Long-term change in the abundances of northern Gulf of Mexico scyphomedusae *Chrysaora* sp. and *Aurelia* spp. with links to climate variability

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Linking variability in jellyfish to climate signals

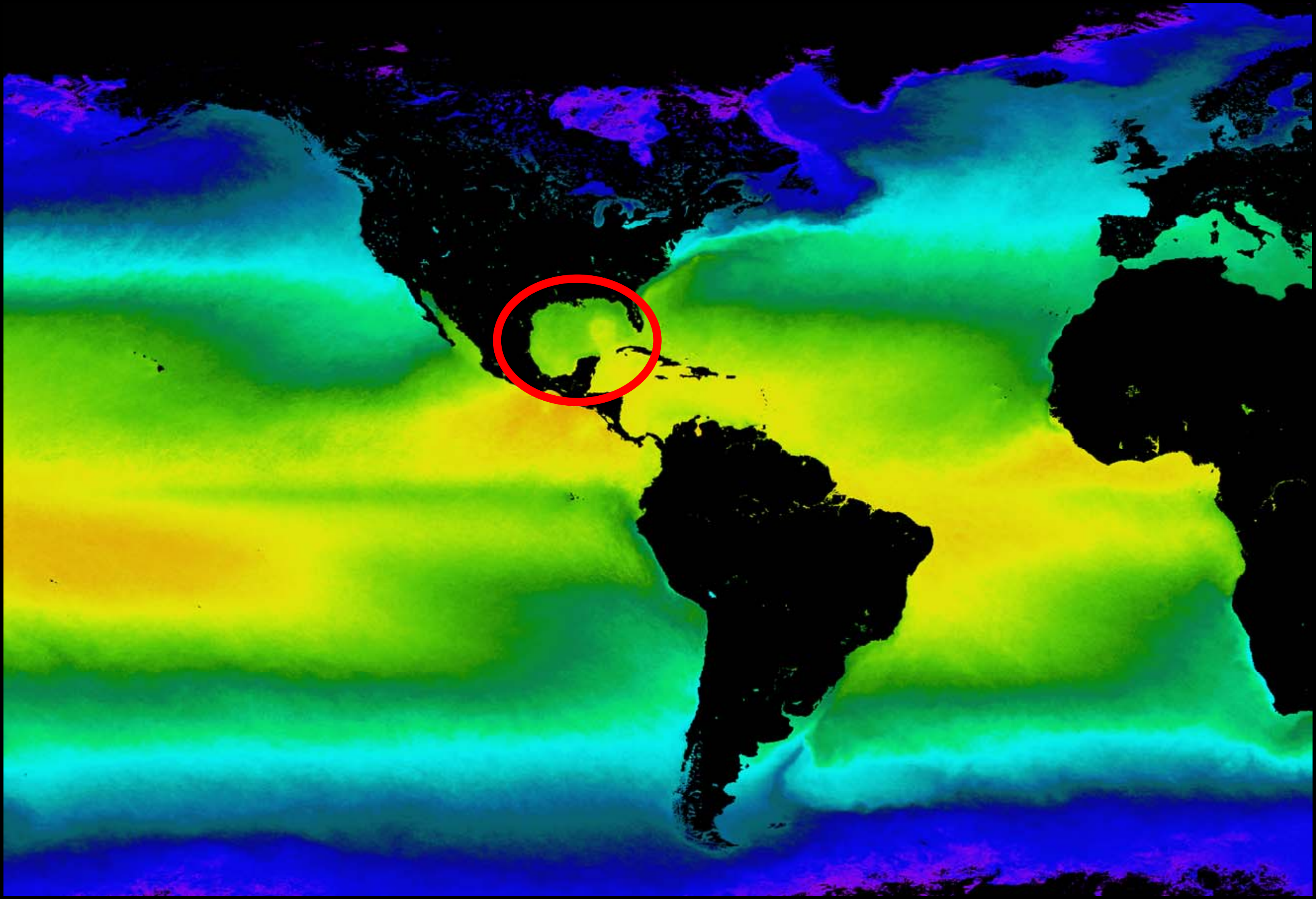
North Atlantic Oscillation (NAO)
- North Sea & Irish Sea (Lynam et al. 2004, 2005, 2011)
- Chesapeake Bay (Decker & Purcell 2005)
- Mediterranean Sea (Molinero et al. 2005)

PDO (Pacific Decadal Oscillation)
- N. California Current (Suchman and Brodeur 2012)
- Bering Sea (Brodeur et al. 1999, 2008)

ENSO (El Niño Southern Oscillation)
- Humboldt Current (Quiñones et al. *In Press*)

Reviews (Purcell 2005, 2007, 2012)

Gulf of Mexico in the middle



Ecological effects of climate drivers

Large

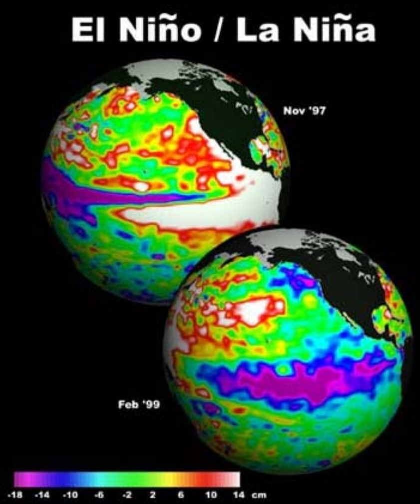
$>10^7$ km^2

Regional

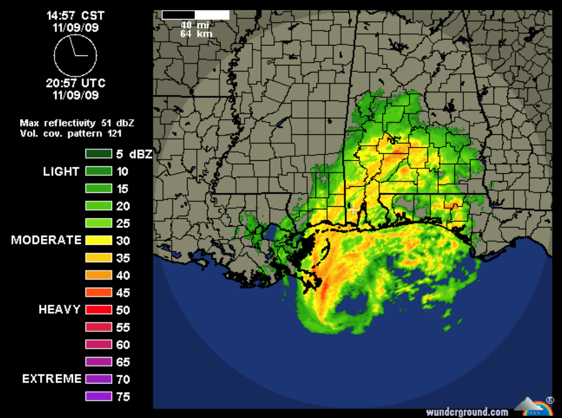
10^4-10^7 km^2

Local

$<10^4$ km^2



SST, rainfall



Are large-scale or regional-scale climate force more important in the northern Gulf of Mexico?

