

# JPL CCS workshop: Science of 10-km L-band Radiometry

October 10-12, 2023 | JPL Room 180-101 & WebEx

**JPL Organizer:** Andreas Colliander

[Topical Agenda](#) (PDF - updated 09/5/2023)

Current State of L-band Radiometry (15 mins)

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# Lessons-Learned from SMOS and SMAP



1. science justification vs. realized science
2. applications justification vs. realized applications
3. lessons-learned and future requirements
  - RFI
  - algorithms
4. dimensions and directions for follow-on
5. community for future L-band radiometry and mission concepts

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# Science and Application Justification

## SMOS

1. further our knowledge of the water cycle
2. exchange of water between the oceans, the atmosphere and the land
3. helping to improve weather and climate models

## SMAP

1. understand processes that link the terrestrial water, energy and carbon cycles
2. estimate global water and energy fluxes at the land surface;
3. quantify net carbon flux in boreal landscapes
4. enhance weather and climate forecast skill
5. develop improved flood prediction and drought monitoring capability.

# Science Realized

Between SMAP and SMOS >4000 journal papers

Delivered on observations-based benchmarks for:

1. the link between the Earth system cycles: Over land soil water-deficit as a rate-limiting factor
2. the coupling of surface moisture deficit and boundary-layer temperature and humidity, static stability of the lower atmosphere
3. soil water dynamics properties from space: thresholds marking water and energy balance regime transitions
4. salinity climatology + salinity dynamics at freshwater fronts, below tropical cyclones, dynamical coastal interactions
5. all-weather vegetation sensing for above-ground biomass dynamics, water movement in the soil-plant-atmosphere continuum, fire and disease disturbances
6. land ice water content and sea ice edge thickness

# Science Not Realized



1. freeze/thaw as the on/off switch of the boreal carbon cycle
2. link of P-E over land and E-P over oceans
3. acceleration of the water cycle

# Applications Realized



1. link to drought severity categorizations (with caveat)
2. demonstration of NWP impact on surface air temperature and humidity
3. forest fires
4. all-weather inundation monitoring

# Applications Not Realized



1. NWP bent-pipe
2. operational hydrology



# The Why for the Not Realized\*

1. duration of data record and cost of transition to possibly experimental data set?
2. spatial resolution?
3. temporal refresh?
4. accuracy?
5. sampling representativeness?

\*institutional reasons not topic for discussion here

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# Lessons-Learned from SMOS and SMAP

1. RFI is dynamic
2. RFI is a use-it-or-lose-it proposition for L-band
3. 0-th order radiative transfer equation (RTE)  $\tau - \omega$  is inadequate

Major sources of error that can be remedied with new mission design:

1. RTE does not capture gaps: $\lambda$
2. vegetation  
$$\tau = (\kappa_a + \kappa_s) \cdot d \quad \text{and} \quad \omega = \frac{\kappa_s}{\kappa_a + \kappa_s}$$
3. vegetation properties from microwave, not optical
4. simultaneous all-weather surface physical temperature

