emep

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

Norwegian Meteorological Institute

Activities at EMEP/MSC-W and proposals for future work

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TFMM, Prague 3-5th may 2017

Overview

- Official transition to the 0.1 degree resolution
- Diesel gate scandal – health effects
- Preliminary results from HTAP2
- *uEMEP –downscaling of EMEP model results - Bruce*
- *EuroDelta Trend work – Svetlana*
- Possible workplan items 2018/2019

The ‘new’ EMEP 0.1°x0.1° grid

- For the first time (2017), countries are requested to report emissions in 0.1x0.1 degree
- Everything ready from the modelling:
  - A reanalysis of ECMWF meteorology has been performed for 1990->2015, available in the new EMEP grid
  - Model adapted to ***emissions in GNFR*** (and other input data)
  - The EMEP model has been tested on 0.1°x0.1° with spatial gridding from TNO-MACC emissions, results are in general better (TFMM report on resolution)
- 0.1°x0.1° EMEP-CEIP emissions:

  The 0.1°x0.1° EMEP-CEIP emissions (autumn 2016) have been tested and results compared to
  - EMEP 50km
  - EMEP national/sector totals + gridding from TNO-MACC emissions
  - ***NOTE: only 4 countries submitted data on 0.1 degree***, most of the distribution is based on proxy data

Model runs for 50km vs 0.1 emis (2014) – comparison to EMEP observations

	50x50 km2 emissions		0.1x0.1° emissions	
	Bias	Correlation	Bias	Correlation
SO2	0	**0.64**	-4	0.57
NO2	-16	**0.84**	-23	0.78
O3 mean	9	0.69	11	0.69
O3 max	0	**0.73**	2	0.69
PM2.5	-13	0.77	-16	**0.78**
PM10	-24	0.74	-24	**0.81**
SOx wet dep.	-16	0.60	-19	**0.64**
NOx wet dep.	2	**0.72**	1	0.70
NHy wet dep.	14	**0.80**	12	0.75

Note: only 4 countries reported 0.1 degree emissions for 2014 (Switzerland, the UK, Finland, Poland)

Comparison to Airbase regional/background – spatial correlation

	50x50 km2	0.1x0.1° (CEIP emis)	0.1x0.1° (EMEP/TNO emis)
	Correlation	Correlation	Correlation
SO2	0.47	0.36	**0.50**
NO2	0.70	0.71	**0.76**
PM2.5	0.66	0.66	**0.70**
PM10	0.47	0.46	**0.52**

Comparison to Airbase urban/suburban observations – spatial correlation

	50x50 km2	0.1x0.1° (CEIP emis)	0.1x0.1° (EMEP/TNO emis)
	Correlation	Correlation	Correlation
SO2	**0.20**	0.08	0.14
NO2	0.54	0.61	**0.67**
PM2.5	0.47	0.43	**0.51**
PM10	0.27	0.24	**0.35**

Emissions play a major role for improving the results when going down in scale
How will the results look when countries have reported 0.1x0.1 emissions?

Transition to the new EMEP grid: 2017 (2015) status runs

- **Base run for 2015** on 0.1x0.1 degree. Countries request that their data is being used
  - compare 50km and 0.1 degree
  - Use EMEP, Airbase measurements
  - Will many countries report? Will the reported 0.1 be of good quality?
  - Feedback to CEIP (and countries)
- **Trend runs**: no
- **Source receptor matrices:** no
- Country reports: no

Effect of NOx from light duty vehichles in Europe

- Background: the diesel gate scandal
- Co-operation with CIAM and CCE
- Light duty diesel vehichles
- Only NOx (the other components are within the limits)
- Health effects from PM resulting from NOx (health effects from NO2 is uncertain and NO2 poorly resolved in 0.1x0.1degree model runs)
- the health effects from direct emissions of PM are probably larger

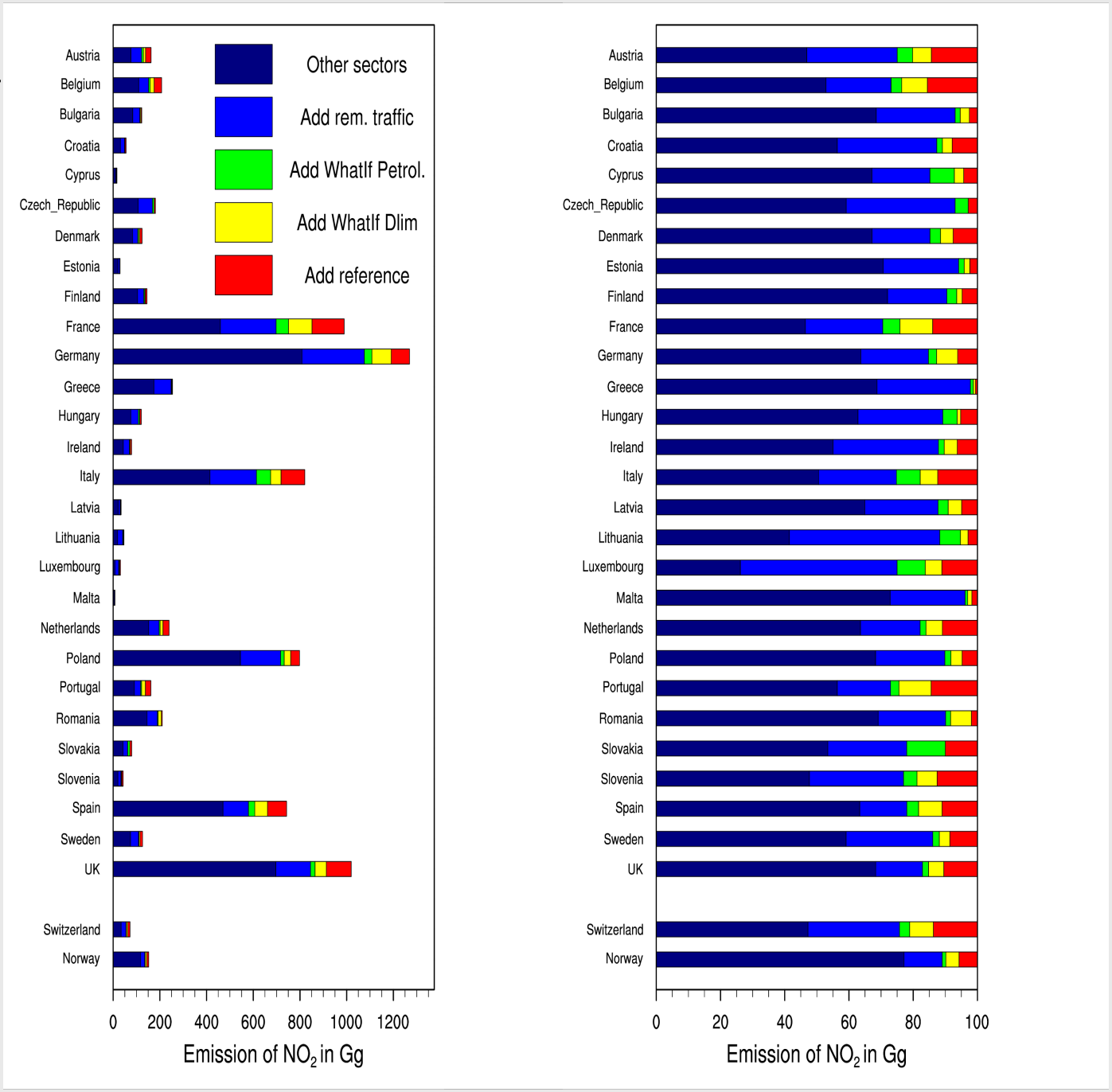
NOx emissions per country.

