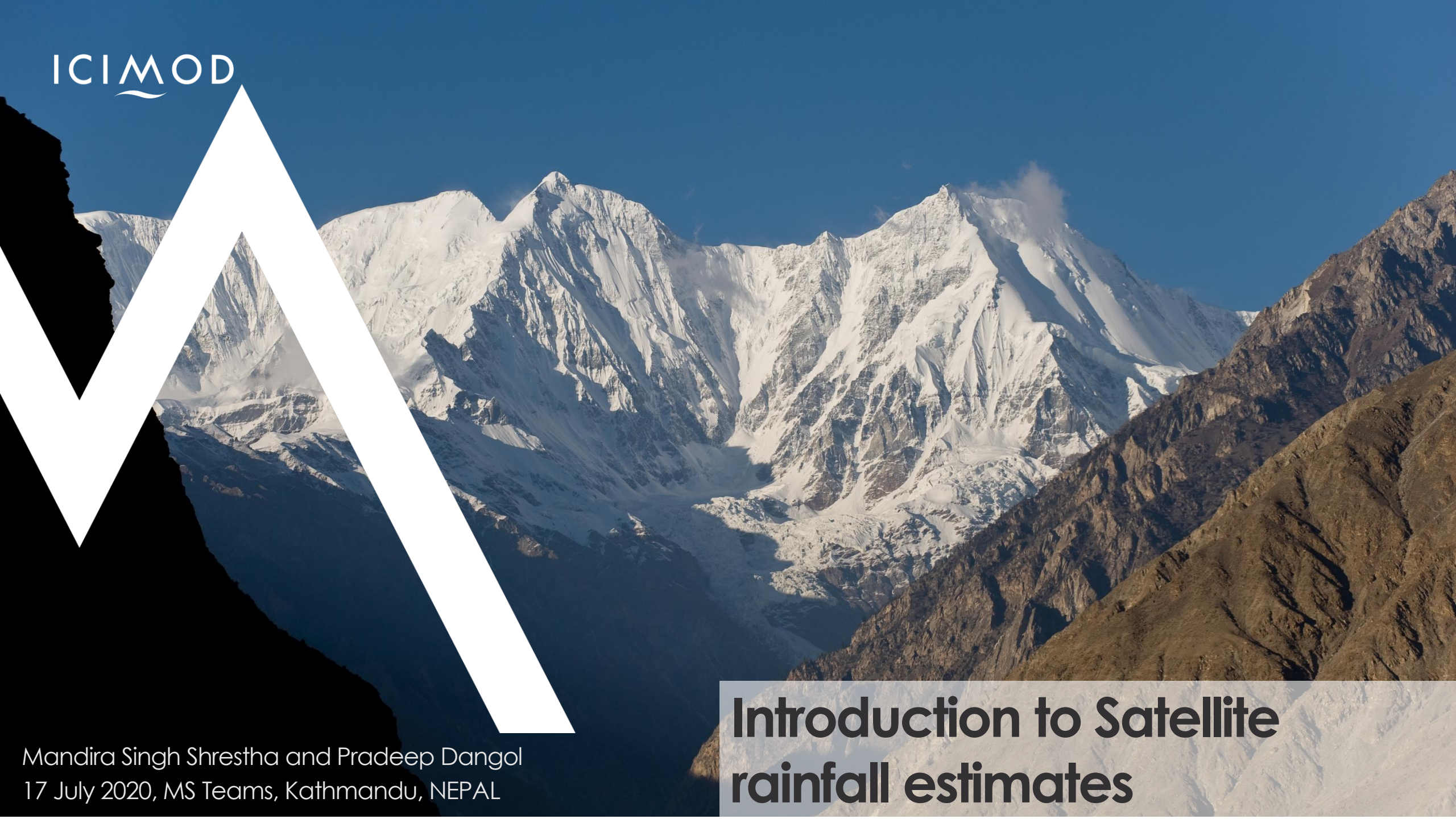


Introduction to Satellite rainfall estimates

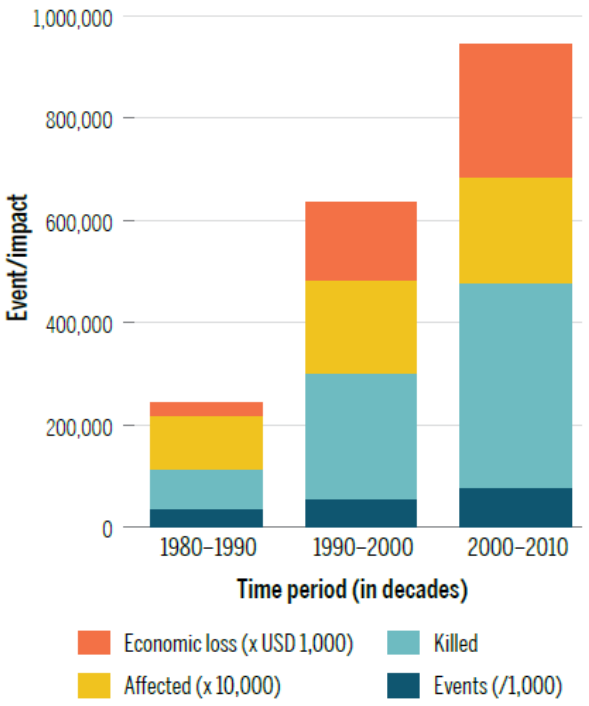
Mandira Singh Shrestha and Pradeep Dangol

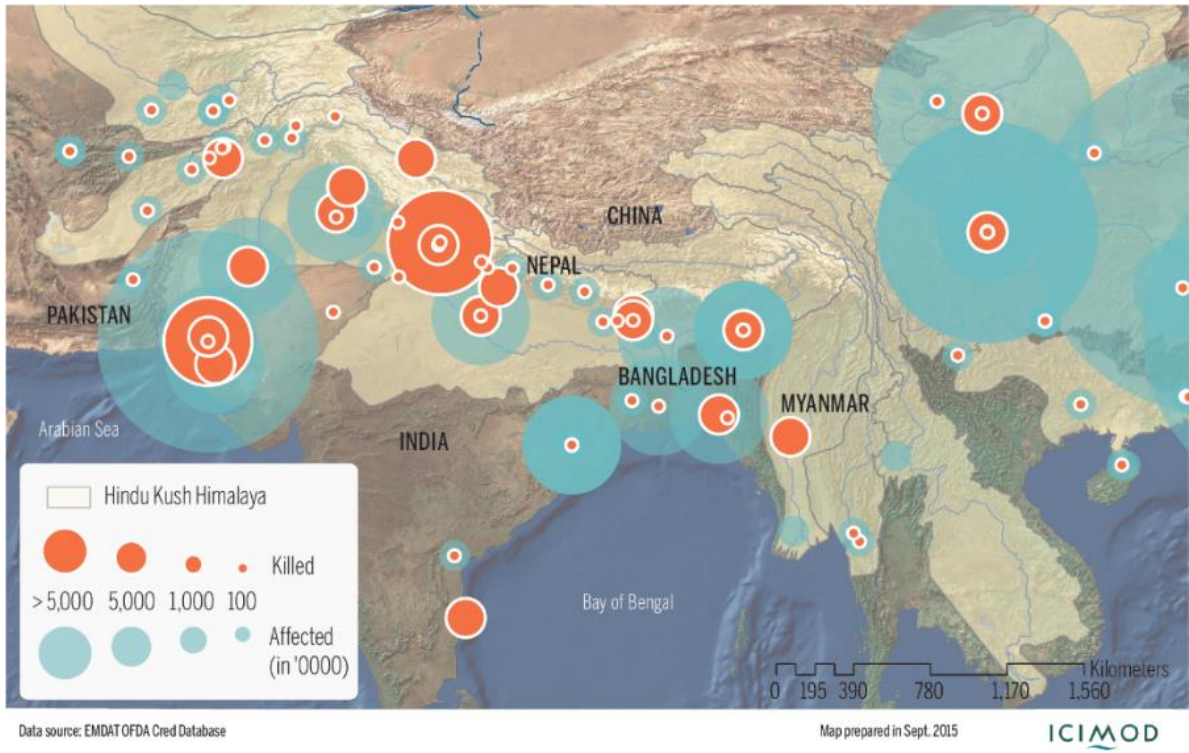
17 July 2020, MS Teams, Kathmandu, NEPAL

The economic and human impacts of natural disasters are increasing

Transboundary floods - shared vulnerability across national borders

Increase in intensity and frequency





Source: Vaidya etal., 2019 (HIMAP report)

