Extending measurements in long-term permanent sites using a mobile observation system

Dan Yakir, Eyal Rotenberg, Efrat Ramati, Shani Rohatyn and Feyodor Tatarinov

Earth & Planetary Sciences,

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Biogeochemical monitoring as a means for tracking ecosystem functioning under changing conditions-using past research for planning future monitoring programs

Support: KKL, Lewis & Wills, ISF, Minerva, Water Authority; WIS

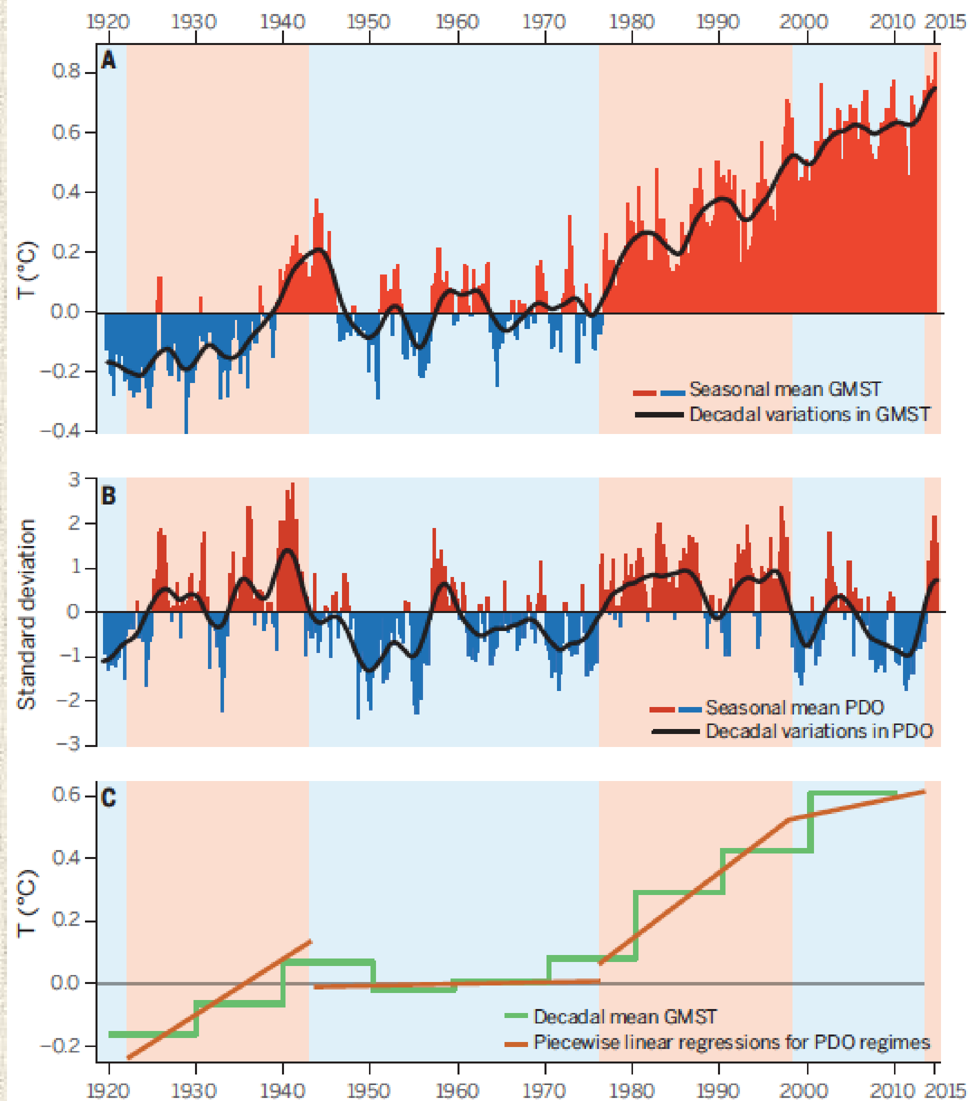
CLIMATE CHANGE

Has there been a hiatus?

Internal climate variability masks climate-warming trends

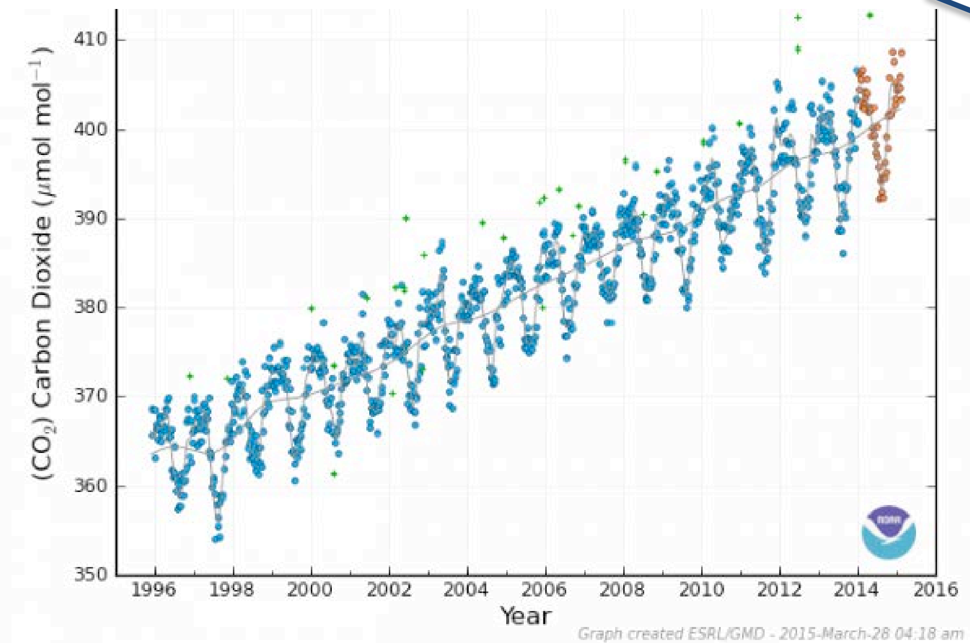
By **Kevin E. Trenberth**

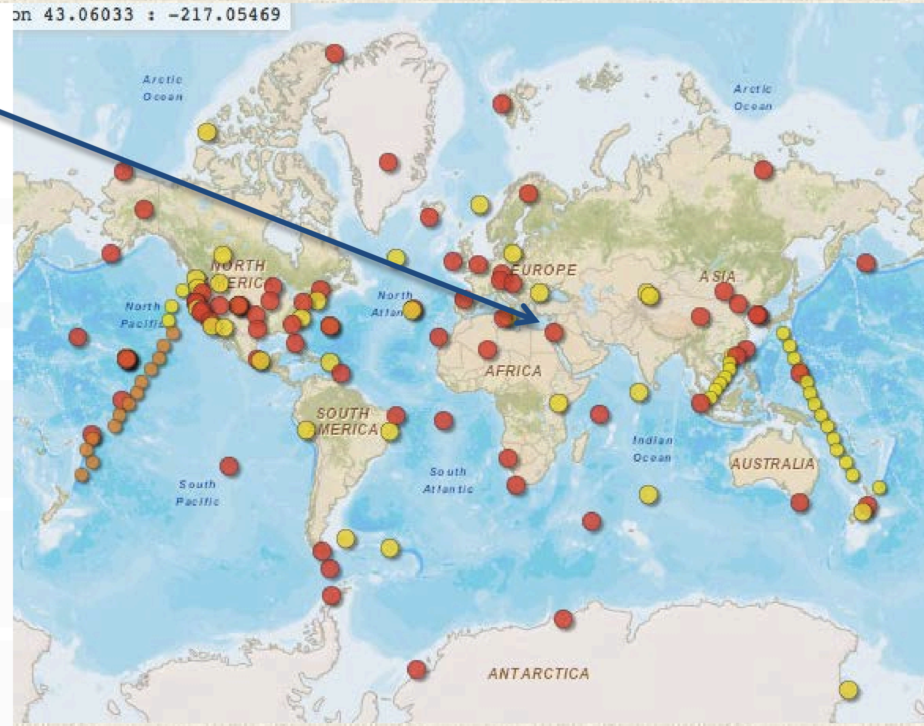
as a result of internal natural variability.

