Questions & Answers Session 1

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 Juan Torres-Pérez (juan.l.torresperez@nasa.gov) or Amber McCullum (amberjean.mccullum@nasa.gov).

Question 1: What is the relation between sea surface temperature and underwater coral? How do they get bleached?
Answer 1: Corals live in a particular temperature range, usually between 25-29 degrees Celsius. Once the water temperatures go beyond that threshold, corals and the zooxanthellae become stressed and bleaching occurs either by losing the pigments or expelling the zooxanthellae (organisms that live inside the coral). It can also happen if they are exposed to other environmental factors such as high sedimentation or UV radiation.

Question 2: Can diseases in coastal areas be caused by anthropogenic actions?
Answer 2: Yes, but it also depends on the disease. Coral diseases for example have been found in areas near river plumes but also occur in isolated areas away from human impacts.

Question 3: How Hyperspectral Remote Sensing helpful for estimating Coral Reef Health Assessment?
Answer 3: Good question! The advantage of hyperspectral remote sensing is the availability of multiple bands (200 + narrow bands) through the electromagnetic spectrum. This helps identify the difference between areas of bleaching vs healthy corals for example, But it also depends highly on other factors such as spatial resolution of the image, and the characteristics of the water column. NASA's CORAL mission (Coral Reef Airborne Laboratory) used the PRISM hyperspectral sensor to map reefs, mostly in the Pacific, at high spectral and spatial resolutions.

Question 4: What are the best satellite products to use to map coral and seagrass distributions at a national level (small scale)?
Answer 4: It has to be a combination of high spectral and high spatial resolution. Nonetheless, moderate resolution sensors have been used to some extent (Landsat,

Sentinel). Lately, other commercial data (high spatial resolution) has been used to map reefs and seagrass beds. This is data from Planet and Maxar (World View). For specific spectral data from seagrasses you may want to check the paper from Thorhaug et al (2007) Spectral reflectance of the seagrasses: Thalassia testudinum, Halodule wrightii, Syringodium filiforme and five marine algae. Int. J. Remote Sens. 28: 1487-1501. For corals, I recommend the book: Coral Reef Remote Sensing by Goodman et al (eds).

Question 5: Is there a maximum pixel size that is suitable to detect corals or kelp forests?
Answer 5: For coral reefs, usually the higher the spatial resolution the better mostly because of their heterogeneity. But meter scale data is useful for detecting major components (coral, algae, seagrass, etc). For kelps, Landsat data has been used extensively along with higher resolution data like World View or similar.

Question 6: I've been looking into purchasing some WorldView 2 data. It can be purchased as either radiance or reflectance. Is reflectance better for this type of work?
Answer 6: Either. The advantage of acquiring reflectance data is that you don’t need to go through the process of converting radiance to reflectance.

Question 7: You did mention that in Puerto Rico, you used an image with 4x4 spatial resolution. Which imagery was that? Is it free?
Answer 7: It was a mission where the AVIRIS sensor was flown in 2004-2005 during the coral bleaching event. Data should be available through NASA JPL.

Question 8: Is it possible to detect invasive species of coastal areas and land using satellites?
Answer 8: It would depend upon the invasive species and how different the spectral signature is from the native plants. Spatial resolution will also be a factor.

Question 9: How can we compute the net primary productivity of the kelp forest? Is there any ground-truth measurement available?
Answer 9: Our colleagues from the UCLA and UC Santa Barbara, Drs. Kyle Cavanaugh and Tom Bell have worked extensively on kelp forest structure, productivity and remote sensing. I recommend checking some of their papers for more details. Here are the links to some of them:
https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1002/ecy.3031

https://www.sciencedirect.com/science/article/pii/S0034425715300031
https://www.int-res.com/abstracts/meps/v403/p13-27/

Question 10: What type of Infections may occur in coastal ecosystems? Bacterial/viral? Which one is more prevalent?
Answer 10: All of the above. In corals in particular, more than 20 different diseases have already been described and depending on the disease, they may be of fungal, bacterial or viral origin. The same applies to other components of coastal environments.

Question 11: What is the spectral differentiation between the submerged water vegetation and suspended sediment water? Which indices could be used to do discrimination???
Answer 11: They both reflect in different parts of the spectrum. Sediments tend to reflect the yellow and red parts of the spectrum. Indices such as a floating algal index are designed specifically for certain types of vegetation like brown seaweeds. In the Remote Sensing of Freshwater Ecosystems webinar (https://arset.gsfc.nasa.gov/land/webinars/2019-freshwater) we covered some indices specific for sediments and CDOM. I also recommend the book: Remote Sensing of Coastal Aquatic Environments (Miller et al editors) where remote sensing of sediments and other constituents is covered in great detail.

Question 12: Is there any way to classify the condition of impact due to manmade destruction like sharing oil splits by ship etc.?
Answer 12: Yes, satellites have been used to detect oils spills. Here's a good review of remote sensing techniques for detection of oil spills:
https://www.sciencedirect.com/science/article/pii/S0025326X14002021

Question 13: Can rapid urbanization have any effect on the coastal ecosystem?
Answer 13: Yes, one of the parameters tied to coastal degradation is sewage and amount of nutrients. Nutrient plumes from sewage discharges and river runoff promote algae growth. Algae grows much faster than corals and eventually can overgrow coral colonies, suffocating them and killing them. Once this happens, the area is not colonized by corals again. Additionally, land use changes as a consequence of urbanization contribute to this problem not only due to sewage but also pollution from other sources.

