Baltic-C

WP 5

Uppsala university

Topic 4: Atmospheric forcing and deposition

Björn Carlsson, Uppsala meeting 14 May 2009

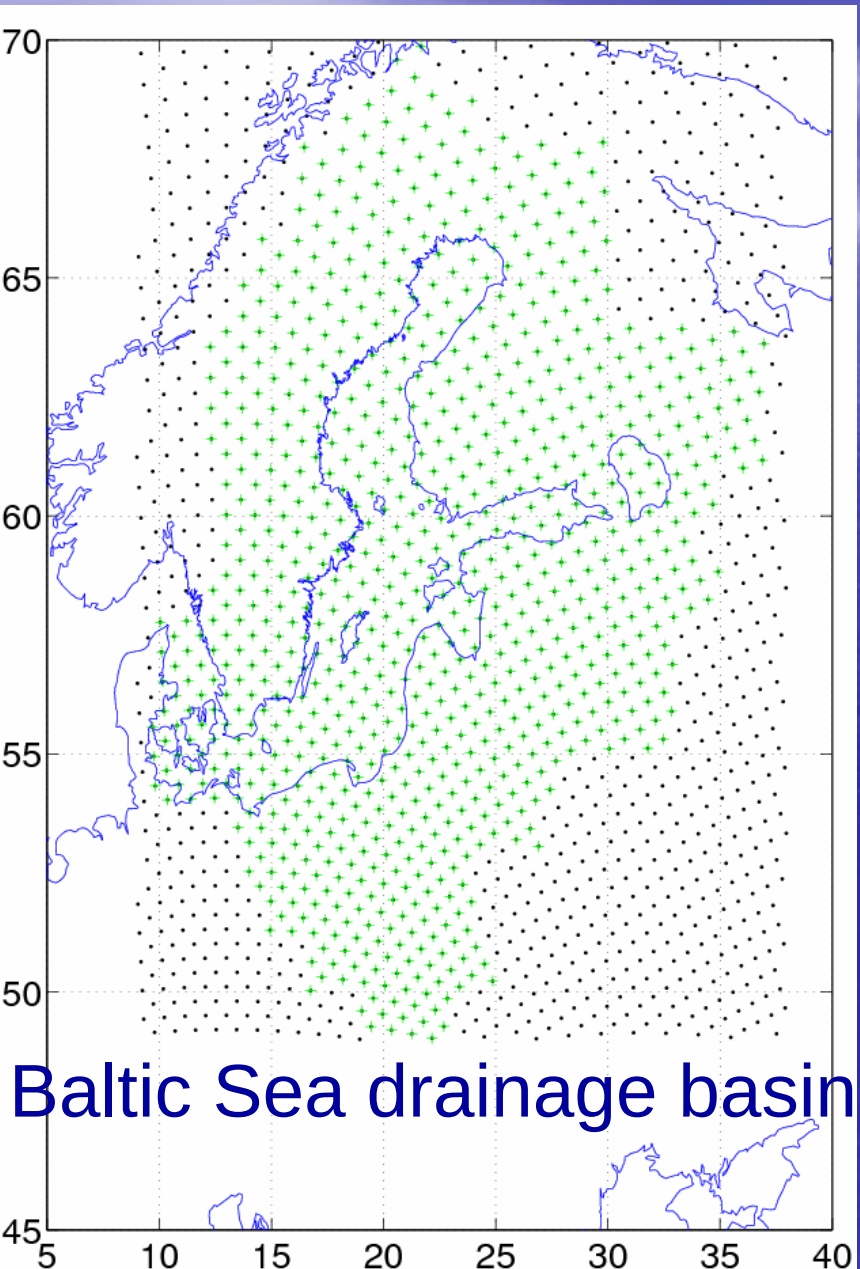
Tasks

- Forcing data to
  - Ocean model
  - land areas: ecosystem and catchment modelling
- Data types
  - Depositions (monthly means) (deliverable 26)
    - NOx, NHx, and SOx
    - Minerals (Na, Mg, K, Ca) for catchment areas
    - pH in precipitation over Baltic Sea
  - Meteorological forcing (Anna)

