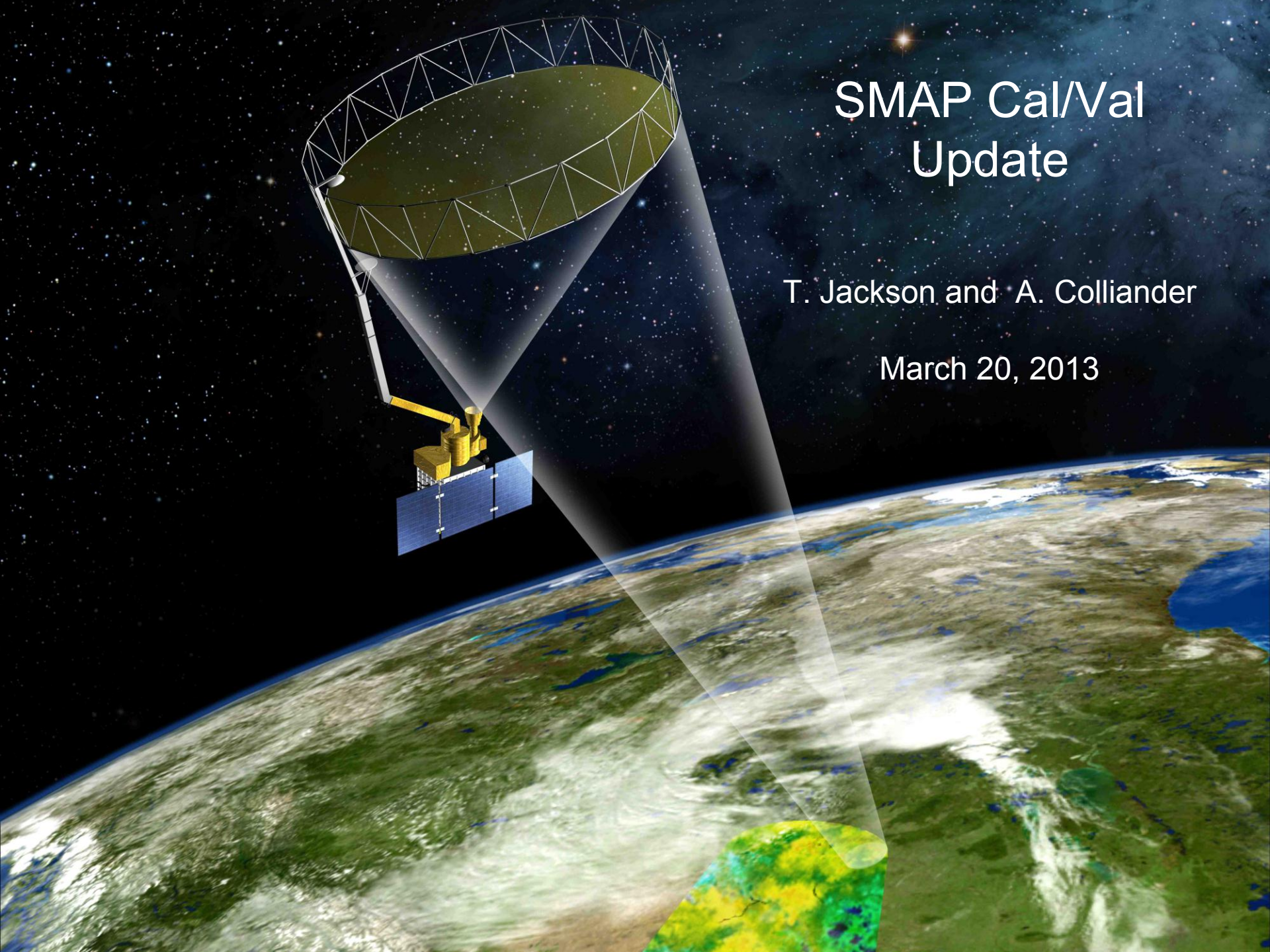


SMAP Cal/Val Update

T. Jackson and A. Colliander

March 20, 2013

Overview

- SMAP is scheduled for launch October 31, 2014
- Some background for context
  - *Mission Requirements and Products*
  - *Cal/Val Timeline*
  - *Cal/Val Approach and Methodologies*
- Cal/Val Partners: Core Validation Sites
- Cal/Val Rehearsals
- Post-Launch Field Campaigns

SMAP Cal/Val Plan

- SMAP Cal/Val Plan has matured over the past 4-years and survived a project review
- Available on the SMAP website
  - http://smap.jpl.nasa.gov/
- Progress has been made on several important Cal/Val issues
  - *In situ calibration (MOISST), more in situ sites (Cal/Val Partners), and up-scaling*
  - *Transitioning from pre- to post-launch concerns*

