EUB/AGS Geo-Note 2003-26

Orthorectified and Principal Component RADARSAT-1 Image Dataset for NTS 84G, Alberta

Alberta Energy and Utilities Board
Alberta Geological Survey

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Shilong Mei

Alberta Geological Survey

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Alberta Energy and Utilities Board
Alberta Geological Survey
4th Floor, Twin Atria Building
4999 – 98th Avenue
Edmonton, Alberta
T6B 2X3
Canada

Tel: (780) 422-3767 (Information Sales)
Fax: (780) 422-1918
E-mail: EUB.AGS-Infosales@gov.ab.ca

Web site: www.ags.gov.ab.ca

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Abstract

This report details the acquisition, characteristics and processing of the orthorectified and principal component RADARSAT-1 images for NTS map area 84G by the Alberta Geological Survey (AGS). The acquisition of the original RADARSAT-1 scene imagery was made through a Provincial Partnership Memorandum of Understanding. Original RADARSAT-1 path images (SGF) have been purchased by Alberta Sustainable Resource Development (SRD) from RADARSAT International (RSI) and then made available to AGS, based on an agreement that AGS would pay for orthorectification of the original RADARSAT-1 imagery in exchange for obtaining the value-added imagery for geological study and public distribution.

This resulted in acquisition of coverage for all of northern Alberta (north of 55 degrees north latitude) for Standard Beam Modes S1 and S7 in both ascending and descending look directions. This imagery is available at a nominal resolution of 12.5 m. Two hundred and fifty scenes have been orthorectified and, in total, cover northern Alberta (north of 55 degrees north latitude) in the four beam positions. They were tiled to 25 1:250 000 scale NTS map areas. The image file for each NTS map area contains four layers to accommodate four images from the four beam positions. These four layers were then used for principal component analysis to produce an image file for each NTS map area containing four layers holding PC1, PC2, PC3 and PC4 images. The orthorectified and principal component RADARSAT-1 dataset for NTS map area 84G is one of the 25 NTS-tiled products to be delivered to the public by AGS. It will permit users to further process and interpret the RADARSAT-1 data to obtain geoscience, environmental, forestry or other information.

1 Introduction

The Government of Alberta participated in a RADARSAT-1 pre-launch agreement that permitted the acquisition of radar imagery at a significantly reduced price. The acquisition of the RADARSAT-1 imagery was made through a Provincial Partnership Memorandum of Understanding that offered participating provinces a price of $609 CDN per scene. This agreement tested the application of RADARSAT-1 satellite imagery for agricultural, mapping and natural resources management. Alberta Sustainable Resource Development (SRD) and the Alberta Geological Survey (AGS) participated in this agreement, and they agreed to a satellite image acquisition plan in 1999. The funding of the original RADARSAT-1 path images (SGF) was covered and managed by SRD, and it was agreed AGS would pay for orthorectification of the original RADARSAT-1 imagery in exchange for its use. AGS agreed to provide a complete set of orthorectified imagery to SRD in return. The RADARSAT-1 imagery was obtained from September to December 1999. A total of 274 scenes of RADARSAT-1 standard beam modes S1 and S7 were captured for both ascending and descending passes, covering all of northern Alberta (north of 55 degrees north latitude). This number was mistakenly reported as 280 scenes in previous reports (Grunsky, 2002a, 2002b, 2002c), due to 6 duplicate records of scenes that were found afterwards. Two hundred and fifty of the 274 scenes were orthorectified and then tiled to 25 NTS map areas (Grunsky, 2002a). The other 24 scenes were not orthorectified because they are peripheral complementary images. The image file for each NTS map area contains four layers to accommodate four images from the four beam positions. These four layers were then used for principal component analysis (PCA) to produce an image file for each NTS map area, which contains four layers with PC1, PC2, PC3 and PC4 images. Each of the four principal components of the 25 tiled NTS areas was then assembled to produce the northern Alberta mosaic of principal component images (Grunsky, 2002b). All of these value-added images are made available to the public by AGS. A detailed documentation of the acquisition and availability of these images is provided by Grunsky (2002a).

The RADARSAT-1 satellite is an active, microwave-based sensor that sends its own microwave signals down to the Earth and processes the signals it receives back. It differs from optical sensors, such as LANDSAT TM and SPOT, which are referred to as passive systems. Since the optical sensors collect data at frequencies of visible and infrared, they rely on sunlight reflected off the Earth and, as a result, are unable to collect data in darkness or poor atmospheric conditions, such as cloud cover, fog, dust, hail or smoke. RADARSAT-1's longer microwave wavelength is better suited for atmospheric penetration and can collect data regardless of the Earth's atmospheric conditions. The radar backscatter qualities are directly related to ground topography, dielectric properties and surface roughness of the terrain being imaged. As a result, RADARSAT-1 images are complementary to optical satellite images. In addition, radar can acquire multiple images to provide stereoscopic viewing.

The imagery obtained by AGS has great potential in geological studies when combined with other satellite images and existing geological data. September to December 1999, when the imagery was obtained, was a dry autumn and, thus, provided ideal conditions of no deciduous foliage and no snow. The four combinations of varying incidence angles and look directions provided four additional dimensions for highlighting differences in geomorphology, surficial and structural features and drainage. For example, Grunsky (2002c) applied the principal component images for land cover and terrain mapping, and Paganelli et al. (2003) used them for structural mapping in a portion of the northern Buffalo Head Hills area. This report describes the acquisition, characteristics and processing of the orthorectified and principal component RADARSAT-1 image dataset for NTS 84G.

2 RADARSAT-1 Standard Beam Mode Images

RADARSAT-1 was launched on November 4, 1995, as a result of a joint venture between the Canadian government, private industry and NASA (RADARSAT International (RSI), 1999). As Canada's first

Earth observation satellite, and the world's first operationally-oriented radar sensor, it provides complete global coverage with the satellite's orbit repeated every 24 days. The Arctic is imaged daily, whereas equatorial areas achieve complete coverage approximately every five days. It differs from research-oriented radar sensors, such as ERS and JERS-1, as it is the first radar sensor totally dedicated to operational applications, and it offers a variety of beam modes to meet requirements for the particular application at hand. It uses a single frequency C-Band (5.3 Ghz frequency or 5.6 cm wavelength) and has the ability to send and receive this microwave energy at a number of spatial resolutions and different incidence angles over a 500-kilometre range. RADARSAT-1's side-looking geometry greatly enhances subtle topographic features that aid in the interpretation of lineaments (RADARSAT International (RSI), 1997). RADARSAT-1 offers 35 beam positions with a viewing angle range of 10 to 60 degrees (Figure 1). The spatial resolution can vary from 8 m to 100 m (Figure 2). As a result, the RADARSAT-1 satellite is programmable so various beam modes and resolutions can be changed according to requirements.

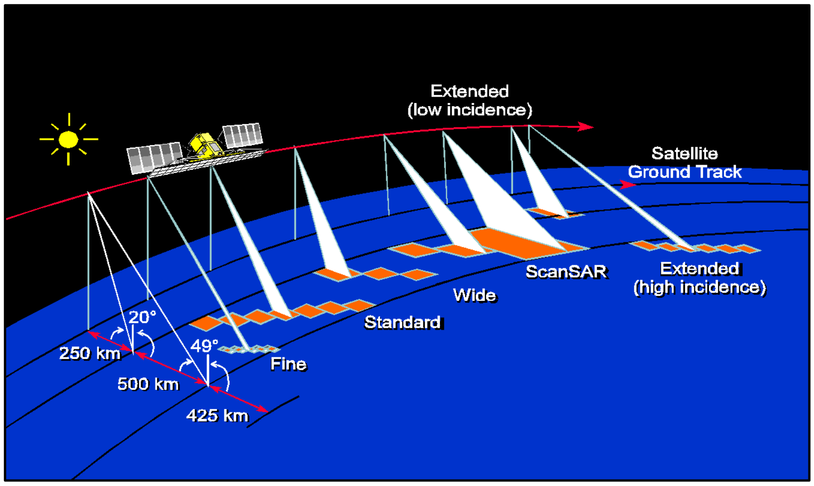

Figure 1. RADARSAT-1 beam modes (used with permision from RADARSAT International (RSI), 1997).

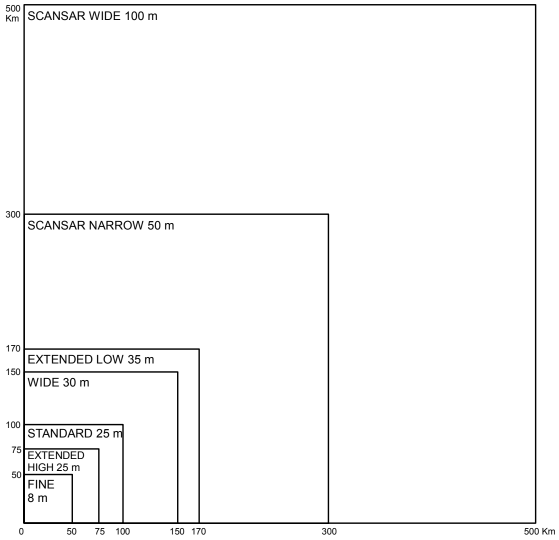

Figure 2. Coverage sizes and resolutions of RADARSAT-1 beam modes (modified after RADARSAT International (RSI), 1999).

The orthorectified and principal component RADARSAT-1 image datasets for NTS 84G contain images from two beam modes and four beam positions: Standard Beam Mode 1 ascending, Standard Beam Mode 1 descending, Standard Beam Mode 7 ascending and Standard Beam Mode 7 descending (Figure 3). It also includes four principal component images (PC1, PC2, PC3 and PC4) derived from them.

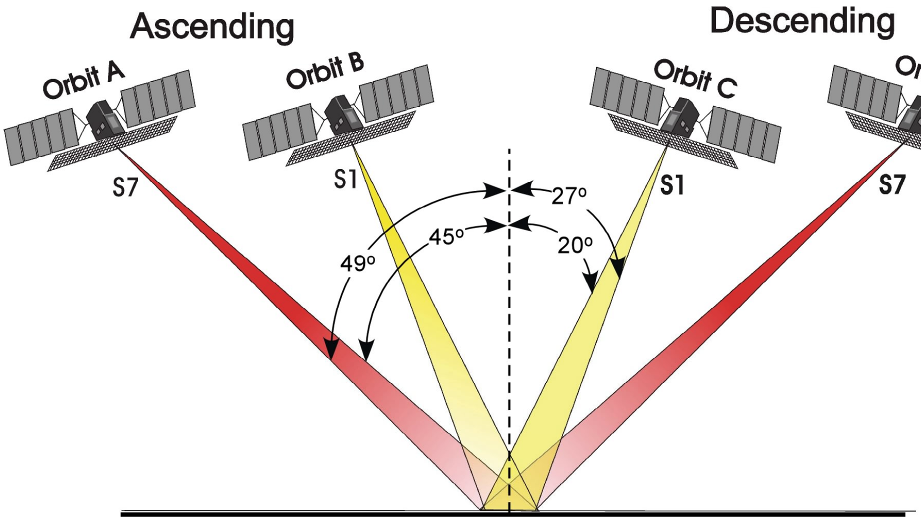

Figure 3. Multi-beam configuration of RADARSAT-1 S1 and S7 ascending/descending imagery (after Grunsky, 2002a).

3 Processes for Acquisition of the Orthorectified and Principal Component RADARSAT-1 Images for NTS 84G

The RADARSAT-1 image orthorectification, mosaic and principal component analysis were carried out by Resource GIS and Imaging Ltd. (RGI) using processing methods and software developed by RGI and proprietary to RGI. Their software and processes run within the ER Mapper processing environment.

The processes for producing the orthorectified and principal component RADARSAT-1 Image dataset for NTS 84G are:

- acquisition of the original RADARSAT-1 Standard Beam Mode path images
- orthorectification of the path images
- mosaicking of the orthorectified scene images to NTS map areas; and
- principal component analysis of the tiled NTS map area images.

Following are detailed descriptions of the original input data and steps to produce the orthorectified and principal component RADARSAT-1 images for NTS 84G.

3.1 Original RADARSAT-1 Standard Beam Mode Images

The original RADARSAT-1 image data are the path images (SGF) and have been converted to ground range and are multi-look processed. Each Standard Beam image is a composite of four looks. This composite increases the signal-to-noise ratio at the expense of the spatial resolution. The imagery is provided at a nominal resolution of 12.5 m (close to the single look spatial resolution), although the true spatial resolution of the averaged four-look image is closer to 25 m. The image is calibrated, but remains oriented in the direction of the orbit path. The image is sampled in unsigned, 16-bit integer format and written in Committee of Earth Observation Satellites (CEOS) standard format. The projection is in UTM zone 11 or 12 with an ellipsoid of WGS84. Figure 4 shows an example of the original path images used for tiling the NTS 84G dataset. Table 1 lists the scenes that overlay the NTS 84G area. Figure 5 shows the spatial locations of the scenes overlaying NTS 84G. Many of these scenes were used for producing the NTS 84G orthorectified and principal component image datasets included on the CD.

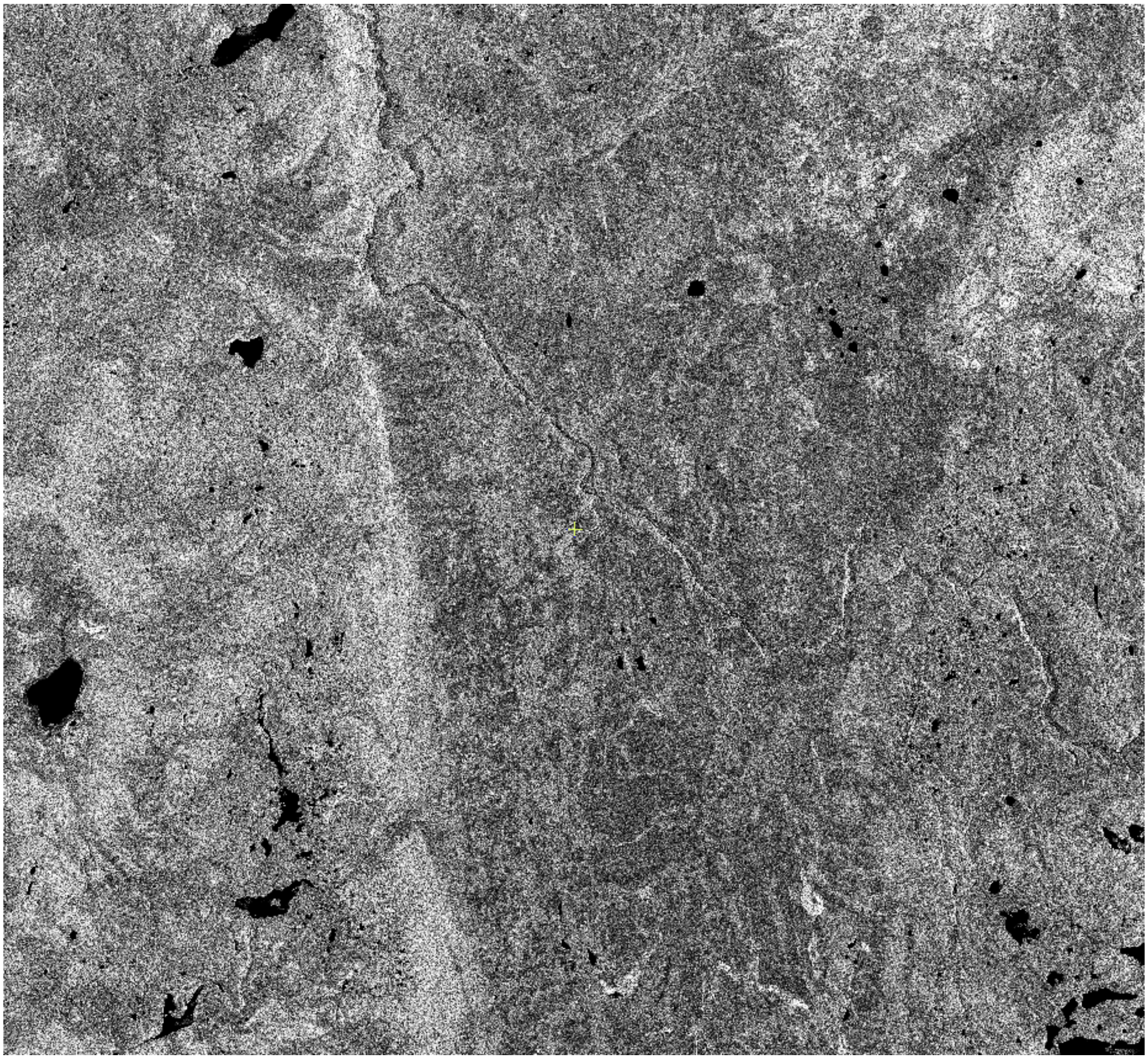

Figure 4. One of the original SGF scene images used for tiling the NTS 84G dataset: scene MO197302 of Standard Beam Mode 1 Descending. RADARSAT data © Canadian Space Agency/Agence spatiale canadienne 1999, processed and distributed by RADARSAT International.

