The Multispectral Thermal Imager (MTI) North Slope of Alaska Project

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Introduction

The Multispectral Thermal Imager (MTI) is a space-based research and development project sponsored by the U.S. Department of Energy, Office of Nonproliferation and National Security. MTI's primary objective is to demonstrate advanced multispectral and thermal imaging, image processing and associated technologies that could be used in future systems for detecting and characterizing facilities producing weapons of mass destruction. However, limited quantities of MTI data can be made available for other purposes on a non-interference, proposal basis. It has been proposed and accepted that MTI be tasked to image the ACRF (ARM Climate Research Facility) North Slope of Alaska and Adjacent Arctic Ocean (NSA/AAO) site and other nearby areas of interest at the convenience of the MTI project. That has turned out to be, on average, every few weeks. However, during periods of particular interest (Intensive Operating Periods), more frequent imaging has been arranged. There are many potential uses of MTI data in support of ACRF NSA/AAO and User objectives. These focus on cloud and surface (land and sea ice) characterization.

Table 1. MTI Band Structure

Band	Wavelength (micrometer)	Detector	Description
A	0.45-0.52	Si-PIN	Blue "true color"
B	0.52-0.60	Si-PIN	Green "true color"
C	0.62-0.68	Si-PIN	Red "true color"
D	0.76-0.86	Si-PIN	VNIR vegetation
E	0.86-0.89	InSb	NIR water vapor reference
F	0.91-0.97	InSb	NIR water vapor
G	0.99-1.04	InSb	NIR water vapor reference
H1, H2	1.36-1.39	InSb	NIR cirrus
I	1.54-1.75	InSb	SWIR surface
O	2.08-2.37	InSb	SWIR surface

Table 1. (cont'd)			
J	3.49-4.1	InSb	MWIR surface
K	4.85-5.05	InSb	MWIR atmosphere
L	8.01-8.39	HgCdTe	LWIR atmosphere
M	8.42-8.83	HgCdTe	LWIR surface
N	10.15-10.7	HgCdTe	LWIR surface

MTI's nadir-pointing resolution is 5 m in the visible and 20 m in the infrared. MTI had a design life of 3 years. That period expired during 2003. However, DOE has chosen to keep MTI operational for as long as MTI remains functional and its utility justifies the cost. That could be up to another 8 years.

Originally, MTI was a tri-lab effort, with Sandia National Laboratories leading the design, operations and data processing tasks, Los Alamos National Laboratory being responsible for pre-launch calibration, and Savannah River Technology Center being responsible for vicarious calibration in orbit. However, after MTI reached its design life, all responsibilities associated with it were assigned to Sandia.

