What is the impact of El Niño on the tropical radiation budget?

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1.Introduction

El Niño is part of the El Niño- Southern Oscillation (ENSO). It is the recurrent of the positive sea surface temperature anomaly occurs in the equatorial Pacific and can be detected using the Niño 3.4 Index [1] .

Radiation budget is the balance between the shortwave and the longwave flux. Clouds play an important role in influencing the budget and remains a challenge to modelling due to its complexity [2], [3].

2. Research Question

This study sought to explore over the El Niño cycle:

- To investigate the change in sea surface temperature pattern.
- To quantify the change in tropospheric temperature, the cloud fraction, and its implication to tropical radiation budget.

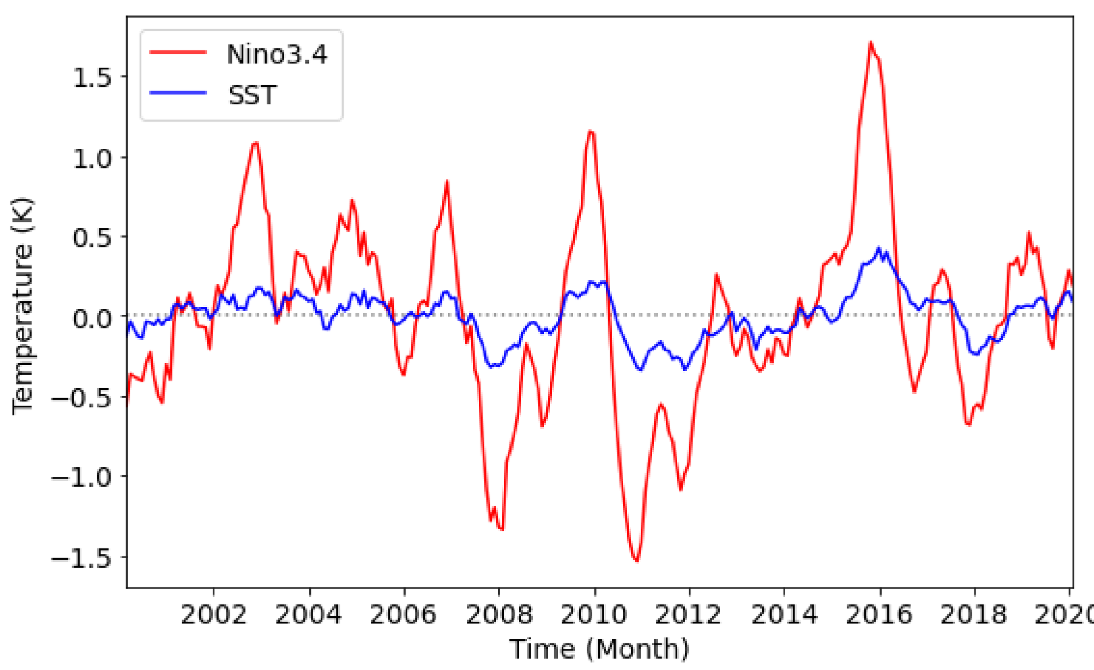

Fig.1: SST refers to the tropically-averaged sea surface temperature anomalies (30N- 30S). Nino 3.4 refer to the averaged sea surface temperature anomalies in the 5N- 5S, 170W- 120W region.

3. Method

The datasets used in the study are 20 years (2000-2020) monthly data from the satellite measurement and are re-gridded to 5-degree interval of latitude and longitude. The variables used are the temperature in [K] and cloud cover fraction in [%].
Lagged regression is used to investigate the evolution of variables over the ENSO cycle and this study focus on the time scale of 5 months. This is carried out by off-setting one of the variables by 5 months in the regression model.

4a. Results

Question: How does the sea surface temperature change during the El Niño cycle?
Result: Five months before El Niño, the warming is focus on the east Pacific. During and after El Niño, there is a significant warming in the central Pacific and in the West Pacific Warm Pool.

