NOAA NESDIS
CENTER for SATELLITE APPLICATIONS and RESEARCH

GOES-R ABI SNOW DEPTH

ALGORITHM THEORETICAL BASIS DOCUMENT

Version 0.3

TITLE: GOES-R ABI SNOW DEPTH ALGORITHM THEORETICAL BASIS DOCUMENT
VERSION 0.1

AUTHORS:

Peter Romanov (CICS, University of Maryland)
Cezar Kongoli (CICS, University of Maryland)

APPROVAL SIGNATURES:

____ June 7, 2011
Jeff Key Date
AWG Cryosphere Team Chair

____ June 7, 2011
Walter Wolf Date
AIT Lead

____ June 7, 2011
Mitch Goldberg Date
Program Manager

GOES-R ABI SNOW DEPTH ALGORITHM THEORETICAL BASIS DOCUMENT
VERSION HISTORY SUMMARY

Version	Description	Revised Sections	Date
0.3	New ATBD Document according to NOAA /NESDIS/STAR Document Guideline		**09/22/2010**

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LIST OF ACRONYMS

ABI	Advanced Baseline Imager
AIT	Algorithm Integration Team
ATBD	Algorithm Theoretical Basis Document
AWG	Algorithm Working Group
CDR	Critical Design Review
CICS	Cooperative Institute for Climate Studies
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CM	Configuration Management
DG	Document Guideline
EPL	Enterprise Product Lifecycle
GS-F&PS	Ground Segment Functional and Performance Specification
IMS	Interactive Multi-sensor snow and ice mapping System
IR	Infrared
MSG	Meteosat Second Generation
NDVI	Normalized Difference Vegetation Index
NDSI	Normalized Difference Snow Index
NESDIS	National Environmental Satellite, Data, and Information Service
NIR	Near Infra-Red
NOAA	National Oceanic and Atmospheric Administration
OCD	Operations Concept Document
OSDPD	Office of Satellite Data Processing and Distribution
QA	Quality Assurance
QC	Quality Control
SEVIRI	Spinning Enhanced Visible and Infra-red Imager
SI	Snow Index
SSEC	Space Science and Engineering Center
STAR	Center for Satellite Applications and Research
SWIR	Shortwave Infrared
TOA	Top of Atmosphere
TOC	Top of Canopy
VIS	Visible Channel
VVP	Verification and Validation Plan

ABSTRACT

This Algorithm Theoretical Basis Document (ATBD) describes the procedures for developing and using the Snow Depth (SD) algorithm for the GOES-R Advanced Baseline Imager (ABI). It

includes a description of the method and the data used for deriving the SD algorithm, the product validation methodology and the datasets, the requirements and specifications of the SD product, and specific information about the ABI that is relevant to the derivation of the SD product.

The approach for deriving the SD algorithm is based on the correlation between pixel-area SD and satellite-derived sub-pixel fractional snow cover over non-forested and sparsely forested areas. An analytical formula was empirically established that approximates the statistical relationship between pixel-area SD and snow fraction. Validation of the developed algorithm was performed off-line through inter-comparison between the GOES-based SD product and SD measurements made at first-order synoptic stations, US Cooperative Network stations and Canadian climate stations. This validation included a multi-year dataset consisting of about ten thousand pairs of collocated satellite and first-order stations data. Based on this test dataset, overall precision and bias of the SD product was found to be 5 cm, and thus the product meets the required specifications. A snow fraction retrieval precision of 10 % is assumed in all the testing of the ATBD research. Framework validation was also performed with MODIS-derived snow fraction using the GOES-R Snow Fraction product embedded into the mainframe. Finally, practical matters such as computer resources, instrument performance and its effects on the product are considered.

1 INTRODUCTION

1.1 Purpose of This Document

The GOES-R ABI Snow Depth Algorithm Theoretical Basis Document (ATBD) provides a high level description of the physical basis (scientific and mathematical) for the derivation of the GOES-R snow depth product using observations from the Advanced Baseline Imager (ABI) flown on the GOES-R series of NOAA geostationary meteorological satellites. GOES-R ABI will be the first GOES imaging instrument making observations in both the visible and in the shortwave infrared spectral bands and therefore can be effectively used to identify snow cover on the ground. Similar to the current GOES Imager, it will also be able to provide information on the depth of the snow pack over plain non-forested areas.

1.2 Who Should Use This Document

The intended users of this document are those interested in understanding the physical basis of the snow depth retrieval algorithm. This document also provides information useful to anyone maintaining or modifying the original algorithm.

