

Using Litter Observations to Evaluate BGC Models

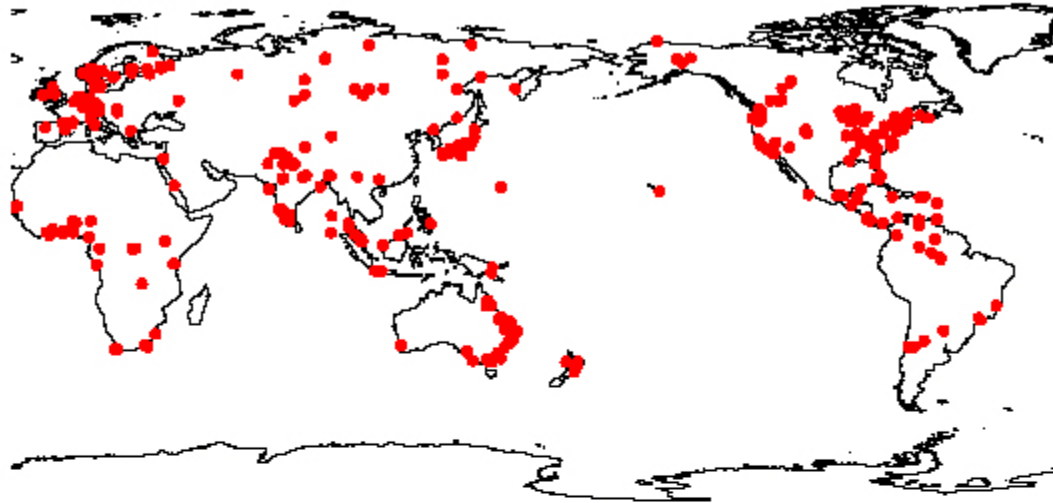
Beth Holland

with help input from James Sulzman, Mac Post, Elaine
Matthews, Forrest Hoffman and Jim Randerson

Land/BGC Working Group
March, 2009

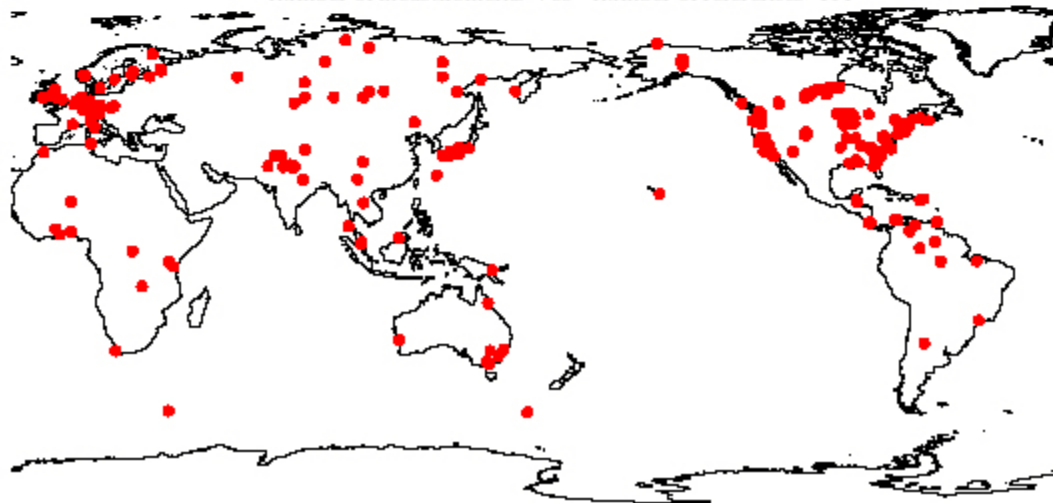
Total fine litterfall measurement sites (tot_fine_fall)

number of measurements=1073 number of references=300



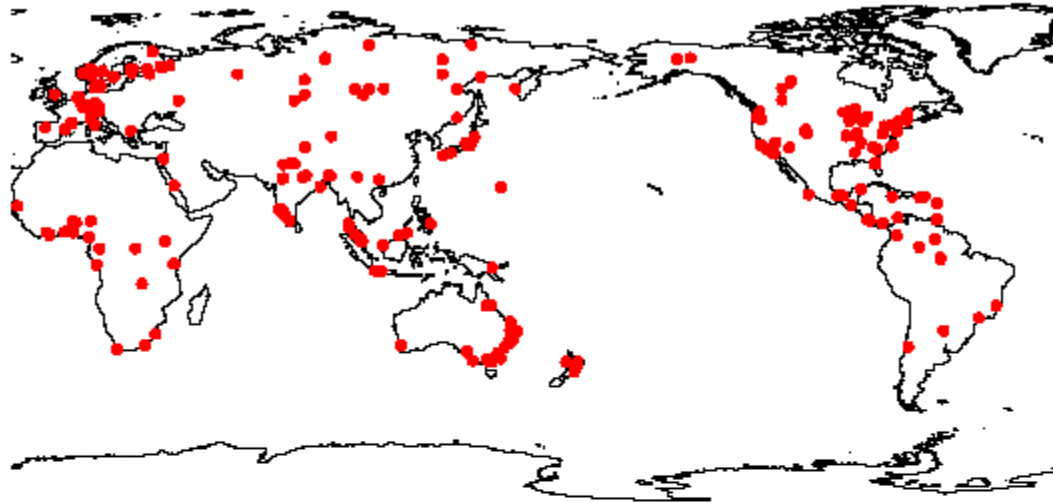
Total fine litterpool measurement sites (tot_fine_pool)

