I-GEM Project

Impact of Groundwater in Earth system Models

ANR/MoST 2014-2018

Late-kickoff & Year-1 meeting

October 8, 2015

Todays agenda

- **Project's overview**
- **Round-table**
- **Advancement :**
  - Task 0: Coordination (and obligations)
  - Task 5: International workshops
  - Task 1: Sensitivity to fixed WTD
- **Discussion**
  - Other scientific tasks
  - Etc.

End @ 12:00 (France) = 18:00 (Taiwan)

Project's overview

Objectives:

- Explore the impacts of GW on regional and global climate, and its links to water resources availability, through model analyses
- Compare the sensitivity of simulated climate to different GW parametrizations within 3 different climate models
- Consolidate the potential of France and Taiwan in the interdisciplinary research field of the global water cycle

Project's overview

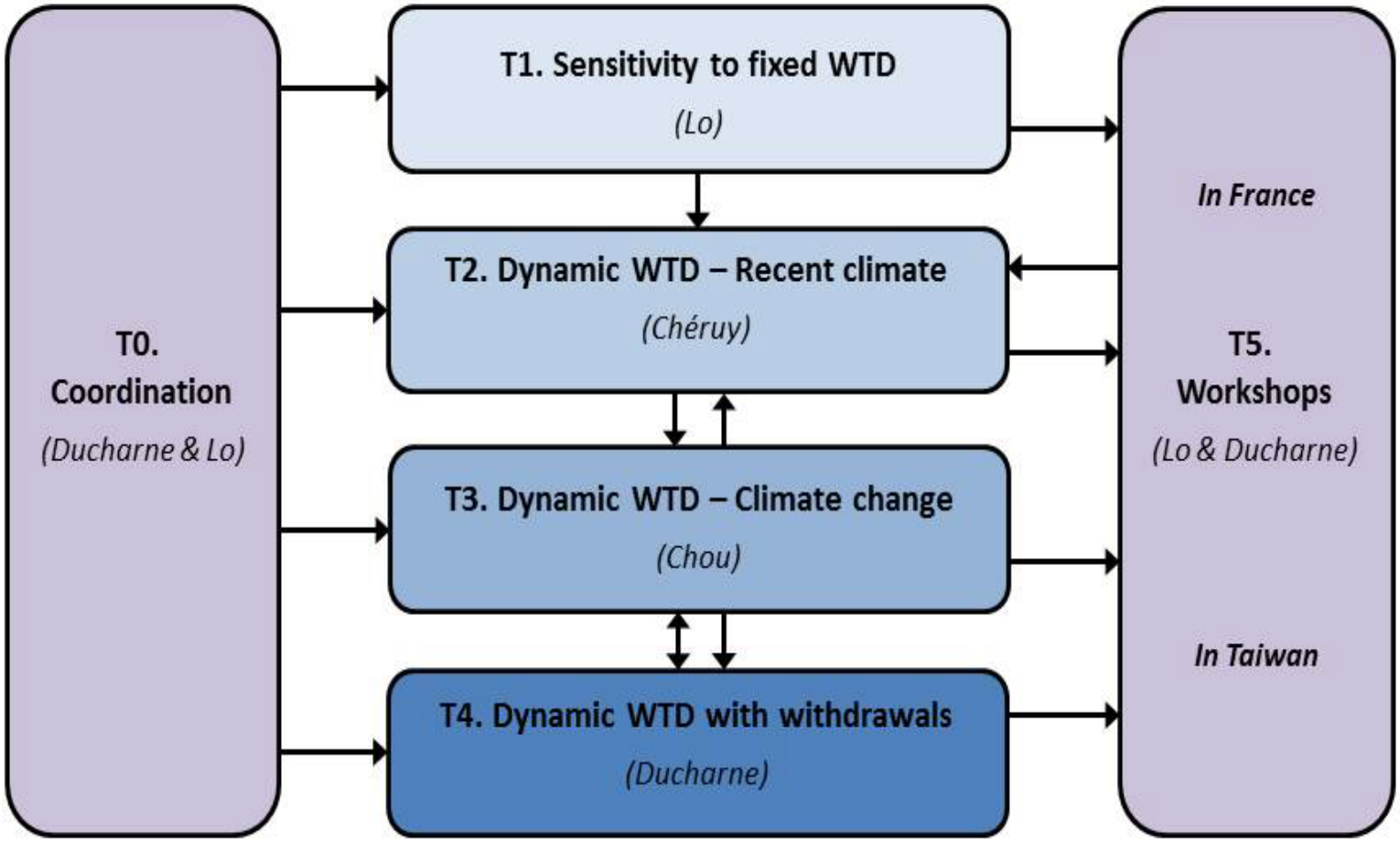
Scientific Tasks:

1. **Sensitivity to fixed water table depths** (WTD), to identify the patterns of "active WTD", below which GW do not impact regional climate
2. **Dynamic WTD over the recent period**, to assess the potential of realistic GW parametrizations to improve the simulated climate, with a focus on land/atmosphere feedback and the persistence/memory in the Earth system
3. **Dynamic WTD and climate change**, with 2 complementary questions:

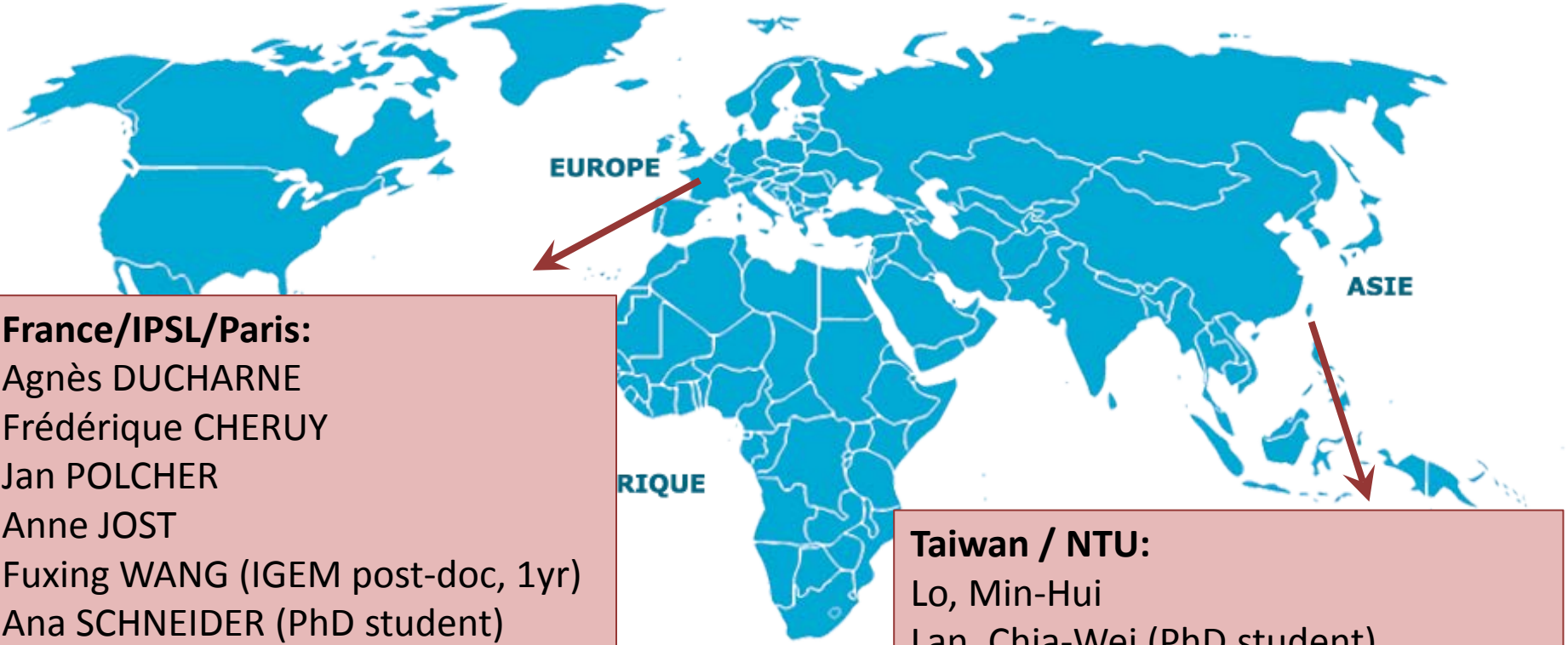
   (1) What is the influence of GW on the climate change trajectory?

   (2) What is the impact of climate change on water resources (including GW)?
4. **Dynamic WTD with withdrawals**, which artificially increase soil moisture via irrigation, with potential impacts on climate until water resources get exhausted.

