Modelling the Backscattering Properties of Anisotropic Rough Snow Surfaces: Implications for the Evolution of Near Surface Features on the Ice Sheets

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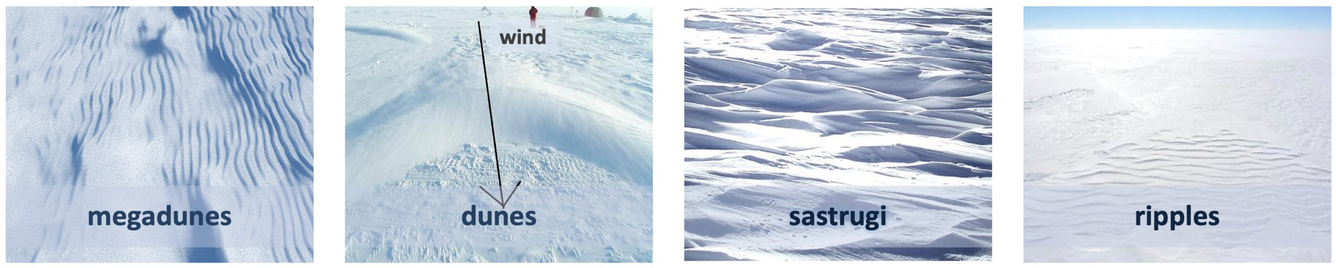
Abstract #C15C-0812

Rationale

Understanding the near surface roughness is paramount for the evolution of surface features and it's contribution to the surface mass balance of upper few meters



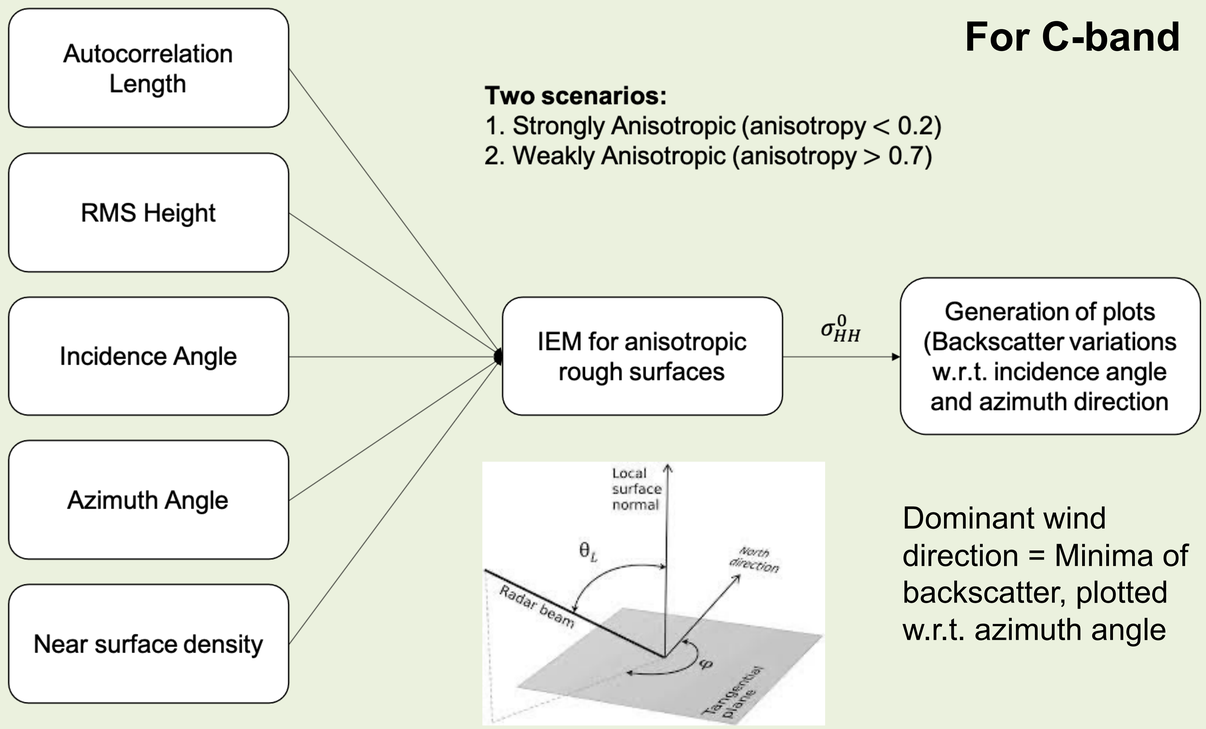
Near surface of ice sheets contains more than one scale of roughness, mostly shaped by wind, thereby introducing anisotropy

