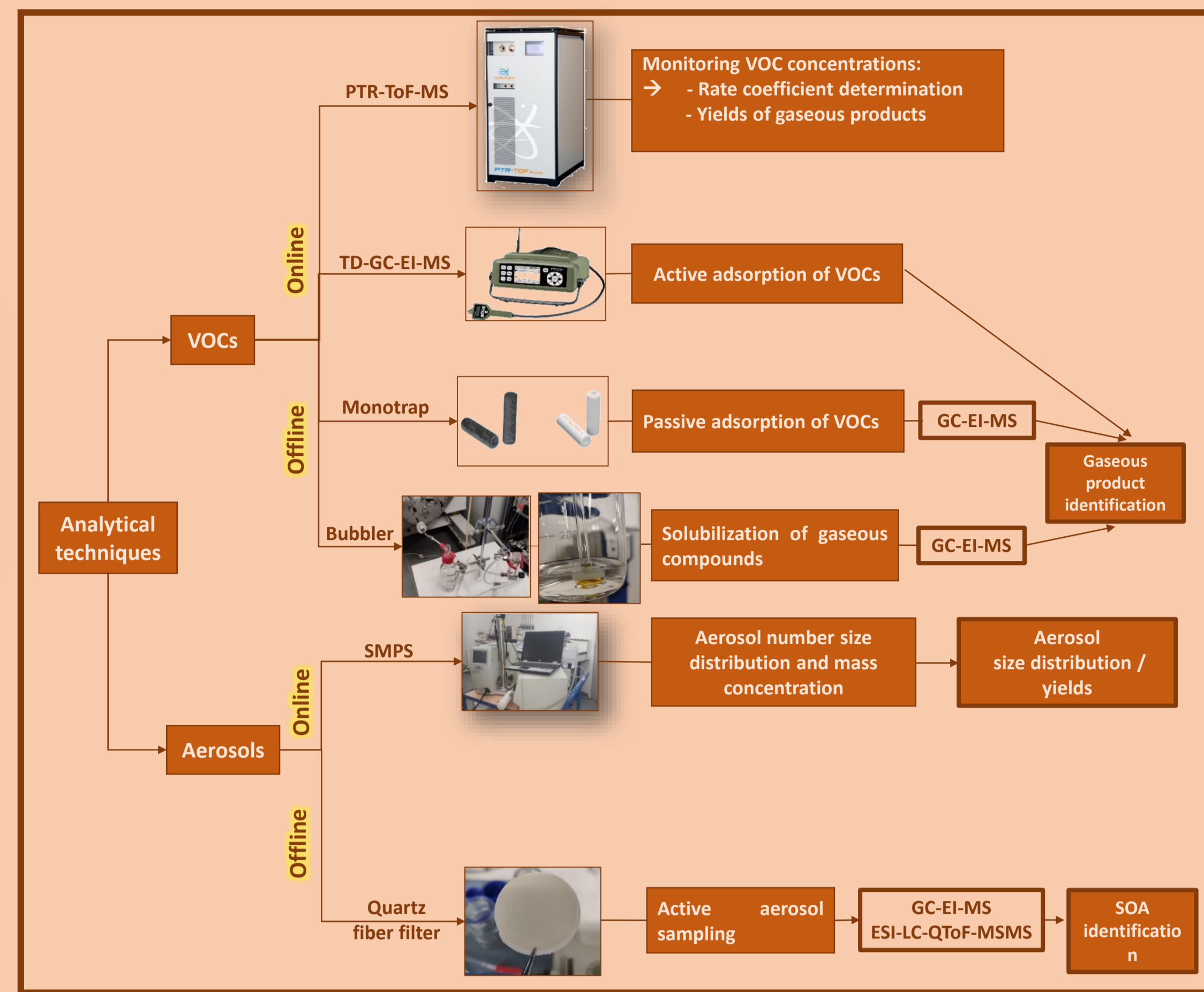


Biomass burning (BB) is the burning of dead or living vegetation, a significant source of particles and non-methane organic gases which will react with atmospheric oxidants producing secondary organic aerosols (SOAs) and ozone. However, BB is an important alternative energy source to fossils fuels and contributes to reduce CO₂ emissions. (Wernke et al., 2011; Bruns et al., 2017)

Recent studies have shown that furan compounds are an important family of organic gases in BB plumes released from cellulose and hemicellulose pyrolysis. (Stockwell et al., 2015)

The few available studies on nighttime oxidation of furans with NO₃ show that this reaction constitutes an important sink for these compounds leading to the formation of numerous products in gas- and particulate- phases (SOAs) (Kind et al., 1996; Berndt et al., 1997; Caballero et al., 2004).