Objectives

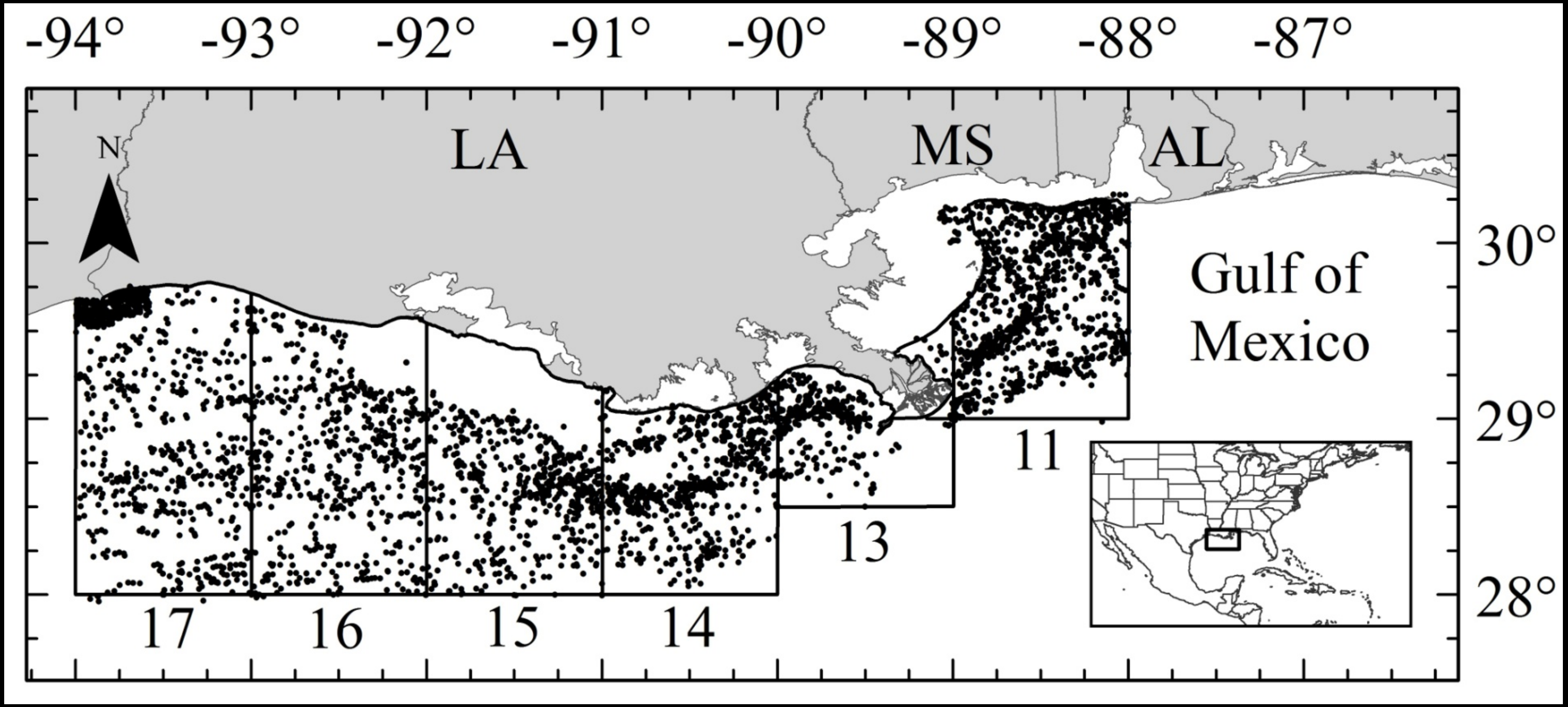
1. Determine if abundance and distribution of *Aurelia* spp. and *Chrysaora* sp. changed during 1985-2007

2. Quantify dependency between jellyfish abundance and climate indices at large and regional scales

3. Identify whether jellyfish-climate relationships are simple or a complex interaction of climate drivers

4. Are those relationships best explained by regional or large scale drivers?

Study area: northern Gulf of Mexico



NOAA NMFS Southeast Area Monitoring and Assessment Program (SEAMAP) jellyfish by-catch records: 1985-2007

