Delft3D – Water Quality Model calibration

M. Zalewski, Z. Witek & M. Wielgat
Sea Fisheries Institute, Gdynia, POLAND

MANTRA - East - Vistula Lagoon
December 2003

State variables

- Diatoms, Other type of Algae
- PO4, NH4, NO3, Si, O_2
- Detritus C, P, N, Si
- Dissolved Organic C, P, N, Si
- Inorganic Matter
- P adsorbed on the Inorganic Matter

WATER

- Sediment Diatoms, Other type of Algae
- Sediment Detritus C, P, N, Si
- Inorganic Matter
- P adsorbed on the Inorganic Matter

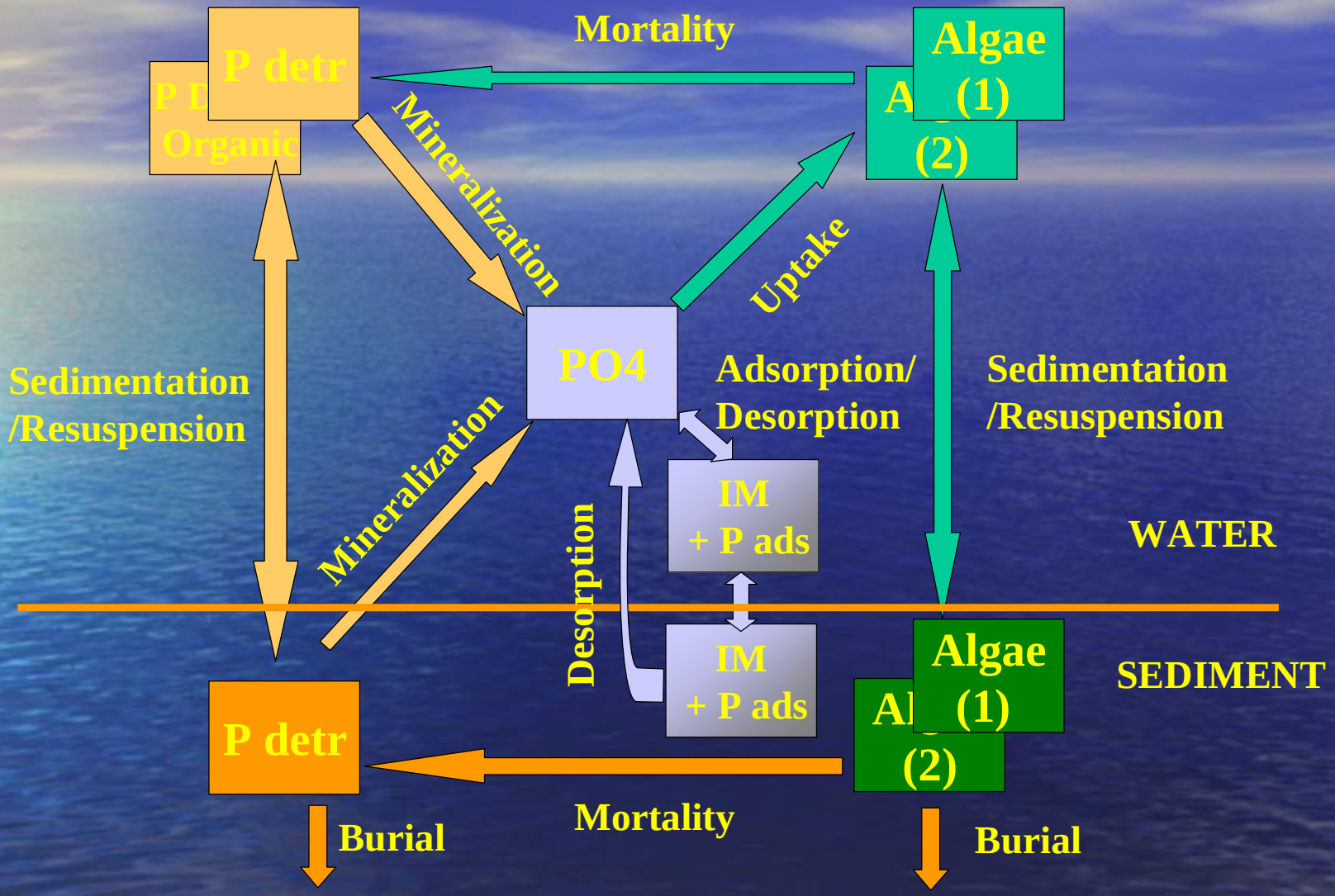
SEDIMENT

Modelled processes

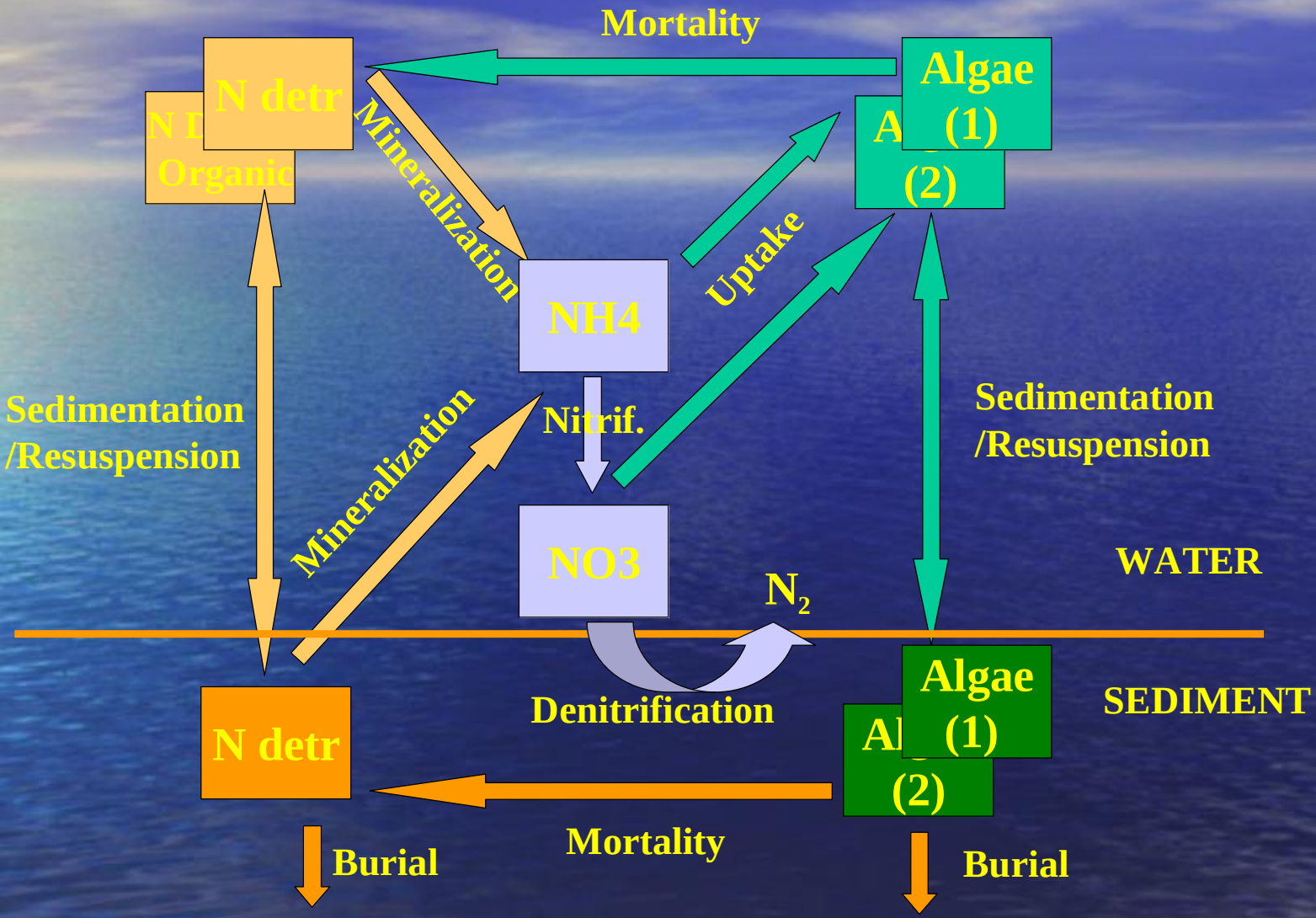
The processes include:

- Algae growth, respiration and mortality (representing natural mortality and zooplankton grazing);
- Mineralization of particulate and dissolved organic matter;
- Sedimentation and resuspension of algae and particulate matter;
- Adsorption and desorption of phosphorus onto inorganic matter;
- Nitrification;
- Denitrification;
- Reaeration of oxygen.

Phosphorus cycle



Nitrogen cycle



Forcing functions

- Hydrodynamics from DELFT3D-Flow
- Water temperature
- Light
- Wind
- Loads

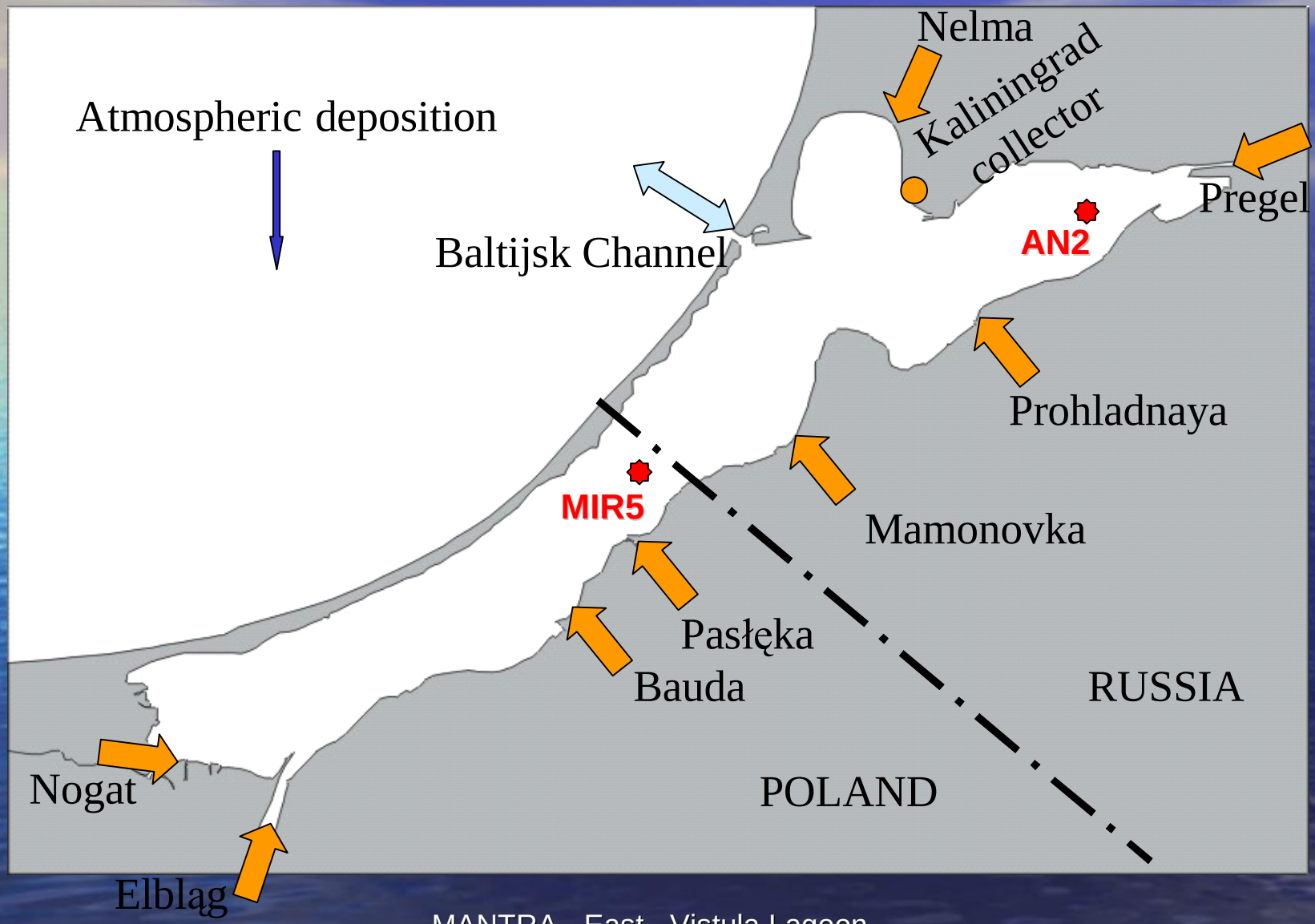
Riverine and Baltic Sea discharges

- Algae
- PO4, NH4, NO3, Si, O_2
- Detritus (Dissolved Organic) C, P, N, Si
- P adsorbed on the Inorganic Matter
- Inorganic Matter

