

ORCHIDEE pour CMIP6

- ▶ Soil thermodynamics in ORCHIDEE
 - I. Vertical discretization & Soil depth
 - II. Spin up duration
 - III. Comparison of vertical discretizations
 - IV. Numerical oscillations

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I . Vertical Discretization & Depth

Name	Soil depth		SM	Discretization
	SM	T	Interpolation	
VD1 (standard)	2m	~5m	Yes	geometrically distributed
VD2 (revised)	8m	<u>8m</u>	No	0-2m: same with standard hydrol.; 2-8m: increase by 1m for each layer.
VD3 (revised)	2m	<u>8m</u>	$SM_{2-8m} = SM_{2m}$	

► For T

- 5m is not enough to simulate the diurnal/annual cycles of soil T;
- 8m is determined with 3 soil texture classes;
- USDA 12 soil texture: ~9.5m-9.6m for 'sand', ~8m for other textures.

► For SM:

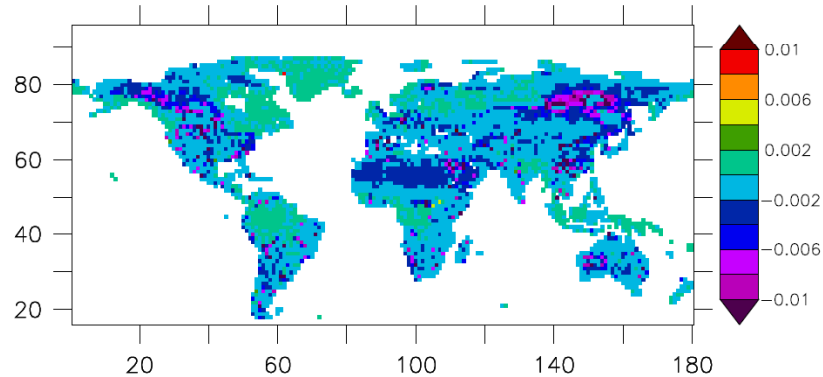
- Is the 8m too deep (spin up, river discharge, ...) ???

I . Soil Depth (ORC vs. other LSMs)

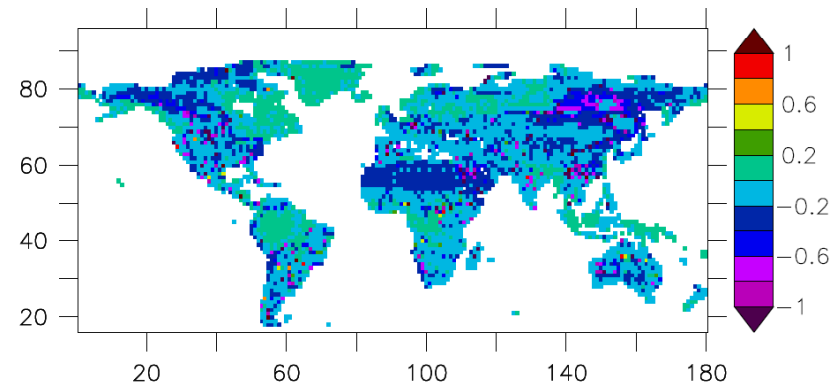
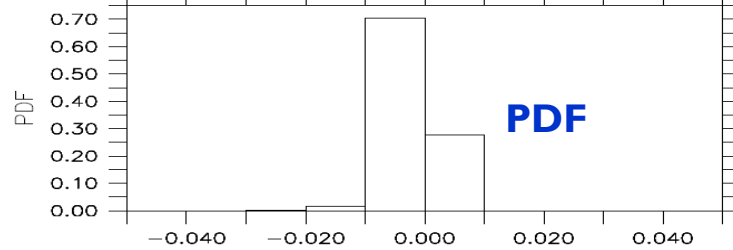
Model	Depth(m)/Layers for SM & T .	Soil Thermal Property	Soil Heat Cond. / Conv..
CLM4/ CCSM3	3.8/10L & 42.10/15L	Cond.: J75; Capa.: <i>de Vries</i> [1963]; organic matter	Cond.
ORCHIDEE/ IPSL-CM	Now: 2.0/11L & 5.0/7L Rev.: ?	Now: Depending on soil moisture Rev.: Cond.: J75; Capa: $\theta * C_w + C_{dry}$	Now: Cond. Rev.: Cond. & Conv. by liquid water
JULES/ MetUM	2.0/4L & 2.0/4L	Cond.: J75, <i>Cox et al</i> [1999]; Capa.: <i>Cox et al</i> [1999]	Cond. & Convec. by water vapor
H-TESEL/ ECMWF	2.89/4L & 2.89/4L	Cond.: J75; Capa.: $2.19 \times 10^6 \text{ J/m}^3/\text{K}$	Cond.
JSBACH/ MPI-ESM	10/5L & 10/5L	Cond.: J75; Capa.: <i>de Vries</i> [1963]	Cond.
ISBA/ CNRM-CM	2-3/10-11L & 12/14L	Cond.: J75; Capa.: <i>de Vries</i> [1963]	Cond.
Noah LSM	2/4L & 2/4L	Cond.: J75; Capa.: <i>de Vries</i> [1963]	Cond.

