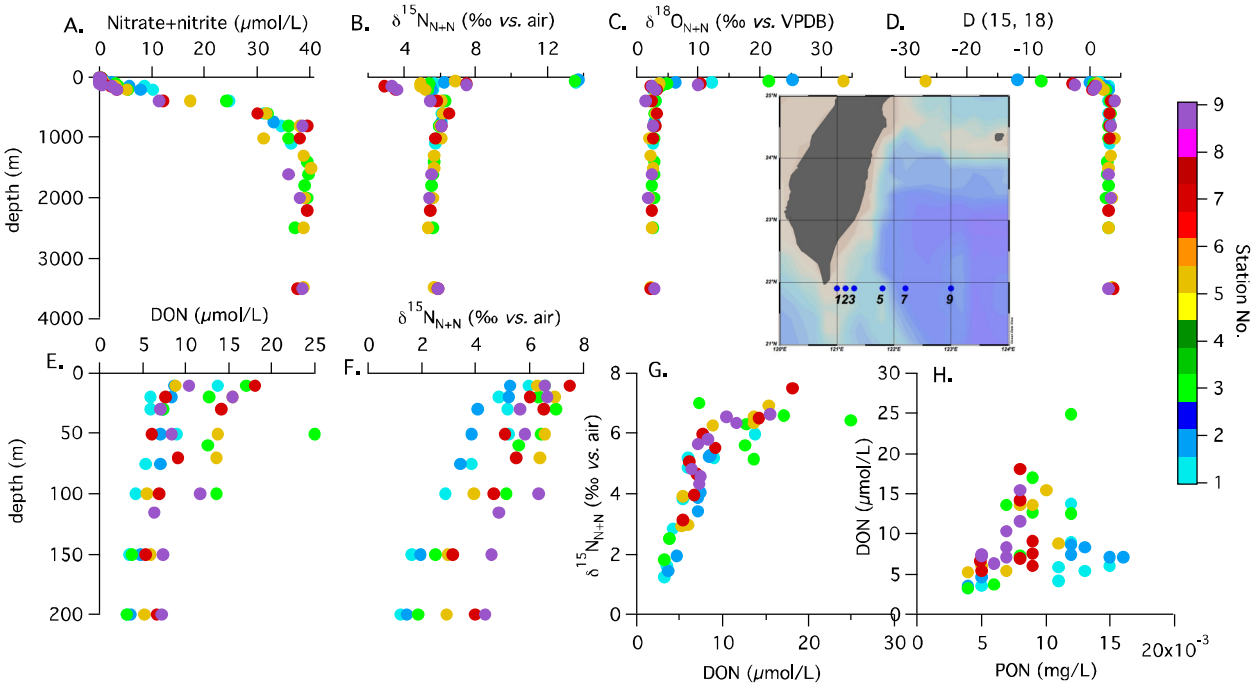
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-TAIPEI

May 1st, 2018 to April 30th, 2019

New scientific results

Dr. Tung-Yuan Ho's group in Research Center of Environmental Changes at Academia Sinica lead a cruise across the Kuroshio current to the east of Taiwan in from Apr. 23 to 17, 2018. In collaboration with Dr. Ho, Dr. Abby Ren's group at National Taiwan University analysed seawater samples for the concentrations and nitrogen isotopic composition on dissolved inorganic nitrogen and dissolved organic nitrogen as well as the oxygen isotopic composition of nitrate in the water column across this transect. The nitrogen isotopic composition of nitrate+nitrite shows the typical North Pacific intermediate and deep water nitrate value (~6‰). But in the shallow thermocline centered around 200m, the $\delta^{15}N$ of nitrate+nitrite decreases to around 3‰ (B), yet the $\delta^{18}O$ remains deep nitrate value (C), and the difference between $\delta^{15}N$ and $\delta^{18}O$ clearly decreases above this depth (D). These observations clearly support the input of nitrogen by nitrogen fixation, and are also supported by the upward increase in N*. The two stations away from Luzon Strait show stronger decrease in $\delta^{15}N$ in the shallower thermocline relative to the other stations. This may be explained by mixing shallow seawater outflow from the South China Sea with higher $\delta^{15}N$ value and open Pacific seawater with lower $\delta^{15}N$ value or different signatures of Kuroshio current versus the open Pacific seawater. On the other hand, the concentration and $\delta^{15}N$ of dissolved organic nitrogen both increase upward in the above 200m, and the two show strong positive correlation. Previous studies on dissolved organic nitrogen from other regions (e.g. BATS, HOTS) show invariant DON concentrations and isotopic values, which have been taken as evidence to support the refractory characteristics of the DON pool. The data from the Northwest Pacific including Kuroshio current reported here may be explained by (1) two end member mixing in this upper water depth between the high DON flux with an elevated $\delta^{15}N$ value from the top and the low DON flux with a low $\delta^{15}N$ value near the base of the euphotic zone; and/or (2) uptake of DON pool with higher $\delta^{15}N$ values. And the positive correlation between the concentrations of particulate organic nitrogen and dissolved organic nitrogen suggests an active cycle between the two pools.



