Advancements in scatterometer wind processing

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9th IWW, Annapolis
www.knmi.nl/scatterometer

Scatterometer work

The scatterometer is a satellite radar-instrument which provides a measure of wind speed and direction near the sea surface.

We develop scatterometer processing software for operational use in weather and marine forecasting. More information on this is available under the 'Software' links on the right hand side of this page.

To preview our near real-time products and obtain access to them and our archive of off-line products, please follow the 'Wind Products' links.

Our activities are diverse and span
• Research on new types of scatterometer for future use
• Development of algorithms for wind retrieval and ice processing
• Wind product processing, quality control, and monitoring
• User support

Your contribution?
We seek beta users for our software and data products in order to get feedback and improve our services. Workshops are planned where users are invited for updating the evolving requirements. Moreover, our developments are supported by a Visiting Scientist scheme, which funds exchange of people between institutes. Topics could include for instance:
• Geophysical interpretation
• Inversion or ambiguity removal
• Data assimilation
• User support
Your suggested contributions are welcomed by us.

Acknowledgement
EUMETSAT SAF activities

• NWP Satellite Application Facility software
  - AWDP available for beta testers (ERS and ASCAT)
  - SDP; beta testers welcome for new version
  - 2D-Var settings and NWP guidance
  - Coastal AWDP ( @25km, later 12.5 km )

• OSI Satellite Application Facility data and services
  - ASCAT Cal/Val
  - ASCAT demo 25 km since March 2007 (first MetOp L2 product)
  - ASCAT 12.5 km – run experimentally at KNMI
  - Coastal product prototype
  - Geophysical modelling and (NOAA hurricane hunter) air campaign
  - SeaWinds update evaluation (updated NOAA stream)

• Timely EARS data
  - ERS data
  - ASCAT; soon 25-km NH ascending orbits in 35 i.s.o. 100 minutes

• Climate Mon. SAF scatterometer ocean stress fields
  [climexp.knmi.nl](http://climexp.knmi.nl)

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KNMI ASCAT Level 1b corrections

Vertical cut for WVC #42

Level 1b 1st release  Level 1b latest release  KNMI total correction

ASCAT measurements fit ocean GMF well after correction

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ASCAT winds

- Very good overall wind statistics
ASCAT L2 calibration

- ASCAT winds first MetOp-A L2 product
- Winds within spec
- ERS compatibility can be achieved
- New swath parts provide good winds, but CMOD5.5 may be biased
- After ASCAT L1b calibration, the $z$ correction table should be removed from AWDP and remaining biases incorporated in CMOD6
- Further L1b calibration, using 3-transponder data, will not result in L2 wind discontinuities
- AWDP checks ongoing: Kp's, MLE, P(V)'s, etc.
- Parallel L2 streams for neutral winds (+0.2 m/s)
Processing
SCAT, SeaWinds, ASCAT

Input ($\sigma_0$ values) → Pre-processing → Inversion

MSS (144) → Inversion → Quality Control

< 4 solutions

2D Var AR → Ambiguity Removal

Ambiguity Removal → Quality Monitoring → NWP model

Output wind field

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SeaWinds @ 25km, Hurricane Dean, 16 Aug 2007

Without MSS
- Retrieval of 4 local solutions
- PDF

With MSS
- Full wind vector

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Improved cold front

QC better Around rain

Wind direction continuity

Balance in rotation and divergence

NOAA/NASA
Median Filter AR

KNMI
2D-Var AR
ERS scatterometer observes wave train
HiRLAM model (and other NWP models) miss the wave train (too smooth)
The MSG clouds are aligned with the wave train, but in themselves provide little dynamical information

Next day a forecast bust occurred for cloud and precipitation in England and the Netherlands
25% wind variance difference

Half of wind variance

4 times less wind variance

Logarithm Wind Spectral Density [-] vs. Wave Number [km]

