LRTAP
Long-range Transboundary Air Pollution

Task Force on Hemispheric Transport of Air Pollution

LRTAP in a Global Context

TF HTAP and collaborative efforts

Co-Chairs

Frank Dentener, PhD — EC JRC

Terry Keating, PhD — U.S. EPA

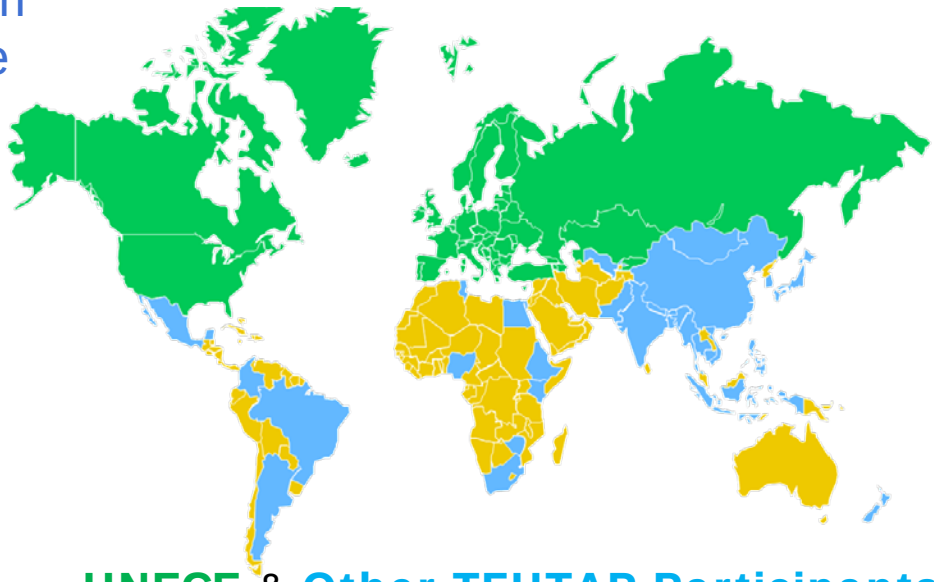
Saltsjöbaden VI Workshop, March 12-14, 2018

www.htap.org

Task Force on Hemispheric Transport of Air Pollution

The TF HTAP, an expert group, was established by the LRTAP Convention in 2005 under the leadership of the EU and the USA to examine the transport of air pollution across the northern hemisphere and its impacts on air quality, human health, ecosystems, and near-term climate change.

- Assess potential emission mitigation options available inside and outside the UNECE region.
- Collaborate with other groups both inside and outside the LRTAP Convention, including international organizations such as UNEP, WMO, WHO, CCAC, and AMAP, etc.
- Reach out beyond the Convention and build a common knowledge base.

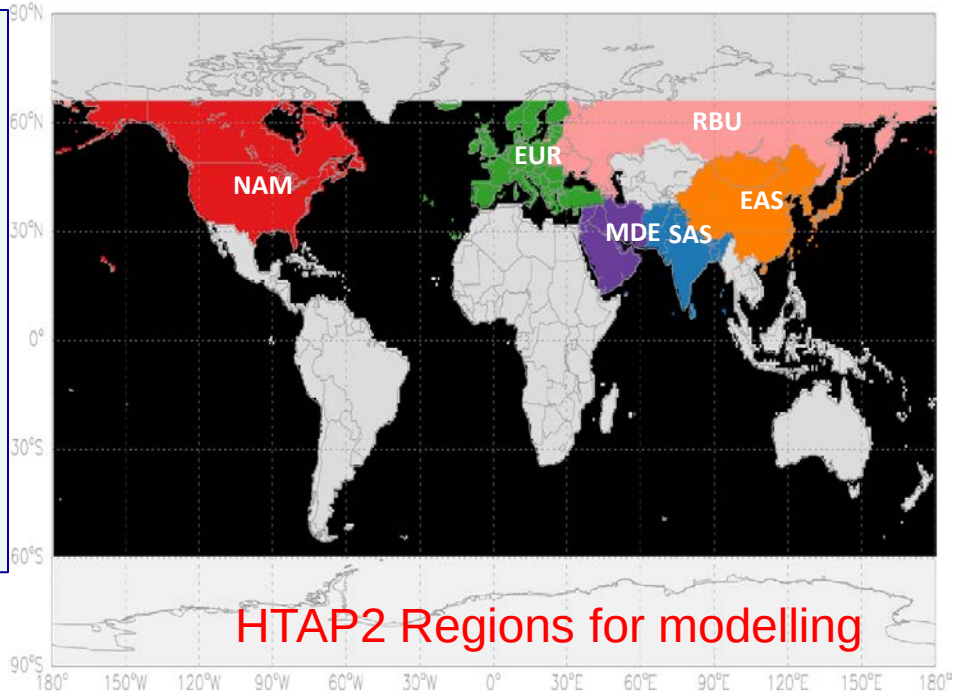


UNECE & **Other TFHTAP Participants**

- Experts participate from European, North American, South and East Asian, African and Latin American countries and use the developed information in their own policy contexts.

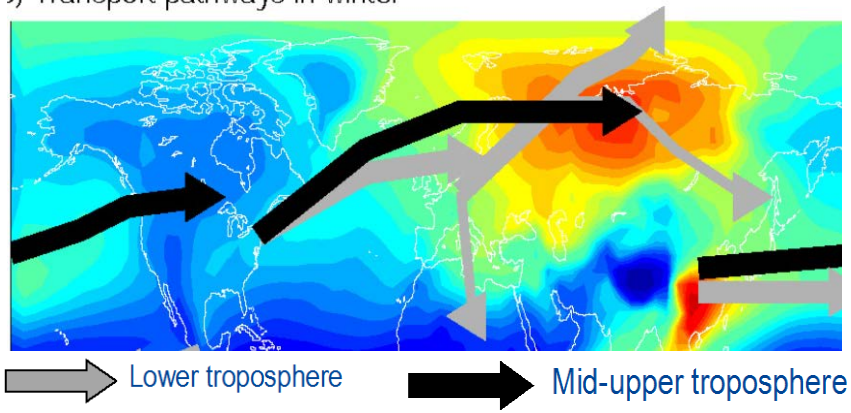
Hemispheric Transport of Air Pollution

- 6 world regions cover ca. 60-70 % of the global human-related air pollutant emissions. These create air pollution problems locally and 1000s of kilometres downwind.
- Pollutants produced in Asia are transported to North America, North American emissions are transported to Europe, etc.
- Within one month the atmosphere in the Northern Hemisphere is mixed.



