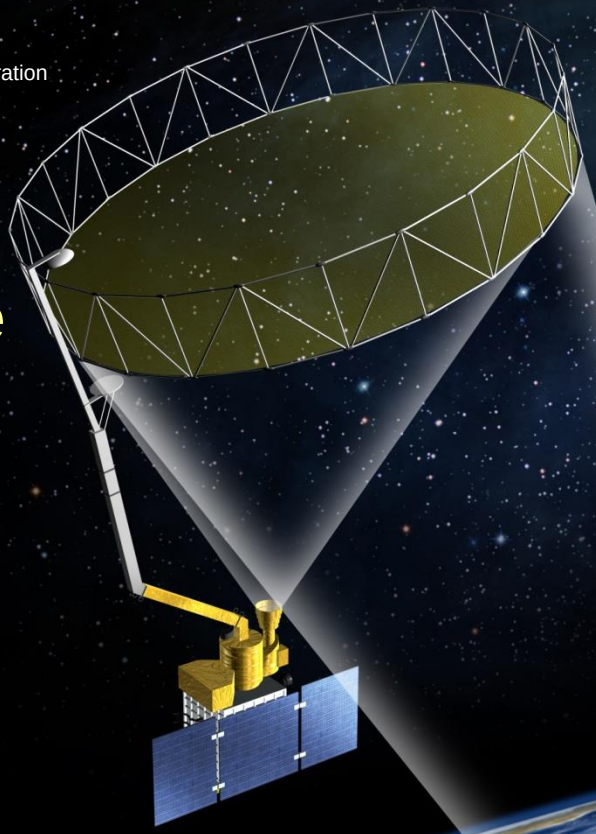
National Aeronautics and Space Administration

Soil Moisture Active Passive Mission

SMAP

4th Cal/Val Workshop



Cal/Val Rehearsal 1: Review of Activities

A. Colliander
Jet Propulsion Laboratory, California Institute of Technology

Outline

Jet Propulsion Laboratory
California Institute of Technology

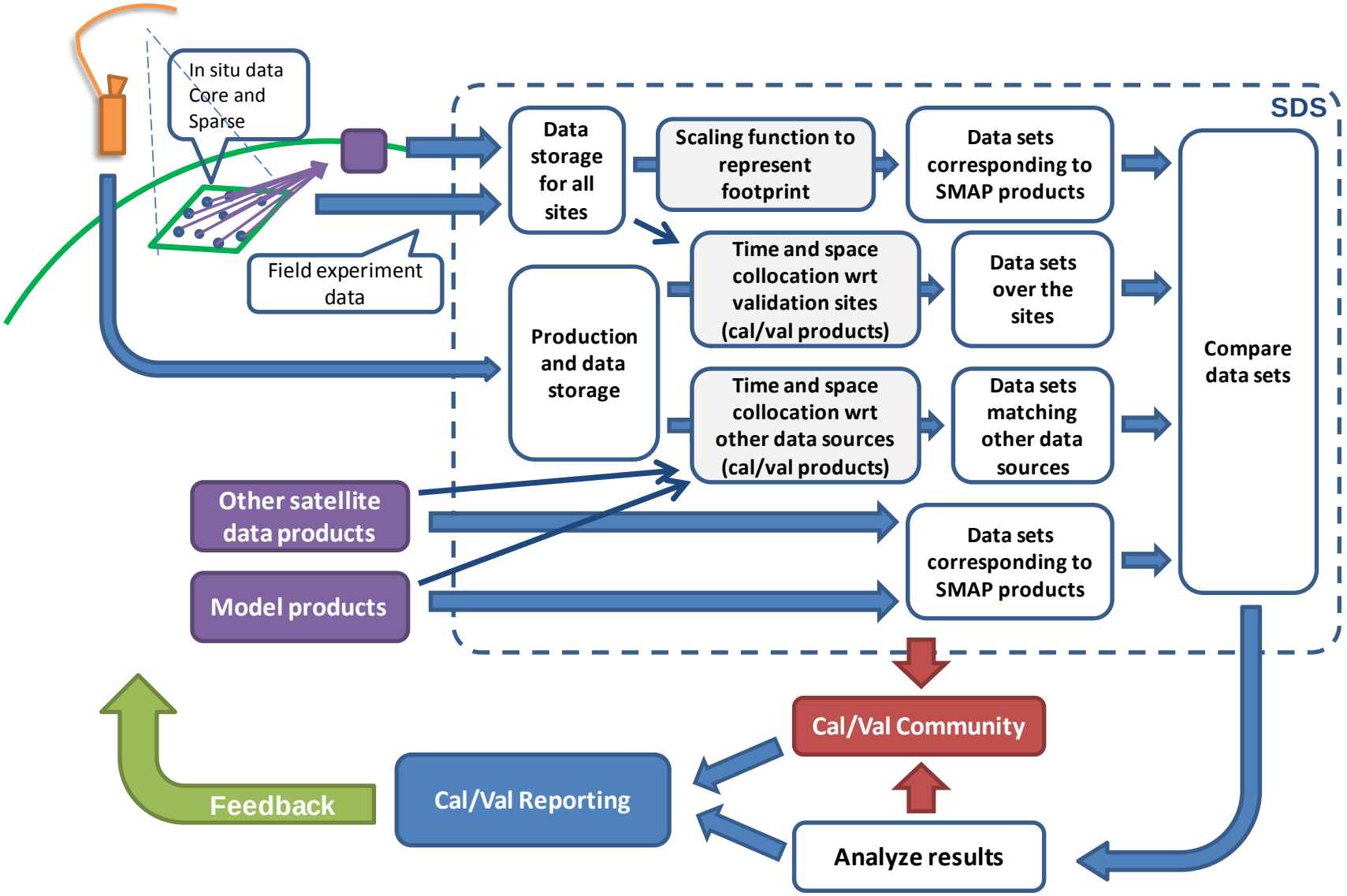
- SMAP L2-L4 Cal/Val Plan Summary
  - Cal/Val data flow
- SMAP L2-L4 Cal/Val Rehearsal-1 Plan Summary
  - Cal/Val data flow in Rehearsal-1
- Cal/Val components exercised
  - Reference pixel comparisons
  - Sparse network comparisons
  - Satellite comparisons
- Summary of achievements

Jet Propulsion Laboratory
California Institute of Technology

SMAP L2-L4 Data Product Cal/Val Plan

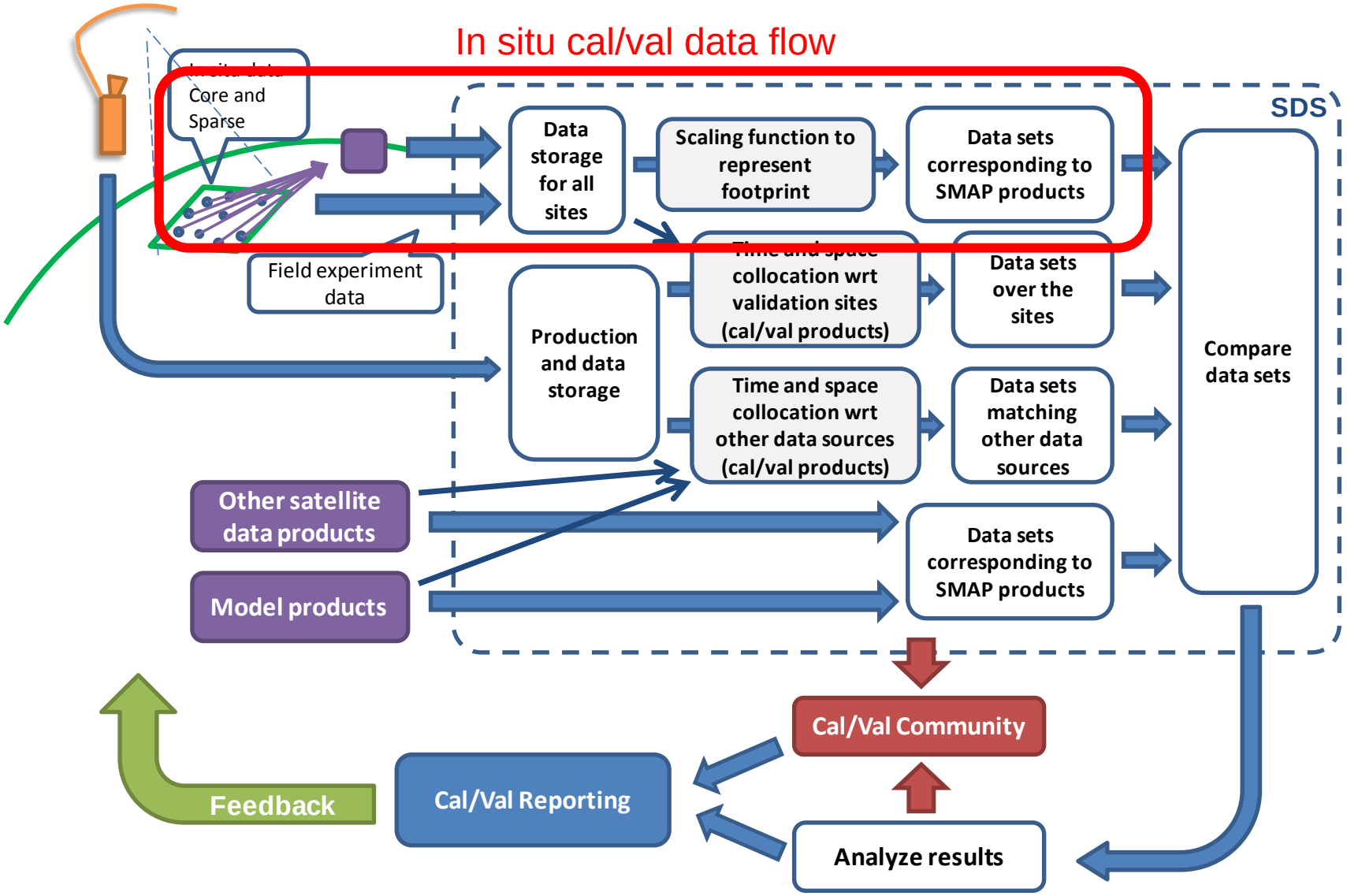
View of Post-Launch L2-L4 Cal/Val Science Operations and Processing Flow

