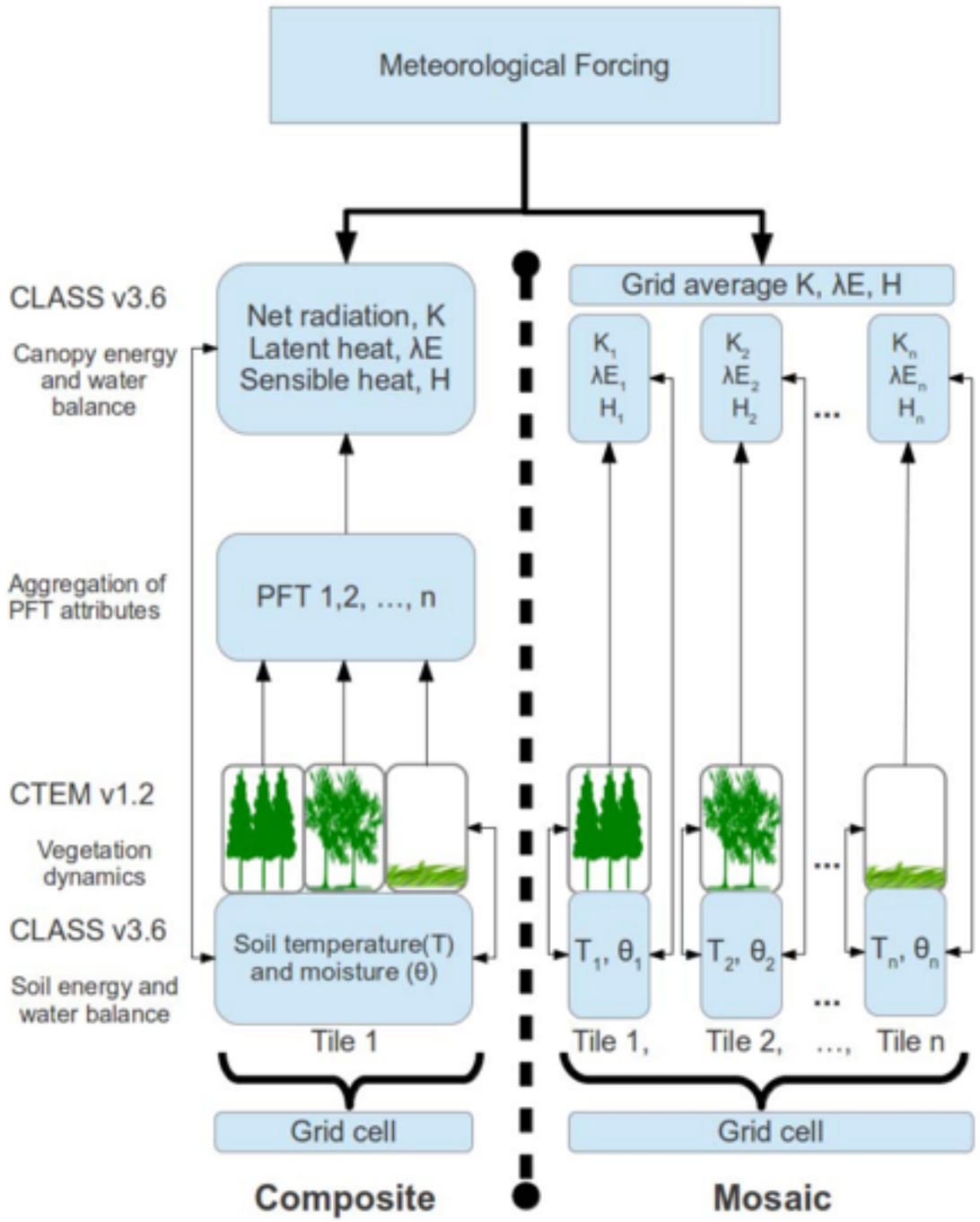
Multiple atmospheric and soil columns for water/energy/carbon…

Context:
Merge of ORCHIDEE – CAN with TRUNK

See wiki :
http://tinyurl.com/subgrid

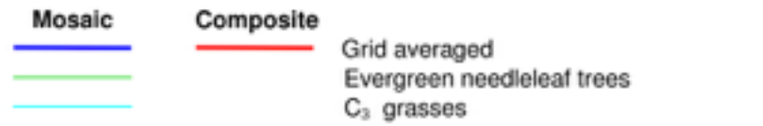
James Ryder, Sebastiaan Luyssaert,
Jan Polcher, Catherine Ottlé and Philippe Peylin

