MODELLING NEAR BOTTOM SEDIMENT TRANSPORT

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SFB 313
TP A2

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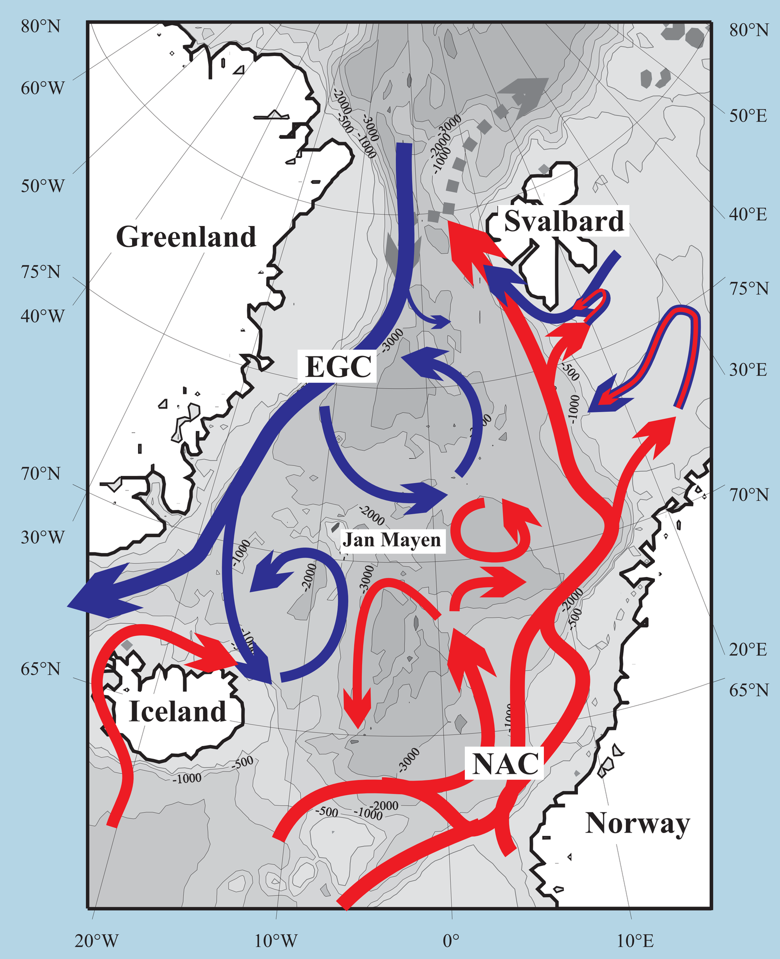
INTRODUCTION

