Long term measurements of VOC exchanges above a maize field at Lonzée (Belgium)

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Background

- Few BVOC measurement studies about crop ecosystems at ecosystem scale, leading to uncertainties for crop BVOC modeling
- Poor understanding of OVOC driving mechanisms and phenology influence on those mechanisms at ecosystem scale

Objectives

- **Qualify and quantify** BVOC fluxes from a maize field
- Identify fluxes **driving mechanisms** and evaluate the impact of phenology on those mechanisms

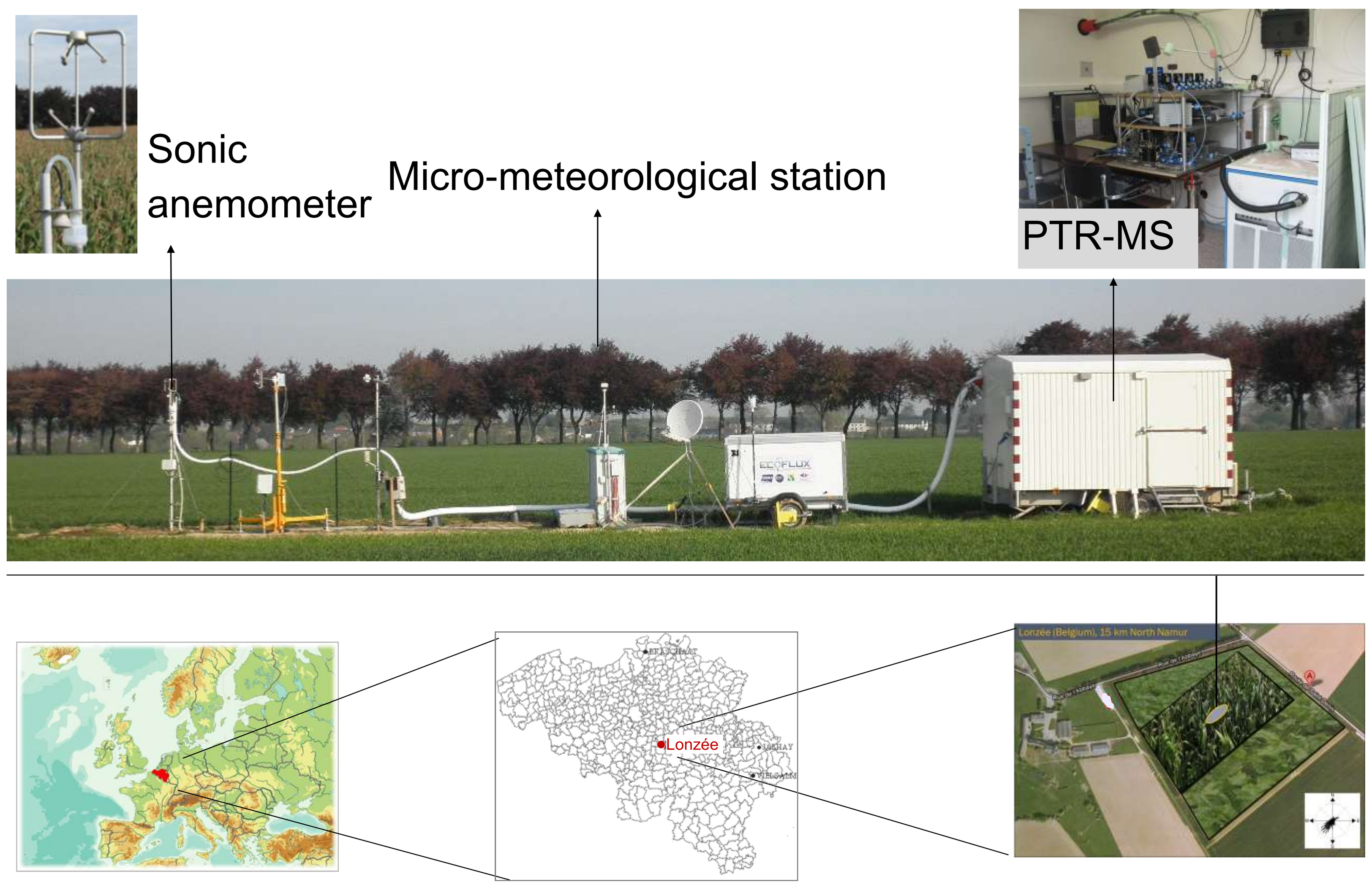

Fig 1. Experimental set-up (picture made on wheat, same site).

Methods

- *Site characteristics:*
  - Site location: Lonzée, 50°33'08'' N, 4°44'42'' E, 165 m elevation, Belgium.
  - Species: *Zea mays,* varieties: Prosil and Rocket.
- *Measurement campaign:*
  - May to October 2012 (whole maize growing season).
- *Instrumentation:*
  - BVOC, CO_2 and H_2O fluxes per eddy covariance (sampling frequency 1/2h).
  - BVOC concentration was measured with a 3s sampling interval using a proton-transfer-reaction mass spectrometer (PTR-MS).
  - Meteorological (sampling frequency 1/2h) and phenological measurements.
- *Investigated BVOC:*
  - Methanol (M33), acetaldehyde (M45), acetone (M59), isoprene (M69), MKV+MACR (M71), MEK (73), benzene(M79), leaf alcohols or GLV* (M83), toluene (M93) and monoterpenes (M137).