1.3 Inside Each Section

This document is divided into the following main sections.

- **Algorithm Description**: Provides all the detailed description of the algorithm including the physical basis, input and output.

- **Assumptions and Limitations**: Provides an overview of the current limitations of the approach and the plan for overcoming these limitations with further algorithm development.

- **System Overview**: Provides relevant details of the ABI and provides a brief description of the products generated by the algorithm.

1.4 Related Documents

This document currently does not relate to any other document other than the GOES-R Ground Segment Functional and Performance Specification (GS-F&PS).

1.5 Revision History

Version 0.1 of this document was created to accompany the code of the version 0.1 snow mapping algorithm to be delivered to the GOES-R AWG Algorithm Integration Team (AIT).

2 OBSERVING SYSTEM OVERVIEW

This section describes the products generated by the ABI Snow Depth algorithm and the related sensor requirements.

2.1 Product Generated

The Snow Depth algorithm will be applied to GOES-R ABI pixels identified as snow covered and will be used for to estimate the depth of the snow pack over plain, non-forested areas. The primary input to the algorithm is the map of snow fraction generated from ABI data. The output of the algorithm is the map of snow depth. The refresh rate of the product is defined as 60 minutes. The daily snow depth product will also be generated.

Table 2.1 – Functional & Performance Specification (GS-F&PS) for ABI Snow Cover and Snow Depth

Name	Output Format for each Coverage	Product Level	Product Geographic Coverage	Product Horizontal Resolution (Product Pointing/ Mapping Accuracy for Space Weather)	Product Mapping Accuracy (Product Pointing Knowledge / Mapping Uncertainty for Space Weather)	Product Measurement Range	Product Measurement Accuracy	Product Refresh Rate/Coverage Time	Product Measurement Precision
Snow Depth	NetCDF		Tall grassy plains only	2 km	1 km	0-27 cm	9 cm	60 min	12 cm

2.2 Instrument Characteristics

GOES-R ABI will provide full disk observations every 5-10 minutes in 16 spectral bands at a spatial resolution of 1-2 km. Availability of observations in the visible, near infrared, shortwave infrared and infrared spectral bands allow for application of ABI data for the automated identification of snow cover in the satellite imagery. Observations in ABI reflective spectral channels will be used to estimate a sub-pixel snow cover fraction. The snow depth product will be derived from the estimated snow cover fraction.

3 ALGORITHM DESCRIPTION

This section presents a complete description of the algorithm to estimate the snow depth at the current level of maturity (which may improve with each revision).

3.1 Algorithm Overview

The objective of the Snow Depth algorithm is to routinely generate maps of snow depth distribution over plain non-forested areas. According to the GOES-R Ground Segment Functional and Performance Specification (GS-F&PS), ABI-based snow depth map should be produced at least every 60 minutes. The required accuracy of snow depth estimation is 9 cm and precision is 12 cm.

The snow depth is estimated for every pixel of ABI image located over plain non-forested area which is classified as snow-covered with the snow cover algorithm. Estimation is based on an empirical formula relating the observed subpixel snow cover fraction with the pixel-area depth of the snow pack. Snow depth algorithm is day-time only algorithm requiring sufficient solar illumination.

Snow depth is a level-2 product in the GOES-R ABI processing system. It relies on the external cloud mask and on the snow fraction map that will be generated at the preceding step of ABI data processing.

The physical basis of snow identification and the detailed description of the algorithm are given below.

3.2 Theoretical Basis

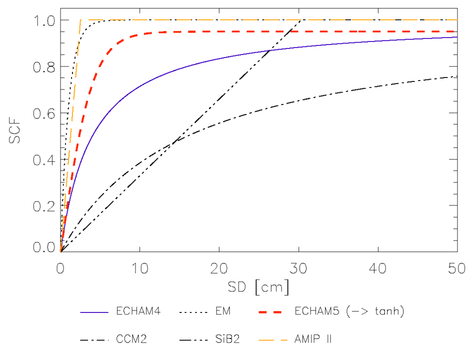


Fig. 3.1 Snow cover fraction parametrizations for grassland areas used within GCM and land surface models (Roesch and Roeckner, 2006). EM: Europa –Model (Edelman et al., 1995), CCM2: NCAR Community Climate Model (Dickenson et al., (1993) SiB2: Simple Biosphere Model (Sellers et al., 1996), AMIP-II (Frei et al., 2003).

