<u>**Response to Referee Comment (RC1)**</u>

Submission ID: egusphere-2026-1545

Submission Title: Application of radar remote sensing for cyclone damage mapping in Bangladesh: A coherence-based approach

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Dear Sir,

Thank you for the constructive and detailed feedback on our manuscript and for the time taken to evaluate our work. The comments were extremely helpful in identifying areas where the methodology, validation, and discussion needed to be clarified and strengthened, and we believe the manuscript has improved considerably as a result. We have carefully considered and addressed all comments, and the manuscript has been revised accordingly. Below, we provide point-by-point responses (C and R denote comment and reply, respectively) to each of the reviewer's comments

C0:

This work is well-written and reports a well-explained methodological approach of SAR coherence analysis. Here, the coherence analysis was used to detected the impact of tropical cyclones in Bangladesh. The methodological approach is well-reported and allow to be reproducible in another context. An important point is the improvements of the outcome description, by way of example improving the visualization of the flooded surfaces. I have very few comments that can help to improve the manuscript.

R0:

We sincerely thank the reviewer for the positive assessment of our methodology and for the constructive suggestions. We have addressed each point below on a point-by-point basis.

C1:

Line 91: Figure 1. With the location of the areas, it could be useful to insert also the cyclone tracks for the events considered in this study.

R1:

Thank you for this helpful suggestion. In the revised manuscript, Figure 1 will be updated to include the official cyclone tracks collected from NOAA, allowing readers to better relate the cyclone trajectories to the investigated study areas.

