Assimilation of TerraSAR-X data into a snowpack model
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OBJECTIVES

• Implementation of a multilayer snowpack electromagnetic backscattering model (EBM), based on Dense Media Transfer Radiative (DMRT), at high frequency bands (X-band and above).
• Application of 3D-V AR data assimilation to constrain the snow metamorphism model Crocus using SAR image data and the EBM.

ELECTROMAGNETIC BACKSCATTERING MODEL

• The simulated snowpack backscattering consists of 3 main backscattering mechanisms:
  \[ \sigma_{\text{sim}} = \sigma_{\text{dak}} + \sigma_{\text{ef}} + \sigma_{\text{g}} \]
• \( \sigma_{\text{dak}} \) and \( \sigma_{\text{ef}} \) are calculated using Integral Equation Model (IEM).
• \( \sigma_{\text{g}} \) - Total volume backscattering of all snowpack layers, derived from DMRT equations.

3D-V AR DATA ASSIMILATION

3D-V AR assimilation adjusts the guess parameters to reduce the discrepancy between \( \sigma_{\text{sim}} \) and \( \sigma_{\text{TSX}} \), according to the error statistics of modeling and observations.

In order to constrain the initial guess data using the observations, one needs to minimize the cost function \( J \):

\[ J = (x - \bar{x})^T B^{-1} (x - \bar{x}) + (y - H(x))^T R^{-1} (y - H(x)) \]

where:
• \( x \) and \( \bar{x} \) - the initial guess and analysed snowpack parameters, contains the values of density and grain size of each snow layer.
• \( y \) and \( H(x) \) - SAR calibrated backscattering (\( \sigma_{\text{TSX}} \)) and simulated backscattering coefficient (\( \sigma_{\text{sim}} \)).
• \( B \) and \( R \) - the error covariance matrices of Crocus and observations.

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CONCLUSION

• Through the use of 3D-V AR data assimilation and the EBM, we are able to constrain the snowpack evolution model Crocus using external remote sensing data from TerraSAR-X satellite.
• Future work will be concentrated on the validation of the proposed method on a large number of in-situ measurements.