Laboratory studies on the formation of secondary organic aerosol (SOA) from the isoprene oxidation

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PEGASOS Pan-European Gas-AeroSOls-climate interaction Study

TROPOS Leibniz Institute for Tropospheric Research

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INTRODUCTION

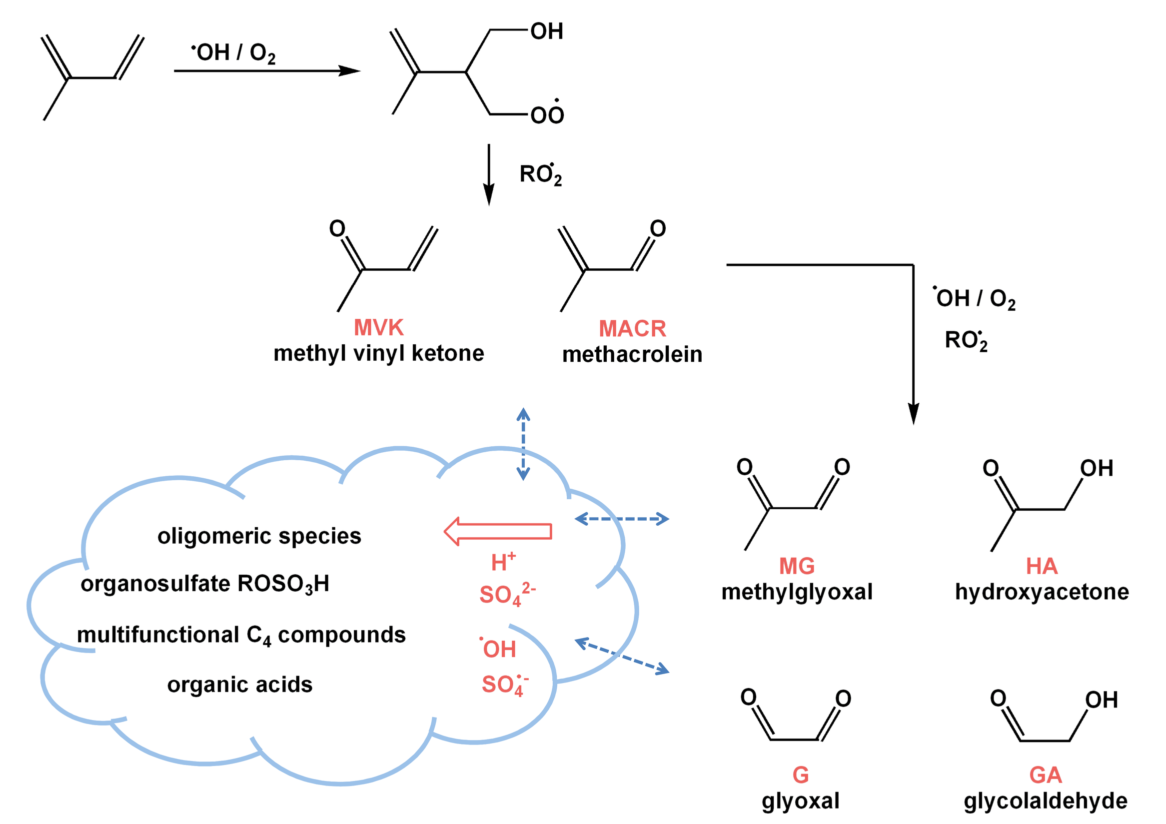


Fig. 1: OH radical induced oxidation of isoprene in the gas phase.