Project's overview



Time for Round-Table



France/IPSL/Paris:
Agnès DUCHARNE
Frédérique CHERUY
Jan POLCHER
Anne JOST
Fuxing WANG (IGEM post-doc, 1yr)
Ana SCHNEIDER (PhD student)
Ardalan TOOTCHI (PhD student)

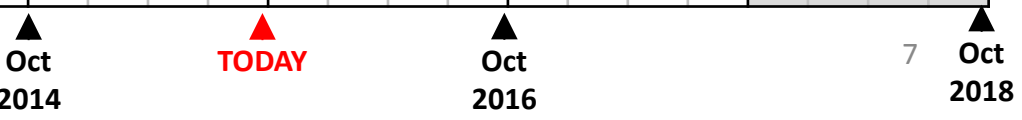
France/CNRM/Toulouse:
Bertrand DECHARME

Taiwan / NTU:
Lo, Min-Hui
Lan, Chia-Wei (PhD student)
Chien, Rong-You (research assistant)
Wu, Ren-Jie (research assistant)
Wu, Wen-Ying (research assistant)

Another 2-yr post-doctoral hire is planned at IPSL

Initial milestones

Tasks and sub-tasks	Leader	Year 1	Year 2	Year 3	Year 4
T0. Coordination	**Ducharne, Lo**				
T0.1 Web site	Ducharne				
T0.2 Annual meetings	Ducharne, Lo				
T0.3 ANR/MoST reporting	Ducharne, Lo				
T1. Sensitivity to fixed WTD	**Lo**				
T1.1 Simulations	*				
T1.2 Analysis & intercomparison	Lo, Ducharne				
T2. Dynamic WTD – Recent period	**Chéruy**				
T2.1 Simulations	*				
T2.2 Validation	Chéruy, Polcher				
T2.3 Influence on climate, L/A feedback	Chéruy, Lo				
T2.4 GW vs ocean memory	Lo				
T3. Dynamic WTD – Climate change	**Chou**				
T3.1 Simulations	*				
T3.2 Influence on climate change trajectory	Chou, Chéruy				
T3.3 Climate change impact	Ducharne				
T4. Dynamic WTD with withdrawals	**Ducharne**				
T4.1 Formatting the withdrawals	Marty				
T4.2 Simulations	*				
T4.3 Historical influence and validation	Polcher				
T4.4 Future climate vs withdrawals	Ducharne, Lo				
T5. International workshops	**Lo, Ducharne**				
T5.1 In France	Ducharne				
T5.2 In Taiwan	Lo				



Planned simulations

1. **Mandatory simulations for all three groups:**

AMIP like, 30 years after initialization

Task	Deliverable	Description	Period	Nb.
T1	D1.1	Reference with free drainage and no WTD/GW parametrization	Recent	1
		With fixed WTD (at 1, 2, 3, 5, 8 m)	Recent	5
T2	D2.1	With dynamic WTD, no withdrawals	Recent	1
T3	D3.1	Reference with free drainage and no WTD/GW parametrization	Future	1
		With dynamic WTD, no withdrawals	Future	1
T4	D4.2	With dynamic WTD + withdrawals	Recent	1
		With dynamic WTD + withdrawals	Future	1

2. **Complementary simulations, e.g:**

- off-line simulations, in particular for T1, T2, and T4
- zoomed-nudged on-line over Europe (IPSL, T2)
- O/A climate model simulation (NTU, T2)

Advancement: T0

Tasks and sub-tasks	Leader	Year 1				Year 2				Year 3				Year 4			
T0. Coordination	**Ducharne, Lo**																
T0.1 Web site	Ducharne	➤															
T0.2 Annual meetings	Ducharne, Lo				➤				➤				➤				➤
T0.3 ANR/MoST reporting	Ducharne, Lo		➤						➤								➤

▲ ▲ ▲ TODAY

- **Web site of the project:**
  http://www.sisyphe.upmc.fr/~ducharne/gem/anr.php
- **Annual meetings:**
  - Sept 2014 in Paris, to prepare T1 simulations
  - Regular update by email and skype
  - Y1-meeting: today
- **ANR reporting:**
  - Progress reports at 18 and 30 months (end of March 2016 and 2017)
  - Final report ? Sept 2018 ? the project is funded up to Sept 2019…
- **MoST reporting:**

Advancement: T0

- **Obligations towards the ANR :**
  - Le Bénéficiaire s'engage à mentionner le soutien apporté par l'ANR en indiquant le numéro de la Convention, dans ses propres actions de communication sur le Projet, ses résultats et publications.
  - L'ANR doit être informée de toute communication ou publication portant sur le Projet.
  - Toute communication ou publication portant sur le Projet doit porter la mention de l'Aide de l'ANR.
  - **Numéro de la convention = ANR-14-CE01-0018-01**

- **Obligations towards the MoST ?**

Advancement: T5

T5. International workshops	Lo, Ducharne
T5.1 In France	Ducharne
T5.2 In Taiwan	Lo

We propose to organize the 1st workshop in Paris during the first half of Oct 2016:

- 3 days, tentatively between Monday Sept 26 and Wednesday, Oct 19
- Full-expense invitation of 5 to 10 prominent international scientists (or colleagues ?)
- Max 30 talks of 30 minutes (5+5 each day) + time for discussion
- Main topic: role of GW in the climate system

- At UPMC + social dinner outside
- IGEM funding : 35 kE for the organization+invitations
- Complementary support : Sorbonne Universités, Labex L-IPSL

Advancement: T5

Whom to invite ?

- **Ying Fan** (Univ. of Rutgers, yingfan@eps.rutgers.edu) **or Gonzalo Miguez-Macho** (Spain): Detailed GW modeling and observations
- **Jay Famiglietti** (JPL, James.Famiglietti@jpl.nasa.gov): History and review the role of GW in LSMs
- **Nick Krakauer** (CUNY, nkrakauer@ccny.cuny.edu): GW model in GISS model
- **Tom Gleeson** (McGill, tom.gleeson@mcgill.ca): Hydrogeological information
- **Reed Maxwell** (Colorado School of Mines, rmaxwell@mines.edu): Detailed 3D GW modeling in regional model
- **Zhenghui Xie** (Chinese Academy of Sciences, zxie@lasg.iap.ac.cn): GWmodel in land surface model
- **Xu Liang** (Pittsburgh university, xuliang@pitt.edu): GW model in VIC
- **Pat Yeh** (National University of Singapore, patyeh2007@gmail.com): GW in land surface model
- **Zong-Liang Yang** (UT-Austin, liang@jsg.utexas.edu): GW model in CLM/NOAH
- **Xubin Zeng** (Univ. of Arizona, xubin@email.arizona.edu): CLM, Soil moisture-climate, hillslope water transfers
- **Yoshi Wada** (GISS, Y.Wada@uu.nl): Impacts of GW withdrawal in global hydrological model
- **Ren van Beek** or **Marc Bierkens** (Utrecht University): GW in PCR-GLOBWB

+ Chris Milly, Randy Koster, Petra Doell ??
+ IGEM team
+ French colleagues from LEFE project

Advancement: T1

T1. Sensitivity to fixed WTD	Lo
T1.1 Simulations	*
T1.2 Analysis & intercomparison	Lo, Ducharne

We are late !

But many things have progressed :

- Mandatory off-line simulations almost finished → **Min-Hui's talk**
- On-line simulations to start soon

Discussion : other Tasks ??

T1. Sensitivity to fixed WTD	**Lo**
T1.1 Simulations	*
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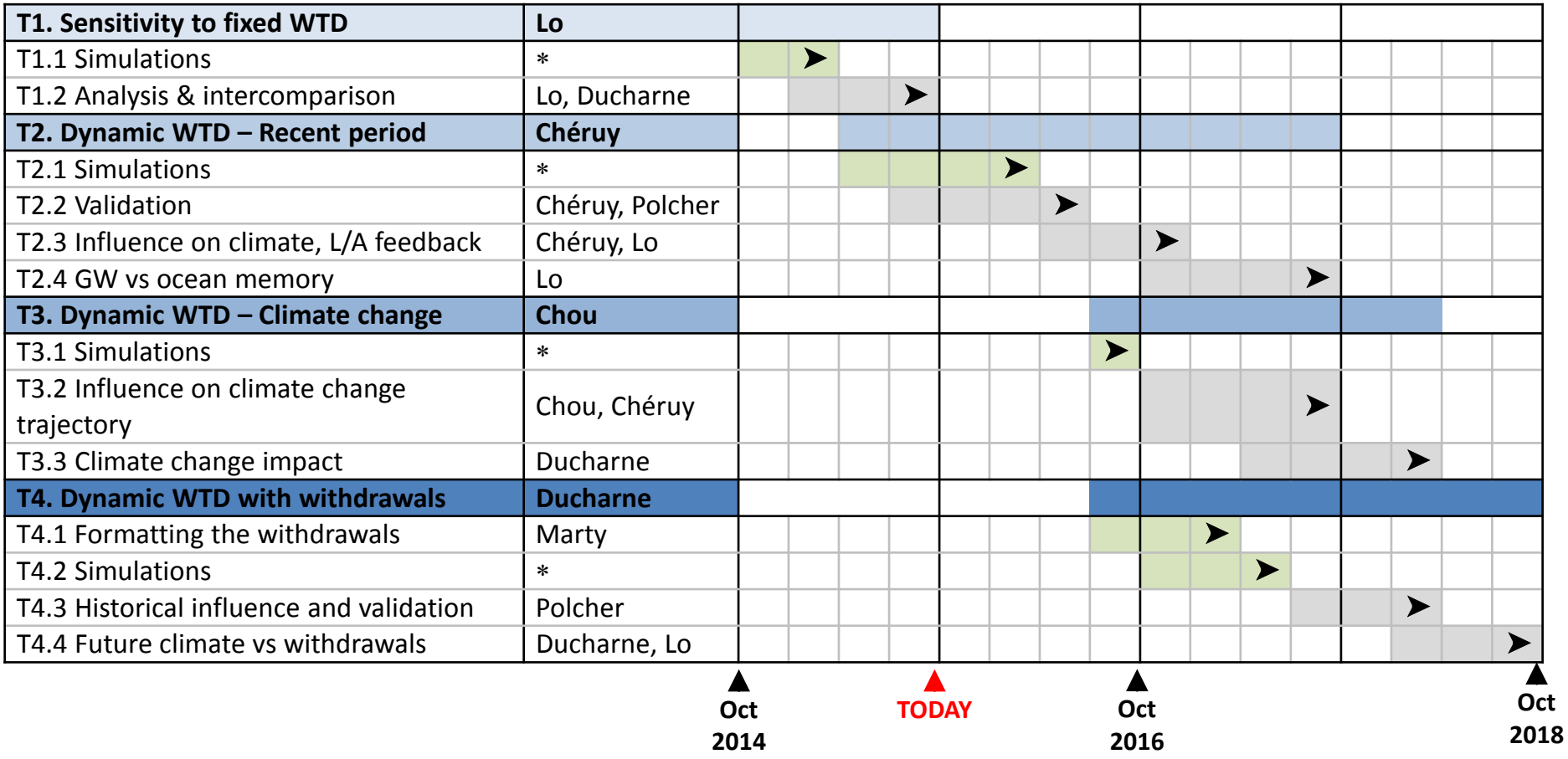


