2019 Surface Biology and Geology (SBG) Community Workshop

SBG Applications Traceability Matrix

Framework[1]

Integration into SATM[2]

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Societal or Science Question/Goal	Earth Science/Applications Objective
QUESTION H-2. How do anthropogenic changes in climate, land use, water use, and water storage interact and modify the water and energy cycles locally, regionally, and globally, and what are the short- and long-term consequences?	**H-2a.** Quantify how changes in land use, water use, and water storage affect evapotranspiration rates, and how these in turn affect local and regional precipitation systems, groundwater recharge, temperature extremes, and carbon cycling.
QUESTION H-3. How do changes in the water cycle impact local and regional freshwater availability, alter the biotic life of streams, and affect ecosystems and the services these provide?	**H-3b**. Monitor and understand the coupled natural and anthropogenic processes that change water quality, fluxes, and storages in and between all reservoirs (atmosphere, rivers, lakes, groundwater, and glaciers) and the response to extreme events.
QUESTION H-4. How does the water cycle interact with other Earth system processes to change the predictability and impacts of hazardous events and hazard chains (e.g., floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem health), and how do we improve preparedness and mitigation of water related extreme events?	**H-4d.** Understand linkages between anthropogenic modification of the land, including fire suppression, land use, and urbanization on frequency of, and response to, hazards. (This is tightly linked to H-2a, H-2b, H-4a, H-4b, and H-4c.)
QUESTION W-1. What planetary boundary layer (PBL) processes are integral to the air-surface (land, ocean, and sea ice) exchanges of energy, momentum, and mass, and how do these impact weather forecasts and air quality simulations?	**W-1a.** Determine the effects of key boundary layer processes on weather, hydrological, and air quality forecasts at minutes to sub seasonal time scales
QUESTION W-3. How do spatial variations in surface characteristics (influencing ocean and atmospheric dynamics, thermal inertia, and water) modify transfer between domains (air, ocean, land, and cryosphere) and thereby influence weather and air quality.	**W-3a.** Determine how spatial variability in surface characteristics modifies regional cycles of energy, water, and momentum (stress) to an accuracy of 10 W/m2 in the enthalpy flux, and 0.1 N/m2 in stress, and observe total precipitation to an average accuracy of 15% over oceans and/or 25% over land and ice surfaces averaged over a 100 × 100 km region and 2- to 3-day time period.
QUESTION E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space ?	**E-1a.** Quantify the distribution of the functional traits, functional types, and composition of terrestrial and shallow aquatic vegetation and marine biomass, spatially and over time. **E-1b.** Quantify the global three-dimensional (3D) structure of terrestrial vegetation and 3D distribution of marine biomass within the euphotic zone, spatially and over time. **E-1c**. Quantify the physiological dynamics of terrestrial and aquatic primary producers. E-1d. Quantify moisture status of soils. **E-1e.** Support targeted species detection and analysis (e.g., foundation species, invasive species, indicator species, etc.).
QUESTION E-3. What are the fluxes (of carbon, water, nutrients, and energy) within ecosystems, and how and why are they changing?	**E-3a.** Quantify the flows of energy, carbon, water, nutrients, and so on, sustaining the life cycle of terrestrial and marine ecosystems and partitioning into functional types.

Data Levels	Examples	Definition https://science.nasa.gov/earth-science/earth-science-data/data-processing-levels-for-eosdis-data-products
L0	Digital Numbers	Reconstructed, unprocessed instrument and payload data at full resolution, with any and all communications artifacts (e.g., synchronization frames, communications headers, duplicate data) removed. (In most cases, the EOS Data and Operations System (EDOS) provides these data to the data centers as production data sets for processing by the Science Data Processing Segment (SDPS) or by a SIPS to produce higher-level products.)
L1	Calibrated Radiance	L1A - Reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (e.g., platform ephemeris) computed and appended but not applied to Level 0 data.
		L1B data that have been processed to sensor units (not all instruments have Level 1B source data).
L2	Land Surface Temperature, Surface Reflectance, Normalized Water Leaving Radiance / Remote Sensing Reflectance	Derived geophysical variables at the same resolution and location as Level 1 source data.
L3	Land Surface Classification, Evapotranspiration, Benthic Cover	Variables mapped on uniform space-time grid scales, usually with some completeness and consistency.
L4	Canopy Trait Diversity, Snow Water Equivalent, Evaporative Stress Index	Model output or results from analyses of lower-level data (e.g., variables derived from multiple measurements).
FAQ		
What is meant by latency		
	time between data acquisition to availability of application data product(s)	

