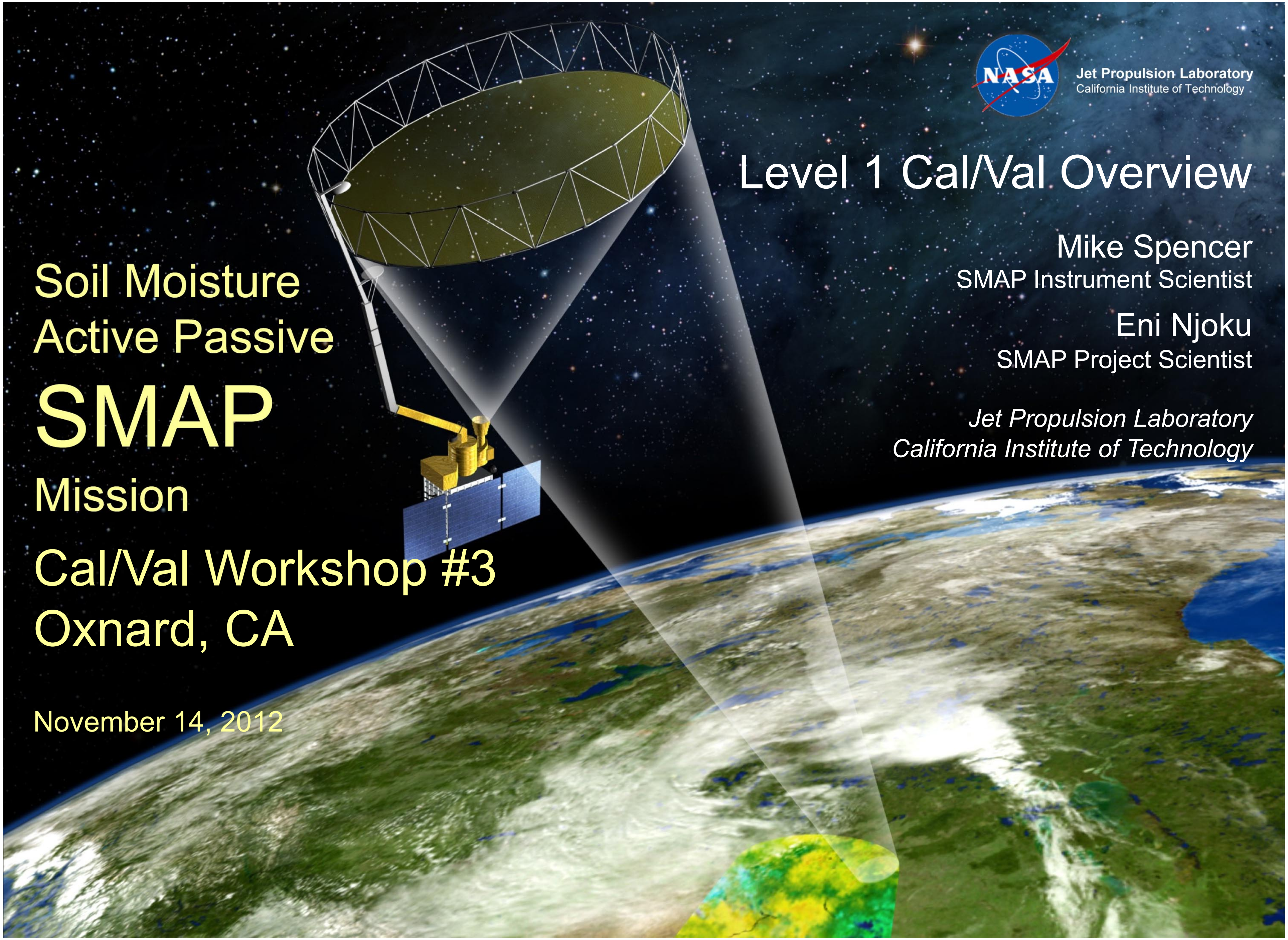
NASA
Jet Propulsion Laboratory
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Level 1 Cal/Val Overview
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Soil Moisture
Active Passive
SMAP
Mission
Cal/Val Workshop #3
Oxnard, CA
November 14, 2012

Level 1 Cal/Val Overview

- Ultimate Objective: Production of geolocated, bottom-of-the-atmosphere T_B and σ_0 products that meet stated radiometric accuracy requirements.
- Level 1 Cal/Val is necessarily a "multi-disciplinary" effort integrating the efforts of:
  - Instrument Development Team (JPL and GSFC instrument development and test), as well as post-launch Instrument Operations Team.
  - Level 1 Algorithm Developers, Algorithm Refinement
  - Science Team Level 1 Cal/Val expertise
- Project held review of overall Cal/Val approach and plan (including Level 1) on October 2, 2012, concluding
  - Cal/val requirements are well understood; cal/val plan is comprehensive and complete; cal/val approaches and methodologies are credible and thorough
  - Still a lot of work to do running up to launch, particularly to prepare for speed with which good products will be expected, and for data issue contingencies.

Level 1 Cal/Val: Approach (1/2)

1. Pre-Launch Instrument Testing and Calibration :
   - Instrument hardware pre-launch test program designed to verify instrument stability and repeatability over temperature (i.e., establish “calibratability”).
   - Collect key calibration data needed by Level 1 algorithms, particularly those items difficult to discern post launch (antenna patterns, temperature coefficients).
   - Flow information from instrument team to algorithm team on how to handle temperature changes, RFI, etc.
2. On-Orbit Commissioning Period (first 3 months on orbit):
   - Verify instrument stability in on-orbit environment, and demonstrate SDS functionality.
   - Upload final instrument command configuration for science data collection.
   - Conduct RFI survey and start “tweaking” RFI filtering parameters. Upload radar frequencies to use.
3. Post-Launch Application of “Internal” Calibration, Antenna Parameters:
   - Utilize internal noise sources (radiometer) and loop-back (radar) to track short-term changes in instrument response.
   - Apply modeled “outside the calibration” temperatures/gains (antenna, radome)
   - Apply antenna pattern in radiometer APC.