number of measurements=733 number of references=164



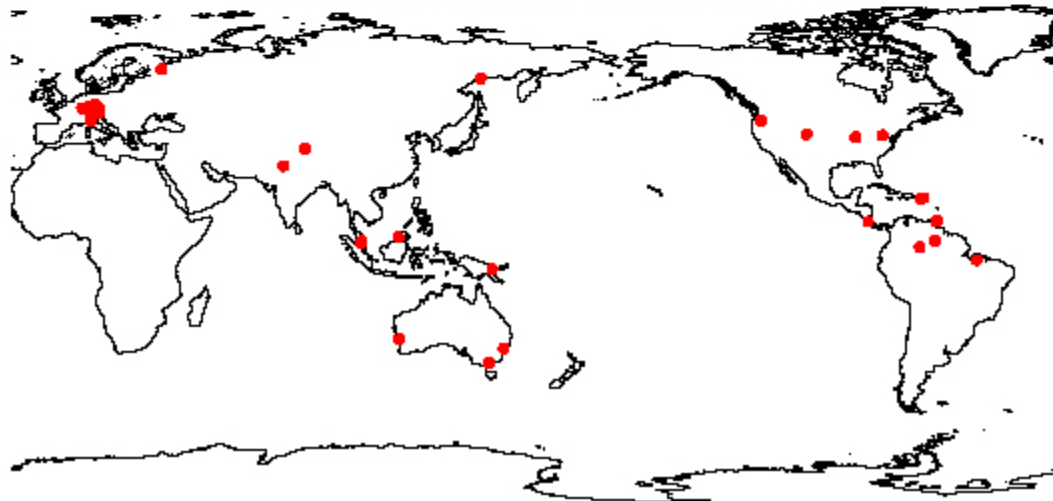
Leaf litterfall measurement sites (lflw)

number of measurements=670 number of references=199



leaf litterpool measurement sites (tleafw)

number of measurements=142 number of references=26



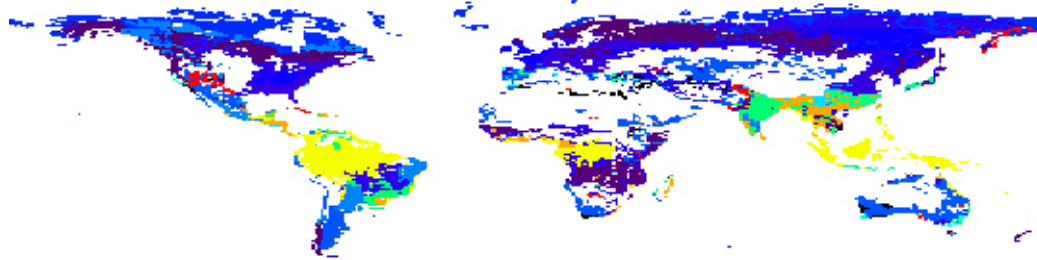
Litter Database Comparison, Total Fine and Leaf Litterfall
CLM-CASA, updated litter/CLAMP values

Biome Class	Modeled Litter Flux (gC/m ² /year)	Observed Total Fine Litterfall Mean (se) (gC/m ² /year)	Observed Leaf Litterfall (se) (gC/m ² /year)	Modeled Litter Pool (gC/m ²)	Observed Litter Pool Mean (se) (gC/m ²)	Litter Turnover (year) modeled <i>observed: total fine/leaf only</i>
Not Vegetated	17	-		29	-	1.7
Needleleaf Evergreen Temperate Tree	608	254(3) n=42	237 (6) n=21	703	1140(20) n=38	1.2 4/2
Needleleaf Evergreen Boreal Tree	396	158(0) n=235	109 (1) n=146	1220	2395 (7) n=289	3.1 15/6
Broadleaf Evergreen Tropical Tree	1152	400(6) n=39	320 (7) n=29	775	643 (19) n=27	0.7 2/1
Broadleaf Evergreen Temperate Tree	554	289(2) n=44	155 (0.004) n=18	712	454 (29) n=6	1.3 2/NA
Broadleaf Deciduous Tropical Tree	1014	295 (4) n=39	201 (3) n=24	782	295 (15) n=15	0.8 1/2
Broadleaf Deciduous Temperate Tree	721	199(0) n=198	158 (1) n=92	983	2089 (69) n=78	1.4 10/3
Broadleaf Deciduous Temperate Shrub	238	463(44) n=2	44 (9) n=2	249	- (-)	1.1
Broadleaf Deciduous Boreal Shrub	111	- (-)	- (-)	568	- (-)	5
C3 Arctic Grass	226	211(15) n=9	204 (17) n=8	846	515(26) n=14	3.8 2/2
C3 Non-Arctic Grass	510	- (-)	- (-)	714	179 (26) n=5	1.4
C4 Grass	750	- (-)	- (-)	596	- (-)	0.8
Corn	621	- (-)	- (-)	751	- (-)	1.42

