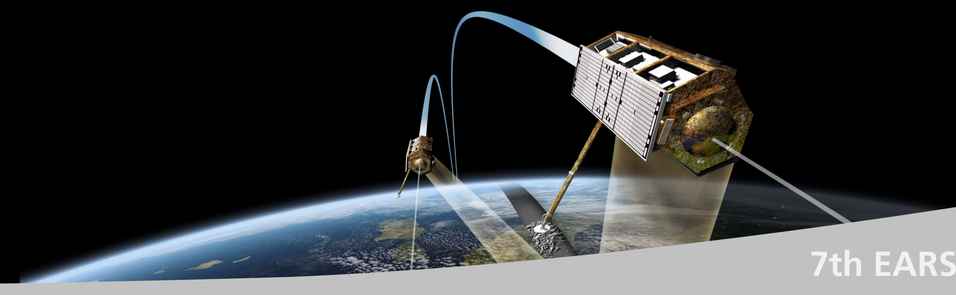
German Aerospace Center
in the Helmholtz Association

Microwaves and Radar Institute



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Temporal Variations of X-Band PolInSAR Coherence over Glaciers

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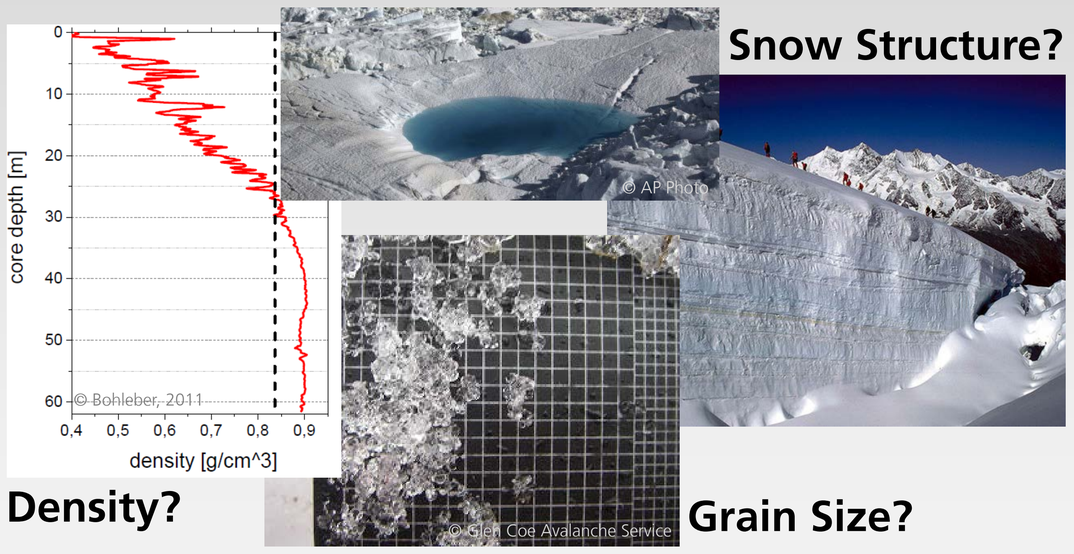
Why PolInSAR?

- Polarimetry gives information about the scattering processes on the snow/ice surface and in the snow/ice volume
- Interferometry exploits phase information for height retrieval
- The combination has potential to allow us to retrieve information about snow and ice parameters which are linked to different scattering behavior at different depths
- Microwave penetration depths in snow/ice show strong variations due to changing snow and ice conditions
- Melt features and snow/ice structure cause different phase center depths for different polarizations

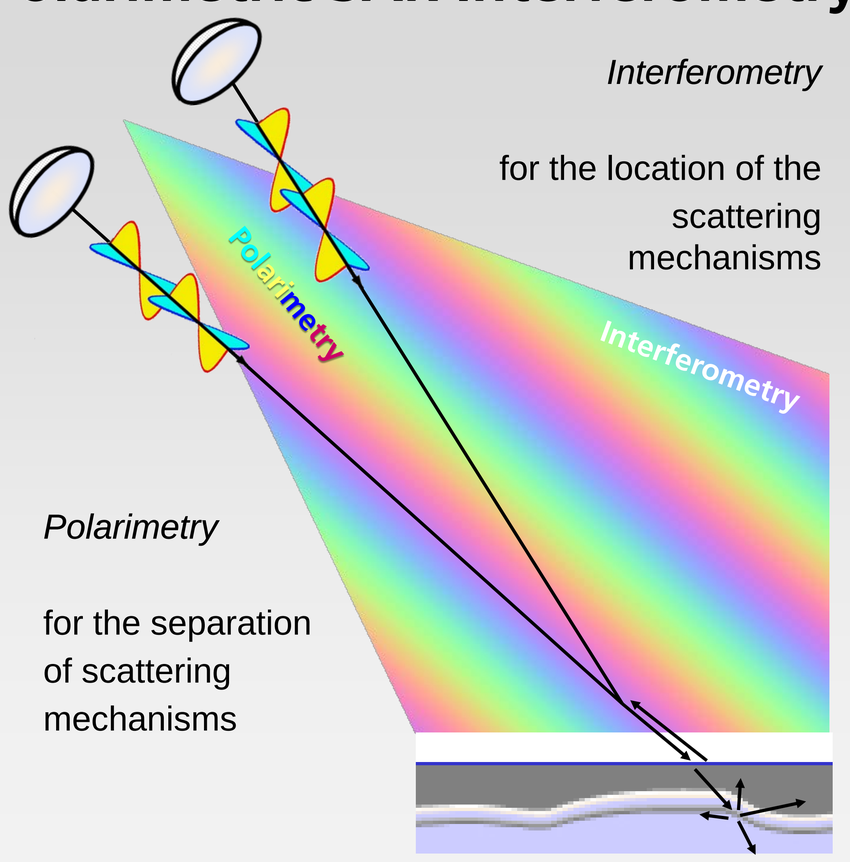
Research Questions:

