Geophysical Research Abstracts
Vol. 13, EGU2011-8924-1, 2011
EGU General Assembly 2011

Impacts of ocean temperature bias along the southwestern African coast

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Fully coupled general circulation models (OAGCMs) unavoidably develop biases due to deficiencies in the physics, low resolution in the simulation of a few processes and forcing errors. Besides, each model component representing a different section of the Earth system may influence variables belonging to others. One of the most common errors affecting OAGCMs is an anomalously warm sea surface temperature (SST) along the coast of southwestern Africa, western South America and California. This bias can be improved by increasing the resolution of the atmospheric model, because of a more realistic simulation of surface winds which leads to enhanced representation of coastal upwelling.

This study makes use of the Community Climate System Model version 4 (CCSM4), whose sea temperature profile is restored along the coasts of southwestern Africa to correct the warm bias. The restoring extends up to the bottom of the ocean (60 levels) by using a combination of HadISST and Levitus datasets.

The annual SST anomaly in the area of the restoring drops from about 5°C to less than 1°C, and the whole Eastern Tropical Atlantic cools off. Moreover, the cold anomaly in the Caribbean is diminished, and remote effects are noticeable in the Indian Ocean and Western Pacific. The lower layers also experience a definite decrease of the intensity of the temperature biases.

The reduced evaporation caused by the colder ocean results in a decline of precipitation in the Gulf of Guinea, where the initial rainfall was much stronger than observation. On the other hand, the negative precipitation anomaly in northern equatorial Atlantic is less strong. Salinity patterns also benefit of the temperature restoring, with improvements noticeable in the whole Tropical Atlantic.

Wind anomalies become smaller along the equator, and surface runoff over central Africa is better represented thanks to the correction. Every season shows progresses after restoring temperature profiles, but during the summer improvements are more noticeable, especially for ocean variables.