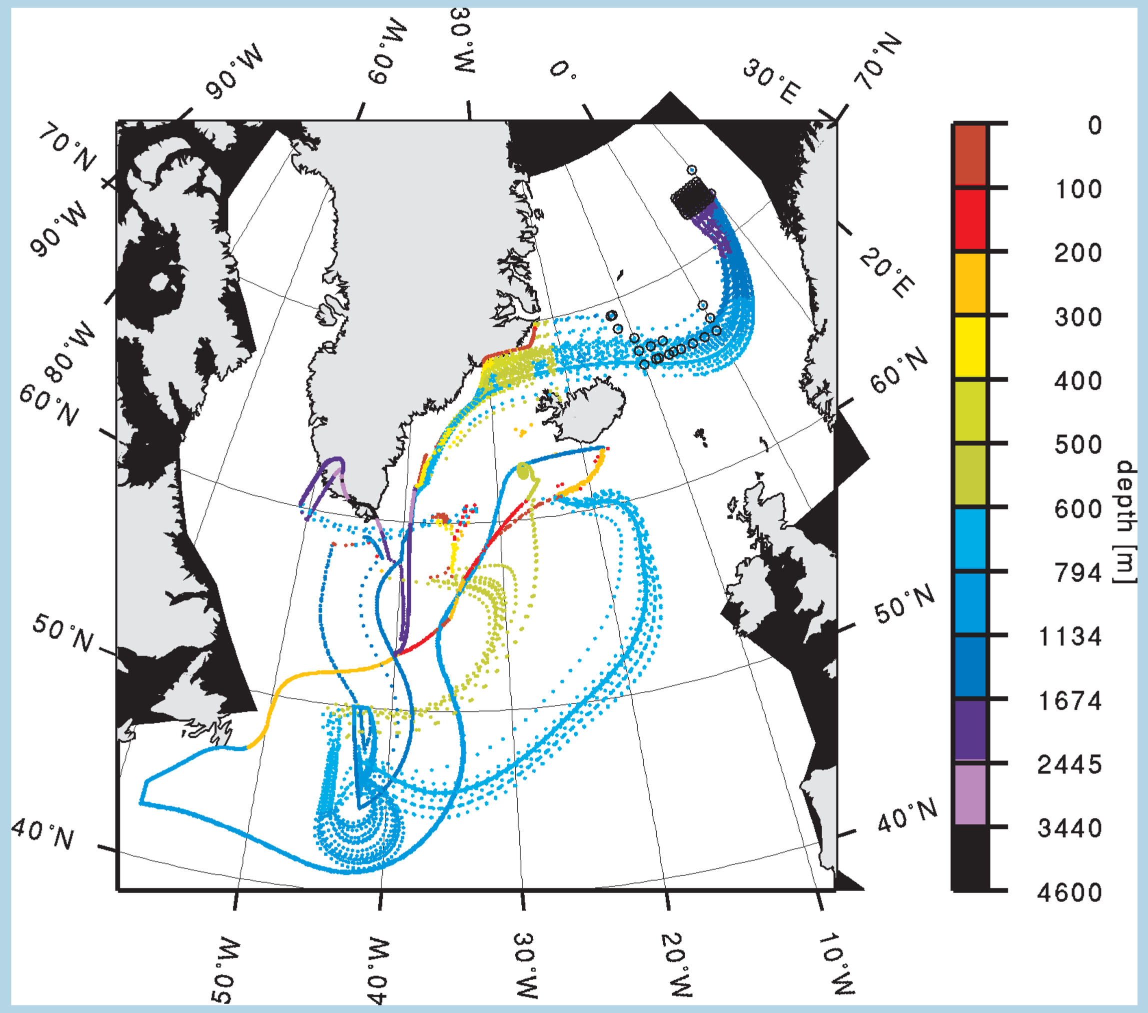
Particle transport in the Norwegian Greenland Seas is coupled to the ocean circulation. The rain of particles sinking through the water column may be spread over the entire basin. This transport by the general circulation regime is modified by, in time and space, small scale transport processes from shallow shelves to the deep basins, which are controlled by the local hydrographic and topographic environment. Those processes are for example cascading of particle laden dense bottom water masses, eddy seafloor interactions, and erosion due to internal surf. Particle interactions modify settling velocities, and may prolong residence times and transport distances in the bottom boundary layer. Convection from the bottom may occur if a turbid plume stagnates in the deep ocean. By this particles may be transported into the water column from below, and spread over a larger area.

LARGE SCALE TRANSPORT



The surface current regime in the GIN Sea intuitively illustrates that particles released somewhere can be deposited anywhere, and that particles may be imported or exported from/to the North and South.

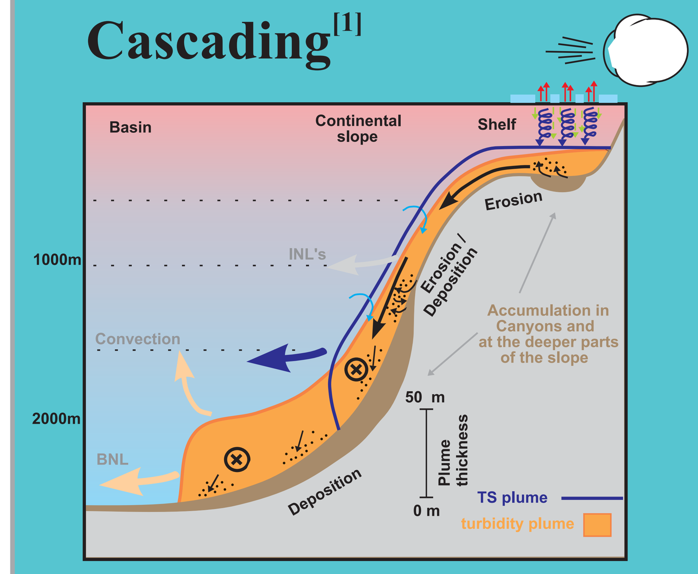
(Figure after Poulain JGR, 101(8)18237-18258)



