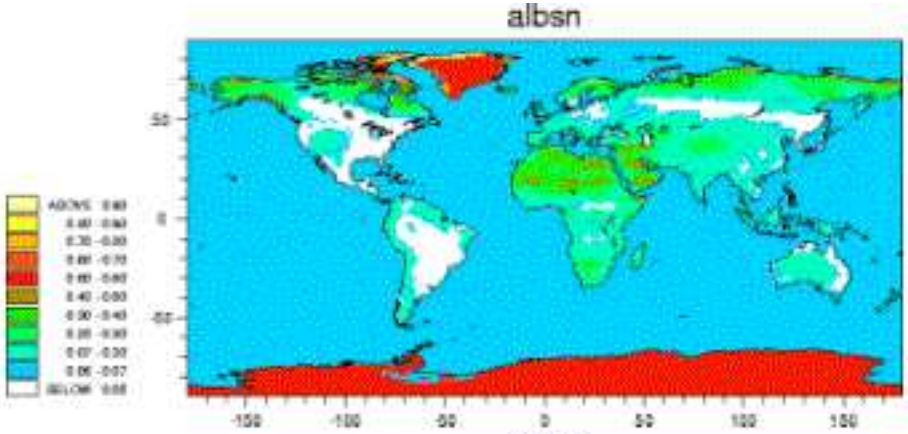
•The sand and clay percentages have been computed with the hydrological depth (d_h) from Sellers et al. (1996).

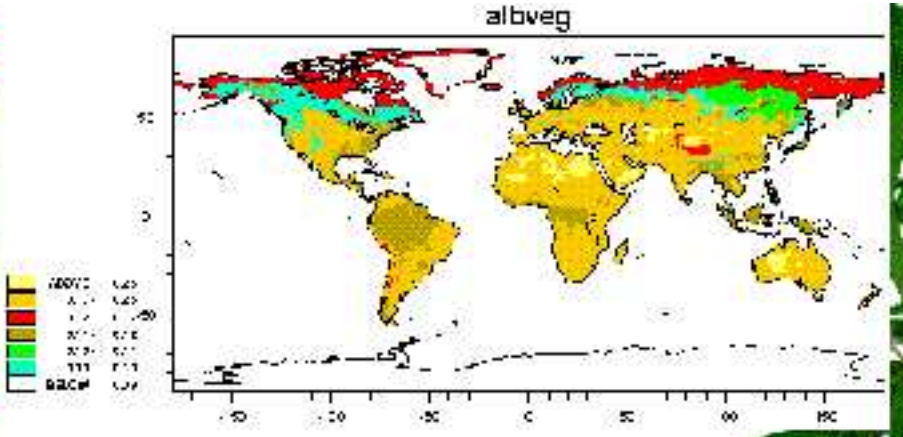
New data for the soil texture

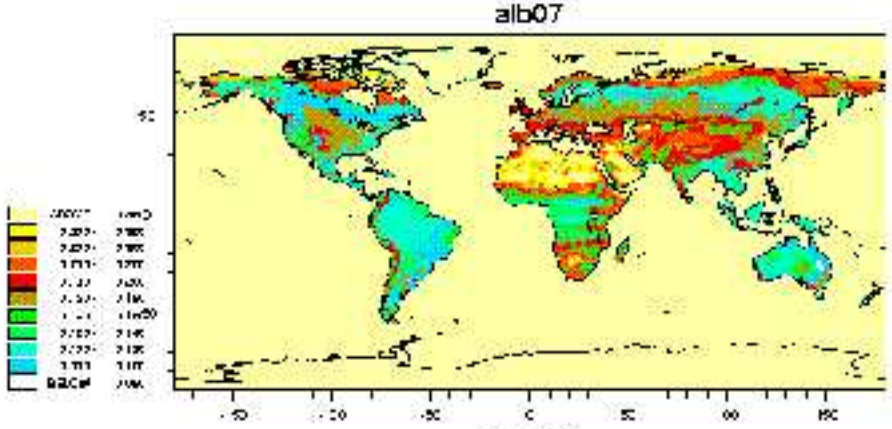
Global data from FAO with 5' of resolution: sand, clay soil depth.

