Task Force on Hemispheric Transport of Air Pollution

HTAP2: Black Carbon and Ozone Results and Next Steps

Co-Chairs

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Vice Chairs

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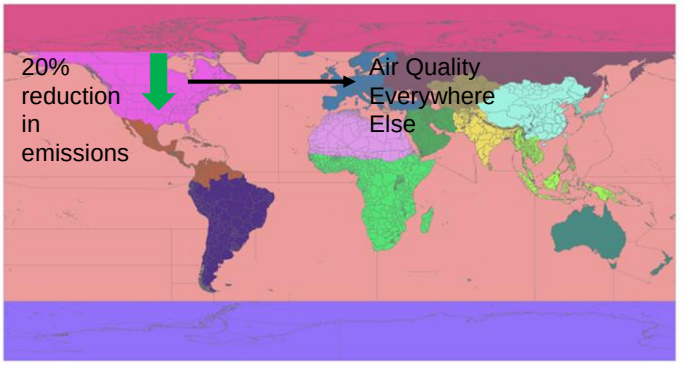
24 October 2019

Task Force Goal:

- Foster international scientific cooperation to improve understanding of intercontinental transport of air pollution across the Northern Hemisphere
  - How do changes in emissions in one part of the world affect air quality in other parts of the world?
  - How do extra-regional emissions affect human and ecosystem health within a given region?

HTAP2: A Suite of Cooperative Experiments

- 2010 Global Emissions Inventory, 2010 meteorology, ~15 global models
- Examined response of 20% reduction in anthropogenic emissions from one source region on air quality in the other source regions



All
NOX
CO
VOC
NH3
PM
Transport
Power and Industry
Residential
Other
Fire
Dust

Atmospheric Chemistry and Physics
An interactive open-access journal of the European Geosciences Union

Special issue

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

Editor(s): F. Dentener, S. Galmarini, C. Hogrefe, G. Carmichael K. Law, B. R. D. Denby, and T. Butler

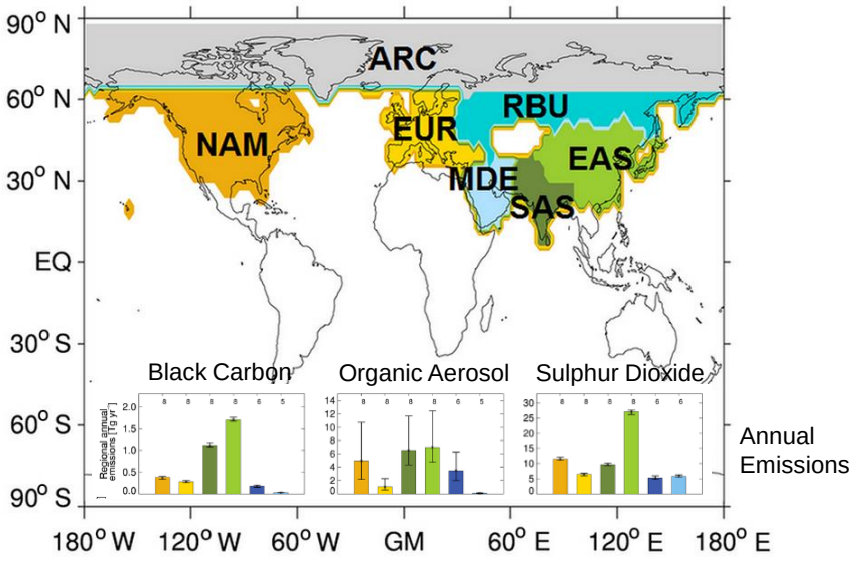
Global and regional radiative forcing from 20 % reductions in BC, OC and SO_4 – an HTAP2 multi-model study

Camilla Weum Stjern[1], Bjørn Hallvard Samset[1], Gunnar Myhre[1], Huisheng Bian[2], Mian Chin[3], Yanko Davila[4], Frank Dentener[5], Louisa Emmons[6], Johannes Flemming[8], Amund Søvde Haslerud[1], Daven Henze[4], Jan Eiof Jonson[7], Tom Kucsera[9], Marianne Tronstad Lund[1], Michael Schulz[7], Kengo Sudo[10], Toshihiko Takemura[11], and Simone Tilmes[6]

