comments (black font) and responses (blue font)

Reviewer #2

General comments:

Xu et al. present a very interesting and useful sediment record from Ninetyeast Ridge with measurements of clay mineralogy and Sr-Nd isotopes. Although the time frame of the record is somewhat limited, it does provide some constraints on orbital variation of terrigenous sediment fluxes. The data are of good quality and the interpretations are reasonable. The paper is well within the scope of Climate of the Past and provides another helpful record of the South Asian monsoon, which drivers are important geological questions. Broadly, I think the paper would be improved by clarifying the uncertainties in the interpretation of the proxies, more information about methods, and interpretation of the driving factors (ITCZ versus other influences on precipitation intensity, weathering and sediment transport).

Specific Comments:

Please add more perspective on disentangling the transport limitations (trapping of sediments on the shelf) and weathering (ITCZ migration and rainfall intensity).

How might the transport conditions mask the ITCZ record (e.g. lower smectite transport is interpreted as lower rainfall). It’s great that both factors are mentioned, but I think the text needs to be clarified as to how these factors may result in different interpretations of the same record. This would give more confidence in the rainfall/ITCZ related interpretations.

I think it is important to discuss the potential factors on rainfall and weathering other than north-south ITCZ migration. For instance, Gebregiorgis et al. 2016 QSR suggest that drivers off the South Asian monsoon may be more complex than migration of the ITCZ. There has been recent work regarding exposure of the Sunda/Sahul Shelves on Indian Ocean hydroclimate (DiNezio and Tierney, 2013 Nat. Geosci; DiNezio et al., 2020 Sci. Adv.; Pico et al., 2020 Paleoc. Paleoclim.), cross-equatorial moisture transport and influence on the monsoon (Clemens et al., 2021, Sci Adv.), the effect of stratification on the monsoon (Tierney et al. 2015, Nat. Geosci), and even a potential El Nino-like mode in the Indian Ocean during the LGM (Thirumalai et al., 2019 Paleoclim. Paleoc.). These are all factors that can influence precipitation that are not necessarily related to just the position of the ITCZ. There is mention of some potential other factors on lines 235-242, but this is not clear and not discussed directly related to your record. It would be good to consider your smectite record in regard to the timing of these other processes; a clearer discussion of these factors would improve the relevance of what sediment flux records like this are actually recording the Indian Ocean.

Re: Thank you for your helpful comments, and we would be happy to add a discussion of other potential factors to the text. We believe that the exposure of the Sunda Shelf (DiNezio and Tierney, 2013; DiNezio et al., 2020; Pico et al., 2020), trans-equatorial water vapor transport (Clemens et al., 2021), surface and subsurface temperature changes (Tierney et al. 2015), Indian Ocean surface temperature gradient(Weldeab et al., 2022) and even ENSO (Thirumalai et al., 2019) and IOD (Abram et al., 2020) changes, if they have an impact on the source area, should lead to variations in the connected indicators, for example, foraminifera, sporopollen, stalagmites and other indicators. Although there are some disturbances from the limitations of various monsoon indicators, the South Asian monsoon is indeed the result of a combination of factors that may contribute to the differences in monsoon rainfall in the Arabian Sea and the BoB, which is why the monsoon intensity variability shown by the monsoon indicators is not the same. The north-south shift of the ITCZ is only one of the factors affecting monsoon rainfall, and the dominance of each influential monsoon rainfall factor may be not the same in different areas within the monsoon region, which is why we have to compare multiple records. The synchronous variations between the relatively high smectite percentages and the northward shift of the ITCZ indicate that the northward movement of the ITCZ is the most important factor influencing the incremental changes in the river sediment load due to the increased smectite percentages in the Myanmar region. Here, we emphasize that the northward (southward) ITCZ shifts cause rainfall increases (decreases) relative to other rainfall drivers and that the changes in clay minerals reflect changes in rainfall and further sediment supply in the source area, which is a response to environmental changes. Regarding the influence of multiple factors on South Asian monsoon rainfall, more climate records and mutual verification of climate simulation work are needed, which is also one of the goals of our future research.