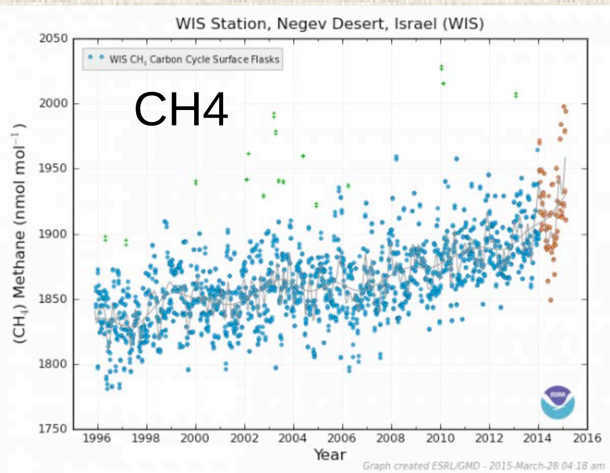


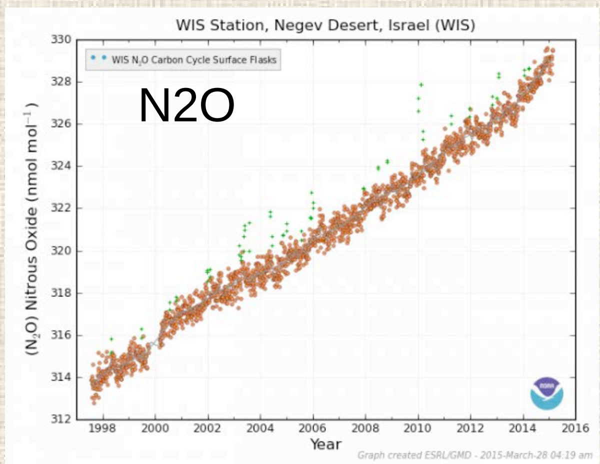
The relentless increase in “greenhouse” gases

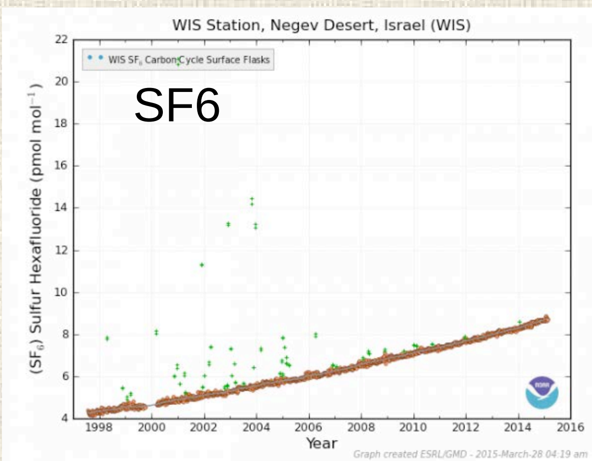
Weizmann Inst. Station Negev Desert Israel (WIS)





