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EMEP MSC-W modelling of O3 and Ndep to ecosystems – recent activities

David Simpson

03/05/18

Main activities

- ICP Forests:

  (ongoing)

  - Ndep evaluation
  - DO3SE-applications – ozone flux
  - Global – comparison with other models (Donna Schwede et al)

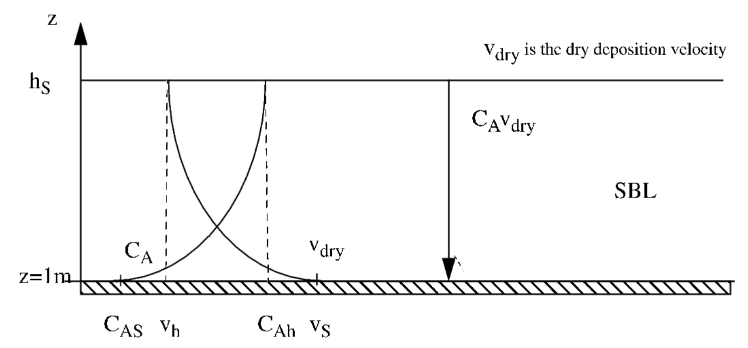
- ICP Vegetation

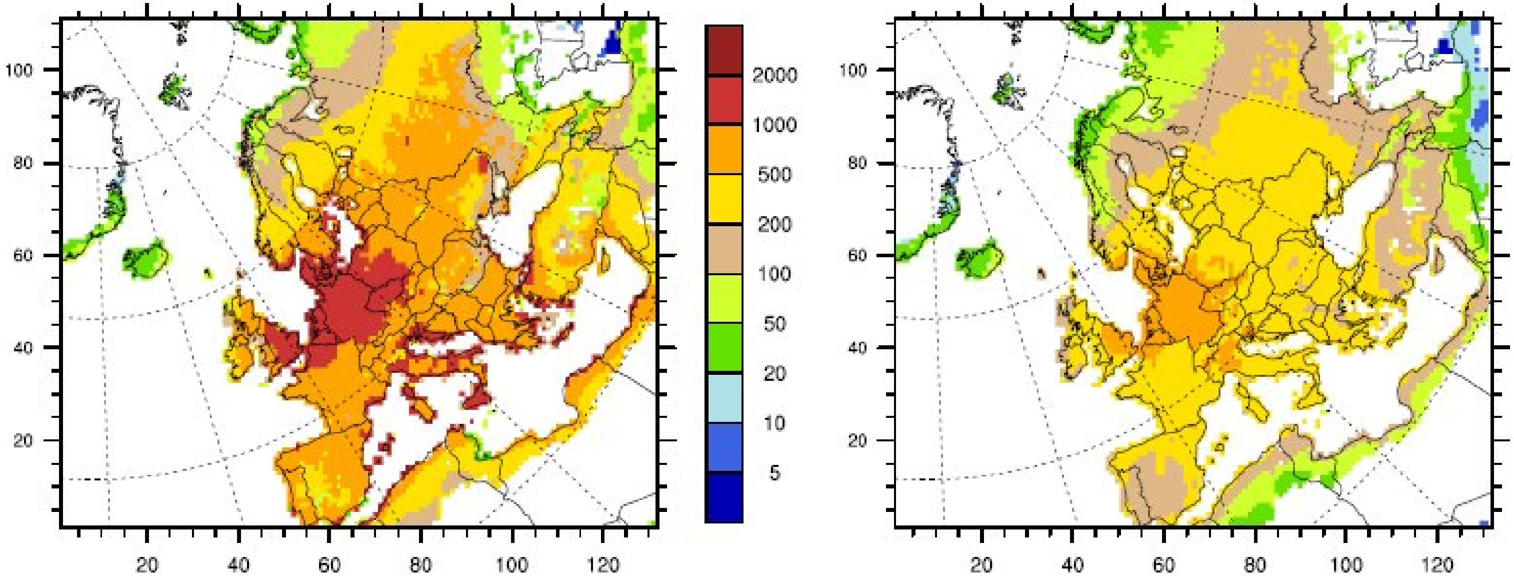
  (w. Gina Mills)

  - Global modelling of O3 fluxes
  - Impact on crop yields
  - ’Designing’ crops for O3 tolerance
  - Contribution to TOAR
  - ’CIEMAT’ project – soil water impacts

EMEP approach to dep: mosaic

- e.g. NOy depn:





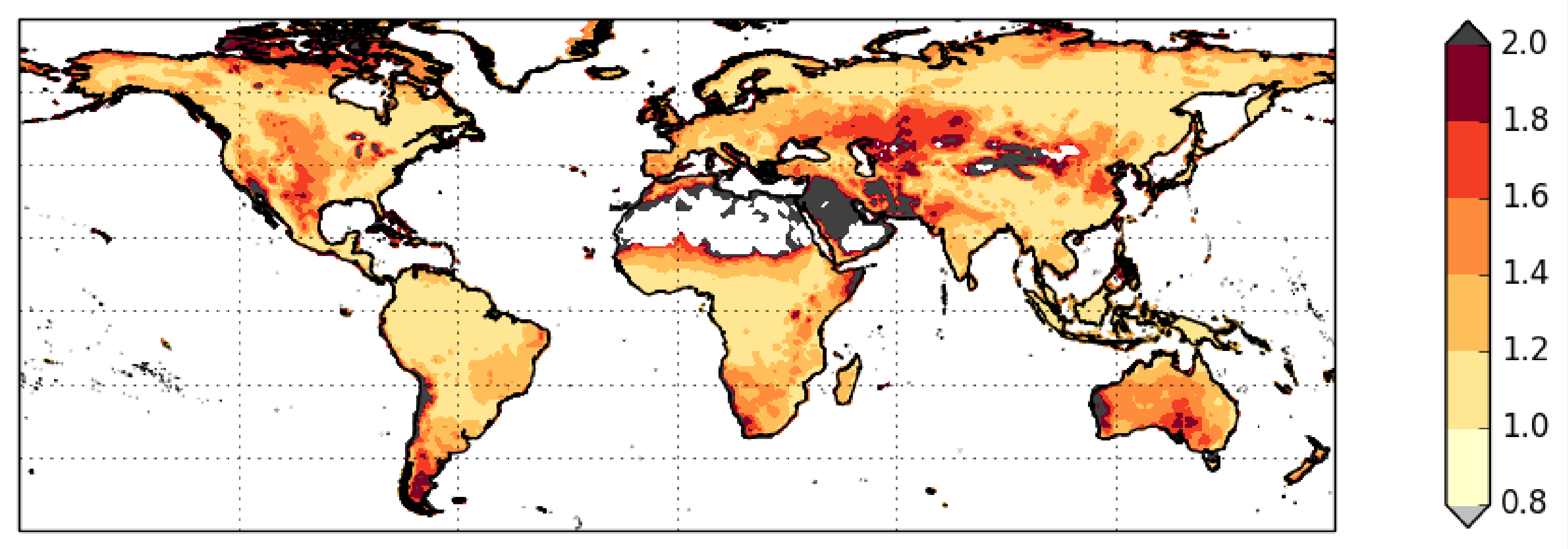
Forests:

Crops:

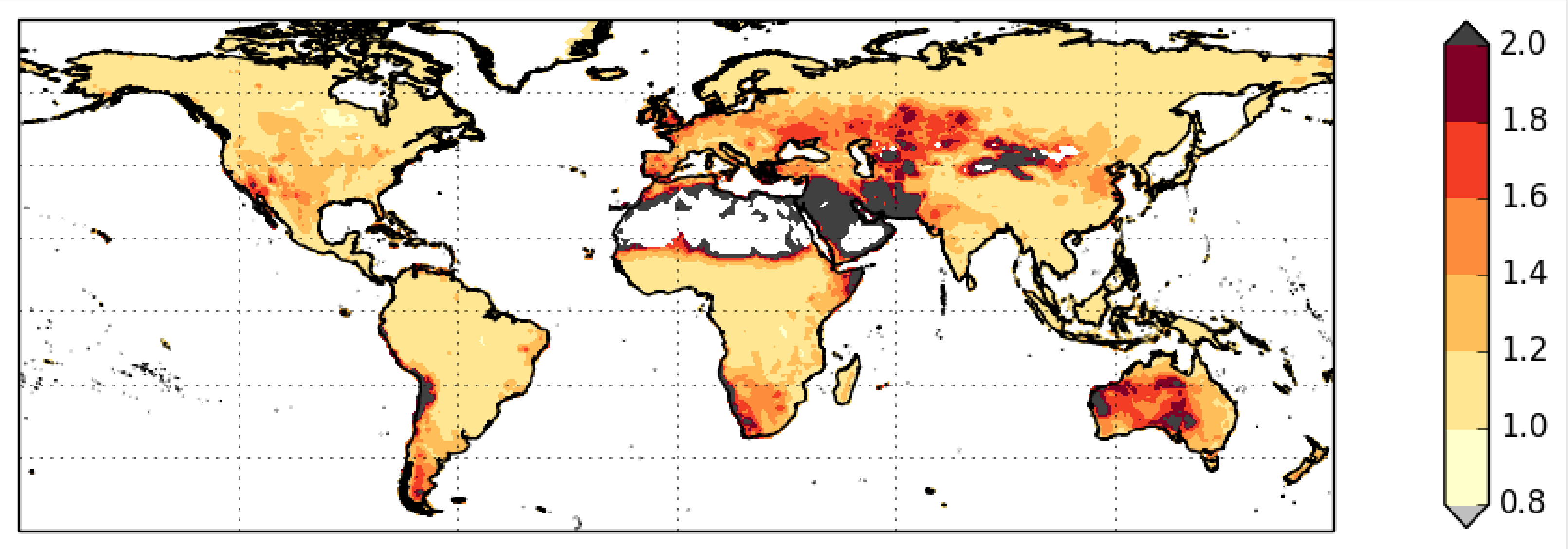
Simpson et al., Atmos. Env., 2006

Deposition modelling 2: ratios, Forest-dep/Grid-dep

NOy

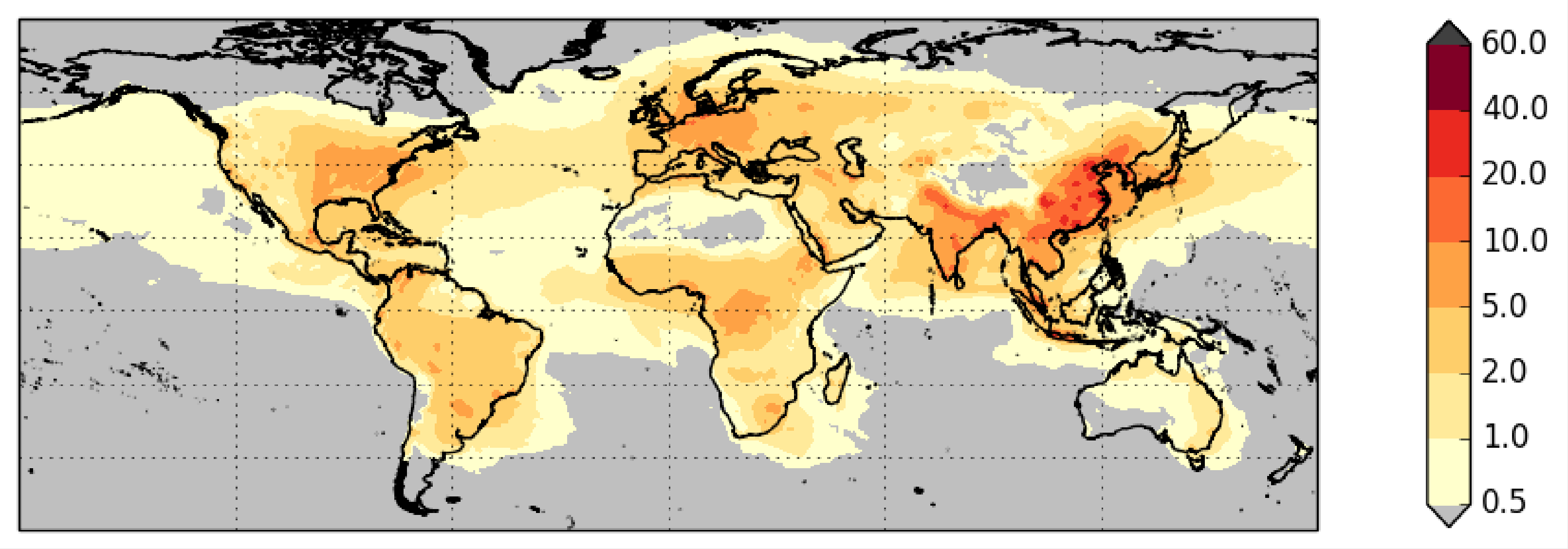


NHx



Deposition modelling 1: TDEP, Grid (kg/ha)

NOy



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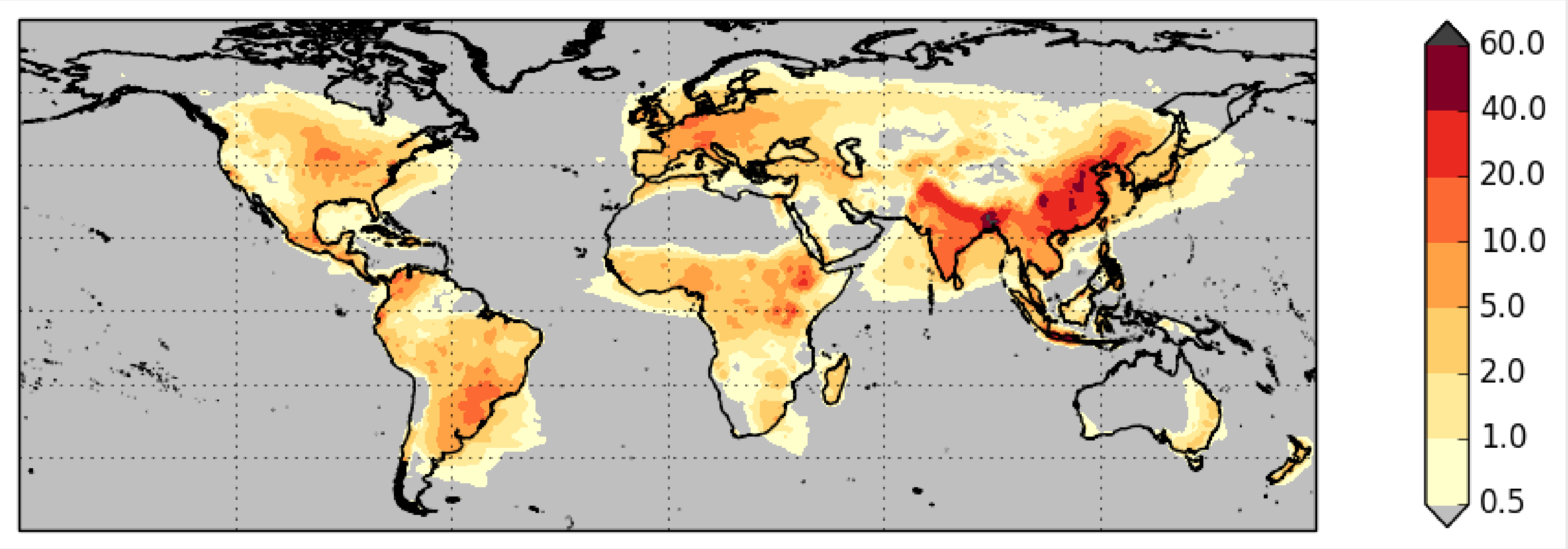

Deposition modelling, conclusions

- EMEP mosaic approach can give very different depositions to different ecosystems
- For dry-deposition, factor between forest-deposition and grid-deposition can be very high

  (mainly in grid squares with little forest)
- Even for total deposition, ratios are significantly different to one in man areas
- Contribution to paper by Donna Schwede, also to GAW TDEP

