# RADARSAT-1 Beams - Which to Choose

*(This information was obtained from the RADARSAT International manual titled, "RADARSAT Illuminated, Your Guide to Products and Services.")*

General guidelines are available for the following subject areas:

* Agriculture / Land Use

* Cartography

* Coastal Zone

* Forestry

* Geology

* Hydrology

* Oceans

* Sea Ice / Icebergs

## RADARSAT-1 Beam Choice, Agriculture / Land Use

### Applications of RADARSAT-1 Data to Agriculture / Land Use

| Application | Typical Activities / Parameters Required |
|---|---|
| Crop Assessment | Determination of crop type and area.<br>Assessment of vegetation biomass; crop damage. |
| Compliance Monitoring | Assessment of farming activity.<br>Differentiation between tilled and cropped land. |
| Land Use Monitoring | Evaluation of land use patterns and temporal change. |
| Soil Condition Monitoring | Assessment of soil moisture and erosion by wind and water. |

## General Guidelines:

- Standard beam mode is useful for crop area estimation and crop type discrimination.
- Fine beam mode is useful for assessing crop damage.
- In deciding on a beam mode, it is advisable to match the resolution with the size of the agriculture field being imaged.
- Shallow incidence angles are useful for delineation of land use activities.
- Shallow incidence angles may be more useful for crop type monitoring.
- Steep (small) incidence angles may be more useful for vegetation and soil moisture studies.

- Selecting an appropriate look direction (ascending versus descending orbit passes) is important when row crops are being imaged. Choose the look direction which will provide the most oblique view of the crop rows.
- Multitemporal imagery is effective for crop type classification and growth stage / change monitoring.
- If imaging time is important, (e.g., early morning if the presence of dew is desired), you can use either an ascending or a descending orbit pass. RADARSAT crosses the equator in descending mode at 6 a.m. and in ascending mode at 6 p.m. (18:00 H).

## RADARSAT-1 Beam Choice, Cartography

### Applications of RADARSAT-1 Data to Cartography

| Application | Typical Activities / Parameters Required |
|---|---|
| Base Mapping | Mapping of terrain form and land use, land cover and cultural features. |
| Topographic Mapping | Mapping of terrain elevation, X, Y, Z coordinates. |

## General Guidelines:

- Fine and Standard beam modes are effective for mapping at medium scales.
- Wide and ScanSAR beam modes are effective for small scale base mapping and terrain mapping.
- Imaging an area using more than one beam position provides different look angles. These can be used for stereo matching in topographic mapping.
- Shallow incidence angles are recommended to avoid terrain distortions in mountainous areas, particularly when no DEMs are available.
- Shallow incidence angles accentuate land cover variations and are effective for mapping terrain form.
- Terrain relief is a factor in beam mode and incidence angle selection.
    - *Low relief* - Incidence angle selection is not critical; medium and small scale mapping is possible with Wide, Standard, and Fine beam modes.
    - *Moderate relief* - Shallow incidence angles are preferable; medium and small scale base mapping is possible with Wide, Standard, and Fine beam modes. Small scale topographic mapping is possible.
    - *High relief* - Shallow incidence angles are preferable; acquisition of ascending and descending pass images should be considered to eliminate radar shadow; medium to small scale base mapping is possible with Wide and Standard beam modes. Small scale topographic mapping is possible with Standard and Fine beam modes.
- For base mapping and correction of imagery using DEMs, ground control points are required to optimize accuracy.
- For base map updating, Standard and Fine beam modes are most effective.