Atmos. Chem. Phys., 16, 13579–13599, 2016
www.atmos-chem-phys.net/16/13579/2016/
doi:10.5194/acp-16-13579-2016

- Of the ~15 models that participated in HTAP2, 10 included a treatment of aerosols
- Stjern et al., used these experiments to assess the impact of a 20% reduction in all anthropogenic emissions from one source region on levels of black carbon (BC), organic aerosols (OA) and sulphate (SO_4) everywhere else (including in the region where the emissions reduction was applied)
- From these BC, OA and SO_4 model outputs, they estimated the effect of reducing emissions on radiative forcing (RF) from the direct aerosol effect
- *Does not include indirect aerosol effects (clouds) or effects of deposition (snow albedo).*

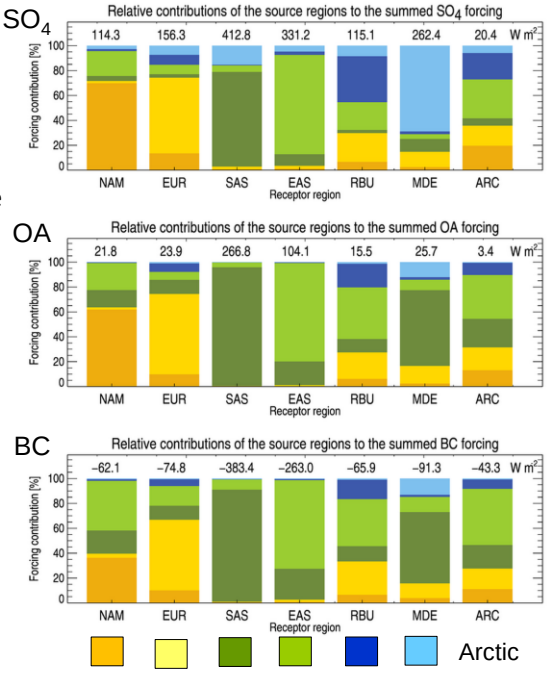
Source-Receptor Regions Analyzed



C.W. Stjern et al., 2016

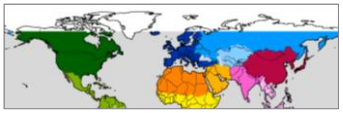
Results

- In most cases, the local influence dominates
- <u>But</u>, emission reductions in south (SAS) and east Asia (EAS) have substantial impacts on the radiative budget of all investigated receptor regions, especially for black carbon (BC)
- For North America, BC emission controls on east Asia (EAS) sources are more important than domestic mitigation



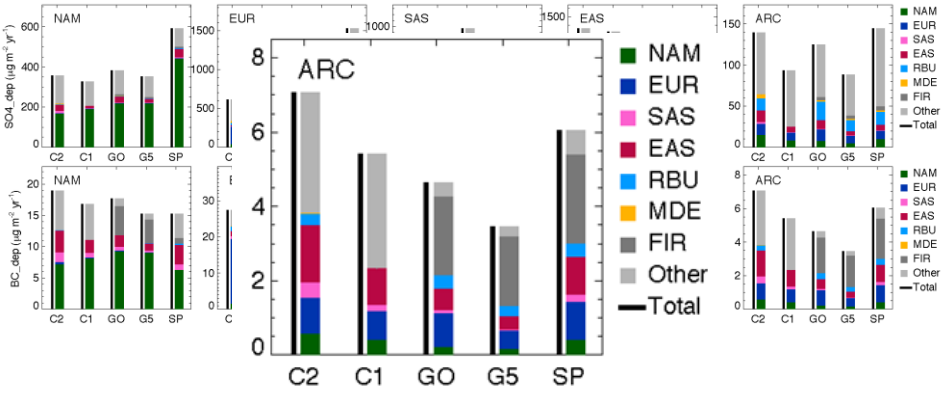
Middle East
Russia
East Asia
South Asia
Europe
North America

From: Chin 2017 Presentation to TF HTAP Meeting, North Carolina



Source Attribution – total deposition

Note: biomass burning (FIR) source attribution only available in GO, G5, and SP.
For other models, contribution from FIR is included in "Other" sources



