ÉCLAIRE Component 1: Emission & Exchange Processes

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+ all C1 Partners

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éclaire
Effects of climate change on air pollution impacts and response strategies for European ecosystems

SEVENTH FRAMEWORK PROGRAMME

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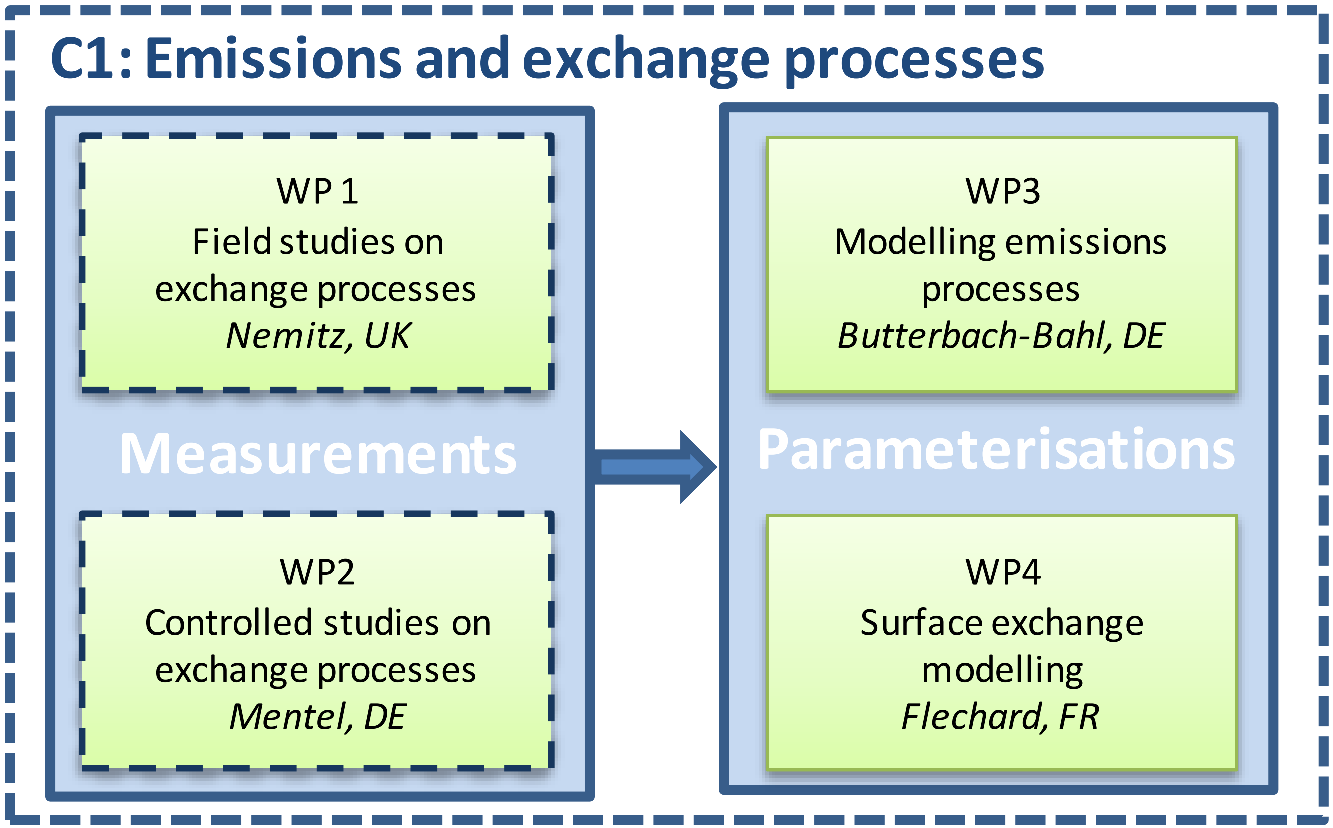
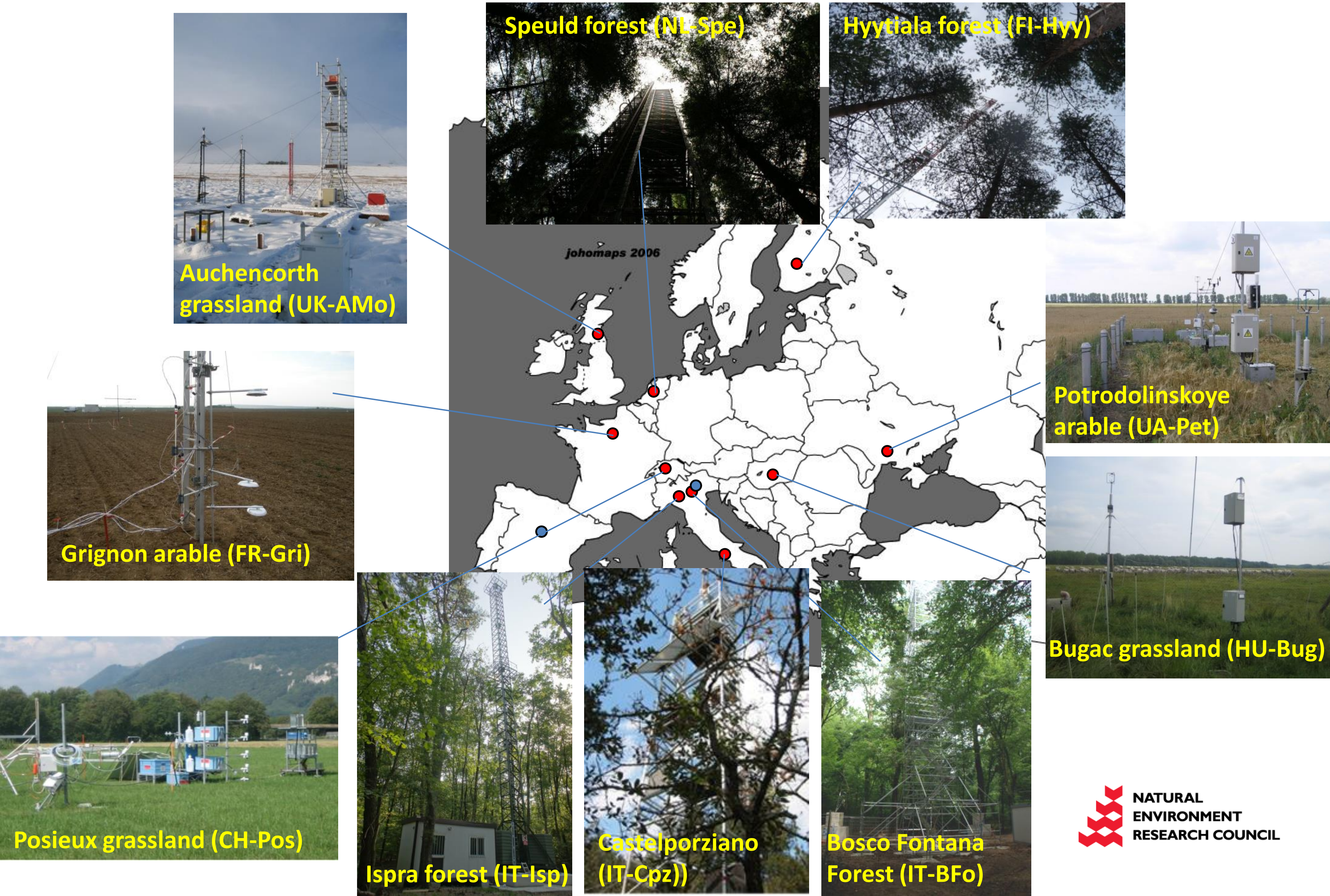
Component 1 Structure



Compounds dealt with

- Ozone
- BVOCs (both ozone precursor & antioxidant)
- Aerosols
- Nitrogen compounds
  - NO_x
  - NH_3

The ECLAIRE flux network (9 + 1 sites)



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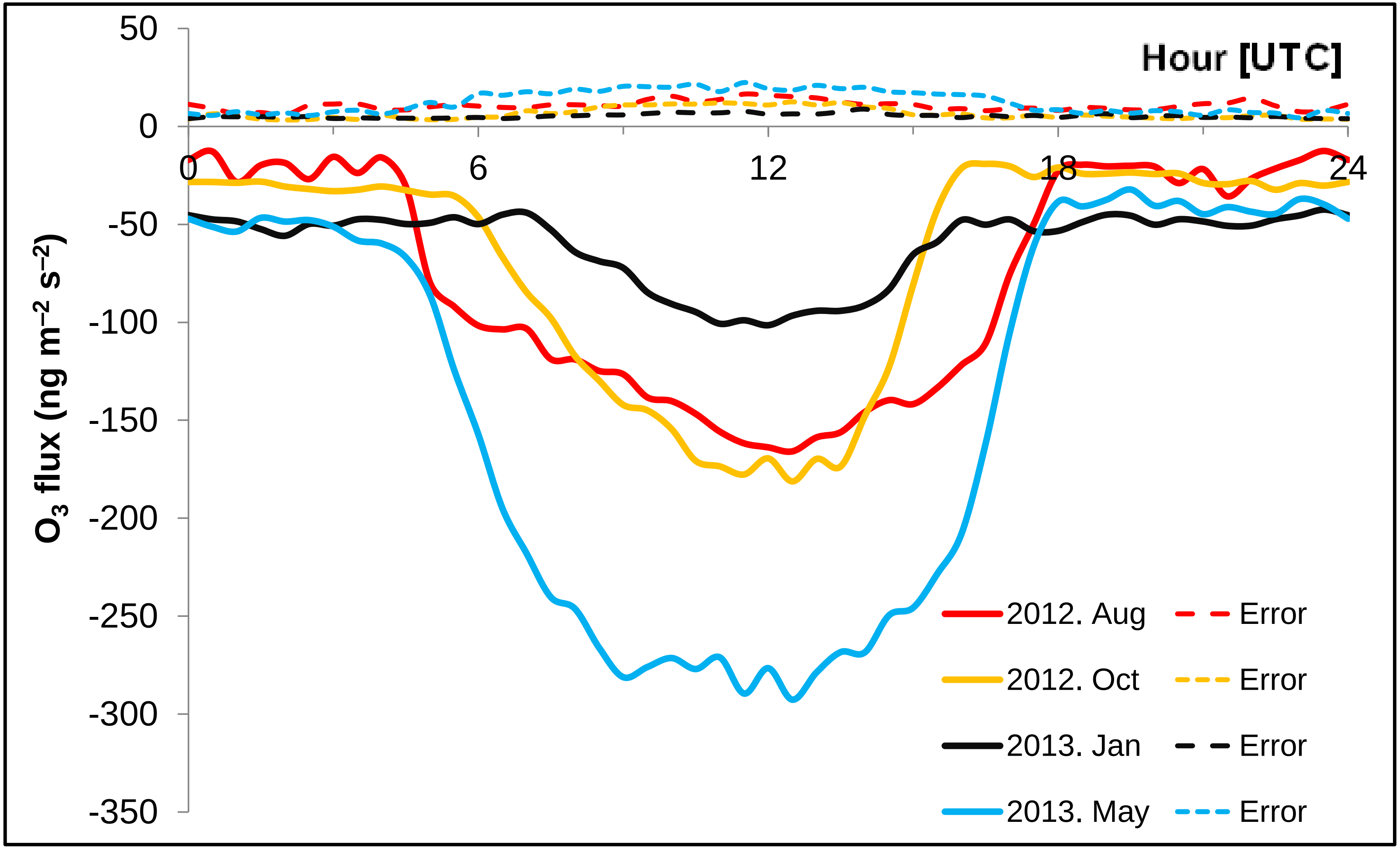
Mean daily variation of ozone flux above grassland (Bugac, Hungary)



