Title

The influence of coastal upwelling front on the diurnal cycle of summer rainfall at the northern South China Sea

Members

Rui Shi[1], Qinbo Cai[1], Lingyu Dong[1], Xinyu Guo[2], & Dongxiao Wang[1]

Affiliations

1. State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, 164 West Xingang Road, Guangzhou 510301, China
2. Center for Marine Environmental Studies, Ehime University, 2-5 Bunkyo-cho, Matsuyama 790-8577, Japan

Aim

Combining the recent research progress from the ongoing projects founded by National Natural Science Foundation of China (NSFC, 2017-2020) and JSPS KAKENHI (2017-2020), make further understanding into the fine structure of coastal upwelling front and its impacts on the local weather at the northern South China Sea

Procedure

1. Analysis the annual variability of coastal upwelling front and its impact on the diurnal cycle of summer rainfall at Hainan Island in the northern South China Sea.
2. Revisit the historical hydrological observation results of coastal fronts at the study area.

Result

The modulation of coastal rainfall at Hainan by large-scale circulation and coastal upwelling is studied using observations and numerical modeling. Tropical Rainfall Measuring Mission data show that the monthly mean rainfall off southern Hainan was considerably higher in August 2010 than in August 2011. The main cause of this difference is an intensification of offshore rainfall from midnight to early morning. Compared with the multiyear (2000-2017) average field, reanalysis data shows that there is an apparent increase in atmospheric humidity in August 2010. During this time, a moderate El Niño was decaying and a new La Niña event was developing, so a significant adjustment of the large-scale circulation was observed in the western Pacific. The resulting anomalous onshore wind depresses the development of upwelling, leading to a relatively warm SST off the south coast of Hainan, which in turn enhances the land–sea thermal contrast and land breeze at night. Decreases in upwelling intensity and asymmetric intensification of nocturnal and daytime offshore rainfall are confirmed not only in the summer of 2010 but also in the summer of 2003. Numerical simulations using the Weather Research and Forecasting model verify that the enhanced land breeze ultimately leads to pronounced coastal rainfall off southern Hainan at night. The results indicate that localized surface convergence associated with the sea and

land breezes may be more important than the atmospheric humidity and convective instability in modulating the diurnal cycle of rainfall for tropical islands.