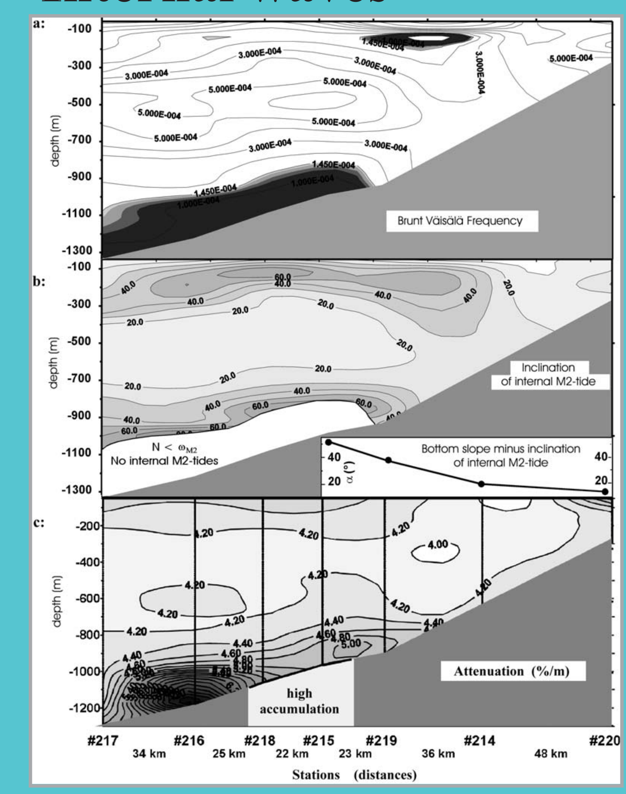
Trajectories of particles deployed close to the seafloor in the Norwegian Greenland Sea. The trajectories are calculated with the impact of convection included. The density stratification with sediment particles is stable (blue line). The first 500 years of the particles are shown. The particle depth is indicated by colors from the color palette; as the particle descends or upwells, the color of the trajectory changes. [5]

SMALL SCALE PROCESSES

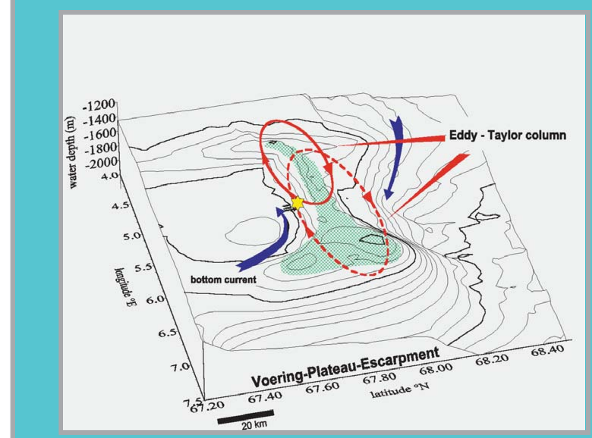
Cascading[1]



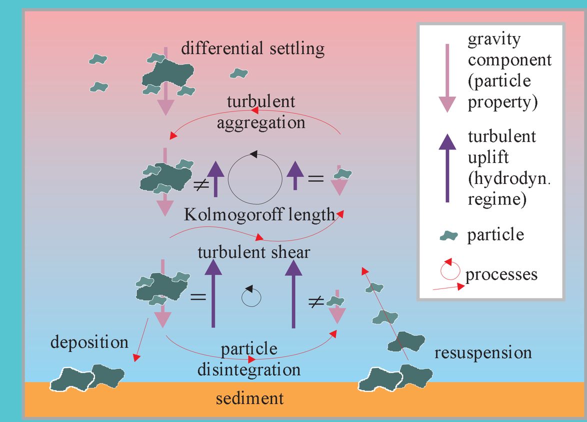
Internal waves[1]