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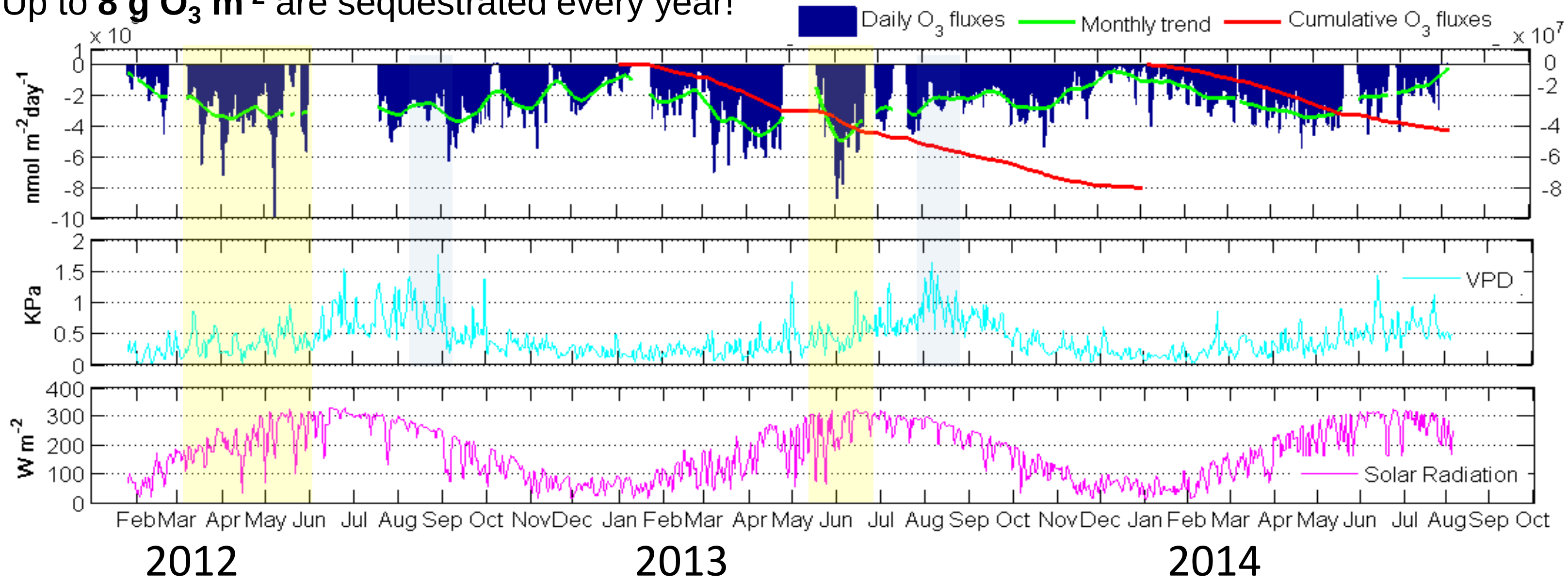
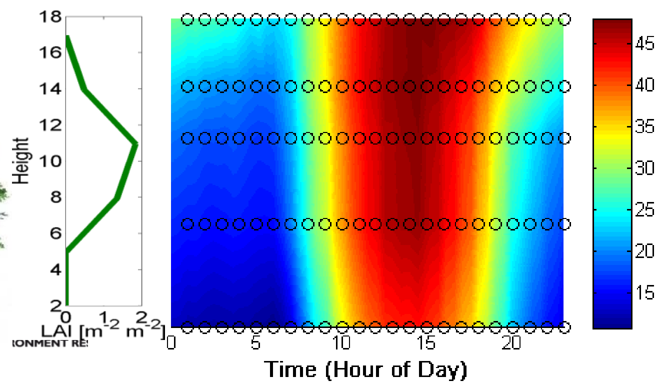
Ozone sink at the Holm oak forest of Castelporziano

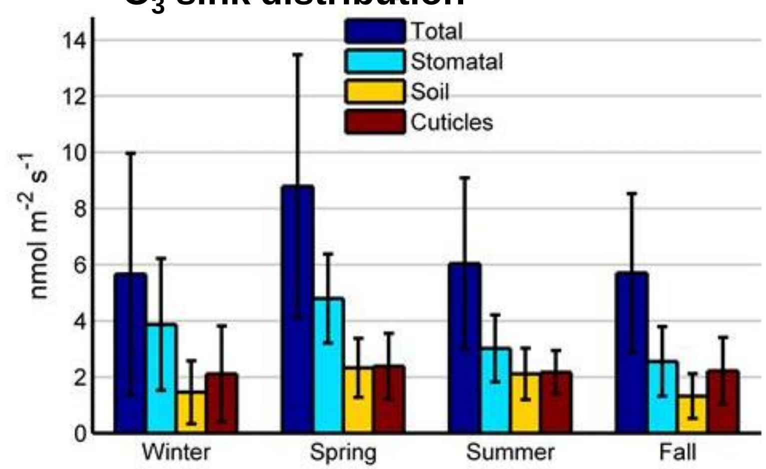
Ozone fluxes are higher during late spring, when stomatal conductance is high.
Up to **8 g O_3 m^{-2}** are sequestrated every year!



Atmospheric O_3 concentration gradient from the soil to above the canopy

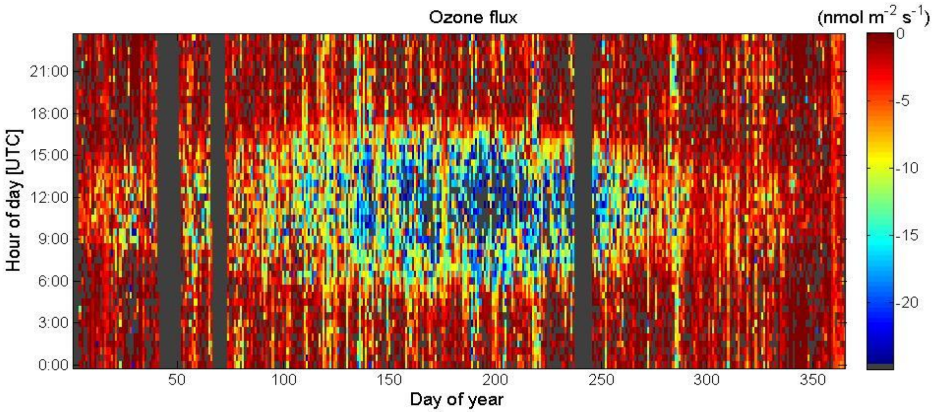


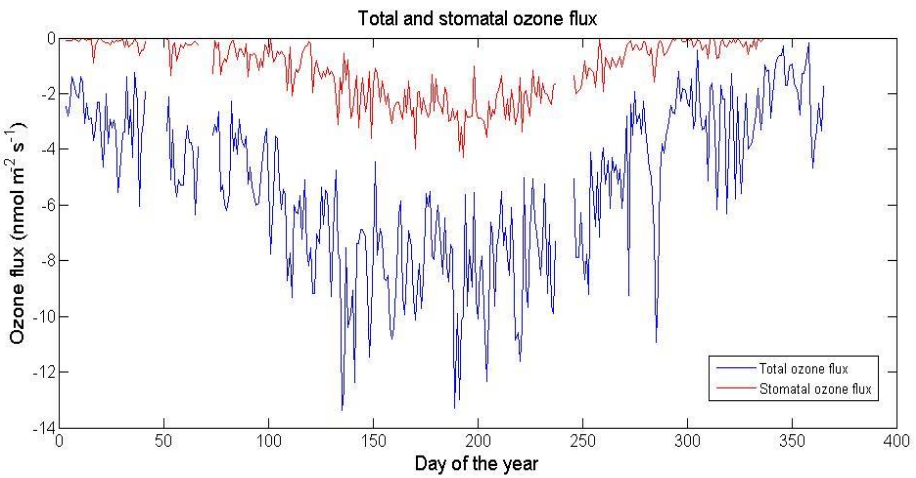
O_3 sink distribution



Fares et al. Agr. For. Met. 2014

Total and stomatal ozone fluxes at Ispra Forest 2013





- Average ozone concentration was 43 ppb (max. ozone concentration up to 110 ppb in summer) and average ozone fluxes -10 nmol m^{-2} s^{-1} (max. -25 nmol m^{-2} s^{-1} in spring and summer)
- Partitioning of ozone fluxes resulted in average stomatal fluxes during the different seasons of 7% in winter, 13% in spring, 23% in summer and 10% in autumn (methodology following Fares et al. AFM 150, 2010)
- Data interpretation and extending into 2014 measurements are ongoing.

