Simultaneous Atlantic and Pacific regime shifts through northern hemisphere teleconnection pattern

Jürgen Alheit
Leibniz Institute for Baltic Sea Research, Warnemünde, Germany

Sukgeun Jung, Motomitsu Takahashi, Yongjun Tian, Yury Zuenko

and more participants of the

ICES/PICES Workshop on the Reaction of Northern Hemisphere Ecosystems to Climate Events: a Comparison (WKNORCLIM)

ICES/PICES Workshop on the Reaction of Northern Hemisphere Ecosystems to Climate Events: a Comparison (WKNORCLIM)

Chairmen: Jürgen Alheit, Germany; Christian Möllmann, Germany; Sugeun Jung, Rep. Korea; Yoshiro Watanabe, Japan

2–6 May 2011, Hamburg, Germany

Terms of Reference:

- Assemble multivariate data sets of long-term time series of physical, chemical and biological variables from regional ecosystems;
- Identify trends and abrupt changes (i.e. regime shifts) in the regional data sets using multivariate statistical and discontinuity analyses;
- Identify the region-specific importance of climate events relative to anthropogenic forcing factors such as eutrophication and exploitation;
- Conduct a meta-analysis of ecosystem trends and their potential drivers over all northern hemisphere ecosystem.

EUR-Oceans Workshop on Comparative analysis of European marine ecosystem reorganizations – a largescale approach to develop the basis for an ecosystembased management of marine resources

1-3 November 2010, Hamburg, Germany.

- **Background**: to implement ecosystem approach to management, there is a need to perform comparative studies of ecosystem dynamics

- **Goal** of the workshop: was to compare ecosystem regime shifts in a multitude of different marine ecosystems

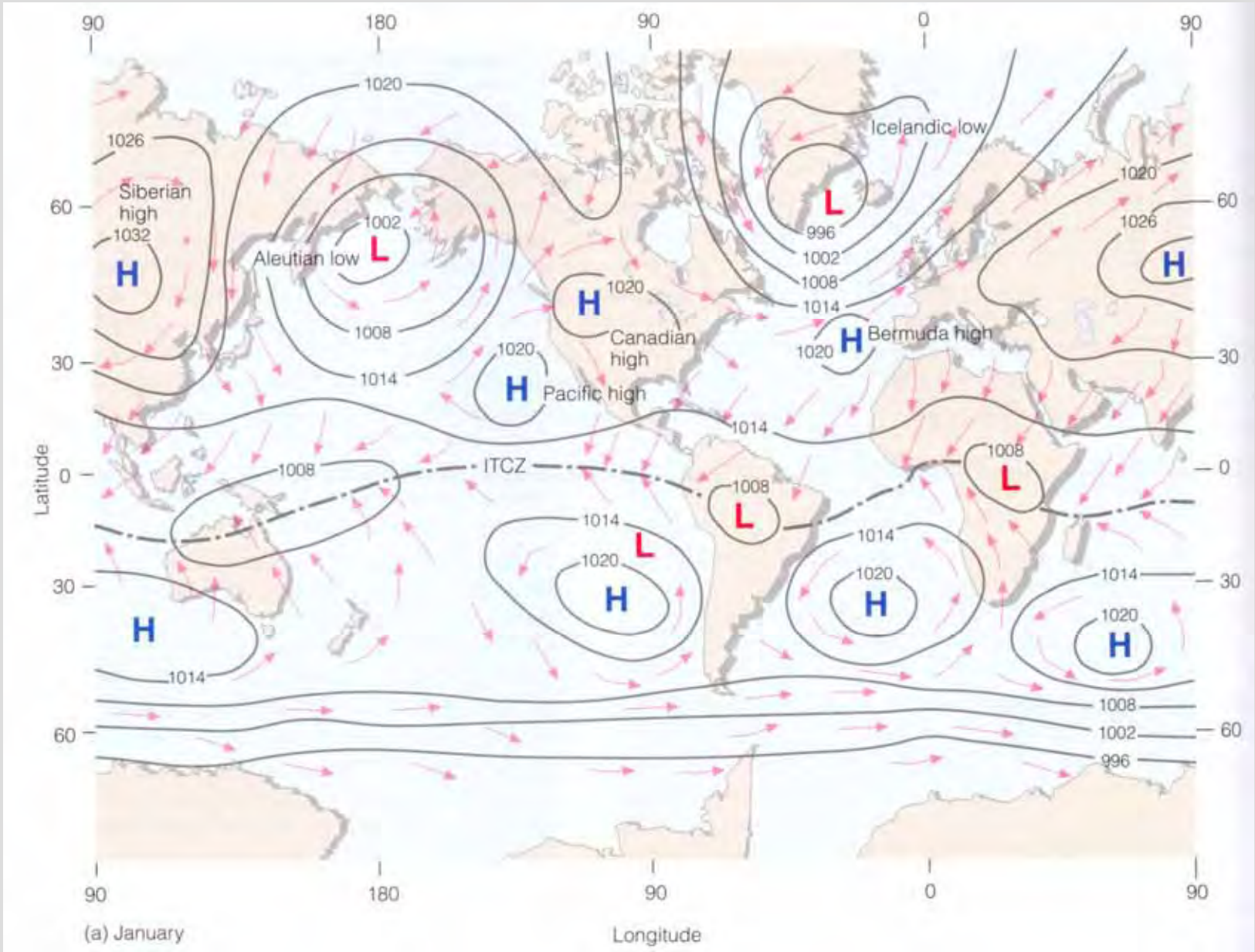
- a set of **standardized statistical techniques** was applied

