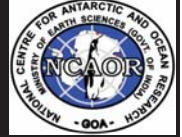




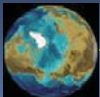
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ESSO
NATIONAL CENTRE FOR ANTARCTIC AND OCEAN
RESEARCH



THE POLAR REGIONS AND THE
INDIAN MONSOON: AN MoES
INITIATIVE

S. RAJAN

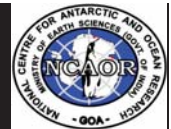


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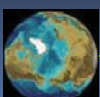


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Organization of the presentation



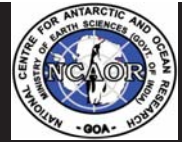
- INDIA AND THE MONSOONS
- MONSOON AND THE POLES
- ARCTIC-MONSOON CONNECTION
- ANTARCTICA-SOUTHERN OCEAN-MONSOON
- THE FORCING FUNCTIONS
- THE BELMONT PROPOSAL



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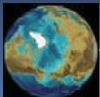


MONSOON AND INDIA



The monsoon accounts for 80% of the rainfall in India. Indian agriculture (which accounts for 25% of the GDP and employs 70% of the population) is heavily dependent on the rains.

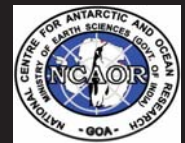
A delay of a few days in the arrival of the monsoon can badly affect the economy, as evidenced in the numerous droughts in India in the 1990s.



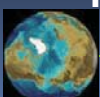
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MONSOON AND THE POLES- IS THERE A TELECONNECTION???



- Is there a teleconnection between the Tropics and the North Atlantic Ocean? If so, what drives it?
- Monsoon is primarily driven by the land-sea temperature gradient. Warm Eurasian winters are correlatable with the anomalously strong monsoon precipitation the following summer
- Warm Eurasian winters with little snow propagate the warmth eastward from winter to spring, leading to the warming of the Asian landmass and increase in land-sea thermal contrast.
- Tropics as an amplifier of climate change?



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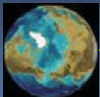
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THE ARCTIC CONVEYOR BELT

The thermohaline circulation that originates in the North Atlantic and southern Arctic is a major force that drives not only the oceanic circulation but also regulates the global climate.



Can possible changes in the global circulation modulate the monsoons?



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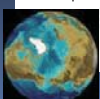
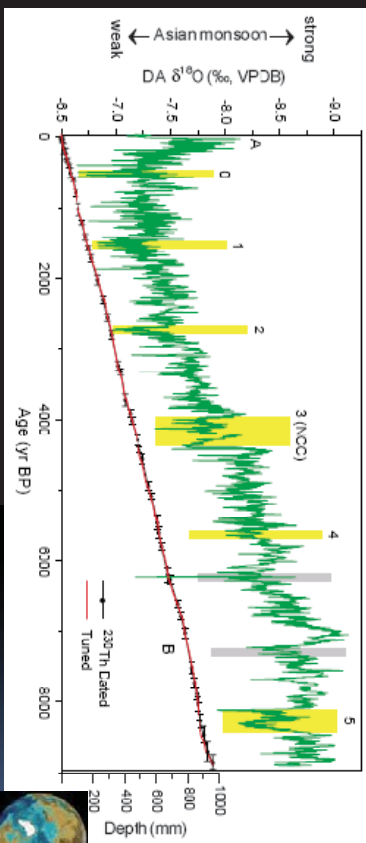


NORTH ATLANTIC EPISODES AND MONSOON: THE POLAR CONNECTION

Several studies indicate-

A link between cold episodes in the North Atlantic and weakened Asian monsoon during the last glacial period as well as during Holocene

