NASA DIRECT READOUT CONFERENCE (NDRC) WEBINAR

September 2, 2020

MINUTES

Purpose/Objectives of the NDRC Webinar Series

At 11:00 a.m. Mr. Brad Quayle (USDA FS GTAC) convened the NASA Direct Readout Conference (NDRC) Webinar. He reviewed the purpose of the NDRC, activities to date, and objectives going forward. This webinar featured Dr. Sang-Ho Yun's (NASA/JPL, California Institute of Technology) presentation, "Synthetic Aperture Radar for Rapid Disaster Response."

Mr. Quayle's presentation, including webinar wrap-up slides, is available here: https://directreadout.sci.gsfc.nasa.gov/links/rsd_eosdb/PDF/NDRC_Webinar_Series_20200902 - Quayle.pptx

Synthetic Aperture Radar for Rapid Disaster Response

Satellite Synthetic Aperture Radar (SAR) is becoming an important remote sensing tool for rapid generation of damage and flood maps thanks to its all-weather and day-and-night imaging capability. However, it is not always straightforward to "translate" what radar sensors see from space into products that are useful for response efforts on the ground. In this presentation, Dr. Yun shared the challenges and opportunities of using spaceborne SAR observations for humanitarian applications and stories of recent disaster responses, including the November 2018 Camp Fire in California, January 2020 Puerto Rico Earthquake and other major events around the world. NASA and the Indian Space Research Organisation (ISRO) are planning to launch the (NASA-ISRO SAR) NISAR mission in 2022. The mission will increase the sensitivity for change detection with its dual-frequency sensors (L & S-band) and contribute to reducing the latency of response product generation.

Question and Answer Session with Dr. Yun

Q: What plans are there for providing a Direct Readout (DR) capability on future NASA SAR missions so that DR users may use SAR data in near real-time?
A: The same group of people who developed the SAR system have been working on the processing and dissemination part of the NISAR mission. The NISAR mission includes rapid response and applications support. NISAR mission data will be used to produce rapid response products.

Q: How does the algorithm handle data from multiple sensors (with different wavelengths)?
A: We have been utilizing different sensors (Sentinel 1, TeraSAR-X, etc.) for both damage and flood events. Sometimes we cross-validate between SAR-derived products to validate and evaluate consistency in derived products due to the lack of available optical data. For example, for Hurricane Harvey, we first used ALOS-2 data to rapidly produce a flood extent map. The next day we used Sentinel-1 data to produce another map, and then we cross-validated between the two maps. Hurricane Harvey lingered over Houston for five days, and strong winds prevented flying over with aircraft. Cloud cover prevented optical satellite imagery from being used. SAR data were the only data immediately available in the aftermath of the hurricane. It is important to remember that sensitivity is different between sensors. If we blindly try to merge products from two

sensors, we throw away important information of different sensitivities. We need to properly propagate uncertainty from each sensor, and we have to carefully understand the characters of different sensors.

Q: Also, do all of the images have to be from the same viewing geometry? Do algorithms have to change to handle different viewing geometries?
A: Damage detection from multiple viewing geometries is being studied. We do not yet know the full extent of the benefits and limitations of leveraging viewing geometries. We have not fully understood the capabilities of even a single viewing geometry. It is an ongoing study, especially with the Beirut explosion event. In my slides you saw four different viewing geometries for the Beirut explosion. I assumed that the ones looking right would have very different polarity of building damage, because the blast emanated from a single point, and it is clear which parts of the buildings are more severely damaged. I was expecting to see that group looking right would produce very different results from those looking left, but that was not really the case. The differences were very subtle. We are investigating that; it could possibly be debris on the ground impacting results, but we do not know yet. Different viewing geometries for flood mapping is potentially more challenging. Buildings remain damaged until repaired, but flood extents change over time, as quickly as a matter of two hours.

Q: Can you explain what you were showing when talking about the Beirut explosion and you showed 4 tracks or viewing angles. What were the TA87, TA14, TD94, and TD21?
A: We used two identical satellites from the same mission. Four different tracks are possible because the image swath width is so wide that there is a great deal of overlap from Track Ascending (TA) to Track Descending (TD) tracks. (TA indicates that the satellite is flying south to north, and TD indicates that the satellite is flying north to south.) Most of the SAR satellites are in sun-synchronous polar orbit in order to image everywhere on Earth.

Q: Can you explain how you went from 30m to 3m pixel resolution on the slide, "Non-local Coherence Calculation?"
A: We use higher resolution source SAR data to produce the 3m products. ALOS-2 3m products were used. Sometimes slightly coarser resolution sensors are used and oversampled to higher resolutions. We wanted to test performance if we actually sampled at 3m, and that worked just fine in comparison to 30m.