Jet Propulsion Laboratory
California Institute of Technology

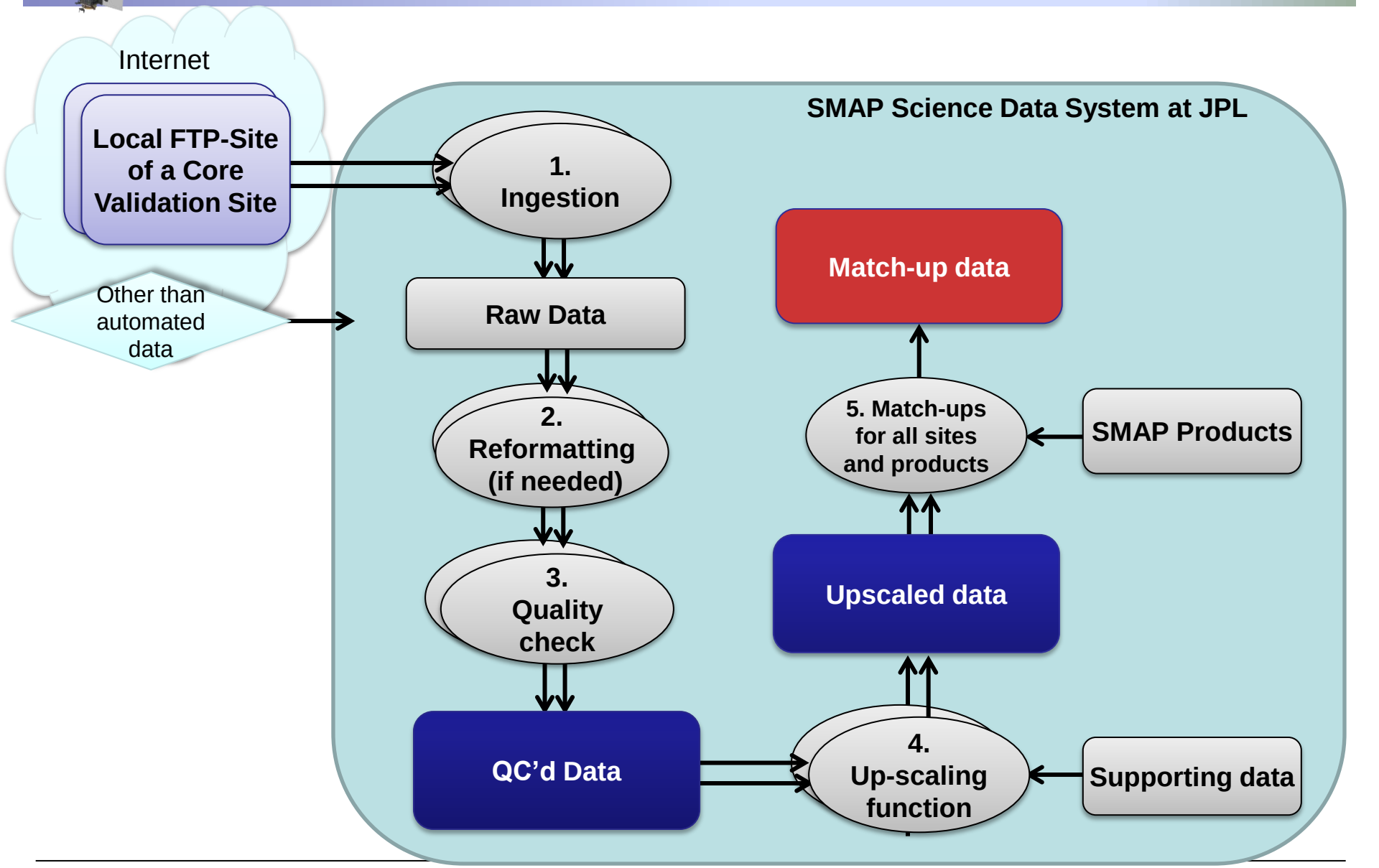


View of Post-Launch L2-L4 Cal/Val Science Operations and Processing Flow

Jet Propulsion Laboratory
California Institute of Technology



In situ cal/val data flow



Cal/Val Process (high level)

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(1) Cal/Val data processing

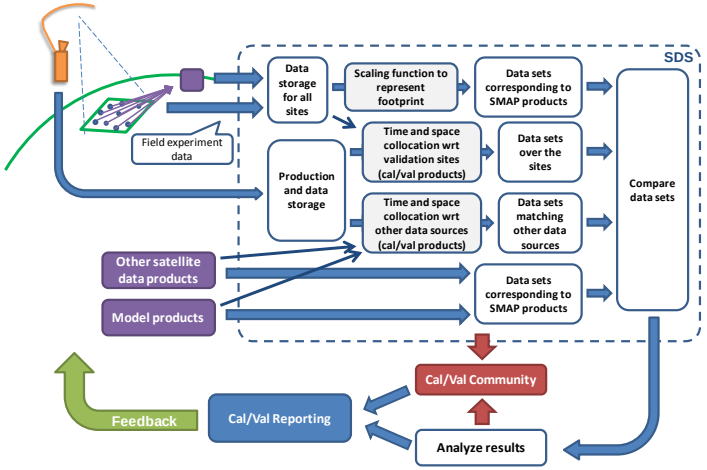
(2) Analyze results

(3a) Validation report

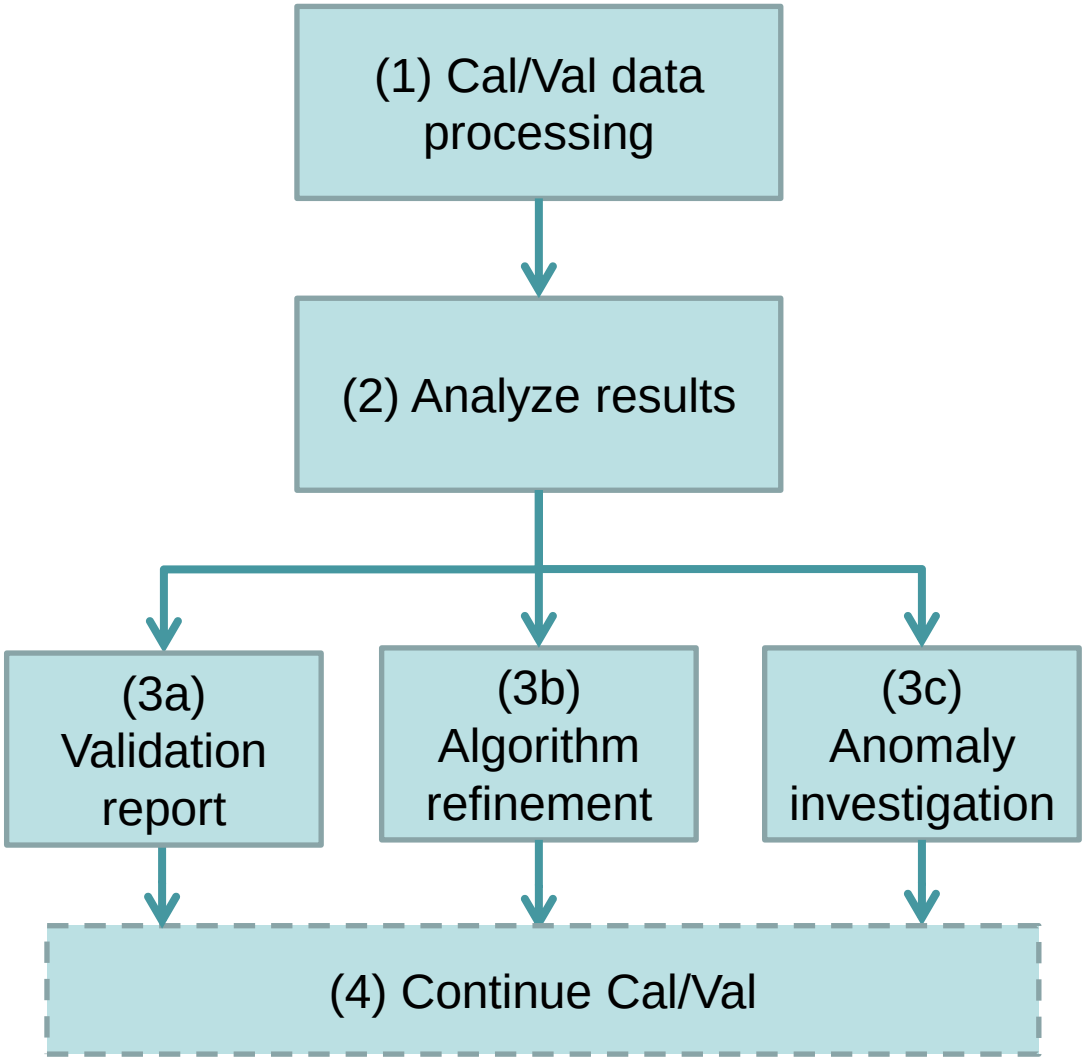
(3b) Algorithm refinement

(3c) Anomaly investigation

(4) Continue Cal/Val



Cal/Val Process (high level)



1. Ingest, QC, Match-up
2. Metrics and other conclusions
3. Actions based on analysis
4. Continue as long as determined by the Project

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SMAP Cal/Val Rehearsal-1 Plan

SMAP Cal/Val Phase 1 Rehearsal Goals

Jet Propulsion Laboratory
California Institute of Technology

- The process and procedures of getting Cal/Val partner data to the SMAP SDS and resolving any ambiguous issues the two sides might have
- Assessing the quality of the data supplied by the Cal/Val partners
- Defining the up-scaling functions for the core sites
- 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

Phase 1 Rehearsal Outline of Activities

Jet Propulsion Laboratory
California Institute of Technology

- Timeline
  - Duration: 10 weeks
  - Phase 1 Rehearsal start: Monday, June 17
  - Phase 1 Rehearsal end: Friday, August 23
- Basic concept for L2-L4 data products
  - Weekly updates of the match-ups and validation metrics (Tuesdays)
  - Analysis, design and development of updates and algorithm refinement tools
  - 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
  - Weekly telecons on Wednesdays to track progress
  - Summary meeting: September 24 (review of results and planning for Phase 2) @JPL
  - 4th Cal/Val Workshop, November 5-7, 2013

Scope of Rehearsal-1

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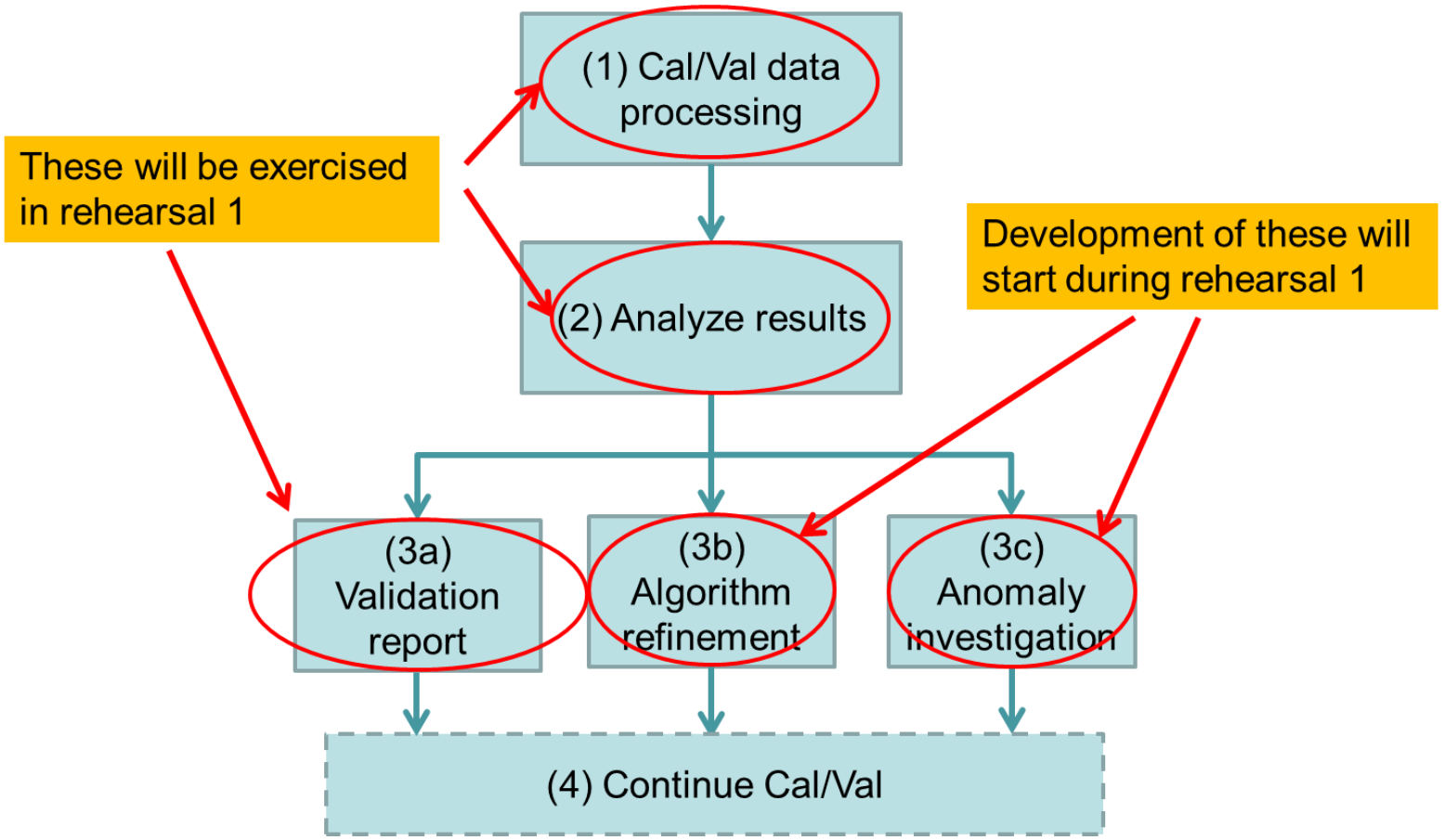
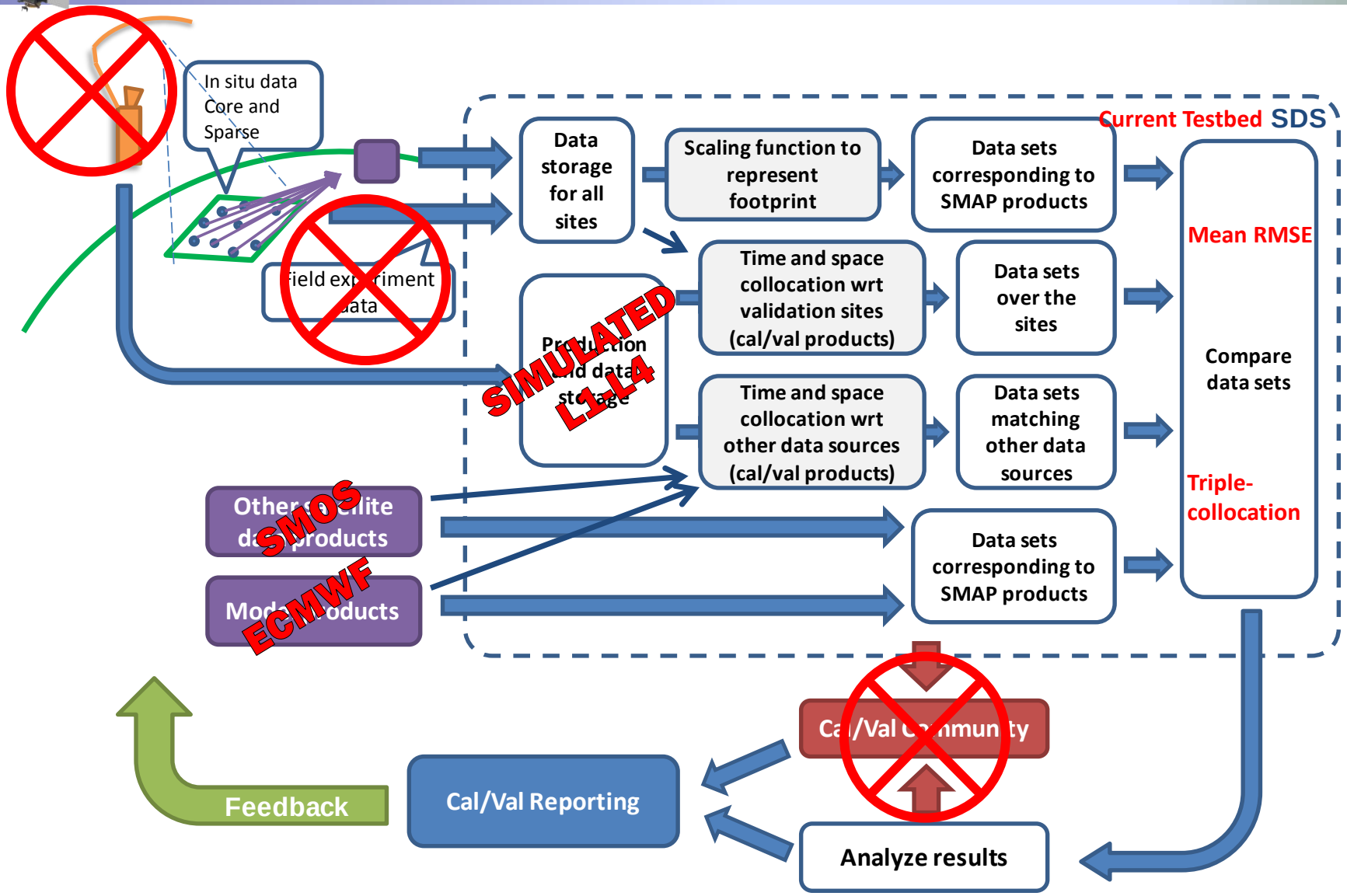