Examples from HysplRI campaigns and related missions - for reference only - do not edit

	ASO	CORAL	EMIT	ECOSTRESS	HysplRI/ AVIRIS
L0	Digital Numbers	Digital Numbers	Digital Numbers	Digital Numbers	Digital Numbers
L1	Calibrated Radiance	Calibrated Radiance	Calibrated Radiance	Calibrated Radiance	Calibrated Radiance
L2	Surface Reflectance	Water Leaving Reflectance/ Remote Sensing Reflectance	Apparent Surface Reflectance	Land Surface Temperature	
		Benthic reflectance	mineral signature band depths and occurrence, and occurrence of other surface types (vegetation, water, etc.)L3: spatially-averaged mineral band depths and occurrence at Earth System Model scales.	Emissivity	Surface Reflectance
L3	Snow albedo	Benthic cover: Coral/Algae/Sand	spatially-averaged mineral band depths and occurrence at Earth System Model scales.	Evapotranspiration (PT-JPL)	GV:NVP:Substrate
	Land surface classification: snow/veg/bare rock, soil/water				Methane Plumes
	Snow radiative forcing				Plant Communities (define by dominant species)
	RGB composite			Evapotranspiration (ALEXI)	Vegetation Traits (C, N, Lignen, etc)
	Snow grain size				Dimensionality
L4	Mosaiked L3	Benthic primary productivity and calcification		Evaporative Stress Index (PT-JPL)	
	Snow Water Equivalent (SWE)			Evaporative Stress Index (PT-JPL)	
				Water Use Efficiency	Canopy Trait Diversity
Ancillary	LIDAR	Optical, benthic cover, and benthic community productivity and calcification calibration/validation		Landcover	

Specific Applications Needs That Impact Architecture

Short-Name	Description
Landsat/Sentinel Orbit	Orbit that is complementary to Landsat-8 / Sentinel series
Event-Driven	Ability to point or be event-driven
TIR/VSWIR	Coincident TIR/VSWIR acquisitions
SNR to SLI	SNR to spectrally convolve to SLI
4 um saturation	Critical for fires and volcano applications: 4 um band saturation
Day/Night pair	Critical for urban climatology and regional climate models: day/night pairs

Applications Traceability Matrix Columns

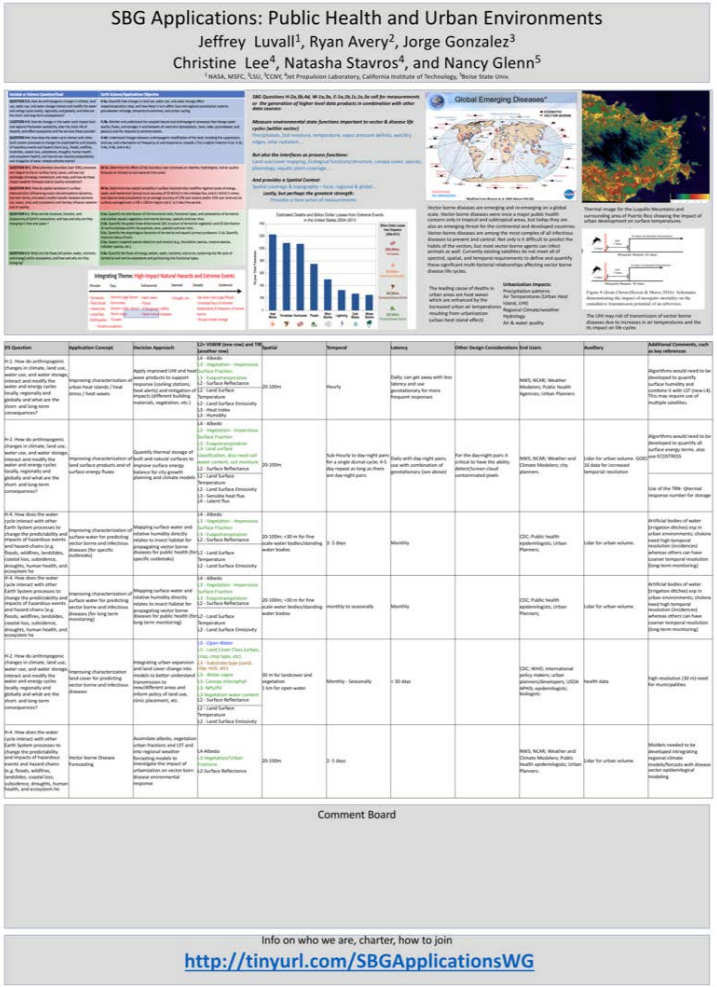
APPWG comments
Reviewed by Focus Group
Reviewed and ready for Focus Group
Based on
Ask to check, including AWG members
DS Question
Focused Science Topic
Application Focus Group
Application Concept
Decision Approach
L2+ VSWIR (one row) and TIR (another row)
Spatial
Temporal
Latency
Other Design Considerations
End Users
Auxiliary
Additional Comments