## RADARSAT-1 Beam Choice, Coastal Zone

### Applications of RADARSAT-1 Data, Coastal Zone

| Application | Typical Activities / Parameters Required |
|---|---|
| Coastal Zone Mapping | Identification of water-land boundaries, coastal vegetation, coastline changes, and human activities.<br>Monitoring zones of high erosion or accretion. |
| Ship Detection | Detection of ships and ship wakes.<br>Ship surveillance. |
| Oil Spill Detection and Monitoring | Monitoring illegal dumping of oil from ships.<br>Strategic support for oil spill emergency response decisions.<br>Identification of natrual oil seepage areas. |
| Aquaculture Site Detection | Identification and monitoring of aquaculture sites.<br>Identification of potential new sites. |
| Bathymetry | Hydrographic mapping for updating hydrographic charts and shipping corridors. |

## General Guidelines:

- See the General Guidelines for Ocean Applications

## RADARSAT-1 Beam Choice, Forestry

### Applications of RADARSAT-1 Data to Forestry

| Application | Typical Activities / Parameters Required |
|---|---|
| Clear Cut Mapping | Identification and delineation of logging roads and forest clear cuts from uncut forest. |
| Deforestation Mapping | Identification and mapping of all types of forest disturbances. |
| Broad Forest Type Mapping | Identification of general forest classes. |

## General Guidelines:

- Fine and Standard beam modes are effective for deforestation mapping at medium scales.
- Wide and ScanSAR beam modes are effective for small scale overview forest mapping.
- Shallow incidence angles are preferred for clear cut and general deforestation mapping because land cover variations are accentuated.
- In mountainous terrain, avoid geometric distortions by using shallow (large) incidence angles. Radar shadow can be reduced or eliminated if images from both ascending and descending orbits are obtained.
- Data acquisitions should be planned for periods of maximum difference between the condition of the cut blocks and the forest, e.g., high humidity in the forest canopy and drier conditions in the cut blocks.
- In temperate regions, it is preferable to plan acquisitions when snow cover is present. Cut blocks have a darker return because the snow pack has a surface roughness smoothing effect and decreases the radar backscatter.
- Species discrimination and broad forest type mapping may require multi-date acquisitions.

- RADARSAT shows good potential for forest base map updating (change detection and forest monitoring) when base information exists.

## RADARSAT-1 Beam Choice, Geology

### Applications of RADARSAT-1 Data to Geology

| Application | Typical Activities / Parameters Required |
|---|---|
| Geologic Mapping | Mapping of geological structure, lithology, and lineaments. |
| Quaternary Mapping | Delineation of landforms and assessment of surface material. |
| Mineral Exploration | Identification of linear and curvilinear features such as dykes, faults, lithological charts, structures, alteration zones, and high fracture zones. |
| Hydrocarbon Exploration | Mapping of bedrock stratigraphy, structure, sedimentology, strikes and dips, and ineaments. |
| Geologic Hazard Identification | Identification of seismic zones and fracture systems.<br>Assessment of landslide hazards and coastal erosion. |

## General Guidelines:

- RADARSAT's multiple imaging modes permit flexibility and offer a selection of optimum resolutions and coverages for specific applications.
- Standard and Fine beam modes provide optimal information for geological structure mapping.
- Wide and ScanSAR beam modes can be used to obtain broad overview coveage, particularly for the definition of major structural patterns and landforms.
- Ability to select shallow (greater than 40 degrees) incidence angles may be useful for optimization of structural definitions.
- Given the orientation of structural features, care should be taken in the selection of ascending versus descending orbit passes. Detection is enhanced when features are aligned near-perpendicular to the satellite's look direction.
- For moderate to high relief terrain, consider acquisitions of both ascending and descending passes to maximize the number of structural features that can be identified.
- Merging RADARSAT data with geophysical data provides surface and sub-surface information.
- Beam mode and position performance will be influenced by topography.

## RADARSAT-1 Beam Choice, Hydrology

### Applications of RADARSAT-1 Data to Hydrology

| Application | Typical Activities / Parameters Required |
|---|---|
| Soil Moisture | Run-off estimates.<br>Watershed modelling. |
| Flood Mapping | Mapping spatial extent of flooding.<br>Tactical support for emergency response to flooding in critical areas. |
| Freshwater Ice Mapping | Detection of ice in rivers and lakes. |
| Snow Mapping | Delineation of the extent of the snow-pack.<br>Measurement of snow water equivalent and snow wetness. |

## General Guidelines:

- Wide and ScanSAR beam modes provide small scale coverage for flood mapping.
- Fine beam mode is effective for monitoring narrow lakes, rivers, and relatively small areas in great detail.
- Increased temporal coverage permits frequent observations of time-sensitive activities such as flood monitoring.
- Steep incidence angles are preferred for soil moisture studies.
- Mapping of snow depends on the degree of snow wetness.
- The backscatter characteristics of freshwater ice are similar to sea ice. However, the detection of freshwater ice can be hampered by the smaller size of some lakes and rivers (as compared to the size of the ocean).