Rehearsal-1 Processing Flow



Overview of Rehearsal-1 Activities: Data sets

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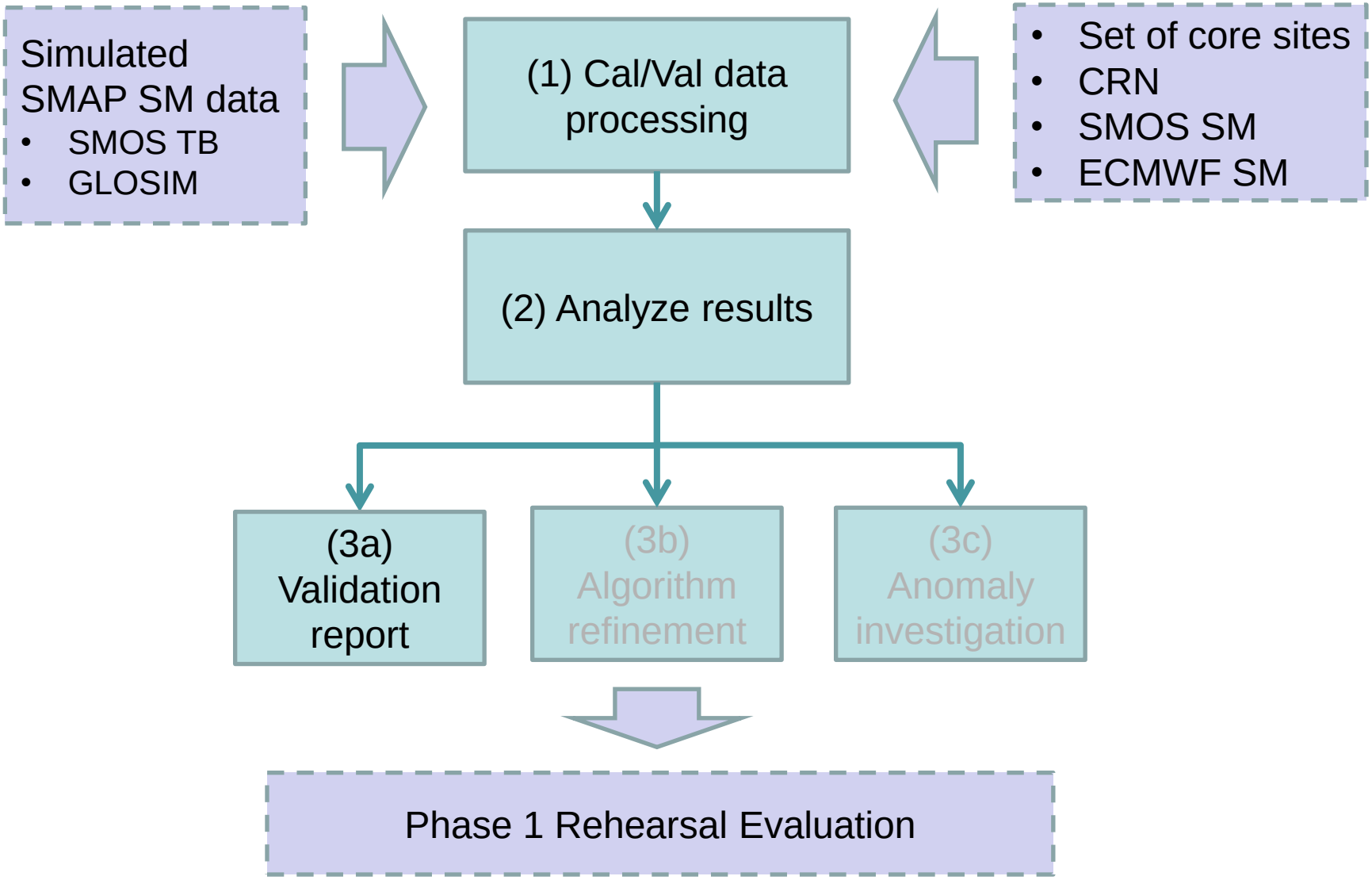

Overview of Rehearsal-1 Activities: SMAP Data Products

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California Institute of Technology

- List of SMAP data products fully involved in Rehearsal-1
  - L1 radiometer
  - L1 radar
  - L2_SM_A
  - L2_SM_P
  - L2_SM_AP
  - L3_SM_A
  - L3_SM_P
  - L3_SM_AP
  - L3_FT_A
  - L4_SM
  - L4_C

- Methodological aspects of soil moisture and NEE exercised
  - The original intention was to include FT as well
- Rigorous exercise of all products will be carried out in Rehearsal-2

Overview of Rehearsal-1 Activities: Validation Resources

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California Institute of Technology

- L2-L4 data product validation resources
  - Core validation sites (reference pixels)
    - Data transfers
    - Reformatting
    - Systematic automated quality checking
    - Up-scaling to SMAP grid resolution
    - Match-ups
  - Contributing validation sites (sparse networks)
    - Application of triple-collocation to estimate scaling associate error and pre-screen stations
    - Multiple combinations of triplets (SMOS, ASCAT, Aquarius, GCOM-W, SAOCOM, ECMWF, NCEP)
  - Other satellite and model-based data products
    - Comparisons over reference pixels
    - Global comparisons directly
    - Triple collocation on global scale
    - Multiple combinations (SMOS, ASCAT, Aquarius, GCOM-W, SAOCOM, ECMWF, NCEP)

Overview of Rehearsal-1 Activities: Validation Resources

Jet Propulsion Laboratory
California Institute of Technology

- L2-L4 data product validation resources
  - Core validation sites (reference pixels)
    - **Data transfers**
    - **Reformatting**
    - Systematic automated quality checking
    - **Up-scaling to SMAP grid resolution**
    - **Match-ups**
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    - Comparisons over reference pixels
    - Global comparisons directly
    - Triple collocation on global scale
    - Multiple combinations (SMOS, ASCAT, Aquarius, GCOM-W, SAOCOM, ECMWF, NCEP)

Reference Pixel Comparisons (Core Validation Sites)

In situ cal/val data flow

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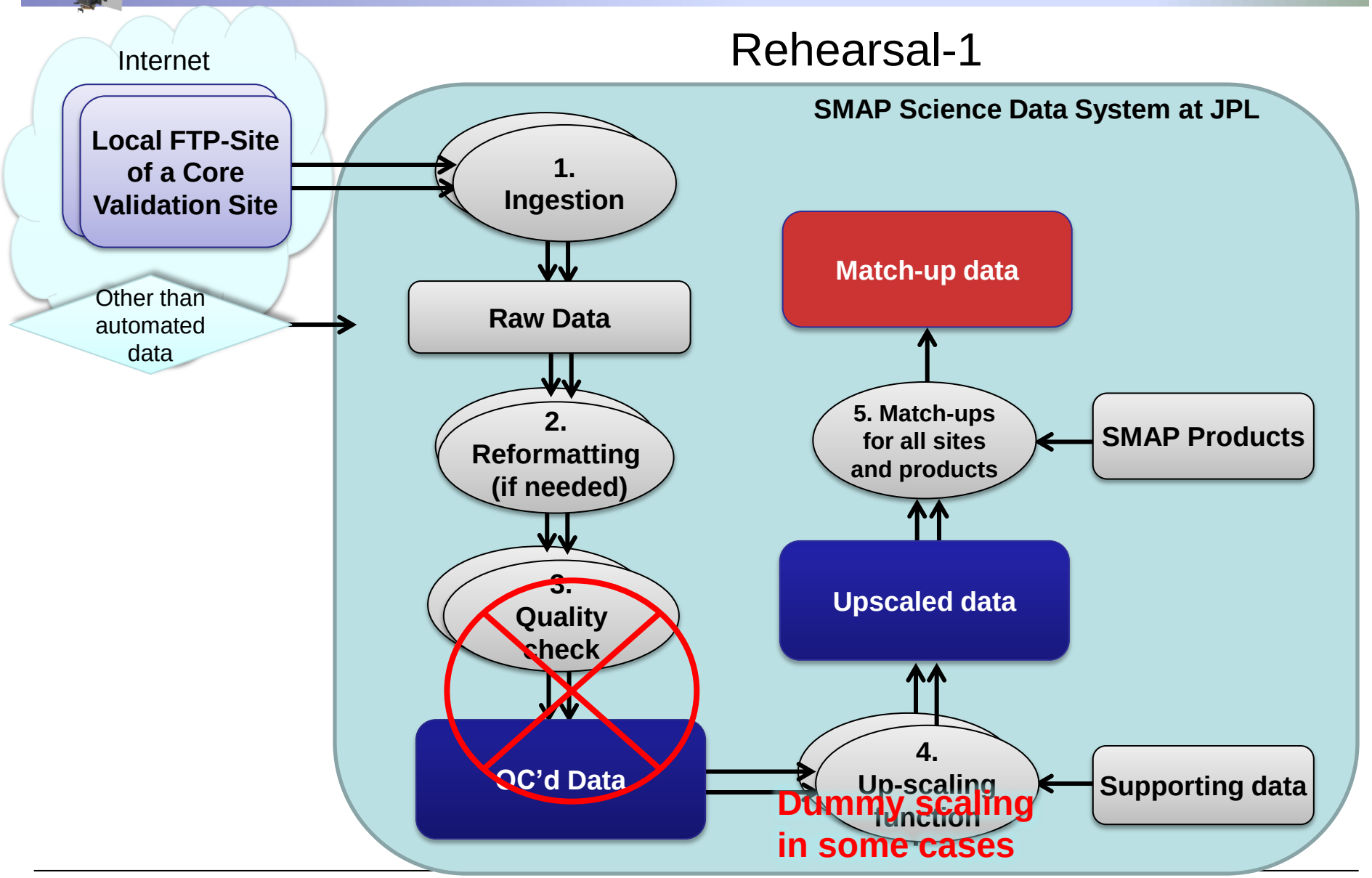
Rehearsal-1



