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Micrometeorological fluxes of carbon dioxide and methane

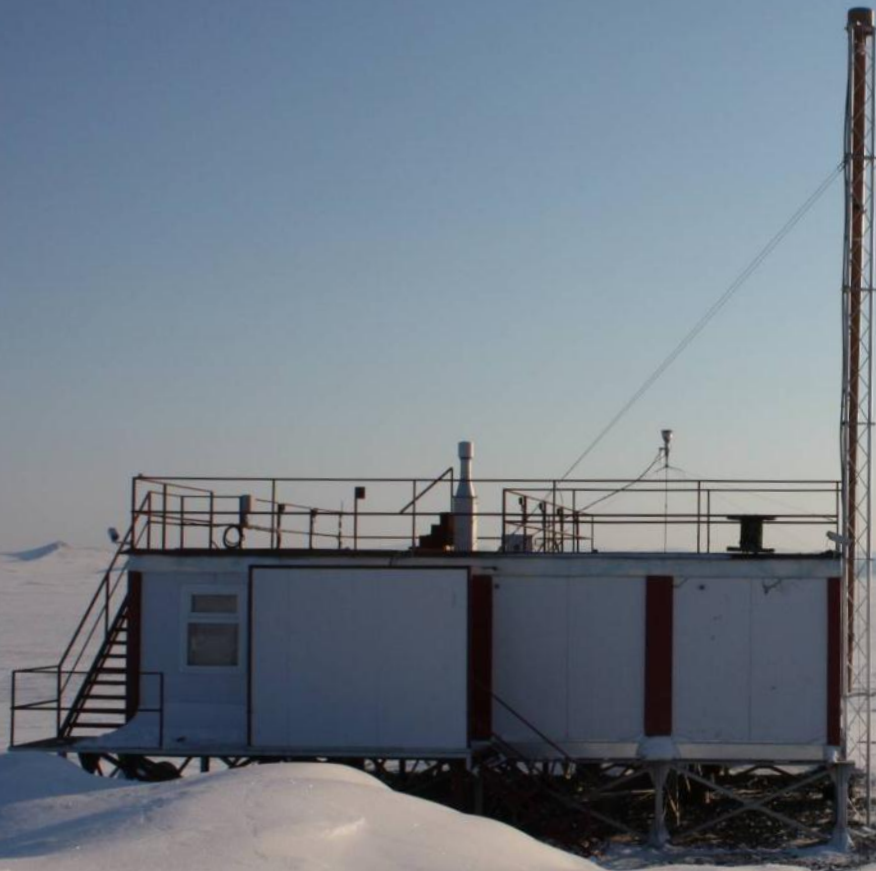
Mika Aurela, Tuomas Laurila, Juha Hatakka, Ari Laaksonen
Finnish Meteorological Institute





FMI in Tiksi

- **CO₂ and CH₄ fluxes**
- **CO₂ and CH₄ concentrations**
- **aerosol concentrations**





