Radar interferometry of moist soil

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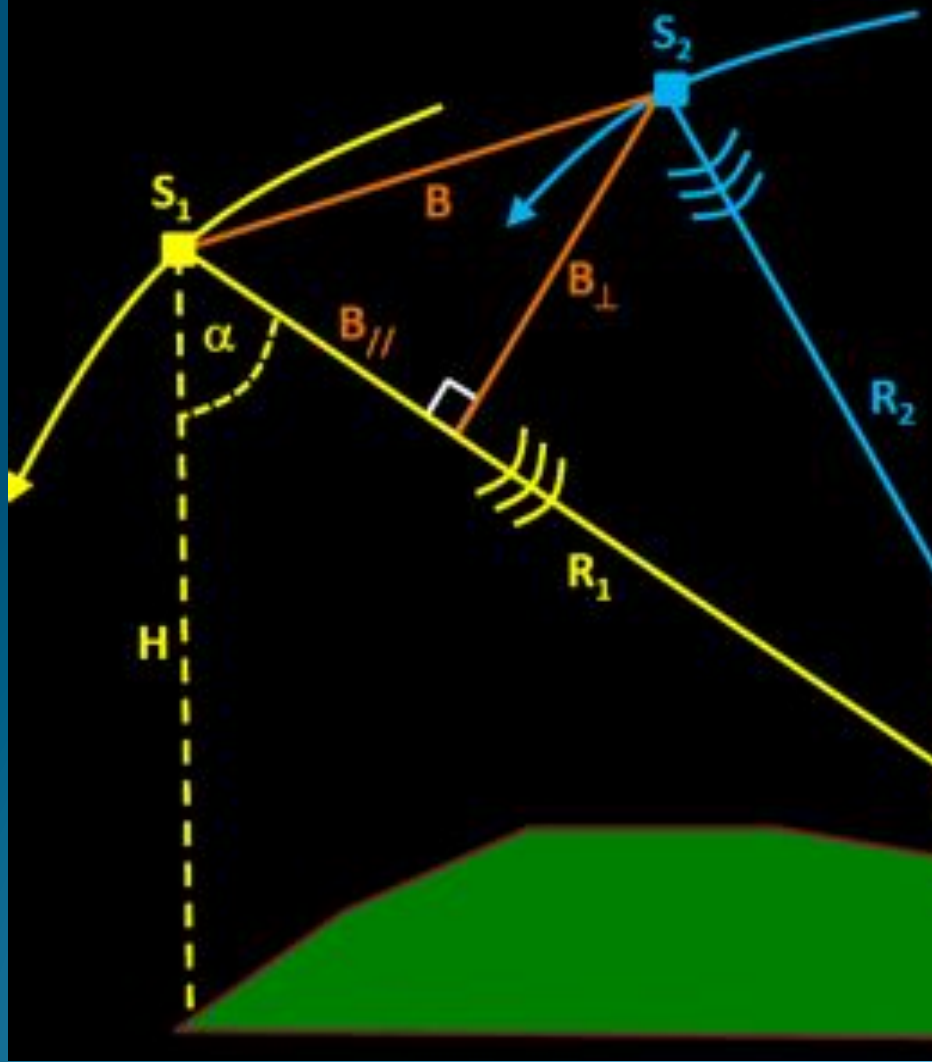
Basic Principle of Interferometry



- The $\Delta R = R_1 - R_2$ can be measured by the phase difference $\phi = 4\pi . \Delta R / \lambda$ between two complex SAR images.
- This can be performed by cross multiplication of one image by the other one, where an interferogram is formed.
- It contains fringes that trace the topography like contours.