Level 1 Cal/Val: Approach (2/2)

4. Post-Launch "External" Calibration:

- Radar and radiometer are anticipated to have absolute calibration biases due to inherent limits of pre-launch calibration campaign.
- "Absolute" calibration is to be performed against a selected set of existing, known, beamfilling brightness and backscatter standards on the Earth (as well as cold space, for the radiometer).
- Key objective is to obtain and confirm a spatially and temporally stable SMAP Level 1 calibration.
- Validation effort will also include cross-comparisons with contemporaneous sensors, as well as models and measurements of other targets of opportunity.
- Update algorithms/coefficients as necessary for external calibration, APC, and RFI.

5. Post-Launch Tracking of Calibration Drifts, Other Variations:

- Track and correct for radiometric drift due to slow aging of instrument parts.
- Track changes in RFI environment and adjust filtering/frequencies.

Level 1 Cal/Val: Implementation

Level 1 Cal/Val "cadre" led by SMAP Cal/Val Phase Lead under the direction of SMAP Project Scientist

Instrument Team/ Instrument Ops

- Pre-Launch calibration coefficients, instrument behaviors.
- Post-launch check-out, certify "calibratability"
- RFI observations, RFI tuning.

L1 Algorithm Development Team/ Algorithm Assessment and Refinement Team

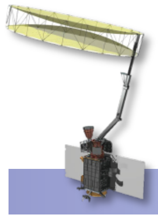
- Develop and code L1 algorithms.
- Perform calibration against external targets.
- Implement calibration adjustments.

Science Team Level-1 Cal/Val "Working Group"

- Independent, complementary assessment and validation of Level 1 products.
- Guidance in algorithm refinement activities.

- Pre-Launch Activities:
  - Collect and incorporate calibration data through instrument test campaign.
  - Develop calibration techniques and identifying external calibration targets (leveraging experience of previous missions).
  - Develop necessarily calibration models, tools and, extensively rehearse.
- Post-Launch Activities:
  - As soon as instrument is turned on, intensive analysis by Level Cal/Val 1 "cadre" to ensure rapid convergence on calibrated product.

Back-Up Slides



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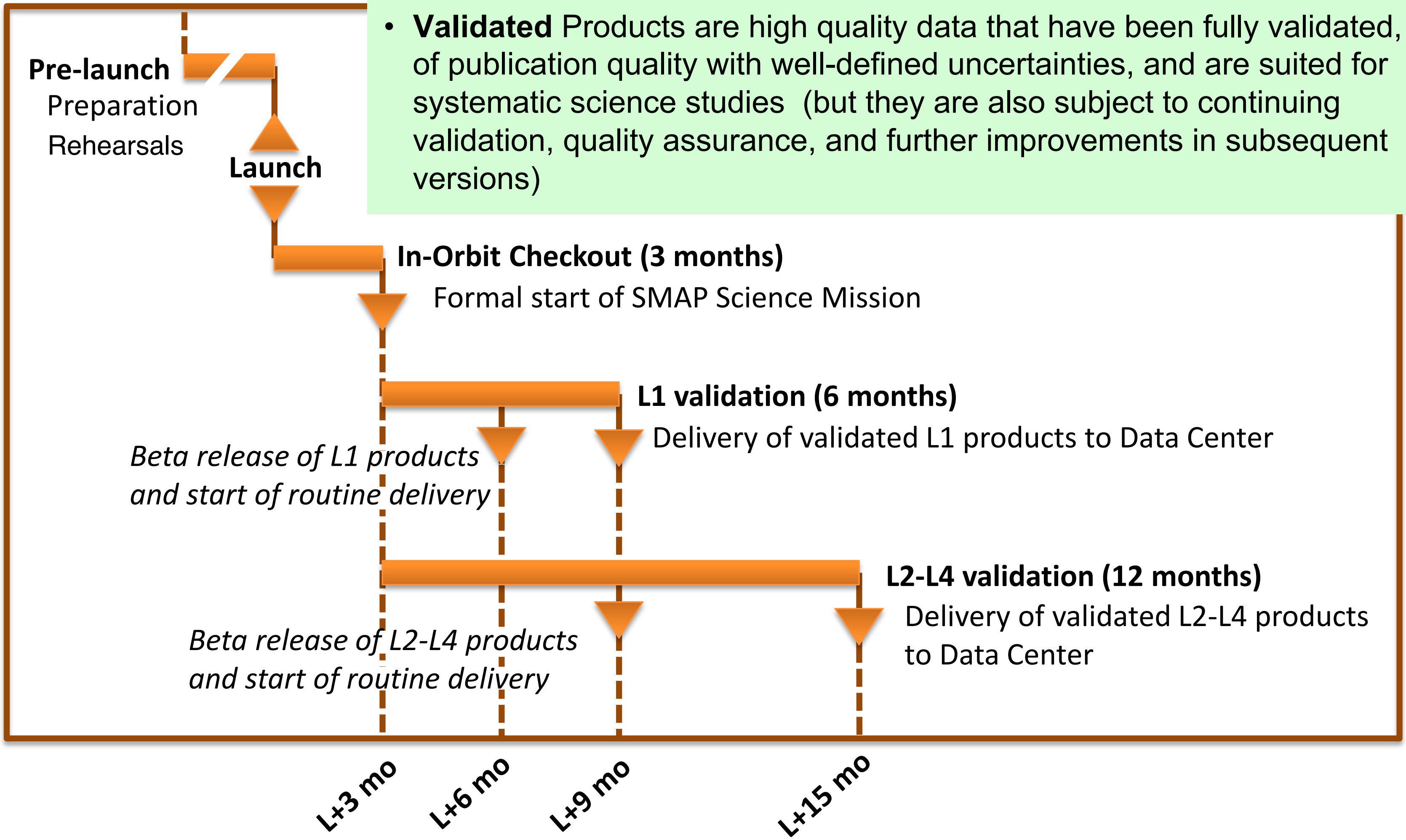
Cal/Val (Post-Launch) Timeline

