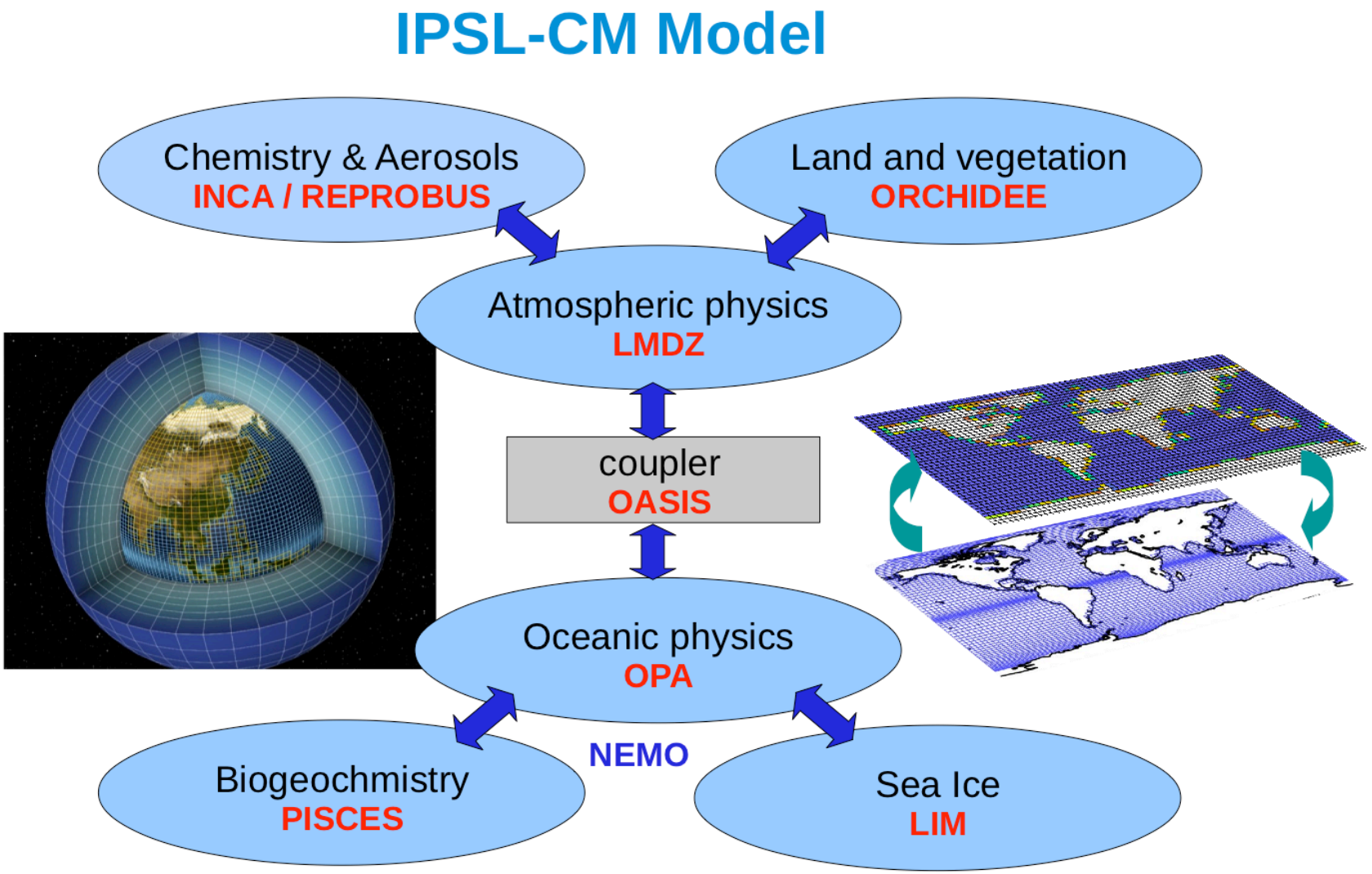
Latest version of ORCHIDEE-TRUNK in the context of CMIP6



Thanks to many contributors

- Specific contribution from people meeting every Tuesday: *Josefine, Fabienne, Agnes, Catherine, Federique, Juliette, Patricia, Nicolas, Nicolas, Bertrand, Matthieu, Vladislav, Sebastiaan, Jan, Pascal, Philippe*

- Several contribution on specific parametrizations (Thermics, land cover, optimization, ...): *Fuxing, Natasha, Devaraju, Anne, Dan, Gerhard, Albert, Shushi, Philippe, Daniel,...*

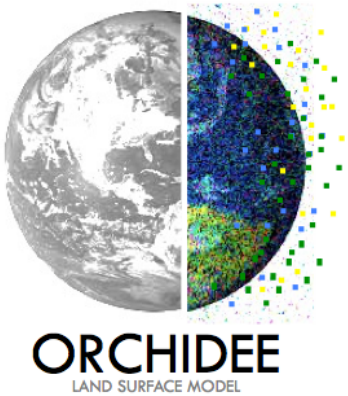
- Direct or Indirect contribution of the whole project group

Outline..

- Introduction: Philippe
- land cover + albedo : Philippe
- Hydrology : Agnes
- Soil thermic : Fuxing
- Snow : Catherine
- Soil freezing: Catherine
- New Roughness calculation: Nicolas
- Update on photosynthesis: Nicolas
- Optimization of Carbon cycle parameters: Philippe
- Conclusion and prospective: Philippe

The long standing issue of the LOGO …

Selected
Democratically
by ALL



Refused
by the government

The long standing issue of the LOGO …

1

2

3

The long standing issue of the LOGO …

4

5

1

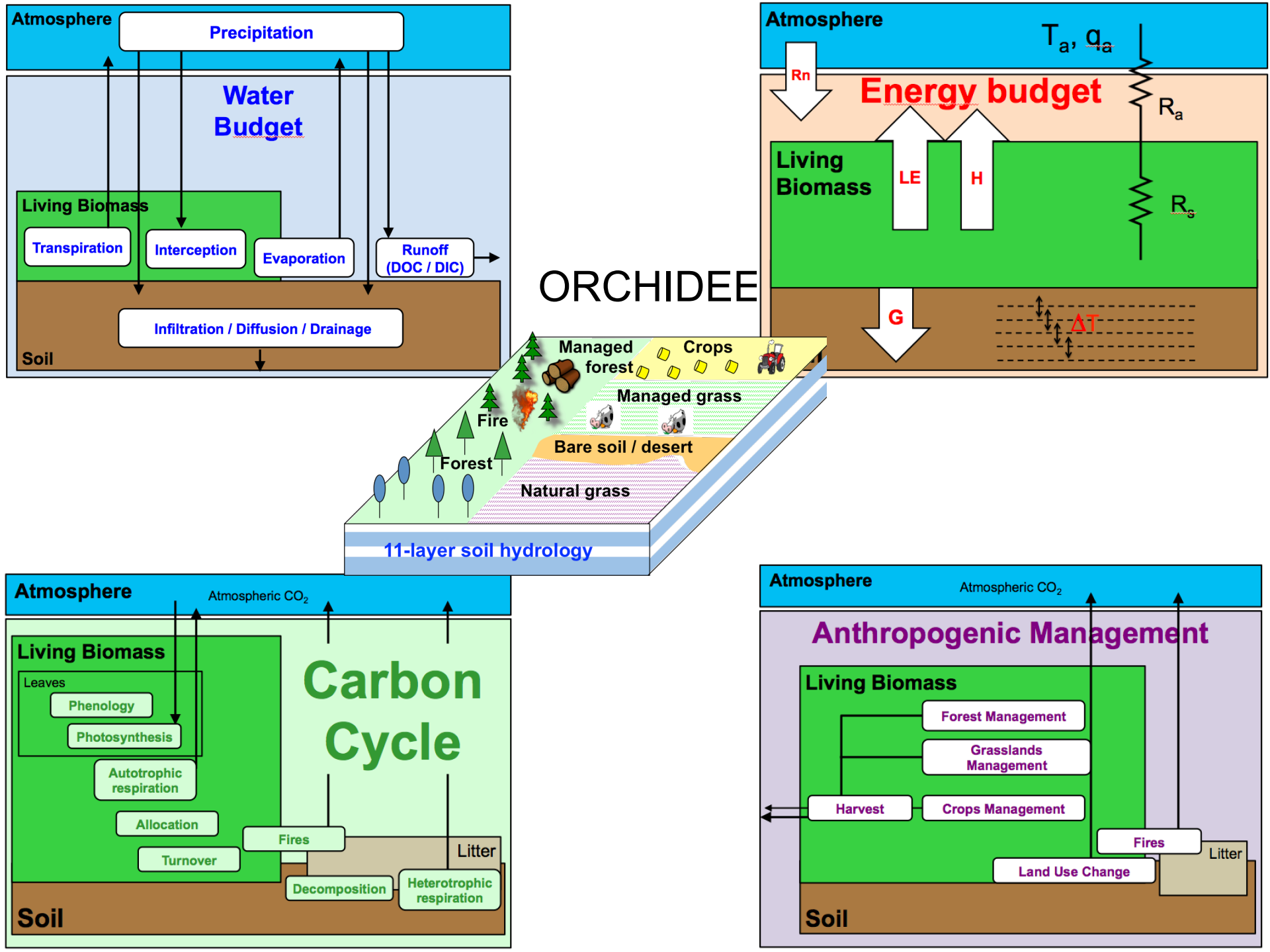
2

3

The long standing issue of the LOGO …

4

5


Atmosphere
Precipitation
Water Budget
Living Biomass
Transpiration
Interception
Evaporation
Runoff (DOC / DIC)
Infiltration / Diffusion / Drainage
Soil
ORCHIDEE
Atmosphere
T_a, q_a
Rn
Energy budget
R_a
Living Biomass
LE
H
R_s
G
ΔT
Managed forest
Crops
Managed grass
Fire
Forest
Bare soil / desert
Natural grass
11-layer soil hydrology
Atmosphere
Atmospheric CO_2
Living Biomass
Leaves
Phenology
Photosynthesis
Autotrophic respiration
Allocation
Turnover
Carbon Cycle
Fires
Litter
Decomposition
Heterotrophic respiration
Soil
Atmosphere
Atmospheric CO_2
Anthropogenic Management
Living Biomass
Forest Management
Grasslands Management
Harvest
Crops Management
Fires
Litter
Land Use Change
Soil

ORCHIDEE developments for CMIP6

Implemented: V1

Soon..: V1.5

Merging

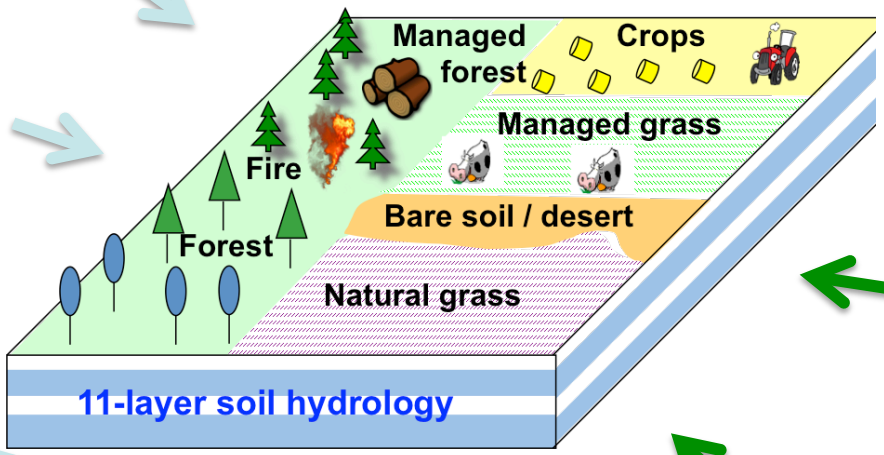
New Aerodynamic resistance

Nitrogen – carbon Coupled cycles

Optimized albedo (using MODIS)