CO₂, CH₄ and energy fluxes

CO₂/H₂O -analyzer: Li-cor LI-7000

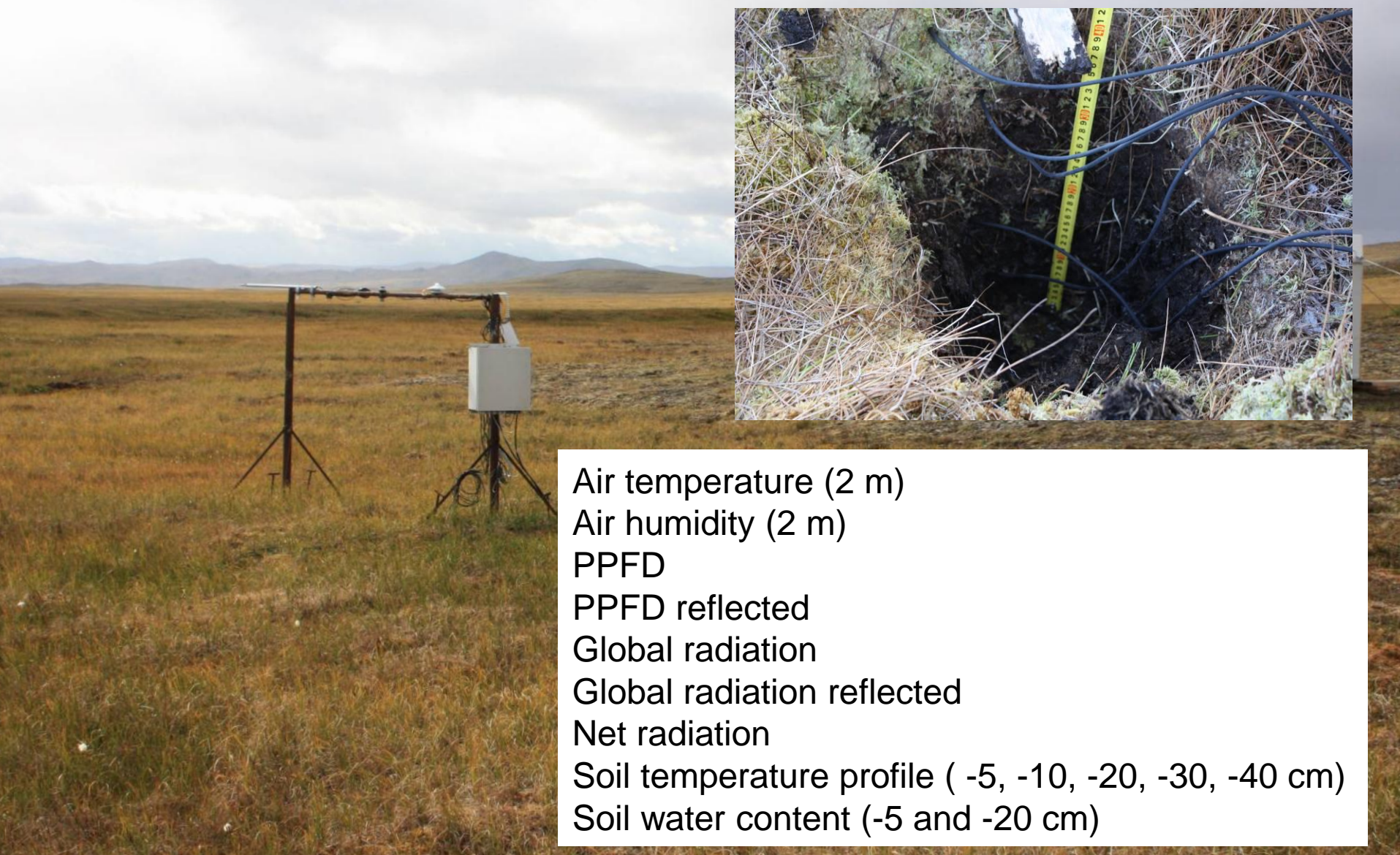
CH₄ -analyzer: LGR RMT-200

Sonic anemometer: Metek USA-1





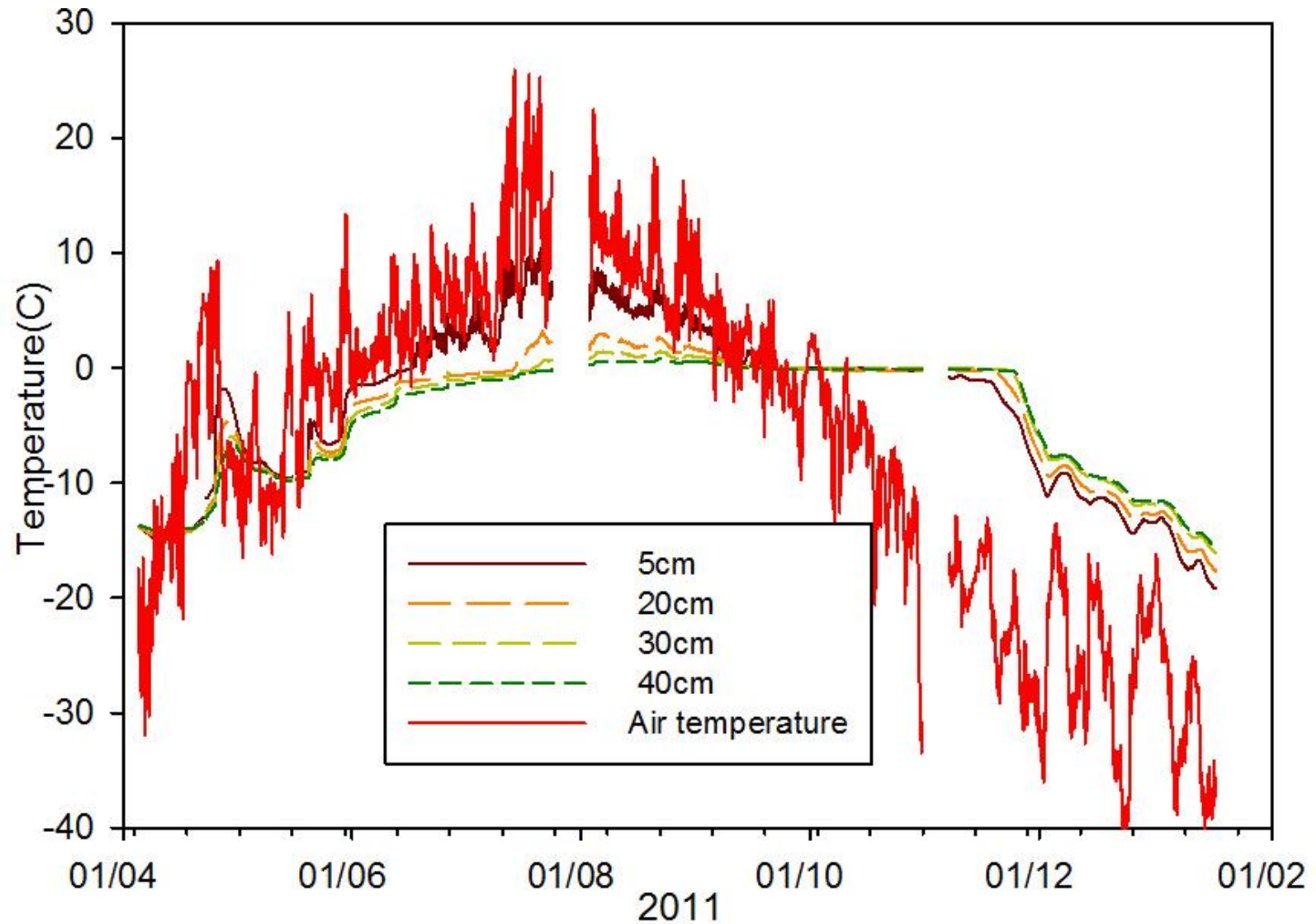
Meteorological observations at Flux site (since 2010)



- Air temperature (2 m)
- Air humidity (2 m)
- PPFD
- PPFD reflected
- Global radiation
- Global radiation reflected
- Net radiation
- Soil temperature profile (-5, -10, -20, -30, -40 cm)
- Soil water content (-5 and -20 cm)

