SMHI

Spatial distribution of the winter nutrient pool 2016

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Key message

Most prominent changes in the assessment of the winter nutrient pool for 2016, when compared with last winter (2015), are the generally lower values of DIN. The concentrations of DIP were lower in south-western parts of Kattegat, parts of Bothnian Sea and outer Gulf of Finland. DIP had increased in northern Kattegat, Bay of Mecklenburg, Kiel Bay, and Gulf of Riga.

In general, the DIN concentrations for the Baltic Sea remain below those observed in the 2001-2015 period and the concentrations of DIP remain higher.

Results and assessments

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, shows 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 phosphorous (DIP) is essential for phytoplankton development. While rivers deliver phosphorus to the Baltic Sea, most of this phosphorus is chemically bound to particles, and is not directly available for biological use. Large amounts of DIP enter the Baltic Sea with inflows of salt deep water, and 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. Both DIP and DIN are also transported from deeper layers to the surface through up-welling processes.

Phytoplankton also requires dissolved inorganic nitrogen (DIN) which is the sum of 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.

Assessment of the winter nutrient pool 2016

Figures 1-3 illustrate the spatial distribution of the winter nutrient pool for the period December 2015 to February 2016. Figure 4 illustrates the difference between the winter 2016 and the winter average of the period 2001-2015. Each circle in the maps represents a monitoring station and data is averaged for the upper 10 meter from December 2015 to February 2016. Please note the extended color bars.

Dissolved inorganic nitrogen (DIN)
Typically, there are low DIN concentrations 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). Compared to the last fact sheet of the winter nutrient pool (2015) concentrations of DIN was generally lower except from the central parts of the Baltic Proper and the Gulf of Riga. When compared with the longer period 2001-2015, DIN concentrations during winter 2016 were generally lower, especially in the Gulf of Finland and Kattegat (figure 4). There are also some stations, in for example the Great Belt, where DIN was higher.

Dissolved inorganic phosphorous (DIP)
Lowest concentrations of DIP were observed in the Gulf of Bothnia and especially 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. Compared to the previous fact sheet (2015) DIP showed this winter lower concentrations in south-western parts of Kattegat, parts of Bothnian Sea and outer Gulf of Finland. DIP had increased in northern Kattegat, Bay of Mecklenburg, Kiel Bay, and Gulf of Riga. Compared to the 2001-2015 period DIP levels were higher in most areas except from the Bothnian Bay where levels were almost the same and south-western parts of Kattegat where levels were lower (figure 4).

