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Methodology and Development for the Thermal Stress Prediction Dataset of Coral Reefs in South China Sea Islands (1982–2100)

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Abstract: The thermal stress prediction dataset of coral reefs in the South China Sea Islands (1982–2100) has been developed based on the NOAA-AVHRR SST data from 1982–2009 and the simulated data by the CanESM2 model at CMIP5 for 2006–2100 in the RCP4.5 and RCP8.5 scenarios. The spatial patterns produced by chronic and acute thermal stress on the coral reefs of the South China Sea Islands were extracted by a linear regression method and the Degree Heating Weeks (DHW) index. The dataset includes (1) chronic thermal stress data, which consist of the summer SST rise rate (ºC/10a) observed by the AVHRR satellite from 1982–2009 and the summer SST rise rate (ºC/10a) simulated by the CanESM2 model for 2006–2100 in the RCP4.5 and RCP8.5 scenarios; (2) acute thermal stress data, which consist of the accumulated recovery time during which coral reefs have reduced ecosystem functions following acute thermal stress events for all reef cells according to AVHRR-observed SST data from 1982–2009, monthly DHW data, and the years in which reef locations start to experience bleaching conditions annually (annual bleaching year) for 2006–2100. The dataset is archived in .tif and .img data format, consisting of 6,862 data files with a data size of 57.5 MB (compressed to one single 12.0 MB file).

Keywords: chronic thermal stress; acute thermal stress; coral reef; South China Sea

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2020.09.07.V1.

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1 Introduction

Since the industrial revolution, the greenhouse effect caused by the large-scale burning of fossil fuels and other substances has caused the earth's surface temperature and ocean temperature to rise[1]. In recent years, the increase in ocean temperature has exceeded the corals survival temperature range of 25–29 ºC, and has led to worldwide large-scale coral bleaching and coral death[2–4]. In addition, rising ocean temperatures enhance the possibility of coral disease outbreaks and affect coral embryo survival, coral larvae attachment, coral growth, and calcification[5–9]. Fortunately, historical evidence shows that corals can migrate to more favorable environments to cope with climate change[10,11]. Under the global changes, the present and future temporal and spatial patterns of thermal stress on coral reefs can help reveal the evolution of thermal stress and predict areas of temporary refuge for coral reefs. This has great significance for the monitoring of coral reef ecosystem resilience and the construction of protected areas.

Abnormally high Sea Surface Temperatures (SSTs) in coral reef areas can be divided into chronic thermal stress and acute thermal stress. Chronic thermal stress refers to the long-term warming rate of seawater, which exhibits a certain pattern of change with latitude[12,13]. Acute thermal stress refers to an abnormal SST rise that occurs within a short period of time, quickly inducing coral bleaching and affecting ecosystem functions[2], such as the El Niño-Southern Oscillation (ENSO) event[14]. The ENSO event in 1997–1998 induced large-scale coral bleaching and caused 27% of the global coral reefs to disappear[14]. Additionally, thermal stress can affect the resilience of coral reef ecosystems. Field investigations have found that thermal stress events can increase the adaptability of corals to higher SSTs. Therefore, reefs located in areas of lower SST rises and larger SST fluctuations suffered less severe bleaching during the large-scale coral bleaching event of 2010 in Southeast Asia[15,16]. In addition, corals undergo rapid species selection after severe acute thermal stress events, and the survival of species with high resistance can improve the resilience of coral reef ecosystems[17,18].

