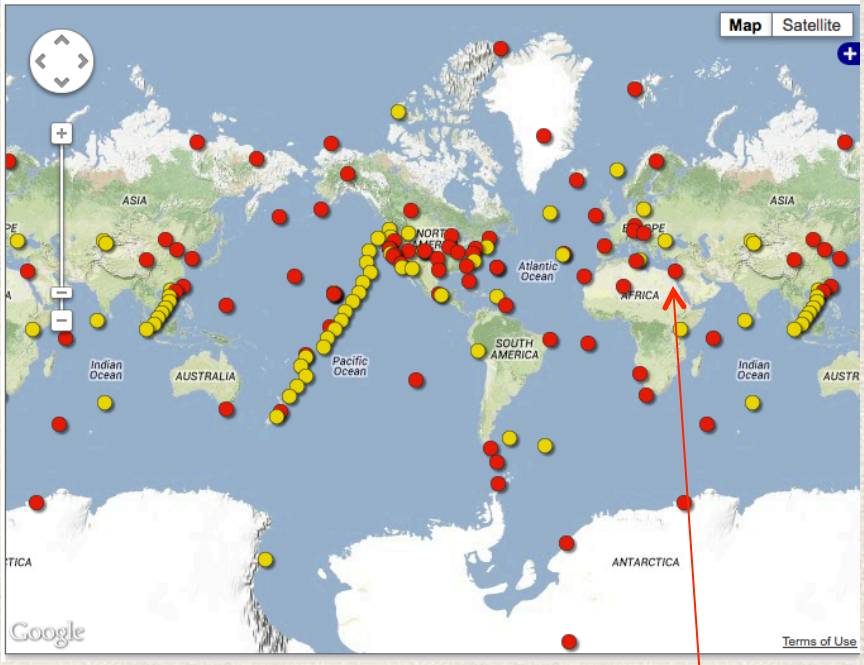
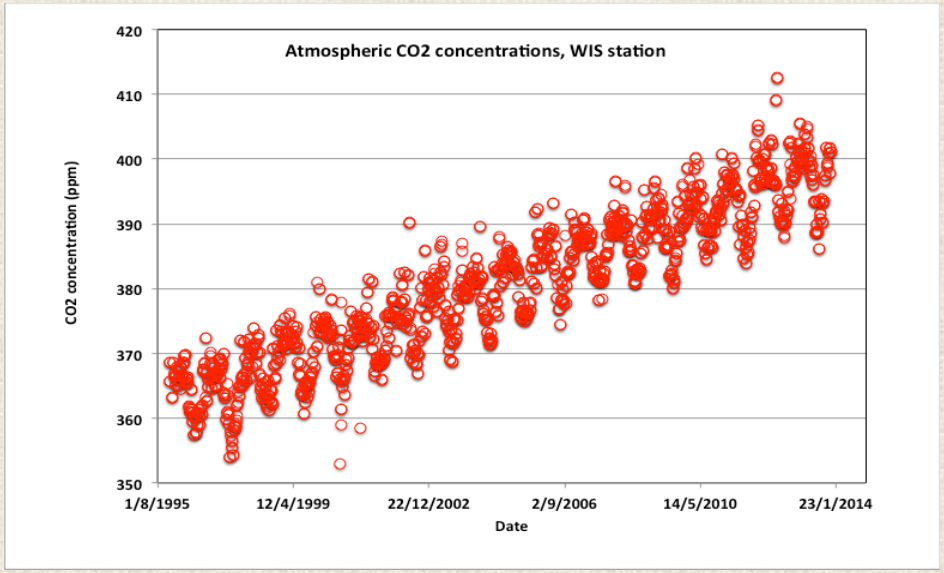
Extending ecosystem measurements across climatic gradient using a mobile observation system

Dan Yakir, Eyal Rotenberg, Shani Roahtyn, Efrat Ramati, Feydor Tatrinov, and the Yatir Team,

Department of Earth & Planetary Sciences

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE



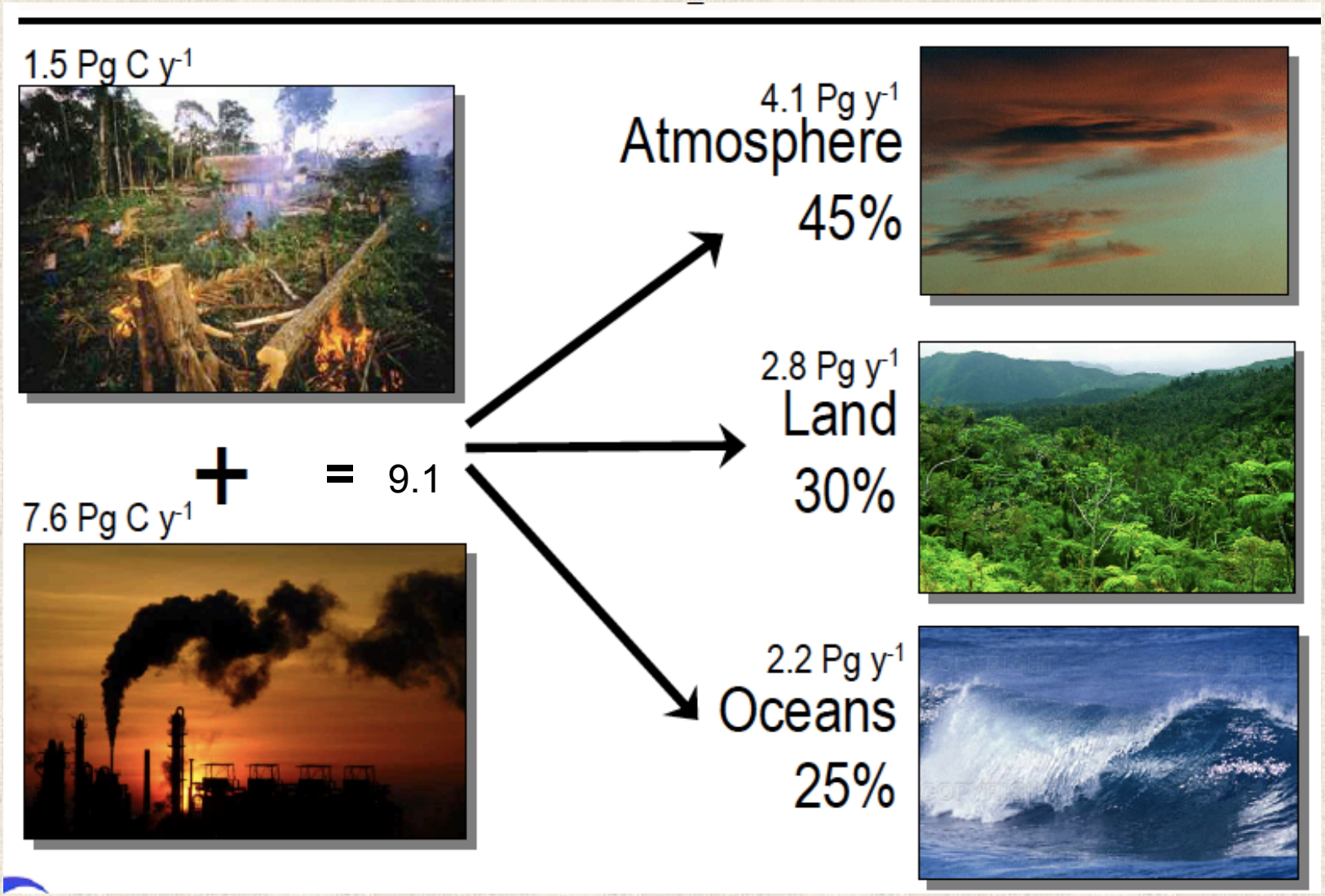


..plus, N_2O, H_2, CH4, CO, SF6, COS, ^{18}O-CO_2

NOAA, Global Cooperative air sampling network
Keeling 1958-1979
1979 8 sites
2013 ~90 sites

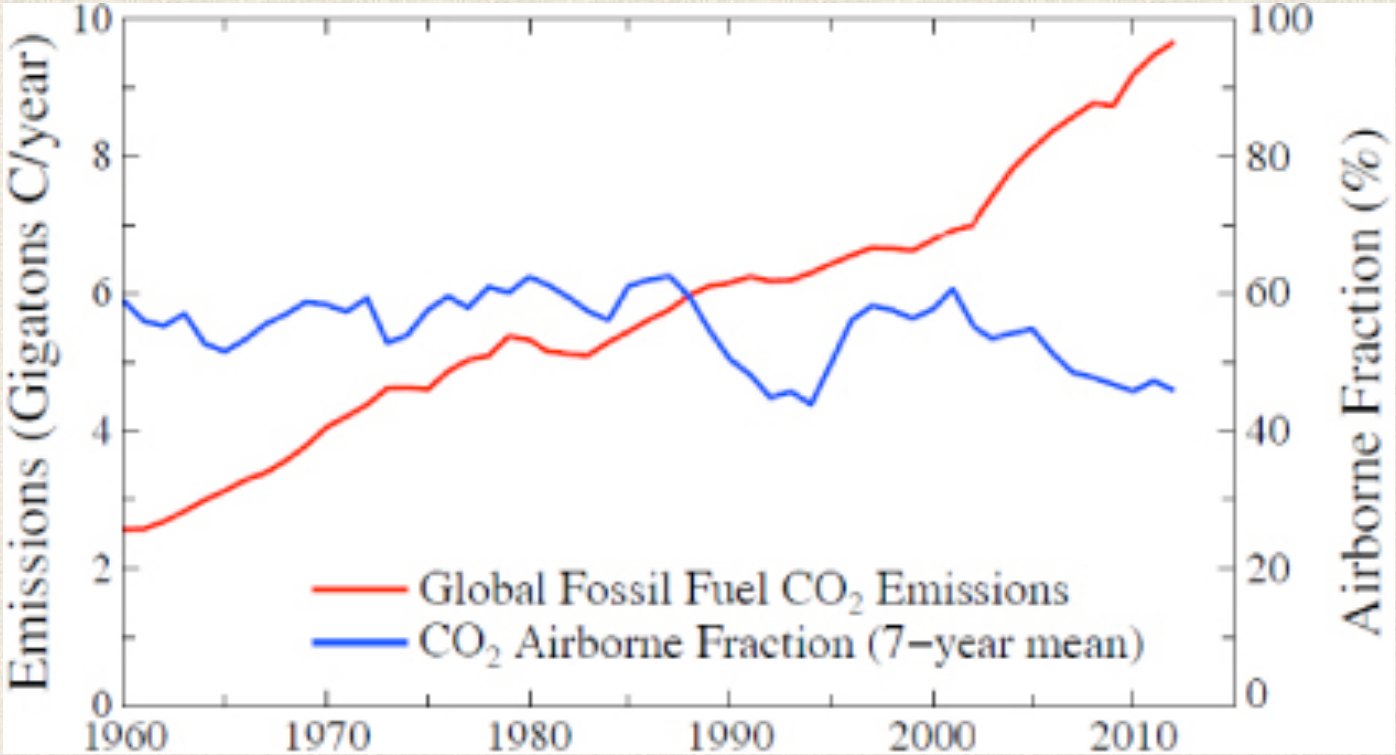
WIS station
(since Nov. 1995)

