

Passive L Band Measurements of Forest Biomass

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Motivation/Outline

- Hydros – L band passive/active sensor scheduled for 2009
- Can Hydros be used to measure biomass?
- If so
 - What is the sensitivity?
 - What are the effects of heterogeneity?
- Outline
 - Experiment at Waverly
 - Modeling
 - Heterogeneity

ESTAR

Frequency : L-band (1.4 GHz)

Polarization : Horizontal

Imaging

Along Track : Real Aperature

Cross Track : Synthetic Aperature

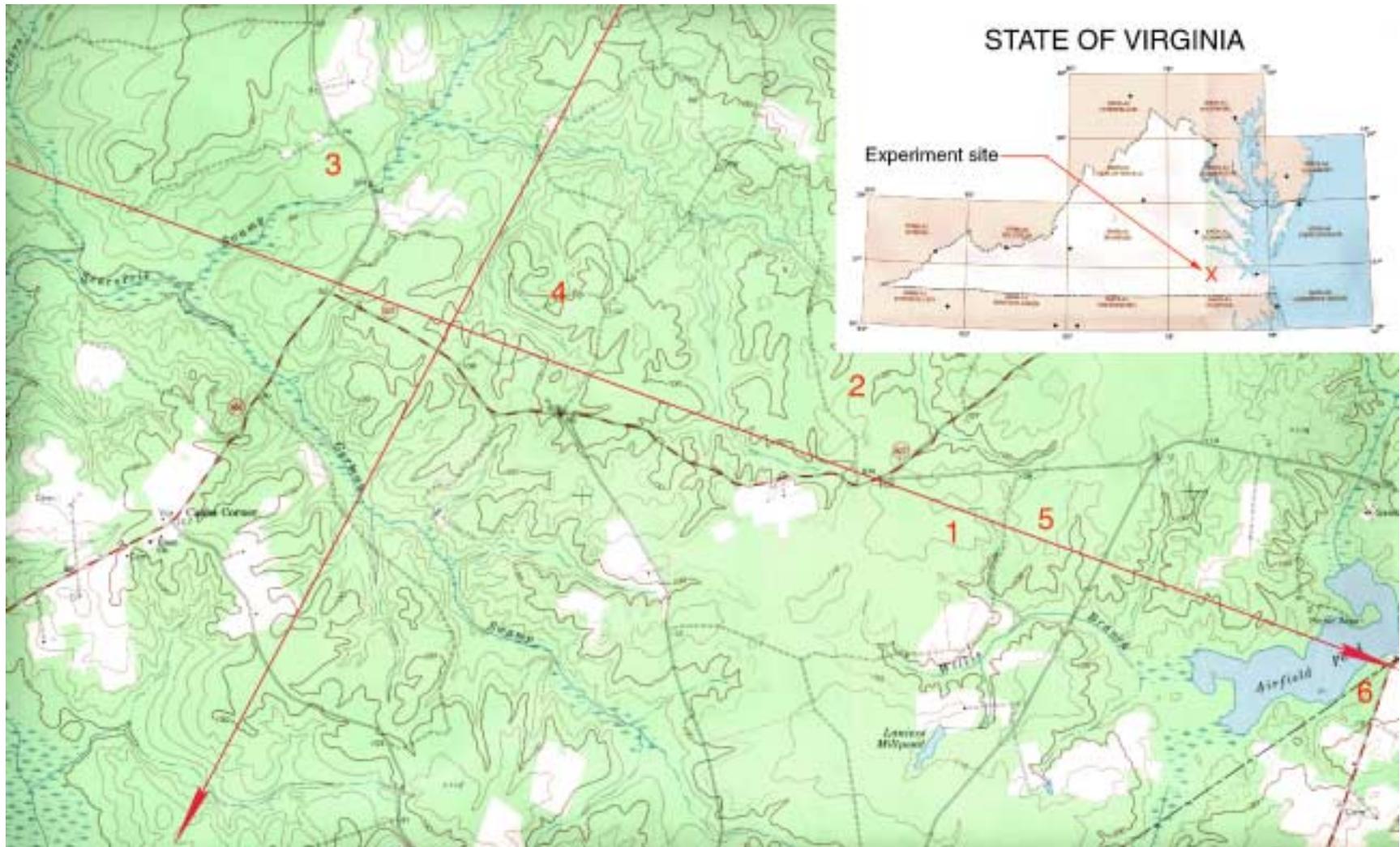
Sensitivity : 0.5 K

Resolution : ± 4 degrees (nadir)