The potential to estimate the depth of the snow pack from satellite observations in the reflective part of the Electromagnetic spectrum is limited. At these wavelengths, the photon penetration into the snow pack does not exceed several centimeters; therefore, there is practically no direct physical relationship between the snow depth and reflectivity of the snow pack. However, because of the vegetation cover and certain terrain roughness inherent to most natural land surfaces, changing snow depth causes a gradual change of the fraction of the land surface masked by snow (e.g., Baker et al, 1991). Along with the snow fraction, the reflectance of the land surface also increases with the increasing snow depth up to some depth where the underlying land surface is completely masked by snow. This relationship between the snow depth and the surface reflectance or the fractional snow cover is quite pronounced for thin to medium thick snow packs and thus provides means for estimating snow depth. Without the tree canopy, which masks and shadows the snow cover, the relationship between the snow depth and the snow reflectance (or snow fraction) is the strongest. Therefore potentials for estimating snow depth exist only over plain areas with no or very little forest cover.

The relationship between the snow fraction and the snow depth is actively used in climate and land surface models to predict the fractional snow cover when the depth of the snowpack is known. Several examples of these parametrizations are given in Fig.3.1.

It is important, that models in Fig.3.1 have been developed to characterize the area ratio of snow covered and snow free land over large areas of tens to hundreds square kilometers. Application of these models to estimate the snow depth from the observed snow fraction at much smaller spatial scales should be justified. Besides that, models predicting an asymptotical behavior of snow fraction at large snow depths are not convenient to use in the inverse problem since even small errors in the snow fraction cause large errors in the derived snow depth.

In order to establish the relationship between the snow depth and the snow fraction suitable for estimating snow depth from satellite data we have adopted an empirical approach where we matched snow fraction derived directly from GOES Imager observations with synchronous in situ measurements of snow depth. The statistics of matched satellite and surface observations was collected over Great Plains and Canadian Prairies during four winter seasons from 1999 to 2003. The selected region presents the best test area due to its mostly flat terrain and little tree vegetation. Snow depth reports were obtained from over 1400 locations within the study area (see Fig. 3.2) where the forest cover fraction was less than 20%. Information on the forest distribution was taken from the percentage tree cover dataset prepared at the University of Maryland (DeFries et al., 2000).

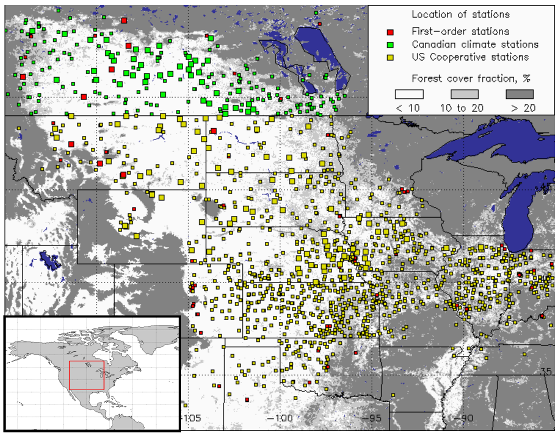
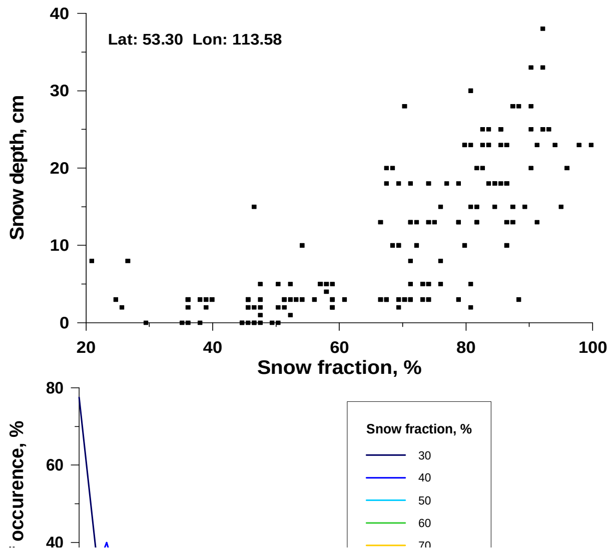


Fig.3.2 Location of stations used in the study. Large squares represent the primary locations used to establish the snow fraction-snow depth relationship. Data from all other stations were used in the validation of the derived relationship.

The snow fraction was derived from GOES Imager observations in the visible spectral band within a linear mixture approach with two end-members corresponding to a completely snow covered and a snow free land surface. Snow fraction estimates are made for pixels identified as snow-covered in GOES-based daily snow cover maps. The latter maps are generated daily at NOAA NESDIS. A complete description of the snow mapping and snow fraction retrieval technique is given in Romanov and Tarpley (2004).

