Questions & Answers Part 2

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Britnay Beaudry (britnay.beaudry@nasa.gov), Juan Torres-Pérez (juan.l.torres-perez@nasa.gov), Sativa Cruz (sativa.cruz@nasa.gov), and/or Amber McCullum (amberjean.mccullum@nasa.gov).

Question 1: How were the different gasses differentiated from the image?
Answer 1: I believe this is referring to slide 23, where researchers from this study used HyTES to quantify ammonia emissions. In these images, they use the TIR abilities of HyTES to monitor surface temperature and ammonia concentrations. Ammonia (and other greenhouse gasses) have specific spectral features that TIR sensors can detect. In the images on the slide, the ammonia concentrations are measured in parts per billion (PPB) and dark blue colors are lower concentrations, while red colors indicate higher concentrations. I encourage you to read the study linked if you'd like to learn more.

Question 2: Is HyTES data only available for the United States and Europe?
Answer 2: So far, HyTES data is available for some sites in the continental US, Hawaii, and the United Kingdom. Here's the site showing where past missions have been flown: https://hytes.jpl.nasa.gov/order

Question 3: Can LVIS be used in near-shore bathymetric mapping?
Answer 3: The best LiDAR for measuring bathymetry is bathymetric LiDAR, which uses the green wavelength of 532 nm that penetrates the water column. Since LVIS uses a 1064 nm laser, it is considered better for topographic measurements.

Question 4: How close to true ground can a LiDAR sensor like LVIS detect in thick grasses?
Answer 4: In regards to the exact accuracy of LVIS, we are unsure and will include the final answer in the final document.

Question 5: Is there a hyperspectral sensor covering the region of Africa?
Answer 5: As this is a new phenomenon, there are currently no global datasets. EMIT currently covers the arid parts of Africa (https://earth.jpl.nasa.gov/emit/).

The Hyperion mission provided older data (https://www.usgs.gov/centers/eros/science/earth-observing-1-eo-1).
EnMAP https://www.enmap.org/
The PRISMA mission (Italian) has some targeted sites in Africa (https://www.eoportal.org/satellite-missions/prisma-hyperspectral).

Question 6: Are the sensors and information only available in Central and North America? If I wanted to obtain information from South America, for example Colombia, what portal could I implement?
Answer 6: These airborne instruments are flown for specific projects and often the data has a very narrow focus and narrow flight lines. It may be instrument-specific depending on the mission. Most of this data is open access, however.

Question 7: Will BioSCape also be able to identify and map invasive plants in the landscape?
Answer 7: Yes, we expect to be able to identify areas of dense invasions and use that information to map them more generally. BioSCape is a one-time project, but satellite sensors (such as EMIT and the future SBG mission) should enable it into the future. However, the spatial resolution of upcoming satellite sensors will be coarser (30+m) than BioSCape (~5m) so will be limited to larger/denser invasions.

We hope to be able to distinguish invasive floating aquatic vegetation as well and this is a research question that will be addressed in the CyanoSCape project (https://www.bioscape.io/science) of BioSCape. Stay tuned!

Question 8: With regards to the BioSCape campaign, how do the animal surveys tie into the airborne data? Is it expected that the sensors will pick something up with regards to animal diversity/abundance, or are they just an additional resource to better understand the ecosystem dynamics?
Answer 8: A few ways: 1) use the remotely sensed data to map ecosystem variability and combine with animal surveys to map suitable habitat, 2) explore relationships between animal diversity and spectral diversity (e.g., are there more animal species in areas that are more spectrally diverse?).

Question 9: For the BioSCape project, how was the classification schema decided upon? Are there hopes to map biodiversity at a finer scale (i.e., increase the number of classes)? If so, what are some challenges the presenter sees in accomplishing finer scale mapping of biodiversity?

Answer 9: I'm not sure I follow the question, but the project involves more diverse approaches than just a classification analysis? In fact, I don't think any of the teams are doing classifications. In terms of classification, this could be in relation to diversity of the spatial scale.

Field spectroscopy and sampling (vegetation and aquatic) will play a role in helping to delineate and improve "classifications" of vegetation/aquatic types/species and accuracy. Hyperspectral data will provide a tidal wave of possibilities. Super exciting results will be resolved following the campaign and analyses for those teams investigating as well as those who capitalize on the ultimate data provided.