-5
-4
-3
-2
-1
0

V (SDP)
V (ECMWF)
k^{-2}

k_T
k_{RC}
k_G

300 km
Buoy verification

- First results
- ASCAT 25 compares best to ECMWF also
- ECMWF misses 1.2 m/s w.r.t. ASCAT
- For SeaWinds, 100km best represents ECMWF winds

<table>
<thead>
<tr>
<th></th>
<th>ASCAT 25</th>
<th>SeaWinds 25</th>
<th>SeaWinds 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD u [m/s]</td>
<td>1.76</td>
<td>1.84</td>
<td>2.19</td>
</tr>
<tr>
<td>SD v [m/s]</td>
<td>1.79</td>
<td>1.83</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Collocation result - speed (2476 wind vectors)

Collocation result - direction (2176 wind vectors)
6-hourly ECMWF update

6-hour variance of 10-meter wind (m/s) analysis increment; N.Hemis 0.49, S.Hemis 0.54, Tropics 0.58

- ECMWF analysis increments are modest wrt spatial deficit
- Most mesoscale scatterometer information remains unexploited

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6-hourly wind change

Ocean forcing is dominated by transient or temporal effects.
Can eddy-scale ocean forcing be provided at hourly scale?
2D-VAR provides scatterometer analyses; can the increments be advected in time? → Topic in MyOcean

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EU Marine Core Services through MyOcean: Thematic Assembly Centers (TAC)

- TACs will feed the global and regional components of the MCS in observation products for space and in situ data.

- From observation systems to the service centres. Specific requirements from modelling and data assimilations centers as well as from users and downstream services.

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ASCAT Level 2 product:
- 50 km resolution
- up to 60 km off the coast to avoid land effects

ASCAT Coastal product:
- 30-40 km resolution
- up to 25 km off the coast
- $\sigma$° more noisy, so MSS
Way forward

- NH ascending ASCAT winds will be delivered in 35 minutes.
- Geophysical modelling improvements and (NOAA hurricane hunter) air campaign are ongoing.
- Prototypes on higher resolution ASCAT winds (12.5 km) and for winds nearer to the coast exist.
- KNMI provides a wind product independent of the SeaWinds input (updated NOAA stream).
- The ASCAT full resolution product is required in NRT.
- ISRO SCAT at 12 LST nicely complements SeaWinds at 6 LST and ASCAT at 9:30 LST for providing temporally-resolved eddy-scale ocean winds.
- Global NRT backscatter (L2A) products would be greatly appreciated from ISRO to aid in a timely exploitation.

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First ASCAT winds

• Now the work starts . . .
Is this noise or geophysical variability?

- Spectral analysis
- Triple collocation of buoy, NWP, and scatterometer winds (in progress)
Validation against ECMWF

Node: 42

Wind speed (m/s) – Z0.625

N = 12783
mx = 7.07
my = 6.45
m(y-x) = -0.62
s(y-x) = 1.37
\text{cor}_{xy} = 0.91

Wind speed (m/s) – ECMWF

Wind dir (deg) – Z0.625

N = 10588
mx = 170.58
my = 171.24
m(y-x) = 0.66
s(y-x) = 17.53
\text{cor}_{xy} = 0.98

Wind dir (deg) – ECMWF

Wind comp. (m/s) – Z0.625

N = 12783
mx = -0.41
my = -0.49
m(y-x) = -0.09
s(y-x) = 1.55
\text{cor}_{xy} = 0.97

Wind comp. (m/s) – ECMWF

Wind comp. (m/s) – Z0.625

N = 10588
mx = -0.01
my = -0.00
m(y-x) = 0.01
s(y-x) = 1.74
\text{cor}_{xy} = 0.93

Wind comp. (m/s) – ECMWF

KNMI corrected

demo version

Level 1b
ASCAT winds

- Better quality than ERS winds
- Stable product
- Files called “t” for test; flagged as unuseful
- MLE’s not yet normalised to ASCAT noise
- QC not yet tuned
- No product monitoring flag yet
- Winds being added for QC-ed WVCs
- Much feedback at scat@knmi.nl Thanks!
- Buoy monitoring in collaboration with ECMWF in progress
- 12.5 km product under test; MSS needed
- Coastal product under development
- Improved geophysical validation
- Guidance for data assimilation using 2D-Var

