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Orthorectified and Principal Component RADARSAT-1 Image Dataset for NTS 73M, Alberta

Alberta Energy and Utilities Board

Alberta Geological Survey

AGS

Orthorectified and Principal Component RADARSAT-1 Image Dataset for NTS 73M, Alberta

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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 73M 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 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 73M 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 73M.

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.
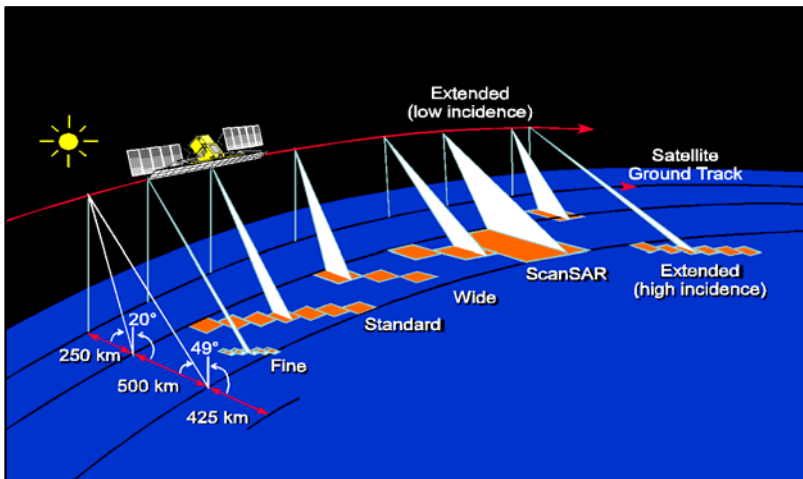

Figure 1. RADARSAT-1 beam modes (used with permision from RADARSAT International (RSI), 1997).
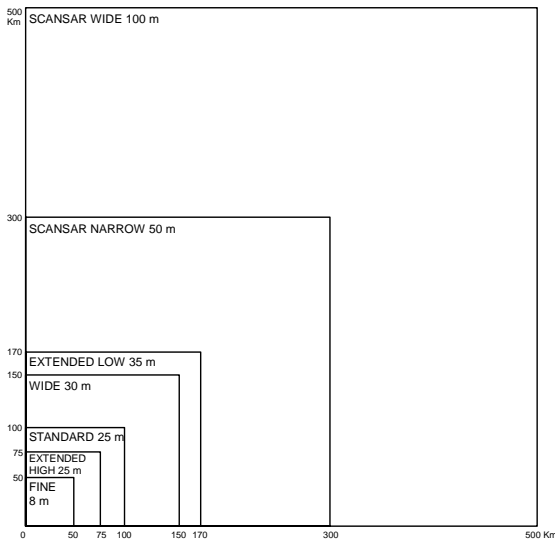

Figure 2. Coverage sizes and resolutions of RADARSAT-1 beam modes (modified after RADARSAT International (RSI), 1999).

The orthorectified and principal component RADARSAT-1 image datasets for NTS 73M 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.
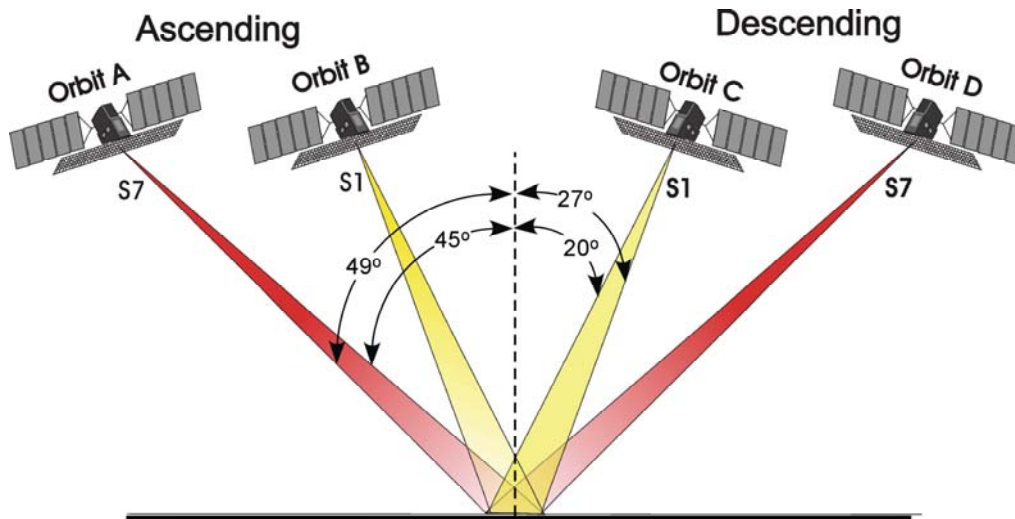
Figure 3. Multi-beam configuration of RADARSAT-1 S1 and S7 ascending/descending imagery (after Grunsky, 2002a).

3 Processes for Acquisition of the Orthorectified and Principal Component RADARSAT-1 Images for NTS 73M

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 73M 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 73M.

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 73M dataset. Table 1 lists the scenes that overlay the NTS 73M area. Figure 5 shows the spatial locations of the scenes overlaying NTS 73M. Many of these scenes were used for producing the NTS 73M orthorectified and principal component image datasets included on the CD.
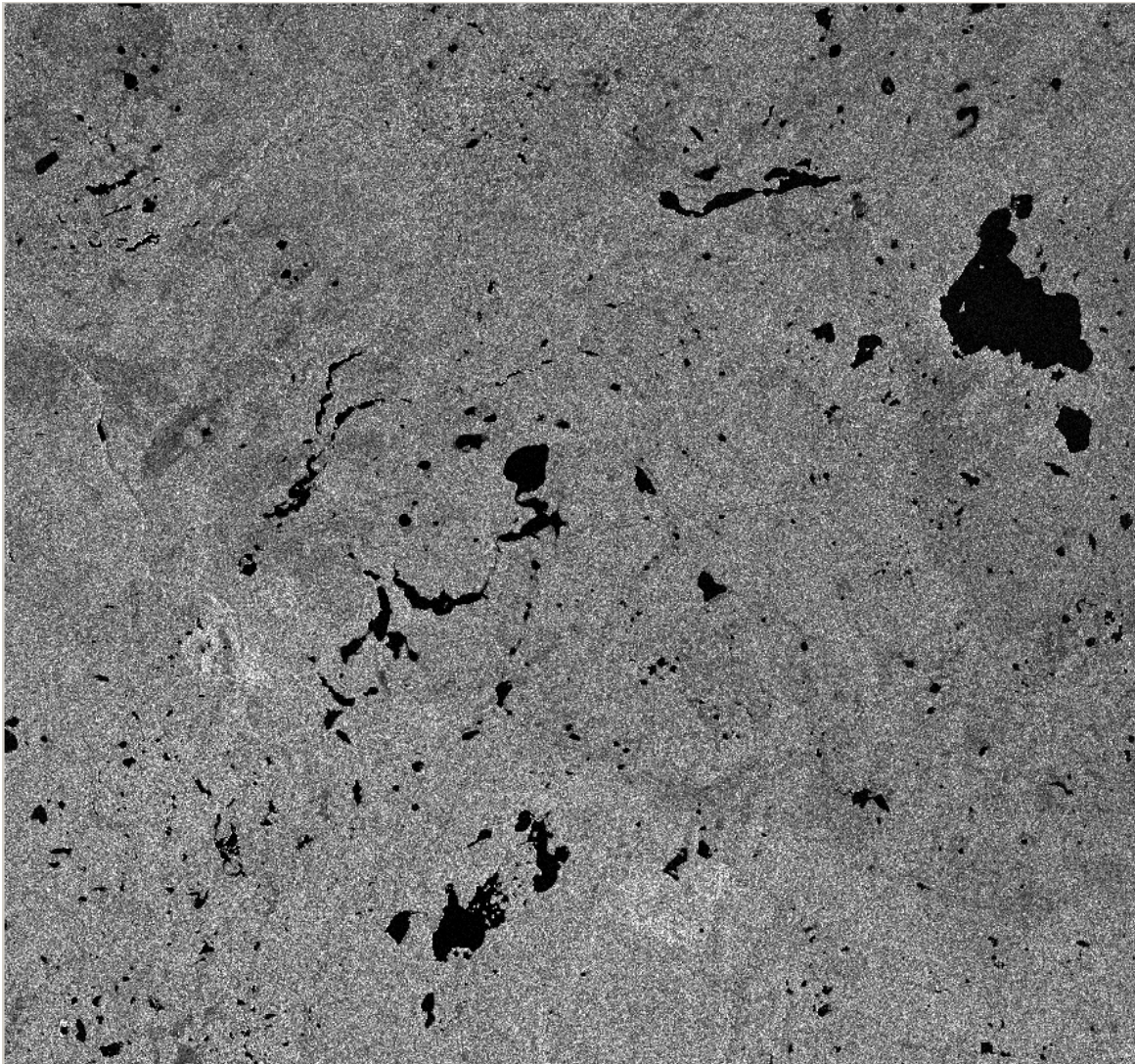

Figure 4. One of the original SGF scene images used for tiling the NTS 73M dataset: scene MO195874 of Standard Beam Mode 7 descending. RADARSAT data © Canadian Space Agency/Agence spatiale canadienne 1999, processed and distributed by RADARSAT International.