Litter Database Comparison, Total Fine and Leaf Litterfall
CLM-CN, updated litter/CLAMP values

Biome Class	Modeled Litter Flux (gC/m ² /year)	Observed Total Fine Litterfall Mean (se) (gC/m ² /year)	Observed Leaf Litterfall (se) (gC/m ² /year)	Modeled Litter Pool (gC/m ²)	Observed Litter Pool Mean (se) (gC/m ²)	Litter Turnover (year) modeled <i>observed: total fine/leaf only</i>
Not Vegetated	8.8	-		4.9	-	0.6
Needleleaf Evergreen Temperate Tree	360.1	254(3) n=42	237 (6) n=21	92.5	1140(20) n=38	0.3 4/2
Needleleaf Evergreen Boreal Tree	220.0	158(0) n=235	109 (1) n=146	164.1	2395 (7) n=289	0.8 15/6
Broadleaf Evergreen Tropical Tree	813.2	400(6) n=39	320 (7) n=29	99.5	643 (19) n=27	0.1 2/1
Broadleaf Evergreen Temperate Tree	414.3	289(2) n=44	155 (0.004) n=18	109.6	454 (29) n=6	.3 2/NA
Broadleaf Deciduous Tropical Tree	622.1	295 (4) n=39	201 (3) n=24	135.7	295 (15) n=15	0.2 1/2
Broadleaf Deciduous Temperate Tree	544.0	199(0) n=198	158 (1) n=92	188.3	2089 (69) n=78	0.4 10/3
Broadleaf Deciduous Temperate Shrub	74.9	463(44) n=2	44 (9) n=2	25.9	- (-)	0.4
Broadleaf Deciduous Boreal Shrub	21.6	- (-)	- (-)	31.7	- (-)	1.5
C3 Arctic Grass	94.1	211(15) n=9	204 (17) n=8	95.7	515(26) n=14	1 2/2
C3 Non-Arctic Grass	256.9	- (-)	- (-)	104.0	179 (26) n=5	1.4
C4 Grass	277.7	- (-)	- (-)	68.2	- (-)	0.8
Corn	383.6	- (-)	- (-)	148.8	- (-)	1.42

Total fine litterfall (tot_fine_fall)

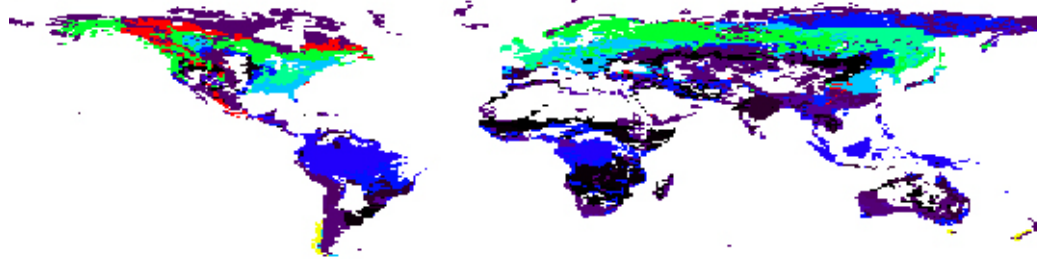
 $\text{kg m}^{-2} \text{yr}^{-1}$

0.25

0.46

0.92

Total Litter Pool (tot_fine_pool)

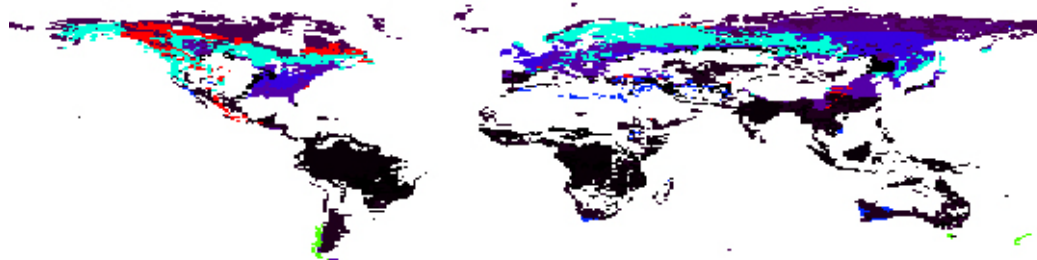
 kg m^{-2}

0.25

4.26

8.53

Turnover (tot_fine_pool/tot_fine_fall)



