Time Series Particle Fluxes from the Iceland Sea: 1986 to Present

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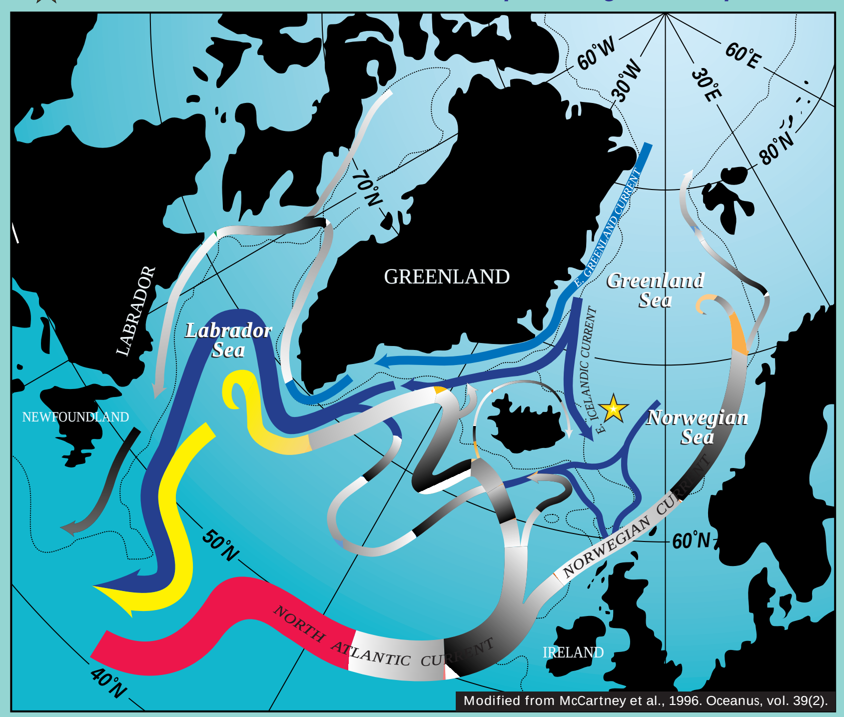
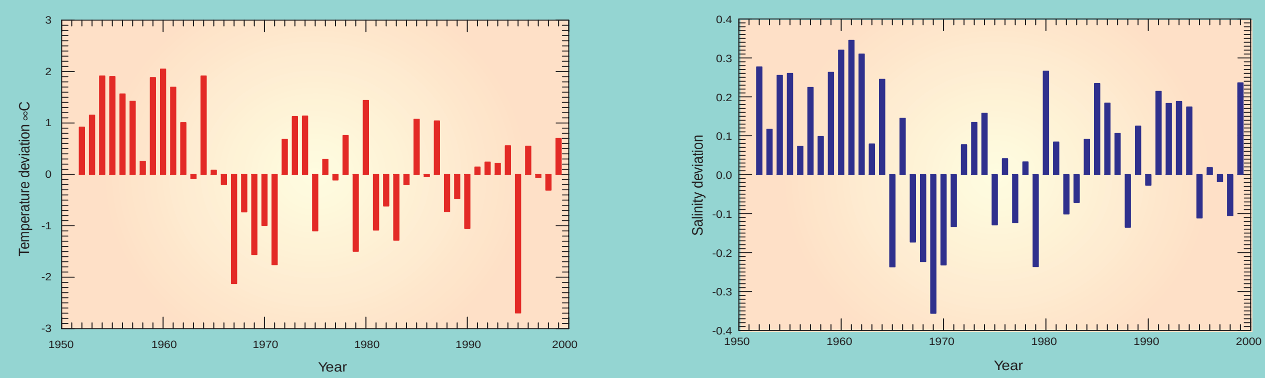
Location of Iceland Sea Sediment Trap Mooring, 1986 – present



Area of Research:

