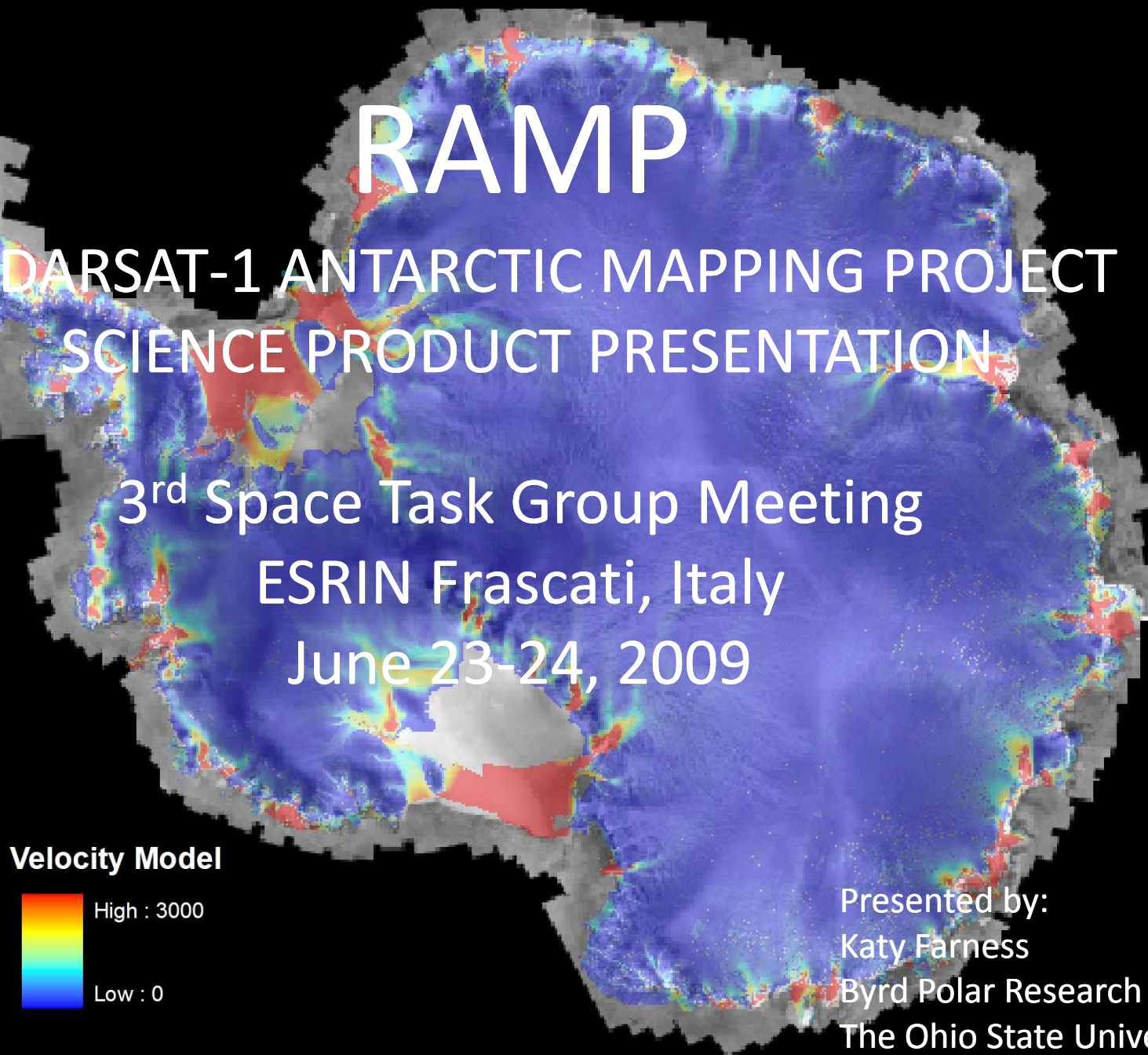
RAMP

RADARSAT-1 ANTARCTIC MAPPING PROJECT SCIENCE PRODUCT PRESENTATION

3rd Space Task Group Meeting
ESRIN Frascati, Italy
June 23-24, 2009



Presented by:
Katy Farness
Byrd Polar Research Center
The Ohio State University
Columbus, Ohio

Introduction

- This presentation highlights RAMP mission products and their associated specifications made available to the science community in fulfillment of a NASA grant.
- Additional ancillary products include ground control points, velocity control points, coastlines, flow lines, sigma naught mosaics, and incidence angle mosaics.
- We recommend that STG endorsed ice sheet mapping missions adopt the products and specifications reviewed in this presentation.

AMM-1 and MAMM 25m Final Tile Products (ascending)

Tile Product Specifications:

Polar Stereographic Projection
WGS 84 ellipsoid
-71° latitude of true scale
25m spatial resolution
Geolocation accuracies of +/- 100m
Geometric distortion <25m in 100km
Relative radiometric accuracy of 1 dB (absolute accuracy of 2dB)

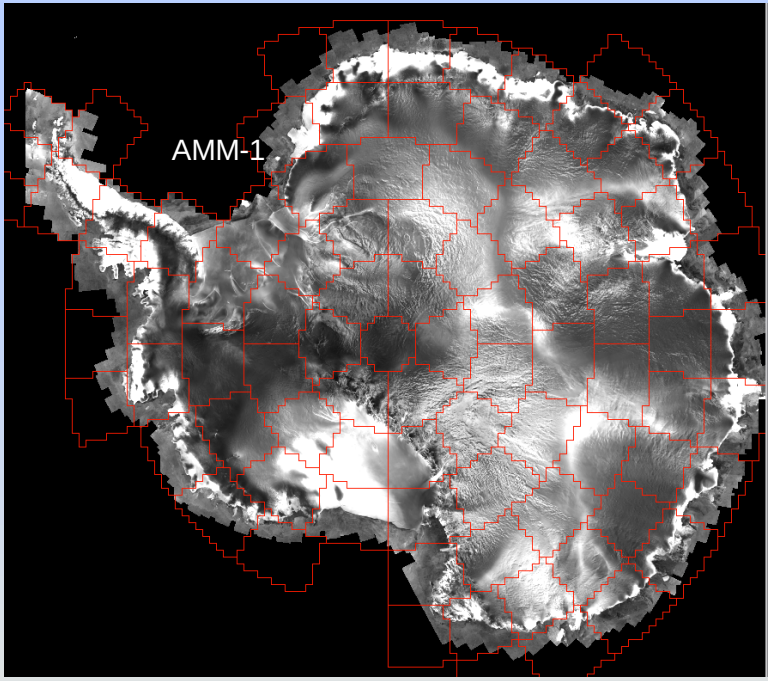
Tile Products comprise:

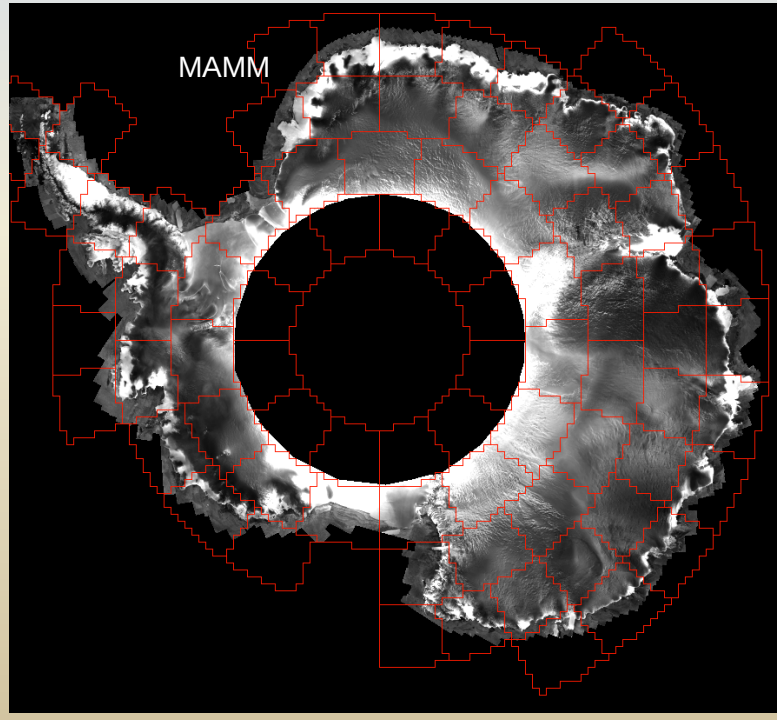
-25m 16-bit SAR Imagery in the form of 50kmx50km subtiles
-SAR Indices Masks
-Incidence Angle Masks
-200m DEM and DEM Index
-MASTER.TXT :

List of subtiles in corresponding tile,
Corner coordinates of the subtiles
Pixel spacing
Projection information
Shadow/layover
Incidence angle masks,
DEMs
Index tiles

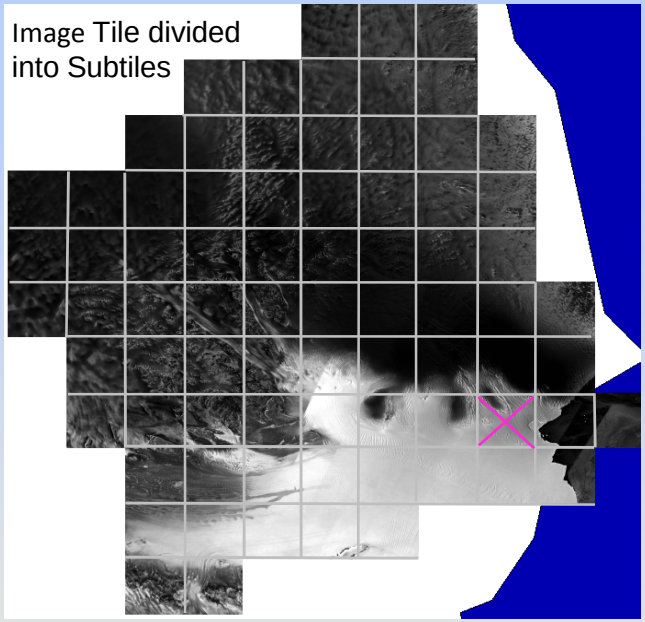
-Utility Programs:

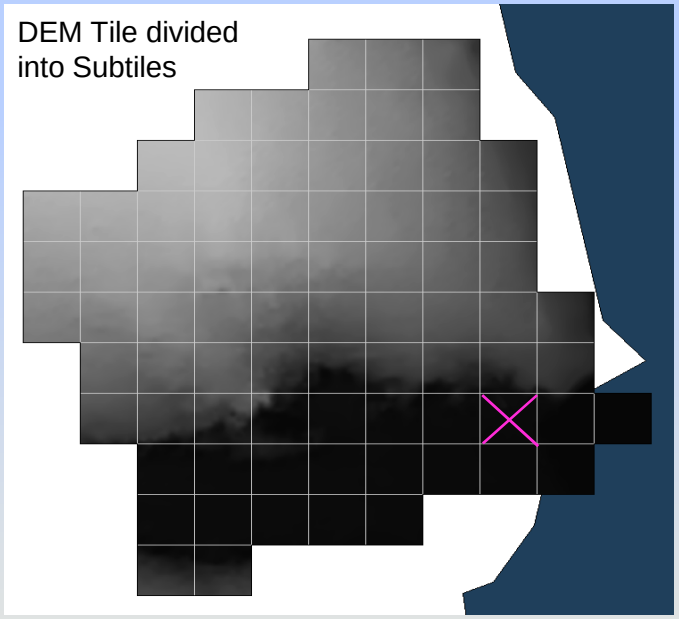
Convert latitude and longitude to x, y map coordinates and vice versa
Convert RAMS tile name, col and row to map x, y coordinates and vice versa
Generate a composite image of the subtiles
Obtain the original sigma naught from orthorectified and radiometrically balanced product.





Complete Suite of AMM-1 and MAMM Image Product Package





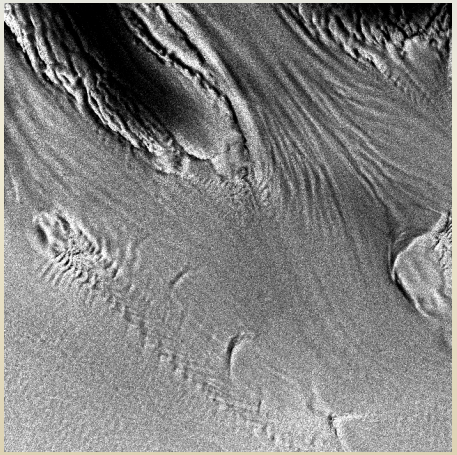


Image Subtile

DEM Subtile

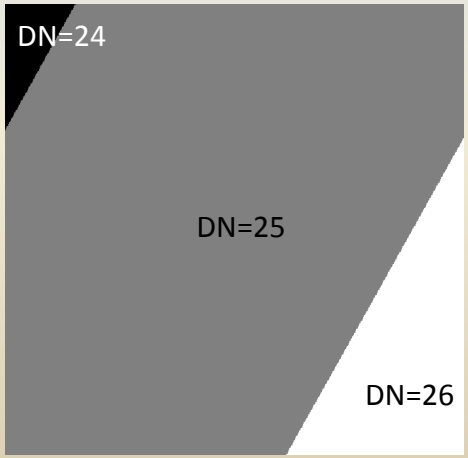
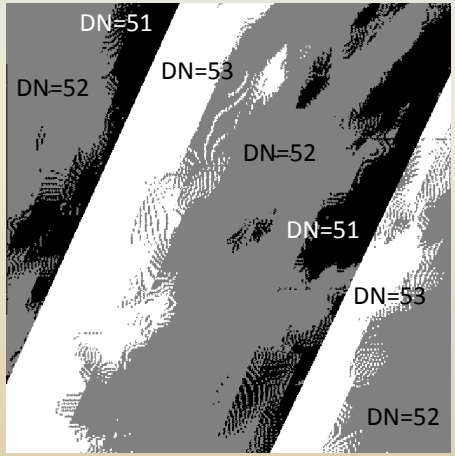


Image Index Subtile

Where DN references orbit & frame number



Indices Subtile

Where incidence angle = 90-DN

MAMM 400 m Velocity Product

Velocity Product Specifications:

Polar Stereographic Projection
WGS 84 ellipsoid
-71° latitude of true scale

Over coherent areas (5km grid):
- *1 m/yr slow flow velocity accuracy*
- *10% fast flow velocity accuracy*
- *5° directional accuracy*

