

Drivers of ozone pollution in Europe

Mariano Mertens^{1*}, Astrid Kerckweg², Volker Grewe¹, Patrick Jöckel¹

¹ Institute for Atmospheric Physics, DLR, Oberpfaffenhofen, Germany

² Meteorological Institute, University Bonn, Germany

COSMO User Seminar 2017

* Mariano.Mertens@dlr.de

Wissen für Morgen



Why does ozone pollution matter?

Ozone is ...

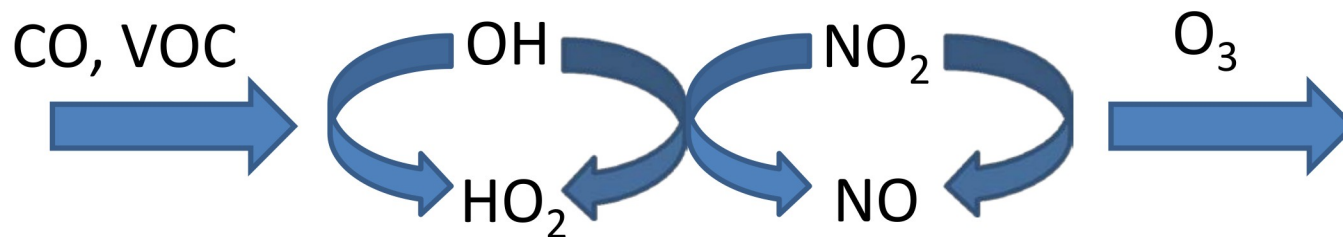
- a strong oxidant (harmful humans and plants)
- a greenhouse gas
- an important source for OH

Ozone lifetime:

- a few hours (urban boundary layer)
- a few weeks (free troposphere)



How is ozone formed in the troposphere?