The ‘Airborne Fraction: 4.1/9.1= 0.45



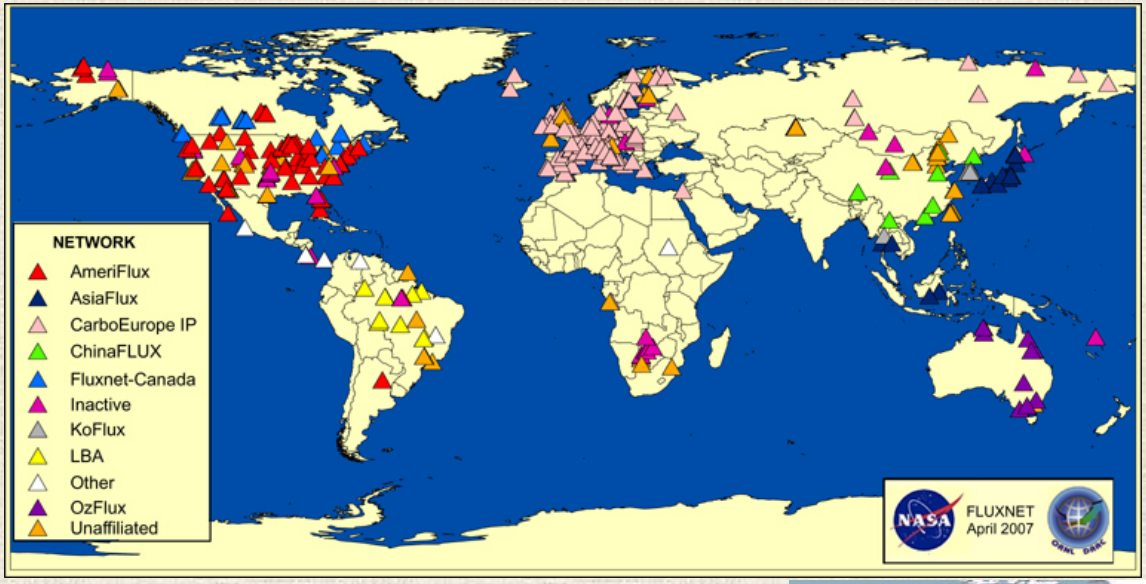
CO_2 fertilization is likely the major effect..

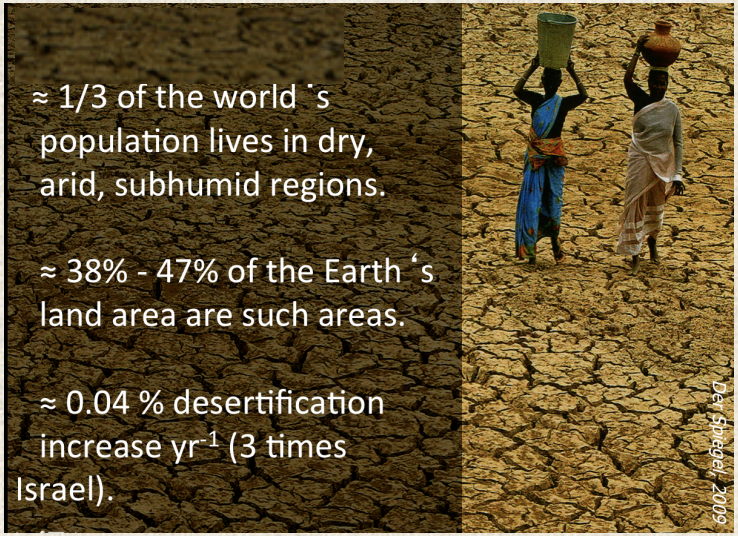
Hansen et al 2013

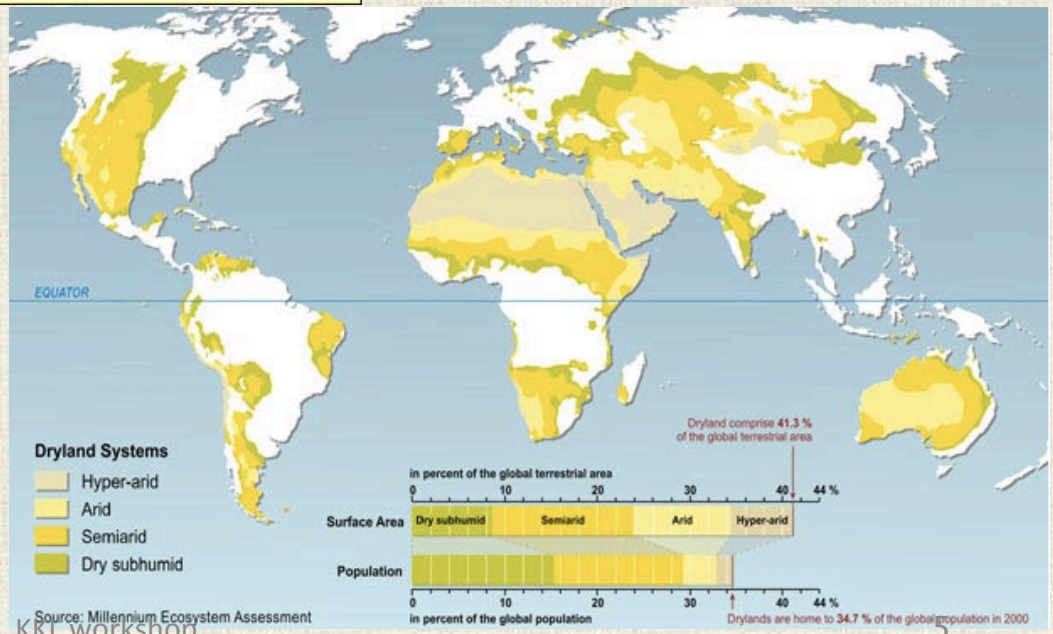


…around 2000, change of emission rate from 1:5%/yr to 3:1%/yr; airborne fraction-down from ~55 to ~45

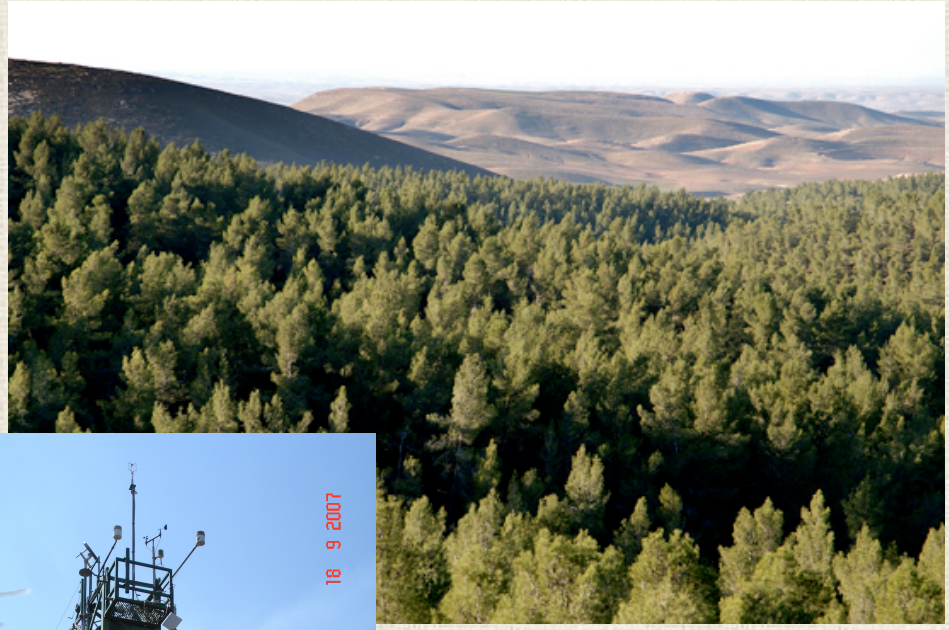
Poor correlation between research sites and climate diversity: Semi-arid regions poorly represented







The Yatir site, at the dry timberline



LETTERS TO NATURE

Fluxes of CO_2 and water between terrestrial vegetation and the atmosphere estimated from isotope measurements

Dan Yakir & Xue-Feng Wang

Department of Environmental Sciences and Energy Research, The Weizmann Institute of Science, Rehovot 76100, Israel

1996

Science AAAS

Influence of Carbonic Anhydrase Activity in Terrestrial Vegetation on the ^{18}O Content of Atmospheric CO_2

