

Overview of the MODIS Snow - Ice Project

Part 1

Dorothy K. Hall

Cryospheric Sciences Branch
NASA / Goddard Space Flight Center
Greenbelt, Md.
dorothy.k.hall@nasa.gov

George A. Riggs

SSAI and Cryospheric Sciences Branch

Nicolo E. DiGirolamo

SSAI and Cryospheric Sciences Branch

Jeffrey A. Miller

Wyle & Cryospheric Sciences Branch

James L. Foster

Sujay Kumar

Soni Yatheendradas

Hydrological Sciences Branch
NASA / Goddard Space Flight Center



MODIS Science Team Meeting
Land Team
College Park, Md.
18 May 2011



Outline

Product Usage

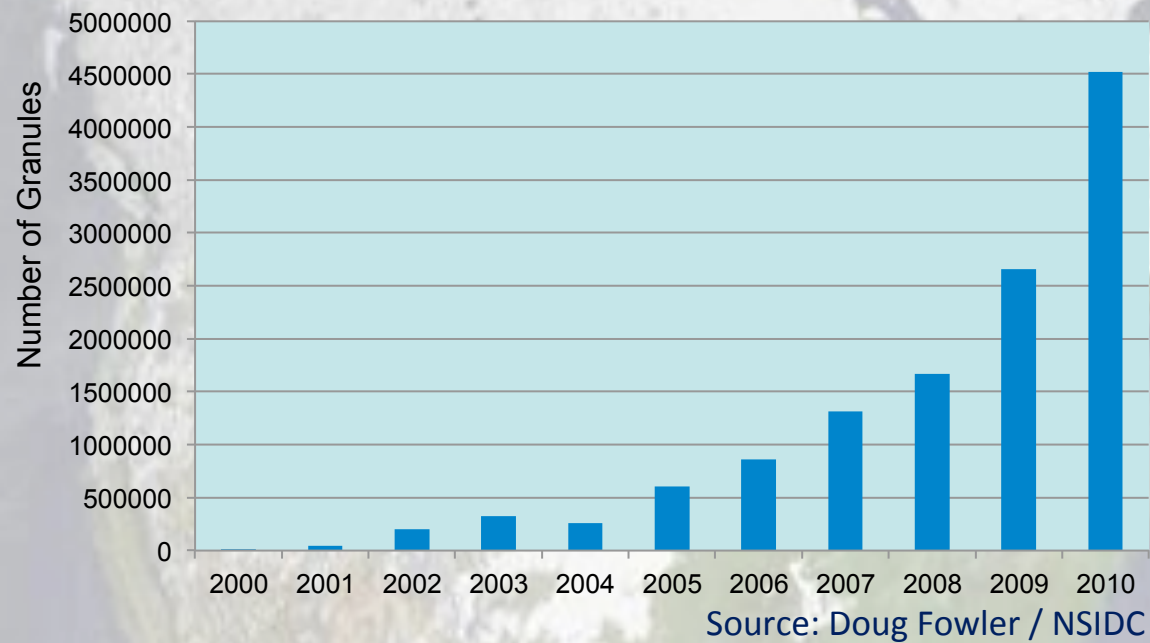
Three New & Related Products

Re-Launched Website [modis-snow-ice.gsfc.nasa.gov]

Science Results

Collection 6 (C6) Changes – Part 2 - George Riggs

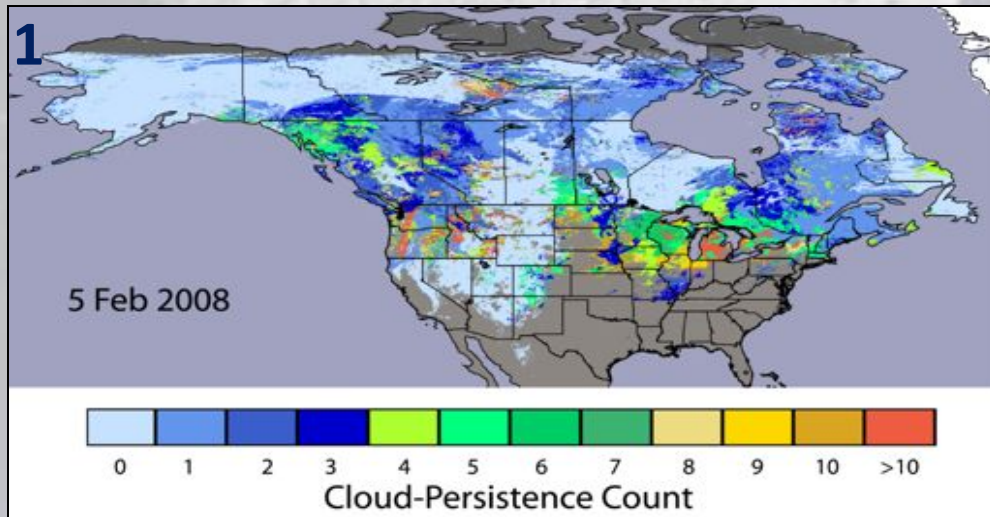
4,500,000 Terra & Aqua Snow-Sea Ice Granules Distributed in 2010



Also see Bibliography of MODIS Snow and Sea Ice Papers, updated 5-9-11 – see “Publications” on Website

