SCOR WG125 “Global comparison of zooplankton time series”: a summary

(most of our members, Nov 05)

What we mean by ‘zooplankton’:

‘Mesozooplankton’:

- ~1 mm – 3 cm
- Trophic level 2-4
- Swim slower than surface currents
- Life span weeks to annual
- Small enough to catch with a plankton net, big and tough enough to be retained
- Life span

Why zooplankton time series?

Key link between "physics" and "fish"

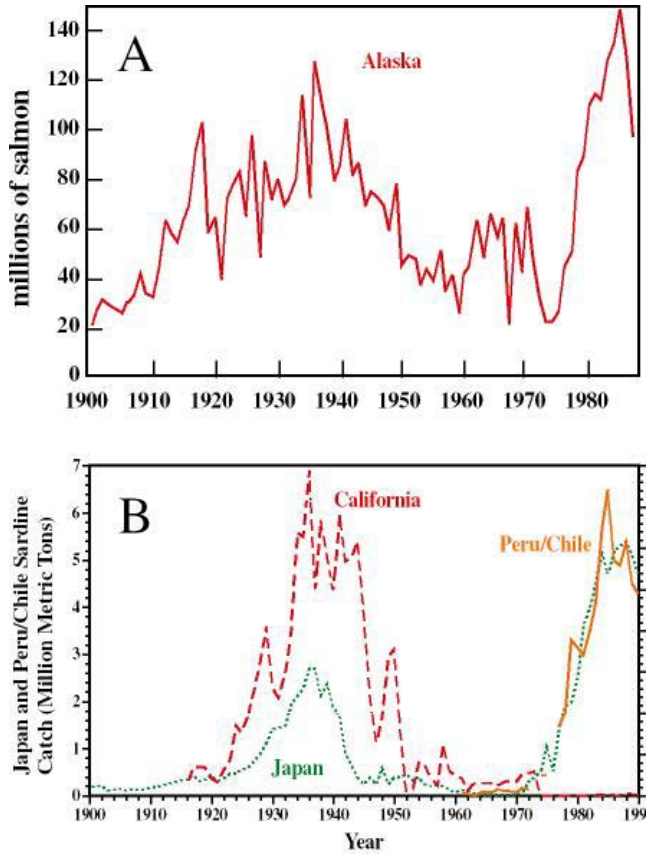
Zooplankton sampling methods are (relatively) :

- **simple,**
- **intercomparable,**
- **fishery-independent**

Time scale of population response (~1 year or less) gives good tracking of climate forcing at interannual-decadal time scales

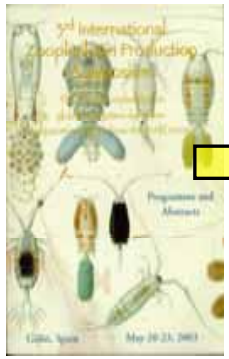
Motives for global comparison of zooplankton time series:

- **Multi-year changes in "ocean climate" and "ecosystem response" are linked**
- **"Long" (20+ year) zooplankton time series available from many ocean regions.**
- **But analyses to date have been "local" in both space and method**
- **Do zooplankton time series resemble those of pelagic fishes??**

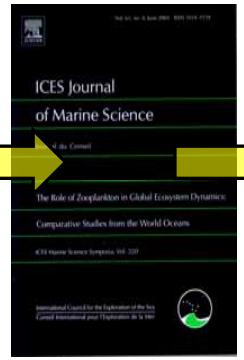


Ancestry and chronology of SCOR WG125

2003 International Zooplankton Symposium (right here in Gijon!)

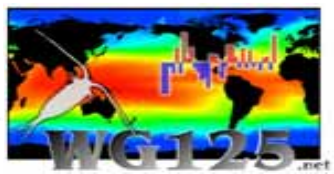


led to



A new SCOR Working Group: "Global Comparison of Zooplankton Time Series"

International Council for Science
Scientific Committee on Oceanic Research



Since then: WG meetings in Nov 05, Dec 06, May 07, May 08

Gigabytes of data and graphics produced & exchanged

Topic session on zooplankton time series at 2007 Int'l Zooplankton Symposium (May 2007, Hiroshima)

More gigabytes of data & graphics (my hard drive overfloweth….)

May 2008 workshop on zooplankton time series (this meeting) ⇒ special issue of *Progress in Oceanography* (2009?)

WG125 'Mandate'

Data: Assemble representative "long zooplankton time series".

Methods 'Toolkit': Develop & share processing, visualization & analysis software

Comparative Analyses to examine:

- Amplitudes of multi-year variability (for total biomass, size and community composition, seasonal timing...)
- Correlation structure
- Zooplankton vs. higher trophic levels
- Synchronies of major interannual fluctuations
- Likely causal mechanisms and consequences

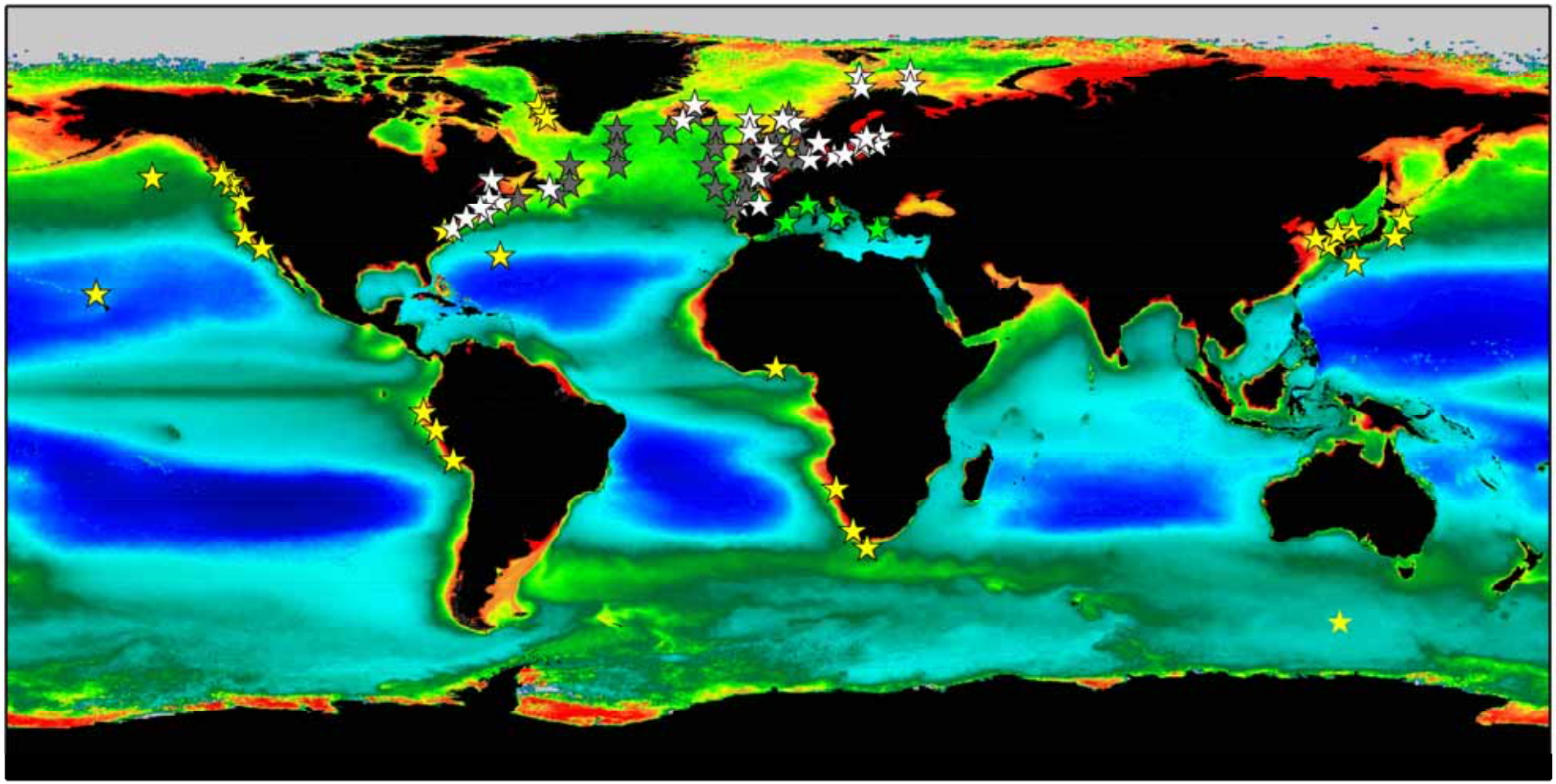
"Cheerleading":