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

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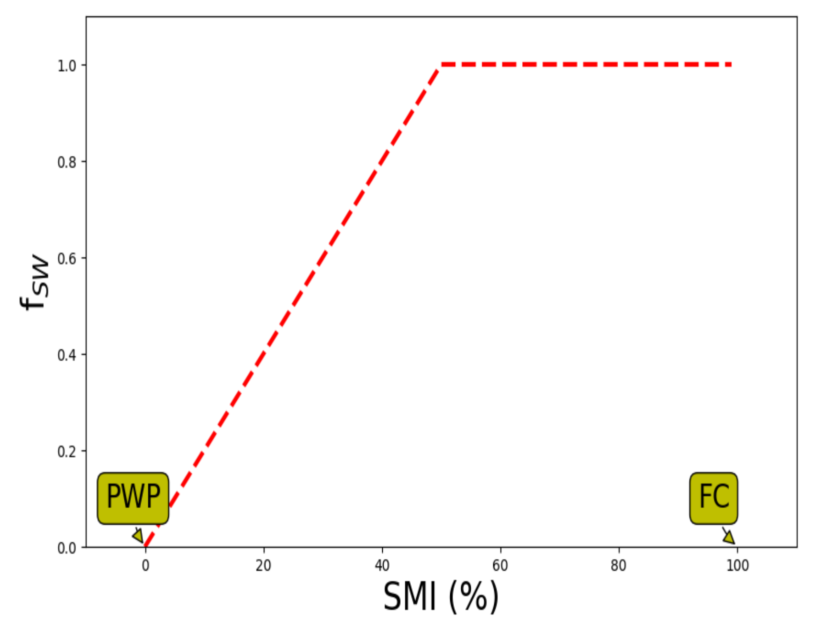
LARGE-SCALE (IAM) OZONE RISK ASSESSMENT IN SOIL MOISTURE LIMITED AREAS

- 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



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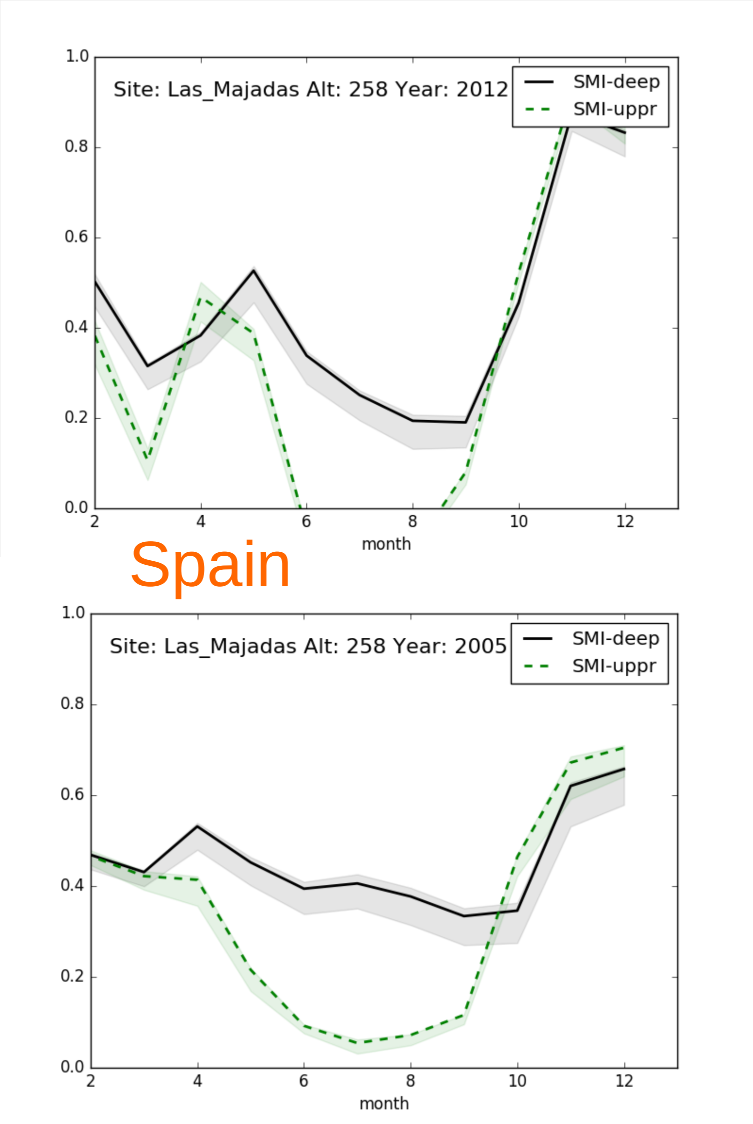
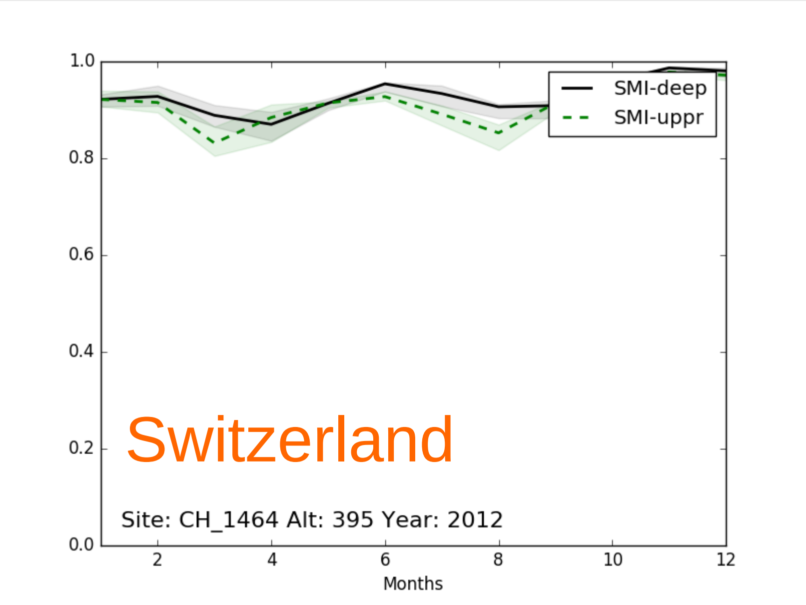
LARGE-SCALE (IAM) OZONE RISK ASSESSMENT IN SOIL MOISTURE LIMITED AREAS

