Task Force on Hemispheric Transport of Air Pollution

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HTAP3-OPNS

Multi-model simulations of Ozone, Particles, and deposition of N and S

Global to regional downscaling of ozone in support of the revision of the CLRTAP Gothenburg Protocol

Tim Butler (co-chair TF-HTAP)

TFMM Annual Meeting, Warsaw, May 6, 2024

TF-HTAP and TFMM joint workplan items ('24-25)

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1.1.1.7	On basis of recent evidence, long- term trends and uncertainty in future projections, provide insight into robustness of modelled long-term O3 projections in relation to CH4 mitigation	Synthesis of O3 mitigation options	TFHTAP, TFMM, MSC- W
1.1.3.0	Contribute to Gothenburg Protocol revision as mandated by Executive Body	Pending decision by Executive Body in December 2023	TFIAM, CIAM, TFMM, MSC-W, CCC, TFHTAP, CCE, WGE
1.1.3.2	O3 modelling of future scenarios	Organize new global model simulations of future scenarios developed by CIAM, including examination of role of CH4, source attribution methods, link to regional scale and impacts	TFHTAP, TFIAM, CIAM, TFMM, MSC-W, ICP Vegetation
1.1.4.2	Organize new global and regional model simulations of historical trends and future scenarios for Gothenburg Protocol pollutants with assessment of human health and vegetation impacts	Initial findings assessment (2025)	TFHTAP, TFMM, MSC-W, CIAM, ICP Vegetation

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General features of HTAP3-OPNS

- Focus on ozone, particles, and the deposition of N and S
  - Assessment of scenarios from the GAINS model
  - How to include methane in the revised Gothenburg Protocol?
  - Quantify and understand the model spread in surface ozone response
- Seeking input from different modelling systems
  - Traditional CTMs and ensemble emulators (as for previous HTAP assessments)
  - Coupled chemistry-climate models
  - **Global-regional downscaling**
- White paper: https://nextcloud.gfz-potsdam.de/s/NqgxtQb6ELJw76S

HTAP3-OPNS White Paper

1. Motivation
2. Science-Policy Questions
3. Experimental Design
4. Input Data Sets
5. Requested Output Data
6. Timelines
7. Links with Other Multi-Model Activities

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HTAP3-OPNS work streams

- Future scenario simulations
  - Transient Global Chemistry-Climate simulations
  - GAINS LRTAP future scenarios for 2010-2050
  - Assessment of future air quality including the role of methane
- Source/receptor (perturbation) simulations
  - Global CTM simulations
  - Source-receptor relationships based on GAINS LRTAP scenarios
  - Ensemble emulator for rapid scenario assessment

Supporting the revision of the Gothenburg Protocol

- Historical transient simulations
  - Specified dynamics / CTM simulations
  - 2000-2020 using the HTAPv3.1 global emission mosaic

Supporting ongoing HTAP work

GAINS LRTAP future scenarios (2010-2050)

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- Scenarios developed by IIASA/CIAM to inform the review of the Gothenburg Protocol
  - **CLE**
    - Includes all current air quality policies and implementation plans
    - Climate forcing broadly consistent with SSP2-4.5
  - **MTFR**
    - Same activity datasets as the CLE scenario
    - Maximum technically feasible reduction in emissions of all air pollutants (including methane)
    - Full implementation of proven measures regardless of cost effectiveness

- Hybrid scenario proposed by TF-HTAP
  - **HILO**
    - Methane from CLE and other pollutants from MTFR
    - High ambition on “Gothenburg Pollutants” and low ambition on methane

GAINS LRTAP future scenarios (GP review)