If you're interested in spectral resolution (hyperspectral) and spatial resolution, both will be playing a role in the ability to get at "finer classification" of cover types/species for BioSCape. The campaign will be a snapshot in time, so the temporal resolution will be possible unless our colleagues in South Africa are able to continue their imaging spectroscopy flights in these sites. SAEON (https://www.saeon.ac.za/) is a relevant partner in this.

Question 10: Does LiDAR data resolution vary?
Answer 10: Yes. The resolution of any airborne instrument depends on the altitude the plane flies at (closer to the ground means finer resolution data). In the case of LVIS, this also varies further depending on which lens is fitted - although altitude remains the main driver of resolution. Part 3 will cover terrestrial scanning and will go into more detail about this topic. There is always a tradeoff between flight altitude and spatial coverage.

Question 11: When analyzing dense forests with multi-layered LiDAR, do you consider differences in the beam with respect to other open canopies or open vegetation so that it can penetrate the ground and be measurable?
Answer 11: We will look into this further.

Question 12: What is the best way to get involved in projects like BioSCape?
Answer 12: Read more about the project on the website (https://www.bioscape.io/) and reach out to us or the team of most interest to you - https://www.bioscape.io/team. All of the BioSCape data will also be made freely available after the campaign - so anyone is welcome to download it and use it.

Question 13: Can you please speak about post-fire vegetation recovery studies that will be done in BioSCape?

Answer 13: Since this is a one-off set of flights (Oct-Dec 2023) we'll only be able to look at post-fire recovery using space-for-time substitution. That said, fire and post-fire recovery dynamics have a huge influence on the ecosystem so we have made it a focus because it cannot be ignored. Some references from our own research are listed below. Furthermore, out of the 16 BioSCape projects (https://www.bioscape.io/science), these teams are working on fire-related research questions:

(1) van Aardt et al "RadSCape: Radiative Transfer Simulation and Validation of the Dynamic Structural and Spectral Properties of the Vegetation of the Cape" - measurements of structure/spectra-to-traits to track biodiversity as a function of post-fire recovery.

(2) Cawse-Nicholson et al. "*Intrinsic Dimensionality and Data Fusion to Monitor Cape Biodiversity*" - measurements of evapotranspiration provides unique insights into plant stress before, during, and after droughts or fire.

(3) Silander et al. "*Spectral and Spatial Scaling in Biodiversity Remote Sensing: Research Conducive to BioSCape Science and Implementation Activities*" - habitat characteristics such as time since fire.

Wilson, Adam M., Andrew M. Latimer, and John A. Silander Jr. 2015. "Climatic Controls on Ecosystem Resilience: Postfire Regeneration in the Cape Floristic Region of South Africa." *Proceedings of the National Academy of Sciences of the United States of America* 112 (29): 9058–63. https://doi.org/10.1073/pnas.1416710112.

Ma, Yue, Yingjie Hu, Glenn R. Moncrieff, Jasper A. Slingsby, Adam M. Wilson, Brian Maitner, and Ryan Zhenqi Zhou. 2022. "Forecasting Vegetation Dynamics in an Open Ecosystem by Integrating Deep Learning and Environmental Variables." *International Journal of Applied Earth Observation and Geoinformation* 114 (November): 103060. https://doi.org/10.1016/j.jag.2022.103060.

Slingsby, Jasper A., Glenn R. Moncrieff, and Adam M. Wilson. 2020. "Near-Real Time Forecasting and Change Detection for an Open Ecosystem with Complex Natural Dynamics." *ISPRS Journal of Photogrammetry and Remote Sensing: Official Publication of the International Society for Photogrammetry and Remote Sensing* 166 (August): 15–25. https://doi.org/10.1016/j.isprsjprs.2020.05.017.

Slingsby, Jasper A., Adam M. Wilson, Brian Maitner, and Glenn R. Moncrieff. 2023. "Regional Ecological Forecasting across Scales: A Manifesto for a Biodiversity Hotspot." *Methods in Ecology and Evolution / British Ecological Society*, January. https://doi.org/10.1111/2041-210x.14046.