sub-grid cell variability

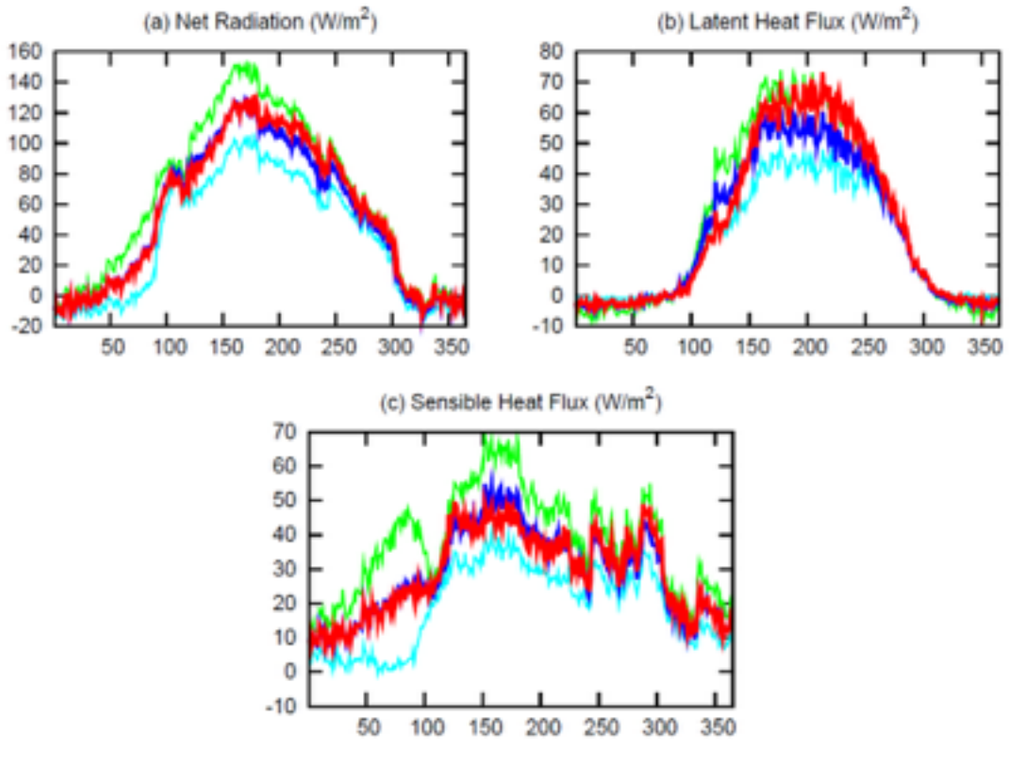


sub-grid cell variability

Differences of 5% between grid averaged heat fluxes when mosaic approach and composite approach are compared (Li & Arora, 2012; Melton & Arora, 2014)

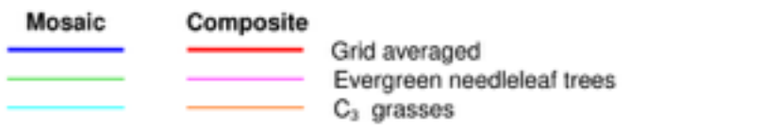


Energy fluxes	Mosaic approach			Composite approach
	Grid averaged	Evergreen needleleaf trees	C_3 grasses	Grid-averaged
Net radiation (W m^{-2})	**51.0**	64.2	37.8	**53.1**
Net radiation over growing season (W m^{-2})	**86.7**	102.0	71.3	**90.0**
Latent heat flux (W m^{-2})	**21.2**	24.7	17.7	**23.3**
Sensible heat flux (W m^{-2})	**28.5**	37.9	19.0	**28.4**

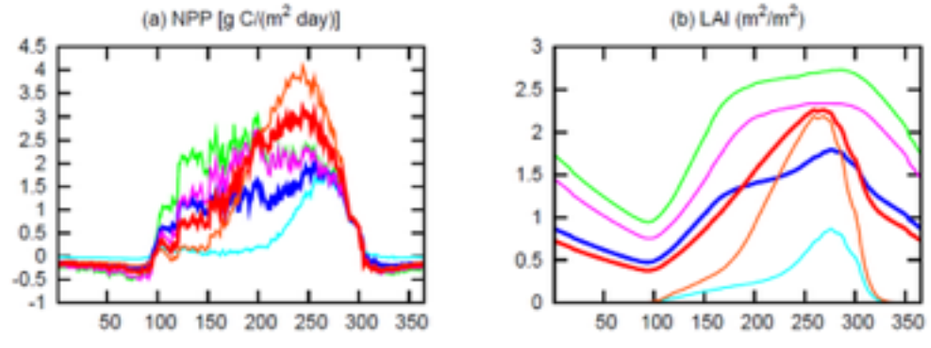


For high within cell heterogeneity, differences are greater in both instances

Differences of ~30-40% between grid averaged NPP, LAI, Soil Carbon and vegetation biomass (Li & Arora, 2012; Melton & Arora, 2014)