South Asia Floods 2017

41m

People affected in three countries

Bangladesh

114 deaths

6.9m affected

India

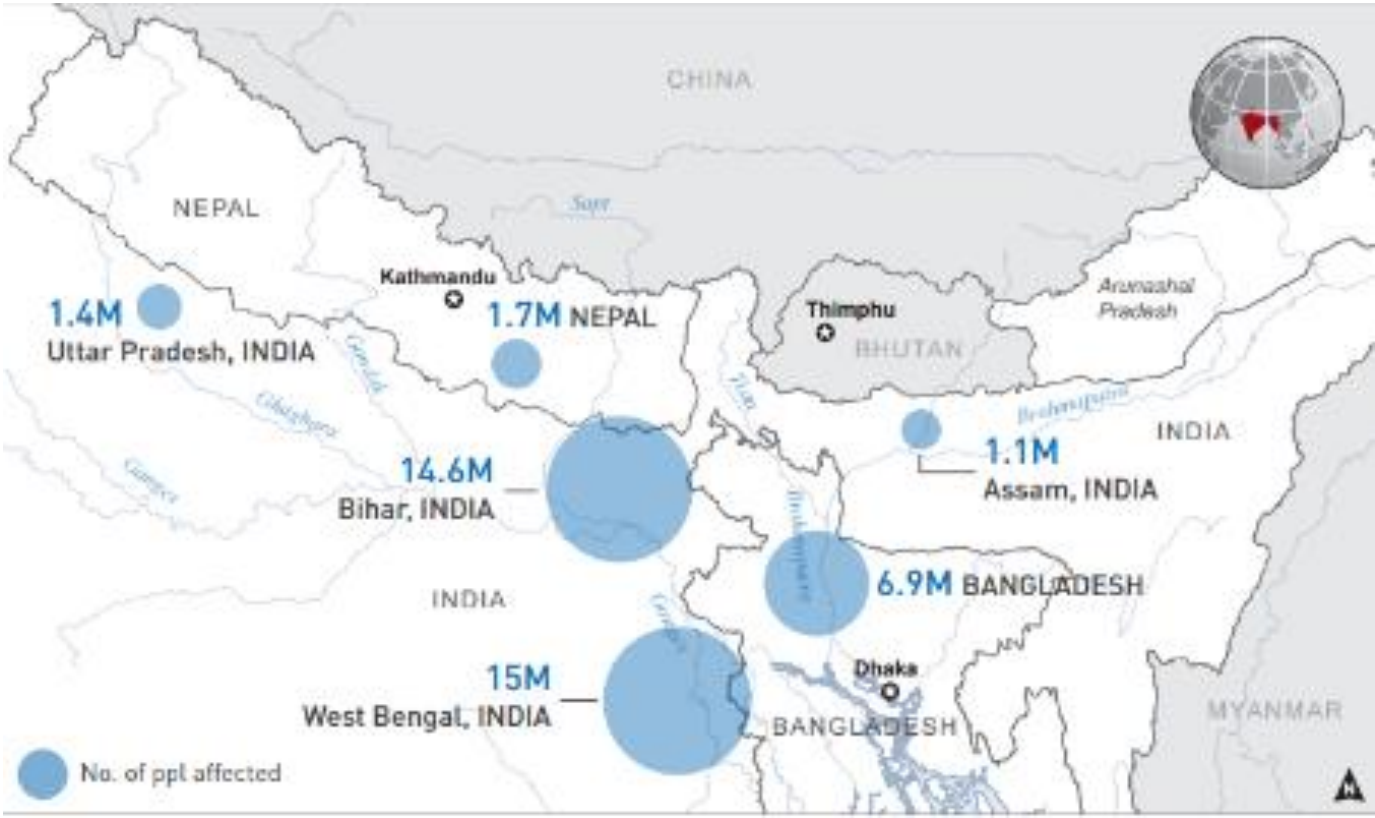
>600 deaths

32.1m affected

Nepal

143 deaths

1.7 m affected



Objectives of the Session

To understand the basics of global SRE products

- What is SRE
- Why SRE

Types of meteorological satellites -
- Temporal and spatial resolutions

Examples of SRE products and bias correction

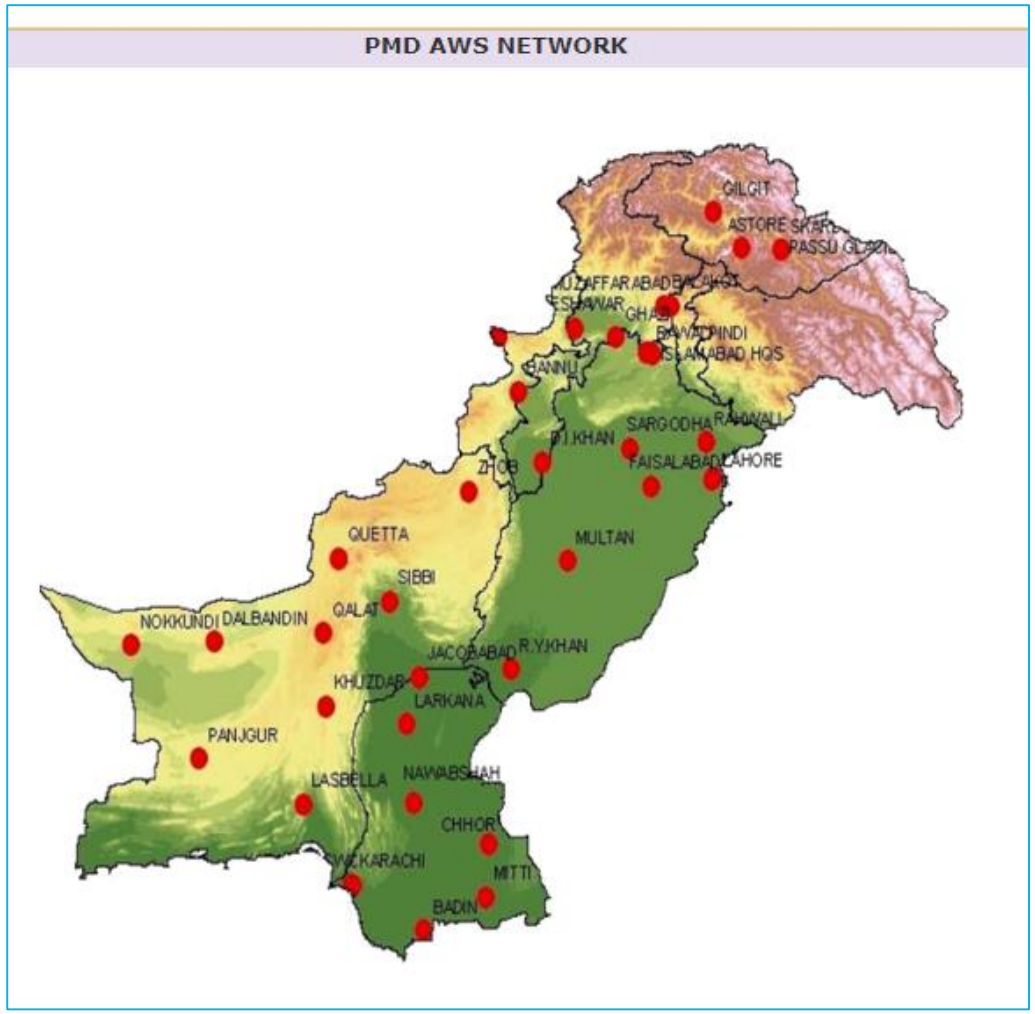
Applications of SRE

Satellite rainfall estimates

Quantitative precipitation estimates (QPE) from space

Meteorological satellite data strengthens the geographical (spatial) coverage and time-base of conventional ground-based rainfall data observation for a number of applications, including hydrology analysis and weather monitoring and forecasting.

Rain gauge network

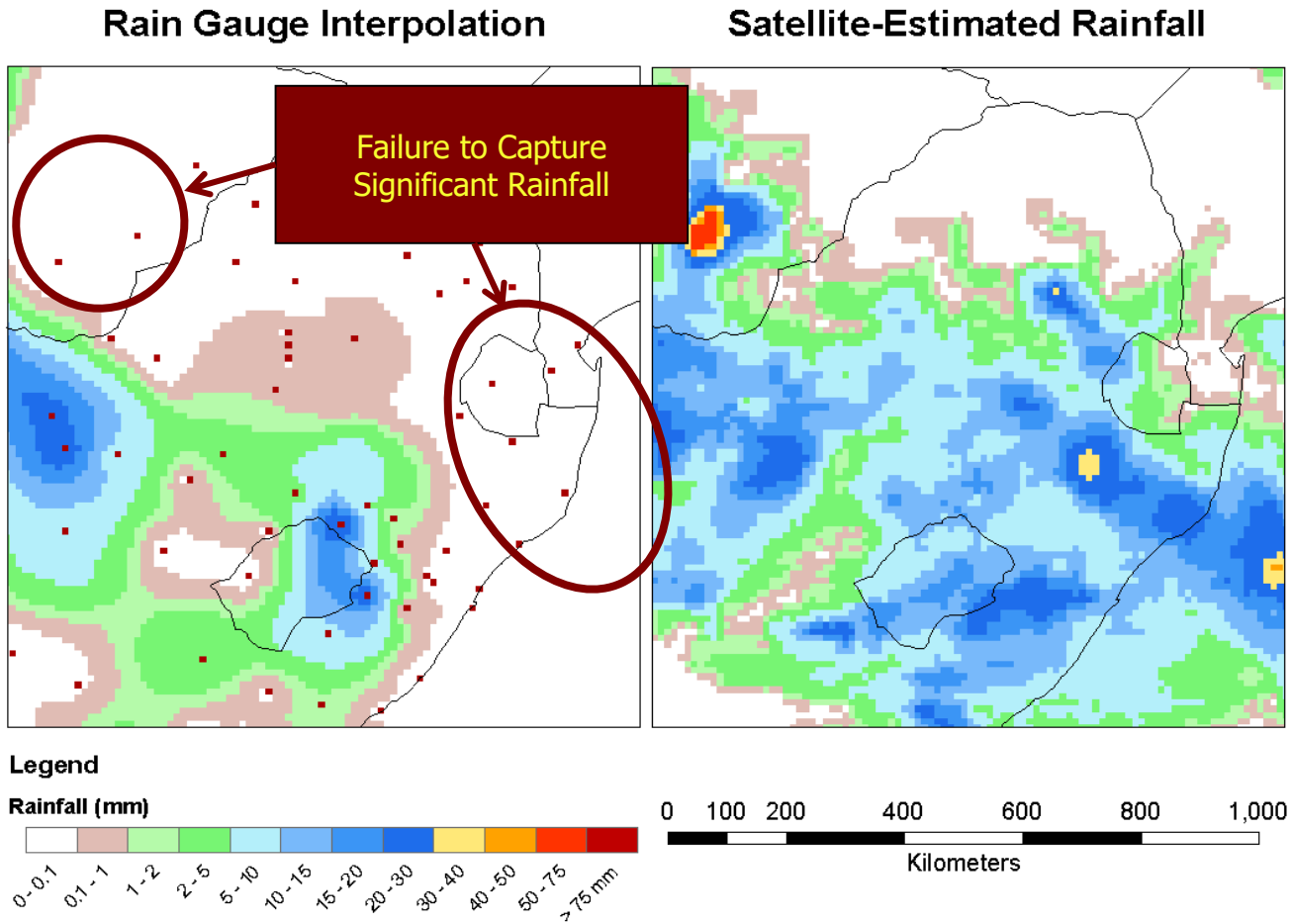


Why SRE?

