ASCAT backscatter processing status

Julia Figa-Saldaña, Craig Anderson, Hans Bonekamp, Colin Duff, Julian J.W. Wilson

ascat_calval@eumetsat.int
Outline

History of main processor upgrades
On-going processor changes
Future developments
Consistency of data record and re-processing status and plans
Routine product generation and dissemination started on February 2007 with provisional calibration

ASCAT L1b products declared operational 03/04/08, including
• First full 3-transponders absolute calibration,
• Format change (header and auxiliary data records)

Tuning of the calibration on 09/12/08 as a reference to start adapting the existing ERS-based geophysical parameter retrieval models to ASCAT data, and used for first re-processing of the mission

Implementation of dynamic (orbit-based) Power-to-s0 normalisation on 10/09/09 and start of non-frozen eccentricity orbit phase on 17/09/09

Current version of L1b processing facility is 7.3
V7.4 - new Kp algorithm

Improved calculation of on-board correlation coefficients $\rho_{ij}$ and implementation of their use on the backscatter variance estimation.

The Kp values from the new algorithm should be slightly higher than those given by the current algorithm.
Improved calculation of on-board correlation coefficients \( \rho_{ij} \) and implementation of their use on the backscatter variance estimation.

The Kp values from the new algorithm should be slightly higher than those given by the current algorithm.
V7.4 – Hamming filter correction for 12.5 km product

Applied until now with reverse across-track node order from far to near swath
No significant effects expected on backscatter or kp

\[
W_x = \alpha_x + (1 - \alpha_x) \cos \left( \frac{\pi x}{L_x} \right)
\]

\[
W_y = \alpha_y + (1 - \alpha_y) \cos \left( \frac{\pi y}{L_y} \right)
\]

International Ocean Vector Winds Science Team Meeting, Annapolis, May 2011
Oscillations w.r.t incidence angle observed over ocean, rainforest and sea ice: systematic azimuth de-pointing effects between ascending and descending passes - now removed before gain pattern estimation.

\[ \sigma_{est}^o = \frac{P_R}{\Omega} \]

Beam 3: Ω w.r.t elevation

Beam 3: γ0 over rainforest (asc) (1 month)
V7.4 - new backscatter calibration

In September 2009, calibration change in Mid Left Beam

<table>
<thead>
<tr>
<th>Beam</th>
<th>LF (0)</th>
<th>LM (1)</th>
<th>LA (2)</th>
<th>RF (3)</th>
<th>RM (4)</th>
<th>RA (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backscatter correction (dB)</td>
<td>0.081</td>
<td>0.201</td>
<td>0.113</td>
<td>0.075</td>
<td>0.070</td>
<td>0.074</td>
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</tbody>
</table>

(poster by Julia Figa-Saldaña)
Future processor developments

- **Level 1A improvements:**
  - Handling of data gaps
  - Better flagging of instrument changes in near real time
  - Faster geolocation
  - Receive filter shape correction refinement

- **Level 1B improvements:**
  - Overall quality flag refinement
  - Line of backscatter triplet nodes generation on a fixed time-based grid
  - Format optimisation of the full resolution geolocated sigma0 product for near real time use
  - Field sizes
  - Addition of a swath grid for re-sampling
  - (example test data available – contact Craig Anderson)

- **New format available for backscatter data as of Sept 2011: netCDF**
Full ASCAT backscatter data record to date

- Reprocessed data 2007 -> 2008
- Operational data 2009 Jan -> June
- Operational data 2009 July -> August (fast NTG)
- Operational data 2009 Sept -> now (dynamic NTG and non-frozen eccentricity orbit)

All with Dec 2008 calibration, no other significant changes in L1b processor!

What is this record useful for?
Consistency of processing configuration allows assessing instrument stability/system performance in the long term

(poster by Julia Figa Saldaña)

Other events influencing the consistency of the data record
- Change in Mid Left Beam calibration: increase of 0.1 dB over all incidence angles
- Manoeuvre record (provided in back-up slides)
Reprocessing overview

Phase 1 of ASCAT sigma0 and soil moisture reprocessing completed and delivered on 07/12/09 (years 2007 and 2008)

http://www.eumetsat.int/Home/Main/News/OperationalNews/715844?l=en

Phase 2 reprocessing planned for sigma0, winds and soil moisture back to January 2007. Planned for 2012.

- Main driver: consistent ASCAT geophysical data records for ERA CLIM
- Agreement at ASCAT Science Advisory Group level on the Reprocessing Product Requirements
- Pre-condition: Validation of calibration results over natural targets
The requirements on the climate data record accuracy and stability are formulated on geophysical parameters over natural targets (e.g. winds over ocean, soil moisture over land, sea ice coverage).

On the other hand, the radar backscatter is the reference property of the Earth surface which can be most directly related to the measurement system. Therefore, our first goal is to provide a consistent radar backscatter record, and to be able to monitor it independently of natural targets (transponder calibration campaigns).

We need to ensure that measurement system changes estimated independently can be validated and are understood in terms of observability over natural targets, in order to be able to give estimates on the accuracy and stability of our geophysical data records.
Phase 2 reprocessing overview - key issues

Validation of calibration results over natural targets is going to be our next challenge in preparing for the next reprocessing effort.

On the positive side, the radiometric accuracy under discussion is beyond what the measuring system was specified to provide!