The Iceland sea is an area where temperate and arctic fronts influence both atmospheric and oceanographic conditions. The Irminger Current is a branch of the North Atlantic Current that carries relatively warm Atlantic water northward and west of Iceland where it splits as the Greenland-Iceland Ridge. One branch of the Irminger Current swings west and south to form the cyclonic circulation of the Irminger Sea and the other branch, generally smaller, rounds the northwest peninsula of Iceland and flows eastward on the shelf as the North Iceland Irminger Current. The Interannual hydrographic variability is much greater north of Iceland in the Iceland Sea than south of the Island, and it results mainly from the input of different proportions of Atlantic Water and Polar or Arctic Water into this area.



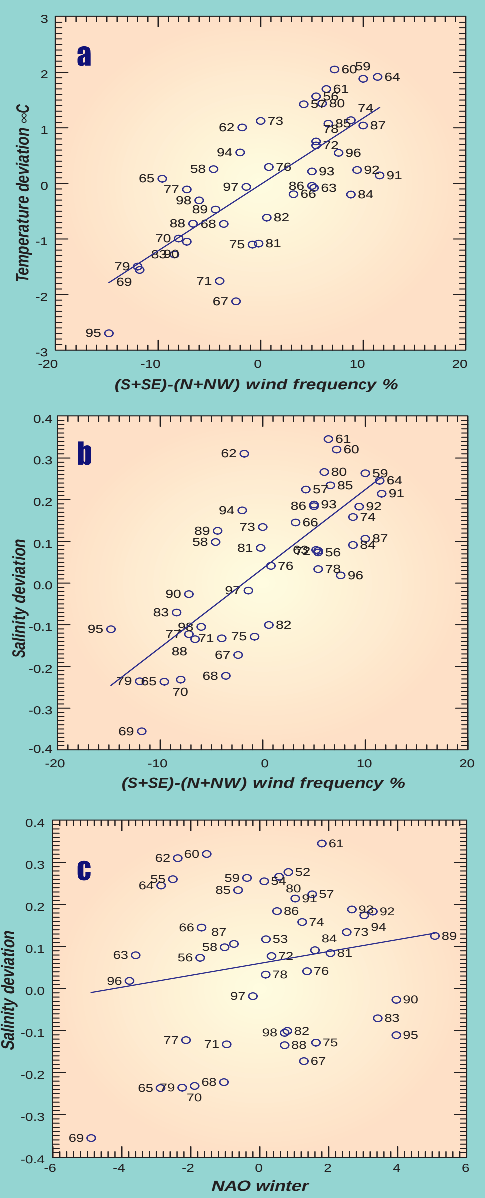
Siglunes section mean temperature and salinity deviations from the 1961-1980 mean, as indicators of hydrographic indicators in the waters north of Iceland.

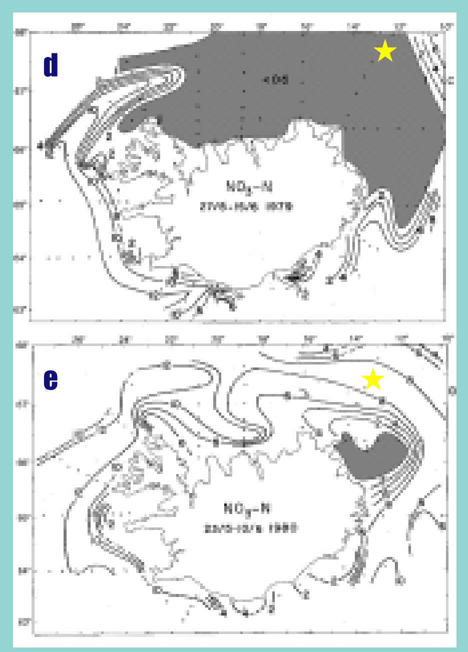
Hydrographic and Meteorologic Observations North of Iceland

Advection of Atlantic Water through the Greenland Strait into the Iceland Sea is connected to the regional meteorologic condition as proposed by Unnsteinn Stefansson.