Main questions:

- Task leader for T3 ?
- Will we able to do T4 ?

T1 at IPSL

ORCHIDEE off-line simulations (32 years over 1979-2010) :

1. Run, checked and correctly formatted on http://dods.idris.fr/rcps001/

IF2ref_1MCT.tar 2m soil and gravitational drainage (after 20-yr warm-up)
IF10ref_1MCT.tar 10m soil and gravitational drainage (after 35-yr warm-up)

2. Run, checked but missing WTD diagnostic :

IF2refd0 & IF10refd0 = ref with no drainage (after 20 and 50 years of warm-up)

3. Prescribed WTD runs :

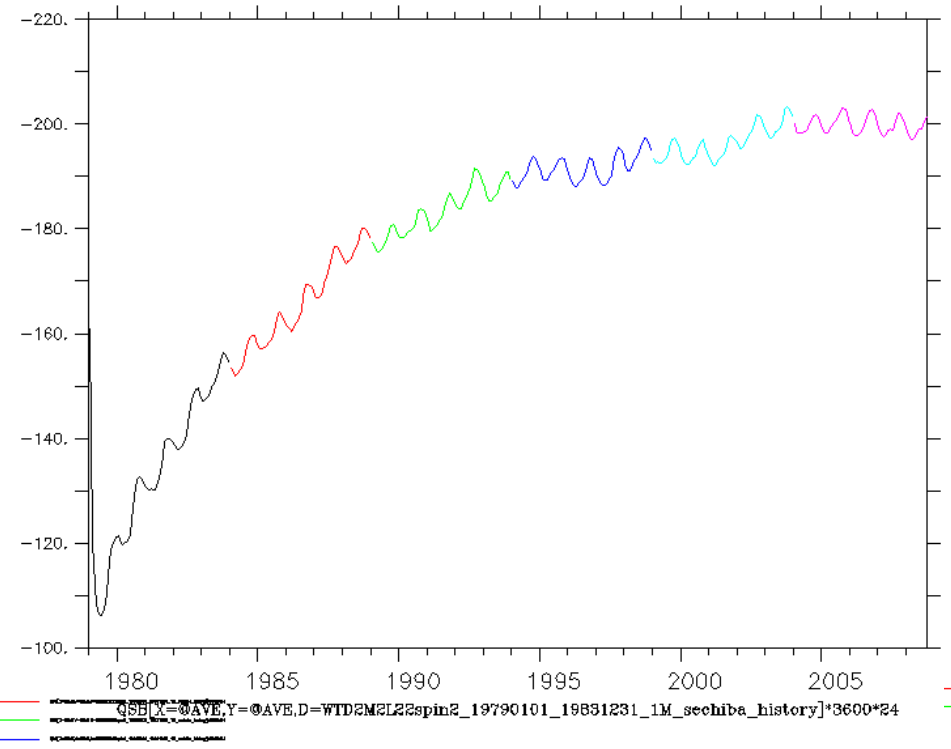
IF2wtd2 WTD@2m in a 2m-soil => 30 years of warm-up
IF10wtd2 WTD@2m in a 10-m soil => 15 years of warm-up
IF2wtd1 WTD@1m in a 2m soil => 15 years of spin-up

T1 at IPSL

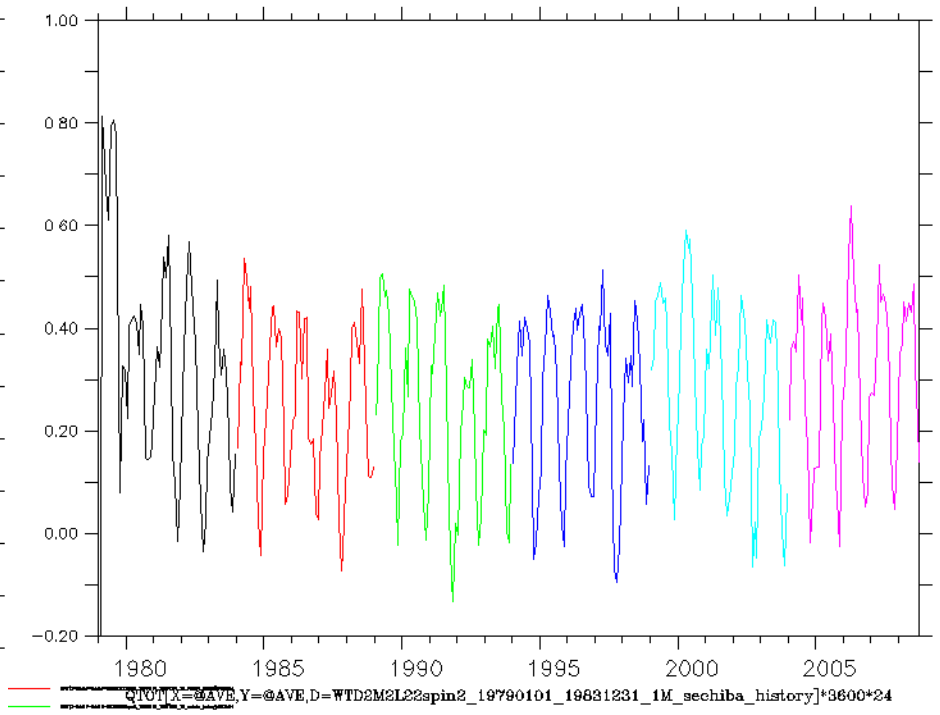
WTD2M2spin (30 ans)

Land averages

Qsb [mm/d]



Qsb+Qs [mm/d]

