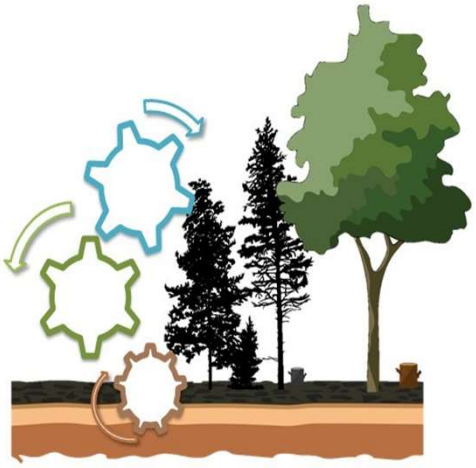
3D-CMCC-FEM



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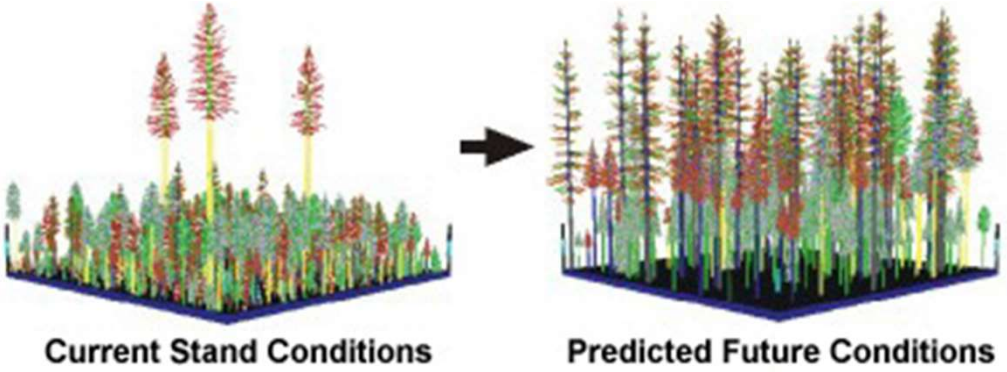
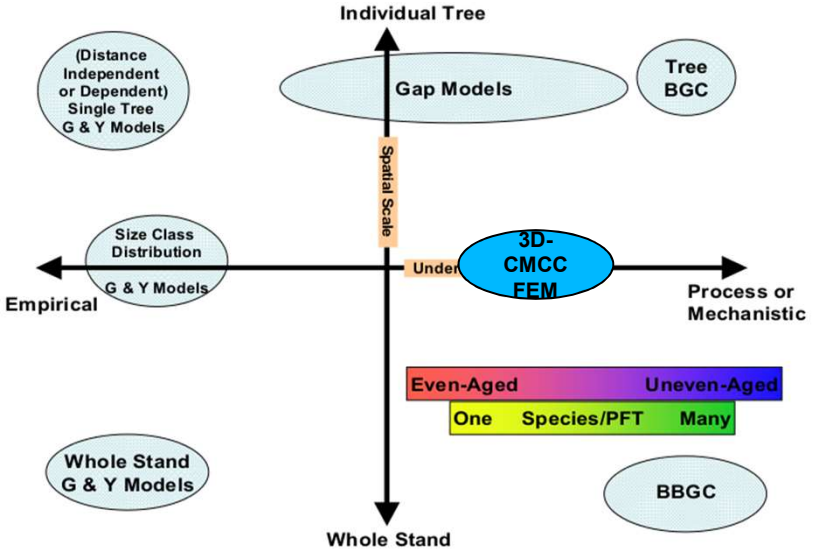
3D-CMCC-FEM v5.5 main characteristics and applicability



- Simulate **stand growth and development** under current and future environmental conditions
- **Bio-chemical, Bio-physical, Process-Based Model**
- Couple the **Process-Based** models' **robustness** of the layer and cohort models
- Variable **temporal** scale(daily to annual)
- Variable **spatial** scale (1ha to *x* Km^2)
- Management (thinning, harvest, replanting)



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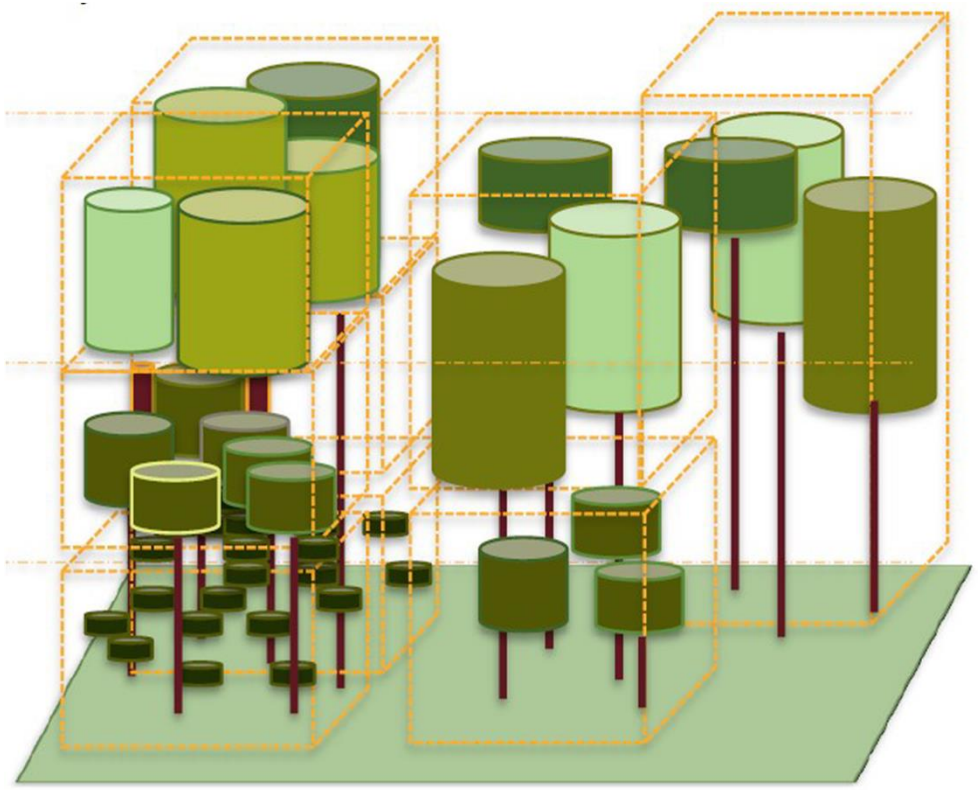
3D-CMCC-FEM forest structure:



- Consider the canopy **horizontal** cell coverage trough algorithms that take into account the **forest density** (trees/ha)
- Can simulates a **mixed** forest composed by different cohorts, species, diameter and **height classes** as simultaneously composed by evergreen/deciduous species (note: currently naturally changes in species composition is not simulated)
- Compute and quantify the effects of this **heterogeneity** also into the daily soil water balance (i.e. evapotranspiration, soil evaporation or rain interception)

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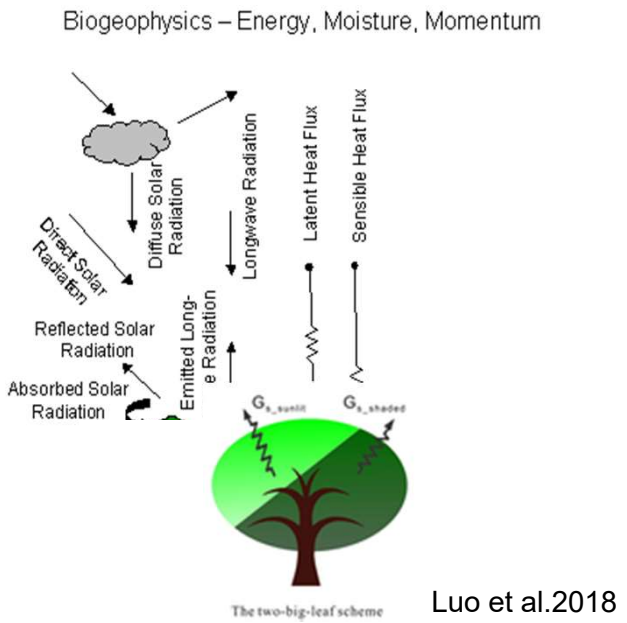
3D-CMCC-FEM Biophysical processes:

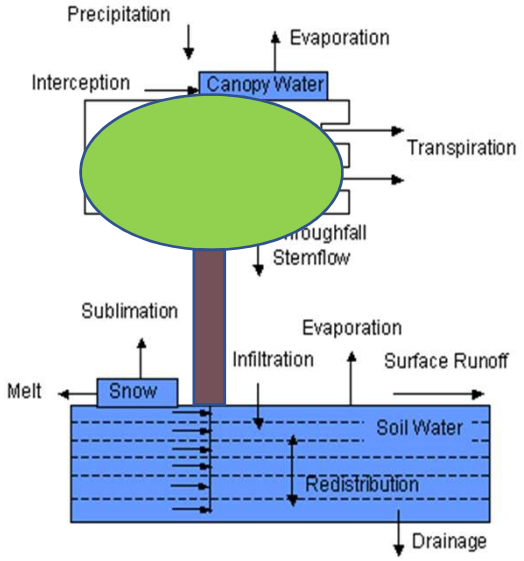
- SURFACE ALBEDOS
- RADIATIVE TRANSFER
- SENSIBLE HEAT AND LATENT HEAT FLUXES
- SOIL AND SNOW TEMPERATURE



Luo et al.2018

3D-CMCC-FEM Hydrological processes:

- CANOPY TRANSPIRATION
- CANOPY INTERCEPTION
- SOIL EVAPORATION
- SNOW
- SURFACE RUNOFF AND INFILTRATION
- SOIL WATER CONTENT



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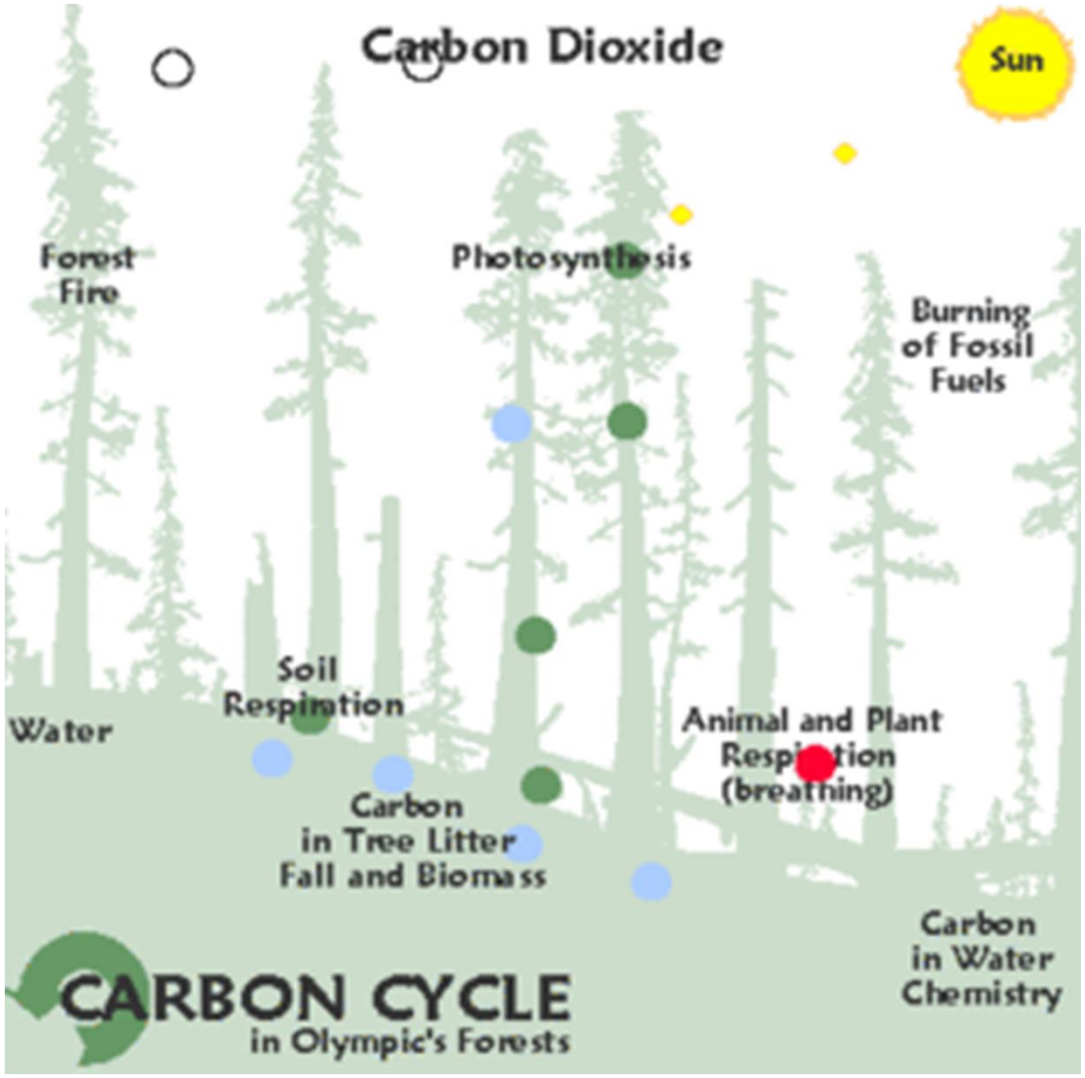
3D-CMCC-FEM Biochemical processes:

