emep

Co–operative programme for monitoring and evaluation of the long–range transmissions of air pollutants in Europe

Norwegian Meteorological Institute

LRTAP
Long-range Transboundary Air Pollution

EMEP/MSC-W activities 2017/2018

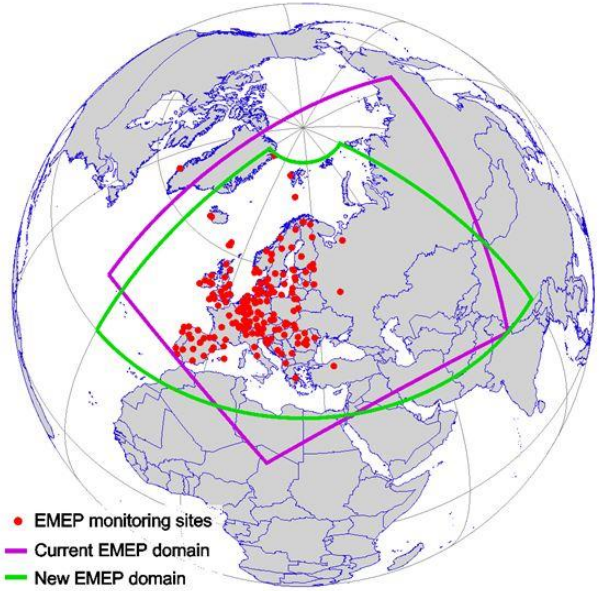
H. Fagerli and co-workers at MSC-W

4th joint session to EMEP Steering Body and WGE 10-14th September 2018

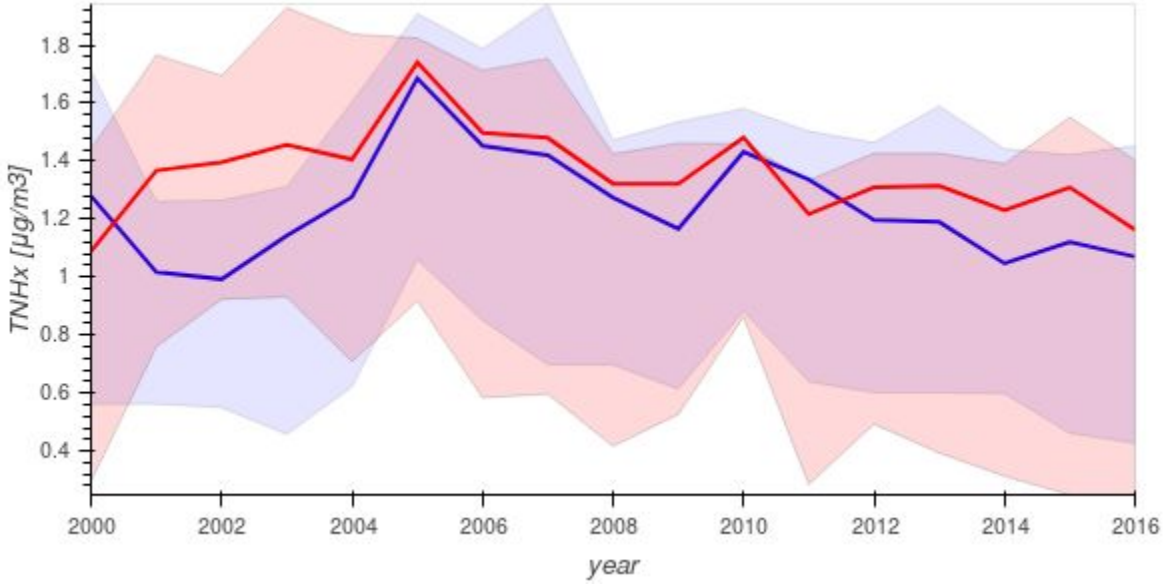
Overview

- **Reporting model runs and analysis**
  - Countries that reported in 0.1x0.1 for the first time
  - Status and episode analysis (complementary to CAMS)
  - **Modelled timeseries 2000-2016(17) and the new trend interface**
  - **SR in different resolutions**
- The effects of international shipping
- Cooperation with WGE
- Plans: Uncertainties in SR due to SOA

Consistent modelled concentration and deposition data for 2000-2016 (17)



- For countries to follow the development in their country
  - **Re-reported emissions by countries**
  - Finer resolution
  - Consistent model version/meteorology
  - Presented in country reports
    - Also comparison to AirBase data for individual countries



EMEP Trend Interface
http://aerocom.met.no/trends/EMEP/

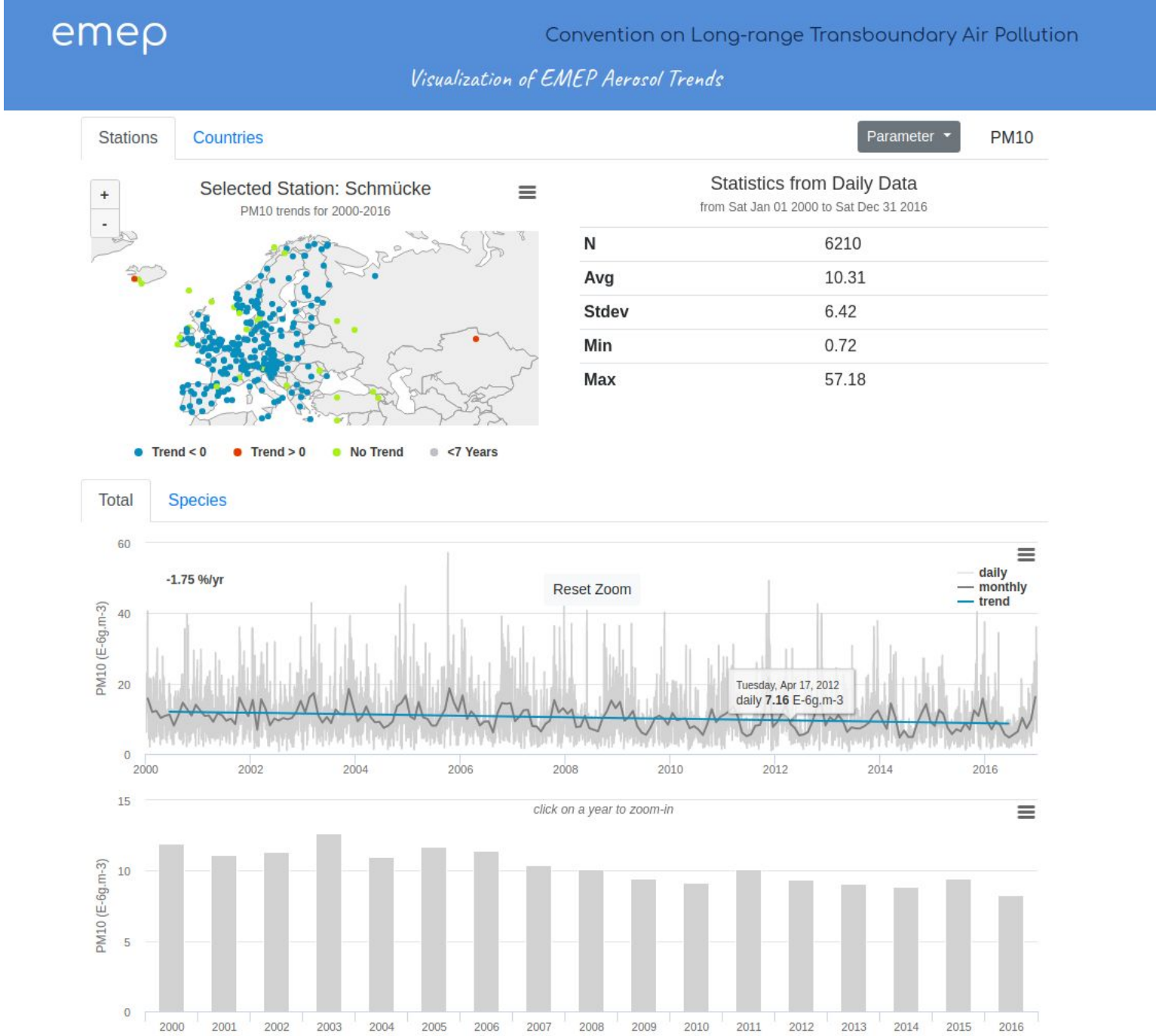
- Build on interface developed for ACTRIS

http://aerocom.met.no/trends/EMEP/

Frontpage

-choose parameter (only PM_{10} now)