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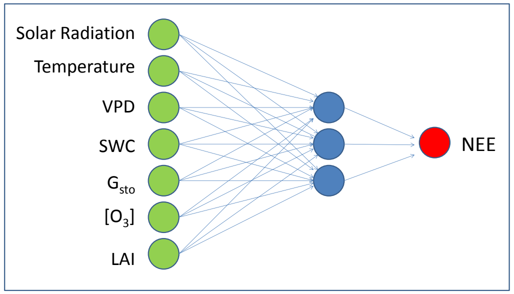
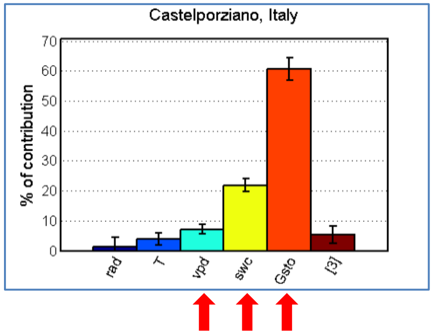
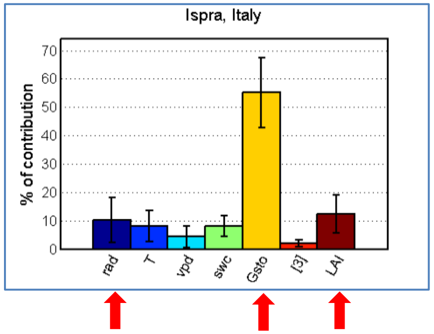
Identifying O_3 effect on GPP in network data

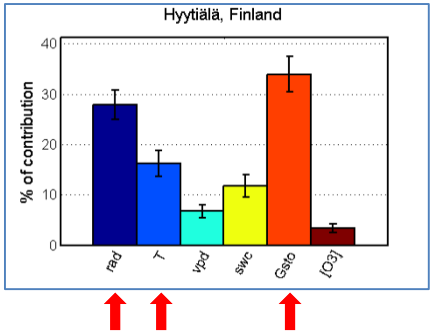
Analysis approach combining:

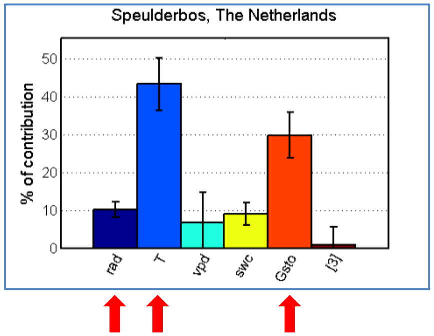
- Singular spectrum analysis
- Artificial Network
- Weight approach
- Partial derivative method











	$[O_3]$ reduction	whole period increase NEE (%)	Spring increase NEE (%)	Summer increase NEE (%)	Autumn increase NEE (%)	Winter increase NEE (%)
Castelporziano	-10%	**0.45 ± 0.05**	**1.04 ± 0.2**	ns	ns	ns
	-20%	**1.43 ± 0.18**	**3.27 ± 0.65**	**0.63 ± 0.26**	ns	**1.42 ± 0.17**
	-30%	**2.55 ± 0.34**	**5.66 ± 1.18**	**1.27 ± 0.4**	**1.43 ± 0.26**	**2.5 ± 0.33**
Ispra	-10%	ns	na	ns	ns	ns
	-20%	ns	na	ns	ns	ns
	-30%	ns	na	ns	ns	ns
Hyytiälä	-10%	ns	ns	ns	ns	ns
	-20%	-1.56 ± 0.16	-0.48 ± 0.46	-6.18 ± 0.41	-1.57 ± 0.26	ns
	-30%	-2.46 ± 0.25	-0.51 ± 0.65	-10.16 ± 0.64	-2.45 ± 0.45	-10.16 ± 0.64
Speulderbos	-10%	ns	ns	ns	ns	ns
	-20%	ns	ns	0.43 ± 0.23	ns	ns
	-30%	ns	-0.65 ± 0.28	0.57 ± 0.48	ns	ns

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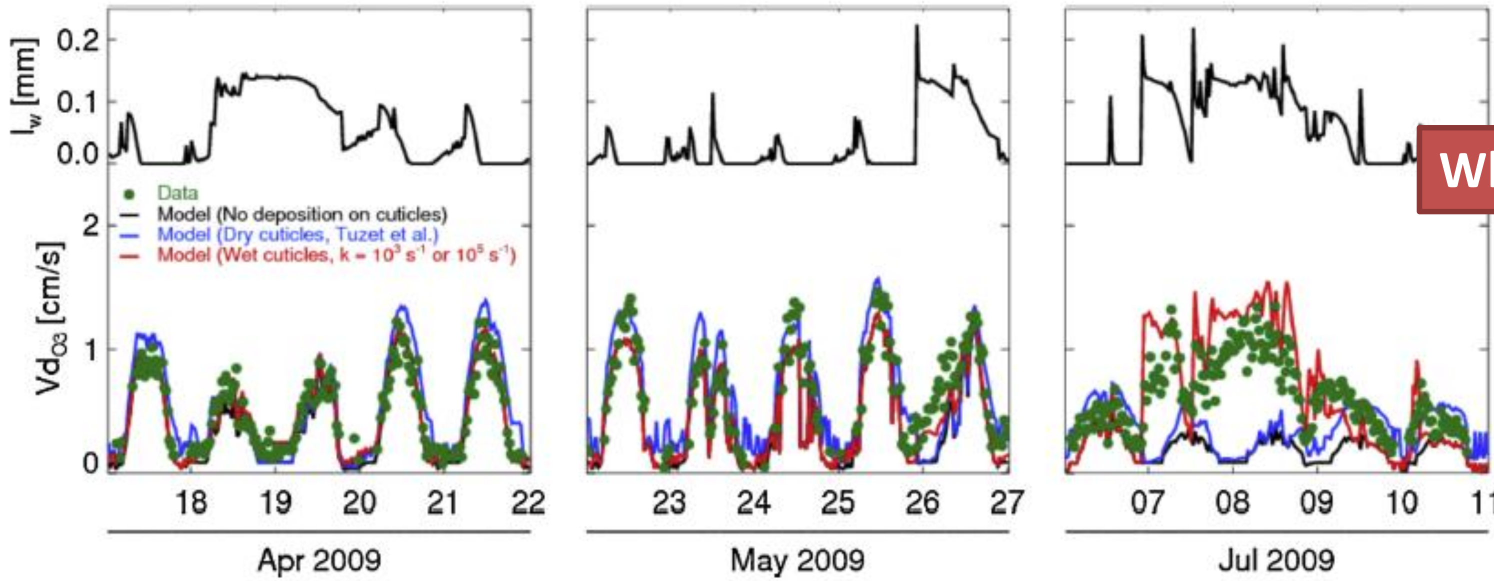
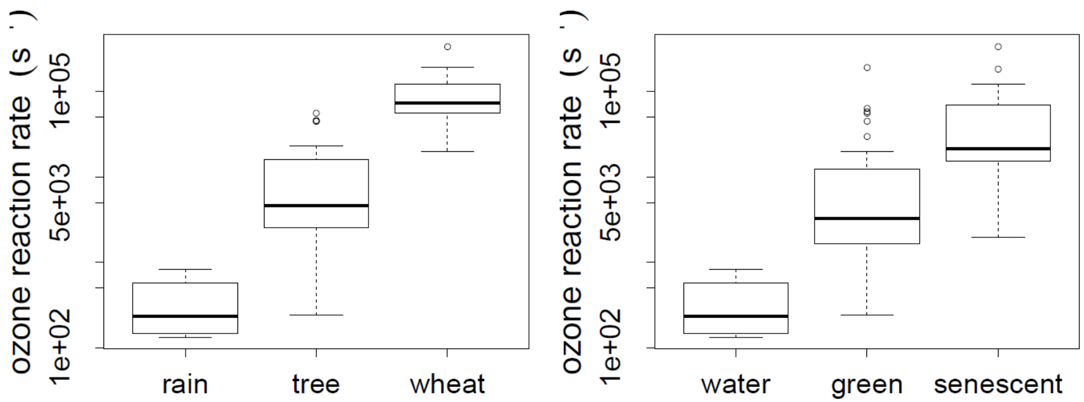
O_3 deposition in crops is larger to wet cuticles and increases during senescence



Wheat



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Potier et al. 2015, & Potier et al. *in prep*