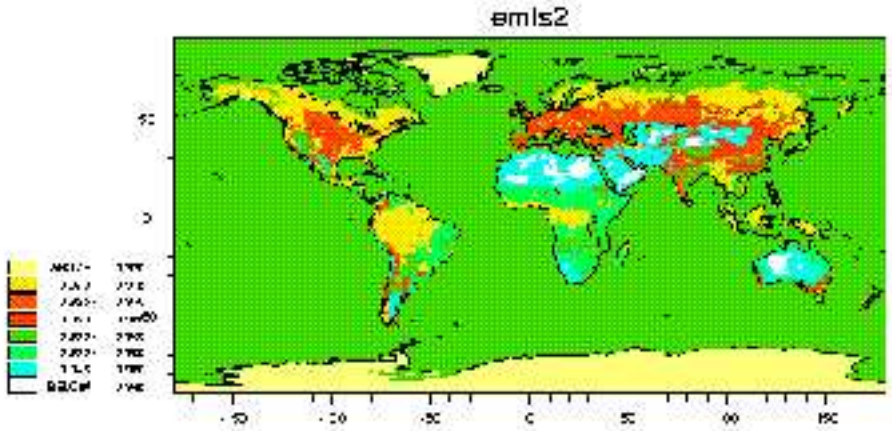


From Giard (EWGLAM 99)







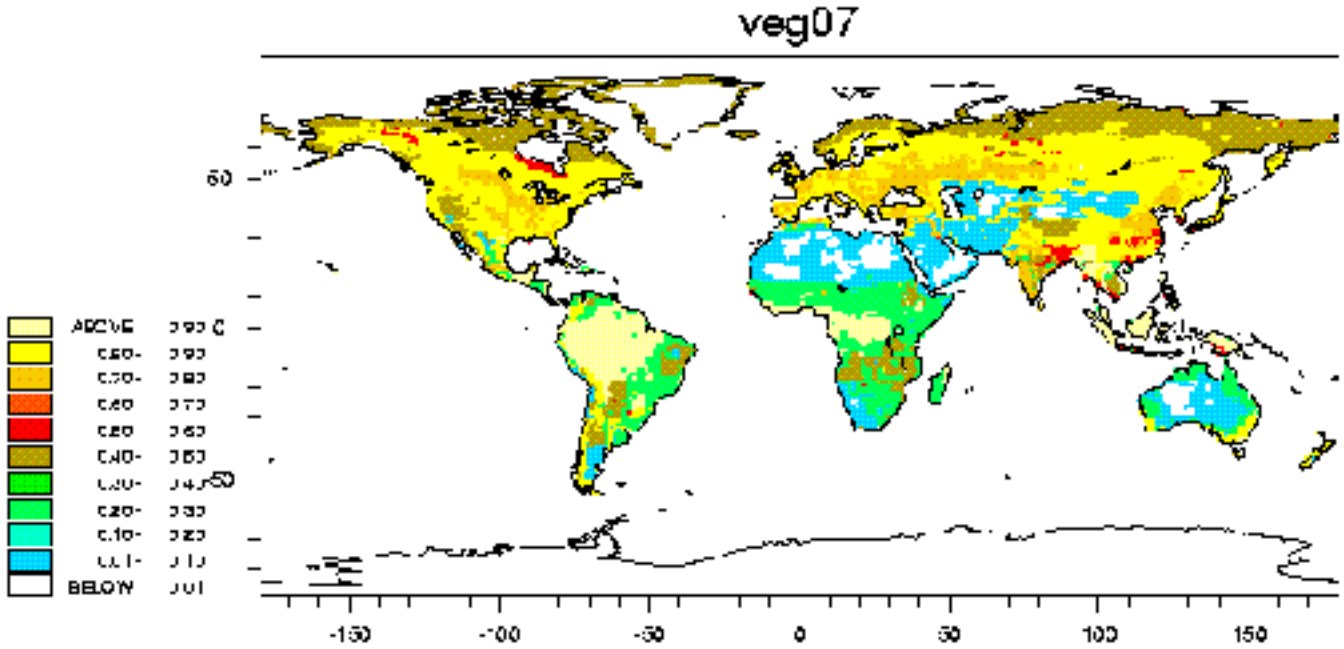


- Albedo (monthly): sea =0.07
  sea-ice =0.65
  ice =0.75
  $\alpha = (1\text{-veg})\ \alpha_{bg} + \text{veg}\ \alpha_{v}$