The north-south wind regime northwest and west of Iceland, in January through May has a strong influence on the Atlantic water advection and resultant hydrographic conditions in late May and early June. The east-west leaning of the wind additionally relates to the salinity variations, possibly by affecting the amount of polar water that is advected eastward from the East Greenland Current. The ocean response time to local wind direction variations is short, on the order of a few months.

The mid-latitude meridional atmospheric pressure gradient variations described by the NAO index, do not explain the observed hydrographic variations North of Iceland.





The surface distribution of Nitrate in two contrasting years 1979 and 1980.

d.) The spring of 1979 was cold and with very little Atlantic water advection onto the North Iceland

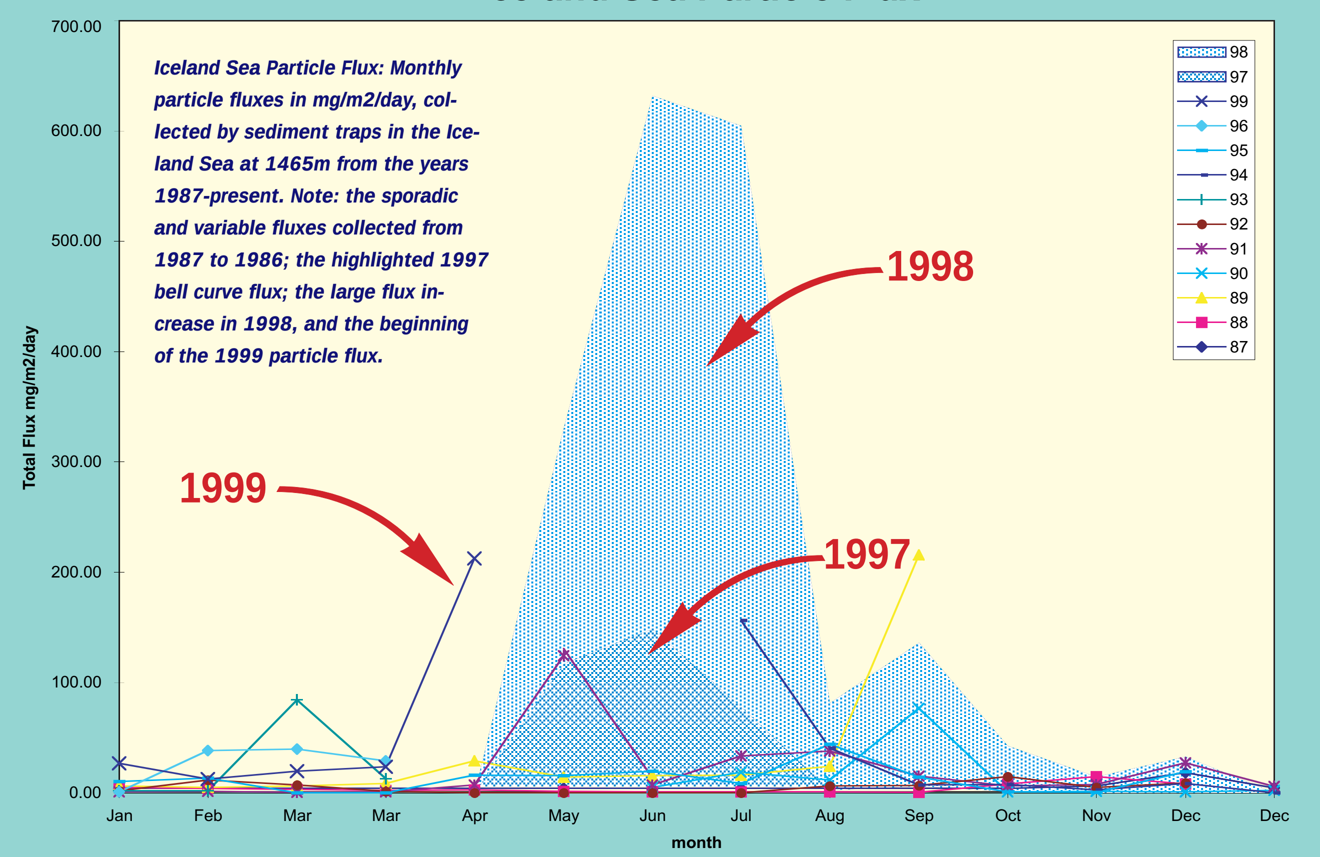
e.) In 1980 the strong Atlantic water inflow replenished nutrients.

