



# Arctic PBL cloud height and motion retrievals from MISR and MINX

Dong L. Wu

NASA Goddard Space Flight Center

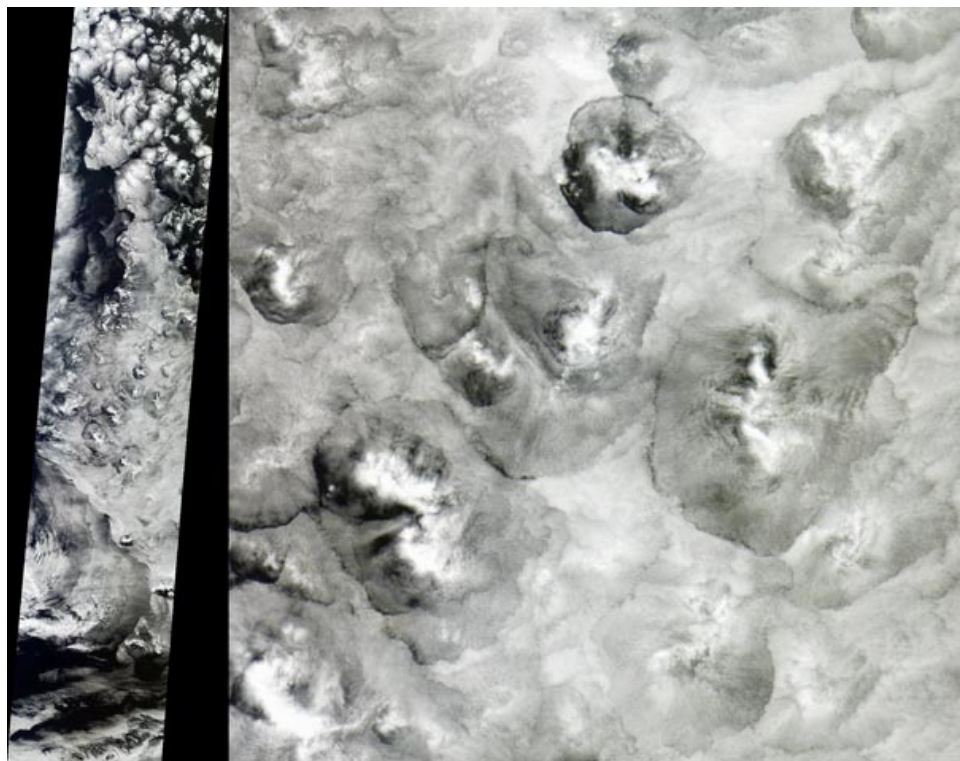
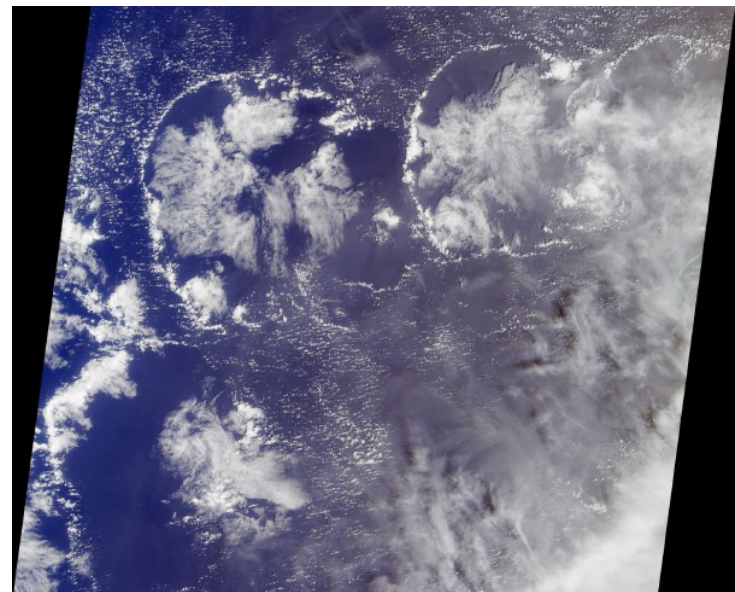
JPL Cloud Stereo Algorithm Team:

Michael Garay, Earl Hansen, Veljko Jovanovic, Catherine Moroney, Kevin Mueller, David Nelson and David Diner (PI)

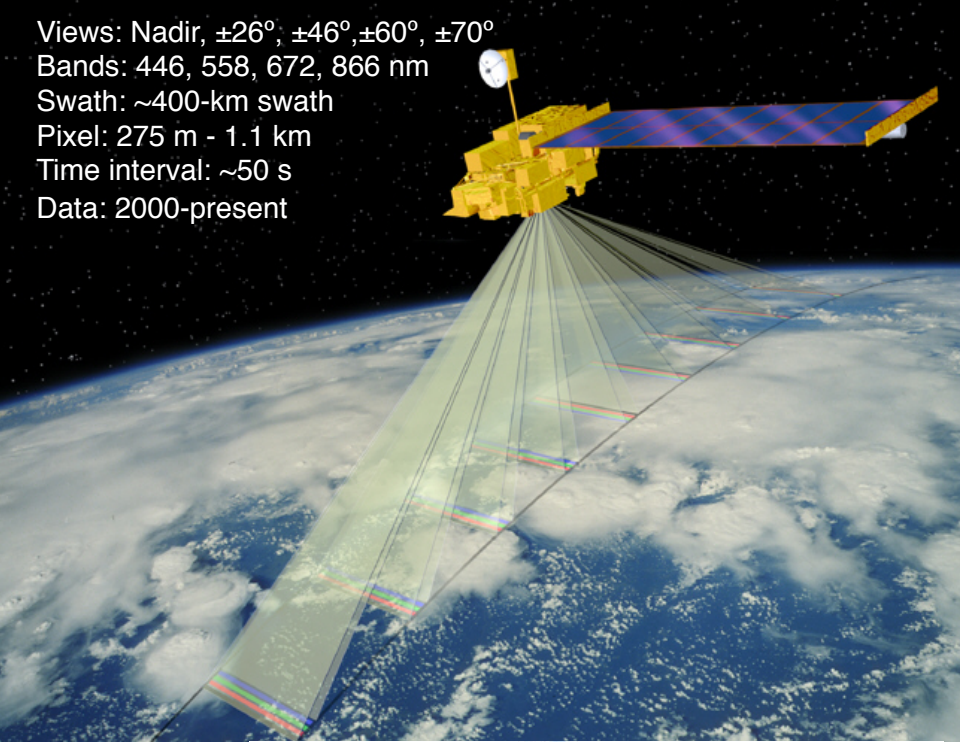


# Outline

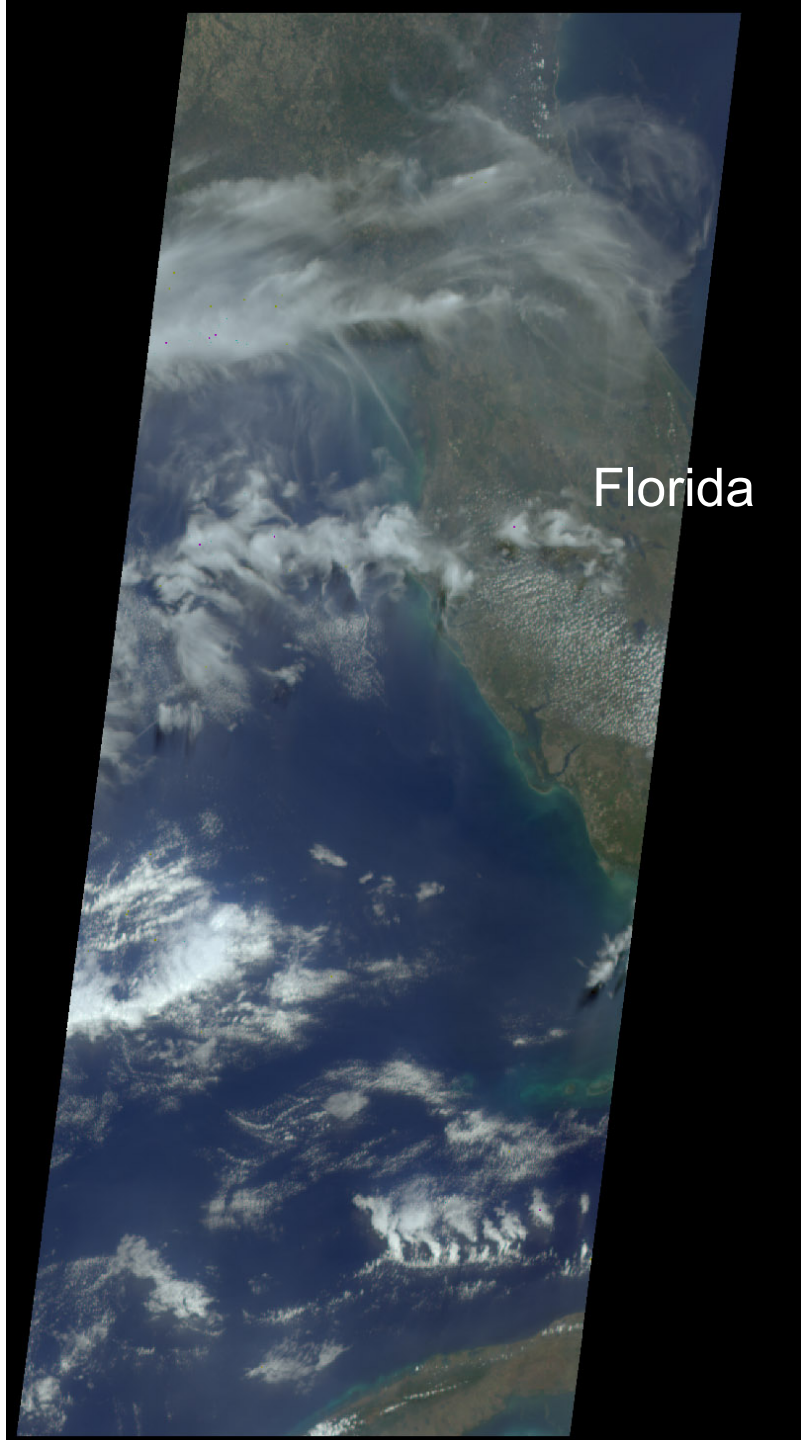
- Boundary-layer CTH and CMV with MISR high vertical resolution
- MISR new version
- Arctic warming and cloud changes
- Arctic PBL dynamics over ice and water from high-res MINX retrievals