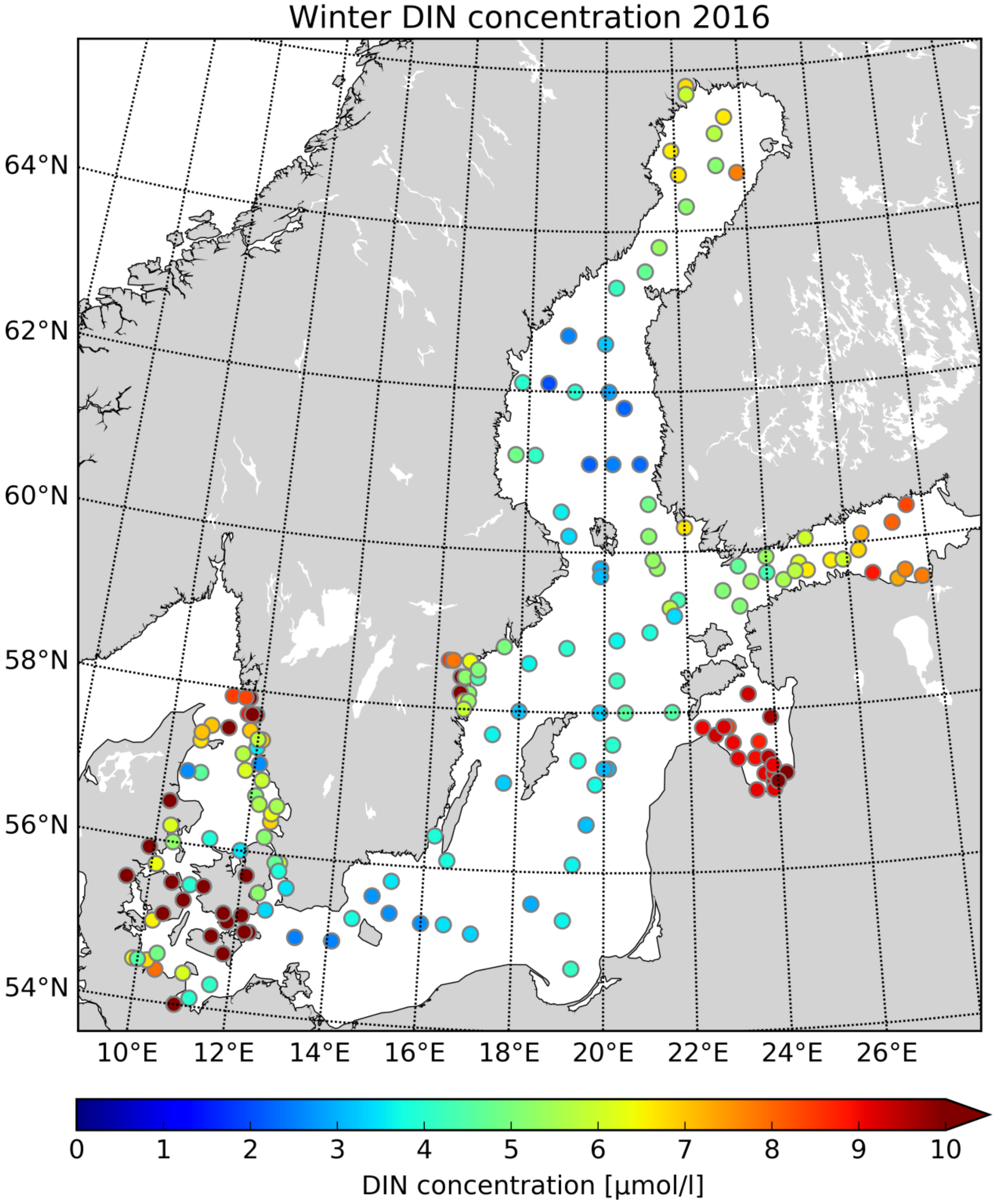

Figure 1. Mean DIN concentrations (µmol/l) in surface waters 0-10 meter: December 2015 - February 2016.