II. Spin up duration (Soil Moist., Temp.) (VD2, 42ndYR, offline, CRU-NCEP v5.3)

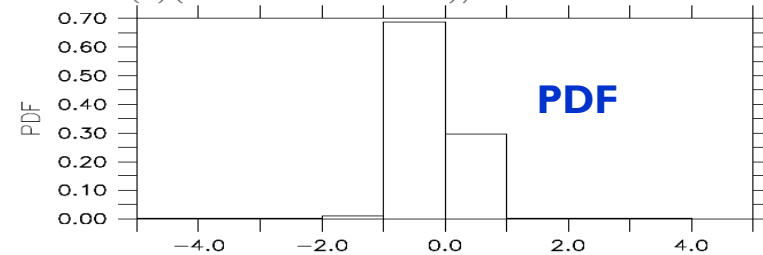
Criterion: (1) $|(SM_{end} - SM_{start})| / SM_{mean} \leq 0.01$; SM in mm. **(2)** $|(VSM_{end} - VSM_{start})| / 0.001 \leq 1$. VSM in m^3/m^3 .



(n) $(SM_{end} - SM_{start}) / \text{mean}(SM)$: 42th Year

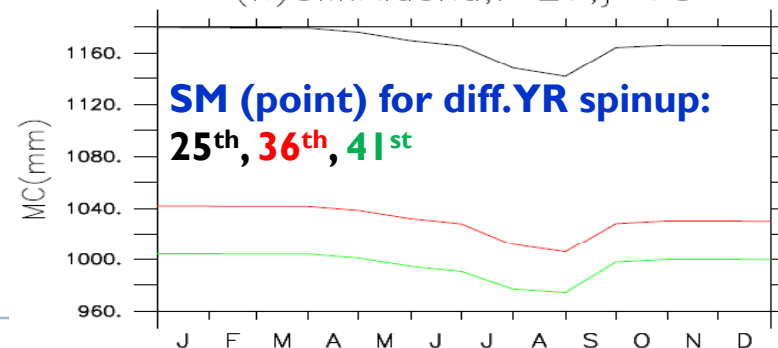
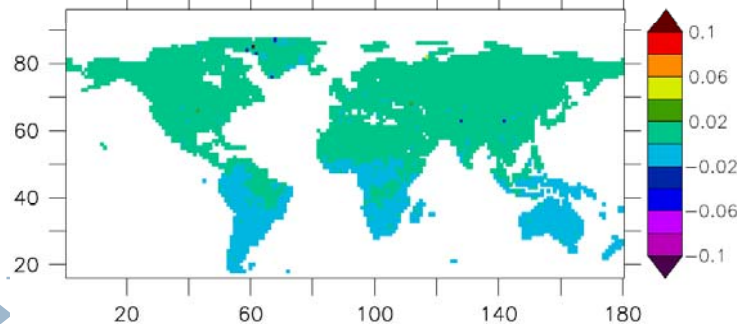