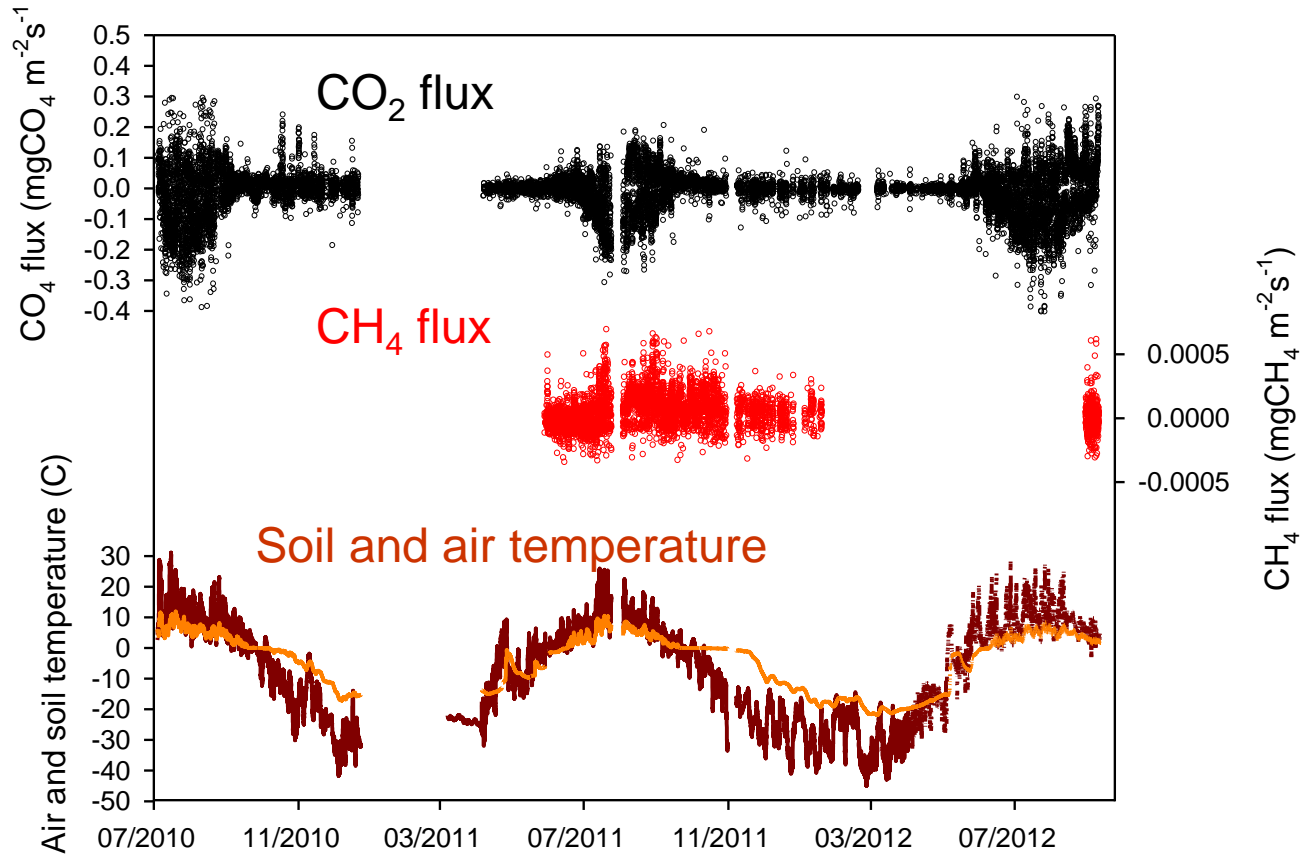


Soil temperatures





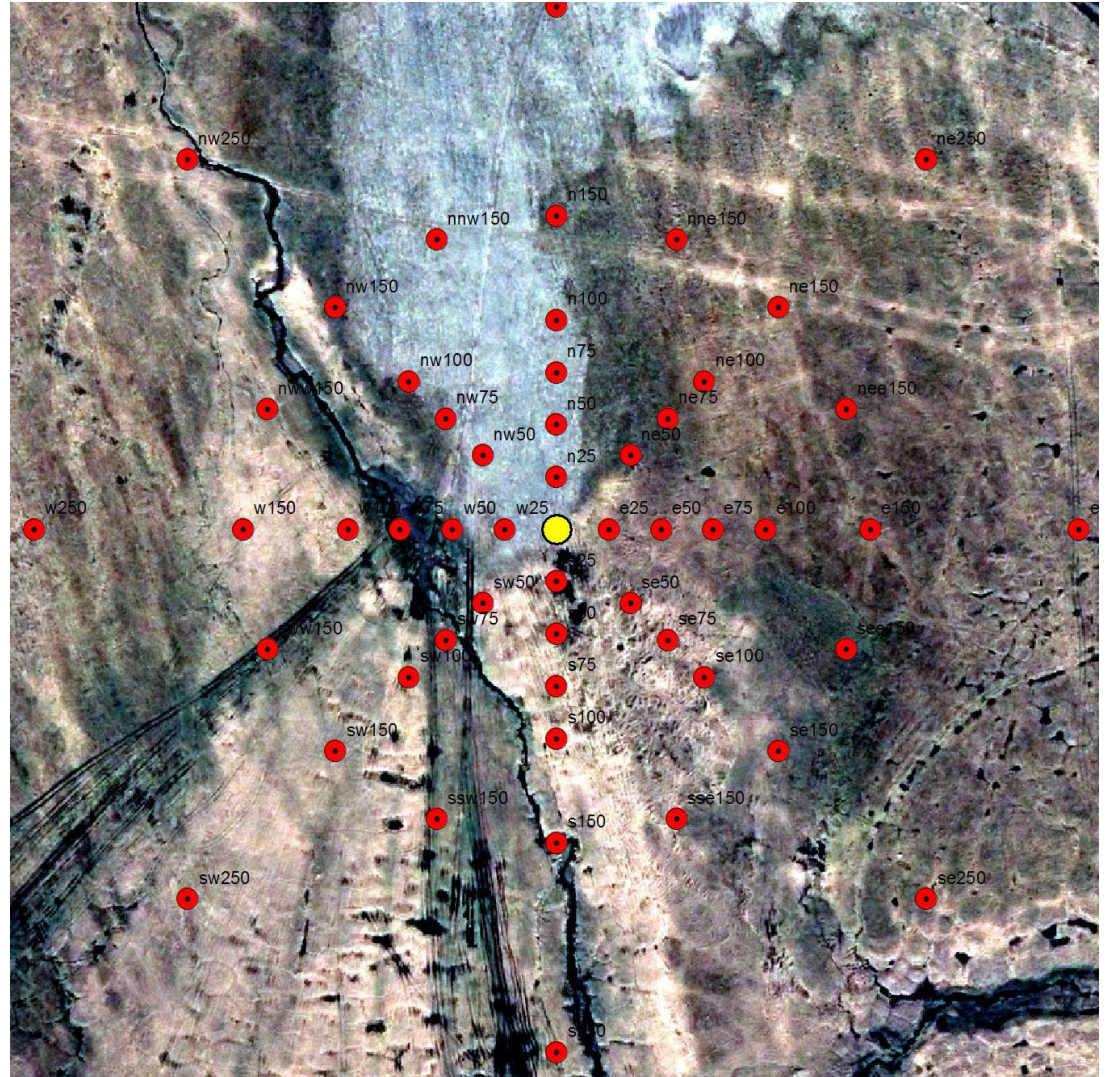
Eddy covariance fluxes of CO₂ and CH₄





Vegetation and soil survey 2012

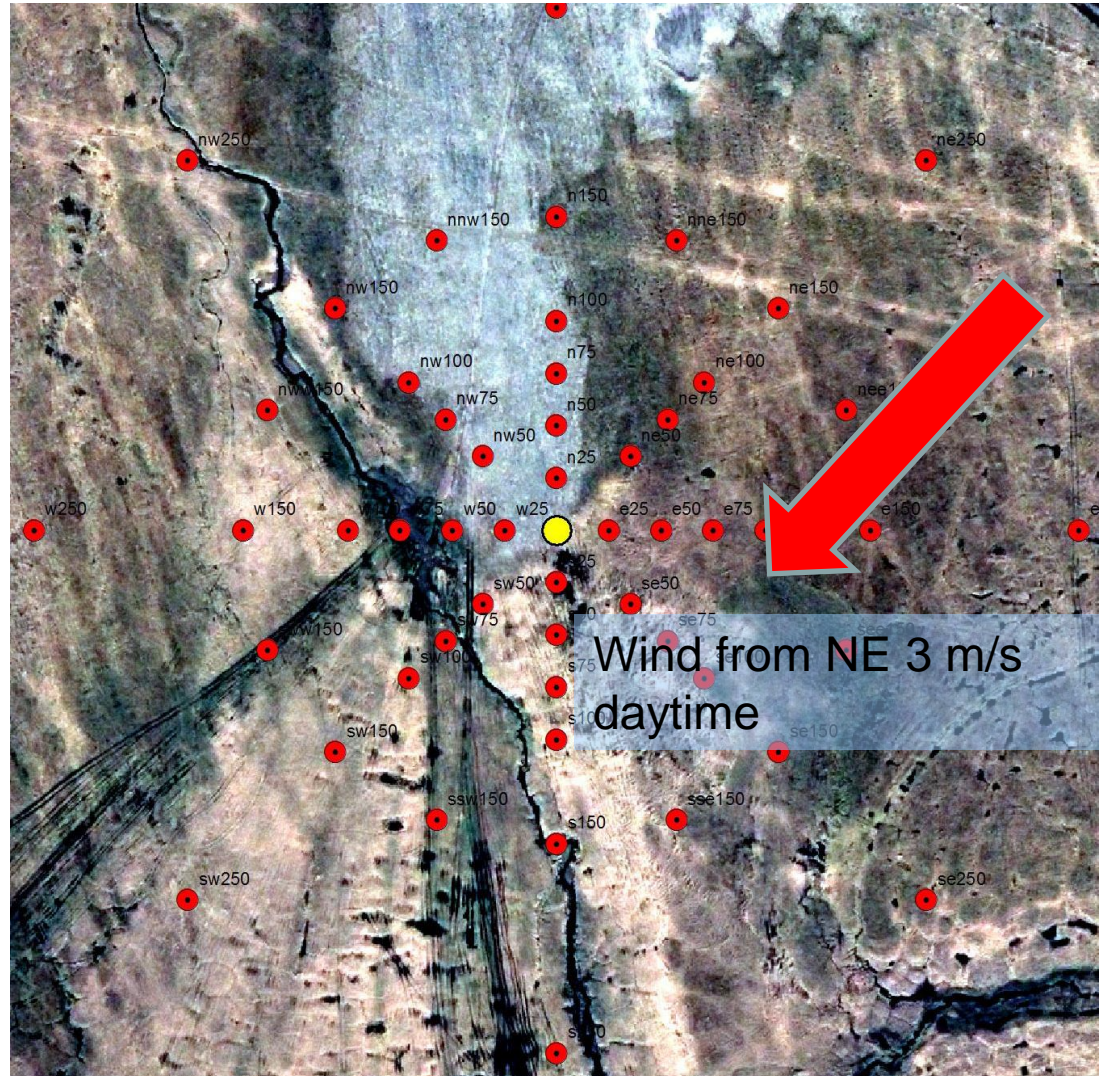
Combining
satellite images and
vegetation/soil survey





Vegetation and soil survey 2012

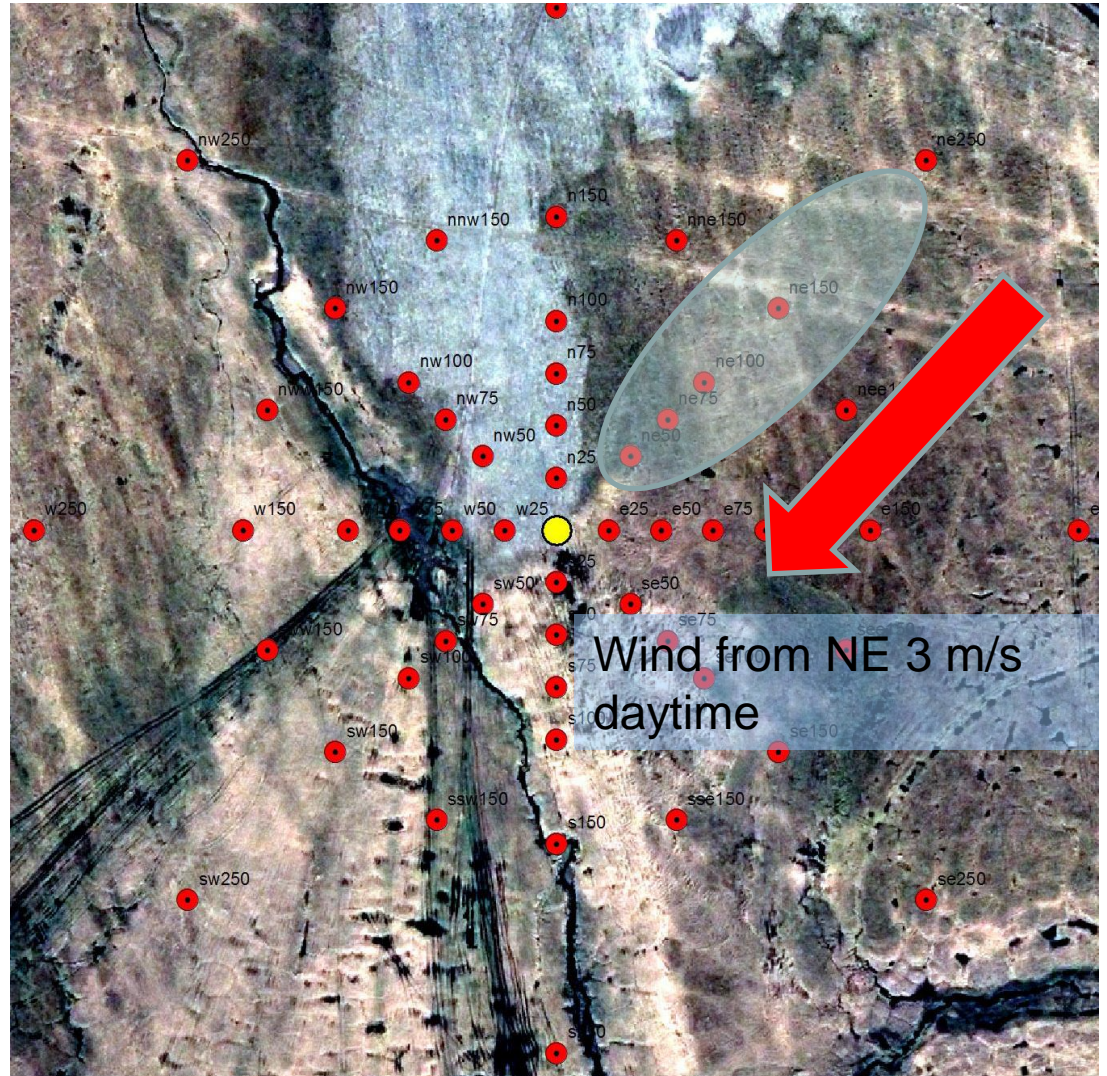
Combining
satellite images and
vegetation/soil survey
with EC footprint
analysis





