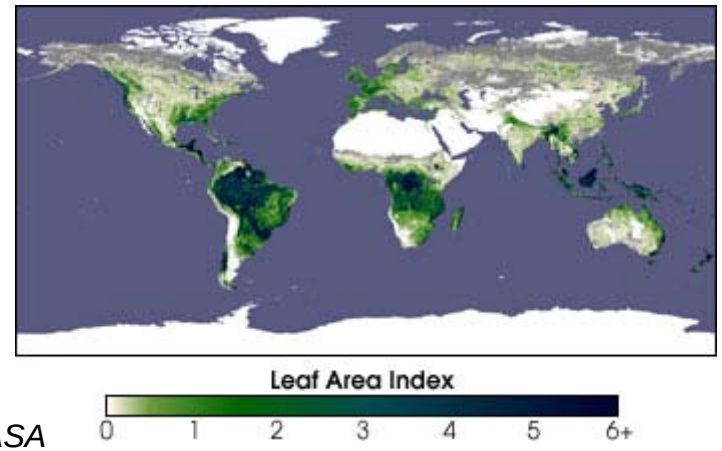
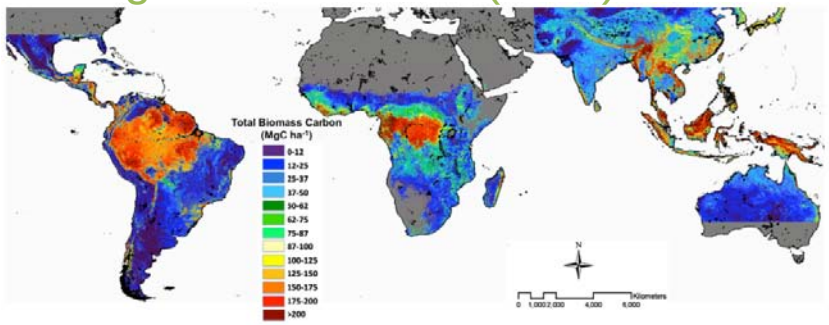
Simple models of the global carbon balance: a data-driven approach to compare with LSMs

MODIS Leaf Area Index (LAI)



NASA

Above-ground Biomass (AGB)



Saatchi et al. 2011

How can we constrain regional C flux estimates using satellite observations of the terrestrial C cycle?

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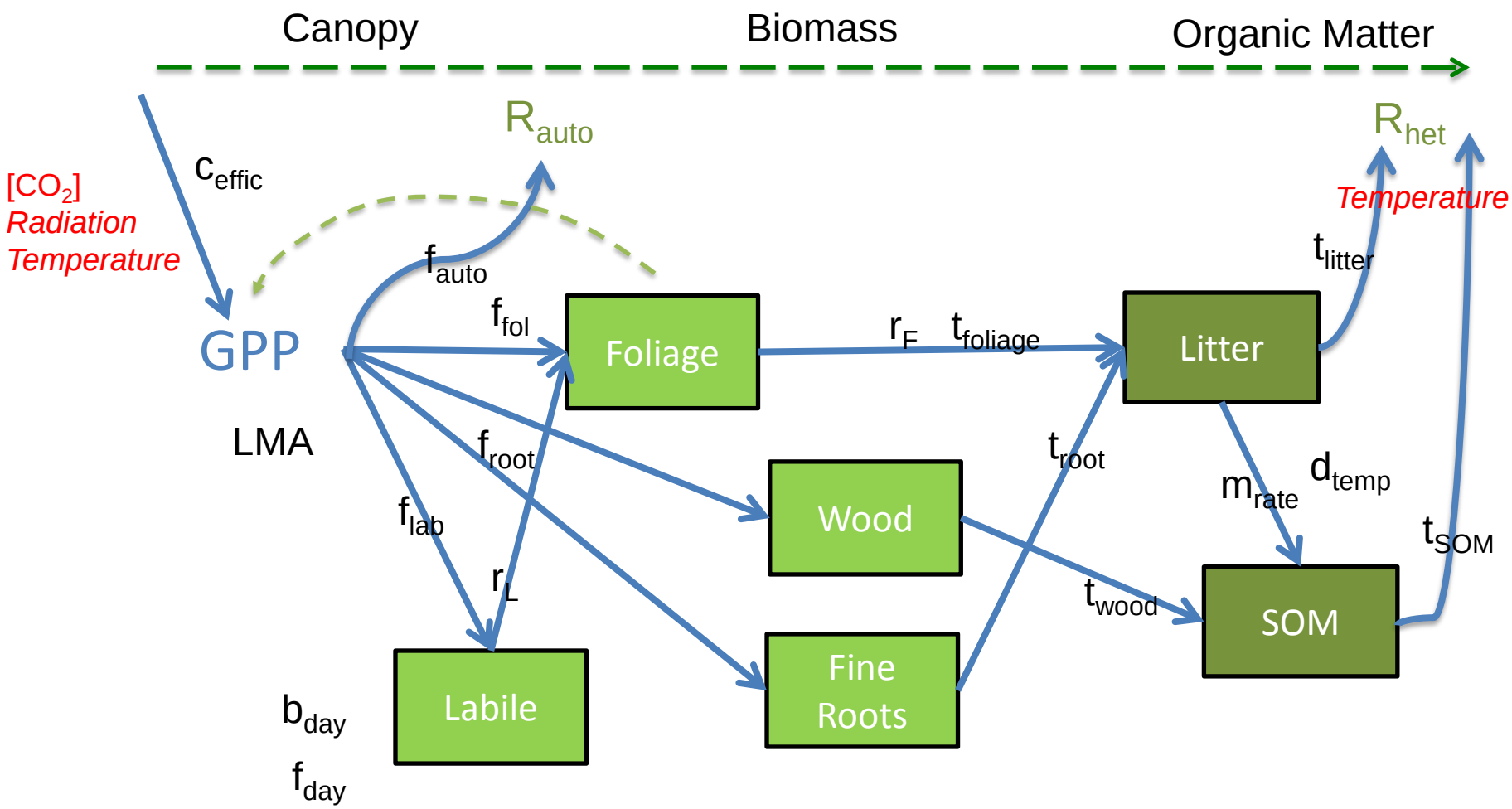
Mat Williams & Anthony Bloom

THE UNIVERSITY OF EDINBURGH

Data Assimilation Linked Ecosystem Carbon (DALEC) model



Model Data Fusion (MDF)