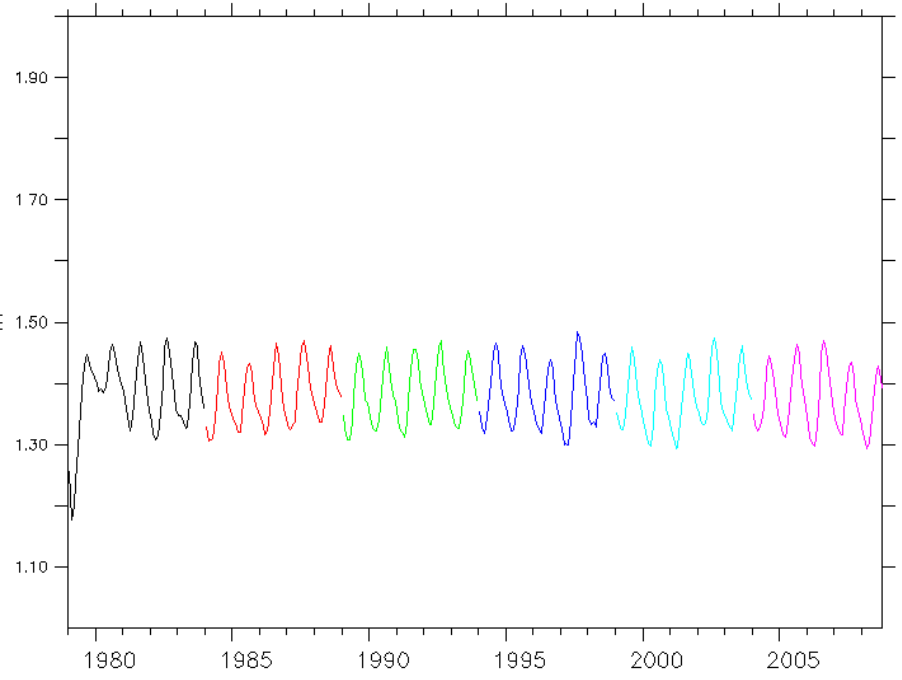


T1 at IPSL

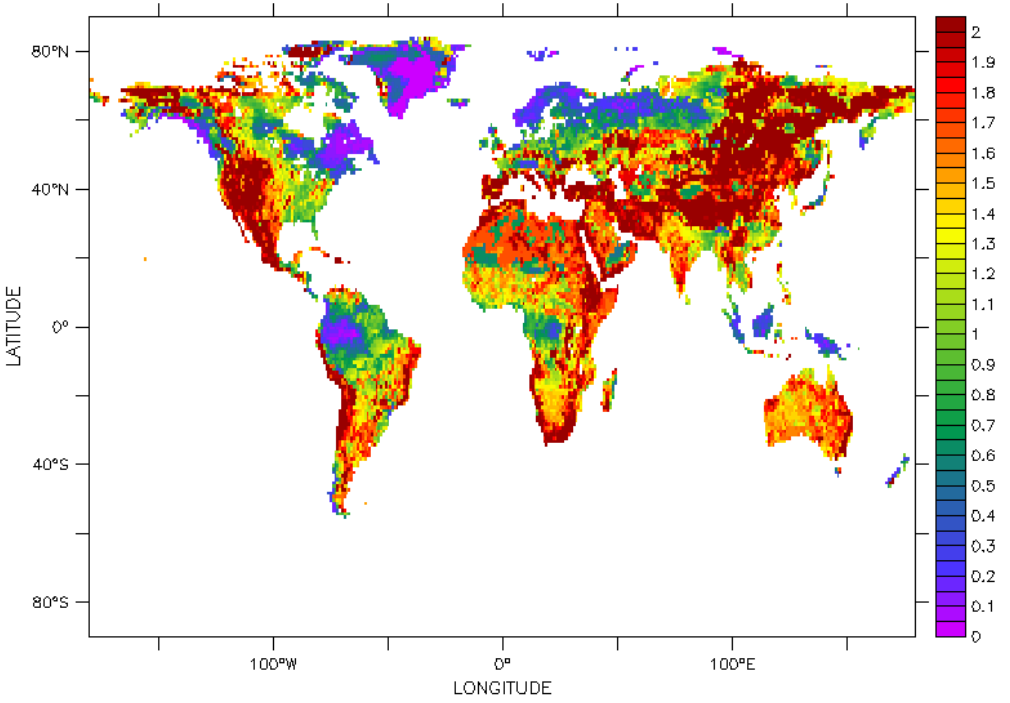
WTD2M2spin (30 ans)

WaterTableD[m]

Land average



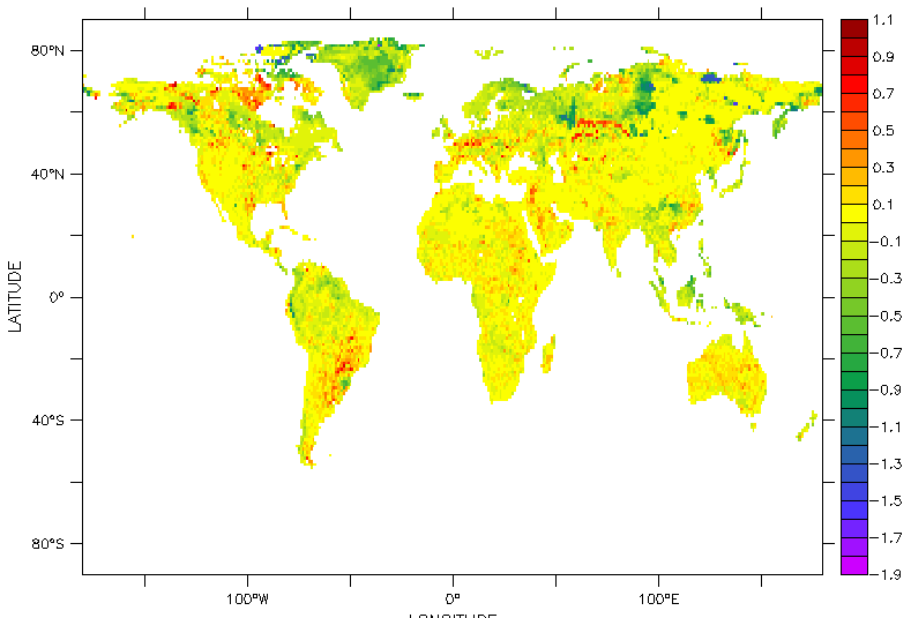
Mean over 2004-2008



T1 at IPSL

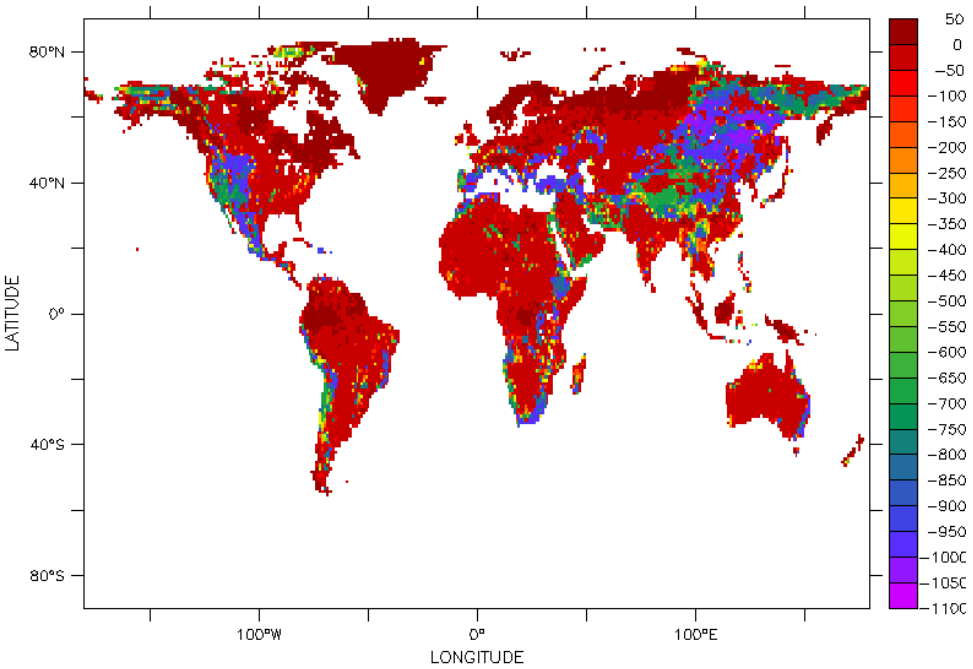
WTD2M2spin (30 ans)

WaterTableD [m]
(2004-2008) - (1979-1983)



WTD ↘ where
ends up way above 2m

Qsb [mmm/d]
(2004-2008)



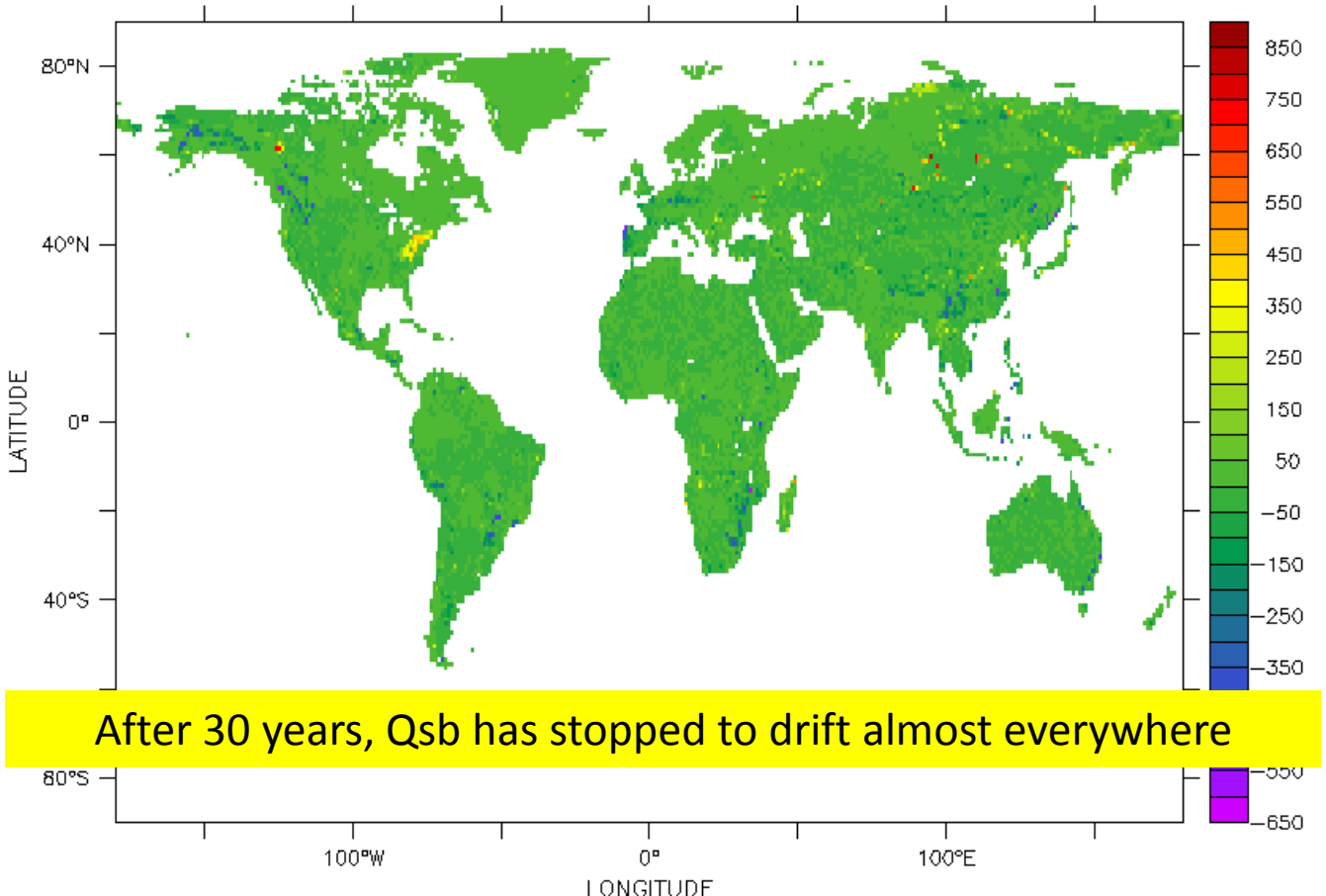
Qsb very negative where WTD=2m,
all along warm-up
(P-Ep < 0 + vegetation)

