Short Range Forecast of Heavy rainfall events Using WRF model

Jyoti Bhate
National Atmospheric Research Laboratory
Gadanki, Andhra Pradesh

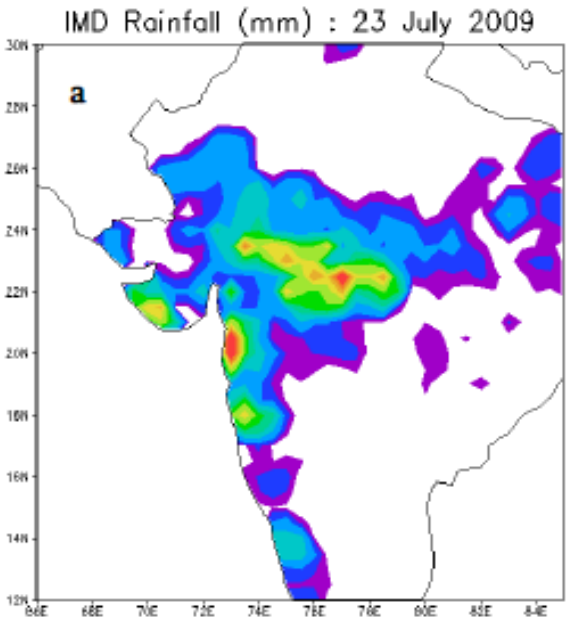
Contributions from
Dr. M. Rajeevan, Dr. Amit Kesarkar,
Mr. Unnikrishnan, Ms. A. Madhulatha

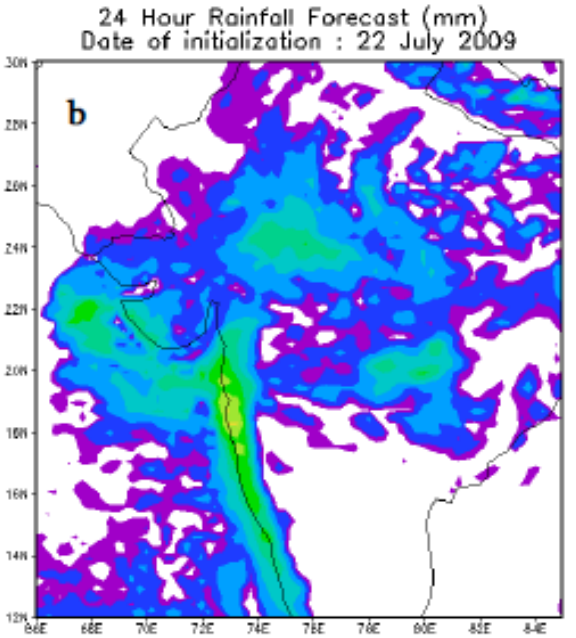
Forecast system at NARL

- Short Range Forecast using WRF model (72 hour forecast)
- Initial and boundary conditions from GFS model
- Model Resolution : 27 km horizontal, 38 vertical levels
- Nudging using Multiquadratic interpolation is used to assimilate ISRO AWS, Kalpana Satellite Winds, GPS sonde data
- Model skill is tested for heavy rainfall events
- Test cases of heavy rainfall and flood event
  - 23rd July and 28th July 2009
  - during 29th Sept-3rd Oct 2009

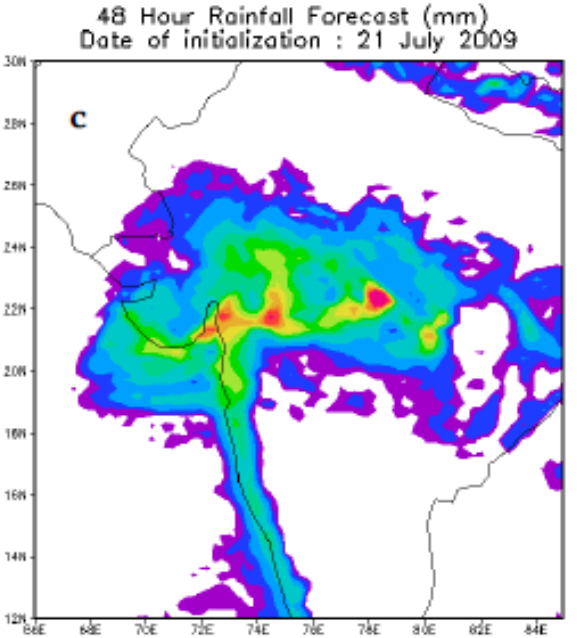
Heavy Rainfall observed in 2009 -1
23rd July 2009