Red, yellow and green is total emissions from light duty diesel vehicles

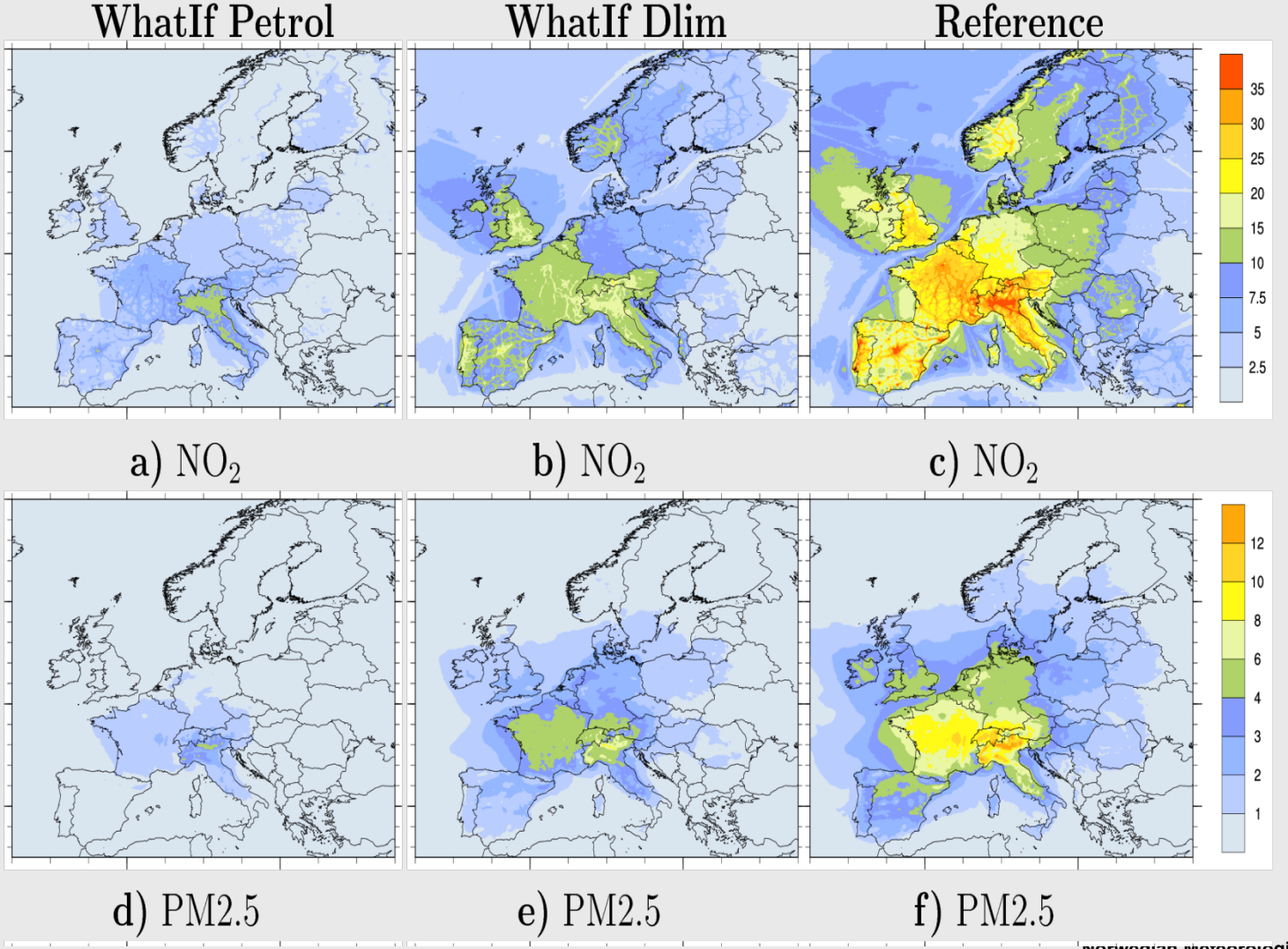
+Green: If all diesel had been petrol

+Yellow: If the limits of diesel cars had been followed

+Red: The ‘real emissions’



Percentage contribution from light duty vehicles



Health effects

- Around 10 000 cases of premature deaths annually in EU28 due to NOx emissions from Diesel cars (3.5% of PM2.5 and 2.3% of O3 premature deaths)
- Almost 50% of these could have been avoided if diesel limits had been achieved for on-road driving
- 80% could have been avoided if diesel cars had emitted as little NOx as petrol cars

