

National Aeronautics and Space Administration



Jet Propulsion Laboratory
California Institute of Technology

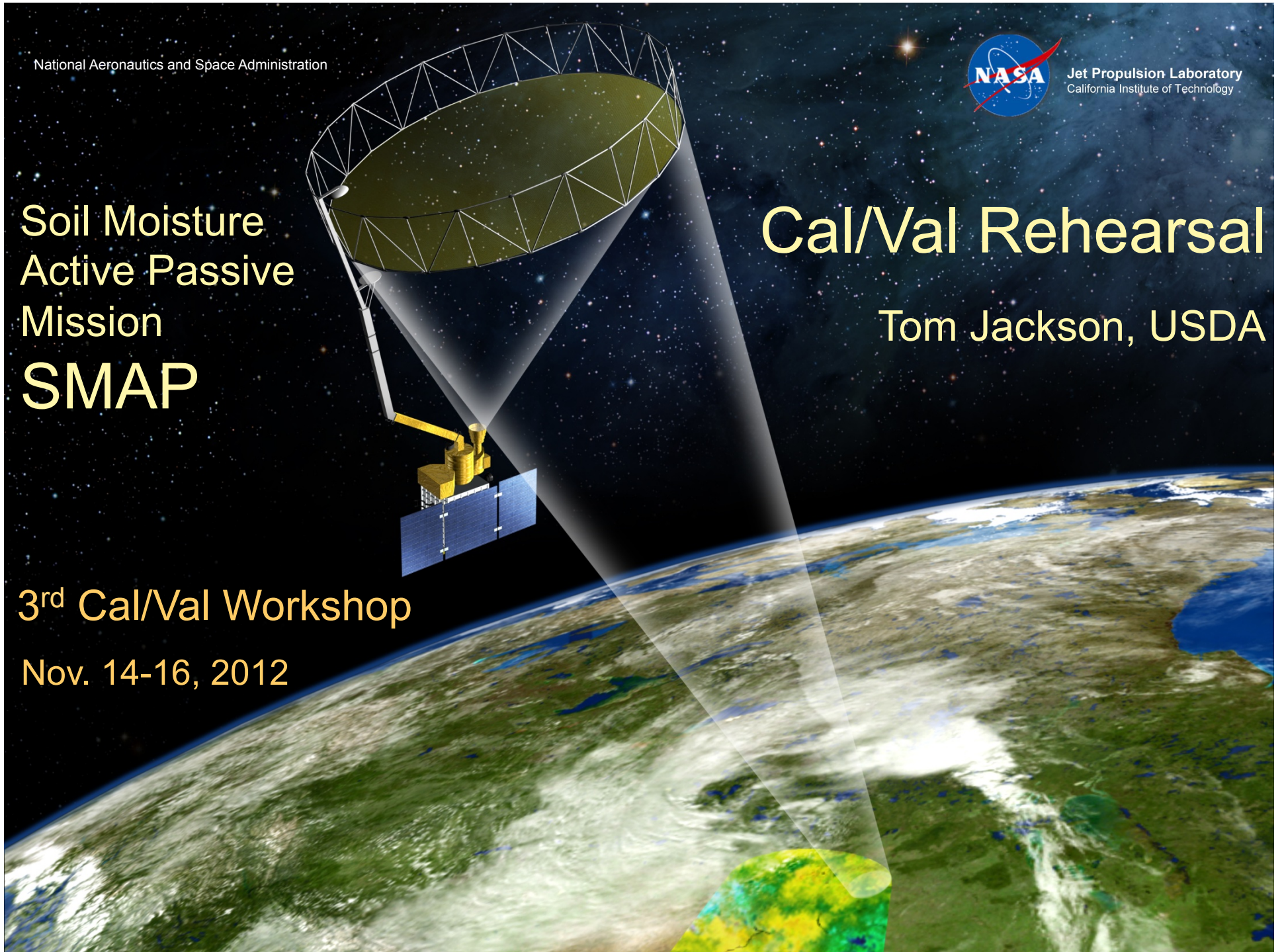
Soil Moisture Active Passive Mission SMAP