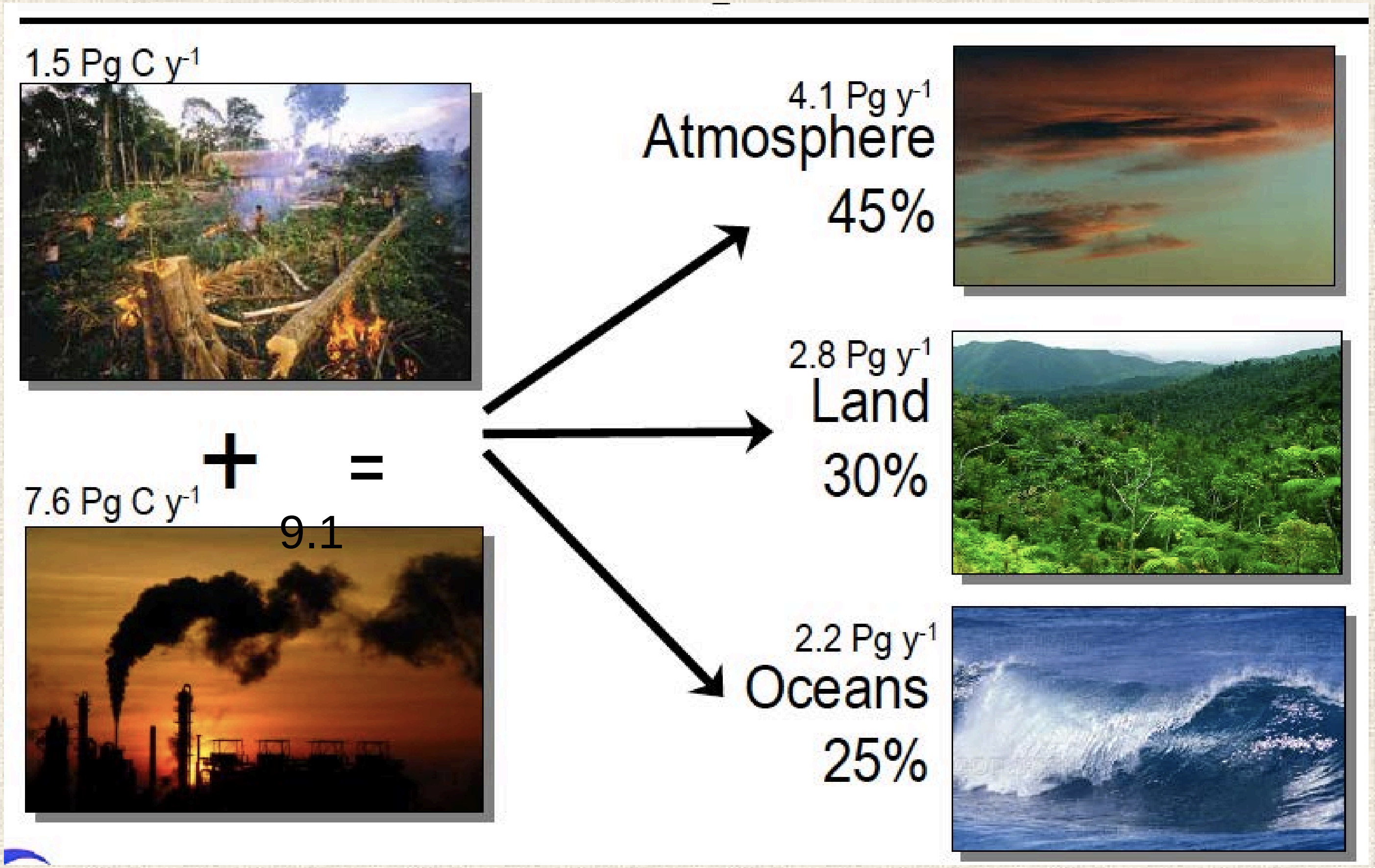




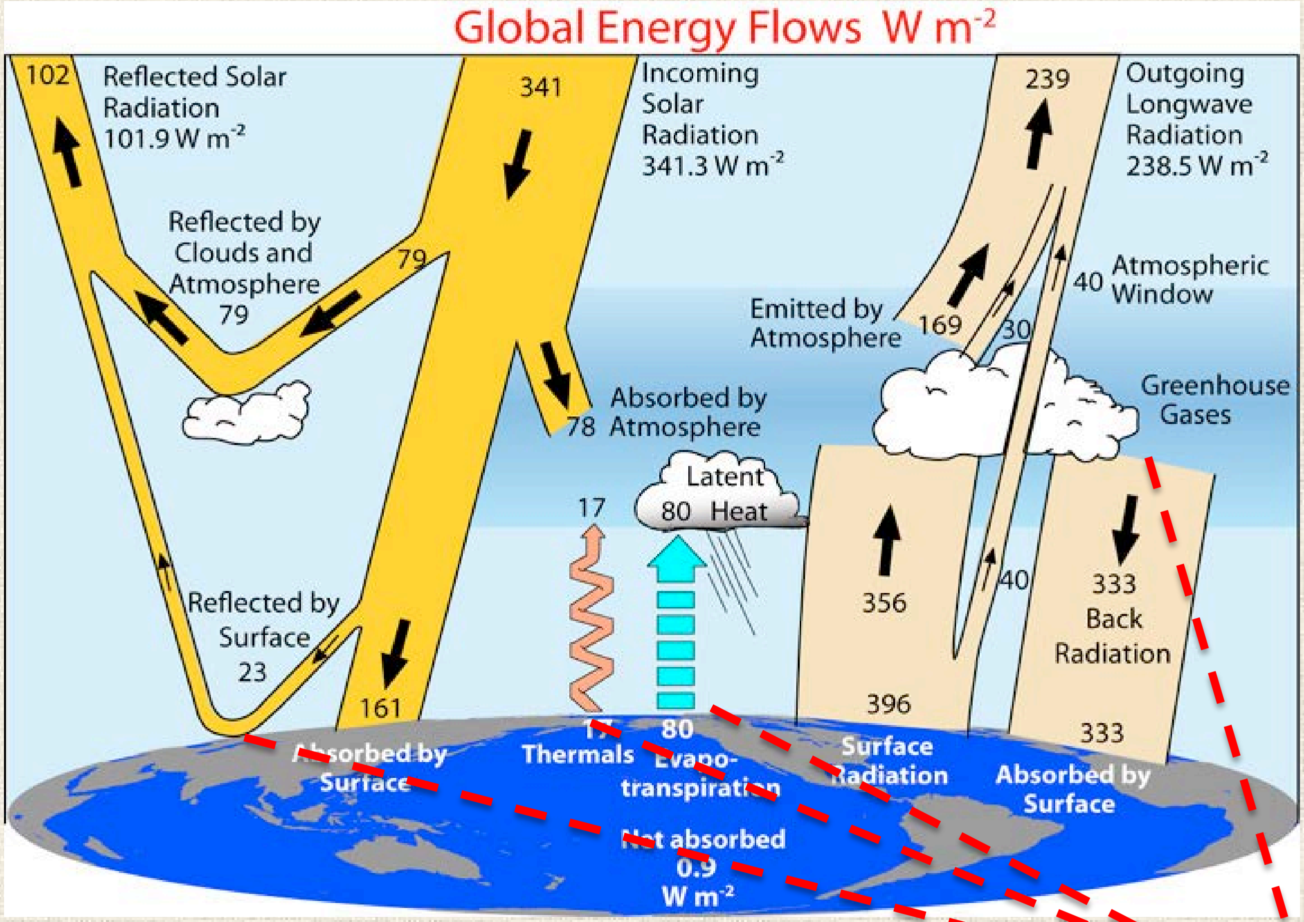


“Biogeochemisty”

Carbon sinks and the ‘Airborne Fraction’ (4.1/9.1= 0.45)



Biogeophysics
The many ways vegetation interacts with the climate system



Forests and land cover, land use effects

Increasing consideration of "biogeophysical" effects

Offset of the potential carbon sink from boreal forestation by decreases in surface albedo

Richard A. Betts

Hadley Centre for Climate Prediction and Research, The Met Office, Bracknell, Berkshire RG12 2SY, UK

Separating the effects of albedo from eco-physiological changes on surface temperature along a successional chronosequence in the southeastern United States

Jehn-Yih Juang,[1,2] Gabriel Katul,[1,3] Mario Siqueira,[1,4] Paul Stoy,[1,5] and Kimberly Novick[1]

Received 24 July 2007; revised 2 October 2007; accepted 15 October 2007; published 15 November 2007.

nature climate change LETTERS
PUBLISHED ONLINE: 24 AUGUST 2014 | DOI: 10.1038/NCLIMATE2347

Human land-use-driven reduction of forest volatiles cools global climate

Nadine Unger

INTERNATIONAL JOURNAL OF CLIMATOLOGY
Int. J. Climatol. **34**: 929–953 (2014)
Published online 21 June 2013 in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/joc.3736
RMetS Royal Meteorological Society

Review

Land cover changes and their biogeophysical effects on climate

Rezaul Mahmood,[a*] Roger A. Pielke, Sr.[b] Kenneth G. Hubbard,[c] Dev Niyogi,[d,e] Paul A. Dirmeyer,[f] Clive McAlpine,[g] Andrew M. Carleton,[h] Robert Hale,[i] Samuel Gameda,[j] Adriana Beltrán-Przekurat,[k] Bruce Baker,[l] Richard McNider,[m] David R. Legates,[n] Marshall Shepherd,[o] Jinyang Du,[p] Peter D. Blanken,[q] Oliver W. Frauenfeld,[r] U.S. Nair[m,s] and Souleymane Fall[t]

REVIEWS REVIEWS REVIEWS

Biophysical considerations in forestry for climate protection

Ray G Anderson[1*], Josep G Canadell[2], James T Randerson[1], Robert B Jackson[3], Bruce A H Dennis D Baldocchi[5], George A Ban-Weiss[6], Gordon B Bonan[7], Ken Caldeira[6], Long Cao[6], Noah S Diffenbaugh[8,9], Kevin R Gurney[8], Lara M Kueppers[10], Beverly E Law[11], Sebastiaan and Thomas L O'Halloran[11]

Biogeophysical versus biogeochemical climate response to historical anthropogenic land cover change