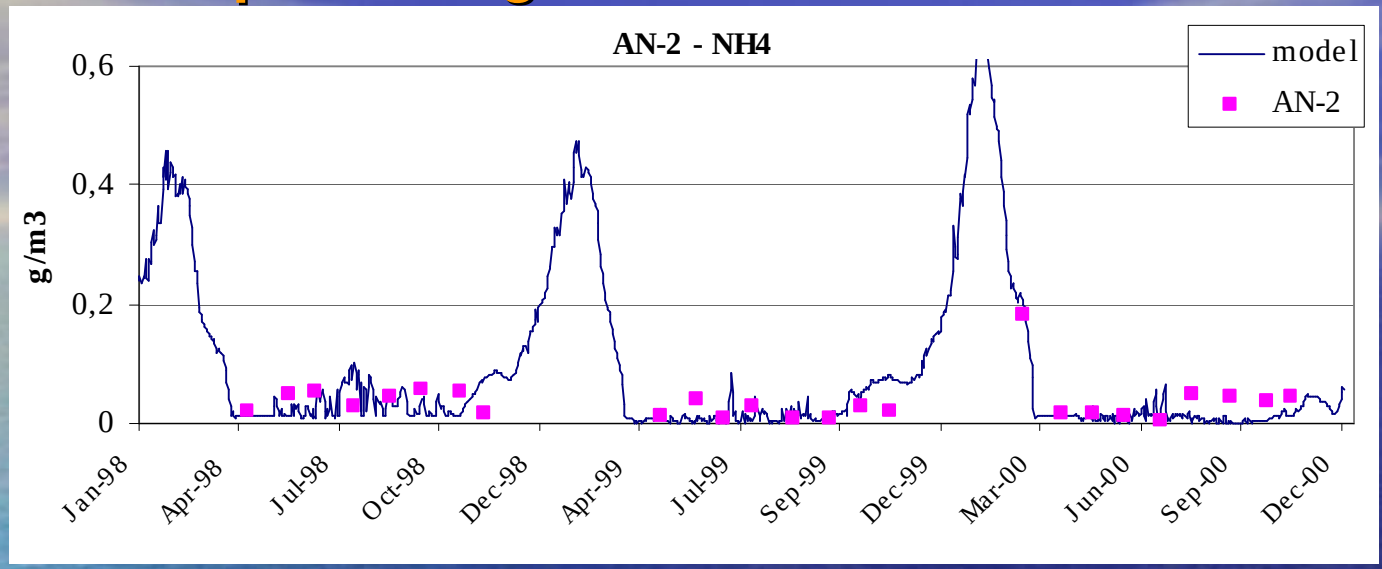
Atmospheric deposition

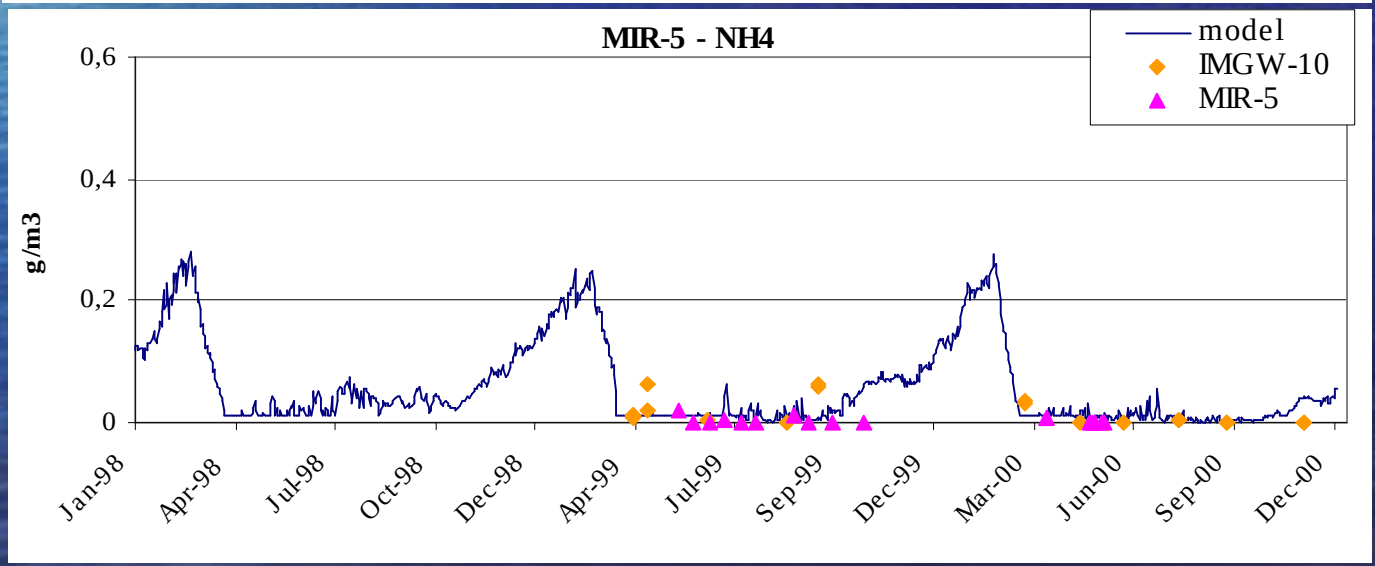
- NH4, NO3, Inorganic Matter

Localization of discharges

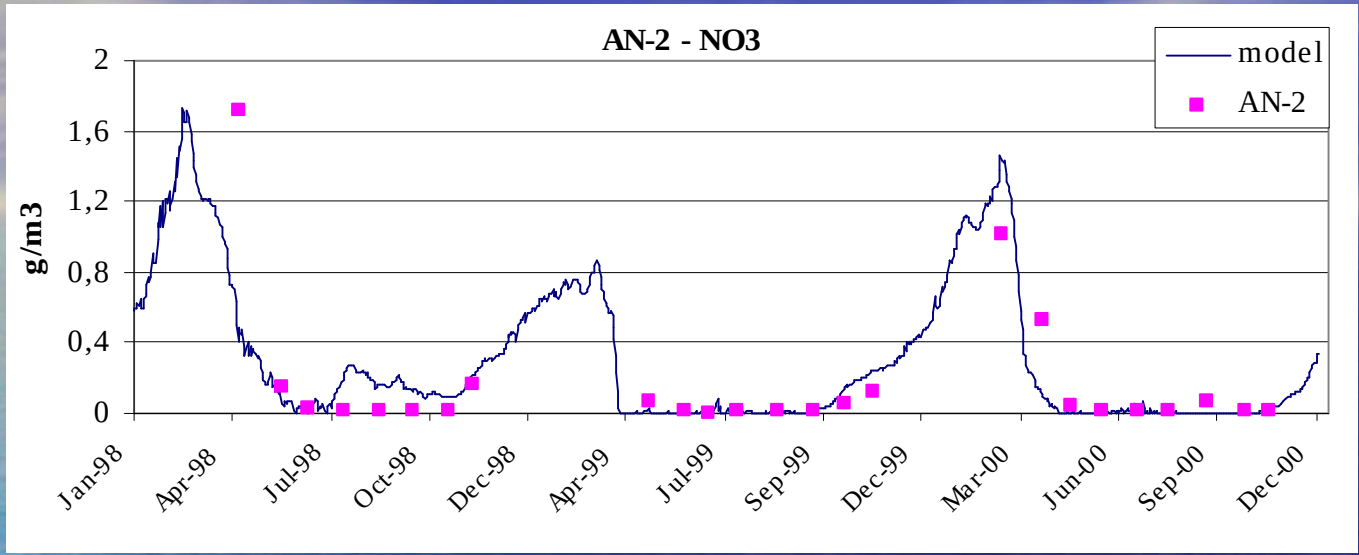


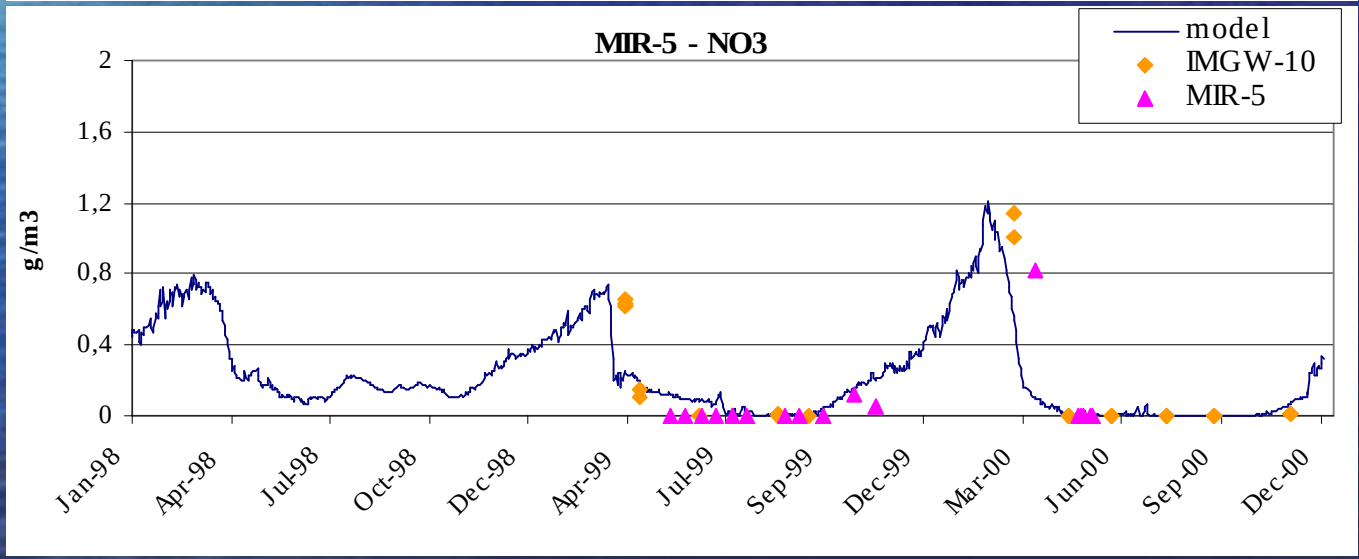
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