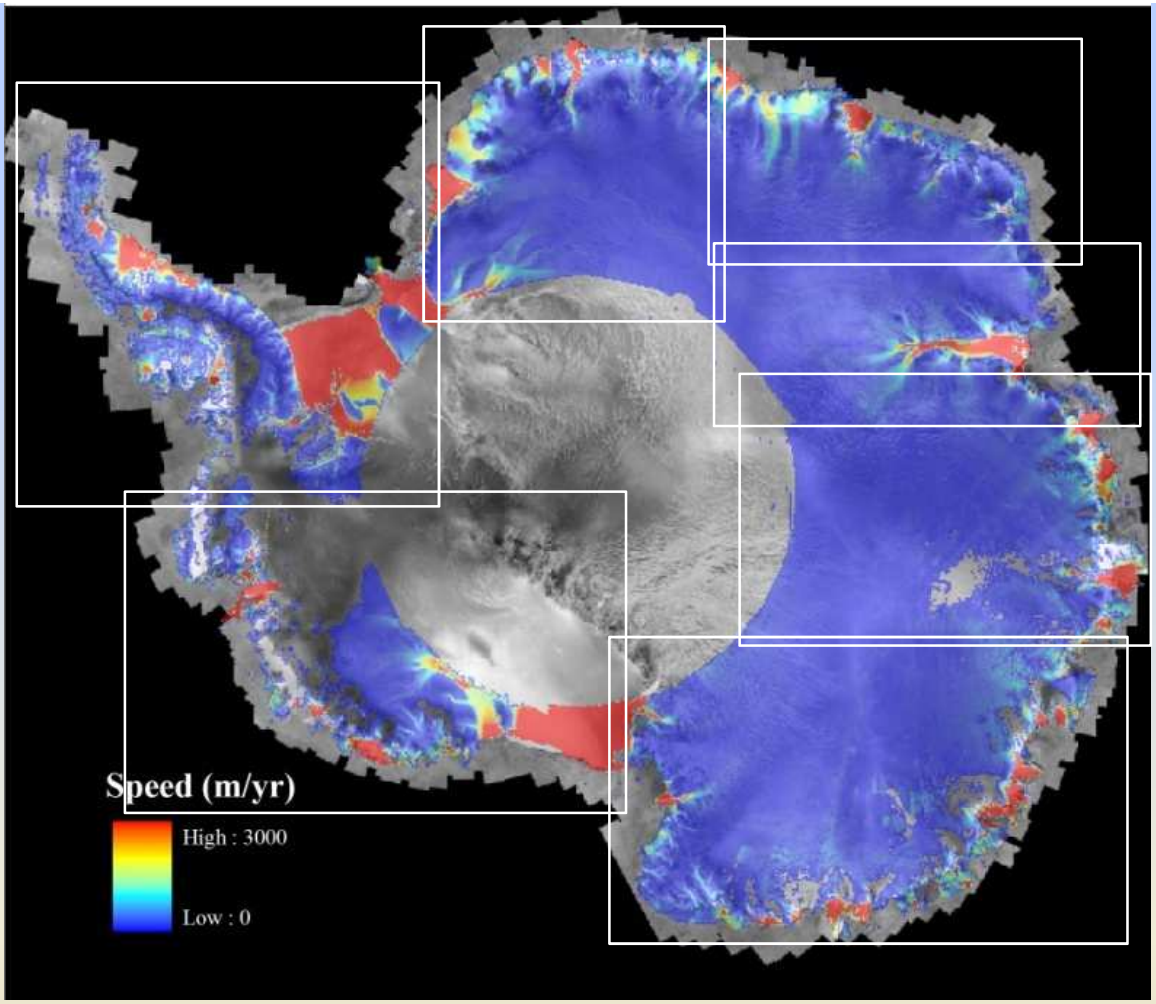
East/West Antarctic Ice Streams (1km grid):
- *5% velocity accuracy*
- *5° directional accuracy*

Grounding Line (500m grid within 20km):
- *20% velocity accuracy*
- *10° directional accuracy*

MAMM Velocity Products comprise:

-Velocity Product Data (400m 16-bit)
-DEM (400m 16-bit)
-Image overview (400m 16-bit)
-Utility Programs
- *To extract velocity product data files*
- *To extract metadata*

-Metadata on all source data contributing to a point
- *Map coordinates*
- *Beam mode*
- *Reference Orbit number, acquisition date*
- *Secondary Orbit number, acquisition date*
- *Baseline*
- *Doppler overlap*
- *Number and list of VGCPs*

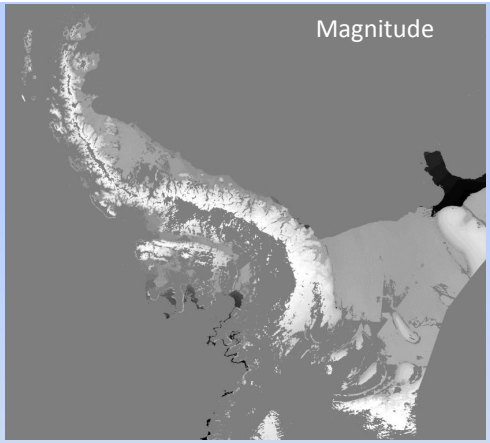


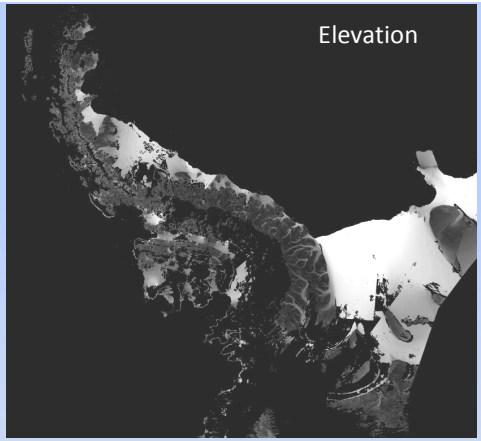
VGCP location, speed, time tags

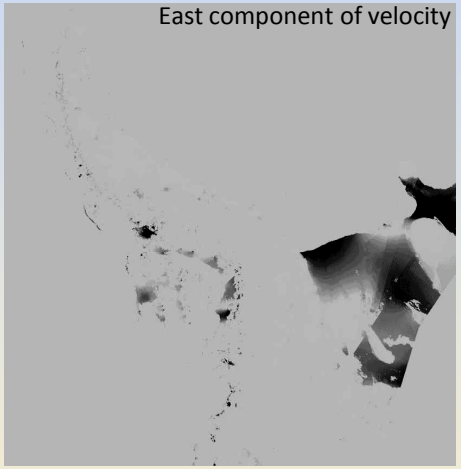
- *NSIDC: VELMAP velocity control**
- *VSD: SCAR velocity control**
- *ADD: Antarctic Data Base**
- *MANUAL: Manually added on rock outcrop*
- *VM: Overlapping swath*
- *BALANCE: Obtained from balanced velocity mosaic*

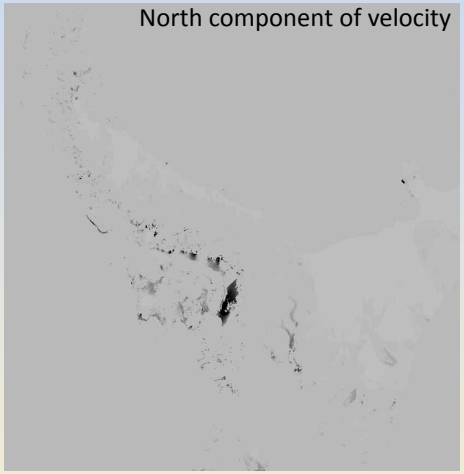
**Date stamp for NSIDC, VSD, and ADD VGCPs can be crossed-referenced at:*
http://bprc.osu.edu/rsl/radarsat/data/mamm/CONTROL_POINTS/vcp_summary.txt

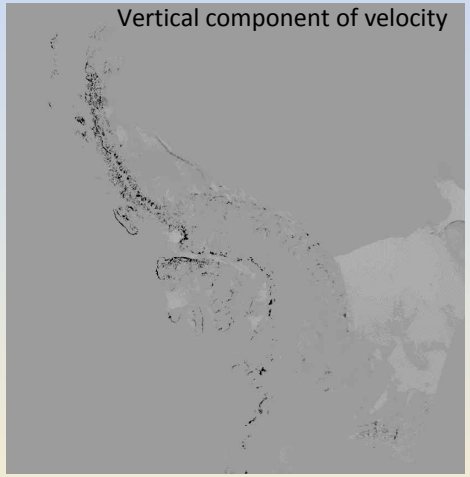
Complete suite of MAMM Velocity Product Data Package

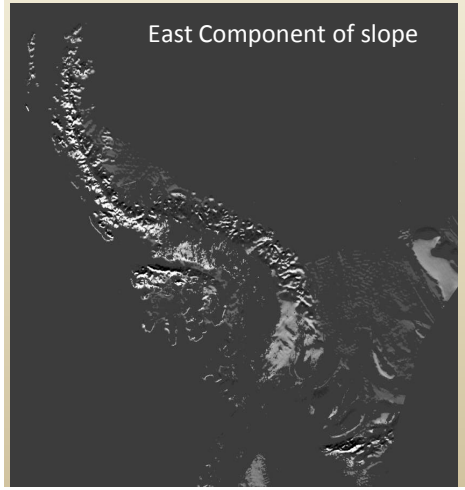


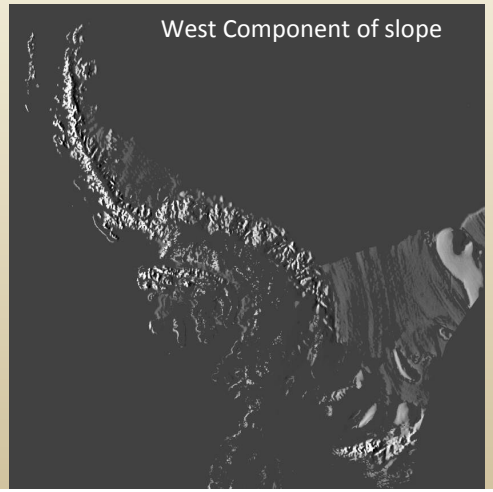


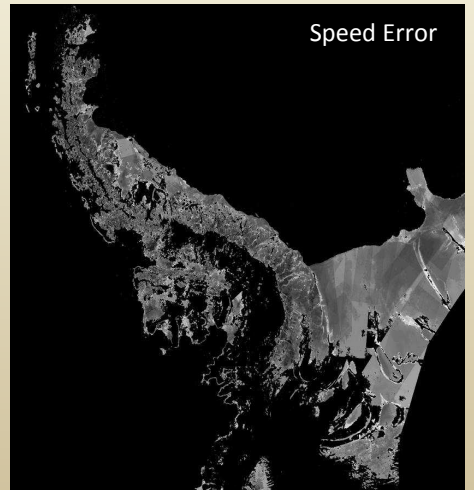


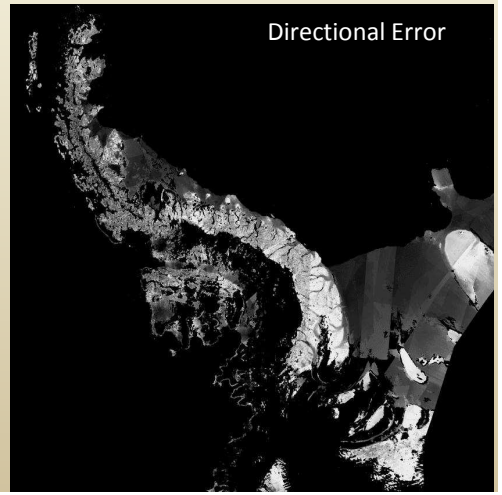










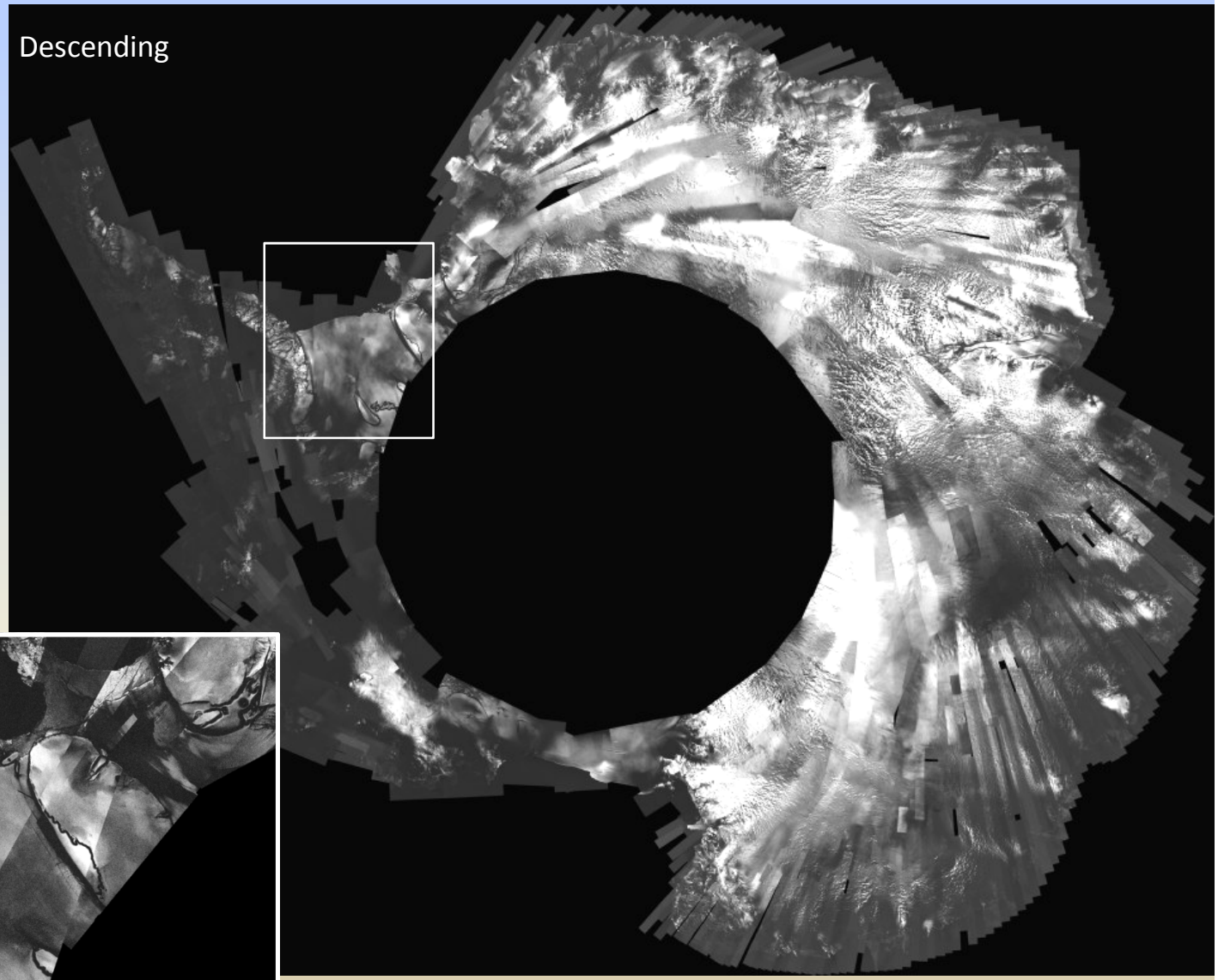


MAMM 200m Coherence mosaic (descending)

Tile Product Specifications:
Polar Stereographic Projection
WGS 84 ellipsoid
-71° latitude of true scale
200m spatial resolution
Geolocation accuracies of +/- 100m

Coherence Products comprise:
200m 16-bit image
200m DEM
MASTER Text
- *Image specifications*
- *Projection information*

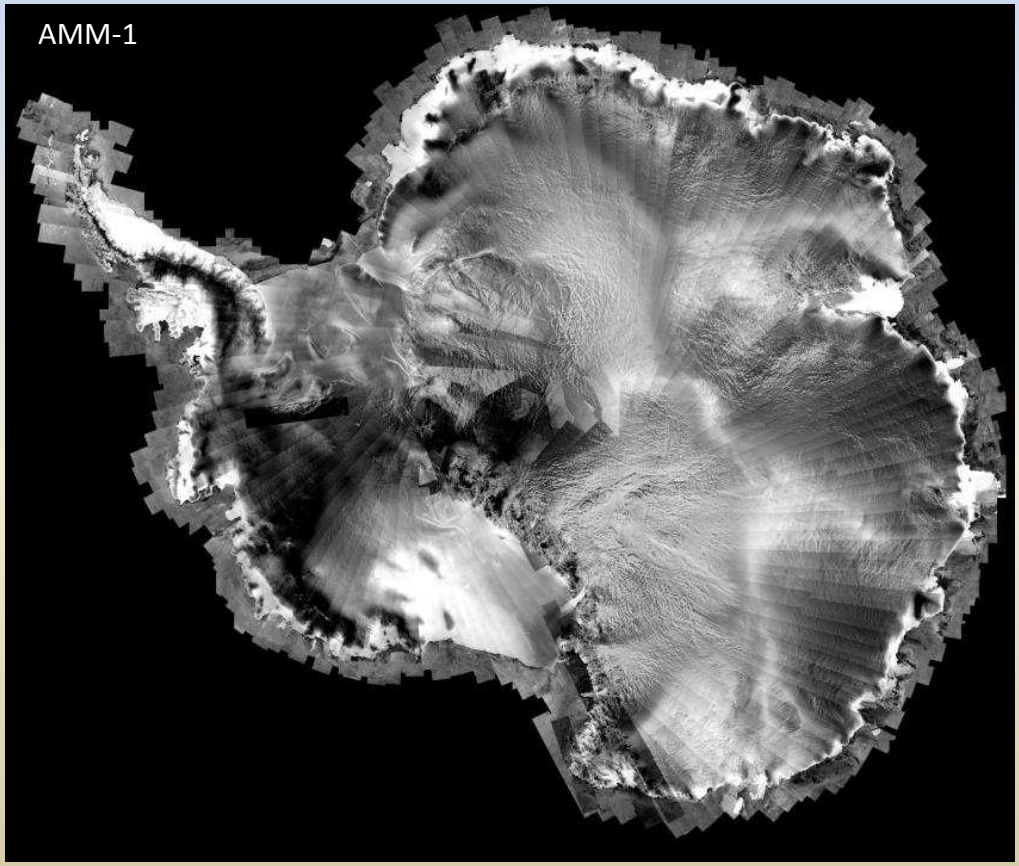
Utility program to extract metadata
- *coherence value*
- *reference & secondary orbits*
- *acquisition dates*
- *along track looks*
- *range looks*
- *baseline*
- *beam mode*