Table 1. List of the Path Images that Overlay NTS 84G

Scene ID	Beam	Path	UL_LAT	UL_LONG	UR_LAT	UR_LONG	LR_LAT	LR_LONG	LL_LAT	LL_LONG
M0197237	S1	ASC	58:08:50.79N	114:36:14.26W	58:23:46.38N	112:42:32.35W	57:28:55.98N	112:18:09.65W	57:14:14.79N	114:08:57.21W
M0197236	S1	ASC	57:19:38.31N	114:11:36.37W	57:34:20.76N	112:20:32.93W	56:39:27.40N	111:56:59.05W	56:24:58.42N	113:45:16.59W
M0196651	S1	ASC	58:09:47.25N	115:39:59.91W	58:24:42.85N	113:46:16.56W	57:29:52.89N	113:21:53.06W	57:15:11.70N	115:12:41.95W
M0196650	S1	ASC	57:20:33.57N	115:15:20.34W	57:35:16.02N	113:24:15.65W	56:40:22.71N	113:00:40.90W	56:25:53.75N	114:48:59.56W
M0196470	S1	ASC	58:10:47.28N	117:45:35.61W	58:25:43.83N	115:51:45.47W	57:30:53.57N	115:27:20.41W	57:16:11.49N	117:18:15.78W
M0195962	S1	ASC	58:11:46.63N	116:43:48.96W	58:26:43.29N	114:49:55.74W	57:31:53.05N	114:25:29.91W	57:17:10.87N	116:16:28.20W
M0195961	S1	ASC	57:22:33.81N	116:19:07.29W	57:37:17.35N	114:27:52.35W	56:42:24.15N	114:04:15.60W	56:27:54.14N	115:52:44.07W
C0014607	S1	ASC	57:21:29.62N	117:20:52.78W	57:36:13.06N	115:29:41.01W	56:41:20.23N	115:06:05.21W	56:26:50.32N	116:54:30.69W
M0197302	S1	DES	57:48:46.72N	115:58:19.95W	57:34:09.05N	114:07:17.31W	56:39:29.57N	114:33:49.19W	56:53:53.70N	116:22:04.66W
M0197301	S1	DES	58:38:10.83N	115:36:10.08W	58:23:20.01N	113:42:28.36W	57:28:44.86N	114:09:58.34W	57:43:21.18N	116:00:44.37W
M0196777	S1	DES	57:46:27.99N	114:56:10.04W	57:31:49.72N	113:05:08.33W	56:37:11.19N	113:31:37.77W	56:51:35.94N	115:19:52.58W
M0196776	S1	DES	58:35:49.10N	114:34:03.34W	58:20:57.67N	112:40:22.59W	57:26:22.72N	113:07:50.24W	57:40:59.68N	114:58:35.55W
M0196737	S1	DES	57:48:14.59N	117:01:45.78W	57:33:36.23N	115:10:41.20W	56:38:56.80N	115:37:13.10W	56:53:21.60N	117:25:30.50W
M0196736	S1	DES	58:37:37.64N	116:39:36.24W	58:22:46.14N	114:45:52.67W	57:28:11.03N	115:13:22.64W	57:42:48.03N	117:04:10.52W
M0196520	S1	DES	57:43:27.81N	113:54:59.26W	57:28:50.71N	112:04:09.47W	56:34:11.94N	112:30:35.38W	56:48:35.57N	114:18:38.84W
M0199943	S7	ASC	58:23:05.80N	116:47:53.58W	58:31:28.07N	114:53:42.51W	57:35:05.11N	114:40:09.18W	57:26:42.44N	116:31:21.28W
M0199942	S7	ASC	57:33:40.73N	116:33:23.48W	57:42:03.29N	114:41:50.58W	56:47:25.54N	114:28:56.29W	56:39:02.28N	116:17:44.73W
M0199360	S7	ASC	58:15:47.55N	114:39:49.09W	58:24:10.22N	112:45:57.95W	57:29:11.27N	112:32:46.28W	57:20:48.18N	114:23:41.15W
M0199359	S7	ASC	57:26:27.91N	114:25:20.41W	57:34:50.96N	112:34:08.13W	56:40:13.21N	112:21:15.35W	56:31:49.42N	114:09:44.40W
M0198894	S7	ASC	57:29:18.25N	115:28:43.95W	57:37:40.84N	113:37:24.43W	56:43:03.07N	113:24:31.41W	56:34:39.76N	115:13:07.24W
M0197332	S7	ASC	58:05:13.55N	117:47:53.40W	58:13:35.81N	115:54:41.24W	57:18:58.60N	115:41:38.33W	57:10:35.84N	117:32:00.35W
M0197331	S7	ASC	57:15:47.25N	117:33:31.11W	57:24:09.92N	115:42:54.06W	56:29:32.10N	115:30:04.59W	56:21:08.61N	117:18:00.33W
C0014848	S7	ASC	58:18:42.08N	115:43:11.52W	58:27:04.29N	113:49:15.45W	57:32:27.14N	113:36:08.67W	57:24:04.52N	115:27:12.06W
M0200508	S7	DES	57:44:55.89N	114:40:43.56W	57:36:37.08N	112:49:21.30W	56:41:59.13N	113:04:57.27W	56:50:18.70N	114:53:35.05W
M0200507	S7	DES	58:34:17.32N	114:28:55.43W	58:25:58.86N	112:34:55.14W	57:31:21.84N	112:50:53.87W	57:39:40.74N	114:42:00.61W
M0199031	S7	DES	57:49:13.90N	116:44:49.89W	57:40:55.13N	114:53:14.39W	56:46:17.23N	115:08:52.30W	56:54:36.73N	116:57:42.55W
M0199030	S7	DES	58:38:34.08N	116:33:00.78W	58:30:15.63N	114:38:46.57W	57:35:38.67N	114:54:47.40W	57:43:57.52N	116:46:07.24W
M0197357	S7	DES	57:40:56.27N	115:46:41.28W	57:32:37.11N	113:55:31.34W	56:37:58.76N	114:11:06.12W	56:46:18.69N	115:59:32.27W
M0197356	S7	DES	58:30:18.39N	115:34:53.63W	58:21:59.61N	113:41:06.31W	57:27:22.58N	113:57:03.64W	57:35:41.82N	115:47:58.16W

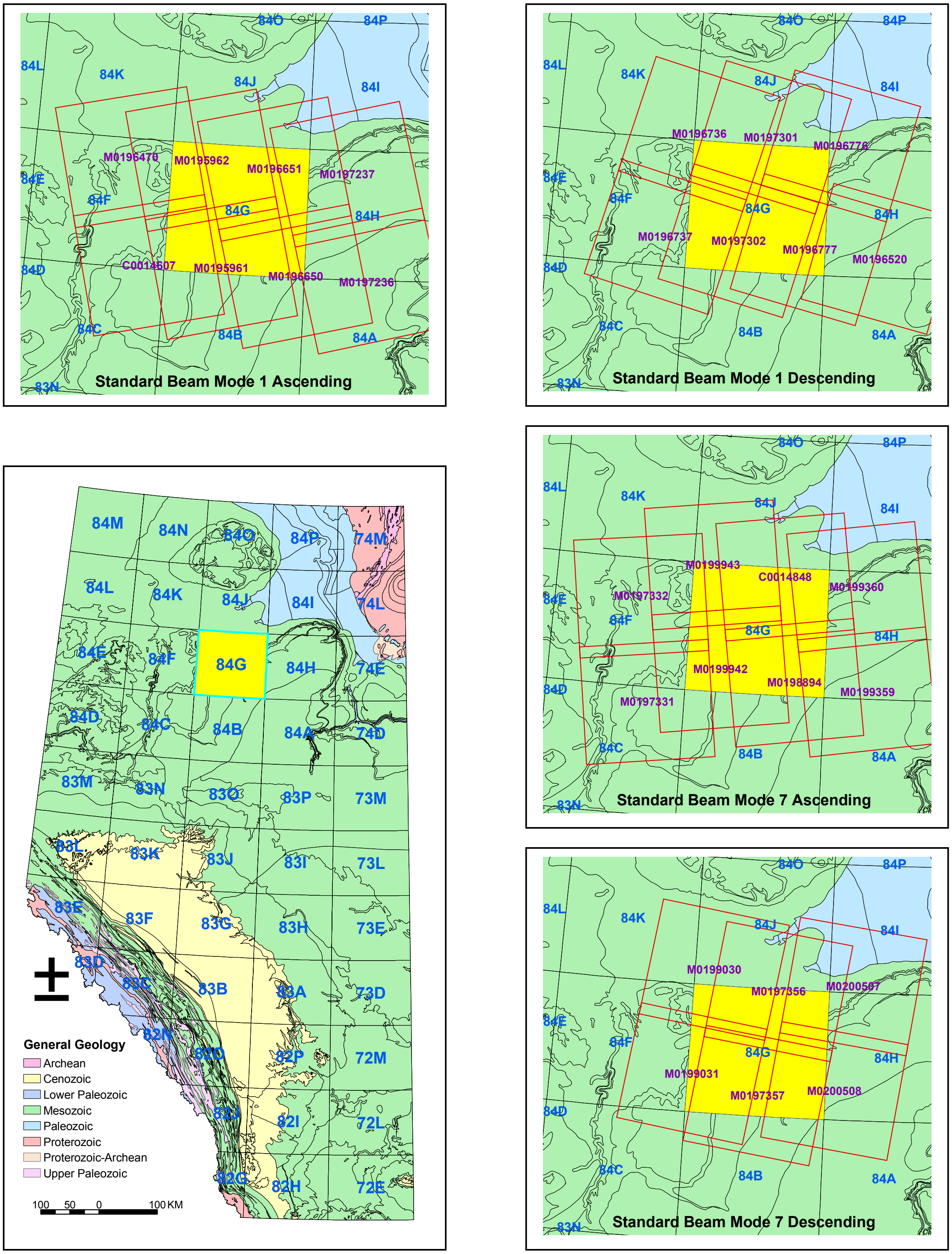

Figure 5. The scenes overlaying NTS 84G.

3.2 Orthorectification Process

The original RADARSAT-1 path images are orthorectified by RGI contracted by AGS. The individual orthorectified RADARSAT-1 images have no filtering nor any radiometric processing applied to them. Radiometrically they are identical to the original images. Orthorectification is performed using digital elevation data provided by the Resource Data Division (RDD) of the Alberta Department of Sustainable Development. The digital elevation data used has a 100 m resolution. Ground control points (GCPs) are collected from 1:20 000 Alberta Access Vectors and an Alberta mosaic of orthorectified Indian remote sensing satellite (IRS) images, which are also provided by RDD. An average GCP root mean-square error of 20 m is obtained. The image file is in ER Mapper format and projected to UTM zone 11 or 12 with a datum of NAD83. The data remain in unsigned, 16-bit integer format, and the pixel size remains at 12.5 m. Figure 6 is an example of the orthorectified images used for tiling the NTS 84G dataset.

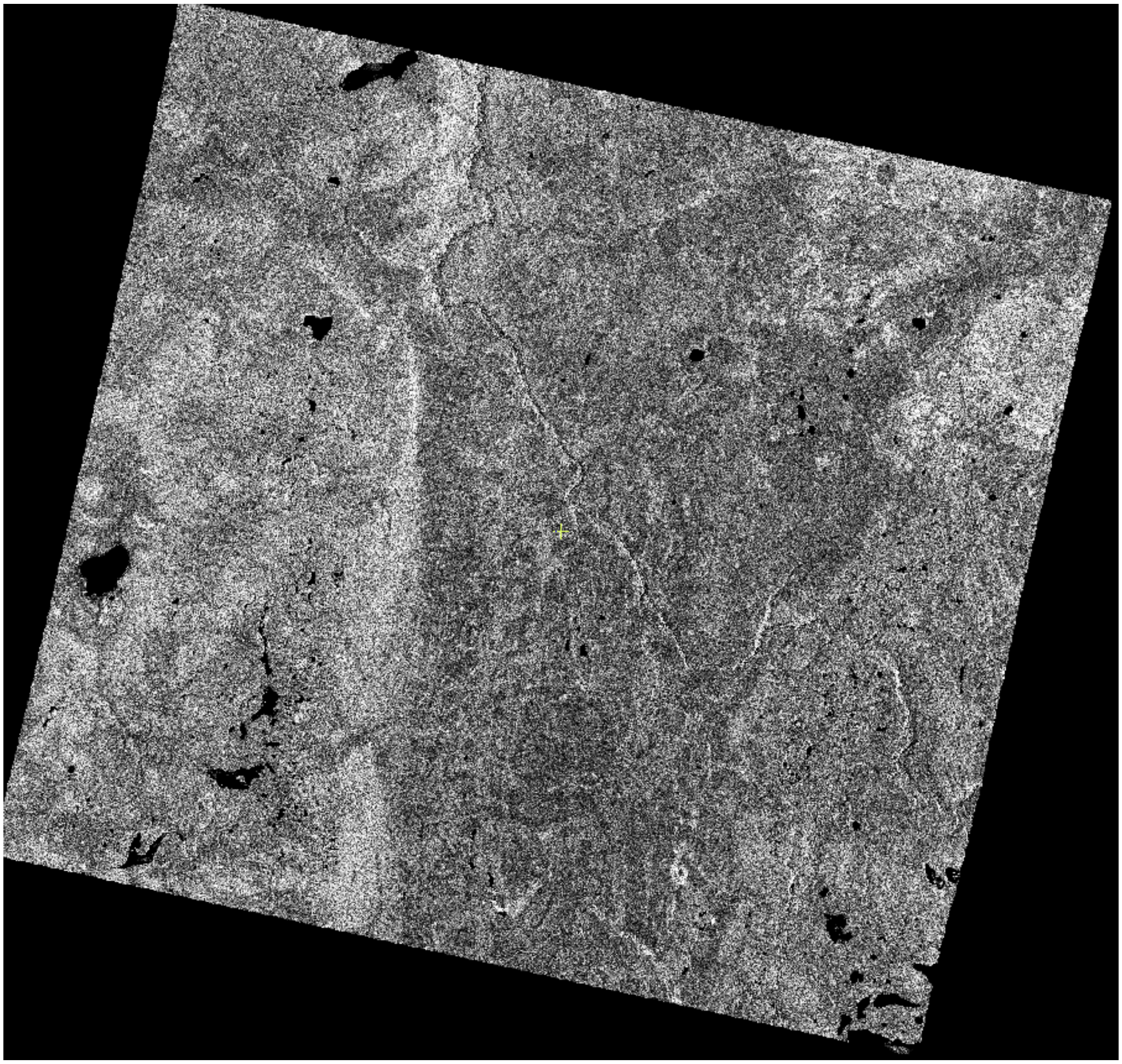

Figure 6. One of the orthorectified scene images used for tiling the NTS 84G dataset: scene MO197302 of Standard Beam Mode 1 Descending.