T1 at IPSL

WTD2M2spin (30 ans)

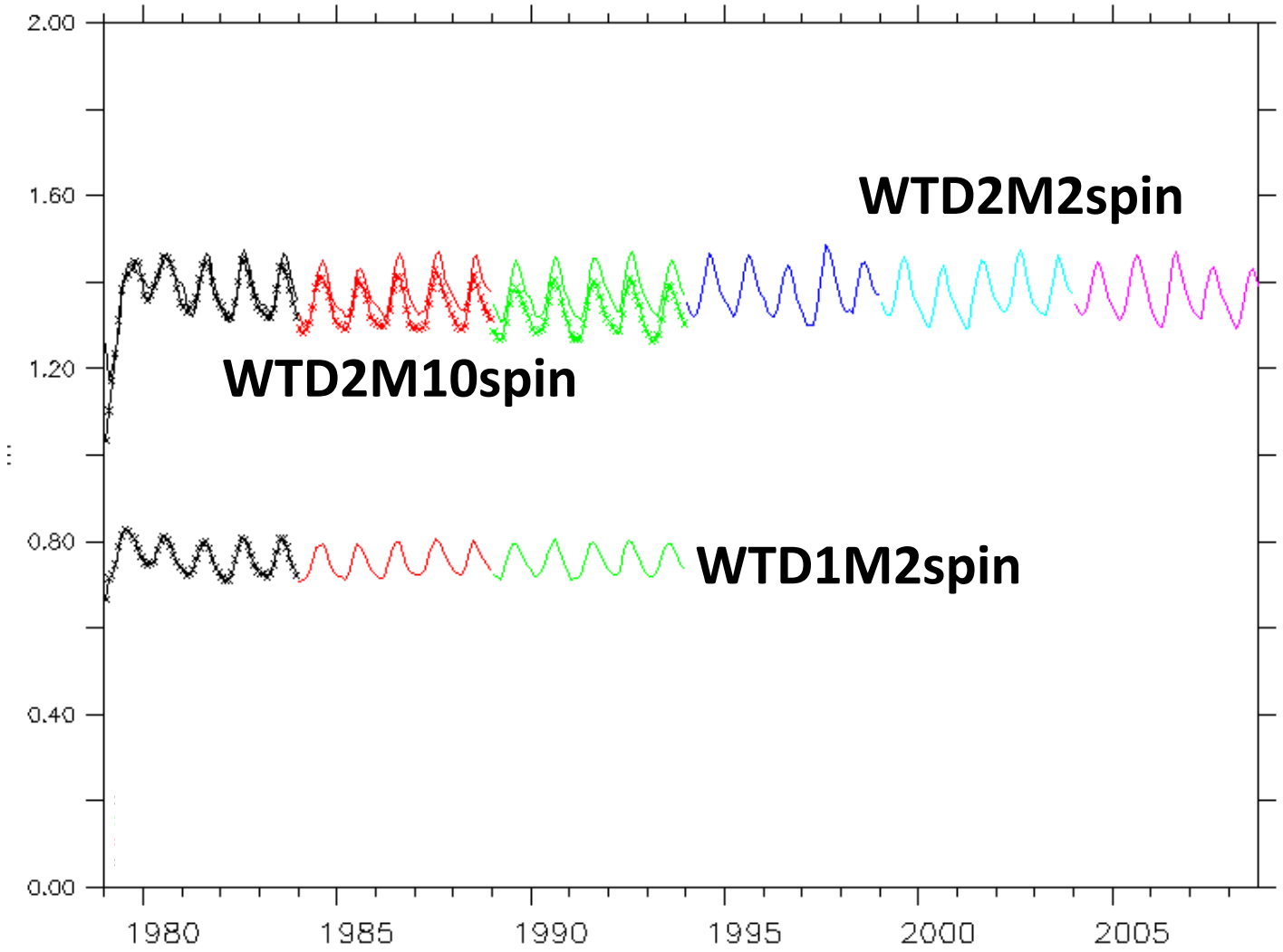
Qsb [mmm/d]

(2004-2008)-(1989-2003)

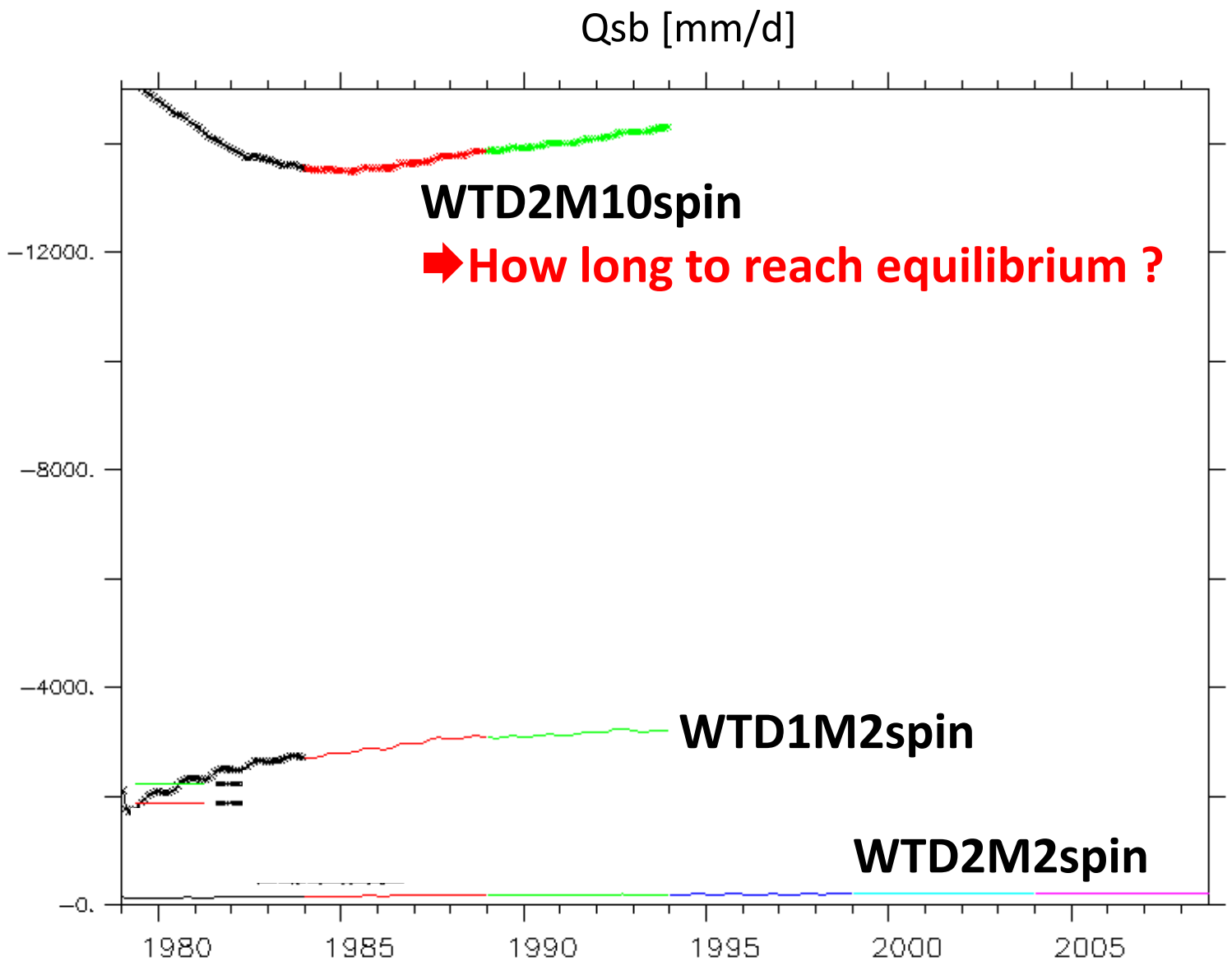


After 30 years, Qsb has stopped to drift almost everywhere

T1 at IPSL


WaterTableD [m]
2.00
1.60
1.20
0.80
0.40
0.00
1980
1985
1990
1995
2000
2005
WTD2M2spin
WTD2M10spin
WTD1M2spin

T1 at IPSL


Qsb [mm/d]
WTD2M10spin
➡How long to reach equilibrium ?
WTD1M2spin
WTD2M2spin
−12000.
−8000.
−4000.
−0.
1980
1985
1990
1995
2000
2005

I-GEM Project

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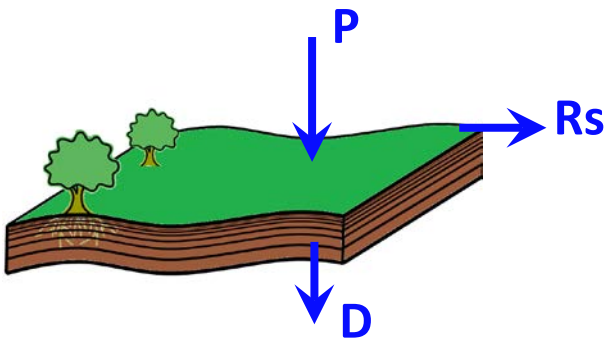
ANR/MoST 2014-2018

Thank you !