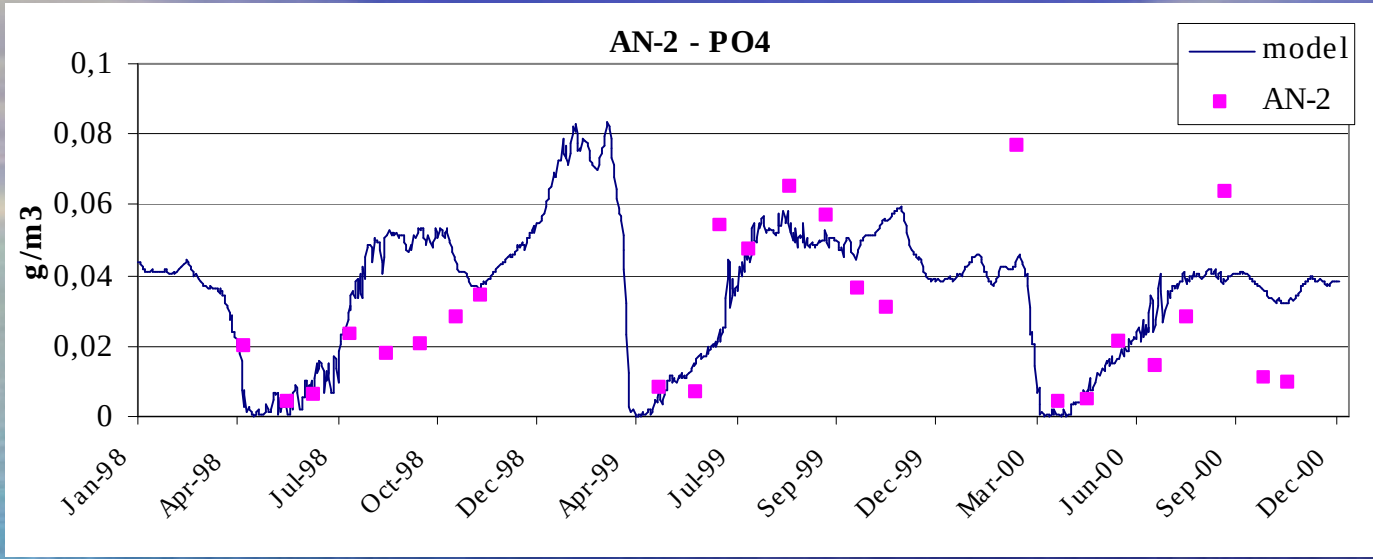


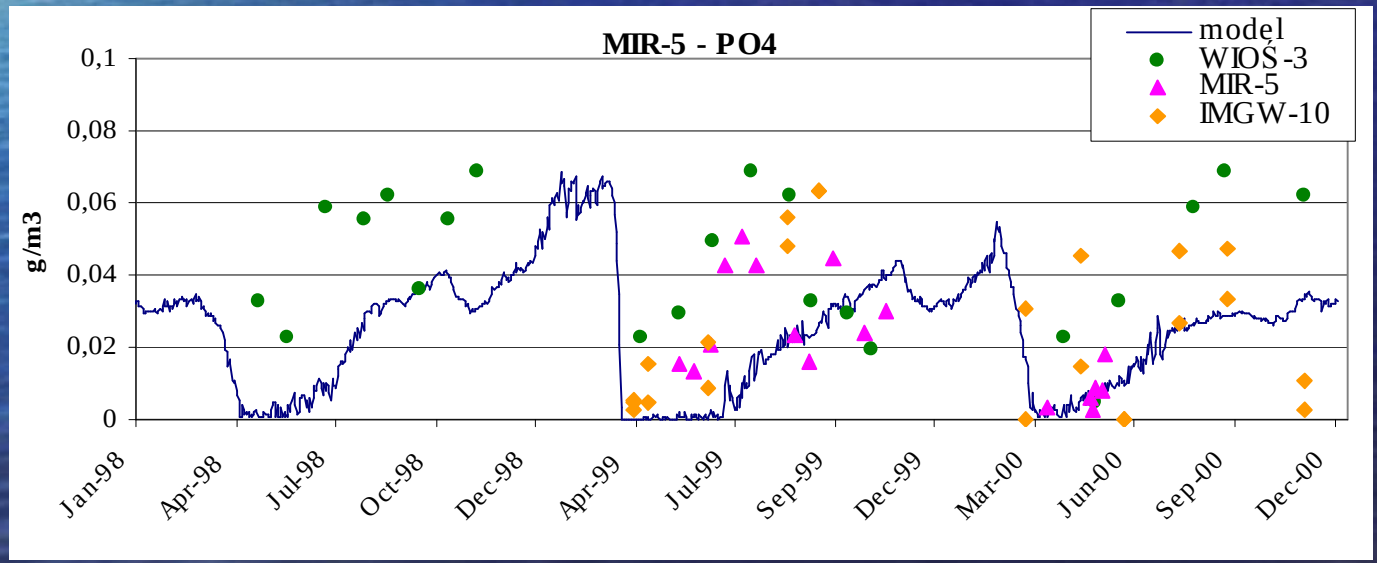
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



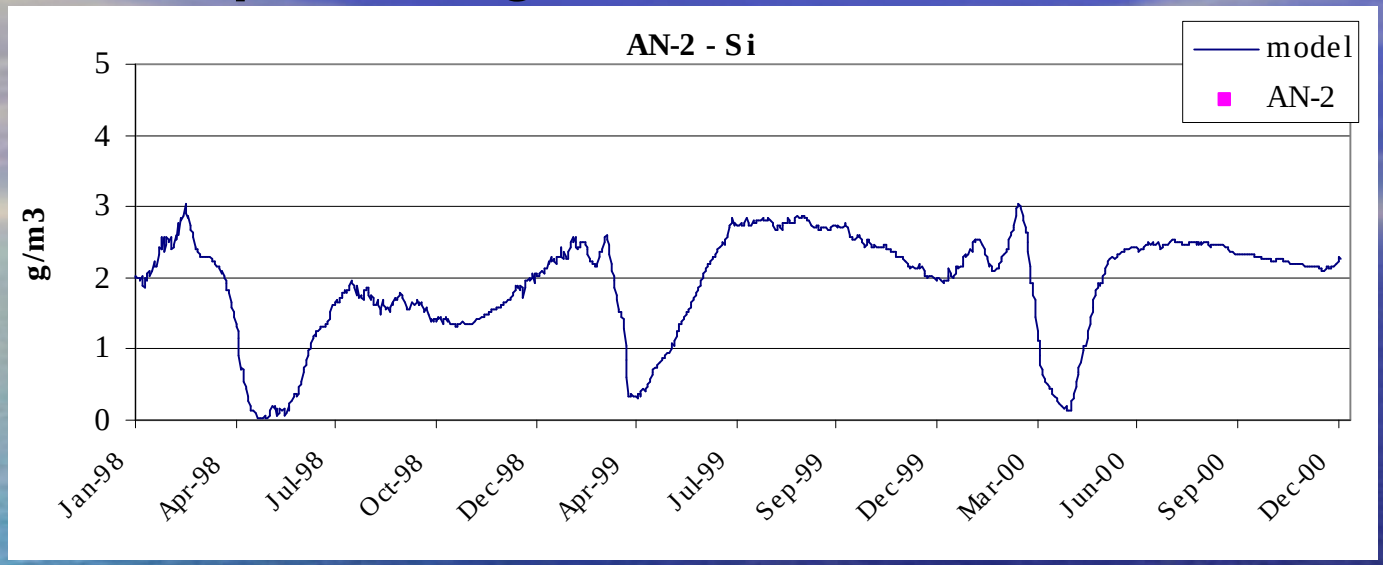


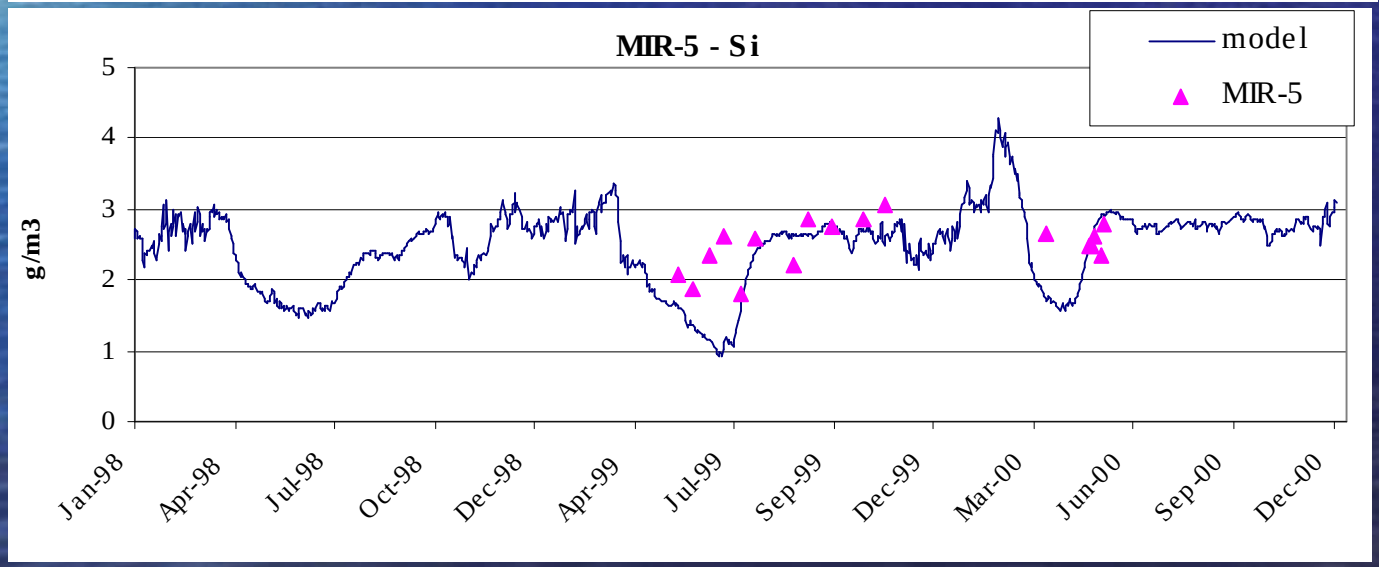
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



