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# Advancements in scatterometer wind processing

Ad.Stoffelen@knmi.nl  
Marcos Portabella  
Anton Verhoef  
Jeroen Verspeek  
Jur Vogelzang

[scat@knmi.nl](mailto:scat@knmi.nl)



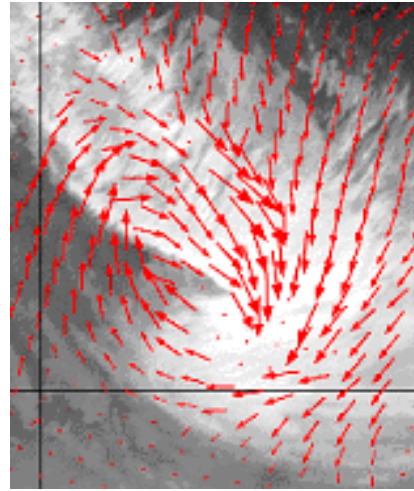
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# [www.knmi.nl/scatterometer](http://www.knmi.nl/scatterometer)

## 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

## Wind Products

[QuikSCAT 100-km winds \(OSI SAF\)](#)

Operational status

[QuikSCAT 25-km winds \(OSI SAF\)](#)

Operational status

[ASCAT 25-km winds \(OSI SAF\)](#)

Pre-operational status

[ERS-2 winds \(EARS\)](#)

Demonstration status

[Archived wind and stress products](#)

## Software

[Wind processing software \(NWP SAF\)](#)

[CMOD5: C-band GMF](#)

[BUFR reader](#)

## R&D work

[Activities](#)

[Publications](#)

## Projects

[OSI SAF: Global wind products](#)

[EARS: Regional wind products](#)

[CM SAF: Climatologic wind stress products](#)

[NWP SAF: Wind processing software](#)

[RFSCAT: Future scatterometer concept](#)



# EUMETSAT SAF activities

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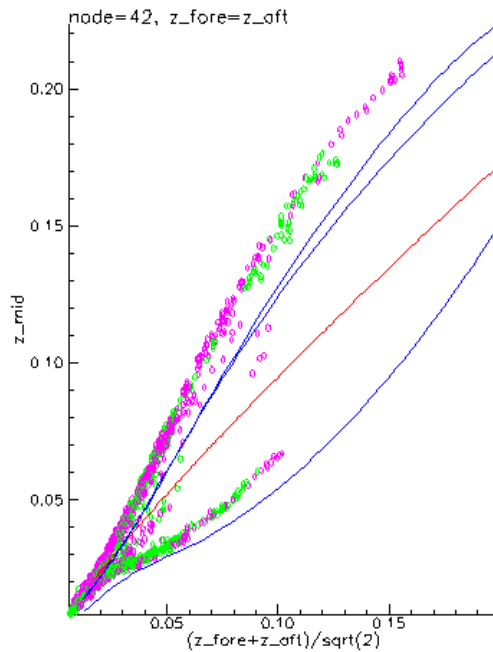
- NWP Satellite Application Facility **software**
  - AWDP available for beta testers (ERS and ASCAT)
  - SDP; beta testers welcome for new version
  - 2D-Var settings and NWP guidance
  - Coastal AWDP ( @25km, later 12.5 km )
- OSI Satellite Application Facility **data and services**
  - ASCAT Cal/Val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



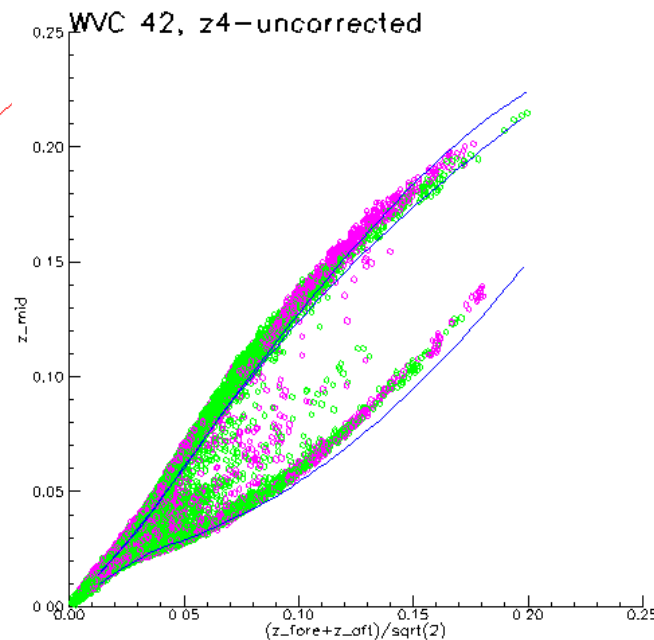
# KNMI ASCAT Level 1b corrections

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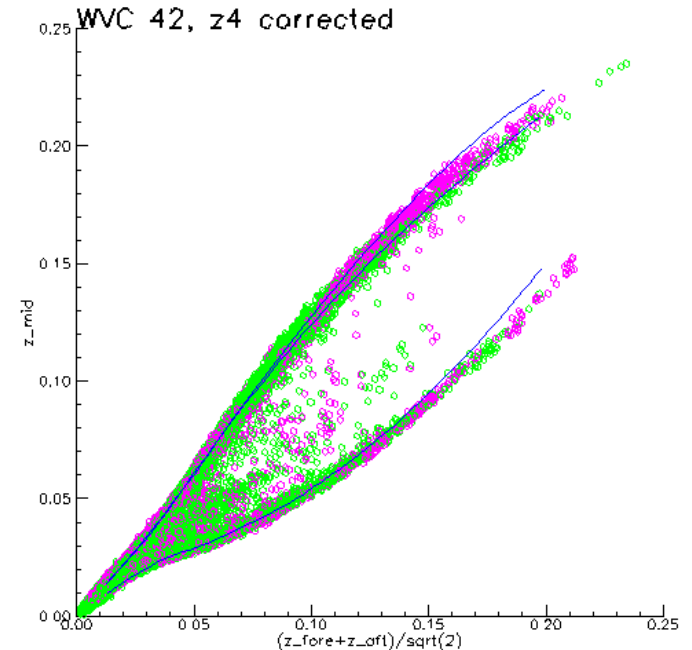
## Vertical cut for WVC #42



**Level 1b 1<sup>st</sup> release**



**Level 1b latest release**



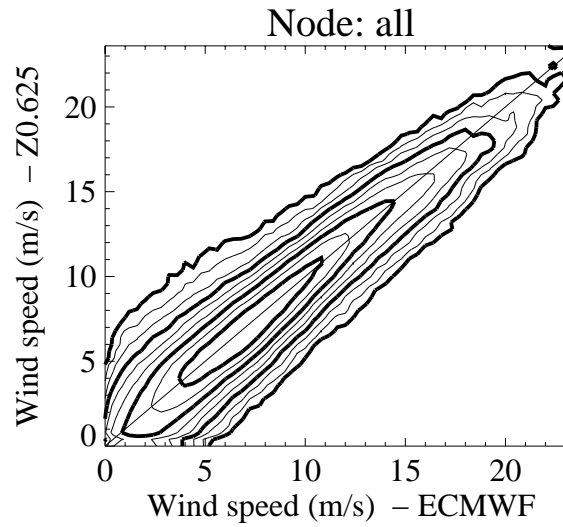
**KNMI total correction**

➤ ASCAT measurements fit ocean GMF well after correction

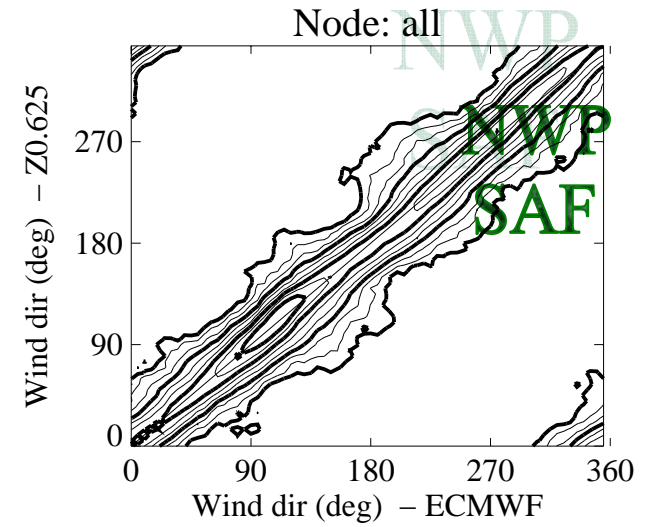


# ASCAT winds

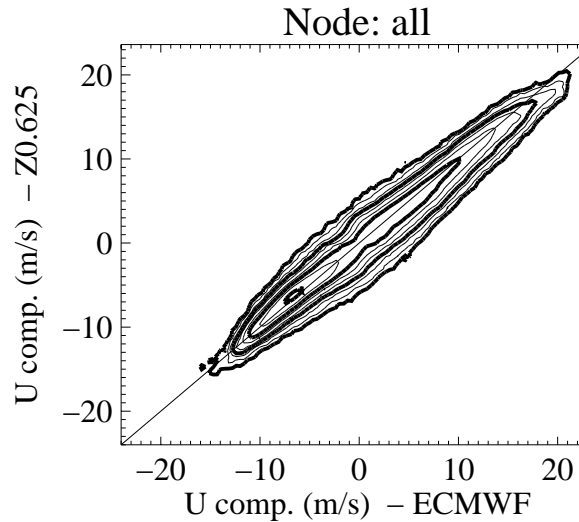
➤ Very good overall wind statistics



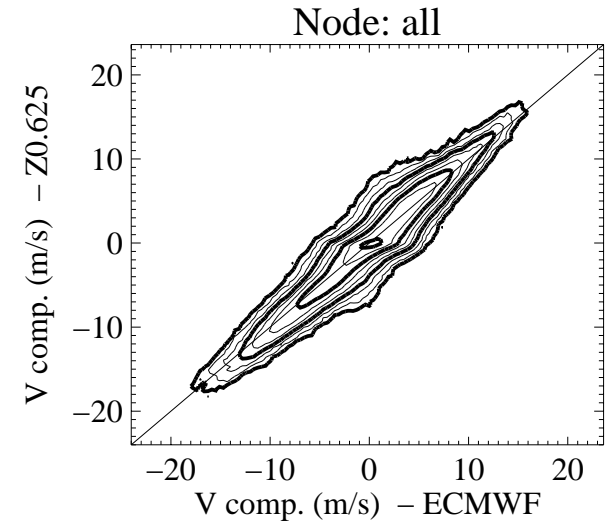
N=3267229  
 mx= 7.66 my= 7.64  
 m(y-x)= -0.02 s(y-x)= 1.26  
 cor\_xy= 0.94



N=2792250  
 mx= 177.72 my= 178.57  
 m(y-x)= 0.86 s(y-x)= 14.94  
 cor\_xy= 0.99



N=3267229  
 mx= -0.15 my= -0.26  
 m(y-x)= -0.12 s(y-x)= 1.45  
 cor\_xy= 0.98



N=3267229  
 mx= 0.78 my= 0.73  
 m(y-x)= -0.05 s(y-x)= 1.62  
 cor\_xy= 0.95

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# ASCAT L2 calibration

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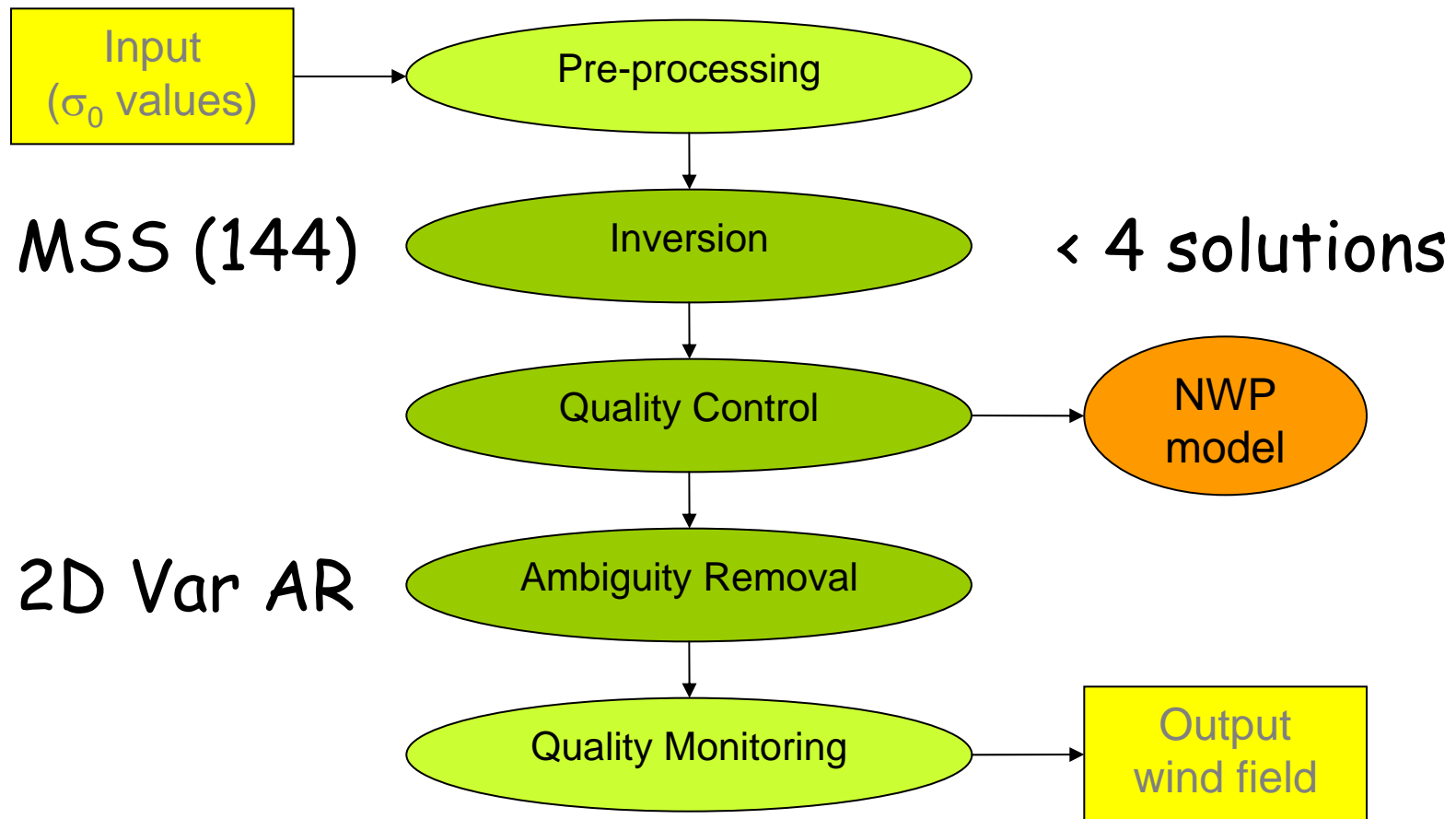
- ASCAT winds first MetOp-A L2 product
- Winds within spec
- ERS compatibility can be achieved
- New swath parts provide good winds, but CMOD5.5 may be biased
- After ASCAT L1b calibration, the  $z$  correction table should be removed from AWDP and remaining biases incorporated in CMOD6
- Further L1b 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