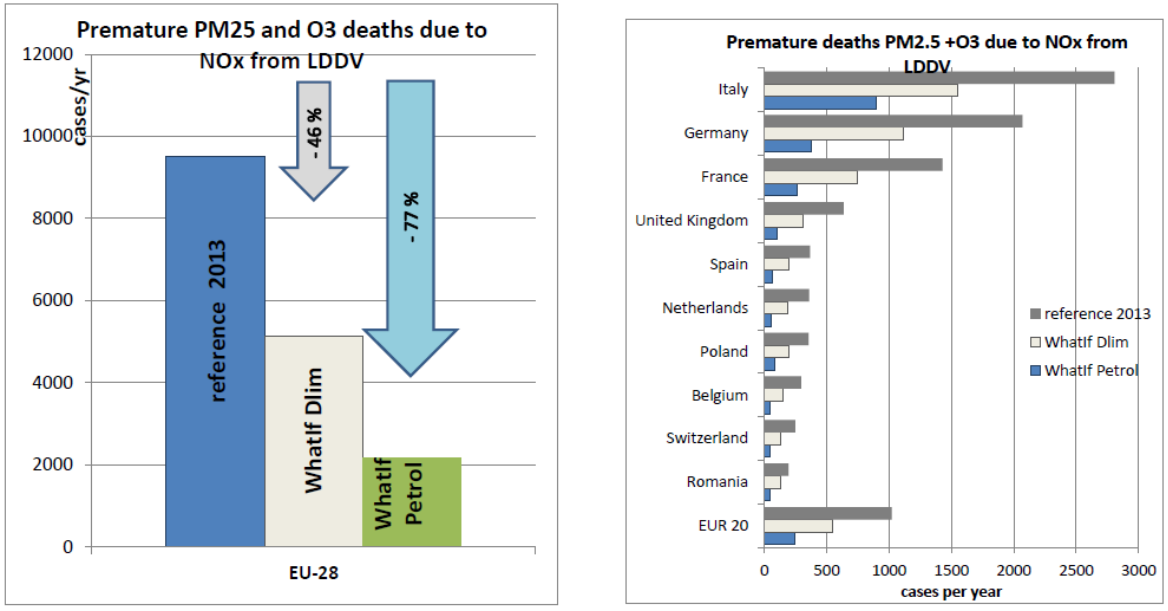


Figure 4. Premature deaths as caused by LDDVs in EU28 as a whole, left, and for 10 the countries with the highest numbers of premature deaths in EU28 plus Switzerland, right. EUR 20 is the sum for the remaining 19 EU countries plus Norway.

Cooperation with IIASA and CCE

HTAP2, some preliminary results

- Questions
  - How do the HTAP2 results look vs HTAP1 with respect to European/exEuropean influence on European ozone now and in the future?
  - How important is methane?

Comparison HTAP1 and HTAP2

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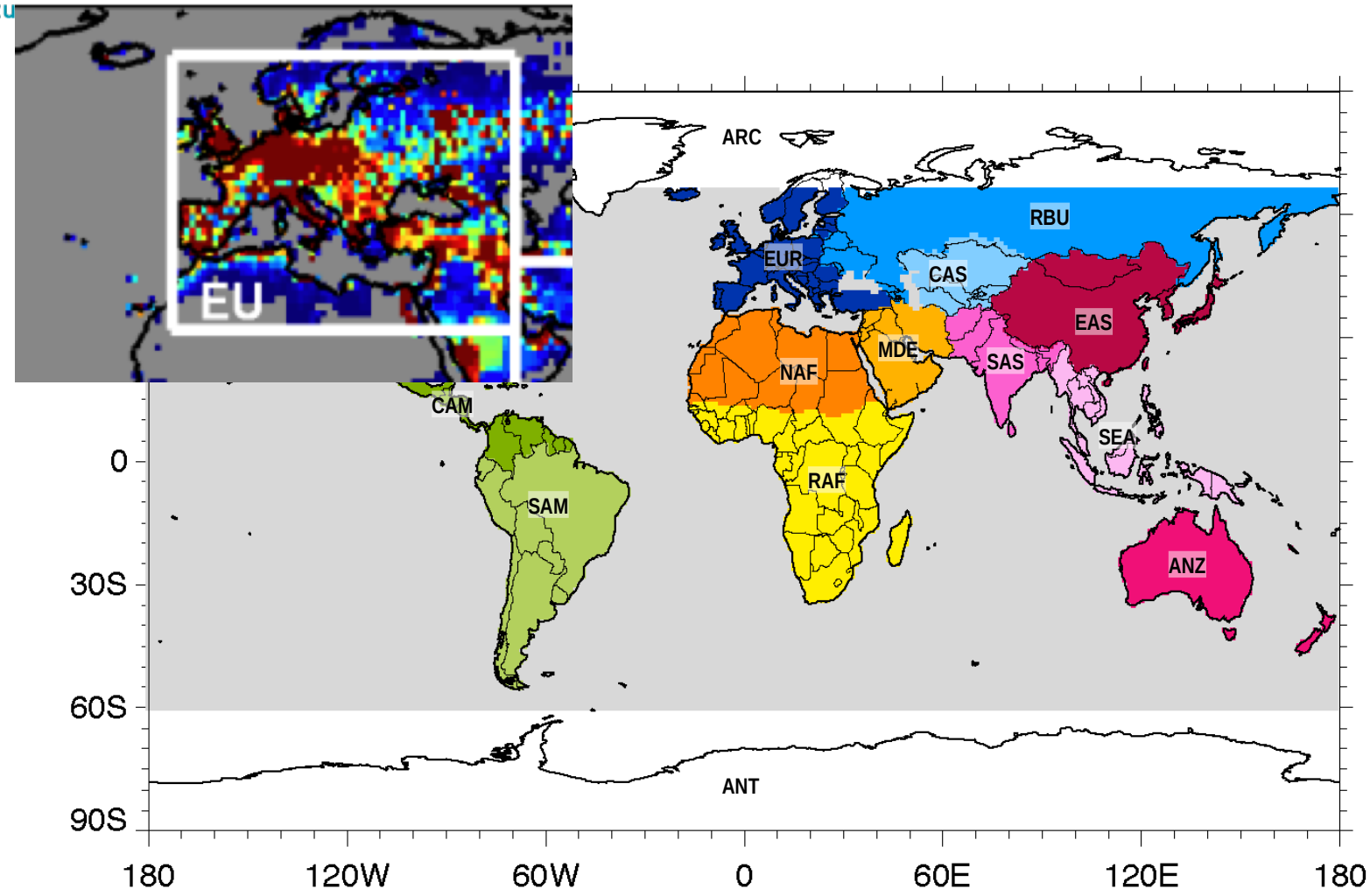
Ozone Concentration Contribution in Europe

due to a 20 % reduction in anthropogenic emissions

[ppb]	from Europe	from North America	from East Asia
HTAP 1 (box)	0.82	0.37	0.17
HTAP 2 (land only)	0.15	0.21	0.22

Why?
Change in source/receptor region definitions
Change in emissions (2001=>2010)
Change in models contributing

Metric: Source region changed



HTAP2: ship emissions in its own 'category'

What is the role of shipping emissions to European surface ozone concentrations?

