CLAMP/NLAMP/Chemistry

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PFTs/Land cover

- CLAMP to date has used max PFT coverage within a grid cell to extract variables for comparison with observations

- How shall the variable extraction be done with changing land cover?

Litterfall analyses of CASA (Q10 1.5) using different assumptions about PFTs

PFT/Biome Class	PFT >70% Litterfall C ($gC/m^2/year$)	PFT > 70% cell count	Max PFT Litterfall C ($gC/m^2/year$)	Max PFT cell count
Not Vegetated	25	252	52	537
Needleleaf Evergreen Temperate Tree	425	8	445	109
Needleleaf Evergreen Boreal Tree	238	151	222	424
Broadleaf Evergreen Tropical Tree	80	6	94	29
Broadleaf Evergreen Temperate Tree	565	170	630	308
Broadleaf Deciduous Tropical Tree	434	14	479	58
Broadleaf Deciduous Temperate Tree	648	2	668	114
Broadleaf Deciduous Temperate Shrub	296	2	424	62
Broadleaf Deciduous Boreal Shrub	55	11	59	210
C3 Arctic Grass	41	1	89	26
C3 Non-Arctic Grass	974	1	566	224
C4 Grass	1013.	34	897	264
Corn	255.4	41	446	388

A way forward

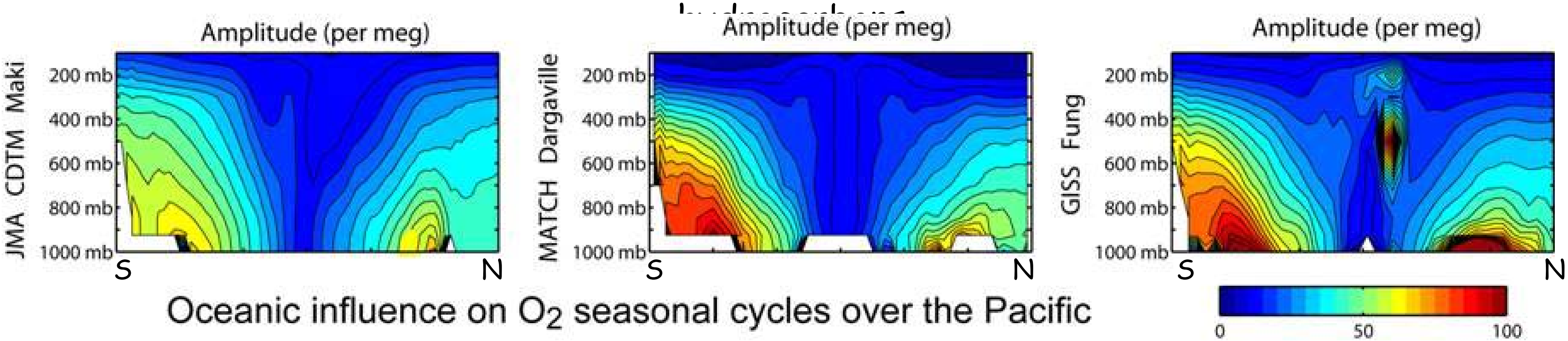
- Phase 1: use aboveground CLAMP diagnostics with changing land cover
- Phase 2: allocation and production
  - use Lebauer and Treseder to look at aboveground production in response to N addition to allow evaluation of C response to N addition
  - Use GLOBENET (Raich) and Jackson root data set as observations to evaluate allocation components of model include leaf/woody allocation and above/belowground allocation
- Phase 3: Belowground CLAMP
  - Litter database, Litter decay Isotopic constraints
  - ISRIC soils database and Luo data sets
- Phase 4: NLAMP- atmospheric data, joint with Chemistry working group
  - N_2O
  - NO_2 in situ and satellite observations
  - Wet and dry deposition measurements ammonium, nitrate and organics
- Phase 5: NLAMP-terrestrial data
  - N data from phase 3
  - 15 N data
  - Watershed and Continental budgeting