HTAP2 Regions for modelling

) Transport pathways in winter



- Pollutants of concern include ozone and its precursors, particulate matter + components, mercury, and persistent organic pollutants.
- Methane is a special case. It stays in the atmosphere for about 10 years and is both a greenhouse gas and precursor to ground-level ozone.

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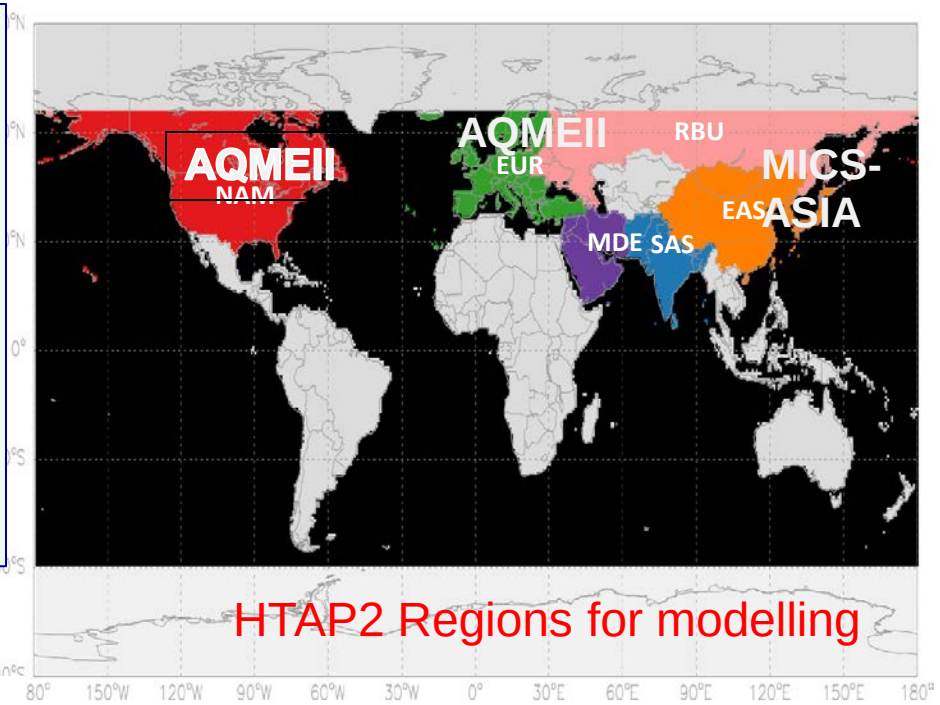

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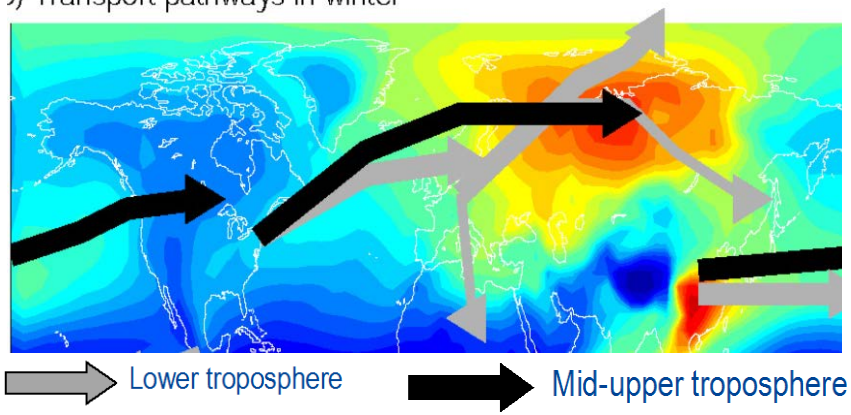
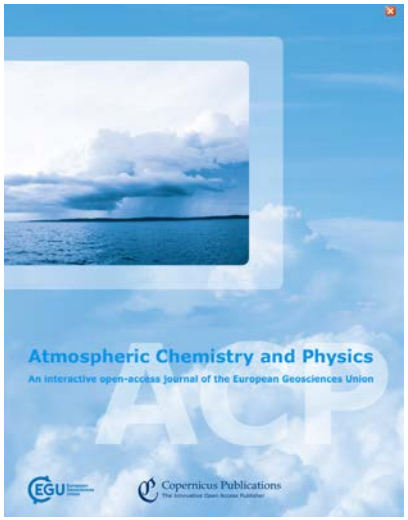


- **Global** and **regional** model simulations (2008-2010), evaluate with observations, emission perturbation simulations to provide parameterized S/R relationships to estimate impacts of future strategies.
- 5-10 global models
- Ca. 15 regional models within AQMEII and MICS-Asia regional modelling projects

Special Issue of Atmospheric Chemistry and Physics



Results from Global and regional assessment of intercontinental transport of air pollution: results from HTAP, AQMEII and MICS-Asia.