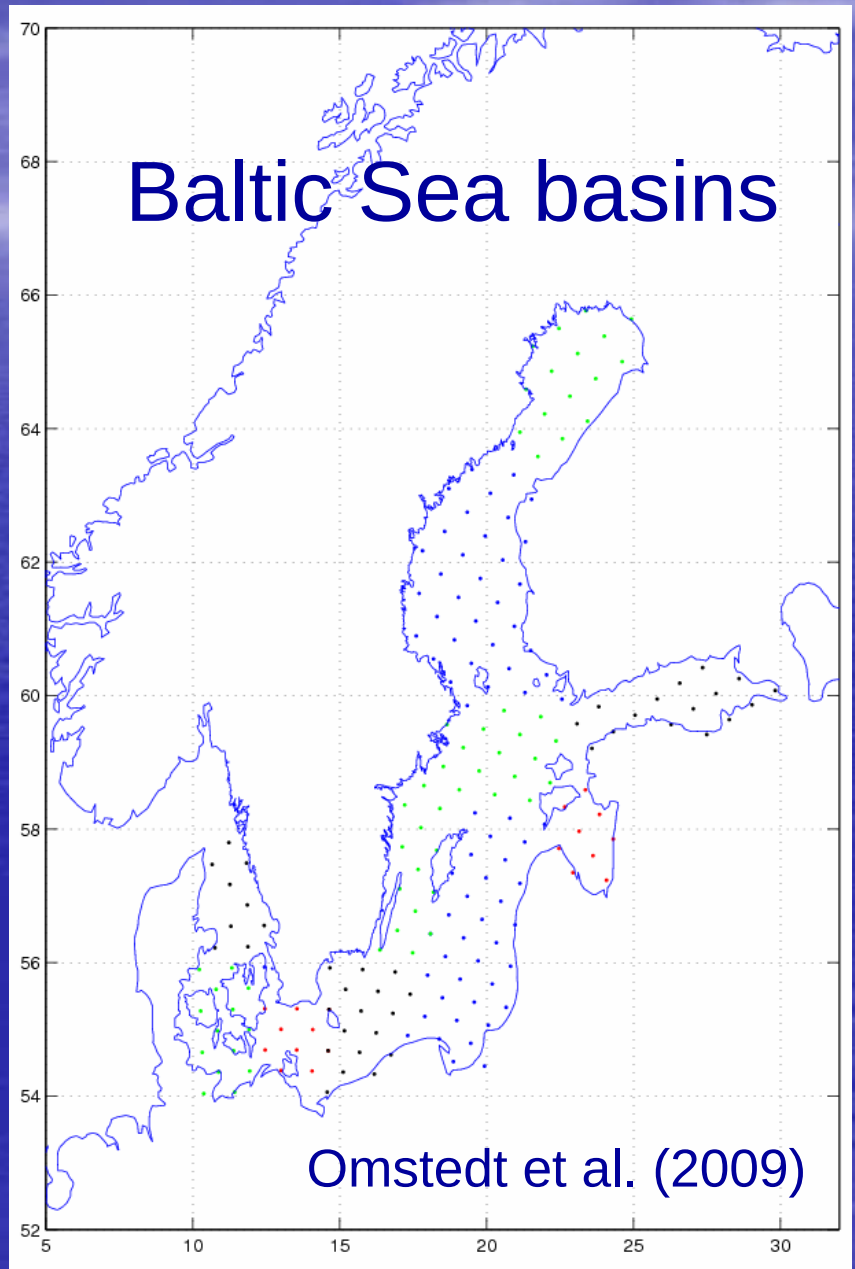
Acid depositions (ocean and catchment modelling)

- Monthly averages of dry and wet oxidized sulphur (SOx) and nitrogen (NOx) and reduced nitrogen (NHx).
- Period 1960–2006
  - 1990, 1995–2006: use the EMEP transport model (driven by emissions reported by parties and validated against measurements)
  - For other years: scale with emissions from EDGAR-HYDE data set
    - annual mean cycle from EMEP model

The EMEP model grid (50 km)