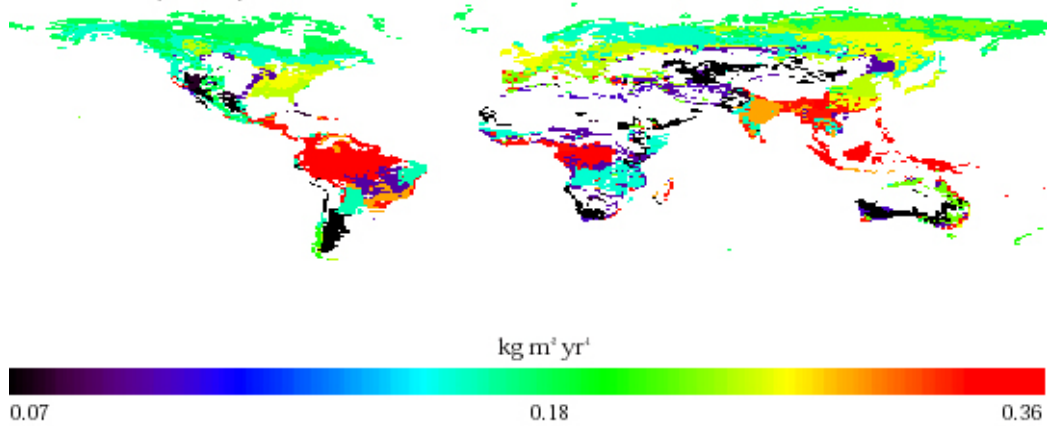
years

0.76

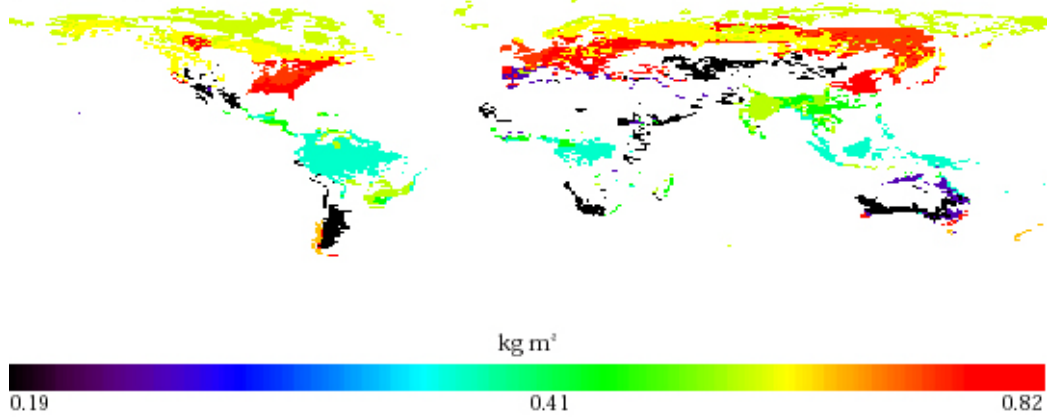
26.3

52.6

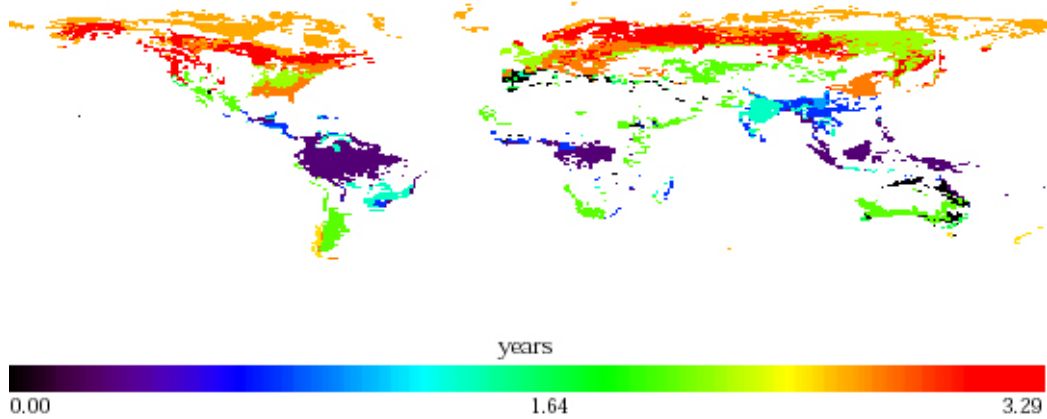
Leaf litter fall (LFLLW)



Leaf pool (TLEAFW)

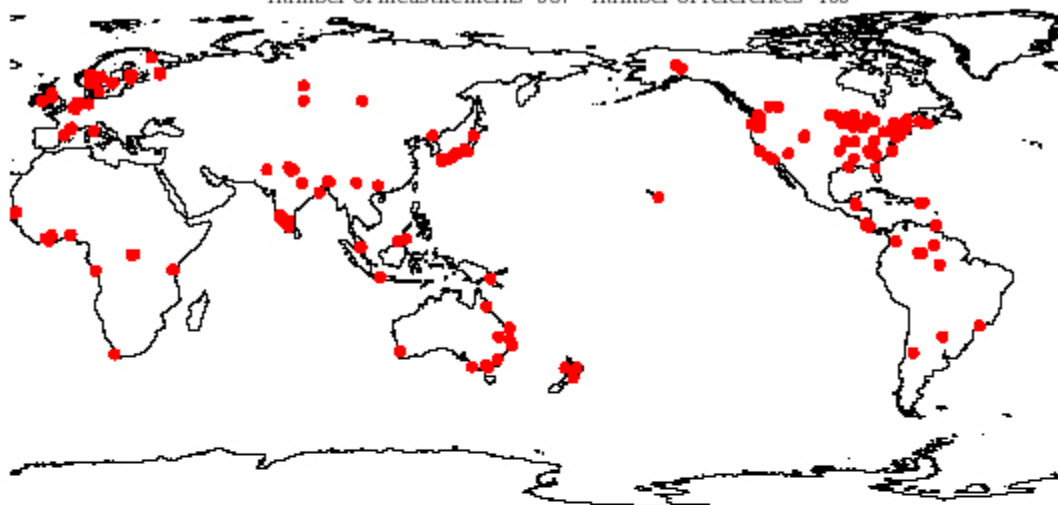


Turnover (TLEAFW/LFLLW)