Q: You mentioned in your presentation about producing higher resolution products. Are there plans by Advanced Rapid Imaging and Analysis (ARIA) to access and use commercial high-resolution SAR imagery, such as from Cappella Space?
A: Yes. We have been looking at data from ICEYE, a company based in Finland. Their higher resolution data will be acquired with a narrower swath, but they will have multiple platforms in their constellation. We need to determine if the data can be used to generate interferometric products. It is necessary to maintain the same orbit geometry (repeat pass capability) as much as possible to perform interferometry/coherence analyses. Otherwise, the similarity between acquisitions has too much noise. We have yet to see ICEYE or Capella or any other commercial satellite maintain repeat pass capability, so

their data would not be useful for damage mapping. The data would be very helpful for amplitude analyses (flood mapping).

Q: Does NASA have access to commercial SAR data acquired by the Department of Defense?
A: Yes, we have access to those data sets. Each event we map is different, and sometimes we just reach out to commercial entities where it may be mutually beneficial. We develop more and more collaborative relationships over time where there is common interest.

Q: It seems that land cover or terrain variations induce issues in SAR coherence/ backscatter and also in the algorithms; affecting the results. How do you intend to go ahead to enhance/refine? Would be glad to hear your approach.
A: That is an accurate observation. Land cover type affects the performance because different land cover types introduce different levels of noise. One way to address this is to use the land cover dependency observed in the SAR data itself. Depending on the SAR data noise level we use that sort of as a weighting function. Or you can use land cover type as an auxiliary layer. There is a debate about engaging deep learning techniques for the use of auxiliary data. Use of auxiliary data can possibly be a hindrance due to the fact that Machine Learning (ML)/Artificial Intelligence (AI) factors that data into the learning. We will continue to explore these issues.

Q: Do you plan to use crowd sourcing to help with validation?
A: Yes. We always do our best to validate our products before release. We have access to commercial high-resolution imagery to validate data. Use of media reports that provide locational information on damage reports to infrastructure, etc., are also used to verify our products. Crowd sourcing is used in instances when that information is available from the local area after an event. For example, crowd sourcing was useful after the Mexico City earthquake in 2017. Sentinel-1 SAR data were acquired within six and a half hours after the earthquake, and we produced a damage map in less than 24 hours. As we were validating our map, there was already a very detailed crowd source-based map, including the locations of collapsed buildings, available through Google Maps.

Q: How do you determine what events ARIA supports and for which it delivers products? Is support request-based?
A: We have a few questions/considerations we use to guide us. Are there going to be end users that will use the data products? We also consider opportunities to advance science or improve algorithms. Are there requests from program offices (e.g., the Program Managers, Program Office, NASA Disasters Program, JPL Leadership, etc.)? We need to consider the availability of pre-event imagery, close enough in time to the event, for conducting change detection analyses. We also check whether we have enough current bandwidth to respond. For instance, we were recently creating maps for the Beirut explosion, COVID-19, and Hurricane Laura, but we also provided maps for the California fires once the fires became more severe. We have limited resources, and need to be careful as to how we allocate them.
Dr. Yun’s presentation is available here:

https://directreadout.sci.gsfc.nasa.gov/links/rsd_eosdb/PDF/Yun_FPM_DPM_NDRC_share.pdf

Meeting Wrap-up

Mr. Quayle thanked Dr. Yun for his presentation, as well as Webinar participants for all of their great questions. Mr. Quayle also thanked the DRL for providing logistics support. Mr. Quayle stressed the value of participant feedback as we evaluate future software technologies and algorithms, and prioritize resources accordingly to meet the needs of the global user community. He invited participants to submit feedback and suggestions for future webinar topics via email to NDRC organizing committee members (refer to Mr. Quayle's presentation for addresses). Before adjourning Mr. Quayle highlighted relevant news and upcoming events. The AGU Virtual Fall Meeting will include the "Near Real-Time/Low-Latency Data for Earth Science and Space Weather Applications Session," which may be viewed at: https://agu.confex.com/agu/fm20/prelim.cgi/Session/104084. Mr. Quayle reported that the VIIRS VNP46A2 - Daily Moonlight-adjusted Nighttime Lights (NTL) Product is now available in NASA Black Marble. For additional details on the product and to access it from LAADS DAAC:

- https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/VNP46A2
- https://blackmarble.gsfc.nasa.gov

Lastly, the NASA ARSET VNP46A2 training webinar is to be scheduled for December 2020. Additional information is available at: https://arset.gsfc.nasa.gov/webinars. Mr. Quayle adjourned the Webinar at 1:10 p.m.

Next Webinar

The next webinar is planned for December 2, 2020. Additional details will be provided via the Direct Broadcast Users email alias.