Table 1. List of the Path Images that Overlay NTS 73M

| Scene ID	Beam	Path	UL_LAT	UL_LONG	UR_LAT	UR_LONG	LR_LAT	LR_LONG	LL_LAT	LL_LONG
M0197235	S1	ASC	56:30:20.23N	113:47:49.38W	56:44:50.52N	111:59:15.78W	55:46:24.65N	111:35:01.79W	55:32:07.72N	113:20:47.62W
M0197234	S1	ASC	55:40:27.93N	113:29:10.59W	55:54:59.89N	111:41:49.70W	54:56:31.89N	111:18:15.73W	54:42:12.74N	113:02:54.79W
M0196914	S1	ASC	56:07:31.50N	110:28:19.13W	56:21:55.93N	108:40:56.05W	55:23:53.57N	108:17:13.05W	55:09:42.00N	110:01:53.28W
M0196442	S1	ASC	56:31:34.23N	111:44:35.62W	56:46:10.09N	109:55:29.34W	55:51:14.26N	109:32:37.73W	55:36:51.14N	111:19:05.02W
M0196441	S1	ASC	55:42:10.71N	111:21:31.97W	55:56:34.97N	109:34:50.05W	54:59:51.77N	109:11:59.25W	54:45:39.78N	110:56:04.97W
M0195878	S1	ASC	56:25:53.81N	112:46:33.03W	56:40:34.60N	110:57:09.64W	55:45:38.82N	110:34:20.63W	55:31:10.82N	112:21:05.00W
M0195877	S1	ASC	55:36:37.23N	112:23:34.44W	55:51:06.44N	110:36:34.77W	54:52:38.19N	110:13:04.81W	54:38:21.67N	111:57:23.53W
M0199212	S1	DES	56:03:02.46N	113:31:32.42W	55:48:50.05N	111:45:44.44W	54:54:03.38N	112:10:25.12W	55:08:04.06N	113:53:42.45W
M0199211	S1	DES	56:52:29.26N	113:10:55.71W	56:38:05.48N	111:22:44.67W	55:43:21.87N	111:48:15.27W	55:57:33.11N	113:33:48.21W
M0196270	S1	DES	55:45:13.90N	111:35:19.77W	55:31:02.36N	109:50:04.70W	54:35:25.61N	110:14:51.25W	54:49:25.45N	111:57:35.64W
M0196269	S1	DES	56:34:41.22N	111:14:55.96W	56:20:18.56N	109:27:20.23W	55:25:34.03N	109:52:33.96W	55:39:44.38N	111:37:33.88W
M0195854	S1	DES	55:54:11.68N	112:34:22.36W	55:39:59.96N	110:48:53.04W	54:46:14.49N	111:12:58.81W	55:00:14.80N	112:56:01.35W
M0195853	S1	DES	56:43:40.25N	112:13:51.61W	56:29:17.27N	110:26:00.34W	55:34:33.60N	110:51:22.39W	55:48:44.15N	112:36:36.77W
M0197034	S7	DES	55:07:52.91N	113:13:20.77W	54:59:30.67N	111:29:27.66W	54:27:35.70N	111:38:00.70W	54:35:58.85N	113:20:31.35W
M0197033	S7	DES	56:00:36.11N	113:01:21.13W	55:52:15.16N	111:15:05.46W	54:54:03.49N	111:30:56.52W	55:02:25.88N	113:14:35.57W
M0197032	S7	DES	56:46:32.75N	112:50:45.80W	56:38:12.67N	111:02:18.80W	55:43:33.01N	111:17:30.92W	55:51:54.18N	113:03:23.28W
M0196377	S7	DES	55:48:50.41N	110:57:01.53W	55:40:27.53N	109:11:11.95W	54:46:10.53N	109:25:57.34W	54:54:34.78N	111:09:22.18W
M0196376	S7	DES	56:39:57.18N	110:45:14.33W	56:31:35.28N	108:57:00.05W	55:35:10.46N	109:12:40.41W	55:43:33.49N	110:58:16.18W
M0195875	S7	DES	55:02:44.65N	112:11:06.11W	54:54:22.12N	110:27:26.12W	54:07:07.03N	110:40:01.95W	54:15:30.96N	112:21:41.42W
M0195874	S7	DES	55:52:07.01N	111:59:53.93W	55:43:45.74N	110:14:01.52W	54:49:05.21N	110:28:52.71W	54:57:27.87N	112:12:18.99W
M0195873	S7	DES	56:41:32.49N	111:48:31.45W	56:33:12.19N	110:00:18.87W	55:38:32.90N	110:15:29.06W	55:46:54.32N	112:01:07.82W
M0199702	S7	ASC	56:38:02.57N	113:08:42.64W	56:46:25.94N	111:19:56.88W	55:51:47.17N	111:07:16.74W	55:43:22.77N	112:53:27.44W
M0199701	S7	ASC	55:48:40.92N	112:54:56.20W	55:57:05.19N	111:08:31.46W	54:58:55.38N	110:55:15.32W	54:50:29.71N	112:39:03.60W
M0199050	S7	ASC	56:12:54.01N	110:54:20.85W	56:21:17.25N	109:06:49.50W	55:23:07.88N	108:53:28.18W	55:14:43.36N	110:38:19.14W
M0198660	S7	ASC	56:34:31.09N	112:04:59.09W	56:42:54.37N	110:16:24.95W	55:48:14.98N	110:03:45.62W	55:39:50.64N	111:49:45.29W
M0198659	S7	ASC	55:45:03.31N	111:51:12.83W	55:53:27.51N	110:04:59.43W	54:55:17.68N	109:51:44.24W	54:46:52.05N	111:35:21.79W
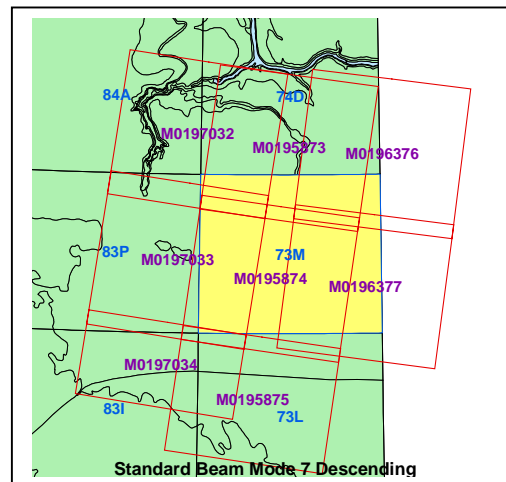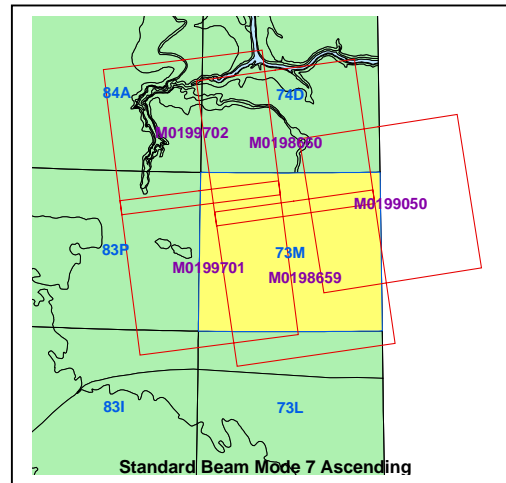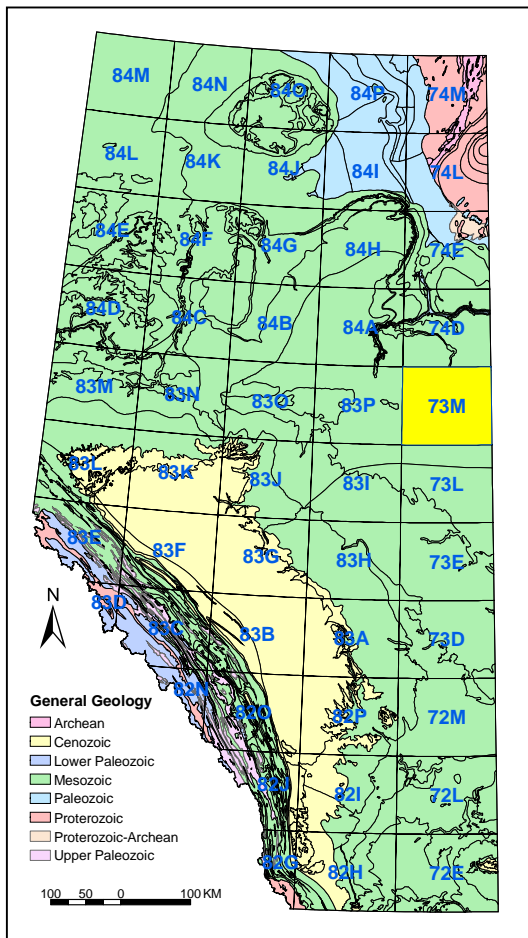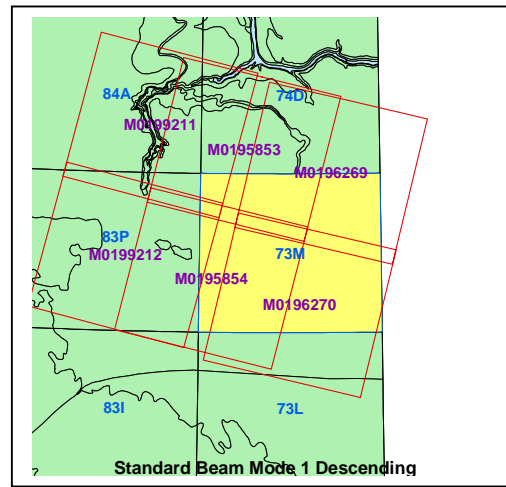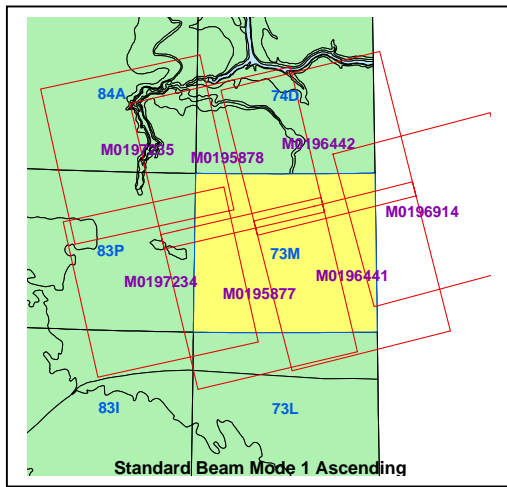
Figure 5. The scenes overlaying NTS 73M.

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 73M dataset.
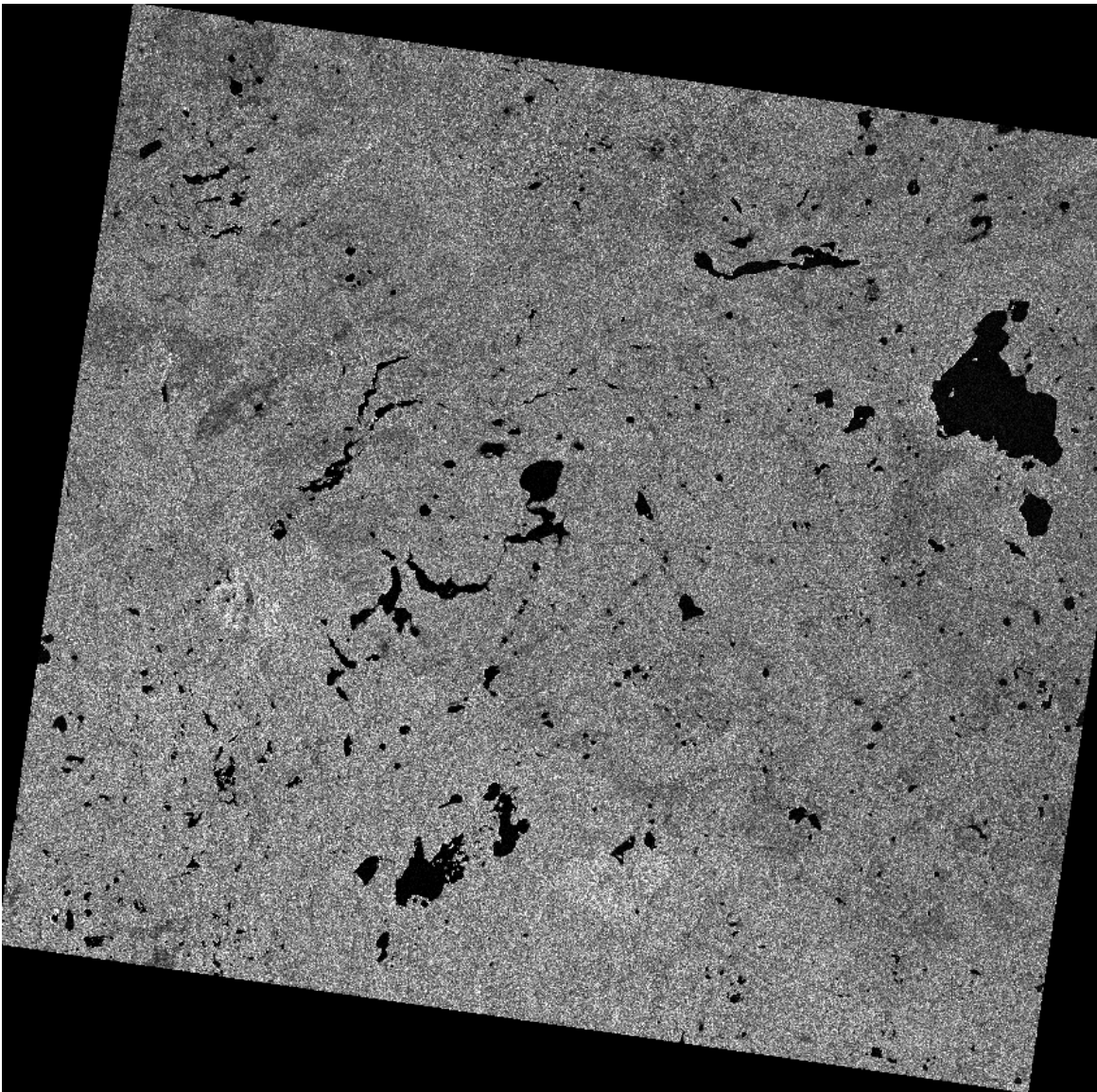
Figure 6. One of the orthorectified scene images used for tiling the NTS 73M dataset: scene MO195874 of Standard Beam Mode 7 descending.

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 73M image dataset.
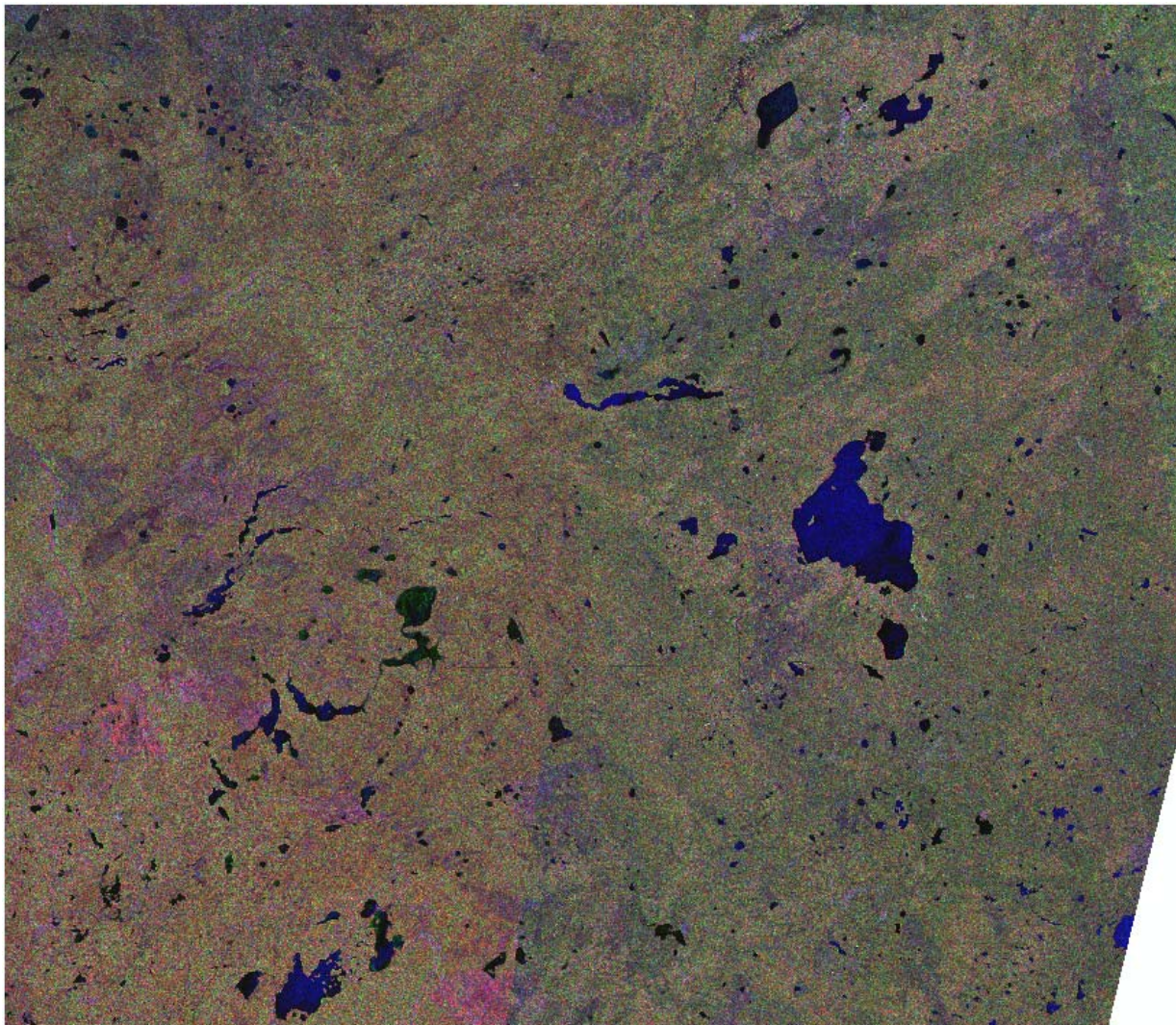

Figure 7. Pseudocolour composite of orthorectified NTS 73M image dataset of Standard Beam Mode S1/S7 ascending/descending beam positions (RGB=S7d, S7a, S1d).

