The Role of RADARSAT-2 for Flood and Agriculture Monitoring

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Outline

- **Introduction**

- **RADARSAT-2 overview**

- **Applications**
  - Flood mapping
  - Agricultural monitoring

- **Summary**

Introduction

- RADARSAT-2 is a high capacity, multipolarized Synthetic Aperture Radar (SAR) satellite designed to meet the needs of operational and research users around the globe.

- Approximately 2200 images from RADARSAT-1 (since 1998) and RADARSAT-2 (since 2007) have been used in India for:
  - rice crop monitoring for the Indian Space Research Organization CAPE program (now called FASAL);
  - flood monitoring.

- RISAT and RADARSAT-1/2 are both C-band SAR sensors that can be combined in a virtual constellation to improve spatial coverage and increase re-visit for agriculture and flood monitoring.

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RADARSAT-2 Features

- Polarimetric modes
  - single/dual polarization
  - quad-pol

- High resolution:
  - Multi-look 10 m
  - UltraFine 3 m
  - SpotLight (0.8 m az)

- Right and left-looking capability

- Enhanced ground system providing:
  - efficient satellite tasking (12 - 24 hours routine)
  - fast data processing
  - data encryption for security
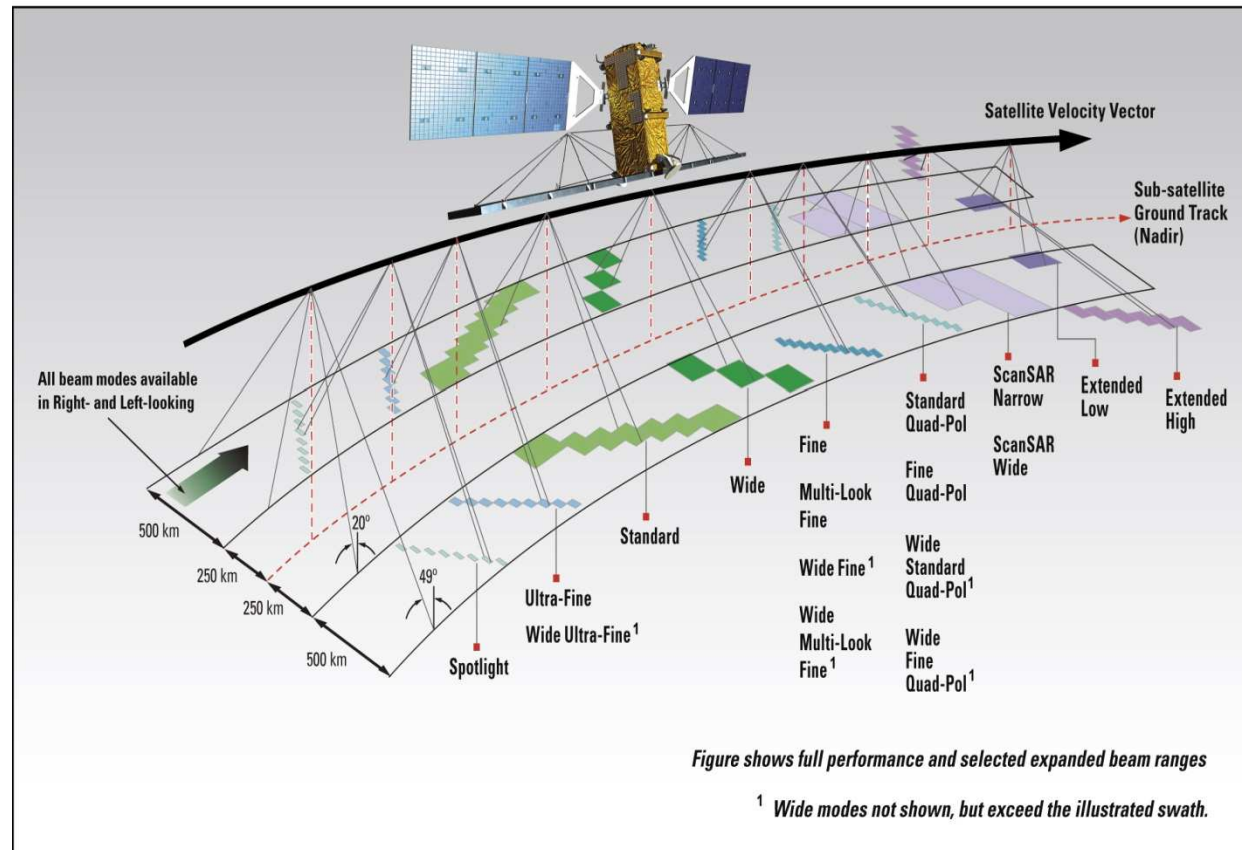
RADARSAT-2 Beam Mode Coverage
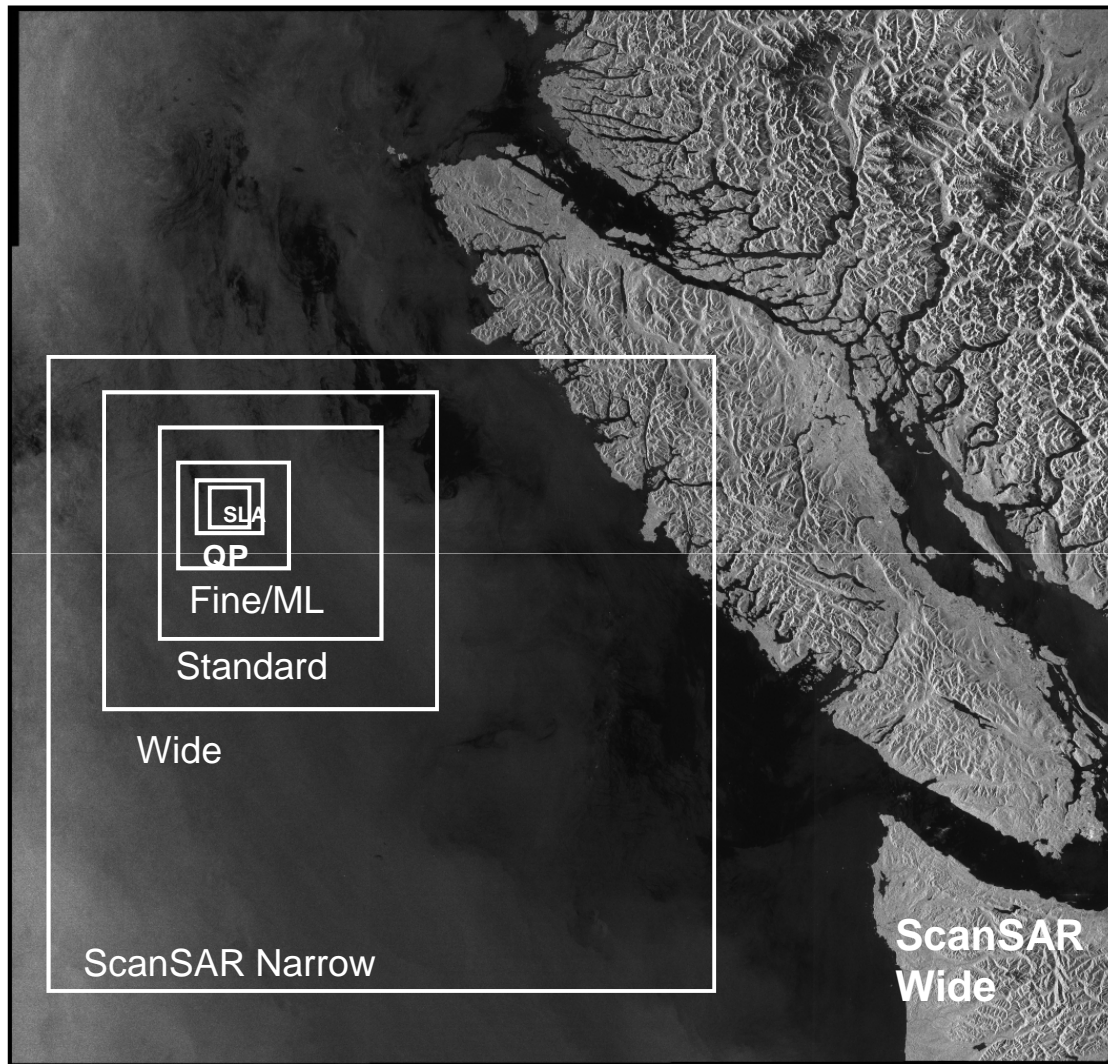
- **ScanSAR Wide**
 - 500 km x 500 km
  - 100 m res
- **ScanSAR Narrow**
  - 300 km x 300 km
  - 50 m res
- **Wide**
  - 140 km x 140 km
  - 30 m res
- **Standard**
  - 100 km x 100 km
  - 25 m res
- **Fine/ML**
  - 50 km x 50 km
  - 10 m res
- **Quad Standard**
  - 25 km x 25 km
  - 25 m res
- **Quad Fine**
  - 25 km x 25 km
  - 10 m
- **SpotLight**
  - 10 km x 20 km
  - .8m x 2.2 m res

