Community Engagement for Surface Deformation and Change

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Applications in Designated Observables Studies

(paraphrased/summarized from ESD Center Forum Slides February 2019)

- Integrate applications in SATMs, consider applications in evaluation of candidate architectures, and broaden the potential of observables to societal benefits in addition to their research emphasis
- Expand knowledge of potential users relevant to the DO topic – traditional partners, desired emphasis to include *industries* as partners
- Incorporate discussions with applications users on desires for latency, formats, and other aspects to consider for mission concepts

Responsibilities in our Study Plan

- Engage the community to develop a series of potential applications derived from the designated observables for SDC
- Emphasize applications from measurements proposed to be available in a given, proposed SDC architecture, and those enabled through an architecture and synergy with other current or future missions
  - *Science requirements* drive available applications to be pursued, rather than a specific application outcome driving mission or new science requirements
- In general, meet requirements of the Directive on Project Applications Program, Pre-Phase A:
  - Develop a Community Assessment Report (CAR) to compile information about application users, with some external support, to support all phases of mission development

Community Assessment Report (CAR)

- More details are forthcoming about the CAR, including support from HQ to assist with engaging the community, but some CAR components include aggregation of:
  - Assessing application opportunities and importance
  - Characterizing “Community of Practice” and “Community of Potential”
  - Describing institutions, organizations, and types of decisions
  - Identifying data formats familiar to the community
  - Assessing spatial, temporal, and other requirements
  - Describing decisions, actions, and potential impacts
  - Assessing latency needs, format, potential operational users, and areas of high societal benefit
- NASA HQ/Applied Science has expressed interest in broadening engagement to the private sector through partners in relevant sectors and state or federal partners.

Other DO Study Team Activities

- A-CCP (via Dalia Kirschbaum/GSFC and Emily Berndt/MSFC)
  - Formed an “Applications Impact Team” leveraging past GPM and Air Quality (HAQAST) efforts to meet ‘A’ and ‘CCP’ goals.
  - Tie enabled applications aligned with A-CCP science objectives, known or potential users, and relevant geophysical variables.
  - “Enabled Applications” series aligned with science traceability matrix to comprise the “A” in “SATM”
  - Engagement through upcoming town hall and other workshop-type efforts
    - Late July Weather and Air Quality Forecasting Workshop (GSFC)
    - HAQAST Community Town Halls (10-50 participants, next is July 10-12 in Pasadena)

Other DO Study Team Activities

- SBG (via Jeff Luvall/MSFC and Natasha Stavros/JPL)
  - Similarly developing an ”applications traceability matrix” linking to proposed geophysical parameters measured by SBG, including needs in terms of thresholds and baselines.
  - SBG has a series of teams established for various aspects of the mission study
    - Modeling, Cal/Val, Applications, Algorithms
  - Various groups have routine conference calls to discuss issues related to their specific area of interest and integration with others.
  - SBG Applications Team is hosting calls for the community to remain engaged on SBG activities, hear status, provide feedback, emphasizing applications.
  - Heavily leveraging past communities around HyspIRI

Other DO Study Team Activities

- MC (via Jeanne Sauber-Rosenberg)
  - As with GRACE and GRACE-FO, Mass Change applications very much focused on hydrological topics (flooding, water management, policy, etc.)
  - MC will engage early with CAR efforts to conduct a community survey to explore other applications areas of interest.

Leveraging NISAR Efforts for SDC

- NISAR has a well-established and ongoing applications effort led by several team members, among them: Sue Owen (JPL), Natasha Stavros (JPL), Batu Osmanoglu (GSFC), NISAR Science Team, etc.
- Large volume of NISAR applications content including:
  - Applications Traceability Matrix
  - Outreach to end users through populated distribution lists
  - 1-2 page white paper summaries for specific applications areas
  - Ongoing workshops with attendance from discipline-specific communities, state and federal partners, and summary reports of outcomes