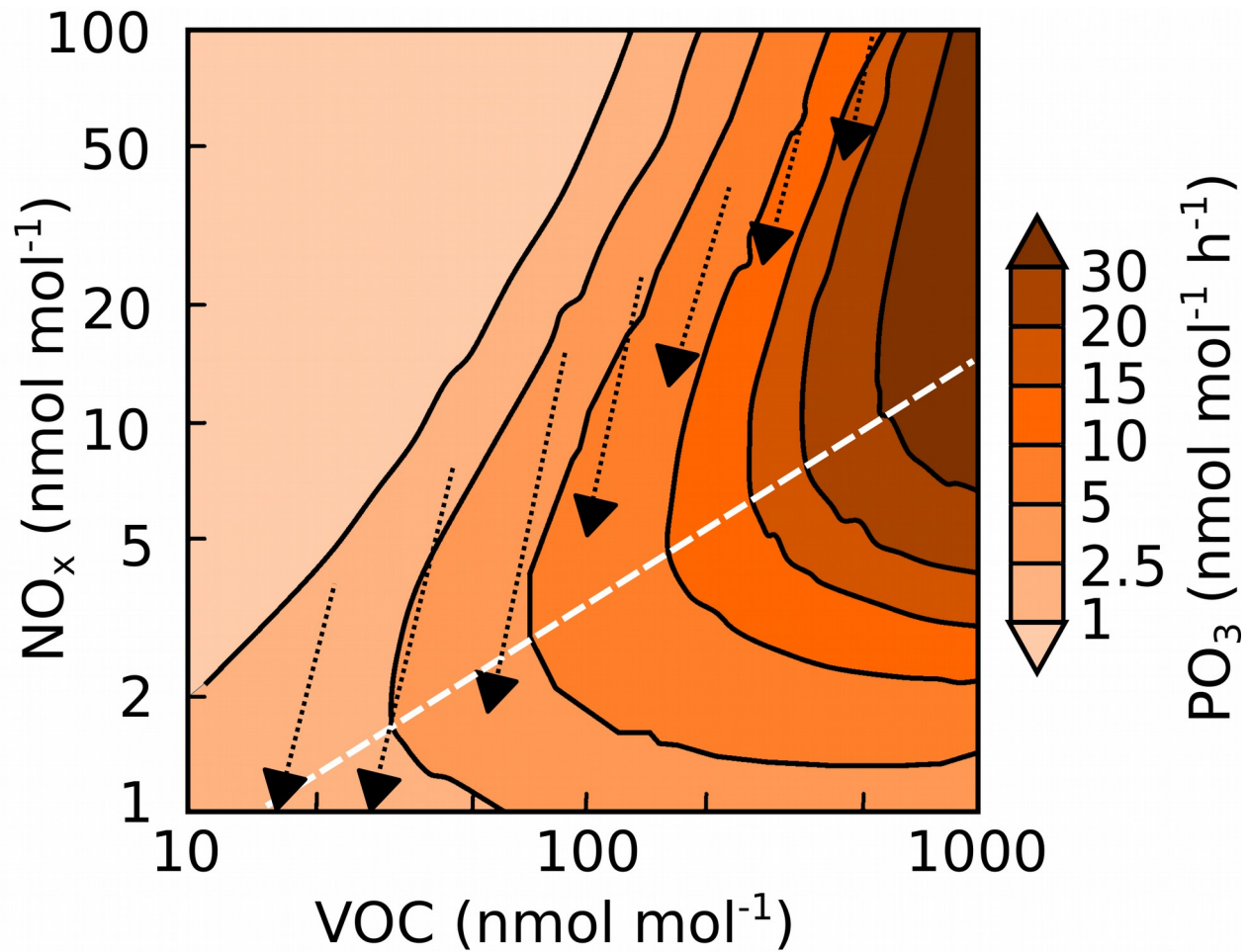


biogenic
solvent use
road traffic
combustion

road traffic
combustion
lightning
soil

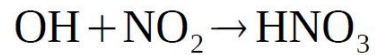
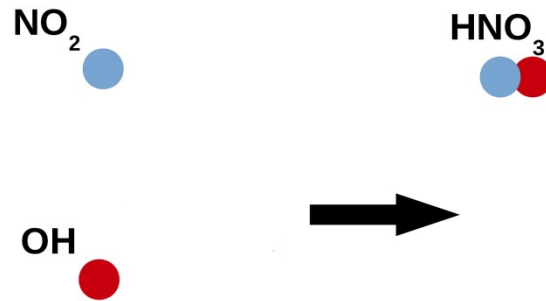


Ozone production is non-linear



Estimating contributions: TAGGING Method

Example: HNO_3



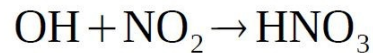
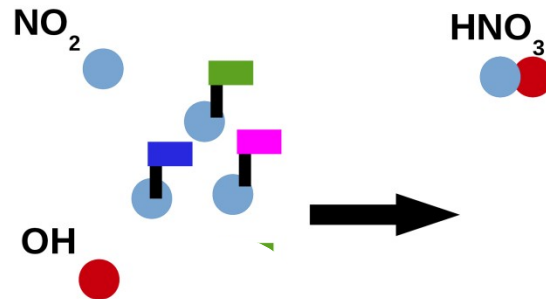
$$\frac{\partial \text{HNO}_3}{\partial t} = \kappa \text{OH} \cdot \text{NO}_2 = P_{\text{HNO}_3}$$

Grewe 2013
Tsati 2014
Grewe et al. 2017



Estimating contributions: TAGGING Method

Example: HNO_3 category j (e.g., $j = \text{road traffic or shipping}$)