- trends marked
- analyze sites or countries
- zoom on a period

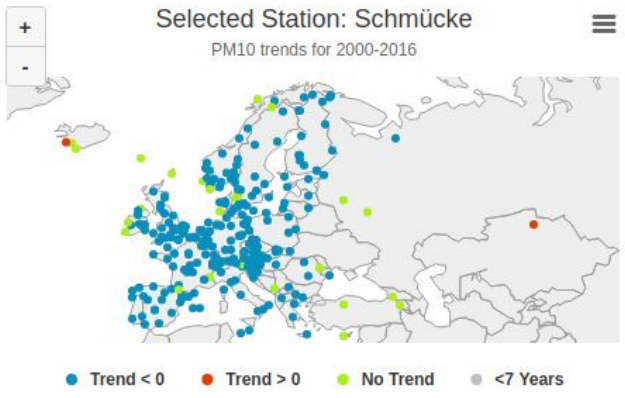


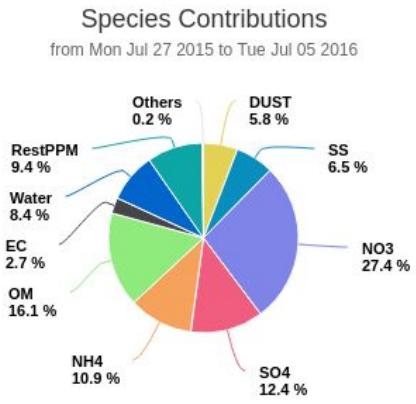
emep

Convention on Long-range Transboundary Air Pollution

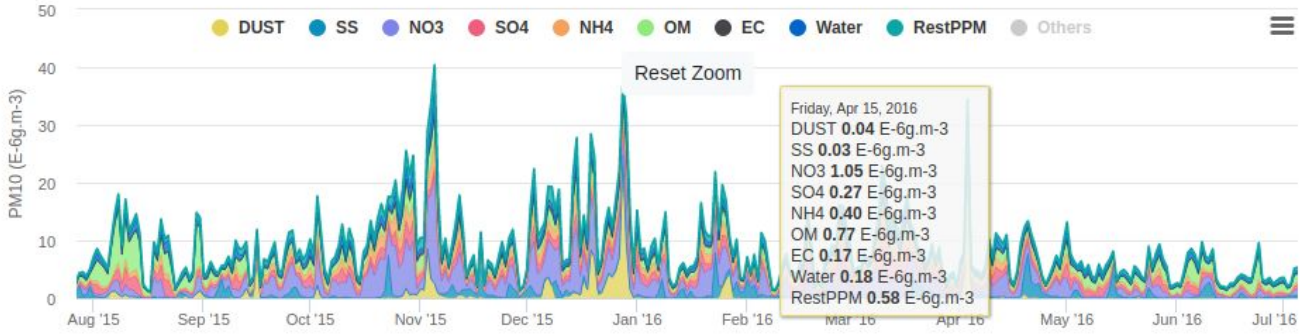
Visualization of EMEP Aerosol Trends

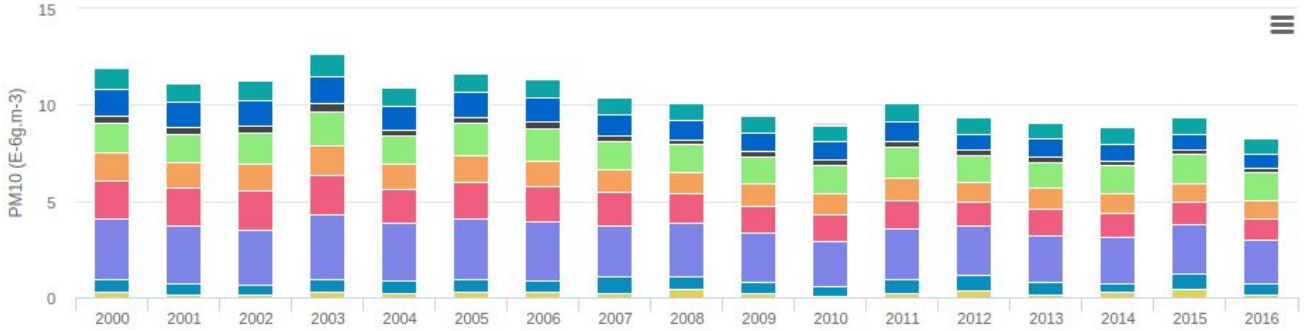
Stations | Countries | Parameter | PM10





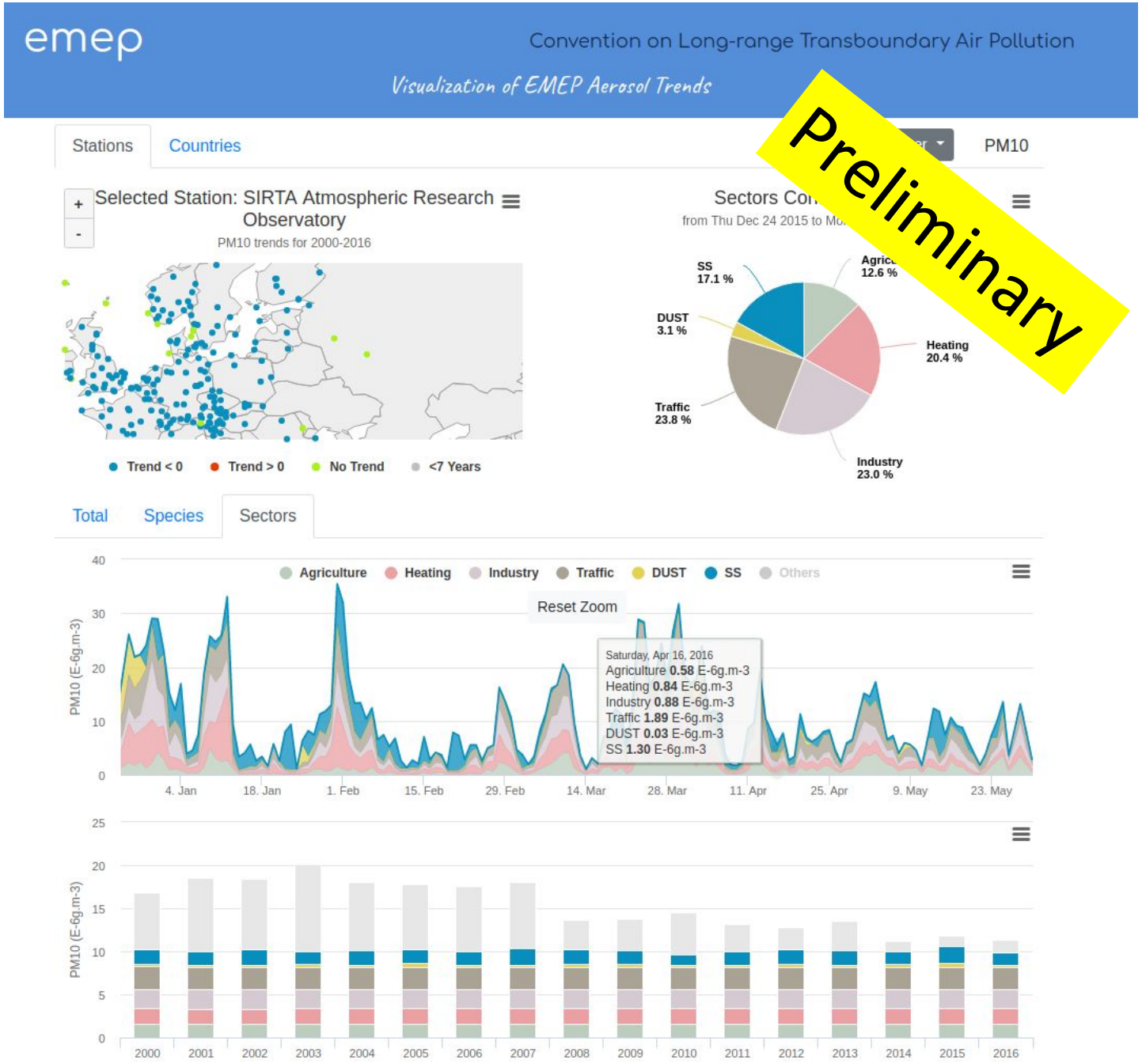
Total | Species





Future:

- Other parameters
- Sector contributions 2000-2016
- Include observations
- Country contributions?