Updated comparisons: Map of reference pixels (w. climate regions)

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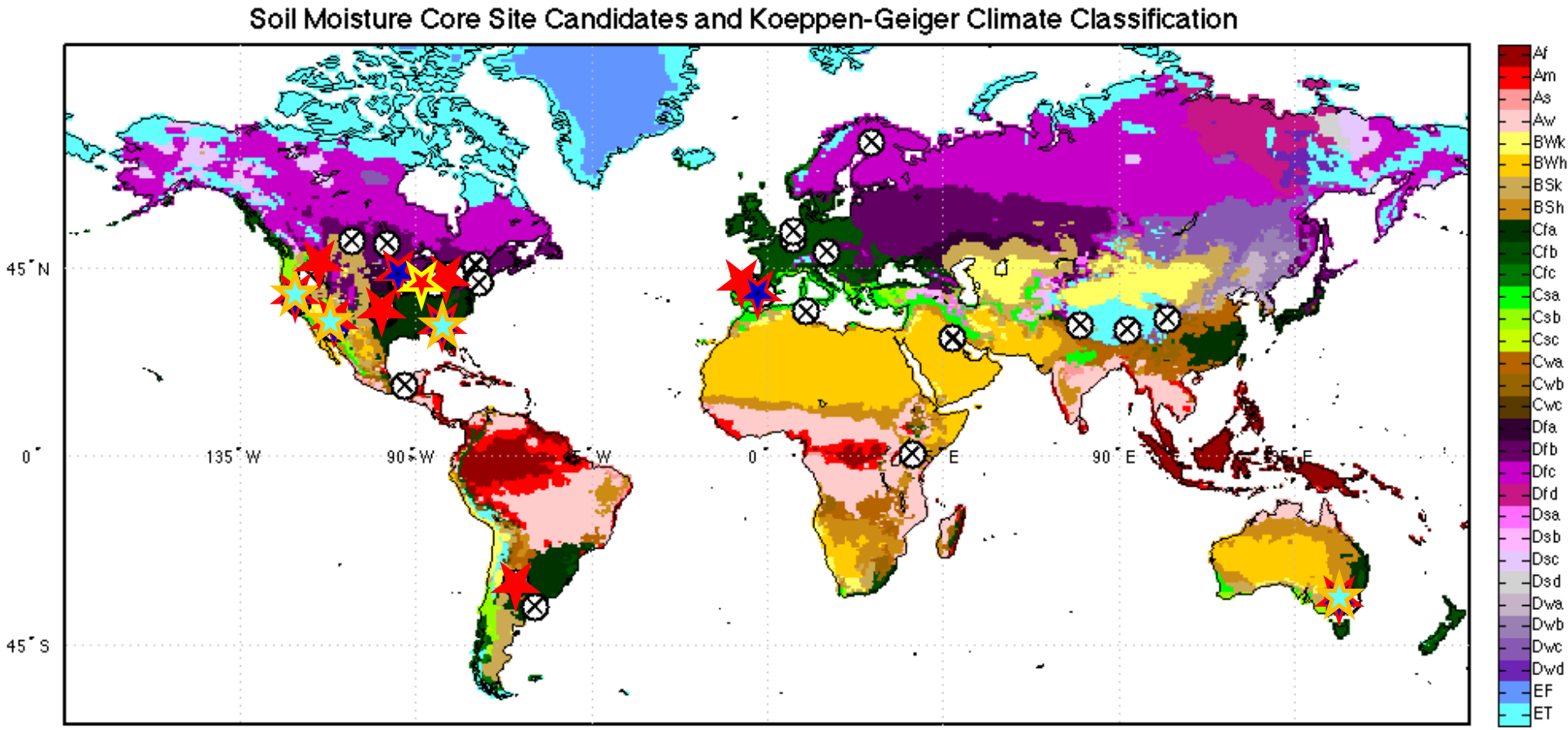

Current 36-km SM reference pixels
Current 9-km SM reference pixels
Current 3-km SM reference pixels

Current 9-km NEE reference pixels

Rehearsal-1 processing status (as of 9/23)

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- In situ data transfers (SM)
  - Automated pull running
    - REMEDHUS (#03)
    - Reynolds Creek (#04)
    - Carman (#09)
    - ARS (#16)
    - FMI (#17)
    - SAOCOM (#19)
    - SoilSCAPE (#25)
    - Valencia (#41)
  - Automated pull ready to start
    - TERENO (#02)
    - Zapotes (#32)
  - Initials setup but some further details need to be worked out
    - Monash (#07)
  - Work needed
    - Saskatoon (#27)
- In situ data transfers (NEE)
  - Automated pull running
  - Automated pull ready to start
    - Scott (#39)
    - Euskirchen (#35)
  - Initials setup but some further details need to be worked out
    - Pulliainen (#17)
    - Desai (#36)
  - Work needed

Updated comparisons: L2_SM_P ref pixel time-series

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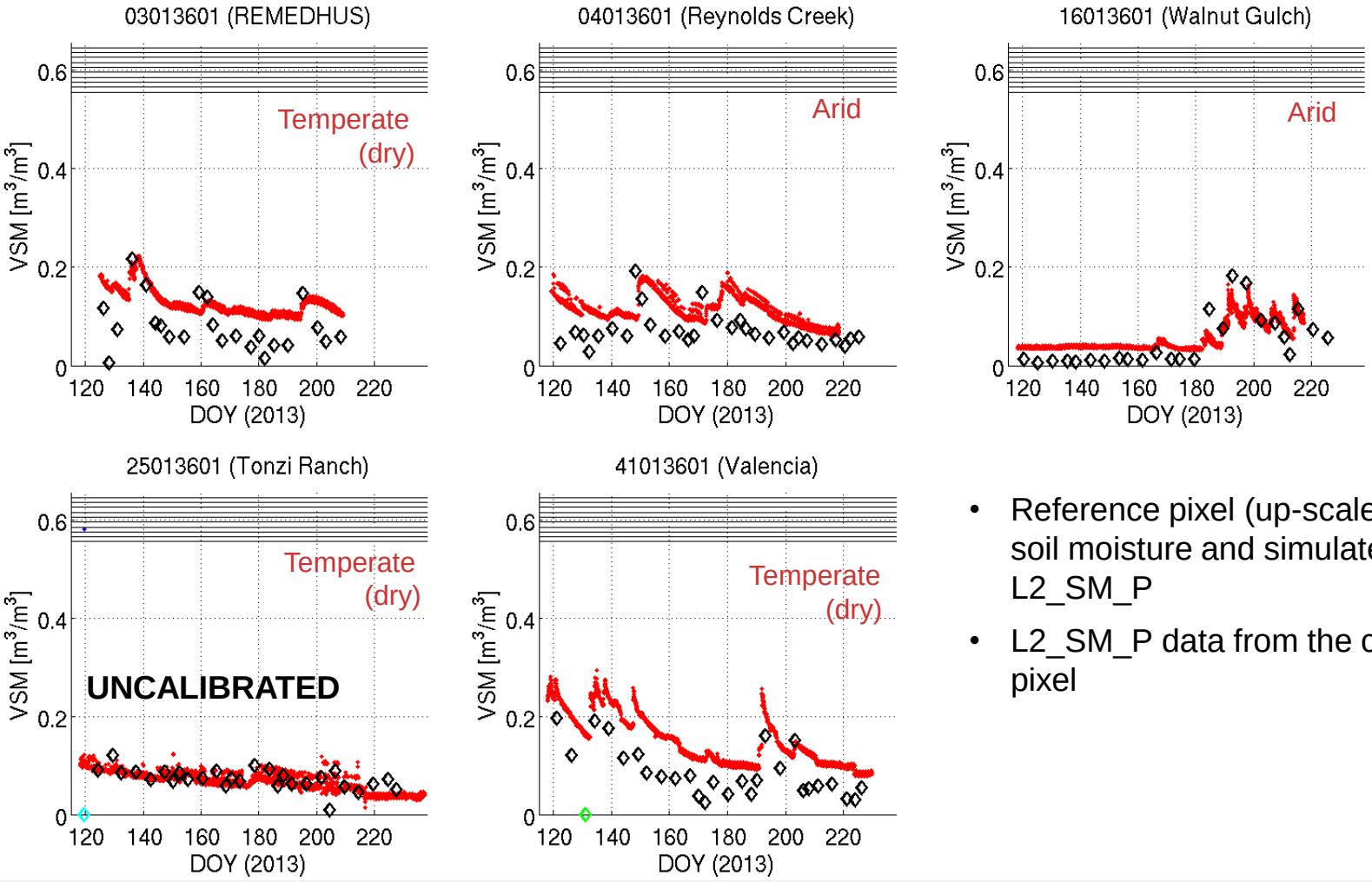

- Reference pixel (up-scaled) in situ soil moisture and simulated L2_SM_P
- L2_SM_P data from the closest pixel

Black: Use recommended (b0 = 0)
Magenta: Retrieval attempted and succeeded but use not recommended (b0 = 1, b1 = 0, b2 = 0)
Green: Retrieval attempted but failed (b0 = 1, b1 = 0, b2 = 1)
Cyan: Retrieval not attempted (b0 = 1, b1 = 1)

Updated comparisons: L2_SM_P ref pixel scatterplots

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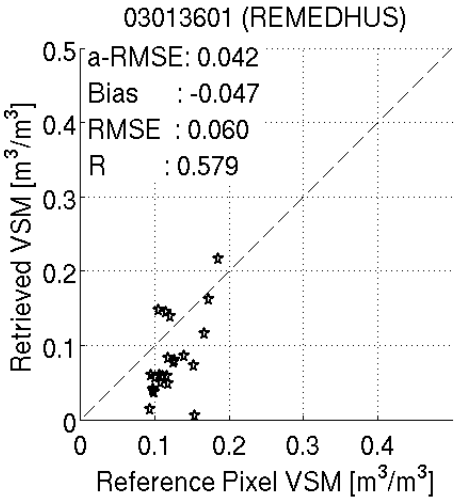

