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More than "just" CO_2: Multiple trace gas exchange measurements at a temperate mountain grassland

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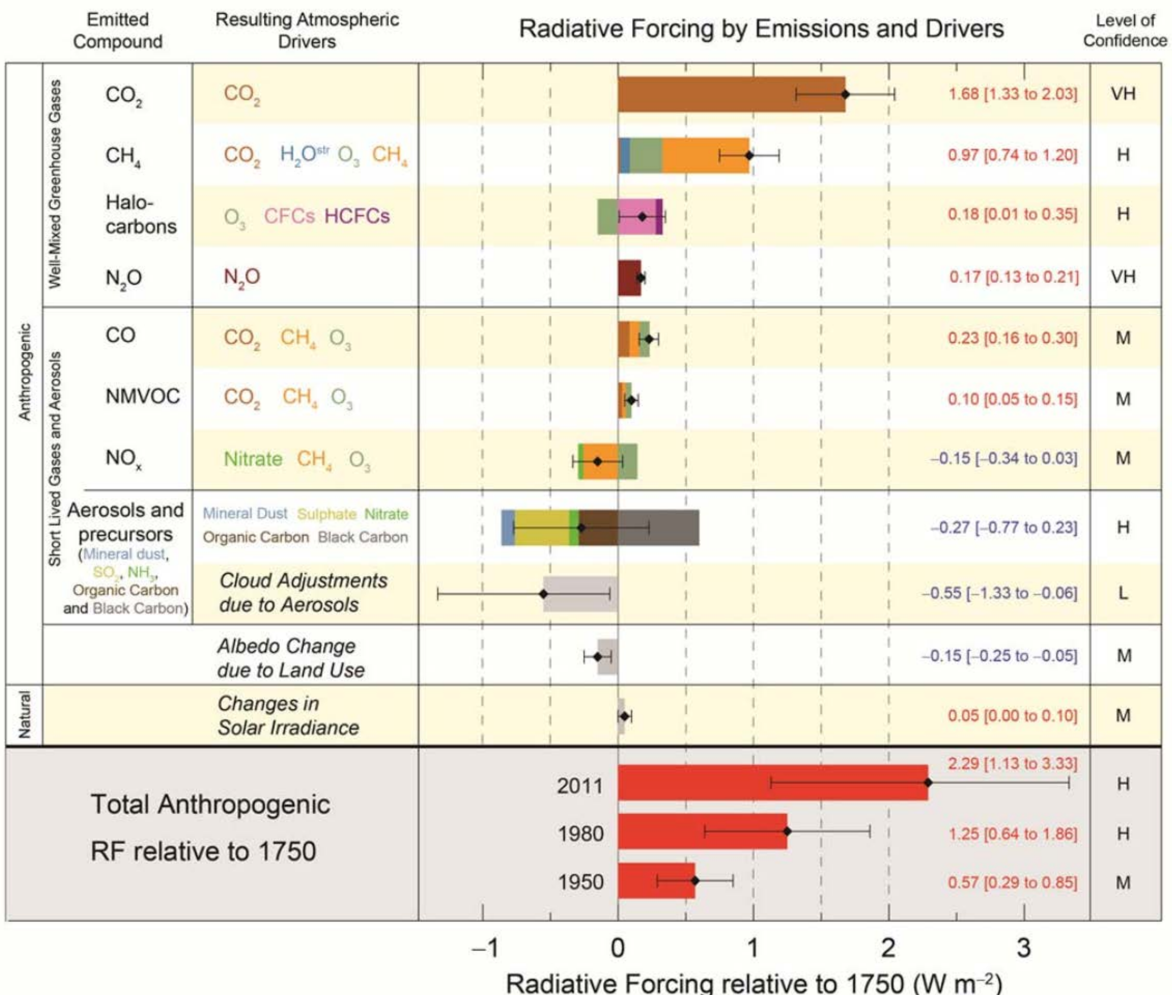
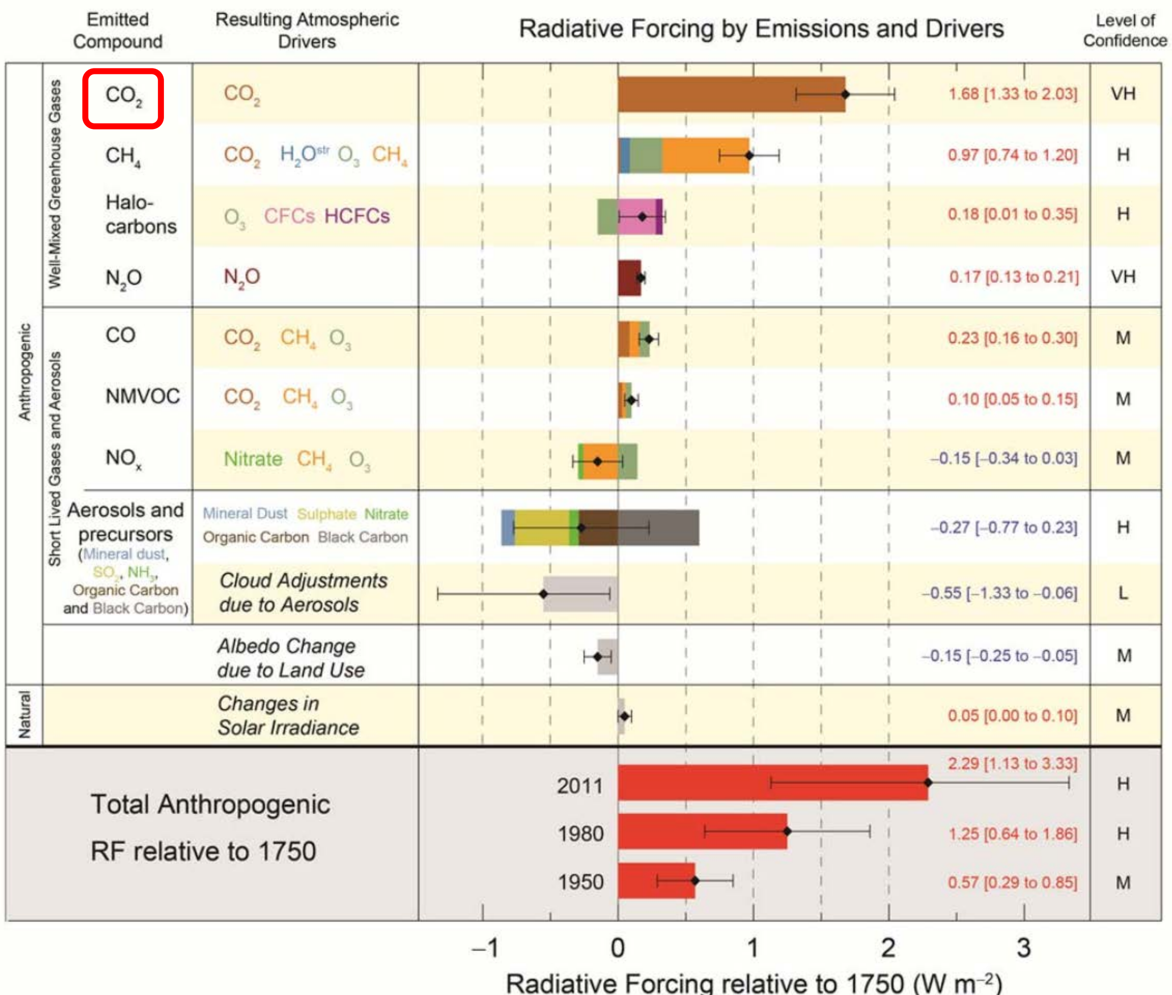
Motivation



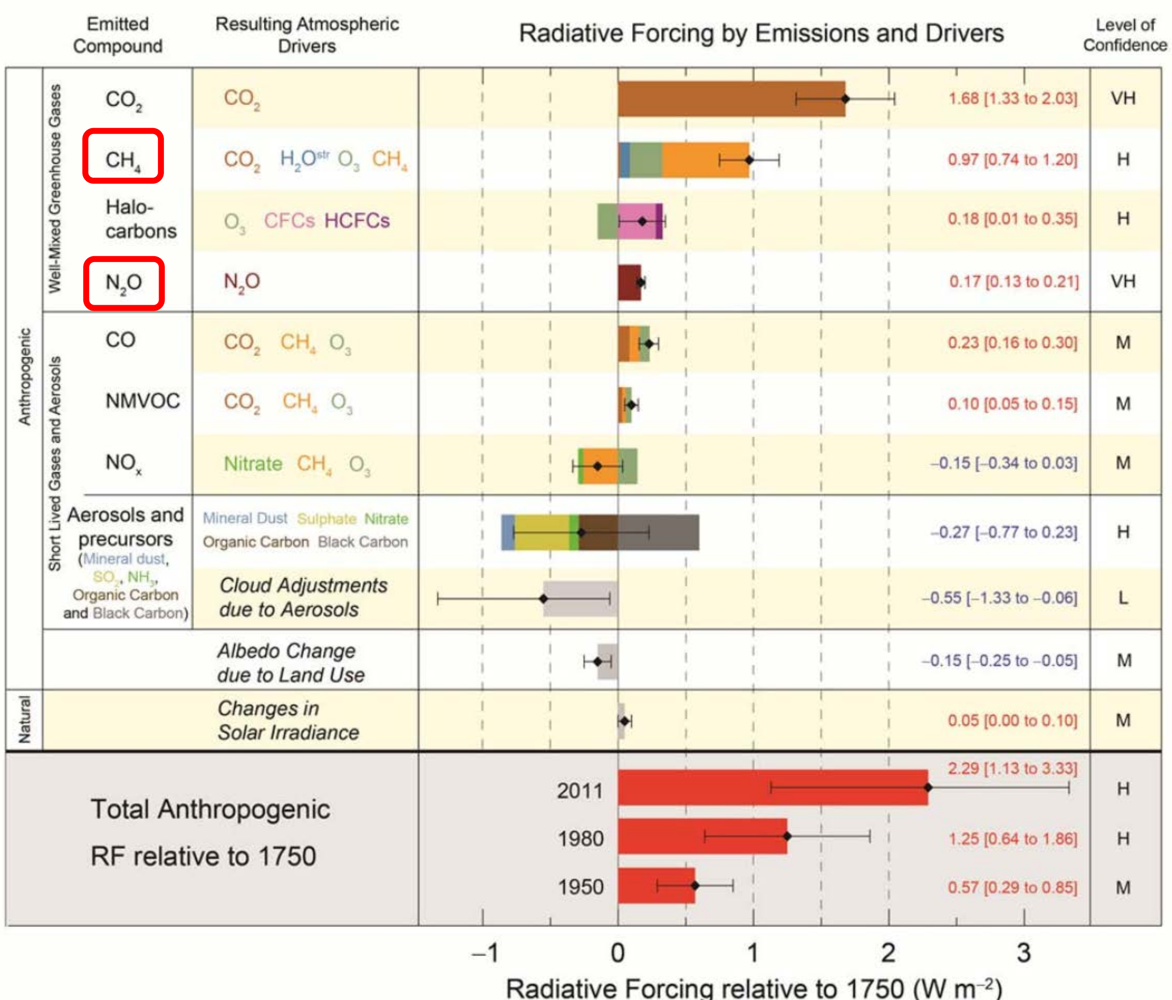
IPCC AR5 WG1 (2013)