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



Spain



Switzerland

Finally, lots of global O3 modelling

- With ICP-vegetation
- O3 flux approach (POD3)
- Interests in crop yields, food security
- Lots of issues!
  - Growing seasons
  - Irrigation?
  - Lack of observations

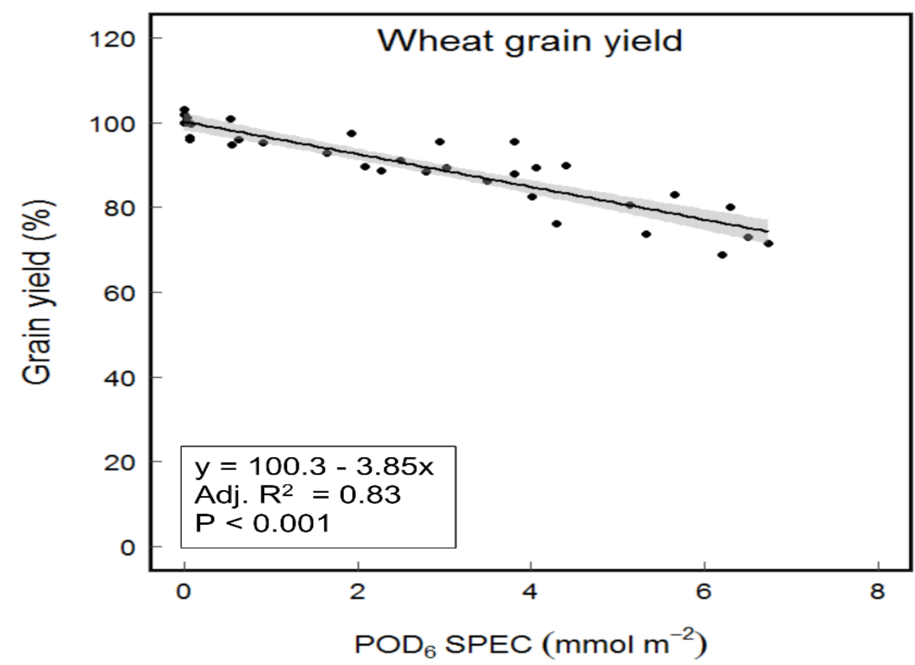
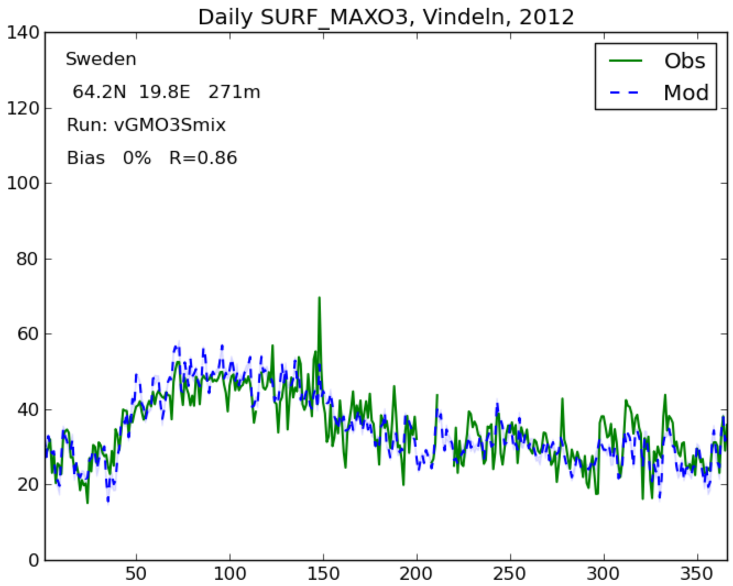
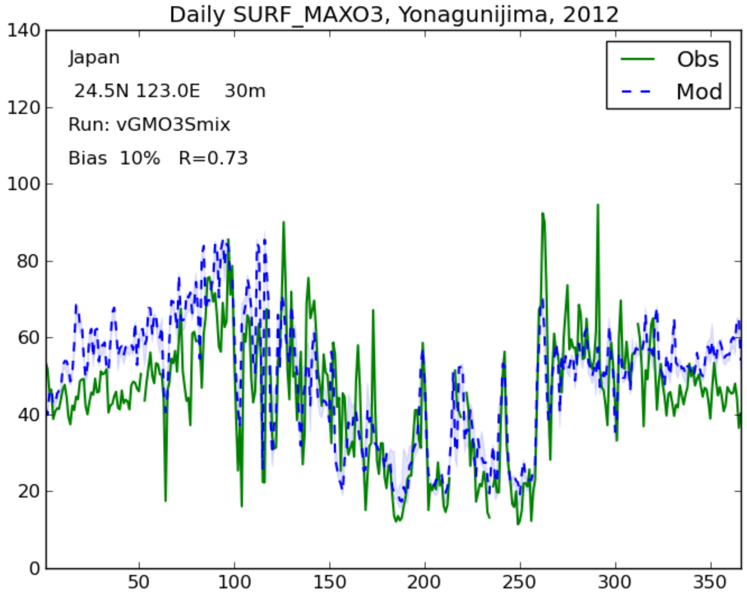