- CANOPY PHOTOSYNTHESIS
- AUTOTROPHIC RESPIRATION
- C ALLOCATION
- PHENOLOGY
- VEGETATION STRUCTURE
- LITTERFALL



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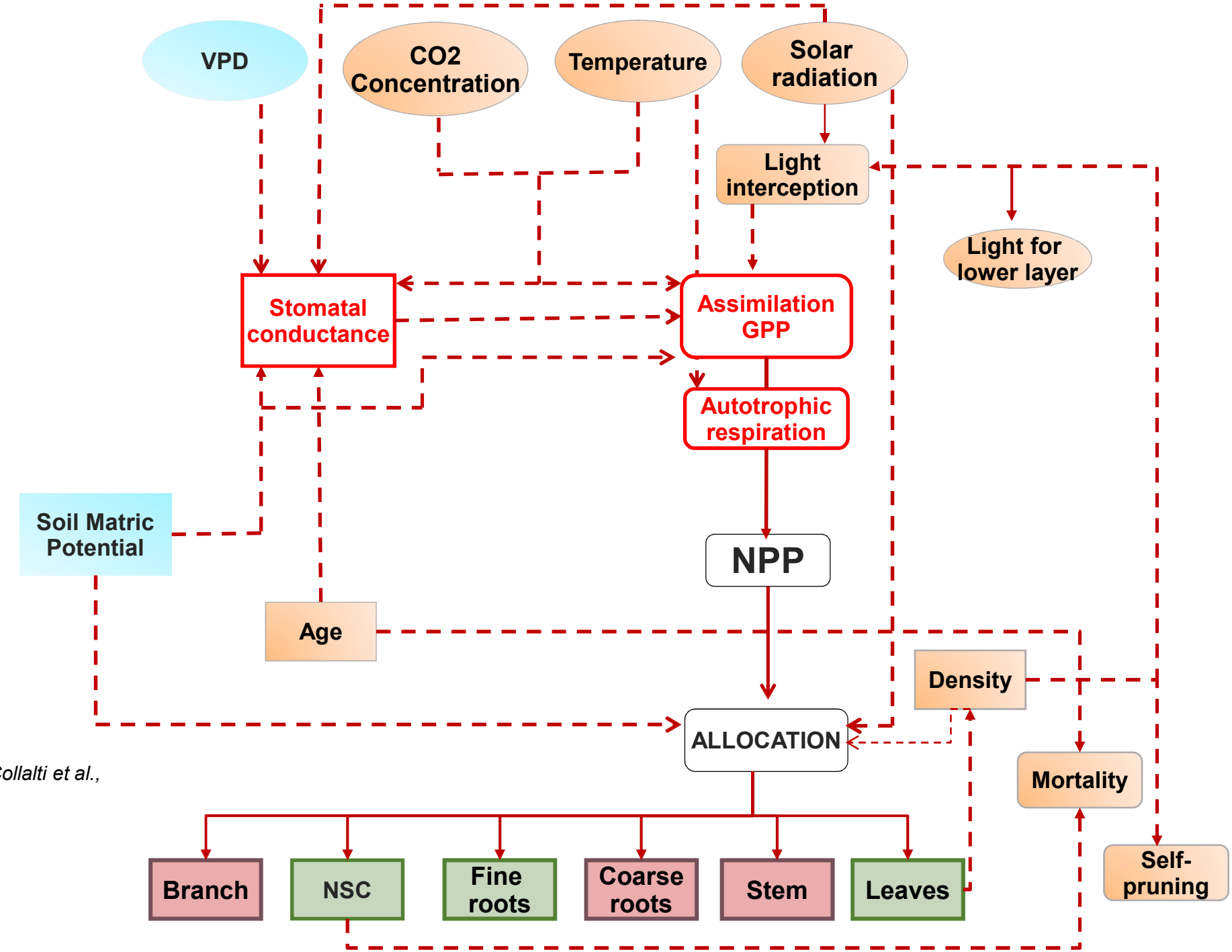
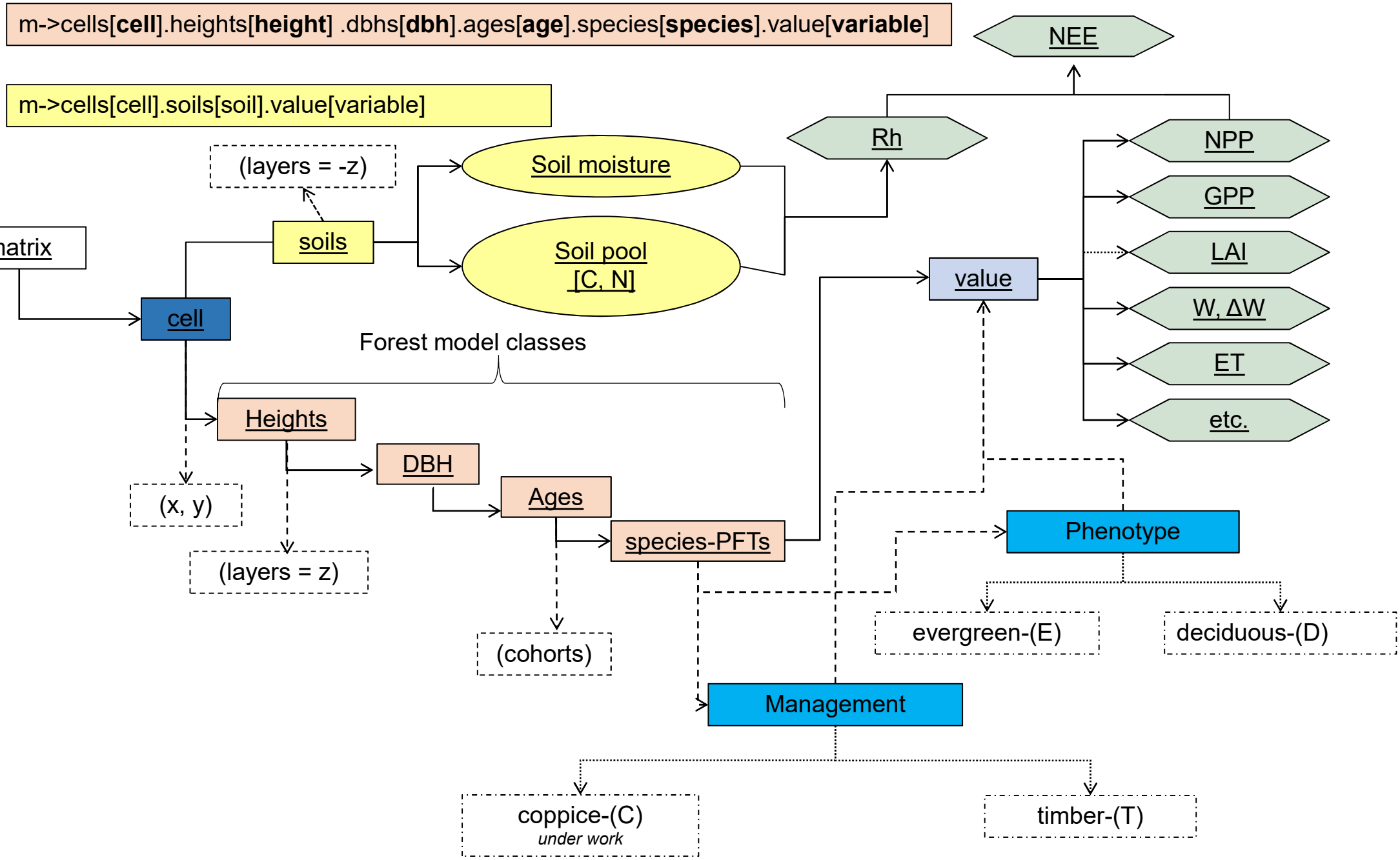
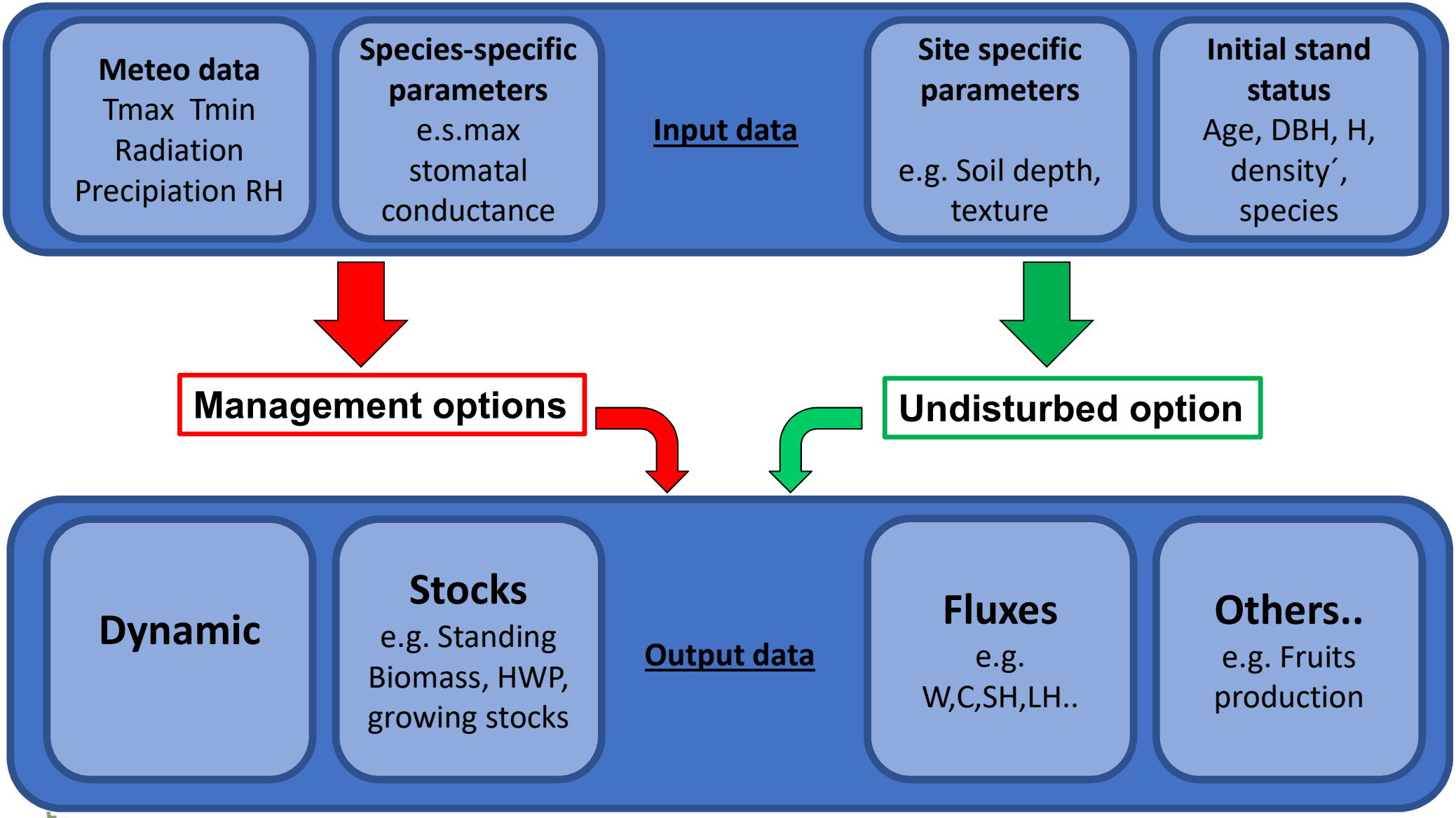


