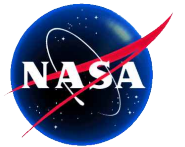


# AirMOSS

Airborne Microwave Observatory of Subcanopy & Subsurface Mission



## SMAP Cal/Val Workshop November 14, 2012

Mahta Moghaddam (PI, U of MI)

Yunling Lou (PM, JPL)

**Science Team (in alphabetical order):**

Wade Crow (USDA), Richard Cuenca (NSF/OSU)

Dara Entekhabi (MIT), Tony Freeman (JPL), Scott Henlsey (JPL)

Dave Hollinger (Collaborator, USDA/UNH), Paul Moorcroft (Harvard)

Rolf Reichle (GSFC), Sassan Saatchi (JPL)

Paul Shepson (Purdue), Steve Wofsy (Collaborator, Harvard)



USC University of  
Southern California





# Science Objectives



## High-level Objective:

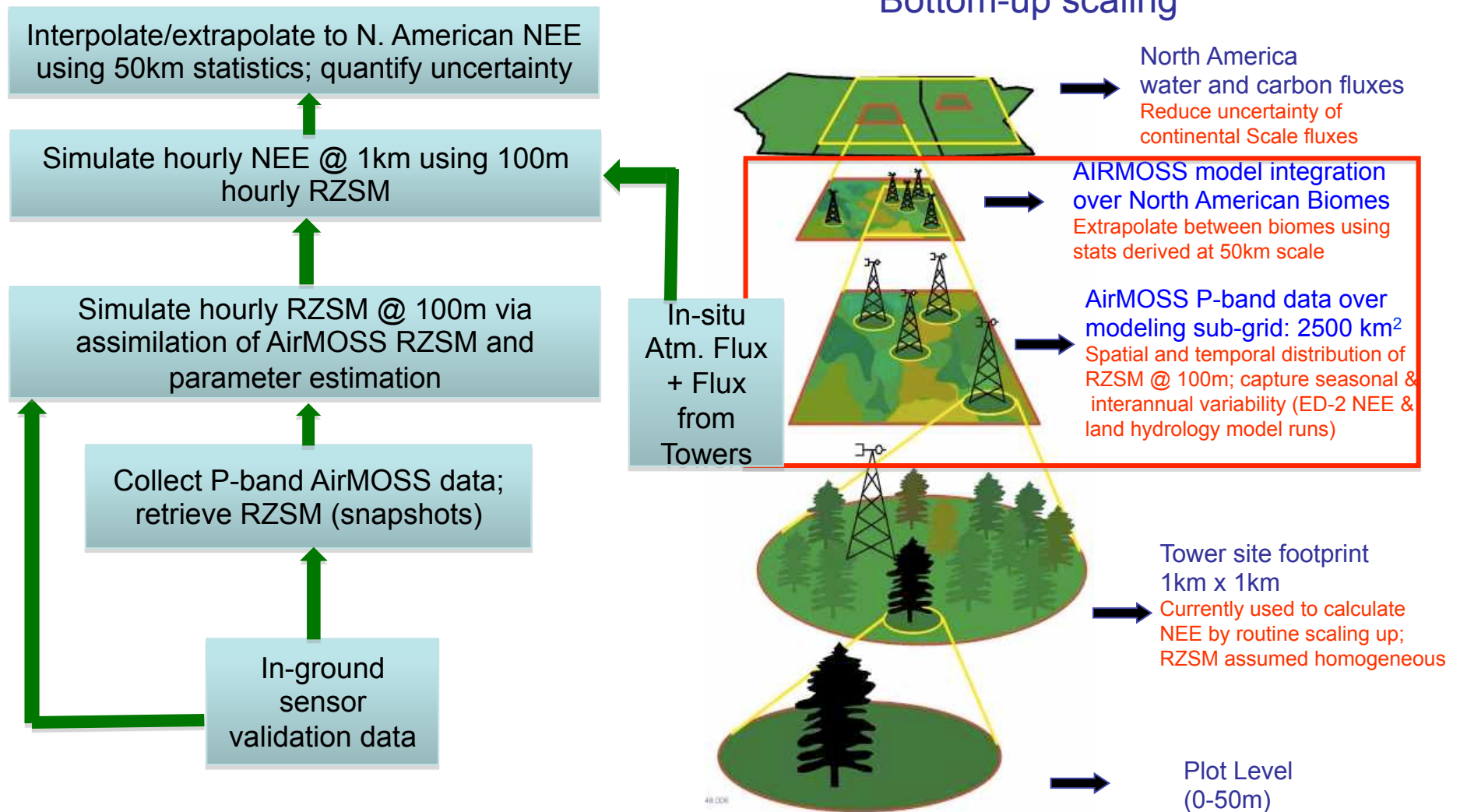
- Provide a new net ecosystem exchange (NEE) estimate for North America with a reduced uncertainty