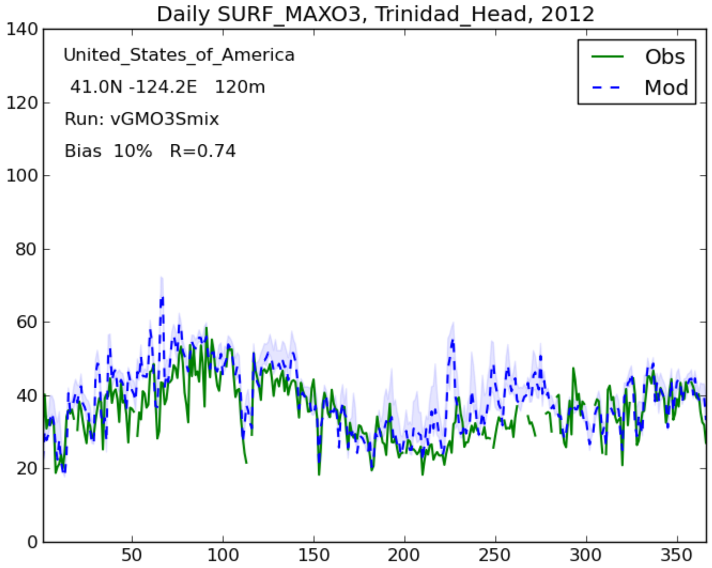
Fig: Mapping Manual

Can we model Ozone? Examples, EMEP model



- Daily max O3 (ppb) vs GAW data





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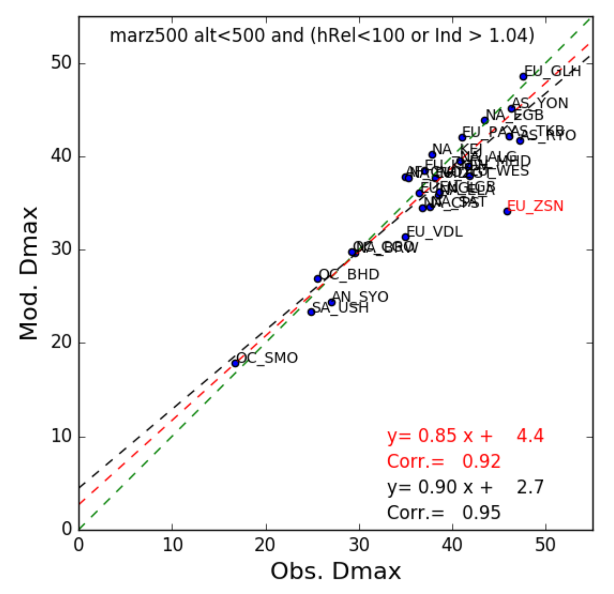
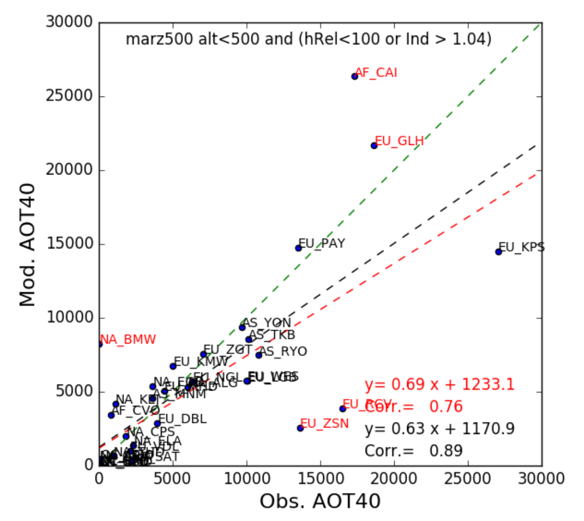
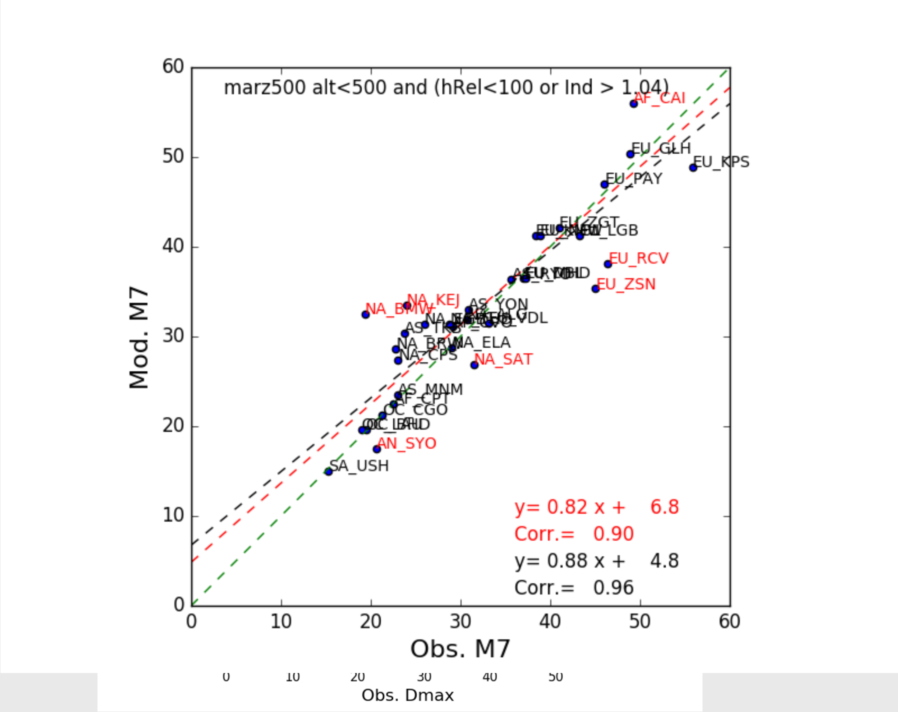
EMEP 3-D CTM performance – global (GAW)