- Advertise existing time series
- Enable new time series, especially where there are gaps

Assembly of Data:

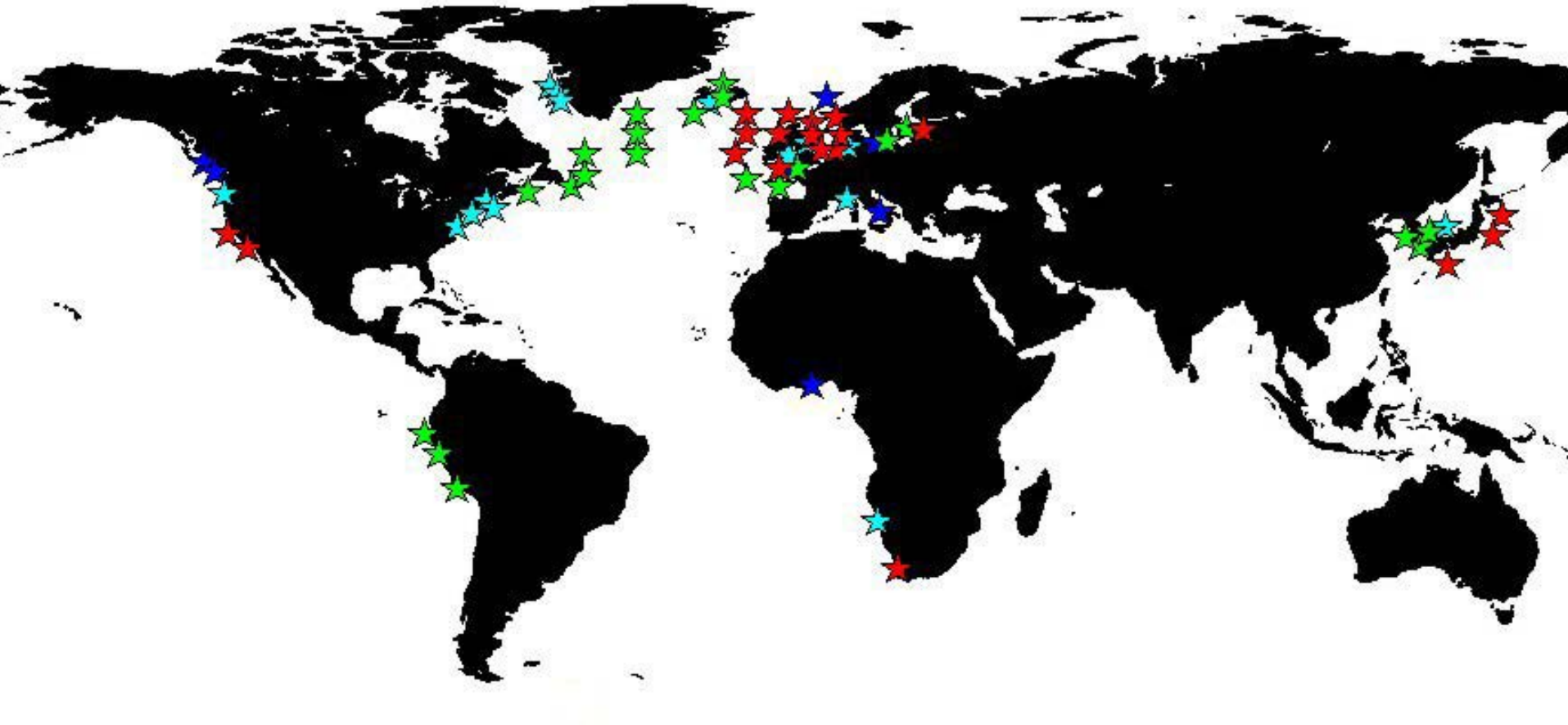
Good progress! Cooperation/buy-in both within and outside the Working Group

Data assembly: We now have nearly 100 'biomass' time series from 23 countries



Many of these are “long“

(However, several are biomass/biovolume only)



Durations (years): **>50** **>40** **>30** **>20**

Methods Toolkit - goals

Separate multiyear fluctuations and trends from other intense modes of zooplankton variability:

Allow comparison across diverse sampling designs:

- **Frequent (weekly to monthly) at one site**
- **Monthly to seasonal on a grid**
- **Monthly to seasonal scattered within a region**
- **Annual surveys at ~fixed season & locations**

Allow comparison across differences in sampling gear and measurement "currency"

