Modeling L-band UAVSAR data through dielectric changes in soil moisture and vegetation over shrublands

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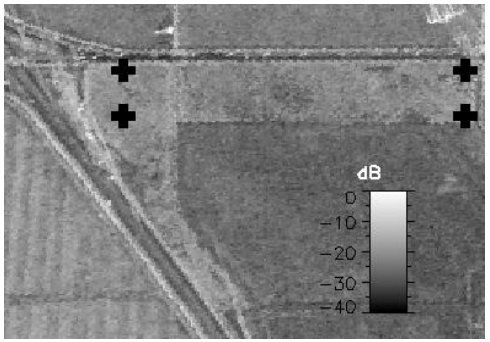
Context & Motivation

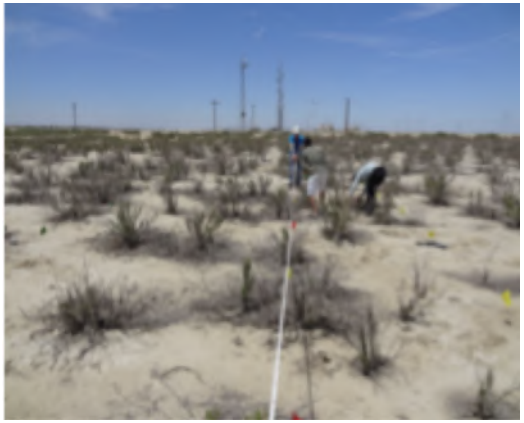
- UAVSAR soil moisture retrieval (NISAR ?)
- Applicability to Sentinel radar-only retrieval
- California Central Valley shrubland (subsidence?)

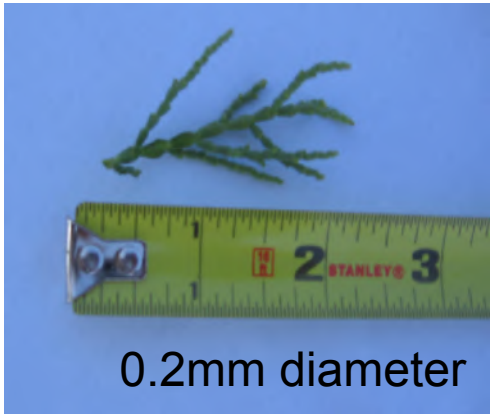
UAVSAR Central Valley Observations

year	10	2011												2012		13	2014					
month	6	5		6			7	8		9	10	11		5	6	11	1	2	4	5	6	8
day	29	19	20	1	16	30	18	12	29	19	11	2	14	29	19	25	17	11	1	28	20	14
UAVSAR																						
soil moisture																						
vegetation																						