Möllmann, C., Conversi, A., Edwards, M. 2011. Comparative analysis of European wide marine ecosystem shifts: a large-scale approach for developing the basis for ecosystem-based management. Biol. Lett. 7: 484-486.

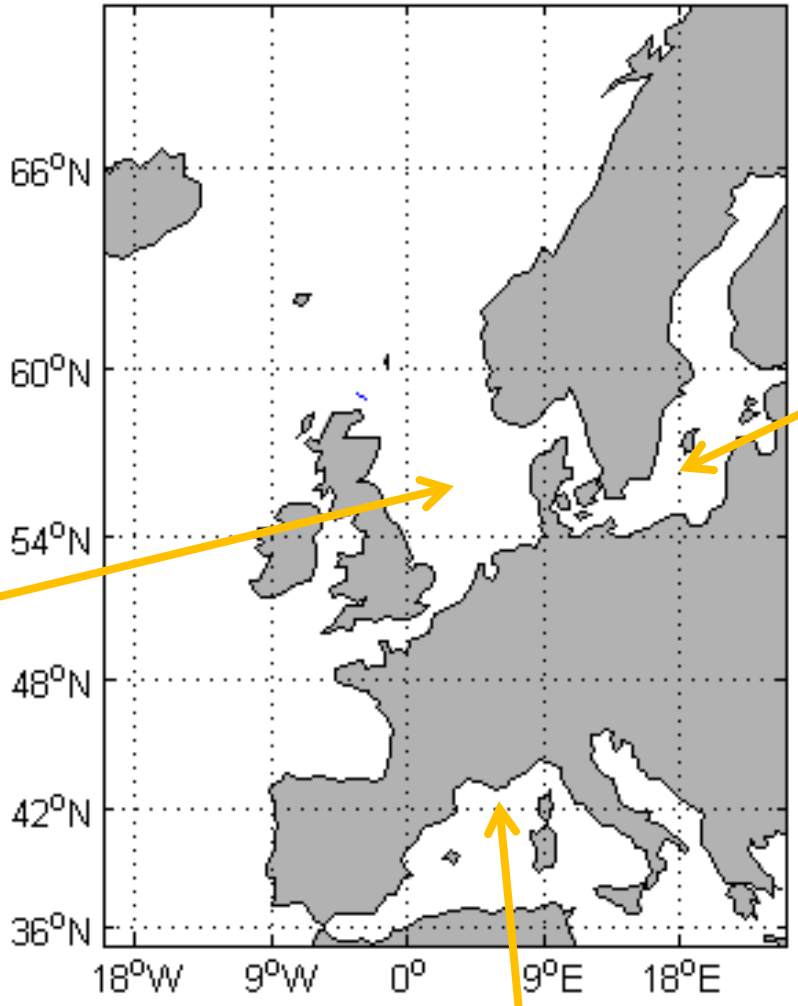
Y. Zuenko, Y. Tian, S. Jung, R. Diekmann
Recent climate changes in the Japan/East Sea ecosystem on the tri-national data set (W4-7726)

S. Jung, I. Choi
Climate-driven ecosystem shifts in Korean waters during the past 40 years (S1-7791)

Y. Tian, H. Kidokoro
Response patterns of the fish community in the Japan Sea to the climate regime shifts and identification of ecosystem indicatots (S4-7703)



