Full Polarimetric Broad Band Scatterometry for Retrieval Soil Moisture Content and Vegetation Properties over a Tibetan Meadow

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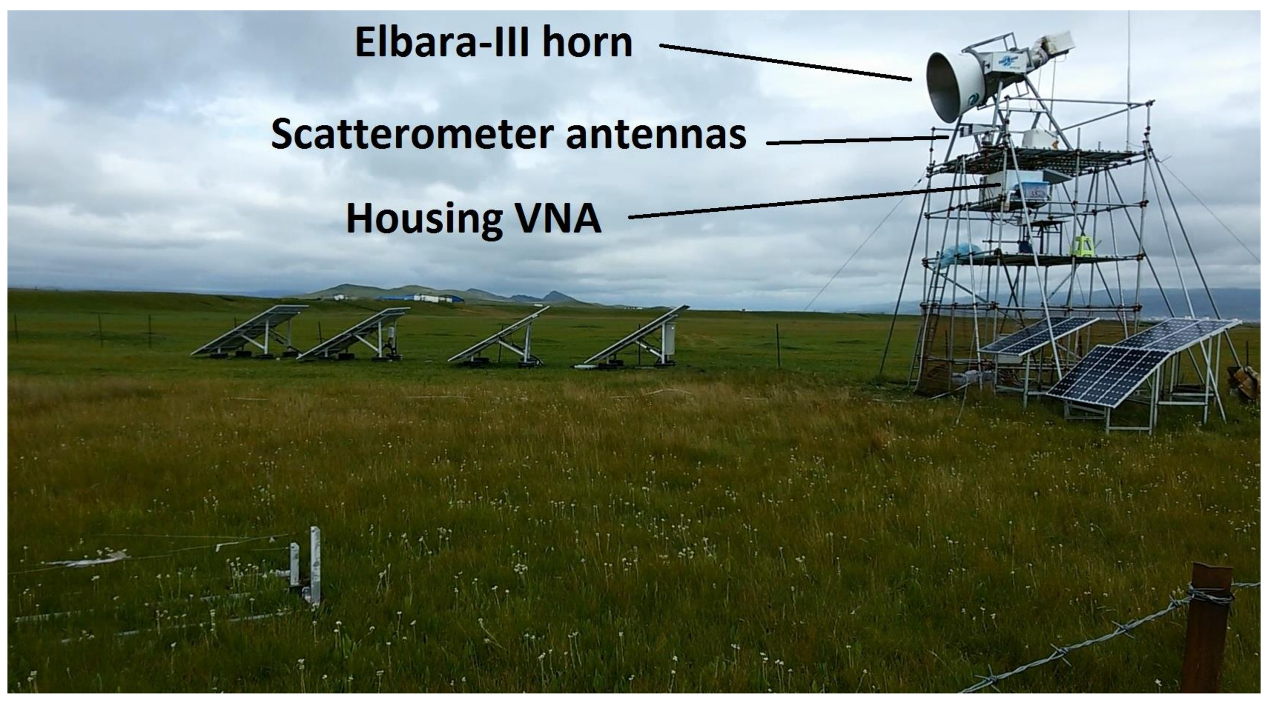
[1] Introduction and objective:

Simultaneous remote sensing in microwave- and optical regime allows for studying vegetation and soil moisture interaction. Combined setup of microwave (active & passive) and optical sensors to be installed at Alpine meadow site near Maqu (China). Site part of regional scale soil moisture monitoring network [1]. L-band radiometer; ELBARA [2] and scatterometer now present.



