Improving Predictability of the South Asian Monsoon: Identifying and Understanding Multidecadal-Centennial Scale Variability in the Asian Monsoon and Surrounding Oceans

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Abstract

Coral skeleton archives contain a wide array of climate and hydrographic information, captured at monthly intervals critical for resolving seasonal phenomena, and extending back for hundreds of years. Geochemical measurements from coral drill cores provide robust proxies for variables including sea surface temperature, salinity, river runoff, and wind strength through eolian dust input and local upwelling.

Corals from regions surrounding southern Asia will be used to reconstruct long-term variability in both the summer and winter South Asian Monsoon, and constrain behavior in both monsoon winds and rainfall across different geographic sectors from the west, south and east. This will provide a complete picture of long-term monsoon variability unbiased by geographical region, season or climate variable, which result in inconsistent interpretations of recent monsoon behavior. Further, corals from surrounding ocean basins, including the central Indian Ocean and West Pacific Warm Pool, will be used to reconstruct similar long-term variability in hydrographic conditions thought to influence the strength and timing of the monsoon.

These long-term perspectives on monsoon and ocean variability from proxy records will be compared to observations and model simulations to understand the drivers, and provide a more dynamically-based understanding, of past, present, and future changes in this important system.

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Challenges addressed

This research program will increase understanding of the ocean's influence on the South Asian Monsoon system. Knowledge of long-term behavior in both the monsoon and surrounding ocean basins will provide a more complete picture of the full spectrum of ocean-climate temporal variability. These datasets will provide the basis for modeling studies to determine the mechanisms linking the oceans and monsoon system over decade-century timescales.

Of particular importance is that identifying multi-decadal to centennial scale patterns of variability in monsoon strength and oceanic drivers may allow monsoon predictability several decades into the future, and thus increase societal preparedness and resilience to monsoon variability and extremes. Intensive outreach efforts targeting teachers, policymakers and the general public will disseminate and explain new information about the ocean's role in climate, and help move society toward a more responsible relationship with the ocean and planet.

This Ocean Shot vision is represented in all challenges, and especially Challenges 5, 6 and 10

Challenge 5: *Enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate and weather.*

Challenge 6: *Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards, and mainstream community preparedness and resilience.*

Challenge 10: *Ensure that the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood, and identify and overcome barriers to behavior change required for a step change in humanity's relationship with the ocean.*

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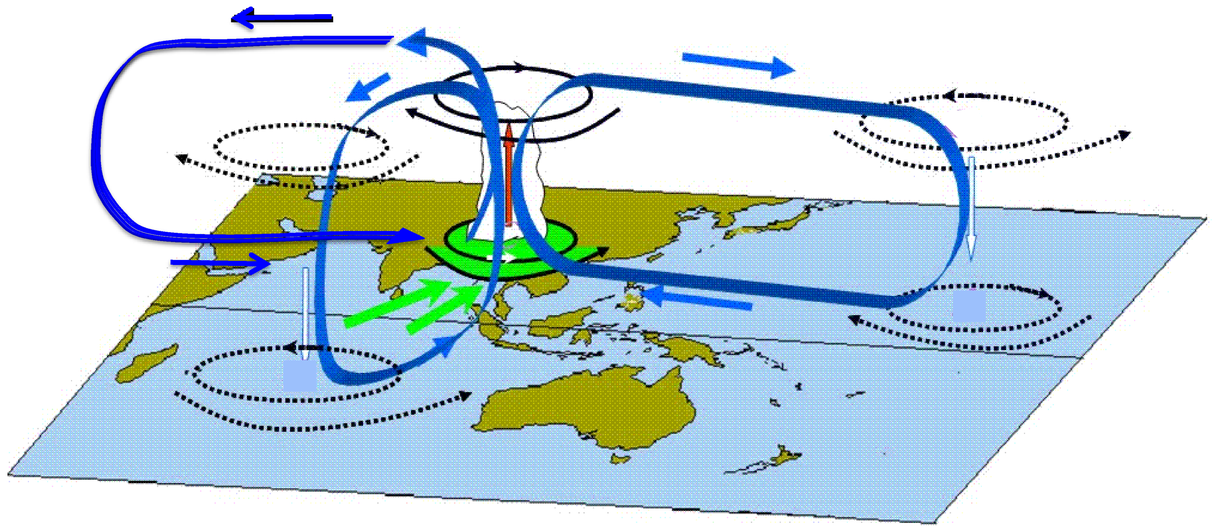
Vision & transformative impact

The South Asian Monsoon is a critical climate system providing water for more than a billion people, yet its variability over long, multidecadal-to-centennial timescales is unknown or, at best, controversial.



The monsoon system itself is a complex interplay of winds and rainfall, with spatial components extending outward from the Asian continent like an octopus. Each of these limbs contributes to monsoon variability, but is also affected by local conditions that can lead to different interpretations of monsoon behavior as a function of geographical location, climate factor and season.

This research campaign would characterize the full temporal and spatial variability of the Asian monsoon and its surrounding oceans, to provide a mechanistic understanding of what drives long-term monsoon variability, and potentially the ability to predict monsoon strength several decades into the future.

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Connections inside and outside of traditional ocean science

The technology required to obtain long coral drill cores, and instrumentation and methodologies for geochemical analysis required to reconstruct climatic and hydrographic conditions from those cores, already exist and are well-suited for the proposed research. This effort will require parallel efforts by multiple collaborators to complete the large number of analyses, but research capacity among coral paleoclimatologists in the U.S. will be sufficient for timely completion of the research. Obtaining ship time for fieldwork is a surmountable challenge, as we have a proven history of partnering with the private sector to obtain access to vessels capable of mounting expeditions to the required field locations.

The fields of geochemistry and biogeochemistry would contribute strongly to the refinement of existing climate proxies, and development of new proxies, particularly for ecological of environmental conditions on the reefs. Climate modeling and atmospheric dynamics would be heavily engaged in identifying mechanisms of ocean-monsoon linkages and making future projections.

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Opportunities for international collaboration and capacity-building

This research represents a broad effort to engage numerous collaborators in focusing on the single goal of characterizing the Asian Monsoon. Collaborators from research institutions internationally, as well as throughout the U.S., will be invited to participate and contribute to the overall spatial-temporal datasets. Climate modeling efforts will also need to be distributed among multiple labs, with opportunities for collaboration by qualified international teams.

By its nature, this research will include collaborators from local regions of interest, most of which are developing countries. Fieldwork to collect new coral drill cores will involve local knowledge and infrastructure, with opportunities for training of local scientists and students, as well as outreach to communities, government officials and military personnel. Collaborators will be invited to U.S. labs to be trained in analytical techniques and instrumentation, resulting in significant intellectual transfer.

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Collaborators…

WOODS HOLE OCEANOGRAPHIC INSTITUTION

UNIVERSITY AT ALBANY
State University of New York

UNION COLLEGE
FOUNDED 1795

AMERICAN MUSEUM OF NATURAL HISTORY

…Maybe You?

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