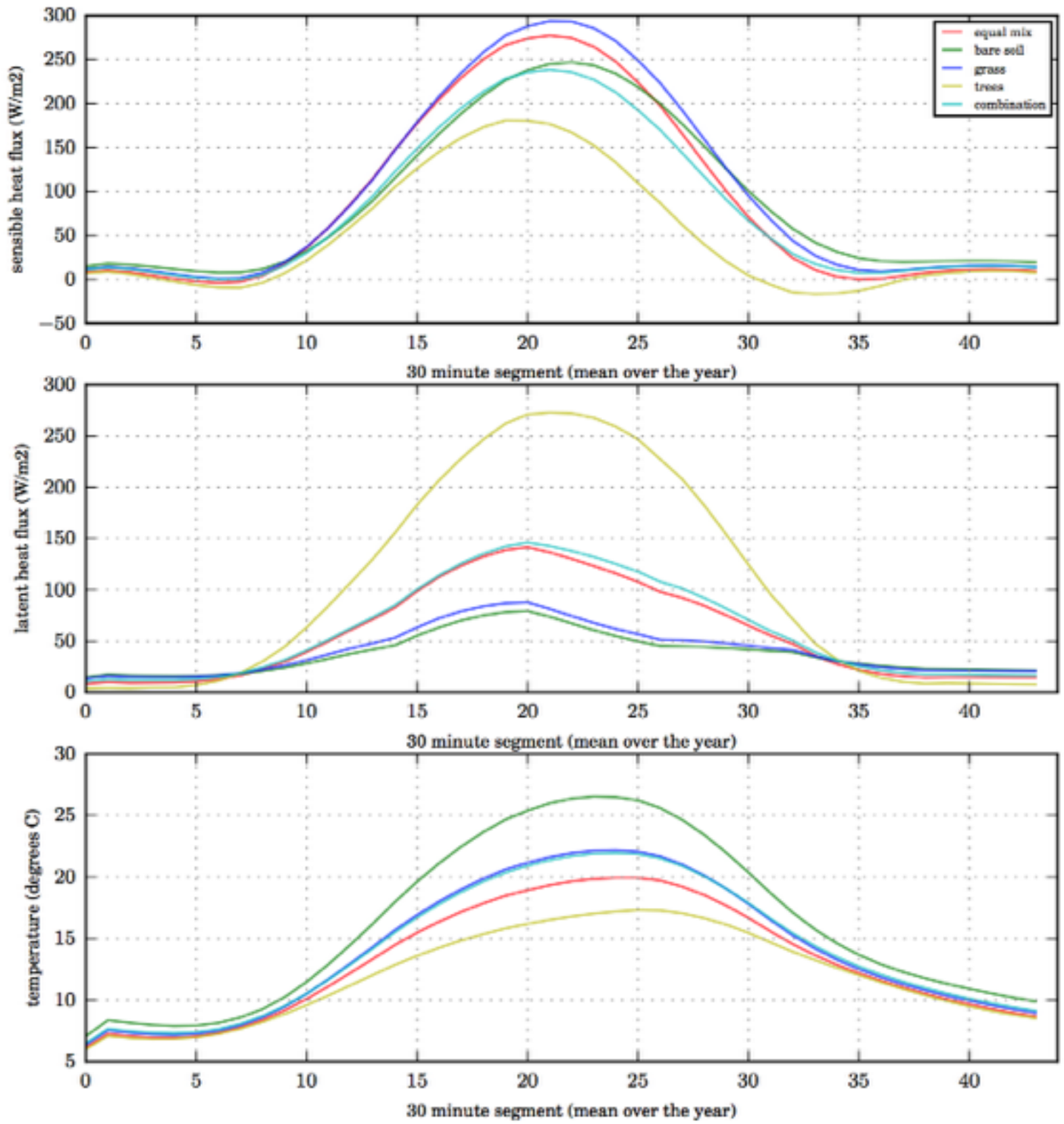


Carbon quantities	Mosaic approach			Composite approach		
	Grid-averaged	Evergreen needleleaf trees	C_3 grasses	Grid-averaged	Evergreen needleleaf trees	C_3 grasses
NPP (g C m^{-2} yr^{-1})	**234.1**	355.0	113.3	**316.8**	292.5	341.1
Max. LAI (m^2 m^{-2})	**1.8**	2.8	0.9	**2.3**	2.4	2.2
Soil carbon mass (Kg C m^{-2})	**6.1**	7.0	5.2	**8.9**	5.5	12.2
Vegetation biomass (Kg C m^{-2})	**2.5**	4.9	0.2	**2.1**	3.7	0.6