Focus Areas

1. Geological Hazards: Volcanoes and Landslides
2. Terrestrial Ecology - Carbon and Conservation
3. Terrestrial Ecology - Wildfires and Restoration
4. Public Health and Urban Environments
5. Water Resources - Snow and Agriculture
6. Aquatic Ecosystems
7. Other

DS Question	Focused Science Topic	Application Focus Group	Application Concept	Decision Approach	L2+ VSWIR (one row) and TIR (another row)	Spatial	Temporal	Latency	Other Design Considerations	End Users	Auxiliary	Additional Comments
H-2. How do anthropogenic changes in climate, land use, water use, and water storage, interact and modify the water and energy cycles locally, regionally and globally and what are the short- and long-term consequences?	Land Surface Fluxes	Disasters	Fuel Mapping for wildfire danger management	Use veg composition, structure, health, chemical properties to inform mitigation actions like thinning based either directly on the maps or integration into fire simulation	L4-Plant functional type L4-Dead/Dormant Vegetation Maps L3-Green Vegetation and Non-photosynthetic vegetation L3/4-Fuel classification L3-Live Fuel Moisture L3-Vegetation	30m x 30m	annual	NA	sun-synchronous	USFS GTAC and regional offices National Parks Service Bureau of Land Management USGS EROS - LANDFIRE	lidar for structure, field data to parameterize	Stavros presentation from HyspIRI closeout workshop

- Objective of the Workshop:
  - Gap-Fill Application Traceability Matrix by subject area
    - Gap-Fill can mean:
      - missing or incorrect requirements (spatial, temporal, latency, etc.)
      - putting ranges of requirements
      - missing application areas
    - Requirements should stem from the decision approach to be justifiable
- Purpose:
  - Comprehensive ATM - inform the threshold and baseline needs of each application
  - Inform SATM (to select architecture)



