SBG Applications: Water Resources and Agriculture

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Targeted Observable	Science/Applications Summary	Candidate Measurement Approach	Designated	Explorer	Incubation
Surface Biology and Geology	Earth surface geology and biology, ground/water temperature, snow reflectivity, active geologic processes, vegetation traits, and algal biomass	Hyperspectral imagery in the visible and shortwave infrared (IR), multi- or hyperspectral imagery in the thermal IR	X		

Surface Biology and Geology	CATE Cap $650 million	Key to understanding active surface changes (eruptions, landslides, and evolving landscapes); snow and ice accumulation, melting, and albedo; hazard risks in rugged topography; effects of changing land use on surface energy, water, momentum, and carbon fluxes; physiology of primary producers; and functional traits and health of terrestrial vegetation and inland and near-coastal aquatic ecosystems. Further contributes to managing agriculture and natural habitats, water use and water quality, and urban development as well as understanding and predicting geological natural hazards and land-surface interactions with weather and climate. Depending on implementation specifics, the Targeted Observable may also contribute to hyperspectral open-ocean observation goals. Addresses many "Most Important" objectives of the Ecosystem, Hydrology, and Solid Earth panels, and addresses key components of the Water and Energy Cycle, Carbon Cycle, and Extreme Events integrating themes.

SBG hydrology and agriculture objectives

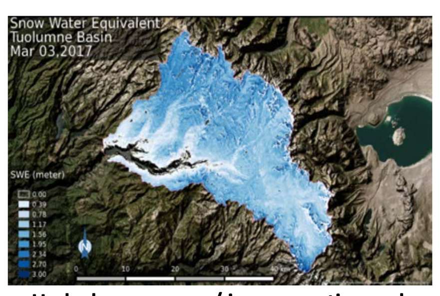
EAS17 SBG TO-18: H-1, H-2, H-3, H-4

H-1: How is the water cycle changing? Are changes in ET and precip accelerating, with greater rates of ET and precip, and how are these changes expressed in the space-time distribution of rainfall, snowfall, ET, frequency of extremes, such as floods and droughts?

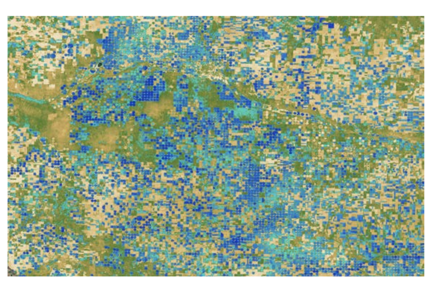
H-2: How do anthropogenic changes in climate, land use, water use, and water storage interact and modify the water and energy cycles locally, regionally, globally, and what are the short and long-term consequences?

H-3: How do changes in the water cycle impact local and regional freshwater availability, alter biotic life of streams, and affect ecosystems and the services these provide?

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 (eg, floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, ecosystem health) and how do we improve preparedness and mitigation of water-related extreme events?



Hydrology – snow / ice properties and predicted streamflow for reservoir operations and allocations planning

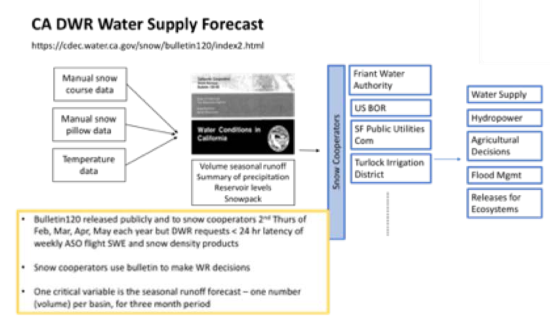


Agriculture – ECOSTRESS evapotranspiration, crop condition/class/properties for improved ag and irrigation practices and drought mgmt

Applying Snow Data

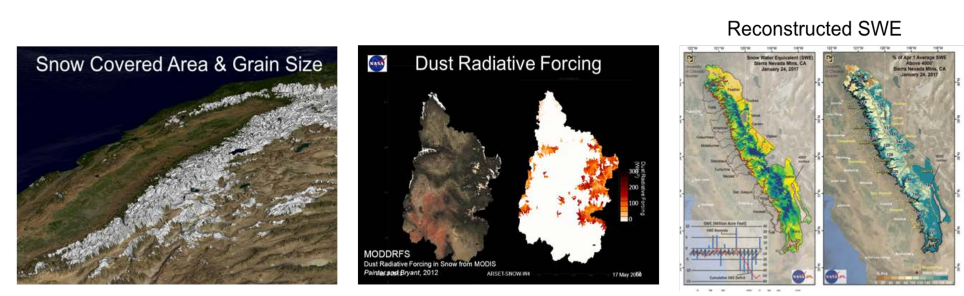
Societal Challenge: water availability and management continues to be one of the greatest risks we face, particularly as it relates to food insecurity and responding / adapting to weather extremes (droughts and floods)

Opportunity: Optimizing reservoir operations for water supply, flood protection, and hydropower production requires accurate predictions of runoff at different lead times.