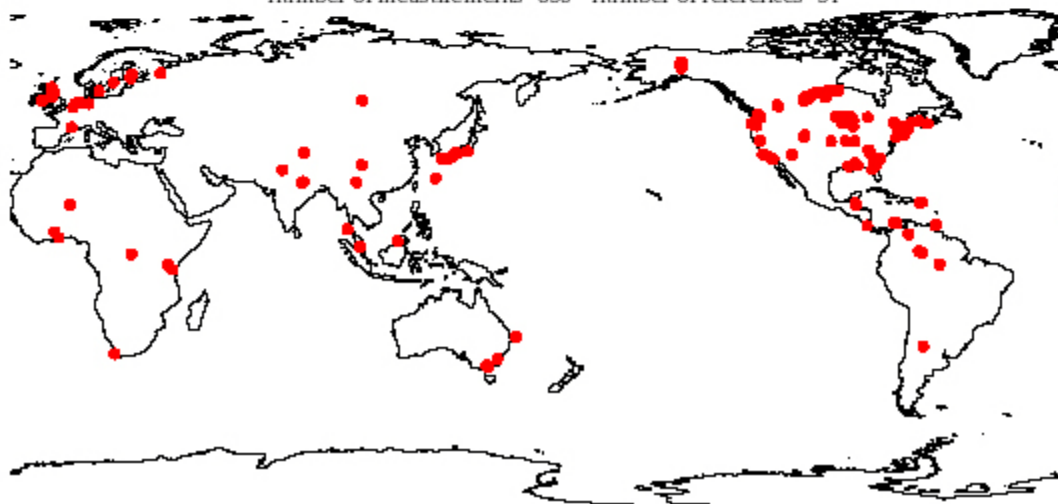
Total fine litterfall N measurement sites (tot_fine_fallN)

number of measurements=507 number of references=155



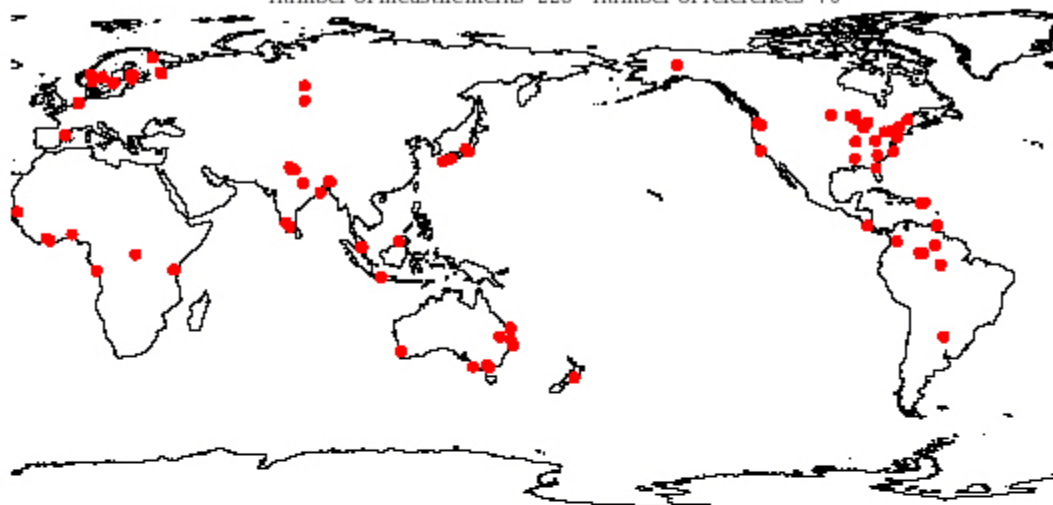
Total fine litterpool N measurement sites (tot_fine_poolN)

number of measurements=393 number of references=94



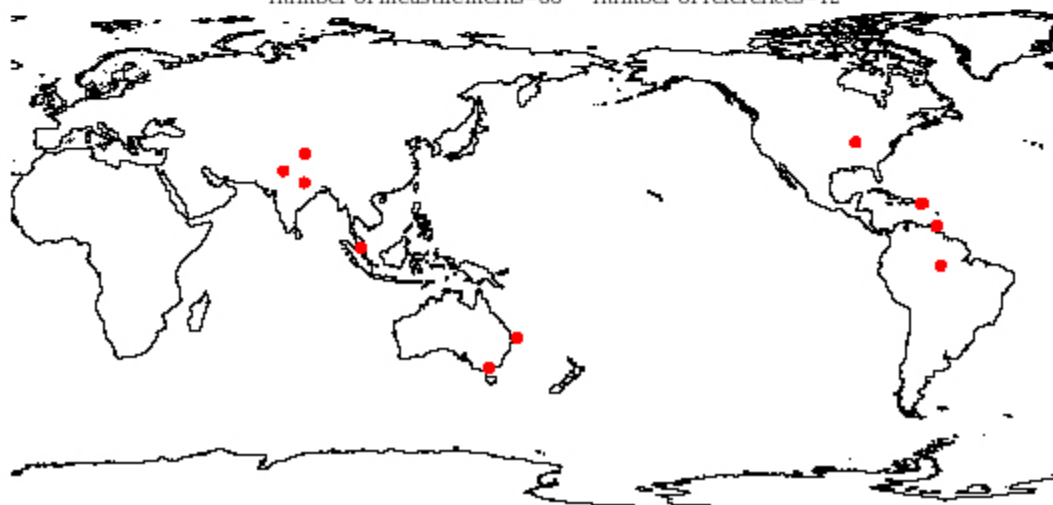
Leaf litterfall N measurement sites (lfln)