- Addressing a set of HTAP policy-science questions
- Open to all analyses relevant to quantifying extra-regional influences
- Closed January 31, 2018.
- 25 articles published in ACP
- 20 articles in open review in *ACPD*

Thematically:

- Emissions: 6 articles
- Aerosol and climate: 8+5 articles
- Impacts (health, deposition): 2+4 articles
- Transport and processes: 6 articles
- Model evaluation methods: 5 articles

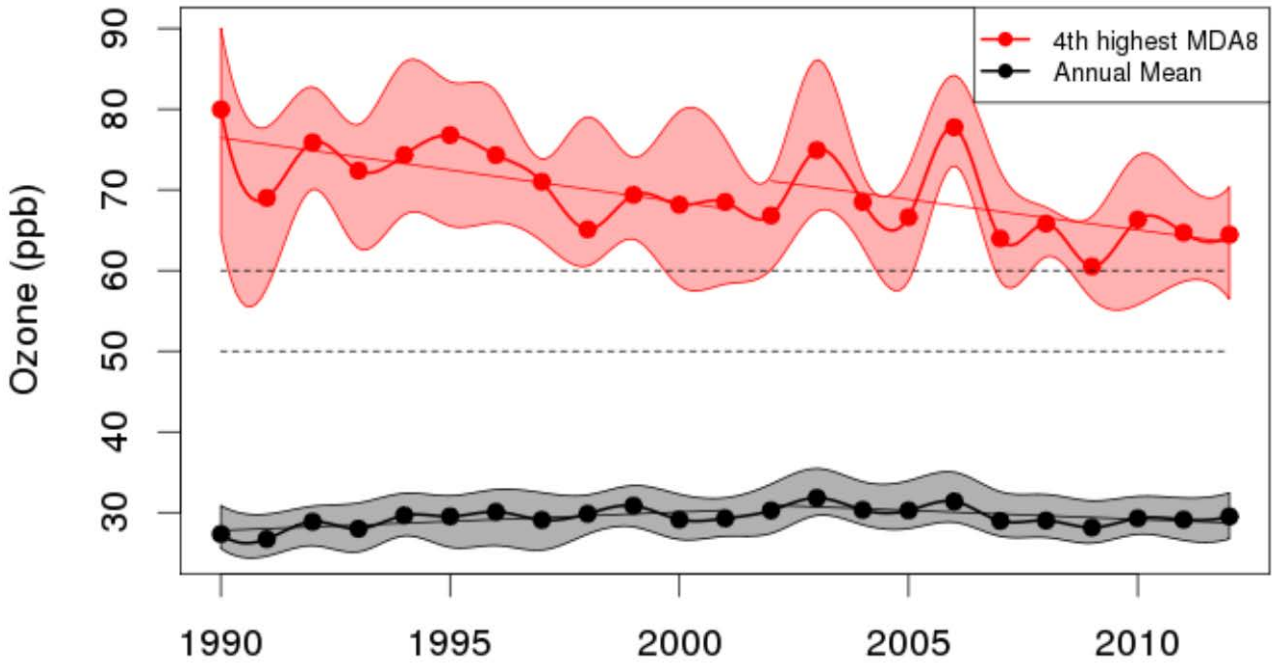
Geographically:

- 10 on Europe, 7 on North America, 9 on Asia, 3 on Arctic, 1 Africa,
- 12 global

Overview paper with highlights and main conclusions in preparation.

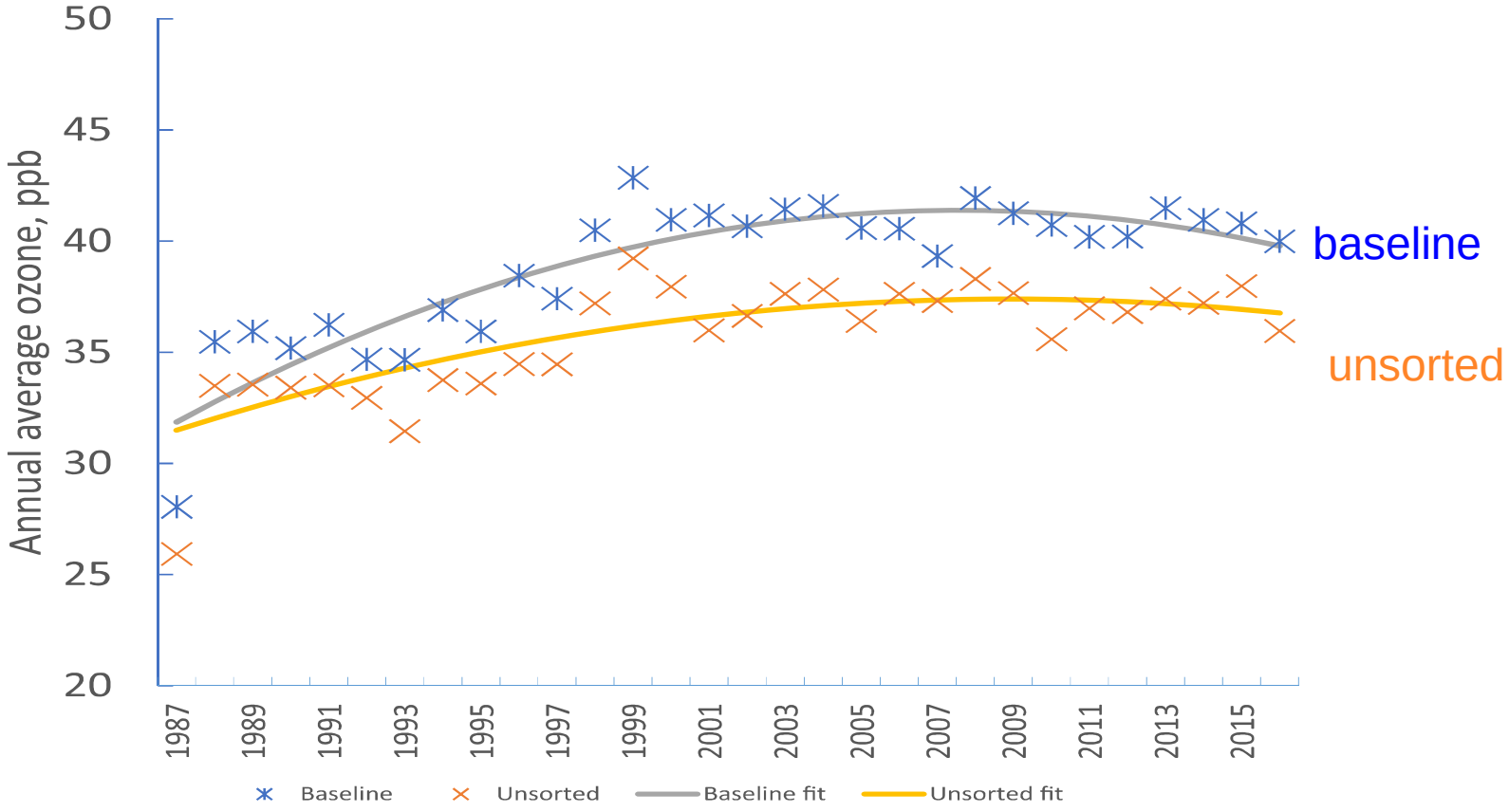
Ozone trends in Europe- CLRTAP 2016 Assessment Report

Daily maximum of 8 hour running mean MDA8 annual trend ppb/yr



- 55 stations, more coverage in Northern Europe
- In Europe peak values decline, annual average O_3 no obvious trend.
- Ca. 50-90 % of trends at individual stations insignificant (depending on metric/period)
- What is the role of hemispheric transport and other factors?