- Can PolInSAR signatures be related to the change of mass-balance terms like ablation or accumulation?
- Is it possible to relate snow/firn density profiles to coherence regions?
- How do the temporal variations of snow and ice characteristics (density, water content, grain size) change the PolInSAR signatures?
- Can we find the true surface height without InSAR elevation bias by means of Polarimetric SAR Interferometry?

Temporal Variation of…



Polarimetric SAR Interferometry



Interferometry

for the location of the scattering mechanisms

Polarimetry

for the separation of scattering mechanisms

Derivation of a Dual Pol Coherence Region

Scattering vectors k_1, k_2 of each acquisition i

$$k_i = \begin{bmatrix} HH \\ VV \end{bmatrix}_i$$

Single baseline coherency matrix

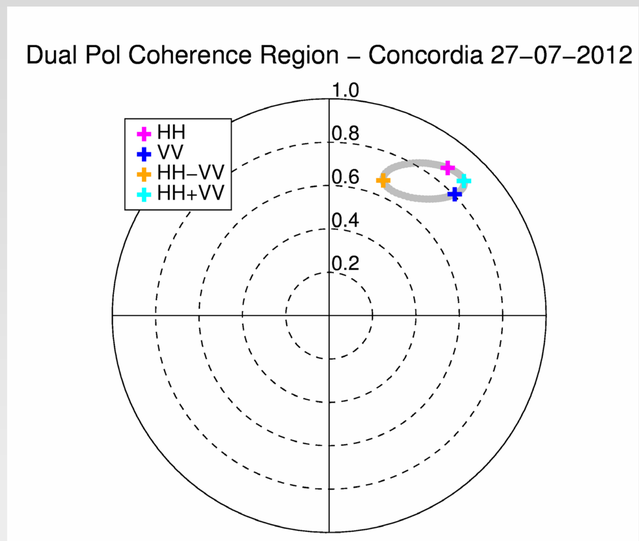
$$\left\langle \begin{bmatrix} k_1 \\ k_2 \end{bmatrix} * [k_1^{*T} \;\; k_2^{*T}] \right\rangle = \begin{bmatrix} T_{11} & \Omega_{12} \\ \Omega_{12}^{*T} & T_{22} \end{bmatrix}$$

Coherence region

$$\tilde{\gamma}(w_1, w_2) = \frac{w_1^{*T} \Omega_{12} w_2}{\sqrt{w_1^{*T} T_{11} w_1} * \sqrt{w_2^{*T} T_{22} w_2}}$$

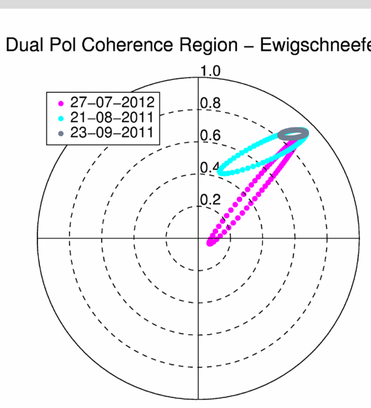
Same unitary vectors on both ends of the baseline

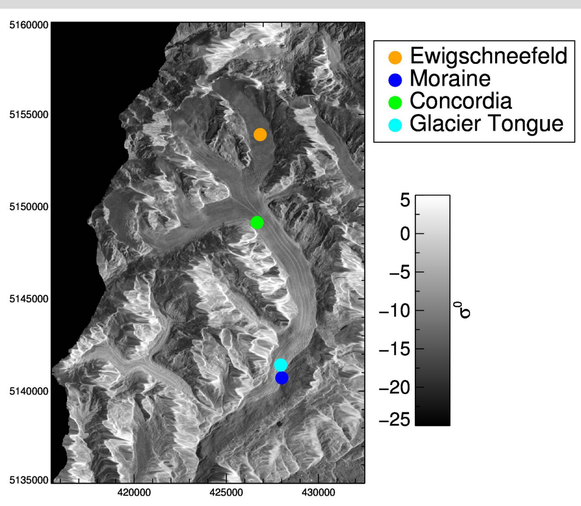
$$w_1 = w_2 = \begin{pmatrix} \cos\alpha \\ \sin\alpha \end{pmatrix} ; \quad -\pi \leq \alpha \leq \pi$$