Permafrost carbon

Land cover based on ESA-CCI



Forest management & forest structure

New 3 layers snow model

11-layer soil hydrology With soil freezing

SPITFIRE and Land use gross transitions

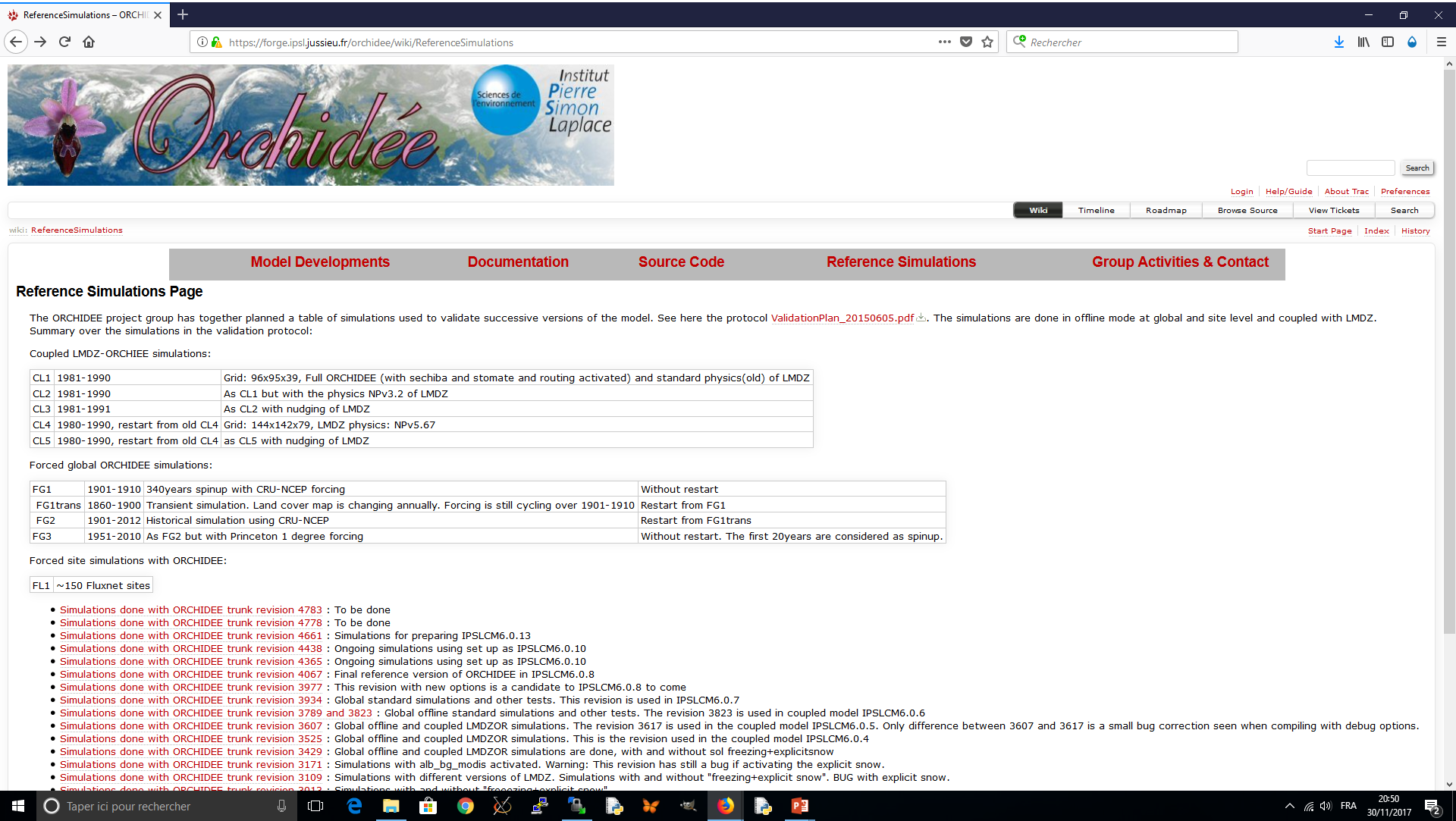
Improved Carbon cycle description

COV fluxes

CH4 emissions (wetland and permafrost)

Tools for comparing simulations and/or observations

Most test done in the past 2 years are described under:
https://forge.ipsl.jussieu.fr/orchidee/wiki/ReferenceSimulations



ReferenceSimulations – ORCHI

https://forge.ipsl.jussieu.fr/orchidee/wiki/ReferenceSimulations

Rechercher

Orchidée — Institut Pierre Simon Laplace — Sciences de l'environnement

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Model Developments | Documentation | Source Code | Reference Simulations | Group Activities & Contact

Reference Simulations Page

The ORCHIDEE project group has together planned a table of simulations used to validate successive versions of the model. See here the protocol ValidationPlan_20150605.pdf. The simulations are done in offline mode at global and site level and coupled with LMDZ.
Summary over the simulations in the validation protocol:

Coupled LMDZ-ORCHIEE simulations:

CL1	1981-1990	Grid: 96x95x39, Full ORCHIDEE (with sechiba and stomate and routing activated) and standard physics(old) of LMDZ
CL2	1981-1990	As CL1 but with the physics NPv3.2 of LMDZ
CL3	1981-1991	As CL2 with nudging of LMDZ
CL4	1980-1990, restart from old CL4	Grid: 144x142x79, LMDZ physics: NPv5.67
CL5	1980-1990, restart from old CL4	as CL5 with nudging of LMDZ

Forced global ORCHIDEE simulations:

FG1	1901-1910	340years spinup with CRU-NCEP forcing	Without restart
FG1trans	1860-1900	Transient simulation. Land cover map is changing annually. Forcing is still cycling over 1901-1910	Restart from FG1
FG2	1901-2012	Historical simulation using CRU-NCEP	Restart from FG1trans
FG3	1951-2010	As FG2 but with Princeton 1 degree forcing	Without restart. The first 20years are considered as spinup.

Forced site simulations with ORCHIDEE:

FL1	~150 Fluxnet sites

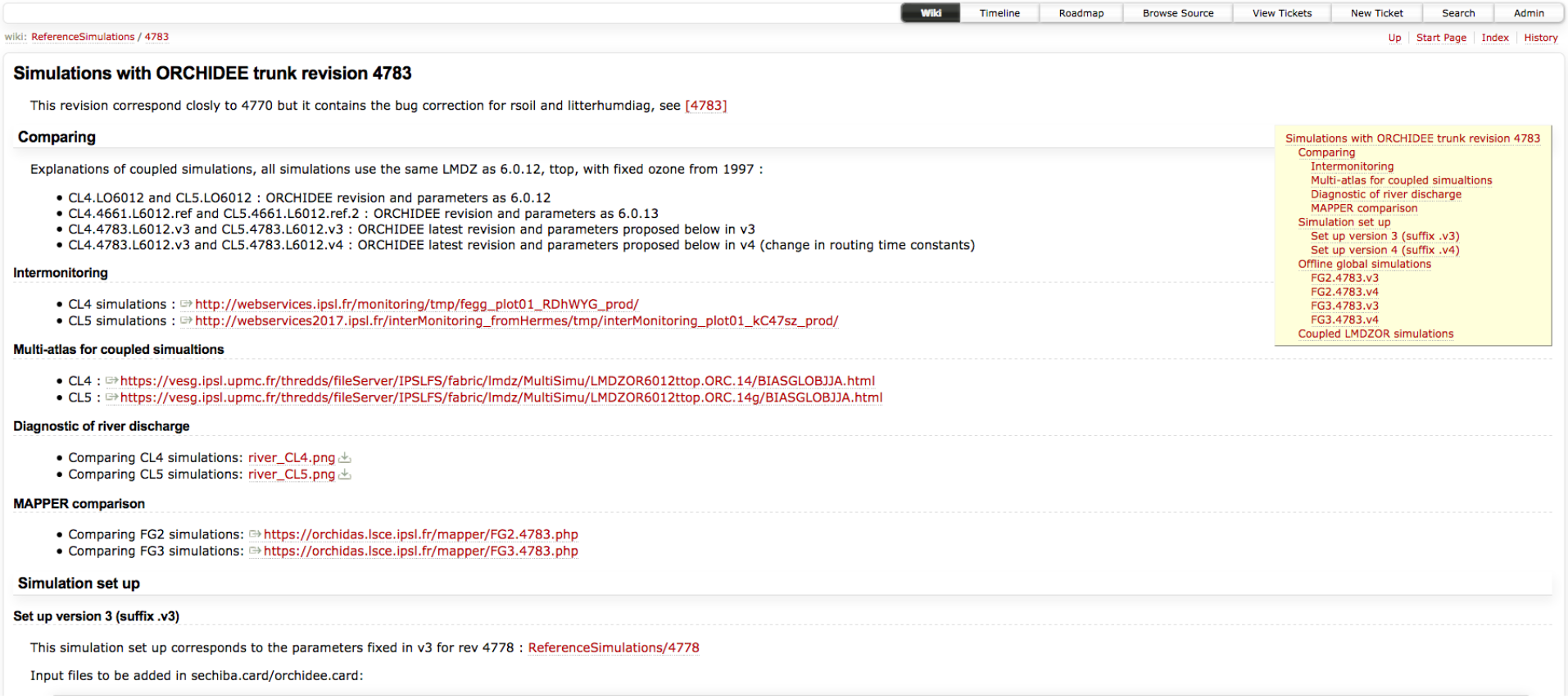
- Simulations done with ORCHIDEE trunk revision 4783 : To be done
- Simulations done with ORCHIDEE trunk revision 4778 : To be done
- Simulations done with ORCHIDEE trunk revision 4661 : Simulations for preparing IPSLCM6.0.13
- Simulations done with ORCHIDEE trunk revision 4438 : Ongoing simulations using set up as IPSLCM6.0.10
- Simulations done with ORCHIDEE trunk revision 4365 : Ongoing simulations using set up as IPSLCM6.0.10
- Simulations done with ORCHIDEE trunk revision 4067 : Final reference version of ORCHIDEE in IPSLCM6.0.8
- Simulations done with ORCHIDEE trunk revision 3977 : This revision with new options is a candidate to IPSLCM6.0.8 to come
- Simulations done with ORCHIDEE trunk revision 3934 : Global standard simulations and other tests. This revision is used in IPSLCM6.0.7
- Simulations done with ORCHIDEE trunk revision 3789 and 3823 : Global offline standard simulations and other tests. The revision 3823 is used in coupled model IPSLCM6.0.6
- Simulations done with ORCHIDEE trunk revision 3607 : Global offline and coupled LMDZOR simulations. The revision 3617 is used in the coupled model IPSLCM6.0.5. Only difference between 3607 and 3617 is a small bug correction seen when compiling with debug options.
- Simulations done with ORCHIDEE trunk revision 3525 : Global offline and coupled LMDZOR simulations. This is the revision used in the coupled model IPSLCM6.0.4
- Simulations done with ORCHIDEE trunk revision 3429 : Global offline and coupled LMDZOR simulations are done, with and without sol freezing+explicitsnow
- Simulations done with ORCHIDEE trunk revision 3171 : Simulations with alb_bg_modis activated. Warning: This revision has still a bug if activating the explicit snow.
- Simulations done with ORCHIDEE trunk revision 3109 : Simulations with different versions of LMDZ. Simulations with and without "freezing+explicit snow". BUG with explicit snow.
- Simulations done with ORCHIDEE trunk revision 3013 : Simulations with and without "freezing+explicit snow"

Taper ici pour rechercher

FRA 20:50 30/11/2017

Latest ORCHIDEE configuration (CMIP6)

https://forge.ipsl.jussieu.fr/orchidee/wiki/ReferenceSimulations/47837



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wiki: ReferenceSimulations / 4783

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Simulations with ORCHIDEE trunk revision 4783

This revision correspond closly to 4770 but it contains the bug correction for rsoil and litterhumdiag, see [4783]

Simulations with ORCHIDEE trunk revision 4783
- Comparing
  - Intermonitoring
  - Multi-atlas for coupled simualtions
  - Diagnostic of river discharge
  - MAPPER comparison
- Simulation set up
  - Set up version 3 (suffix .v3)
  - Set up version 4 (suffix .v4)
- Offline global simulations
  - FG2.4783.v3
  - FG2.4783.v4
  - FG3.4783.v3
  - FG3.4783.v4
- Coupled LMDZOR simulations

Comparing

Explanations of coupled simulations, all simulations use the same LMDZ as 6.0.12, ttop, with fixed ozone from 1997 :

- CL4.LO6012 and CL5.LO6012 : ORCHIDEE revision and parameters as 6.0.12
- CL4.4661.L6012.ref and CL5.4661.L6012.ref.2 : ORCHIDEE revision and parameters as 6.0.13
- CL4.4783.L6012.v3 and CL5.4783.L6012.v3 : ORCHIDEE latest revision and parameters proposed below in v3
- CL4.4783.L6012.v3 and CL5.4783.L6012.v4 : ORCHIDEE latest revision and parameters proposed below in v4 (change in routing time constants)

Intermonitoring

- CL4 simulations : http://webservices.ipsl.fr/monitoring/tmp/fegg_plot01_RDhWYG_prod/
- CL5 simulations : http://webservices2017.ipsl.fr/interMonitoring_fromHermes/tmp/interMonitoring_plot01_kC47sz_prod/

Multi-atlas for coupled simualtions

- CL4 : https://vesg.ipsl.upmc.fr/thredds/fileServer/IPSLFS/fabric/lmdz/MultiSimu/LMDZOR6012ttop.ORC.14/BIASGLOBJJA.html
- CL5 : https://vesg.ipsl.upmc.fr/thredds/fileServer/IPSLFS/fabric/lmdz/MultiSimu/LMDZOR6012ttop.ORC.14g/BIASGLOBJJA.html

Diagnostic of river discharge

- Comparing CL4 simulations: river_CL4.png
- Comparing CL5 simulations: river_CL5.png

MAPPER comparison

- Comparing FG2 simulations: https://orchidas.lsce.ipsl.fr/mapper/FG2.4783.php
- Comparing FG3 simulations: https://orchidas.lsce.ipsl.fr/mapper/FG3.4783.php

Simulation set up

Set up version 3 (suffix .v3)

This simulation set up corresponds to the parameters fixed in v3 for rev 4778 : ReferenceSimulations/4778

Input files to be added in sechiba.card/orchidee.card:

Main tools used for recent model evaluation

- Intermonitoring (IPSL)
  http://webservices2017.ipsl.fr/interMonitoring_fromHermes/tmp/interMonitoring_plot01_6eqqjW_prod/

- ATLAS (IPSL, Jerome S.)
  https://vesg.ipsl.upmc.fr/thredds/fileServer/IPSLFS/fabric/lmdz/MultiSimu/LMDZOR6012ttop.ORC.14/BIASGLOBJJA.html

- Mapper (LSCE, Vladislav)
  https://orchidas.lsce.ipsl.fr/mapper/FG2.4661.v2.php

