



# Design and Development of Earthquake/Seismic Activity Detection(prediction) System using NavIC Signals

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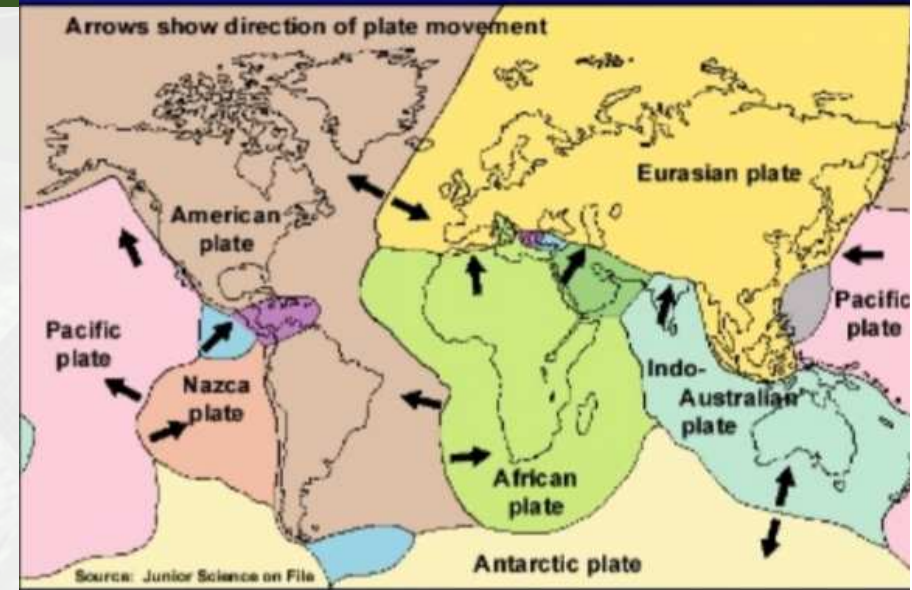
**Date  
ICG-14, Bengaluru**

- Introduction-Earthquake & Seismic waves
- Introduction-Ionosphere
- Physics behind Co-seismic ionospheric disturbances
- Need for Seismic Activity Monitoring
- Ongoing Research
- Concept for Seismic Activity Monitoring
- Results
- Summary

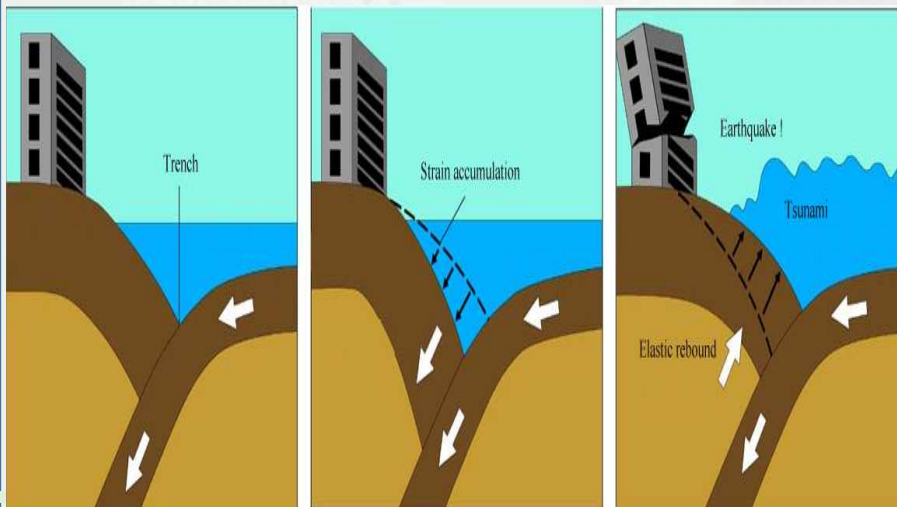
- **What is Earthquake?**

An earthquake is the result of a sudden release of stored energy in the earth's crust that creates seismic waves.

- **Seismology** is the study of the generation, propagation and recording of seismic waves in the Earth (and other celestial bodies) and of the sources that produce them.



