

Continental Carbon Budget: bottom-up approach and synthesis

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Faculty of Earth and Life Sciences



Continental Carbon Budget

- Available flux measurements in Siberia
- Raw upscaling exercise →
- what are the main issues?
- COCOS
- ghg balance of Siberian tundra wetlands

TCOS-Siberia Carbon flux measurements



Tver
2x forest + bog



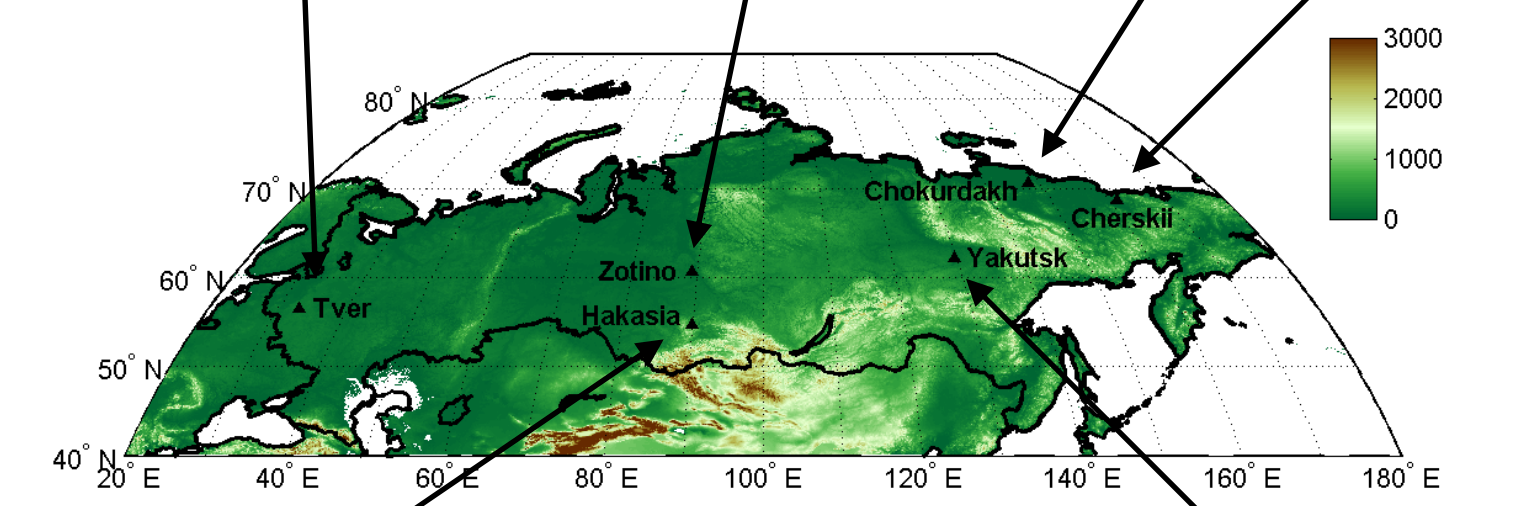
Zotino forest + bog +
fir + mixed



Chokurdakh
tundra



Cherskii
floodplain tundra

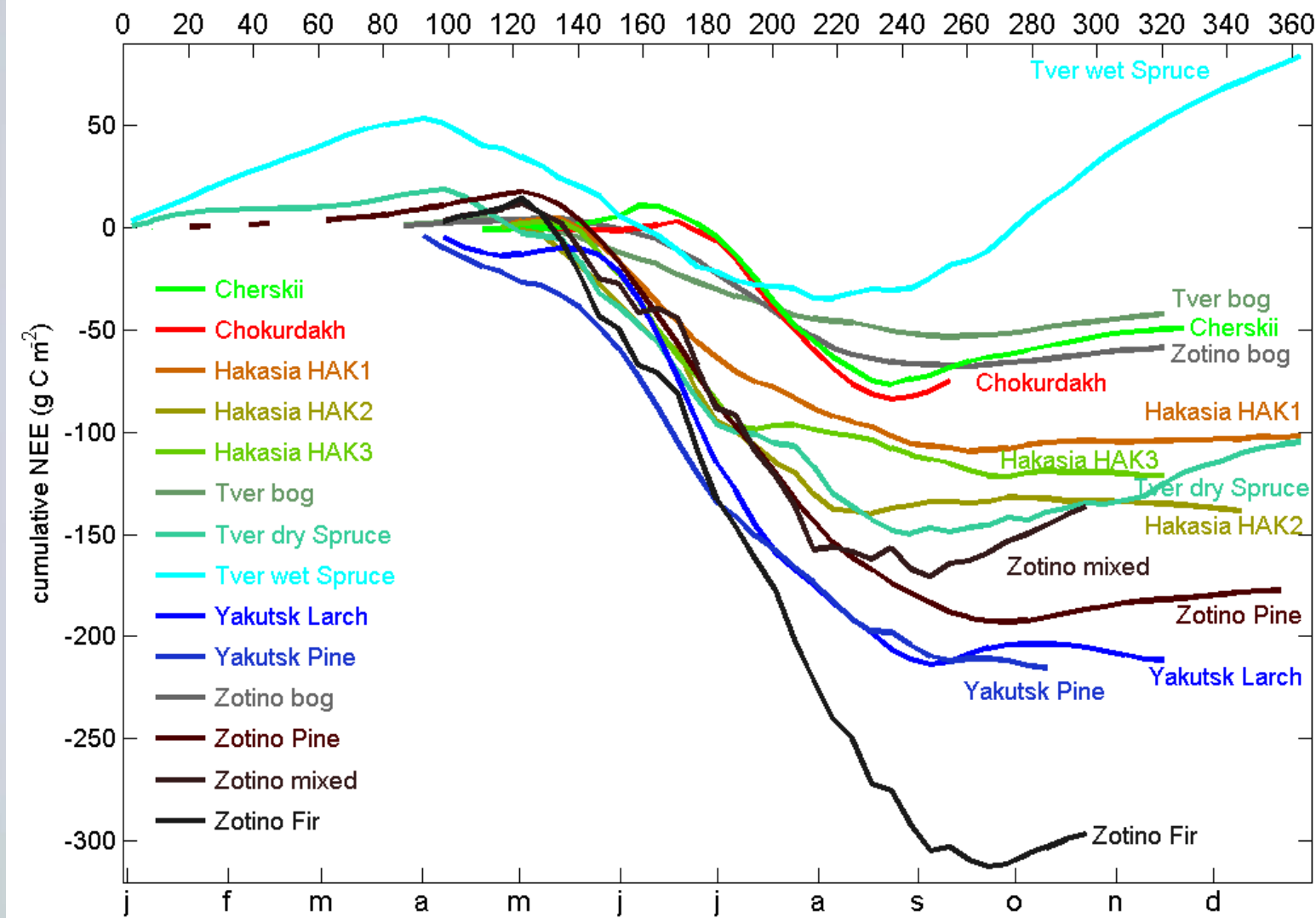


Hakasia
natural and regenerating steppe



Yakutsk
Larix + Pine forest

Available flux measurements



Upscaling

Relevant upscaling variables:

- Land cover, climate & weather
- LAI, soil type, soil moisture

for now we do an upscaling by land cover,
just to see how far we can get.

Upscaling

Rough upscaling by land cover:

	mean	st.dev.	NEP
			gC m ⁻² yr ⁻¹
tundra	22.9	3.3	-58
wetlands	3.0	0.9	-52
agricultural and grassland	15.7	2.1	-43
forest	49.1	6.2	-151
other	9.2	3.3	0
total	100%	=17.1e6 km ²	



Initial bottom-up estimate of C-sink in RF: -1.6 Pg C yr⁻¹

Upscaling

Corrections

- Winter fluxes: $\sim +0.5 \text{ Pg C yr}^{-1}$
- Open path: $\sim +0.09 \text{ Pg C yr}^{-1}$
- New sink estimate $-1.0 \text{ Pg C yr}^{-1}$

Upscaling: fire emissions

Ecosystem dynamics → Slow in-Fast out C-flux

1st approach:

Estimate RS fire emission (van der Werf et al, 2006)