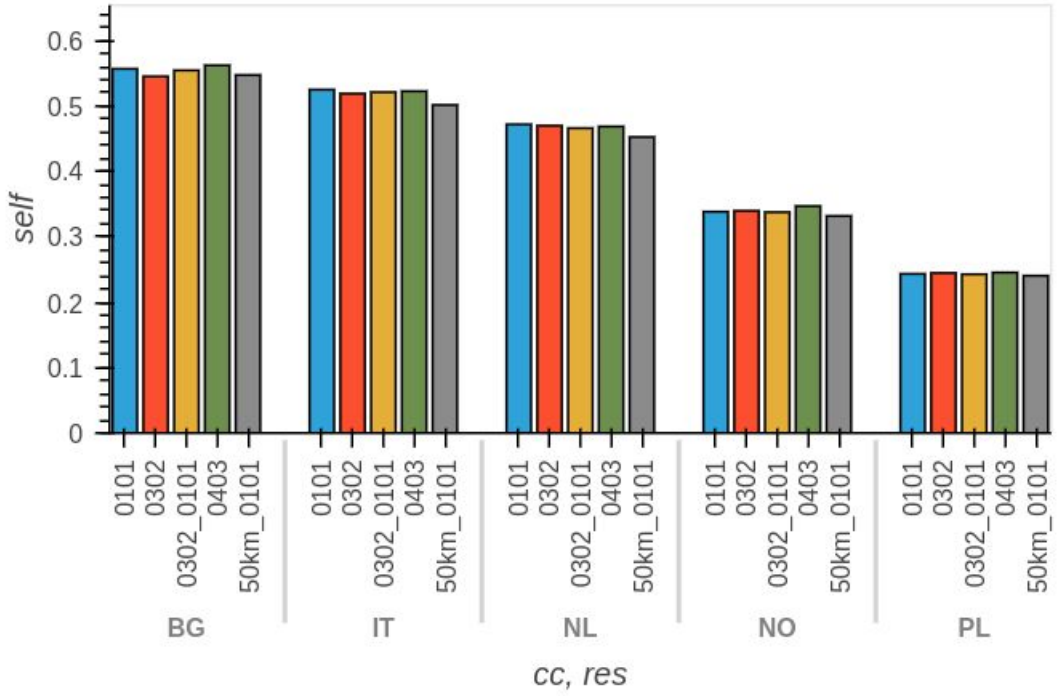


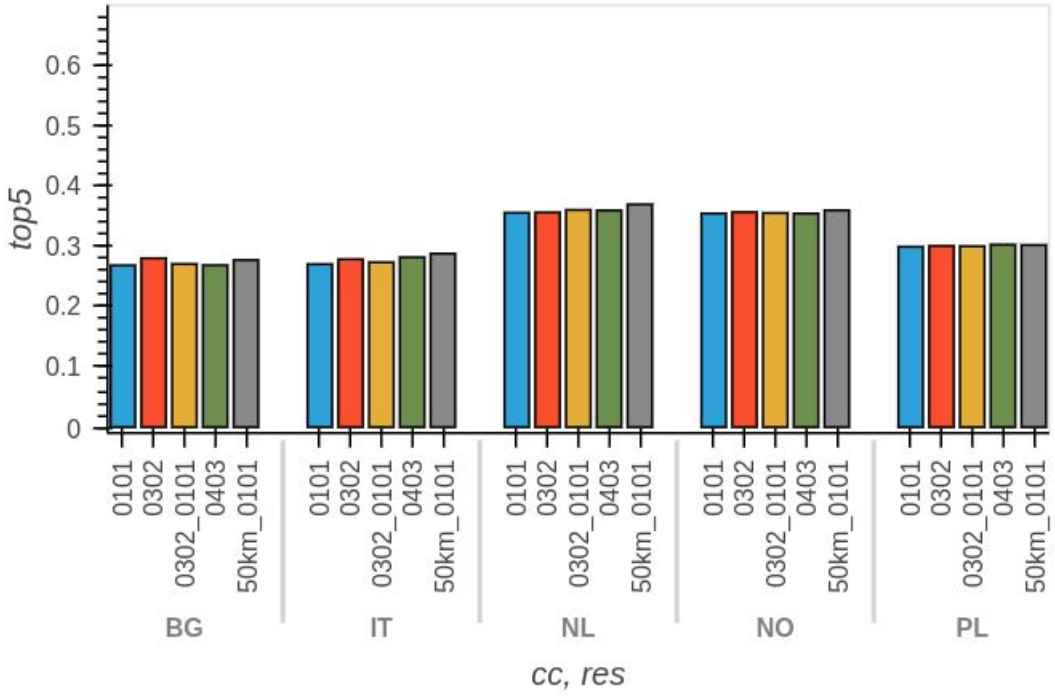
Source-receptor (SR) calculations in the new EMEP grid

- For the first time, reported emissions in 0.1°x 0.1° are used in SR
- Different resolutions (0.4°x 0.3° 0.3°x 0.2° and 0.1°x 0.1°) tested for 5 countries: BG, IT, NL, NO, PL – which resolution should be used operationally?
- New, more detailed, country border data. How does it affect results?

- *Changes wrt old SR also due to improved model version, updated emissions (especially 'expert estimates' for EECCA countries have changed)*

$PM_{2.5}$: Relative contribution from the country to itself and to the top5 receptors





Self

Top 5

Choice of SR resolution

- Overall difference for depositions within a few percent, larger for ozone and PM (up to 11% for country-to-itself)
- Differences in individual transboundary contributions can be larger, especially when pollution is transported across mountain areas and/or is small
- The differences caused by using an improved country border data set is as large as differences due to different resolutions

→ **SR in 0.3°x 0.2°, as these results are closer to 0.1°x 0.1°**

Effect of international shipping on European ozone

- Paper focused on Europe based on HTAP2:

The effects of intercontinental emission sources on European air pollution levels. Jonson et al., accepted

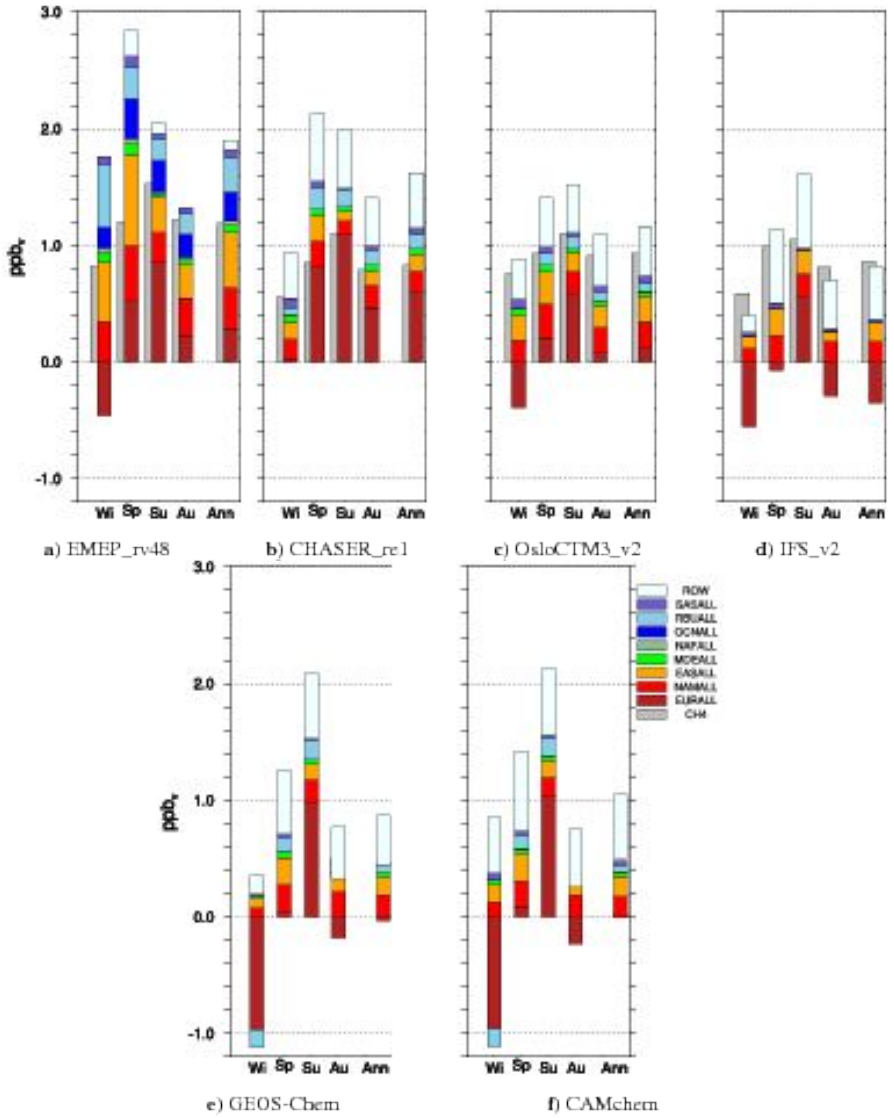
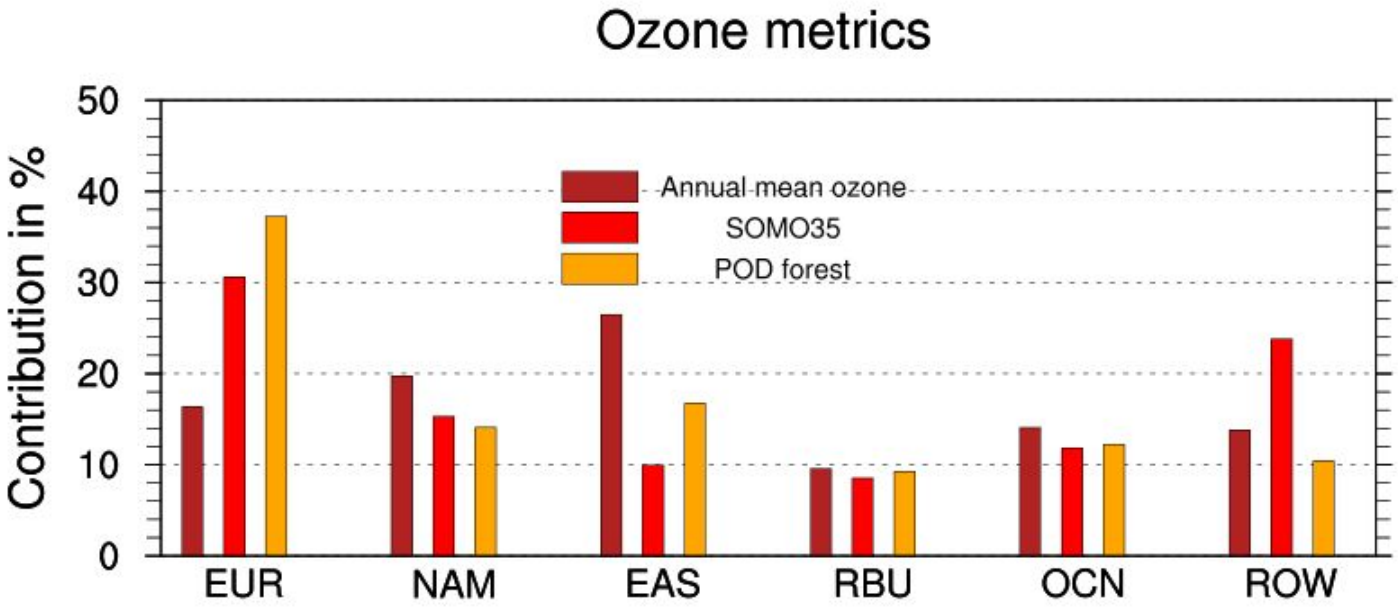


Figure 5. Contributions to European ozone levels (in ppb) from different world regions. (WI is December, January, February. SP is March, April, May. SU is June, July, August. AU is September, October, November). Note that the separate contribution from North Africa (NAFALL) and ocean shipping (OCNALL) is only included in the EMEP_rv48 model calculations. The Middle East (MDEALL) and Russia, Belarus and Ukraine (RBUALL) is not included in the IFS_v2 model. For all models contributions from missing regions are included as ROW (rest of the world). Note that the areas included in ROW is model dependant. For the four top row models the effects of a 20% increase in CH_4 is shown as a separate bar.