B – Base Line
H – Satellite Altitude
h – Elevation of a point
R – Range
S – Satellite
α – Look angle
θ_r – Incident Angle

Differential Interferometry

- The phase difference $\phi = 4\pi . \Delta R / \lambda$ is the sum of several contributions.
- The objective of the Differential Interferometry (DInSAR) is to extract from the different components, for example, the displacement ($\phi_{Movement}$)

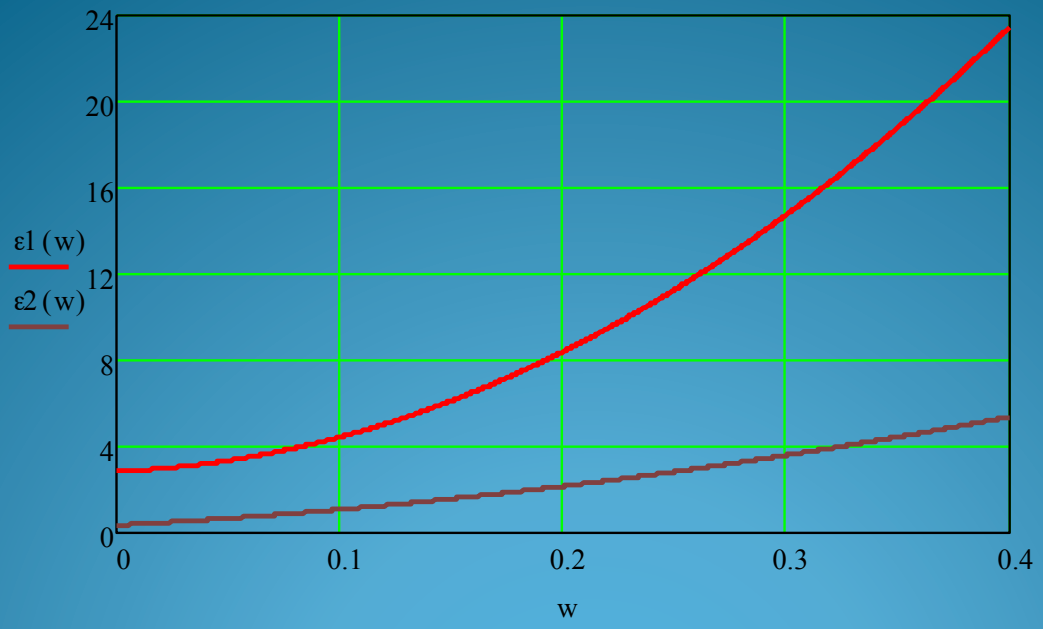
$$\phi = \phi_{Movement} + \phi_{Change} + \phi_{Topography} + \phi_{Atmosphere} + \phi_{Noise}$$

Complex dielectric constant of moist soil

$$\varepsilon = \varepsilon_1 - i\varepsilon_2$$

$$\varepsilon_1 = (2{,}862 - 0{,}012S + 0{,}001C) + (3{,}803 + 0{,}462S - 0{,}341C)w + (119{,}006 - 0{,}500S + 0{,}633C)w^2$$

$$\varepsilon_2 = (0{,}356 - 0{,}003S - 0{,}008C) + (5{,}507 + 0{,}044S - 0{,}002C)w + (17{,}753 - 0{,}313S + 0{,}206C)w^2$$