number of measurements=223 number of references=76



Leaf litterpool N measurement sites (tleafn)

number of measurements=36 number of references=12



Litter Database Comparison, Total Fine and Leaf Litterfall N

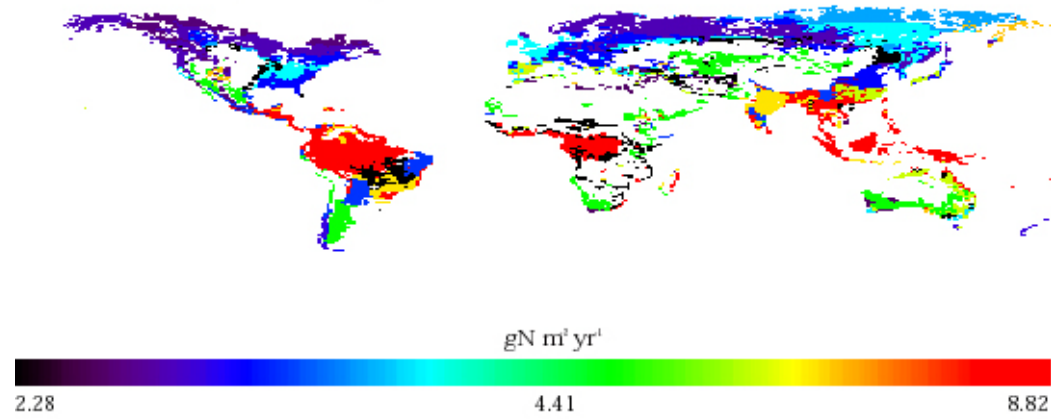
CLM-CASA updated litter/CLAMP values

Biome Class	Modeled Litter Flux (gN/m ² /year)	Observed Total Fine Litterfall Mean (se) (gN/m ² /year)	Observed Leaf Litterfall (se) (gN/m ² /year)	Modeled Litter Pool (gN/m ²)	Observed Litter Pool Mean (se) (gN/m ²)	Litter N Turnover (year) modeled <i>observed: total fine/leaf only</i>
Not Vegetated	-	-	-	-	-	NA
Needleleaf Evergreen Temperate Tree	-	4(0.2) n=25	3 (0.2) n=17	-	5 (0.4) n=6	NA 4/2
Needleleaf Evergreen Boreal Tree	-	3(0.02) n=141	4 (0.1) n=62	-	- (-)	NA 8/NA
Broadleaf Evergreen Tropical Tree	-	8(0.3) n=21	8 (0.5) n=7	-	7 (0.4) n=9	NA 2/1
Broadleaf Evergreen Temperate Tree	-	7(0.1) n=9	5 (0.2) n=6	-	- (-)	NA 1/NA
Broadleaf Deciduous Tropical Tree	-	7 (0.3) n=19	7 (0.5) n=12	-	11 () n=1	NA 1/1
Broadleaf Deciduous Temperate Tree	-	5(0.1) n=78	4 (0.2) n=33	-	7 () n=1	NA 25/2
Broadleaf Deciduous Temperate Shrub	-	- (-)	- (-)	-	- (-)	-
Broadleaf Deciduous Boreal Shrub	-	- (-)	- (-)	-	- (-)	-
C3 Arctic Grass	-	- (-)	- (-)	-	- (-)	-
C3 Non-Arctic Grass	-	- (-)	- (-)	-	1(0.03) n=2	-
C4 Grass	-	- (-)	- (-)	-	- (-)	-
Corn	-	- (-)	- (-)	-	- (-)	-

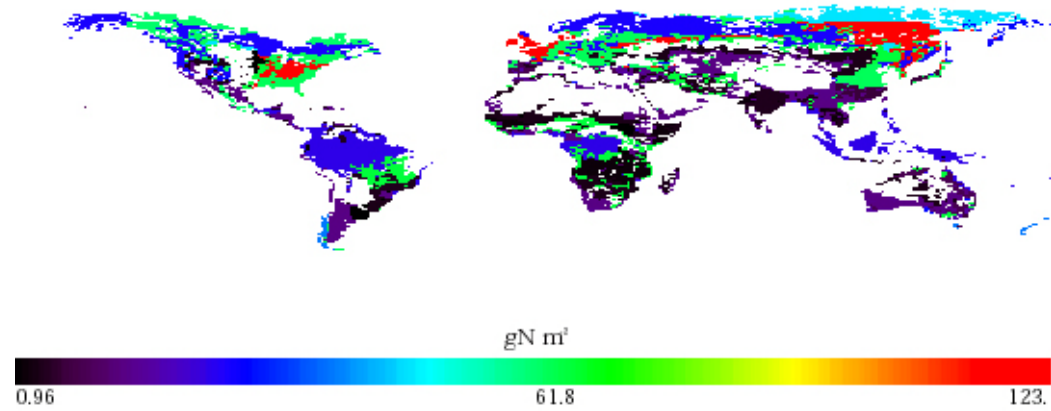
Litter Database Comparison, Total Fine and
Leaf Litterfall N
CLM-CN, updated litter/CLAMP values

