The Quality Control Indicator \textit{Joss} on Ku-band Wind Scatterometry for Sea Ice Applications with Reference to C-band, Passive Measurements and Precipitations

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The Scatterometer Ice GMFs

- The Ice GMFs are obtained from pure ice surfaces, with references to wind GMF in speed.

- Sea ice backscatter shows no directional preference in azimuth, tightly conforming to a 1-D straight-line model that features sea ice brightness (or proxy sea ice age) as its only independent variable

- The function does not change with time or geographical location

(Belmonte et al., 2012; R. Belmonte, A. Stoffelen et. al, 2011)
Identification of sea ice in the ocean from wind scatterometers

**MLE**: Weighted Euclidian distance to the wind cone or sea ice line

\[
MLE = \frac{1}{N} \sum_{i}^{N} \frac{(\sigma_{i}^{0} - \sigma_{sim,i})^2}{(K_{pi} \cdot \sigma_{i})^2}
\]

\(\sigma_{i}^{0}\) is the \(i^{th}\) NRCS of the \(N\) NRCSs within a Wind Vector Cell (WVC),

\(K_{pi}\) represents the variance of \(\sigma_{i}^{0}\) in it.

\(\sigma_{sim,i}\) is from a wind or sea ice GMF using observing geometry and local wind vector or sea ice information.

**MLE quantifies NRCS deviations from wind GMF, and are used for Bayesian inference of sea ice together with ice GMF**

(Marcos Portabella and Ad Stoffelen, 2006; Belmonte and Stoffelen, 2011)
The indicator $J_{oss}$ measures heterogeneity of the WVC.

2DVAR is used for ambiguity removal on the basis of a spatial wind field analysis $J_{oss}$, the local difference in speed of the selected wind ambiguity and the analysis wind speed, naturally locates and quantifies local disturbances.

$$J_{oss} = f - f_s$$

$f_s$ is the 2DVAR analysis wind speed at a WVC, $f$ is the local WVC-selected wind speed.

Wind component spectra obtained from all ASCAT-12.5 data of January 2009. A variational data assimilation scheme based on statistical interpolation acts as a low-pass filter. (Jur Vogelzang, Ad Stoffelen, 2011)
Method:

• The differences of NRCS with wind GMF represented by MLE in different frequencies
• The heterogeneity of the averaged scene represented by $J_{oss}$
• Different features of MLE and $J_{oss}$ for ice screening and smaller scale iceberg detection with references from different sources
Data descriptions

Scatterometer data: Collocation of Ku-band and C-band Scatterometer from OSCAT-2, ASCAT-A and ASCAT-B (from 2016-2019)

Other information applied:
• Sea Ice Concentration: AMSR-E
• Iceberg information: the Sentinel-1.
• Surface Rain Rates: GPM final run

Illustration of area-weight collocating for SIC and rain rates, a circle is used instead of the blue WVC (X. Xu et al., 2020)
MLE, $J_{oss}$, and SIC from collocated Ku and C-band observations

- C band MLE has been well applied for sea ice identification
- Verification of ice screening for Ku band $J_{oss}$ and compared with C band MLE

QC- all:

Sorted by Joss: (a) SIC (b) MLE Ku (c) MLE C (d) Rain rate (e) Density

QC- II (Ku-rejection, C acceptance):

Sorted by Joss: (a) SIC (b) MLE Ku (c) MLE C (d) Rain rate (e) Density
MLE, $J_{oss}$, and SIC from Ku band observations

HY-2B Ku band $J_{oss}$

QC-all:

Sorted by Joss: (a) SIC  (b) MLE Ku  (c) Rain rate  (d) Density

QC-rejection:

Sorted by Joss: (a) SIC  (b) MLE Ku  (c) Rain rate  (d) Density
Summary for MLE, $J_{oss}$, and SIC from collocated Ku and C-band observations

- Low to medium wind speed, effects of SIC similar with rains, in higher wind speeds SIC affect more often for high latitude.
- MLE good in identifying rains and SIC, both C band and Ku band MLE more sensitive to SIC than rains, while C MLE is more likely to be linked with sea ice.
- The indicator $J_{oss}$ companionary to MLE flags.
Ku band scatterometer MLE and Joss v.s. SAR iceberg

• A case

-The potential large sic set is obtained under the condition (white line):

\[ J_{\text{oss}} \leq 0.33 f^{-5} \]

-A specific iceberg case between Greenland and Canada:

Low Joss values corresponds to high iceberg concentration (IBC) and high SIC
Ku band scatterometer MLE and Joss v.s. SAR iceberg

- **Statistics**

SIC and IBC are different in different observations and not in good correlation.
**Statistics**

Sorted by Joss: (a) IBC
(b) SIC
(c) MLE
(d) Rain rate

Sorted by Joss: (a) IBC
(b) SIC
(c) MLE
(d) Rain rate

IBC >=15%

Ku band scatterometer MLE and Joss v.s. SAR iceberg

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Ku band scatterometer MLE and Joss v.s. SAR iceberg

• **Statistics (averaged view)**

Sorted by Joss: (a) IBC  (b) SIC  (c) MLE

(d) Rain rate
(e) Density

IBC >=15% curve corresponding to large density
Conclusions and Discussions

• Conclusions:
  - Bayesian scatterometer sea ice screening is operational
  - In the collocation set, the ice screening ability of $J_{oss}$ in addition to $MLE$ has been confirmed
  - Combined C and Ku band is favorable in discriminating rain and sea ice effects
  - Iceberg is in smaller scales different from SIC. Though iceberg induce larger signal return, they require better spatial resolution in measurement, and better resolved by $MLE$.
  - Inclusion of precipitation probability could improve ice Bayesian.

• Further Research:
  - NRCS features due to mixed ice, icebergs and open ocean

(X. Xu and A. Stoffelen, 2003)
Key References

Thanks!