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On the role of advection for the net ecosystem carbon dioxide exchange of a subalpine grassland

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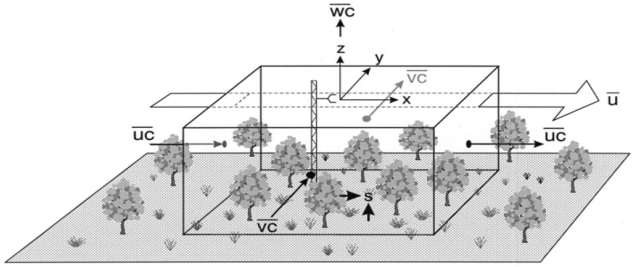
Background

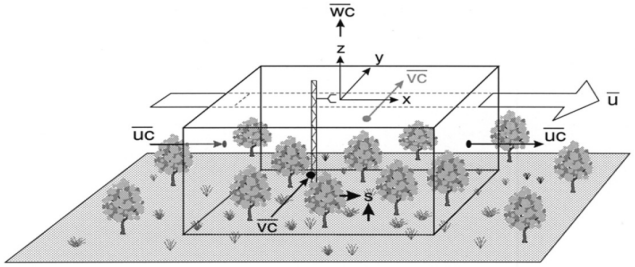


$$\overline{F} = \frac{1}{L^2}\int_0^L\int_0^L\int_0^h \overline{c_d}\,\frac{\overline{\delta\chi}}{\delta t}\,dxdydz +$$

$$\frac{1}{L^2}\int_0^L\int_0^L\int_0^h \left[\overline{uc_d}\,\frac{\overline{\delta\chi}}{\delta x} + \overline{vc_d}\,\frac{\overline{\delta\chi}}{\delta y} + \overline{wc_d}\,\frac{\overline{\delta\chi}}{\delta z}\right] dxdydz +$$

$$\frac{1}{L^2}\int_0^L\int_0^L\int_0^h \left[\frac{\delta\,\overline{c_d}\,\overline{u'\chi'}}{\delta x} + \frac{\delta\,\overline{c_d}\,\overline{v'\chi'}}{\delta y} + \frac{\delta\,\overline{c_d}\,\overline{w'\chi'}}{\delta z}\right] dxdydz$$

Background



$$\overline{F} = \int_0^h \overline{c_d} \frac{\overline{\delta \chi}}{\delta t} dz + \overline{c_d} \overline{w' \chi'}$$

Complex terrain

me

1000km

Ray in Canberra

drafting his 1995 PCE papers

Plant, Cell and Environment (1995) 18, 339–355

THEORETICAL PAPER

A critical appraisal of a combined stomatal-photosynthesis model for C_3 plants

R. LEUNING

CSIRO Centre for Environmental Mechanics, PO Box 821, Canberra, ACT 2601, Australia

Plant, Cell and Environment (1995) 18, 1183–1200

Leaf nitrogen, photosynthesis, conductance and transpiration: scaling from leaves to canopies

R. LEUNING,[1] F. M. KELLIHER,[2] D. G. G. DE PURY[3] & E.-D. SCHULZE[4]

[1]CSIRO, Centre for Environmental Mechanics, PO Box 821, Canberra, ACT 2601, Australia, [2]Manaaki Whenua – Landcare Research, PO Box 69, Lincoln, New Zealand, [3]Research School of Biological Sciences, Australian National University, GPO Box 475, Canberra, ACT 2601, Australia, and [4]Lehrstuhl Pflanzenökologie, Universität Bayreuth, Germany

Complex terrain

http://youtu.be/UshxZSOoeCg

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Complex terrain

AGRICULTURAL AND FOREST METEOROLOGY 148 (2008) 1777–1797

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Measurement of horizontal and vertical advection of CO_2 within a forest canopy

Ray Leuning [a,*], *Steven J. Zegelin* [a], *Kevin Jones* [b], *Heather Keith* [c], *Dale Hughes* [a]