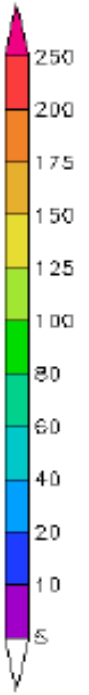
Observed Rainfall





24 hour Forecast

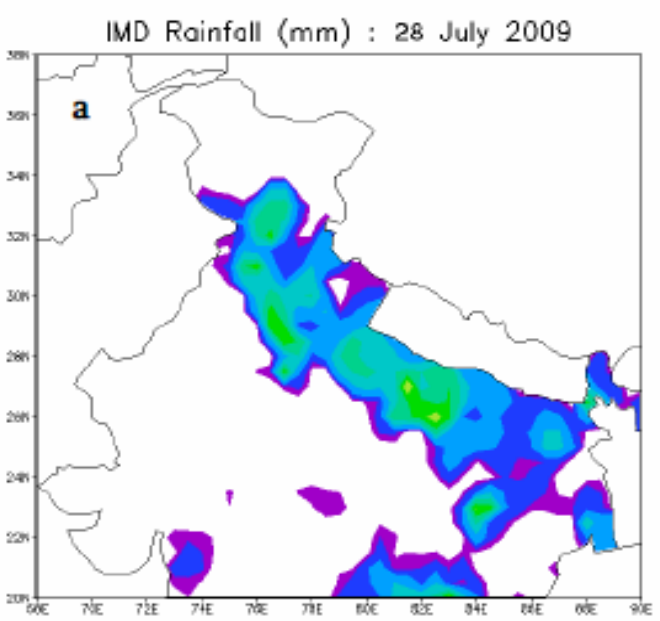


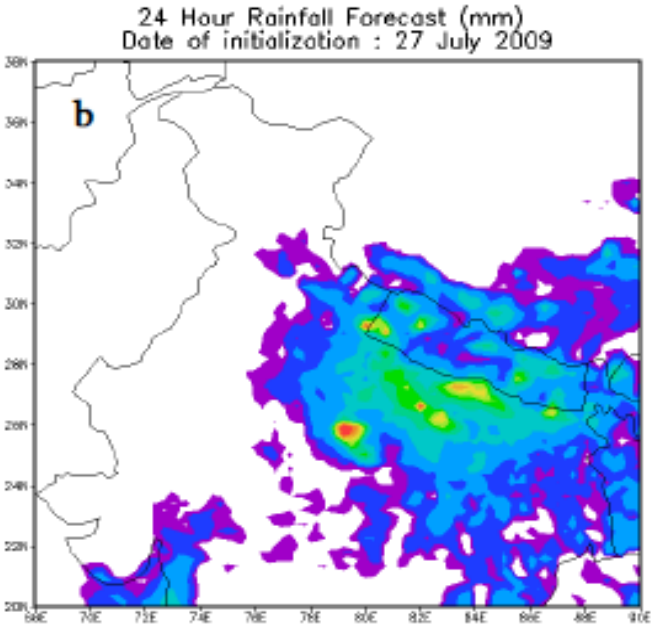


48 hour Forecast

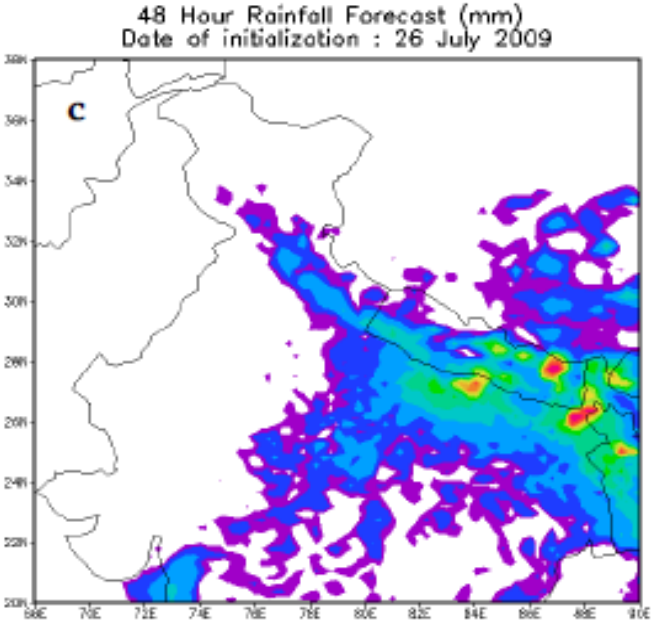
Heavy Rainfall observed in 2009 – 2 28th July 2009