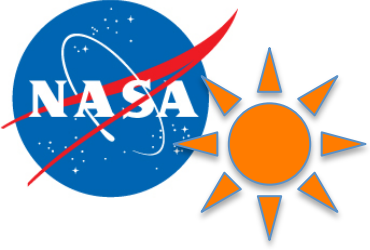


Views: Nadir,  $\pm 26^\circ$ ,  $\pm 46^\circ$ ,  $\pm 60^\circ$ ,  $\pm 70^\circ$   
Bands: 446, 558, 672, 866 nm  
Swath: ~400-km swath  
Pixel: 275 m - 1.1 km  
Time interval: ~50 s  
Data: 2000-present



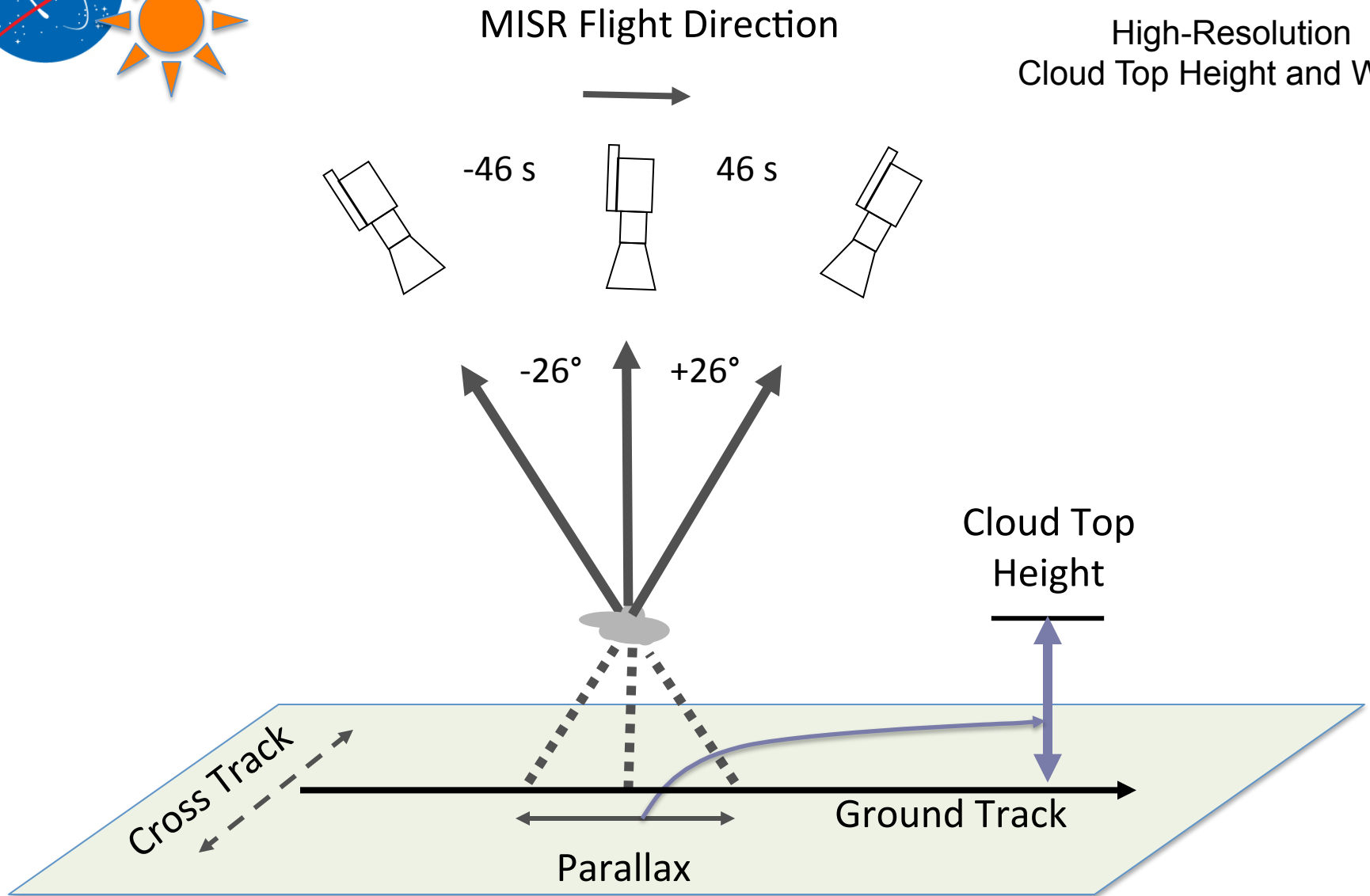
Beaufort Sea (Oct 2007)

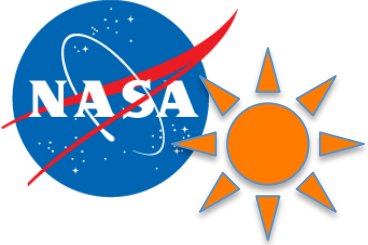




## MISR Stereo Technique

High-Resolution  
Cloud Top Height and Winds

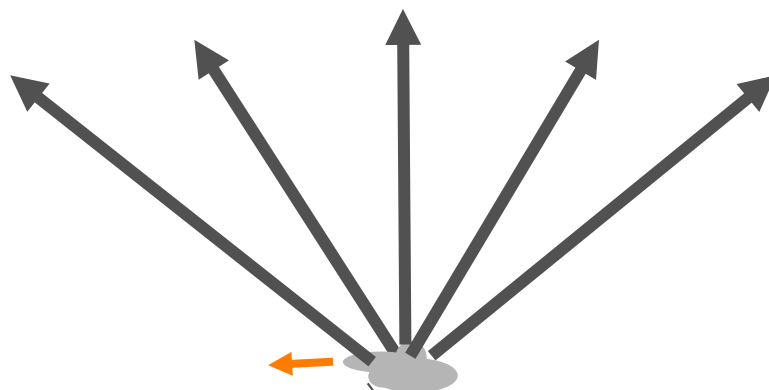
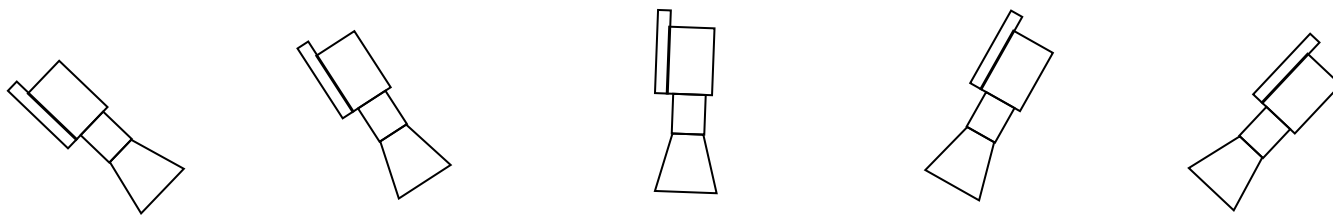




# MISR Stereo Technique

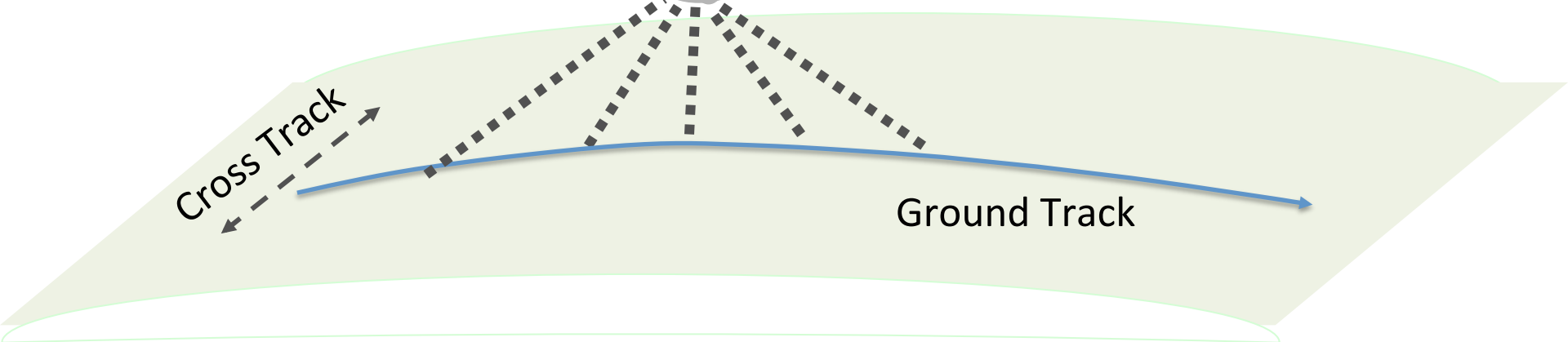
High-Resolution  
Cloud Top Height and Winds

MISR Flight Direction



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

1.1-km (zero wind)  
CTH0  
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)

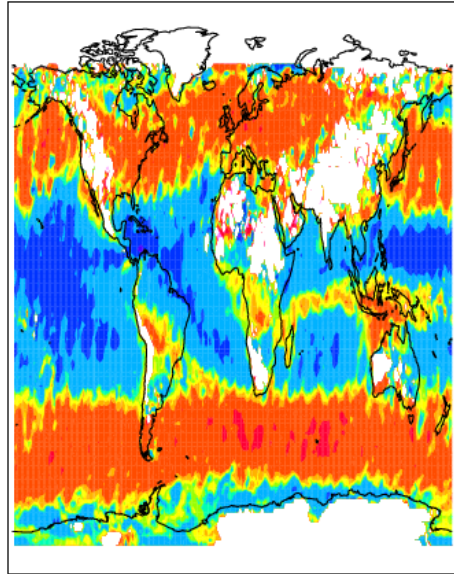
- *A priori* wind direction
- High resolution retrievals for CTH/CMV or plumes
- Portable to PC, Mac, and Linux
- Intense computation
- Easy to learn and good for regional case studies

Reanalysis  
Winds

CTH

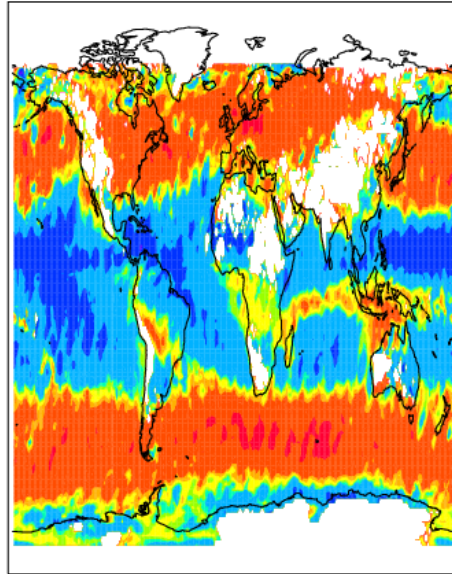
# MISR (New Version) vs ERA-Interim Winds at 0-2 km (Jan 2007)