[a] CSIRO Marine and Atmospheric Research, PO Box 3023, Canberra, ACT 2601, Australia
[b] Institute of Atmospheric and Environmental Science, School of GeoSciences, The University of Edinburgh, Edinburgh EH9 3JK, United Kingdom
[c] The Fenner School of Environment and Society, Australian National University, Canberra, ACT 0200, Australia

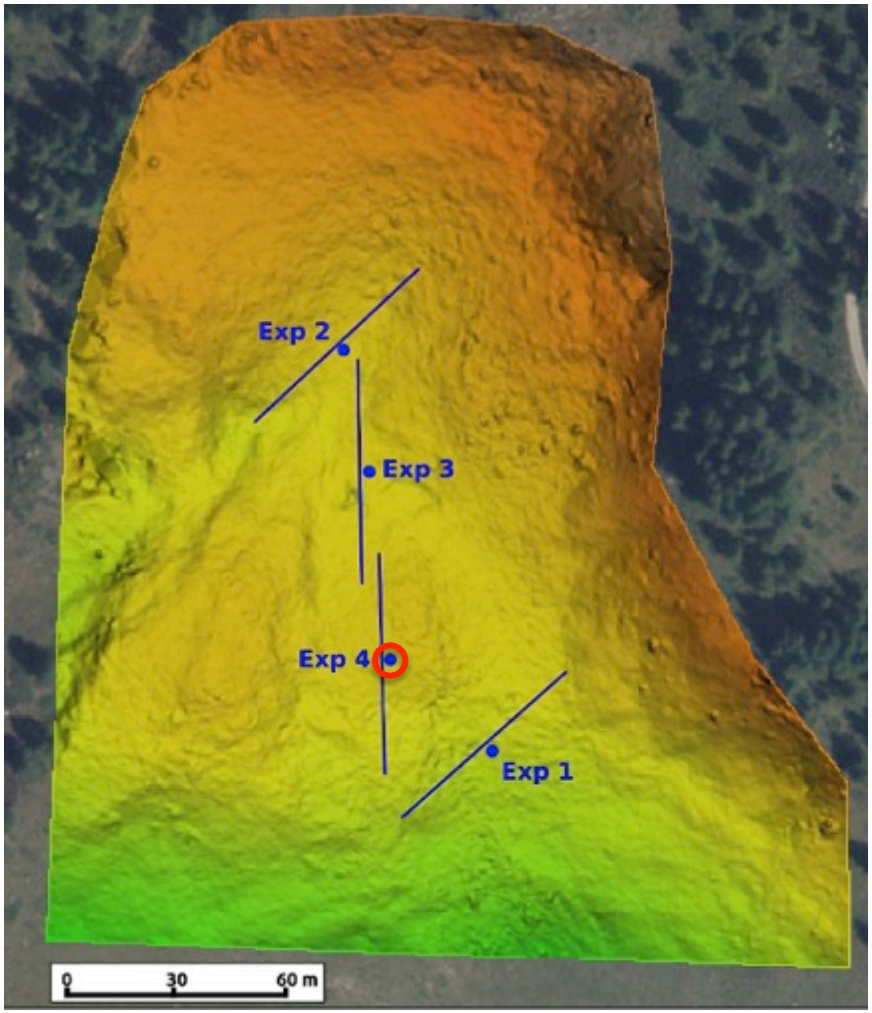
"… errors associated with measurement uncertainties outweigh the advantages of the micrometeorological mass balance approach …" (Leuning et al., 2008)



Study site

- Study site: Torgnon
- Subalpine grassland (2160 m)
- EC site on little plateau, bounded by steep slopes
- Complexity at all spatial scales
- Short canopy (20 cm)