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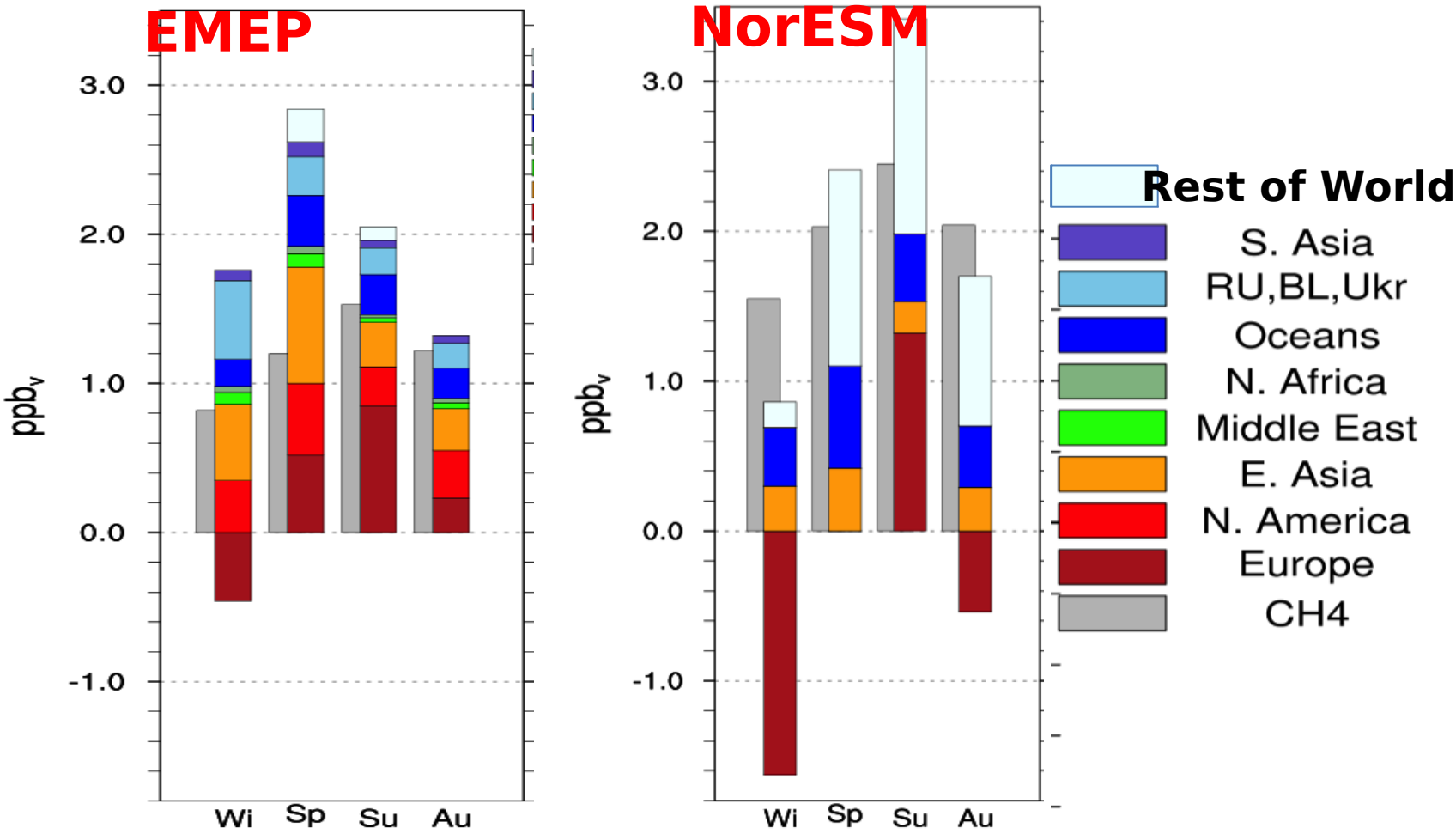

Shipping emissions matter

HTAP II source contributions to European Surface Ozone due to Δ20% anthropogenic emissions / CH4 levels

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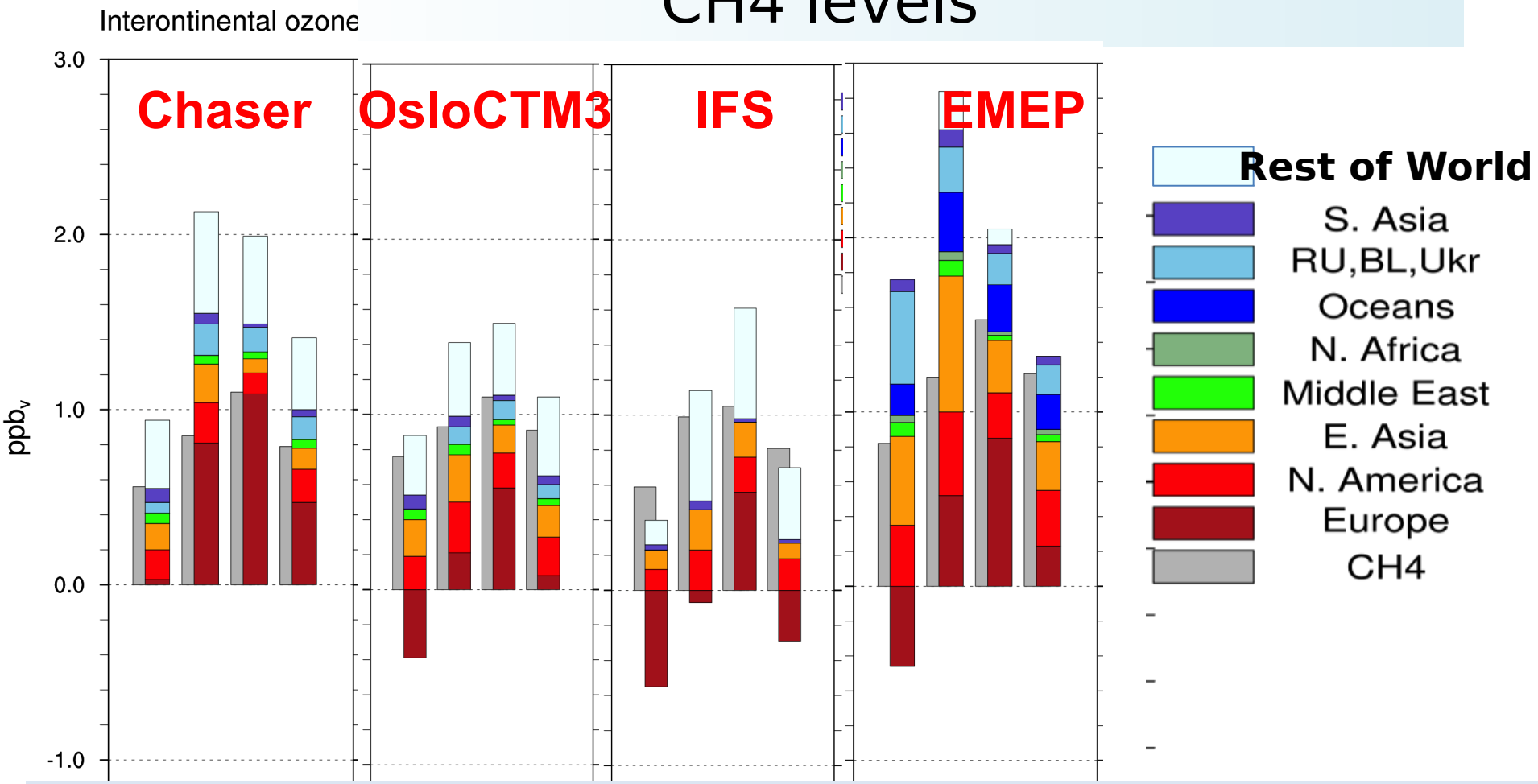


