

**Marine Phytoplankton Blooms in the Barents Sea
2011 and 2012**

edited by

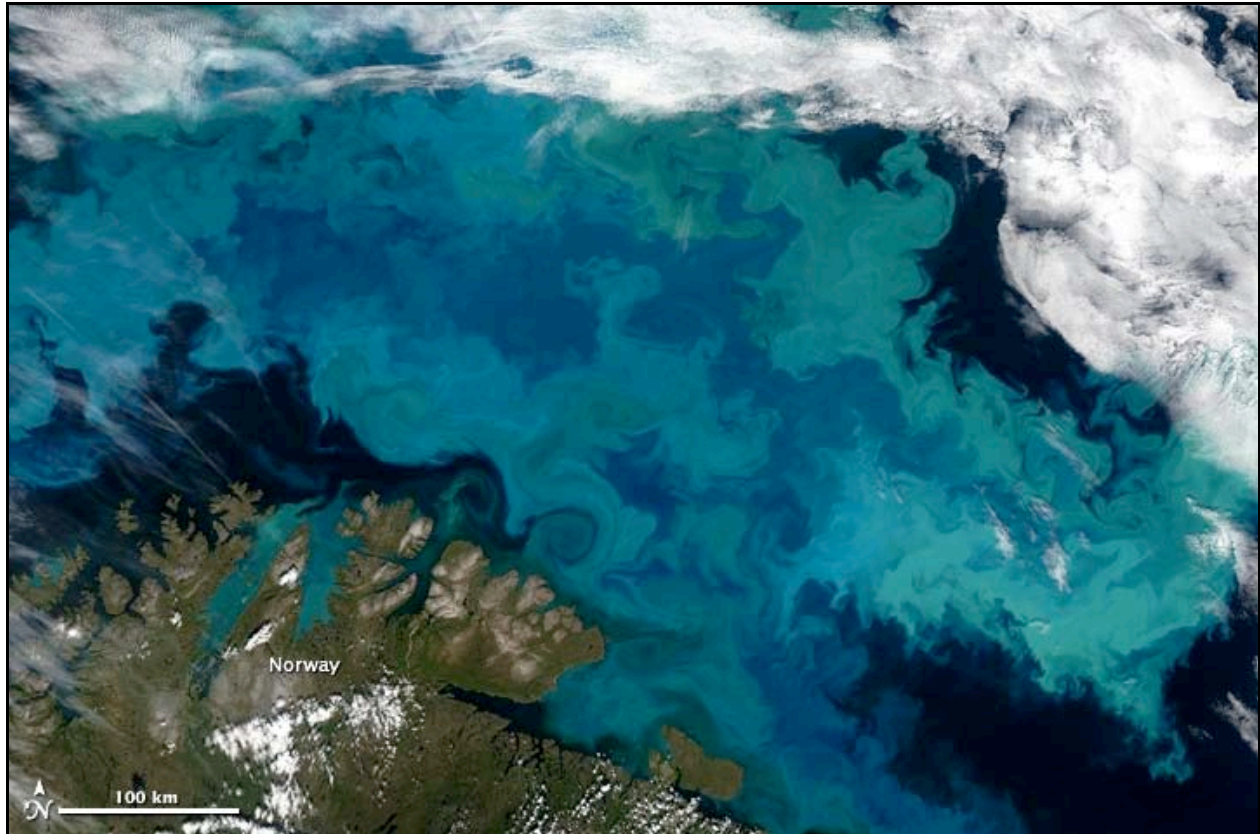
David L. Alles

Western Washington University

e-mail: alles@biol.wvu.edu

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Note: In PDF format most of the images in this web paper
can be enlarged for greater detail.



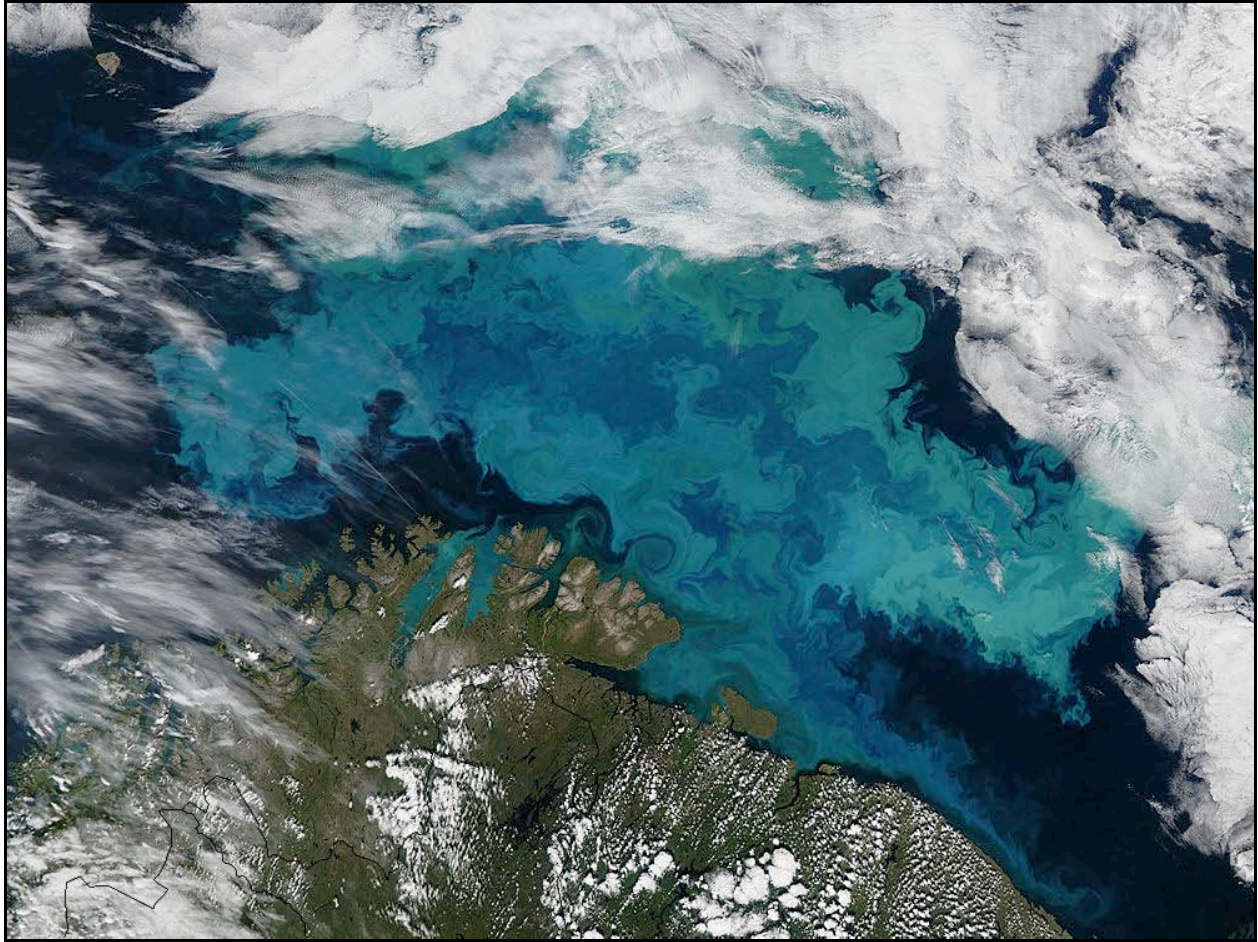
Phytoplankton Bloom in the Barents Sea 2011-8-14

Brilliant shades of blue and green explode across the Barents Sea in this natural-color image taken on **August 14, 2011** by the MODIS instrument aboard the Aqua satellite. The blue and green colors were created by a massive blooms of phytoplankton that are common in this area each August. The range of colors from shades of green to light blue reflect the shades of **green algae and diatoms** to the **light blues of coccolithophore species**. This bloom had been in progress for ~ 2-1/2 week when this image was acquired.

The clear view is a rare treat since the Barents Sea is cloud-covered roughly 80 percent of the time in summer. The bloom is off the North Cape of Norway and east along the Kola Peninsula to the much smaller Rybachiy Peninsula and the entrance into the Murmansk fiord in Russia.

Web Reference

<http://earthobservatory.nasa.gov/IOTD/view.php?id=51765>



Phytoplankton Bloom in the Barents Sea 2011-8-14

In this NASA Gallery image more of the extent of the bloom is shown. Phytoplankton blooms spanning hundreds or even thousands of kilometers occur across the North Atlantic and Arctic Oceans every year. Many species thrive in the cooler ocean waters, which tend to be richer in nutrients and plant life than tropical waters.

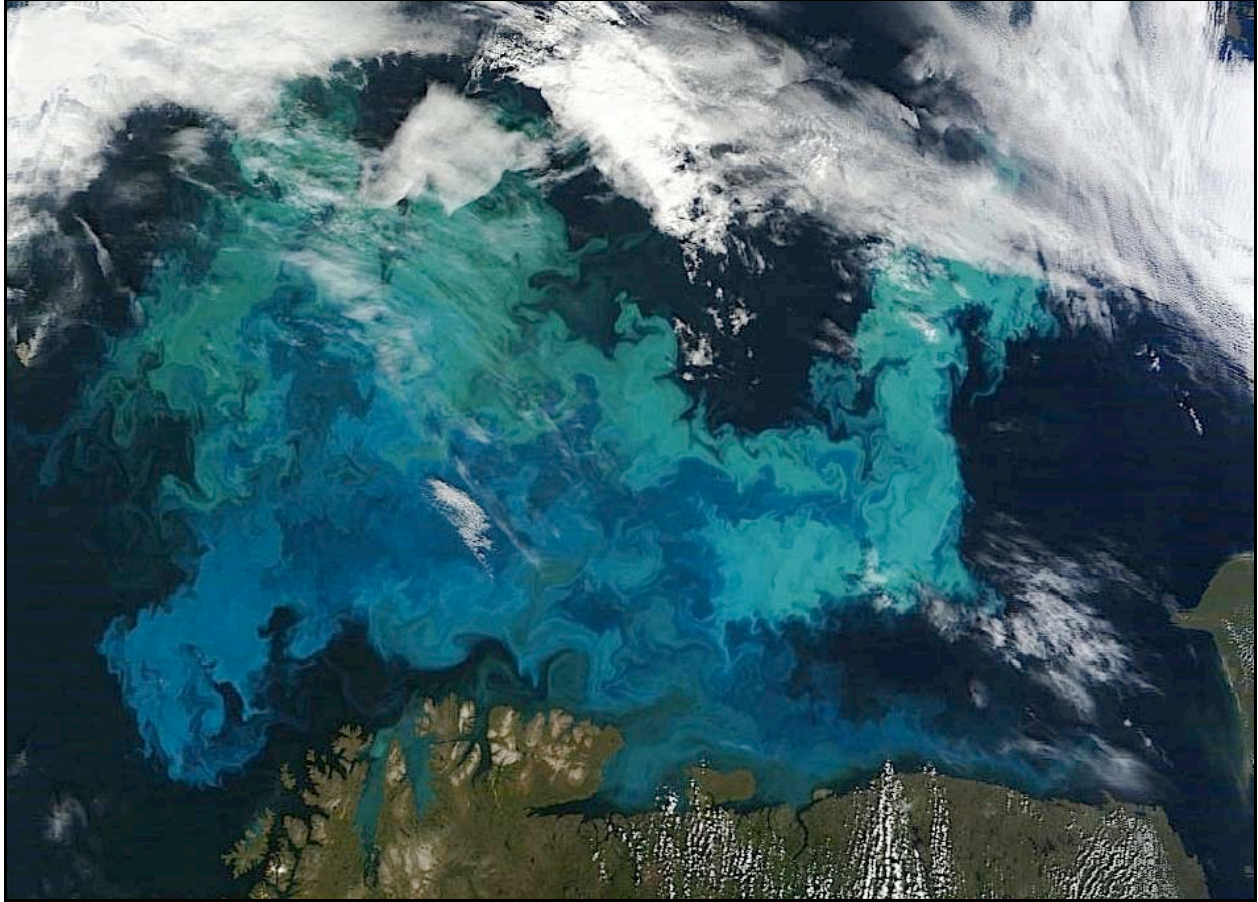
This and the previous image from the 14th are oriented so that north is at the top of the image. This means that the **prevailing winds are from the south/southwest** providing clear skies for this bloom just off and along the coastline. But also note the clouds blowing from the west/northwest along the upper left side of the image.

(As an aid for orientation, note the gray dot of Bear Island in the top left corner of this image and on the following map.)