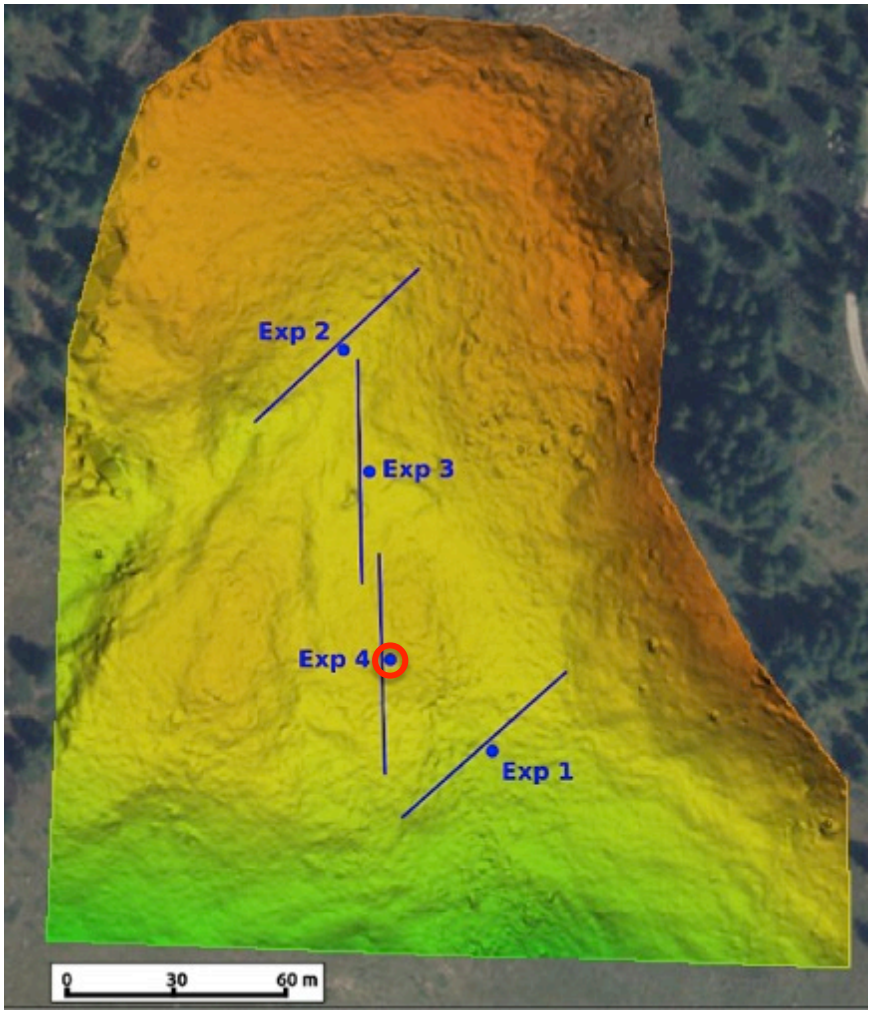
Methods

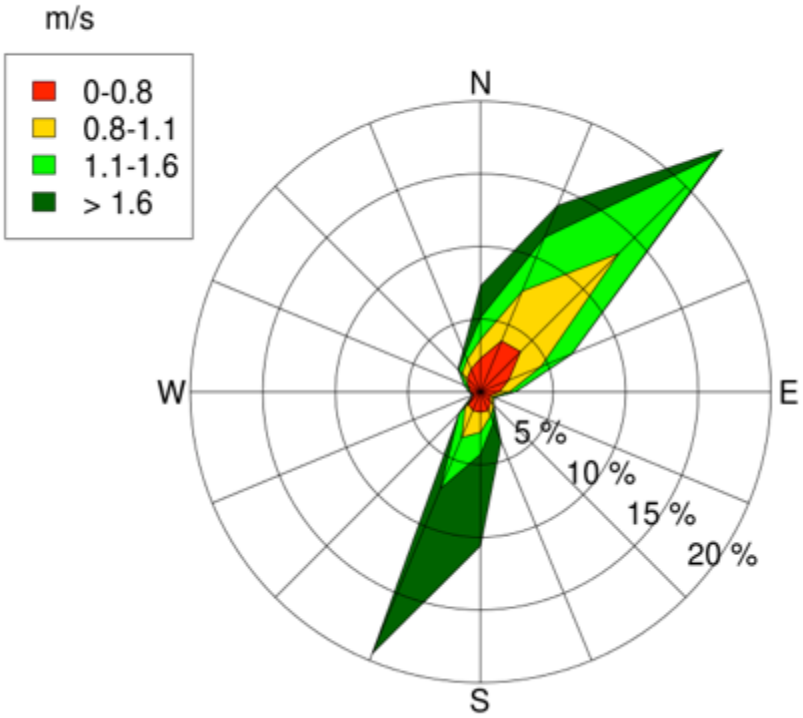