J. Pongratz,[1,2,3] C. H. Reick,[2] T. Raddatz,[2] and M. Claussen[2,4]

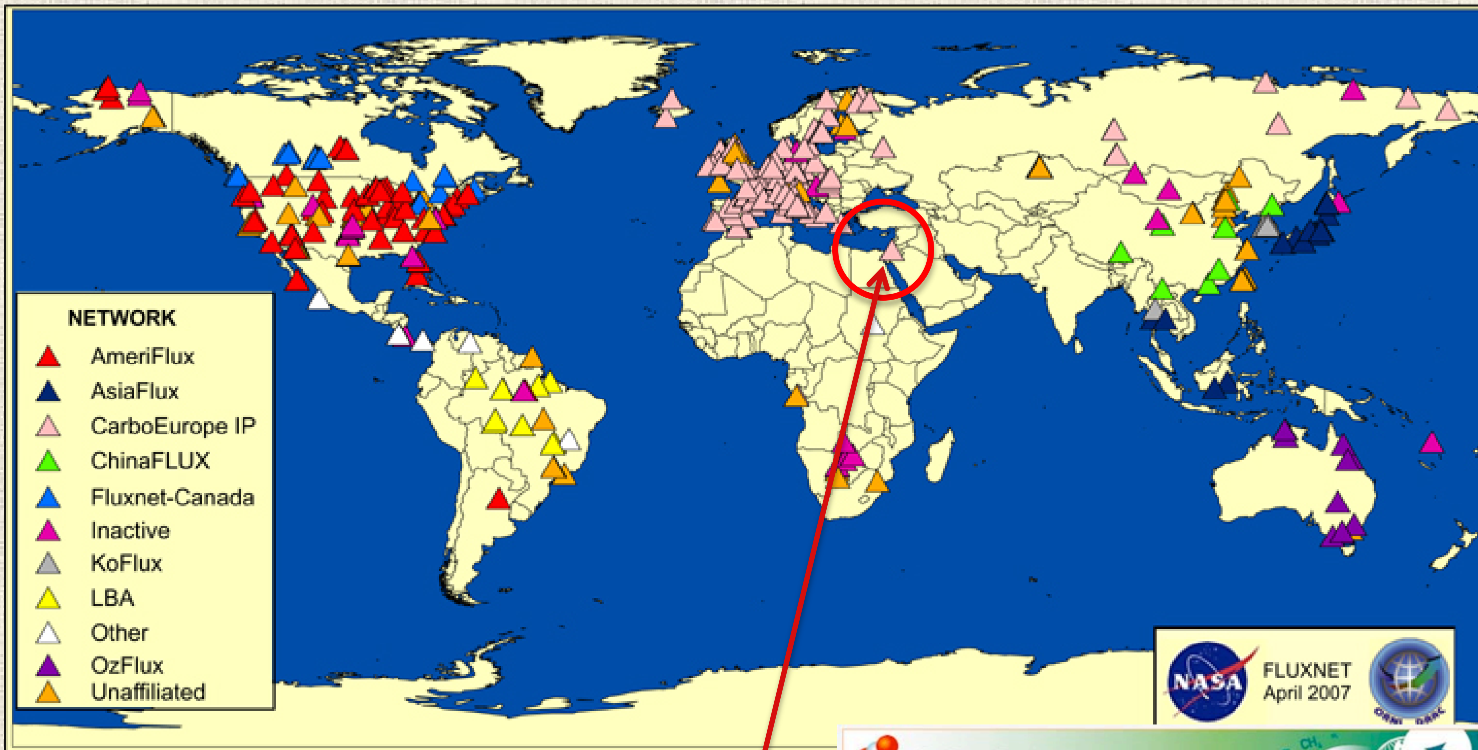
Received 22 February 2010; revised 11 March 2010; accepted 15 March 2010; published 22 April 2010.

Climatic Impact of Global-Scale Deforestation: Radiative versus Nonradiative Processes

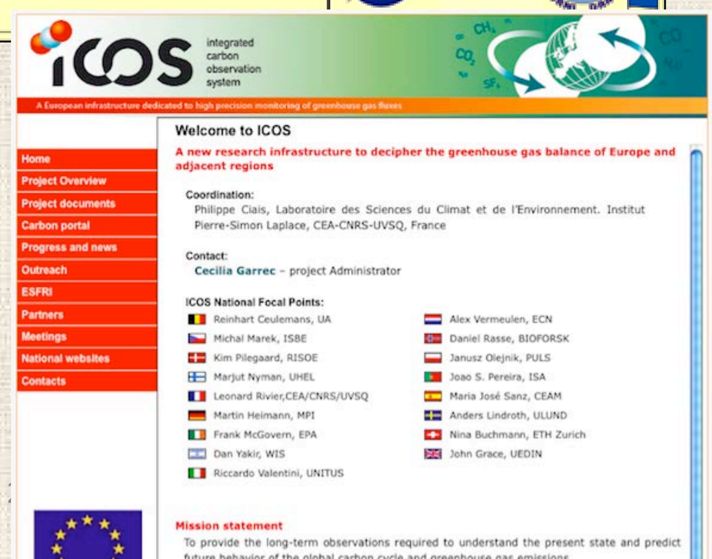
EDOUARD L. DAVIN* AND NATHALIE DE NOBLET-DUCOUDRÉ

Le Laboratoire des Sciences du Climat et l'Environnement, L'Institut Pierre-Simon Laplace (UMR CEA–CNRS–l'Université de Versailles Saint-Quentin-en-Yvelines), Gif-sur-Yvette, France

Great global effort, but imperfect coverage...



Yatir Research Site



Increasing consideration of the semi-arid regions effects

CARBON CYCLE

The dominant role of semi-arid ecosystems in the trend and variability of the land CO_2 sink

Anders Ahlström,[1,2*] Michael R. Raupach,[3†] Guy Schurgers,[4] Benjamin Smith,[1] Almut Arneth,[5] Martin Jung,[6] Markus Reichstein,[6] Josep G. Canadell,[7] Pierre Friedlingstein,[8] Atul K. Jain,[9] Etsushi Kato,[10] Benjamin Poulter,[11] Stephen Sitch,[12] Benjamin D. Stocker,[13,14] Nicolas Viovy,[15] Ying Ping Wang,[16] Andy Wiltshire,[17] Sönke Zaehle,[6] Ning Zeng[18]

LETTER

doi:10.1038/nature13376

Contribution of semi-arid ecosystems to interannual variability of the global carbon cycle

Benjamin Poulter[1,2], David Frank[3,4], Philippe Ciais[2], Ranga B. Myneni[5], Niels Andela[6], Jian Bi[5], Gregoire Broquet[2], Josep G. Canadell[7], Frederic Chevallier[2], Yi Y. Liu[8], Steven W. Running[9], Stephen Sitch[10] & Guido R. van der Werf[6]

Science AAAS

Contribution of Semi-Arid Forests to the Climate System
Eyal Rotenberg and Dan Yakir
Science **327**, 451 (2010);
DOI: 10.1126/science.1179998

Carbon sequestration in semi-arid forest

Table 1. Indicators of carbon use efficiency in pine forests: Gross primary productivity (GPP), ecosystem respiration (R_e) and net ecosystem exchange (NEE) of carbon for the 12 European pine forest sites (62 data years, *36*), for the entire global Fluxnet network (*43*), and for semiarid forest (Yatir; *44*).

Pine forest	GPP	Re	NEE	NEE/GPP
European (Carboeurope)	1142	944	200	0.17
Global (FluxNet)	1540	1280	260	0.17
Semi-arid (Yatir)	820	600	220	0.27

gr carbon m^{-2}

Large albedo effect, +24 Wm^{-2}
(high radiation, no clouds)

Air-cooled canopy…
('convector effect')

Water-cooled canopy…

*Cooling vs. non-forest area:
~5C annual mean;
up to ~30C in mid-day

*Thermal emission
suppression of +25 W m^{-2}

Semi-arid afforestation balance sheet:

Variable	Forest	Shrubland	
Global radiation (Eg, Wm^{-2})	238	238	
Albedo (unit-less)	0.11	0.21	d=+23.8 Wm^{-2}
Net solar radiation (Sn, Wm^{-2})	212	188	
Net longwave radiation (Ln, Wm^{-2})	-96	-121	d=+25 Wm^{-2}
Net radiation (Rn=Sn+Ln, Wm^{-2})	115	67	d=+48 Wm^{-2}
Skin temperature [°C]	19	24*	

