SEDIMENT BUDGET OF THE GREAT BAHAMA BANK - PRODUCTION AND TRANSPORT

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PROJECT OBJECTIVES

- To conduct a GBB-wide sediment budget analysis and reconcile sediment production with sediment accumulation.
- To assess the influence of hydrodynamics on sedimentary facies distribution and on and off-platform sediment transport.
- To quantify the importance of uniformitarian versus catastrophic (storm) events on the sedimentary processes of GBB.

PROJECT RATIONALE

Recent GBB sedimentological studies have primarily focused on either examining platform sediment production, mapping of on and off-platform sediment distributions, or analyzing variable filling of accommodation space. However, a new, integrative GBB-wide sediment budget analysis has yet to be conducted. SLIM numerical hydrodynamic modelling (developed at the Université Catholique de Louvain, Belgium) indicates that the current velocities induced by fair-weather conditions on the platform top are too lethargic to resuspend meaningful volumes of sediment. Storm-weather conditions, however, resuspend a great deal. Elevated current velocities during and shortly after storms are consistent with satellite-based observations of suspended sediment (Fig. 1).

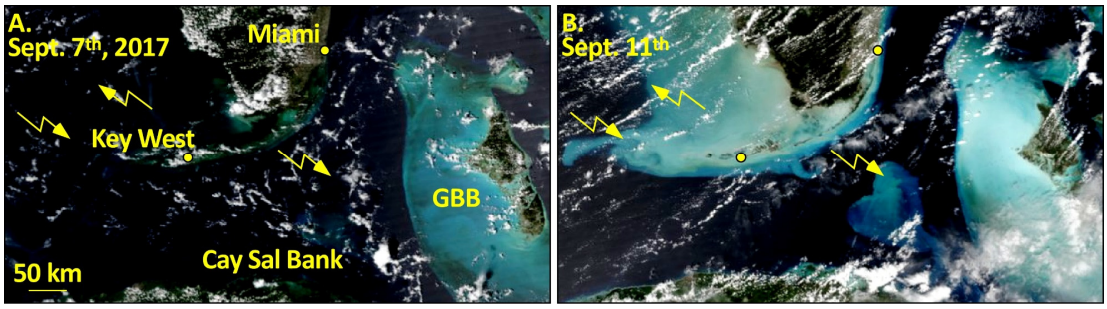

Figure 1. Waters around the southern tip of the Florida Peninsula, Straits of Florida, Great Bahama and Cay Sal Banks before (A. Sept. 7th, 2017) and after (B. Sept. 11th, 2017) the passage of Hurricane Irma (Sept. 9-10th, 2017) as captured by the VIIRS instrument on the NOAA/NASA Suomi NPP satellite. The hurricane is seen to loft vast sediment plumes from the West Florida Shelf, Great Bahama and Cay Sal Banks which become entrained in the Florida Current. It is postulated that during such events, meaningful quantities of sediment are lost from the Bahamas platform tops and redeposited on the slopes and beyond. Hurricanes might exert important control on the sediment budget of carbonate platforms. Yellow arrows equally positioned in A. and B. for comparison. North is top.

Although the dominant mechanism behind off-platform sediment transport, uniformitarian versus catastrophism, remains unknown, large volumes of platform-top derived sediment have been mapped on the platform's flanks. Further, the sediment architecture and facies of the flanks indicate substantial along strike-variability (e.g. Anselmetti et al., 2000; Mulder et al., 2012; Schnyder et al., 2018). Building off the substantial research conducted by our CSL collaborators past and present, we aim to quantify the relationship between prevailing sedimentation and hydrodynamic flow on and off platform. Through this multiple dataset comparison, we will determine the amount of sediment being produced atop the GBB, quantitate the sediment transport by currents, measure off-platform sediment volumes, and conduct a comprehensive sediment budget for GBB.

APPROACH

Environmental facies delineated by satellite imagery have been populated with literature-based sediment production rates assembled to produce yearly total sediment production estimates. The SLIM hydrodynamic model is being used to examine the likely fate of platform-produced sediment during fair and storm-weather conditions alike. Model outputs will then be compared to satellite audits of total water column suspended sediment concentrations, as well as CHIRP sub-bottom and seismic data acquired on the western slope of GBB.

SIGNIFICANCE

An understanding of sediment production and water movement atop the GBB is paramount to understanding the volumetric significance of sediment dispersal. These processes exert physical control over platform-top sedimentation, which, in turn, govern slope architecture, and the along-strike variability in that architecture. The investigation of both sediment production and accumulation in a hydrodynamic context allows for a novel carbonate source-to-sink analysis.

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