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 73M. Features, such as roads, are more clearly presented in the principal component image than in the original NTS 73M image (Figure 7).
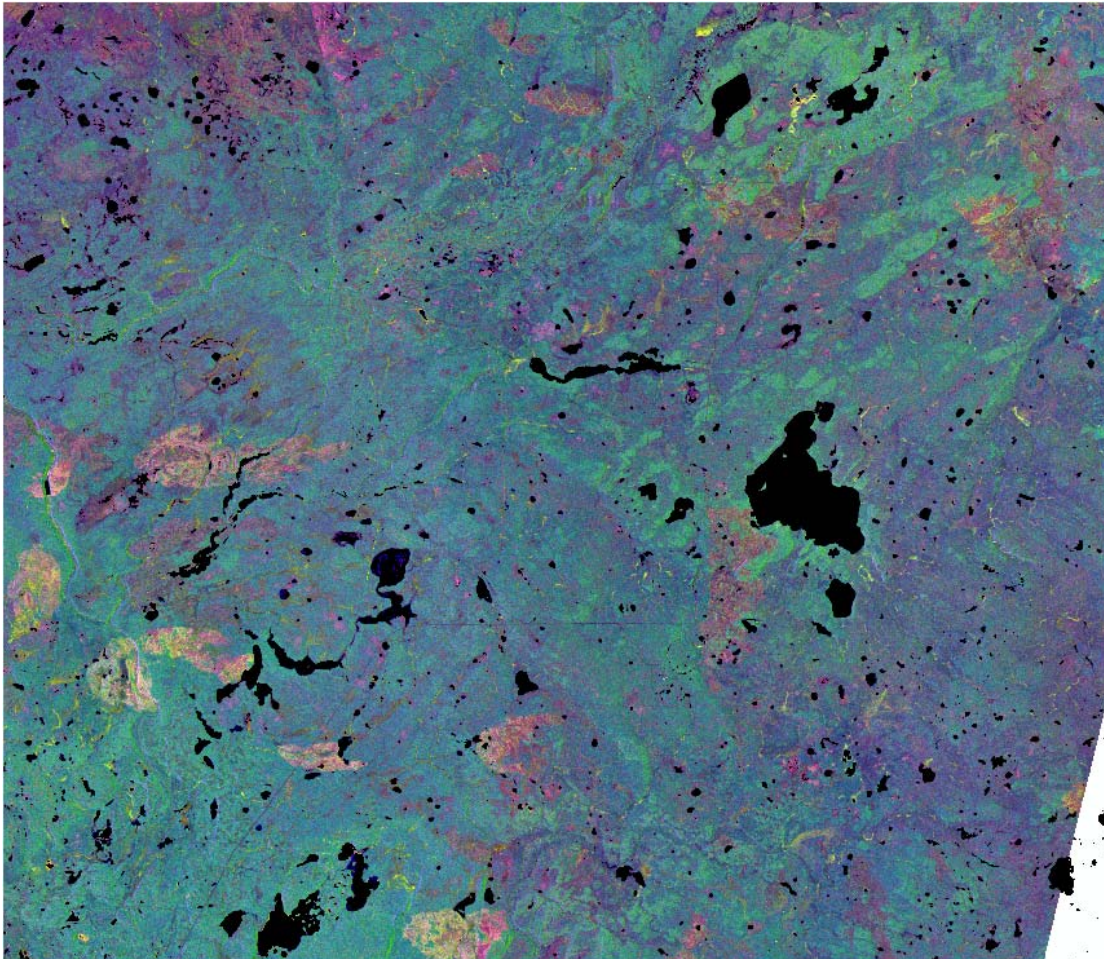

Figure 8. Pseudocolour composite of NTS 73M image dataset of principal component PC1, PC2, PC3 and PC4 (RGB=PC2, PC1, PC3).

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.
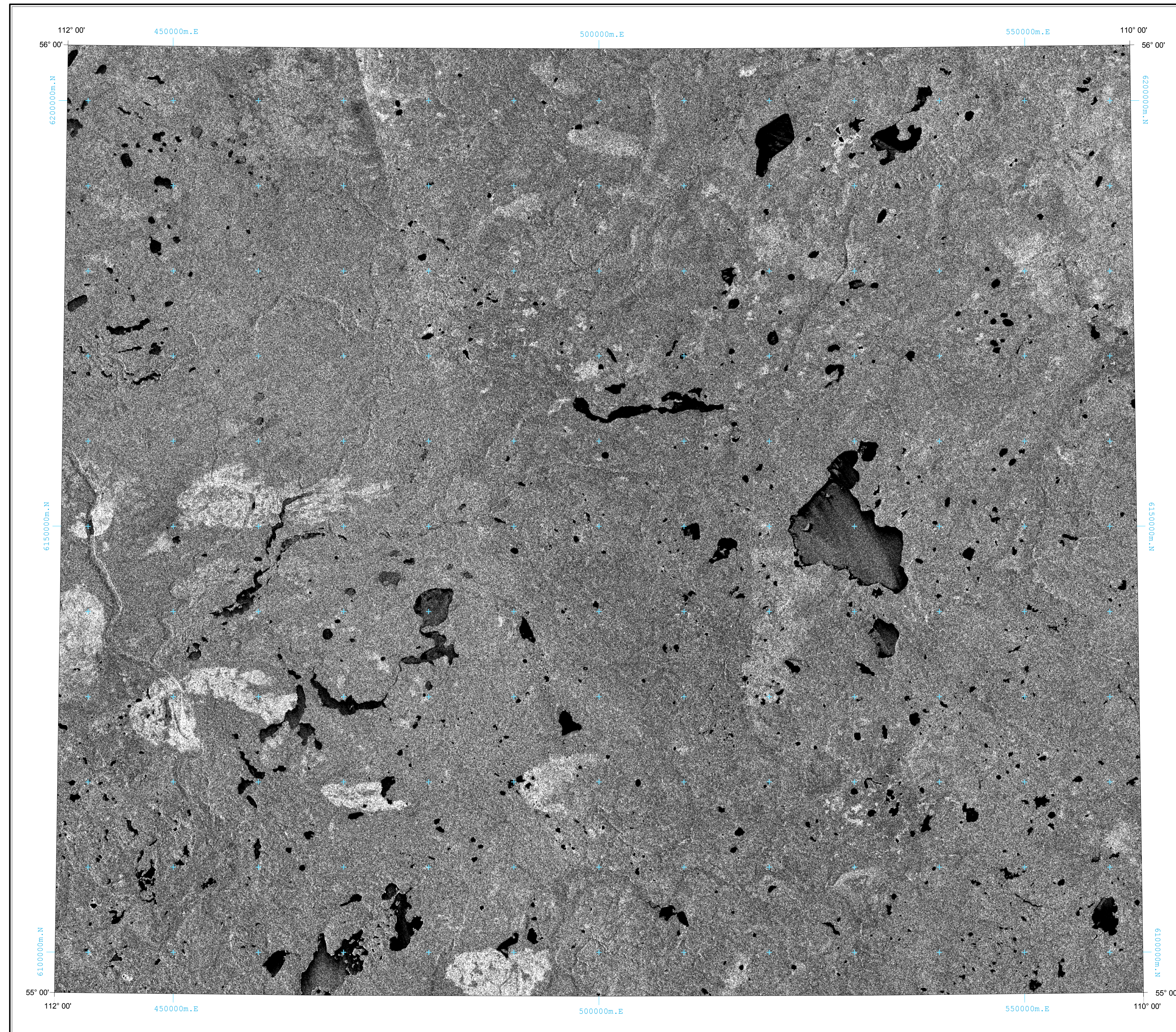
4 Conclusion

The image datasets for NTS 73M 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 73M. 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 73M map area.

5 References

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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.
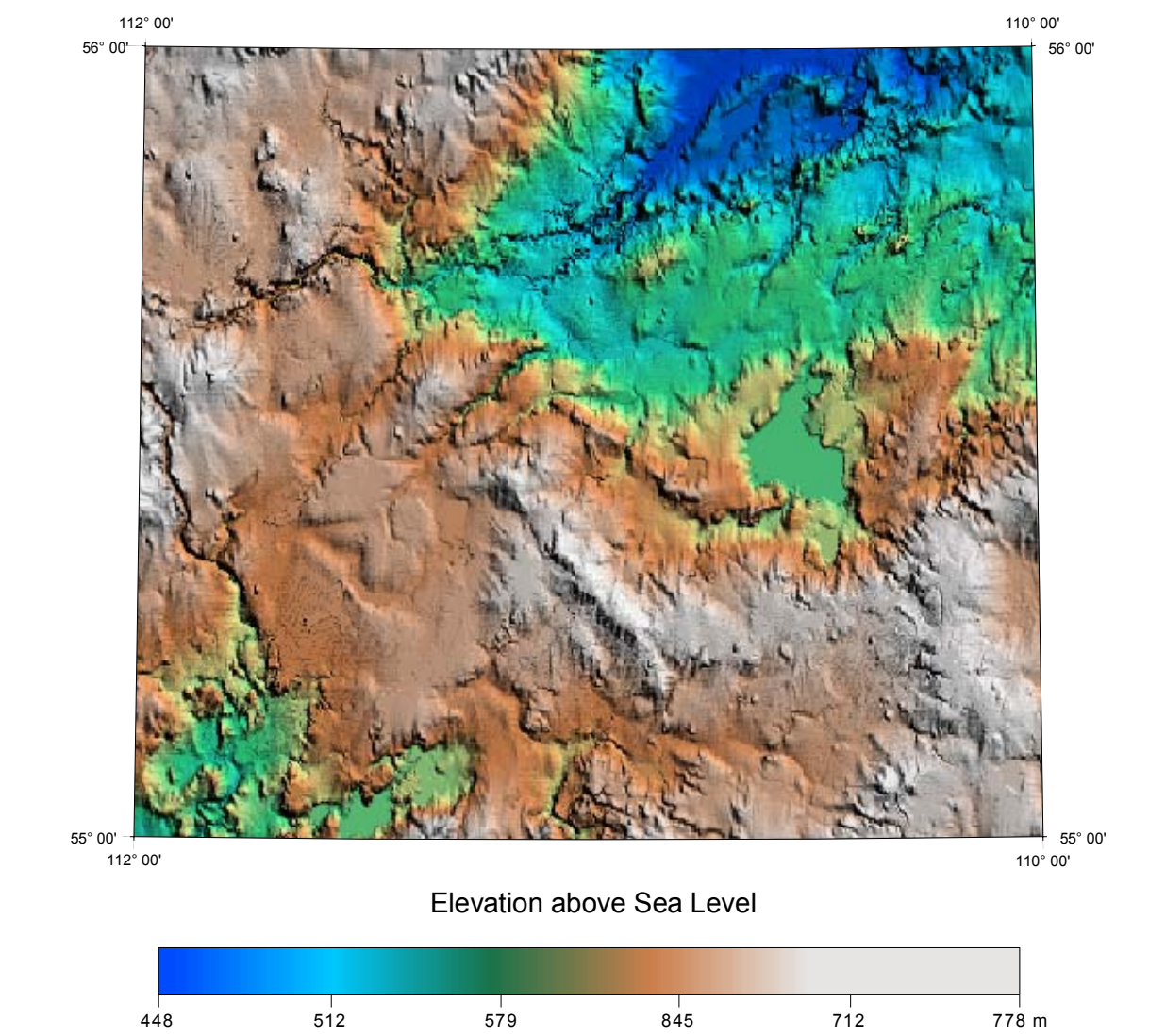
As part of their regional mapping strategy, the Alberta Geological Survey acquired RADARSAT-1 images over northern Alberta (north of 55 degrees north latitude) with the following four beam positions: Standard Beam 1 (S1) ascending (71 scenes), S1 descending (70 scenes), Standard Beam 7 (S7) ascending (65 scenes) and S7 descending (68 scenes). The resolution of each of these datasets is about 25 m (that is, the resulting radar responses reflect or encompass a square cell that is areally about 25 m on each side). The strategy of acquiring S1 and S7 imagery was done to contrast the radar responses based on two incidence angles and two look directions. The images were obtained in a dry autumn (September to December 1999) and, thus, provided ideal conditions of no to little deciduous foliage or snow. The acquired scene images were individually orthorectified and then tiled into 25, 1:250 000 scale NTS map areas that cover all of northern Alberta north of latitude 55°N. This results in four RADARSAT-1 images from the four beam positions for each NTS map area (Figures 9 to 12). As well, the four Radarsat image datasets (i.e., S1A, S1D, S7A and S7D) for each NTS map area were processed using Principal Component Analysis (PCA). PCA is a statistical method that evaluates correlation among the signals from the S1A, S1D, S7A and S7D image data, and generates resultant principal component images for each NTS map area. The first four principal components for each NTS map area were then used to produce four simple PCA maps (Figures 13 to 16).