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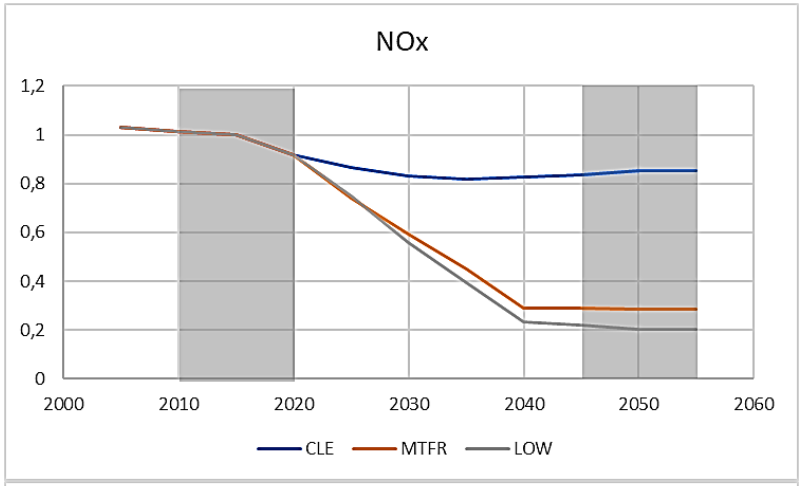