Ahrens: Meteorology Today

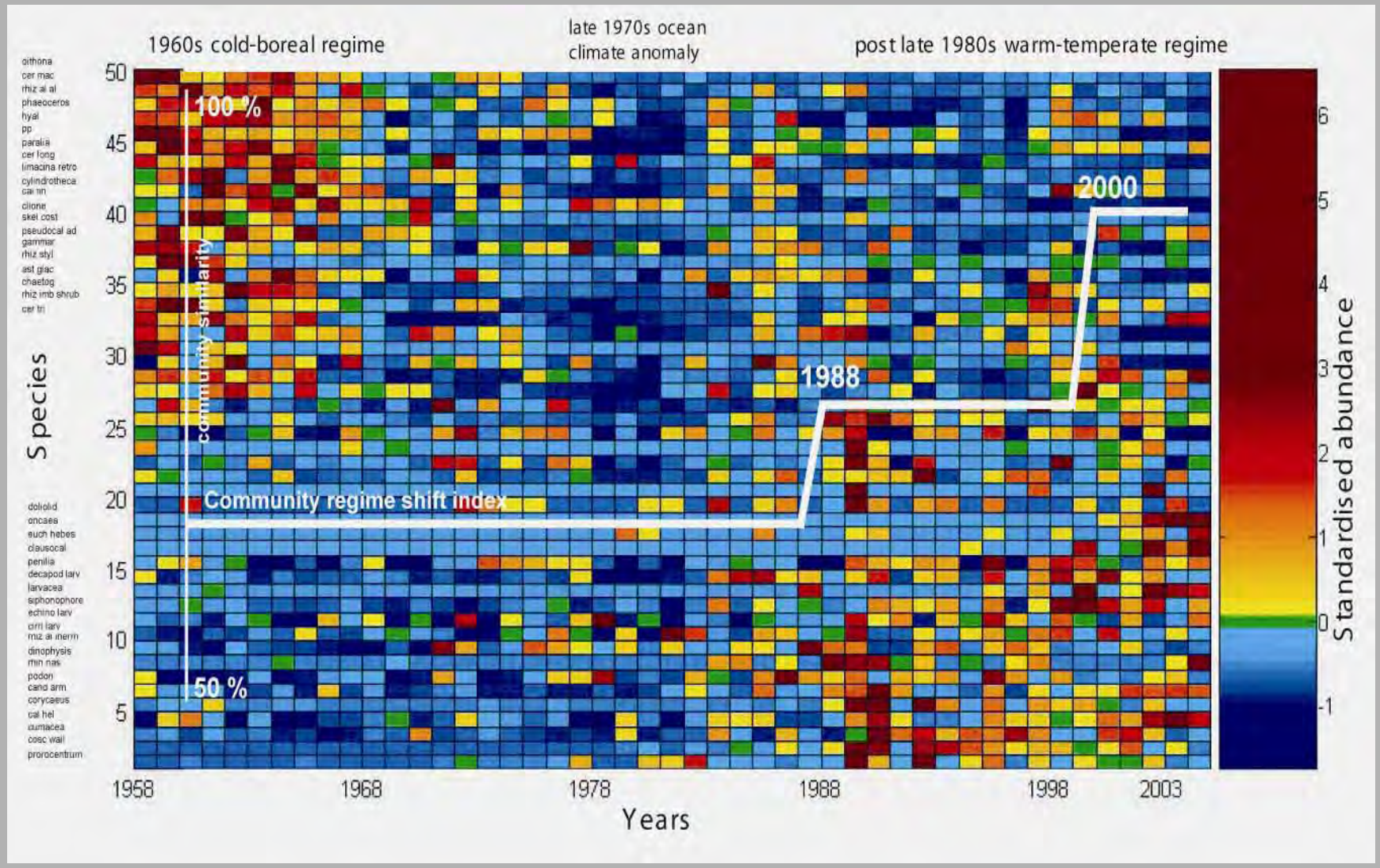


Baltic Sea

North Sea

Northern Mediterranean

Regime Shift Nordsee



Edwards et al., SAHFOS Techn. Rep. (2007)