## RADARSAT-1 Beam Choice, Oceans

### Applications of RADARSAT-1 Data to Oceanography

| Application | Typical Activities / Parameters Required |
|---|---|
| Mesoscale Features | Mapping of mesoscale currents and regional circulation patterns.<br>Identification of frontal zones, internal waves, eddies, upwellings, shears, and wind fronts. |
| Wave Spectra | Synthesized wave spectra from SAR spectra for forecast / numerical models. |

## General Guidelines:

- The success of RADARSAT in detecting various coastal and ocean parameters will depend not only on the beam mode and position, but also on environmental and weather related conditions. It may be useful to collect auxiliary information (such as wind speed) on the date of the RADARSAT acquisition to help you in your interpretation.
- Wide and ScanSAR beam modes are useful for small scale monitoring and mapping activities. ScanSAR is effective for mapping mesoscale ocean features.
- Standard beam mode is effective for monitoring small to medium scale oil spills and ship detection.
- Fine beam mode is useful for monitoring aquaculture sites.
- Increased temporal coverage over selected areas can be achieved by varying the beam position and using extended beam modes.
- Fine beam modes and steep incidence angles are preferred for wave spectra applications.
- Wave spectra applications require information on local wind direction to eliminate the 180 degree ambiguity in the wave direction.
- Shallow incidence angles improve the detection of oil spills. Detection will also depend on the spill size and the resolution of the beam mode.
- The detection of oil spills is also affected by the ability to discriminate between oil-induced backscatter and ambient background noise. This is influenced by environmental parameters such as wind speed, wave conditions, and oil type.
- The probability of detecting ships increases using shallow incidence angles.
- The detection of ships is also affected by ship length, ship travel speed, wind speed, and to some extent, the travel direction of the ship with respect to the satellite's look direction. In general, the probability of detecting ships increases with ship length and decreases with high wind speeds. The detection of ship wakes improves as the speed of the vessel increases and as the speed of the wind decreases.

- The detection of aquaculture cages and weirs depends on the size versus the resolution of the beam mode. Detection increases using shallow incidence angles and when wind speeds are low.
- Differences in sea bottom topography can be inferred when the ocean depth is less than 10 - 15 m.

## RADARSAT-1 Beam Choice, Sea Ice

### Applications of RADARSAT-1 Data to Sea Ice Studies

| Application | Typical Activities / Parameters Required |
|---|---|
| Sea Ice Mapping | Regional scale mapping of ice concentration, edge location, ice type, motion, and surface topography. |
| Marine Transportation Support | Tactical identification of leads, ice type, and surface topography. |
| Fisheries Support | Identification of ice edge. |
| Iceberg Monitoring | Detection and tracking of icebergs. |

## General Guidelines:

- ScanSAR provides regional mapping capability for sea ice concentration, ice edge, motion, and ice type classification.
- ScanSAR may be useful for tactical navigation depending on the actual ice environment.
- Standard beam mode provides detail for medium scale mapping and tactical navigation support.
- Incidence angle is not a critical factor in sea ice monitoring, however, shallow angles are more effective in highlighting surface topography.
- Shallow incidence angles can improve detection of icebergs.
- RADARSAT's polar orbit enhances coverage for ice environments.
- Guaranteed SAR coverage supports frequent monitoring and short notice acquisitions.
- RADARSAT's HH polarization differentiates between open water and ice better than VV polarization.
- The appearance of a given ice feature may differ significantly in wet versus dry conditions. When surface meltwater is on the ice or near the ice edge where ocean spray may occur, feature brightness may differ from dry conditions.
- When wet surface conditions prevail, it is useful to have a reference image acquired before the onset of melt conditions.