Observed Rainfall





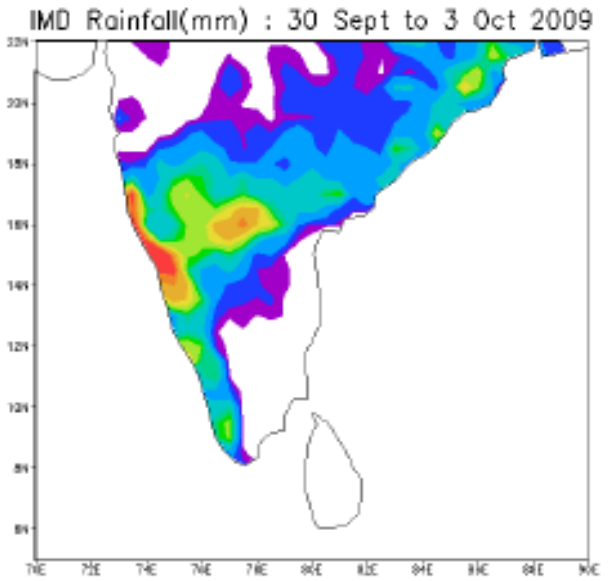
24 hour Forecast

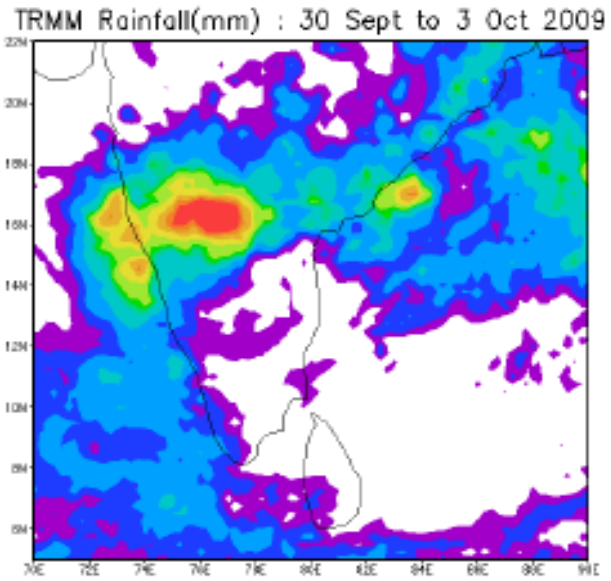


48 hour Forecast

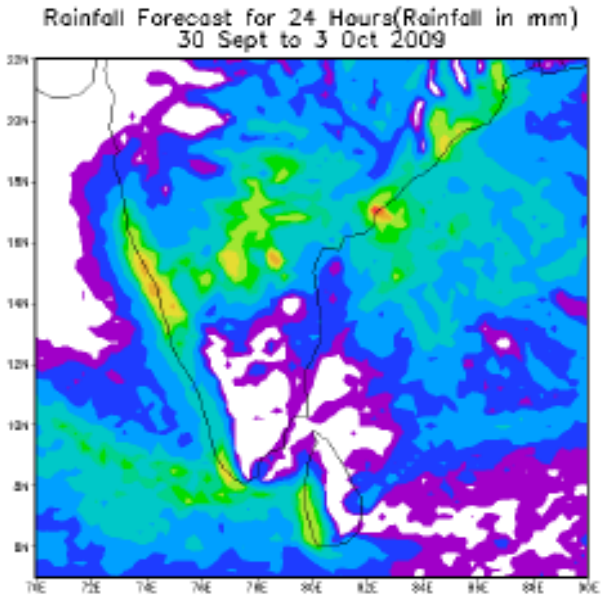
Heavy Rainfall observed in 2009 – 3 30th Sept – 3rd Oct 2009