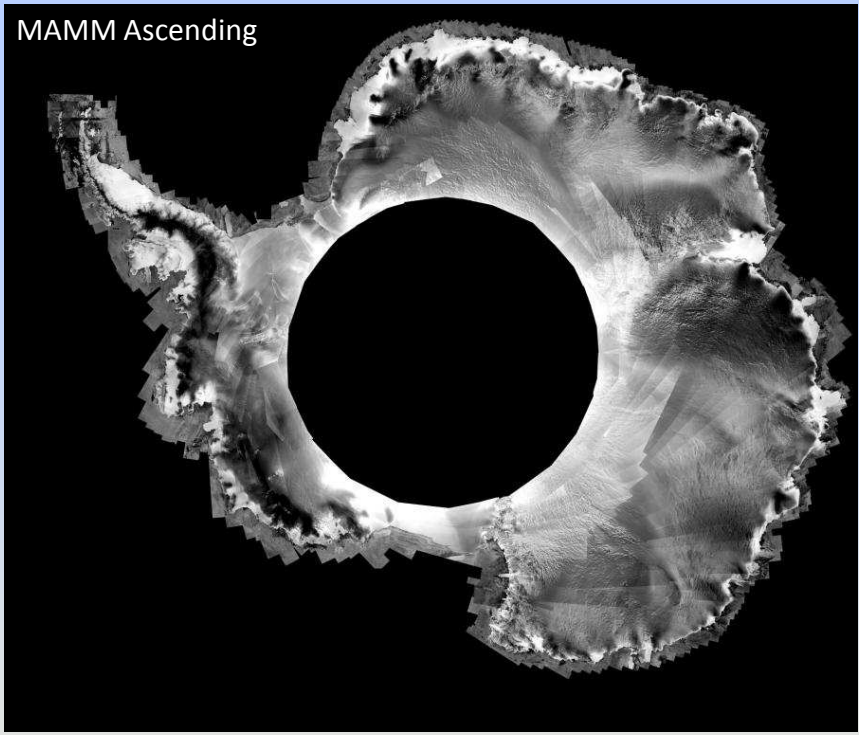


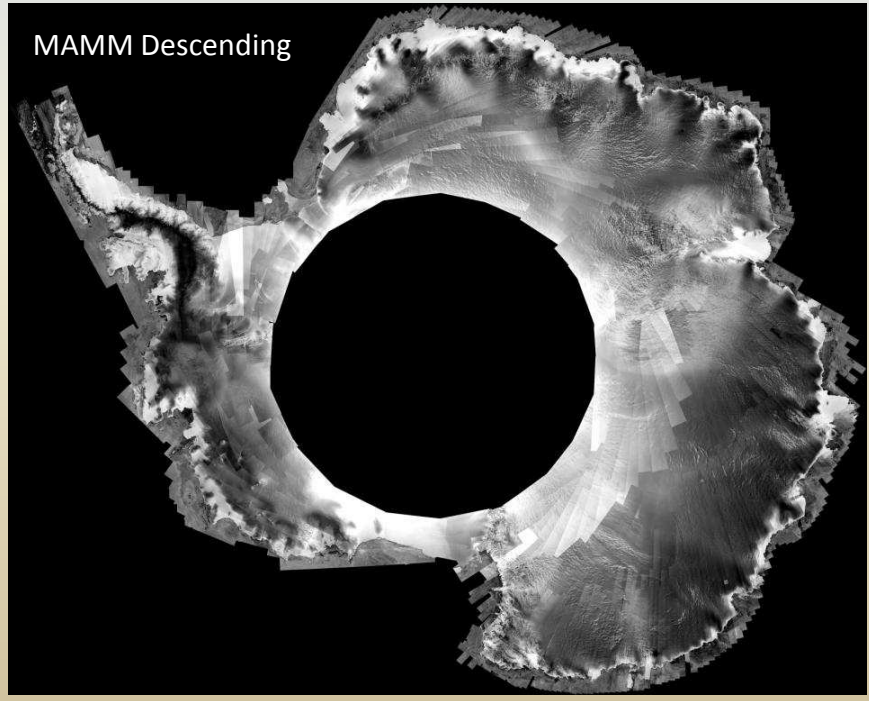
Sigma Naught Mosaics

High resolution 25m 16-bit Tile-based mosaics

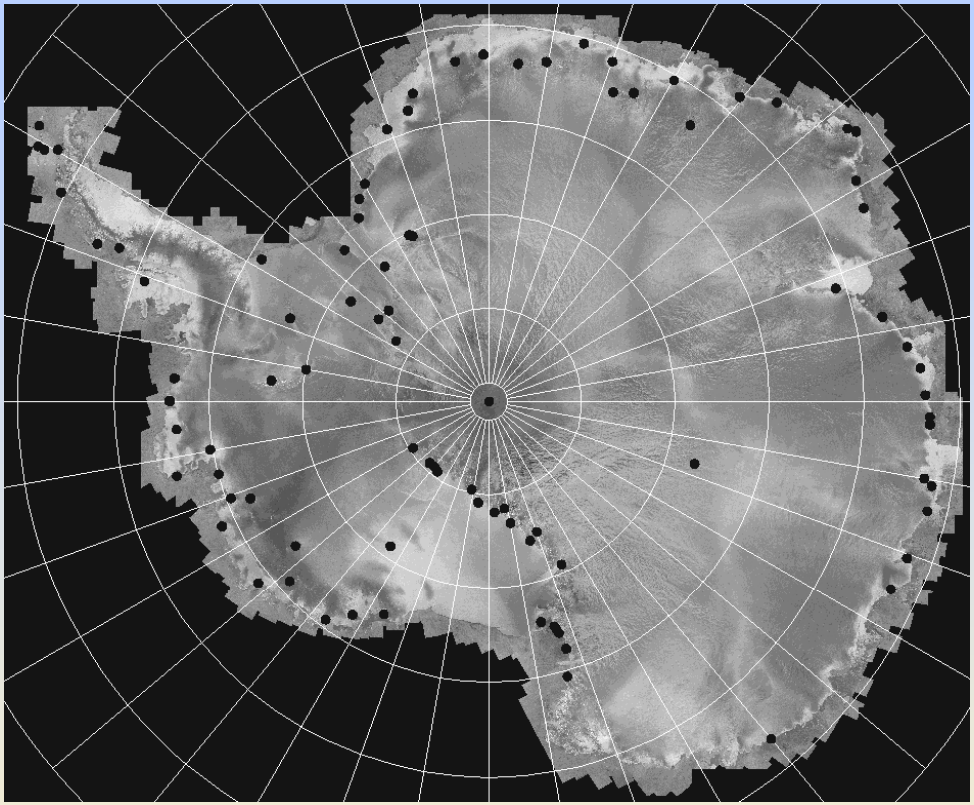
Low resolution 16-bit and 32-bit backscatter mosaics in 100, 200, 400, 800m resolutions



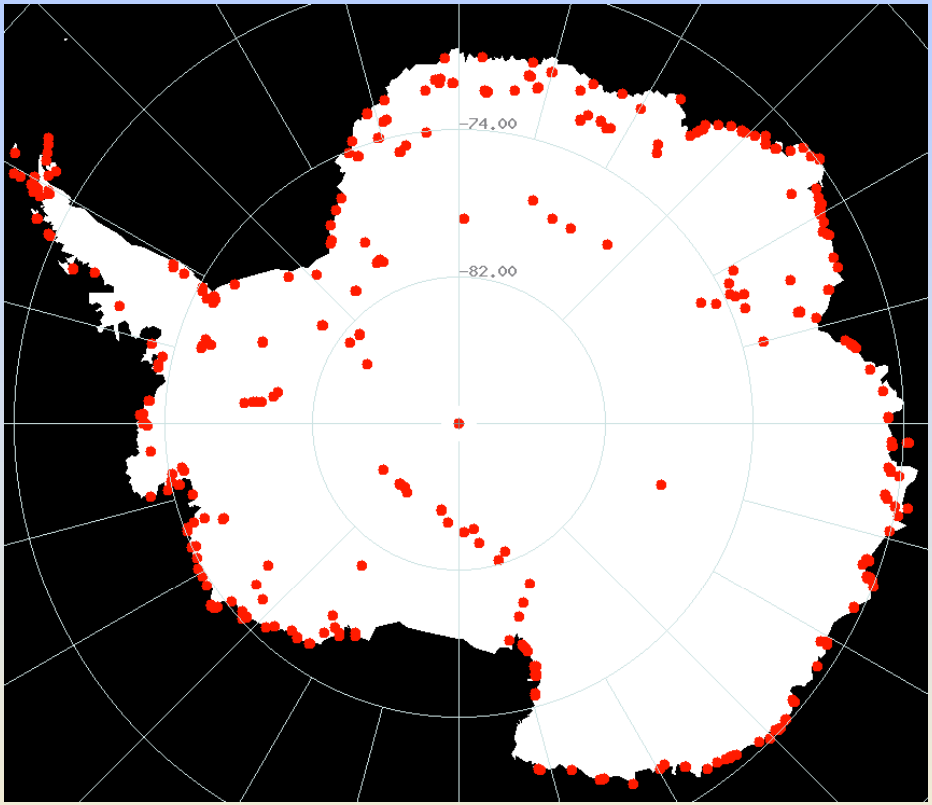




Ground Control Points



Distribution of GCPs acquired specifically to constrain the AMM-1 image geometries.

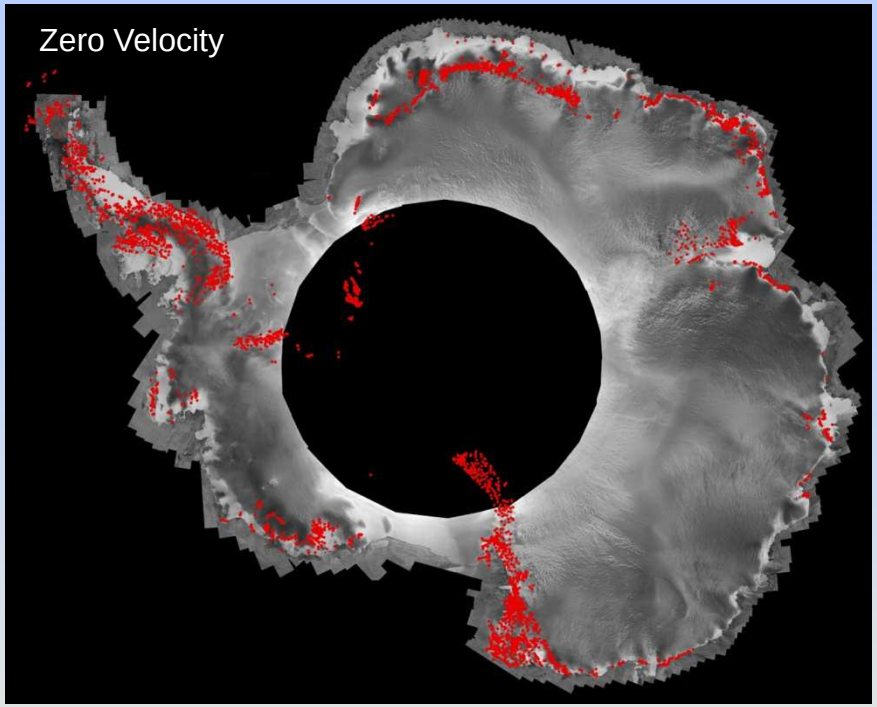


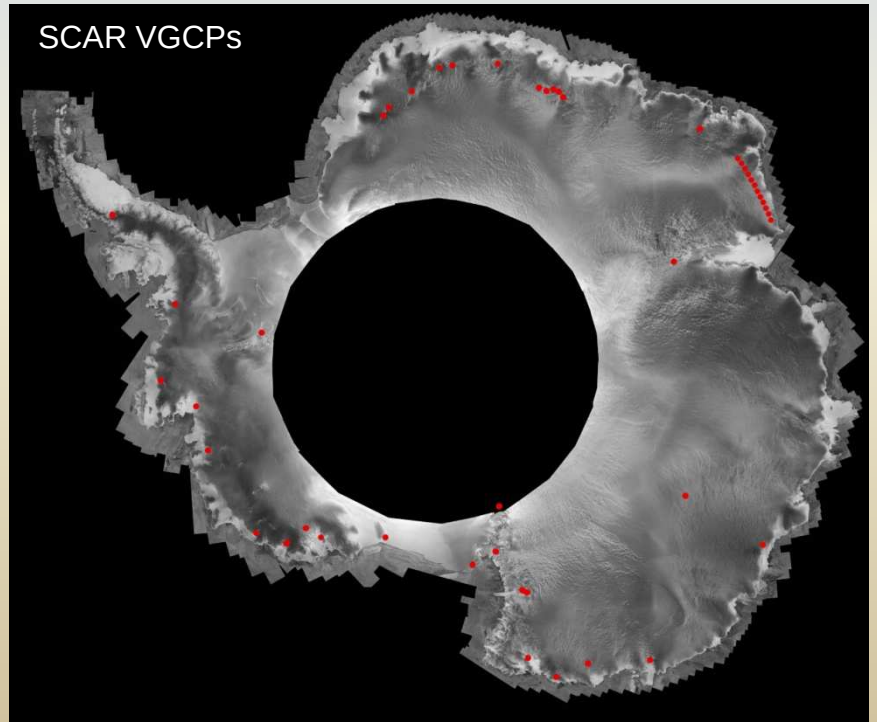
Distribution of GCPs acquired specifically to constrain the MAMM image geometries.

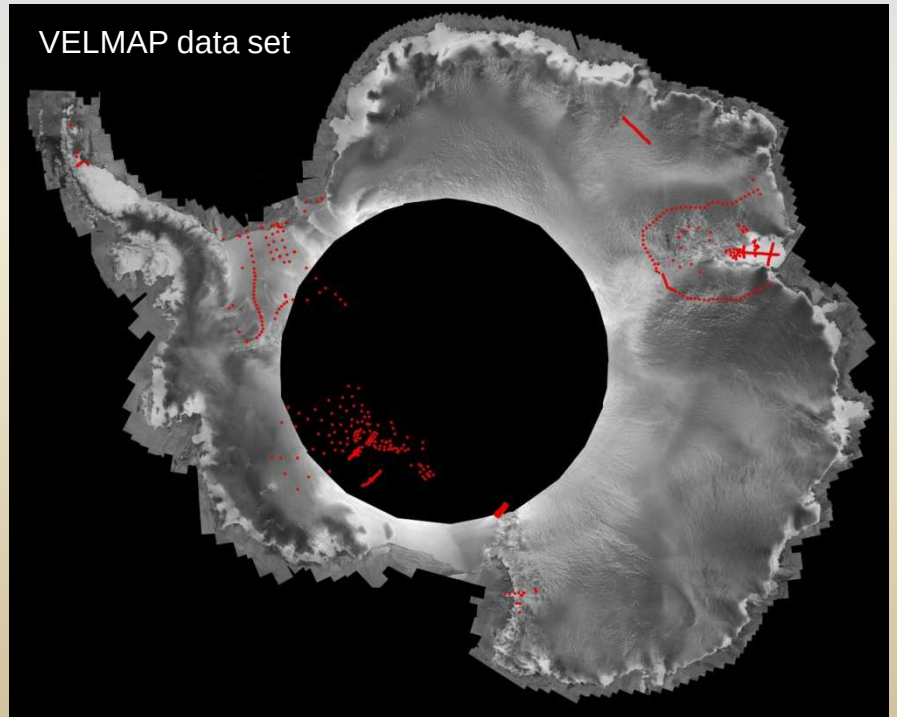
Prior to the mapping mission, the quality of the position and pointing data over the Antarctic were uncertain. Consequently, ground control points (GCPs) were needed to refine position knowledge and to act as a validation of the final products. With the assistance of many organizations which participate in the Scientific Committee for Antarctic Research (SCAR) a data base was compiled which associates the latitude, longitude, and elevation with points on pre-specified RADARSAT image chips.