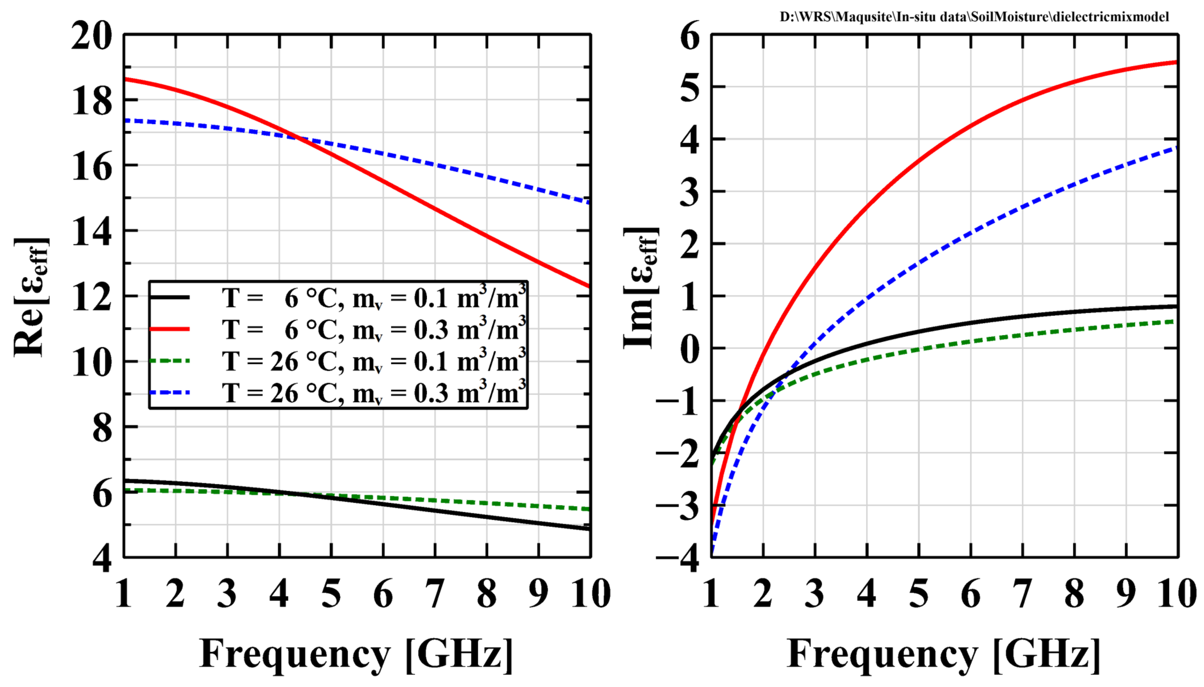
This poster: Show latest progress of scatterometer installed August 2017.

[2] Methodology scatterometer remote sensing:

- Measure backscatter coefficient σ^0 for four polarization channels (vv, hv, vh, and hh) over broad frequency range (1 – 10 GHz).
- Fixed antennas. Measure every hour over whole year.
- Hydrometeorological measurements simultaneously

[3] Theory:

Magnitude Backscattered waves proportional to dielectric constant soil surface ε_{eff}. Mixture model [3] shows ε_{eff} function of water content m_v and temperature T.