MISR Zonal Wind (m/s)



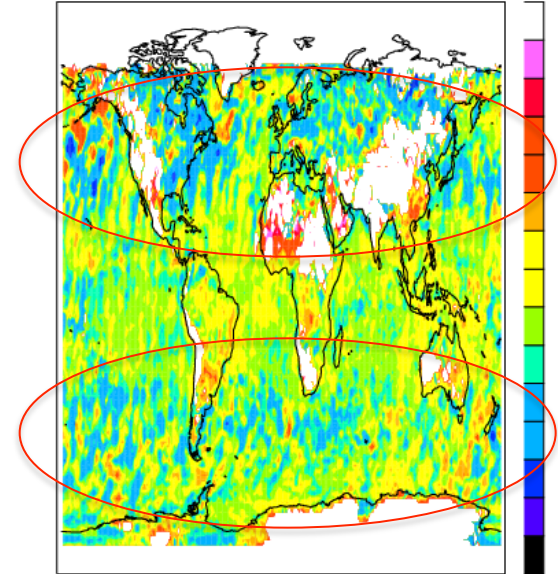
64  
32  
16  
8  
4  
2  
1  
0  
-1  
-2  
-4  
-8  
-16  
-32  
-64

ERA-Interim Zonal Wind (m/s)



64  
32  
16  
8  
4  
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1  
0  
-1  
-2  
-4  
-8  
-16  
-32  
-64

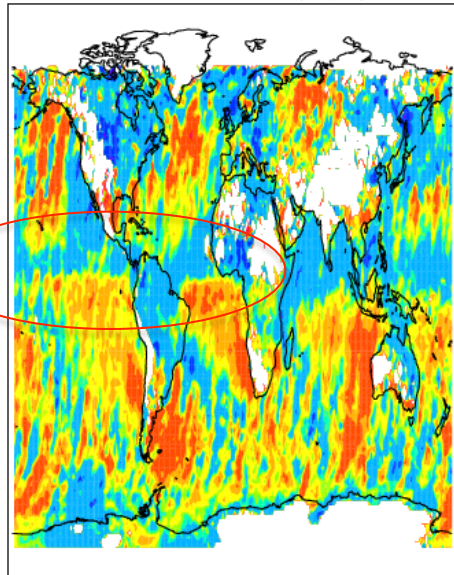
MISR-ERA Wind Diff (m/s)



64  
32  
16  
8  
4  
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0  
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-2  
-4  
-8  
-16  
-32  
-64

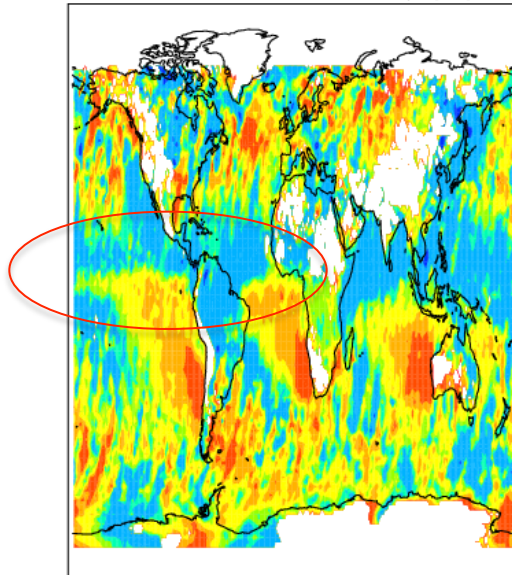
## Meri Wind

MISR Meri Wind (m/s)



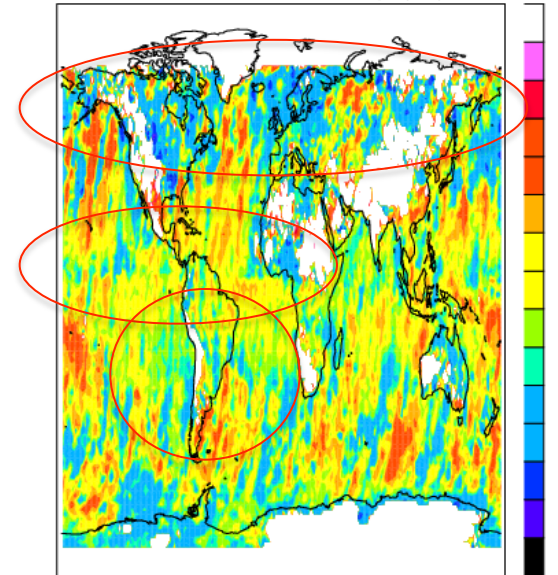
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8  
4  
2  
1  
0  
-1  
-2  
-4  
-8  
-16  
-32  
-64

ERA-Interim Meri Wind (m/s)



64  
32  
16  
8  
4  
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0  
-1  
-2  
-4  
-8  
-16  
-32  
-64

MISR-ERA Wind Diff (m/s)

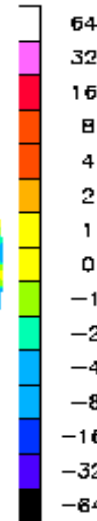
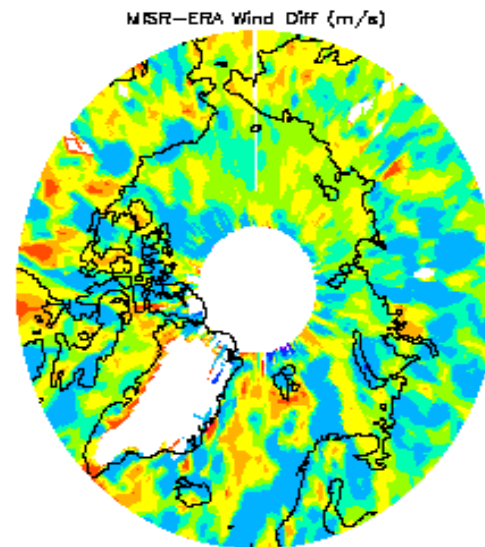
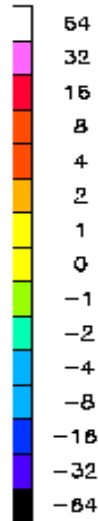
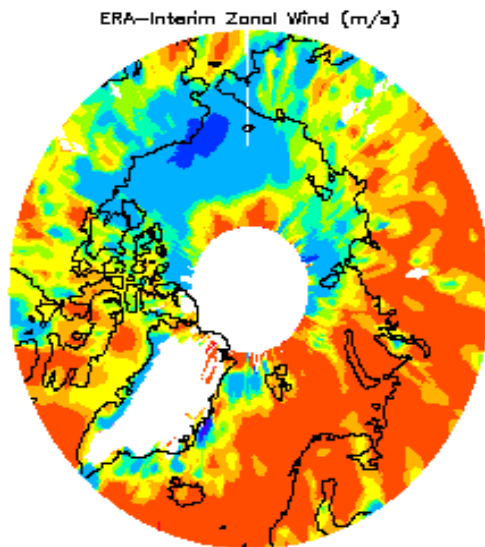
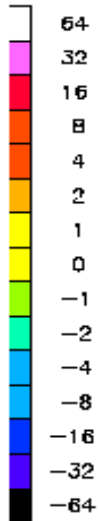
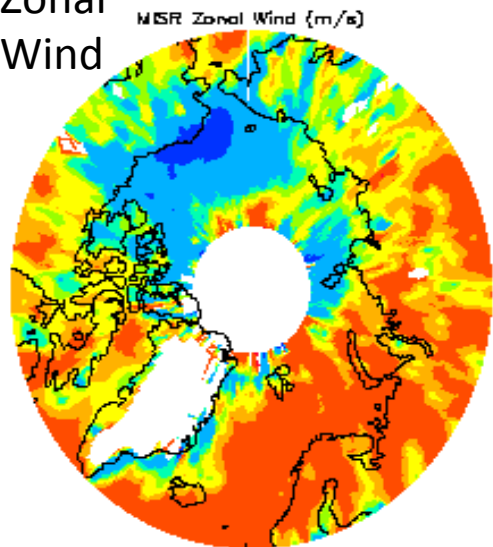


64  
32  
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-2  
-4  
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-16  
-32  
-64

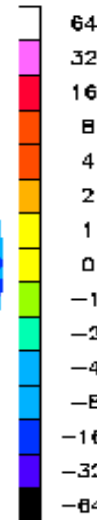
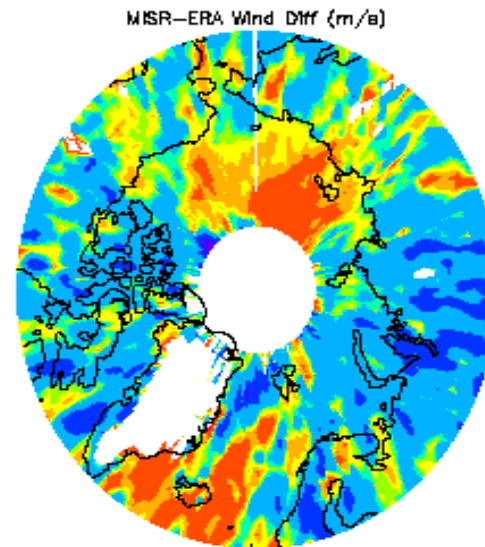
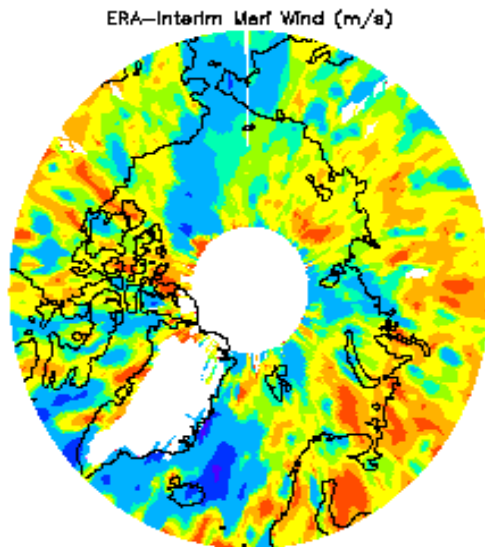
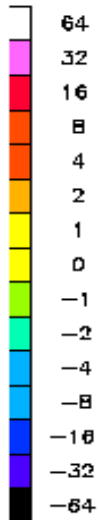
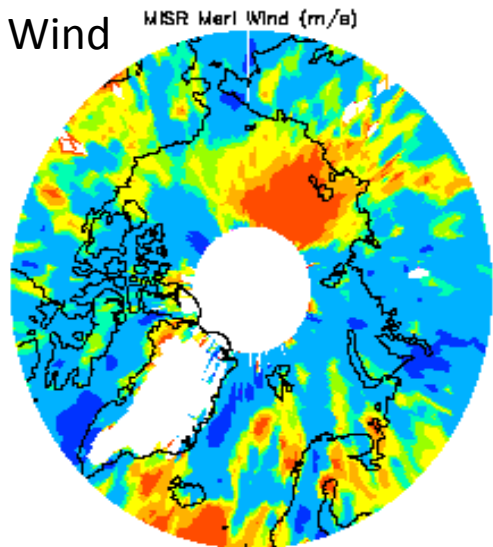