Three New Products Have Been Developed

Daily Cloud-Gap-Filled Snow Map









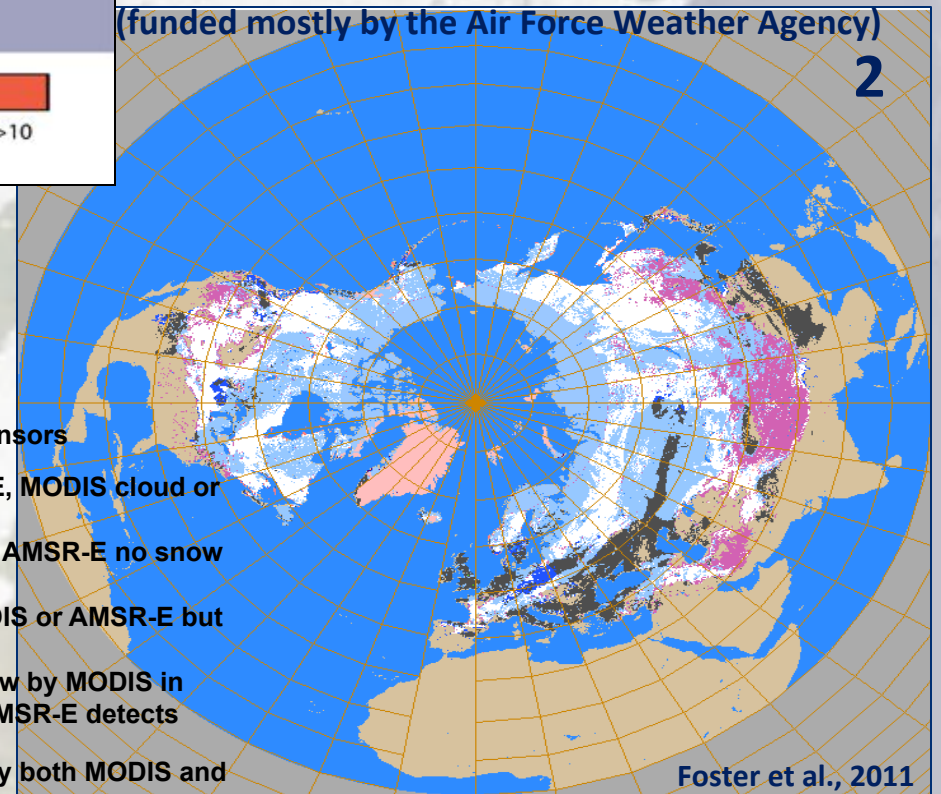
Hall et al., 2010

Daily Blended MODIS-AMSR-E Snow Map

(funded mostly by the Air Force Weather Agency)

2

-  Snow by both sensors
-  Snow by AMSR-E, MODIS cloud or no data
-  Snow by MODIS, AMSR-E no snow
-  No snow by MODIS or AMSR-E but cloud obscured
-  No snow: no snow by MODIS in clear view, but AMSR-E detects snow
-  Snow free land by both MODIS and AMSR-E