Data analysis

Jellyfish population size

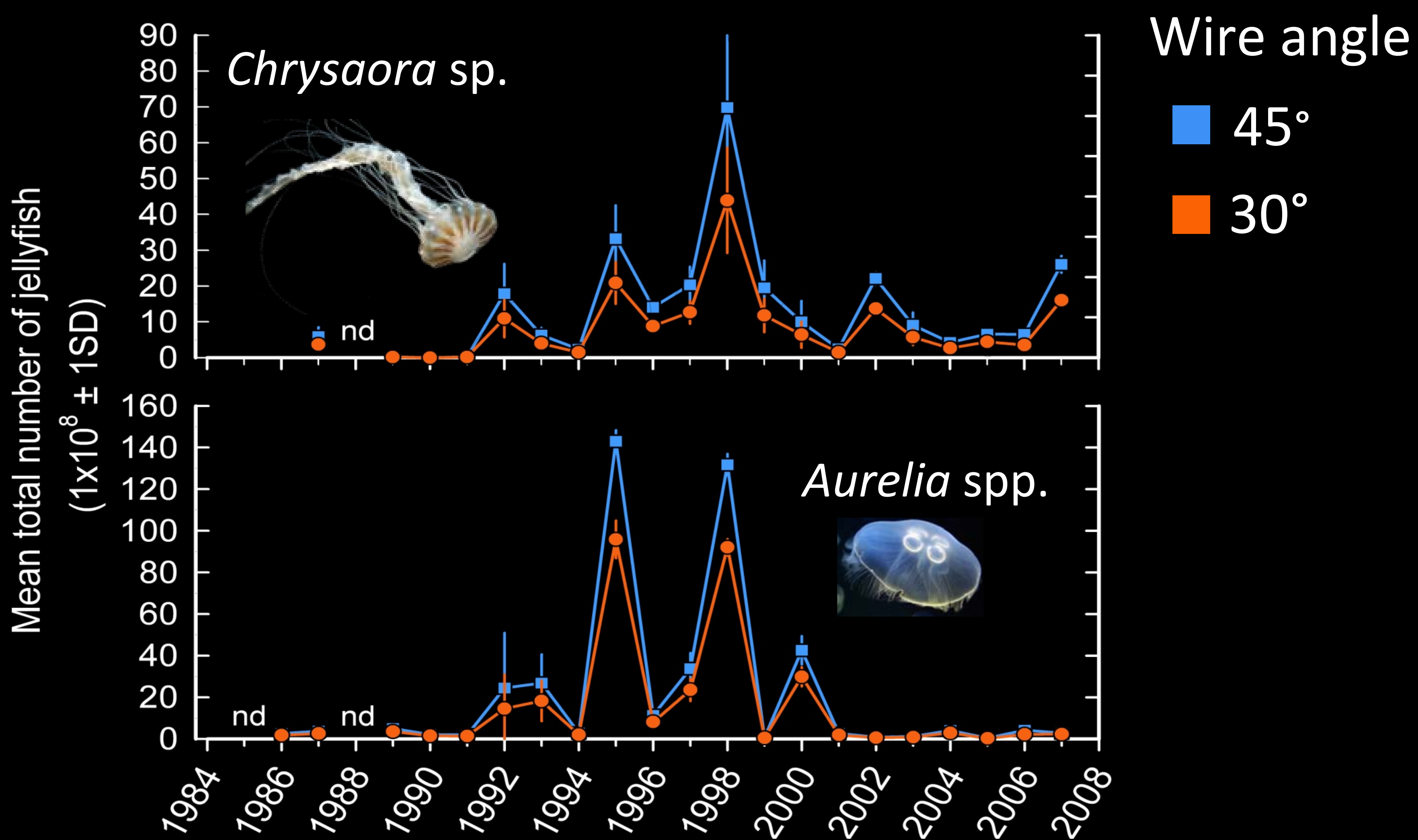
- Summer & fall SEAMAP trawls
- Jellyfish caught on “up” & “down” casts of bottom trawls
    - Depth-integrated abundance → 1st- order estimates of total population size
- Biases in trawl data

Climate indices and sea surface temperature (SST)

- NAO, ENSO, PDO, GPLLJ and AMO (monthly)
    - Seasonal subsets: winter = Dec-Jan-Feb
- SST (monthly)
- Indices & SST synthesized using Principle Component Analysis after de-trending data sets

Pearson Product Moment or Spearman Rank Correlation

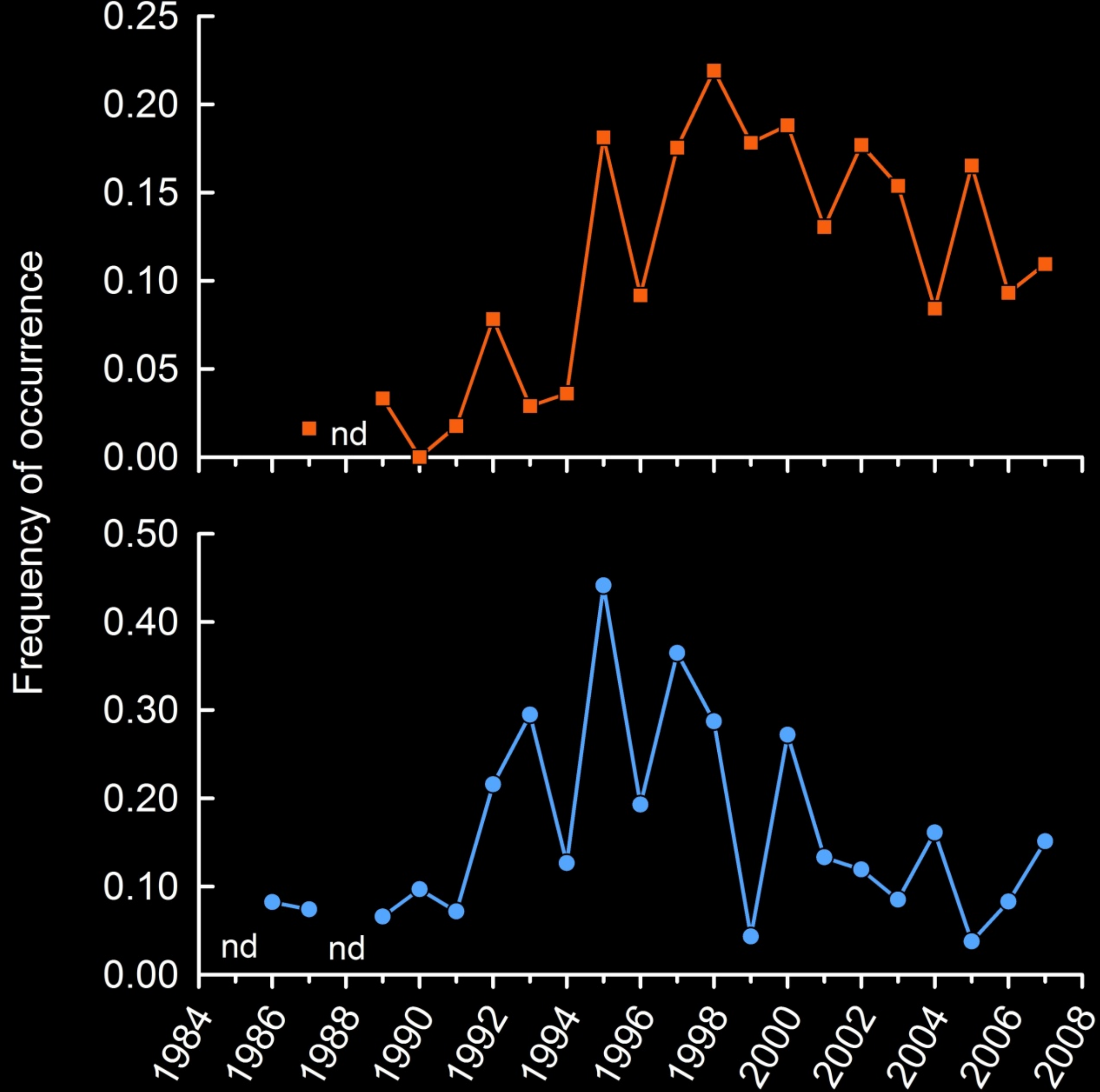
Chysaora sp. and *Aurelia* spp. tended to vary together in abundance



