Sea ice SAR backscattering analysis in Antarctic navigation zones

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OBJECTIVE

In view of the upcoming launch of the SAR SAOCOM (L-Band, Quadripolarization), which will integrate the SIASGE (Sistema Italo-Argentino de Gestión de Emergencias) Constellation with the COSMO Skymed satellites, it becomes important to analyze the potentialities of the complementary use of different bands and polarizations to detect sea ice types.

INTRODUCTION

This study presents the results obtained with COSMO (X-Band, HH and VV) and Sentinel images (C-Band, HH) for an Antarctic area (*Figure 1*) of frequent navigation, north of the Antarctic Peninsula (Mean latitude: 63 ° 30'S; Mean longitude: 56 ° 30'W), during the period of campaigns for supplying the scientific stations in December 2016 (Austral Summer time).

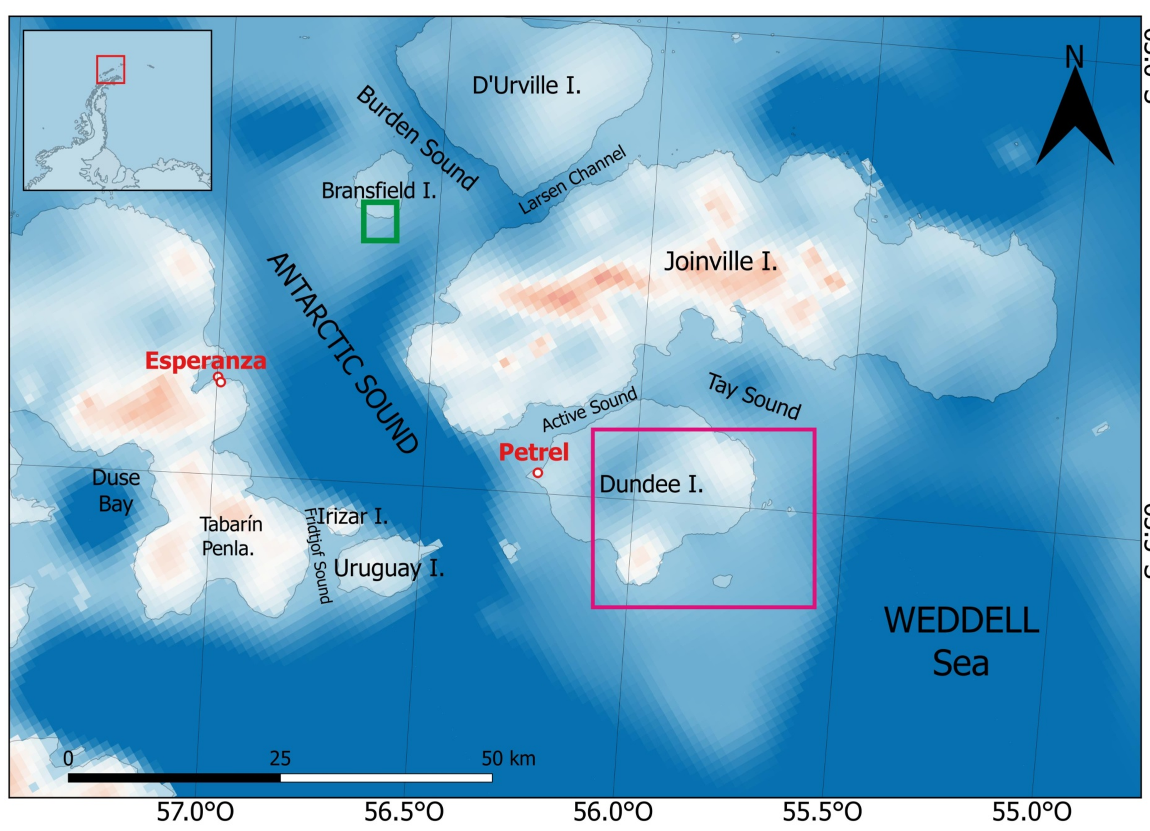

Figure 1. Study area.