The contribution of isoprene to SOA

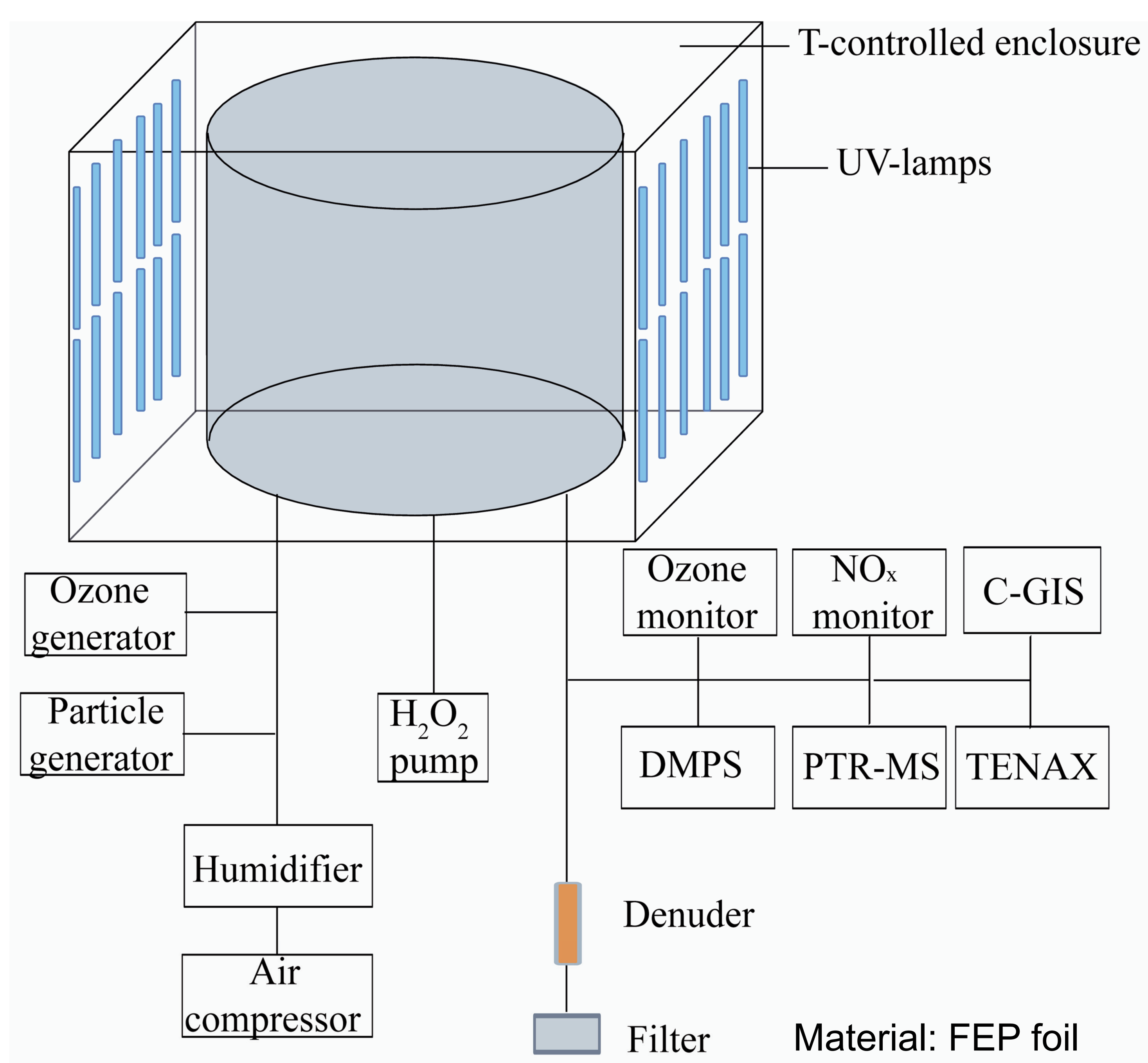
- Emission of biogenic volatile organic compounds (BVOCs) in large amounts
- Reaction with oxidants (ozone, OH and NO_3 radicals)
- Effect on atmospheric chemistry and the climate
- Isoprene contributes 50% to the total BVOC emission (global emission rate of 660 TgC/y)
- Major source: tropical rainforest[1,2]
- Isoprene is highly reactive
- Degraded by hydroxyl and nitrate radicals as well as ozone
- Formation of oxidized, semi-volatile organic compounds (SVOCs)[3]
- SVOCs can condense on particles or partition into the aqueous phase of cloud and fog droplets
- Further processing -> highly oxidized species such as organic acids, organosulfates and functionalized oligomeric compounds
- Adds mass to the atmospheric organic particle matter and change the chemical and physical properties of the tropospheric aerosol
- Effect on ability to act as CCN and the radiation budget of the atmosphere.[4]

SETUP AND FIRST RESULTS

Experiments at LEAK (Leipziger Aerosol Kammer)

- Isoprene + OH radicals
- Varying rel. humidity (0, 75%)
- Varying seed acidity (pH 7, 3, 0)

- OH source:
  - At 0% RH -> H_2O_2 + hv
  - At 75% RH -> O_3 + hv + H_2O



Material: FEP foil
Volume: 19 m³
8 UV lamps (254 nm)

Fig. 2: Scheme of the Leipziger Aerosol Kammer (LEAK).