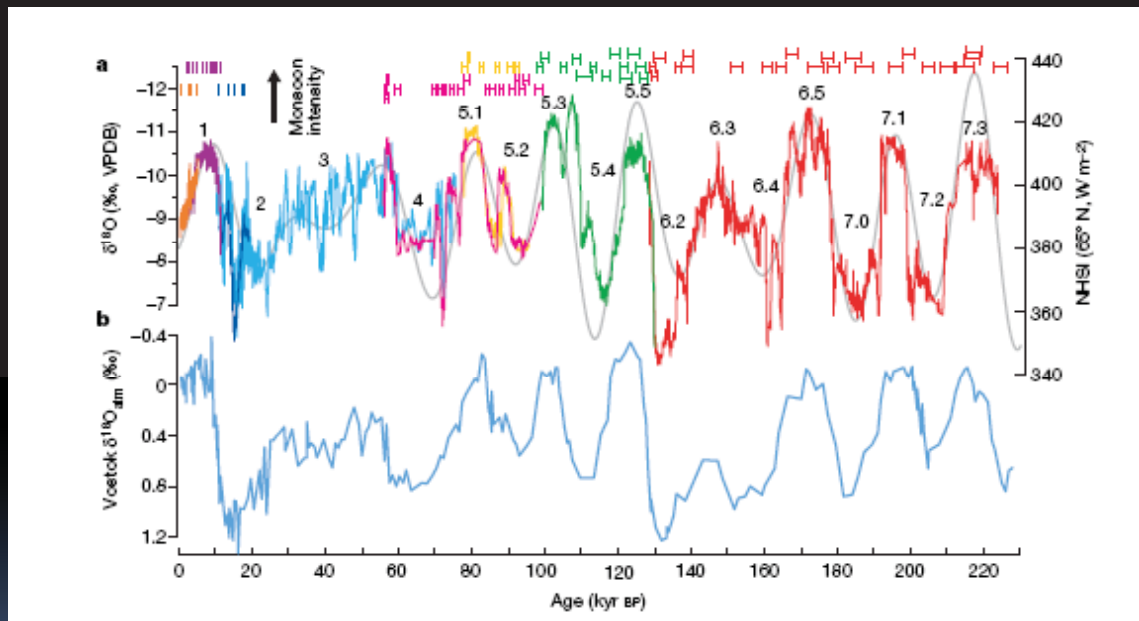
Speleothem records from China indicate the links between Asian monsoon and solar input and North Atlantic ice-raftering events, during the Holocene



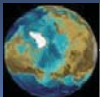
(Wang et al., 2005, Science)



Millennial and orbital-scale changes in the East Asian Monsoon from speleothem records



Wang et al., 2008, Nature



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Indian Summer Monsoon record from Dandak cave $\delta^{18}\text{O}$ stalagmite record

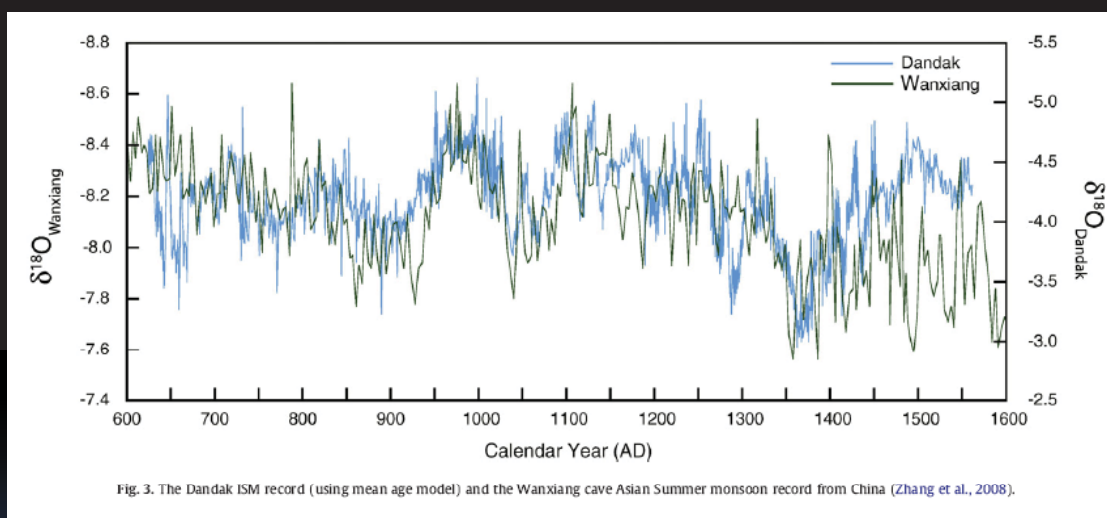
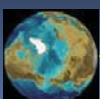


Fig. 3. The Dandak ISM record (using mean age model) and the Wanxiang cave Asian Summer monsoon record from China (Zhang et al., 2008).



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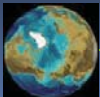
NORTH ATLANTIC AND THE INDIAN MONSOON VARIABILITY ON SHORTER TIME SCALES

Studies indicate-

- **links between North Atlantic and Indian summer monsoon on inter-annual and decadal time scales**

On an inter-annual scale, strong negative (positive) NAO/NAM events, lead to Tropospheric Temperature anomalies, which decrease (increase) meridional gradient of TT resulting in below (above) normal monsoon rainfall.

On an inter-decadal scale, the forcing function is achieved by the Atlantic Multidecadal Oscillation (AMO) in much the same way.