(Nominal values)

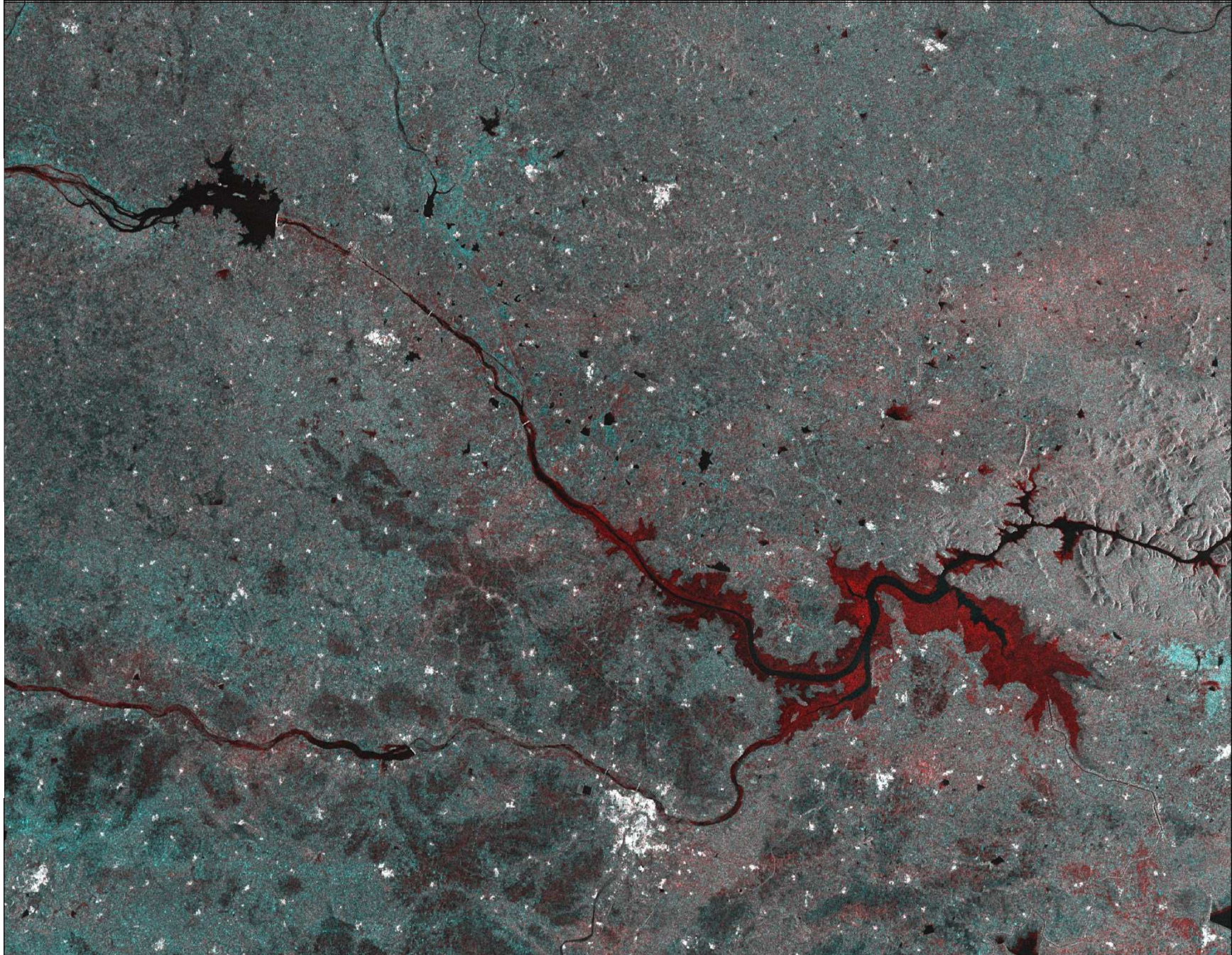**MDA**

Flood Monitoring

- Flood monitoring is a well-proven, operational SAR application

- Flooded areas can be readily detected on the SAR image due to the sharp contrast between the flooded and non-flooded areas

- Various imaging modes are used for flood monitoring:
  - wide-swath modes provide coverage of the overall extent of the flooding
  - high resolution modes provide detailed images that can be used to map flood extent with respect to critical infrastructure.

April 8, 2011   April 15, 2011   April 18, 2011

April 20, 2011   April 22, 2011   May 3, 2011
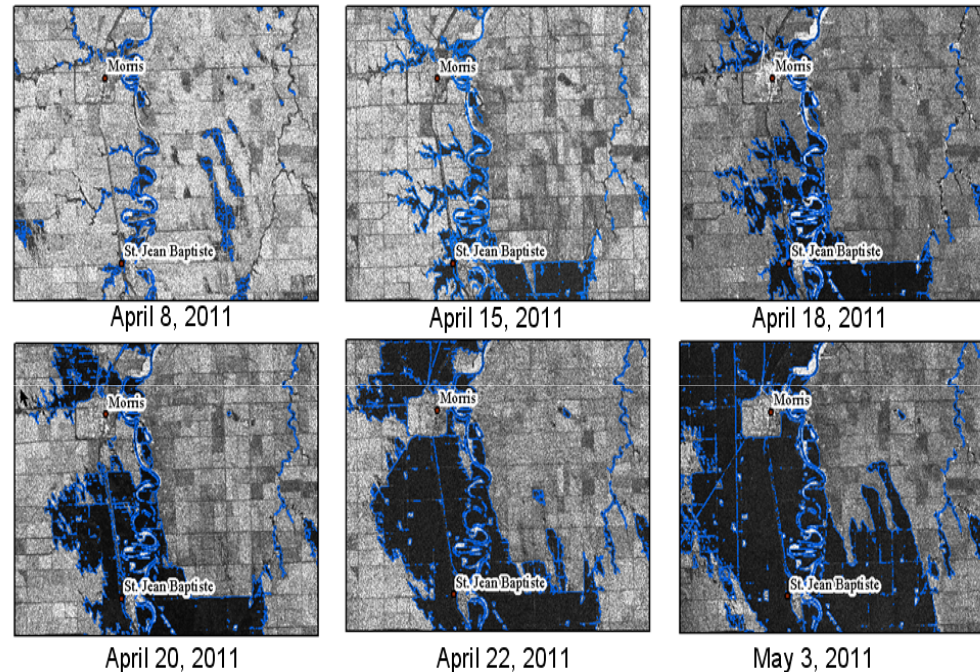
Flood extent from April to May, Manitoba, Canada

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Synergy of RISAT and RADARSAT-2
Flood Monitoring

- RISAT and RADARSAT-2 can be combined in a virtual constellation to:
  - Increase spatial coverage to image the flood extent
  - Increase the re-visit to assess flood increase
 - Monitor overall flood extent and areas of critical infrastructure