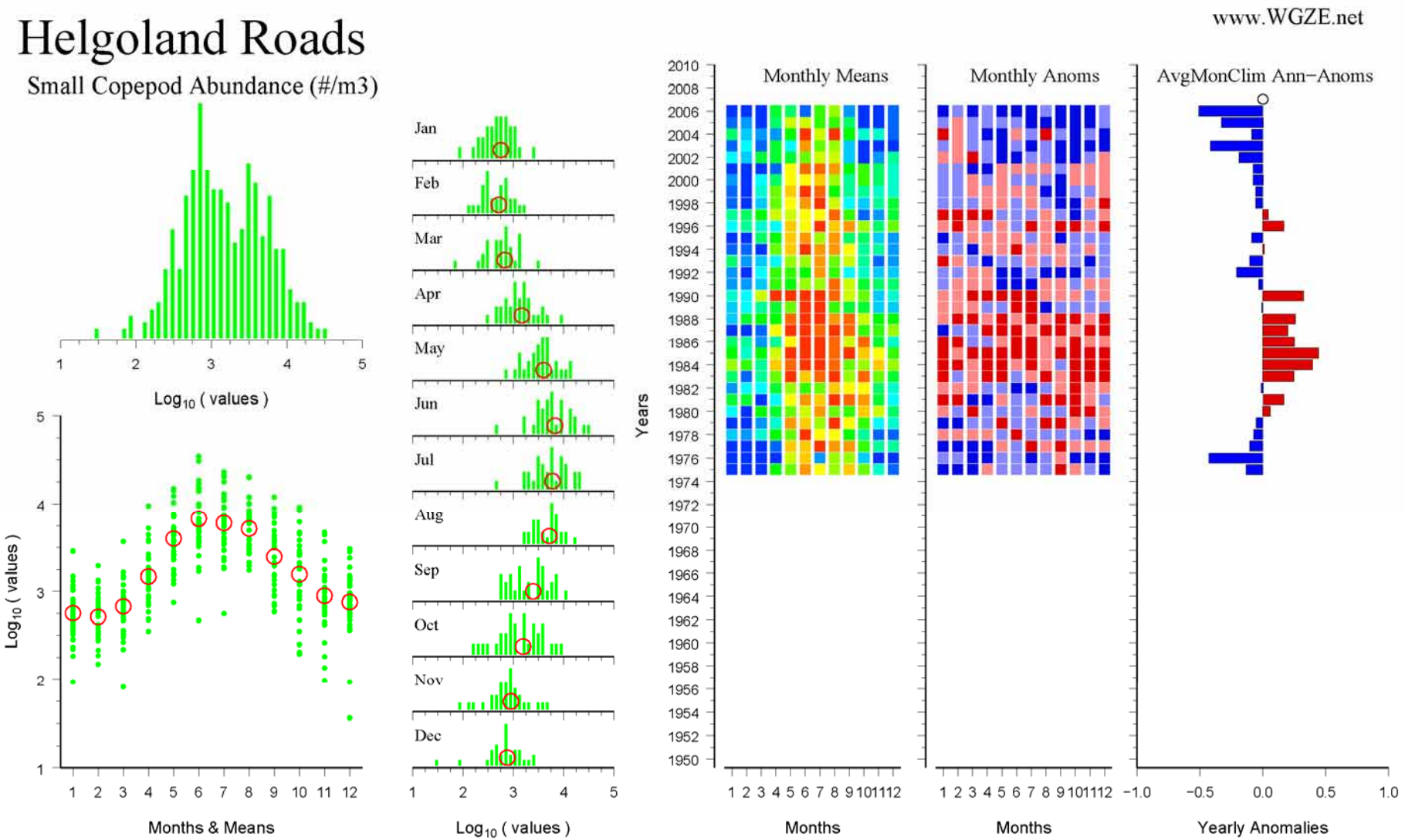
Our eventual choice as WG125 'standard' :

1. **Log transform data and calculate monthly means ($B_{m,y}$) For each calendar month, calculate a monthly resolution seasonal climatology B_{clim}**
2. **For each month in each year, calculate a log scale monthly anomaly $A_{m,y} = B_{m,y} - B_{clim}$**
3. **For each year, calculate an annual anomaly A_y by averaging the available monthly anomalies. Examine both $A_{m,y}$ and A_y**

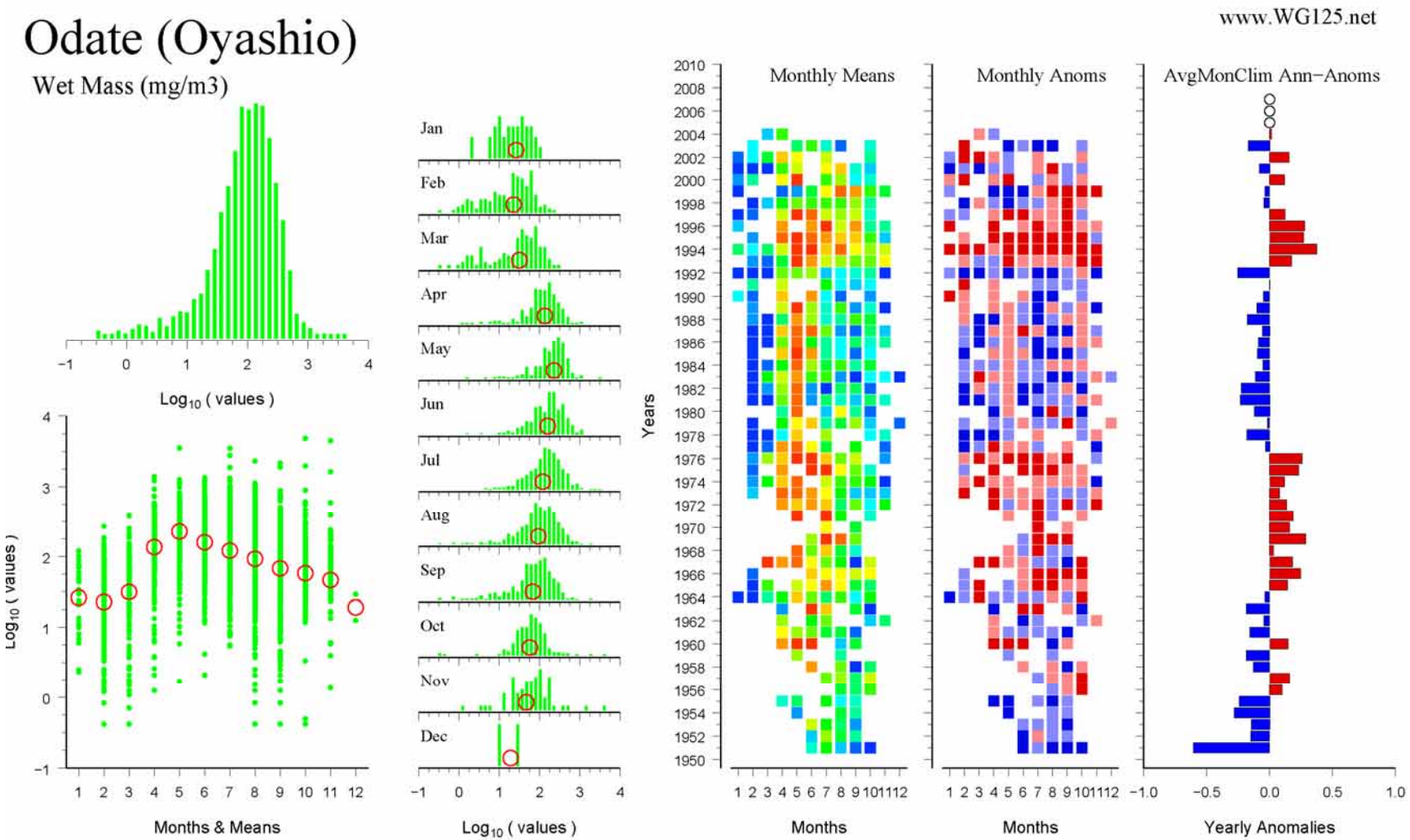
N.B: log scale anomalies measure multiplicative change (1.5x, 3x, 10x). They are dimensionless (blind to measurement currency) AND also cancel out any sampling bias shared by data and climatology baseline.