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# Future Envelope

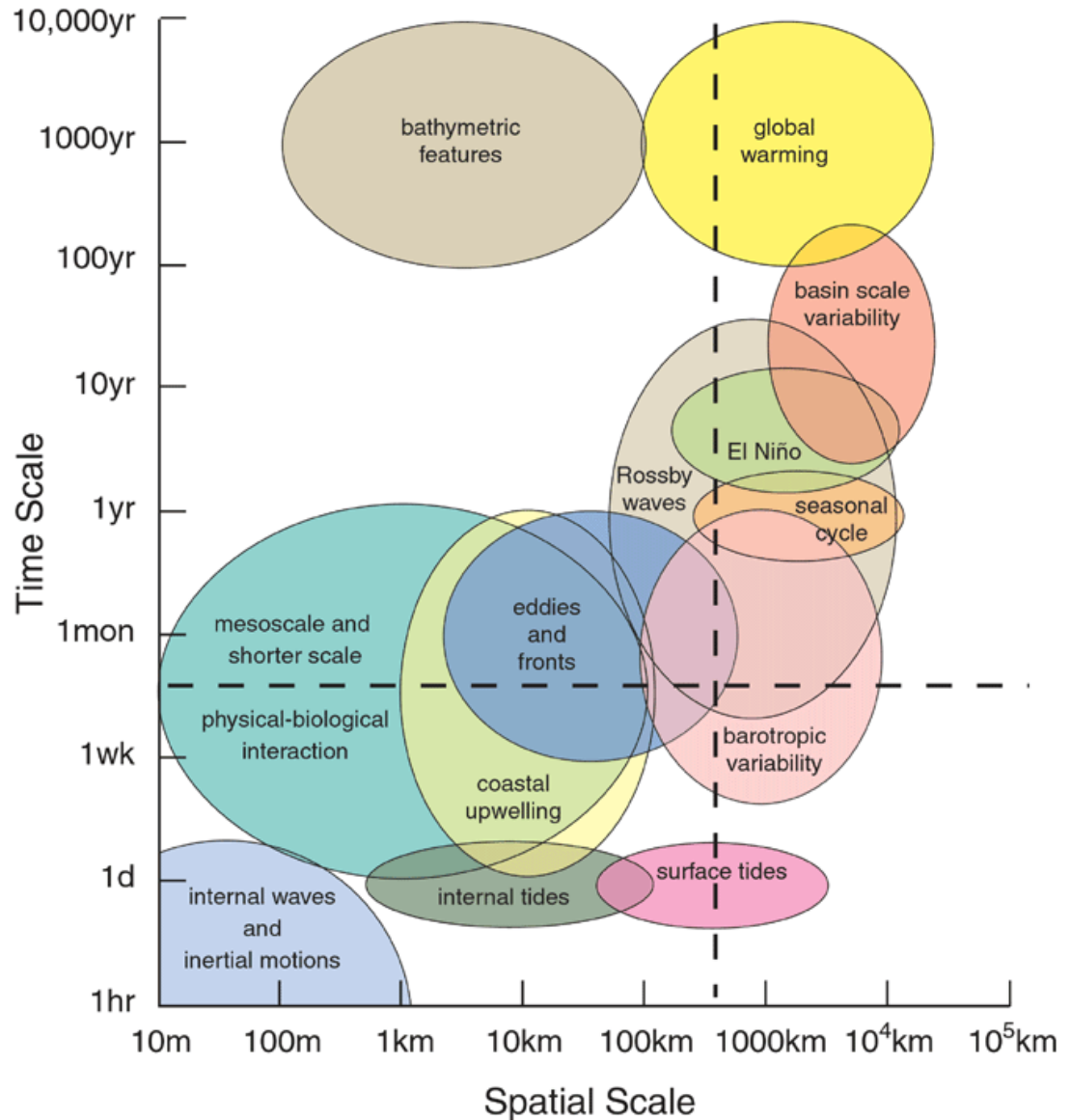
## The Why for the Not Realized\*

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Need to scientifically demonstrate that the next mission outperforms in a direction that crosses a scientific boundary

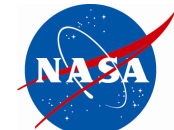
# Scientifically Demonstrate a Boundary Crossing