1987-2016 baseline O_3 at Mace Head, Ireland (Derwent et al. 2018)

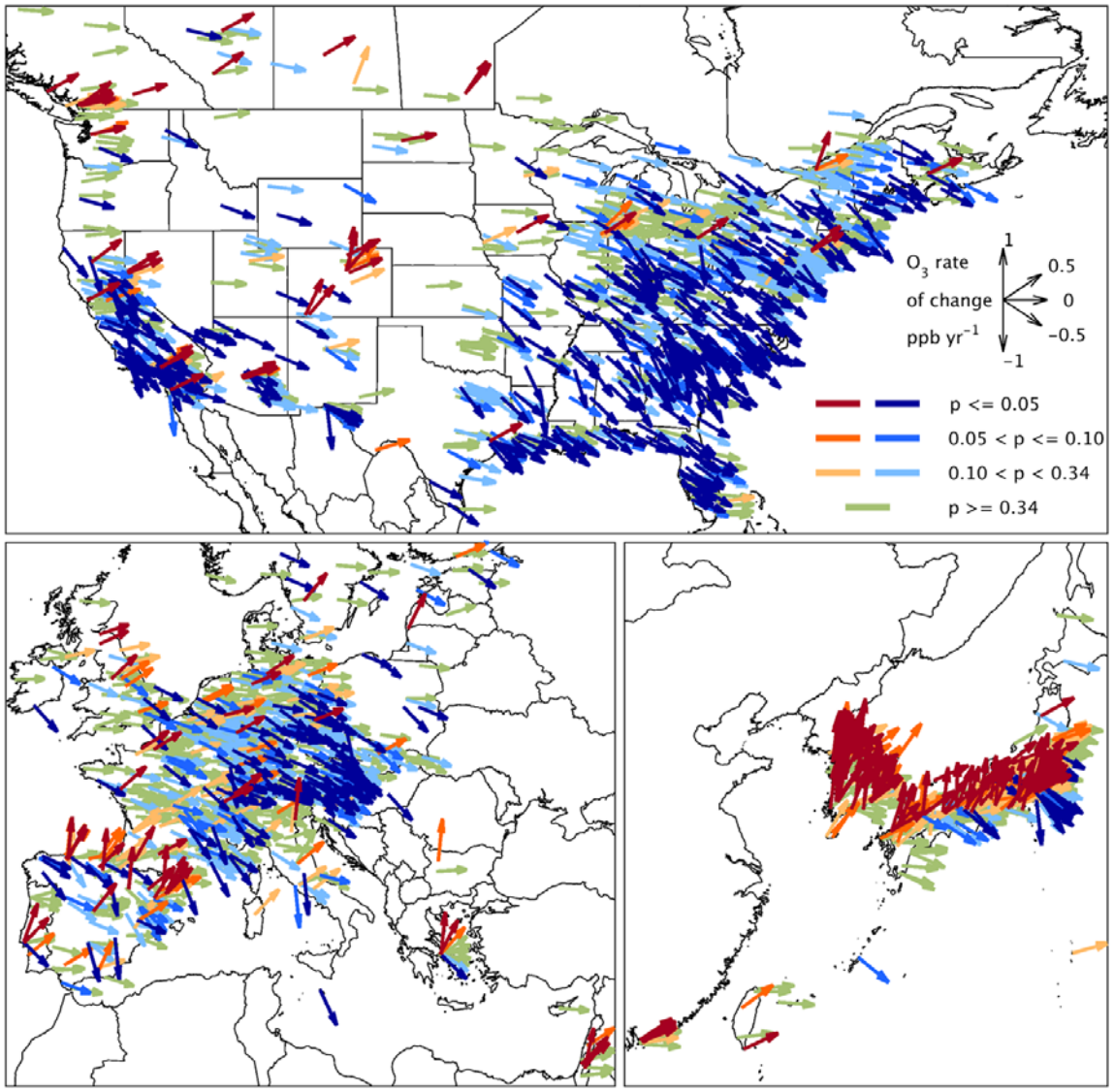


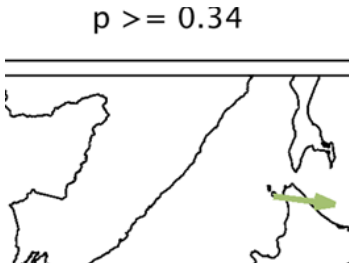
"Baseline (clean sector) and annual ozone at Mace Head increased in the 1980s and 1990s, was stable in the 2000s and started to decline after 2010"

What is the role of hemispheric transport and other factors?