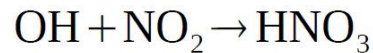
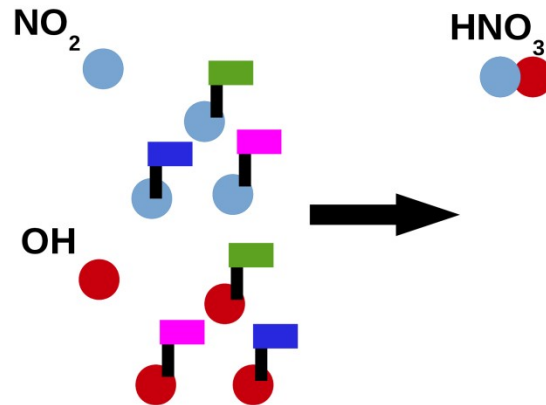
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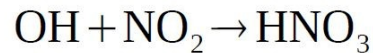
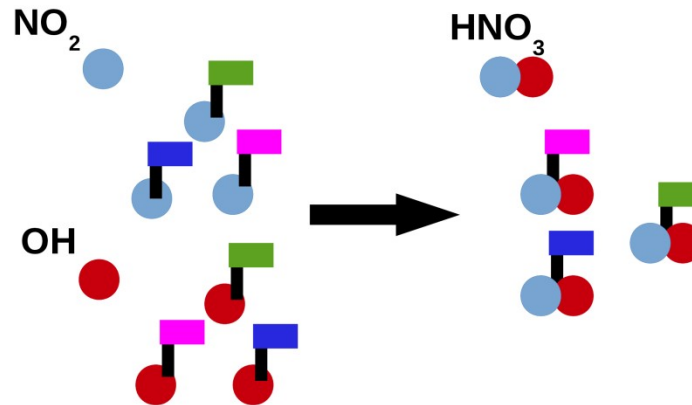
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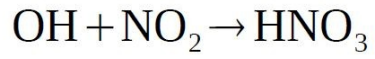
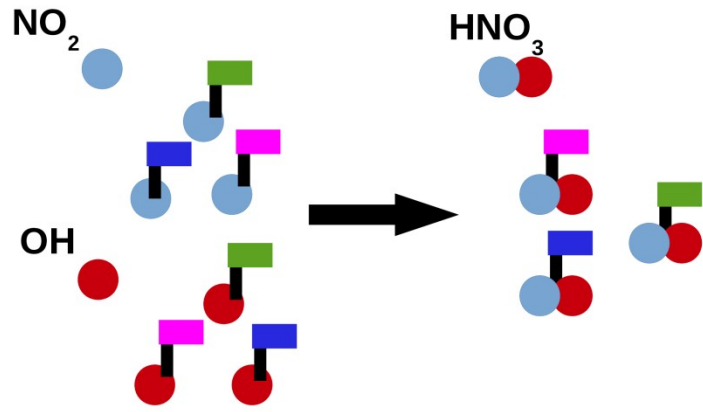
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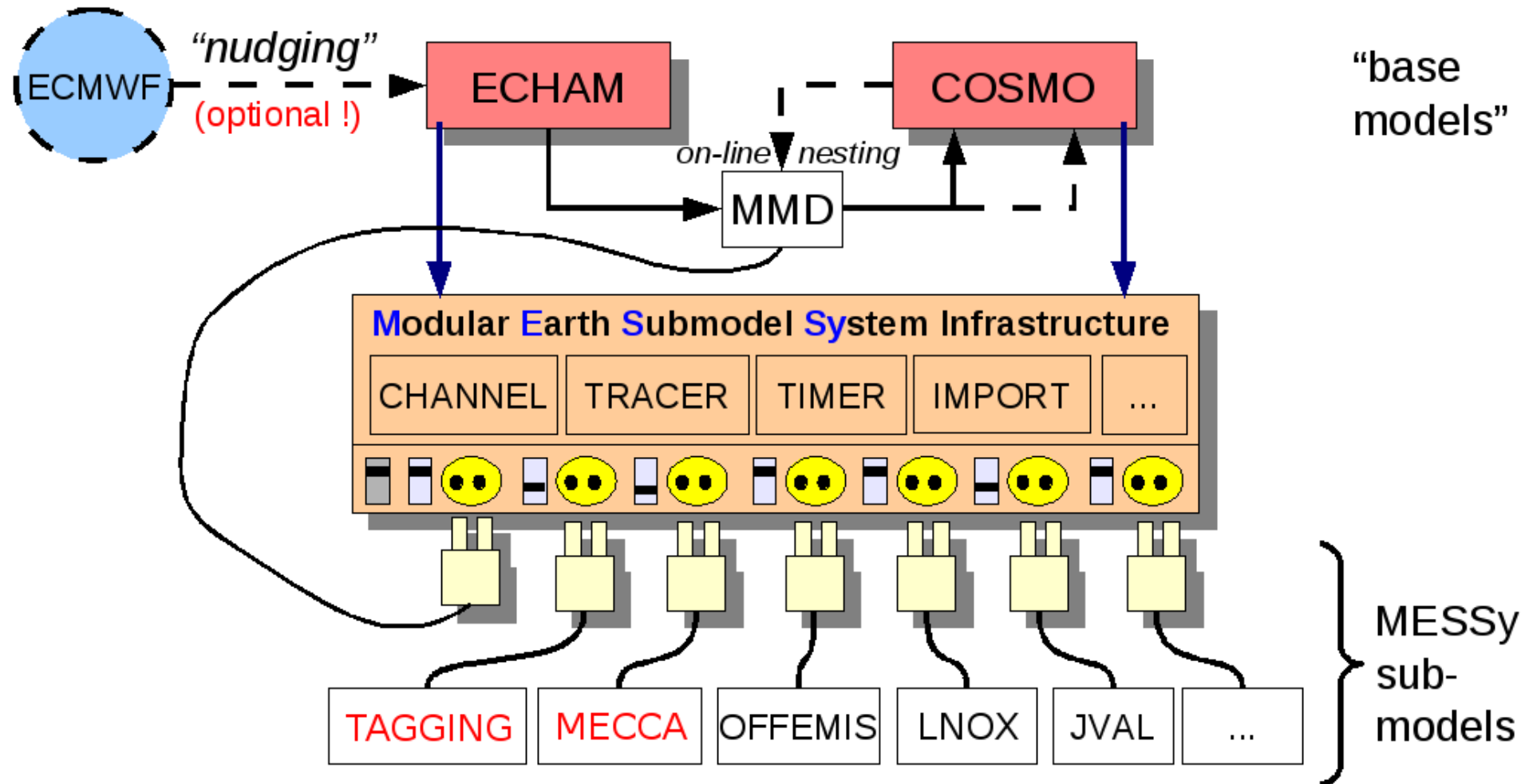
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$$\frac{\partial \text{HNO}_3^j}{\partial t} = \frac{1}{2} P_{\text{HNO}_3} \left(\frac{\text{OH}^j}{\text{OH}} + \frac{\text{NO}_2^j}{\text{NO}_2} \right)$$