(for more detail see T. OBrien posters in SCOR area)

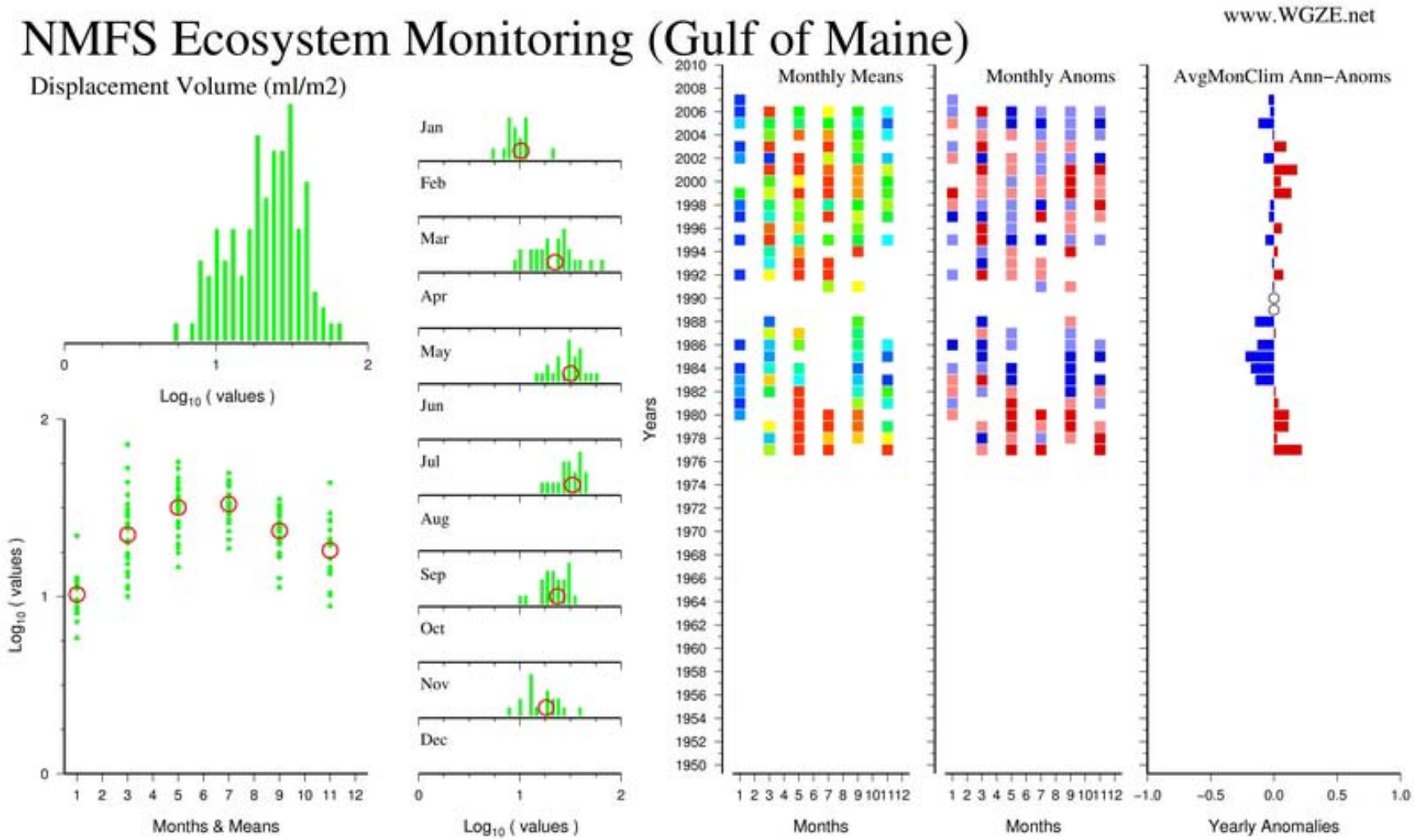
Example 1: a long, dense time series



Example 2: a long time series but with ‘holes’



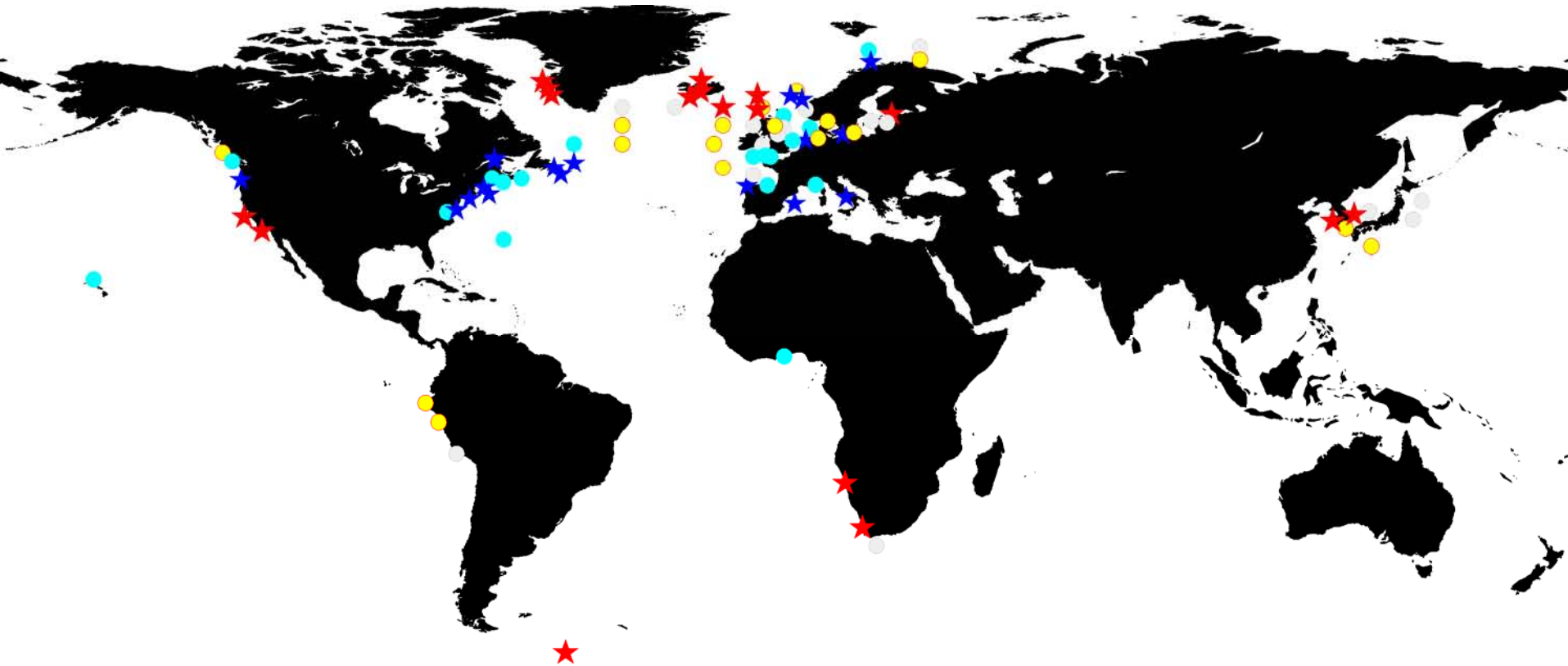
Example 3: seasonal sampling



Global comparison of biomass time series (nearly complete):