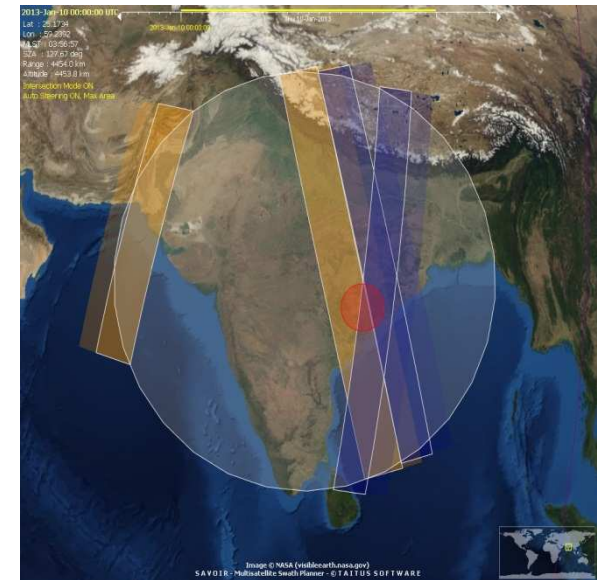| RISAT	RADARSAT-2
Fine Resolution Stripmap Mode-1 (3 m resolution, 25 km swath)	UltraFine (3 m resolution, 20 km swath)
Fine Resolution Stripmap Mode-2 (12 m, quad-pol, 30 km swath)	Fine quad-pol (10 m resolution, 25-50 km swath)
Medium Resolution ScanSAR (25 m resolution, 120 km swath)	Standard (25 m resolution, 100 km swath)
Coarse Resolution ScanSAR (50 m resolution, 240 km swath)	ScanSAR Narrow (50 m resolution, 300 km swath)
High Resolution Spotlight Mode (2 m resolution, 10 km swath)	SpotLight (0.8 m x 2.2 m resolution, 18 rg x 8 az km swath)

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Increasing Re-visit with RISAT and RADARSAT-2

- In a 25-day period the imaging opportunities increase to 18 from 10 when RISAT and RADARSAT-2 are used.
- There are two opportunities when RISAT and RADARSAT-2 image multiple times in a single day.
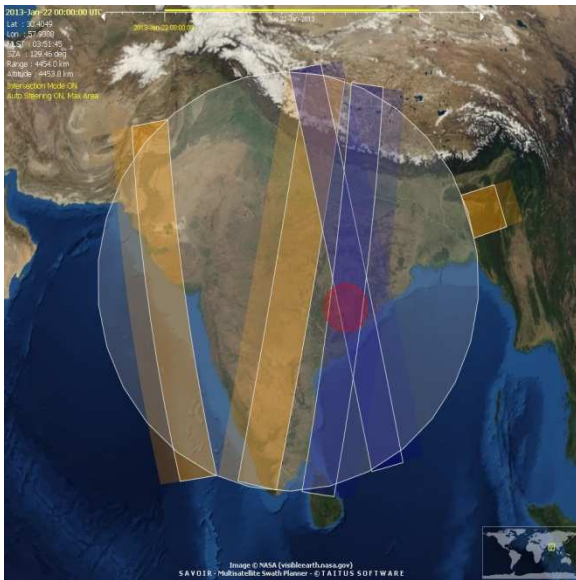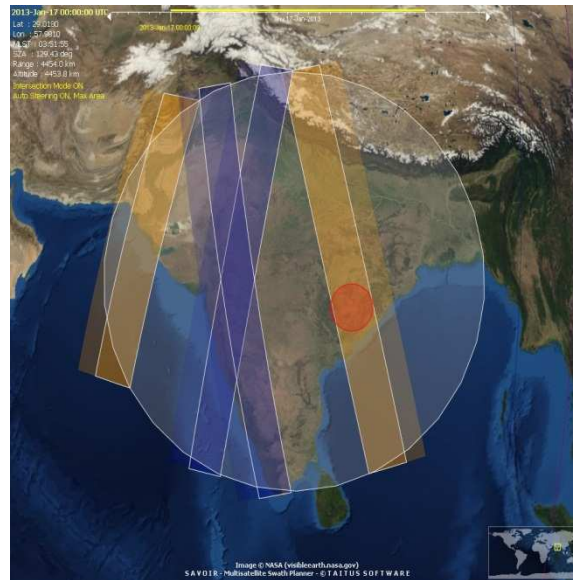
RISAT only: 10   RADARSAT-2 only: 8   RISAT+RADARSAT-2: 2

Agriculture

- Crop parameters of interest include:
  - Classification
  - Health
  - Yield

- Crop classification is viable with RADARSAT-2, but crop health and yield are still in the research phase