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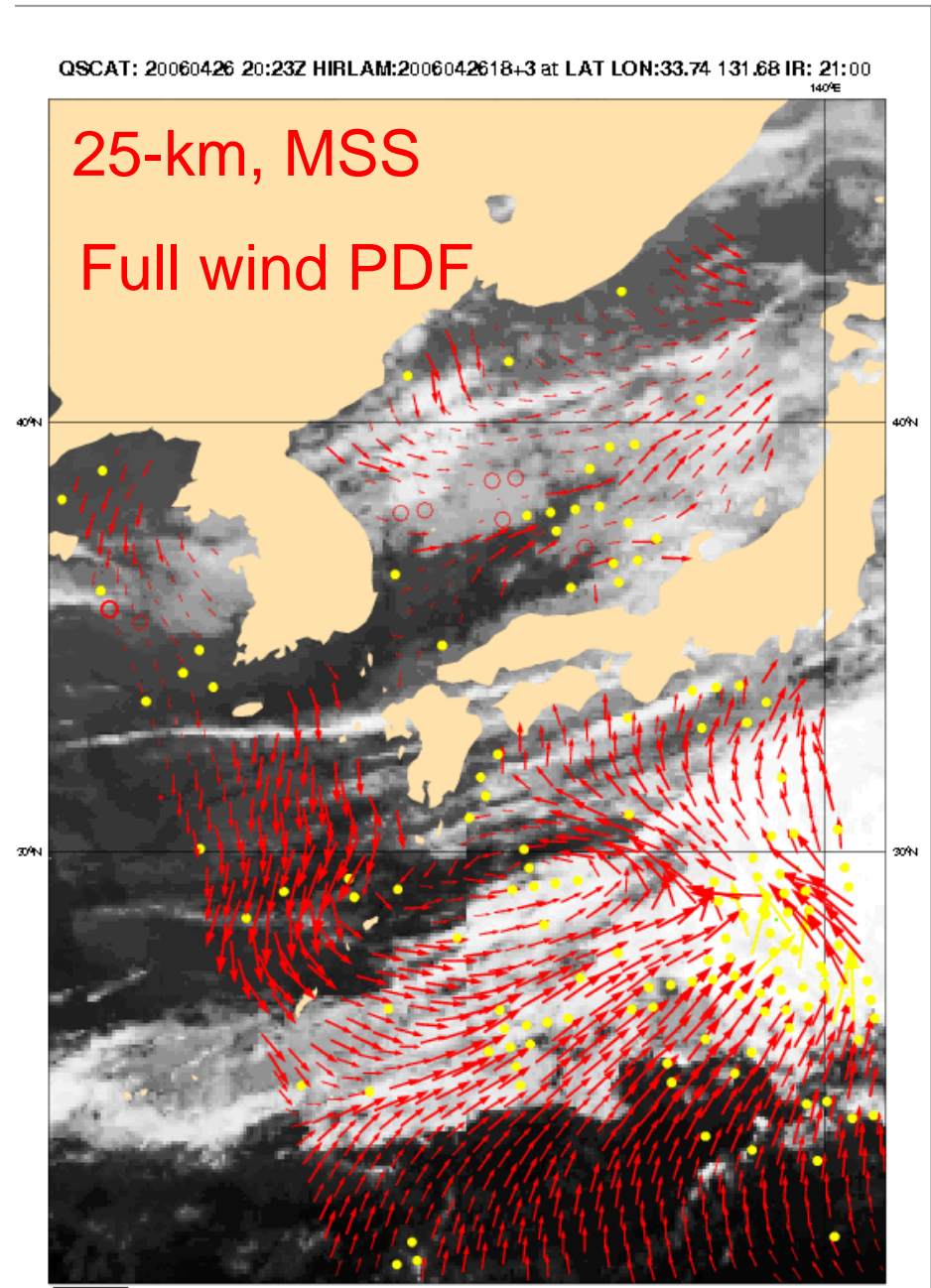
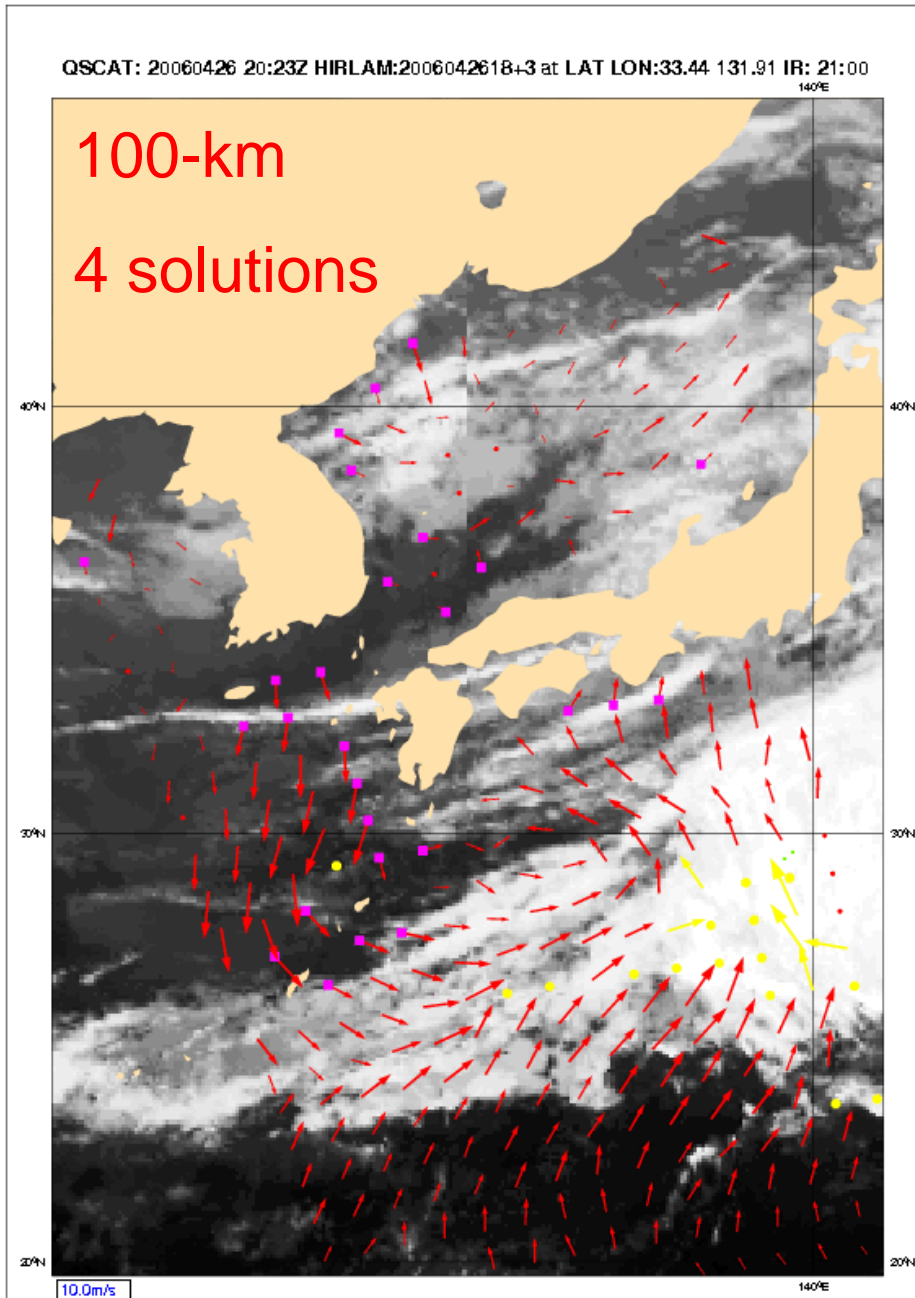






# SeaWinds Data Processor

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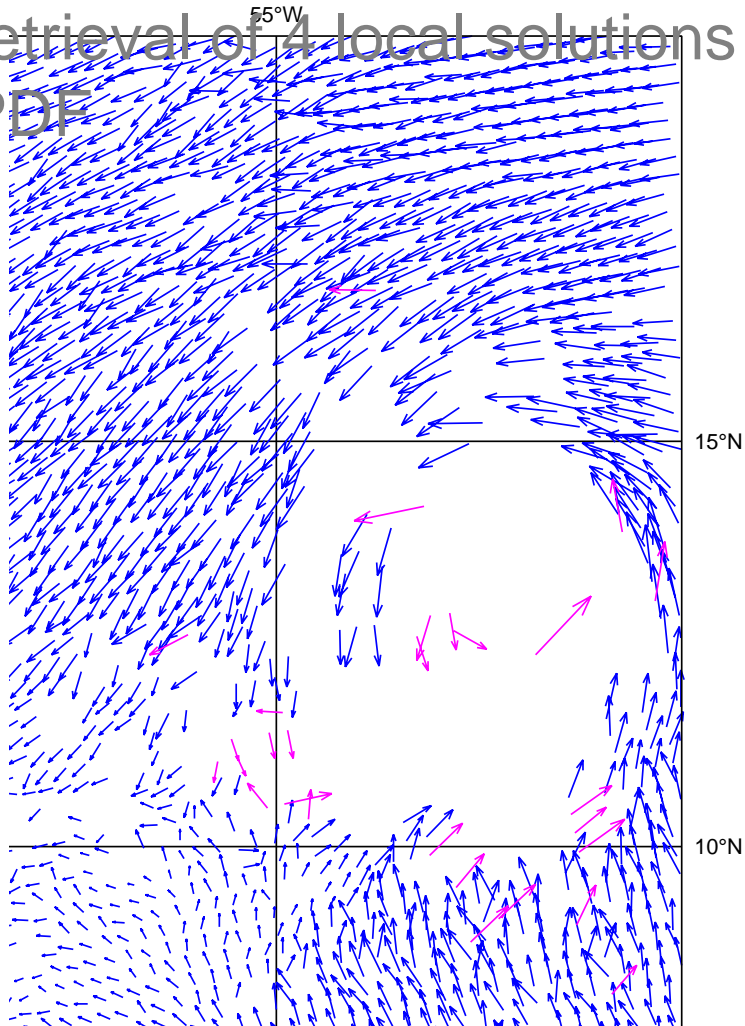




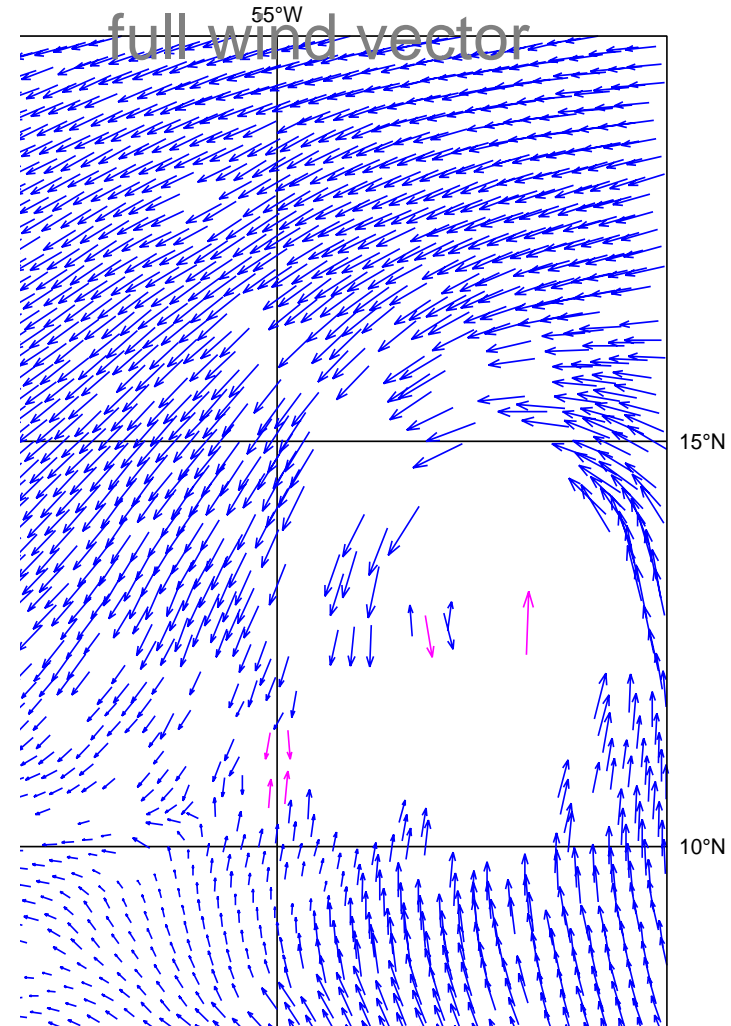
# SeaWinds @ 25km, Hurricane Dean, 16 Aug 2007