- **Beta** Products intended to enable users to gain familiarity with the parameters and the data formats.
- **Validated** Products are high quality data that have been fully validated, of publication quality with well-defined uncertainties, and are suited for systematic science studies (but they are also subject to continuing validation, quality assurance, and further improvements in subsequent versions)



Pre- and Post-Launch Activities

Pre-launch: Planning and Preparation

- Focus on ensuring that there are means in place to fulfill the mission objectives
  - Acquire and process data to calibrate, test, and improve models and algorithms
  - Develop and test the infrastructure and protocols for post-launch validation

Post-launch: Execution and Refinement

- Focus on 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
- L1 Cal/Val methodologies and L2-L4 methodologies differ, but activities are inter-related

L1 Cal/Val Methodologies and Activities

- L1 Cal/Val for both radar and radiometer employs similar methodologies
- **Prelaunch:**
  - Establish instrument cal models to reflect the instrument systems and ops environment
  - Collect calibration data on as-built system for cal modeling
  - Implement automated calibration algorithms in the Science Data System
  - Implement tools to perform Cal/Val evaluation
  - Perform forward simulation and data processing to validate Cal/Val tools and procedures
- **Postlaunch**
  - *Internal calibration:* Monitor instrument electronics variability and effectiveness of using "built-in tests" to remove short-term variability
  - *External calibration:* Establish system end-to-end references and characterize long term stability using measurements from homogeneous, stable, well-understood targets
  - *Cross-calibration:* Compare data from other satellite missions with similar measurements (e.g., AQ, SMOS) and under-flights, if available
  - *Validation:* Consider for validation those ground targets and other mission data products that are well calibrated and themselves validated, and have not been used in calibration
- Prelaunch algorithms and cal models are the starting point for postlaunch calibration
  - Algorithms will be updated based on inflight calibration results and external cal target experience

Internal Calibration Using Built-In Test Data

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Radiometer

- Non-linear correction: Prelaunch characterized to establish correction coefficients; recompute in flight (using data exclusive of RFI)
- Linearized measurements to radiometer front-end (RFE) T_A^{RFE}: Use RFE internal reference load and noise source
- RFE temperature T_A^{RFE} to Feed Horn temperature T_A: Use the lumped model with correlated noise source (CNS) to correct impedance mismatch

Radar

- Remove gain and loss variation from the radar signals
  - Measure transmit power P_t
  - Use Cal Loop data to "normalize" electronics fluctuation of $G_R L_T L_R$ in the radar signal equation
- Cal Loop data provides attenuated loop back transmit signals; can be used for pulse compression
- Internal load path data provide receiver variation estimates and one "temperature" for estimating system noise
- CNS RFE reference for RBA losses

- The techniques and algorithms for internal calibration will be demonstrated before flight, with prelaunch as-tested/calibrated data for reference

External Calibration for End-to-End Reference

Radiometer

- Targets to determine T_B bias and its (long-term) drift
  - Antarctica Dome-C: T_B ~ 200K
  - Open Ocean: T_B ~ 100K
  - Cold Sky: T_B ~ 3–15K (TBC) stable
- Determine antenna pointing and product geo-location
- Cross-calibrate sub-band and full-band measurements
- Assess factors in the APC
  - Compare Earth-looking correction with cold-sky correction to refine APC

Cross Calibration and Validation

- Compare with Aquarius and ESA SMOS L1 products
  - Leverage Aquarius and SMOS validation experience and personnel expertise

Radar

- Targets for determining post-processed system performance and stability
  - Amazon: track σ_0 stability ~0.2 dB
  - Open Ocean: track σ_0 stability ~0.1 dB
    - Fit wind model with low-res data and ancillary wind data
    - Apply wind model to low-res data processing to evaluate residual error
  - Cold Sky: Known noise source, for noise system noise estimate
  - Corner reflectors on a dry lake bed for assessing impulse response
- Determine antenna patterns, antenna pointing and product geo-location
  - Feedback antenna residual errors to radiometer
- Cross-calibrate high-res and low-res products

L1 Cal/Val Activities During Commissioning

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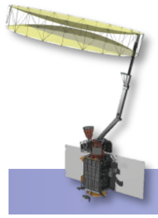
- Shadow instrument commissioning and use data acquired during commissioning to verify Science Data System functionality, including Cal/Val processes
- Process data to characterize initial system performance, assess stability, and determine systematic biases
  - Compare results with prelaunch and Cal/Val site data

S = deployment/spin-up subphase complete

*	L+10D	Instrument health check	Reflector stow; feed to sky; radar/ radiometer on	Obtain cold sky observation; ascertain no radar-radiometer interference; exercise internal cal scheme
*	L+40D	Instrument non-spin test	Reflector deployed; non-spin; radar/radiometer on	Exercise internal calibration and antenna pattern correction
	L+53D [S+02D]	Instrument timing/ pointing test	Reflector spinning; radar/ radiometer on	Exercise calibration processing; evaluate SAR processing; determine antenna pointing, PRI timing
	L+56D [S+05D]	Instrument RFI survey	Reflector spinning; radar rec-only	Exercise calibration processing, including noise estimation and RFI mitigation
	L+64D [S+13D]	Instrument thermal stabilization	Reflector spinning; radar/ radiometer on	Extract data to observe system stability and trending Establish system resolution
	L+71D [S+20D]	Instrument ops starts	Reflector spinning; radar/ radiometer on	Continue to observe system stability
§	L+89D [S+38D]	1st cold sky cal maneuver	Reflector spinning; radar/ radiometer on	Determine radiometer system bias and estimate radar internal noise