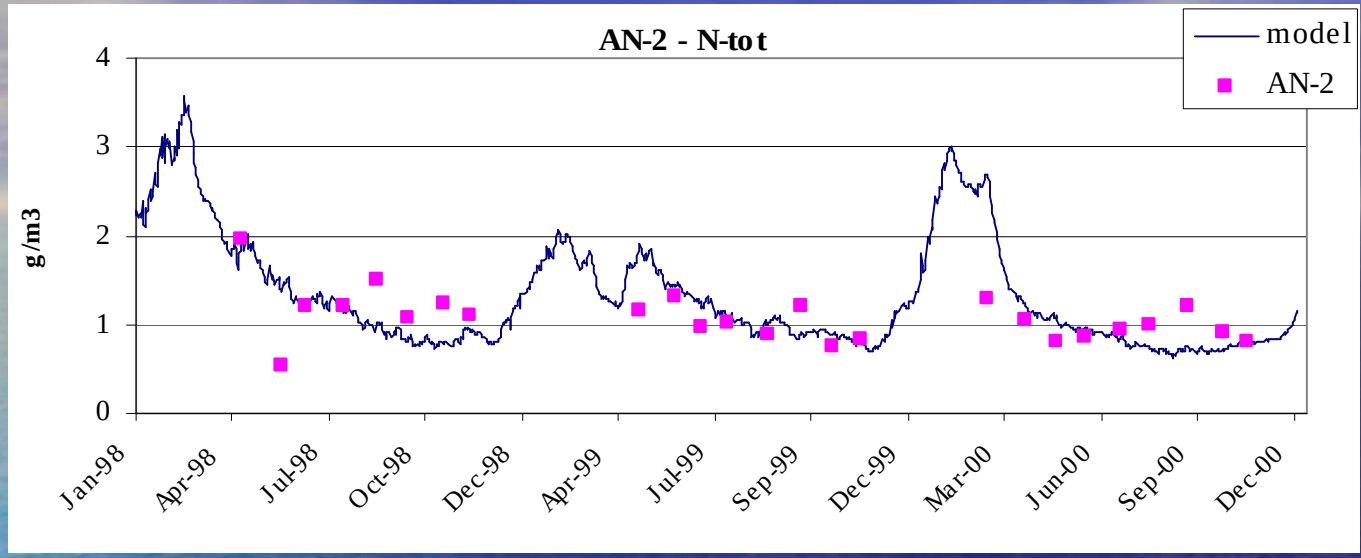


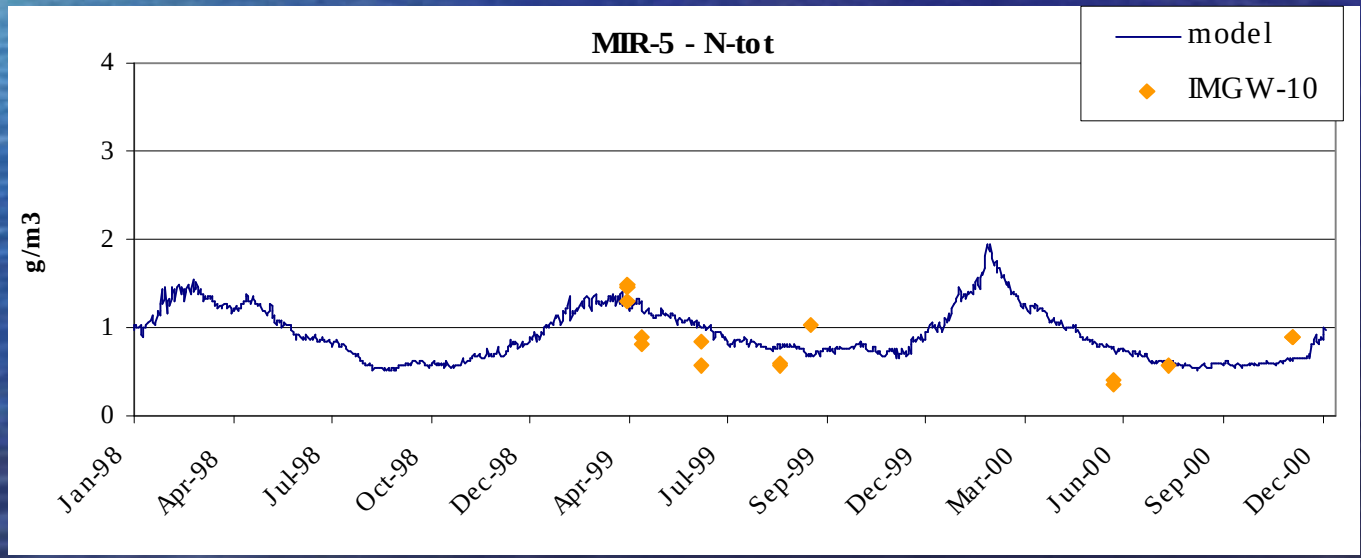
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



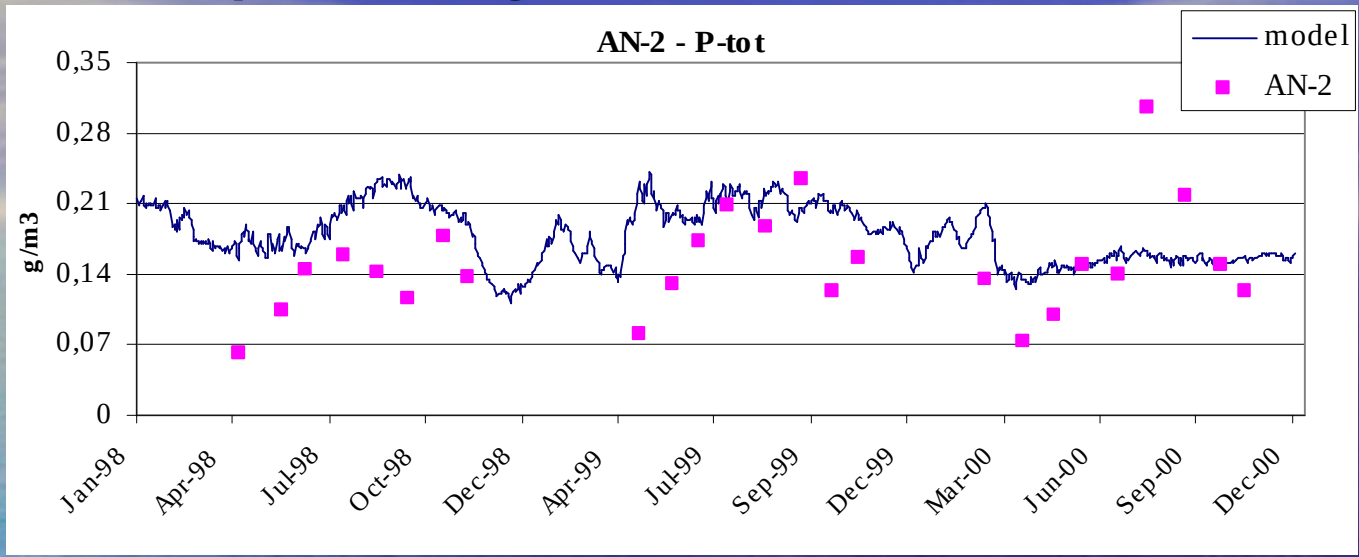


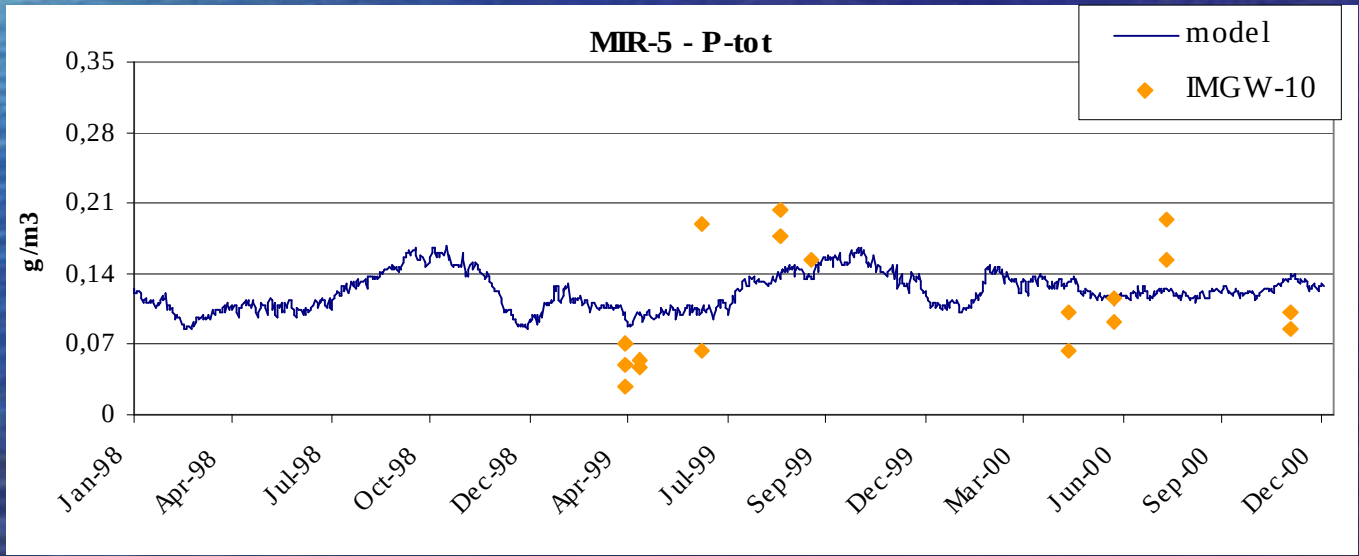
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



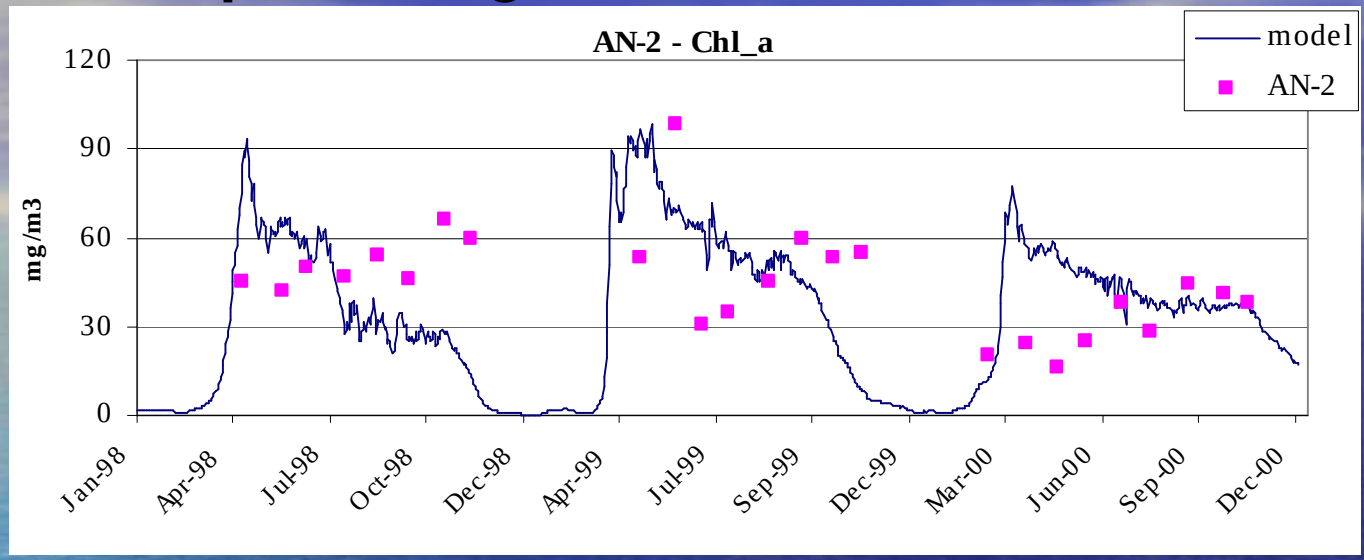


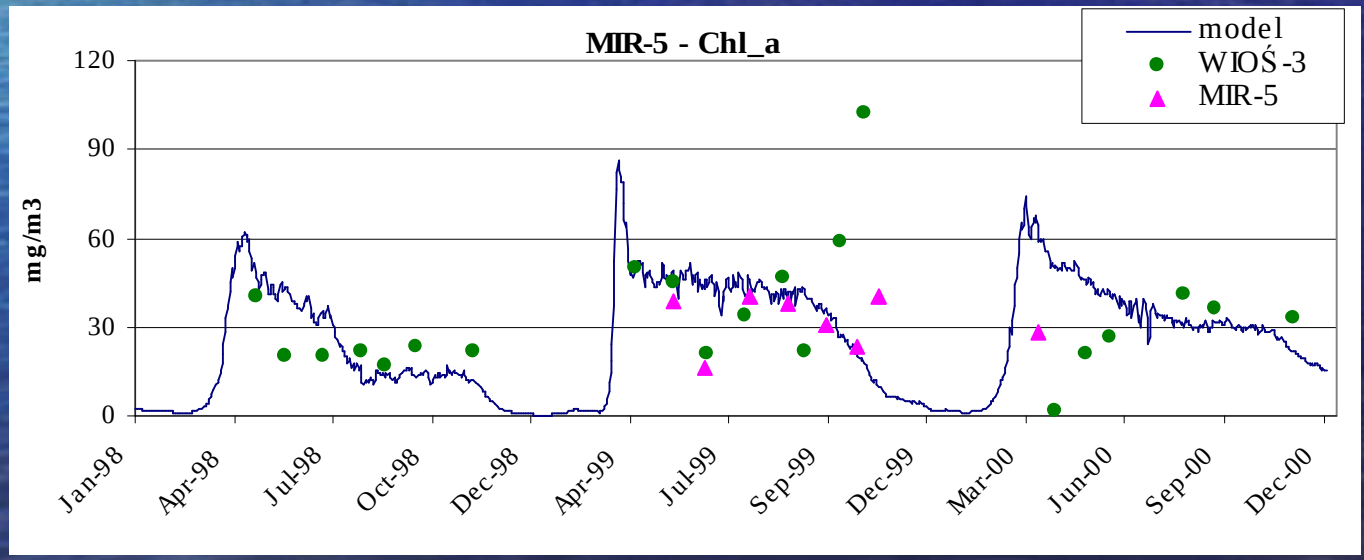
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