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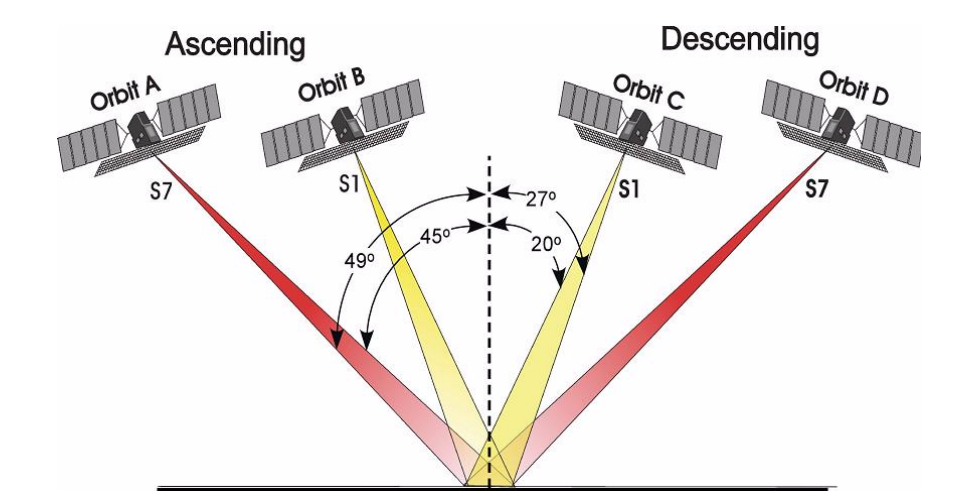
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Elevation Map for NTS 73M

Elevation above Sea Level

| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Geo-Note 2003-11, Figure 9

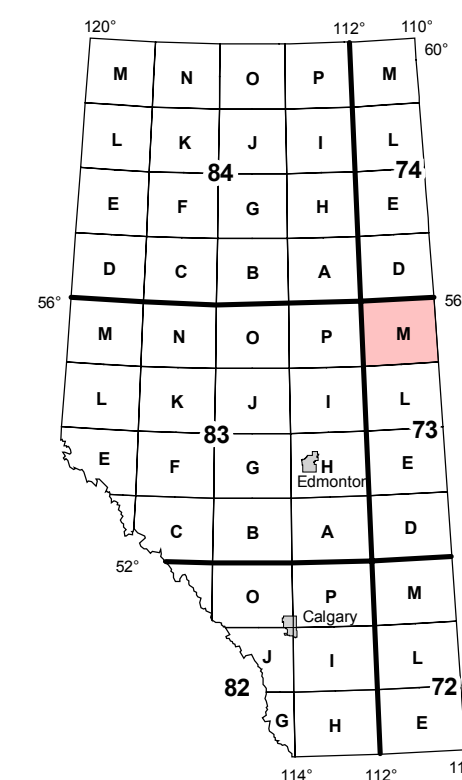# RADARSAT-1 Standard Beam 1 Ascending Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000

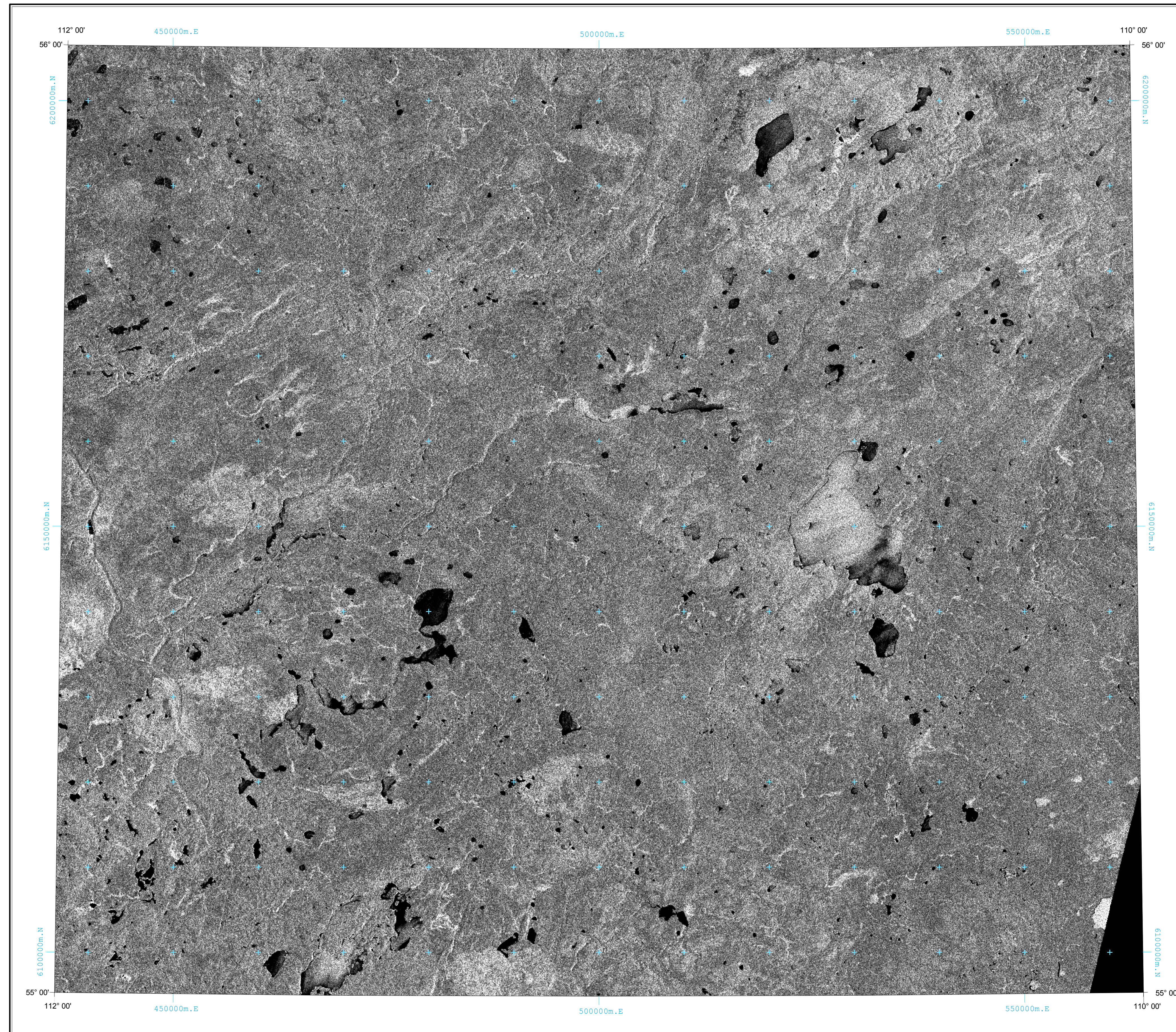Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

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Introduction

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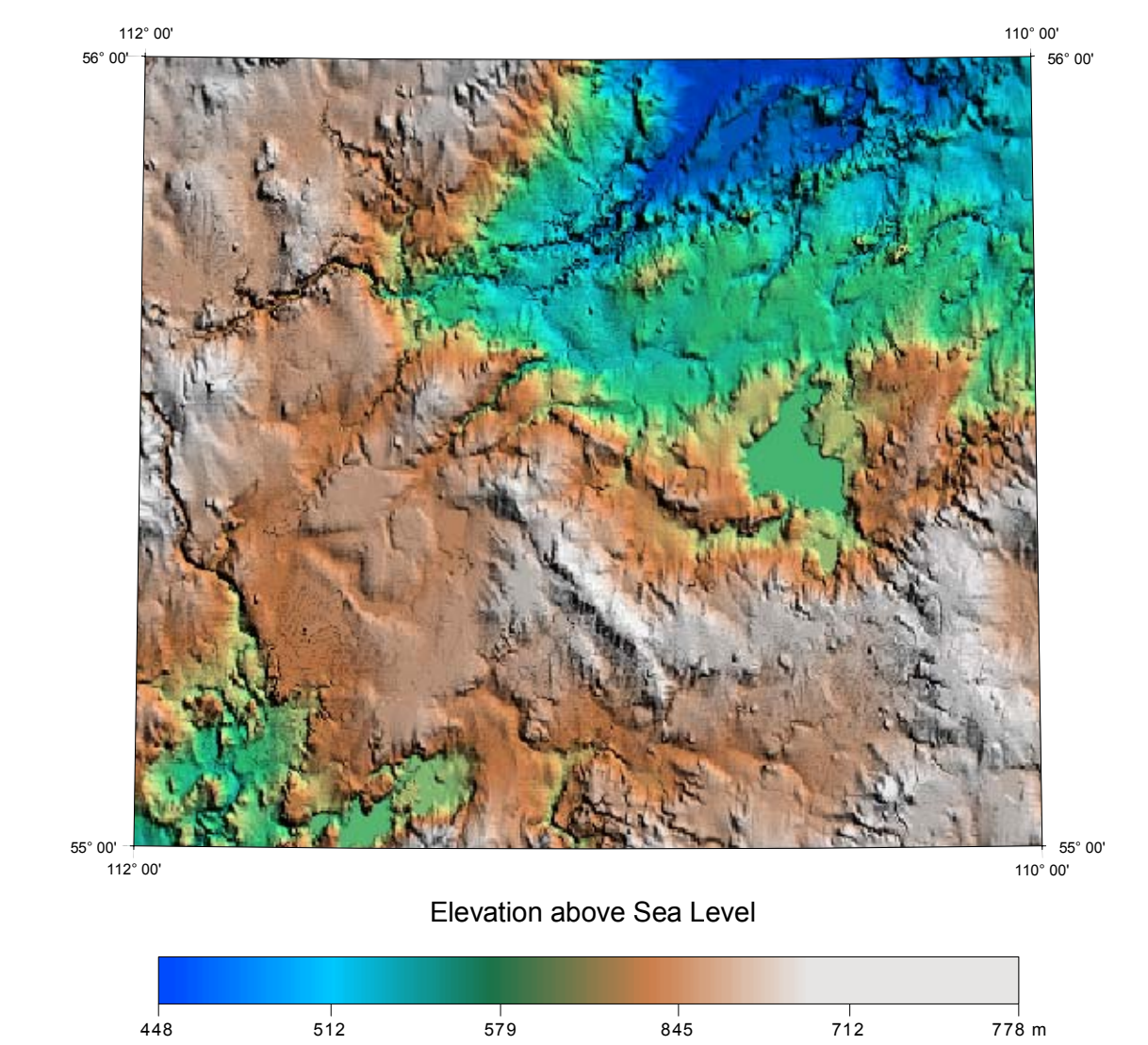
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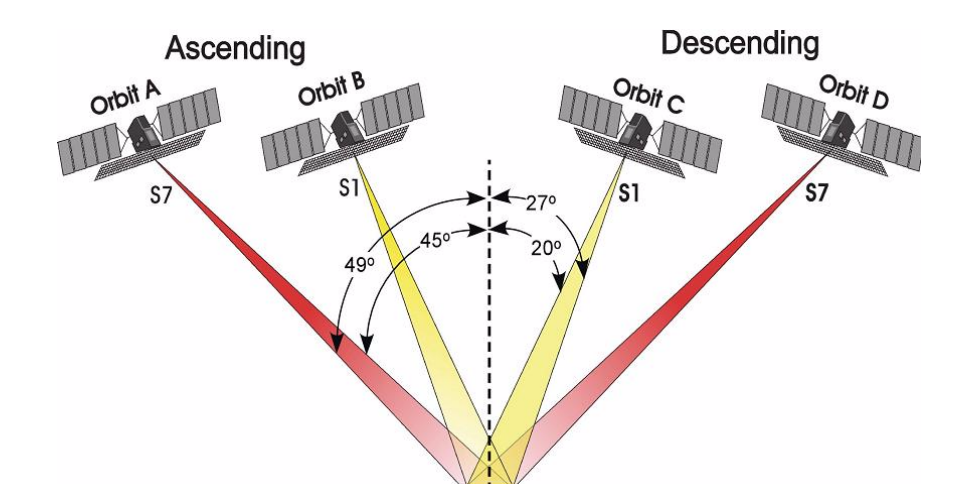
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Elevation Map for NTS 73M

Elevation above Sea Level

| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Ascending   Descending

Geo-Note 2003-11, Figure 10

RADARSAT-1 Standard Beam 1 Descending Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

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112° 00' 450000m.E 500000m.E 550000m.E 110° 00'
56° 00' 6200000m.N 6150000m.N 6100000m.N 6109000m.N 55° 00'

Introduction

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Elevation Map for NTS 73M

112° 00' 110° 00'
56° 00'
55° 00'
112° 00' 110° 00'