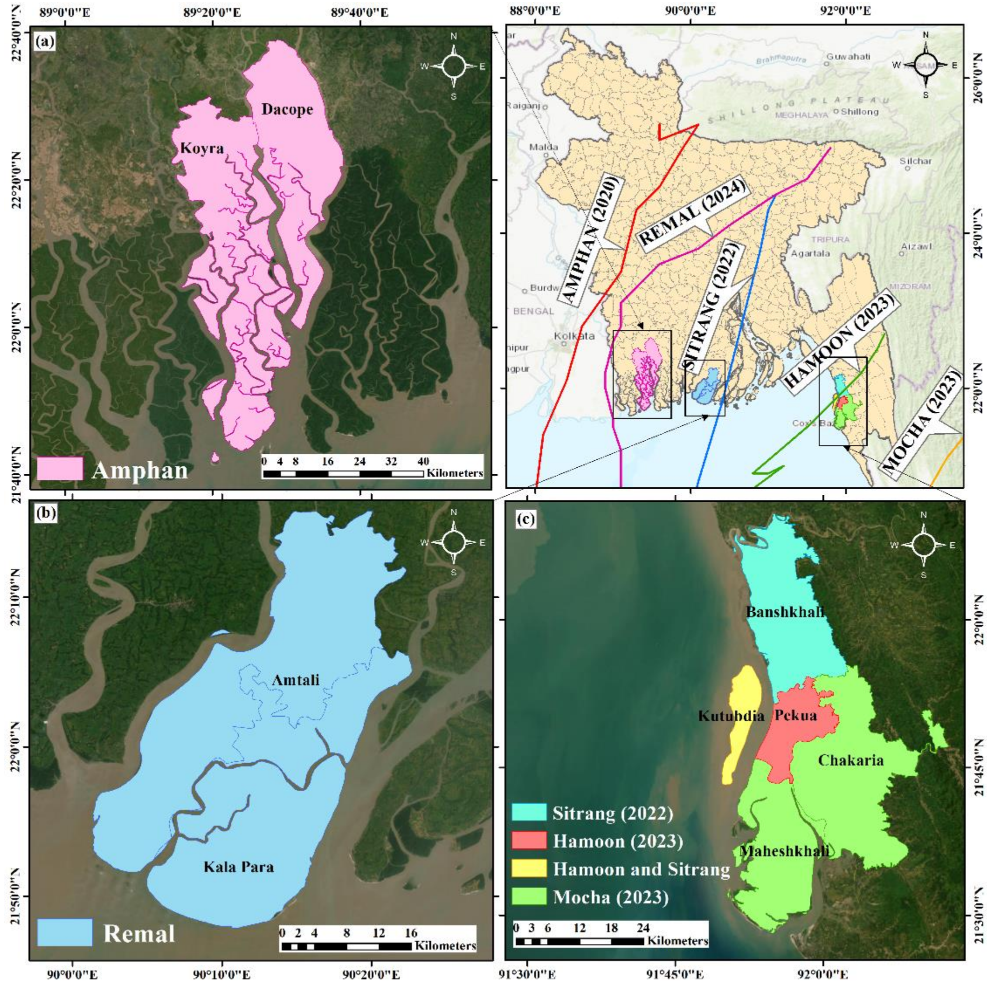

Figure 1: Study area location based on the cyclone landfall. (a) Areas affected by Cyclone Amphan (2020); (b) Areas affected by Cyclone Remal (2024); (c) Areas affected by Cyclone Hamoon (2023), Cyclone Mocha (2023, Cyclone Sitrang (2022). Base maps are from ESRI World Imagery and World Topographic Map, with data sources including Esri, Maxar, Earthstar Geographics, HERE, Garmin, OpenStreetMap contributors, and the GIS User Community | Powered by Esri.

C2:

Line 149: the acronym SNAP was defined before.

R2:

Thank you for pointing this out. We have moved the full definition of "Sentinel Application Platform (SNAP)" to its first occurrence in Section 3.1.

C3:

Line 229: For Figures 4 and 5, can you highlight the coastal areas? In order to highlight the flooded areas from other. Furthermore, insert some toponyms following those cited in the main text.

R3:

Thank you for this helpful suggestion. We have revised both Figure 4 (coherence-based damage maps) and Figure 5 (inundation maps) to include a highlighted coastline boundary in each panel, distinguishing coastal zones from inland areas. We have also added toponyms (e.g., Cox's Bazar, Kutubdia, Maheshkhali, and union-level place names such as Nilganj, Mithaganj, Sarikkhali, and Lalua) directly to the maps, consistent with the place names cited in the main text of the discussion section.