Study site

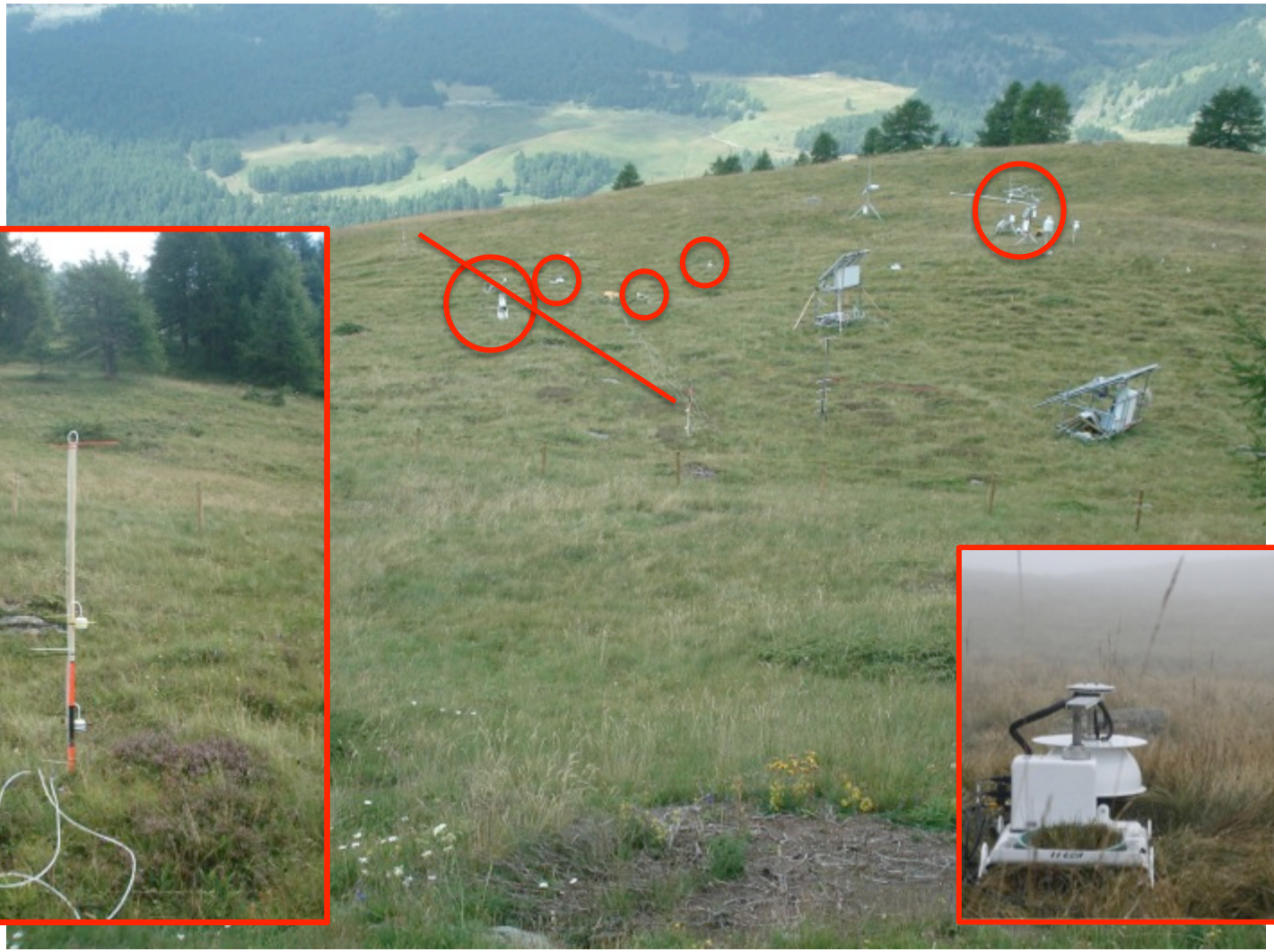
Study site

Methods