Motivation



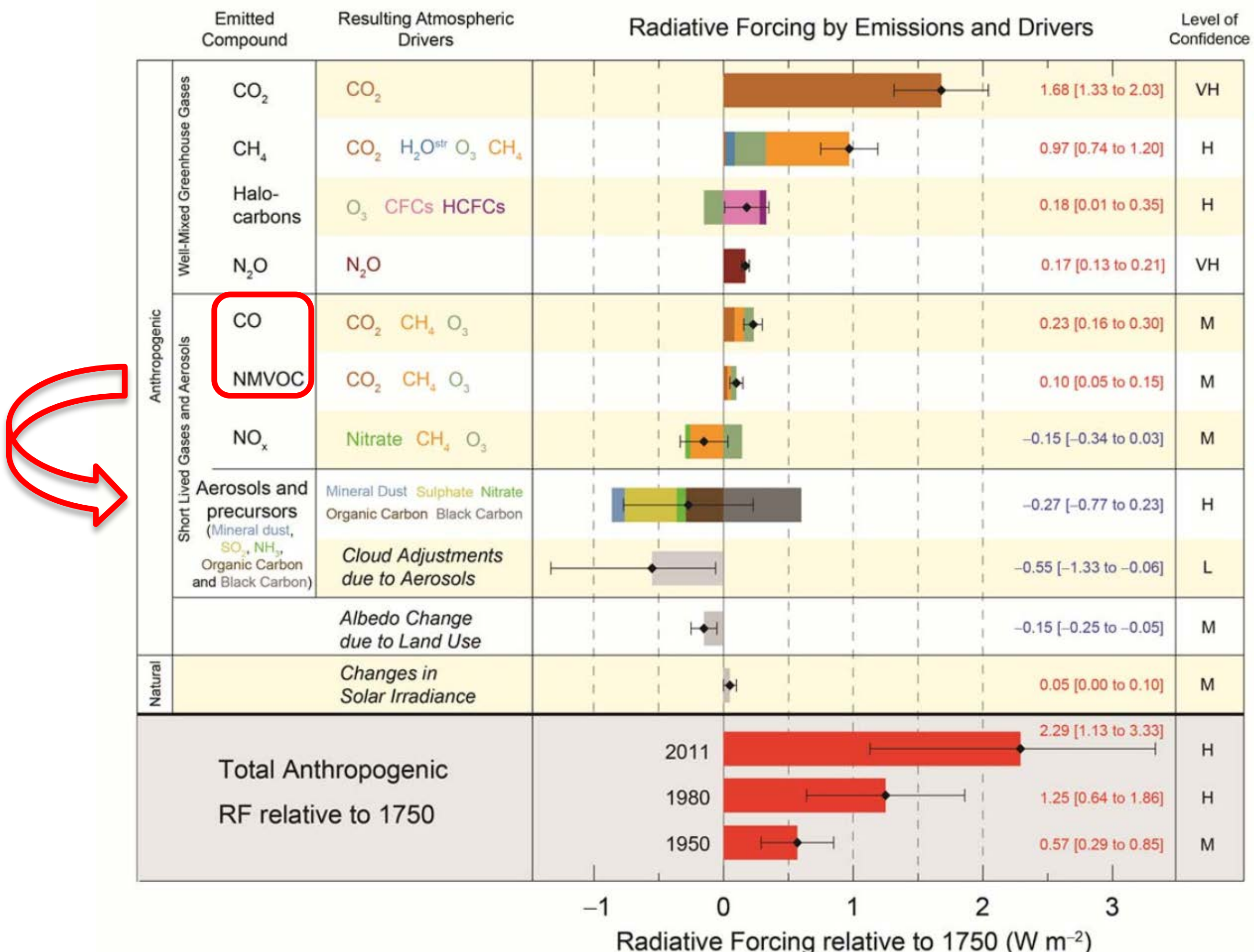
IPCC AR5 WG1 (2013)

Motivation



IPCC AR5 WG1 (2013)

Motivation



IPCC AR5 WG1 (2013)

Study site Neustift

Mission statement

"… a field laboratory to quantify environmentally relevant interactions between a managed temperate mountain grassland and the atmosphere on a long-term basis …"

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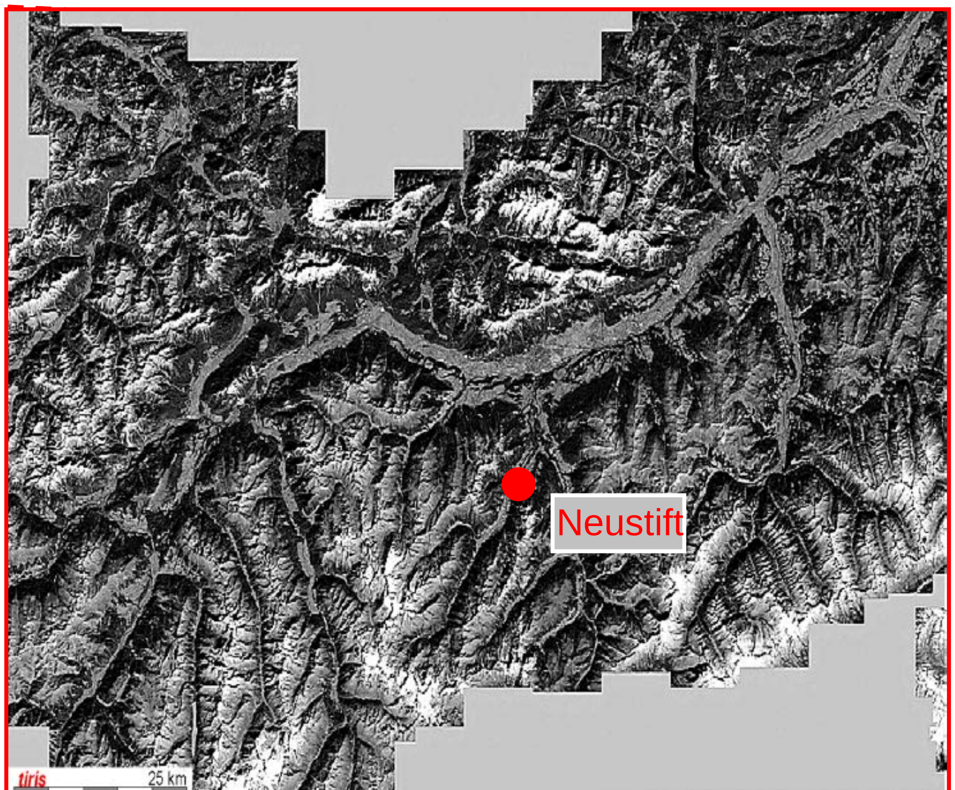
Study site Neustift



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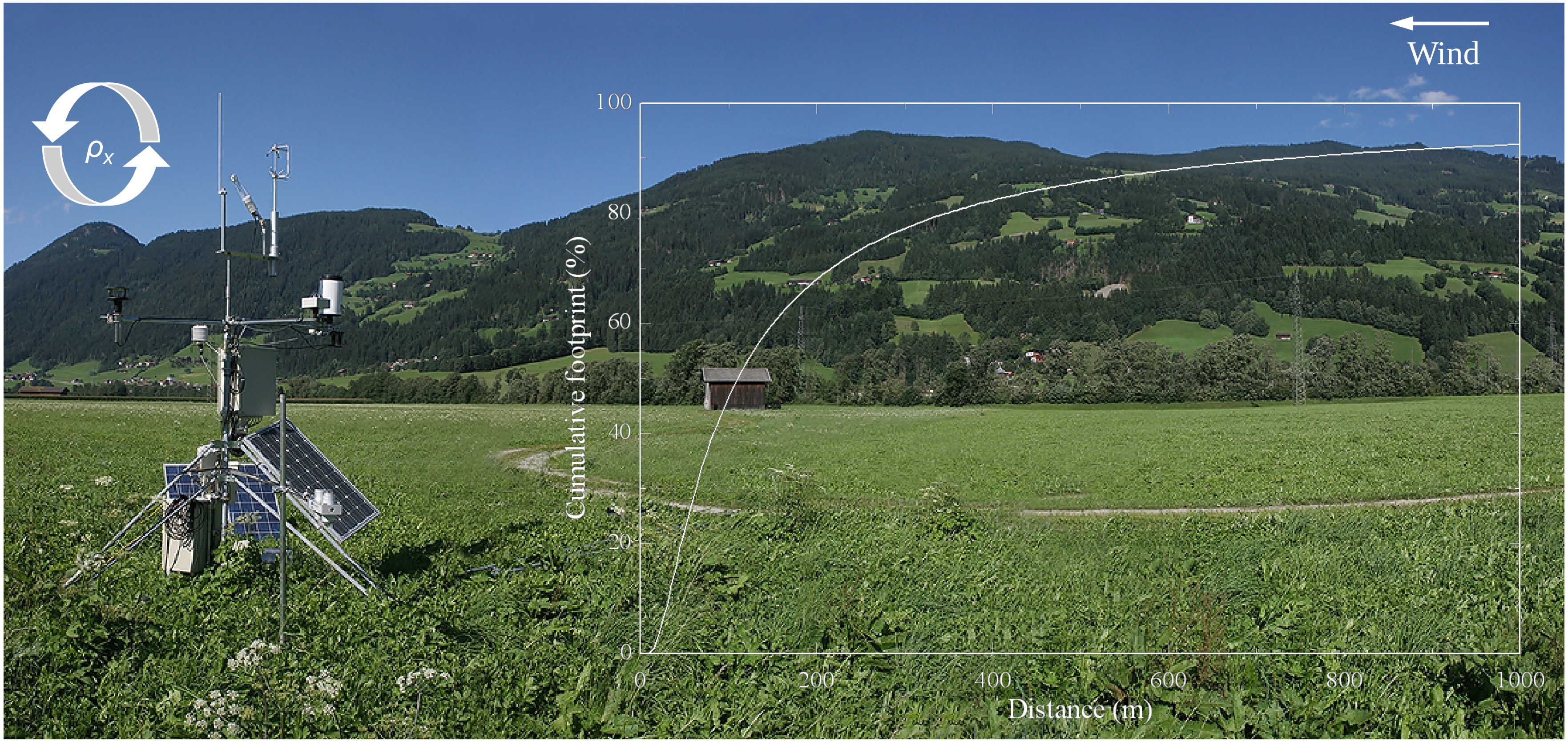
Study site Neustift