The relationship between the snow depth and snow fraction was established with the data for 139 primary locations in the study area (shown with large squares in Fig.3.2) each having 50 or more matched pairs of surface and satellite observations. Data from more than 1200 other stations were used in the validation of the algorithm. Overall the dataset accounted for over 40 000 matched observations. The statistics for primary locations consisted of about 10 300 matched observations. Fig. 3.3a presents an example of the distribution of matched snow fraction and snow depth data collected at 53^{o} 30’ N and 113^{0} 58’ W. The graph demonstrates an apparent increasing trend in the reported snow depth with increase in snow fraction. There is a substantial scatter in snow depth values corresponding to the same snow fraction, which suggests that it is impossible to relate the snow fraction unambiguously to the snow depth. The primary reason for the scatter is most probably a high spatial variability of the snow depth, along with a different spatial resolution of the satellite and surface measurements. When the snow fraction decreases below 50%, the station sometimes reports a ‘zero’ snow depth (or no snow on the ground), thus giving an indication of a patchy snow cover.

A substantial scatter in the overall snow depth–snow fraction statistics collected at all primary locations is also obvious in Figure 3.3b, which shows frequency distributions of the snow depth



for a set of snow fraction binned into 10% ranges. The scatter in the snow depth values increases substantially with an increase in the snow fraction. Average values of the snow depth calculated for every 10% snow fraction interval exhibit a clear non-linear dependence on the snow fraction (see Figure 3.4). To represent the relationship between the snow fraction and the snow depth analytically, we adopted an exponential-type function:

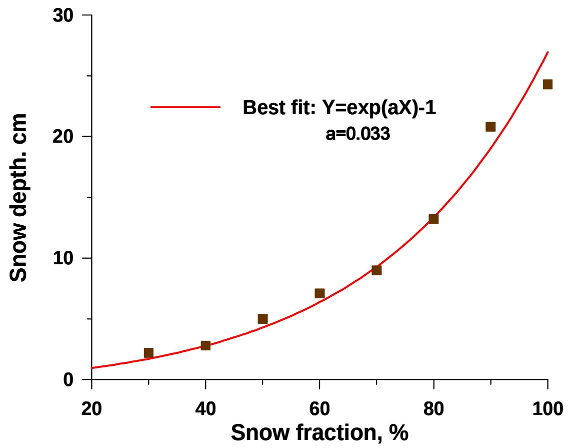


Figure 3.4. Snow depth versus the observed snow fraction. Results are averaged over 10% snow fraction bins. The line represents the best fit to the data with a single parameter exponential function.

$$\boldsymbol{D} = \exp(\boldsymbol{aF})-1 \qquad (1)$$

where ***D*** (cm) is the snow depth, ***F*** (%) is the snow fraction and ***a*** is a parameter. The best approximation of the snow fraction/snow depth relationship with Equation (2) is achieved with ***a*** = 0.0333.

The major factor that controls the snow depth to snow fraction relationship is protrusions of low-level vegetation through the snowpack. Once snow cover masks the vegetation cover completely, the observed snow fraction becomes insensitive to a further increase in the snow depth. Equation (2) yields a 100% snow fraction for a snow depth of around 27 cm. The value of the snow depth corresponding to a completely snow-covered land surface may be interpreted as an upper limit of the retrievable snow depth.

3.3 Processing Outline

The data processing system includes the blocks that read the input data, calculate the snow depth and generate the output map (see Fig. 3.5).

The primary input to the snow depth algorithm consists in the snow fraction map. The snow fraction map will be derived at the previous step of GOES-R ABI data processing. For cloud clear portions of the imagery over land surface the snow fraction is converted to snow depth using formula (1) above. Estimates made at high (over 70 degrees) satellite and solar zenith angles, in the areas with forest cover fraction of 20% or with needle-leaf forest cover fraction of over 10% and over and in mountainous areas with elevation above 2000 m are flagged as "unreliable". Retrieval is not performed if the snow fraction is zero.

3.4 Algorithm Input

This section describes the input needed to process the Snow Depth Product. The Snow Depth Product will be derived with every generated snow fraction map. It uses dynamic sensor data, a derived ABI product and static ancillary data inputs. The data in each of these categories are described below.