- Surface emissivity: sea=0.96
  ice=0.98
  low vegetation= 0.968
  high vegetation=0.974
  bare ground = 0.943
  $\varepsilon = \varepsilon_{v}\ \text{veg}_{x} + \varepsilon_{bg}\ (1\text{-veg}_{x})$

Vegetation database

•For the global vegetation database we use Wilson and Henderson-Sellers (1985) with a resolution of 1°, reduced to 13 classes by Mahfhouf et al. (1995) with new lookup tables. There define for each classe the LAI, the vegetation cover, the root depth, the albedo of vegetation, the roughness length of vegetation and the minimum surface resistance.



Mahfouf et al (1995)

APPENDIX A
Lookup Tables for the Global Land Cover Database

TABLE A1. Leaf area index ($m^2\ m^{-2}$).

Type of vegetation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Non-varying
Crop	0.1	0.1	0.1	0.5	1.0	2.0	3.0	3.5	4.0	0.1	0.1	0.1	
Short grass													1.0
Evergreen needleaf tree													5.0
Deciduous needleaf tree	0.1	0.1	0.5	1.0	2.0	4.0	5.0	5.0	4.0	2.0	1.0	0.1	
Deciduous broadleaf tree	0.1	0.1	0.5	1.0	2.0	4.0	5.0	5.0	4.0	2.0	1.0	0.1	
Evergreen broadleaf tree													6.0
Savannah	0.5	0.5	0.5	0.5	0.5	0.5	1.0	2.0	2.0	1.5	1.0	1.0	
Tundra	1.0	1.0	0.5	0.1	0.1	0.1	0.1	1.0	2.0	1.5	1.5	1.0	
Semidesert													0.5
Bog or marsh													4.0
Evergreen shrub													3.0
Deciduous shrub	0.5	0.5	1.0	1.0	1.5	2.0	3.0	3.0	2.0	1.5	1.0	0.5	
Mixed wood	3.0	3.0	3.0	4.0	4.5	5.0	5.0	5.0	4.0	3.0	3.0	3.0	

TABLE A2. Vegetation cover.