Elevation above Sea Level

448 512 579 845 712 778 m

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Ascending   Descending
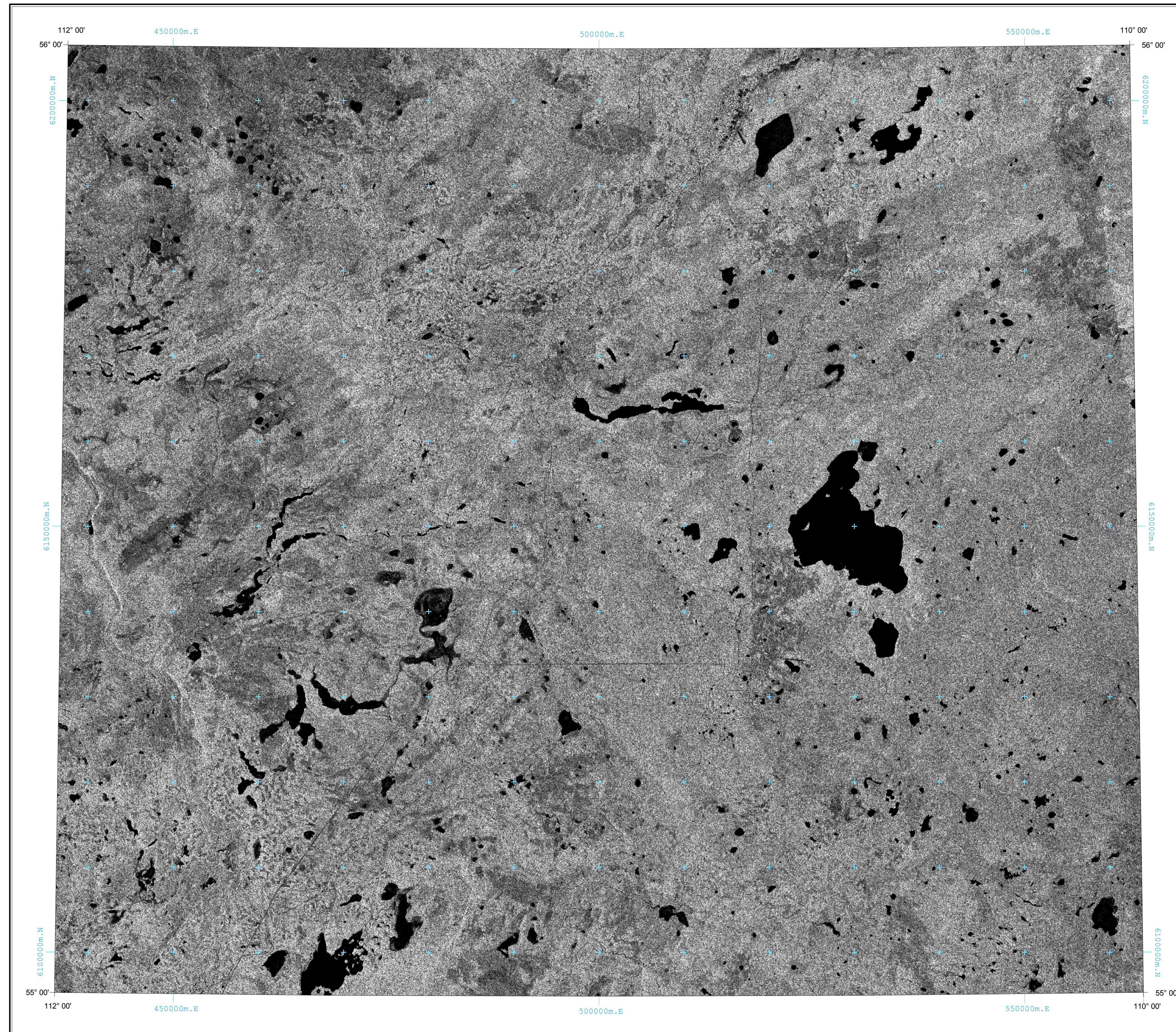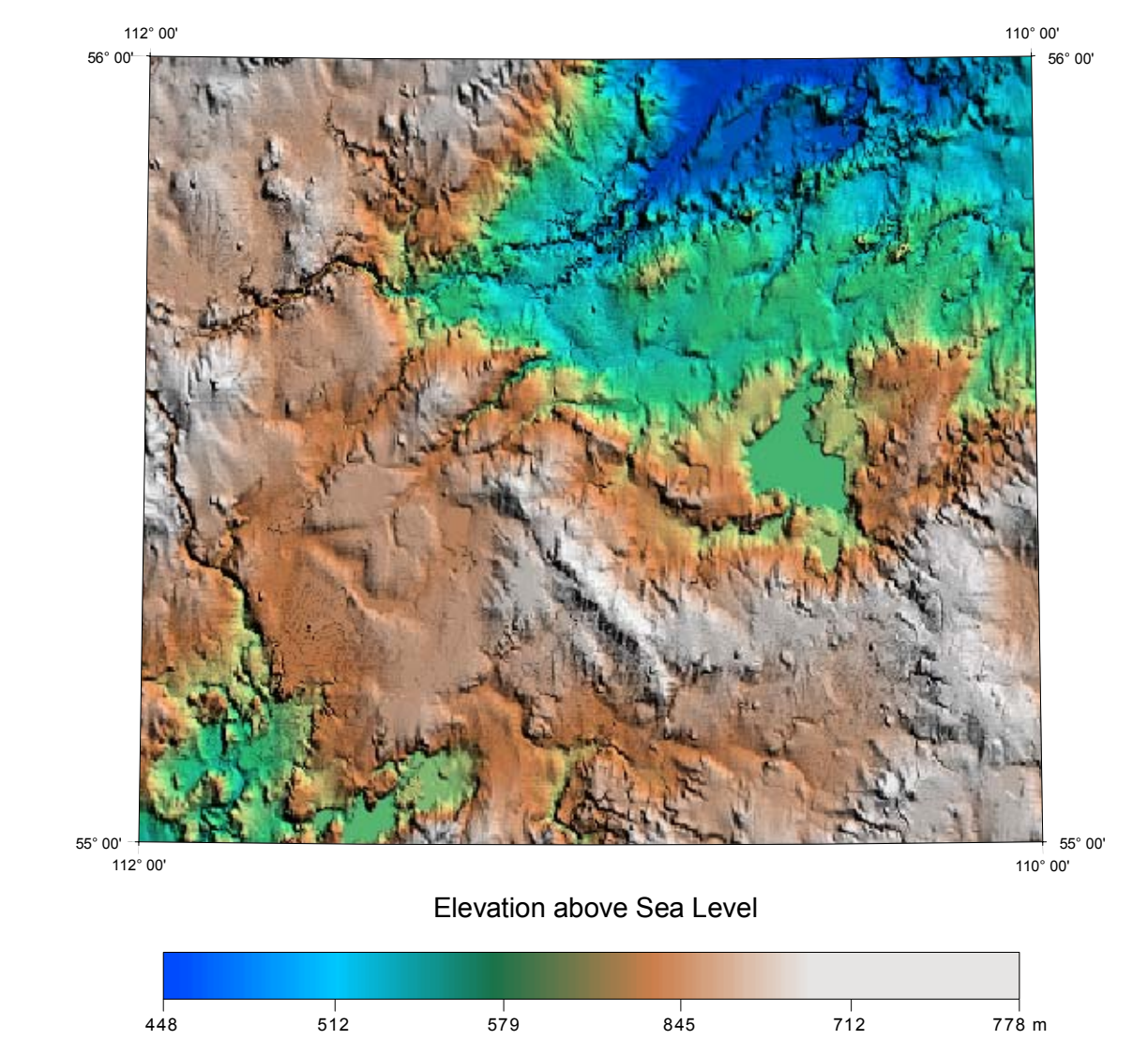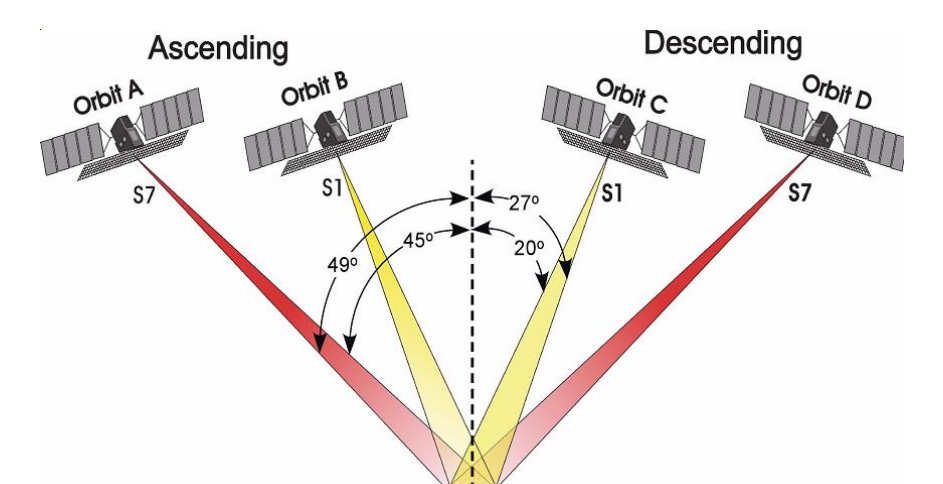Orbit A Orbit B   Orbit C Orbit D
S7   S1   27°   S1   S7
49°   45°   20°

Geo-Note 2003-11, Figure 11

RADARSAT-1 Standard Beam 7 Ascending Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

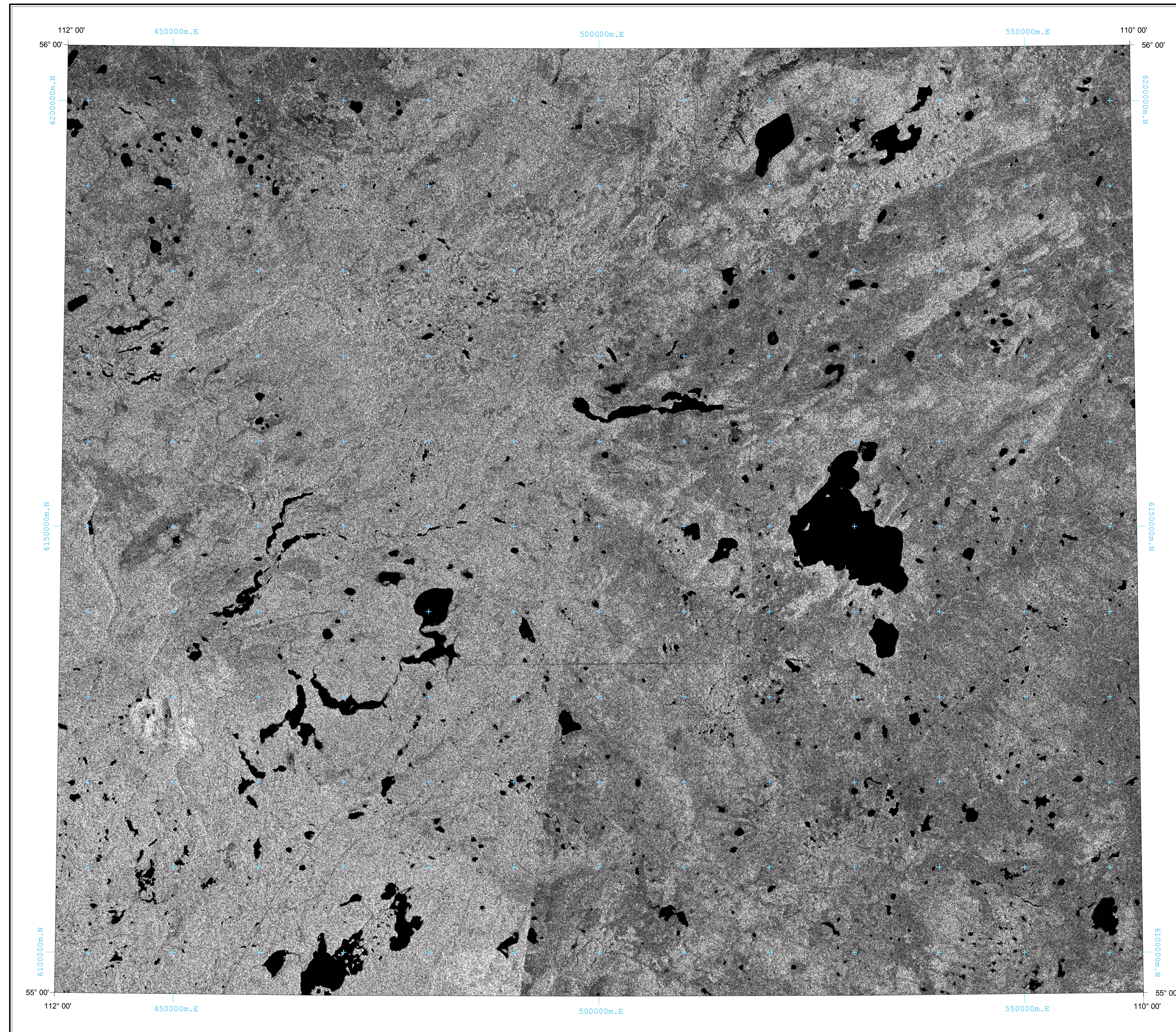Scale 1:250 000

5   0   5   10   15   20   25   30 kilometres
5   0   5   10   15   20 miles

Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

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112° 00'   450000m.E   500000m.E   550000m.E   110° 00'
56° 00'   56° 00'
6200000m.N
615000m.N
6150000m.N
610000m.N
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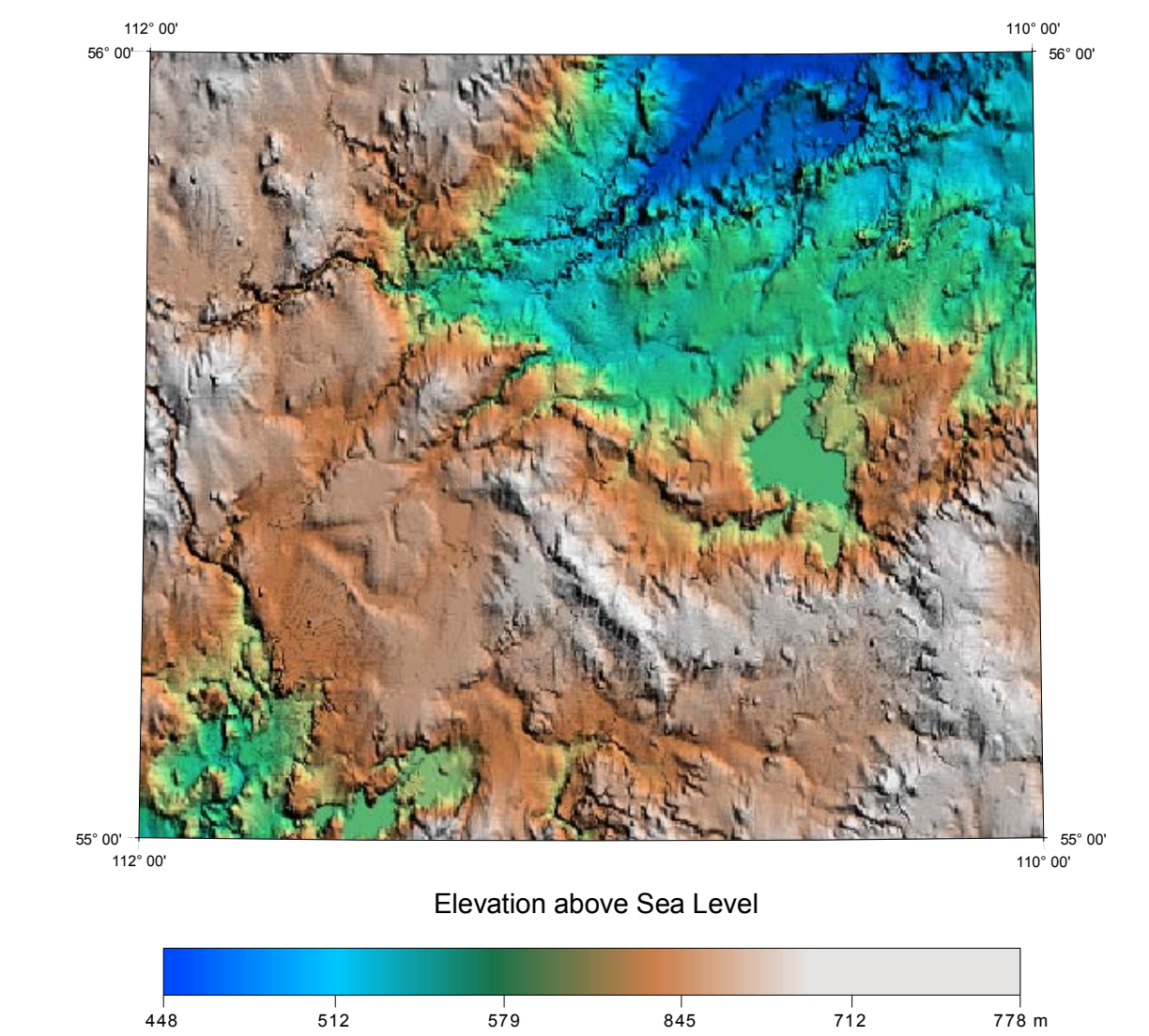
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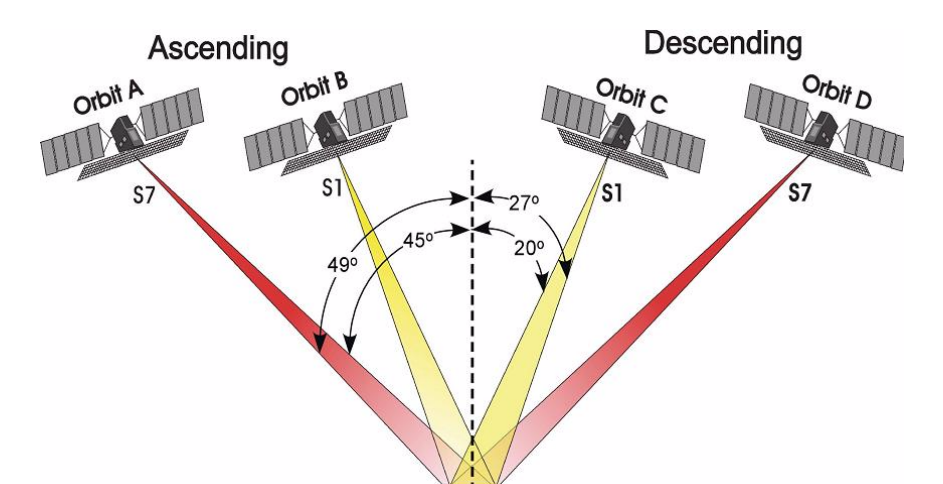
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Elevation Map for NTS 73M