Site Description

- Location : South Eastern Virginia
- Forest Region : Loblolly Pine, owned by International Paper
- Stands : Uniform on mostly flat ground, 1-2 km on one side
- Stand Age : Varies from 2-40 years with some older sites

Topographic Map of Waverly Site



Sites of various ages in Waverly



Two year old trees at site # 1



Seven year old trees at site # 2

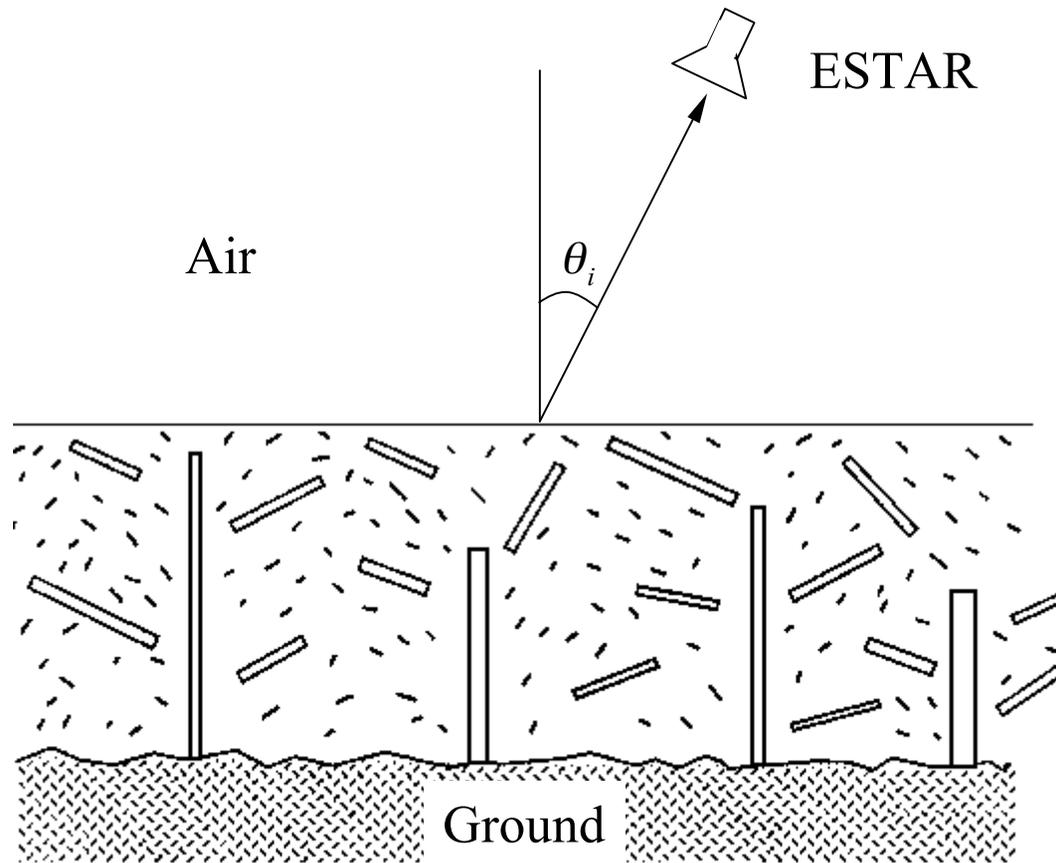


Eighteen year old trees at site # 5



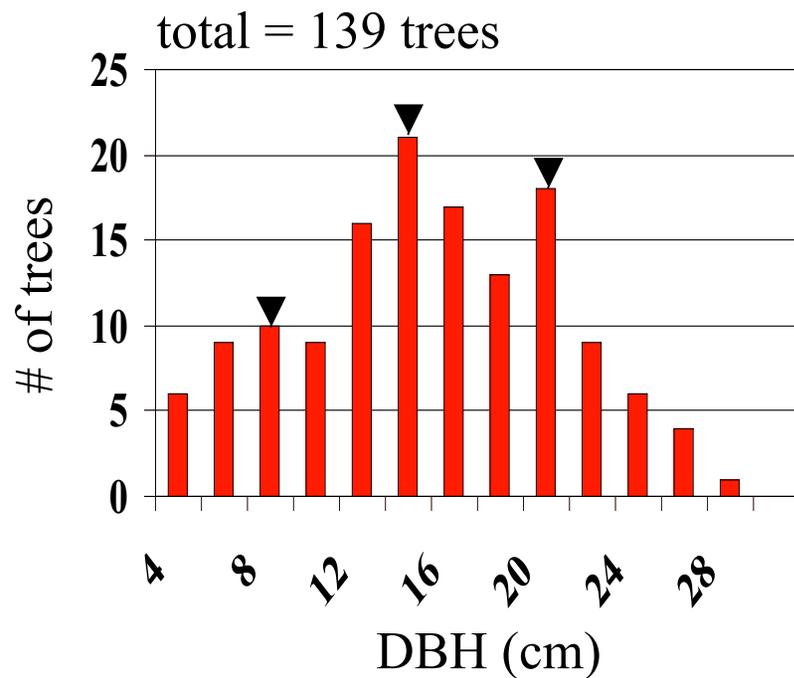
Huge old trees at site # 6

Forest Model

