# The new altimetric module in Snow Microwave Transfer Model for snow (SMRT)

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# Context

**2015-2017:**

SMRT is initiated in the MICROSNOW ESA project on snow microstructure signature in the microwaves i.e. "grain size scattering".
→ passive microwave focused.

**2018:**

Development of a sea-ice module. Fresh ice / lake-ice  is a side product.

**2019-2020:**

Development of an altimeter module in the ESA Polar Monitoring / Cristal
First validation in Antarctica

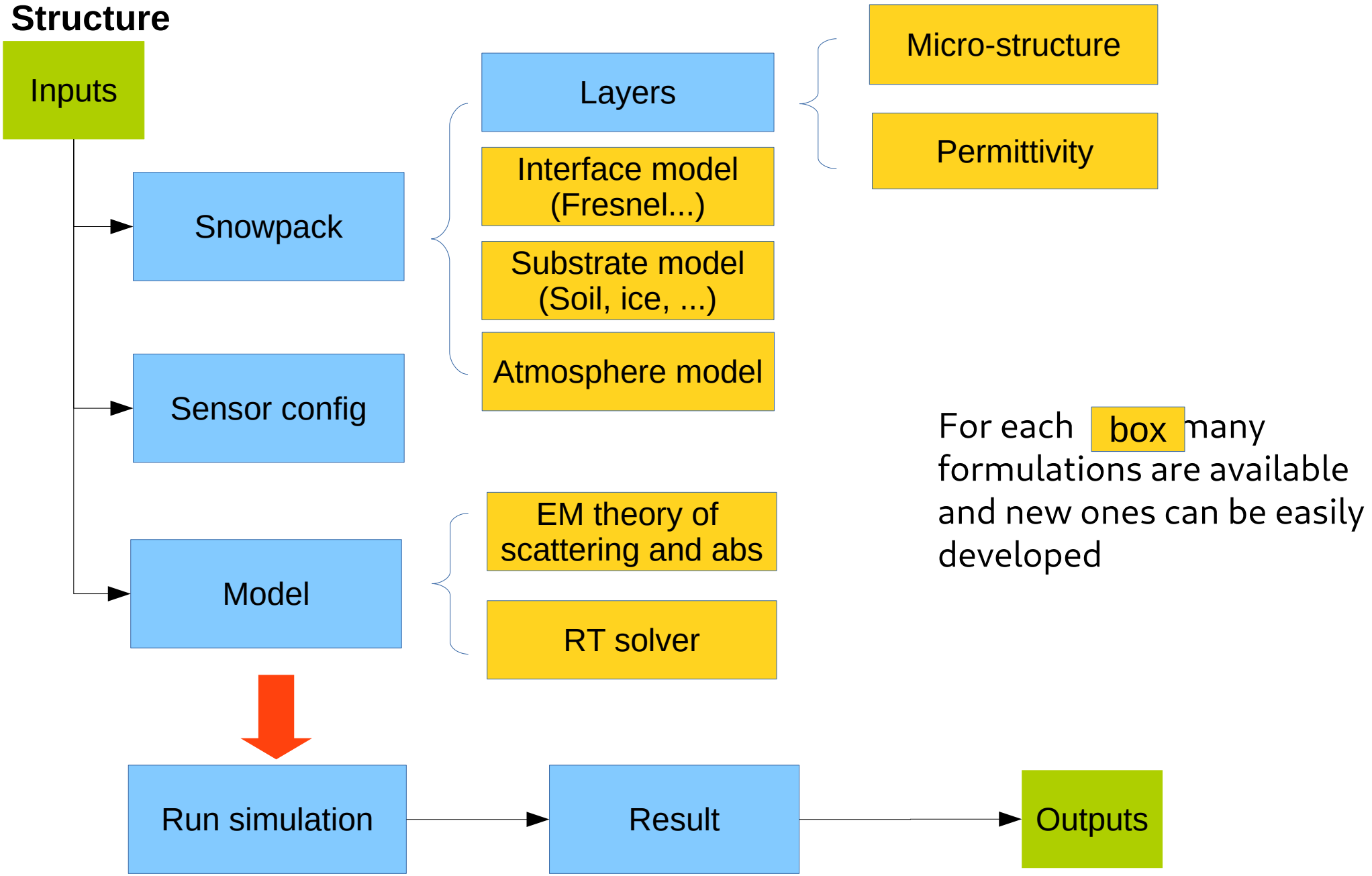
**2020 - :**

LIAM (PI. C. Duguay) : validation of SMRT Altim on frozen lakes

AKROSS (PI. M. Sandells): validation of SMRT Altim on sea-ice

# Snow Microwave Radiative Transfer (SMRT)

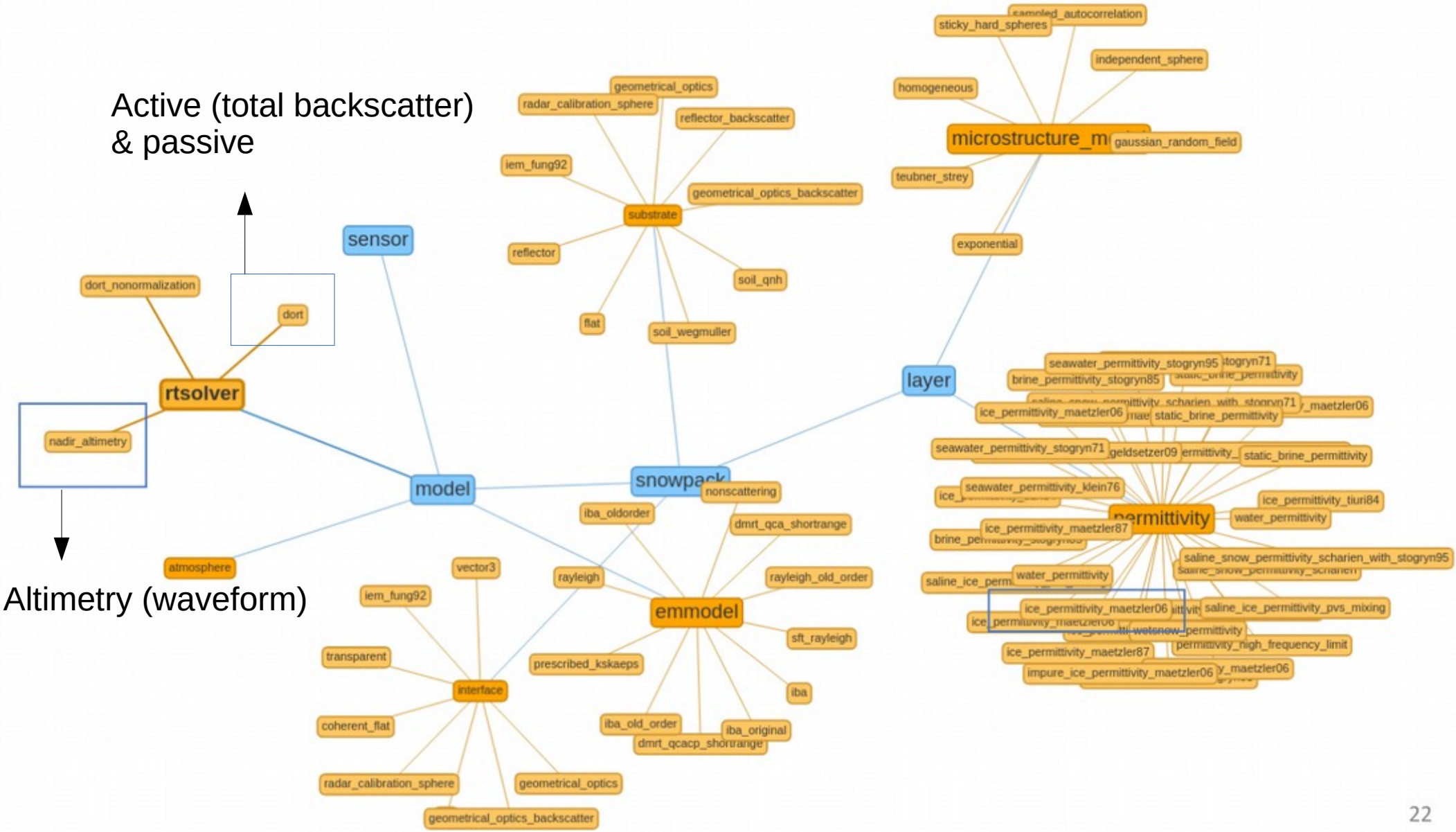
SMRT is highly structured modular model




For each box many formulations are available and new ones can be easily developed