** Pending flight system thermal assessment*

§ Earlier if commissioning margin (18 days) not expended



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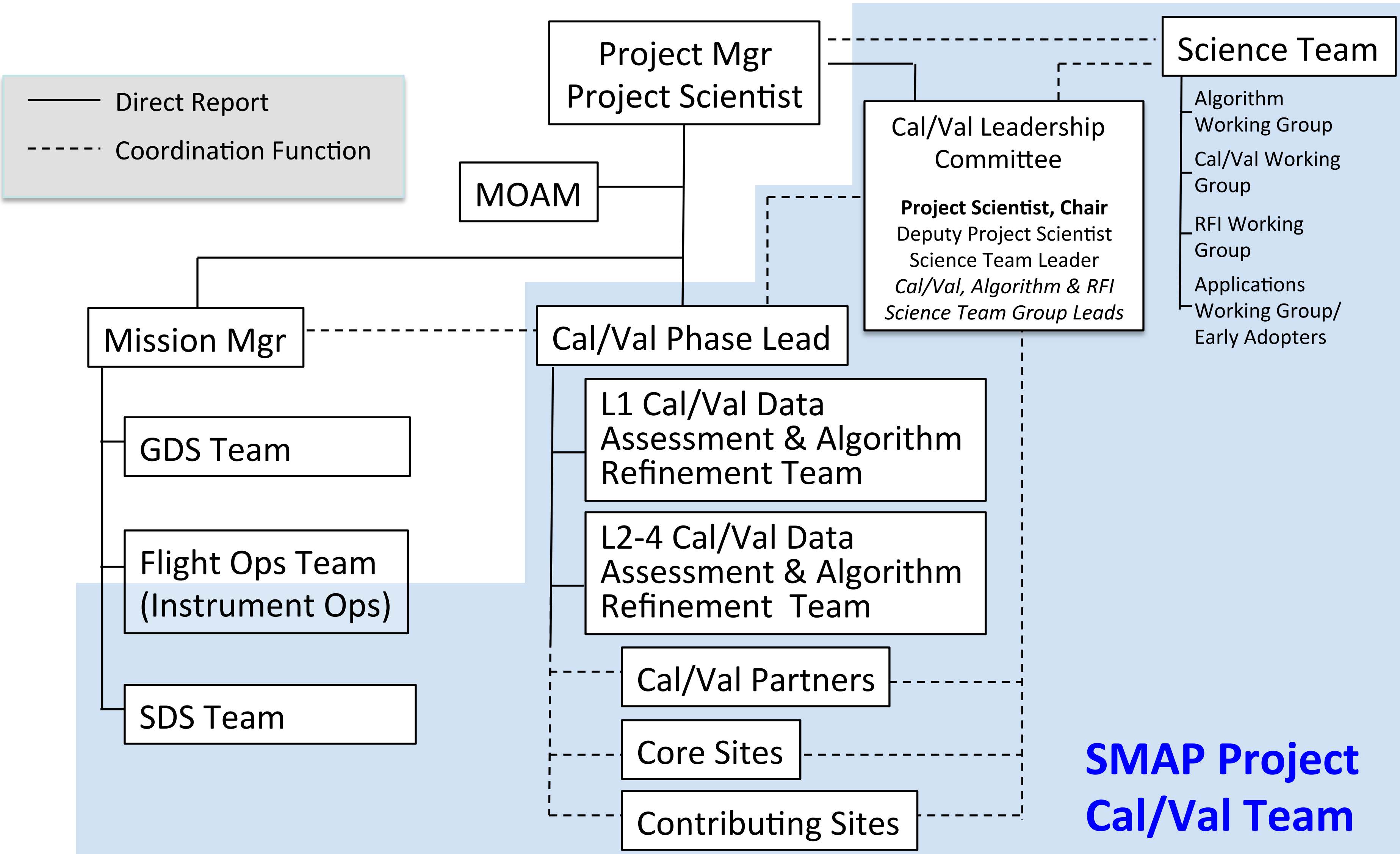
Cal/Val Organization



Cal/Val System Environments

Five distinct computational environments will support mission calibration and validation efforts:

Research and Analysis

Tools that assess current output, provide insight for correction and improvement

Software Development

Workspace to implement new software or existing software with modified parameters