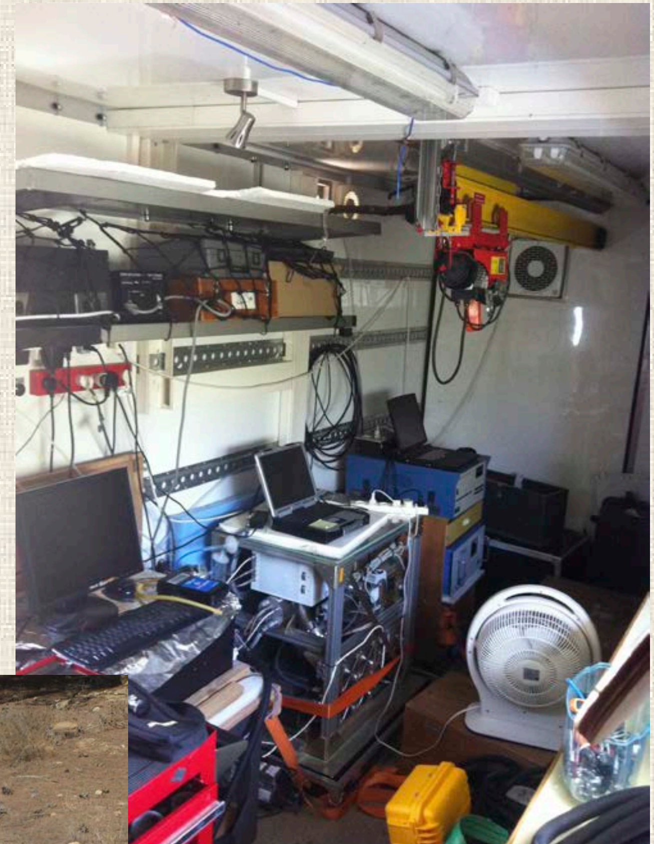
1. Cooling effect: C sequestration ~2.2 t ha-1 <1 W m^{-2}

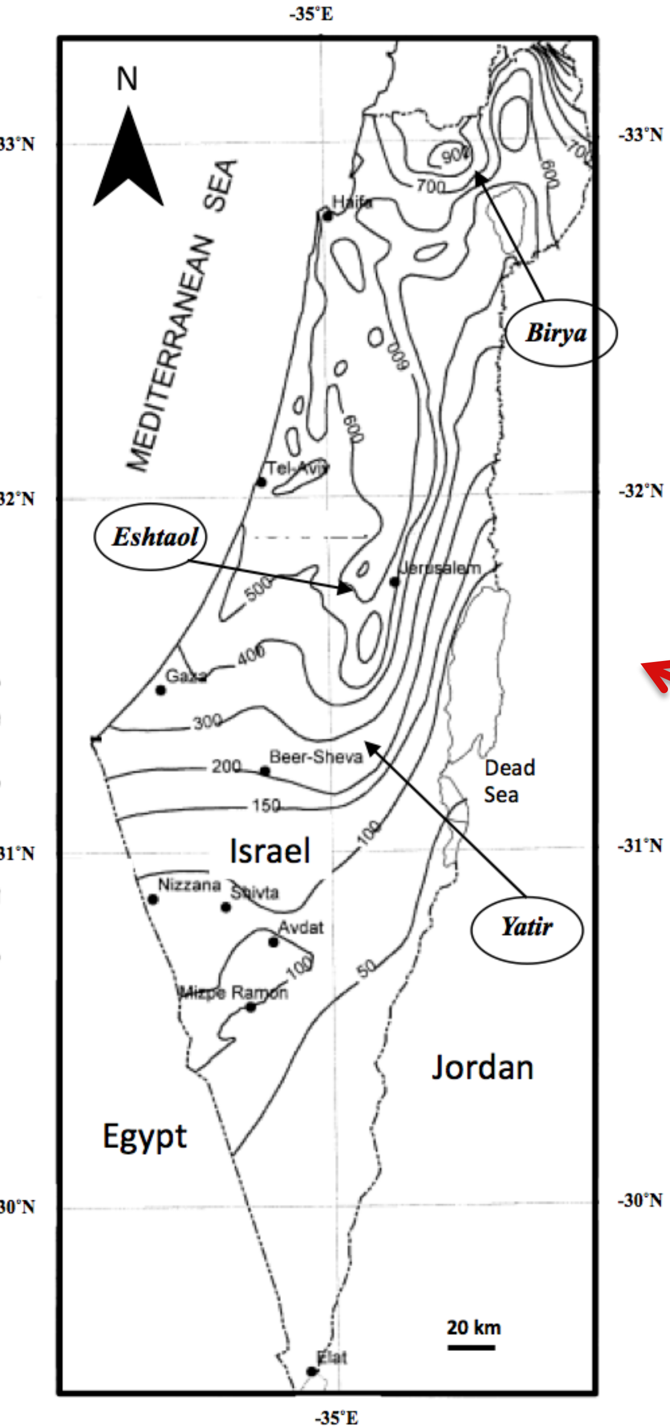
1. Warming effect: Increased surface radiation load ~48 w m^{-2}

1. Balance achieved only after ~50 years of C sequestration (worst case scenario)

Contribution of Semi-Arid Forests to the Climate System
Eyal Rotenberg, *et al.*
Science **327**, 451 (2010);
DOI: 10.1126/science.1179998

