3a,ii) Atmospheric chemistry

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Main questions

- what are the main atmospheric chemical changes over the Baltic Sea region?

- What are their inputs to the Baltic region, now and in the previous 100-200 years?

- How well can we quantify this?

Overview

Atmospheric Chemistry

- Introduction

- Emissions

- Concentrations

- Depositions

- Historical and future deposition estimates

- Uncertainties of estimates

Why focus on Nr?

Reactive Nitrogen (Nr)

Why focus on Nr?

- Bartnicki et alc (2011) calculated that about 25–33% of Nr input to Baltic from airborne Nr, deposited directly to the sea surface.

- In addition, part of the nitrogen deposition into the Baltic Sea drainage basin reaches the sea via runoff from land.

Emissions

Covers: main sources of emissions to air - shipping, industry, agriculture etc., including trends and projections.

Shipping emissions receive extra focus

- still increasing

- lax regulations

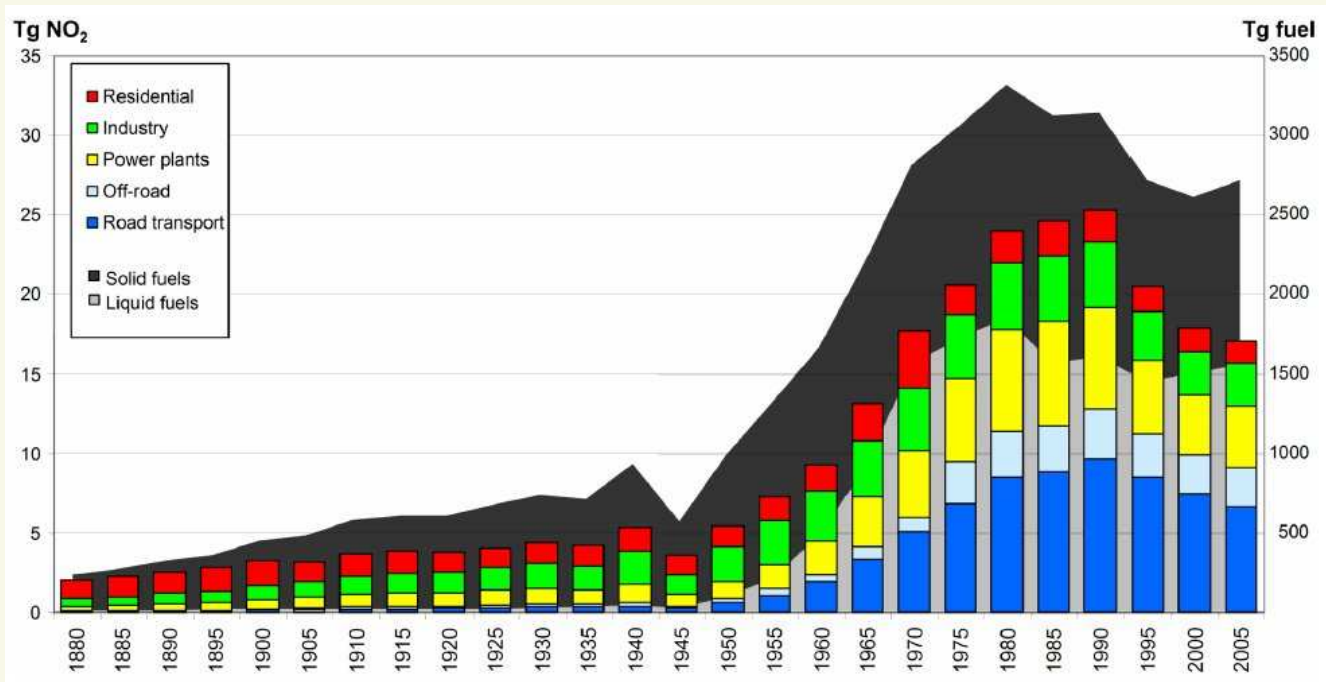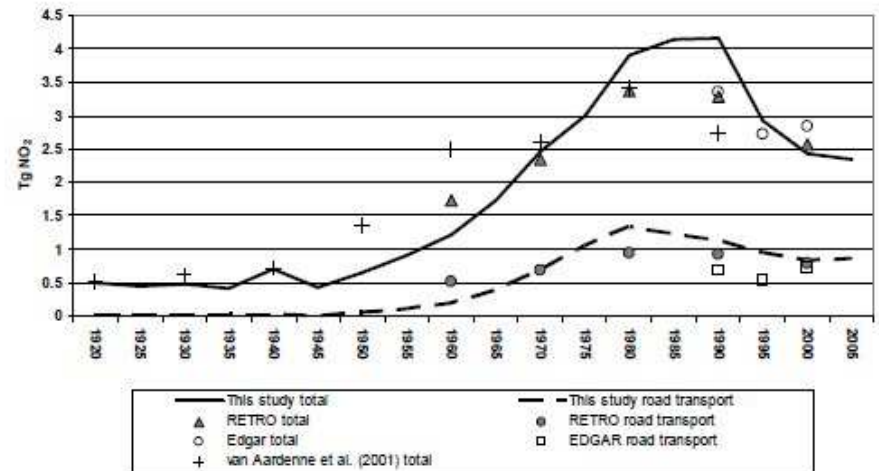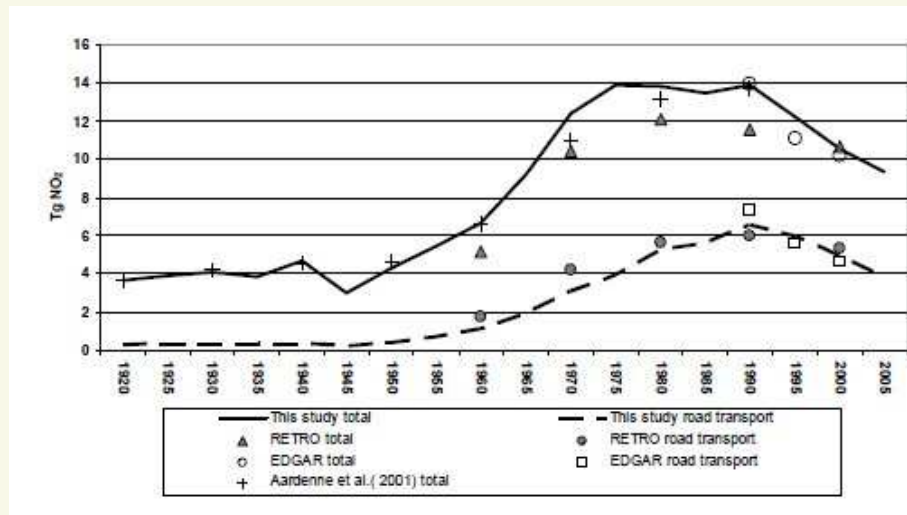- recent technologies (AIS, remote sensing) allow much better emission evaluation