Elevation above Sea Level

448   512   579   845   712   778 m

Looking Directions and Incident angles of
RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Ascending   Descending
Orbit A   Orbit B   Orbit C   Orbit D

Geo-Note 2003-11, Figure 12

RADARSAT-1 Standard Beam 7 Descending Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000
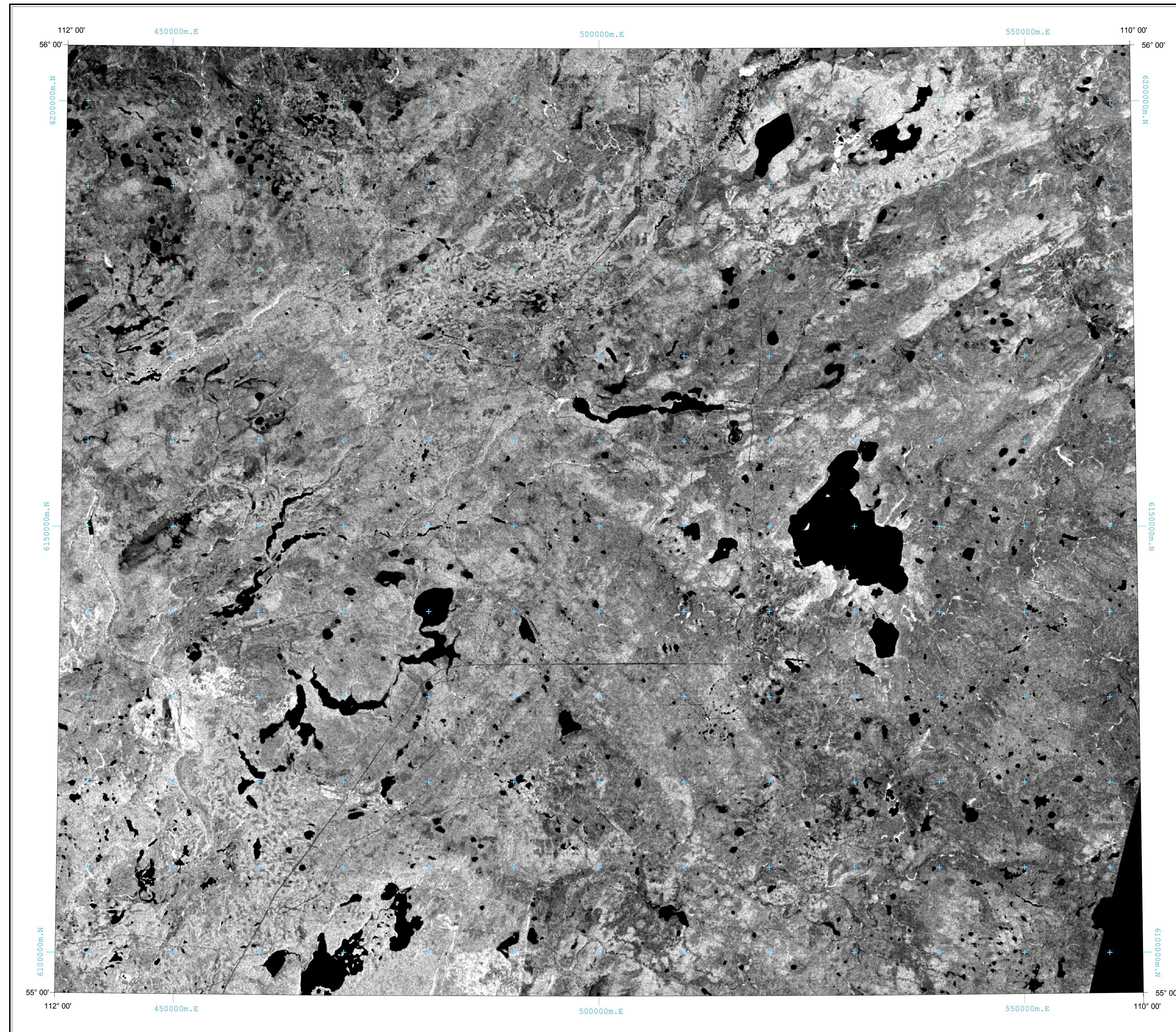
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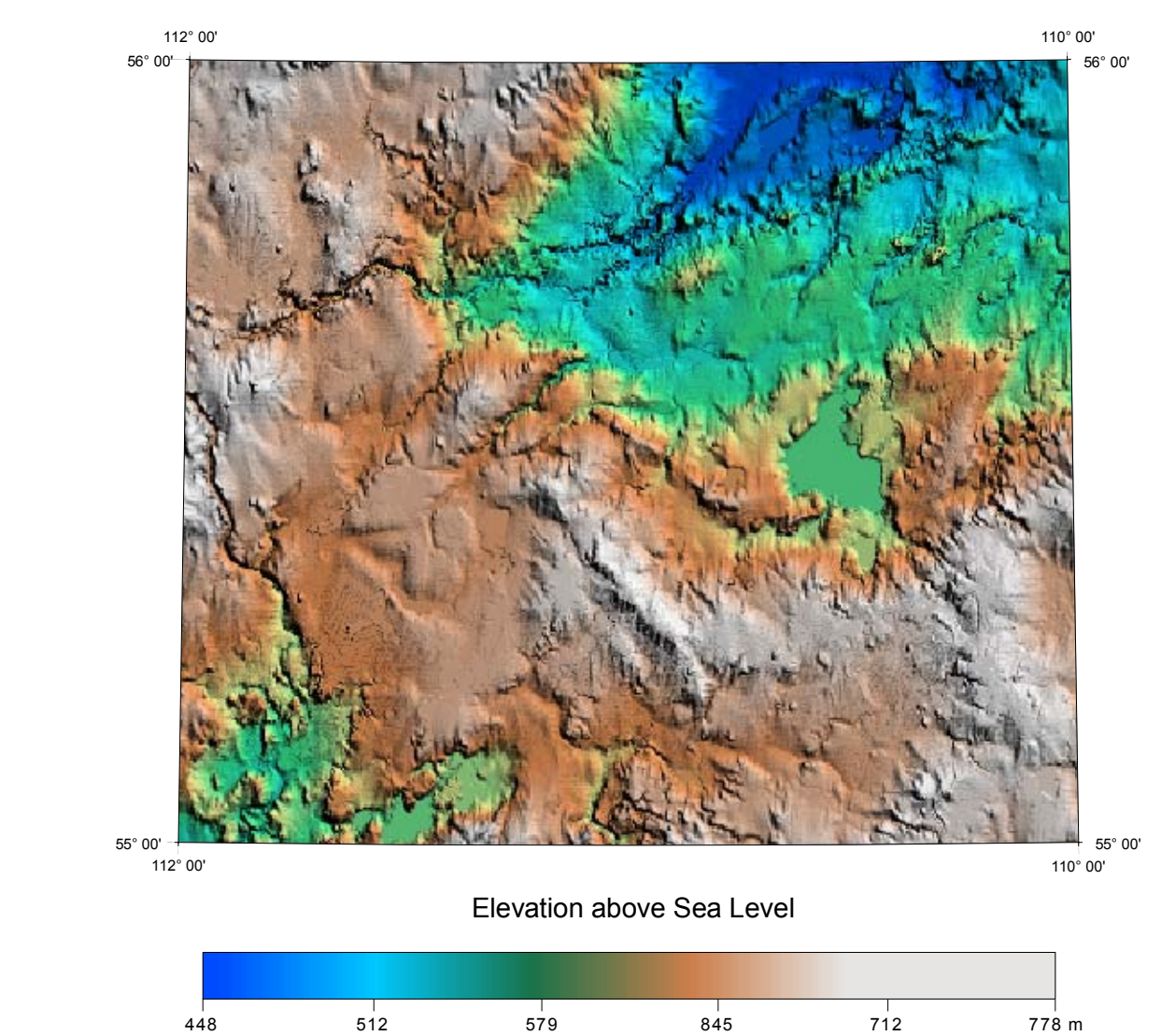
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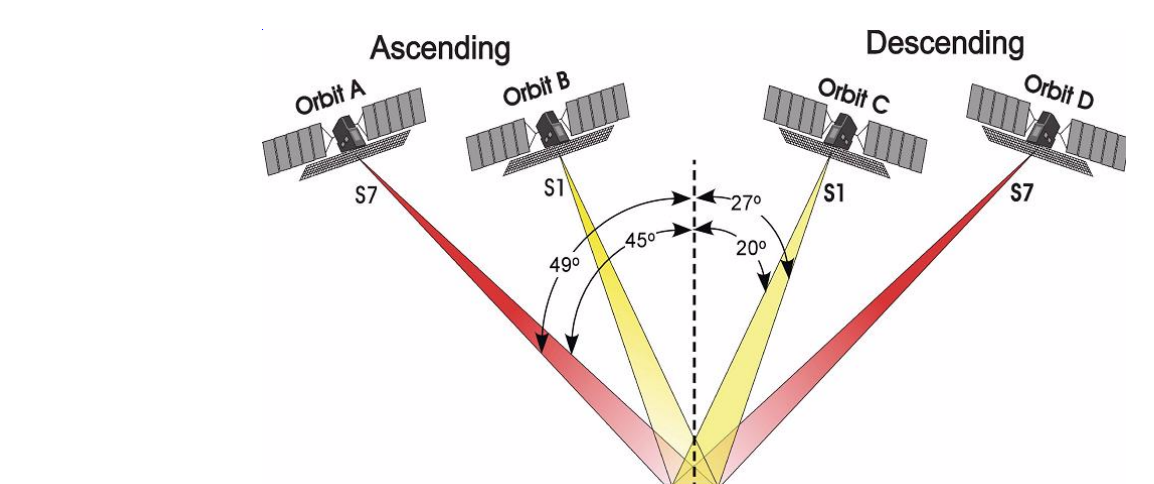
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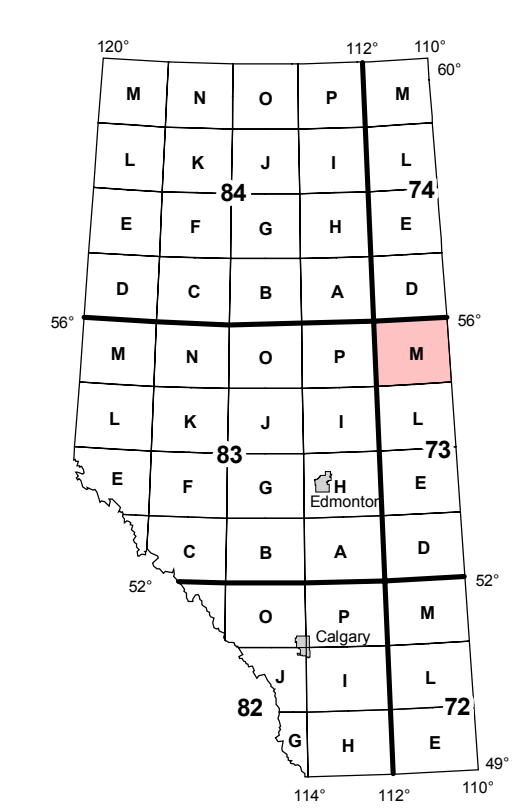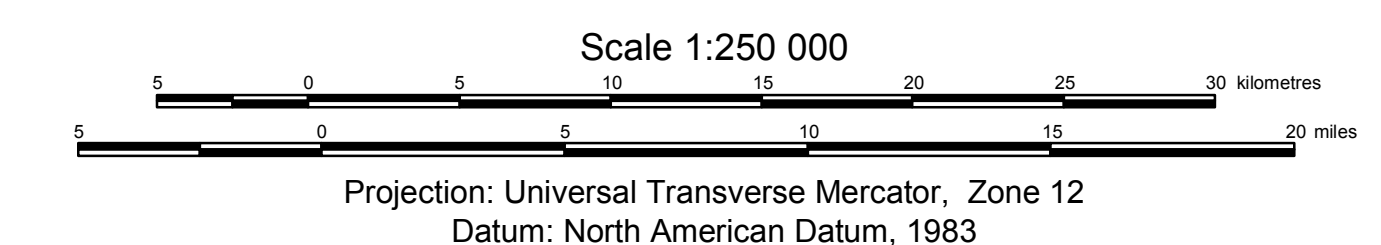
Elevation Map for NTS 73M

Elevation above Sea Level

| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Ascending — Descending

Geo-Note 2003-11, Figure 13

RADARSAT-1 Principal Component 1 Image for Winefred Lake, Alberta (NTS 73M)