- Why is shipping more important in the HTAP2 calculations than in our regional calculations?
  - Choice of indicator (mean ozone, POD, SOMO35)
  - Importance of ship emissions outside the EMEP domain
  - Scale

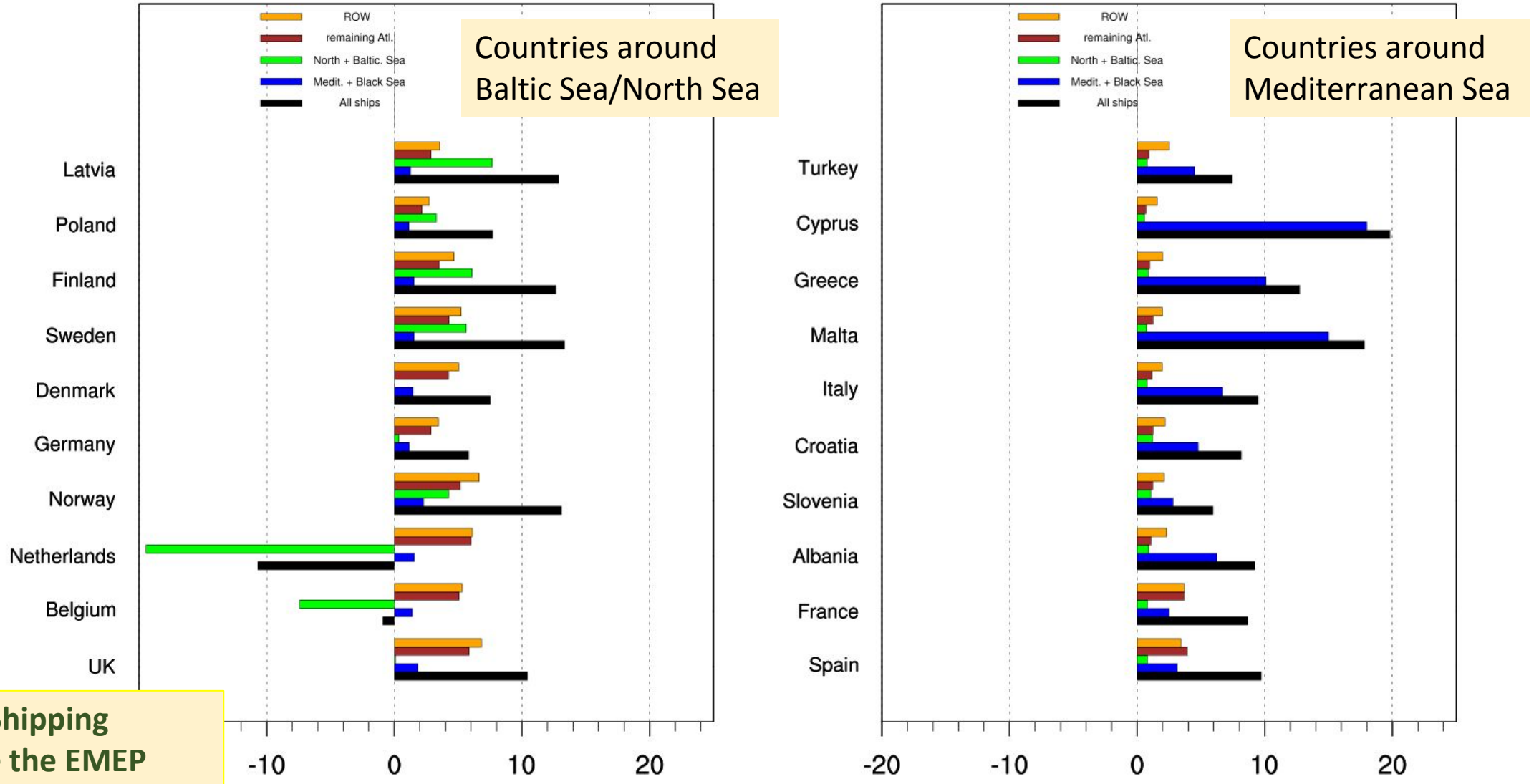
Choice of ozone metric is important…

- …but did not matter much for the total effect of international ship emissions. But the Europe-to-Europe effect is larger with POD/SOMO35



Shipping

How does ship emissions in different areas, and especially outside the EMEP domain, affect European ozone? SOMO35



ROW=Shipping outside the EMEP area is important!

Percentage contribution compared to all global antropogenic emissions

Summary

- Choice of ozone metrics important; POD and SOMO35 put a larger weight on European emissions
- Ship emissions outside the EMEP domain are important

Cooperation with ICP Vegetation

- global scale summaries of ozone metrics and impacts on crops (EMEP/MSC-W model used to provide Phyto-toxic Ozone Dose, POD)

Global Change Biology

PRIMARY RESEARCH ARTICLE

Ozone pollution will compromise efforts to increase global wheat production

Gina Mills, Katrina Sharps, David Simpson, Håkan Pleijel, Malin Broberg, Johan Uddling, Fernando Jaramillo, William J Davies, Frank Dentener, Maurits Van den Berg, Madhoolika Agrawal, Shahibhushan B. Agrawal, Elizabeth A. Ainsworth, Patrick Büker, Lisa Emberson, Zhaozhong Feng, Harry Harmens, Felicity Hayes, Kazuhiko Kobayashi, Elena Paoletti, Rita Van Dingenen,
... See fewer authors

First published: 31 March 2018 | https://doi.org/10.1111/gcb.14157 | Cited by: 3

[Copyright line corrected after first online publication on 3rd September 2018].

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Abstract

Introduction of high-performing crop cultivars and crop/soil water management practice that increase the stomatal uptake of carbon dioxide and photosynthesis will be instrumental in realizing the United Nations Sustainable Development Goal (SDG) of achieving food security. To date, however, global assessments of how to increase crop yield have failed to consider the negative effects of tropospheric ozone, a gaseous pollutant that enters the leaf stomatal pores of plants along with carbon dioxide, and is increasing in concentration globally, particularly in rapidly developing countries. Earlier

PRIMARY RESEARCH ARTICLE

WILEY Global Change Biology

Closing the global ozone yield gap: Quantification and cobenefits for multistress tolerance

Gina Mills[1,2] | Katrina Sharps[1] | David Simpson[3,4] | Håkan Pleijel[2] | Michael Frei[5] | Kent Burkey[6] | Lisa Emberson[7] | Johan Uddling[2] | Malin Broberg[2] | Zhaozhong Feng[8] | Kazuhiko Kobayashi[9] | Madhoolika Agrawal[10]

[1]Centre for Ecology and Hydrology, Bangor, UK
[2]Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden
[3]EMEP MSC-W, Norwegian Meteorological Institute, Oslo, Norway
[4]Department of Space, Earth & Environment, Chalmers University of

Abstract

Increasing both crop productivity and the tolerance of crops to abiotic and biotic stresses is a major challenge for global food security in our rapidly changing climate. For the first time, we show how the spatial variation and severity of tropospheric ozone effects on yield compare with effects of other stresses on a global scale, and discuss mitigating actions against the negative effects of ozone. We show that the

ELEMENTA Science of the Anthropocene

Reading: Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends... Share:

Research Article

Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation

Authors: Gina Mills, Håkan Pleijel, Christopher S. Malley, Baerbel Sinha, Owen R. Cooper, Martin G. Schultz, Howard S. Neufeld, David Simpson, Katrina Sharps, Zhaozhong Feng, Giacomo Gerosa, Harry Harmens, Kazuhiko Kobayashi, Pallavi Saxena, Elena Paoletti, Vinayak Sinha, Xiaobin Xu

Abstract

This Tropospheric Ozone Assessment Report (TOAR) on the current state of knowledge of ozone metrics of relevance to vegetation (*TOAR-Vegetation*) reports on present-day global distribution of ozone at over 3300 vegetated sites and the long-term trends at nearly 1200 sites. *TOAR-Vegetation* focusses on three metrics over vegetation-relevant time-periods

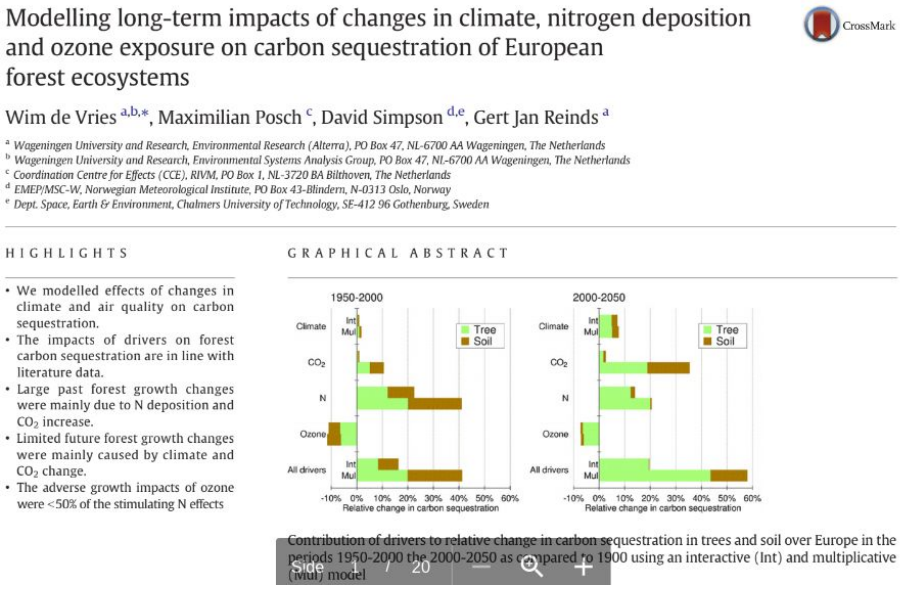
http://ec.europa.eu/jrc/en/science-update/global-wheat-yields-risk-due-ozone-pollution

https://www.ceh.ac.uk/press/new-research-could-help-farmers-mitigate-impact-ozone-pollution-crop-yields

https//cires.colorado.edu/news/plant-damaging-ozone-pollution-highest-east-asia-declining-north-amer