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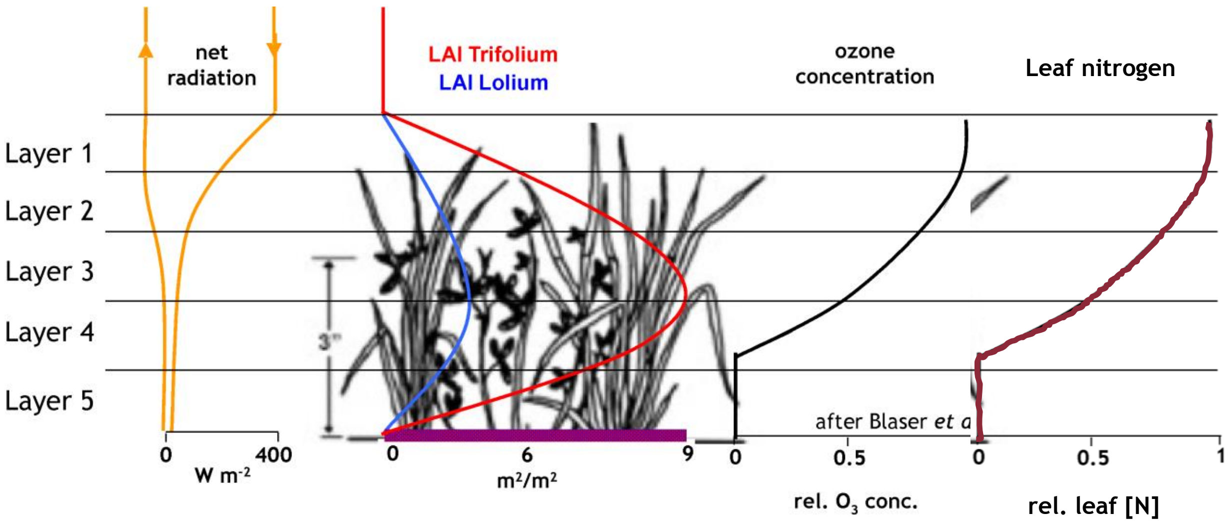
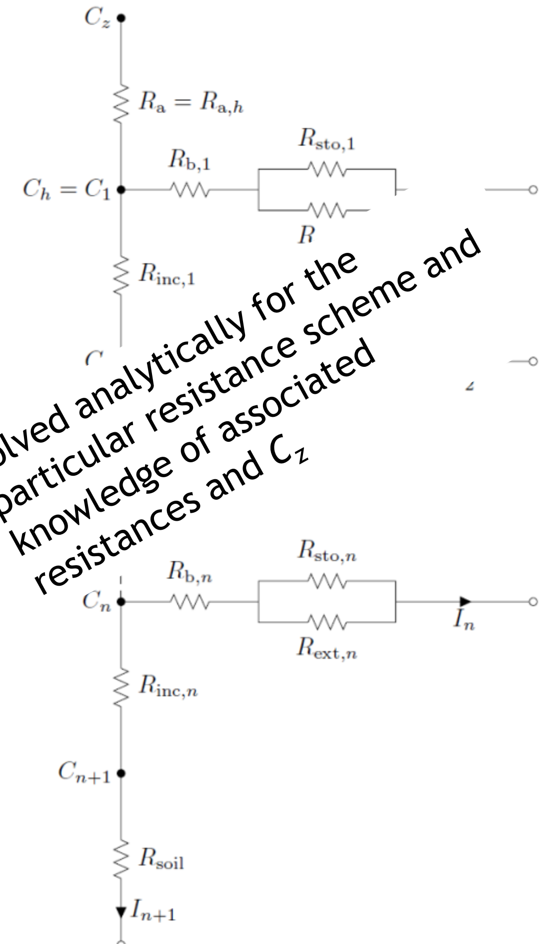
Development of DO_3SE for deposition assessment

Hybrid multi-layer multi-component model for O_3 deposition





Solved analytically for the particular resistance scheme and knowledge of associated resistances and C_z

- Irradiance affects An-g_{sto} (through J_{max})
- O_3 concentration affects An-gsto (through effective O_3 dose – affected by wind speed through Rb and Rinc)
- N profile through canopy gives different V_{cmax} for LAI layers affecting An-g_{sto}

Species effects can also be assessed according to their position in the canopy

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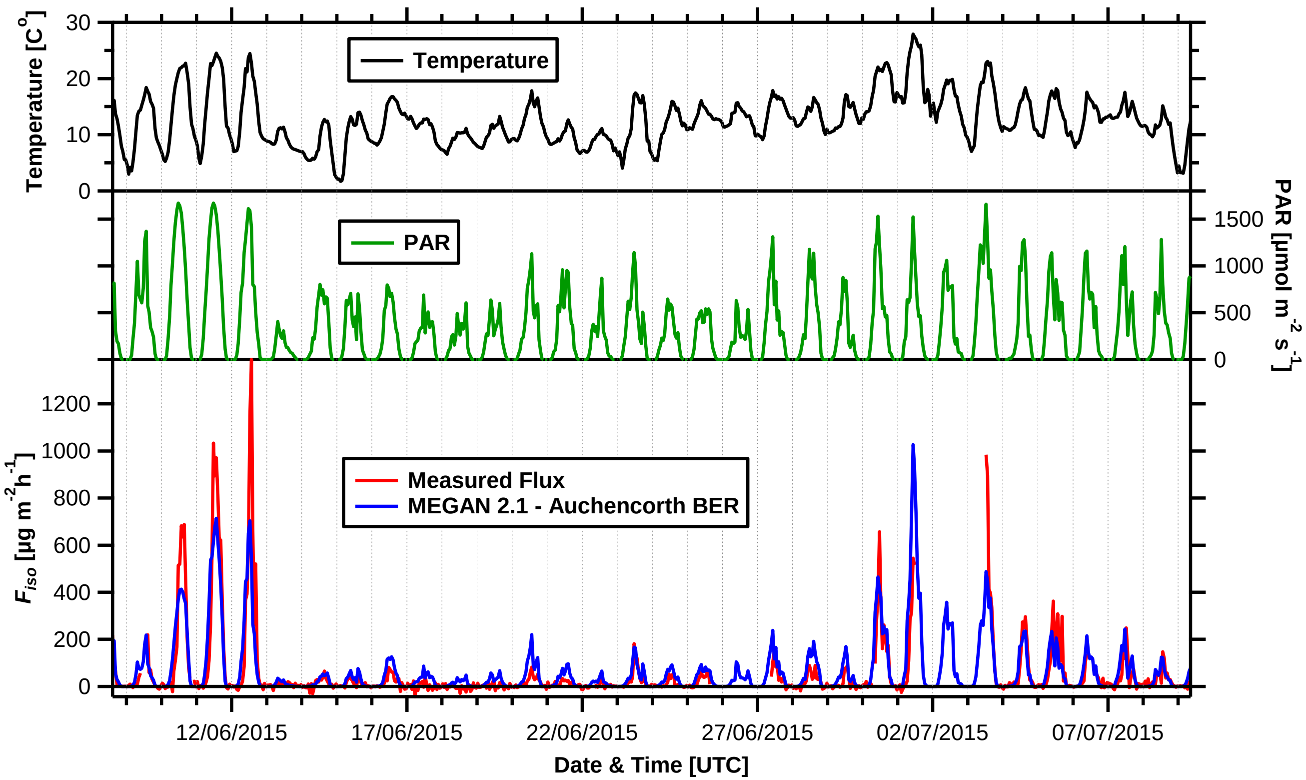
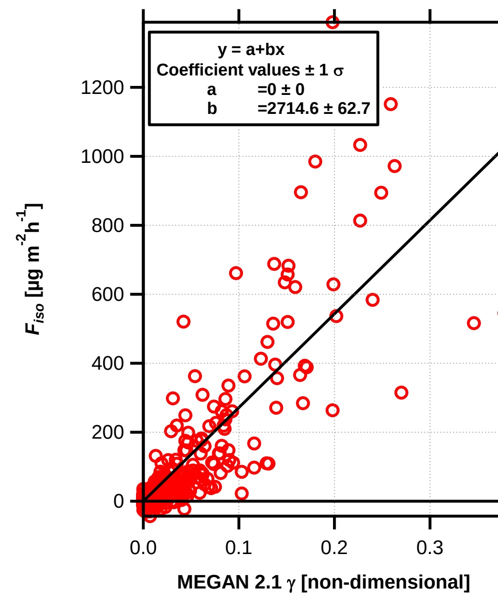
Isoprene emission from moorland (Auchencorth)

MEGAN 2.1 Emission Factors (normalised to LAI = 5)

C3 Grasses = 800 µg m^{-2} h^{-1}

Auchencorth = 2715 µg m^{-2} h^{-1}





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Auchencorth Moss	= 1032	(Accounting
Alice Holt (Oak)	= 1499	for LAI)

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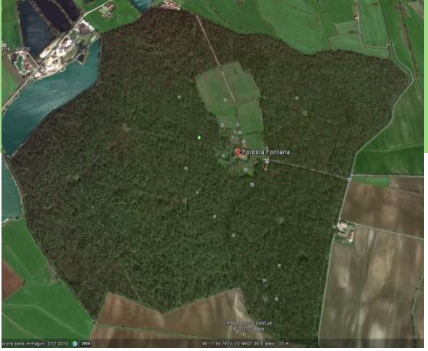
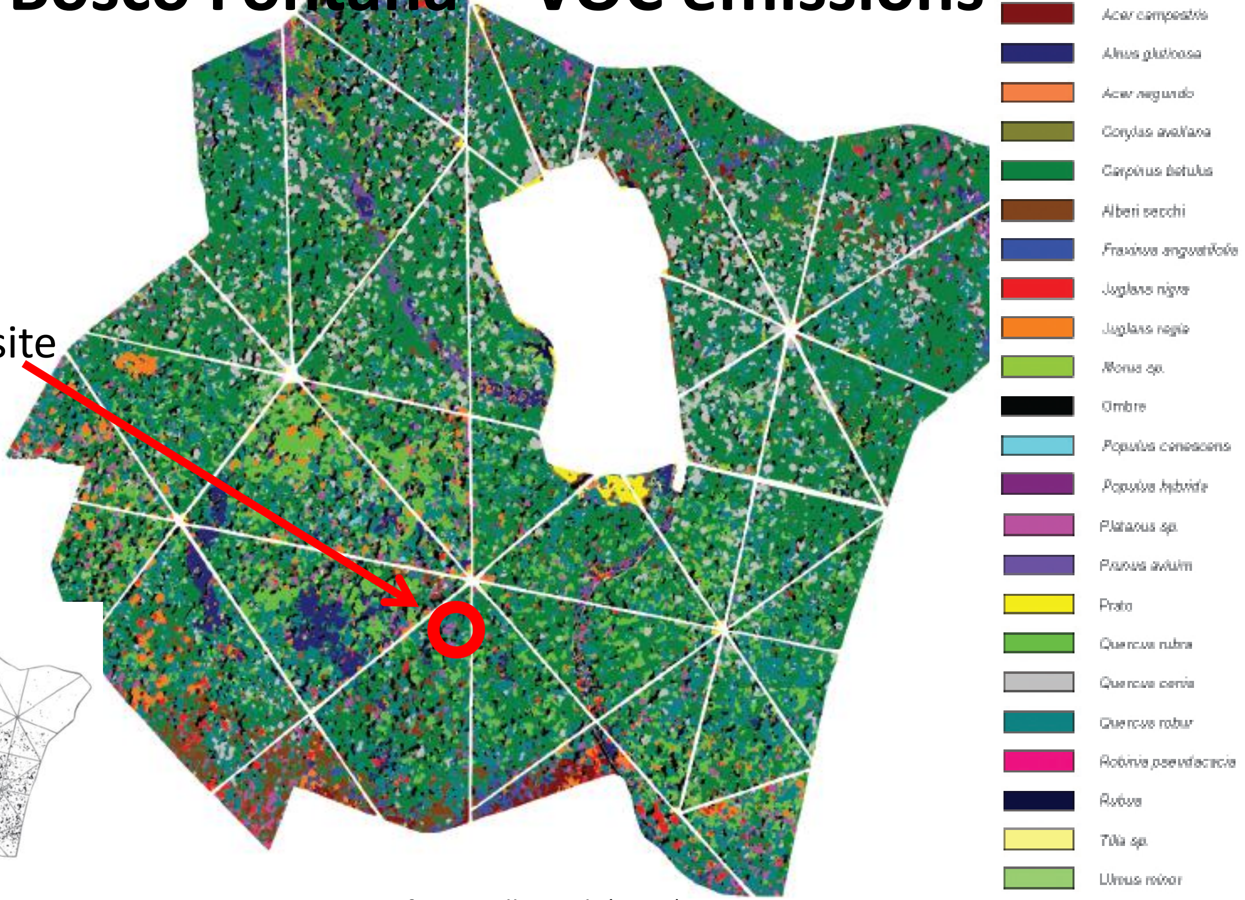
Bosco Fontana – VOC emissions