Additional reductions in Europe are less important than CH4 and ROW

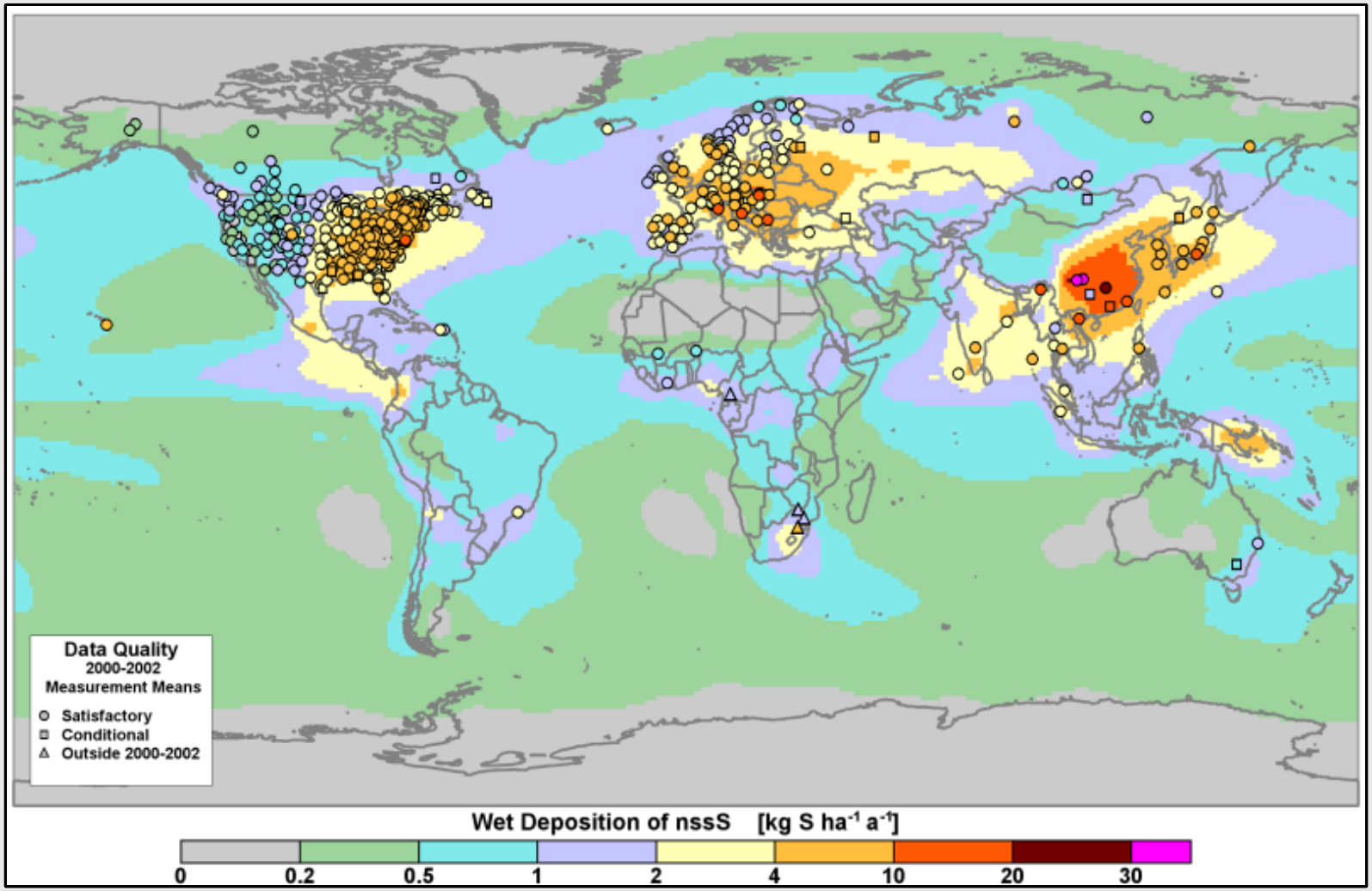
Preliminary summary ...

- **CH_4 ~ exEU >> European effect**
- **European effect on Europe much smaller in HTAP2**
  - **Ship emissions are important (from which areas?)**
- **Future work?**
  - How important will measures on ship emissions for different seas in Europe be compared to land based emissions, exEU emissions and ship traffic emissions outside Europe?

Workshop on Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD)