3.3 Mosaic (Tiling) Process

The orthorectified images are tiled to 25 NTS map areas of Standard Beam Mode S1/S7 ascending/descending. For the S1 mosaics, the near-nadir sides of the images have been favoured in the mosaic process. For the S7 mosaics, the off-nadir sides of the images have been favoured. This maximizes the incidence angle difference between the S1 and S7 mosaics. Radiometric differences between adjacent images are minimized using two-dimensional, piecewise linear gain and offset adjustment functions, which are interactively adjusted to achieve an optimum balance. The balanced mosaics are then clipped to 1:250 000 NTS tiles. The NTS tile image file is in ER Mapper format and projected to UTM zone 11 or 12 with a datum of NAD83. The data are converted into unsigned, 8-bit integer format, and the pixel size remains at 12.5 m. Figure 7 is a pseudocolour composite of the orthorectified and tiled NTS 84G image dataset.

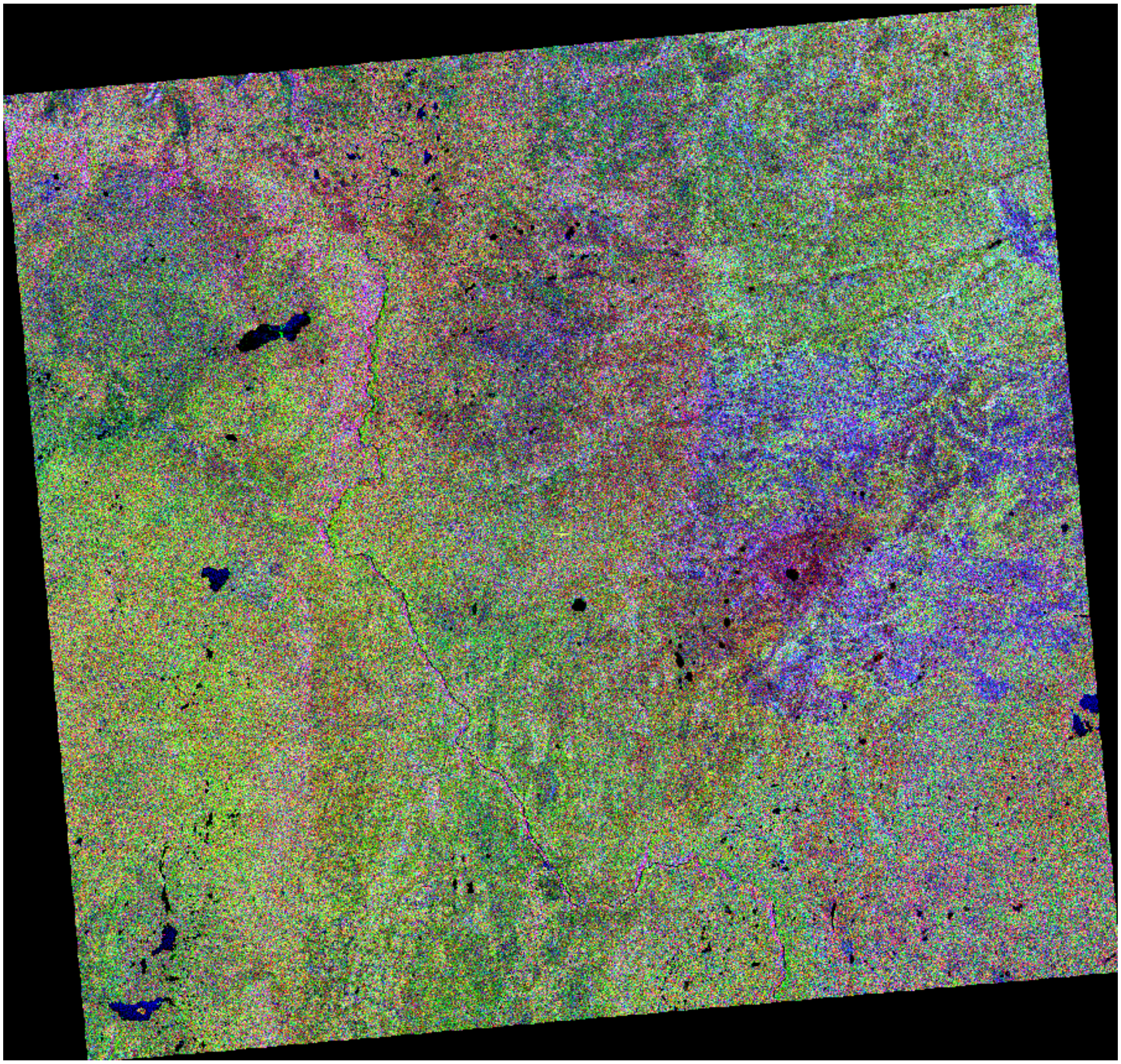

Figure 7. Pseudocolour composite of orthorectified NTS 84G image dataset of Standard Beam Mode S1/S7 ascending/descending beam positions (RGB=S7d, S7a, S1d).

3.4 Principal Component Analysis

NTS images of four beam positions (S1 ascending/descending and S7 ascending/descending) for the same NTS map area are used as input channels for principal component analysis (PCA). This results in 25 PCA image datasets; each contains four layers for the PC1, PC2, PC3 and PC4 images for the same NTS map area. During the PCA, the S7 ascending image is used to mask the lakes so as to remove the lakes from the calculation of the covariance eigenvectors. The S1 ascending image is multiplied by 1.35, and the S1 descending image is multiplied by 1.60 so as to match the means of the S1 and S7 ascending/descending images. The covariance eigenvectors are determined using a 10 000 columns by 20 000 rows window of the four beam mode images. The window is located between UTM zone 12 NAD 83 coordinates 339313 E to 464319 E and 6414500 N to 6164502 N. An ER Mapper std_dev_1.6 filter is applied to each of the four beam position images. After PCA, a value of 11 000 was added to PC3 values and 5 000 to PC4 values to bring all of the image values into the positive range. The resultant image dataset is in ER Mapper format and projected to UTM zone 11 or 12 with a datum of NAD83. The dataset was converted into unsigned, 8-bit integer format, and the pixel size remains at 12.5 m. Figure 8 is a pseudocolour composite of the principal component dataset for NTS 84G.

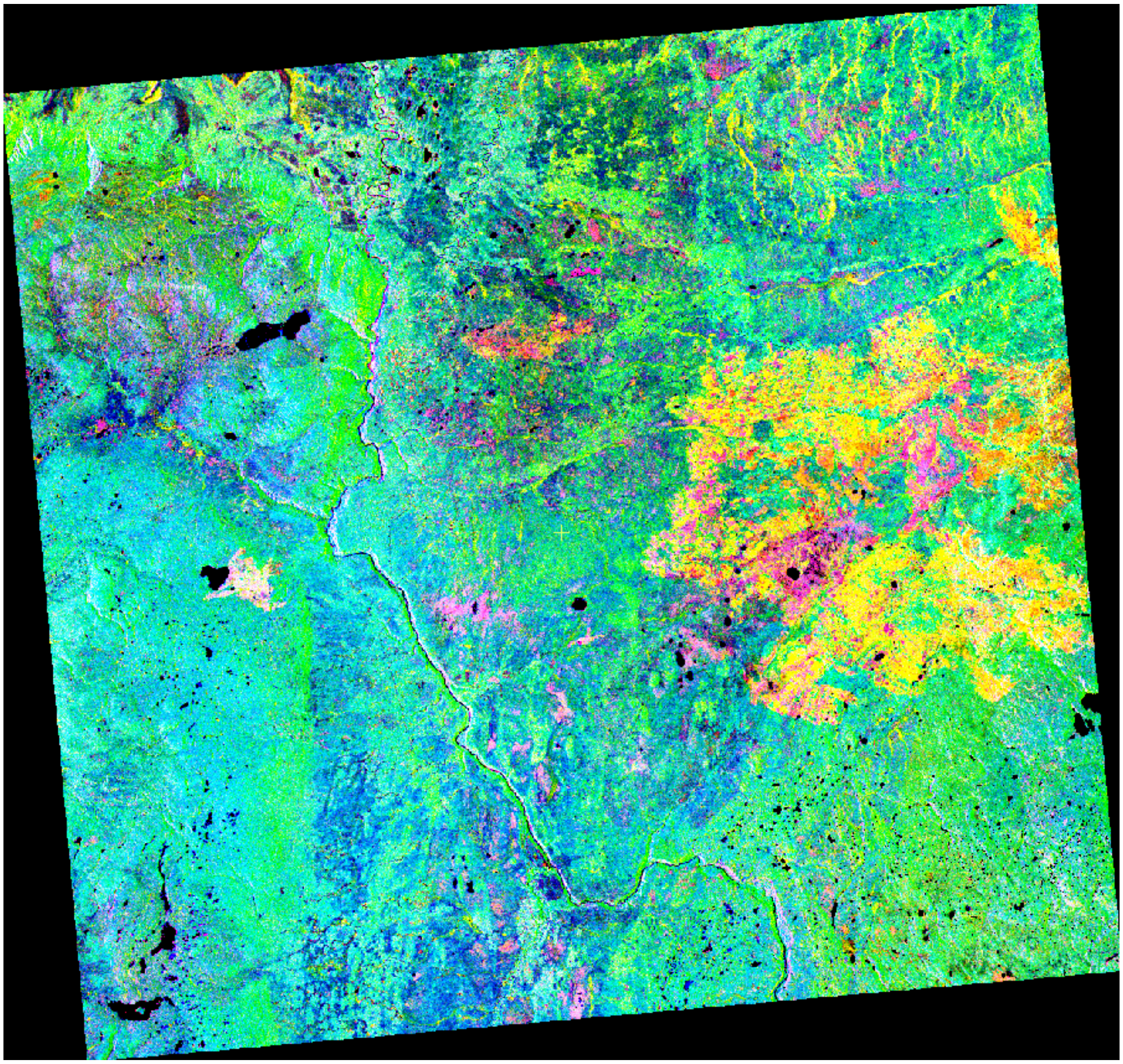

Figure 8. Pseudocolour composite of NTS 84G image dataset of principal component PC1, PC2, PC3 and PC4 (RGB=PC2, PC1, PC3).

3.5 Additional Resampled Images and Maps

For a wider scope of users, including non-GIS or inexperienced professionals to use the data, single-band images in GeoTIFF format were created from each band of the orthorectified and PCA image datasets mentioned above. This results in 8 images for each NTS map area. They are: (1) S1 ascending, (2) S1descending, (3) S7 ascending, (4) S7 descending, (5) PC1, (6) PC2, (7) PC3 and (8) PC4 images. The GeoTIFF images are in the same projection as the orthorectified and PCA image datasets, but have been re-sampled into 27 m pixel size in order to reduce file size. They can be used with other GIS data to generate maps of specific interests to the user.

In addition, simple maps for these images were created. This results in 8 maps for each NTS map area. These maps are included on the two accompanying CDs as Figures 9 to 16. They can be printed or plotted, depending on the users' software and output capability, and each map includes some general tips for interpretation.

4 Conclusion

The image datasets for NTS 84G contain two sets of data: orthorectified RADARSAT-1 image dataset with images of four beam mode positions: S1/S7 beam modes and ascending/descending paths; and principal component image dataset containing images of PC1, PC2, PC3 and PC4, which are derived from the orthorectified image dataset. The imagery is obtained through orthorectification and mosaicking of the RADARSAT-1 path images covering NTS 84G. Additional single-band images in GeoTIFF format were also created. The various image datasets included herein can be used for a wide range of applications, including forestry, land cover classification, soil moisture mapping, hydrology, geomorphology and geology for the NTS 84G map area.

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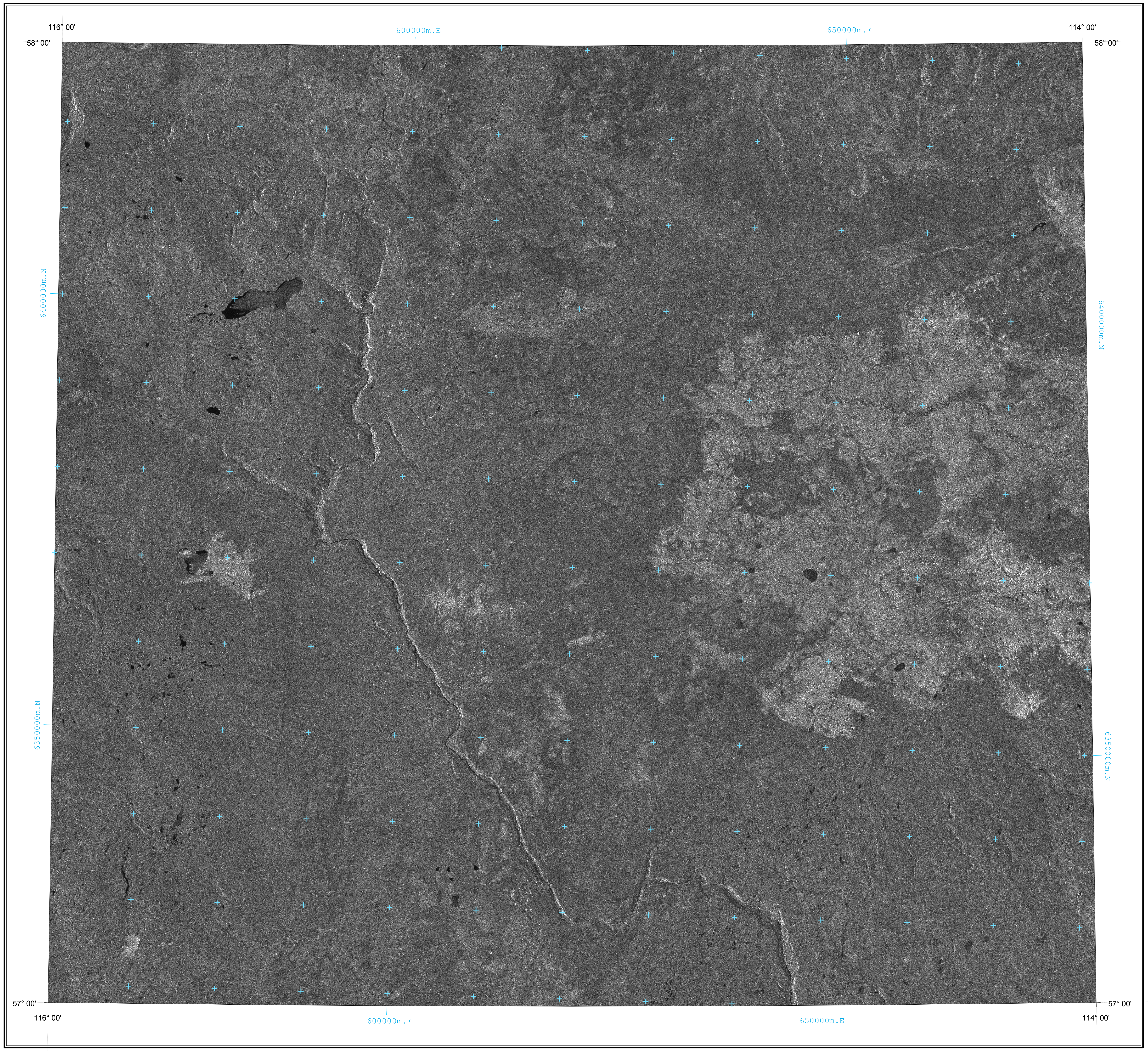
NTS 84G
RADARSAT-1



Introduction

The RADARSAT-1 satellite, launched by Canada in 1995, is an active, microwave-based sensor that sends its own microwave signals down to the Earth and processes the signals that it receives back. It differs from optical sensors, such as LANDSAT, SPOT and IRS, which collect data at visible and infrared frequencies and rely on reflected sunlight from the Earth. In addition, RADARSAT-1 employs variable beam modes (i.e., differing incidence angles, scene coverage and resolutions) and look directions (i.e., ascending or east looking and descending or west looking), hence the opportunity exists for acquiring a number of separate radar signals, which then can either be evaluated individually or combined statistically in various ways to produce additional information. The quality of the radar backscatter signal is directly related to ground topography, dielectric properties and surface roughness of the terrain being imaged. As a result, RADARSAT-1 images are well suited for mapping geological structure, geomorphology and the moisture content of vegetation or sediment surface materials to a very shallow depth.