Jim Gillon and Dan Yakir

Science **291**, 2584 (2001);
DOI: 10.1126/science.1056374

COMMENTARY

LETTERS | BOOKS | POLICY FORUM | EDUCATION FORUM | PERSPECTIVES

LETTERS

edited by Jennifer Sills

Forests and Climate: A Warming Paradox

E. ROTENBERG AND D. YAKIR ("CONTRIBUTION OF SEMI-ARID FORESTS TO THE CLIMATE SYSTEM," Reports, 22 January, p. 451) showed that forestation may not be an effective tool for climate change mitigation. They found that in a semi-arid landscape, the warming potential of a for-

Forests and Climate: The Search for Specifics

E. ROTENBERG AND D. YAKIR ("CONTRIBUTION of semi-arid forests to the climate system,"

nature International weekly journal of science

concepts

Nature **416**, 795 (25 April 2002) | doi:10.1038/416795a

Global enzymes: Sphere of influence

Dan Yakir[1]

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

LETTERS

PUBLISHED ONLINE: 17 FEBRUARY 2013 | DOI: 10.1038/NGEO1730

nature geoscience

Ecosystem photosynthesis inferred from measurements of carbonyl sulphide flux

David Asaf[1], Eyal Rotenberg[1], Fyodor Tatarinov[1], Uri Dicken[1], Stephen A. Montzka[2] and Dan Yakir[1]*

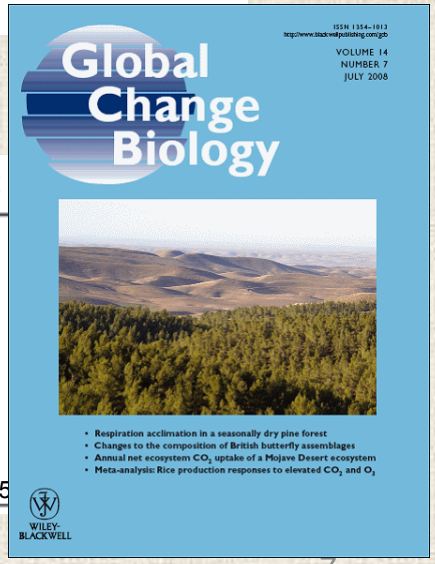
LETTERS TO NATURE

ant invasion of newly
xposed hypersaline
ead Sea shores

Dan Yakir* & Yoseph Yechieli†

ntal Sciences and Energy Research,
cience, Rehovot 76100, Israel
l, Jerusalem 95501, Israel

1995

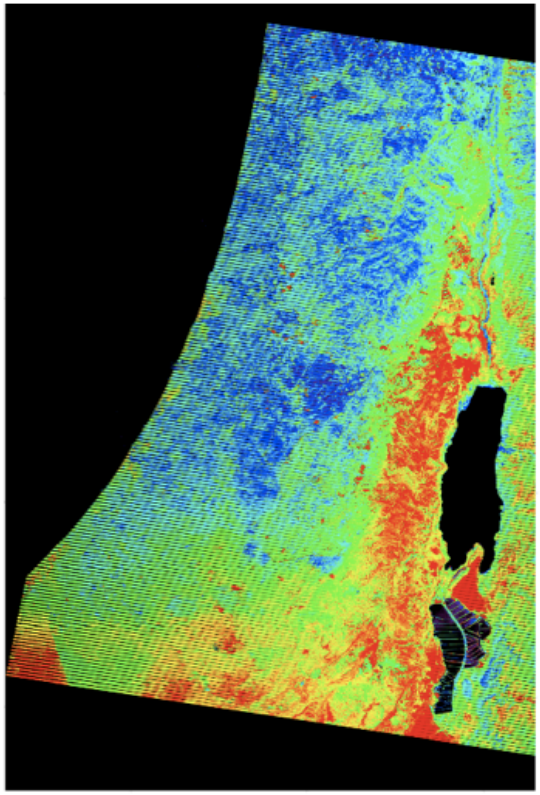


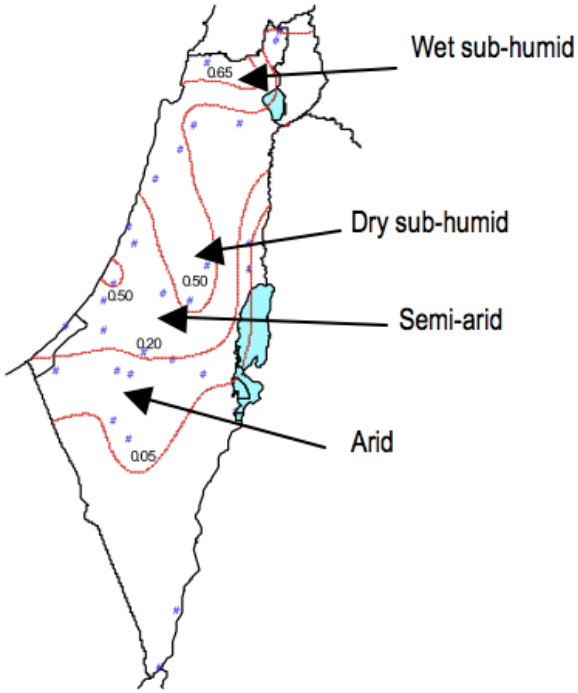
CLIMATE

Drylands in the Earth System

David S. Schimel

A study of one of the world's driest forests elucidates the climatic effects of drylands.

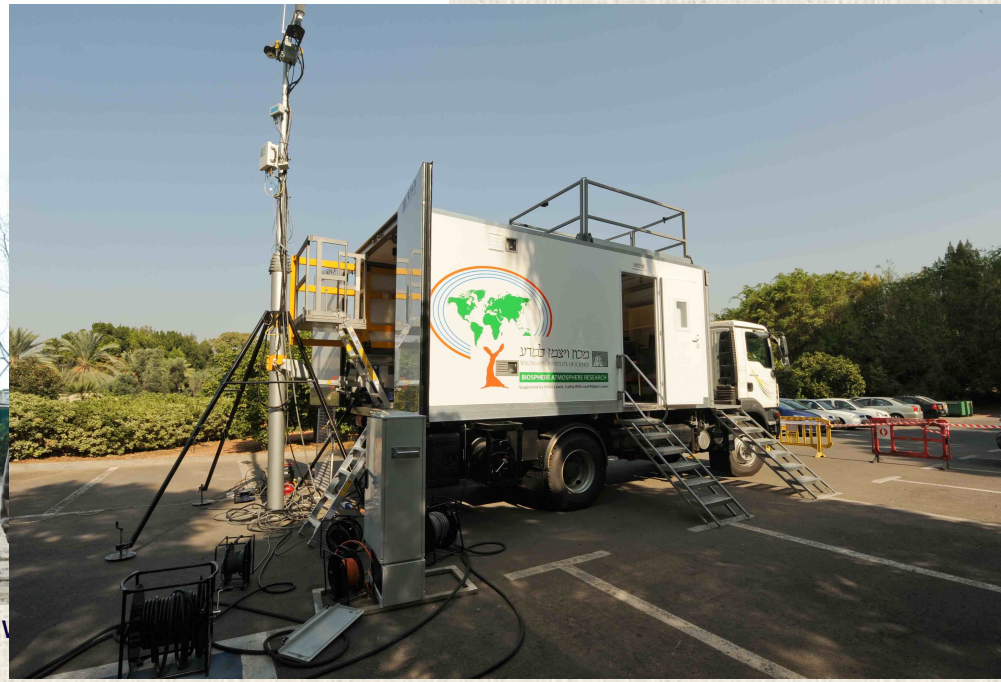




- Limitations of Measurements at one site in a highly heterogeneous region
- The need to quantify the response to climate
- The need for comparative data on different vegetation
- Utilizing the climatic gradient for the ‘space for time’ approach