Anisotropy in roughness is also caused due to gravity on tilted surface, especially when melting or rainfall on snow occurs

Approach

For C-band

Two scenarios:
1. Strongly Anisotropic (anisotropy < 0.2)
2. Weakly Anisotropic (anisotropy > 0.7)



Dominant wind direction = Minima of backscatter, plotted w.r.t. azimuth angle

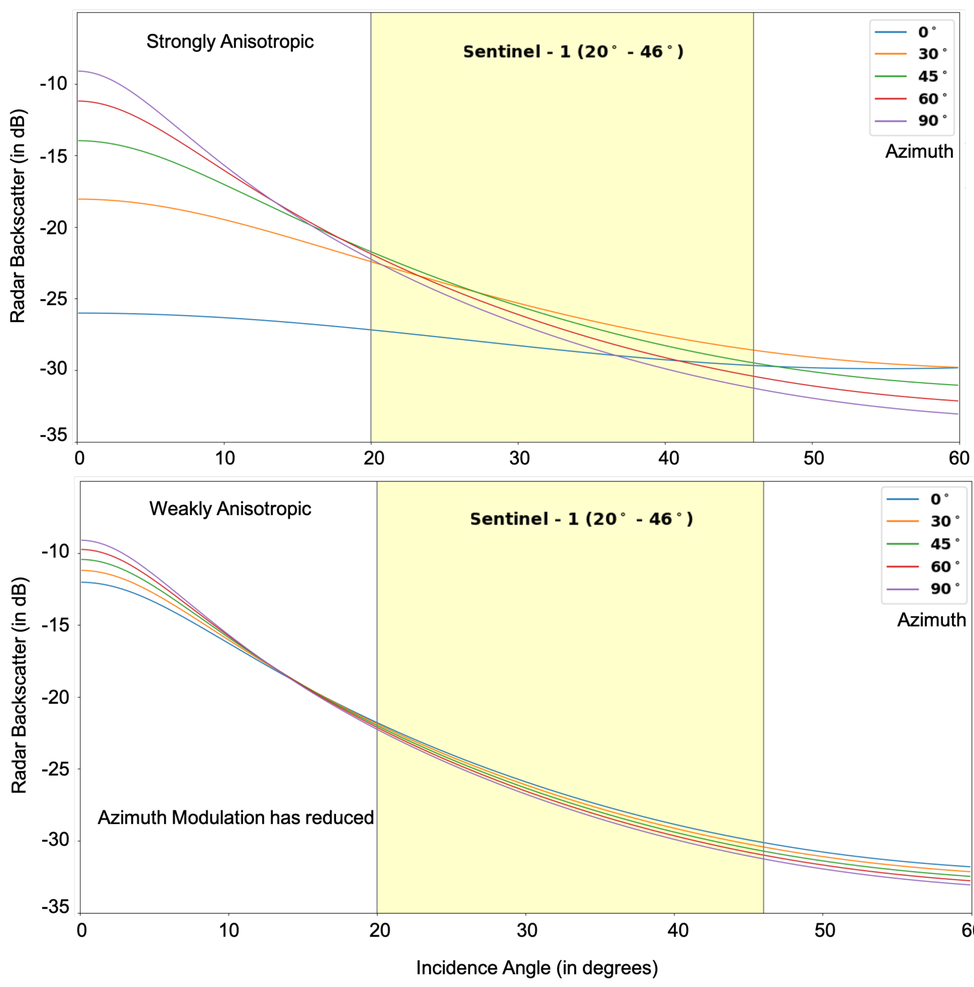
What we are doing?