- Inter-ATLAS (LSCE, Nicolas Vui)
  https://vesg.ipsl.upmc.fr/thredds/fileServer/work/p529vui/OL2/DEVT/Eval-ORCHIDEE/r4067/CL4/CL4.4067.L608.flp_VS_CL4.4067.L608/index.html

Land cover update for CMIP6

- CMIP5 based on Olson map
  - ➔ Update with ESA-CCI Land Cover new maps

- Historical reconstruction based on 3 steps
  1. Derive present-day PFT maps from ESA land cover classes
  2. Merge present-day ESA PFT with LUHv2 land use/cover map
  3. Define historical reconstruction based on LUHv2 past LU/LC maps
  4. Additional specific treatments (inland water, coast, cities,…)

- All steps summarized in:

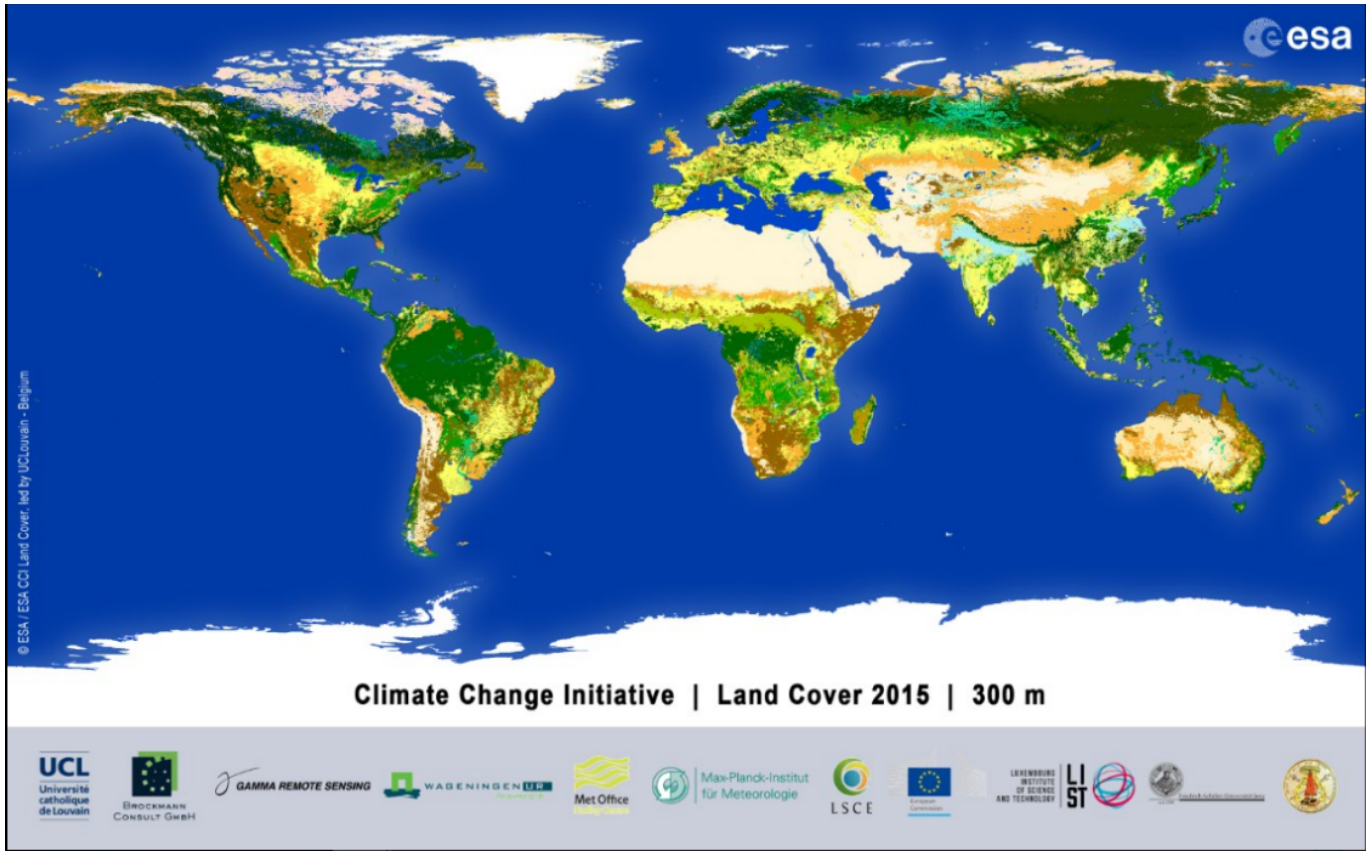
  https://orchidas.lsce.ipsl.fr/dev/LCCCI.php

Main contributors: Vladislav, Natasha, Nicolas, Devaraju, Catherine, Nathalie, Philippe

ESA CCI Land Cover

European Space Agency program:

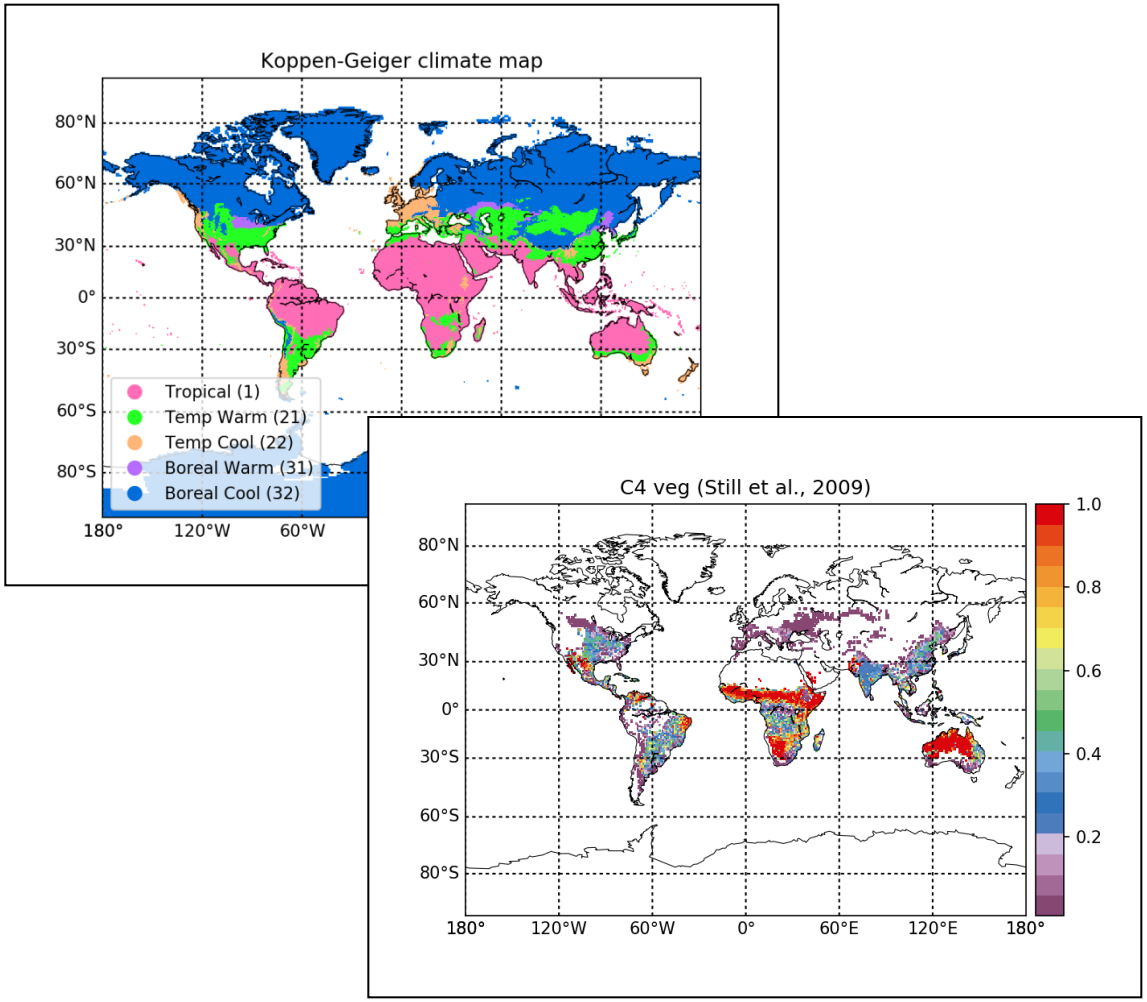
Global Monitoring of Essential Climate Variables (Climate Change Initiative)



http://www.esa-landcover-cci.org

ESA CCI Land Cover

CCI CLASS	KG CLASS	TREES					SHRUBS				GRASSES		Bare Soil	Water	Snow and Ice	Urban	No Data
		TrBrEv	TrBrDe	TrNeEv	TrNeDe	ShBrEv	ShBrDe	ShNeEv	ShNeDe	NatGr	Crops						
0 no data																	100
10 cropland, rainfed										10 0	90 100						
11 cropland, rainfed, herbaceous cover										10 0	90 100						
12 cropland, rainfed, tree or shrub cover							70 50				30 50						
20 cropland, irrigated or post-flooding										10 0	90 100						
30 mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)		5	5			5	5	5		15	60						
40 mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)		7.5 5	7.5 5			10 7.5	15 10	10 7.5		30 15	20 40						
50 tree cover, broadleaved, evergreen, closed to open (>15%)		90				5	5										
60 tree cover, broadleaved, deciduous, closed to open (>15%)			30 70				30 15			30 15							
61 tree cover, broadleaved, deciduous, closed (>40%)			70				15			15							
62 tree cover, broadleaved, deciduous, open (15-40%)			30				25			45 35		0 10					
70 tree cover, needleleaved, evergreen, closed to open (>15%)				70		5	5	5		15							
71 tree cover, needleleaved, evergreen, closed (>40%)				70		5	5	5		15							
72 tree cover, needleleaved, evergreen, open (15-40%)				30			0 5	25 5		45 30		0 30					
80 tree cover, needleleaved, deciduous, closed to open (>15%)					30 70	2.5 5	2.5 5	2.5 5	12.5 0	30 15							
81 tree cover, needleleaved, deciduous, closed (>40%)					70	5	5	5		15							
82 tree cover, needleleaved, deciduous, open (15-40%)					30		0 5	0 5	25 0	45 30		0 30					
90 tree cover, mixed leaf types (broadleaved and needleleaved)			30	20	10	5	5	5		25 15		0 10					
100 mosaic tree and shrub (>50%) / herbaceous cover (<50%)		10	20	5	5	5	10	5		40							
110 mosaic herbaceous cover (>50%) / tree and shrub (<50%)		5	10	5		5	10	5		60							
120 shrubland	def					20	20	20		20		20					
	1					15	30	15		40							
	21					15	30	15		40							
	22					15	30	15		40							
	31					20	40	20		20							
	32					20	40	20		20							
121 shrubland, evergreen	def					30		30		20		20					
	1					30		30		40							
	21					30		30		40							
	22					30		30		40							
	31					40		40		20							
	32					40		40		20							
122 shrubland, deciduous	def						60			20		20					
	1						60			40							
	21						60			40							
	22						60			40							
	31						60			20							
	32						60			20							
130 grassland										100 60		0 40					
140 lichens and mosses										100 60		0 40					
	def	1	1	1		1	1	1		1		85					
150 sparse vegetation (tree, shrub, herbaceous cover) (<15%)	1		5				5			20		70					
	21		5	5			5	5		30		50					
	22		5	5			5	5		30		50					
	31		3	3	3		4	4	3	65		15					
	32		3	3	3		4	4	3	65		15					
151 sparse trees (<15%)	def		2	5	2					5		85					
	1		10							20		70					
	21		10	10						30		50					
	22		10	10						30		50					
	31		7.5	7.5	5					65		15					
	32		7.5	7.5	5					65		15					
152 sparse shrub (<15%)	def					2	5	2		5		85					
	1						10			20		70					
	21						10	10		30		50					
	22						10	10		30		50					
	31						7.5	7.5	5	65		15					
	32						7.5	7.5	5	65		15					
153 sparse herbaceous cover (<15%)	def									15		85					
	1									30		70					
	21									50		50					
	22									50		50					
	31									65		15					
	32									65		15					
160 tree cover, flooded, fresh or brakish water		37.5 50	37.5 50							25 50			0 50				
170 tree cover, flooded, saline water		75 50				25 50							0 50				
180 shrub or herbaceous cover, flooded, fresh/saline/brakish water			0 5	0 10			25 10	15 5		60 40			0 50				
190 urban areas			0 2.5	0 2.5						0 15		0 75	0 5		100 0		
200 bare areas												100					
201 bare areas, consolidated												100					
202 bare areas, unconsolidated												100					
210 water bodies													100				
220 permanent snow and ice														100			



