

## Report for the year 2022 and future activities

### **SOLAS Taiwan**

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

**First things first...Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?**

### **PART 1 - Activities from January 2022 to Jan/Feb 2023**

#### **1. Scientific highlight**

The equatorial upwelling brings nutrients and deeper cold water to the ocean surface, playing an important role in the marine ecosystems and the earth's climate. The annual equatorial upwelling cycle greatly impacts the background surface ocean temperature, deep convections, and the air-sea interactions. It is also important toward the cold tongue evolution, as well as changing marine ecosystem and climate variabilities. Therefore, understanding the changes in both long-term trend and the annual cycle of equatorial upwelling in a future warmer climate is essential to predict the changes in marine ecosystems and the earth's climate. The equatorial upwelling was reported to weaken in the equatorial Pacific, while it strengthened in the Atlantic under global warming.

This study explores the dynamics of the equatorial upwelling annual cycle under global warming using the Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations, showing an apparent weakening in the magnitude of the annual fluctuations in the entire equatorial Pacific. Such a result is robust among 19 chosen CMIP5 models. Generally, the meridional surface wind stress divergence weakens the Ekman upwelling. Meanwhile, the gradually smoothing inclination in the overall equatorial thermocline depth was responsible for weakening the wave upwelling. Consequently, the weakening of the wave upwelling in the east and the Ekman upwelling in the west jointly contributed to the gradual weakening of the equatorial Pacific upwelling annual cycle. The implication is that a continuous weakening of the annual upwelling cycle over the equatorial Pacific Ocean could likely affect the major climate phenomena variability with strong seasonal-locking characteristics by modifying the background strength at their peak phases in the future.