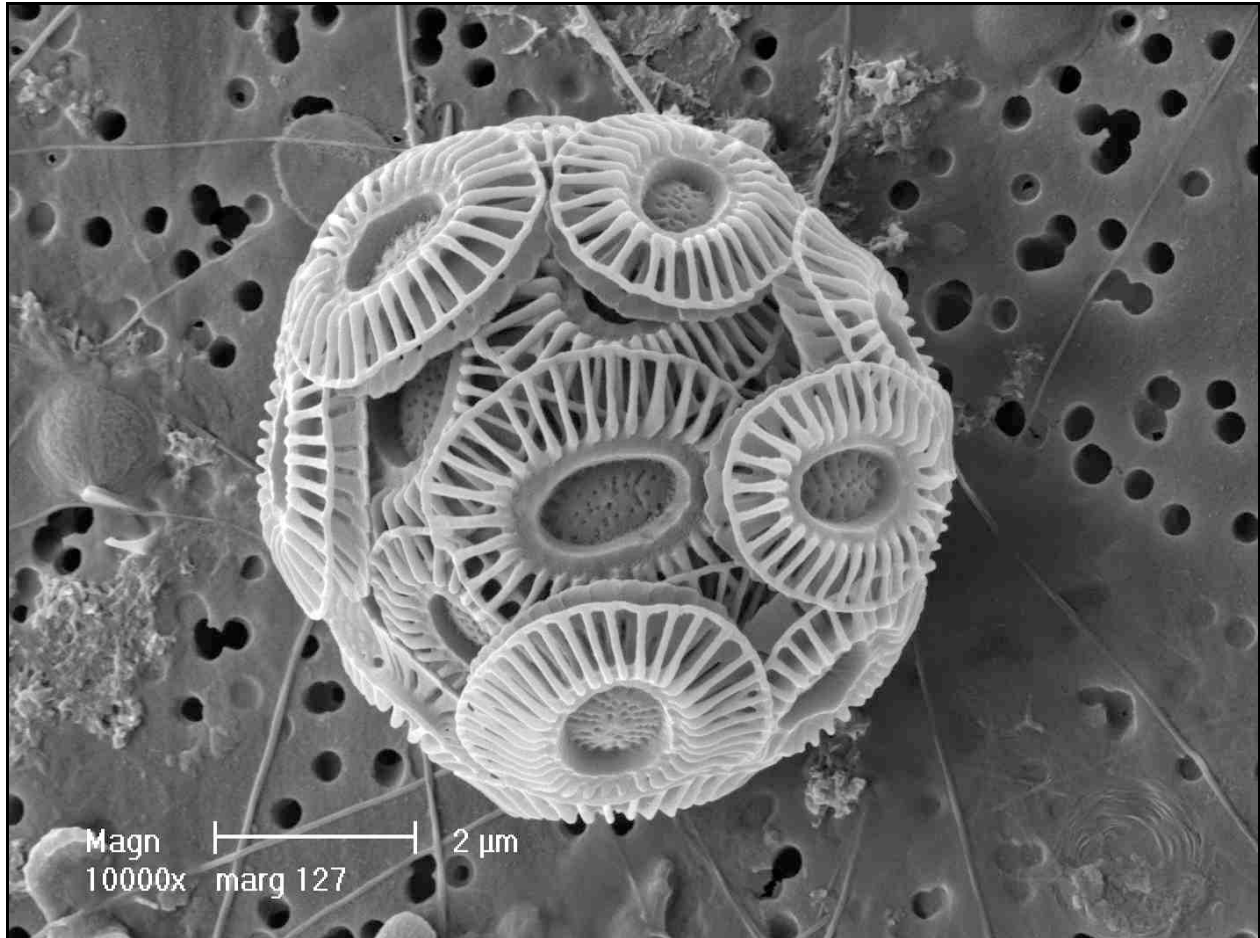
With the exception of the first image north is not indicated on the satellite images in this paper. This map along with some distinctive features of the northern coast of Norway and adjoining Russia can be used to orient the position of the ongoing phytoplankton bloom. In addition to Bear Island, note the location of the Russia port city of Murmansk east of the rugged North Cape of Norway and west of the relatively even coastline of the Kola Peninsula southeast of Murmansk.

(Map courtesy of Wikipedia entry for Barents Sea)
http://en.wikipedia.org/wiki/Barents_Sea



Phytoplankton Bloom in the Barents Sea 2011-8-15

In this image, the milky light blue color strongly suggests that the bloom contains coccolithophores, microscopic plankton that are plated with white calcium carbonate. When viewed through ocean water, a coccolithophore bloom tends to be bright blue. The species is most likely *Emiliana huxleyi*, whose blooms tend to be triggered by high light levels during the 24-hour sunlight of Arctic summer. The variations in bloom brightness and color in satellite images is partly related to its depth: *E. huxleyi*, can grow abundantly as much as 50 meters below the surface.

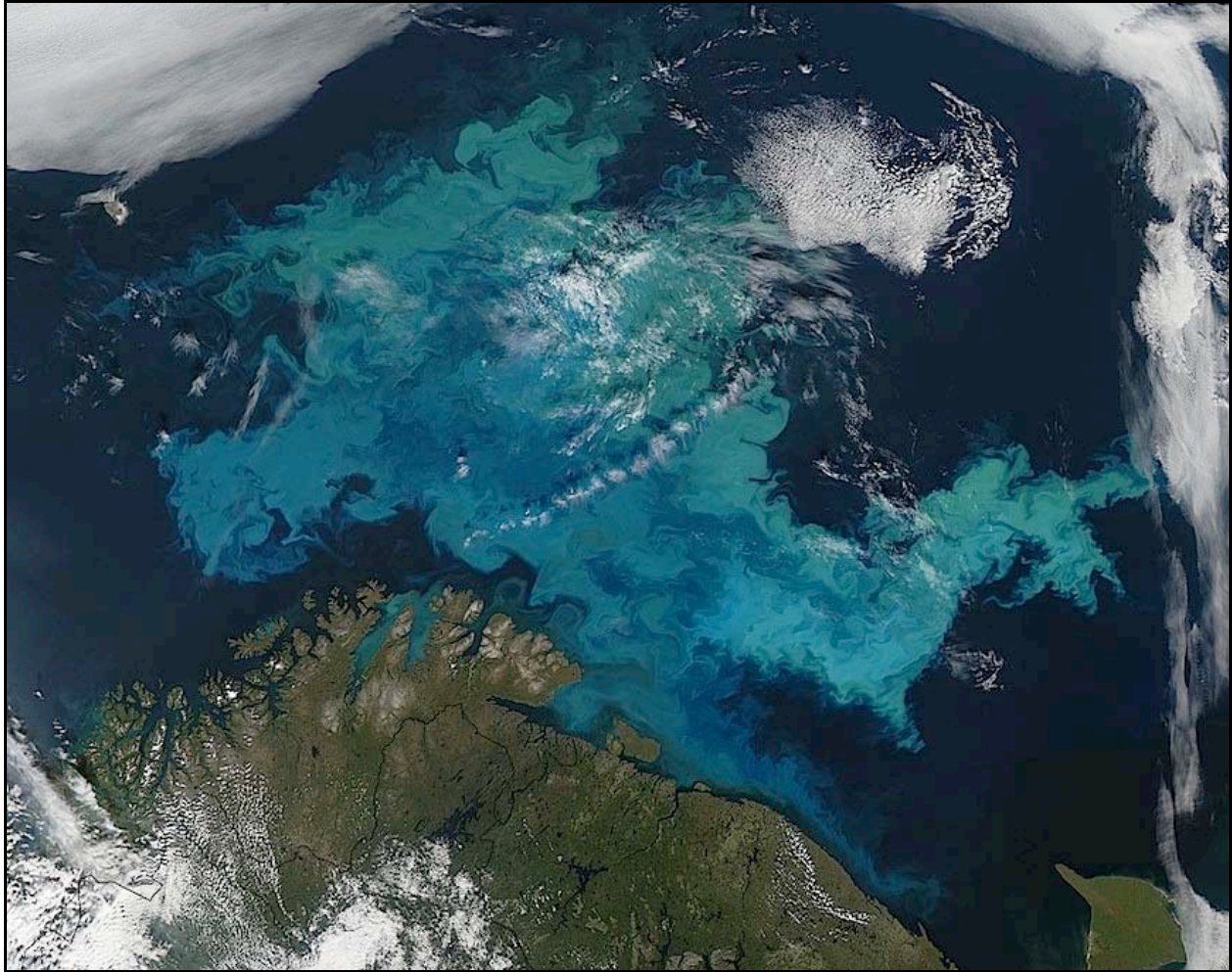


Shown above is a single coccolithophore of *Emiliana huxleyi*, which consists of a soft phytoplankton cell covered by white calcite (CaCO_3) plates called coccoliths secreted by the cell.

Ice-covered for most of the year, the shallow Barents Sea reaches its warmest surface temperatures (6.6 C) in August, when ice cover is at a minimum and the water is freshest (less saline due to ice melt and river runoff) and most nutrient depleted. Those conditions, researchers have found, are perfect for coccolithophores to take over from other species and dominate the surface waters.

In a 2009 paper by Signorini et al, the researchers note: Coccolithophores, among which *E. huxleyi* is the most abundant and widespread species, are considered to be the most productive calcifying organism on Earth. They are important components of the carbon cycle via their contribution and response to changes in atmospheric CO_2 levels. Coccolithophores appear to be advancing into some sub-Arctic Seas and climate change induced warming and freshwater runoff may be causing an increased frequency of coccolithophore blooms within the Barents Sea.

(Scanning electron microscope image by Jeremy Young)



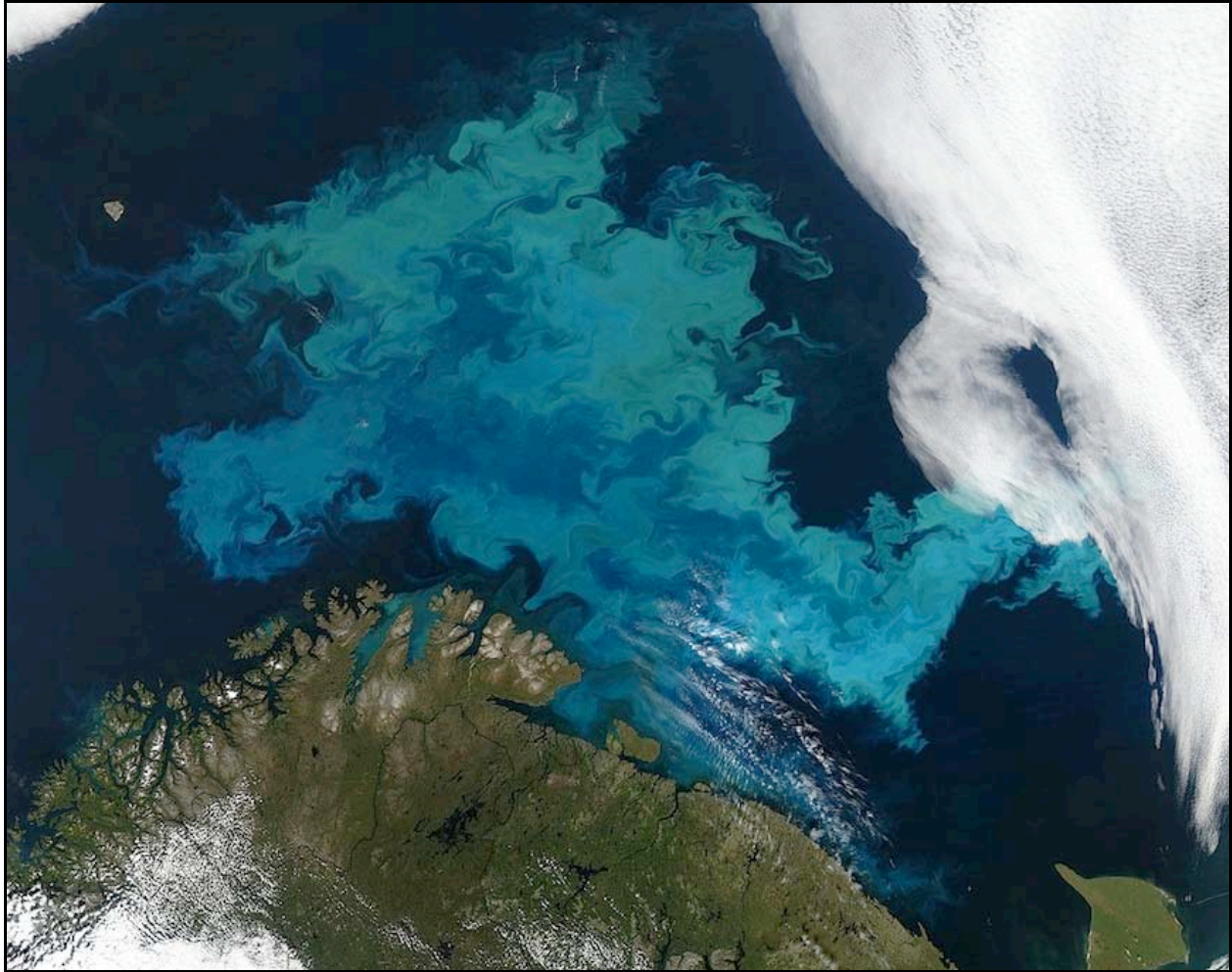
Phytoplankton Bloom in the Barents Sea 2011-8-16

Other colors in the same bloom a day later may come from other species of phytoplankton, particularly diatoms (see web references). The Barents Sea usually witnesses two major bloom seasons each year, with diatoms peaking in May and June, then giving way to coccolithophores as certain nutrients run out and waters grow warmer and more stratified. Then a second bloom season that runs from late July to mid-September such as the bloom above.