Cooperation with ICP-Forests

- Spatial variation of modelled total, dry and wet deposition to forests at global scale. D. B. Schwede, D. Simpson, J. Tan, J. S. Fu, F. Dentener, E. Du and W. de Wries. In revision
- Assessment of ozone flux for Swiss Level II plots. (Schaub et al)
- Comparison of ICP-Forests dep and EMEP/MSC-W model (A. Marchetto)
- Continental-scale forest growth in Europe is driven by management and further modulated by nitrogen deposition. In prep. Etzold et al



Modelling long-term impacts of changes in climate, nitrogen deposition and ozone exposure on carbon sequestration of European forest ecosystems

Wim de Vries [a,b,*], Maximilian Posch [c], David Simpson [d,e], Gert Jan Reinds [a]

[a] Wageningen University and Research, Environmental Research (Alterra), PO Box 47, NL-6700 AA Wageningen, The Netherlands
[b] Wageningen University and Research, Environmental Systems Analysis Group, PO Box 47, NL-6700 AA Wageningen, The Netherlands
[c] Coordination Centre for Effects (CCE), RIVM, PO Box 1, NL-3720 BA Bilthoven, The Netherlands
[d] EMEP/MSC-W, Norwegian Meteorological Institute, PO Box 43-Blindern, N-0313 Oslo, Norway
[e] Dept. Space, Earth & Environment, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden

HIGHLIGHTS

- We modelled effects of changes in climate and air quality on carbon sequestration.
- The impacts of drivers on forest carbon sequestration are in line with literature data.
- Large past forest growth changes were mainly due to N deposition and CO_2 increase.
- Limited future forest growth changes were mainly caused by climate and CO_2 change.
- The adverse growth impacts of ozone were <50% of the stimulating N effects

GRAPHICAL ABSTRACT

Contribution of drivers to relative change in carbon sequestration in trees and soil over Europe in the periods 1950-2000 the 2000-2050 as compared to 1900 using an interactive (Int) and multiplicative (Mul) model

Plans

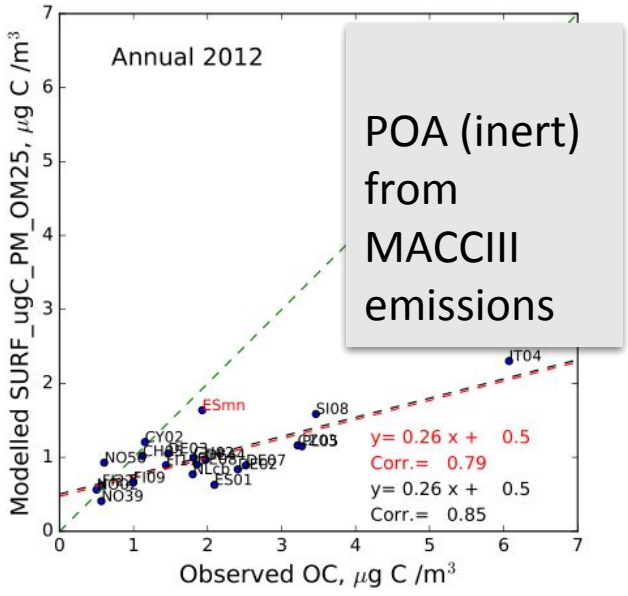
-**Uncertainty in SR due to SOA, incl ‘Condensables’**

-Bidirectional exchange of ammonia

++

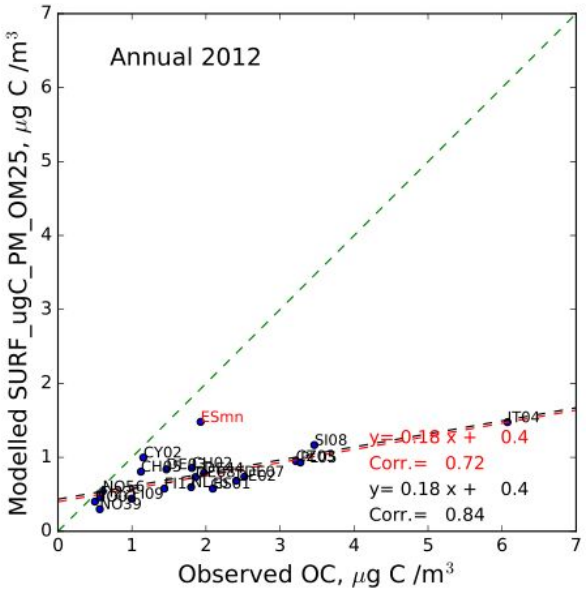
Impacts of uncertainties in SOA modelling for source-receptor matrices, progress

- Illustrate and quantify the likely uncertainties in the source receptor matrices for PM as a results of current knowledge and data gaps for SOA modelling
  - Summer: BVOC modelling
  - Winter: ‘Condensables’
- SR calculations with different model configurations and input data