- direct emissions:	0.196 Pg C yr ⁻¹
- indirect emissions:	0.133 Pg C yr ⁻¹
- other disturbances (est)	0.160 Pg C yr ⁻¹
Total emissions:	0.489 Pg C yr⁻¹

Total continental sink: -0.544 Pg C yr⁻¹

Upscaling: ecosystem dynamics

Ecosystem dynamics → Slow in-Fast out C-flux

2nd approach:

Integrate NEP over ecosystem life cycle

- Only for forests
- TCOS forest sites appear to be located in (over-) mature forests
- Young forests are a source of C
- At some stage they turn into sinks and become very productive
- (over-)mature forests reach towards an equilibrium
- The shape of this NEP-cycle is critical to interpret eddy fluxes
- We estimate an impact between +0.27 and -0.06 Pg C yr⁻¹.

Total continental sink: -0.76 to 1.1 Pg C yr⁻¹

Upscaling: conclusions

Conclusions:

- Eurasia is likely a sink between 0.5 and 1.0 Pg C yr⁻¹
- Winter fluxes are important, but can be corrected for
- Advection as a non-random error source
- Ecosystem dynamics is a major source of uncertainty

COCOS

COordinated action Carbon Observing Systems

two main lines:

- improve the exchange of data sets between separate projects and
- use datasets together with other continental and basin scale projects and programs.

