Part 2 Questions & Answers Session A

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 Sean McCartney (sean.mccartney@nasa.gov), Denis Felikson (denis.felikson@nasa.gov), or Phil Thompson (philiprt@hawaii.edu).

Question 1: What do you recommend in terms of the Dead Sea in Jordan? I used changes in surface area of the water body using satellite images.
Answer 1: The Dead Sea is not connected to the ocean, so we would not expect sea level rise to matter for the Dead Sea. What would matter would be the balance of evaporation and precipitation/runoff into the Dead Sea.
If you are interested in measuring the surface height of the Dead Sea, we recommend you explore NASA's Surface Water and Ocean Topography mission (SWOT) for surface heights of global oceans and inland waters. For more information on this mission please refer to the following ARSET training: Monitoring Global Terrestrial Surface Height using Remote Sensing (May 2025).
Another ARSET training of interest is: Mapping and Monitoring Lakes and Reservoirs with Satellite Observations (February 2021).

Question 2: I want to know how to check sea level at a point location worldwide.
Answer 2: The IPCC AR6 Projection Tool can be used to check sea level projections at point locations worldwide. The tool can show projections at any location on Earth, including tide gauge locations. Users need to click on a location on the map to pull up the projections at that location and entering a specific latitude/longitude is not an option, however the underlying projection datasets can be accessed here: https://github.com/Rutgers-ESSP/IPCC-AR6-Sea-Level-Projections. Using this data, the projections at any latitude/longitude location can be extracted.

Question 3: You mentioned that your post-AR6 work showed that 1.5 m in 2100 cannot be ruled out. Does this mean that 2.0 m in 2100 can now be ruled out?
Answer 3: No, 2.0 m of global-mean sea-level rise in 2100 cannot be completely ruled out. Based on preliminary results from the updated version of the Framework for Assessing Changes To Sea-level (FACTS), under a very high emissions scenario that includes "low confidence" processes (SSP5-8.5 Low Confidence), the 95th percentile projection is about 2.2 m. Current emissions trends are substantially below this

scenario. Under a moderate emissions scenario that includes low-confidence processes (SSP2-4.5 Low Confidence), the 95th percentile projection is about 1.7 m. SSP2-4.5 involves emissions that are stable through mid-century and decline thereafter. Under SSP3-7.0, an emissions scenario with sustained growth of emissions at a level more plausible than in SSP5-8.5, the 95th percentile projection is about 2.0 m. So, although it is not likely, GMSL rise of 2.0 m cannot be ruled out, and its plausibility depends strongly on future emissions.

Question 4: What key differences or updates regarding sea level rise projections and the understanding of ice sheet dynamics have emerged since previous IPCC assessment reports?
Answer 4: Ice sheet dynamics continue to be an active frontier of scientific research, with some evidence arguing for a lower probability of rapid ice-sheet loss and other evidence arguing for a higher probability of rapid ice-sheet loss. The difference between the IPCC medium-confidence and low-confidence projections remains a good indicator of the divergence of evidence within the research community.

Here are some recent studies that have been published after IPCC AR6 that focus on ice sheet dynamics:

- Choi et al. (2021)
- Mejia et al. (2021)
- Aitken et al. (2023)
- Dow (2022)

Question 5: The data that is being presented regarding sea level rise under different scenarios—can this data be applied at a local scale, for example, to analyze a small area? And is it appropriate to use these values as input for building a predictive model at that scale?
Answer 5: Yes, this information can be applied at local to regional scales, including as an input for models that include other local processes such as waves or storm surge. The SLR projections do include the local impact of ocean warming and ice melt. However, it is important to note that the resolution of the ocean dynamic projections is about 100 km; unresolved coastal processes can lead to differences in this component of sea level. This is of particular concern in areas with limited connectivity to the ocean (e.g., estuaries, embayments, and marginal seas).

The vertical land motion projections are based on data from tide gauge locations; in some areas, vertical land motion can vary substantially on a scale smaller than resolved. If higher resolution local subsidence data is available, it is often useful to combine this data with projections from the IPCC of the climate-driven components of sea level. Projections excluding vertical land motion can be downloaded as described at https://github.com/Rutgers-ESSP/IPCC-AR6-Sea-Level-Projections.

Question 6: Beyond the presented total rise and rates, does the underlying Sea Level Projection Tool or its associated documentation offer data on extreme sea level events (e.g., storm surge statistics, tidal ranges) that are essential for dynamic flood modeling?