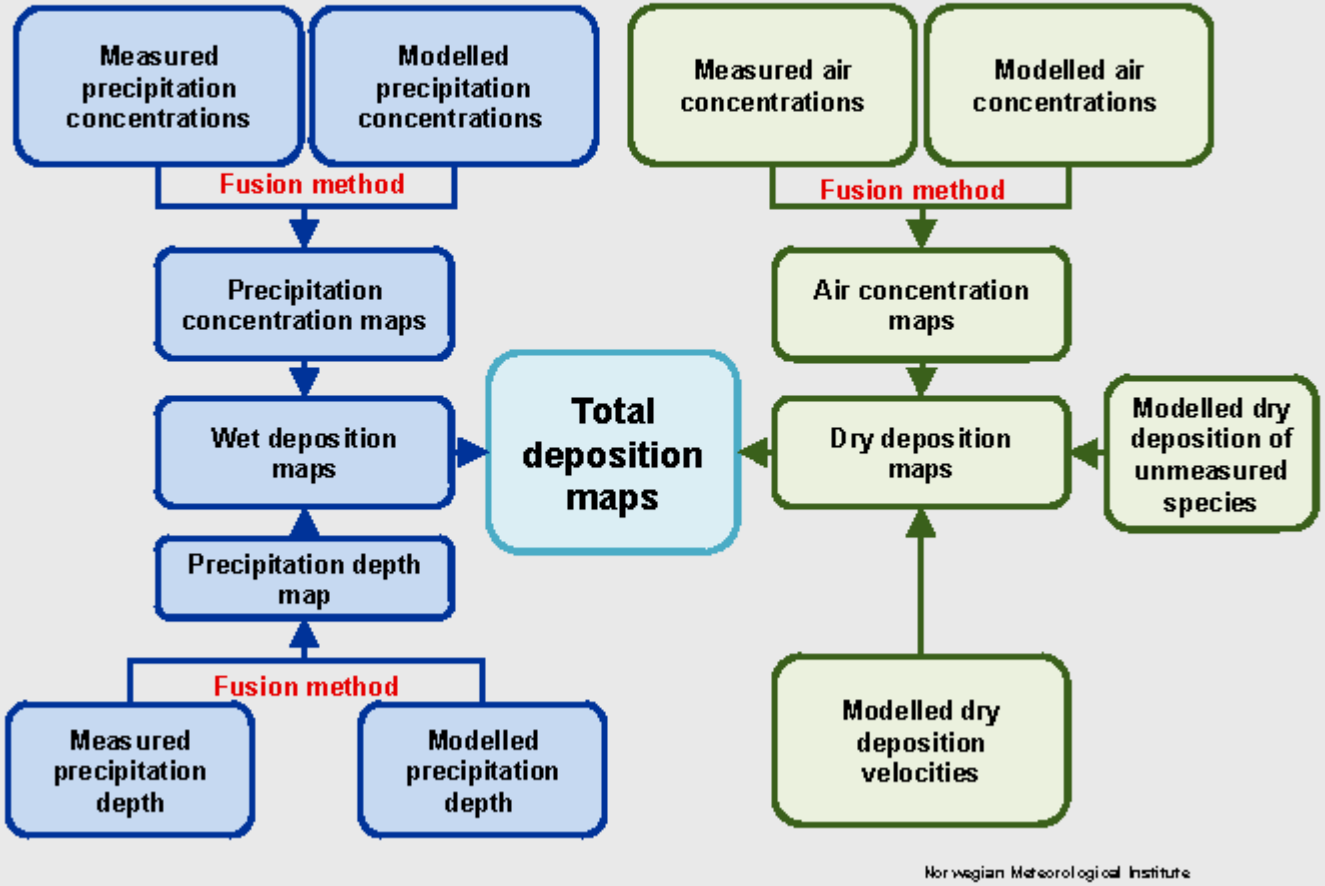
- **An initiative of GAW's Scientific Advisory Group for Total Atmospheric Deposition (SAG-TAD)**
- Goal: To **review the state-of-the-science** on *Measurement-Model Fusion for Global Total Atmospheric Deposition* and **establish a GAW project** for the purpose of generating **global maps** of **total atmospheric deposition,** important **atmospheric gases, and particles**

Combined measurement-model global maps of atmospheric deposition



Vet et al. 2014. A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorous, *Atmospheric Environment*, 93: 3-100.

MMF-TAD Approach



MMF-GTAD EMEP work?

- Why should EMEP be involved?
  - ecosystem critical loads/levels and effects
  - Global maps of **wet plus dry** deposition, aerosol species and reactive gases
  - Make use of available data sets
- How should EMEP be involved?
  - Canada has offered to make their scripts/models/methods available (OI), but there are lots of other possibilities
  - CCC & MSC-W
  - HTAP, EuroDelta participation?

Co-operation with WGE (WP 2018/2019)
Large-scale (IAM) ozone risk assessment in soil moisture limited areas

- 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.
- Final products (2019):
  - Parameterization of SMI function tested in water limited regions of Europe.
  - Ozone flux maps adapted for soil moisture limited areas including the Mediterranean

Possible WP elements 2018/2019

- How important are reductions in ship emissions in different seas of Europe compared to other emission reductions?
- Model-Measurement fusion for Europe
- Improved flux-based ozone risk assessment for soil moisture limited areas (MSC-W & ICP-Veg)
- *Downscaling EMEP/MSC-W model results*
  - *PM, NO2 , NH3*
  - *depositions*
  - *Pilot studies with voluntary countries*

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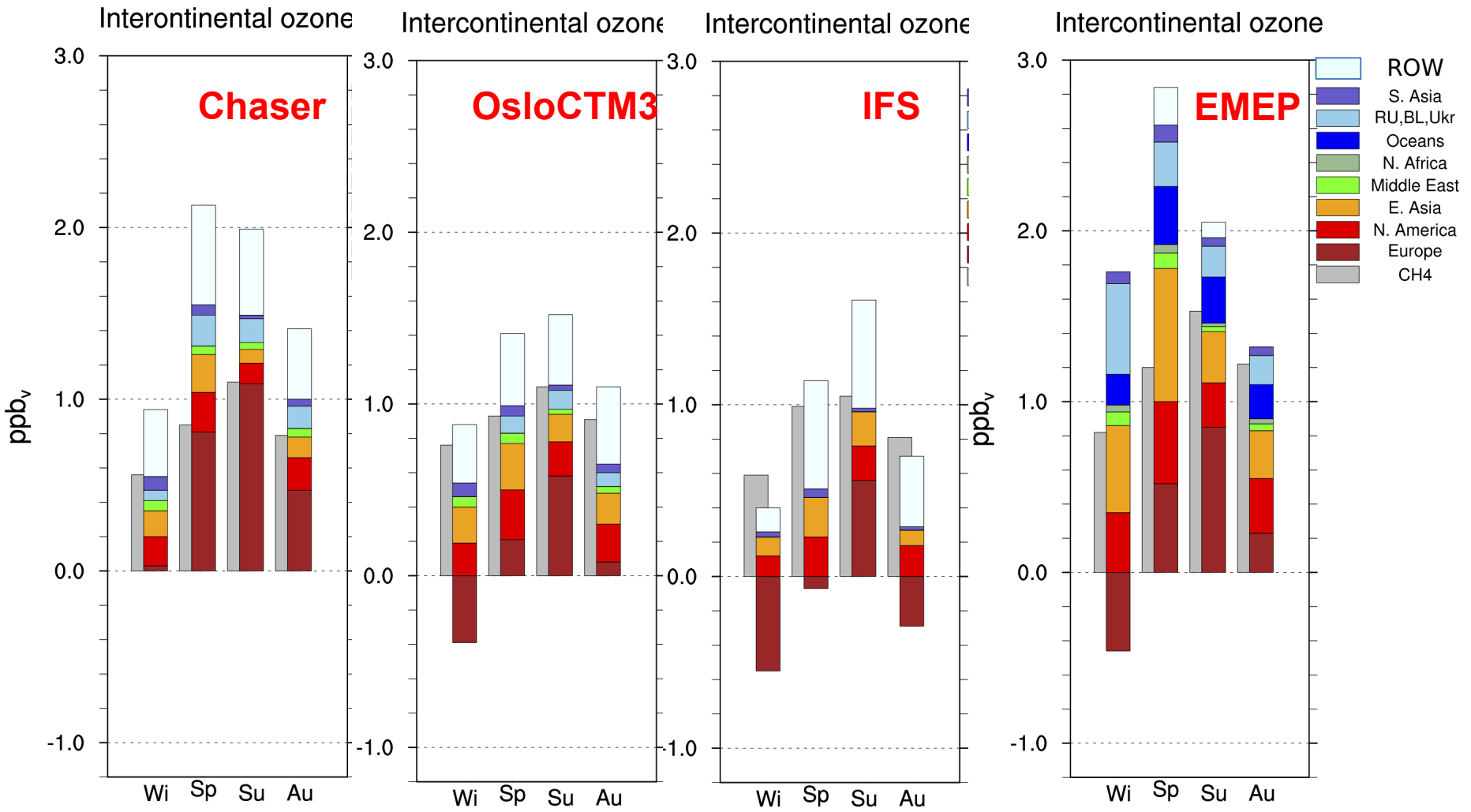
Source contributions to European Surface Ozone