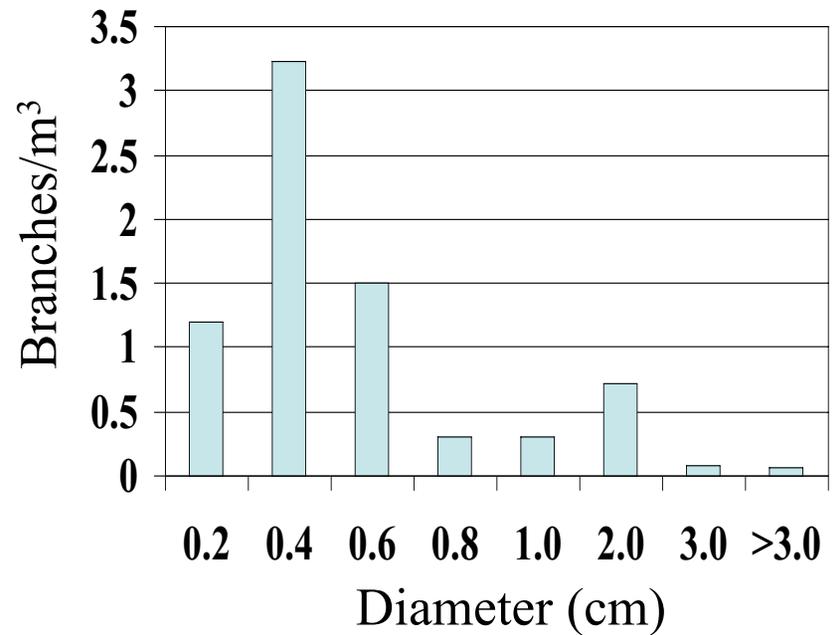


Tree Architecture

DBH Distribution



Branch Distribution

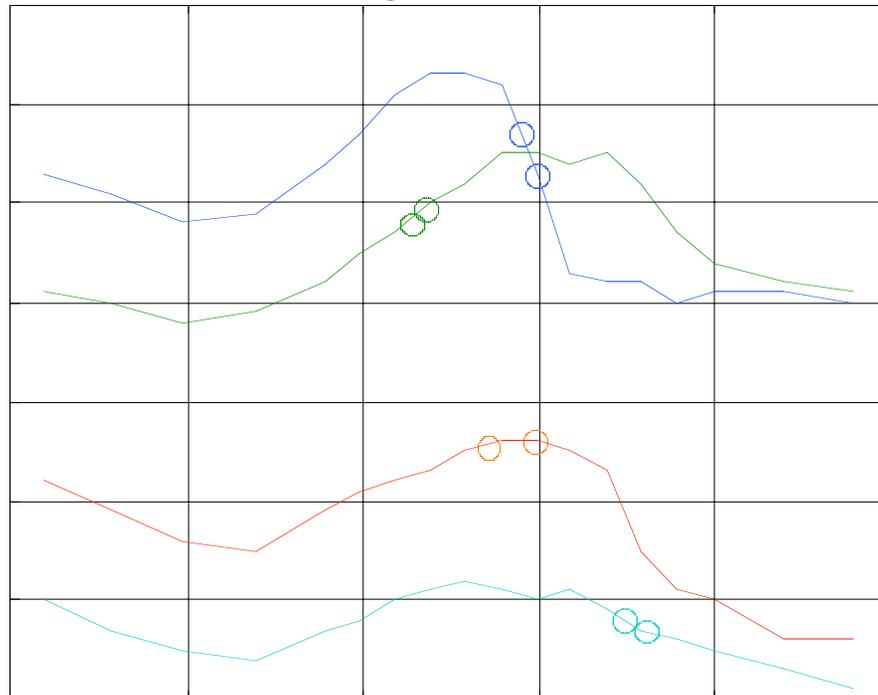


- Average stem density = 0.186 stems/m²

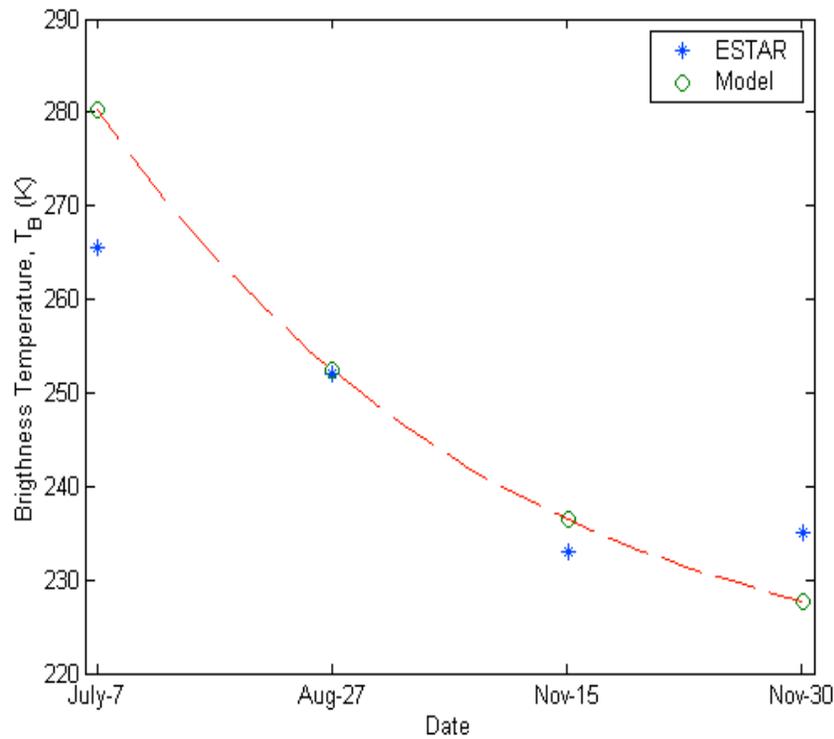
Wakefield Temperature History on the Dates of Flights in 1999