(r) $(VSM_{end} - VSM_{start}) / 0.001$: 42th Year



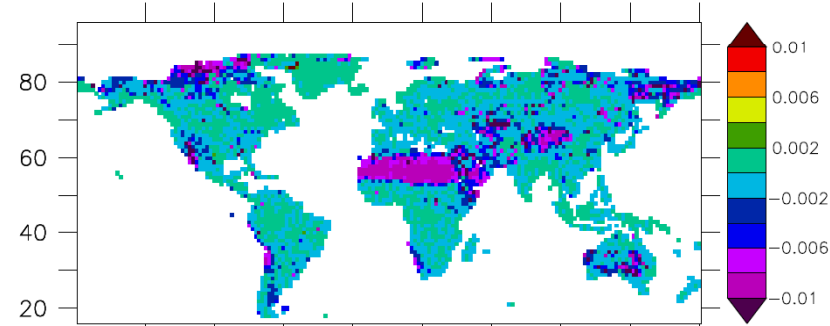
(h) SM:Alaska, $i=27, j=78$

Criterion for T: $|T_{end} - T_{start}| \leq 0.1$

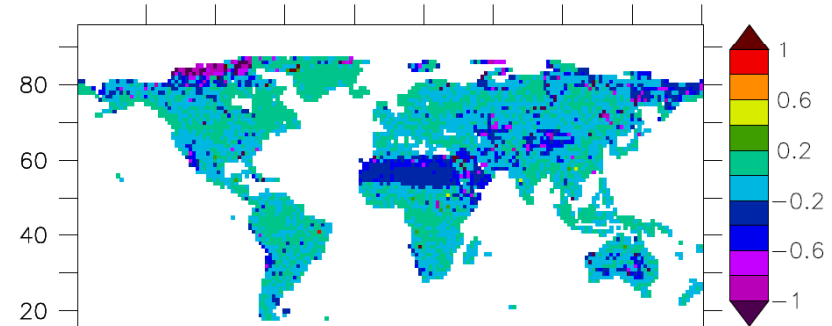
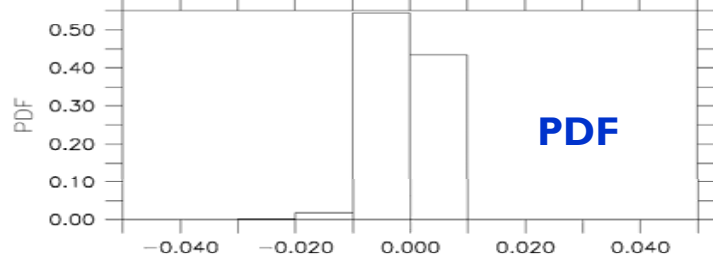


II. Spin up duration (Soil Moist., Temp.) (VD3, 19thYR, offline, CRU-NCEP v5.3)

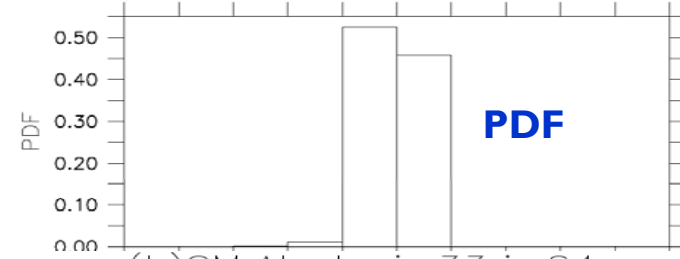
Criterion: (1) $|(SM_{end} - SM_{start})| / SM_{mean} \leq 0.01$; SM in mm. **(2)** $|(VSM_{end} - VSM_{start})| / 0.001 \leq 1$. VSM in m^3/m^3 .