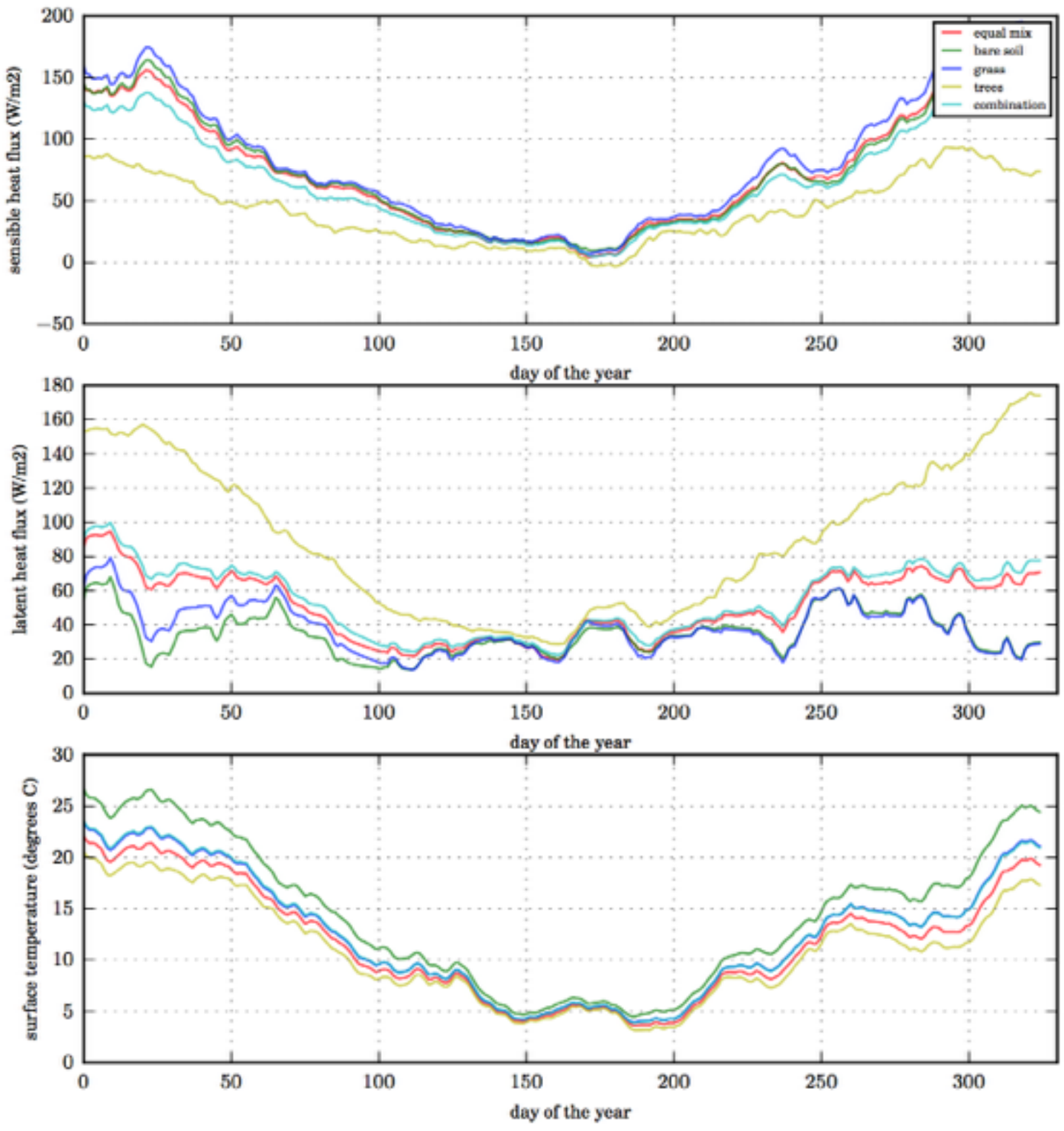


Mosaic or composite - which is 'correct'?
Not yet verified on a large regional or global scale

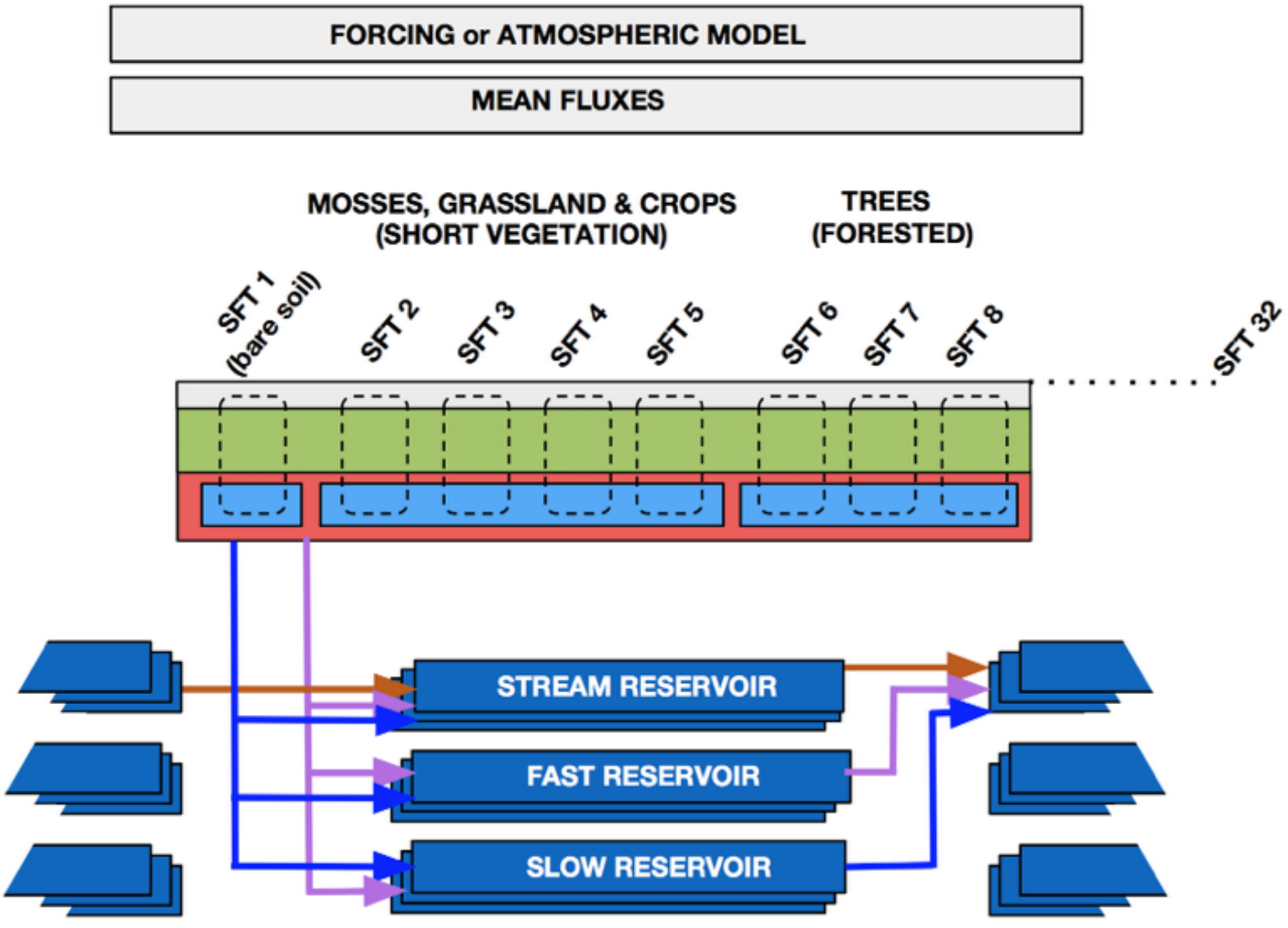
Orchidee tests (30 min averages)