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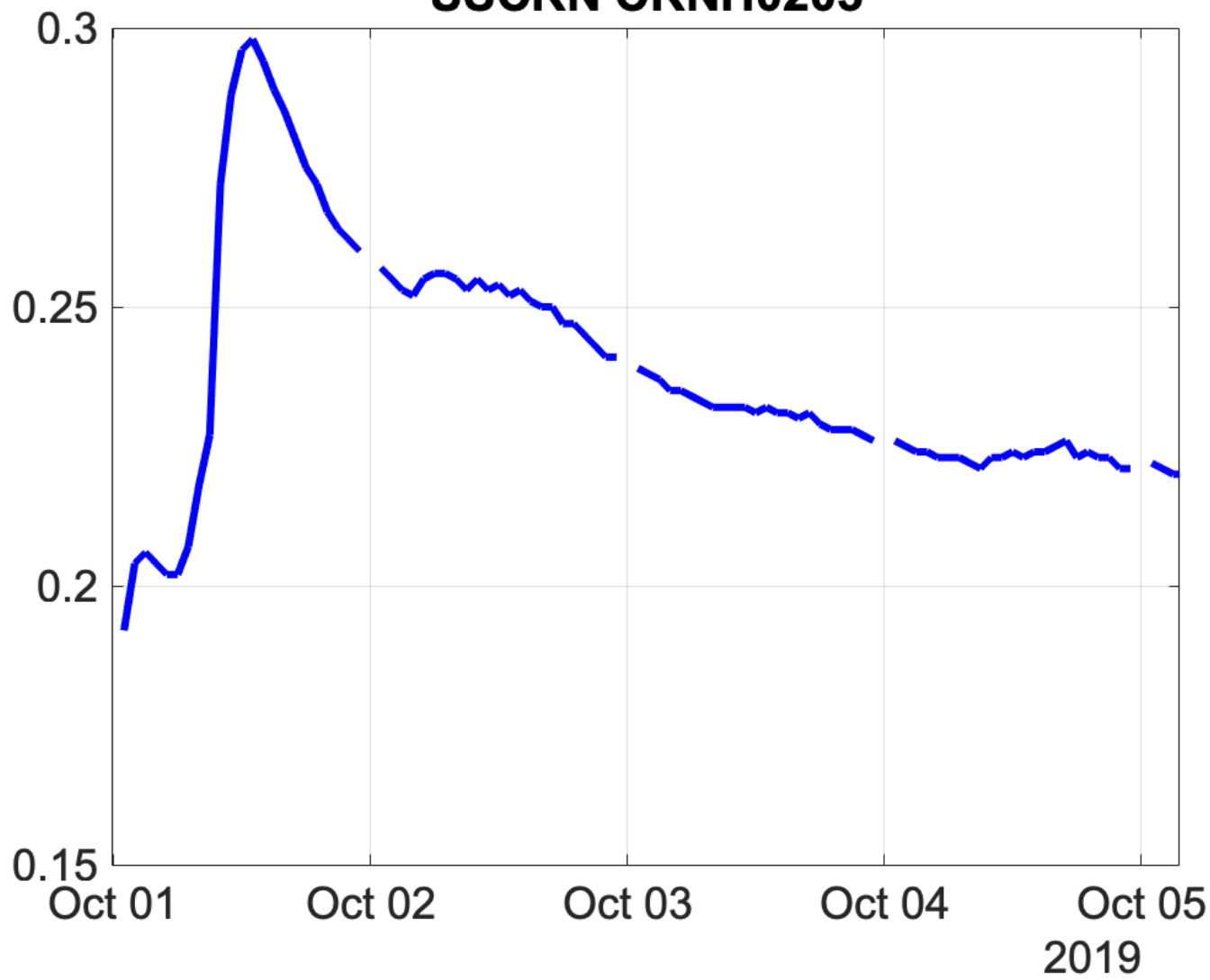




