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Method Article

A methodological approach to the air-sea energy fluxes data collection and analysis at the tropical coastal ocean

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ABSTRACT

The southern South China coastal oceans within the South East Asian region are much lacking in the perception of the surface energy budget and evaporation over the ocean waters in response to climatic changes. The eddy covariance method was used to measure the energy fluxes, microclimate variables, and surface water temperature from November 2015 to October 2017 at the Straits of Malacca, South China Sea; Pulau Pinang, Malaysia, situated at latitude 5°28′06″N, and longitude 100°12′01″E. This work focused on the methodological approach to the air-sea energy fluxes data collection and analysis. In this regard, the method applied for the direct measurements and analysis of energy fluxes and other meteorological parameters in the site is considered and reported.

- The paper summarizes the analysis of energy fluxes, microclimate variables, and surface water temperature data in a tropical coastal ocean station using the eddy covariance method.
- The methodological approach illustrates the method of analysis applied in this study which can be compared and used for similar studies in other places.
- The reproducible data analysis technique matches similar comparative methods such as Matlab and Python.

ARTICLE INFO

Method name: R statistical analysis of eddy covariance data

Keywords: R statistical software, Microclimate variables, Tropical coastal ocean, Energy fluxes, Eddy covariance

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Specifications table

Subject area	• Earth and Planetary Sciences • Environmental Science
More specific subject area	*Atmospheric Science*
Method name	*R statistical analysis of eddy covariance data*
Name and reference of original method	*R programming, eddy covariance processing using EddyPro version 6*
Resource availability	*Data and the data analysis programming codes*

Method details

Understanding of the exchange of energy at the Earth's surface is necessary for the improvement of regional weather forecast and global climate models. The main source of energy come from the Sun in the form of the global radiation symbolized by R_G. The amount of energy absorbed by the ocean is denoted as the net radiation (R_N). Part of the energy is stored inside the ocean as the residual, G. The ocean emitted some energies in the form of evaporation as latent heat (LE) and sensible heat (H) fluxes, to the atmosphere [1]. Assuming horizontal homogeneity, the surface energy balance, (Fig. 1) of ocean could be expressed as,

$$R_N = LE + H + G \quad (1)$$

where $R_N R_n$ and G are positive when the ocean absorbed the energy. However, LE and H are positive when the energy is released from the ocean. The unit of measurement of the fluxes is in W m^{-2} [2].

From Eq. (1), energy balance closure can be used to give an overview on the validity of surface layer measurements using the Eddy Covariance (EC) system of measurements. Though there is no perfect energy balance equation, it is understandable that energy balance at the Earth's surface could not be closed for many experimental datasets from varied surfaces, e.g., oceanic and terrestrial surfaces [1].

The ratio between LE and H fluxes could be computed to evaluate the energy balance closure (or EBC in the form of fraction or percentage). The absolute energy residual (R_{es}, W m^{-2}) was calculated using Eq. (2). R_{es} is added to (1) to get a complete balance equation for the energy as shown in (3) [1,2]. G is calculated from the integration of the changes in the underwater temperature profile with time.

$$R_{es} = R_N - H - LE - G \quad (2)$$

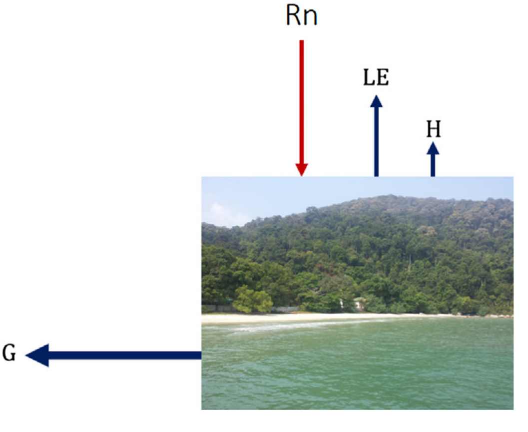

Fig. 1. The energy budget at the tropical coastal ocean station named as the Muka Head station, Pulau Pinang, Malaysia, in the southern South China Sea (5°28′6″N, 100°12′1″E).