MATERIAL AND METHOD

Images used:

- COSMO (X-Band, HH and VV) from December 23, 24 and 25th 2016 and;
- Sentinel images (C-Band, HH) from December 21, 27 and 28th 2016.
- Images were processed (calibrated, projected, etc.) and;
- homogeneous windows (100 x 100 m) were sampled for the different "recognized" surfaces.
- Backscattering coefficients "σ^0" (mean and standard deviation) for each sample (window-surface) were calculated for each band, polarization and incidence angle available.
- Backscatter values (in dB) vs incidence angles were plotted for each polarization and band, and;
- the VV/HH ratio was calculated when data were available.

Responses were distinguished, corresponding to different conditions of sea and sea ice types (first year ice, brash, fixed ice, open water).

- ❑ In situ meteorological and glaciological data provided by Antarctic stations, a glaciological airborne flight and nautical cartography of the area were considered.

Fixed ice at South of Bransfield I., identified by a glaciological flight, is shown in *Figure 2*. Also some icebergs (▲) are visualized.

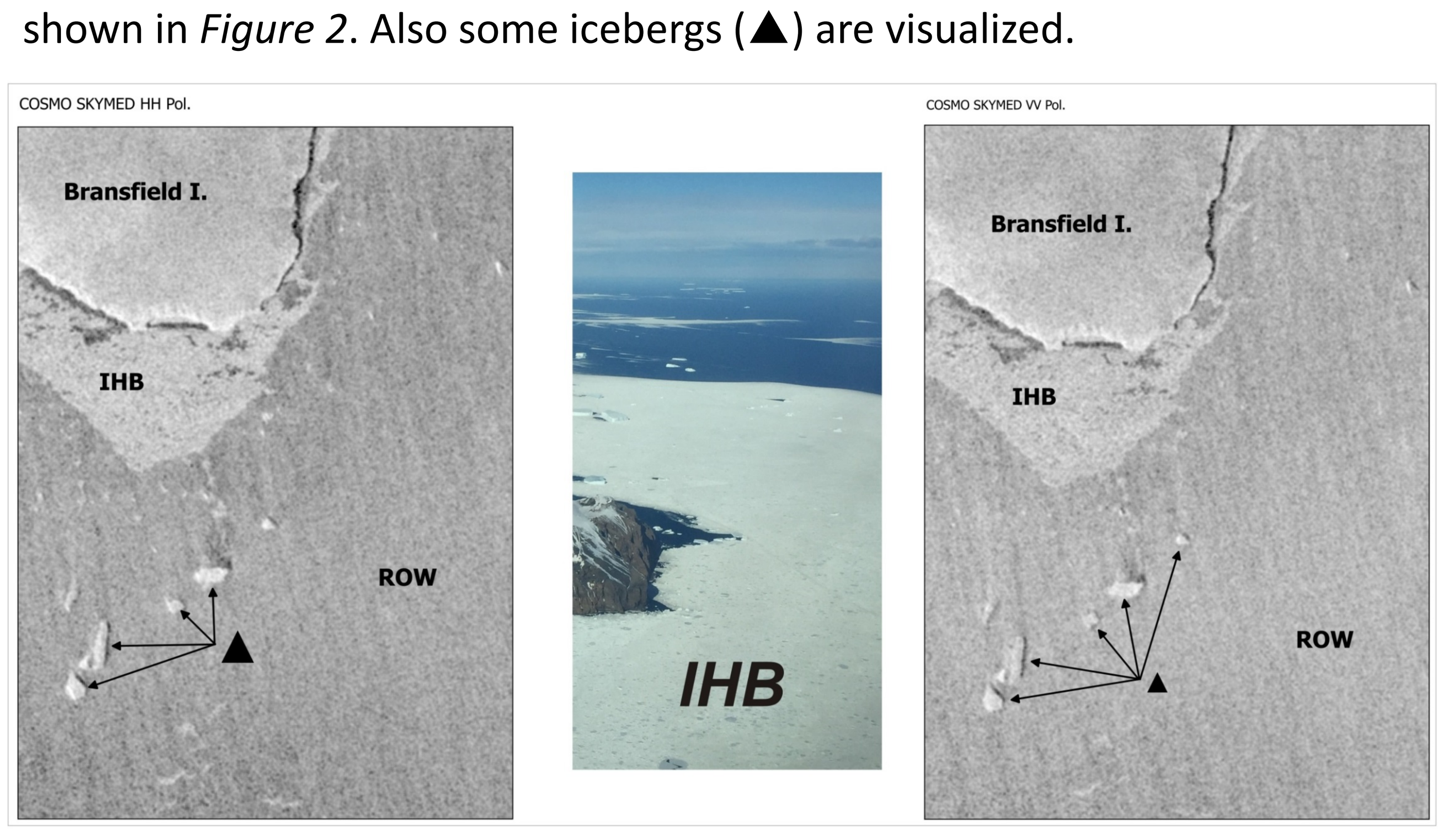

Figure 2. COSMO Skymed HH and VV images.