NISAR Applications Traceability Example

Application - General	Application - Specific	Urgent Response?	Geographic Region	Time of Year	Polarization	Temporal Repeat	Spatial Resolution	Data Latency	Mission Data Product (L1 or L2) (InSAR/PolSAR)	Application Data Product	References to Current / Previous End-User Engagement	Comments / Other Requirements
Volcano Hazards	1. Monitor surface deformation at active & quiescent active volcanoes. 2. Derive models of magma plumbing systems consistent with surface deformation and other observations and constraints. 3. Map localized deformation associated with volcanic flows to understand physical property of volcanic flows, guide ground-based geodetic benchmarks, and help avoid misinterpretations caused by unrecognized deformation sources. 4. See also "Volcano Eruption Responses"	No	Aleutian, Cascades, Long Valley, Yellowstone and Hawaii volcanoes	Generally around the year. However, if it is determined that 12-day L-band NISAR does not maintain coherence at all during winter times (October through next May), winter acquisitons can be reduced.	HH is slightly preferred due to better coherence; however this is not a real requirement	Absolutely every satellite pass; an ascending interferogram and a descending interferogram for every satellite pass; no data culling is allowed over the Aleutian due to its geographic locations.	NISAR SP or DP modes: ~10 m	1 day ~ 1 week	L1 and L2 InSAR	Deformation interferograms, time-series deformation images; Magma source parameters	USGS Volcano Hazards Program: Alaska Volcano Observatory, Cascades Volcano Observatory, Hawaiian Volcano Observatory, Long Valley Volcano Observatory, and Yellowstone Volcano Observatory	No data culling is allowed for active volcanoes in US!!!
Volcano Eruption Response	1. Monitor volcanic processes such as lava-dome growth/collapse, map the extent of eruptive products (lava, lahars, landslides, and pyroclastic flows and ash deposits) from SAR backscattering and coherence imagery during an eruption. 2. Map voclanic deformation during the eruption to constrain amount of eruption material.	Yes	Aleutian, Cascades, Long Valley, Yellowstone and Hawaii volcanoes	Event Specific, Around the year	Any	As often as possible - daily	high-resolution such as NISAR SP is preferred: ~5 m	1 day or less	L2 (or L1 - if dissemination of L2 takes longer time) InSAR	SAR intensity images and their temporal changes, coherence image (or damage proximy map) and their changes in time, interfergrams spanning the eruptions and during the eruptions, magma source parameters and their evolution in time, DEM and DEM changes	USGS Volcano Hazards Program: Alaska Volcano Observatory, Cascades Volcano Observatory, Hawaiian Volcano Observatory, Long Valley Volcano Observatory, and Yellowstone Volcano Observatory	
Coastal Subsidence (Gulf Coast)	1. Aquifers compaction and subsidence hazard monitoring. 2. Deformation mapping associated with hydrocarbon, wastewater injection, and carbon sequestration. 3. Mapping active faulting and fissure, and strain accumulation on faults and co-seismic deformation associated with induced seismicity. 4. Building and infrastructure monitoring. 5. Damage proximy (coherence) map for rapid flooding. 5. Sinkhole hazard monitoring.	No	Gulf Coast	Generally around the year.	HH is slightly preferred due to better coherence; however this is not a real requirement	12-24 days	1. Most applications can be met by NISAR DP modes: ~10 m. 2. Sinkhole, and infrastructure monitorinig requires NISAR SP model: ~5 m.	1 day ~ 1 week	L1 and L2 InSAR	Deformation interferograms, time-series deformation images; secular deformation maps; coherencemap for rapid flooding	USGS,...	
Sinkholes	Sinkhole detection: Identify defomation related to sinkhole precursors & progression	No	US: Florida, East Coast & Southwest Karst	Year round	Single pol, HH or VV	12-24 days	~12 m	14 days	InSAR	Deformation maps		

(*waaaaay* more than just this excerpt…)

Applications concepts developed for NISAR will provide tremendous insight on what would likely be desired of an SDC architecture for continuity and new capabilities, a rich resource to tap as a first look at potential applications.

Example: A-CCP Concepts

A+CCP	A	CCP	Objectives
			O5 **Threshold:** 1) Provide measures of the occurrences and rates of snowfall at the earth surface as a function of different weather systems. 2) Relate snowfall to cloud physical properties, environmental factors, and to surface properties. **Baseline:** Same as Threshold with the additional focus on the surface energy balance particularly at higher latitudes.

Enabled Applications	OG	Goal	Obj	Var	Meas
EA6 - Geospatial Analytics – Big data for planetary resource surveillance (Defense department, public and private industry, IBM) EA11 - Hydrologic modeling, disease tracking, animal migration, insurance modeling and disaster applications (CDC, NOAA, Red Cross, World Bank, public/private comp.) EA12 - Forecasting heavy rain, snow, flooding events (NOAA, DoD, FAO, reinsurance) EA13 - Flood and landslide monitoring and forecasting within mountain environments (modeling and emergency response communities, NGOs, PDC) EA 14 - Streamflow, flooding, drought, energy, and agricultural monitoring and modeling (USDA, Water resource managers) EA 16 - Forecasting snow/mixed precipitation events (NWP, private weather companies)			X		

A+CCP	A	CCP	POR	App#	P#	Geophysical Variables
						Threshold
					P4	Cloud top height
					P32	Cloud top temperature
					P47	Snowfall water content
					P48	Surface or near surface precipitation rate
					P49	Snowfall vertical motion >1m/s
					P50	Cloud snow vertical structure 500m
					P51	Blowing surface snow
						Baseline (= Threshold+)
					P10	Surface or near surface precipitation phase
					P52	Bulk snow microphysics (particle size)
					P53	Snowfall vertical motion <1m/s
					P54	Cloud water phase
						Ancillary Data
					P24	Synoptic scale motion
					P55	Snowfall density
					P16	Thermodynamic profiles
					P56	Water vapor advection
					P35	Cloud radiative effects, LW & SW
					P57	Surface radiation budget