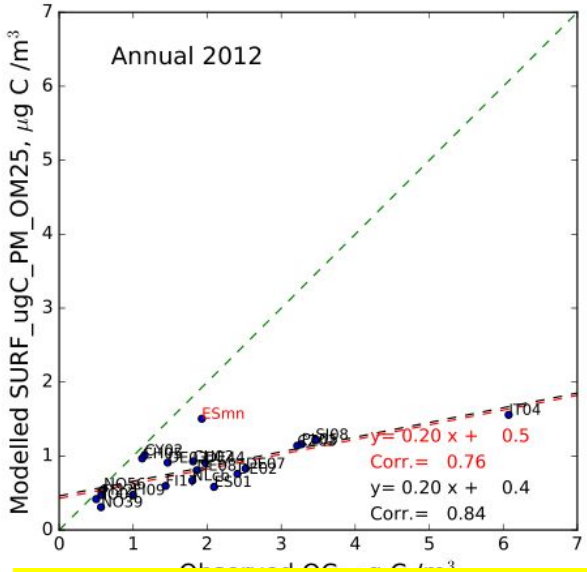


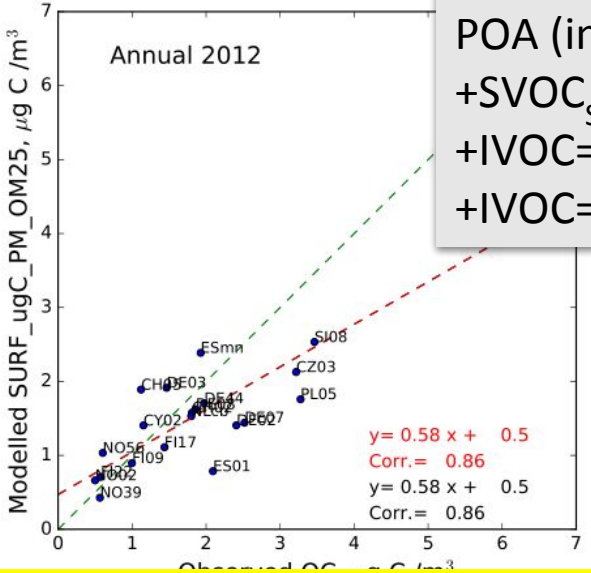
POA (inert) from MACCIII emissions

(a) Ref1, Inert POA



(b) Ref1, volatile POA



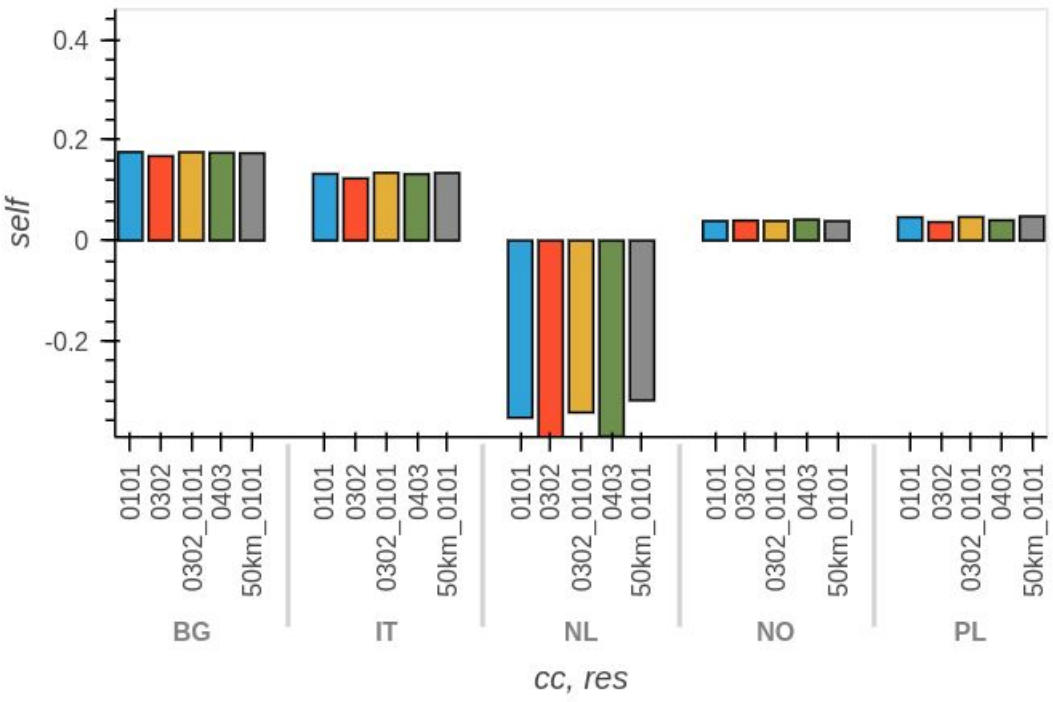


POA (inert)
+$SVOC_{SNAP2}$ (CAMS81)
+IVOC=3x$(POA+SVOC)_{SNAP2}$
+IVOC=0.25x$NMVOC_{SNAP7}$

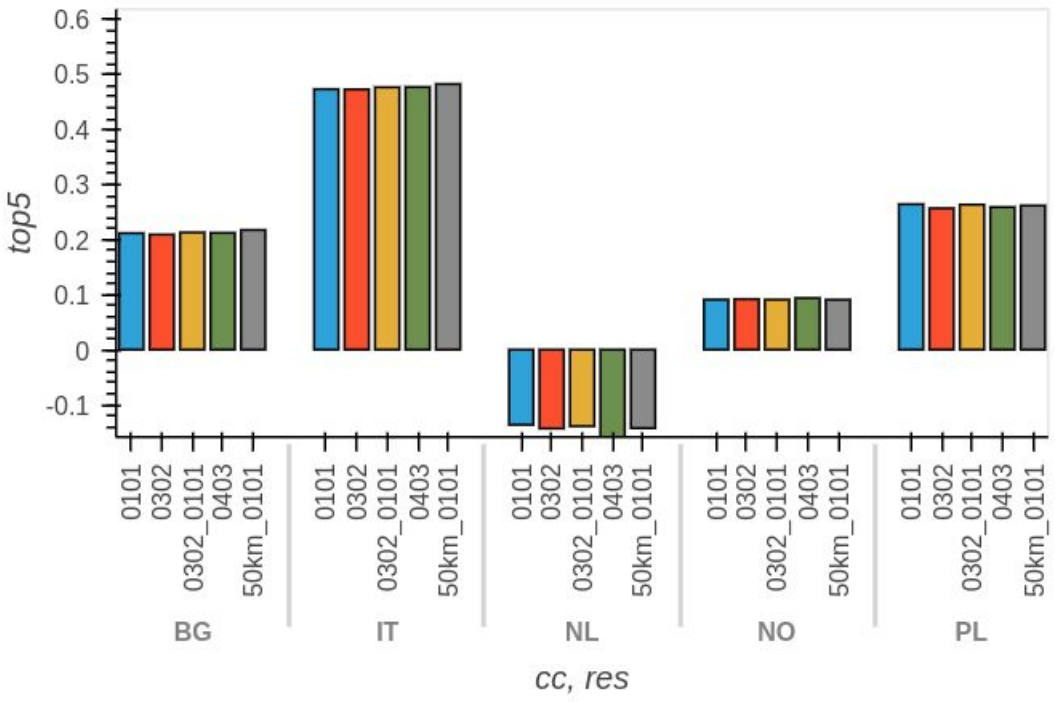
Fairly good agreement to OC observations when introducing SVOC and IVOC pluss SOA chemistry

The End

Yearly average of daily max O_3: Contribution from the country to itself and to the top5 receptors due to NO_x (ppb per 15% reduction)

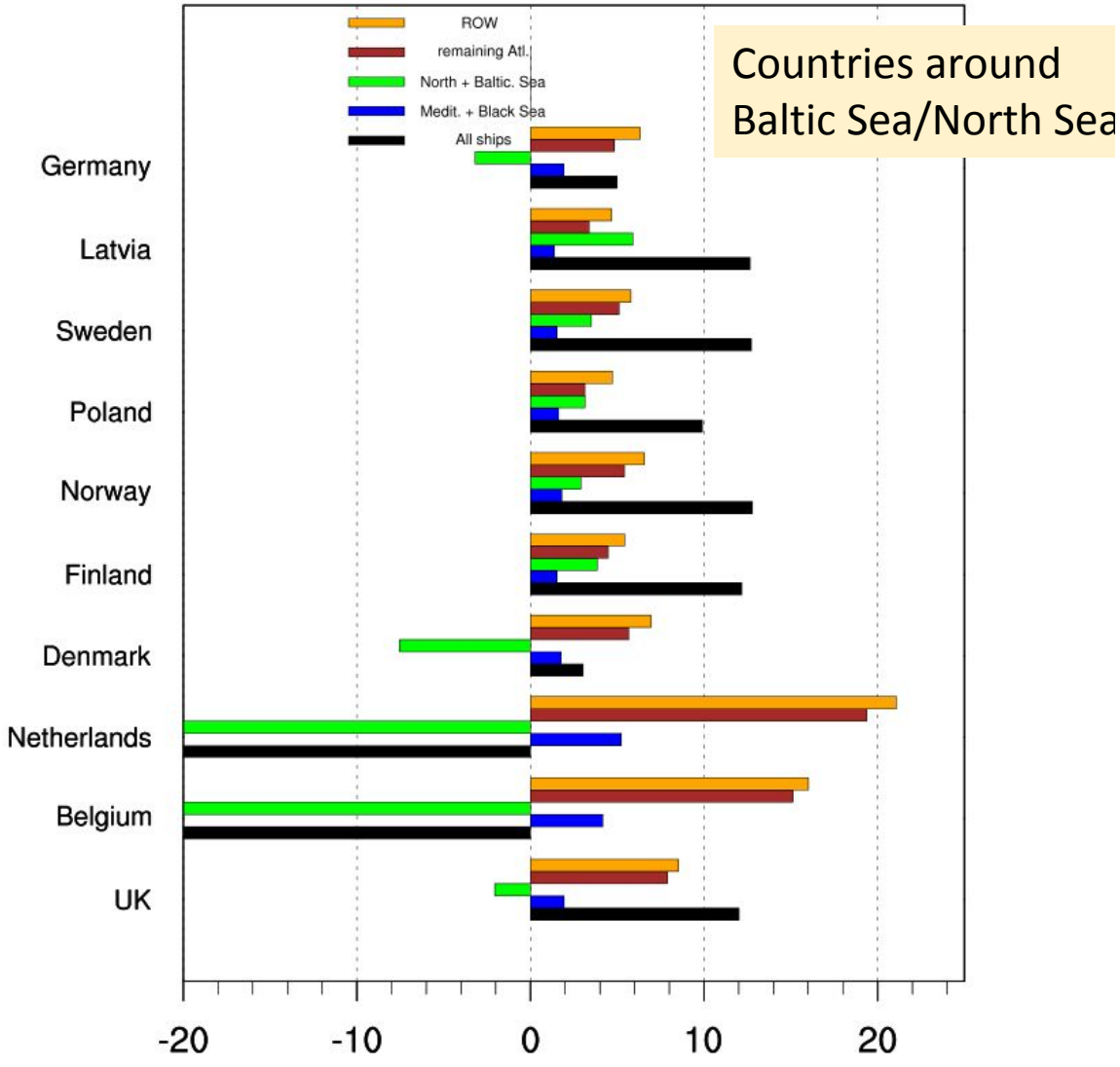


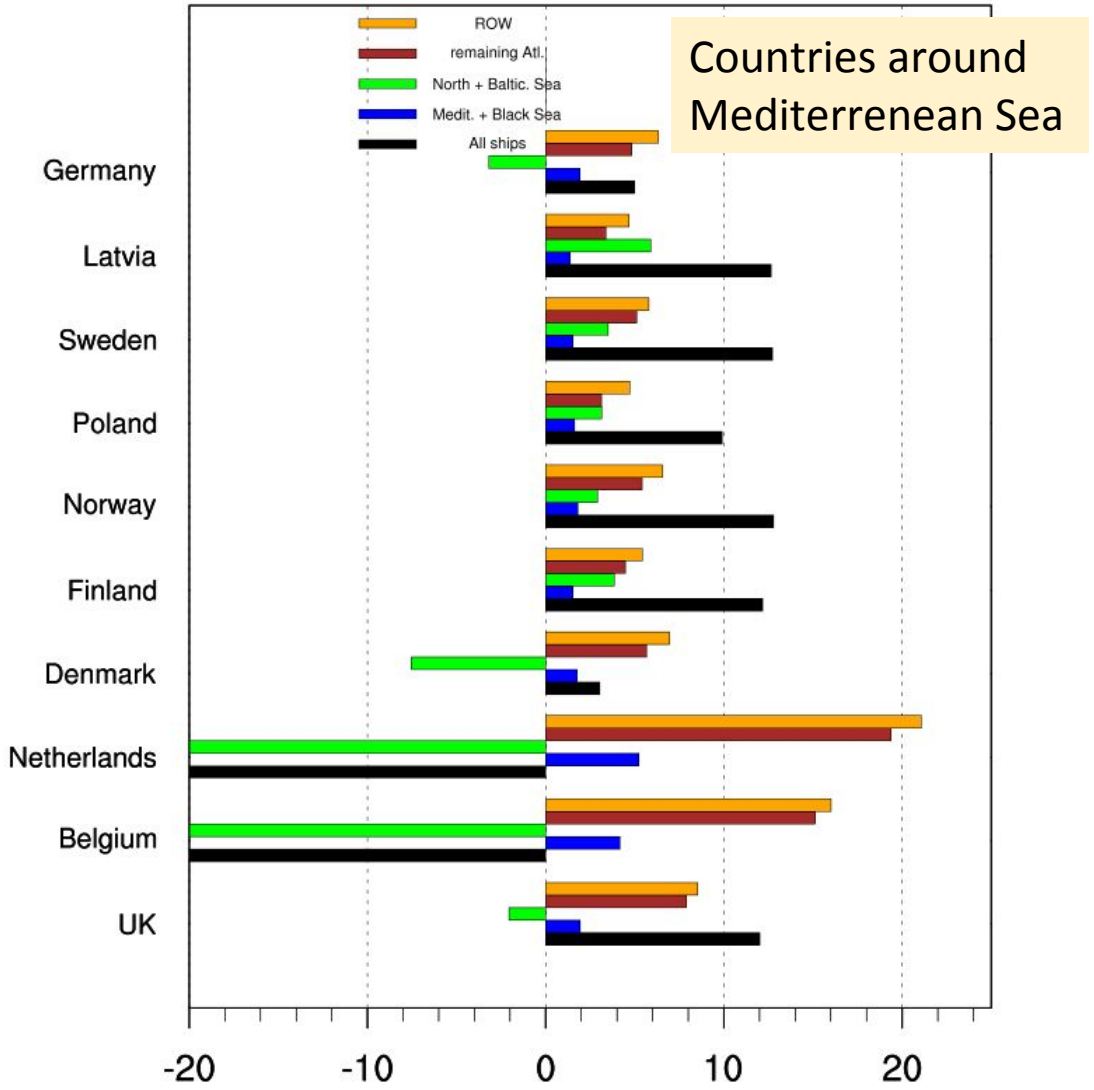
Self



Top 5

How does ship emissions in different areas, and especially outside the EMEP domain, affect European ozone? Annual ozone





ROW is important!