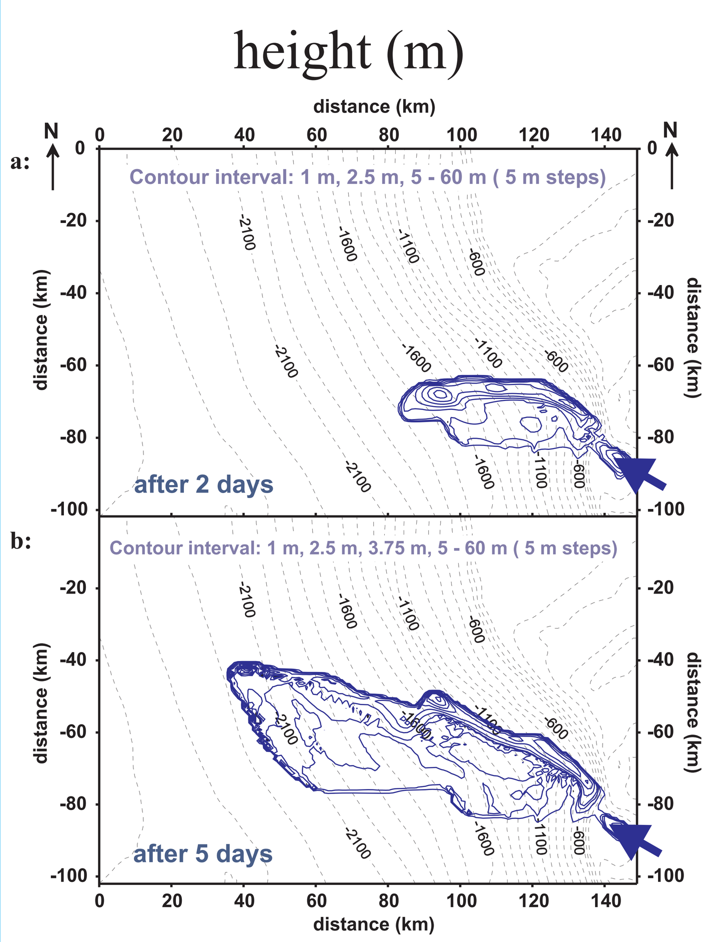
Eddies[6]



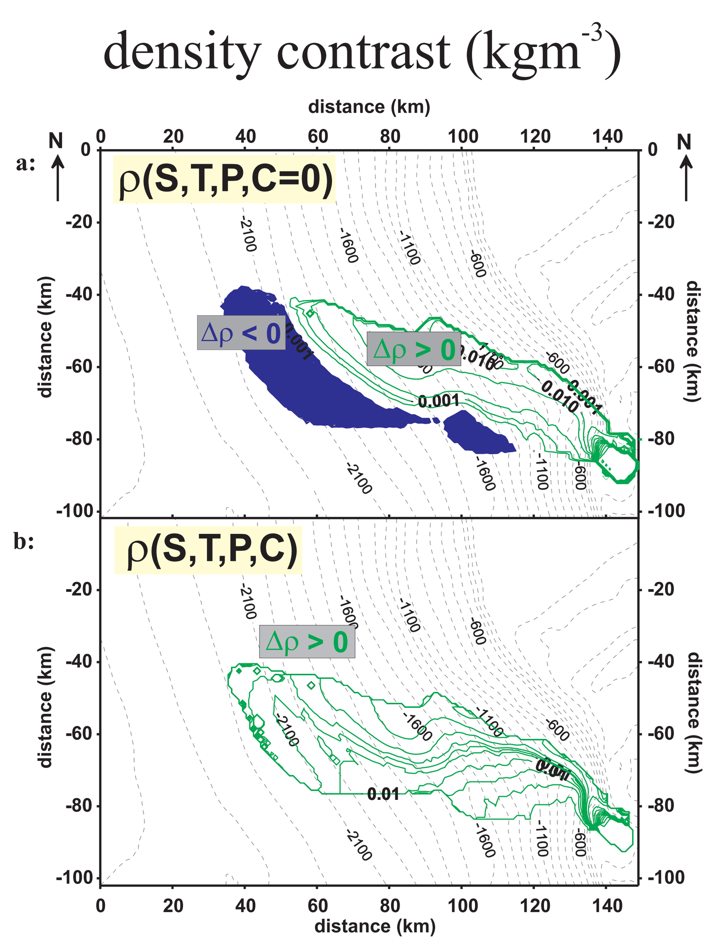
Particle interactions[4]