Results and discussion

VOC composition

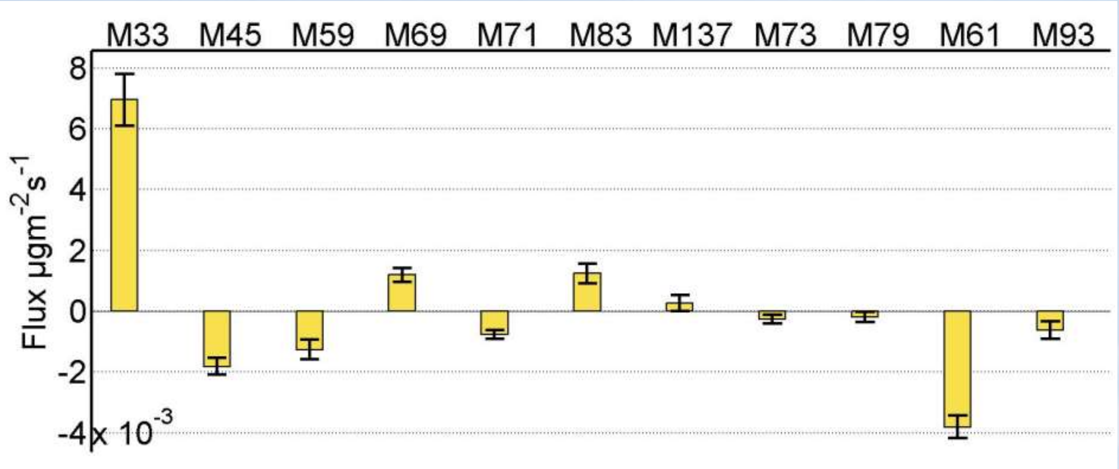

Fig 2. Mean flux ±SE of investigated VOC.

- Main emitted VOC (+): methanol
- Main taken up VOC (-): acetic acid
- Significant exchange of GLV*(+), acetaldehyde(-), isoprene(+) and acetone (-).

Comparison with other maize flux studies

- Qualitatively, VOC fluxes composition similar to other maize studies[1,2], although we found a net uptake of acetic acid whereas other studies found a net emission[1].
- Quantitatively, flux range four[1] to ten[2] times lower than measured by other studies. This could be due to:
  - Differences in environmental or site conditions (other than T°) ,
  - Presence of methanol sinks at ecosystem-scale,
  - Uncertainties linked to flux up-scaling from leaf-scale and flux measurement at ecosystem scale.

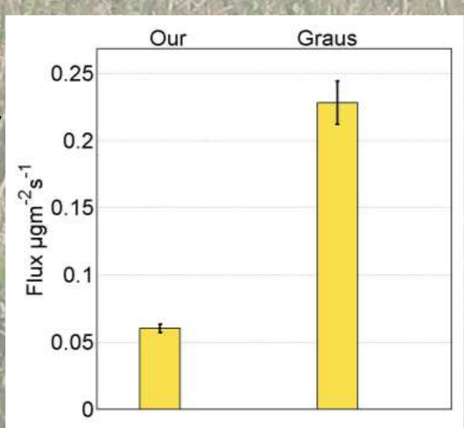

*Fig 3. Comparison of methanol fluxes at 30°C during the R stage. Graus flux estimated from leaf scale**.*

* GLV include here a large blend of molecules such as cis-3-hexenol, cis-2-hexenol, trans-3-hexenol, trans-2-hexenol, hexanal, cis-3-hexenylacetate and trans-2-hexenylacetate. Such compounds cannot be discriminated at mass 83 using the PTR-MS. Concentrations have been calculated from M83 measurements using cis-3-hexenol calibration gas and fluxes have been calculated on a cis-3-hexenol basis.

** Fluxes estimated at ecosystem-scale from leaf-scale measurements maintained at 30°C, by estimating a LAI value of 6m^{-2} m^{-2}.