Gas phase

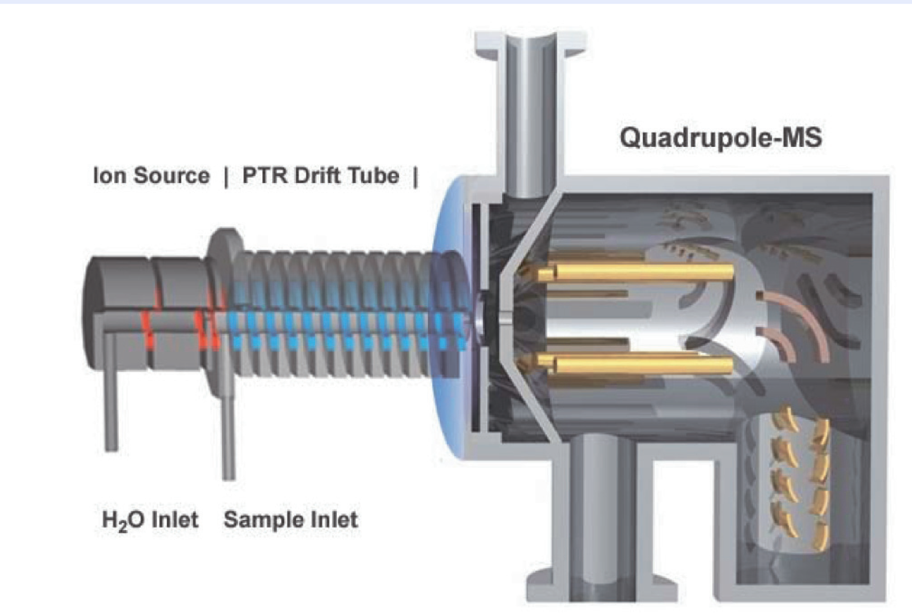


Fig. 3: Working principle of the PTR-MS.

PTR-MS (Proton-Transfer-Reaction Mass Spectrometer)

Time-resolved measurement of the gas phase mixing ratios of isoprene and its oxidation products in their protonated form