Reduction of 20% in anthropogenic sources and CH4



CH_4 signal ~ exEU >> European effect

Summary - effect of NOx from light duty vehichles in Europe

- New European Driving Cycle (NEDC) did not work very well and will be replaced by Worldwide harmonized Light vehicles Test Procedure (WLTP).
- Light duty vehicles (also Euro 6) emit more NOx than allowed.
- New Euro 6 heavy diesel vehicles meet the requirements (but the cleaning can easily be disconnected)
- Advanced gasoline direct injection engines are now the main concern regarding high emissions of particle numbers. ‘’Gasoline particulate emissions:The next auto scandal?’’ These petrol cars have probably larger health effects than diesel cars. Particle filters will now also be required for petrol cars.

Can ship emissions explain disrepancy between RAIR-htap1 and RERER-htap2 ?

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(GLO-EU) / GLO

EMEP **European RERER** is similar to mean RERER from all models

MODEL	RERER
Chaser re1	0.62
Chaser t106	0.60
C-IFS v2	1.05
EMEP	0.82
OsloCTM3	0.84
CAMchem	0.90
GEOSchemADJ	0.80
Mean htap2 =>	80%
Mean RAIR htap1 =>	43%

Recompute htap1 “RAIR” from EMEP htap2 results

HTAP1:European response was larger EU+25% OCN

HTAP1:Global response was smaller NA+EU+SE+AS+ 50% OCN

RERERhtap2-emep **82%**
=> RAIRhtap2-emep **70%**

CA 30% OF DISCREPANCY RAIR - RERER
DUE TO DIFFERENT SHIP EMISSION INCORPORATION

Co-operation with WGE (WP 2018/2019)
Large-scale (IAM) ozone risk assessment in soil moisture limited areas

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

Activity 1.1.- Analyze spatial and temporal variability of the current SMI index across Europe and at field scale for selected sites in Activity 1.2 (EMEP) 2017 (started in 2016)

Activity 1.2. Collate field data with soil moisture measurements for different vegetation covers (CIEMAT, other partners?). 2017 (started in 2016 already)

Activity 1.3. Compare SMI estimates with field data (EMEP). 2017/2018 (started in 2016 already)

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

Activity 2.1. Study relationship between SMI and other soil moisture indices with gas exchange and rooting depth for species from soil moisture limited areas (CIEMAT, other partners?). 2017-2018

Activity 2.2. Parameterize SMI (and if appropriate fphen) based on field data of gas exchange and soil water content for common Mediterranean species (CIEMAT, other partners?). 2018

Activity 2.3. Compare ozone flux maps with new/current SMI parameterization (EMEP?). 2019?

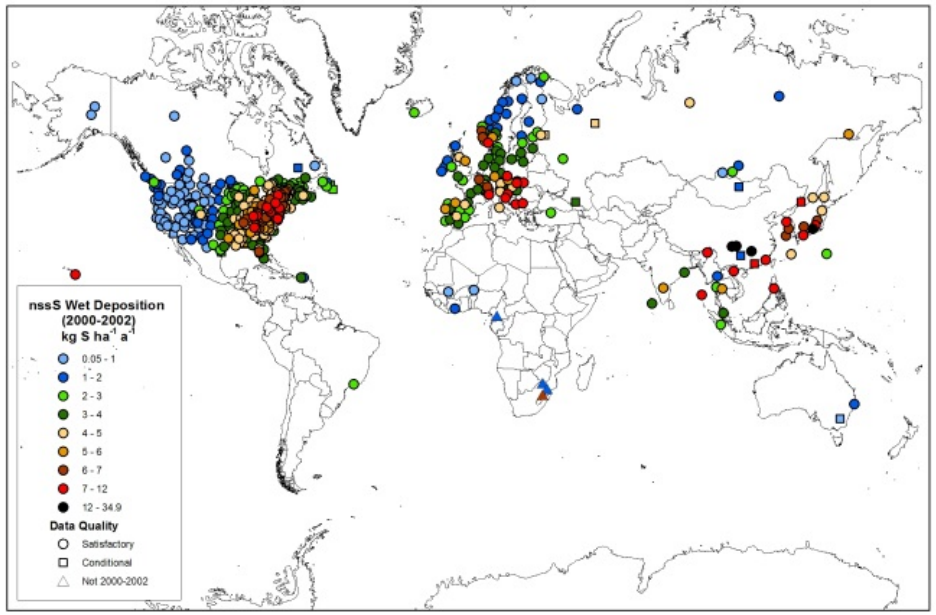
Objective 3. Update for parameterizations for large scale ozone flux estimation in European soil moisture limited areas (2018-2019)

Activity 3.1. Adapt/update flux parameterizations available for common European vegetation species from soil moisture limited areas for their use by EMEP in large scale flux estimation (IAM) (CIEMAT/EMEP). 2018