Dr. Ho's group has had the following three new TEI related studies. (1) We investigated the cycling processes of aerosol Fe in the surface water of the NWPO region through Taiwan GEOTRACES cruises by analyzing aerosols, seawater, suspended and sinking particles during the periods of high and low aerosol deposition seasons. With one order of magnitude higher aerosol Fe deposition flux during high deposition period than low deposition period, the elevated aerosol Fe input was not reflected in the dissolved form but in the suspended particulate pool. Elemental ratios indicate that biotic and abiotic suspended particulate Fe exhibited size-dependent distribution patterns. Lithogenic particles originating from aerosol deposition were mainly in the particles with sizes ranging from 2 to 25 μm in the surface water. Biotic particles smaller than 2 μm were the major carriers of intracellular, precipitated and aggregated Fe, possessing longer residence time and higher bioavailability than the large and dense lithogenic particles in the euphotic zone (Wang and Ho under review). (2) We determined $\delta^{66}Zn$ in the water column of the NWPO and its marginal seas to investigate the processes causing the vertical and spatial variations. Comparable to previous studies, dissolved $\delta^{66}Zn$ was relatively light in the top 200 m and increased with depths toward to an averaged value (+0.38±0.10‰) in the deep water. We found that the $\delta^{66}Zn$ observed in the deep water were much lighter than the NEPO. Box model approaches suggest that the spatial variations in the deep water may be attributed to isotopically light Zn input originated from anthropogenic aerosols or benthic sediments. In terms of the surface water, the fractionation factors derived from either close or open system fractionation models supported that scavenging is the dominant process regulating Zn cycling in the surface water. However, either closed or open system models exhibits relatively poor fitting with the measured data. We proposed a conceptual model to include the effect of external input on [Zn] and $\delta^{66}Zn$ values in the surface water. Our model was supported by a significant correlation between Zn fractionation factors and aerosol optical depths we observed globally, implying that external aerosol deposition is an important process causing the variations of [Zn] and $\delta^{66}Zn$ in the global oceanic surface water. (Liao et al. under review). (3) We investigated the effect of Ni supply on H_2 production and N_2 fixation by using a model marine cyanobacterial diazotroph, *Cyanothece* (Tuo et al. under review). Ni is an essential cofactor in NiFe-uptake hydrogenase, an enzyme regulating H_2 metabolism in diazotrophic cyanobacteria, the major H_2 producers in the surface ocean globally. By mediating total dissolved Ni concentrations, we demonstrated that Ni deficiency would result in H_2 accumulation and diminution of N_2 fixation, coupling with decreasing growth rates and Ni quota. These results indicate that Ni deficiency limits the growth of the *Cyanothece* to some extent, considerably decreases H_2 uptake by hydrogenase and leads to H_2 accumulation and N_2 fixation reduction in the diazotroph. These findings show that Ni availability is a critical environmental factor on controlling H_2 production and N_2 fixation in marine diazotrophic cyanobacteria.

New projects and/or funding

- In continuation of Dr. Abby Ren and Dr. Tung-Yuan Ho's MOST funded projects, the two teams conducted another spring cruise in this region during March 1 to 10, 2019. To address the above described findings on the DON sources and recycling in the upper ocean, they have collected aerosol samples and PON samples in addition to the seawater samples in order to quantify atmospheric source of DON in this region, and address the cycling between PON and DON pool using their δ15N values.
- Dr. Tung-Yuan Ho's has submitted two new proposals, including the one entitled "Marine biogeochemical cycling of anthropogenic aerosol Fe" to MOST, Ministry of Science and Technology, 2019/08-2022/07 (under review); and the other pre-proposal entitled "PM2.5

trace metal biogeochemistry in the Northwestern Pacific Ocean" to Academia Sinica, 2020/01/01-2024/12/31 (under review).

GEOTRACES workshops and meetings

- 2018 GEOTRACES SSC meeting and training workshop were held in Taipei from July 23 to 26, 2018, which was hosted by Tung-Yuan Ho. A GEOTRACES training workshop was held on 26th at Academia Sinica with topics including the introduction of GEOTRACES and IDP2017, TEI sampling and analysis, and Ocean Data View application and operation.
- Dr. Abby Ren participated in the joint GEOTRACES-PAGES workshop in Aix-en-Provence from Dec. 3-5 2018. She joined the Paleo-Productivity work group, and is actively involved in the intercalibration of methods used to analyze core-top sediments and sediment trap samples for foraminifera-based proxies.

Outreach activities

- "Learning Oceanography by cartoon posters & Q&A with gifts", October 26, 2018, Academia Sinica Open house, https://openhouse.sinica.edu.tw/event/detail/65

New publications

- Liao, W.-H. and T.-Y. Ho (2018) Particulate trace metal composition and sources in the Kuroshio adjacent to the East China Sea: the importance of aerosol deposition. Journal of Geophysical Research: Oceans doi: 10.1029/2018JC014113.
- Lee, C.-P., Wen, L.-S., (2018) Physical and chemical characterization of dissolved arsenic in the South China Sea. Marine Chemistry doi.org/10.1016/j.marchem.2019.02.001.

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