## Specific Objectives:

- Provide high-resolution observations of RZSM over regions representative of the major North American biomes
- Quantify the impact of RZSM on the estimation of regional carbon fluxes
- Upscale the reduced-uncertainty estimates of regional carbon fluxes to the continental scale of North America

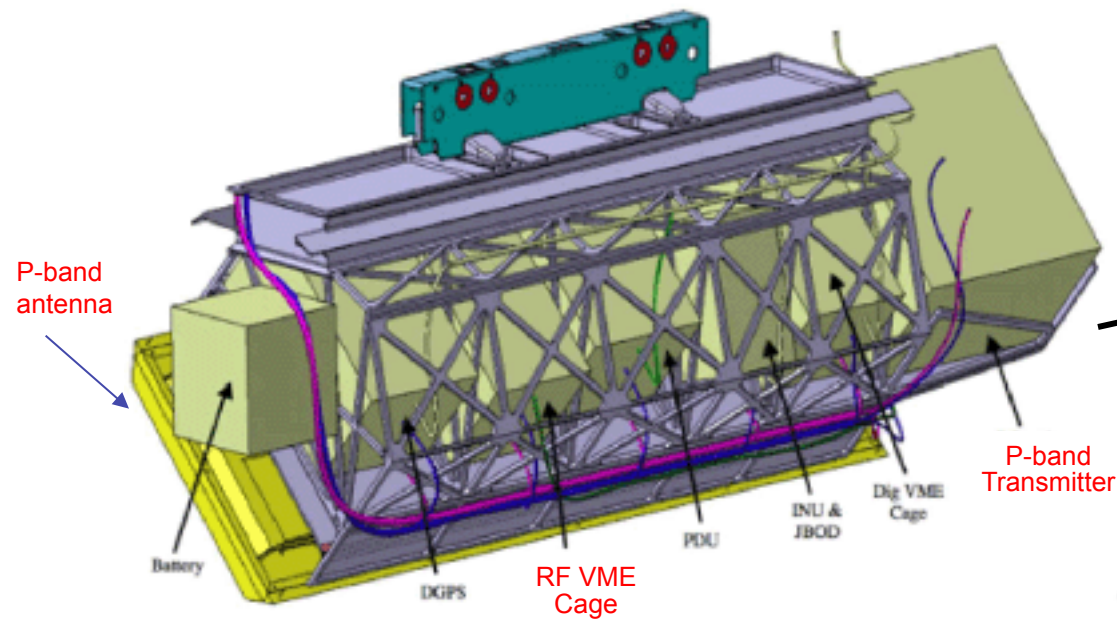


# Approach





# P-band Radar



Radar instrument is contained within a pod attached to a Gulfstream 3 aircraft





# North American Biomes to Cover



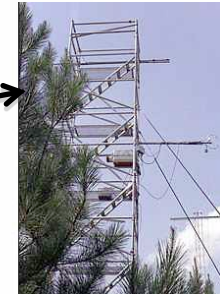
Biome IV



Biome I



Biome III



Biome II



Biome IX



Biome VI



Biome VII

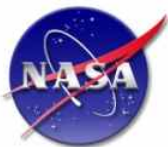


Biome V



Biome VIII





# AirMOSS Flight Sites



	Name and Location	Biome Type / IGBP veg class
1	BERMS, Saskatchewan, Canada	Boreal forest/ conifer, mixed
2	Howland and Harvard Forests, ME/MA	Boreal transitional/ mixed
3	Duke Forest, NC	Temperate forest/ mixed
4	Metolius, OR	Temperate forest/ conifer
5	Marena (MOISST site), OK	Temperate grassland/ crops
6	Tonzi Ranch, CA	Medit. Forest/ Woody Savanna
7	Walnut Gulch, AZ	Desert & shrub/ open shrubland
8	Chamela, Mexico	Subtropical dry forest/ woody savanna, deciduous, crops
9	La Selva, Costa Rica	Tropical moist forest/ broadleaf, crops