- ✓ Simulating the backscatter response from anisotropic rough surface and quantifying the most dominant wind direction at different incidence angles
- ✓ We parameterize Integral Equation Model (IEM) for rough snow surfaces, introducing anisotropy
- ✓ Roughness is quantified by RMS height and Autocorrelation length
- ✓ When anisotropy is considered, autocorrelation length is a function of azimuth direction
- ✓ C-band radar configuration; different incidence angles (30°, 45°, 60°)

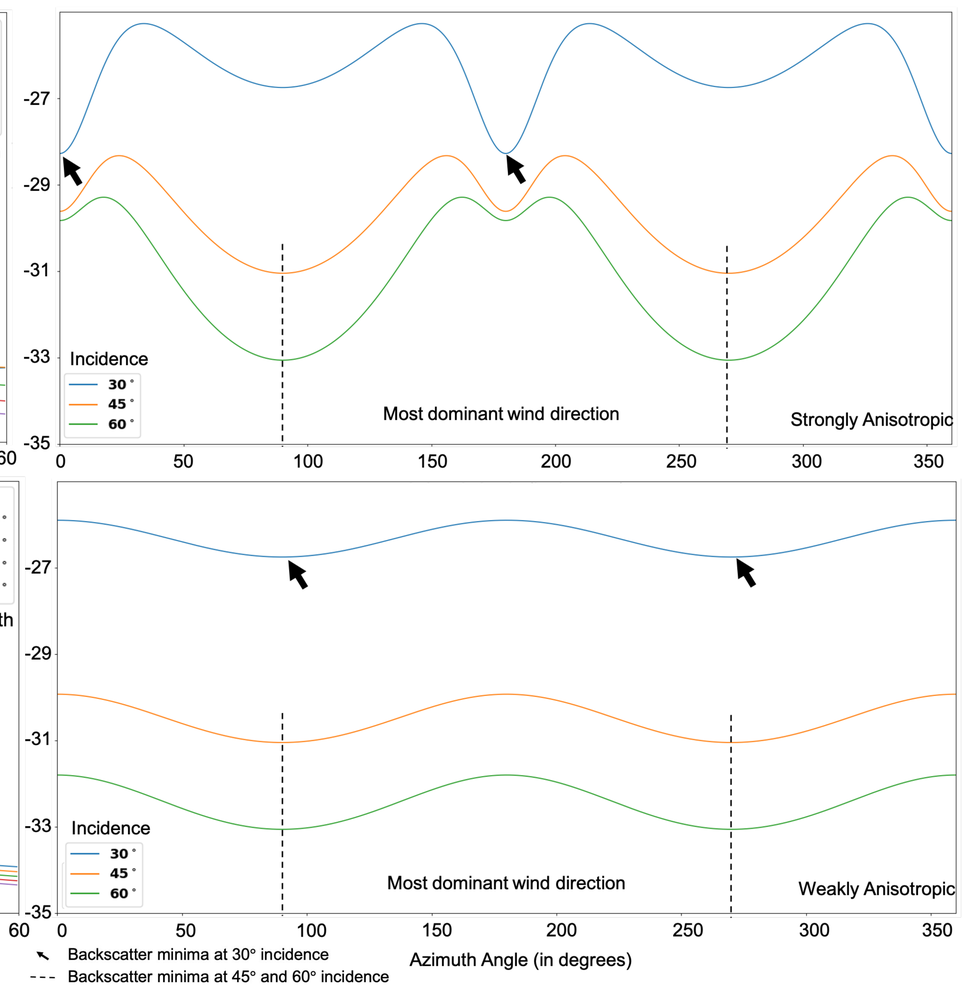
Limitations

Lack of roughness field data (RMS heights and autocorrelation length)

Variations in backscatter w.r.t. incidence angle



Variations in backscatter w.r.t. azimuth direction



Results

- ✓ Significant azimuth modulation is observed at low incidence angles
- ✓ Most dominant wind direction changes from 0° to 90° azimuth direction for 30° incidence angle when the surface transforms from strong anisotropic to weakly anisotropic
- ✓ Potential of backscatter at 30° incidence angle for tracking the changes in wind flow pattern based on the degree of roughness anisotropy

Future Scope

- ✓ Applying our model on radar images for retrieval of dominant wind directions
- ✓ Comparing the directionality of roughness with katabatic wind flow patterns and AWS measurements
- ✓ Calibration of our model with in-situ roughness data

Take Away Home Message

Roughness anisotropy is important for modeling near-realistic backscatter and for understanding the orientation of surface features in the ice sheets, with particular application to wind flow