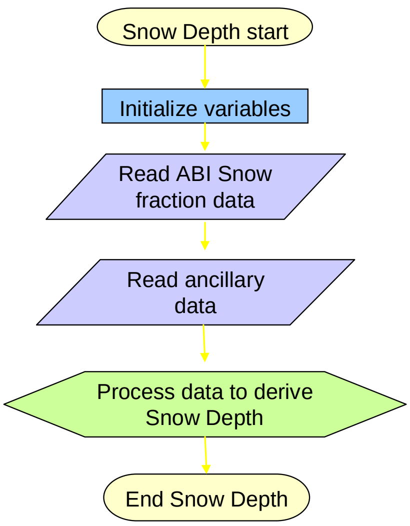


Fig. 3.5 Flow chart of GOES-R ABI snow depth processing

3.4.1 Primary Sensor Data

The primary sensor data used by the snow depth product consists in the solar and satellite zenith angle of observations The angles are used to identify unreliable snow depth retrievals made at high observation and illumination angles (above 70 Degrees)

3.4.2 Derived Sensor Data

The derived sensor data include the GOES-R ABI hourly snow fraction product.

3.4.3 GOES-R Product Precedence Data

The Snow Depth algorithm uses the snow fraction map as an input and should therefore run after the snow fraction map is generated. .

3.4.4 Ancillary Data

Ancillary data are represented by static off-line data files. The ancillary data sources used for the GOES-R snow depth product include elevation, surface type, forest cover fraction and needle-leaf forest fraction datasets. Each data set is briefly described below.

- **Surface type/Land-water mask**

  The land water mask is based on the surface type classification produced by the University of Maryland Department of Geography in 1998 (Hansen et al. 1998, 2000). Imagery from the AVHRR satellites acquired between 1981 and 1994 were analyzed to distinguish fourteen land cover classes (http://glcf.umiacs.umd.edu/data/landcover/). This product is available at three spatial scales: 1 degree, 8 kilometer and 1 kilometer pixel resolutions. For the algorithm development and testing 1 km data were aggregated in 4 km size grid cells. The 1 km resolution product will be used for GOES-R ABI products.

- **Forest Cover Fraction and Needle-leaf forest cover fraction**

  The percentage tree cover dataset and the needle-leaf forest cover fraction dataset have been developed by the University of Maryland Department of Geography (DeFries et al., 2000). The first dataset reports the percent of the area covered with forest, whereas the second one reports the fraction of the area covered with needle-leaf trees. The original spatial resolution of both datasets is 1 km. For the algorithm development and testing the spatial resolution of both datasets were degraded to 4 km. One kilometer resolution data set will be used for GOES-R.

- **Digital Elevation**

  Elevation information for every pixel is used to screen high-elevation areas where snow depth retrievals may be inaccurate. The elevation dataset in the current version of the algorithm is based on USGS GTOPO30 model data. The original 30’ spatial resolution dataset will be used in the GOES-R processing system. For algorithm validation and testing elevation data were averaged within 4 km grid cells.

3.5 Algorithm Output

The final output of the snow depth algorithm consists of an output file denoting snow depth or missing values, and a quality control (QC) output file denoting the snow pixels that failed the processing tests.

Table 3.2 – Output and QC file format and naming convention

Filename	Format	Contents
SnwDepthyyyydddhhmm	One byte binary array	Snow depth in cm or missing value
QC	One byte binary array	Quality flag

Table 3.3 – Output and QC File content

Output

Value	Category
0-100	Snow depth in cm (minimum snow depth is set at 1 cm, zero corresponds to snow free land or zero snow cover fraction)
128	Missing value

QC

0	Good value
10	Bad value - Water
20	Bad value - Clouds
30	Bad value - Dense forest
40	Bad value - High elevation
50	Bad value - Insufficient illumination (high solar zenith angle)
60	Bad value - High satellite zenith angle

In addition, the Snow Depth retrieval processing will also produce some metadata describing snow depth processing information, e.g., date/time stamp, description of QC flag values, the percentage of retrievals for each QC flag value and summary snow depth retrieval statistics (mean, max, min and standard deviation) for good retrievals. Other sensor and snow cover metadata information will be produced from the Snow Fractional Area GOES-R product.

4 TEST DATASETS AND OUTPUTS

4.1 Simulated/Proxy Input Datasets

Snow fraction derived from the Imager instrument onboard Geostationary Operational Environmental satellite (GOES) is used as a proxy for GOES-R ABI snow fraction in off-line verification/validation of the snow depth algorithm (Table 4.1). The snow depth derived from GOES Imager data was compared to ground-based snow depth observations and with snow depth data generated within the SNODAS model at NOHRSC.

