From forest to atmosphere: towards a more comprehensive assessment of BVOC exchanges in a mixed temperate forest

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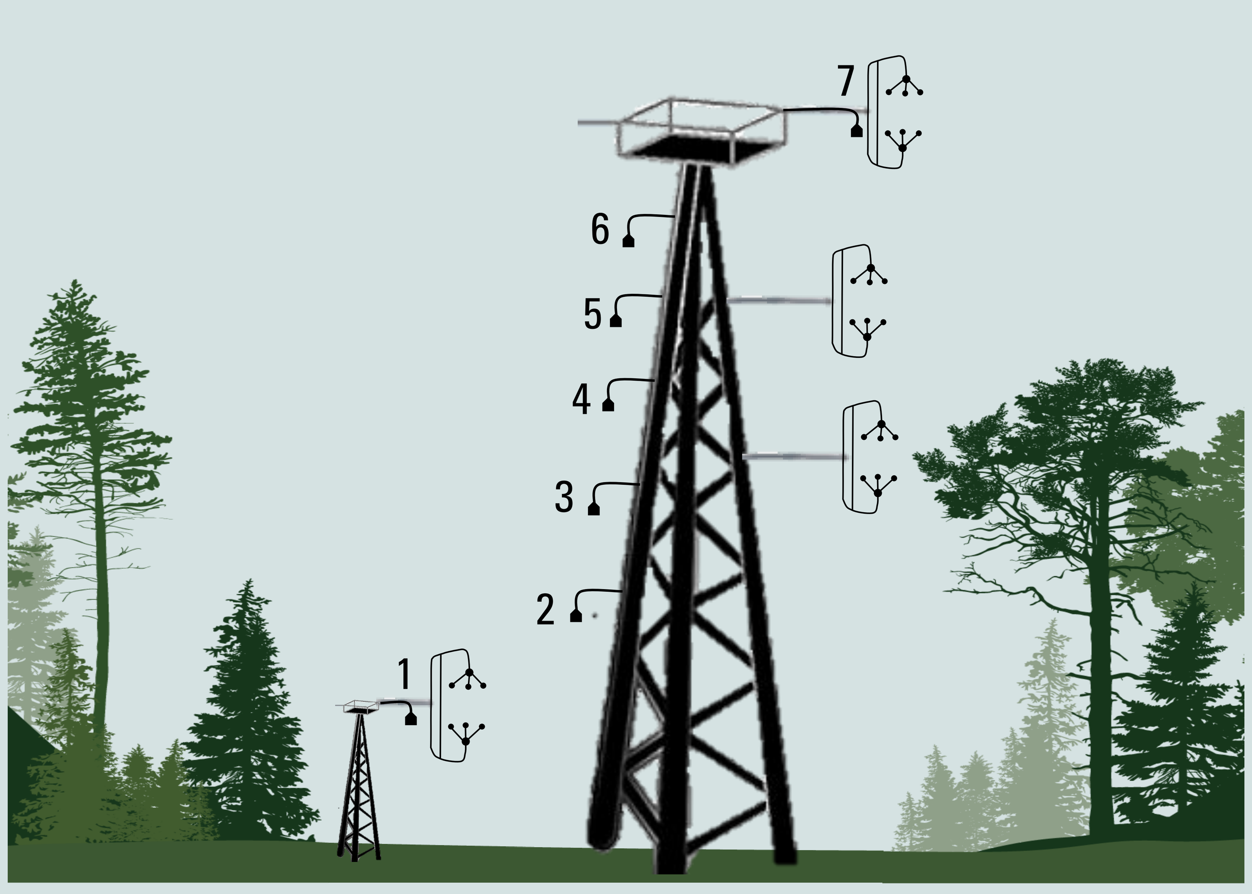
CONTEXT & OBJECTIVES

- **Forests** act as a **major source of biogenic VOCs** (BVOCs), which are precursors of air quality and climate related substances (O_3, SOA).
- Forest/atmosphere BVOC **exchange** is often **bidirectional** and above canopy fluxes result from a **variety of processes** occurring along the soil-canopy-atmosphere continuum.
- **Uncertainties** remain regarding the diversity, magnitude, and temporal variability of BVOC exchanges. A **better characterization** is needed for improved BVOC emission, air quality and climate modelling.

MEASUREMENTS AND DATA PROCESSING



Set-up

- Vielsalm station, Belgium: **mixed temperate forest** equipped with a flux tower (part of the ICOS network, BE-Vie)
- Measurements in 2023 from **April 22^d** until **November 30^th**
- **BVOC fluxes** at 51 m and 3 m above ground level by **PTR-TOF-MS** (PTR-TOF-4000) + **eddy covariance** techniques
- **BVOC conc.** (7 points) + **turbulence** (4 sonic anemometers) profiles