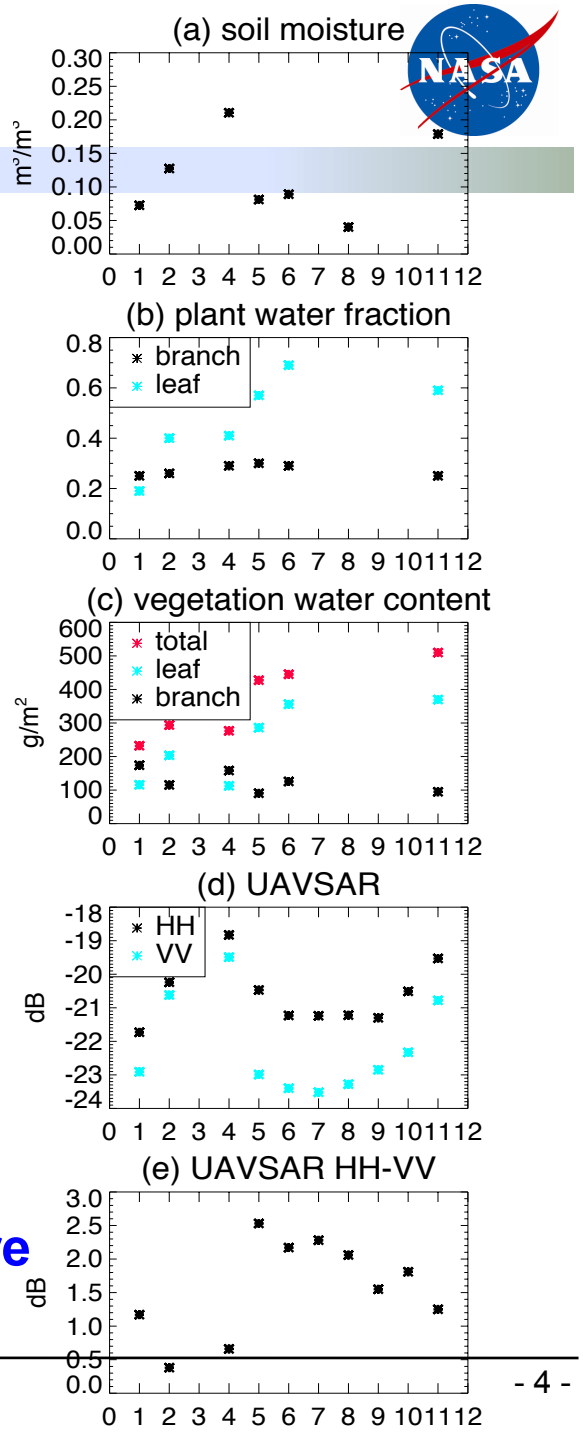
UAVSAR Central Valley Observations



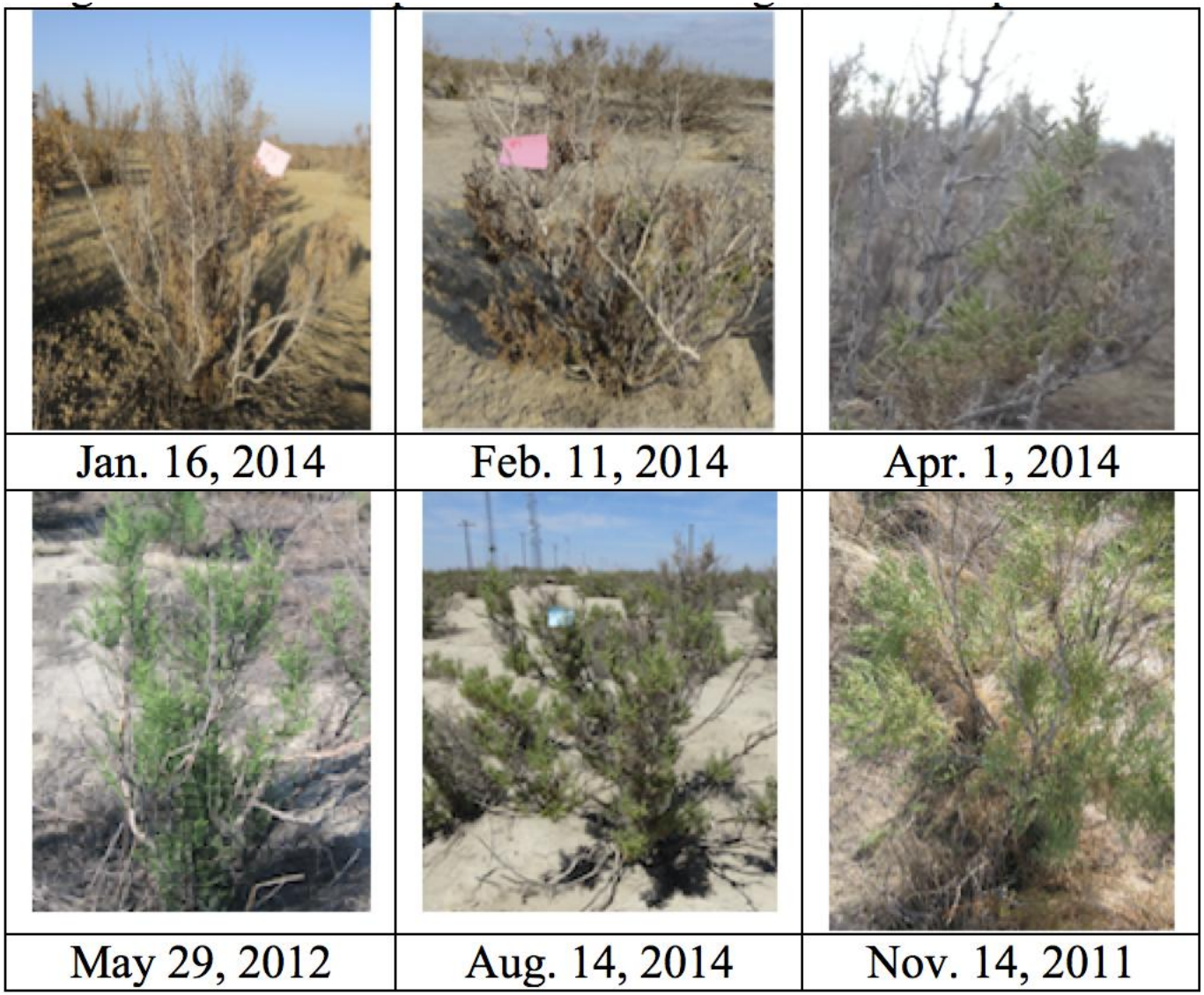


Science Questions

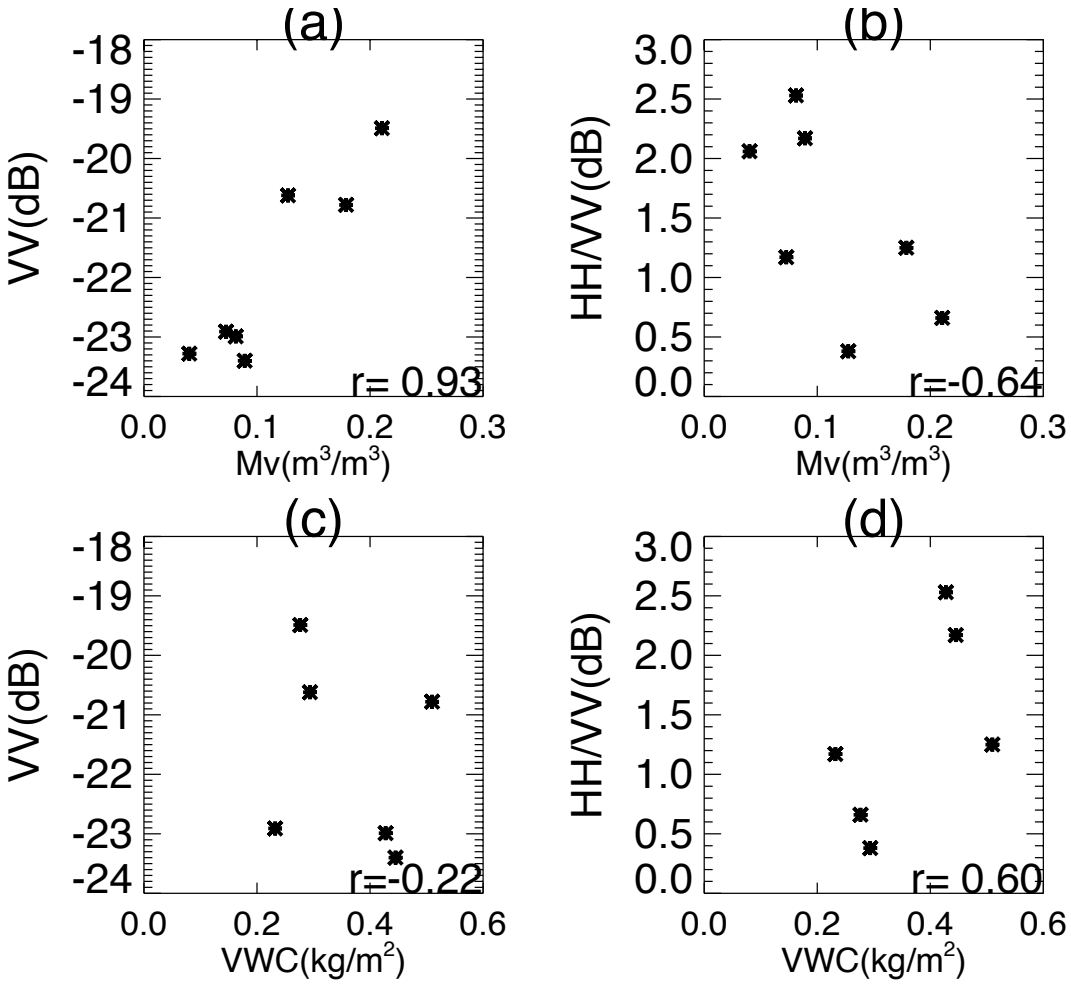
- Soil moisture (a) – in situ samples
  - California's wet winter and dry summer
- Plant water fraction (b) – destructive samples
  - Branch: temporally static
  - Leaf: wet summer, dormant winter→
- Vegetation water content (c) – destructive samples
  - Leaf VWC is dominant
  - Branch VWC is temporally static
- UAVSAR HH or VV (d)
  - Correlates highly with soil moisture
  - Correlates poorly with VWC →
- UAVSAR HH/VV (e)
  - HH > VV
  - Anti-correlates with soil moisture
- Questions to investigate
  - **HH > VV → vegetation has strong effect**
  - **BUT HH (and VV) correlates with soil moisture**
  - Will explain through modeling