Accurate estimation of spatial and temporal distribution of observed precipitation is important for input to river and flash flood models, analysis of floods and droughts, water resources assessments

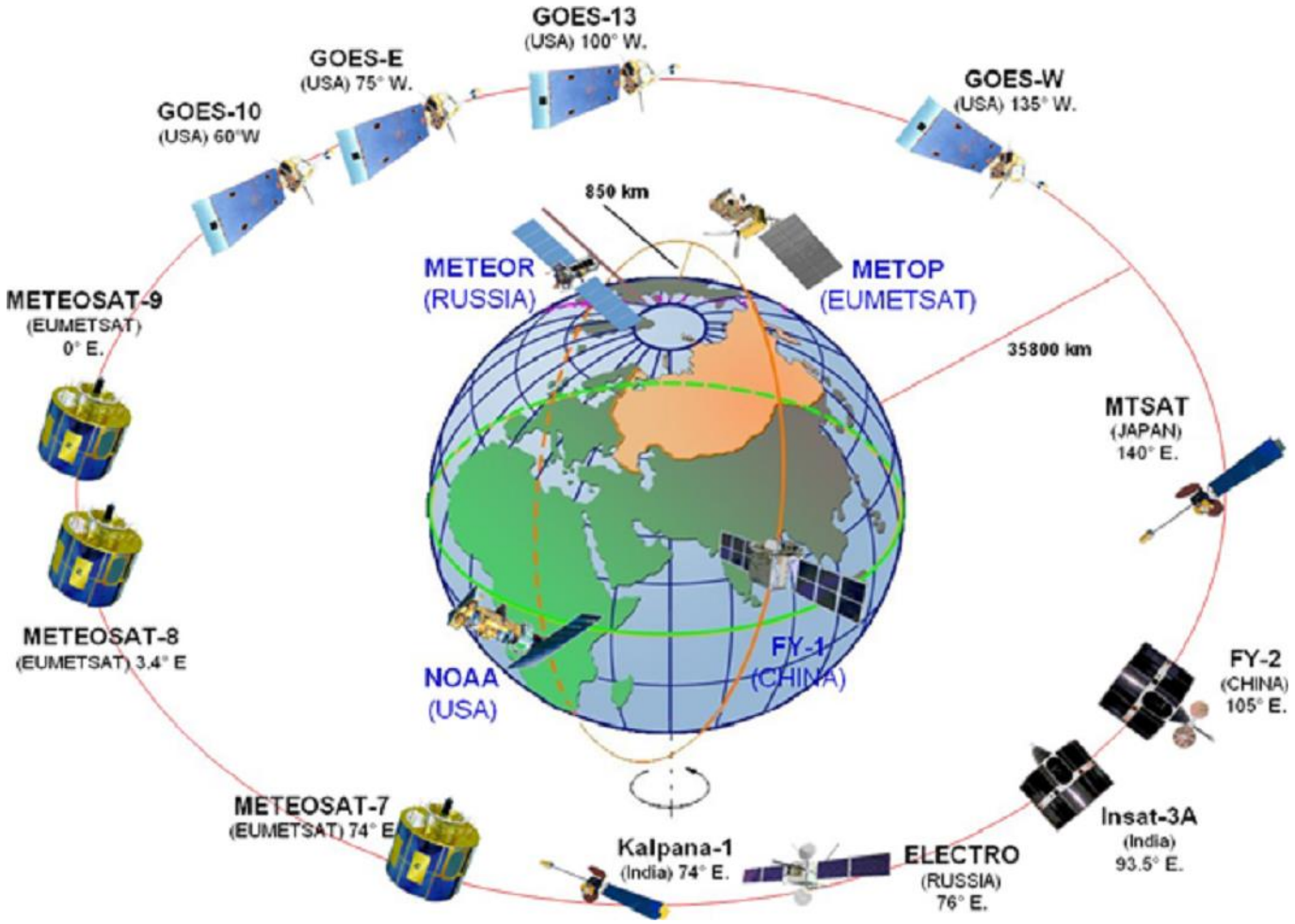
In areas of poor coverage of radars and rain gauges

Not adequate lead time – absence of data sharing across transboundary borders



Types of Meteorological Satellites

- GeoStationary – 35,800 km
- Polar Orbiting – 800 km



Geostationary satellites

provides continuous observation of the earth's surface

provides data on a half hourly basis

imagery obtained from these satellites is mainly visible (VIS) and Infra Red (IR)

resolution of about 4 km, with information on clouds collected once every 30 minutes

MTSAT, GOES, Meteosat, FY series, and INSAT

Polar Orbiting Satellites

Satellites fly in polar orbiting (sun synchronous) swaths

the sensors are closer to the Earth's surface about 800 km

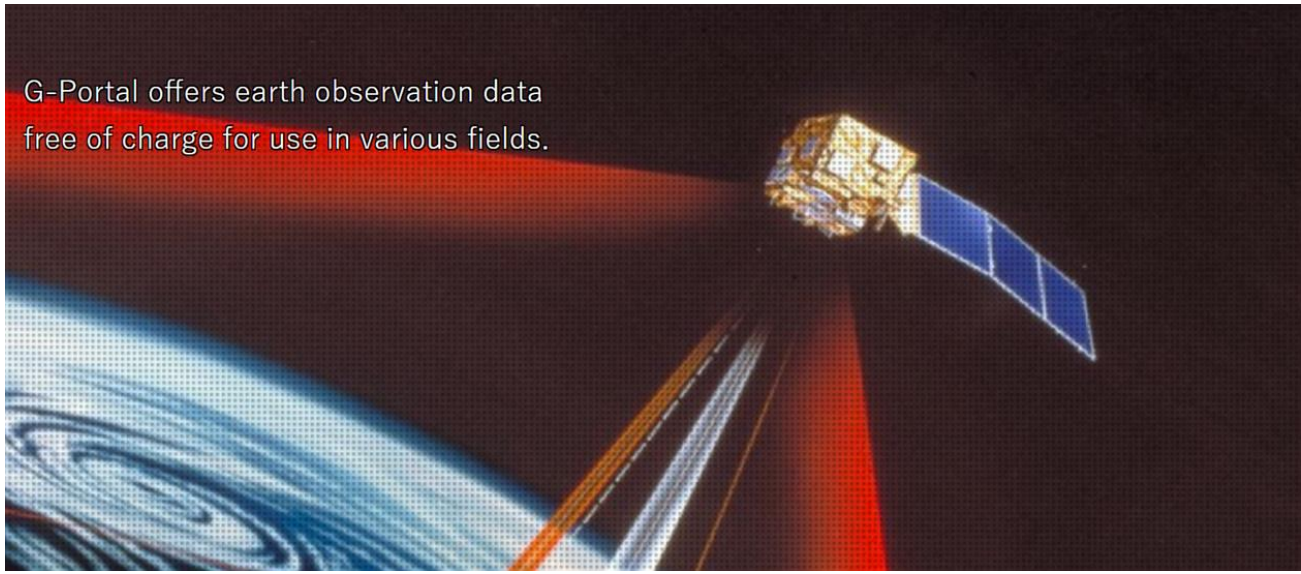
Main sensors are on board US DMSP and NOAA satellites

Includes microwave sensors

Some examples are SSMI/AMSU-B

Satellite-based rainfall estimation methods

- VIS/IR Method
- Passive Microwave method
- Mutli-Sensor Technique



IR sensor estimation methods

Standard infrared remote sensing technique approximates the temperature of the first surface encountered

- No clouds: surface temperature
- Clouds: cloud top temperature

Temporal and spatial resolution is high every half hour and 4 km pixel

Rapid data availability

Easily accessible

IR sensor estimation methods - *Limitations*

Rainfall estimation method is not physical

The high orbit of the sensor leads to attenuation / scattering of the IR signal by particulates in the Earth's atmosphere

Errors sensing high level, non precipitating clouds such as cirrus: Constant 235K threshold

Failure to capture warm cloud processes such as coastal rain and orographics

Passive microwave sensor estimation method

Measures directly radiation emitted by thermal states in the media and is more physical than IR

