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Interactive comment on "Last interglacial sea levels within the Gulf of Mexico and northwestern Caribbean Sea" *by* Alexander R. Simms

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The author has made a meta-analysis of 62 papers investigating RSL indicators in fossil beach-dune systems and coral reefs with LIG U-series or OSL ages around the Gulf of Mexico and the eastern Yucatan Peninsula. In general the scholarship is good and the manuscript reads well. However there are issues with consistency in determining valid estimates of RSL, methodological problems, and unstated assumptions that need addressing, as outlined below.

For the LIG beach-dune systems rimming the Gulf of Mexico, he finds that few of the studies have quantitative estimates of RSL and attempts to piece together RSL indicators based on a comparison between the average elevation of modern beach-dune

systems and the fossil systems (drawing from his own work in the area). For the NE Gulf he estimates that RSL was +1 to +5 m above present, and for the NW Gulf +2 to +2.75. The stated errors on these estimates however are large, and in some cases exceed the amplitude of the estimated highstand.

In addition to this uncertainty, there are several unstated assumptions in this analysis which I think could be addressed. First, comparing the elevation on modern beach-dune systems directly with their LIG counterparts ignores any subsequent erosion, both during the initial SL downdraw when these deposits first became inactive but were still composed of mobile sands, and later when they became part of the inshore during the 125 m lowstand. In active modern systems there is a balance between deposition and erosion, but once they became inactive, the dominant process would be erosion. Similarly the second assumption, that the elevation variability of modern beach-dune systems is representative of the LIG systems downplays the differences between transgressive vs regressive systems. For example, transgressive systems tend to be sediment starved compared to (forced) regressive systems where a slight fall in SL can expose large unlithified sediment sources and thus contribute to higher sediment flux.

For the LIG beach-dune systems running along the NE Yucatan coast, the author ignores the elevation of the beach ridge (and does not attempt to compare it with modern systems in the area) and focuses instead on the more reliable boundary between the cross-bedded beach facies and fore/back shore dunes which is reported by Ward and Brady (1979) to be +4.8 m. However the interpretation of the RSL highstand by these authors is +5 to +6 m, which is inexplicably accepted and a RSL of 5.5 $\pm$1.5 m is assigned. There is no analysis of stratigraphic evidence to support this interpretation or it's uncertainty. Is this beach-dune system representative of the RSL highstand, or its subsequent regressive stage?

This is followed by a strange section on dated corals found in lagoonal units associated with the beach-dune systems. (Again the significance of the underlying/adjacent

lagoonal unit is unclear in terms of transgressive vs regressive stage). The author attempts to use dated, non-depth-specific coral genera (Montastrea, which is now Orbicella) to constrain the RSL highstand, following the protocol in Hibbert et al 2016. The author states that using Hibberts strict interpretation a Montastrea (species unstated) at +2 m gives a RSL interpretation of 11.7 +8.6/-7.3 m. This makes no sense. You cannot precisely constrain the RSL highstand using an unidentified coral, with a low-precision age, and a large habitat range. And you cannot say that an in-place coral found at +2 m could have grown 7.3 m deeper! The only option is to determine their consistency with respect to the most reliable RSL indicators (like an intertidal beach or reef crest). This is a problem with the Hibbert et al (2016) protocol and should be addressed in the section on 'uncertainty and data quality'.

For the LIG reef systems in the same area, the author details the elevation of reliable RSL indicators such as reef crests, before dismissing these in favor of individual corals. This time the coral species is the depth-restricted reef-crest coral A. palmata, which is only a reliable RSL indicator when found in a monospecific assemblage. Using the coral's total depth range (as suggested by Hibbert et al 2016) clearly dilutes its utility as a RSL indicator. So instead of using the most precise indicator, the reef crest itself, the elevation of in-situ corals from the 0-5 m depth zone are used to determine the RSL highstand, giving a +6.4 (+1.2/-7.9) value for an in-situ coral at 4.9 m. Again this makes no sense. You cannot claim that an in-situ coral found at +4.9 m actually grew 7.9 m below this level. The only thing you can say is it grew at a maximum of 1.2 m below SL. When evidence of a lower reef-crest unit is assessed, the level of the reef crest is used as the RSL indicator, not the elevation of its corals. This is correct, but completely the reverse of what was accepted for the highstand reef. This inconsistency is the problem.

For LIG reefs from Belize, the same problems occur with the age and elevation of individual corals being used to define RSL highstand estimates that are significantly below those in the Yucatan. These may be a result of subsidence, as the author suggests, but it could be that reef development during the LIG occurred at a lower stand of SL before

the highstand was attained, and that the other non-reefal deposits developed further inland along the unstudied coast of Belize. (i.e., that reefal deposits might equally be transgressive systems and do not represent highstand units). Clearly without a precise and reliable chronology different stages of development cannot be identified. And regardless of what geochronologists claim, the present system of correcting LIG ages for open-system behaviour has yet to provide a well-constrained SL reconstruction, or even stratigraphic consistency between and within sedimentary units.

Details: Line 383: the tidal range stated by Blanchon et al 2009 and Blanchon 2010 is 0.3 m with any data point having an uncertainty of $\pm$0.15 m.

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