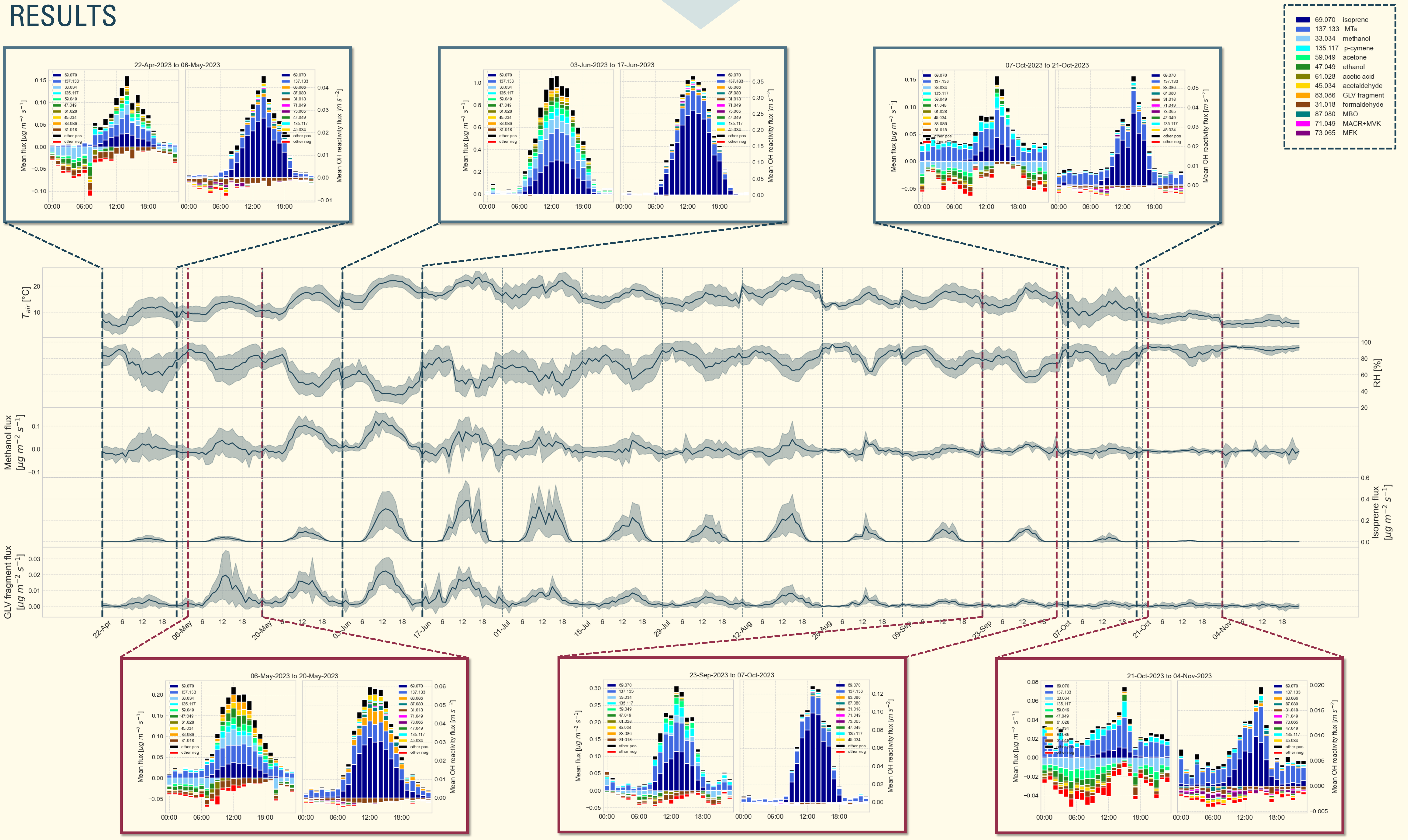
Processing

- BVOC data processed by **IDA** (Ionicon Data Analyser) software and fluxes computed by GEddySoft (home-made script)
- Computation of **OH reactivity fluxes**:

$$Flux_{OH,i} = k_{OH,i} \cdot Flux_i$$

with $k_{OH,i}$ the reaction rate constant with hydroxyl radical

RESULTS



This figure presents mean diel cycles per periods of 2 weeks for air temperature & relative humidity + methanol, isoprene and GLV fragment fluxes at 51 m (note: varying y-scales). Six periods are highlighted for which budgets of mean flux and mean OH reactivity flux are presented for 30 calibrated m/z values, of which the 10 most exchanged are detailed.

ANALYSIS

Times series

60 m/z values were **significantly exchanged** during the measurement campaign. The dynamics of their exchange can be classified into **3 groups**:

(1) Bidirectional exchange: low molecular mass oxygenated compounds (methanol, ethanol, formic acid, acetic acid, acetaldehyde,…) Depositions mainly occurring at night, enhanced by high relative humidity

(2) Dominant emission: isoprene, monoterpenes, p-cymene, sesquiterpenes,… Highly dependent on air temperature and solar radiation

(3) Burst of emision 2 weeks **after budbreak**: C6 compounds (GLV) and nonanal Highest emissions around May 9^th (9 days after budbreak) even though temperature and solar radiation are not highest

Flux budget

- **10** most exchanged **BVOCs** = **90%** of the total exchange
- The budget shifts from a **bidirectional** budget to dominant **emissions** and again to a **bidirectional** budget throughout the campaign (spring – summer – autumn) following phenological and meteorological conditions

OH reactivity flux budget

- **Isoprene** and **monoterpenes** = **70%** and **22%** of total OH reactivity flux
- **BVOCs** with non-negligible **negative fluxes** are **under-represented** in the OH reactivity flux budget
- **Burst of GLV** emission (m/z 83.086) in mid-May: **high contribution** in the OH reactivity flux budget

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