Adapted from *Collalti et al., 2016*

Model's C core logic structure



Input/output model data and simulation options



Currently output provided as .txt files

```
Year,x,y,Age,Species,Management,N,Stool,AvDBH,Height
1950,0,0,29,Fagussylvatica,T,1326,0,5.961357466,8.814479638
```

Stand data for model initialization

```
X,Y,LANDUSE,LAT,LON,CLAY_PERC,SILT_PERC,SAND_PERC,SOIL_DEPTH,FR,FN0,FNN,M0,LITTERC
0,0,F,55.29,11.38,15.33,21.59,63.08,180,0.90,0.5,0.5,0.2,-9999,-9999,-9999,-9999,-9
```

Climate forcing data

Year	Month	n_days	Rg_f	Ta_f	Tmax	Tmin	RH_f	Ts_f	Precip	SWC	LAI	ET	WS_f		
1996	1	1	1.011096		-3.6090625	-3.302	-4.086	93.6399526015545			-9999	1.332	-9999	-9	
1996	1	2	1.0734138		-3.33170833333333		-2.63	-3.723	90.3779847933055			-9999	1.13	-9	
1996	1	3	1.4199408		-5.3066875	-3.492	-6.291	99.2751001746145			-9999	0.032	-9999	-9	
1996	1	4	1.5142032		-6.81502083333333		-6.18	-7.298	99.7222269427755			-9999	0	-9	
1996	1	5	1.3848732		-4.58025	-2.718	-6.599	98.1872053425175			-9999	0.291	-9999	-9	
1996	1	6	1.2437874		-2.4601875	-1.469	-2.993	95.4609050296131			-9999	1.118	-9999	-9	
1996	1	7	0.6736788		-1.724375	1.154	-3.356	94.7818497205114			-9999	2.373	-9999	-9	
1996	1	8	1.583577		0.2525625	1.565	-0.911	100	-9999	0.906	-9999	-9999	-9999	3	
1996	1	9	0.8853246		-0.0287708333333333		0.503	-0.553	100	-9999	0.474	-9999	-9999	-9	
1996	1	10	0.5837922		-0.628541666666667		0.331	-1.098	100	-9999	0.804	-9999	-9999	-9	
1996	1	11	0.8660754		-0.554208333333333		-0.068	-0.967	100	-9999	1.092	-9999	-9999	-9	
1996	1	12	0.6812334		0.178541666666667		0.731	-0.333	99.9784985124904			-9999	0.969	-9	
1996	1	13	1.8782874		0.993979166666667		2.341	-0.122	99.6951326527565			-9999	0.833	-9	
1996	1	14	1.6573896		-0.561520833333333		1.371	-1.415	100	-9999	0.295	-9999	-9999	-9	
1996	1	15	1.2636	-2.43466666666667		-1.468	-2.884	100	-9999	0.545	-9999	-9999	-9999	4	
1996	1	16	1.0278684		-2.7741875	-2.341	-3.236	100	-9999	0.522	-9999	-9999	-9999	2	
1996	1	17	0.6174108		-2.30297916666667		-2.059	-2.661	100	-9999	0.4	-9999	-9999	-9	
1996	1	18	1.1812914		-2.01714583333333		-1.443	-2.544	100	-9999	0.515	-9999	-9999	-9	
1996	1	19	1.3088088		-1.6066875	-0.724	-2.72	100	-9999	0.786	-9999	-9999	-9999	4	
1996	1	20	2.2823964		-2.5606875	-1.34	-3.6	90.4072451907435			-9999	0.728	-9999	-9	
1996	1	21	2.1834018		-2.7654375	-2.265	-3.224	86.5034915790072			-9999	0.637	-9999	-9	
1996	1	22	2.281104		-3.4424375	-2.481	-4.566	90.1515955744099			-9999	0.753	-9999	-9	
1996	1	23	2.3972112		-5.20008333333333		-4.615	-5.805	94.265959601704	-9999	0.796	-9999	-9		
1996	1	24	2.3097006		-5.1308125	-4.634	-5.77	94.0612062814829			-9999	0.89	-9999	-9	
1996	1	25	2.2666446		-4.96322916666667		-4.443	-5.717	85.415256828771	-9999	2.428	-9999	-9		
1996	1	26	2.4256368		-4.83754166666667		-3.634	-6.285	85.3798298986317			-9999	1.974	-9	
1996	1	27	3.5293662		-4.07264583333333		-3.344	-5.031	89.2121215009884			-9999	0.256	-9	
1996	1	28	3.7351908		-6.22558333333333		-5.098	-7.232	100	-9999	0	-9999	-9999	-9	
1996	1	29	3.573513		-5.64322916666667		-4.296	-7.248	100	-9999	0	-9999	-9999	-9	
1996	1	30	2.7856098		-4.23422916666667		-3.258	-4.93	100	-9999	0.199	-9999	-9999	-9	
1996	1	31	2.8225296		-5.12995833333333		-4.656	-5.515	98.2368807949429			-9999	0.293	-9	
1996	2	1	3.913029		-6.17510416666667		-5.163	-7.516	99.8886247872708			-9999	0.048	-9	
1996	2	2	2.6451648		-6.82460416666667		-5.346	-7.825	99.8809831068128			-9999	0.47	-9	

