Recent Advancements to the Interactive Multisensor Snow and Ice Mapping System (IMS).

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IMS Version 3 Capacities – Starting Dec 2 2014

- 1, 4, & 24km Northern Hemisphere Analysis
- Snow & Ice Cover
- ASCII, BIN, GeoTiff, Grib2
- 2x day production
- Improved MetaData
- Automated 2km Southern Hemisphere Analysis
- Date since last confirmed observation
- Snow Depth (with uncertainty values)
- Sea Ice Thickness (with uncertainty values)
- VIIRS, SAR, MODELS, More Surface obs,
- Ability to import derived data sources
- Same underlying Snow & Ice cover resample algorithms - Vital to keeping consistent record

Legacy Version 2

New to Version 3
**Interactive Multi-Sensor Snow and Ice Mapping System (IMS)**

Sierra Nevada Snow Cover – March 18, 2015

### 1km Products

- 2xday production
- Snow Cover, Ice Cover, Days since last Observed
- Continues to apply the same regridding from 1km to 4km to 24km since March 2004
IMS V3 Input Direct Data

GOES (E & W)
MeteoSat (MSG (ch 1,2,3) & 7)
MTSAT
NOAA Automated Snow & Ice
AVHRR (Channels 1,2,3)
MODIS (Channels 1,2,7,8)
ASCAT
AMSU (Derived snow, ice, rain)
NIC Marginal Ice Zone
NIC & CIS Ice Charts
Surface Obs (METAR)
NOHRSC SNODAS
AFWA Snow Depth
SSMI/S (Derived snow, ice, rain)
MMAB Sea Ice Cons

ATMS MIRS Algorithm (SWE, Sea Ice Con, Snow Grain Size)
VIIRS Snow Cover
VIIRS Ice Age
VIIRS Imagery (I1, I2, I3, & I5)
RadarSat & Sentinel SAR imagery
US RADAR
COOP and SYNOP reports
CMC Snow Depth Analysis
CMC RIPS 3D var Ice Analysis
US Navy Arctic Cap (ACNFS) Ice Cons & Thickness
GFS Snow Depth Change (24hrs)

Legacy Version 2
New to Version 3
Direct Import of Automated Snow & Ice Cover

- Analysts will be able to selectively import the data from satellite derived products directly into the IMS analysis.
- Analysis will have selection box to select snow cover and ice cover from the VIIRS, NOHRSC, and NH AutoSnowIce.
- Human data selection to optimize product use based on expert knowledge and imagery interpretation.
- Combines the speed and reliability of automated products with the QC and flexibility of Human Analysts.
New IMS Ice Products

Mean Level Ice Thickness

Blended Ice Concentration

Darker Blue = Higher Concentration
**Key features:**

- 2-D OI Analysis integrated into IMS V3
- Multi-Source Scheme: MW+in-situ + Climatology + Analyst Updates
- IMS Analyst SD and Uncertainty estimates are also ingested into OI as independent data stream
- MW Downscaling based on elevation
- Applies previous day as initial guess

*NOAA’s Global Change Observation Mission (GCOM) AMSR2 SD is first option and expected to go operational this year*

**Acknowledgement:** Cezar Kongoli (NOAA CICS)
CLIMO-BASED SD-ELEVATION RELATIONSHIPS

Elevation and annual distribution of non-zero SYNOP (Blue) and COOP (red) stations (January)

For Elev < 2500 m
SD = $a_1 \times \exp(b_1 \times \text{Elev})$

For Elev $\geq$ 2500 m
SD = $a_2 + b_2 \times \text{SD}$

Where $a_1$, $b_1$, $a_2$, $b_2$ monthly coefficients
MW-Downscaling based on Elevation

\[ SD_{4km} = SD_{MW} + \Delta SD_{4km} \]

\[ \Delta SD_{4km} = \left( \frac{\Delta SD}{\Delta ELEV} \right) (ELEV_{4km} - ELEV_{MW}) \]

For SD < 2500 m:
\[ SD = a1 \times \exp(b1 \times ELEV) \]
\[ \Delta SD/\Delta ELEV = a1 \times b1 \times \exp(b \times ELEV) \]

For SD > 2500 m:
\[ SD = a2 + b2 \times ELEV \]
\[ \Delta SD/\Delta ELEV = b2 \]
IMS Blended Snow Depth

NASA AMSRE-SD

Blended Analysis SD

Jan/ 5, 2013

Acknowledgement: Cezar Kongoli (NOAA CICS)
Snow Depth Estimate Maps
In Jan 2010, SD Analysis within 20 cm of the GHCN-Daily measurements 86.9% in snow covered areas, while in Feb 2010 within 20 cm 85.1% of the time. This is a very good overall result considering large SD variability, 4-km res. and inclusion of high elevation areas.

Bi-modal distribution of errors – low bias/RMSE in low-elevation areas (4/7 cm) and larger bias/RMSE in high elevation areas (35 cm/45 cm)

RMSE still reasonable over high elevation terrain considering large SD values

Acknowledgement: Cezar Kongoli (NOAA CICS)
1) MIRS appears to saturation snow depth at about 20-30 cm. This is far under than observed at in-situ stations.

2) Snow / Elevation relationship is global rather than regional

3) US COOP stations may be up to 36 hrs old.

4) Does not account for other geostatistical relationship

5) Poor transition along boundaries
Revision 1: Regional Snow / Elevation relationships
  *Intermontane N. Amer.; Tibet, Alaska, Eurasia*

Revision 2: Replace MIRS 9.2 with MIRS 11.1
  *Applies SWE climatology*

Revision 3: Add AMSR 2 Snow Depth
  *NOAA AMSR 2 SD in pre-op stage*

Revision 4: Add Southern Hemisphere
  *Use NOAA Southern Hemisphere AutoSnow*

Revision 5: Add Daily-GHCN data
  *Current COOP data feed can be 18 hrs old*
Addition of GHCN - D

January 5, 2010 Results

Acknowledgement: Milton Torres-Martinez and Cezar Kongoli
New Regional SD / Z relationships

Old Relationship

New Relationships

January 5, 2010 Results

Acknowledgement: Lawrence Vulis and Cezar Kongoli
AMSR 2 Snow Depth

Applies NASA AMSR-E Snow Depth algorithm (Kelly, 2009)

Acknowledgement: Yong-Keun Lee & Cezar Kongoli
Other upcoming improvements

Add new data sources
- GOES R, Himawari 8, VIIRS IC, Sentinels 1 & 3, NAVO GOFS

Ability to edit Ice Con and Ice Thickness
Add new replace/import tools great
  - Will allow analysts to select data from most automated and modeled products in IMS
  - Ability to use replace on Ice Con, Snow Depth
  - Ice thickness

Improved Ice Concentration and Thickness algorithms

Architecture improvements
Where to get the data?

www.natice.noaa.gov/ims/

http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/