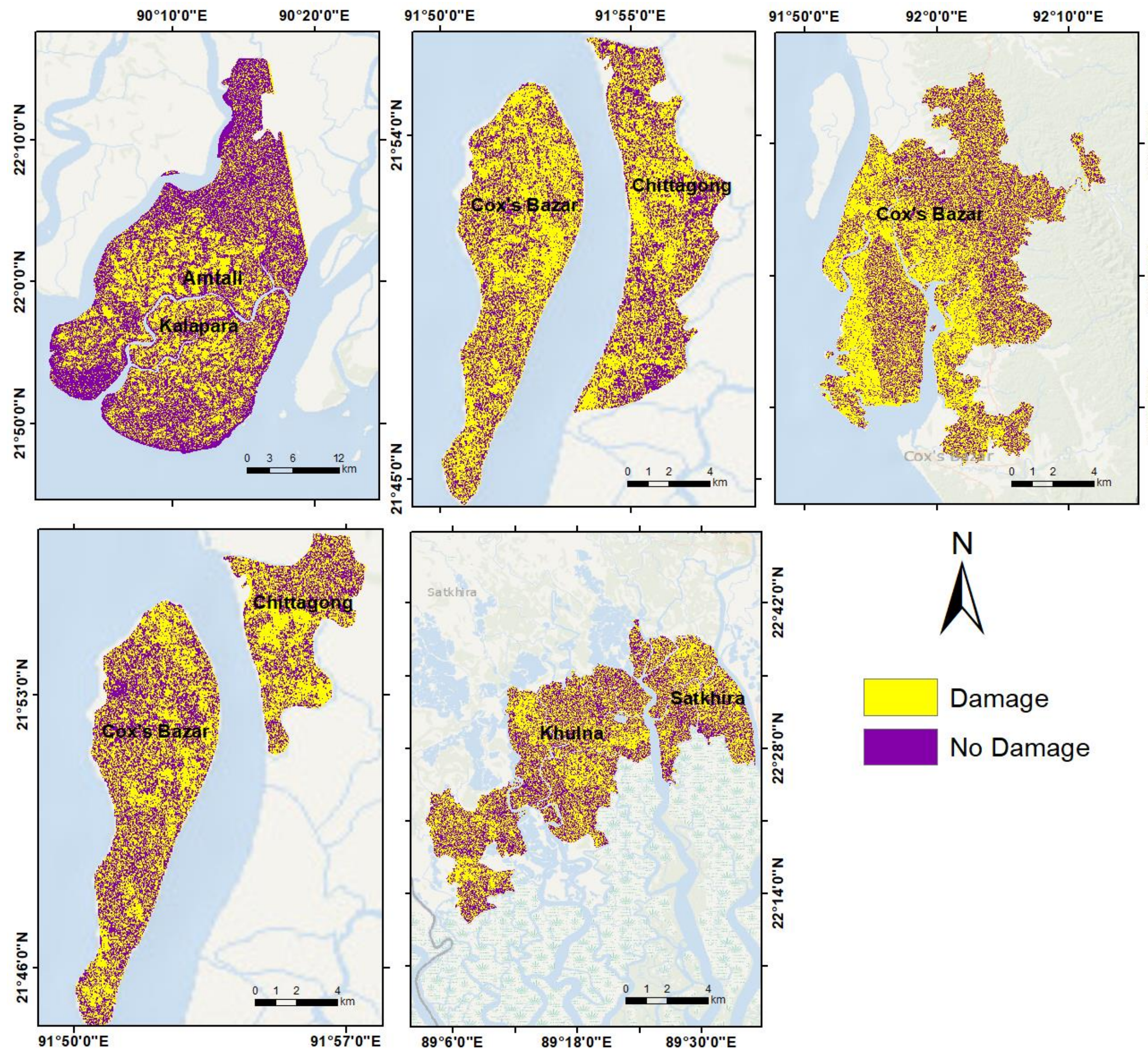

Figure 2: Coherence-based damage map of (a) Cyclone Remal (2024); (b) Cyclone Hamoon (2023); (c) Cyclone Mocha (2023); (d) Cyclone Sitrang (2022); (e) Cyclone Amphan (2020). Basemap sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, and other contributors.