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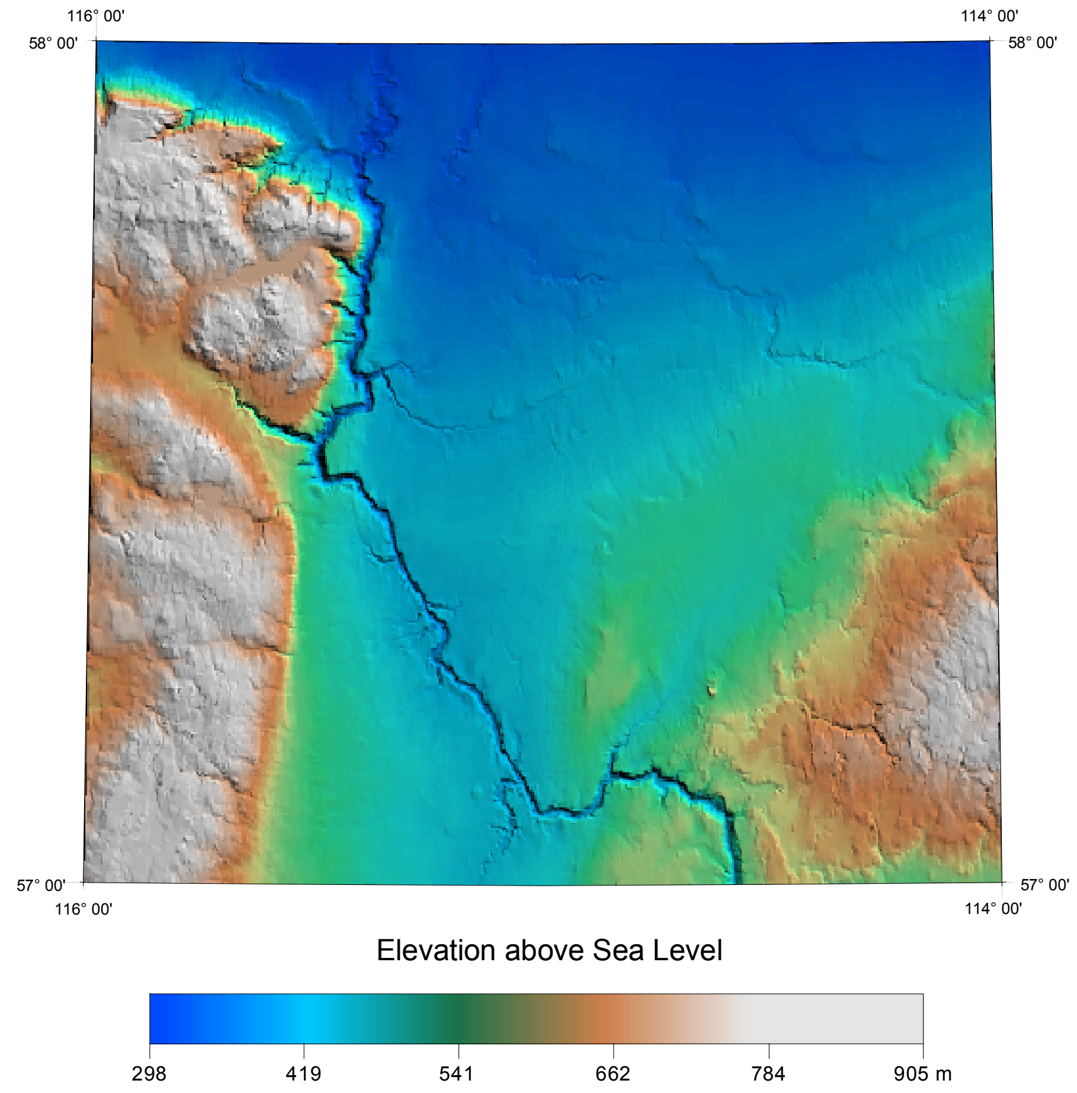
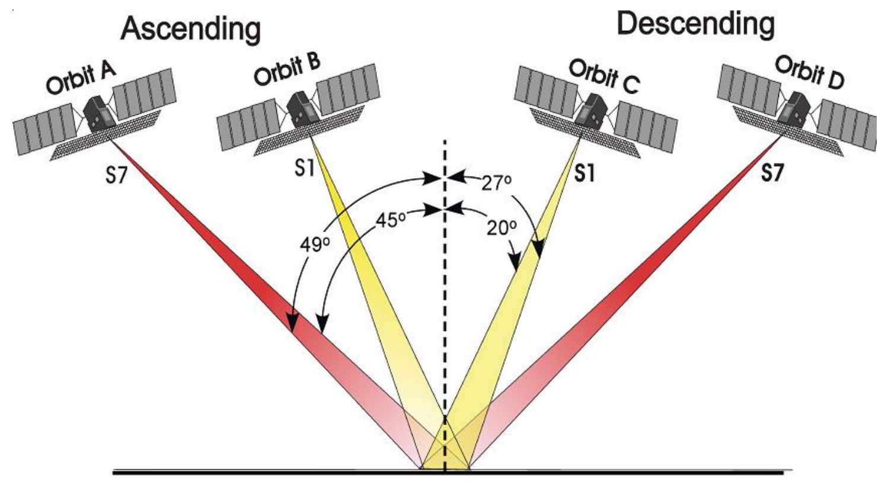
Elevation Map for NTS 84G



Look Directions and Incident Angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes



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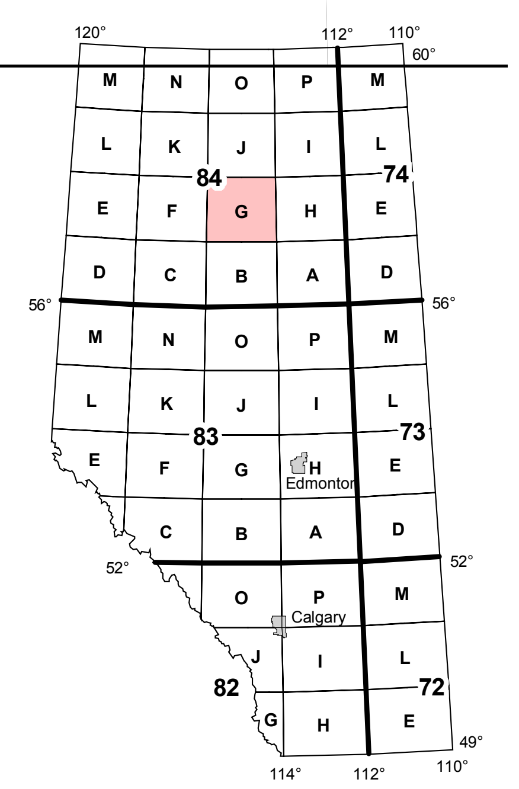
Geo-Note 2003-26, Figure 9

RADARSAT-1 Standard Beam 1 Ascending Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003



Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983

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AGS
Alberta Geological Survey

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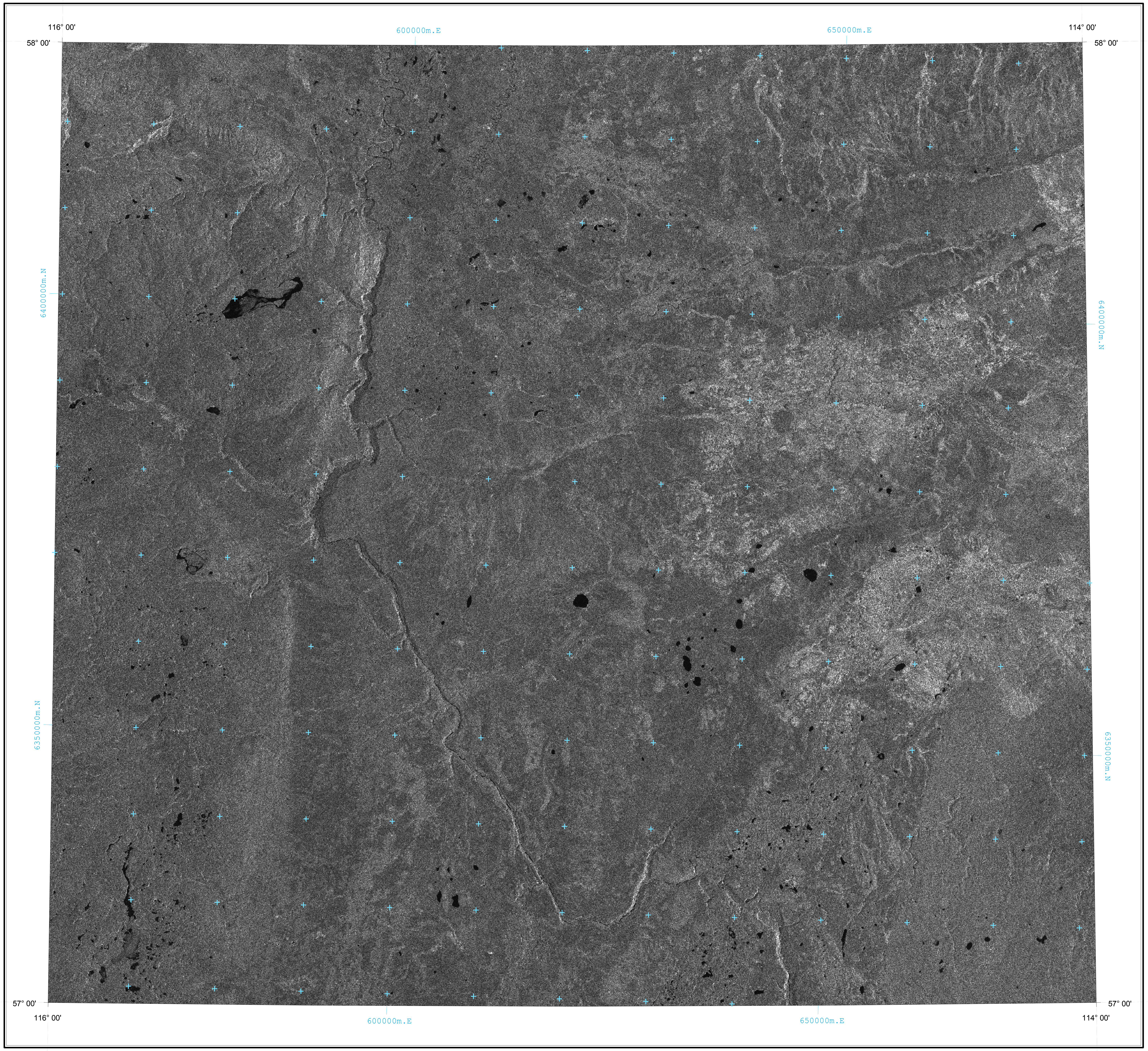
Disclaimer:

NTS 84G
RADARSAT-1



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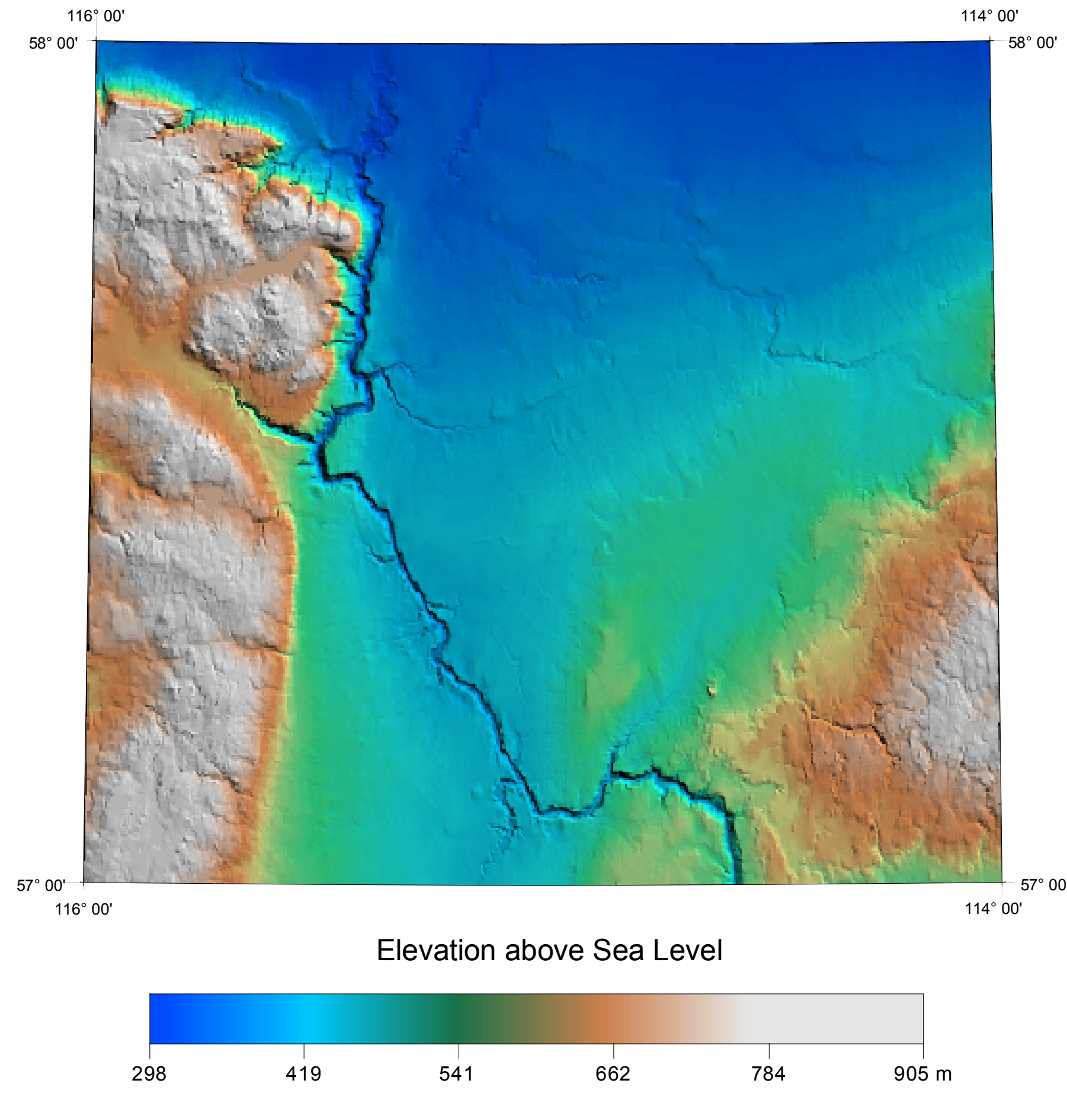
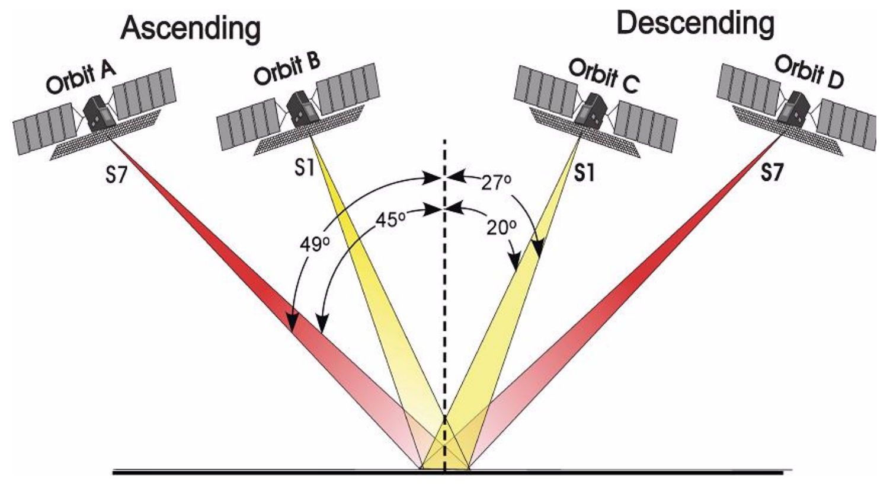