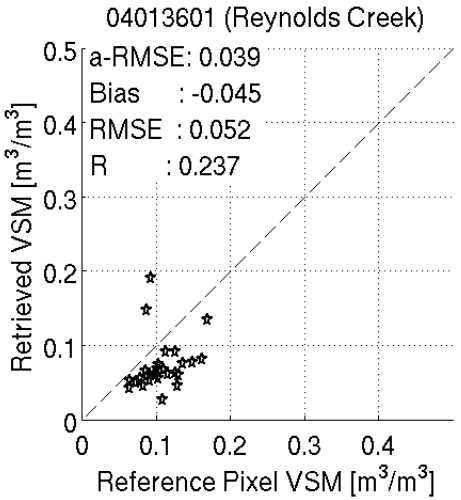

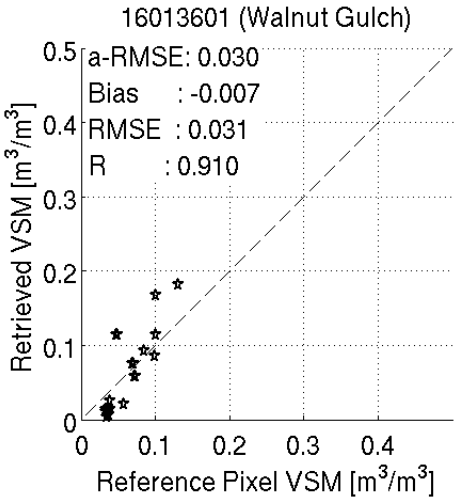

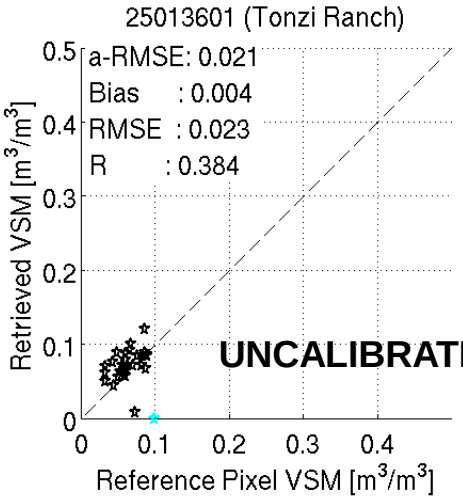

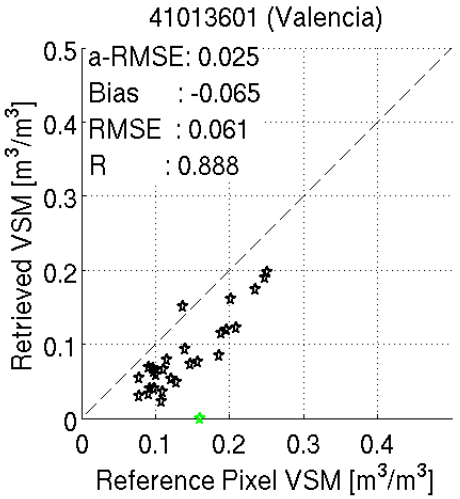

Only “use recommended” data applied to the computation of the metrics

1607 – South Fork
3601: L2SM

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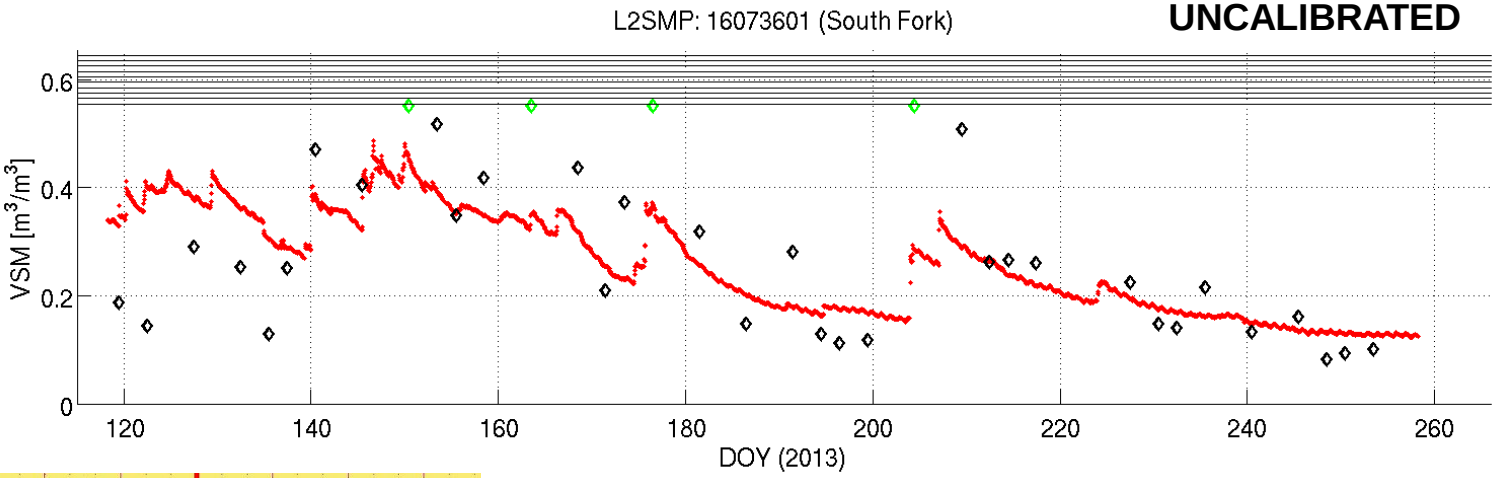
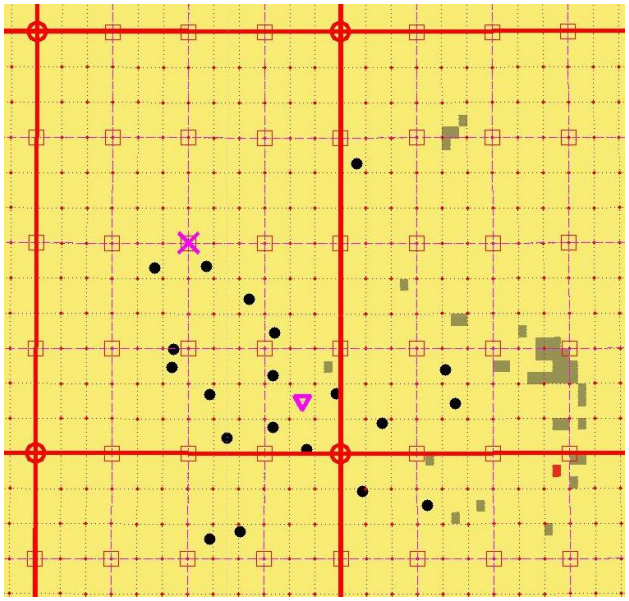
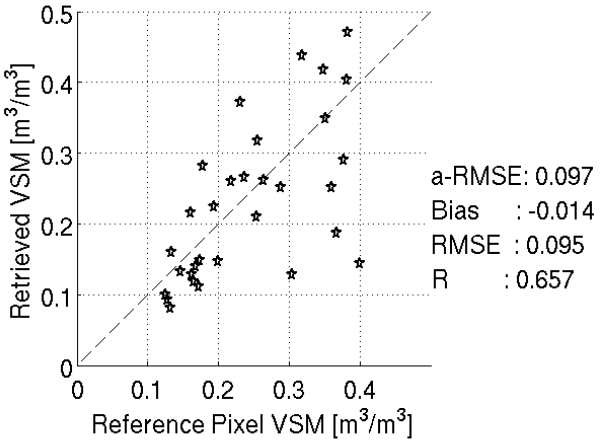
UNCALIBRATED







1607 – South Fork
0901: L2SM

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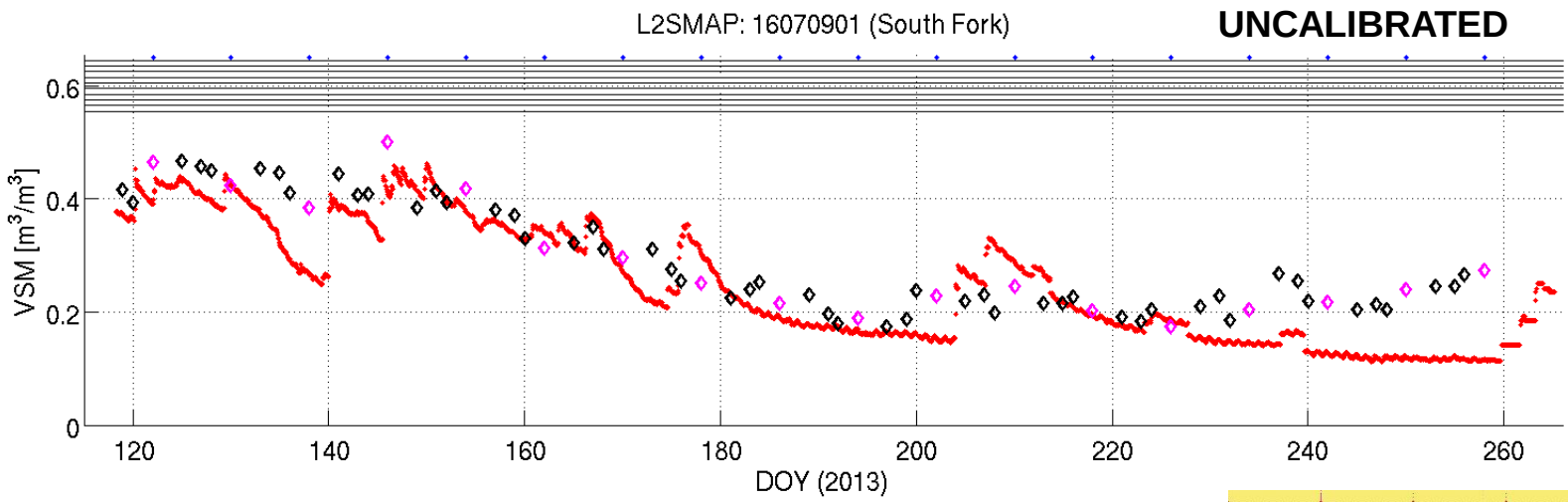

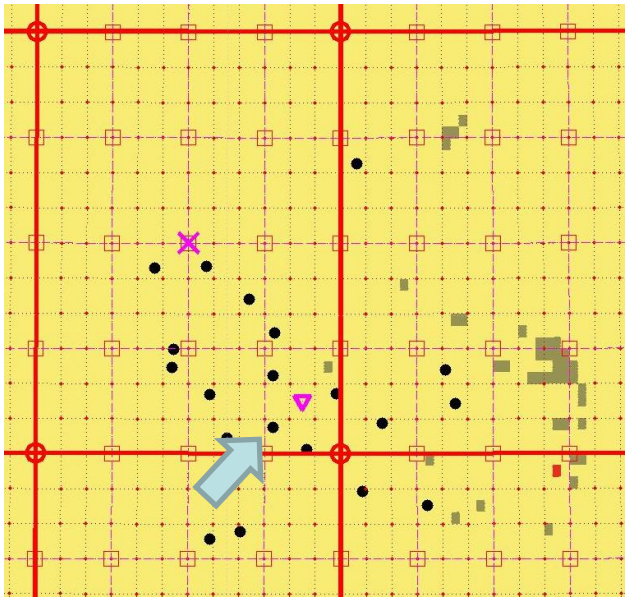

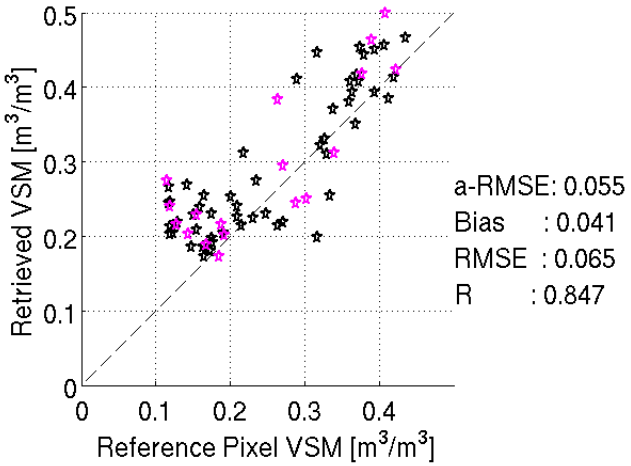

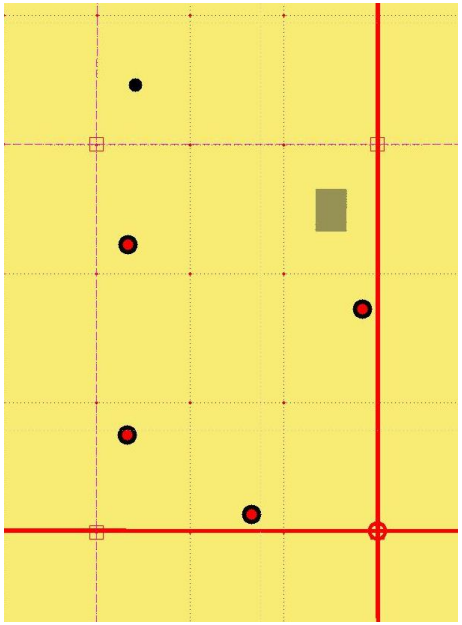

1607 – South Fork
0901: L4SM (surface)