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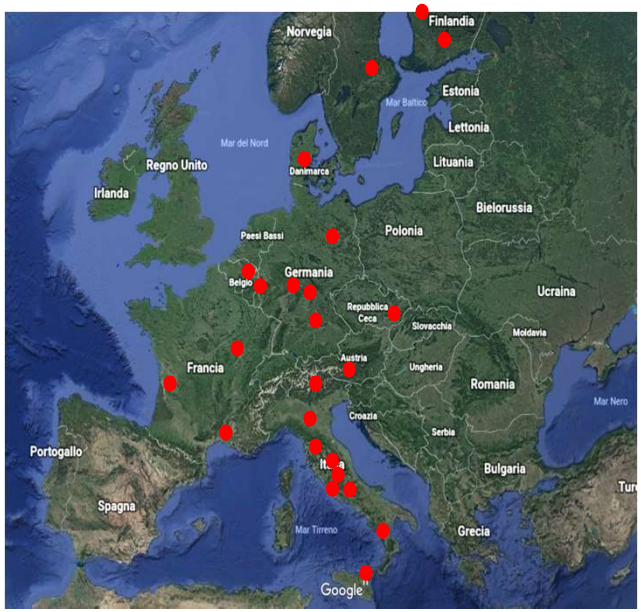
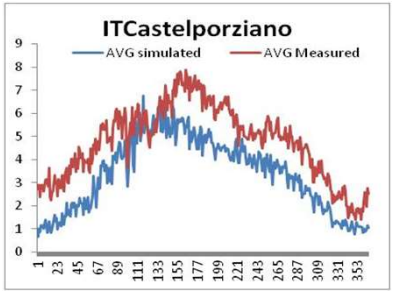
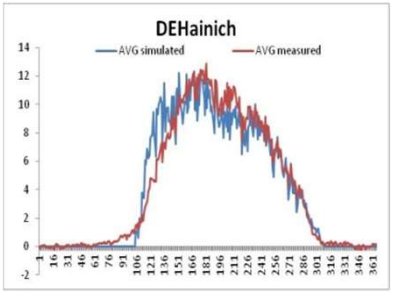
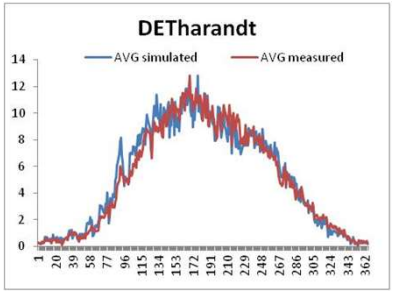
(*3D-CMCC-FEM model input*)

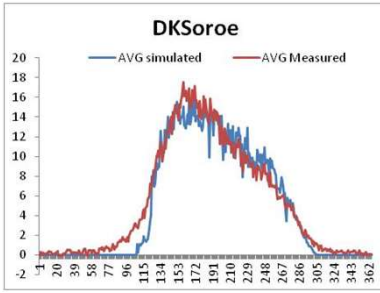
Simulated GPP vs GPP- Eddy Covariance data