Methods



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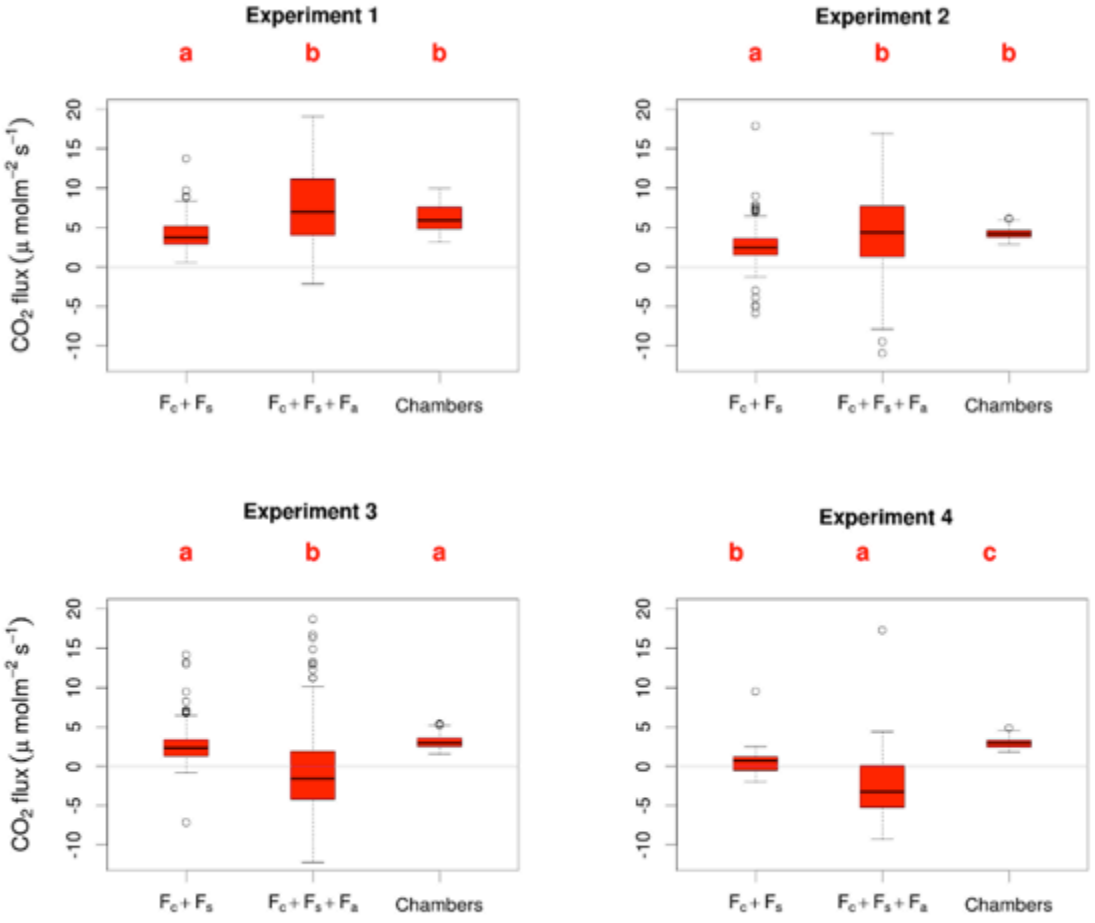
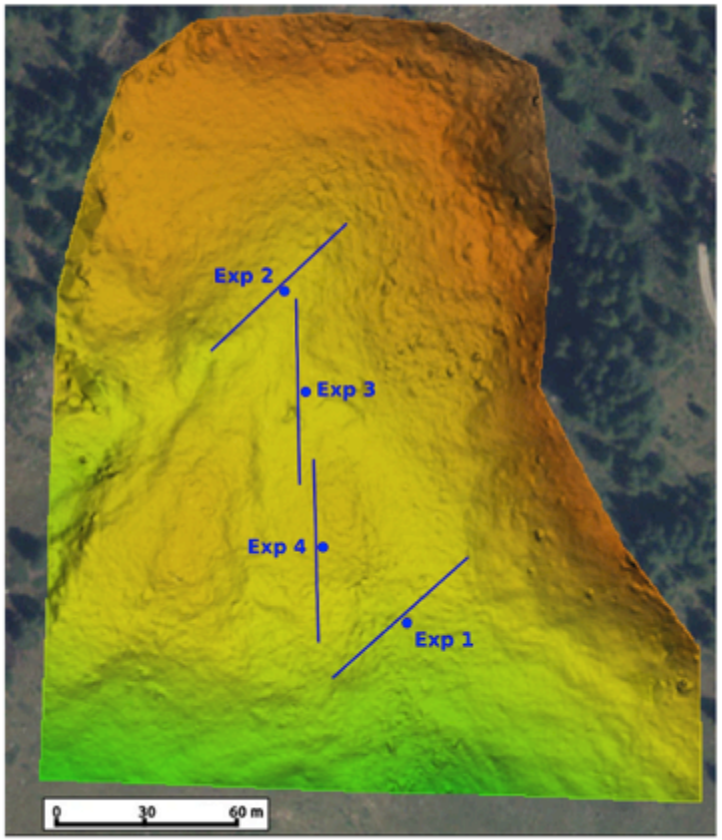