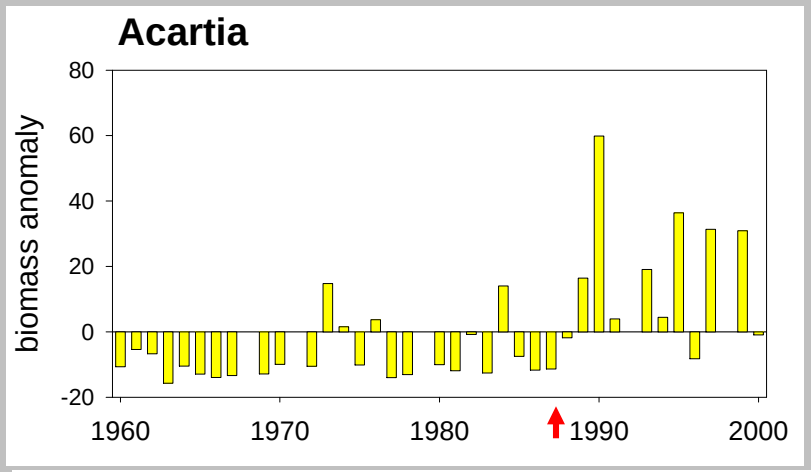
CPR data

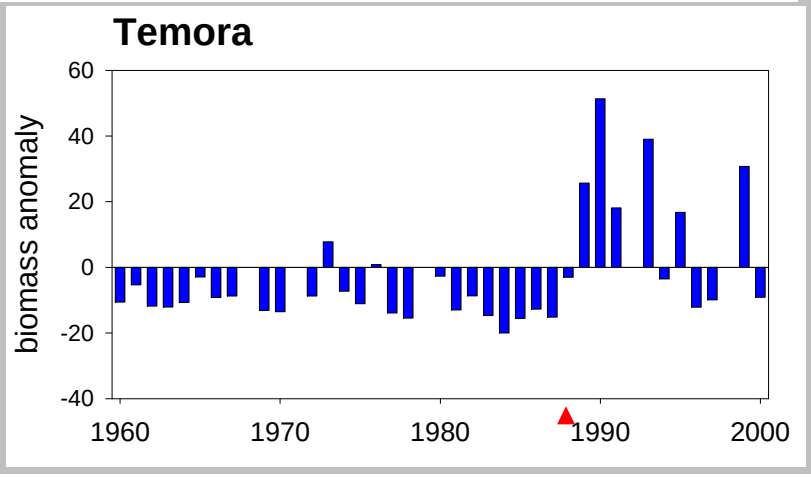
Baltic Sea

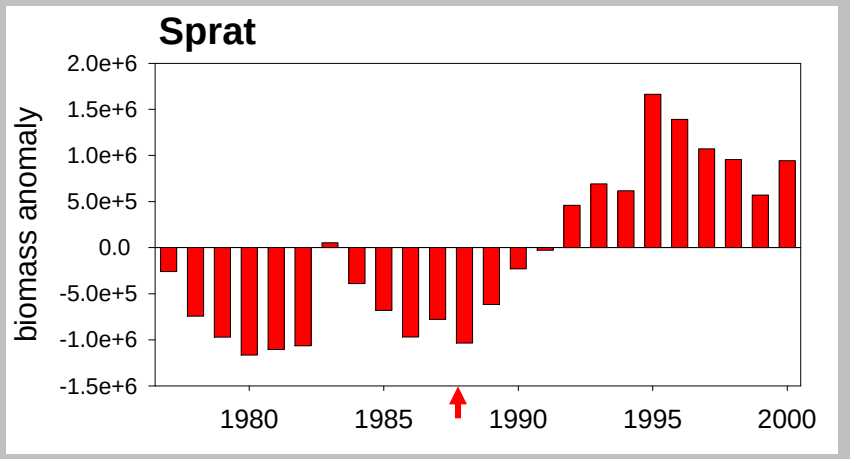
Changes on 3 trophic levels:

- **phytoplankton**
- **zooplankton**
- **fish**

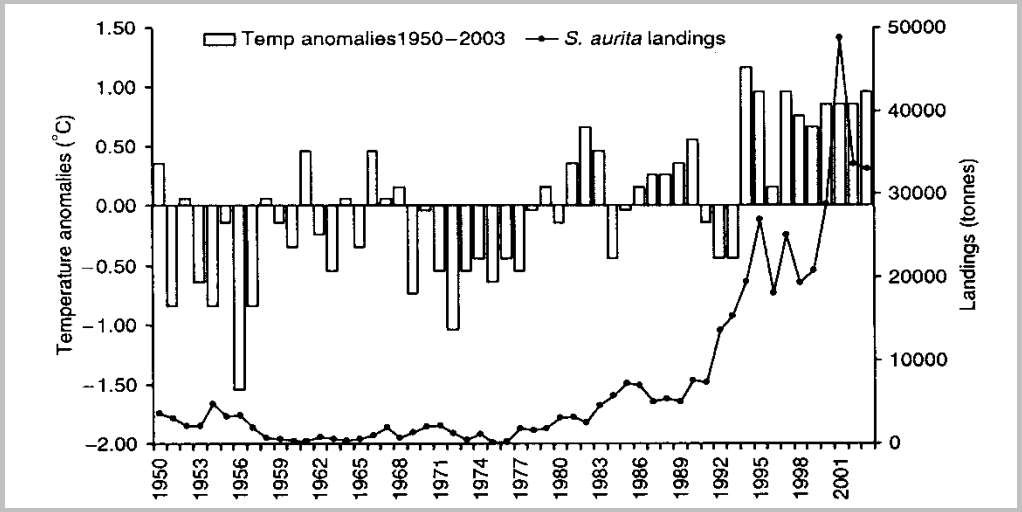
Alheit et al. 2005





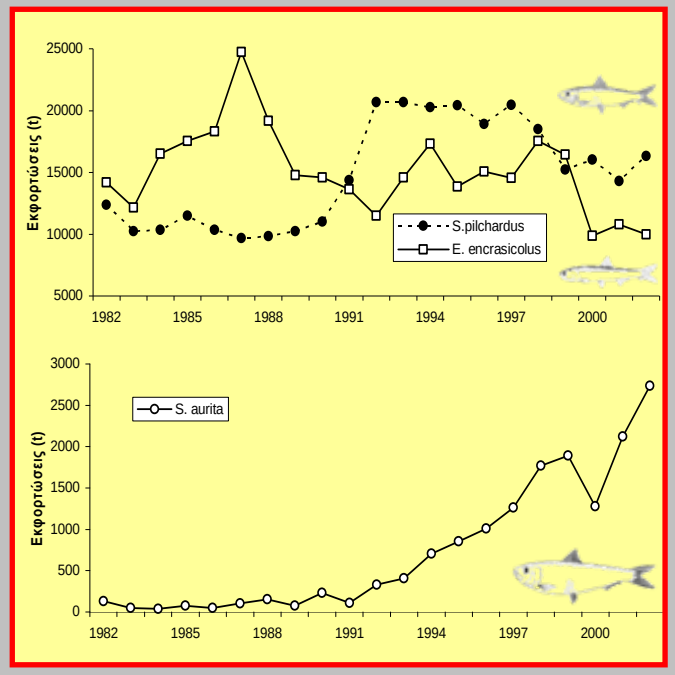