# Snow Microwave Radiative Transfer (SMRT)

SMRT in 2020 :



# Nadir LRM altimetry in SMRT

SMRT computes the waveforms in two steps:

1- compute the **vertical** profile of backscatter

Sigma = f(z)

- backscatter from the surface
- backscatter from the volume (scattering)
- backscatter from the inter-layer interfaces
- backscatter from the substrate (bottom interface)

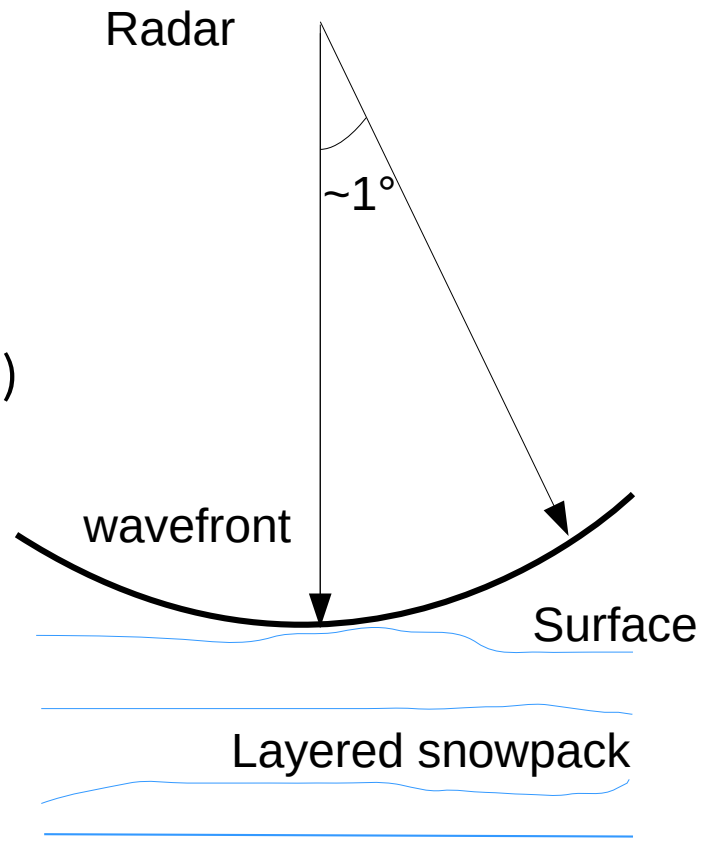
Main approx: 1st order backscatter only

2- distribute in time accounting for the **horizontal** spread/delay of the wavefront

- Brown's model → flat or tilted surface.
- « convolution with the pulse surface response »

Main approx: LRM model, no complex topography

Sigma = f(t)



