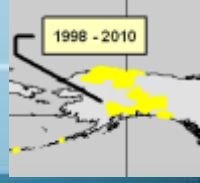
STAR IfSAR Collection

M. Lorraine Tighe - Director, NEXTMap

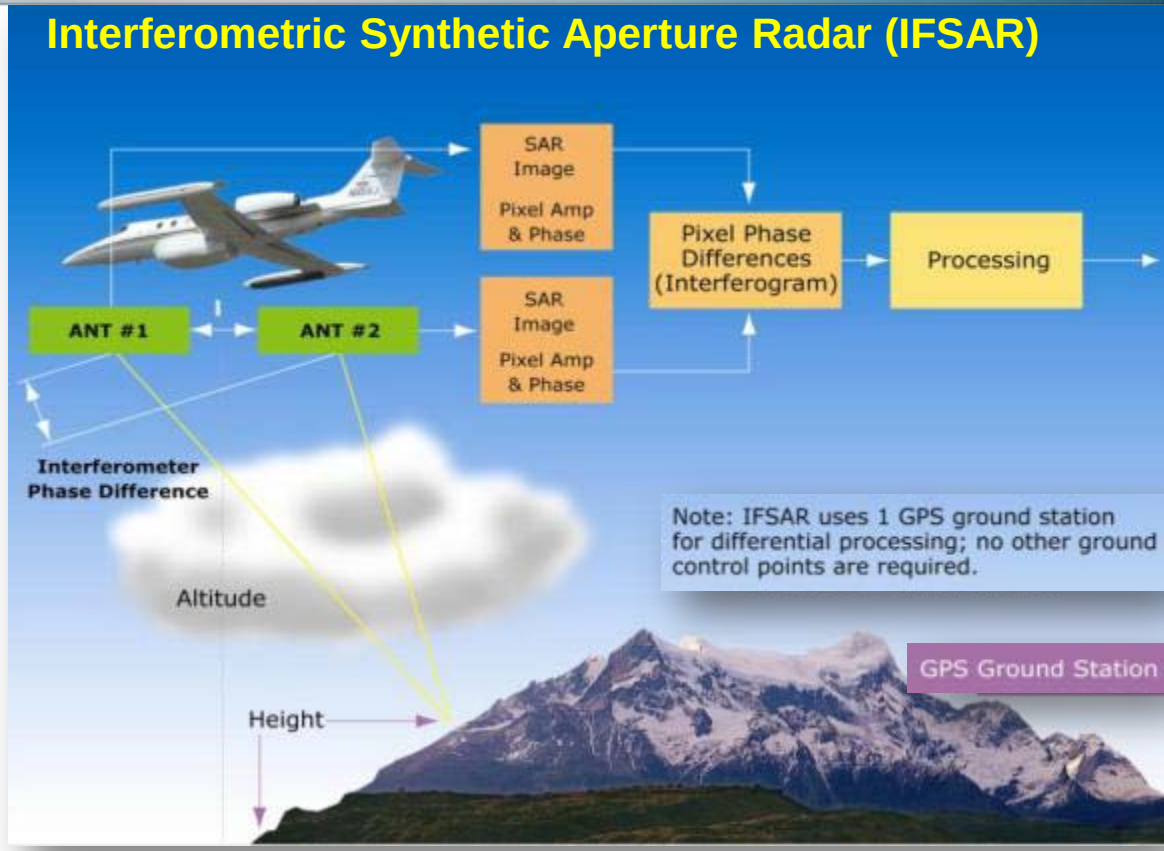
02/24/11

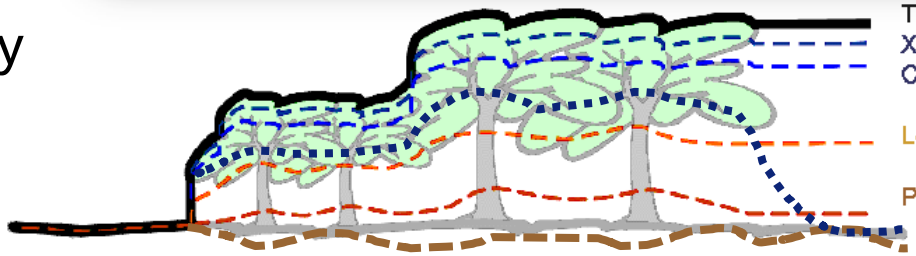
STAR Technology X-HH Band SAR



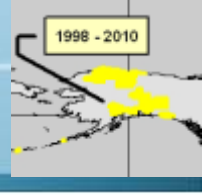
- Penetration at radar wavelengths is a function of many factors (moisture, structure, canopy density, land cover type, slope, incidence angle, position in swath, resolution, post processing).

- This illustration is often accepted to represent signal penetration into the canopy, but is reality – focusing on the X and P bands, penetration is deeper.

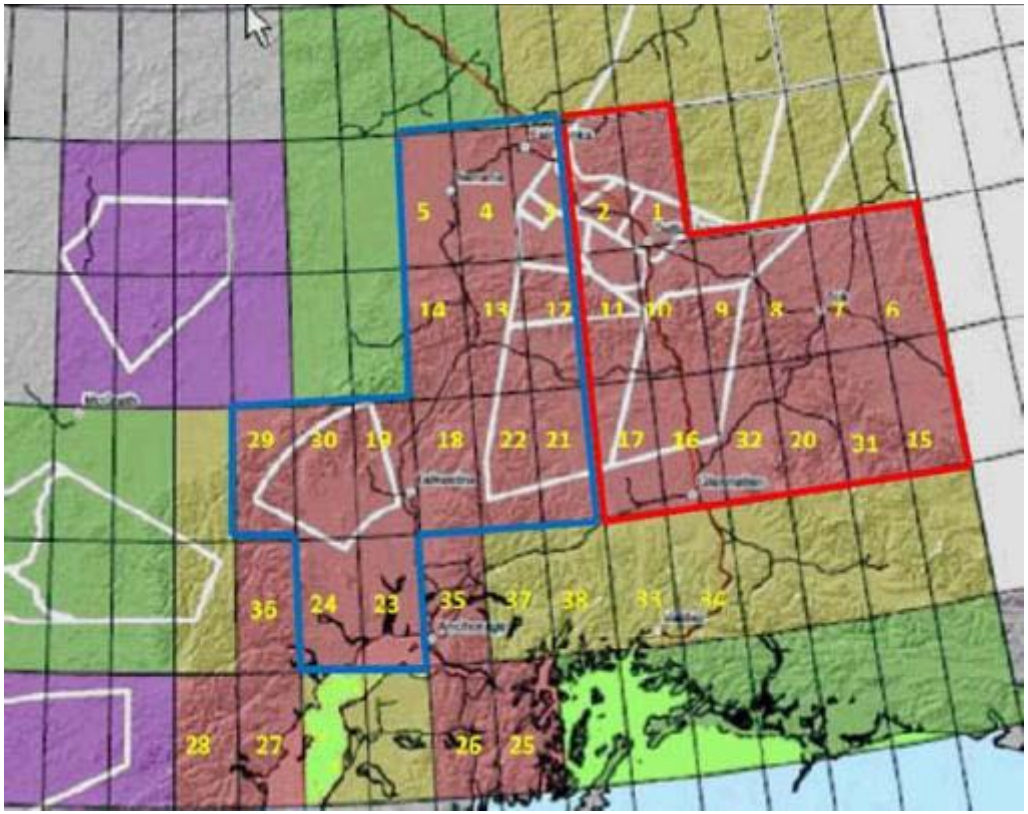




Data Acquisition: Study Site

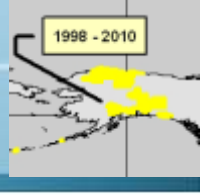


- This initial effort (Red & Blue Shapes) in 2010 has a total of ~28 1º X 1º cells
- Approximately 157,434 km^2 (60,785 mi^2) = 8.5% of Alaska
- <5% voids in the data required data acquisition from 5 different look directions.
- Average Vendor Price = $34.73/km^2 /.39 mi^2
- The data was collected in WGS84 (GPS constellation for navigation). Output products have NAD83 (Vertical) & NAVD88 (Horizontal) datum applied using GEOID09



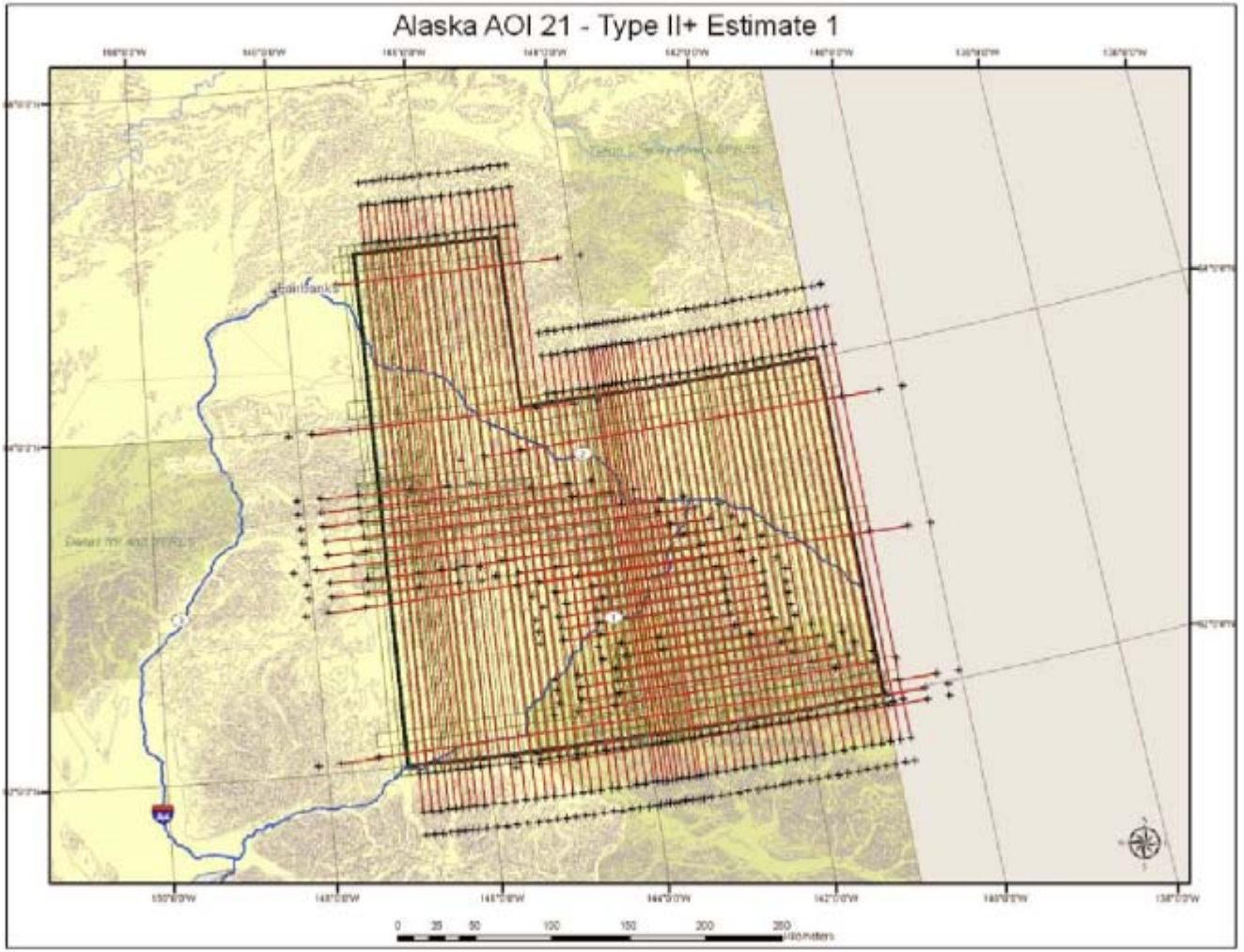
Fugro Intermap

STAR Data Acquisition: Flight Lines

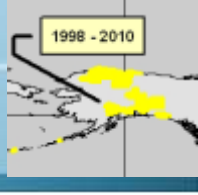


- Intermap maximizes data collection by using Ultra-Long lines (ULL) which can be in excess of 700 km = greater data collection per sortie.