Sardinella aurita



NW Mediterranean

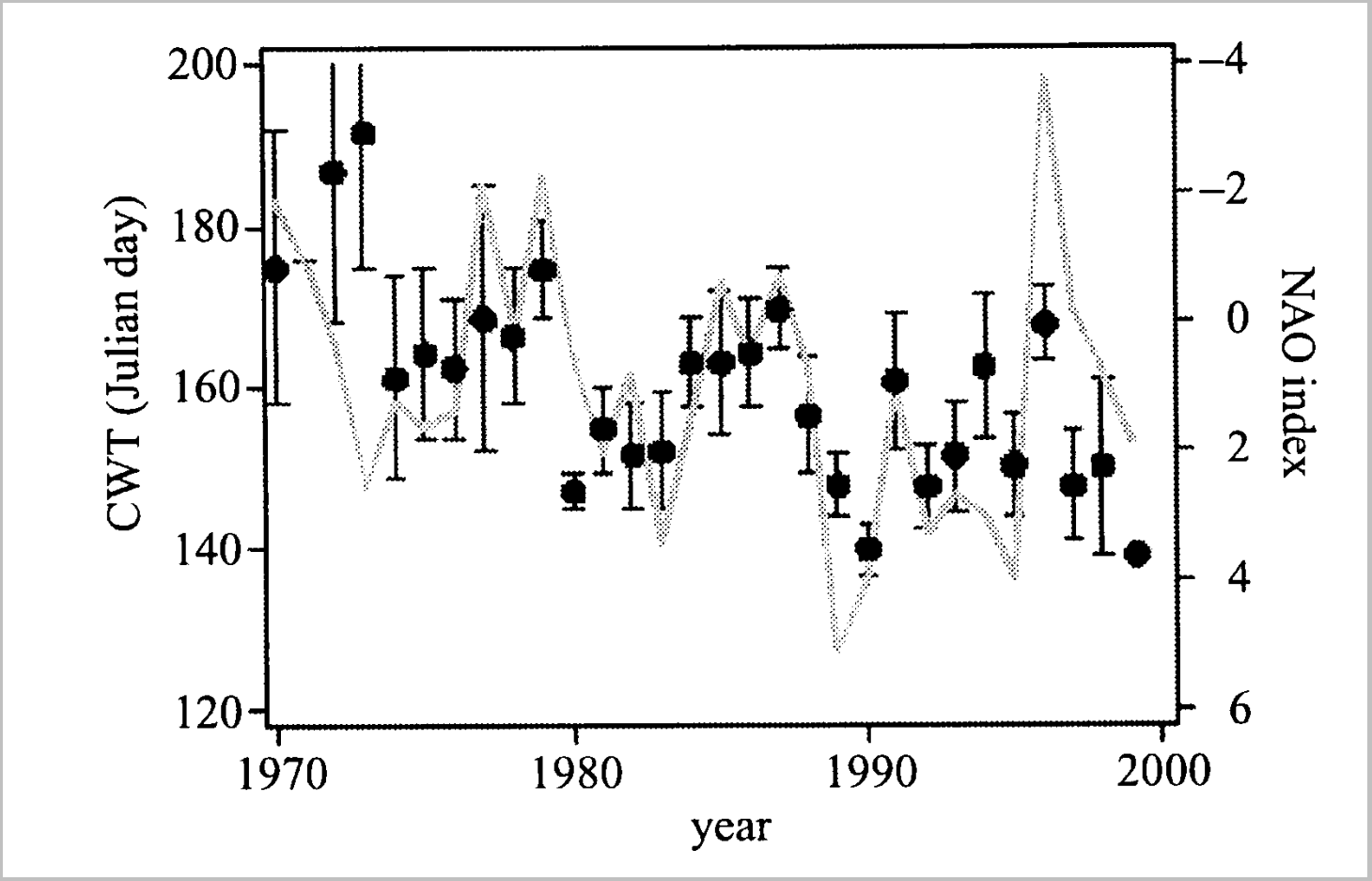
Sabatés et al. 2006



Aegean waters

Tsikliras and Stergiou 2006