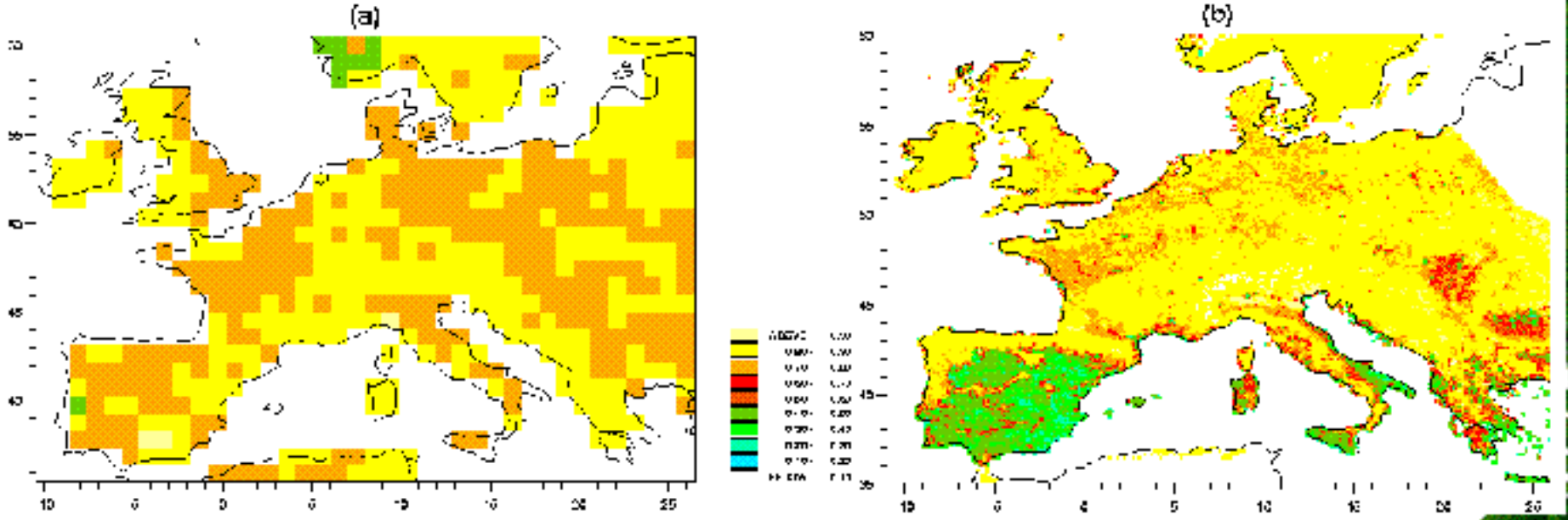
Type of vegetation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Non-varying
Crop	0.05	0.05	0.05	0.10	0.20	0.40	0.80	0.80	0.90	0.05	0.05	0.05	
Short grass													0.85
Evergreen needleaf tree													0.90
Deciduous needleaf tree													0.90
Deciduous broadleaf tree													0.90
Evergreen broadleaf tree													0.99
Savannah													0.30
Tundra													0.50
Semidesert													0.10
Bog or marsh													0.60
Evergreen shrub													0.50
Deciduous shrub													0.50
Mixed wood													0.90

TABLE A3. Root depth (d), albedo of vegetation (α_v), roughness length of vegetation ($z0$), and minimum surface resistance (R_{sc}).

Type of vegetation	d (m)	α	$z0$ (m)	R_{sc} ($m\ s^{-1}$)
Crop	2.0	0.20	0.15	40
Short grass	1.5	0.20	0.02	40
Evergreen needleaf tree	3.0	0.10	2.00	250
Deciduous needleaf tree	1.0	0.11	2.00	250
Deciduous broadleaf tree	3.0	0.12	2.00	250
Evergreen broadleaf tree	3.0	0.12	4.00	250
Savannah	2.0	0.20	0.10	40
Tundra	1.0	0.16	0.05	150
Semidesert	1.0	0.25	0.05	150
Bog or marsh	1.0	0.12	0.05	150
Evergreen shrub	2.0	0.20	0.10	150
Deciduous shrub	2.0	0.20	0.10	120
Mixed wood	2.0	0.12	2.00	250

• For the global model ARPEGE with a stretching factor c=3.5 we need a high resolution data over FRANCE (20 km), but at the antipodes with a resolution around 240 km 1° is enough. Also, for many LAM with an horizontal resolution around 10km fine mesh data is needed.

• Champeaux and Le Gléau (1995) provide a database over Europe with a 2km mesh and a better description of the annual cycle in particular for crops. An extension northwards and eastwards with a new forest mask was realized in 1998.



Champeaux and Le Gléau (1995)

APPENDIX B
Lookup Tables for the Champeaux Land Cover Database

TABLE B1. Leaf area index (m^2 m^{-2}).