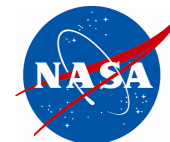
Cal/Val Rehearsal

Tom Jackson, USDA

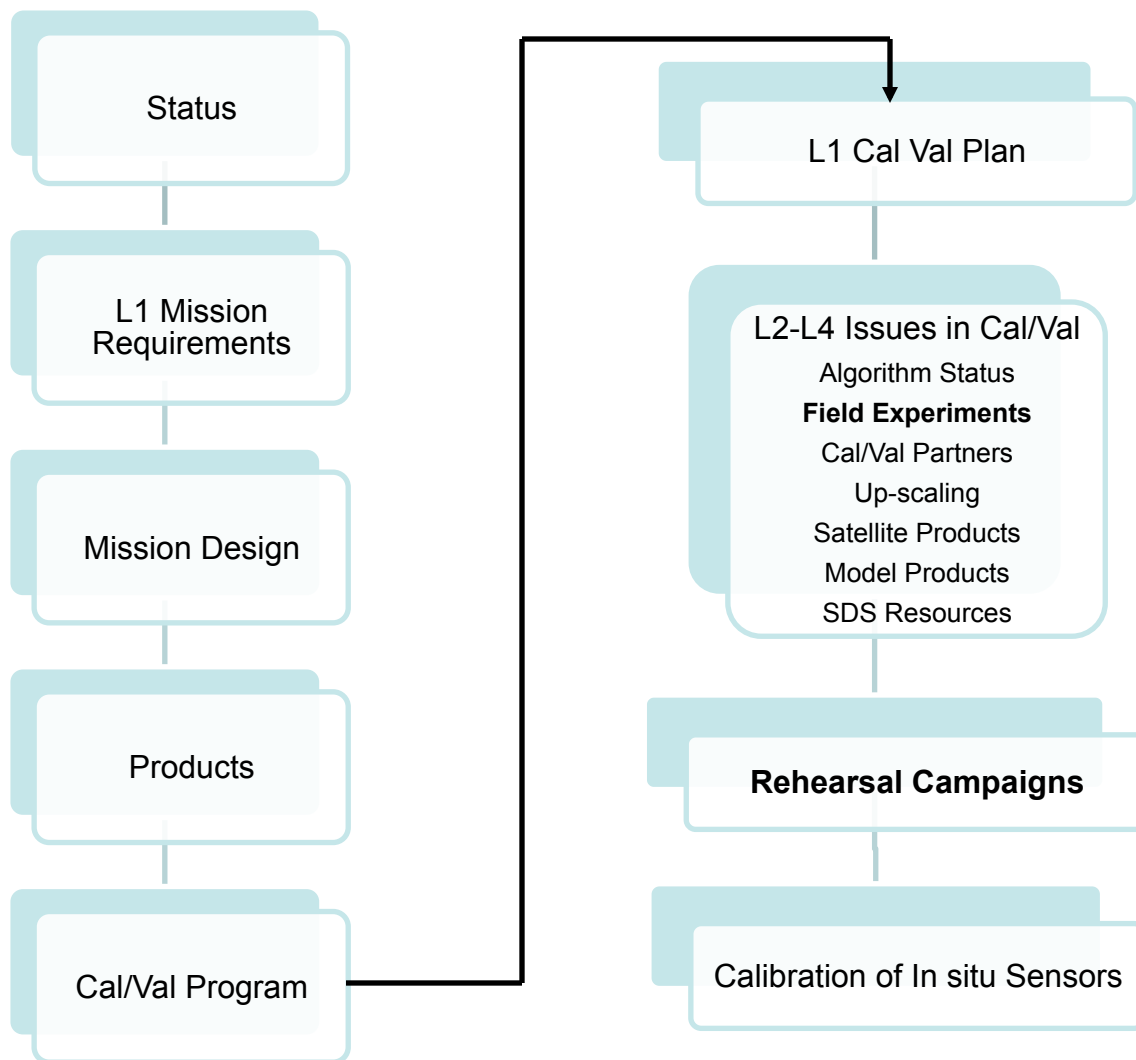
3rd Cal/Val Workshop

Nov. 14-16, 2012





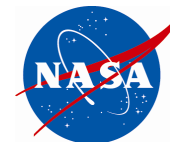
Workshop Overview





SMAP Cal/Val Rehearsals

- Review of key background items
 - *Product List*
 - *Post-launch Cal/Val Timeline*
 - *Methodologies and Tools*
- Why Conduct a Cal/Val Rehearsal?
- Phase 1 Planning
- Phase 2 Planning (Barry)



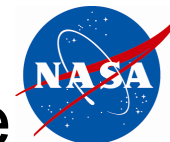
SMAP Science Products

There are a lot of products! (Organization)