Maps of snow cover and snow fraction have been produced daily from GOES-East and GOES-West Imager data since 1999. The spatial resolution of maps is about 4 km. The estimated accuracy of snow fraction retrievals from the current GOES Imager is about 10%, i.e. the derived snow fraction satisfies the requirements for GOES-R ABI. Within the existing GOES data processing system snow fraction maps are generated once a day from daily composited images. The maximum temperature compositing is applied to reduce the cloud contamination. The portion of the imagery centered on US Great Plains and Canadian Prairies was used in the algorithm testing.

Snow fraction derived from MODIS sensor on board the Terra satellite is used as proxy for GOES-R ABI framework verification/validation of the snow depth algorithm. The GOES-R ABI Snow Cover Algorithm was used to derive instantaneous snow fraction from MODIS data, which in turn was used as input to derive instantaneous snow depth.

Table 4.1 – Sensor channel mapping of off-line validation proxy data

Sensor	Channel No	Wavelength Center (μm)	Bandwidth (μm)
ABI	2	0.64	0.59 ~ 0.69
	7	3.9	3.8 ~ 4.0
	14	11.2	10.8 ~ 11.6
GOES-8	1	0.6	0.52 ~ 0.72
	2	3.9	3.78 ~ 4.03

	4	10.7	10.2 ~ 11.2
GOES-10	1	0.6	0.52 ~ 0.72
	2	3.9	3.78 ~ 4.03
	4	10.7	10.2 ~ 11.2

4.2 Output from Simulated/Proxy Inputs Datasets

4.2.1 Precisions and Accuracy Estimates

Statistical assessment of product performance against a large and representative dataset shows that overall, the mean product bias (accuracy) and standard deviation (precision) is 5 cm within the product retrieval range of depths up to 27 cm, and thus the product meets the required specifications.

Fig 4.1 presents an example of a snow depth map derived from GOES-East Imager data using off-line snow depth algorithm. The enlarged portion of the map shows that there is a good correspondence between the retrieved snow depth and the snow depth observed at ground-based stations. Some difference between the two products along the snow cover boundaries may be due to the combined effect of snowmelt and the time difference of observations. Most of the stations used in the comparison belong to the US Cooperative station network. Observations of snow depth at these stations are performed once a day in the early morning. On the other hand, due to the daily image compositing algorithm implemented as part of the processing system, satellite retrievals tend to represent the snow cover and snow depth conditions in the middle of the day.

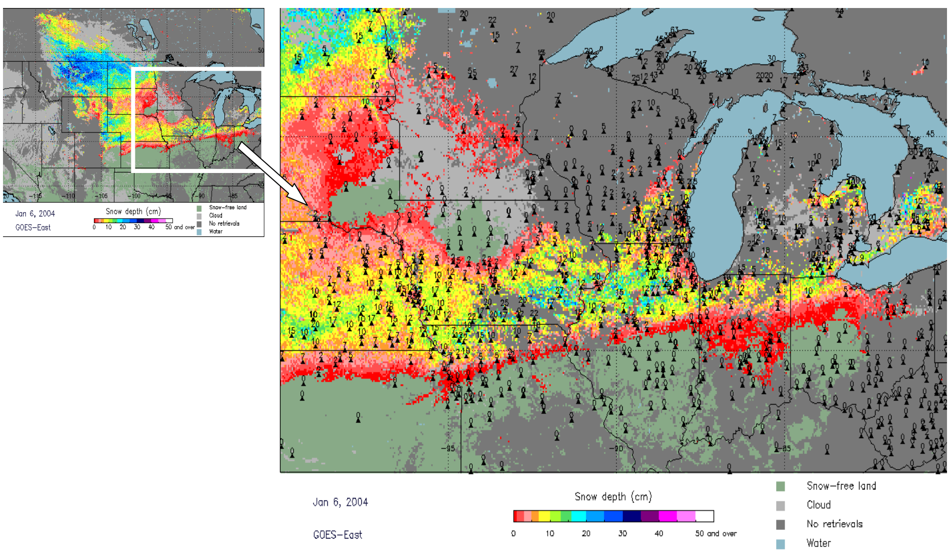


Fig. 4.1 Left: an example of snow depth map over Great Plains derived from GOES Imager data. Right: enlarged portion of the snow depth map with surface observations overlaid.

