Snow extent (SE) and lake surface water temperature (LSWT) retrieval with AVHRR

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Available snow information or sensors for time series

- **SE**: snow extent
- **FSC**: fractional snow cover
- **SWE**: snow water equivalent

<table>
<thead>
<tr>
<th>Year</th>
<th>SE</th>
<th>FSC</th>
<th>SWE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>NOAA Snow Charts</td>
<td>AVHRR</td>
<td>SMMR</td>
</tr>
<tr>
<td>1980</td>
<td>NOAA IMS</td>
<td>ATSR-2</td>
<td>SSM/I</td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td>AATSR</td>
<td>AMSR-E</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>MODIS</td>
<td>SSM/I-S</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>VIIRS</td>
<td></td>
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</tbody>
</table>
Project overview for 2 ECVs

> **Snow Extent (SE)**
  - ESA Globsnow (WP 2: Snow Extent Algorithm Development – snow fraction and snow extent); NRT – back up; done
  - NRT – SE retrieval for Snow and Avalanche Institute, Davos (WSL-SLF); ongoing
  - European SE time series; ongoing
  - ESA/WB Lesotho snow mapping (but based on MODIS, MERIS)

> **Lake Surface Water Temperature (LSWT)**
  - GCOS-MeteoSwiss: feasibility study; done
  - SNF: A European Lake Surface Water Temperature data set derived from NOAA/Metop-AVHRR (1983 – 2013) – a proxy for climate change; ongoing
  - GCOS-MeteoSwiss: Lake Ice retrieval; submitted
Validation strategy

Hüsler et al. 2012
Algorithm modifications

RGB + scatterplot

original version: Khlopenkov&Trishchenko 2007

optimized thresholds Hüsler et al. 2012

Hüsler et al. 2012
The probability map

- **probability map** is provided for each snowmask
- Uncertainty indication very important for climate change studies
Monthly SCA time series vs. *in situ* data Switzerland

- high agreement between satellite data and ground-based SCA
- No artificial trend introduced by irregular data availability

Hüsler et al. 2012
Regional variability of snow cover
European Alps

Hüsler et al. 2014
Available AVHRR snow products for Europe

- **Daily scene SE** for available NOAA satellite overpasses
- **Daily Maximum SE** composite, from all NOAA satellite overpasses of a given day
- **Multi-day spatially and temporally filtered SE** composite over 7 days

Dates:
- 20100122
- 20100314
- 20060322
Monthly mean lake surface temperature

Method to retrieve SST/LakeST

- Split-window NOAA NESDIS
- Split-window Pathfinder (climate project of NOAA)
  → temporal homogenous retrieval (improvement to NOAA NESDIS)
- Independent from buoy measurements: use of radiative transfer code RTTOV-10

Satellite measurement

- linear or non-linear fitting

Buoy

NOAA NESDIS, Pathfinder

Satellite simulated

- To model
- linear/non-linear fitting

T_s od. T_{skin}

Simulation

Correction of T_{skin} to T_{bulk} after Minnett et al., 2010

M. Riffler, RSGB, 2012; Riffler et al. 2015
Validation of time series

- In-situ data (monthly profiles of Murtensee) used for all NOAA/Metop satellites

RMSE = 3.2
Bias = -2.1

RMSE = 2.2
Bias = -1.4

RMSE = 1.8
Bias = -0.6

LSWT of Lake Constance (1989 – 2009) - Seasonal linear trends

Figure 9. Seasonal mean water temperature and linear trends derived from in situ (dash-dotted) and satellite (solid) observations at Lake Constance for the period 1989 to 2009. Seasons are defined as JFM (January-February-March, winter), AMJ (April-May-June, spring), JAS (July-August-September, summer), and OND (October-November-December, autumn).

Riffler, M., G. Lieberherr and S. Wunderle (2015); Earth Syst. Sci. Data, 7, 1–17,
Critical issues

> Ideal data set:
  — Calibrated and geocoded AVHRR time series to fulfill GCOS and EUMETSAT requirements
  — Cloud retrieval: developments should be usable for AVHRR/2 and AVHRR/3 without many external data.

> MOST important: daily data availability from 1981 – today

> A one-stop-shop for data access is a strong requirement from climate users.
Conclusion

> The developed algorithms for snow extent and lake surface water temperature show a high level of validity and temporal stability.

> Also the algorithms for albedo and AOD are in a status to be used for time series processing.

> A careful post-processing is recommended to find erroneous retrievals (e.g. geocoding and remaining fractional clouds)

> MOST important from climate user perspective: extend the archive to the past (1981 – 1989) and fill some weekly gaps.

> Thanks!