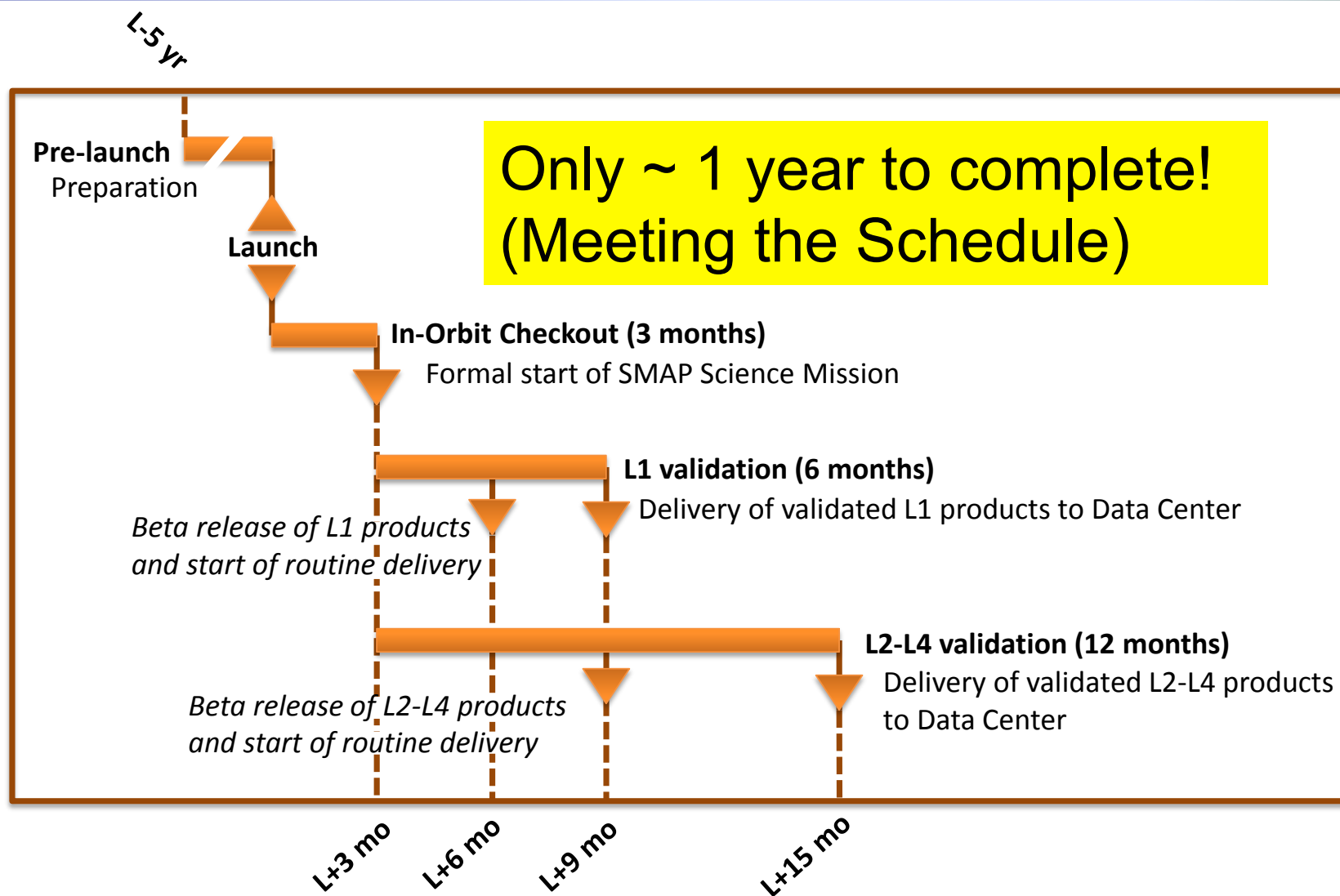
Product	Description	(Resolution)	Latency	
L1A_Radiometer	Radiometer Data in Time-Order	-	12 hrs	Instrument Data
L1A_Radar	Radar Data in Time-Order	-	12 hrs	
L1B_TB	Radiometer T_B in Time-Order	(36x47 km)	12 hrs	
L1B_S0_LoRes	Low Resolution Radar σ_o in Time-Order	(5x30 km)	12 hrs	
L1C_S0_HiRes	High Resolution Radar σ_o in Half-Orbits	1 km (1-3 km)	12 hrs	
L1C_TB	Radiometer T_B in Half-Orbits	36 km	12 hrs	
L2_SM_A	Soil Moisture (Radar)	3 km	24 hrs	Science Data (Half-Orbit)
L2_SM_P	Soil Moisture (Radiometer)	36 km	24 hrs	
L2_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	24 hrs	
L3_FT_A	Freeze/Thaw State (Radar)	3 km	50 hrs	Science Data (Daily Composite)
L3_SM_A	Soil Moisture (Radar)	3 km	50 hrs	
L3_SM_P	Soil Moisture (Radiometer)	36 km	50 hrs	
L3_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	50 hrs	
L4_SM	Soil Moisture (Surface and Root Zone)	9 km	7 days	Science Value-Added
L4_C	Carbon Net Ecosystem Exchange (NEE)	9 km	14 days	

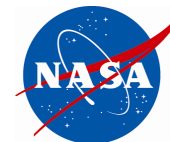
* Over outer 70% of swath.

** The SMAP project will make a best effort to reduce the data latencies beyond those shown in this table.



Science Data Validation and Delivery Timeline





Cal/Val Methodologies and Tools

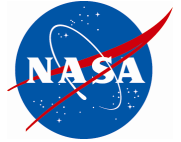
- Methodologies

(Functionality)

- *Practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; i.e. comparing retrievals to a dense and representative network of in situ observations using RMSE, bias, and R as metrics.*
- *For L2-L4: Comparisons to Core Validation Sites, Sparse Networks, Satellite Products, Model Products, and Field Campaigns*

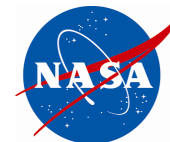
- Tools

- *Software-based routines used to construct statistical and visual products to facilitate the methodologies; i.e. a program that routinely extracts SM products over a validation site.*



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.
 - *Organization*
 - *Schedule*
 - *Functioning*
- Based upon initial discussions of the SMAP SDT and SDS, there are different but complementary objectives that led to an overall approach consisting of two phases.