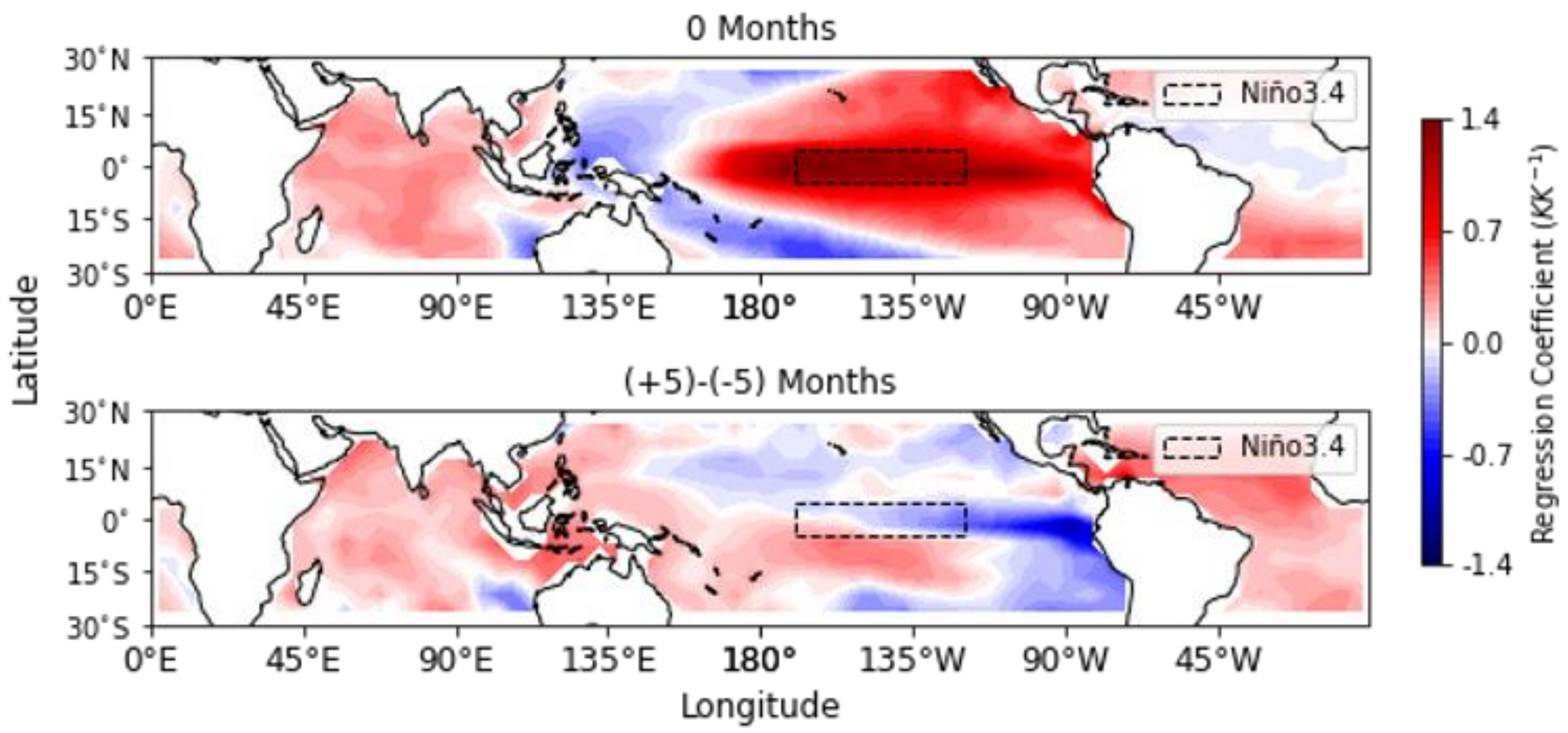

Fig.2: Showing regression coefficient of tropically-averaged sea surface temperature anomalies onto Niño 3.4 index. (a) shows regression coefficient during El Niño. (b) shows the difference between the lagged regression coefficient 5 months after (+5) and before (-5) El Niño.

4b. Results

Question: How does the cloud fraction and the tropospheric temperature change over the El Niño cycle?
Result: The atmosphere is heated from below and the warming is most significant during El Niño. The warming propagates through out the troposphere after. There are more clouds after El Niño and is shown most significantly in the low cloud cover.