SBG Applications Traceability Matrix

Integration into SATM²

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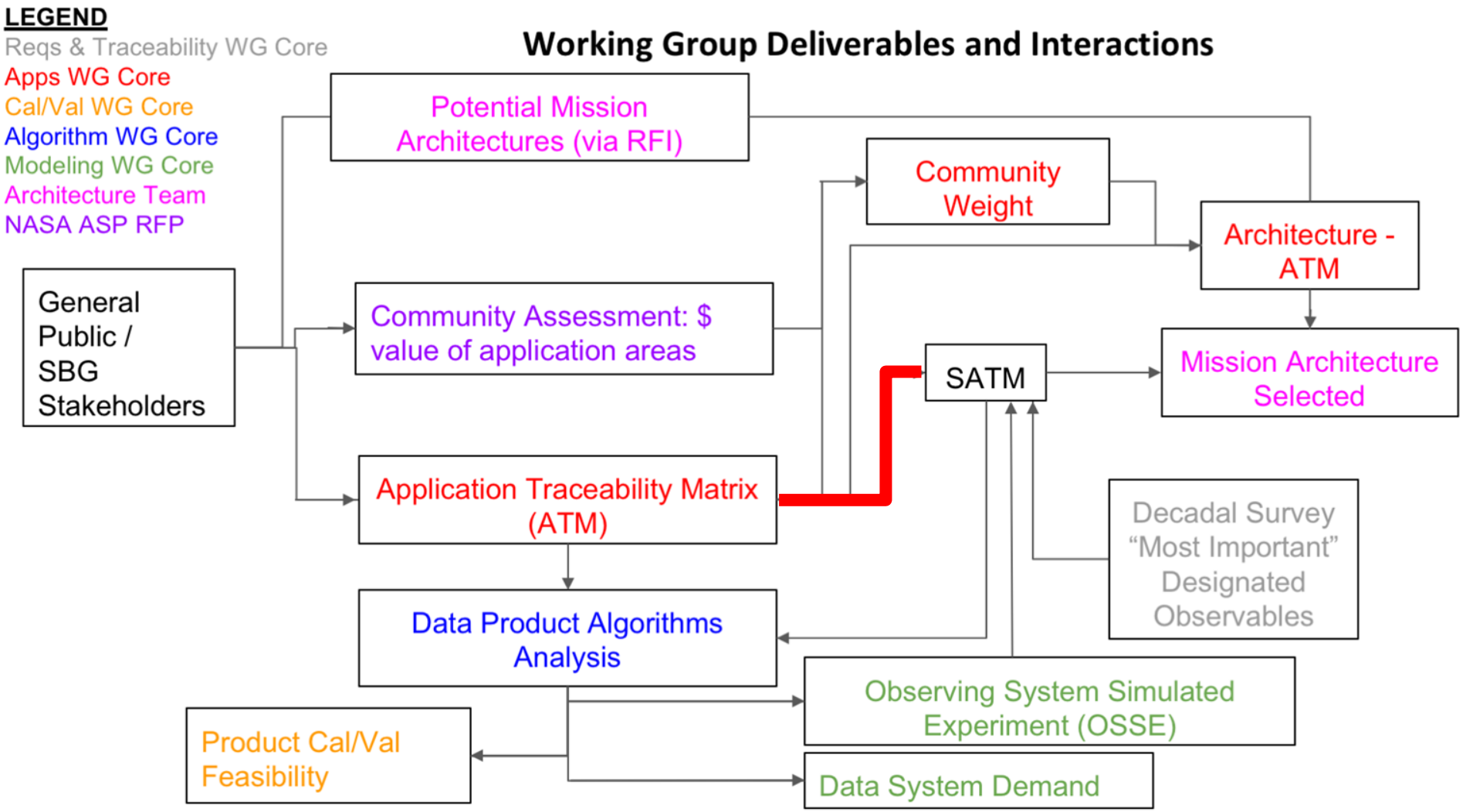

LEGEND
Reqs & Traceability WG Core
Apps WG Core
Cal/Val WG Core
Algorithm WG Core
Modeling WG Core
Architecture Team
NASA ASP RFP
Working Group Deliverables and Interactions
Potential Mission Architectures (via RFI)
Community Weight
Architecture - ATM
General Public / SBG Stakeholders
Community Assessment: $ value of application areas
SATM
Mission Architecture Selected
Application Traceability Matrix (ATM)
Decadal Survey "Most Important" Designated Observables
Data Product Algorithms Analysis
Observing System Simulated Experiment (OSSE)
Product Cal/Val Feasibility
Data System Demand

Applications Traceability Matrix (ATM)

What connects them?

