Evaluation of updated JXAM5 snow cover extent product using ground based snow depth information

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Outline

• Snow Cover Extent (SCE) Products in JAXA
• Technical Specification of SCE Products
• Processing Flowchart
• Examples of SCE Results and SnowPEx Conversion
• Updates of JXAM5 Snow Cover Extent
• Validation Protocol and Reference Data
• Validation Results
• Summary
Snow Cover Extent Products in JAXA

• Three SCE products (available on JASMES web)
  – Global SCE derived from MODIS spanning from 2000 to 2015 [5km, daily, half-month, monthly] [Algorithm: JXM10, use 10 channels of MODIS]
  – Regional (around Japan) SCE derived from MODIS spanning from 2003 to 2015 [500m, daily, weekly, half-month, monthly] [Algorithm: JXM10]
  – Global (currently excl. the Antarctica) SCE derived from AVHRR and MODIS spanning from 1979 to 2015 [5km, daily, weekly, half-month] [Algorithm: JXAM5, use only the five channels same as AVHRR]
Optical sensors used to generate JXAM5 SCE

Optical sensors in the past and future (1978-2029)

1980
- TIROS-N
- AVHRR

1990
- NOAA-07
- NOAA-11
- NOAA-09
- NOAA-14

2000
- NOAA-18
- NOAA-16

2010
- MODIS series
- operation continuing by FO sensors

2020
- MODIS-FO
- SUOMI NPP / VIIRS
- GCOM-C/SGLI
- GCOM-C2/SGLI
- GCOM-C3/SGLI
- HIMAWARI-9号
- HIMAWARI-8号
- New gene. GMS series

GMS
- Polar orbiter
- MODIS
- OCTS/GLI/SGLI

Geo-stational

AQUA/MODIS
- NOAA/AVHRR series
- MODIS-F0

TERRA/MODIS
- ADEOS series (OCTS, GLI)
- ADEOS series (OCTS, GLI)
- ADEOS-II/GLI
Technical Specification of SCE Product [JXAM5]

- **Product Name:** Snow Cover Extent for Climate Studies
- **Sensor and applied spectral channels:** AVHRR + MODIS (5CHs of AVHRR)
- **Temporal Characteristics:**
  - Temporal resolution (1 day, 1 week, ..): 1 day, 1 week, half month...
- **Spatial Characteristics**
  - Spatial resolution / Pixel size: 0.05° (approx. 5km) 7200x3601 pix
  - Spatial Coverage: global (but Antarctic SCE is not good)
  - Map Projection / Datum: Equirectangular (lat/lon) projection
- **If applicable: Cloud screening**
  - Algorithm: Threshold tests & Temporal filtering
- **If applicable: Valid / non-valid areas**
  - Invalid/masked areas: Ocean and Antarctic areas are not valid
- **Product Format:** HDF4 and binary + ascii (for snow area)
- **Products accessible at** Available through JASMES website (GHRM5C)
- **Contact Person**
  - Name: Masahiro Hori (EORC/JAXA)
  - email: hori.masahiro@jaxa.jp
Analysis Results (Examples)

Snow Extent Binary (SEB) & Valid Area (VAA)

Daily SE Binary Map (Original Flag)

Valid Area Definition (SnowPEx Format)

CSF20120309_M5C_GLBOD01D_SNWFG_EQ05KM_1h9

JXAM5_V01_VAA_SNOWPEX

Mar.09, 2012

Mar.05-11, 2012

Daily SE Binary Map (SnowPEx Format)

Weekly SEB Map (SnowPEx Format)

JXAM5_V01_SEB_20120309_D01_MAX

JXAM5_V01_SEB_20120305_D07_MAX

Snow
No snow
Clouds
Polar Night
Not Valid (Sea)
No satellite data

Mar.09, 2012

Out of range (Sea)

Out of range (Antarctica)

Not Valid (Sea)
No satellite data
User’s and Producer’s Accuracy of JASMES SCE (and Wet SCE)

SCE’s UA is nearly equal to PA except for in the spring months.

UA > PA → Underestimation in melting season
Updates of JXAM5 Snow Cover Extent

**Ver. 1e9/1f9** (uploaded version) -> **Ver. 1h9** (new)

- To increase accuracies in melting season, the detectability of wet snow (& cloud) is enhanced.
Updates of JXAM5 Snow Cover Extent

Ver. 1e9/1f9 (uploaded version) -> Ver. 1h9 (new)

• To increase accuracies in melting season, the detectability of wet snow (& cloud) is enhanced.
Validation Protocol for SCE (SCE & Wet SCE)

Snow Cover Extent vs. In-situ Snow Depth
Comparisons were made using Weekly Composite Data.

Criteria for SCE Val.: if Snow Depth (SD) > 25mm, NN pixel -> “Snow Covered”
Criteria for Wet SCE Val.: if $T_{max}$ > 2.5 deg.C, NN pixel -> “Wet Snow”

Comparison with in-situ snow depth & $T_{max}$ (GHCND obtained from NCDC/NOAA)

Definition of the accuracies shown in this ppt

Users accuracy (UA) $= \frac{1}{1+2}$

(Commission error : Rate of correct answer)

Producers accuracy (PA) $= \frac{1}{1+3}$

(Omission error : Rate of snow detection)
Validation results (2015)

User’s and Producer’s Accuracy of JASMES SCE (and Wet SCE)

SCE’s UA is nearly equal to PA, and both accuracies are temporally stable. UA & PA of Wet SCE is high in melt seasons, but variable in JJA due to low snow pixel numbers.
Validation results (2015)

User’s and Producer’s Accuracy of JASMES SCE (and Wet SCE)

