SMHI

Spatial distribution of the winter nutrient pool 2017

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Key message

Concentrations of DIN had decreased in Kattegat, Great Belt, the Sound, Kiel Bay, Bay of Mecklenburg, Northern Baltic Proper, Gulf of Finland and parts of Gulf of Riga when compared with the time period 2001-2015. An increase was observed mainly in the Bornholm Basin, Eastern Gotland Basin and the Bothnian Sea. The main difference from the previous year (2016) was an increase of DIN in the Gulf of Finland.

When comparing with the time period 2001-2015, the concentrations of DIP had increased from the Bothnian Bay to the Baltic Proper with the largest increases observed in Gulf of Riga. From the Arkona Basin to Kattegat the concentrations of DIP had decreased. It was a similar change when comparing with previous year but the areas where DIP had increased showed a smaller increase than for the longer period. Also, DIP had decreased somewhat in parts of Bothnian Bay and the Eastern Gotland Basin. The fact sheet last year presented an increase in DIP in Bay of Mecklenburg and Kiel Bay but this year the situation was the reverse and DIP had decreased.

This fact sheet is a presentation of the latest available nutrient data for the winter 2017 and result may be different from the status assessment of winter nutrients made in HOLAS II (HELCOM, 2017).

Results and assessment

Relevance of the indicator for describing developments in the environment

Eutrophication is the supply of excessive amounts of nutrients to an ecosystem. The spatial distribution of the primary bio-available nutrients, in the surface waters during the low-productive winter, indicates the availability of nutrients for the spring bloom. The winter concentrations of nutrients may also highlight problem areas and changes in the spatial distribution may indicate changes in the hydrography, or the effect of remedial work.

Dissolved inorganic phosphorus (DIP) is essential for phytoplankton development. While rivers deliver phosphorus to the Baltic Sea, most of it is chemically bound to particles, and is not directly available for biological use. Phosphorus is also released from bottom sediments during periods of anoxia. Deep water DIP becomes bio-available when it is transported to the surface waters, but this transport is partially hampered by the permanent stratification in the Baltic.

Phytoplankton also requires dissolved inorganic nitrogen (DIN) which is the sum of the nitrate, nitrite and ammonium compounds. According to the Redfield ratio (Redfield et. al 1963) marine phytoplankton requires 15-16 times as much DIN as DIP. Although DIN concentrations are much higher than DIP in surface waters an imbalance between the two nutrients may occur and the phytoplankton activity may be limited by either one of them. There are, for example, problems with DIN deficiency during summer in the Baltic Proper. Where DIN is used up, those bacteria that can fix nitrogen from the atmosphere can still flourish, making use of the remaining DIP, and causing blooms. Cyanobacteria exhibit this behaviour, and so flourish in mainly the Baltic Proper. Nitrogen is cycled within the water column and sediment, while 'fresh' nitrogen is supplied from agricultural run-off and sewage discharges, either directly or via rivers. Nitrogen is also added through atmospheric deposition.

Silicate is supplied to the Baltic Sea via rivers as a result of weathering processes and is recycled in the marine system. An excess of silicate is typical of the Baltic surface water, due to the large supply of river water and the high concentrations present in the deep anoxic water that may well up and enrich the surface layer. Excess silicate is not considered problematic in the Baltic.

Nutrients are also transported from deeper layers to the surface through up-welling processes.

Policy relevance and policy references

Eutrophication, the excess of nutrients, is one of the major problems facing the Baltic Sea. A major part of the HELCOM Baltic Sea Action Plan is focused on reducing eutrophication and the negative impacts it has on the Baltic Sea ecosystem. Also European directives such as the Water Framework Directive and the Marine Strategy Framework Directive identify eutrophication as a major hinder which could prevent the Baltic Sea from achieving Good Environmental Status in the near future.