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User issues

• Keep ASCAT test status while stable product?
• ASCAT - ERS continuity absolutely needed?
• Provide winds in case of flags whenever possible: inversion QC and 2D-VAR spatial check
• Demo hi-resolution and/or coastal products for distribution?
• L2 stress product required or only software and guide?
• Archive data format in BUFR/NetCDF/HDF
• Accessibility and compatibility of archives at EUMETSAT, PODAAC
• User requirements MyOcean Wind TAC?: higher level wind products to spatially and temporally contain eddy-scale winds (SAG/OVWST presentation)
Less speed bias

Lower direction SD

WVC speed and direction sensitivities vary
QuikSCAT/ASCAT vs ECMWF

Dataset: 1-5 July 2007

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QuikSCAT/ASCAT vs ECMWF

Dataset: 1-5 July 2007

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QuikSCAT vs ECMWF

9th IWW, Annapolis
ASCAT vs ECMWF

Node: all

Wind speed (m/s) - ECMWF

Wind speed (m/s) - Z0.625

N = 2305231
mx = 7.59
my = 7.55
m(y−x) = -0.05
s(y−x) = 1.28
cor_xy = 0.94

N = 1965456
mx = 177.57
my = 177.86
m(y−x) = 0.29
s(y−x) = 15.75
cor_xy = 0.99

Node: all

Wind dir (deg) - ECMWF

Wind dir (deg) - Z0.625

U comp. (m/s) - ECMWF

U comp. (m/s) - Z0.625

N = 2305231
mx = 0.23
my = 0.11
m(y−x) = -0.12
s(y−x) = 1.52
cor_xy = 0.97

N = 2305231
mx = 0.75
my = 0.72
m(y−x) = -0.03
s(y−x) = 1.62
cor_xy = 0.96

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OSI SAF Operational Service Architecture (Subsystem 3)

Input Services at KNMI, The Netherlands

Satellite data pre-processing

SeaWinds

NWP model output data

FTP

GTS/RMDCN

Product Generation Services – Wind Production Centre at KNMI, De Bilt, The Netherlands

Interactive Tools

Visualise final products

Produce Global 10-m Wind Vectors

Distribute the data

Archive and retrieve the data (interim)

Output Services at KNMI, De Bilt

GTS

EUMETCast distribution

FTP Server

Web Server

MSG Data via EUMETCast

Local NOAA data via HRPT

GOES-East via GVAR

Subsystem 1 at Météo-France, Lannion

Local NOAA data via HRPT

EPS data via EUMETCast

Subsystem 2 at met.no, Norway

Other OSI SAF Subsystem

Product Generation Service (Operational)

Input Services (operational)

Scheduled by the Kernel (operational)

Service Data Delivery and Access (operational)
### OSI SAF ASCAT product release schedule

<table>
<thead>
<tr>
<th>Product</th>
<th>Coverage</th>
<th>Demonstration</th>
<th>Operational</th>
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<tbody>
<tr>
<td>25 km</td>
<td>Global</td>
<td>2007</td>
<td>2008</td>
</tr>
<tr>
<td>12.5 km</td>
<td>Global</td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>Coastal</td>
<td>Global</td>
<td>2009</td>
<td>2011</td>
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<tr>
<td>12.5 km</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Integration of regional EARS products into global OSI SAF products in 2008

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KNMI SeaWinds
experimental
25 km resolution
June 8, 2006, 12:00 UT

www.knmi.nl/
scatterometer
Monitoring of each product

- 1st rank MLE
- Speed bias
- RMS u&v scat - EC
- Timeliness

NWP SAF integrated monitoring at
www.metoffice.gov.uk/research/interpro/nwpsaf/scatter_report

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