EMEP model: History, Principles

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Outline:

• Brief history
• Aims
• Code design + principles
In the beginning:

- **OECD project**
  - Lagrangian model - enabled «fair» calculations of transport between countries
  - First long-range transport model
  - Used to calculate “blame” matrix
  - Sulphur

  => EMEP (*MSC-W, MSC-W and CCE*)
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=> EMEP (MSC-W, MSC-W and CCE)
Next step: NOx

- NOx model, 1985 …
  - Lagrangian, performed rather well.
  Basis of 1st Gothenburg multi-pollutant multi-effect Protocol
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Onwards to Ozone

- O3 model, 1992 ...
  - Lagrangian - also performed rather well!
Eulerian: 1990s

• Eulerian acid deposition model
  - Erik Berge and Roar Skaalin
• Designed from scratch for parallel computing
  - Basis of today's fast code
  - EMEP models are almost perfectly scalable
• Eulerian acid deposition - mid 1990s
• Eulerian ozone - late 1990s
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Unified model: 2003

- Achieved 2003
- Merged Eulerian acid deposition and ozone codes, also using routines (chemistry, emissions) from Lagrangian O3 code.
- Nearly 100% pure F90/F95
- Aims:
  - To attain one model structure
  - To avoid divergence
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Public domain:

• First: 2007

• Why?
  - EMEP is a Community - should have a community model
  - To encourage use of EMEP model among Parties/scientists
  - To help improve model
Pros and Cons:

• Cons:
  - MSC-W has few resources for documentation and follow-up, .... we are usually overwhelmed with work
  - Aids `competitors'
  - Possibility of “mis-use”
Pros and Cons:

- Pros:
  - Involves more scientists, better evaluation and acceptance of model
  - Possibility of users to influence model development, and hence policy results
  - Build community (as with e.g. WRF)
Examples:

• EMEP4HR:
  - Application of EMEP model to Croatia
  - Focus on evaluation of turbulence and Hmix
    - → new routines in core EMEP

• EMEP4UK
  - Application in UK, originally at 5km scale
  - Now down to 1km
  - Development of WRF+EMEP link
  - Extensive evaluation
Code design?

• Modular
  - e.g. different chemical schemes, different aerosol modules, ... (in progress)

• Flexible
  - Global to 1 km scale
  - Meteorology from PARLAM, ECMWF, WRF, Aladin
  - See talks by Peter, Massimo
Code flaws?

• Yes, there are some ;-)  

- The MSC-W team has a heavy workload, with a constant need to extract special outputs, add new components, etc,.. often leading to ad-hoc solutions

- e.g. system for outputs is rather messy - needs clean

- Contributions to code improvement very welcome!
Philosophy, concepts?

• G.E.P. Box
  - All models are wrong, but some are useful

• Einstein:
  - Models should be as simple as possible, but no simpler
  - (not sure we follow this one these days!)
Philosophy, concepts?

• **Main ideas:**
  - to capture the main atmospheric processes, keeping a balance between different components.
  - Make sure model is grounded in measurements!
  - ... but, prefer sound science over best-possible result for specific compounds - avoid tuning.
  - Make sure the model is useful!
An aside: surface $\Delta z = 90$ m - is that a flaw?

• No it is good :-)  
  - can be discussed...
  
  - With 90m we resolve analytically differences over forest, grass, water.
  - Very difficult with 20m layer!
  - Okay down to ~ 5 km (fetch)
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Philosophy, concepts, cont.

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  - The code is public domain, and documented.
  - Model performance is assessed continuously, with results (good and bad) published on the web and in reports
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Philosophy, concepts, cont.

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• So, here we are!
Some EMEP papers of historical interest..

- Eliassen, A. The OECD study of long-range transport of air pollutants..., Atm. Env., 1978, 12, 479-487
- Hov, Ø.; Eliassen, A. & Simpson, D. Isaksen, I. (Ed.) Calculation of the distribution of NO$_x$ compounds in Europe..., Regional and global scale interactions, D. Reidel, 1988, 239-262
- Jonson, J.; et al., EMEP Eulerian model for atmospheric transport and deposition of nitrogen species over Europe Environ. Poll., 1998, 102, 289-298
- Simpson, D.; et al., The EMEP MSC-W chemical transport model -- technical description Atmos. Chem. Physics, 2012, 12, 7825-7865

- BUT SEE www.emep.int (or Simpson et al., 2012) for many more!!!
The end.