Answer 6: No, the Sea Level Projection Tool provides projections of mean sea level only, which do not include extreme sea levels caused by tides or storm surge. However, the Flooding Analysis Tool does incorporate changes in tidal ranges and factors such as natural climate fluctuations like El Niño and others. You can set a threshold close to various extreme surge levels (which is listed on the observed flooding tab) and then see how the frequencies of those types of events will evolve.

Question 7: Is there a connection between sea level rise and groundwater flooding? If so, how does sea level rise influence or contribute to increased groundwater flooding?

Answer 7: Yes. As sea level rises, the higher oceanic water level applies additional pressure on the ground water, which causes it to rise vertically toward the land surface.

Question 8: I used Ge-Run for flood monitoring in Jordan in m3/sec. Can I merge the results with flooding days here, or is it just about the ocean?

Answer 8: Unfortunately, we are not familiar with the Ge-Run tool and we cannot provide feedback on how to incorporate it within the results from the NASA Sea-Level Change Tools.

Question 9: Is sea level rise a contributing factor to coastal erosion? Rock barriers are used to stop sea waves and reduce coastal erosion, but will they also lower the flooding threshold?

Answer 9: Yes, sea level rise contributes to coastal erosion. The details of that can be tricky to quantify, as erosion in one place may lead for that sand/sediment to accumulate in another place. But on the whole, sea level rise does tend to lead to an overall increase in erosion. Adding barriers to stop waves and reduce erosion generally raises the threshold for flooding, meaning more sea level rise and/or higher water levels are necessary to create flooding conditions.

Question 10: Is the tool only for the Pacific Region? Can it also be used for other parts of the world?
Answer 10: Currently, the flooding analysis tool is only for the pacific region, but there is a plan to expand it globally in the coming year. Please continue to check back to see whether additional locations have been added.

Question 11: Is there any published scientific papers or research accessible through this tool's documentation that detail the methodologies, data inputs (beyond global mean sea level), and validation of its projections for chronic or extreme flooding events, similar to the future flooding frequency assessment shown in the previous slide?
Answer 11: Yes, there are published, peer-reviewed scientific papers that describe the methods used to create the information served by both tools presented in Part 2 of this training:

- IPCC AR6 Projection Tool: Kopp et al. (2023)
- Pacific Island Flooding Analysis Tool: Thompson et al. (2021)

Question 12: How frequently are these tools updated as SLR projections improve/increase?
Answer 12: These tools are based on IPCC projections, and we expect the tools to update as the IPCC projections update, so something like a 6–7 year update cycle.

Question 13: Is there a simulator website available to see what happens (worldwide or for a region) if the sea level changes (up or down)?
Answer 13: The combination of the tools we demonstrated today can help provide an overall picture of changes. There may be some other tools on the Sea Level Change website that can be used, however, it is still hard to see fine scale changes at the coastline.

Examples of tools that do allow investigation of inundation associated with different water levels include NOAA's Sea Level Rise Viewer for the United States (https://coast.noaa.gov/slr/) and Climate Central's Coastal Risk Screening Tool (https://coastal.climatecentral.org/) globally. Note that inundation projections are highly sensitive not only to sea level but also topography, and quality of topographic data varies globally. These tools also do not consider the effects of storms on flooding.

Part 2 Questions & Answers Session B

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 Sean McCartney (sean.mccartney@nasa.gov), Denis Felikson (denis.felikson@nasa.gov), or Phil Thompson (philiprt@hawaii.edu).

Question 1: How can sea level projection tools be used to inform local urban planning and coastal infrastructure design?
Answer 1: I think the flooding analysis tool discussed during the second talk in this session is a great way to get started on that. Following the workflow described there (i.e., choosing location → choosing threshold → choosing SLR scenario → flooding frequency) provides an excellent entry point into putting the pieces together for decision making. However, there are pieces of the puzzle not addressed there, such as what flooding extents and frequencies are tolerable and at what point mitigation and/or adaptation approaches need to be enacted. These factors need to be considered at the local level by decision makers with local knowledge. Going one step further, it is also possible to use the SLR amounts and flooding heights/frequencies as inputs to local models that can include additional processes such as waves/erosion/etc.