1. Relative intensity of variation (how large are the anomalies?)
2. Long term trends? (slope vs time)
3. Correlation/Synchrony vs spatial separation

Relative intensity = ‘span’

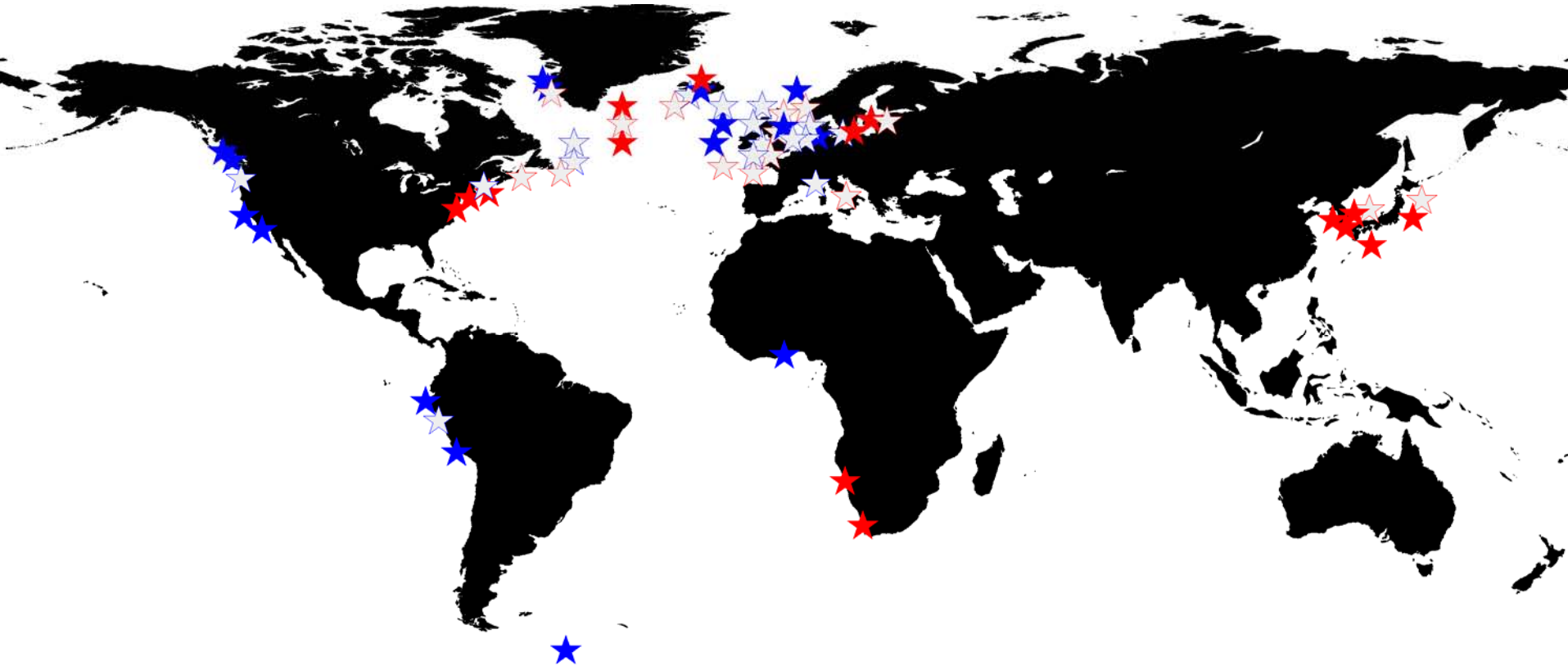


The most intense multiyear variation (red-yellow symbols) has been at subpolar-polar latitudes, in EBC upwelling regions, and around Korea-Japan

The weakest (light to dark blue) has been in the subtropical gyres and mid-latitude shelf seas

Note: Short time series may not yet have showed their full ‘span’

Sign and magnitude of long term trend:

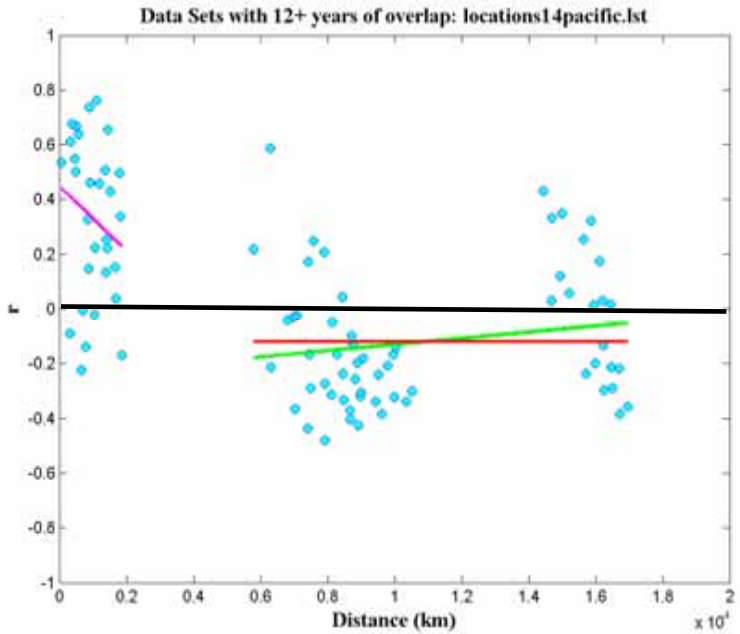


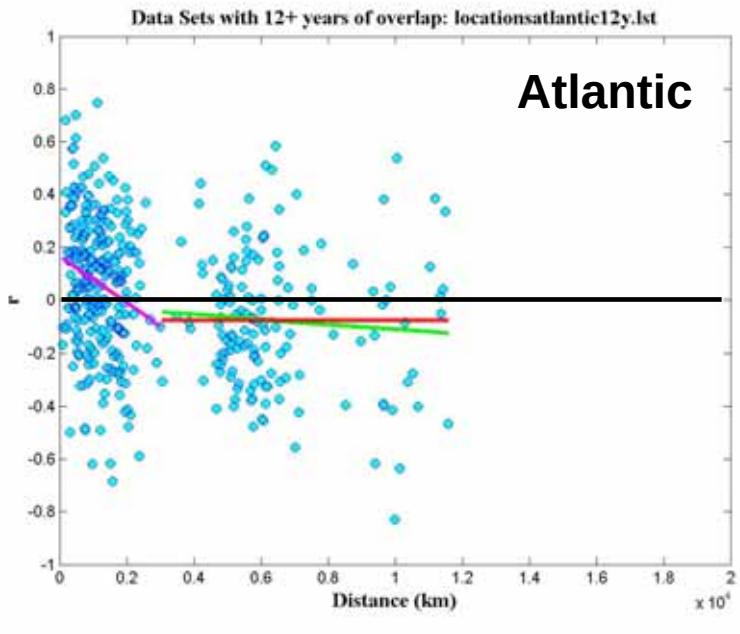
Downward trends (blue) along eastern basin margins (except Benguela and Baltic),

Upward trends (red) along western margins, Benguela and Baltic

Little trend 50-60°N in N Atlantic (where span was very large

Correlation declines with spatial separation: NO global scale synchrony for biomass some correlation/synchrony within basin (at separations <2000-4000 km)





Pacific: Spatial autocorrelation averages ~0.3 (stronger than Atlantic) at separations <2000 km.

