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# AT THE SAME TIME AS THE RUSSIA HEAT ...

**BBC** Mobile

## NEWS SOUTH ASIA

1 August 2010 Last updated at 03:17 ET

### Pakistan flood death toll 'passes 1,100'

The worst monsoon floods in living memory have killed 1,100 people and affected one million in north-west Pakistan, officials have said.

**BBC** Mobile

## NEWS SOUTH ASIA

6 August 2010 Last updated at 08:33 ET

### Pakistan's flooding sweeps south

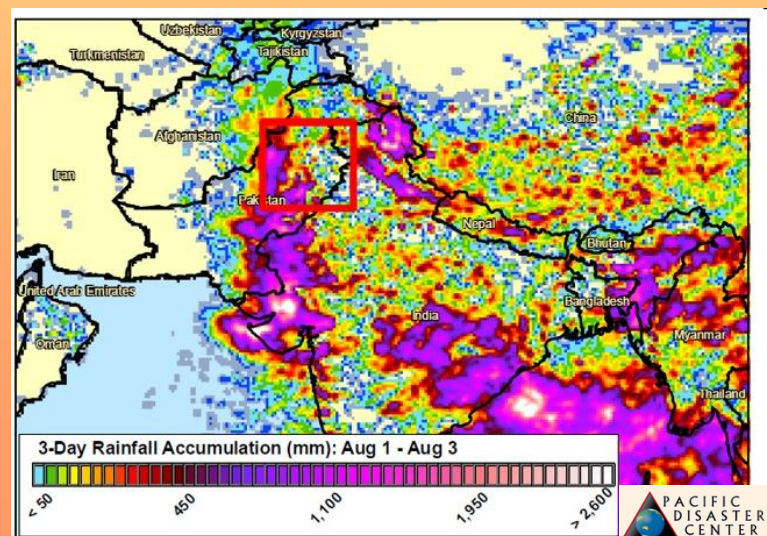
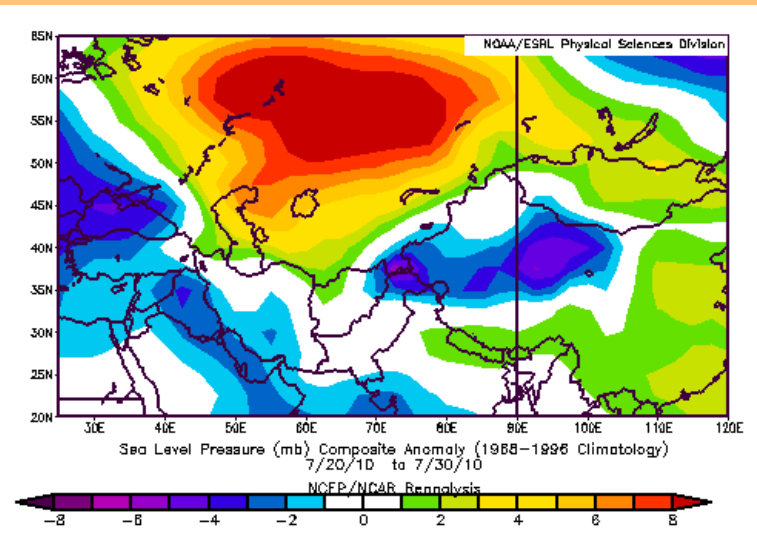
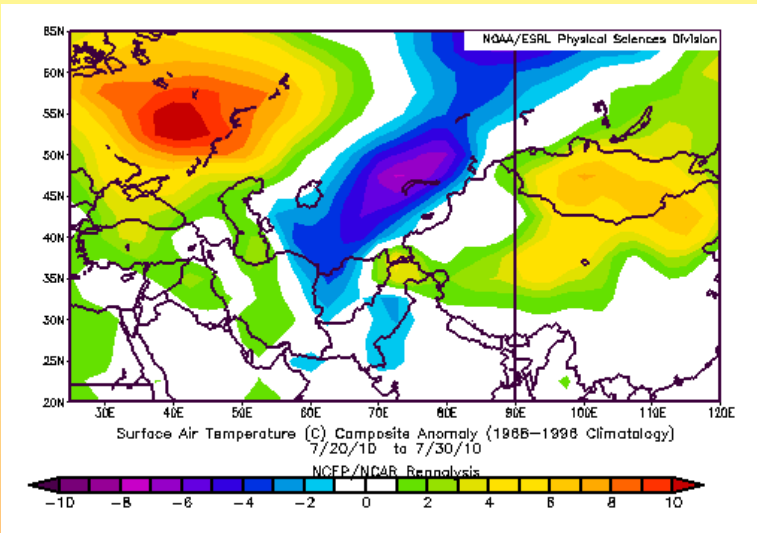
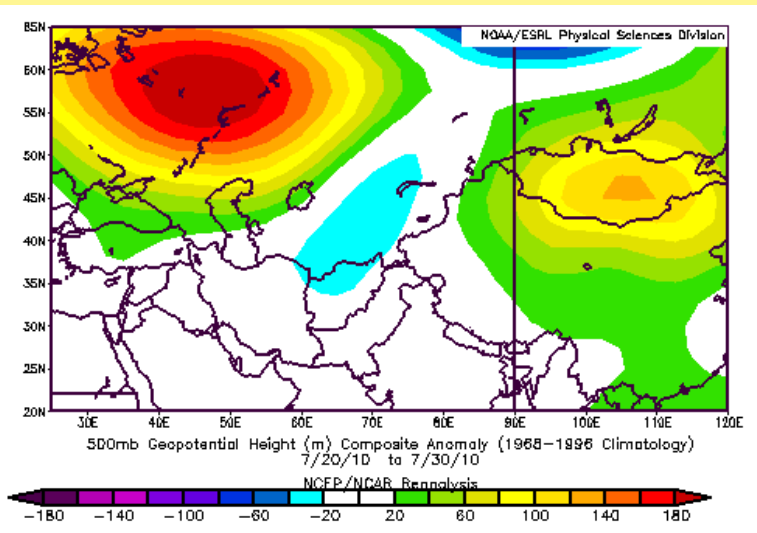
The worst monsoon rains in 80 years are continuing to sweep from the north-west to south and central Pakistan.