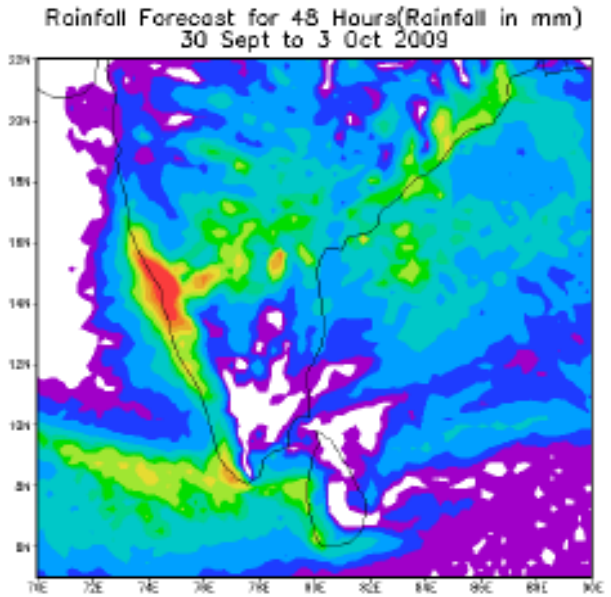
Observed Rainfall

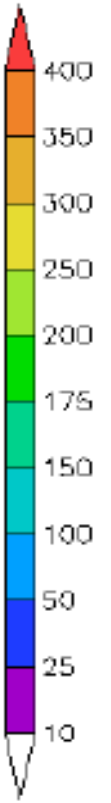




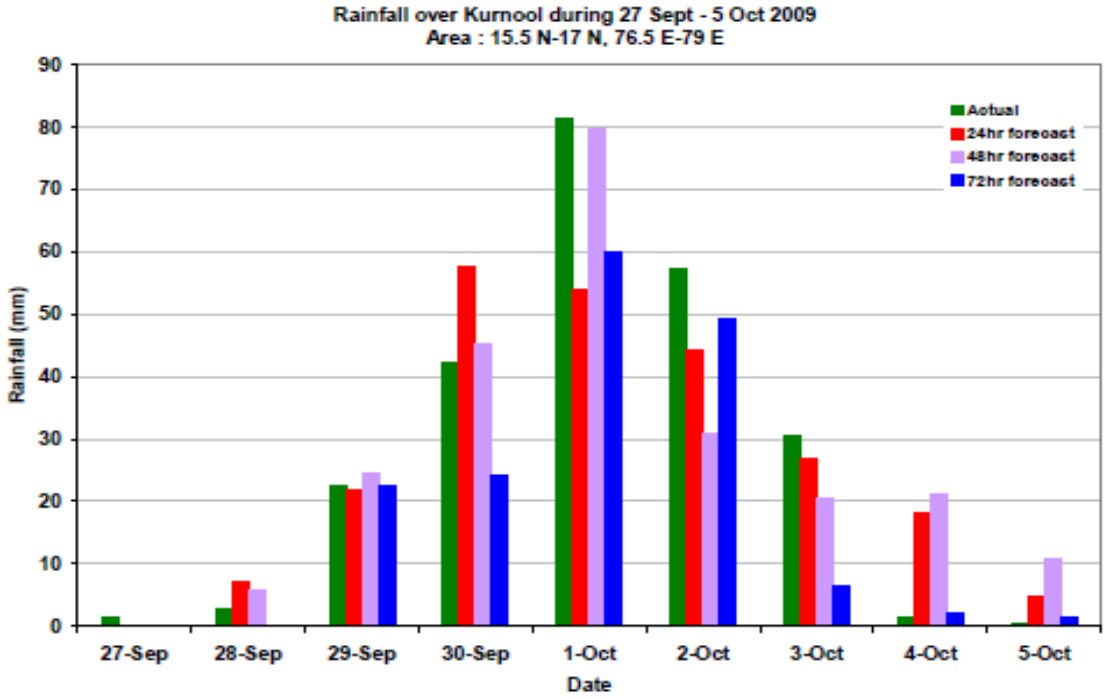
24 and 48 hour forecast

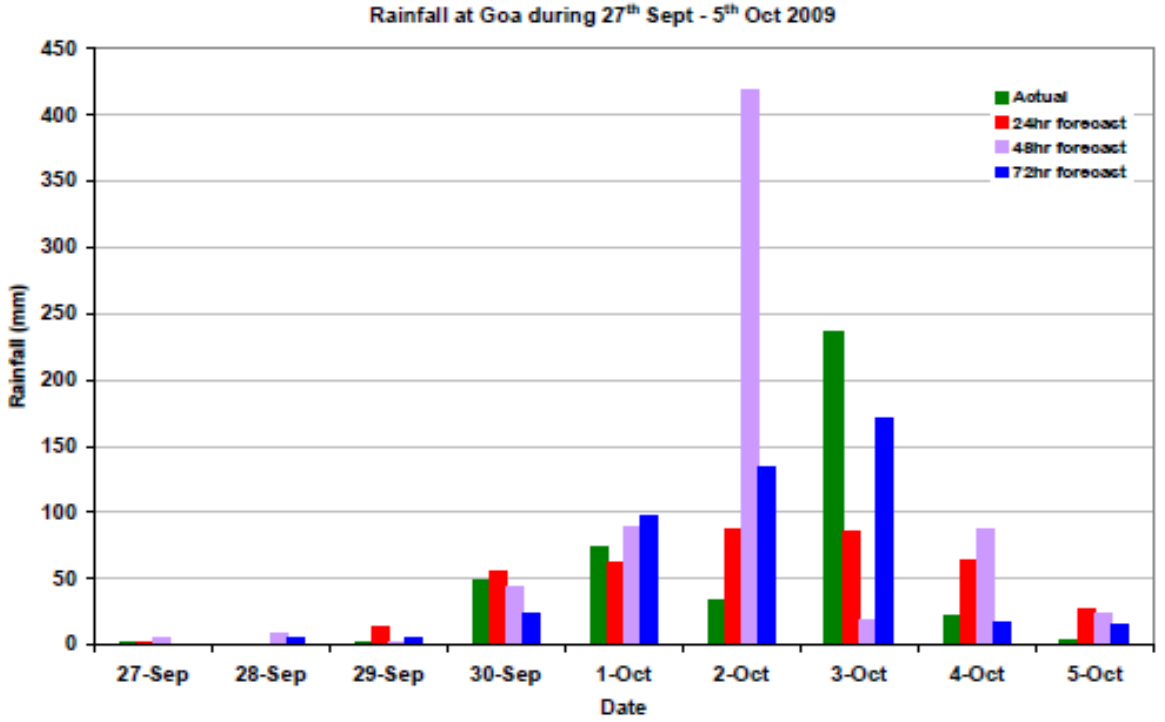






Time series plot for Case-3





Data Assimilation using Nudging