ORCHIDEE: soil hydrology

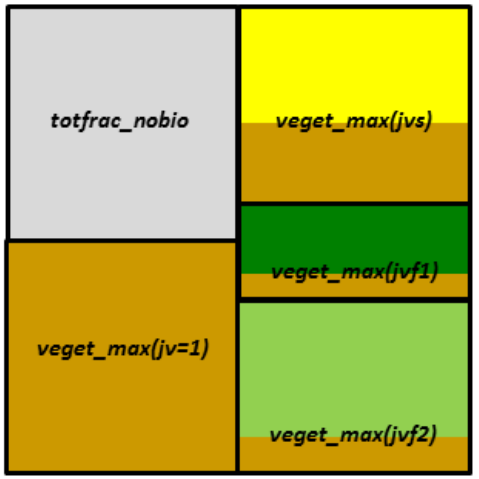
CWRR = ORC11

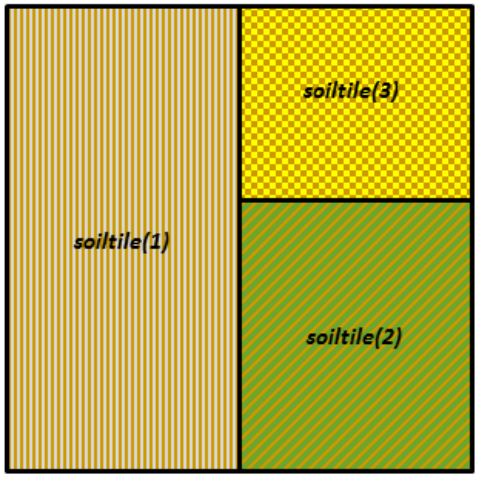
de Rosnay et al., 2002; d'Orgeval et al., 2008



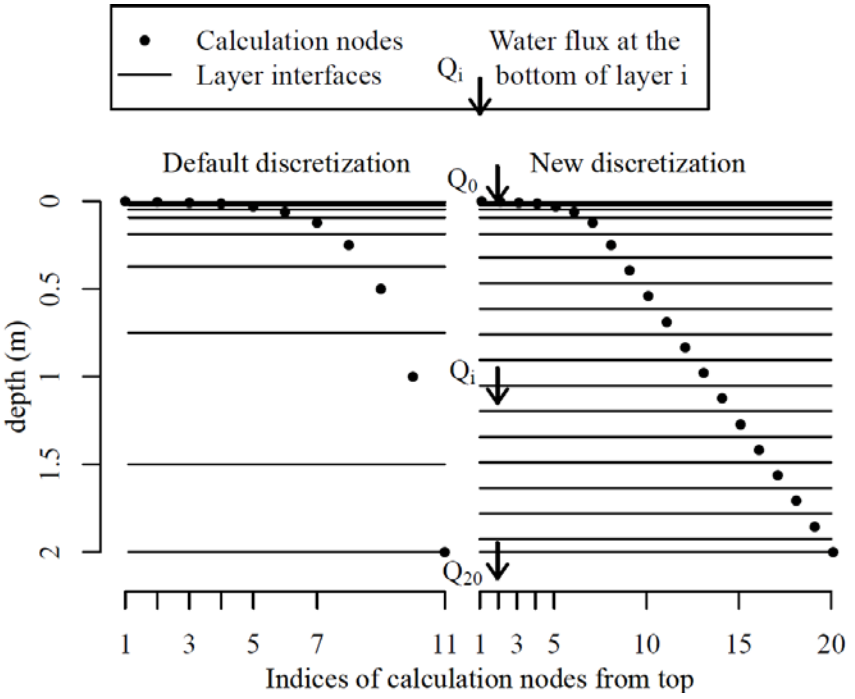
- **Physically-based description of soil water fluxes using Richards equation**
- **2-m soil and 11-layers**
- Formulation of Fokker-Planck
- Hydraulic properties based on van Genuchten-Mualem formulation
- Related parameter based on texture (fine, medium, coarse)
- Surface runoff = P – Esol – Infiltration
- Free drainage at the bottom