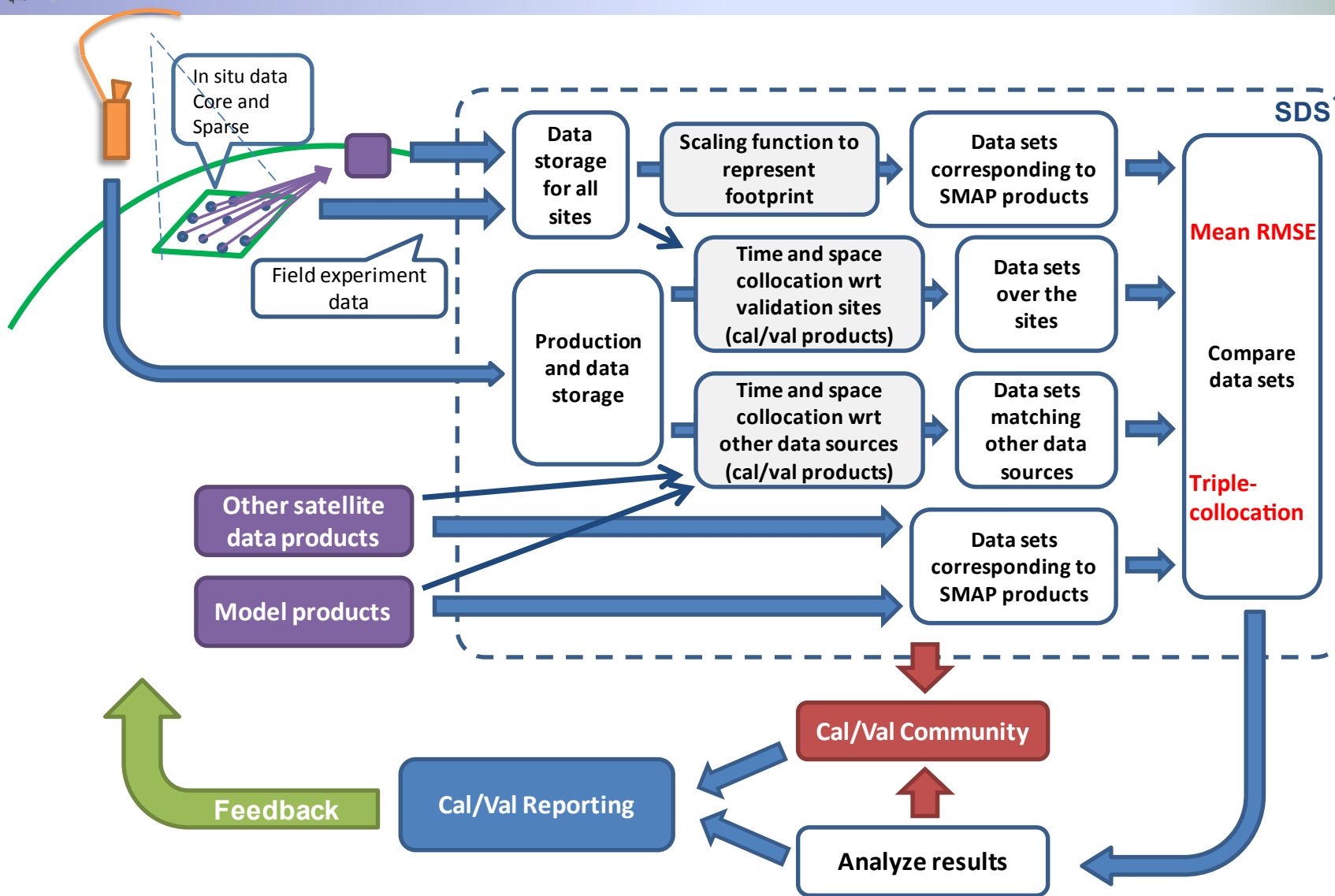
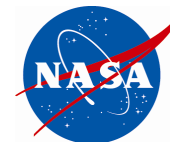


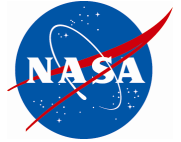
SMAP Cal/Val Rehearsal Phases

- 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)*



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



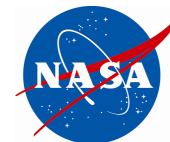


What Should Be Included in Phase 1?

- Products?
- Methodologies?
- Tools?
- What data resources?
- Schedule?



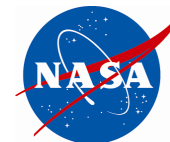
Which Products Should Be Included in Phase 1?



Product Level	Product	Cal/Val Heritage	Dependence on Outside Data Resources	Concerns over Outside Data Resources	Concerns over Methodology
L1	Radiometer				
	Radar				
L2/3	SM Passive				
	SM Active				
	SM Combined				
	FT				
L4	SM				
	NEE				



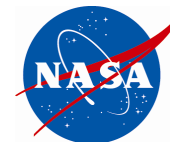
Which Products Should Be Included in Phase 1?



Product Level	Product	Cal/Val Heritage	Dependence on Outside Data Resources	Concerns over Outside Data Resources	Concerns over Methodology
L1	Radiometer	Y			
	Radar	Y			
L2/3	SM Passive	Y			
	SM Active	N			
	SM Combined	N			
	FT	N			
L4	SM	Y			
	NEE	Y			



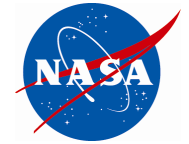
Which Products Should Be Included in Phase 1?



Product Level	Product	Cal/Val Heritage	Dependence on Outside Data Resources	Concerns over Outside Data Resources	Concerns over Methodology
L1	Radiometer	Y	M		
	Radar	Y	L		
L2/3	SM Passive	Y	H		
	SM Active	N	H		
	SM Combined	N	H		
	FT	N	H		
L4	SM	Y	H		
	NEE	Y	H		



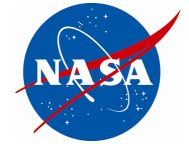
Which Products Should Be Included in Phase 1?