- Crop classification:
  - Dual-polarized data (VV+VH) provides a significant improvement in classification accuracy versus single-pol data
  - Quad-polarized data provides improvement with-respect-to dual-polarized, and may also provide classification results using fewer acquisitions or earlier in the cropping cycle relative to dual-polarized data
  - Data acquisition in the early part of the cropping cycle and 3-4 acquisitions afterwards provides good classification performance
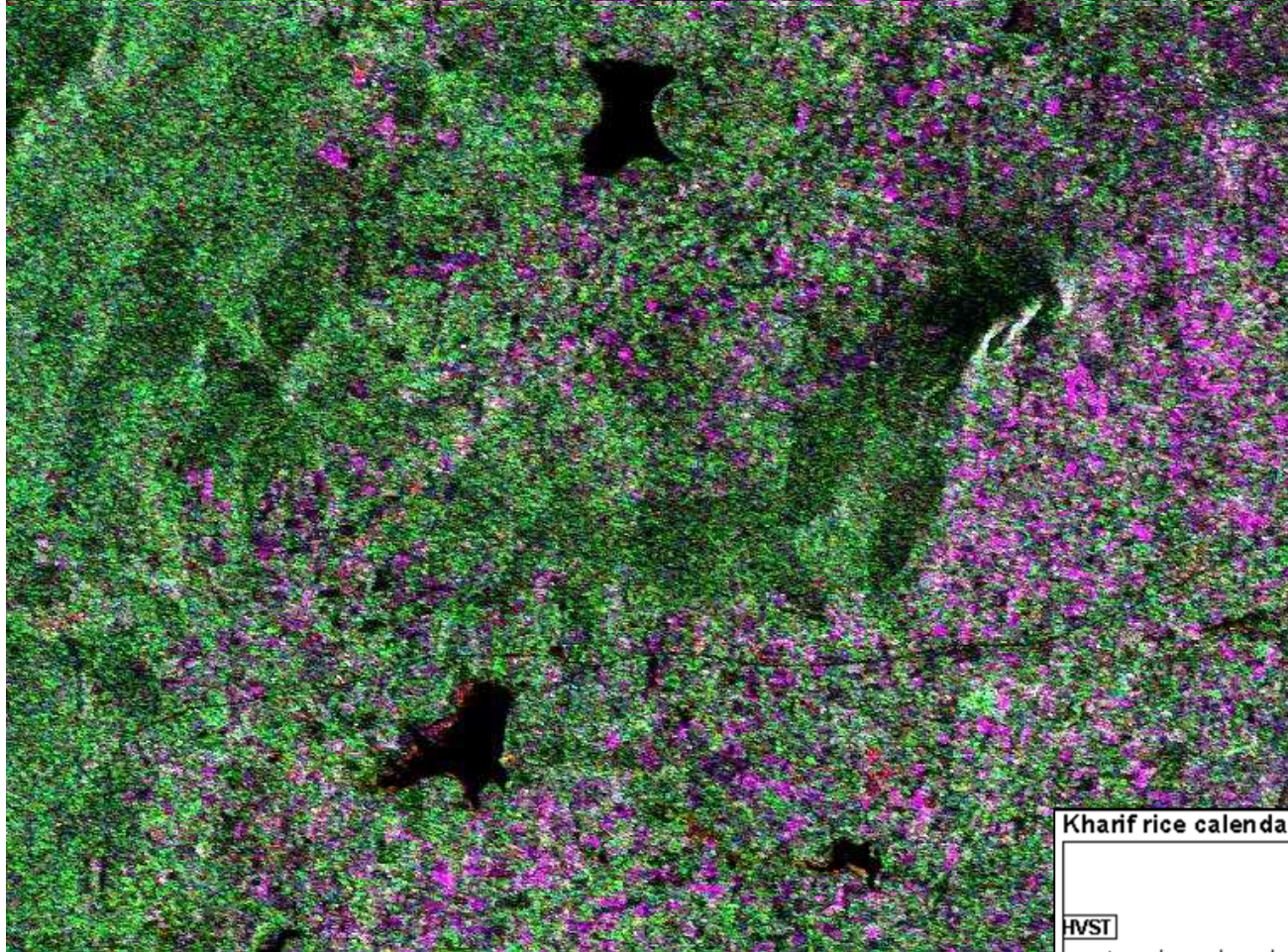
India Rice Crop Monitoring Example
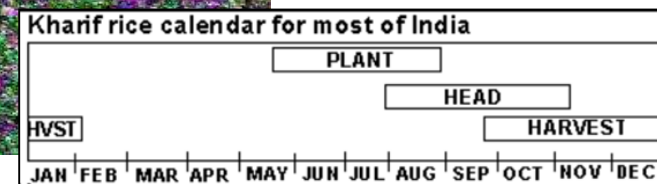