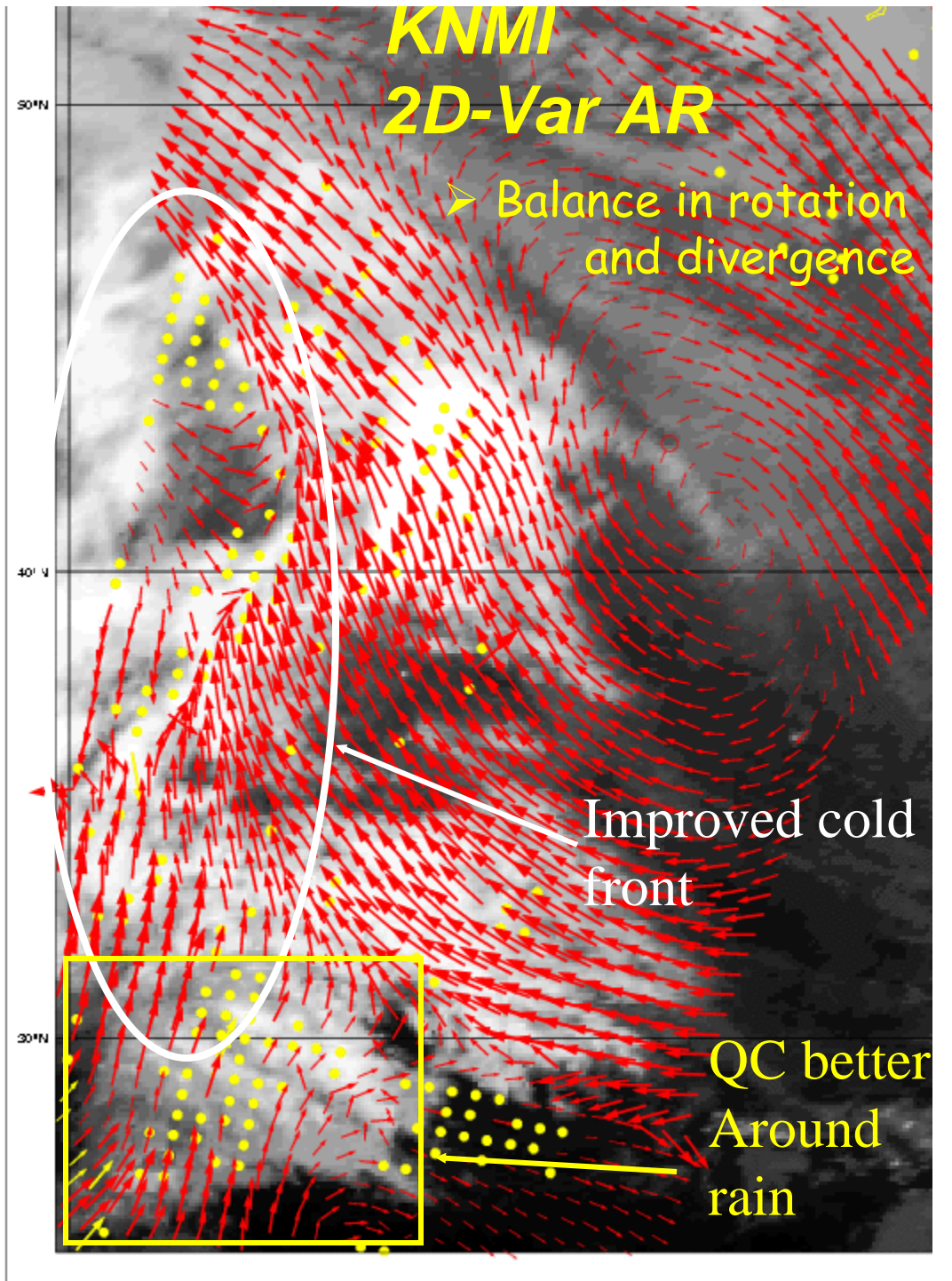
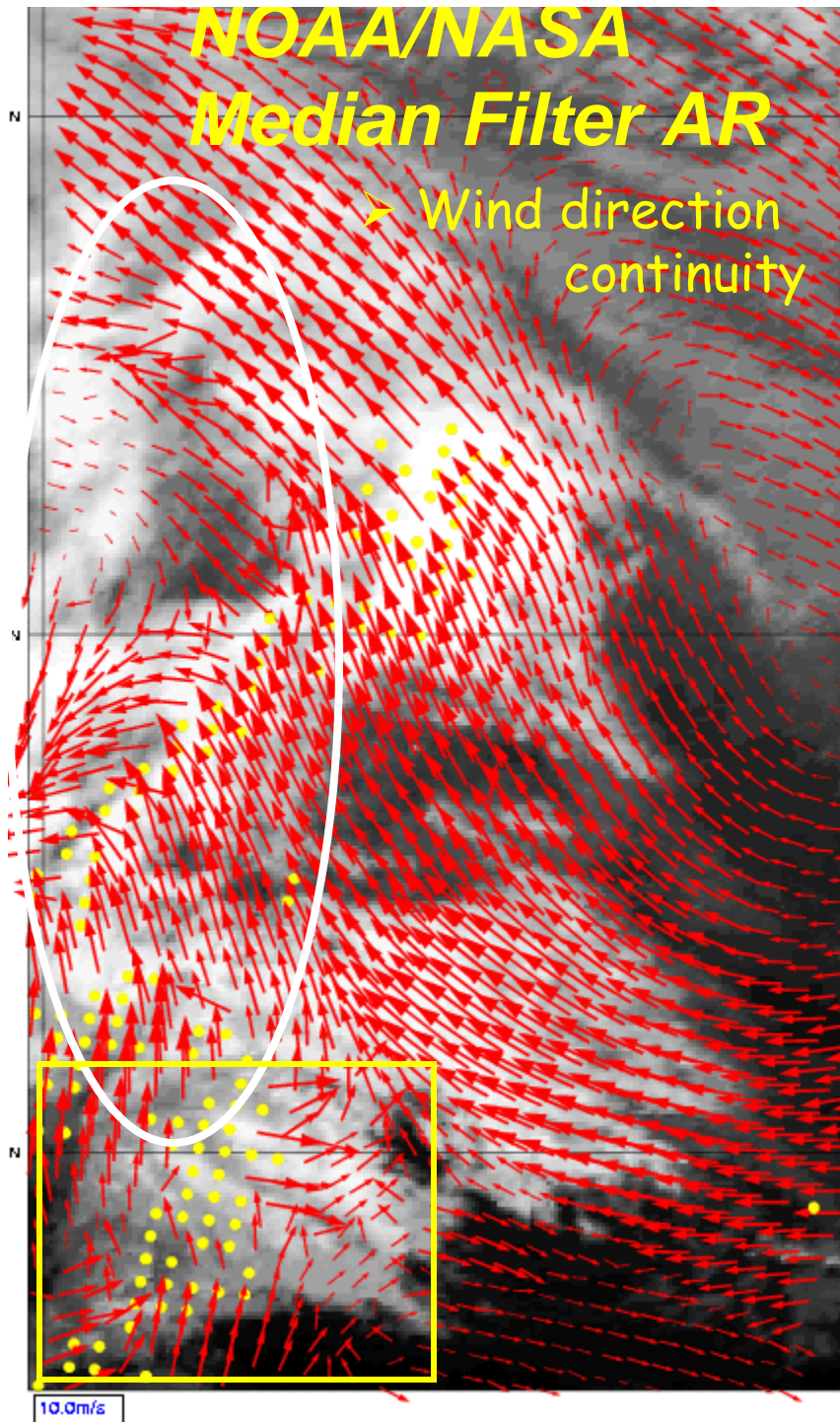
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Without MSS  
retrieval of 4 local solutions  
PDF



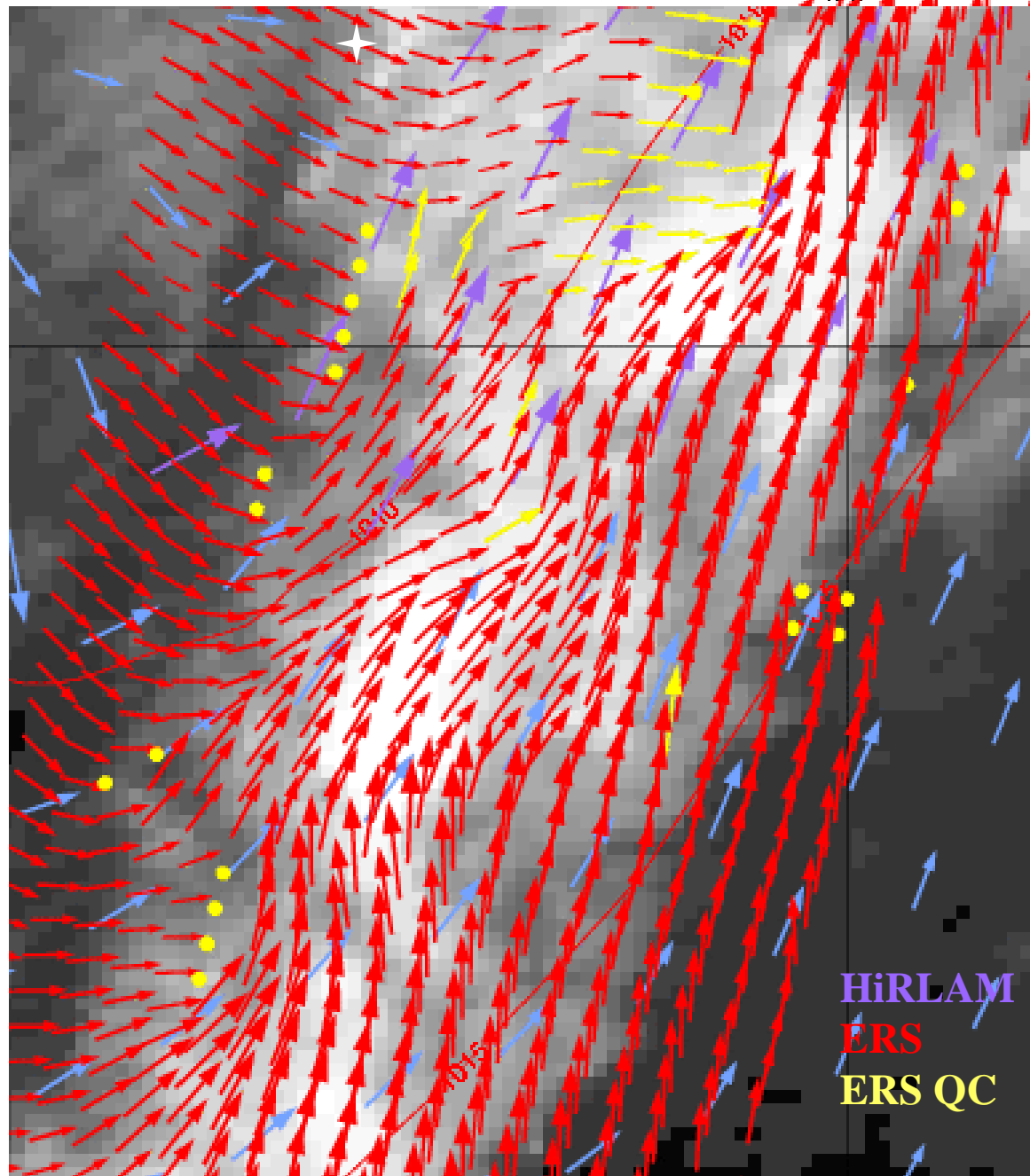
With MSS  
full wind vector







20060828 13:30Z HIRLAM : 2006082809+3 lat lon: 39.19 41.86

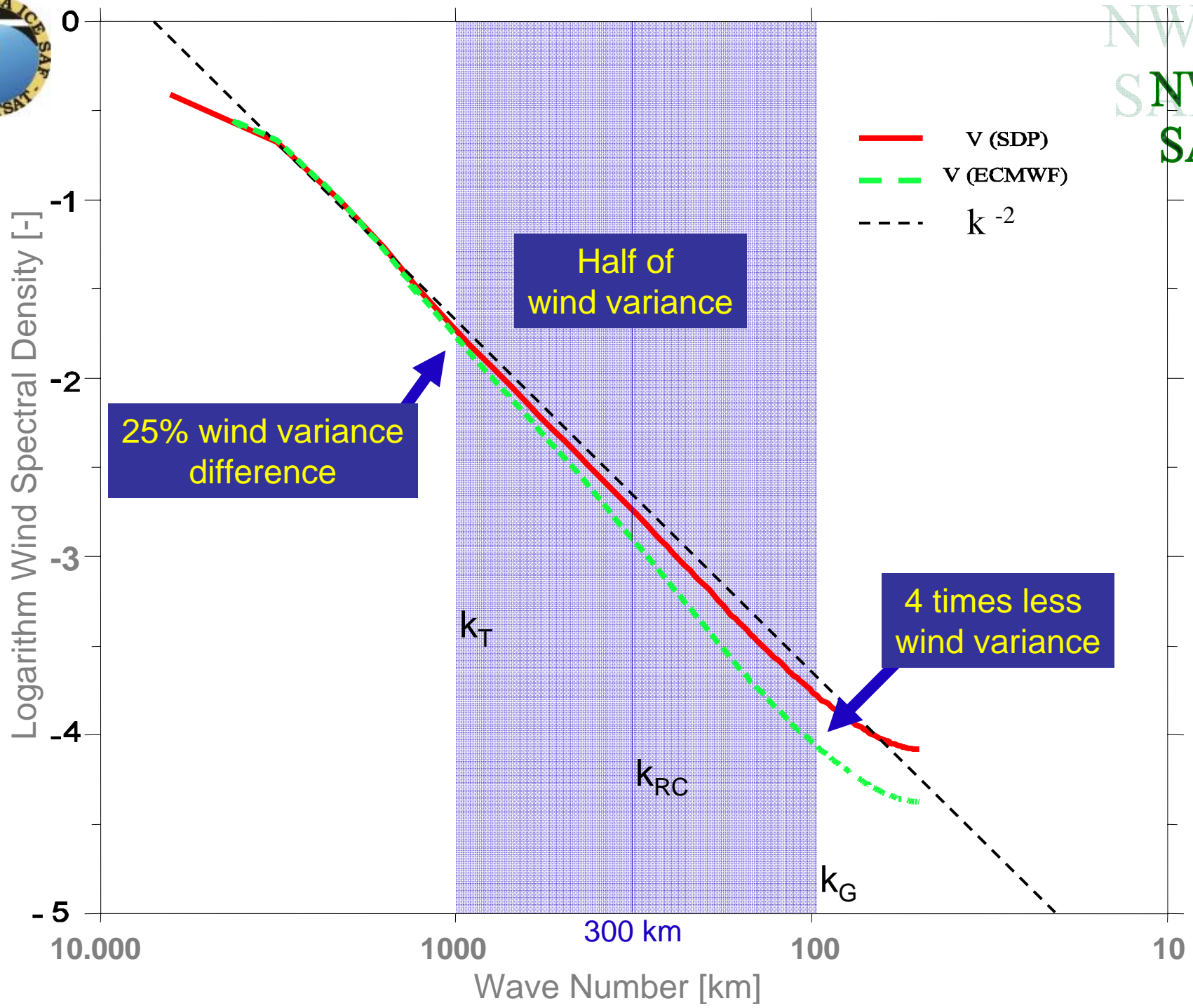


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- ERS scatterometer observes wave train
  - HiRLAM model (and other NWP models) miss the wave train (too smooth)
  - The MSG clouds are aligned with the wave train, but in themselves provide little dynamical information
- Next day a forecast bust occurred for cloud and precipitation in England and the Netherlands