SMAP Cal/Val Approach

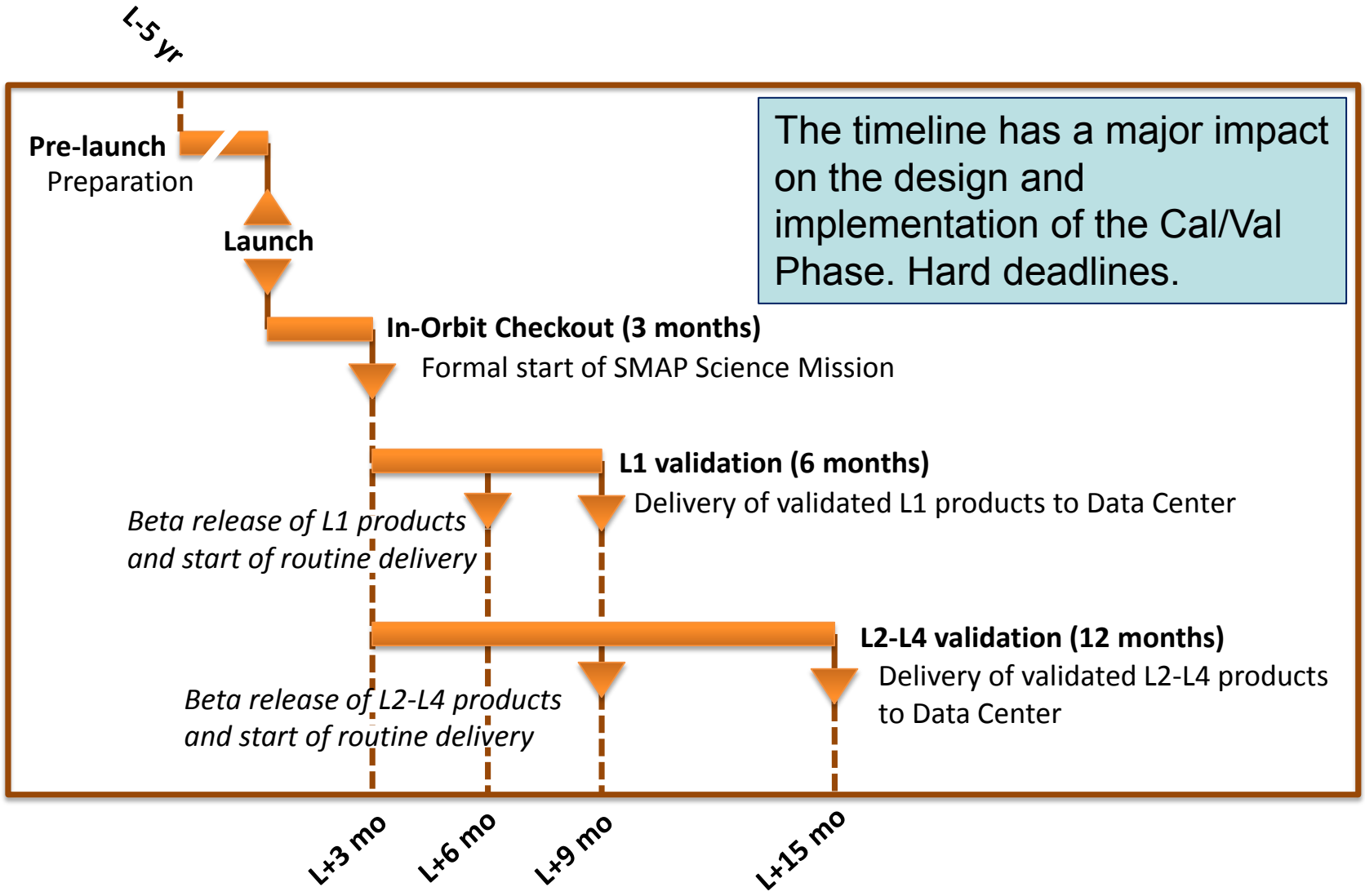
Pre-launch

- Insuring that there are means in place to fulfill the mission objectives
  - *Acquire and process data with which to calibrate, test, and improve models and algorithms used for retrieving SMAP science data products*
  - *Develop and test the infrastructure and protocols for post-launch validation*

Post-launch

- Validating that the products meet their quantified requirements
  - *Calibrate, verify, and improve the performance of the science algorithms*
  - *Validate accuracies of the science data products as specified in L1 science requirements according to Cal/Val timeline*

Science Data Validation and Delivery Timeline



CEOS Validation Stages Adopted for SMAP

Validation: The process of assessing, by independent means, the quality of the data products derived from the system outputs. The quality is determined with respect to the specified requirements.