Rivers in Sindh province, home to Karachi, Pakistan's biggest city and business hub, are bursting their banks.

Pakistani authorities have evacuated 500,000 people in 11 districts of Sindh and issued warnings to people in low-lying areas of the Indus river

Flooding has submerged whole villages in the past week, killing about 1,600 people and affecting another 4.5m.

# PAKISTAN FLOODS



# Anomalous Atmospheric Events Leading to the Summer 2010 Floods in Pakistan

By R. A. Houze, Jr.<sup>1</sup>, K. L. Rasmussen, S. Medina, S. R. Brodzik, and U. Romatschke

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The development of a highly anomalous pressure pattern brought rainstorms of a type that normally occur in the region of Bangladesh into the arid mountainous region of Pakistan.

Submitted to

*Bulletin of the American Meteorological Society*

September 2010, revised November 2010, revised December 2010

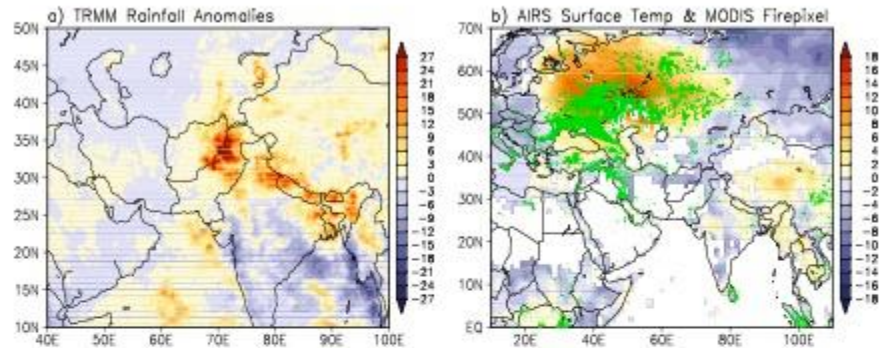


# Russia Heat Wave and Pakistan Flood, 2010: Teleconnection of Hydrometeorologic Extremes

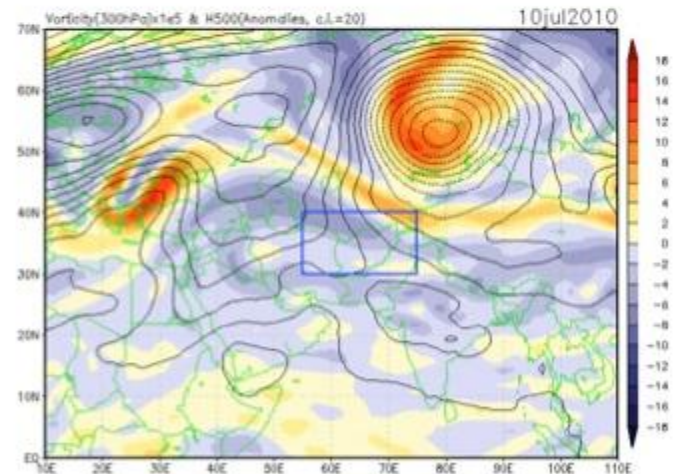
William Lau, and Kyu-Myong Kim, NASA GSFC, Code 613.2

The two record setting hydrometeorologic extreme events during summer 2010, *i.e.*, the Russian heat wave/wildfires and Pakistan flood occurred almost contemporaneously. A recent study (Lau and Kim 2011) shows that these two seemingly unrelated events were indeed physically related. The torrential rain that caused the Pakistan flood was not an isolated event, but rather coupled to excess rain over the Himalaya foothill, and reduced rain over the Bay of Bengal and southern India (Fig. 1a). The intense heat wave and wildfires in Russia (Fig. 1b) was caused by a strong and prolonged atmospheric blocking event. The blocking initiated a surface-to-mid-troposphere high pressure system and a mid-to-upper level Rossby wave train propagating eastward and southeastward. Vorticity perturbations in the leading edge of the trough was instrumental in triggering of torrential rain over northern Pakistan.

Approximately 24-48 hours before the onset of heavy rain events over northern Pakistan (July 19, July 27, August 3), an upper-level V-shaped positive (cyclonic) vorticity filament formed at the southeastern edge of the 500 hPa anticyclone, entering the target region from the north (Fig. 2). The upper level vorticity perturbations triggered upward motion ahead (to the east), leading to the development of subtropical mid-tropospheric cyclones (MTC). The vertical motion associated with the MTC pumped moisture from the Bay of Bengal, and the northern Arabian Sea, feeding the extreme rainfall events over northern Pakistan.



**Figure 1:** a) TRMM rainfall anomaly ( $\text{mm day}^{-1}$ ), b) AIRS surface temperature ( $^{\circ}\text{C}$ ) and MODIS fire pixels (green dots) during July 25 – August 8, 2010.



**Figure 2:** The movie shows the daily evolution of MERRA 300hPa vorticity (shading,  $10^{-6} \text{ s}^{-1}$ ) and 500 hPa geopotential height (contour, with 20 m interval) anomalies during, July 10 – August 10, 2010. The blue box indicates the target region over northern Pakistan and adjacent regions.