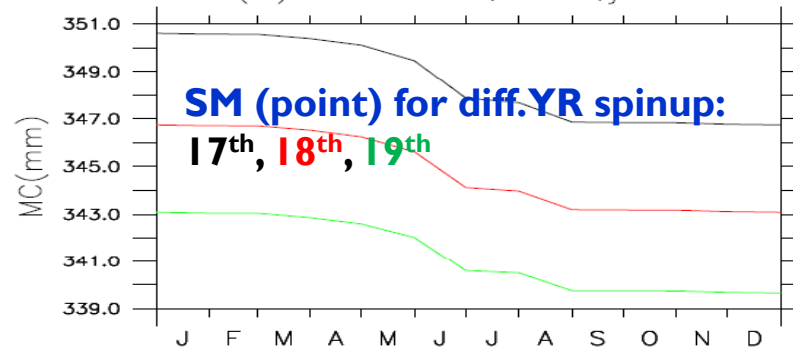
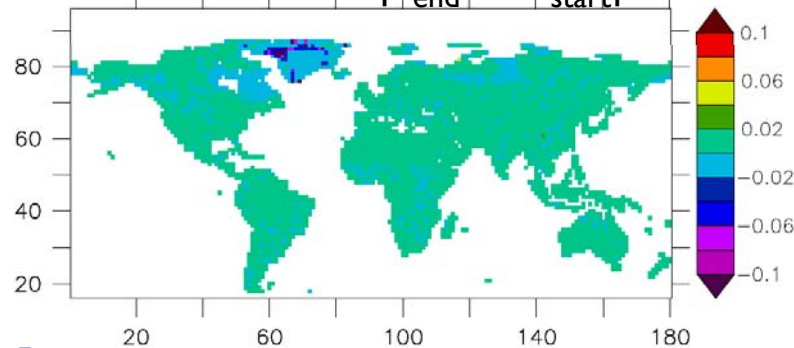
(h) $(SM_{end} - SM_{start}) / \text{mean}(SM)$: 19th Year



(j) $(MC_{end} - MC_{start}) / 0.001$: 19th Year



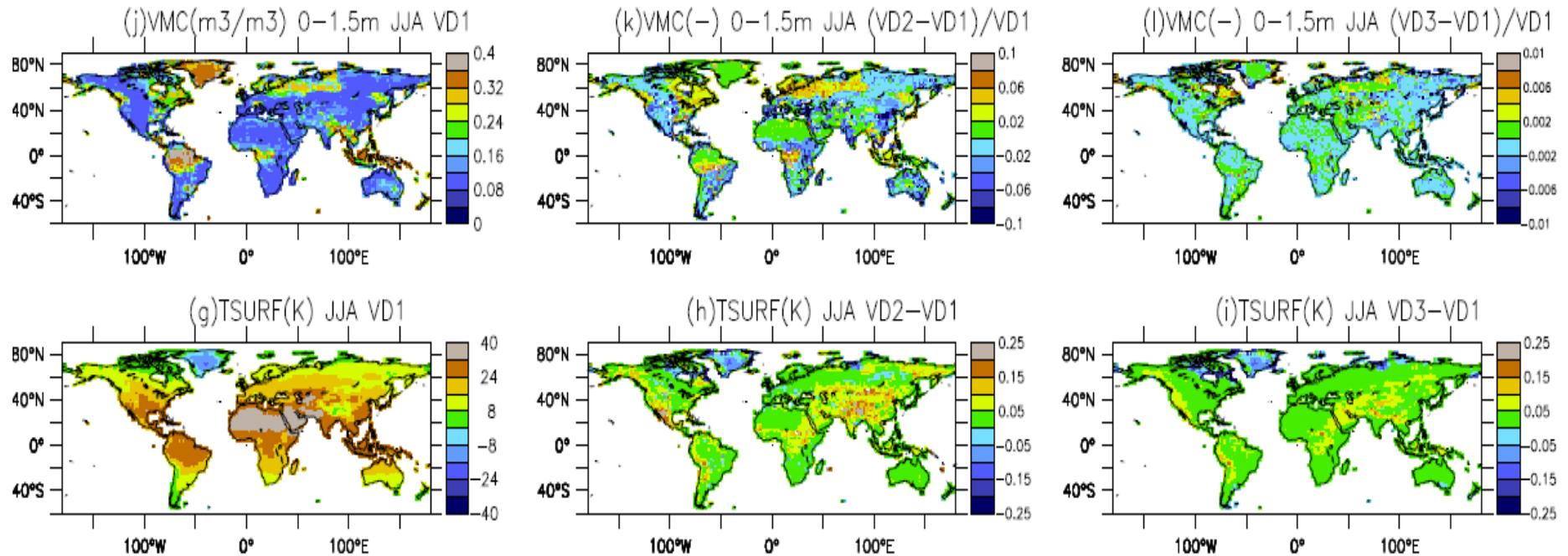
Criterion for T: $|T_{end} - T_{start}| \leq 0.1$



