Heavy Rains and Historic Flooding over Pakistan in Late July 2010: Synoptic Conditions and Physical Mechanisms

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Introduction

Historic Flooding Over Pakistan

• Widespread extremely heavy rains (> 200 mm) and historic flooding occurred in the Indus River basin throughout Pakistan during 24–31 July 2010
• Heaviest rains fell on 28–29 July, where many stations in the northern provinces and tribal areas received over 200 mm of precipitation
• The high-impact flooding affected nearly 17 million people, resulted in over 1500 fatalities, and left over 4 million people without homes

Synoptic Analysis

Large-Scale Overview

• High-latitude blocking over eastern Europe and western Asia, responsible for producing record heat over Russia, helped anchor an anomalously deep trough northwest of Pakistan throughout much of June and July (Figs. 6 and 8)
• Downstream amplification contributed to ridge building over the Tibetan Plateau during 20–31 July (Figs. 6 and 8)
• Anomalous low-level southwesterly upslope flow over northern India and eastern Pakistan was prevalent during 20–31 July (Figs. 9–10)

Subsynoptic-Scale Analysis

• Subsynoptic-scale transient disturbances helped reinforce the Himalayas, south-central India, and Bay of Bengal stronger SE upslope flow in NE India and Pakistan

Historical Comparison

• TRMM data was used to compute the daily area-average precipitation over northern Pakistan for June–August 1998–2010 (Fig. 17)
• The top 2% wettest days (> 20 mm of area-average rainfall) over northern Pakistan during 1998–2010 were selected for composite analysis
• Composite 200-hPa winds and precipitable water show that low-level weak upslope flow over India and E Pakistan (Fig. 18)

Ensemble Prediction

• ECMWF EPS initialized 00Z/24 indicated 50% (10%) probabilities of > 50 mm (100 mm) of rainfall over N Pakistan during days 4–6
• Probabilities for > 50 and 100 mm of rainfall over N Pakistan increased markedly at shorter lead times (i.e., the 00Z/26 and 00Z/28 runs) (Figs. 20, 21)
• Note that the “wettest” EPS members from 00Z/24 run are compared in Fig. 22

Data Sources

• 2.5° NCEP/NCAR Reanalysis (for composites)
• 1.0° GFS Analyses (for synoptic analysis)
• TRMM rainfall data
• NCDC GIBBS satellite archive
• ECMWF ensemble prediction system (EPS) from TIGGE archive
• 50 members + control run
• Spectral truncation of T639 (~32 km resolution)
• 62 vertical levels

Source: http://www.geographicguide.net/asia/pakistan.htm
Source: NASA Earth Observatory
Source: www.esrl.noaa.gov/thomas.galarneau
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