Effective in detecting soil moisture and temperature

Assessing snow melt conditions

Can be measured in all weather and day and night

Can penetrate through clouds

Passive Microwave Sensor Estimation Methods - *Limitation*

Coarse spatial and temporal resolution

- 16-25 Km pixel & ~2 hour sampling
- HIGH LATENCY

Though predictable, satellite tracks are not consistent between observations

Orographic processes are not well-captured

Problematic when attempting to sense H_2O over snow/ice/desert regions

Satellite rainfall estimate products: NOAA CPC_REE2.0

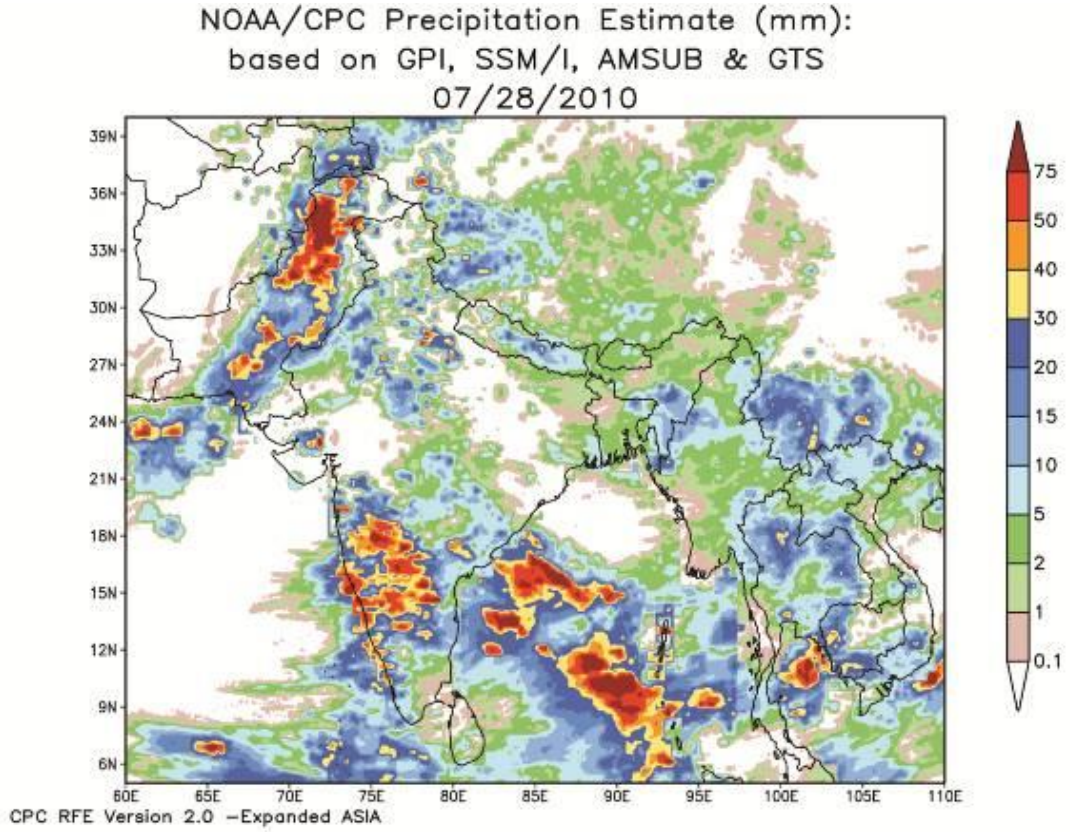
Temporal resolution – daily

Spatial resolution – 0.1 degrees

Domain –

60 -110 degrees E

5 - 40 degrees N



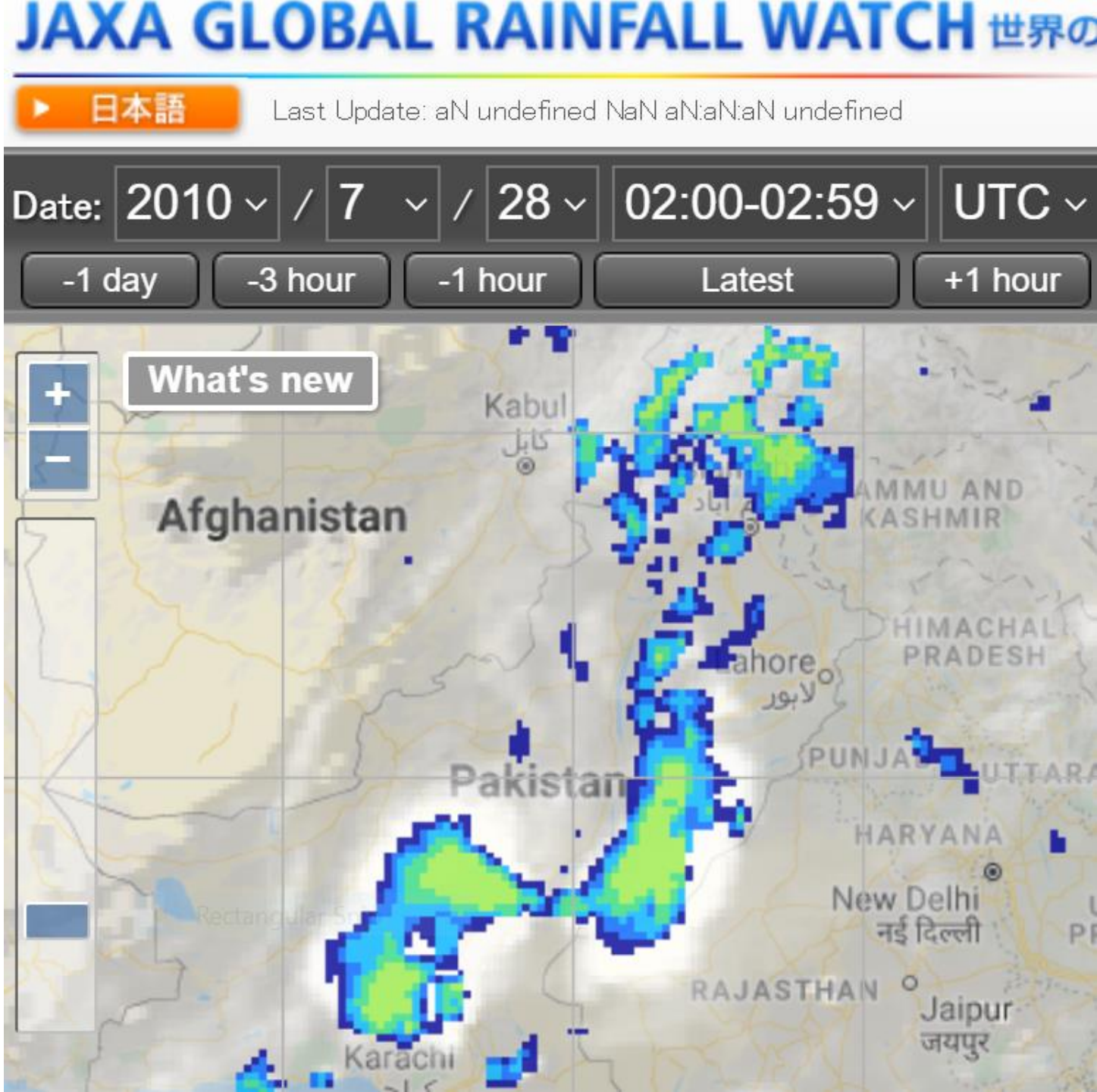
Satellite rainfall estimate products: GSMaP

Temporal resolution – hourly

Spatial resolution – 0.1 degrees

Domain –

60 N - 60 S



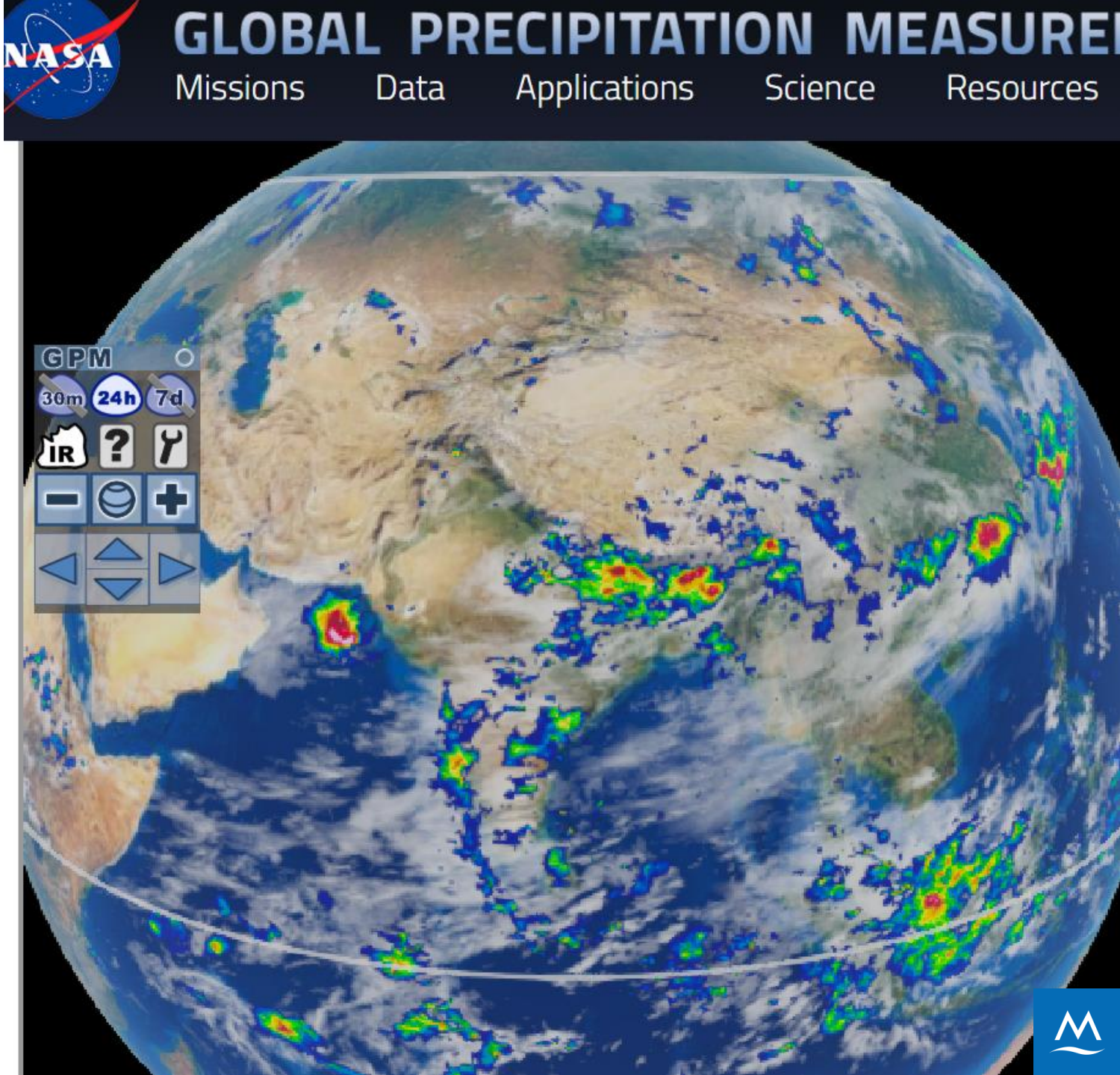
Satellite rainfall estimate products: GPM