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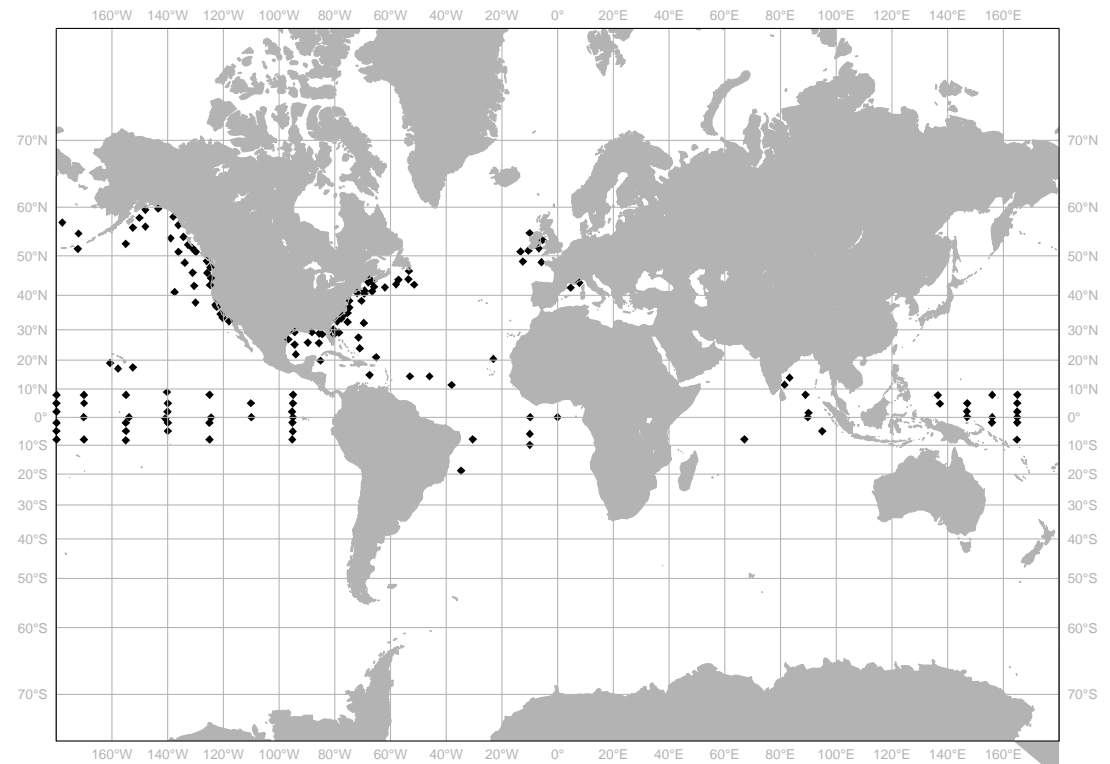
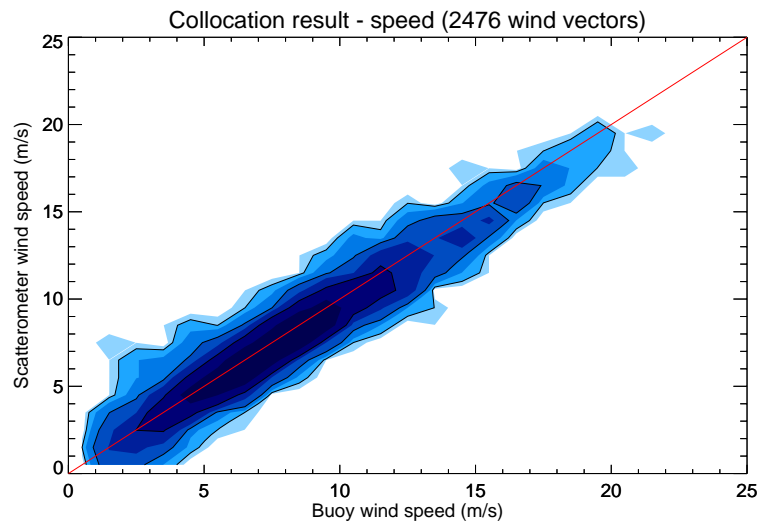


# Buoy verification

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- 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

ASCAT 25		SeaWinds 25		SeaWinds 100	
SD u [m/s]	SD v [m/s]	SD u [m/s]	SD v [m/s]	SD u [m/s]	SD v [m/s]
1.76	1.79	1.84	1.83	2.19	2.00

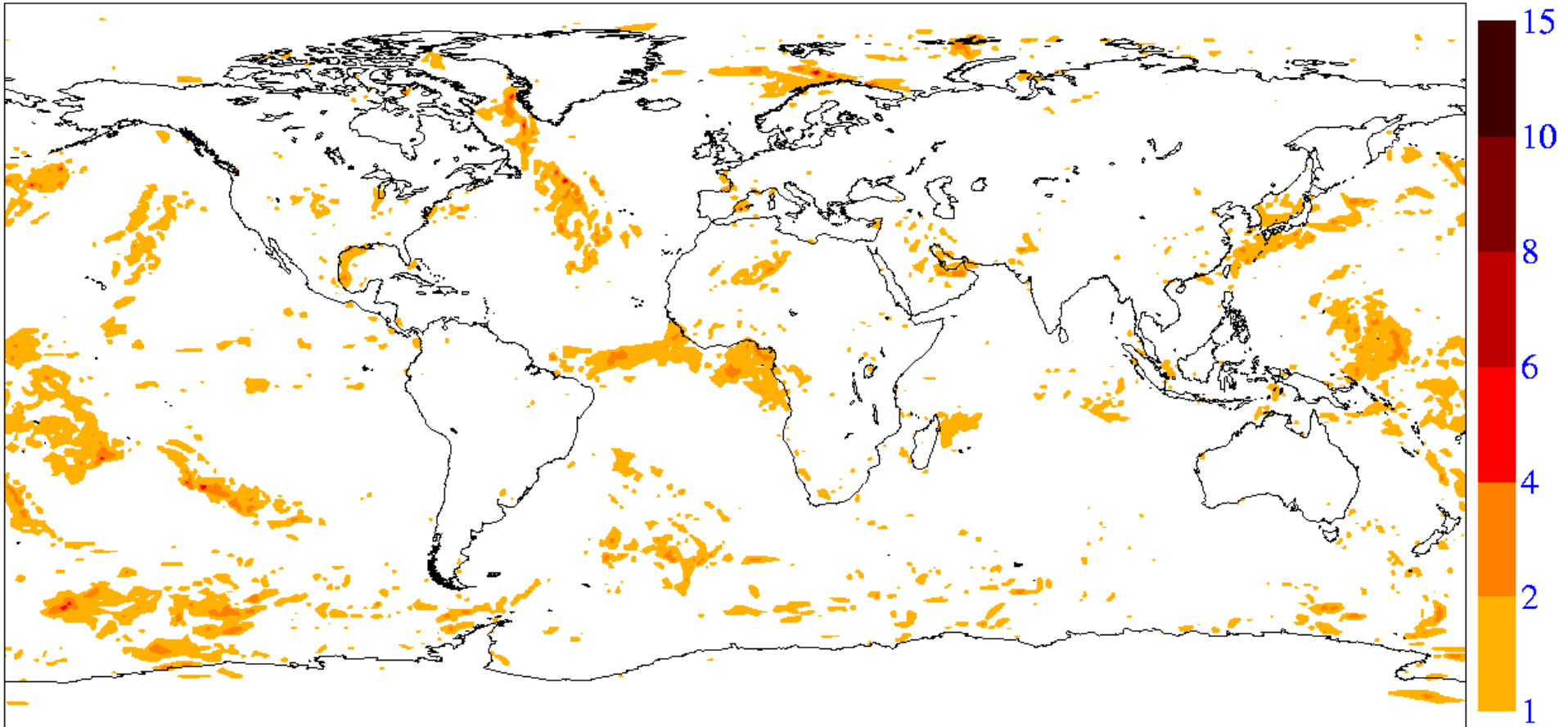




# 6-hourly ECMWF update

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

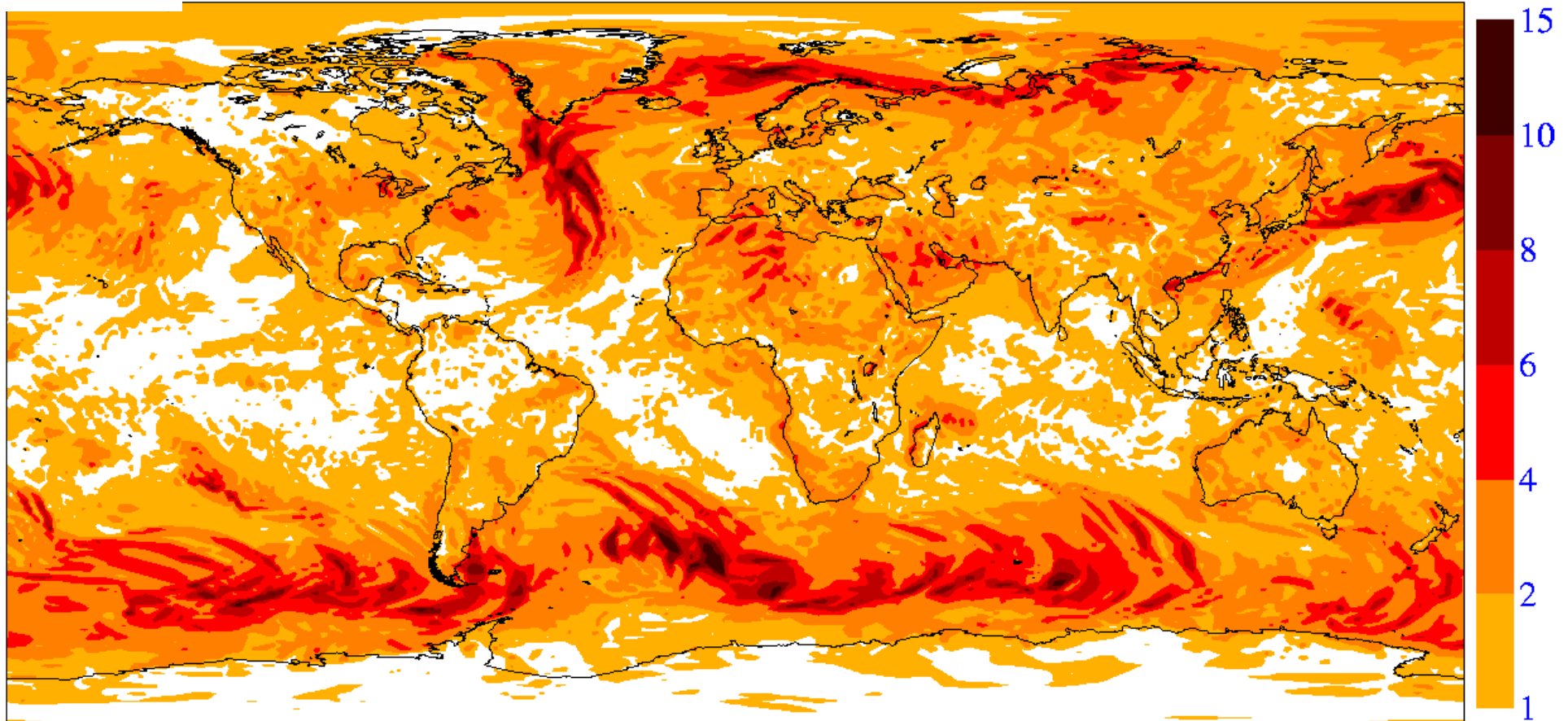


- ECMWF analysis increments are modest wrt spatial deficit
- Most mesoscale scatterometer information remains unexploited



# 6-hourly wind change

variance of 10-meter wind (m/s); N.Hemis 2.14, S.Hemis 2.48, Tropics 1.23

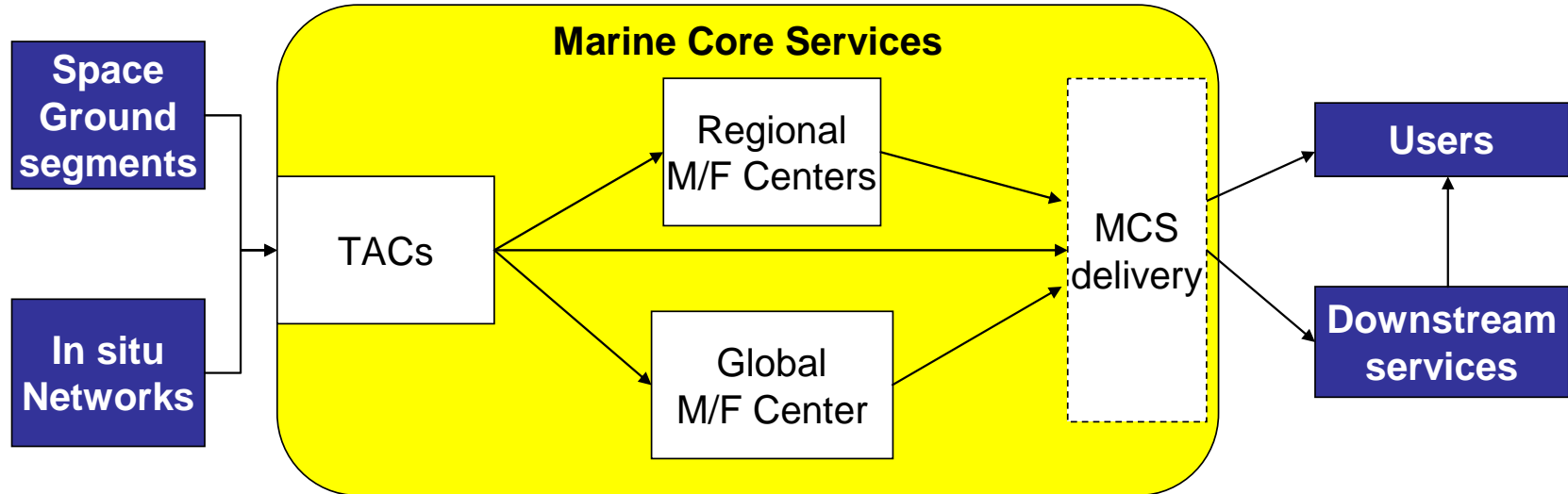


- Ocean forcing is dominated by transient or temporal effects
- Can eddy-scale ocean forcing be provided at hourly scale ?
- 2D-VAR provides scatterometer analyses; can the increments be advected in time? → Topic in MyOcean