# October 2007, CMV (New Version) at 0-2 km

Zonal Wind



Meri Wind

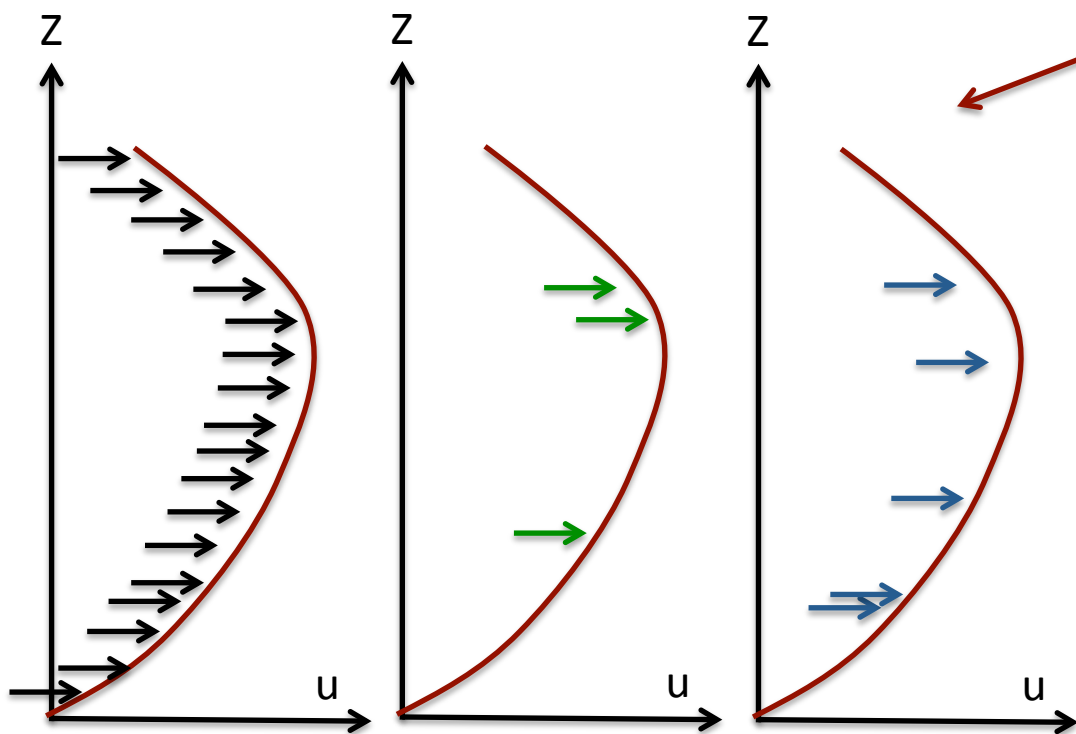






Past Present Future  
Motivation: 70.4 km → 17.6 km → 4.4 km

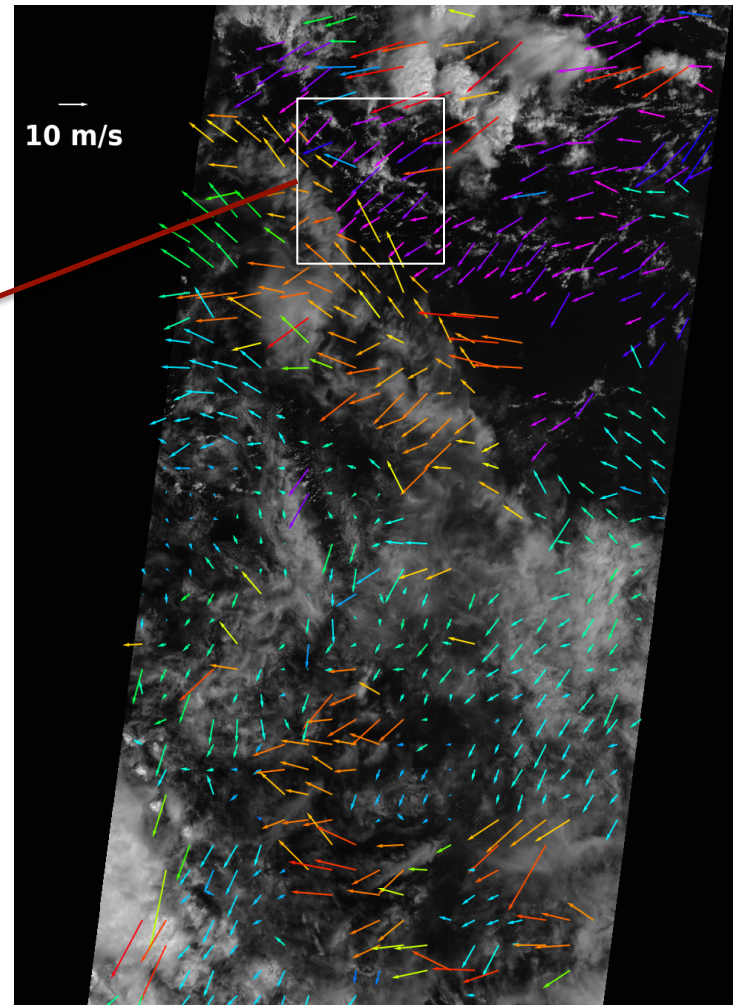
## CMV height problem and a solution



Analysis Wind

IR Wind

MISR Wind

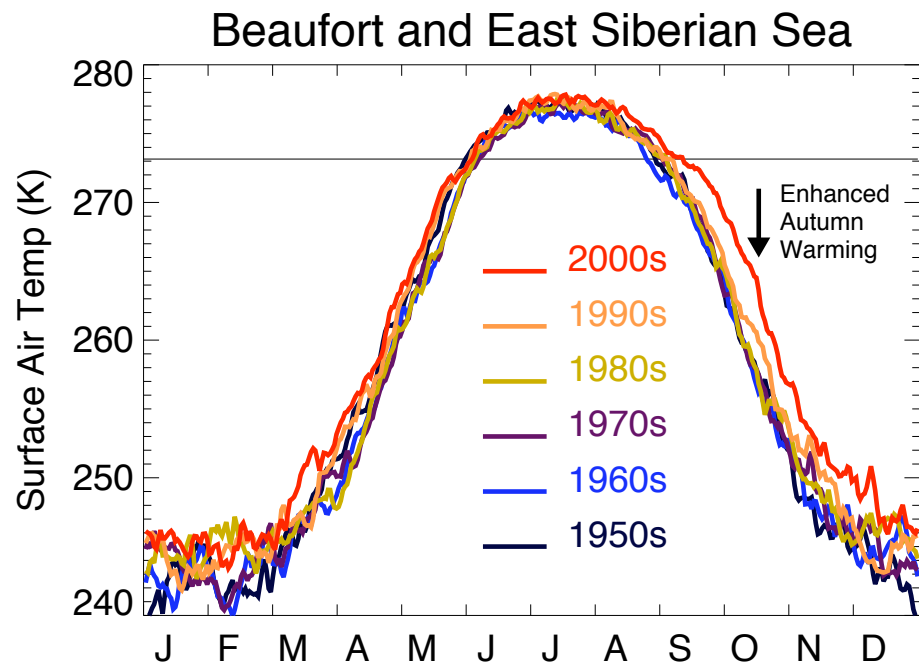
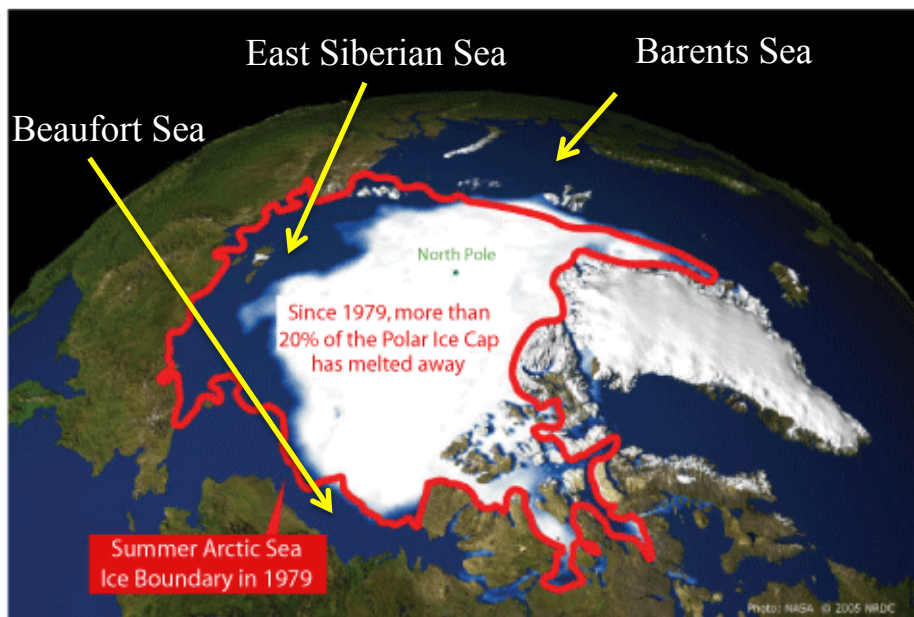


