#300486 Monitoring Intense Thunderstorms in the Hindu-Kush Himalayan Region

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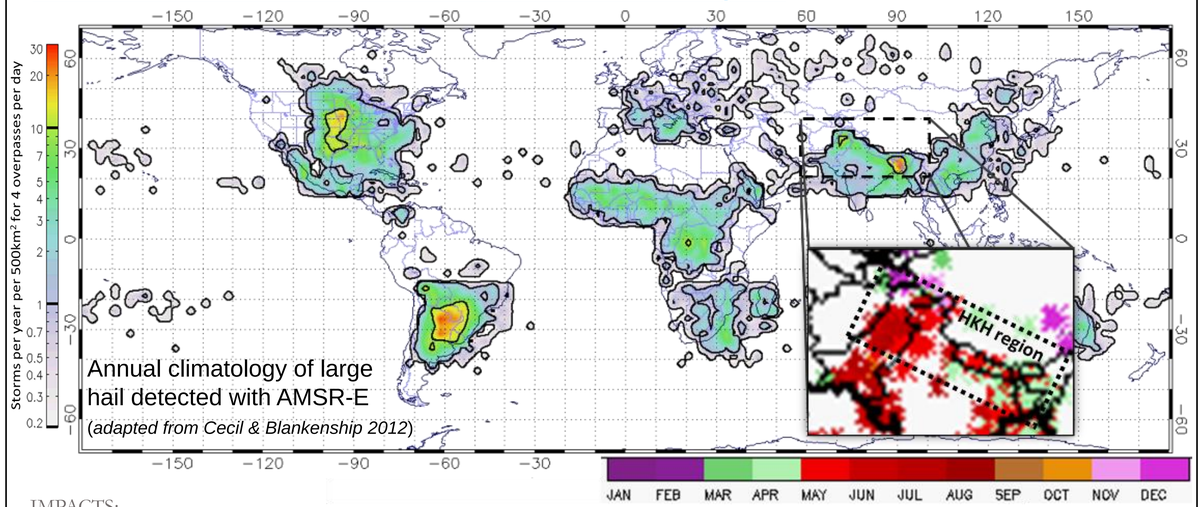
Abstract. Some of the most intense thunderstorms on the planet routinely occur in the Hindu-Kush Himalaya region (HKH) region—where many government organizations lack the capacity needed to predict, observe and effectively respond to the threats and hazards associated with high impact convective weather. 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.

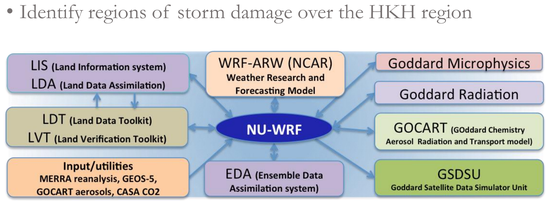
Intense Thunderstorm Activity in the HKH Region

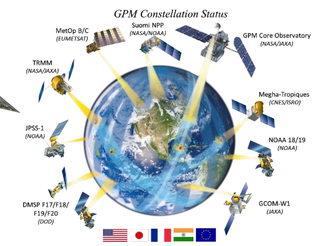


IMPACTS:
- Tornadoes have resulted in over 9,000 fatalities in Bangladesh during the 20th century (Bikos et al. 2016). A tornado in 1989 caused 1,300 deaths and another in 1996 caused over 700 deaths.
- A hailstorm over Katmandu Stadium in 1988 resulted in 72 deaths
- Lightning in 1995 struck a Pakistani village killing 35 (Holle 2010), and a 2015 windstorm in Peshwar killed 25
- Commercial production of cherry peppers in Bhutan in 2016 was foiled by a large hailstorm
- Flash flooding and resultant landslides killed over 100 people in Nepal during monsoonal rain storms of 2016

Objectives

- Develop a convection 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





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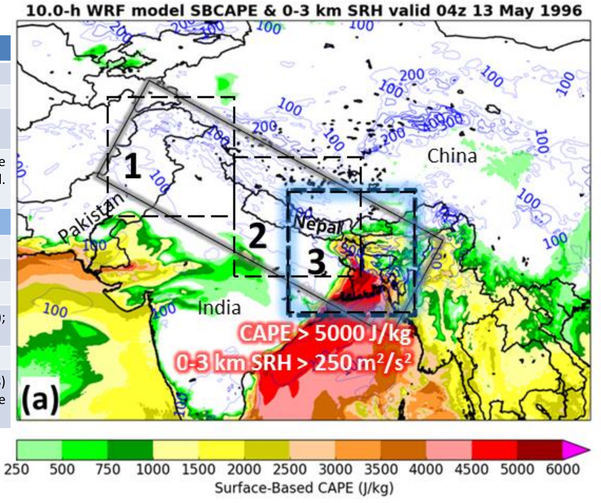
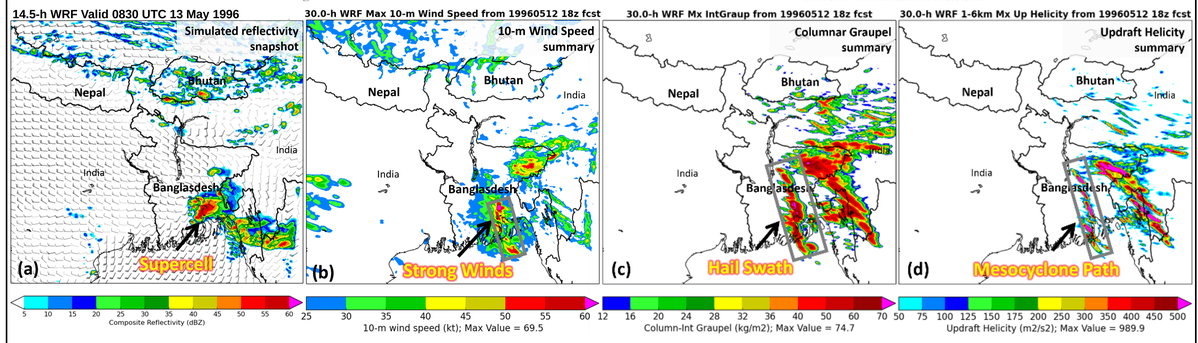
Situational Awareness with NU-WRF