Transponders

Rain forest

Ocean

(provided by J. Verpeek, KNMI)
Thanks

see backup slides for more details
Functional overview

Level 1A
- Measured power echoes
- Localisation
- Echo corrections (including calibration and receiver characteristics)
- Corrected calibration power echoes
- Estimation and localisation of peak transponder echo
- Antenna gain pattern samples

Level 1B averaged at 25 km swath grid
- Re-sampling to a 25 km swath grid (spatial averaging)
- Power to sigma0 normalisation
- Normalisation factors
- Dynamic NTG
- 2-dimensional antenna gain pattern and de-pointing

L1b full resolution geolocated
- Near real time Metop orbit prediction

Level 1B averaged at 12.5 km swath grid
- Re-sampling to a 12.5 km swath grid (spatial averaging)
- Off-line validation of external calibration results

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Algorithm overview

\[
S = \frac{1}{\text{PGP}} \left[ \frac{E}{h_{RX}} - \text{NP} \right]
\]

\[
\sigma_0 = \frac{S}{\Omega}
\]

\[
\sigma_{0\text{NODE}} = \frac{\sum W_0 \sigma_0}{\sum W_0}
\]

\[ W_0 = W_x W_y \]

\[
K_p = \sqrt{\text{var}(\sigma_{0\text{NODE}})} / \sigma_{0\text{NODE}}
\]

E: raw echo
S: corrected echo
PGP: Power Gain Product (internal calibration)
NP: Noise Power
hRX: Receive filter shape
Ω: Power-to σ₀ normalisation factors
Wo: weighting function for spatial averaging

\[
W_x = \alpha_x + (1 - \alpha_x) \cos \left( \frac{\pi x}{L_x} \right)
\]

\[
W_y = \alpha_y + (1 - \alpha_y) \cos \left( \frac{\pi y}{L_y} \right)
\]
Hamming spatial averaging

\[ W_x = \alpha_x + (1 - \alpha_x) \cos \left( \frac{\pi x}{L_x} \right) \]

\[ W_y = \alpha_y + (1 - \alpha_y) \cos \left( \frac{\pi y}{L_y} \right) \]
### Spatial Resolution SZR

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<tr>
<th>Left Swath Distance to near swath</th>
<th>ANTLF</th>
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<th>ANTLM</th>
<th></th>
<th>ANTLA</th>
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<td>AL</td>
<td>AC</td>
<td>AL</td>
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<td>AL</td>
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</table>
Fix time grid for sigma0 triplet lines of nodes

Along track node grid spacing for SZO product within an orbit

Current (constant distance)  Proposed (fixed time grid)
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
<th>Mode</th>
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<tbody>
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<td>2006/10/21</td>
<td>18:58:08</td>
<td>OOP</td>
<td>GEO performed by ESOC</td>
</tr>
<tr>
<td>2006/10/22</td>
<td>06:30:43</td>
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<td>GEO performed by ESOC</td>
</tr>
<tr>
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<td>07:20:35</td>
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<td>GEO performed by ESOC</td>
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<td>2006/11/02</td>
<td>15:06:32</td>
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<td>YSM</td>
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<td>YSM</td>
</tr>
<tr>
<td>2007/04/19</td>
<td>14:56:40</td>
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<td>YSM</td>
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<tr>
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<td>YSM:</td>
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<td></td>
<td>Yaw Steering pointing mode</td>
</tr>
<tr>
<td>2008/04/08</td>
<td>13:26:21</td>
<td>OOP</td>
<td>GEO: Geocentric pointing mode</td>
</tr>
<tr>
<td>2008/04/09</td>
<td>03:48:39</td>
<td>IP</td>
<td>OOP: Out of Plane manoeuvre</td>
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<tr>
<td>2008/04/24</td>
<td>14:46:31</td>
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<td>YSM</td>
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<td>14:30:02</td>
<td>OOP</td>
<td>GEO</td>
</tr>
<tr>
<td>2008/10/30</td>
<td>14:11:05</td>
<td>IP</td>
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<tr>
<td>2008/10/30</td>
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<td>YSM</td>
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<td>2009/01/22</td>
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<td>YSM</td>
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<tr>
<td>2009/09/17</td>
<td>14:17:41</td>
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<td>2009/12/10</td>
<td>15:31:21</td>
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<td>YSM</td>
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<td>2010/06/10</td>
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<td>2010/10/05</td>
<td>12:16:45</td>
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<td>2010/10/06</td>
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<td>2011/05/01</td>
<td>03:28</td>
<td>IP</td>
<td>YSM Collision avoidance manoeuvre</td>
</tr>
</tbody>
</table>

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Cal 2010: rainforest $\gamma_0$ patterns

International Ocean Vector Winds Science Team Meeting, Annapolis, May 2011
Cal 2010: rainforest γ0 patterns (average removed)
Analysing possible changes

$$\sigma_{est}^o = \frac{P_R}{\Omega} = \frac{P_T Kg^2 \sigma_{true}^o}{\Omega}$$

$$K = \frac{F \lambda^2}{(4\pi)^3 R^4}$$

What other changes are plausible in the measuring system that might artificially result in apparent changes in the measured NRCS?

\(\sigma^o_{true}\) is the true NRCS from the ocean

\(PR\) is the received power

\(PT\) is the transmitted power

\(R\) is range

\(\lambda\) is the signal wavelength

\(F\) is the measured footprint

\(G\) is the true instrument gain

\(K\) contains then the measurement geometry, including orbit and attitude (pointing)

\(\Omega\) is the normalisation factors, calculated with given settings of measuring geometry and radar signal transmission, propagation and receiving