- Only 3 models saved total OA deposition, so it is not shown here
- Models are more similar in total deposition than in surface concentrations (except one model in some cases)
- Depositions in the source regions are generally dominated by regional pollution sources except SO4 in EUR
- Over the Arctic, NH mid-lat non-BB anthropogenic source contributes to no more than half of the total deposition

For O_3, HTAP2 has also examined different methods for source attribution:

- Emissions Sensitivity (i.e., 20% reductions)
- Adjoint Modeling
- Chemical Species Tagging

TOAST 1.0: Tropospheric Ozone Attribution of Sources with Tagging for CESM 1.2.2

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Geosci. Model Dev., 11, 2825–2840, 2018
https://doi.org/10.5194/gmd-11-2825-2018

Source attribution of European surface O_3 using a tagged O_3 mechanism

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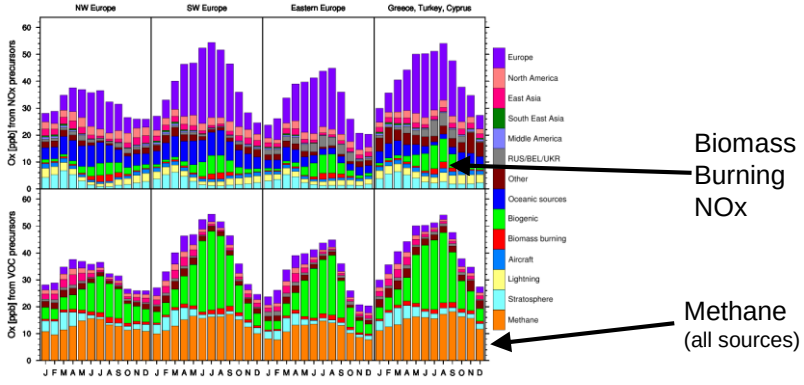
Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-225
Manuscript under review for journal Atmos. Chem. Phys.
Discussion started: 29 April 2019

Key Messages

- Intercontinental transport of ozone dominates over intercontinental transport of particulate matter (PM)
- Background ozone is very sensitive to methane concentration