Analytical techniques used for kinetics and product analysis



Atmospheric Simulation Chamber

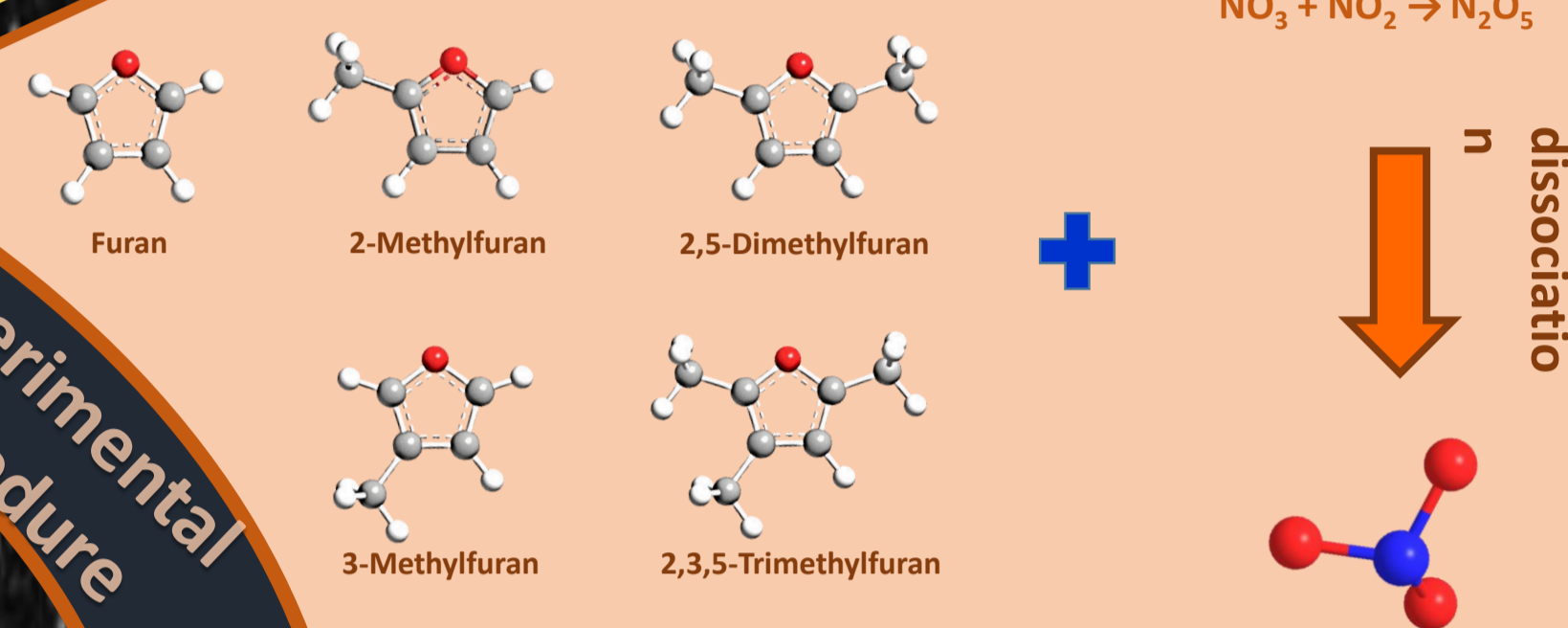


CHARME

CHARME characteristics
9.2 m³, stainless steel, cylindrical, electropolished
Vacuum compatible
Mixing system (4 fans)
Room temperature (293 ± 2) K
RH (<2%) ; Atmospheric pressure

Synthesis of N₂O₅ Precursor of NO₃

Reactions occurring in system for N₂O₅ production
NO + ½ O₃ → NO₂
NO + O₃ → NO₂ + O₂
NO₂ + O₃ → NO₃ + O₂
NO₃ + NO₂ → N₂O₅



Introduction

Aim

Understanding the nighttime atmospheric chemistry of methylated-furan compounds toward NO₃ radical reaction

Objective

Determination of NO₃ rate coefficients → Lifetime determination

Product analysis in gas- and particulate-phases → Chemical mechanisms

Potential of SOA formation → Air quality and climate impacts

Experimental Procedure

Conclusion

Reaction of furan compounds with NO₃ is the dominant removal pathway in the atmosphere (Lifetime = 0.5-55 min).