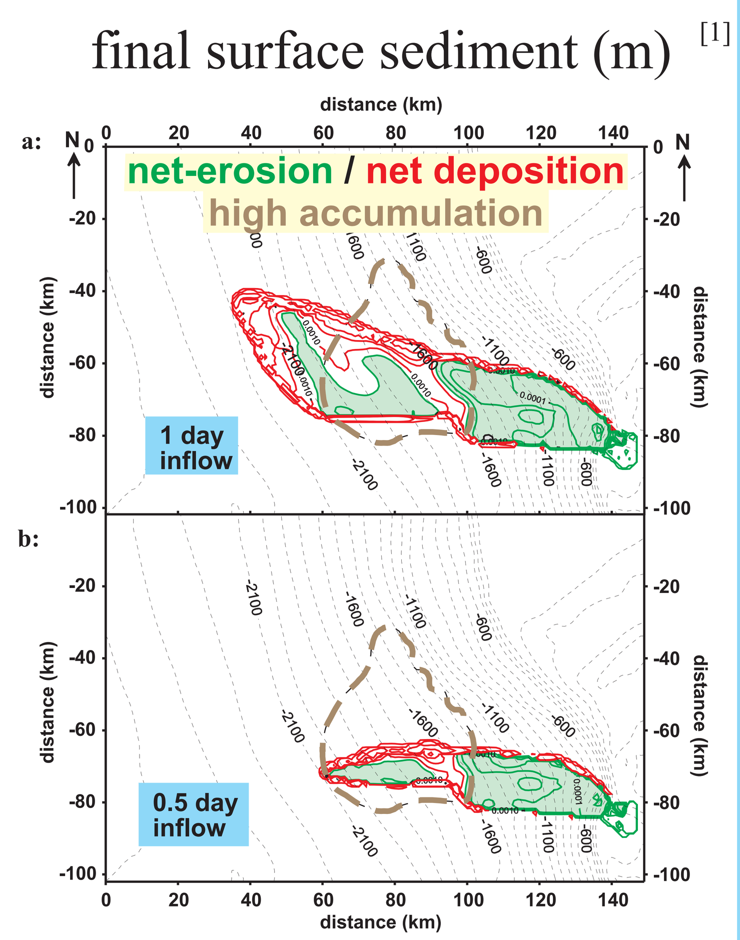
KVEITEHOLA SIMULATION



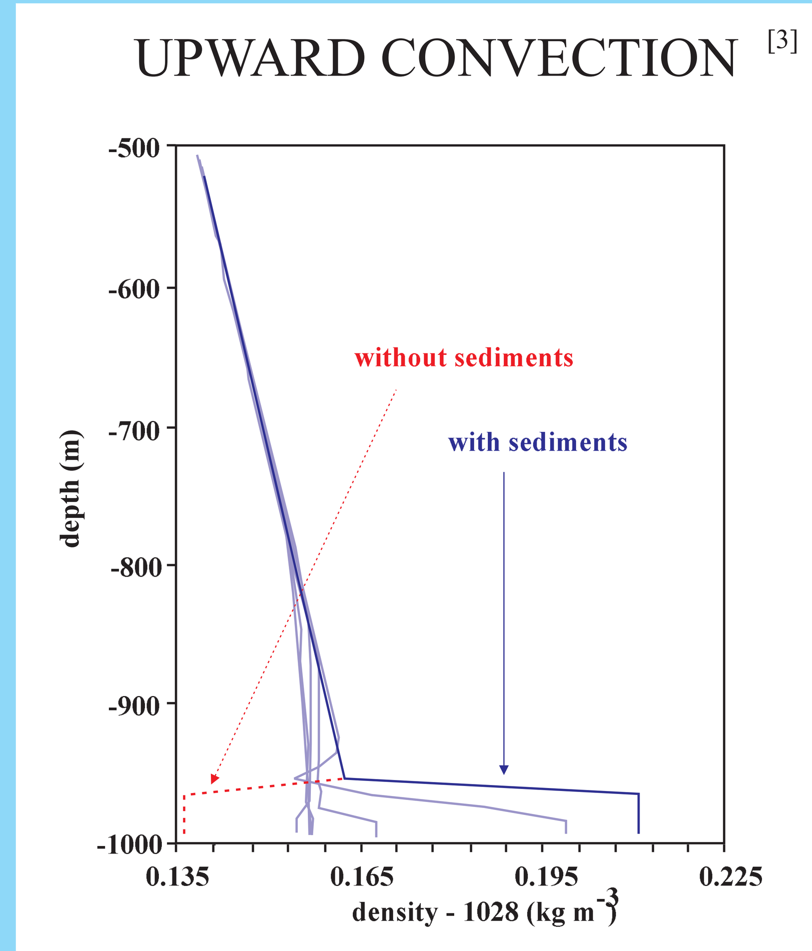
Within the first two simulation days the plume descends rapidly down to 1800 m. During the next 3 days the plume sinks further down to 2200 m. While depositing its particle load the plume slows down and finally stops.



After most particles are deposited the density contrast is close to zero (green contours). Including the remaining particles the density is everywhere positiv (b.). Excluding particles the density contrast is partly negativ (a. blue area).