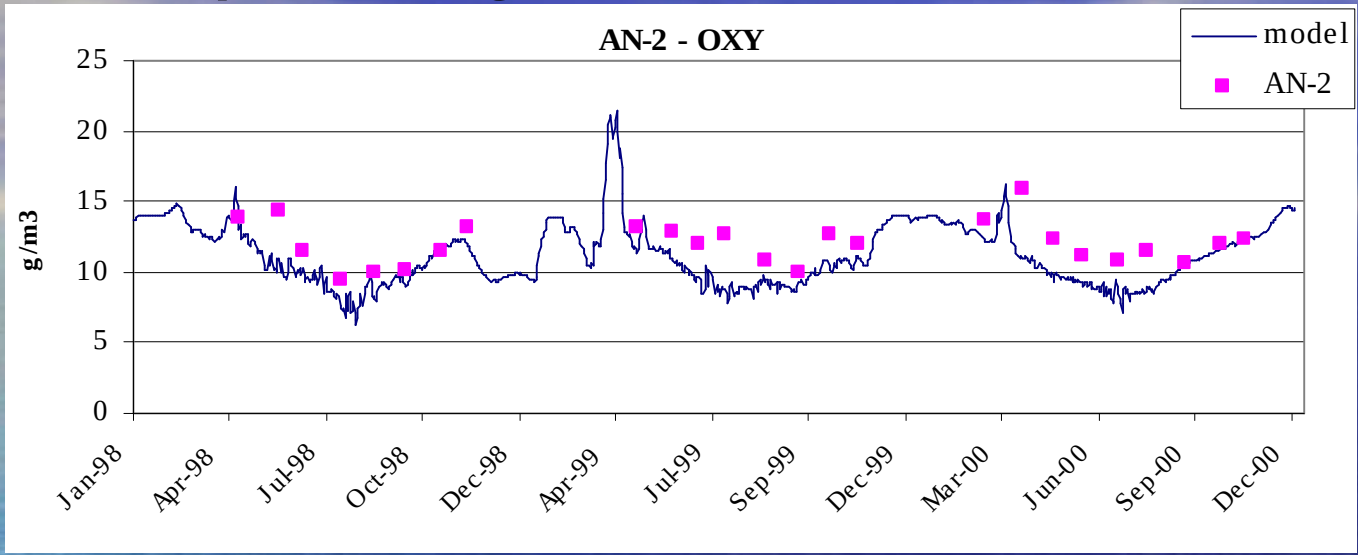


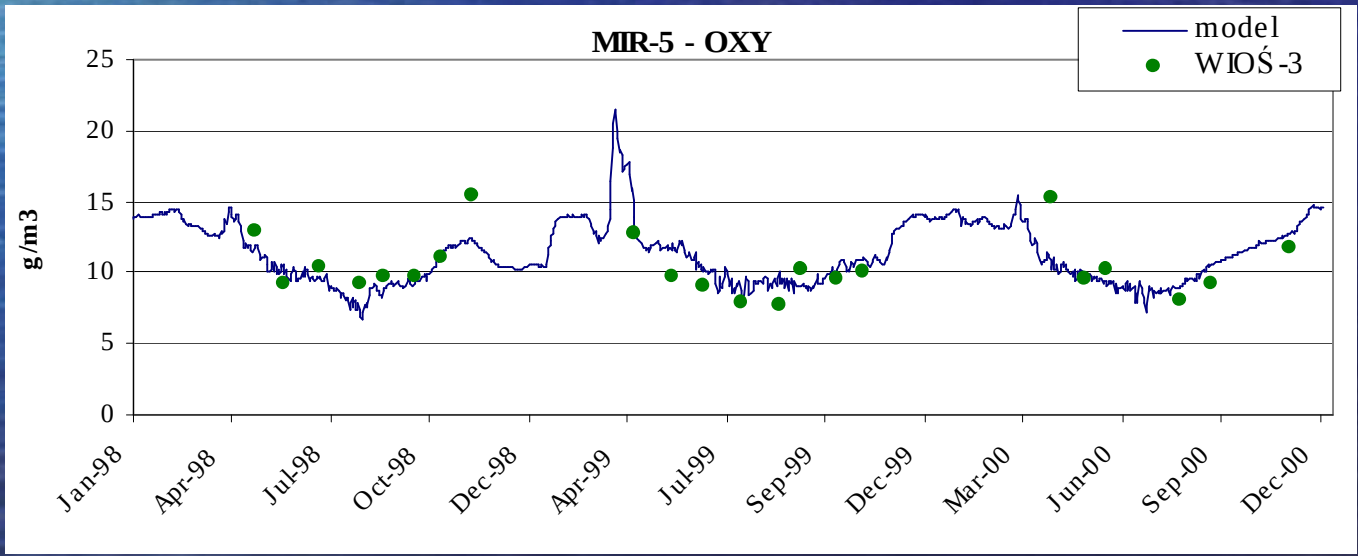
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



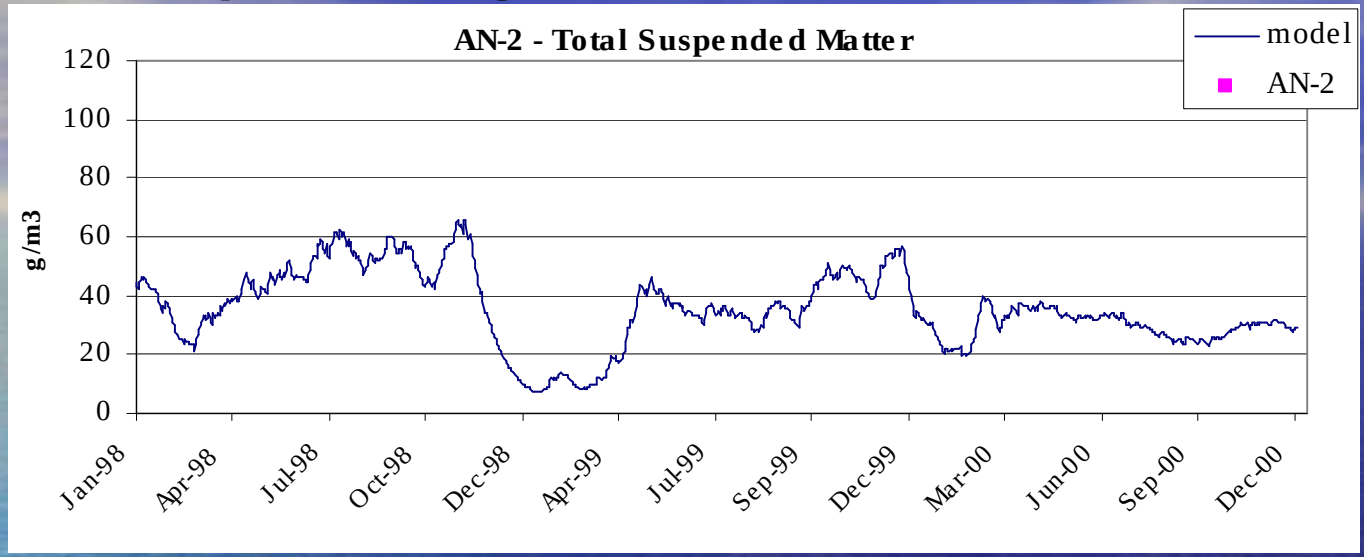


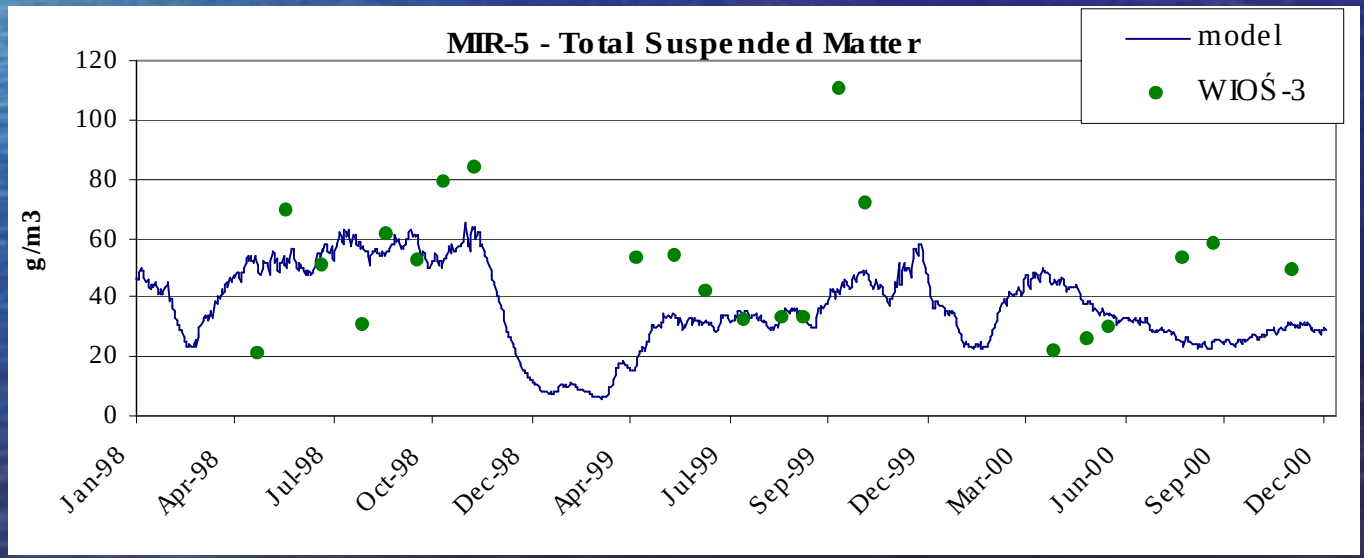
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements