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MECO(n) model system

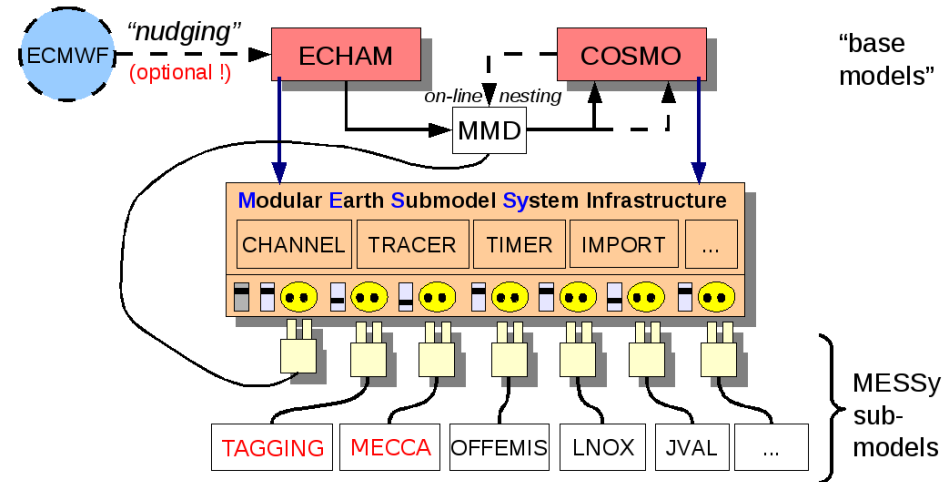
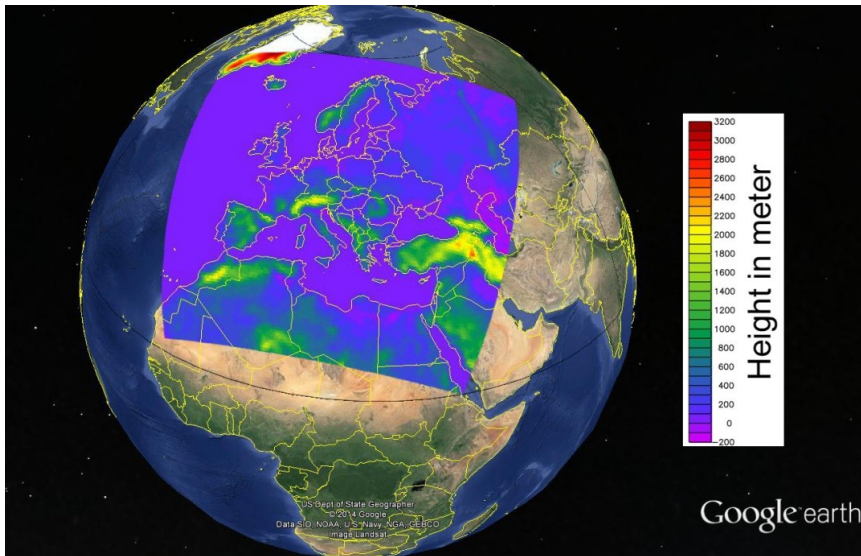