Figure: European solid and liquid fossil fuel consumption 1880 2005. Data from the GAINS model 1990–2005 (Tg fuel/year, right axis). Sector trends in European NO2 emissions 1880–2005 (Unit Tg NO2, left axis). From Vestreng et al,2009.

Development of NOx emissions in Europe, 1920–2005.
Comparison between emissions of Vestreng et al,2009, Aardenne
et al., 2001, RETRO and EDGAR inventories for OECD Europe
(left) and Eastern Europe (right); EDGAR domain definitions.

Emissions from Baltic Sea shipping, 2008-2010
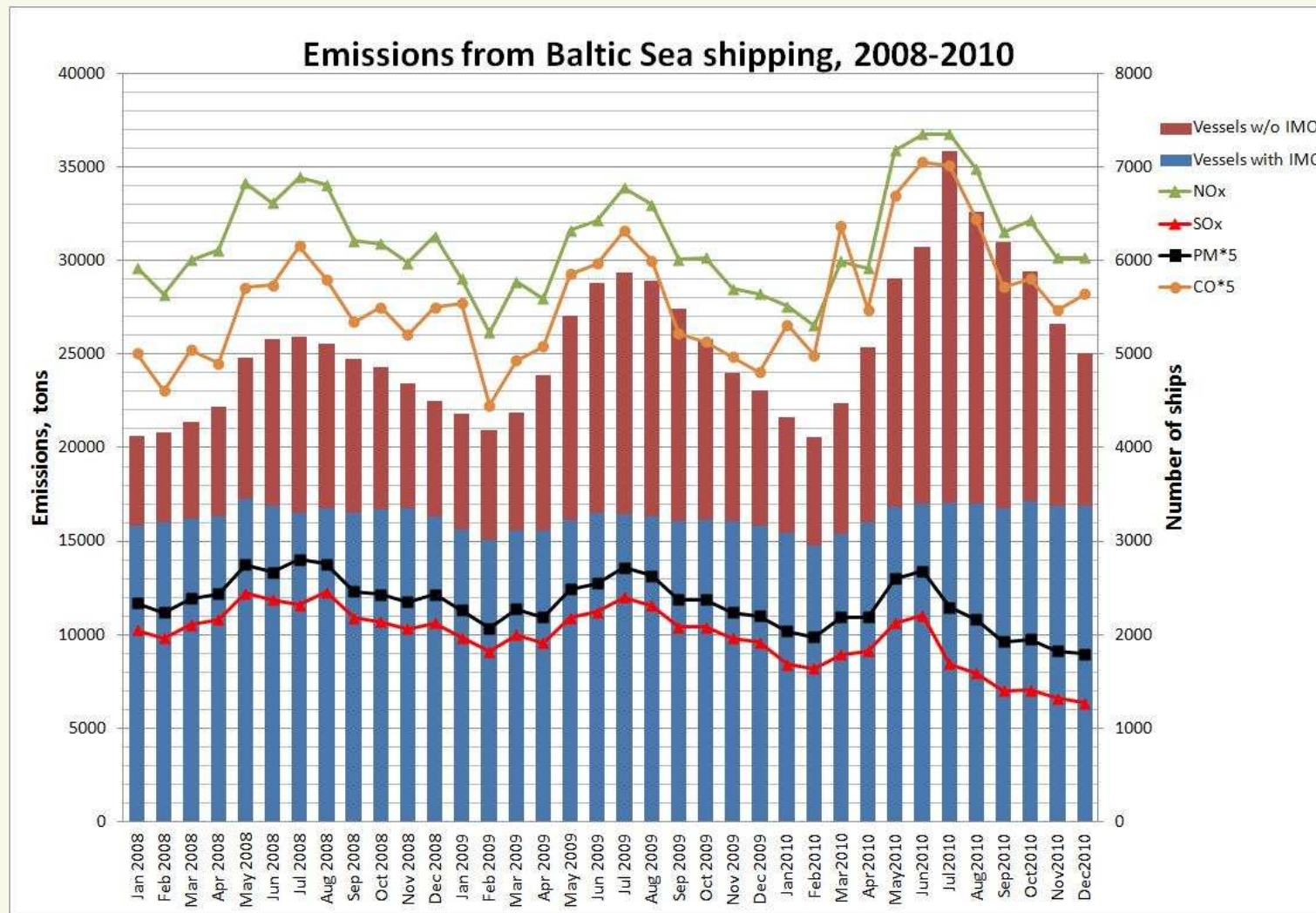
Blue bars indicate the number of large vessels (with an IMO registry number) and red bars illustrate the number of small vessels (without IMO registry number). Lines represent the emissions of various pollutants each month in the units of tons (Green=NOx, Orange=CO
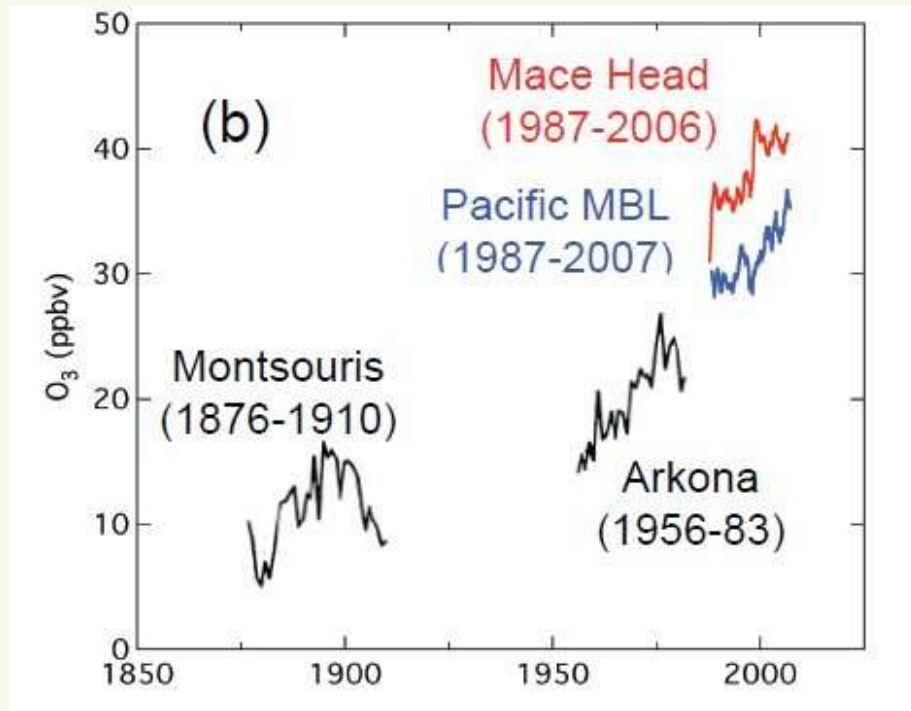
Comparison of the 12-month running mean O3 concentrations from three northen European sites: Mace Head, Arkona, and Paris, and the marine Pacific boundary layer (MBL). Figure from Parrish et al, 2009.