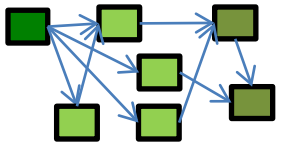
$$p(x|c) \propto p(c|x)\, p(x)$$

Posterior parameter probability

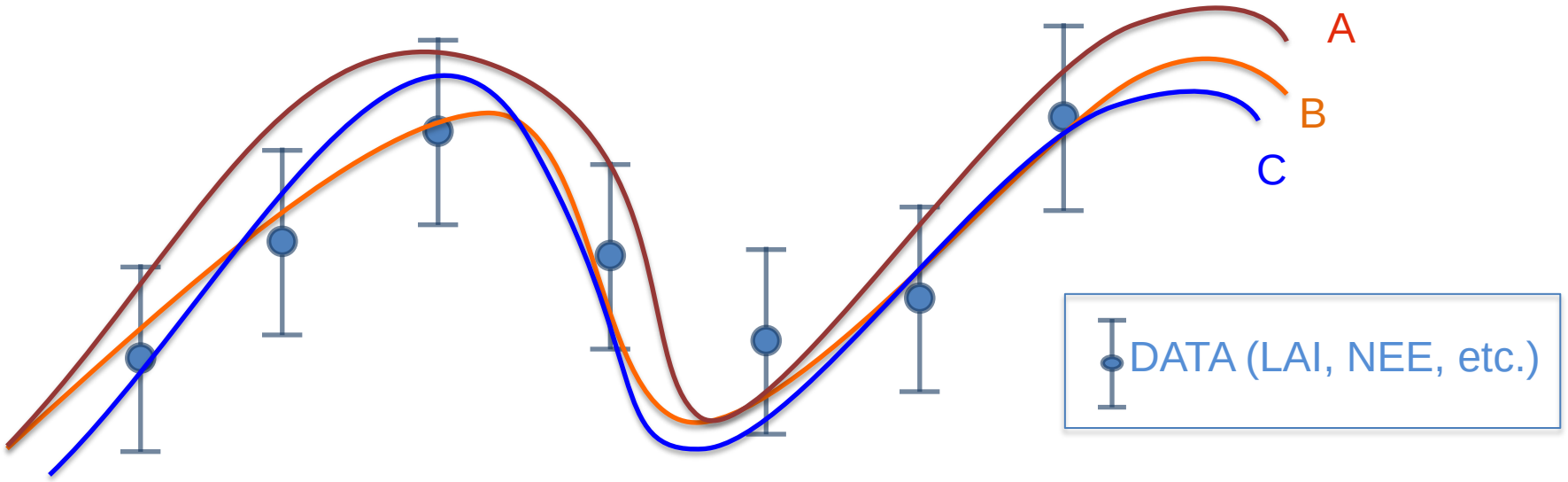
Observation likelihood, given parameters

Prior Parameter Probability

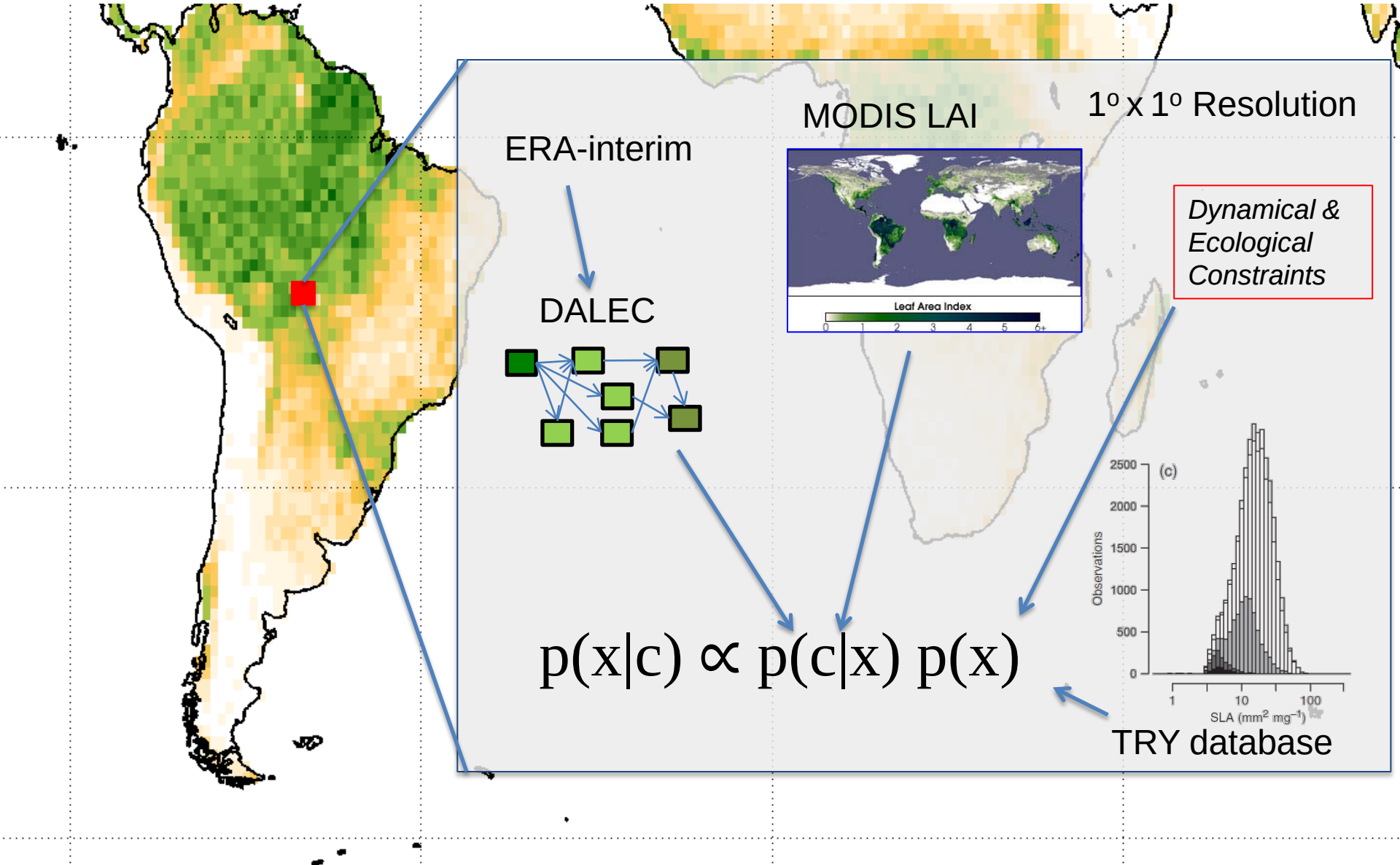
A. $p_1, p_2, \ldots, p_{23}$
B. $p_1, p_2, \ldots, p_{23}$
C. $p_1, p_2, \ldots, p_{23}$