More than 200 coral reefs are widely distributed around the South China Sea Islands, only a few of them were observed by weather stations. Therefore, SST data obtained by satellites still constitute the main source of data for analyzing the thermal stress intensity of coral reefs in the South China Sea Islands. The FilledSST data in the Coral Reef Anomaly Database (CoRTAD)[1] are generated by interpolating the mean day and night SST data from the AVHRR satellite, with weekly a spatial resolution of 4 km[19]. The historical SSTs simulated by the Canadian Earth System Model of the CCCma (CanESM2) for CMIP5 can also be used, as can the linear trend of the SST over the next 100 years as estimated by CanESM2 in the South China Sea[20,21]. This study adopts the widely used SST rise rate index and the Degree Heating Weeks (DHW) index to analyze the chronic and acute thermal stress intensities over the past 30 years and for the next 80 years for the coral reefs of the South China Sea Islands. Our analysis is based on the satellite-observed SST in the CoRTAD database for the period 1982–2009 and the SST data simulated by the CMIP5 CanESM2 model in the RCP4.5 and RCP8.5 scenarios for 2006–2100. The chronic thermal stress dataset includes the SST rise rate. The acute thermal stress dataset includes three types of data: DHW data, the accumulated recovery time in which coral reefs have reduced ecosystem functions, and the annual bleaching year of coral reefs.

[1] The Climate Data Guide: CoRTAD: Coral Reef Temperature Anomaly Database (SST). https://climatedataguide.ucar.edu/climate-data/cortad-coral-reef-temperature-anomaly-database-sst.

2 Metadata of the Dataset

The metadata of the Thermal stress prediction dataset of coral reefs in South China Sea Islands (1982–2100) is in Table 1[22].

Table 1 Metadata summary of the Thermal stress prediction dataset of coral reefs in South China Sea Islands (1982–2100)

Items	Description
Dataset full name	Thermal stress prediction dataset of coral reefs in South China Sea Islands (1982–2100)
Dataset short name	ThermalStressCoralReefs_SCSIs
Authors	Chen, Z. K. ABG-1644-2020, Guangxi Laboratory on the Study of Coral Reefs in the South China Sea, School of Marine Sciences, Guangxi University; Heilongjiang Agricultural Reclamation Survey, Design and Research Institute, 453699504@qq.com Su, F. Z. 0000-0003-4972-3595, State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, sufz@lreis.ac.cn Zuo, X. L. ABF-9658-2020, Guangxi Laboratory on the Study of Coral Reefs in the South China Sea, School of Marine Sciences, Guangxi University, zuoxl@gxu.edu.cn
Geographical region	2°N–27°N, 107°E–122°E Year 1982–2009, 2006–2100
Temporal resolution	monthly (2006–2100) Spatial resolution 4 km (1982–2009), 1°(2006–2100)
Data format	.tif, .img Data size 57.5 MB (12.0 MB in compression)
Data files	6,862 data files in two folders, compressed into one file (1) ChronicThermalStress folder. This contains the SST rise rate extracted by the linear regression method. There are 12 files in total, including three .tif data files. (2) AcuteThermalStress folder. This contains the DHW data, the accumulated recovery time data specifying how long coral reefs spend with reduced ecosystem functions, and the annual bleaching year data. There are five folders in total. The RCP4.5DHW_200603-210012 and the RCP8.5DHW_200603-210012 folders contain the DHW data. There are 6836 files in total, including 1138 .img data files in each folder. The AccumulatedRecoveryTime_1982-2009 folder contains the accumulated recovery time data. There are 4 files in total, including one .tif data file. The YearsStartBleachingAnnually_CanESM2_RCP4.5_2006-2100 and the YearsStartBleachingAnnually_CanESM2_RCP8.5_2006-2100 folders contain the annual bleaching year data. There are 10 files in total, including one .tif data file in each folder.
Foundations	National Natural Science Foundation of China (41801341); Guangxi Natural Science Foundation of China (2018JJB150030); Chinese Academy of Sciences (XDA13010400)
Computing environment	ArcGIS 10.2
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the ‘ten per cent principal’ should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[23]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref

3 Methods

3.1 Algorithm

3.1.1 Data Correction

The CoRTAD FilledSST data are accurate when compared with the SST data of coral locations at a depth of at least 10 m[19]. Therefore, no corrections are required for the FilledSST data. To ensure that the SST data output by the CanESM2 model are consistent with the observed SST data, the monthly "tos" (i.e., SST) data of r1i1p1, given by the CanESM2 model in the RCP4.5 and RCP8.5 scenarios, are resampled to 1°×1° resolution. The mean SST data for 2006–2011 output by the CanESM2 model is subtracted from the resampled data, and the meteorological mean data from NOAA's Optimum Interpolation Sea Surface Temperature (OISST) for 1982–2005 are then added to obtain the corrected data[3].