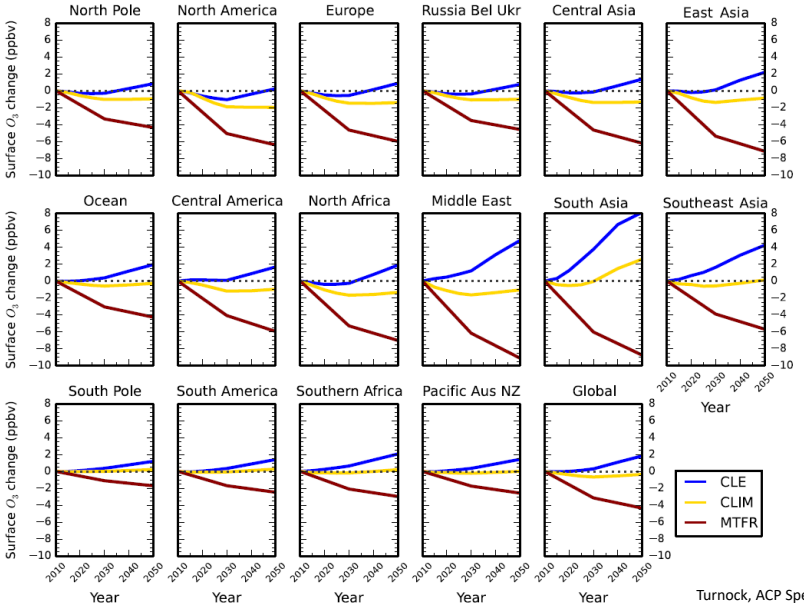
Seasonal cycle of surface ozone: Europe



Future Scenarios

Annual Average Surface O_3 Change 2010-2050

based on parameterizations of HTAP2 ensemble

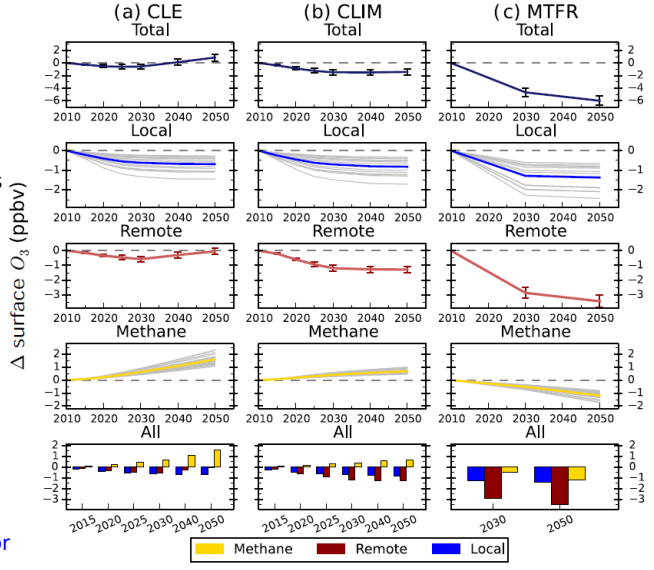


Turnock, ACP Special Issue

Future Scenarios

Regional and Extra-Regional Components of Change in Europe

- CLE: O_3 in Europe will decrease as a result of European and (mainly) North American air pollution legislation. Increasing CH_4 will more than offset other emissions decreases after 2030.
- CLIM: Decreased CH_4 emissions and cobenefits from the energy sector will help to stabilize the O_3 concentrations after 2030.
- MTFR: Enhanced technologies inside and outside Europe will decrease emissions of O_3 precursors, including CH_4, and have strong benefits for air quality.



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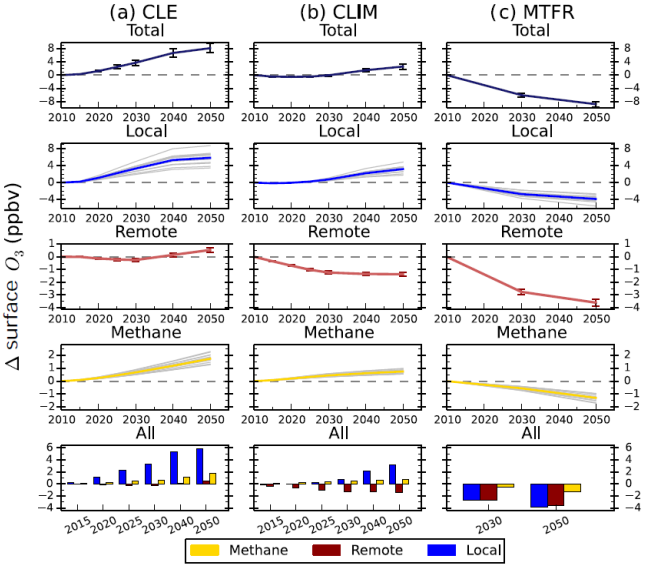
Future Scenarios

Regional and Extra-Regional Components of Change in S Asia

- CLE: O_3 in South Asia will strongly grow as a function of local air pollutant emissions.
- CLIM: Climate policies will decrease O_3 through co-benefits on local air emissions and decreasing CH_4 emissions.
- MTFR: Clean technologies in South Asia and elsewhere, and global decreases in CH_4 emissions all contribute substantially to decreased O_3, with large benefits for health and crop production.



Turnock, ACP Special Issue

Next Steps: HTAP3

1) Updated Harmonized Global Emission Inventory
   - Global Emissions Mosaic Update (HTAPv3)
     - GEIA Meeting, Chile, ~~November 2019~~ 15-17 April 2020
     - How might we address agricultural burning?

2) Improve our understanding of the relationship between global methane emissions, intercontinental transport of ozone and human and ecosystem health
   - Workshop, Edinburgh, 22-24 April 2020, with TOAR, ICP Veg, AQMEII, MICS, CCAC/UNEP …

3) Continued Development of the openFASST Tool
   - For Global Scenario Analysis and Uncertainty Assessment
   - Could agricultural burning mitigation as a scenario option?

4) Foster discussion/scientific work on the following topics:
   - Extra-Regional Attribution of O3, PM Trends for Gothenburg Review
   - Impacts of Shipping
   - Taking Stock of Progress in Other Forums, Identifying Policy Relevant Needs