Solar Arctic-Mediated Climate Variation

PAGES 2nd Global Monsoon Symposium
Tongji University, Shanghai
September 13-15, 2010

Willie Soon
A Sun–Climate Coincidence?

Arctic-wide Surface Air Temperature Anomalies

Sun

Year

Soon (2004)
A Sun–Greenland Coincidence?

Source: Soon (2009)
Why and how?
Insolation gradient and temperature gradient as a persistent forcing and modulator of dynamic exchanges of heat flux between the equator and the Arctic rather than strict irradiance change per se
Pathways for freshwater and salt balancing on millennial timescales: Relevance for multidecadal-to-centennial scale?

Keigwin and Cook (2007)
There are empirical evidence for an inverse multidecadal relation between Arctic SAT and sea ice extent: *New perspective from “Zakharov” data*

Maximum correlation for SAT + Zakharov sea ice $r = 0.6$ compared to 0.3 for SAT + Walsh sea ice data

Sea ice reductions for two relative warm periods in the Arctic: 1979-1997 (obs.) vs. 1916-1955 (deduced)

Kauker et al. (2008)
Evidence for a link between Labrador Sea’s bottom water temperature and tropical Atlantic ITCZ (via THC)?

Core Locations: Laurentian Slope

- Two Intermediate-water sediment cores
  - 1030m (MC11, GGC13)
  - 1850m (MC10, GGC09)
- Approx. 20-50yr sampling

Links to the subtropics?

Bottom Water Temperatures

- BWT (°C)
- Age (cal. kyr BP)
- Reproducibility ±0.2°C

Florida Straits surface ocean

Venezuela Humidity/runoff

Peter deMenocal, SORCE 2005 meeting
Max. zonal MOC strength around 30-35°N
Evidence for a link between Nordic Seas SST and tropical Atlantic ITCZ (via THC)?

Prof. Eystein Jansen of Bjerknes Centre for Climate Research
Century-scale Solar Variability and Movement of Atlantic ITCZ

G. Sacculifer (planktic foraminifer) from Northern Gulf of Mexico: Proxy sensitive to movement of the Atlantic Intertropical Convergence Zone (ITCZ)

stronger solar activity

proxy of solar variability

\( ^{14}C \) production record

Present

North

ITCZ

South

Calibrated Years BP (2000)
Not dissimilar to the Vellinga-Wu (2004)’s mechanism linking co-variation of ITCZ and Atlantic THC (or MOC): But places different emphasis on the sources and relative importance of thermal, freshwater and salt perturbations.

Also note that the requirement for this mechanism is not stringent: Interhemispheric SST contrast of 0.1°C in the tropics and >0.5°C in mid-to-high latitudes.

Evidence on AMO modulation of the Indian summer monsoon rainfalls

Goswami et al. (2006)
Empirical teleconnection between AMO and temperature and rainfalls in East Asia

(1) Temperature

Empirical teleconnection between AMO and temperature and rainfalls in East Asia

(2) Rainfall


Key AMO-related physical processes modulating Indian and East Asian Monsoonal Rainfalls


Tropospheric heating at Eurasia land mass for four seasons causing enhanced summer monsoon and weakened winter monsoon for AMO+ phase
A plausible scheme linking solar TSI forcing, Equator-to-Pole Temperature Gradient, Arctic SAT, Arctic freshwater flux, Atlantic THC and ITCZ and related teleconnections on multidecadal and longer timescales?
The story of *hei nakaiy dhooni* ("October flyer") transoceanic journey following the rain as told by Dr. R. Charles Anderson of Male, Maldives

Source: From Dr. Anderson TED India talk November, 2009
http://www.ted.com/talks/charles_anderson_discovers_dragonflies_that_cross_oceans.html
Globe Skimmer (*Pantala flavescens*)
Arrival Dates of Dragon Flies

- 24 Sept
- 12 Oct
- 17 Oct
- Malé, 21 Oct
- 29 Oct
- 7 Nov
The long transoceanic journey of dragon flies

Note: roundtrip journey is 14,000-18,000 km; in comparison Monarch butterfly annual migration from Southern Canada to Mexico, while impressive, covers only 7,000 km
The birds are doing the ocean-crossing too!

Amur falcon

Eurasian hobby

Pied cuckoo

European roller
The birds are doing it too
(with the dragon flies help!)

Blue-cheeked bee-eater
From Koutavas and Lynch-Stieglitz (2005) [courtesy of Athanasios Koutavas July 13, 2006]
How do the dragon flies get across the Indian Ocean?

Coasting with help of northeasterly winds (at 10 m/s!) in the ITCZ aloft at 1000-2500 meters (despite the surface summer monsoonal SSW-NW wind)

See Fleitmann et al. (2003) Science for cloud cover does not rise higher than 1500 meters because of the temperature inversion
Why the dragon flies travel 14,000-18,000 km?

In search of rain!
(Freshwater)

Hypothesized return of the fourth generation dragon flies to Indian continent in June-July