Correlogram 'range' poorly determined because few site pairs at separations between 2-6x10^3 km)

Atlantic: Autocorrelation declines from ~0.2 to 0 as spatial separation increases to 3000 km.

Correlogram 'range' ~3000 km

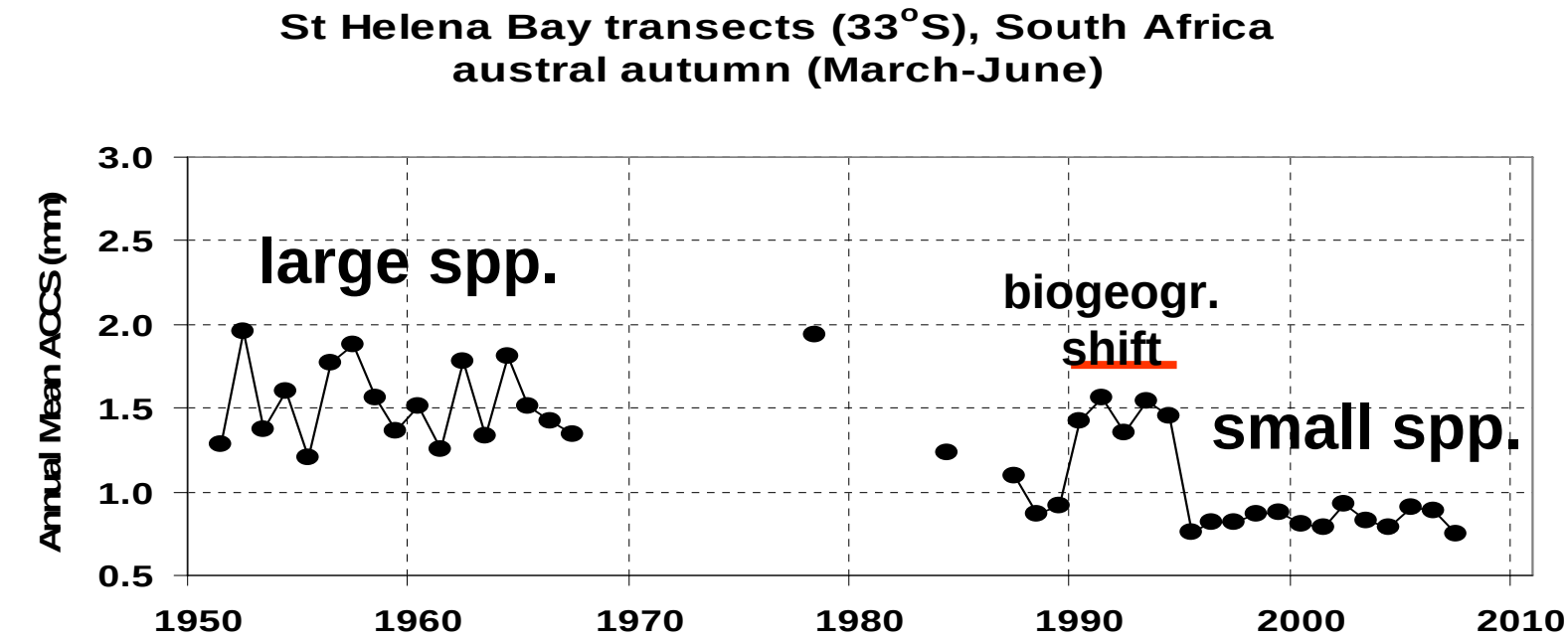
For more info see Batchelder poster in SCOR area

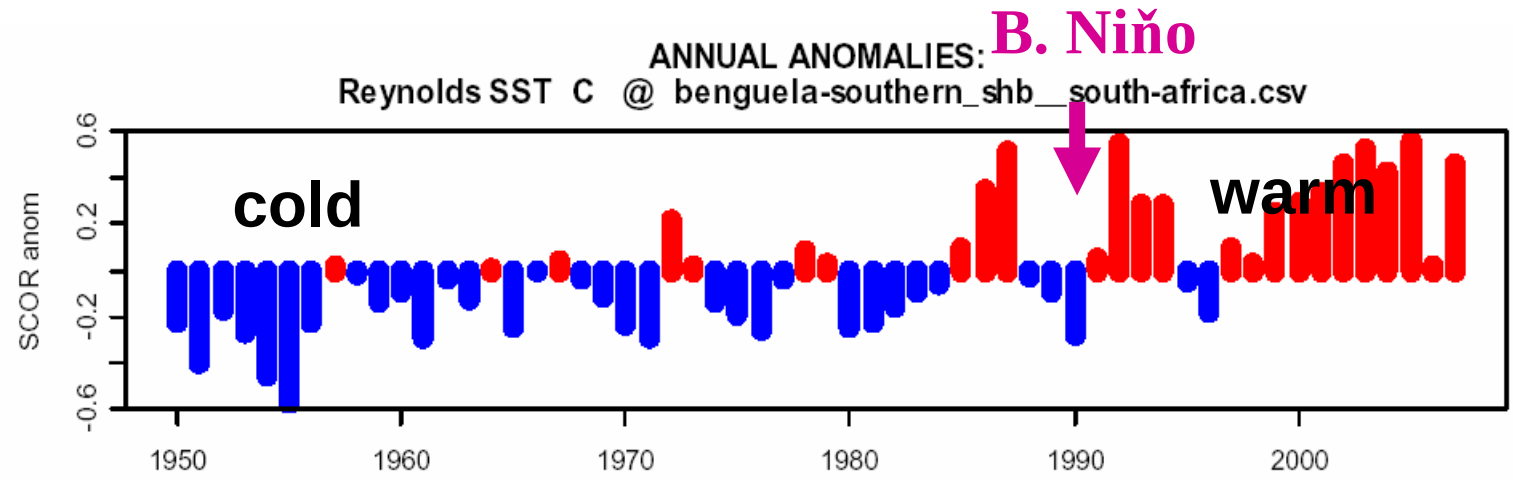
There are other important (perhaps more important!) modes of zooplankton variability: (e.g. average body size, community composition, chemical composition, phenology).