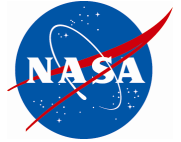
Product Level	Product	Cal/Val Heritage	Dependence on Outside Data Resources	Concerns over Outside Data Resources	Concerns over Methodology
L1	Radiometer	Y	M	Y	
	Radar	Y	L	N	
L2/3	SM Passive	Y	H	Y	
	SM Active	N	H	Y	
	SM Combined	N	H	Y	
	FT	N	H	N	
L4	SM	Y	H	Y	
	NEE	Y	H	N	



Which Products Should Be Included in Phase 1?



Product Level	Product	Cal/Val Heritage	Dependence on Outside Data Resources	Concerns over Outside Data Resources	Concerns over Methodology
L1	Radiometer	Y	M	Y	Y
	Radar	Y	L	N	N
L2/3	SM Passive	Y	H	Y	N
	SM Active	N	H	Y	Y
	SM Combined	N	H	Y	Y
	FT	N	H	N	Y
L4	SM	Y	H	Y	Y
	NEE	Y	H	N	Y

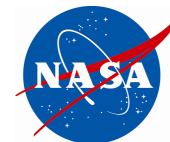


What Should Be Included in Phase 1?

- Products?
 - (1) *All*, (2) *L2-L4*, (3) *L2-L3*, (4) *L2-L3 SM*, or (5) *L2-L3 SM-Passive*
 - Heritage: Lacking for active-based products
 - Dependence: L2-L4 are more dependent
 - Concerns: SM more than FT and NEE
 - Methodologies: Most
 - *Recommendation*
- Methodologies?
- Tools?
- What data resources?
- Schedule?

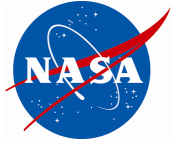


Which Methodologies Should Be Included in Phase 1?



L2-L4 Validation Methodologies

Methodology	Role	Constraints	Resolution
Core Validation Sites	Accurate estimates of products at matching scales for a limited set of conditions	<ul style="list-style-type: none">• In situ sensor calibration• Limited number of sites	<ul style="list-style-type: none">• In Situ Testbed• Cal/Val Partners
Sparse Networks	One point in the grid cell for a wide range of conditions	<ul style="list-style-type: none">• In situ sensor calibration• Up-scaling• Limited number of sites	<ul style="list-style-type: none">• In Situ Testbed• Scaling methods• Cal/Val Partners
Satellite Products	Estimates over a very wide range of conditions at matching scales	<ul style="list-style-type: none">• Validation• Comparability• Continuity	<ul style="list-style-type: none">• Validation studies• Distribution matching
Model Products	Estimates over a very wide range of conditions at matching scales	<ul style="list-style-type: none">• Validation• Comparability	<ul style="list-style-type: none">• Validation studies• Distribution matching
Field Campaigns	Detailed estimates for a very limited set of conditions	<ul style="list-style-type: none">• Resources• Schedule conflicts	<ul style="list-style-type: none">• Airborne simulators• Partnerships



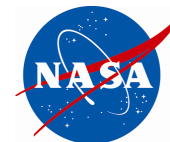
Methodology Concerns

- Core Sites
 - *Data delivery*
 - Formatting
 - Transmission
 - Latency
 - *Up-scaling*
 - *Data Quality*
- Sparse Networks
 - *Data delivery (not as much of an issue)*
 - *Up-scaling*
 - *Data Quality*
- Satellite Products
 - *Data delivery and processing*
 - *Metrics*
- Model Products
 - *Same as satellite products*
- Field Campaigns
 - *Many concerns discussed earlier*
 - *SMAPVEX12 was a rehearsal*



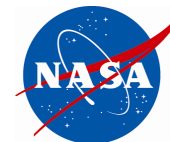
What Should Be Included in Phase 1?

- Products?
 - (1) All, (2) L2-L4, (3) L2-L3, (4) L2-L3 SM, or (5) L2-L3 SM-Passive
 - Recommendation:
- Methodologies?
 - Recommendation: All expect Field Campaigns
- Tools?
- What data resources?
- Schedule?



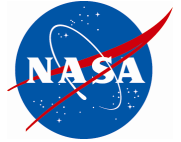
SMAP Cal/Val Rehearsal Data Resources

- What data will drive the exercise?
- Setting up the acquisition and processing of the outside data resources (in situ, SMOS, model) and examining their quality is a very important aspect of the Phase 1 Rehearsal.
 - *If we use simulated L1 data to drive the production of L2-L4 that is based on some period in the past (GLOSIM), comparisons between the simulated products and current in situ, etc. data will not be quantitative, it will only support establishing the methodology and associated tools.*
 - *For instance, evaluating the utility of TCL in Cal/Val is important. However, statistical assessments based on the scenario above would not be representative.*
- Do we need to simulate delivery of satellite data or treat it as a batch?