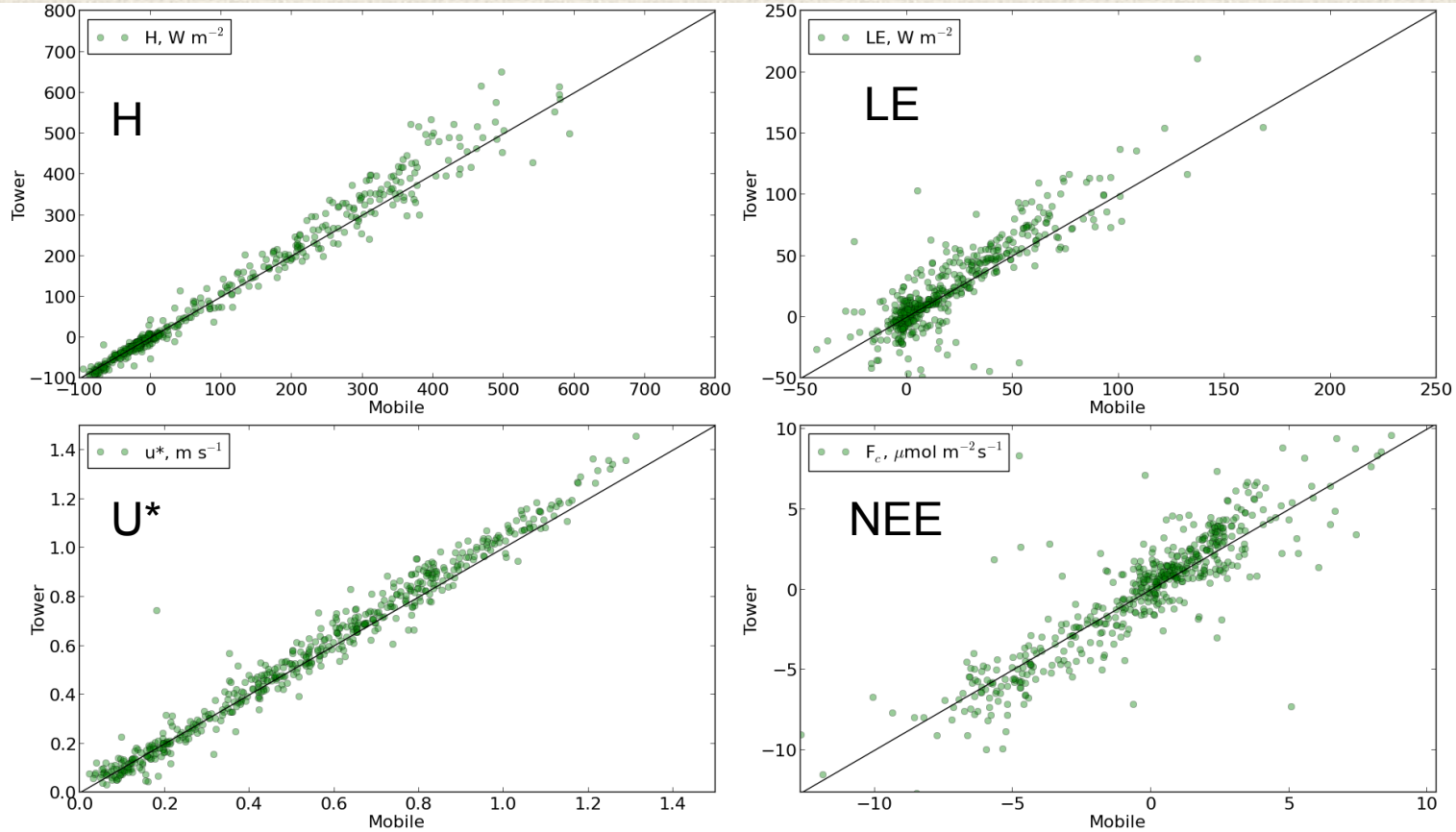
MAN

Extending the range With the WIS Mobile flux lab

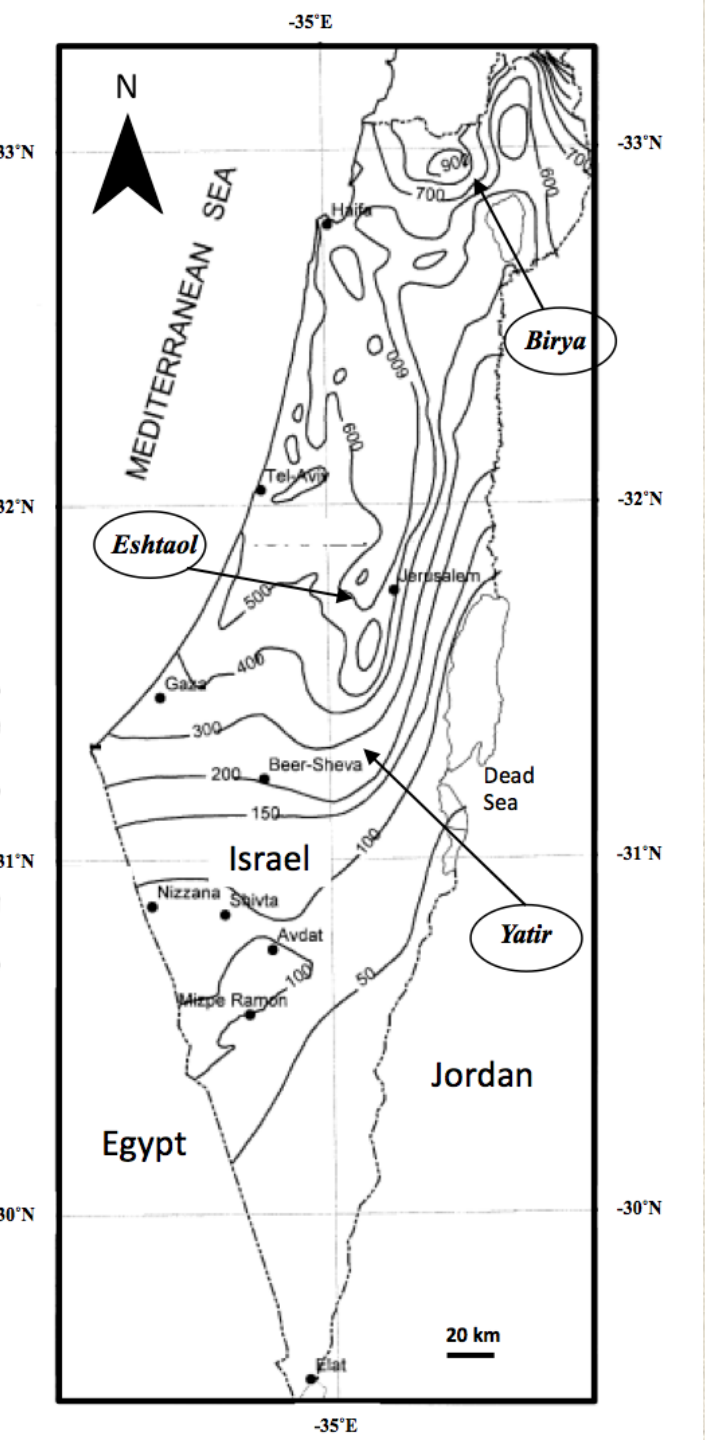


Comparison between Mobile Lab and permanent flux tower

Flux Tower



Mobile Lab



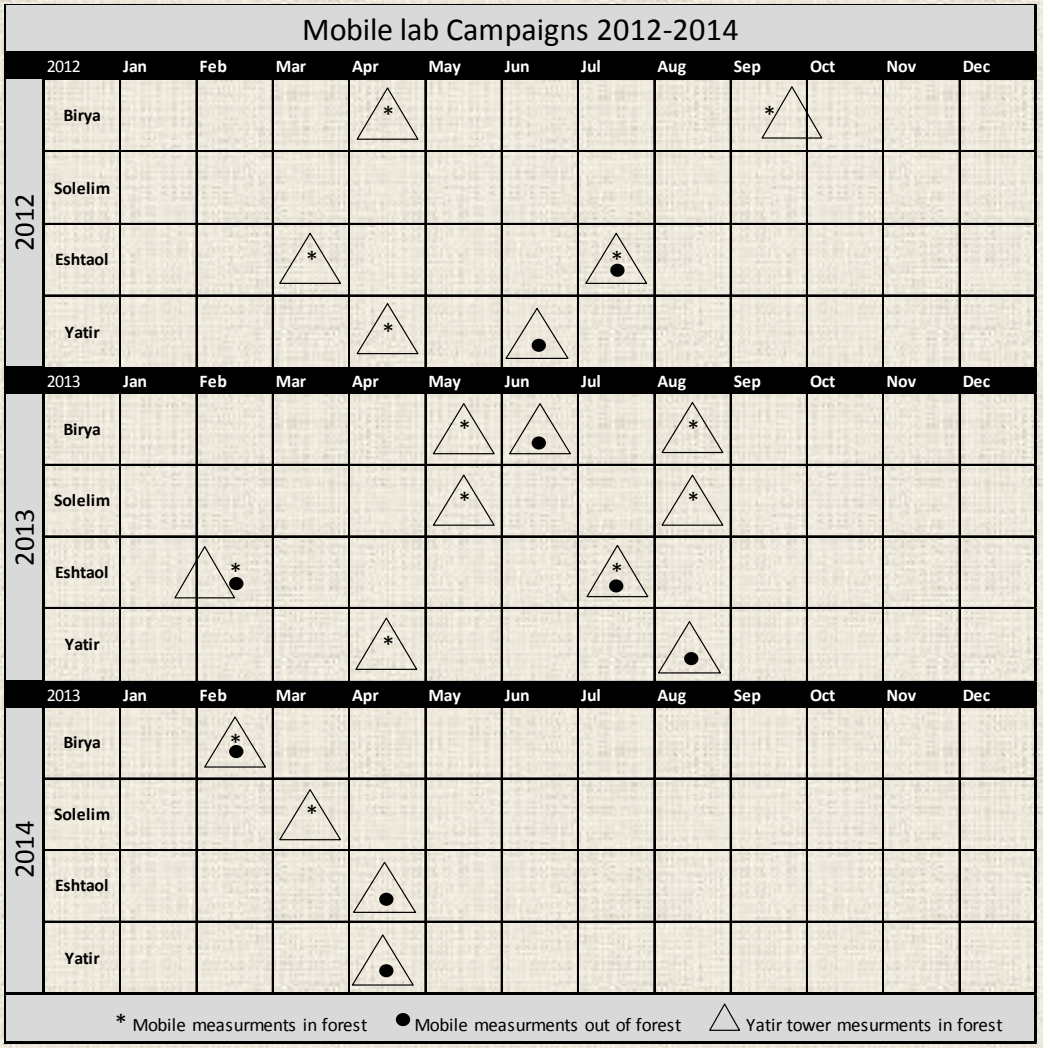
Climatic Gradient: precipitation data

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

Table 2. Characteristics of the three sites explored in the current study (* average of the measurement fetch).