3.1.2 Chronic Thermal Stress

The linear regression method is used to estimate the summer SST rise rate (ºC/10a) of the South China Sea for the period 1982–2009 and in the RCP4.5 and RCP8.5 scenarios for 2006–2100. The calculations are based on the average SST of each pixel in summer (May–September) in each year.

3.1.3 Acute Thermal Stress

(1) DHW index:

The DHW data for 1982–2009 are calculated using Eq. (1) based on weekly SST data[24], and the DHW data for 2006–2100 are calculated using Eq. (2) based on monthly SST data[3].

$$DHW = \sum_{i=1}^{12} Hotspot_{\mathrm{w}} \,(Hotspot_{\mathrm{w}} \geqslant 1\,℃) \tag{1}$$

Or

$$DHW = \sum_{i=1}^{3} Hotspot_{M} \times 4.34 \tag{2}$$

$$Hotspot_{w}(Hotspot_{M}) = SST - MMM \tag{3}$$

where $Hotspot_w$ and $Hotspot_M$ denotes the climatological SST anomaly based on weekly resolution and monthly resolution, respectively. *MMM* was taken to be the average CoRTAD SST of the hottest week in this period; for 2006–2100, *MMM* was taken as the average OISST of the hottest month obtained using satellite data from 1982–2005 (http://www.esrl.noaa.gov/psd/).

(2) Recovery time in which coral reefs have reduced ecosystem functions (capacity to grow, repair, and reproduce) from 1982–2009:

$$t_c = \frac{c}{1 + ae^{-bx}} + d \tag{4}$$

where t_c is the estimated time of reduced ecosystem function following exposure to an annual maximum *DHW* of *x* for each year. Scientific evidence indicates that coral reefs that have experienced severe acute thermal stress events with coral mortality (*DHW* = 8 °C·weeks) require at least 5 years to return to their original status; 20 years is defined as the longest time required for shifting back to an unaltered state when coral mortality has caused the complete degradation of the reef ecosystem[25]. The values of the parameters *a* and *b* were calculated by an experimental curve-fitting procedure; *c* is the asymptotic value or maximum observed time for a coral reef to fully return to its original condition after bleaching caused massive mortality; $d = -c/1+a$.

The accumulated recovery time is calculated as the sum of recovery time in which coral reefs have reduced ecosystem functions in each coral reef pixel from 1982 to 2009.

(3) Annual bleaching year in 2006–2100:

The DHW threshold is set to six to indicate that coral bleaching will be occurred above this value, which is regarded as the optimal bleaching threshold for global coral reefs[26]. Based on the time series DHW data in the RCP4.5 and RCP8.5 scenarios for 2006–2100, the starting year in which bleaching events (>6DHWs) occurred for 10 consecutive years was extracted using the coral reef pixels; this is also defined as the annual bleaching year.

3.2 Technology Route

The methods used to generate the data described in this paper can be divided into the following major phases. First, the chronic thermal stress for 1982–2009 was calculated based on the linear regression method using the satellite-observed CoRTAD FilledSST data, and that for 2006–2100 was calculated under the RCP4.5 and RCP8.5 scenarios using the SST data output by the CanESM2 model. Second, the DHW data for 1982–2009 and 2006–2100 were calculated based on Equations (1)–(3). On this basis, an index for the accumulated recovery time during which coral reefs have reduced ecosystem functions was calculated for 1982–2009 based on Equation (4) and the annual bleaching year index under the RCP4.5 and RCP8.5 scenarios was calculated for 2006–2100. The four types of data described above constitute the thermal stress dataset for coral reefs in the South China Sea Islands. The data include the SST rise rate, DHW, the accumulated recovery time during which coral reefs have reduced ecosystem functions, and the annual bleaching year. The technical route is shown in Figure 1.