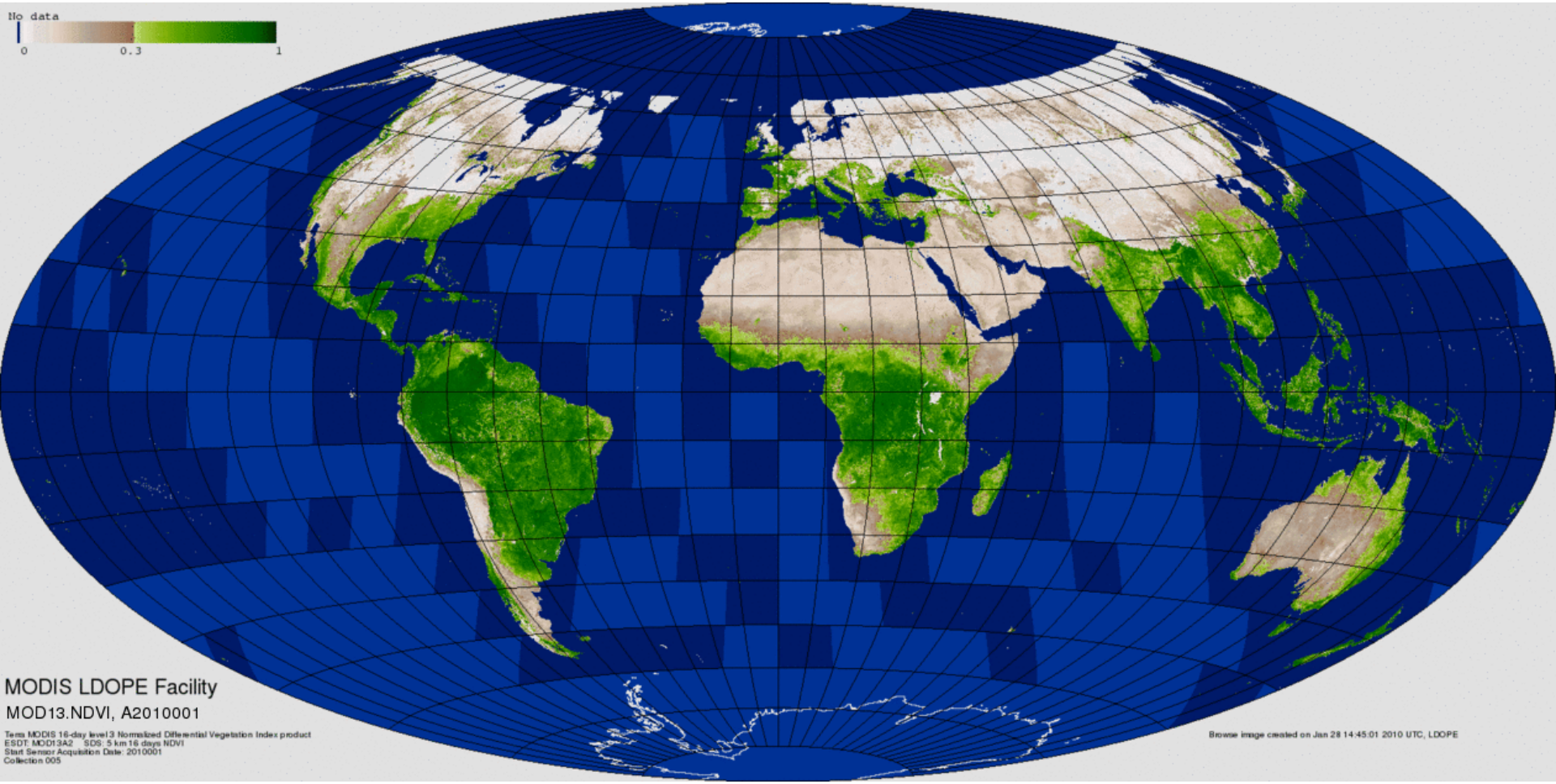
DALEC



Global Implementation

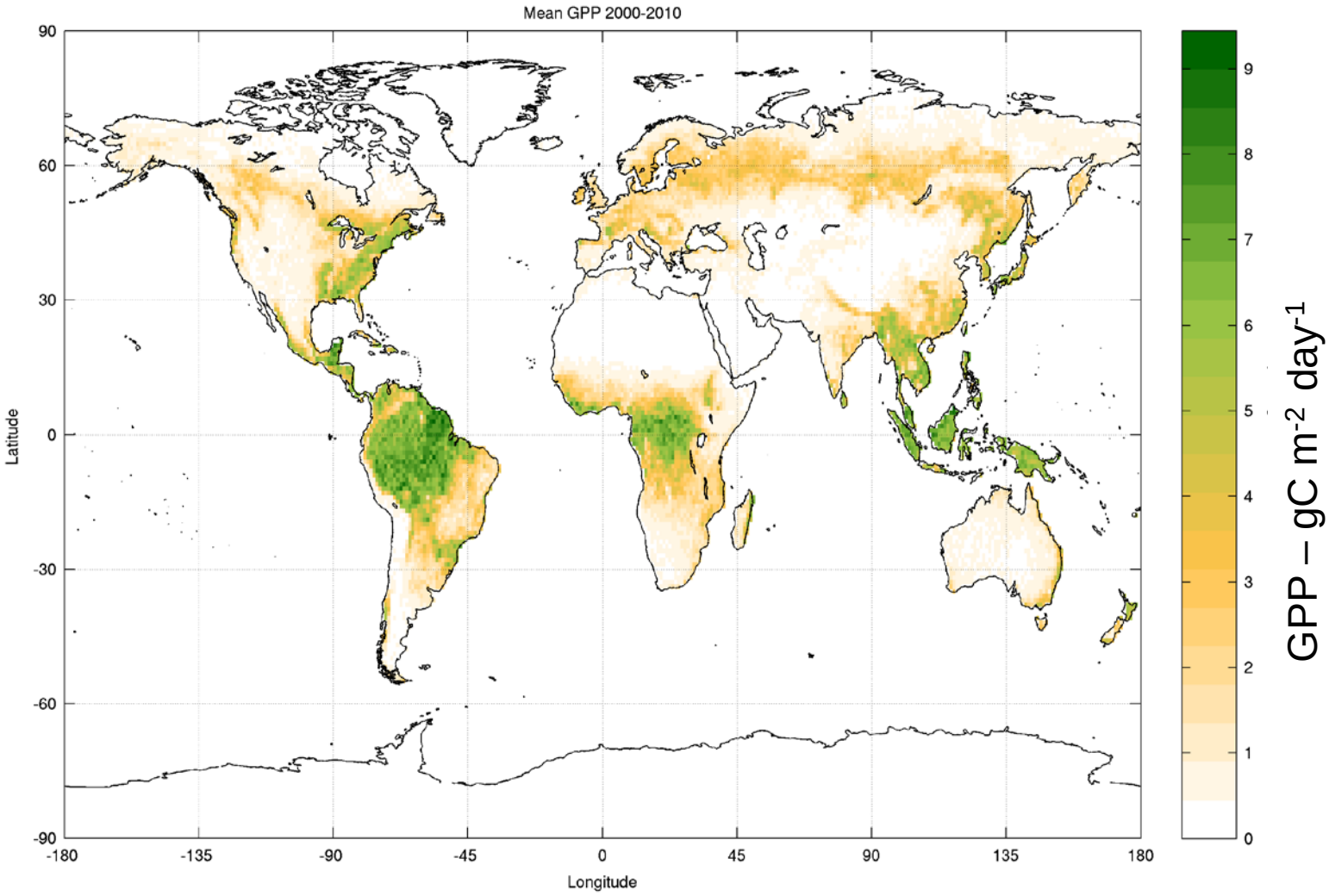


MODIS LAI time series



NASA GSFC

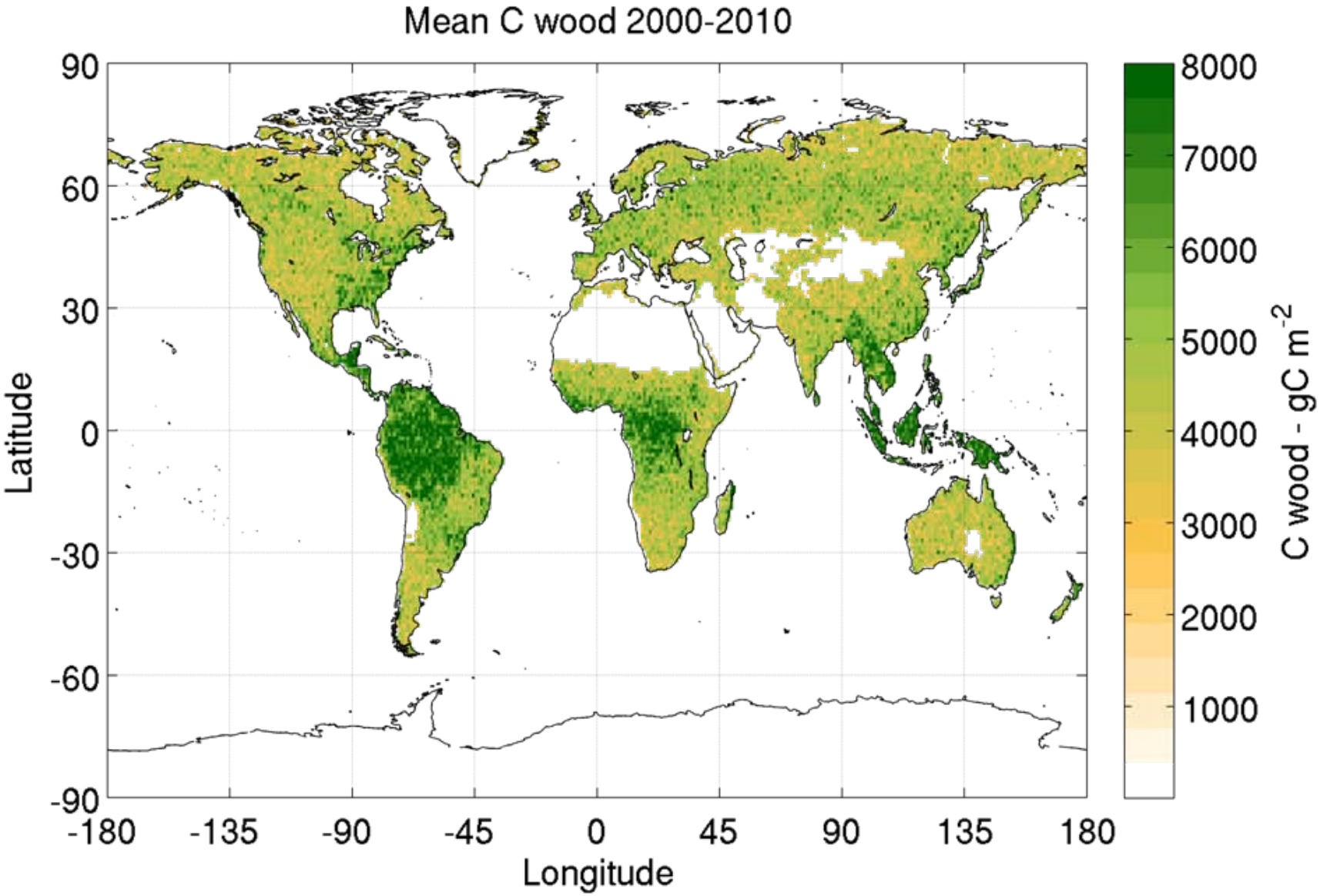