Science and Applications Traceability Matrix (SATM)

Application Traceability Matrix

- Any application enabled by global imaging spectrometer / TIR radiometer

Decadal Survey

H-1, H-2, and H-4: Hydrology
W-3: Weather
E- 1, E-2, and E-3: Ecosystems
C-3: Cryosphere
S-1 and S-2: Geological Hazards

Science Application Traceability Matrix

- Only science and applications identified as “Most Important” and “Very Important” by the Decadal Survey

ATM Integration into SATM

1. Find applications associated with Decadal Survey Science Question
2. Review ATM Applications Concept and Decision Approach and merge into single sentence and add to SATM under “Enabled Applications”
3. Review and resolve SATM “Example SBG Geophysical Parameters” using ATM (L2+ VSWIR/TIR) product list
4. Review comments from the focused discussions and add applications-related design considerations into VSWIR/TIR Capabilities using Capability Codes
5. Add references as ”Notes”

1		3	4	5	2

STM for DS Targeted Observables TO-18 (Surface Biology & Geology)

Decadal Survey Science Topics, Questions, Objectives, and Geophysical Observables					SBG Example Geophysical Variables and Capabilities											
Topic	DS Science Question	DS Science/Application Objective	Priority	DS Suggested Geophysical Parameters	Example SBG Geophysical Parameters	VSWIR Spatial	VSWIR Temporal	VSWIR Range	VSWIR Sensitivity	TIR Spatial	TIR Temporal	TIR Range	TIR Sensitivity	Notes	Enabled Applications	DO Synergies
	H-1. How is the water cycle changing? Are changes in evapotranspiration and precipitation accelerating, with greater rates of evapotranspiration and thereby precipitation, and how are these changes expressed in the space-time distribution of rainfall, snowfall, evapotranspiration, and the frequency and magnitude of extremes such as droughts and floods?	**H-1c.** Quantify rates of snow accumulation, snowmelt, ice melt, and sublimation from snow and ice worldwide at scales driven by topographic variability.	Most important	Snow and glacier albedo and surface temperature. Spectral albedo of suxbpixel snow and glaciers at weekly intervals to an accuracy to estimate absorption of solar radiation to 10%.Ice/snow temperature to ± 1K. At spatial resolution of 30 to 100 m.	Snow and ice coverage fraction (cryosphere)	A	A	A	B					R1, R8, R12, R26	A1, A2, A4, A5, A6	
					Snow spectral albedo From Visible to Thermal (cryosphere)	A	A	A	B	A	B	B	A	R1, R8, R12, R26	A1, A2, A4	
					Snow surface temperature (cryosphere)					A	B	B	A	R4, R5, R8, R26	A3	