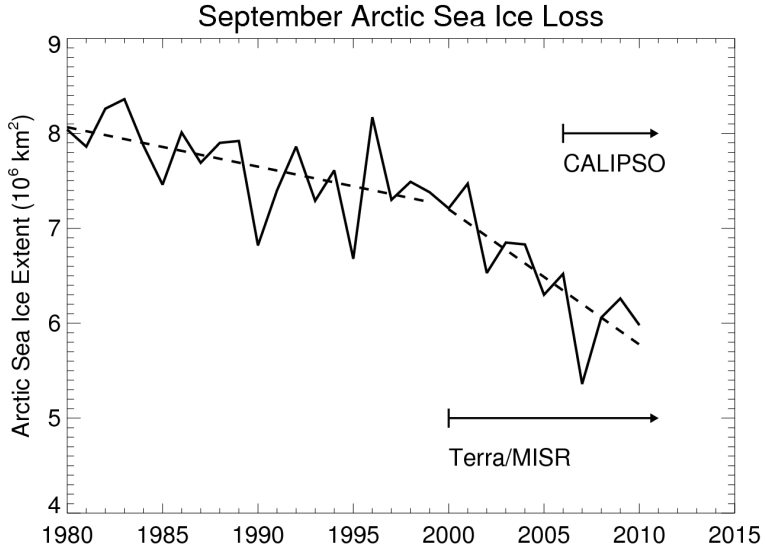
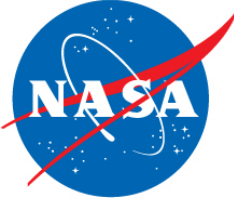
MISR 17.6 km CMV  
(courtesy of K. Mueller)



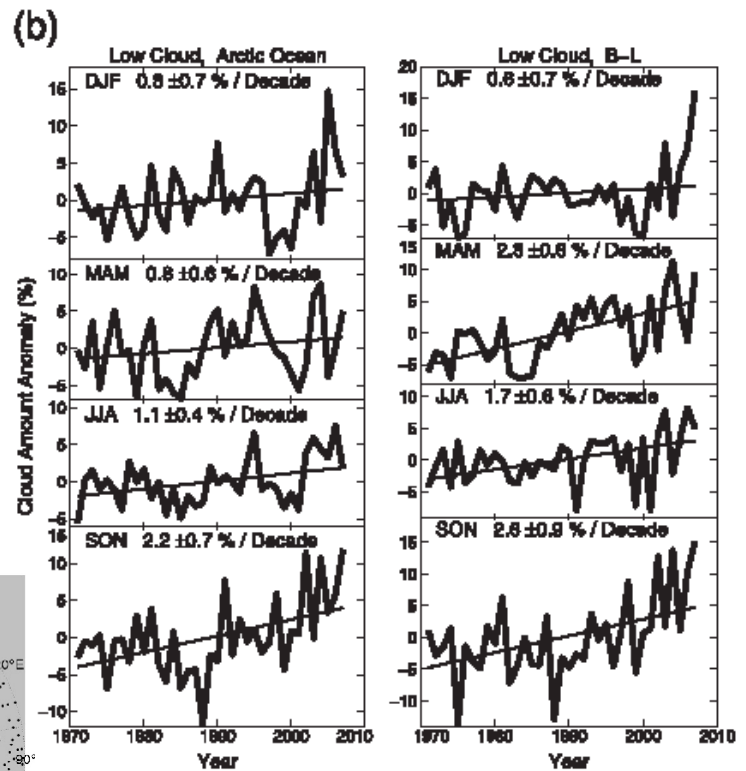
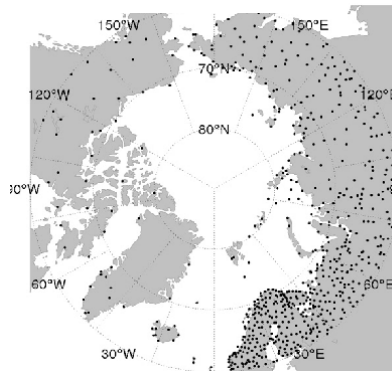
# Arctic Warming:

## Roles of Boundary-Layer Clouds and Dynamics

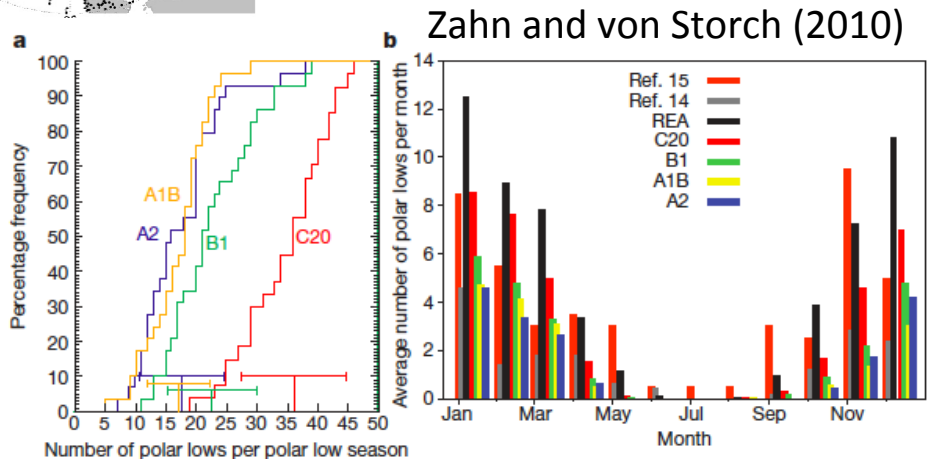




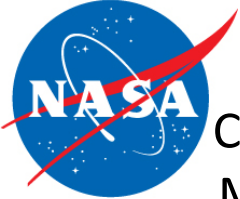
## Rapid Climate Changes in the Arctic



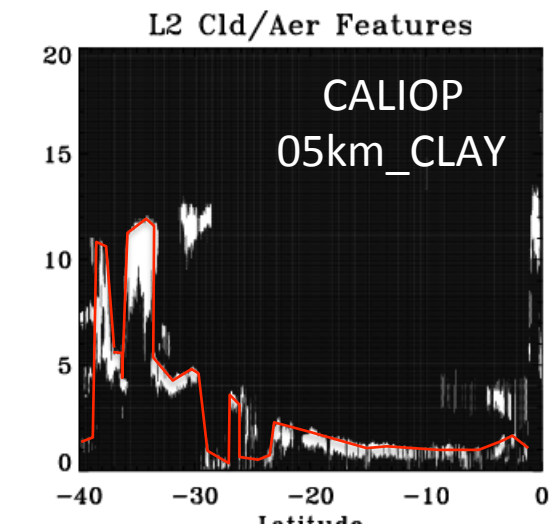
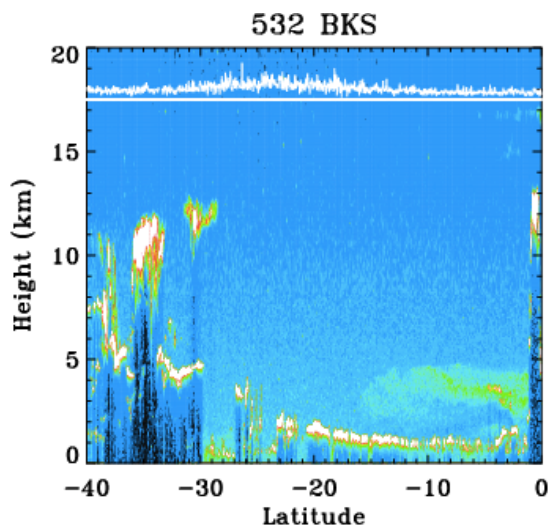
Eastman and Warren (2010)



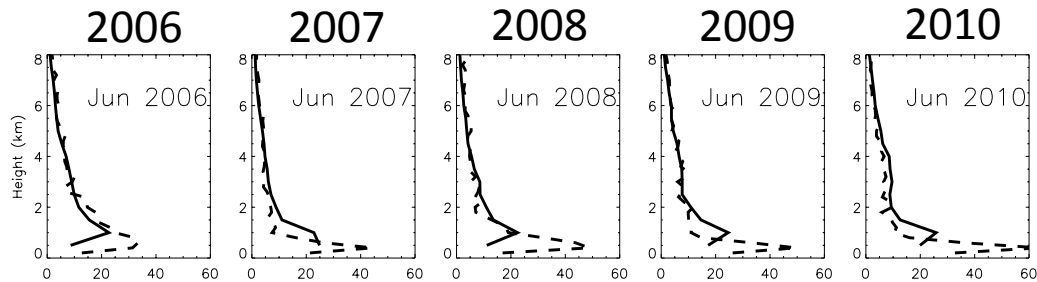
- What is the role of cloud feedbacks in Arctic warming?
- How do dynamics response to more open water in the Arctic Ocean?



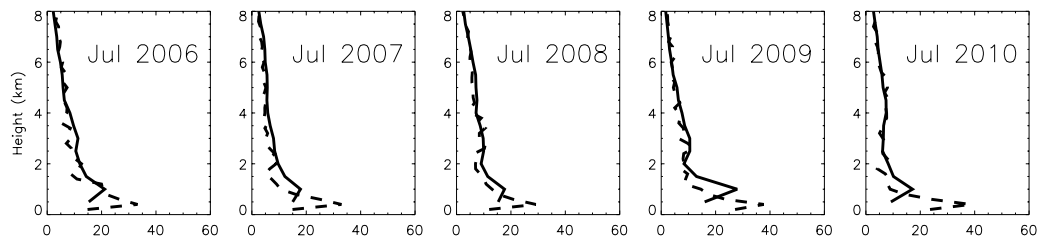
# Comparisons of MISR & CALIOP (Beaufort-Laptev Region)



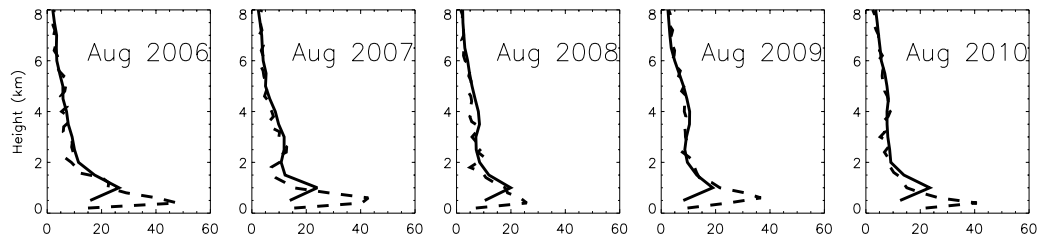
Jun



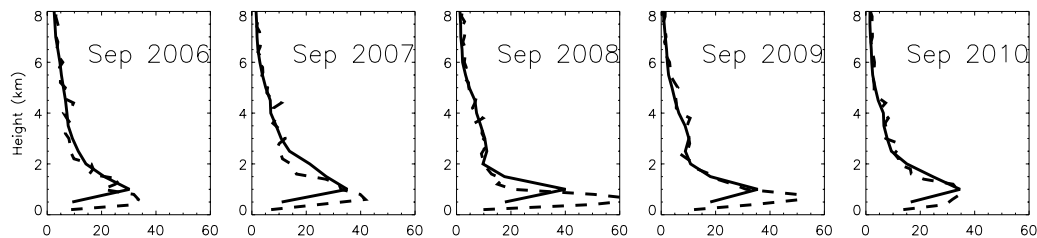
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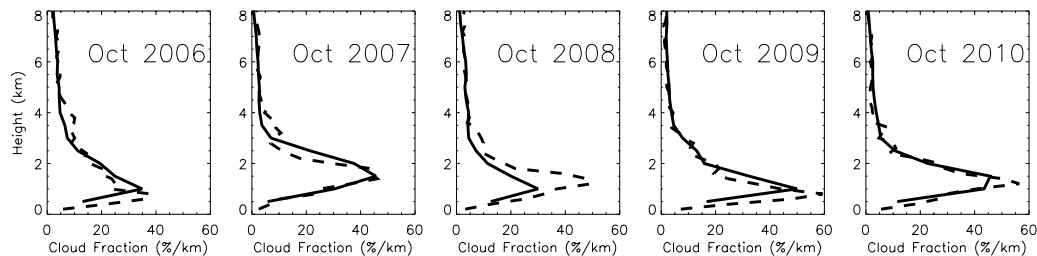
Aug