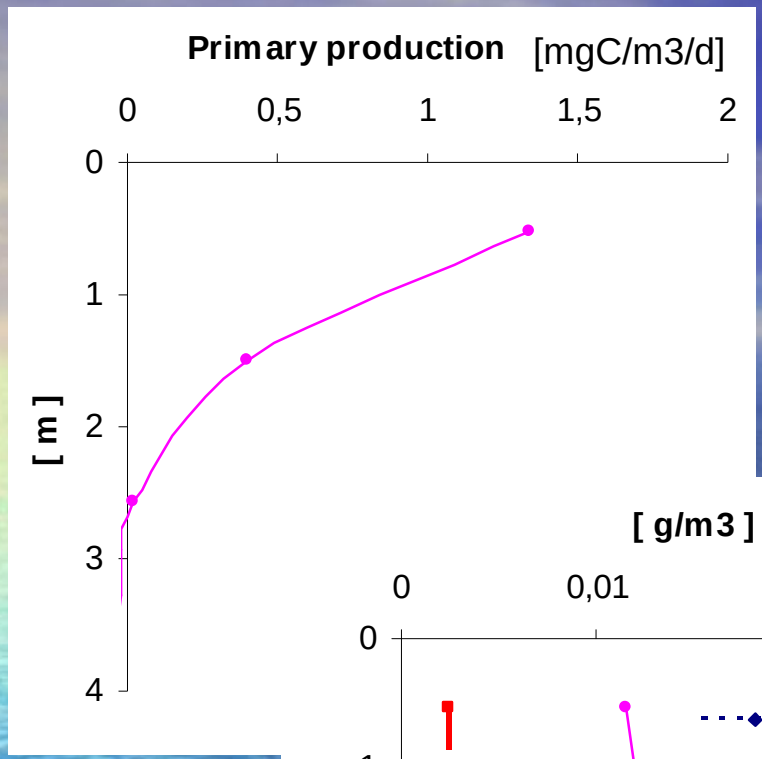


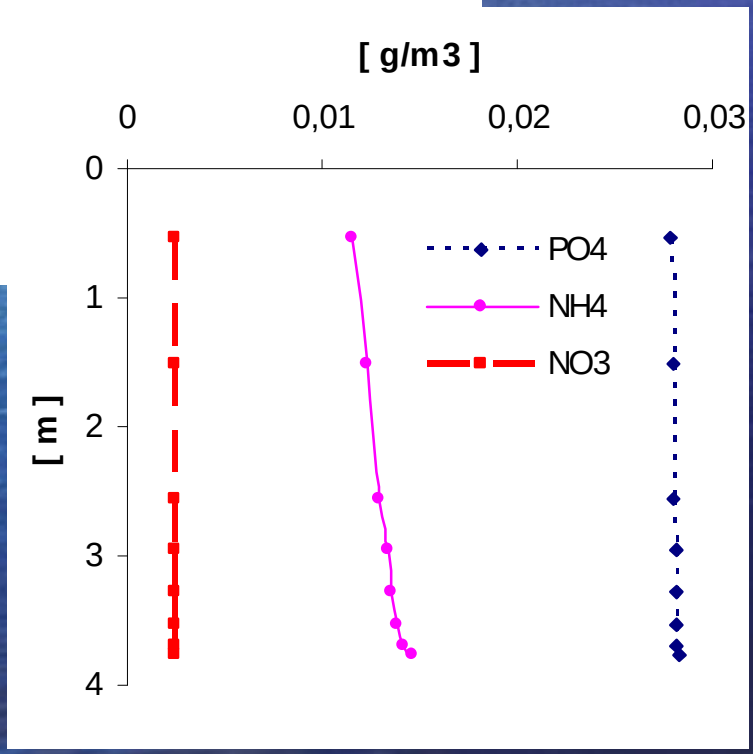
Vistula Lagoon modelled values in years 1998 – 2000 plotted against measurements

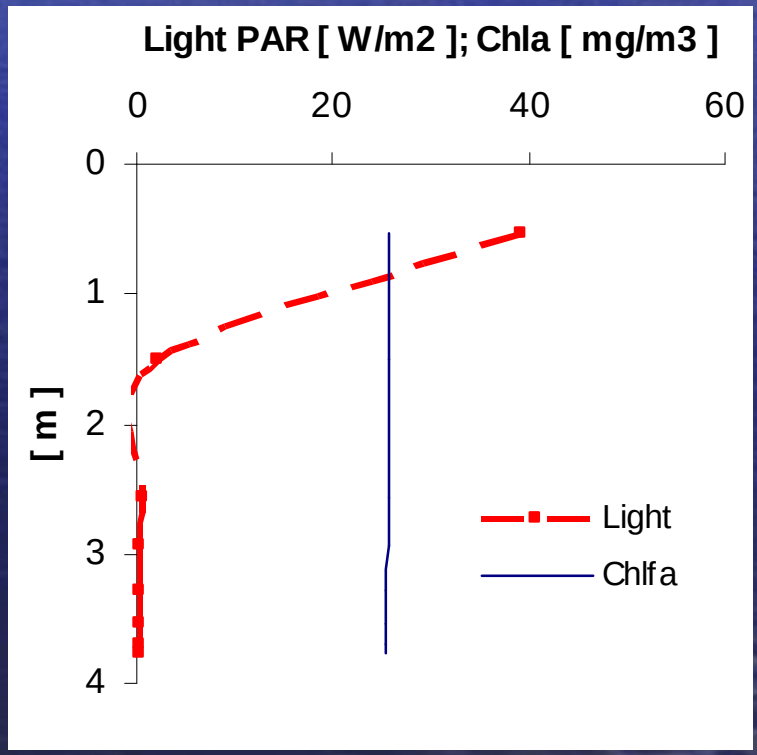




Vertical distribution of primary production, nutrients, chlorophyll a and light in the central part of the Vistula Lagoon – modelled values for the 1st of July 2000

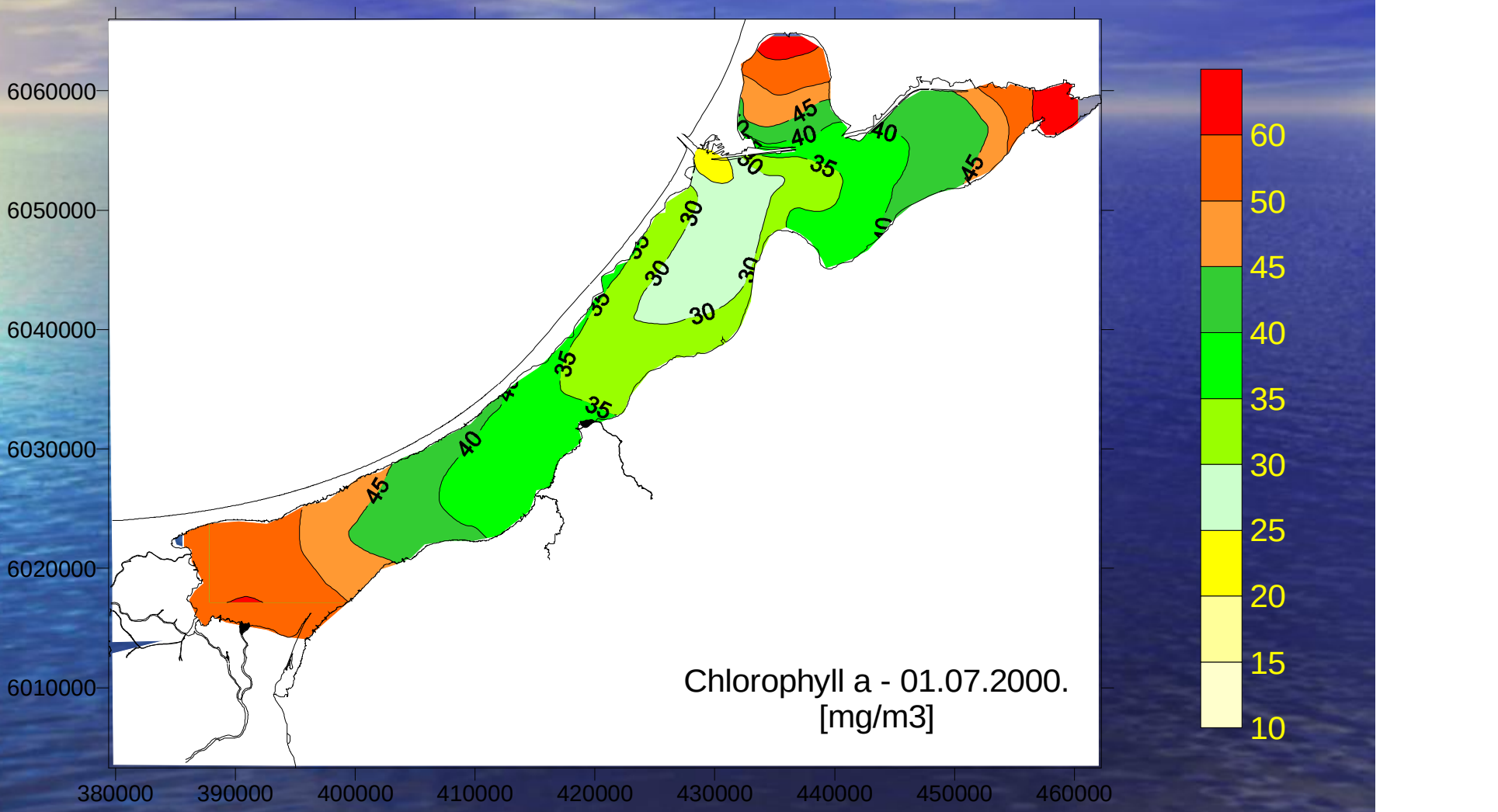






MANTRA - East - Vistula Lagoon
December 2003

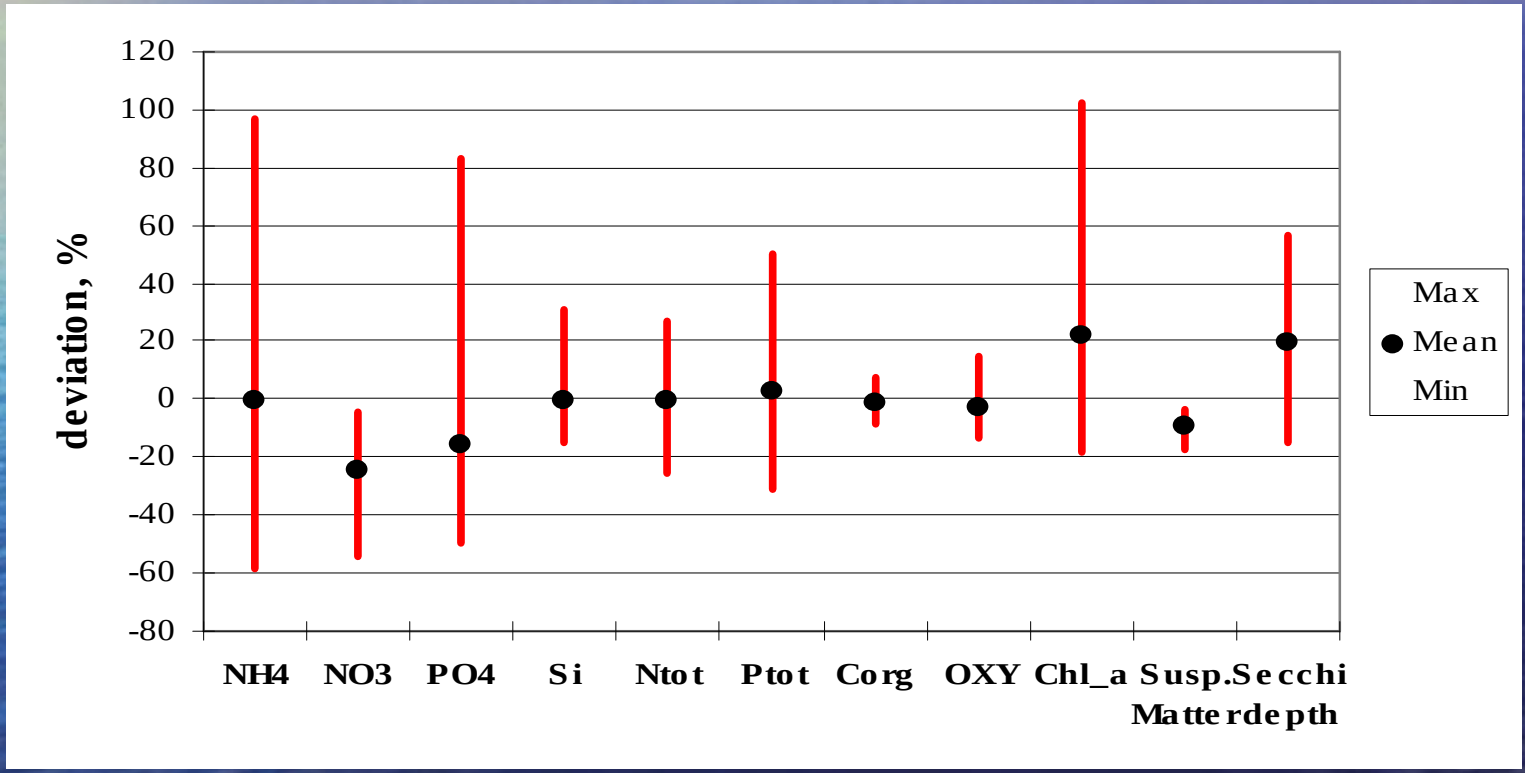
Spatial distribution of chlorophyll in the Vistula Lagoon – modelled values for the 1st of July 2000