UAVSAR Central Valley Observations

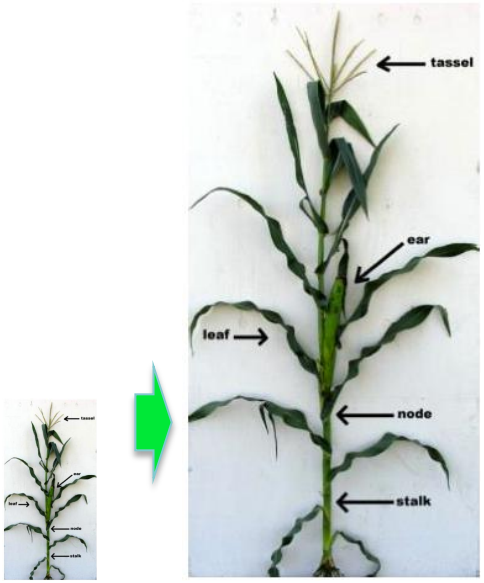


Sigma0 vs Mv (or VWC)

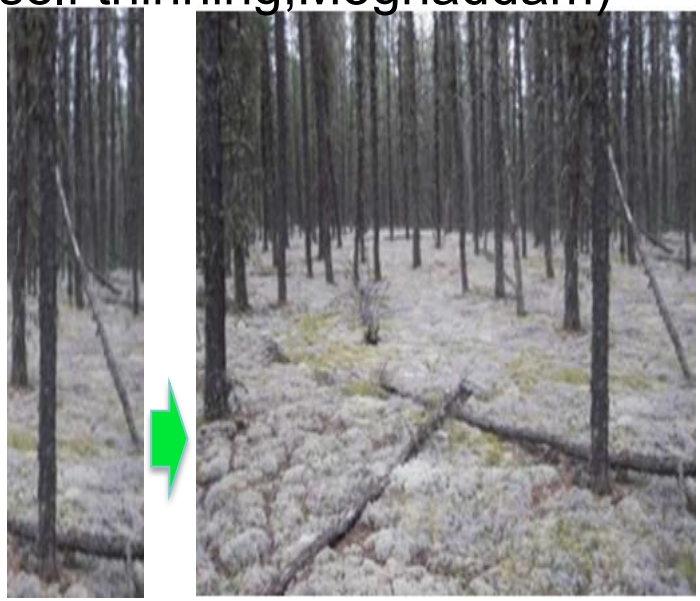


Strategy of Scattering Modeling: Geometric vs. Dielectric Control of VWC

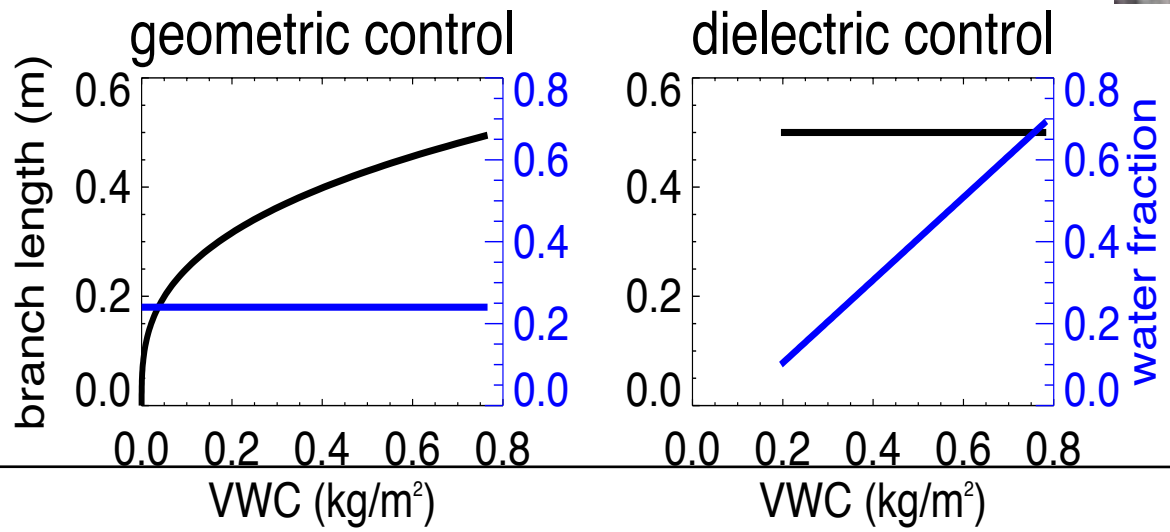
(I) Geometry controls VWC:Crops (Tsang)



(II) Density controls VWC: Forest (self thinning;Moghaddam)