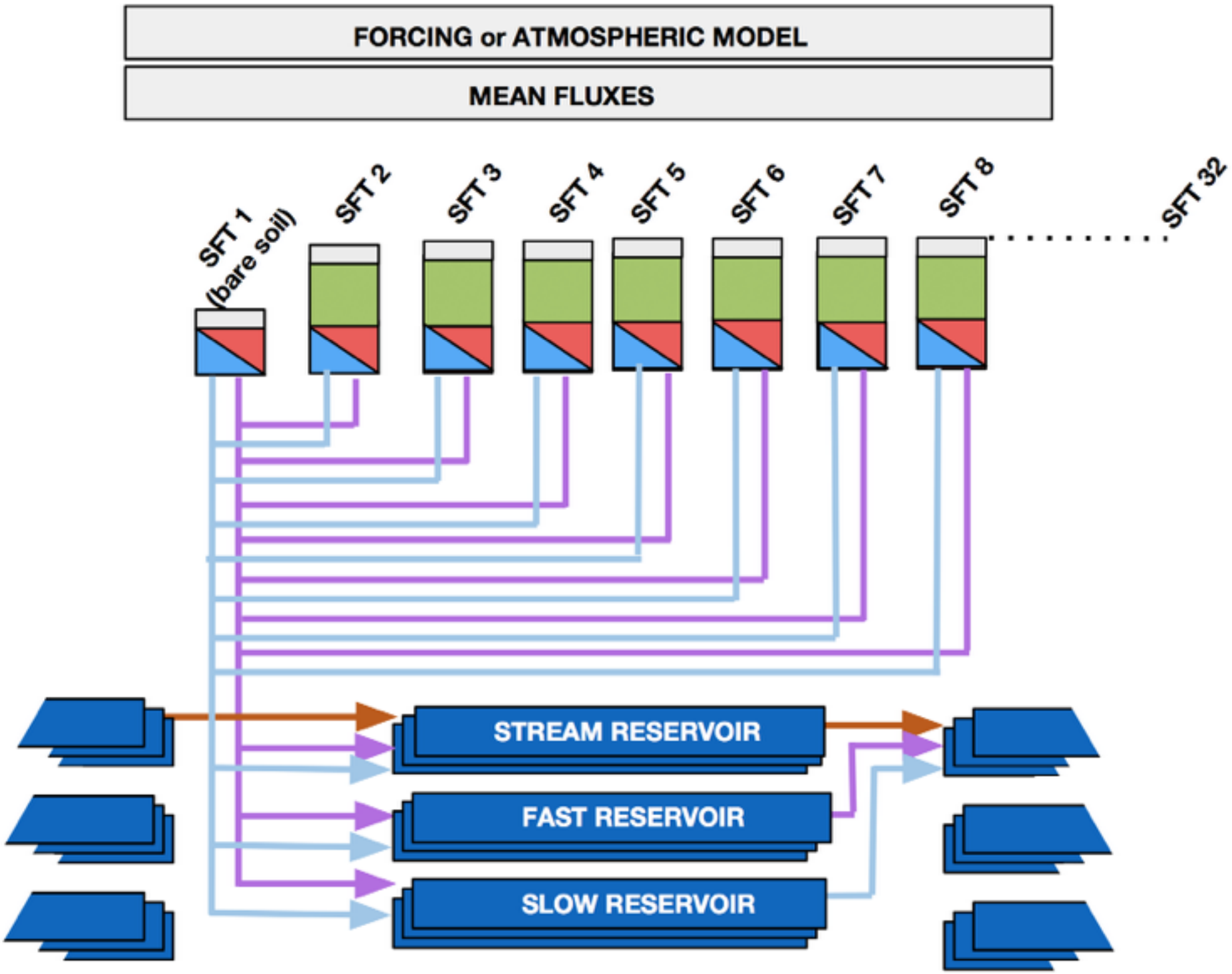
Orchidee tests (daily averages)