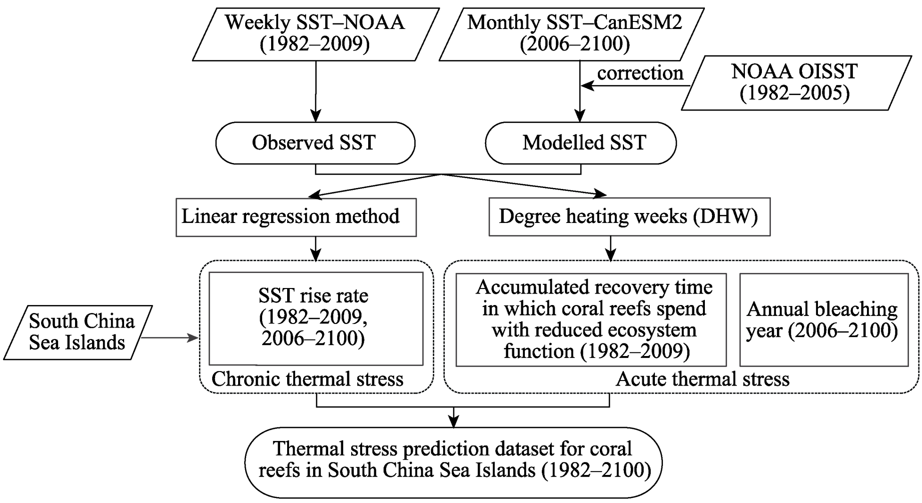

Figure 1 Technology route of the dataset development

4 Data Results and Validation

4.1 Dataset Composition

The "Thermal stress prediction dataset of coral reefs in South China Sea Islands (1982–2100)" includes the SST rise rate data (1982–2100), DHW data (2006–2100), the accumulated recovery time during which coral reefs have reduced ecosystem function data (1982–2009), and the annual bleaching year data (2006–2100). The name, data description, data format, number of files and data volume are listed in Table 2.

(1) Chronic thermal stress data. These data include the satellite-observed summer SST rise rate for 1982–2009 given by the linear regression method and the modeled summer SST rise rate under the RCP4.5 and RCP 8.5 scenarios for 2006–2100 according to the CanESM2 model, which are named SSTIncreasing_1982-2009.tif, SSTIncreasing_CanESM2_RCP4.5_2006-2100.tif and SSTIncreasing_CanESM2_RCP8.5_2006-2100.tif.

(2) Acute thermal stress data. These data include the accumulated recovery time during which coral reefs have reduced ecosystem functions, as calculated by the DHW index

(1982–2009), DHW data (2006–2100), and the annual bleaching years of coral reefs (2006–2100). The accumulated recovery time during which coral reefs have reduced ecosystem functions for 1982–2009 is named AccumulatedRecoveryTime_1982-2009.tif. Annual bleaching years calculated by the DHW data in the CanESM2 model under the RCP4.5 and RCP8.5 scenarios are named YearsStartBleachingAnnually_CanESM2_RCP4.5_2006-2100.tif and YearsStartBleachingAnnually_CanESM2_RCP8.5_2006-2100.tif. The DHW data of the coral reef pixels for the South China Sea Islands under the RCP4.5 and RCP8.5 scenarios for 2006–2100 are estimated based on the SST data output by the CanESM2 model, and they are stored in the RCP4.5DHW and RCP8.5DHW folders, which are named RCP45_yyyy_mmDHW.img and RCP85_yyyy_mmDHW.img respectively, where yyyy represents a four-digit year and mm represents a two-digit month.

Table 2 List of data files in the Thermal Stress Prediction Dataset of Coral Reefs in South China Sea Islands (1982–2100)