Field site



The vegetation survey was performed for the all area, but Quercus was more abundant in our site

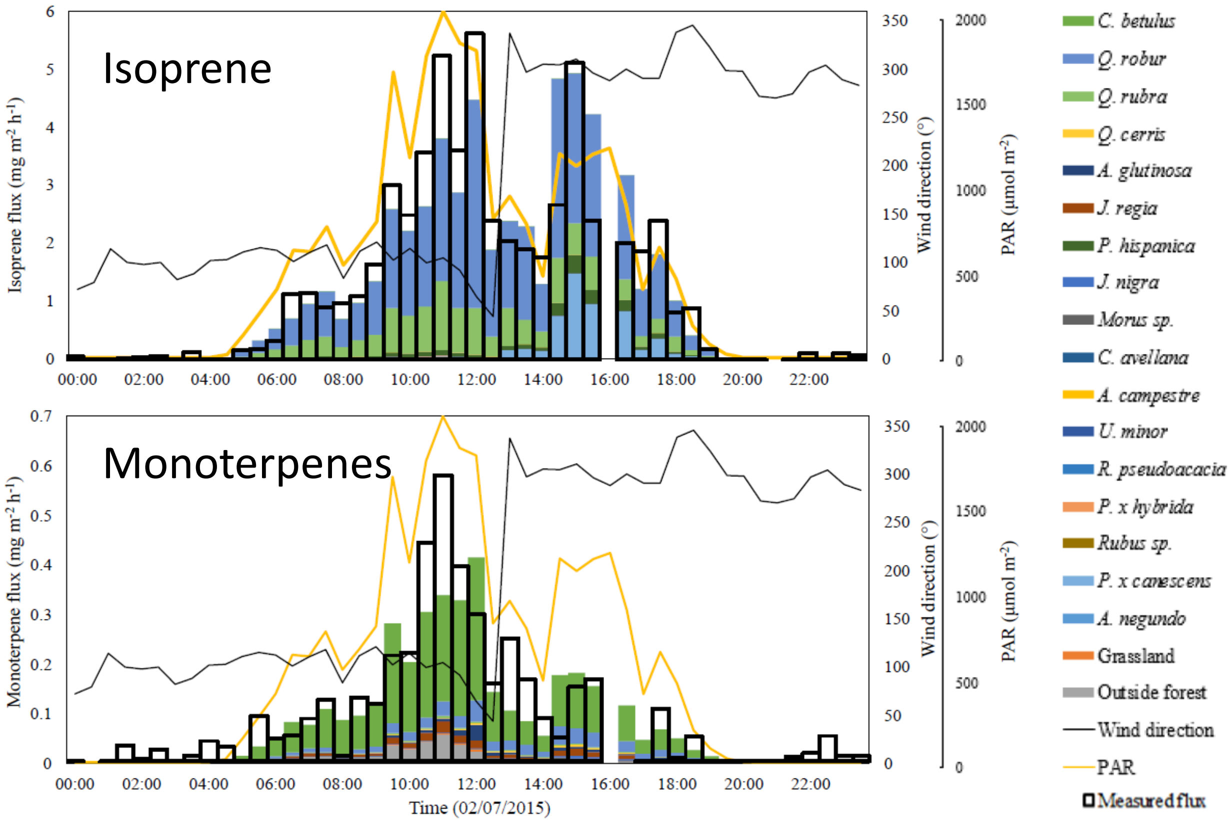
Quercus robur

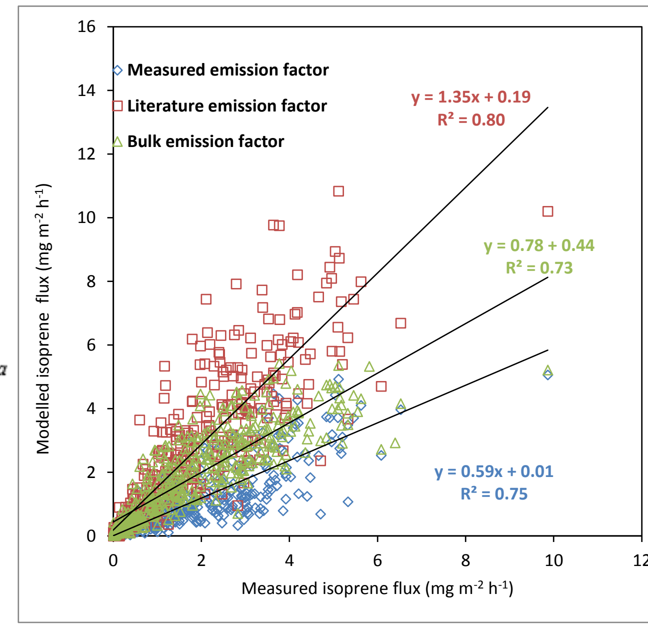
Quercus rubra

Courtesy of Giannelle et al. (2007)

	Coverage (%)	Isoprene		a-pinene		sabinene		b-pinene		limonene		MT totals
	(LIDAR)	*nmol m-2s-1*	*Dev. St.*	*nmol m-2s-*	*Dev. St.*	*nmol m-2s-*	*Dev. St.*	*nmol m-2s-*	*Dev. St.*	*nmol m-2s-*	*Dev. St.*	*nmol m-2s-1*
Quercus robur	17	2.639	0.675	0.016	0.009	n.d.	n.d.	0.001	0.001	0.025	0.016	0.042
Quercus rubra	9.6	1.008	0.268	0.000	0.003	n.d.	n.d.	0.003	0.003	n.d.	n.d.	0.003
Carpinus betulus	40.2	0.002	0.002	0.005	0.002	0.006	0.005	0.013	0.003	0.106	0.056	0.129
Corylus avellana	0.88	0.001	0.000	0.004	0.003	n.d.	n.d.	0.002	0.005	0.135	0.091	0.140
Acer campestre	0.626	0.000	0.005	0.013	0.005	n.d.	n.d.	0.019	0.007	0.006	0.002	0.038
Sambucus nigra	n.a.	0.005	0.302	0.000	0.000	n.d.	n.d.	0.001	0.001	0.001	0.001	0.002
Cornus sanguinea	n.a.	0.441	0.266	0.001	0.022	0.000	0.000	0.001	0.005	0.050	0.050	0.051
Shadow + Grassland	8											
TOTAL	76.306											