Joint Chemistry Experiments

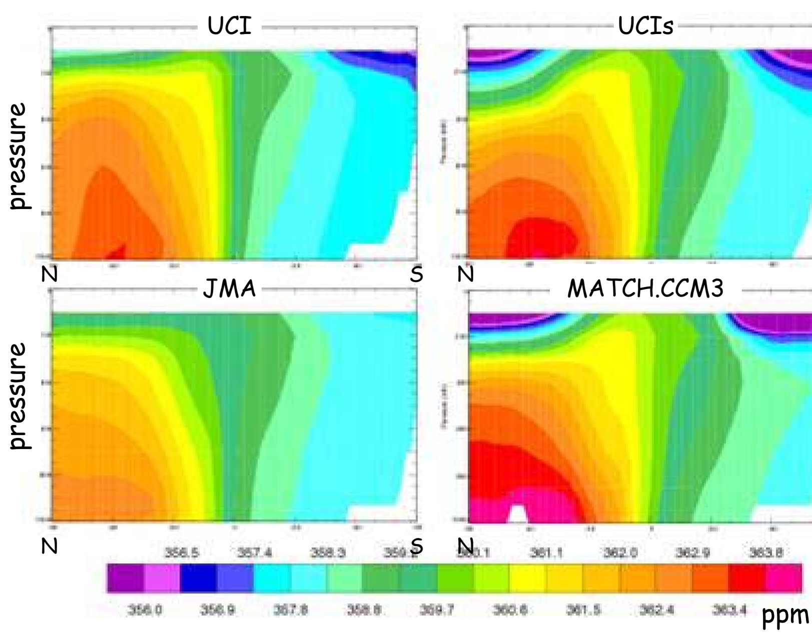
- HIPPO simulations-Pole to Pole observations (Holland/Lamarque)
- O_3 feedbacks on the carbon and water cycles (Felzer/Lombardozzi/Hess)
- Integration of carbon, dry deposition and O_3 uptake (Holland)
- Fully coupled N cycle—as proposed by Hess, Holland, Moore, and Doney, NSF proposal pending

HIAPER Pole-to-Pole Observations of Atmospheric Tracers Wofsy, Stephens et al

HIPPO (PIs: Harvard, NCAR, Scripps, and NOAA): A global and seasonal survey of CO_2, O_2, 13CO2, CH_4, CO, N_2O, H_2, SF_6, COS, CFCs, HCFCs, O_3, H_2O, and hydrocarbons



Fossil fuel CO_2 gradients over the Pacific



Weak Northern and Strong Tropical Land Carbon Uptake from Vertical Profiles of Atmospheric CO_2

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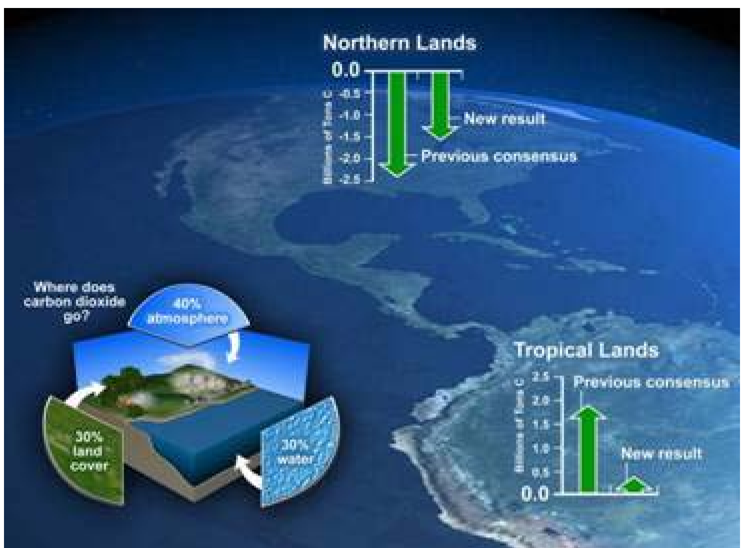
Measurements of midday vertical atmospheric CO_2 distributions reveal annual-mean vertical CO_2 gradients that are inconsistent with atmospheric models that estimate a large transfer of terrestrial carbon from tropical to northern latitudes. The three models that most closely reproduce the observed annual-mean vertical CO_2 gradients estimate weaker northern uptake of −1.5 petagrams of carbon per year (Pg C $year^{-1}$) and weaker tropical emission of +0.1 Pg C $year^{-1}$ compared with previous consensus estimates of −2.4 and +1.8 Pg C $year^{-1}$, respectively. This suggests that northern terrestrial uptake of industrial CO_2 emissions plays a smaller role than previously thought and that, after subtracting land-use emissions, tropical ecosystems may currently be strong sinks for CO_2.

