Understanding the bioreactor Wadden Sea: a geochemical and physical approach

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Introduction

Tidal flats are subject to short- and long-term fluctuations of biological, geochemical, and physical parameters, leading to a highly dynamic system. The major goal of our project is the characterization and quantification of the dissolved and particulate matter and their flux between the Wadden Sea and the North Sea on a tidal and seasonal scale. Moreover, biogeochemical transformations in the water column are investigated with a special focus on redox-sensitive trace metals.

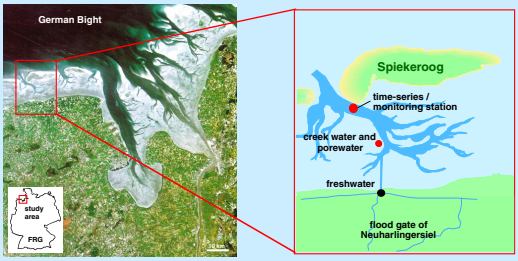


Fig. 1: Map of the study area showing the Spiekeroog backbarrier intertidal system. The red dots mark time-series stations and porewater sampling.

Results and discussion

• The salinity shows tidal and seasonal variations, which are controlled by the rainfall over land. Although the salinity is almost constant in May and August the water temperature evidences the exchange of different water masses (Fig. 2).

• Dissolved Mn shows a distinct tidal pattern with maximum concentrations during low tide and summer (Fig. 2). In contrast, Mo behaves conservative with maximum concentrations during high tide. Only in summer Mo shows unexpected increasing concentrations towards low tide, which indicates a coupling of Mo to the Mn cycle in the Wadden Sea during summer.

• The major Mn sources are the freshwater and the porewater. Especially in summer the dominating Mn source seems to be the porewater, which shows increasing Mn concentrations from winter to summer (Fig. 3) due to increasing microbial activity.

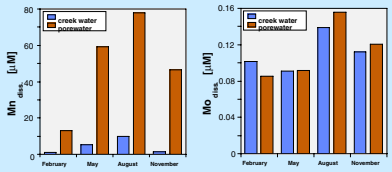


Fig. 3: Concentrations of dissolved Mn and Mo of tidal creeks and porewater (compare Fig. 1).

• Mn on individual particles increases towards summer due to enhanced microbial and/or photo-oxidation of dissolved Mn (Fig. 4a). However, regarding the scatter plot of excess Mn versus Al of the particles per water volume (Fig. 4b) it is obvious that higher SPM concentrations in winter and fall lead to a high concentration of particulate Mn in the water column.

• The comparison of the total Mn input via the freshwater with the observed mean concentrations of Mn in the Wadden Sea shows that sufficient Mn is contributed by the freshwater in February. On the other hand, a distinct porewater input is necessary to explain the observed Mn concentrations in August.

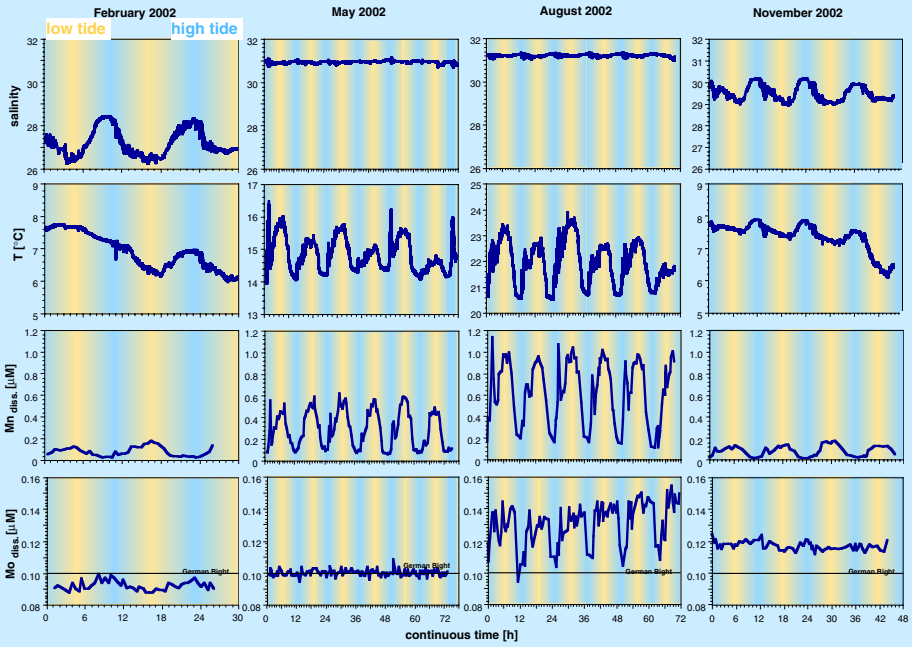


Fig. 2: Salinity, temperature, and dissolved Mn and Mo of the time-series stations in the major tidal outlet of the backbarrier system.

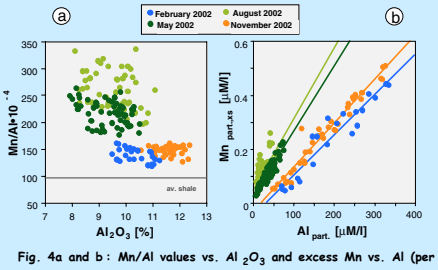


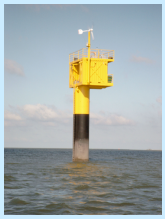
Fig. 4a and b: Mn/Al values vs. Al $_2O_3$ and excess Mn vs. Al (per water volume) for time-series particulates.

Tab. 1: Estimates of the Mn input by freshwater and porewater into the Wadden Sea system on the basis of salinity variations (total Mn = dissolved + particulate [µM]).

	February	May	August	November
mean salinity German Bight	33	33	33	33
mean salinity Wadden Sea	27.2	30.9	31.2	29.5
Δ salinity	5.8	2.1	1.8	3.5
% freshwater input	17.7	6.3	5.4	10.6
total Mn freshwater	2.5	5.1	7.8	2.9
total Mn input via freshwater	0.44	0.32	0.42	0.31
total Mn Wadden Sea	0.35	0.40	0.75	0.39
Mn input via porewater	-0.08	+0.07	+0.33	+0.08

Outlook

Given the importance of establishing the input/output budgets between the intertidal system and the open sea, physical parameters are now monitored by a newly installed monitoring station in the major tidal outlet.



We appreciate the support of the crew of the "FK Senckenberg" during several cruises.
This project is funded by the German Science Foundation (DFG) through grant FOR 432/1-1