Extending the range with the WIS Mobile flux lab



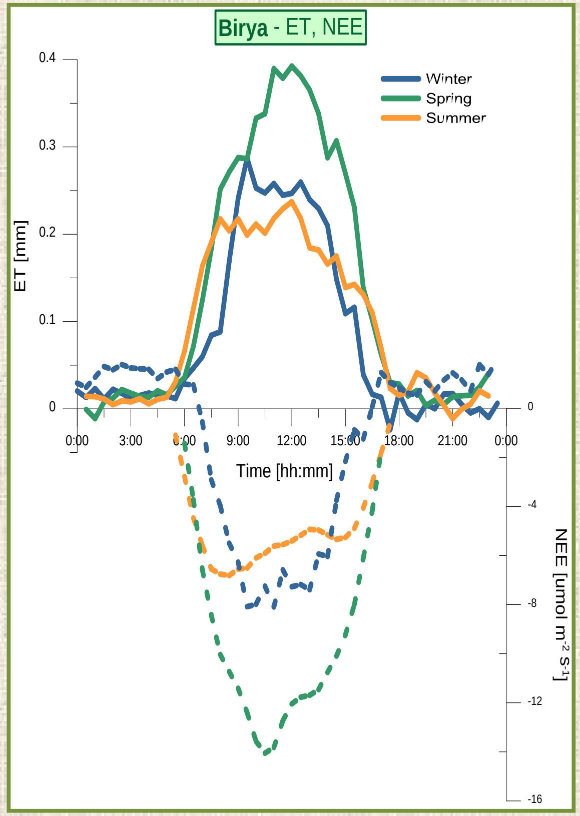


Climatic Gradient: precipitation data

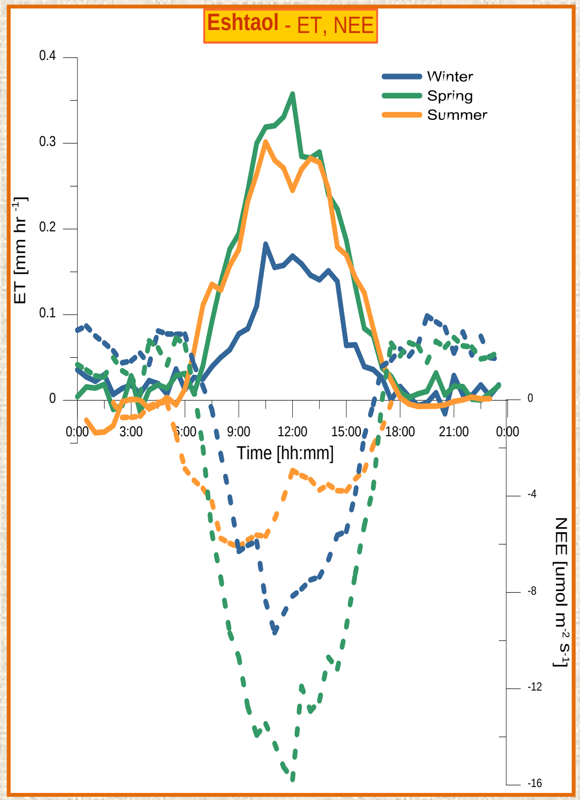
Forest	Location	records	mean (mm)	SE	min (mm)	min year	max (mm)	max year
Yatir	South	61	282	12	78	62/63	541	91/92
Eshtaol	Center	108	524	15	201	59/60	1107	91/92
Birya	North	74	750	21	412	78/79	1319	91/92

Forest scale NEE & ET diurnal curves
Along the climatic gradient

Campaign's daily average flux

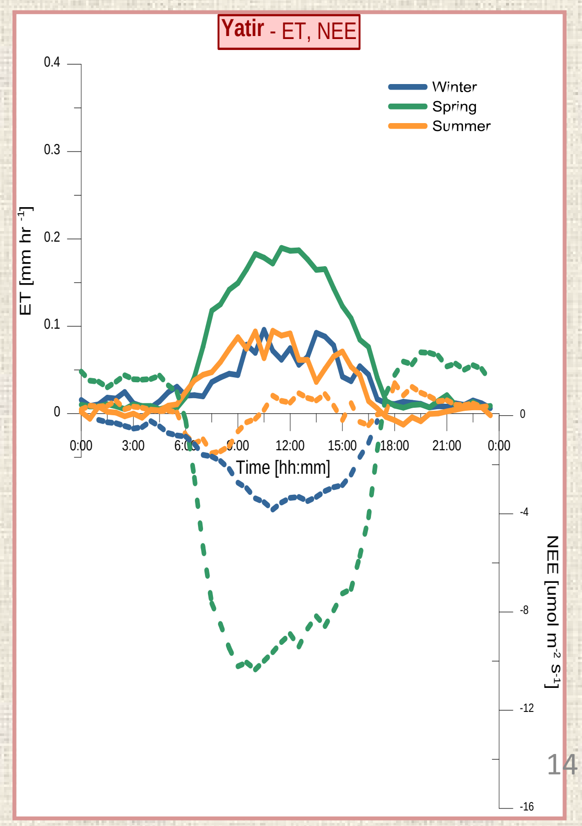


Sub-humid



Dry Mediterranean

Semi-arid/arid



Extrapolating data from short-term campaign to annual budgets

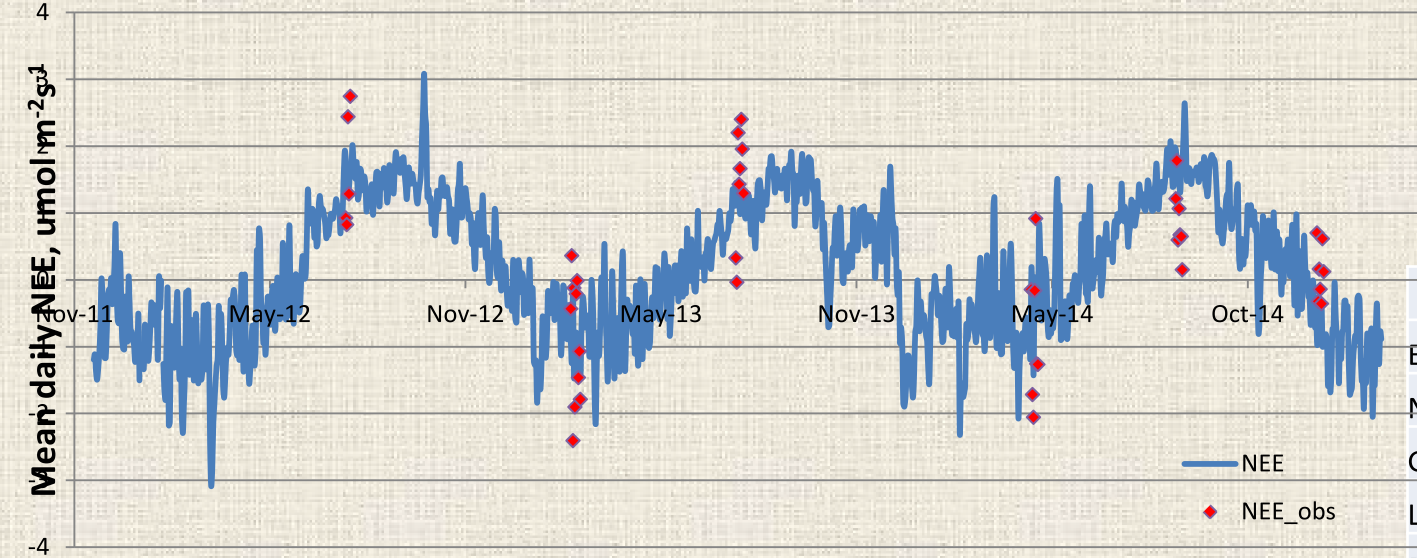
1
Flux data processing - average and sum per day

2
Multiple regression - Fluxes vs. Met. data

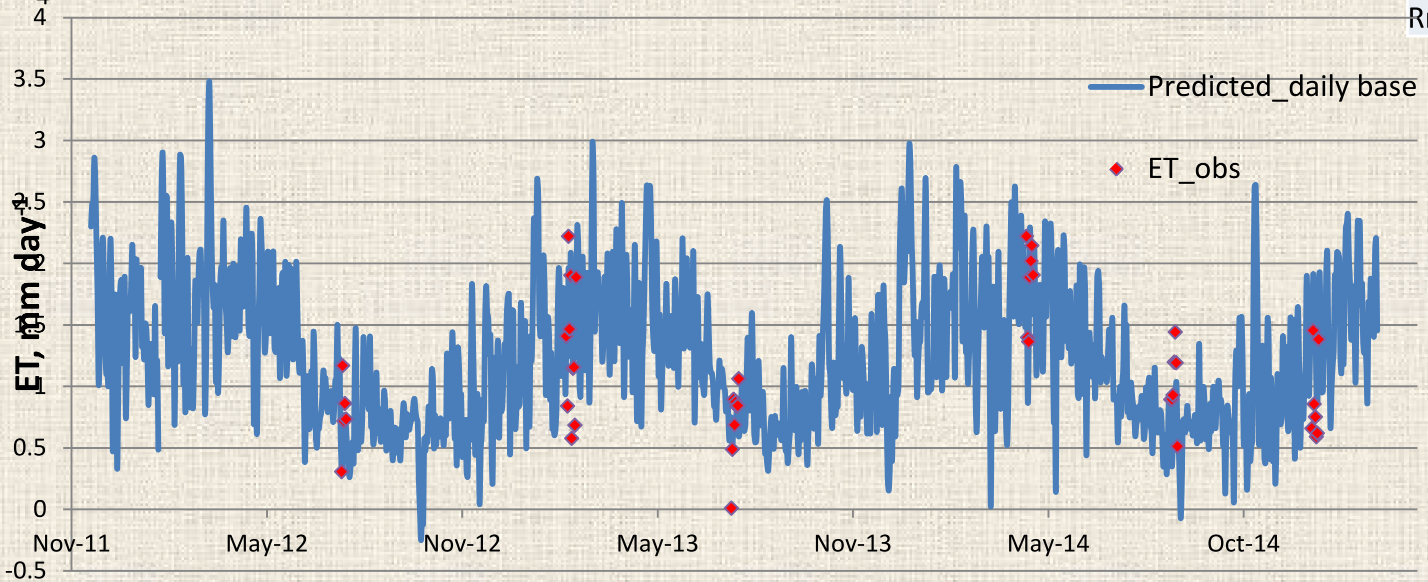
3
Meteorological data collecting & processing