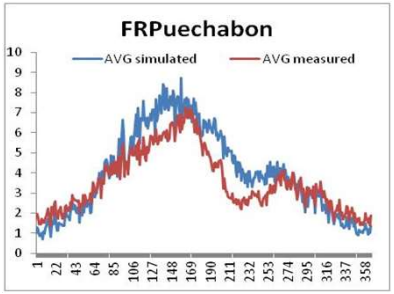


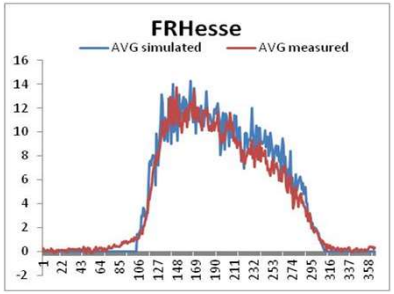


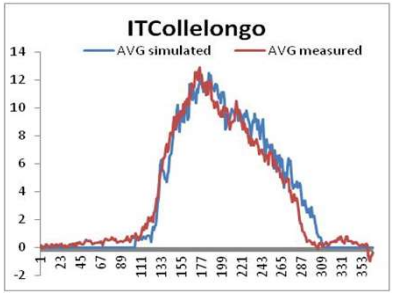


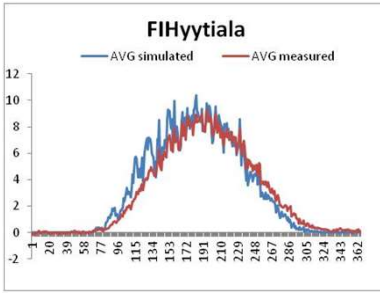






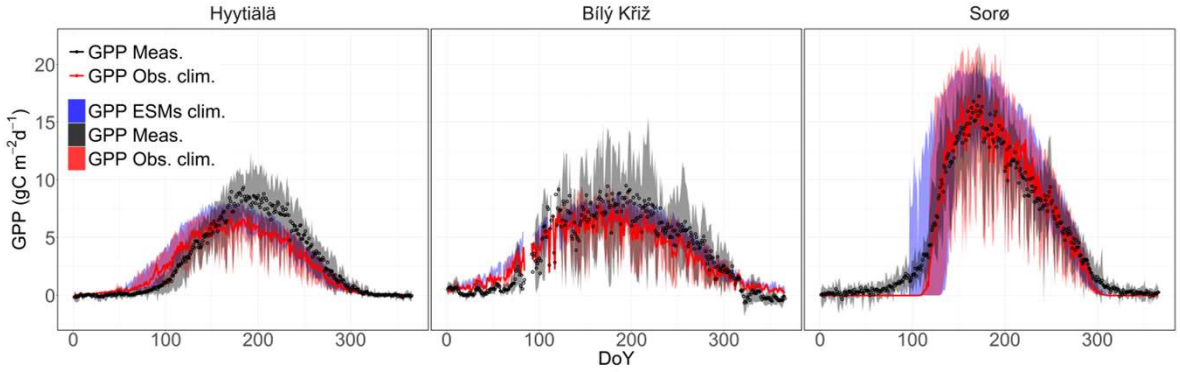


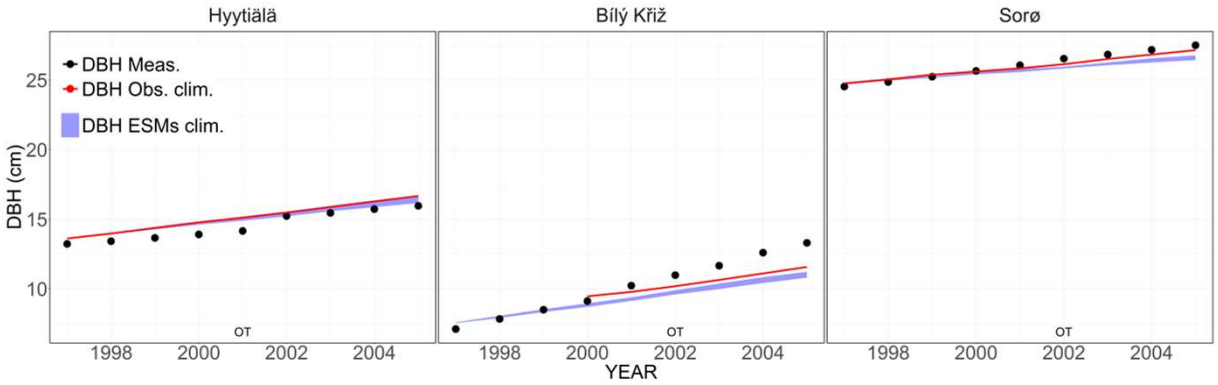




Collalti et al.2016

Simulated GPP vs GPP- Eddy Covariance data
Simulated DBH vs measured DBH





Collalti et al. in preparation

NPP UNDER CLIMATE CHANGE AND MANAGEMENT

Baseline (no CC)