$$\Phi_x = \overline{w' \rho_x'}$$



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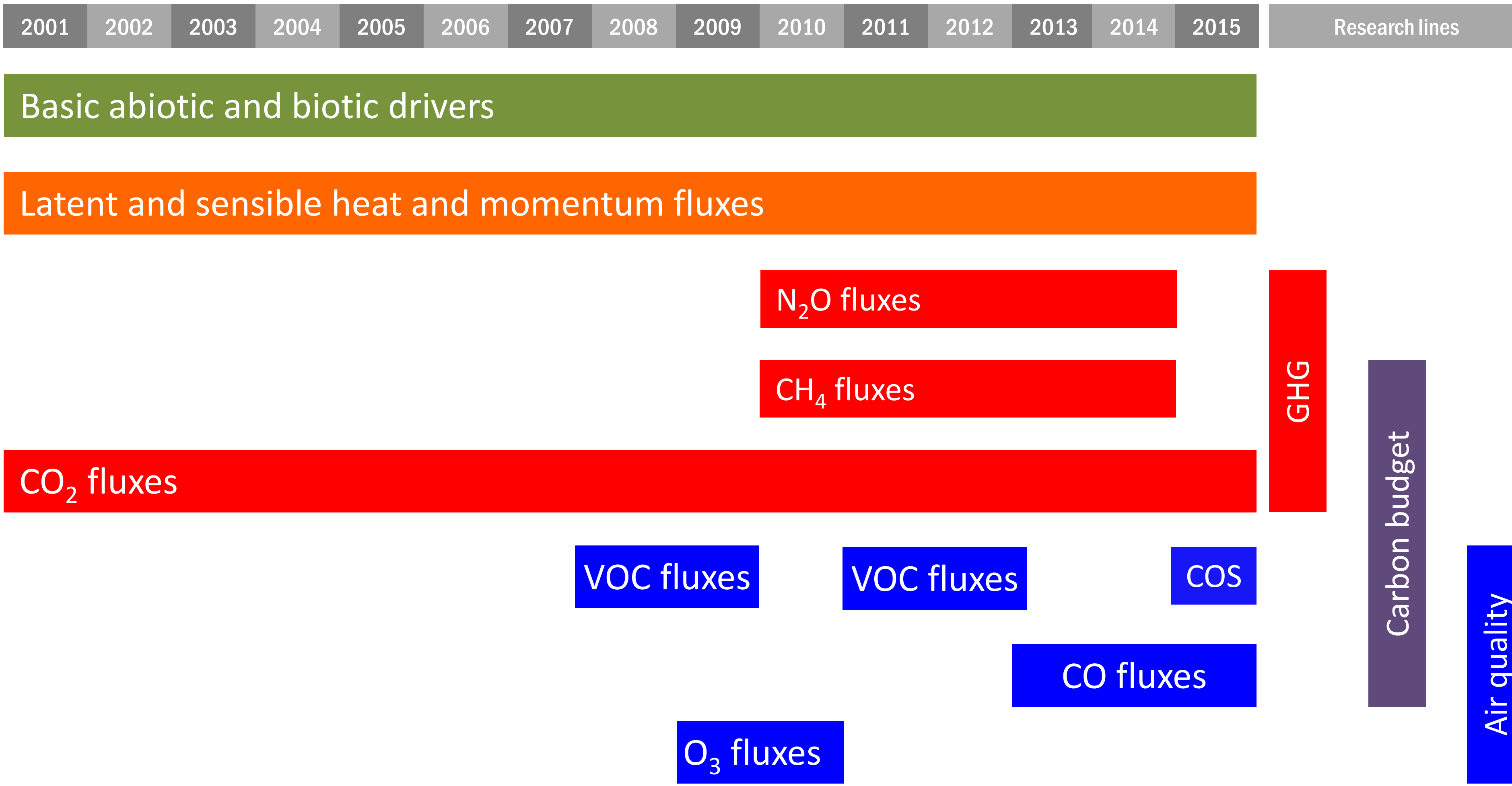
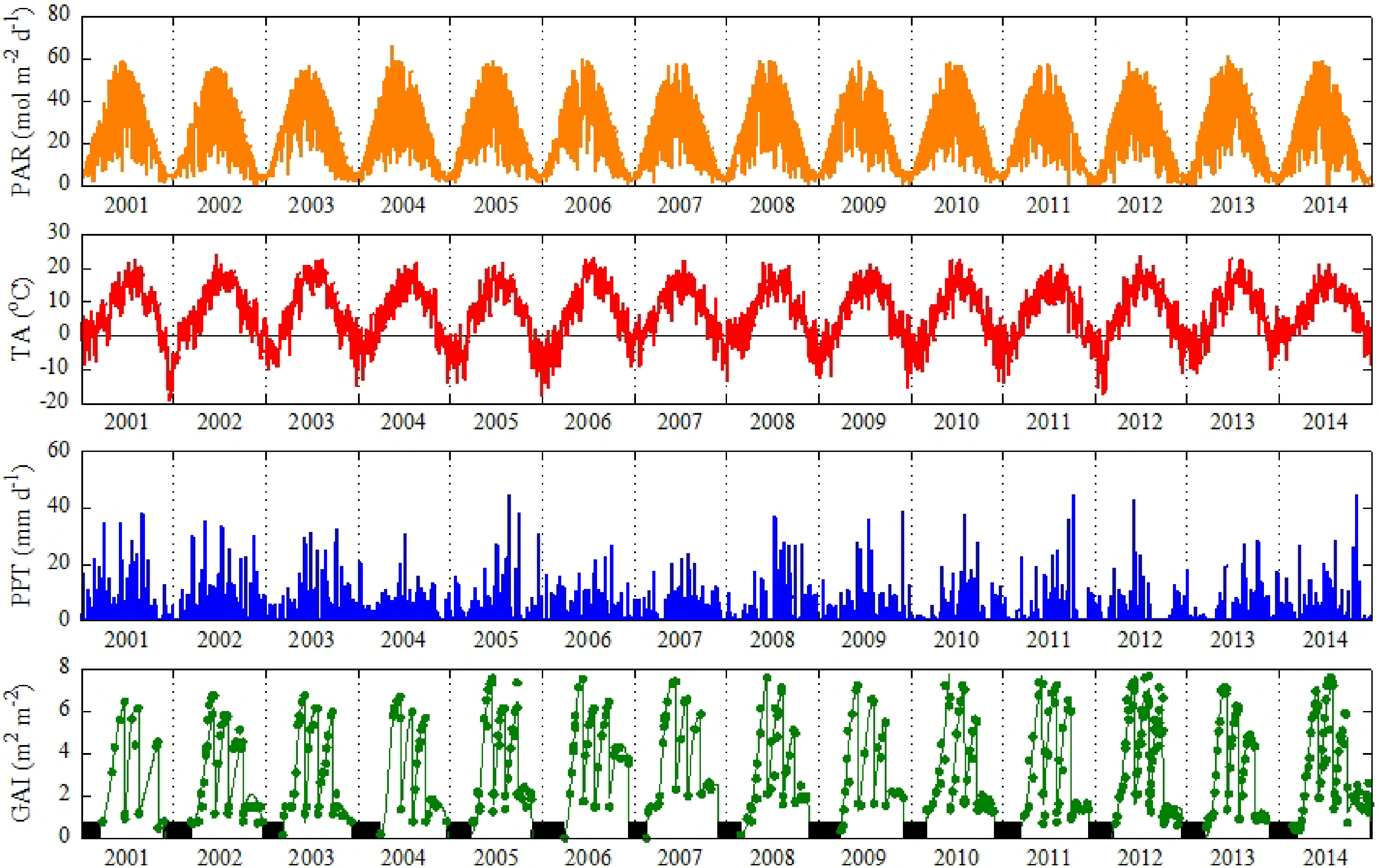


Biotic and abiotic drivers



Wohlfahrt et al. (2008) & unpublished data (2007-2014)

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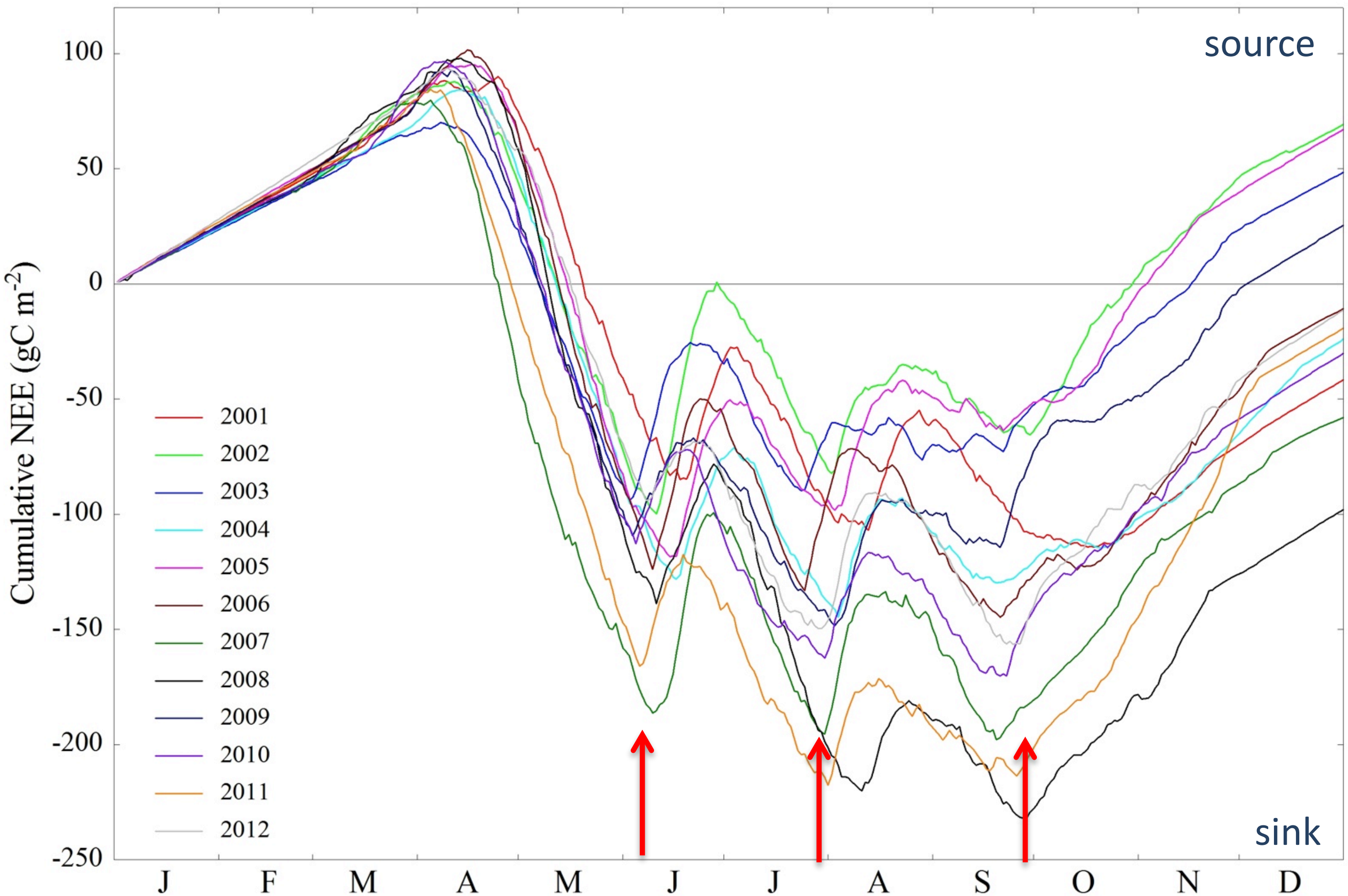
CO_2 exchange



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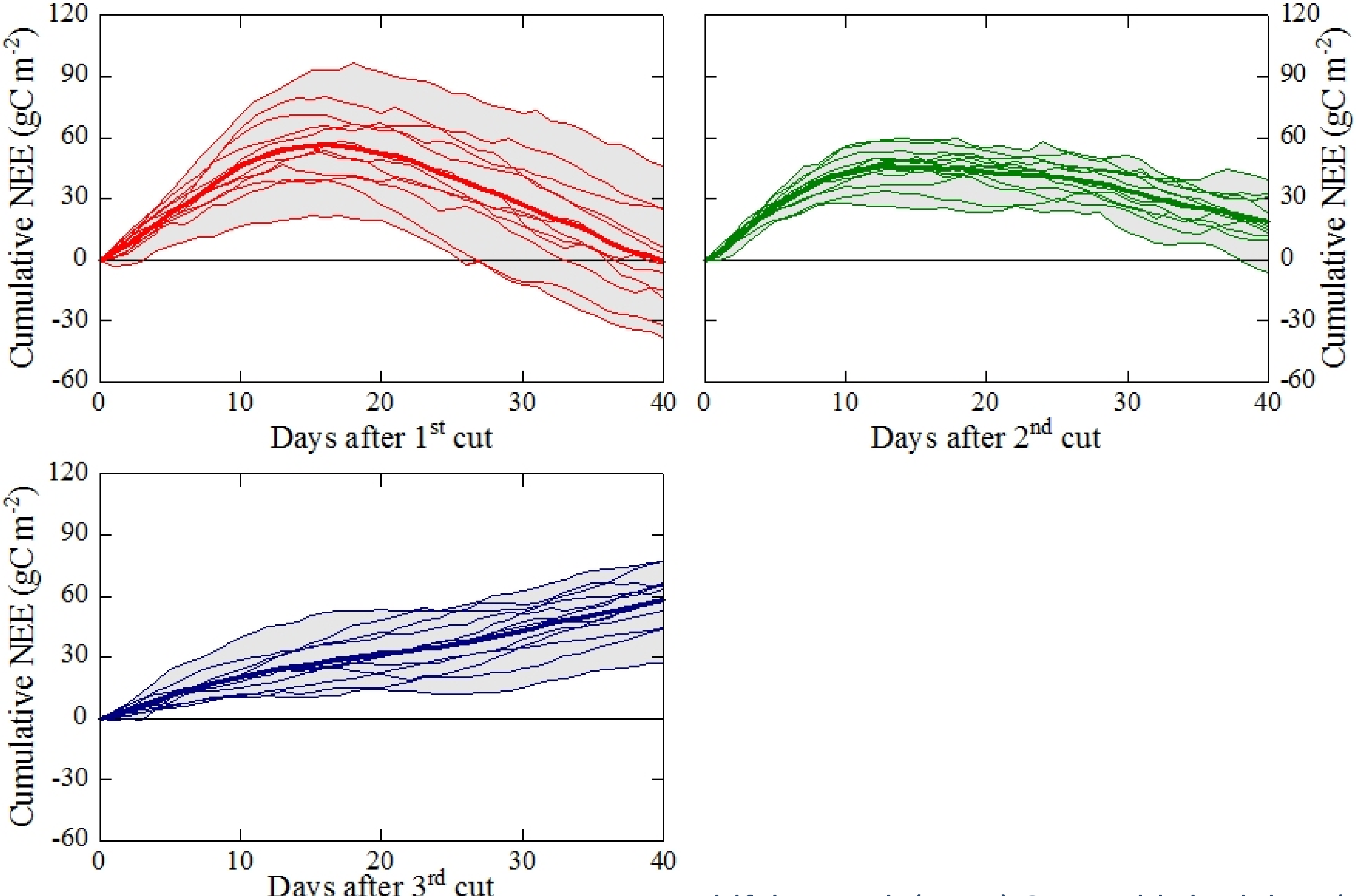