Many fewer data sets, but more are arriving and being processed

Our preliminary results (based on comparisons between among 2-5 regions):

Size composition: community shift to smaller body size when 'climate' is warmer

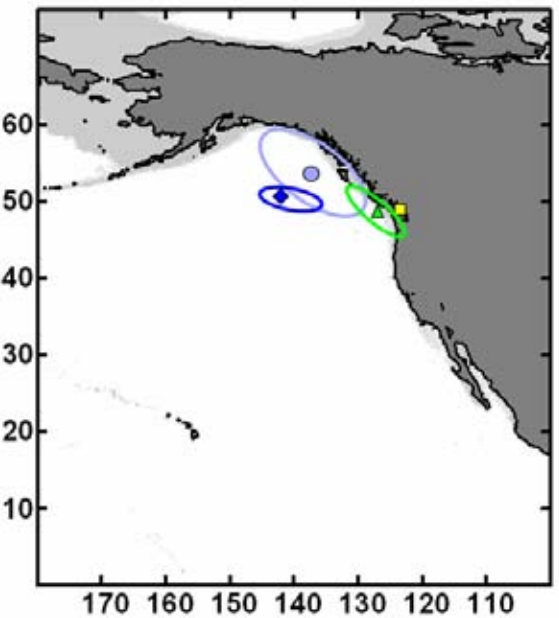


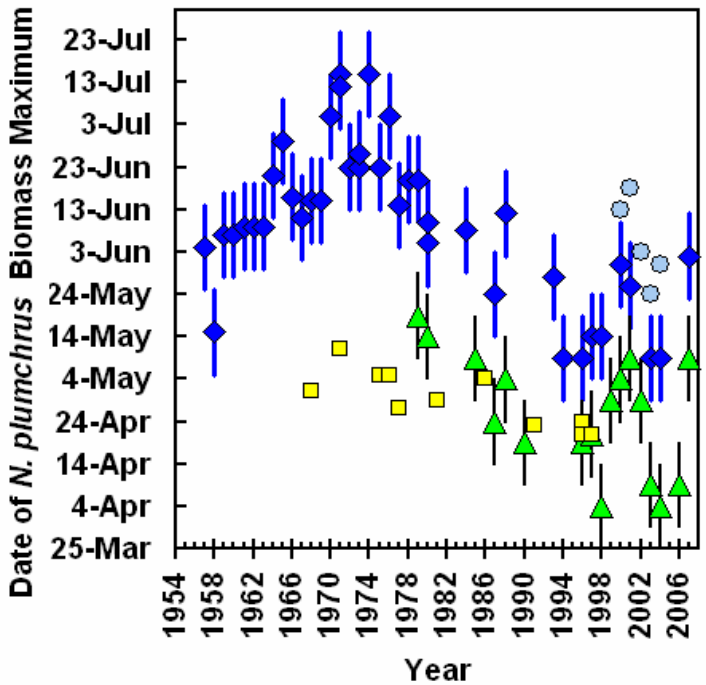


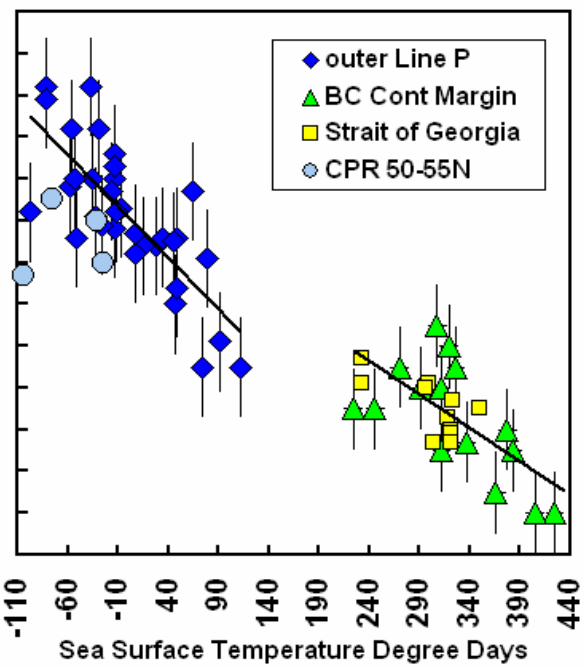
Seasonal timing (a.k.a. Phenology):

Many species show trends correlated with temperature anomalies:

e.g. copepod *Neocalanus plumchrus,* Alaska Gyre & BC coast

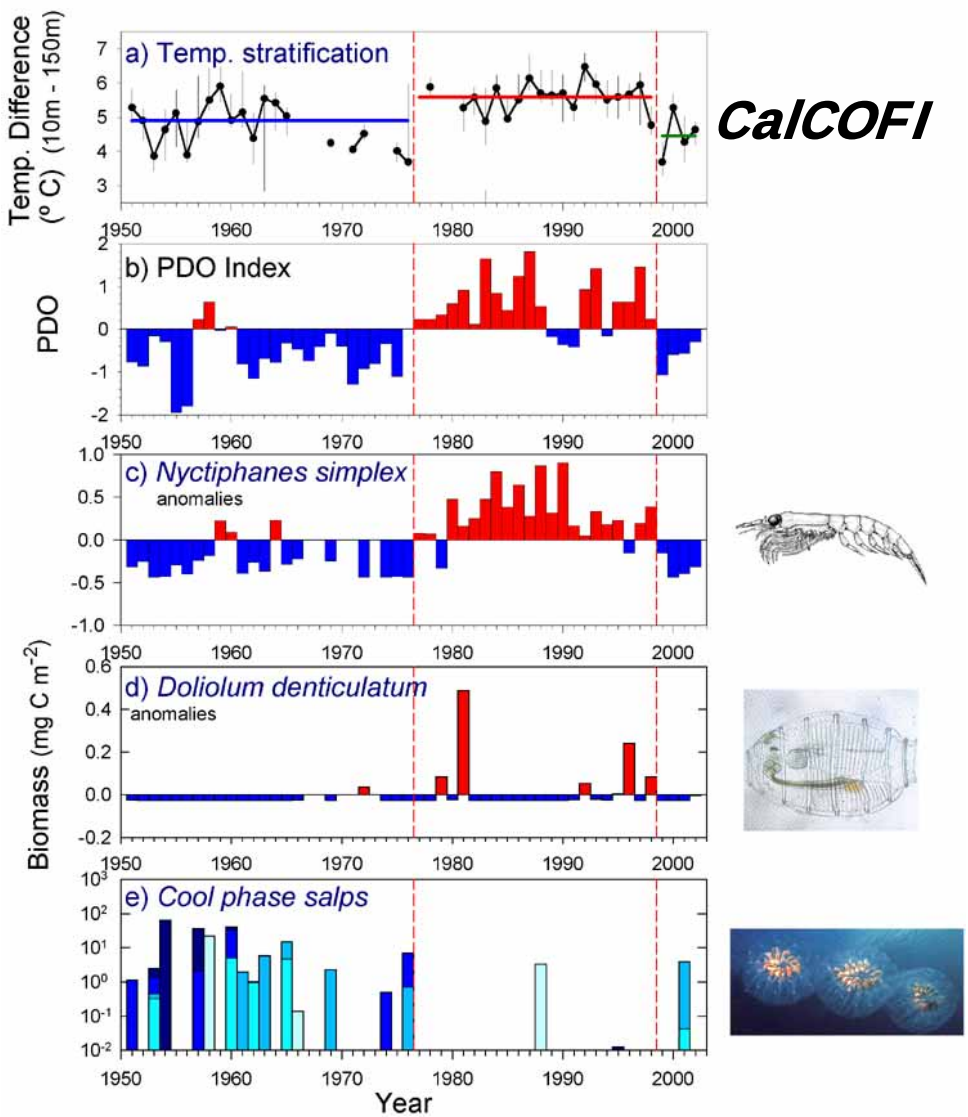






For more examples see Mackas etal poster in SCOR area

"Composition Regimes"
(California Current and North Sea)