Velocity Control Points

Since interferometry only yields relative displacements across a scene an adjustment needs to be make by knowledge of absolute motion for several points in each radar image.

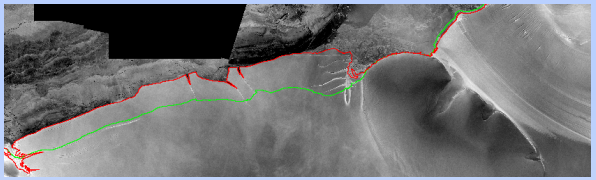




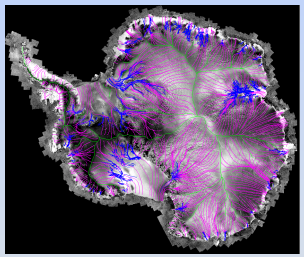


Derived Data Products:

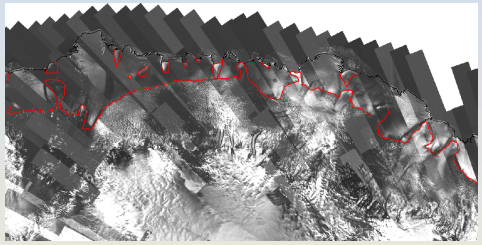
Coastline Mapping
(1997 & 2000)



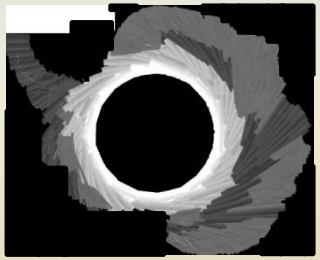
Flow Lines



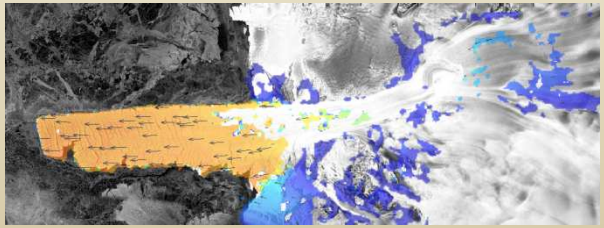
Grounding Lines



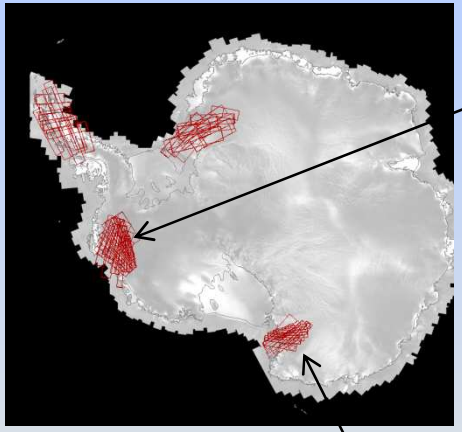
Incidence Angle Maps

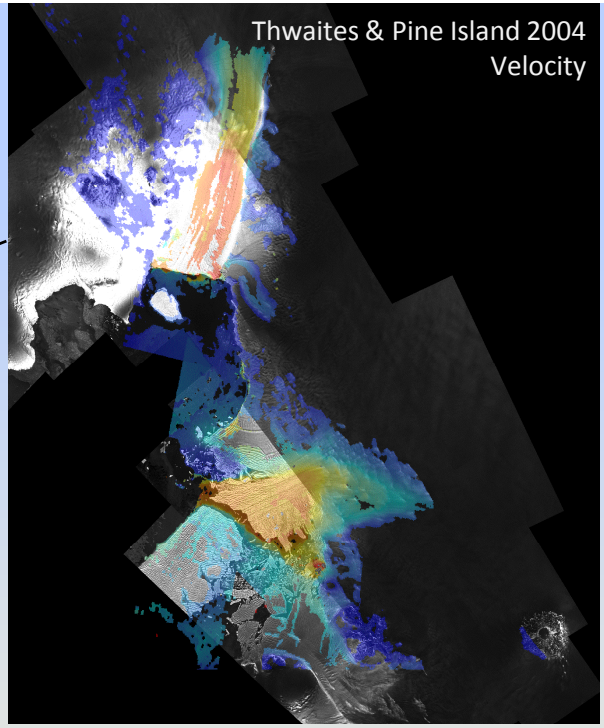


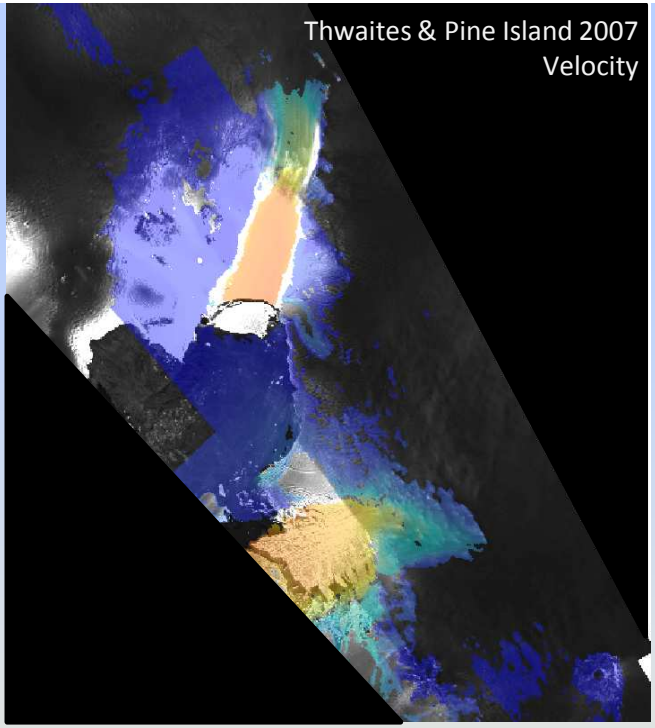
3-year Velocities
(1997 & 2000)

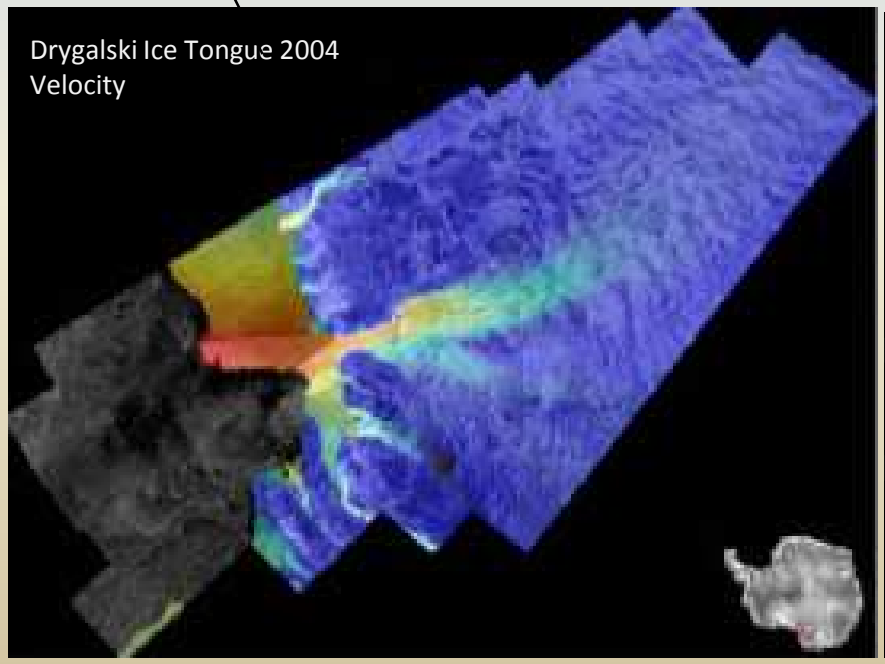


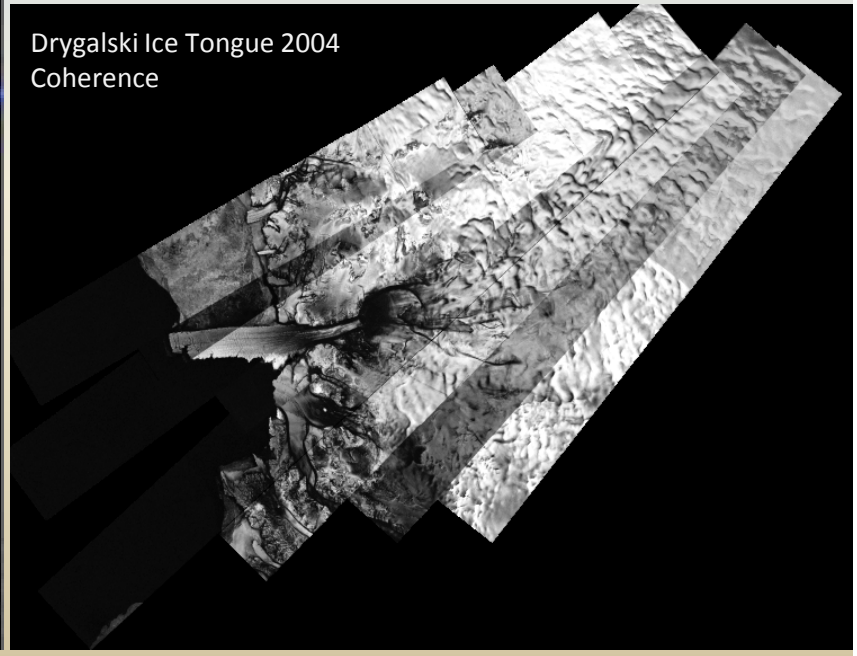
Examples of 2004 and 2007 Mini-MAMM Products











RAMP Product Web Page

http://bprc.osu.edu/rsl/radarsat/data

RADARSAT-1 Antarctic Mapping Project (RAMP) Data

Welcome to the RSL RAMP data download system. Please select a product below to view associated datasets.

Or, view original download structure: AMM-1 (Antarctic Mapping Mission) ▪ MAMM (Modified Antarctic Mapping Mission)

AMM-1 (Antarctic Mapping Mission)

AMM-1 Science Products

- AMM-1 Final Tile Product (25 m)
- 25 m Tile Overviews
- Balanced Mosaics (8-bit)
  - 100m
  - 200m
  - 400m
  - 800m

AMM-1 Research Products

- Scaled dB Unit Mosaics (16 bit)
  - 100m
  - 200m
  - 400m
  - 800m
- dB Units Mosaics (32 bit)
  - 100m
  - 200m
  - 400m
  - 800m
- Scaled dB units 25 m Tiles (16 bit)
- Incidence Angle Mosaic
- Quicklook Mosaic (1km)
- DEM
- AMM-1 Coastline
  - Flowlines

Control Points

ERIM supplied GCPs. Includes location GIFs, summary, and source data.

- View Directory

East Antarctic

InSAR work done by Z. Zhao on the East Antarctic Ice Streams using AMM-1 repeat pass data. Includes GRID data, Imagine files, line coverage, and other data.

- View Directory

Documentation

- View Directory
- AMM1_8-bit_conversion_equations.pdf
- AMM1_ASF_Calibration.pdf
- AMM1_Noise_Recalibration_Sum.xls
- AMM1_Radar_Caliber_Deployment_Spole.pdf
- AMM1_radiometry.pdf
- AMM1_Sci_Requirements.pdf
- AMM1_Sig0_evalr4.pdf
- AMM1_sig0_tiers evaluation.pdf
- Amplitude.pdf
- Final_Tile_Valid.pdf
- RAMP_Description.pdf
- Sigma0_comparison.pdf

MAMM (Modified Antarctic Mapping Mission)

MAMM Science Products

- Velocity Product

Ascending

- Ascending 25 m Final Tiles (Tile Product)
- Ascending 25m Tile overviews
- Ascending 200m Final Coherence (Coherence Product)
- Ascending 200m Coherence overviews
- 10 m mini-mosaics
- Balanced Ascending Mosaic (8 bit)
  - 100m (Linear)
  - 100m (Logarithmic)
  - 125m (Linear)
  - 125m (Logarithmic)
  - 200m (Linear)
  - 200m (Logarithmic)
  - 400m (Linear)
  - 400m (Logarithmic)
  - 800m (Linear)
  - 800m (Logarithmic)
- Ascending Coherence Mosaic 200m (8 bit)
- Ascending Coherence Mosaic 200m (32 bit)

Descending

- Descending 25m Block Overviews (16 bit)
- Descending 200m Final Coherence (Coherence Product)
- Descending 200m Coherence Overviews
- Descending Mosaic (8 bit, no radiometry)
  - 100m
  - 200m
  - 400m
  - 800m
- Descending Coherence Mosaic 200m (8 bit)
- Descending Coherence Mosaic 200m (32 bit)

MAMM Research Products

- Balance Velocity Map

Ascending

- MAMM Coastline
- Scaled dB Ascending Mosaic (16-bit)
  - 100m
  - 200m
  - 400m
  - 800m
- dB Ascending Mosaic (32-bit)
  - 100m
  - 200m
  - 400m
  - 800m

continued

Fun Stuff

- Movies & Stills

Mission Plans

- Mission planning data for the AMM-1 Mission

Publications

- AMM-1 Mission-related publications

Dissertations / Theses

- AMM-1 Mission-related dissertations

- Scaled dB Ascending 25m Tile Overviews (16-bit)
- Ascending Swath Coherence Mosaic (Arc) (8 bit)
- Ascending Swath Coherence Mosaic (Arc) (32 bit)
- Ascending Coherence Blocks 200m (8 bit)
- Smoothed Ascending Coherence Mosaic (8 bit)
- Incidence Angle Mosaic

Descending

- Scaled dB Descending Mosaic (16-bit)
  - 100m
  - 200m
  - 400m
  - 800m
- dB Descending Mosaic (32-bit)
  - 100m
  - 200m
  - 400m
  - 800m
- Scaled dB Descending 25 m Block overviews (16-bit)
- Descending Swath Coherence Mosaic (Arc) (8 bit)
- Descending Swath Coherence Mosaic (Arc) (32 bit)
- Descending Coherence Blocks 200m (8 bit)
- Smoothed Descending Coherence Mosaic (8 bit)
- Incidence Angle Mosaic

Control Points

ERIM supplied GCPs. Includes location GIFs, summary, and source data.