Reflection coefficient

Homogeneous soil

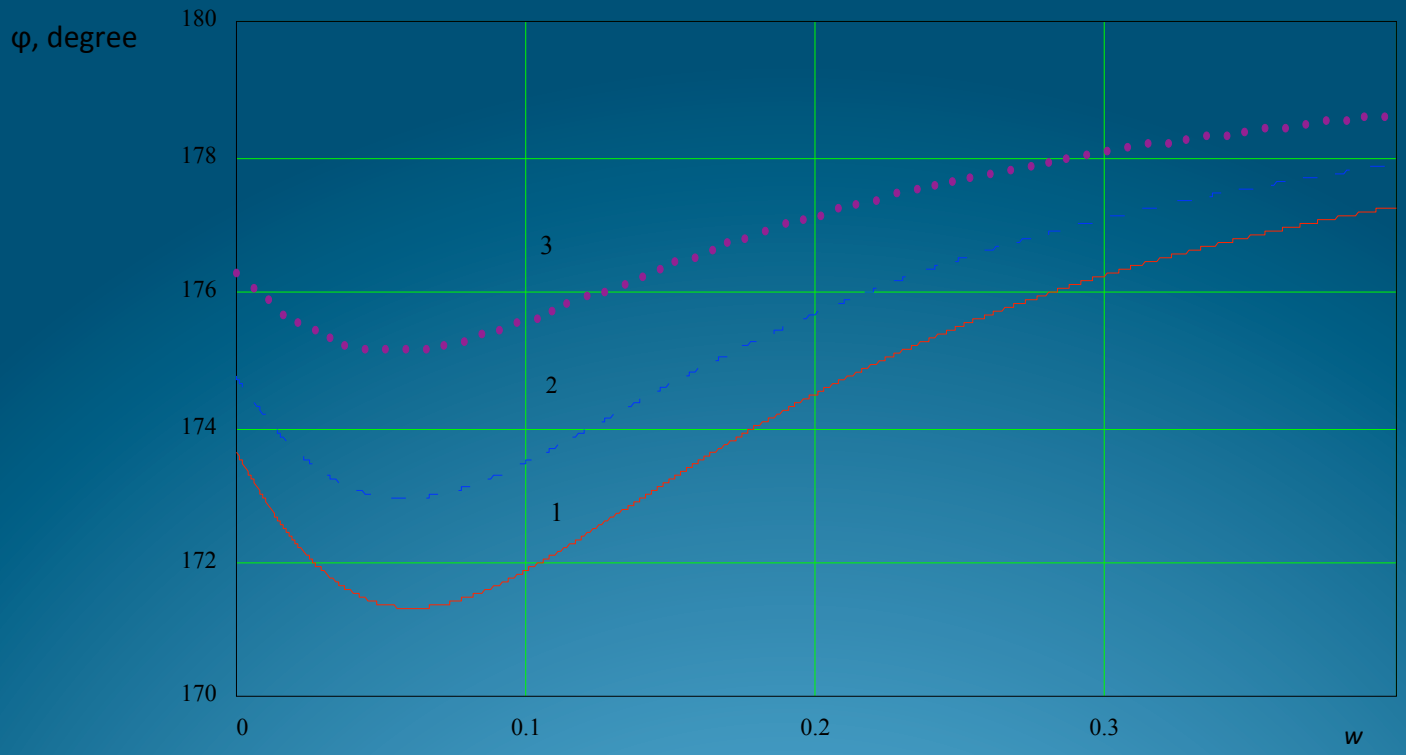
$$R_H = \cos\theta - \sqrt{\varepsilon - (\sin\theta)^2} \,/\, \cos\theta + \sqrt{\varepsilon - (\sin\theta)^2}$$

$$R_V = \varepsilon\cos\theta - \sqrt{\varepsilon - (\sin\theta)^2} \,/\, \varepsilon\cos\theta + \sqrt{\varepsilon -}$$