Results for VDI are close to VD3.

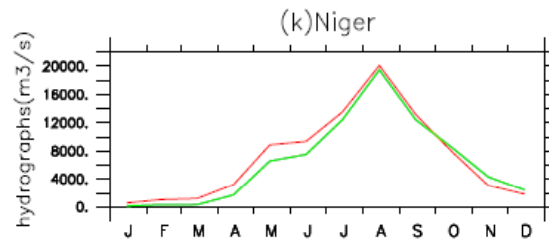
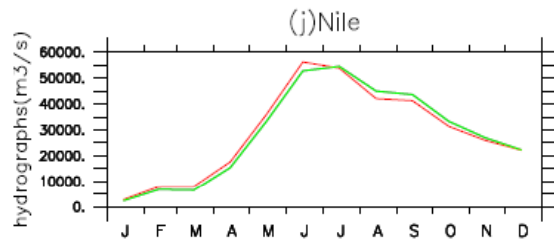
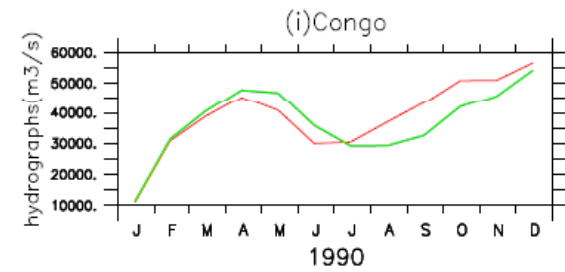
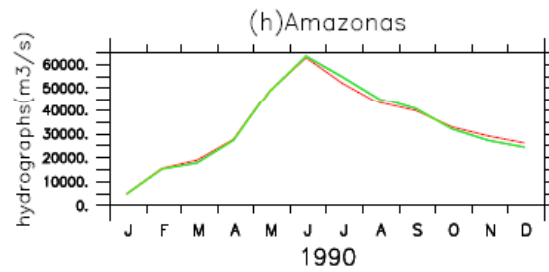
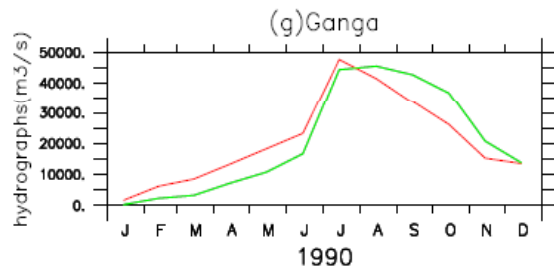
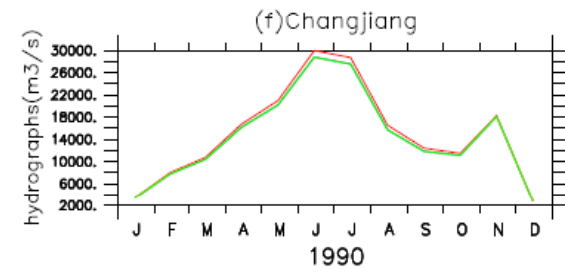
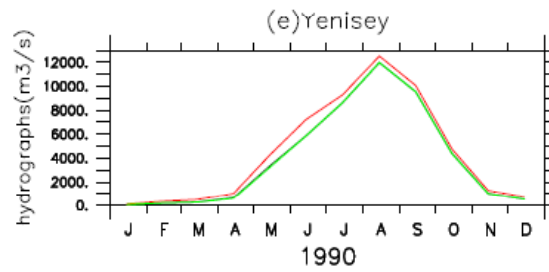
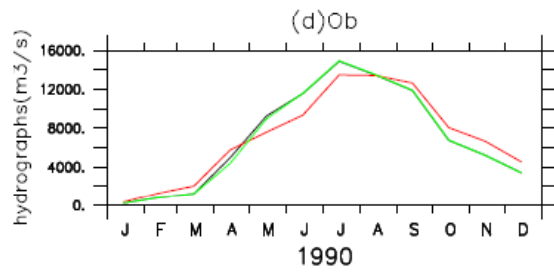
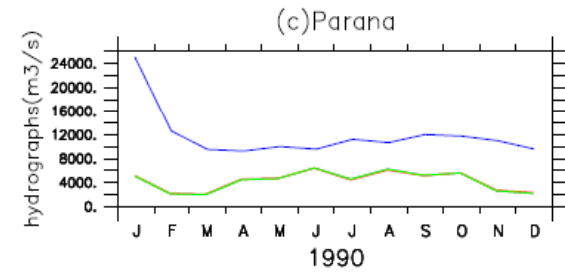
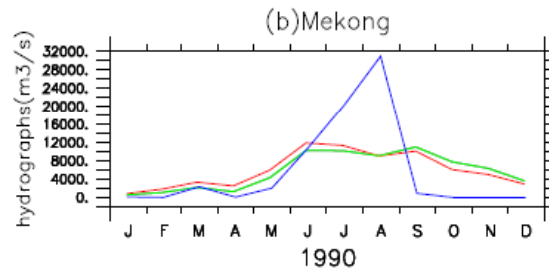
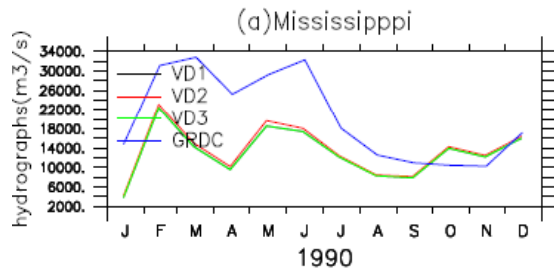
III. VD2 vs VD3 vs VD1 (VMC & T)