Technical corrections:

Q: Line 16: “millennial” instead of “millennium”

Re: Thank you; we have corrected these incorrect words.

Q: Line 18: Maybe “supply” or “transport” is better than “supplementation”

Re: Thank you; we have corrected these incorrect words.

Q: Line 20: exposure of Sunda Shelf?

Re: Thank you for your question. We did not express it clearly here. Here, we refer to the exposure of Andaman-Nicobar Island.

Q: Line 21 “millennial” instead of “millennium”

Re: Thanks; we corrected these inappropriate words.

Q: Line 23 “millennial” instead of “millennium”

Re: Thank you; we have corrected these incorrect words.

Q: Line 30: It would read better to replace “the paleoclimate and paleo-ocean” with “paleoclimate and paleoceanographic conditions”

Re: Thank you; we have corrected these incorrect words.

Q: Line 38: “important” might be a better word than “nonnegligible”

Re: Thank you; we have corrected these incorrect words.

Q: Line 53: I don’t think statements like “discussed as a hot topic” add much to the context. Better to state which studies have discussed provenance in the BoB and the collective contribution of these studies.

Re: Thank you for your kind reminder. In the revision, we have reorganized the introduction section according to your comments and outlined the previous work done in the BoB area on the source of the terrigenous materials. We have modified it to the following statement: Previous studies have suggested that Himalayan material transported by the G-B River was the overwhelmingly dominant source of materials in the northern BoB during the Holocene (Li et al., 2018; Ye et al., 2020), and the main sources were the Indian Peninsula and Himalayan weathered material in the western BoB (Kessarkar et al., 2005; Tripathy et al., 2011; Tripathy et al., 2014). In the eastern BoB, the sediment sources are the Himalayan Range (transported by the G-B River), Indo-Burman Ranges and the Myanmar regions, through which the Irrawaddy River flows (Colin et al., 1999; Joussain et al., 2016). The terrigenous detrital material in the Andaman Sea are mainly Myanmar-origin sediments transported by the Irrawaddy River (Ali et al., 2015; Awasthi et al., 2014; Colin et al., 2006). A series of terrigenous problems, such as changes in the source area and the proportion of terrigenous matter in various regions of the BoB from the Last Glacial Maximum to the Holocene, the distribution range of terrigenous materials in the Indian Peninsula on the west side of the BoB and in the Myanmar region on the east side, and how G-B River sediments migrated in the Bay of Bengal, are not yet clear.

Q: Line 65-66: Please explain more about why Ninetyeast Ridge is an ideal location- appropriate sed rates for a gravity core? And only receiving fine-grained hemipelagic sediments because it is bathymetrically above fan sedimentation?

Re: Thank you; we have revised it in the article. The core is located above the abyssal plain at ~900 m, and the channels on the eastern side of the BoB is at ~700 m. The channel near core 17I106 is dead (Curray et al., 2003) and does not support that large turbidity activity occurred there and provided vast amounts of clay minerals. The ~900 m height and approximately 400 km straight line distance between the core and active channel preliminarily indicate that turbidites are not the major provider compared to surface current input, and site 17I106 received fine-grained hemipelagic sediments from the surrounding area, which is an ideal area to understand paleoclimatic and paleoceanographic conditions in the BoB.

Q: Line 83: Centrifuged? What rpm and duration?

Re: Thank you for your reminder; we have added the complete experimental procedure. The sedimentation method involved placing the sample in a beaker with an inner diameter of 7 cm and a height of 10 cm at an experimental temperature of 19 ˚C. The sedimentation time was calculated as 4 hours and 10 minutes according to the Stokes formula, and the upper 5 cm of liquid was extracted, followed by centrifugation at 5000 rpm for 10 minutes. The smear was made into a natural slice, and the natural slice was heated in an oven at 60 ˚C for 24 hours to make a glycol-saturated slice for the subsequent test.