Layer soil

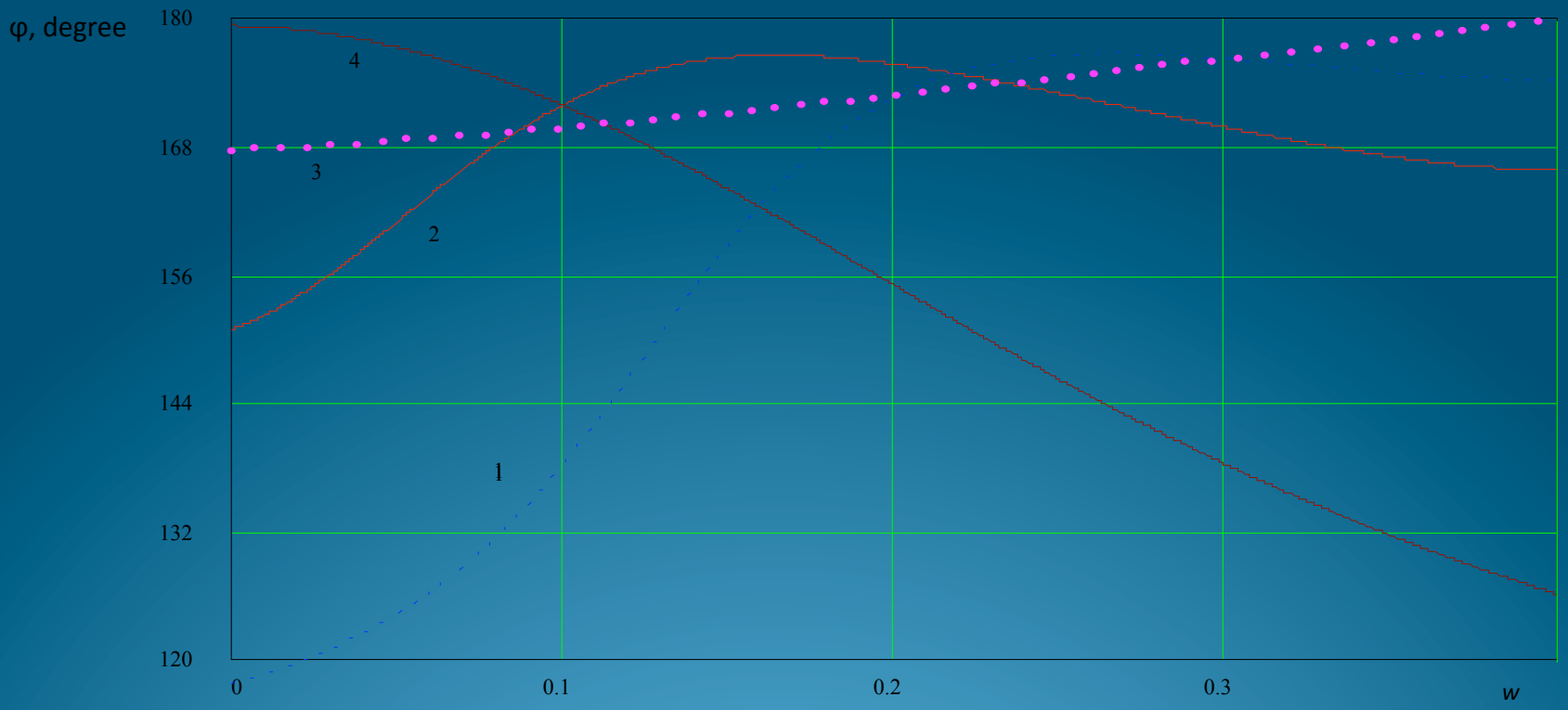
$$R = (Z_3 + Z_2)(Z_2 - Z_1)e^{ik_{2z}d} + (Z_3 - Z_1)(Z_2 + Z_1)e^{-ik_{2z}d} \,/\, (Z_3 + Z_2)(Z_2 + Z_1)e^{ik_{2z}d} + (Z_3 - Z_1)(Z_2 - Z_1)e^{-ik_{2z}d}$$

The argument of the reflection coefficient versus volumetric moisture content. Homogeneous soil.



1 - $\theta = 0^o$, 2 - $\theta = 40^o$, 3 - $\theta = 60^o$

The argument of the reflection coefficient versus volumetric moisture content. Layer soil.



d = 2 см , λ = 23 cm

1, 2 – moisture content of the layer varies, moisture of the soil is 0.3 and 0.1, respectively;

3, 4 - moisture content of the soil varies, moisture of the layer is 0.3 and 0.1, respectively.

Conclusions

It is shown that the layered structure of the moist soil leads to significant changes in the argument of the reflection coefficient, reaching several tens of degrees.
These variations should be taken into account in the method of differential radar interferometry (DInSAR).

Thanks for your attention!