Decision relevant information from SBG:
TIR and SWIR data are important for improved characterization of snow properties, such as albedo and dust on snow, as well as for prediction of snowmelt and streamflow for improved operations.

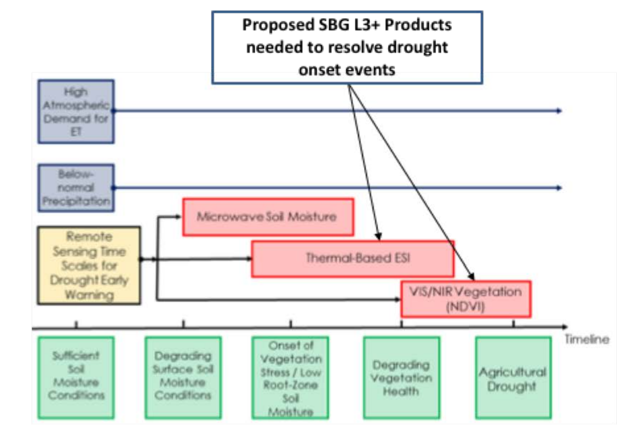
Example from NASA Western Water Applications Office, with Airborne Snow Observatory Team



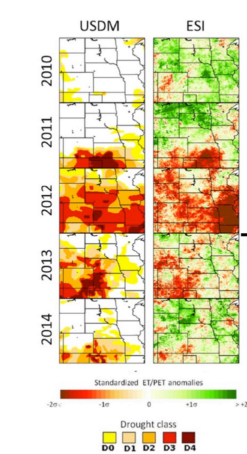
Drought Onset

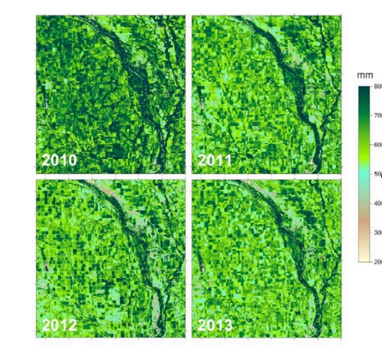
Societal Challenge: water availability and management continues to be one of the greatest risks we face, particularly as it relates to food insecurity and responding / adapting to weather extremes (droughts and floods)

Opportunity: improved detection and characterization of key freshwater sources and the single largest use of freshwater (agriculture) could improve our ability to address and mitigate effects of drought, especially rapid onset droughts and their impacts on agricultural systems



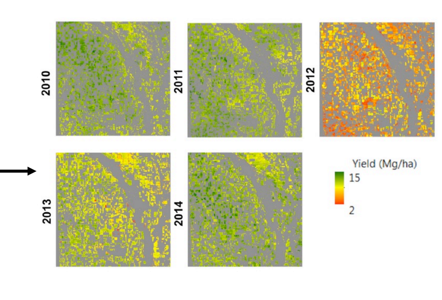
Decision relevant information from SBG:
TIR and SWIR data are necessary for high-resolution impacts of drought and vegetation stress on agricultural systems.