Chrysaora sp. frequency in trawls has increased with time

Chrysaora sp.

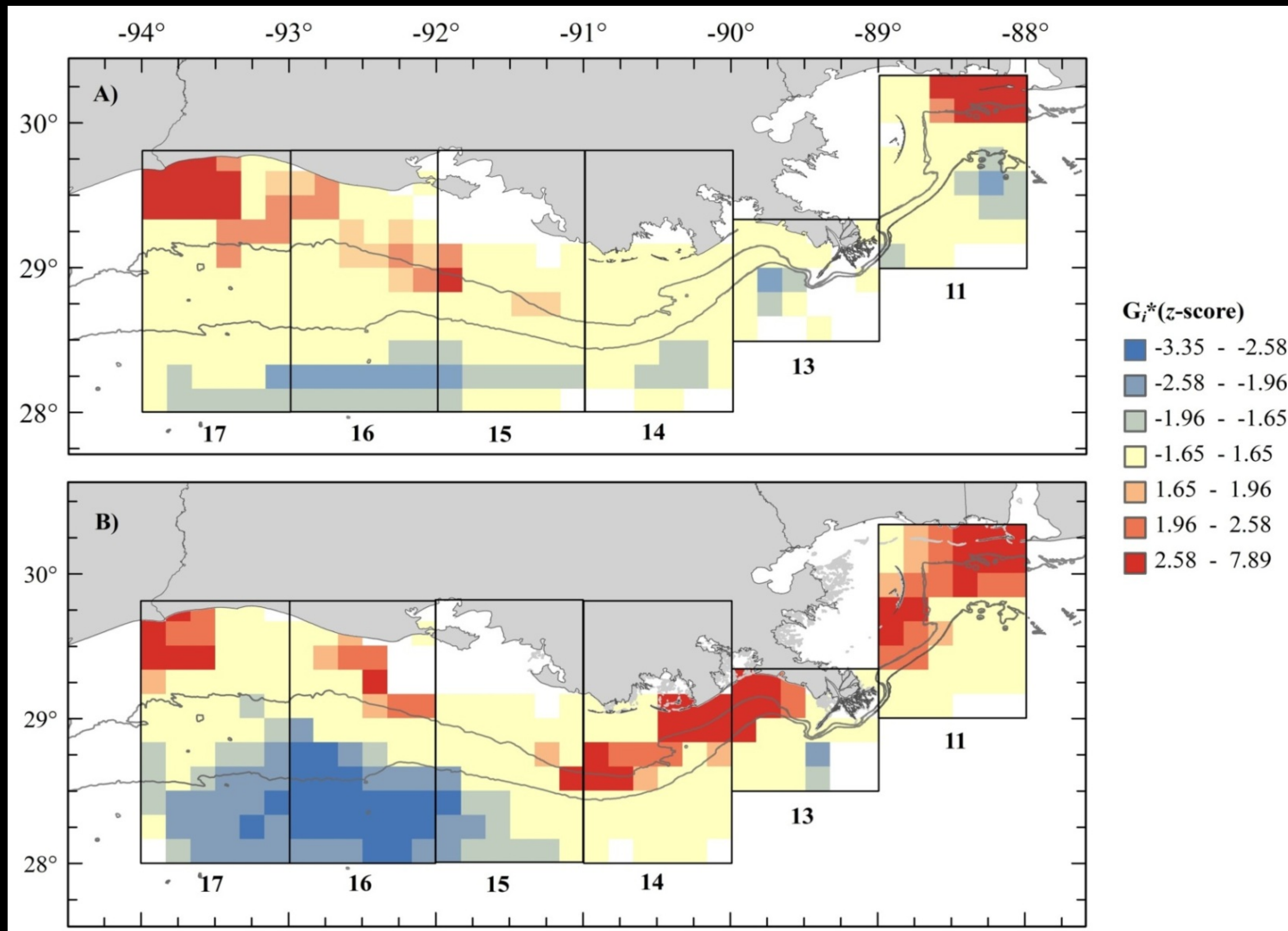
Aurelia spp.



Long-term distribution patterns in scyphomedusae

Chrysaora sp.