Validation Stage	Description
Stage 1	Product accuracy is assessed from a small (typically < 30) set of locations and time periods by comparison with *in situ* or other suitable reference data.
Stage 2	Product accuracy is estimated over a significant set of locations and time periods by comparison with reference *in situ* or other suitable reference data. *Spatial and temporal consistency of the product and with similar products have been evaluated over globally representative locations and time periods.* Results are published in the peer-reviewed literature.
Stage 3	Uncertainties in the product and its associated structure are well quantified from comparison with reference *in situ* or other suitable reference data. *Uncertainties are characterized in a statistically robust way over multiple locations and time periods representing global conditions.* Spatial and temporal consistency of the product and with similar products have been evaluated over globally representative locations and periods. Results are published in the peer-reviewed literature.
Stage 4	Validation results for stage 3 are *systematically updated* when new product versions are released and as the time-series expands.

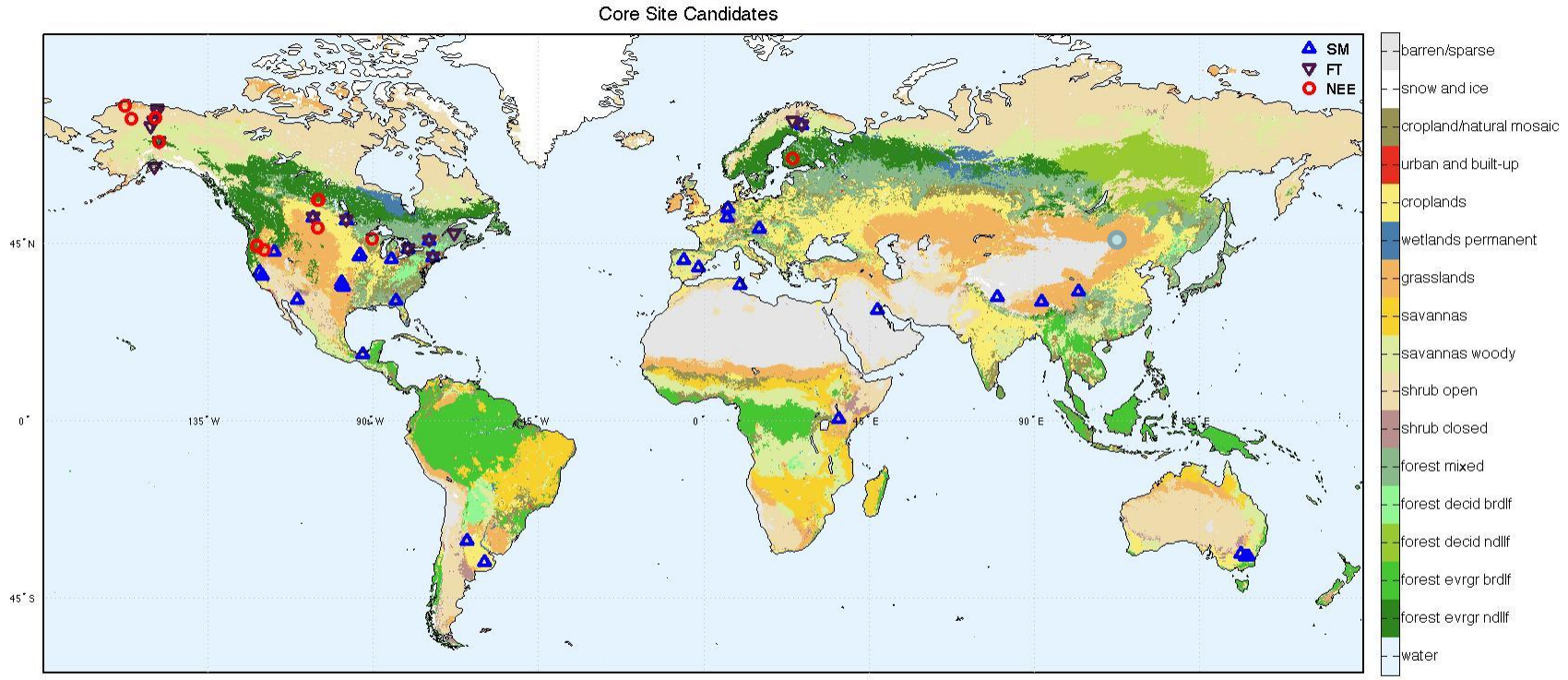
L2-L3 Soil Moisture Validation Methodologies