Kerkweg & Jöckel, 2012

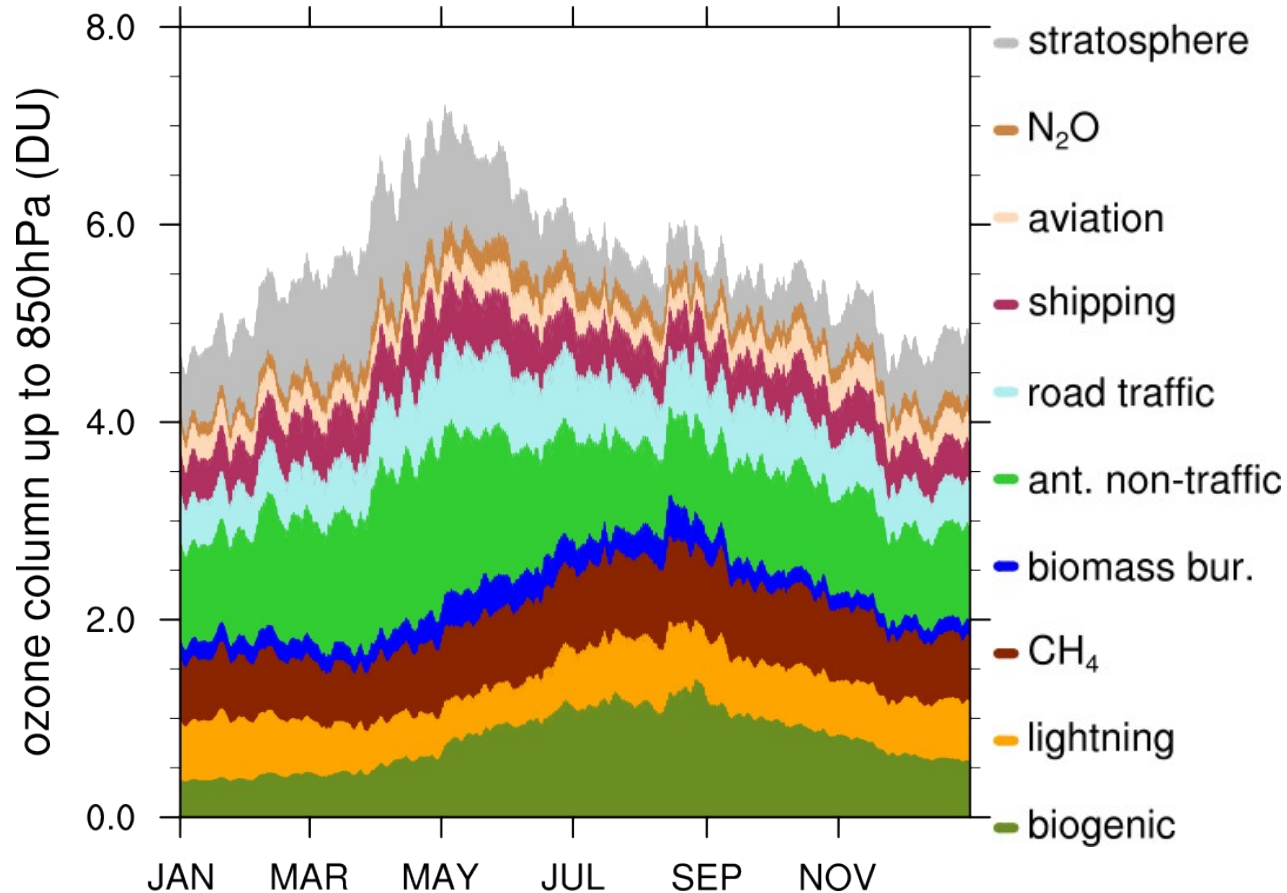
MECO(n) model system

- MECO(1)
 - Global: EMAC ~280 km resolution
 - “Nudged” against ERA-Interim reanalysis data (2008)
 - Nest 1: COSMO/MESSy ~ 50 km resolution (Europe)

- Chemically evaluated (Mertens et al. 2016, GMD)
- Anthropogenic emissions based on MACCity (Granier et al. 2011)