Site	Yatir	Eshtaol	Byria
Coordinates	31° 20' 49.20" N 35° 03' 07.20" E	31° 47' 34.50" N 35° 00' 11.50" E	33° 00' 00.50" N 35° 30' 40.50" E
Ecosystem	Pine forest (*Pinus halepensis*)	Pine forest (*Pinus halepensis*)	Pine forest (*Pinus halepensis*)
Trees age*	45	41 (20-60)	36 (20-60)
Ins. ht [m]	19	20	19
Canopy ht* [m]	10	11(7-15)	11
Elevation [m]	650	380	755
Average annual rainfall	280	520	740
trees per hectare*	350	880	600
Date	9.4-29.4, 2013	6-22/3, 2012	1-12/4, 2012

Campaigns Summery

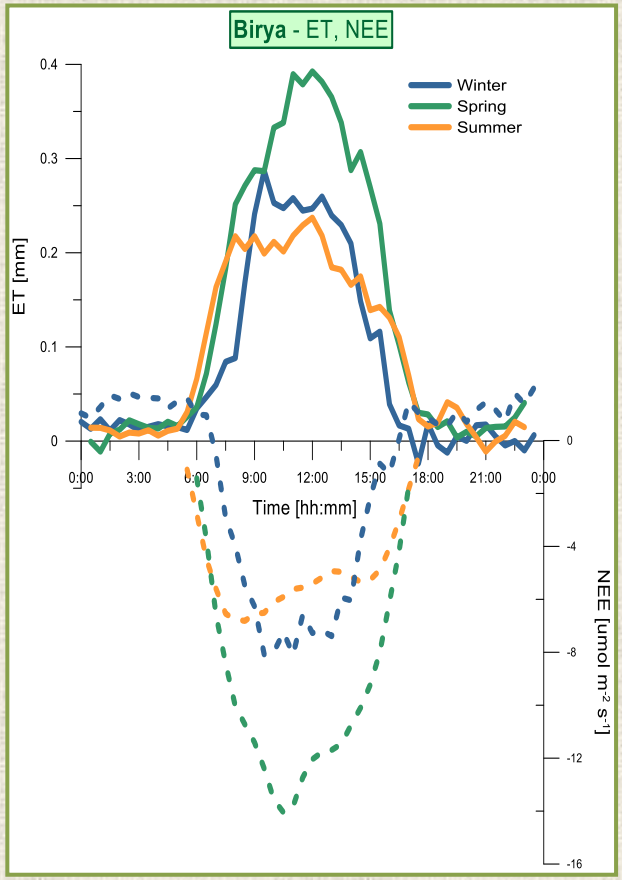


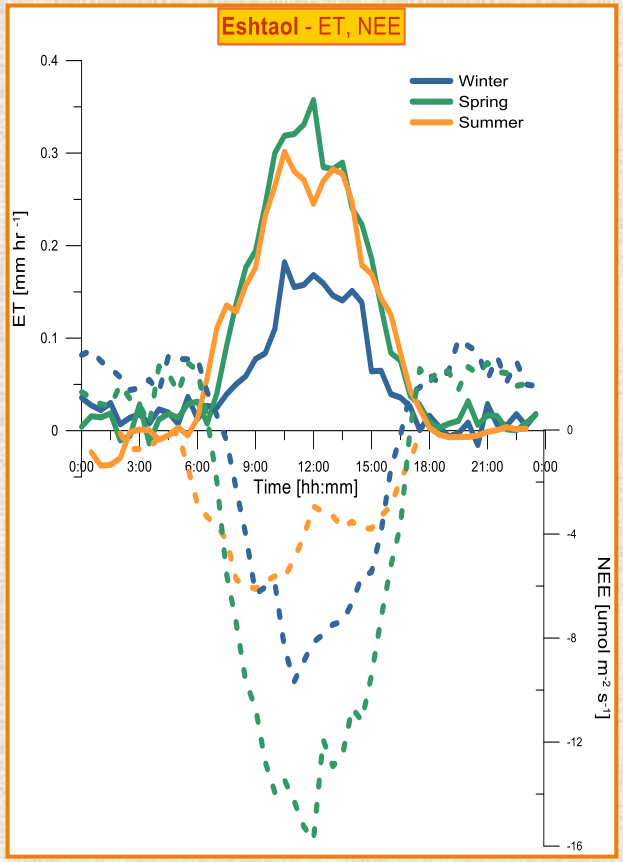
Shani Roahtyn, Efrat Ramati

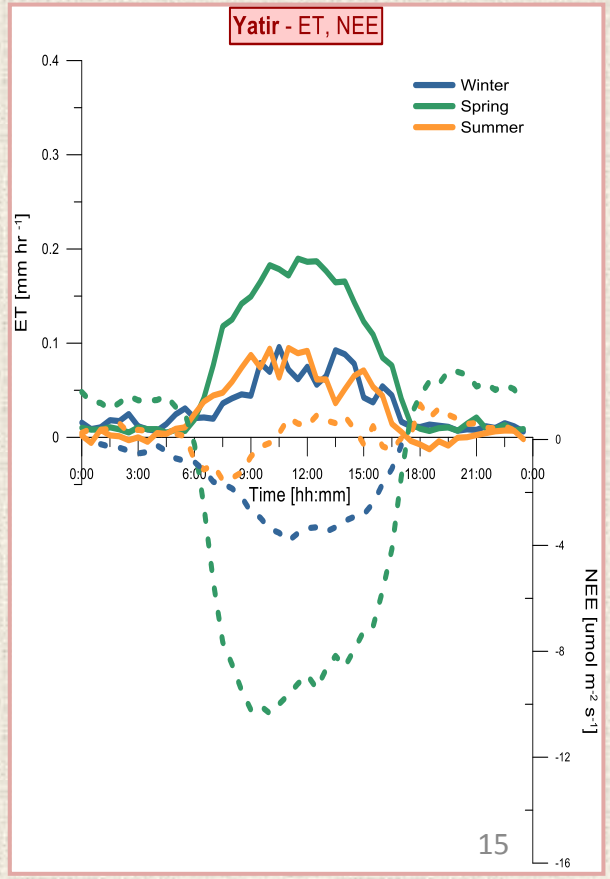
Table1- Campaigns schedule during 2012-2014 in four different sites along the precipitation gradient in Israel.

	# days of measurements	# days processed	% producivity
Birya	47	39	83
Kadita	**30**	**17**	**57**
Eshtaol	45	37	82
Moddin	**36**	**32**	**89**
Solelim	29	20	69
Yatir D	36	29	81
Total	**223**	**174**	

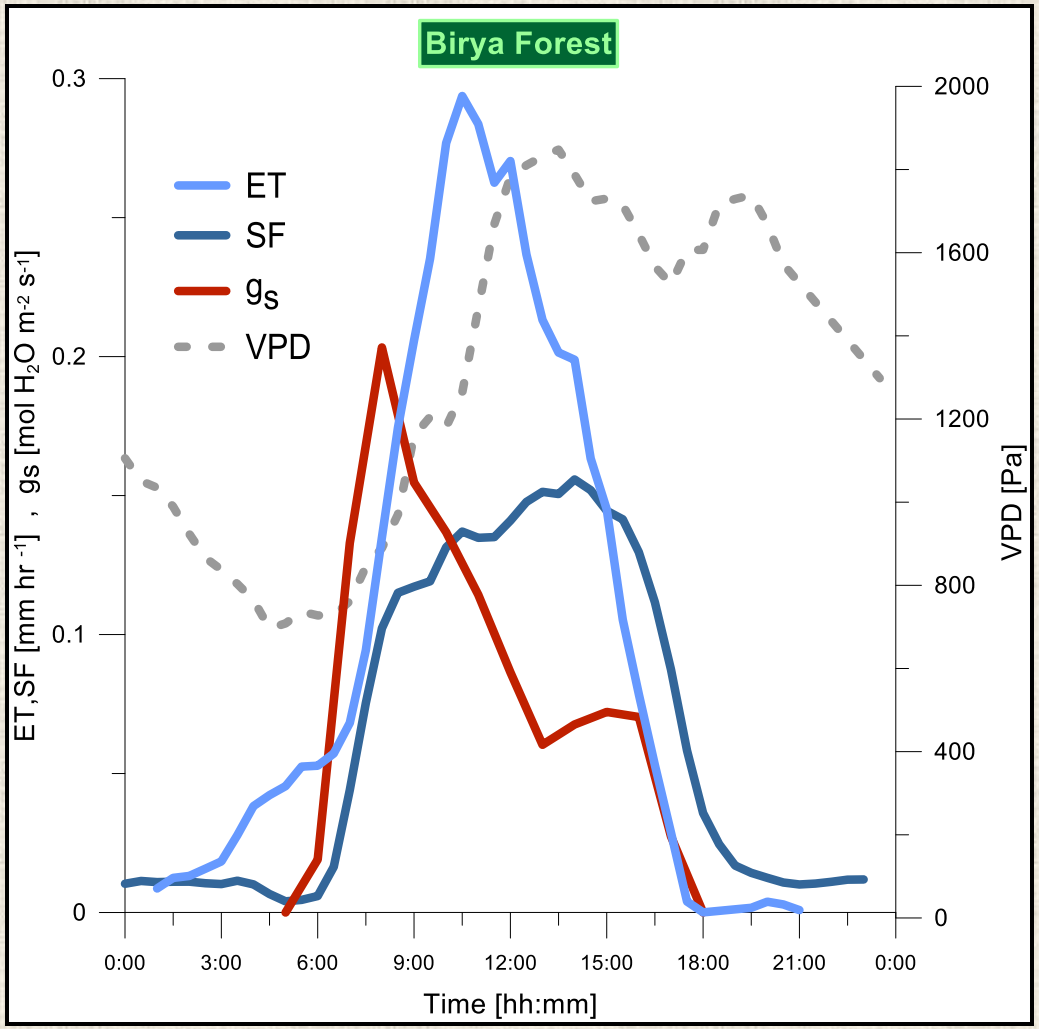
Canopy scale NEE & ET diurnal curves
Along the climatic gradient