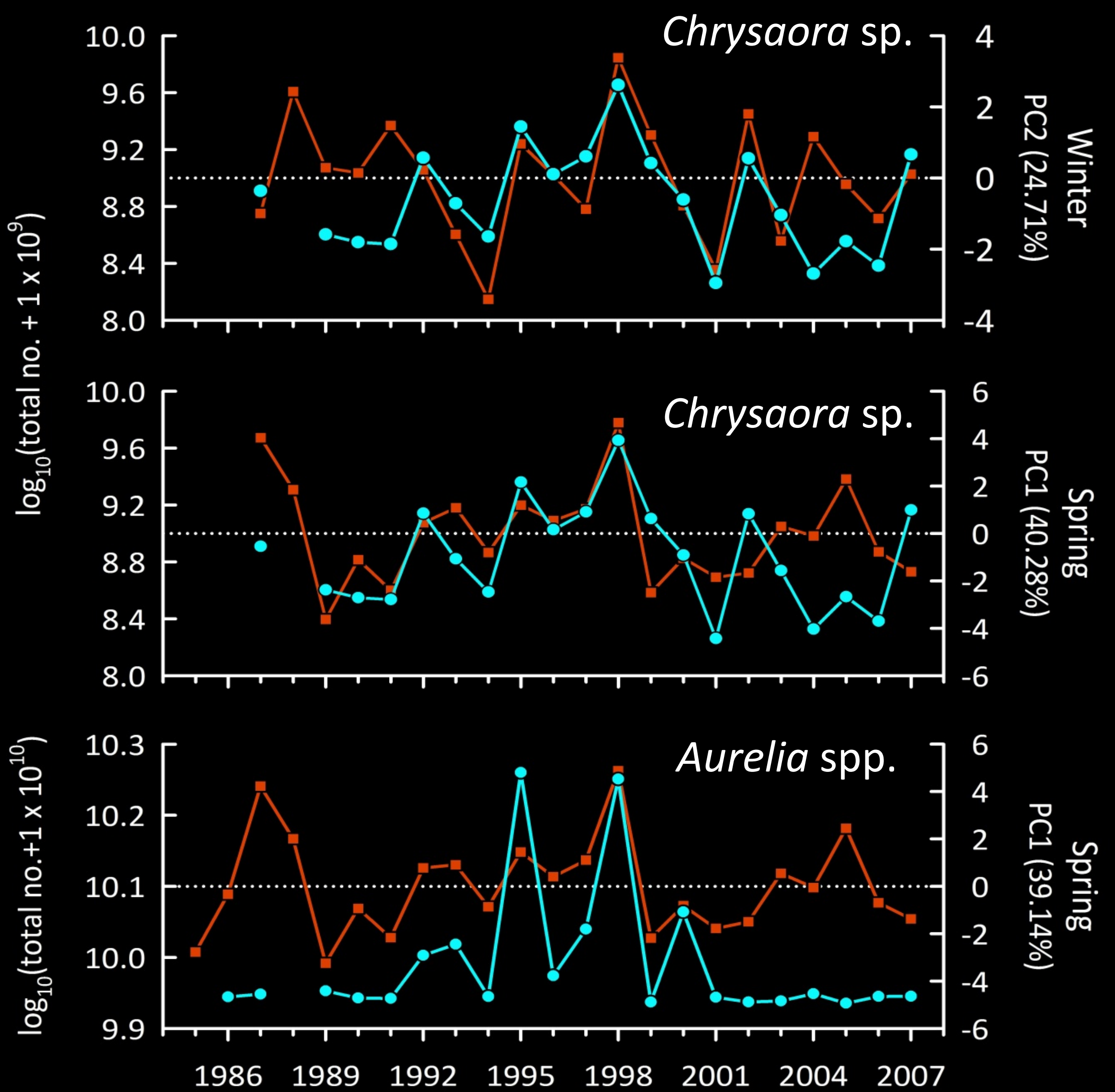
Aurelia spp.



Scyphomedusae abundance varied with winter & spring climate signals

Jellyfish

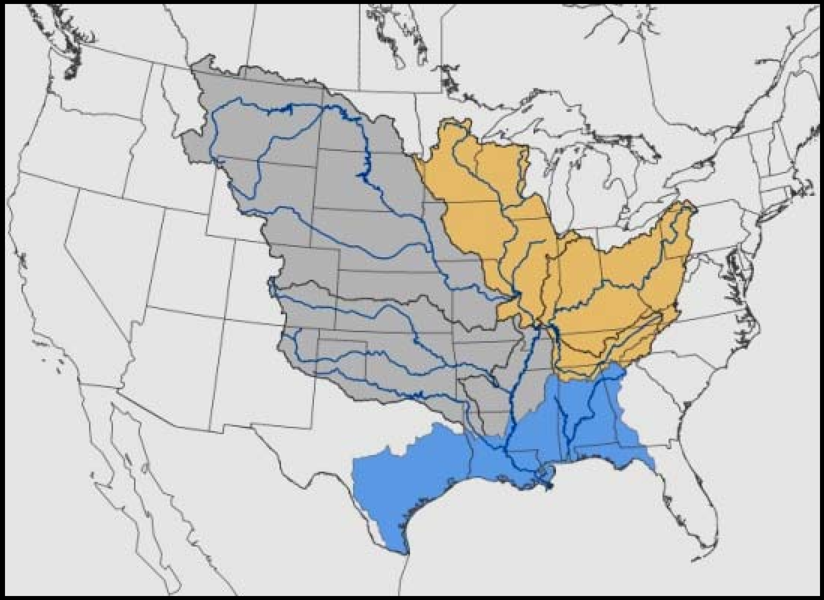
Climate PC



Winter & spring climate signals influenced regional rainfall patterns in river watersheds

