Modification of density profile: preliminary results

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Model results: continuous profile (no noise)

- the model overestimates the experimental measurements
- the difference between V and H polarizations is not reproduced at all
- the trend of the V pol is not reproduced at all

Dots = measured data at V and H polarization
Model analysis:

- Real data shows fluctuation of density and grain radius along the profile
- Density, grain radius and layering profiles were perturbed with a dumped gaussian noise

\[
\tilde{\rho}(z) = \rho(z) + N(\sigma_{\rho}) e^{-z/\alpha}
\]

\[
\tilde{\text{rad}}(z) = \text{rad}(z) + N(\sigma_{\text{rad}}) e^{-z/\alpha}
\]

\[
\tilde{d}(z_i) = d(z_i) + N(\sigma_d) e^{-z/\alpha}
\]

where \(\sigma_{\rho}, \sigma_{\text{rad}}\) and \(\sigma_d\) are the standard deviation of the gaussian noise.

\[
\sigma_{\rho} = 50 \\
\alpha = 40
\]

\[
\sigma_{\rho} = 0.25 \\
\alpha = 40
\]
Example of Thickness Variability

\[ \tilde{d}(z_i) = d(z_i) + N(\sigma_d = 1.5 \text{ cm}) \, e^{-z/40} \]
Examples of Obtained Results – L band

Combinations of different density std dev and damping factor.
The effect of the density fluctuations is a decreasing of $T_b$ as $\sigma_\rho$ and/or $\alpha$ increase (fluctuations less damped)
Model analysis: grain size effect

Incidence Angle (deg)

σ_{\text{rad}}

\begin{array}{ccc}
\sigma_{\rho}=60 & \alpha=25 & \sigma_{r}=0 \\
\sigma_{\rho}=60 & \alpha=25 & \sigma_{r}=0.25 \\
\sigma_{\rho}=60 & \alpha=25 & \sigma_{r}=0.5 \\
\end{array}

L – Band

Negligible effects

C-Band

Appreciable effects
Model analysis: Layer thickness effects

A gaussian noise with a zero mean and a std dev of 1.5 cm was added to the layer thickness profile (the gaussian bell contains 99.7% of the distribution in the range $\pm 3\sigma$, thus the top layer thickness could vary from 1cm to 19cm by limiting the tails of the bell).
Model analysis: Layer thickness effects

Layering perturbed

Small Effect
By analyzing the RMSE between the model simulations and the measurements it is possible to find the set of density noise parameters which best fit the exper datasets.

![Heatmaps](image)

- **L-band**
- **C-band**
- **V**
- **H**
- **V+H**

RMSE (K)
For $\sigma_p = 60 \text{ Kg/m}^3$ and $\alpha = 30 \text{ m}$ we obtain

The introduction of fluctuations in the snowpack density profile makes possible:

- to fit quite well the experimental measurements
- to reproduce the difference between V and H polarizations
- to reproduce the trend of the V pol