Type of vegetation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crop (1)	1.0	1.0	1.0	2.0	4.0	4.0	4.0	4.0	3.0	2.0	1.0	1.0
Mediterranean crop	0.5	0.5	0.5	0.5	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5
Cereal (1)	0.5	0.5	0.5	2.0	3.0	4.0	4.0	3.0	2.0	1.0	0.5	0.5
Crop (2)	1.0	1.0	1.0	2.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Cereal (2)	0.5	0.5	1.0	2.0	4.0	4.0	3.0	2.0	1.0	1.0	0.5	0.5
Crop and grassland	1.0	1.0	2.0	2.0	3.0	3.0	2.5	2.5	2.0	2.0	1.0	1.0
Pasture land	1.0	1.0	1.0	2.0	3.0	3.0	3.0	3.0	3.0	2.0	1.0	1.0
Crop (3)	1.0	2.0	3.0	3.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Crop (4)	1.0	1.0	2.0	2.0	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vineyard	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Forest	2.0	2.0	2.0	2.5	3.0	4.0	4.0	4.0	3.0	2.5	2.0	2.0

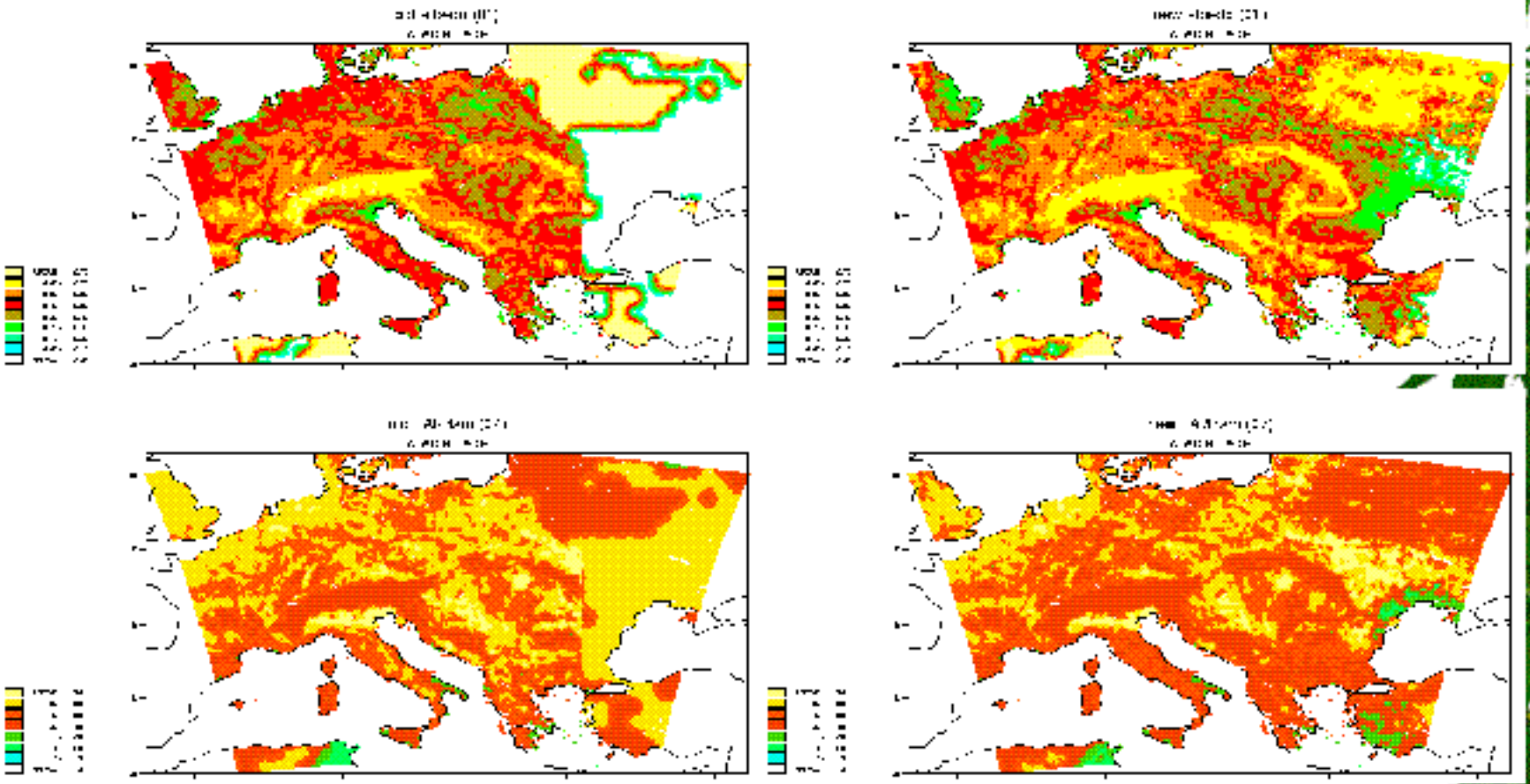
TABLE B2. Vegetation cover.