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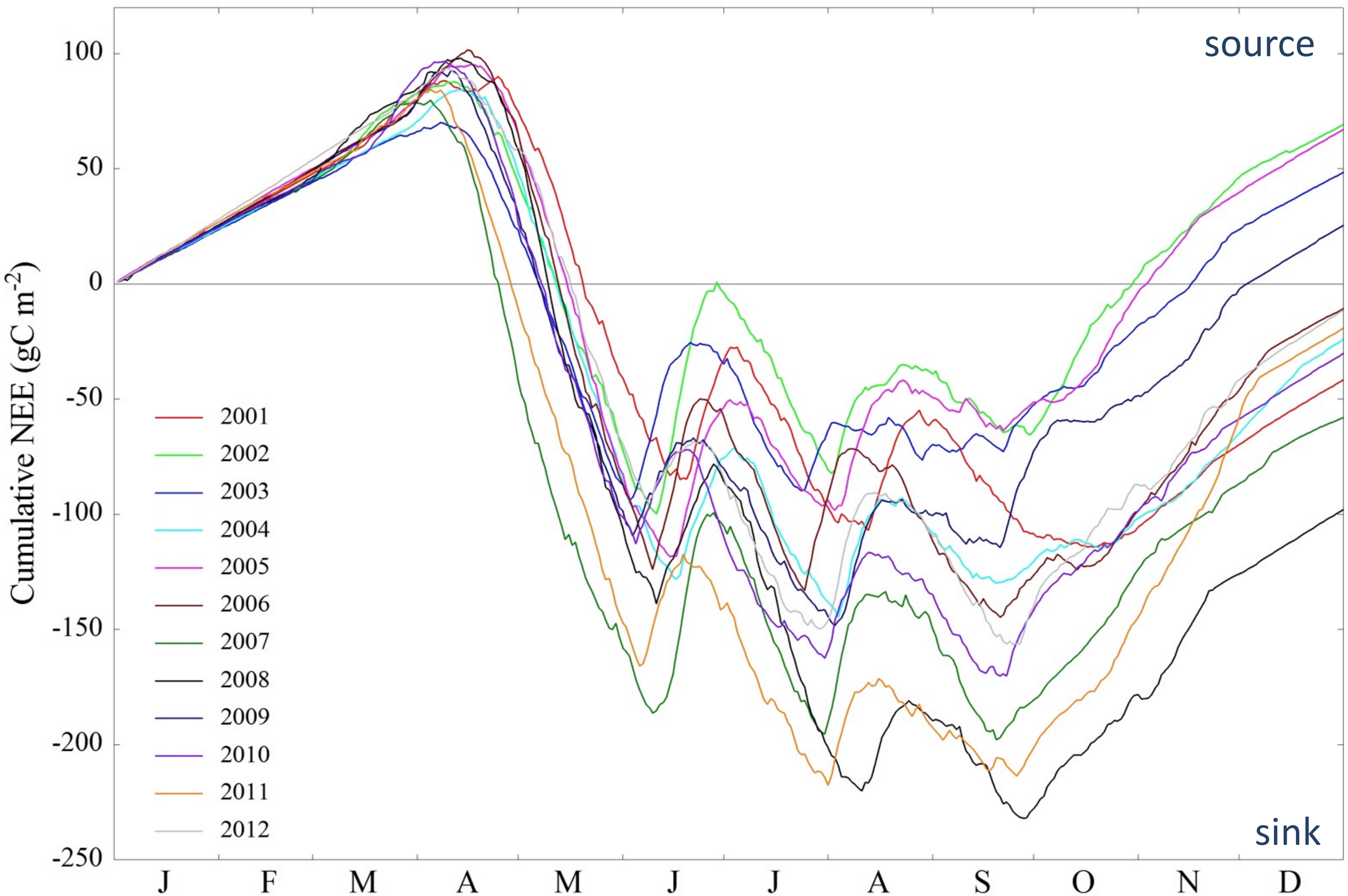
CO_2 exchange



Max: +69 gC m^{-2}

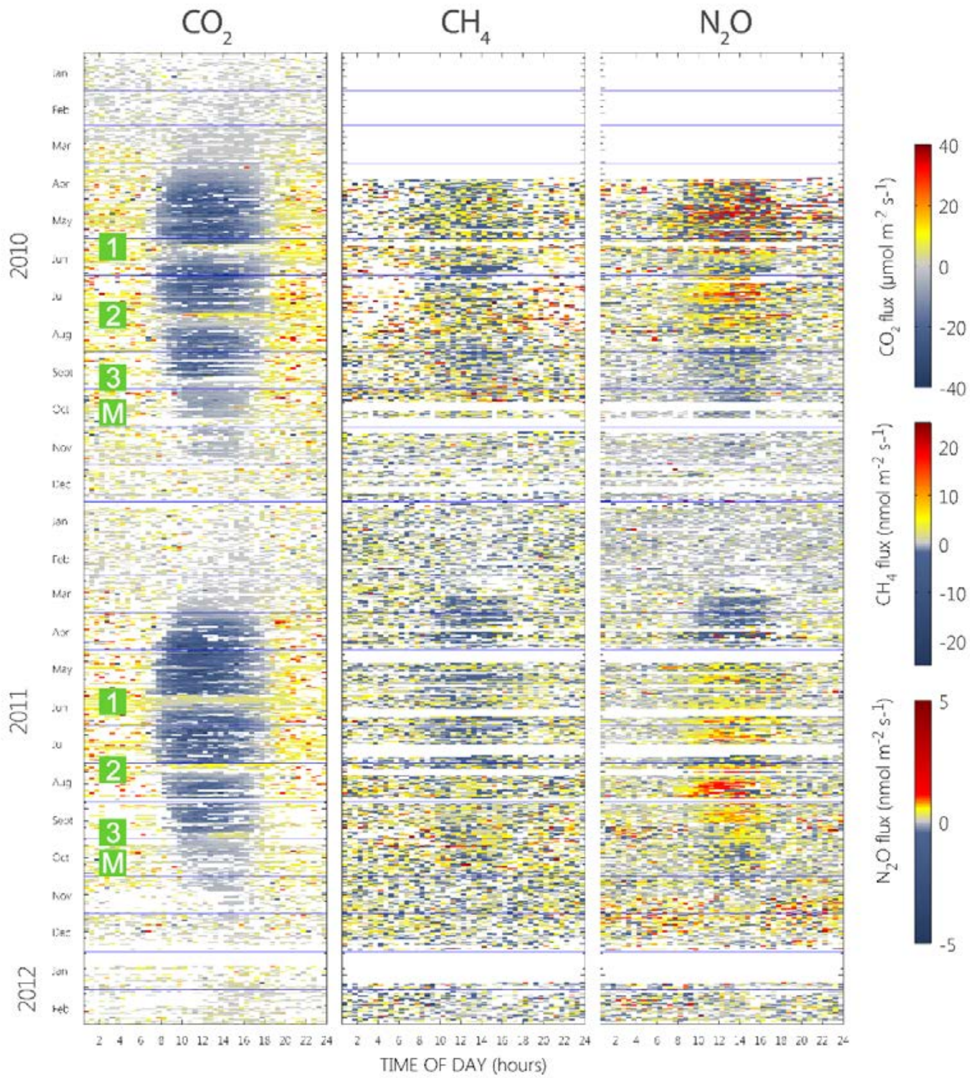
Avg: -7 gC m^{-2}

Stdv: ±50 gC m^{-2}

Min: -97 gC m^{-2}

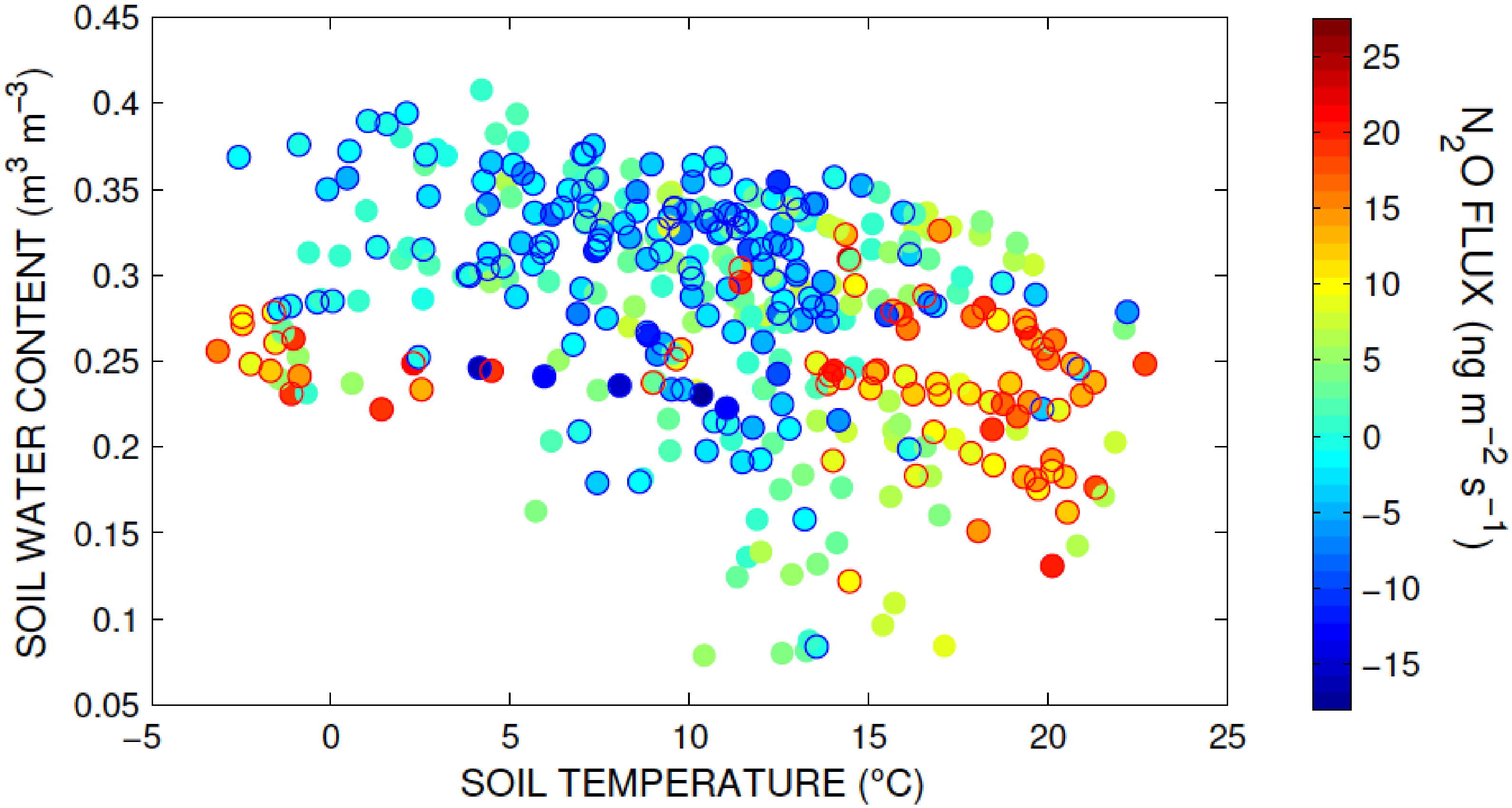
Wohlfahrt et al. (2008) & unpublished data (2007-2012)

CH_4 and N_2O exchange



Hörtnagl & Wohlfahrt (2014)

CH_4 and N_2O exchange



Hörtnagl & Wohlfahrt (2014)

