Markus Amann
Centre for Integrated Assessment Modelling (CIAM)
International Institute for Applied Systems Analysis (IIASA)

The inclusion of near-term radiative forcing into a multi-pollutant/multi-effect framework

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Air pollutants have also effects on climate change in the near-term

There are concerns about climate effects of air pollutants:

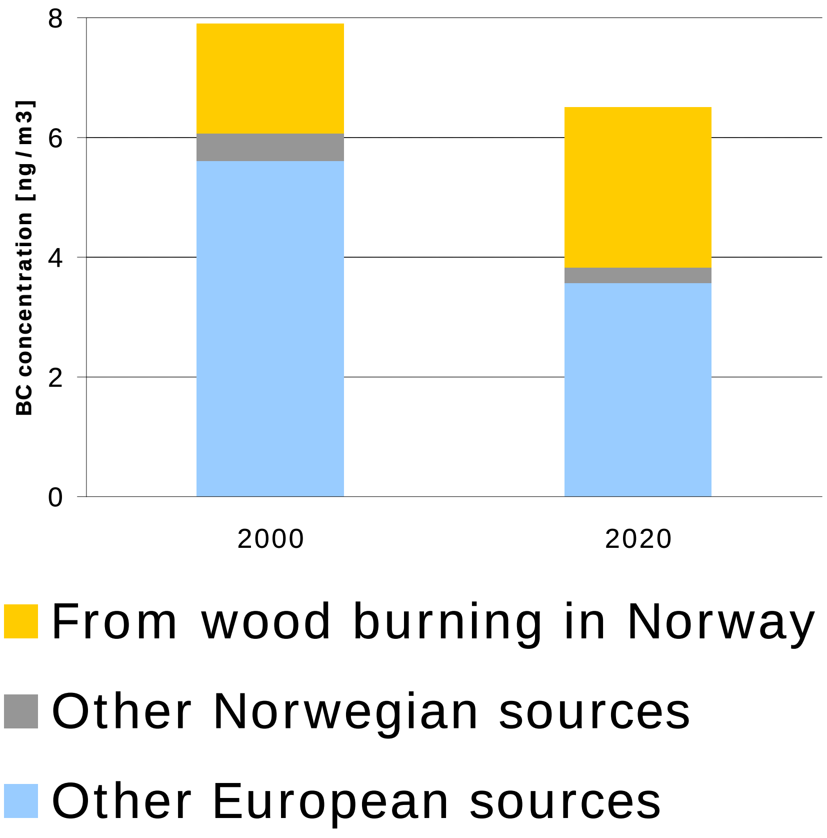
1. Near-term forcing of air pollutants
   - Warming: BC, CH_4, O_3 (i.e., CH_4, CO, VOC, NO_x)
   - Cooling: SO_2, OC

   - accelerates or delays ongoing climate change at the regional scale,
   - changes regional weather circulation and precipitation patterns.

2. Increases arctic melting through deposition of (black) carbon

BC concentrations in the Arctic

from European sources (preliminary GAINS/EMEP calculations)



How could near-term climate effects be introduced into GAINS?

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- Near-term climate impacts could be included into the GAINS multi-pollutant/multi-effect concept as **an additional effect of air pollutants**

- Relevant precursors:
  SO_2, NO_x, NH_3, VOC, O_3, PM2.5, BC, OC, CO, CH_4

- Note that many pollutants are co-emitted, and isolated reductions of single pollutants (e.g., BC) are often not possible in reality.
  GAINS captures these interdependencies!

Extension of the GAINS multi-pollutant/multi-effect framework to include near-term climate impacts

	PM (BC, OC)	SO_2	NO_x	VOC	NH_3	CO	CO_2	CH_4	N_2O	HFCs PFCs SF_6
Health impacts: PM (Loss in life expectancy)	√	√	√	√	√					
O_3 (Premature mortality)			√	√		√		√		
Vegetation damage: O_3 (AOT40/fluxes)			√	√		√		√		
Acidification (Excess of critical loads)		√	√		√					
Eutrophication (Excess of critical loads)			√		√					
Climate impacts: Long-term (GWP100)							√	√	√	√
Near-term forcing (in Europe and global mean forcing)	√	√	√	√	√	√				
Black carbon deposition to the arctic	√									