TOAR: Tropospheric Ozone Assessment Report

Trend in April-Sept. summer daytime ozone for 2000-2014

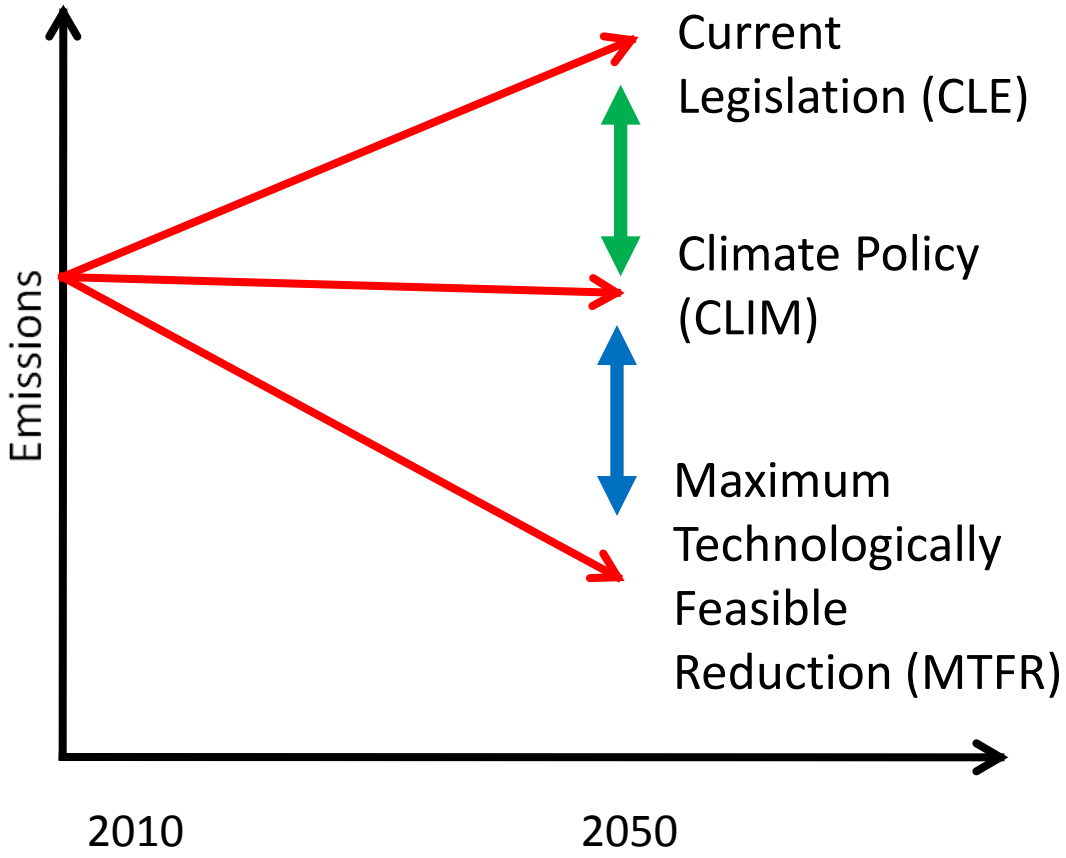




- Summer O_3 in Eastern US and parts of Europe strongly declines by 0.5 ppb/year
- Asia- downwind of China: large increases by 0.75-1 ppb/year
- In Europe AOT40 at 35 % of stations declines, and at 15 % increases (Mills et al. 2018).
- Satellite observations of tropospheric ozone are now more consistent and within 4 %. But disagree on trends.

Chang et al., Elementa, 2018

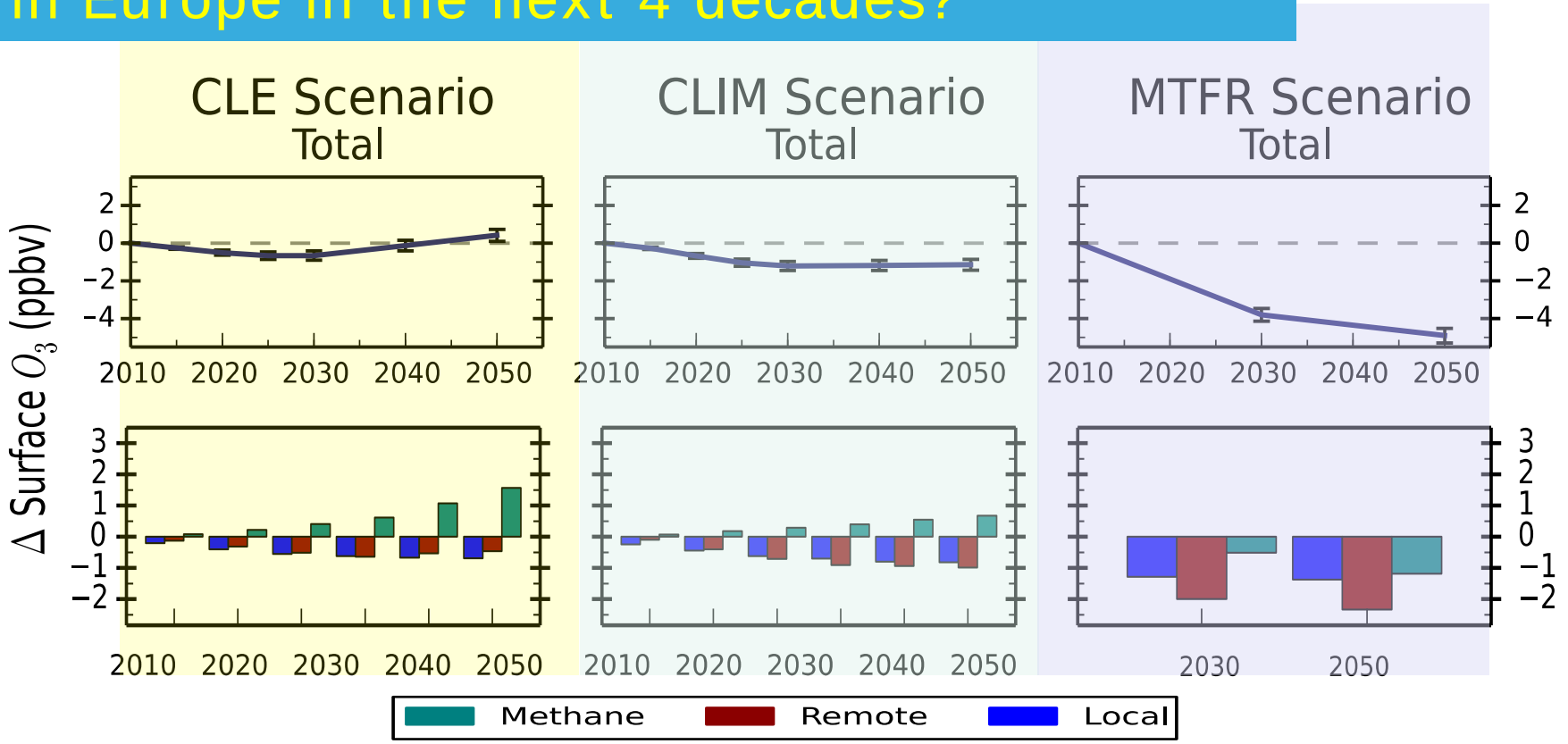
HTAP Air Pollution Benchmark Scenarios



Policy Relevant Questions
CLE: Given current policies, what are emissions likely to be in the future?
CLE-CLIM: What is the benefit of implementing climate policies for air pollution? Focus on energy
MTFR: What technology and policy options will be available (at a reasonable cost) to further mitigate pollution problems in the future?