Type of vegetation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Crop (1)	0.45	0.45	0.70	0.91	0.91	0.91	0.91	0.91	0.83	0.70	0.45	0.45
Mediterranean crop	0.26	0.26	0.26	0.26	0.45	0.45	0.26	0.26	0.26	0.26	0.26	0.26
Cereal (1)	0.26	0.26	0.26	0.70	0.83	0.91	0.91	0.83	0.70	0.45	0.26	0.26
Crop (2)	0.45	0.45	0.45	0.70	0.83	0.83	0.70	0.70	0.70	0.45	0.45	0.45
Cereal (2)	0.26	0.26	0.45	0.70	0.91	0.91	0.83	0.70	0.45	0.45	0.26	0.26
Crop and grassland	0.45	0.45	0.70	0.70	0.83	0.83	0.77	0.77	0.70	0.70	0.45	0.45
Pasture land	0.45	0.45	0.45	0.70	0.83	0.83	0.83	0.83	0.83	0.70	0.45	0.45
Crop (3)	0.45	0.45	0.70	0.83	0.83	0.70	0.45	0.45	0.45	0.45	0.45	0.45
Crop (4)	0.45	0.45	0.70	0.70	0.59	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Vineyard	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Forest	0.63	0.63	0.63	0.71	0.78	0.87	0.87	0.87	0.78	0.71	0.63	0.63

TABLE B3. Root depth (d), albedo of vegetation (α), roughness length of vegetation ($z0$), and minimum surface resistance ($R_{s_{min}}$).

Type of vegetation	d, (m)	α	$z0$, (m)	$R_{s_{min}}$ (m s^{-1})
Crop (1)	2.0	0.2	0.15	40
Mediterranean crop	2.0	0.2	0.15	80
Cereal (1)	1.5	0.2	0.15	40
Crop (2)	2.0	0.2	0.15	40
Cereal (2)	2.0	0.2	0.15	40
Crop and grassland	2.0	0.2	0.15	40
Pasture land	1.5	0.2	0.15	40
Crop (3)	2.0	0.2	0.15	40
Crop (4)	2.0	0.2	0.15	40
Vineyard	1.0	0.2	0.15	80
Forest	3.0	0.1	2.0	150

Albedo and LAI/Rsmin



From Giard D. (EWGLAM 99)

How do we transform the initial data to the model grid ?