RESULTS AND DISCUSSION

X and C Band images offer different characteristics related to the identification of ice and open water, as seen in *Figure 3*.

Open Water (OW) recognition is influenced by wind or snowfall. When wind conditions are calm, Smooth OW (SOW) can be easily separated in X Band, with σ^0 from -25 to -35 dB, depending on the incidence angle.

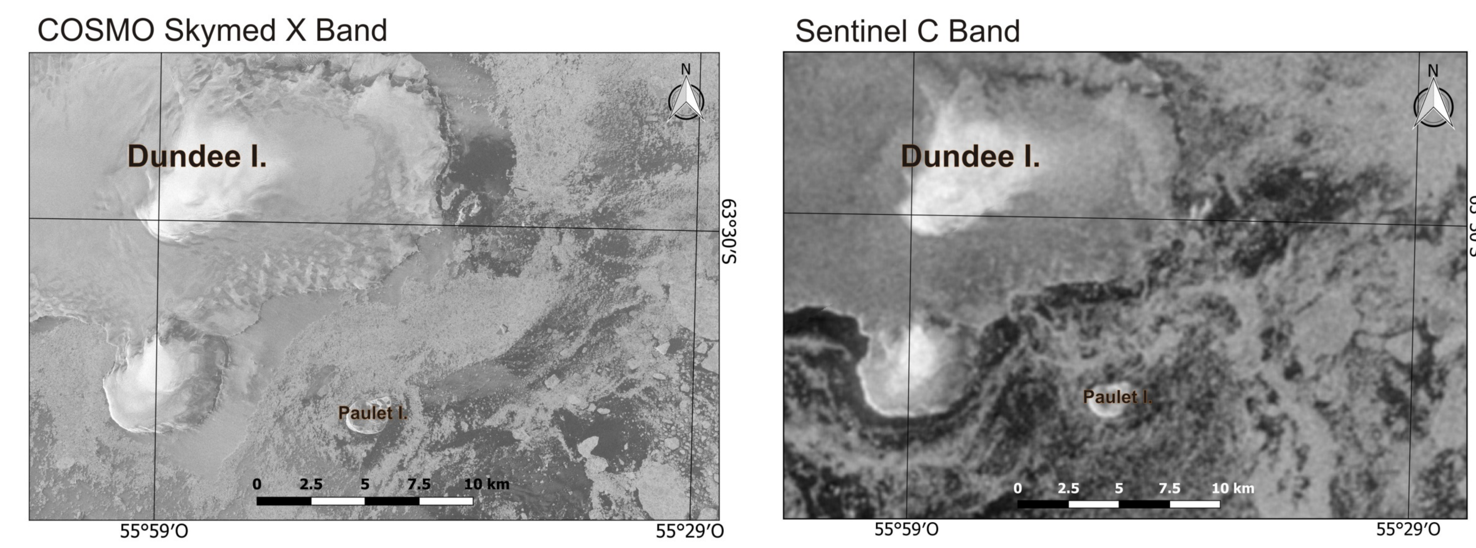

Figure 3. COSMO Skymed and Sentinel HH compared

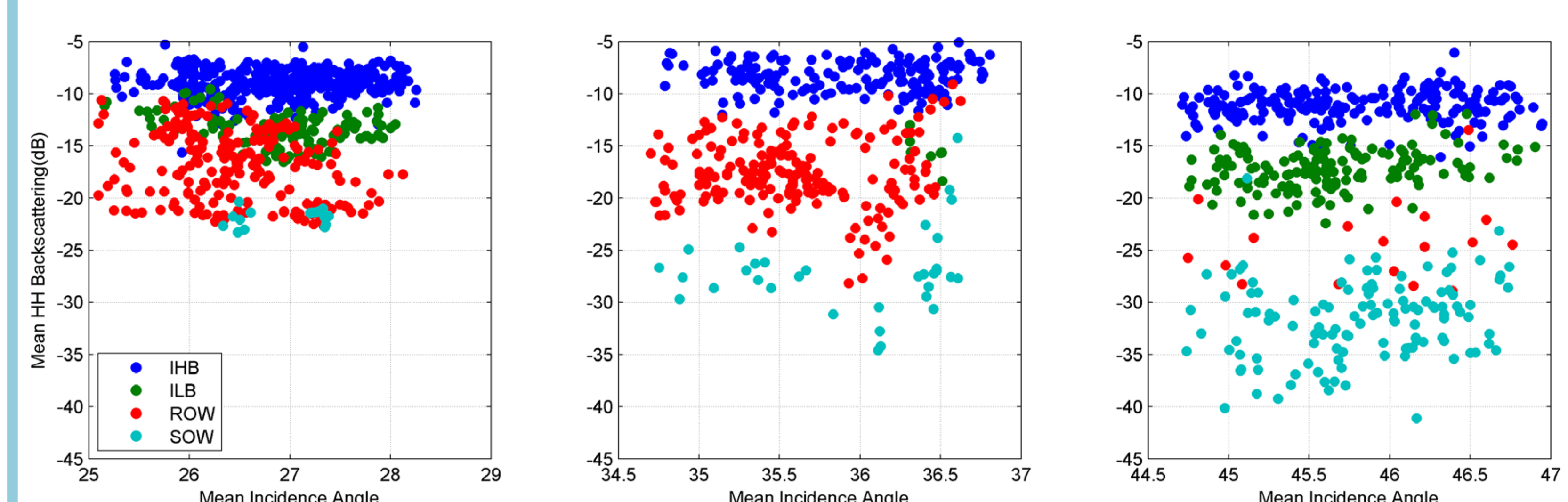

Figure 4. COSMO Skymed HH mean backscatering vs Incidence angle

When significant winds are measured or snowfall event occurs, HH backscattering in X-Band is in the order of -16 dB, considered as Rough Open Waters (ROW), similar to Low Backscattering Ice (ILB) with σ^0 around -14,5 dB in HH and -16,6 dB in VV polarization (*Figure 4*).

Brash and First Year Ice show High Backscattering (IHB), around -9 dB (Figure 4).
On the other hand, VV/HH ratio allows a better distinction between classes with incidence angles between 35° and 47°.