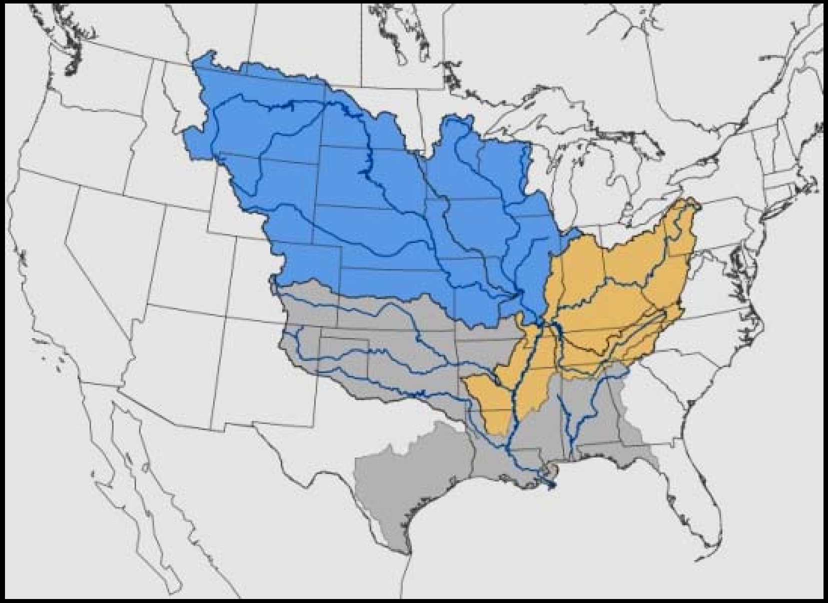
Winter

(+) AMO, ENSO & NAO



Spring

(+) AMO, ENSO & PDO

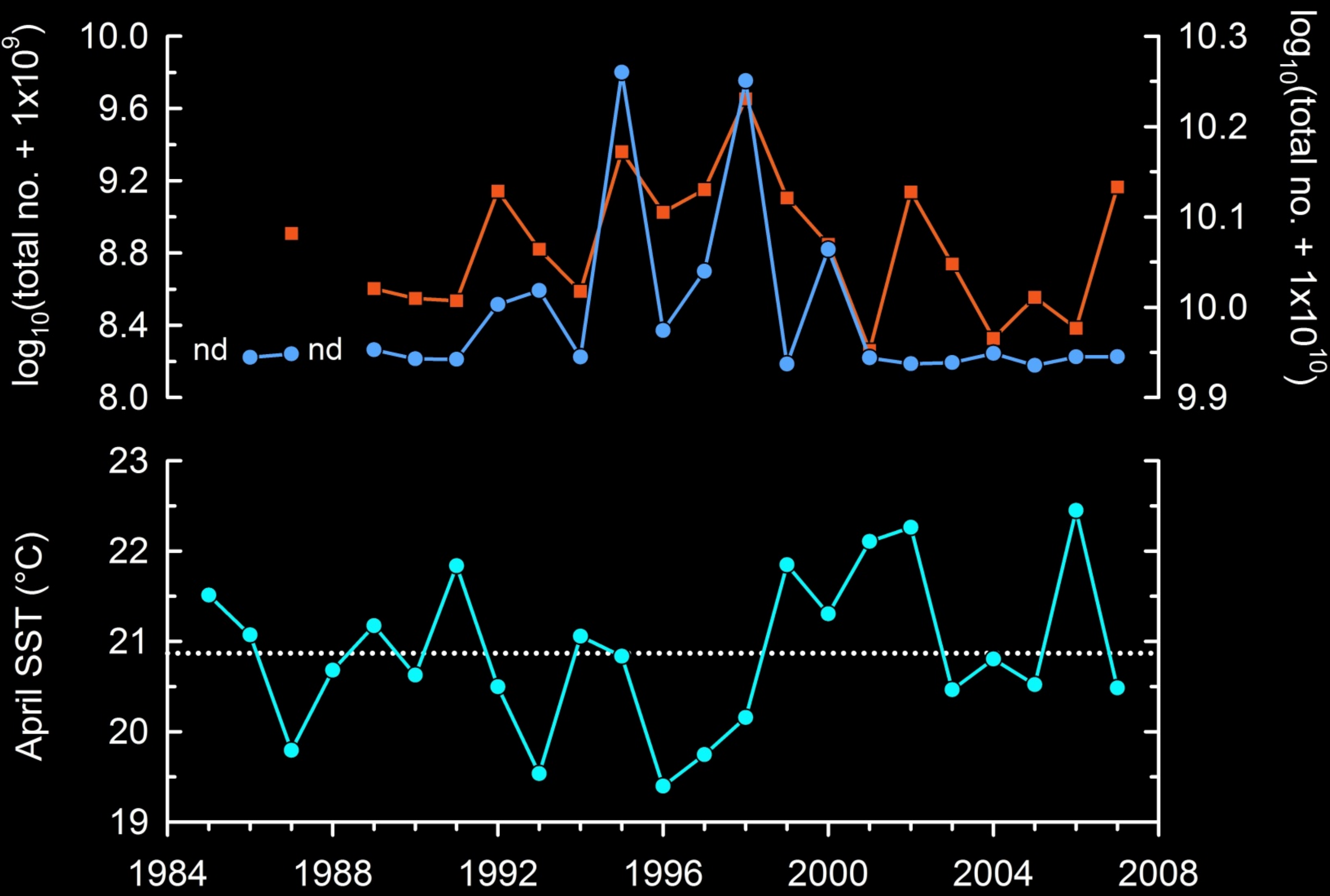


above-average   below-average   average