The rate coefficient increases with addition of methyl group(s), but is not influenced by the position of the methyl group on the ring.

Addition of nitrate radical to furan ring and hydrogen abstraction from methyl-group are the major pathways for the reaction of methylated-furans with NO₃ and can explain the formation of the major primary products.

Addition of NO₃ is favored on C2/C5 carbon due to the higher stability of the produced intermediates.

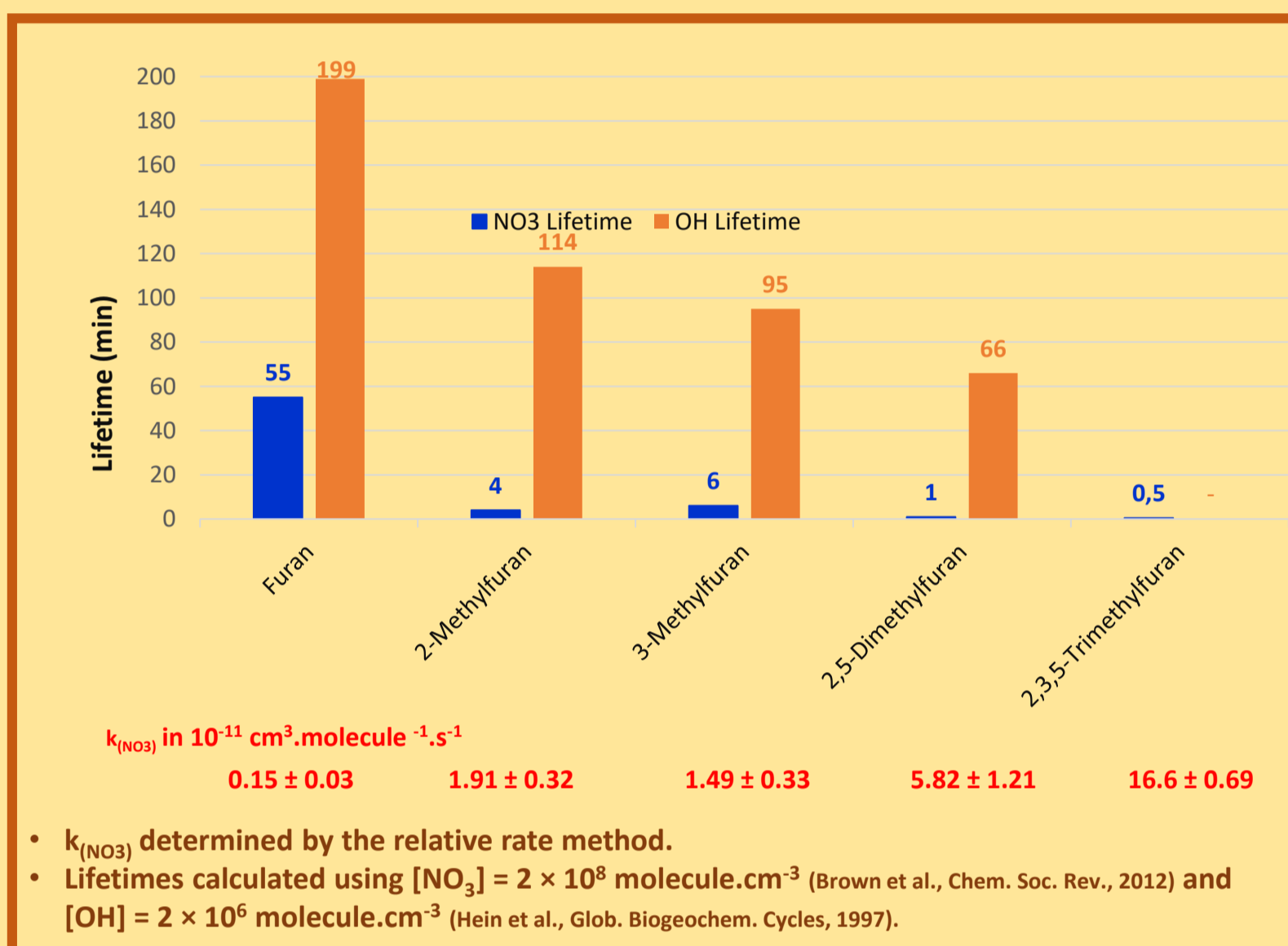
SOAs are formed from the reaction of methylated-furan compounds with NO₃ with maximum yields up to 12%.