SCE’s UA is nearly equal to PA, and both accuracies are temporally stable. UA & PA of Wet SCE is high in melt seasons, but variable in JJA due to low snow pixel numbers.
User’s and Producer’s Accuracy of JASMES SCE (and Wet SCE)

SCE’s UA is nearly equal to PA except for in the spring months.
User’s and Producer’s Accuracy of JASMES SCE and Wet SCE (WSCE)

Validation results (2015)

SCE’s UAs are approx. 0.8 nearly equal to PA, and both accuracies are temporally stable (expt in 1994-95 due to AN crossing time drifts). UA & PA of WSCE is 0.6-0.65.
Validation results (2015)

User's and Producer's Accuracy of JASMES SCE and Wet SCE (WSCE)

SCE’s UAs are approx. 0.8 nearly equal to PA, and both accuracies are temporally stable (expt in 1994-95 due to AN crossing time drifts). UA & PA of WSCE is 0.6-0.65.
# Summary of UA & PA

## JASMES SCE (Dry+Wet Snow) vs. GHCND

<table>
<thead>
<tr>
<th>Season</th>
<th>UA Ave</th>
<th>UA Std</th>
<th>PA Ave</th>
<th>PA Std</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJF</td>
<td>0.82</td>
<td>0.03</td>
<td>0.82</td>
<td>0.04</td>
</tr>
<tr>
<td>MAM</td>
<td>0.81</td>
<td>0.03</td>
<td>0.66</td>
<td>0.04</td>
</tr>
<tr>
<td>JJA</td>
<td>0.23</td>
<td>0.09</td>
<td>0.21</td>
<td>0.07</td>
</tr>
<tr>
<td>SON</td>
<td>0.48</td>
<td>0.04</td>
<td>0.57</td>
<td>0.03</td>
</tr>
<tr>
<td>Annual</td>
<td>0.80</td>
<td>0.02</td>
<td>0.78</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**SCE:** Annual averages (UA & PA) ≈ 0.8
- High (UA & PA >0.8) in winter
- High UA & Moderate PA in spring
- Low in summer and autumn

## JASMES WSCE (Wet Snow) vs. GHCND

<table>
<thead>
<tr>
<th>Season</th>
<th>UA Ave</th>
<th>UA Std</th>
<th>PA Ave</th>
<th>PA Std</th>
</tr>
</thead>
<tbody>
<tr>
<td>DJF</td>
<td>0.49</td>
<td>0.05</td>
<td>0.43</td>
<td>0.07</td>
</tr>
<tr>
<td>MAM</td>
<td>0.77</td>
<td>0.03</td>
<td>0.73</td>
<td>0.04</td>
</tr>
<tr>
<td>JJA</td>
<td>0.55</td>
<td>0.23</td>
<td>0.73</td>
<td>0.23</td>
</tr>
<tr>
<td>SON</td>
<td>0.54</td>
<td>0.08</td>
<td>0.48</td>
<td>0.11</td>
</tr>
<tr>
<td>Annual</td>
<td>0.66</td>
<td>0.03</td>
<td>0.61</td>
<td>0.05</td>
</tr>
</tbody>
</table>

**WSCE:** Annual averages > 0.6
- High in spring (>0.7)
- Moderate in summer (0.5-0.7)
- Low in winter & fall (0.4-0.5)

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**Validation Results (2015)**

<table>
<thead>
<tr>
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<th>PA Ave</th>
<th>PA Std</th>
</tr>
</thead>
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<tr>
<td>Annual</td>
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<td>0.78</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Validation results for 2001-2010

Commission Error [%] (1-UA)

January

April

June

October

1h9, SD & Tmax sites
Validation results for 2001-2010

Omission Error [%] (1-PA)

January

April

June

October

1h9, SD & Tmax sites
Summary

- Binary files of global snow cover extent (SCE) products (JXAM5 and JXM10) have been uploaded to the SnowPEx ftp server.
- The algorithms employ conventional decision tree threshold tests including the discrimination between dry snow and wet snow.
- The algorithm for JXAM5 was updated this year to enhance the accuracies of SCE detection in melting season.
- Comparisons with in-situ snow depth (GHCND) indicate that SCE’s UA/PA are about 0.80/0.78, whereas those of wet SCE are about 0.66/0.61. Annual values are temporally stable during 1982-2013.
- Commission errors (1-UA) of SCE tend to be large at southern Scandinavia, Germany, and southern US regions in early to mid-winter (Oct. & Jan.), while omission errors become large at the same regions in melting season (April) (clouds, vegetation?).
- Future works: further quality assessment of in-situ data sites (temporal & spatial uniformity) is necessary for the trend analysis.
Supplemental slides
Technical specification of snow product [JXM10]

- **Product Name**: Snow Cover Extent for MODIS (snwcfr)
- **Sensor and applied spectral channels**: MODIS (10 channels)
- **Temporal Characteristics**:
  - Period (Start – End): 2000-2013
  - Temporal resolution (1 day, 1 week, ..): 1 day, 1 week, half month, monthly
- **Spatial Characteristics**:
  - Spatial resolution / Pixel size: 0.05° (approx. 5km)  7200x3601 pix
  - Spatial Coverage: global and local around Japan
  - Map Projection / Datum: Equirectangular (lat/lon) projection
- **If applicable: Cloud screening**
  - Algorithm: Threshold tests & Temporal filtering
- **If applicable: Valid / non-valid areas**
  - Invalid/masked areas: Ocean not validated (should be masked)
- **Product Format**: HDF4 and binary + ascii (for snow area)
- **Products accessible at**: http://kuroshio.eorc.jaxa.jp/JASMES/index.html
- **Contact Person**
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