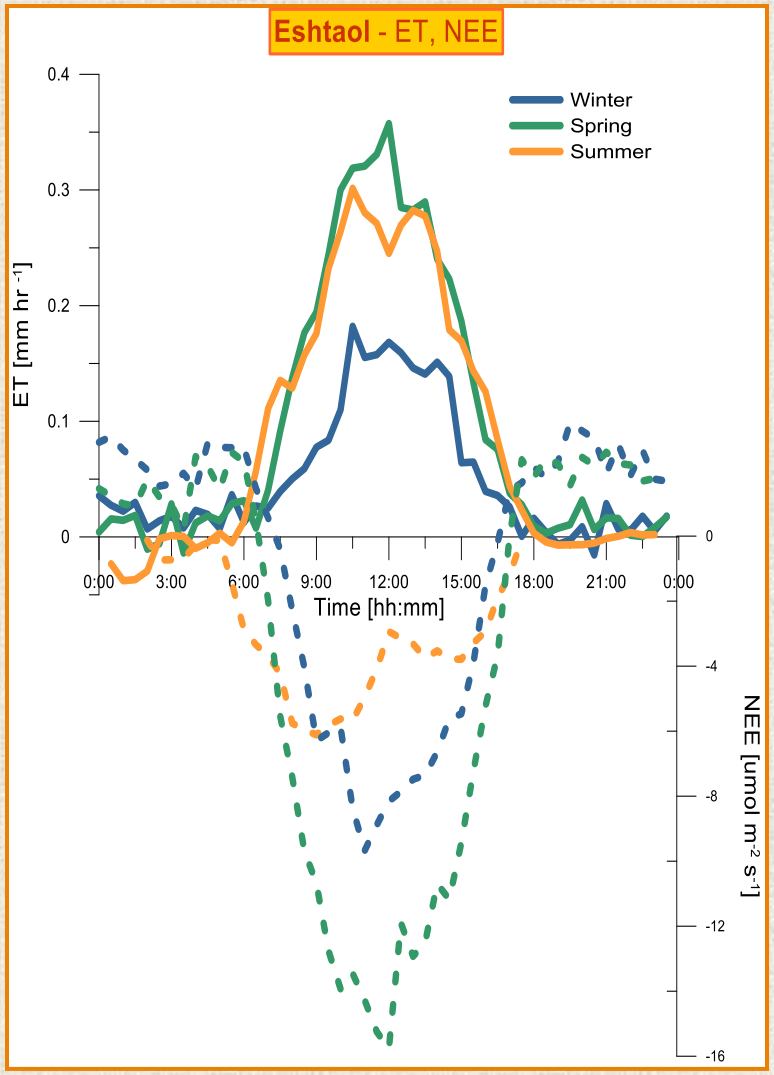


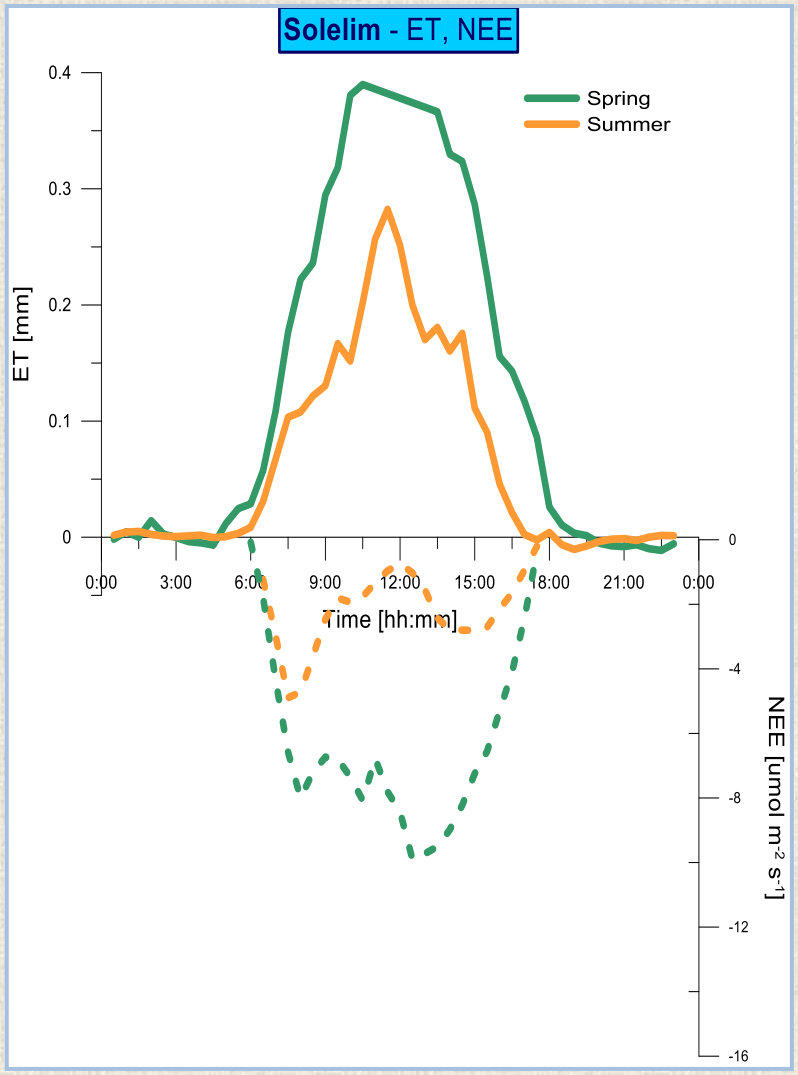


Partitioning of H_2O fluxes diurnal curves

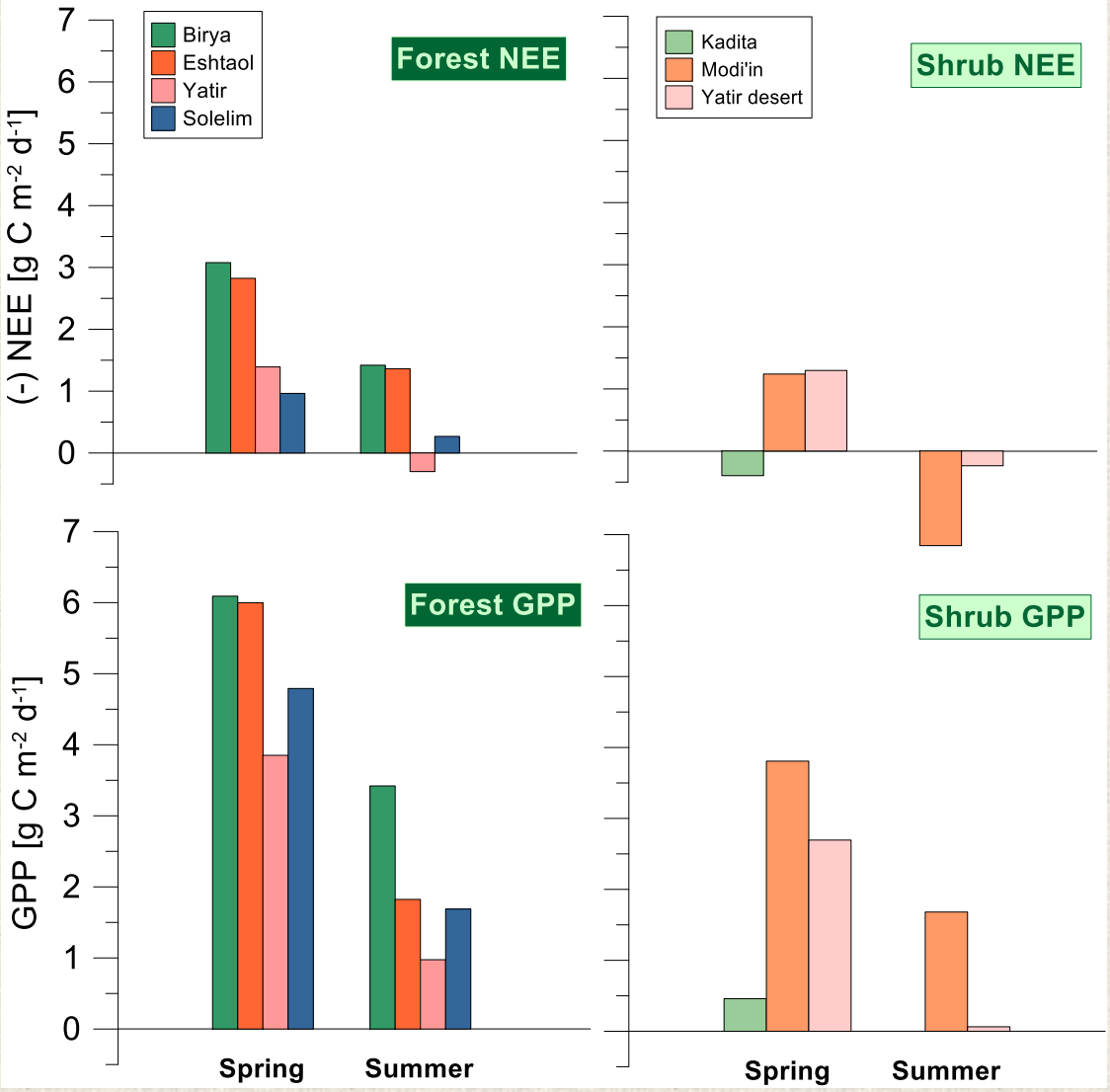


Canopy scale NEE & ET diurnal curves: Pine vs. Oak at the

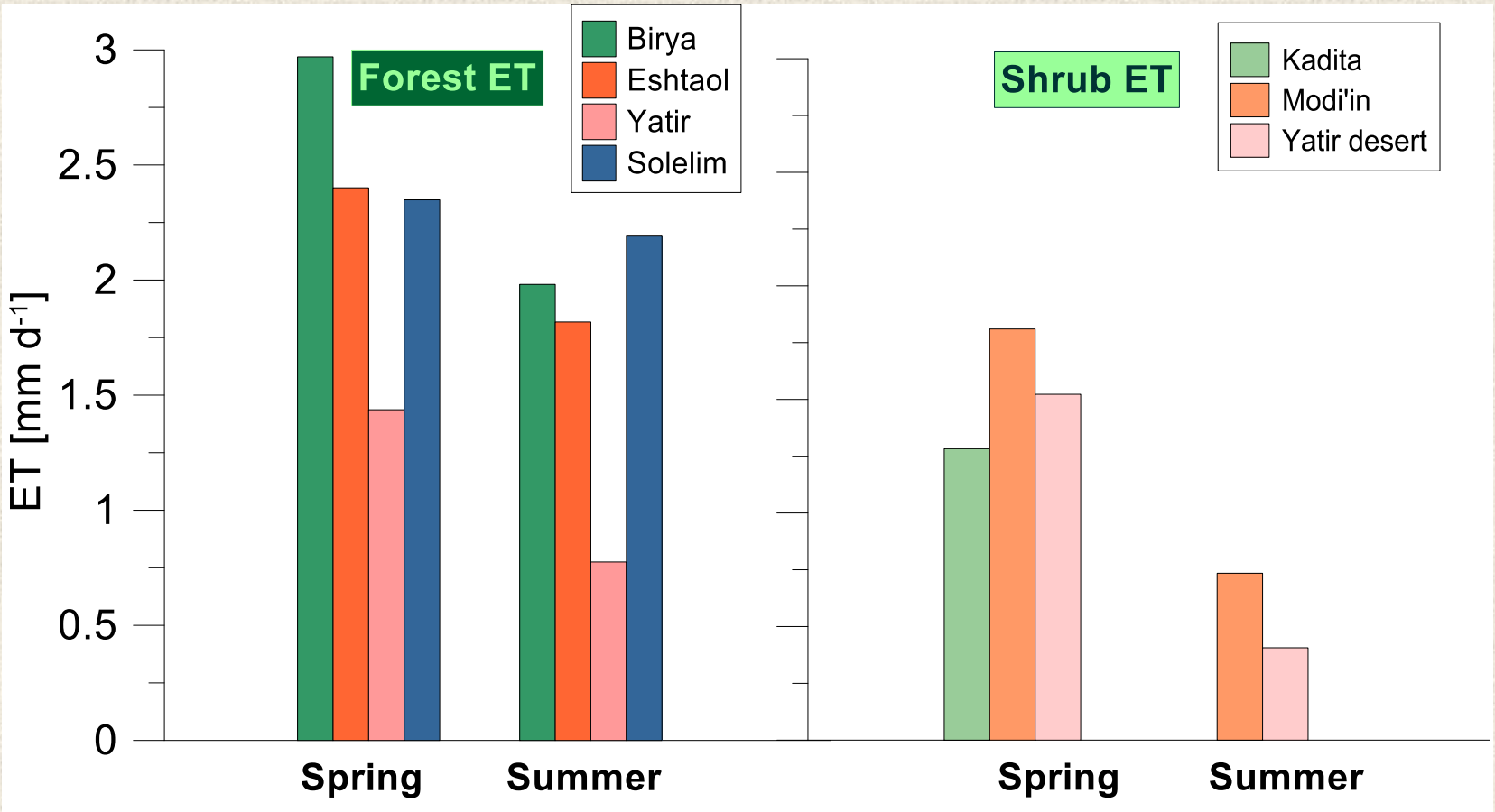