- Daily max O3, AOT40, M7, 2012





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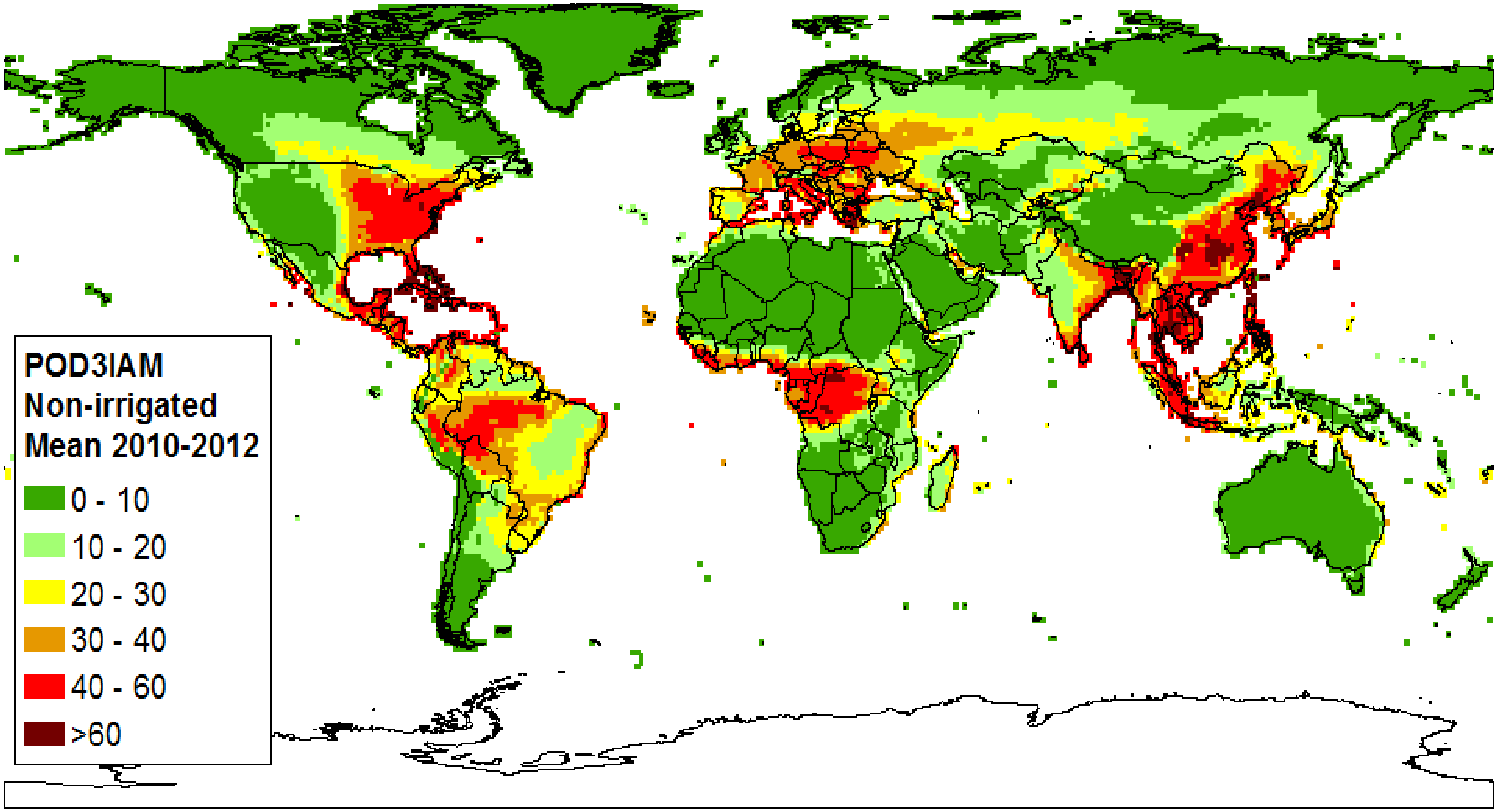
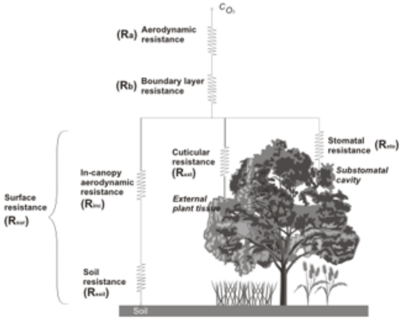
Cooperation with ICP-vegetation
Modelled O_3 upake data (POD)– EMEP MSC-W



Mapping global impacts of ozone on crops

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

Modelled O3



(DO$_3$SE and EMEP)

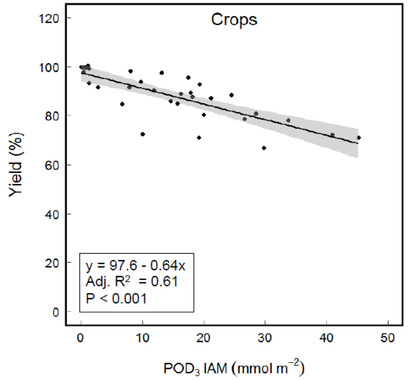
AND

Crop production data (spatial)