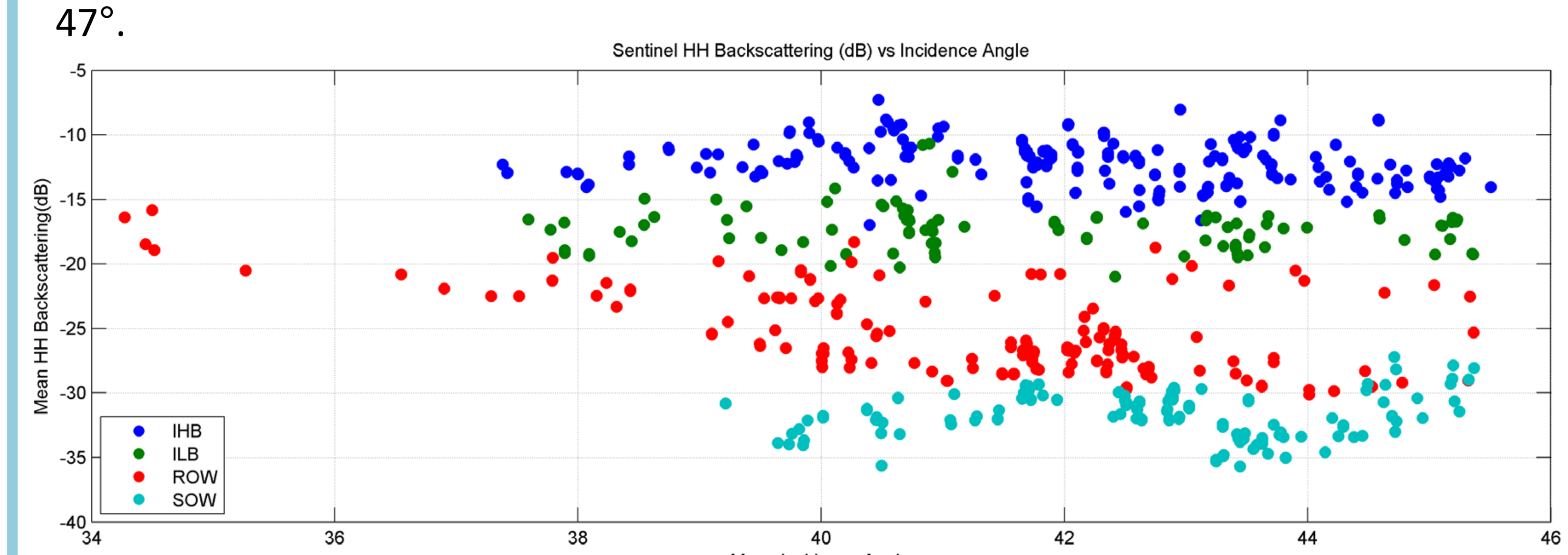

Figure 5. Sentinel HH mean backscatering vs Incidence angle

Besides, σ^0 differences in HH C-Band allow to distinguish four surface types, considering environmental conditions: calm OW (-33 dB), wind or snowfalls influenced OW (-26 dB), smooth (IHB) and rough (IHB) backscattering Ice (-18 & -14 dB) (*Figure 5*). They are clearly separated, as can be seen in *Table 1*.

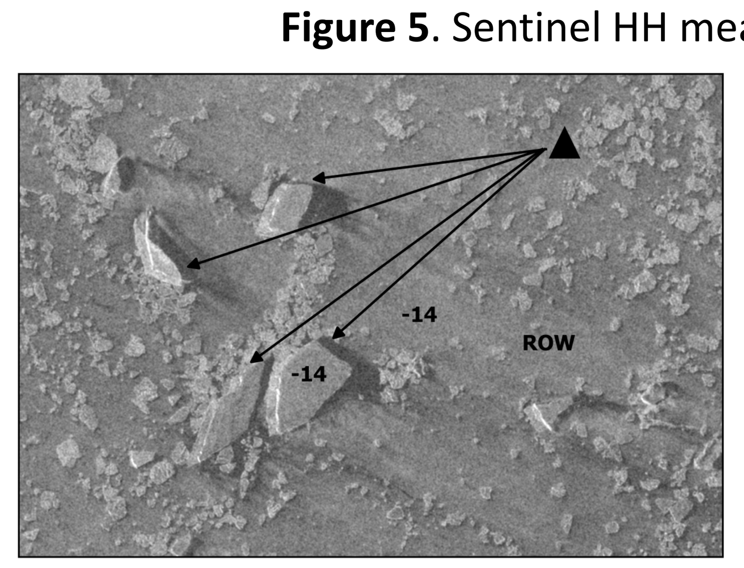

Figure 6. Icebergs surrounded by brash and open waters.

Snow cover, due to a recent (or present) snowfall, produces a homogenization of the spectral response (-14 dB) in the area (*Figure 6*), regardless of the surface type (sea ice, open water, etc.).

Table 1. Mean backscattering (Mean σ^0) values of the different features identified in the analyzed images

Band/Pol.	SOW (dB)	ROW (dB)	ILB (dB)	IHB (dB)
X / HH	-26,24	-15,90	-14,48	-9,06
X / VV	-23,44	-13,65	-16,63	-9,58
X / VV/HH	4,83	2,83	≈	≈
C / HH	-32,59	-26	-17,62	-14,38

CONCLUSIONS

- ☑ The first results confirm what has been previously published: the combination of different bands improved discrimination of sea ice types.
- ☑ In all bands and polarizations analyzed, in windy conditions, open water shows an increase of backscattering response in the order of 5-10 dB.
- ☑ Icebergs observations in the different images have allowed inferring certain conditions of the surface of the prevailing ice type at the time of the analysis (snow cover at the moment of the image acquisition, etc).

FUTURE WORK

In summary, studies and tests, with a greater quantity and diversity of images, should be continued in order to obtain a procedure for the automatic classification of sea ice (in the most way as possible) with SAR data. The availability of L-band quadpol SAR from future SAOCOM will certainly help for the distinction of the sea ice types and high spatial resolution icebergs positioning.