Example: A-CCP Concepts

A+ CCP	A	CCP	EA #	Enabled Applications	Partners	Geophysical Variables	Relevant Objective(s)
			1	Cloud and precipitation properties enable the weather prediction and modeling communities to improve parameterizations of clouds to improve weather forecasting, energy planning, air quality forecasting, and agriculture forecasting.	NWP Centers (NOAA, NRL, ECMWF, JMA, NCAR), USDA, AFWA, IBM, Private Companies	Cloud height, depth, radius, amount, phase, precipitation rate and phase	O2, O4, O6, O7 O2 O4 O5 O9
			2	Observations of aerosol and cloud properties used by the weather and air quality communities to understand and issue alerts about the development of fog/vog.	NOAA, NCAR, NASA, EPA and State Agencies	Aerosol and cloud properties	O6, O2
			3	Observations of aerosols and clouds enable the weather forecasting and modeling communities to improve modeling/forecasting on the impact of aerosols on precipitation development.	NOAA, NASA, NCAR, NWP modeling community, IBM	Aerosols, precipitation, and cloud properties	O1, O2, O4
			4	Observations of aerosol and vertical velocities are used to improved modeling of vertical transport and scavenging and links to ice particles and severe storm development.	NWS, NOAA, CTM	Vertical velocity, aerosol properties, precipitation properties, cloud properties	O1, O2, O4
			5	Cloud and aerosol optical depths are used to estimate radiative fluxes for applications such as estimating available photosynthetically active radiation (PAR) for air quality modeling, attenuated solar insolation for solar power companies, and agricultural forecasting. Solar power companies use estimates of size resolved aerosol concentrations and precipitation to model dry and wet deposition on the panels, respectively.	Air quality modelers (EPA, NOAA, state agencies), solar energy companies, agricultural communities	Aerosol Optical Depth, Aerosol Concentration Profiles, Aerosol Speciation, cloud properties	O1, O8, O9
			6	Data fusion techniques through geospatial analytics and “big data” management rely on aerosol, cloud and precipitation properties to provide continuous, detailed, multidimensional, and global monitoring as an invaluable tool for planetary resource surveillance.	Private industry (e.g., IBM, Weather Underground), Defense Department, public companies (e.g. Mars corporation)	Aerosol Optical Depth, Aerosol Concentration Profiles, Aerosol Speciation, brightness temperatures, surface precipitation	O4, O5, O6, O7, O8
			7	Observations of cloud height and droplets enable the aviation industry and weather prediction community to improve situational awareness of cloud evolution.	NOAA, FAA, DoD, DoE	Cloud phase, height, depth, radius, and amount	O2, O4
			8	Brightness temperature and precipitation rates enable the weather forecasting and modeling communities to improve storm track and intensity forecasts of hurricanes and severe storms.	NOAA, NASA, NCAR, ECMWF, NRL, JTWC, and other NWP centers, IBM	Brightness temperature (Cloud top temperature) and precipitation rates	O4

Leveraging NISAR Efforts for SDC

- In the 2016 Applications Workshop Report, NISAR team carved out three categories of users:
  - Experienced Users
    - Those doing their own analysis already, NISAR integrates naturally
  - Product-Ready Users
    - Sufficient technical background to integrate SAR into their efforts, to directly benefit through early involvement with products inspired by Sentinel 1A/B outcomes
  - Potential Users
    - Users who could potentially benefit but require additional support for adoption
- More gradation of user categories than CAR (Practice/Potential), perhaps helpful to continue and provide more detail in CAR outcomes

Preliminary Thoughts on SDC Applications

- Research and Analysis Workshop (this week!)
  - Thorough discussions to help SDC R&A leadership team revise and polish revised draft of science traceability matrix
  - Provide feedback on community engagement needs to guide remaining first year efforts and sustained engagement efforts
- Late May/June 2019
  - Start with STM, integrate NISAR Applications Traceability Matrix as a first cut on the types of applications of known interest from an SDC architecture
  - Develop this further into a list of “Enabled Applications” (adopting A-CCP terms), with traceability to STM, resulting in a draft S***A***TM.
  - Provide feedback to leadership team on where gaps may (or not) exist in providing continuity of applications valuable from NISAR and PoR.
  - Following HQ/Applied Science guidance, look for any opportunities for outreach to “industries” where their inclusion would add value.
  - Further understand HQ support for CAR efforts and how R&A team ties in.

Preliminary Thoughts on SDC Applications

- June, July, and August 2019
  - How do we engage with our science and applications community?
    - Possibility: Host a series of webinars that allow and encourage continued participation
    - Topics could be: R&A workshop outcomes, draft SATM, applications-area engagement to get feedback and more precision on SATM …and “Enabled Applications” following NISAR communities of interest
  - IGARSS Presentation (Rosen) on SDC Study Plan efforts
- September 2019
  - Host a Second R&A Workshop, likely in the Washington, D.C. metro area
  - Provide community with update on 1st R&A Workshop Outcomes, Technology Workshop, A-Team, SATM evolution, enabled applications, etc.
  - Host breakouts and discussions in discipline-focused application areas to build further information needed for architecture evaluation and CAR.
- December 2019
  - Submitted request to host a Town Hall Meeting on SDC Study Plan / Updates