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

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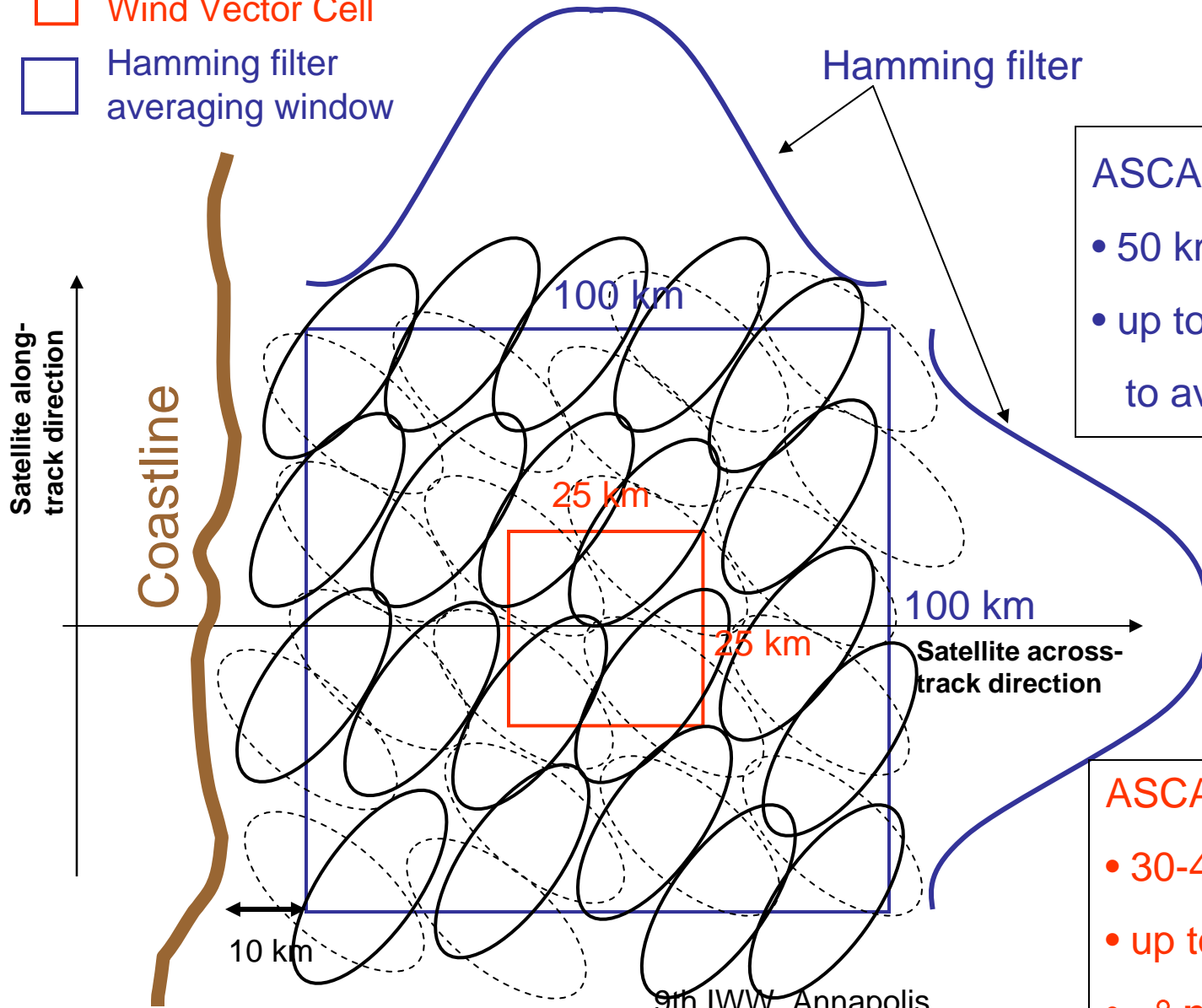
- TACs will feed the global and regional components of the MCS in observation products for space and in situ data.
- From observation systems to the service centres. Specific requirements from modelling and data assimilations centers as well as from users and downstream services.



# 50-km resolution backscatter averaging

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- Wind Vector Cell
- Hamming filter averaging window



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
- $\sigma^0$  more noisy, so MSS

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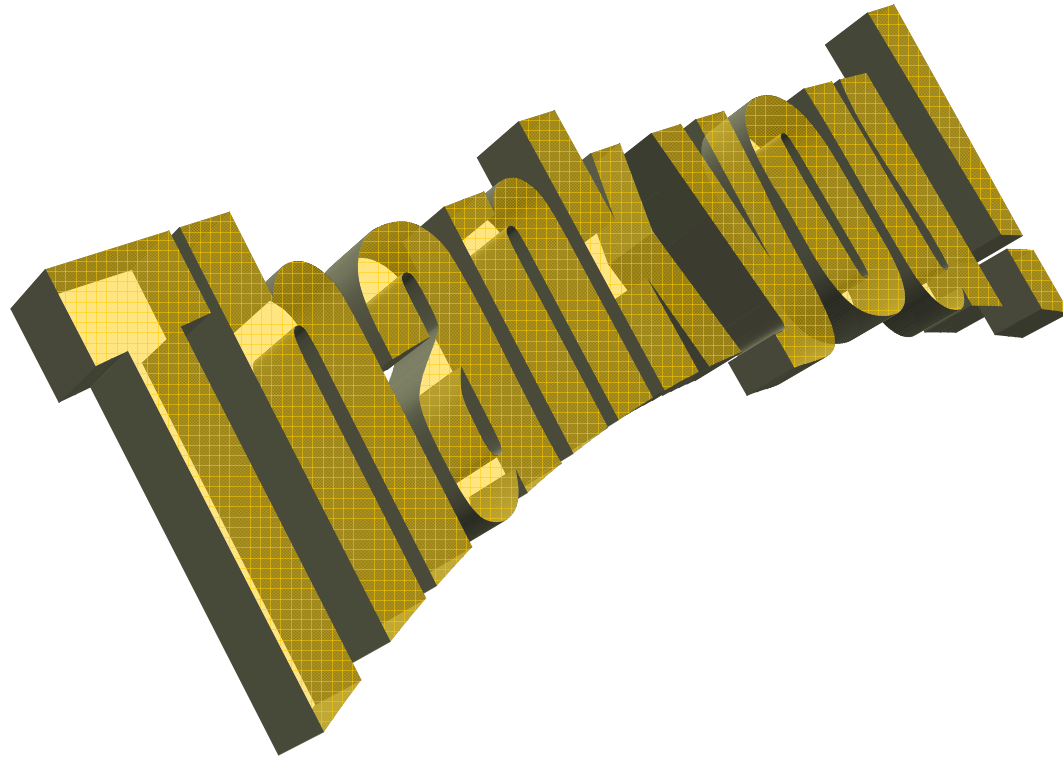
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# Way forward

- 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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*[www.knmi.nl/scatterometer](http://www.knmi.nl/scatterometer)*

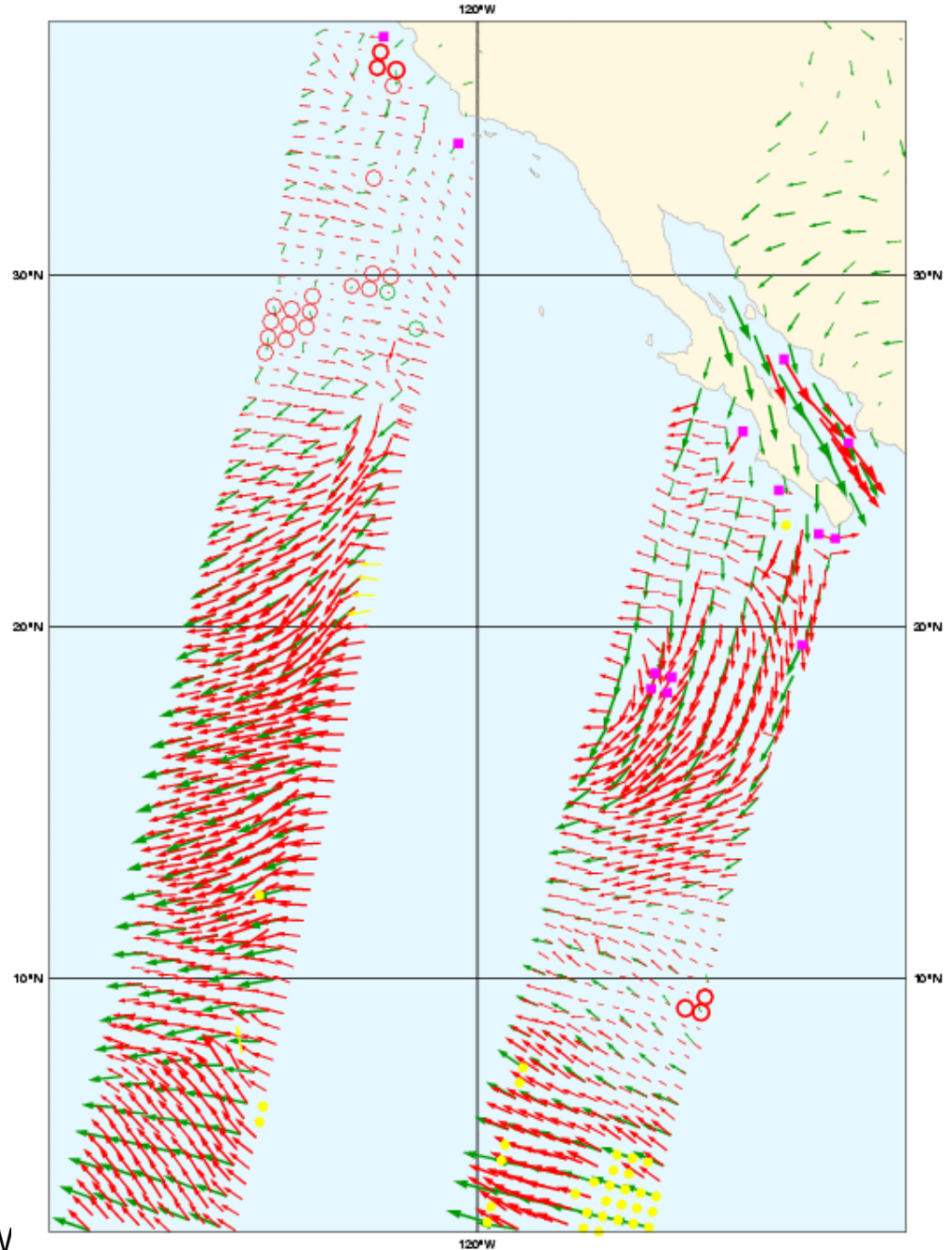
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# First ASCAT winds

- Now the work starts . . .

ASCAT: 20061027 17:30Z lat lon: 20.00 -120.00



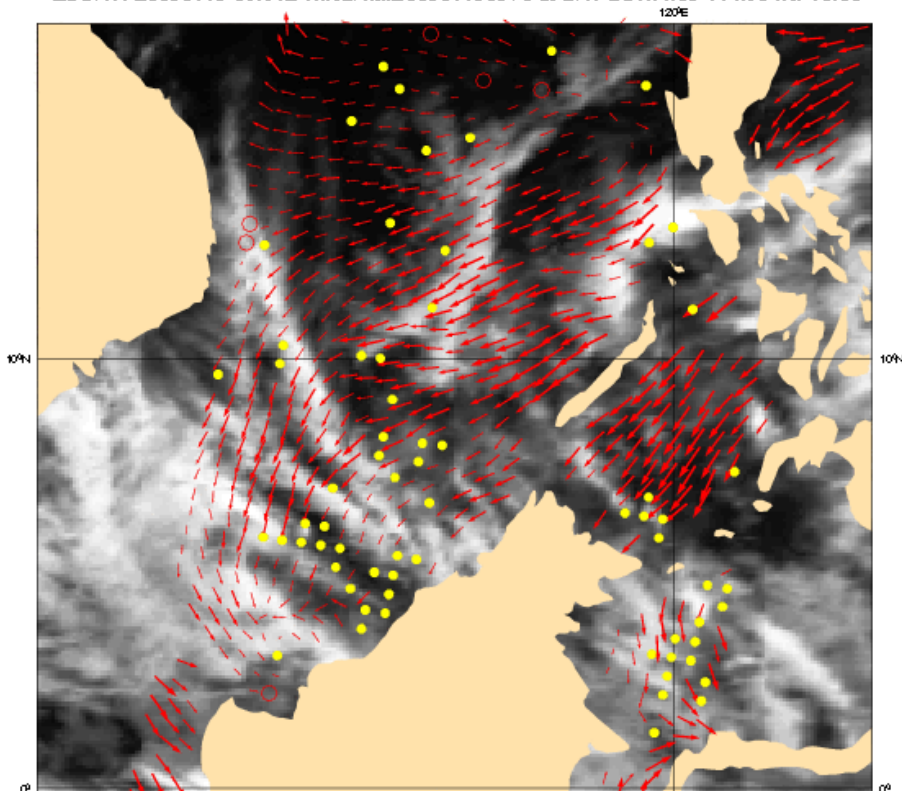
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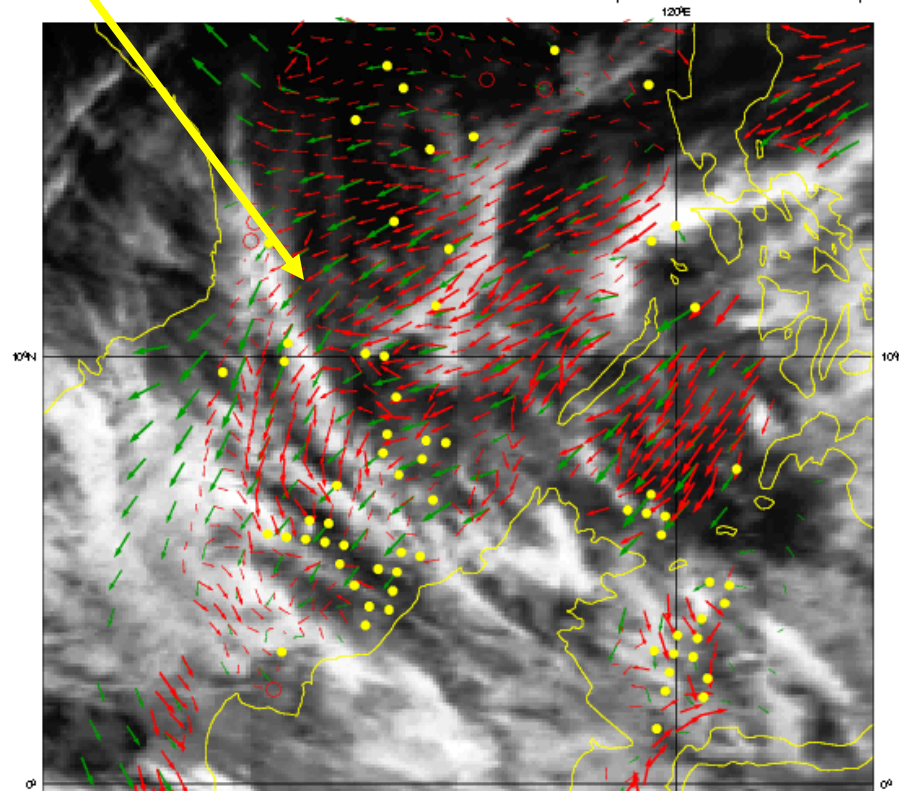
# *Is this noise or geophysical variability?*