Temporal resolution – 30 minutes

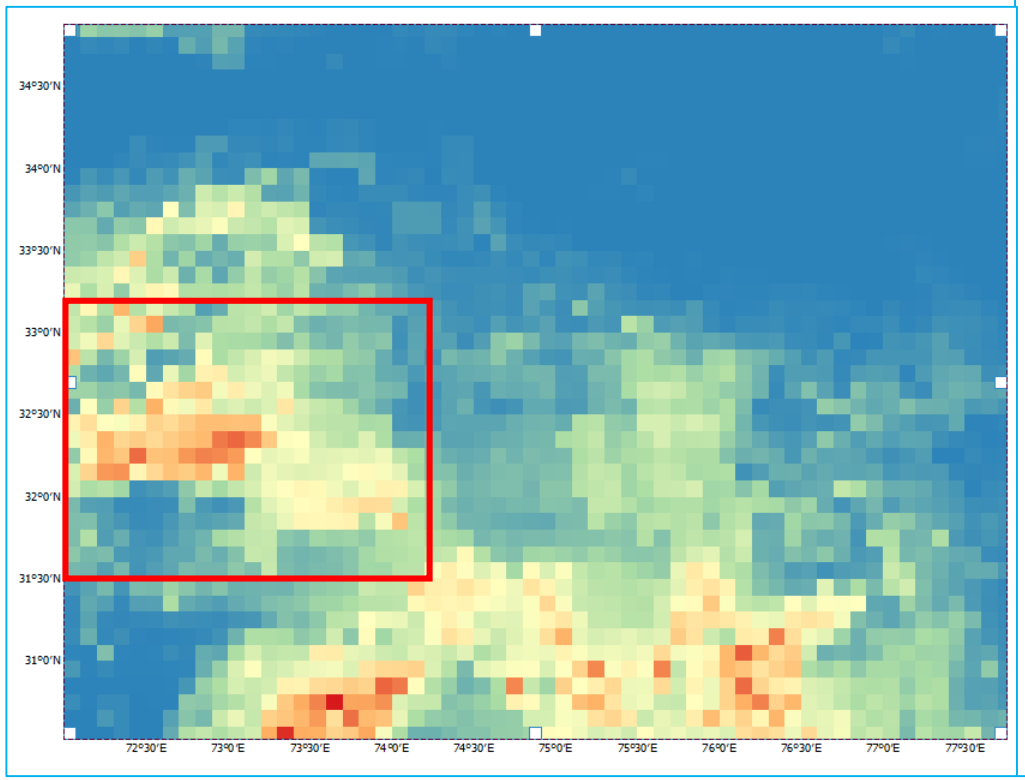
Spatial resolution – 0.1 degrees

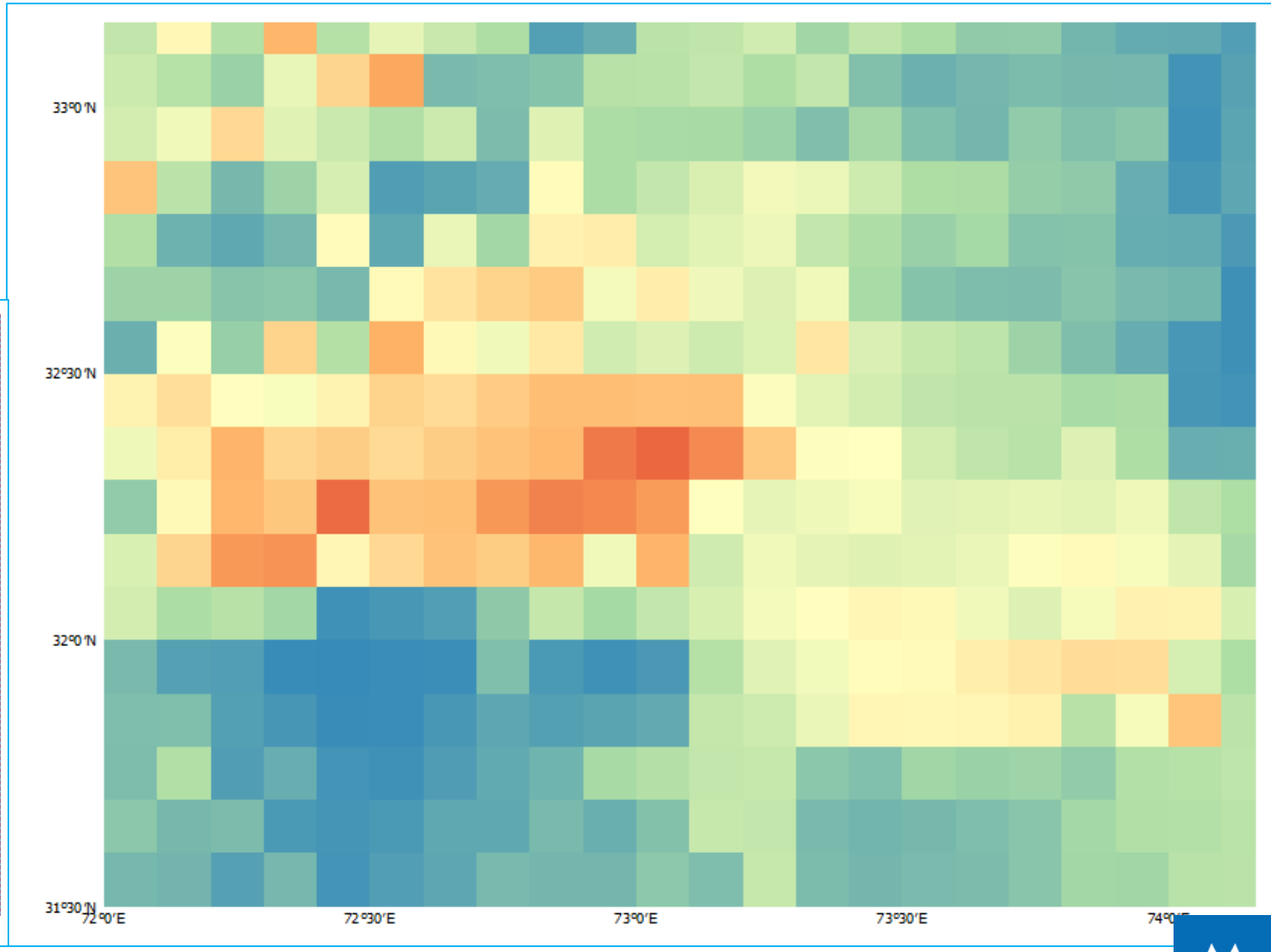
Domain –

60 N - 60 S

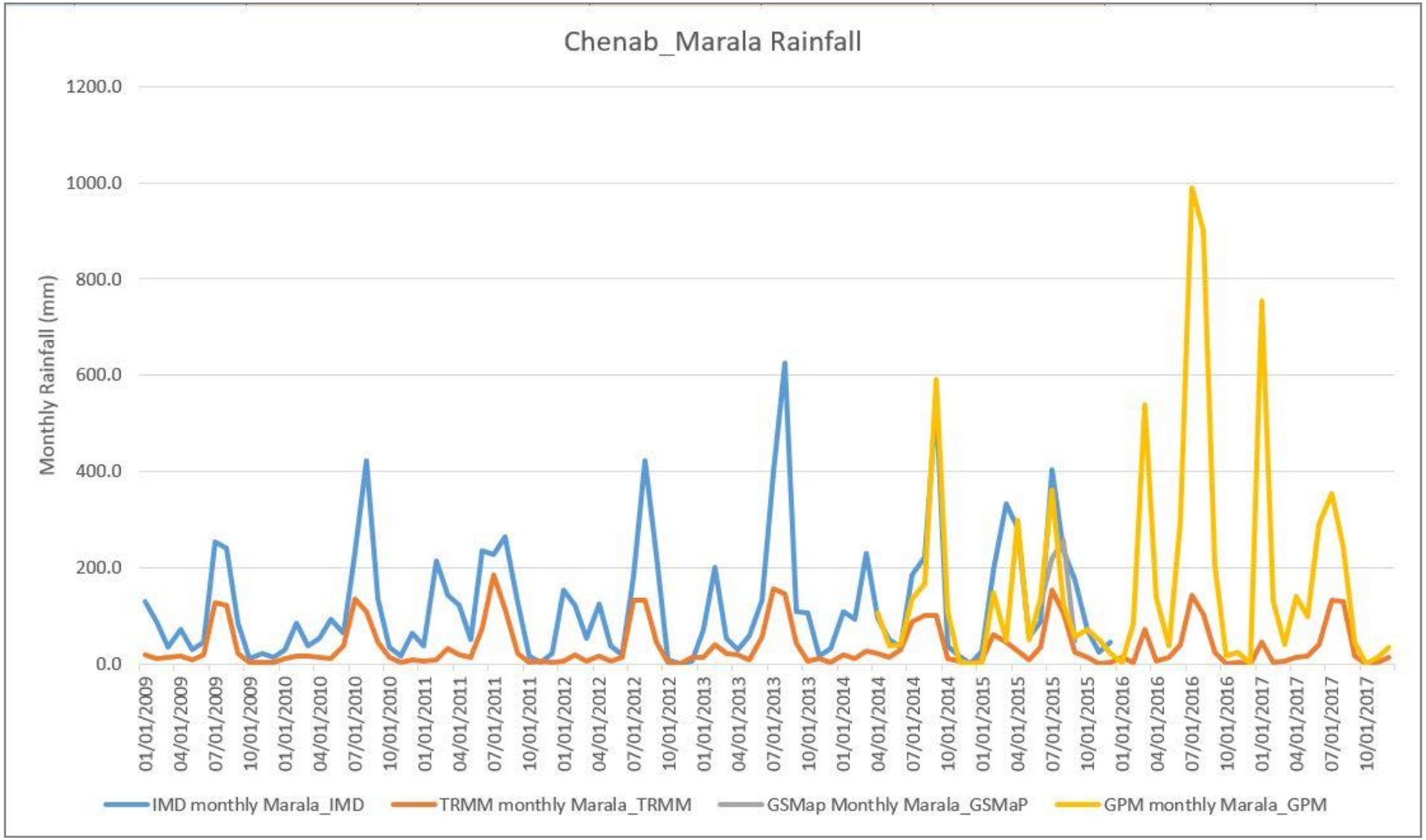


Satellite rainfall estimate products: grid size resolution