4
Modeling annual fluxes and budgets

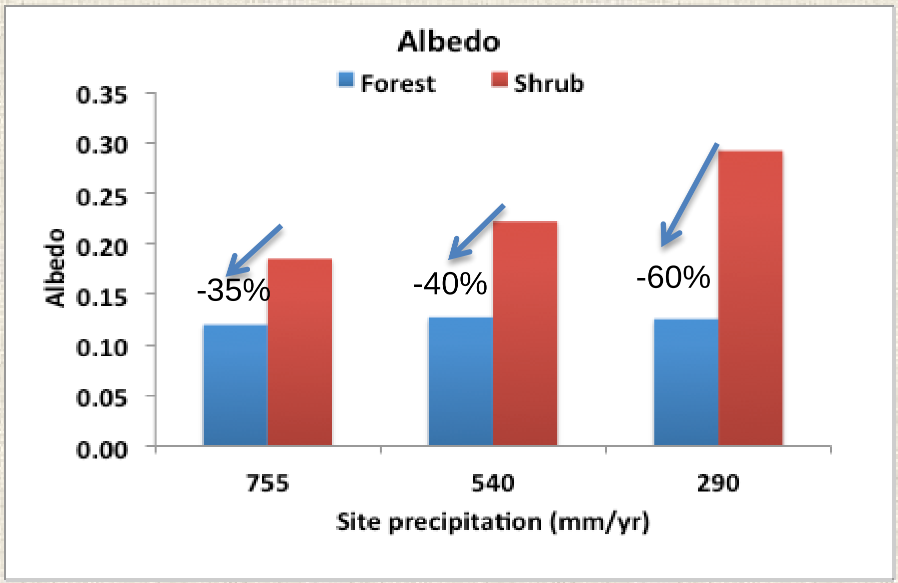
Extrapolations: single regression for all campaigns, daily-based (540 mm non-forest site)

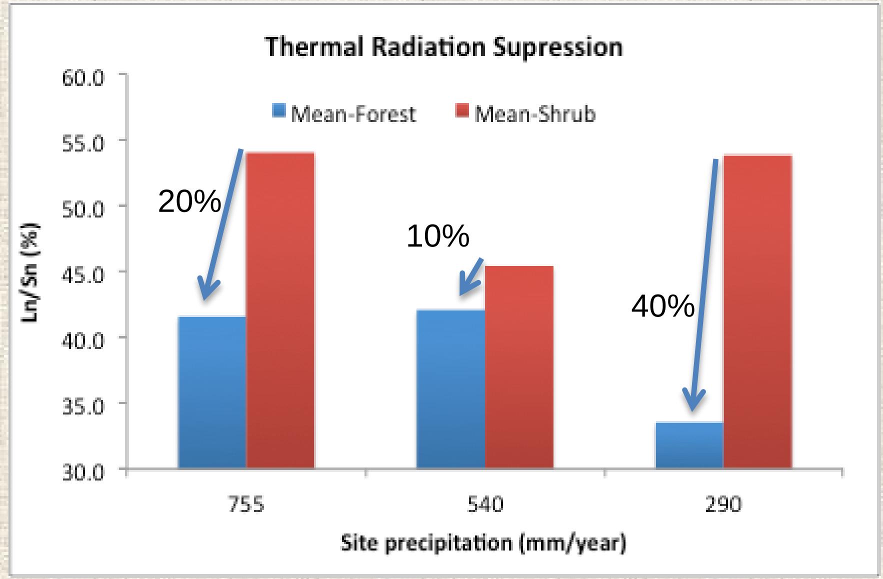


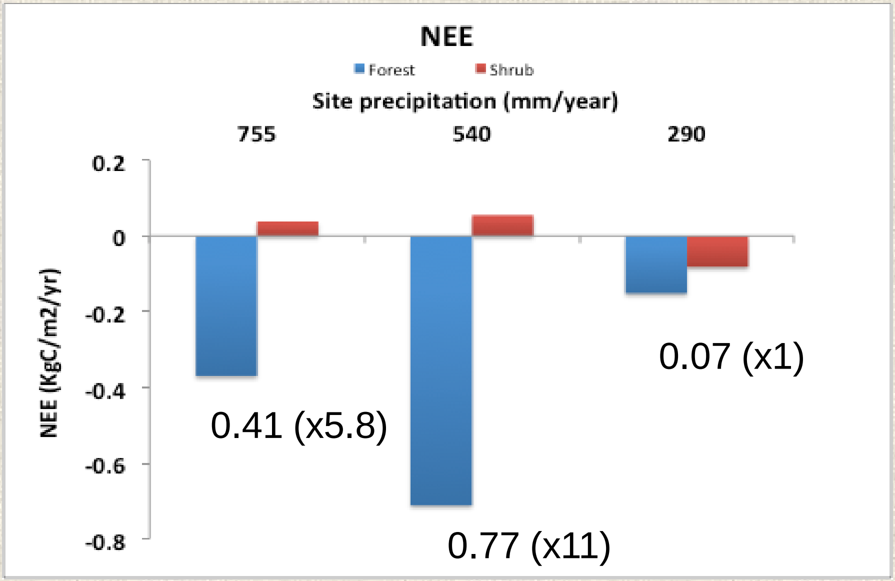
	R^2	R: all
ET	0.66	0.73
NEE	0.47	0.71
GPP	0.86	0.93
Lwnet	0.91	0.94
Rnet	1.00	0.97

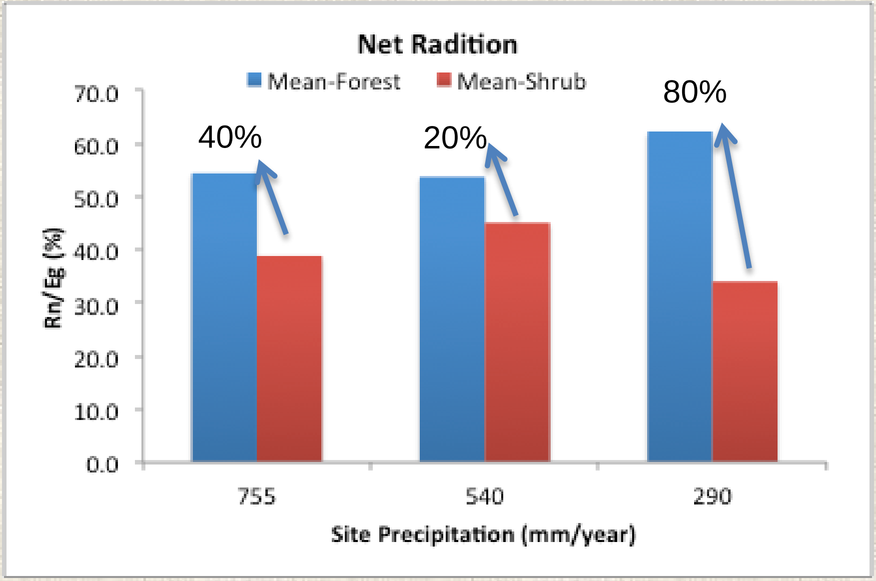


Annual scale estimates of changes in forestation effects









Afforestation along precipitation gradient: **Preliminary** balance sheet

Variable	Yatir (290 mm)	Birya (870 mm)
Albedo (W m-2)	24	12
Net Long Wave (W m-2)	25	16
Carbon uptake (NEE, Kg ha-1)	2	6
Net "Warming"	49	28
Net "Cooling"	<1	~5
Time to balance (years)	**>50**	**<6**