Maximum SOA yields increase as the substitution of the furan ring increases (more methyl groups) from 2% (2-methylfuran) to 12% (2,5-dimethylfuran).

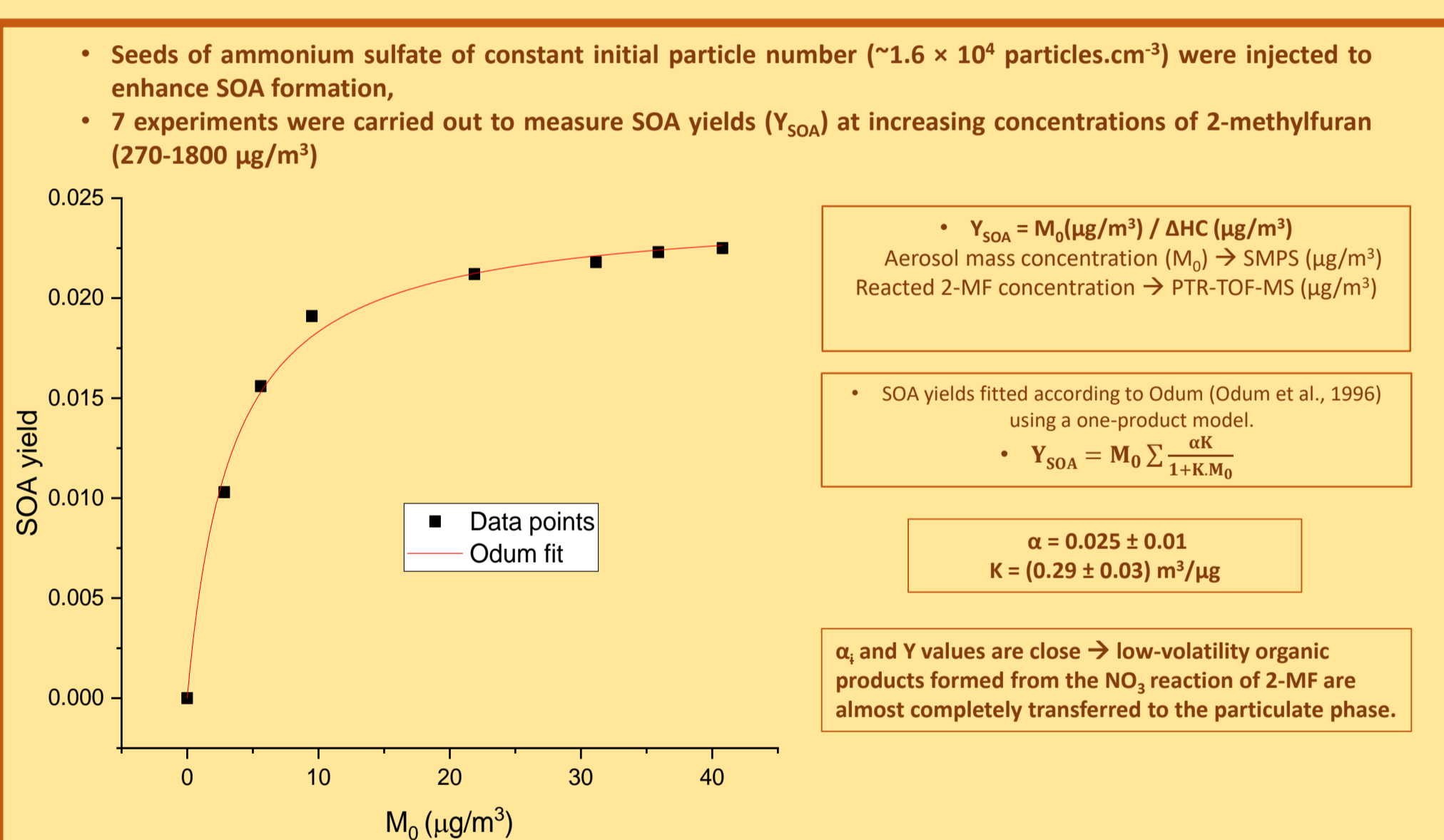
Perspectives

Kinetic & product study at various temperatures in Thalamos Simulation Chamber (T= 233 - 373 K) for the reaction of methylated-furan compounds with NO₃