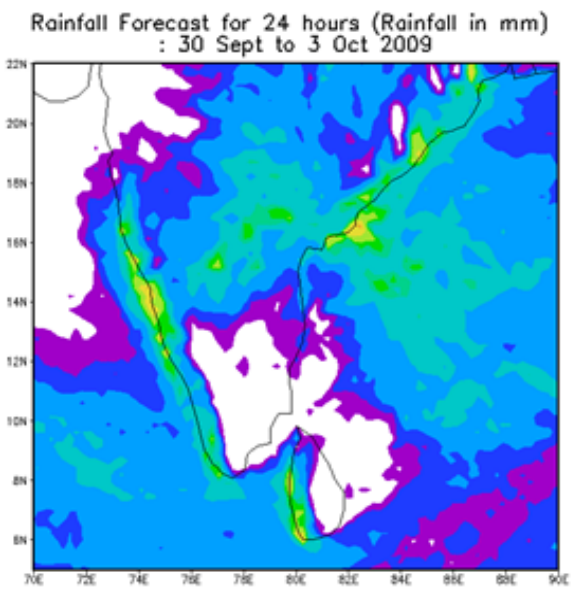
- Multiquadratic Interpolation method is used for nudging (Nuss and Titley,1994)
- Uses hyperboloid radial basis function to fit scattered data to uniform grid
- The interpolation equation for radial basis function is