Methodology	Role	Constraints	Resolution
Core Validation Sites	Accurate estimates of products at matching scales for a limited set of conditions	• In situ sensor calibration • Limited number of sites	• In Situ Testbed • Cal/Val Partners
Sparse Networks	One point in the grid cell for a wide range of conditions	• In situ sensor calibration • Up-scaling • Limited number of sites	• In Situ Testbed • Scaling methods • Cal/Val Partners
Satellite Products	Estimates over a very wide range of conditions at matching scales	• Validation • Comparability • Continuity	• Validation studies • Distribution matching
Model Products	Estimates over a very wide range of conditions at matching scales	• Validation • Comparability	• Validation studies • Distribution matching
Field Campaigns	Detailed estimates for a very limited set of conditions	• Resources • Schedule conflicts	• Airborne simulators • Partnerships

SMAP Cal/Val Partners: Sites

- **Core Validation Sites**: In situ observing sites that provide well-characterized estimates of a L2-L4 product at a matching spatial scale, a direct benchmark reference for the products. Additional minimum criteria are:
  - *Provides calibration of the in situ sensors*
  - *Up-scaling strategy provided (implemented by Project)*
  - *Provides data in a timely manner*
  - *Long term commitment by the sponsor/host*
- **Contributing Validation Sites**: In situ observing sites that provide estimates of a L2-L4 product but do not meet all of the minimum criteria for a Core Validation Site. (i.e. sparse networks)
  - *Contributing Validation Sites are a supplemental resource (In assessing meeting mission requirements but important in Stage 2 Validation).*
  - *The baseline approach to using sparse networks is the triple-collocation technique. Efforts to improve this approach are desirable.*

SMAP Core Validation Site Candidates



Ongoing efforts to formally engage more Partners.

Soil Moisture Cal/Val Partner Work Plan

- Formalize agreements
- Rigorous evaluation of data quality
- Assessment of up-scaling
- Resolve data formatting issues
- Resolve data latency issues
- Rehearsal campaigns
- Final selection

Why Have a Cal/Val Rehearsal?

- Cal/Val rehearsal reduces the risk of not meeting checkpoints by identifying and correcting issues encountered in the exercises.
- “My” primary concern in SMAP Cal/Val?
  - *L2-L4: The in situ component: because it relies on external cooperation and integration of diverse resources.*

SMAP Cal/Val Rehearsal Phases

- Phase 1 Now
  - *Emphasizes development of validation methods*
    - Test calibration and validation methods that the team plans to use during mission cal/val
    - Resolve external validation resource issues
  - *Researchers run code on available hardware (SDT and CV)*
- Phase 2 Later
  - *Emphasizes effective use of tools in an operational setting*
    - Ensure that the tools function in the operational environment
    - Ensure that tools operate on selected input appropriately
    - Ensure that tools generate anticipated output
  - *Team members run code on same hardware that will be used during cal/val (SDS)*