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 12
Datum: North American Datum, 1983

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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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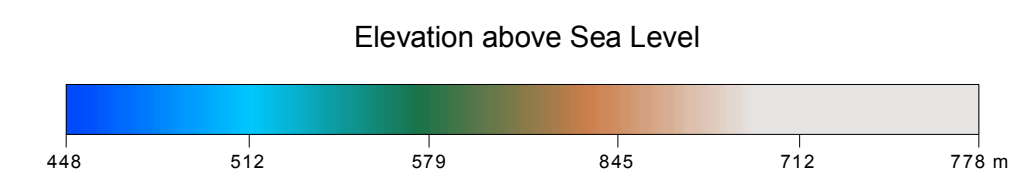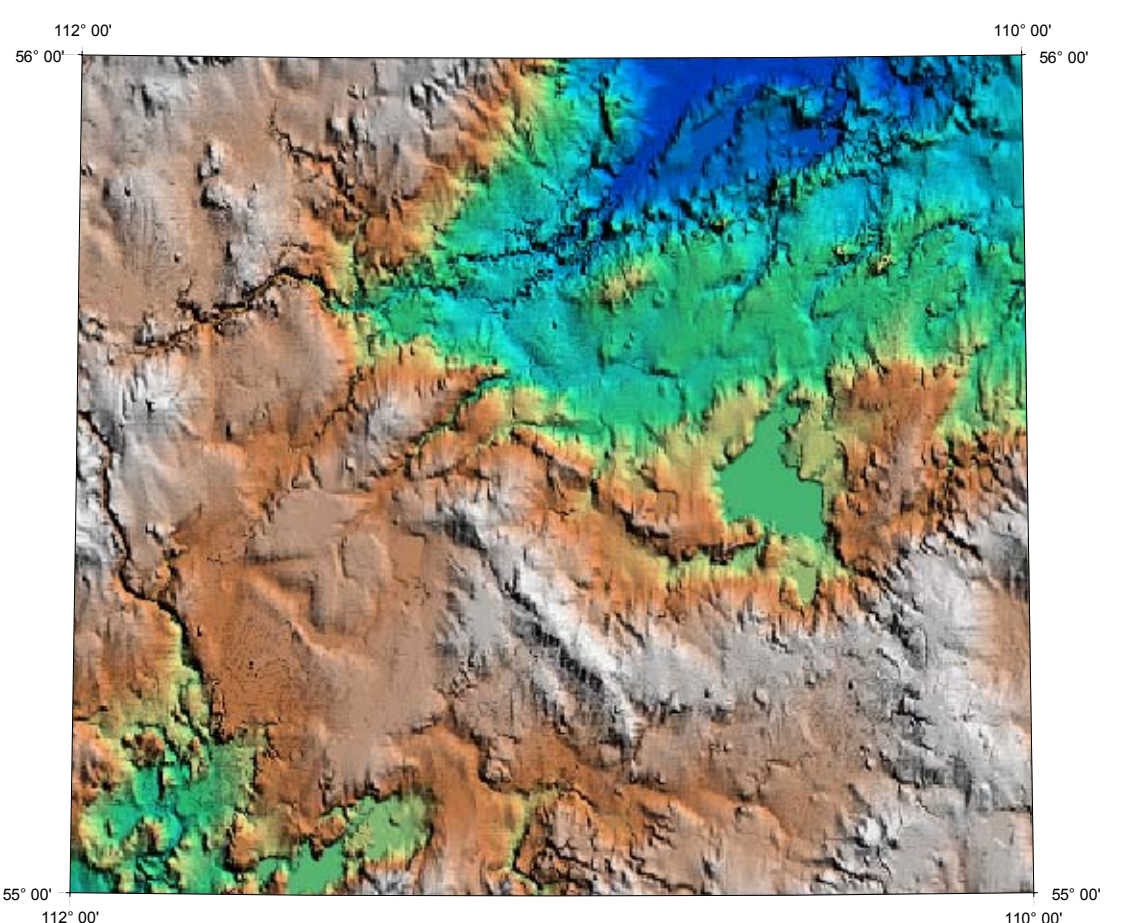
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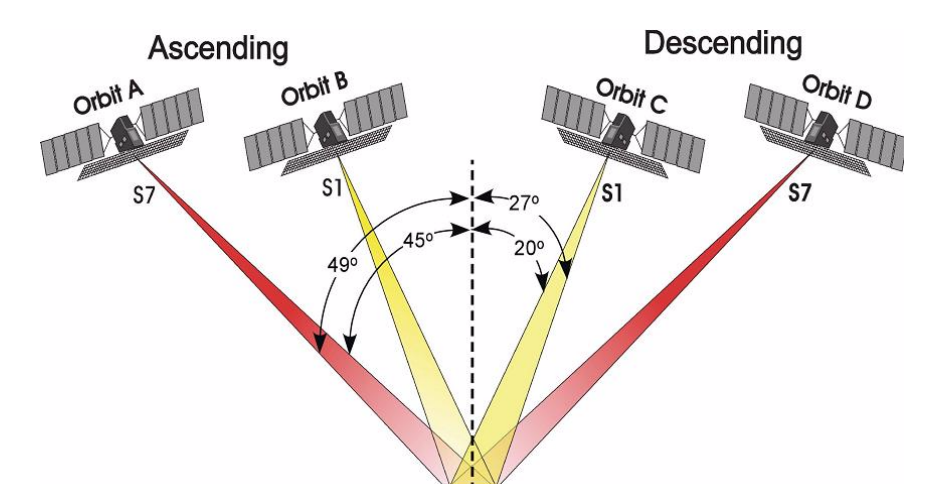
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Elevation Map for NTS 73M

Elevation above Sea Level

| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Geo-Note 2003-11, Figure 14

RADARSAT-1 Principal Component 2
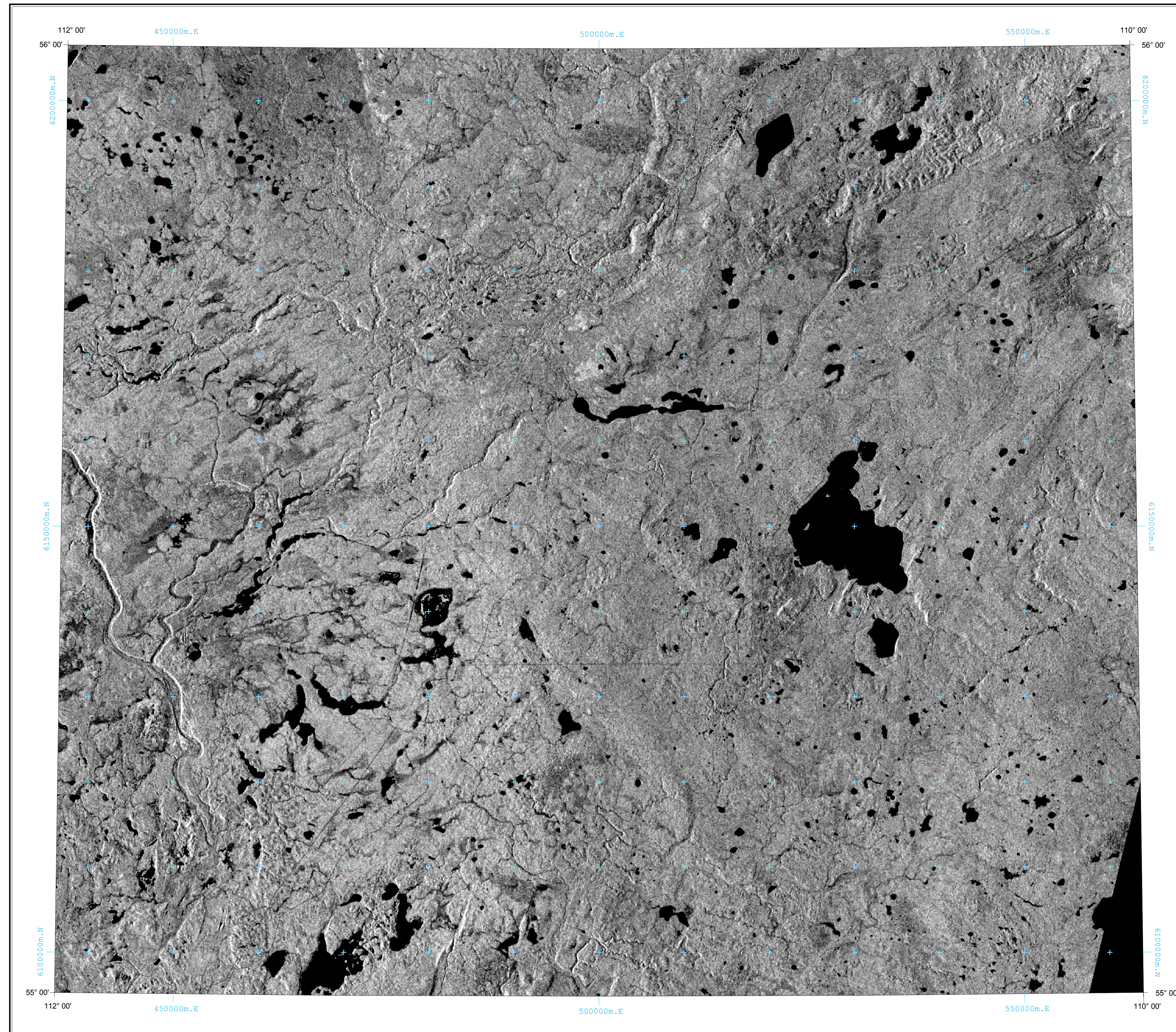# Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

EUB | AGS
Alberta Energy and Utilities Board | Alberta Geological Survey

Introduction

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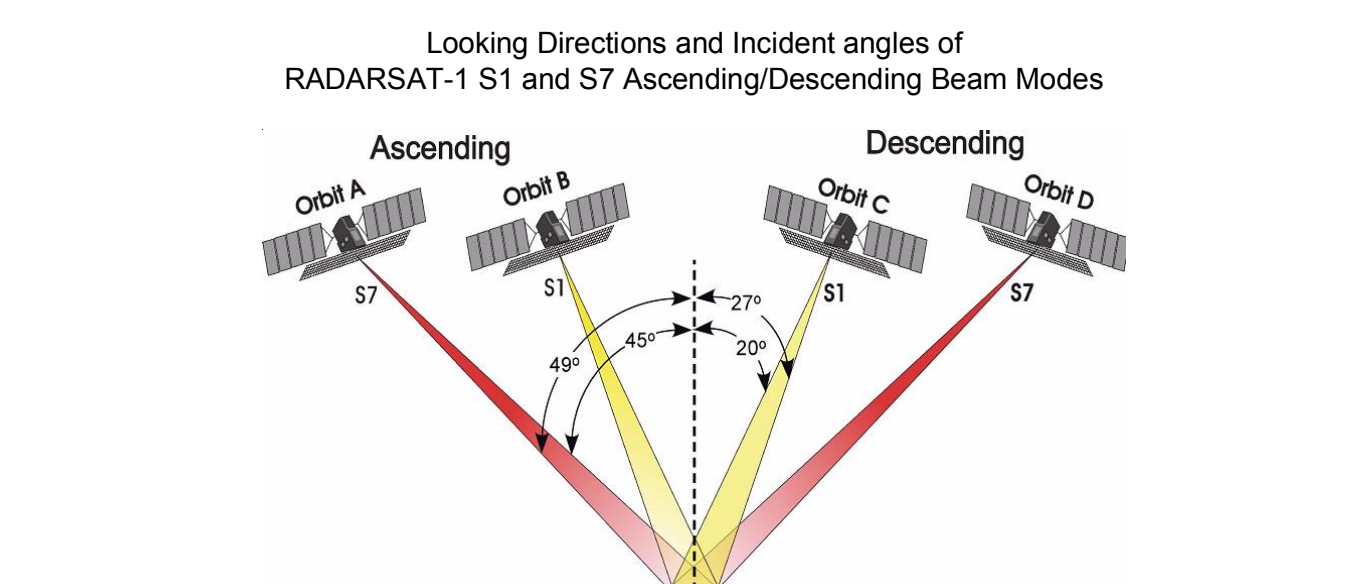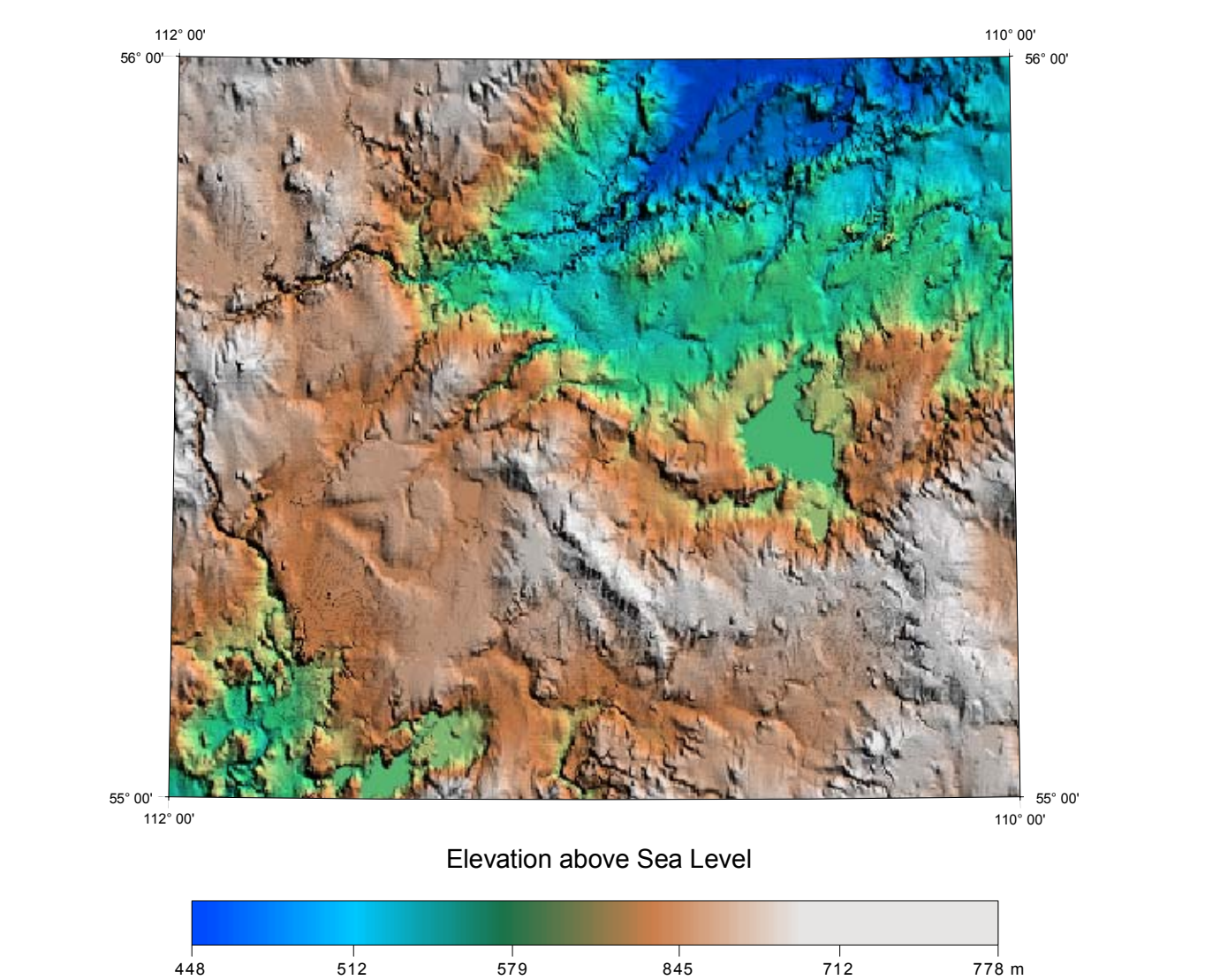
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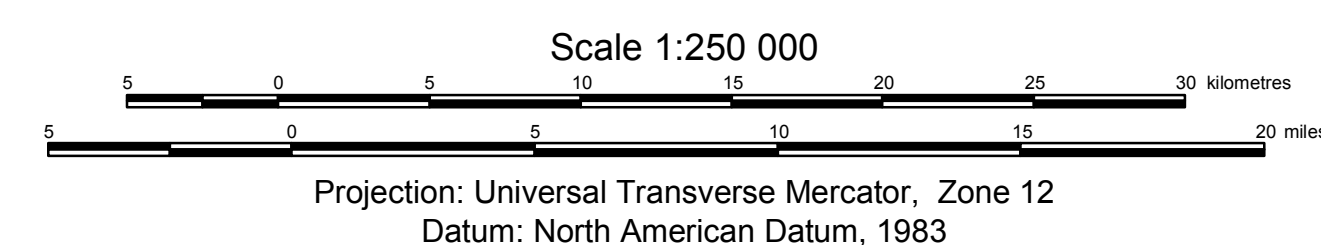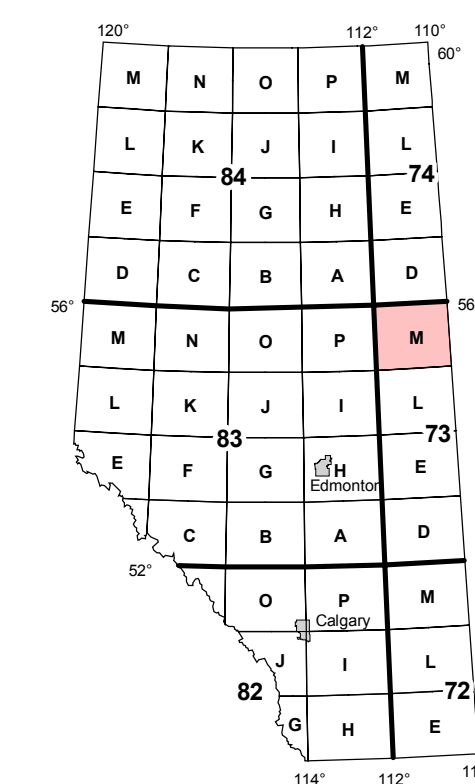
Elevation Map for NTS 73M