3 HTAP scenarios for expected ozone changes in Europe in the next 4 decades?

Turnock et al.
ACPD, 2018

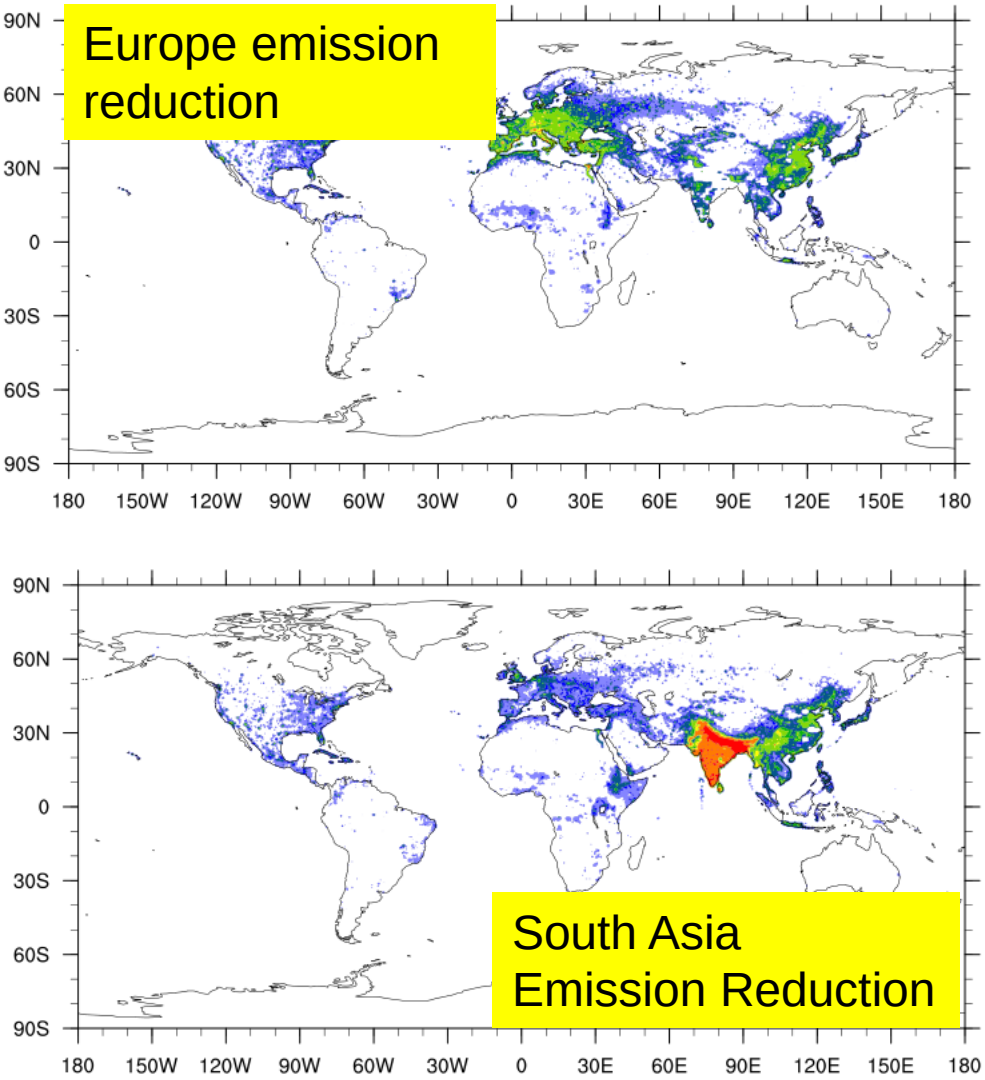


CLE: O_3 in Europe will be reduced as a result of European and North American air pollution legislation. However, increasing CH_4 will more than offset other emissions decreases after 2030.

CLIM: Decreased CH_4 emissions from the energy sector will help to stabilize the O_3 concentrations after 2030. Climate policy also helps reducing pollutant emissions

MTFR: Enhanced technologies inside and outside Europe will decrease emissions of O_3 precursors, including CH_4, and have strong benefits for air quality.