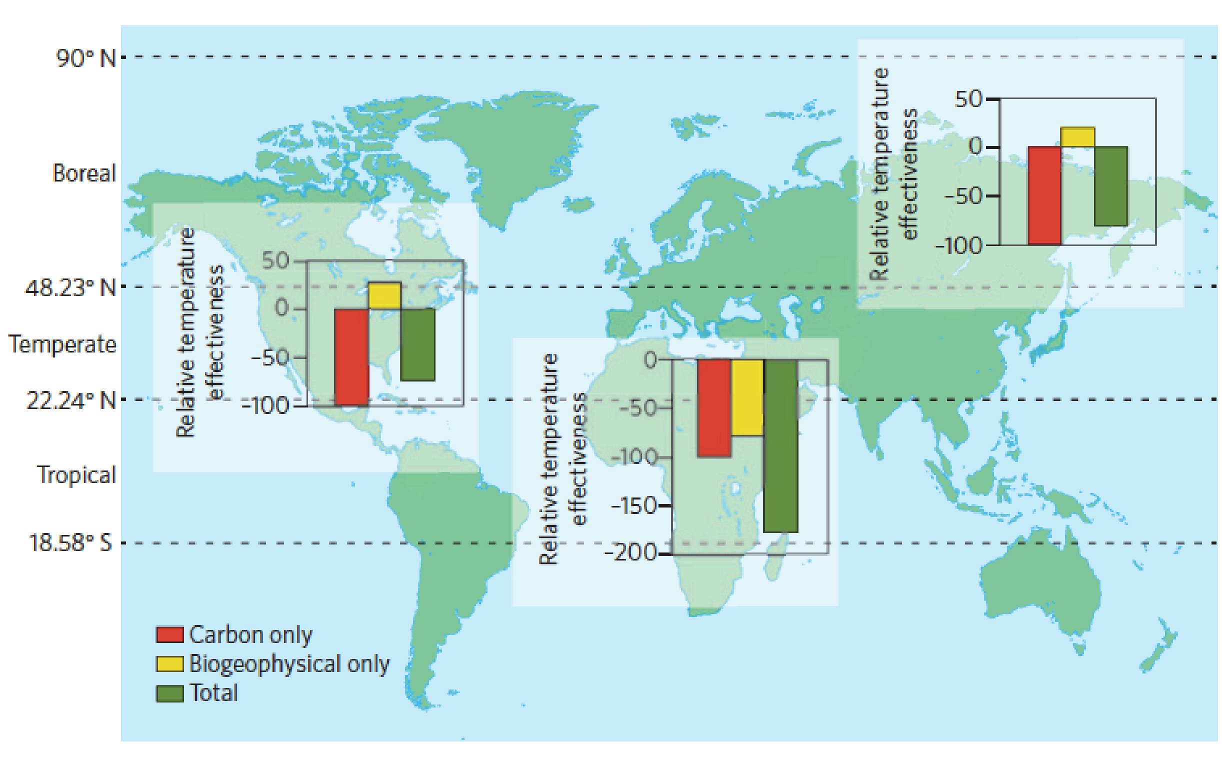
Tradeoffs between biogeochem. and biogeophys. effects occurs at higher resolution in the semi-arid transition zones—>the regions with the largest potential for afforestation?

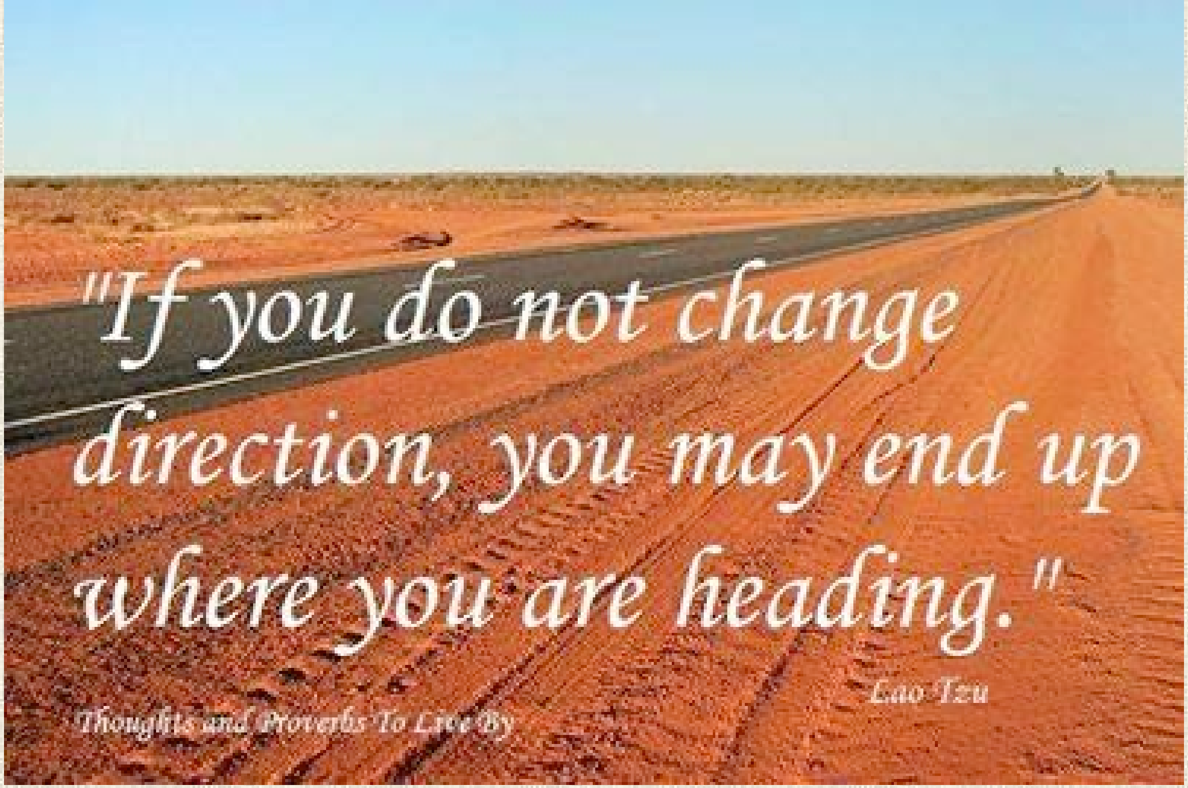
CLIMATE SCIENCE

Afforestation cools more or less

Forests affect climate not only by taking up carbon, but also by absorbing solar radiation and enhancing evaporation. In the tropics, the climate benefit of afforestation may be nearly double that expected from carbon budgets alone.

Richard A. Betts




"If you do not change direction, you may end up where you are heading."
Lao Tzu
Thoughts and Proverbs To Live By