SAC-D/Aquarius

An Observatory for Ocean, Climate and Environment

First Results of SAC-D MWR Sea Ice Concentration Product

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NASA Team algorithm

The MWR sea ice algorithm
The Model
Sea ice concentration function for CONAE algorithm

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Feasibility of determine Sea Ice Concentration from MWR

Models for determine sea ice concentration and age are based on differences in the polarizing qualities of sea ice and ocean water, and greater spectral dependence of ocean water than sea ice.

Electromagnetic properties of sea ice and ocean water

Brightness temperature of MWR can identify the presence of sea ice

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NASA Team (NT) algorithm

The algorithm was designed for deriving sea ice products from three SSM/I channels (19.4GHz H and V and the 37GHz V). It supose that the brightness temperature measured is coming from Open Water (O), First Year Sea Ice (F) and Multi Year Sea Ice (M).

\[
T_B = T_{BO}(1 - C_F - C_M) + T_{BF}(C_F) + T_{BM}(C_M)
\]

\[
PR = \frac{T_B^V(19) - T_B^H(19)}{T_B^V(19) + T_B^H(19)}
\]

\[
GR = \frac{T_B^V(37) - T_B^V(19)}{T_B^V(37) + T_B^V(19)}
\]

\[
C_i = f(GR, PR)
\]

Where PR and GR are the **Polarization and Gradient Ratios**.


[http://nsidc.org/data/docs/daac/nasateam/]
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The MWR sea ice model

We assume that the brightness temperature received by the radiometer comes from open ocean \(T_{BO}\) with concentration \(C_O\), and from sea ice \(T_{BI}\) with concentration \(C_I\).

\[
T_B = T_{BO}C_O + T_{BI}C_I
\]

\[
1 = C_O + C_I \quad C_I = C_F + C_M
\]

Inspired in NT model, we define the next quantities using the MWR bands (23.8 GHz H, 36.5 GHz V and H):

\[
\Delta T^P = T_B^V(36.5) - T_B^H(36.5) = PR(T_B^V(36.5) + T_B^H(36.5))
\]

\[
\Delta T^G = T_B^H(36.5) - T_B^H(23.8) = GR(T_B^V(36.5) + T_B^H(36.5))
\]

Where \(\Delta T^P\) and \(\Delta T^G\) are the **Polarization and Gradient differences**.
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Sea ice concentration function for CONAE algorithm

We can find the Sea Ice Concentration as a function of gradient and polarization differences, ie, $C_I = f(\Delta T^G, \Delta T^P)$:

$$ C_I = \frac{\Delta T^G - \Delta T^G_O (\Delta T^P - \Delta T^P_O) \alpha}{\Delta T^G_M - \Delta T^G_O (\Delta T^P_M - \Delta T^P_O) \alpha} $$

$$ \alpha = \frac{\Delta T^G_F - \Delta T^G_M}{\Delta T^P_F - \Delta T^P_M} $$

where:
- $C_I$ is the ice concentration,
- $\Delta T^G$ and $\Delta T^P$ come from data measured by MWR,
- $\Delta T^G_O, \Delta T^G_P$ and $\Delta T^G_F$ are reference points that must be determined.
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**Step 1**: Brightness temperatures gradient and polarization differences calculation.

**Step 2**: Scatter plots construction.

**Step 3**: Reference points obtention.

**Step 4**: Sea Ice Concentration calculation.

**Step 5**: Sea Ice Concentration representation in a map.
Prototype: Step 2

The scatter plots are constructed separately for each beam, ascending (top) and descending passes (bottom). For example, for beams 1 to 3 we obtain:
Prototype: Step 3

<table>
<thead>
<tr>
<th>Point</th>
<th>$\Delta T^P$ (K)</th>
<th>$\Delta T^G$ (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odd Open Water</td>
<td>62.73</td>
<td>12.36</td>
</tr>
<tr>
<td>Even Open Water</td>
<td>73.31</td>
<td>13.87</td>
</tr>
<tr>
<td>Odd First Year Ice</td>
<td>27.35</td>
<td>-5.66</td>
</tr>
<tr>
<td>Even First Year Ice</td>
<td>21.60</td>
<td>-4.40</td>
</tr>
<tr>
<td>Odd Multi Year Ice</td>
<td>25.04</td>
<td>-10.24</td>
</tr>
<tr>
<td>Even Multi Year Ice</td>
<td>20.51</td>
<td>-11.20</td>
</tr>
</tbody>
</table>

Points used for obtaining Open Water and Sea Ice reference points (odd beams).
Prototype: Steps 4 and 5
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We calculate the differences of both data embedded in a common grid. Here we show the results corresponding to one day (08/31/2011).

NSIDC data are provided by SHN.
Differences between MWR and NSIDC (08/31/2011)

We plot those differences in a histogram, obtaining an error of:

\[ E_{IC} \approx 15\% \]
A five days MWR product

01/09/2011 al 05/09/2011

01/09/2011 al 05/09/2011
Remarks

- The presented algorithm is a self calibrated one.
- The IC error is about 15 %, in comparison with NSIDC results.
- An improved land mask, global grid and climate filters will be applied in further products.
- The validation of the Sea Ice estimation continue with colaboration of the Hidrography Naval Service of Argentina.
- The algorithm presented is implemented in CUSS and it is producing data.
- An ATBD with the details is available.
- A poster with more details is available in poster session.