### Tectonic plates getting stuck and putting a strain on the ground



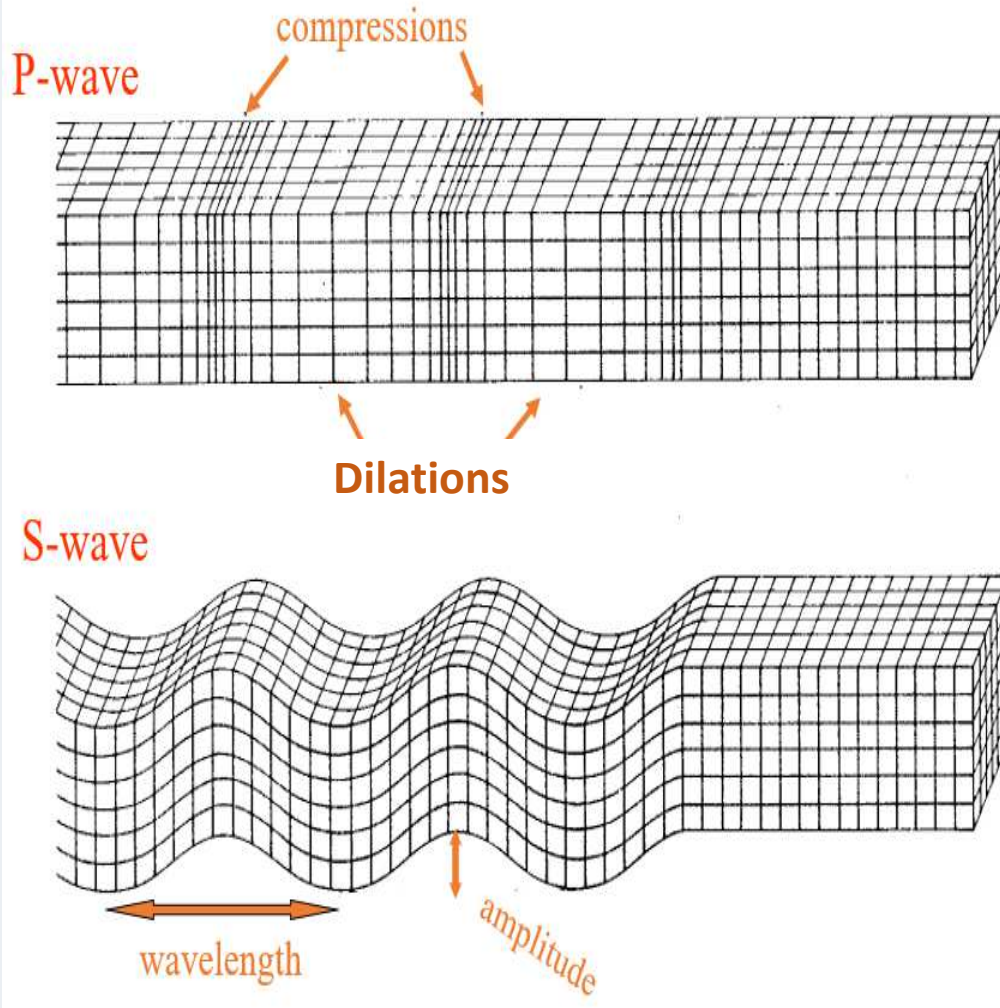
Class	Magnitude	Impact
Great	8 and more	Total destruction
Major	7-7.9	Serious damage
Strong	6-6.9	Damage in populated area
Moderate	5-5.9	Slight damage