- The STAR system is able to adjust its antennae angle while on-line to compensate for drift (from track) caused by winds aloft.

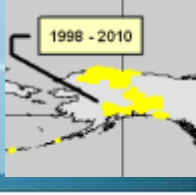


Alaska Data Products

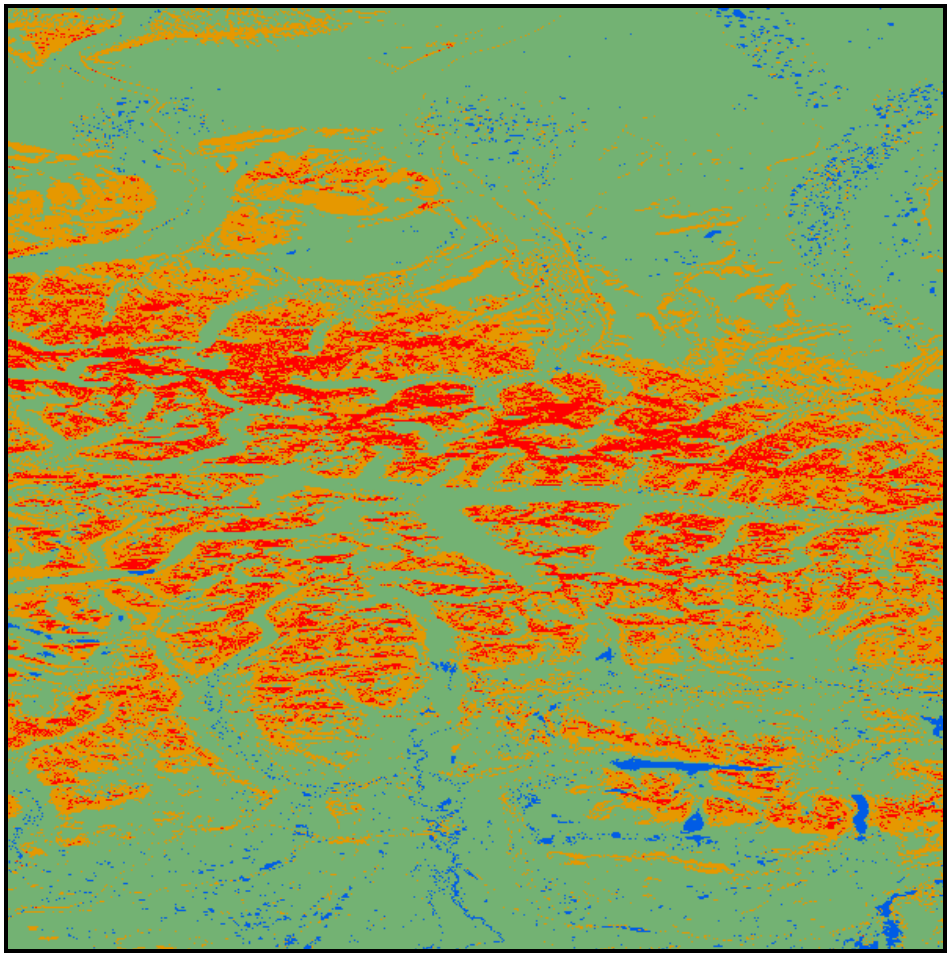


Product	Brief Description
DSM	High Resolution DSM with 5 m posts, Alaska Albers 15' X 15' tiles
DTM	High Resolution DTM with 5 m posts, Alaska Albers 15' X 15' tiles
ORI	Contrast-stretched ORI (or similar product) magnitude with 5 m pixels or better, Albers, 15' X 15'
Metadata	FCDC-compliant metadata files and swath locator diagram
Quarter Cells	Resampled edge-matched bare earth quarter cells (30' by 30') in geographic projection at 0.4 arc/second X 0.8 arc/second post spacing in HRTe3 format.
Void Mask	Void mask and a list of ancillary sources to fill voids shall be generated for each surface and resolution
Slope Mask	Slope mask to define accuracy categories and edit criteria
Reports	Monthly progress reports; Certified USO 9001 data-quality report information

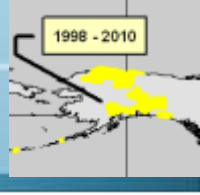
Slope Based on DTM



- **Alaska Cell #:11**
- Area of slopes < 10^{o}: 3468km^2 (62%)
- Area of slopes 10^{o}- 20^{o}: 1562km^2 (28%)
- Area of slopes > 20^{o}: 441km^2 (8%)



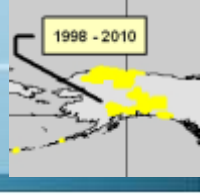
Percentage of Void Data



- **Alaska Cell #:11**
  - Total land area of 5551 km^2
  - 1.28% Void (71.58 km^2 of the cell area is decorrelated)
  - **None** of the 15' tiles exceed a decorrelation value of 5%
  - Majority of decorrelation corresponds to the mountain range in this block

N63w146h8 N63w146h7 **0** N63w146g8 N63w146g7	N63w146h6 N63w146h5 **0** N63w146g6 N63w146g5	N63w146h4 N63w146h3 **0** N63w146g4 N63w146g3	N63w146h2 N63w146h1 **0** N63w146g2 N63w146g1
N63w146f8 N63w146f7 **3.23** N63w146e8 N63w146e7	N63w146f6 N63w146f5 **3.96** N63w146e6 N63w146e5	N63w146f4 N63w146f3 **4.42** N63w146e4 N63w146e3	N63w146f2 N63w146f1 **0.83** N63w146e2 N63w146e1
N63w146d8 N63w146d7 **1.05** N63w146c8 N63w146c7	N63w146d6 N63w146d5 **1.84** N63w146c6 N63w146c5	N63w146d4 N63w146d3 **2.28** N63w146c4 N63w146c3	N63w146d2 N63w146d1 **2.24** N63w146c2 N63w146c1
N63w146b8 N63w146b7 **0.85** N63w146a8 N63w146a7	N63w146b6 N63w146b5 **0** N63w146a6 N63w146a5	N63w146b4 N63w146b3 **0** N63w146a4 N63w146a3	N63w146b2 N63w146b1 **1.73** N63w146a2 N63w146a1

Vertical Accuracy Assessment Using ICESat

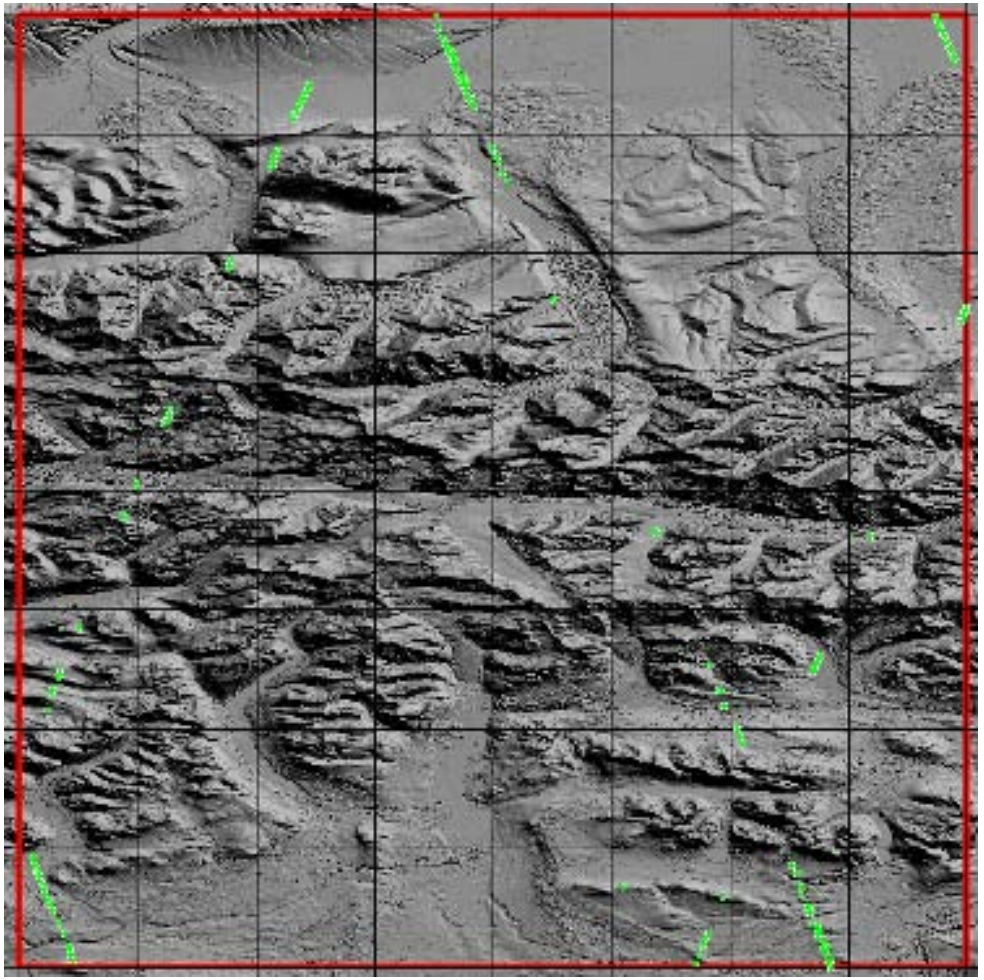


- The vertical accuracy of the DTM is 0.63m RMSE or 1.04m LE90%

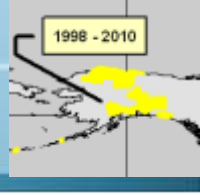
- ICESat typically has a 25 cm RMSE (<5cm mean) in bare ground unobstructed areas.