Potential impact indicators

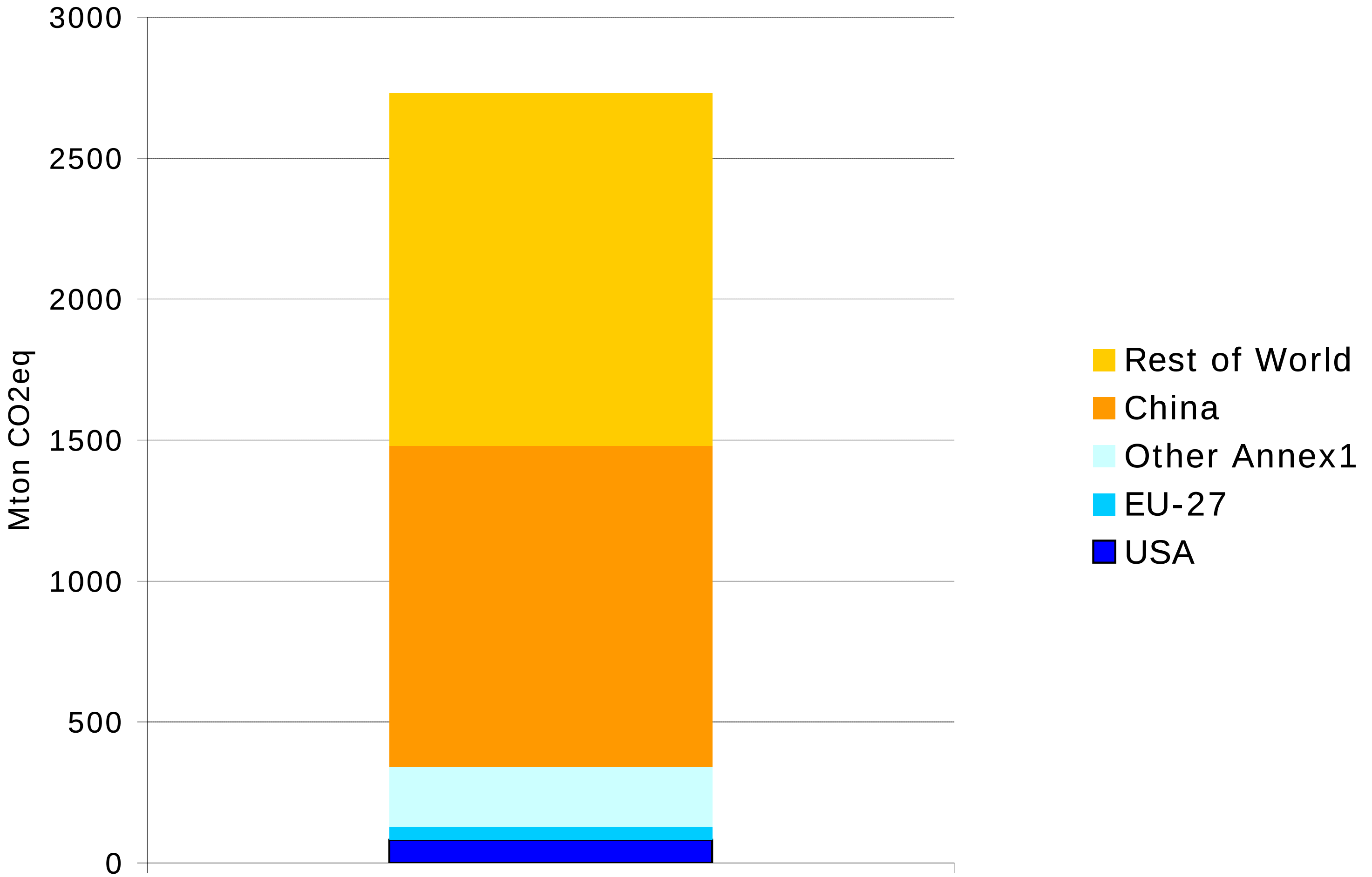
- As there is significant scientific uncertainty on the quantification of actual climate impacts, indicators should refer to physical indicators that can be quantified with reasonable robustness.

- Potential metrics (impact indicators):
  1. Instantaneous radiative forcing of sustained emissions (at regional and global scales)
  2. Deposition of (black) carbon in the arctic.

- These metrics would not interfere with UNFCCC objectives (long-term stabilization, reflected through 100 years GWP)
- As they do not involve CO_2, no conflict between control of air pollutants and CO_2 mitigation could be constructed

CH_4 mitigation potential <40 €/ton CO_2eq

2020, by World region (GAINS estimate)



Potential approaches for GAINS optimization for CLRTAP protocol

Starting from an energy scenario that achieves given (long-term) climate objectives (expressed through GWP_{100}):

<u>Option 1:</u>

- Optimize for environmental targets on
  - health and ecosystems (as before),
  - near-term forcing and BC deposition to the arctic.

<u>Option 2:</u>

- Optimize for environmental targets on
  - health and ecosystems (as before),
  - under the condition that near-term forcing and BC deposition to arctic does not deteriorate

Work elements

- Development of cost curves for BC, OC, CO (CIAM)
- Quantification of source-impacts relationships (between national emissions and regional forcing)
  - Calculation of source-receptor relationships between (country) precursor emissions and (grid) column concentrations (MSC-W)
  - Estimation of (regional) radiative forcing from (grid) column concentrations (Uni.Oslo)
- Extension of GAINS optimization routine (GAINS)

Prototype implementation feasible in 2010 (depending on available resources!), full implementation and validation thereafter

Conclusions

- Near-term forcing and carbon deposition to the Arctic could be included as an additional effect of air pollutants into the existing multi-pollutant/multi-effect framework

- Suggested metrics:
  - Instantaneous radiative forcing at the regional/global scale
  - Carbon deposition to the Arctic

- A prototype version could be developed by mid 2010 (if funding is available)

- In a first step, such information could be used to prioritize reductions of precursor emissions to reduce PM2.5 levels