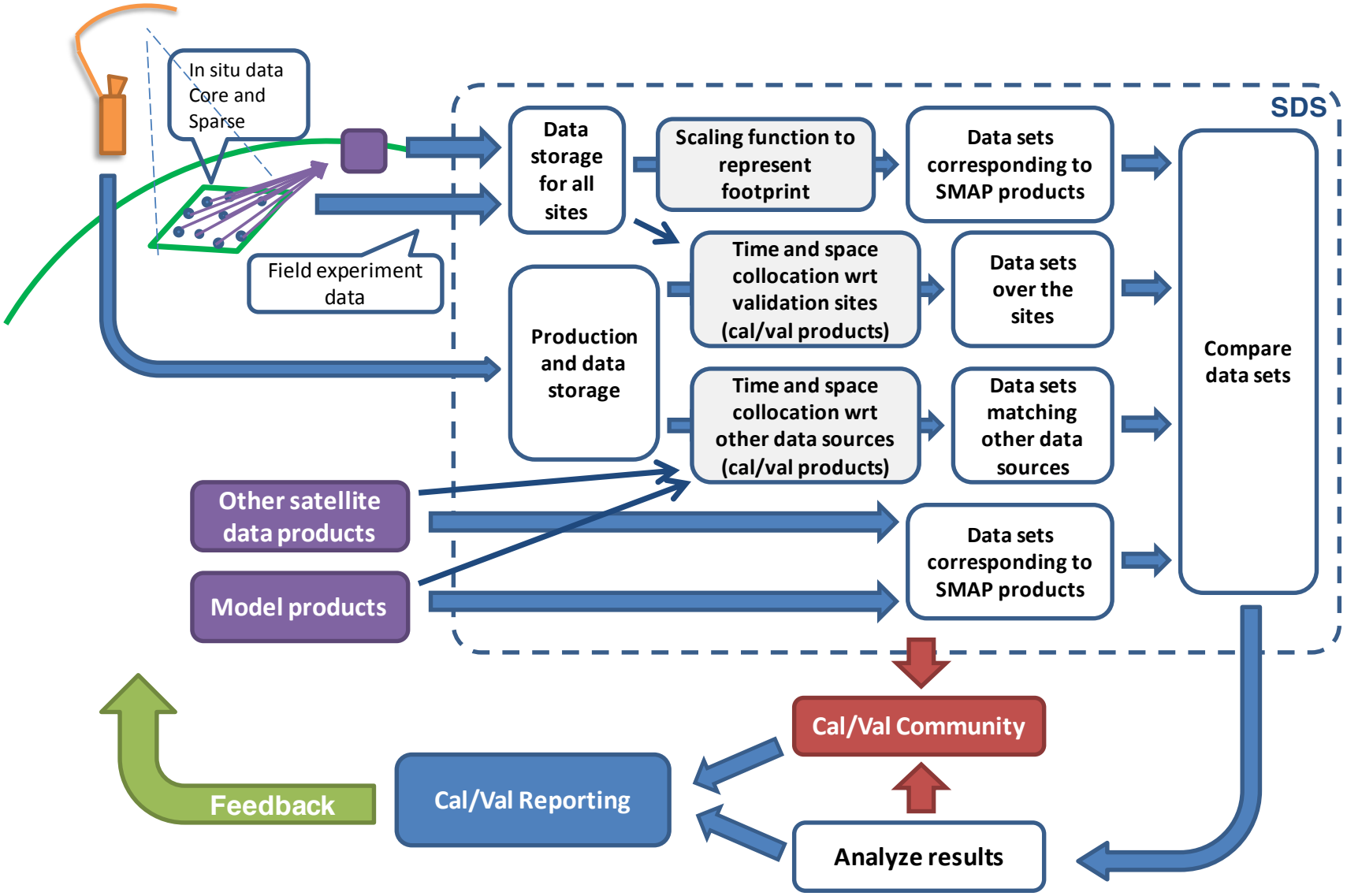
SMAP Cal/Val Phase 1 Rehearsal Goals

- The process and procedures of getting Cal/Val partner data to the Project and resolving any ambiguous issues the two sides might have
- Defining the up-scaling functions for the core sites
- Assessing the quality of the data supplied by the Cal/Val partners
- Formalizing and implementing the up-scaling approach and analysis procedures that will be used for sparse networks
- Assessment and qualification of specific points in the available sparse network data
- Providing feedback to the Cal/Val partners, which might be implemented before launch
- Exercising the procedures for acquisition and analysis of satellite products from SMOS, Aquarius, and GCOM-W
- Exercising the procedures for acquisition and analysis of model products from ECMWF, NCEP, GMAO
- Formalizing tools and analysis procedures used by the Cal/Val team

