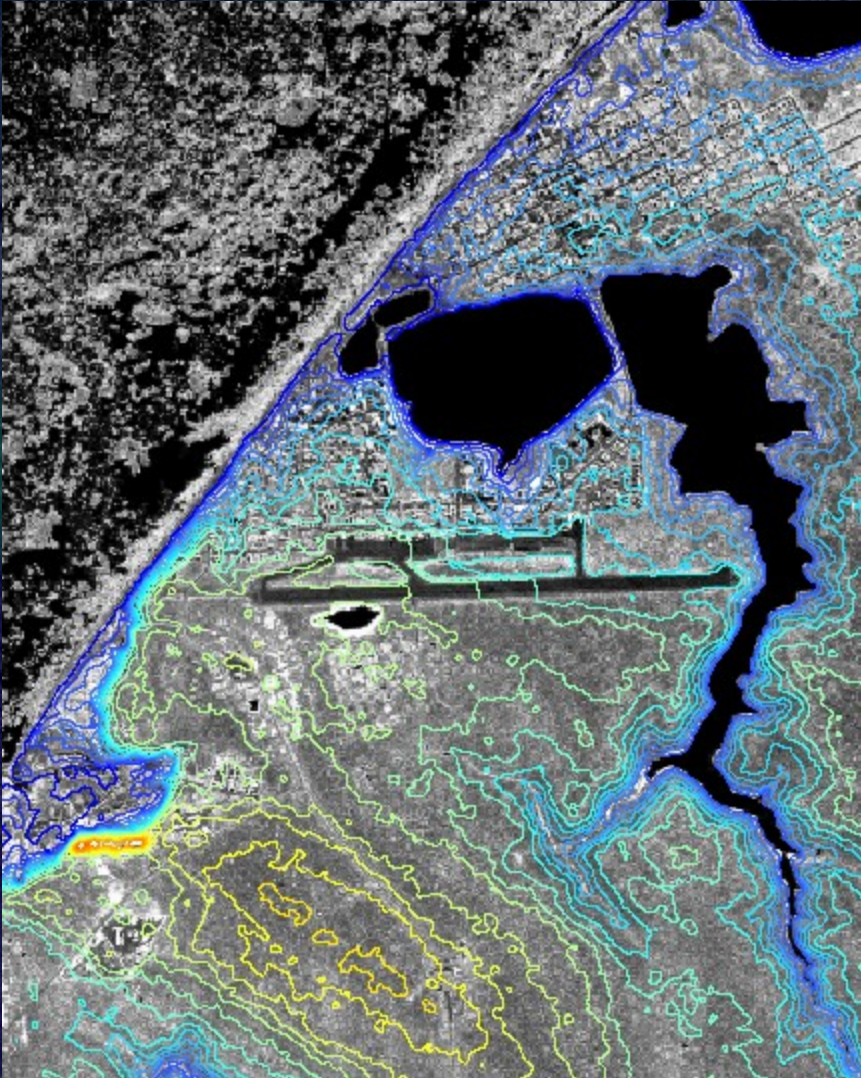# High-Resolution Radar Imagery and Terrain Models for Collaborative Research of Environmental Change at Barrow, Alaska

Radar imagery, Digital Elevation Models, and satellite imagery acquired for the Barrow area will:

- ➢ take advantage of state-of-the-art remote-sensing technologies to produce baseline geospatial data.
- ➢ benefit education and outreach.
- ➢ promote multi-disciplinary research of environmental change in the Barrow area.

← 1 m contours over ORRI at Barrow

Background: ORRI over DSM

The project is broadly collaborative.

Investigators

William Manley[1], Leanne Lestak[1], Craig Tweedie[2], and James Maslanik[1]
[1] University of Colorado, [2] Michigan State University

Collaborators

Richard Beck, Kenneth Hinkel, & Wendy Eisner	University of Cincinnati
Glenn Sheehan	Barrow Arctic Science Consortium
Jerry Brown	International Permafrost Association
Anne Jensen	Ukpeagvik Inupiat Corporation
Tim Buckley	Barrow High School
Frederick Nelson & Anna Klene	University of Delaware
Patrick Webber	Michigan State University
Rudolf Dichtl	ARCSS Data Coordination Center

Landsat 7 imagery, July 20 2002
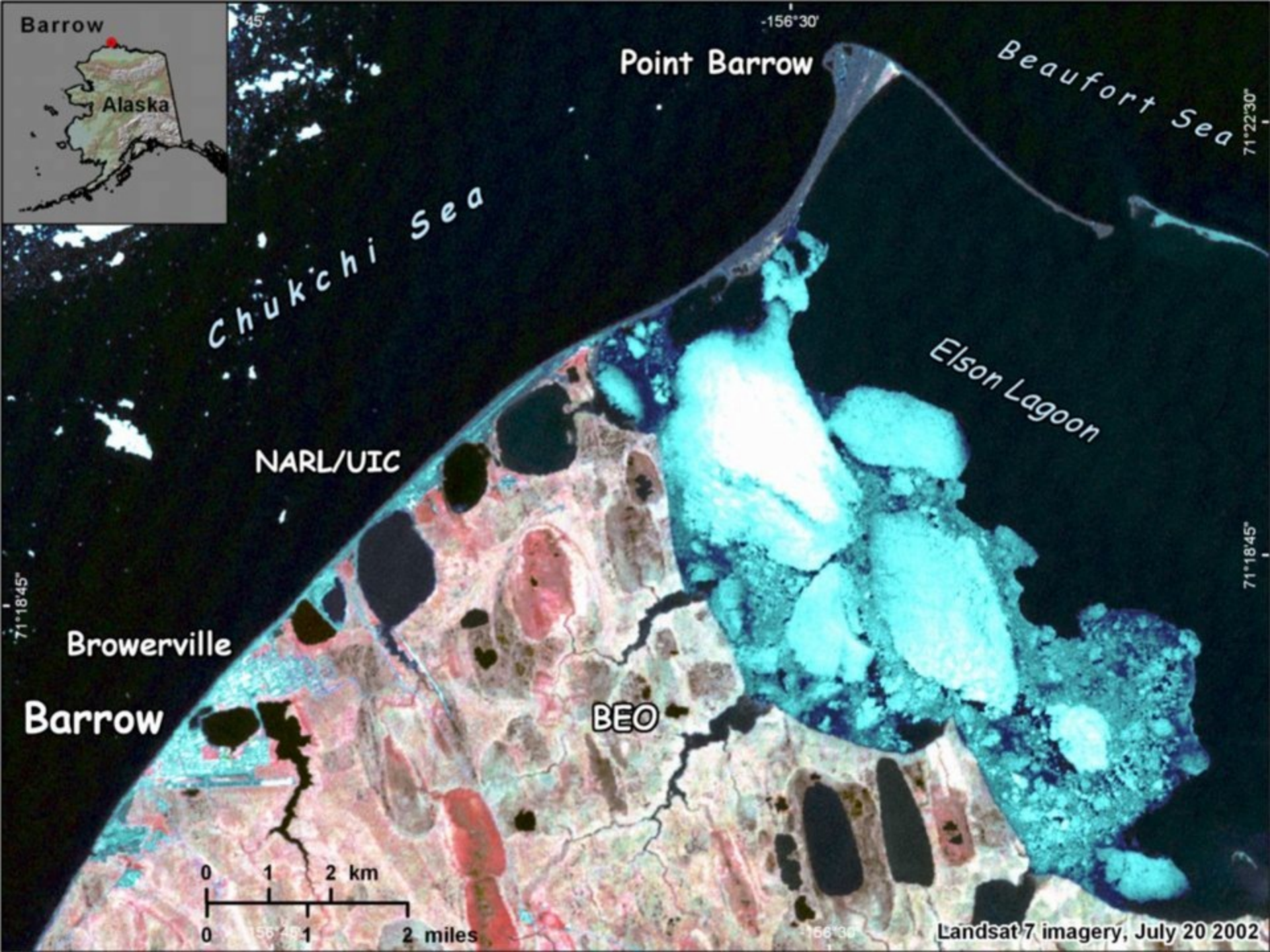
Scientific research is concentrated at Barrow.
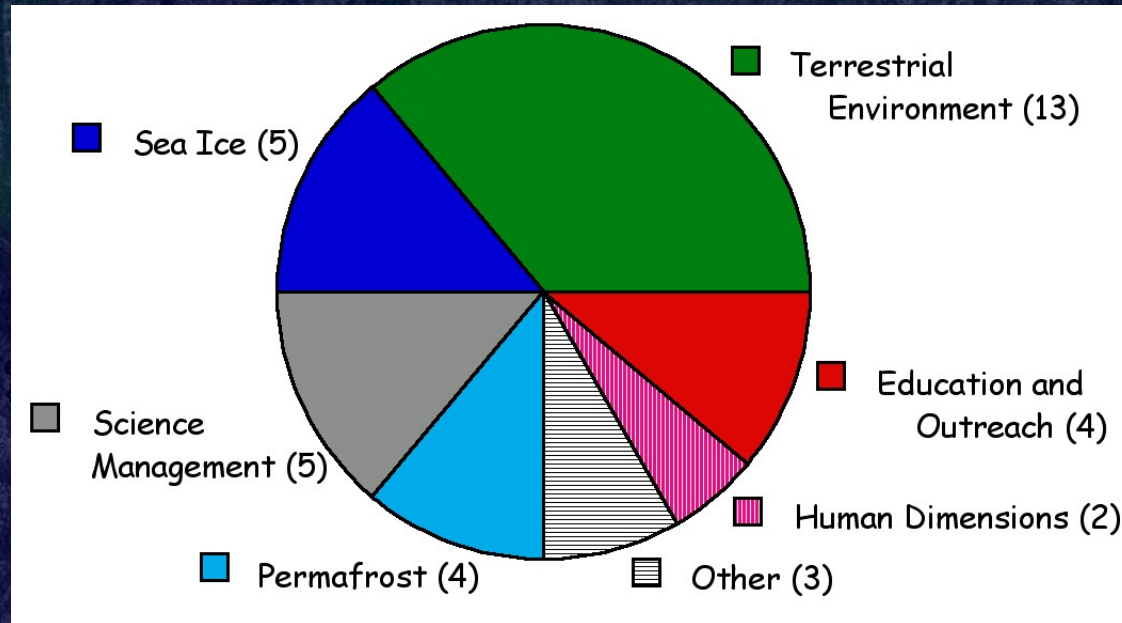
Categories of NSF-funded research conducted in the Barrow area (and number of awards as of 2002).