Numerical Weather Prediction Configuration	
Model	NASA Unified WRF (NU-WRF; Peters-Lidard et al. 2015)
Domain	Hindu-Kush Himalaya
Horizontal Grid Spacing	12-km (regional), 4-km (ensemble)
Output fields to be used as trigger for ensemble	Supercell composite, significant tornado, derecho and large hail parameters (Thompson et al. 2004; Thompson et al. 2012; Evans and Doswell 2001; Johson and Sugden 2014)
Ensemble Model Configuration	
Number of ensemble members	12
Initial Conditions	NCEP/EMS GEFS (EMC 2015)
Planetary Boundary Layer	MYJ (Janić 1994); YSU (Hong et al. 2006)
Microphsysics	Goddard single-moment (Tao et al. 2003; Lang et al. 2007); Morrison 2-moment (Morrison et al. 2009)
Land surface	NASA Land Information System
Output high impact weather proxy fields	Composite reflectivity, updraft helicity, (Kain et al. 2008) columnar graupel, 10-m wind speed, lightning flash rate (McCaul et al. 2009), accumulated rainfall



EXAMPLE: 13 May 1996 Bangladesh Significant Tornado Event
- HIGH CAPE + STRONG SHEAR forecasted by 12-km model for Day 1

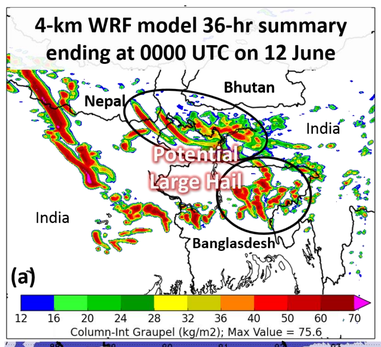
→TRIGGERS 4-km convection allowing ensemble model runs over domain 3

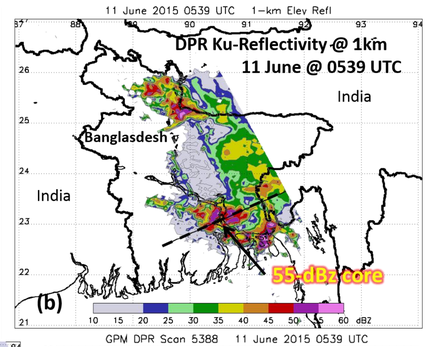


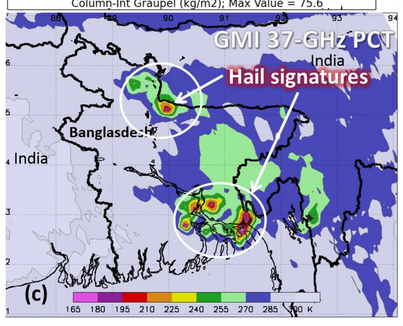
Threat Assessment Using GPM

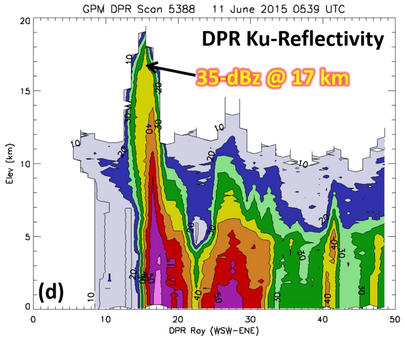
EXAMPLE: 11 June 2015 Hail Event
- High-res WRF indicates potential for large hail over eastern Bangladesh on 11 June
- GPM overpass at 0539 UTC on 11 June
  - DPR detected 55-dBz reflectivity cores associated with 17-km deep convection
  - GMI detected very cold 37-GHz PCT

→ Intense storm with large hail

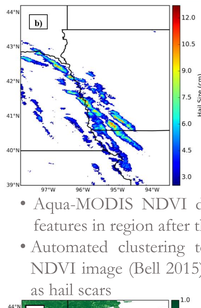




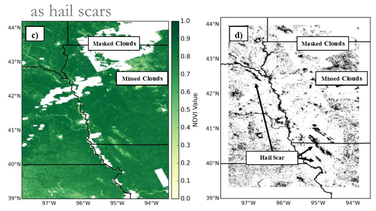




Impact Assessment Using Land Imagery



EXAMPLE:
Crop damage scars from 31 Aug 2011 Hail Event
- NEXRAD detects swaths of large hail across lower Missouri River Valley
- Aqua-MODIS NDVI depicts anomalous linear features in region after the event
- Automated clustering technique using a single NDVI image (Bell 2015) identifies these features as hail scars



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