### Modified Mercalli Intensity Scale

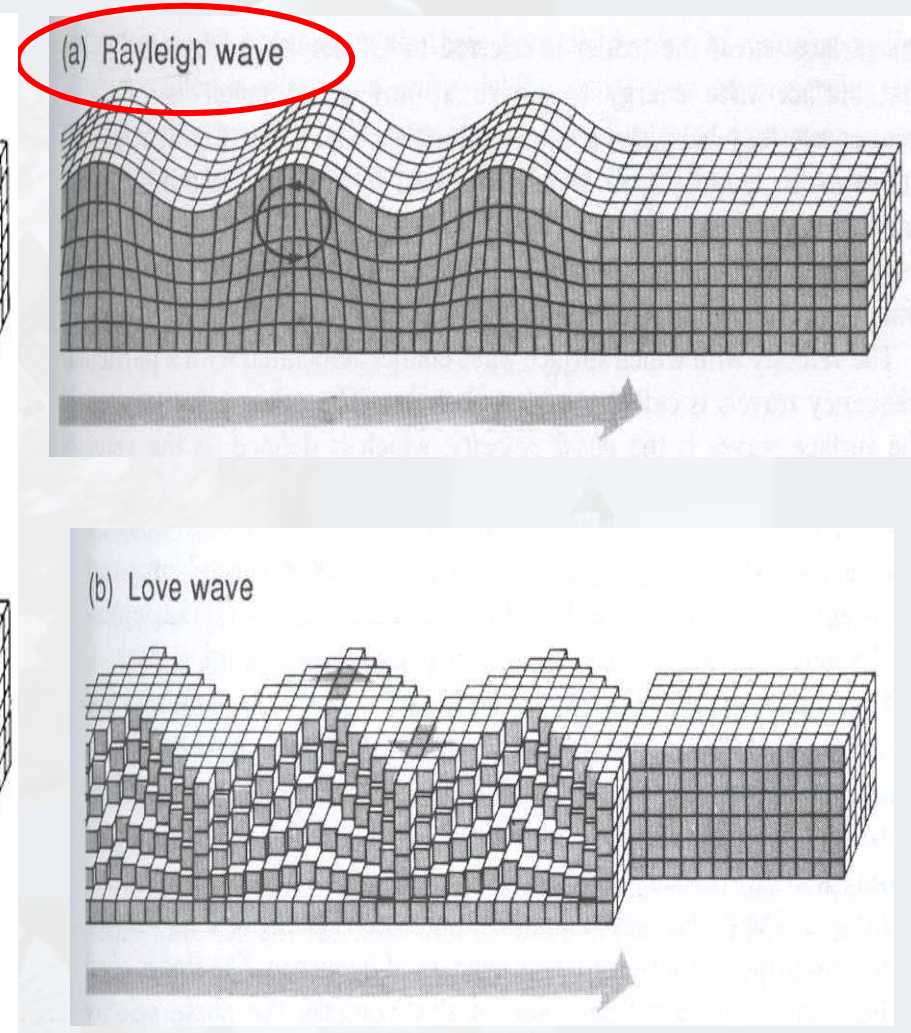
- I Not felt
- II Felt only by persons at rest
- III-IV Felt by persons indoors only
- V-VI Felt by all; some damage to plaster, chimneys
- VII People run outdoors, damage to poorly built structures
- VIII Well-built structures slightly damaged; poorly built structures suffer major damage
- IX Buildings shifted off foundations
- X Some well-built structures destroyed
- XI Few masonry structures remain standing; bridges destroyed
- XII Damage total; waves seen on ground; objects thrown into air