$Millions are dedicated each year by NSF to research in the Barrow area, including the Barrow Environmental Observatory (BEO). Other research is supported by IARC, DOE, USGS, EPA, NASA, and other agencies.

The Problem:

Existing GIS layers and satellite imagery are incomplete in time and space, highly non-uniform, and of varying quality.

Existing geospatial datasets are often difficult or impractical to use, because they vary in:

- ➤ Map projection
- ➤ Datum
- ➤ Extent
- ➤ Data format
- ➤ Timeframe
- ➤ Spatial resolution
- ➤ Horizontal & vertical accuracy
- ➤ Accessibility

A Solution:

QuickBird satellite imagery

IFSAR OrthoRectified Radar Imagery

IFSAR Digital Elevation Models

with "value-added" processing & layers

- UTM zone 4
- NAD83
- Barrow Peninsula and Triangle
- GeoTIFF, shapefile, and floating-point raster
- July 27 – Aug. 2, 2002
- High resolution
- Highly accurate
- Accessible

QuickBird satellite imagery

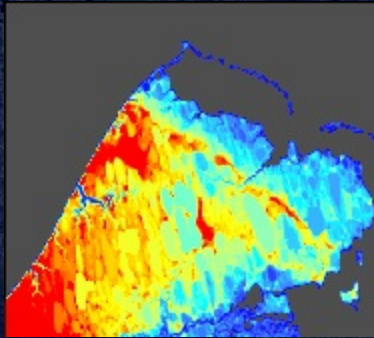70 cm pixels panchromatic
(Black and White)

2.8 m pixels multispectral
(Blue, Green, Red, and Near-InfraRed)

Intermap IFSAR Products
### (GT1 Product Level for "Barrow Peninsula": 2350 km^2; acquired July 27-29, 2002)

Digital Surface Model (DSM)
- surface reflectance elevation
- 5 m grid cells, 13,020 rows x 14,461 columns
- vertical accuracy of +/- 1.0 m or better (RMSE)
- horizontal accuracy of +/- 2.5 m or better (RMSE)
- best for detailed visualization and analysis
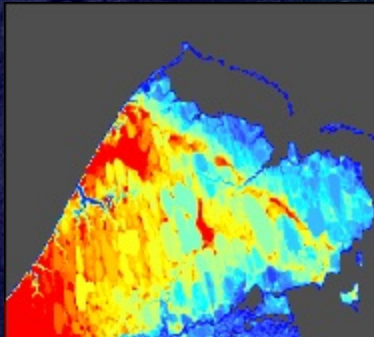
Digital Terrain Model (DTM)
- custom "Bald-Earth Lite" process for North Slope
- Terrain Fit processing and median filter to remove speckle noise in very low-relief coastal plain
- 5 m grid cells, 13,020 rows x 14,461 columns
- accuracies unspecified but comparable to DSM
- best for derived layers (e.g., slope angle, contours, etc.)
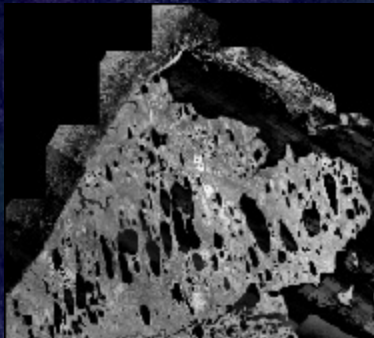
OrthoRectified Radar Imagery (ORRI)
- radar surface reflectance
- 1.25 m pixels, 52,080 rows x 57,844 columns
- horizontal accuracy of +/- 1.25 m or better (RMSE)
- both unenhanced and contrast-stretched versions
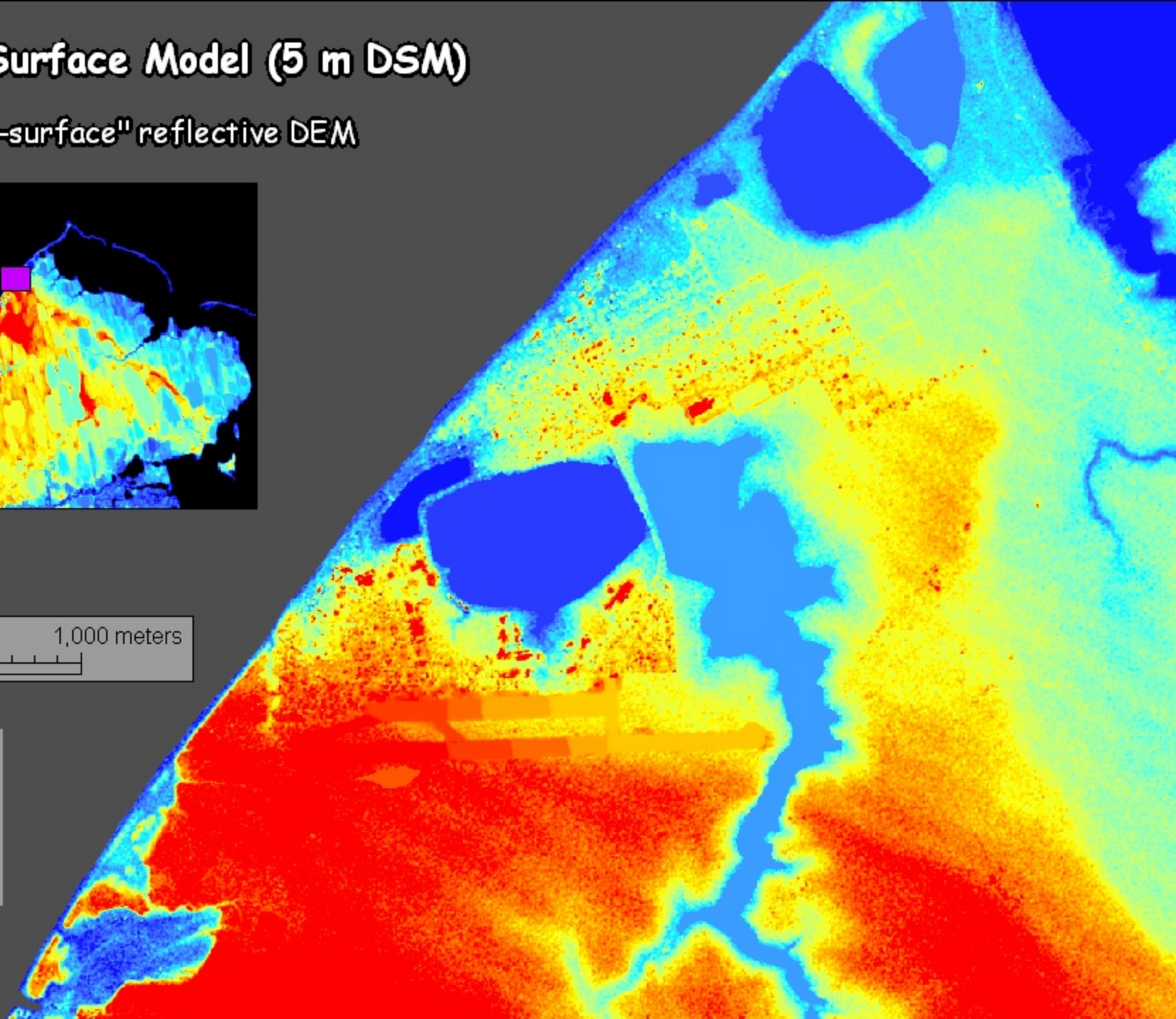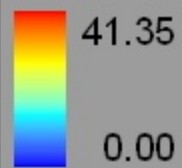- best for visualization, mapping, various analyses