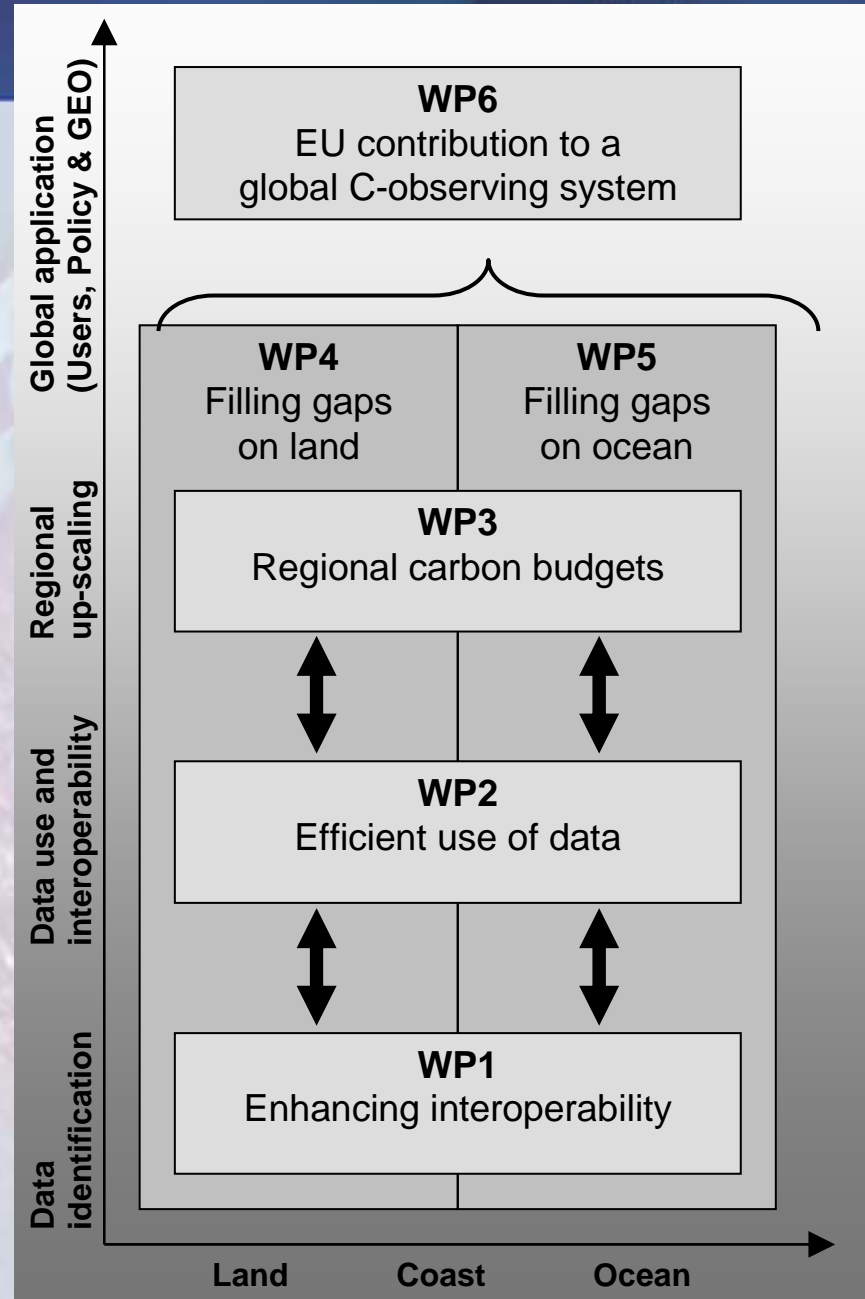
starting spring 2008

COCOS

COCOS intends to

- assess the current status of carbon research around the globe
- bring together scientists in thematic meetings and workshops
- harmonize plans and protocols for the way ahead in global carbon research

COCOS



COCOS

WP4: Filling gaps in data of vulnerable global carbon pools and fluxes on land

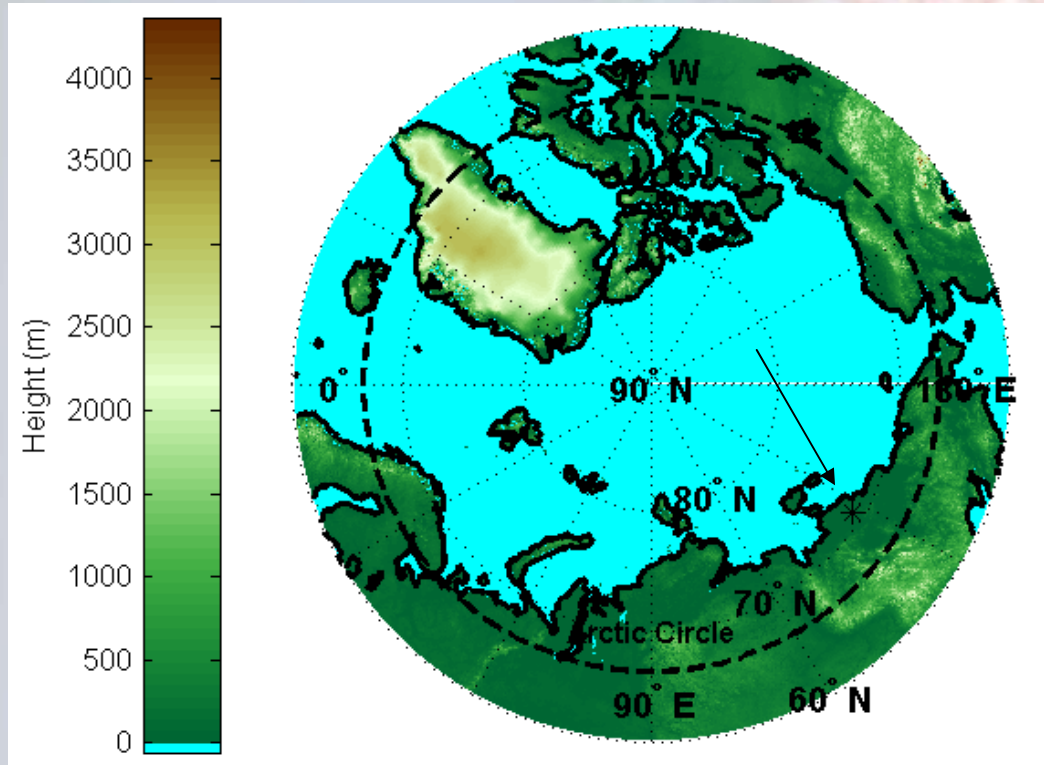
- carbon pools
 - biomass & soil carbon
 - wetlands, peatlands
 - permafrost, tropical lands
- fire emissions and burned area from space
 - (tropical) deforestation
 - fire hotspots