Nutrient input North of Iceland

The onset of nutrient uptake in spring in the area North of Iceland area seems to depend largely on the influx of Atlantic water to that area and/or the admixture of Polar water. On the basis of data from warm and cold years Thordardottir (1984) has suggested that because of strong stability in the surface layer of the coldest years of the period 1970-1980 the onset of the spring bloom appears to have occurred about one month earlier than in the warmer years. This does not however imply that the annual production will be greater in the cold years than in the warm years. On the contrary, the Atlantic water inflow provides an important nutrient source to the North Icelandic area, both directly due to relatively high nutrient concentrations and indirectly because of much more efficient renewal in the surface layer by eddy diffusion in the Atlantic water than in the highly stratified Arctic water. During warm periods with small extension of drift ice and consequently small or even negligible admixture of polar water to the surface layers, continued inflow of Atlantic water to the North Icelandic Sea should therefore maintain favorable mixing conditions and make a longer lasting plant production possible.

a. and b.) Connections between temperature and salinity deviations at the Siglunes section and mean (S+SE)-(N+NW) wind frequencies.

c.) Connections between salinity deviations at the Siglunes section and the NAO indices for winter (Dec.-Mar).



Iceland Sea Particle Flux: Monthly particle fluxes in mg/m2/day, collected by sediment traps in the Iceland Sea at 1465m from the years 1987-present. Note: the sporadic and variable fluxes collected from 1987 to 1986; the highlighted 1997 bell curve flux; the large flux increase in 1998, and the beginning of the 1999 particle flux.

Iceland Sea Particle Fluxes

The Marine Research Institute (MRI), Reykjavik, Iceland, and the Woods Hole Oceanographic Institution (WHOI), Woods Hole, MA, USA, have deployed a time series sediment trap at 1457 meters in the Iceland Sea (68.0' N, 12.6' W) and collected monthly particle flux samples from 1987 to present. Prior to 1998, seasonal maximum peak particle fluxes were sporadic, of short duration and variable, fluctuating from 14.5 mg m^{-2} day^{-1} (Nov. 1988) to 215 mg m^{-2} day^{-1} (Aug. 1989). The annual average total particle flux of 5.6 g m^{-2} yr^{-1} ranged from 1.4 g m^{-2} yr^{-1} (1988) to 9.9 g m^{-2} yr^{-1} (1997) and was dominated by biogenic components consisting of an average of 39.7 percent $CaCO_3$ and 21.7 percent biogenic SiO_2. In contrast to these typical annual particle fluxes in this area, we have observed greatly increased total particle fluxes during the 1998-1999 collecting period. In 1998 the increased total particle fluxes were sustained from May through September with a maximum peak in July of 526 mg m^{-2} day^{-1} resulting in a yearly total particle flux of 42.7 g m^{-2} yr^{-1}.

The hydrographic variability in the Iceland Sea results essentially from differences in the influences of relatively warm and nutrient rich Atlantic Water on one hand and cold Polar Water on the other hand. **Hydrographic conditions observed and reported from the Siglunes transect are not directly correlated to the increased fluxes.**

Other explanations are required to explain the 1998 particle flux in the Iceland Sea. Continued collection of particulate fluxes are necessary to determine if this will be a reoccurring condition or a single event. As can been seen in the Iceland Sea Particle Flux early 1999 increased fluxes indicate that it will continue into the next year.