Bottom-up & top-down VOC emission fluxes





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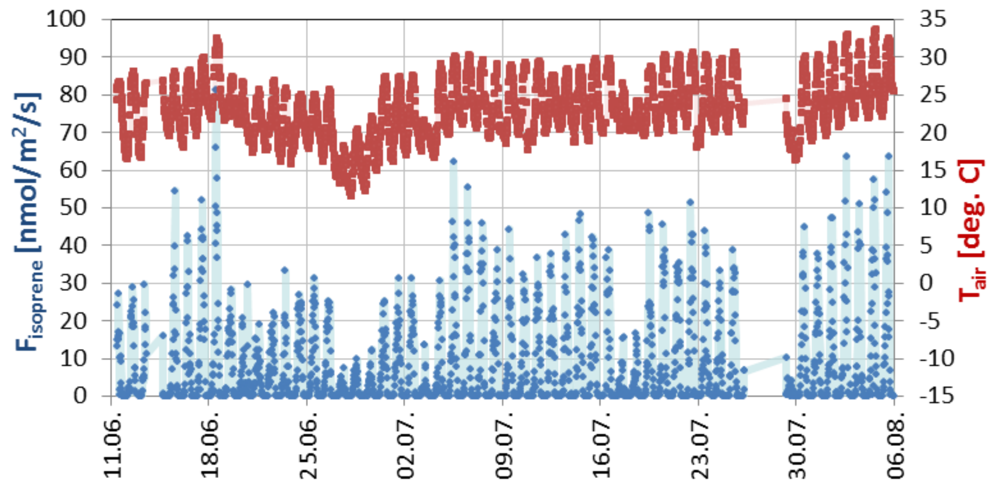
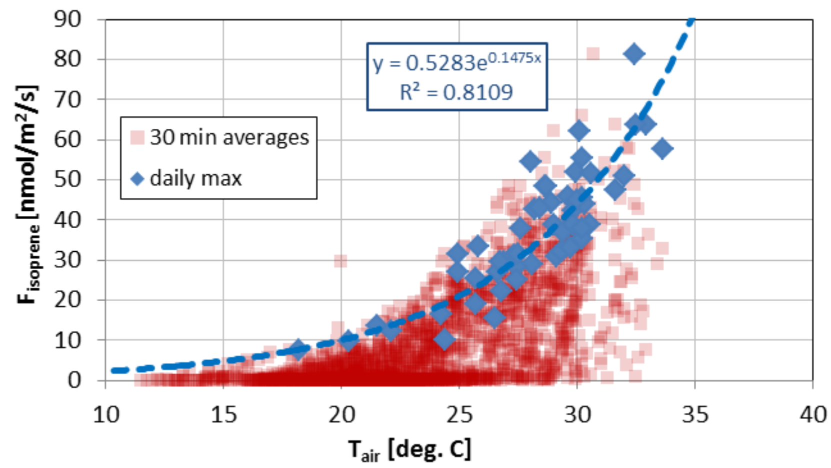
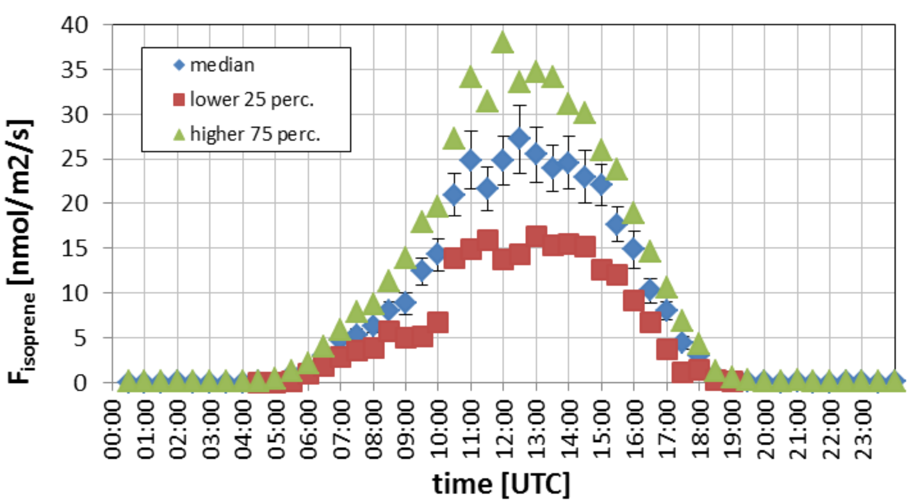
Isoprene fluxes at Ispra Forest measured with Fast Isoprene Sensor







Median diurnal cycle of Isoprene fluxes, error bars indicate random error estimates

- Isoprene concentrations were measured continuously during the IMP (11.06 – 06.08.2013) with a Fast Isoprene Sensor (Hills Scientific).
- Isoprene concentrations were up to 16 [ppb] and fluxes up to 80 [nmol/m²/s]
- Using all measurement days, daily maximum values of Isoprene fluxes correlate quite nicely with daily maximum temperatures.
- Work on Isoprene standardized fluxes and emission factors is ongoing – some issues probably due to forest heterogeneity

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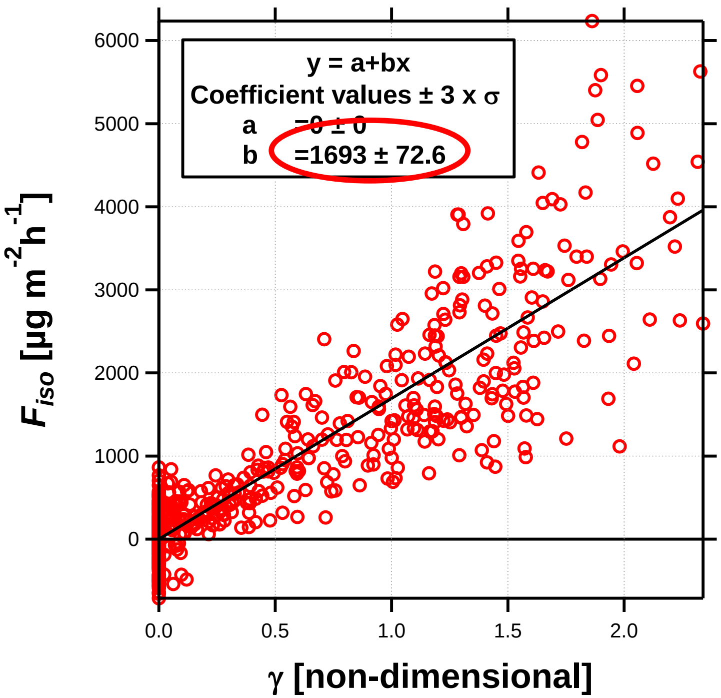
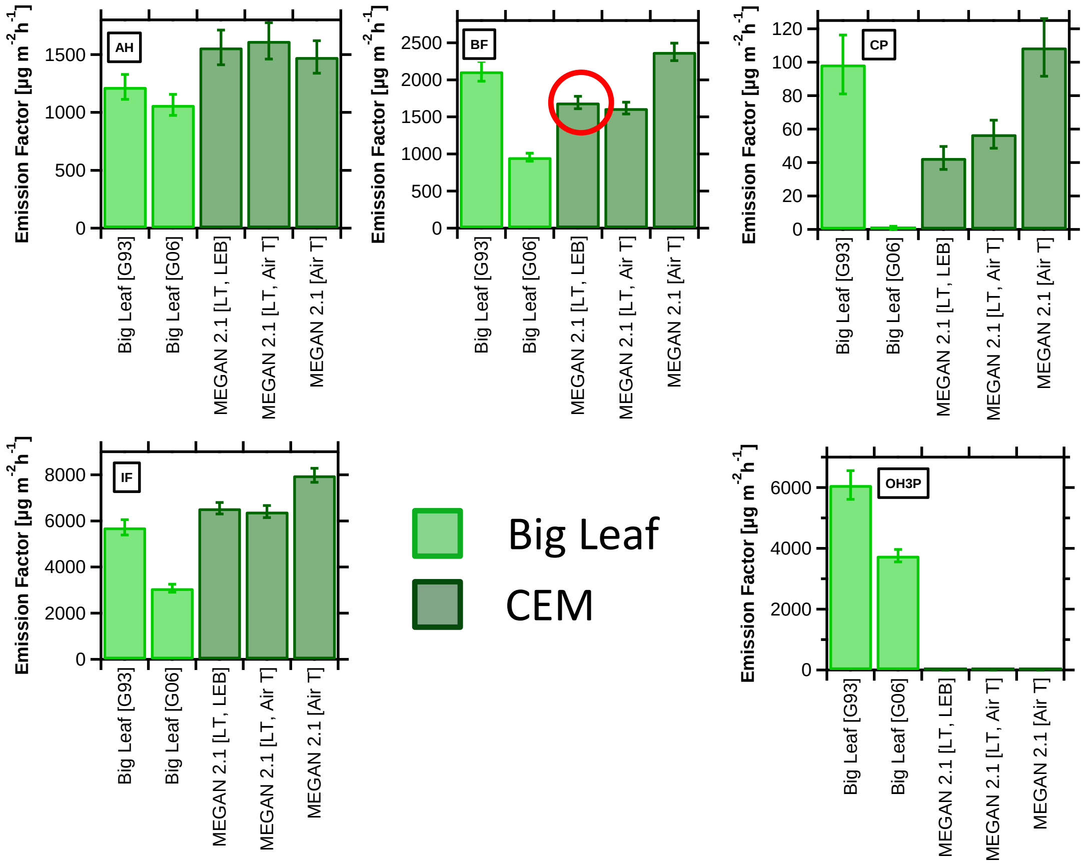
Summary of oak emission factors and dependence on emission algorithm

Example: BF – MEGAN 2.1 (Full)





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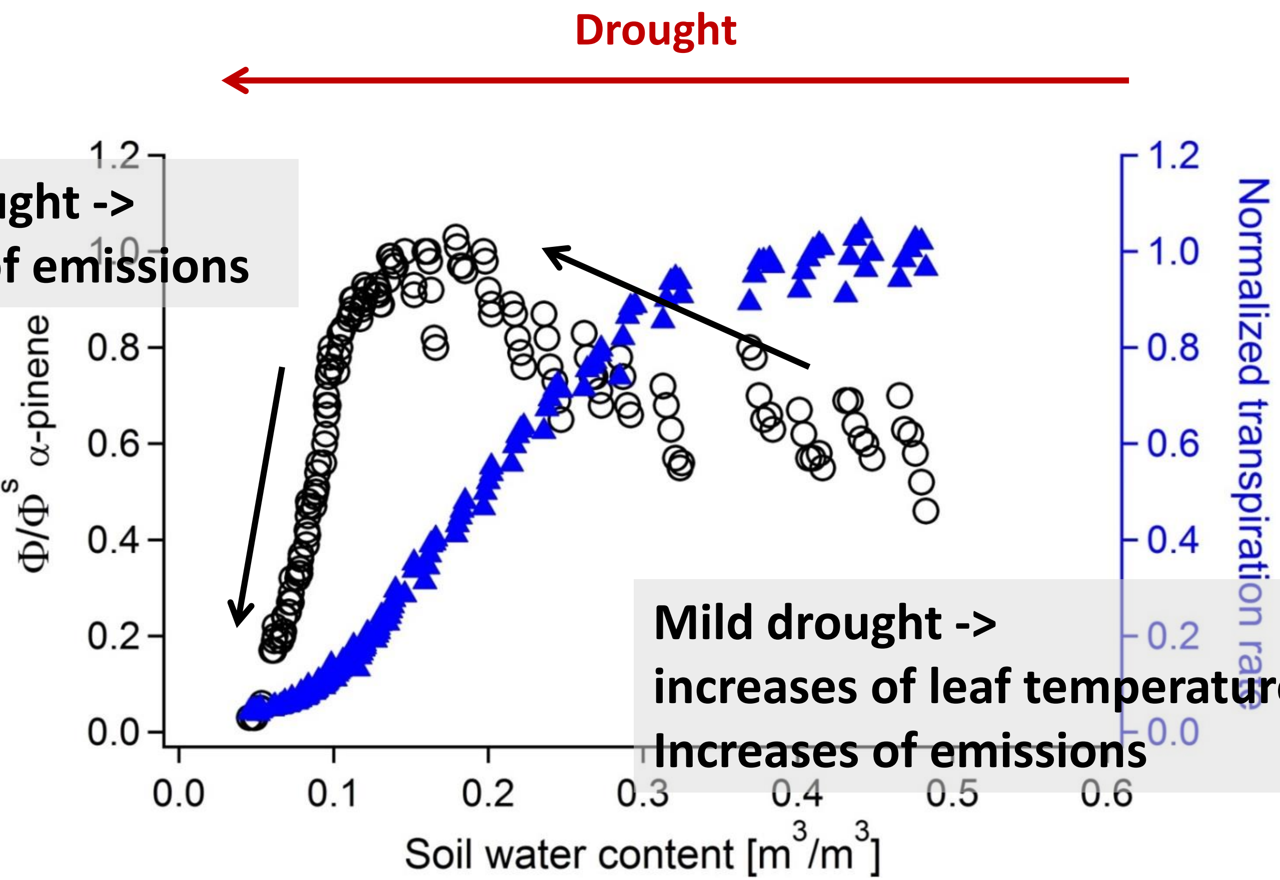
Parameterization of *de-novo* MT emissions under drought using volumetric water content of the soil (θ)