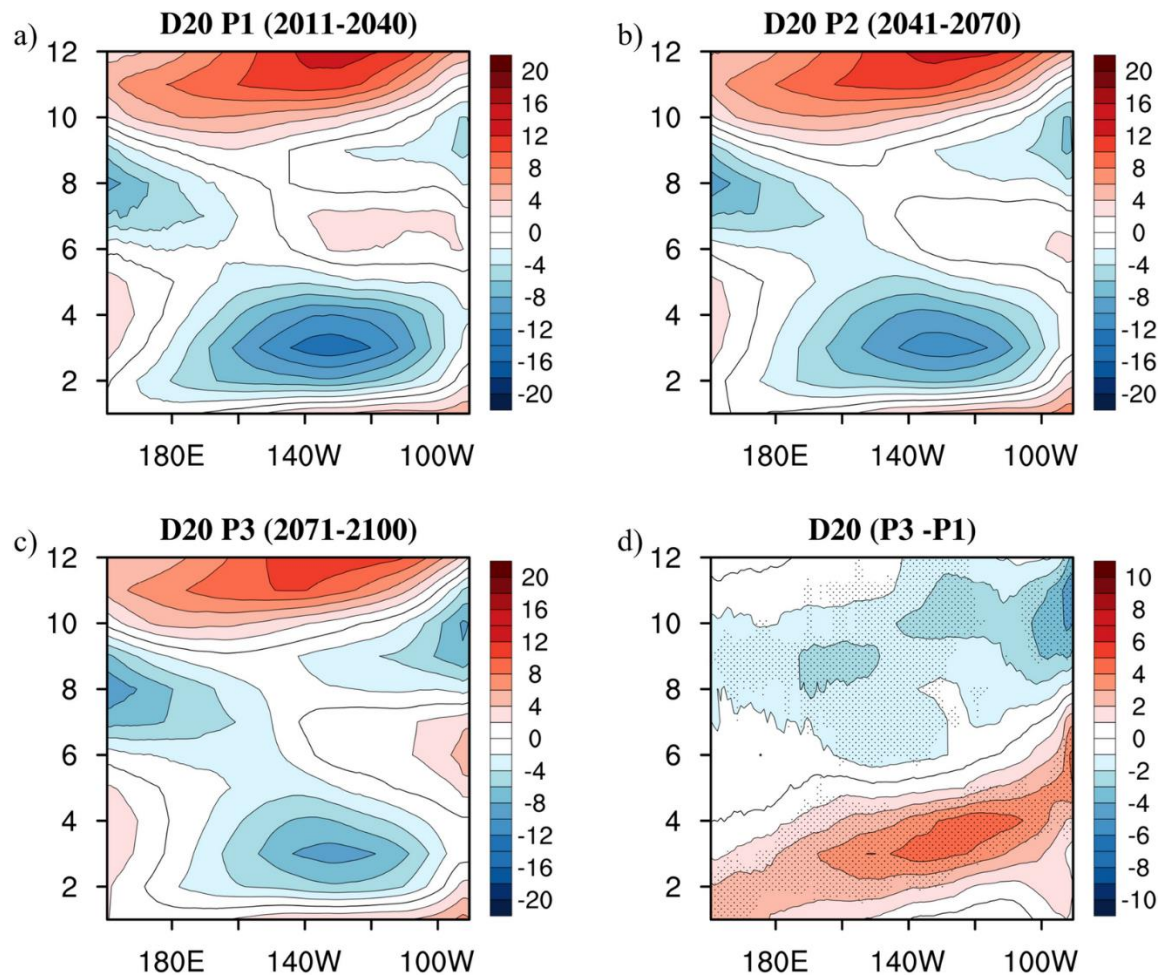


Figure: The equatorial Pacific annual cycles (averaged over 3°N–3°S) of the thermocline (meters) considering (a) P1 (2011-2040), (b) P2 (2041-2070), (c) P3 (2071-2100), and (d) the difference between P3 and P1. Black dots indicate locations where more than 70% of models producing the same sign of thermocline difference between present and future simulations.

Citation: L.C. Wang, T.L. Dao, J.Y. Yu (2022) Continued weakening of the equatorial Pacific upwelling annual cycle in CMIP5 future projections. *Scientific Reports*: 15595.

**2. Activities/main accomplishments in 2022 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).**

In 2022, 'Ocean Acidification, Deoxygenation and Freshening Research Center was established in the College of Marine Sciences at National Sun Yat-sen University. Biweekly or monthly meetings were held regularly to discuss the contents of a five-year-based integrated project related to the SOLAS. In January of 2023, a proposal covering chemistry, biology, geochemistry, and physics was submitted to investigate the driving forces of ocean acidification, deoxygenation and freshening of seawater around Taiwan.

**3. Top 5 publications in 2022 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.**

L.C. Wang, T.L. Dao, J.Y. Yu (2022) Continued weakening of the equatorial Pacific upwelling annual cycle in CMIP5 future projections. *Scientific Reports*: 15595.

C..F. You\*, P.Y. Lin, K.F. Huang, C.H. Chung Z. Liu (2022) Ocean acidification in the Western Pacific: Boron isotopic composition recorded in a tropical massive coral core from Lanyu Islet SE Taiwan. *Frontiers in Marine Science*, 9:877810

S.E. Tsao, P.Y. Shen, C.M. Tseng (2023) *Rapid increase of pCO<sub>2</sub> and seawater acidification along Kuroshio at the east edge of the East China Sea*, *Marine Pollution Bulletin*, 186:114471

Y.H. Tseng\*, J.H. Huang, H.C. Chen\* (2022) Improving the Predictability of Two Types of ENSO by the Characteristics of Extratropical Precursors, *Geophysical Research Letters*, 49(3): e2021GL097190.

J.Y. Hsu\*, M. Feng, S. Wijffels (2022) Rapid restratification of the ocean surface boundary layer during the suppressed phase of the MJO in austral spring, *Environmental Research Letter*, 17 (2) : 024031.

**4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2022? If yes, who? How did you engage?**

## **PART 2 - Planned activities for 2023 and 2024**

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

Ocean acidification, deoxygenation and freshening of tropical oceans are the central themes of the SOLAS Taiwan in the coming years. The investigators are from various departments, including National Sun Yat-sen University, National Cheng Kung University, National Chung Hsing University, National Yang Ming Chiao Tung University, National Pingtung University of Science and Technology, and the National Applied Research Laboratories.

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

Meetings will be held regularly at National Sun Yat-sen University in 2023, discussing the progress of the works on the theme topics. The Annual Ocean Science Meeting between 2023/5/2 and 5/4 will be good timing for SOLAS-related scientists to meet and discuss.

### **3. Funded national and international projects/activities underway.**

National Sun Yat-sen University has funded the research of ocean acidification, deoxygenation, and freshening since 2022. A five-year proposal is submitted to ask for additional funding. Part of the funding is expected to come mainly from the participants' different industry-academia cooperative research projects.

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

In the coming years, the theme topics will be focused mainly on the tropical oceans. The SOLAS Taiwan plans to build collaborations with Universities in Sri Lanka and Tuvalu. Hopefully, international projects could be generated after years.

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

Once the submitted proposal is funded, the SOLAS Taiwan will try to collaborate and work with the University of Delaware and Hokkaido University.

**Comments**