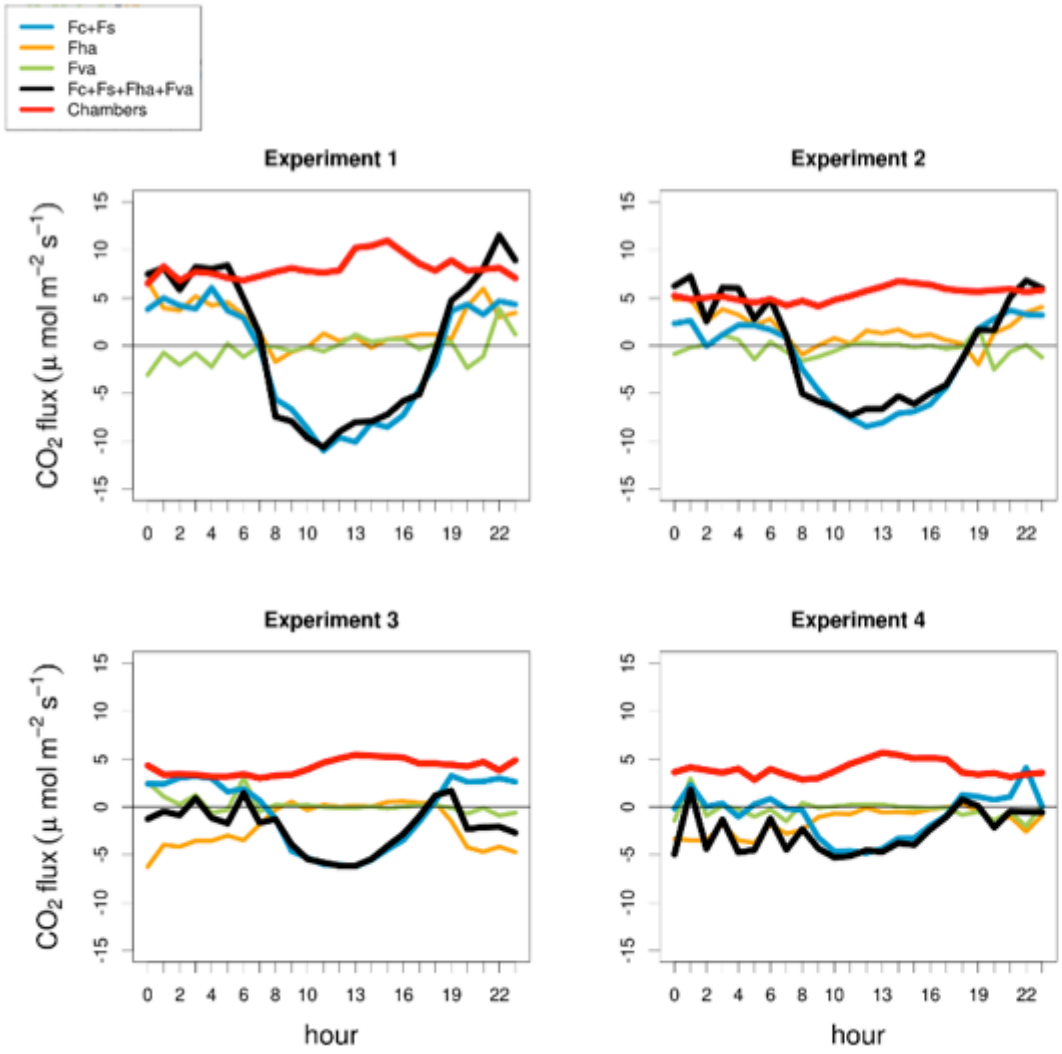
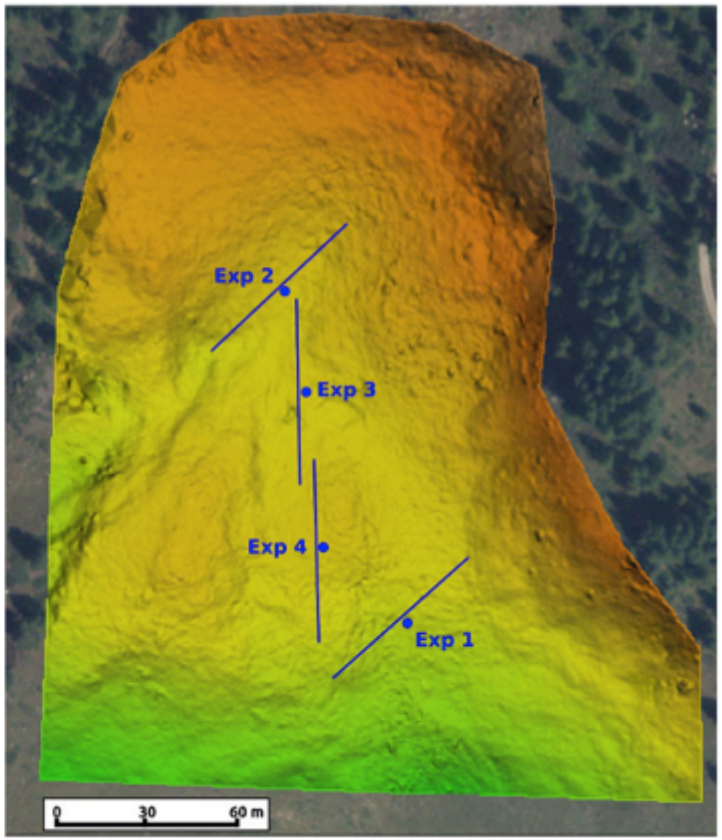
Results