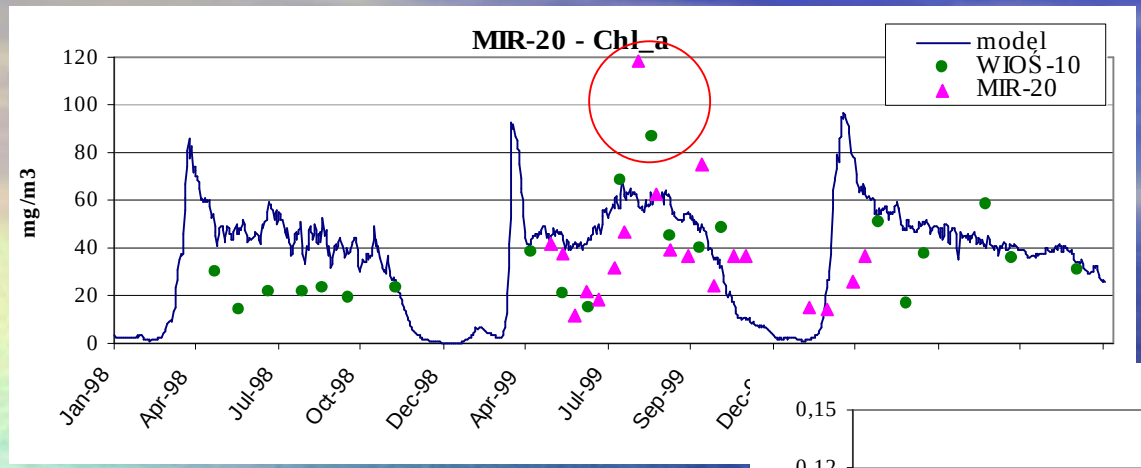
MANTRA - East - Vistula Lagoon
December 2003

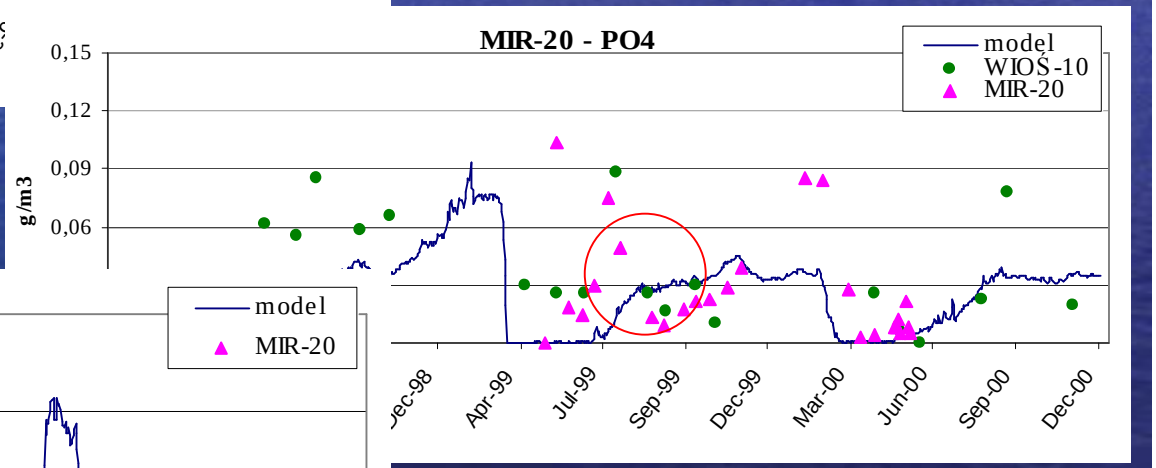
Calibration results

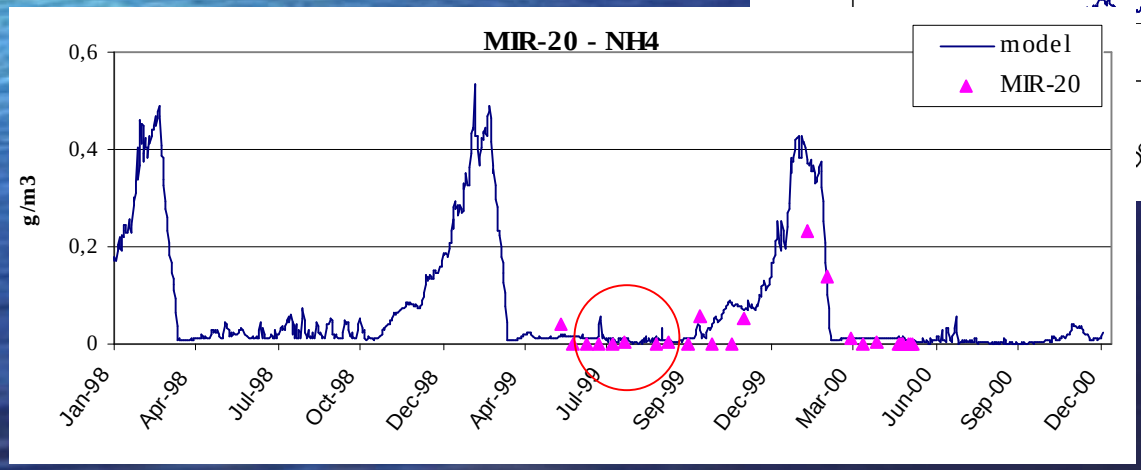
Difference between average modelled and measured values at particular stations



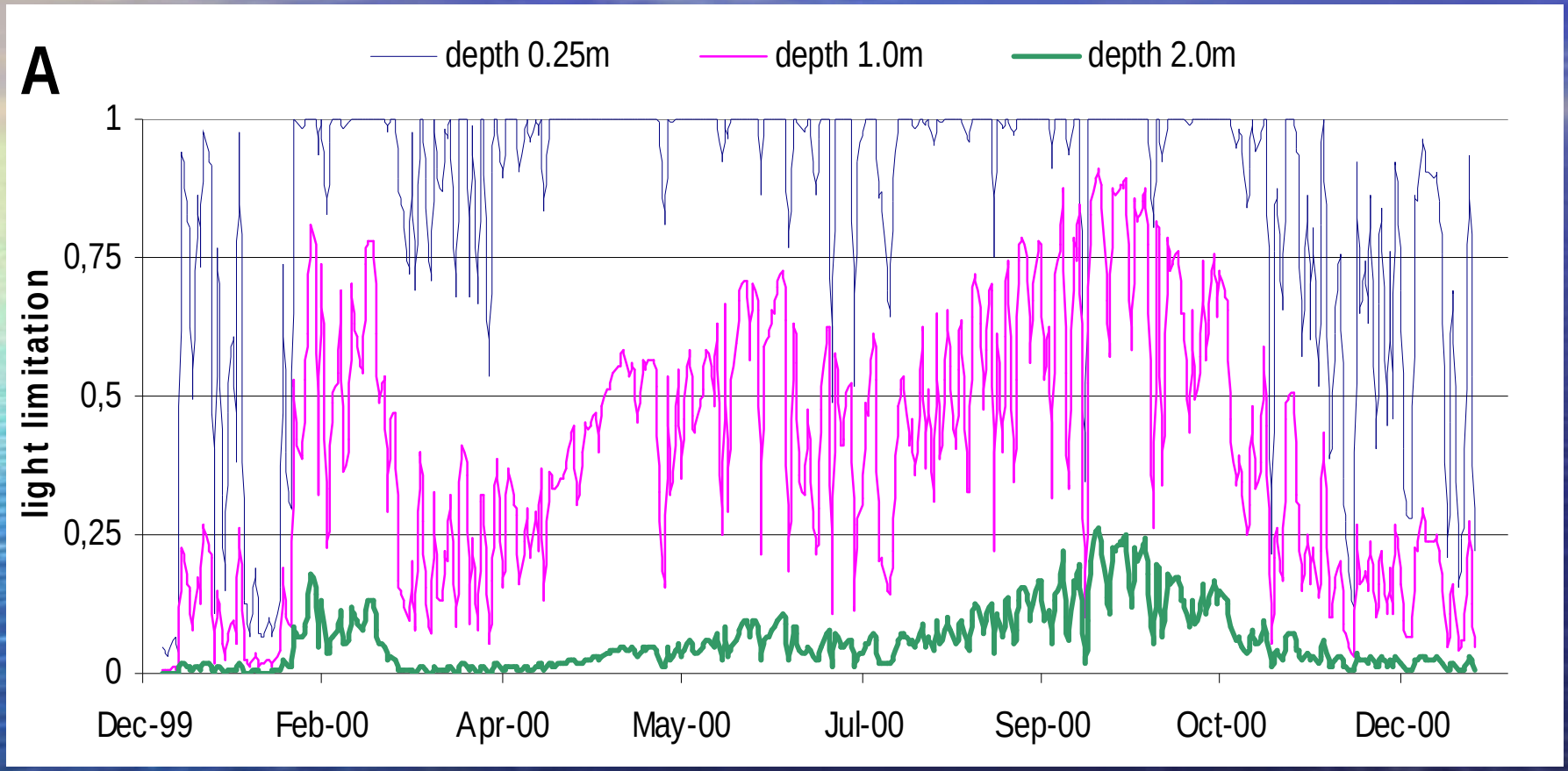
Vistula Lagoon ecosystem – model shortcomings
N-fixation, lack of chlorophyll peak in the model results