# Seismic Waves

## Body Waves

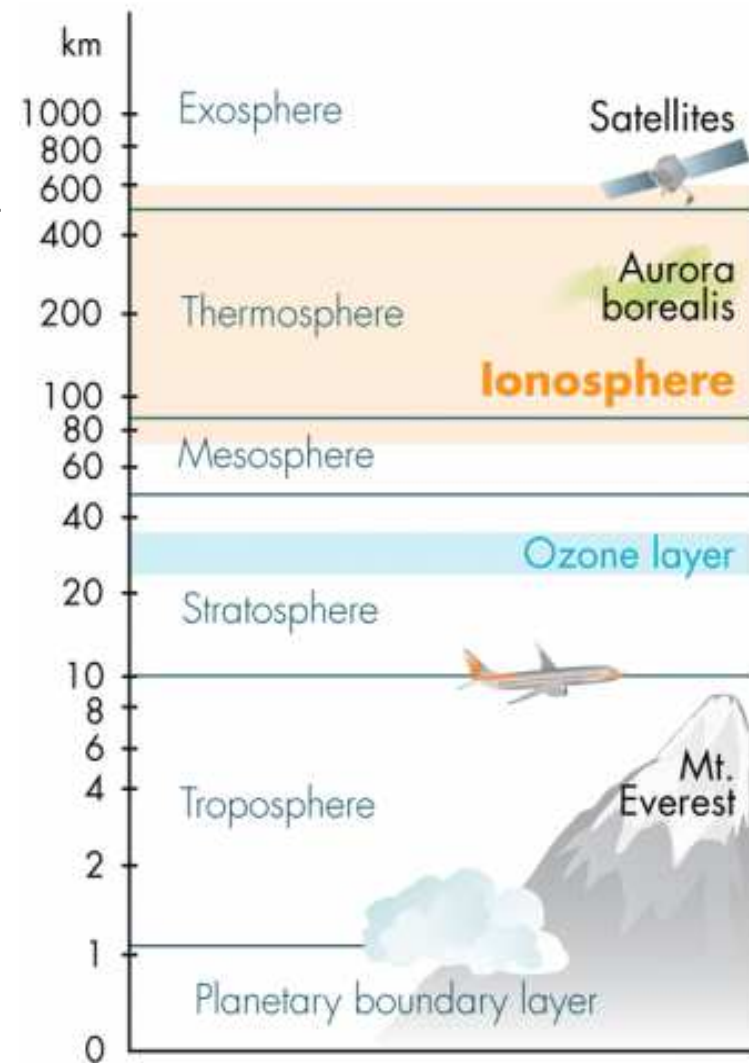
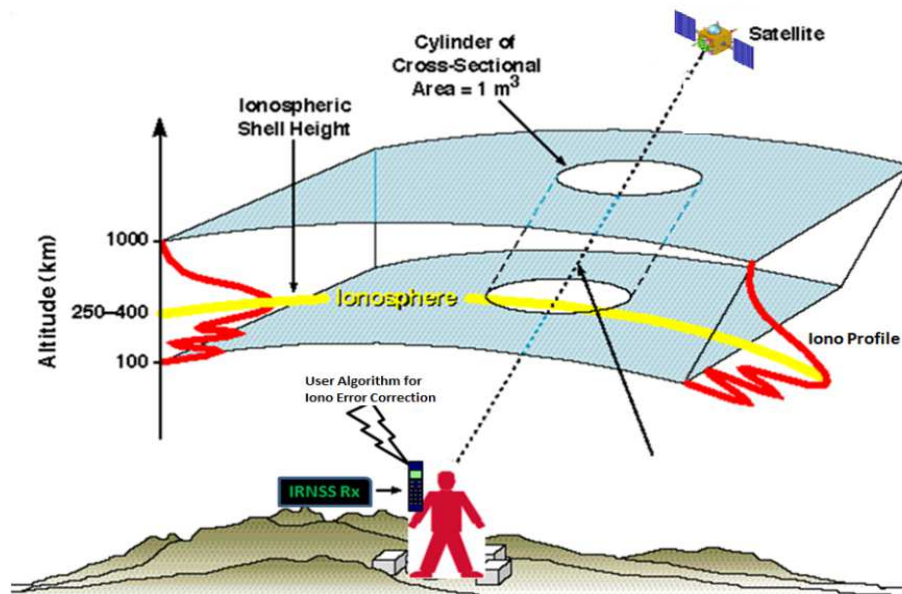