Question 2: How does the ocean's ability to absorb carbon affect sea level rise?
Answer 2: There is a link between carbon in the ocean and sea level rise but it's not a simple cause-effect relationship. The ocean's ability to absorb carbon affects carbon dioxide concentrations in the atmosphere, and therefore planetary energy balance. Higher atmospheric carbon dioxide concentrations lead to warmer surface temperatures and more ocean heat uptake, thus more thermal expansion and land-ice mass loss.

Question 3: Can this be adapted for use in the Indian Ocean islands?

Answer 3: Yes, the methodology behind the Pacific Islands Flooding Analysis Tool can be applied to the Indian Ocean islands. There is a plan to expand the analysis globally in the near future that is dependent on sustained funding for the tool.

Question 4: The data that is being presented regarding sea level rise under different scenarios—can this data be applied at a local scale, for example, to analyze a small area? And is it appropriate to use these values as input for building a predictive model at that scale?
Answer 4: Yes, the IPCC AR6 Projection Tool provides localized projections of mean sea level, including the local impacts of ocean warming and ice melt. However, these projections do not include extreme sea levels caused by tides or storm surge localized. Depending on the predictive model in question, these extreme processes may be important and external information, outside of the mean sea level projections, may be needed.

Question 5: How can we adapt the different processes to West and Central Africa?
Answer 5: Sea level rise projections are available for West and Central Africa, though vertical land motion is poorly constrained in these regions due to a sparsity of tide-gauge data.

Question 6: During the webinar, there was an important discussion of uncertainty and likelihood using IPCC methods. The point was made (if I heard correctly) that only with medium or high confidence could one assess likelihood. It was my understanding that the IPCC guidance says only with high or very high confidence should such estimates of likelihood be made. Can you please clarify, and perhaps point to the relevant IPCC statement?
Answer 6: While the 2010 IPCC guidance (Mastrandrea et al., 2010) advised making likelihood judgements only in cases of high or very high confidence, current practice allows exceptions to this rule where appropriate to communicate relevant uncertainties. See IPCC AR6 WG1, Box 1.1: “Unless otherwise indicated, likelihood statements are related to findings for which the authors’ assessment of confidence is high or very high.” The communication of sea-level uncertainty is an example where the decision was made to allow likelihood statements regarding processes for which at least medium confidence existed. Kopp et al. (2023) for an extended discussion of the communication of sea level rise uncertainty and ambiguity by the IPCC.

Question 7: In general, I believe that IPCC assigns medium confidence for its SLR projections. This means (if I am correct about their guidance as in the previous question) one would not then go on to a statement of likelihood. But this then hamstrings estimates of risk to specific entities, if one thinks of risk as likelihood x consequence. It would seem, if we can't estimate likelihood, we can't estimate risk. I understand that IPCC uses hazard, exposure and vulnerability, but does that really finesse the likelihood issue?
Answer 7: Please see the answer to the previous question for information on this topic.

Question 8: How do you account for active volcanoes and the "Hot Spot"; and new land mass affecting sea level in the Pacific?
Answer 8: Changes in the shape of the ocean basin do not have a significant effect on sea level on relevant timescales.

Question 9: There has been a lot of focus on Pacific islands, do you have any comments about how accurately this tool would apply to the Macaronesian Islands, being in the Atlantic ocean, being volcanic, etc.?
Answer 9: Similar to questions we have addressed above. Every island is different, so we would discourage the use of projections for one place to another.

Question 10: What proxies are used to measure dissolved oxygen or salinity from satellites?
Answer 10: We will review before posting. We believe salinity can be measured from satellites, while dissolved oxygen may not be.

Question 11: As data from PACE mission becomes available to evaluate coastal water quality, are there tools that are planned to be developed that connect the flooding analysis tools here and water quality impacts/projections?
Answer 11: ARSET has a training on water quality and the PACE mission. The PACE mission is still relatively new, so plans for releasing future tools are possible but not yet certain. A new PACE-related ARSET training is scheduled for Fall of 2025. Please visit the ARSET website for new trainings as they open.

Question 12: How do NASA's sea level change tools integrate multi-source satellite altimetry data with GRACE and GNSS measurements to improve regional projections for vertical land motion?

Answer 12: Vertical land motion projections in the current sea level tools are not currently informed by satellite altimetry data, which are limited for this purpose because of their relatively short timespan. Ongoing research (e.g., Oelsmann et al., 2024) is working to fuse satellite and tide-gauge data to improve estimates of long-term vertical land motion.