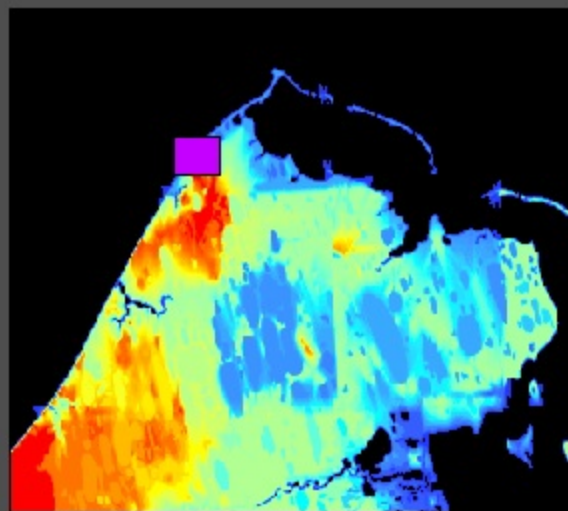Digital Surface Model (5 m DSM)
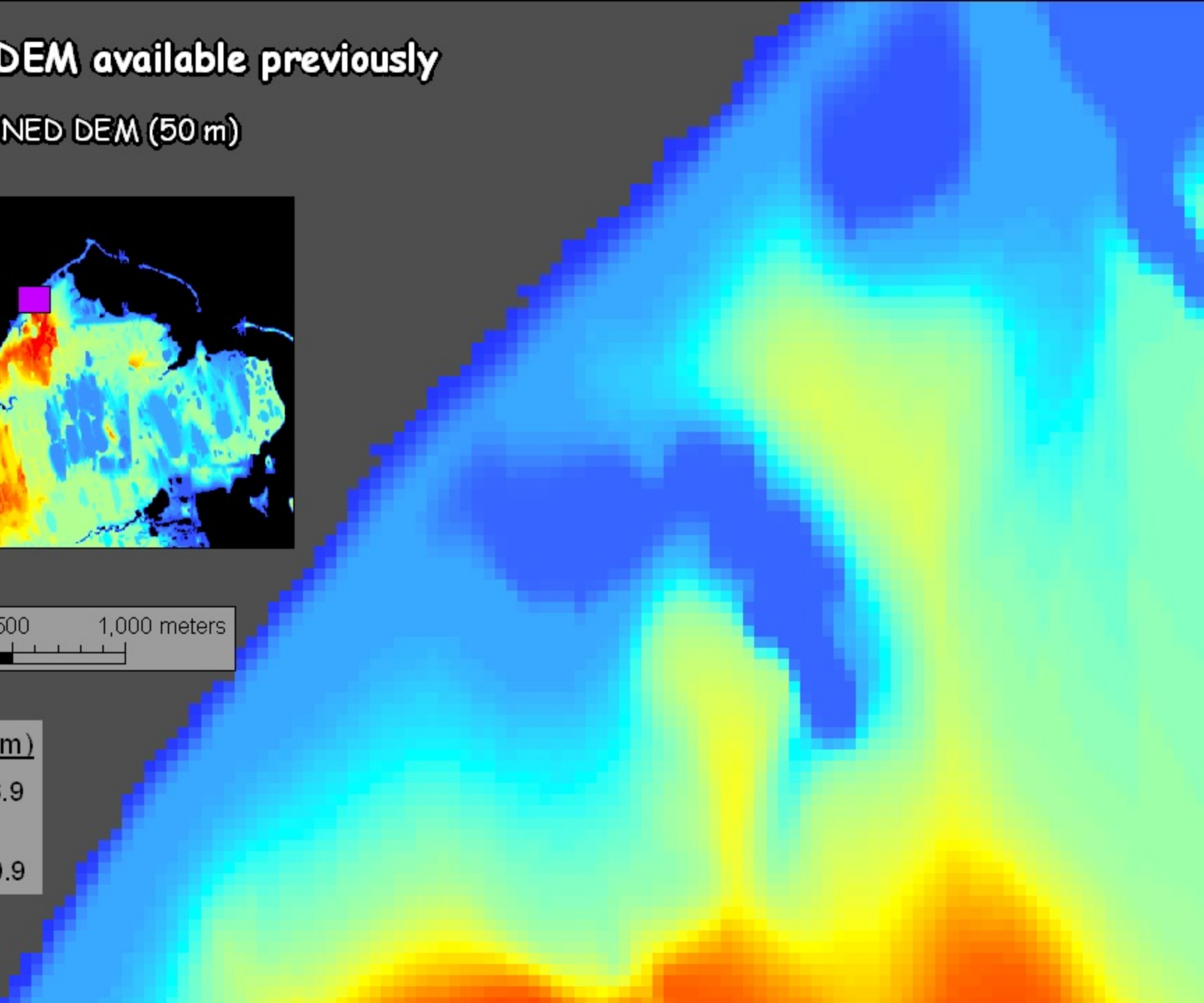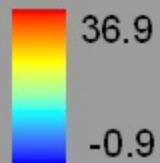
the "first-surface" reflective DEM

0   500   1,000 meters

Elev. (m)

41.35

0.00
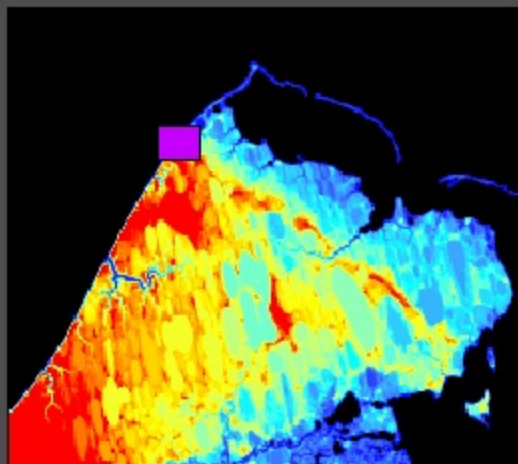
Best DEM available previously

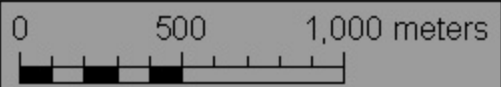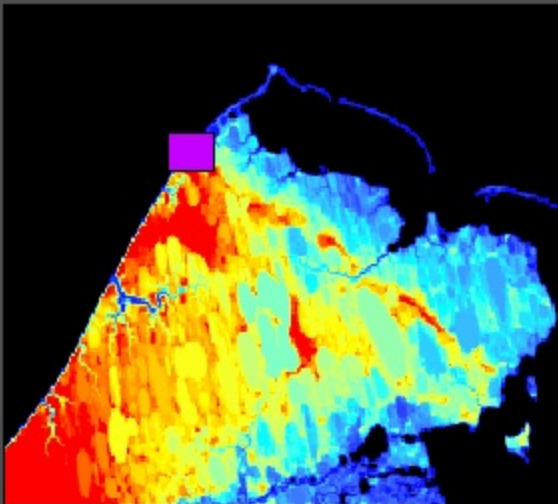USGS NED DEM (50 m)
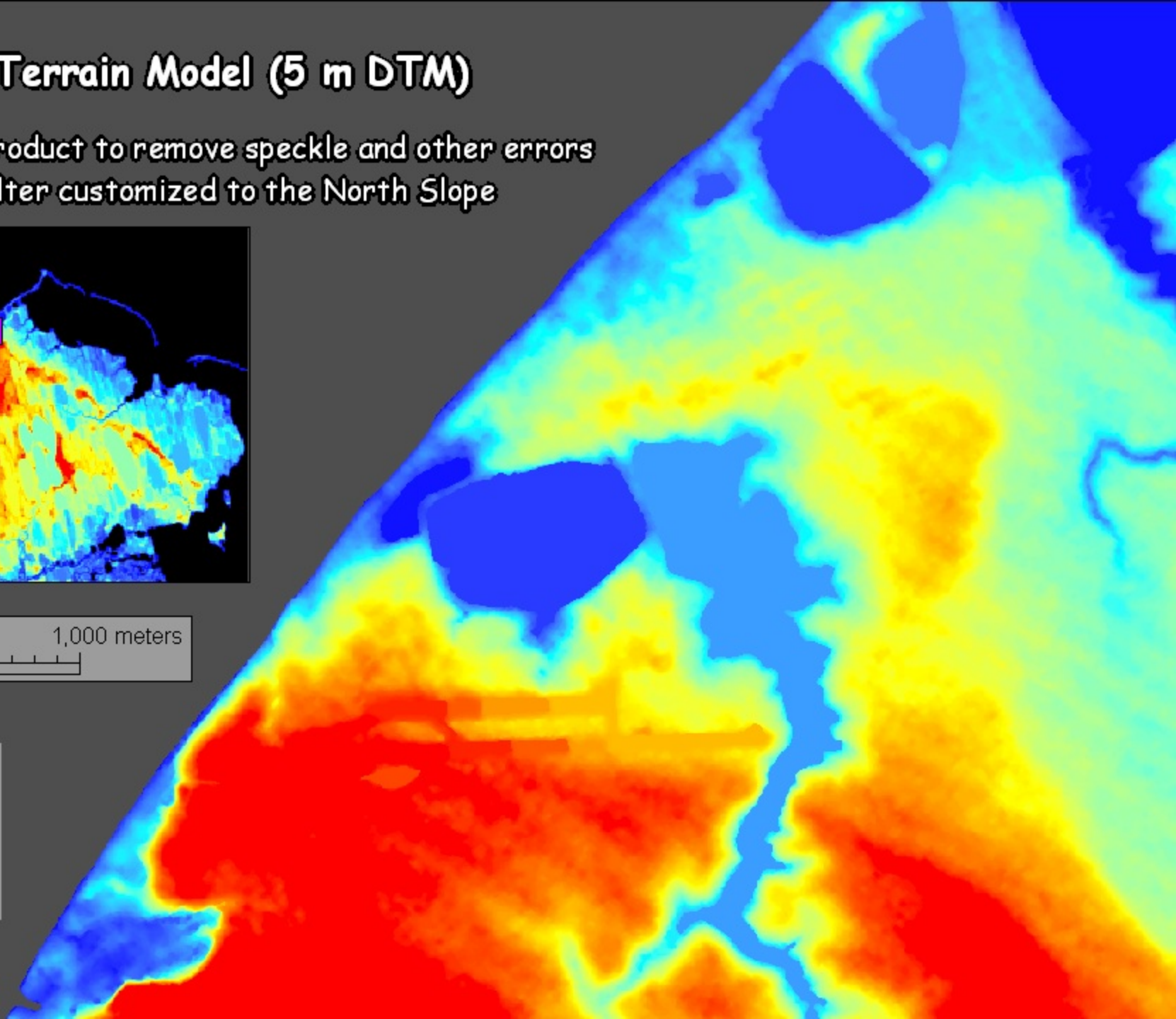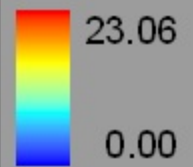
0   500   1,000 meters