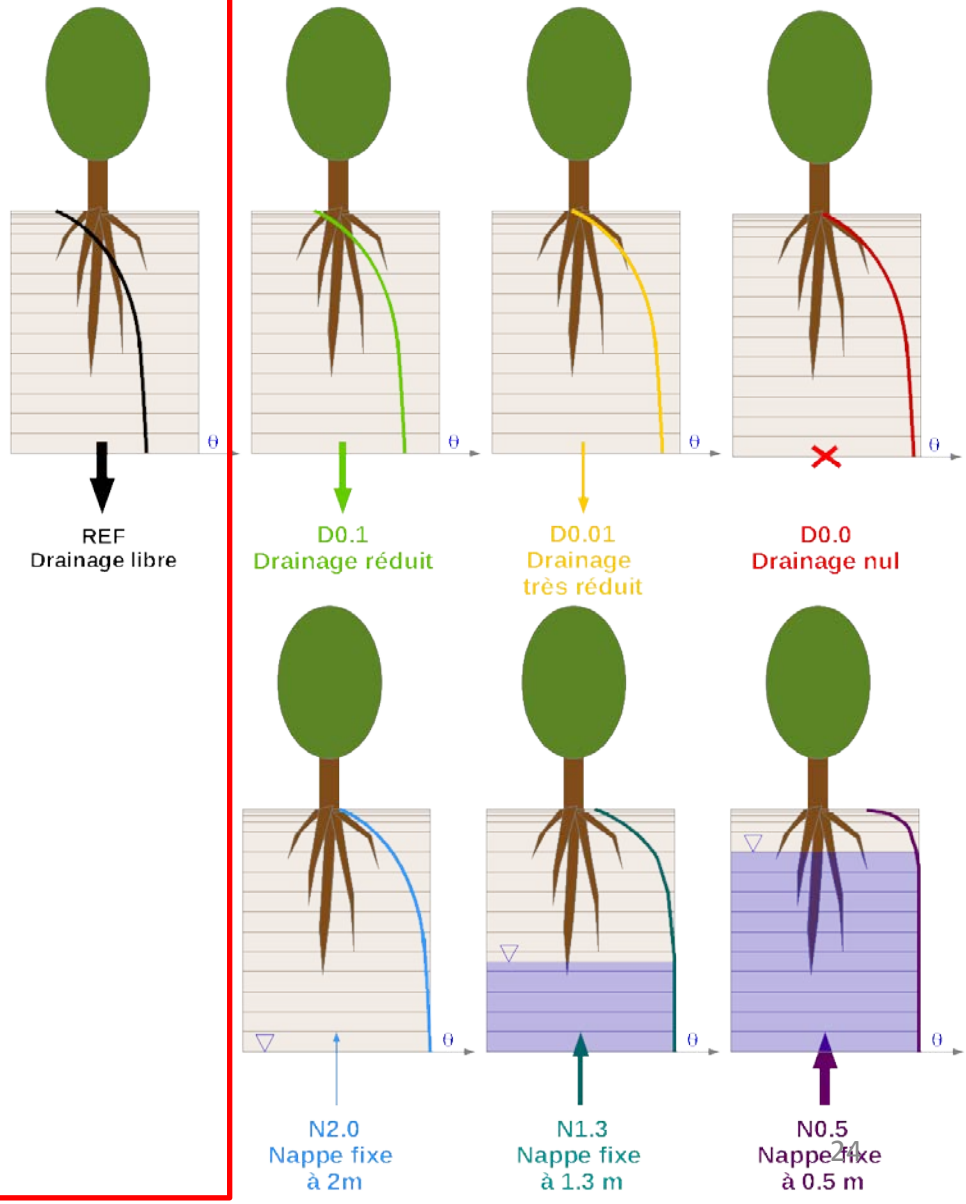
With below-ground tiling



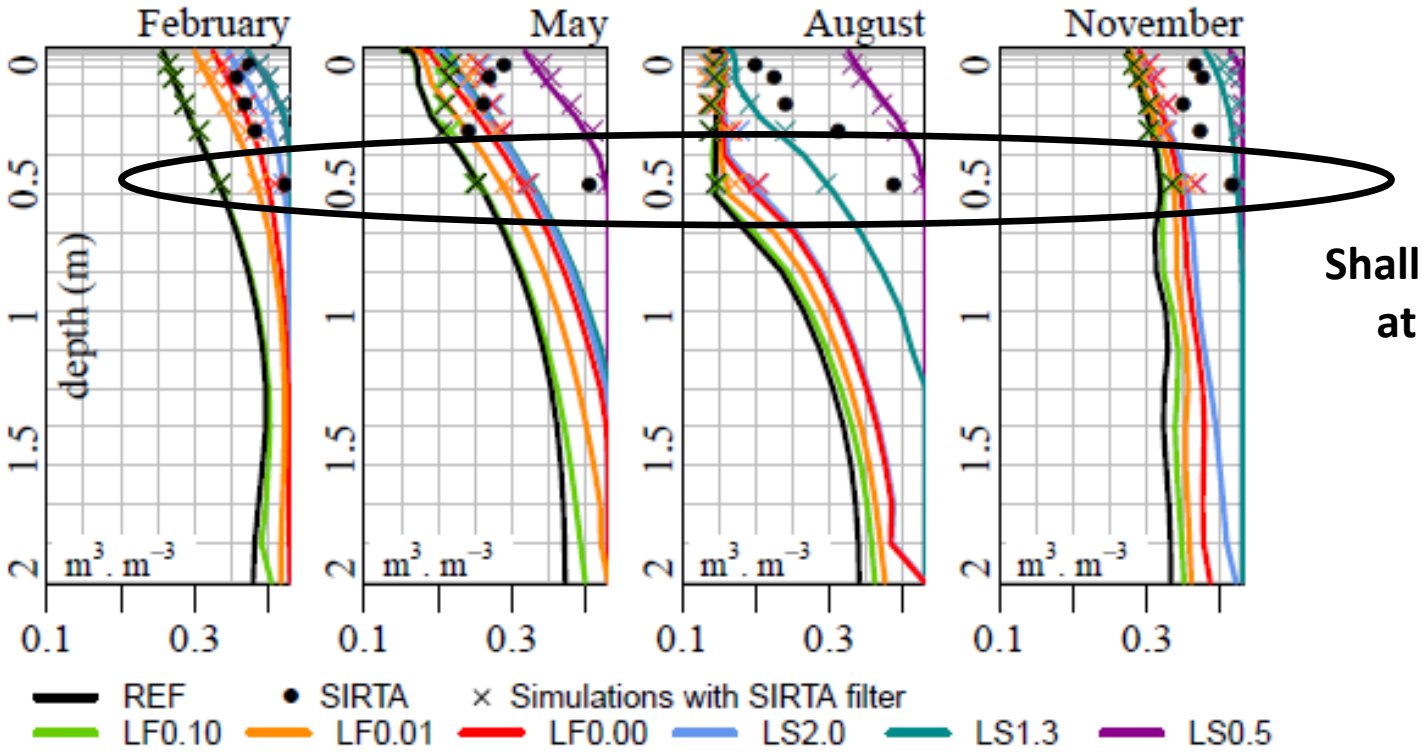


Campoy et al., 2013

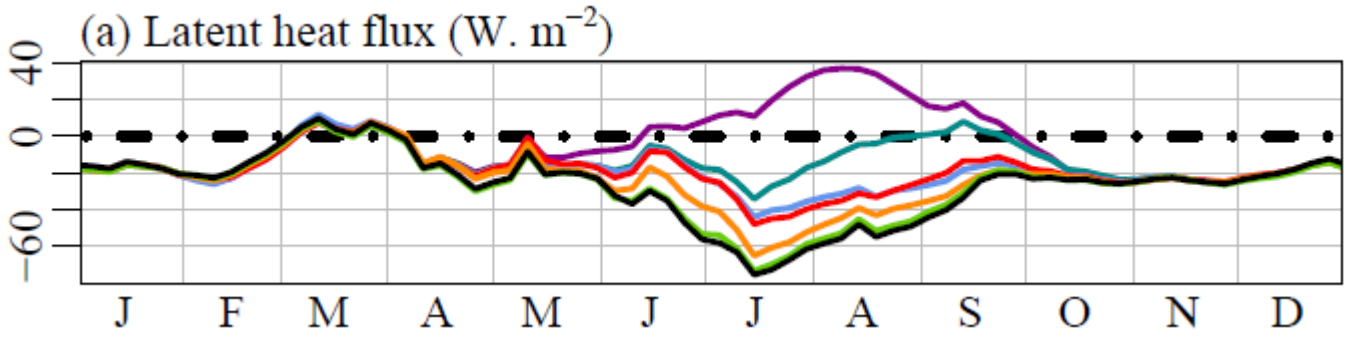




Campoy et al., 2013

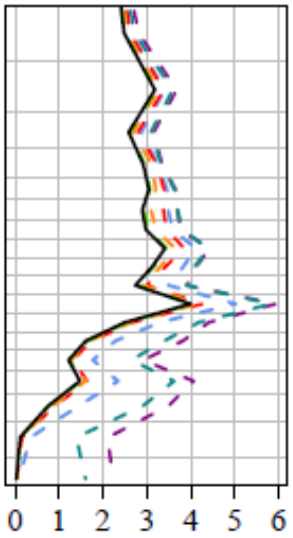


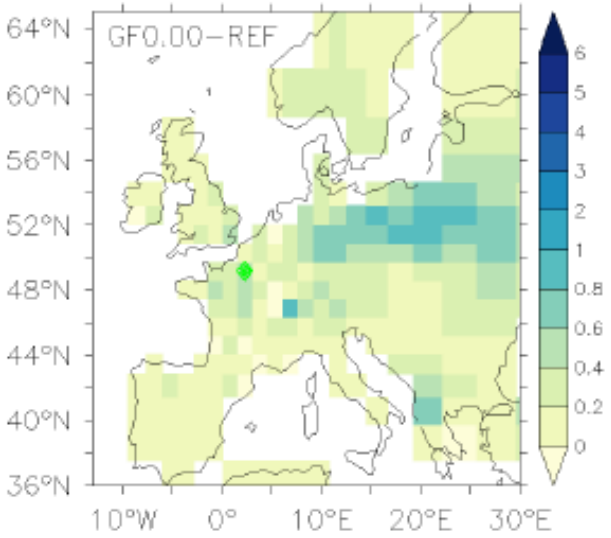
Shallow WTD at SIRTA

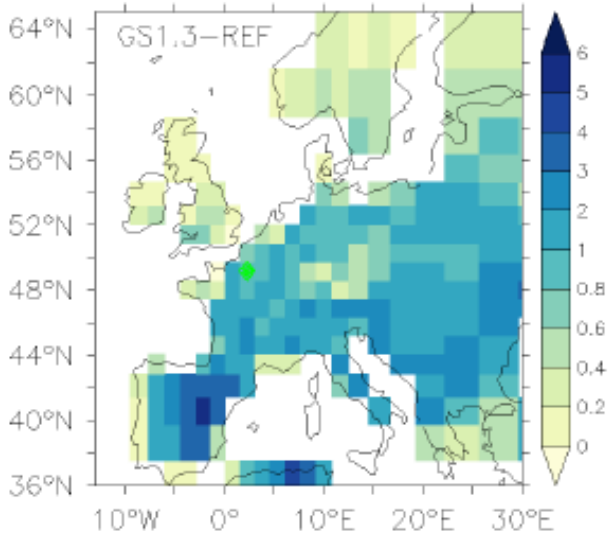


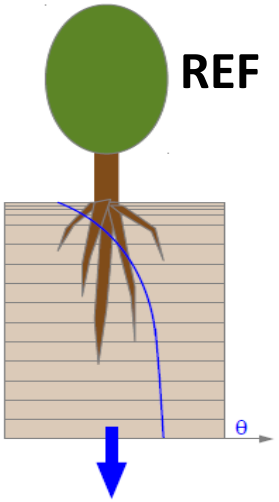
Campoy et al., 2013

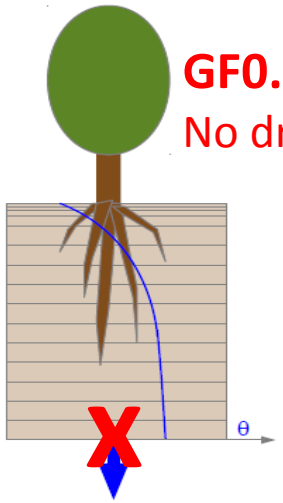
Précipitations estivales (JA, mm/j)