- View Directory

Fun Stuff

- Movies & Stills

Mission Plans

- Mission planning data for the MAMM Mission

Documentation

- View Directory

Publications

- MAMM Mission-related publications

Dissertations / Theses

- MAMM Mission-related dissertations

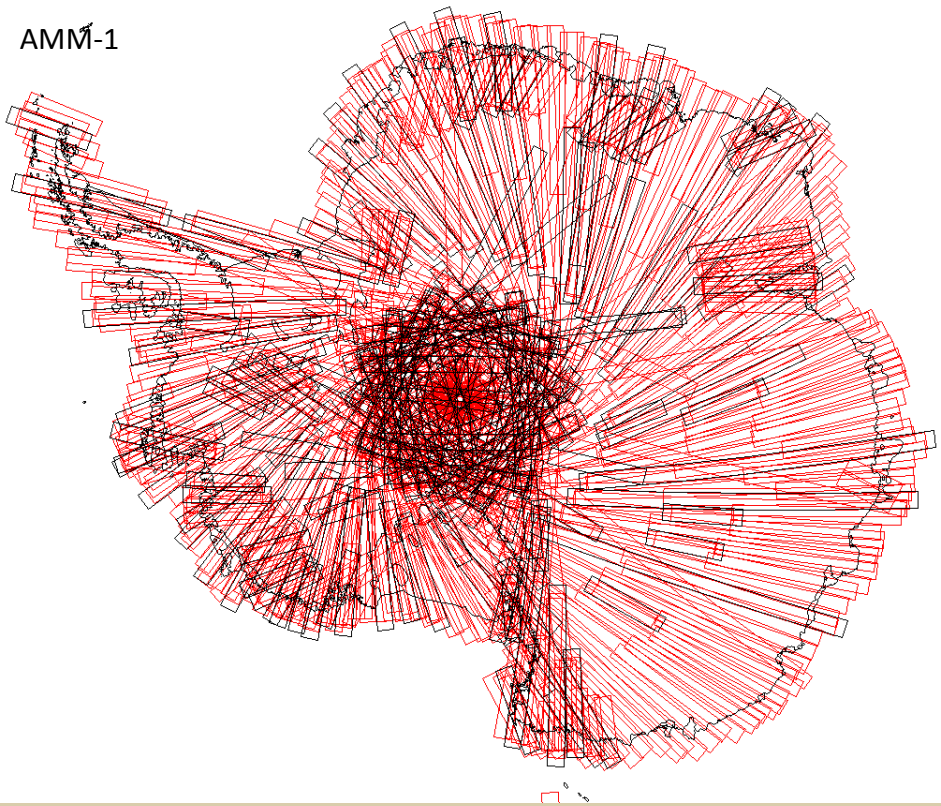
Thank you

Mission Plans

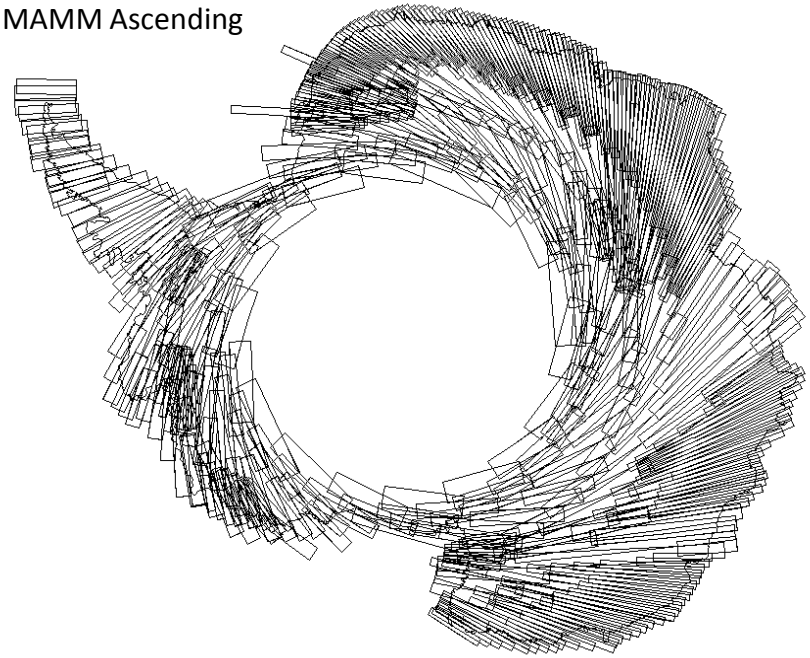
AMM-1 swath coverage. Red swaths are the nominal acquisitions. Black swaths show 24-day repeat passes suitable for interferometry

Files available are exported SPA files that can be readily imported into ARC/Info