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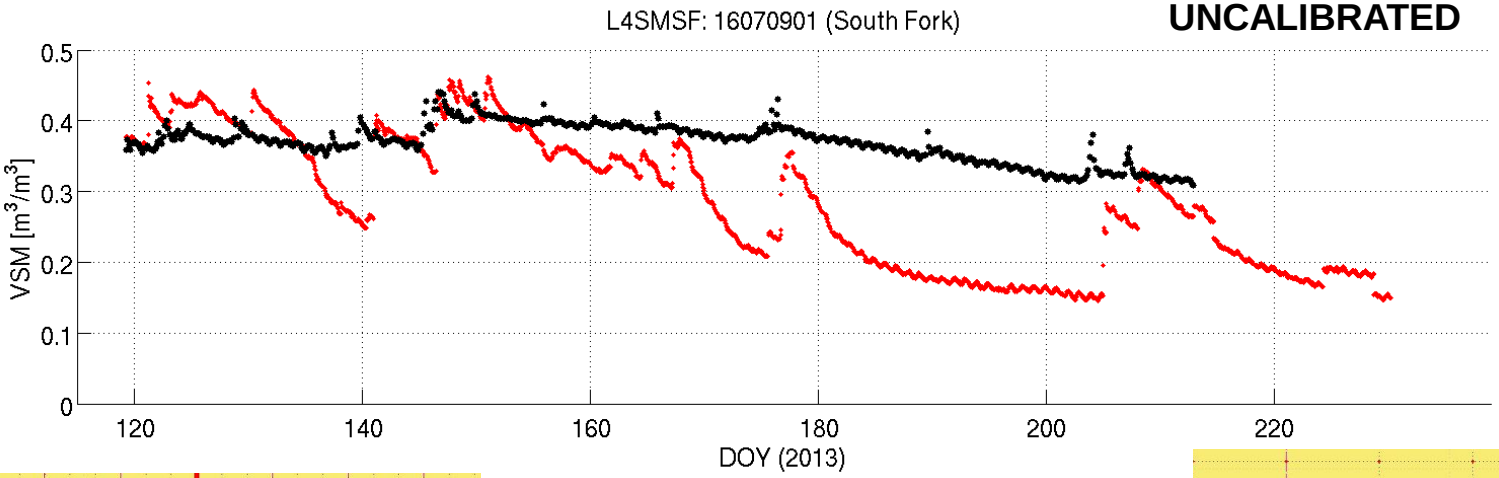
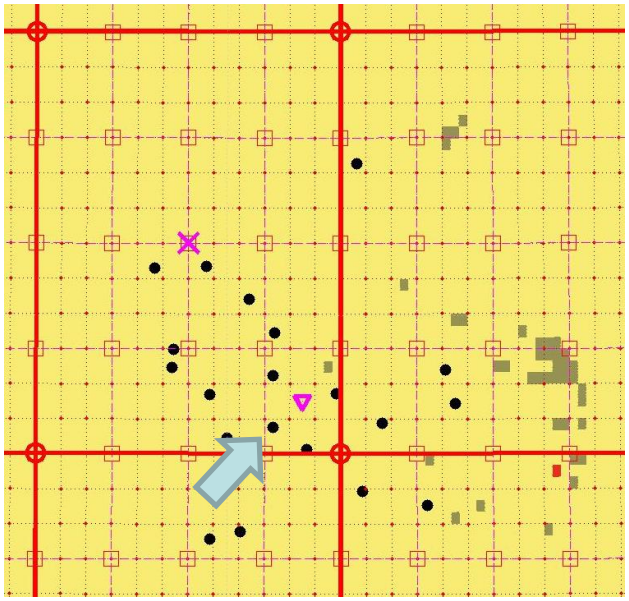
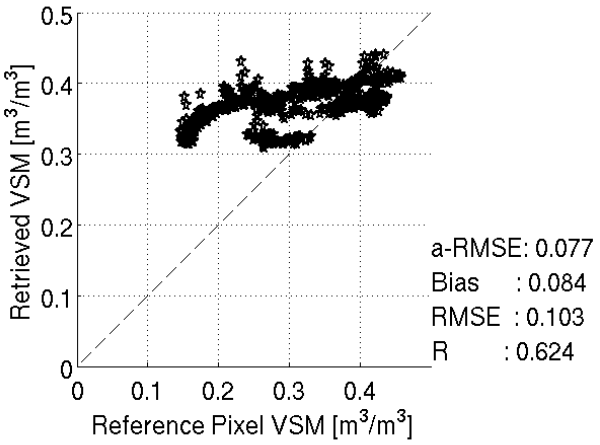
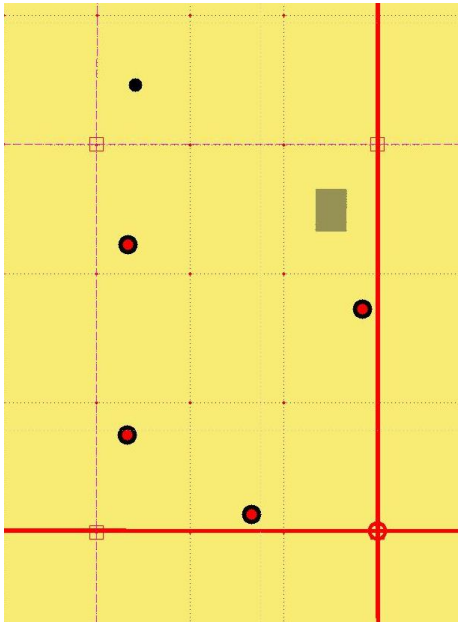
UNCALIBRATED









1607 – South Fork
0901: L4SM (root zone)

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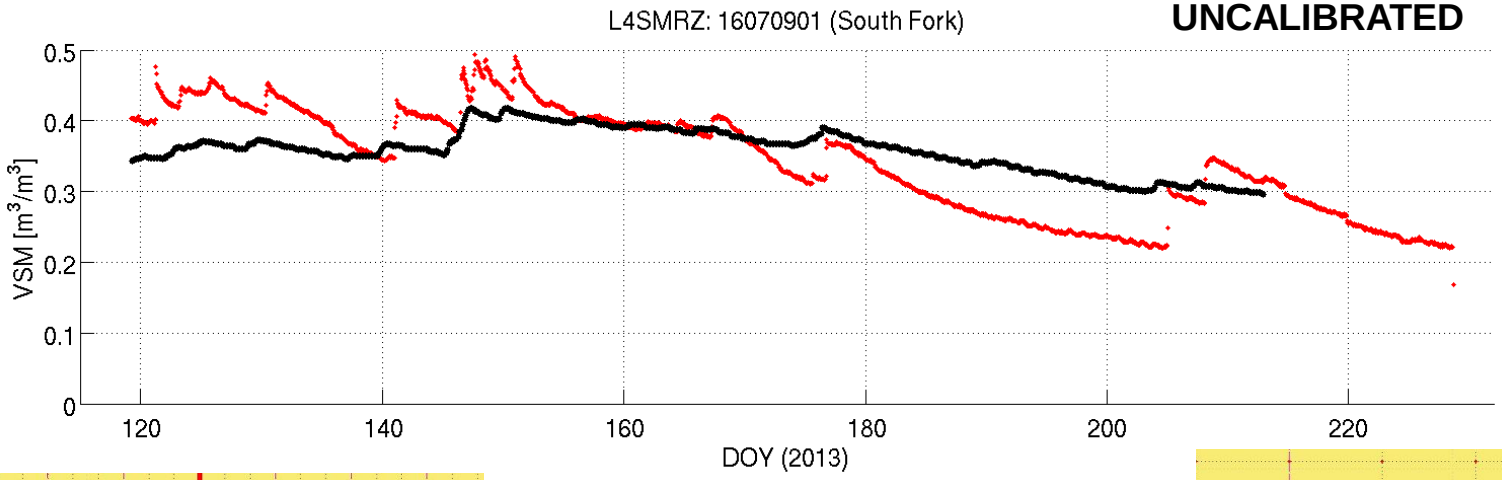

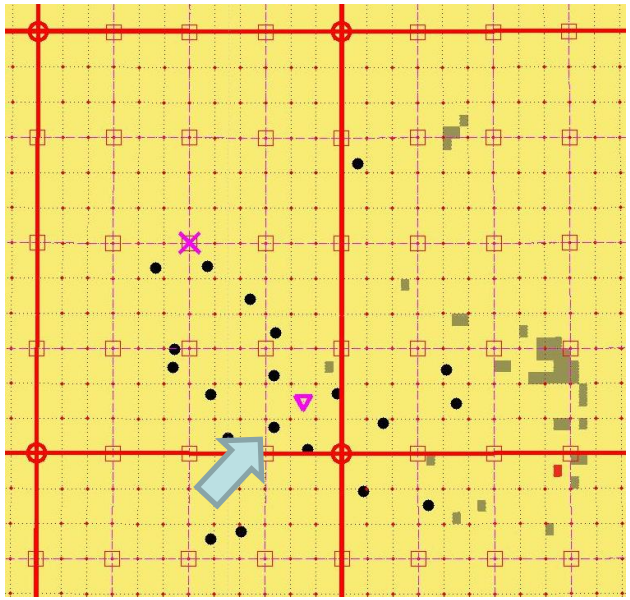

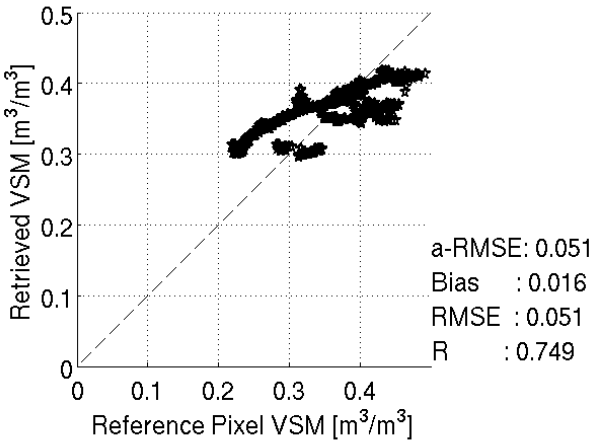

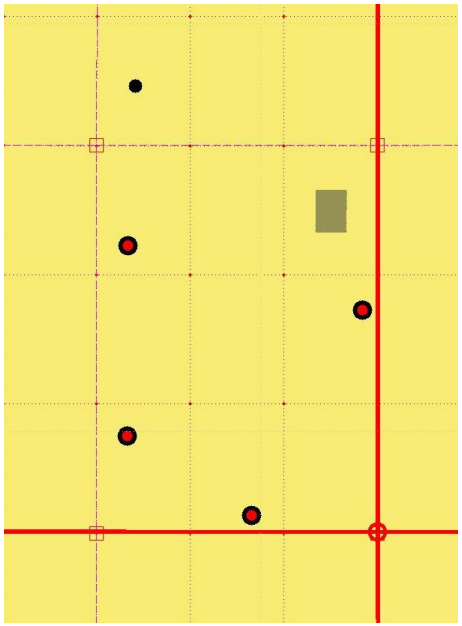

Sparse Network Comparisons (Contributing Validation Sites)

Sparse network utilization approach

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California Institute of Technology

- Expansion of spatial domain of the calibration and validation
- In Rehearsal-1 used CRN data to test an approach for screening out stations using earlier data sets
  - Tools ran for L2_SM_P and L2_SM_AP
- More on this on Thursday by Wade Crow