38 ESA CCI classes
29 KG climate zones
C_3/C_4-split data

15 GENERIC PFTs

ESA CCI Land Cover

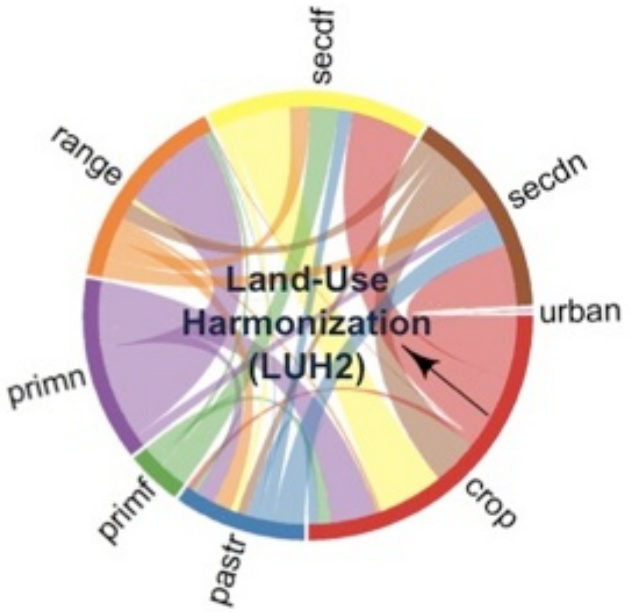
GENERIC PFTs → **ORCHIDEE PFTs**

KG CLASS	TrBrEv	TrBrDe	TrNeEv	TrNeDe	ShBrEv	ShBrDe	ShNeEv	ShNeDe	NatGr	Crops	BS	Water	SnowIce	Urban	NoData
1 (tropical)	PFT2	PFT3	PFT4	PFT3	PFT2	PFT3	PFT4	PFT3	PFT10 PFT11 using C4veg (Still)	PFT12 PFT13 using C4veg (Still)	PFT1	PFT1 at land dillute between PFT2-13 at coast	PFT1	80% → BS 20% → NatGr	PFT1
21 (temp warm)	PFT5	PFT6		PFT6	PFT5	PFT6		PFT6							
22 (temp cool)				PFT9				PFT9							
31 (boreal warm)															
32 (boreal cool)		PFT8	PFT7			PFT8	PFT7								

Currently 15 PFTs

- Standard old 13 PFTs
- But PFT10 split using Koppen Geiger data into Tropical (14), Temperate (10), Boreal (15)

ESA CCI Land Cover + LUH2



LUH CLASS	Description
primf	forested primary land
primn	non-forested primary land
secdf	potentially forested secondary land
secdn	potentially non-forested secondary land
urban	urban land
c3ann	C3 annual crops
c4ann	C4 annual crops
c3per	C3 perennial crops
c4per	C4 perennial crops
c3nfx	C3 nitrogen-fixing crops
pastr	managed pasture
range	rangeland

http://luh.umd.edu

ESA CCI Land Cover + LUH2

Calculation of the natural vegetation fractioning between PFTs :

$LUH_{NAT} = LUH_{PRIMF} + LUH_{PRIMN} + LUH_{SECDF} + LUH_{SECDN} + LUH_{RANGE} + LUH_{URBAN}$
$LUH_{C3} = LUH_{C3ANN} + LUH_{C3PER} + LUH_{C3NFX}$
$LUH_{C4} = LUH_{C4ANN} + LUH_{C4PER}$
$ANTH = LUH_{C3} + LUH_{C4} + LUH_{PASTR}$

$GRASS_{ANTH} = \max(0, ANTH - ORC_{12} - ORC_{13})$
$GRASS_{NAT} = \max(0, ORC_{10} + ORC_{11} - GRASS_{ANTH})$
$GRASS_{NAT\_C3} = GRASS_{NAT} \cdot ORC_{10} / (ORC_{10} + ORC_{11})$
$GRASS_{NAT\_C4} = GRASS_{NAT} \cdot ORC_{11} / (ORC_{10} + ORC_{11})$

$TOTAL_{NAT} = ORC_1 + ... + ORC_9 + GRASS_{NAT\_C3} + GRASS_{NAT\_C4}$

$f_1 = ORC_1 / TOTAL_{NAT}$
...
$f_9 = ORC_9 / TOTAL_{NAT}$
$f_{10} = GRASS_{NAT\_C3} / TOTAL_{NAT}$
$f_{11} = GRASS_{NAT\_C4} / TOTAL_{NAT}$

ESA CCI Land Cover + LUH2

For each year :

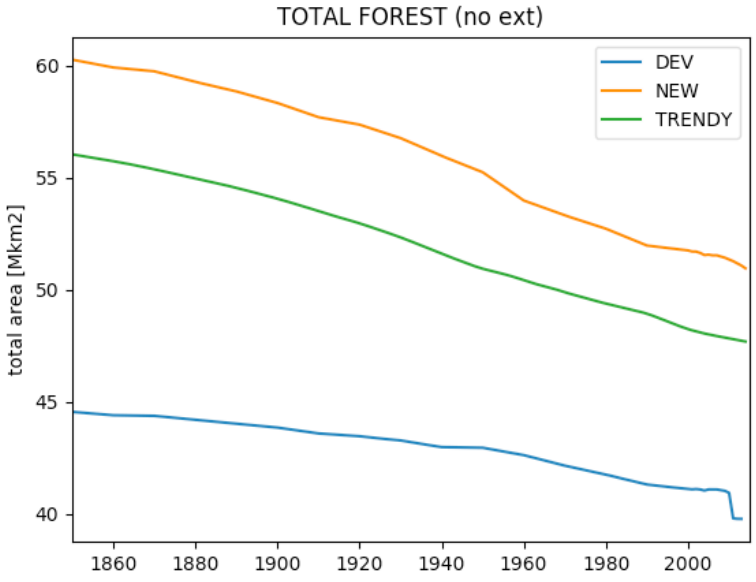
➔ Crops imposed from LUH2,

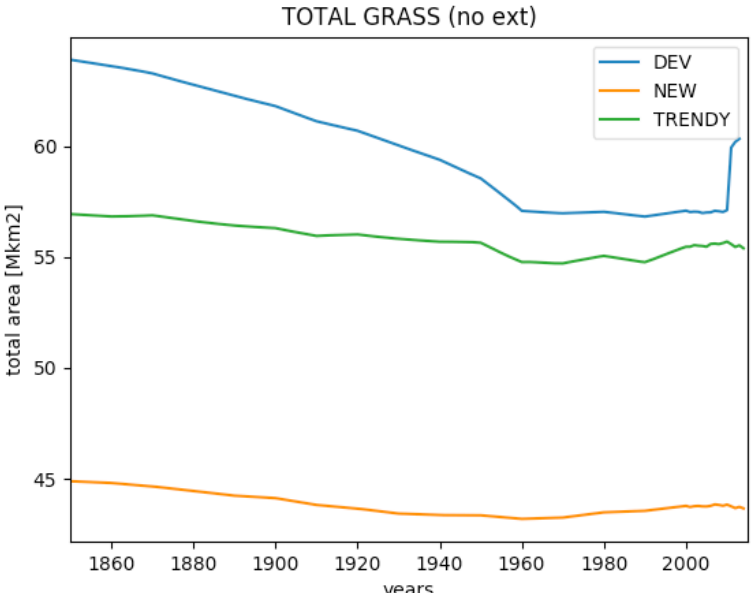
➔ other LUH2 classes distributed between PFTs using the present-day split:

$$LUH_{NAT} = LUH_{PRIMF} + LUH_{PRIMN} + LUH_{SECDF} + LUH_{SECDN} + LUH_{RANGE} + LUH_{URBAN}$$
$$LUH_{C3} = LUH_{C3ANN} + LUH_{C3PER} + LUH_{C3NFX}$$
$$LUH_{C4} = LUH_{C4ANN} + LUH_{C4PER}$$

$$PFT_1 = f_1 \cdot LUH_{NAT}$$
...
$$PFT_9 = f_9 \cdot LUH_{NAT}$$
$$PFT_{10} = f_{10} \cdot LUH_{NAT} + Still_{C3} \cdot LUH_{PASTR}$$
$$PFT_{11} = f_{11} \cdot LUH_{NAT} + Still_{C4} \cdot LUH_{PASTR}$$
$$PFT_{12} = LUH_{C3}$$
$$PFT_{13} = LUH_{C4}$$

Exemple of reconstructions

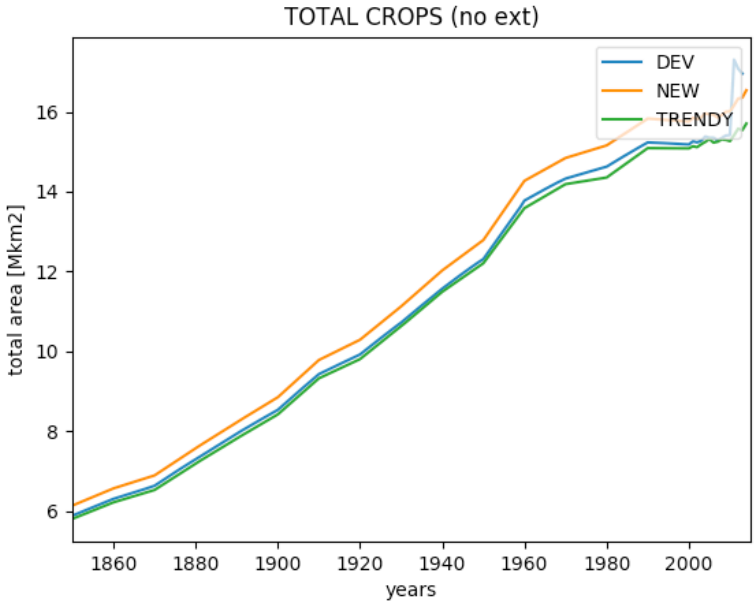


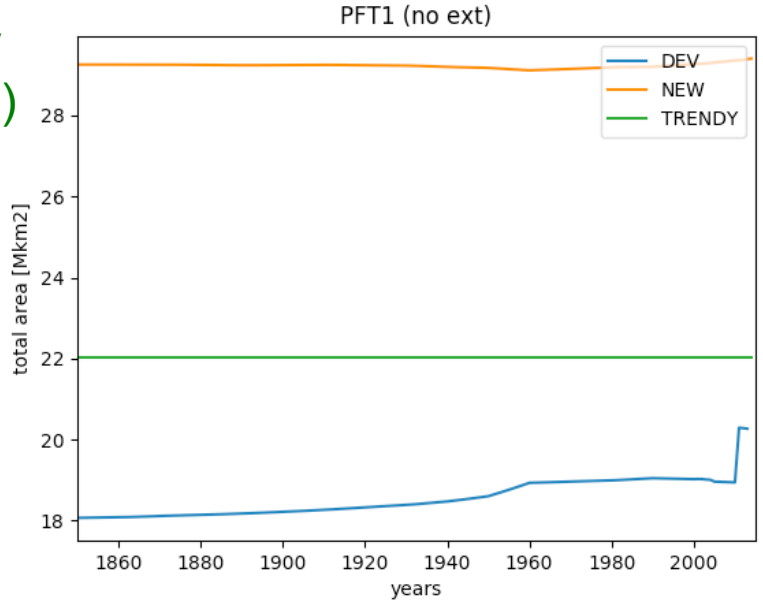


Initial (Devaraju)

New

Trendy (Shushi)





Soil texture maps

- Currently two options
  - Zobler (initial): 3 classes
  - USDA (new): 12 classes

- Everything displayed on: https://orchidas.lsce.ipsl.fr/dev/mc.php

- For CMIP6 old Zobler map selected (issue with interpretation of sol type from USDA => Texture classes)

Main contributors: Vladislav, Catherine, Philippe

Albedo update for CMIP6

- Updated albedo using MODIS observations (2001-2010)

- Principle:
  - Step 1: « hand » optimization of snow albedo parameters (mean value, age dependency)

  - Step2:
    Optimization of veget albedo parameters
    (visible and near infrared) and bare soil albedo
    using « background » derived JRC TIP as prior value

- Everything is described under:
  https://orchidas.lsce.ipsl.fr/dev/fit2.php

Main contributors: Vladislav, Catherine, Philippe

ALBEDO OPTIMIZATION

Data used for optimization:

- **satellite observations of the land surface albedo for 2001-2010 (MODIS – Moderate Resolution Imaging Spectroradiometer)**
- **background albedo (albedo of bare soil), derived from MODIS (JRCTIP – Joint Research Centre Two-stream Inversion Package)**
- **ORCHIDEE simulations for the same period**

Optimized parameters:

- **coefficients** $alb\_leaf\downarrow pft$ **(12)**
- **coefficients** $snow\_aged\downarrow pft$ **and** $snow\_dec\downarrow pft$ **(13 + 13)**
- **background albedo value at each grid cell (~ 62 000)**

Total number of data points: ~ 710 000

Optimization algorithm: L-BFGS-B, 100 iterations

$$x = \begin{Bmatrix} \text{alb\_leaf}_{pft} \\ \text{bg}_{pts} \end{Bmatrix}$$

$$\text{vegetfrac}_{pft} = \left[1 - \exp(-\text{LAI}_{pft} \cdot 1)\right] \cdot \text{maxvegetfrac}_{pft}$$

$$\text{tot\_bare\_soil} = \sum_{pft=1}^{13} \text{maxvegetfrac}_{pft} - \sum_{pft=2}^{13} \text{vegetfrac}_{pft}$$

$$\text{fraction\_veg} = 1 - \text{nobiofrac}$$

$$\text{agefunc\_veg} = \exp(-\text{snowage}/\text{tcst\_snowa})$$

$$\text{agefunc\_nobio} = \exp(-\text{snownobioage}/\text{tcst\_snowa})$$

$$\text{snowage} = \left[\text{snowage} + (1 - \text{snowage}/\text{max\_snowage}) \cdot \text{dt}\right] \cdot \exp(-\text{precip\_snow}/\text{snow\_trans})$$

$$\text{snowa\_veg} = \sum_{pft=1}^{13} \text{maxvegetfrac}_{pft}/\text{fraction\_veg} \cdot (\text{snowa\_aged}_{pft} + \text{snowa\_dec}_{pft} \cdot \text{agefunc\_veg})$$

$$\text{snowa\_nobio} = \text{snowa\_aged}_1 + \text{snowa\_dec}_1 \cdot \text{agefunc\_nobio}$$

$$\text{snowdepth} = \sum_{i=1}^{3} \text{snowdz}_i$$

$$\text{snowdensity} = \frac{\sum_{i=1}^{3}(\text{snowdz}_i \cdot \text{snowrho}_i)}{\text{snowdepth}}$$