Web References

<http://www.soes.soton.ac.uk/staff/tt/eh/index.html>

<http://en.wikipedia.org/wiki/Coccolithophore>



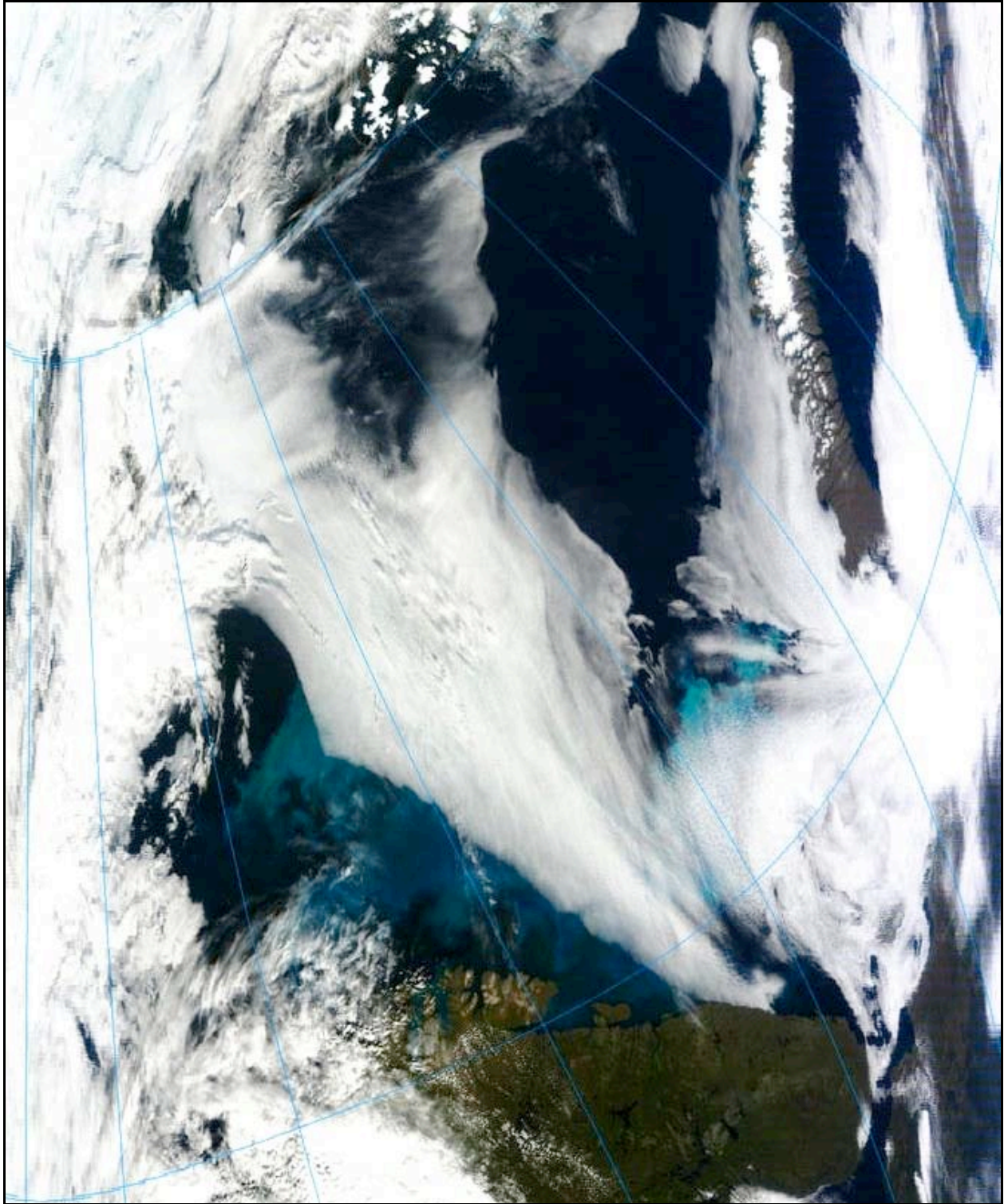
Phytoplankton Bloom in the Barents Sea 2011-8-17

The area in this and the previous image is located immediately north of the Scandinavian peninsula. The region is a junction where several ocean current systems—including the Norwegian Atlantic, the Persey, and east Spitsbergen currents—merge and form a front known as the North Cape Current. The intersecting waters, plus stiff winds, promote mixing of waters and of nutrients from the deep.



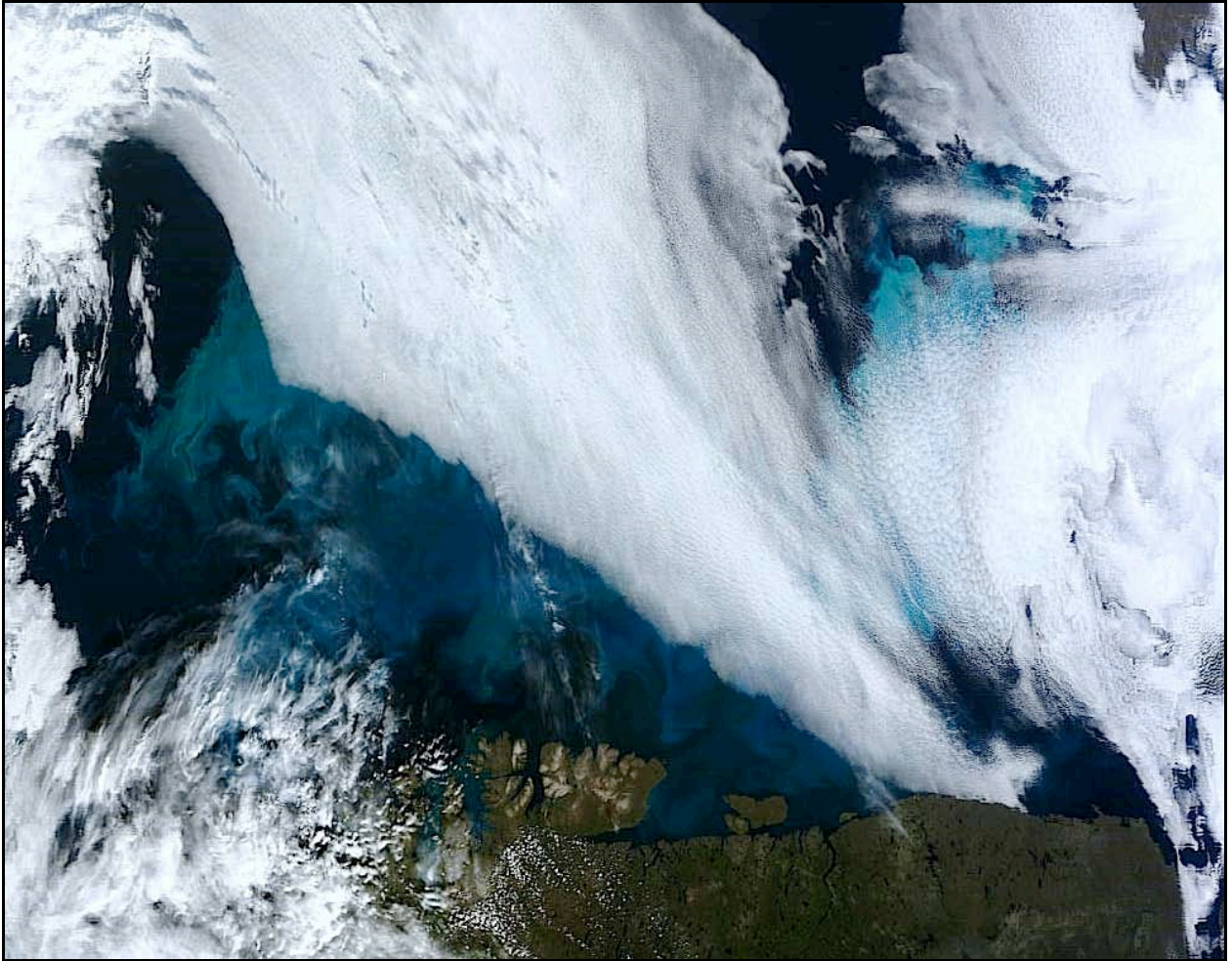
Phytoplankton Bloom in the Barents Sea 2011-8-18

By the next day, the 18th, clouds moving down from the northwest had obscured the northern half of the bloom. For orientation note Bear Island in the middle to upper left side of the image, and the Rybachiy Peninsula on the coastline of the Kola Peninsula just left of the fiord that connects Murmansk to the Barents Sea. Also note the clouds just entering into the White Sea around the tip of the Kola Peninsula.



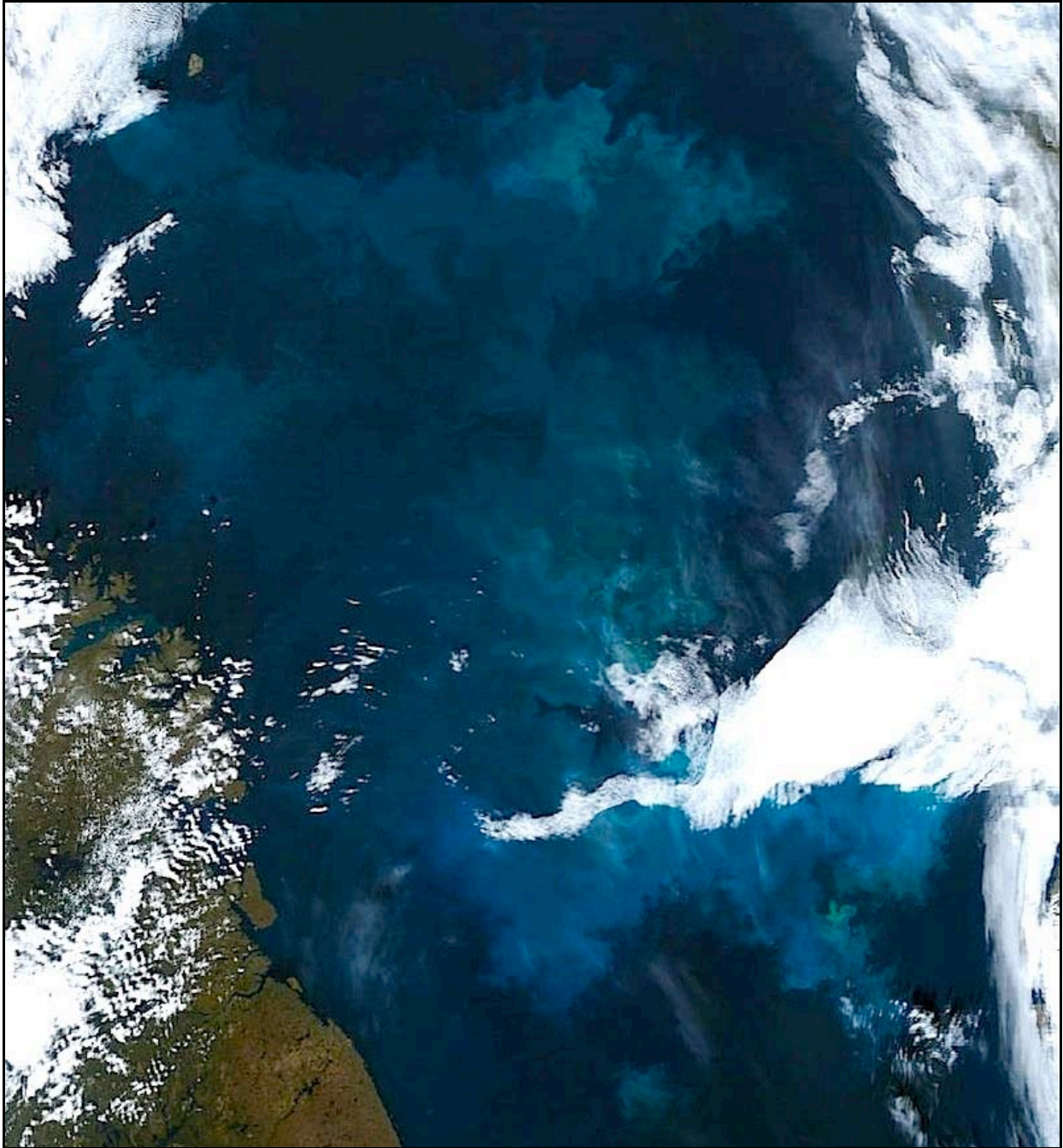
Phytoplankton Bloom in the Barents Sea 2011-8-22

In this locator image note Novaya Zemlya Island running up the upper right of the image.