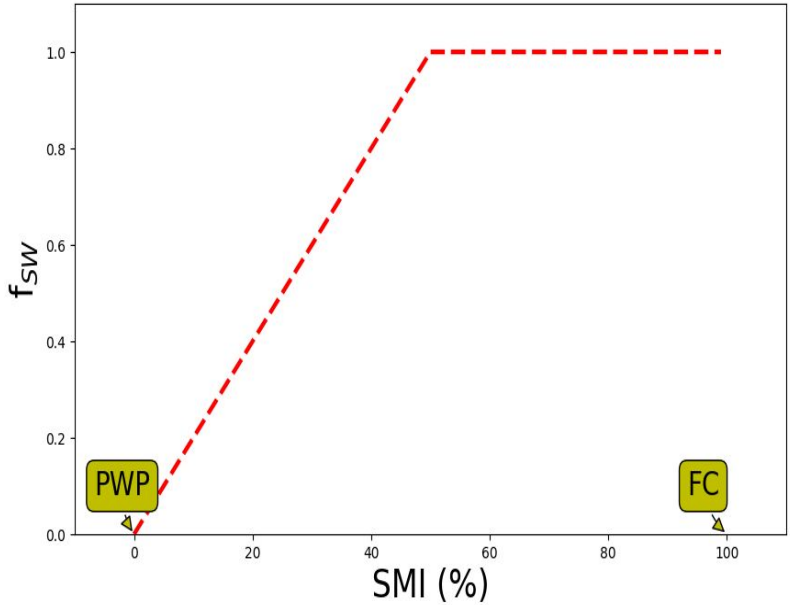
Percentage contribution compared to all global antropogenic emissions

LARGE-SCALE (IAM) OZONE RISK ASSESSMENT IN SOIL MOISTURE LIMITED AREAS

- Why? Ozone uptake is driven by stomatal conductance:

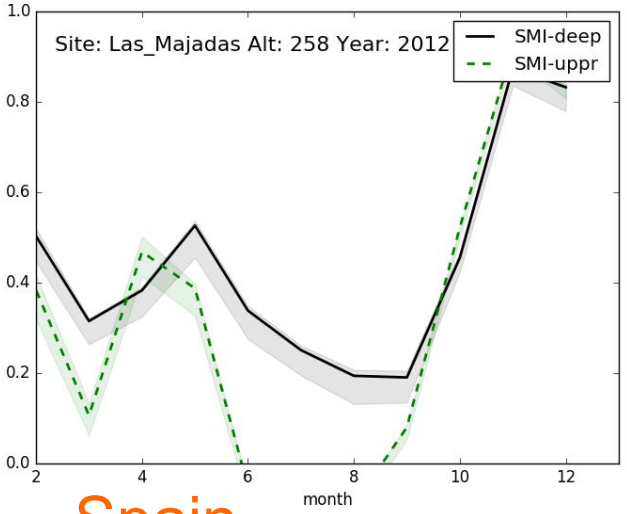
$$g_s = g_{max} * f_{phen} * f_{light} * \max\{f_{min}, (f_{temp} * f_{VPD} * f_{SWP})\}$$

- fSWP (now fSMI) is a key driver
- SMI = soil moisture index:
  - 1=fully moist, 0 = fully dry

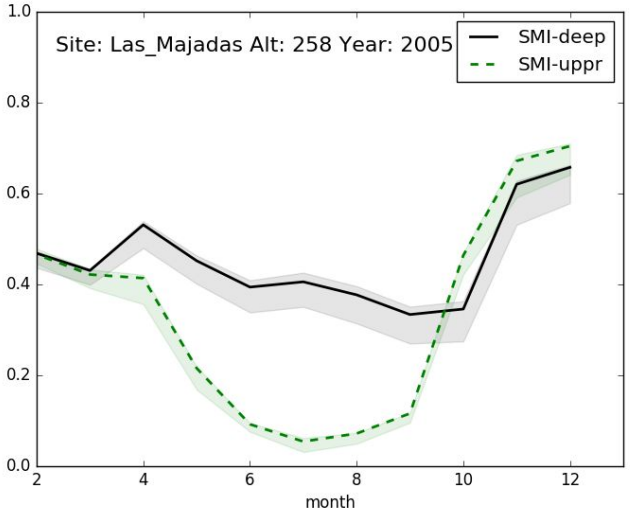


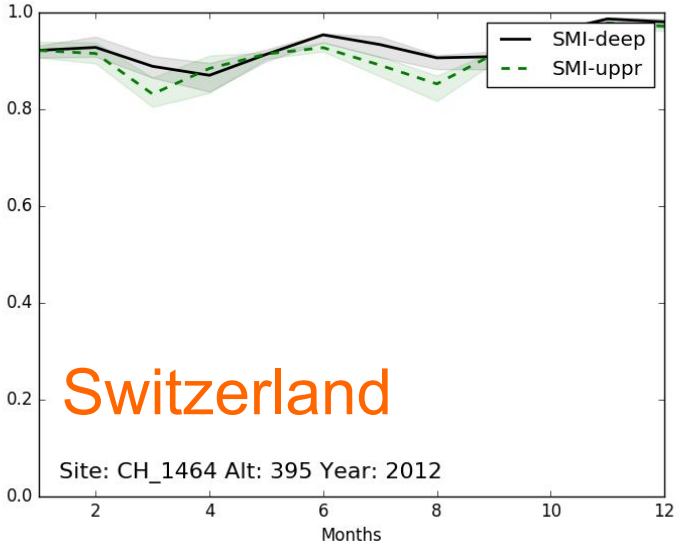
LARGE-SCALE (IAM) OZONE RISK ASSESSMENT IN SOIL MOISTURE LIMITED AREAS

- SMI data sent for 12 Mediterranean sites, 45 Swiss sites, 25 Swedish sites
- 1990-2012