	DSM	DTM
Number of VCPs	228	228
Mean	0.14	0.05
Max +	1.62	1.58
Max -	-1.58	-2.10
Std dev	0.61	0.63
RMSE	0.62	0.63
90 Percentile	1.05	1.04

Slope (degrees)	Alaska Accuracy Requirement 90% Confidence
0-10	3m
10-20	6m
20-30	9m
30+	12m

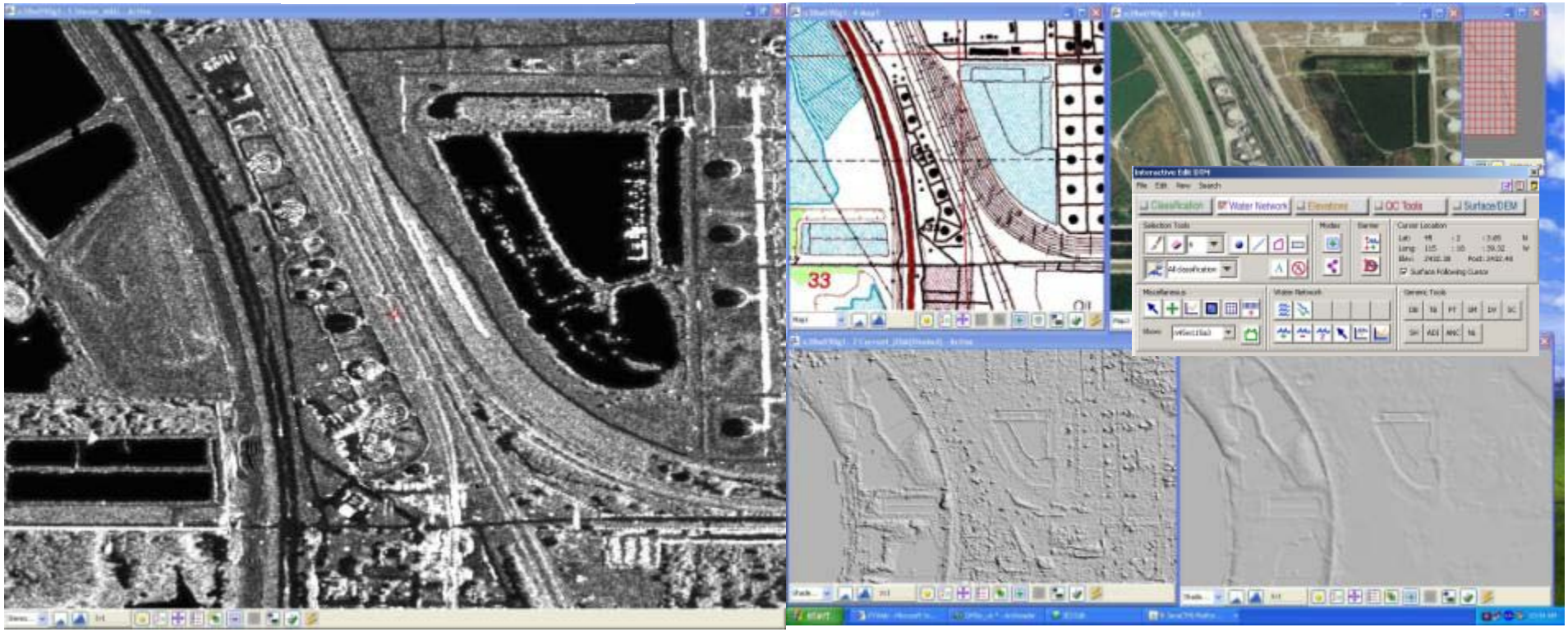


Data Processing is 3D

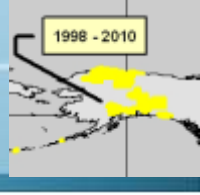


- IES allows for fully **interactive** 3D editing of DEMs
- **Multiple ancillary** data sources can be loaded and manipulated simultaneously

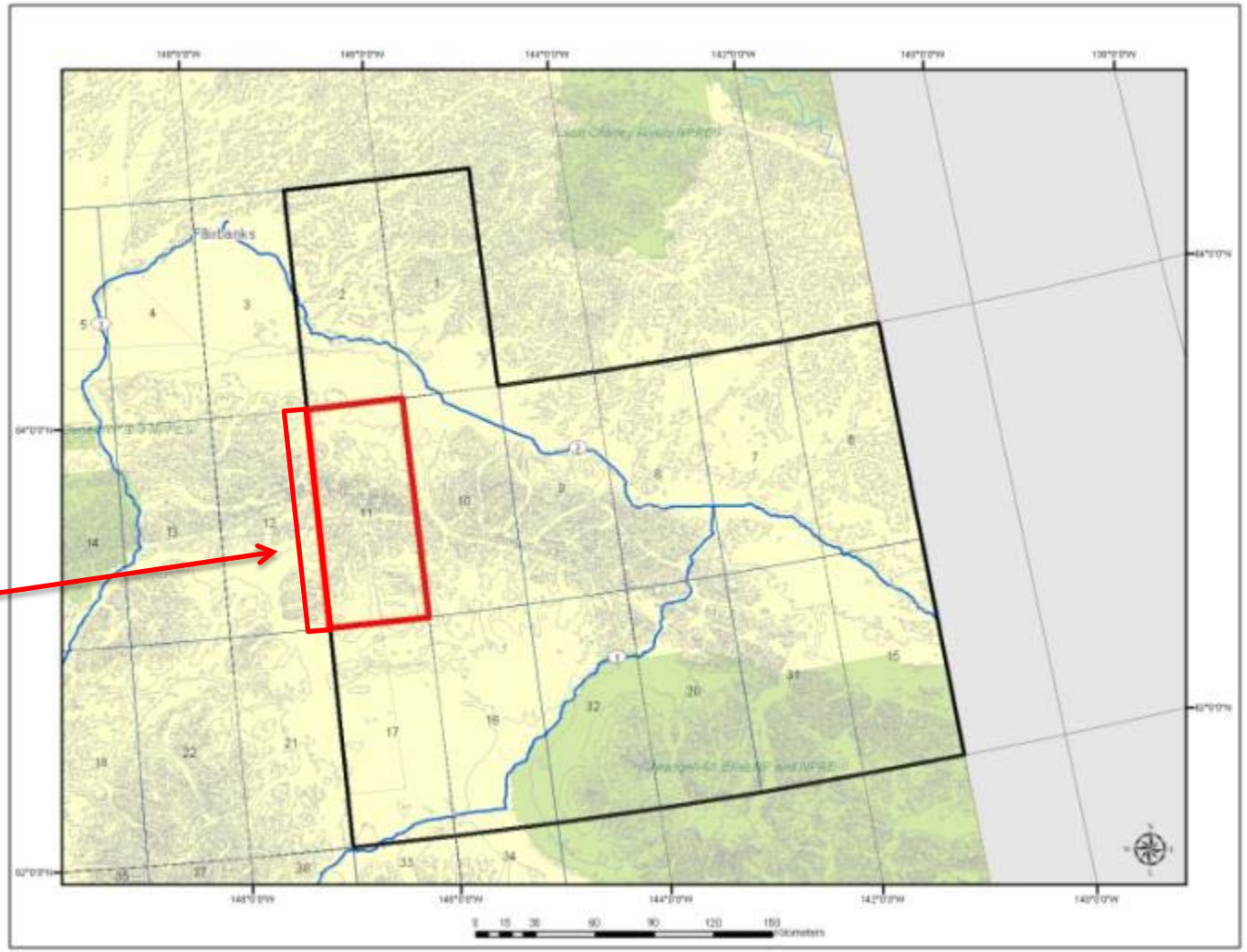
Left Monitor (Stereo)



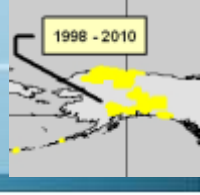
Data Processing - Editing Area



- Pilot Cell #11
- 64 Tiles in one 1º X 1º cell, plus 36 surrounding tiles for a total of 100 tiles.
- Some of the tiles are partial on the west side.



Getting to the Bare Ground



- Although not required by contract, Intermap applied the same editing rules to this project as we applied to the lower 48 (☺).

- Every posting receives a classification: Water, Transportation or Terrain (Terrain is classified in three groups to assist the edit tools: Bald, NotBald or PreFITS).

  - All Water meeting core specifications will be classified and flattened.
  - Airports are flattened and classified as Transportation.
  - Drainage features are hydro enforced (Hydro-enforcement was applied to the DTMs and DSMs, but not required as part of the project).
  - Obstructed areas (e.g. vegetation) are rebuilt using SSE & ancillary data.
  - Embankments are maintained.

- Tile edges are tied to all surrounding tiles

- Quality control and error checking are critical

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Key 1: Terrain Classification

The editors have special draw tools that allow them to manipulate, change or create mask areas according to the terrain so that the best posible edit is run for each area

Key 2: Breaklines

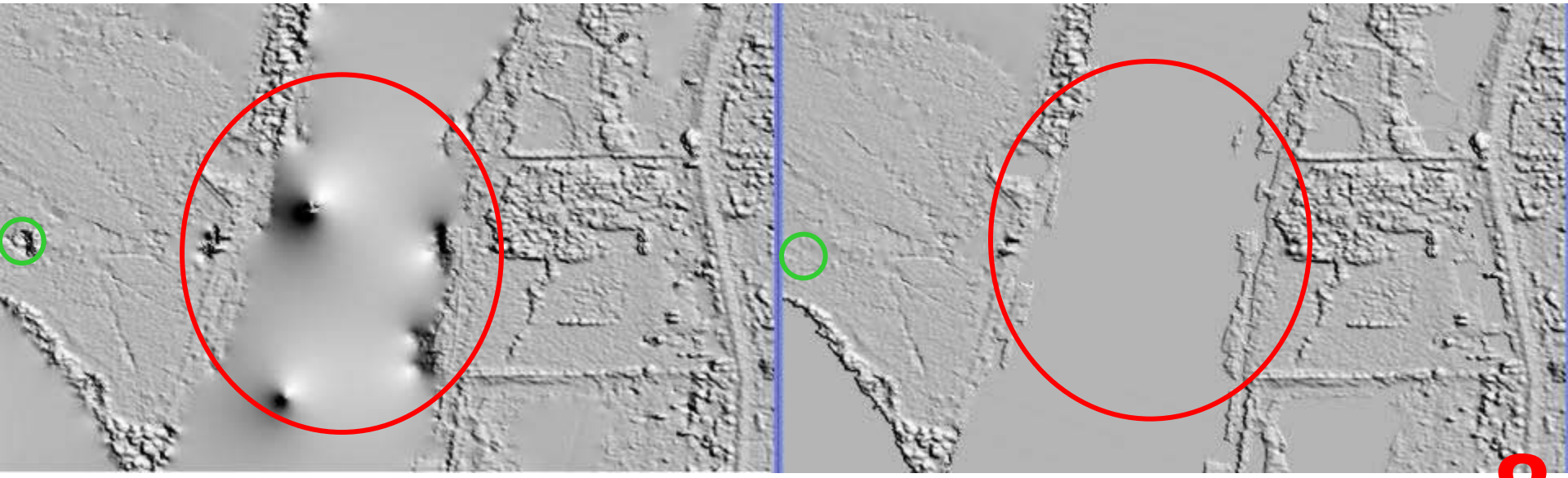
Key 3: Editing Rule sets: Water Edit Example

Removing Radar Artifacts in the DSM

- Water is flattened
  - Rivers are stepped in 10cm steps
- Radar blunders are removed