Baltic Sea drainage basin

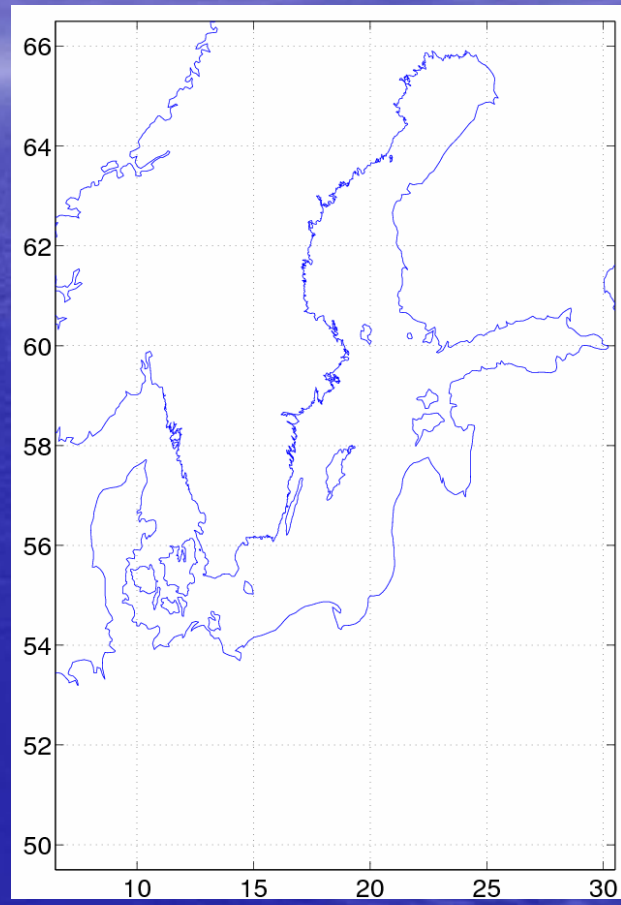


Baltic Sea basins

Omstedt et al. (2009)

Acid depositions: extrapolation method

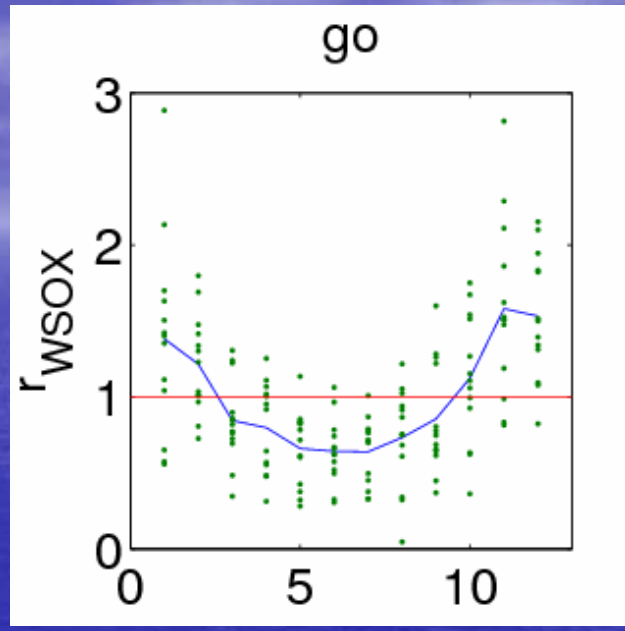
- Use gridded (1° x 1°) emission data from EDGAR-HYDE
  - Global anthropogenic emissions of NOx, SO2, NH3, (CO2, CH4, N2O), among others
  - 1960–1990, (10 year time step) used for extrapolation
  - 1990, 1995, 2000 used in comparison to EMEP output to find the proper domain of emissions

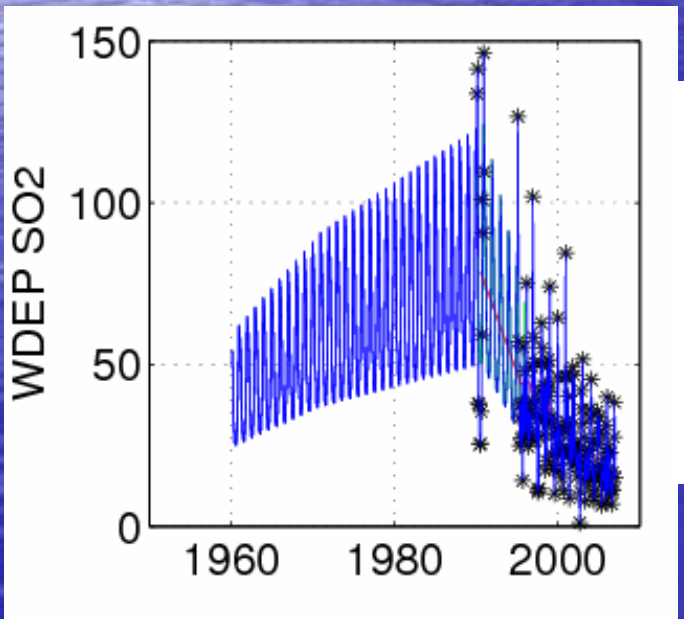


Proper domain?