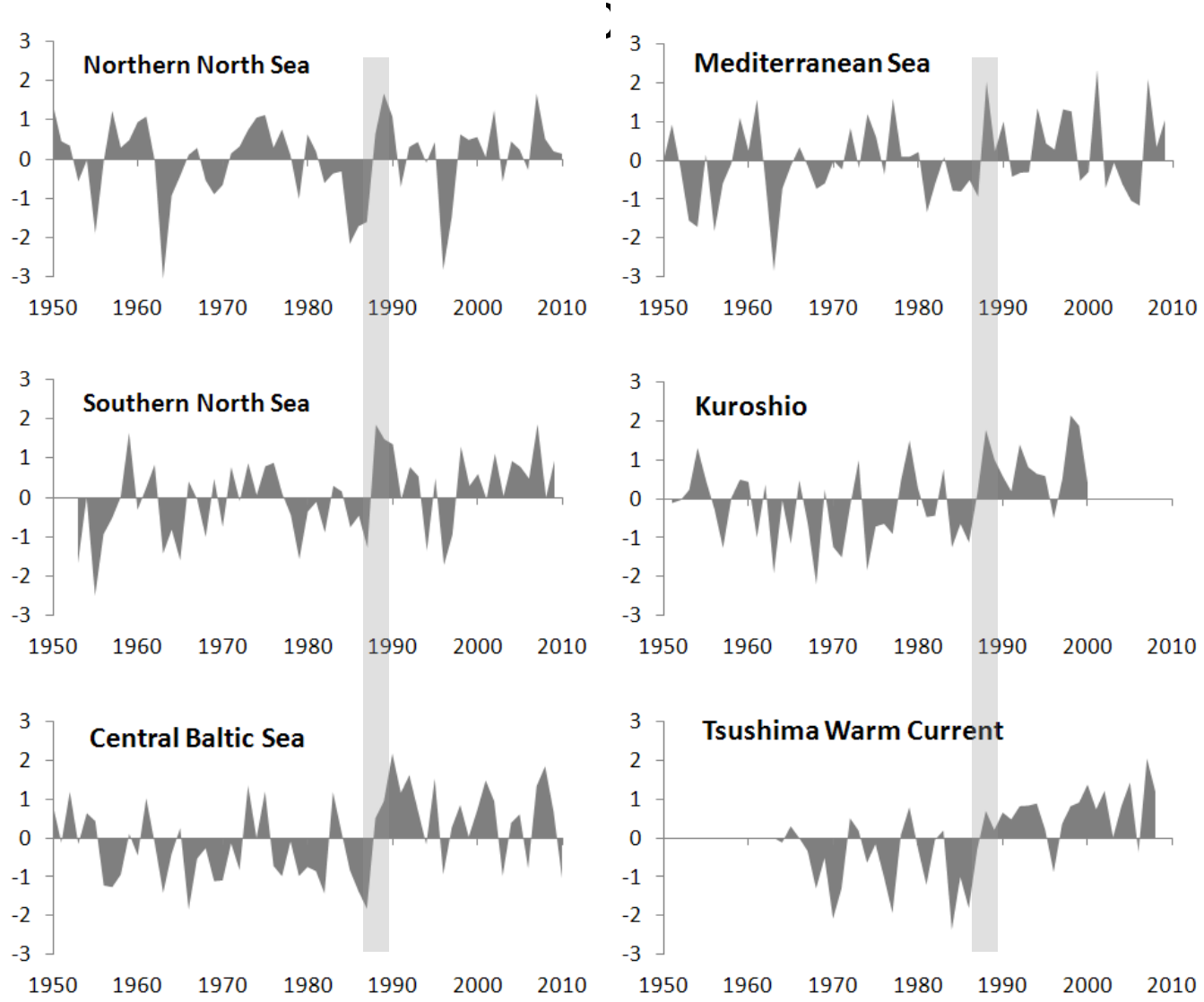
Proc. Hell. Symp. Oceanogr. Fish



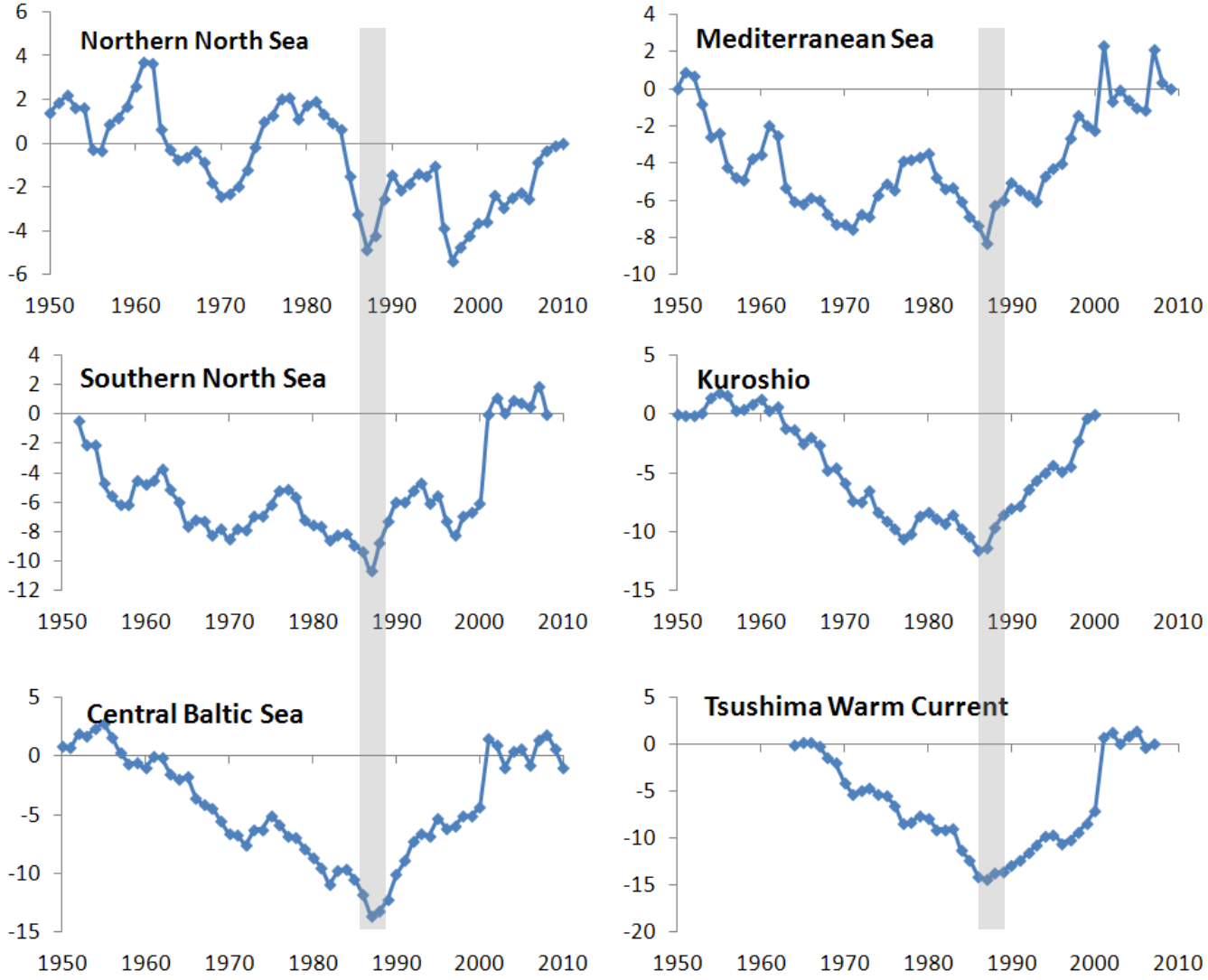
NAO index and timing of clearwater phase in 28 European lakes