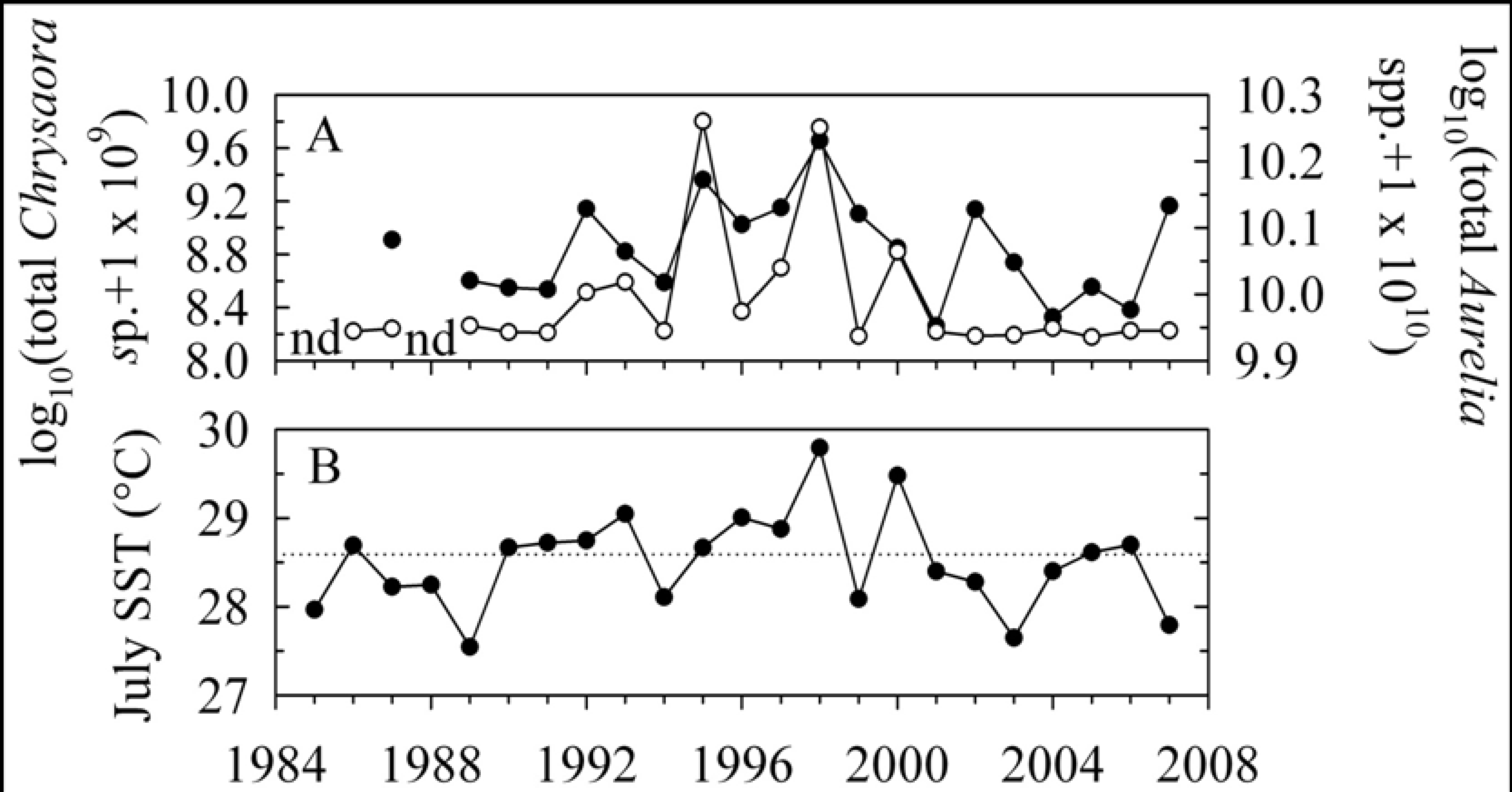
Cool SST in spring favor jellyfish

Chrysaora sp.

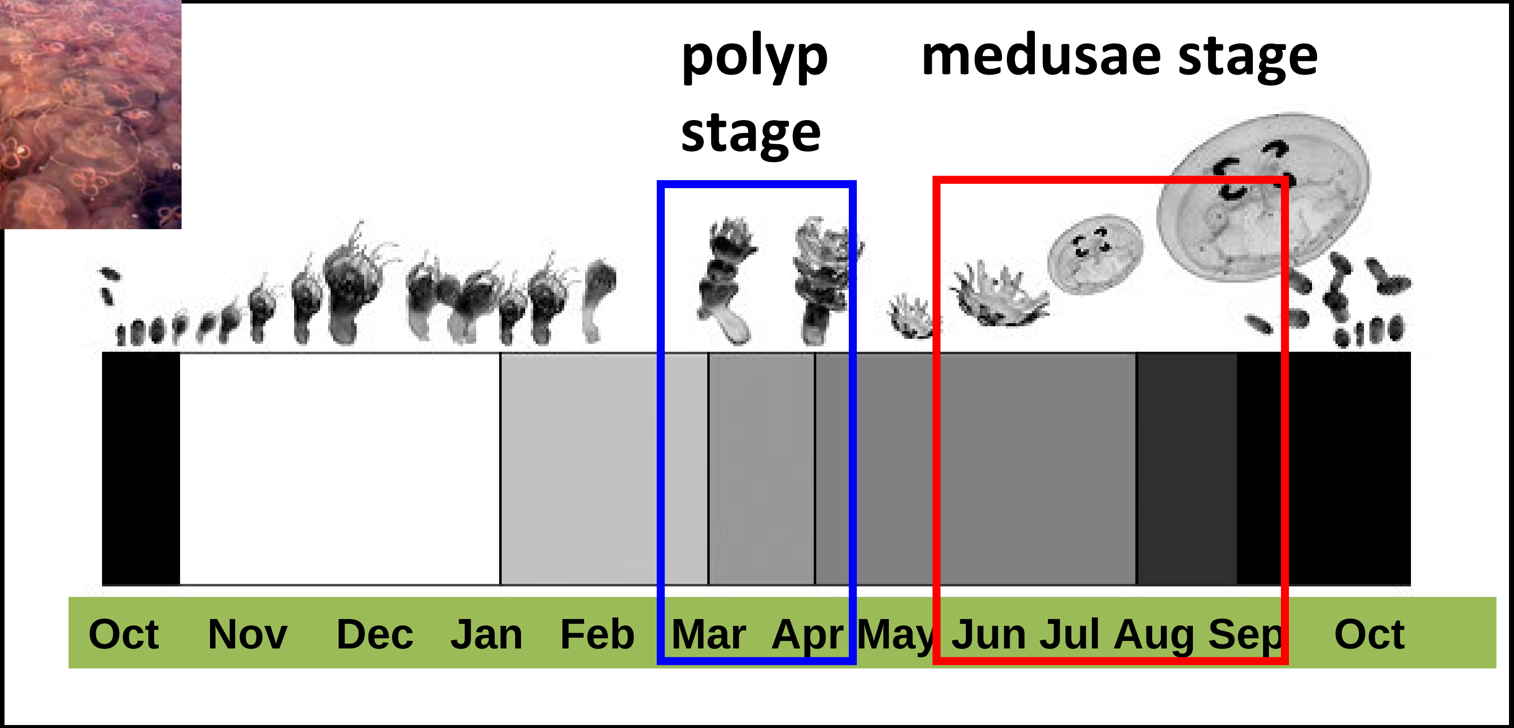
Aurelia spp.