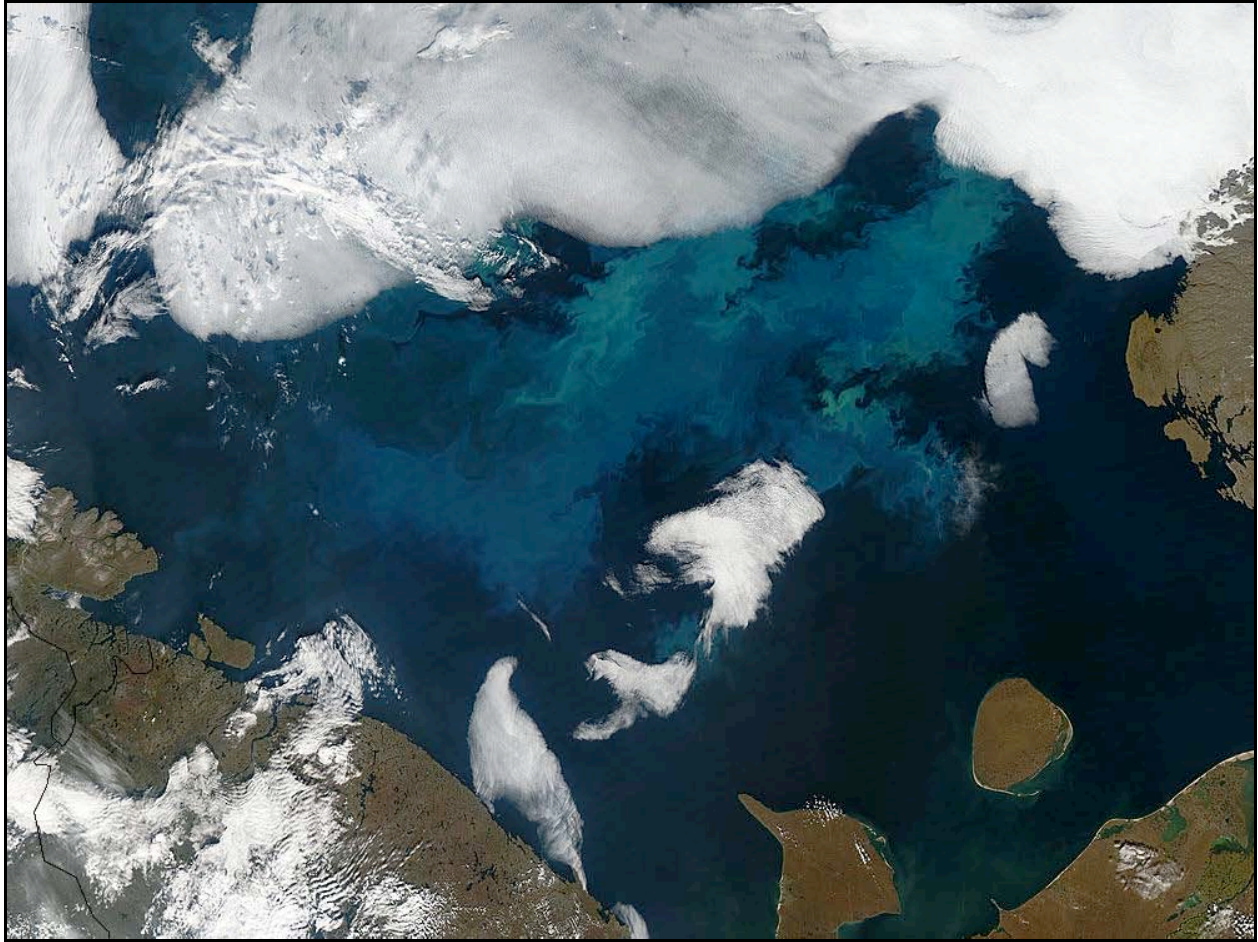
Phytoplankton Bloom in the Barents Sea 2011-8-22

This larger version of the previous image shows the coast of the Kola Peninsula running along the bottom of the image with the Rybachiy Peninsula and Murmansk right of center along its length.



Phytoplankton Bloom in the Barents Sea 2011-9-8

In this image note the change in the bloom's colors compared to **2011-8-17**. This area was cloud covered for three weeks changing the composition of phytoplankton species from a mixture of diatoms and coccolithophores to mostly coccolithophores. Note Bear Island is in the upper left and Murmansk in the lower left with the North Cape and Kola Peninsula running diagonally from lower right to upper left.

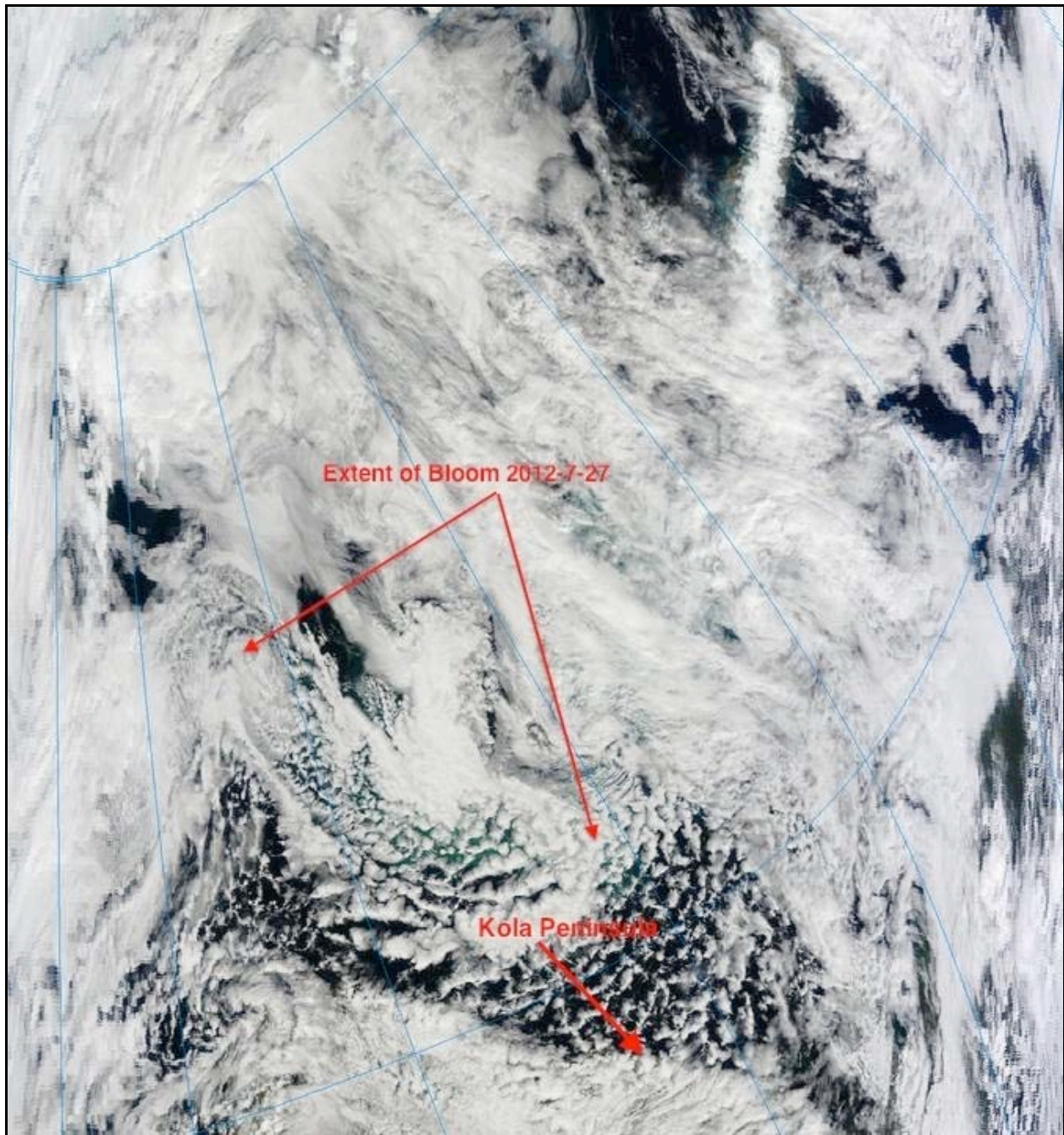


Phytoplankton Bloom in the Barents Sea 2011-9-10

This Gallery image shows an area around the bloom that includes the southern end of Novaya Zemlya Island near the middle of the right edge, with Murmansk and the Kola Peninsula opposite across the Barents Sea in the lower left. Ostrov Kolguyev Island lies just off the mainland of Russia in the southeast corner, with the Kanin Peninsula southwest of the Island.

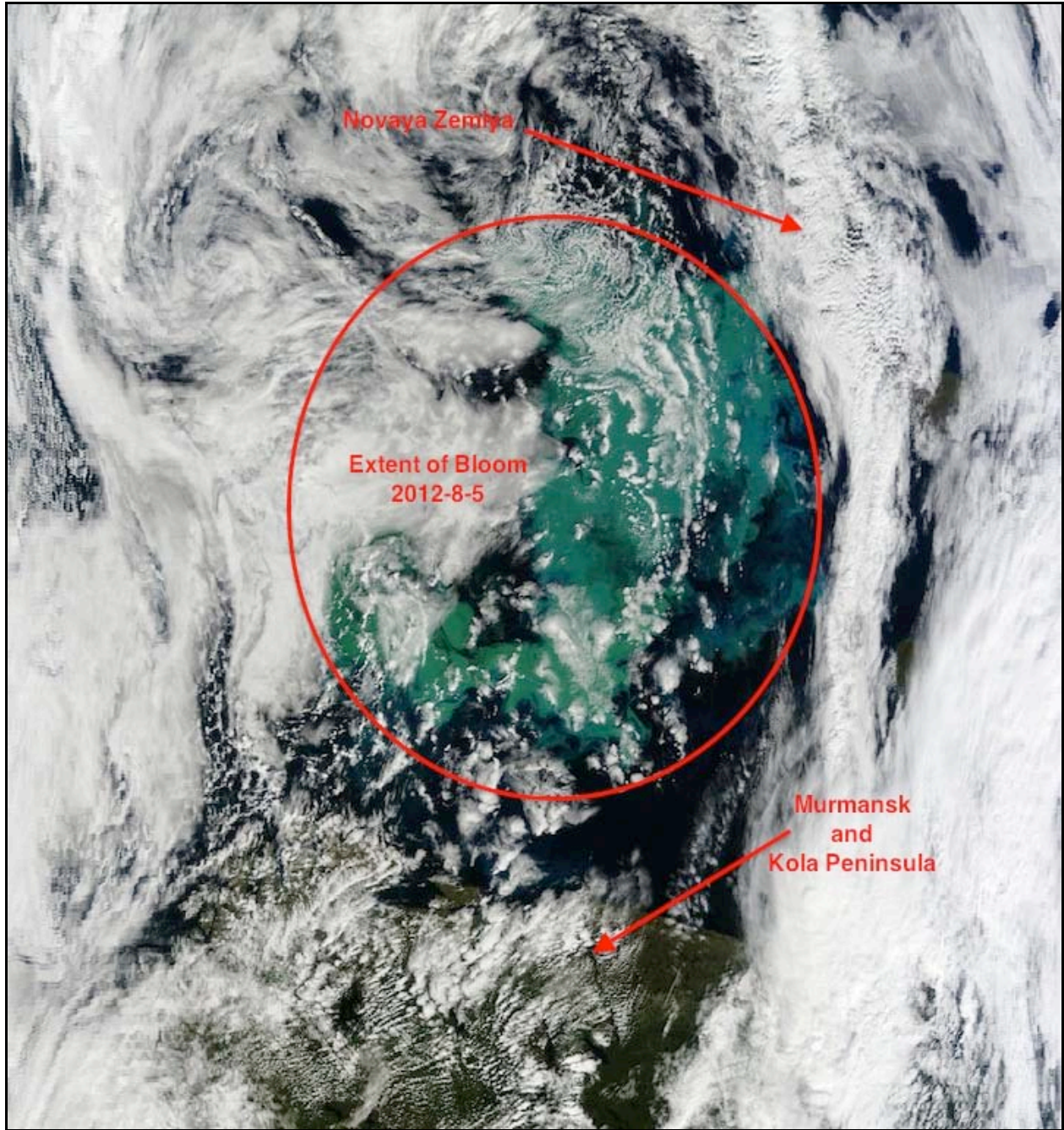
During the summer of 2011, this bloom persisted in the Barents Sea for almost seven weeks, and was still visible to satellites the second week of September. Fortified by plentiful nutrients, phytoplankton often thrive in the cool waters of the Arctic and North Atlantic Oceans as long as they have sunlight. But by the 12th clouds had closed in on the Barents Sea obscuring any phytoplankton that may have remained.