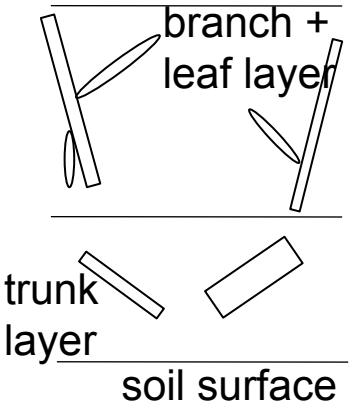


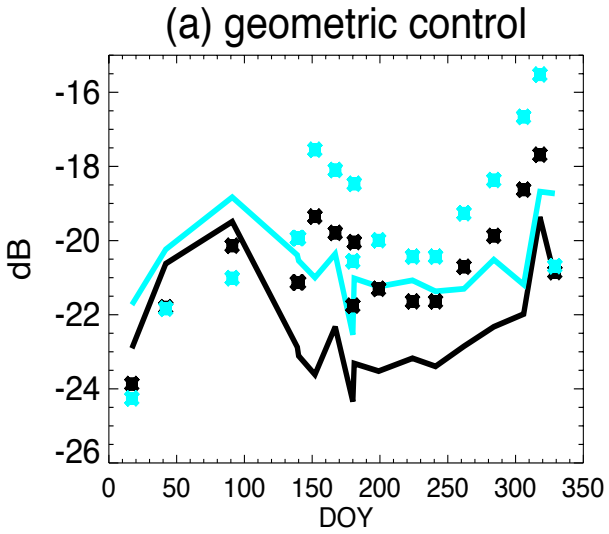
(III) Dielectrics controls VWC

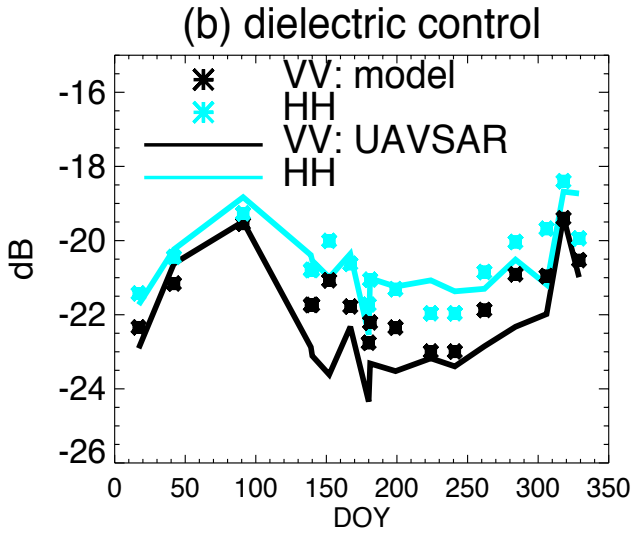


Forward Model Formulation

- DSM (discrete scattering model)
  - Durden/van Zyl (1993), Arii (2009, thesis), Arii et al. (2016)





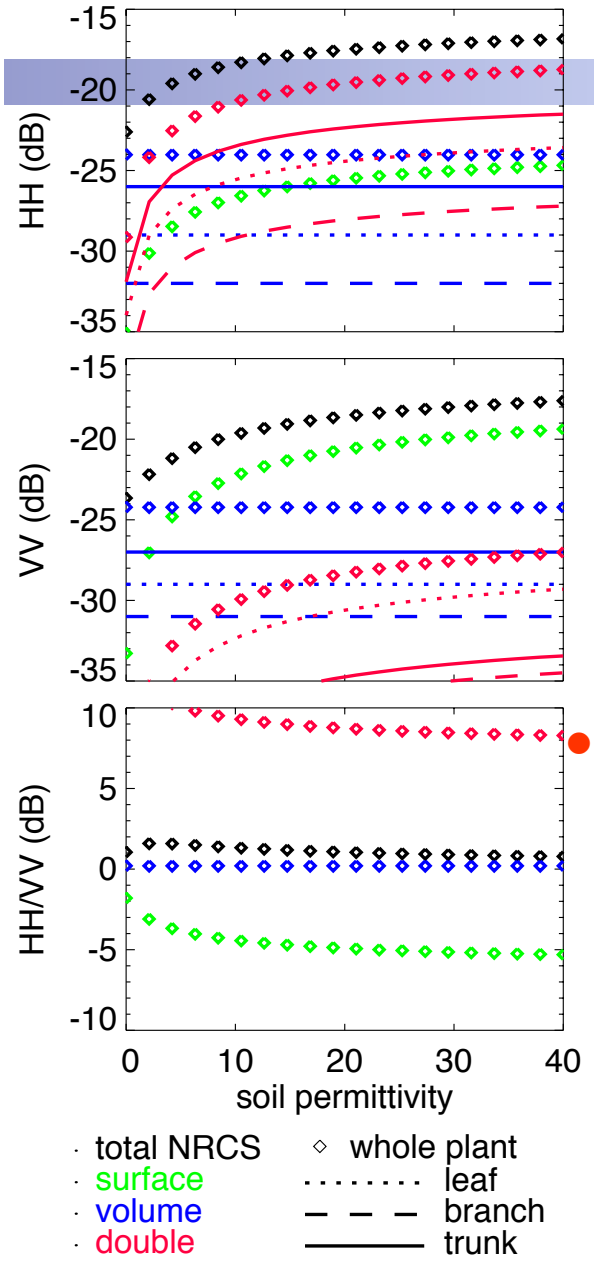


If VWC changes were to be due to plant growth by 1.5 times, it would increase s0 by ~5 dB (= modelled!)