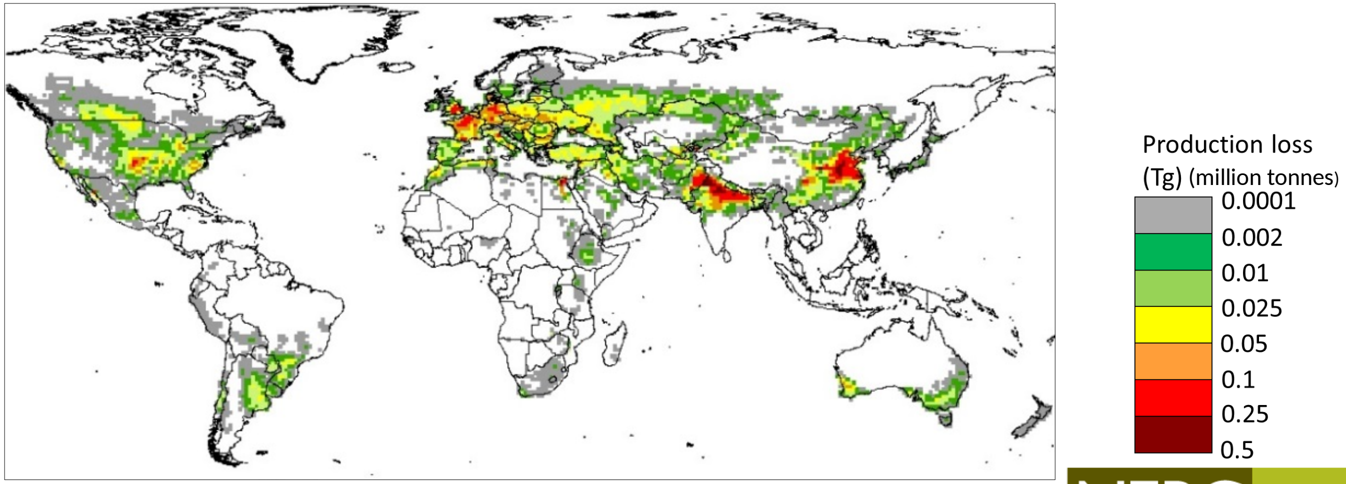
GAEZ
Global Agro-Ecological Zones

AND

Dose response relationships



Global production loss - wheat



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Mills et al., Global Change Biology (in press).

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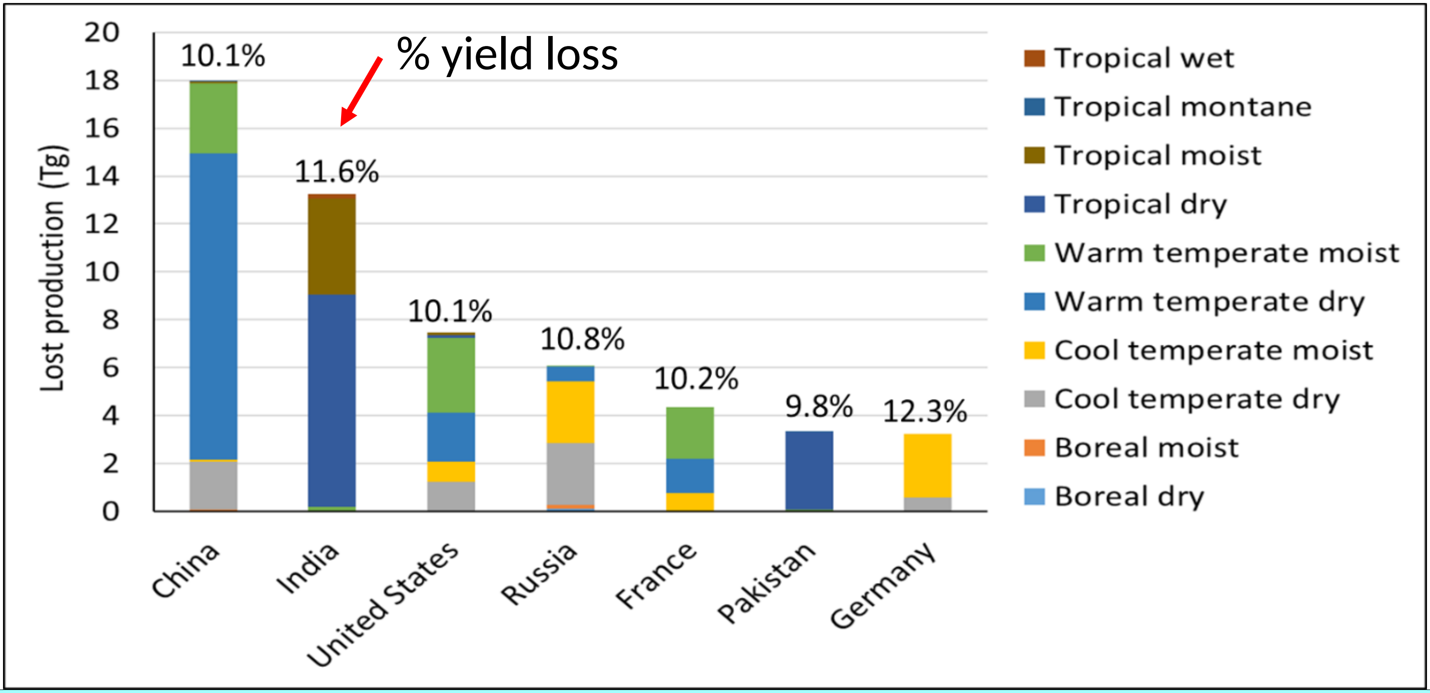
Wheat production loss due to ozone (mean 2010 – 2012)



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

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