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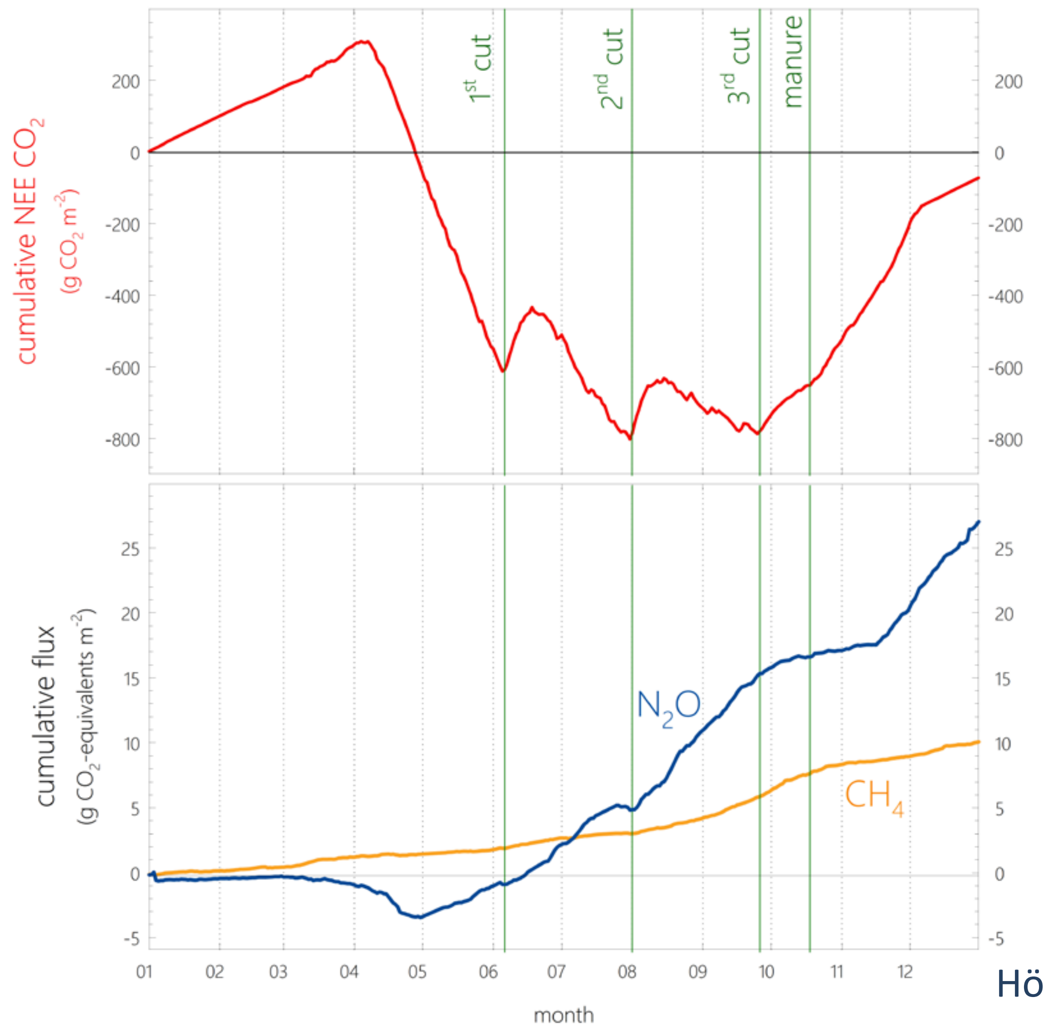
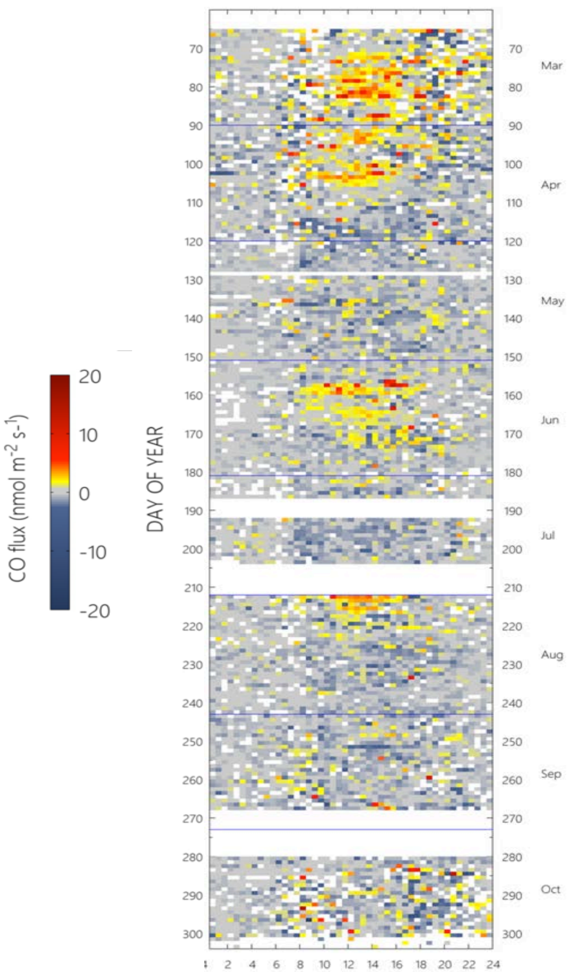
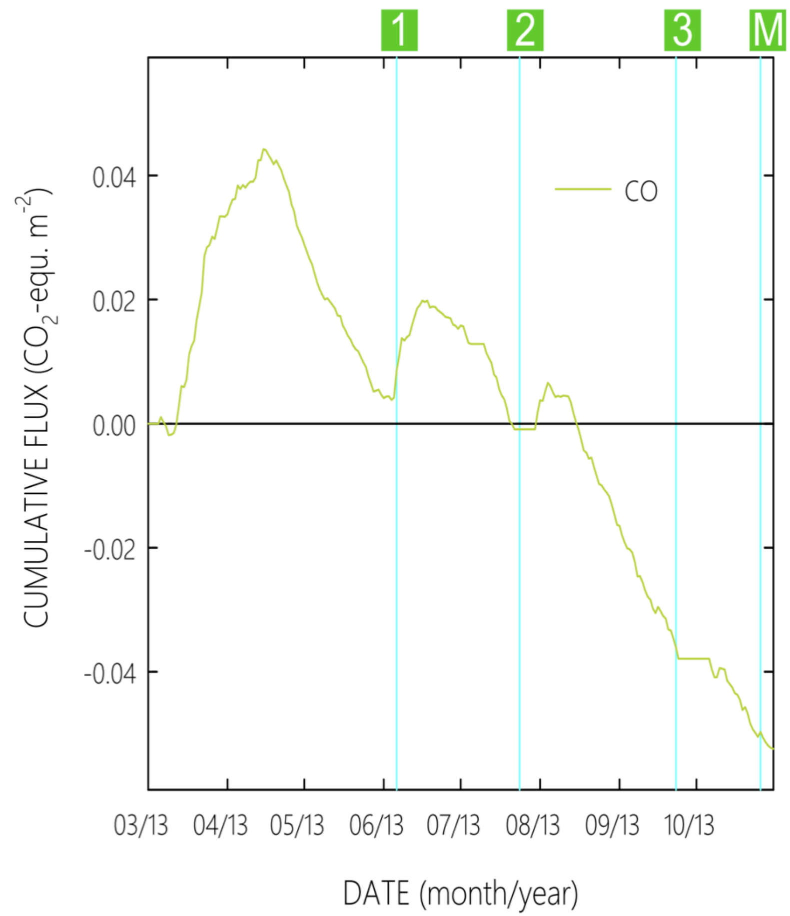
CO_2 equivalents



Hörtnagl & Wohlfahrt (2014)

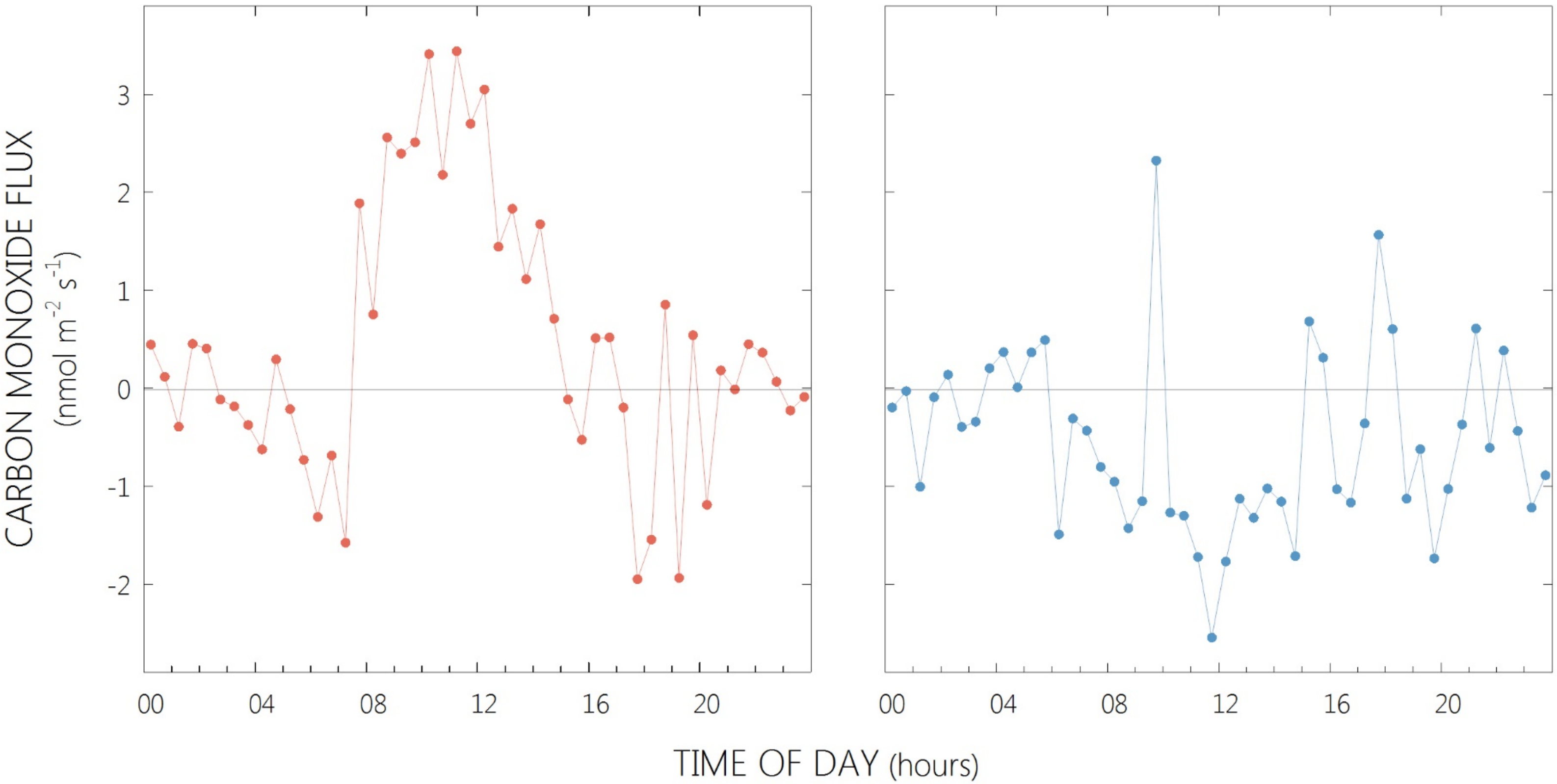
CO exchange





Hörtnagl et al. (in prep.)

CO exchange



Hörtnagl et al. (in prep.)