Elev. (m)

36.9

-0.9

Digital Terrain Model (5 m DTM)

filtered product to remove speckle and other errors
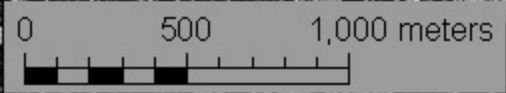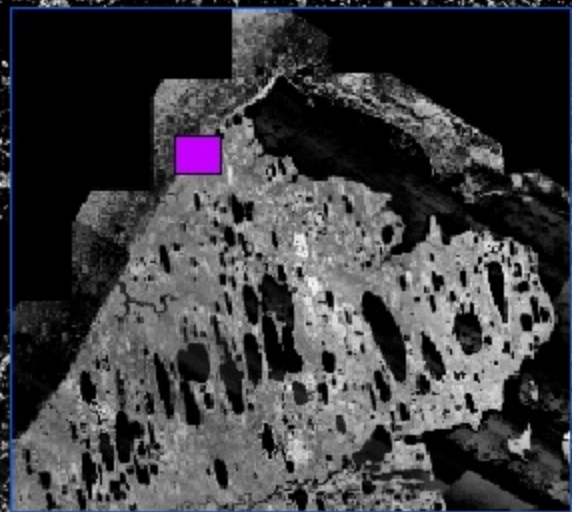process filter customized to the North Slope

0   500   1,000 meters
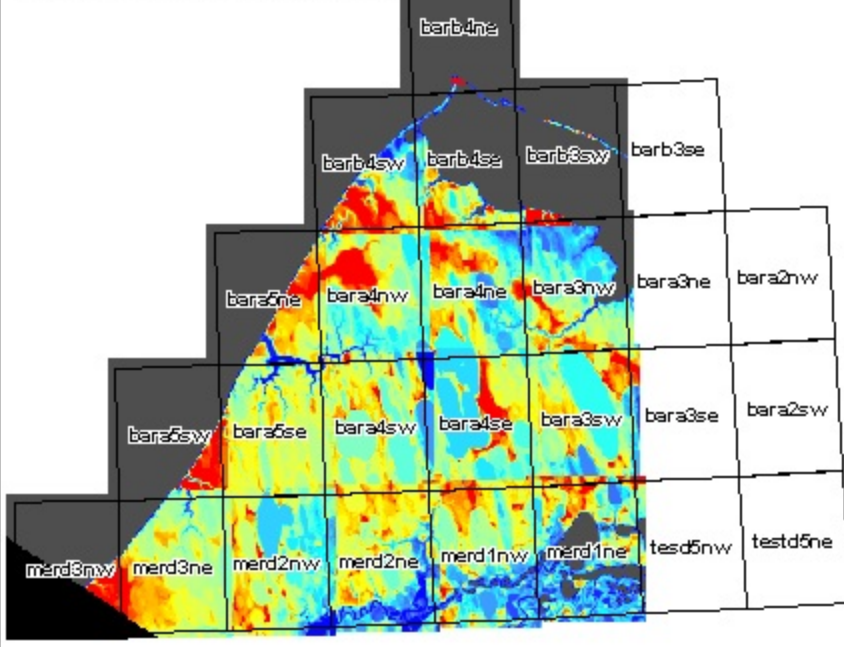
Elev. (m)

23.06

0.00

OrthoRectified Radar Imagery (1.25 m ORRI)

0   500   1,000 meters

IFSAR data as delivered
(26 tiles across 2 UTM zones)
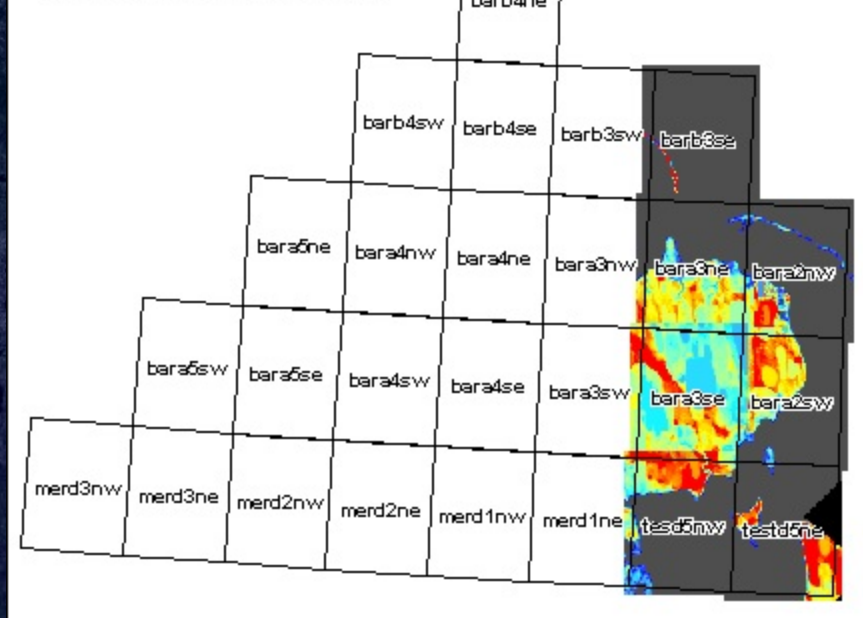
➤ Difficult to work with!

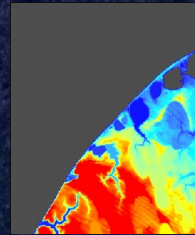# 21 files for each of the 26 tiles
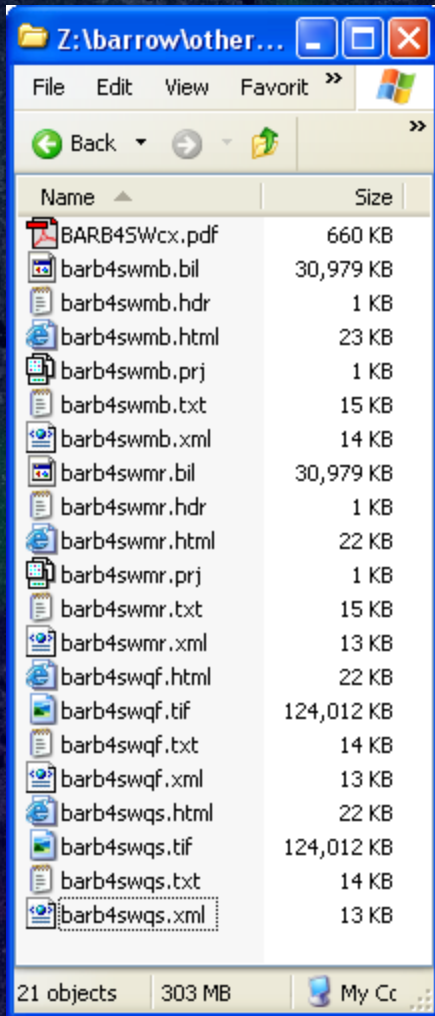
|			
Certification Report	tilename... (e.g. barb4sw...)	...cx.pdf	(acquisition details)
DTM	tilename... (e.g. barb4sw...)	...mb.bil	floating point binary file
		...mb.hdr	header file
		...mb.prj	projection file
		...mb.txt	FGDC metadata
		...mb.html	FGDC metadata
		...mb.xml	FGDC metadata
DSM	tilename... (e.g. barb4sw...)	...mr.bil	floating point binary file
		...mr.hdr	header file
		...mr.prj	projection file
		...mr.txt	FGDC metadata
		...mr.html	FGDC metadata
		...mr.xml	FGDC metadata
Unenhanced ORRI	tilename... (e.g. barb4sw...)	...qf.tif	GeoTIFF file
		...qf.txt	FGDC metadata
		...qf.html	FGDC metadata
		...qf.xml	FGDC metadata
Contrast-Stretched ORRI	tilename... (e.g. barb4sw...)	...qs.tif	GeoTIFF file
		...qs.txt	FGDC metadata
		...qs.html	FGDC metadata
		...qs.xml	FGDC metadata
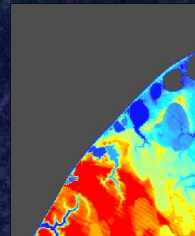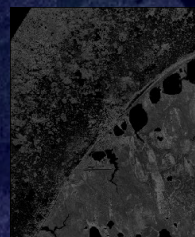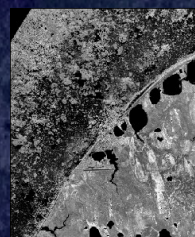
Processing:

import tiles into ArcInfo
merge tiles within each zone
project zone 5 to zone 4
mosaic
clip to "peninsula"