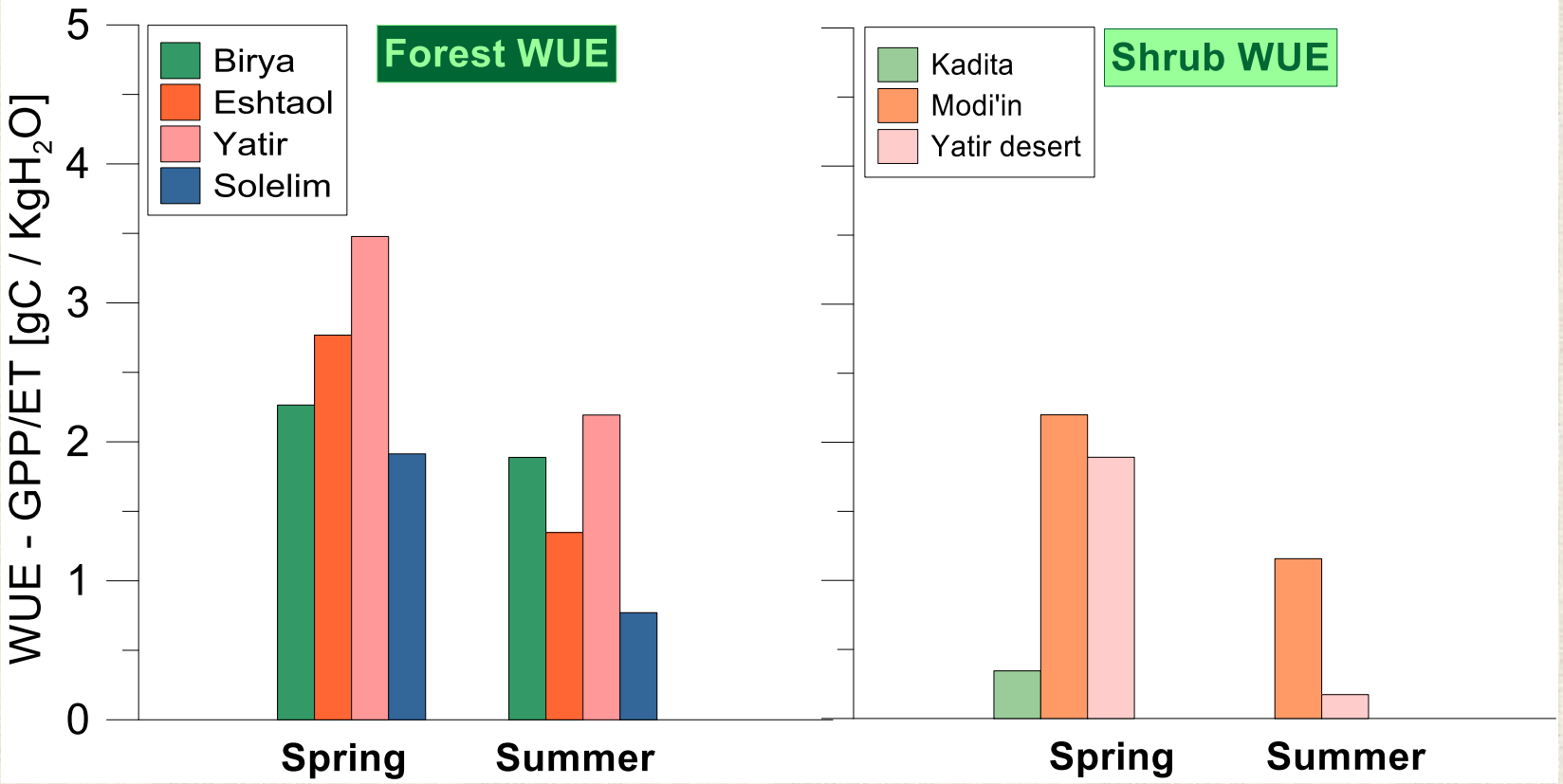
Forest &. Shrubland NEE & GPP along the climatic gradient
Carbon use efficiency: NEE/GPP



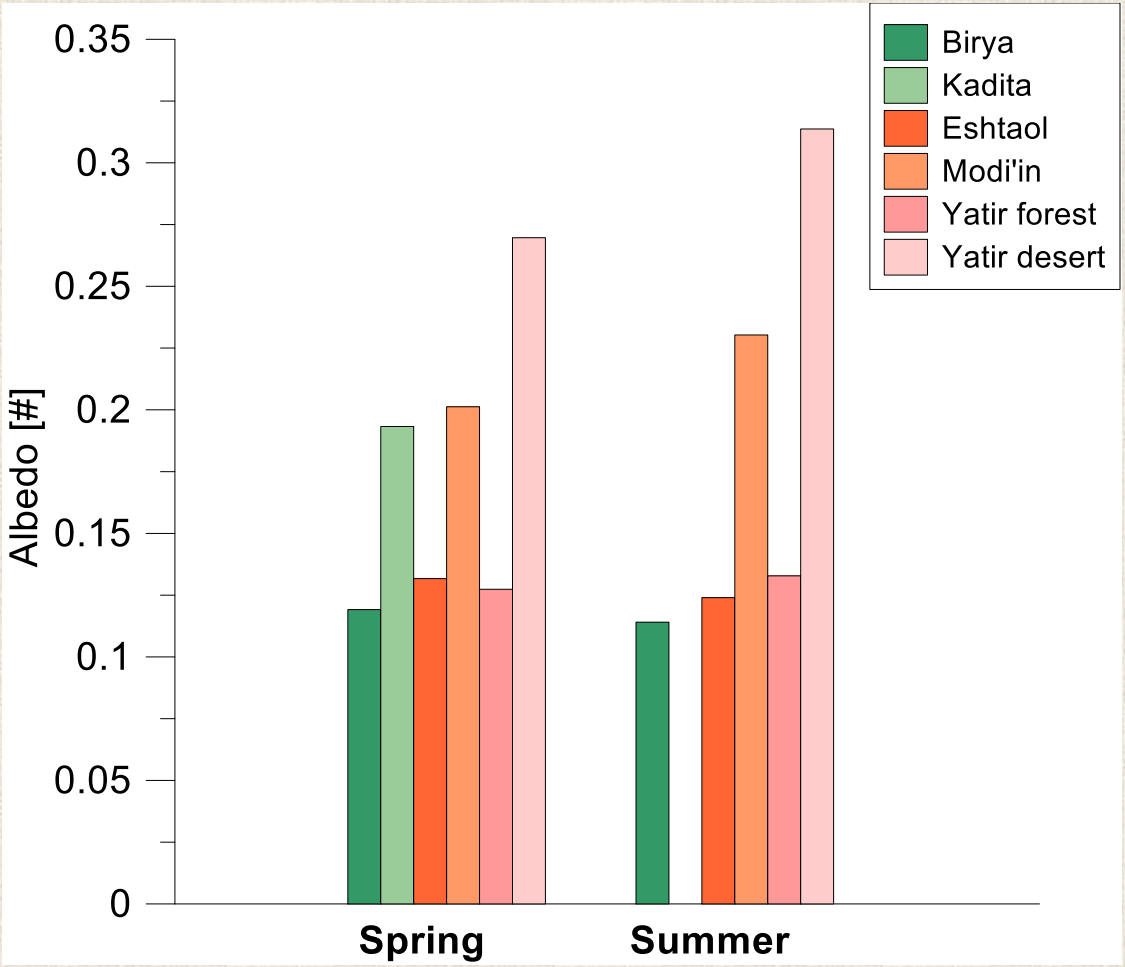
EvapoTranspiration Forest & Shrub along the climatic gradient