Before Editing

After Editing



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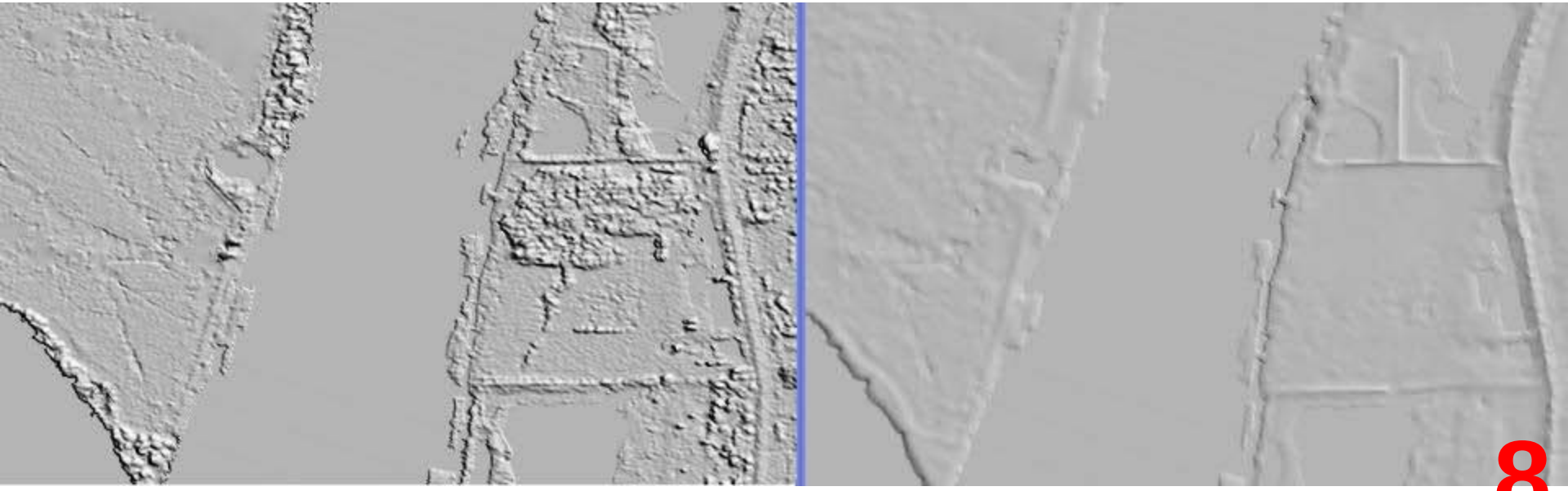
Areas of Obstruction are removed in the DTM

DSM to DTM

- A DTM is created by removing vegetation and man-made constructs
- A variety of techniques can be used
  - Interpolation
  - DEM substitution and correction

Completed DSM

Completed DTM



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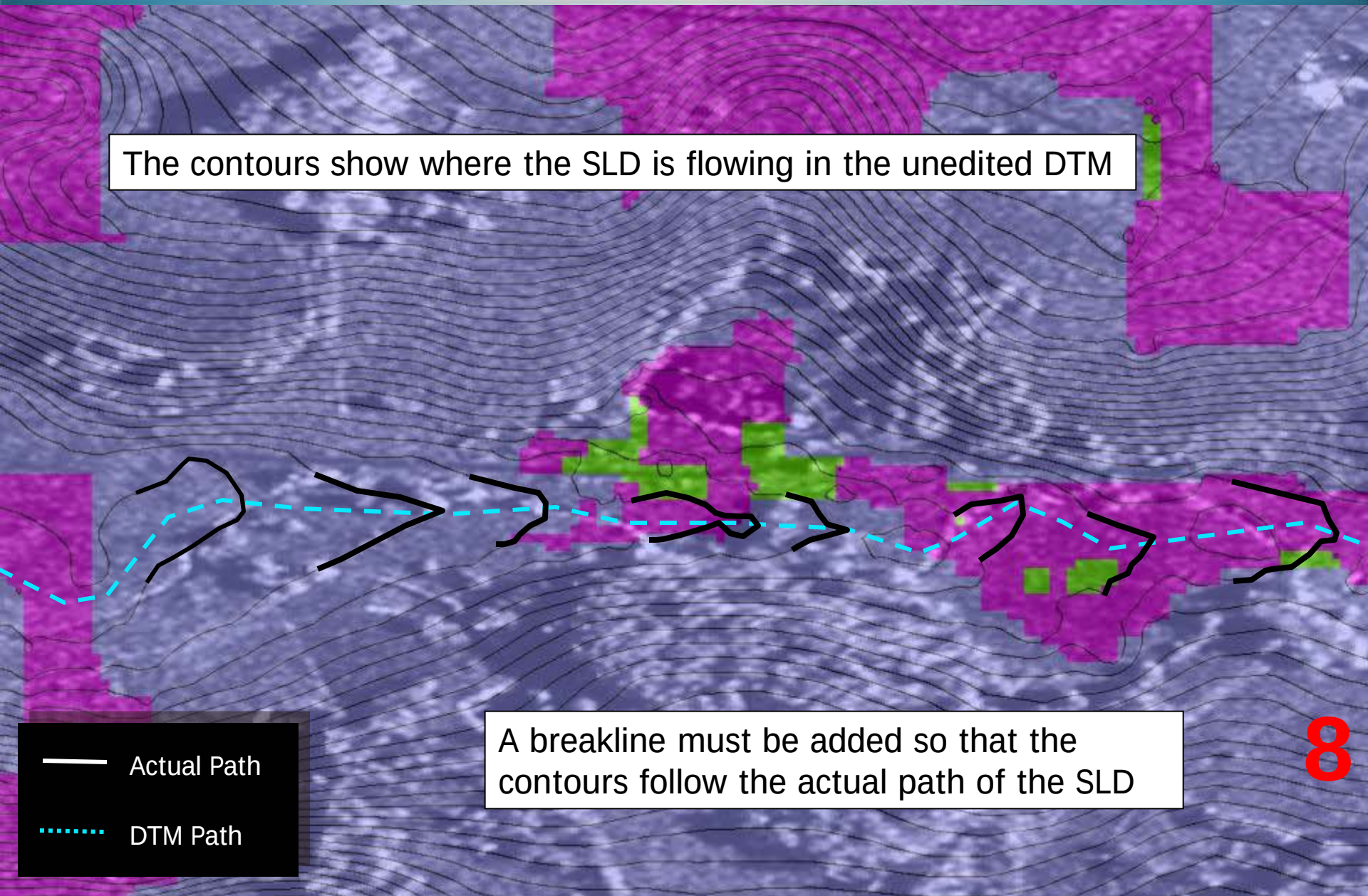
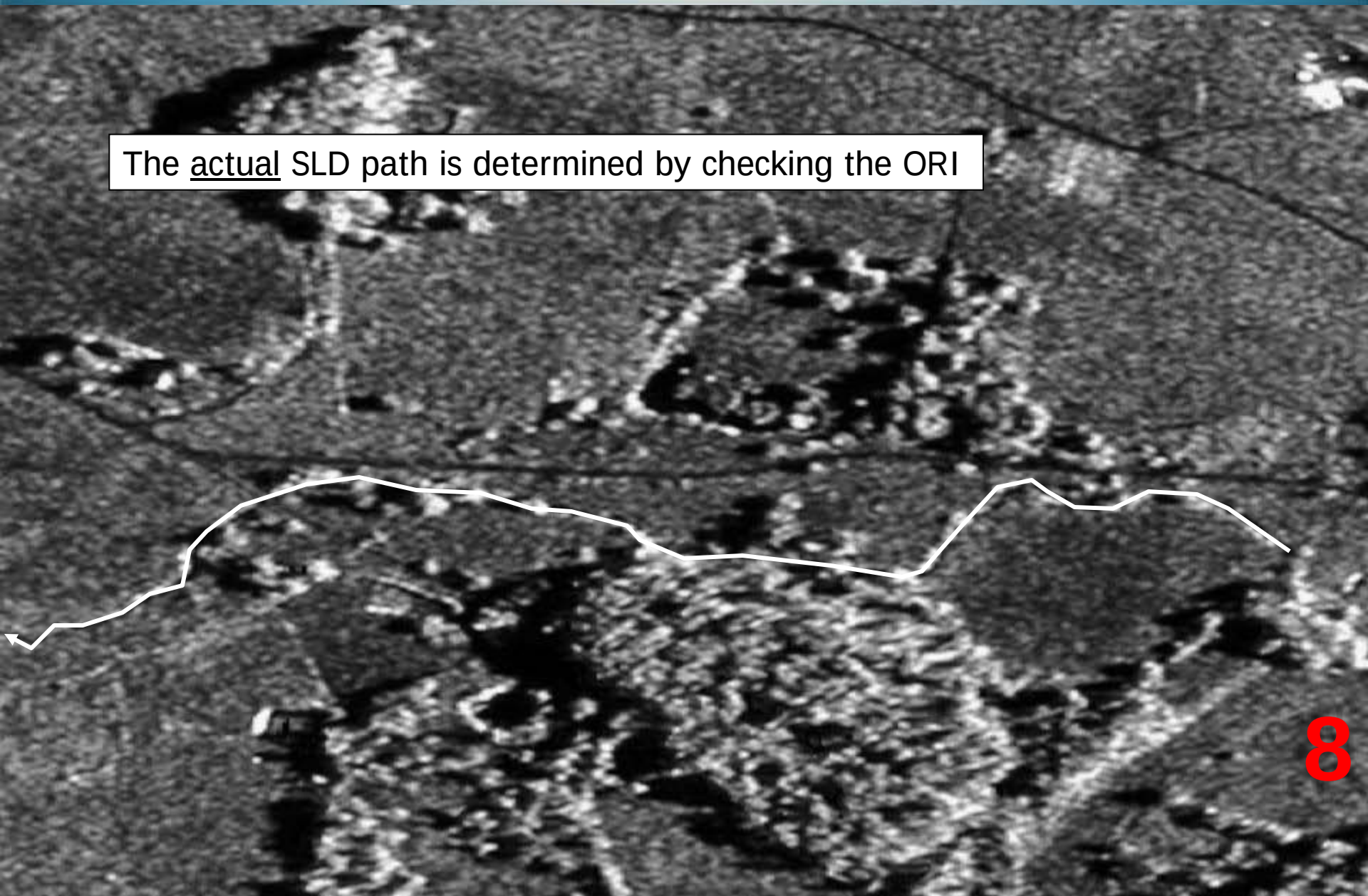
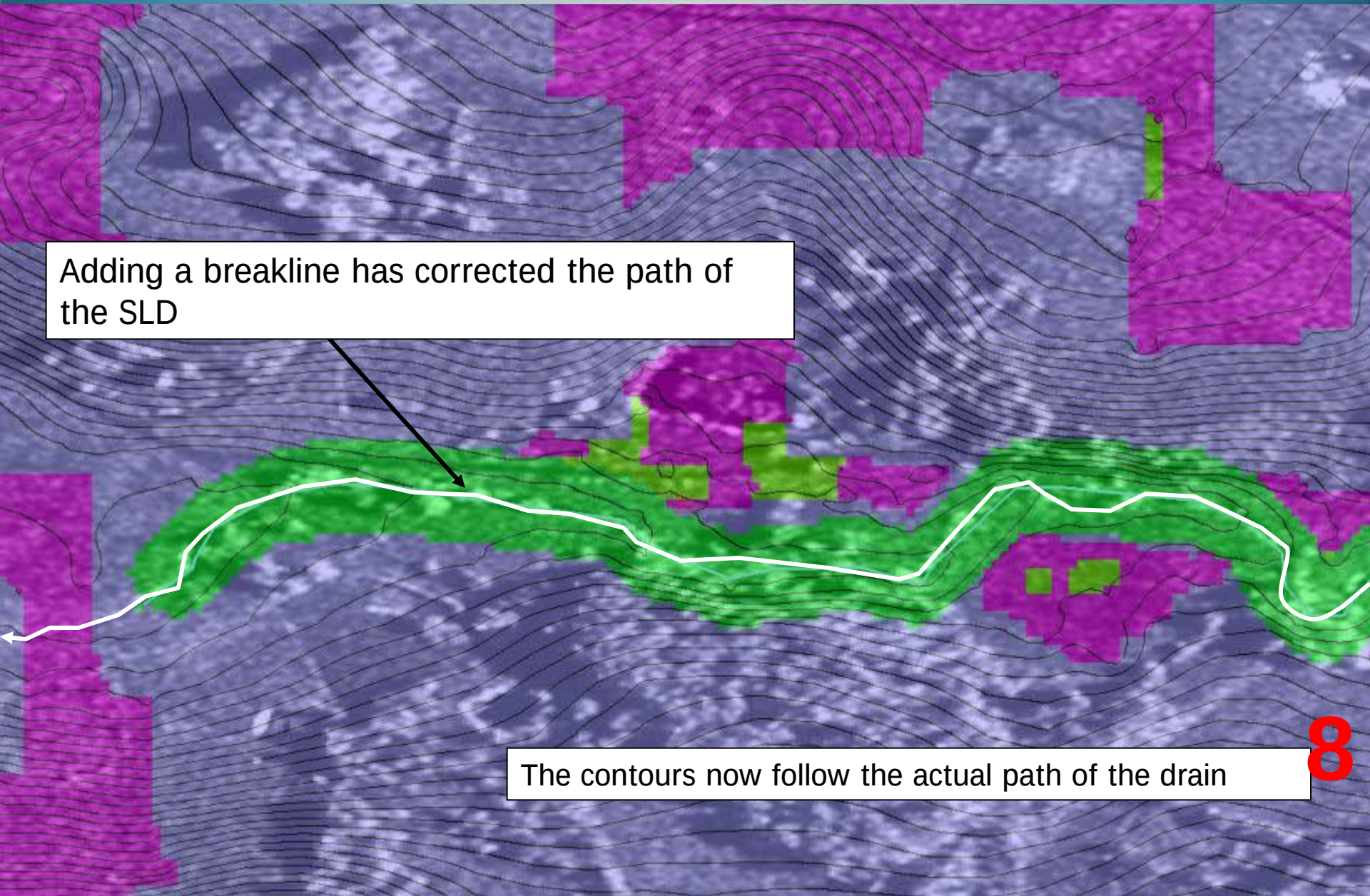
Editing Single Line Drain (SLD)