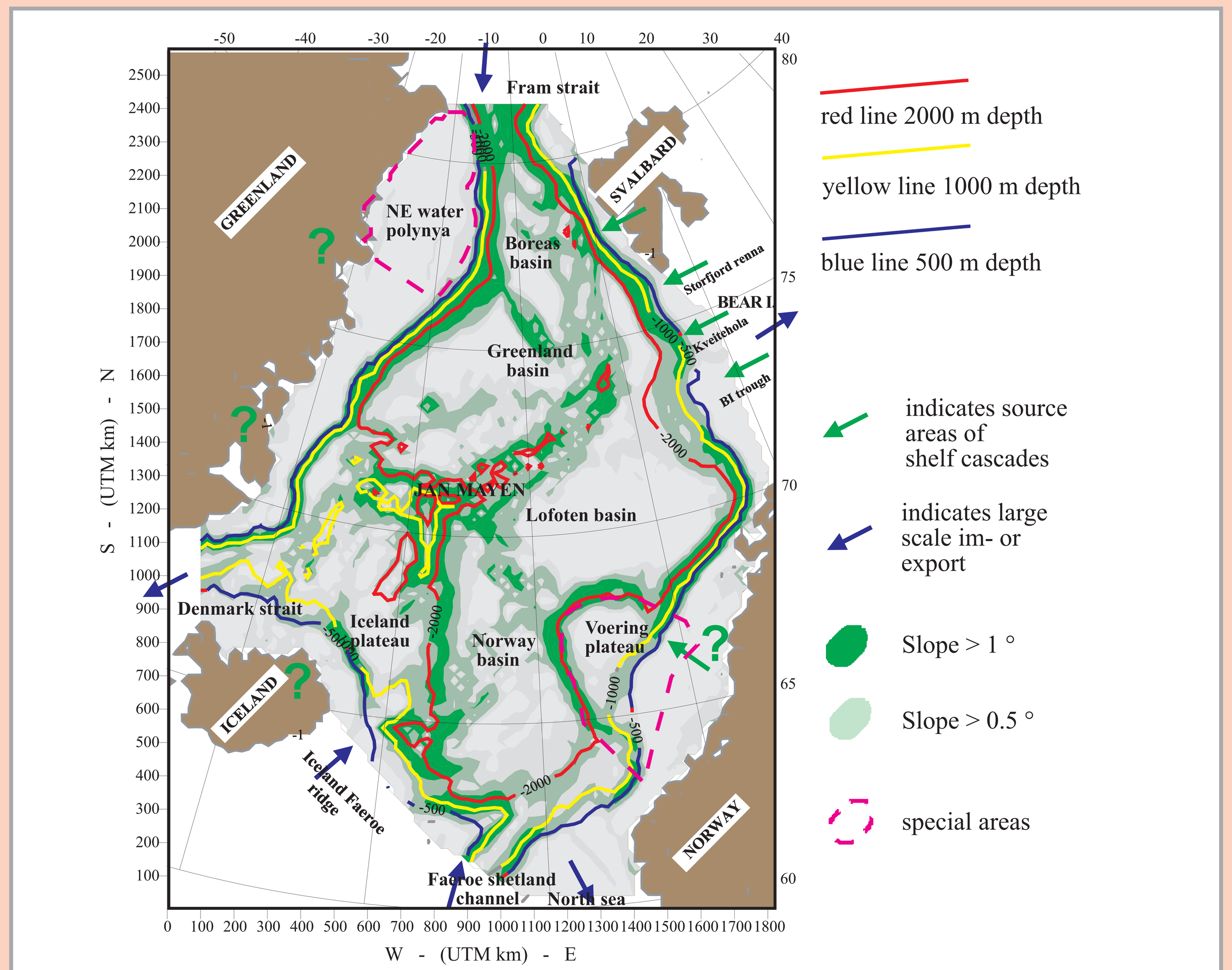


At water depths above 1400 m erosion (red) dominates the final sediment distribution. Below that deposition (green) dominates. With an inflow duration of one day (a.) the main deposition is below the high accumulation are (brown). With half a day of inflow (b.) the depositon is mainly within the high accumulation area.



Without sediments the density stratification (red line) in a 40 m thick bottom boundary layer (the plume) is unstable. The density stratification with sediment particles is stable (blue line). Upward convection occurs by settling of particles if the plume stagnates. Evolution of density stratification (light blue lines) plotted every third hour of simulation.

ACCUMULATION				OUTFLOW				DEEP WATER [1]	
area	1260 km²	total mass	$2.64\ 10^9$ t	width	5 000 m	instantan	$5\ 000\ m^3\ s^{-1}$	produced deep water	0.001 Sv
thickness	1.5 m	duration	8000 a	height	20 m	water total	$3.3\ 10^9\ m^3\ a^{-1}$	outflow duration	2.5 days
volume	$1.88\ km^3$	deposition/a	$330\ 000\ t\ a^{-1}$	velocity	$0.15\ m\ s^{-1}$	entrainment	800 %	or	5 * 1/2 days



The Northern North Atlantic can be devided into certain areas, where different particle transport processes may occur. For example: Step slopes at the continental margin are areas with a high probability of cascading, the depth interval between 500 and 100 m is preferred by internal waves, but some special areas have unique characteristics.