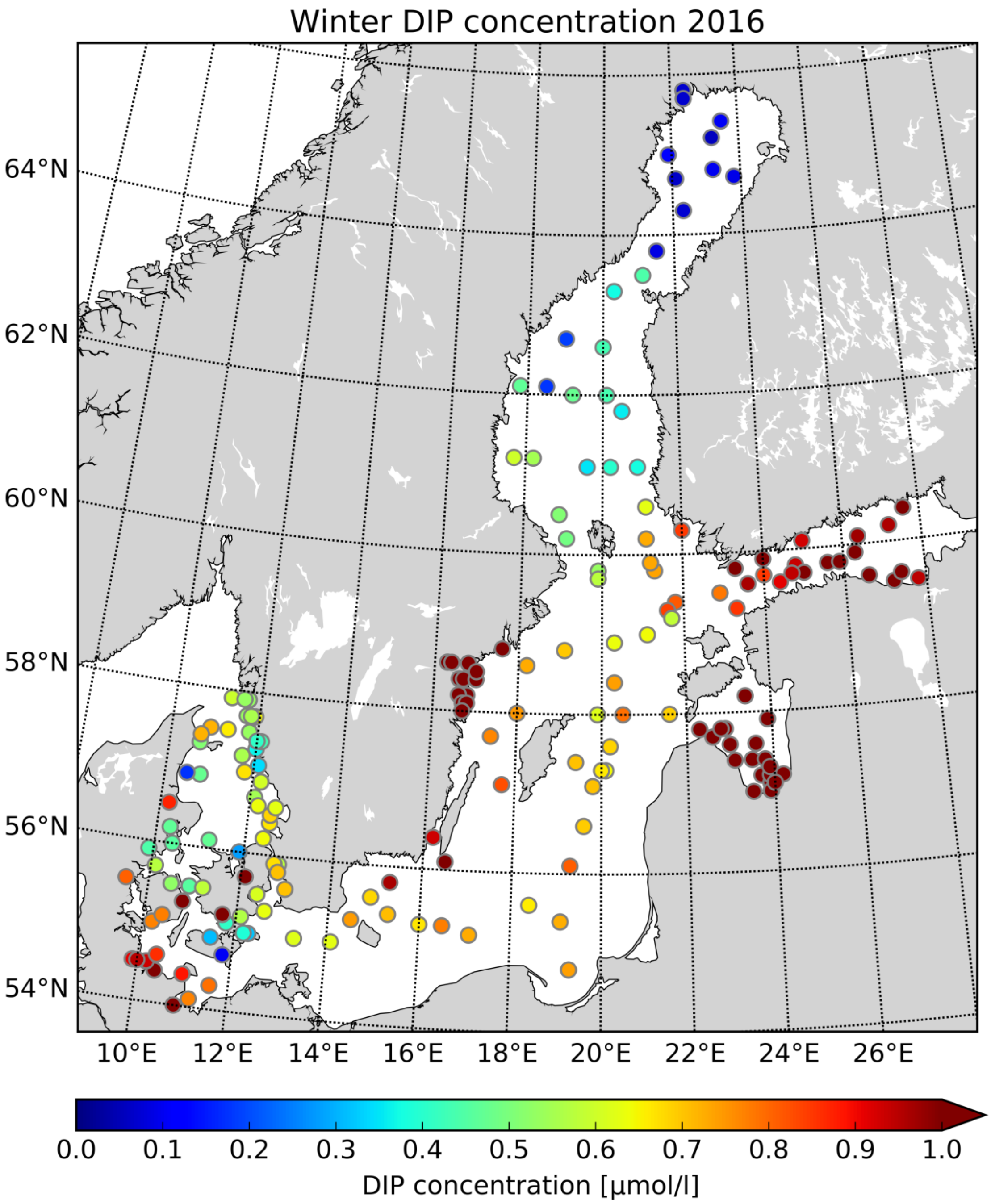

Figure 2. Mean DIP concentrations (µmol/l) in surface waters 0-10 meter: December 2015 - February 2016.

Silicate (Si)

The concentrations of silicate (Si) were highest in the Bothnian Bay and Gulf of Riga, as the great rivers deliver large amounts of silicate. Concentrations decreased from the Baltic Proper towards the Kattegat where the lowest values were observed. Concentrations of Si have generally decreased since previous winter (2015) except from the Gulf of Riga, Bay of Mecklenburg, Kiel Bay and Kattegat where it increased. Compared to the 2001-2015 period the Si levels were higher in the Gulf of Finland, Gulf of Riga and Baltic Proper. For other areas silicate concentrations were lower.