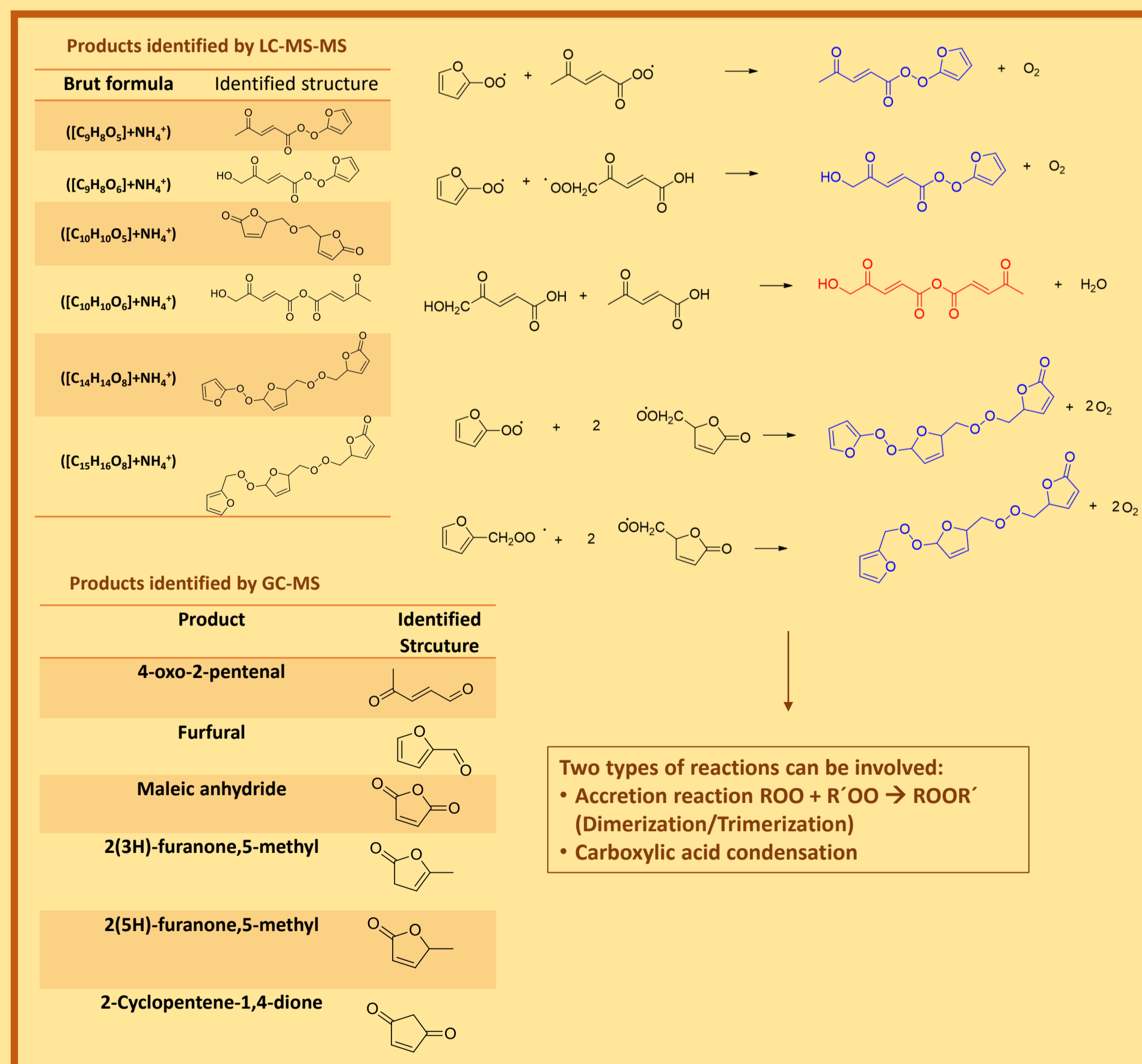
1) Rate coefficient measurement & lifetime calculation