Acid depositions: extrapolation method

- Find mean annual cycle for each basin and species from the EMEP model
- Apply the emission trend

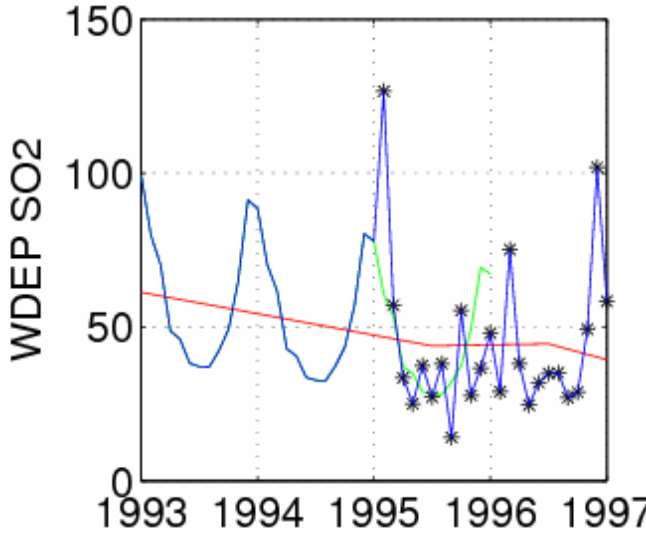




* EMEP model

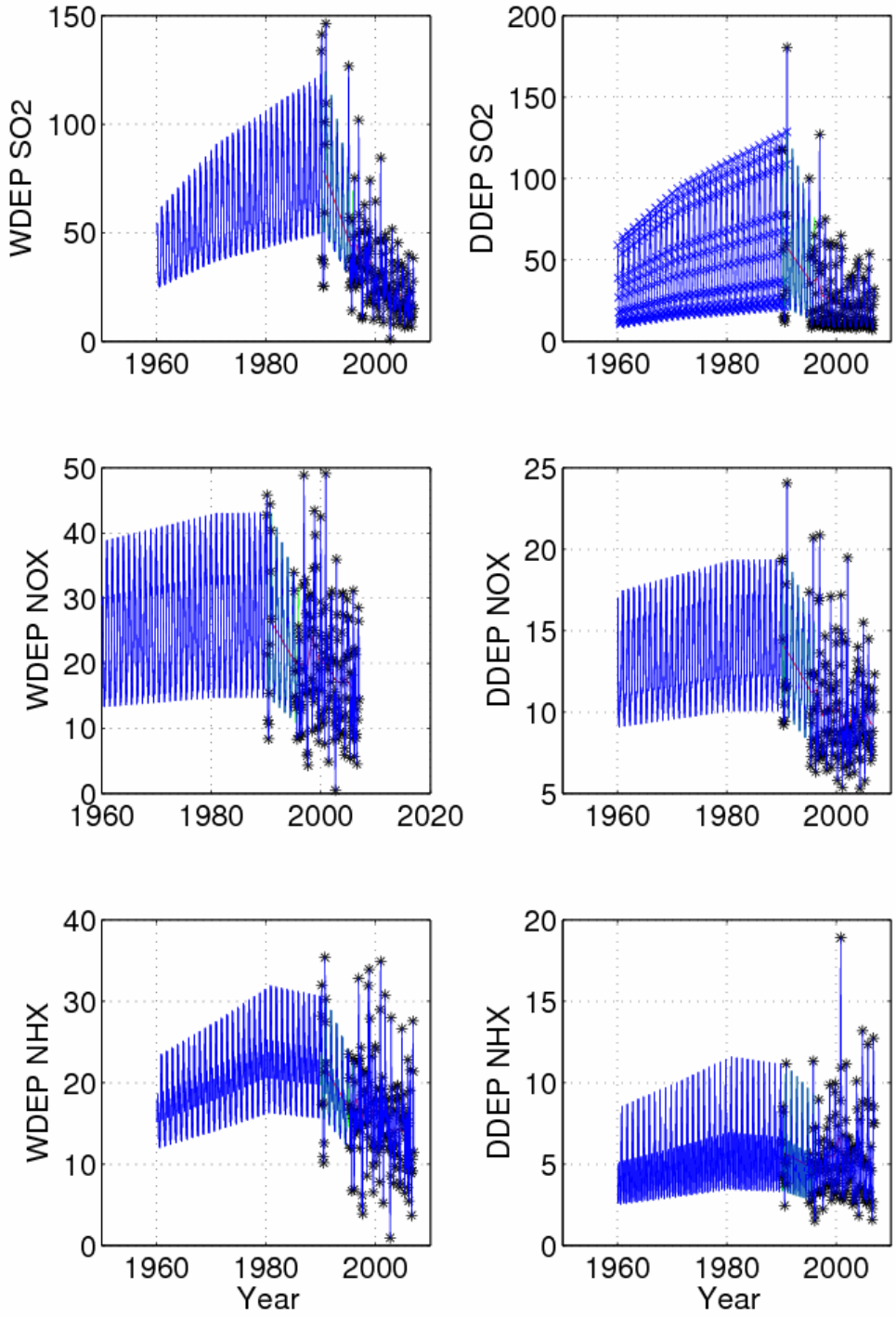
Mean annual cycle

Yearly mean



Acid deposition

- Upward trends until 1980s
- Then decreasing
  - maybe levelling out?
- Using the presented extrapolation method underestimates variability when no measurements
  - Problem?



Acid depositions