Fig. 4.2 shows bias and correlation statistical results of comparison of derived and observed in situ snow depth at several stations in the study area. It s shown that correlation between the snow depth and snow fraction exceeds 0.7 in most cases, and bias and standard deviation are less than 5 cm. Consistent underestimates of the snow depth may be caused by underestimated forest cover fraction. A possible reason for persistent overestimates of snow depth consists in a very small height of the grass cover.

Fig. 4.2 Bias and correlation statistics of observed and derived snow depth at selected stations across the Great Plains.

Figure 4.3 shows absolute bias variation as a function of snow depth values up to 30 cm. The mean absolute bias of all the cases analyzed is about 5 cm. The absolute bias increases with snow depth, from 3–4 cm for shallow snow cover (below 10 cm) to 7–10 cm for snow depths of 20–30 cm.

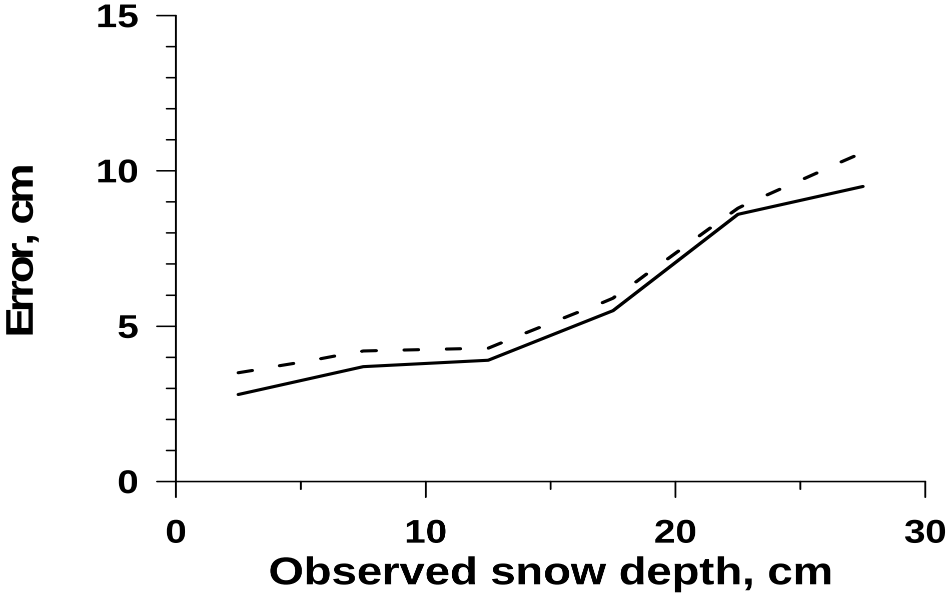


Fig 4.3 Mean absolute bias of the derived snow depth as a function of the observed snow depth. Solid and dashed lines present the results for stations in completely non-forested area and in partially forested area (less than 20% of forest cover), respectively.

Figure 4.4 depicts retrieved instantaneous snow depth from MODIS data on Terra satellite on March 15, 2009 at 17:50 Z. Granule size was 1354 by 2030. Instantaneous snow fraction was estimated from the GOES-R Snow Cover Algorithm, which was used as input to GOES-R Snow Depth Algorithm (both imbedded into the mainframe) to retrieve snow depth. Subjective analysis of the map depicting retrieved snow depth and point surface observations shows reasonable retrievals. Additional testing and a quantitative evaluation are needed to assess robustness of the integrated snow algorithms.