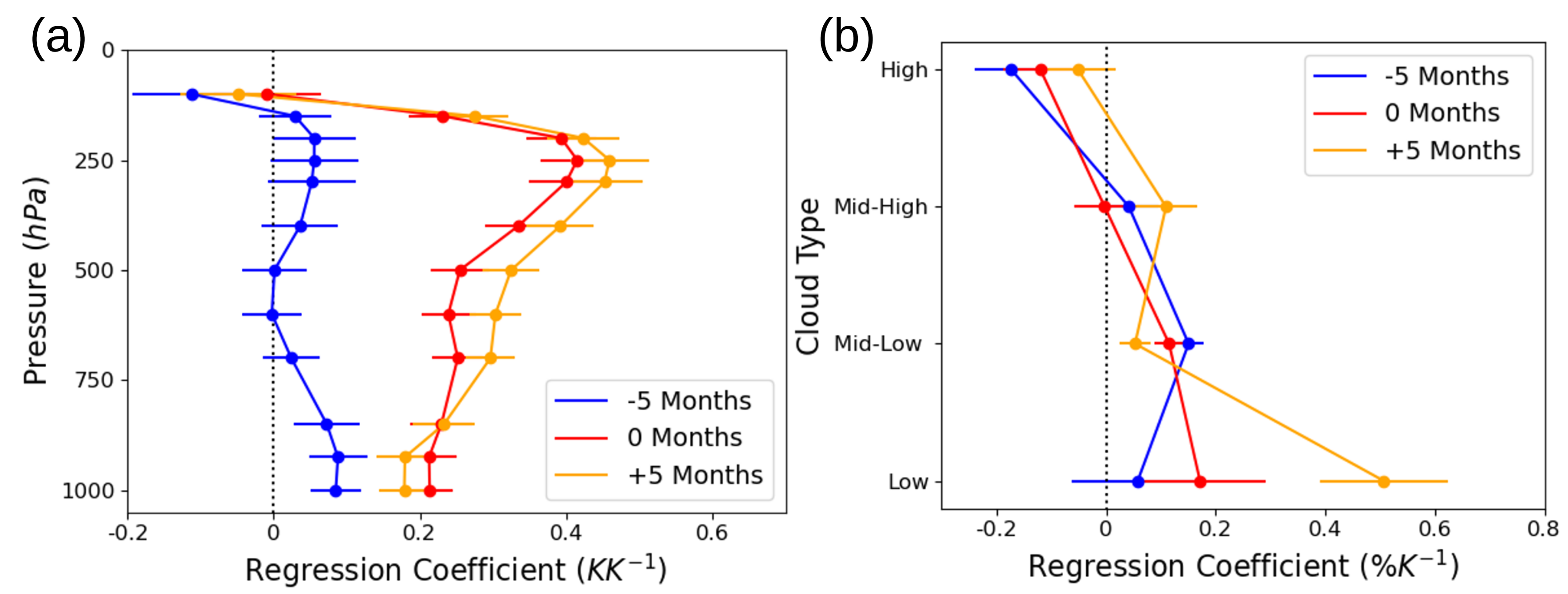

Fig.3: (a) shows the regression coefficient of tropically-averaged tropospheric temperature anomalies at different pressure levels. (b) shows the regression coefficient of percentage cloud cover anomalies with four cloud type. Low cloud fraction is adjusted assuming a random overlap.

5. Conclusion

Before El Niño, the initial warming **destabilises** the lower troposphere which promotes convection and the transportation of moisture from the boundary layer to the free troposphere. This leads to a reduction in the marine low clouds cover.

After El Niño, the warming propagates throughout and **restabilises** the troposphere. This discourages convection and the transportation of moisture to the free troposphere which enhances the formation of marine low clouds, thus having a **net cooling effect**.

6. Reference

[1] Wallace JM, Hobbs PV. Elsevier; (2006).

[2] Guilyardi, E., et al. *AGU Fall Meeting Abstracts*. (2013).

[3] Fueglistaler, S. *Geophysical Research Letters* 46.16 (2019).