Sea-Ice Flagging and Mitigation for SMAP Salinity Retrievals

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➢ Sea-ice contamination in the field of view constitutes a large error source in salinity retrievals.
   • Worse than land contamination because of low sensitivity in cold water.
➢ Reliable flagging for sea-ice contamination is most crucial.
➢ Ideally: Develop a far-sidelobe correction for sea-ice contamination, similar to what we did for land.
   ➢ Problem:
     For land we know the fraction (contamination) very accurately.
     For sea-ice we do not.

1% sea-ice contamination results in a salinity error of about 5 psu!
1. Flag/mask which is designed to remove any sea-ice concentration in RSS ocean products (winds, SST, vapor) near the sea-ice edge.

2. Most reliable product for flagging compared with any other products.
   - Value = 0 (purple): no-ice
   - Value = 1 (red): some ice

3. No specific information on concentration. Cannot be used for side-lobe correction.
Evaluated Sea-Ice Products

1. **NASA-Team Algo**
   - SSMIS.
   - 25 km stereographic grid.

2. **NSIDC CDR**
   - SSMIS.
   - 25 km stereographic grid.
   - Combination of NASA-Team and Bootstrap: Maximum value.

3. **OSI-SAF**
   - Denmark/Norway (EUMETSAT)
   - AMSR2 (18.7 – 89 GHz).
   - 10 km stereographic grid.
   - Bootstrap algorithm with dynamical tie points.
   - Atmospheric correction based on ECMWF profiles.
   - Uncertainty estimates.
   - Information on sea-ice age.
Antenna Gain Weighted Fraction $g_{\text{ice}}$

$$g_{\text{ice}} = \int d\Omega G(\Omega) f_{\text{ice}}$$

$f_{\text{ice}} =$ sea – ice concentration that is recorded in the data products

Gaussian shape for antenna gain with half-power width of 45 km.

Goal of **sidelobe correction** is to get close to the colored ring as possible.
There is no hope to retrieve salinity if there is actual sea-ice within the SMAP footprint.
General good correlation between gain-weighted ice-concentration and SMAP TB for NASATEAM, CDR, OSISAF.

- Slope of the curve increases slightly with increasing gice.
- Lower ice-concentration (near ice-edge) has also lower thickness.
- L-band penetration depth ≈50 cm.
- RSS AMSR2 flag has only 0 or 1. By design it does not correlate with SMAP TB (close to step function).
Uncertainty in Sea-Ice Products

- There are **large uncertainties** in the sea-ice concentration near the ice-edge, where we need it for the side-lobe correction.
- That puts a strong limitation to the whole method.

1% sea-ice contamination results in a salinity error of about 5 psu!
1% error in sea-ice contamination also results in a salinity error of about 5 psu!
OSISAF has artifacts: it shows low sea-ice concentration in open ocean.

Not present in RSS AMSR2 mask, NASATEAM, SMAP SSS/TB.

Mostly cloud water / high winds in the open ocean that are misidentified as sea-ice.

Lethal for sidelobe correction with this product.
If RSS AMSR2 mask has no sea-ice, set OSISAF ice-concentration to 0.
Simple Physical Model for Correcting Sea-Ice Contamination in Antenna Sidelobes

\[
T_{B,\text{corr}} \approx T_{B,\text{meas}} - g_{\text{ice}} \cdot T_{B,\text{sea-ice}} = T_{B,\text{meas}} - g_{\text{ice}} \cdot E_{B,\text{sea-ice}} \cdot T_{\text{surface}}
\]

\[
\rightarrow T_{B,\text{meas}} - \sum_{\text{type } I} g_{\text{ice},I} \cdot E_{B,\text{sea-ice},I} \cdot T_{\text{surface},I}
\]

Young Ice TB:
\[T_{B,\text{sea-ice (v-pol)}} = 240 \text{ K}\]
\[f_{\text{ice}, g_{\text{ice}}} < 0.02\]
Antarctic

TB SUR0 MEAS (SMAP)- EXP (HYCOM) 40-km GICE OSISAF CORR 2018 07 15

OSISAF

TB SUR0 MEAS (SMAP)- EXP (HYCOM) 40-km GICE NASATEAM CORR 2018 07 15

NASATEAM

V4
Hudson Bay

OSISAF

NASATEAM

V4
Summary and Conclusions

- The RSS AMSR-2 sea-ice mask that are used in SMAP Version 4 work for flagging sea-ice contamination.
- Sidelobe correction needs accurate information on sea-ice concentration.
- Canned products (NASA-Team, CDR, OSISAF) cannot be used for sidelobe correction.
  - Large uncertainties.
  - Artifacts (Clouds, wind in the open ocean are misidentified as sea-ice.).
- Combination **OSISAF – RSS mask** is more realistic.
- Case studies indicate the possibility of modest improvement for performing a sidelobe correction near the sea-ice zone using a physical sea-ice emissivity model.
- Uncertainties in sea-ice concentration are not random but clustering.
  - Going from 40-km to 70-km is not helping much.