$H_3O^+ + X \rightarrow XH^+ + H_2O$

First Result

Dependency of the 2nd generation oxidation products on relative humidity

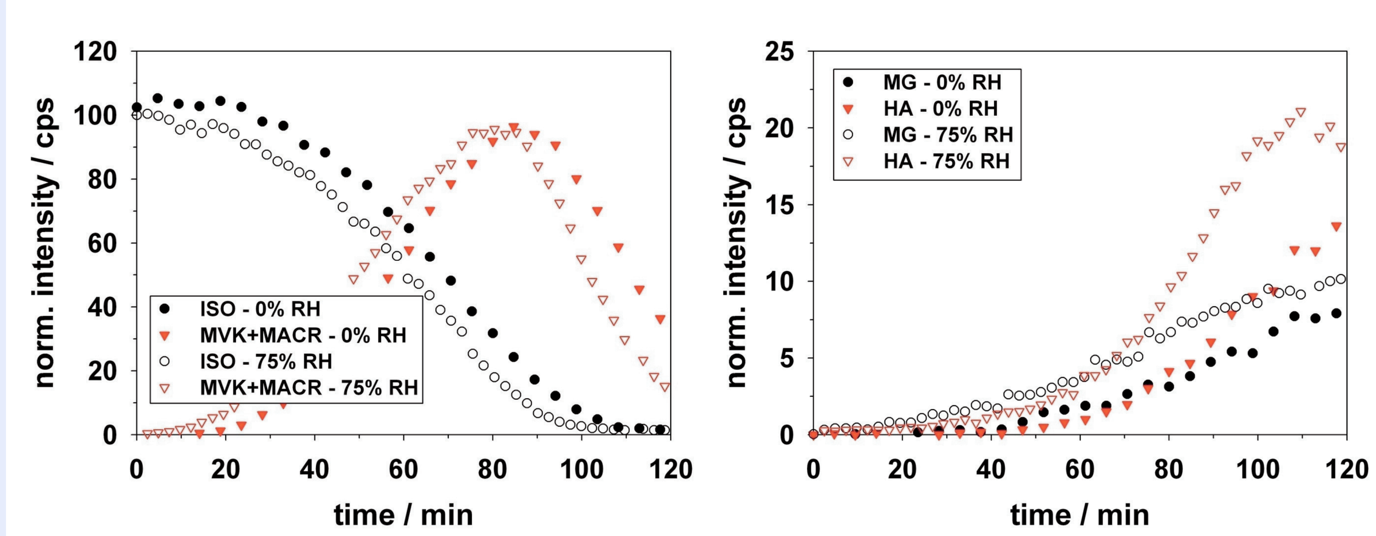


Fig. 4: Effect of humidity on the product distribution.

Particle phase

TDMPS (tandem differential mobility particle size)

Time-resolved measurement of the number-size-distribution of particles diameters: 3 - 900 nm

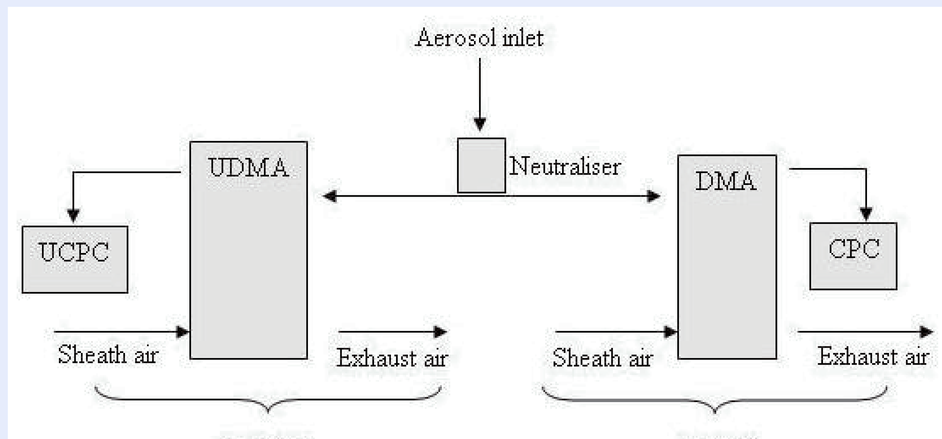


Fig. 5: Scheme of a TDMPS.

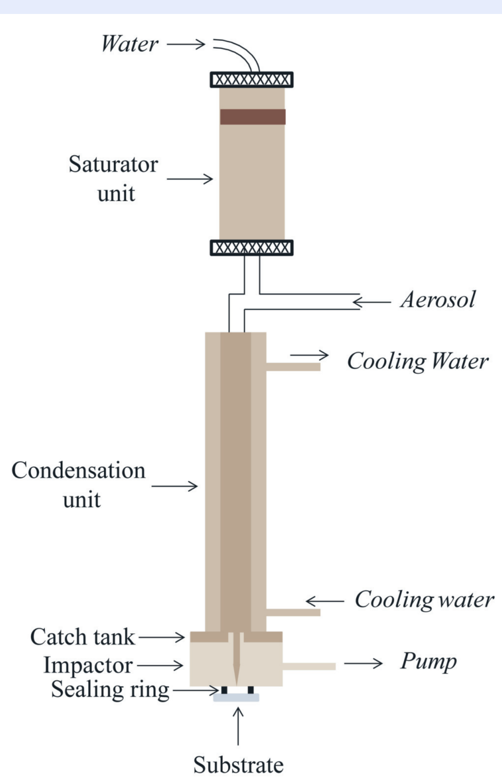


Fig. 6: Scheme of CGIS.