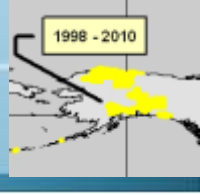
Single Line Drain (SLD) becomes a breakline



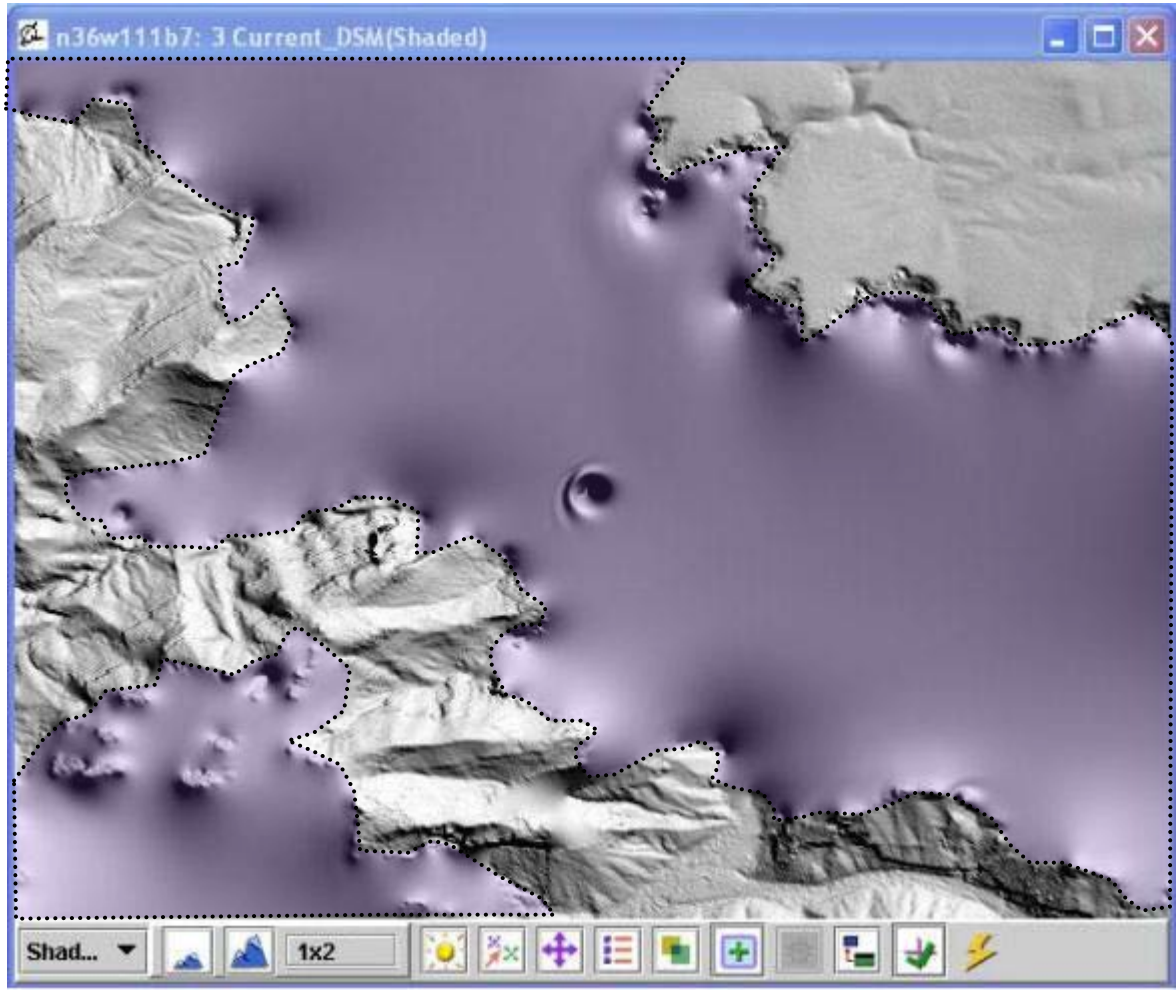
Edited path of SLD



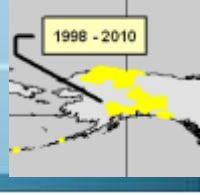
Handling Obstructed and Void Areas



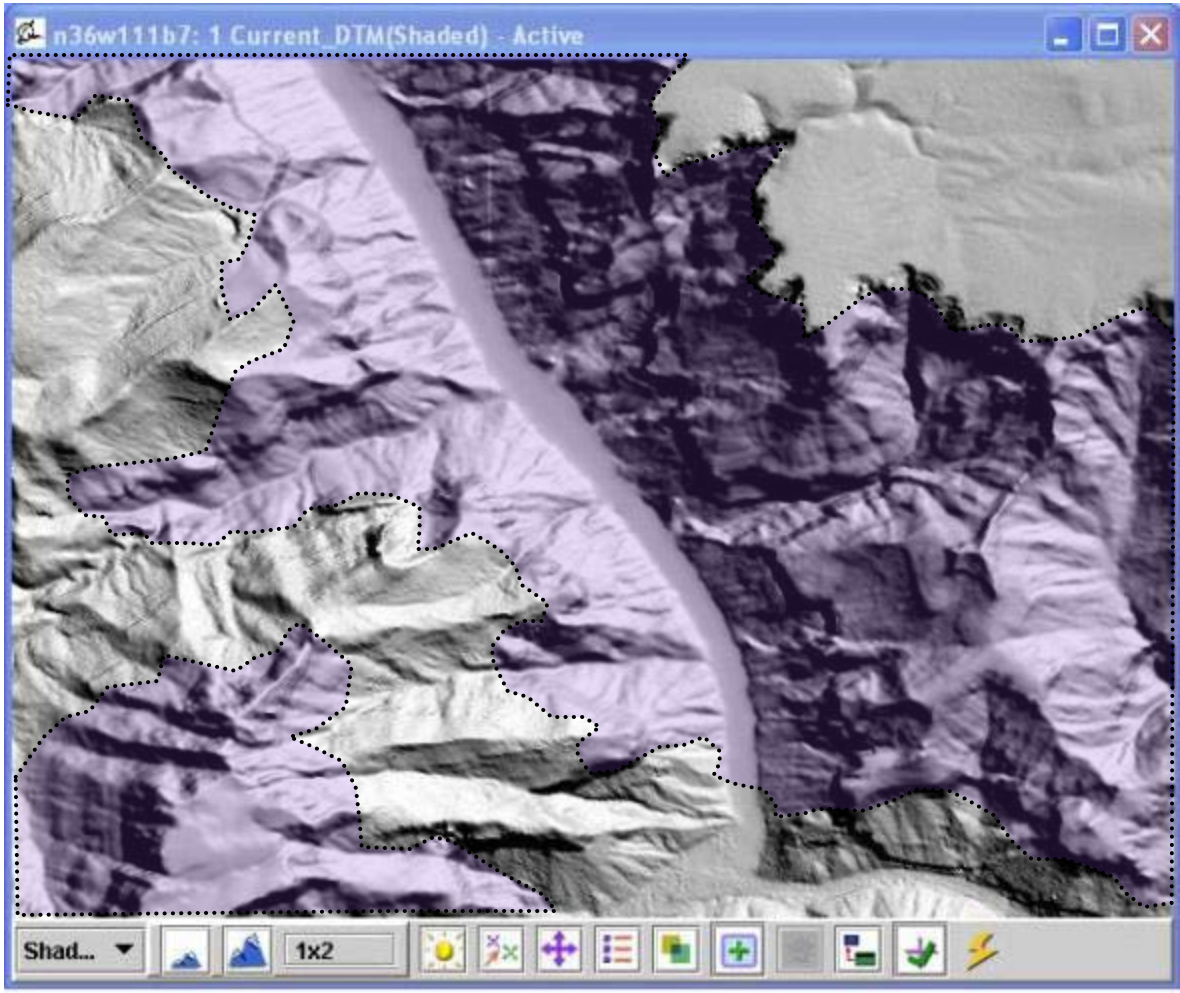
- The acquisition plan is designed to minimize the percent of void data in the output product.
- We have a fully integrated terrain solution (FITS) that can utilize modified DSM data or ancillary data to fill in voids and to help recalculate the terrain surface beneath vegetation canopies.
- **<u>e.g. Before</u>** the “Void Infill” process has been automatically run, void areas have an *interpolated* appearance