Phytoplankton Blooms in the Barents Sea during 2012



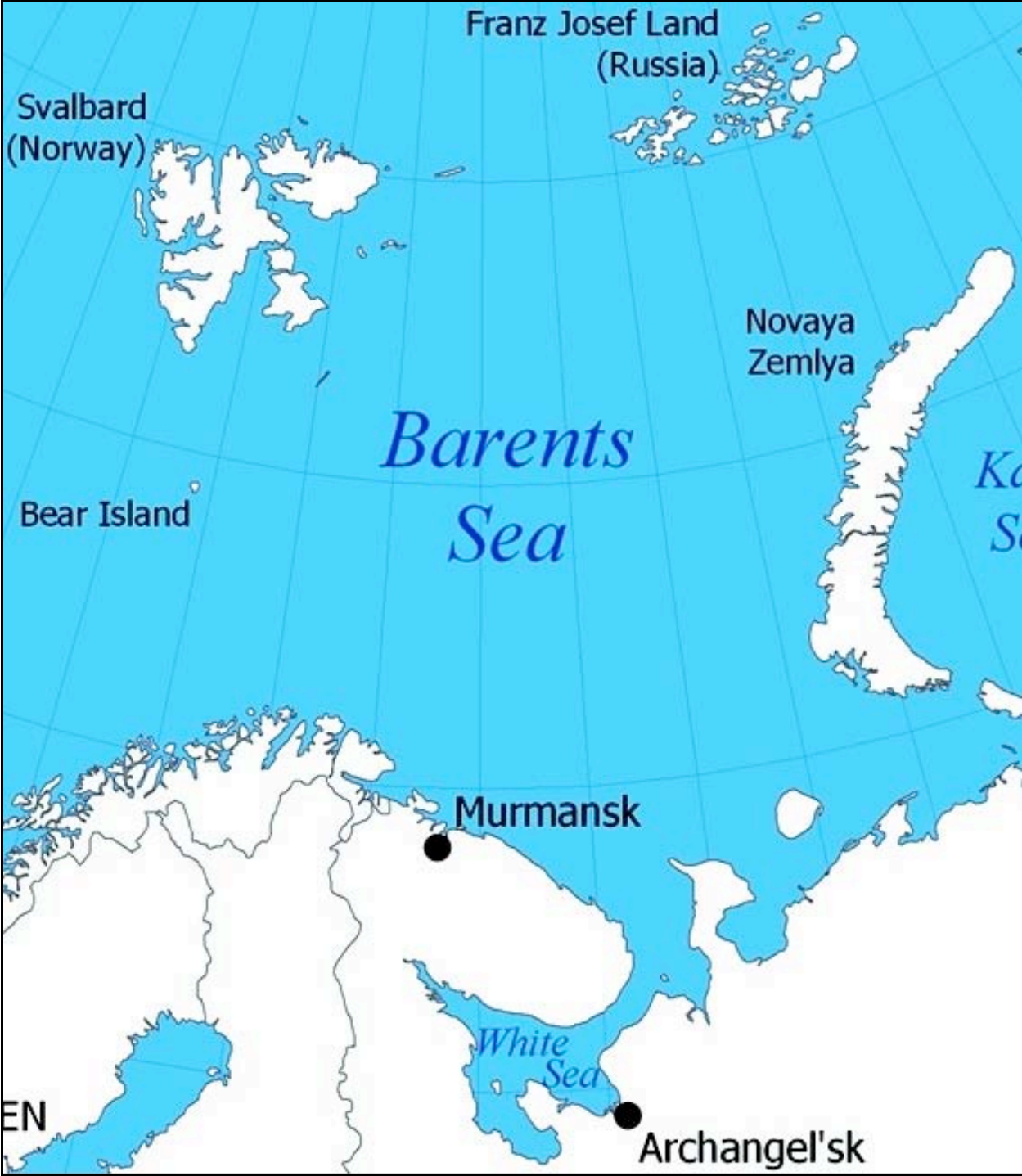
2012-7-27 Approximate Start of Barents Sea Blooms for 2012

A year later a phytoplankton bloom again formed in the Barents Sea. The first indication of this bloom appeared around 2012-7-27 barely visible through the clouds.

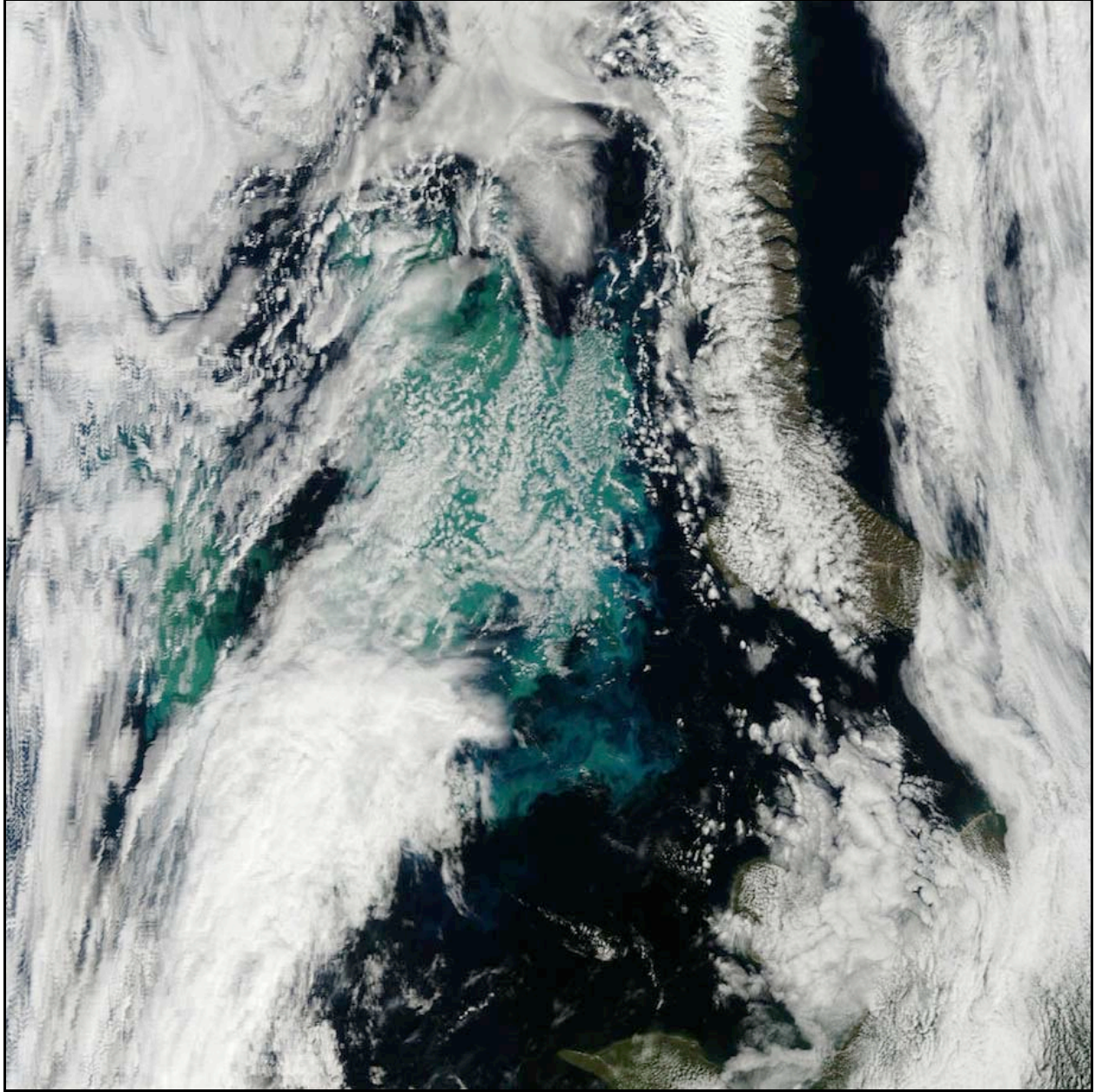


Phytoplankton Blooms in the Barents Sea 2012-8-5

By August 5th the bloom had grown immensely and had been blown northeast up against Novaya Zemlya Island, which runs straight down from the top of this image on the right side, by southwest winds. Note the green color of the bloom.