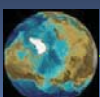
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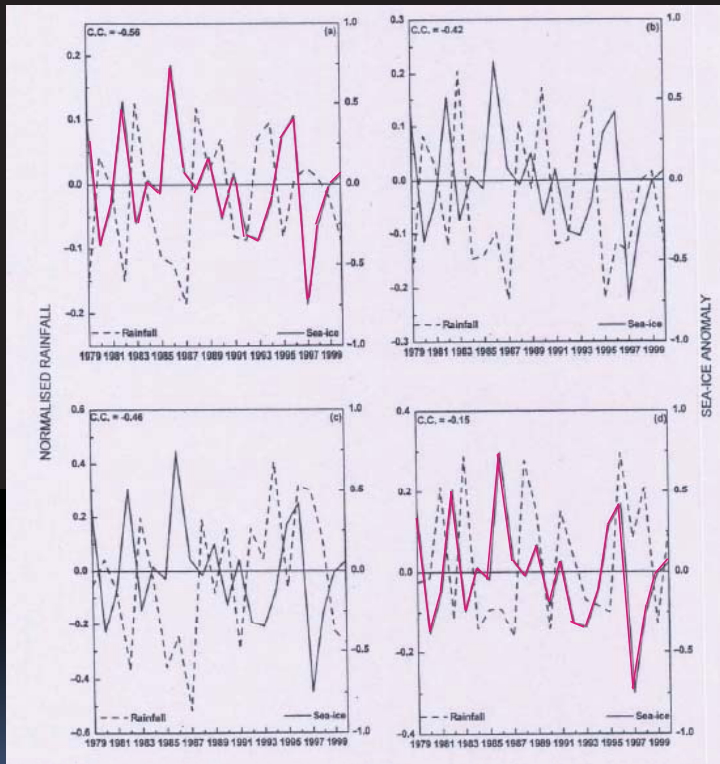


The Link between Asian (Indian) Monsoon and Antarctic sea ice



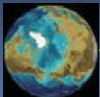
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Correlation of Antarctic sea-ice anomaly in winter with monsoon rainfall over (a) all India, (b) West-Central India, (c) North-West India and (d) Southern Peninsular India for 1979-2000 (Dugam and kakade, 2004)

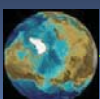
Deficient monsoon years preceded by more than normal sea-ice extent and vice versa



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BELMONT FORUM SCOPING @ GOA



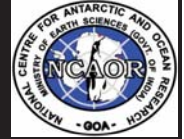
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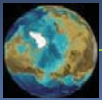


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OBJECTIVES



- ❑ Monsoon and its teleconnections with the Arctic and Antarctic on annual, decadal and longer time scales
- ❑ Transportation of heat from the tropics to the poles and its implication on monsoon
- ❑ Simulation of sea-ice and its effect on monsoon variability (modelling aspect).
- ❑ Exploring climate predictability at seasonal and decadal time scales



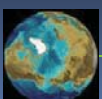
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VALUE ADDITION AT A GLOBAL LEVEL

- Will help to understand the processes that influence the variability in polar climate and their influence on monsoons at millennial, decadal and climate scales
- Models aimed at better predicatability at shorter time scales



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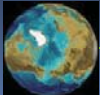




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CONTRIBUTION TO BELMONT CHALLENGE

- Understanding the Monsoon variability would address some of the important issues related to the occurrence of extreme events including drought, floods, extreme cold and heat wave conditions, and other weather hazards
- With inclusion of realistic sea-ice evolution in the models sought to be developed, the possibility of improvement of model skill particularly for monsoons increases and this has direct impact on the earth climate system



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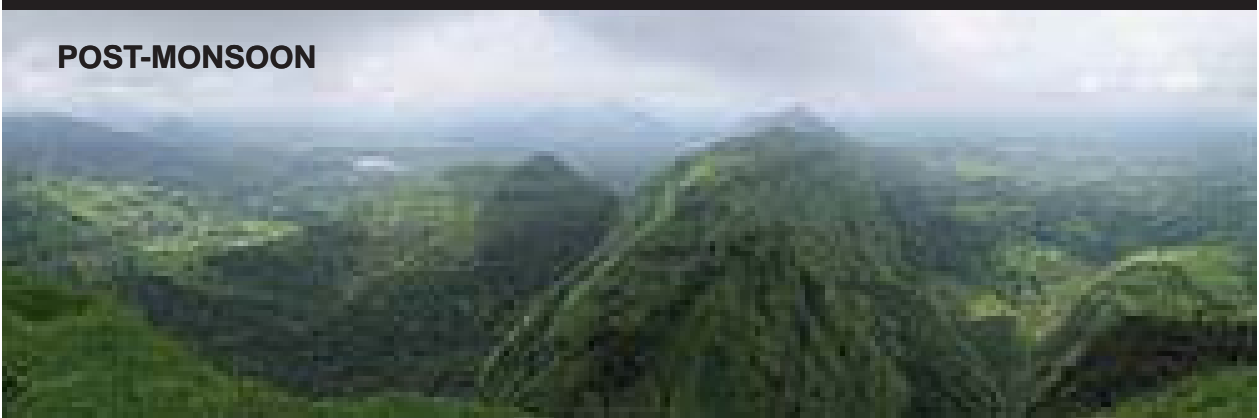


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GREENING OF THE WESTERN GHATS



POST-MONSOON



Thanks!!