Sep

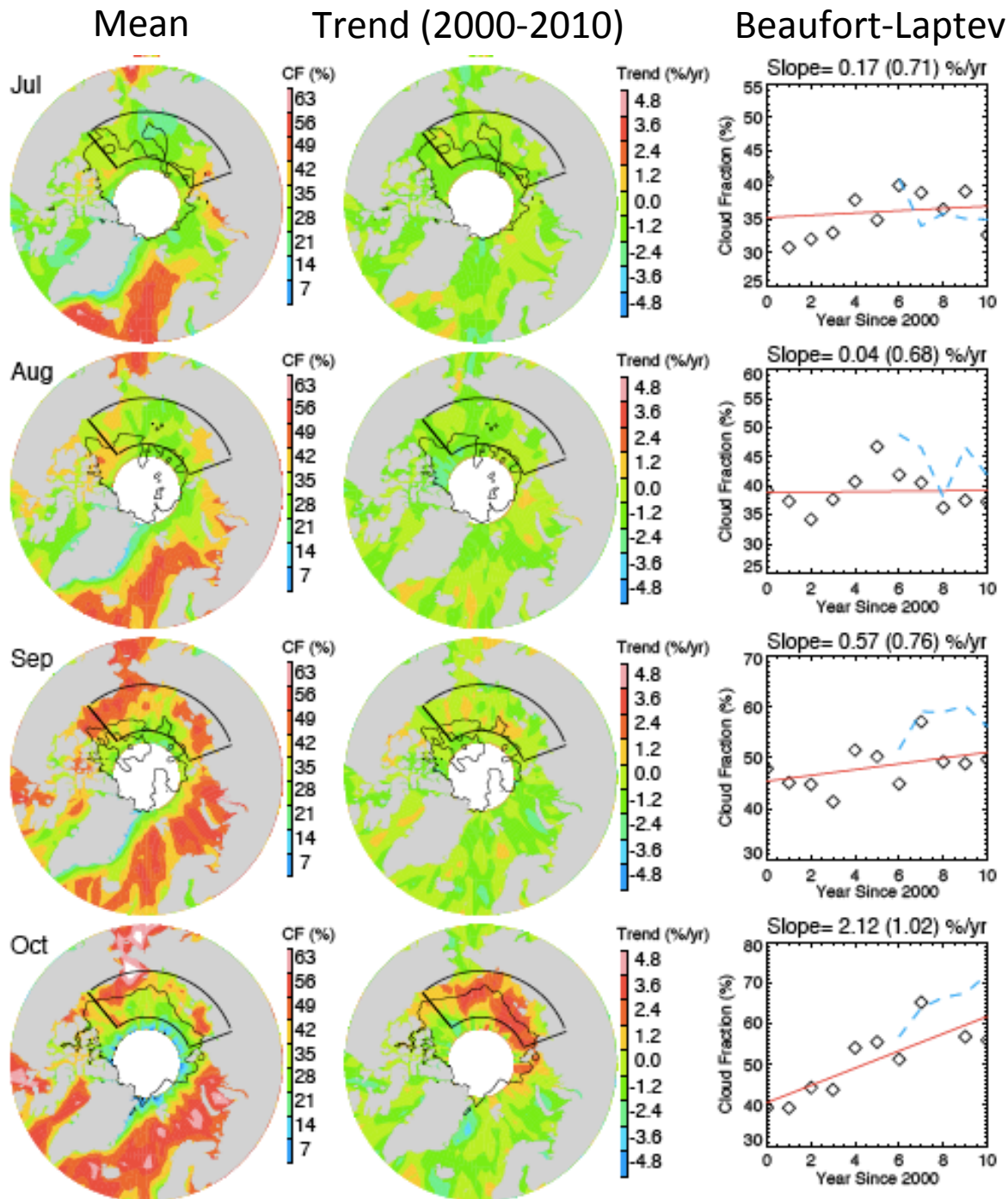


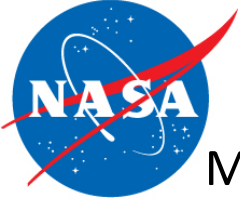
Oct





# MISR Low-Cloud (0-3 km) Fraction

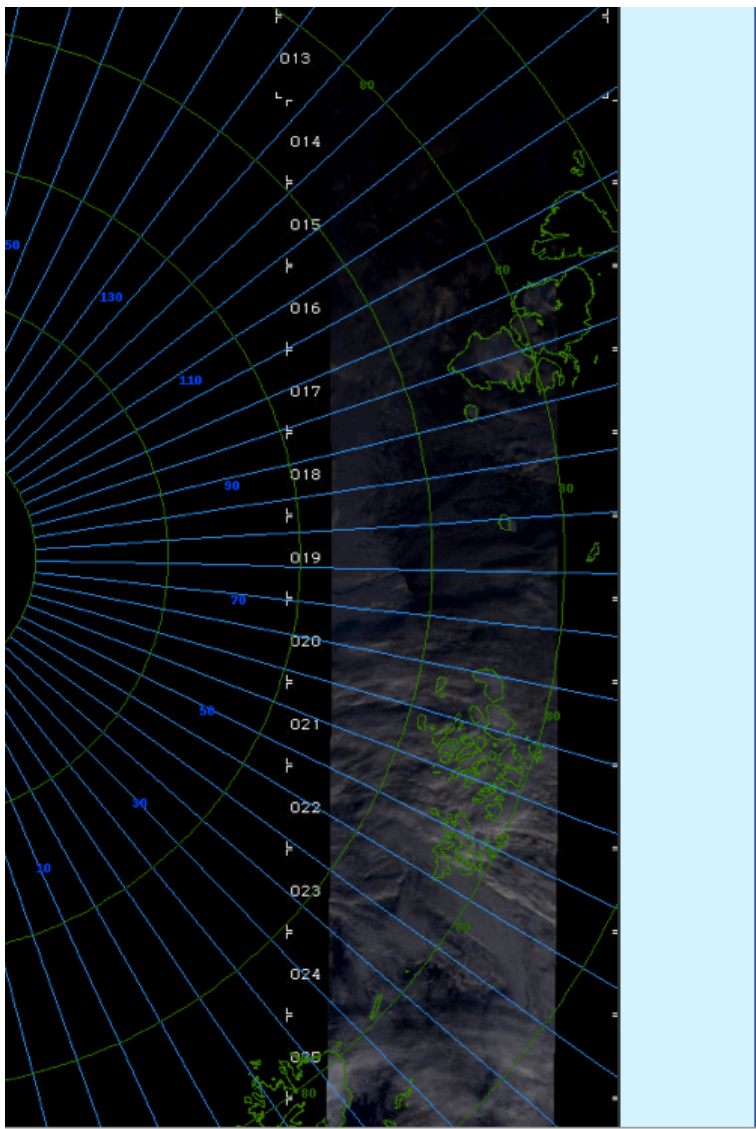




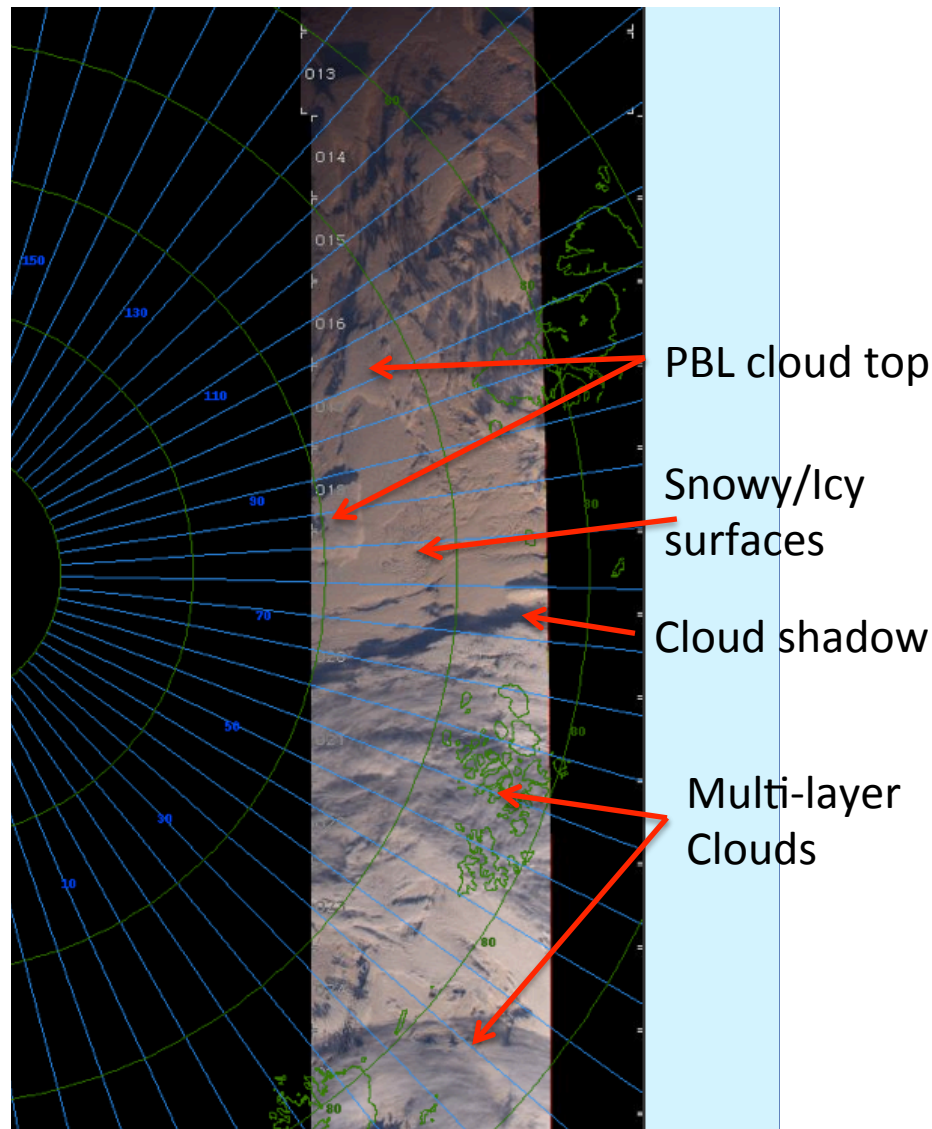
# MISR Orbit 62271 (October, 2007)