Vegetation and soil survey 2012

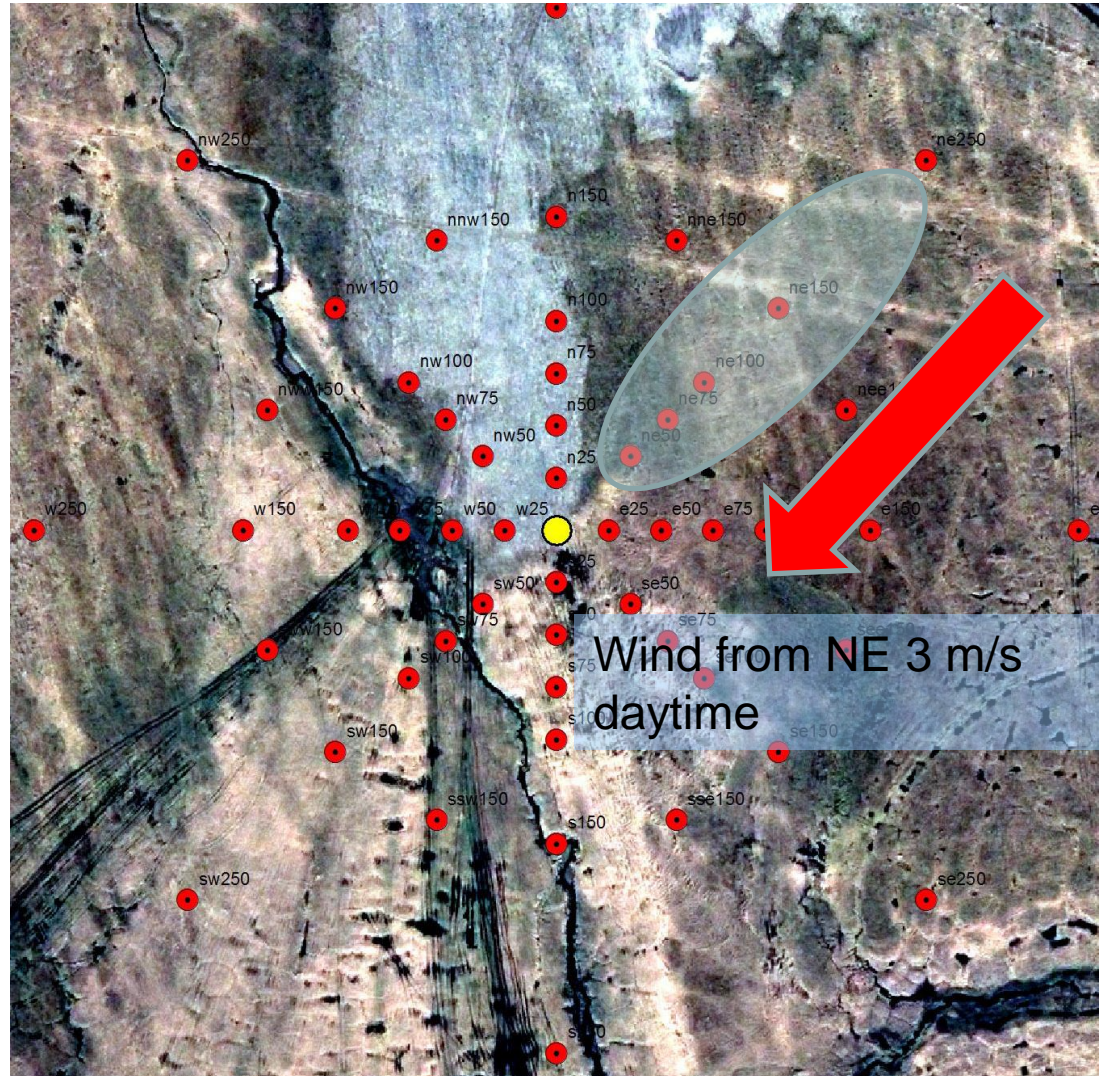
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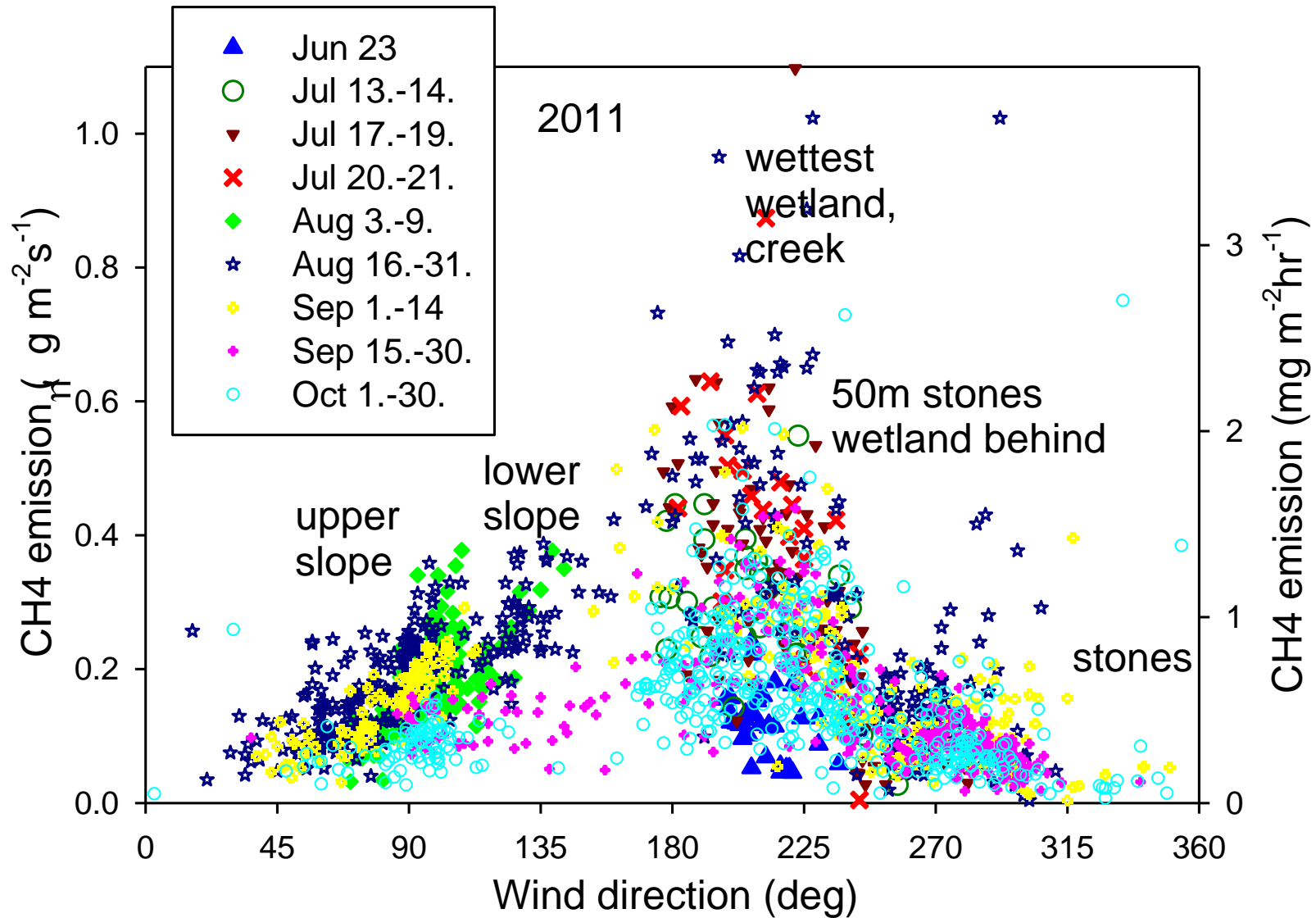
Vegetation and soil survey 2012

Combining satellite images and vegetation/soil survey with EC footprint analysis provides us means for estimating CO_2 and CH_4 exchange of different vegetation types and hydrological regimes