Example of a TanDEM-X dual pol coherence region, displayed in a unit circle, at the Concordia plateau of the Aletsch Glacier. The loci of different polarisations on the coherence region are indicated

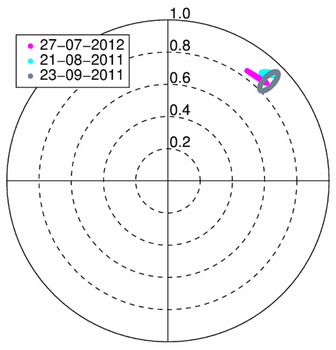
Temporal Variation (First Examples on Aletsch Glacier)





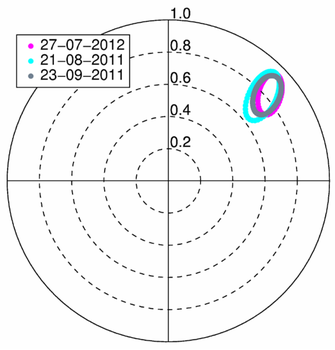
- Accumulation zone
- High temporal variation

Dual Pol Coherence Region – Moraine



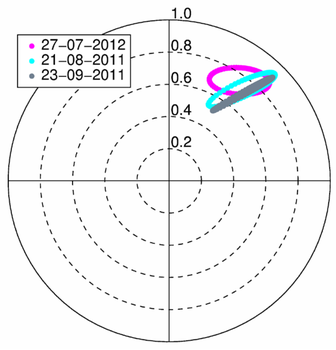
- Lateral moraine
- Bare rock
- Surface scattering

Dual Pol Coherence Region – Glacier Tongue



- Near glacier outlet
- Bare ice, debris covered
- Surface scattering

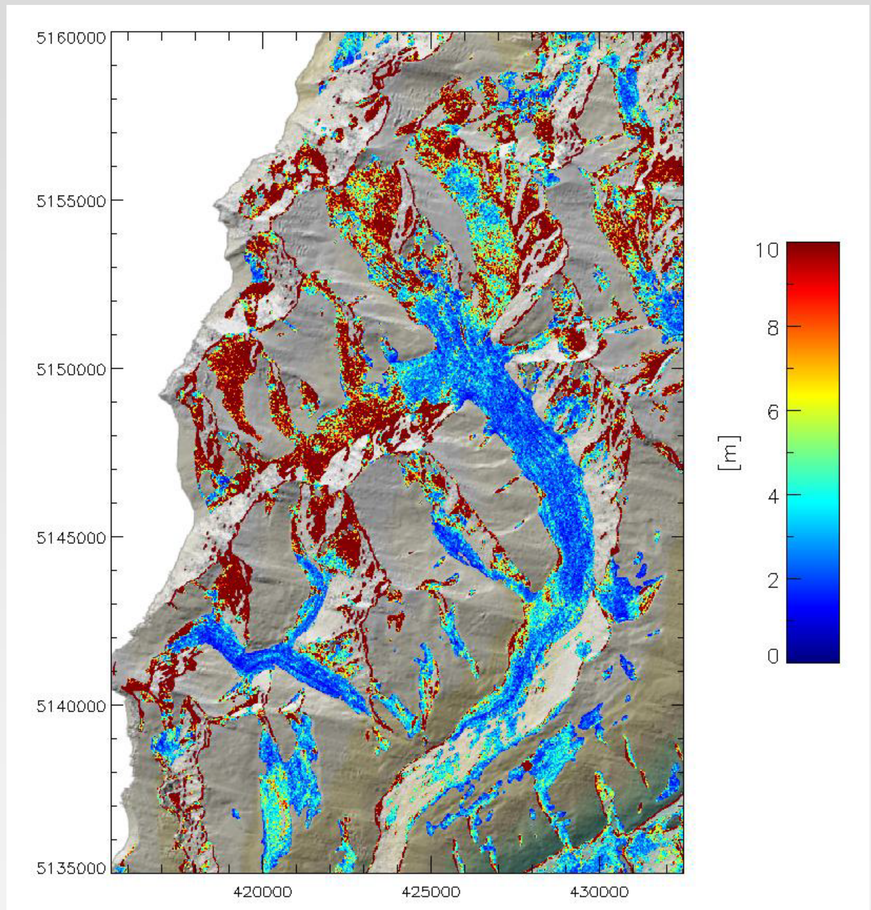
Dual Pol Coherence Region – Concordia



- Medium temporal variation

Spatial Variation

Maximum phase difference of the dual pol coherence region scaled to meters (baseline = 62 m; vertical wavenumber k_z = 0.08)



Cloude, S. R. & Papathanassiou, K. P., "Polarimetric SAR Interferometry" IEEE Transactions on Geoscience and Remote Sensing, vol. 36, no. 5, pp. 1551-1565, September 1998

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