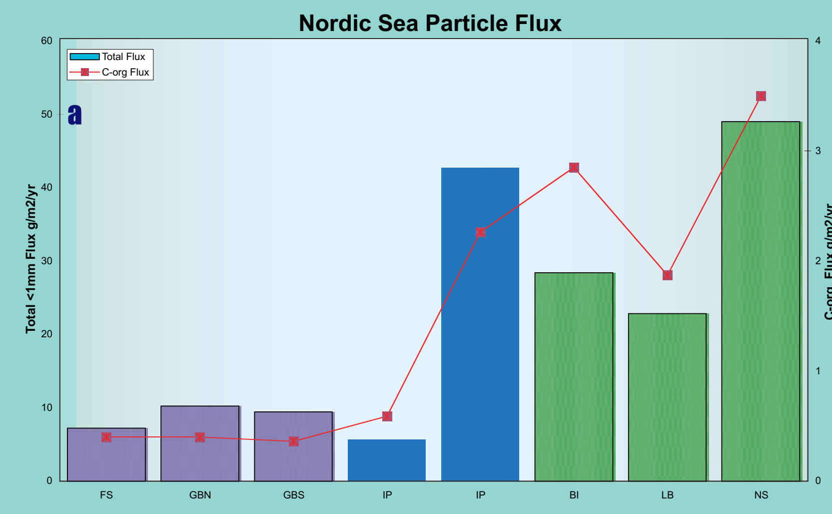
Nordic Sea Particle Fluxes

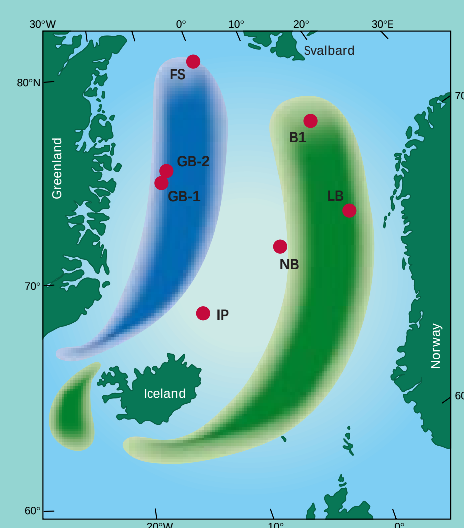
The annual Iceland Sea particle fluxes for the years 1987-1997 and 1998 have been compared to several time series sediment trap particle fluxes in the Nordic Sea. We find a dramatic difference between deep ocean total particulate fluxes in areas influenced by Atlantic waters, and fluxes collected in areas influenced by polar waters. The average annual Iceland Sea particle fluxes 1987-1997 are similar in amount to the polar influenced fluxes of the Fram St. and Greenland Basin, whereas the Iceland Sea 1998 annual particle flux is similar to the Atlantic influenced sites of the Norwegian Sea and Bear Island and Lofoton Basin areas. **This may indicate a possible connection of the 1998 particle fluxes with the Atlantic and Polar influence on the biogeochemical processes in the Iceland Sea.**

Global Perspective

As a Global framework, annual particle deep ocean fluxes collected from the Arctic regions are the smallest of all the oceans and are comparable to the South Pacific gyre (EQPAC 12S). The biological pump in the Arctic region results in the reduced delivery of particles to the deep sea when compared to the polar regions of the Southern Ocean and the North Pacific. The biological pump of the Arctic is also dissimilar to the polar regions of the Southern Ocean and North Pacific in that the **relative amount of Biogenic Si is also reduced.**

Annual particle fluxes in the Iceland Sea appear to switch from low delivery of biogenic particles to the deep sea to a very high delivery of biogenic particles to the deep ocean. Conditions altering the Polar regions not only influence the atmosphere and the surface ocean but also will influence the deep ocean.



