Arctic PBL cloud height and motion retrievals from MISR and MINX

Dong L. Wu
NASA Goddard Space Flight Center

JPL Cloud Stereo Algorithm Team:
Michael Garay, Earl Hansen, Veljko Jovanovic, Catherine Moroney, Kevin Mueller, David Nelson and David Diner (PI)
Outline

• Boundary-layer CTH and CMV with MISR high vertical resolution
• MISR new version
• Arctic warming and cloud changes
• Arctic PBL dynamics over ice and water from high-res MINX retrievals
Views: Nadir, ±26º, ±46º, ±60º, ±70º
Bands: 446, 558, 672, 866 nm
Swath: ~400-km swath
Pixel: 275 m - 1.1 km
Time interval: ~50 s
Data: 2000-present

Beaufort Sea (Oct 2007)
MISR Flight Direction

MISR Stereo Technique
High-Resolution Cloud Top Height and Winds

Cross Track

Ground Track
Parallax

Cloud Top Height

-46 s
46 s

-26° +26°
MISR Flight Direction

MISR Stereo Technique
High-Resolution Cloud Top Height and Winds

Ground Track
Cross Track
Ground Track
MISR Data and Tools

Level 1B (9 Views, Red band, 275 m pixel, ~350 km swath)

New Version (Global Standard Products)
- 17.6-km
  - CTH
  - CMV
- 1.1-km
  - CTH
  - CMV_cross_track

Version F08-0017 (Global Standard Products)
- 70.4-km
  - CTH
  - CMV
- 1.1-km (aka CFbA)
  - CTH
  - CMV_cross_track
- 1.1-km (zero wind)
  - CTH0
  - CMV_cross_track

MISR Interactive Explorer (MINX)
- A priori wind direction
- High resolution retrievals for CTH/CMV or plumes
- Portable to PC, Mac, and Linux
- Intense computation
- Easy to learn and good for regional case studies

Reanalysis Winds → CTH
MISR (New Version) vs ERA-Interim Winds at 0-2 km (Jan 2007)
October 2007, CMV (New Version) at 0-2 km
CMV height problem and a solution

Motivation: 70.4 km → 17.6 km → 4.4 km
Arctic Warming:
Roles of Boundary-Layer Clouds and Dynamics

Beaufort and East Siberian Sea

Since 1979, more than 20% of the Polar Ice Cap has melted away

Enhanced Autumn Warming

Surface Air Temp (K)

2000s
1990s
1980s
1970s
1960s
1950s
Rapid Climate Changes in the Arctic

- What is the role of cloud feedbacks in Arctic warming?
- How do dynamics response to more open water in the Arctic Ocean?
Comparisons of MISR & CALIOP (Beaufort-Laptev Region)

CALIOP 05km_CLAY
MISR
Low-Cloud (0-3 km)
Fraction

Wu and Lee (2012)
MISR Orbit 62271 (October, 2007)
Multi-Angle Stereo Technique for Cloud Detection over Snowy/Icy Surfaces

Nadir (AN)

70° Forward (DF)

PBL cloud top
Snowy/Icy surfaces
Cloud shadow
Multi-layer Clouds
MISR on Oct 17, 2007

Nadir

Wind vector

Winds (m/s)

Height (km)

Wind vector

Height Profiles (ASL) for 041657-B29-SPWR1

MISR on Oct 17, 2007

26° Forward

46° Forward

60° Forward

70° Forward
Marginal Ice Zone (MIZ)
Dramatic Transition in PBL and Cloud Properties

Arctic boundary layer

U (wind)

Clouds: Latent Heat

T ice = ~243K

T water = ~270K

Sea Ice

Open Ocean

Turbulence: Sensible Heat

Ice Edge

Ice Edge
Hartmann et al. (1997)
Summary

• MISR stereo CMV/CTH products
  – Different requirements for CMV an CTH
  – Accurate height assignment for inter-platform comparisons and reanalysis
  – New version: greatly improved in coverage

• Rapid changes in Arctic PBL cloud
  – Significant in MISR (since 2000) and CALIOP (since 2006)
  – Indicative of a positive cloud feedback to sea ice loss

• Detailed dynamics and structures from MINX
  – PBL processes
  – Verification for NWP DA