Composition Folder	Composition File and Naming method		Description	Format	Number of files	Data size
Chronic-Thermal-Stress	SSTIncreasing_1982-2009.tif		Satellite-observed SST rise rate(℃/10a) from 1982–2009	.tif	4	1.36 MB
	SSTIncreasing_CanESM2_ RCP4.5_2006-2100.tif		Modelled SST rise rate (℃/10a) in RCP4.5 scenario for 2006–2100 according to CanESM2 model	.tif	4	67 KB
	SSTIncreasing_CanESM2_ RCP8.5_2006-2100.tif		Modelled SST rise rate (℃/10a) in RCP8.5 scenario for 2006–2100 according to CanESM2 model	.tif	4	67 KB
AcuteThermal-Stress	AccumulatedRecoveryTime_1982-2009 folder	AccumulatedRecoveryTime_1982-2009.tif	Accumulated recovery time during which coral reefs have reduced ecosystem functions for 1982–2009 calculated based on DHW data	.tif	4	1.37 MB
	RCP4.5DHW_200603-210012 folder	RCP45_yyyy_ mmDHW.img	DHW data in RCP4.5 scenario for 2006–2100 predicted using SST data output by CanESM2 model (yyyy represents a four-digit year and mm represents a two-digit month)	.img	3,418	27.3 MB
	RCP8.5DHW_200603-210012 folder	RCP85_yyyy_ mmDHW.img	DHW data in RCP8.5 scenario for 2006–2100 predicted using SST data output by CanESM2 model (yyyy represents a four-digit year and mm represents a two-digit month)	.img	3,418	27.3 MB
	YearsStart-Bleach-ingAnnual-ly_CanESM2_ RCP4.5_2006-2100 folder	YearsStart-BleachingAnnually_ CanESM2_RCP4.5_2006-2100.tif	Annual bleaching year predicted for 2006–2100 in RCP4.5 scenario according to CanESM2 model	.tif	5	36 KB
	YearsStart-Bleach-ingAnnual-ly_CanESM2_ RCP8.5_2006-2100 folder	YearsStart-BleachingAnnually_ CanESM2_RCP8.5_2006-2100.tif	Annual bleaching year predicted for 2006–2100 in RCP8.5 scenario according to CanESM2 model	.tif	5	37 KB

4.2 Data Product

Description of the data product is in two parts covering chronic thermal stress and acute thermal stress, respectively. The chronic thermal stress includes the summer SST rise rate observed by satellites from 1982–2009, and simulated by the CanESM2 model in the RCP4.5 and RCP8.5 scenarios for 2006–2100. Acute thermal stress includes the accumulated recovery time during which coral reefs have reduced ecosystem functions estimated based on satellite-observed SSTs from 1982–2009 and the annual bleaching years of coral reefs based on the CanESM2 model in the RCP4.5 and RCP8.5 scenarios for 2006–2100. The DHW data based on the CanESM2 model in the RCP4.5 and RCP8.5 scenarios for 2006–2100 are only provided in the dataset, and this data product is not included.

4.2.1 Chronic Thermal Stress Data for 1982–2100

The satellite observed summer SST rise rate from 1982–2009 is higher in the northern South China Sea (>0.2 °C/10a), where the Xisha Islands and Dongsha Islands are located, than in the southern South China Sea (<0.2 °C/10a), where the Zhongsha Islands and Nansha Islands are located. The sea areas of the Dongsha Islands and the southeastern part of the Nansha Islands have the highest summer SST rise rates, at 0.3–0.4 °C/10a (Figure 2a).

The summer SST rise rate for 2006–2100, as simulated by the CMIP5 CanESM2 model in the RCP4.5 scenario, does not exceed 0.2 °C/10a in the sea area where the coral reefs of the South China Sea Islands are located. The sea area of the Nansha Islands has the highest summer SST rise rate of 0.16–0.20 °C/10a, with the summer SST rise rate of other coral reef sea areas ranging from 0.14–0.16 °C/10a (Figure 2b). In the RCP8.5 scenario, the summer SST rise rate in the sea areas of the coral reefs of the South China Sea Islands exceeds 0.2 °C/10a, ranging from 0.34–0.40 °C/10a. In particular, it is slightly higher (at 0.38–0.40 °C/10a) in the southwestern part of the Nansha Islands, and varies from 0.34–0.38 °C/10a at other coral reef sea areas (Figure 2c).