Science, June 22, 2007



graphic from NCAR communications (Steve Deyo)

Airborne CO_2 measurements indicate:

- Northern forests, including U.S. and Europe, are taking up much less CO_2 than previously thought
- Intact tropical forests are strong carbon sinks and are playing a major role in offsetting carbon emissions

Implications of this work:

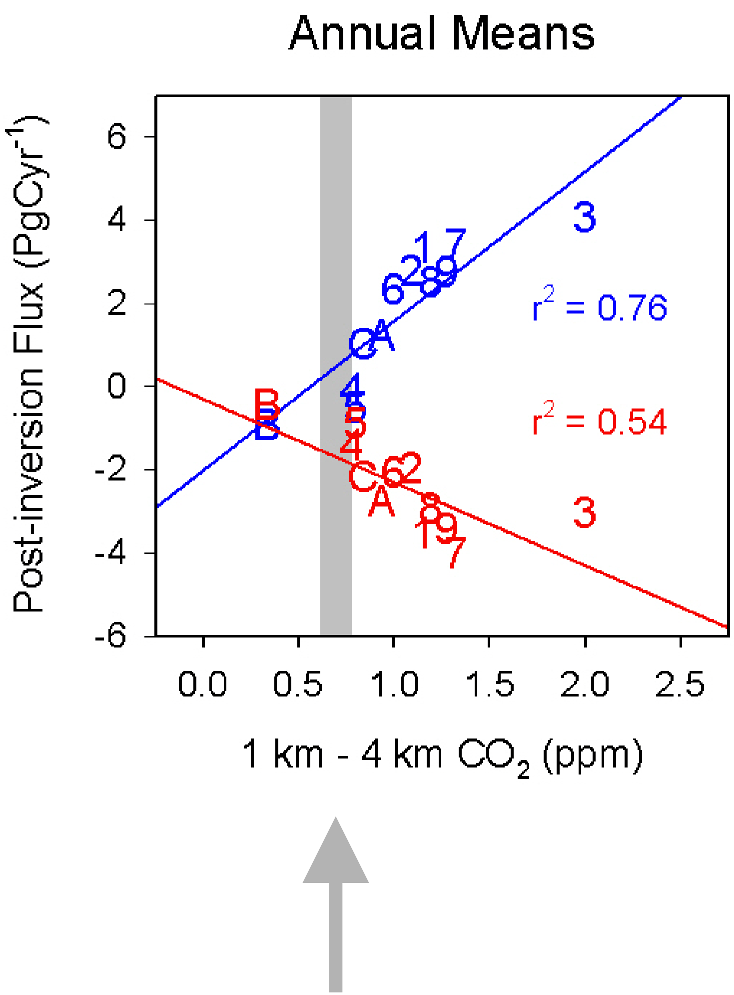
- Helps to resolve a major environmental mystery of the past two decades

  → Northern "missing carbon sink" has not been found because it is not there

- Improved understanding of processes responsible for carbon uptake will improve predictions of climate change and assessment of mitigation strategies

Estimated fluxes versus predicted 1 km – 4 km gradients

Model	Model Name
1	CSU
2	GCTM
3	UCB
4	UCI
5	JMA
6	MATCH.CCM3
7	MATCH.NCEP
8	MATCH.MACCM2
9	NIES
A	NIRE
B	TM2
C	TM3



Observed value

- 3 models that most closely reproduce the observed annual-mean vertical CO_2 gradients (4, 5, and C):

  Northern Land = -1.5 ± 0.6 $PgCyr^{-1}$

  Tropical Land = $+0.1 \pm 0.8$ $PgCyr^{-1}$

- All model average:

  Northern Land = -2.4 ± 1.1 $PgCyr^{-1}$

  Tropical Land = $+1.8 \pm 1.7$ $PgCyr^{-1}$

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 *observed: total fine/leaf only*
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

Observed Leaf Litter pool and Total Fine and Leaf Litterfall Compared to CLAMP CLM-CASA Q=1.5, Leaf Litterpool and Leaf Litter fall