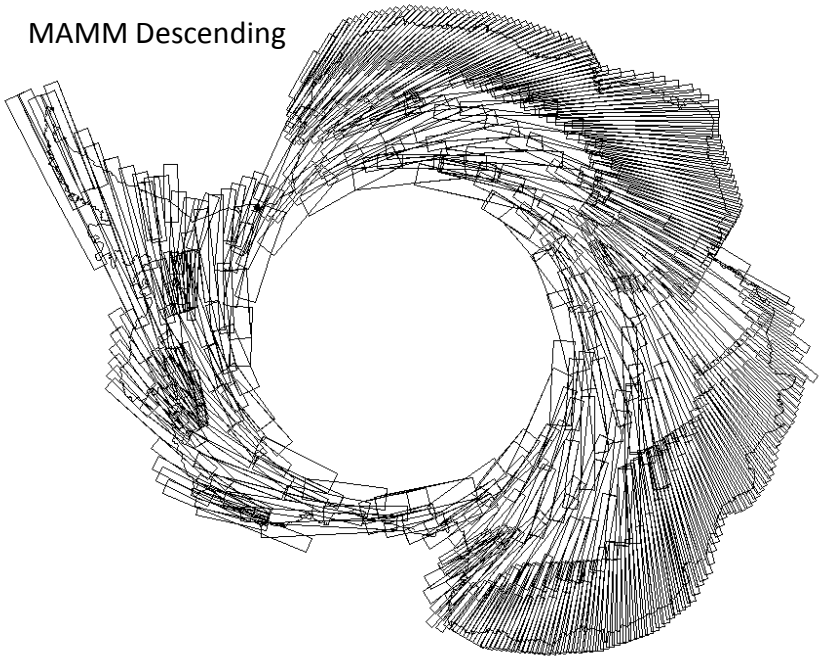
AMM-1



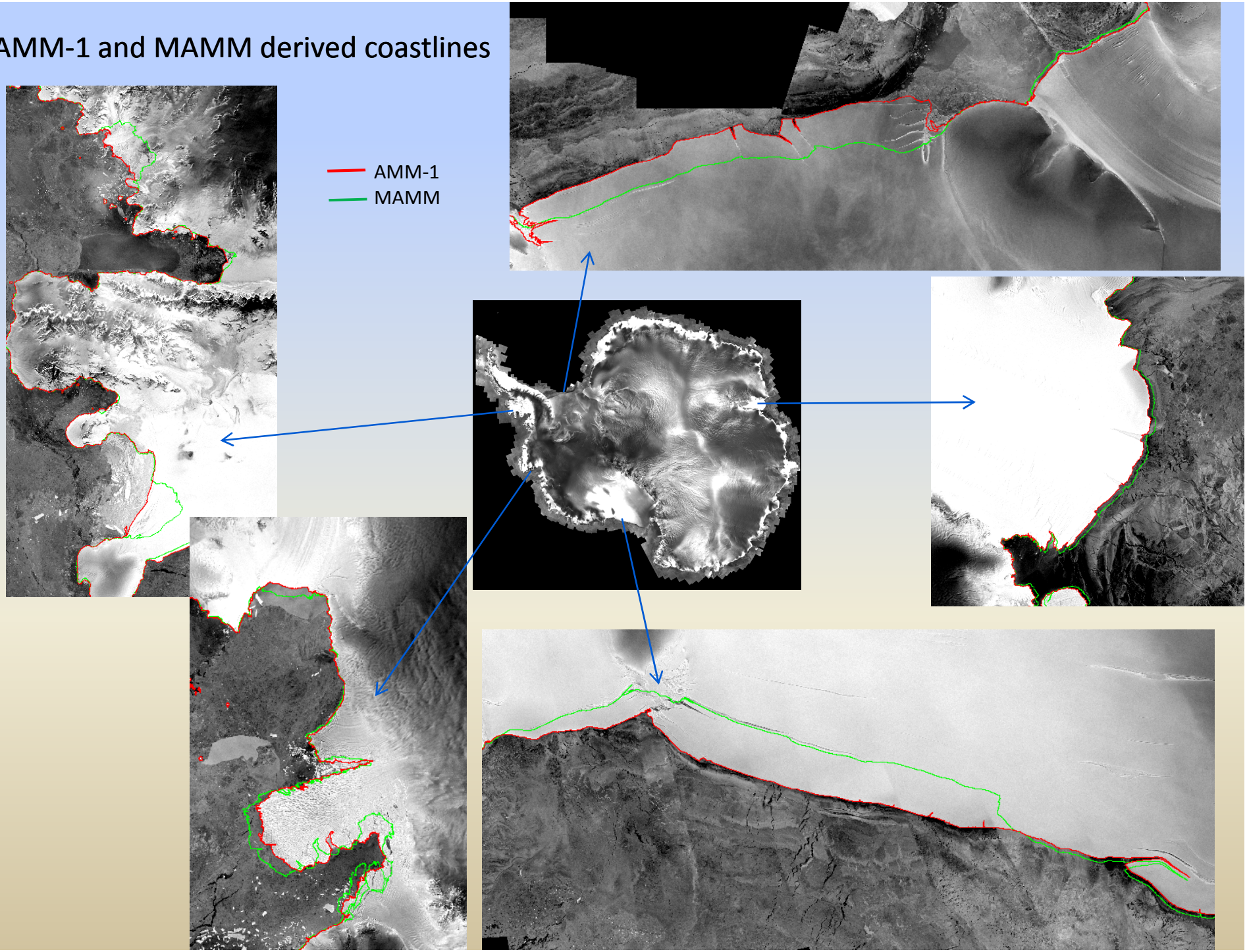
MAMM Ascending



MAMM Descending

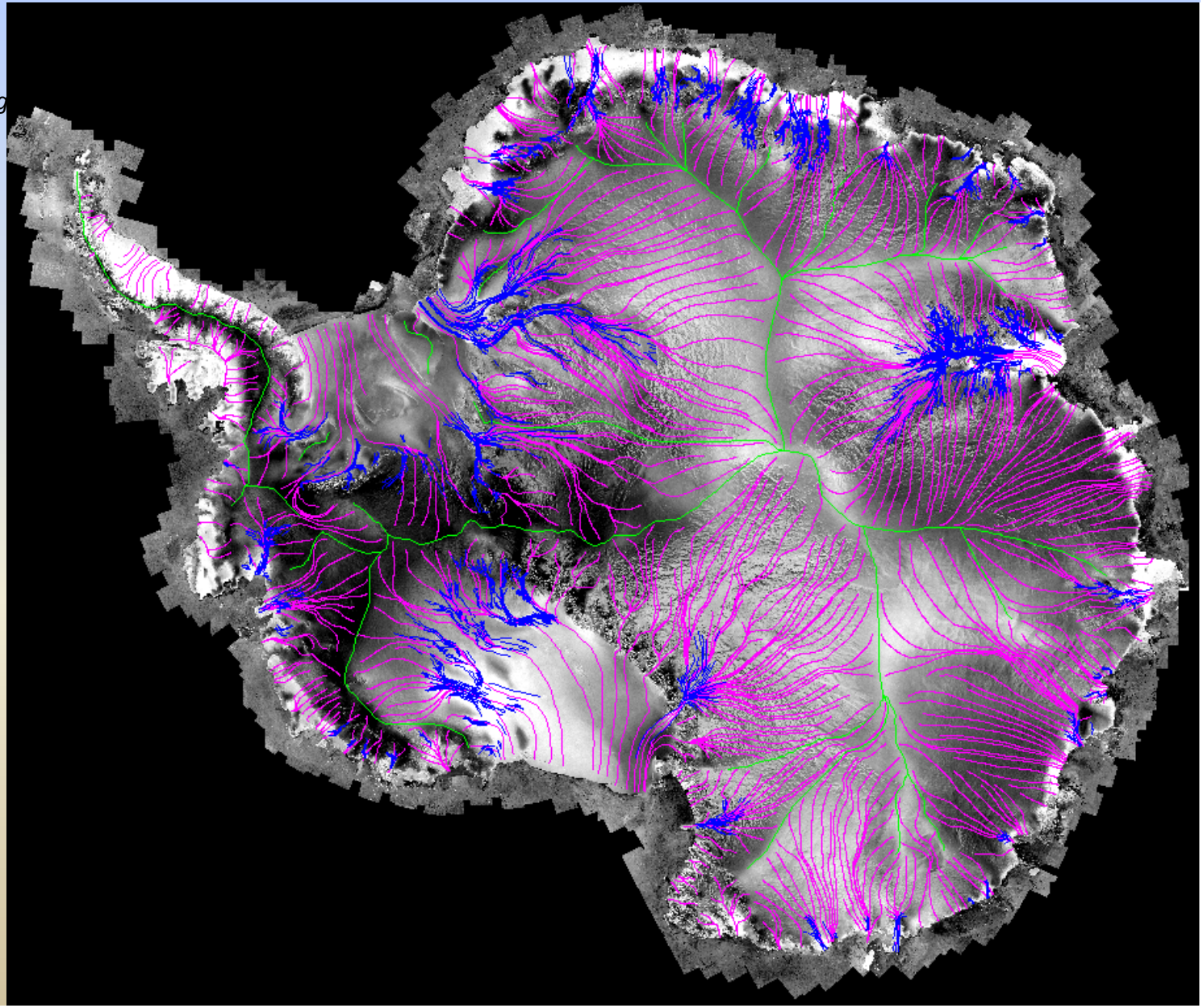


AMM-1 and MAMM derived coastlines

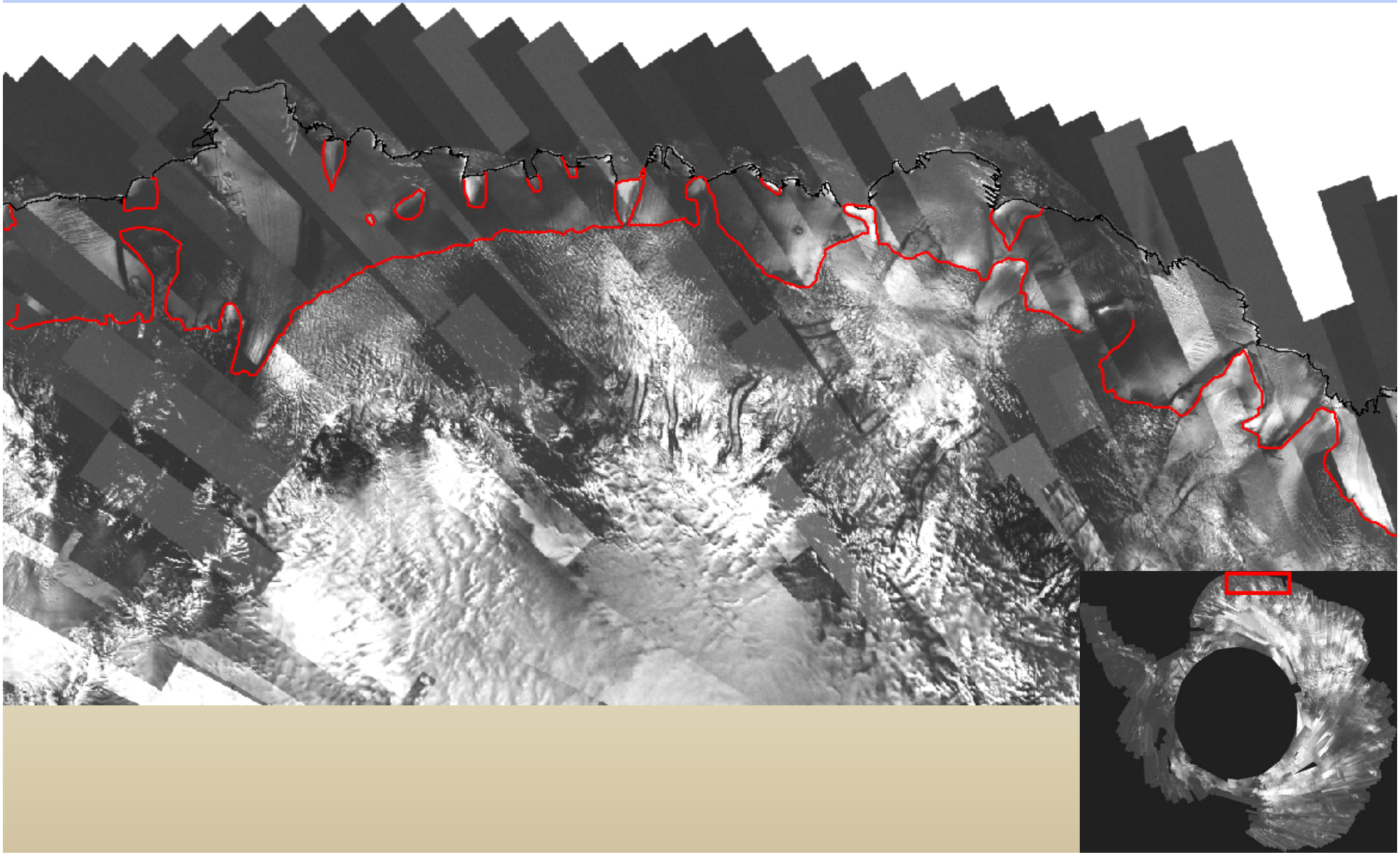


AMM-1 Derived Ice Divide, Flow Lines, and Flow Stripes

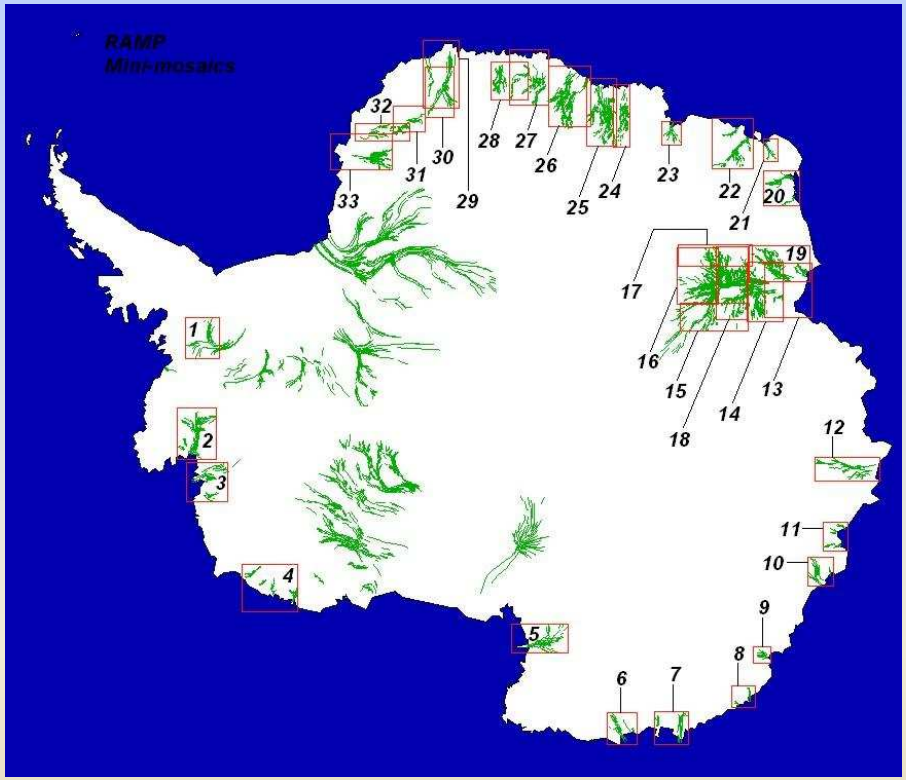
- *Ice Divide*
- *Flow Lines*
- *Flow Stripes for fast moving glaciers and shear margins*

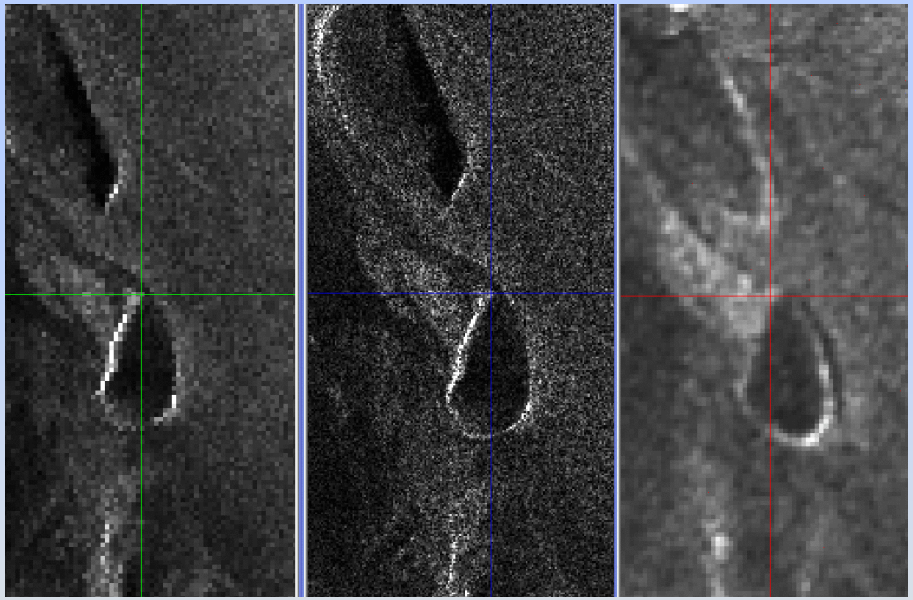


Grounding Line derived from MAMM ascending coherence mosaic



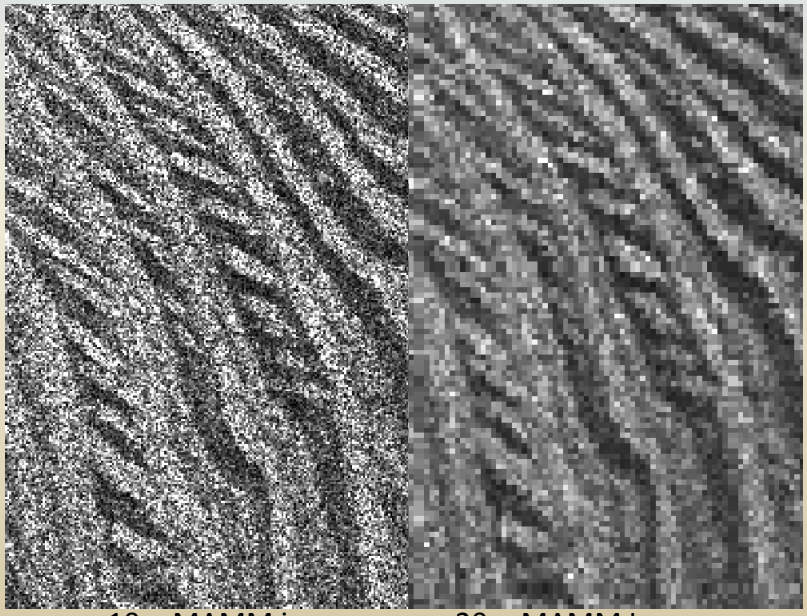
Ascending 10 meter ‘mini-mosaics’





25m MAMM image 10m MAMM image 25m AMM-1 image

Good geolocation and improved quality of MAMM vs AMM-1 25m data



10m MAMM image 20m MAMM I mage

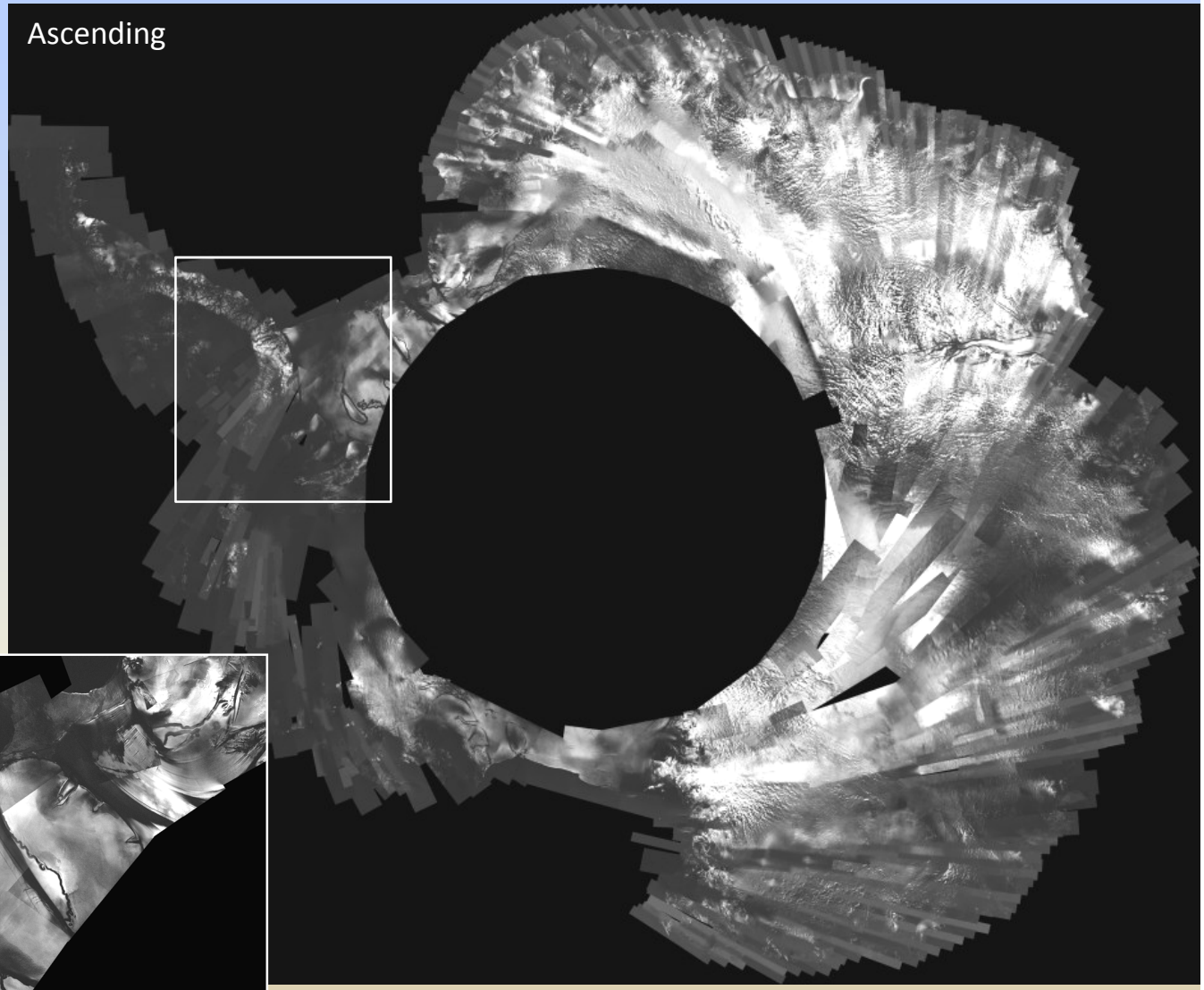
highly crevassed region

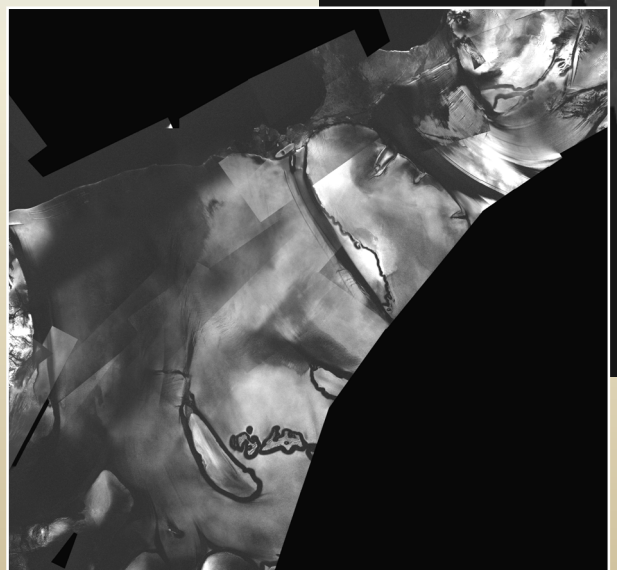
MAMM 200m Coherence mosaic (ascending)

Tile Product Specifications:
Polar Stereographic Projection
WGS 84 ellipsoid
-71° latitude of true scale
200m spatial resolution
Geolocation accuracies of +/- 100m

Coherence Products comprise:
200m 16-bit image
200m DEM
MASTER Text
- *Image specifications*
- *Projection information*

Utility program to extract metadata
- *coherence value*
- *reference & secondary orbits*
- *acquisition dates*
- *along track looks*
- *range looks*
- *baseline*
- *beam mode*