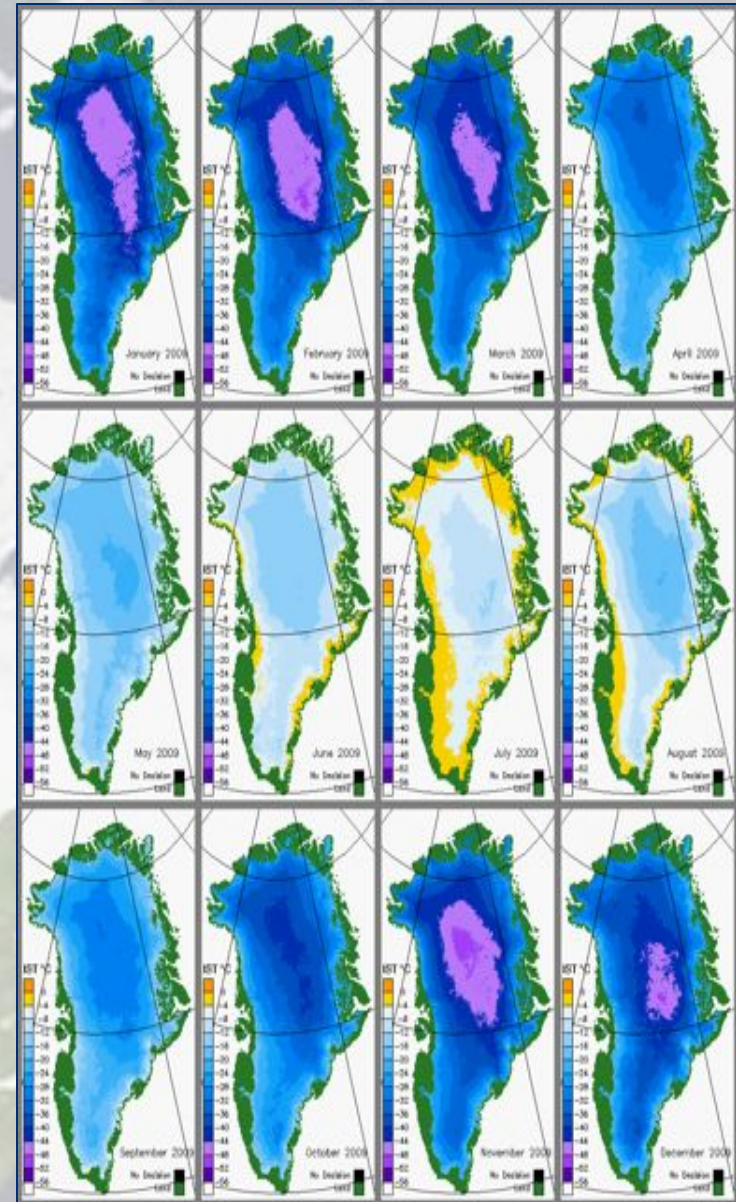
Foster et al., 2011

Mean-Monthly IST of the Greenland Ice Sheet for 2010

3

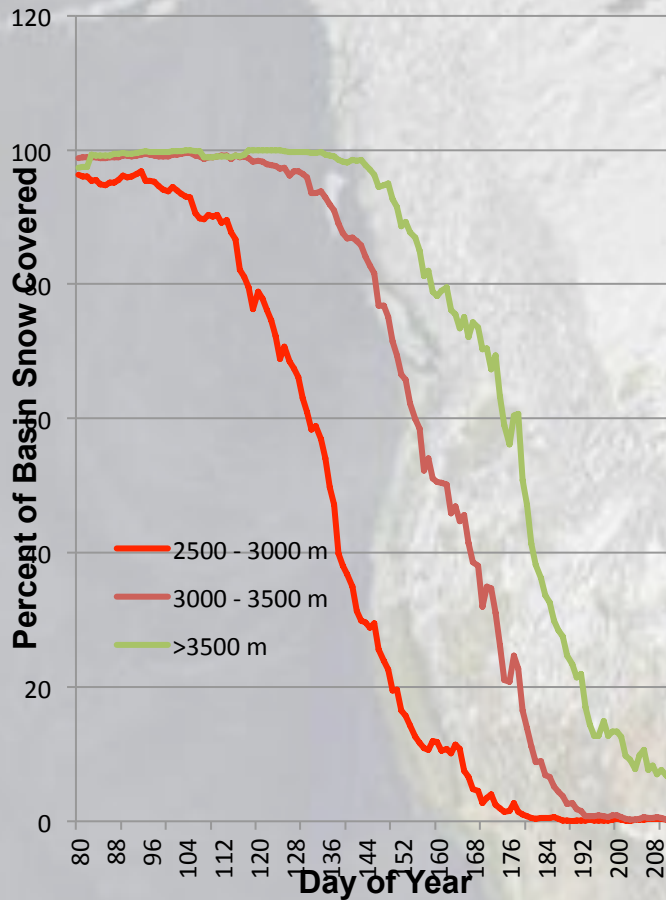
MODIS Climate-Data Record (CDR) of the Surface Temperature of the Greenland Ice Sheet , 2000 - 2010

- Uses MODIS ice-surface temperature (IST) algorithm currently used for sea ice IST algorithm
- CDR to be available for downloading in summer 2011
- Related product developed with NASA Cryospheric Sciences Program funding

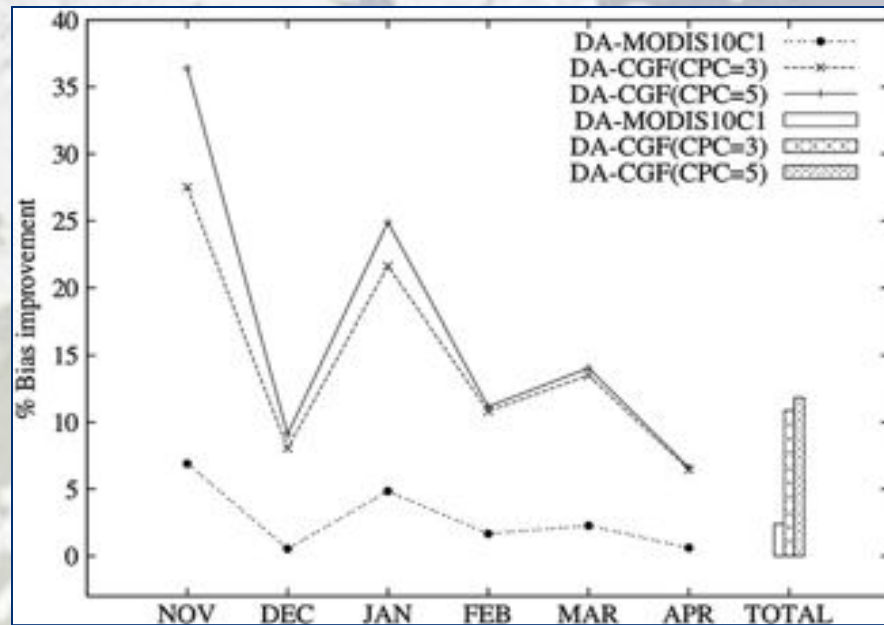


Science and Modeling Applications

Snow-cover depletion curves for the Wind River Range, Wyo., 2000 – 2010 from MODIS CGF snow-cover data



MOD10 and CGF snow-cover products used to correct modeled SWE and snow depth fields in data-assimilation modeling



Model runs by Sujay Kumar / GSFC Code 614.3

Overview of the MODIS Snow - Ice Project Snow Algorithms and Products for C6

Part II

George Riggs

MODIS Science Team Meeting

18 – 20 May 2011

College Park, MD



Overview

C6 changes, are response to users' feed back regarding accuracy and errors reported for various applications of the MODIS snow products , and our evaluation of MODIS snow products.