Question 14: Given that SAR is increasingly being used to model biomass, are there any ARSET webinars planned for using airborne UAVSAR data?
Answer 14: We will consider this going forward and there is an upcoming SAR training covering Crop Mapping. Also, ARSET has done a series of webinars on SAR data previously:
https://appliedsciences.nasa.gov/join-mission/training?search_api_fulltext=SAR

Question 15: Typically how powerful are the LiDAR lasers?
Answer 15: The laser transmitter for LVIS in particular has a NIR transmitter of 1064 nm. Her you may find more details on the LVIS instrument:
https://lvis.gsfc.nasa.gov/Home/instrumentdetails.html

Question 16: Will the eDNA data collected in aquatic ecosystems in the Cape lead to contributions to the DNA database for aquatic organisms (such as river invertebrates) in South Africa?
Answer 16: NASA funded campaigns like BioSCape follow an open science framework, so the data will be made available to the public. We would love to be able to incorporate into existing data repositories in South Africa - Notably though, this specific team is unlikely to be creating their own DNA library, but will instead use existing libraries, so they will be able to detect that there are species present that have not been previously identified in existing DNA libraries, but they may not be able to identify these.

Question 17: Is there any data to compare the previous and recent data in Europe, especially from the area of Turkey, aiming to compare the differentiations after the M:7.4 and 7.6 devastating earthquakes?
Answer 17: You might be able to find data pre-and post-earthquake, but it is dependent on the campaign. There are some datasets that can identify the physical damage intent of an earthquake.
NASA is using satellite data to assess the damage
https://earthobservatory.nasa.gov/images/150949/earthquake-damage-in-turkiye

Question 18: Could you go into more detail regarding the Bio Sound scapes and the independent autonomous recording units (ARUs) designed to sample sites across land cover types?
Answer 18: These ARU's are small boxes that house recorders (AudioMoths - https://www.openacousticdevices.info/audiomoth in this case). These boxes are attached to trees and left alone to record the soundscape for weeks at a time. Once the recorders are retrieved, the recording will be analyzed to identify specific bird and frog calls. Eventually, there is also hope that with enough training data this process could be run via machine learning. https://soundscapes2landscapes.org/. This team will also be looking at how distance from anthropogenic features (like roads) and distance from water (like rivers) influences how frequent and diverse the bird and frog calls you can hear are.

Question 19: How is BioSCape funded? Is it co-funded by USA-NASA and South African parties? Suppose there is interest in planning and running a similar campaign in a different biodiversity spot anywhere else. Could you provide a piece of advice on how to approach such collaboration?
Answer 19: Yes, it is co-funded by NASA and the South African Space Agency (SANSA). Please check out all the great information about BioSCape: https://www.bioscape.io/home and reach out to the BioSCape leadership. Some teams are building capacity through various funding sources. One opportunity for US faculty is through the NSF/NASA funding for EPSCoR:
https://www.nasa.gov/stem/epscor/rii-track-4/index.html
But proposals are due soon for this round, so future opportunities might be possible. These projects also tend to be very expensive and can be cost prohibitive for certain countries and organizations and we take this into consideration. These projects can also help to build capacity in relation to biodiversity as well.

Question 20: Why duplicate airborne LiDAR with terrestrial? You have issues with occlusion, that has to be extrapolated, with terrestrial so it is difficult to calibrate airborne data. The LVIS waveform data should be adequate in quantifying vegetation structure, particularly if you can access the raw waveform data. So, why the additional sampling effort, which is considerable in collection and processing?
Answer 20: The terrestrial lidar scanning (TLS) informs our understanding of vegetation structure, which affects airborne LiDAR and imaging spectroscopy. The team I'm working with (Jan van Aart et al) is not comparing airborne data to TLS, but is using TLS to help build radiative transfer models for the vegetation in the BioSCape domain

to model what the sensors should be seeing from first principles. Atticus Stovall (presenting in the Part 3 of this webinar series) may be planning (and show) other applications.

Question 21: It would be nice to know what type of LiDAR sensor LVIS is (i.e., full waveform, discrete return, etc.) and what is the expected point spacing from a 2 km swath at 10 km altitude specification. Is the blue-green waveform sensor EAARL still operational?
Answer 21: https://lvis.gsfc.nasa.gov/Home/index.html

Question 22: The airborne campaigns seem to be associated with specific projects in specific locations. I wonder how often other researchers are able to reuse the data for different applications?
Answer 22: That is a good question. We are trying to make BioSCape as useful in the long term as possible by making the data freely available. We're also trying to develop much of the ground-truthing in a manner that allows it to inform or form the basis of long term environmental observation.