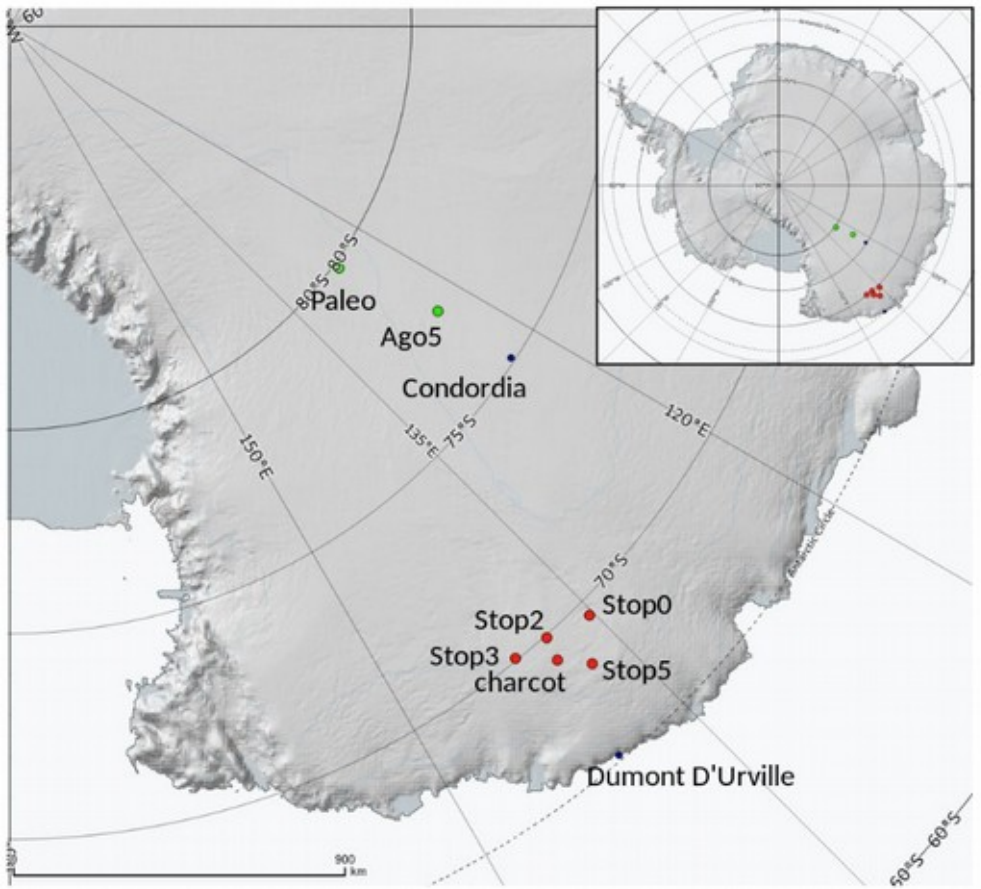

Note:
SMRT + AltiDop (by CLS) relaxes these approx

# Nadir LRM altimetry in SMRT

Validation in Antarctica :

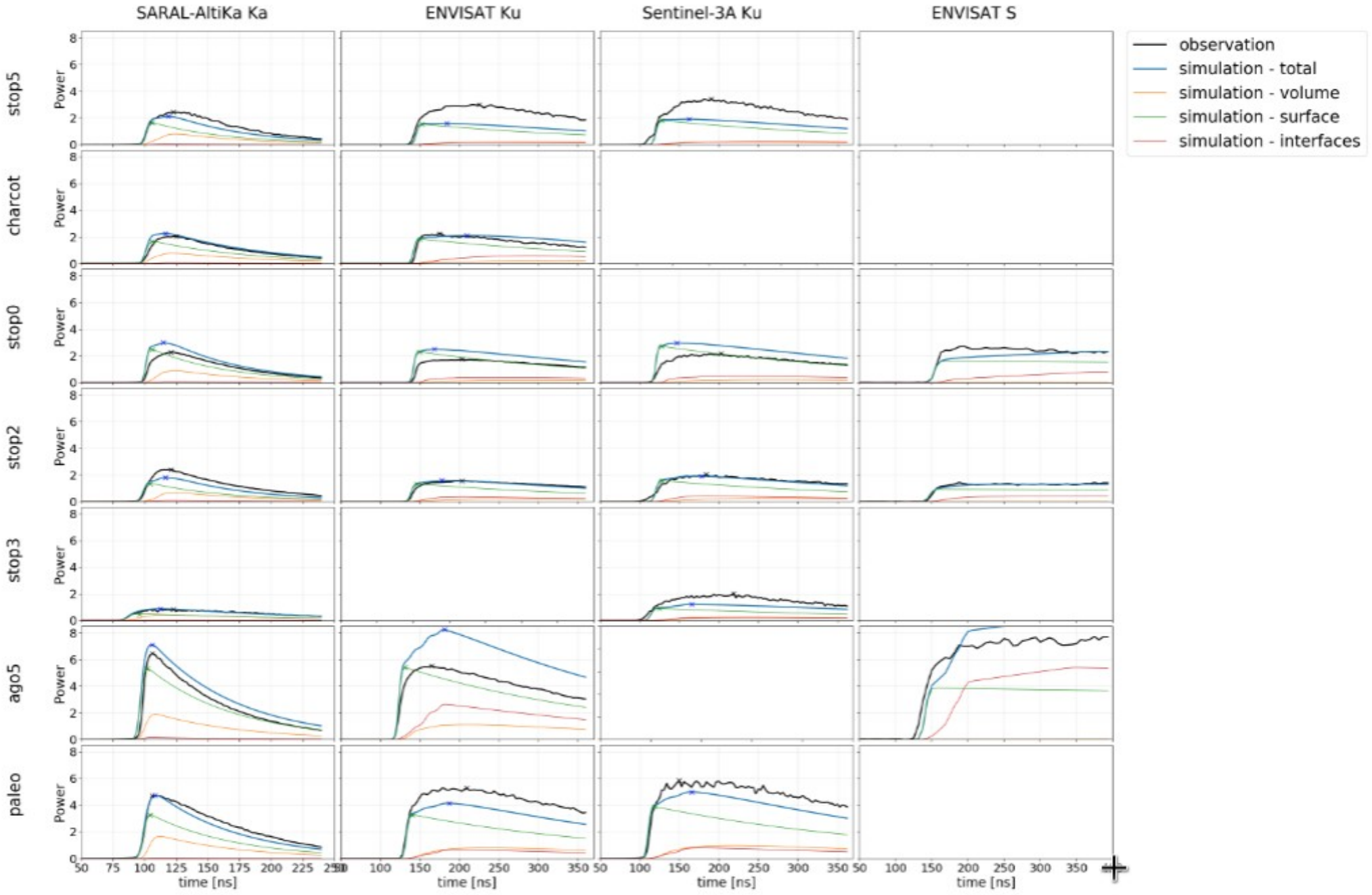
Acquisition of in-situ data during two traverses (2016 and 2019) and at Concordia:

- density profile
- snow grain size profile
- surface roughness




# Nadir LRM altimetry in SMRT

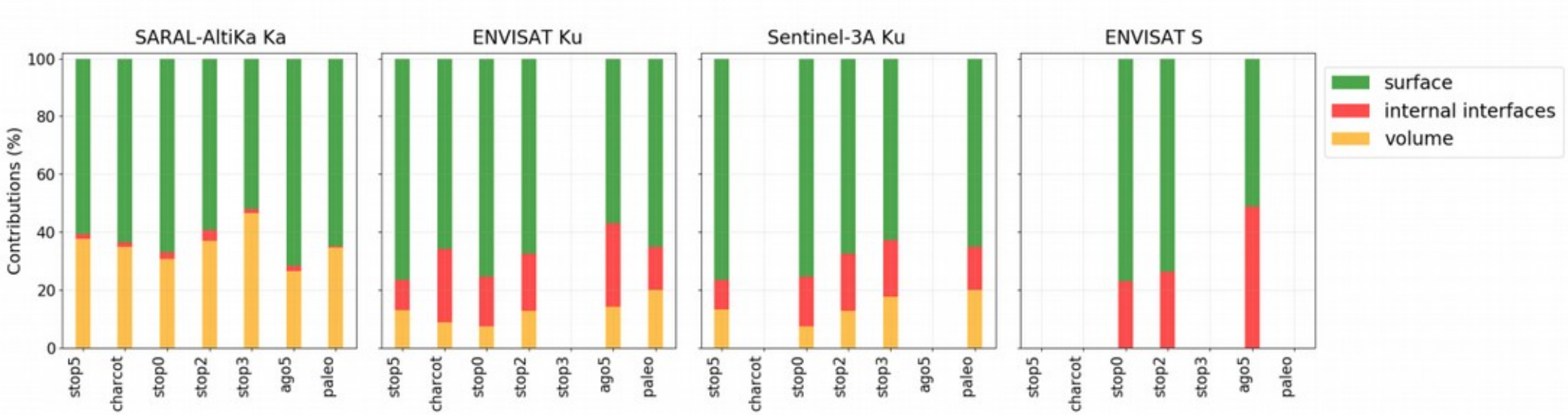
## Results in Antarctica



# Nadir LRM altimetry in SMRT

**Main conclusions:**

- The surface backscatter dominates at all the frequencies




- Volume (scattering) is larger at Ka-band, but penetration depth is much less than at the lower frequencies.

- Total backscatter is increasing from the coast to the interior. Due to bigger grains and rougher surface

# Conclusion

A lot remain to be done in terms of validation, exploitation and further development

SMRT is open-source: http://github.com/smrt-model/smrt