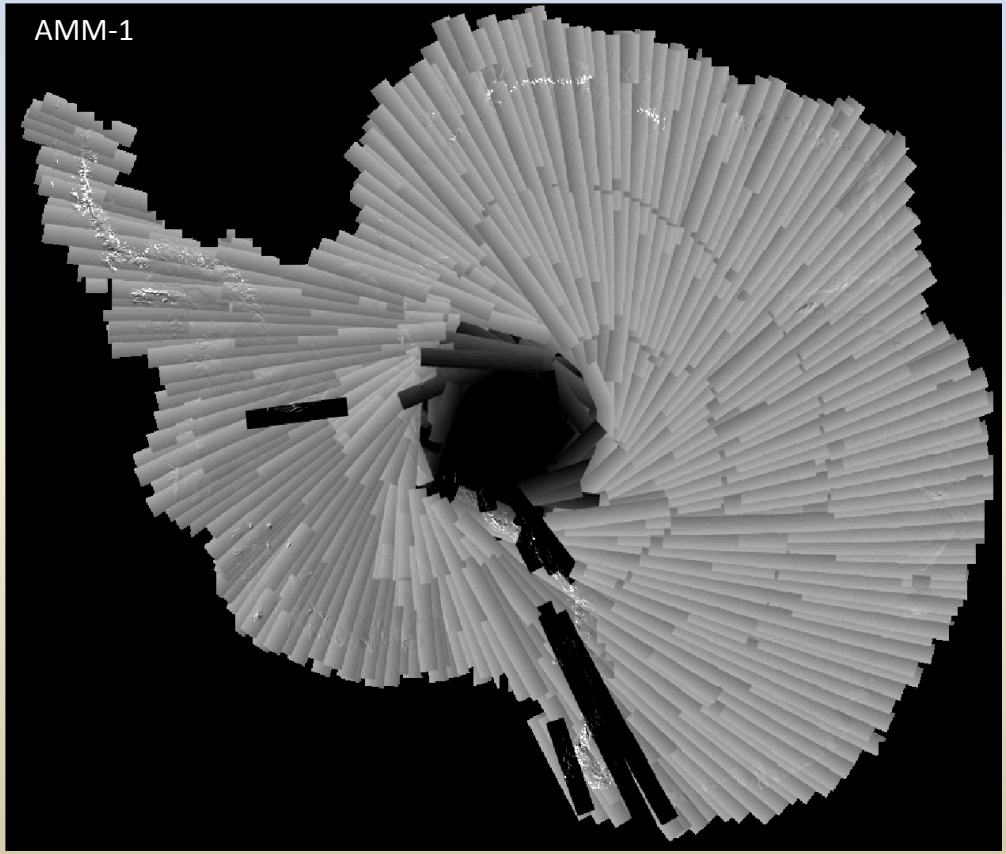


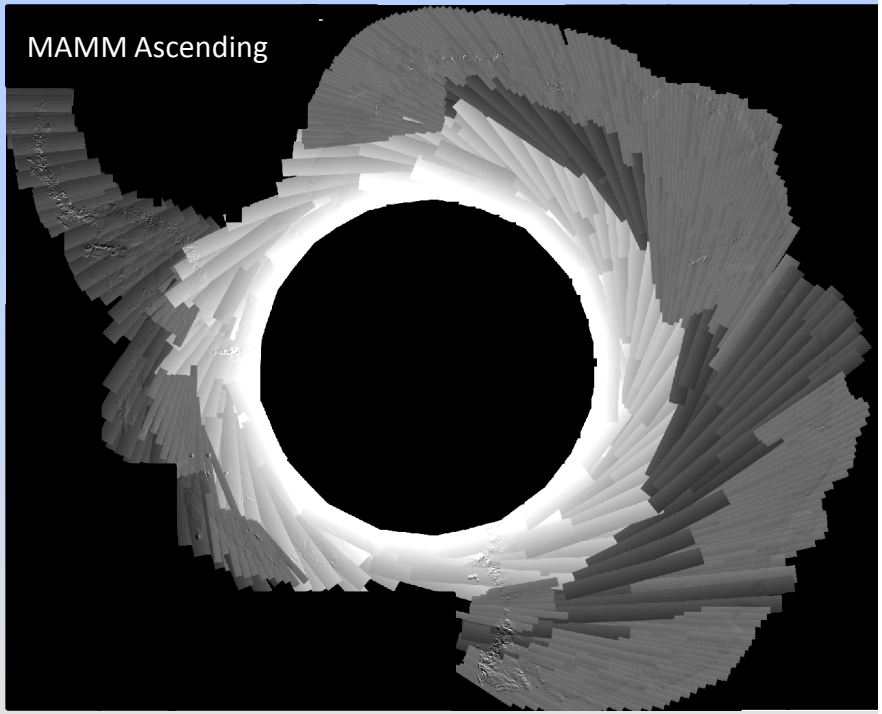


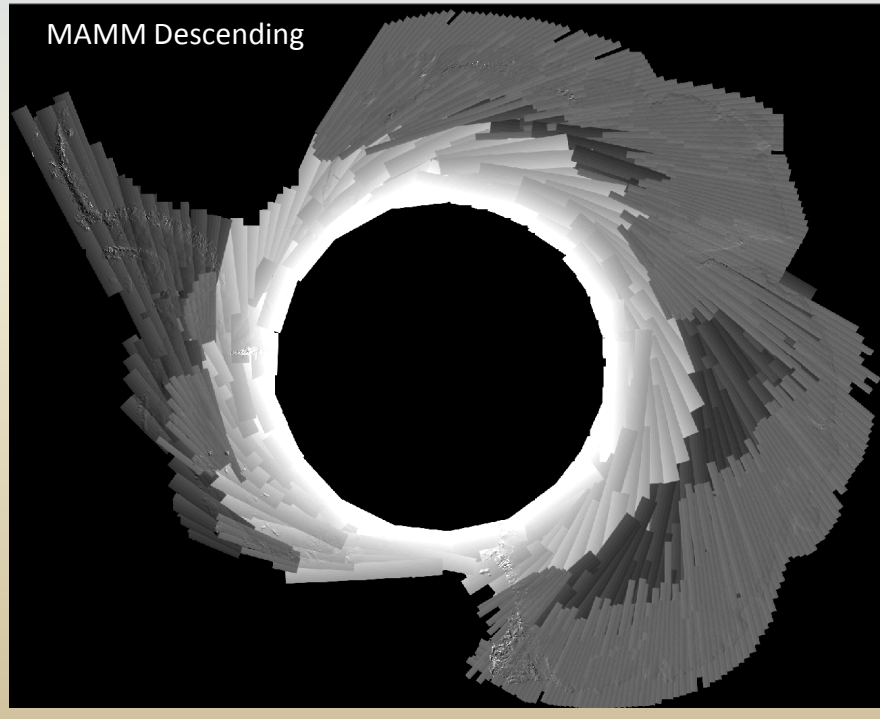
Incidence Angle Mosaic

100 m 8-bit mosaic of incidence angles and shadow/layover

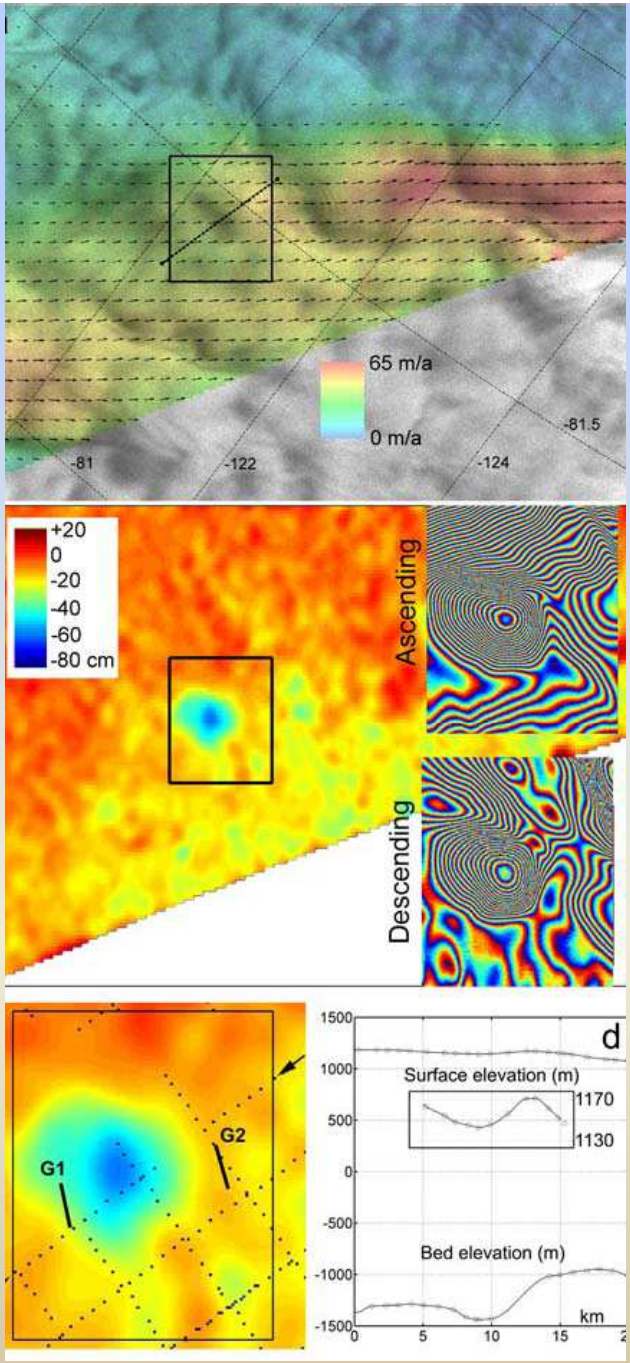
incidence angle = 90 – (8bit data number)



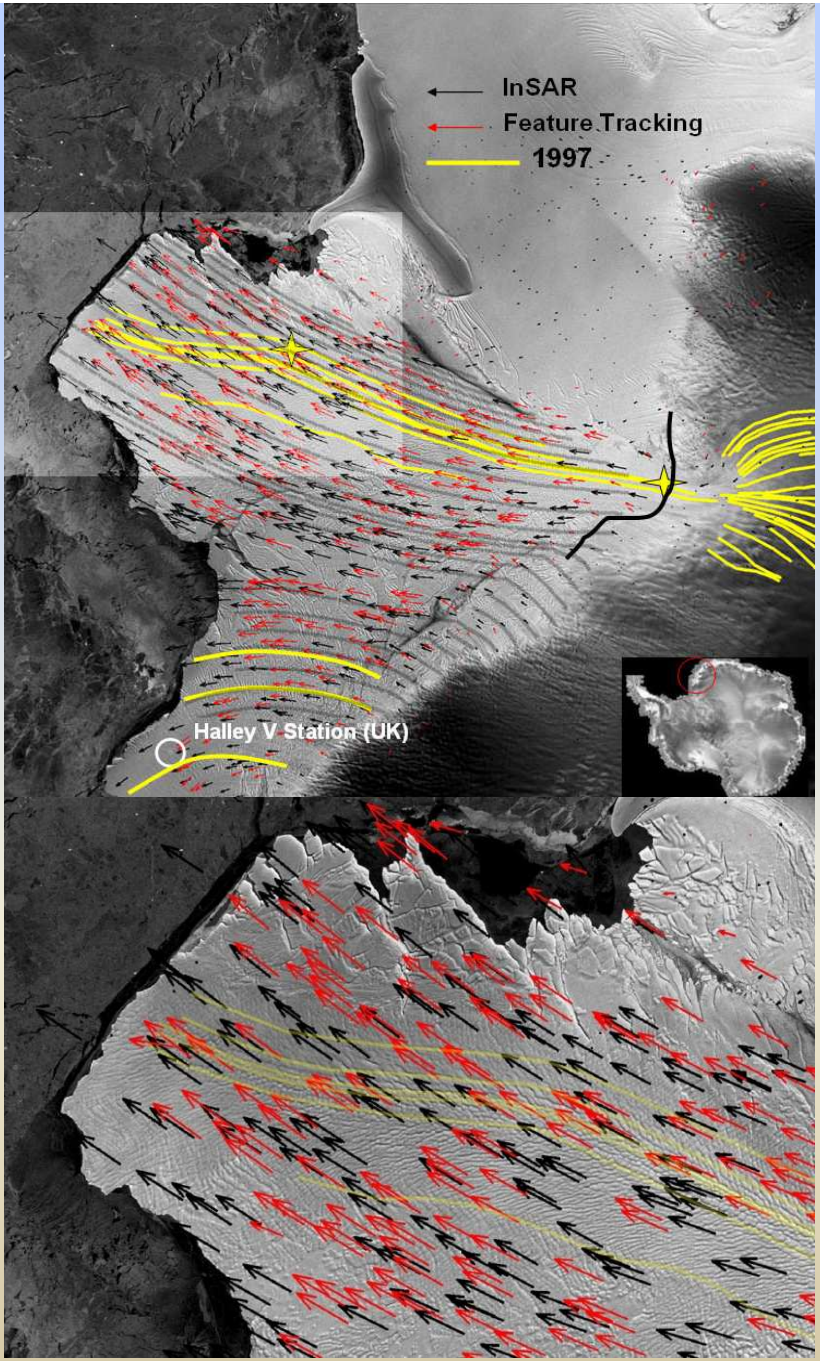




DERIVED VELOCITY PRODUCTS

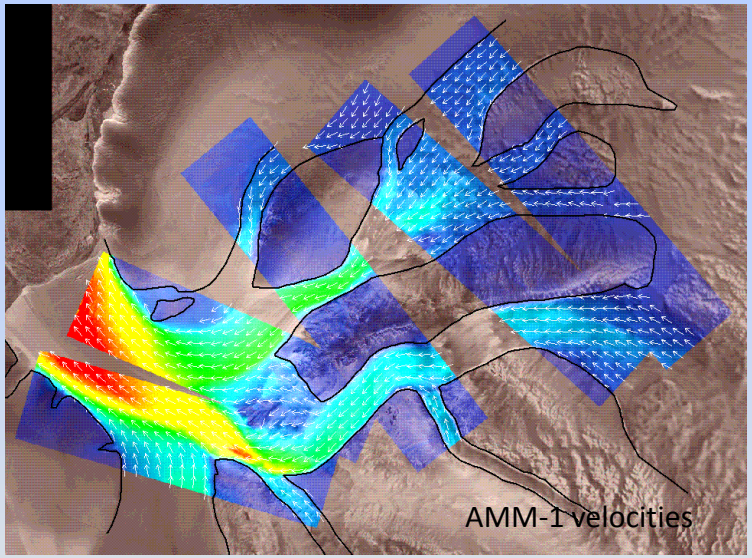


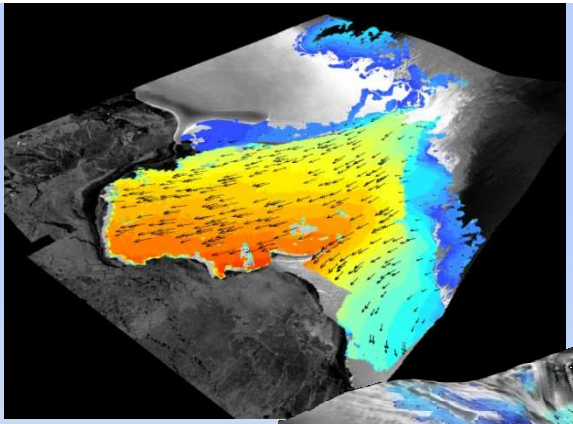
Example of using ascending and descending InSAR pairs to derive vertical displacement



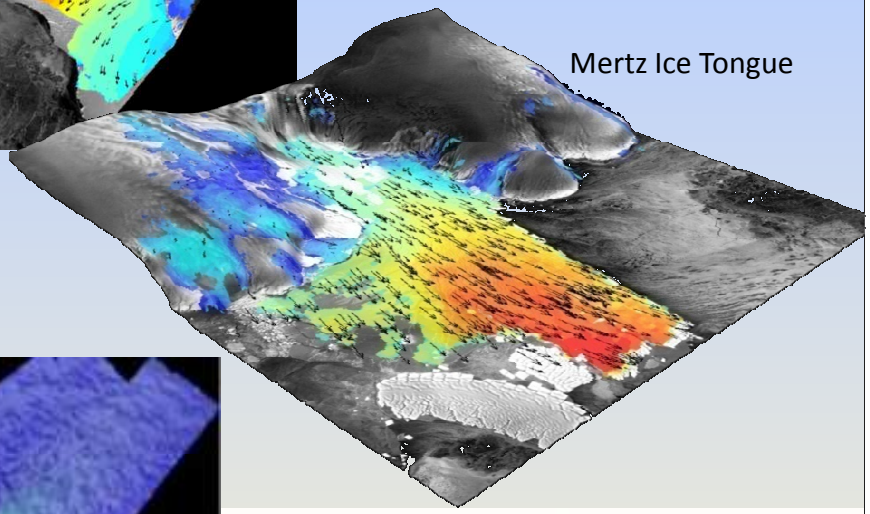
Illustrates the divergence between relict flow stripes and current velocity vectors discovered as a result of interferometric coverage