© Google™ earth

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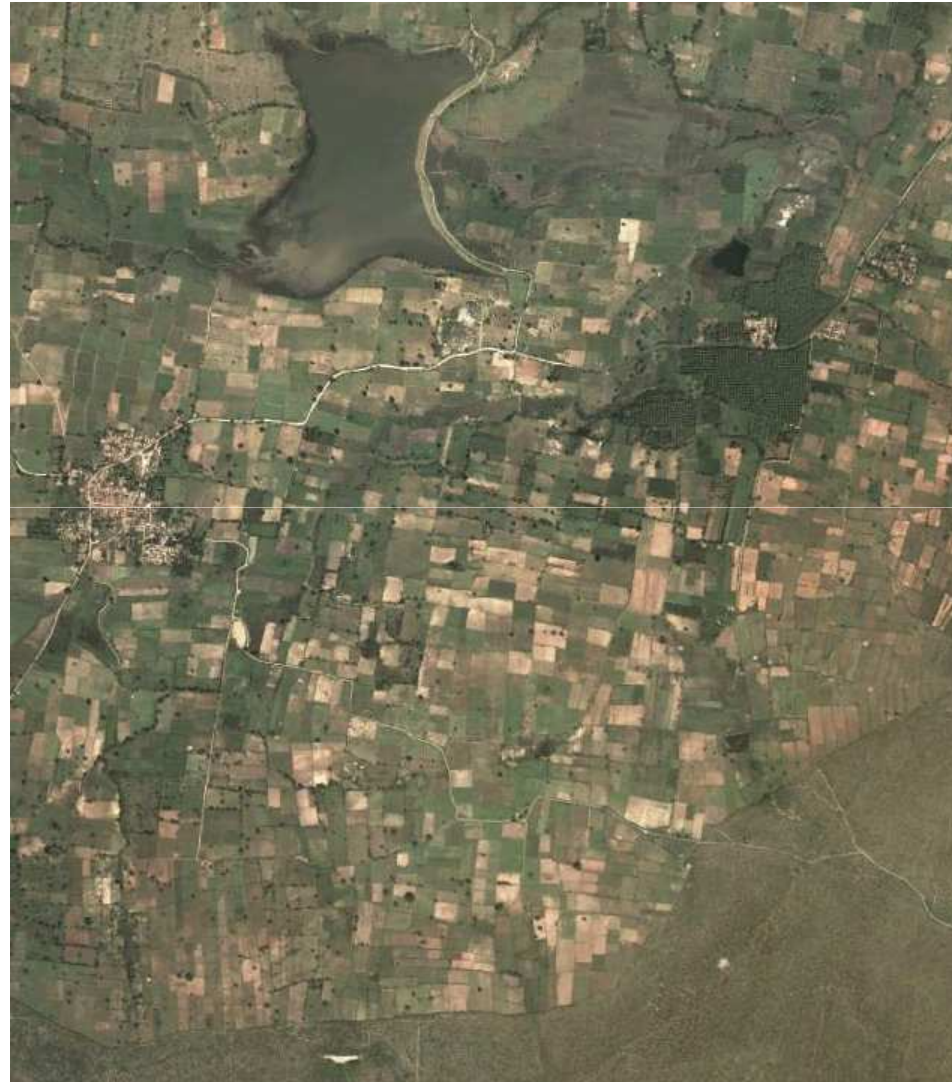
Rice Crop Growth Sequence

May 26

June 19

July 13

August 6

August 30

September 23

October 17

- Time series of RADARSAT-2 Fine Quad data showing rice cropping from fallow fields in May-June through heading July-October.
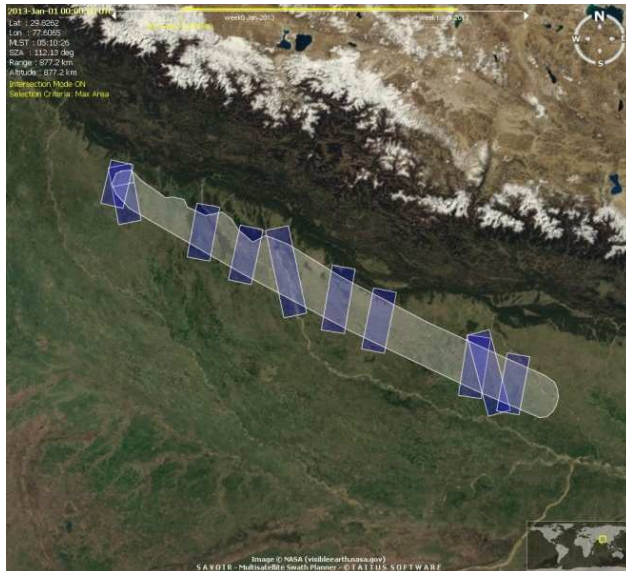
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Synergy of RISAT and RADARSAT-2
## Rice Crop Monitoring

- RISAT and RADARSAT-2 can be combined in a virtual constellation for
  - Increased spatial coverage to estimate crop area
  - Increased re-visit to provide quicker rice-crop area information
  - Crop classification, e.g. rice and jute