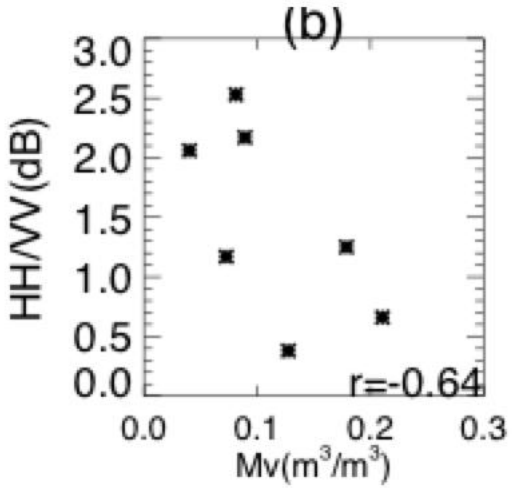
In reality, VWC varies by leaf water fractions. But leaf is insignificant.

When VWC is modelled by changing water fraction in leaf, the model simulates the observation within 0.8 dB over the entire seasons/multi-years

Modelled Mechanisms

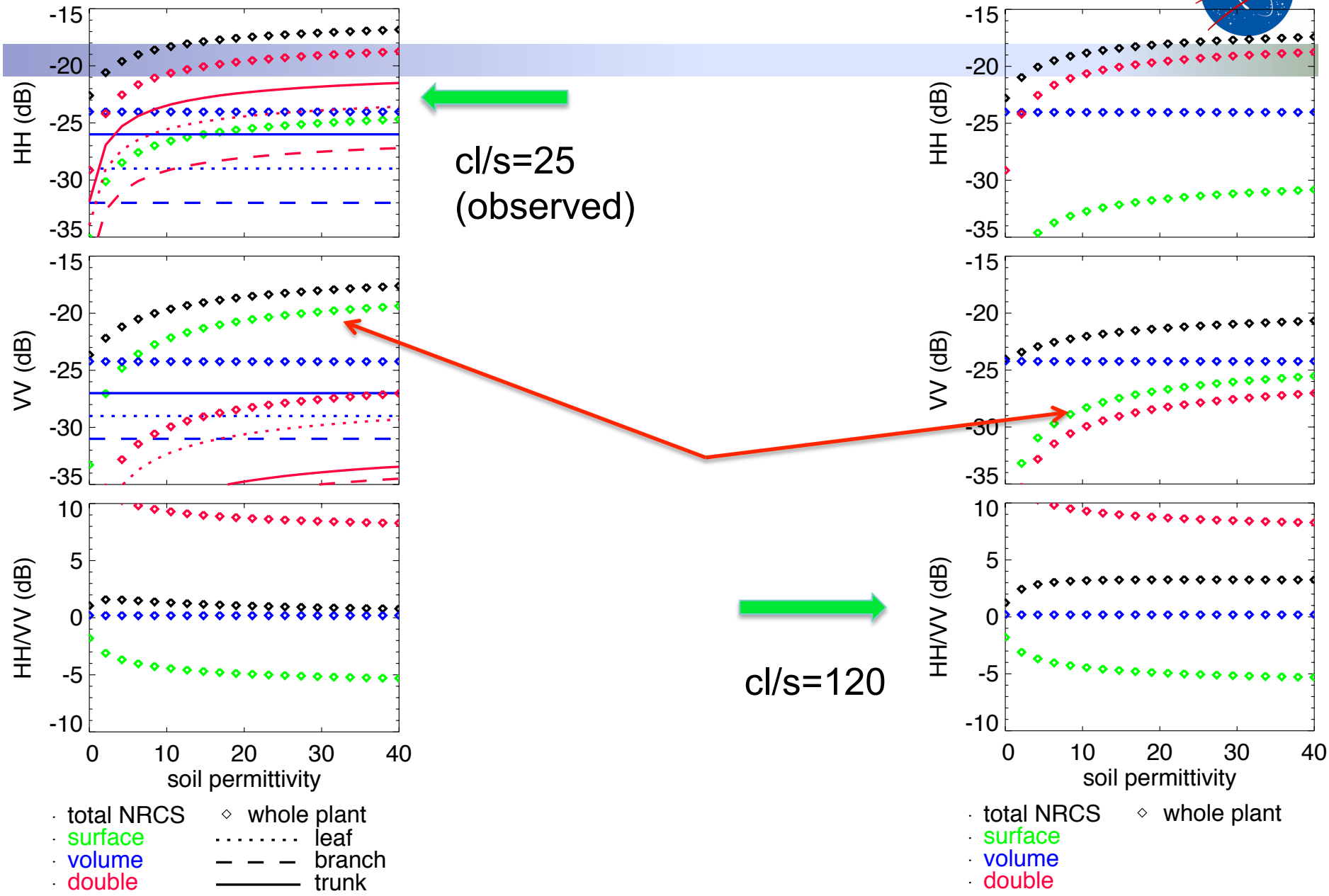


- Total HH is due to double bounce and by trunk
  - responding to soil moisture
- Total VV is due to surface scattering
  - Leaf (dots) contributons are always minor
- HH/VV decreaseas as SM increases.
  - signature of soil surface

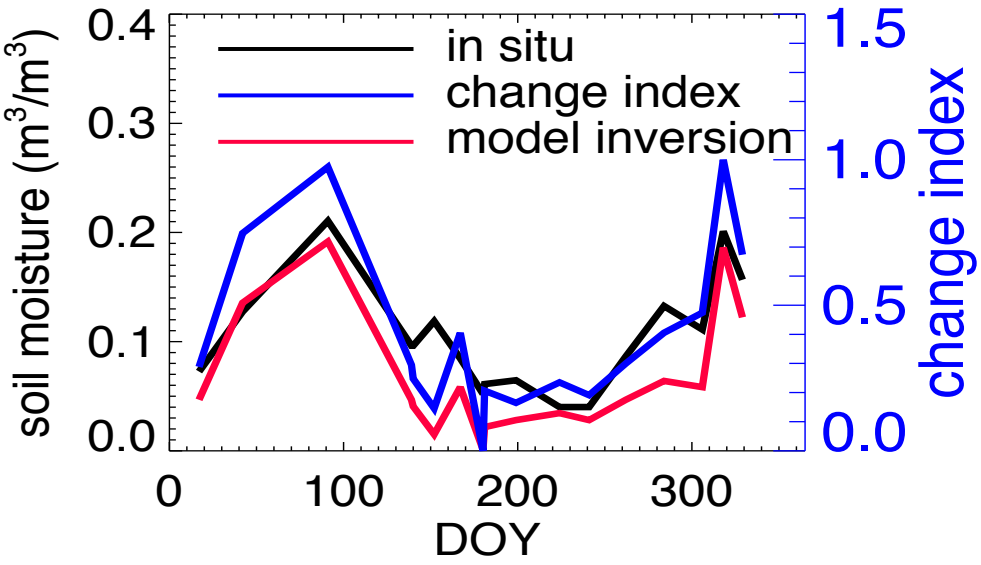


- **HH > VV → vegetation has strong effect**
- **HH (and VV) correlates with soil moisture through double bounce (surface)**

Modelled Mechanisms



Retrieval



- Datacube time-series retrieval:
  - Ub-rmse = 0.025 m3/m3, meane = 0.04 m3/m3, correlation 0.86
- Change index
  - Correlation: 0.89

Summary

- Shrubland L-UAVSAR simga0 varied by 3 dB seasonally and
  - Correlated strongly with soil moisture (despite VWC changes)

- Modelling was
  - Successfully when VWC is controlled by leaf dielectric
  - Not well when VWC changes by geometry

- S0 changes were due to soil moisture changes (leaf VWC insignificant)
  - Double bounce (HH) and surface scattering (VV) are major terms
  - HH/VV decreases with soil moisture (consistent with data)

- Retrieval
  - ub-rmse = 0.025 m3/m3, meane = 0.04 m3/m3, correlation 0.86

- Continued demo that
  - forward modeling is successful
  - the time-series datacube retrieval works.

[S. Kim, M. Arii, T. Jackson, Modeling L-band synthetic aperture radar data through dielectric changes in soil moisture and vegetation over shrublands, J. Selected Topics Applied Earth Obs. Remote Sensing, DOI: 10.1109/JSTARS.2017.2741497, 2017]