Comparison to other satellite products over reference pixels and globally

Comparison with another satellite data product over reference sites

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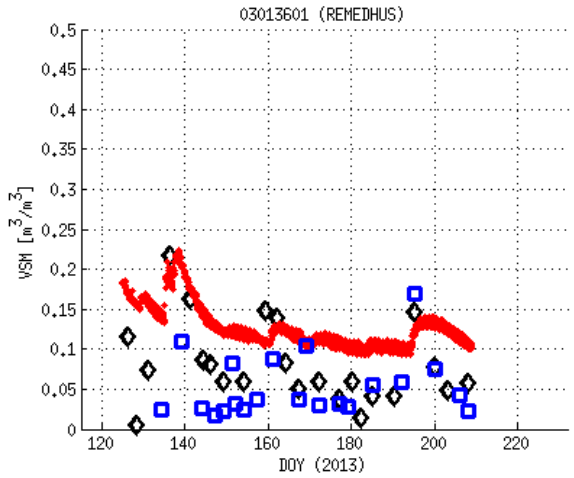
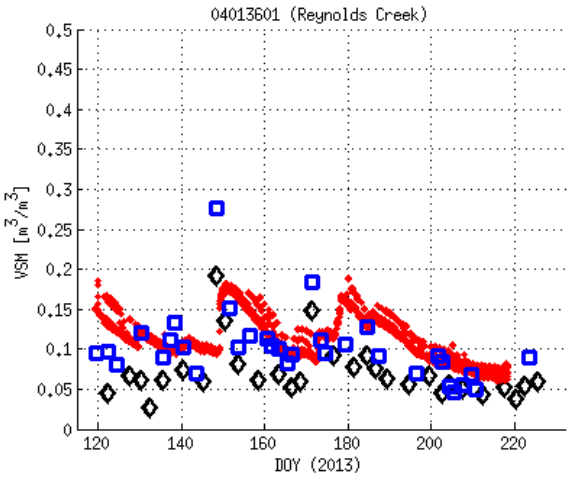
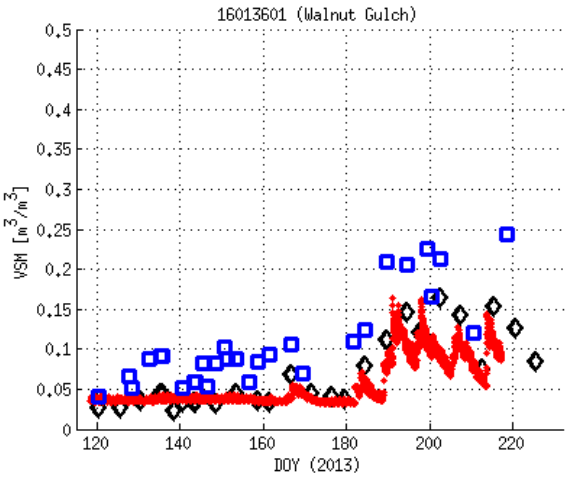
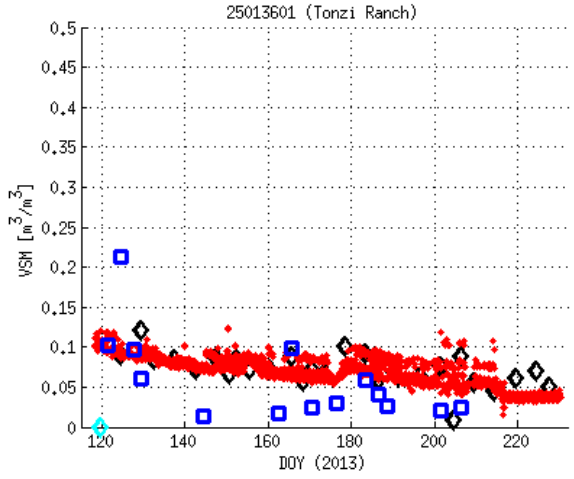
California Institute of Technology

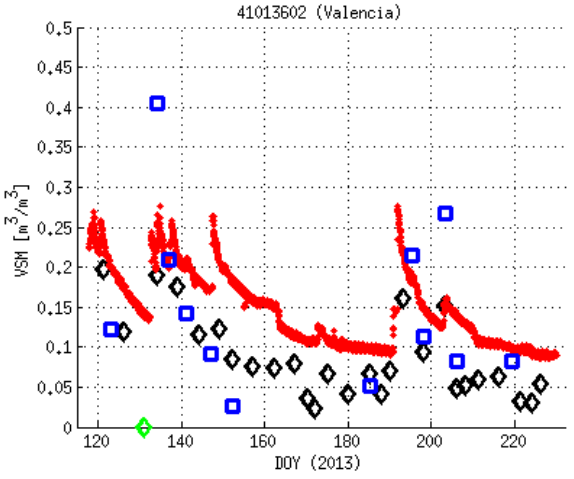
- Matchup both products over the same site and compute metrics











Black = Simulated SMAP; Blue = SMOS L2 SM; Red = In situ

Comparison with another satellite data product over reference sites

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California Institute of Technology

- Comparison of statistics (SMOS L2SM with yellow back ground)

Site	RefPix	aRMSE		Bias		RMSE		R		Site name
301	3601	0.042	0.039	-0.047	-0.074	0.06	0.074	0.579	0.27	REMEDHUS
401	3601	0.039	0.045	-0.045	-0.013	0.052	0.045	0.237	0.253	Reynolds Creek
1601	3601	0.024	0.036	0.016	0.058	0.028	0.066	0.951	0.891	Walnut Gulch
2501	3601	0.021	0.077	0.002	0.047	0.023	0.096	0.384	0.285	Tonzi Ranch
4101	3601	0.025	0.073	-0.065	0.025	0.061	0.082	0.888	0.326	Valencia
1602	3601	0.05	0.073	-0.009	0.166	0.05	0.187	0.725	0.622	Little Washita
1603	3601	0.049	0.055	-0.004	-0.049	0.049	0.073	0.686	0.687	Fort Cobb
1604	3601	0.019	0.133	0.001	-0.061	0.019	0.141	0.877	0.588	Little River
1606	3601	0.074	0.045	0.003	-0.01	0.073	0.044	0.702	0.66	St Josephs
1607	3601	0.099	0.088	-0.035	0.004	0.102	0.086	0.413	0.585	South Fork
1901	3601	0.042	0.044	-0.125	-0.088	0.132	0.095	0.293	0.359	Bell Ville
		0.042	0.064	-0.031	0.000	0.059	0.090	0.636	0.502	

- **These values are not for scientific use**

Comparison with another satellite data product globally

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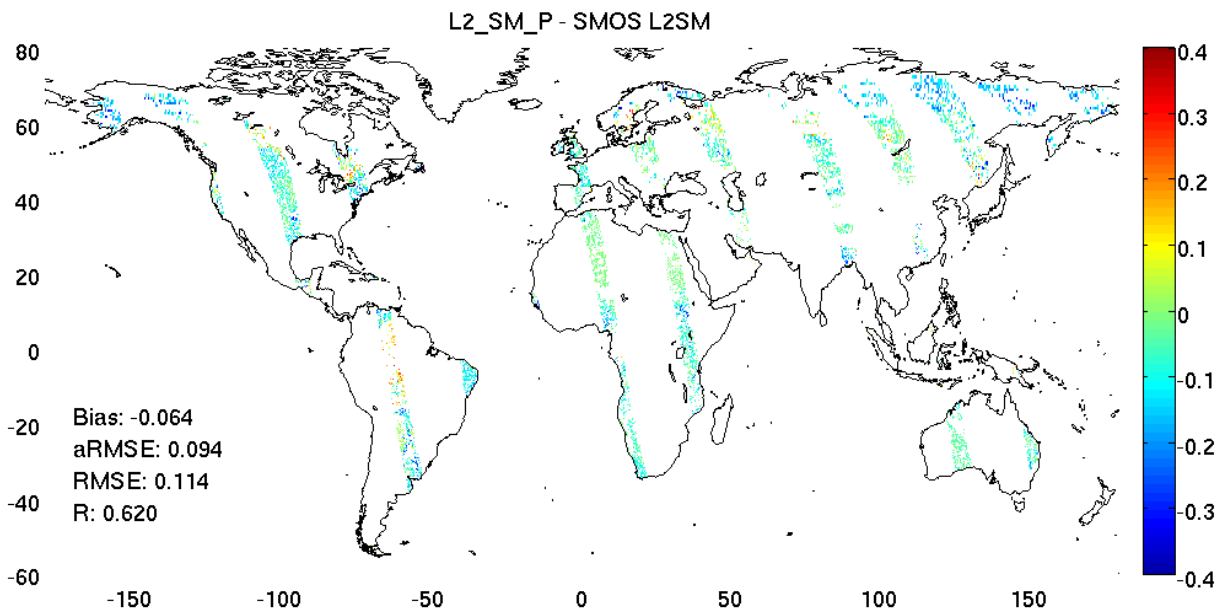
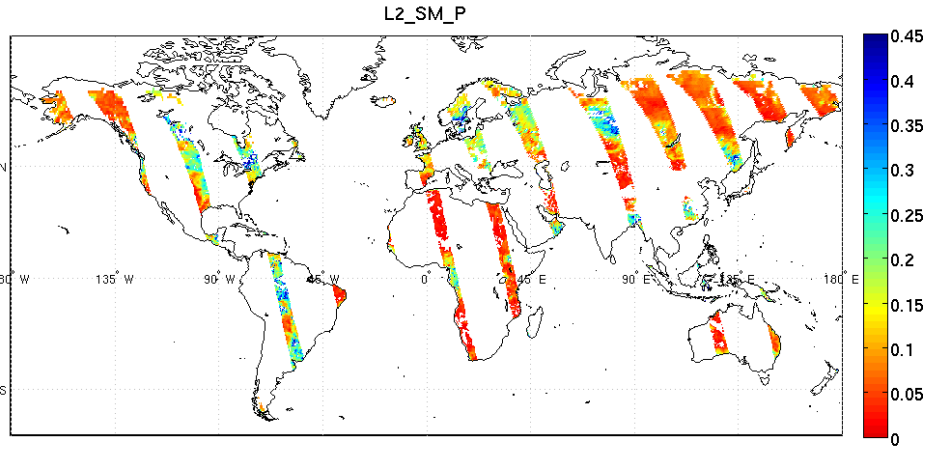
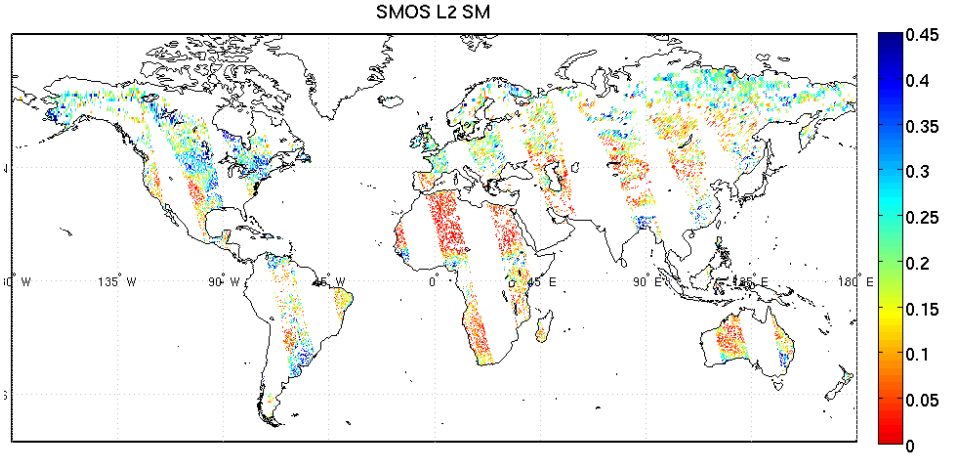
California Institute of Technology

- Spatial and temporal daily match-ups
  - The other product gridded to SMAP grid
  - Acquisitions within 2 hours
- Daily metrics computed
- Automated pull and processing of SMOS SM product exercised in Rehearsal-1