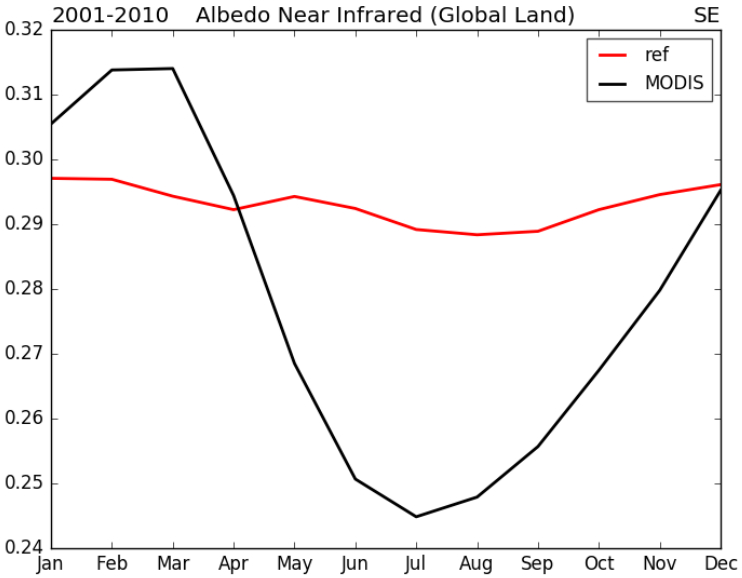
$$\text{frac\_snow\_veg} = \tanh\left(\frac{50 \cdot \text{snowdepth}}{0.025 \cdot \text{snowdensity}}\right)$$

$$\text{frac\_snow\_nobio} = \min\left(1, \frac{\max(0,\text{snownobio})}{\max(0,\text{snownobio}) + \text{snowcri\_alb} \cdot \text{sn\_dens}/100}\right)$$

$$\text{albedo\_veg} = \text{bg} \cdot \text{tot\_bare\_soil} + \sum_{pft=2}^{13} (\text{vegetfrac}_{pft} \cdot \text{alb\_leaf}_{pft})$$

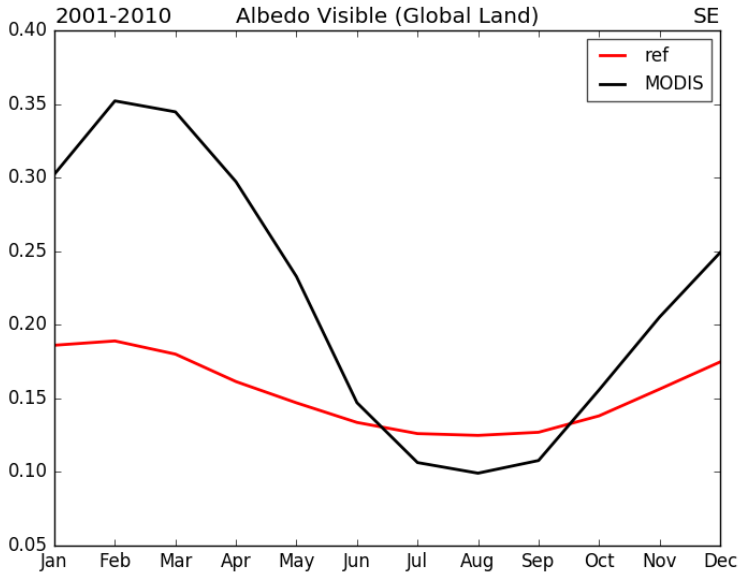
$$\text{albedo\_veg\_snow} = (1 - \text{frac\_snow\_veg}) \cdot \text{albedo\_veg} + \text{frac\_snow\_veg} \cdot \text{snowa\_veg}$$

ALBEDO OPTIMIZATION

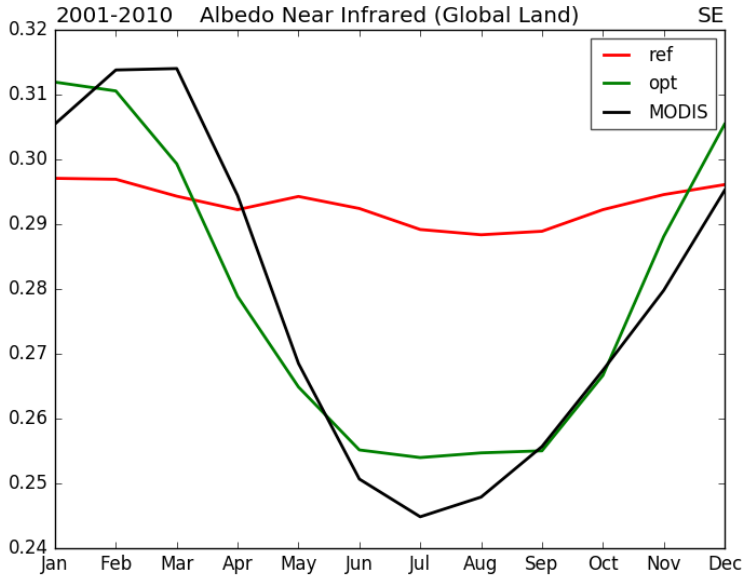


Initial

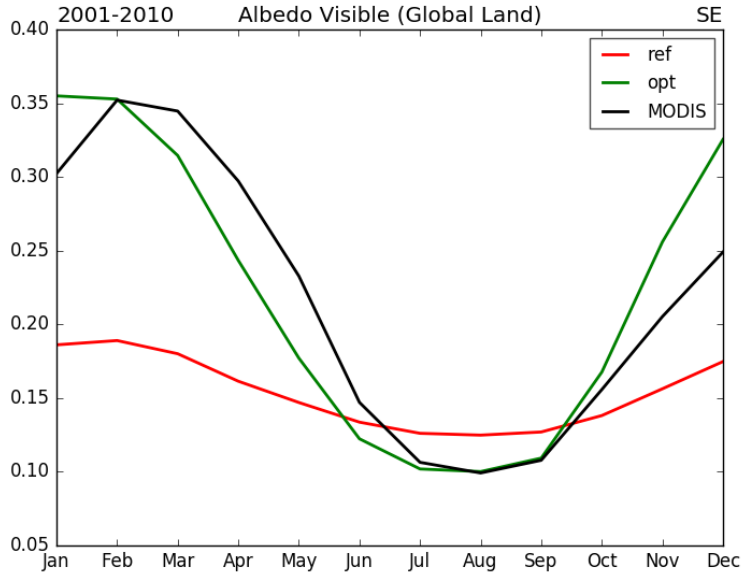
Modis



➔ Initial seasonal cycle was not captured well



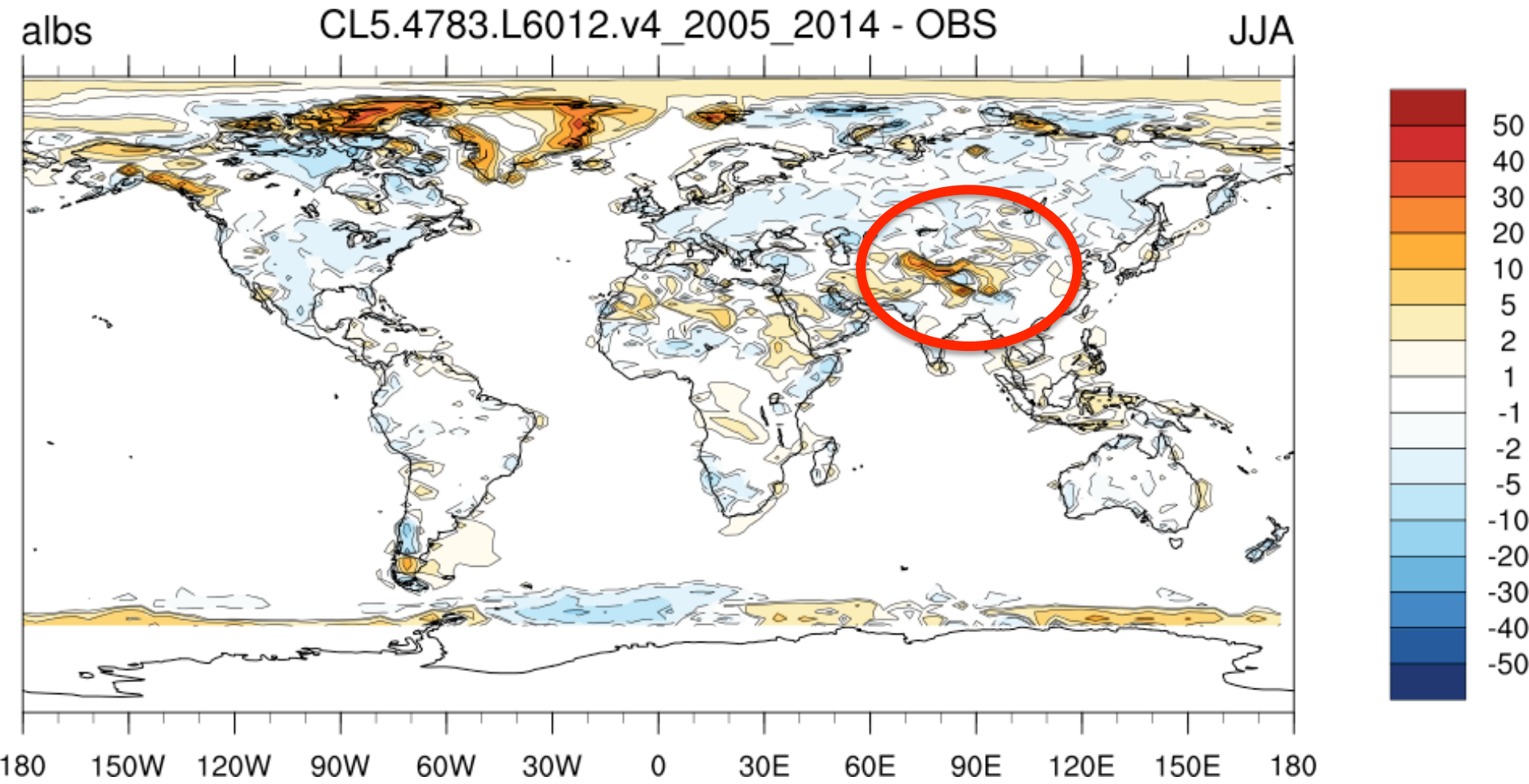
Initial
Optim
Modis



PFT	alb_leaf_nir		snow_aged_nir		snow_dec_nir	
PFT1	—	—	0.35	0.50	0.45	0.13
PFT2	0.15	0.23	0	0	0	0
PFT3	0.15	0.18	0	0	0	0
PFT4	0.15	0.18	0.14	0.10	0.06	0.10
PFT5	0.15	0.20	0.14	0.37	0.06	0.10
PFT6	0.15	0.24	0.14	0.08	0.11	0.16
PFT7	0.15	0.15	0.14	0.16	0.06	0.04
PFT8	0.15	0.26	0.14	0.17	0.11	0.07
PFT9	0.15	0.20	0.14	0.27	0.11	0.08
PFT10	0.2	0.24	0.18	0.44	0.52	0.12
PFT11	0.2	0.27	0.18	0.44	0.52	0.12
PFT12	0.2	0.28	0.18	0.44	0.52	0.12
PFT13	0.2	0.26	0.18	0.44	0.52	0.12

PFT	alb_leaf_vis		snow_aged_vis		snow_dec_vis	
PFT1	—	—	0.35	0.74	0.45	0.21
PFT2	0.01	0.04	0	0	0	0
PFT3	0.02	0.04	0	0	0	0
PFT4	0.02	0.04	0.14	0.08	0.06	0.14
PFT5	0.02	0.04	0.14	0.24	0.06	0.08
PFT6	0.02	0.03	0.14	0.07	0.11	0.17
PFT7	0.02	0.03	0.14	0.18	0.06	0.05
PFT8	0.02	0.03	0.14	0.18	0.11	0.06
PFT9	0.02	0.03	0.14	0.33	0.11	0.09
PFT10	0.04	0.06	0.18	0.57	0.52	0.15
PFT11	0.04	0.06	0.18	0.57	0.52	0.15
PFT12	0.04	0.06	0.18	0.57	0.52	0.15
PFT13	0.04	0.06	0.18	0.57	0.52	0.15

Albedo: remaining issues



Change in physics..