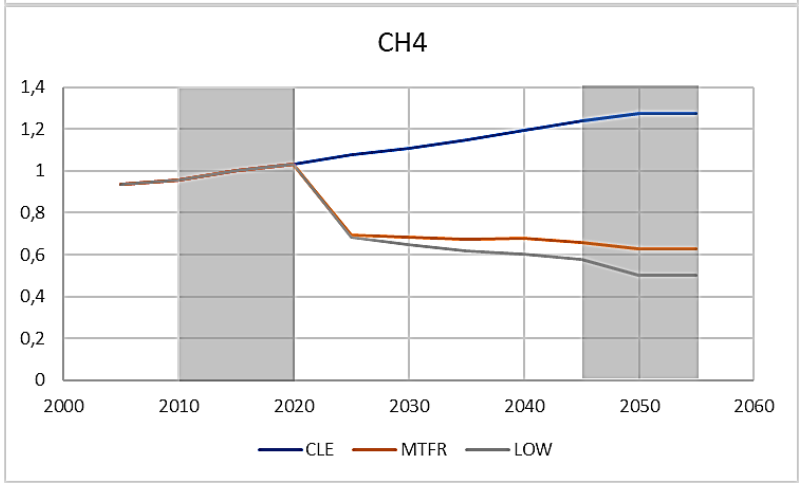
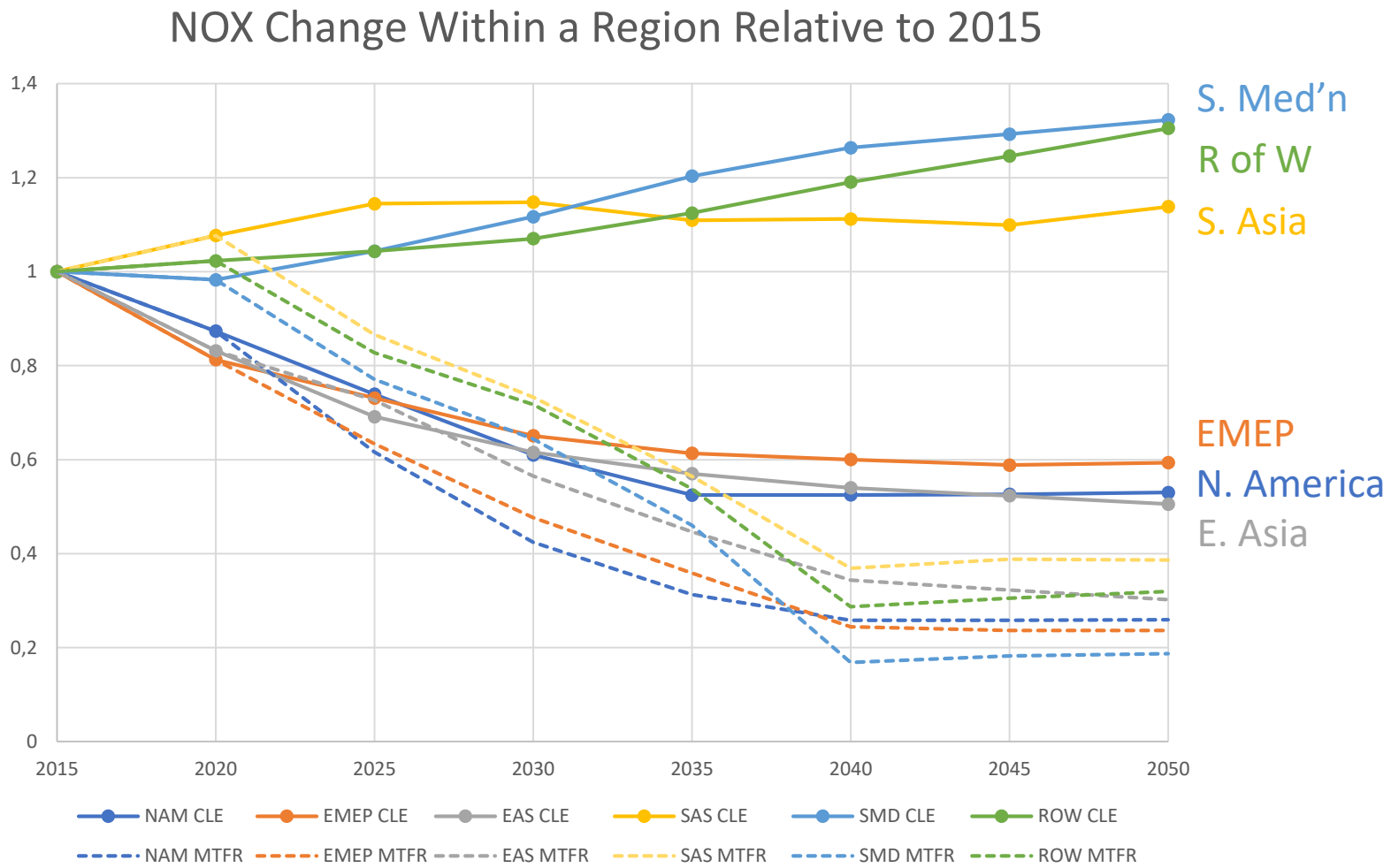
Global emissions of NOx and methane