Growing Season ET

Example from Yang et al 2018



Estimated Crop Yield from Field-Scale Indicators

DS Question	Focused Science Topic	Application Concept	Decision Approach	L2+ VSWIR (one row) and TIR (another row)	Spatial	Temporal	Latency	Other Design Considerations	End Users	Ancillary	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?	Ecosystem traits and biodiversity - terrestrial	Improve agricultural practices (not related to water resources)	Use crop composition, structure, health to optimize application of fertilizers and reduce nutrient runoff.	L3-Crop Type L3-Vegetation Traits L3-Dead/Dormant Vegetation Maps L3-Green Vegetation and Non-photosynthetic vegetation L2-Surface Reflectance	30m x 30m (field scale)	weekly to monthly (based on cycles for irrigation and fertilizers?)	< 1 week	sun-synchronous	US Department of Agriculture NASS, ARS, FAS Water Districts Private agricultural businesses, like Gallo, Monsanto, John Deere ALL Federal Land Managers; Conservation NGOs; State Land Managers; Private land managing Industries (forestry, etc.) US Fish and Wildlife, AgriFood Canada, USGS FEWSNET, GEOGLAM	lidar and / or radar for vegetation structure	need category for federal agencies, perhaps broken into land managers vs. regulators, etc.
				L4-Water Use Efficiency L4-Evaporative Stress Index L3-Evapotranspiration L2-Land Surface Temperature						ECOSTRESS ancillary	
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?	Ecosystem traits and biodiversity - terrestrial	Improve agricultural practices (not related to water resources)	Use crop composition, structure, health to improve detection of crops that are diseased. May inform treatment of pest / disease mitigation.	L3-Crop Type L3-Vegetation Traits L3-Dead/Dormant Vegetation Maps L3-Green Vegetation and Non-photosynthetic vegetation L2-Surface Reflectance	30m x 30m (field scale)	weekly to monthly (based on cycles for irrigation and fertilizers?)	< 1 week	sun-synchronous	US Department of Agriculture NASS, ARS, FAS Water Districts Private agricultural businesses, like Gallo, Monsanto, John Deere ALL Federal Land Managers; Conservation NGOs; State Land Managers; Private land managing Industries (forestry, etc.) US Fish and Wildlife, AgriFood Canada, USGS FEWSNET, GEOGLAM	lidar and / or radar for vegetation structure	need category for federal agencies, perhaps broken into land managers vs. regulators, etc.
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				L4-Water Use Efficiency L4-Evaporative Stress Index L3-Evapotranspiration L2-Land Surface Temperature						ECOSTRESS ancillary	
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?	Snow Monitoring	Improving estimates of streamflow volumes and timing for water resources management, flood control, ecosystem flows, and hydropower	Apply snow properites products in streamflow estimates provided by operational agencies to inform water allocation, flood control, hydropower, and water use.	L4-Albedo L4-Snow Water Equivalent L4-Snow Density L2-Surface Reflectance	30m x 30m	albedo and reflectance-daily (ideal), swe and snow density-daily	daily (ideal)		Western States Water Council State Water Agencies (in areas where snow is major water supply) NOAA (responsible for hydroforecasts)	Lidar snow depth	
				L2-Land Surface Temperature	30m x 30m	sub-daily, diurnal	daily or less				
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?	Snow Monitoring	Improving mountain-derived runoff in snowmelt driven regions (e.g. Western US, Himalayas) where dust and black carbon (BC) deposition in snow alters runoff volume and timing. Implications to water resources management, flood control, ecosystems, hydropower.		L4-Albedo L4-Snow Water Equivalent L4-Snow Density L4-Snow Grain Size L4-Light Absorbing Impurities		daily - 3 days			same as above (WSWC, State water agencies in western US) but also interenationally, e.g. Himalaya region	Lidar snow depth	Select references: Painter et al., 2010 Painter et al., 2007; Flanner et al., 2007; Qian et al, 2009; Oaida et al., 2015; Belnap et al., 2009; Flanner and Zender, 2007; Li et al., 2013;
				L3-Evapotranspiration L2-Land Surface L2-Land Surface Emissivity							
(H-2) Impact of Land Use Changes on Water and Energy Cycles. 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?	Snow Monitoring, Natural Resources Management	As above, but with further implications during extended droughts. Improve understanding of how droughts affect dust sources and BC from wildfires, and how those changes might further impact dust/BC in snow effects on mountain		L4-Albedo L4-Snow Water Equivalent L4-Snow Density L4-Snow Grain Size L4-Light Absorbing Impurities	1 m - 50 m	3 -16 days			National Forest Service, Bureau of Reclamation, National Park Service	Lidar snow depth	Select references: Painter et al., 2010; Painter et al., 2007; Flanner et al., 2007; Qian et al, 2009; Oaida et al., 2015; Westerling et al., 2006; Neff et al., 2008; Belnap et al., 2009;
				L3-Evapotranspiration L2-Land surface temperature							