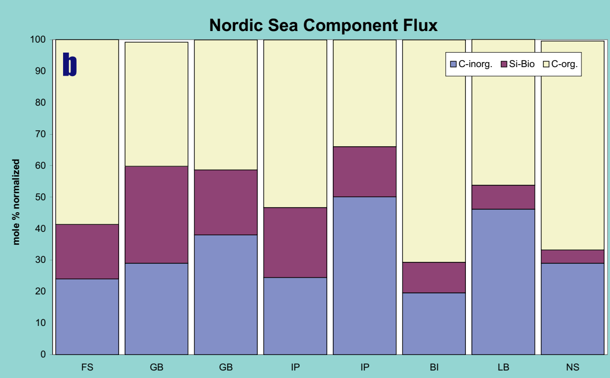


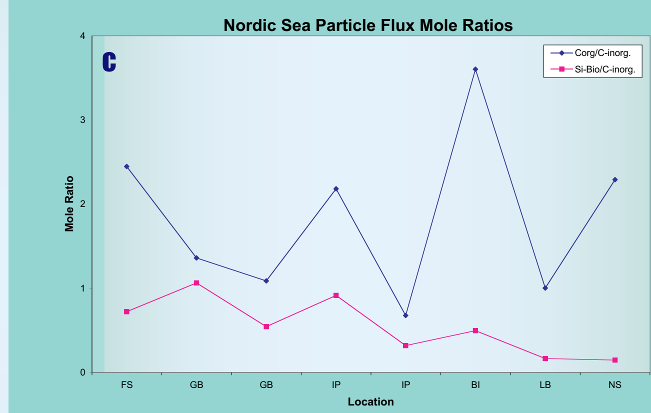
Positions of the Sediment Traps in the Nordic Sea and the Polar (blue) and Atlantic (green) influenced areas.

A comparison of the deep ocean particle fluxes (total <1mm and C-org annual fluxes) collected in the area of the Nordic Sea influenced by polar water in blue (Fram Strait, North Greenland Basin, South Greenland Basin) and the deep ocean particle fluxes collected in the area of the Nordic Sea influenced by Atlantic extension waters in green (Bear Island, Lofoton Basin and Norwegian Sea) with the Iceland Sea particle fluxes of 1986-1997 average and the 1998 flux.

Note the similar fluxes in the Iceland Sea 1986-1998 average fluxes with the arctic influenced Nordic Sea and the 1998 Iceland Sea flux with the Atlantic influenced Nordic Sea region.

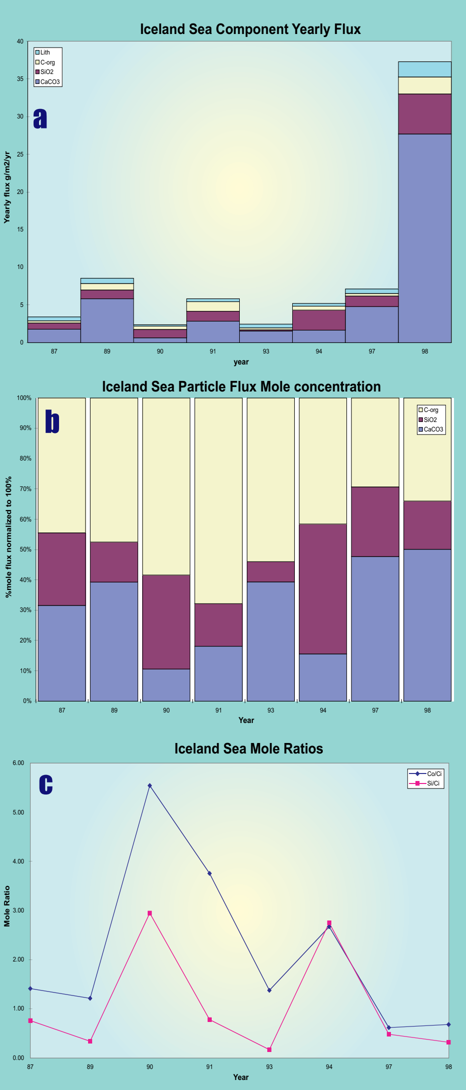
a.) Nordic Sea total <1mm annual fluxes g/m2/yr (histogram) and C-organic annual fluxes in g/m2/yr (lines).