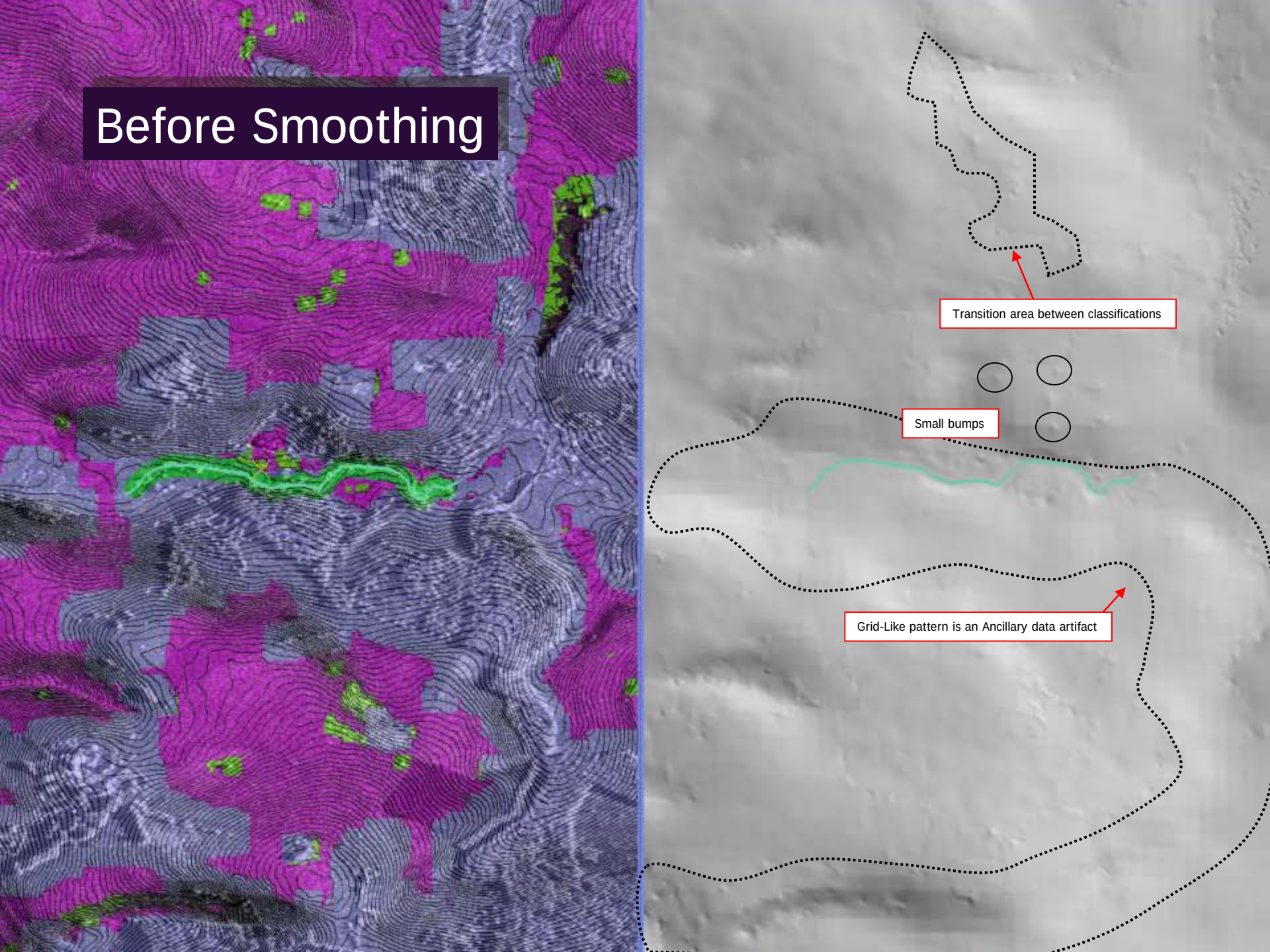


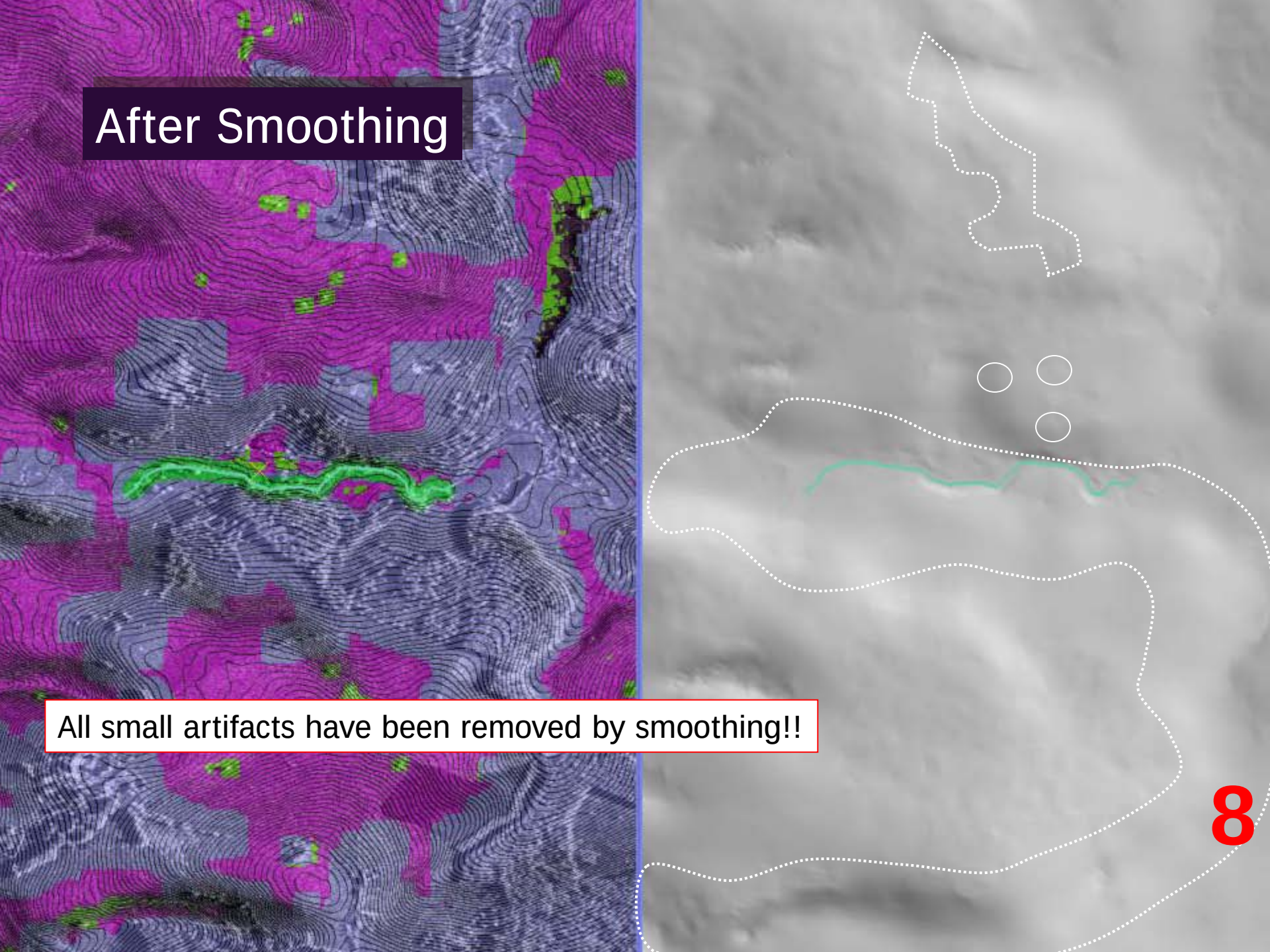
Terrain Solution



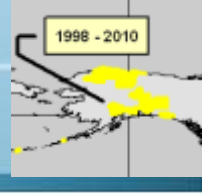
- We use a modified version of our multiple DSM passes or ancillary data to rebuild the DTM in areas of void and obstruction.
- We will use available ancillary data as a last resort.
- **e.g. After** the “Void Infill” process has been automatically run, the ancillary DEM has a more *natural* appearance

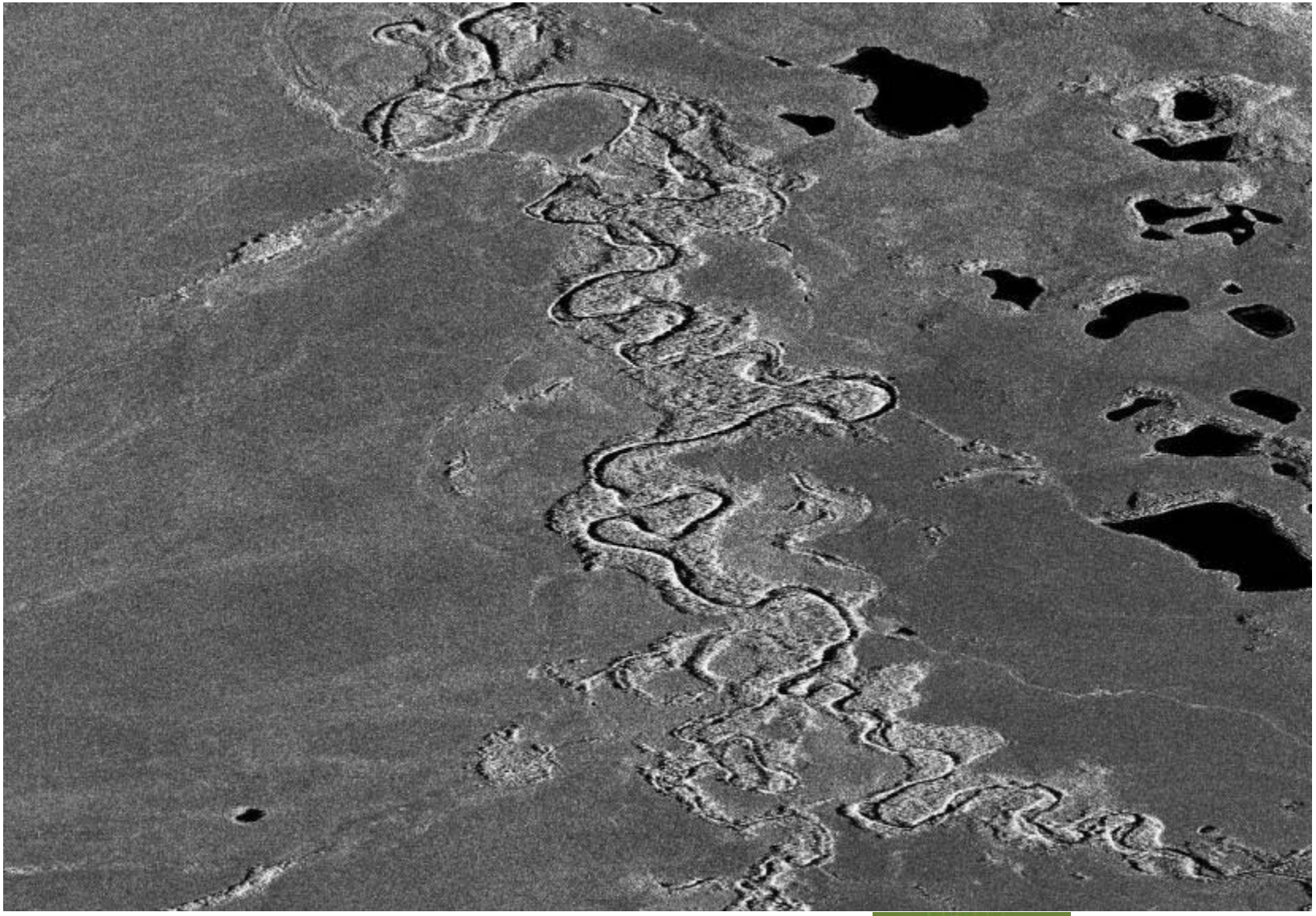



Before Smoothing
Transition area between classifications
Small bumps
Grid-Like pattern is an Ancillary data artifact


After Smoothing
All small artifacts have been removed by smoothing!!

