surface ocean solas lower atmosphere study

Report for the year 2018 and future activities

SOLAS *Taiwan*

compiled by: Chon-Lin Lee and Hon-Kit Lui

PART 1 - Activities from January 2018 to Jan/Feb 2019

1. Scientific highlight

(1) Massive coral mortality could be exacerbated by distant volcanic eruption under the influence of global warming

Coral reefs, the so-called rainforests of the sea, are one of the important components of the marine ecosystems. However, mainly because of seawater warming, coral bleaching even mortality has been spread widely since the early 1980s. One such episode occurred in 1991 over the tropical Pacific-Indian Ocean region. It was suggested that the main cause was due to high summer sea surface temperatures. However, sea surface temperature from the South China Sea did not support for that. Time series records of rare earth elements, trace element Al/Ca ratios, and microdomain images from corals collected in the South China Sea suggested that the coral mortality event was exacerbated by heavy ash fallout from the cataclysmic 1991 volcanic eruption of Mount Pinatubo in Philippines (ca. 1,300 km from the sampling site). It was suggested that the volcanic ash released acids and metals after falling to the ocean, causing reef degradation and coral mortality with other stressors. This study demonstrated that massive coral mortality could be exacerbated by distant volcanic eruption.

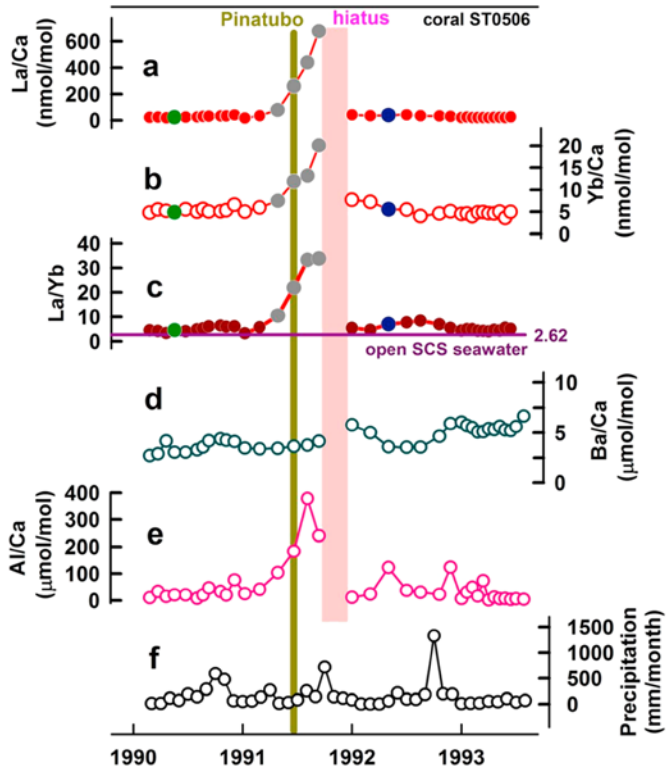

Figure: Monthly-to-bimonthly resolved coral ST0506 rare earth element records between CE 1990 and 1993. (a) La/Ca ratios, (b) Yb/Ca ratios, and (c) La/Yb ratios. The purple line shows La/Yb baseline values from an open South China Sea seawater station. (d) Ba/Ca ratios, (e) Al/Ca ratios, and (f) monthly instrumental precipitation from 1990 to 1993 (from Da Nang Weather Station). The pink bar indicates the duration of a coral growth hiatus. The dark yellow line denotes the climactic eruption of Pinatubo on 15 June 1991. The green, grey, and blue circles represent the layers corresponding to the rare earth element patterns.

Citation: Wu, C -C, Shen, C C*, Lo, L, Hsin, Y C, Yu, K, Chang, C C, Lam, D D, Chou, Y M, Liu Y, Pallister, J, Song, S -R., Chiang, H W, and Burr G S (2018), Pinatubo volcanic eruption exacerbated an abrupt coral mortality event in 1991 summer, Geophysical Research Letters, 45(22), 12396-12402, doi:10.1029/2018GL079529.

(2) Remote coral reef in the northern South China Sea recorded the anthropogenic nitrogen deposition signal

It is well known that the pollution-associated nitrogen is an important nutrient input in the coast of western Pacific Ocean. It has been suggested that open ocean would also be affected. This study used a coral core from Dongsha Atoll, a remote coral reef ecosystem, to show an observable decline in the $^{15}N/^{14}N$ of coral skeleton-bound organic matter. Such a result was due to the increase of anthropogenic atmospheric N deposition. The deposition of anthropogenic nitrogen began at the end of the 20th century, and this pathway supplied 20 ± 5% of the annual N input to the surface ocean in this region.