051015202530405060708090100TIME: Local time, hours July 7 Aug 2

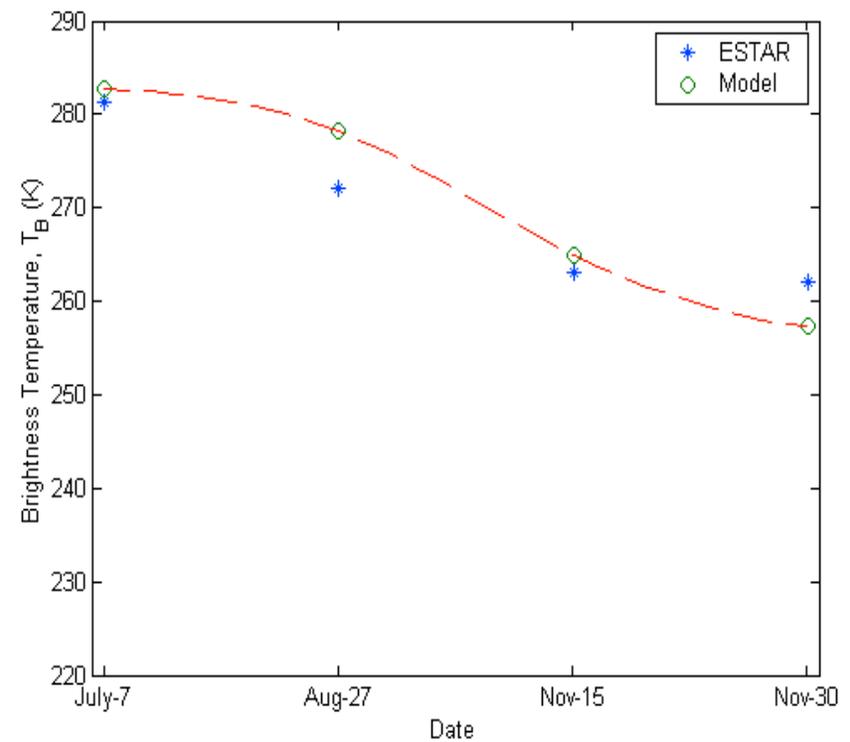
circles = time of flights



Comparison of ESTAR Data and Model Results



APR Site



APM Site

Hydros



Instruments: L band active/passive with shared 6-m rotating antenna

Polarization: H, V, U (radiometer) HH, VV, HV (radar)

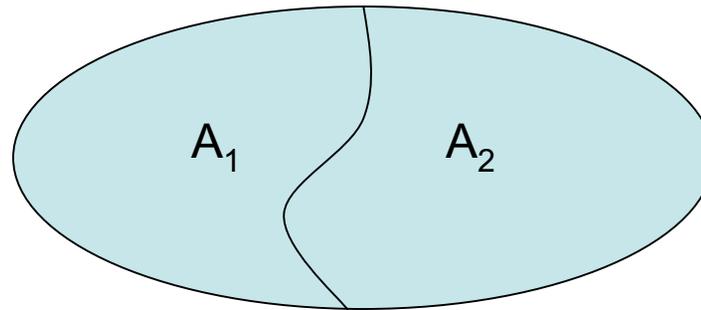
Accuracy: 0.5 dB (radar), 1 K (radiometer)

Resolution: 3 km (radar), 40 km (radiometer)

Orbit: 6 am/pm sun-synch at 670 km; wide swath (1000 km) at constant

look angle of 39° Revisit: 2-3 days (mid-lat.), 1-2 days (polar)

Heterogeneous Patch Illumination



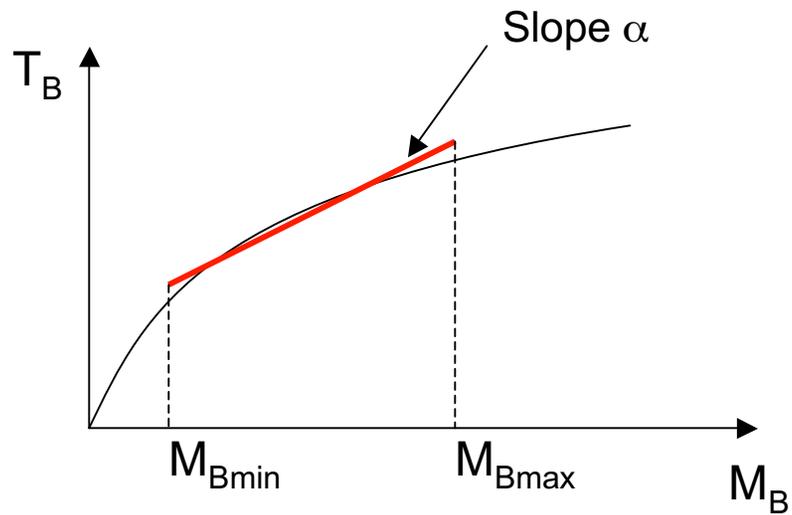
$\langle \rangle$ ————— - Average Brightness Temperature