Tundra

Tundra

- covers ~ 23 % of Eurasia
- although the (annual) sink is small, the majority of NEP is turned into SOM
- permafrost stability is important
- Large amount of C in soil

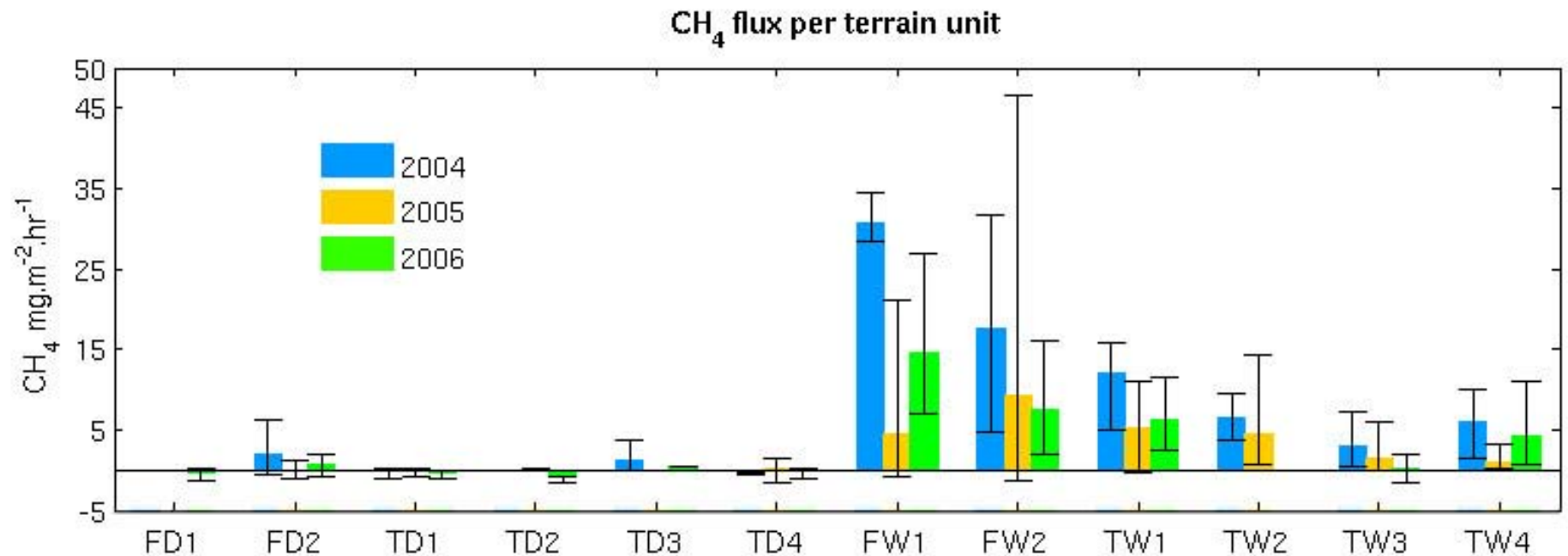
Tundra GHG balance



Chokurdakh site

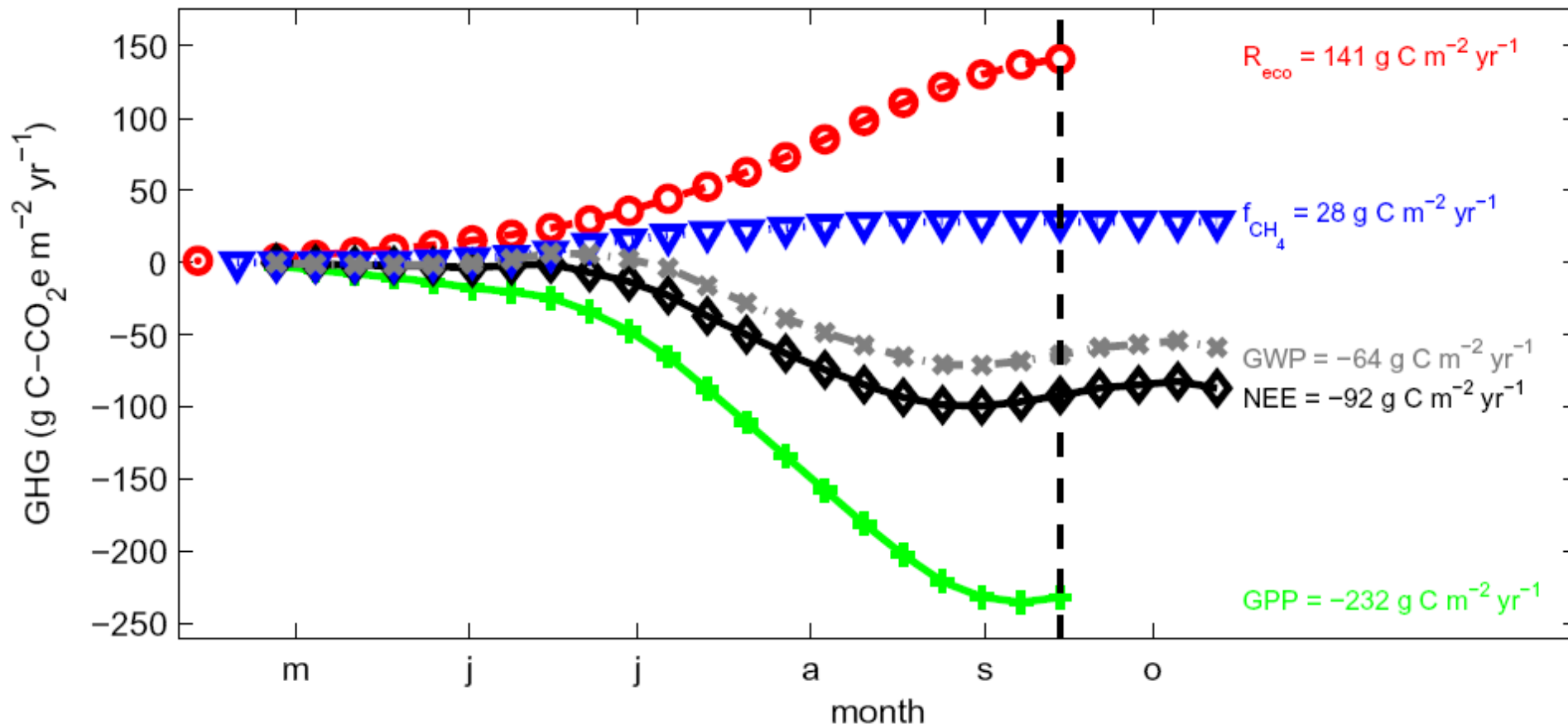
- Indigirka lowlands
- Relatively continental for tundra sites
- CO₂ and CH₄ balance

Tundra GHG balance



van Huissteden, J. C., Maximov, T. C., and Dolman, A. J. (2005)
High methane flux from an arctic floodplain (Indigirka lowlands, eastern Siberia)
J. Geophys. Res., 110, G02002, doi:10.1029/2005JG000010, 2005