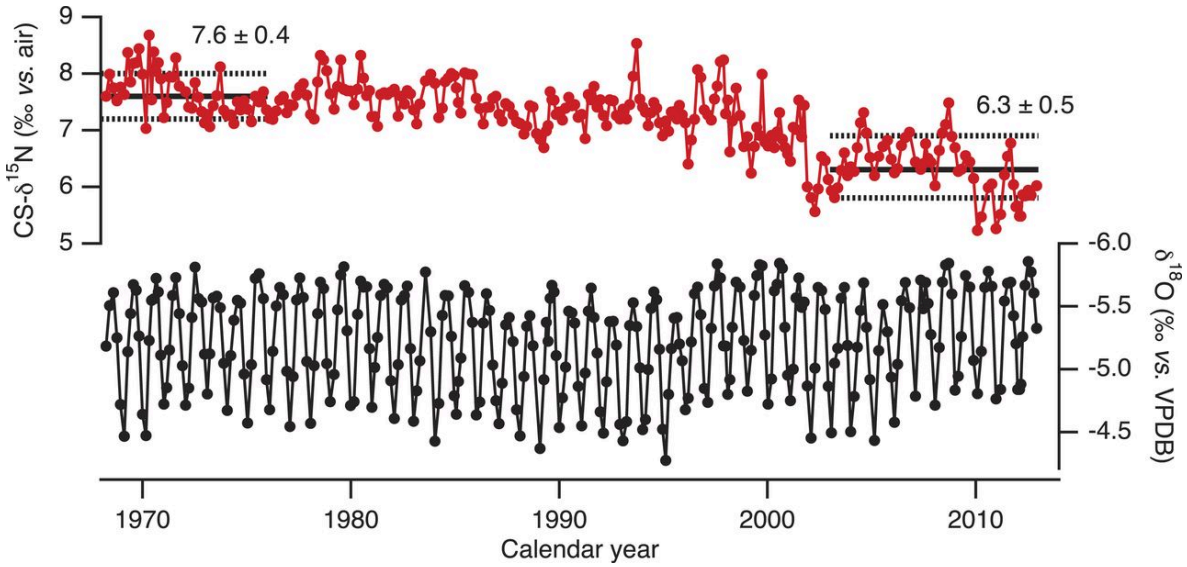

Figure
The 45-year records of CS-$\delta^{15}N$ and skeletal carbonate $\delta^{18}O$. CS-$\delta^{15}N$ declined across the record, with a 1.3‰ difference between the average $\delta^{15}N$ values from 1968–1977 and 2003–2012. The major decline in CS-$\delta^{15}N$ occurred in the 21st century. VPDB refers to Vienna Pee Dee Belemnite standard.

Citation: Ren, H, Chen, Y C, Wang, X T, Wong, G T F, Cohen, A L, DeCarlo, T M, Weigand, M A, Mii, H S, Sigman, D M (2017) 21st-century rise in anthropogenic nitrogen deposition on a remote coral reef, Science, 356(6339), 749-752, DOI: 10.1126/science.aal3869.

(3) Reduced ventilation of the oceans under warming might accelerate the deep-ocean acidification

Oceans worldwide are undergoing acidification due to the dissolution and penetration of anthropogenic CO_2 from the atmosphere. Generally, the rate of seawater acidification diminishes with increasing depth. Yet, the pH in the deep oceans could be reduced due to the slowdown of the thermohaline circulation (reduced ventilation) under the influence of global warming, as more organic material would decompose with a longer residence time. This study shows that deep waters in the Sea of Japan are undergoing reduced ventilation. Consequently, the acidification rate near the bottom of the Sea of Japan is 27% higher than that of the surface. As an oceanic microcosm with its

own deep- and bottom-water formations, the Sea of Japan provides an insight into how future warming might alter the deep-ocean acidification.