Look Directions and Incident Angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes



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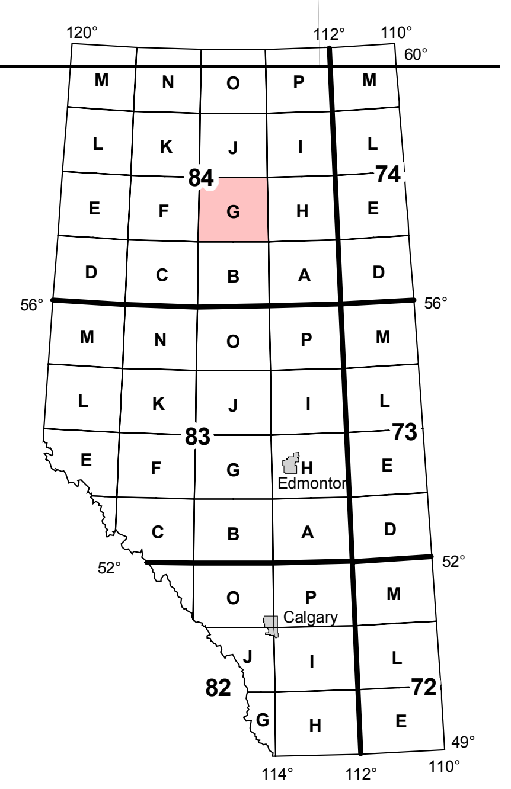
Geo-Note 2003-26, Figure 10

RADARSAT-1 Standard Beam 1 Descending Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



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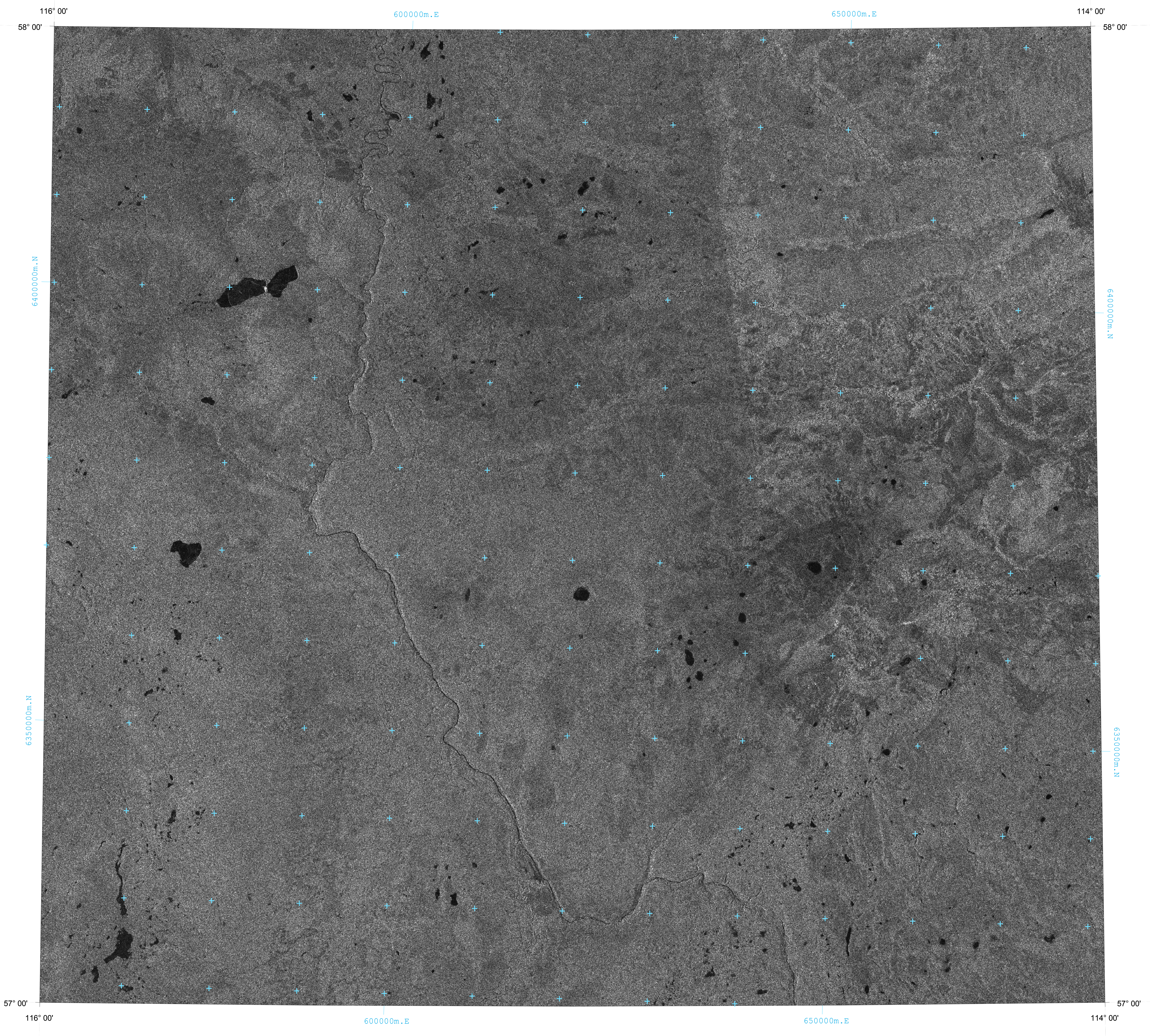
NTS 84G
RADARSAT-1



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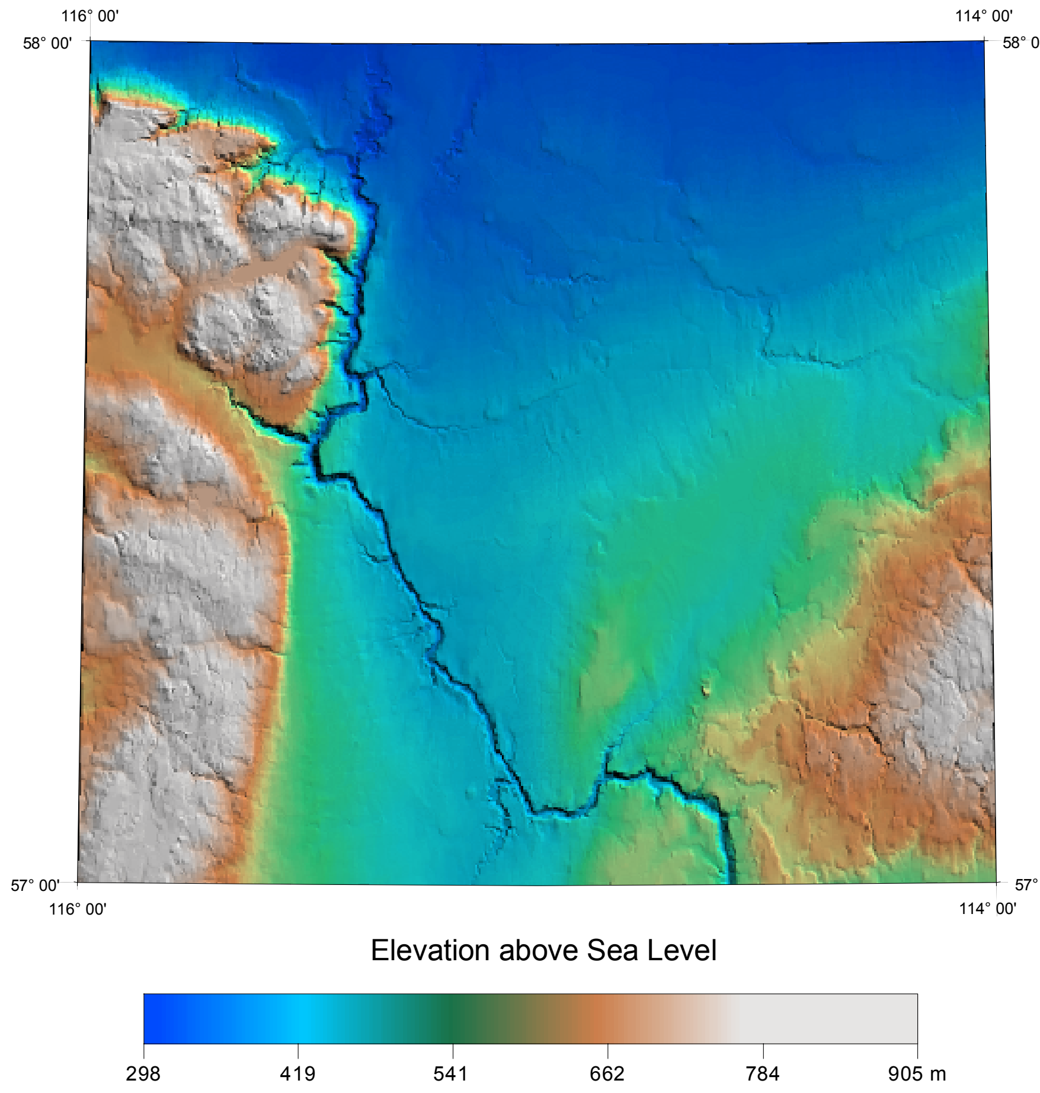

Look Directions and Incident Angles of
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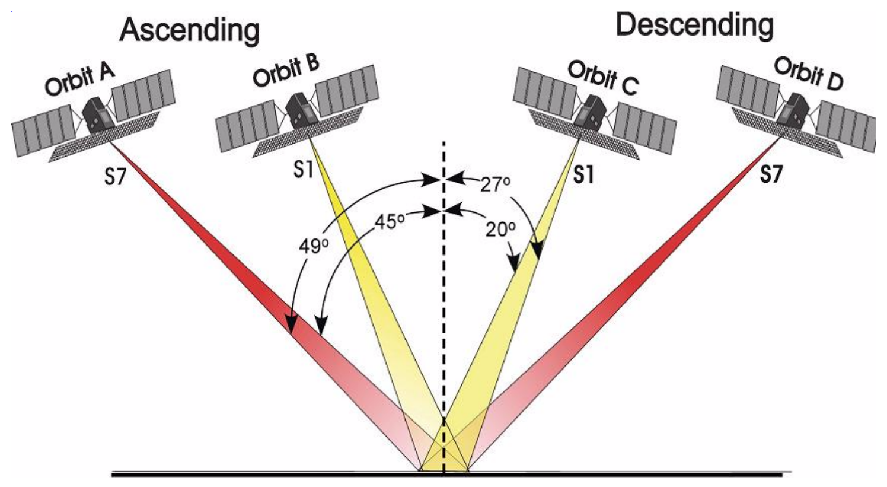

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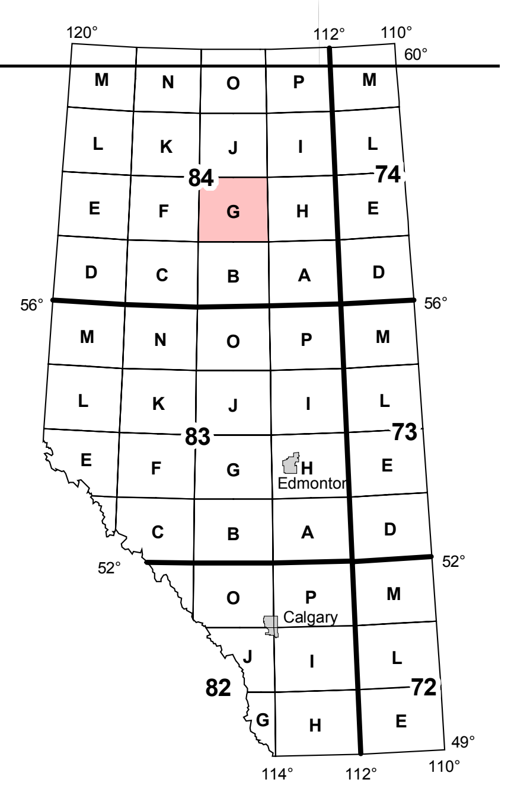
Geo-Note 2003-26, Figure 11

RADARSAT-1 Standard Beam 7 Ascending Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



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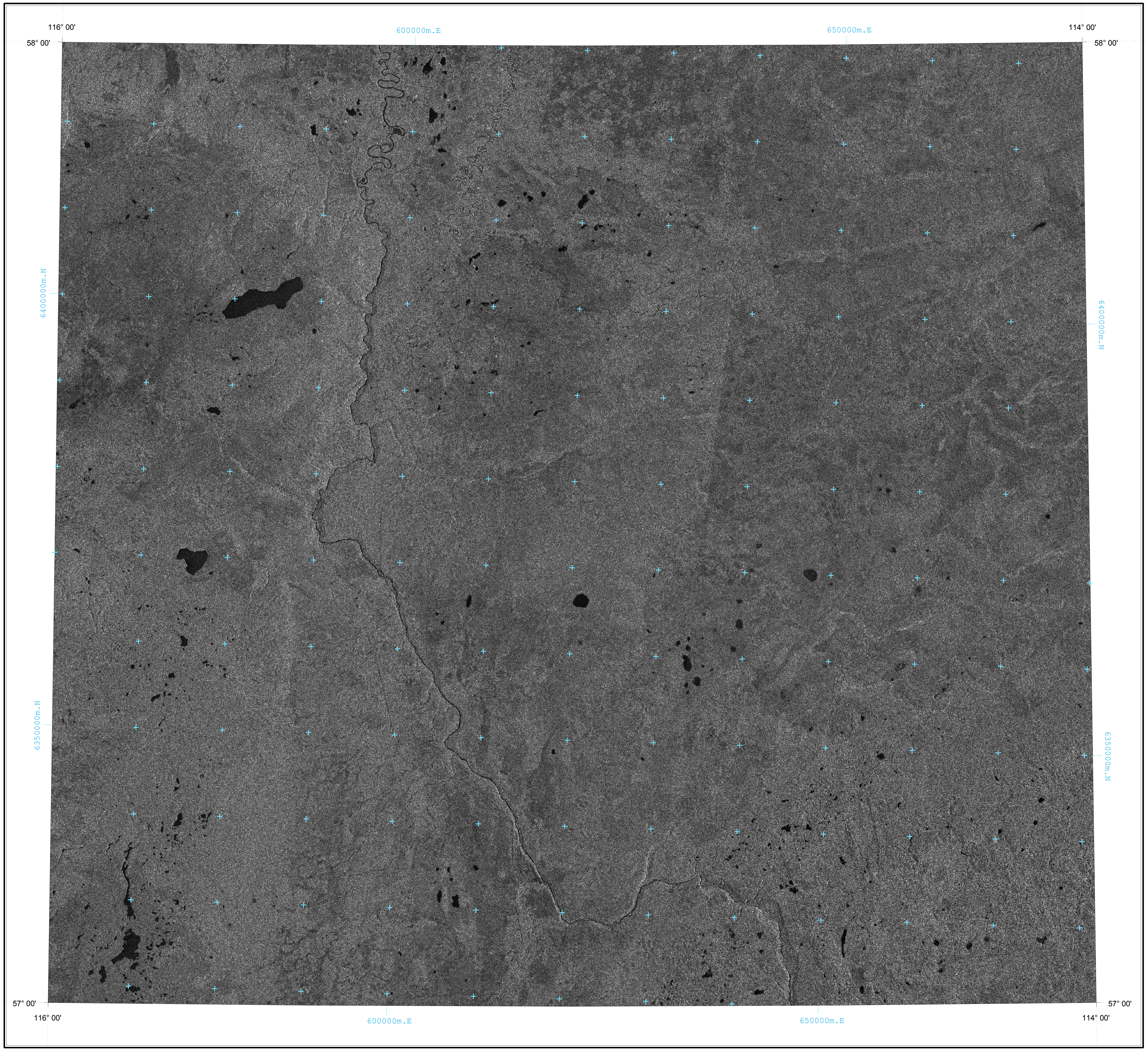
NTS 84G
RADARSAT-1