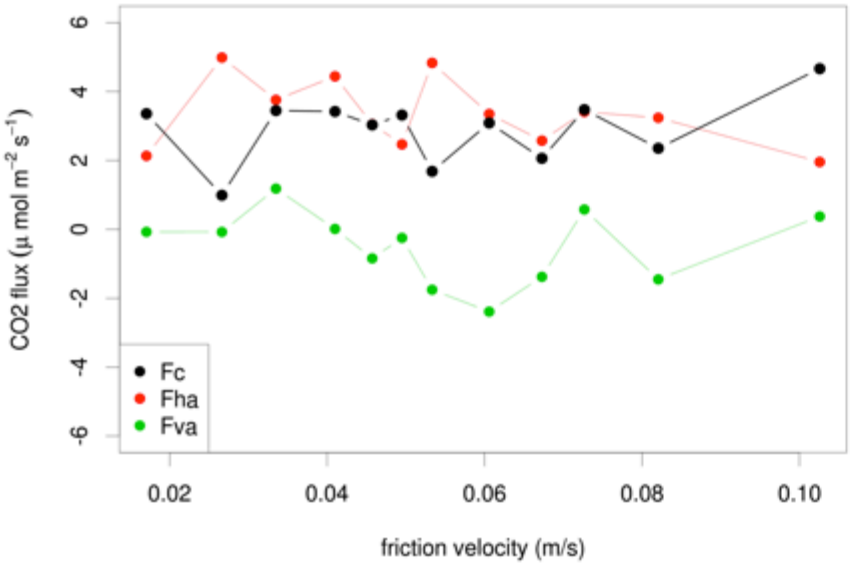
Results

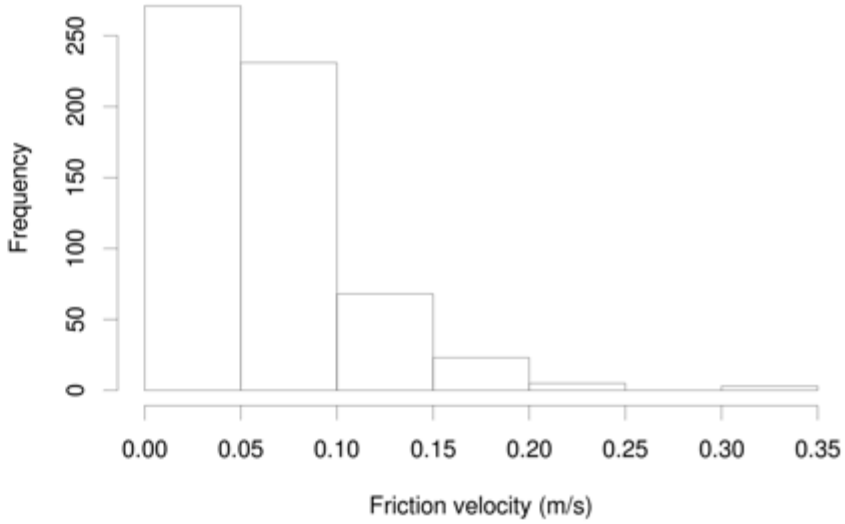

Fc+Fs
Fha
Fva
Fc+Fs+Fha+Fva
Chambers
Experiment 1
Experiment 2
Experiment 3
Experiment 4
CO2 flux (µ mol m-2 s-1)
hour


Exp 2
Exp 3
Exp 4
Exp 1
0
30
60 m



Results


CO2 flux (µ mol m^{-2} s^{-1})
6
4
2
0
-2
-4
-6
Fc
Fha
Fva
0.02
0.04
0.06
0.08
0.10
friction velocity (m/s)


Frequency
250
200
150
100
50
0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Friction velocity (m/s)

Conclusions

- The sum of the vertical covariance term and the storage term considerably underestimated nighttime ecosystem respiration as measured by the automated ecosystem chambers.
- Advection measurements indicated that both horizontal and (less so) vertical advection were important terms of the mass balance during nighttime.
- The NEE calculated by taking advection into account closely resembled nighttime ecosystem respiration as measured with the automated ecosystem chambers.
- During daytime, advection appeared to make a negligible contribution to NEE.
- Large spatial variability in the vertical eddy covariance term within short distances.

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Acknowledgments

FWF

Der Wissenschaftsfonds.

ARPA Valle d'Aosta

www.arpa.vda.it

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