ORI Example – 62.5 cm pixels & 5 m DSM/DTM





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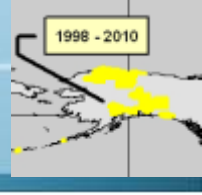

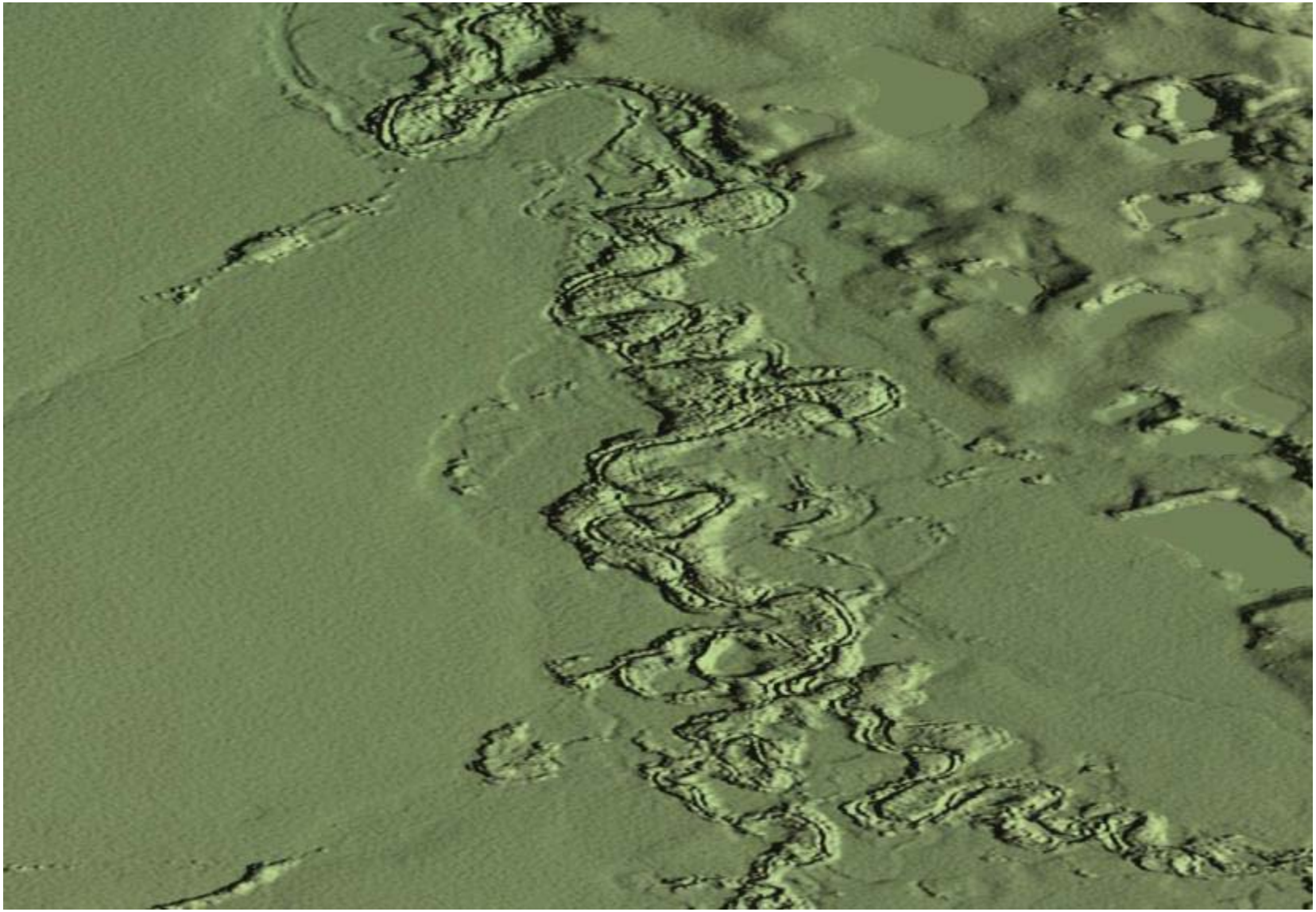

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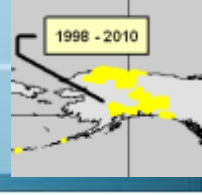

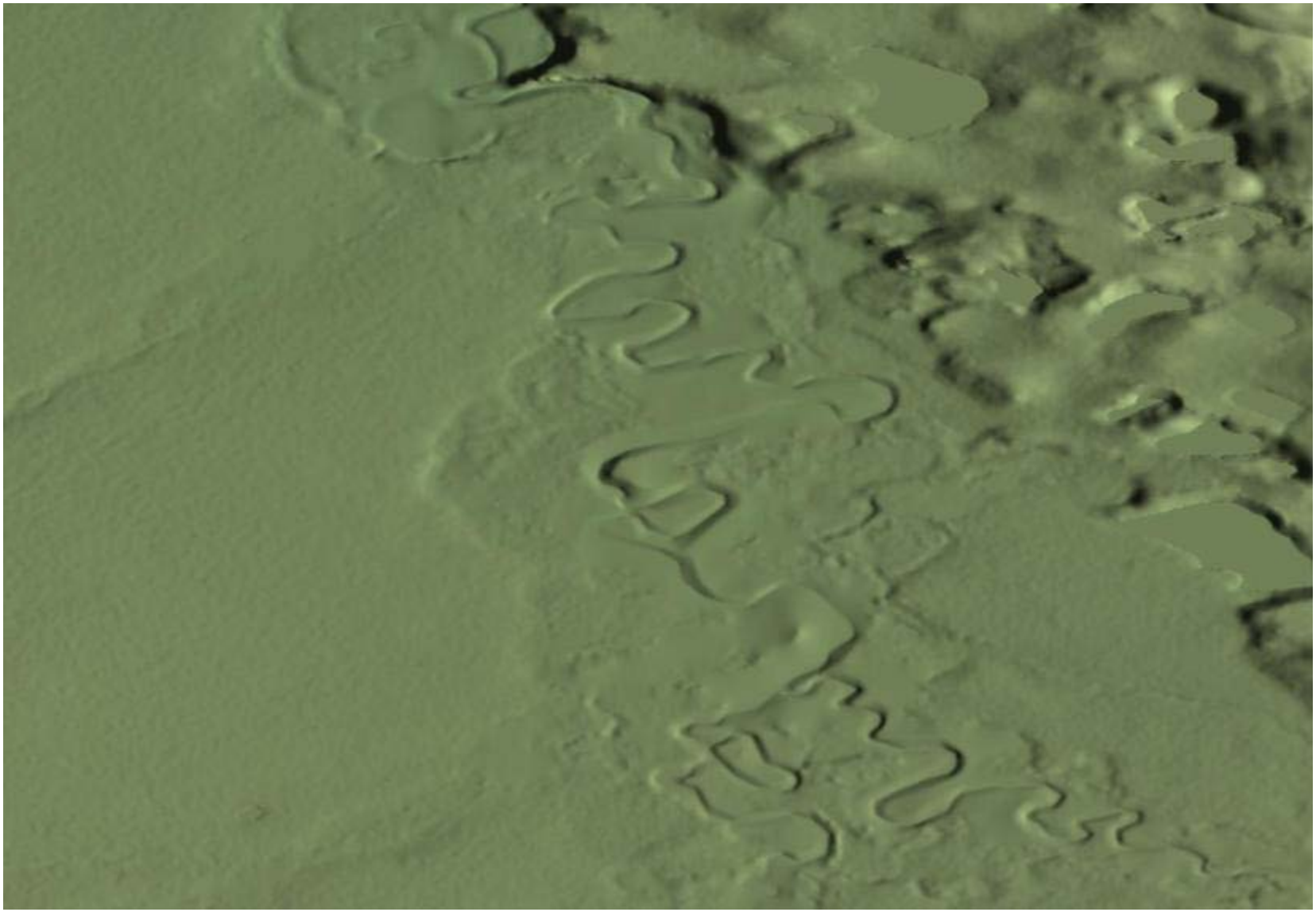

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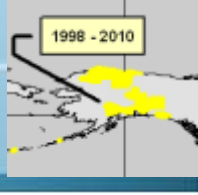

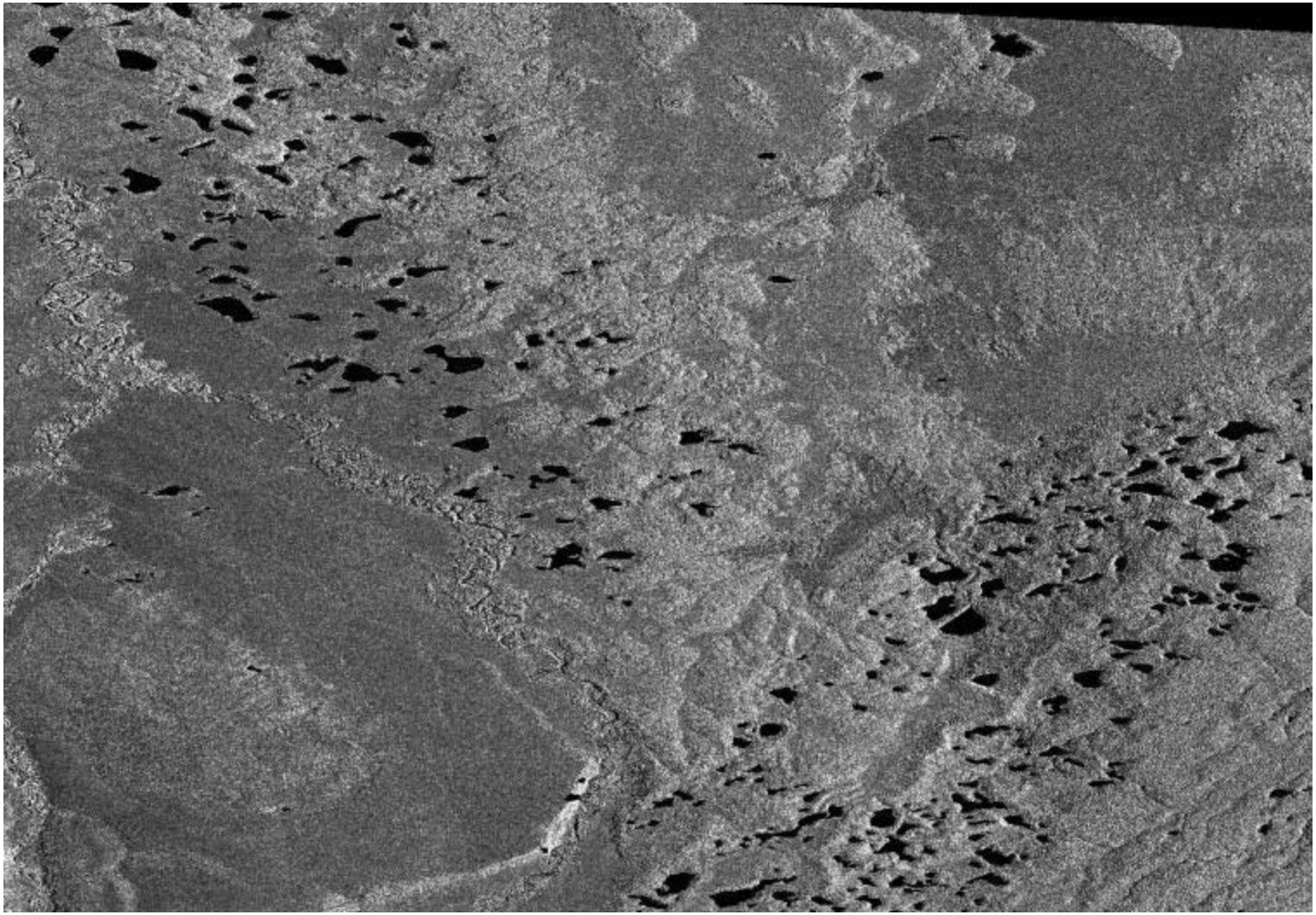

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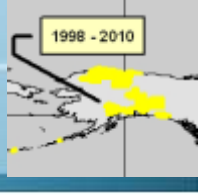