## Surface Waves

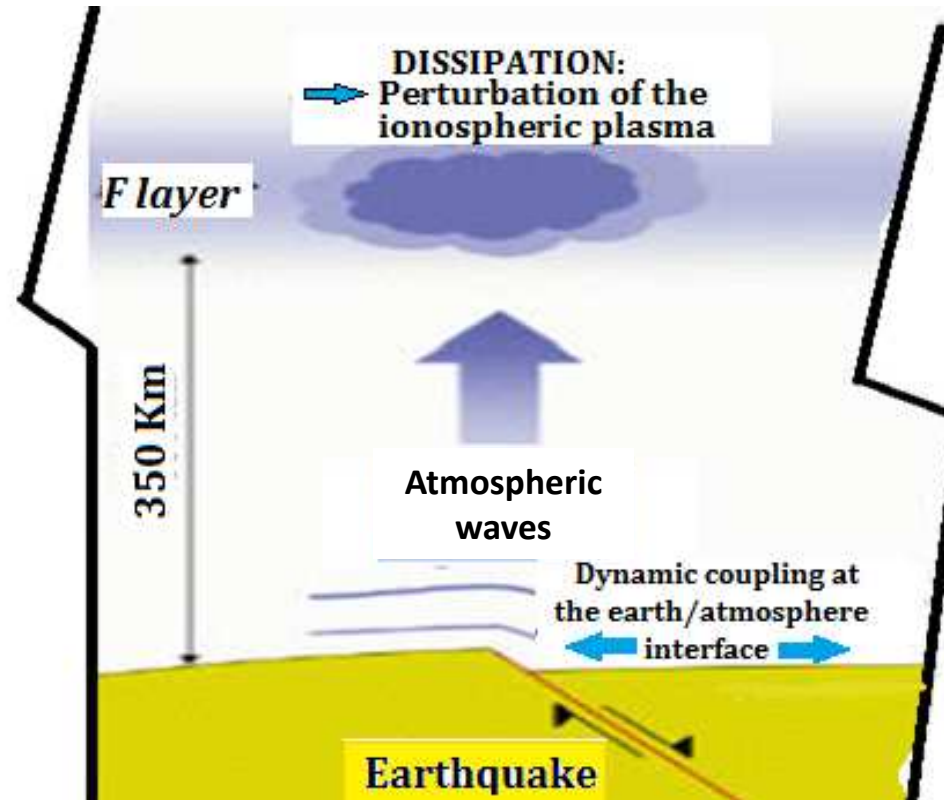


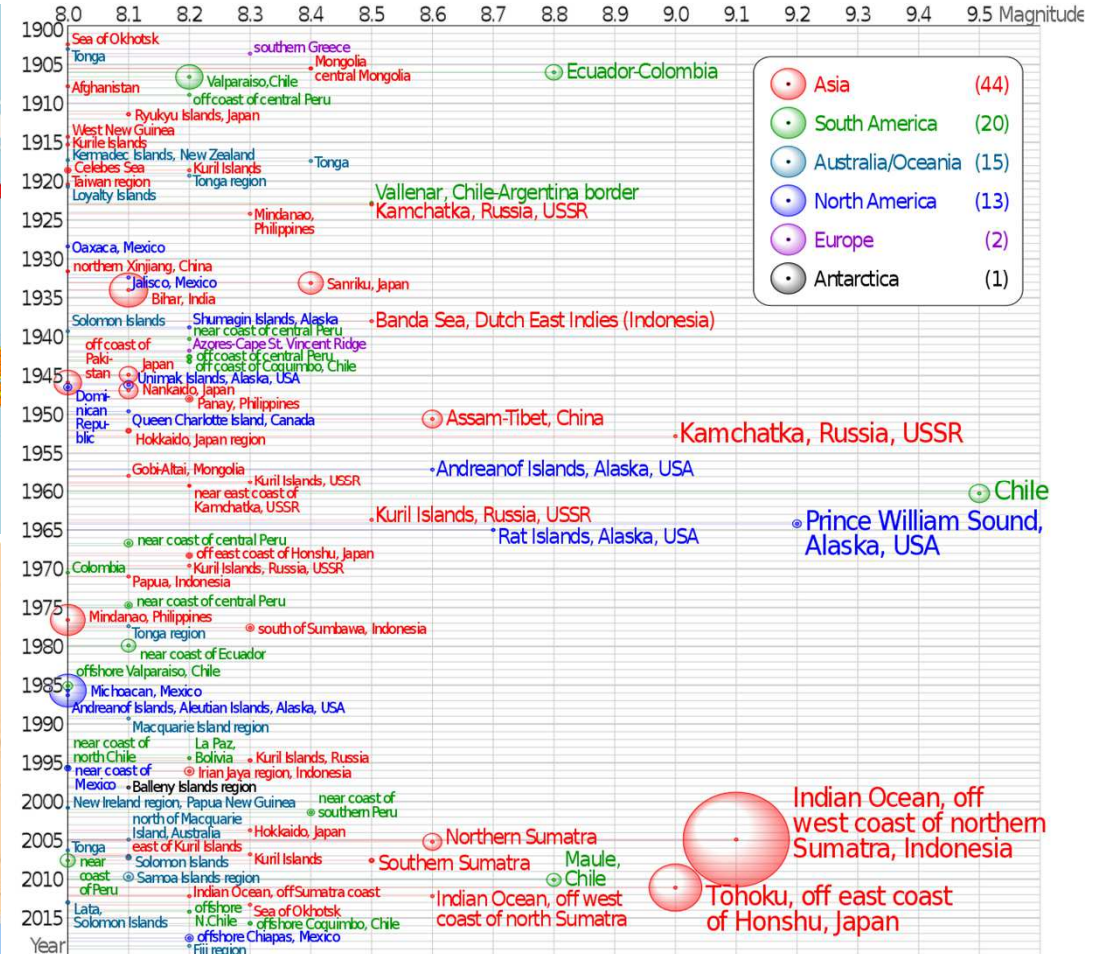
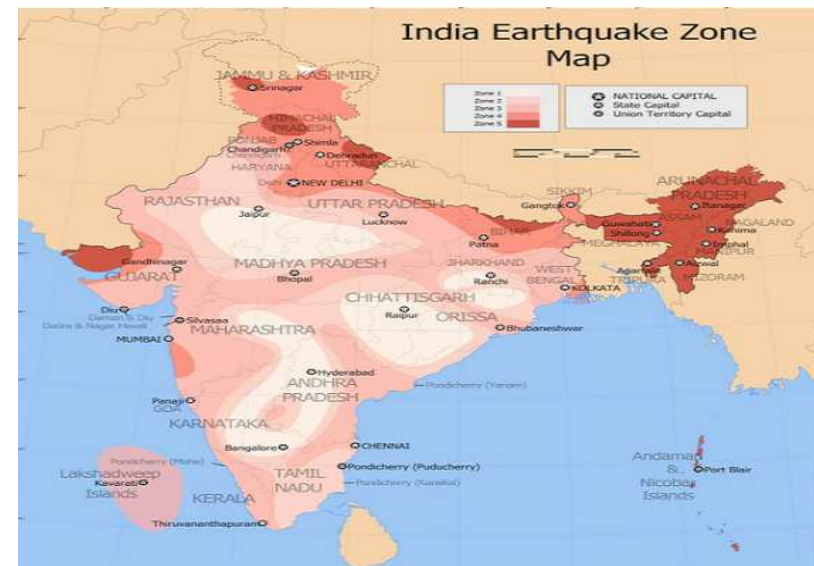
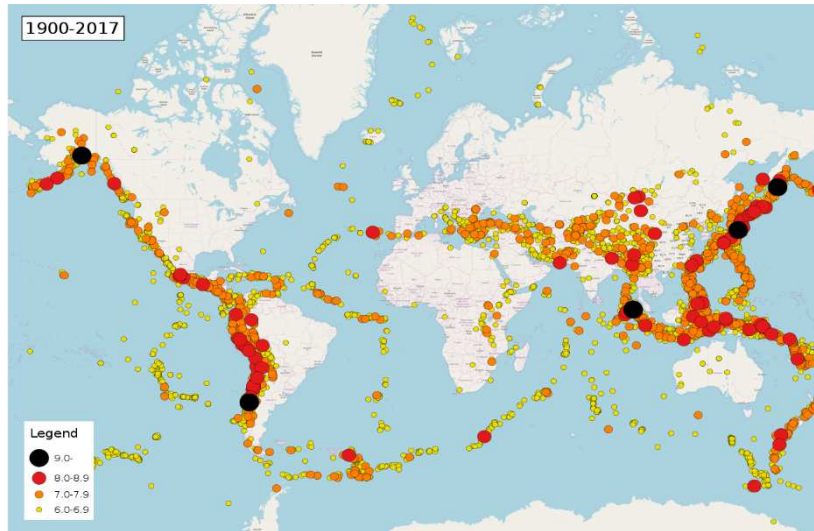
- Ionosphere is defined as the layer of the earth's atmosphere that is ionized by solar and cosmic radiation
- It is formed when energetic electromagnetic and particle radiation from the sun and space ionize air molecules in the upper atmosphere.