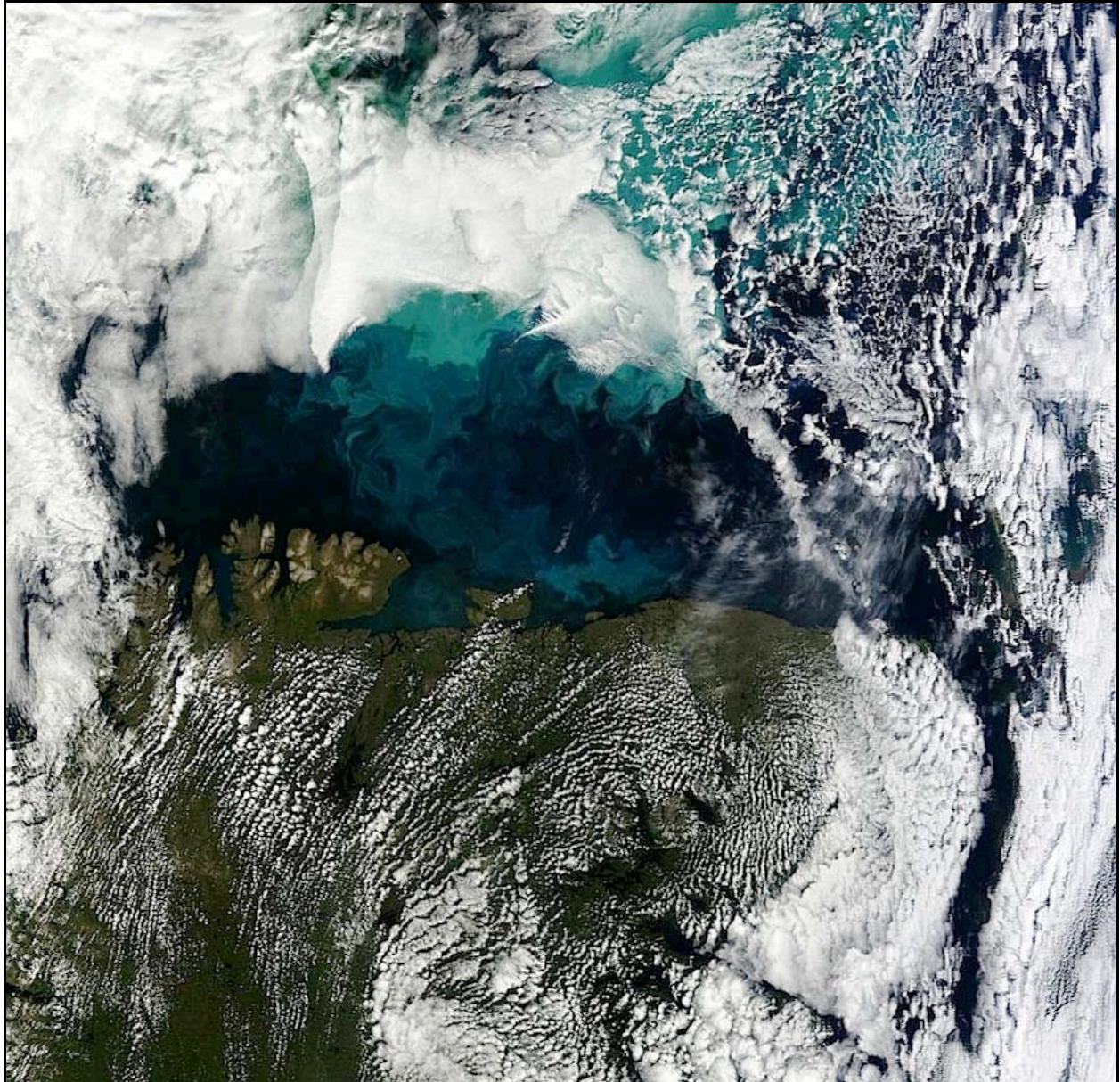


Enlarged Barents Sea Map



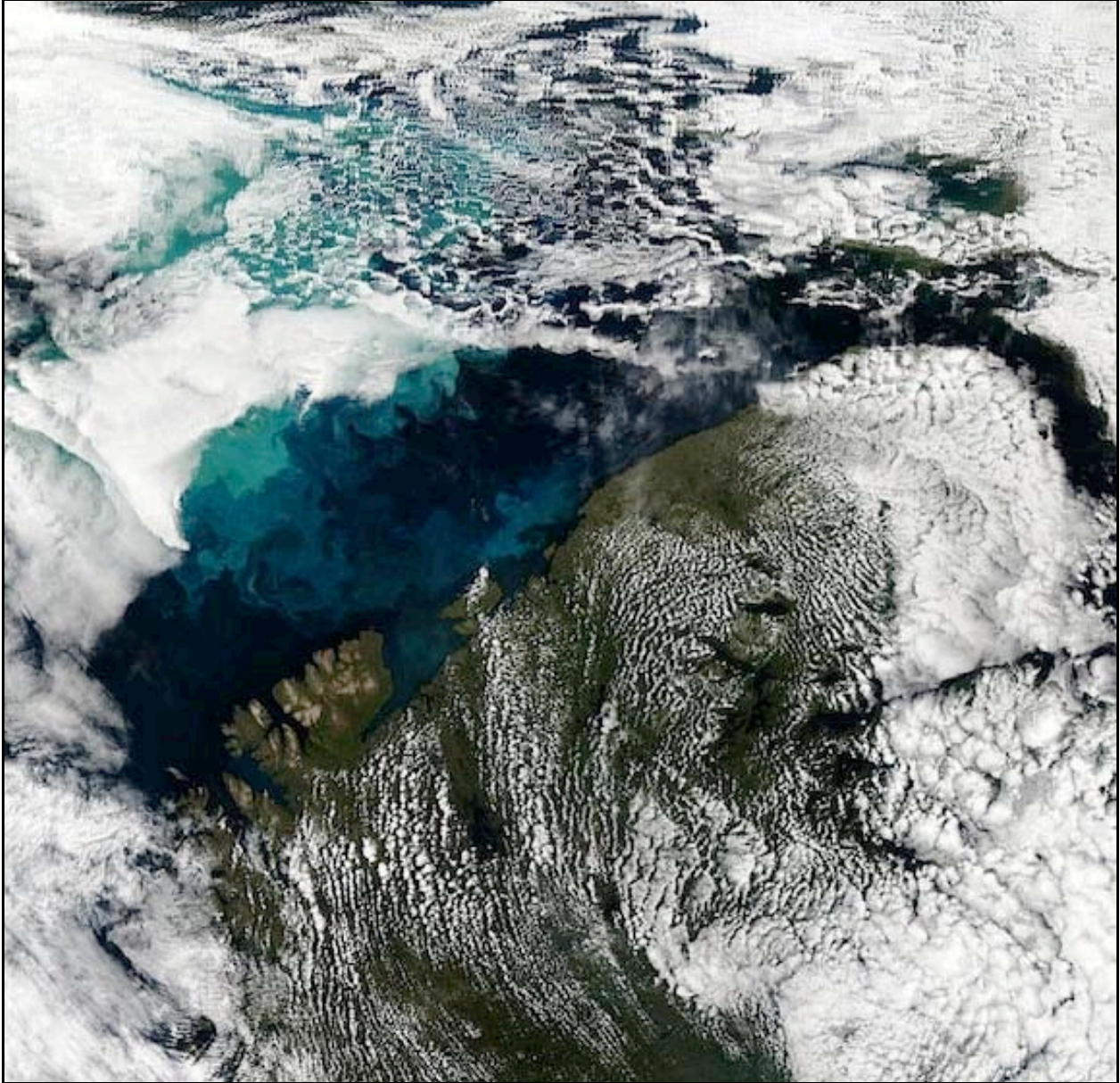
Phytoplankton Bloom in the Barents Sea 2012-8-6

The most notable characteristic of this bloom when compared to last year's is its color. Note the green shades typical of diatoms and algae as opposed to the milky-light blues of coccolithophores. The Kanin Peninsula is along the bottom edge of this image just right of center with Novaya Zemlya Island almost directly above it.



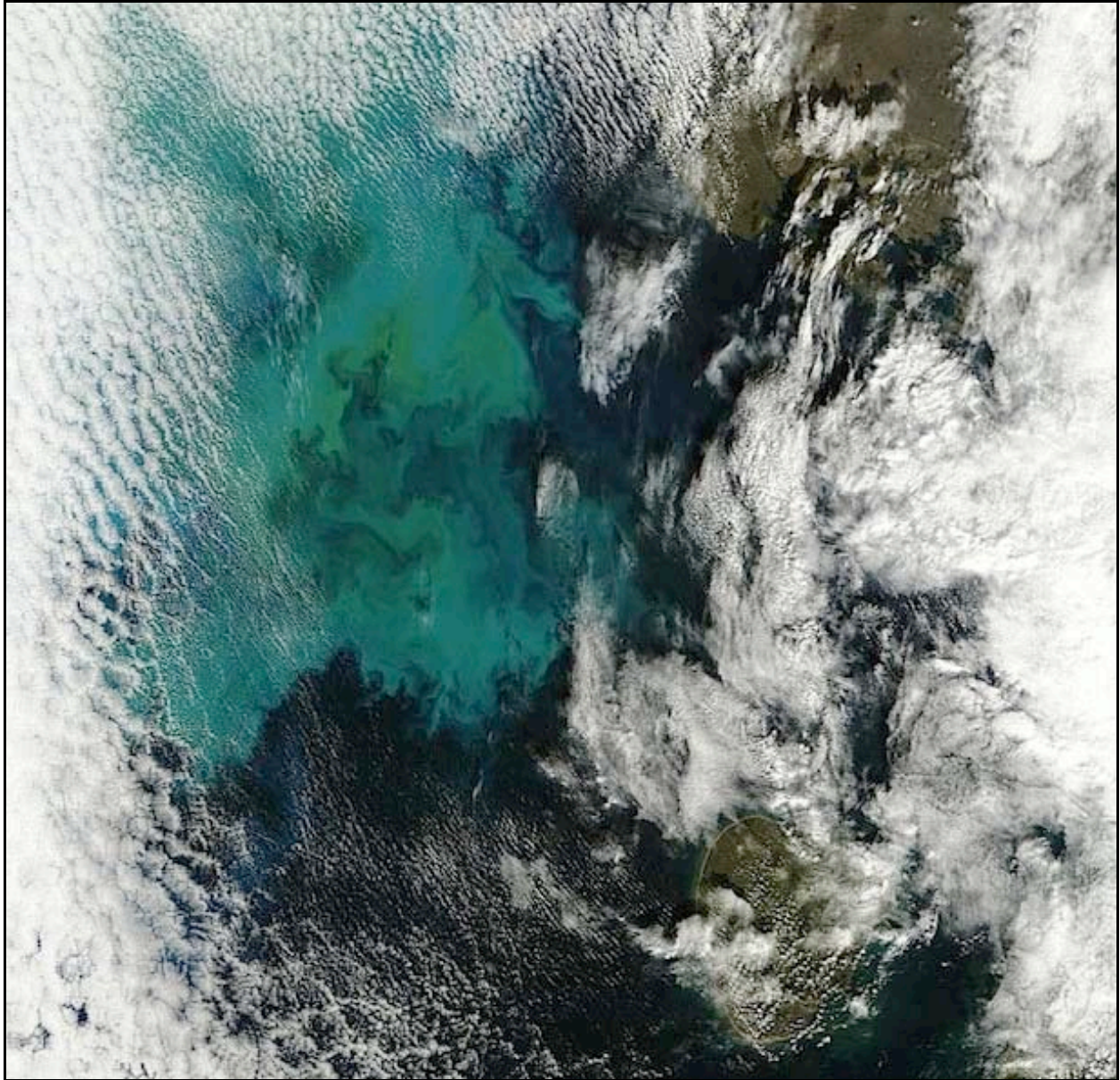
Phytoplankton Blooms in the Barents Sea 2012-8-10

By August the 10th the bloom had grown southward to the North Cape and the Kola Peninsula. Note the green algae blooms to the north and the light blue coccolithophores blooms south to the coast. Also note that strong south winds are blowing off the land from Norway with west winds still blowing the northern body of the bloom eastward.



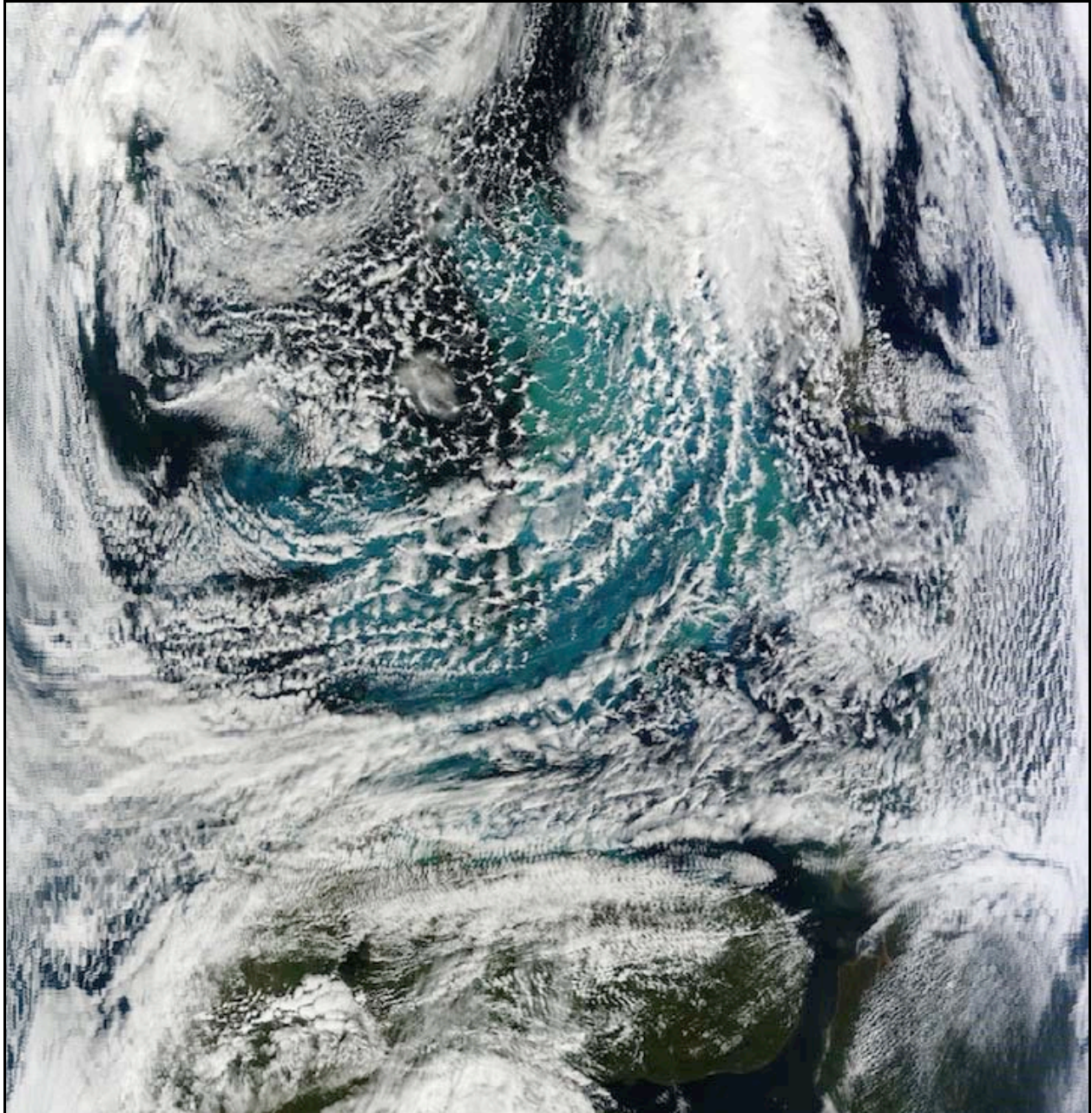
Phytoplankton Blooms in the Barents Sea 2012-8-10

In this August the 10th view one can see through the clouds that the green algae and diatom blooms extend north over a vast area.