Revised C6 snow algorithms

Adapt to the L2G lite storage format

New C6 snow products

Two groups affected by C6 changes production -- down stream products that use MOD10* products, new products, and NSIDC EOS-DAAC users – applications using primarily MOD10A1 and higher levels

Learned from Users

Usage: *[listing of papers that use MODIS snow products at modis-snow-ice.gsfc.nasa.gov/]*

- MOD10A1 is most often used in applications, MOD10CMG for global scale modeling, e.g. Noah land surface model
- Though both the snow covered area (SCA) and fractional snow cover (FSC) maps available, the SCA is most often used
- QA data used infrequently

Comparison:

- MOD10A1 compared to other snow covered area algorithms/products and surface station data

Snow errors:

- Snow/cloud confusion at snow cover edge
- Snow/cloud confusion in other situations associated with cloud cover, producing snow commission or omission errors
- Snow errors in less than ideal viewing conditions
- Disappearance of snow cover during summer in mountains

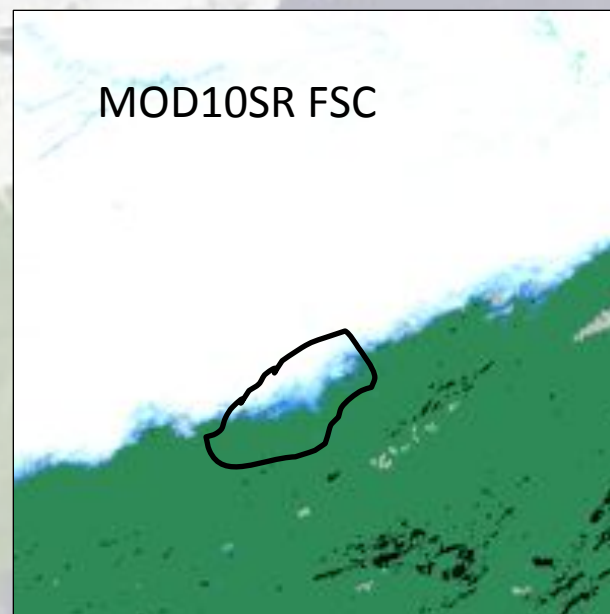
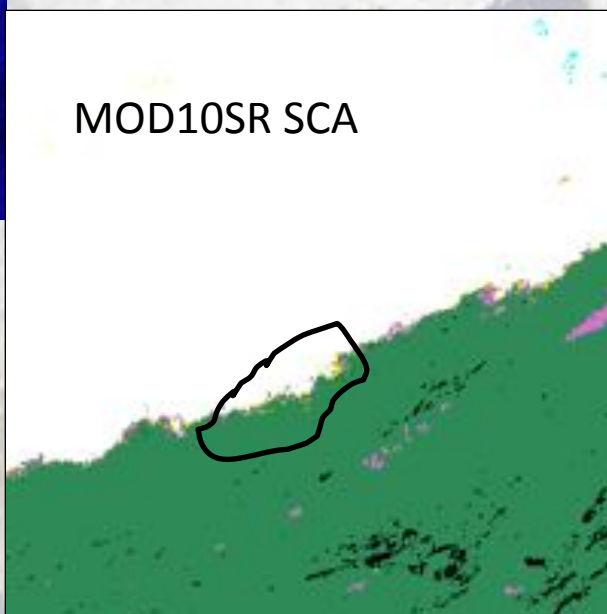
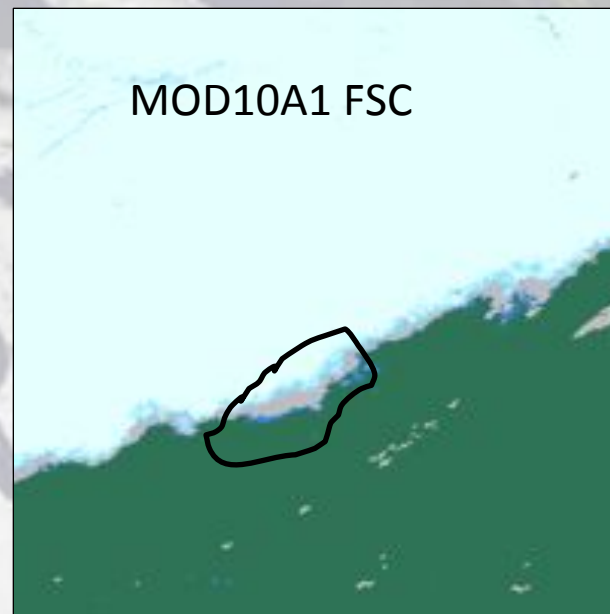
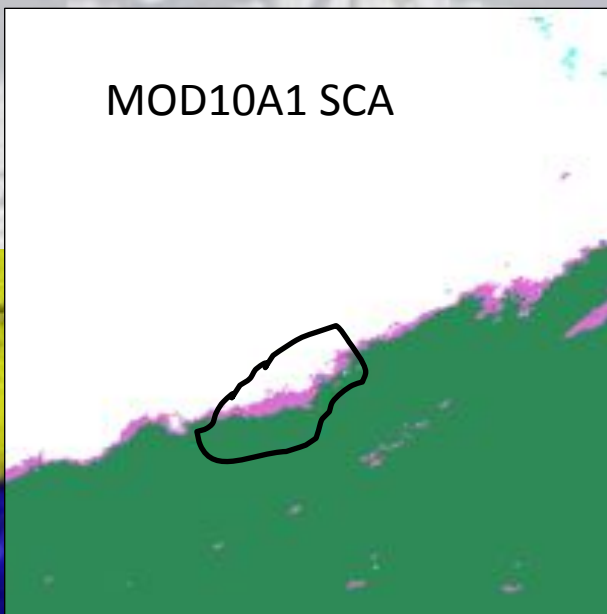
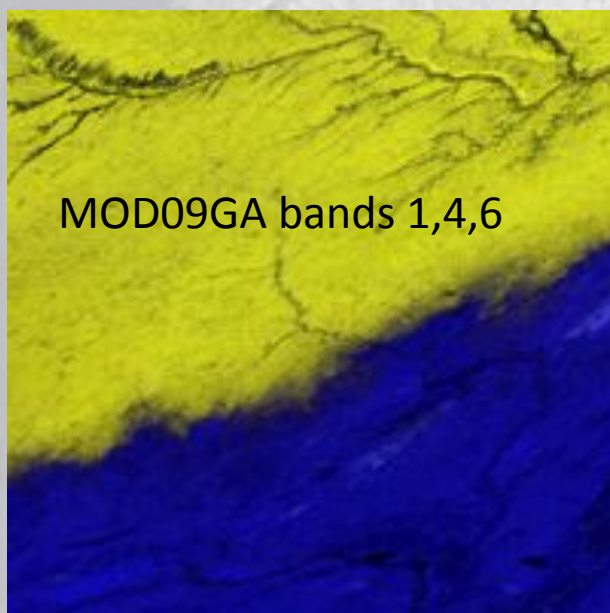
Summary Major C6 Revisions