P

QSCAT: 20060118 09:51Z HIRLAM:2006011806+3 at LAT LON:4.06 114.90 IR: 10:00



QSCAT: 20060118 09:51Z at LAT LON:4.06 114.90 IR: 10:00 (meteoset5 200601181000)



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

10.0m/s



120°E

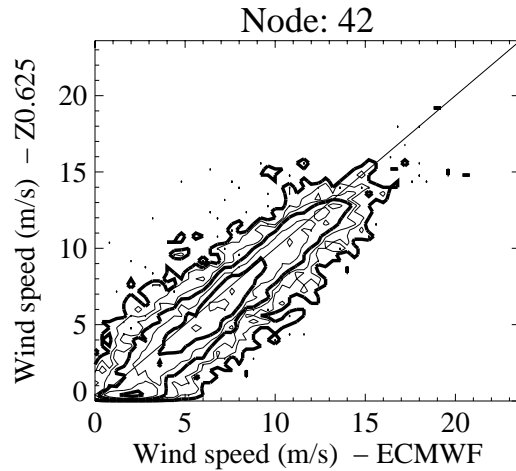
120°E



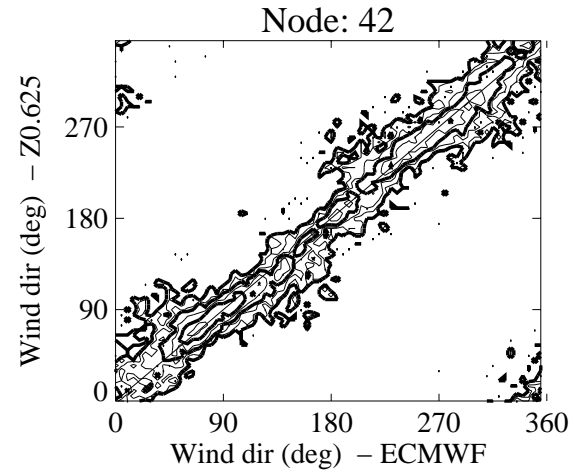
# Validation against ECMWF

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**Level 1b  
demo version**

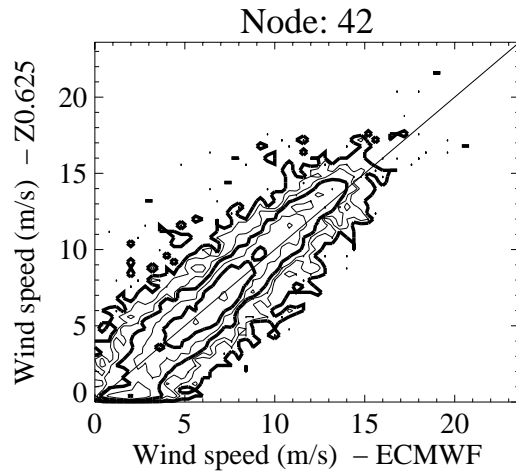


N= 12783  
mx= 7.07 my= 6.45  
m(y-x)= -0.62 s(y-x)= 1.37  
cor\_xy= 0.91

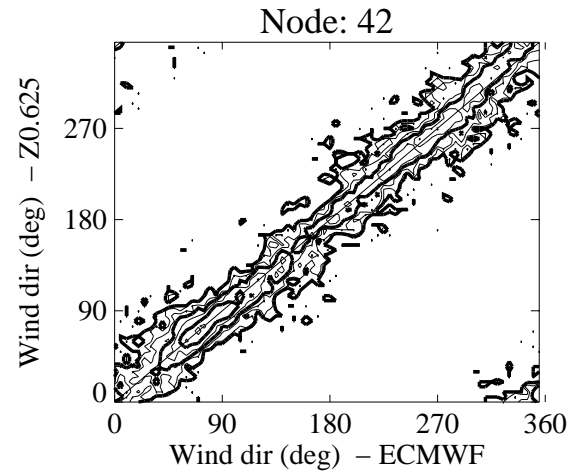


N= 10588  
mx= 170.58 my= 171.24  
m(y-x)= 0.66 s(y-x)= 17.53  
cor\_xy= 0.98

**KNMI  
corrected**



N= 12782  
mx= 7.08 my= 7.16  
m(y-x)= 0.08 s(y-x)= 1.47  
cor\_xy= 0.90



N= 10588  
mx= 170.24 my= 170.58  
m(y-x)= 0.34 s(y-x)= 16.08  
cor\_xy= 0.99



# 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](mailto: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



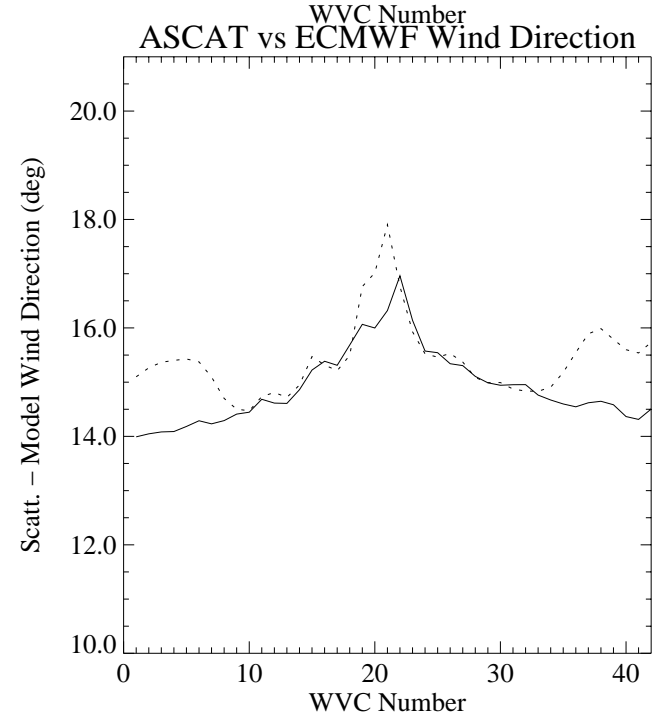
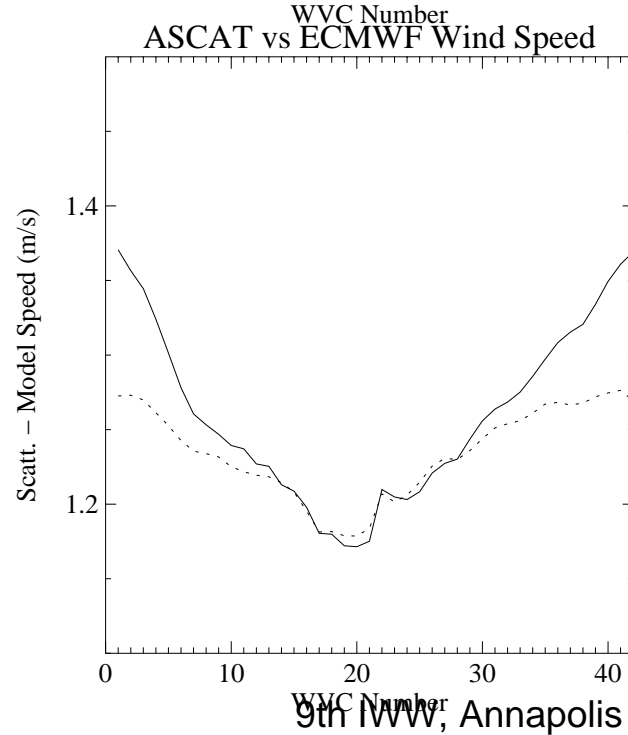
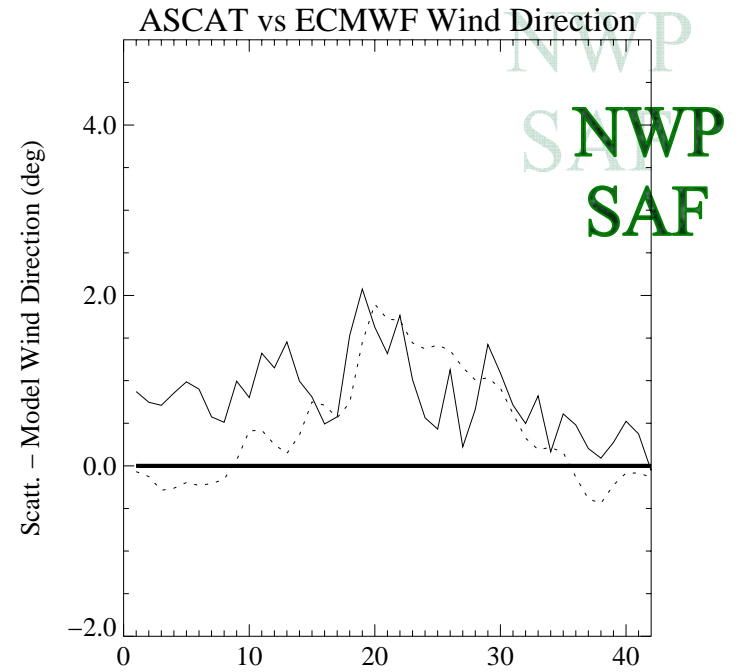
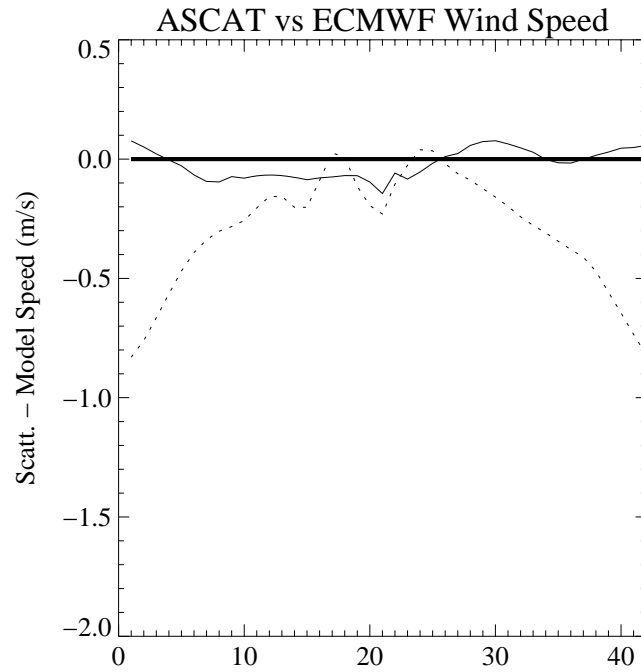
# User issues

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- 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



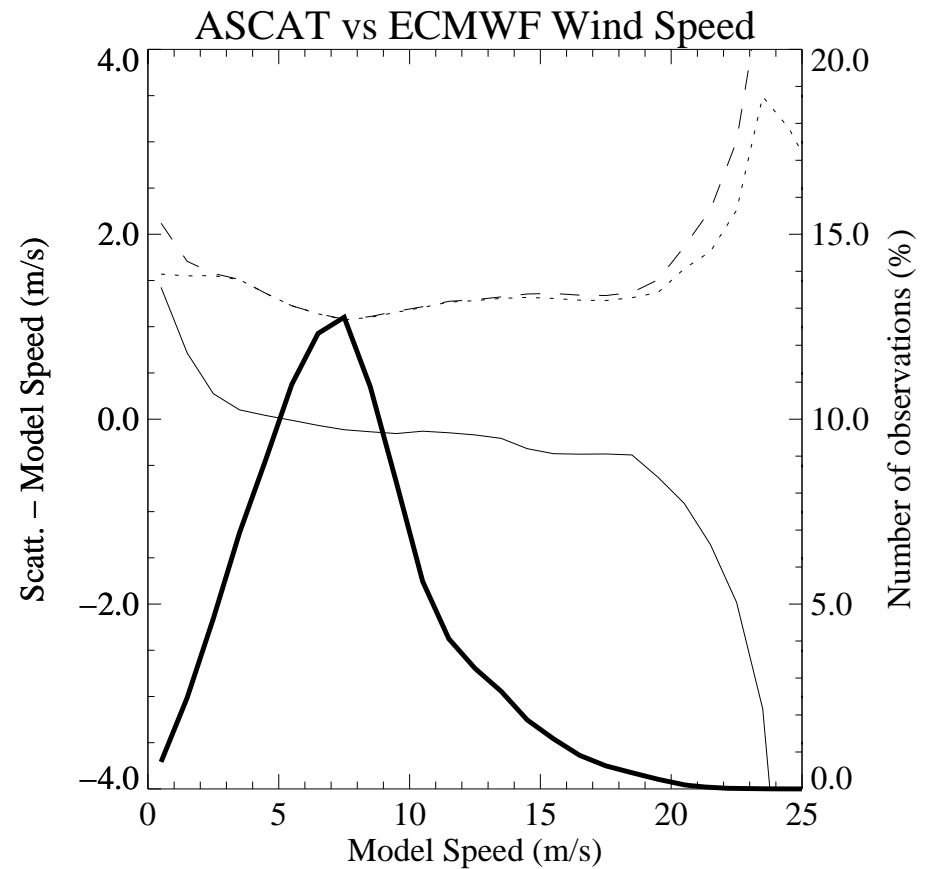
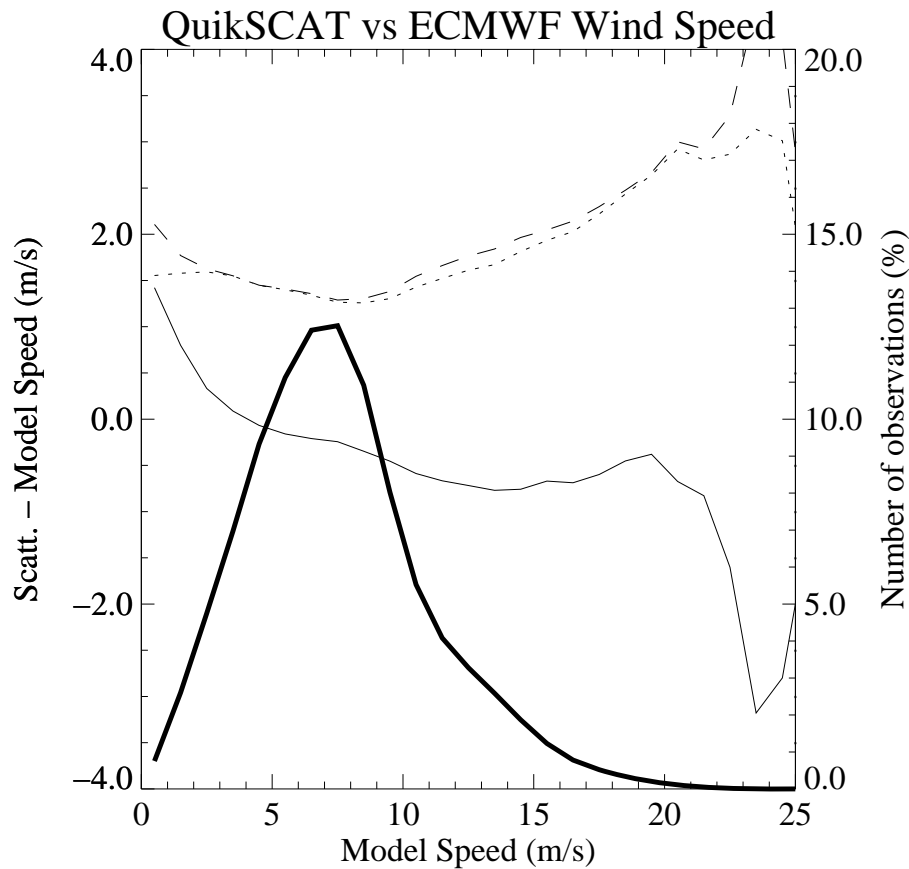
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# QuikSCAT/ASCAT vs ECMWF