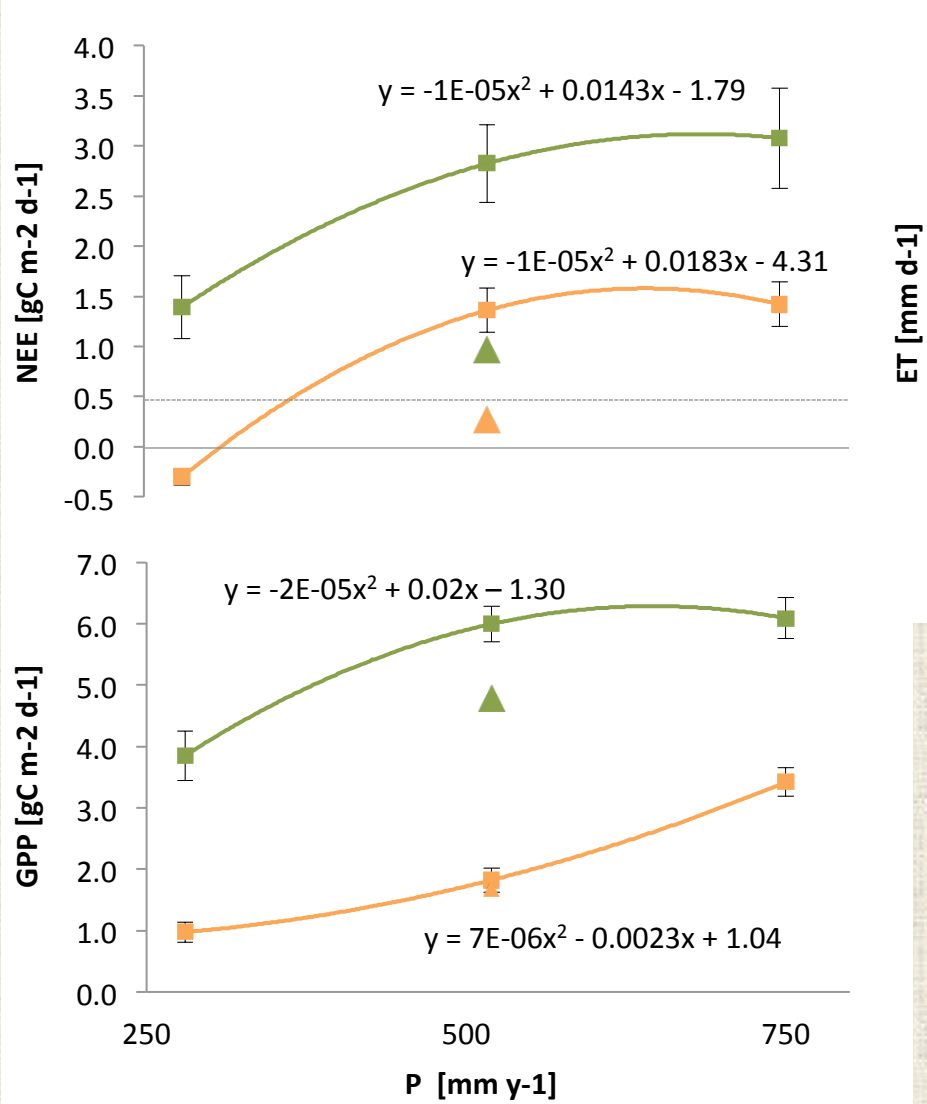


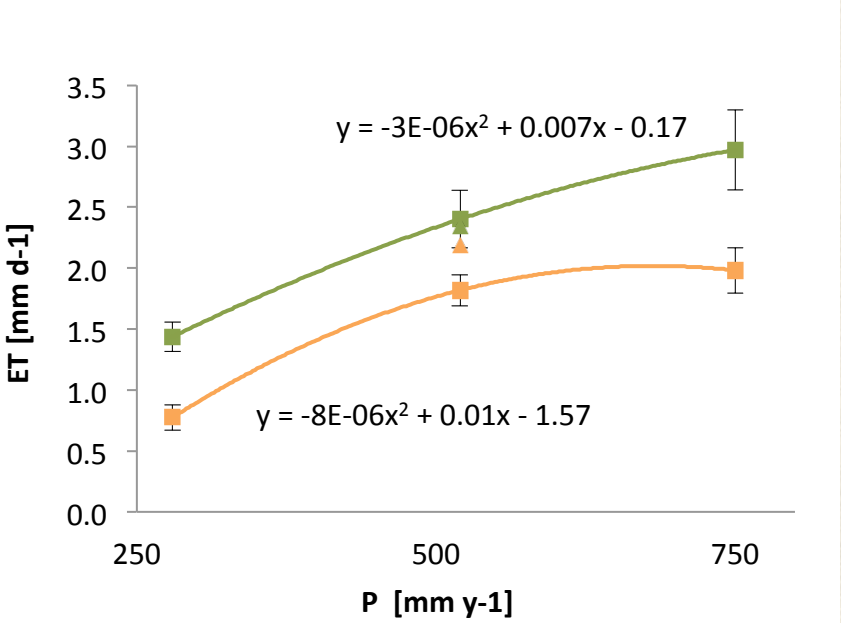
Ecosystem **W**ater **U**se **E**fficiency Forest vs. Shrub along the climatic gradient



Surface **Albedo** Forest & Shrub
Along the climatic gradient

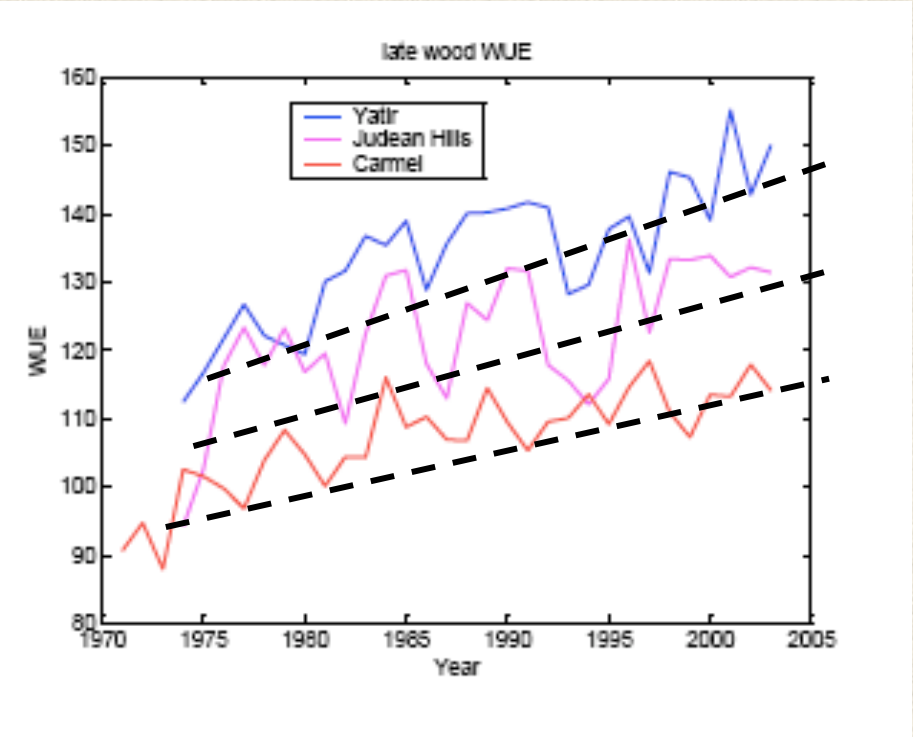


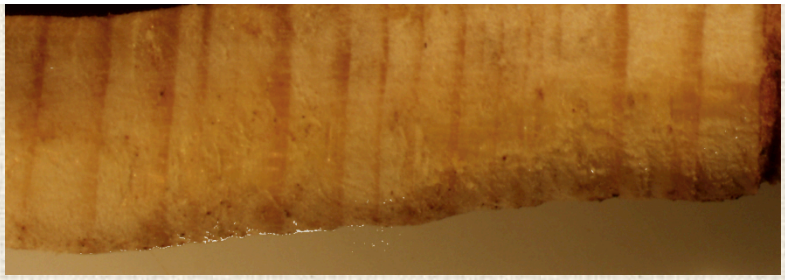




- Pine spring
- Pine summer
- Oak spring
- Oak summer

Increasing WUE: ~25% increase in WUE (CO_2 "fertilization effect")





Oecologia (2011) 167:573–585
DOI 10.1007/s00442-011-2010-4

GLOBAL CHANGE ECOLOGY - ORIGINAL PAPER

Increase in water-use efficiency and underlying processes in pine forests across a precipitation gradient in the dry Mediterranean region over the past 30 years

Kadmiel Maseyk · Debbie Hemming · Alon Angert · Steven W. Leavitt · Dan Yakir

LETTER

doi:10.1038/nature12291

Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise

Trevor F. Keenan[1], David Y. Hollinger[2], Gil Bohrer[3], Danilo Dragoni[4], J. William Munger[5], Hans Peter Schmid[6] & Andrew D. Richardson[1]

- CO_2 up 330 to 380 ppm
- T up ~1.5C,
- No trend in P
- Tree age variable

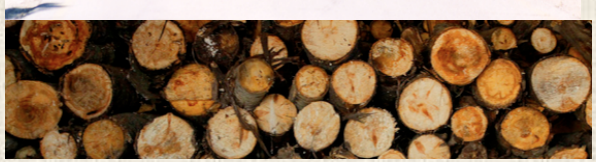
- Preliminary conclusions:

- Pine forests strongly & systematically respond to climatic changes
- The response is non-linear, but predictable
- Pine forest show adjustments to drying conditions; remain active throughout year
- Response of non-forest ecosystem more complex
- Oak forest shows lower WUE compared to Pine forest
- Albedo contrast between forest & non forest diminish in wetter conditions

--- Thank you ---

Semi-arid ecosystem, providing a range of 'Ecosystem Services'

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}