Severe drought -> decreases of emissions



Mild drought -> increases of leaf temperature -> Increases of emissions

Normalized transpiration rate and α-pinene emission rate of a Holm oak in dependence on θ.

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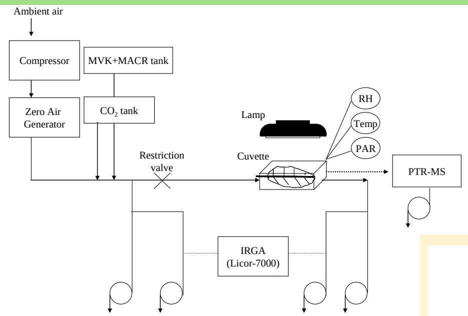
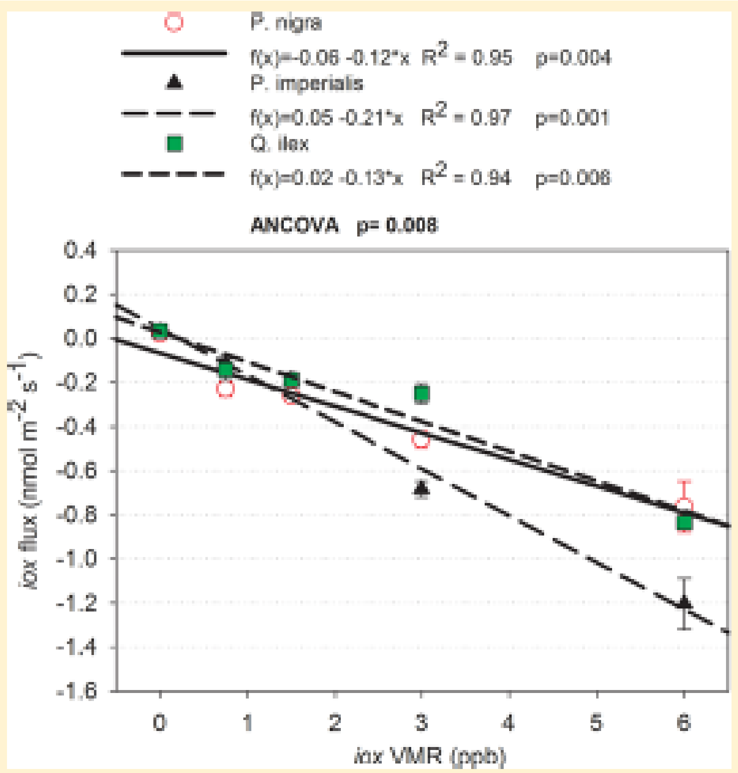
Bidirectional flux of methyl vinyl ketone and methacrolein with trees





Populus nigra
isoprene emitter

Paulownia imperialis
not emitter

Quercus ilex
monoterpene emitter

By manipulating isoprene and ROS production (by fosmidomycin, O3 exposure (300 ppbv for 4 h) and dark conditions), we found:

- A negligible level of constitutive iox emission and a near-zero compensation point
- A significant foliar uptake of iox that increased linearly with exposure to increasing concentrations

→ **Plant capacity to take up iox should be included in global models**

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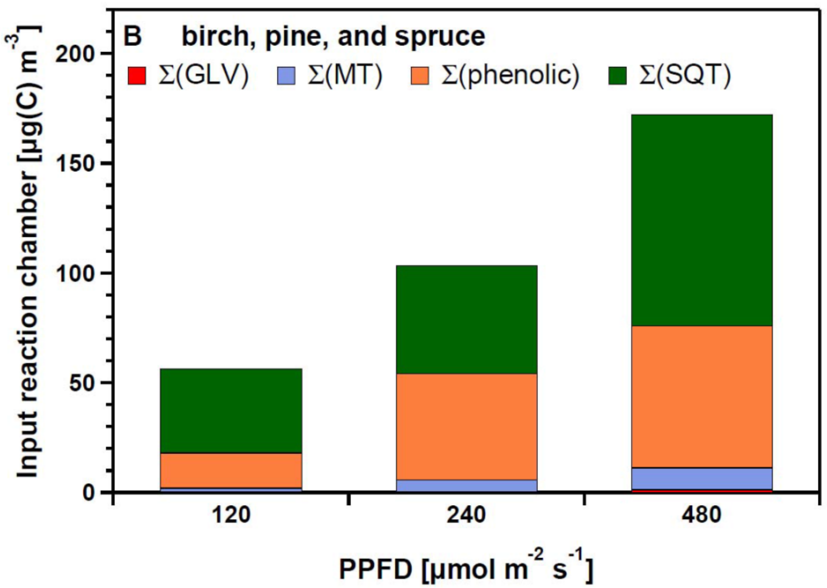
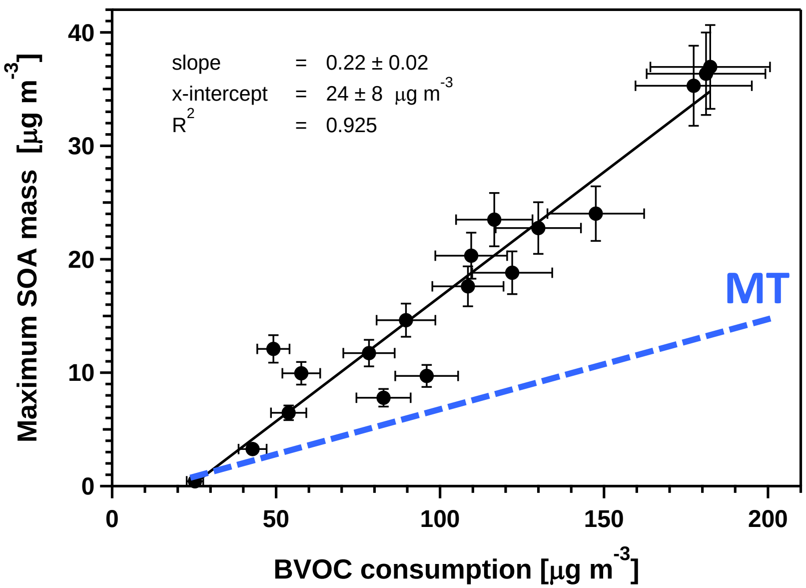
Some stress induced VOC emissions (SIE) have higher potential to form secondary organic aerosols (SOA) mass than constitutive emissions.

E.g. Silver birch & Scots pine & Norway spruce
(high degree of aphid infestation of spruce)





SIE-yield: (SQT & MeSA) = 22 ± 2 %
3 -4 times higher than for the constitutive and stress-induced MT