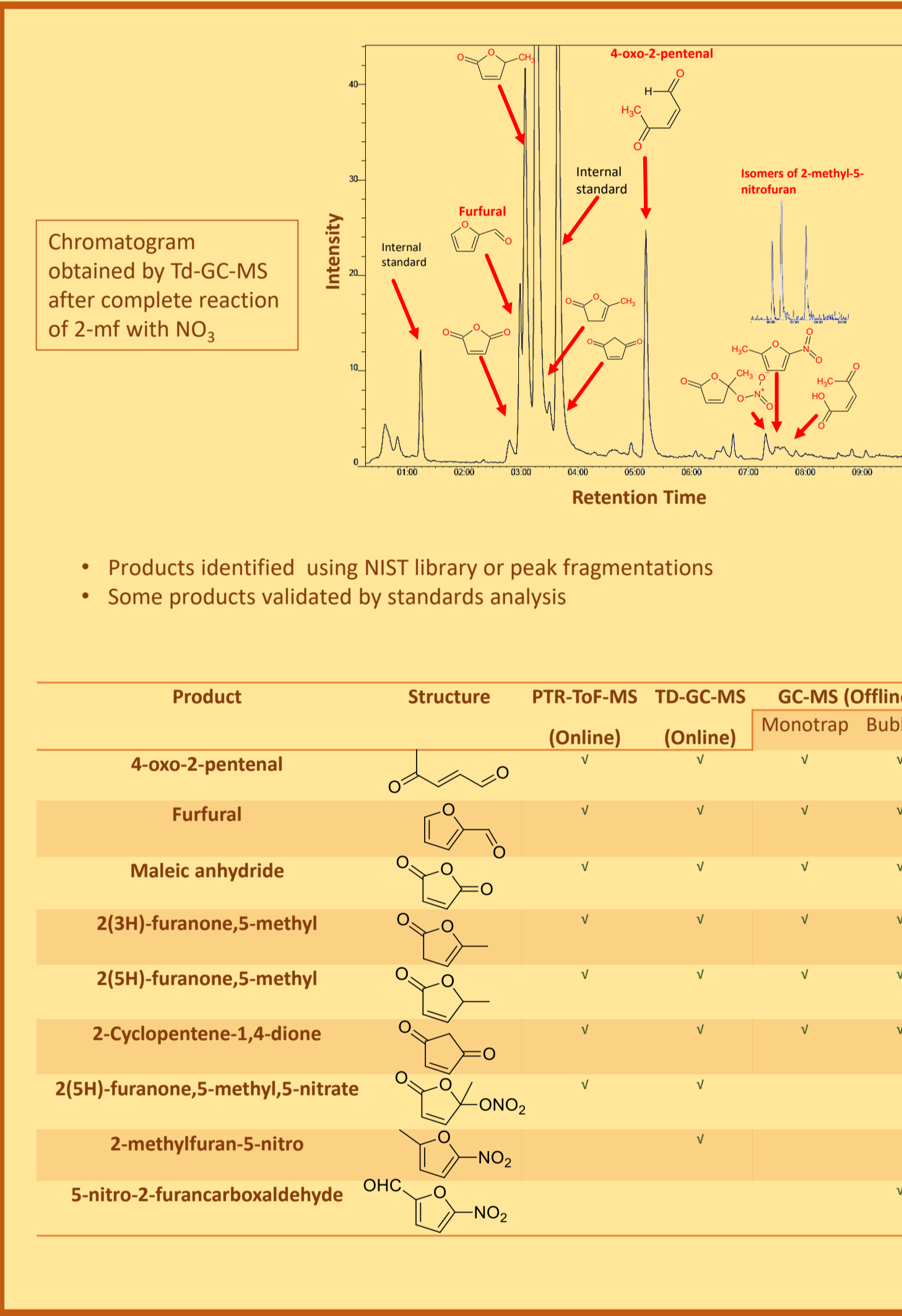
4) SOA yield for the reaction of 2-MF with NO₃