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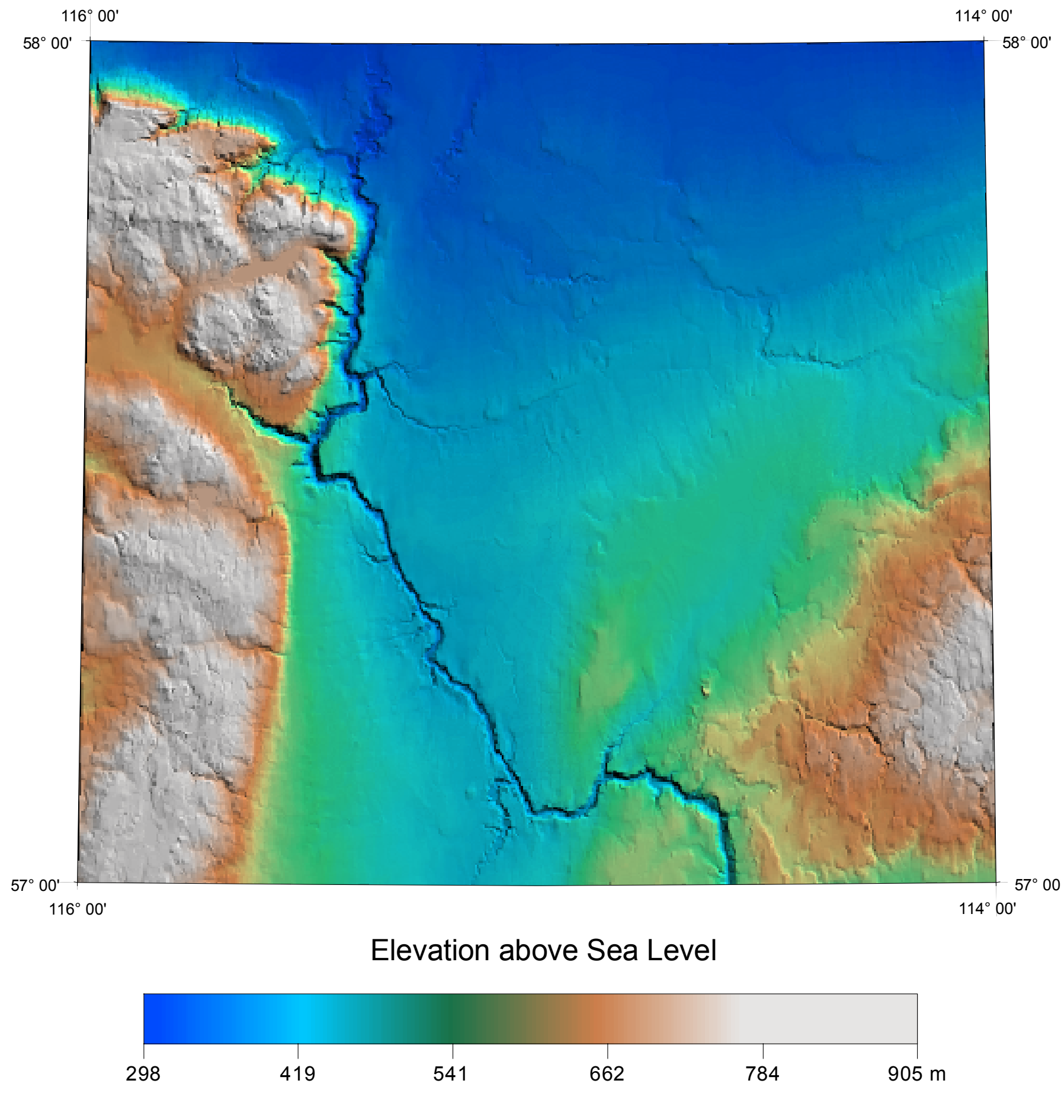

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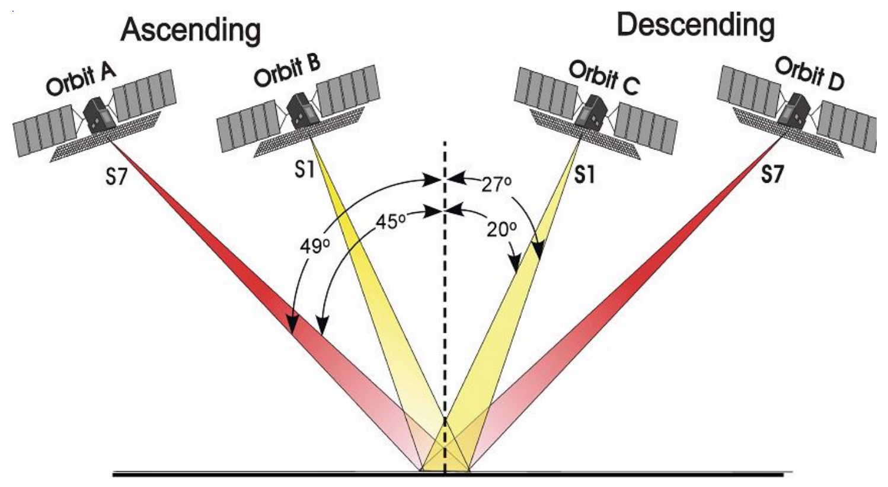

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Geo-Note 2003-26, Figure 12

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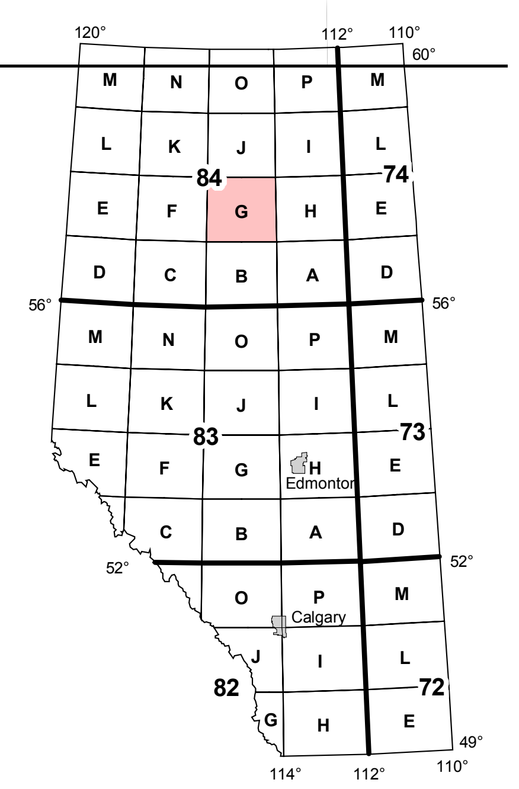
Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



Alberta Energy and Utilities Board
Alberta Geological Survey

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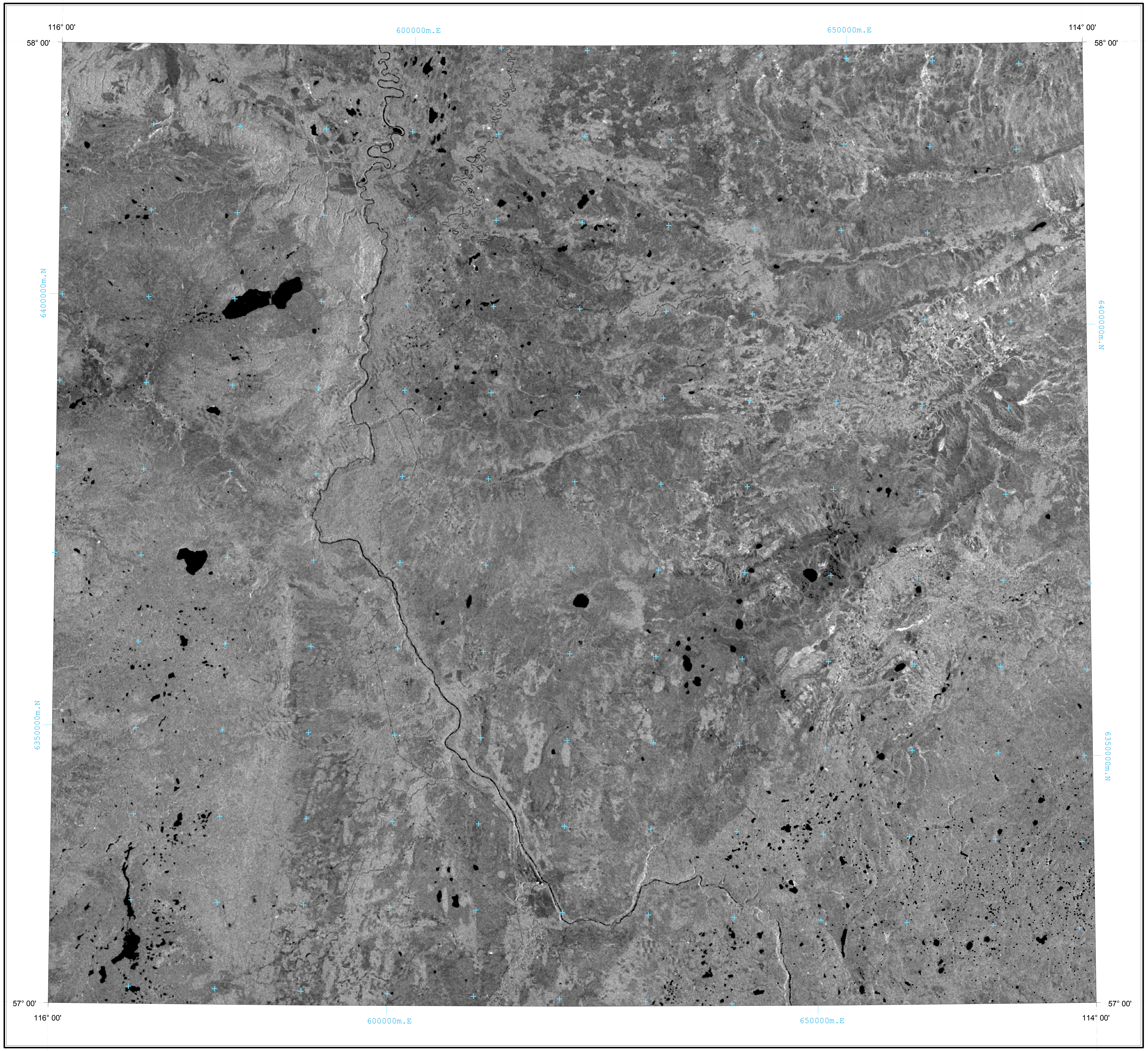
Disclaimer:

NTS 84G
RADARSAT-1



Introduction

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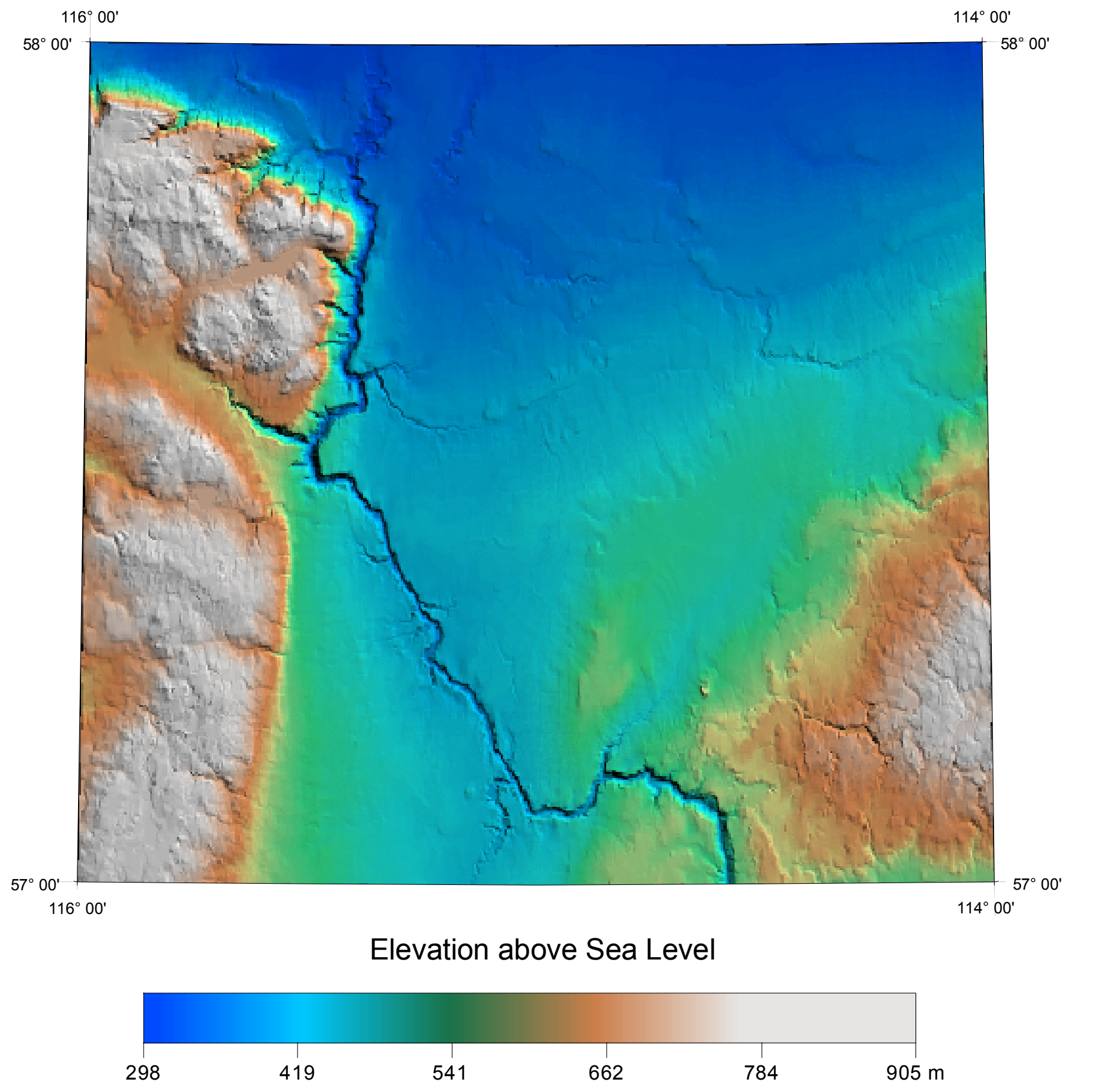
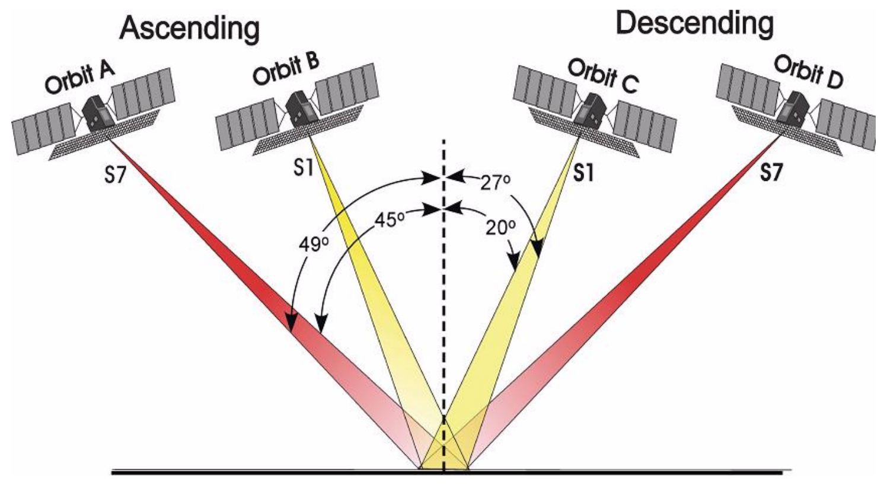
Elevation Map for NTS 84G



Look Directions and Incident Angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes