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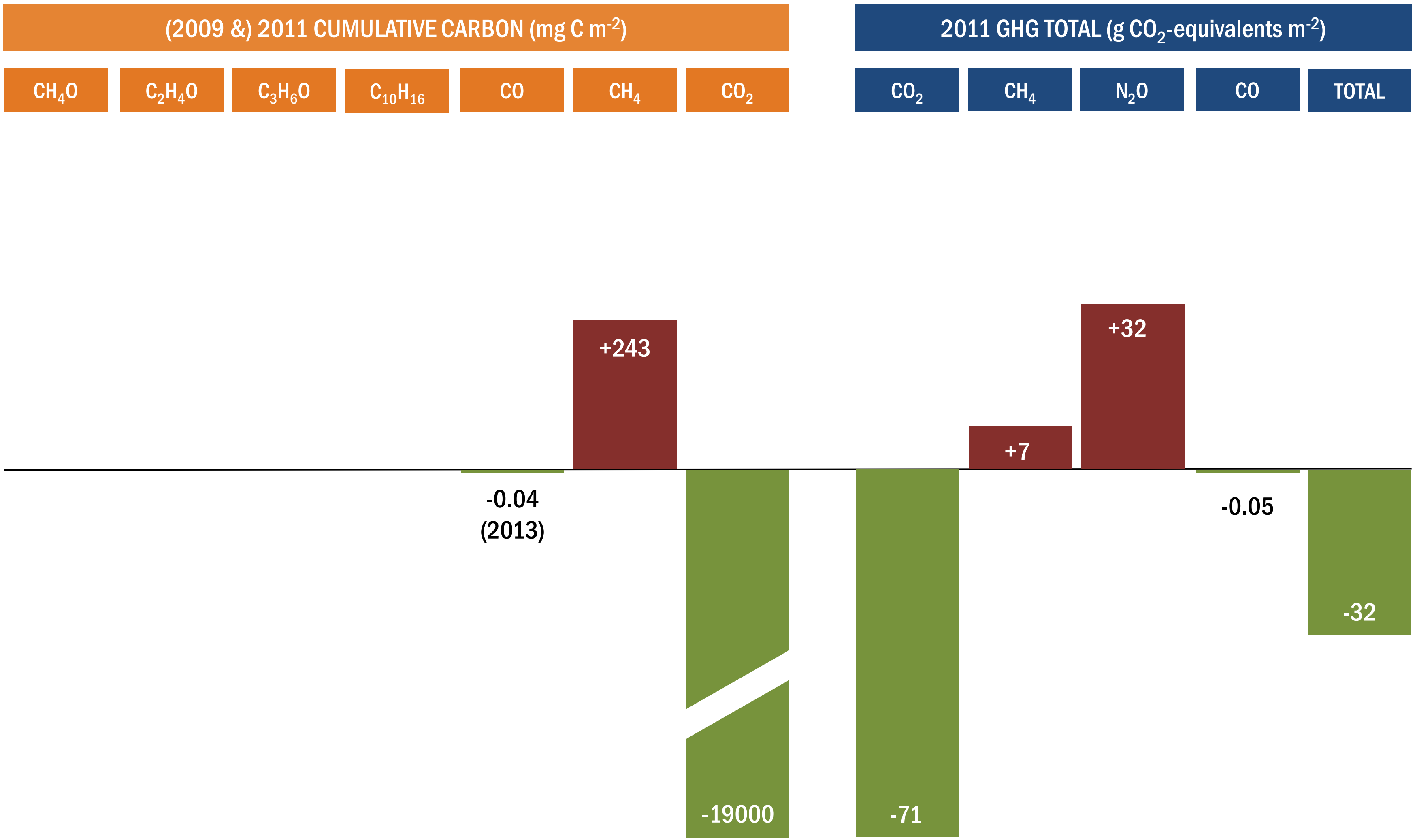
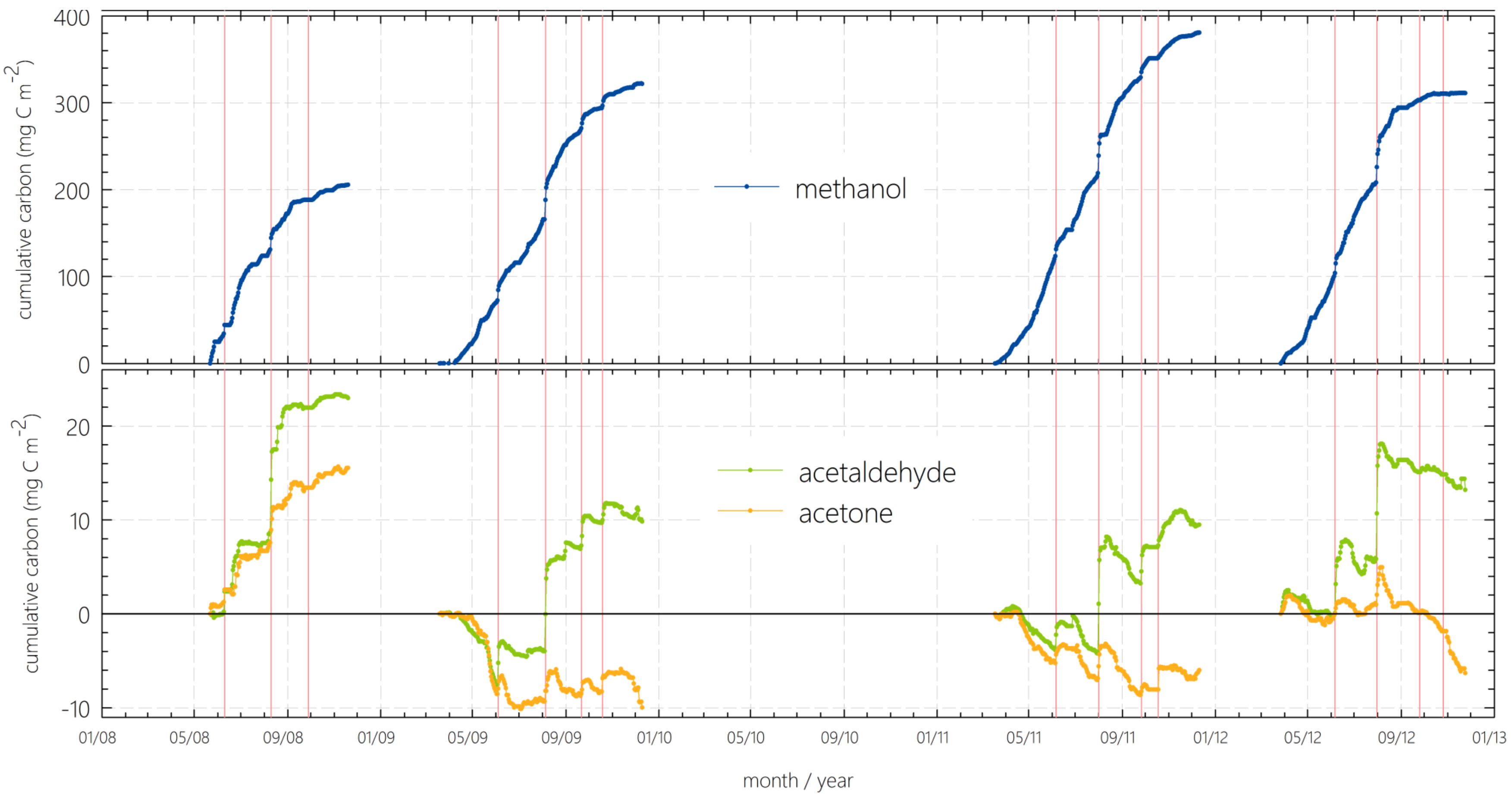
Summary #1

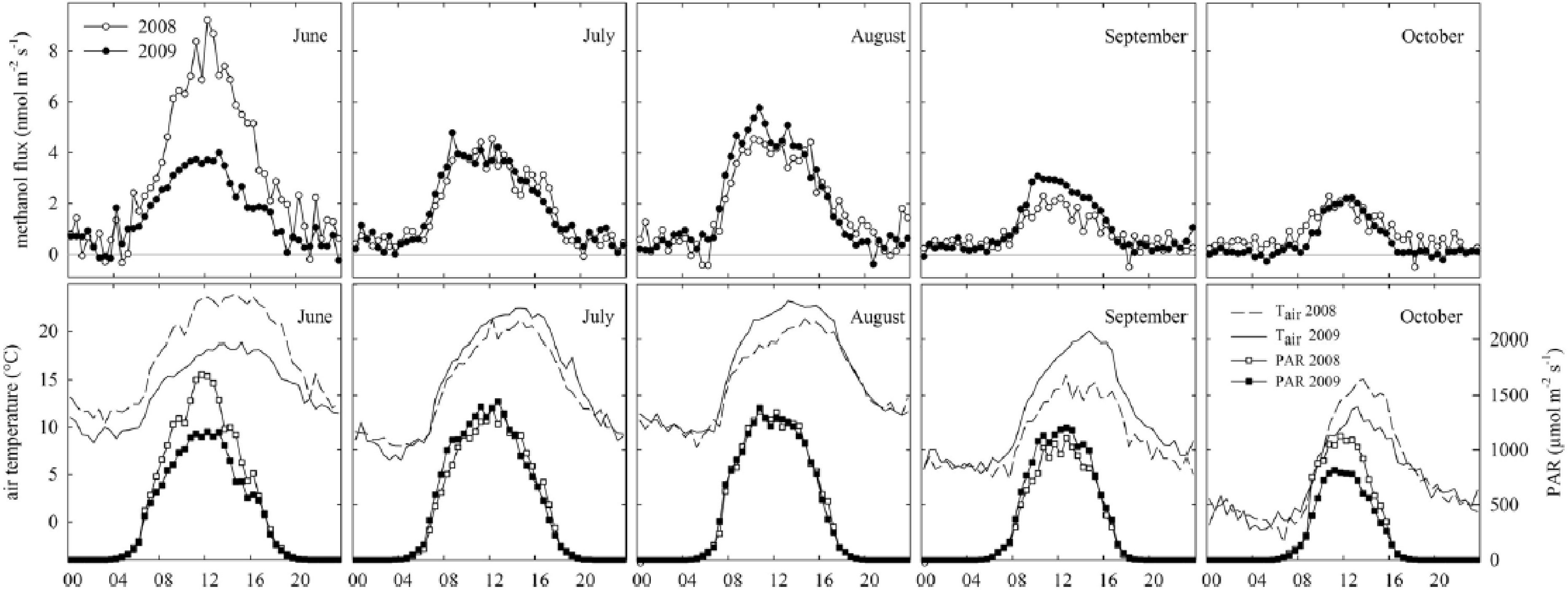


Oxygenated VOC exchange



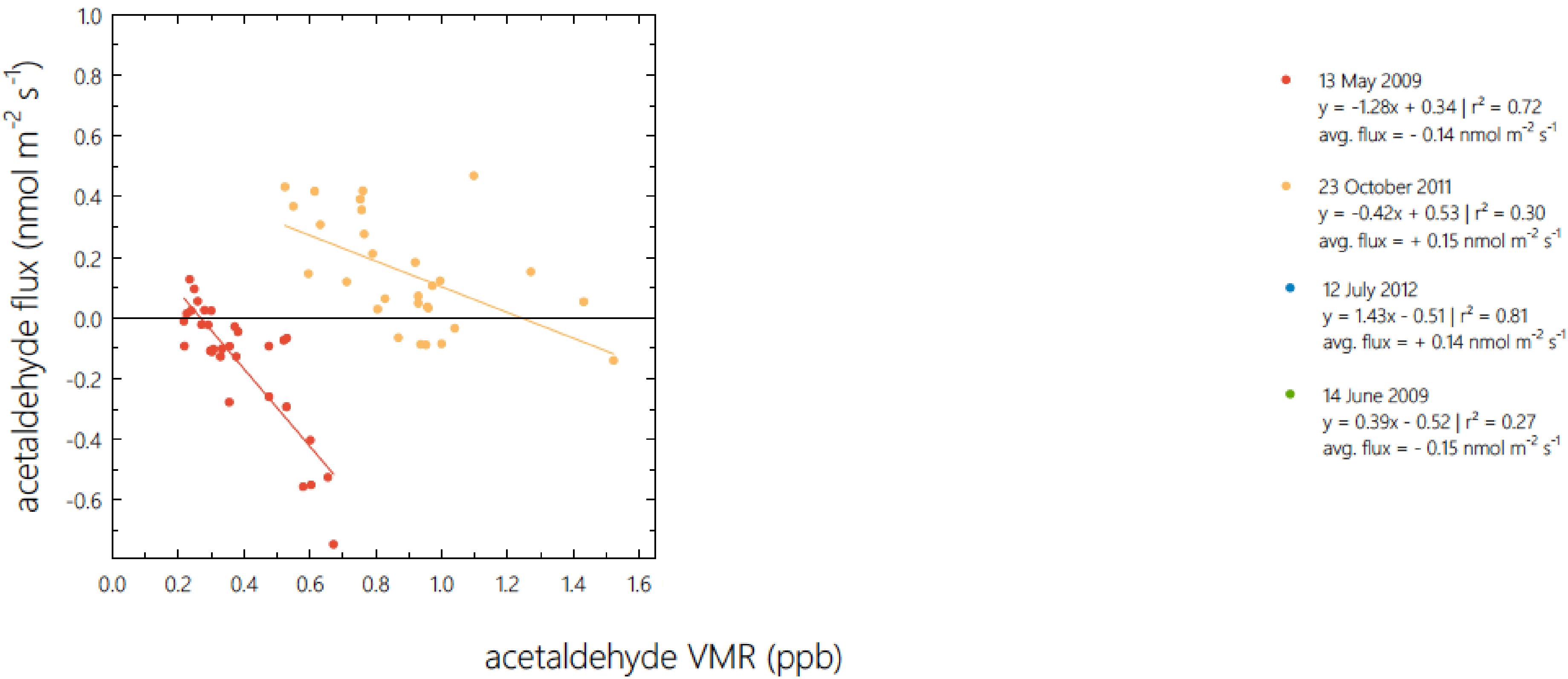
Hörtnagl et al. (2011, 2014), Wohlfahrt et al. (in prep.)