DALEC - GPP 2001-2010



1º x 1º resolution

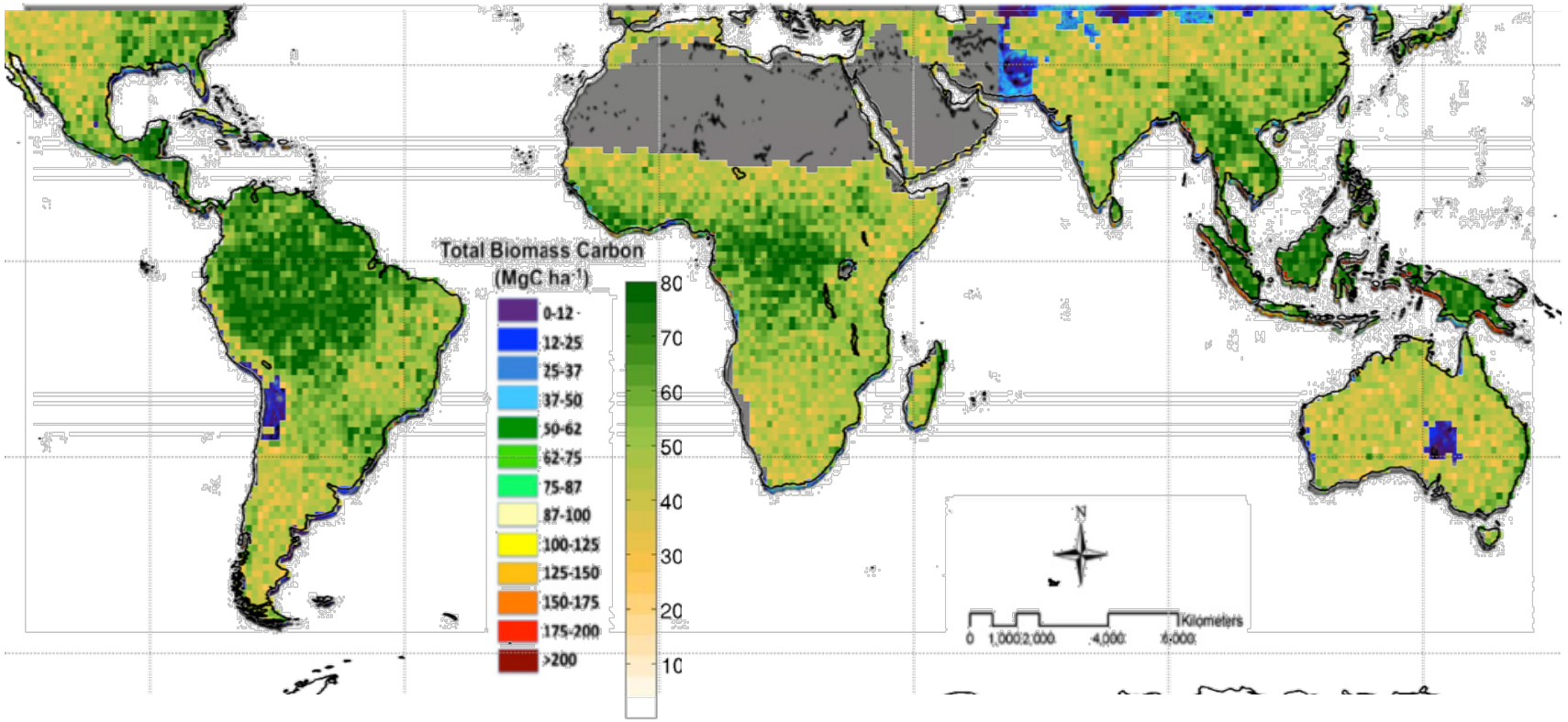
GPP total = 93 PgC yr^{-1}

Aboveground Biomass



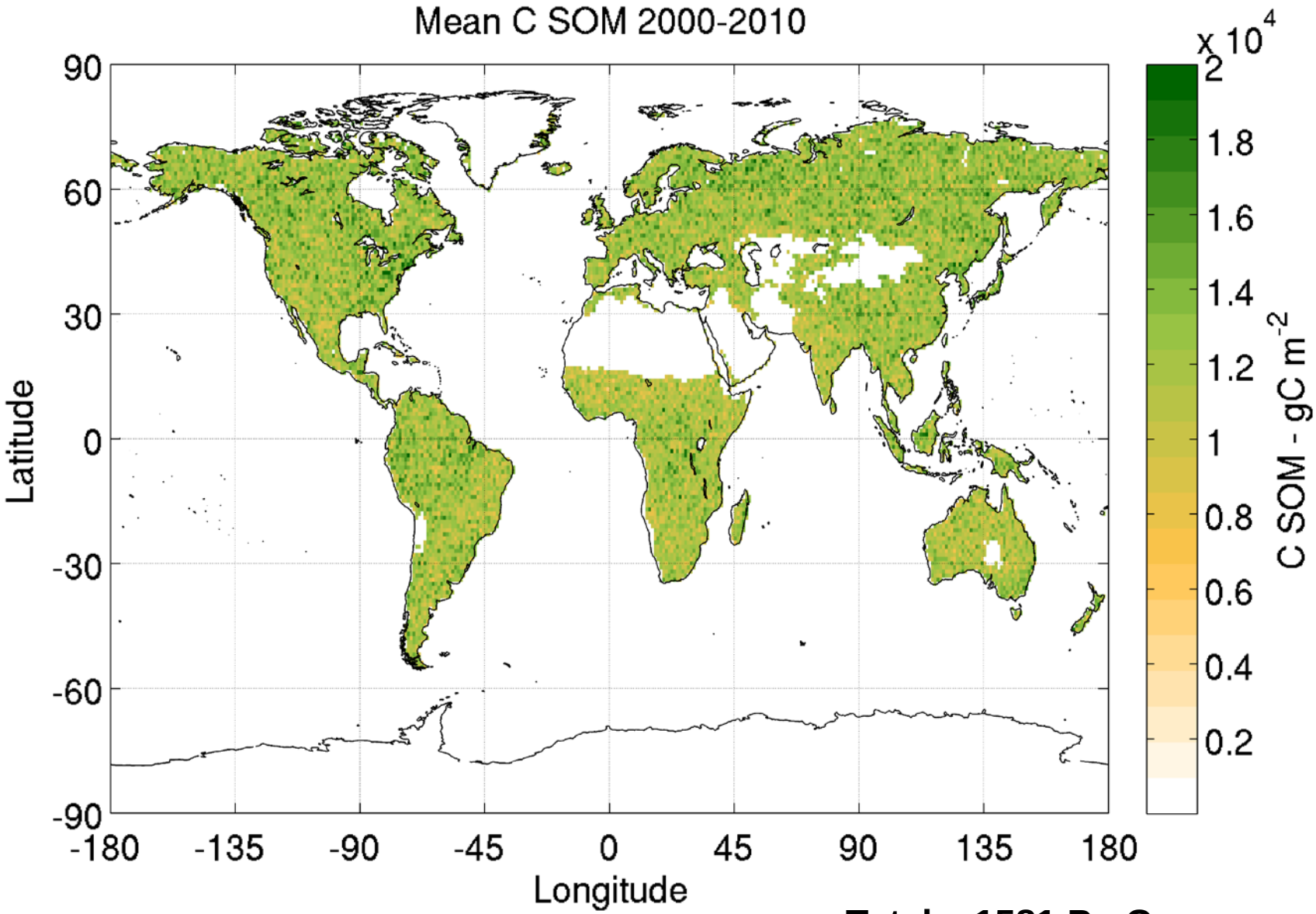
Total = 649.2 PgC