Examples

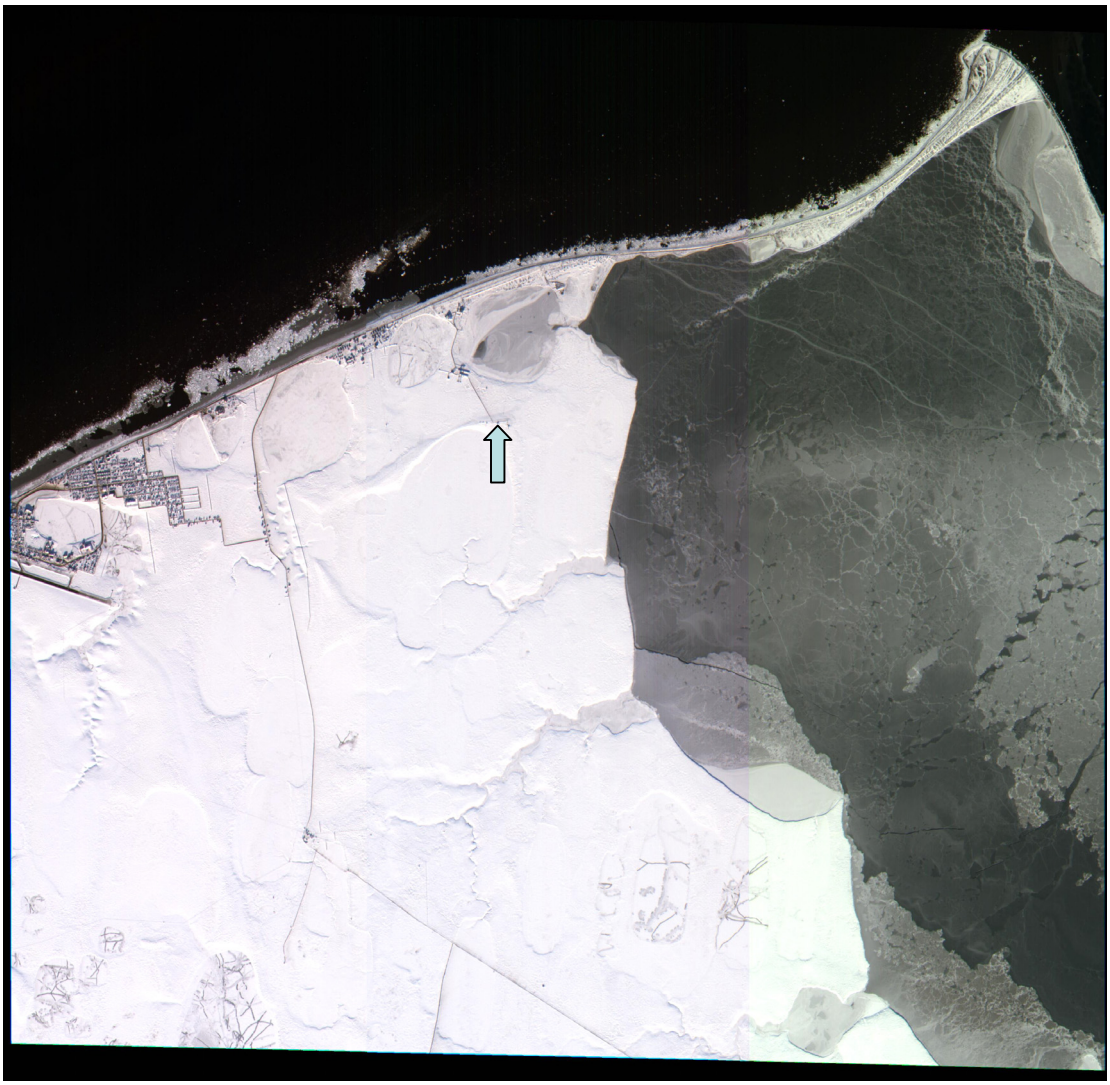

Figure 1. Barrow Area in Fall (Visible)