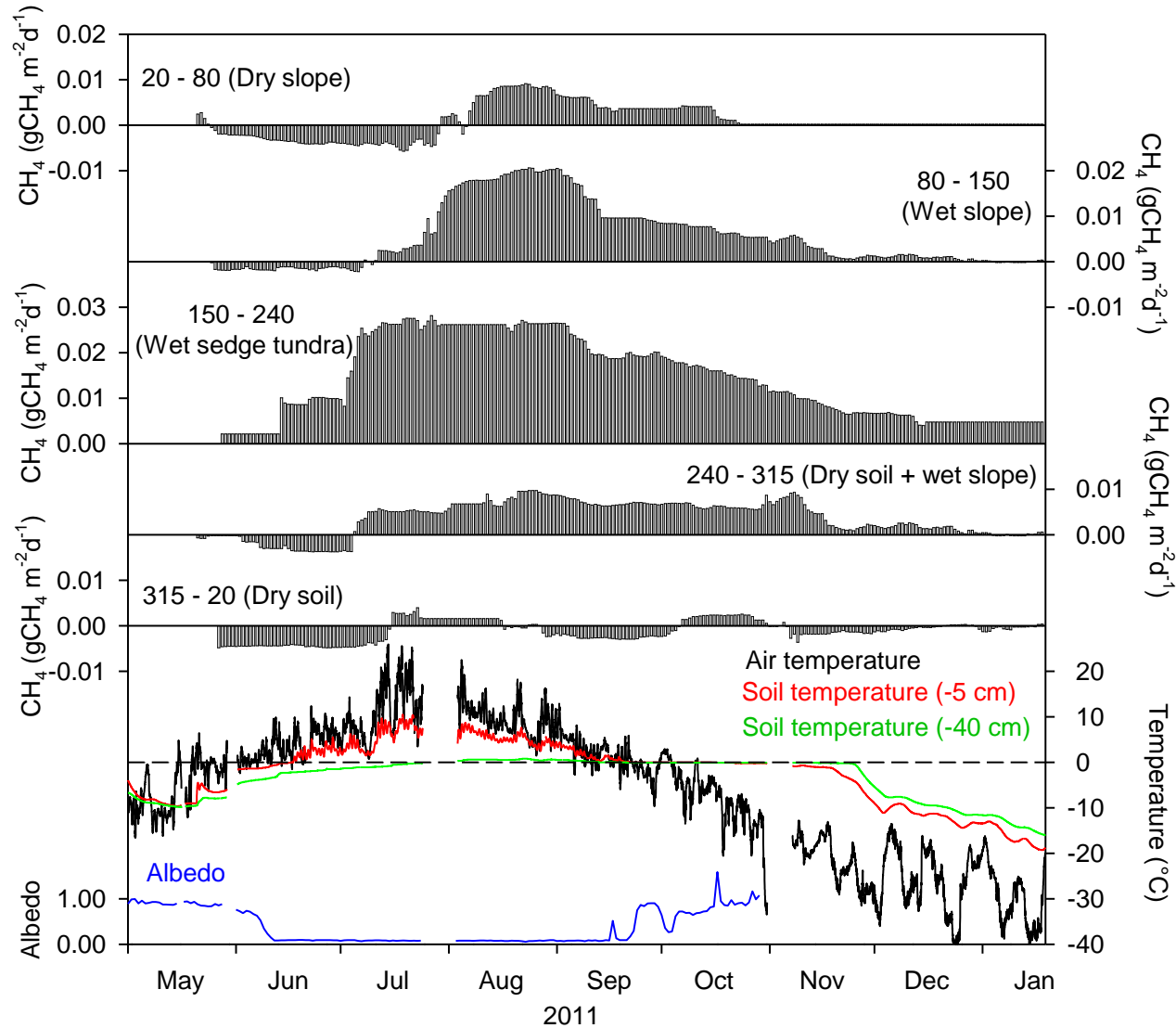
CH₄ fluxes from different wind directions





Daily and annual CH₄ balances

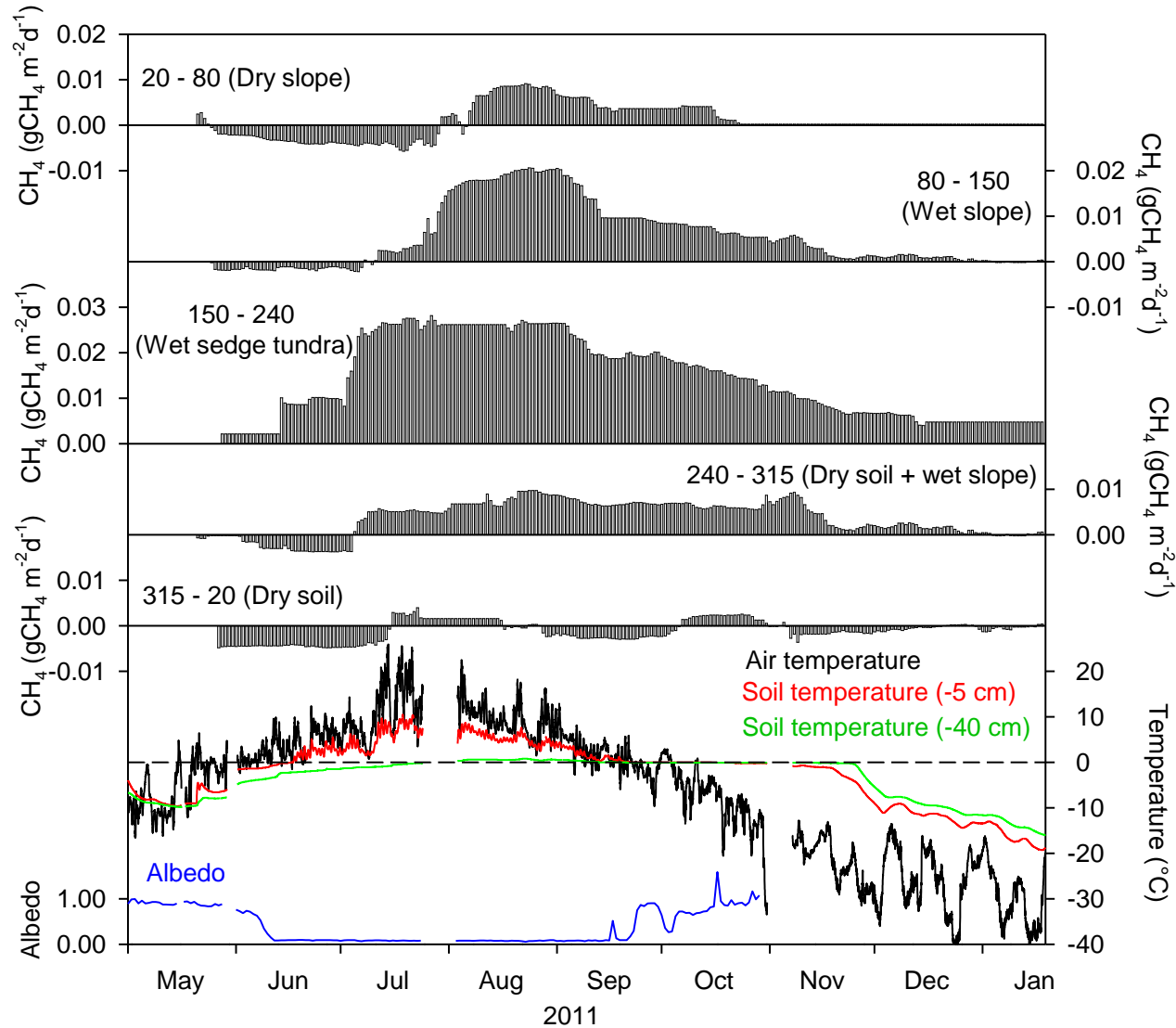
	Wind direction	CH ₄ gm ⁻² yr ⁻¹
Dry upland	315-20	-0.3
Dry slope	20-80	0.2
Wet slope	80-150	1.3
Wet sedge fen	150-240	3.4
Dry upland/ wet slope	240-315	0.9