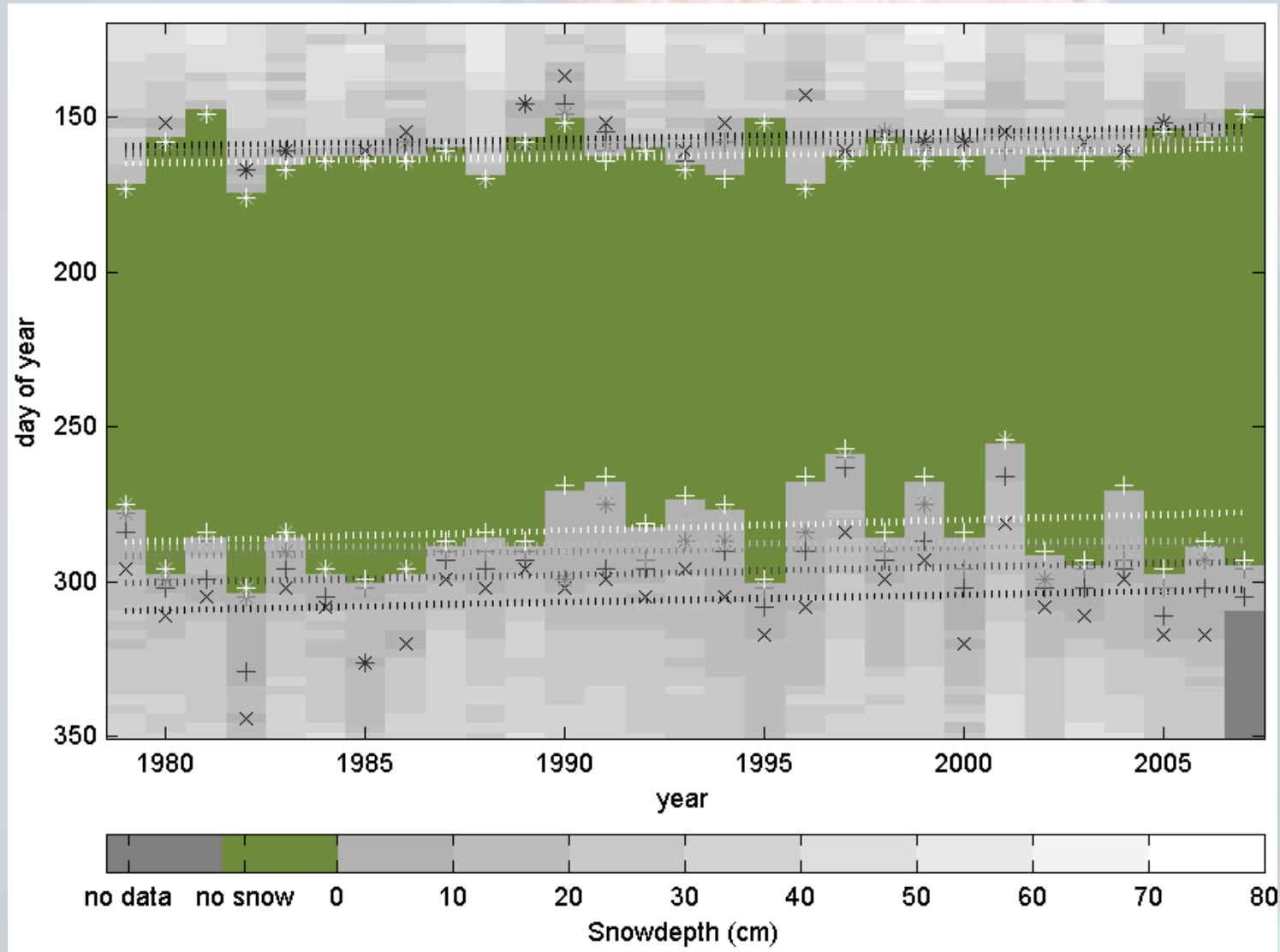
Tundra GHG balance



van der Molen, M.K., J. van Huissteden, F.J.W. Parmentier, A.M.R. Petrescu, A.J. Dolman, T.C. Maximov, A.V. Kononov, S.V. Karsanaev, and D.A. Suzdalov (2007).

The growing season greenhouse gas balance of a continental tundra site in the Indigirka lowlands, NE Siberia. *Biogeosciences*, 4, 985-1003.

29-year Microwave snow depth record



Radiative forcing of growing season advancement

Radiative forcing is a common measure to express the impact of something that changes climate.

	trend days per 29 years		radiative forcing due to 29-year trend $10^{-15} \text{ W m}^{-2} (29\text{-yr})^{-1} \text{ m}^{-2}_{\text{tundra}}$			
			$R_{s,\text{net}}$	GPP	R_{eco}	f_{CH_4}
spring	7		4.7	-0.145	0.058	0.011
autumn	-3 to -10		-0.4 to -1.4	0 to 0	-0 to -0.1	-0.005 to -0.016

The albedo feedback to changing snow cover is 10^2 stronger than the ghg feedback on a global scale.

Siberia is cold

Questions?