The Helcom COMBINE programme uses nutrient data to help quantify the effects of anthropogenic activities. Inorganic nutrients, DIN and DIP, during winter are core indicators in the HELCOM assessment work. The Baltic Sea Environmental Fact Sheet on winter nutrients contributes to the information about:

- the winter pool of nutrients
- the supply of nutrients and nutrient limitation in coastal waters

The winter nutrient pool 2017

Figures 1-3 illustrate the spatial distribution of the inorganic winter nutrient pool for the period December 2016 to February 2017 and data is averaged for the upper 10 meter. Figure 4 and 5 illustrates the difference between the winter 2017 and the winter average of the period 2001-2015 and the previous (2016) year respectively. Each scatter point in the maps represents a monitoring station and please note the extended color bars.

Dissolved inorganic nitrogen (DIN)

Typically, there are low concentrations of DIN in the Baltic Proper with increasing values towards the Bothnian Bay, Gulf of Finland, Gulf of Riga and Kattegat. Concentrations of DIN are also generally higher closer to land than in the open sea since the major source of DIN to the Baltic Sea is via land run-off. The spatial distribution of DIN followed the general pattern also this winter (figure 1) apart from the low concentrations of DIN at some stations in the Kiel Bay and Bay of Mecklenburg.

Compared with the time period 2001-2015 (figure 4), concentrations of DIN 2017 had decreased in Kattegat, Great Belt, the Sound, Kiel Bay, Bay of Mecklenburg, Northern Baltic Proper, Gulf of Finland and parts of Gulf of Riga. An increase was observed mainly in the Bornholm Basin, Eastern Gotland

Basin and the Bothnian Sea. The main difference from the previous year (2016) was an increase of DIN in the Gulf of Finland (figure 5).