Science Data Systems Integration and Test

Ensures that new or modified software will function in operations environment

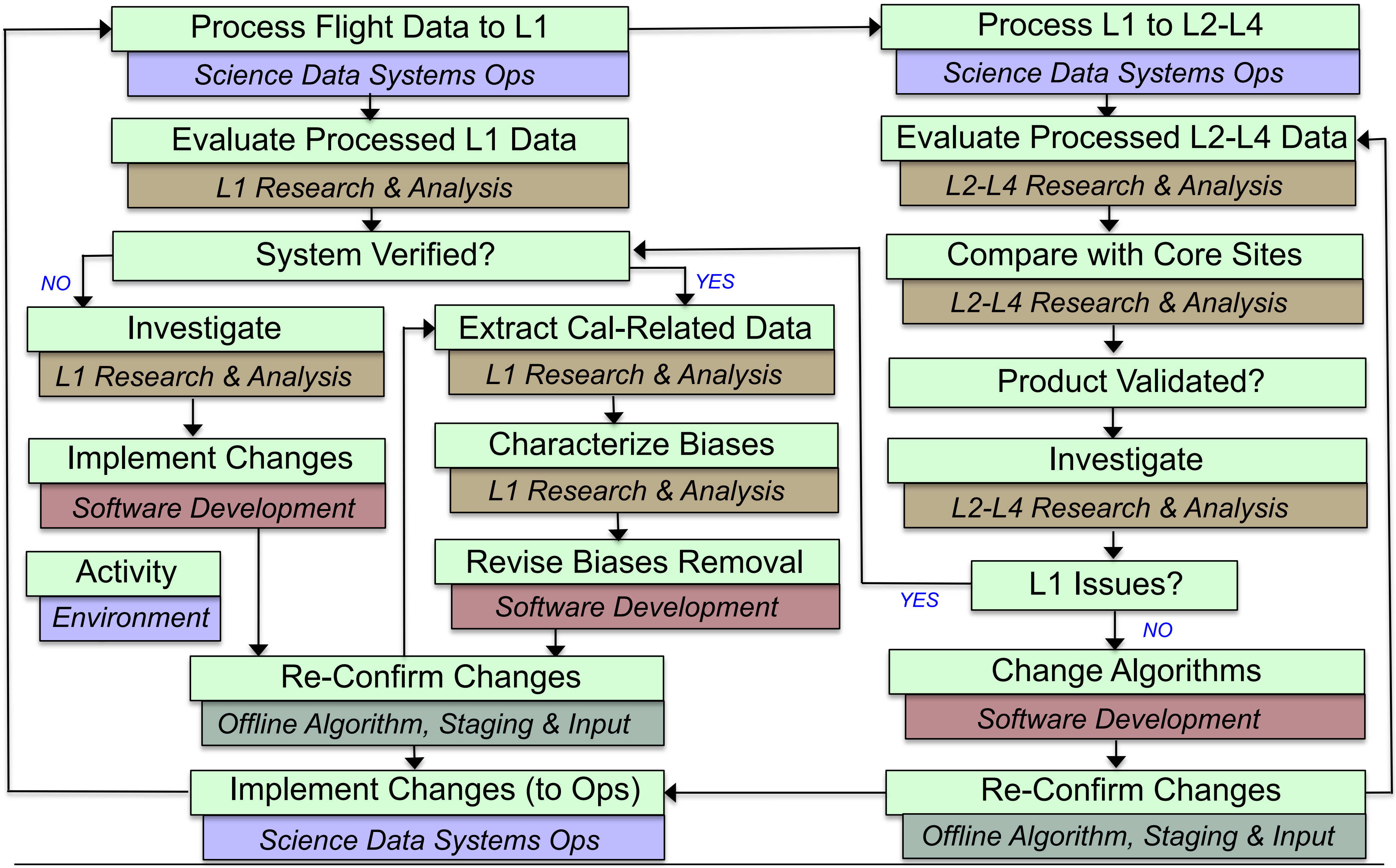
Science Data Systems Operations

Automated Data Production for Product Users
Employs Rigorous Configuration Control

Offline Algorithm and Staging and Input System (OASIS)

Flexible Shadow of Science Data System Operations
Runs specific test algorithms and parameters in a selected stream with selected data

Cal/Val System/Data Flow/Environments



Summary of Cal/Val Peer Review Results

- Commissioning Phase Peer Review held on October 3, 2012
  - board report dated October 18

- Review Board:

• Randall Friedl, chair	Shannon Brown	Ted Engman
• Shawn Goodman	Yunjin Kim	Dara Entekhabi
• David Perz	David Schimel	Edward Wollack
• Simon Yueh	Frank Wentz	

- Three Findings:
  - see subsequent pages… responses incorporated into advisory responses

- Thirty-two RFA Advisories:
  - grouped responses indicated below
  - will be referenced as development of cal/val plans continue

Assessment Findings

- Cal/val requirements are well understood; cal/val plan is comprehensive and complete; cal/val approaches and methodologies are credible and thorough
- A few issues were of particular concern
  - Tight timeline between now and validated products release: Need cal/val phase lead as early as possible; ensure OASIS in place and functional for rehearsals and flight operations cal/val
  - Rapid post-launch data turnaround and release, data quality flagging, and rapid data evaluation by cal/val and science teams
  - Validation highly challenging with all the envisioned external sites and activities; needs prioritization and coordination
- 32 RFAs, all accepted as advisory
  - Concerns spit into three groups: Calibration (14 RFAs), Validation (13 RFAs), Science Data System (5 RFAs)
  - Only portion of RFAs apply to Mission System; the remainder apply to Science

RFA Summary (1/2)

MS?	RFA #s	Concern	Response
yes	Cal 3, Cal 7, Cal 8, SDS 5	Instrument calibrations will likely vary over time: How will this variability be handled in the algorithms; are there sufficient reprocessing resources in SDS; does Science have the resources for repeat calibration?	Discussion among Cal/Val lead, SDS team, and Science team within integrated Cal/Val organization about algorithms and interfaces for periodic calibration updates. Ensure OASIS has infrastructure and resources for partial (and perhaps complete) cal-related reprocessings. SDS to examine possibility of additional official reprocessings with updated calibrations.
yes	Cal 1, Cal 2, Val 4, Val 6, SDS 1, SDS 3	There is a tight timeline between now and validated product release: Need improved cal/val schedule and planning prior to launch, in the cal/val phase, and for the remainder of mission.	Cal/Val planning and scheduling will mature after Cal/Val lead and team are chosen in near future. The SDS and MS will ensure that systems and tools are available and adequate for Rehearsals, as plans become finalized, and for flight ops. Evaluate if rehearsal scope can include evaluating post-launch data turnaround, data quality evaluation, and data flagging.
yes	Cal 4, Cal 10, Cal 13, SDS 2	Near-term planning tasks such as on-orbit simulator, joint L1/L2 cal coordination issues, cal/val during IOC, OASIS requirement definitions for cal/val.	Cal/Val lead and integrated cal/val organization will work these planning issues with MS, ISE and Science over next several months.