Question 14: I know benthic/bottom reflectance is better, but can we use surface reflectance for coral reef mapping and bleaching detection?
Answer 14: It would depend on the clarity of the water. The effect of the water column, the deeper you go the more it will have an effect. Very shallow areas for coral, surface reflectance may work.

Question 15: Is it advisable to use remote sensed based SST for coastal areas? Would the land areas affect measurements too much so that they are no longer useful? Or will this depend on the pixel size?
Answer 15: MODIS SST can be used. MODIS has a lower spatial resolution though. Similar sensors such as VIIRS and even Landsat have been used to study SST. If using low spatial resolution data , then it is recommended to use pixels somewhat far from the coastline to avoid the influence of mixed land/sea information. Here's a paper that combines Landsat with AVHRR for SST analysis in coastal areas: https://www.sciencedirect.com/science/article/pii/S0034425702000044

Question 16: I noticed that you have got perfect spectra from your case shown in page 22 and 35. What is the depth that remote sensors can penetrate in your case? In my case it's very difficult to have blue band and red band signals.
Answer 16: In slides 22 and 35, the spectrum shown was collected in the field with a handheld spectroradiometer and has been smoothed with a Zavitsky-Golay filter.

Question 17: My question is on the factors affecting coastal ecosystems. Why did you use the term "Illegal" dumping of waste? Are there legal ways to dump waste in coastal ecosystem?
Answer 17: No, no legal way. But beyond a certain distance from the coast, certain waste can be dumped. Here's a webpage from the US Environmental Protection Agency with more info: https://www.epa.gov/ocean-dumping/learn-about-ocean-dumping

Question 18: Could you recommend literature that assesses methods to intercept silt before it enters coastal waters?
Answer 18: Sediments, you can use the same methodology. Please see the ARSET series, Remote Sensing of Freshwater Ecosystems. (https://arset.gsfc.nasa.gov/land/webinars/2019-freshwater)

Question 19: how does the curvature of the earth influence the spectra of reflectance? How is this corrected for? Is the reflectance for say a seagrass bed along the equator the same as reflectance for a seagrass bed at 30 degrees?
Answer 19: Satellite data is already corrected for this.

Question 20: What scope is there for Artificial Intelligence analyses to increase data analysis reliability? Could AI be more sensitive to subtle differences making it easier to correctly classify species and monitor species health?
Answer 20: CNN (machine learning) has been used to interpret satellite data in coastal ecosystems.

Question 21: Can LiDARs be used for estimating the carbon stock of the submerged ecosystems?
Answer 21: The use of LiDAR in submerged ecosystems is limited. Here's a paper that combined LiDAR with multispectral data to study carbon stocks in a marsh ecosystem: https://www.sciencedirect.com/science/article/pii/S0034425714000959

Question 22: How can I develop a regional algorithm for retrieving chlorophyll-a from the northern Bay of Bengal (highly turbid area)?
Answer 22: The best way is to obtain in situ samples and analyze them for chlorophyll concentration. Remember, this has to be done during the satellite overpass to make sure you are characterizing the same water mass.

Question 23: what is your method to compare spectral profile between spectrophotometer vs hyperspectral data considering the spatial resolution and the heterogeneity of the coral reef in one area (one pixel)?
Answer 23: You can select specific wavelengths from both, the in situ data and the sensor data and do a correlation analysis to check for similarities or differences. I suggest looking into the CORAL mission website for more details and references: https://coral.jpl.nasa.gov/

Question 24: Do you think the estimated chlorophyll concentration by OLCI sentinel 3 is presented with the same concentrations of in situ chla measurements?

Answer 24: Although I have not done it myself, apparently it is very promising. Here's a paper that may have more information:
https://www.sciencedirect.com/science/article/pii/S0034425719306248

Question 25: On your slide number 22, you had the Rhizophora reflectance among A cervicornis Palythoa and Thalassia. The Rhizophora is vegetation above the water surface and others are under the water column, is it comparable? And which condition when you measure the reflectance of cervicornis Palythoa and Thalassia?
Answer 25: In this particular case, we took coral and seagrass samples outside the water and immediately collected the spectral reflectance of them and then brought them back to their environment. This was done so spectral curves were more comparable. We have obtained similar results only for the coral, Palythoa and seagrass measures when collecting the spectral data underwater and correcting with a diffuse surface panel (Spectralon).

Question 26: in the case of seagrass, the %reflectance measured in situ is lower than the RS data. Is it because of a different sample, or why this big difference? Does this mismatch happen for a particular species, does it depend on cloud cover, water column clarity, or other environmental parameters influencing the times of analysis both from space and in-situ?
Answer 26: The graph with the seagrass in situ spectra is an average of many spectra collected from different leaves. When you look at all the samples it is similar to the airborne data. But yes, differences can be related to all those factors you mention. What is most important here is that the spectral features are maintained, not necessarily the magnitude of the curves.

Question 27: In slide no 24, You have shown the spectral profile of three seagrass sp. There were 2 line graphs, one was with reflectance and other was with first derivative of reflectance. I wish to know, why do we have to do derivative analysis? and What interpretation can we make out of it?
Answer 27: The long story short, is that derivative analysis of spectral curves help in identifying those inflection points in the curve which are associated with the presence of particular pigments and where in the spectrum they absorb. This can be used as a proxy for differentiating species when the spectral curves are very similar. In my paper of Torres-Perez et al (2012), I discuss this in some additional detail. Here's the link:
https://www.mdpi.com/2072-4292/4/12/3813