Sci. Bull. (2016) 61(2):178–184
DOI 10.1007/s11434-015-0967-9

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Article

Earth Sciences

The Eastern China flood of June 2015 and its causes

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Received: 8 October 2015 / Revised: 18 November 2015 / Accepted: 19 November 2015 / Published online: 16 January 2016

Abstract Two record-breaking rainfalls in late June of 2015 led to widespread flooding in Eastern China, especially over the Yangtze River Delta, and this in turn led to huge economic losses. Analysis suggests that the El Niño-like sea surface temperature pattern during that month facilitated an intensified and southwestward-shifted western Pacific subtropical high and enhanced water vapor convergence along the Meiyu front, which provided a favorable environment for the occurrence of heavy rainfall over Eastern China. Meanwhile, two midlatitude troughs were successively formed over East Asia in the second half of the month as a consequence of the downstream energy dispersions of two midlatitude blockings. These configurations facilitated the southward intrusion of the extratropical high potential vorticity toward the Meiyu front. In this way, the ascent was enhanced along the Meiyu front over Eastern China, and the occurrence of heavy rainfalls was triggered. Moreover, a tropical intraseasonal active convection propagated northward and also contributed constructively to the heavy rainfall.

Electronic supplementary material The online version of this article (doi:10.1007/s11434-015-0967-9) contains supplementary material, which is available to authorized users.

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Keywords Flooding · El Niño · Blocking · Potential vorticity · Tropical–extratropical interaction

1 Introduction

Eastern China is the most developed and densely populated region of China. It usually receives its major rainfall from June to August when the East Asian summer monsoon (EASM) prevails [1]. This is particularly the case for the middle and lower reaches of the Yangtze River valley where the Meiyu front is located. In June of 2015, successive heavy rainfalls were observed in Eastern China, especially over the Yangtze River Delta (Figs. 1, 2), causing widespread flooding and huge economic losses in the second half of the month. According to statistics from the Ministry of Civil Affairs, 46,600 houses collapsed and 5,380,000 people suffered from the hazard in Eastern China during the period 21–30 June alone. Lake Tai, the biggest lake in the Yangtze River Delta, exceeded its warning water level by 0.06 m on 29 June, which was the first such occurrence since 2012. Many cities (such as Shanghai, Nanjing) experienced severe city waterlogging. Sixty-nine lines of the China Railway High-speed were canceled, and more were delayed during the heavy rainfall periods.

The variability of Eastern China's summer rainfall is controlled by the EASM and influenced by both tropical and extratropical factors [2–4]. On one hand, suppressed convections over the western North Pacific can excite Gill-type anticyclonic Rossby wave response [5, 6] and lead to the intensification and westward extension of the western Pacific subtropical high, which could result in enhanced water vapor convergence and rainfall along the Meiyu front [7, 8]. On the other hand, the blocking- or wave-like patterns over the mid- and high latitudes often induce southward intrusion of cold air toward the Meiyu front, which could facilitate

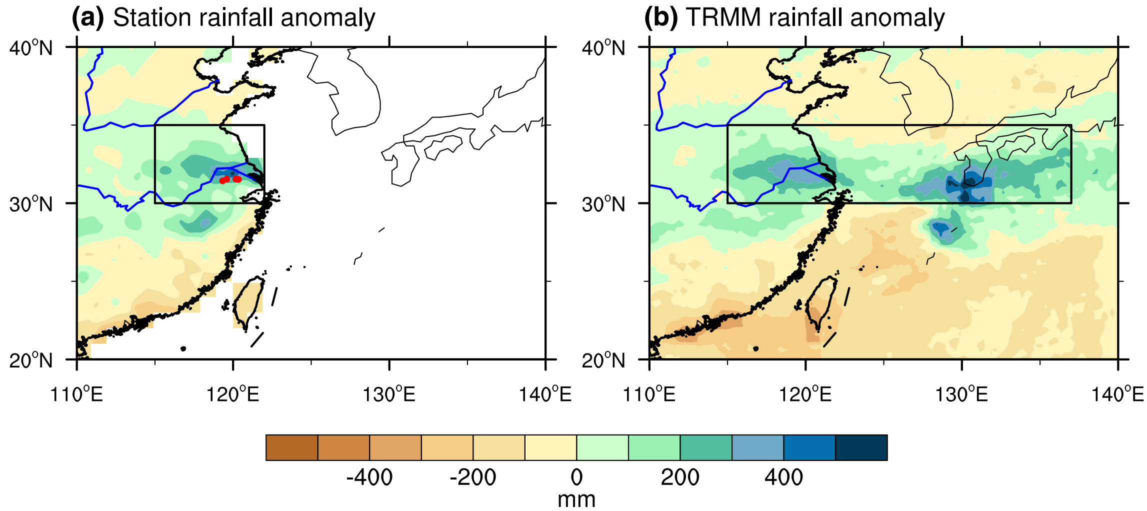

Fig. 1 Rainfall anomalies in June 2015 based on **a** station data and **b** TRMM data. The climatology is defined as the average of 1961–2014 for (**a**) and 1998–2014 for (**b**). Rectangles in (**a**) and (**b**) indicate the regions based on which Fig. 2a, b are calculated, respectively. Red dots in (**a**) indicate the location of four stations shown in Fig. 2c–f