# Baseline and Threshold Missions (1)



- Baseline mission:
  - 9 Biomes
  - Up to 3 Seasons/year depending on biome type (Fall 2012 – Fall 2015)
  - 3 Years
  - Mission will provide capability for further reduction of uncertainty through sustained longer-term measurements and for other ecosystems globally
- Threshold mission:
  - 3 Biomes
  - 3 Seasons/year
  - 2 Years
  - Mission will provide capability for further reduction of uncertainty through sustained longer-term measurements and for other ecosystems globally



# AirMOSS Data Products and Latencies



Product Name	Product Description	Latency (Acquisition + )
L1-S0	Level 1 polarimetric backscattering coefficient (sigma-0), multilook complex, polarimetrically calibrated, 100 m resolution, georeferenced	45 days
L2/3-RZSM	Level 2/3 RZSM, daily composite, 100 m resolution, Earth grid	3 months
L4-RZSM	Level 4 assimilated RZSM, 100 m–1000 m spatial resolution, hourly temporal resolution, Earth grid	6 months
L4A-NEE	Level 4 modeled NEE, 1 km spatial resolution over each biome's coverage, Earth grid	6 months
L4B-NEE	Level 4 modeled NEE, 50 km spatial resolution N. America, up-scaled from L4A-NEE	Closeout
L2-Precip	Precipitation measurements	2 months
L2-IGSM	In-Ground soil sensor measurements	2 months
L2-CFlux	Atmospheric tracer flux measurements	Closeout





# Relevance to SMAP



- AirMOSS baseline mission will have ~ 10 months of overlap with SMAP: last flights scheduled for August 2015
- Will provide in-situ soil moisture profiles at 10 sites
- Will provide field campaign data ( $m_v$  and veg) during most flights
- Will provide 25km x 100 km domains of high-resolution (100m) RZSM products at 10 sites
- Data and products can help with scaling analyses and with validation of L2 and L4 products
- Provides opportunity for two-frequency radar retrievals
- Contribution will not be limited to nominal AirMOSS mission window; can continue underflights and algorithm evaluations



# State of the Mission

## (1) Flight Instrument



- P-band Radar was successfully built; delivered for aircraft integration 08/12
  - 4-month delivery delay due to high-power amplifier (HPA) vendor delay
- Engineering and calibration flights: August - Sept '12 and early Nov '12
  - Compressed schedule
  - First few flights at ~half altitude (22kft) due to HPA pressure leak
  - Pressure line from cabin to pod installed on NASA 992 late September; allowed all subsequent flights at the planned 41kft
  - Radar “worked” on first try; few idiosyncrasies to sort through
- First radar science flight: late Sept '12 over Walnut Gulch, AZ
  - Have flown 20 more science flights since
  - Only a 3-month delay for first science flights; have caught up with baseline now



# State of the Mission

## (2) Ground Instruments



- OSU team has installed 3 sensor profiles at 5 sites, 6<sup>th</sup> site pending
  - Metolius
  - Duke forest
  - Harvard forest
  - BERMS
  - Tonzi ranch
  - Chamela: pending re-ship of equipment and customs clearance
- Status of other sites:
  - Walnut Gulch: similar high quality data available at two sites (Lucky Hills and Kendall), installed back in 2001-2002 for MOSS IIP; will receive data from USDA/ARS
  - Howland forest: high quality data available; will receive from Dave Hollinger at USDA Forest Service
  - La Selva: soil moisture data available at several points but no profile information
  - MOISST: high quality data available from multiple sensors; will receive from site managers
- Other data sources:
  - COSMOS at Metolius, Walnut Gulch, Howland, Harvard, Tonzi ranch, MOISST