Data from Zig Klimont

Perturbation runs and ensemble emulator development

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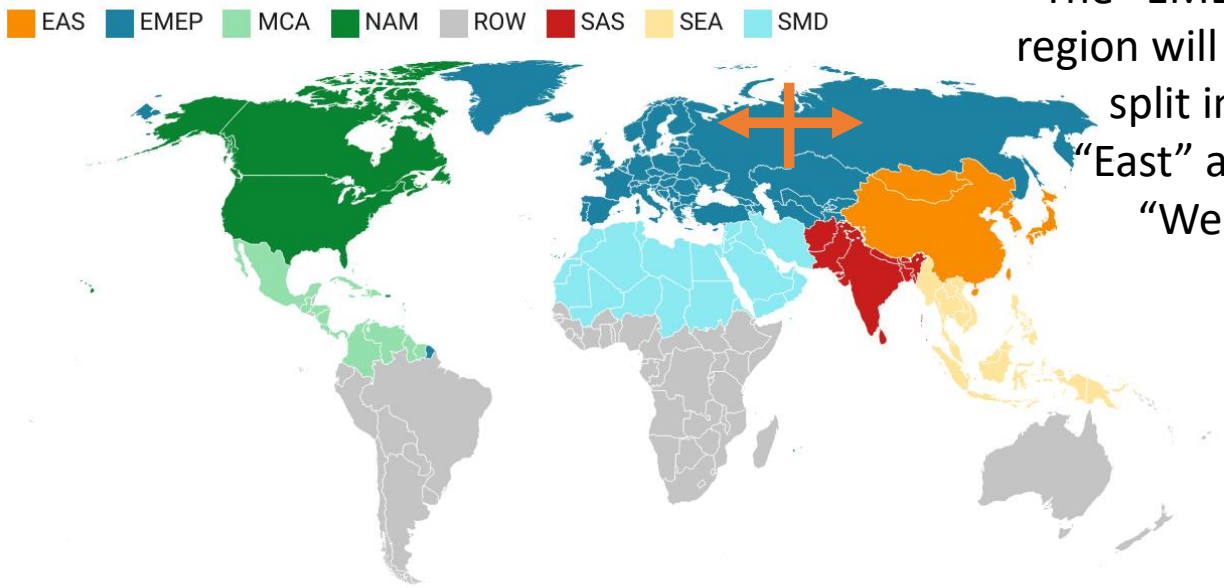
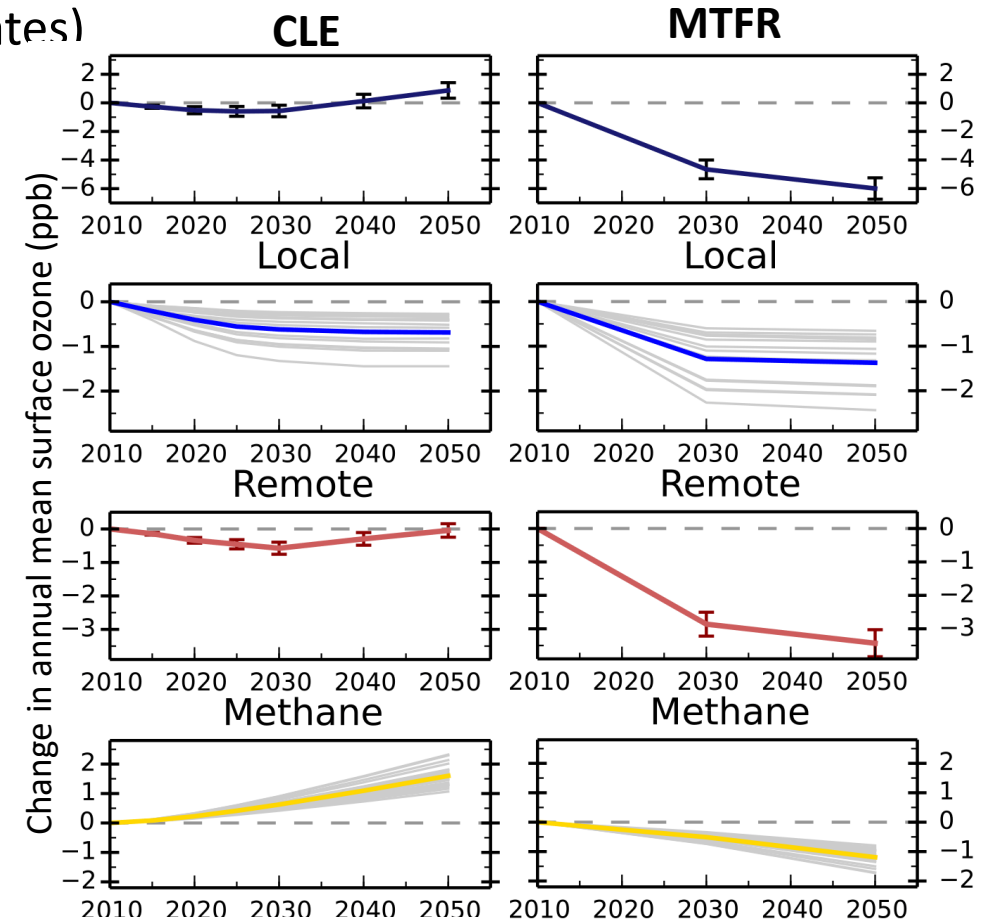
- Simulations with an ensemble of global CTMs (2015 meteorology)
  - Set of ~25 emission perturbation runs (GAINS 2050 CLE emissions)
    - Source-receptor relationships (with uncertainty estimates)
      - Emulator development

Possible HTAP3 Source Regions



The "EMEP" region will be split into "East" and "West"

Results from HTAP2 (Europe)