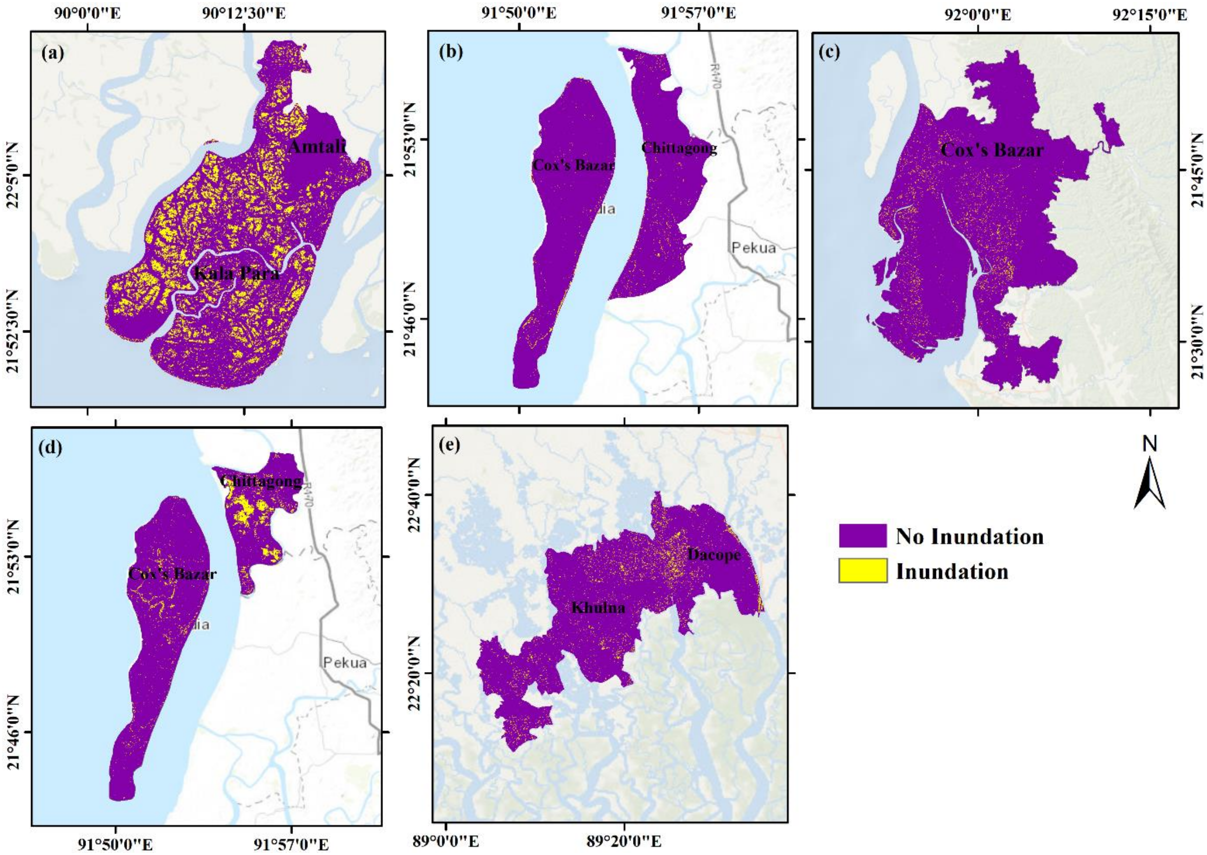

Figure 3: Inundation Maps of (a) Cyclone Remal (2024); (b) Cyclone Hamoon (2023); (c) Cyclone Mocha (2023); (d) Cyclone Sitrang (2022); (e) Cyclone Amphan (2020). Basemap sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, and other contributors.

C4:

Line 258: Higlight in the maps the location of coastal barrier islands impacted by cyclone Hamoon.

R4:

Thank you for this suggestion. Following the same approach used in our response to Comment 3, we have revised the relevant map for Cyclone Hamoon to highlight the coastal barrier islands impacted by the event, including Kutubdia and Maheshkhali, ensuring these locations are clearly marked and consistent with the place names referenced in the main text.

C5:

Line 264: Here the subsection deserves to be improved. The validation is not adequately reported. I suggest to plot the output of the coherence analysis with the same geotagged picture.

R5:

We thank the reviewer for this important comment. We have substantially revised Section 3.5 (Validation and Accuracy Assessment). To report more transparently, we have enhanced the description of the validation approach and included a comparison between the coherence-based outputs and corresponding geotagged field photographs. The revised content is presented in Section 4.4: Result Validation, along with the updated figure.

“***4.4 Result Validation***

To validate the Sentinel-1 SAR-based coherence map for Cyclone Remal (2024), a total of 50 representative points were initially selected from the predicted damaged areas. These points were chosen to represent varying levels of predicted damage and corresponding coherence values. The selected points were successfully evaluated through field visits and visual confirmation, allowing direct comparison with the predicted damage map. Each point was categorized as True Positive (TP), False Positive (FP), True Negative (TN), or False Negative (FN) based on the agreement between ground observations and the SAR-derived predictions. The mixed validation framework used across cyclone events: field-based validation with geotagged ground photographs was conducted only for Cyclone Remal (2024), while validation for the earlier cyclones (Sitrang, Amphan, Mocha, Hamoon) relied on secondary datasets and published damage assessments.”