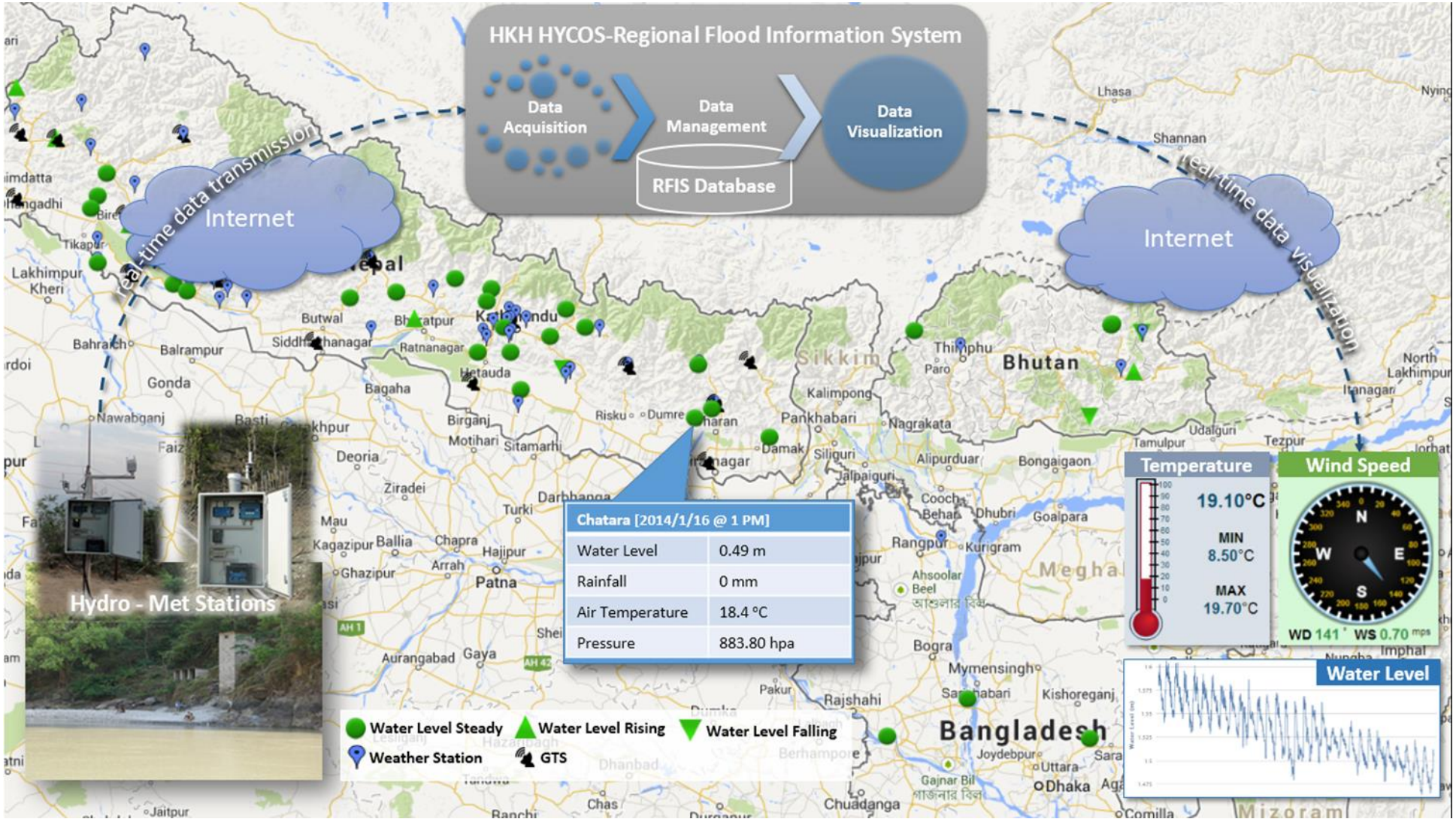




Satellite rainfall products performance



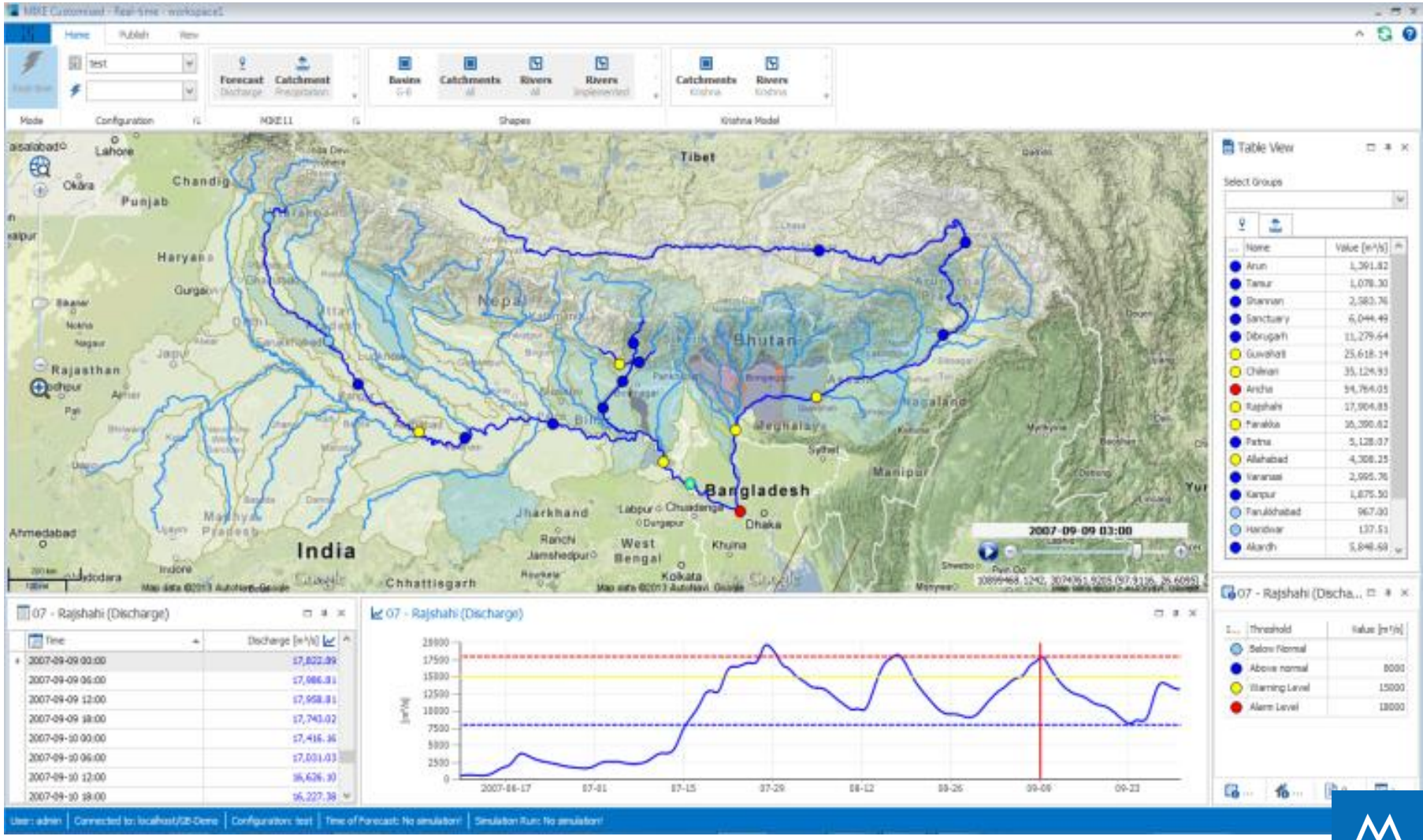
Regional flood information system



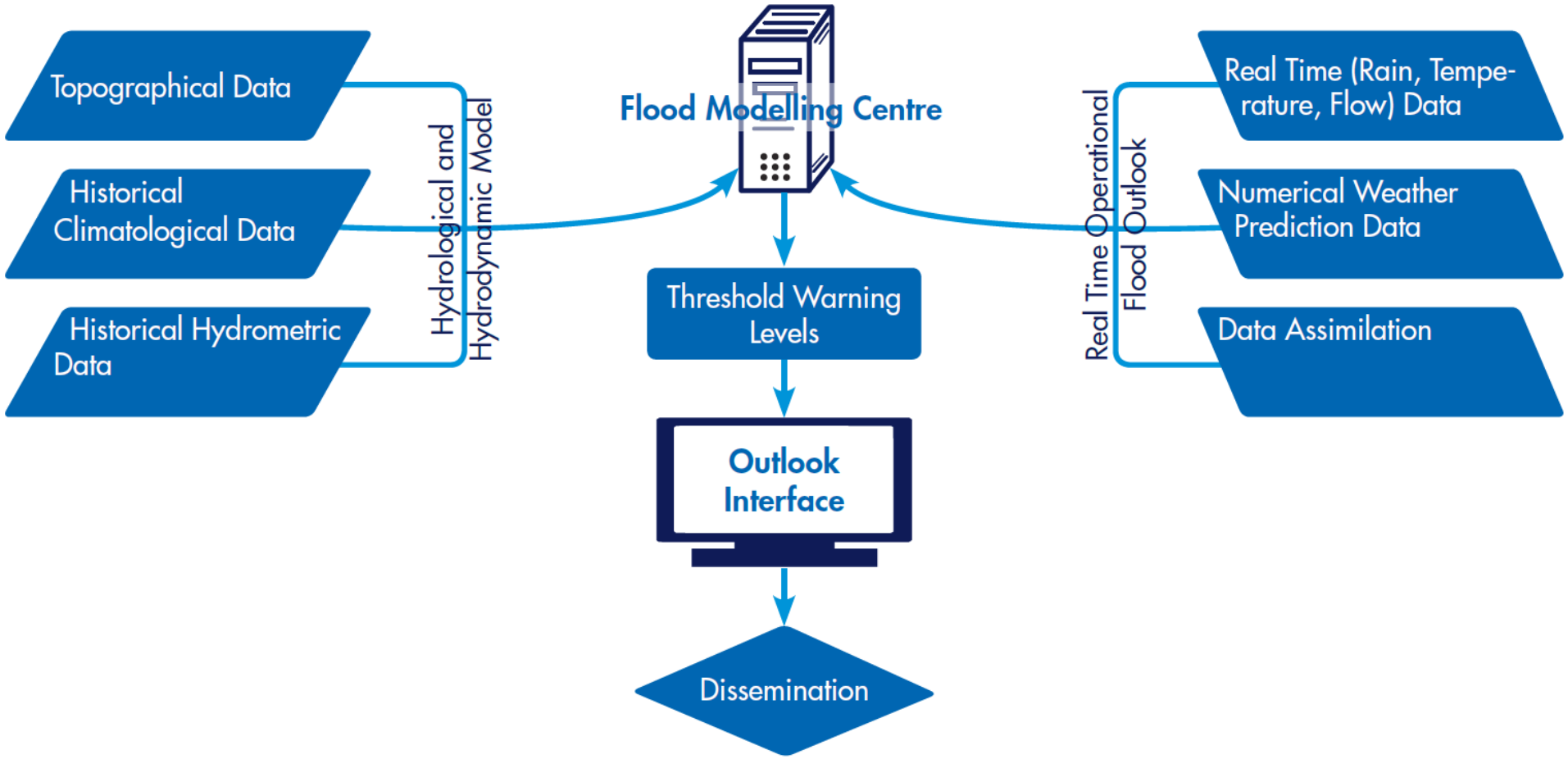
Regional flood outlook