99-percentiles of hourly observed ozone concentrations in the years 1990–2000 for sites in the southern parts of Norway, Sweden and Finland, respectively. The shaded grey line indicates the regression of the average of these 99th percentiles. The trend estimated by this regression is given in the diagrams together with the estimated trend in modelled 99-percentiles (MATCH model). From Solberg et al, 2005.
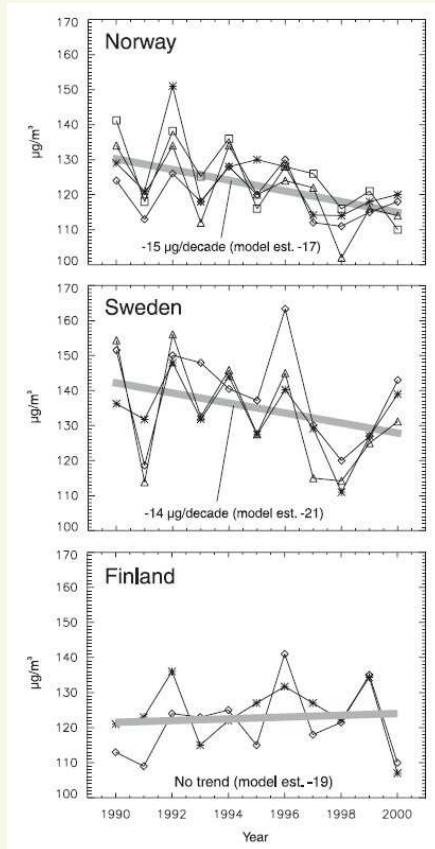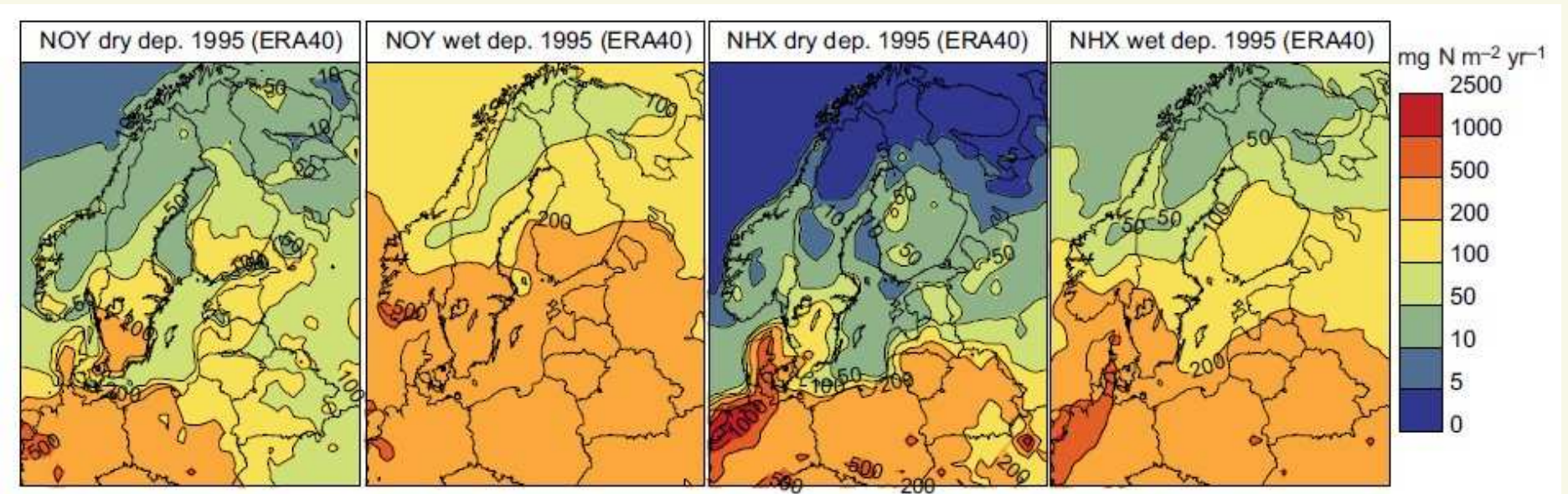
Dry deposition