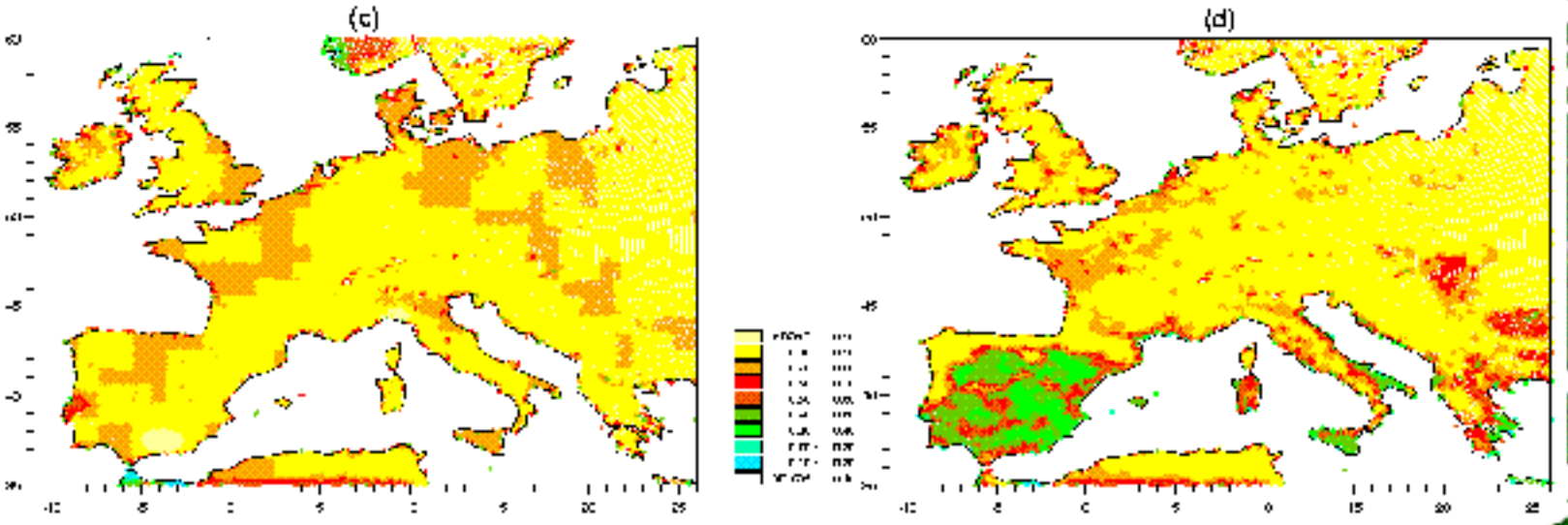
- Four-points interpolation with a land sea mask and/or the mask of missing data.
- For the soil depth we combine the hydrological soil depth and the root depth: $d_p = (1-veg_x)\, d_h + veg_x\, d_r$
- For R_{smin}, we interpolate LAI first and afterwards LAI/R_{smin} so $(R_{smin})^A = (LAI)^A/(LAI/R_{smin})^A$. Previously $1/R_{smin}$ was proposed by Noilhan & Lacarrère (1995) but in ISBA and in the soil moisture assimilation the ratio LAI/R_{smin} which is more important.
- For the roughness length, first the $\log(z_{0v})$ is interpolated on to the model grid.

$$z_{0v} = veg \cdot z_{0v} + urb \cdot z_{urb} + (1 - veg - urb) \cdot z_{des}$$

$$z_0 = \sqrt{z_{0r}^2 + z_{0v}^2}$$ with z_{des}=0.001m and z_{urb}=2.5m

Impact of the new database

- Impact of the new high-resolution data for the vegetation (Champeaux and Le Gléau, 1995) with respect to the global dataset. Over Spain in July the vegetation cover and the LAI decrease from 0.83 to 0.53 and from 2.9 to 1.5 m^2m^{-2}.