Elevation above Sea Level

| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Ascending   Descending

Geo-Note 2003-11, Figure 15

RADARSAT-1 Principal Component 3
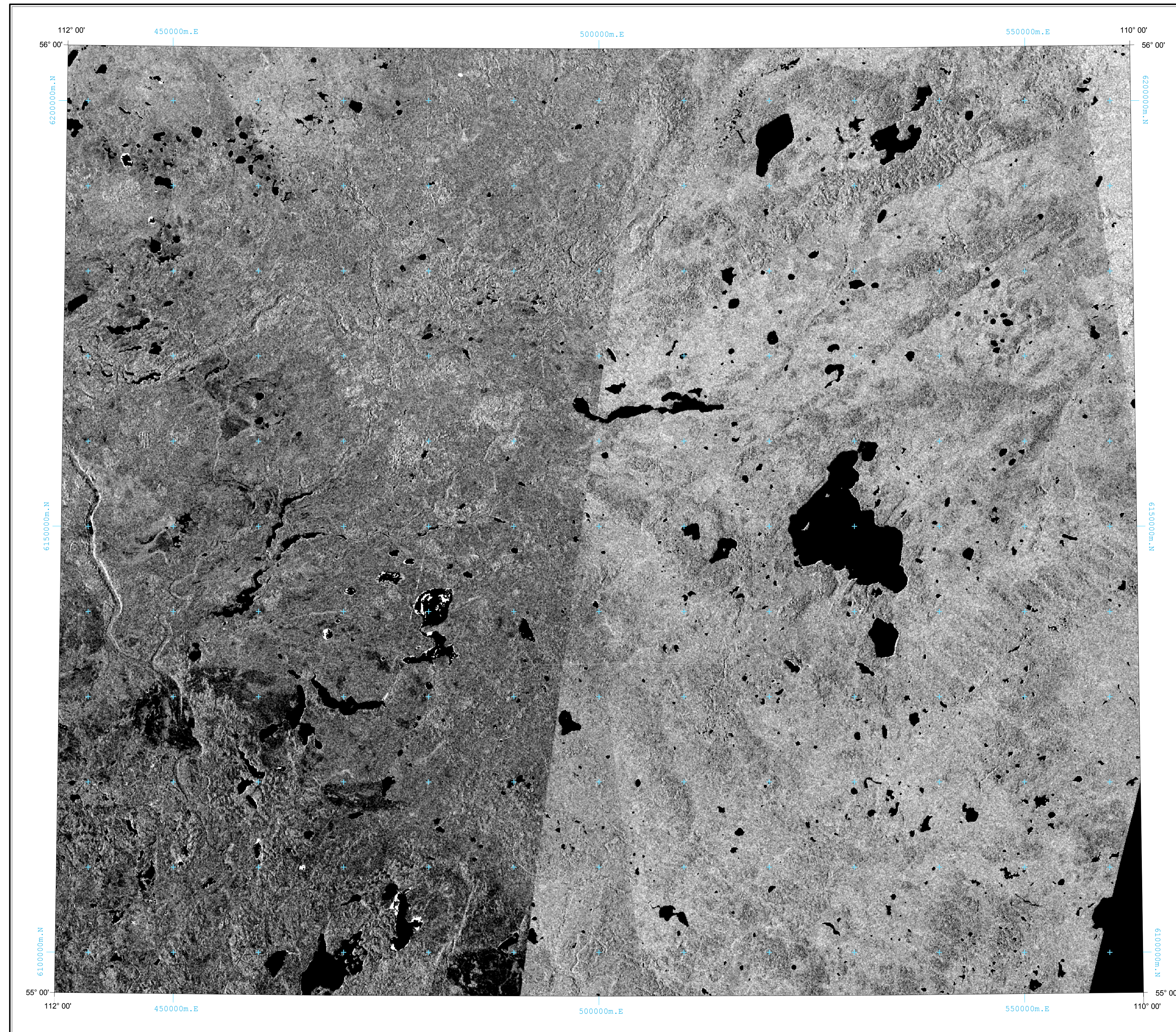# Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

EUB | AGS
Alberta Energy and Utilities Board | Alberta Geological Survey

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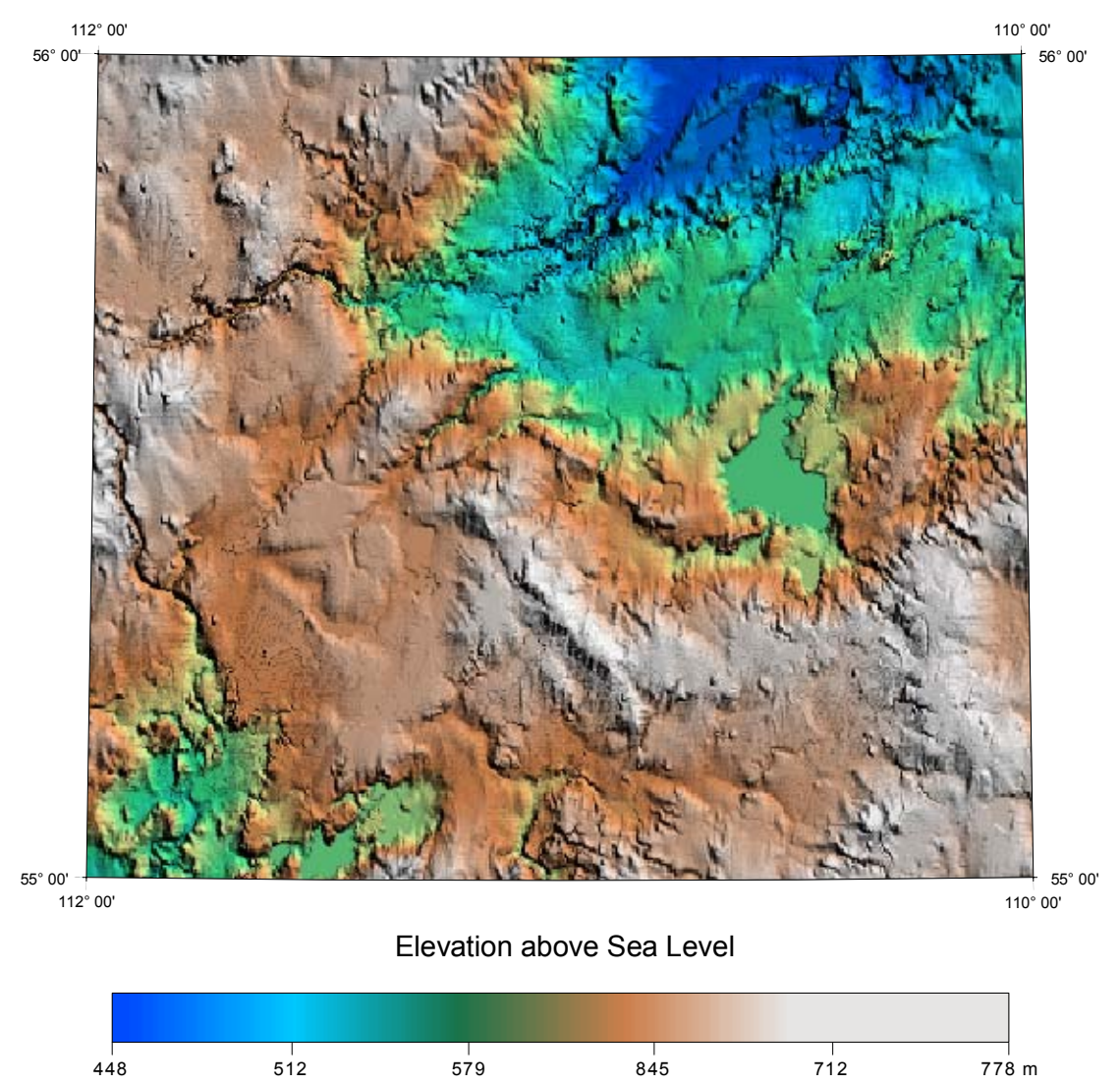
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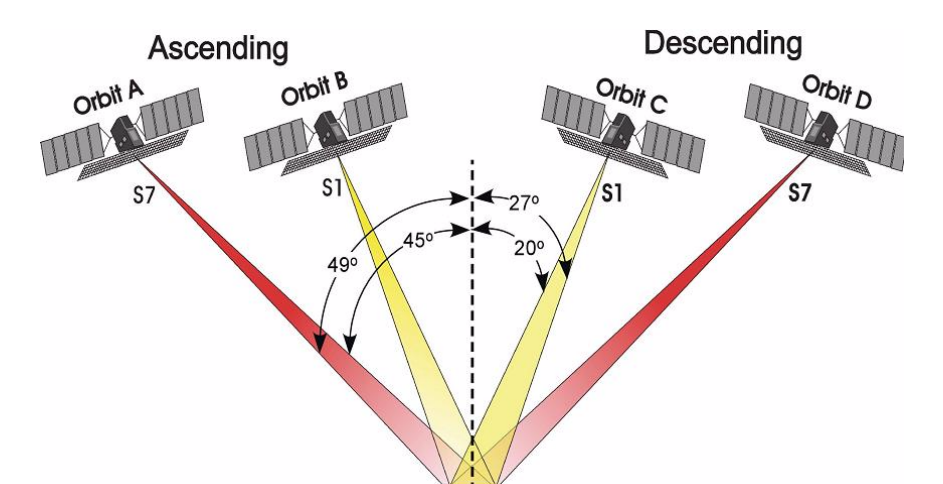
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| 448 | 512 | 579 | 845 | 712 | 778 m |

Looking Directions and Incident angles of RADARSAT-1 S1 and S7 Ascending/Descending Beam Modes

Geo-Note 2003-11, Figure 16

RADARSAT-1 Principal Component 4 Image for Winefred Lake, Alberta (NTS 73M)

Compilation by S. Mei, 2003

Scale 1:250 000

Projection: Universal Transverse Mercator, Zone 12
Datum: North American Datum, 1983

EUB | AGS
Alberta Energy and Utilities Board | Alberta Geological Survey