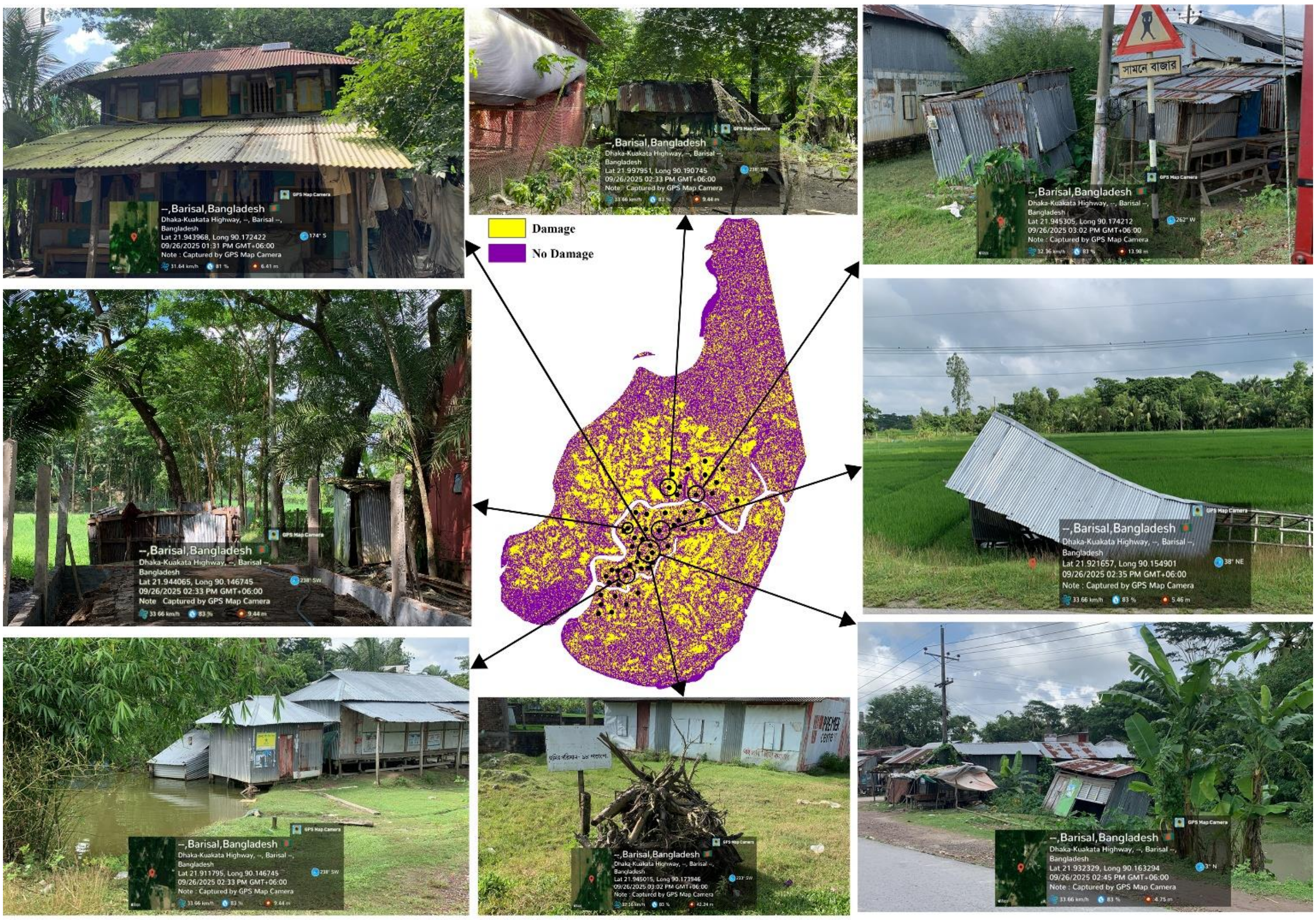

Figure 4 *Damages of Cyclone Remal (2024) found during field validation in Kala Para Subdistrict.”*

C6:

Line 296: The subsection 5.1 needs to be improved, in which the discussion should report a comparison of the applied method with the literature. Here, no literature is reported.

R6:

We thank the reviewer for pointing this out. We agree that Section 5.1 previously discussed our findings without reference to comparable studies. We have revised the subsection to incorporate literature-based comparisons throughout, situating our results relative to six previous SAR/coherence-based damage assessment studies covering earthquakes, hurricanes, and typhoons (Fielding et al., 2005; Plank, 2014; Washaya and Balz, 2018; Malmgren-Hansen et al., 2020; Mouquet et al., 2020; Meneses and Blanco, 2022). The updated discussion is provided in Section 5.1.

"The results establish interferometric coherence as an effective and useful indicator of cyclone-induced surface change and disturbance. The observed temporal decline and gradual recovery after the landfall indicate the short-term destabilization caused by cyclone winds, while the spatial distribution of coherence loss broadly corresponds with reported patterns of cyclone impact from the secondary literature reviews. Partial overlap with inundation layers confirms that coherence captures flooding and inundation, wind-caused damage, and land surface changes within a single radar-derived measure. Thus, CCD as a method offers key advantages such as cloud independence, sensitivity to both flooded and wind-damaged surfaces, and scalability for temporal monitoring, proving to be complementary and a potential alternative approach to other optical or field-based damage monitoring and assessment methods.