Comparison with another satellite data product globally

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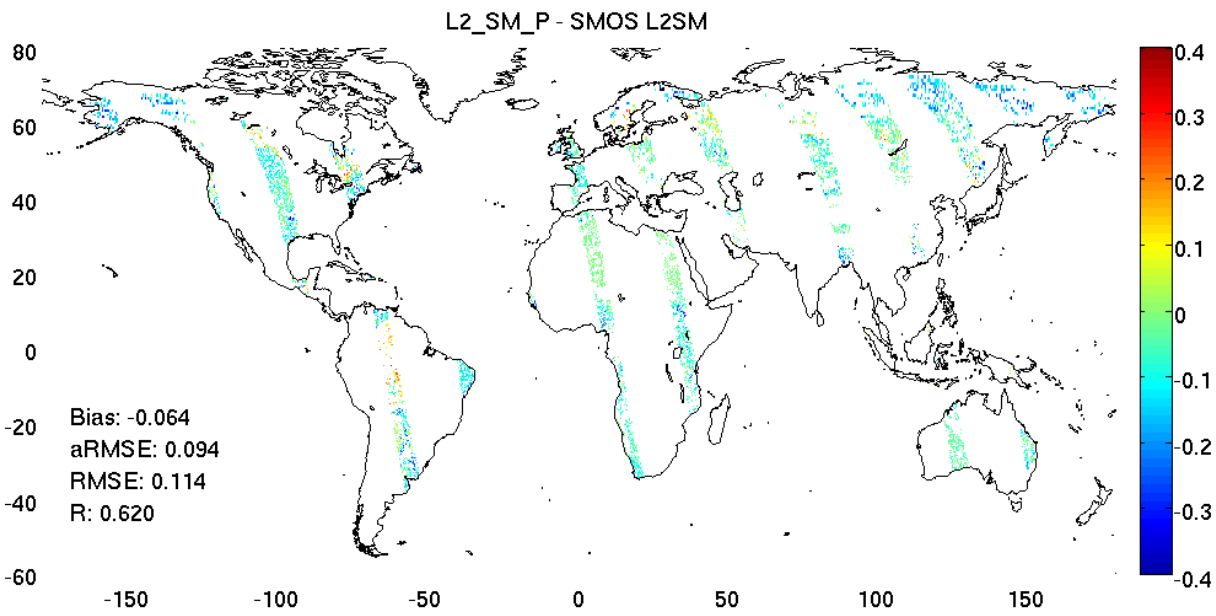
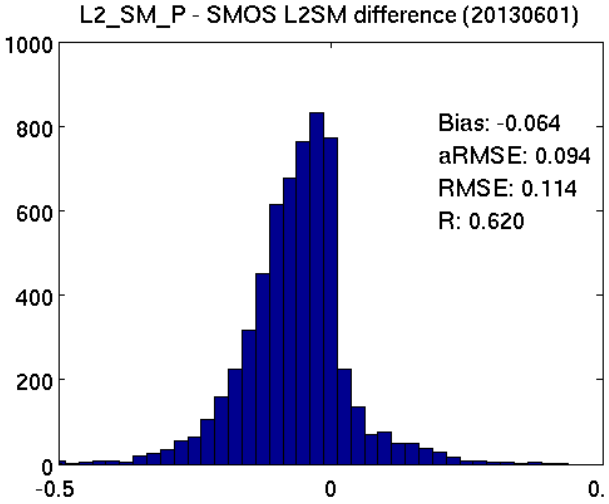
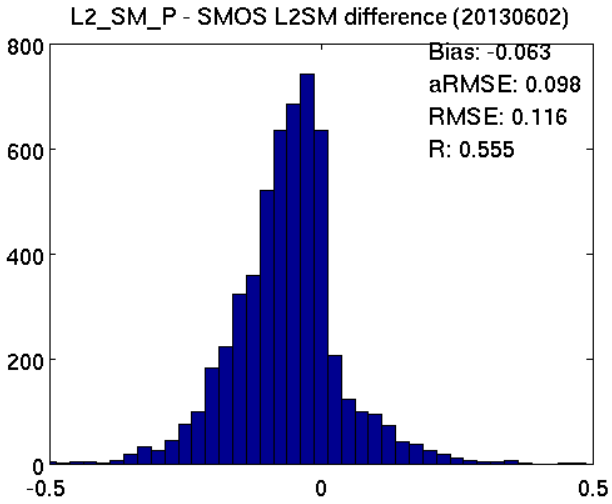
- Spatial and temporal daily match-ups
  - The other product gridded to SMAP grid
  - Acquisitions within 2 hours
- Daily metrics computed
- Automated pull and processing of SMOS SM product exercised in Rehearsal-1







Comparison with another satellite data product globally

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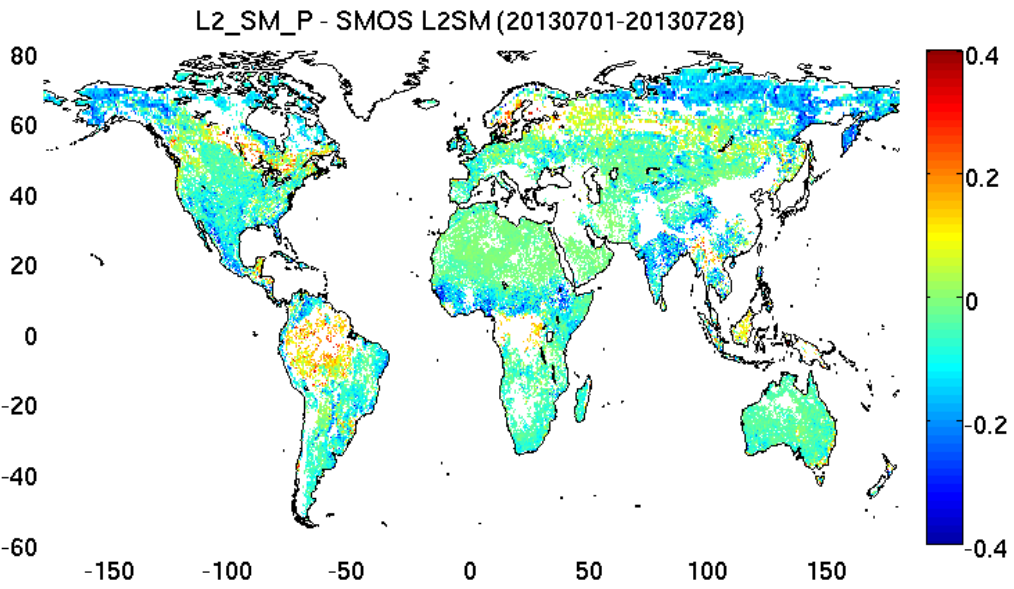
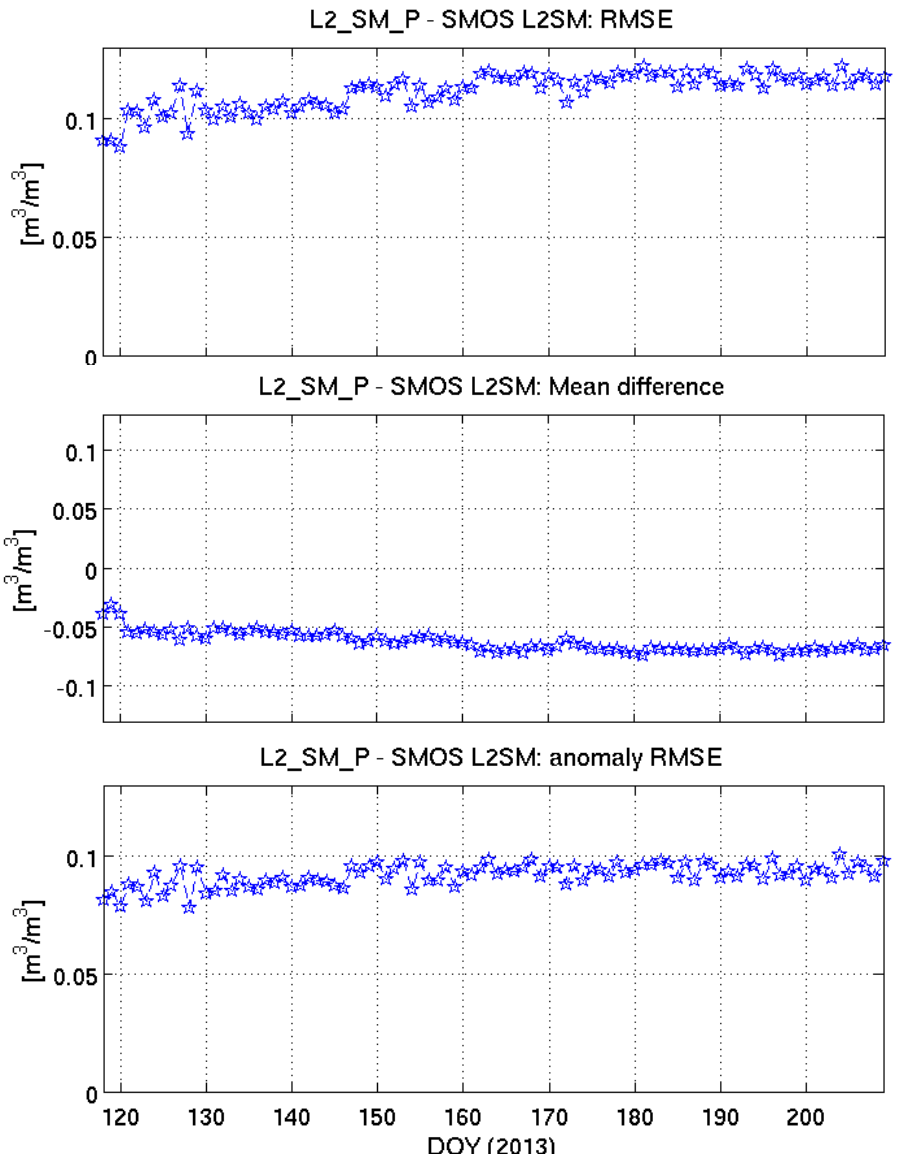
- Metrics as a function of time
- Mean values over the period
  - RMSE: 0.102
  - aRMSE: 0.091
  - Bias: -0.044
  - These values are not for scientific use
- Rehearsal-2: inclusion of other data sets and use of triple-collocation





Summary of achievements

Achieving of Rehearsal-1 Objectives

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- Overall the main objectives were met
- Particularly good progress
  - Core site data transfers
    - Excellent participation by the cal/val partners
    - Awareness of data quality issues
  - Soil moisture reference pixel match-ups for different products and scales
  - Application of sparse network
- Lack of progress
  - L3_FT_A
  - Displaced pixel processing
  - QC tool

Accomplishments

- Partner site data transfer and processing automation
  - Many of the partner sites automated and a few more made ready for automation (will be worked on in the short term); the rest will be brought on-line by Rehearsal-2
  - Excellent participation by the cal/val partners
  - Awareness of data quality issues
  - QC tool started
  - Automated reference pixel creation
- Soil moisture reference pixel match-ups for different products and scales
  - Visual display of match-up summaries, time-series, scatterplots and metrics
- Application of sparse networks
  - Tool developed to assess the scaling associated errors with point-wise measurements (triple-collocation based tool using another satellite and a model-based product, here SMOS and ECMWF)
  - Tool developed to screen out stations based on the scaling associated errors and compute metrics
- Comparison with respect another satellite soil moisture product
  - Run matchups in parallel over reference pixels
  - Make global direct comparisons
- Automated gridding of other satellite and model-based datasets (SMOS and ECMWF)
  - Used for comparisons with sparse networks, other satellite data products and model-based data products

Lessons Learned and Actions from Rehearsal 1

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- It was very useful to run a rehearsal at this point as expected
  - The objective of establishing working relationships and data transfer connections with many of the Cal/Val Partners has been met excellently
  - A lot has been learned about the methodologies and their implementation for a situation when they need to be applied immediately after data acquisition
  - Many details related to different scales of the soil moisture products and their comparison to reference data have been revealed and also resolved
  - Condensation of the wealth of data for quick review while preserving the details for detailed analysis requires a lot of thought
- Going through the full suite of results with the Project Team and the Cal/Val Partners members takes time
  - Manage meeting agenda, participant lists and roles carefully to ensure effectiveness
- Ensure availability of the full team for Phase 2 Rehearsal
  - For Phase 1 many algorithm developers were too busy with the algorithm development work to fully engage in the rehearsal activities