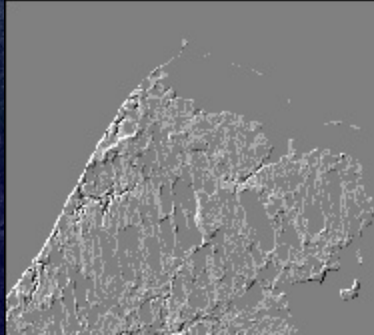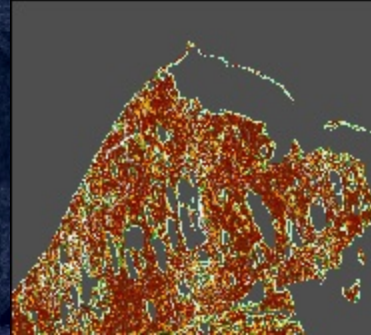Digital Surface Model (DSM)

Barrow Peninsula
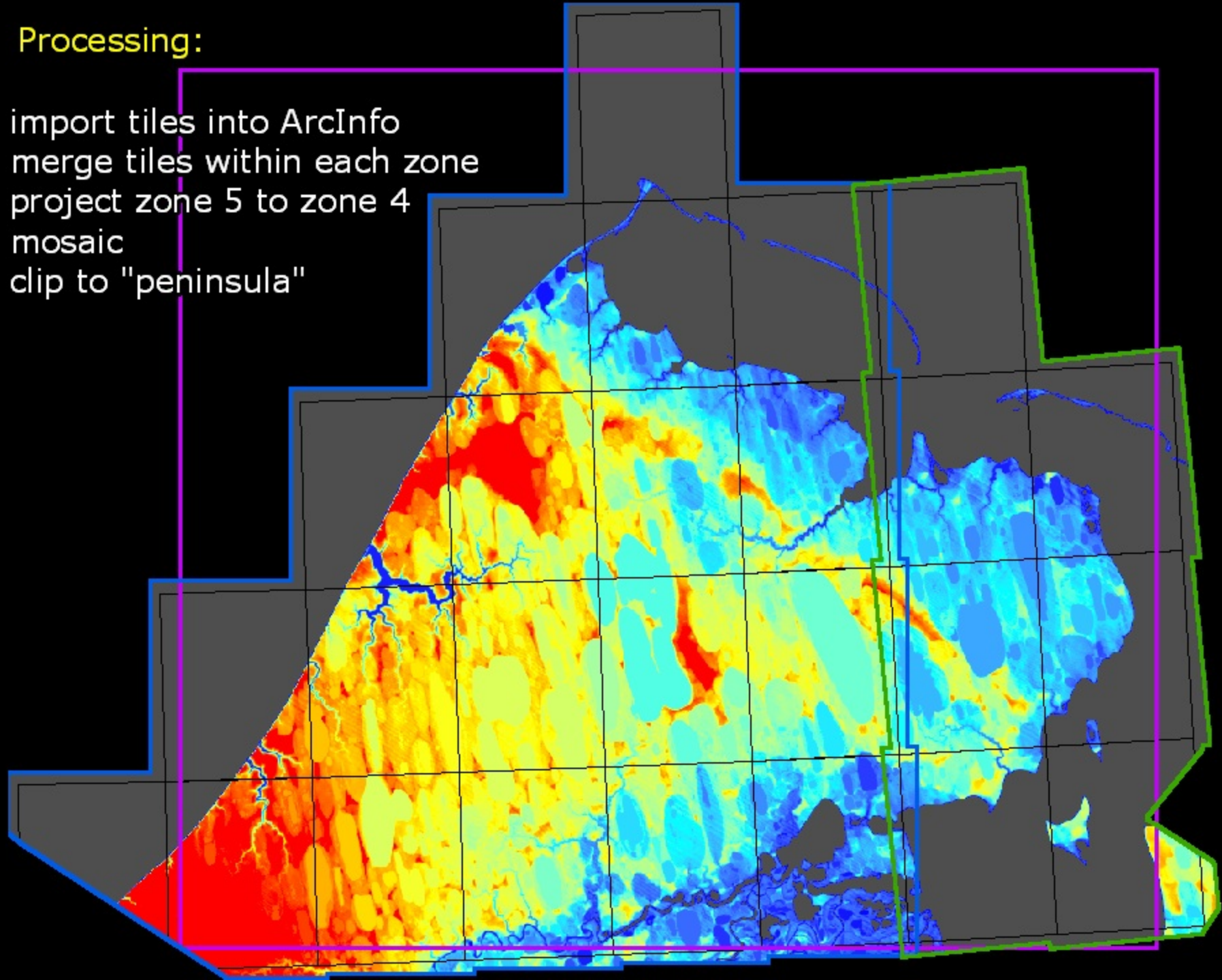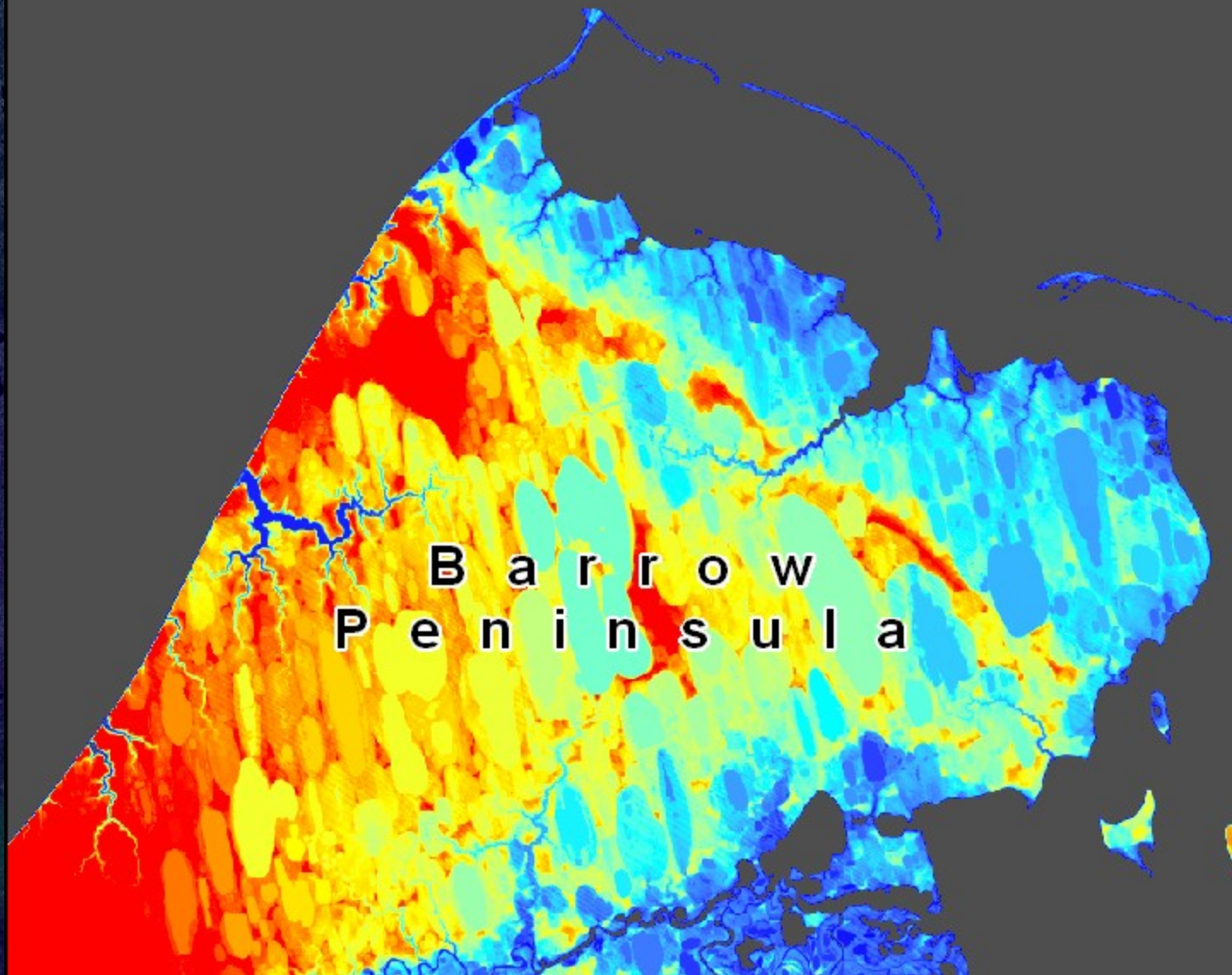
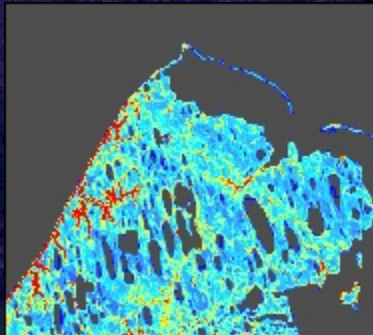# Derived Layers
(uniform projection, datum, extent, processing, documentation, accessibility, etc.)