- ❖ Sequence of snow products will continue in C6
- ❖ MOD10_L2 snow algorithm C6 revised to improve snow cover detection
- ❖ MOD10A1 algorithm revised to use L2G lite format
- ❖ MOD10SR – new independent product to be made using MOD09GA input
 - ❖ Supersede the MOD10A1
- ❖ MOD10 CGF – new L3 cloud gap filled (CGF) products added to sequence of products

Investigation & Evaluation relevant to users' feedback

- Investigated using more data/information from inputs to reduce snow errors of omission and commission in some situations
- Evaluated using MOD09GA as input to the snow algorithm and running it at L3
- Using MOD09GA, daily surface reflectance, resulted in similar SCA and FSC maps compared to MOD10A1 that originated from MOD02HKM TOA input.
- Improvements gained with MOD09GA are;
 - decreased snow/cloud confusion in some situations, done by use of both MOD35 and MOD09 cloud flags (*snow/cloud confusion might also be decreased at L2 by use of individual cloud spectral test results, previous investigation done*)
 - decrease in snow commission errors associated with cloud fringes and/or shadows
 - slightly increased accuracy in low illumination and low surface reflectance situations.
- Disappearance of summer snow in mountains is caused by low (10%) visible reflectance screen that prevented snow detection. Removing that screen allows detection of summer snow cover in mountains.

Great Plains snow edge
mapping
1 December 2001
tile h10v04



MOD10SR -- combined
usage of MOD_35 and
MOD09 flags to
alleviate snow/cloud
confusion at edge of
snow cover in
MOD10A1 snow maps

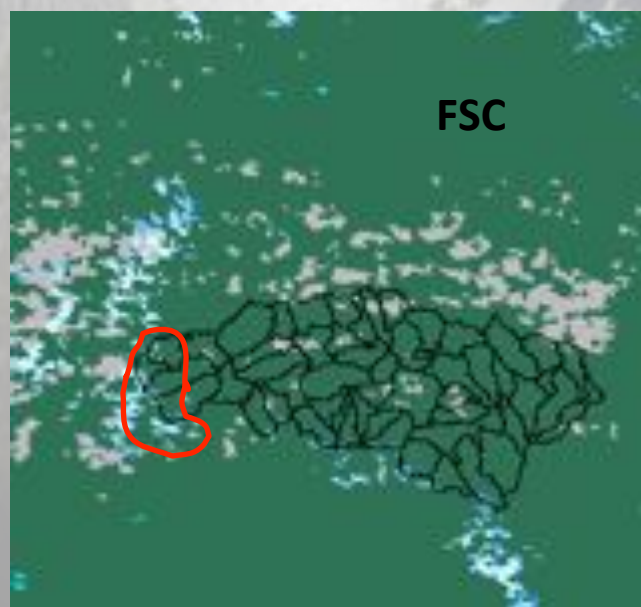
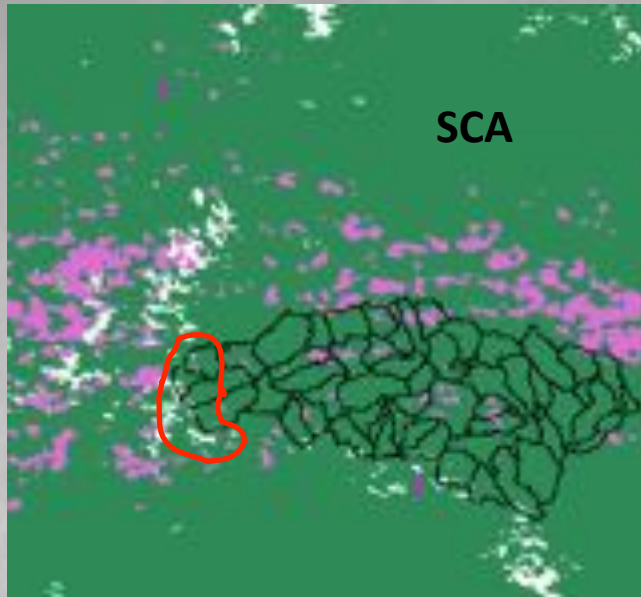
Improved snow
detection using
MOD09GA input to
MOD10SR