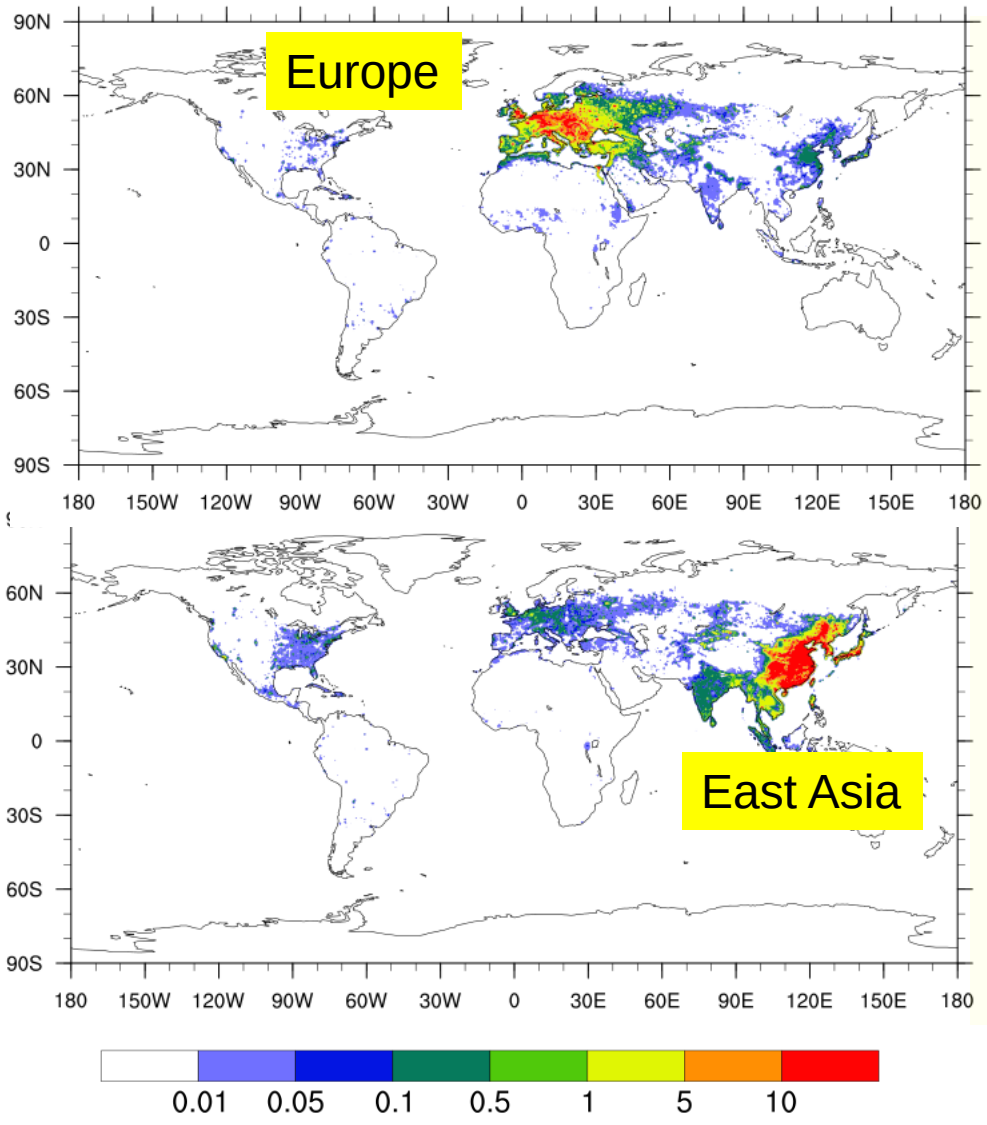
Avoided ozone premature deaths by 20 % regional emission reduction



- HTAP2 estimated O_3-related mortality worldwide 290,000
- Reducing all O_3-precursor emissions by 20 % (excluding CH_4) would save 47,400 lives worldwide, about half in South Asia.
- Reducing O_3-precursor emissions in North America, Europe, Middle East and Russia/Ukraine have similar or larger impacts outside than within the region.
- Reducing emissions avoids 10,300 deaths by inter-regional atmospheric transport of ozone

Liang et al 2018

Avoided $PM_{2.5}$ premature deaths by 20 % regional emission reductions



- HTAP estimated $PM_{2.5}$-related mortality worldwide 2.8 million
- Reducing global emissions by 20 % saves 334 thousand deaths/yr, of which 40 % in East and South Asia.
- $PM_{2.5}$ inter-regional atmospheric transport of $PM_{2.5}$ 42,000 PD.
- O_3 inter-regional atmospheric transport (10,000)
- $PM_{2.5}$ transport influences mortality more strongly than O_3- due to higher dose-response relationships
- Large uncertainties- e.g. an ensemble of European models with IAV estimates twice higher $PM_{2.5}$ health impacts for the same emissions and year.