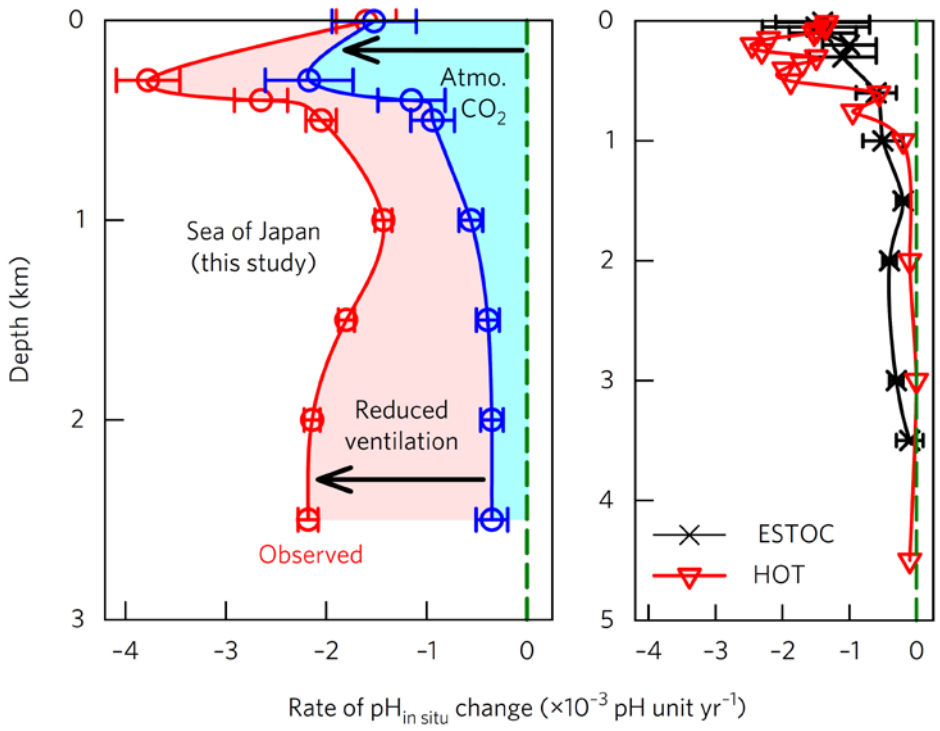

Figure
Rate of temporal changes of pH at various depths between 1965 and 2015. The arrows and the coloured regions represent the magnitudes of changes due to the increasing atmospheric CO_2 and reducing seawater ventilation. The blue circles show the rate of pH change due to increasing atmospheric CO_2, while the red circles show the results with additional considerations of the reduced seawater ventilation. The acidification rates at the ESTOC (taken from Santana-Casiano et al.2007, *Glob. Biogeochem. Cycle,* 21, GB1015) and HOT (from Dore et al. 2009, *Proc. Natl Acad. Sci. USA,* 106, 12235–12240) stations are shown in the right panel for comparison. The dashed lines show the zero rate of change of pH.

Citation: Chen, C T A, Lui, H K, Hsieh, C H, Yanagi, T, Kosugi, N, Ishii M. and Gong, G C (2017). Deep oceans may acidify faster than anticipated due to global warming, *Nature Climate Change*, 7, 890-894, DOI: 10.1038/s41558-017-0003-y.

2. Activities/main accomplishments in 2018 (projects, field campaigns, events, model and data intercomparisons, capacity building, international collaborations, contributions to int. assessments such as IPCC, interactions with policy makers or socio-economics circles, social sciences, and media).

3. Top 5 publications in 2018 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.

Wu, C -C, Shen, C C, Lo, L, Hsin, Y C, Yu, K, Chang, C C, Lam, D D, Chou, Y M, Liu Y, Pallister, J, Song, S -R., Chiang, H W, and Burr G S (2018), Pinatubo volcanic eruption exacerbated an abrupt coral mortality event in 1991 summer, *Geophysical Research Letters*, 45(22), 12396-12402, DOI:10.1029/2018GL079529.

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Chen, C T A, Lui, H K, Hsieh, C H, Yanagi, T, Kosugi, N, Ishii M. and Gong, G C (2017). Deep oceans may acidify faster than anticipated due to global warming, *Nature Climate Change*, 7, 890-894, DOI: 10.1038/s41558-017-0003-y.

Liao, W H and Ho, T Y (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, 123(9), 6207-6233, DOI:10.1029/2018JC014113.

Chen, H Y and Huang, S Z (2018) Effects of atmospheric dry deposition on external nitrogen supply and new production in the northern South China Sea. *Atmosphere, 9(10),* DOI:10.3390/atmos9100386

Wang, Y L, Wu, C. R. (2018) Discordant multi-decadal trend in the intensity of the Kuroshio along its path during 1993-2013. *Scientific Reports,* 8:14633, DOI: 10.1038/s41598-018-32843-y.

Huang, W J, Kao, K J, Liu, L L, Liao, C W, and Han, Y L (2018). An assessment of direct dissolved inorganic carbon injection to the coastal region: A model result. *Sustainability,* 10(4), 1174. DOI:10.3390/su10041174

4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2018? If yes, who? How did you engage?

PART 2 - Planned activities for 2019/2020 and 2021

1. Planned major field studies and collaborative laboratory and modelling studies, national and international (incl. all information possible, dates, locations, teams, work, etc.).

The Taiwan representative plans to join scientists related to SOLAS in Taiwan together, integrating individual teams from different disciplines, co-designing and proposing a multidisciplinary research project of SOLAS. The project is planned to submit to the Sustainable Development discipline of the Ministry of Science and Technology (MOST) of Taiwan before the end of 2019.

2. Events like conferences, workshops, meetings, schools, capacity building etc. (incl. all information possible).

The Taiwan representative plans to propose and chair a session for SOLAS in Taiwan in the Annual Ocean Meeting in Taiwan in May, 2020.

3. Funded national and international projects / activities underway.

The funding is expected to come mainly from the MOST, various universities and Academia Sinica of Taiwan, as well as different industry-academia cooperative research projects of the participants.

4. Plans / ideas for future projects, programmes, proposals national or international etc. (please indicate the funding agencies and potential submission dates).

Based on the current situation, the projects in 2020 plans to focus mainly in ocean acidification **(**Greenhouse gases and the oceans), fate of aerosol (Atmospheric deposition and ocean biogeochemistry), as well as popular science promotion (science and society). The project will try to meet the common interests and scopes of the MOST of Taiwan, SOLAS, and the Future Earth by Science and Technology Alliance for Global Sustainability.

5. Engagements with other international projects, organisations, programmes etc.

Comments