4.2.2 Acute Thermal Stress Data for 1982–2100

The satellite-observed acute thermal stress from 1982–2009 is most serious around the Dongsha Islands, Yitong Shoal, and Zhongnan Shoal of the Zhongsha Islands, and the accumulated recovery time during which coral reefs have reduced ecosystem functions is 20–30 years. The acute thermal stress in the northern, southeastern, and southernmost parts of the Nansha Islands is moderate, and the accumulated recovery time during which coral reefs have reduced ecosystem functions is 10–20 years. The acute thermal stress in other sea areas containing coral reefs is lower, and the accumulated recovery time is 0–10 years (Figure 3a).

The acute thermal stress intensity of the coral reefs in the South China Sea Islands under the RCP4.5 and RCP8.5 scenarios for 2006–2100, as simulated by the CMIP5 CanESM2 model, shows that the annual bleaching year in the southeast of the Nansha Islands occurs earlier than that of other coral reefs. In the RCP4.5 scenario, coral reefs with an annual bleaching year no later than the global average annual

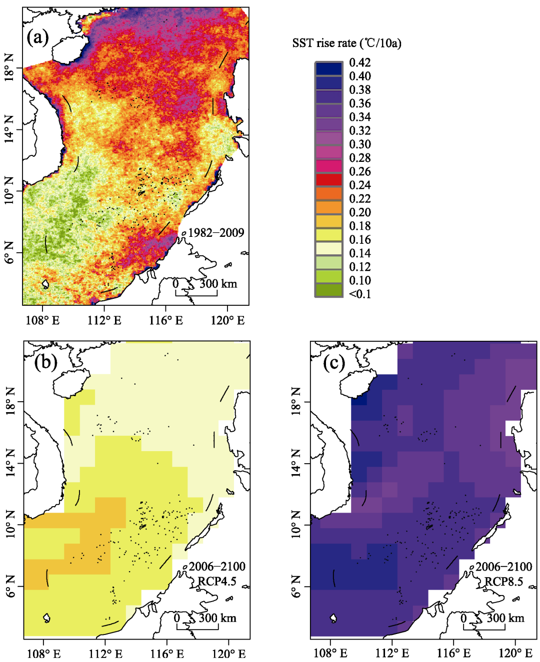

Figure 2 Chronic thermal stress intensity map in the South China Sea Islands for 1982–2100

(a. Summer SST rise rate observed by satellite from 1982–2009; b. Summer SST rise rate simulated by CMIP5 CanESM2 model in RCP4.5 scenario for 2006–2100; c. Summer SST rise rate simulated by CMIP5 CanESM2 model in RCP8.5 scenario for 2006–2100) bleaching year (Figure 3b, 2047, blue) are distributed in the central, southeast, and southern parts of the Nansha Islands (Figure 3b). In the RCP8.5 scenario, coral reefs with an annual bleaching year no later than the global average annual bleaching year (Figure 3c, 2040, blue) are distributed in the southeast and south of the Nansha Islands (Figure 3c).

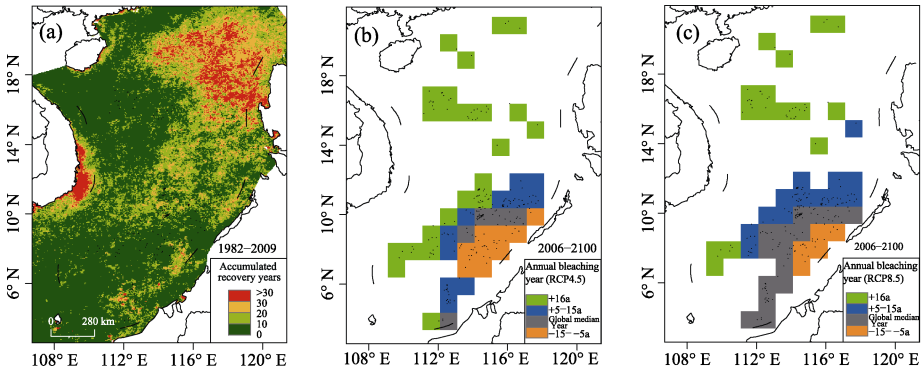

Figure 3 Acute thermal stress intensity map in the South China Sea Islands for 1982–2100