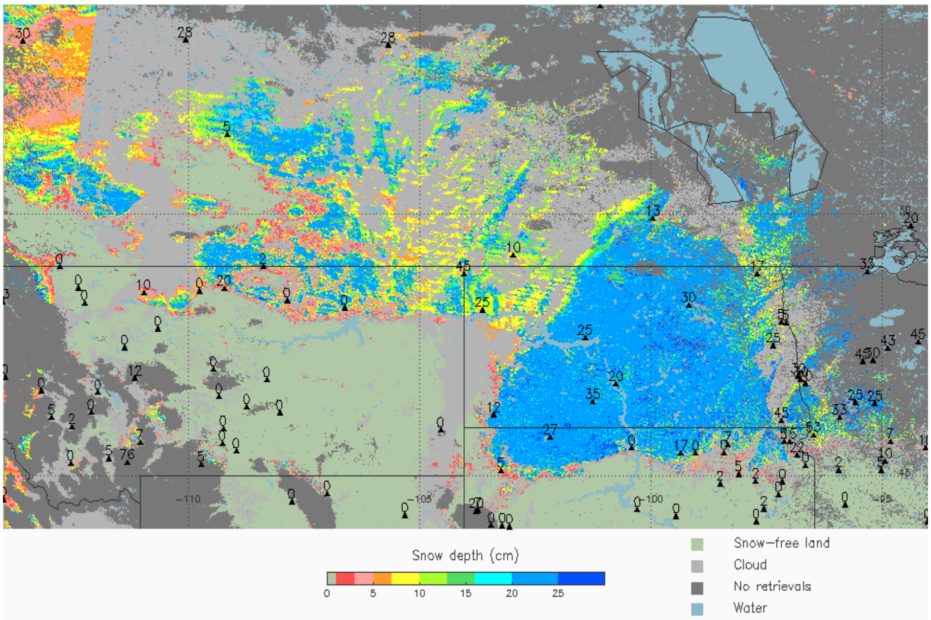


Figure 4.4 Retrieved Snow Depth from MODIS data with point surface observations overlain

5 PRACTICAL CONSIDERATIONS

5.1 Numerical Computation Considerations

The snow depth is a product derived through simple pixel-by-pixel computation. Ancillary data need to be applied to identify land pixels where snow depth retrievals are possible and reliable.

5.2 Programming and Procedural Considerations

The algorithm is straight-forward and easy to implement.

5.3 Quality Assessment and Diagnostics

The following procedures will be implemented to routinely assess the quality of the product.

- Snow depth retrievals will be matched with synchronous observations of snow depth. The accuracy of snow depth retrievals will be assessed through their comparison with in situ measurements.
- Qualitative comparison will be performed between the derived snow depth and snow depth maps generated within SNODAS system at NPHRSC.

5.4 Exception Handling

The GOES-R snow depth algorithm will check the status of the required input data and availability of ancillary data. If any of the input data are unavailable the corresponding quality control flag will be set and the algorithm will exit. The QC flags will be sent back to the framework and the processing will continue to other algorithms.

A more detailed quality control of input data (including the snow fraction data) will be implemented in the subsequent version of the algorithm.

5.5 Other Considerations

Other considerations include the following:

- The meaning of snow fraction in the current GOES-R ABI MRD is not clearly defined. It is not clear whether the snow fraction will characterize the fraction of snow as seen by the satellite instrument (i.e. it will exclude snow masked by vegetation) or it will characterize the snow cover on the ground (i.e. will attempt to estimate the snow cover beneath the canopy).
- Snow depth retrievals are limited in terms of the accuracy, the range of the derived values as well as in terms of the geographical area coverage.

6 ASSUMPTIONS AND LIMITATIONS

The following sections describe limitations and assumptions in the current version of the snow depth algorithm.

6.1 Assumptions

The following assumptions have been made in developing and estimating the performance of the snow depth algorithm:

- The error in the derived snow cover fraction is within limits specified for GOES-R ABI (10%)
- The algorithm implicitly assumes the same characteristics of low level vegetation across the whole area of snow depth retrievals.
- There is no masking or shadowing of snow cover by tree vegetation.
- Snow is not moved or removed. This assumption is not valid in densely populated regions therefore snow depth retrievals in urban areas are not accurate.
- All subresolution water bodies are frozen. Unaccounted open water reduces the apparent snow fraction and results in an underestimation of snow depth.

6.2 Assumed Sensor Performance

- Errors in navigation from image to image will not affect the performance of the snow depth algorithm but will cause spurious temporal variations in the derived snow depth.
- Inadequate sensor performance will not affect the quality of the product directly. However it may cause errors in the derived snow fraction which would reduce the accuracy or prevent from deriving the snow depth from snow fraction.

6.3 Limitations

The following limitations are identified and cautioned for the snow depth algorithm and product:

- No snow cover/snow depth retrievals will be conducted in cloudy conditions and at night time.
- Efficiency of snow identification and mapping is expected to depend on illumination conditions and the satellite zenith angle. Retrievals are expected to be less accurate at very low solar elevation and high, above 70 deg satellite zenith angle.

6.4 Pre-Planned Product Improvements

In the next version of the algorithm a detailed quality control of the input snow fraction map will be implemented. Identification of both clouds and the snow cover will be tested and new flags will be set if the previous classification is found inaccurate.

The domain of snow depth retrievals may be expanded into moderately forested regions by introducing proper corrections to the retrieval algorithm (Romanov and Tarpley, 2007). Additional statistics on snow fraction and snow depth over partially forest covered areas will be collected and a refined algorithm will be established.

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