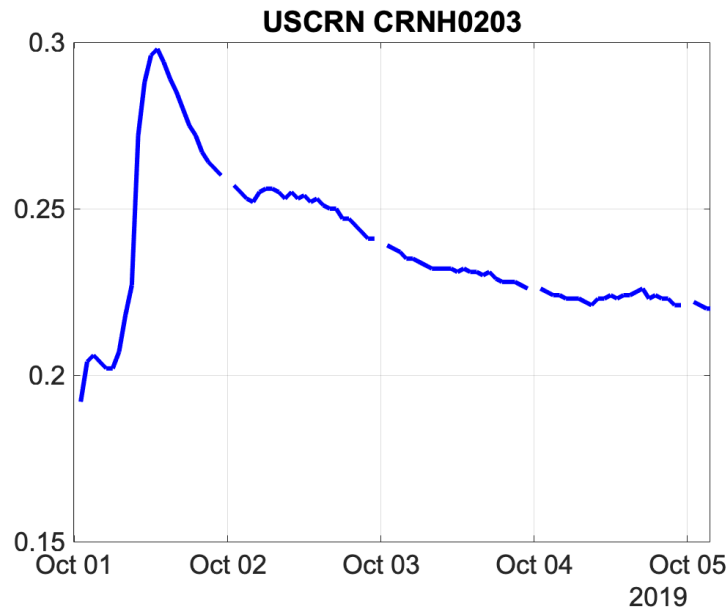
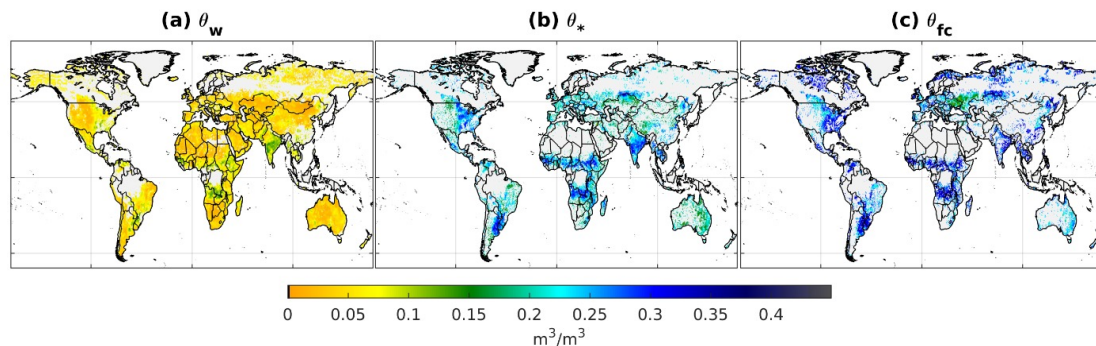
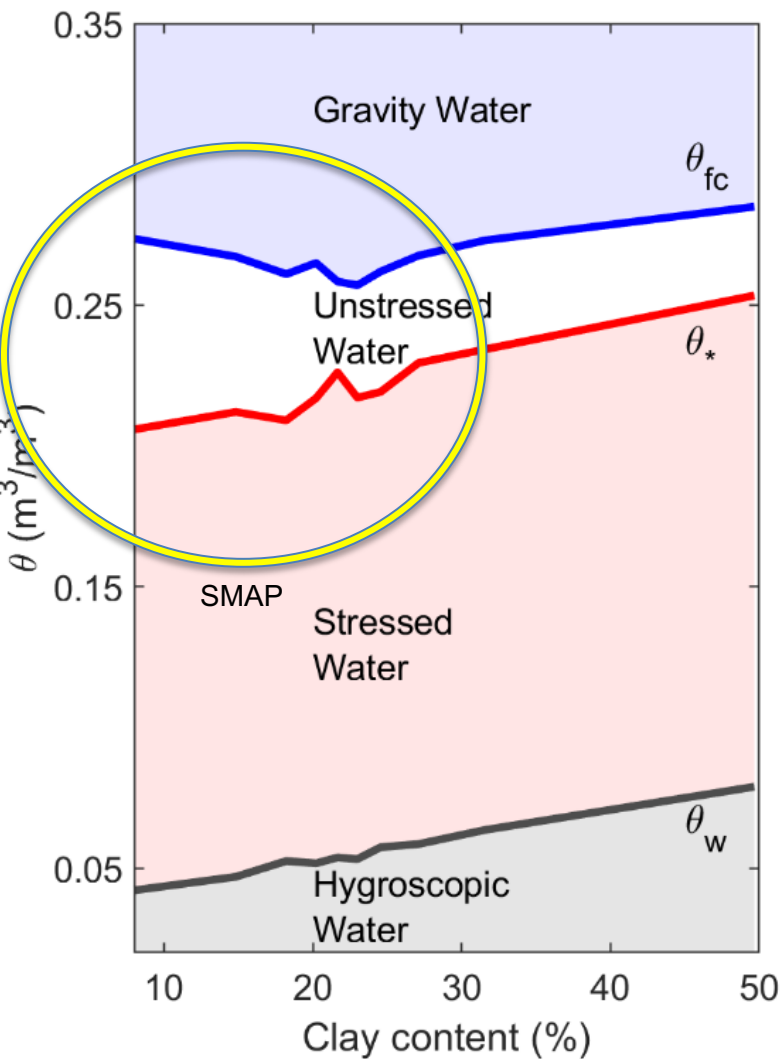
# Drainage to Field Capacity



## USCRN CRNH0203



# Critical (Threshold) Soil Moisture Levels





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# Summary



1. need to form community around the observable, not the mission concept
2. trying to inch ahead by criticizing or faulting the other mission is
3. need to define precise roadmap for addressing the missed science objectives
4. research-to-operations and operational users are not (never been) adequate justification