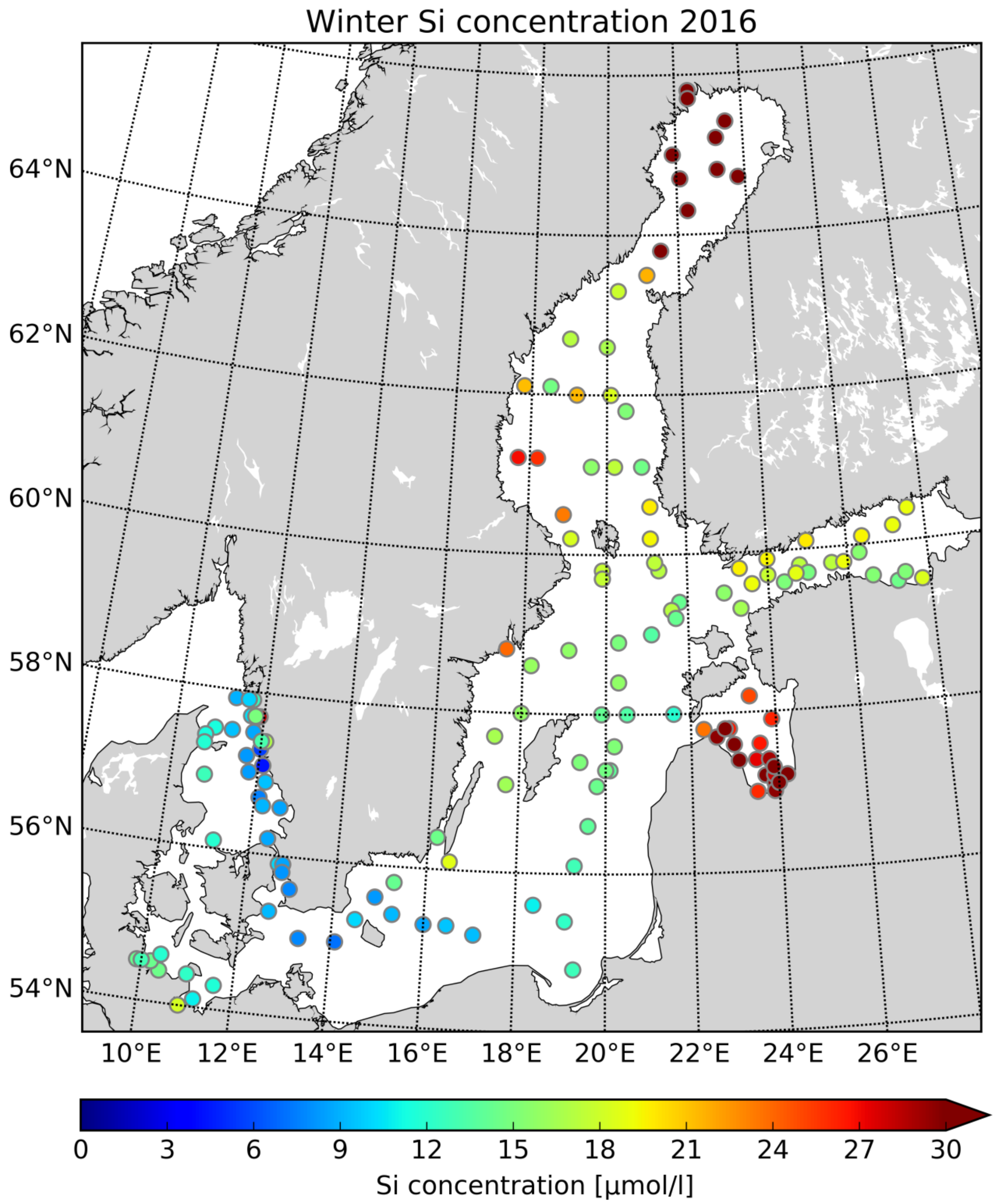

Figure 3. Mean Si concentrations (µmol/l) in surface waters 0-10 meter: December 2015 - February 2016.

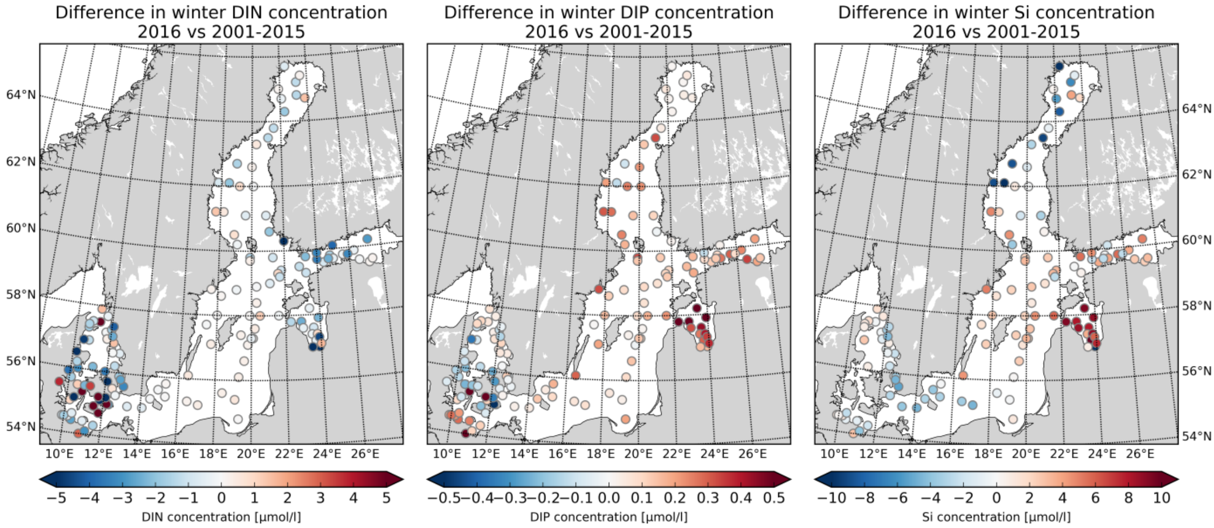

Figure 4. Difference between winter 2016 nutrient concentrations (DIN: left; DIP: centre; Silicate: right) and the 2001-2015 surface winter means.

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

References

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Redfield.A.C, Ketchum.B.H. and Richards F.A., (1963). The influence of organisms on the composition of sea water. In Hill, M.N. (ed.), The Sea 2. Wiley, New York, pp. 26-77

Data

The surface water layer is defined as the average of 0-10 m and the winter 2016 is defined as December (2015), January (2016) and February (2016). Data 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 2016 will therefore not be available until the upcoming year. However, Baltic Sea monitoring data from Denmark, Finland and Latvia was kindly shared and is included in the fact sheet. In addition, open sea data and coastal data collected as part of Swedish national and regional monitoring programmes, and made available by the oceanographic data centre at SMHI through the database SHARK (Svenskt Havs ARKiv,) is included.

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:

[Author's name(s)], [Year]. [Baltic Sea environment fact sheet title]. HELCOM Baltic Sea Environment Fact Sheets. Online. [Date Viewed], http://www.helcom.fi/baltic-sea-trends/environment-fact-sheets/.