RFA Summary (2/2)

MS?	RFA #s	Concern	Response
yes	Val 11, Val 12	RFI is challenging: RFI mitigation schemes require verification; cal/val sites may have excessive RFI contamination.	SDS and IOT are developing and testing RFI processing tools for L1 corrections. RFI phenomenology in L2-L4 products is a Science question, as are RFI issues with cal/val site selection.
yes	Cal 5, Cal 9	Cross-calibration with other satellites and missions requires more detail and planning.	The cal/val lead and integrated cal/val team will work to ensure data access and tool availability for any needed L1 cross calibration. Details of cross-calibration algorithms to be developed by Science.
no	Cal 6, 11, 12, 14, Val 1, 2, 3, 5, 7, 8, 9, 10, 13, SDS 4	Various Cal/Val site issues, cal/val algorithm questions and L2-L4 science questions.	Cal/Val Site issues are allocated to Science. Science will refine use of calibration sites for Tb, soil moisture, sigma0, etc. Science will spearhead prioritization and coordination of external calibration sites and site activities.

Summary

- The cal/val plan is comprehensive and complete
  - Scope of work, procedure and tool development schedule, rehearsal timeline, and rapid operational data turn around are all ambitious
  - Integrated cal/val team under cal/val lead will form in very near future to address these issues
- The cal/val approach and methodologies are credible and rigorous
  - A number of challenges exist, but these will be dealt with by the Science portion of the integrated cal/val team
  - These include validation site planning, calibration accuracy, cross-pol and inter-frequency calibration, etc.
- The implementation of the pre-launch cal/val plan is on track
  - Considerably more work lies ahead
  - Details of cal/val processes and procedures will be developed over the next few months

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SMAP Science Data Products

Product Short Name	Product Description	Requirement	Gridding(Resolution)	Delivery Latency
L1A_Radar	**Radar raw data in time order**	–	–	12 hours
L1A_Radiometer	**Radiometer raw data in time order**	–	–	12 hours
L1B_S0_LoRes	**Low resolution radar σ_0 in time order**	–	(5x30 km)	12 hours
L1B_TB	**Radiometer T_B in time order**	H, V ≤ 1.3K	(36x47 km)	12 hours
L1C_S0_HiRes	**High resolution radar σ_0 (in half orbit, gridded)**	HH, VV ≤ 1.0 dB HV, VH ≤ 1.5 dB	1 km (1-3 km)**	12 hours
L1C_TB	**Radiometer T_B (in half orbit, gridded)**	H, V ≤ 1.3K	36 km	12 hours
L2_SM_A	Soil moisture (radar, half orbit)	≤ 0.06 cm3/cm3	3 km	24 hours
L2_SM_P	Soil moisture (radiometer, half orbit)	≤ 0.04 cm3/cm3	36 km	24 hours
L2_SM_A/P	Soil moisture (radar/radiometer, half orbit)	≤ 0.04 cm3/cm3	9 km	24 hours
L3_F/T_A	Freeze/thaw state (radar, daily composite)	≥ 80% class. acc.	3 km	50 hours
L3_SM_A	Soil moisture (radar, daily composite)	≤ 0.06 cm3/m3	3 km	50 hours
L3_SM_P	Soil moisture (radiometer, daily composite)	≤ 0.04 cm3/cm3	36 km	50 hours
L3_SM_A/P	Soil moisture (radar/radiometer, daily composite)	≤ 0.04 cm3/cm3	9 km	50 hours
L4_SM	Soil moisture (surface & root zone)	≤ 0.04 m3/m3	9 km	7 days
L4_C	Carbon net ecosystem exchange (NEE)	≤ 1.6 g C m^{-2} d^{-1}	9 km	14 days

* Mean latency under normal operating conditions. Latency is defined as time from data acquisition by the observatory to availability to the public data archive. The SMAP project will make a best effort to reduce these latencies.

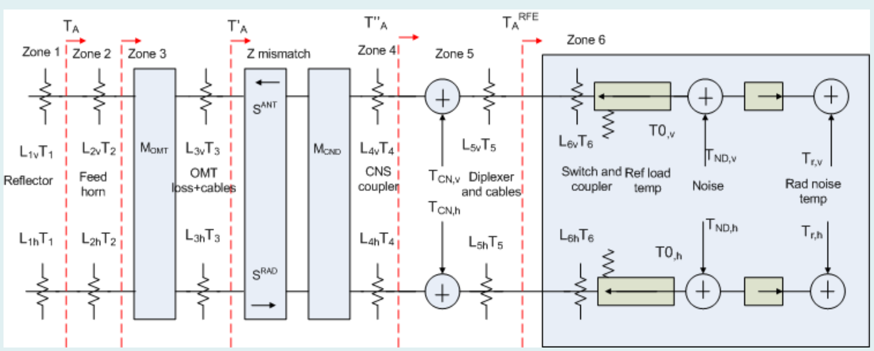
** Over outer 70% of the swath.

Instrument Calibration Models

- The instrument calibration model depicts the end-to-end relation from the antenna to the back-end electronics
- The calibration model is also used to prescribe prelaunch characterization for and as-tested calibration data set from prelaunch V&V

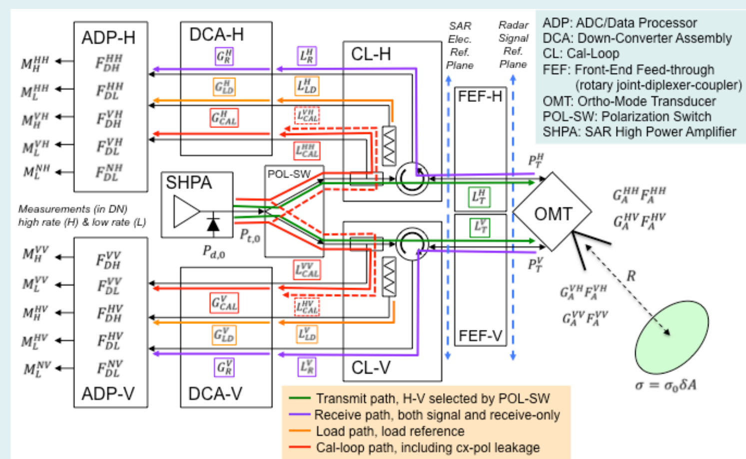
Radiometer

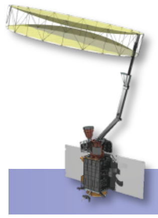
- Divide into zones of losses and temperatures between measured temperature T_r and antenna temperature T_A at the feedhorn
- Include two built-in noise sources and a reference load