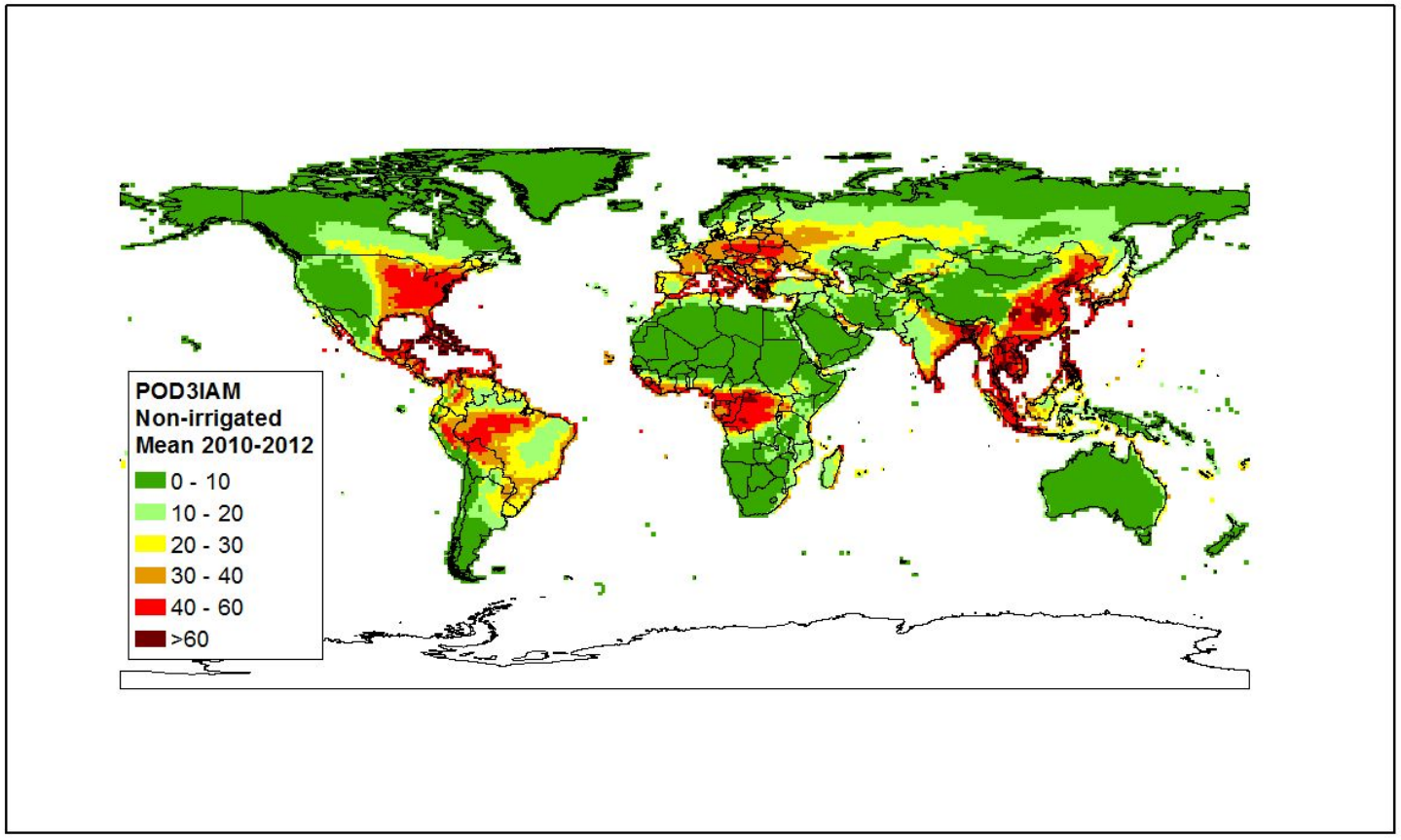
Spain





Switzerland

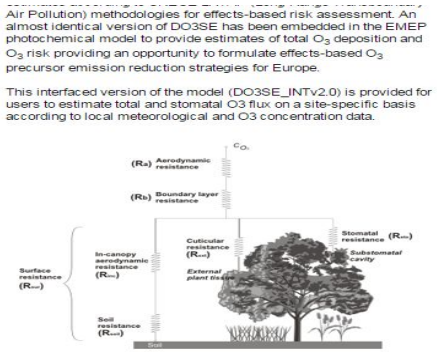
Cooperation with ICP-vegetation
Modelled O_3 uptake data (POD)– EMEP MSC-W



Mapping global impacts of ozone on crops

(Slide from: Katrina Sharps – katshar@ceh.ac.uk)

Modelled O3

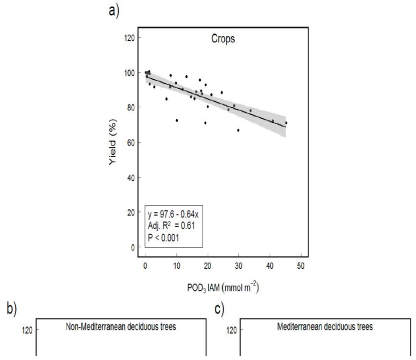


(DO_3SE and EMEP)

Crop production data (spatial)

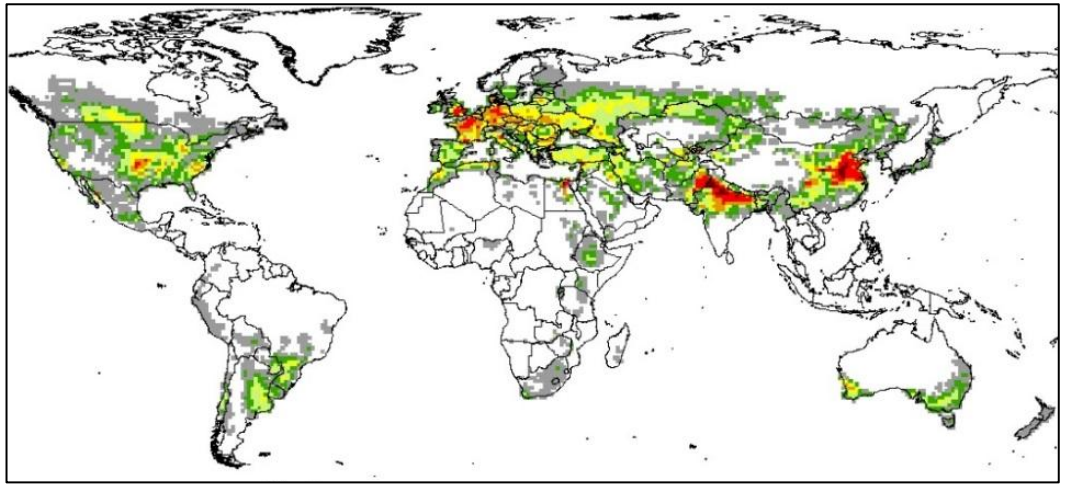
AND

Dose response relationships



AND

Global production loss - wheat

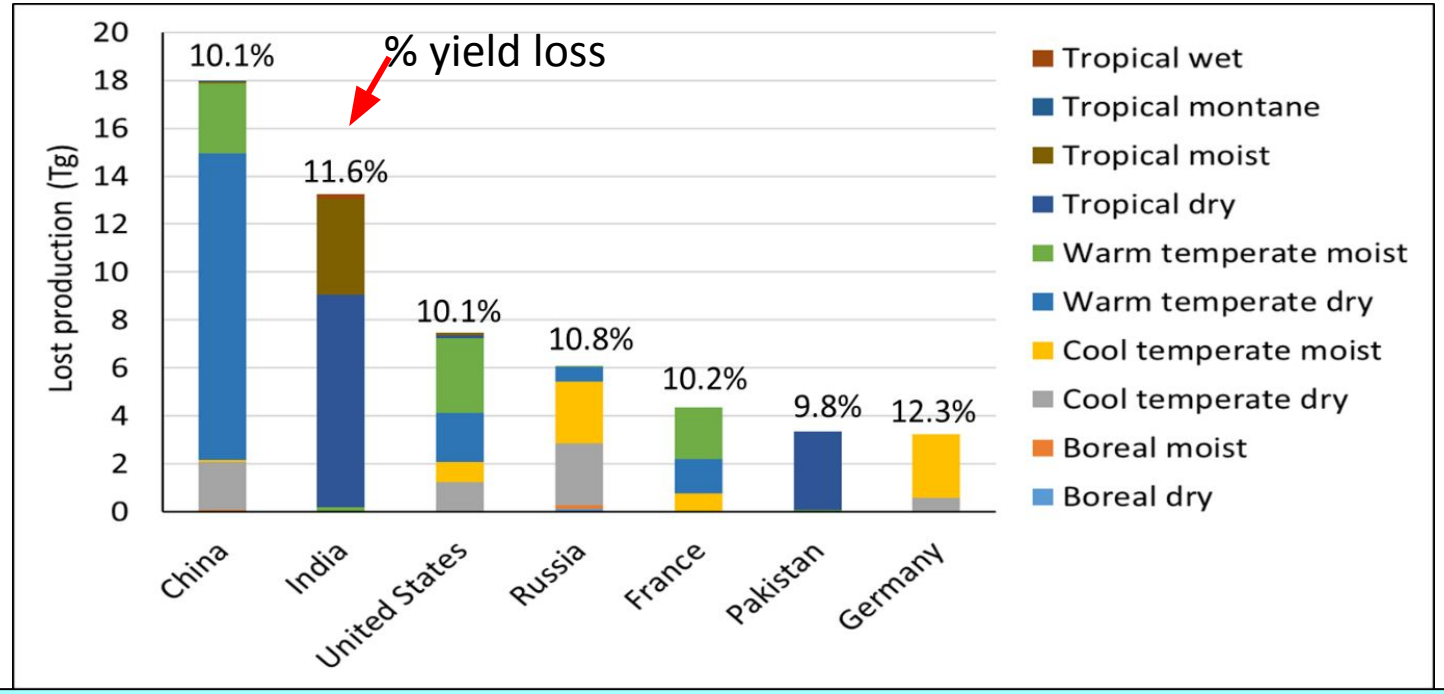


Production loss (Tg) (million tonnes)

- 0.0001
- 0.002
- 0.01
- 0.025
- 0.05
- 0.1
- 0.25
- 0.5

Mills et al., Global Change Biology, 2018.

Wheat production loss due to ozone (mean 2010 – 2012)



Highest quantity of losses are in the high wheat producing countries, especially in:

- warm temperate dry and tropical dry climates (blue colours) where irrigation is used
- temperate moist climates (yellow and green) where soil moisture is not limiting to ozone uptake

Overall, a mean global annual yield loss of 9.4% and 85 Tg (million tonnes) of grain, worth $24.2 billion at global market price

Mills et al., Global Change Biology, 2018

LARGE-SCALE (IAM) OZONE RISK ASSESSMENT IN SOIL MOISTURE LIMITED AREAS

Main goal:

Collaboration between ICP-Vegetation and EMEP MSC-W for improving current flux-based ozone risk assessment applications for large scales (IAM), especially for soil moisture limited areas such as the Mediterranean, Central and Eastern Europe, and in most of Europe under future scenarios of climate change.

Objectives:

1. Check Soil Moisture Index (SMI) performance in soil moisture limited areas (2017-2018)

2. Parameterize SMI limitations to ozone flux for common European vegetation species from soil moisture limited areas (2018-2019)

3. Update for parameterizations for large scale ozone flux estimation in European soil moisture limited areas (2018-2019)

- Led by CIEMAT, also with Sabine Braun
- Status: EMEP soil water estimates data for.... sent to CIEMAT for 1st comparisons

Other work

- Status run analysis in 0.1x0.1 degree, episode analysis etc.
- Bidirectional exchange of ammonia
- OA modelling – SR preparation. SVOC/IVOC
- O3 flux – cooperation with WGE
- TFHTAP: hosting web server & model calculation. Paper on Europen O3
- TFMM twin site study
- EMEP/MSC-W Model updates/improvements
- Country report updates
- Local fraction tests

Proposed workplan elements

1. Large-scale (IAM) ozone risk assessment in soil moisture limited areas
2. Impacts of uncertainties in SOA modelling for source-receptor matrices
3. Impacts of bi-directional exchange of NH3 on source-receptor relationships for nitrogen and PM2.5
4. Contribution of international ship traffic emissions to ozone in Europe –cooperation with TFHTAP