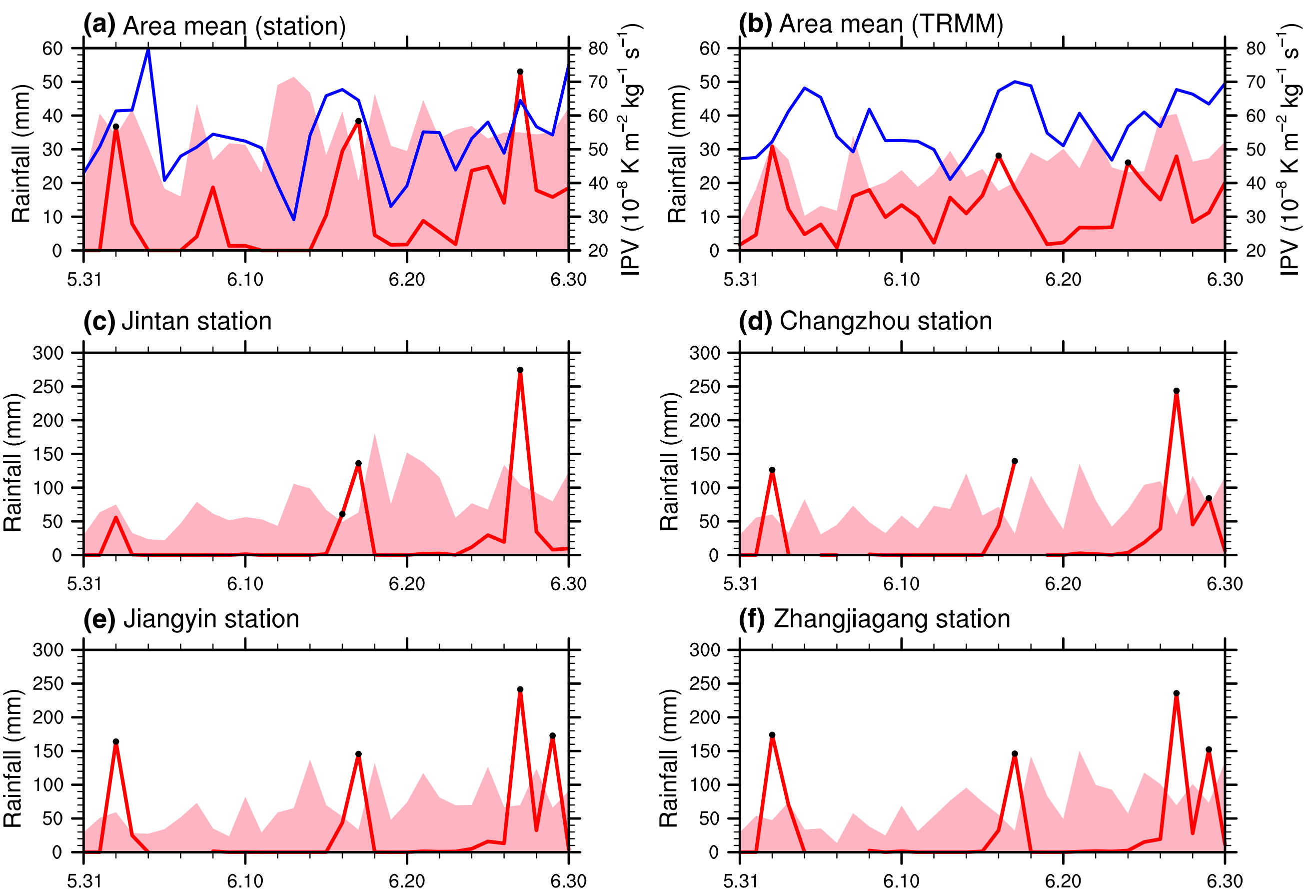

Fig. 2 The time series of daily mean rainfall in June 2015 (red line) and the daily historical maximum rainfall in June (shading) based on **a** station data (1961–2015) over the region (115°–122°E, 30°–35°N, indicated with a rectangle in Fig. 1a) and **b** TRMM data (1998–2015) over the region (115°–137°E, 30°–35°N, indicated with a rectangle in Fig. 1b). **c**–**f** are the same as (**a**), but based on four single stations indicated with dots in Fig. 1a. Dots indicate that the rainfall exceeds the historical maximum of the corresponding date. The blue lines in (**a**) and (**b**) denote the IPV averaged over the same region as rainfall at the 310 K level