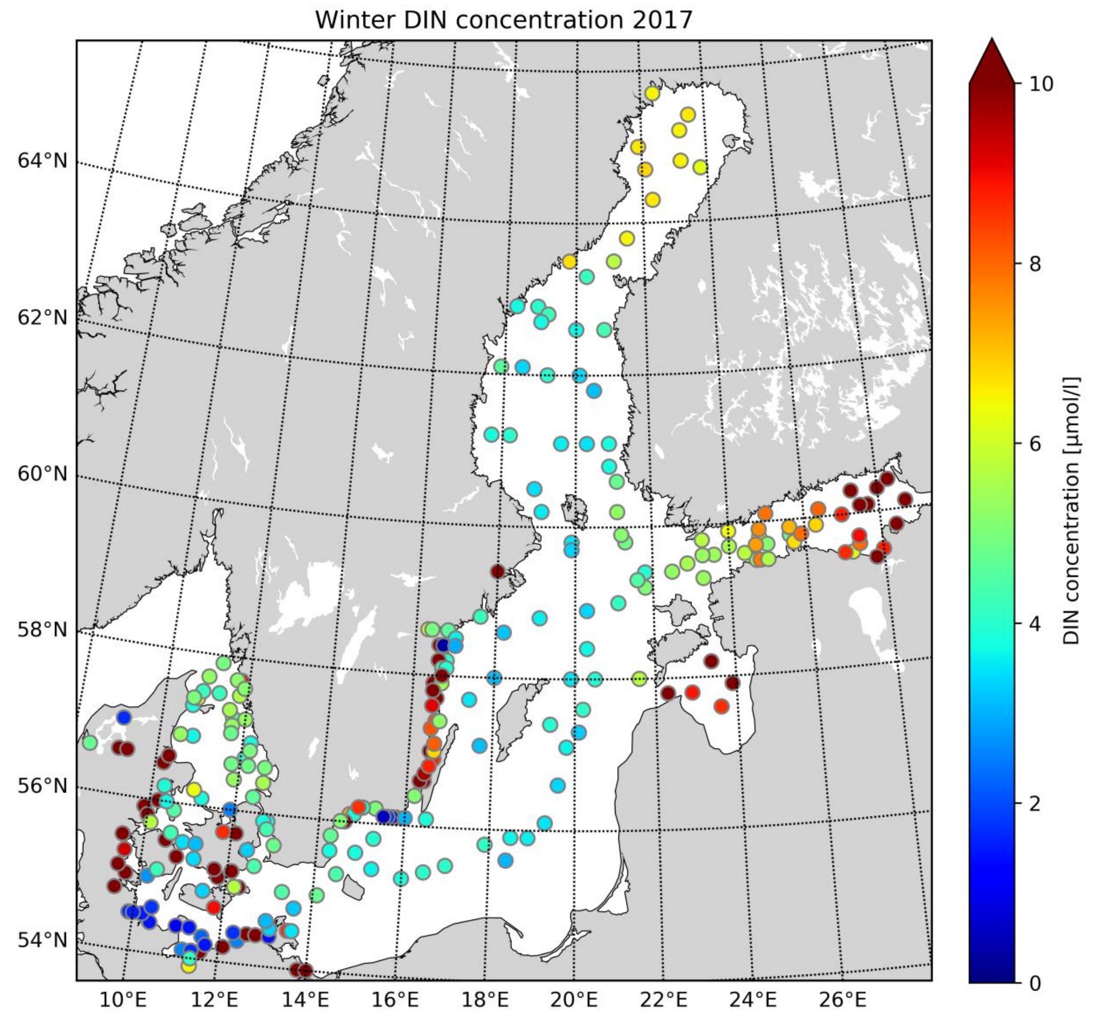

Figure 1. Mean DIN concentrations (µmol/l) in surface waters 0-10 meter: December 2016 - February 2017. Note the extended color bar.

Dissolved inorganic phosphorus (DIP)

Lowest concentrations of DIP were observed in the Bothnian Bay (figure 2). Highest concentrations were observed at coastal stations, the Gulf of Finland and the Gulf of Riga. In the Baltic Proper, high phosphate values near the coast may be partially due to up-welling along the Swedish east coast, from the Hanö Bight northwards. Deep waters of the Baltic Proper have high DIP concentrations due to enrichment of the stagnant bottom water and the release of phosphate from sediments during anoxic conditions. When the wind blows from the west, this enriched deep water sometimes wells up along the Swedish east coast.

When comparing with the time period 2001-2015 (figure 4), the concentrations of DIP had increased from the Bothnian Bay to the Baltic Proper with the largest increases in Gulf of Riga. From the Arkona Basin to Kattegat the concentrations of DIP had decreased. It was a similar change when comparing with previous year but the areas where DIP had increased showed a smaller increase than for the longer period (figure 5). Also, DIP had decreased somewhat in parts of Bothnian Bay and the Eastern

Gotland Basin. The fact sheet last year presented an increase in DIP in Bay of Mecklenburg and Kiel Bay but this year the situation was the reverse and DIP had decreased.