- Hydrology
- Thermic
- Aerodynamic resistance
- Photosynthesis

Carbon cycle optimization for CMIP6

- Recent effort (last 6 months)

- Mainly with parameter optimization and specific « flag » selection

- Using 3 main types of « constraint »
  - GPP seasonal cycle of Jung et al.
  - Atmospheric [CO2] trend + seasonal cycle
  - NPP : GPP ratio
  - Ecological observations (TRY, …)

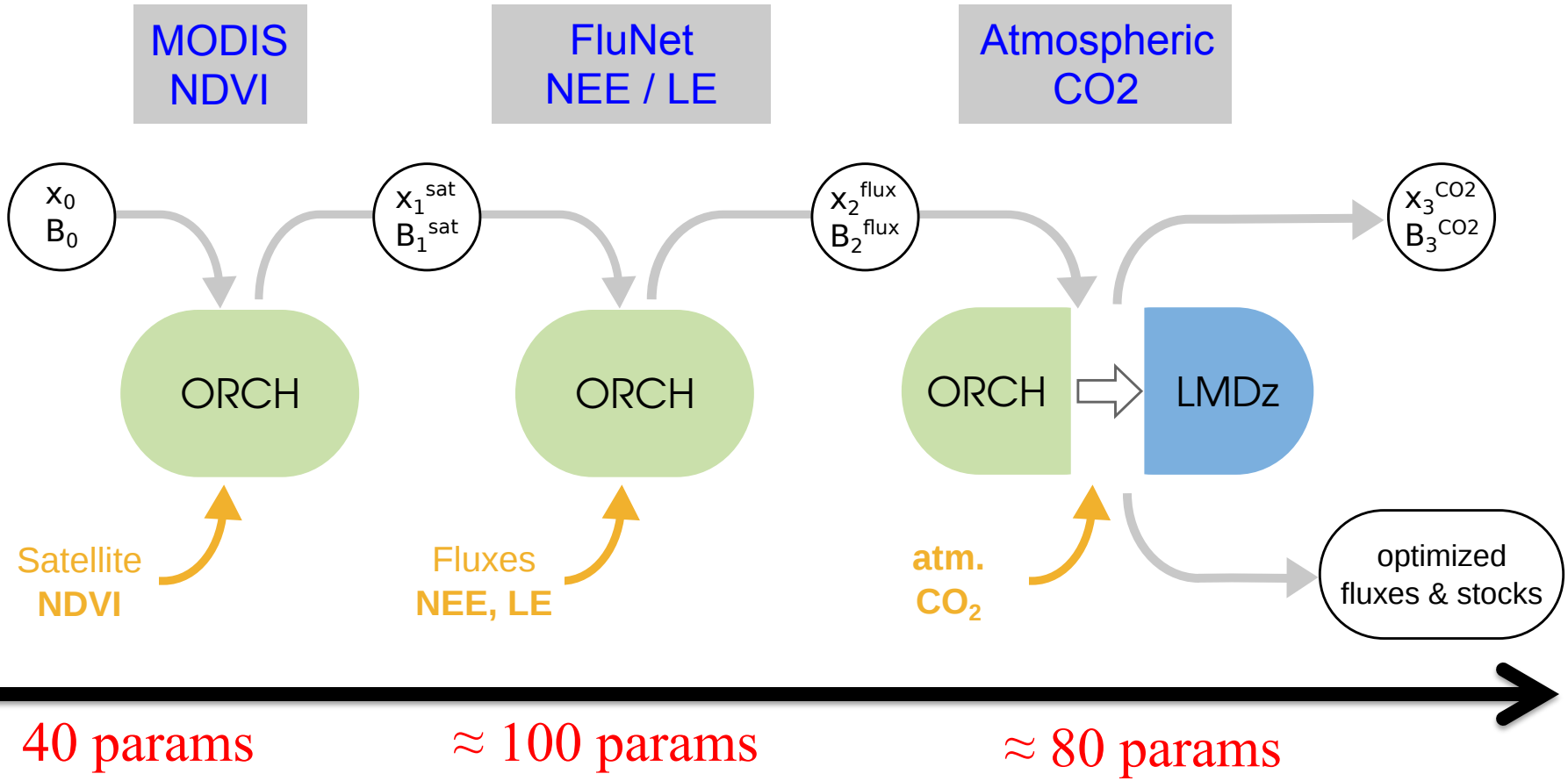
Main contributors: Sebastiaan, Nicolas x2, Bertrand, Patricia, Fabienne, Natasha, Vlad, Philippe

Stepwise parameter optimization..

$$J(x) = \tfrac{1}{2}(\mathbf{H}.x-y)^T \mathbf{R}^{-1}(\mathbf{H}.x-y) + \tfrac{1}{2}(x-x_b)^T \mathbf{B}^{-1}(x-x_b)$$

Observation term

Prior parameter term (from previous step)



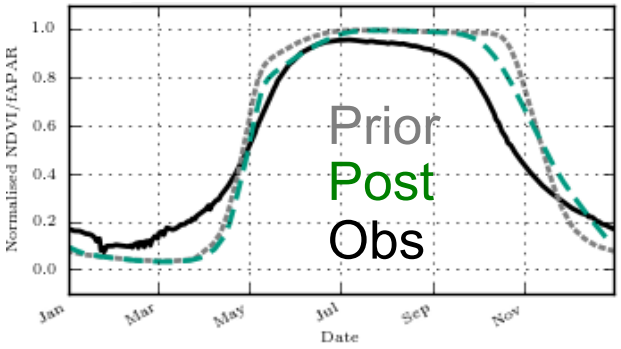
Recent calibrations

➔ **Phenology parameters**
calibrated from MacBean et al. 2015

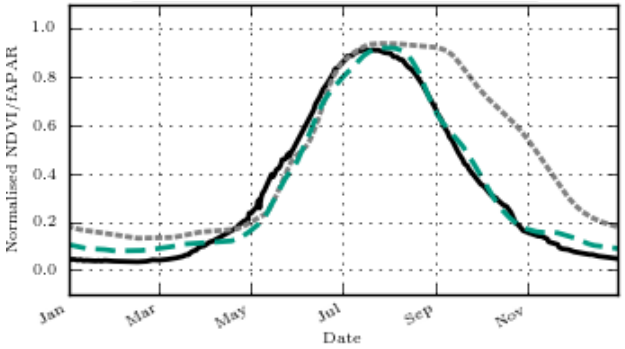
Step 1:
MODIS-NDVI

4 params /PFT

Temp DBF



Bor DBF



➔ **Parameters**

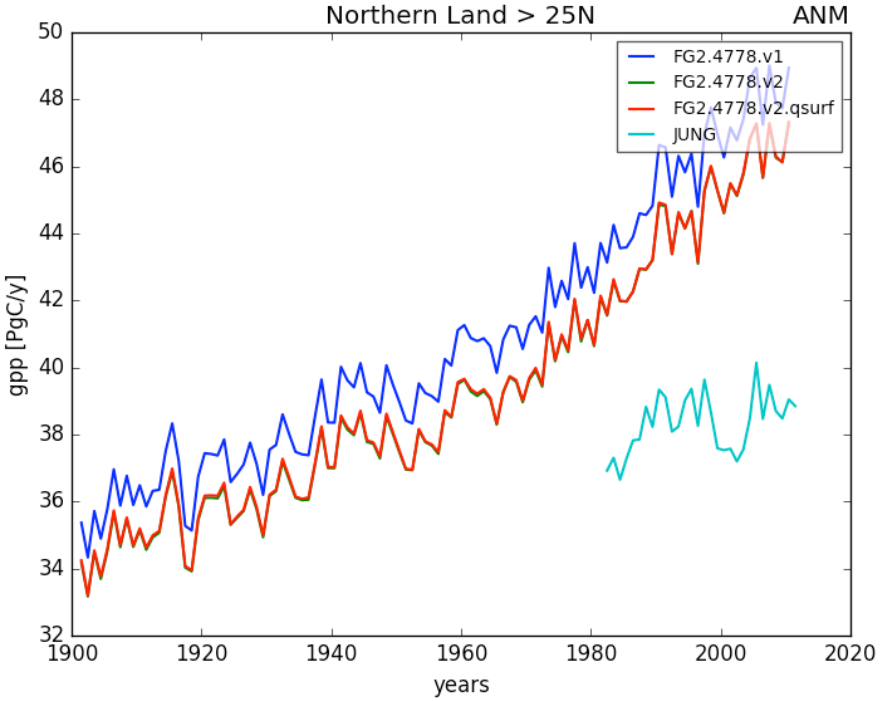
- hum_min_time_10 : 35 -> 36 Moisture control
- leaffall_06 /08: 10/10 -> 30/05 days Length of death of leaves
- leafage_crit_06/08/09 : 180/220/180 -> 160/160/120 days Critical leaf age
- senescence_hum_10 : 0.3 -> 0.6 unitless !! relative moisture availability
- senescence_temp_07/08/09 : 7/2/-1.3 -> 14/10/5 (coef of sensitivity to Temp)

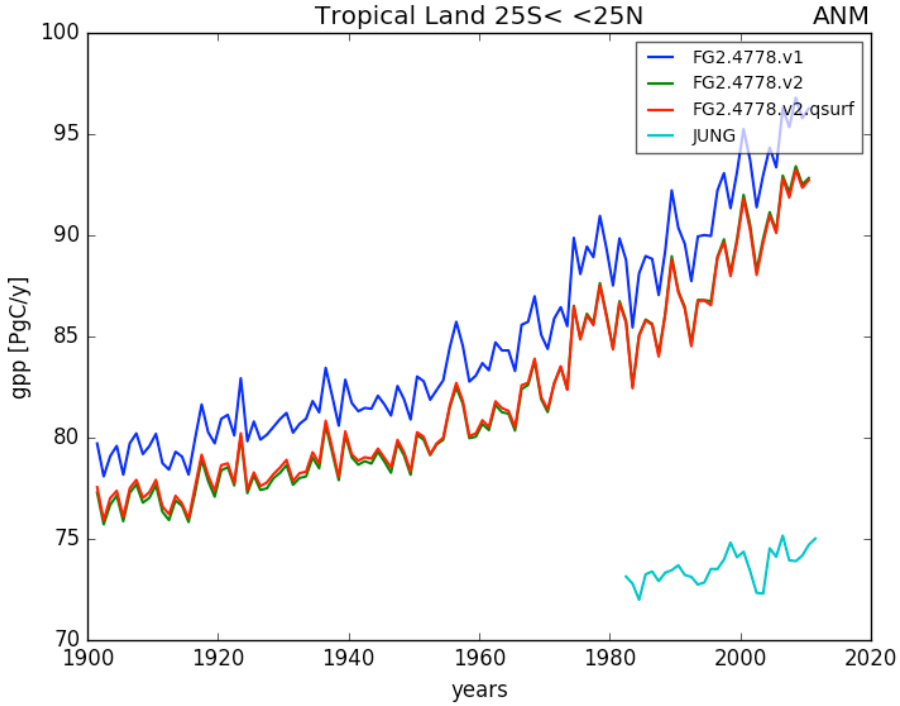
Direct contributors: Natasha, Fabienne, Philippe, Cedric

Ecophysiological calibrations

➔ « Fast processes » C-cycle parameters

Annual GPP (PgC/yr)



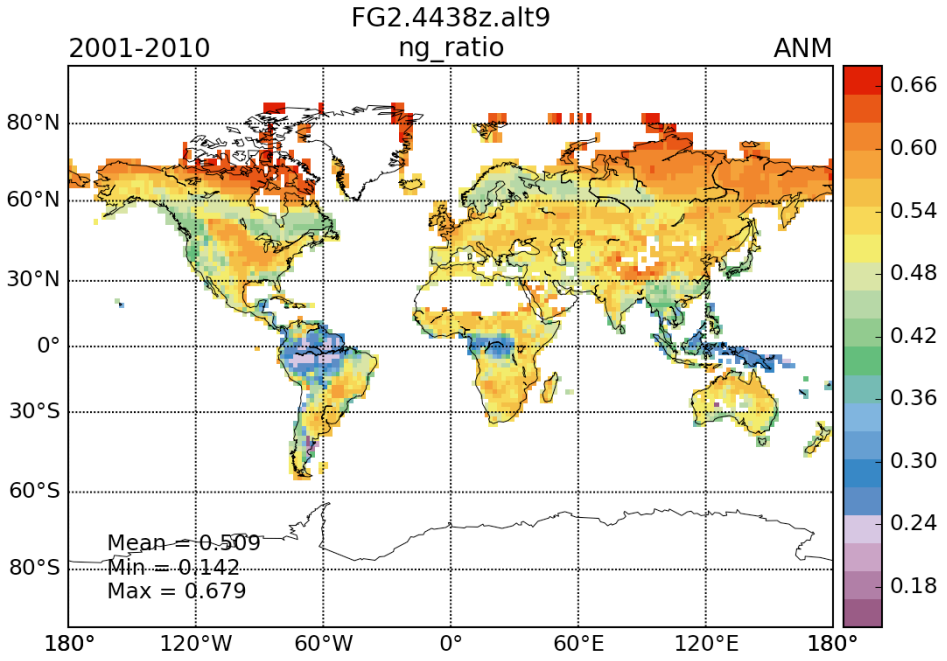


Ecophysiological calibrations

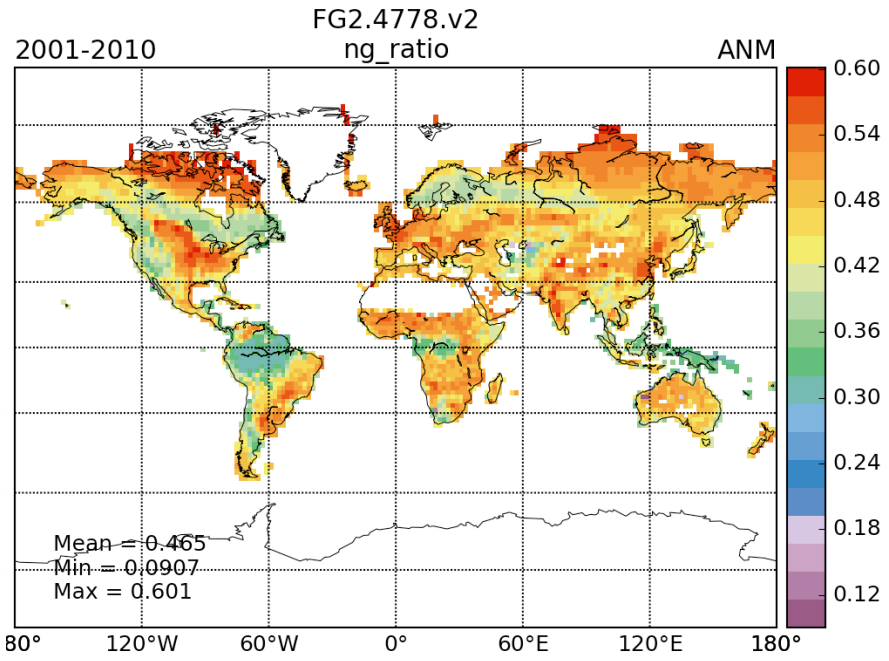
➔ « Fast processes » C-cycle parameters

NPP : GPP ratio (to contraint Ra)

