NISAR Mission

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NISAR Mission: Monitoring Earth's Surface with Unmatched Accuracy

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Context

India has marked a major milestone in its space and climate science journey with the successful launch of the **NISAR (NASA-ISRO Synthetic Aperture Radar)** satellite from the **Satish Dhawan Space Centre in Sriharikota**. This mission is a significant example of international collaboration between India and the United States in space research, particularly in the field of Earth observation and climate monitoring.

Introduction

NISAR is a joint mission developed by the **Indian Space Research Organisation (ISRO)** and the **National Aeronautics and Space Administration (NASA)**. It is the **world's first dual-frequency radar imaging satellite** designed to observe and monitor dynamic changes on the Earth's surface with high precision. The mission is expected to enhance understanding of natural disasters, climate change, agricultural patterns, and ecosystem transformations.

Key Features and Objectives of NISAR

- **Full form**: NASA-ISRO Synthetic Aperture Radar
- **Launch Vehicle**: **GSLV Mk-II (LVM3)**
- **Orbit**: Sun-synchronous polar orbit at **747 km altitude** with **98.4º inclination**
- **Mission duration**: **3 years**, with a **design life of at least 5 years**

Major Objectives

- Study changes in the Earth's surface, including **earthquakes, volcanoes, landslides, floods**, and **ice sheet dynamics**
- Monitor **ecosystems**, **farmland productivity**, and **forest biomass**
- Capture **high-resolution data** with a spatial resolution of **3–10 metres** and vertical mapping at **centimetre scale**
- Provide repeated scans of each area **every 12 days**

Technical Highlights

- **Synthetic Aperture Radar (SAR)** uses motion of radar antennas to produce fine-resolution images
- **L-band SAR (1.257 GHz)** penetrates vegetation and soil to detect ground deformations
- **S-band SAR (3.2 GHz)** captures surface-level features like crops and water
- Operates in both **horizontal and vertical polarisation**, enabling material identification
- **Swath width** of **240 km** without sacrificing image clarity
- Employs **scan-on-receive** technology for wide-area coverage

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Contribution of India and the US

ISRO contributed:

- **I-3K spacecraft bus**, **4 kW solar power system**, **S-band radar electronics**
- **Ka-band telecom subsystem**, **launch services**, and **high-gain antenna**

- Ground stations at **Shadnagar** and **Antarctica**

NASA contributed:

- Complete **L-band SAR system**, **12-m antenna**, **9-m carbon boom**
- **GPS receiver**, **solid-state recorder**, **Ka-band communication system**
- Oversight of **mission operations from Jet Propulsion Laboratory (JPL)**

Mission Operations and Data Sharing

- **Flight operations** managed by ISRO's **Bengaluru centre**
- Data transmitted via **NASA's Near-Earth Network** in **Alaska, Norway**, and **Chile**
- Capable of transmitting **3 TB of data per day**
- Processed and distributed in India by **National Remote Sensing Centre (NRSC)**
- **S-band radar** focused on India-specific data for **soil moisture** and **biomass mapping**
- Dual radar operations planned to **minimise mode conflicts** over Indian territory

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Working Mechanism

- Once in orbit, **NISAR** bounces radar pulses off the Earth's surface
- Measures **time delay** and **phase shift** of returning signals
- Combines multiple echoes to generate high-quality, coherent images
- Uses **different polarisations** to distinguish between **soil, water, snow, vegetation, and infrastructure**

- Enables **continuous monitoring**, regardless of **weather conditions or daylight**

Significance of the NISAR Mission

- **First dual-frequency radar satellite** for Earth observation
- Operates **day and night**, through **clouds, smoke**, and **dense forest cover**
- Delivers **annual maps** of aboveground biomass at **1 ha resolution**
- Produces **quarterly cropland maps** and **flood mapping data**
- Provides **damage proxy maps** during disasters within **five hours**
- **Open-access data policy** ensures benefits for researchers and governments worldwide

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Conclusion

The launch of **NISAR** underscores India's growing expertise in advanced space technology and reinforces the strength of its international partnerships. By offering comprehensive, high-resolution data on Earth's dynamic systems, the mission will serve as a vital tool for **disaster response, climate adaptation**, and **sustainable development planning**. NISAR is poised to transform the way Earth is monitored, making a profound contribution to both **scientific research** and **policy-making** in the years ahead.