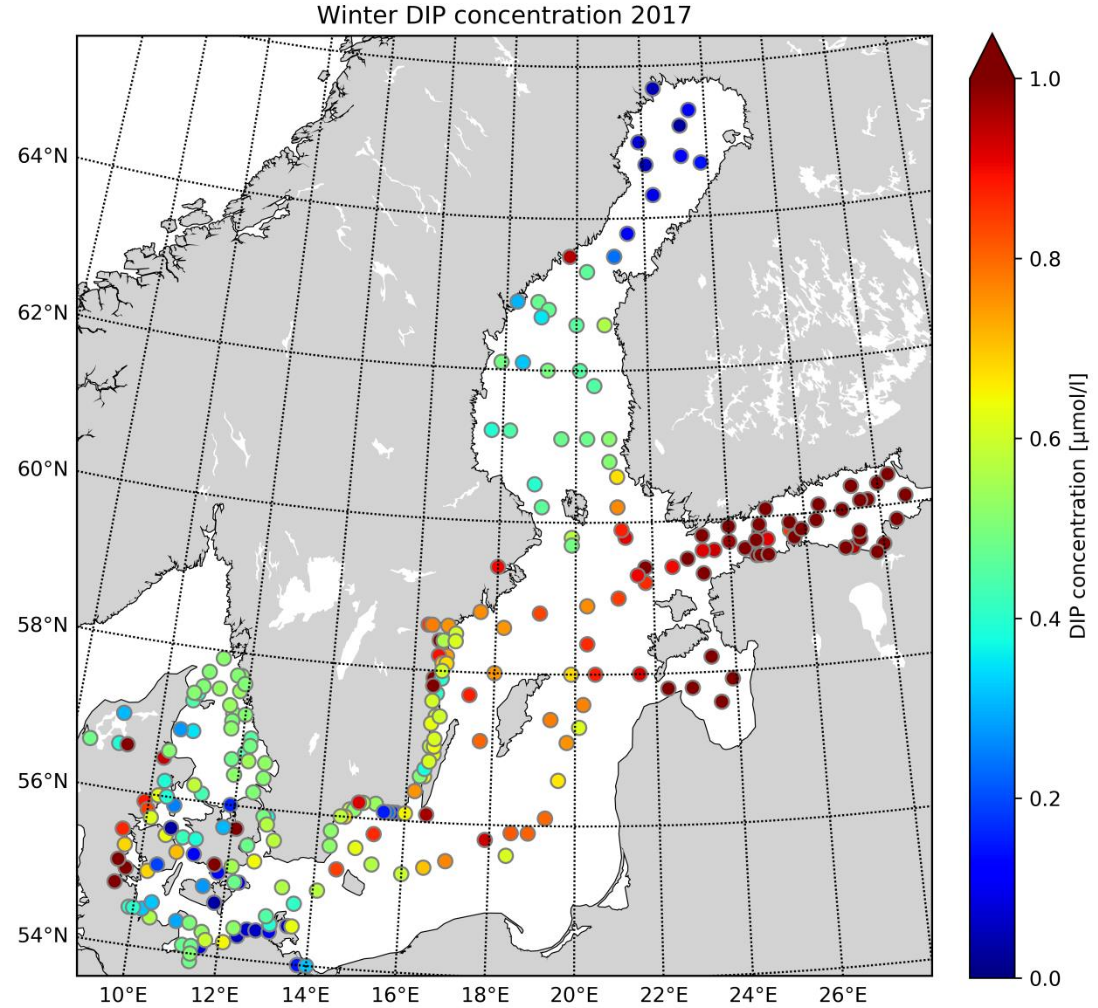

Figure 2. Mean DIP concentrations (µmol/l) in surface waters 0-10 meter: December 2016 - February 2017. Note the extended color bar.

Silicate (Si)

The concentrations of silicate (Si) were highest in the Bothnian Bay, inner parts of Gulf of Finland, coastal stations and in Gulf of Riga. This is expected since the great rivers deliver large amounts of silicate. Concentrations of silicate decreased from the Baltic Sea towards the Kattegat where the lowest values were observed.

Compared to the 2001-2015 period the concentrations of silicate were higher in almost all basins apart from Kattegat to Arkona Basin where it was lower. Silicate was also lower in the inner parts of Gulf of Finland. Since previous winter (2016), concentrations of silicate have generally decreased except from mainly the Arkona and Bornholm Basins (figure 5). The fact sheet last year presented an increase in silicate in Bay of Mecklenburg and Kiel Bay but this year the situation was the reverse and silicate had decreased.