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Dataset: 1-5 July 2007



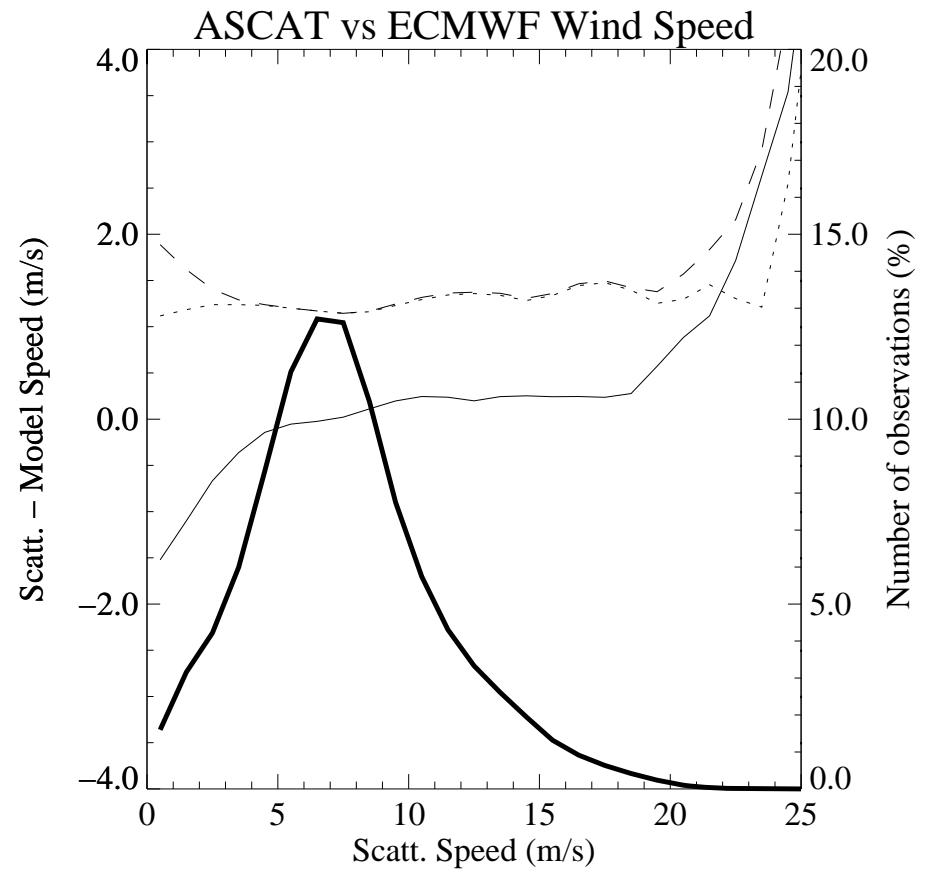
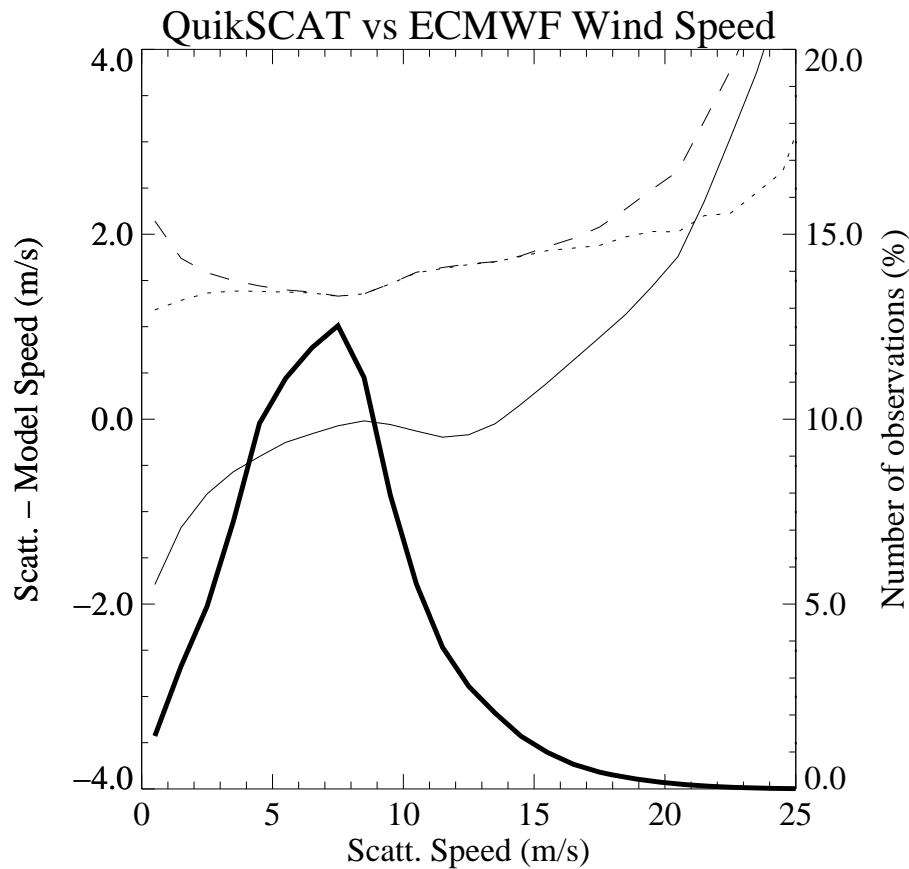




# QuikSCAT/ASCAT vs ECMWF

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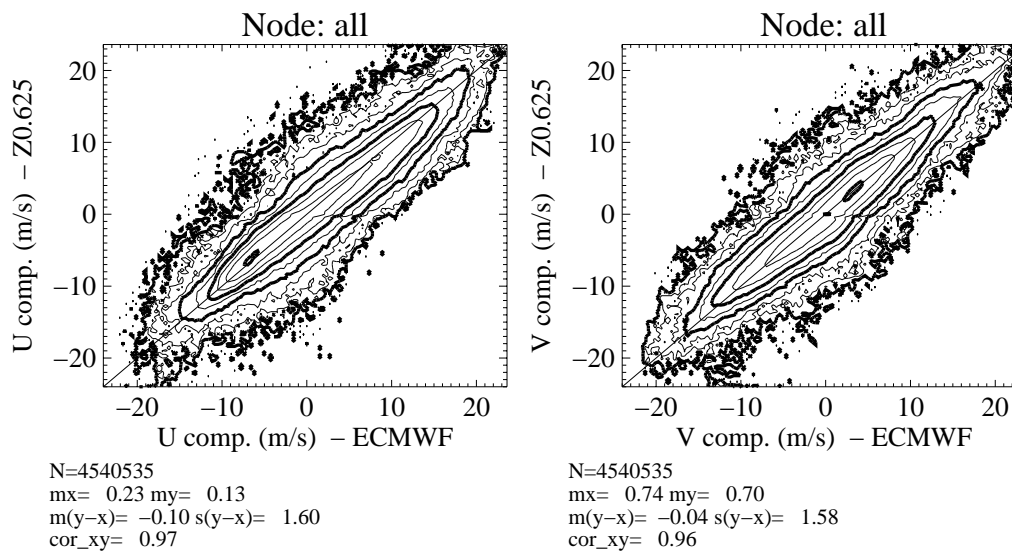
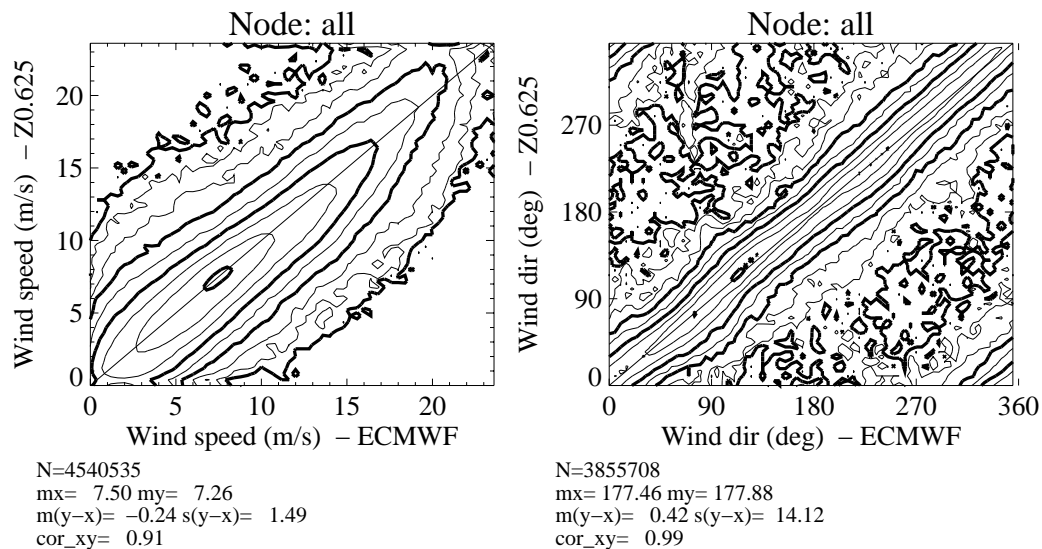
Dataset: 1-5 July 2007





# QuikSCAT vs ECMWF

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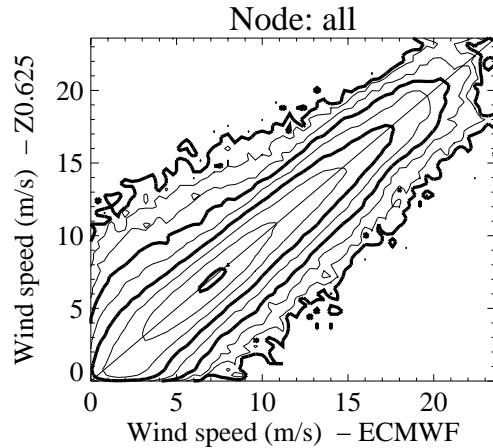


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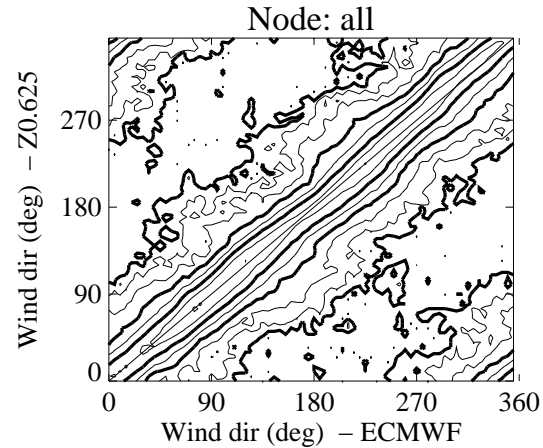


# ASCAT vs ECMWF

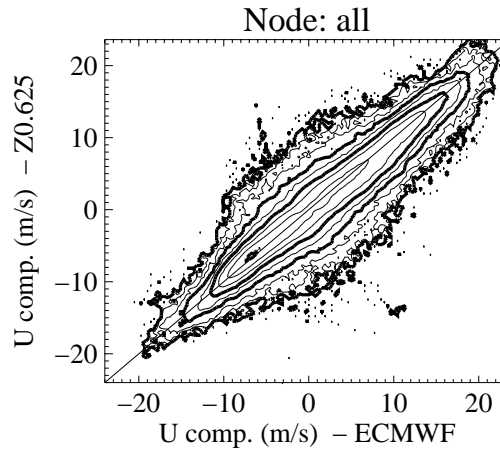
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NWP  
SAF



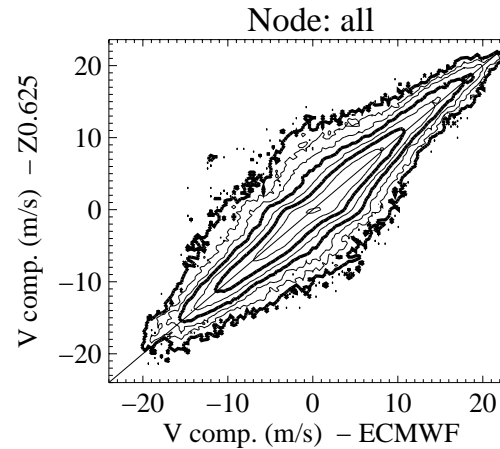
N=2305231  
mx= 7.59 my= 7.55  
m(y-x)= -0.05 s(y-x)= 1.28  
cor\_xy= 0.94