$\ggg \langle \rangle$ —————

- Biomass

$\langle \rangle \langle \rangle$

Heterogeneous -Nonlinear

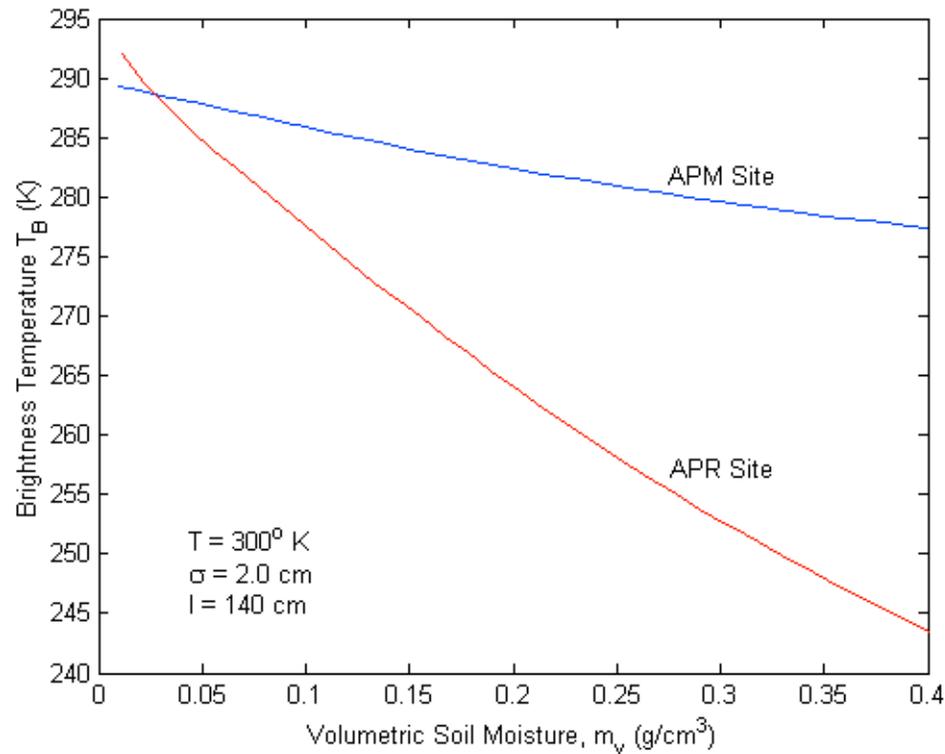


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Conclusions

- Passive L band microwave has potential to measure average biomass.
- Hydros, Aquarius and SMOS are future passive L band satellites (2007-2009).
- Develop potential of these satellites to measure biomass of forests globally.
- Explore synergism between lidar and passive L band to measure forest biomass more accurately.

Brightness Temperature vs. Soil Moisture for Fixed Physical Temperature



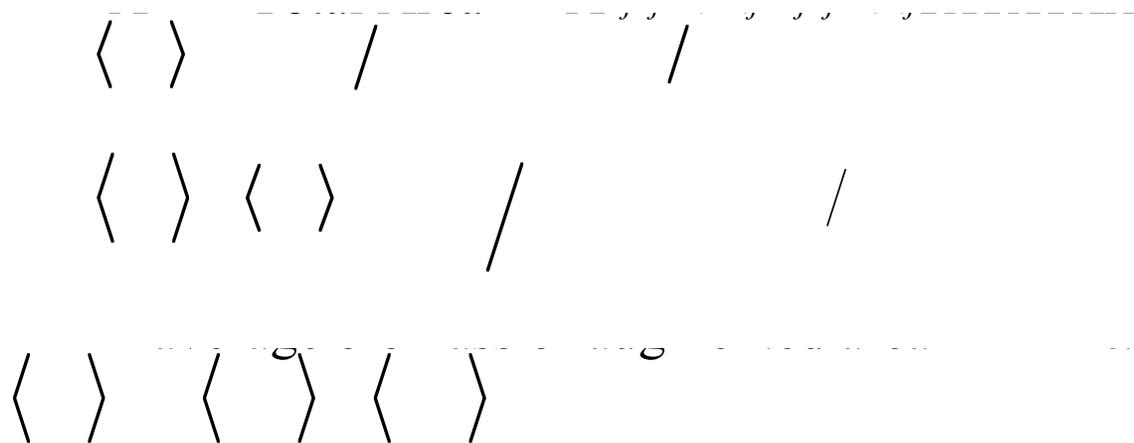
$$T_B = T_B(T, m_v)$$

- T_B varies approximately 10°K for APM site and 50°K for APR site as soil moisture changes from wet to dry.

Heterogeneous Patch

T_B Known for Subpatch

- Assume subpatch of area A_j and T_{Bj}
- Subtract out its effect
- Obtain augmented Brightness Temperature



Example: Water Bodies of known temperature and extent