Oxygenated VOC exchange



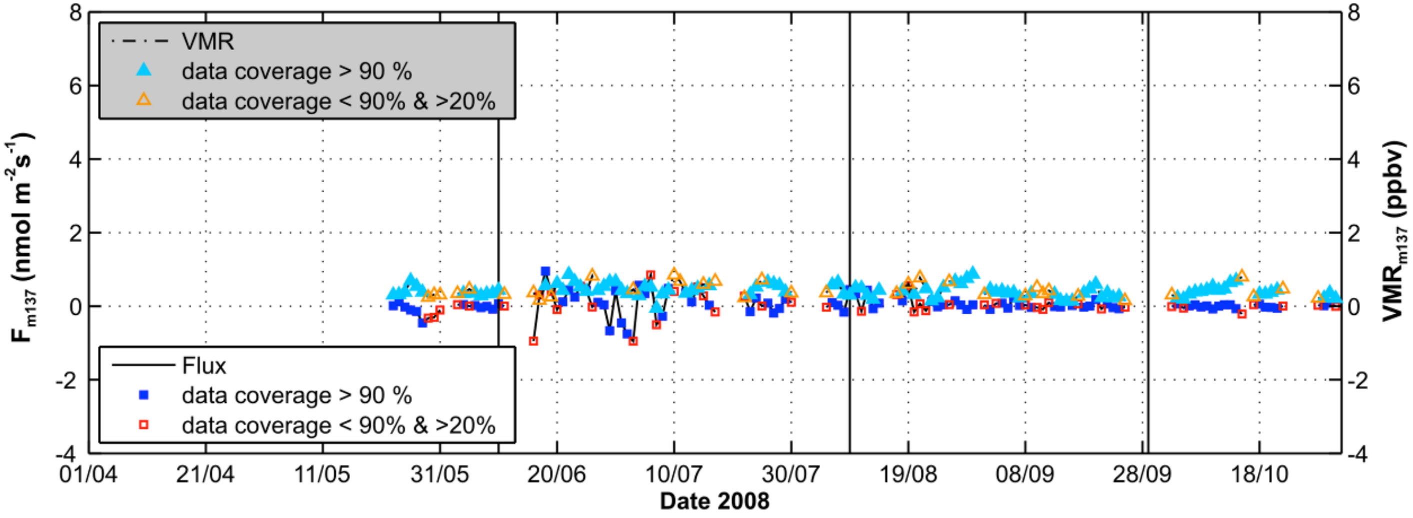
Hörtnagl et al. (2011)

Oxygenated VOC exchange



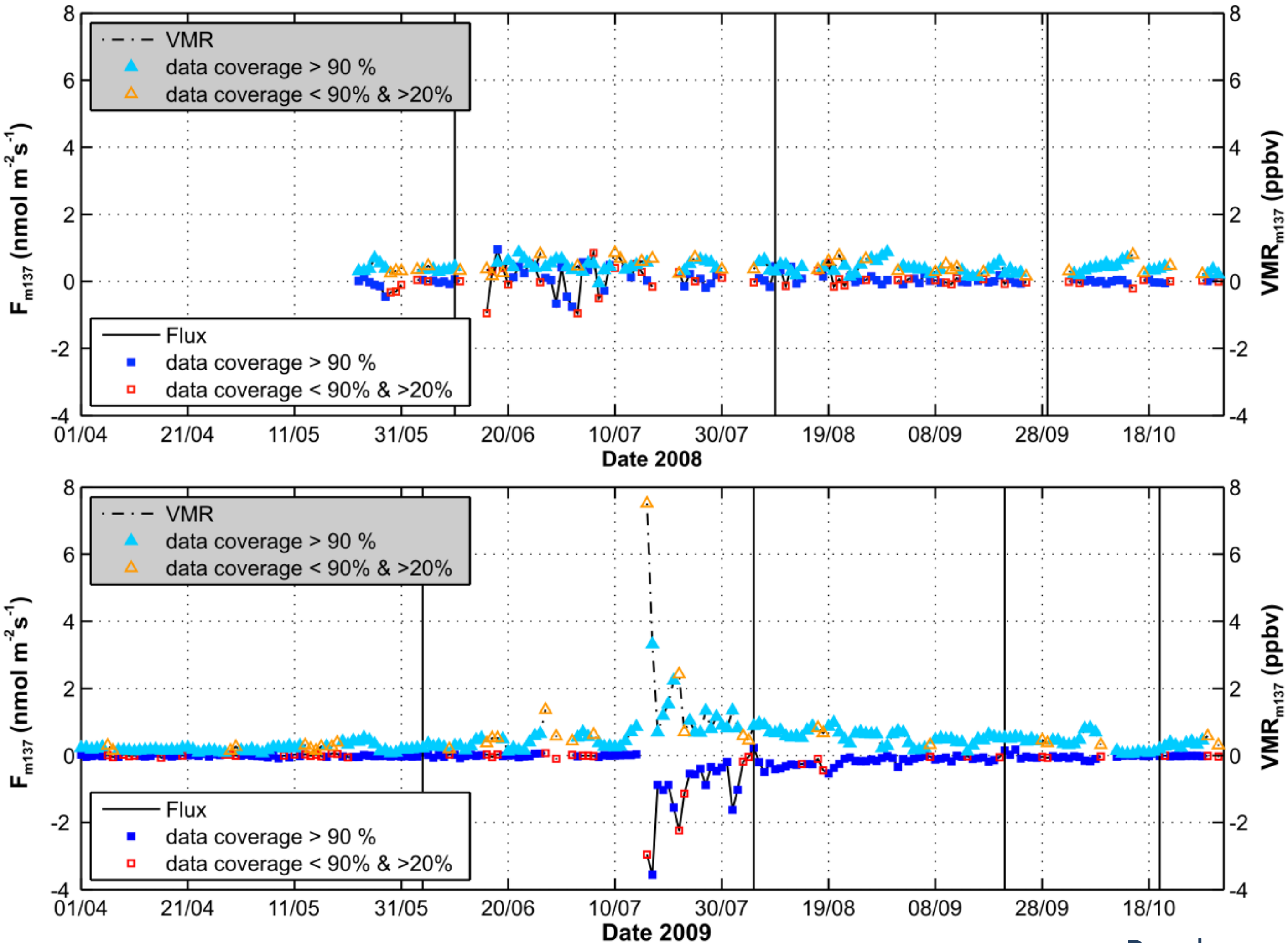
Hörtnagl et al. (2014)

Monoterpene exchange



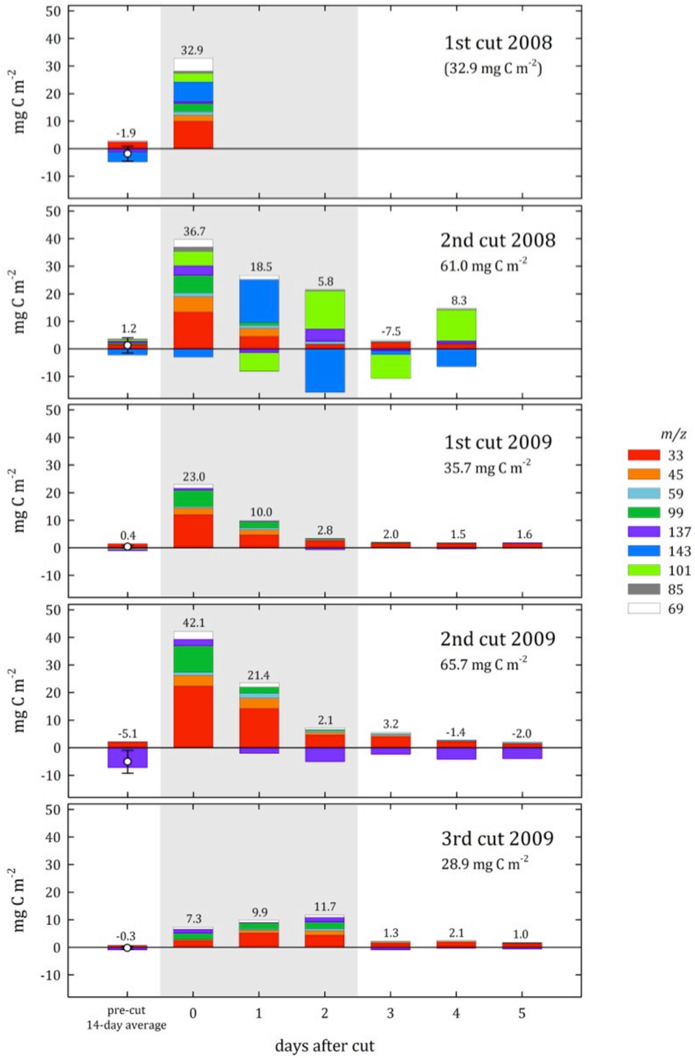
Bamberger et al. (2011)

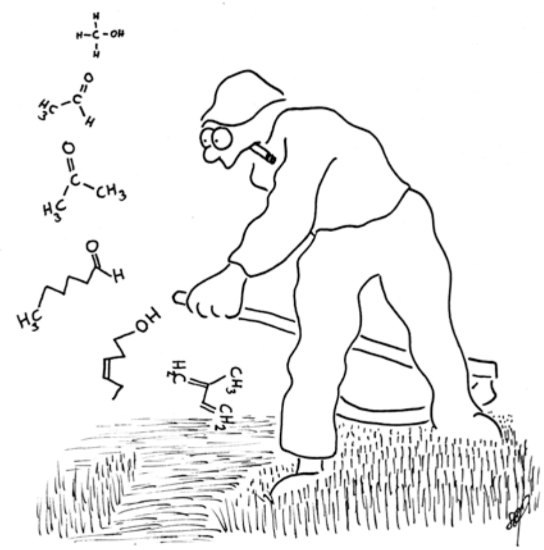
Monoterpene exchange



Bamberger et al. (2011)

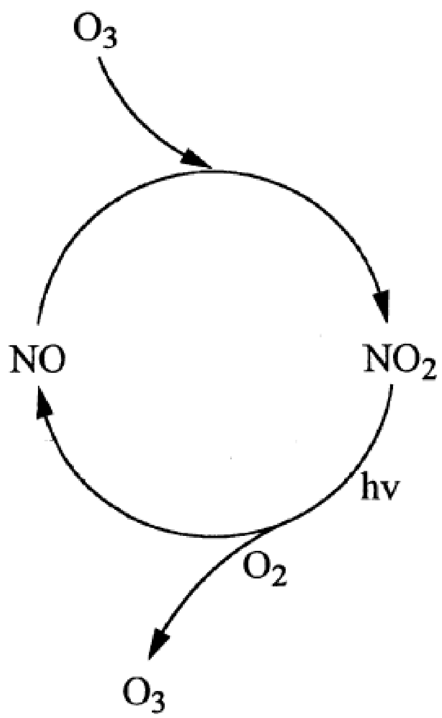
VOC exchange after harvest





Brilli et al. (2012)