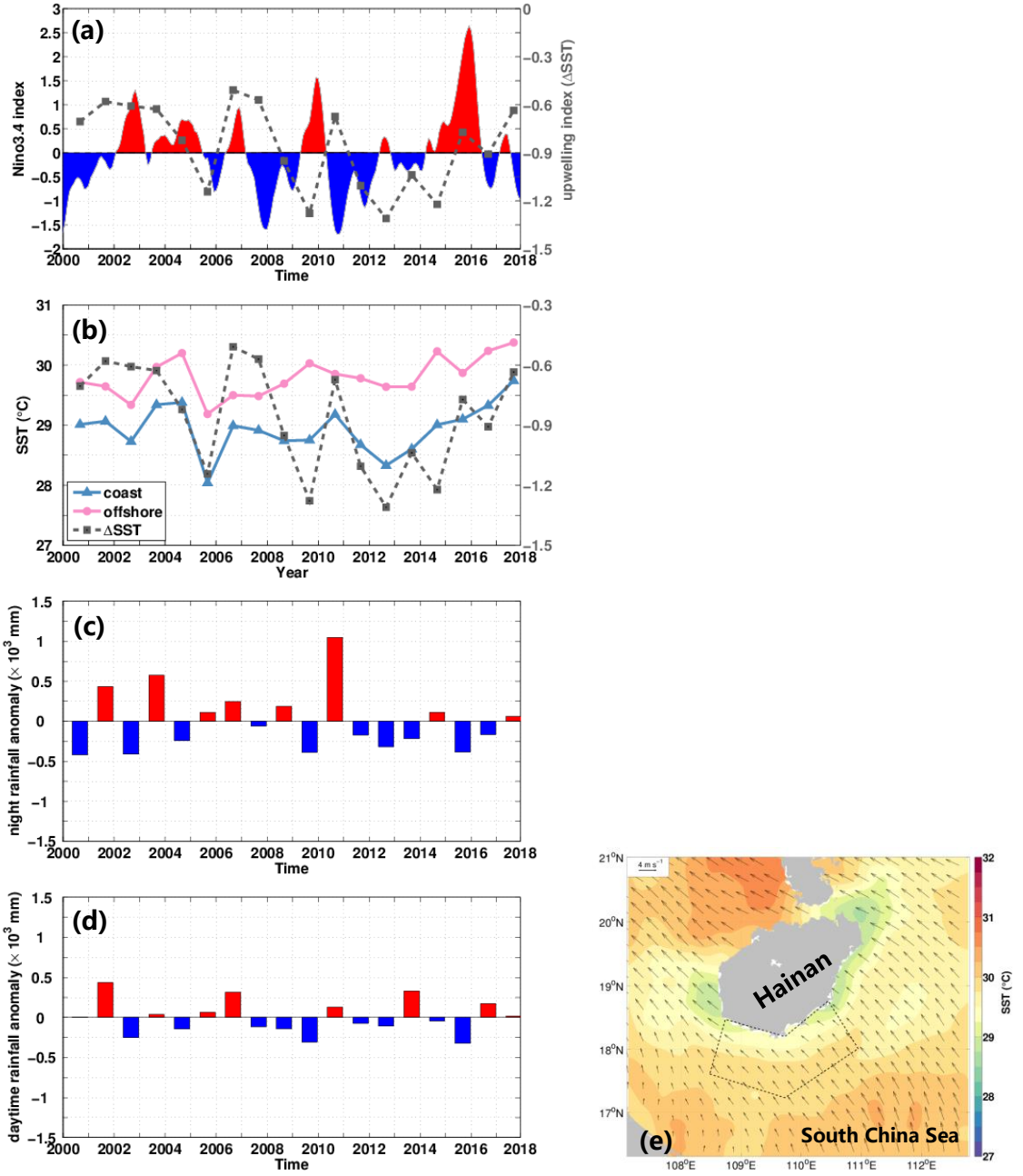

Figure 1 (a) Monthly Oceanic Niño Index (ONI) from NOAA (color shading) and upwelling index $\mathrm{UI}_{\Delta\mathrm{SST}}$ (gray dashed line) from 2000 to 2017; (b) upwelling index $\mathrm{UI}_{\Delta\mathrm{SST}}$ (gray dashed line), SST near coast (blue line), and SST of open ocean (magenta line) from 2000 to 2017; (c) anomalies in total nocturnal rainfall (0200–0800 LST) for August from 2000 to 2017; (d) as the same in (c) but for daytime rainfall (1400–2000 LST). $\mathrm{UI}_{\Delta\mathrm{SST}}$ is the upwelling index which is defined as the difference of SST between the area near the coastline and 100 km away from coastline. $\mathrm{UI}_{\Delta\mathrm{SST}}$ and total rainfall are calculated for the region shown in (e). Anomalies are calculated as the monthly mean minus the multiyear average from 2000 to 2017.

Publication

1. Rui Shi, Qinbo Cai, Lingyu Dong, Xinyu Guo, & Dongxiao Wang, 2019. Response of the diurnal cycle of summer rainfall to large-scale circulation and coastal upwelling at Hainan, South China, Journal of Geophysical Research: Atmospheres. (accepted, DOI: 10.1029/2018JD029528).

Perspectives in future

During my visiting, except for working on above article, I also worked on data analysis for an observation carried out in the Seto Inland Sea several years ago. I almost fixed the outline of a paper on this analysis. I will keep working on the observed different response of atmospheric boundary layer to the tidal front in summer and autumn at Seto Inland Sea, and publish the research article.