Biome Class	Modeled Leaf Litterfall ($gC/m^2/year$)	Observed Total Fine Litterfall Mean (se) ($gC/m^2/year$)	Observed Leaf Litterfall (se) ($gC/m^2/year$)	Modeled Litter Leaf Pool (gC/m^2)	Observed Total Fine Litter Pool Mean (se) (gC/m^2)	Observed Leaf Litter Pool Mean (se) (gC/m^2)	Leaf Litter Turnover (year) modeled *observed: total fine/leaf only*
Not Vegetated	25	-		67	-	-	2.7
Needleleaf Evergreen Temperate Tree	414	254(3) n=42	237 (6) n=21	2210	1140(20) n=38	412(27) n=8	5.3 *4/2*
Needleleaf Evergreen Boreal Tree	238	158(0) n=235	109 (1) n=146	2227	2395(7) n=289	614 (8) n=47	9.4 *15/6*
Broadleaf Evergreen Tropical Tree	551	400(6) n=39	320 (7) n=29	1963	643(19) n=27	281(62) n=2	3.6 *2/1*
Broadleaf Evergreen Temperate Tree	429	289(2) n=44	155 (4) n=18	2914	454(29) n=6	-(-) n=-	6.8 *2/-*
Broadleaf Deciduous Tropical Tree	644	295 (4) n=39	201 (3) n=24	1511	295 (15) n=15	439(41) n=5	2.3 *1/2*
Broadleaf Deciduous Temperate Tree	287	199(0) n=198	158 (1) n=93	1630	2089(69) n=78	1232(39) n=30	5.7 *10/8*
Broadleaf Deciduous Temperate Shrub	-	463(44) n=2	44 (9) n=2	-	- (-)	- (-)	-
Broadleaf Deciduous Boreal Shrub	56	- (-)	- (-)	450	- (-)	- (-)	8.0
C3 Arctic Grass	41	211(15) n=9	204 (17) n=8	318	515(26) n=14	384(28) n=6	7.8 *2/2*
C3 Non-Arctic Grass	986	- (-)	- (-)	2514	179 (26) n=5	-(-)	2.5
C4 Grass	1014	- (-)	- (-)	2210	- (-)	- (-)	2.2
Corn	364	- (-)	- (-)	1097	- (-)	- (-)	3.0

Observed Leaf Litter pool and Total Fine and Leaf Litterfall Compared to CLAMP CLM-CASA Q=2.0, Leaf Litterpool and Leaf Litter fall

Biome Class	Modeled Leaf Litterfall ($gC/m^2/year$)	Observed Total Fine Litterfall Mean (se) ($gC/m^2/year$)	Observed Leaf Litterfall (se) ($gC/m^2/year$)	Modeled Litter Leaf Pool (gC/m^2)	Observed Total Fine Litter Pool Mean (se) (gC/m^2)	Observed Leaf Litter Pool Mean (se) (gC/m^2)	Leaf Litter Turnover (year) modeled *observed: total fine/leaf only*
Not Vegetated	25	-		86	-	-	3.4
Needleleaf Evergreen Temperate Tree	425	254(3) n=42	237 (6) n=21	3476	1140(20) n=38	412(27) n=8	8.2 *4/2*
Needleleaf Evergreen Boreal Tree	238	158(0) n=235	109 (1) n=146	4667	2395(7) n=289	614 (8) n=47	19.6 *15/6*
Broadleaf Evergreen Tropical Tree	565	400(6) n=39	320 (7) n=29	2188	643(19) n=27	281(62) n=2	3.9 *2/1*
Broadleaf Evergreen Temperate Tree	434	289(2) n=44	155 (4) n=18	5122	454(29) n=6	-(-) n=-	11.8 *2/-*
Broadleaf Deciduous Tropical Tree	648	295 (4) n=39	201 (3) n=24	1593	295 (15) n=15	439(41) n=5	2.5 *1/2*
Broadleaf Deciduous Temperate Tree	296	199(0) n=198	158 (1) n=93	2662	2089(69) n=78	1232(39) n=30	9.0 *10/8*
Broadleaf Deciduous Temperate Shrub	-	463(44) n=2	44 (9) n=2	-	- (-)	- (-)	-
Broadleaf Deciduous Boreal Shrub	55	- (-)	- (-)	1048	- (-)	- (-)	19.1
C3 Arctic Grass	41	211(15) n=9	204 (17) n=8	719	515(26) n=14	384(28) n=6	17.6 *2/2*
C3 Non-Arctic Grass	974	- (-)	- (-)	3243	179 (26) n=5	-(-)	3.3
C4 Grass	1013	- (-)	- (-)	2120	- (-)	- (-)	2.1
Corn	355	- (-)	- (-)	1536	- (-)	- (-)	4.3