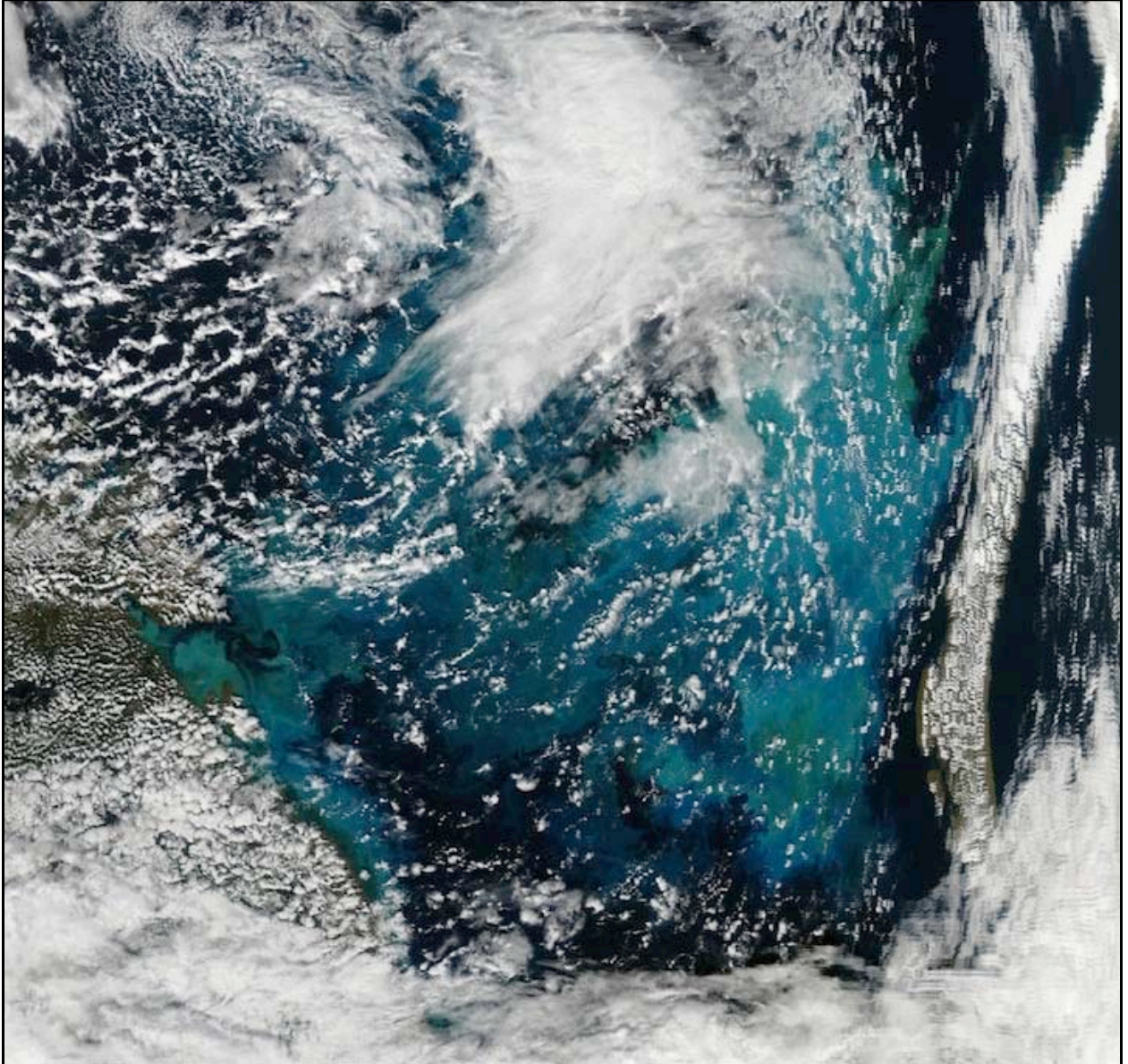
Barents Sea Phytoplankton Blooms 2012-8-15

Massive green algae and diatom blooms extend northwest of Ostrov Kolguyev Island in the lower right. The south end of Novaya Zemlya Island can be seen in the upper right. This means the main bloom has extended southwest in the last five days.



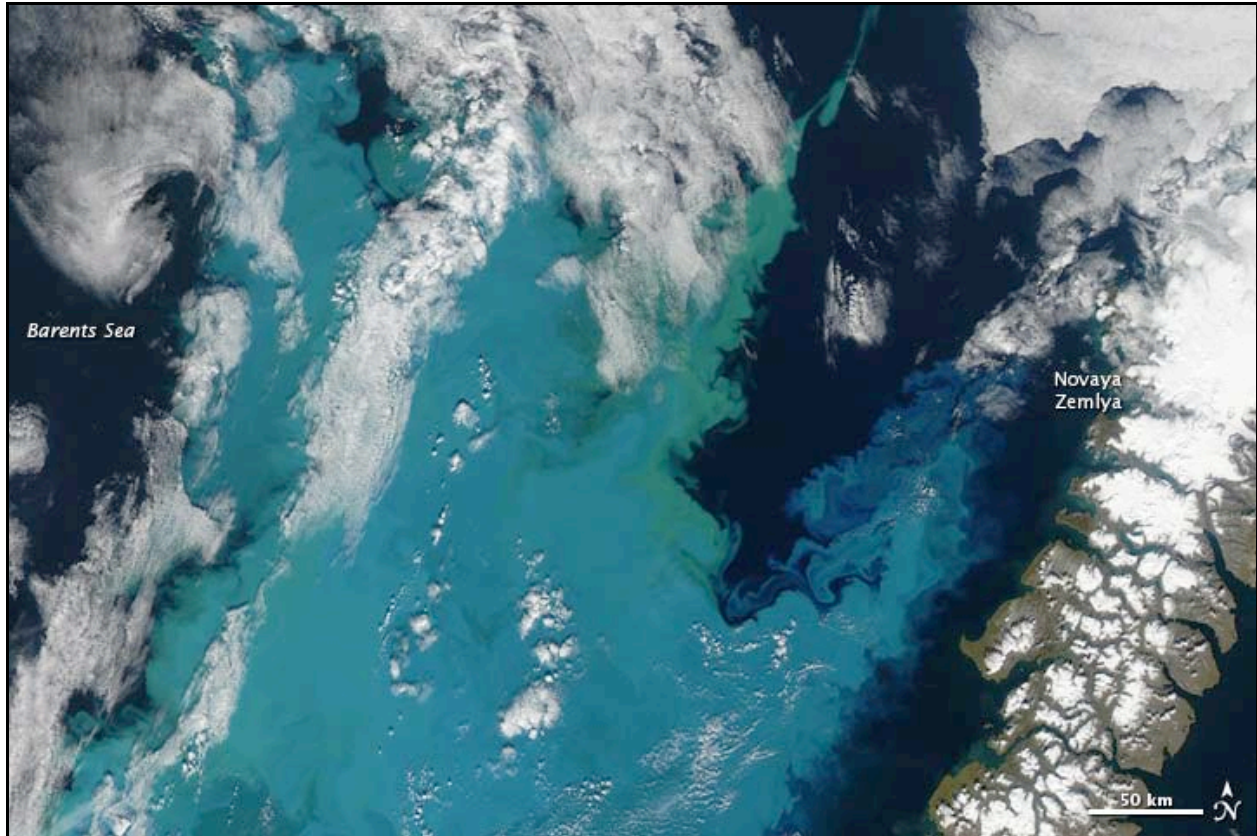
Phytoplankton Blooms in the Barents Sea 2012-8-21

By the 21st of August, however, strong winds were pushing the blooms east then north toward Novaya Zemlya Island.



Barents Sea Phytoplankton Blooms 2012-8-23

Note the bloom has grown from the Kola Peninsula to Novaya Zemlya Island.



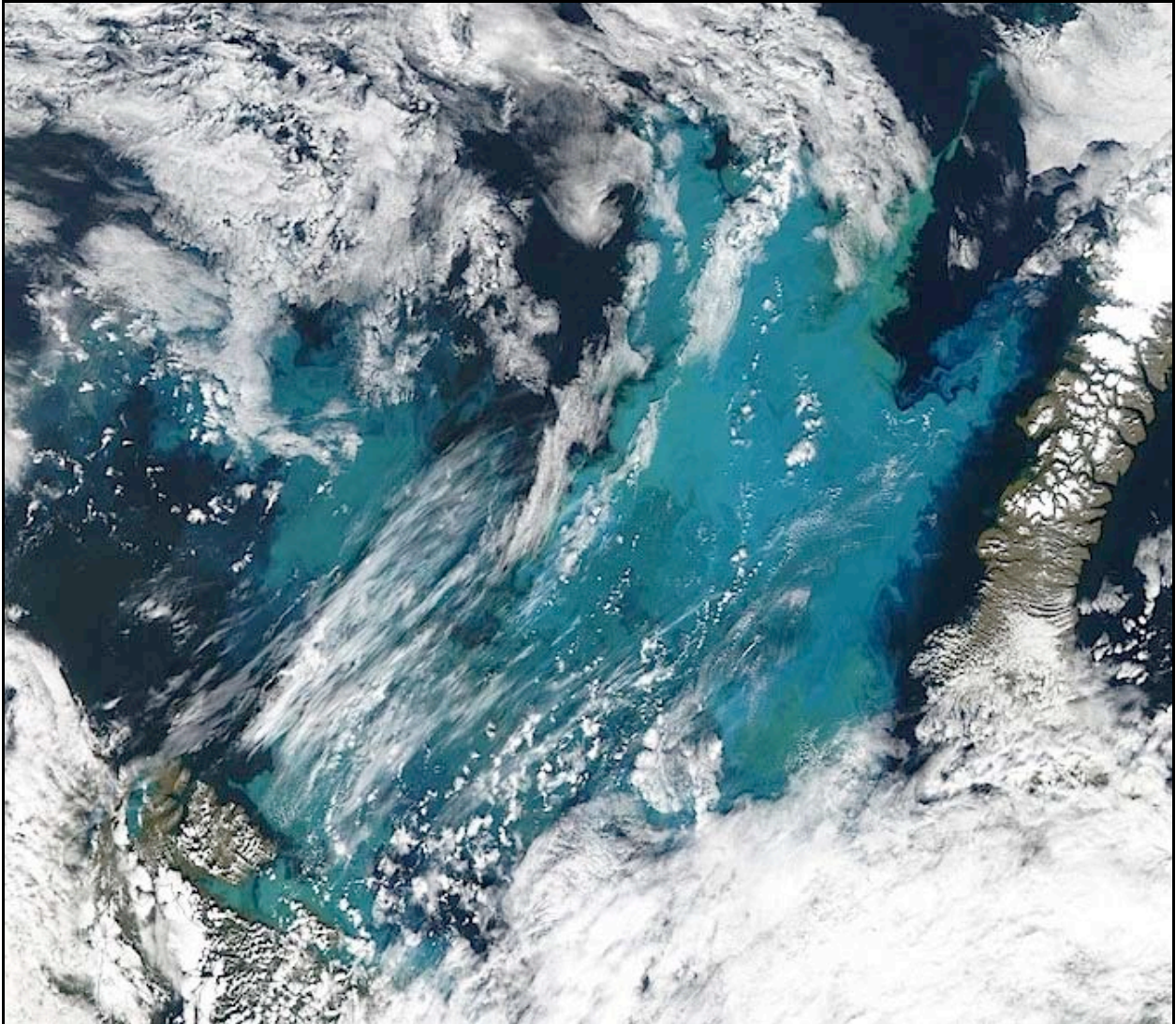
Phytoplankton Blooms in the Barents Sea 2012-8-24

All phytoplankton need sufficient carbon dioxide, sunlight, and dissolved nutrients to bloom. Any given bloom can include a broad range of species, but different species dominate the seas under different conditions. A study published in 2009 (Signorini & McClain 2009) found that in the Barents Sea, diatoms generally bloom each May, after winter and spring storms have mixed the ocean layers and brought up abundant nutrients from the deep. But this image was acquired in late August. Normally coccolithophore blooms proliferate during the calmer conditions of the late summer. The calcite of coccolithophore blooms especially lends light blue hues to ocean water not the heavy green colors that dominate above. This leads to the conclusion that diatoms still dominate with only the far right jet of phytoplankton showing more coccolithophores.