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?	Extremes (drought, flooding) predition	Improving drought/flood events by incorporating role land and land-ocean-atmosphere interactions play in drought/flooding extremes, in forecasting models. Changes in regional scale snowpack, subsoil and soil temperature have been shown to contribute to flood/drough extreme events downstream, through interactions with atmosphere, dynamic processes.	Incoroporate snow (amount) and surface temperature data (and processes) in regional forecasts for extreme events like drough/flooding.	L4-Albedo L4-Snow Water Equivalent L4-Snow Depth		8 - 16 days			NOAA (climate prediction center), National Weather Service,		Select references: Xue et al., 2016: Spring land temperature anomalies in northwestern U.S. and the summer drought over Southern Plains and adjacent areas. Xue et al, 2018: Spring Land Surface and Subsurface Temperature Anomalies and Subsequent Downstream Late Spring-Summer Droughts/Floods in North America and East Asia
				L3-Evapotranspiration L3-Land Sub-surface Temperature L2-Land Surface Temperature L2-Land Surface Emissivity							
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	Improving estimates of consumptive water use in agriculture, rangelands, and other managed landscapes for purposes of improving efficiency in irrigation, water use accounting, water rights administration and water allocations.	Develop and apply improved ET products in estimates of water demand to improve water management and allocations, important for responding to drought and groundwater overdraft.	L4-Dead/Dormant Vegetation Maps L4-Gross Primary Productivity L4-Irrigated area maps L3-Green Vegetation and Non-photosynthetic vegetation L3-Evapotranspiration (L3) L2-Surface Reflectance L2-NDVI	30m (ideal), 50m (acceptable), 100 m (minimum)	Daily (ideal), 3-5 days (acceptable), < = 8 days (minimum)	1-2 days for agricultural applications, 4-8 days for other applications, monthly - water rights	Improving temporal resolution higher priority than spatial (with min at 100m). For ET, need coicident VSWIR and TIR measurements every 8 days, with desired higher temporal revisit for thermal. For LST, need 3-5 bands.	Local, state, federal water management agencies, agricultural companies, ag tech companies, NGOs		Comment on Kerry / ECOSTRESS 5-->3 bands and LST accuracy
				L2-Land Surface Temperature L2-Land Surface Emissivity	30m (ideal), 50m (acceptable), 100 m (minimum)						
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	Improving estimates of evapotranspiration from wetlands and riparian ecosystems to monitor water demands for wetland and riparian ecosystems, improve accurate accounting of consumptive use by in water limited regions, and identify habitat	Apply improved ET products in estimates of water demand to improve water accounting and ensure adequate instream flows for wetland and riparian ecosystems.	L4-Irrigated Area Maps L3-Green Vegetation and Non-photosynthetic vegetation L3-Evapotranspiration L2-Surface Reflectance L2-NDVI	30m (ideal), 50m (acceptable), 100 m (minimum)	Daily (ideal), 3-5 days (acceptable), < = 8 days (minimum)	8-16 days		Federal, state and local water management agencies, NGOs		
				L2-Land Surface Temperature L2-Land Surface Emissivity	30m (ideal), 50m (acceptable), 100 m (minimum)						
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	Improving estimates of consumptive water use in agriculture for irrigation scheduling.	Apply improved ET products in estimates of water demand / crop consumptive use to support advances in irrigation scheduling and on-farm water use efficiency.	L4-Irrigated Area Maps L3-Green Vegetation and Non-photosynthetic vegetation L3-Evapotranspiration L2-Surface Reflectance L2-NDVI	30m (ideal), 50m (acceptable), 100 m (minimum)	Daily (ideal), 3-5 days (acceptable), < = 8 days (minimum)	1-2 days		Agricultural companies, ag extension agencies and farm advisors, ag tech companies		
				L2-Land Surface Temperature L2-Land Surface Emissivity	30m (ideal), 50m (acceptable), 100 m (minimum)						
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	Improving estimates of consumptive water use in agriculture to facilitate development of water markets.	Apply improved ET products in estimates of water demand / crop consumptive use to support development of incentive-based conservation programs and water trading programs to enhance sustainability of water supplies and long-term viability of agriculture in water limited regions.	L4-Irrigated Area Maps L3-Green Vegetation and Non-photosynthetic vegetation L3-Evapotranspiration L2-Surface Reflectance L2-NDVI	30m (ideal), 50m (acceptable), 100 m (minimum)	Daily (ideal), 3-5 days (acceptable), < = 8 days (minimum)	8-16 days		Agricultural companies, state and local water management agencies, NGOs		
				L2-Land Surface Temperature L2-Land Surface Emissivity	30m (ideal), 50m (acceptable), 100 m (minimum)						

Comments:

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