Pan-tropical AGB map



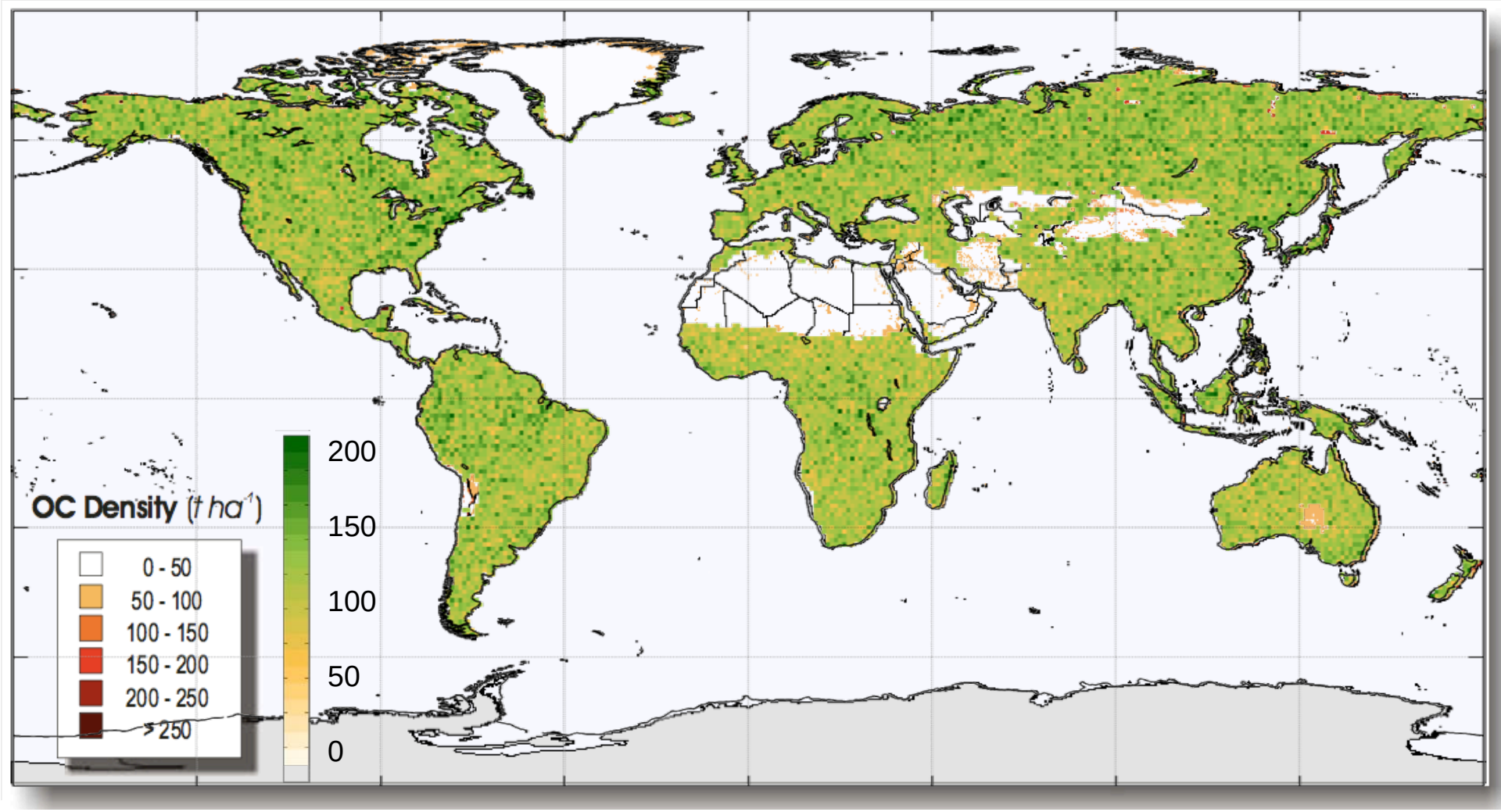
Total AGB (global) = 649 PgC

Soil Carbon

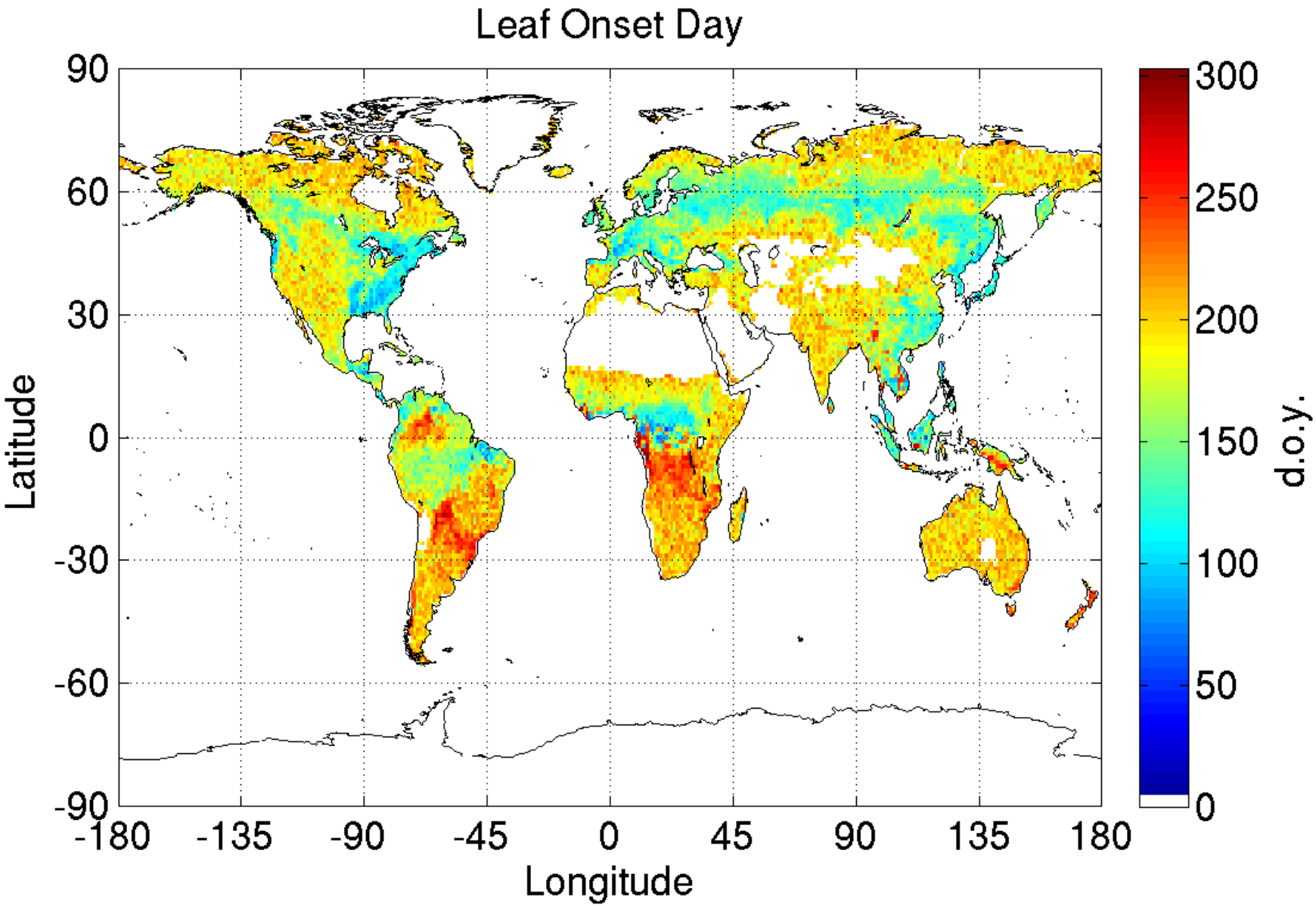


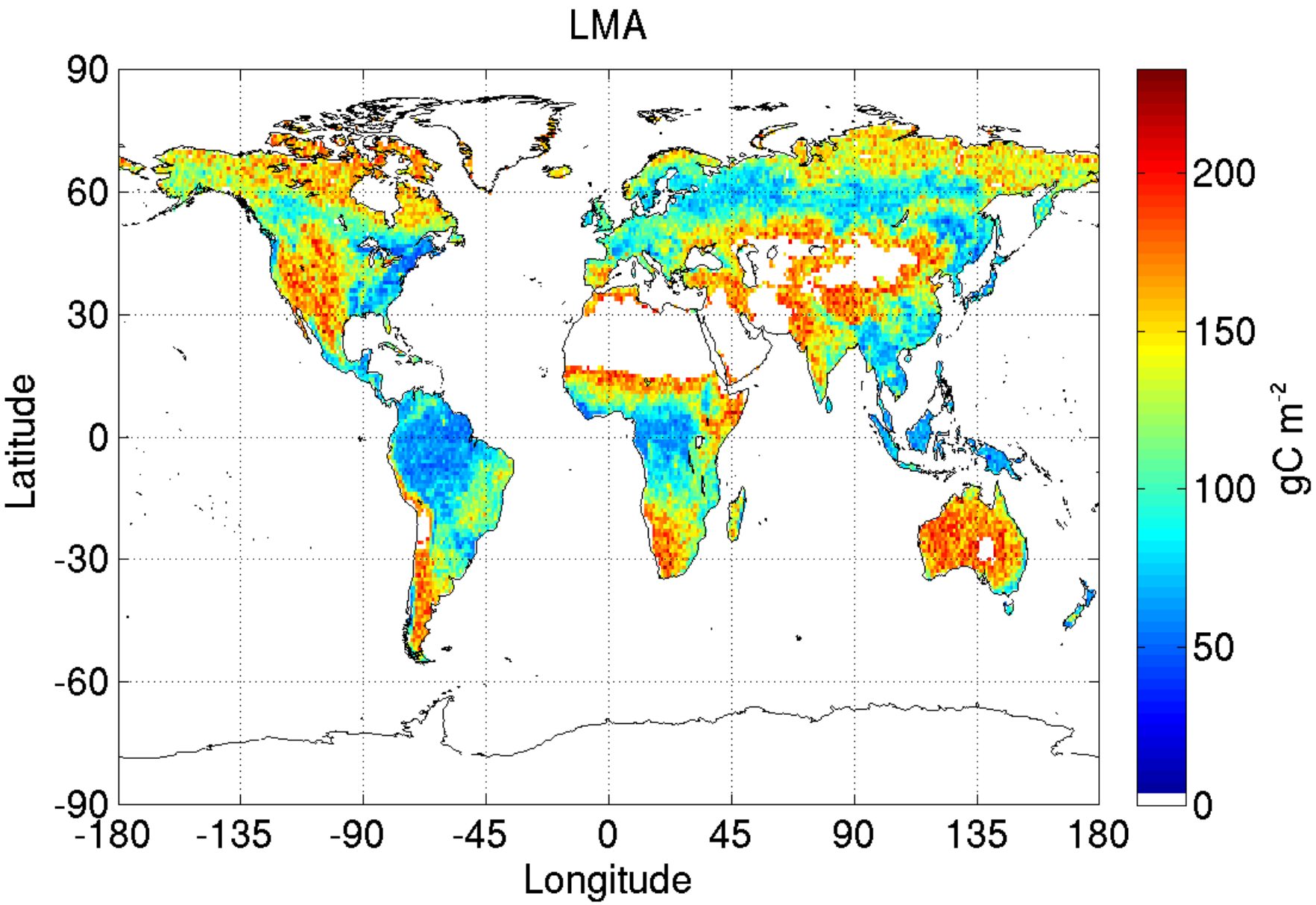