Warm SST in summer & early fall also favor jellyfish

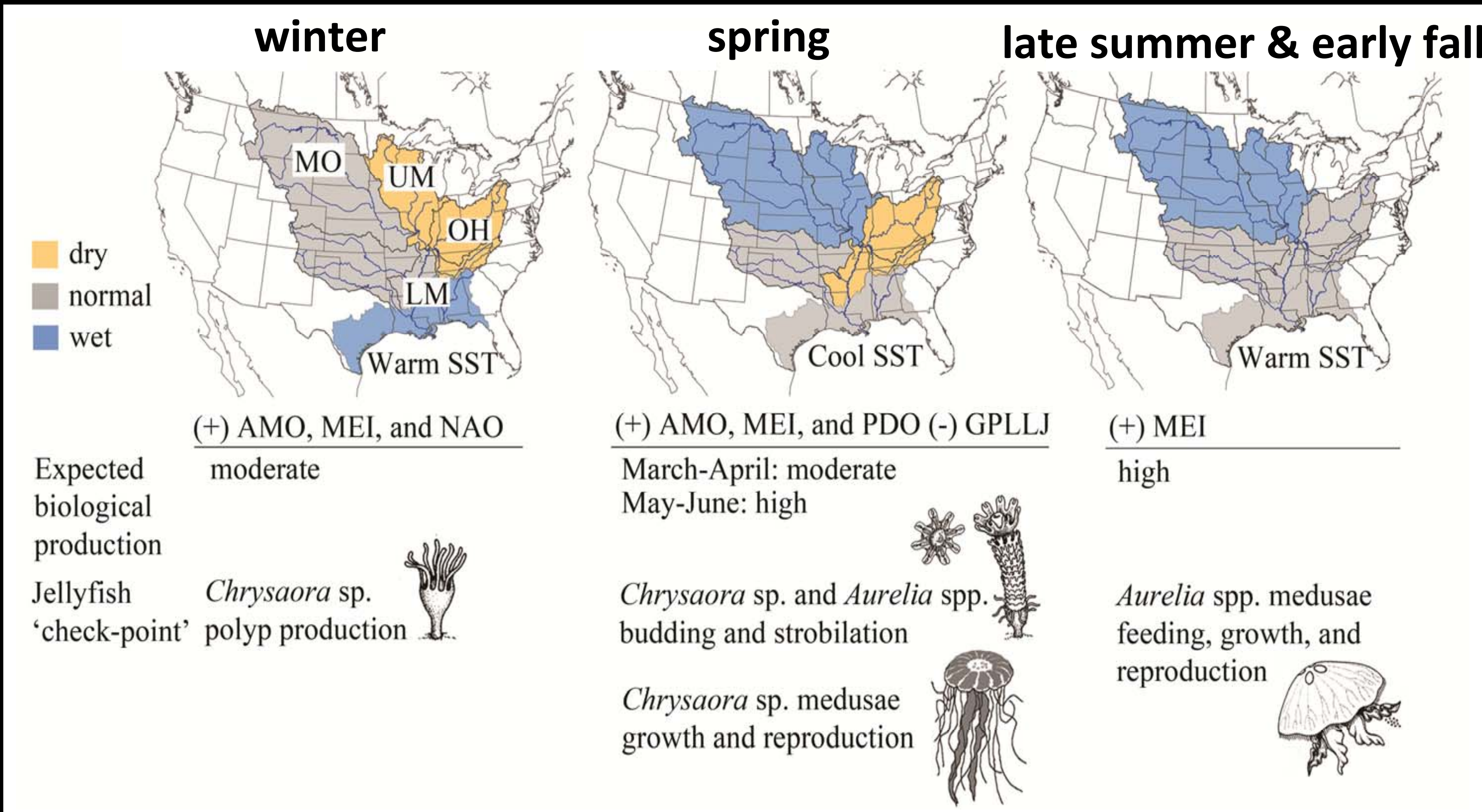


Medusae were more abundant during years when SST was below-average in spring and above-average in summer and early fall



Miller and Graham (2012) J. Exp. Mar. Biol. Ecol.

Conceptual model



Summary

- Scyphomedusae populations varied greatly but tended to do so with each other
- Frequency of *Chrysaora* sp. occurrence in SEAMAP trawls rose significantly during 1985-2007
- Gulf jellyfish-climate relationships are complex
  - Large and regional scale climate forces influenced a set of biophysical factors that directly affected jellyfish production during different seasons

Jellyfish production is favored when…

- Northern Gulf experiences wet and warm winters, dry and cool springs, wet and warm summers
- Mississippi River watershed to experience dry winters, wet springs and wet summers

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