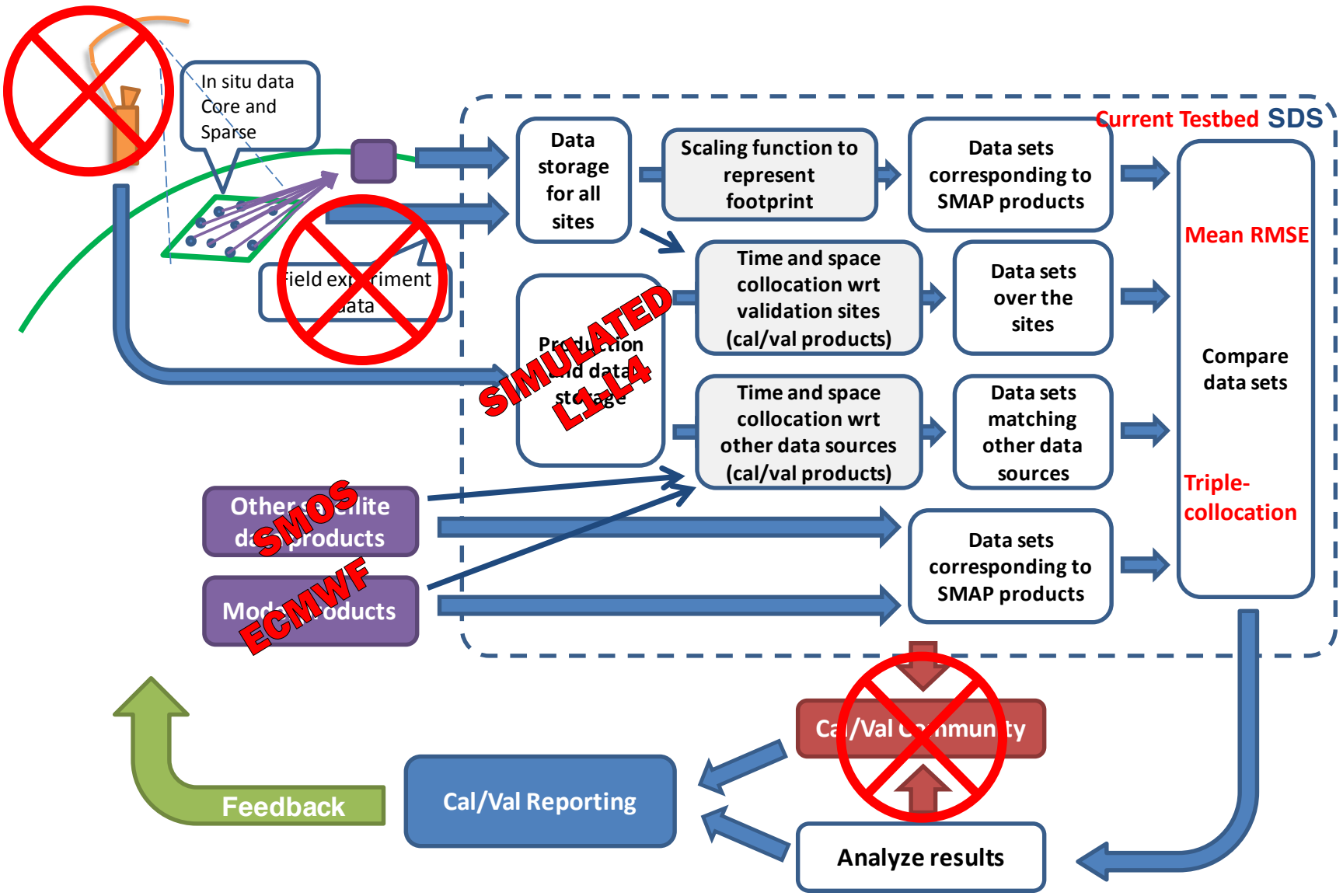
Cal/Val Workshop Discussions

- What to include in Phase 1?
  - *Products (all)*
  - *Methodologies (all except field campaigns)*
  - *Tools (identify and develop)*
  - *Data resources (SMOS, GLOSIM)*
- Schedule
- Action: Start developing Cal/Val use cases

Prototype View of Post-Launch L2-L4 Cal/Val Science Operations and Processing Flow



Example: Soil Moisture (L2 Passive) Validation Rehearsal Processing Flow for 2013



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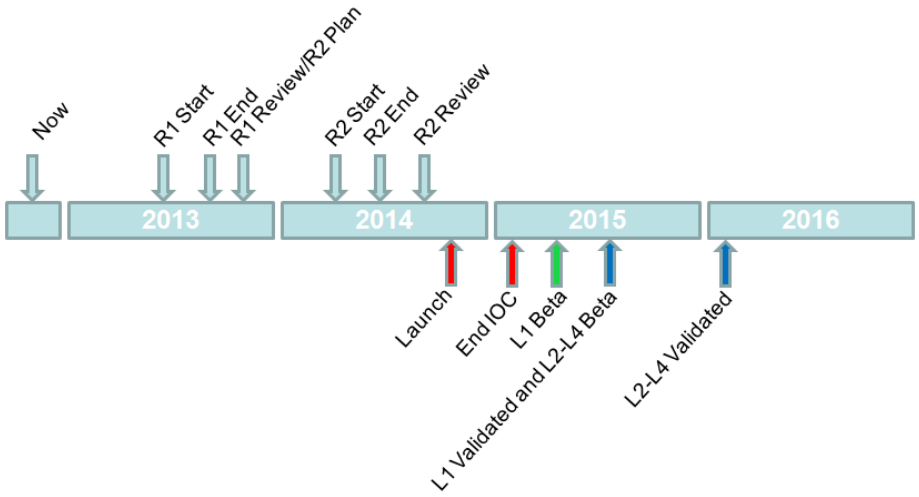
SMAP Cal/Val Rehearsals Schedule

November 2012	Cal/Val Workshop planning for Phase 1
February 2013	Collect initial description of all cal/val tools, data required to run tools
June 2013	Start Phase 1 rehearsals
September 2013	End Phase 1 rehearsals
October 2013	Cal Val Workshop review and feedback
January 2014	Collect operational description of all cal/val tools
May 2014	Complete cal/val procedure document
May 2014	Start Phase 2 Rehearsals
July 2014	End Phase 2 Rehearsals
Fall 2014	Rehearsal review