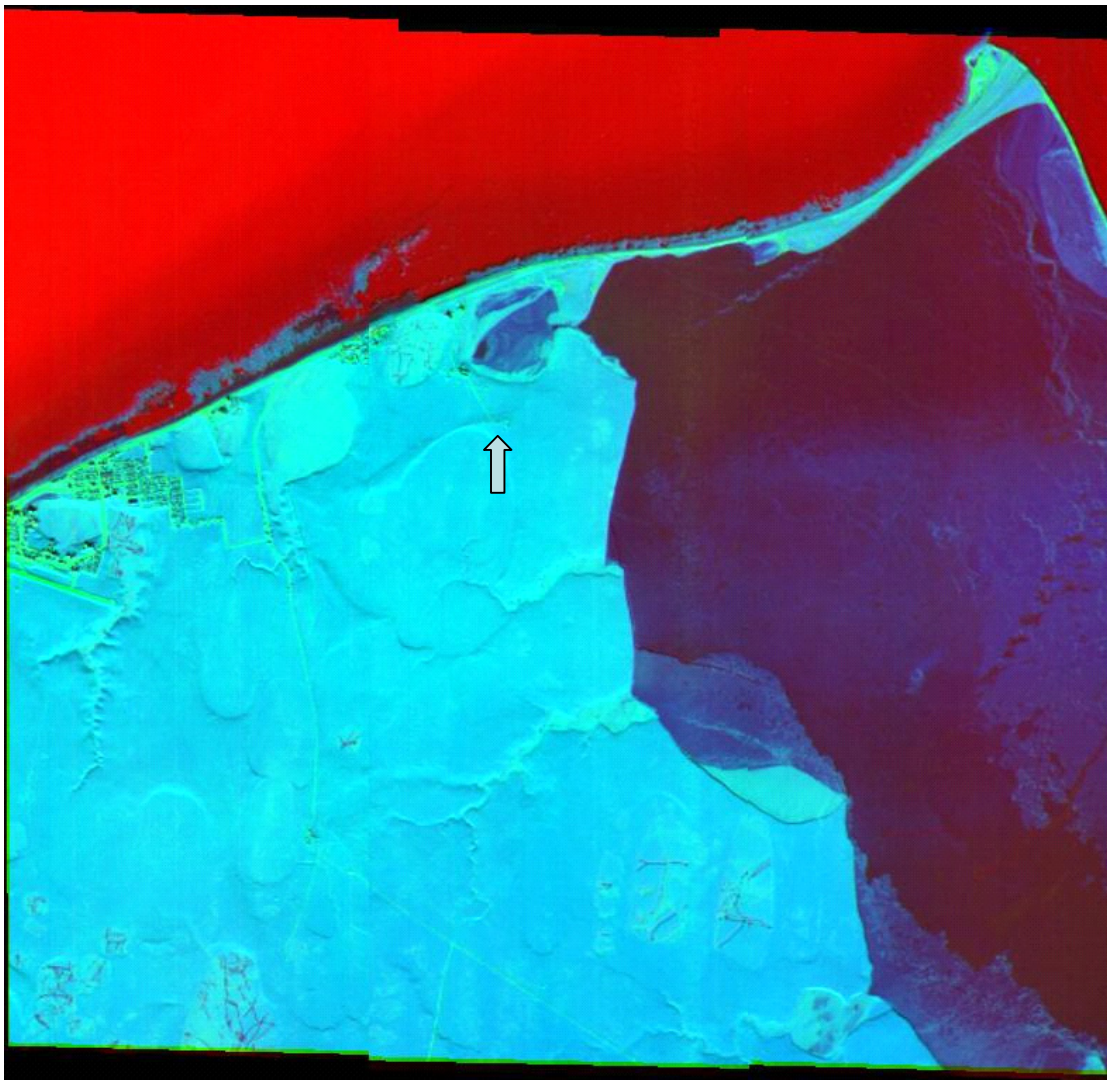

Figure 2. Barrow Area in Fall (IR)

Visible and IR images acquired Oct. 12, 2000, 21:42 UTC. In the IR image, the Red/Green/Blue colors code for bands MOE respectively. The town of Barrow is at the far left. Point Barrow, the farthest northern point of US land, is at the upper right. The ACRF Barrow Instrumentation is indicated by the arrow. Elson Lagoon, a shallow body of water separated from the ocean by a chain of barrier islands, is on the right. Referring to the IR image: the Arctic Ocean (upper left) is unfrozen and relatively warm. Elson Lagoon is covered with thin ice, but very little snow, and is colder than the ocean. The snow-covered land is reflective in the near IR, but even colder than the lagoon (less red). More quantitative information can be obtained from specific bands, and from algorithms combining data from different bands.