Biome Class	Modeled Litter Flux (gN/m ² /year)	Observed Total Fine Litterfall Mean (se) (gN/m ² /year)	Observed Leaf Litterfall (se) (gN/m ² /year)	Modeled Litter Pool (gN/m ²)	Observed Litter Pool Mean (se) (gN/m ²)	Litter N Turnover (year) modeled <i>observed: total fine/leaf only</i>
Not Vegetated	-	-	-	-	-	NA
Needleleaf Evergreen Temperate Tree	-	4(0.2) n=25	3 (0.2) n=17	-	5 (0.4) n=6	NA 4/2
Needleleaf Evergreen Boreal Tree	-	3(0.02) n=141	4 (0.1) n=62	-	- (-)	NA 8/NA
Broadleaf Evergreen Tropical Tree	-	8(0.3) n=21	8 (0.5) n=7	-	7 (0.4) n=9	NA 2/1
Broadleaf Evergreen Temperate Tree	-	7(0.1) n=9	5 (0.2) n=6	-	- (-)	NA 1/NA
Broadleaf Deciduous Tropical Tree	-	7 (0.3) n=19	7 (0.5) n=12	-	11 () n=1	NA 1/1
Broadleaf Deciduous Temperate Tree	-	5(0.1) n=78	4 (0.2) n=33	-	7 () n=1	NA 25/2
Broadleaf Deciduous Temperate Shrub	-	- (-)	- (-)	-	- (-)	-
Broadleaf Deciduous Boreal Shrub	-	- (-)	- (-)	-	- (-)	-
C3 Arctic Grass	-	- (-)	- (-)	-	- (-)	-
C3 Non-Arctic Grass	-	- (-)	- (-)	-	1(0.03) n=2	-
C4 Grass	-	- (-)	- (-)	-	- (-)	-
Corn	-	- (-)	- (-)	-	- (-)	-

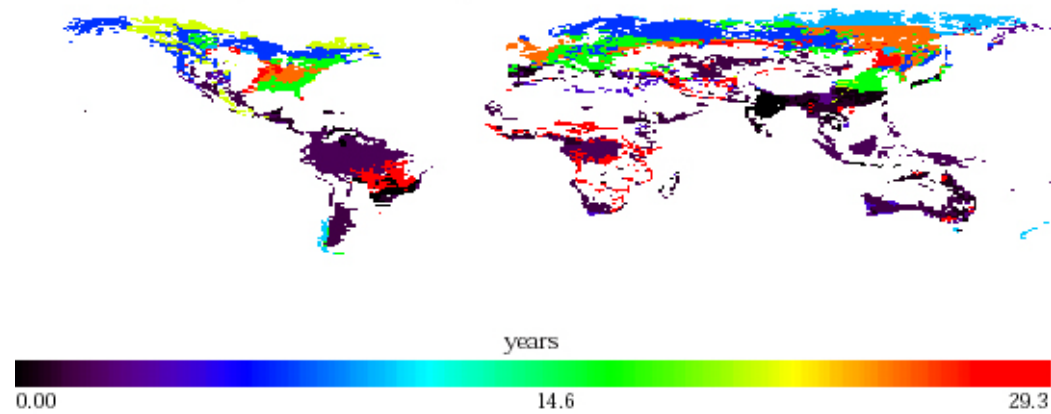
Total fine litterfall N (tot_fine_fallN)



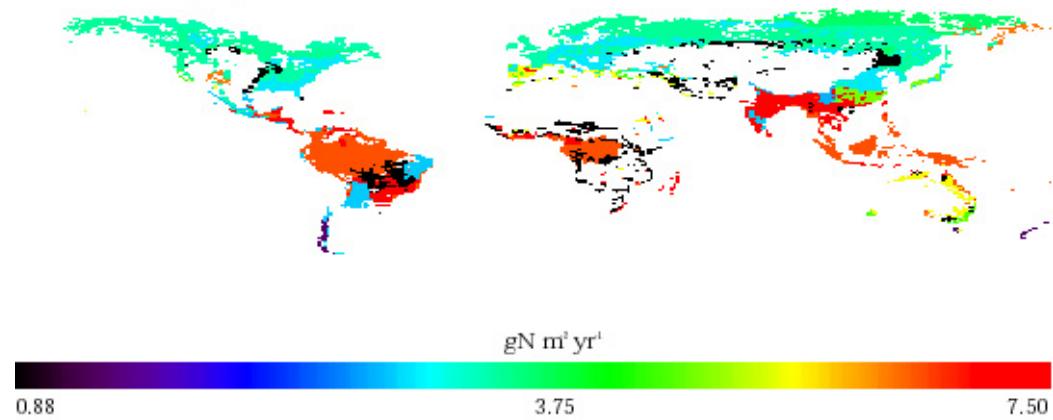
Total Litter Pool N (tot_fine_poolN)