## Mapping Ionosphere Using NavIC Signals



# Physics Behind Pre and Post Co-Seismic Ionospheric Disturbances





The reason for the frequent earthquakes in Indian sub continent is due to Indian plate driving into Asia at a rate of approximately 47mm/year.

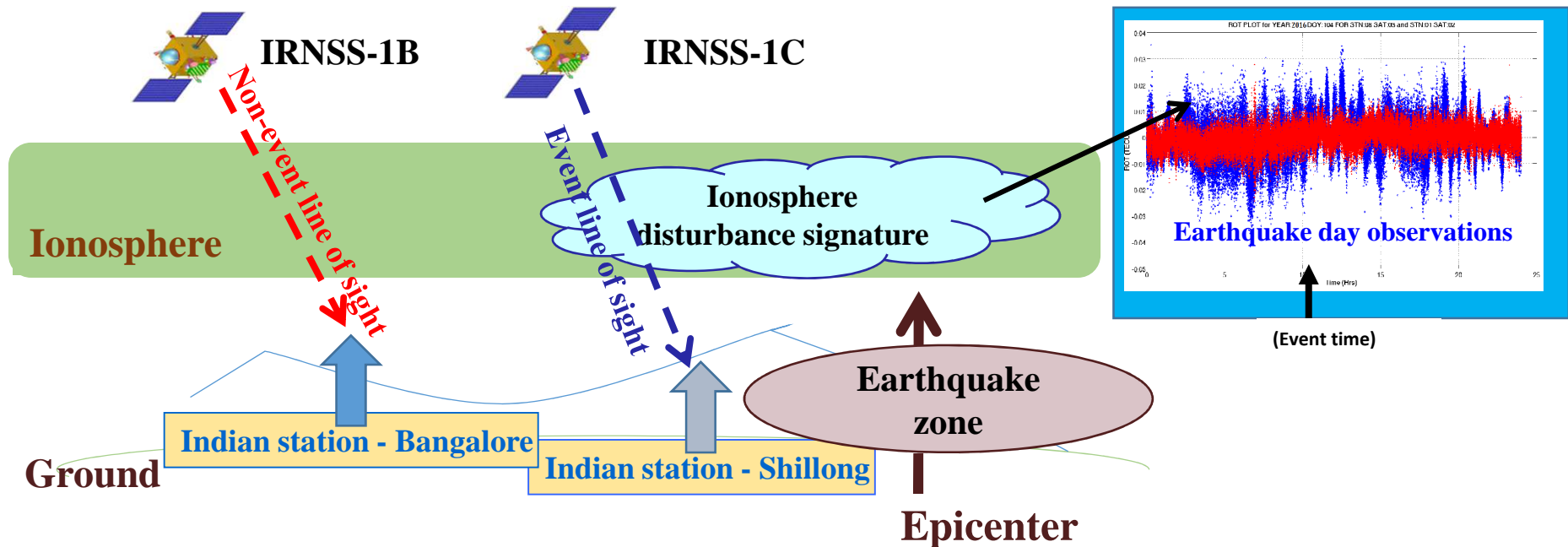
- Magnitude wise TEC variation study.
- Epicenter-Station geodetic distance based seismic activity observation study.
- Space based distance and spread of Ionospheric disturbances.
- Usage of solar and magnetic activity related information. (for filtering data)
- **Indian stations availability near identified seismic zone.**