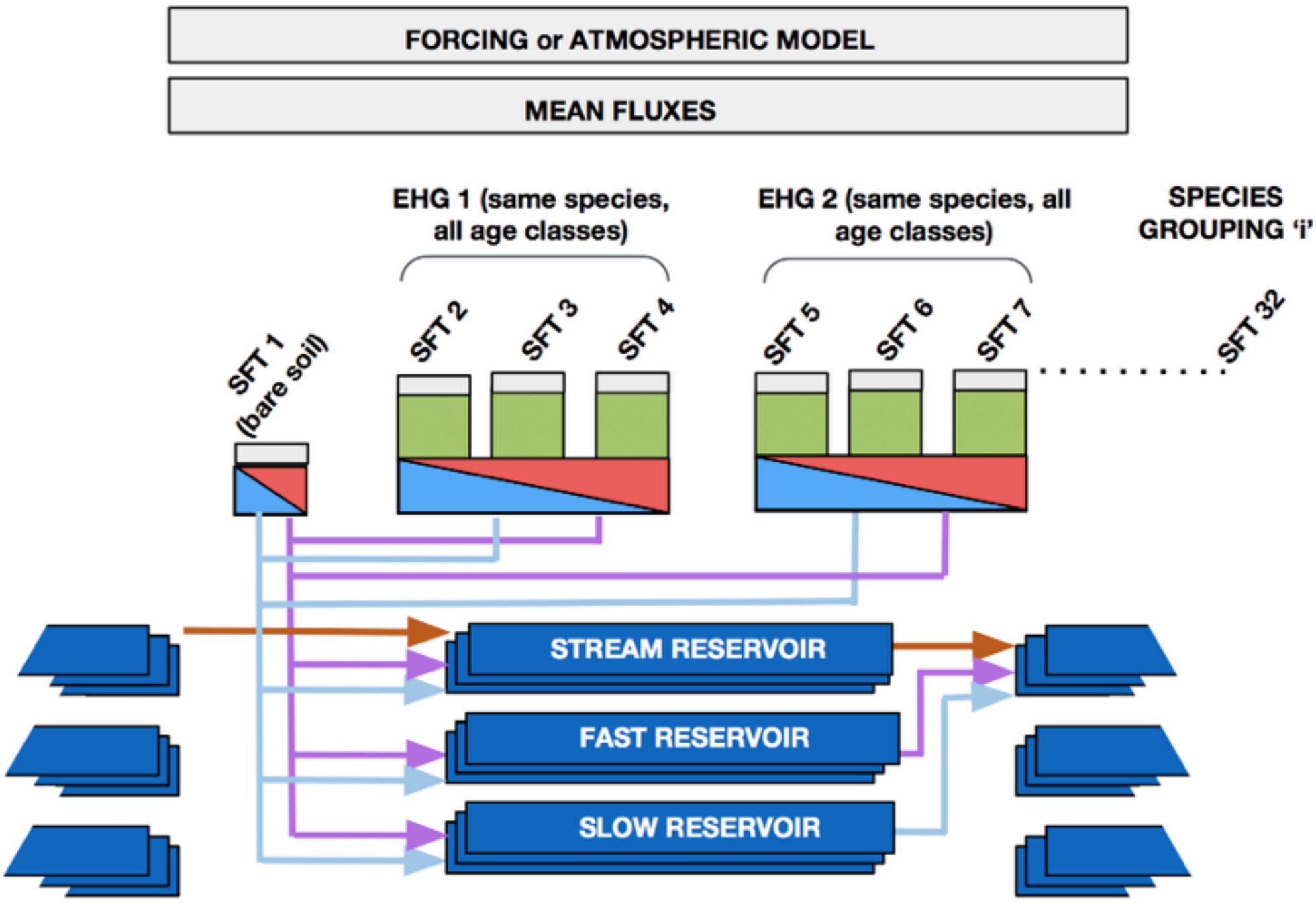
Option A


FORCING or ATMOSPHERIC MODEL
MEAN FLUXES
MOSSES, GRASSLAND & CROPS
(SHORT VEGETATION)
TREES
(FORESTED)
SFT 1
(bare soil)
SFT 2
SFT 3
SFT 4
SFT 5
SFT 6
SFT 7
SFT 8
SFT 32
STREAM RESERVOIR
FAST RESERVOIR
SLOW RESERVOIR