SMAP Cal/Val Rehearsal Data Resources

Product Level	Product	Data Source Options for Simulating SMAP Data
L1	Radiometer	GLOSIM or SMOS
	Radar	GLOSIM
L2/3	SM Passive	GLOSIM, SMOS, GCOM-W, Aquarius
	SM Active	GLOSIM
	SM Combined	GLOSIM
	FT	GLOSIM
L4	SM	-
	NEE	-



What Should Be Included in Phase 1?

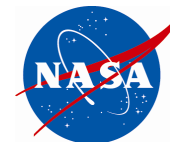
- Products?
 - (1) All, (2) L2-L4, (3) L2-L3, (4) L2-L3 SM, or (5) L2-L3 SM-Passive
 - Recommendation:
- Methodologies?
 - Recommendation: All expect Field Campaigns
- Tools?
- What data resources?
 - Recommendation:
- Schedule?



SMAP Cal/Val Rehearsals Schedule Considerations

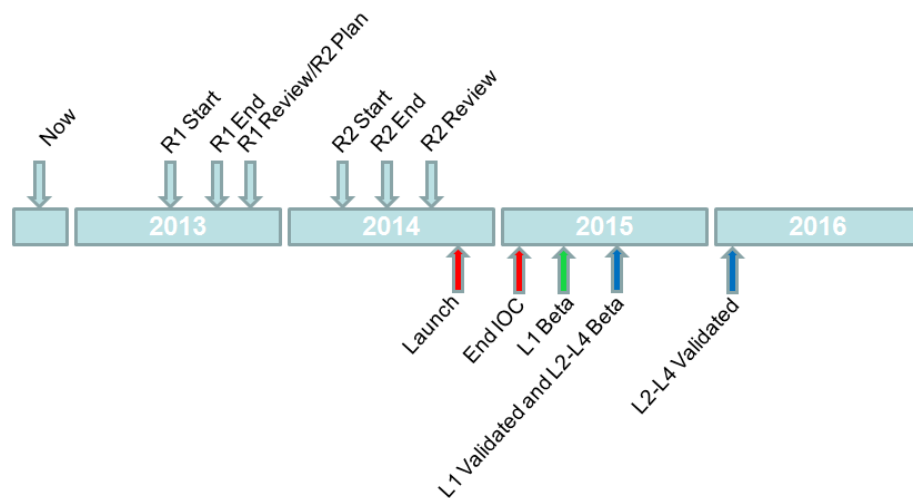


- Can't start too soon
 - *Organizing the infrastructure to conduct a rehearsal will take time.*
 - Phase 1 –
 - Phase 2 -
 - *Conditions should be representative of the primary ca/val period.*
- Can't wait too long
 - *If the feedback from the exercise is to be of value and if corrections are necessary, time is needed for analyses and implementation*
 - Phase 1 -
 - Phase 2 -
 - ...



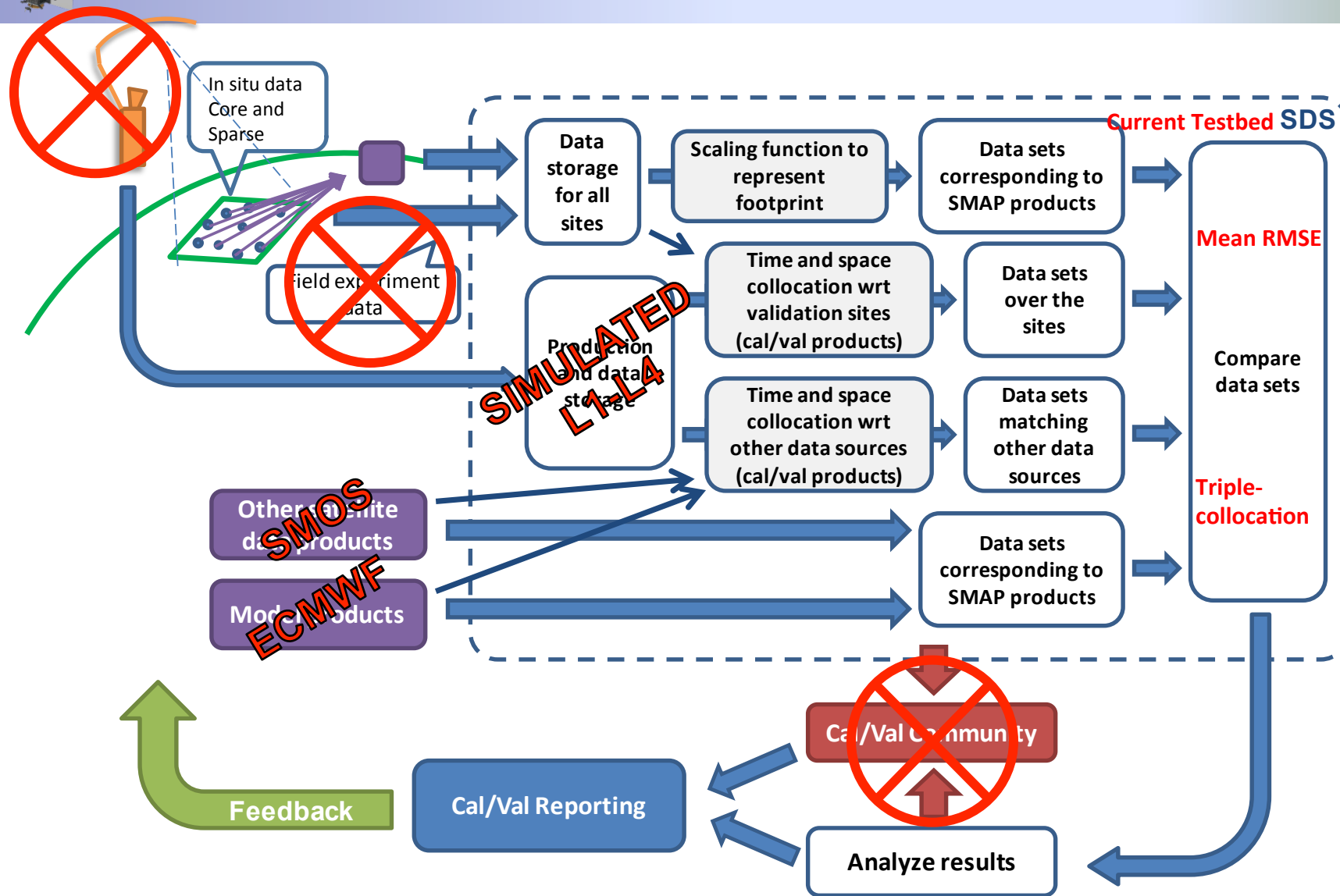
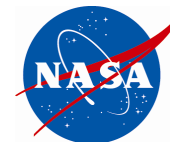
SMAP Cal/Val Rehearsals Schedule