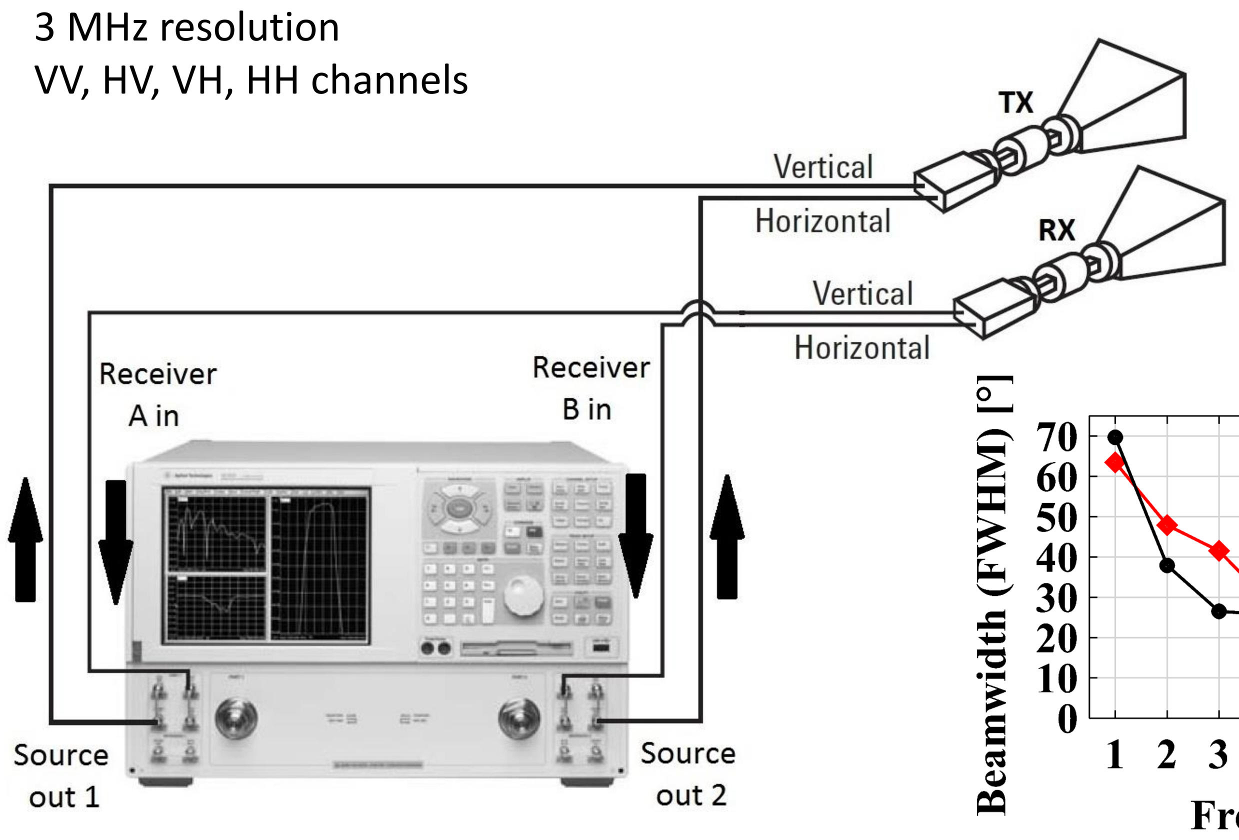
Real part (left graph) most sensitive to m_v and less to T.

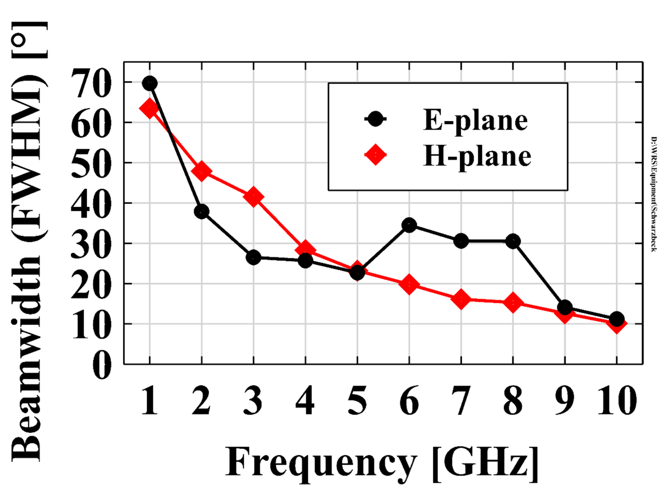
Imaginary part (right graph) more sensitive to temperature than real part. Still effect of m_v stronger than T.

[4] Equipment:

Vector Network Analyser (VNA) + 2 dual polarization broadband antennas

- 0.75 – 10.25 GHz
- 3 MHz resolution
- VV, HV, VH, HH channels

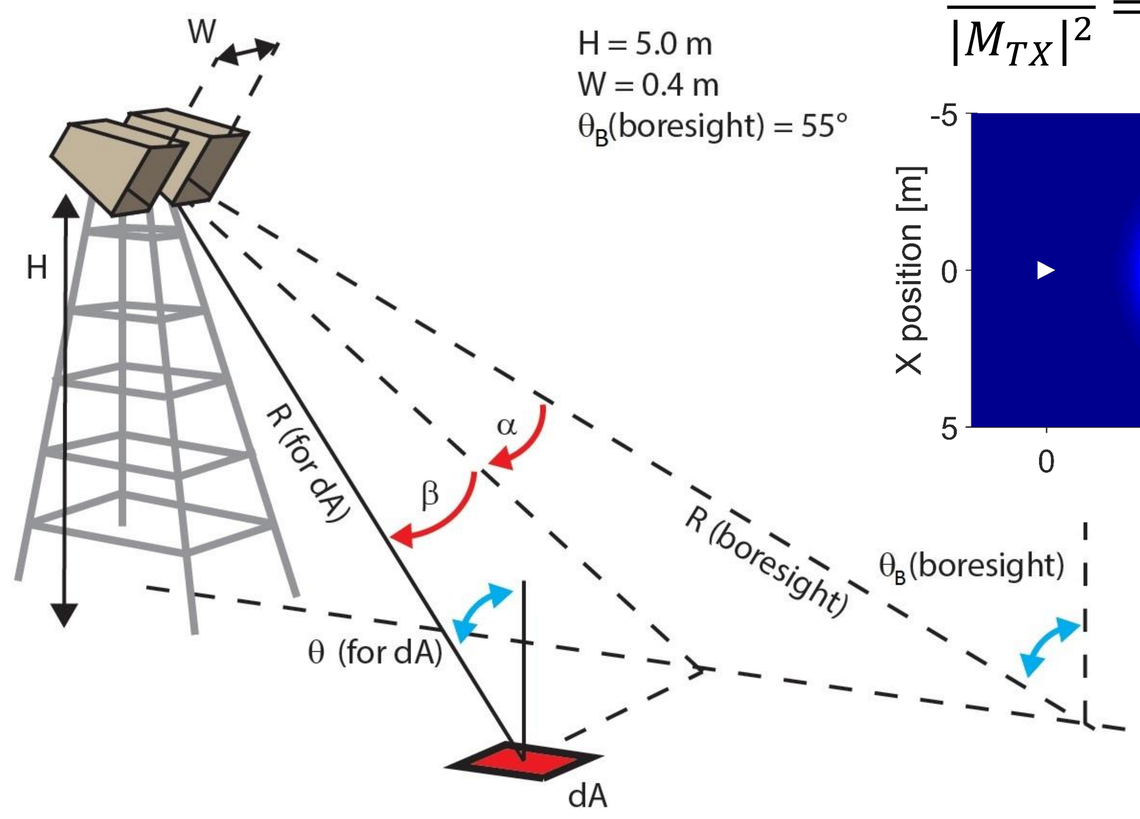


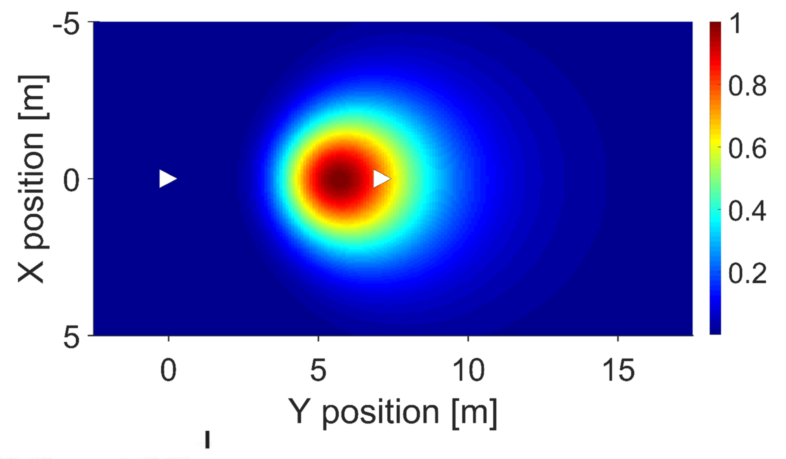


[5] Calculation backscatter coefficient σ^0:

σ^0 assumed isotropic. Antenna gain patterns $G(\alpha,\beta)$ and varying ranges R accounted for. Scatterometer calibrated with rectangular plate and dihedral reflector (see supplemental material).

$$\frac{|M_{RX}|^2}{|M_{TX}|^2} = \frac{\lambda^2}{(4\pi)^3}\int \frac{G^2}{R^4}\sigma^0(\theta).dA$$