Developed a flood outlook system for the Ganges- Brahmaputra basin utilizing freely available data and weather forecasts

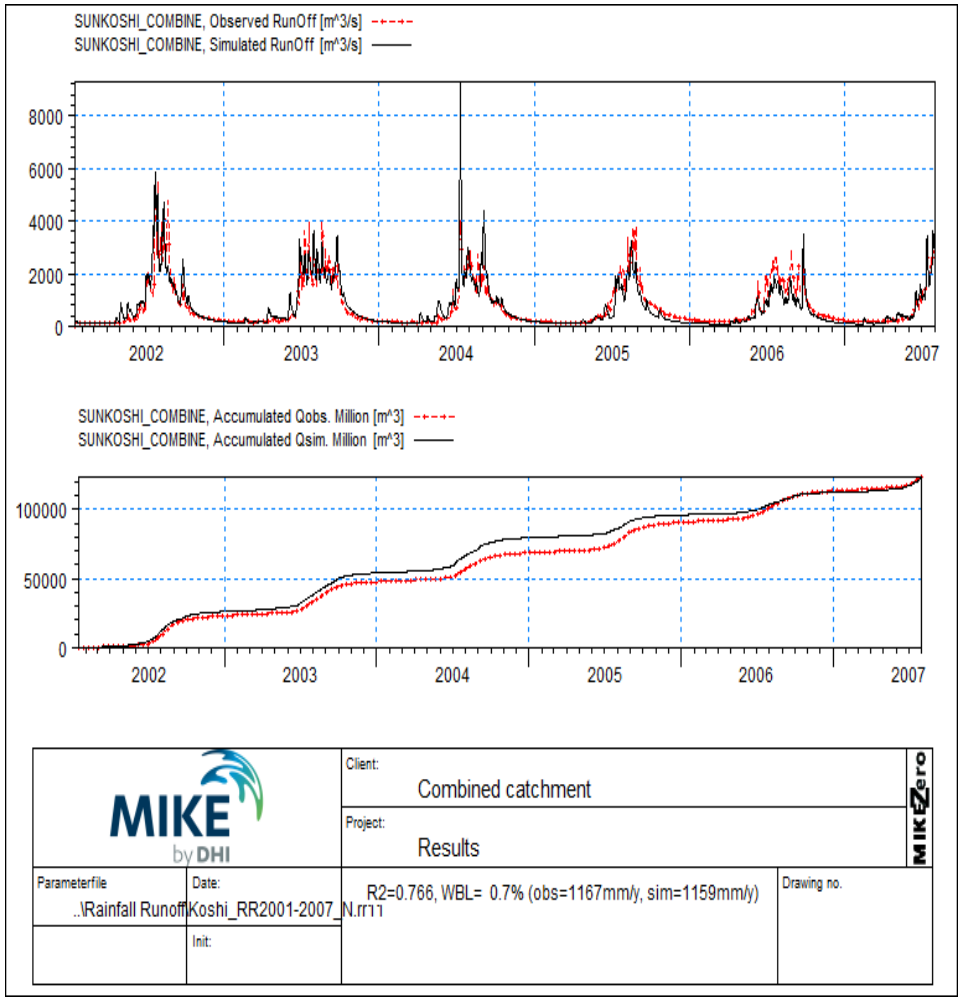
Mathematical model describing the **precipitation-runoff process** in the catchments and **hydrodynamic flood routing** along the river system.