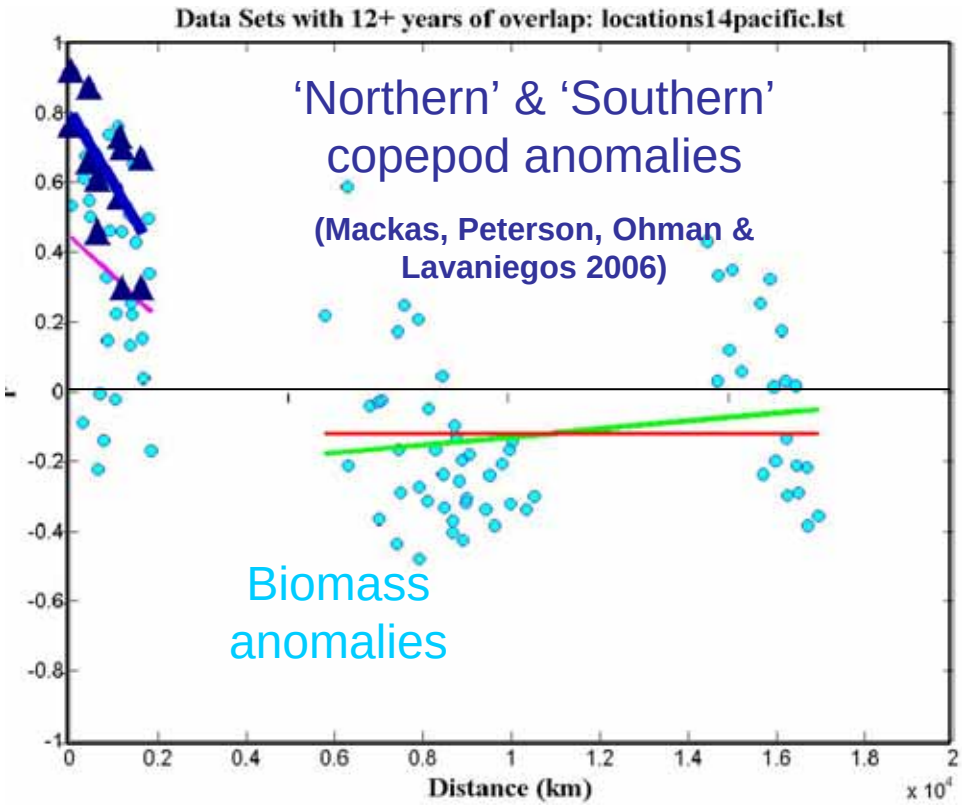


CalCOFI

Ohman and Venrick 2003

Individual species (and 'species group') anomalies at any given site have larger amplitudes (by 3-10x) and are less noisy than corresponding biomass anomalies.

Alongshore synchrony of 'Composition Regimes' (California Current)



At separations <2000 km, spatial correlation among 'community' anomalies is much higher than correlation among biomass anomalies. Covariance with climate and predator time series is also stronger.

'Range' ~4000km?

NEED MORE EXAMPLES & BROADER RANGE OF SPATIAL SEPARATIONS!!!

Contributors

WG125 Members & Associates:

D. Mackas & H. Verheye (cochairs)

P. Ayon, A. Arashkevich, H. Batchelder, S. Chiba,

D. Checkley, M. Edwards, J. Flinkman, YS Kang, A. Lopez-Urrutia, W. Melle, T. O'Brien, M. Ohman, C. Reason, A Richardson, L. Valdes

'Data Partners':

W. Greve, W.Peterson, S. Batten, G. Mazzocchi, D. Eloire, B. Lavaniegos, G. Beaugrand, K. Tadokoro

(Please join this list!)

Sponsors:

International Council for Science

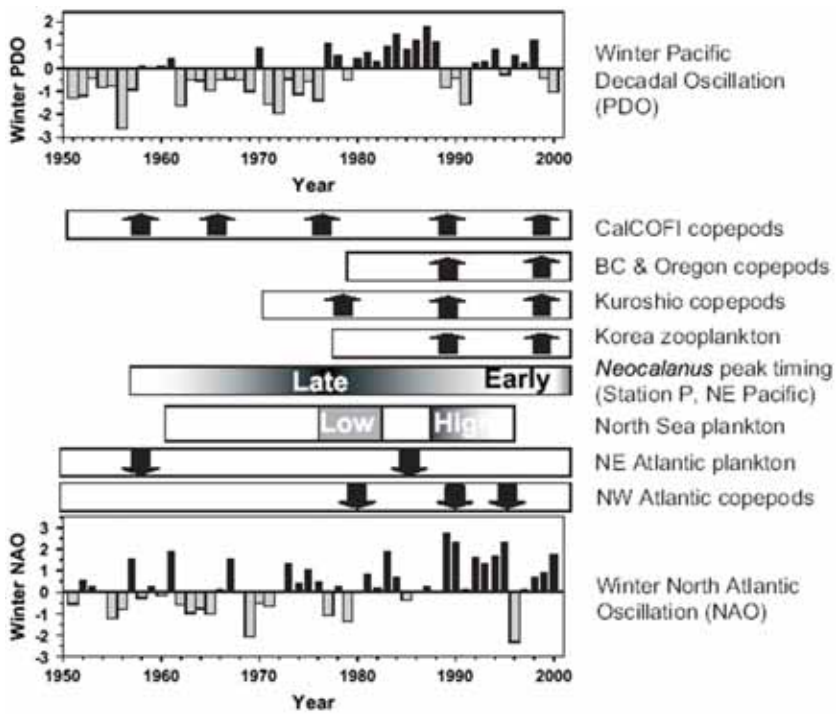
Scientific Committee on Oceanic Research

PICES

GLOBEC

Motives for global comparison of zooplankton time series (cont).

- **"Long" (20+ year) zooplankton time series becoming available from many ocean regions**
- **Analyses to date had been 'local' in both space and method (hard to compare results)**
- **Recent improvements in tools for data exchange, visualization, and analysis**



And hints that some modes of zooplankton variability are indeed large scale!!

Northeast Atlantic (CPR)