Daily and annual CH₄ balances

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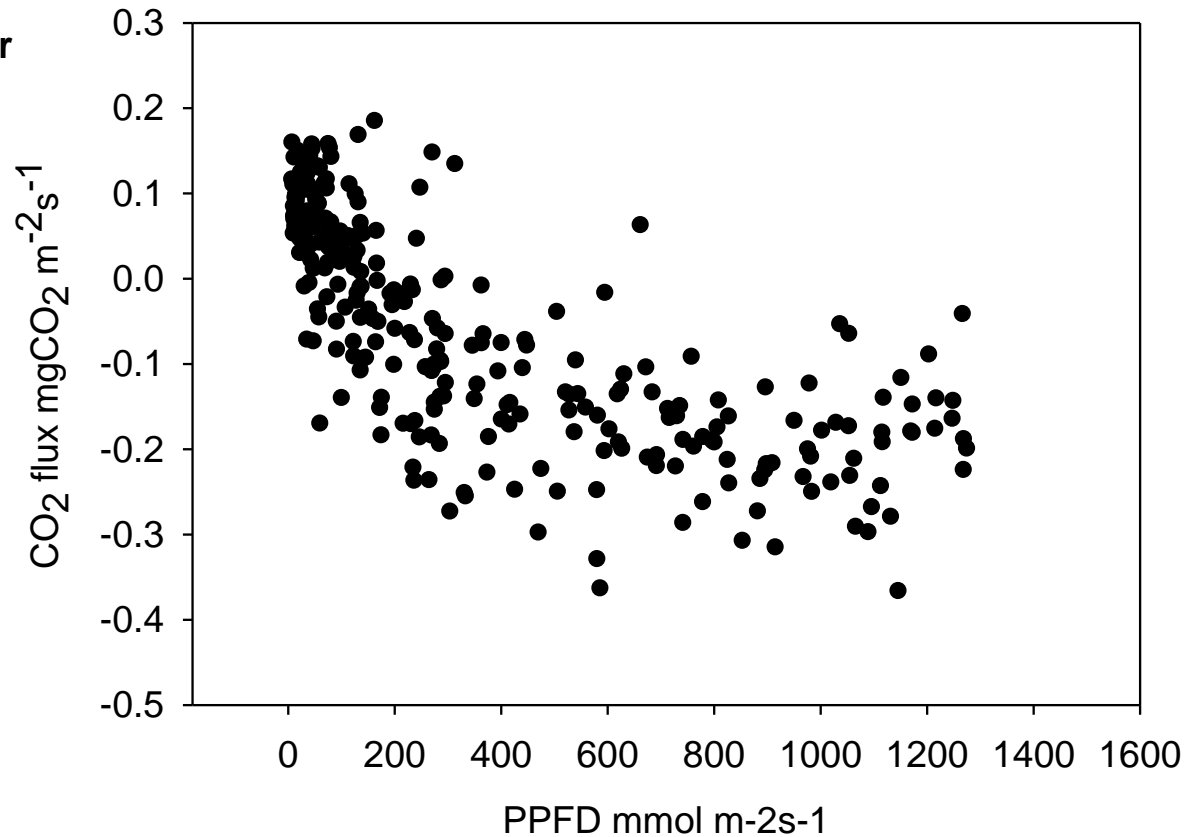