Before Respiration optimization

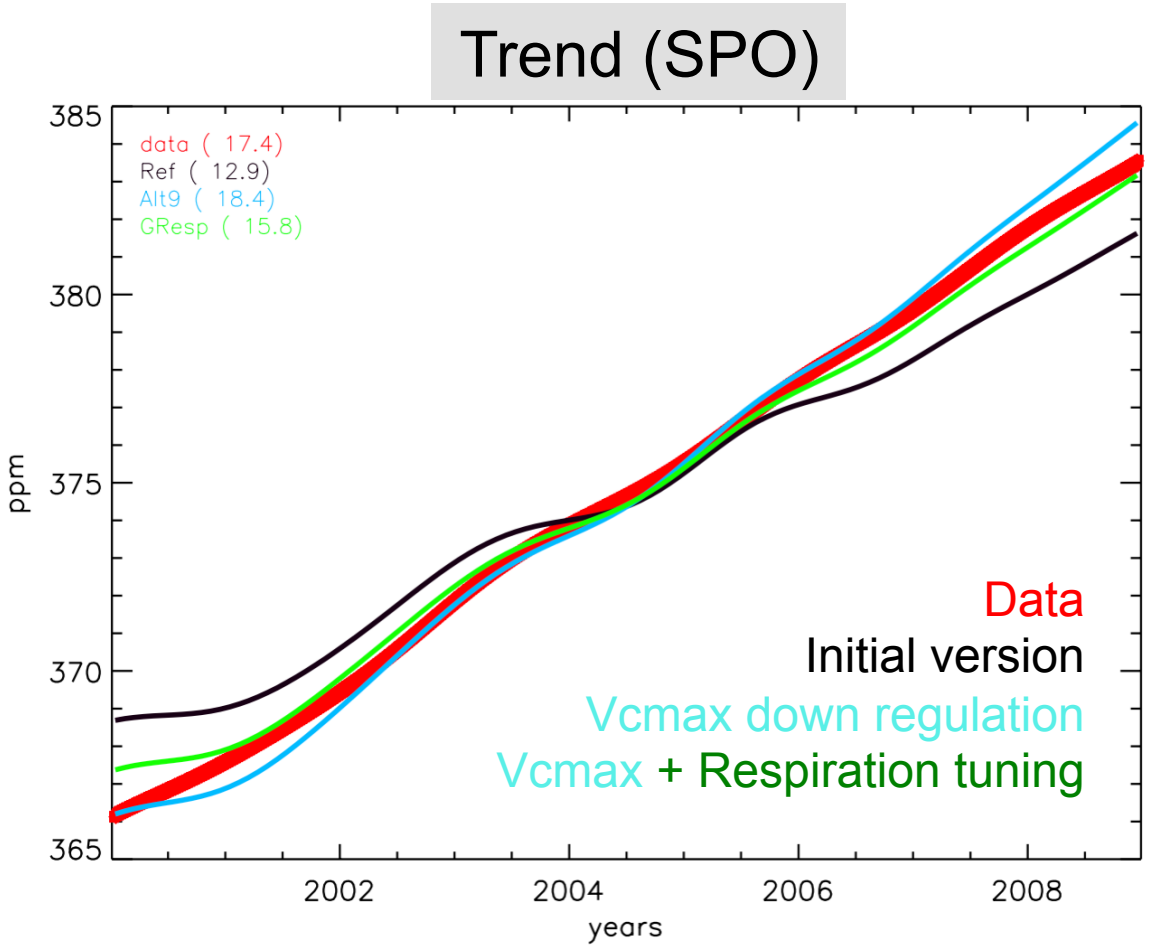


Final version



Calibration of the mean C sink (nbp)

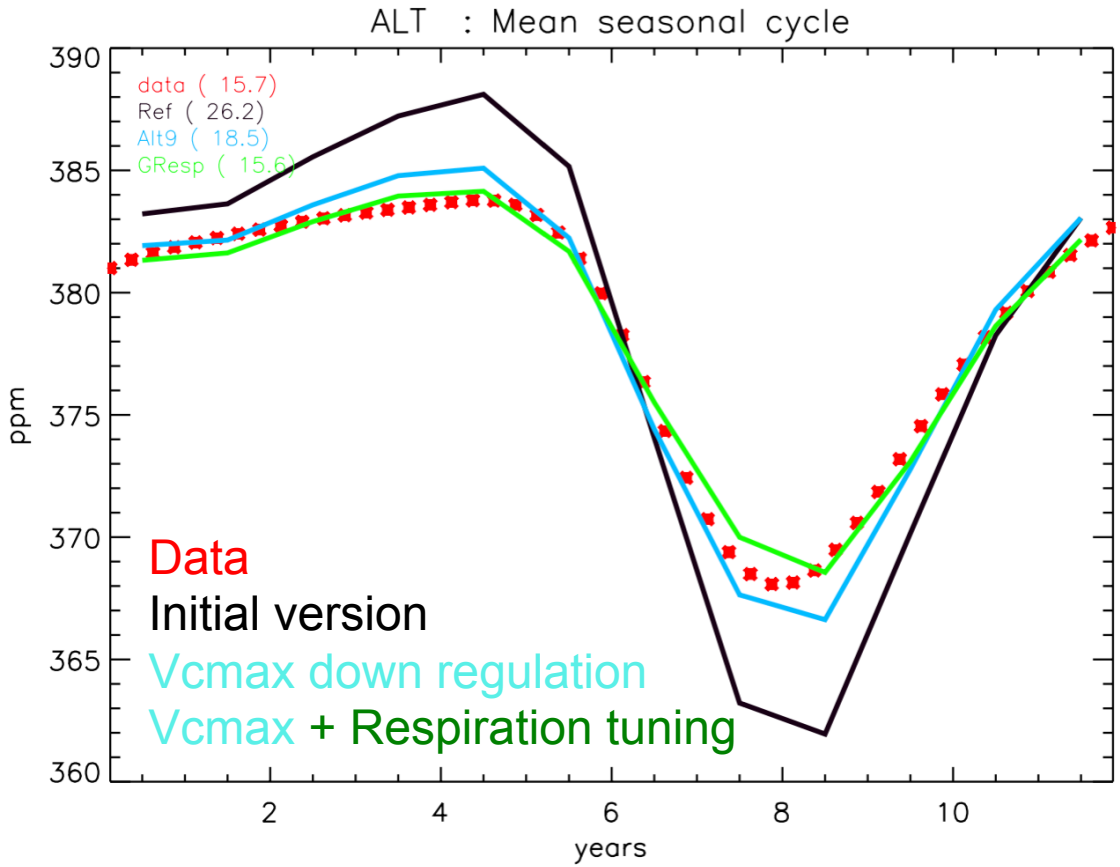
➔ **Optimization** of key parameters (Vcmax, LAImax, respiration parameters (growth, Maintenance),... using calibration with atm. CO2 concentrations (LMDz)



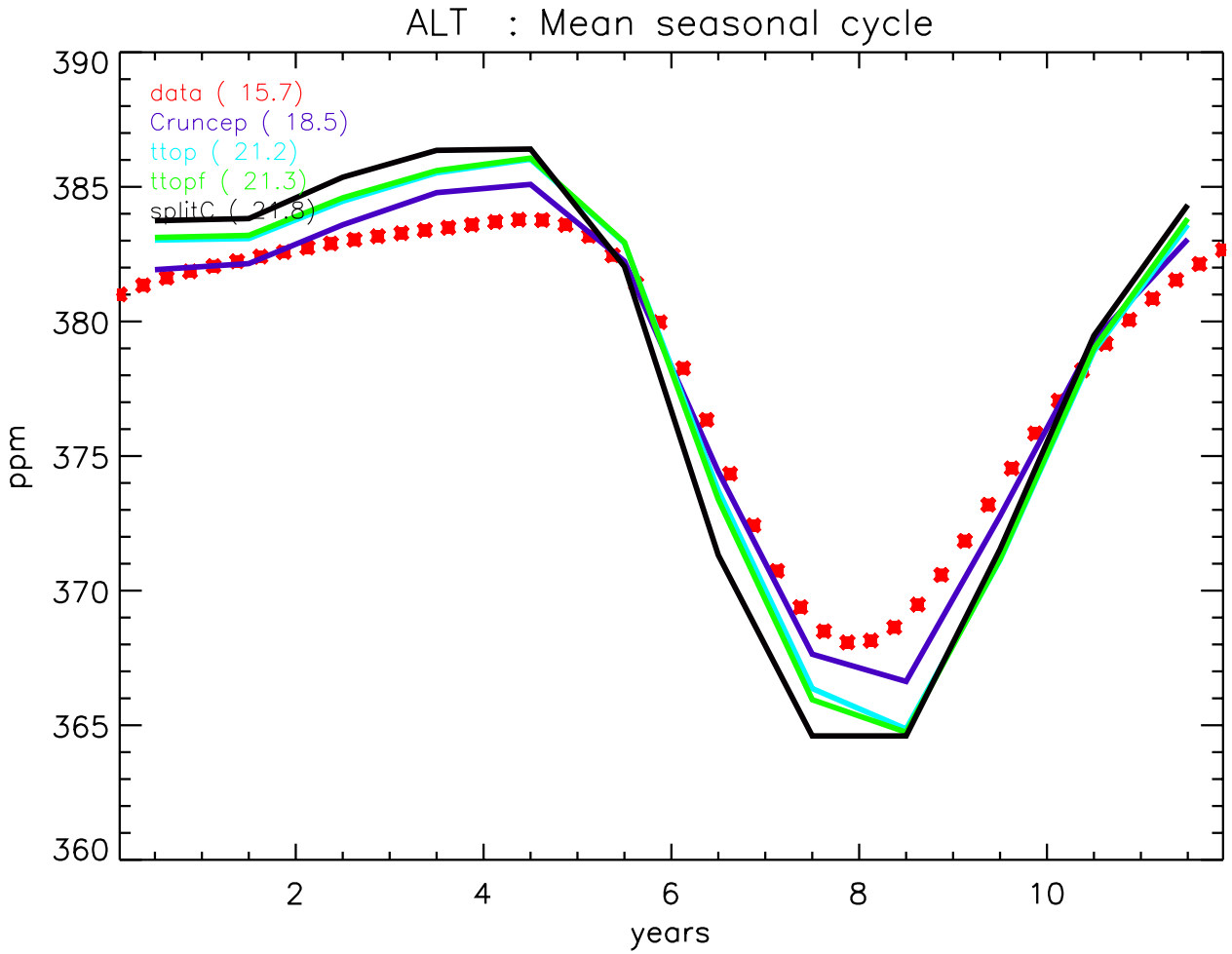
Calibration of the mean NEE seas cycle

➔ **Optimization** of key parameters (Vcmax, LAImax, respiration parameters (growth, Maintenance),... using calibration with atm. CO2 concentrations (LMDz)

Mean seas. Cycle (ALT)



Using the climate from coupled ESM



Final parameter set

```
# STRESS_GS, STRESS_GM, STRESS_VCMAX : Stress on GS, GM and VCMAX
STRESS_GS=1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.
STRESS_GM=1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.
STRESS_VCMAX=1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.
```

```
# Optimized parameters
VCMAX25__02 = 45.0
#VCMAX25__03 = 50.0 in v1
VCMAX25__03 = 45.0
VCMAX25__04 = 35.0
VCMAX25__05 = 40.0
VCMAX25__06 = 50.0
VCMAX25__07 = 45.0
VCMAX25__08 = 35.0
VCMAX25__09 = 35.0
VCMAX25__10 = 50.0
VCMAX25__11 = 50.0
#VCMAX25__12 = 70.0 in v1
#VCMAX25__13 = 70.0 in v1
VCMAX25__12 = 60.0
VCMAX25__13 = 60.0
VCMAX25__14 = 50.0
VCMAX25__15 = 40.0
LAI_MAX__02 = 7.0
#LAI_MAX__03 = 7.0 in v1
LAI_MAX__03 = 5.0
LAI_MAX__04 = 5.0
LAI_MAX__05 = 4.0
LAI_MAX__06 = 5.0
LAI_MAX__07 = 3.5
LAI_MAX__08 = 4.0
LAI_MAX__09 = 3.0
LAI_MAX__10 = 2.5
LAI_MAX__11 = 2.0
LAI_MAX__12 = 5.0
LAI_MAX__13 = 5.0
LAI_MAX__14 = 2.5
LAI_MAX__15 = 2.0
DOWNREGULATION_CO2=y
DOWNREGULATION_CO2_BASELEVEL=380.
```