Results from Turnock et al. (2018) https://doi.org/10.5194/acp-18-8953-2018

Priorities for HTAP3 Simulations	2015 meteorology / 2050 emissions	
Base (CLE 2050 emissions)	BASE (CLE 2050)	1
Global Perturbations		
Increase CH4 Conc	CH4INC	
Decrease CH4 Conc	CH4DEC	1
Decrease CH4 Conc and all anthro emissions	CH4ALL	1
Decrease CH4 Conc and anthro NOx emissions	CH4NOX	
Decrease H2 conc	H2DEC	
Decrease All anthro emissions	GLOALL	1
Decrease anthro NOX	GLONOX	1
Decrease anthro VOC	GLOVOC	1
Decrease anthro CO	GLOCO	1
Global Scenario Runs		
CLE 2015 emissions	CLE2015	1
MTFR (2050)	MTFR	3
HILO (2050)	HILO	3

Highest Priority	1
Next Priority	
Lower Priority	

Global CTM runs for regional boundary conditions

Regional Emissions Perturbation (2015 meteorology, 2050 CLE emissions)		All	NOX	VOC	CO	SO2	NH3	PM
N America	NAM	1	2	2	4			
EMEP Domain	EMEP	1	2	2	4			
EMEP West	EMEPW	3	4	4	4			
EMEP East	EMEPE	3	4	4	4			
East Asia	EAS	1	2	2	4			
South Asia	SAS	1	2	2	4			
South and East Mediterranean	SMD	1	2	2	4			
Middle East	MDE	3	4	4	4			
North Africa	NAF	3	4	4	4			
SE Asia	SEA	3	4	4	4			
Mex/C America/Caribbean	MCA	3	4	4	4			
Rest of World (SAM+SAF+PAN)	ROW	3	4	4	4			
South America	SAM							
Southern Africa	SAF							
Aust/NZ/Pacific	PAN							
Inernational Shipping	SHIP	1						
Aviation	AVI	3						
Fires (all fires)	FIRE	3						

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Proposal for joint TF-HTAP / TFMM work

- TF-HTAP provides boundary conditions for the CAMS domain from four GAINS scenarios
  - CLE2015; CLE2050; MTFR2050; HILO2050
- Boundary conditions from at least three global models
  - EMEP model
  - Two other global models (“high” and “low”)
- Regional models simulate the four GAINS scenarios + one
  - CLE2050 boundary condition + MTFR2050 within the CAMS domain
- Regional model setup
  - Ozone season: April- September
  - 2015 meteorology

Proposal for joint TF-HTAP / TFMM work

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	Global model boundary condition											
	EMEP				Model A				Model B			
Regional model simulation	CLE2015	CLE2050	MTFR2050	HILO2050	CLE2015	CLE2050	MTFR2050	HILO2050	CLE2015	CLE2050	MTFR2050	HILO2050
CLE2015	x				x				x			
CLE2050		x				x				x		
MTFR2050			x				x				x	
HILO2050				x				x				x
CLE2050+MTFR2050-CAMS		x				x				x		

- Maximum number of simulations per regional model: 15 (six months April-September)
  - Prioritisation needed?

- Expected results:
  - Air pollution impacts under the GAINS scenarios
  - Role of local ozone precursors, remote ozone precursors, and methane
  - Assessment of the robustness of the results from the EMEP model
  - Comparison of the regional ensemble with the global ensemble

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Proposed timeline for this work

- July 2024
  - Revised GAINS LRTAP scenarios available
  - HTAP3-OPNS global simulations can begin
- September 2024
  - Presentation of first results using GAINS scenarios to CLRTAP
  - First set of joint TF-HTAP/TFMM regional simulations can begin
- Early 2025
  - Most HTAP3-OPNS global simulations completed
- First half of 2025
  - Remaining joint TF-HTAP/TFMM simulations can be done
- September 2025 – May 2026
  - Window for presentation of results to inform the revision of the Gothenburg Protocol

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Summary and outlook

- Opportunity for a joint TF-HTAP / TFMM contribution to the revision of the Gothenburg Protocol
  - Global-regional downscaling of GAINS LRTAP future scenarios
  - Role of European/remote ozone precursors and methane
  - Robust results due to ensembles of global and regional models
- Regional simulations to be done between September 2024 and June 2025
- Results presented to CLRTAP between September 2025 and May 2026

- Interest?