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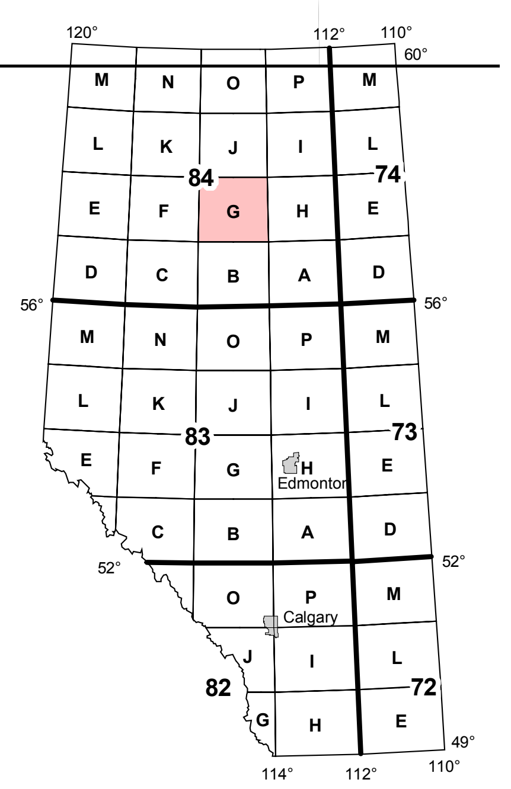
Geo-Note 2003-26, Figure 13

RADARSAT-1 Principal Component 1 Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



Alberta Energy and Utilities Board
Alberta Geological Survey

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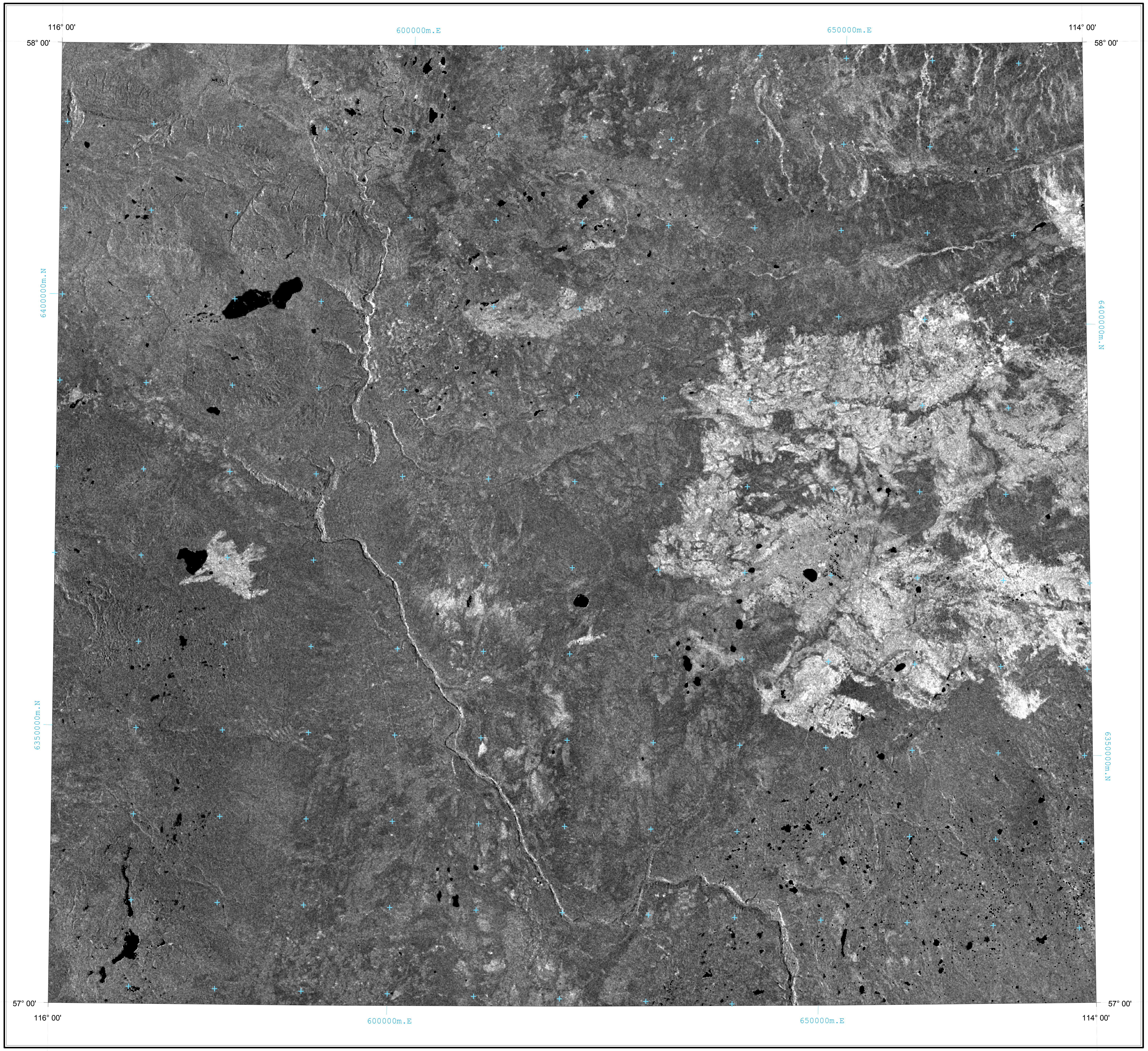
NTS 84G
RADARSAT-1



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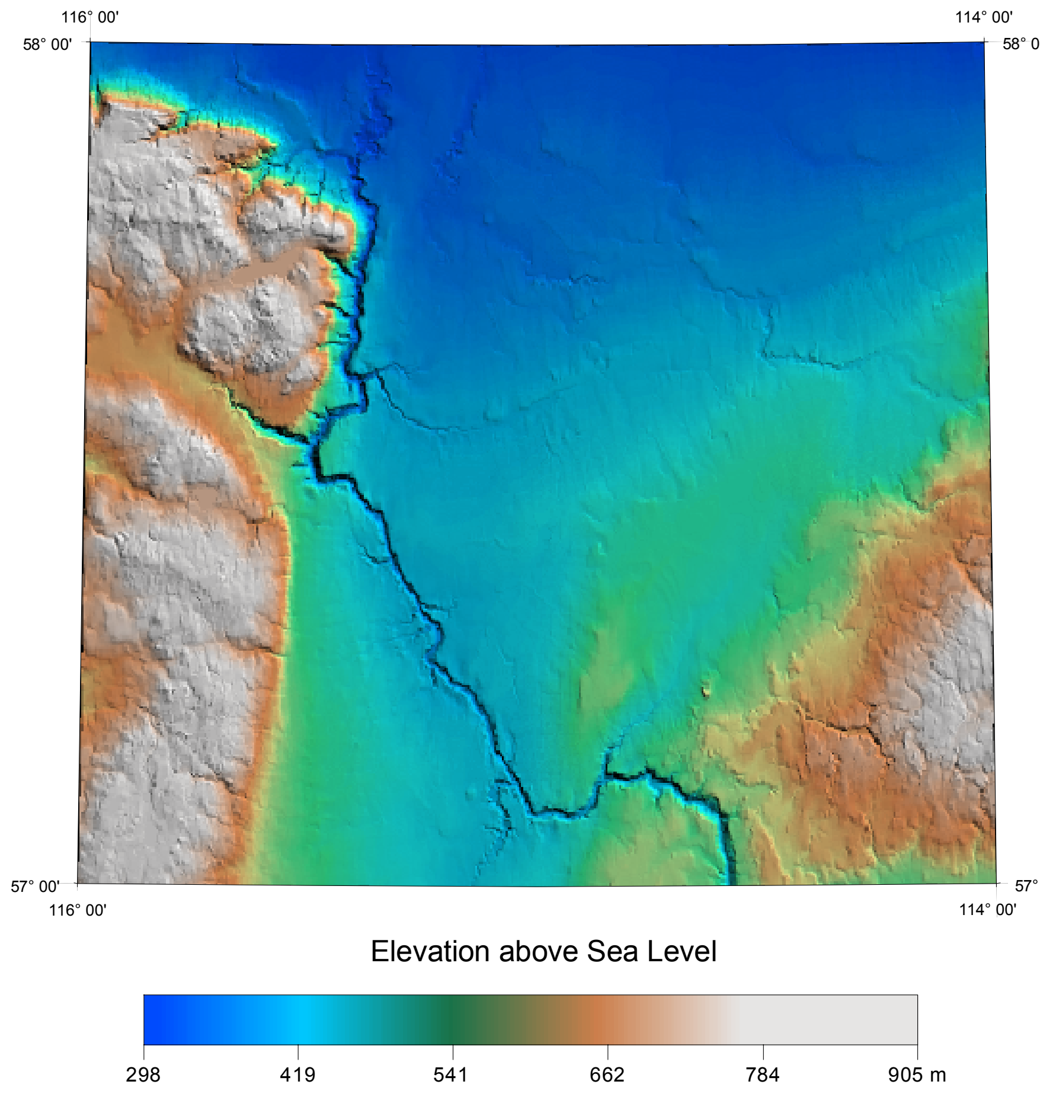
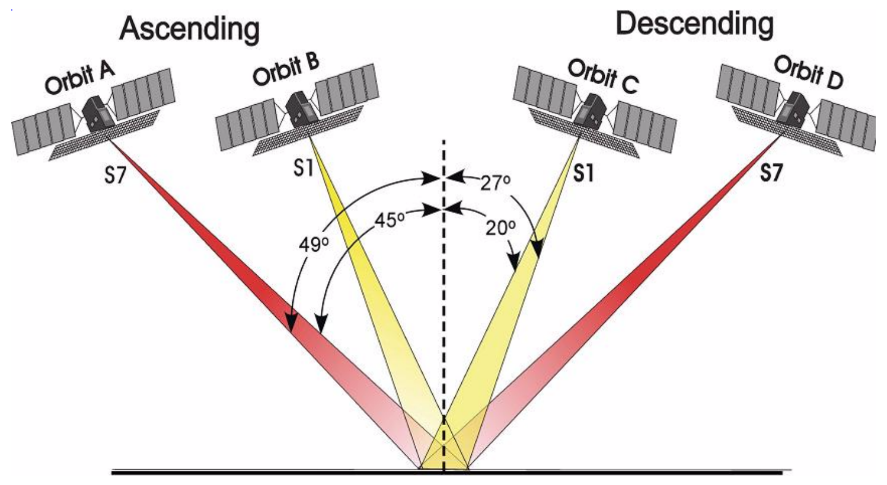
Elevation Map for NTS 84G



Look Directions and Incident Angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes



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Geo-Note 2003-26, Figure 14

RADARSAT-1 Principal Component 2 Image for Wadlin Lake, Alberta (NTS 84G)

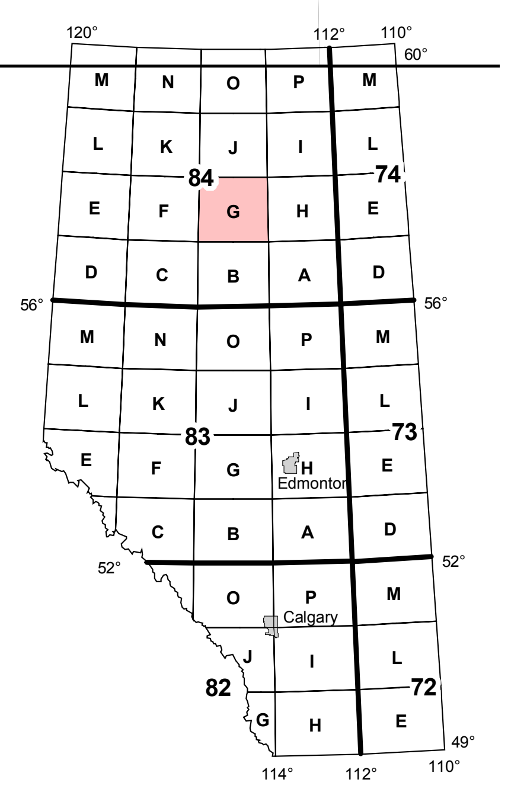
Compilation by S. Mei, 2003

Scale 1:250 000

5 0 5 10 15 20 25 30 kilometres

5 0 5 10 15 20 miles

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



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Disclaimer:

NTS 84G
RADARSAT-1

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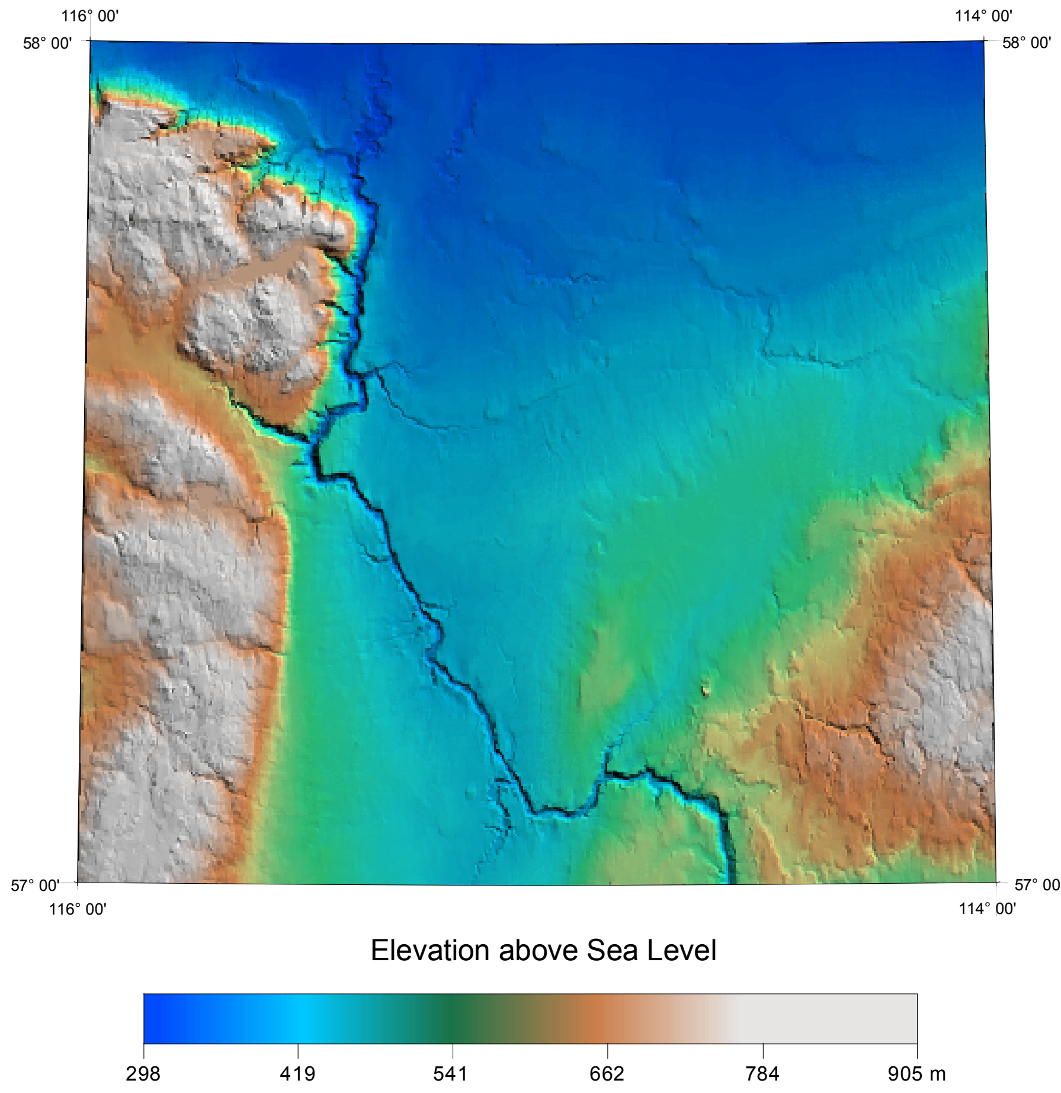