N=1965456  
mx= 177.57 my= 177.86  
m(y-x)= 0.29 s(y-x)= 15.75  
cor\_xy= 0.99



N=2305231  
mx= 0.23 my= 0.11  
m(y-x)= -0.12 s(y-x)= 1.52  
cor\_xy= 0.97



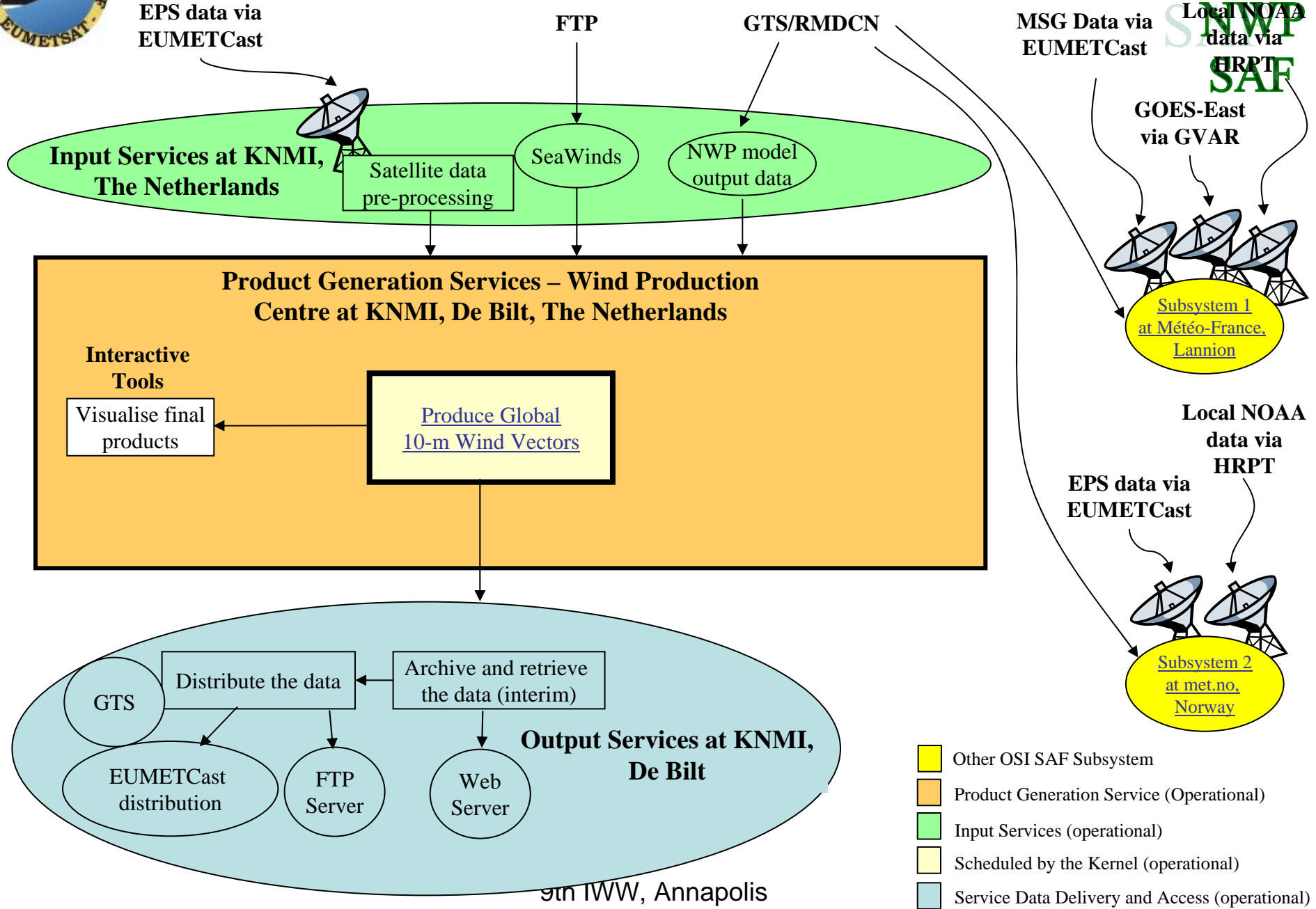
N=2305231  
mx= 0.75 my= 0.72  
m(y-x)= -0.03 s(y-x)= 1.62  
cor\_xy= 0.96

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# OSI SAF Operational Service Architecture (Subsystem 3)

NWPF  Close





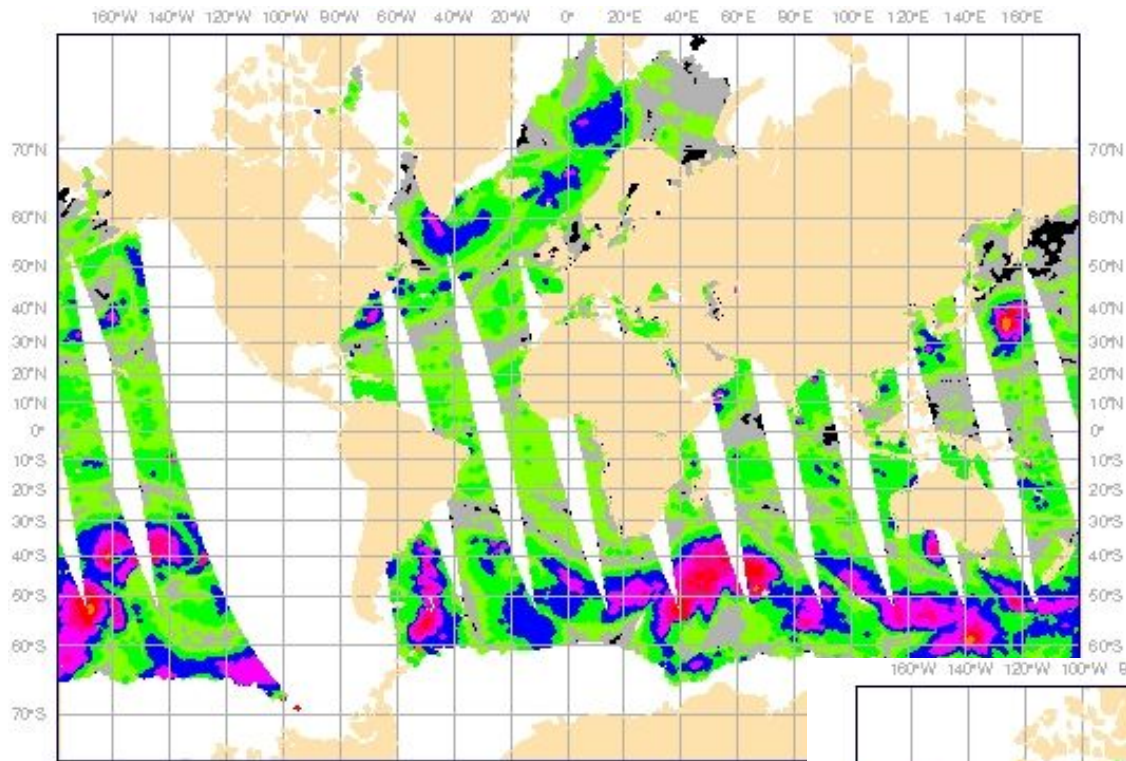
# OSI SAF ASCAT product release schedule

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Product	Coverage	Demonstration	Operational
25 km	Global	2007	2008
12.5 km	Global	2008	2009
Coastal 12.5 km	Global	2009	2011

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





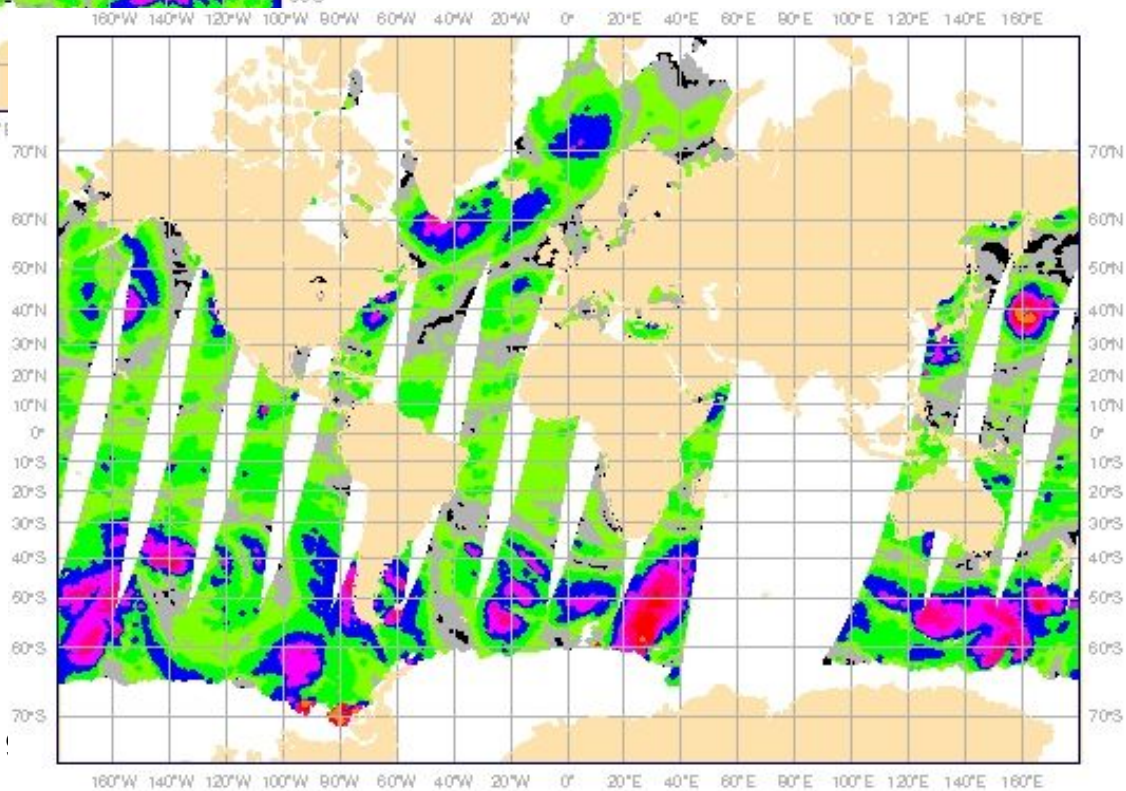
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NWP  
SAF

KNMI SeaWinds  
experimental

25 km resolution

June 8, 2006, 12:00 UT

[www.knmi.nl/  
scatterometer](http://www.knmi.nl/scatterometer)



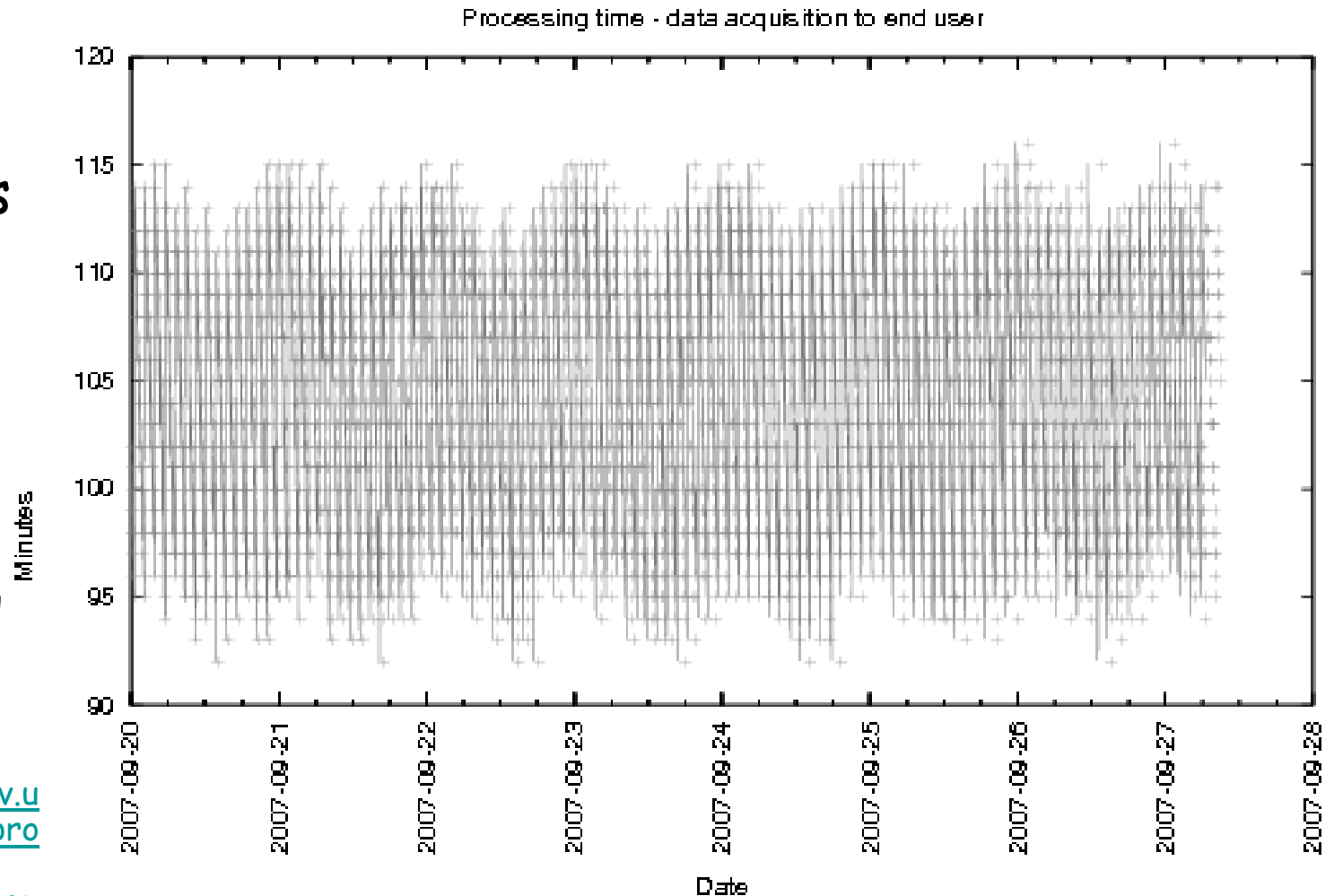




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SAF

# Monitoring of each product

- 1<sup>st</sup> rank MLE
- Speed bias
- RMS u&v scat - EC
- Timeliness
- NWP SAF integrated monitoring at [www.metoffice.gov.uk/research/interpro](http://www.metoffice.gov.uk/research/interpro)  
↓  
[/nwpsaf/scatter\\_report](http://nwpsaf/scatter_report)



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