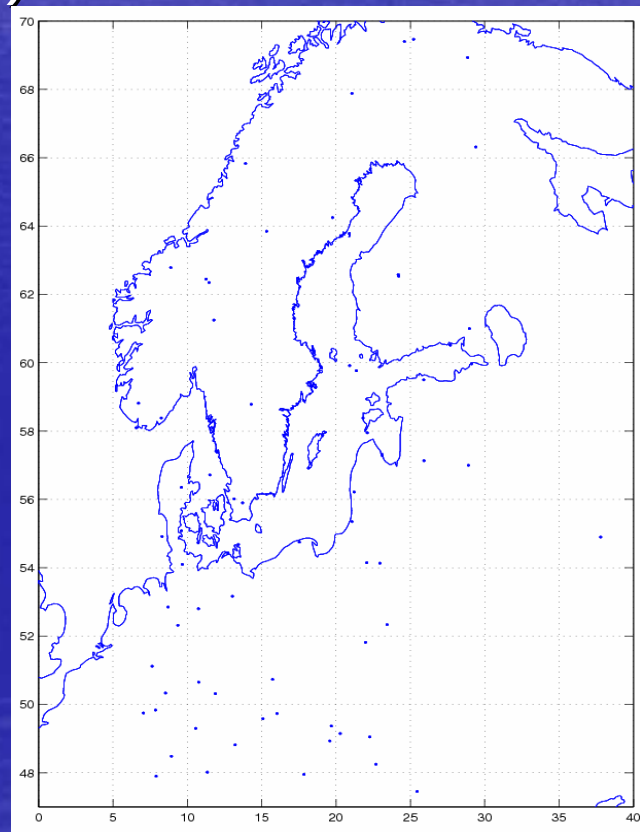
- Resulting data set:
  - Text files for
    - each basin in Baltic Sea
    - each catchment area (not defined yet)
  - Format: monthly data

Year	Month	WDEP SOX mgS/m²	WDEP OXN mgN/m²	WDEP RDN mgN/m²	DDEP SOX mgS/m²	DDEP OXN mgN/m²	DDEP RDN mgN/m²
1960	1	54.20612	28.99084	15.20485	59.09343	16.99895	2.589824
1960	2	47.66772	30.22342	18.60966	38.89434	12.34430	3.321080
1960	3	33.10535	23.20019	17.38174	26.94709	9.837782	4.919280
…	…	…	…	…	…	…	…