Finnish wetlands:
Kaamanen: 5 gCH₄m⁻²yr⁻¹
Lompolojänkkä: 20 gCH₄m⁻²yr⁻¹



CO₂ – PPFD response during peak summer

Winds from sector
150-240

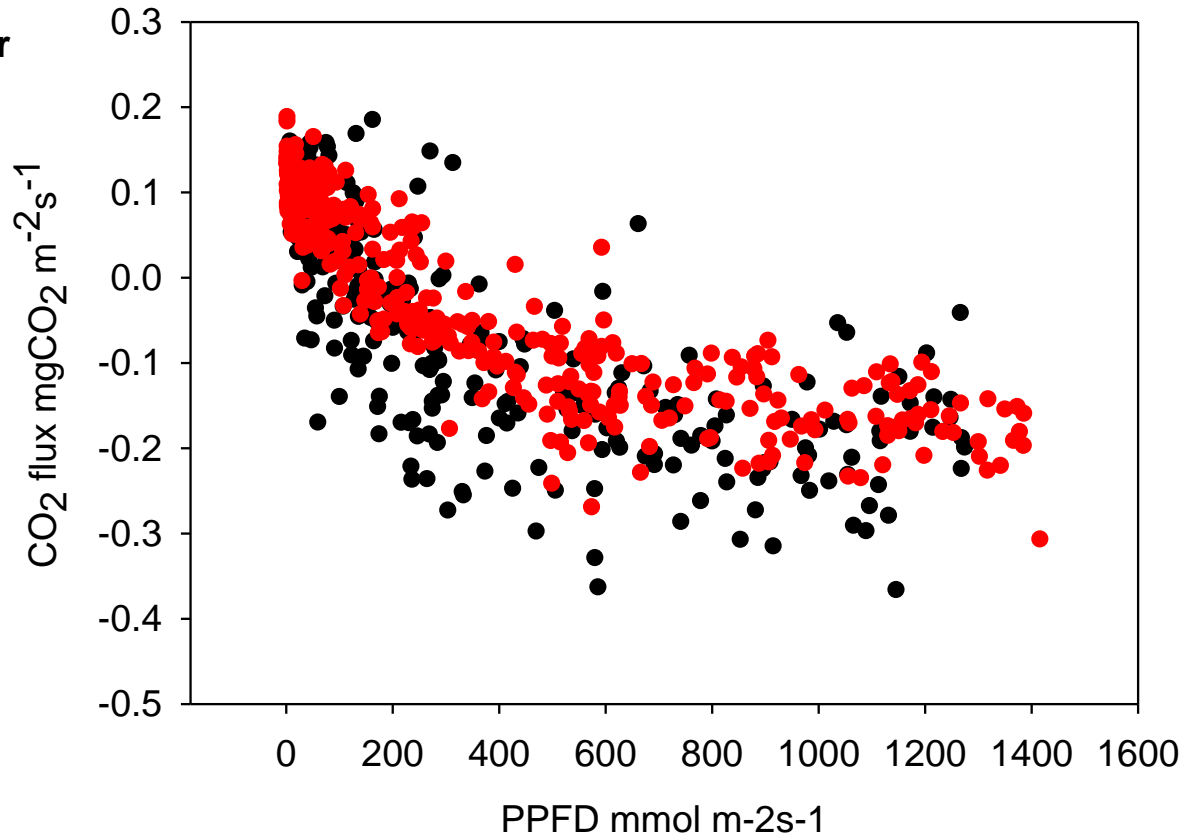


Tiksi 2010



CO₂ – PPFD response during peak summer

Winds from sector
150-240



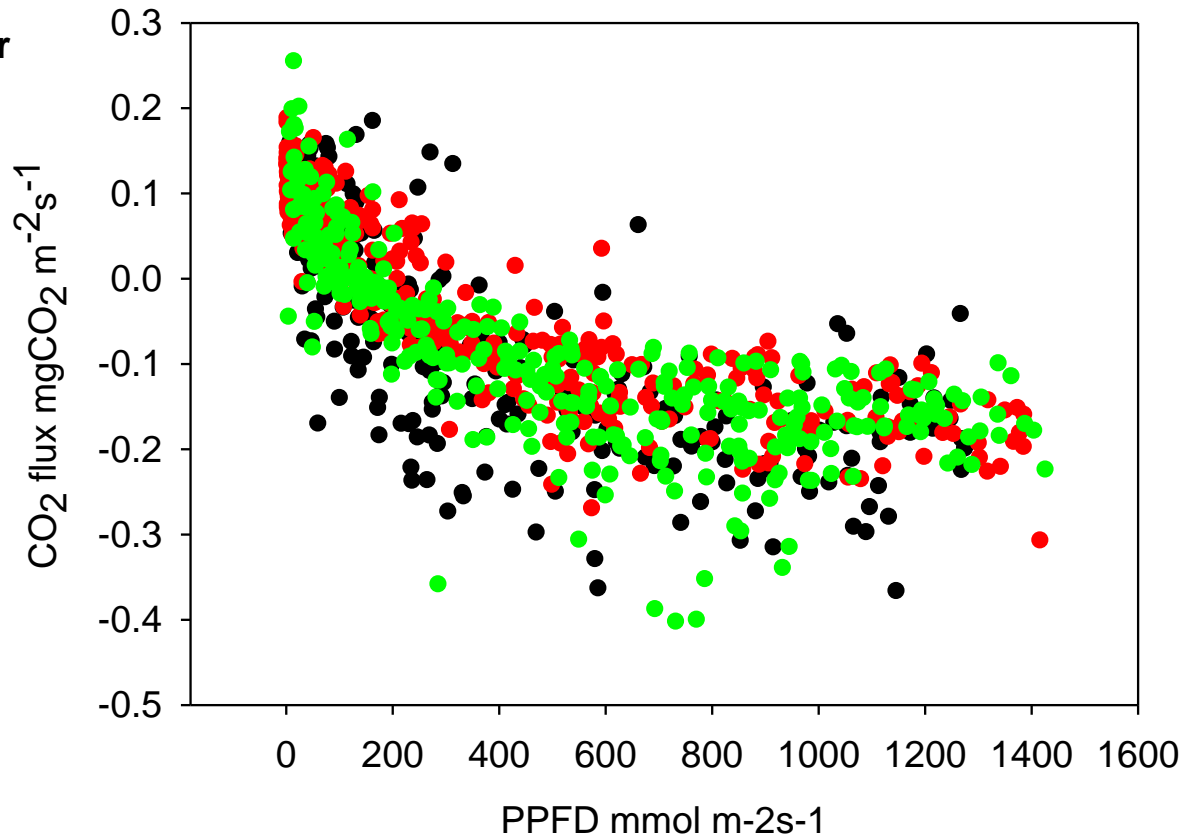
Tiksi 2010

Tiksi 2011



CO₂ – PPFD response during peak summer

Winds from sector
150-240



Tiksi 2010

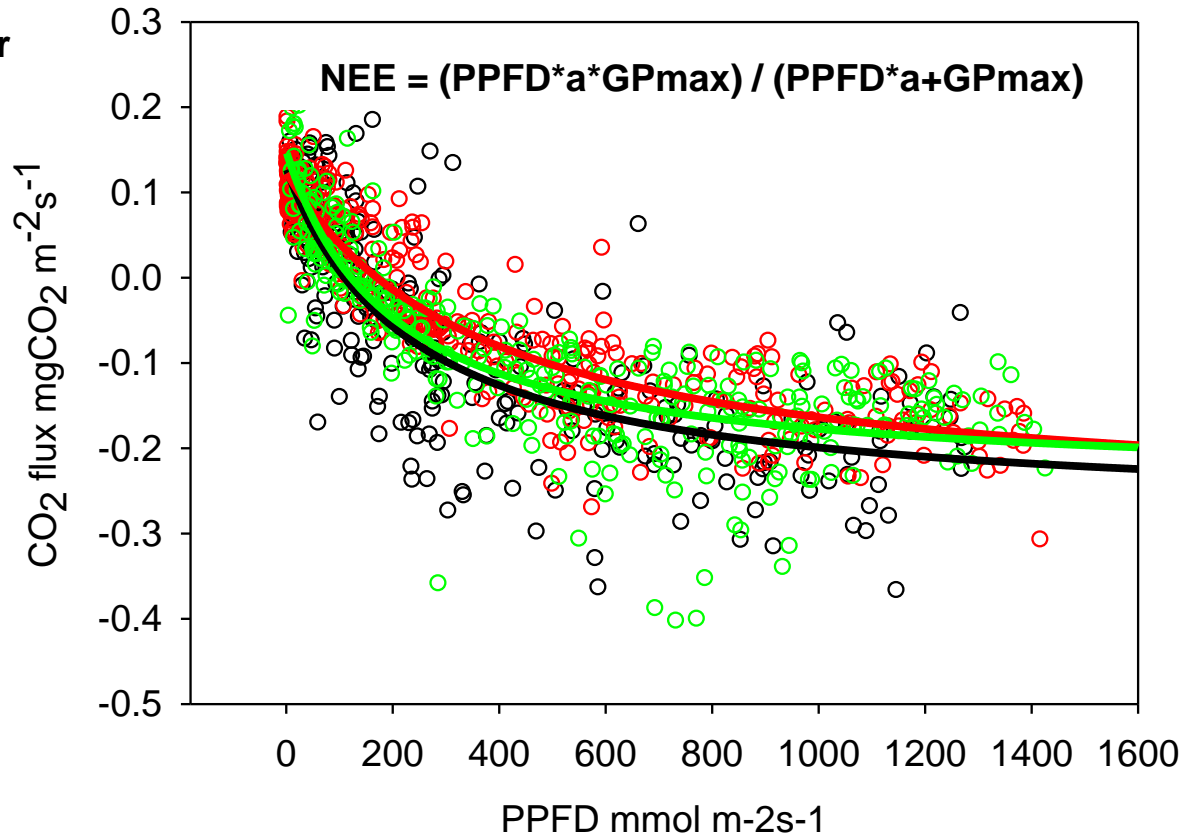
Tiksi 2011

Tiksi 2012



CO₂ – PPFD response during peak summer

Winds from sector
150-240



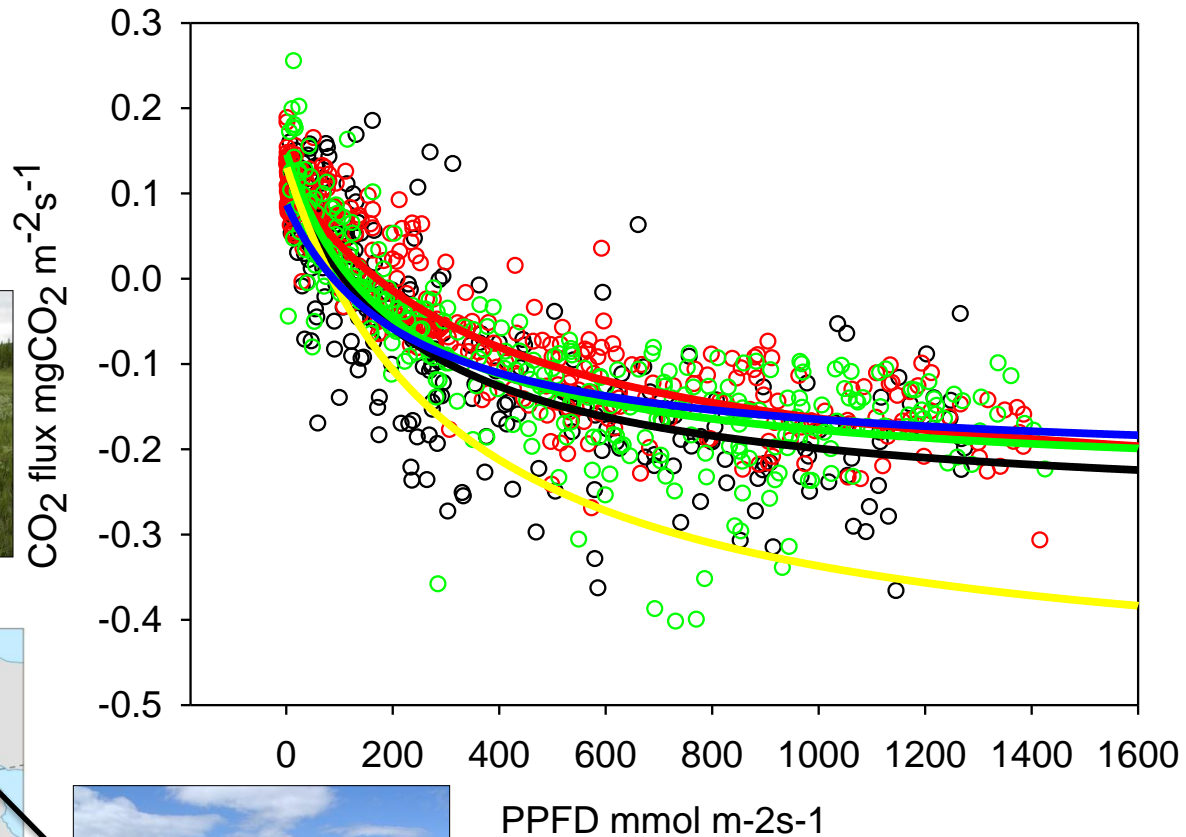
Tiksi 2010

Tiksi 2011

Tiksi 2012



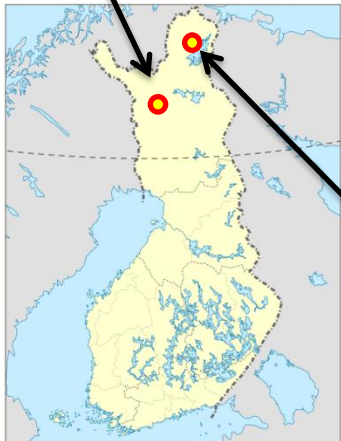
CO₂ – PPFD response during peak summer



Tiksi 2010

Tiksi 2011

Tiksi 2012



Kaamanen

Lompolojänkkä



Towards complete GHG and C balances

- Annual CO₂ and CH₄ balances
- Interannual variation of CO₂ and CH₄ balances
- Areal CO₂ and CH₄ balances
 - Areal extrapolation using satellite data
 - More detailed plant survey for the measurement valley
 - Rough plant survey for greater area (5*5 km² around CAF)
- Total C balance (CO₂ + CH₄ balances + lateral C flow)
 - Analysis of TOC (DOC and DIC) in water
 - Not analyzed in Tiksi
 - Water samples abroad? Analysis in SPb?
- Additional site information important for understanding the processes
 - Soil survey
 - C/N ratio, soil texture, age of the organic column...