[1] **Fohrmann, H,** JO Backhaus, F Blaume & J Rumohr **(1998)**, **Sediments in bottom arrested gravity plumes - numerical case studies,** *Journal of Physical Oceanography*, in press.
[2] **Fohrmann, H, (1996), Sedimente in bodengeführten Dichteströmungen - numerische Fallstudien,** ph.D. thesis published as *Report of the Sonderforschungsbereich 313*, **66**: 106, [available from Kiel University, Library, or from the Author].
[3] **Kämpf, J,** H Fohrmann & JO Backhaus, **(1997),On the potential role of sediments in Arctic slope convection,** Proceedings of the conference on *Polar Processes and Global Climate*, Rosario, Orcas Island, USA, November 1997.
[4] **Ritzrau, W** & H Fohrmann, **(1998), Field and numerical studies of near bed particle dynamics,** *International symposium computerized modeling of sedimentary systems*, Güstrow, 1996, ed. J Harff & K Stattegger, Springer, pp. 25.
[5] **Seidov, D,** & BJ Haupt, **(1997), Simulated ocean circulation and sediment transport in the North Atlantic during the last glacial maximum and today,** Paleoceanography, **12**, 281-305.
[6] **Rumohr, J**, and Coworkers, **(1996), Prozesse, Bilanzen und Modelle des Sedimentransportes,** published as *Report of the Sonderfoschungsbereich 313*, [available from the Author].