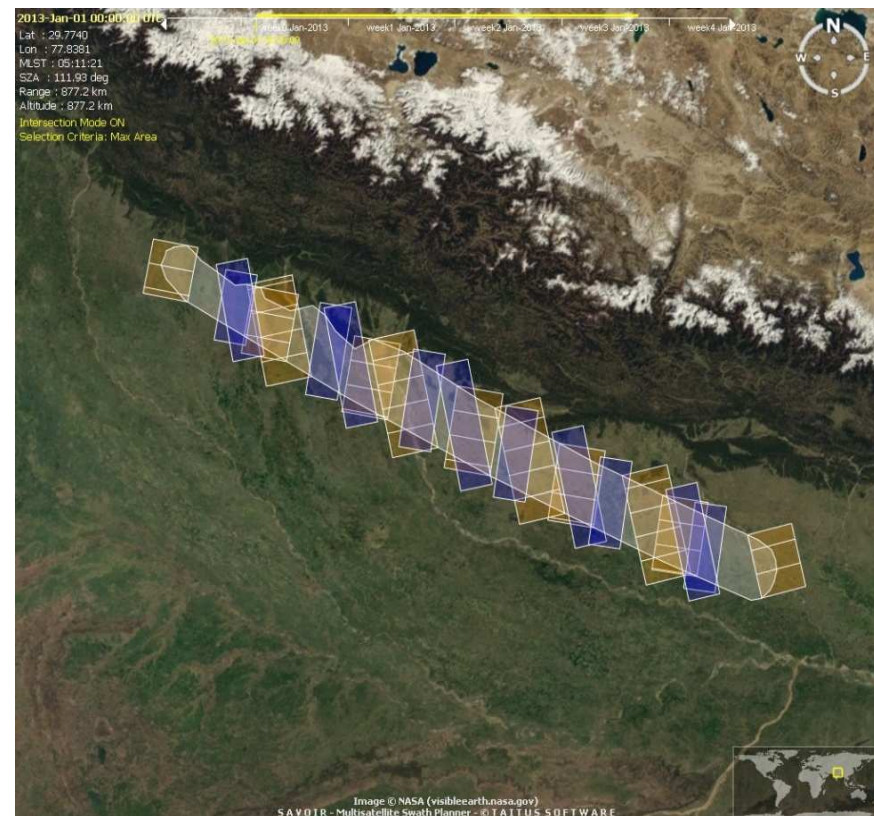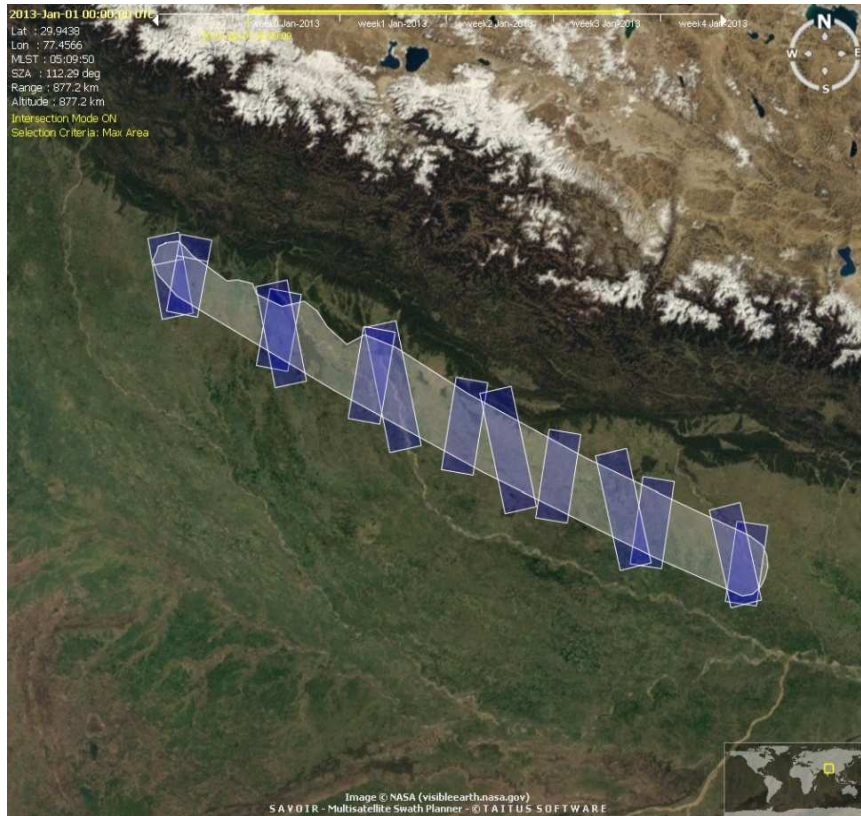| RISAT	RADARSAT-2
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Rice Crop Monitoring Example

- A major rice growing area in state of Uttar Pradesh was selected for analysis using RISAT and RADARSAT-2 quad-polarized data

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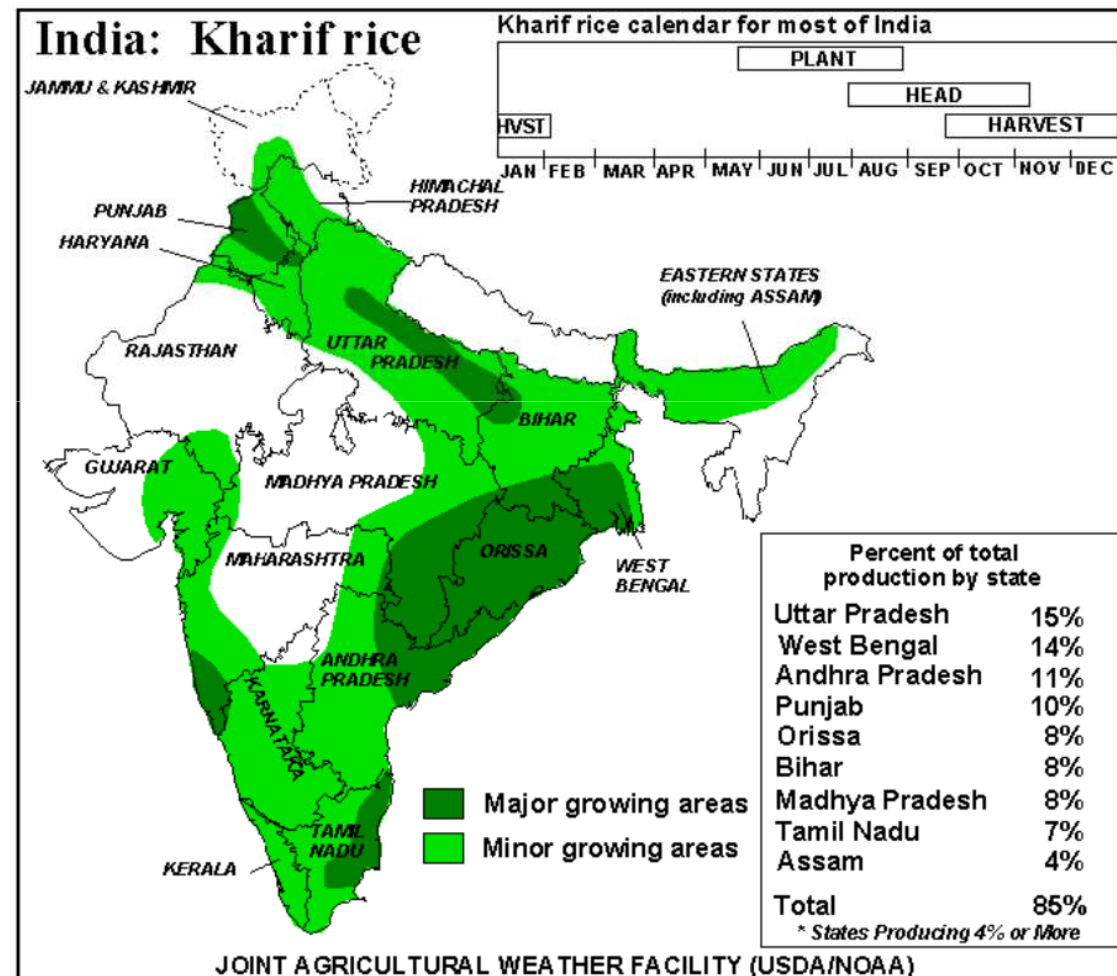
RISAT and RADARSAT-2 Provide Increased Spatial Coverage