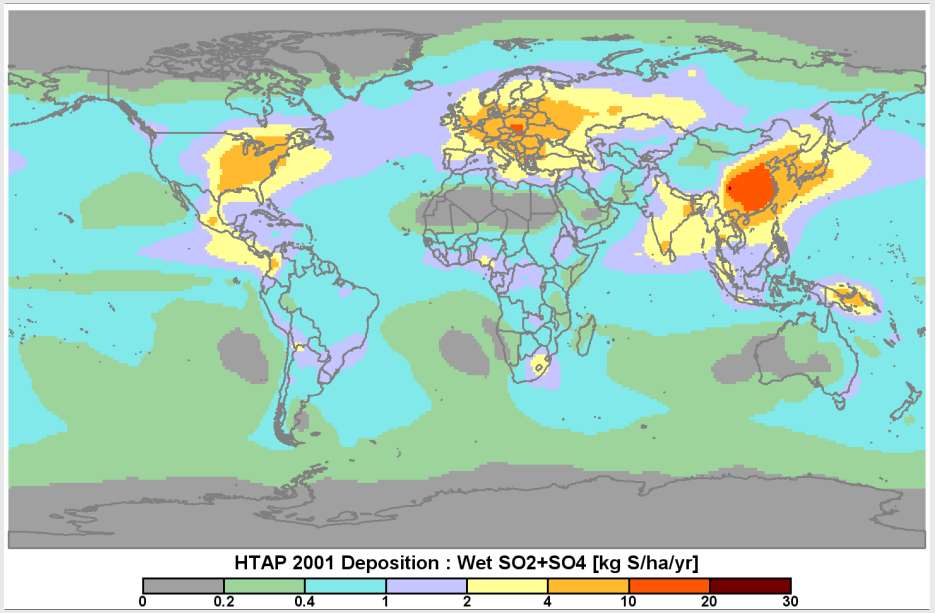
Activity 3.2. Produce ozone flux maps adapted for European vegetation from soil moisture limited areas (EMEP). 2019

Combined measurement-model global maps of deposition

Measurement (2000-2002)



Model (2001 Ensemble Mean)



Vet et al. 2014. A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorous, *Atmospheric Environment,* 93: 3-100.

EMEP model development: local versus long range transport

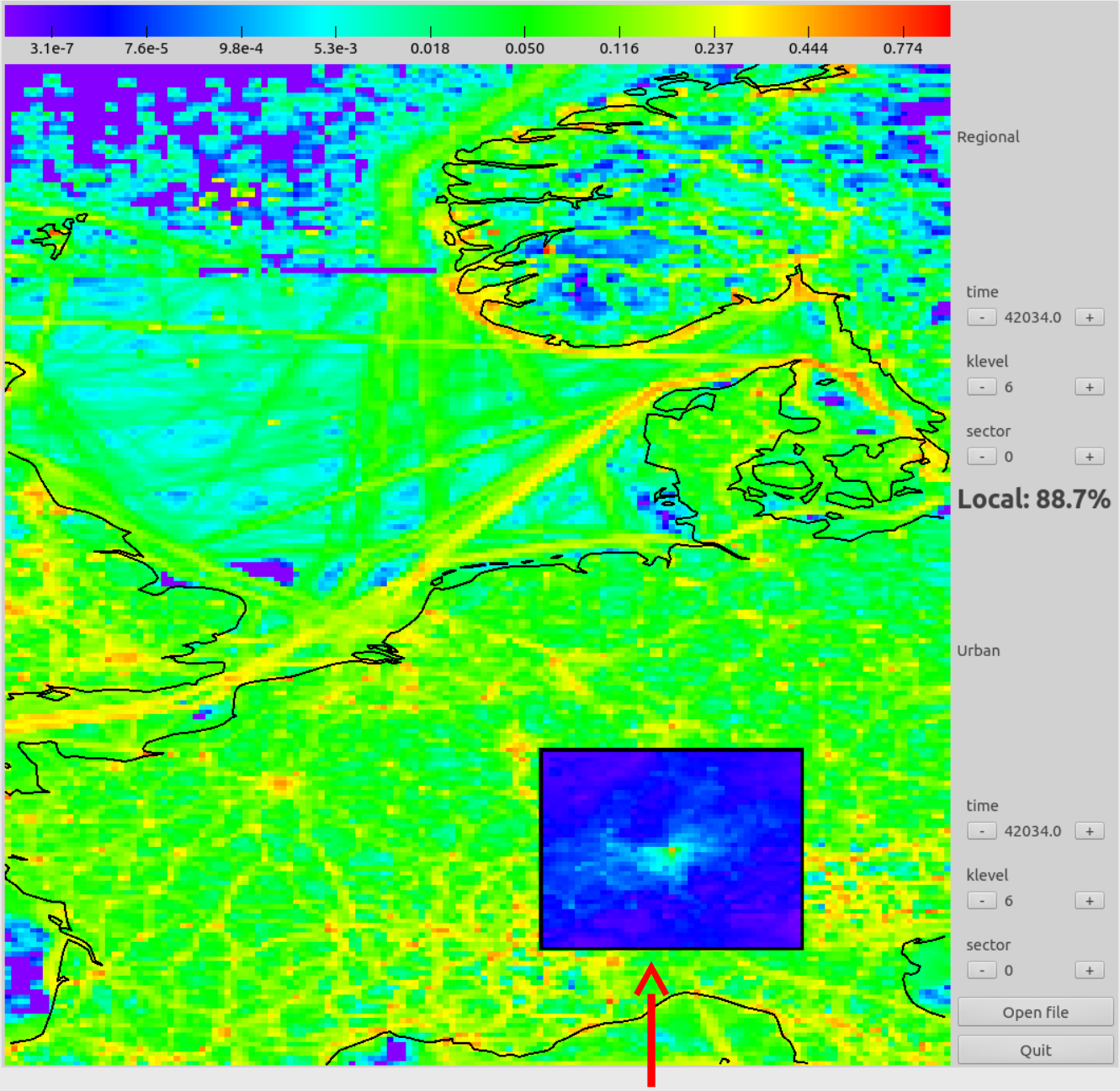
- The model computes the fraction of a pollutant that has its origin in a given gridcell
- For a particular emitted pollutant and sector:

$$\text{Local fraction} = \frac{concentration\ resulting\ from\ emissions\ in\ local\ grid}{total\ concentration}$$

Principle of the method

- The fraction of pollutant from a given origin (emission source) is stored in memory (similar to tag pollutants with its source).
- The values are updated at each timestep, so that they are consistent
- A large number of sources can be stored
- Uses more memory, but scales with the number of CPU
- Order of magnitude: 10 times more CPU time for contributions from 1000 neighboring gridcells
- Only for NOx and PPM
- Work in progress!

Local contribution



Contributions from all cells to centre cell within 4x4 degree, Available for all grid cells

Applications (tbc)

- Downscaling
- Different vertical profiles for local and background pollutants
- Better modelling of depositions (??)
- Better estimation of surface concentrations (health effects)
- Better understanding of origin of pollutants
- Tool for choosing a city/region and calculate on-line local/non-local contribution per sector (Missing – the down-scaling)
- Twin-sites
- To be used in a ‘Framework’ for local vs. LRT policies?

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