Total = 1581 Pg C

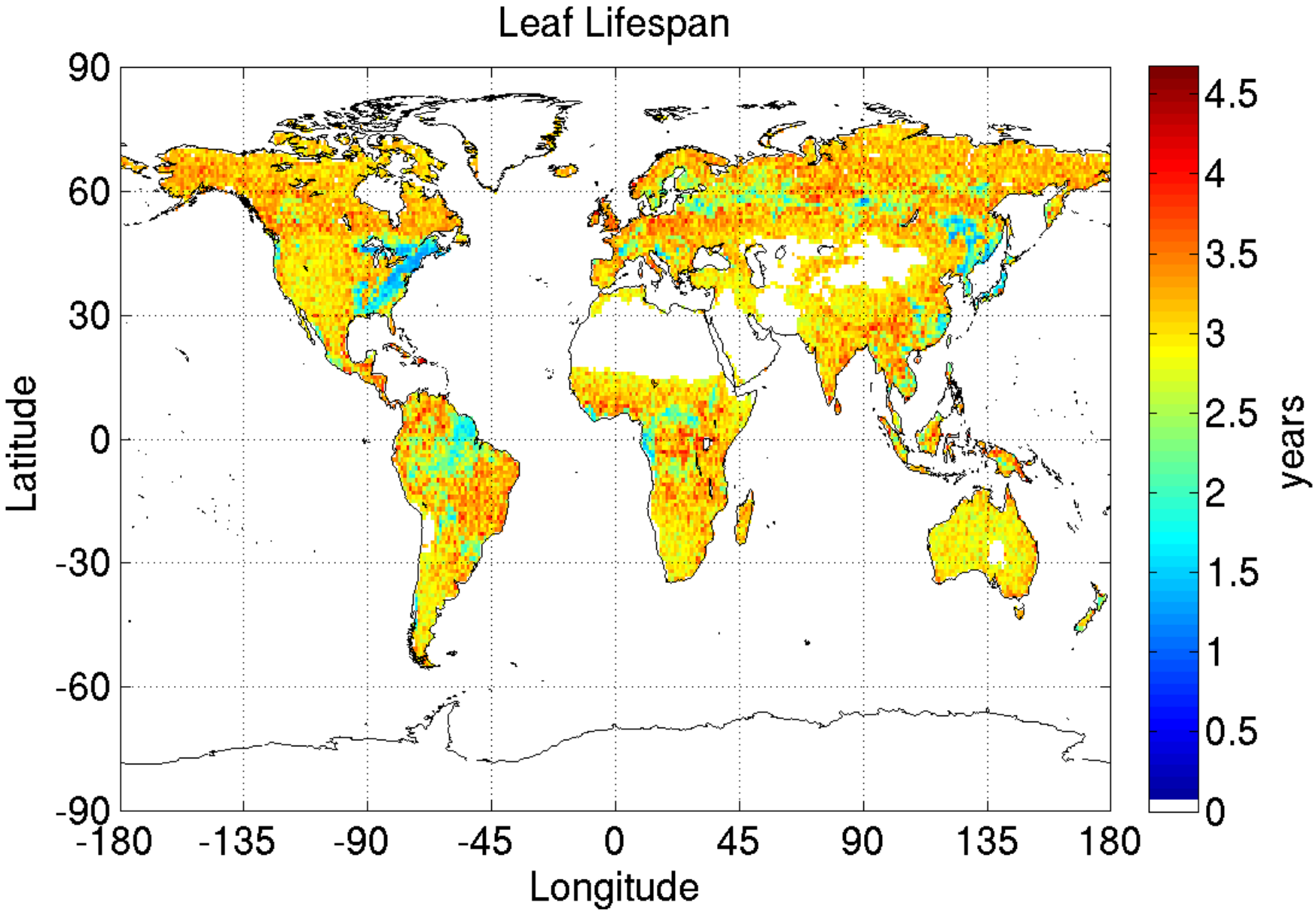
HWSD – Soil Carbon

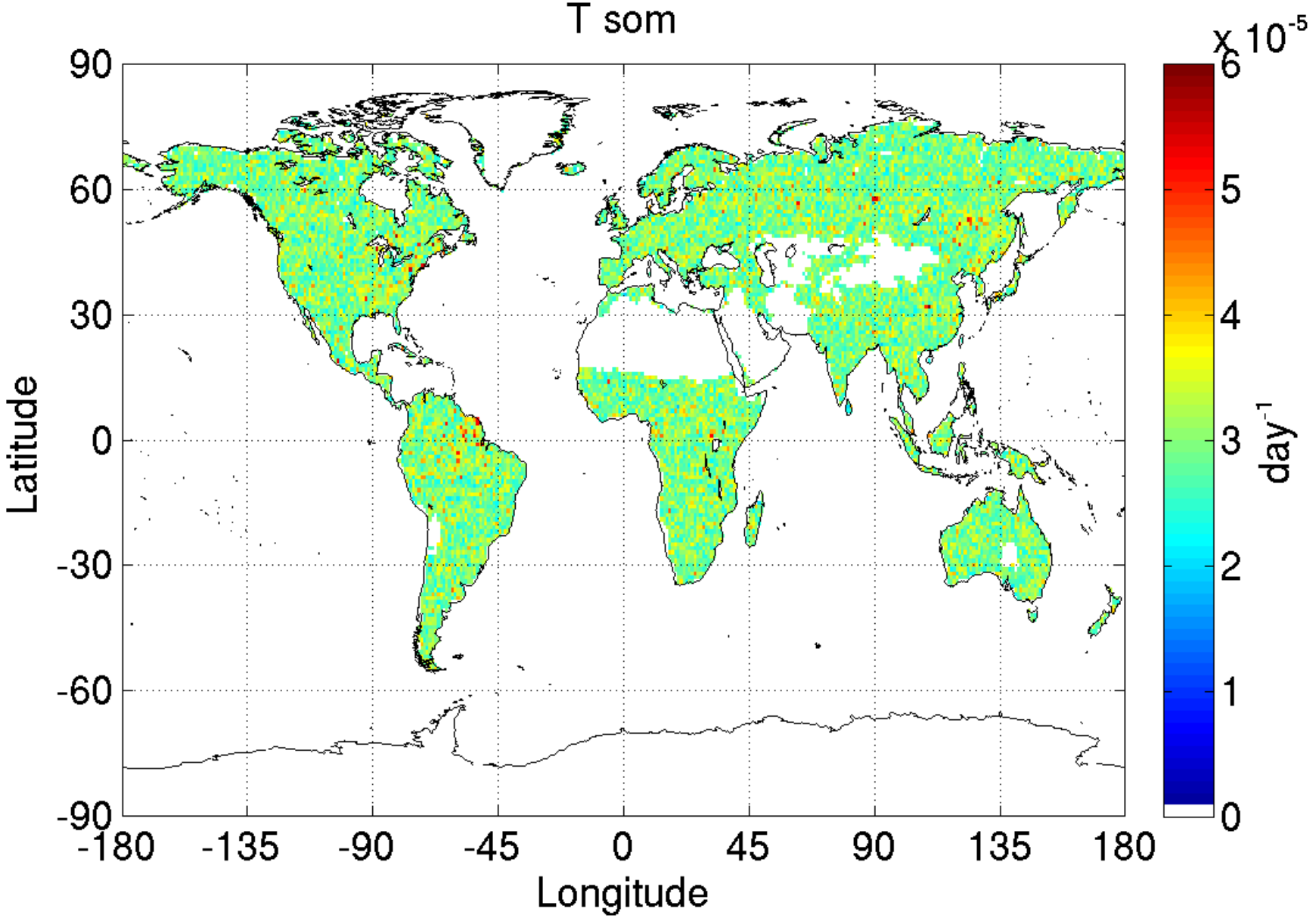


HWSD - Hiederer & Köchy (2011)


Leaf Onset Day
Latitude
Longitude
d.o.y.
90
60
30
0
-30
-60
-90
-180
-135
-90
-45
0
45
90
135
180
300
250
200
150
100
50
0


LMA
90
60
30
0
-30
-60
-90
Latitude
-180
-135
-90
-45
0
45
90
135
180
Longitude
200
150
100
50
0
gC m-2