5.1 Comparison of Cyclone Damage Scenario and Inundation Scenario

Coherence-based damage maps showed clear variation in the spatial extent and distribution of affected areas, reflecting both threshold selection and underlying cyclone dynamics. Cyclone Remal produced a broad low-coherence zone around Kalapara and Amtali subdistricts, consistent with reported inundation and embankment failure; Hamoon showed a more localized footprint around Kutubdia; and Mocha generated a widespread, relatively uniform decorrelation pattern across southern Cox's Bazar, consistent with its extensive wind field. These differences indicate that coherence response varies with cyclone characteristics and the spatial distribution of surface disturbance. This event-dependent variation in the magnitude of decorrelation is consistent with Washaya et al. (2018), who reported marked differences in overall coherence losses for a hurricane (75%) and an earthquake (65%) using comparable Sentinel-1 coherence change detection (CCD), indicating that the degree of decorrelation is closely tied to influenced by hazard characteristics and surface conditions rather than being a fixed property of the method itself.

Compared with inundation maps, although 78.85% of pixels within mapped inundation areas were classified as coherence-derived disturbance, a substantial proportion of all coherence-disturbed pixels occurred outside the mapped inundation extent. Substantial decorrelation was frequently detected in inland areas with little or no inundation, where field observations documented structural damage and vegetation loss that were consistent with wind-related impacts. For example, Remal showed notable coherence loss in Nilganj, Baliatali, and Lalua unions despite limited flooding, and Hamoon produced strong inland damage signals in Barabakia and Lemshikhali unions; Mocha and Sitrang showed similar wind-driven decorrelation, while Amphan showed both overlapping and distinct zones of flood- and wind-related damage. This partial overlap with inundation extent is broadly consistent with the SAR-based cyclone flood-mapping literature: Alexandre et al. (2020) applied a Sentinel-1 normalized difference ratio (NDR) chain specifically to delineate flood extent after cyclones AVA and DIANE in Madagascar, and reported strong agreement with Copernicus EMS flood products, but their approach was designed to isolate inundated area rather than the wider set of surface changes considered here. The present results suggest that a coherence-based formulation detects flood-related changes together with additional forms of surface disturbance, including wind-related structural and vegetation changes that a flood-focused change-detection method may not be expected to identify. A similar distinction between water-related and non-water-related surface change was noted by Malmgren-Hansen et al. (2020), who used Sentinel-1 intensity-based Wishart change detection for Cyclone Idai in Beira and found that filtering changes by building footprints was necessary to separate impacts on houses from changes in the surrounding natural environment; their analysis likewise showed that a substantial share of detected change could not be attributed to inundation alone. The methodological logic of isolating hazard-related decorrelation from other sources of surface change also parallels Fielding

& Jung (2024), who used correlation-difference mapping between pre- and co-event image pairs to separate earthquake-induced building damage from vegetation-driven decorrelation at Bam, Iran; although the hazard type differs, this supports the broader principle that a single coherence or correlation measurement conflates multiple surface processes unless compared against a reference state, as done here through the pre-event coherence baseline.

Together with the temporal coherence behavior and field validation described above, these patterns indicate that coherence loss may reflect multiple interacting hazard processes- including flooding, wind damage, and surface disturbance rather than a single component, and that coherence-based change detection provides a more comprehensive representation of cyclone impacts than flood mapping alone. This integrated sensitivity, combined with independence from cloud cover and daylight, makes the approach potentially useful for rapid post-event assessment in data-constrained environments such as Bangladesh, consistent with the rationale for SAR-based rapid damage assessment established by Plank (2014). The consistency of these patterns with findings from other cyclone and hurricane studies further supports the physical basis and potential applicability in other geographic and hazard contexts of coherence-based change detection. Meneses & Blanco (2022) similarly used Sentinel-1 complex coherence to map typhoon damage across multiple islands of the Philippines, reporting up to 93% correspondence with UNITAR/UNOSAT damage tags when classification was simplified to a binary damaged/not-damaged scheme, demonstrating the potential value of binary coherence-based classification, although their validation framework is not directly comparable with the inundation-overlap analysis used in the present study. Together with the cross-hazard consistency reported by Washaya & Balz (2018) across an earthquake and a hurricane using the same coherence framework, these findings indicate that the approach has potential for application beyond the present study area, subject to local calibration and validation."

We appreciate your guidance and look forward to the next steps in the review process.