Snow cover
underestimation using
SCA (binary) has been
reported, for example
*Molotch, N.P. and Margulis S.A.
2010. Response to comment by...
Advances in Water Resources
33:231-239, doi:10.1016/
j.advwatres.2009.11.008*

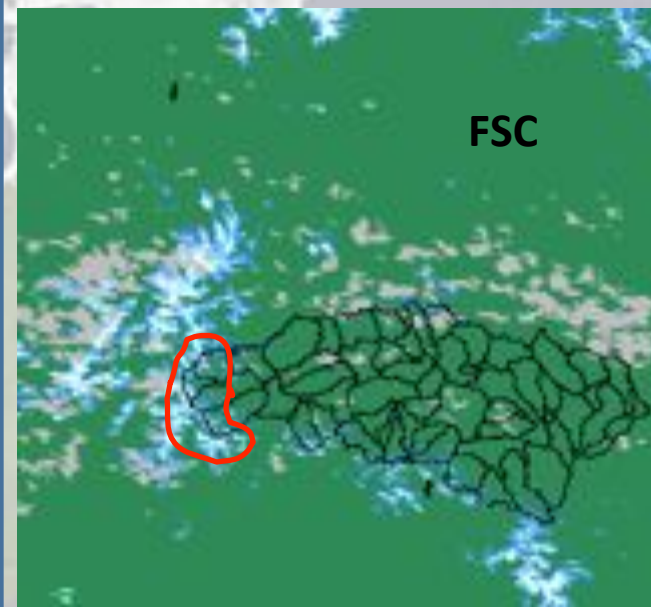
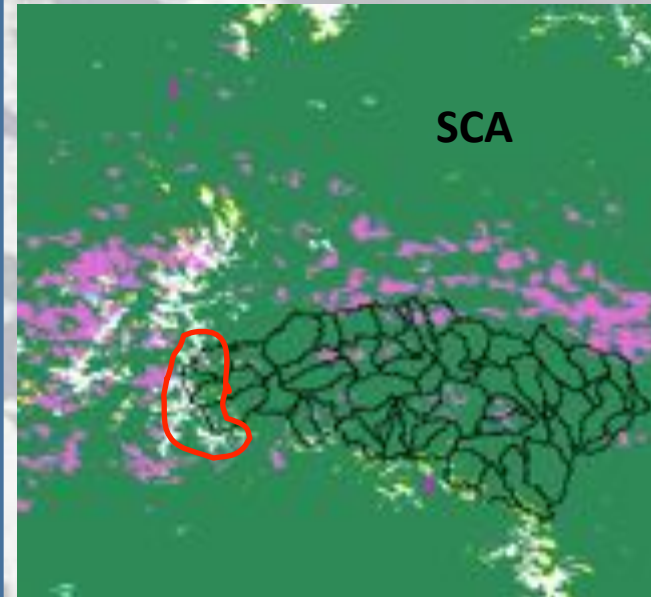
MOD10A1.A2002126.h
09v05 (6 May)
Rio Grande headwaters

Improved snow
detection with
MOD10SR

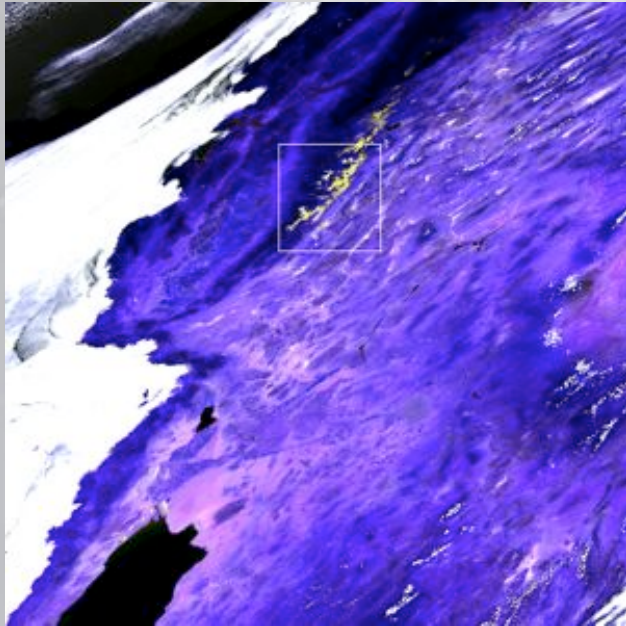
MOD10A1 C5



MOD10SR C6



MOD09GA.2010187.h08v05
July 6, 2010



Disappearance of summer snow in mountains is caused by low (10%) visible reflectance screen that prevented snow detection. Removing that screen allows detection of summer snow cover in mountains. *(Caveat, snow commission errors can be made on unmasked water bodies without that screen. Other screens for water bodies implemented; being tested.)*