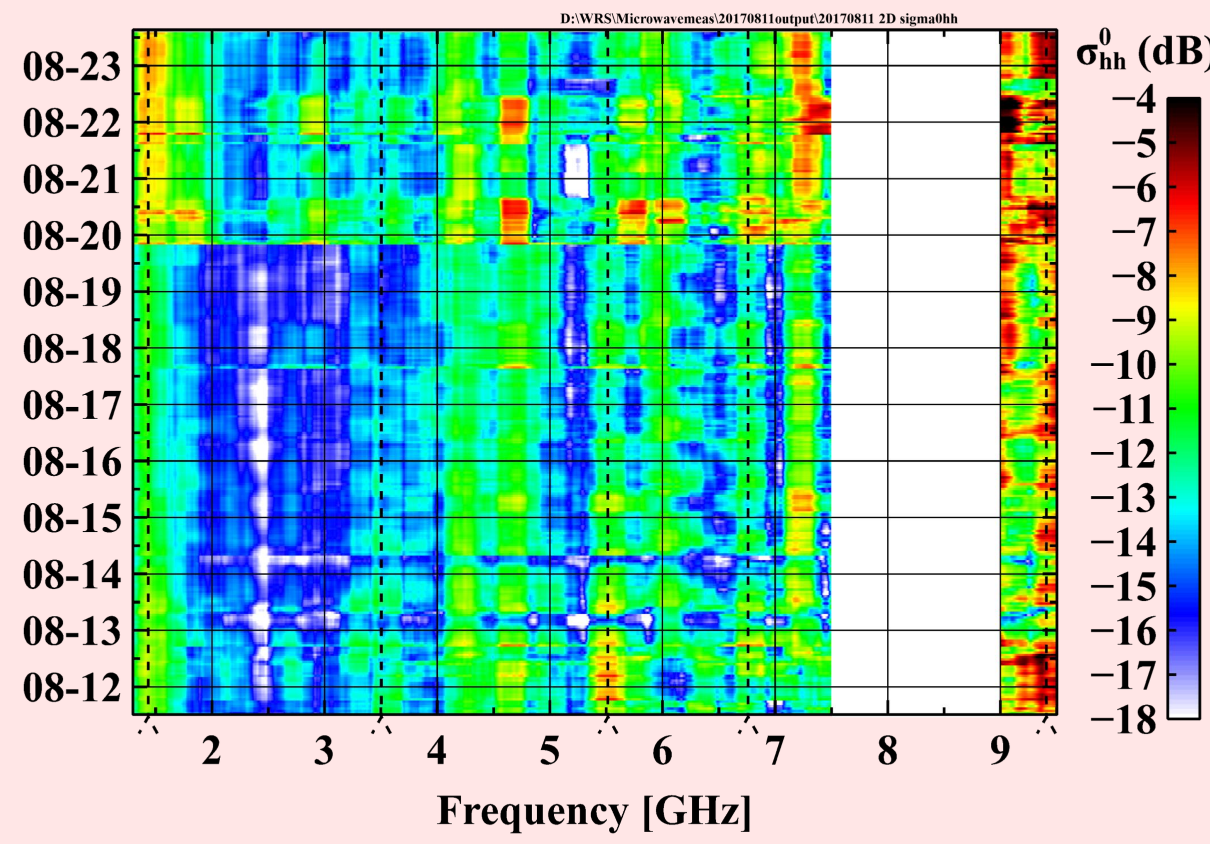




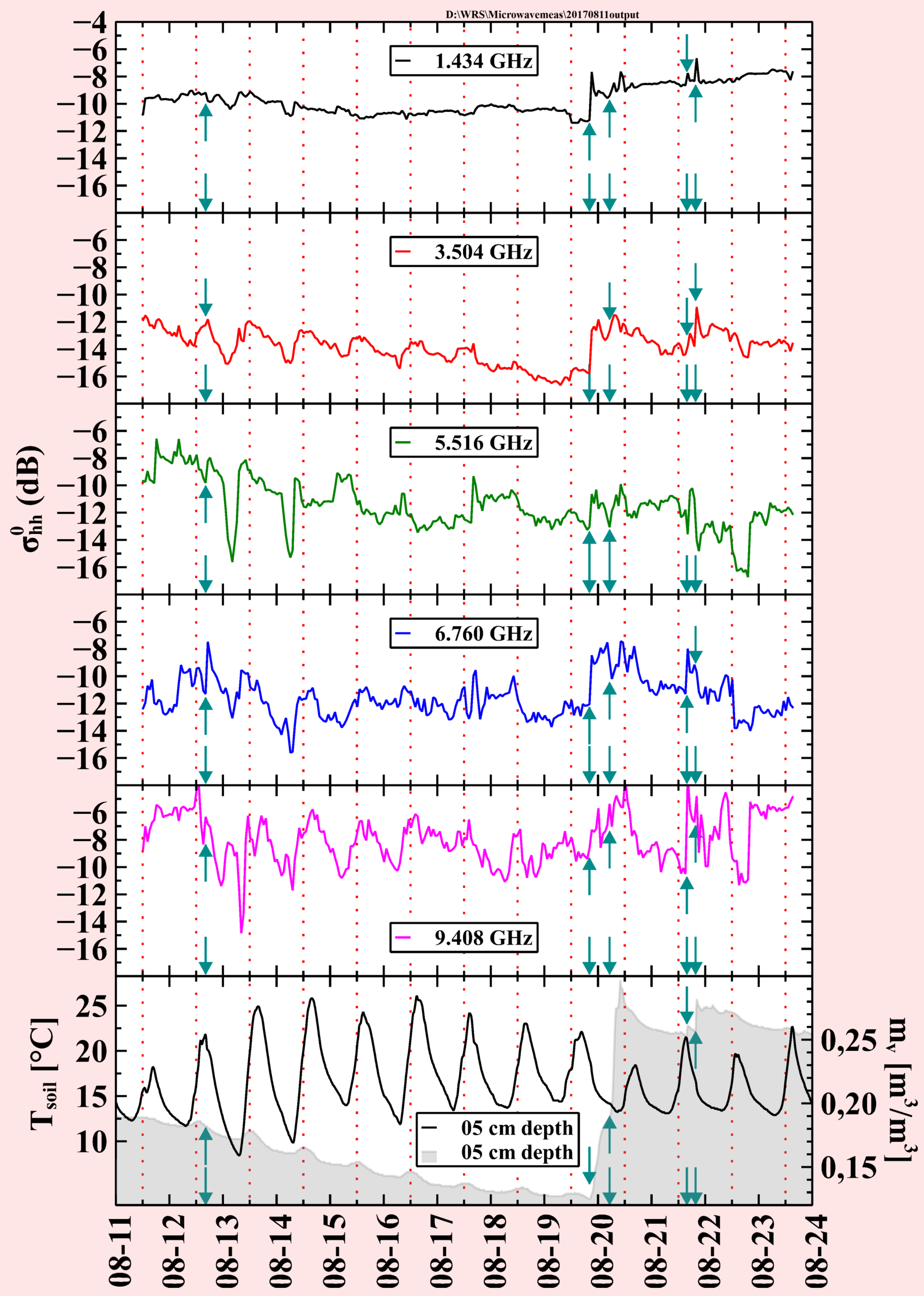
Graph shows values Integrand G^2/R^4 over ground surface for 5 GHz. Marker (0,0) is position tower, boresight line hits ground at (0,7.1)

[6] Results:

Below: σ^0 for hh polarization during August. Variations over frequency caused by variable ε_{eff} soil, soil roughness, fading, and (possibly) vegetation. Variations over time due to change of ε_{eff} soil. Note jump in σ^0 for all frequencies on Aug. 19th 20:41. Behaviour vv polarization similar.



Below: Cross sections at frequencies indicated with dashed lines above. Bottom graph shows m_v and T_{soil} at 5 cm depth. Arrows indicate rain events (see supplemental material).



- σ^0 increases for all frequencies on Aug. 19th 20:41 due to heavy rainfall event
- Most frequencies show slow decay σ^0 from Aug. 11th due to drying soil
- Diurnal variation of m_v and T_{soil} also visible in σ^0 . With some frequencies σ^0 seems to follow m_v (see 3.504, 6.760 GHz), while others seem to follow T_{soil} (9.408 GHz).

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[7] Next steps:

- Modelling to retrieve m_v from σ^0 quantitatively
- Further measurements to investigate influence vegetation
- Optical spectroscopy measurements (including sun-induced chlorophyll fluorescence).

[1] Su Z., Wen J., et al., 2011, Hydr. and Earth Syst. Sc.
[2] Zheng D., Wang X., et al., 2017, IEEE Trans. on Geo-Sc. and Rem. Sens.
[3] Dobson M.C., Ulaby F.T., et al. 1985, IEEE Trans. on Geo-Sc. And Rem. Sens.