Shaded Relief

Aspect

Slope Angle

Contours

Accessory Layers
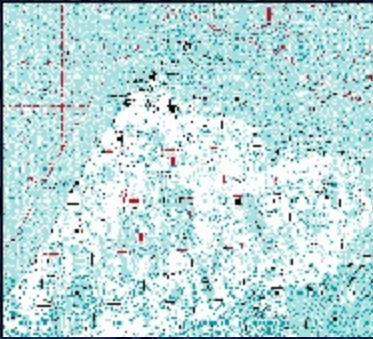
1:250K DRG

1:250K index map
("qmquad")
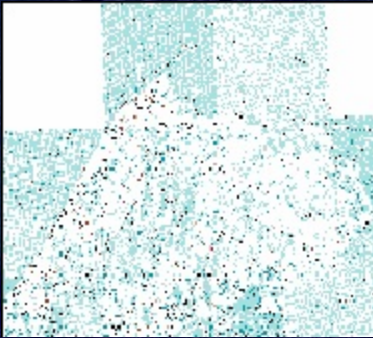
1:63K DRG

1:63K index map
("itmquad")

Quarter Quads
(essential for ORRI tiles)

Digital Surface Model (5 m DSM)
over
Shaded Relief

0   500   1,000 meters

Elev. (m)

41.35

0.00
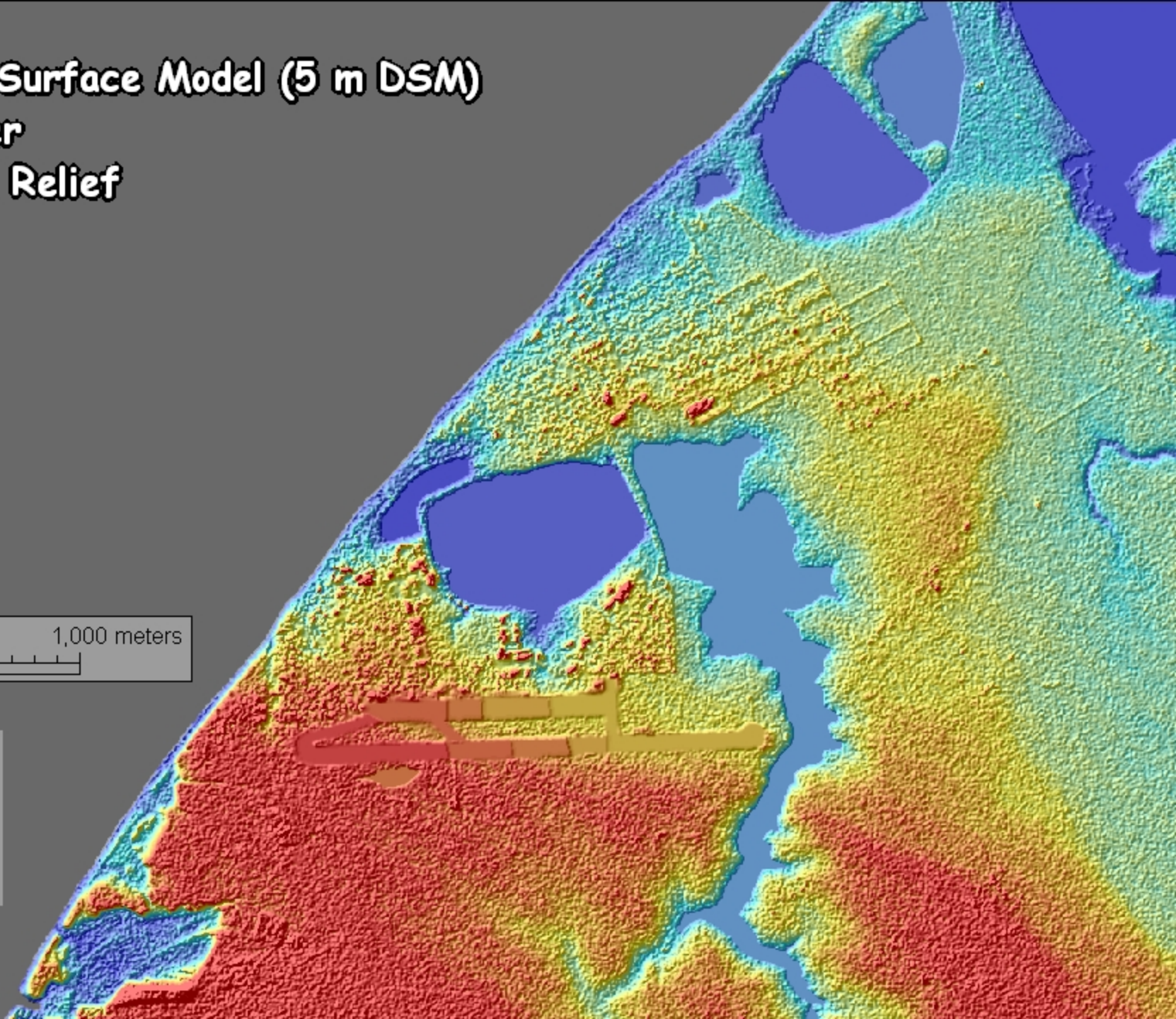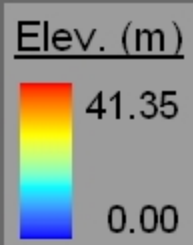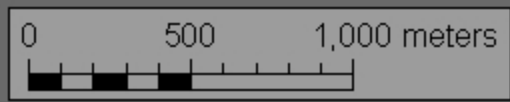
OrthoRectified Radar Imagery (1.25 m ORRI)
over
Digital Surface Model (5 m DSM)

0   500   1,000 meters

Elev. (m)

41.35

0.00

Slope Angle over ORRI

0   500   1,000 meters

Angle (degrees)