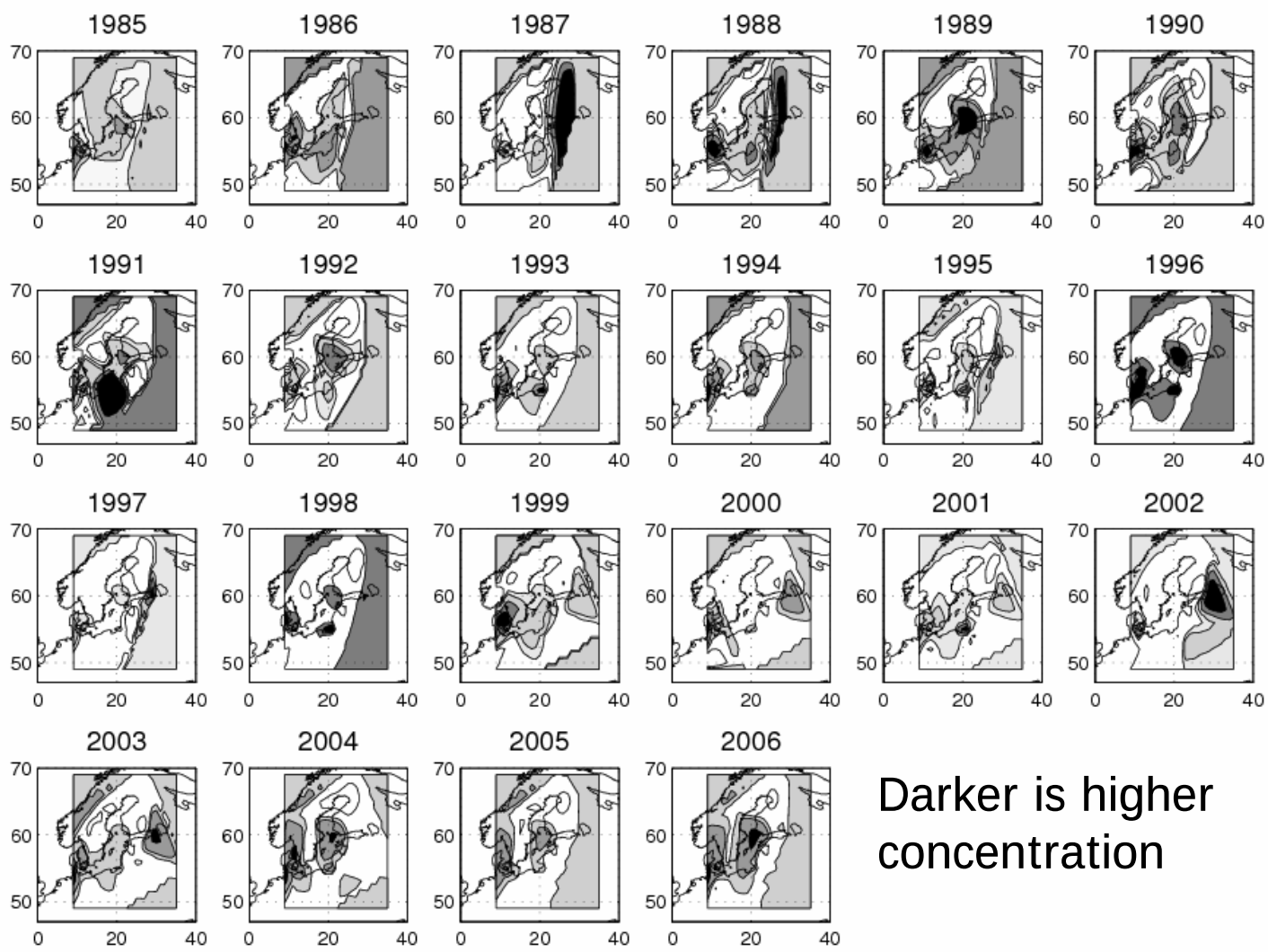
  - No found scenarios

Deposition of “minerals” (land areas)

- EMEP (co-operative programme) measurements
  - Monthly weighted averages of Na, Mg, K, Ca (according to precipitation)
  - Unit: mg/l in precipitation
  - Sources: sea salt, except K which is mostly from forest fires and wood burning (more sources?)
- Period 1960–2006
  - 1985–2006 (limited number of stations before)
    - Spatial interpolation (problem: concentration is a function of precipitation intensity)
    - For deposition (mg/m^2), use modelled precipitation?
  - Other years
    - Extrapolation as with acid deposition?
    - Mean annual cycle from measurements?
    - Scale with what emissions? Particulate matter?
- No found scenarios



Inter-annual variability in mean concentration of Na (mg/l)