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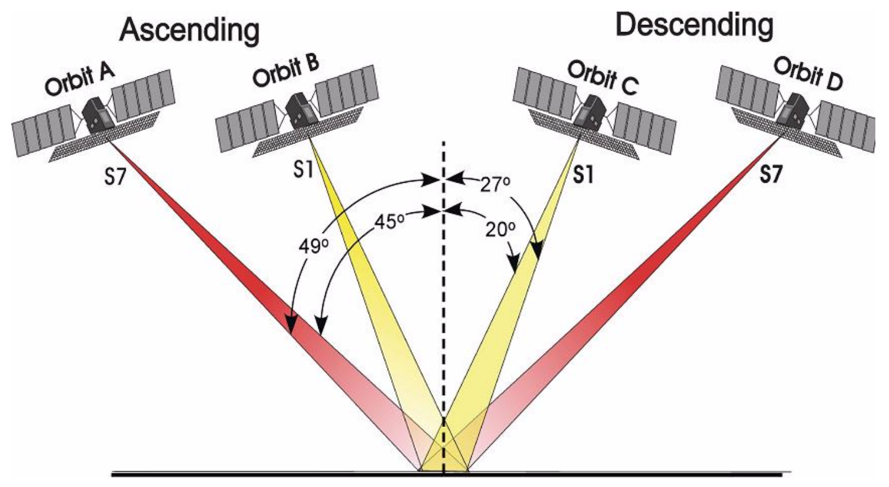

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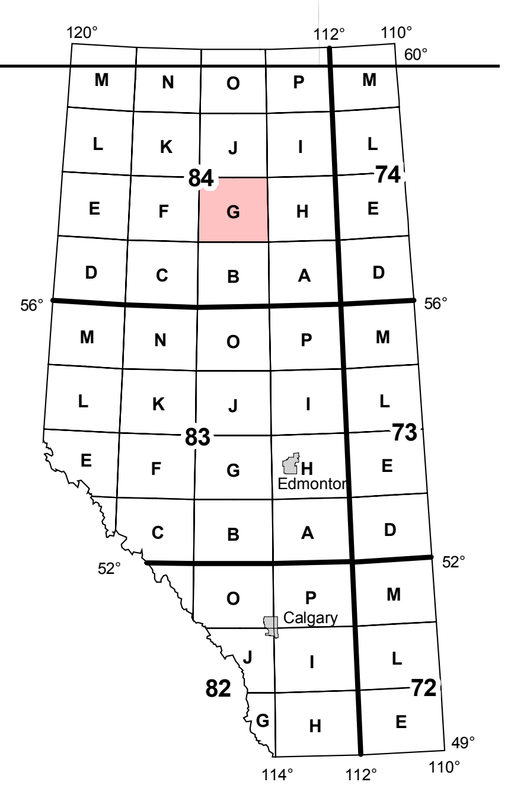

Geo-Note 2003-26, Figure 15

RADARSAT-1 Principal Component 3 Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003

Scale 1:250 000

5 0 5 10 15 20 25 30 kilometres

5 0 5 10 15 20 miles

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983

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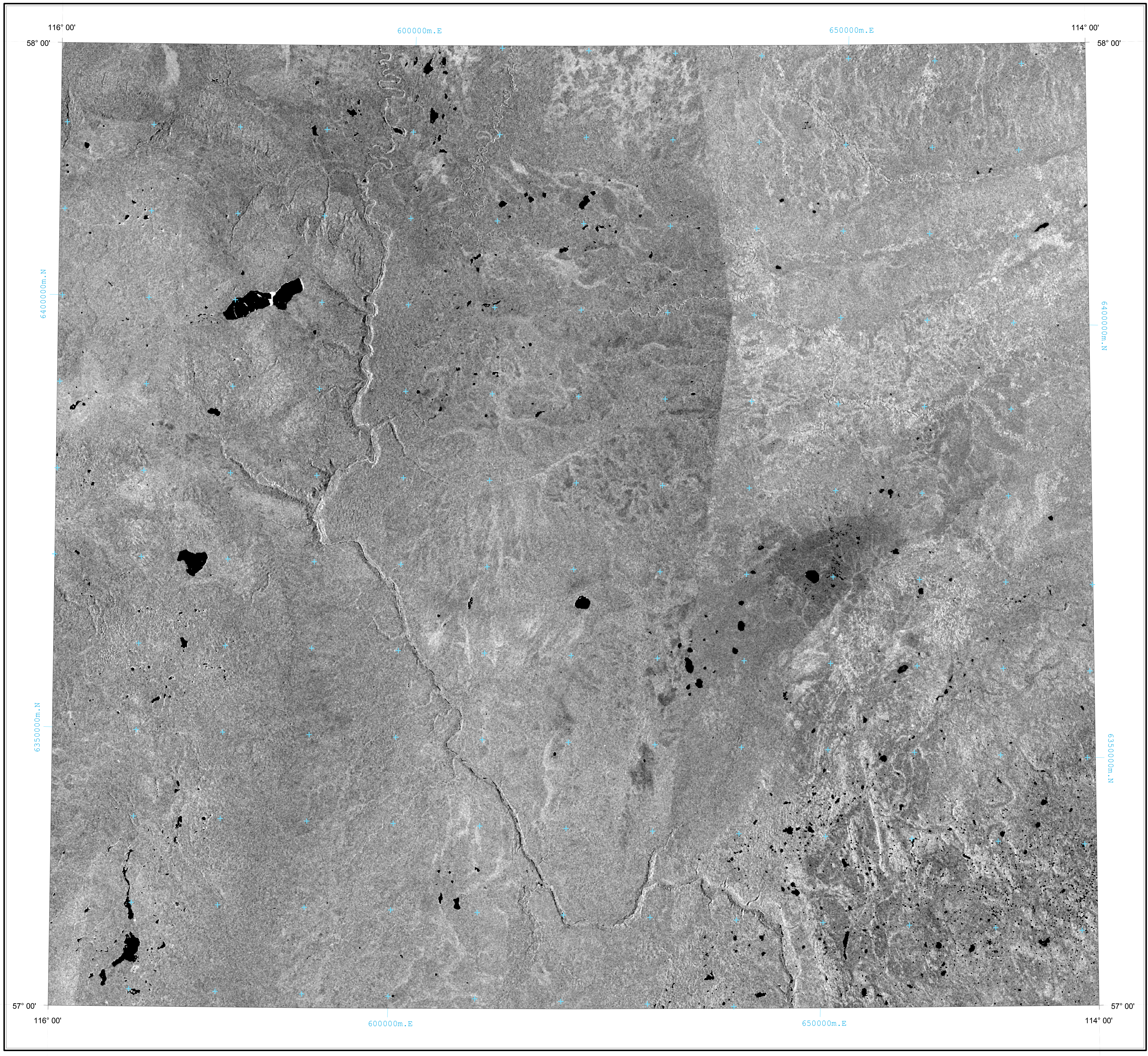
NTS 84G
RADARSAT-1



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Having said this, some general tips for interpreting the Figures 13 to 16 PCA images are provided below, but these are generalizations and intended only for assisting less experienced users to browse the image or evaluate variations on the printed map.

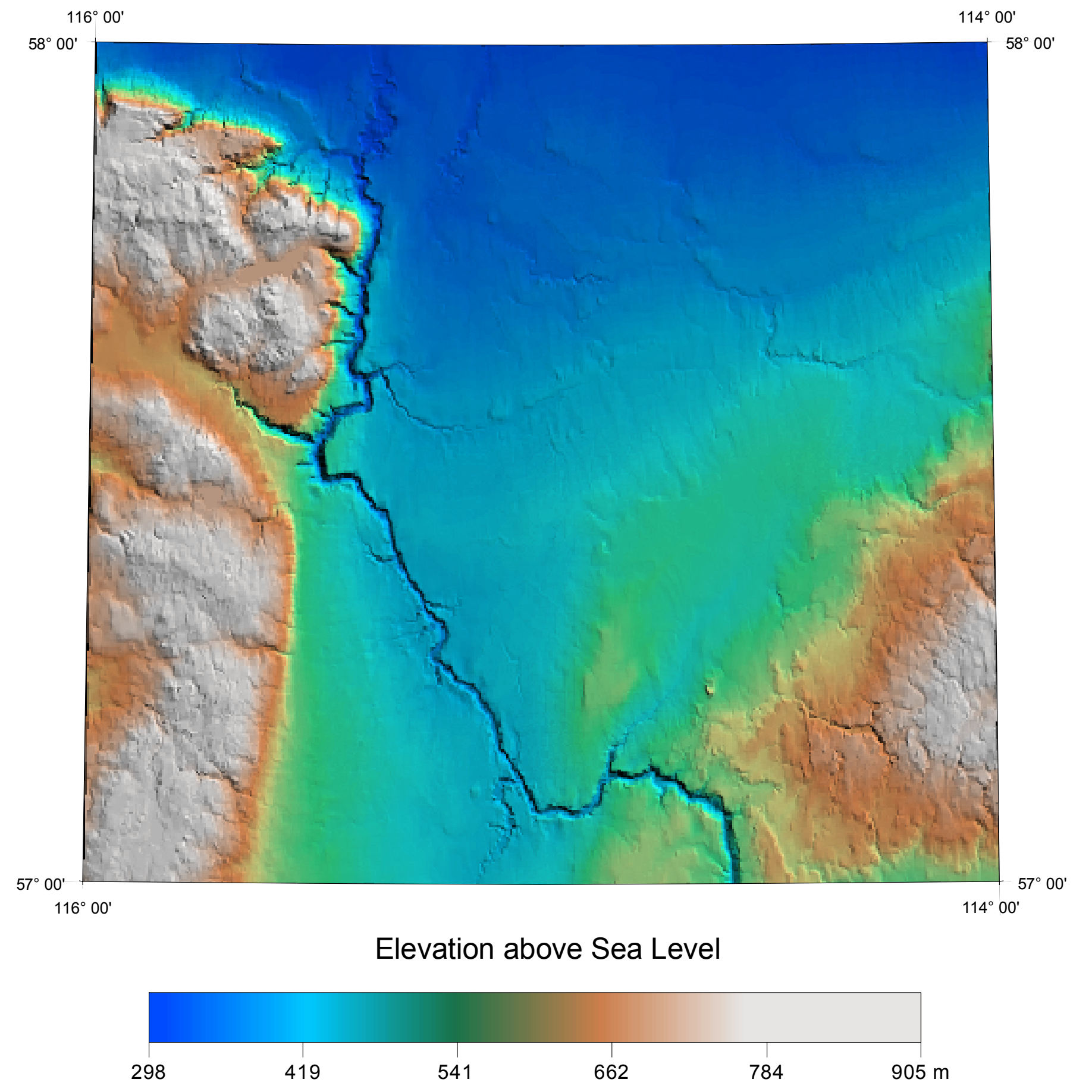
The First Principal Component (PC1) image (Figure 13) shows a range of brightness and texture that highlights features associated with differences in vegetation type and density. Areas of closed Aspen, closed Pine, open deciduous vegetation, grasslands and exposed soil appear to have a brighter tone with variable texture. Areas of open black spruce tend to show up as mid tone to dark grey. Shrubby and grassy wetlands also appear as dark areas. In general, darker tones tend to reflect areas of increased moisture (e.g., wetlands and areas of black spruce), whereas lighter tones reflect areas of drier conditions (e.g., better drainage with pine, aspen or exposed soil).

The Second Principal Component (PC2) image (Figure 14) provides information about the degree of land cover type and vegetation density. For example, well-forested lands show up as darker tones, whereas areas of burn and grassy or barren lands show up as lighter tones. Further, open black spruce forest is characterized by darker tones; closed pine forest is displayed in mid-range tones, and areas of dunes and exposed soil show up as the lightest tones. Finally, areas dominated by grass or little vegetation or of burned forest, show up as light- to medium-grey tones.

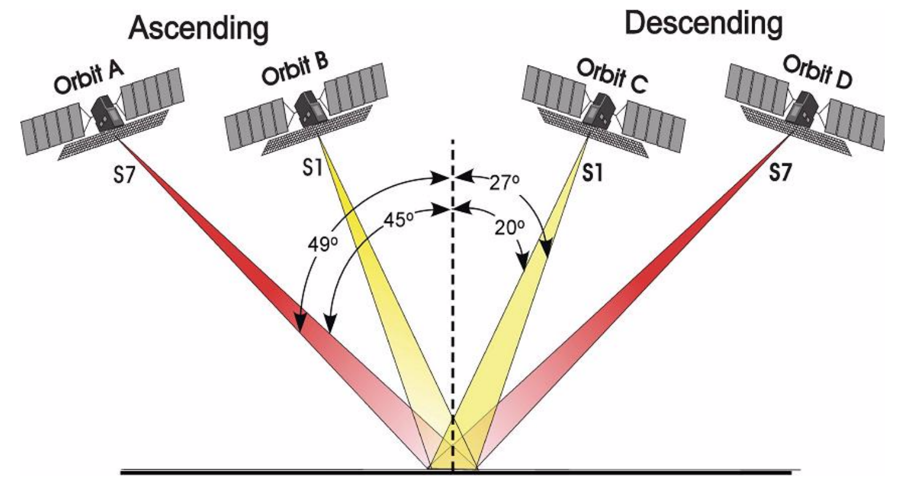
The Third Principal Component (PC3) image (Figure 15) highlights 'surface roughness'; hence it reflects topographic effects and surface texture of the ground or vegetation canopy. In fact, the discrimination of topographic features using the PC3 image is superior to any other optical commercial satellite imagery, with similar spatial resolution. As a result, areas of drumlins, sand dunes, eskers, embankments and other prominent topographic features typically are more clearly shown on PC3 images than on the other PCA images. Further, areas of outwash, dune fields, stream alluvium and ice contact deposits usually exhibit unique textural characteristics, which can act to assist in the preliminary mapping or differentiation of surficial materials.

The Fourth Principal Component (PC4) image (Figure 16) shows some added differences in vegetation surface and volume scattering response that are not noted from the other three PCA images. Interestingly, open black spruce forest usually appears to display a lighter tone on PC4 images. Such differences on PC4 may reflect a combination of vegetation density and morphology.

Elevation Map for NTS 84G



Look Directions and Incident Angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes



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Telephone: (780) 422-3767
Web site: www.ags.gov.ab.ca

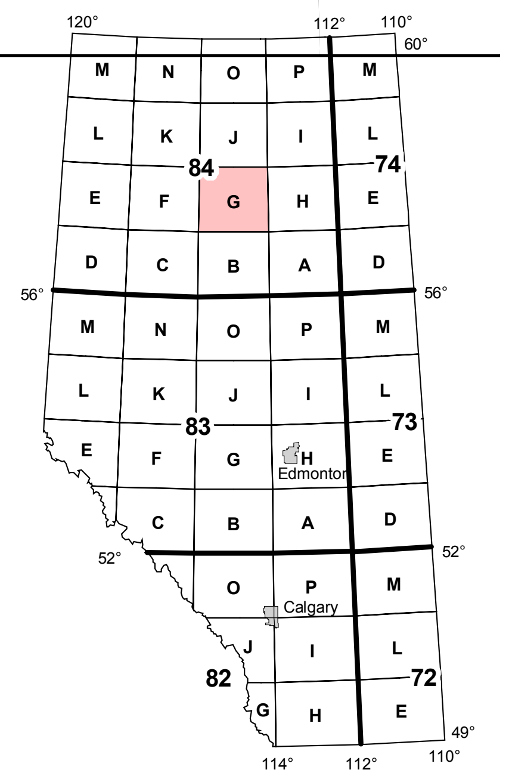
Geo-Note 2003-26, Figure 16

RADARSAT-1 Principal Component 4 Image for Wadlin Lake, Alberta (NTS 84G)

Compilation by S. Mei, 2003

Scale 1:250 000
5 0 5 10 15 20 25 30 kilometres
5 0 5 10 15 20 miles

Projection: Universal Transverse Mercator, Zone 11
Datum: North American Datum, 1983



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