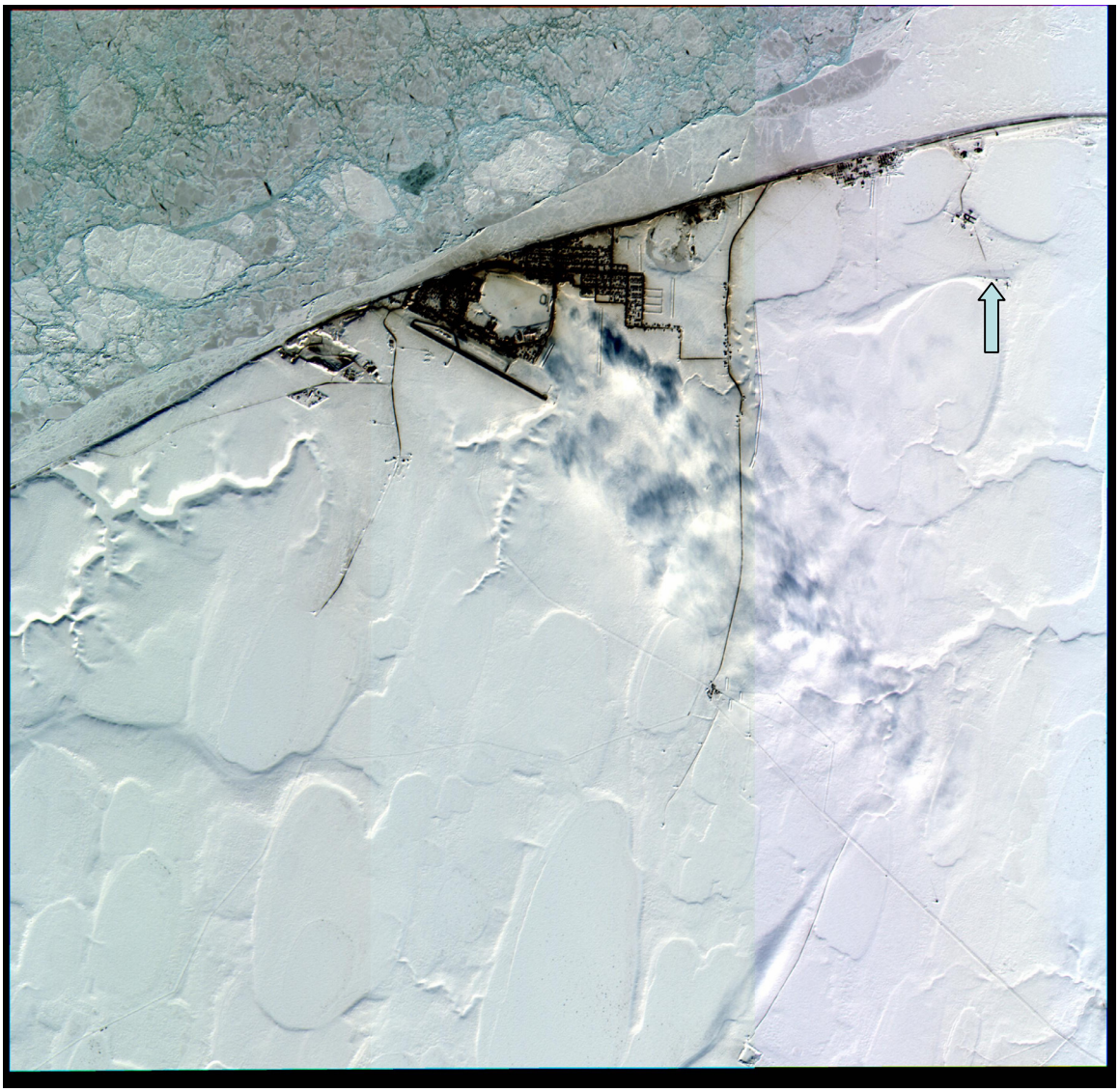

Figure 3. Barrow in Spring (Visible)