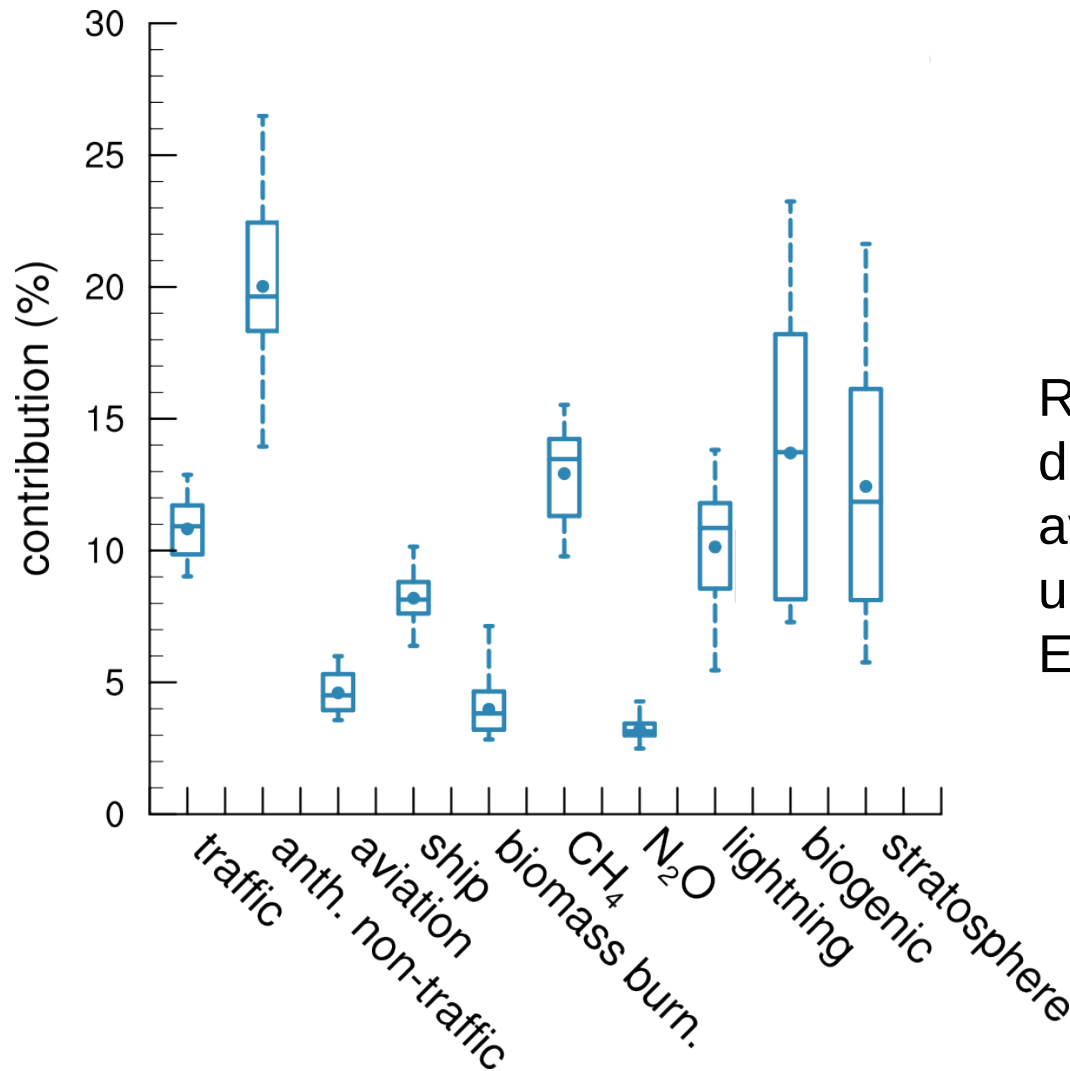
Contributions to ozone in Europe



Absolute contributions of different source to average ozone column up to 850 hPa over Europe (2008).