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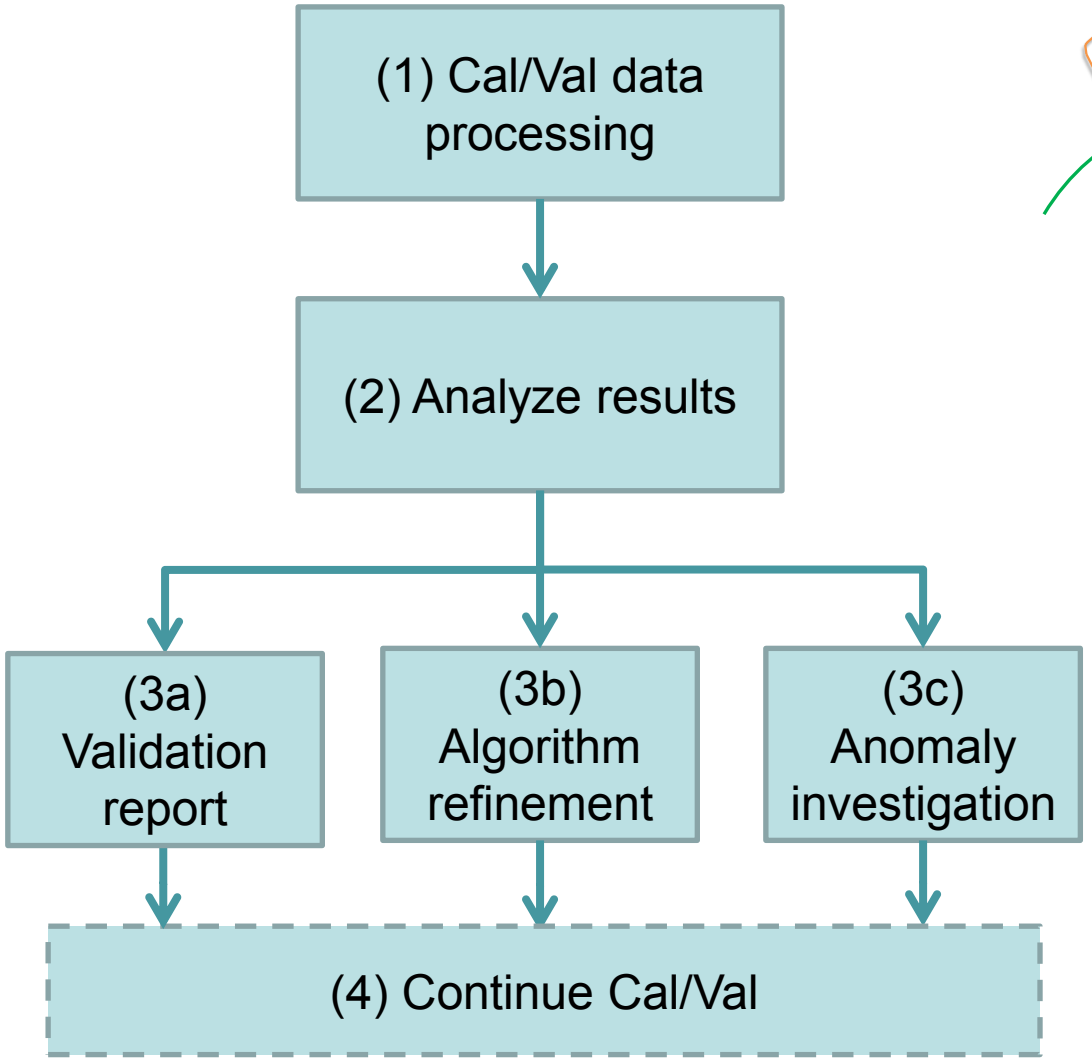
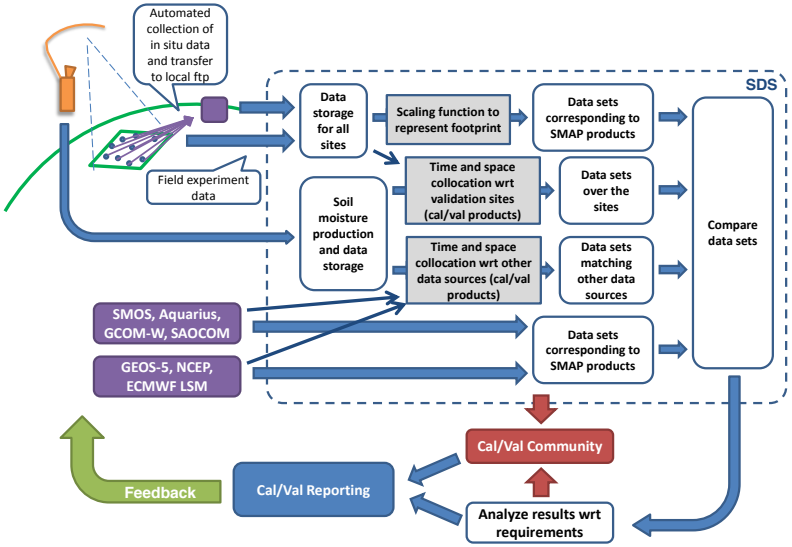
Cal/Val Use Cases: General

- Describes actions taken during the Cal/Val Phase and preparation for the calibration and validation the data products
  - *Includes identifying the people involved*
- Expected results
  - *Better definition of required elements*
  - *Leads to tools and requirements*
  - *Rehearsal design*

L2-L4 Cal/Val Use Cases: Highest level What will we try to do during Cal/Val?