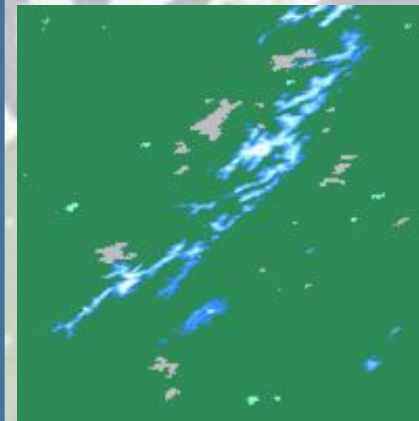
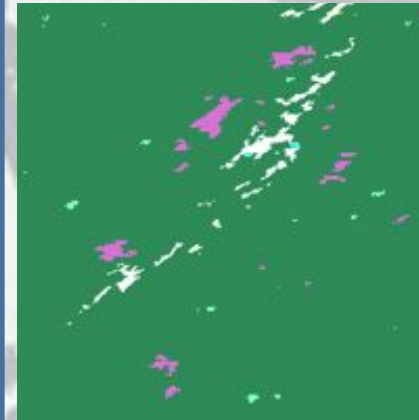
MOD10A1 C5
With low visible
reflectance screen

SCA



MOD10SR C6
No low visible
reflectance screen

FSC



LEGEND

- SNOW
- LAND
- CLOUD
- INLAND WATER
- OCEAN
- NO DATA

FRACTIONAL
SNOW COVER

- 1-20%
- 21-40%
- 41-50%
- 51-60%
- 61-70%
- 71-80%
- 81-90%
- 91-100%

- Cloud
- Water
- Land

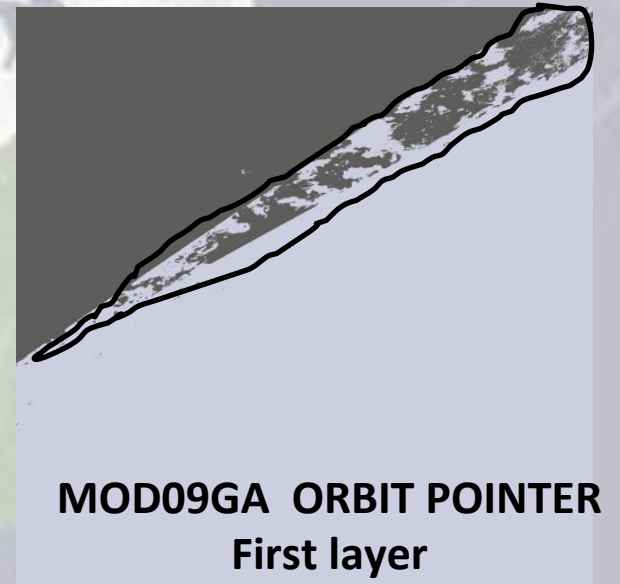
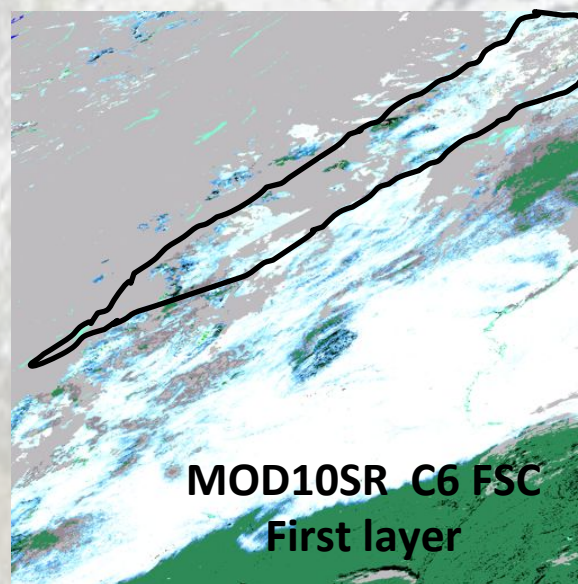
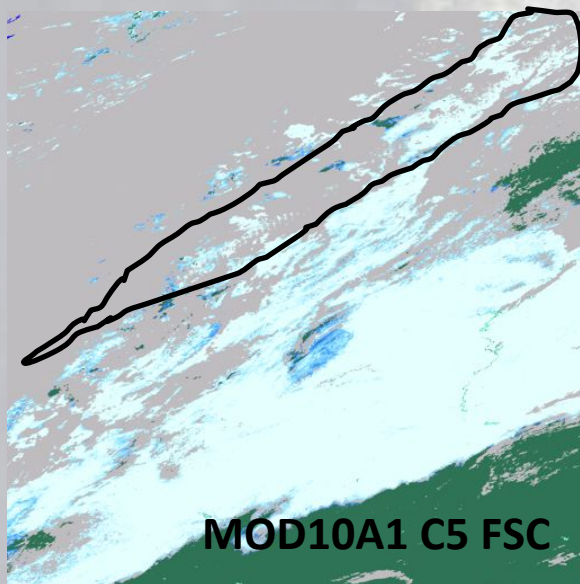
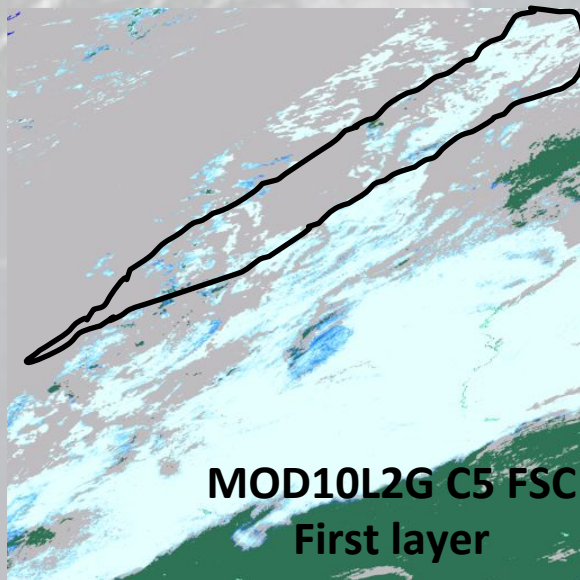
New Daily Snow Product MOD10SR C6