## Multi-Angle Stereo Technique for Cloud Detection over Snowy/Icy Surfaces

Nadir (AN)

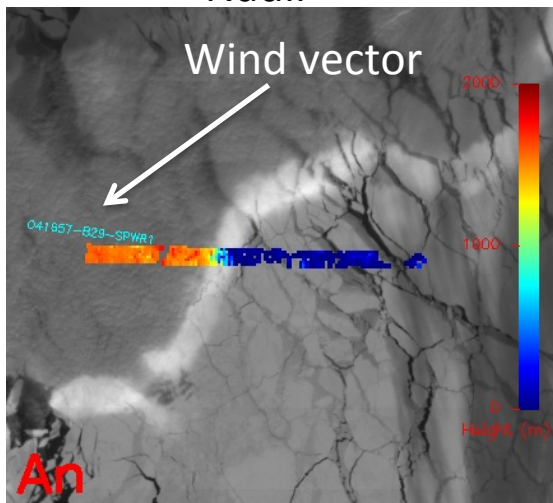


70° Forward (DF)



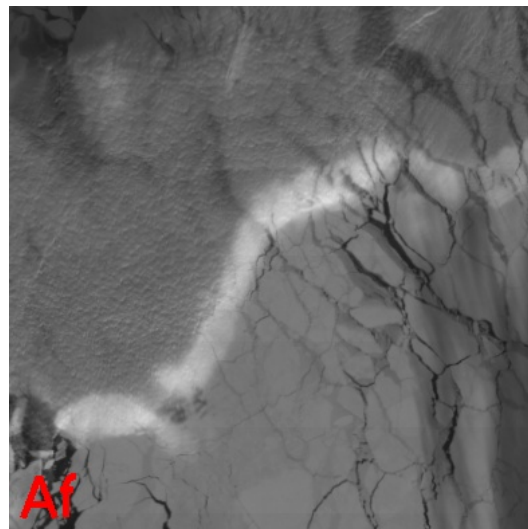


Nadir

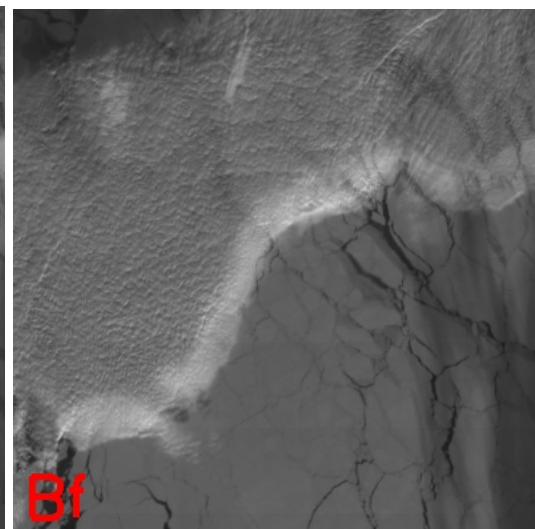


# MISR on Oct 17, 2007

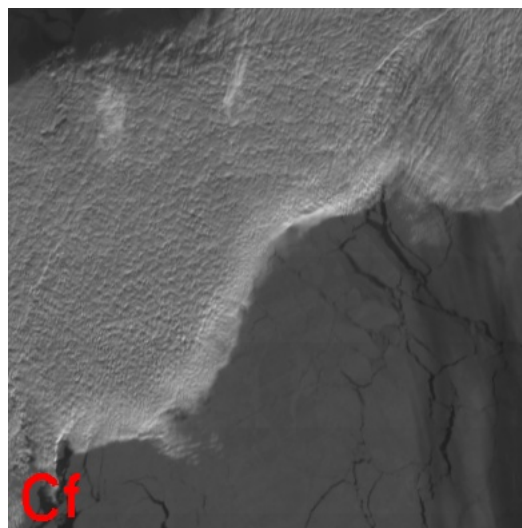
26° Forward



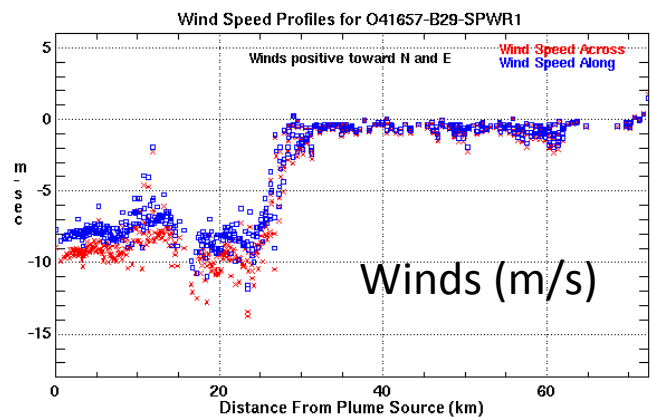
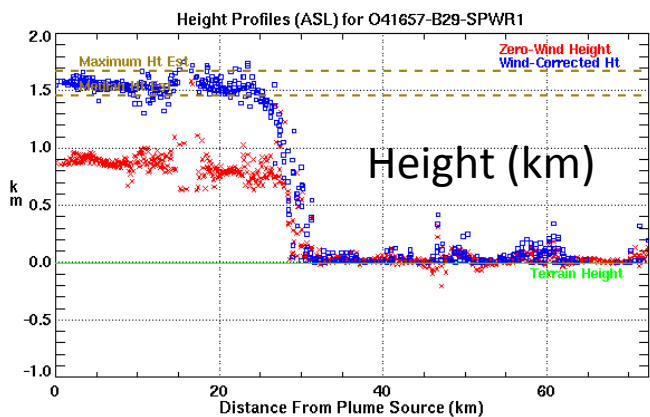
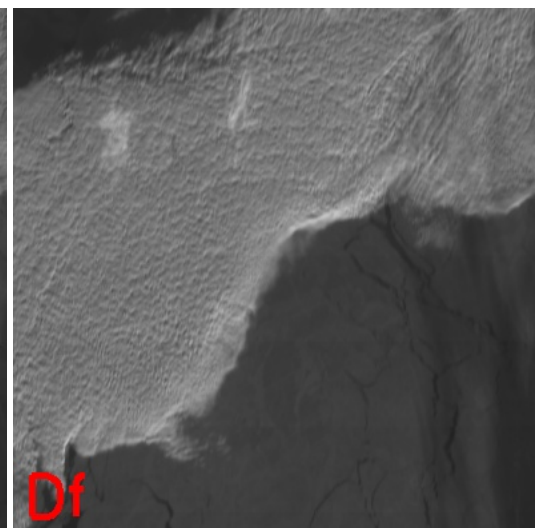
46° Forward



60° Forward



70° Forward

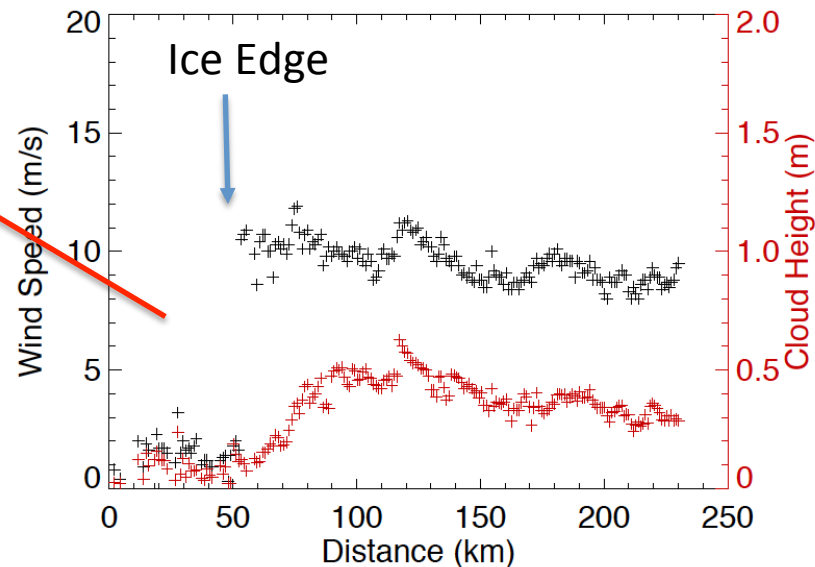
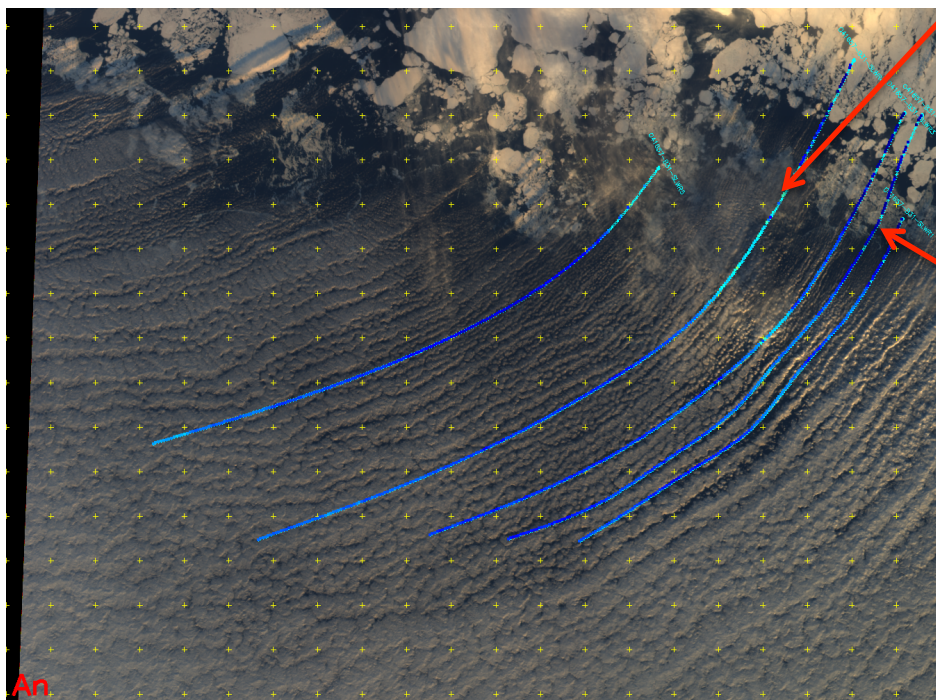
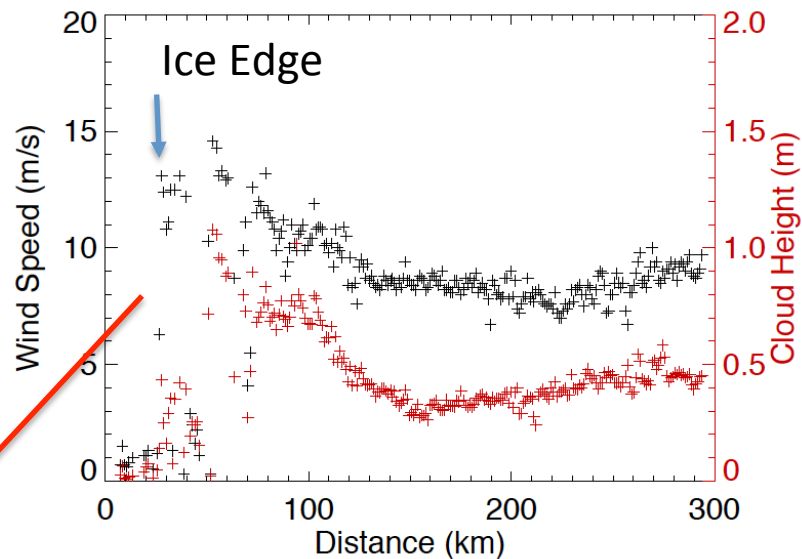
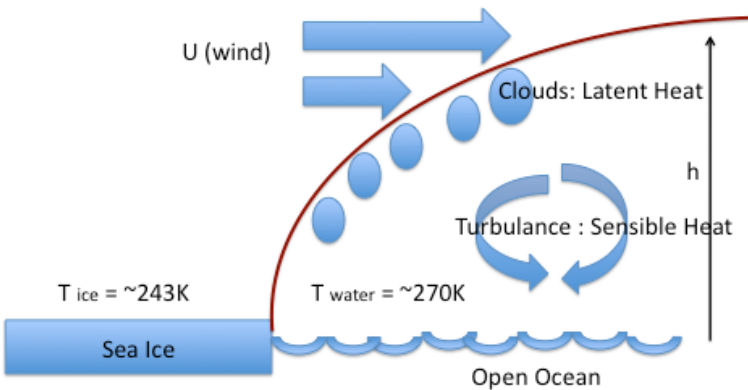