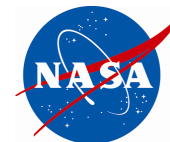
November 2012	Cal/Val Workshop planning for Phase 1
February 2013	Collect initial description of all cal/val tools, data required to run tools
June 2013	Start Phase 1 rehearsals
September 2013	End Phase 1 rehearsals
October 2013	Cal Val Workshop review and feedback
January 2014	Collect operational description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





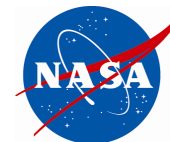
Soil Moisture (L2 Passive) Validation Rehearsal Processing Flow for 2013





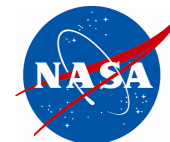
SMAP Cal/Val Phase 1 Rehearsal Goals

- 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



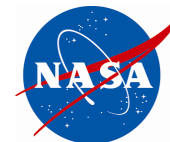
SMAP Cal/Val Phase 2 Rehearsal Goals

- Demonstrates the use of the operational environments and facilities and all of the tools required for the cal/val effort
 - *Effective use of tools in an operational setting*
 - Tools function in the operational environment
 - Tools operate on selected input data sets
 - Tools generate anticipated output
 - Tools run on same hardware that will be used during cal/val
 - *Effective use of the available data*
 - Incorporates SMAP data products
 - Incorporates validation data sets
 - Incorporates QA products and analysis products
 - *Effective use of communication channels and process tools*
 - Employ all established means that the team will use to communicate issues and results and exercise tools for changes



Phase 2 Cal/Val Rehearsal Procedures

- Prerequisites
 - *Mission hardware is configured for cal/val*
 - *Data repositories are configured for cal/val*
 - *Software tools and applications are configured for cal/val*
 - *Software tools and applications reside where they will be used during cal/val*
- Exercises
 - *Schedule specific time periods in May/June 2014 to run test cases*
 - *Assign team members to execute specific parts of the exercise*
 - *Run all tools with available data with resources intended for mission use*
 - *Employ all report mechanisms and repositories*
 - *Evaluate results and, if necessary, modify procedures accordingly*
- Some exercises will test the use of procedures and tools under anomalous conditions
- Demonstrate mission readiness in time for ORR in August

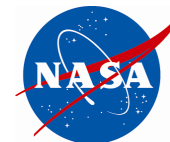


Phase 2 Cal/Val Rehearsal Planning

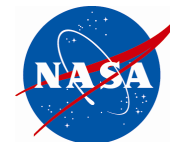
- Generate cal/val use cases
 - *The full set of use cases covers all planned cal/val activities*
 - *Use cases will ensure that*
 - The data storage plan provides necessary data sets
 - The tool development plan covers necessary functions
- Document procedures that are common to all cal/val activities.
 - *Those procedures will specify:*
 - Facilities in use and how to access them
 - Location of various data sets
 - Communication methods the cal/val team will use to share information and prepare reports
- Document cal/val procedures that are specific to each use case.
 - *Those procedures will specify:*
 - Prerequisite conditions for each use case
 - Specific sequence of activities
 - Alternatives for expected anomalous conditions