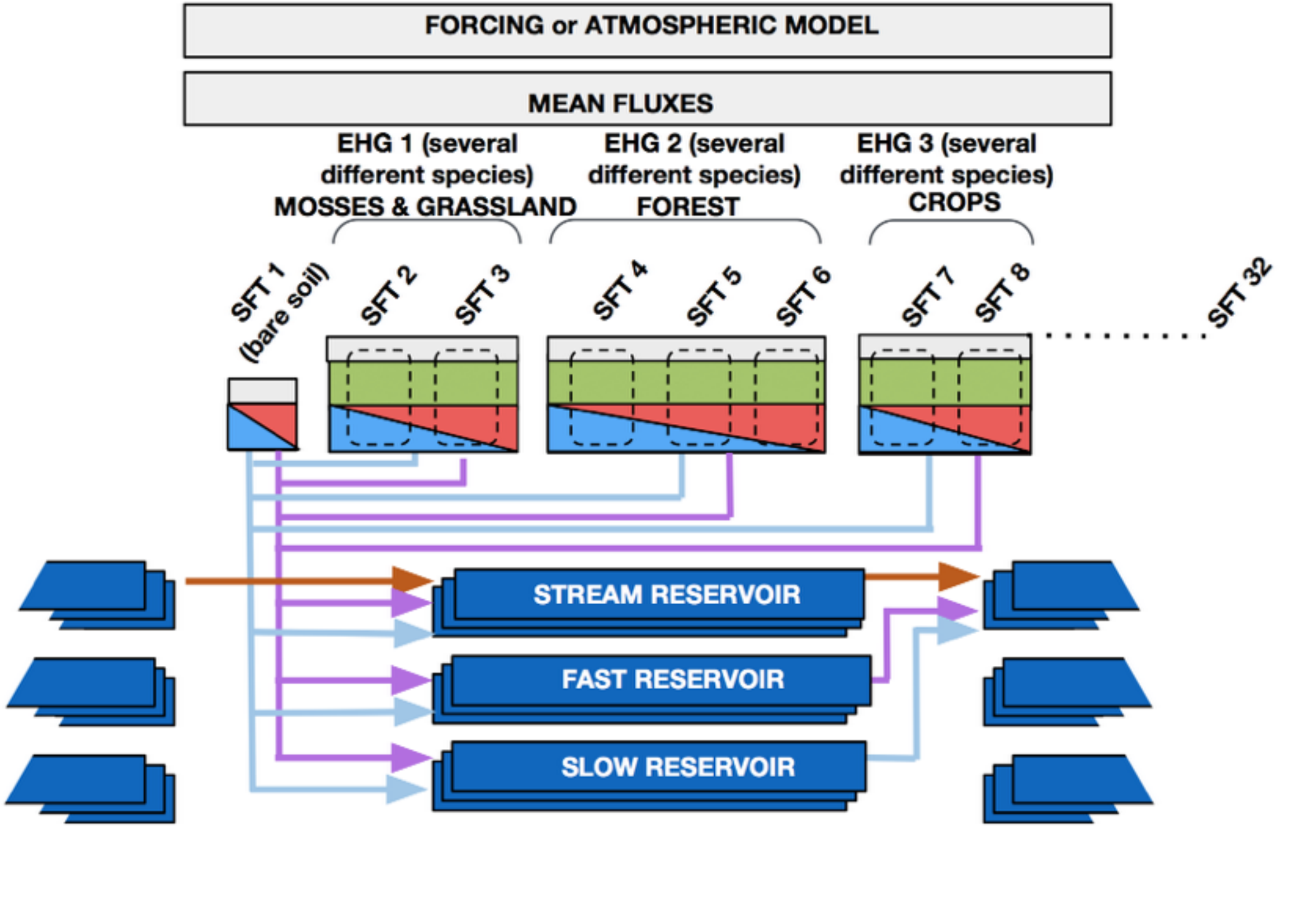
Option B


FORCING or ATMOSPHERIC MODEL
MEAN FLUXES
SFT 1 (bare soil)
SFT 2
SFT 3
SFT 4
SFT 5
SFT 6
SFT 7
SFT 8
SFT 32
STREAM RESERVOIR
FAST RESERVOIR
SLOW RESERVOIR