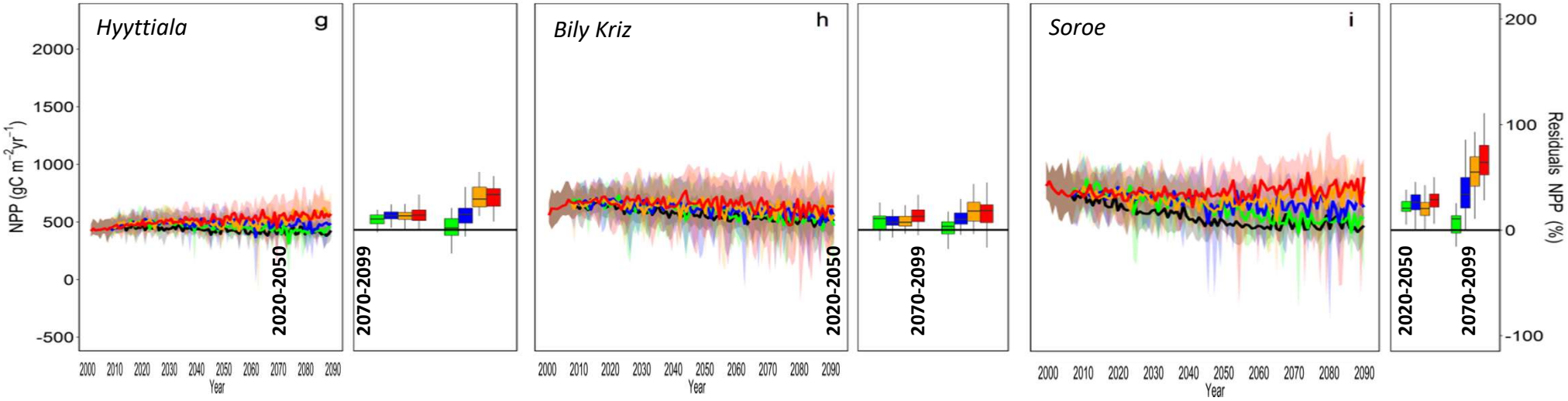
RCP2.6

RCP4.5

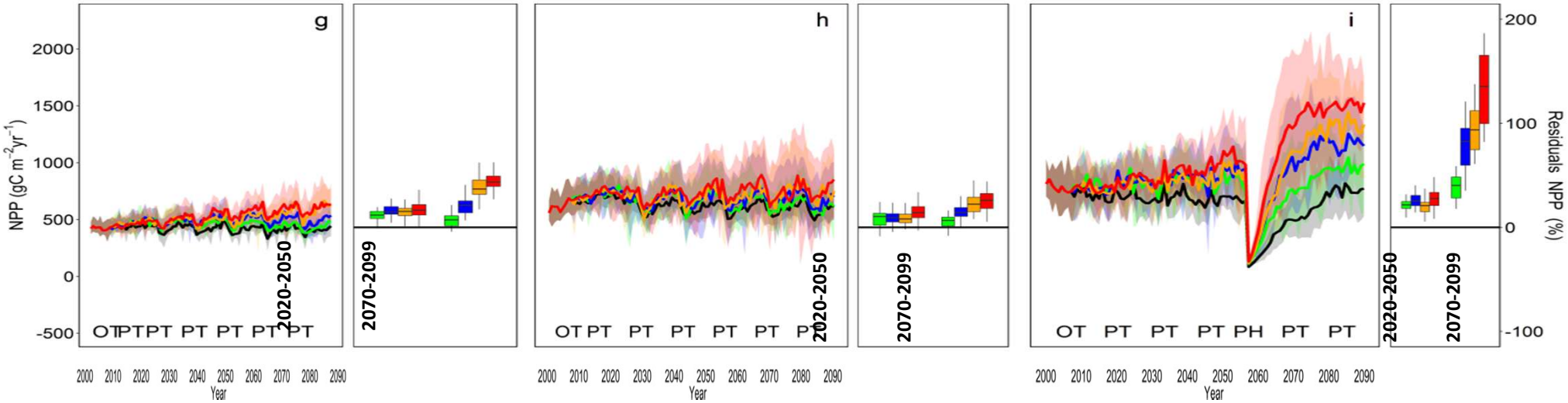
RCP6.0

RCP8.5

NO MANAGEMENT



MANAGEMENT

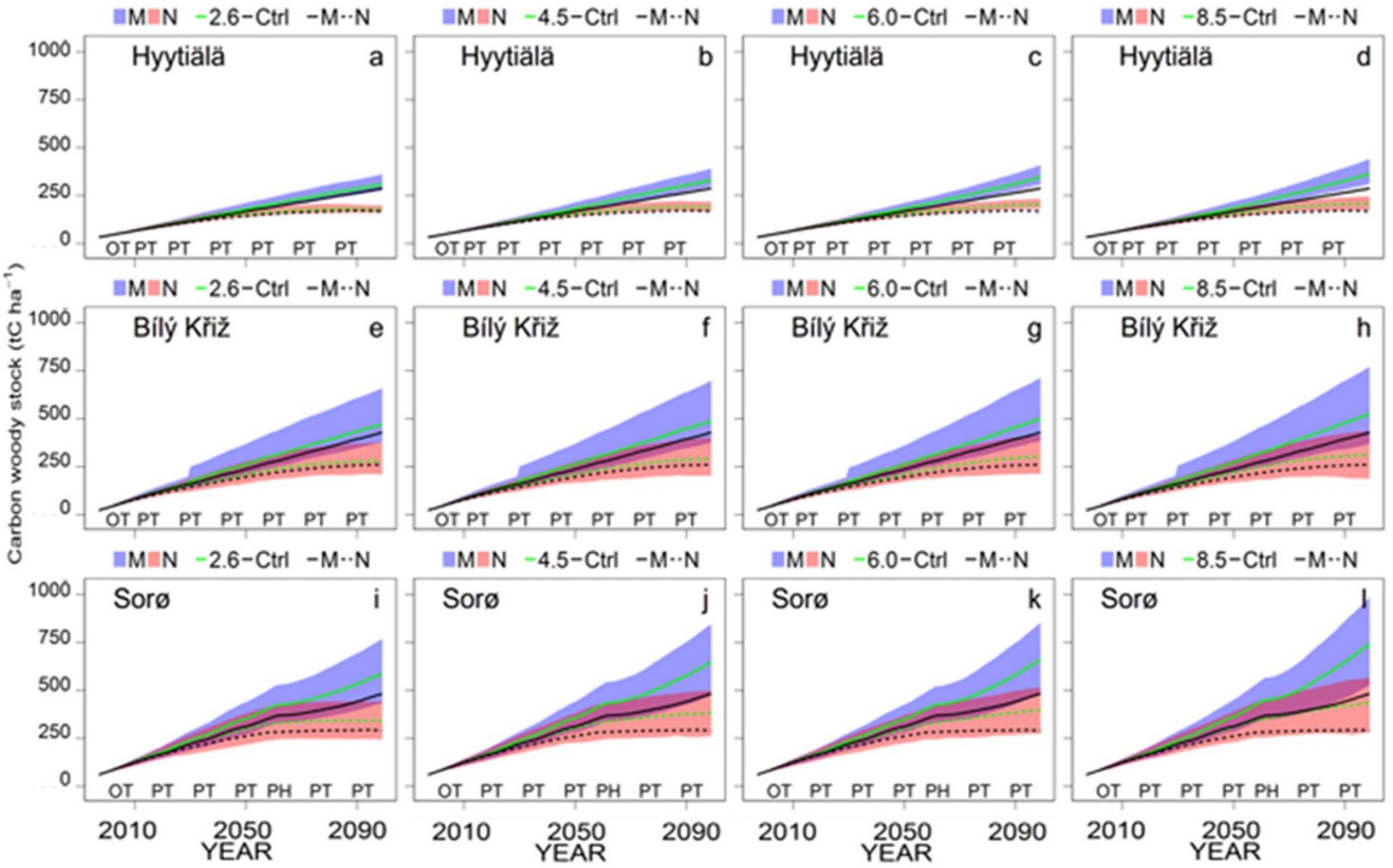


OT = observed thinning, PT = prescribed thinning, PH = prescribed harvesting

(Collalti *et al.*, 2018)

MANAGEMENT VS. NO MANAGEMENT UNDER CLIMATE CHANGE

CARBON WOODY STOCKS



UnManaged

Managed

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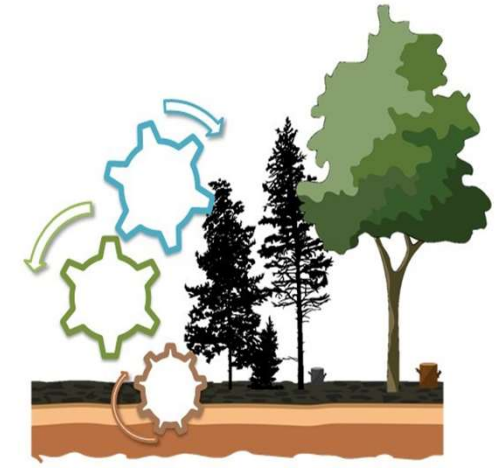
(Collalti *et al.*, 2018)

GRAZIE PER L'ATTENZIONE!



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