Value

32.4

0.0
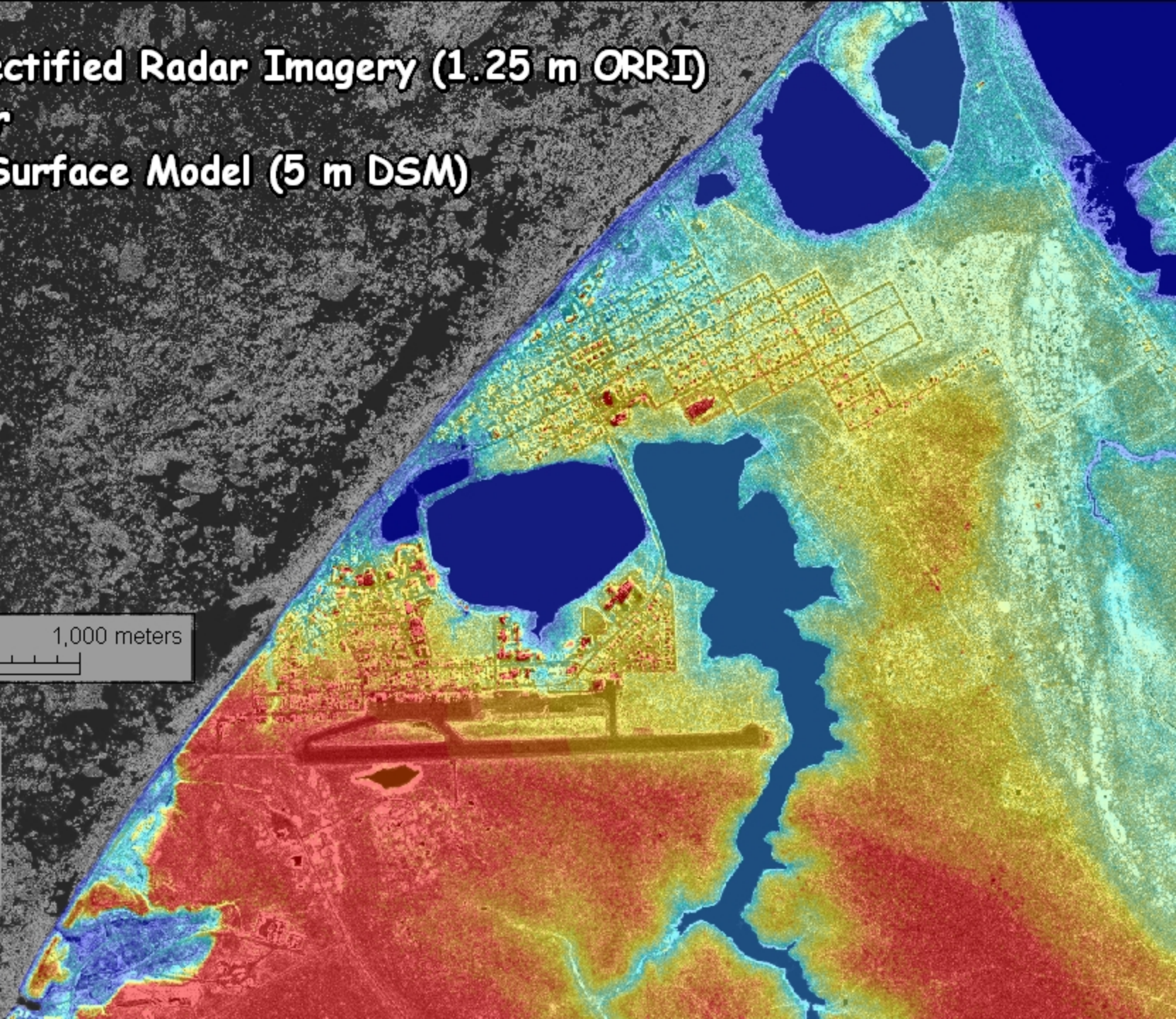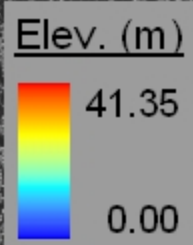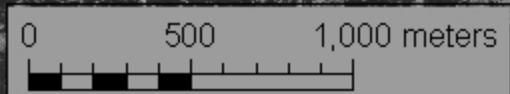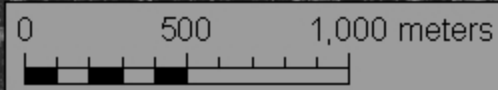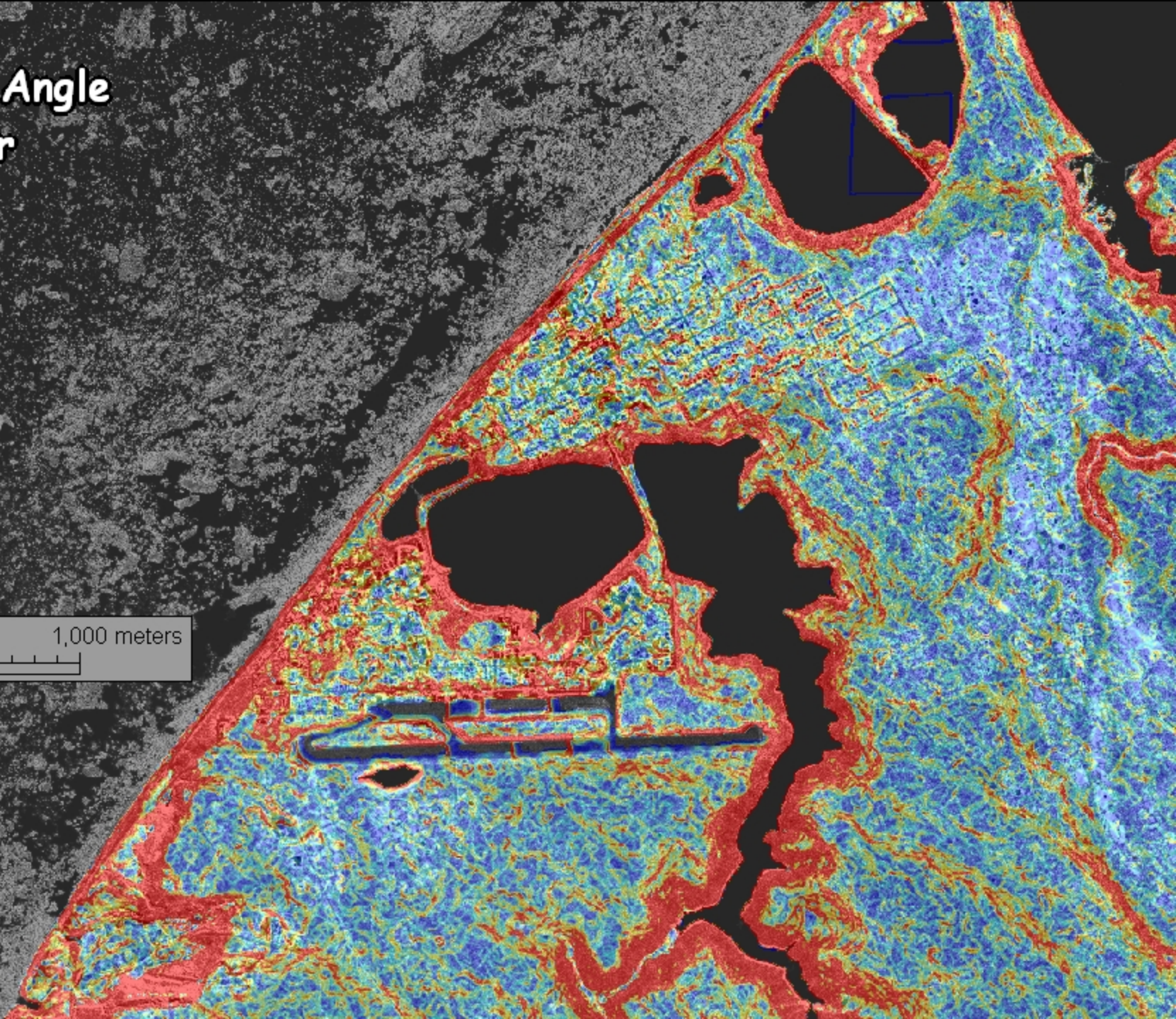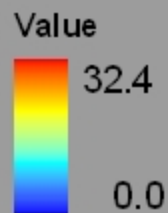
Contours
over
ORRI
over
Shaded Relief

1 m contour interval
0 - 19 m

0   500   1,000 meters
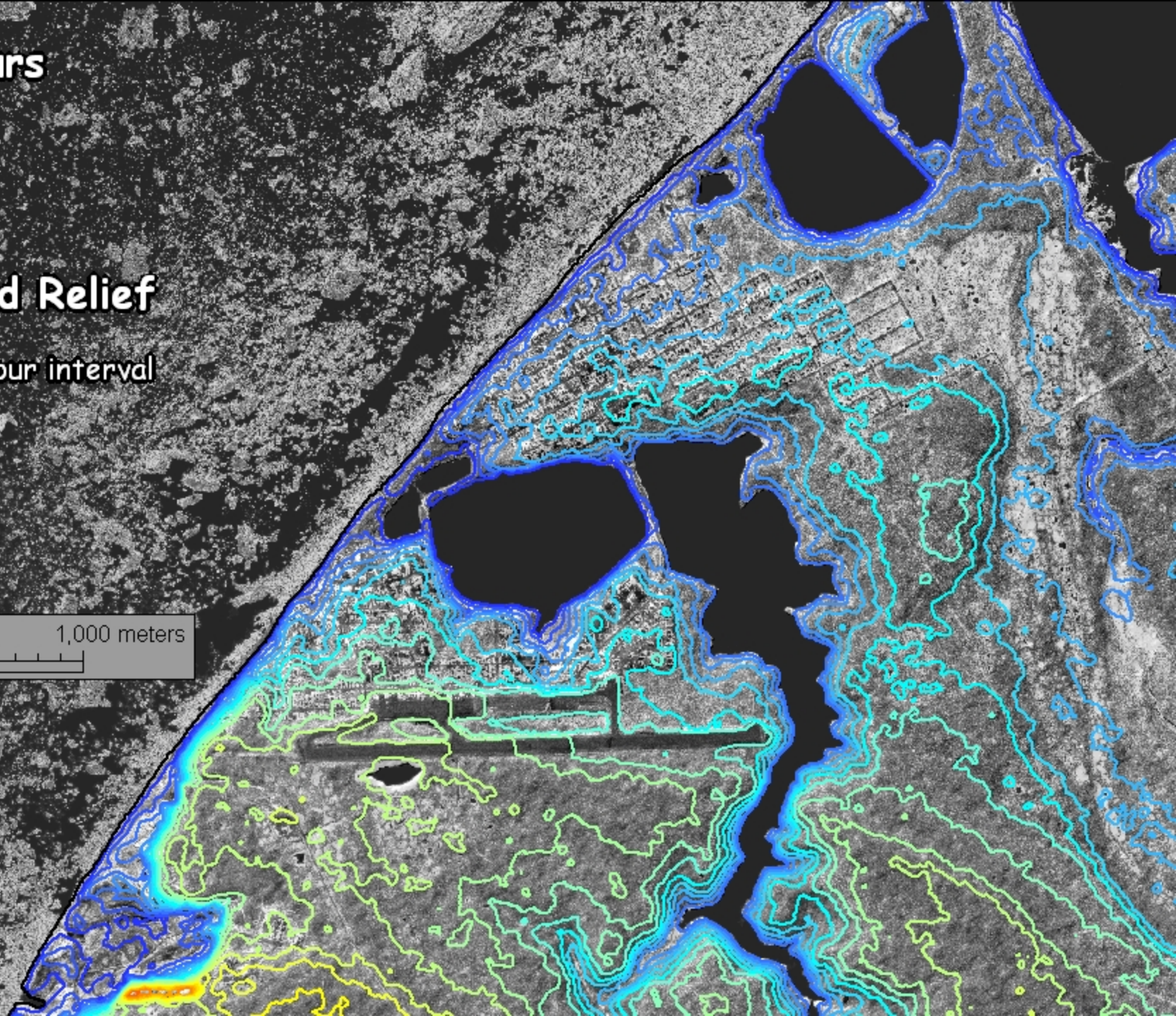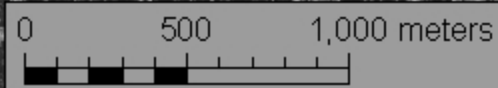
USGS Topo (1955, scale 1:63,360)
  over
ORRI