- ▶ Volumetric soil moisture (up), Tsurf (down) between VD1 (19th year), VD2 (42nd year) & VD3 (19th year) over JJA (the last year of spin up)



The forcing data ?
Evaluate with observations ?

III. Discharge: **VD2**, **VD3**, **VD1**, **GRDC**



Comparison over the last year of spin up !

IV. Numerical oscillations (1)

▶ **Problem description:**

- Oscillations when rad. is called each hour (VD2>VD1).
- They are mainly in humid regions;
- The vertical profiles of Tsoil are fine;
- Rad. 7.5 mn step → oscillations in both VD2 and VD1.

▶ **Sensitivity tests results:**

Step rad.	Cloud rad. Effects (test by neglecting CRE)	Cdrag (test by given const. value)	lwup (test by updating lwup each 1 hour)	lwdown (test by using lwdown from radlsw in pbl)
7.5 mn	Main reason		Very small effects	Larger effects than lwup, but can not remove oscillations
1 hr		Main reason		

More information: wiki/Meetings/CMIP6/Physic

IV. Numerical oscillations (2)

► **Sensitivity tests of the top layer** (in LMDZOR, climatology run):

- The top N ($=1\dots5$ here) layers are merged,
- The moisture for the merged top layer is from the N th layer node to avoid interp.

	node (m)	interf (m)	description		node (m)	interf (m)	description
VD1	1.419E-2	3.426E-2	Standard	VD5	5.865E-3	9.775E-3	1-3 merged
VD2	0.489E-3	0.978E-3	No merge	VD6	1.369E-2	2.151E-2	1-4 merged
VD4	1.955E-3	3.910E-3	1-2 merged	VD7	2.933E-2	4.497E-2	1-5 merged