b.) Nordic Sea annual fluxes in mole% concentration calculated as; (moles of C-inorganic)+(moles of Si-biogenic)+ (moles of C-organic) =100%

c.) Nordic Sea annual flux moles ratios C-org./C-inorg. And Si-bio/C-inorg.



a) Iceland Sea annual fluxes in g/m2/yr for the 8 years where elemental analysis is available.

b) Iceland Sea annual fluxes in mole% concentration calculated as; (moles of C-inorganic)+(moles of Si-biogenic)+ (moles of C-organic) =100%

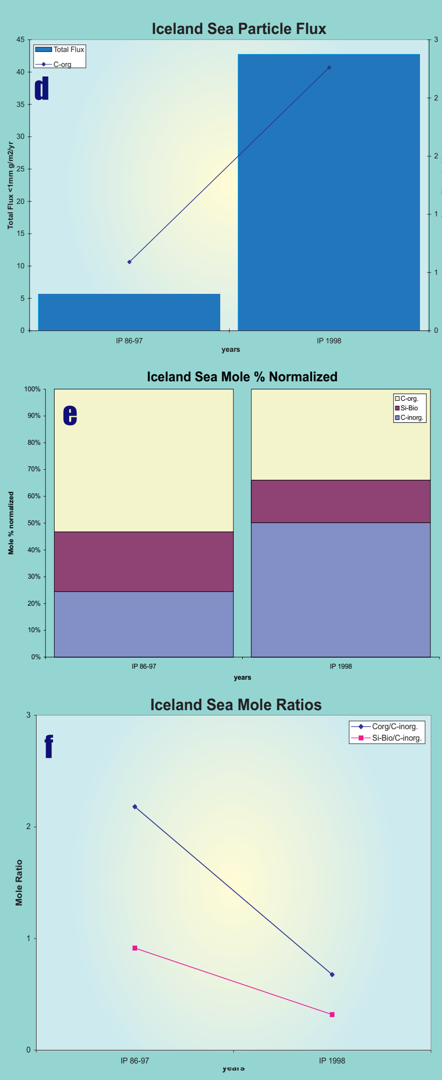
c) Iceland Sea annual flux moles ratios C-org./C-inorg. And Si-bio/C-inorg.

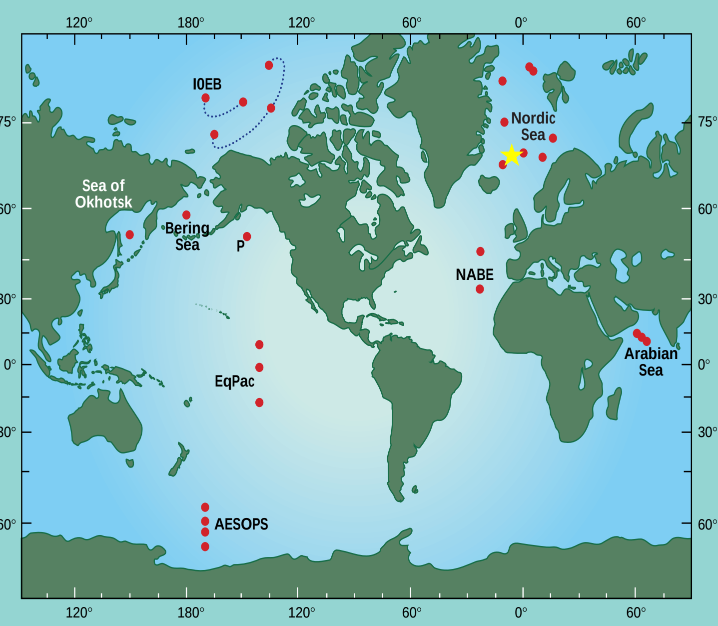
Iceland Sea average annual particulate fluxes for the years 1987-1997, compared to the annual particle flux collected in 1998

d) Iceland Sea average annual fluxes in g/m2/yr for the 7 years where elemental analysis is available, and the 1998