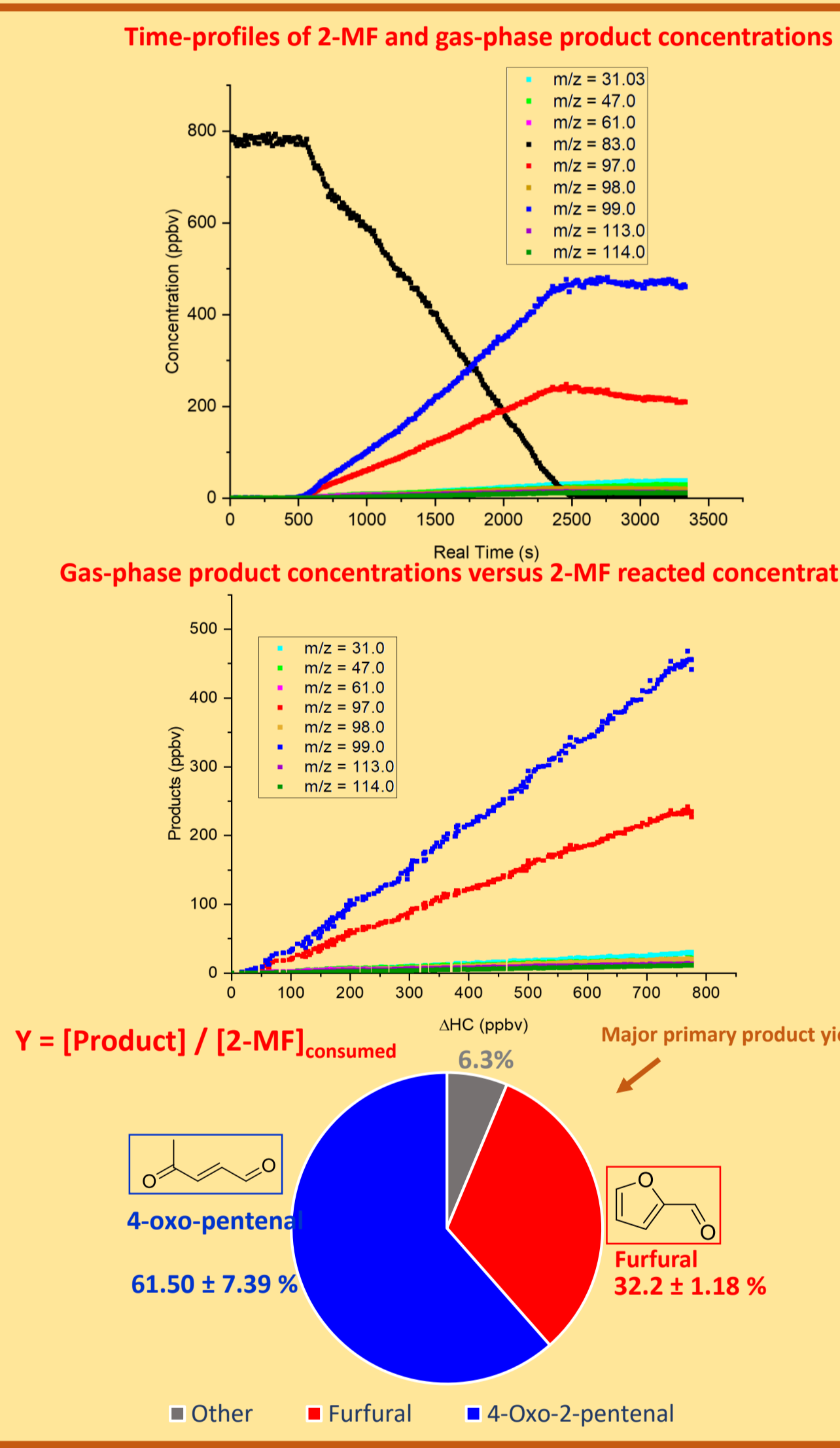
5) SOA composition for 2-MF reaction



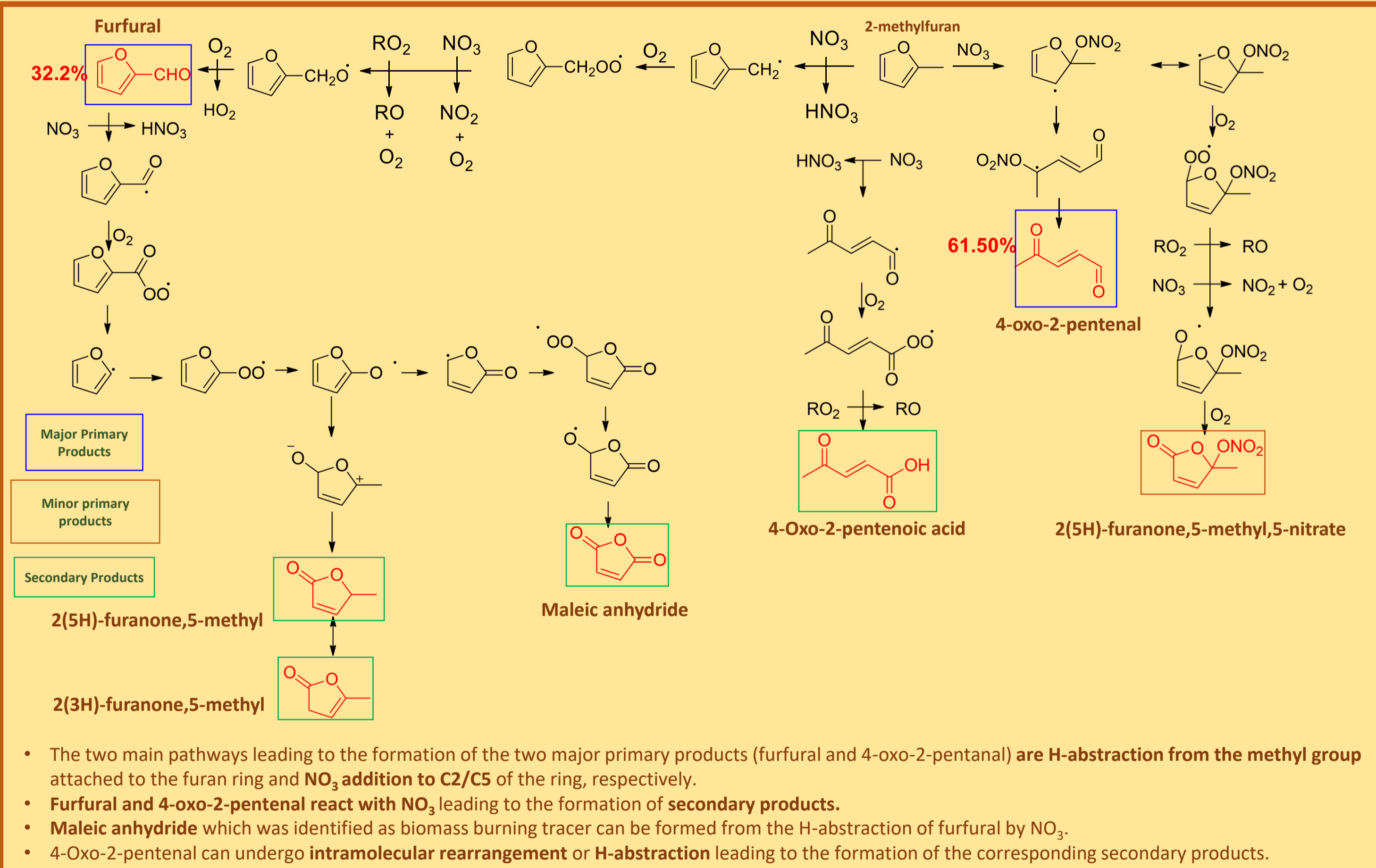
2) Gaseous Product identification for the reaction of 2-methylfuran (2-MF) with NO₃



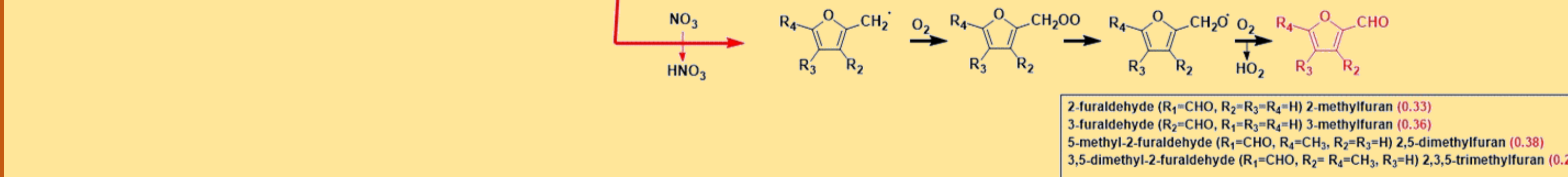
3) Yields of major primary gaseous products



6) Proposed mechanism for the gas-phase reaction of 2-MF with NO₃



7) General reaction mechanism for the reaction of furan compounds with NO₃



Odum et al., (1996) 'Gas/Particle Partitioning and Secondary Organic Aerosol Yields', Environ. Sci. Technol. 30, 8, 2580-2585
Bruns, E.A. et al., 'Characterization of gas-phase organics using proton transfer reaction time-of-flight mass spectrometry: fresh and aged residential wood combustion emissions', Atmos. Chem. Phys. 17, 705-720
Berndt, T. et al., (1997) 'Products of the gas-phase reactions of NO₃ radicals with furan and tetramethylfuran', Environ. Sci. Technol. 31(4), pp. 1157-1162
Wernke et al. (2011) 'VOC identification and inter-comparison from laboratory biomass burning using PTR-MS and PTR-TOF', Intern. J. Mass Spec., 303, 6-24
Stockwell et al. (2015) 'Characterization of biomass burning emissions from cooking fires, peat, crop residue, and other fuels with high-resolution proton-transfer-reaction time-of-flight mass spectrometry', Atmos. Chem. Phys. 15, 845-865

Acknowledgement

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