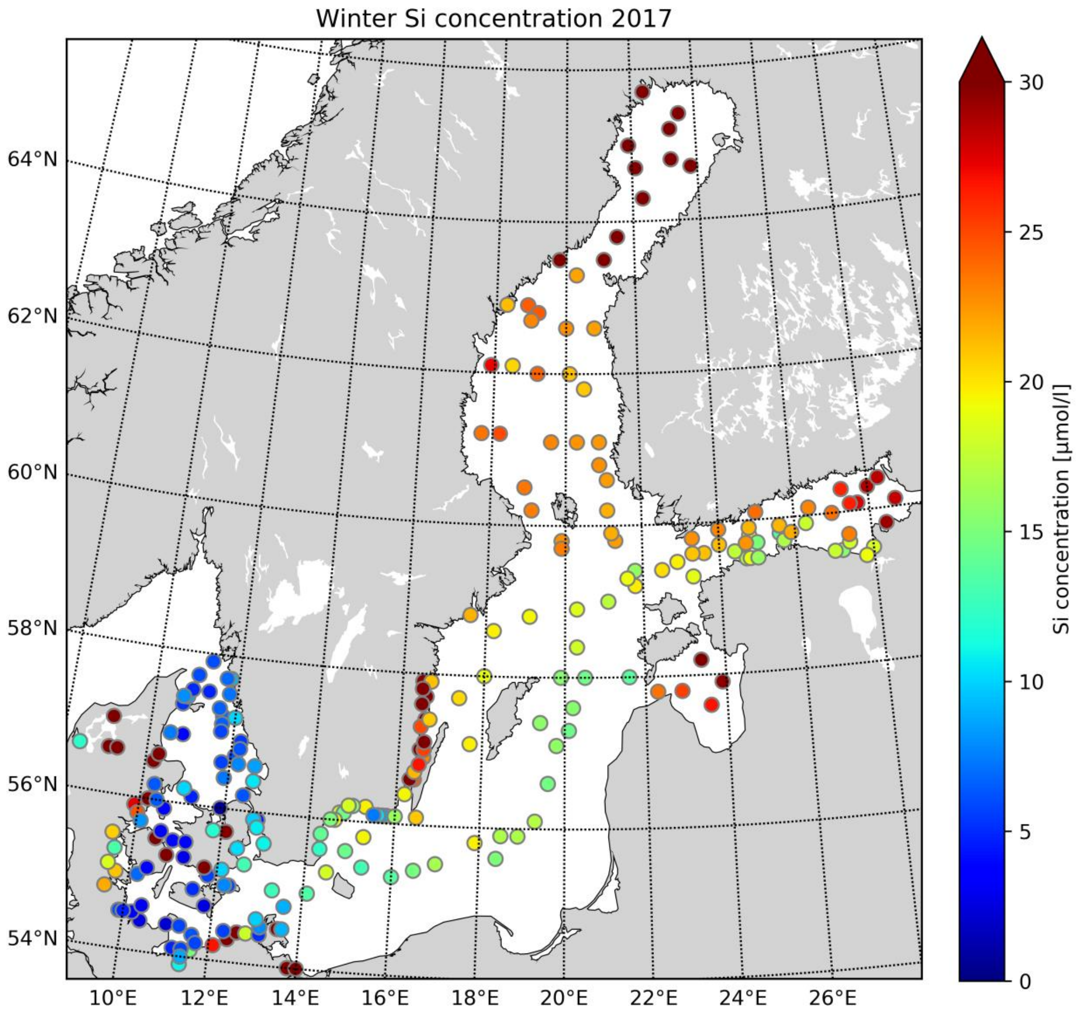

Figure 3. Mean Si concentrations (µmol/l) in surface waters 0-10 meter: December 2016 - February 2017. Note the extended color bar.

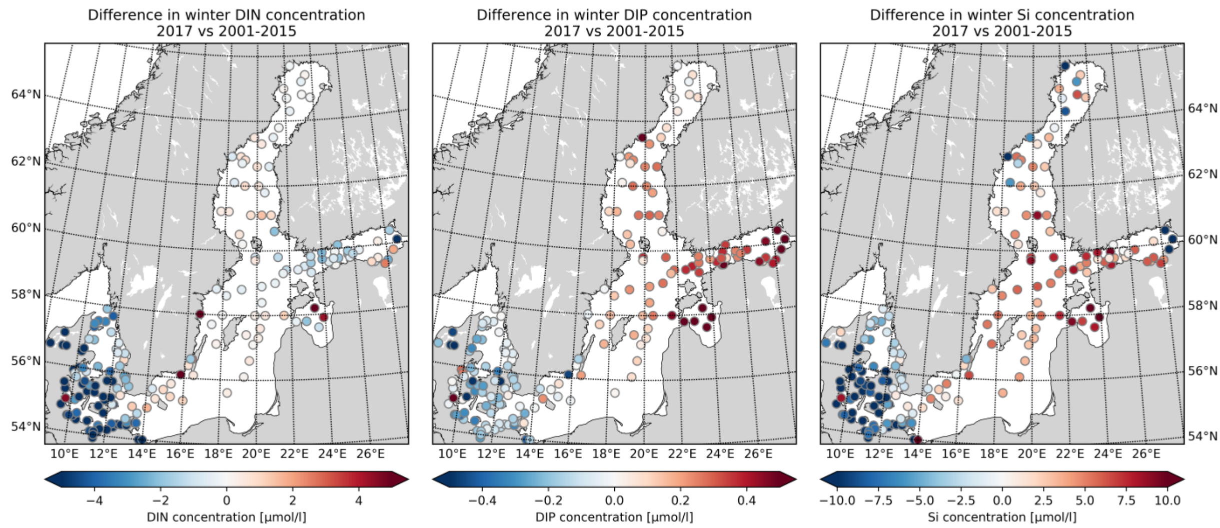

Figure 4. Difference between winter 2017 nutrient concentrations (DIN: left; DIP: centre; Silicate: right) and the 2001-2015 surface winter means. Note the extended color bar.