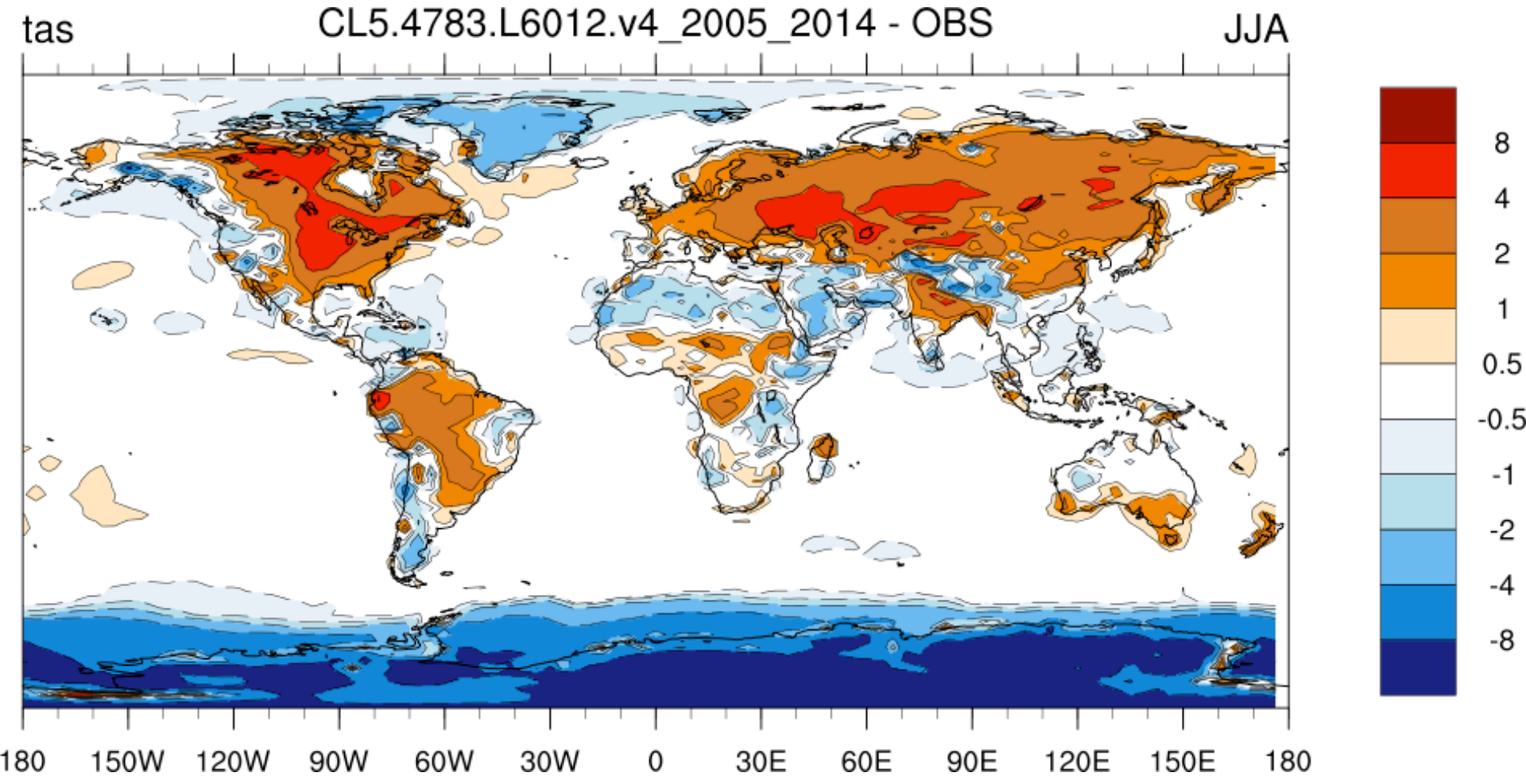
```
# Activate harvest wood
DO_WOOD_HARVEST=y

# Growth respiration
FRAC_GROWTHRESP__02 = 0.35
FRAC_GROWTHRESP__03 = 0.35
FRAC_GROWTHRESP__04 = 0.28
FRAC_GROWTHRESP__05 = 0.28
FRAC_GROWTHRESP__06 = 0.28
FRAC_GROWTHRESP__07 = 0.35
FRAC_GROWTHRESP__08 = 0.35
FRAC_GROWTHRESP__09 = 0.35
FRAC_GROWTHRESP__10 = 0.28
FRAC_GROWTHRESP__11 = 0.28
FRAC_GROWTHRESP__12 = 0.28
FRAC_GROWTHRESP__13 = 0.28
FRAC_GROWTHRESP__14 = 0.35
FRAC_GROWTHRESP__15 = 0.35

# Maintenance respiration slope C
MAINT_RESP_SLOPE_C__02 = 0.12
MAINT_RESP_SLOPE_C__03 = 0.12
MAINT_RESP_SLOPE_C__04 = 0.16
MAINT_RESP_SLOPE_C__05 = 0.16
MAINT_RESP_SLOPE_C__06 = 0.16
MAINT_RESP_SLOPE_C__07 = 0.25
MAINT_RESP_SLOPE_C__08 = 0.25
MAINT_RESP_SLOPE_C__09 = 0.25
MAINT_RESP_SLOPE_C__10 = 0.16
MAINT_RESP_SLOPE_C__11 = 0.12
MAINT_RESP_SLOPE_C__12 = 0.16
MAINT_RESP_SLOPE_C__13 = 0.12
MAINT_RESP_SLOPE_C__14 = 0.12
MAINT_RESP_SLOPE_C__15 = 0.25

# Soil turnover
CARBON_TAU_ISLOW = 7
CARBON_TAU_IPASSIVE = 300
```

Current ESM simulations

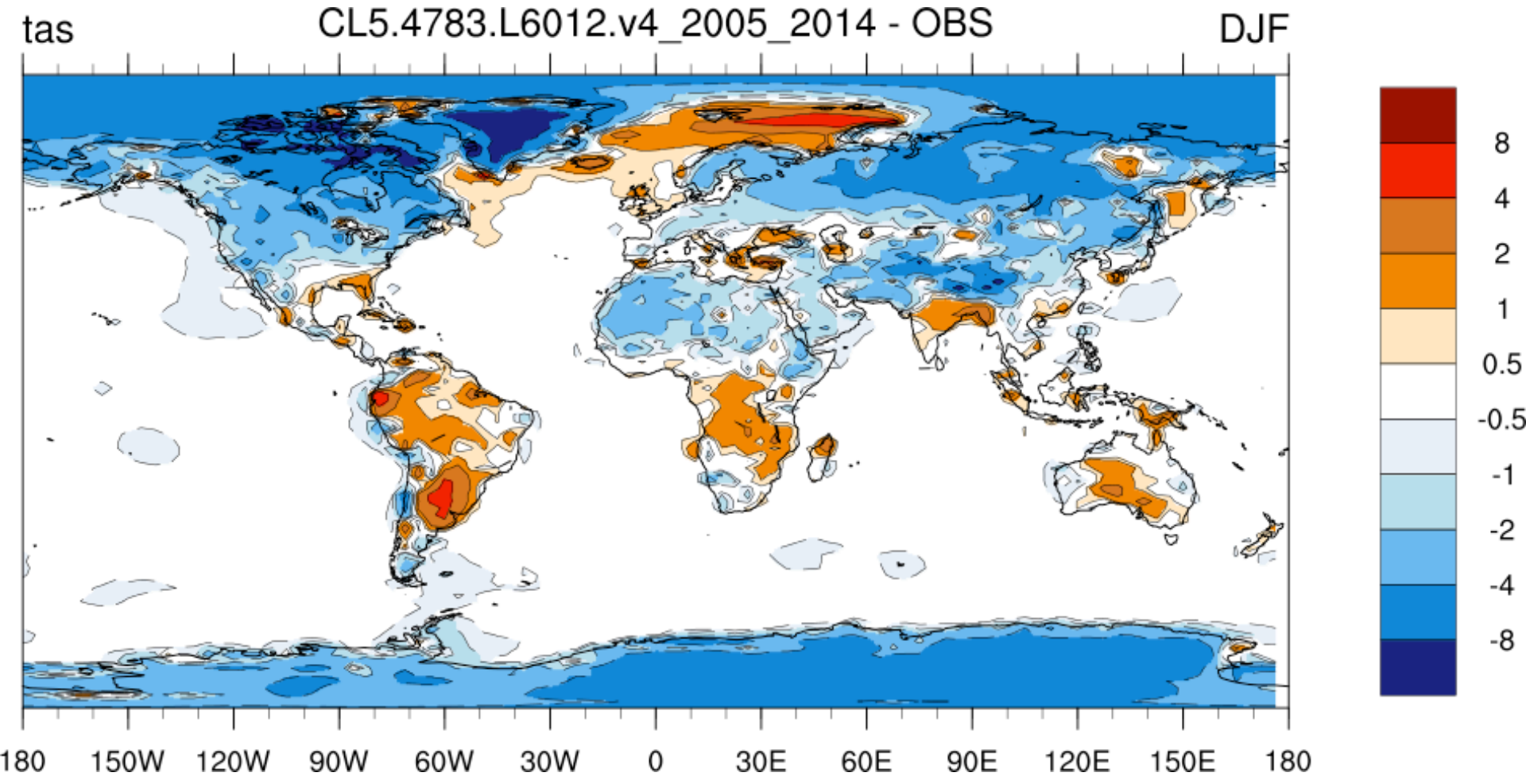
- Atlas with the Latest LMDz-ORC simulation
  - CL4 (free run): https://vesg.ipsl.upmc.fr/thredds/fileServer/IPSLFS/fabric/lmdz/MultiSimu/LMDZOR6012ttop.ORC.14/BIASGLOBJJA.html
  - CL5 (wind nudged): https://vesg.ipsl.upmc.fr/thredds/fileServer/IPSLFS/fabric/lmdz/MultiSimu/LMDZOR6012ttop.ORC.14g/BIASGLOBJJA.html
- ➔ Still some surface air temperature biases (T2m)
  - Warm bias in summer over temperate/boreal continents
  - Cold bias in winter…

Atlas provided by Frederique / Jerome

Summer bias…


tas
CL5.4783.L6012.v4_2005_2014 - OBS
JJA
8
4
2
1
0.5
-0.5
-1
-2
-4
-8
180
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
180

Winter bias…


tas
CL5.4783.L6012.v4_2005_2014 - OBS
DJF
8
4
2
1
0.5
-0.5
-1
-2
-4
-8
180
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
180

Current major branches

- TRUNK (Tag version 2.0) : to be used for CMIP6
- CN : coupled Nitrogen – Carbone:
- CAN-CN : Canopy structure – forest management – CN
- MICT : high latitude focus

➔ Challenge for 2018 : merge current developments

➔ Moving to CN / CAN / MICT will break the backward compatibility!! (Tag v2.0 will become a branch)

Other recent ongoing developments

Biophysical

Lake model (FLAKE)

Irrigation

Termokarst lake

DOC – DIC transport by river

Ground water modeling

New river routing scheme

New boreal PFTs (Mosses, lichens, shrubs)

Plant Traits

Biogeochemical

Nitrogen – Phosphorus - Carbon coupled cycles

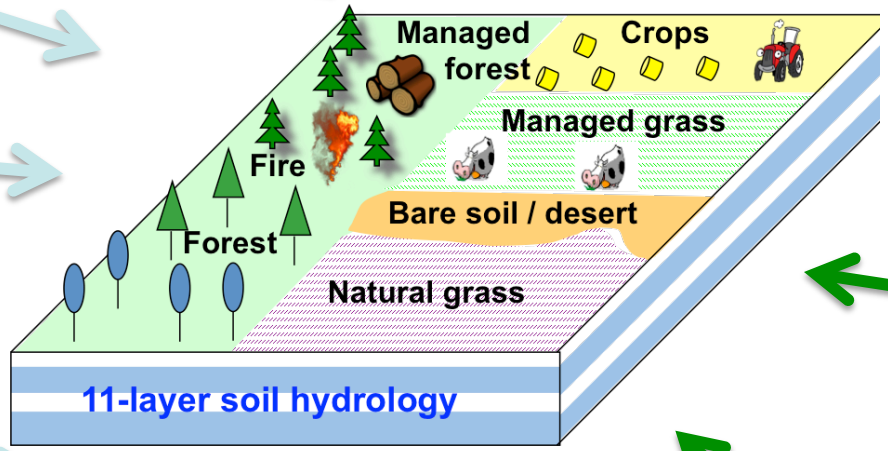
Soil Carbon discretization

Crop model (wheat, corn, rice,…)

Grassland management

Peatland model (CH4)

Herbivory (large herbivore)



ORCHIDEE today…

ORCHIDEE tomorrow…

Need collaboration from EVERYONE !

Next ORCHIDEE-DEV

- Model Evaluation : 30 january 2018
  Organizer: Agnes D.

- Regional coupling ORCHIDEE – WRF
  Organizer: Jan P.

- Nitrogen cycle
- Plant acclimatation
- Ecosystem resilience and disturbances
- Sapiens module in ORC: GM, Crop
- Wetlands in ORCHIDEE
- MIPs associated with ORCHIDEE

Project organisation

- Need a new « breath » for next model version.

- Project Organisation needs to improve learning from past years difficulties..

- Your thoughts are more than welcome
  - what should be improved (communication, valorisation, fair use, …)
  - What works well

  ➔ Dedicated meeting Early January

- Your contribution to the wiki & to code improvement is important..

Thank you…

ORCHIDEE

LAND SURFACE MODEL