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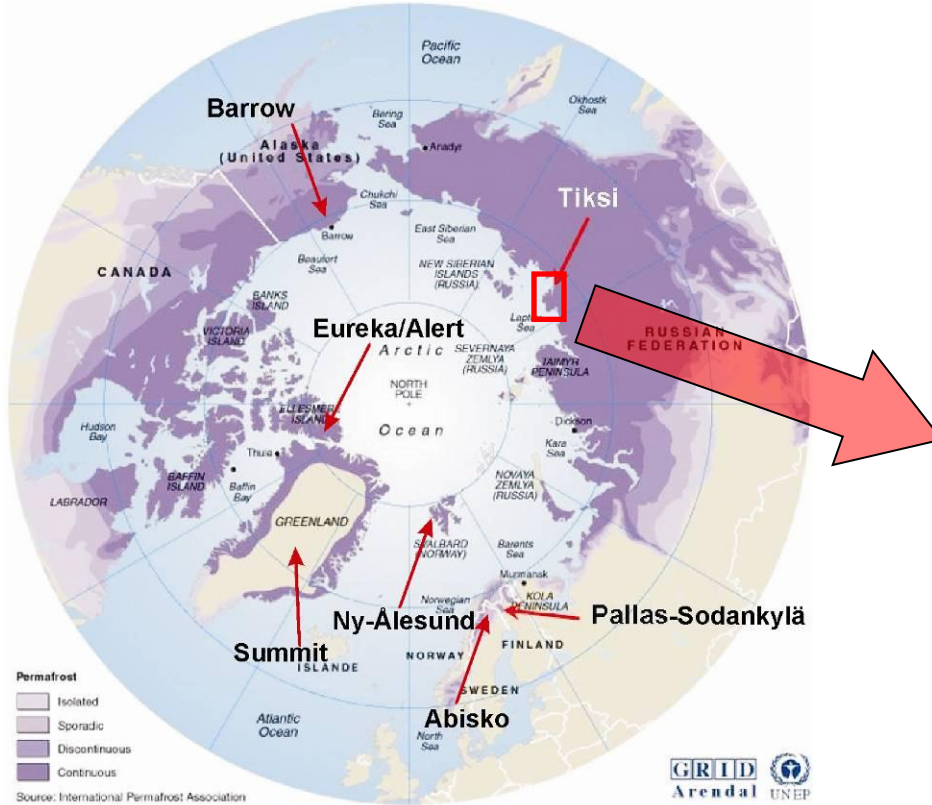


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Tiksi and Samoylov Island





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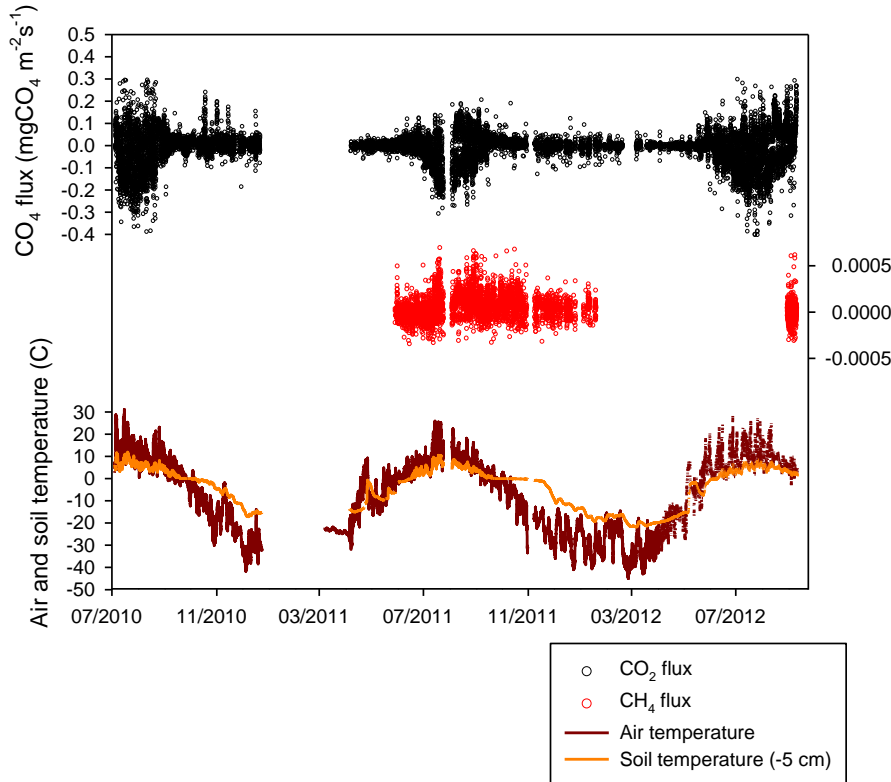
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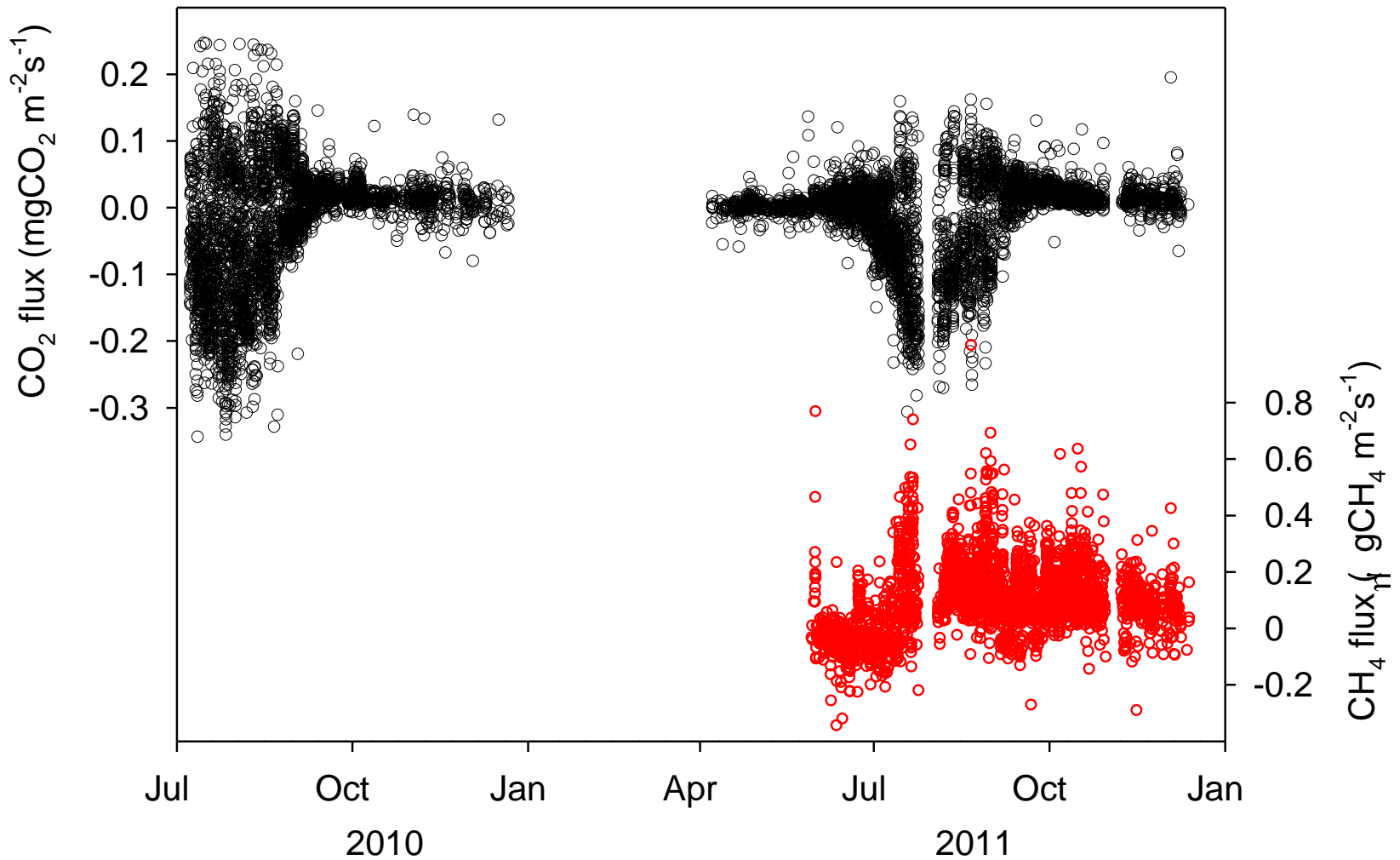


- FMI has measured GHG and energy fluxes at Tiksi since July 2010
- According to preliminary estimates the site has been acting as a small sink for CO₂ during last two years. Assuming similar autumn for 2012 as was observed in 2011 the annual balances for 2011 and 2012 were -35 and -40 gCO₂ m⁻²yr⁻¹, respectively.
- The CH₄ exchange varies markedly on different directions from the mast depending on the hydrological conditions. The first estimates for annual balances varied from a small sink (-0.3 gCH₄ m⁻²yr⁻¹) on dry rocky soil to a moderate source (3.2 gCH₄ m⁻²yr⁻¹) on the wet sedge fen area.





CO₂ and CH₄ fluxes





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-1.7145e-3	-1.0551e-3	-1.9530e-3	-1.9477e-3	-1.3876e-3
-0.4049	-0.3948	-0.3904	-0.6180	-0.3095
0.1284	0.1236	0.1480	0.1322	0.0882
0.6500	0.8600	0.7500	0.8500	0.8400
18 Jul - 3 Aug	16 Jul - 15 Aug	8 Jul - 13 Aug	Ambient air monitoring	

Weather Station