- Revised implementation of the MODIS snow algorithm in response to user feedback on use of the MOD10A1 product
- The snow algorithm will be run at L3 in processing sequence but will use MOD09GA input.
SCA algorithm and FSC regression equation are not changed.
Low visible reflectance screen dropped, replaced by other screen(s)
Use MOD35 and MOD09 cloud flags for cloud/masking and apply more snow/cloud discrimination screens
FSC will be the first SDS in the product
- Supersede MOD10A1 because of improved snow maps, SCA and FSC, for users.
- Independent of any other MOD10* products in sequence
- New ESDT, MOD10SR, is independent of other MOD10* PGEs and ESDTs Will require a new PGE in MODAPS and ESDT at NSIDC EOS-DAAC

L2G LITE storage affect on MOD10A1

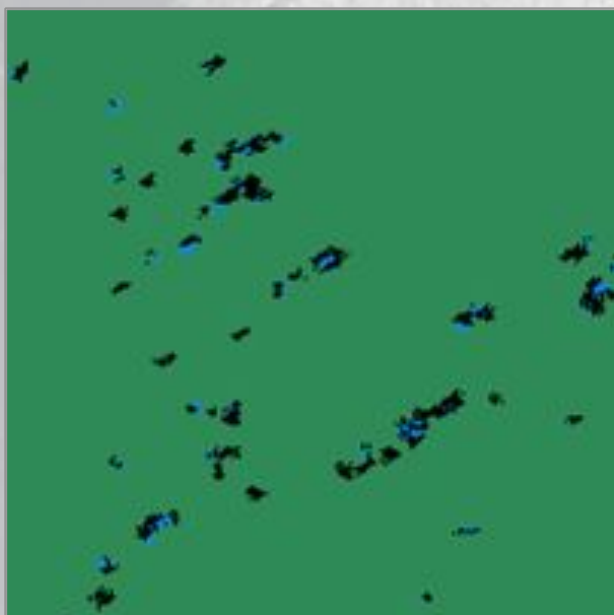
Change in observation selection technique

L2G lite selection algorithm essentially the same as MOD10A1 but with added criterion for clear over cloud observation. Differences can occur in orbit overlap region. MOD10L2G lite science test pending. Change MOD10A1 C6 to use only the first layer in MOD10L2G lite. Eliminates an algorithm step and may decrease cloud cover in regions of orbit overlap. MOD09GA lite storage used in this analysis; 1 Dec 2001, tile h10v04, covering Great Plains.

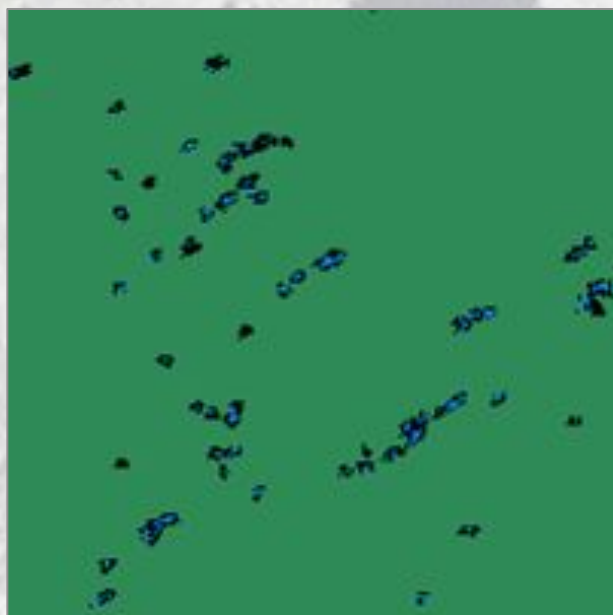


The land/water mask exhibits day to day changes in L3 products
Noted by users and NSIDC in MOD10A1

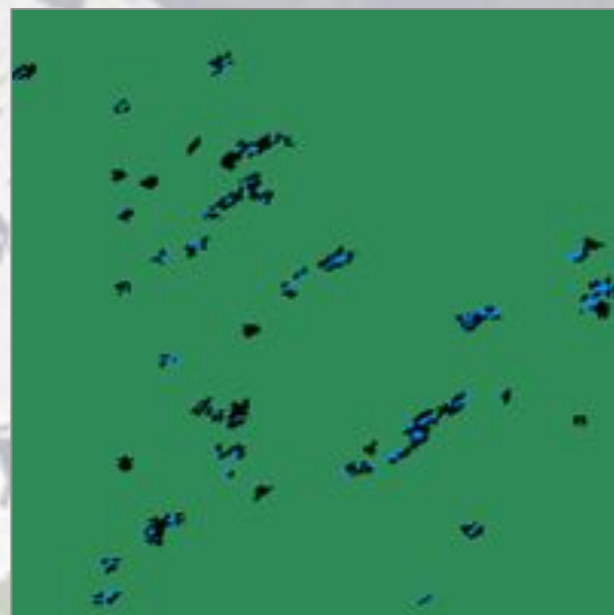
Land/water mask subset extracted from MOD09GA tile h09v05



2006 106



2006 107



2006 108

Land/water mask is static but mapping through product levels causes day to day changes
in location of a lake (blue) or boundary (black) in a tile.

Pixel mapping error through product levels affects applications and analysis done by
users.

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