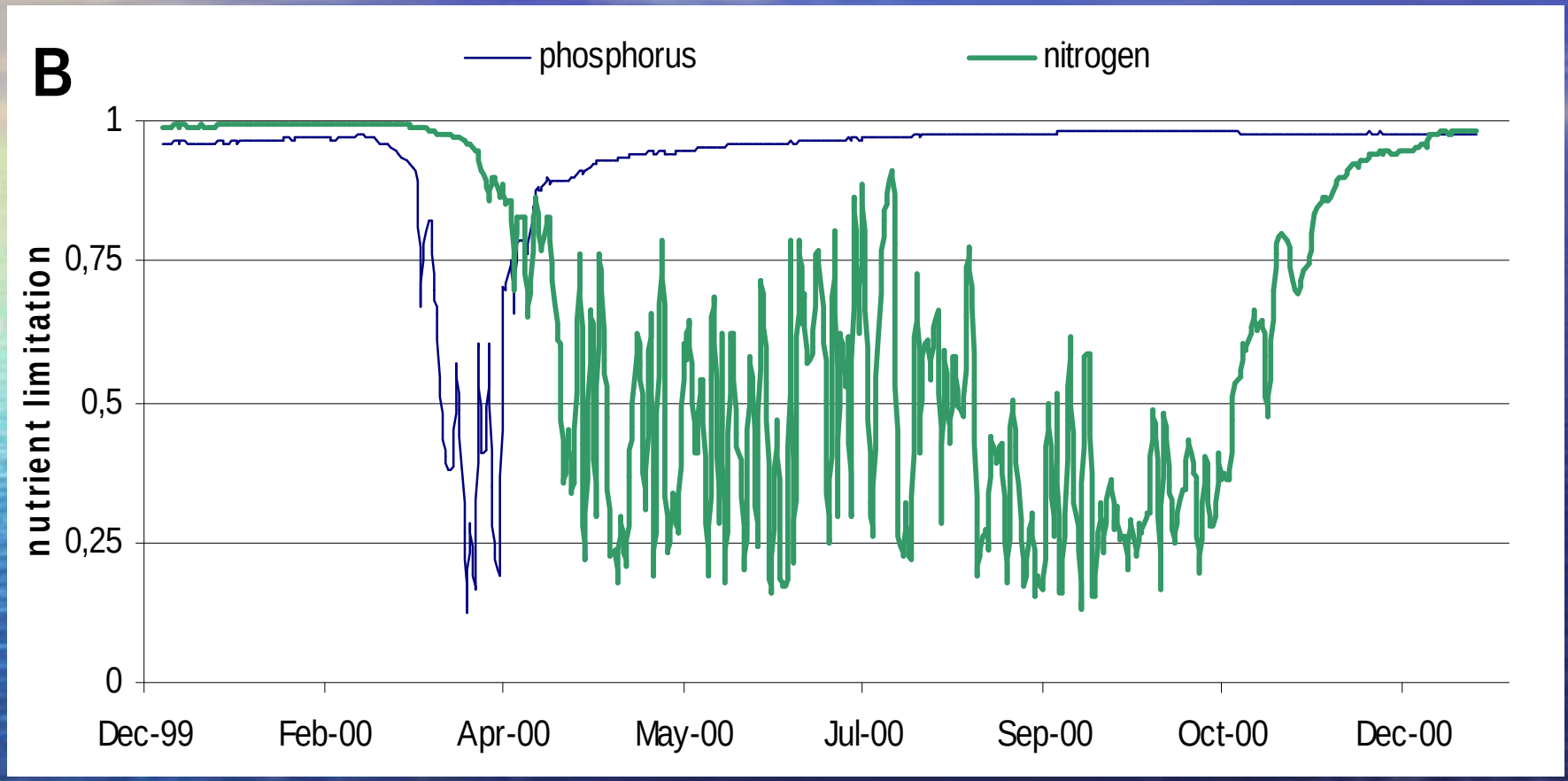
Phytoplankton growth limitation by light at different depth levels



0 value indicates total growth inhibition while value = 1 indicates no growth limitation.

MANTRA - East - Vistula Lagoon
December 2003

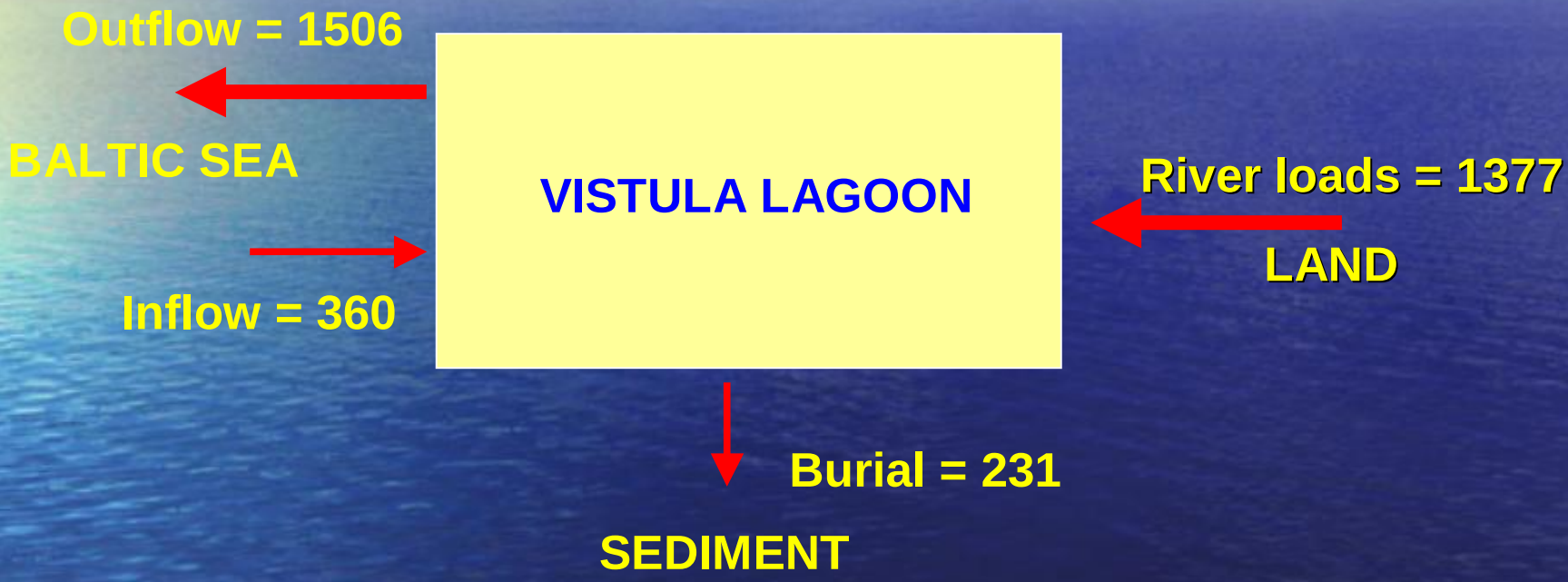
Phytoplankton growth limitation by inorganic nitrogen and phosphorus in the surface layer



0 value indicates total growth inhibition while value = 1 indicates no growth limitation.

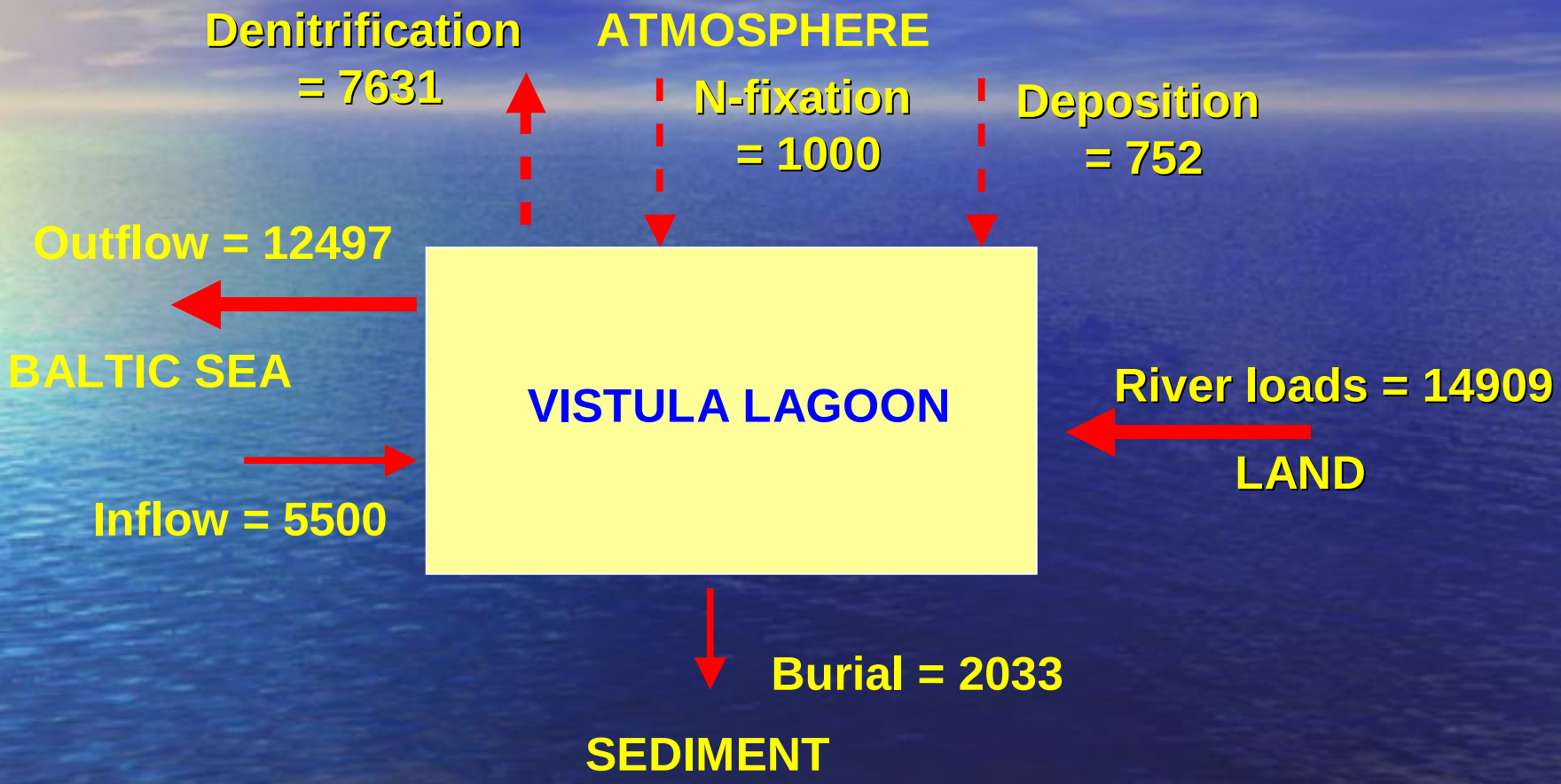
MANTRA - East - Vistula Lagoon
December 2003

Total phosphorus budget, tones/year



Net outflow = 83% of the input from the drainage basin

Total nitrogen budget, tones/year



Net outflow = 47% of the input from the drainage basin

Conclusions

- There was a good agreement between average concentrations of all modeled and measured parameters. Deviations were less than 25%, and in most cases less than 5%.
- For majority of parameters the seasonal changes were properly represented in the model. However, changes of phytoplankton biomass and phosphate concentrations were not satisfactorily resolved.
- The limiting factors for phytoplankton growth were inorganic phosphorus in spring and inorganic nitrogen in summer.
- The main sources of horizontal inhomogenity in the Vistula Lagoon were the mouths of Pregel, Elbląg and Nogat rivers, the outlet of Kaliningrad sewage collector and the Baltijsk Strait.

Conclusions

- There was no vertical zonation in the model, except for light availability and primary production. The model could not be properly calibrated in this aspect, due to scarce number of field observations.
- Nutrient budget calculations suggest, that there was little retention of phosphorus in the Lagoon, while the retention of nitrogen was more substantial. The important pathway in nitrogen cycle in the Lagoon appears to be the denitrification.