Q: Line 84: hydrochloric acid

Re: Thank you; we have corrected these incorrect words.

Q: Line 86: Were the slides treated with ethylene glycol? Were clay mineral standards used? Or just the Biscaye method?

Re: Thank you. These slides were treated with ethylene glycol and used only the Biscaye method.

Q: Line 92: Are these bulk sediments or a specific grain size fraction?

Re: Thank you for your question. It was an oversight not to note the sample information clearly; we use < 63μ m sediments for Sr-Nd isotope experiments.

Q: Line 96: How were the Sr and Nd isolated? Info on columns, etc.

Re: Thank you for your suggestion. Our experimental method is not sufficiently described in the initial article, and we have revised it to "used the experimental method as described by Dou et al. (2016)". Carbonates were removed from 70 to 100 mg bulk powder samples by leaching with 0.25 N HCl for 24 h at 50 °C. The residues were then completely digested in high-pressure Teflon bombs using a $HCl + HNO_3 + HClO_4 + HF$ solution. Rb and Sr were separated in 2.5 N HCl using Bio-Rad AG50W-X12, 200–400 mesh cation exchange resin. Sm and Nd were separated in 0.15 N HCl using P507 cation exchange resin.

Q: Line 137: "cannot" is a strong word, but yes, kaolinite transport can be limited, but some regions of open ocean have substantial aeolian kaolinite

Re: Thank you; we have corrected these incorrect words.

Q: Line 148: I suggest "abyssal plain" instead of "the normal seafloor"

Re: Thank you; we have corrected these incorrect words.

Q: Line 149: turbidity currents

Re: Thank you; we have corrected these incorrect words.

Q: Line 169-170: Not just the narrowing of the straight but exposure of the continental shelves including the Sunda Shelf and all the way up to Myanmar. The relative exposure of 200 km from the current Irrawaddy delta can affect how sediments are trapped on the shelf or delivered to the deep ocean.

Re: Thank you for your question. We have added a discussion to the revised manuscript. Large amounts of fluvial sediments are trapped in deltaic and shelf areas, especially coarse-grained sediments, but core 17I106 sediments were deposited after the long-distance transport of large amounts of fine-grained terrestrial material, and the fine-grained material in fluvial sediments can be transported over long distances. The 200 km change in shelf distance is not a large transport distance compared to the transport distance from the source area to core 17I106. Moreover, exposed shelf areas generally result in more weathered materials entering the deep sea, but the simultaneous decrease in smectite percentages from the Myanmar area as sea level decreases suggests that shelf denudation is not the main factor affecting our smectite record, and previous studies in the Andaman Sea also reveal no relevant effect on the alteration of terrestrial source material supply by exposed shelves (Ali et al., 2015; Awasthi et al., 2014).

Q: Line 182: “transport” is a better word choice than “importation”

Re: Thank you; we have corrected these incorrect words.

Q: Line 229: Please highlight any information about how far northward the ITCZ may have shifted before and after the LGM. Would this bring noticeable change to the Indo-Burma area?

Re: Thank you for your comments, and we have made further changes. Our smectite record shows that before the LGM, the ITCZ was in a relatively southerly position in the Myanmar area, while during the late LGM, the northward movement of the ITCZ in the Bay of Bengal led to increased rainfall in the Myanmar source area and an increased supply of smectite. At the same time, the ITCZ did not significantly shift in the Arabian Sea region in either the early LGM or late LGM, which is what the Arabian Sea ITCZ record shows (Deplazes et al., 2013).

Q: Line 245: Himalayas, mention the G-B transport.

Re: Thank you; we have corrected these incorrect words.

Q: Figure 5. Label the name of your core on the map.

Re: Thank you for the reminder. We have modified Figure 5 and added the core name to the map.

References

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