Effect of Surface Heating over Indochina on the Summer Monsoon over South China

K. C. CHOW* AND JOHNNY C. L. CHAN
Laboratory for Atmospheric Research, Department of Physics & Materials Science
City University of Hong Kong, Hong Kong, China
*E-mail: apkchow@cityu.edu.hk

1. Introduction

The onset of the Asian summer monsoon is commonly considered to begin firstly over the region of the Bay of Bengal and Indochina. From climatology, a heating center can be found over the Indochina Peninsula in May when this first transition of summer monsoon occurs. This heating center is characterized by the presence of an anticyclone in the upper troposphere. While it appears that the development of the heating center over the Indochina region is important to the onset of the Southeast Asia monsoon, the factors that determine its establishment and location are not clearly known. Since the heat capacity of land is generally much less than that of the ocean, solar radiation reaching land surfaces can go back to the atmosphere quickly. Considering this point and the particular geographical location of Indochina, this study aims to examine the heating effect of the Indochina landmass in the development of the heating center and the onset of the summer monsoon over south China.

2. Model and experiment design

The model used in this study is a regional climate model developed by the China National Climate Center and the City University of Hong Kong, based on the NCAR RegCM2. The design of the experiments for the present study is to isolate the thermal effect of the Indochina landmass on the atmosphere, so that when comparing with the results of the control run (CTRL), the heating effect of the Indochina landmass can be estimated.

Two sensitivity experiments have been carried out for the year 1998. In the first experiment, the longwave radiation emission from the ground is set to be equal to that reaching the ground. For heat exchange at the surface, the surface sensible heating and evaporation are turned off. With such a setting, the presence of the Indochina landmass should have no particular effect on the atmosphere other than providing the drag. In another experiment (EXPIC_HT), the same setting on the longwave radiation and sensible heat flux is applied, but surface evaporative flux is allowed. The objective of the second experiment is to investigate the contribution of the surface heating (long wave radiation + sensible heating) over the Indochina landmass in the total heating effect.

3. Results

Results of the two experiments show that over Indochina, surface heating is much more significant on both the monsoon circulation and precipitation, compared with the effect of surface evaporation or latent heat. Some preliminary results of EXPIC_HT are as follows. The effect of surface heating of the Indochina landmass on the Asian summer monsoon is most significant in May while its effect is much less in June. Precipitation is reduced significantly in southern China and the western North Pacific (Fig. 1). In the lower troposphere, the heating effect induces an anomalous negative height field so that an anomalous cyclonic circulation occurs over eastern China and the western North Pacific (Fig. 2a). The result is a reduction in the strength of the southwest monsoon. The anomalous geopotential height fields show a northeastward shift as the monsoon season proceeds. The anomalous flow and geopotentail height fields in the upper troposphere are closely related to those in the lower troposphere but with reverse phases (Fig. 2b). However, the amplitudes of the anomalies are much larger than those in the lower troposphere. This indicates the sign of upper atmospheric heating and suggests that the corresponding atmospheric circulation in the lower troposphere may be driven by this heat source.

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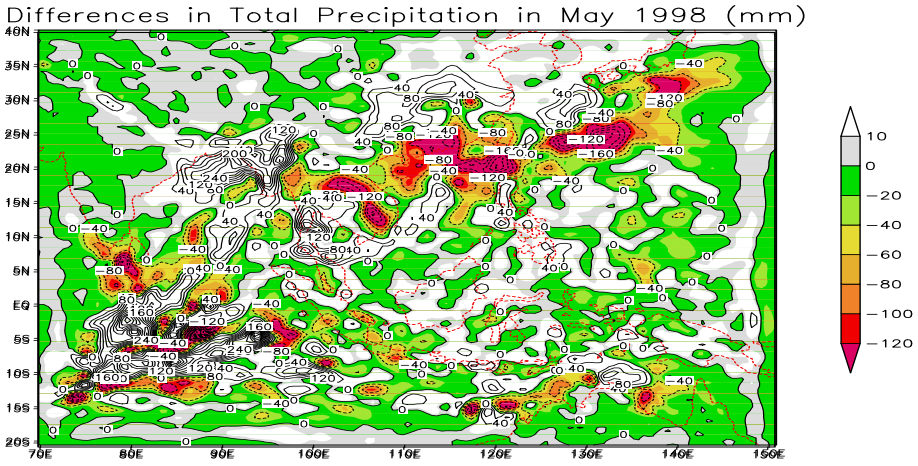
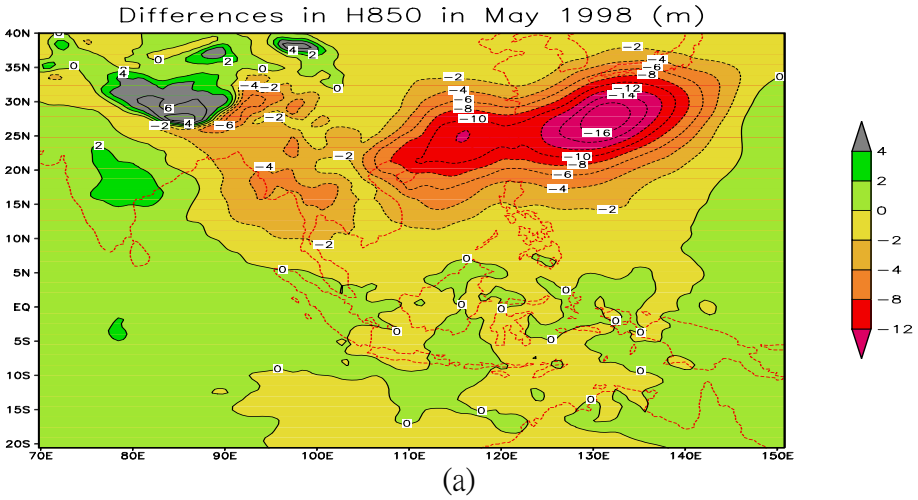
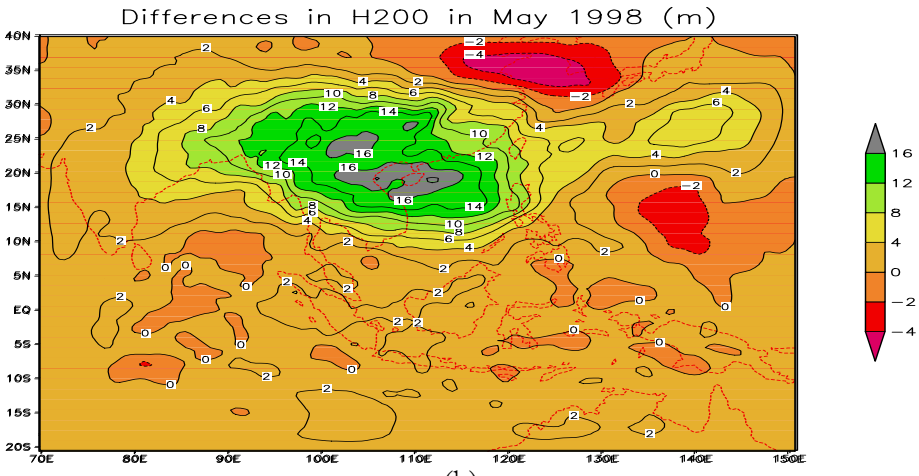


Fig. 1. Differences in precipitation (EXPIC_HT – CTRL) for May 1998. Unit: mm.



(a)



(b)

Fig. 2. As in Fig. 1 except for geopotential heights at (a) 850 hPa (b) 200 hPa. Unit: gpm.