# State of the Mission

## (3) Ground Field Campaigns



- Several teams have been on the ground during flight campaigns
- Walnut Gulch, Arizona:
  - USC: 9/18-9/20, collected vegetation and soil moisture at Lucky Hills, Kendall
  - USC: 10/22-10/24, will be in the field collecting soil moisture at LH, KEN, Empire ranch; vegetation at Empire ranch time permitting; roughness at LH, KEN, Empire ranch
- Howland forest:
  - JPL: 10/14-10/20, collected vegetation and soil moisture at transects in the vicinity of tower site
- Harvard forest:
  - Harvard: 10/15 and 10/18, collected vegetation and soil moisture at transects in the vicinity of tower site
- Metolius:
  - USC: 10/8-10/12, collected vegetation and soil moisture at transects near intermediate pine and young pine tower sites
- MOISST
  - MIT: week of 10/22, collected primarily soil moisture and some vegetation samples at sites around Stillwater and Blackwell, OK, mesonet stations



# Campaign Schedule Already Flown



## October 2012

- Placeholder Flight Dates
- AirMOSS Campaigns

September 2012	October 2012	November 2012
S M T W T F S	S M T W T F S	S M T W T F S
1	1 2 3 4 5 6	1 2 3
2 3 4 5 6 7 8	7 8 9 10 11 12 13	4 5 6 7 8 9 10
9 10 11 12 13 14 15	14 15 16 17 18 19 20	11 12 13 14 15 16 17
16 17 18 19 20 21 22	21 22 23 24 25 26 27	18 19 20 21 22 23 24
23 24 25 26 27 28 29	28 29 30 31	25 26 27 28 29 30
30		

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
30	1	2	3	4	5	6
		BERMS (Saskatchewan) and Metolius (OR) Campaigns				
		OR	Sask			
		Deploy D...to KGTF				
7	8	9	10	11	12	13
BERMS (Saskatchewan) and Metolius (OR) Campaigns						
Sask			OR	Sask	Deploy KGTF to MDT	East-Coa...mpaigns
OR						NC
14	15	16	17	18	19	20
East-Coast Campaigns						
	MA and ME		NC	MA and ME		
21	22	23	24	25	26	27
East-Coast Campaigns						
MA and ME	Deploy to EFD	Walnut Gulch (AZ) and MOISST (OK) campaigns				OK (joint w/L-band)
	NC	AZ (joint w/L-band)	OK (joint w/L-band)			
28	29	30	31	1	2	3
Walnut Gulch (AZ) a...ISST (OK) campaigns		OK	Eng/Cal...osamond	Remove...from 992	Transition to EFD	
	AZ			Eng/Cal...osamond		