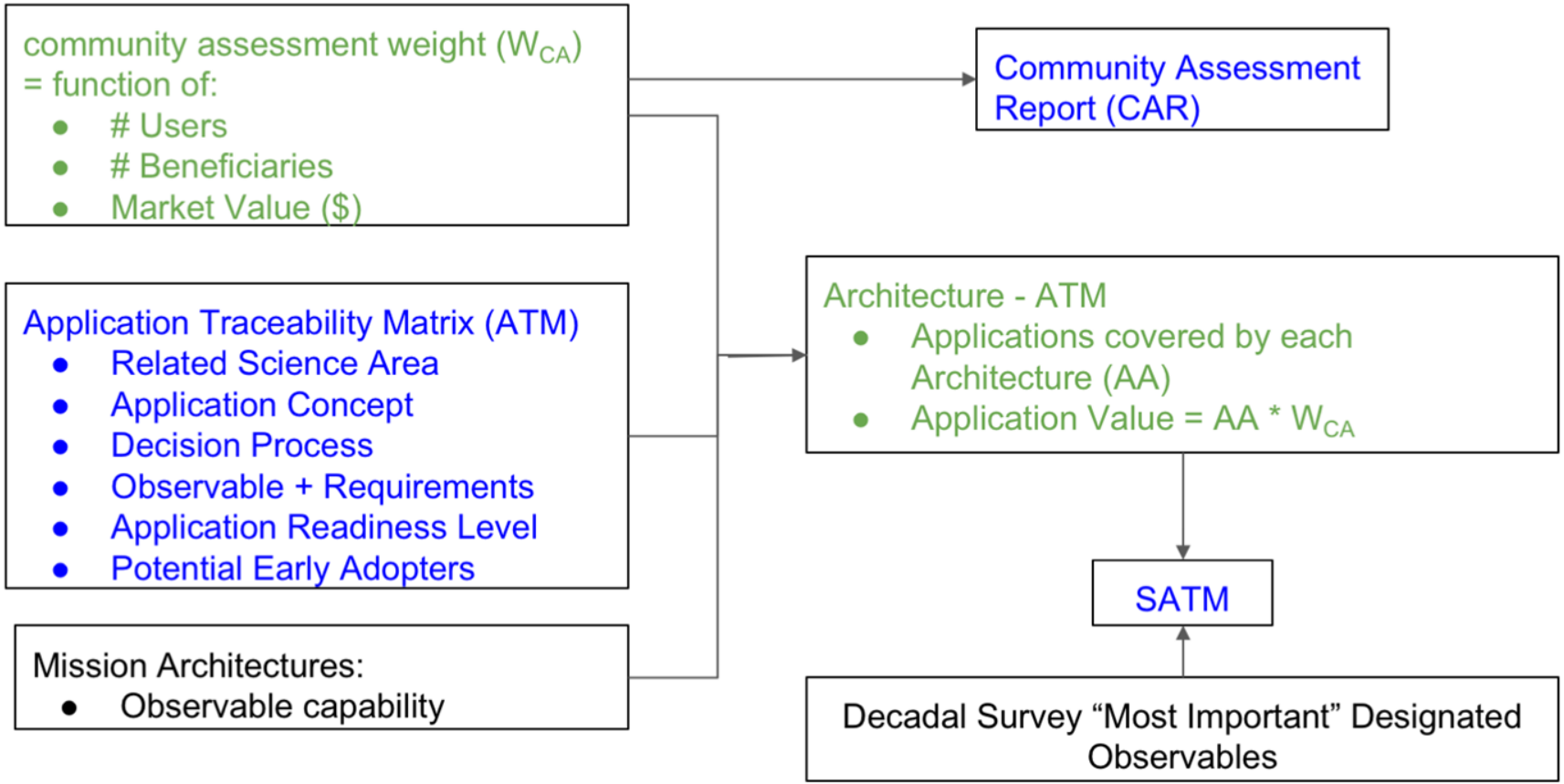
ATM Integration into SATM

1. Find applications associated with Decadal Survey Science Question
2. Review ATM Applications Concept and Decision Approach and merge into single sentence and add to SATM under “Enabled Applications”
3. Review and resolve SATM “Example SBG Geophysical Parameters” using ATM (L2+ VSW
4. Revi esign cons
5. Add references as ”Notes”

We have documented latency and temporal resolution needs for events (eg volcanoes, wildfires, oil spills) -- but we ask you to help provide **references**

1					3	4								5	2
STM for DS Targeted Observables TO-18 (Surface Biology & Geology)															
Decadal Survey Science Topics, Questions, Objectives, and Geophysical Observables					SBG Example Geophysical Variables and Capabilities										
Topic	DS Science Question	DS Science/Application Objective	Priority	DS Suggested Geophysical Parameters	Example SBG Geophysical Parameters	VSWIR Spatial	VSWIR Temporal	VSWIR Range	VSWIR Sensitivity	TIR Spatial	TIR Temporal	TIR Range	TIR Sensitivity	Notes	Enabled Applications	DO Synergies
	H-1. How is the water cycle changing? Are changes in evapotranspiration and precipitation accelerating, with greater rates of evapotranspiration and thereby precipitation, and how are these changes expressed in the space-time distribution of rainfall, snowfall, evapotranspiration, and the frequency and magnitude of extremes such as droughts and floods?	**H-1c.** Quantify rates of snow accumulation, snowmelt, ice melt, and sublimation from snow and ice worldwide at scales driven by topographic variability.	Most important	Snow and glacier albedo and surface temperature. Spectral albedo of suxbpixel snow and glaciers at weekly intervals to an accuracy to estimate absorption of solar radiation to 10%.Ice/snow temperature to ± 1K. At spatial resolution of 30 to 100 m.	Snow and ice coverage fraction (cryosphere)	A	A	A	B					R1, R8, R12, R26	A1, A2, A4, A5, A6	
					Snow spectral albedo From Visible to Thermal (cryosphere)	A	A	A	B	A	B	B	A	R1, R8, R12, R26	A1, A2, A4	
					Snow surface temperature (cryosphere)					A	B	B	A	R4, R5, R8, R26	A3	

Applications Working Group Deliverables and Intermediate Products



Questions?