- In a 25-day period, the region is approximately 50% covered using only RISAT (left). If RISAT and RADARSAT-2 are combined (right), the region is approximately 90% covered.

- Note that RISAT has a 25-day repeat cycle and RADARSAT-2 has a 24-day repeat cycle. The coverage is based on a fixed incidence angle.

RISAT and RADARSAT-2 Provide Faster Spatial Coverage
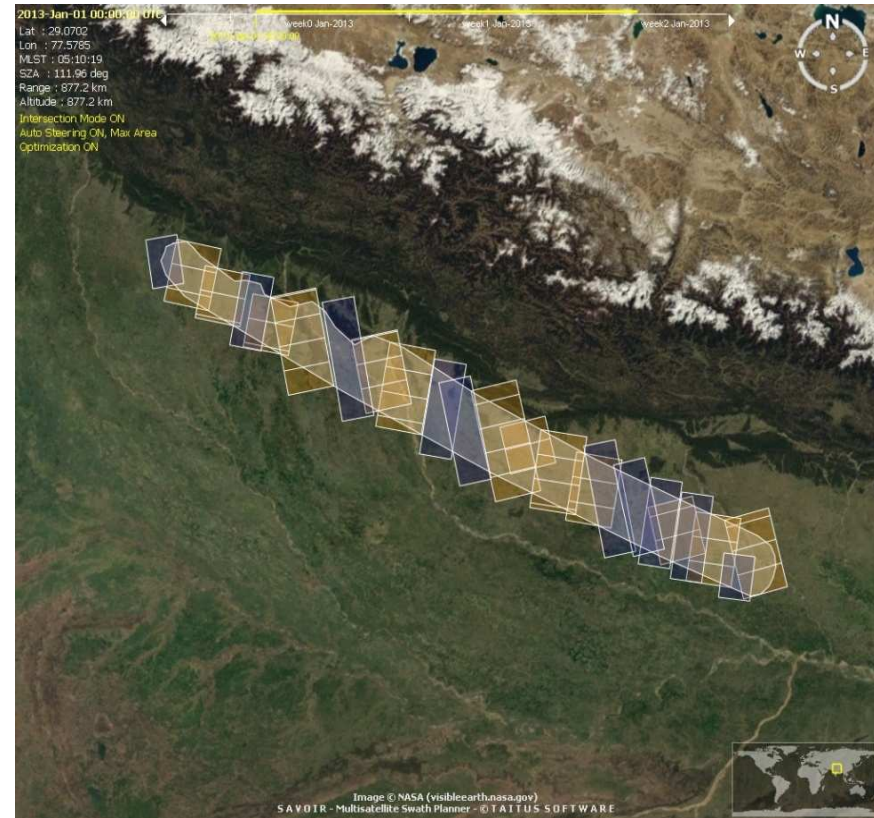
- Complete coverage using only RISAT requires 33 days (left). If RISAT and RADARSAT-2 are combined, complete coverage requires only 15 days.

- Note that the coverage is based on using multiple incidence angles.

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Summary

- RADARSAT-1/2 has a proven, operational capability for flood and agriculture monitoring

- India has been using RADARSAT data since 1998 for flood and agricultural monitoring

- RISAT and RADARSAT-2 can be combined to form a virtual constellation that allows:
    - improved spatial coverage
    - increased re-visit
    - rapid respond to emergencies, e.g. flooding

- Looking ahead, the RADARSAT Constellation Mission is under development in Canada with launch planned for 2016. Three RADARSAT-2-like satellites will be in orbit and provide daily re-visit anywhere in the world.

RADARSAT-1

RADARSAT-2

RADARSAT Constellation Mission

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