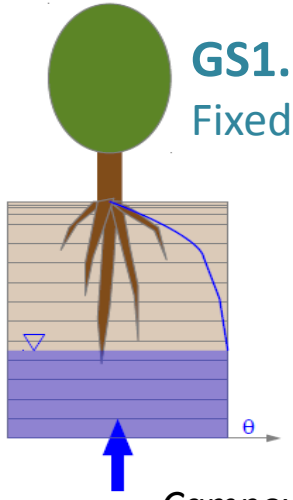








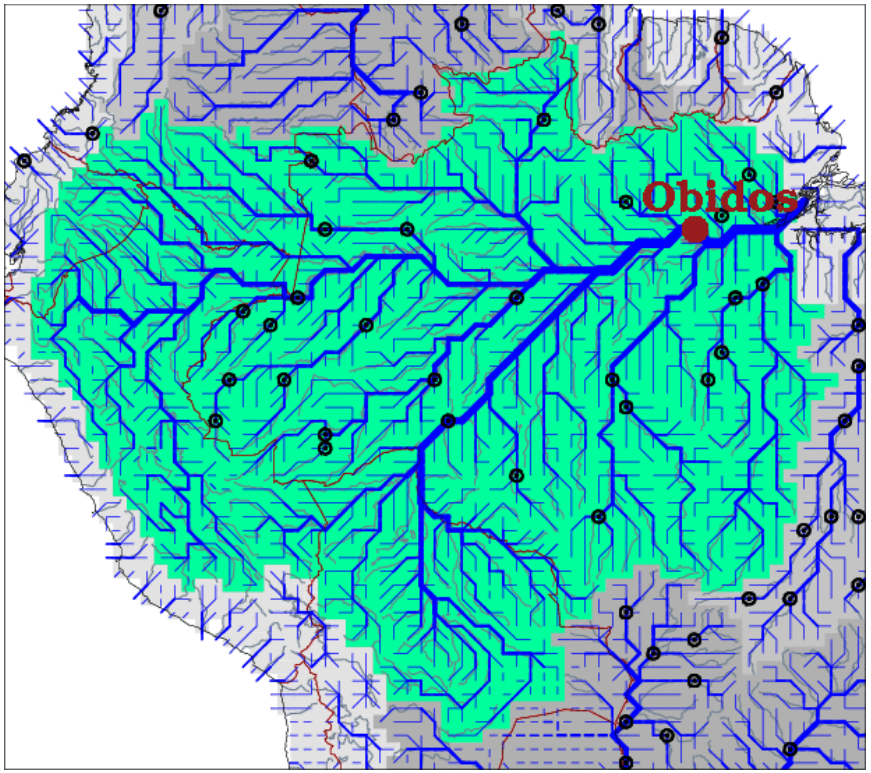




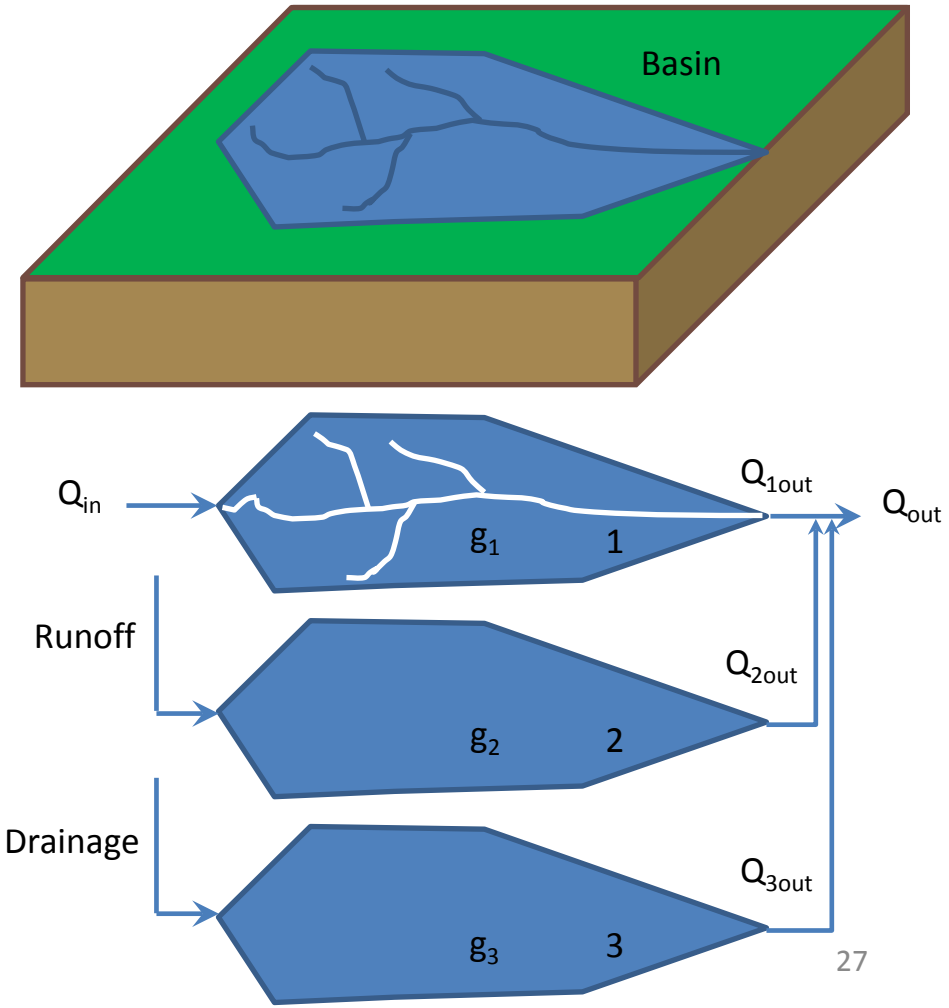
Campoy et al., 2013

GW & Runoff routing

Cascade of linear reservoirs along the river network

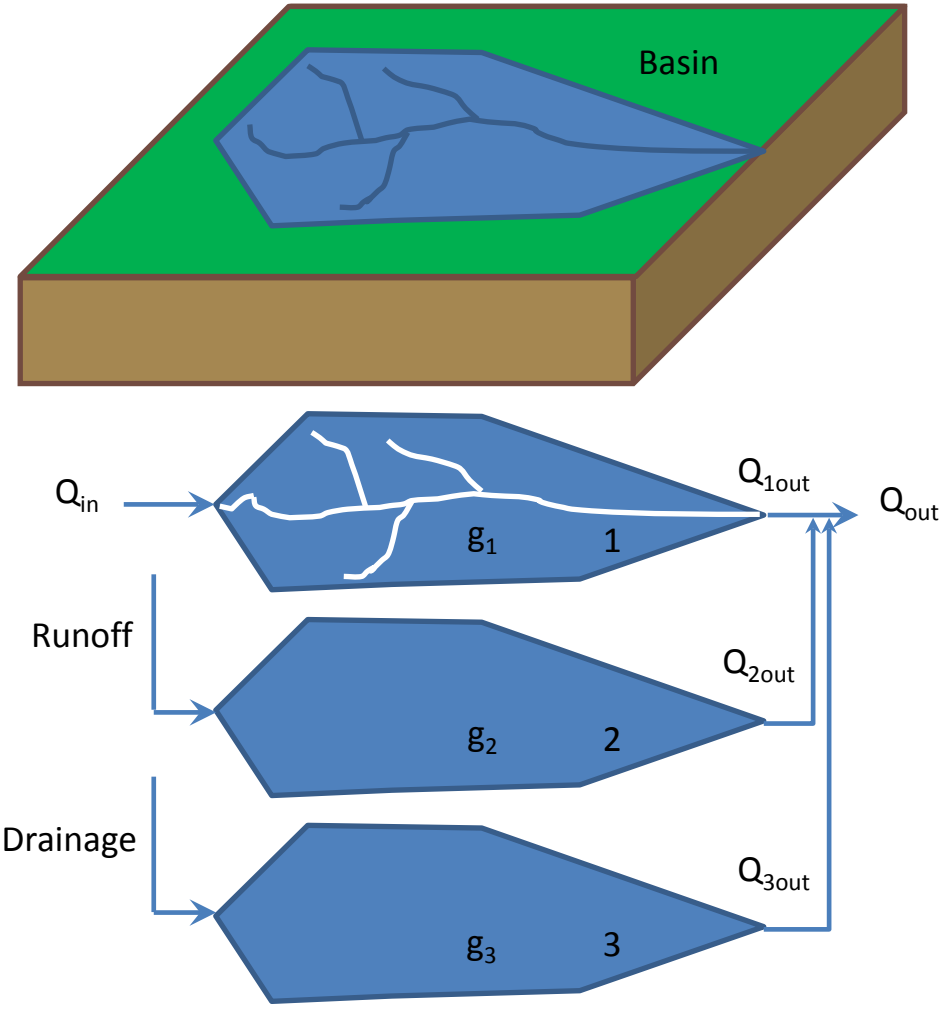


With separate reservoirs for streams, hillslopes and GW



Polcher 2003; Guimberteau et al., 2012

GW & Runoff routing



$Qi_{out} = Si/(topo\_resid*gi)$

$[m^3/d]$ $[m^3]$ [km] [d/km]

topo_resid = d/√slope

Ana Schneider's PhD
More realistic GW residence times

From 0.5° DEM by Vorosmarty et al. (2000)

Stream reservoir g1 = 0.24
Fast reservoir g2 = 3
Slow/GW reservoir g3 = 25 or 3

Dynamic WTD interacting with SM

1. Pas d'échanges souterrains entre mailles ORCHIDEE
2. Introduction d'une fraction de maille « potentiellement humide »
   - caractérisée à partir de topographie (et autres infos ?)
   - avec possibilité d'une nappe (ZS dans le sol ORCHIDEE)

➡ **PhD project of Ardalan Tootchi**