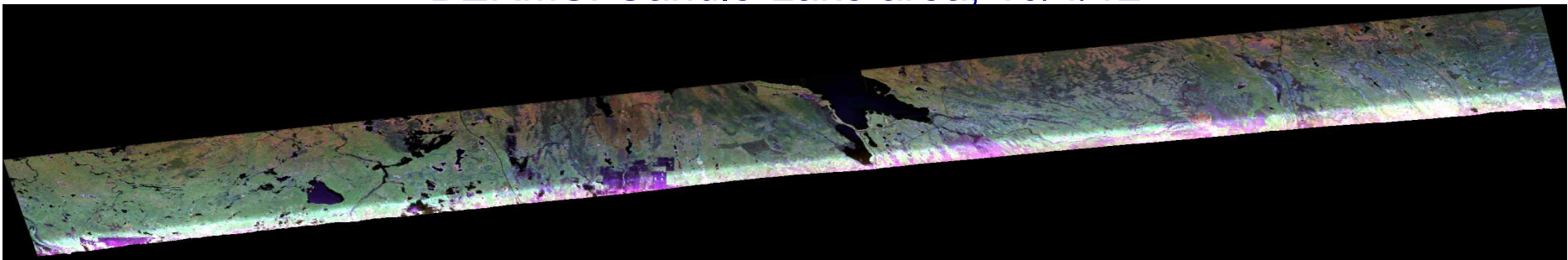




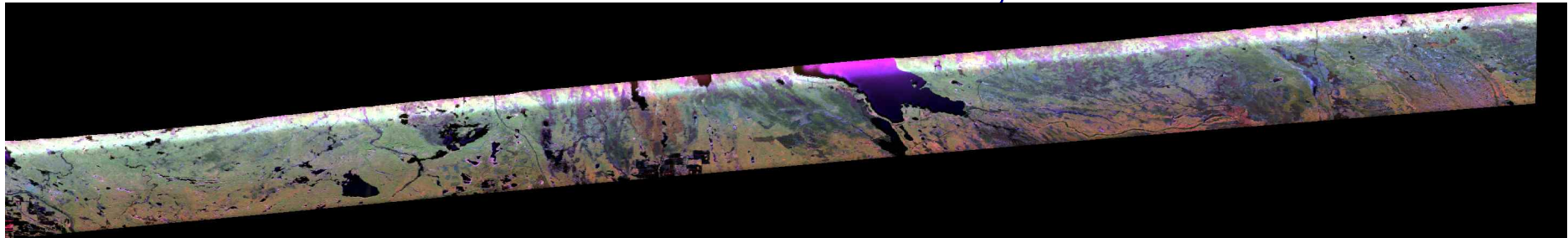
# Sample Preliminary Uncalibrated Images (1)