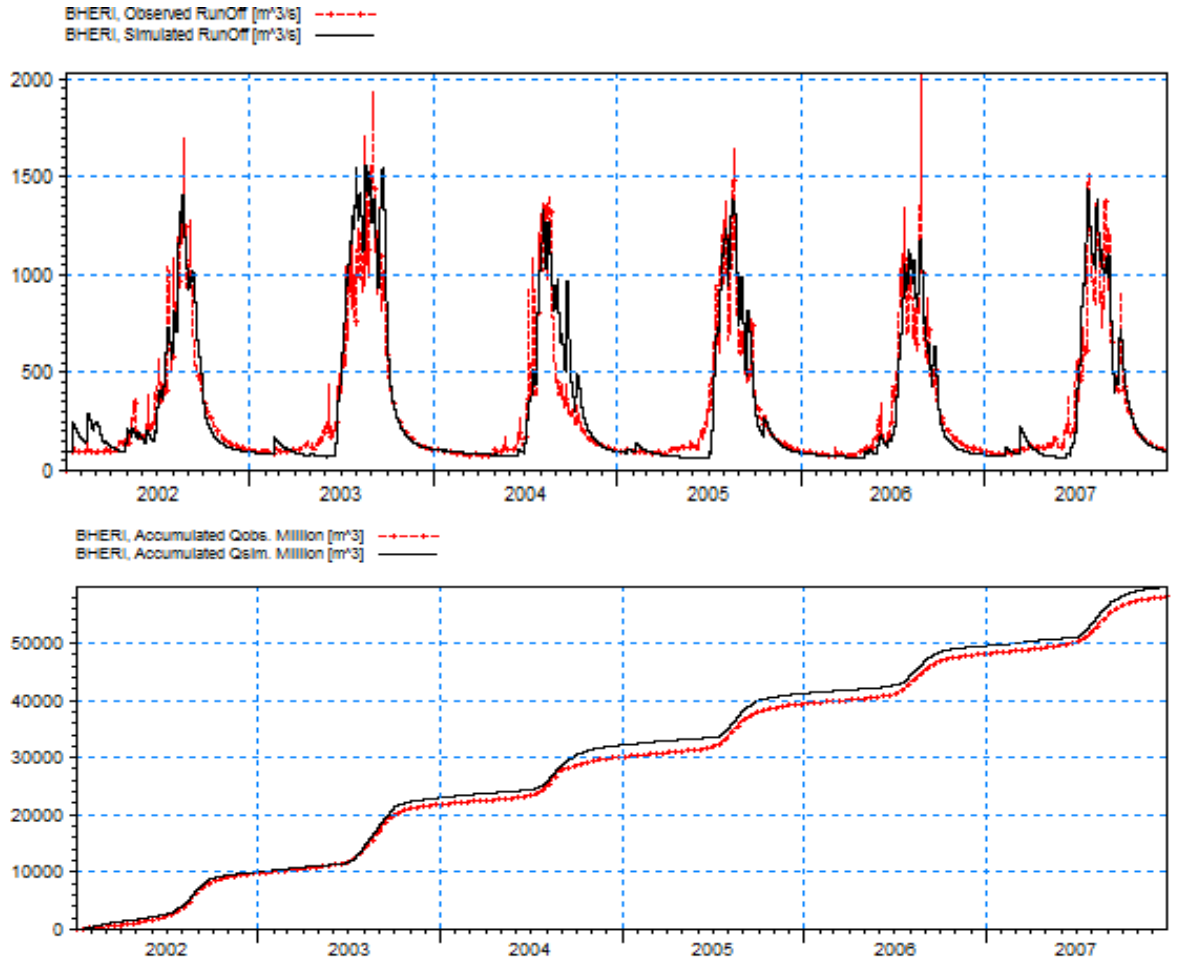


Schematic structure of the flood outlook system

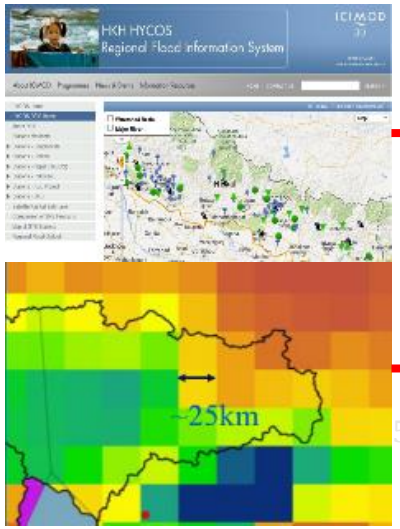


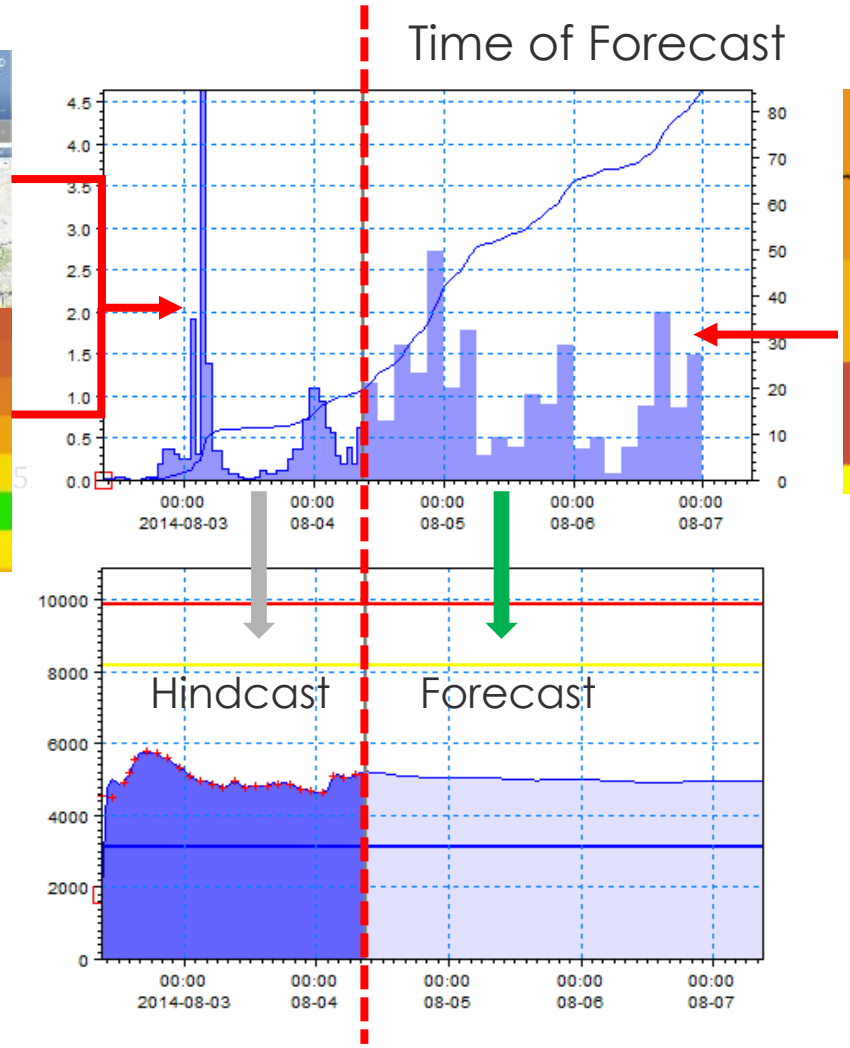
Calibration of rainfall-runoff (NAM) model

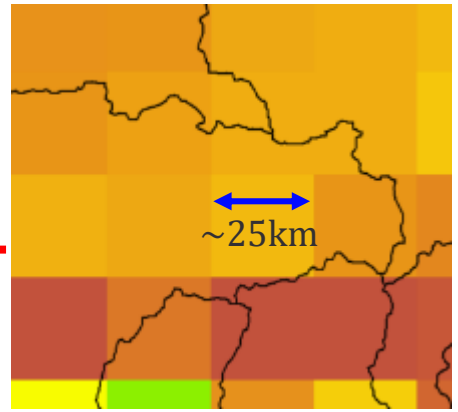




System of flow forecast







Hindcast (Observed RT data, TRMM (RT), NASA

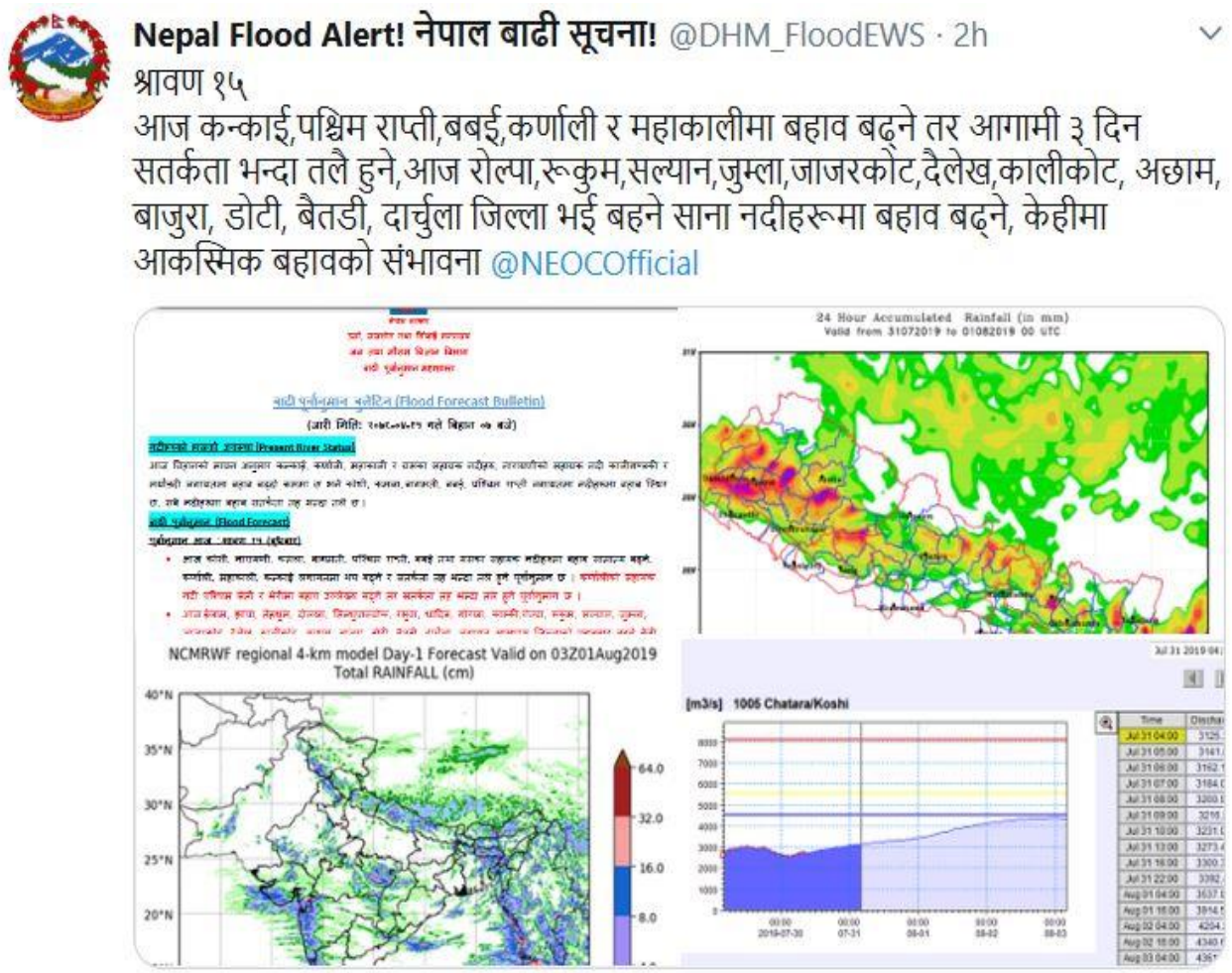
Quantitative Precipitation/ Temp Forecast (GFS, NOAA)

Use of flood outlook

DHM is using the flood outlook as one of the references for issuing the flood advisory

Real-time data assimilation to improve the forecast

DHM has developed dedicated models for two basins in Nepal – Koshi and the West Rapti



Key Messages

Satellite rainfall estimate provides spatial and temporal variability of precipitation

Satellite rainfall estimates come with biases

Validation and Bias correction is required before application

Thank you

Protect the pulse