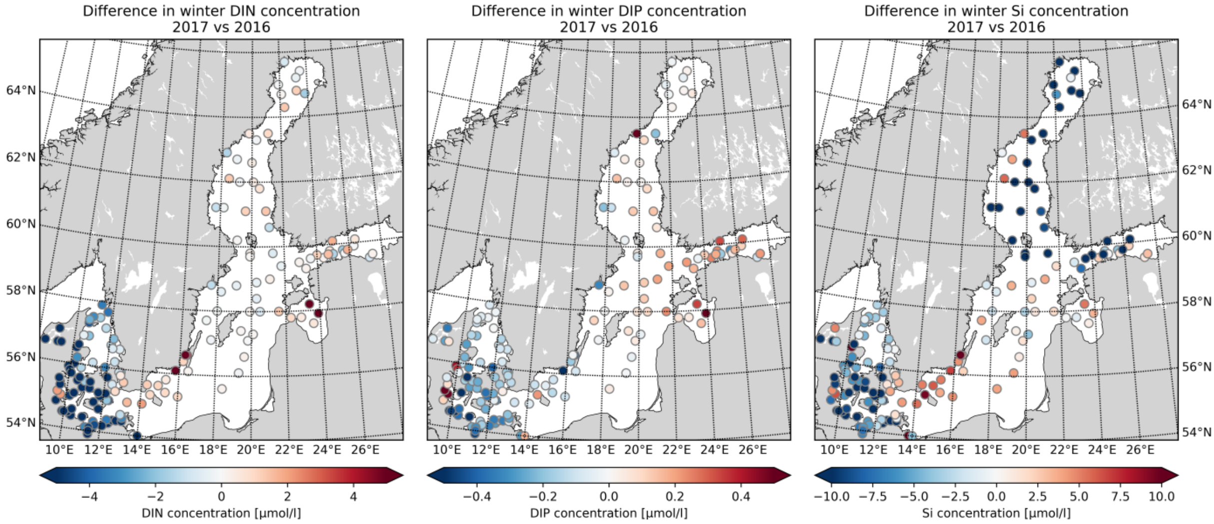

Figure 5. Difference between winter 2017 nutrient concentrations (DIN: left; DIP: centre; Silicate: right) and the 2016 surface winter means. Note the extended color bar.

References

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Data

The surface water layer is defined as the average of 0-10 m and the winter 2017 is defined as December (2016), January (2017) and February (2017). Data (bottle samples) is primarily from the HELCOM data archive held at the International Council for the Exploration of the Sea (http://www.ices.dk). Data to ICES is normally reported by contracting parties on annual basis and all data for 2017 will therefore not be available until the upcoming year. However, 2017 winter monitoring data from Finland was kindly directly shared and is included in the fact sheet. In addition, until now (December 2017) reported coastal data collected as part of Swedish regional monitoring programmes, and made available by the oceanographic data centre at SMHI through the database SHARK (Svenskt Havs ARKiv,) is included.

Note that data is not available for all three months from all countries/platforms/stations due to both reporting and monitoring frequency. For December 2016, data is available from Danish, Estonian (one station), Finnish, German and Swedish platforms. For January 2017, data is available from Danish, Estonian, Finnish and Swedish platforms. For February 2017, data is available from Finnish and Swedish platforms. Please be aware that the monitoring platform is not always the same as the monitoring country. For example, the data from January is monitored by Sweden but with a Danish vessel (platform).

Data collected for the HELCOM COMBINE programme is collected and analysed according to agreed methods (COMBINE Manual). Laboratories participate in quality assurance consortia such as QUASIMEME and are almost uniformly ISO accredited for good laboratory practice.

For reference purposes, please cite this Baltic Sea environment fact sheet as follows:

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