0   500   1,000 meters

Lagoon

South
Salt

Lagoon

Xmit

32

33

Browerville

31

Isatkoak

Lagoon

TRACTOR

4

Barrow

Wiley Post—Will Rogers
Memorial Airport

6

5

TRAIL
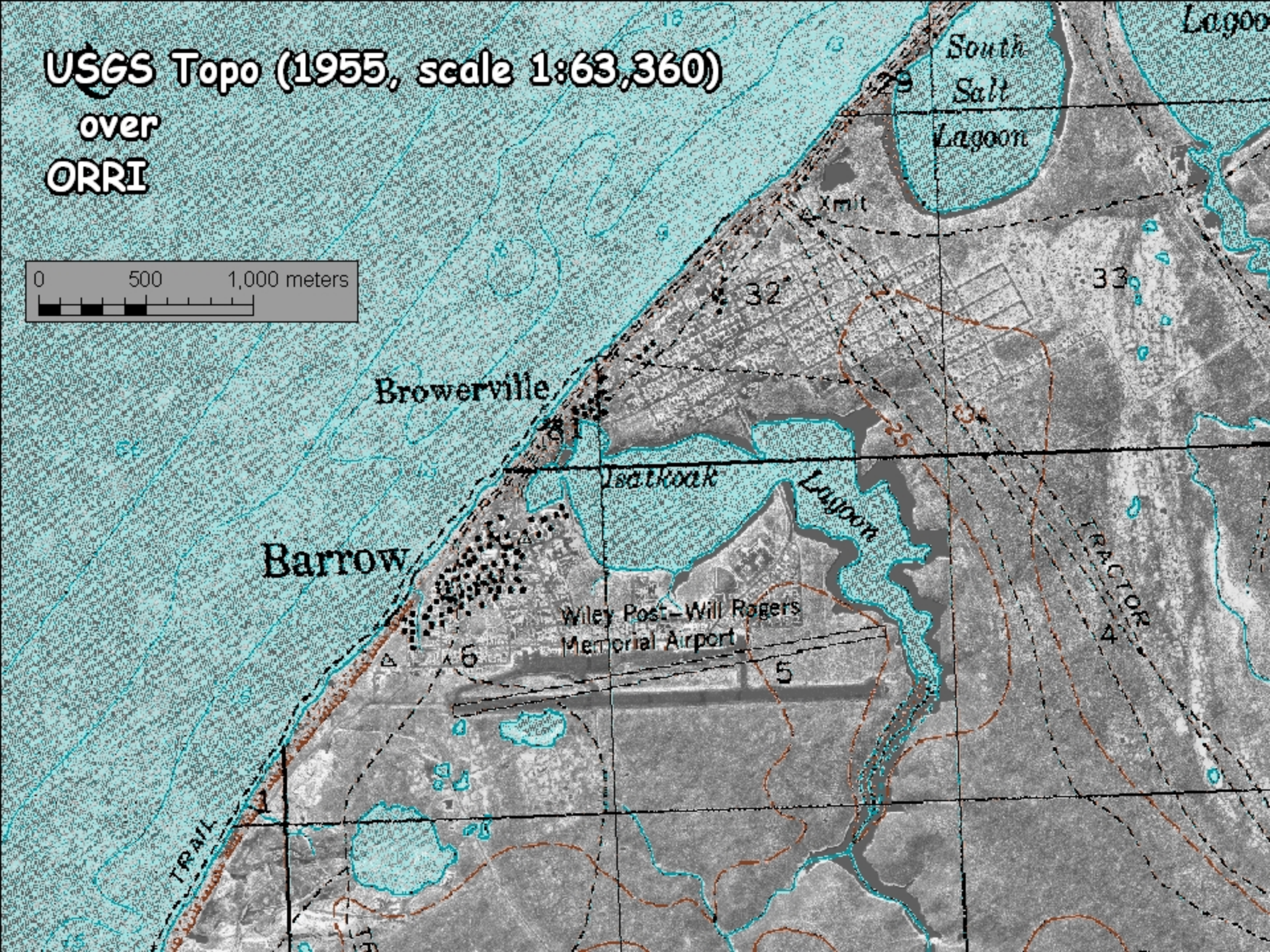
IFSAR Licensing:
(per necessary agreement with Intermap Technologies Inc.)

Release to All NSF-funded researchers:
full-resolution IFSAR DEM's, ORRI & related value-added layers ("derivative works")

Public Release:
low-resolution versions (yet to be determined) of the restricted layers, plus full-resolution DRG's and other "value-added" layers

Our IFSAR data and the USGS:

➢ The USGS, in coordination with the BLM and DOI, acquired 293 tiles from Intermap for the nearby NPRA in 2002 and 2003. They will make the tiles available to the public at low- or no-cost, through an unrestricted license.

➢ They have *also* purchased the "Barrow NSF" tiles from Intermap's archive (relatively cheaply), and will distribute them to the public.

➢ *Please Note:* **The Barrow IFSAR data would not have been created without the NSF support.** The USGS did not have funds or justification to contract with Intermap for the Barrow area. In other words, the NSF grant was absolutely necessary. Indeed, because of the NPRA acquisition plans, we were able to avoid mobilization costs.

➢ Details and timeline for USGS distribution are uncertain.

➢ This development will benefit research in the area, enabling wide distribution of the data. It's a "win-win" situation, and adds extra weight to the "value-added" processing and layers.

Layer Subsets for the Barrow "Triangle":
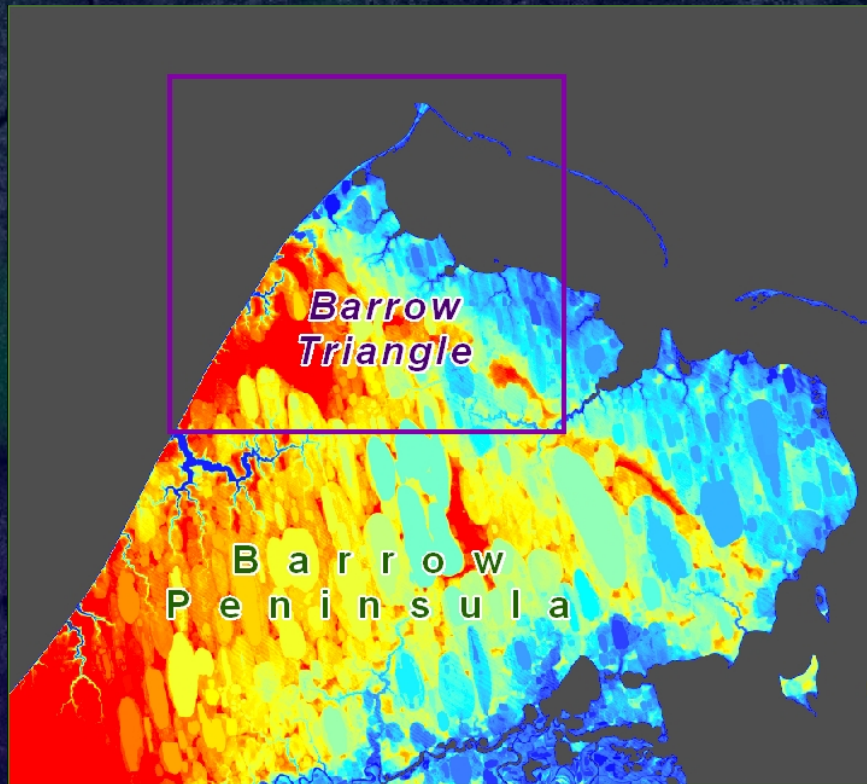
➢ much smaller files (80% smaller files than the "Peninsula")

➢ easier to work with

➢ coincides with the QuickBird extent

➢ many researchers would be interested only in this area

The Solution:

A set of well-documented, readily available, pre-packaged layers to avoid confusion and redundant effort.

Research Significance:

➢ a long-lasting, common base for orthorectifying and georegistering other layers

➢ a temporal baseline for decades of change-detection studies

➢ education and outreach

➢ quantitative analysis, modeling, and interdisciplinary collaboration in the fields of:

- ecosystem classification, health, & dynamics
- terrestrial-atmospheric fluxes of greenhouse gases
- natural & anthropogenic landscape dynamics
- archeology
- stream and thaw-lake hydrology & change
- coastal flooding
- coastal erosion
- permafrost melting
- other environmental responses to unprecedented arctic warming

Progress To Date:

July, 2002
planning
GCP's placed and surveyed
IFSAR acquisition

Jan.-Feb., 2003
technical DGPS issues resolved
GCP's sent to Intermap

Aug.-Sept., 2003
draft product delivered
thorough quality review
Intermap revisions of the data

Oct., 2003
Intermap delivers final IFSAR product (Oct. 1)
value-added processing
QuickBird scenes delivered

In Progress for IFSAR Data:

➢ creation of FGDC metadata
➢ creation of other documentation
➢ coordination with ADCC
➢ review of licensing agreement

Authorized Release (to NSF PI or CoPI) from ADCC:

➢ Primary, Derived, and Accessory Layers
➢ By DVD
➢ ASAP

Public Release from ADCC:

➢ Accessory layers
➢ Low-resolution versions of Primary and Derived Layers
➢ By ftp
➢ ASAP

ASAP = as soon as documentation & metadata are completed, and as soon as distribution channels are completed. In other words, a few months.

Information:

Project Website
    http://instaar.colorado.edu/QGISL/barrow_high_res

Information and Data Access:

ARCSS Data Coordination Center (ADCC):
    http://nsidc.org/arcss

View Online:

Barrow Area Information Database – Internet Map Server
(BAID-IMS)
    http://ims.arcticscience.org