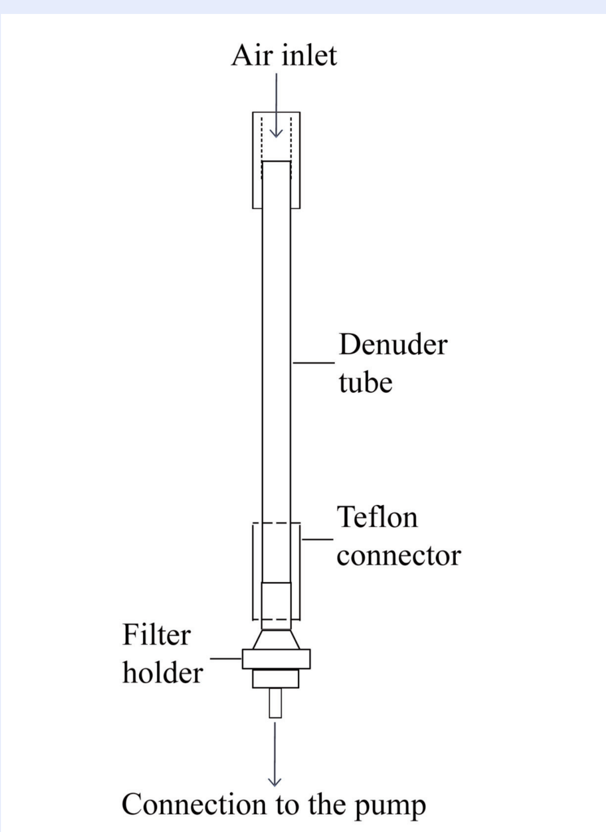


Fig. 7: Scheme of a denuder-filter-device.

C-GIS (condensation-growth and impaction system)

Time-resolved sampling of particles as droplets due to condensation-growth.
Sampling Time: 15 min

Denuder-Filter-Device

Filter are collected mainly at the end of the experiments. To avoid artefacts a denuder, coated with XAD-4, is installed upstream. Furthermore the denuder can be extracted for quantification of gas phase products.

First Result

Increasing acidity of the seed leads to an increase of particle mass

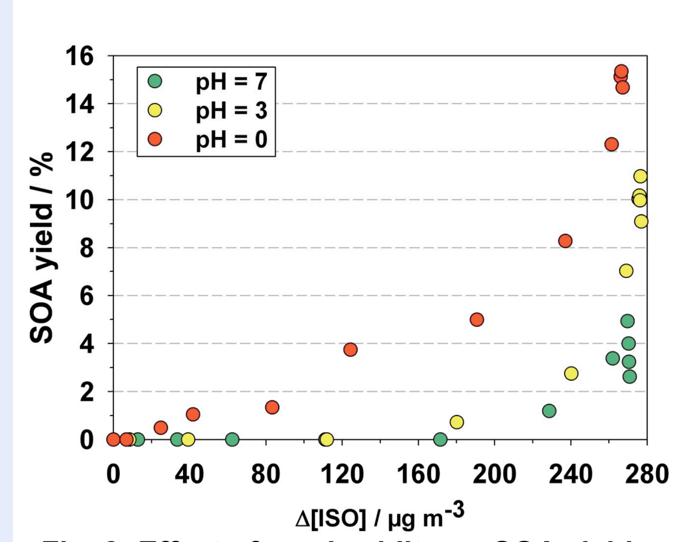


Fig. 8: Effect of seed acidity on SOA yield.

ACKNOWLEDGEMENT

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REFERENCES

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[2] Günther et al., *J. Geophys. Res.* (1995), **100**, 8873-8892.
[3] Carlton et al., *Atmos. Chem. Phys.* (2009), **9**, 4987-5005.
[4] Kanakidou et al., *Atmos. Chem. Phys.* (2005), **5**, 1053-1123.

OUTLOOK

- Further analysis of filter and C-GIS samples
- Degradation of MACR and MVK with OH radicals in LEAK and in bulk phase (reactor experiment)
- Study on the formation of organosulfates due to SO_4^- radical reactions in LEAK and bulk phase