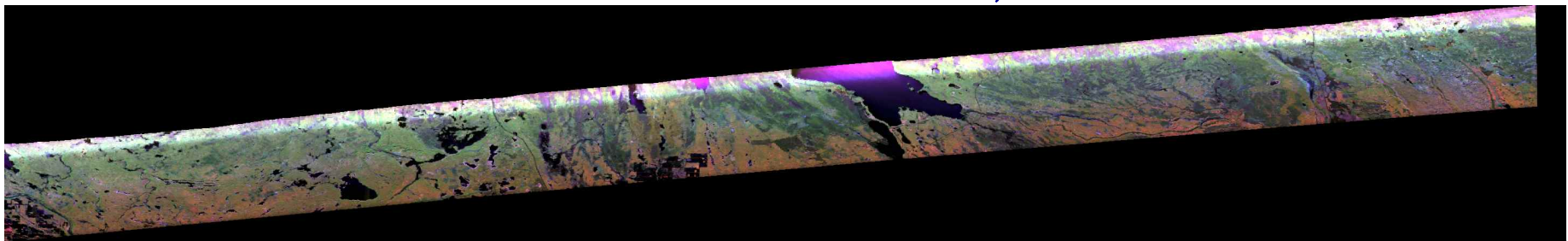
BERMS: Candle-Lake area, 10/4/12



BERMS: Candle-Lake area, 10/7/12



BERMS: Candle-Lake area, 10/11/12

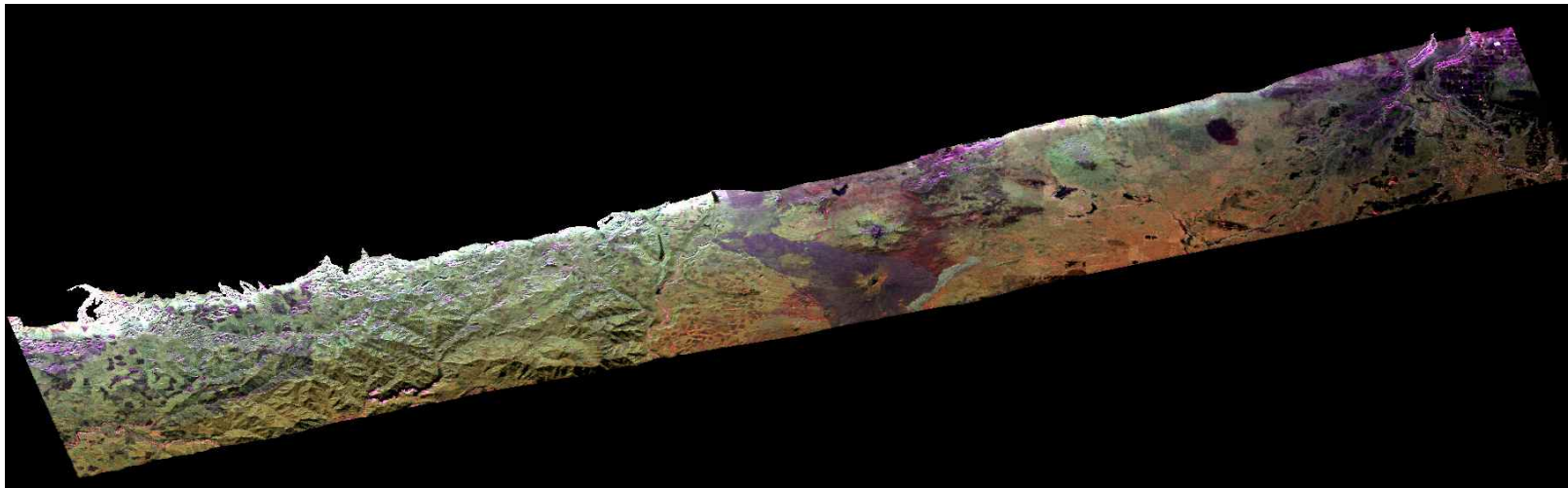




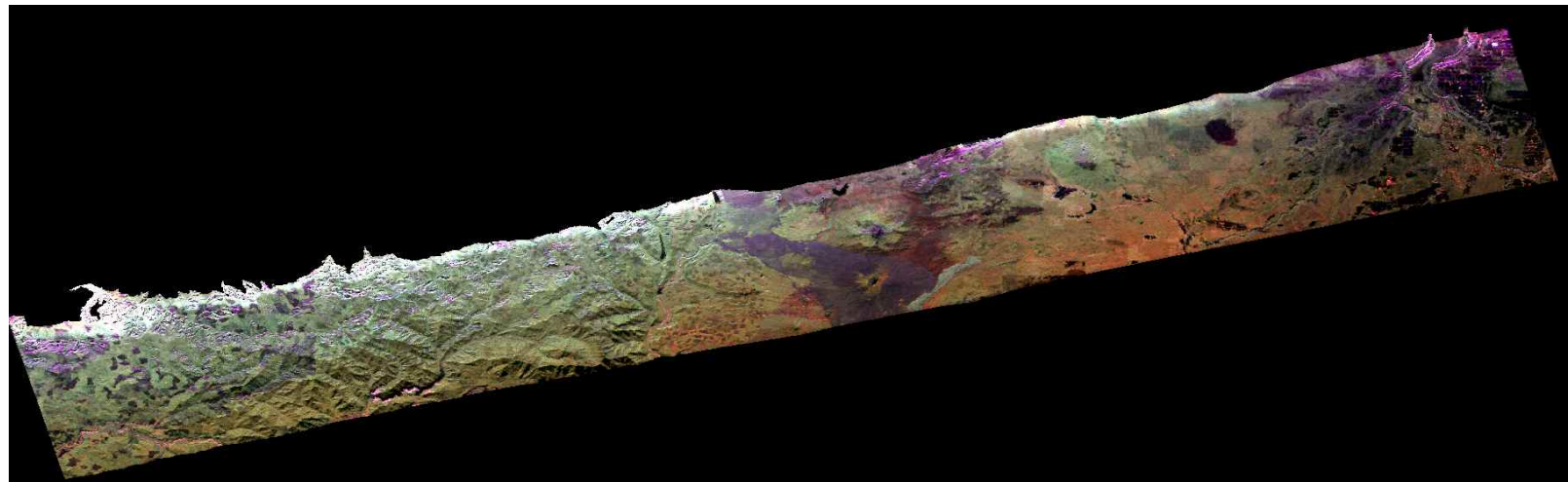
## Sample Preliminary Uncalibrated Images (2)



Metolius: 10/7/12



Metolius: 10/10/12







# Radar Flight Team



At DAOF, 8/21/12



Duke forest, 10/13/12



Duke forest, 10/13/12



MDT, pre flight,  
10/13/12



MDT, after flight, 10/13/12





# AirMOSS 2013 Schedule



## Notional AirMOSS Campaign Schedule

Biome	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tonzi Ranch, CA (2013)												
Tonzi Ranch, CA (2014 and 2015)												
Walnut Gulch, AZ												
ARM/SGP, OK												
Metolius, OR												
BERMS, Saskatchewan												
Howland & Harvard Forests, ME/MA & Duke Forest, NC												
Chamela, Mexico & La Selva, Costa Rica												

Desirable period for science observation  
 Tentative placeholder for flights, which falls in the desirable period  
 Not suitable for science observation  
 G-III not available  
 only in 2013 and 2014 since already had one campaign in 2012  
 Beale compatibility tests at Tonzi ranch

Will repeat largely the same schedule in 2014 and 2015