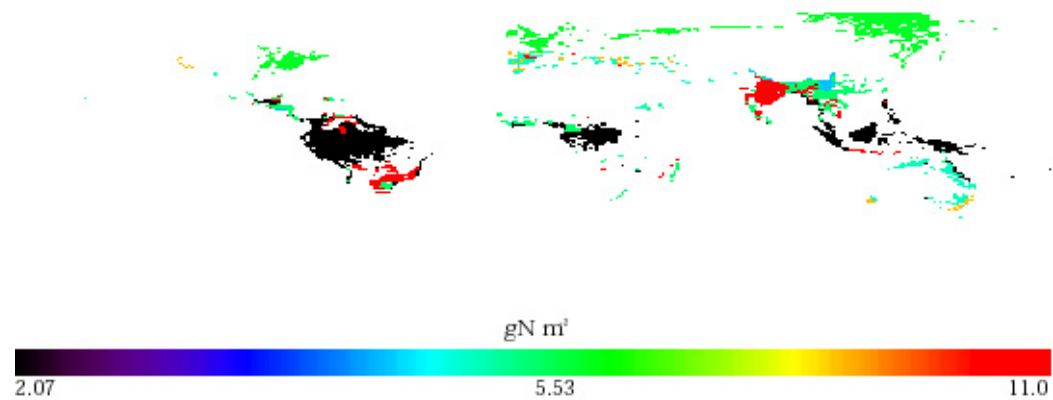
N Turnover (tot_fine_poolN/tot_fine_fallN)



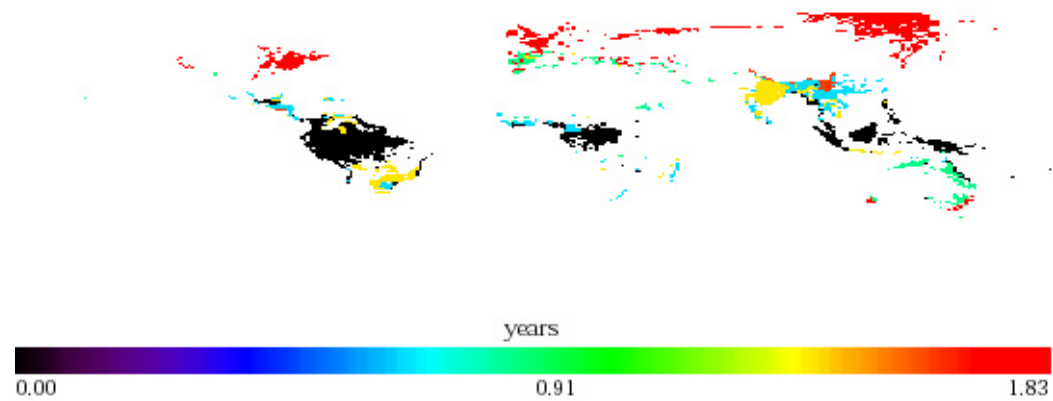
Leaf litter fall N (lfln)



Leaf pool N (tleafn)



N Turnover (tleafn/lfln)



Using N Observations to Constrain N Modeling

Beth Holland
with input from Jim Randerson

Land/BGC Working Group
March, 2009

NLAMP:

Atmospheric Constrains on N Cycle, **N₂O**

NLAMP:

Atmospheric Constrains on N Cycle, **NO₂**

from T.P.C. van Noije

N-LAMP observational constraint:	Data uncertainty	Model-data scaling mismatch	Process that is constrained by obs.	Source
NPP sensitivity to N additions	moderate	low	N application-plant uptake-GPP-NPP linkage	LeBauer and Treseder (2008) meta analysis
Atm. N2O during Holocene (steady state)	moderate	low	Nitrification, denitrification, and fire losses	Ice core records
Atmospheric NO2	low	low	Atm chemistry links	GOME
Soil NO and N2O emissions	moderate	moderate	ATM/BIO emisissions, nitrification, denitrification	Stehfest and Bouwman 2008, INI
N fixation synthesis of observations	high	moderate	N fixation	Cleveland maps and biome means, Houlton et al 2008
Hubbard Brook deforestation experiment	low	high	Decomposition, nitrification, denitrification, leaching, hydrology	Likens - graph of nitrate loss in Schlesinger's book
N levels in litter pools	low	moderate	Decomposition and N allocation	Holland data set
Atm. N2O transient 20th century (1700=2010)	low	low	N application rates, flow of N in agriculture, nitrification ...	Ice core records, Holland et al 2004 and Ri et al 2009
Root N?	moderate	moderate	N uptake in roots	Jackson?
Wet deposition of NO3 US and Europe	low	moderate		Holland data set
Wet deposition of NH4+ US and Europe	low	moderate		Holland data set
Dry deposition of HNO3 US and Europe	moderate/high	high		Holland data set
Dry deposition of particulate NH4+ and NO3-	moderate	moderate		Holland data set
Other constraints (are there data sets for these?)				
nitrogen fluxes from major rivers			Nitrification, denitrification, leaching, hydrology	Vorosmarty, Smith et al, USGS ???
leaf N observations				
Reactive N loss from fires			Fire emissions and N levels in leaves, litter pools	GFEDv2 + Andrea and Merlet emission factors
N2 loss from fires				GFEDv2 + Kulsbusch ratios
allocation responses				