Radar

- Designate signal paths through assemblies from digitized measurements to the OMT
- Include cal loop back, load, receive-only paths





Internal Calibration over Scan

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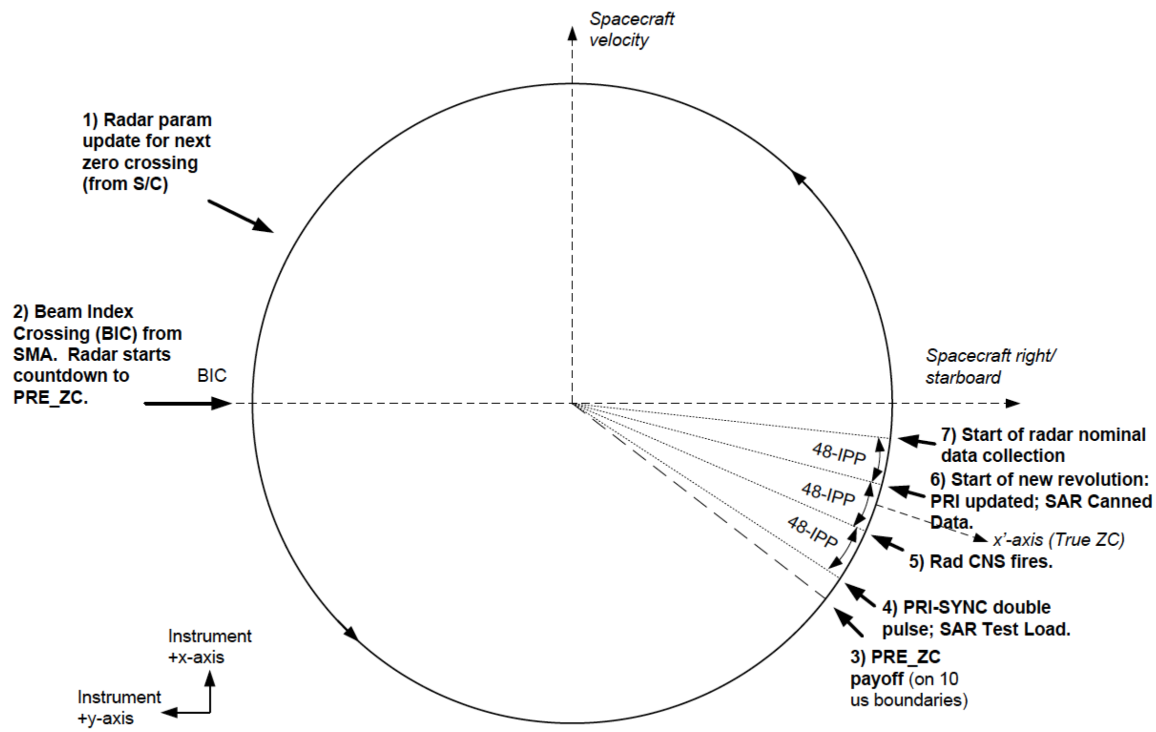
- Internal calibration performed regularly over scan.
- Radiometer:
  - *Noise diodes and reference load "looks" programmable (nominally two firings each per 48 PRI's)*
  - *96 PRI's of Correlated Noise Source (CNS) looks every scan at edge.*



- Radar:
  - *Loop-back power averaged over 48 PRI's. "Loop back trap" 16 times per rotation.*
  - *Ambient load, canned data, and RAD CNS viewed once per rotation.*
  - *"RFI sniffing scan" every 5 minutes (programmable).*

Antenna Correction and External Source Removal

Radiometer

- Detect and minimize RFI contamination to the calibrated T_A measurements
- Antenna pattern correction (APC) converts T_A to T_B: Remove antenna pattern error and other unwanted emission sources detected by the antenna
- Faraday rotation estimates correct polarization state changes
  - Estimated using T_3; correction applied using the APC
  - Use ancillary total electron content (TEC) to calculate rotation angle and apply the correction
- Atmospheric correction, including loss

Radar

- Detect and reduce RFI
- Estimate noise and subtract noise from measurements
- Use prelaunch antenna patterns but estimate residuals from external calibration site data
- Faraday rotation estimates correct polarization state changes
  - Use ancillary TEC to calculate rotation angle and apply the correction
  - Use estimated one-way rotation supplied from T_3 and apply correction
- Correct for topography effects

Offline Algorithm Staging and Input System (OASIS)

- Enables software and algorithm development teams to ascertain the impact of changes over several executable steps in the processing pipeline
- Enables the SMAP team to ascertain the impact of changes over a large number of datasets
- Provides a means to verify the impact of proposed changes before submission to a Change Control Board
- The environment is flexible. Team members can configure test runs. Testers may choose:
  - A specific pipeline to test
    - Can select one specific SPS, or a specific series of SPSes that run in tandem.
  - The algorithmic approach
    - Can modify the content of parameter files, or replace an executable with another that contains modified logic.
  - The test data set
    - Can select a single orbit, a single day, a single orbit cycle, or some other data set that best represents the test requirements.