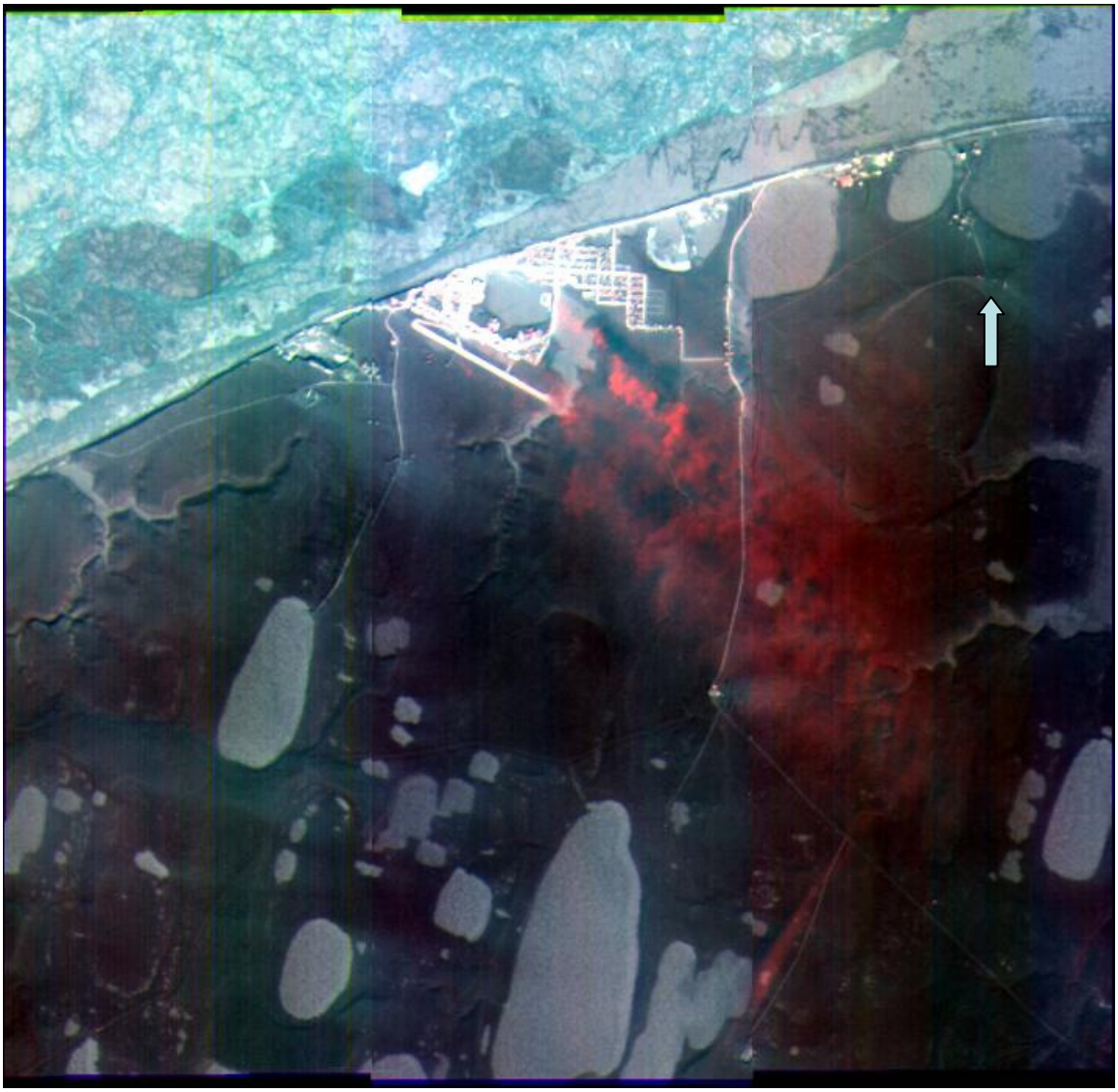

Figure 4. Barrow in Spring (IR)

Visible and IR images acquired April 11, 2002, 19:36 UTC. In the IR image, the Red/Green/Blue colors code for bands JKN respectively. In these views, the town of Barrow is in the upper center. Again, the ACRF instrumentation is indicated by an arrow. Referring to the IR image: notice that the ocean is covered with sea ice, but the ice is broken, of variable thickness, and much warmer than the land. All land surfaces are covered with snow, but with this band selection, the lakes, which are covered with snow and ice, still show up clearly. The surface of the snow above the lakes, not frozen to the bottom, is still slightly warmer than the surface of the snow over the frozen land. Note also in the visible, evidence of a plume downwind of Barrow. That plume stands out more clearly in the IR, especially in band J (red). It is presumed that the plume consists primarily of condensed and frozen water from vapor emitted by anthropogenic sources. Again, more quantitative information can be obtained from specific bands, and from algorithms combining data from different bands.

MTI Restrictions

There are restrictions on the dissemination of raw MTI data. Users of raw MTI data must be U.S. citizens with approved MTI projects, who have signed appropriate non-distribution agreements. However, JPEG images created from MTI data of the ACRF NSA/AAO site, such as those here, have been declared public access, and may be published or further disseminated in any way. Other forms of processed MTI data may be further disseminated with MTI project approval. Those interested in MTI in the context of the NSA/AAO ACRF site, please contact the lead author (BDZak@sandia.gov). More information on MTI is available at http://nis-www.lanl.gov/nis-projects/mti/.

Acknowledgement

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