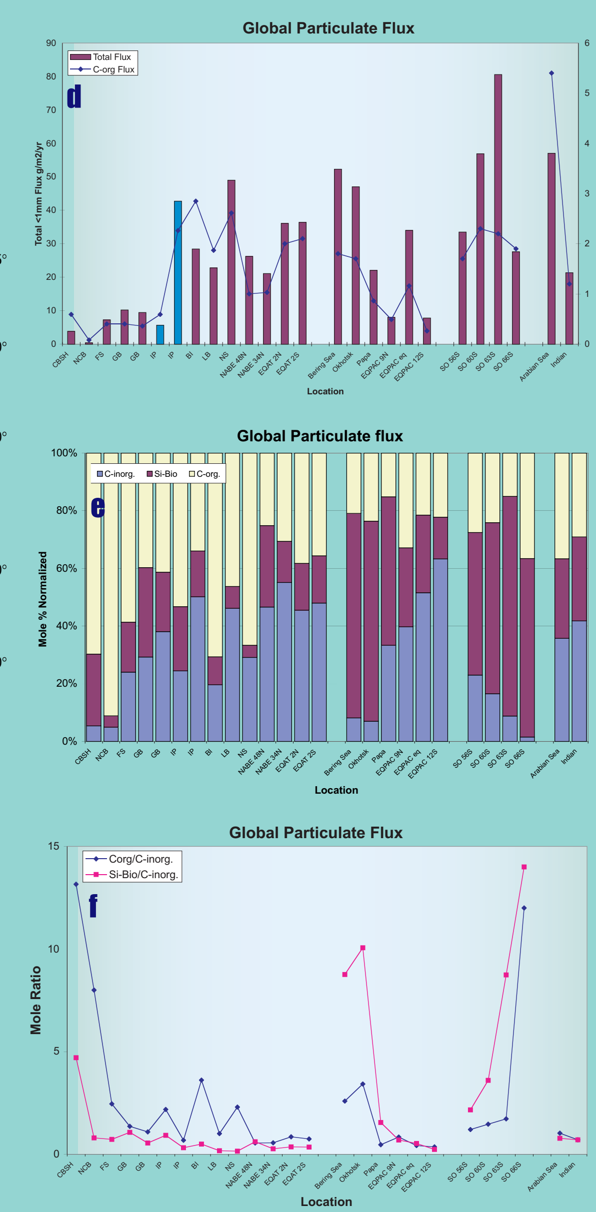
e) Iceland Sea average annual fluxes in mole% concentration calculated as; (moles of C-inorganic)+(moles of Si-biogenic)+ (moles of C-organic) =100% for the 7 years where elemental analysis is available, and the 1998

f) Iceland Sea average annual flux moles ratios C-org./C-inorg. And Si-bio/C-inorg. for the 7 years where elemental analysis is available, and the 1998





Sediment trap samples from the Parflux Lab, and GB and NS data from B.von Bodungen, Geol Rundch (1995) 84:11-27



d.) Global Ocean total <1mm annual fluxes g/m2/yr (histogram) and C-organic annual fluxes in g/m2/yr (lines).

e.) Global Ocean annual fluxes in mole% concentration calculated as; (moles of C-inorganic)+(moles of Si-biogenic)+ (moles of C-organic) =100%

f.) Global Ocean annual flux moles ratios C-org./C-inorg. And Si-bio/C-inorg.