Acknowledgments

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Temporal dynamics by phenological stage

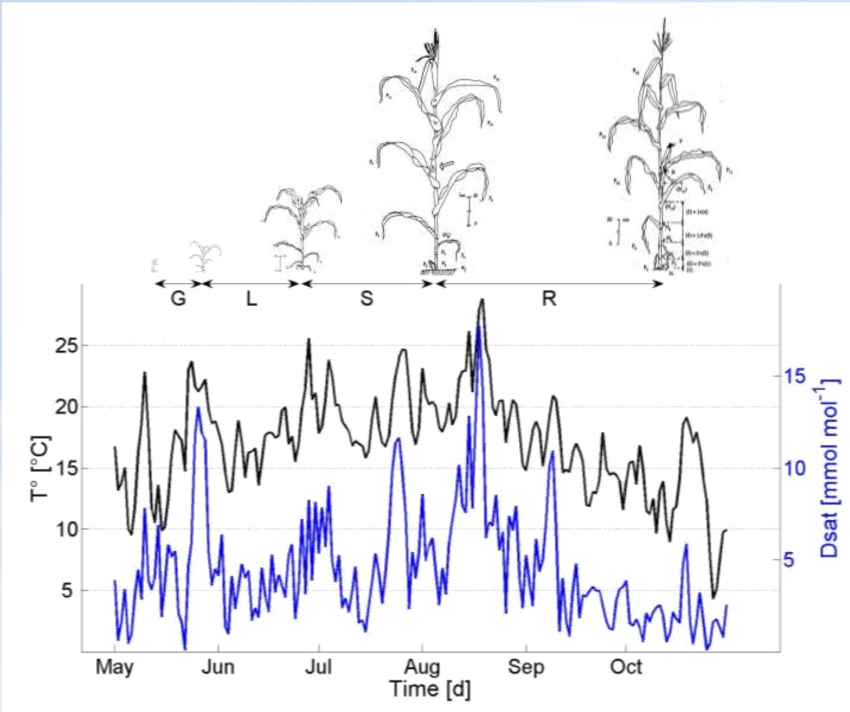

Fig 4. Daily mean temperature (black line) and saturation deficit (blue line). Phenological stages of maize: G = germination, L = leaf development, S = stem elongation and R = reproduction (picture)[3].

- *Climatic conditions over the growing season:*
  - Heat and drought waves at the end of stage G and at the beginning of stage R .
  - Cold but dry period during stage G. Warm and dry period during stage S. No significant difference in temperature for stages L and R, but stage L was wetter than other periods.
- *Temporal dynamics of methanol fluxes*
  - Clear diel dynamics with higher emissions during daytime and small uptake during nighttime.
  - Variation of emission rate across phenological stages, with more emissions during dryer periods. Disentangling between phenological and environmental influence on fluxes is being investigated.
  - Emissions during G stage are assumed to arise from soil under dry and warm conditions.
- *Temporal dynamics of acid acetic fluxes*
  - Less clear diel dynamics with more important uptake in the morning, especially during stage G.
  - No obvious differences across phenological stages.
  - Acetic acid sinks and mechanisms are being investigated.

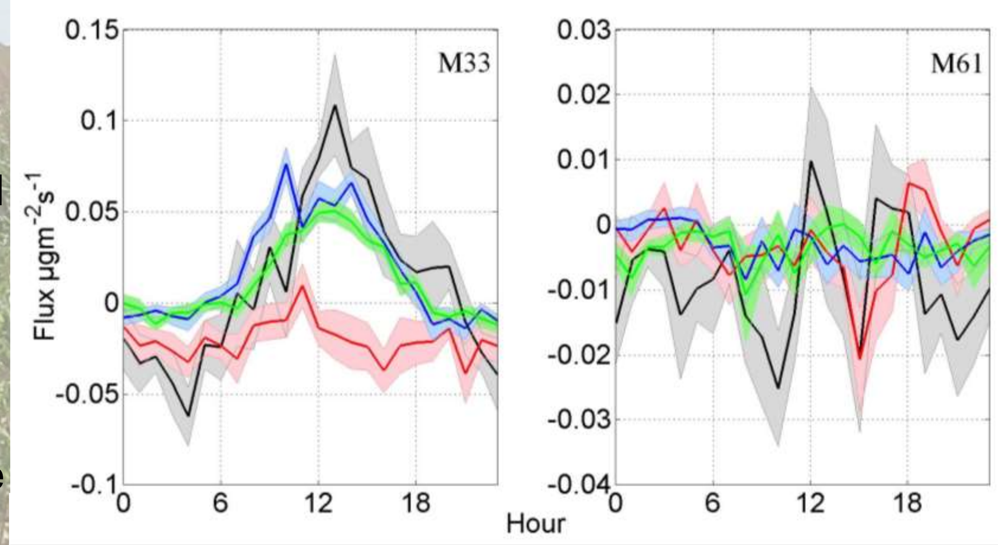

Fig 5. Hourly mean ± SE of methanol (left) and acetic acid (right) fluxes per phenological stages: G (black), L (red), S (blue) and R (green).

Conclusion and prospects

We are the first study measuring VOC fluxes at ecosystem scale on maize during a whole growing season. Results show significant methanol emissions varying across phenological stages, as well as significant acetic acid uptake. We are furthermore investigating exchange mechanisms for methanol fluxes and other OVOC. Such kind of study can provide to modelers more accurate OVOC exchanges rates from croplands and deeper comprehension of their exchange mechanisms for up-scaling efforts, knowing that croplands are important OVOC sources[2] and that maize is the 2nd most cultivated crop in the world (FAOSTAT).

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