Darker is higher concentration

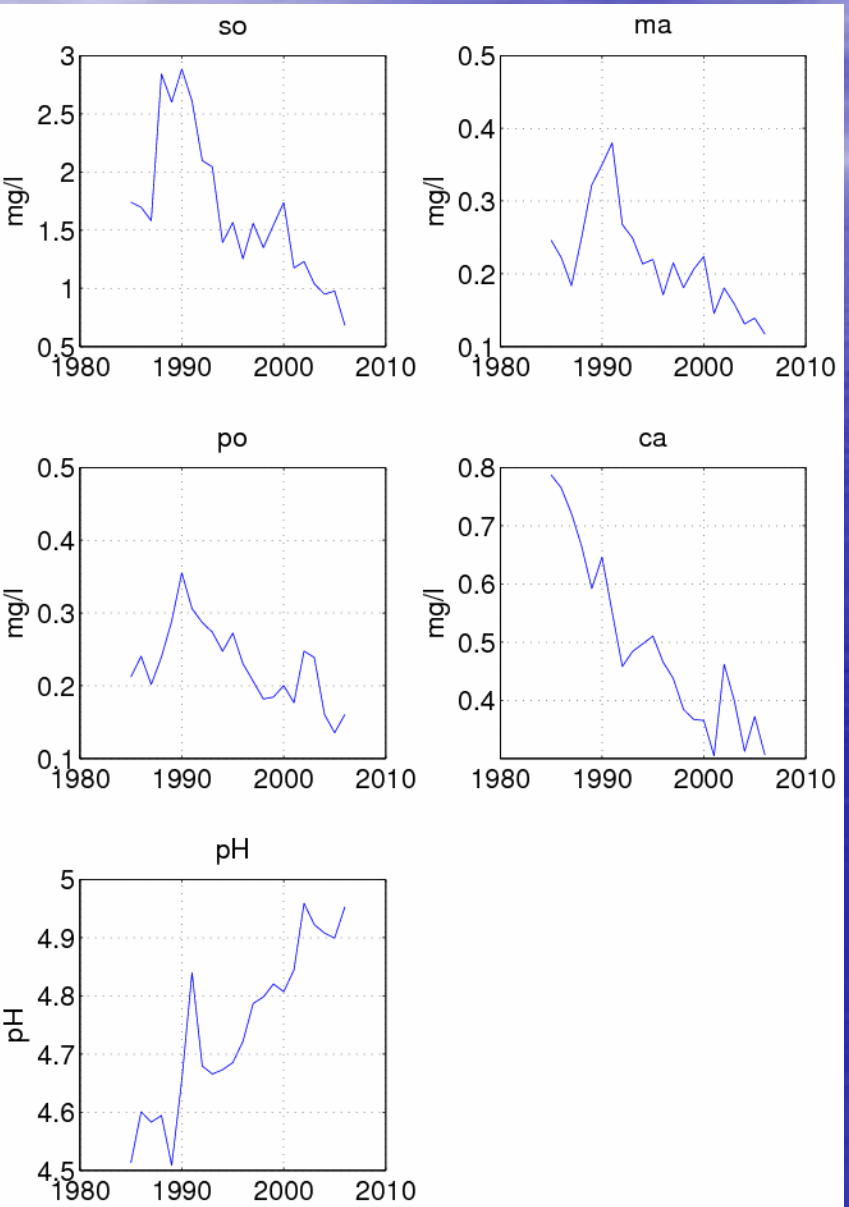
Meteorological variability only?

not good at boundaries

pH in precipitation (Baltic Sea)

- EMEP (co-operative programme) measurements
  - Weighted monthly averages
- Period 1960–2006
  - 1985–2006 (can perhaps use data from earlier date)
    - Spatial interpolation (in some exponential way?)
    - For deposition, use modelled precipitation?
  - Other years
    - Extrapolation as with acid deposition?
    - (mean annual cycle from measurements)
    - But scale with what emissions?
    - (maybe emissions of SOx, NOx and NHx)
- No found scenarios

Trends in mineral deposition and pH



- Clear positive trend in pH! (we have negative trends in acid deposition, mainly SOx)
- Why negative trends in Na and Ca?
- Some meteorological variability but some must be from anthropogenic emissions.
  - Seen in north-eastern U.S.
- Emissions of particulate matter decreased during this time period
  - One cannot however assume that ratio is constant

Depositions of minerals and pH in precipitation

- Planned data sets:
  - Text files for
    - each basin in Baltic Sea (pH)
    - each catchment area (minerals)
      - (not defined yet)
  - Format: monthly data

Summary

- The data set of dry and wet oxidized sulphur and nitrogen and reduced nitrogen is in principle solved.
- Catchment areas are still to be properly defined.
- To solve:
  - Deposition of minerals and pH in precipitation before measurements started. Historical emissions of SOx (and NOx and NHx) may be used to determine pH. Interpolation between monitoring stations hard without transport model.
- No scenarios for emission of minerals, sulphur and nitrogen found yet.