Hamme, R. C., P. W. Webley, W. R. Crawford, F. A. Whitney, M. D. DeGrandpre, S. R. Emerson, C. C. Eriksen, K. E. Giesbrecht, J. F. R. Gower, M. T. Kavanaugh, M. A. Peña, C. L. Sabine, S. D. Batten, L. A. Coogan, D. S. Grundle, and D. Lockwood (2010) Volcanic ash fuels anomalous plankton bloom in subarctic northeast Pacific, *Geophys. Res. Lett.*, **37**, L19604, doi:10.1029/2010GL044629.

Summary in layman's terms:

Many of us know that plants on land need sunlight and nutrients from the soil to grow. The microscopic plants that live in the ocean, called phytoplankton, are the same. In the open ocean off the BC coast, phytoplankton have plenty of the usual nutrients that make up agricultural fertilizer that we add to land plants: nitrogen and phosphorus, but they are a missing a key ingredient: iron. They only need a tiny amount of iron, but there is usually very little available, so phytoplankton growth is much lower than it could be in this region. In August 2008, the phytoplankton in an area over 1000-km wide off the BC coast suddenly began to grow rapidly. In our paper, we show that ash from the volcanic eruption of Kasatochi Volcano in the Aleutian Islands was deposited over this region supplying iron to the ocean and fueling phytoplankton growth.

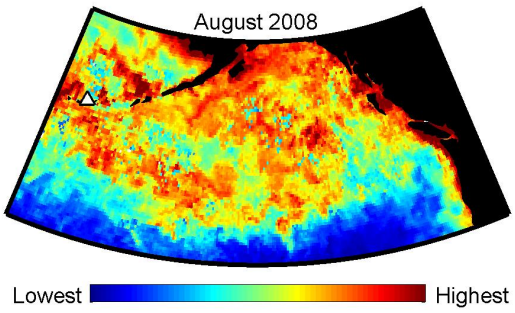
Satellites in space can detect chlorophyll, the pigment that makes plants green. Pictures from these satellites show that this August 2008 high growth event was the largest ever seen in this region of the ocean since at least 1997, when the first satellites began measuring ocean chlorophyll. Eruptions occur in the Aleutian Islands several times a year, but we do not know of a previous instance of a widespread fertilization effect. Usually ash from volcanic eruptions is swept in one narrow direction by the wind. However, in this case, a storm system was forming just over Kasatochi Volcano when it erupted. The ash from Kasatochi was caught in this forming storm system, which swirled over the ocean depositing volcanic ash over an unusually large area. Scientists had recently hypothesized that volcanic ash could fertilize the ocean in this way, but this August 2008 event in the North Pacific is the first time we have conclusive evidence that this really occurs.

One of the reasons scientists want to understand the growth of phytoplankton is that this process absorbs carbon dioxide. When the phytoplankton die and sink into the deep ocean, that carbon is carried to the deep sea, away from the atmosphere where it could have contributed to the greenhouse effect. People have proposed that global warming might be combated by adding iron to these parts of the ocean that have too little iron for phytoplankton to grow effectively. We looked at how much carbon dioxide was absorbed by this event and found that it was around 0.01 Pg of carbon (a Petagram is 10^{15} grams). Compare that to the ~6.5 Pg of carbon released every year by the burning of fossil fuels or the ~2 Pg of carbon that the ocean absorbs naturally each year. Despite the huge area of iron addition and the optimal time of year when there was plenty of sunlight, the impact of this August 2008 event in terms of carbon dioxide absorption was quite small. This tells us that

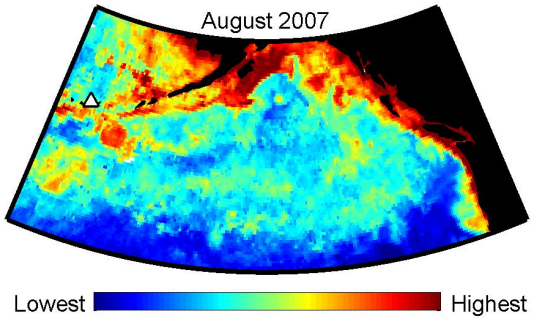
iron fertilization would have to be performed on a truly gigantic scale to have an impact on our climate.

Another exciting part of this event was the combination of new and old ways of observing the ocean that allowed us to narrow the possible causes for this event down to a single explanation. This area of the ocean has the longest series of regular observations of any area of the ocean, made by Fisheries and Oceans Canada (DFO) in Sidney, BC. This phenomenal observing effort has given us a deep understanding of how the ecosystem in this area of the ocean works and what factors can change it. One of the DFO oceanographic cruises to this location happened to occur during this event. The truly unusual data from that cruise combined with the satellite maps of chlorophyll were what alerted us that something very unusual had taken place. Added to these more traditional observations were new instruments that measured dissolved carbon dioxide and ocean acidity on a buoy in the centre of this region and a glider that dives up and down measuring chlorophyll concentration. This combination of measurements provided conclusive evidence that iron fertilization from a volcanic eruption caused this event.

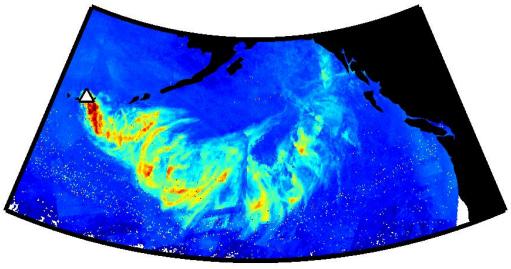
The following figures show maps of surface ocean chlorophyll concentrations in the NE Pacific for the August 2008 event and for August 2007 (for comparison). Also shown is a map of the path of volcanic ash from the Kasatochi eruption. Note the correspondence between the area of high chlorophyll and the area covered by ash. The white triangle marks the position of Kasatochi Volcano.



Satellite image of phytoplankton in North Pacific



Satellite image of phytoplankton in North Pacific



Satellite image of airborne volcanic ash, August 2008