Web References

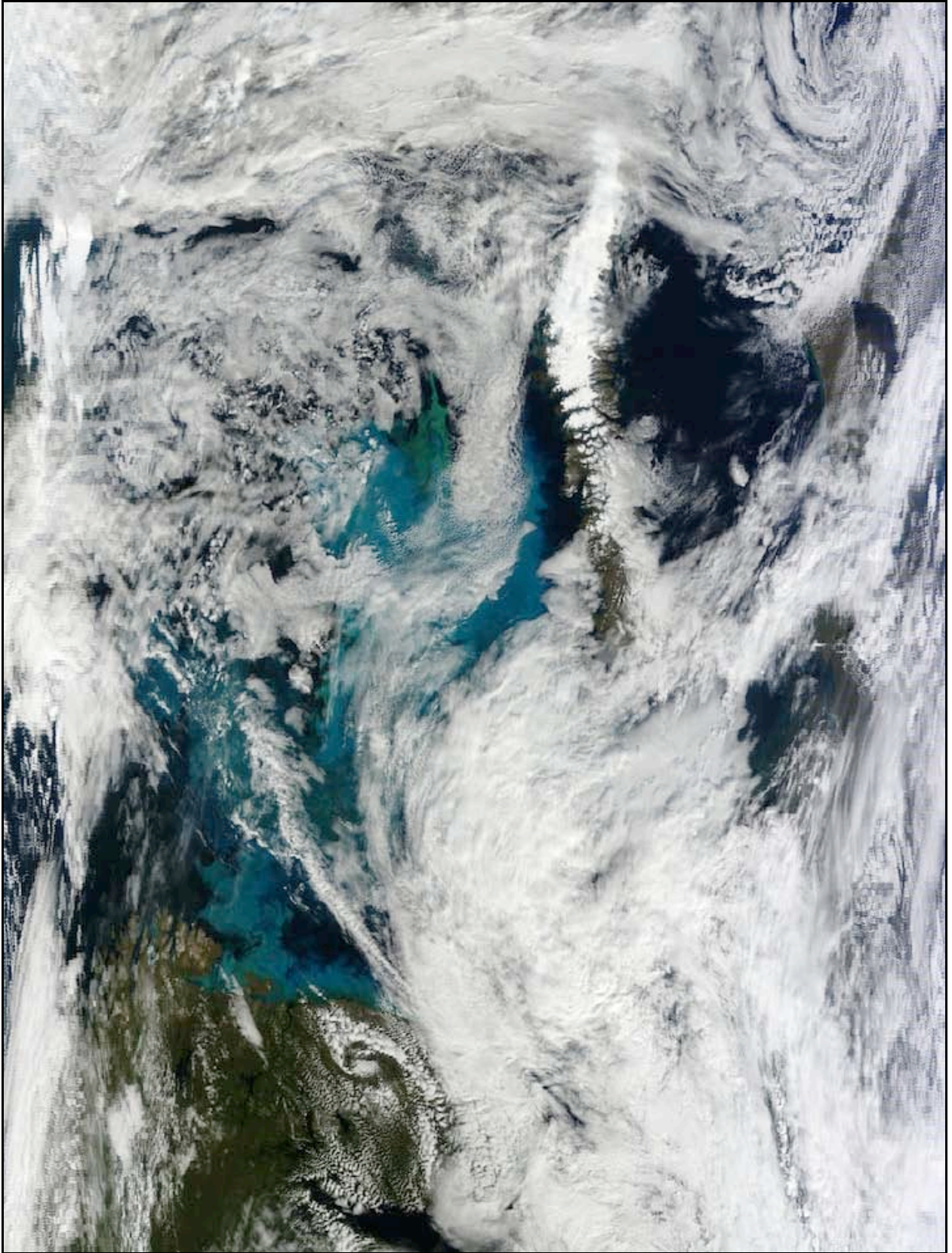
<http://www.agu.org/pubs/crossref/2009/2009GL037695.shtml>

<http://centerforoceansolutions.org/climate/impacts/ocean-warming/water-column-stratafi/>

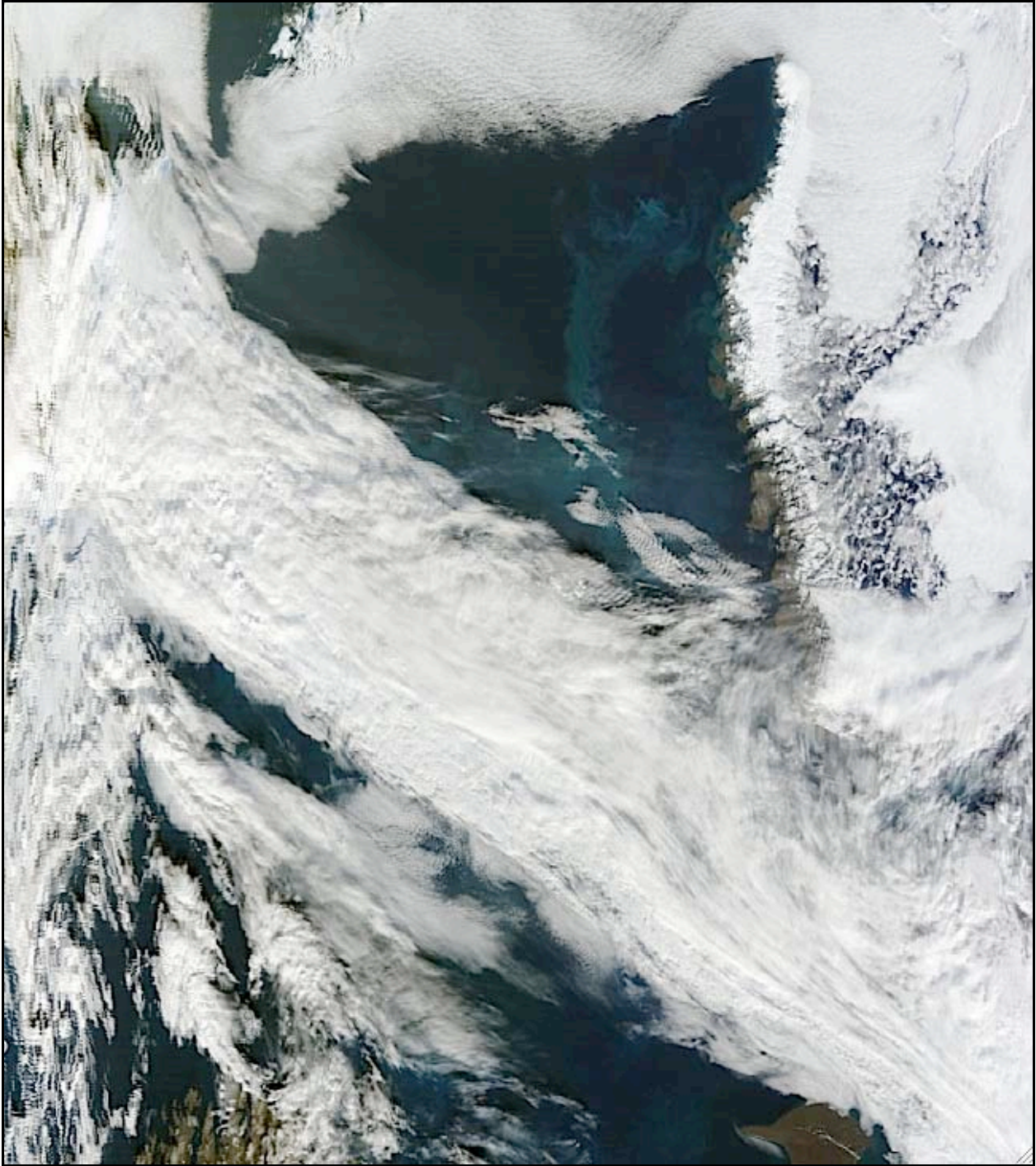


2012-8-24 Real Time Aqua Barents Sea

One possible hypothesis is the direction of the prevailing winds during the late summer of 2012, which were from the west northwest, contributed to the dominance of diatoms and algae.

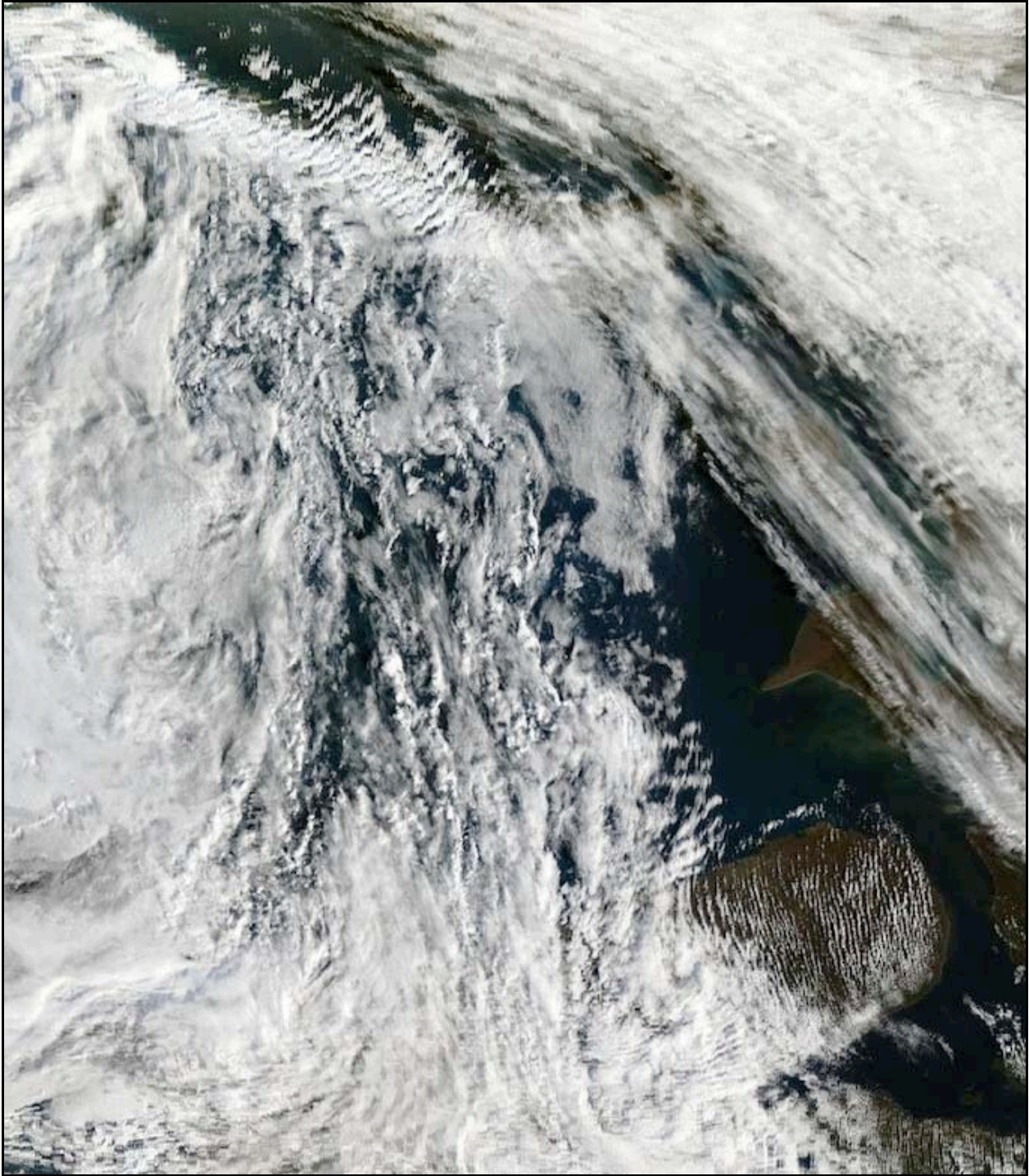


2012-8-25 Real Time Terra Barents Sea



The near the end of the 2012 Bloom

On **2012-9-17**, toward the end of the 2012 bloom, what is left of the bloom is still pushed up against Novaya Zemlya Island. The Kanin Peninsula is directly below the island with the North Cape opposite the peninsula in the bottom left. The slate color of the remaining bloom may be caused by coccolithophores blooming at depth.



The Barents Sea on 2012-9-21

By the third week of September the clouds had moved in put an end to this years blooms. Altogether, the bloom of 2012 lasted almost 8 weeks (~54 days) and was dominated by diatoms and algae. Whereas the 2011 lasted 7 weeks and was dominated by mostly by coccolithophores blooms.

Web References for:

Mann, David G. 2010. Diatoms. Version 07 February 2010 (under construction).
<http://tolweb.org/Diatoms/21810/2010.02.07> in The Tree of Life Web Project,
<http://tolweb.org/> Web Reference: <http://tolweb.org/Diatoms/21810>

Burenkov, V.I., Kopelevich, O.V., Rat'kova, T.N., Sheberstov, S.V. (2011) Satellite observations of the coccolithophorid bloom in the Barents Sea. *Oceanology*, 51(5), 766–774. Web Reference: <http://link.springer.com/article/10.1134%2FS0001437011050043>

Signorini, S. R., and C. R. McClain (2009), Environmental factors controlling the Barents Sea spring-summer phytoplankton blooms. *Geophysical Research Letters*, 36, L10604, Web Reference: <http://www.agu.org/pubs/crossref/2009/2009GL037695.shtml>

Phytoplankton see: <http://earthobservatory.nasa.gov/Features/Phytoplankton/>

Coccolithophores see: <http://www.soes.soton.ac.uk/staff/tt/> ;

http://en.wikipedia.org/wiki/Emiliana_huxleyi ; and

<http://earthobservatory.nasa.gov/Features/Coccolithophores/>
