Monitoring Intense Thunderstorms in the Hindu-Kush Himalayan Region

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Abstract. Some of the most intense thunderstorms on the planet routinely occur in the Hindu-Kush Himalaya region (HKH) region—where many government organizations lack the capacity needed to predict, observe and effectively respond to the threats and hazards associated with high impact convective weather. This project combines innovative numerical weather prediction, satellite-based precipitation and land imagery techniques into a high impact weather assessment toolkit (HIWAT) that will build the capabilities of national meteorological departments and other weather sensitive agencies in the HKH region to assess the potential threats and impacts of high impact convective weather.

Intense Thunderstorm Activity in the HKH Region

Annual climatology of large hail detected with AMSR-E
(Adapted from Cecil & Blankenship 2012)

IMAPCTs:
• Tornadoes have resulted in over 9,000 fatalities in Bangladesh during the 20th century (Bikos et al. 2016). A tornado in 1989 caused 1,500 deaths and another in 1996 caused over 700 deaths.
• A hailstorm over Kamchatka Russia in 1988 resulted in 72 deaths.
• Lightning in 1995 struck a Pakistani village killing 35 (Holik 2010), and a 2015 windstorm in Peshawar killed 25.
• Commercial production of cherry peppers in Bhutan in 2016 was foiled by a hailstorm.
• Flash flooding and resultant landslides killed over 100 people in Nepal during monsoonal rain storms of 2016.

Objectives:
• Develop a conversion allowing ensemble type modeling system over the HKH region for an end-user with very limited computational resources.
• Provide an observational means for assessing thunderstorm hazards over the HKH region.
• Identify regions of storm damage over the HKH region.

Situational Awareness with NU-WRF

<table>
<thead>
<tr>
<th>Model</th>
<th>NAM-LEPSBB (ERU-WRF, Rees-Eaterman et al. 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>Hindu-Kush Himalaya</td>
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<tr>
<td>Vertical Grid Spacing</td>
<td>12-km (regional), 4-km (ensemble)</td>
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<tr>
<td>Output Fields to be used as trigger for ensemble</td>
<td>Areal rainfall, duration, large hail parameters (Thompson et al. 2016; Thompson et al. 2012; Evans and Dawson 2001; Johnson and Sugden 2014)</td>
</tr>
</tbody>
</table>

Situational Awareness using GPM

Threat Assessment Using GPM

EXAMPLE: 13 May 1996 Bangladesh Significant Tornado Event
• HIGH CAPES. STRONG WRF forecast by 12 km model for Day 1
• TRIGGERS 4 km convective allowing ensemble model runs over domain

Impact Assessment Using Land Imagery

EXAMPLE: 11 June 2015 Hail Event
• High-elev WRF indicates potential for large hail over eastern Bangladesh on 11 June
• DPR (polarimetric) detected 55 dBZ reflectivity core associated with 17.4 km deep convection
• GMI detected very cold (−37 °C) PCMI −20 dBZ to −17 dBZ
• Intense storm with large hail

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