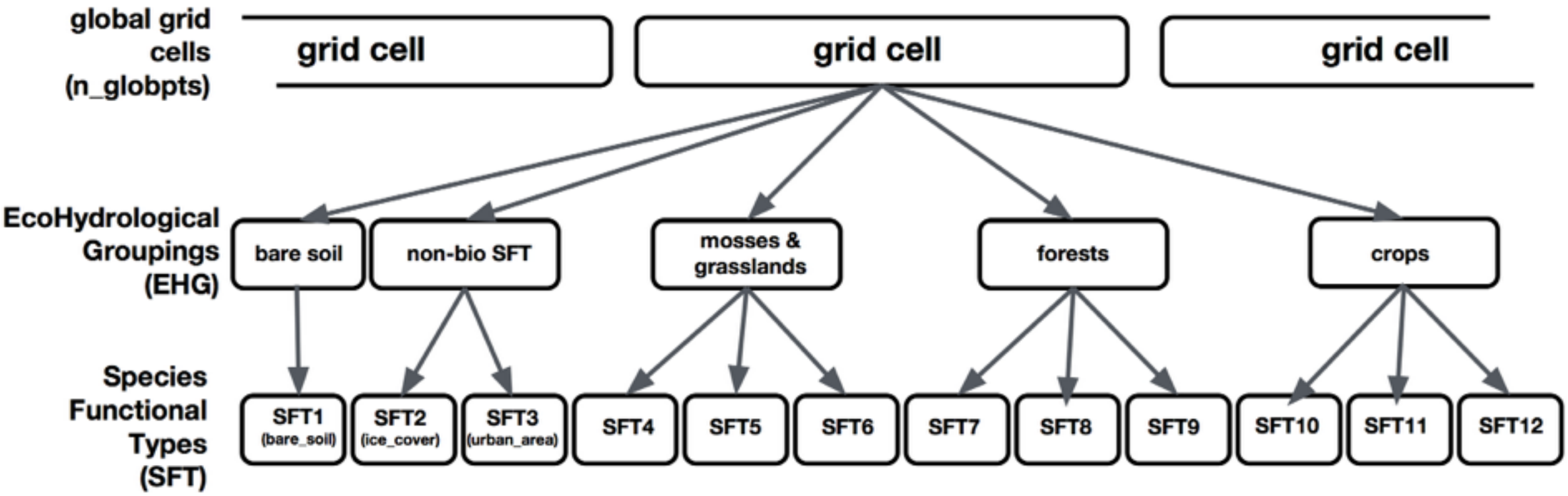
Option C


FORCING or ATMOSPHERIC MODEL
MEAN FLUXES
EHG 1 (same species, all age classes)
EHG 2 (same species, all age classes)
SPECIES GROUPING 'i'
SFT 1 (bare soil)
SFT 2
SFT 3
SFT 4
SFT 5
SFT 6
SFT 7
SFT 32
STREAM RESERVOIR
FAST RESERVOIR
SLOW RESERVOIR

Option D


FORCING or ATMOSPHERIC MODEL
MEAN FLUXES
EHG 1 (several different species) MOSSES & GRASSLAND
EHG 2 (several different species) FOREST
EHG 3 (several different species) CROPS
SFT 1 (bare soil)
SFT 2
SFT 3
SFT 4
SFT 5
SFT 6
SFT 7
SFT 8
SFT 32
STREAM RESERVOIR
FAST RESERVOIR
SLOW RESERVOIR

Surface types hierarchy



General context

- Building the next version of the TRUNK (CM6v2) based on ORC-CAN + CN

- Improve « model structure » for a more flexible combination of PFTs / soil W - E - C / atmospheric columns: necessary for multi-layer canopy implementation

- Prepare the inclusion of new PFTs (i.e. cities, lakes etc.)

Questions / brainstorming

- Is the proposed scheme adapted for all purposes?
- Soil carbon tiles: one soil carbon per SFT ?
- (how to treat gross LCC)
- How to describe « practically » SFT grouping for all grid cells ? (also in case of LCC ?)
- Other combinations of E / W budgets ?

Memory issues for global simulations..

- Current variables: (pts, pfts, ndiam, …)
  - Sparce matrices as « nb pfts highly vary per pixels » (pfts include forest age classes)
  - Possibly too big given that npfts can be large (including age classes)
- Proposition
  - Group « pts » and « pfts » into one dim « ptpfts »
  - (ptpfts, ndiam, …) with Specific functions:
  - ipts = func_pts(iptpfts) ; ipft = func_pft(iptpfts)
  - npft = func_pft2(ipt) ; …
  - Replace loops: « For ipt=1,npts Do ; For ipft=1,npft Do »
  - By « For ipt=1,npts Do ; For ipft=1, func_pft2(ipt) Do »
  - Problem of parallelisation under investigation…

Table 1: *summary of different variables within each grid square of the model*

original name	proposed new name	description	original value (opt. A)	new value (opt. B)	new value (opt. C)	new value (opt. D)
kjpindex	n_globpts	number of grid squares in the model	≥1	≥1	≥1	≥1
nnbio	n_notbio	the number of not-biological scenarios represented by an atmospheric column	1	NNB	NNB	NNB
nvm	n_bio	the number of biological species and size classes within those species, represented by an atmospheric columns	31	NSFT - NNB	NSFT - NNB	32 - NNB
natmos	ncol_enerbil	the total number of atmospheric columns that are used, in the case of option 3, above, (natmos = nnobio + nvm), and where columns are amalgamated	1	NSFT	NSFT	NEHG
nsnowcol	ncol_snow	number of snow columns that are simulated, which for simplicity are set to natmos	1	NSFT	NSFT	NEHG
nbcol	ncol_heatsoil	number of thermal columns in the soil (‘number of soil tiles’)	1	NSFT	NEHG + 1	NEHG
nstm	ncol_hydlsoil	number of hydrological columns in the soil	3	NSFT	NEHG + 1	NEHG
nbasmax	nbasin_max	maximum number of water basins in the scheme (‘the maximum number of basins we wish to have per grid box - truncation of the model’)	5	5	5	5

n.b.
NNB: Number of not-biological surface (i.e. bare soil, urban cover, lakes);
NEHG: Number of Ecohydrological Groupings;
NSFT: Number of surface functional types.
(We assume a ‘cap’ of 32 NSFT but following the externalisation in 2011 this number is now unlimited.