More examples of velocity products

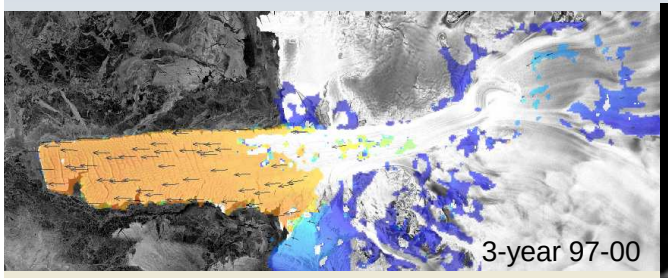


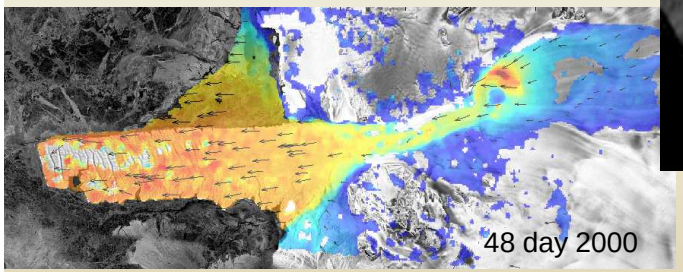


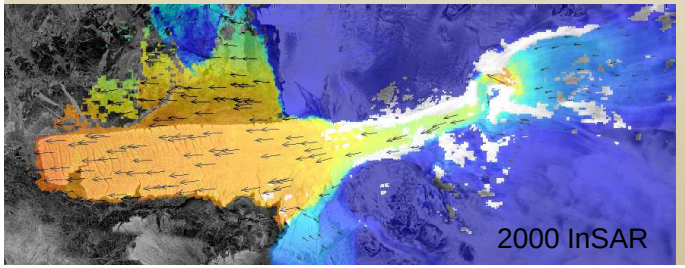
Stancom-Willis Ice Tongue

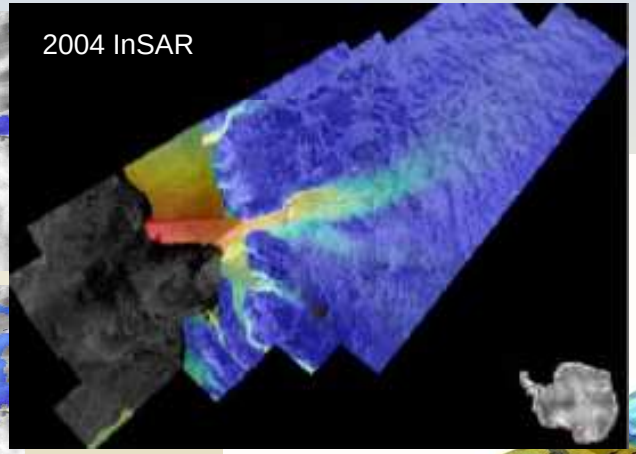


Mertz Ice Tongue

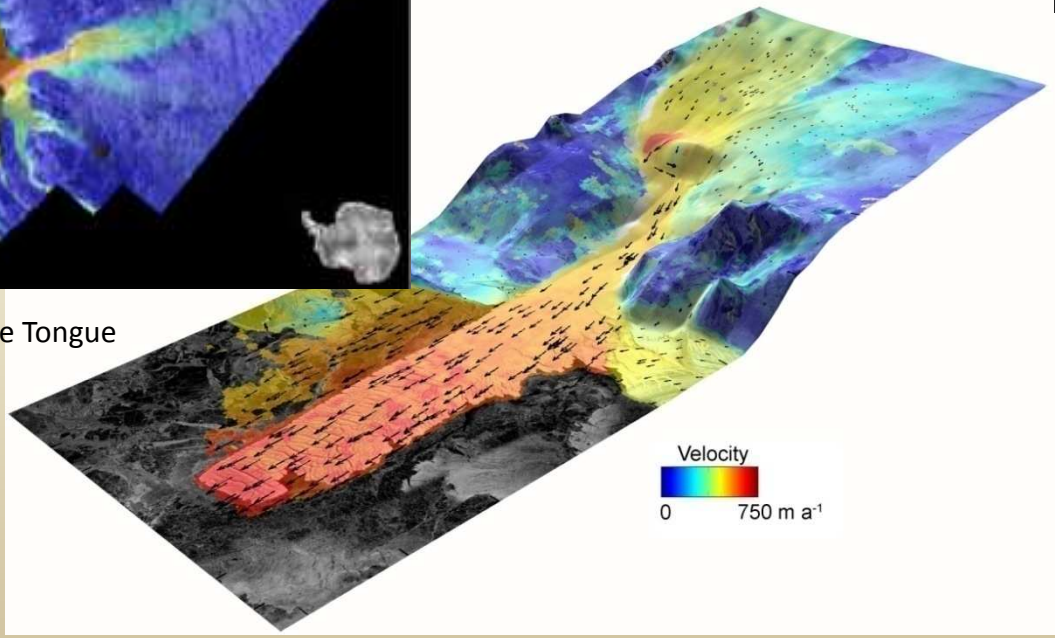






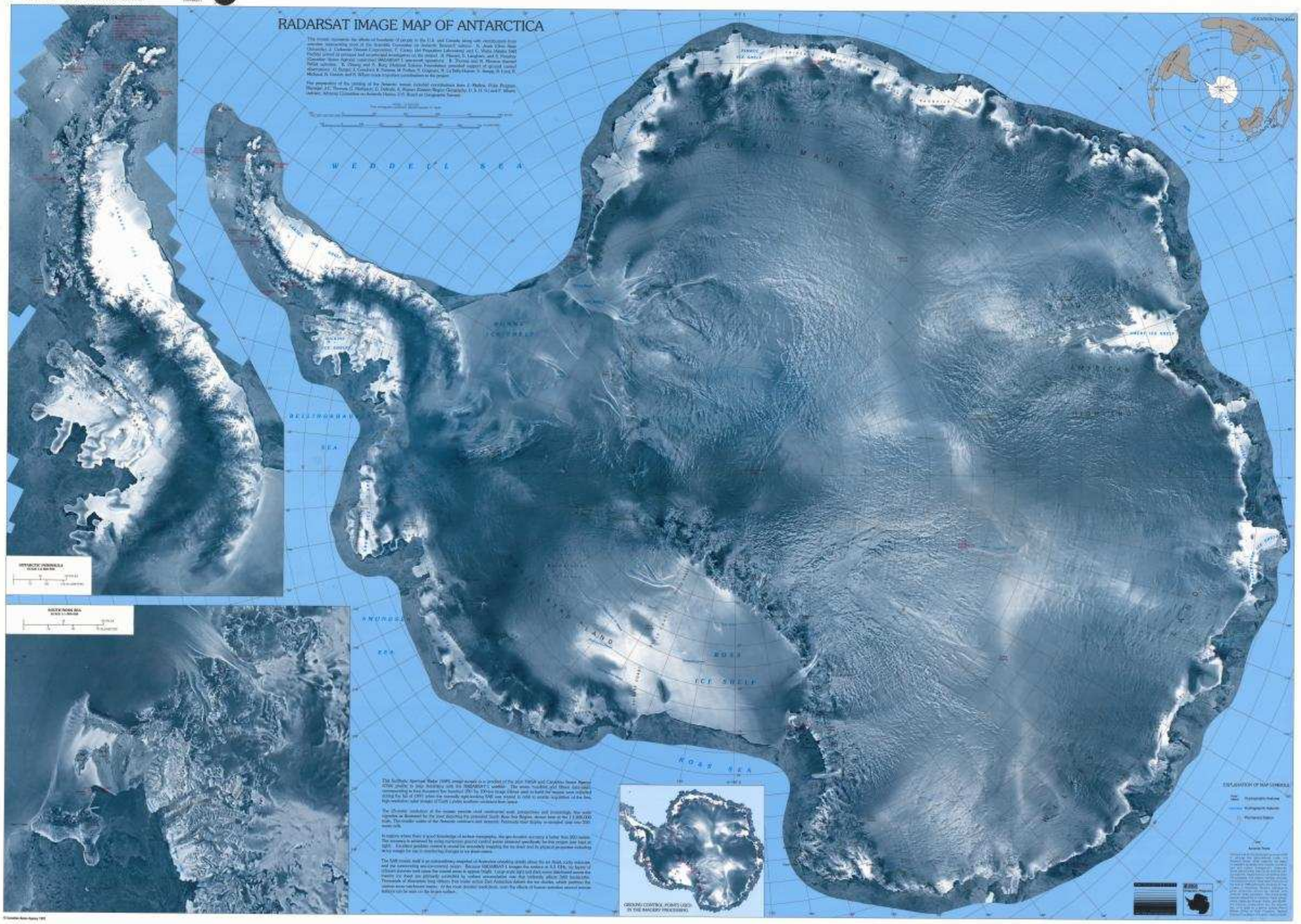


Drygalsky Ice Tongue



USGS U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

RADARSAT IMAGE MAP OF ANTARCTICA



http://bprc.osu.edu/rsl/radarsat/data

Reading Material

Publications

Baggeroer 1996.pdf: Geophysical Data Management System
Baumgartner 2002.pdf: On Reconciling Ground-Based With Spaceborne Normalized Radar Cross Section Measurements
Forster 1998.pdf: Analysis of Glacier Flow Dynamics from Preliminary RADARSAT InSAR Data of the Antarctic Mapping Mission
Forster2003.pdf: Measurement of Glacier Geophysical Properties From InSAR Wrapped Phase
Gogineni 1995.pdf: Application of Plane Waves for Accurate Measurement of Microwave Scattering from Geophysical Surfaces
Gray 1998.pdf: InSAR Results from the RADARSAT Antarctic Mapping Mission Data: Estimation of Glacier Motion using a Simple Registration Procedure
Gray_WAIS_Subglacier_Water_Transport.pdf: Evidence for subglacial water transport in the West Antarctica Ice Sheet through three-dimensional satellite radar interferometry
Jezek 1996.pdf: RADARSAT: The Antarctic Mapping Project
Jezek 1998.pdf: THE RADARSAT ANTARCTIC MAPPING PROJECT
Jezek 1998b.pdf: SNAPSHOTS OF ANTARCTICA FROM RADARSAT-1
Jezek 1998c.pdf: Flow Variations of the Antarctic Ice Sheet from Comparison of Modern and Historical Satellite Data
Jezek 1999.pdf: Glaciological Properties of the Antarctic Ice Sheet from RADARSAT-1 Synthetic Aperture Radar Imagery
Jezek 2002.pdf: RADARSAT-1 Antarctic Mapping Project: change-detection and surface velocity campaign
Jezek_2003.pdf: OBSERVING THE ANTARCTIC ICE SHEET USING THE RADARSAT-1 SYNTHETIC APERTURE RADAR1
Jezek 2005.pdf: Structure of southeastern Antarctic Peninsula ice shelves and ice tongues from synthetic aperture radar imagery
Jezek_Aug2005.pdf: Structure of Eastern Antarctic Peninsula Ice Shelves and Ice Tongues from Synthetic Aperture Radar Imagery
Kim 2001.pdf: Ice shelf advance and retreat rates along the coast of Queen Maud Land, Antarctica
Liu 1999.pdf: Development of an Antarctic Digital Elevation Model by Integrating Cartographic and Remotely Sensed Data: A Geographic Information System Based Approach
Liu 2001.pdf: Detecting outliers in irregularly distributed spatial data sets by locally adaptive and robust statistical analysis and GIS
Liu 2004.pdf: Automated extraction of coastline from satellite imagery by integrating Canny edge detection and locally adaptive thresholding methods
Liu_May2004.pdf: A Complete High-Resolution Coastline of Antarctica Extracted from Orthorectified Radarsat SAR Imagery
Liu_Sept2004.pdf: Correction of Positional Errors and Geometric Distortions in Topographic Maps and DEMs Using a Rigorous SAR Simulation Technique
Liu 2005.pdf: Delineation of Dry and Melt Snow Zones in Antarctica Using Microwave Remote Sensing Data
Liu_Sept2005.pdf: Synergistic Fusion of Phase Unwrapping and Speckle Tracking Methods for Deriving Surface Velocity from Interferometric SAR Data
Liu 2006.pdf: Automated Delineation of Dry and Melt Snow Zones in Antarctica Using Active and Passive Microwave Observations From Space
Liu 2007.pdf: Synergistic Fusion of Interferometric and Speckle-Tracking Methods for Deriving Surface Velocity From Interferometric SAR Data
Liu_ISQ_insar.pdf: Calibrating and Mosaicking Surface Velocity Measurements from Interferometric SAR Data with a Simultaneous Least-squares Adjustment Approach
Noltimier (Farness) 1996.pdf: Variations in Radar Backscatter Across the Great Ice Sheets
Noltimier (Farness)1998.pdf: 'Evidence for tbe Tectonic Segmentation of the Antarctic Peninsula from Integrated ERS-1 *SAR Mosaic and Aeromagnetic Anomaly Data*
Noltimier (Farness)1999.pdf: RADARSAT Antarctic Mapping Project- Mosaic Construction
Noltimier (Farness) 2000.pdf: Combining SAR and DISP Imager to Investigate the Structural and Glaciological Setting of the Transantarctic Mountains
Paden 2005.pdf: Wideband Measurements of Ice Sheet Attenuation and Basal Scattering Stearns 2005.pdf: Decadal-scale variations in ice flow along Whillans Ice Stream and its tributaries, West Antarctica
VanDerVeen_2007.pdf: Shear measurements across the northern margin of Whillans Ice Stream
Wen_2006.pdf: Accumulation variability and mass budgets of the Lambert Glacier–Amery Ice Shelf system, East Antarctica, at high elevations
Wen_Amery_MassBudget.pdf: Mass budgets of the Lambert, Mellor and Fisher glaciers and basal fluxes beneath their flowbands on Amery Ice Shelf
Wu_Balance_Velocities.pdf: Antarctic Ice Sheet Balance Velocities from Merged Point and Vector Data

Thesis

kim_Dissertation.pdf "Satellite Mapping and Automated Feature Extraction: Geographic Information System-Based Change Detection of the Antarctic Coast"
kim_ms_thesis.pdf Application of Time Series Satellite Data to Earth Science Problems"
liu_dissertation.pdf "Generation and Refinement of a Continental Scale Digital Elevation Model by Integraating Cartographic and Remotely Sensed Data: A GIS-Based Approach"
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wu_thesis.pdf "Estimating Balance Velocities Using GIS-based Techniques"
zhao_dissertation.pdf "Surface Velocities of the East Antarctic Ice Strams from Radarsat-1 Interferometric Synthetic Aperture Radar Data"

AMM-1 Documentation

8-bit_conversion_equations.pdf Method used to convert the 16-bit Amplitude data to 8-bit AMM1_ASF_Calibration.pdf ASF document outlining calibration procedure AMM1_Noise_Recalibration_Sum.xls Calibration error spreadsheet
AMM1_Radar_Caliber_Deployment.pdf South pole deployment of an active radar calibrator (ARC). AMM1_radiometry.pdf AMM-1 radiometry validation
AMM1_Sci_Requirements.pdf AMM-1 Science Requirements document
AMM1_Sig0_evalr4.pdf detailed information on dB conversion and validation reference data in /amm_v2/TILES_dB
AMM1_sig0_tiers evaluation.pdf evaluation on averaging scheme used to create lower resolution tiers for the Sigma0 data.
Amplitude.pdf gives the amplitude equation and an explanation on how it was used in AMM-1 and MAMM processing
FinaTileValidation.pdf detailed information on Final Tile Products and Validation reference data in /amm_v2/TILES
RAMP_Description.pdf Description of the RAMP project as found on our website www-bprc.mps.ohio-state.edu/rsl
Sigma0_comparison.pdf A comparison document of AMM-1, MAMM_Ascending, MAMM_Descending sigma0 datasets using global and local statistics.

MAMM Documentation

8-bit_conversion_equations.pdf Method used to convert the 16-bit Amplitude data to 8-bit for the ascending data
8-bit_conversion_equations_desc.pdf Method used to convert the 16-bit Amplitude data to 8-bit for the descending data
Asc_Bandwidth_Along_Track.pdf Map of problematic bandwidth values for Ascending IFR Pairs Asc_Baseline_Perpendicular.pdf Map of problematic Baseline values for Ascending IFR Pairs
Asc_Coastal_25m.pdf Ascending geometry evaluation at 25m for coastal regions
Asc_Coastline_100m.pdf Comparison with AMM-1 1997 coastline in rocky or stable areas
Asc_Geo_Rad.pdf Overview document on ascending geometry evaluation and validation
Asc_Interior_100m.pdf Ascending geometry evaluation at 100m for interior regions
Asc_Interior_25m.pdf Ascending geometry evaluation at 25m for interior regions
Asc_Radiom_Artifact_map.html Interacting map of radiometric artifacts
Asc_Radiom_Artifact_map.jpg executable on any device with internet jpgs (directory) access.
Bandwidth_baseline.xls Centroids and values for bandwidth and baseline for Ascending and Descending IFR pairs (several spreadsheets embedded)
Bandwidth_baseline_hist.pdf Histograms of bandwidth and baseline for Ascending and Descending IFR Pairs
Coh_Asc.pdf Short doc on Ascending Coherence Mosaics
Coh_Desc.pdf Short doc on Descending Coherence Mosaics
Coh_Prod_valid.ppt Validation of Coherence Products
Coh_Smooth_Mosaic.doc Procedure manual for creation of smoothed coherence mosaics Desc_Bandwidth_Along_Track.pdf Map of problematic Bandwidth values for Descending IFR Pairs Desc_Baseline_Perpendicular.pdf Map of problematic Baseline values for Descending IFR Pairs
Final_Tile_Valid.ppt Validation of Final Tile Products
MAMM_ASF_Calibration.pdf ASF document outlining Calibration effort
MAMM_ASF_processing_sys.pdf ASF document outlining Processing System
MAMM_ASF_Processing_Requirements.pdf ASF document outlining SLC production and final product distribution
MAMM_ASF_TestPlan.pdf ASF document outlining test plans and procedures for the MAMM mission MAMM_ASF_SatelliteOpsPlan.pdf ASF document outlining Satellite Operations Plan
MAMM_CSA-NASA_agreement.pdf Agreement document between CSA and NASA using RADARASAT-1 for an interferometric mission.
MAMM_JPL_project_agreement.pdf JPL project agreement
MAMM_L1_SLC_Product_Valid.pdf Leve 1 product validation documentation
MAMM_Sci_Requirements.pdf MAMM Science Requirements document
MAMM_Vexcel_FRD.pdf Vexel Corp. functional requirements document for RADARSAT ANTARCTIC MAPPING SYSTEM-2
Mini_Mos_offset.pdf Documentation of the geometric offset adjustment made to the 10m Mini-Mosaic data. RAMP_Description Description of the RADARAST ANTARCTIC MAPPING PROJECT as found on our website www-bprc.mps.ohio-state.edu/rsl
Sigma0_comparison.pdf A comparison document of AMM-1, MAMM_Ascending, MAMM_Descending sigma0 datasets using global and local statistics.
Sigma0_Processing.pdf Document outlining MAMM Ascending and Descending Backscatter product creation. Vel_Prod_Valid.ppt Validation of Velocity Products