Cal/Val Team Interactions

- Combination of: (1) Regular meetings, (2) Scheduled workshops

Timeframe	(1) Meetings	Frequency
Now till L–12M	Coordination Group for L1-L4 Cal/Val	Bi-Weekly
L–12M to L–6M	Coordination Group for L1-L4 Cal/Val	Bi-Weekly (more frequently, as needed for ORTs and Rehearsals)
L–6M to L+6M	Cal/Val Team Meeting	Weekly (more frequent during IOC and afterwards, as needed)
L+6M to L+15M	Cal/Val Team Meeting	Weekly
L+15M to EOM	Cal/Val Team Meeting	Bi-Weekly

Timeframe	(2) Workshops	Primary Purpose
Nov 14-16/2012	3rd Pre-launch Cal/Val Workshop	Rehearsal planning
L–12M	4th Pre-launch Cal/Val Workshop	Rehearsal-I results & Rehearsal-II planning
L–3M	5th Pre-launch Cal/Val Workshop	Rehearsal-II results & final preparations
L+5M	1st Post-launch Cal/Val Workshop	Preliminary cal/val results
L+8M	2nd Post-launch Cal/Val Workshop	Pre-release review of L1 validated data
L+14M	3rd Post-Launch Cal/Val Workshop	Pre-release review of L2+ validated data

Current scheduled meeting (light purple)
Current weekly Algorithm Development Team meeting will transition to Cal/Val Team meeting at L-12M to L-6M (teal)

RFA Summary (1/3)

RFA #	Initiator	Concern	Response
Cal 1	Goodman	Cal/val planning not enough margin for first 90 days for product release	Ensure sufficient workforce to support cal/val over first 6-12 months
Cal 2	Goodman	Need improved cal/val scheduling and milestones to chart progress	Wait for cal/val lead to work
Cal 3	Entehabi	Insufficient reprocessing plans and resources for all cal opportunities and implementations	Ensure OASIS has infrastructure and resources for complete and partial cal-related reprocessings
Cal 4	Wentz	On-orbit simulator for SMAP: insufficient detail	Cal/val lead to coordinate with SDS and Science personnel. Who is to respond?
Cal 5	Kim	Cross-calibration plan for other satellites	Group with Cal 9. L1 cross calibration: ensure data access to other sources; data tools for L1 product comparisons; details of comparison strategies to be developed with Science.
Cal 6	Brown	No plans or requirements for rad/SAR inter-calibration	Primarily L2, but may affect L1 tools in future if needed
Cal 7	Yueh	How to deal with time-varying calibrations in processing system	Combine with SDS 5 and Cal 8. Need SDS infrastructure for implementing time-variable cal model. Also question to Science team how to evaluate and implement cal drifts.
Cal 8	Engman	How to update rad calibration and reprocess if drift detected	Combine with Cal 7 and SDS 5.
Cal 9	Goodman	How to best use data from other relevant missions for calibration.	Group with Cal 5.
Cal 10	Brown	Need better connection between L1B and L2 and higher calibration steps	Will have dedicated instrument cal/val workforce to interact with L2+ cal/val as needed, as well as with L1B as planned. Science needs to interact with this instrument team

RFA Summary (2/3)

RFA #	Initiator	Concern	Response
Cal 11	Brown	Third Stokes and Faraday rotation correction	Science algorithm question (although part of the L1B algorithm)
Cal 12	Yueh	Need improved post-launch cross-pol calibration plan	Science algorithm question (although part of the L1B algorithm)
Cal 13	Kim	cal/val opportunities during instrument non-spin period	Will evaluate possibility for additional cal/val steps during this test.
Cal 14	Brown	sub-band intercalibration of radiometer	Radiometer science question
Val 1	Schimel	Not enough resources for full cal site evaluation and data assimilation	Science L2-L4 question
Val 2	Goodman	Minimum number of cal/val sites needed	Science L2-L4 question. Answer will affect MS LUT planning, however. (RFA references L1 requirement, but cal sites are considered by definition outside MS domain)
Val 3	Friedl	Need improved L2-L4 product validation plans	Science L2-L4 question
Val 4	Wollack	Need Cal/Val Phase Lead and improved schedule and plans	Wait for cal/val lead and integrated team
Val 5	Yueh	More detail and responsibilities needed in soil moisture cal/val scheme	Cal/Val lead and Science L2-L4 question
Val 6	Perez	Phase 2 pre-launch planning inadequate.	Wait for cal/val lead and integrated team.
Val 7	Wentz	Define better procedure for determining Tb accuracy	Although Tb is L1 product, calibration depends on how to use cal sites
Val 8	Friedl	Absolute cal/val of Antarctic Tb	Although Tb is L1 product, calibration depends on how to use cal sites

RFA Summary (3/3)

RFA #	Initiator	Concern	Response
Val 9	Wentz	Spatial resolution of Tb and soil moisture	Science L2-L4 question
Val 10	Kim	Soil moisture calibration and core sites	Science L2-L4 question
Val 11	Wentz	RFI mitigation verification	Group with Val12. Large part of RFI mitigation will be verified by L1 and IOT. RFI phenomenology in L2-L4 product is a Science question
Val 12	Goodman	Cal/val sites and RFI contamination	Group with Val 11.
Val 13	Goodman	Use of opportunity/complementary validations sites	Science L2-L4 question
SDS 1	Entekhabi	SDS software and procedure prep for Phase 2 Rehearsal	Wait for cal/val lead to clarify timeline, workforce, etc. Use of L2-L4 cal sites in SDS software.
SDS 2	Yueh	Need improved OASIS user requirements and plans	Wait for cal/val lead. General SDS requirements need refinement
SDS 3	Engman	Need schedule for pre-launch tool development	Wait for cal/val lead.
SDS 4	Perz	How to detect cal issues in out years	Science L2-L4 question
SDS 5	Brown	How to implement drifting rad corrections in software with limited reprocessings	Combine with Cal 7 and 8.