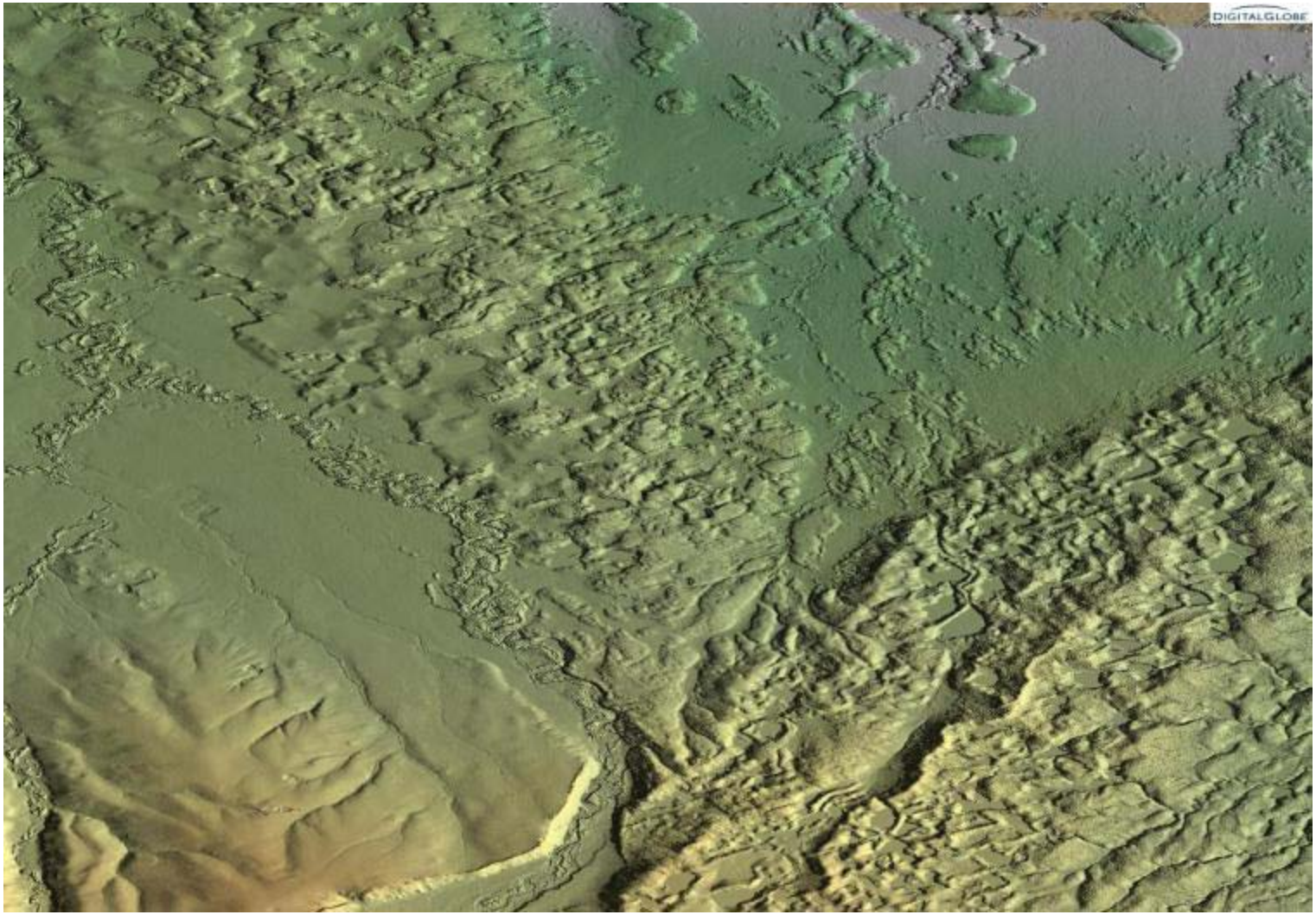

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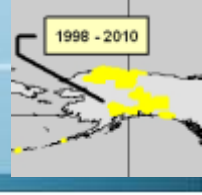
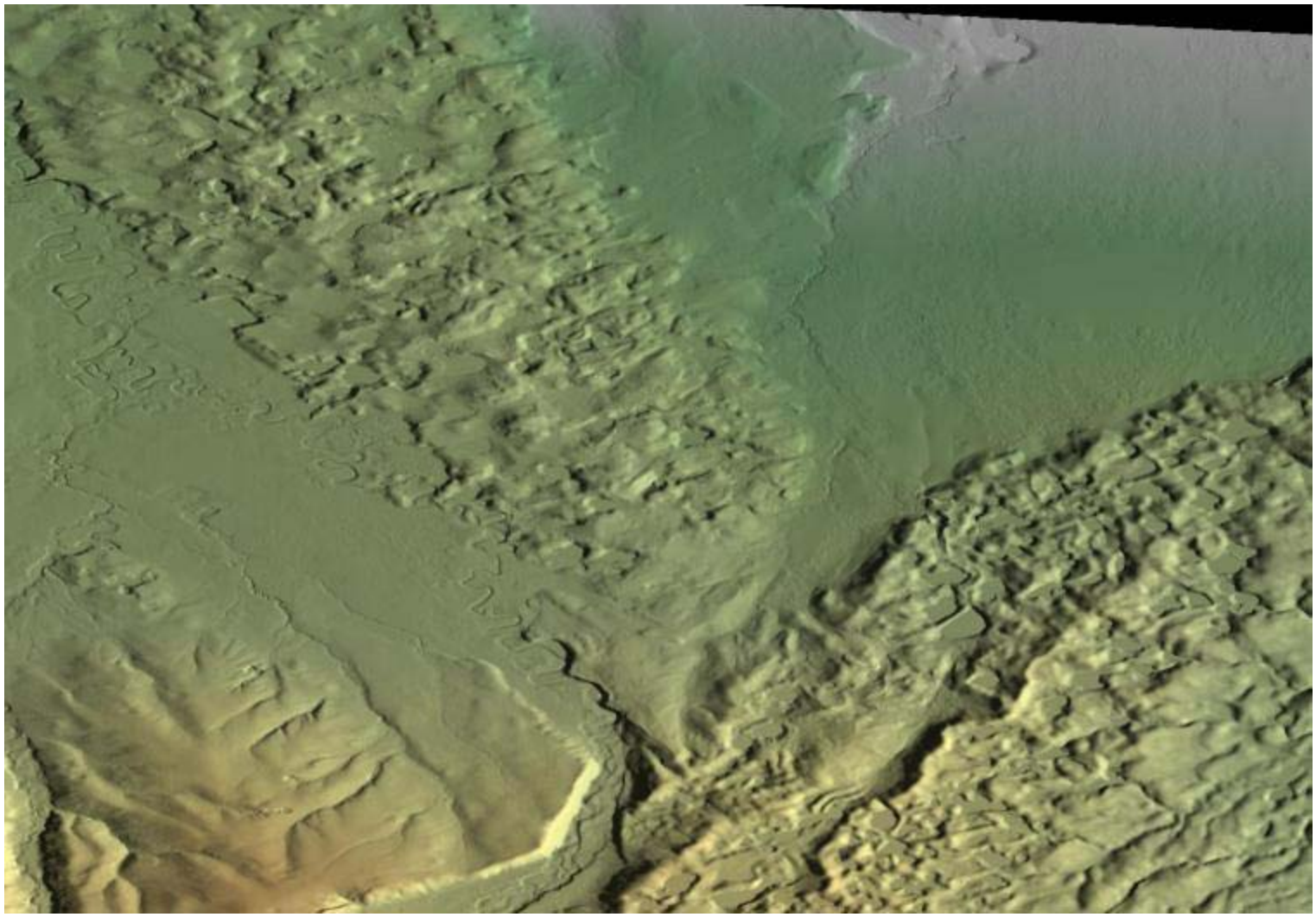
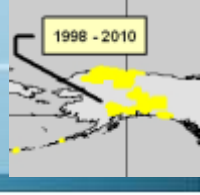
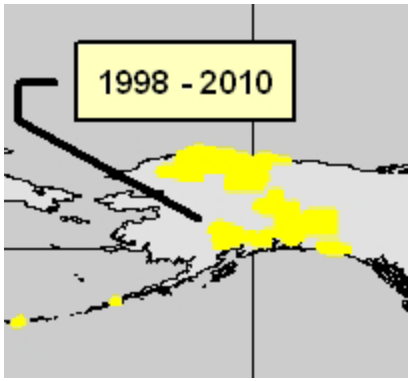




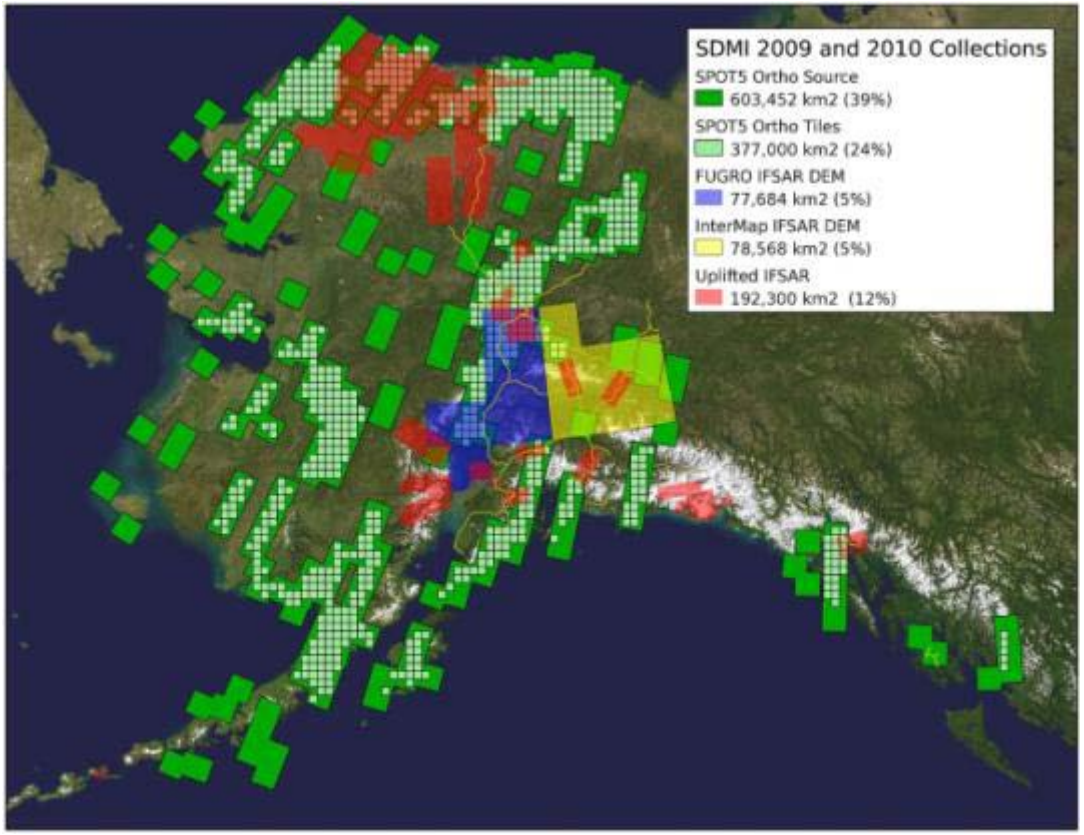


Questions?

Ltighe@intermap.com



Intermap Data Collection



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