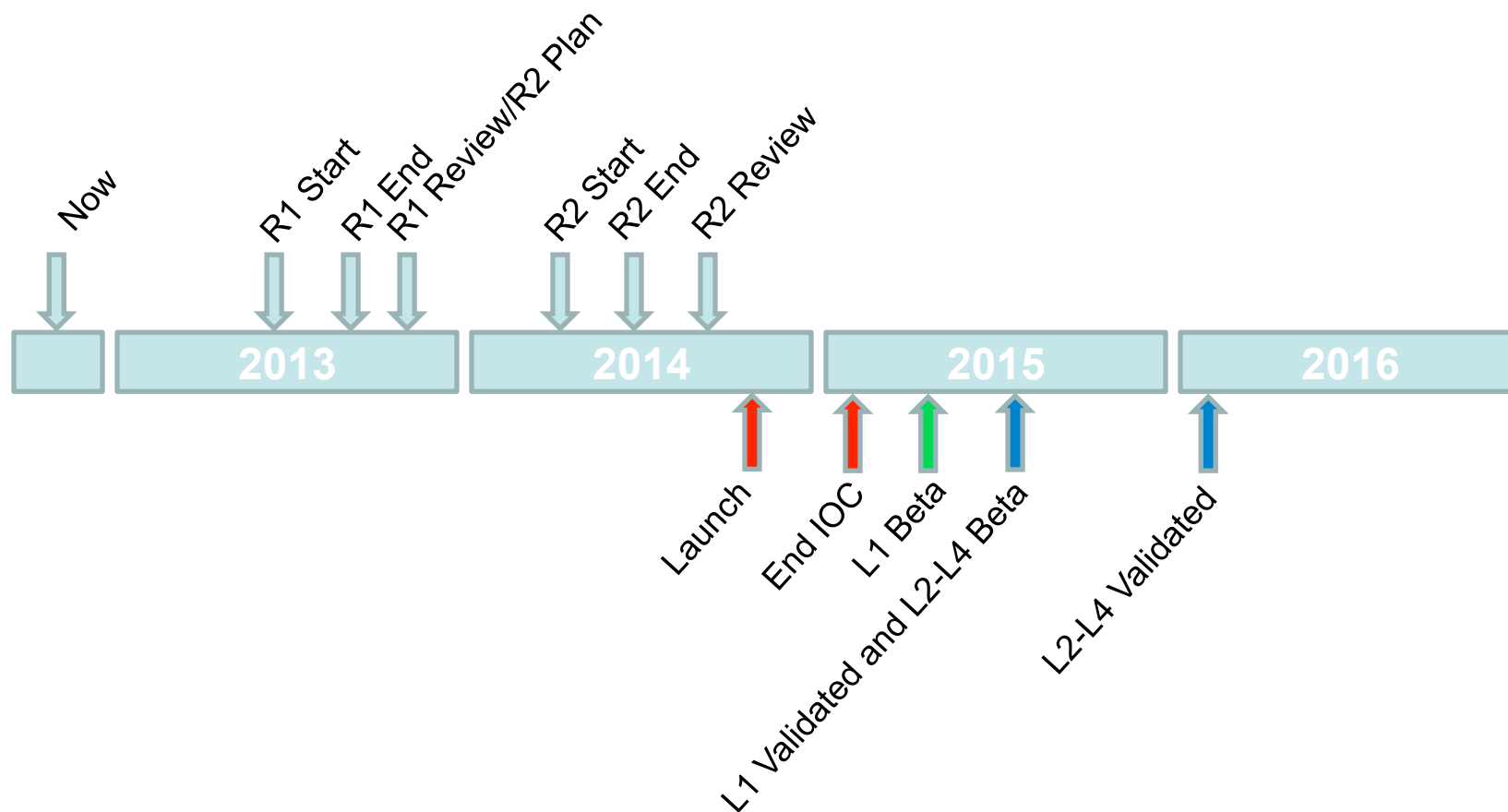
SMAP Cal/Val Phase 1 Rehearsal Tasks

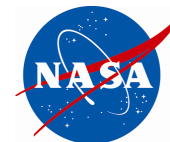


Date	Task
11/14/12	Scope and schedule defined
11/15/12	Prioritization of tasks, follow-up comments
	Organizational chart
	Agreements with Cal/Val Partners completed
	Tools identified and development initiated
	Priority core site data acquisition process established
	Sparse network data acquisition process established
	Satellite product acquisition process established
	Model product acquisition process established
	All core site data acquisition process established
	Simulated SMAP data set available
	QC Procedures
	Stage 1 test case
	Stage 2 with sparse networks
	Stage 2 with satellite and model products
	Monthly reviews
	Workshop, Report, Feedback



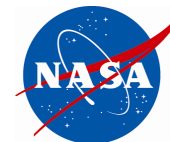
Rehearsal, Validation and Delivery Timeline





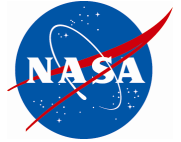
SMAP Cal/Val Tools

- Examples or List



Cal/Val Workshop Agenda-Day 3

<i>Friday (November 16)</i>		
	<i>Calibration and Scaling of In Situ Resources</i>	<i>Cosh (Lead)</i>
0815	MOISST	Cosh
0840	GPS	Small
0850	CRN	Bell
0900	COSMOS	Zreda
0915	COSMOS Rover/SMAPVEX11	Ochsner
0930	Discussion: Lessons Learned and Implementation	Cosh
1015	<i>Break</i>	
1030	Breakout Sessions	
1130	Workshop Issues, Actions, and Summary	Njoku
1200	<i>End</i>	



Summary and Actions

- Cal/Val Program Status
- Progress on Cal/Val activities
- Field Experiments
 - *SMAPVEX12*
 - *SMAPVEX15: Decide?*
- Cal/Val Rehearsals
 - *Phase 1*
 - *Phase 2*
- Future Cal/Val Workshops
 - *Fall 2013: SMAP ST will likely hold its first meeting Oct/Nov?*
 - Same time or separate?
 - Logistics