Old New

Vegetation cover in July

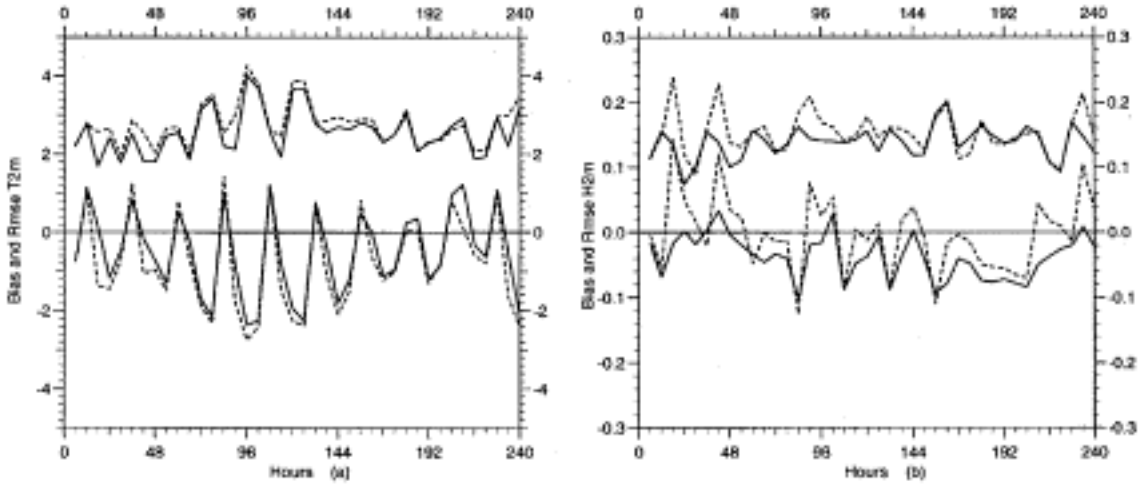
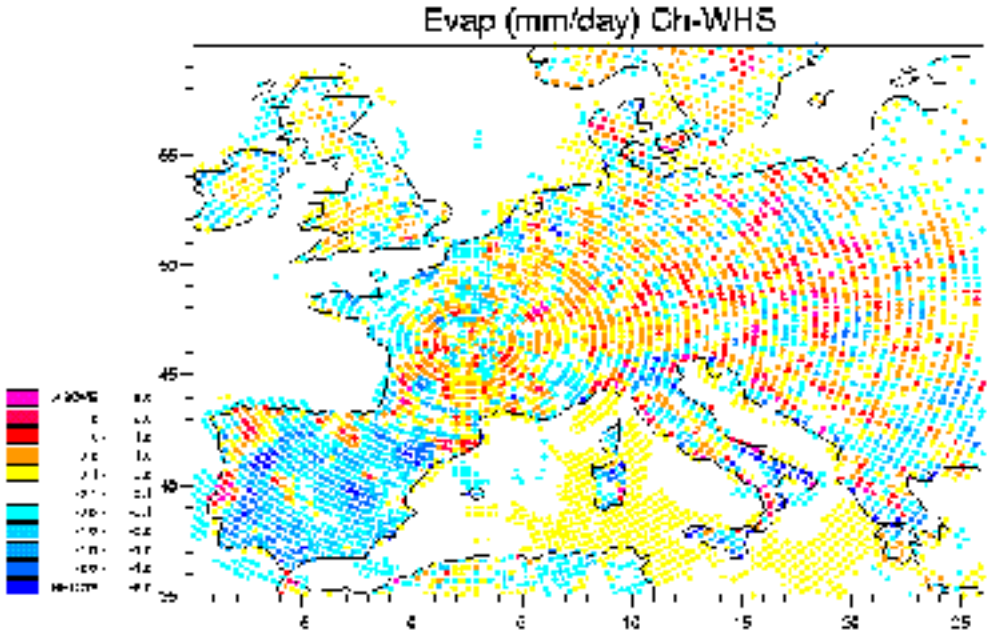


FIG. 1. Difference between predicted and observed (SYNOP) values (mean and rms errors) during 10-day long assimilation experiments from 2 July 1995, over Spain (36°N, 10°W; 44°N, 0°): (a) T_{2m}, (b) H_{2m}. Full line: new high-resolution vegetation. Dashed line: old vegetation (model − obs. is plotted).

Giard and Bazile 2000, MWR. 10-ten days long assimilation experiments. Guess – Synop



Champeaux et al. 2000, IJRS. Evaporation is reduced about 0.4mm/day even if is still too high.

BAZILE E. Météo-France May 2000

Conclusion

- High resolution data can improve the 2m scores and the evaporation flux. The impact is more significant with a soil moisture assimilation because the corrections are functions of the vegetation cover and the ratio LAI/Rsmin.
- The new soil texture dataset (sand, clay, soil depth) really improves the Webb data but unfortunately the impact on the forecast is very small (O. Latinne Int. Note).
- More details on the vegetation mapping from AVHRR in Champeaux, Arcos, Bazile, Giard, Goutorbe, Habets, Noilhan and Roujean, Int. J. Remote Sensing 2000 Vol 21 1183-1199.
- Before next year (2001) we should have a global land cover database with a 1km mesh.