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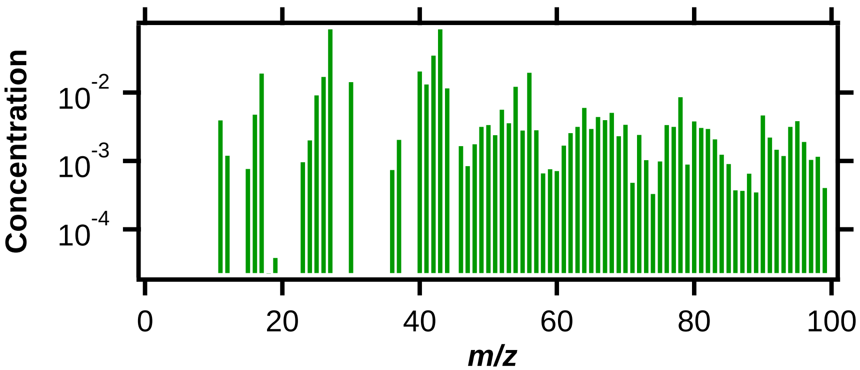
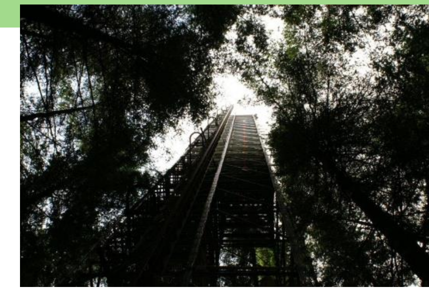
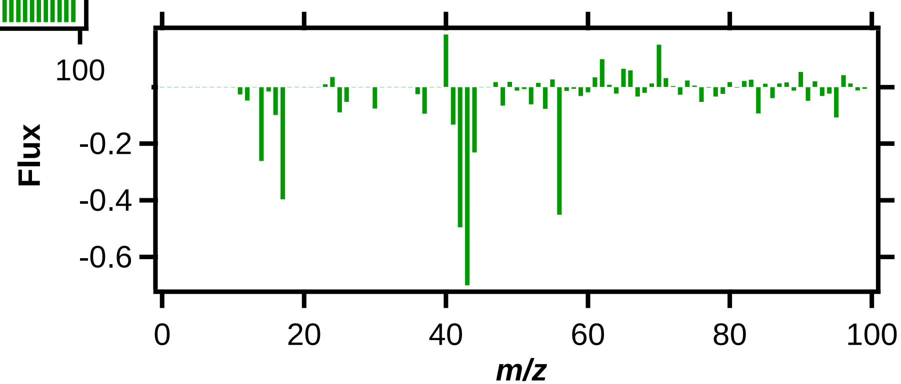
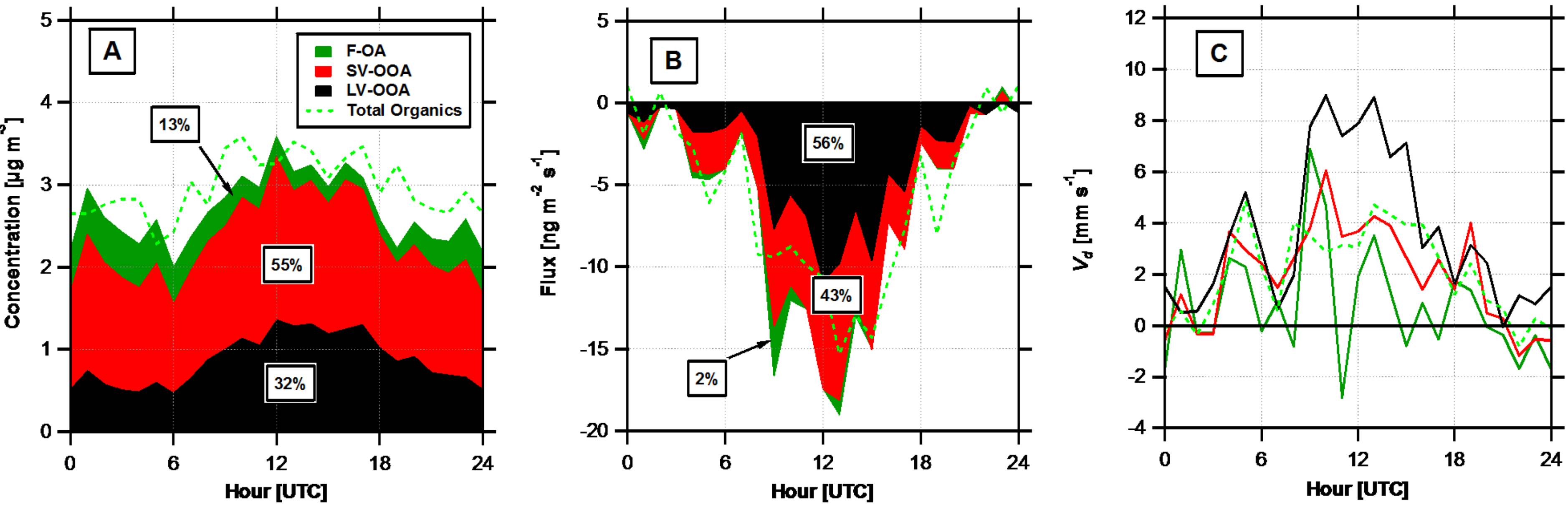
Speuld: Forest as a sink of organic aerosol components









NO/NO$_2$ soil flux in a Ukrainian crop

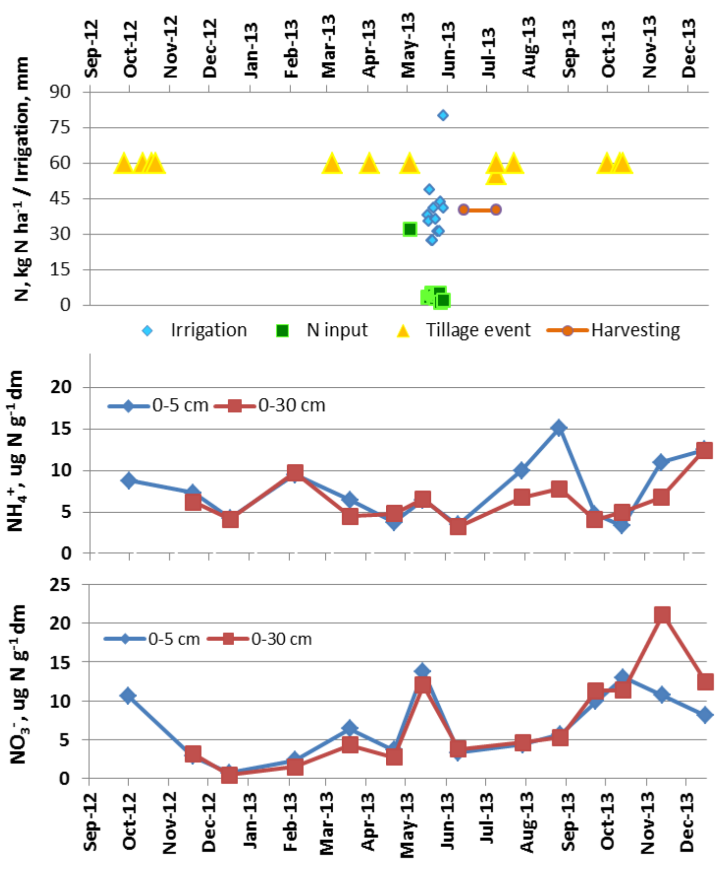


Fig. X1. Soil management and DIN (in forms of NH_4^+ and NO_3^-) changes in two integrated horizons (0-5 cm and 0-30 cm)

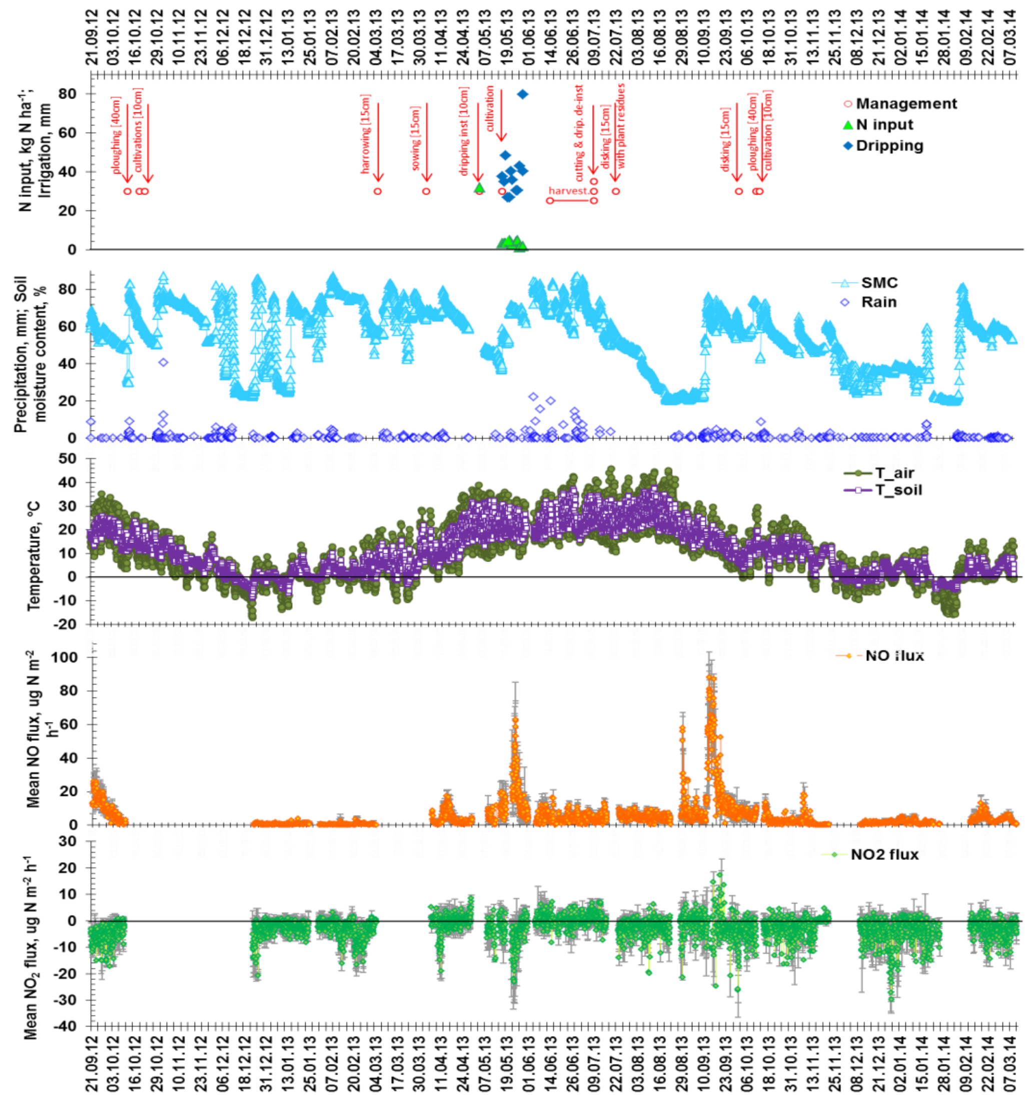


Fig. X2. Variability of NO and NO_2 fluxes, environment conditions and management practice during study period (N input - N fertilization (surface and fertigation); dripping – dripping irrigation; SMC – soil moisture content; Rain – precipitation amount; T_air – air temperature; T_soil – 5 cm depth soil temperature)