Local air chemistry effects



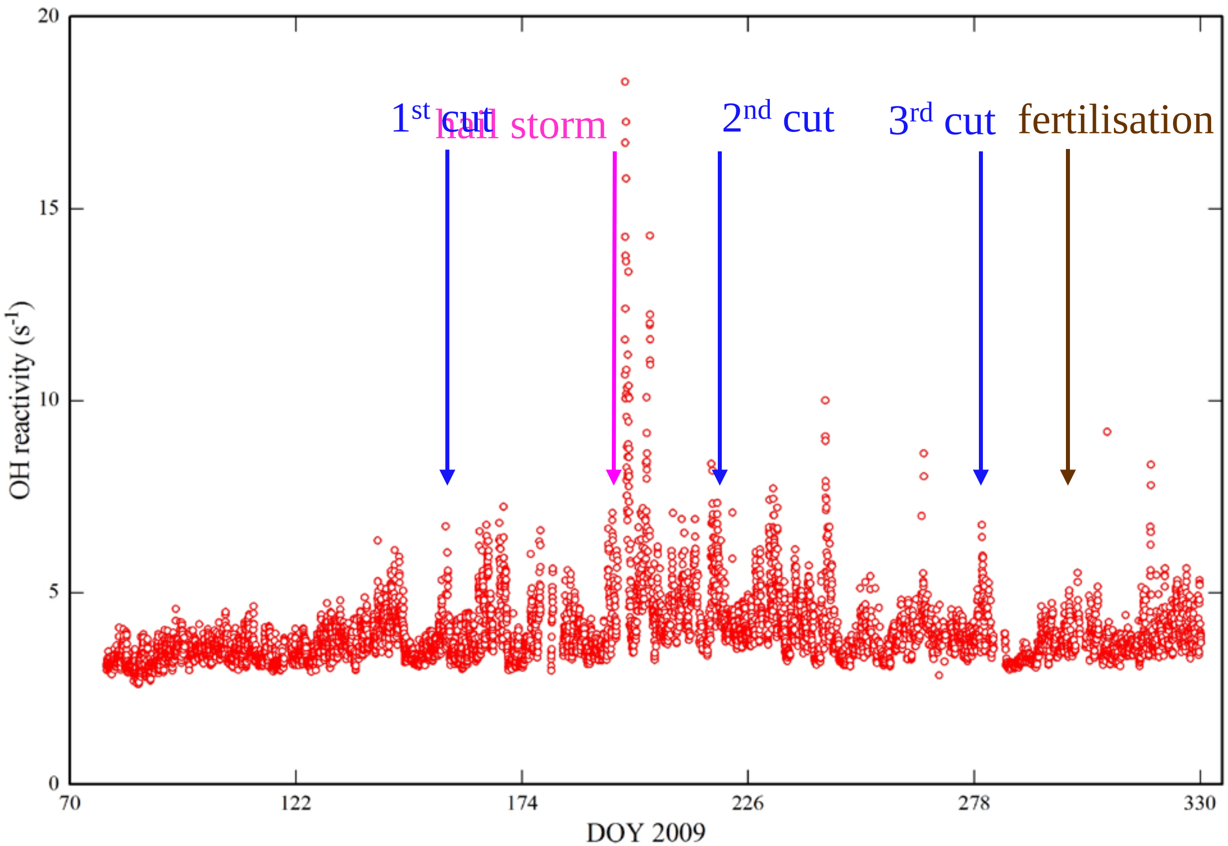
A

B

Atkinson (2000)

Local air chemistry effects

$$R_{OH\_total} = k_{OH\_CH_4}[CH_4] + k_{OH\_CO}[CO] + k_{OH\_NO_2}[NO_2] + k_{OH\_VOC}[VOC]$$



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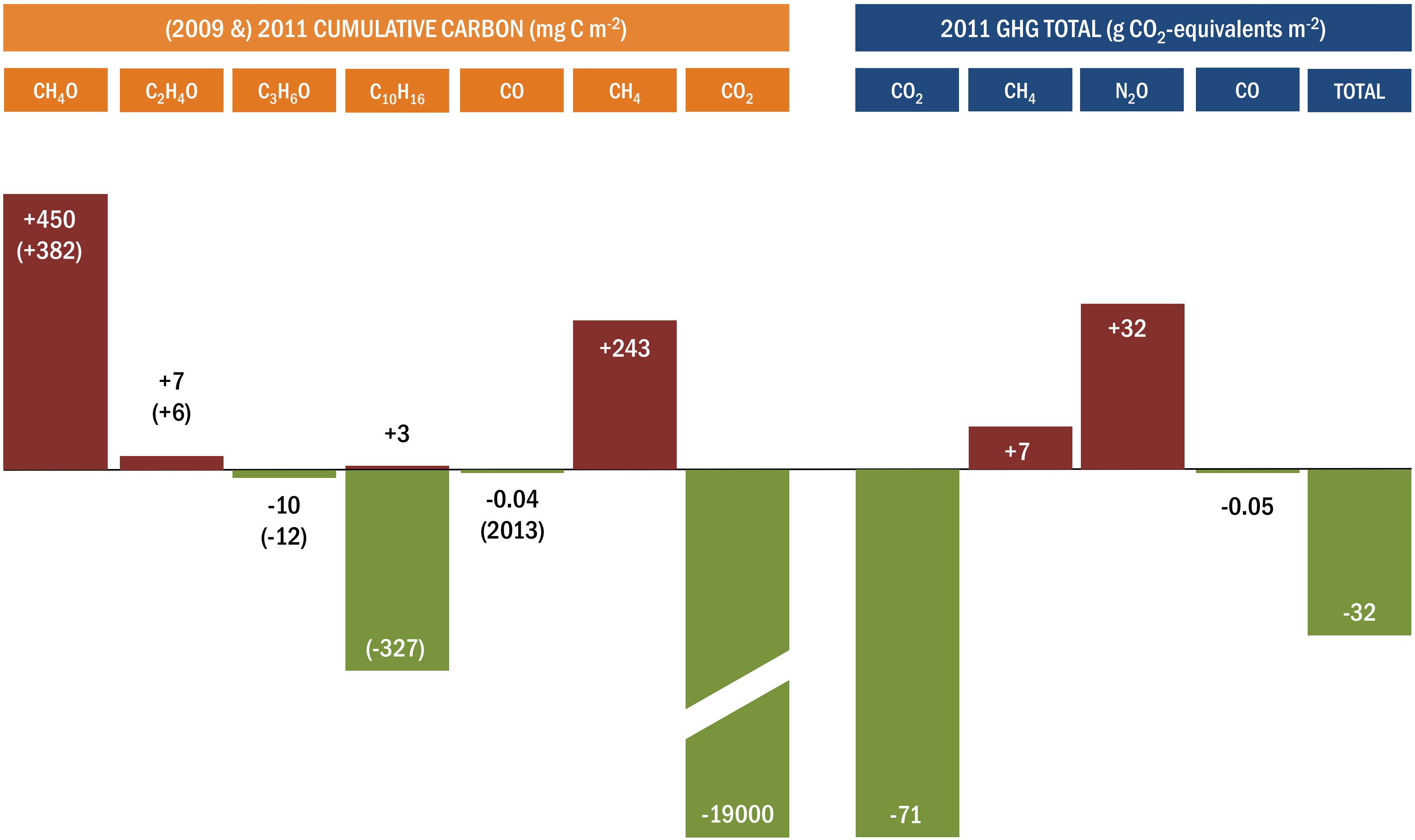
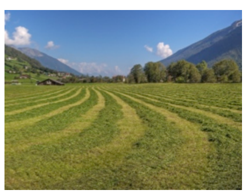
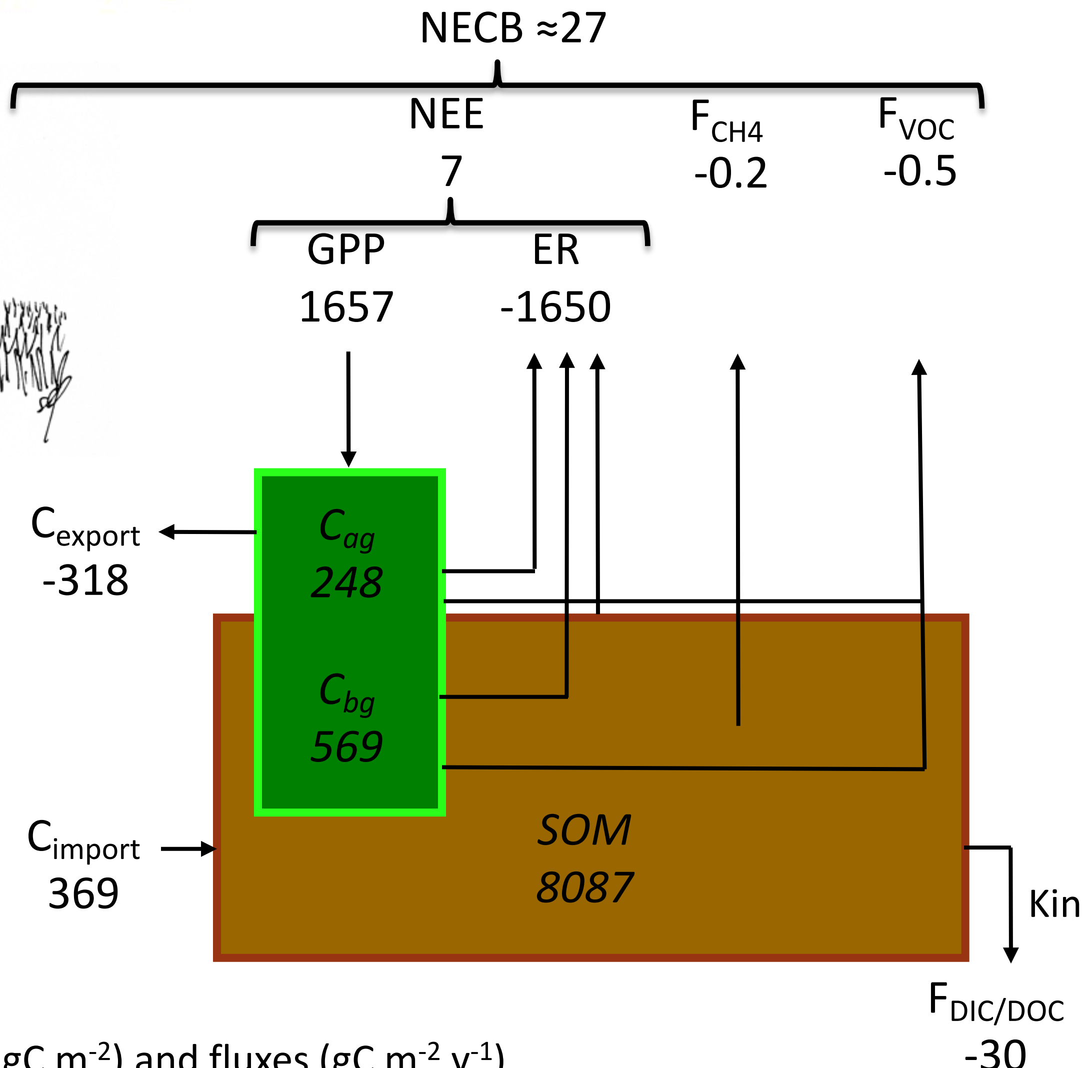
Summary #2



Net ecosystem carbon balance





Kindler et al. (2011)

Units: pools (gC m^{-2}) and fluxes (gC m^{-2} y^{-1})

Conclusions

- The investigated mountain grassland in addition to the long-lived GHG (CO_2, CH_4 and N_2O) exchanges several short-lived GHG which have an indirect radiative forcing and affect regional air quality.
- In terms of GWP, emissions of CH_4 and N_2O negate about 50% of net CO_2 uptake (at least in 2011).
- For the carbon balance, CO_2 is quantitatively by far the most significant gaseous component flux.
- Sum of VOC exceeds CH_4 fluxes in terms of carbon emission.
- Particulate carbon fluxes associated with management are large and differences between carbon in- and output have significant effects on carbon balance.

Conclusions

- CO_2 and methanol fluxes are well understood. Most other compounds exhibit complex patterns of net emission and deposition, driven by seasonal changes in abiotic and biotic forcings.
- Harvesting dates represent “hot moments” at this managed ecosystem with composition and magnitude of ecosystem-atmosphere transfer changing dramatically.

Acknowledgments

FWF Der Wissenschaftsfonds.

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tirol STADT INNSBRUCK

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EU FP 5 CarboMont (2001-2004)
EU FP 7 GHG-Europe (2010-2013)

ÖAW Austrian Academy of Sciences

ÖAW DOC fellowship to
Albin Hammerle (2007-2009)

Sparkling Science > Wissenschaft ruft Schule Schule ruft Wissenschaft BM.W_F

GrassClim (2010-2012)

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Lukas Hörtnagl (2009-2010)
Felix Spielmann (2014-2015)