Uncertain estimates!
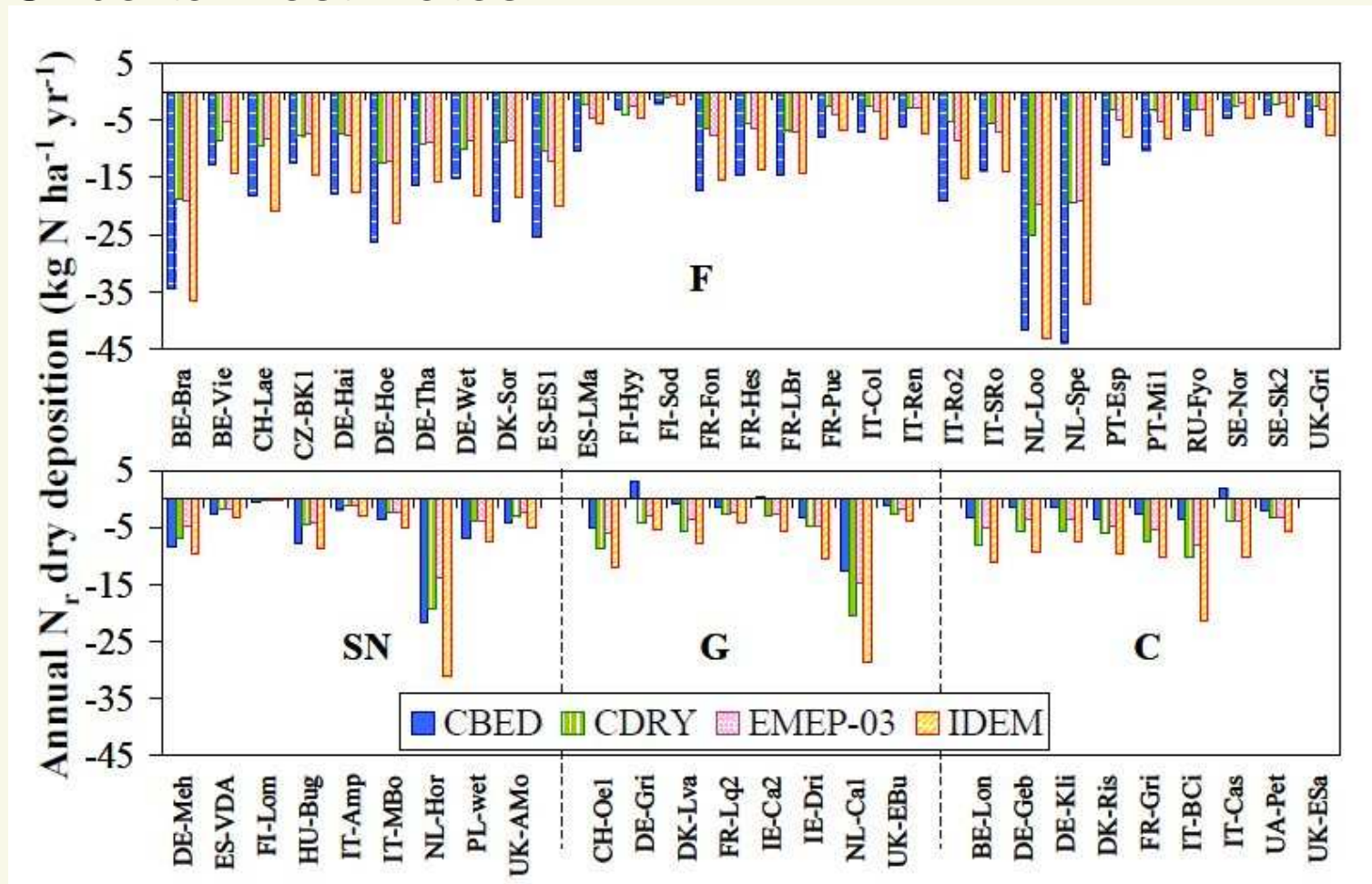
Modelled annual Nr dry deposition to NEU monitoring sites. Data are calculated as the sum of NH3, HNO3, aerosol NH+4 and NO-3 fluxes from DELTA measurements, plus NO2 dry deposition from modelled (EMEP 50 km) or measured NO2 concentrations.

Dry and wet deposition

Simulated dry and wet depositions of NOy and NHx in 1995 from the MATCH-ERA40 model Langner et al, 2009.

Climate impacts

main climate impacts are probably:

- C-sequestration issues associated with:

  N-deposition changes

  ozone-effects

- aerosols

(Need to discuss with aerosol lead author).

Caveats

- First draft

- Main focus on nitrogen, some O3, not much on S

- Easy to add more, but chapter expands...

- Main focus on models, partly due to lack of measurements

- Need to find observational data on trends, especially pre-1980

- Need more on longer-term trends, past and future.