# Concept for Seismic Activity Monitoring Using NavIC Signals

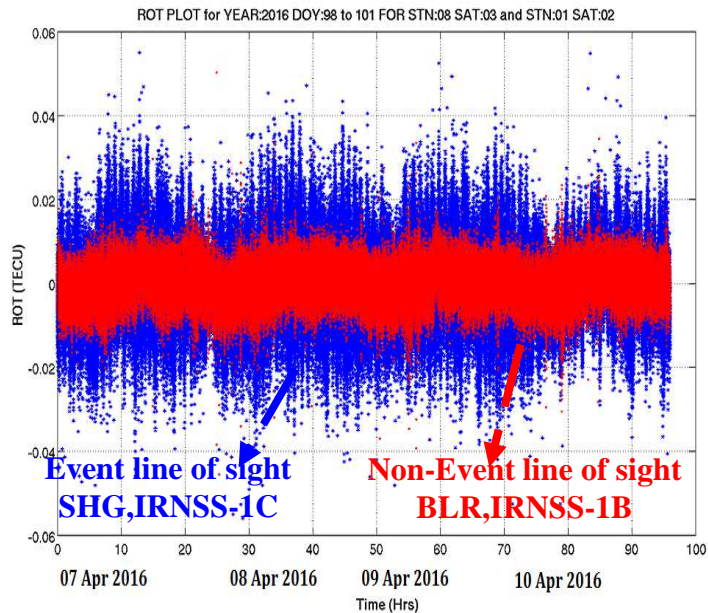
**Objective:** To build seismic activity detection (prediction) system using NavIC Signals

**Concept (Methodology):**

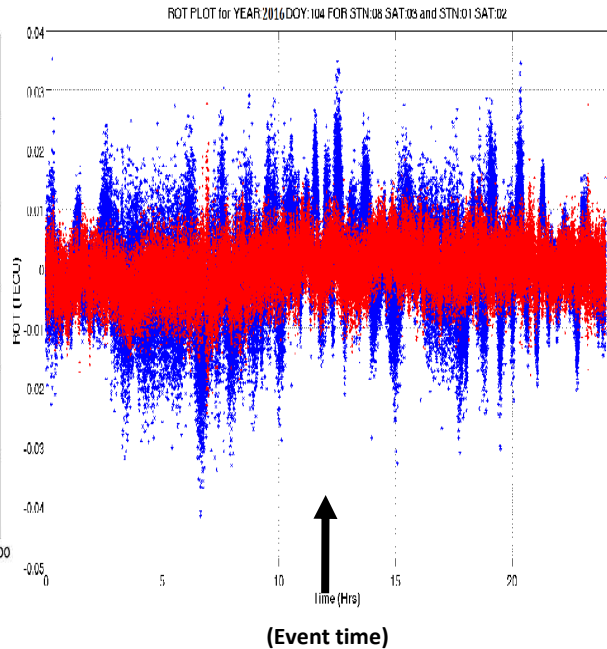


First time **NavIC ionospheric data has been used to detect** Earthquake that occurred in Myanmar 135 km (84 miles) north-west of Mandalay on April 13, 2016 with a maximum intensity of VI (Strong) at 8:25 pm LT (13:55 UTC)

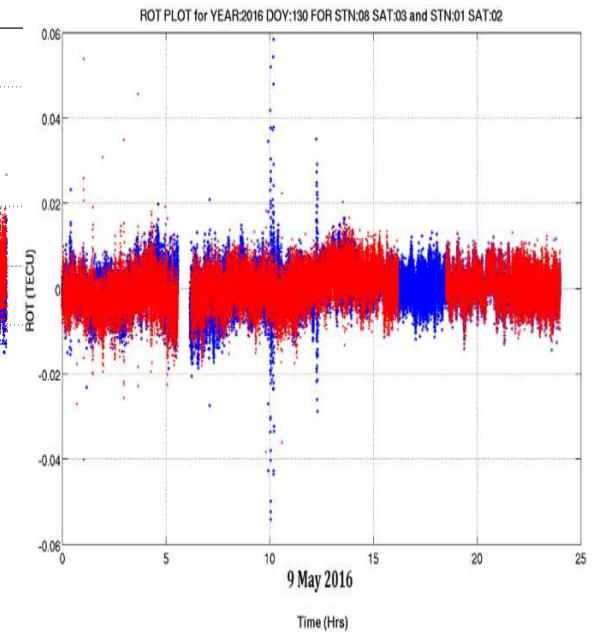
**Pre earthquake observations**



**Earthquake day observations**



**Post earthquake observations**



- A new Concept/Methodology for Seismic Activity Monitoring in Indian region has been designed and developed using the regional NavIC System signals as input in near real time.
- Further refinement and validation of the developed concept is in progress.