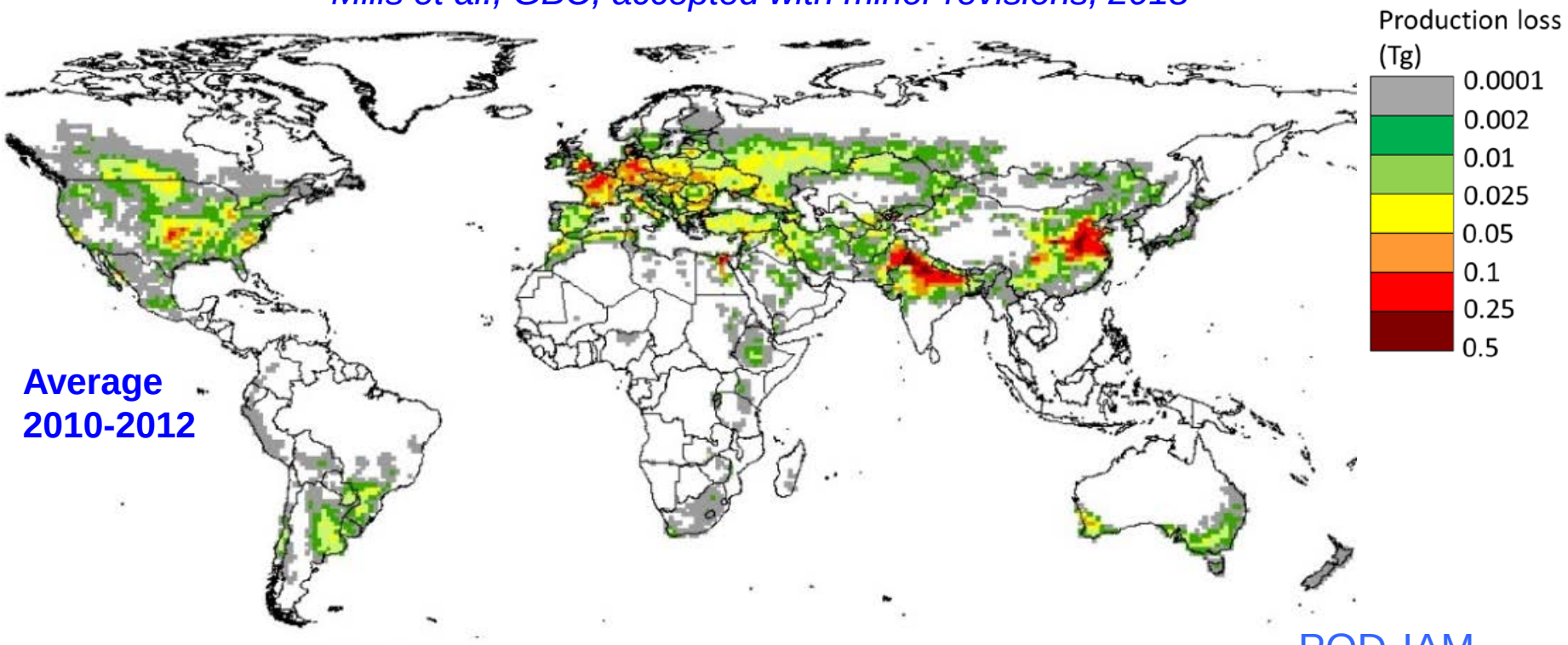
Liang et al 2018; Im et al, 2018

12 PM2.5 premature deaths per 1000 km^2

Global ozone flux-based assessment wheat yield loss

(in collaboration with EMEP/MSC-West, ICP VEG)

Mills et al., GBC, accepted with minor revisions, 2018



POD_3IAM, weighted by proportion rain-fed & irrigated

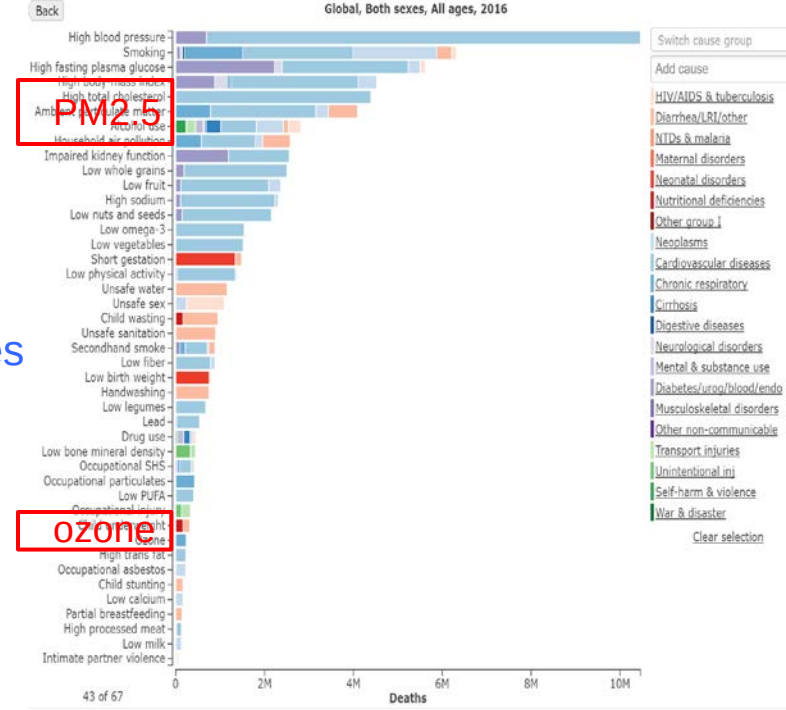
- Mean global yield loss: 9.4% (worth $24 billion)

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Contact: Harry Harmens (hh@ceh.ac.uk)

NERC SCIENCE OF THE ENVIRONMENT

Global Burden of Disease Project- 2017



- Ambient air pollution ($PM_{2.5}$, O_3) a leading risk factor, e.g. $PM_{2.5}$ 4.1 million deaths (**7.5% of global total**)
- Annual updates
  - Each update recreates 1990 - present time series
  - Exposure methodology ~identical to WHO
  - $PM_{2.5}$: Satellite-based estimates + ground monitors (WHO database +) in Bayesian Hierarchical Model
  - O_3: Multi-model blend with bias correct from ground monitors (TOAR)
- Compilation of available ground measurements $PM_{2.5}$, Ozone (and potentially NO_2) extremely important

Global Burden of Disease – potential future directions

- Strong interest in **global** source sector attribution (e.g. GBD-MAPS*)
- CTM, future emissions scenarios
- Increasing emphasis on finer-scale resolutions- Currently 0.1 ° x 0.1 °
- Short-term ozone (exacerbation of disease)
- NO_2 (within-city variation / Traffic-related air pollution)
- Mercury
- Participation of LRTAP community in database development /curation VERY welcome

Contact: Mike Brauer, Canada

LRTAP and global cooperation: role of TF HTAP

TF HTAP tries to:

- Provide policy relevant information to the UNECE/CLRTAP, the EU, western US,..
- Collaborate with most relevant organizations- i.e. AMAP, IGAC/GEIA, UNEP, GBD, ….but are we managing to build bridges to regional activities?
- Create common understanding on hemispheric transport issues, emissions, modelling methodologies and evaluation, tools,….
- Provide collaborative opportunities to scientists - without funding –

… and of course should improve on many issues….

- Resources are limited…how can other bodies in the convention contribute to global cooperation?

Take Home Messages

- The HTAP2 assessment estimates relative contributions of regional and extra-regional air pollution, characterizes uncertainties, and give inputs to assessments of impacts and control strategies. Coordinated with AQMEII and MICS-Asia, 45 publications in *Atmospheric Chemistry& Physics* provide a wealth of new information since HTAP2010 report.
- HTAP emission inventory shows the increasing significance of air pollutant and CH_4 emissions from developing countries, in 2010 contributing by ca 70-80 % to the global total.
- Global increases in methane emissions can offset local emissions reductions (or amplify local emissions increases) to increase ground level ozone pollution. Greenhouse gas mitigation policies will help decrease air pollutant emissions +methane, but more can be done (MFR).
- Intercontinental PM2.5 transport more premature deaths than ozone- large uncertainties.
- Technology to mitigate air pollution emissions exists and government action (and cooperation) is needed to implement effective strategies. Mitigation potential and economic analysis are two fields of future work.

THANK YOU

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