- Simplified overall diagram of the cal/val process
- How far do we go in Phase 1?
  - *Up to 3a?*

L2-L4 Rehearsal 1 Activities

- Timeline
  - *Duration: 10 weeks*
  - *Rehearsal 1 start: Monday, June 17*
  - *Rehearsal 1 end: Friday, August 23*
  - *Possibly extend to end Sept.- early Oct. to accommodate algorithm review work*
- Basic concept for L2-L4 data products
  - *Weekly (Monday?) updates of the match-ups and validation metrics*
  - *Analysis, design and development of updates and algorithm refinement tools; weekly telecons*
  - *Keep automated parts on after the end of the rehearsal*
- Meetings
  - *Preparation meeting: May 9 (designation of the rehearsal team acting as the Calibration Assessment and Algorithm Refinement Team) @JPL*
  - *Summary meeting: TBD September*
  - *Result review: Cal/Val Workshop, November 5-7, 2013*
- Actions before the start of the rehearsal 1 (preparation meeting as a milestone)
  - *Set up generation of simulated SMAP-products*
  - *Develop the selected tools*

L2-L4 Validation Methodologies

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Post-Launch Aircraft Experiments

- Science objectives (This can be expanded)
  - *Validate the entire L2_SM_AP algorithm process; scaling and radiative transfer*
  - *Understand the effects and contribution of heterogeneity on coarser resolution retrievals*
  - *Evaluate the impact of known RFI sources on retrieval*
  - *Investigate and resolve anomalous observations and products*
- The following discussion focuses on the L2_SM_AP item. Other objectives can be integrated as they develop.

Post-Launch Aircraft Experiments (cont.)

- Aircraft experiment concept
  - *Flights over one or more L2_SM_P grid cells at a site, possibly for multiple sites with different conditions (i.e. Canada, Arizona, Oklahoma,…)*
  - *Higher spatial resolution TB coverage of the entire site that can be used to generate TB values for the L2_SM_AP (9 km) as well as the L2_SM_A grid (3 km)*
  - *SM products at both 3 and 9 km generated using the SMAP L2_SM_P algorithm*
  - *Ground sampling to validate higher spatial resolution retrievals.*
- What this will contribute
  - *Validation of the L2_SM_AP product over an entire L2_SM_P grid cell*
  - *Validation of the L2_SM_P product*
  - *Validation of the L2_SM_A product over an entire L2_SM_P grid cell*
  - *Correlative analysis of the SMAP TB and σ^o and the aircraft TB and σ^o over the L2_SM _P grid cell*
  - *Correlative analysis of the "TB" produced as an intermediate step in the L2_SM_AP algorithm. This is a very important contribution that can only be achieved using aircraft.*

Post-Launch Aircraft Experiments

- Instrument Requirements
- Scheduling Issues
- Current Baseline

Schedule Considerations

- Campaign might be in 2016
  - *Many key project personnel will be tied up during the first year after launch to focus on the analysis of the SMAP data set and will not be available to support a field campaign or analyze the data in 2015.*
  - *The analysis of the first year of SMAP data will allow us to identify the critical scaling issues as well as problem areas (specific regions/land covers) that can then be incorporated into the final design of SMAPVEX16.*
  - *Could incorporate additional science objectives.*
- Time Line (relative to Cal/Val)
  - *2014: Preparation for launch and post launch cal/val activities*
  - *2015: Conduct SMAP Cal/Val activities and refine the plan for SMAPVEX16*
  - *2016: Carry out the SMAPVEX16 and data processing*
  - *2017: Complete the analysis of SMAPVEX16 data with results applicable to the reprocessing of SMAP data*

SMAPVEX16 Current Baseline

- Duration: 45 days (12 days for each of 3 sites and 3 days for transit between sites)
- Flight hours: 150 (120 for science and 30 for test flights and transit.)
- Two Aircrafts: PALS on Twin Otter (or C23 and equivalent) and UAVSAR on G3
- Three sites: each site will cover 36 km x 36 km
  - *One with baseline studies, good infrastructure, and a range of conditions; i.e. Winnipeg*
  - *Two more sites selected based on the SMAP data collected in 2015*

PALScan

What SMAP Cal/Val Needs From You Now

(My Opinion Only!!)

- Full involvement of Canadian Team as Cal/Val Partners
  - *Documentation of the calibration of in situ sensors*
  - *Definition of up-scaling functions*
  - *Resolution of delivery and formatting by May 2013.*
  - *Full participation in the Rehearsal Phase 1*
- Consideration of the tradeoffs between a post-launch aircraft experiment in 2015 or 2016
- Agreement on support for field campaign