(a. Satellite-observed acute thermal stress on coral reefs from 1982–2009, expressed as the accumulated recovery time during which coral reefs have reduced ecosystem functions; b. acute thermal stress predicted by CanESM2 model in RCP4.5 scenario for 2006–2100, expressed as the annual bleaching year (the global average year in the figure is 2047); c. acute thermal stress predicted by CanESM2 model in RCP8.5 scenario for 2006–2100, expressed as the annual bleaching year (the global average year in the figure is 2040)

4.2.3 Data Accuracy Evaluation

The summer SST rise rate in the RCP4.5 and RCP8.5 scenarios for 2006–2100, as simulated by the CMIP5 CanESM2 model, shows a decreasing trend from low to high latitudes. This trend is consistent with the most significant ocean warming areas in the fifth assessment report of the IPCC, which are located in the tropical and subtropical sea areas of the northern hemisphere[27]. As the satellite-observed summer SST rise rate in the South China Sea from 1982–2009 may be affected by changes in SST over short period, such as ENSO events, the abnormal SST rise during the ENSO event is very important to the coral reef ecosystem. In the SST simulation, the model's ability to predict ENSO is vital to the coral reefs of the South China Sea Islands, as it influences the accuracy of future predictions of the intensity of chronic thermal stress and acute thermal stress. In addition, the accumulated recovery time during which coral reefs have reduced ecosystem functions and the annual bleaching year are comprehensive assessment indexes of ecosystem degradation based on the DHW data observed by satellite and simulated by the CanESM2 model. However, the accuracy of the two indexes varies at each coral reef, and is independent of the model accuracy. Different coral reefs, corals in different locations on the same reef, and different coral species at the same location have distinct abilities to resist thermal stress. Therefore, a comprehensive evaluation can be made according to the distribution and species of corals when these results are used in applications.

5 Discussion and Conclusion

The summer SST rise rate of the South China Sea Islands from 1982–2009 was 0.2°C/10a, significantly higher than the global SST rise rate of 0.11°C/10a from 1971–2010[1]. This indicates that the coral reefs of the South China Sea Islands are experiencing a high intensity of chronic thermal stress. At the same time, the summer SST rise rate of the South China Sea

Islands for 2006–2100, as simulated by the CanESM2 model, shows that these reefs will continue to face chronic thermal stress under the effects of global climate change, and the thermal stress intensity is related to the greenhouse gas emission scenario. According to the acute thermal stress results, the coral reefs near the Dongsha Islands experienced the highest acute thermal stress intensity from 1982–2009, while the Nansha Islands will face the highest and Dongsha Islands will face the lowest acute thermal stress intensity under the RCP4.5 and RCP8.5 scenarios for the period 2006–2100. This is of great significance to the restoration of coral reefs in the Dongsha Islands.

At present, there is a lack of available chronic thermal stress and acute thermal stress data for the coral reefs of the South China Sea Islands. The data publicly released in this article are the thermal stress data obtained by the AVHRR sensor from 1982–2009 and simulated by the CMIP5 CanESM2 model for 2006–2100. The thermal stress of coral reefs observed by satellite from 1982–2009 was mainly measured by the SST rise rate and the accumulated recovery time during which coral reefs spend have reduced ecosystem functions. The thermal stress of coral reefs simulated for 2006–2100 was measured by the SST rise rate and the annual bleaching year. These data have filled a gap in our knowledge of the thermal stress that has been experienced in recent years and will be faced in the future by coral reefs in the South China Sea Islands. The DHW data simulated by the CanESM2 model for 2006–2100 have also been publicly released. This dataset is suitable for determining the temporal and spatial evolution of thermal stress on coral reefs, predicting temporary refuges for thermal stress on coral reefs, assisting in monitoring the resilience of coral reef ecosystems, and serving coral reef management and protection area construction.

Author Contributions

Zuo, X. L., Yu, K. F., and Su, F. Z. contributed to the design of the research framework of the dataset, Zuo, X. L. and Chen, Z. K. contributed to the collecting and processing sea surface temperature data, as well as designing data models and algorithms; Zuo, X. L. contributed to the evaluating of the data. Chen, Z. K. contributed to the writing of the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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