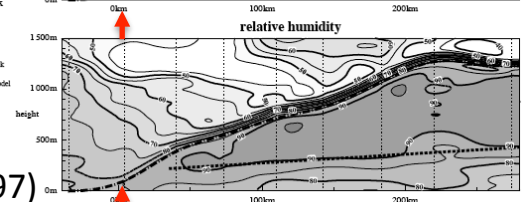
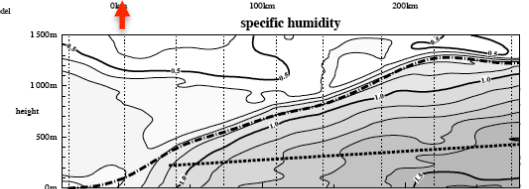
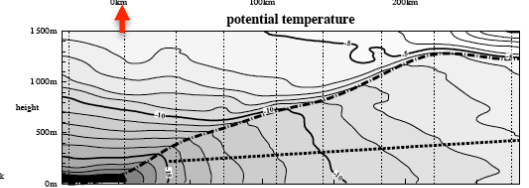
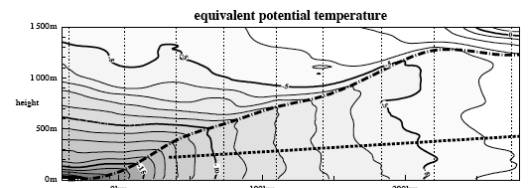
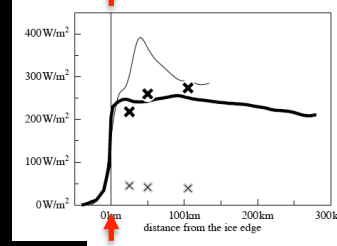
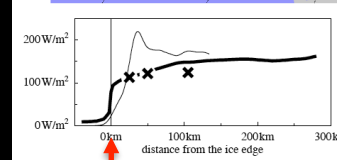
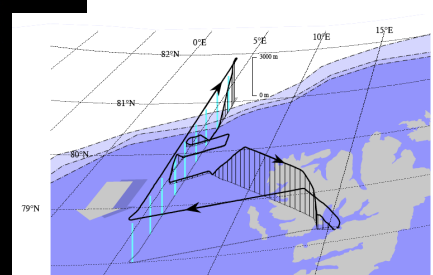
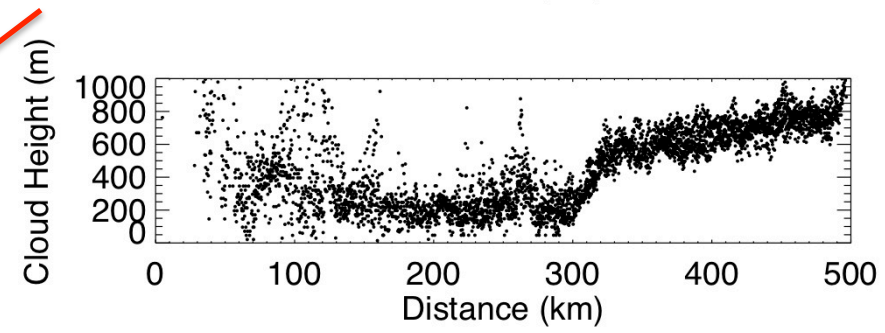
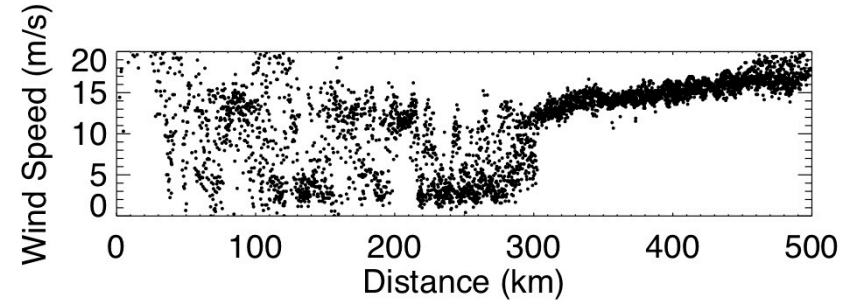
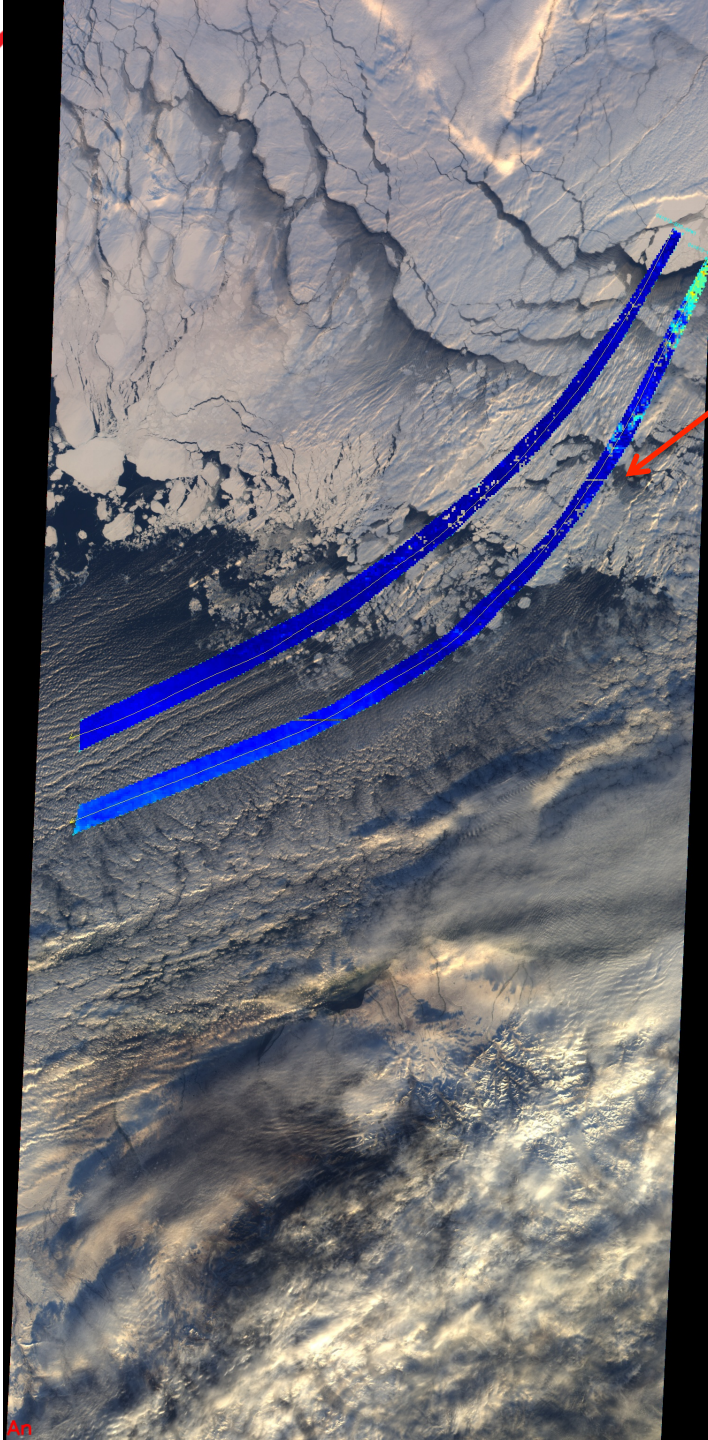
# Marginal Ice Zone (MIZ)

## Dramatic Transition in PBL and Cloud Properties

### Arctic boundary layer







Hartmann et al. (1997)



# Summary

- MISR stereo CMV/CTH products
  - Different requirements for CMV and 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