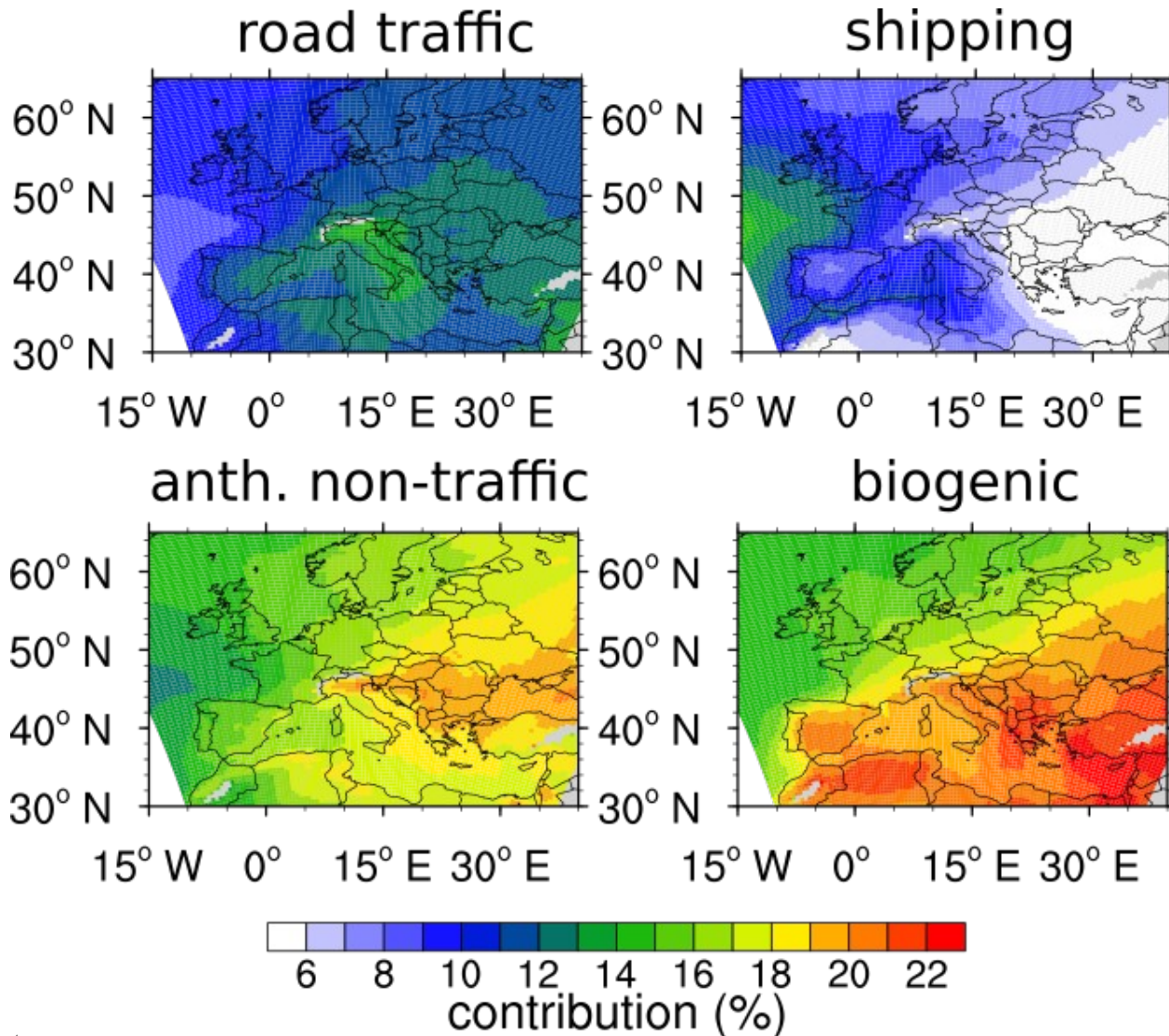
Contributions to ozone in Europe



Relative contributions of different source to average ozone column up to 850 hPa over Europe (2008).



Contribution of different sources



JJA average contributions to ozone column up to 850 hPa.



Summary

- TAGGING diagnostic allows us to quantify the contribution of different sectors to the tagged species (e.g. ozone, carbon monoxide etc.)
- Besides stratospheric ozone and ozone due to methane oxidation three sources are most importance in Europe:
 - Biogenic (especially soil NO_x)
 - Anthropogenic non-traffic
 - Road traffic



Outlook

The German Federal Ministry of Education and Research (BMBF) funds further MESSy application, development and support within the framework of the

BMBF project CMIP6-Chemie





FONA

Forschung für Nachhaltige
Entwicklung

BMBF

01 July 2016 – 30 June 2020

BMBF CMIP6

Verbund 1
“DICAD”

Verbund 2
“Chemie”





BMBF CMIP6⁺

Verbund 1
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Verbund 2
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TeilProjekt 1
CMIP6 simulations
with EMAC:
DECK/hist.
AerChemMIP