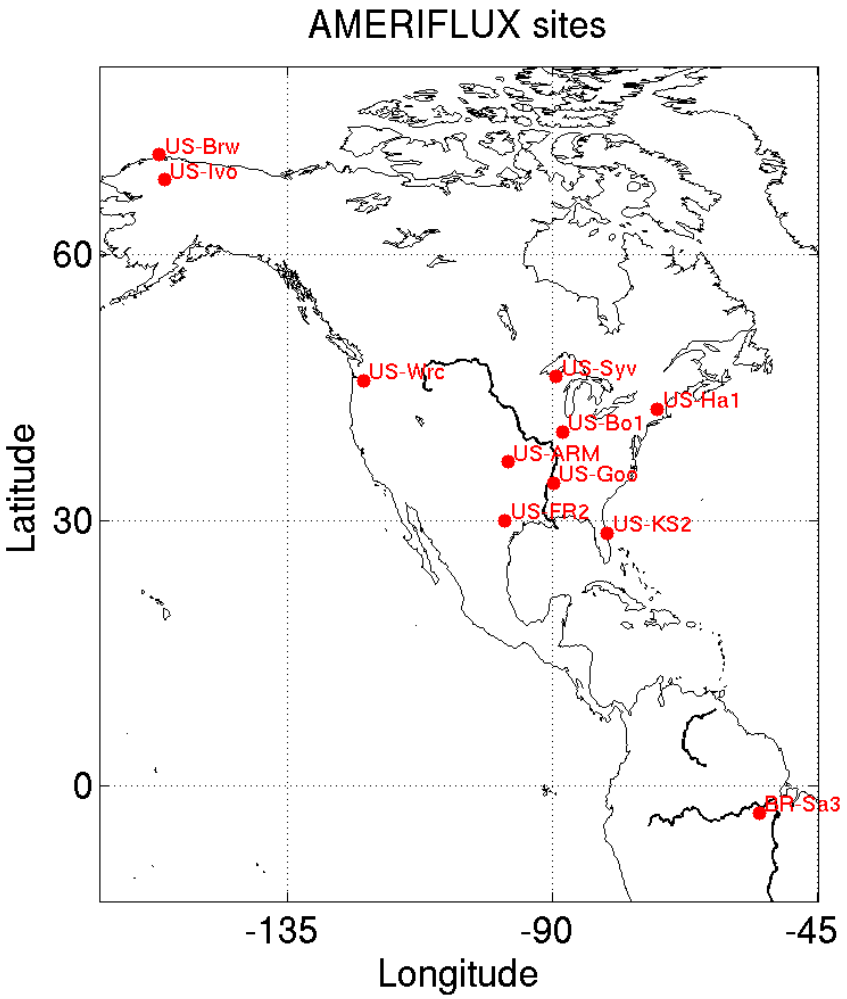

Leaf Lifespan
90
60
30
0
-30
-60
-90
Latitude
-180
-135
-90
-45
0
45
90
135
180
Longitude
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
years


T som
x 10^-5
6
5
4
3
2
1
0
day^-1
90
60
30
0
-30
-60
-90
Latitude
-180
-135
-90
-45
0
45
90
135
180
Longitude

Summary and Conclusions

1. Fluxes and stocks can be constrained from MODIS LAI
2. Global implementation of DALEC with ecological and dynamic constraints: GPP, AGB and SOM totals encouraging, GPP and AGB spatially resolve key biomes.
3. Parameter estimation indicates information content of assimilated data
4. **NEXT**: Integrate AGB maps and HWSD into D-GLOBAL as priors; include parameter correlations from TRY database
5. Spatial process information from MDF can help evaluate LSM parameterisations

Testing Parameter estimation at 10 AmeriFlux Sites



Testing DALEC & ecological/dynamical constraints

Biomes: Tropical, Sub-tropical, Temperate, Arctic.

Plant Functional Types: Forests, Crops, Grasslands, Shrublands, Woody Savanna.

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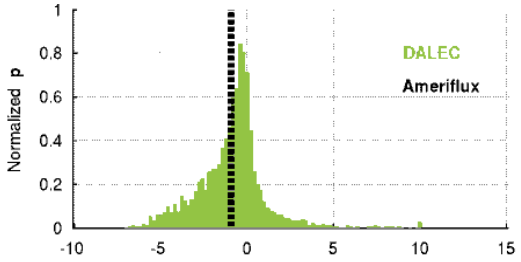
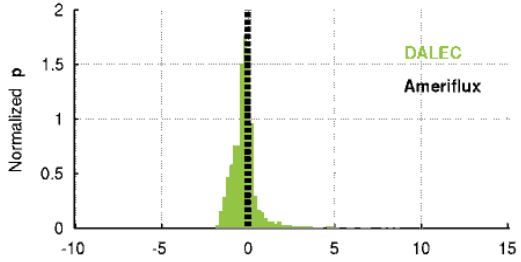
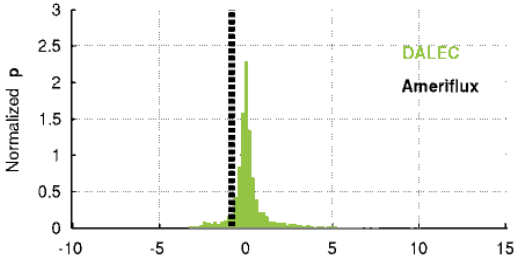
Evergreen Broadleaf



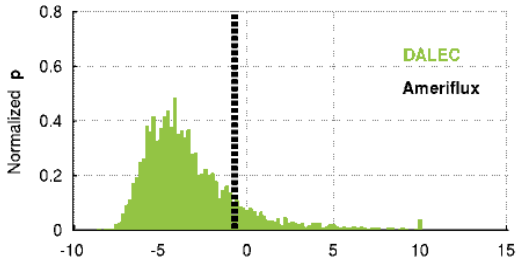
Open Shrubland



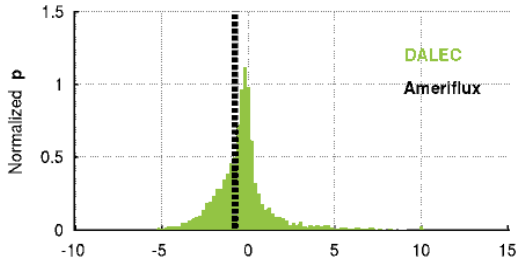
Woody Savanna



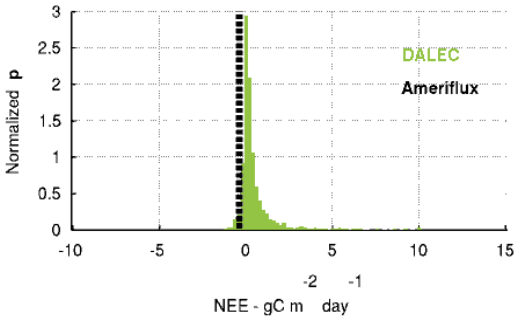
Closed Shrubland



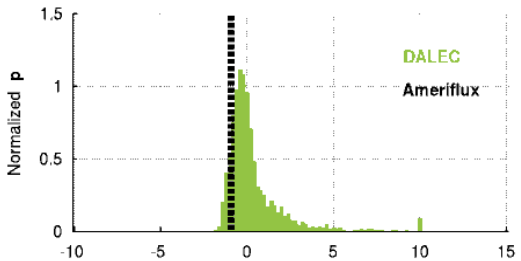
Deciduous Broadleaf



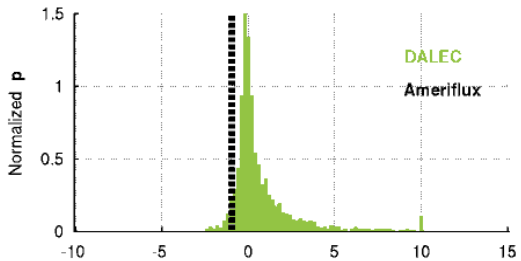
Cropland



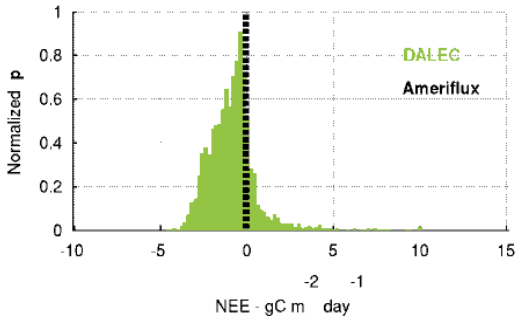
Cropland



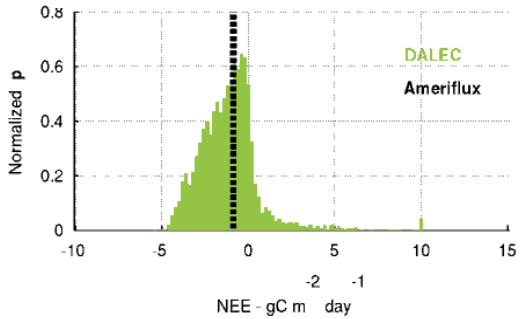
Grassland



Mixed Forest



Evergreen Needleleaf



AmeriFlux
DALEC

Bias
-0.7 – 1.7 gC m^{-2} day^{-1}
RMSE
1.1-2.8 gC m^{-2} day^{-1}

*excluded US-KS2

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