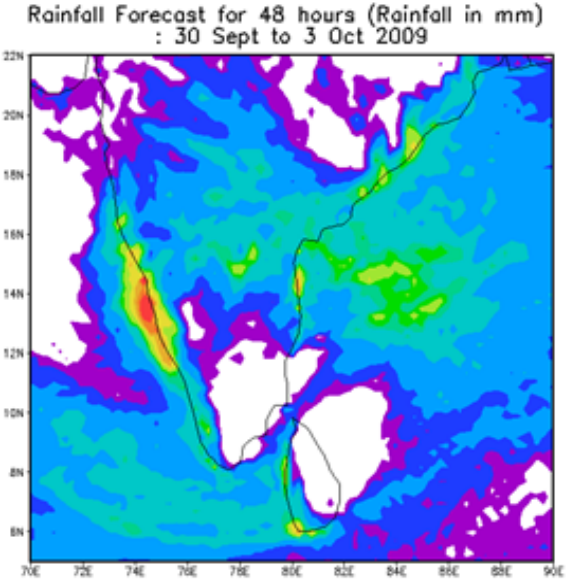
$$H(X) = \sum_{i=1}^{N} \alpha_i Q(X - X_i).$$

- H(X) is spatially variang field and Q is radial basis function. α_i are weighting factors.

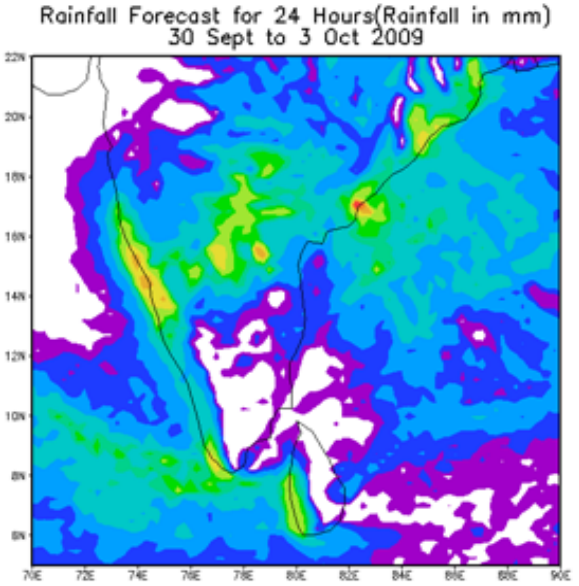
Before and After assimilation

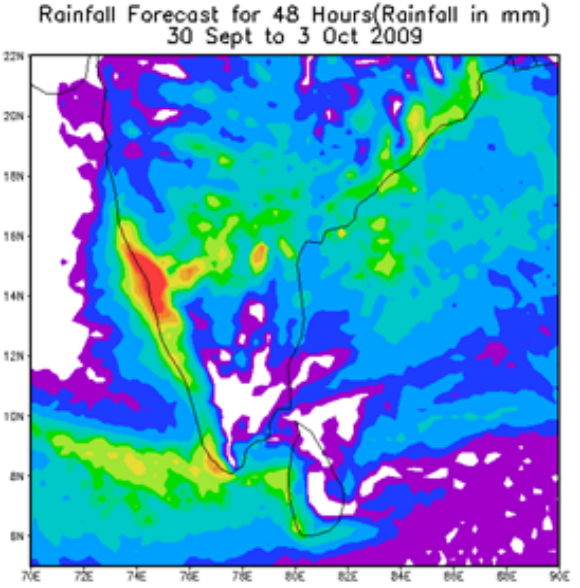
No Data Assimilation

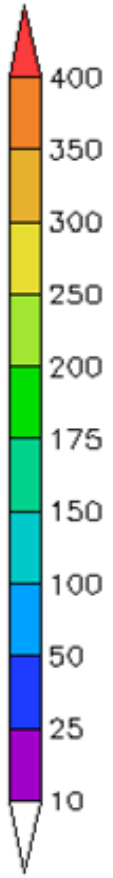




With Data Assimilation







Problems with rainfall forecast

- Poor skill for 24 hour forecast
- Not able to capture heavy rainfall regions over West coast and Himalayan regions
- The propogation of rainfall during monsoon depressions is not well captured
- Needs to study in detail using other data assimilation methods (3D var, 4D var, EnKF)
- Also sensitivity to various cumulus parametrizations needs to be examined

Thank You