1 py / y @ DLR



BMBF CMIP6⁺

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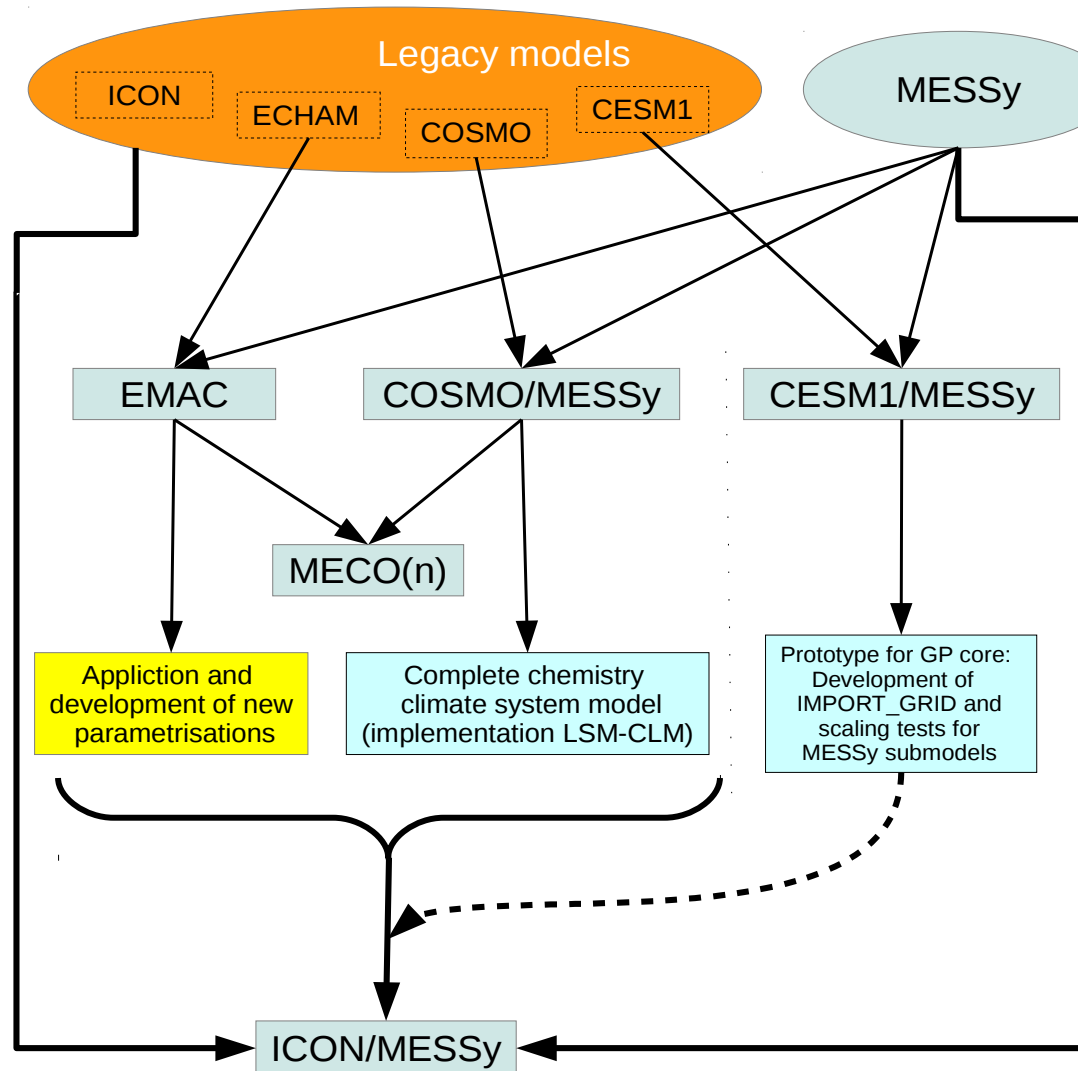
TeilProjekt 2
ICON/MESSy development
& MESSy-Consortium
Coordination / Community
support

1.5 py / y @ Uni Bonn





CMIP6-Chemie: Model development:





FONA

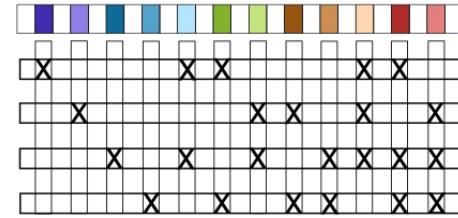
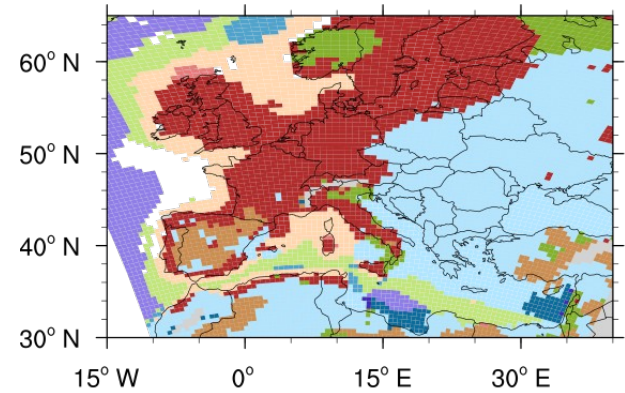
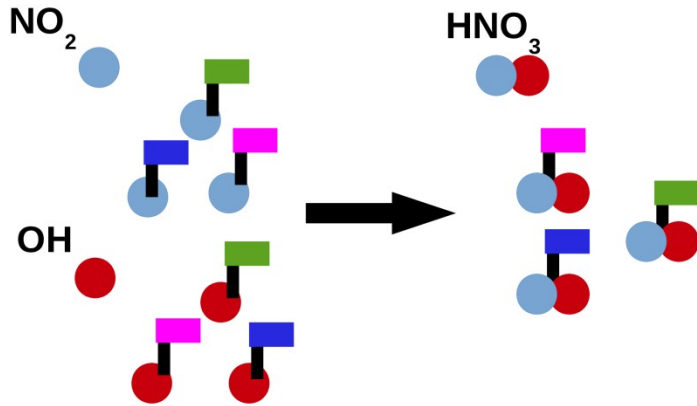
Forschung für Nachhaltige
Entwicklung

BMBF

Support of MESSy Community

- code version maintenance
- meeting organisation
- web site
- ...





anth. non-tra.
shipping
biogenic
road traffic

Thanks for your attention!



MAX-PLANCK-INSTITUT
FÜR CHEMIE

