IOW press release – February 3, 2022

What happens to the nutrient cycle when typhoons churn the sea: Insights from the eye of the storm

In September 2018, an expedition as part of the German-Chinese project MEGAPOL was affected by the super typhoon "Mangkhut". This resulted in the collection of unique data sets on the nutrient budget in the impacted part of the South China Sea. It became clear that serious changes were triggered by the super typhoon not only on land but also at sea: Enormous amounts of nutrients were mixed into the surface water from deeper layers, where they tripled the growth of phytoplankton in a few weeks. The typhoon had a particularly pronounced effect in the transition from the deep sea to the shallow coastal ocean.

The destructive power of typhoons is evident on land. Their trajectories can be seen as a trail of devastation across the landscape. But what happens underwater during such extreme events?

In September 2018, a so-called super typhoon with wind speeds of nearly 200 km per hour passed through the South China Sea and caused enormous damage around Hong Kong. A team of scientists from the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) was on board the Chinese research vessel HAI YANG DI ZHI SHI HAO at the time. They were on their way as part of the German-Chinese research project MEGAPOL, which is investigating the effects of megacities on their offshore sea areas. The station network planned for this purpose, on which samples were taken to determine the nutrient content in addition to current, temperature, salinity and oxygen measurements, extended from the shelf area over the shelf edge to the deep sea areas of the South China Sea. Parts of the station network were directly in the path of the super typhoon, which went down in the annals under the name "Mangkhut". When Mangkhut reached the area, the Warnemünde scientists had already started their work. This circumstance made a unique before / after comparison possible.

The researchers have now published the results of the hydrodynamic and nutrient analyses in the *Journal of Geophysical Research: Biogeosciences*. "The greatest changes took place in the upper 100 m of the water body," reports first author Joachim Kuss, marine chemist at the IOW. "The values measured before the typhoon all changed drastically." In order to comprehensively understand the nutrient situation, the inorganic nutrients nitrate / nitrite, phosphate and silicate, as well as particulate organic carbon and nitrogen, dissolved organic carbon, and total dissolved nitrogen, oxygen, chlorophyll and suspended solids were analysed. The analyses took place in the Warnemünde laboratory.

In general, the impact on the shelf and on the shelf edge was much greater than in the deep-sea areas. Nutrients were introduced into the surface water in enormous quantities – on the one hand by the extreme freshwater runoff from the land, on the other hand by upwelling events. This immediately triggered very strong algal growth and also maintained these algal blooms for several weeks.

The effects of typhoons in the sea can usually be recorded well via satellites, which, however, only depict the uppermost metres of surface water. Due to the presence of

the Warnemünde team in the area affected by the typhoon, unique data could also be obtained from deeper water layers, which allow a much better assessment. The data also made it possible to calculate a carbon budget of the enormous algal blooms triggered by the mixing processes.

Joachim Kuss summarises: "Mangkhut has almost tripled primary production compared to the normal situation. However, we have to disappoint any hopes that this could have bound so much CO2 that there might be a positive concomitant effect on the climate: On the basis of our data, we presume that CO2 sequestration and emission triggered by Mangkhut were in balance."

Further details can be found at: Kuss, J., Frazão, H. C., Schulz-Bull, D. E., Zhong, Y., Gao, Y., & Waniek, J. J. (2021). T*he impact of typhoon "Mangkhut" on surface water nutrient and chlorophyll inventories of the South China Sea in September 2018*. Journal of Geophysical Research: Biogeosciences, 126, e2021JG006546. https://doi.org/10.1029/2021JG006546

The work of the German team was carried out within the framework of the BMBF-funded project "MEGAPOL-Megacity's fingerprint in Chinese southern marginal seas" (grant number: 03F0786A).

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