Straile 2001

Water temperatures – Longterm trends



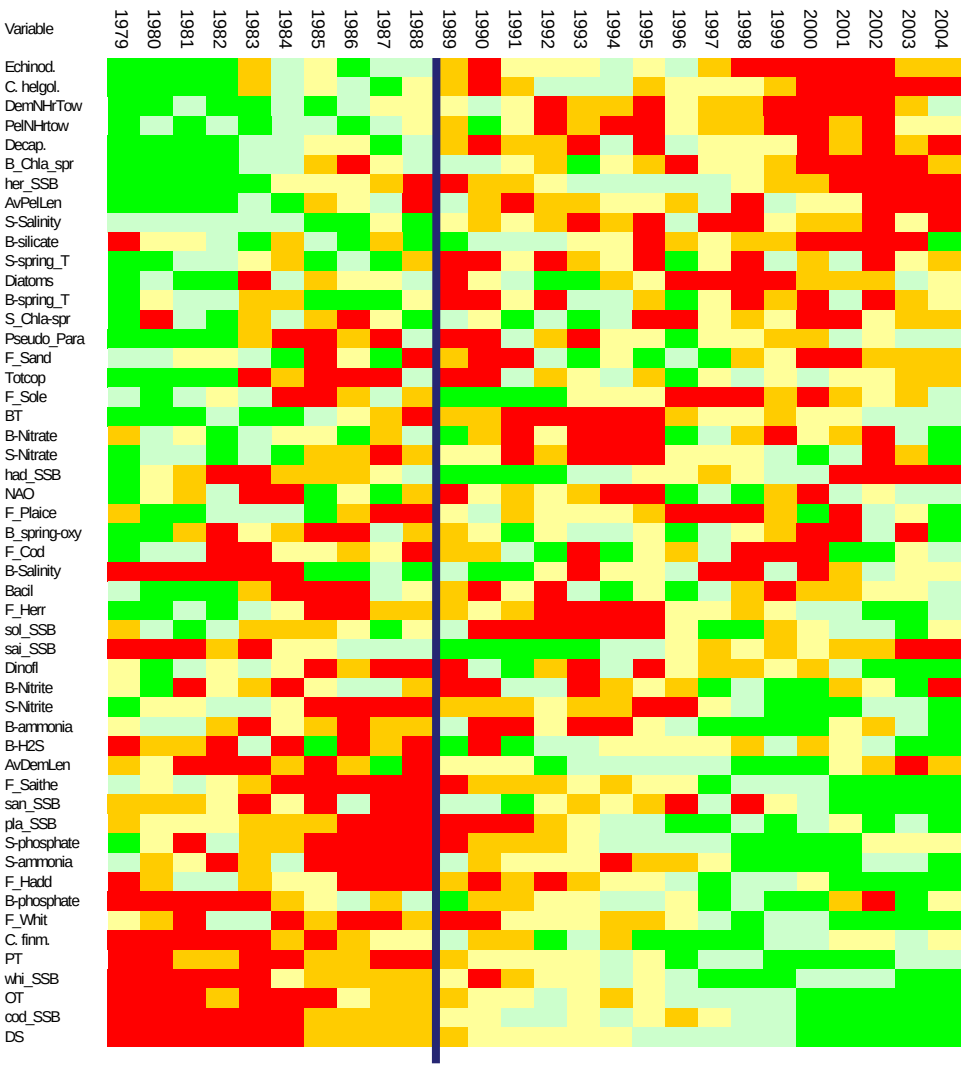
Water temperatures – CuSums



Traffic light approach (sorted according to PC1-scores)

North Sea
51 variables

Courtesy of
R. Diekmann

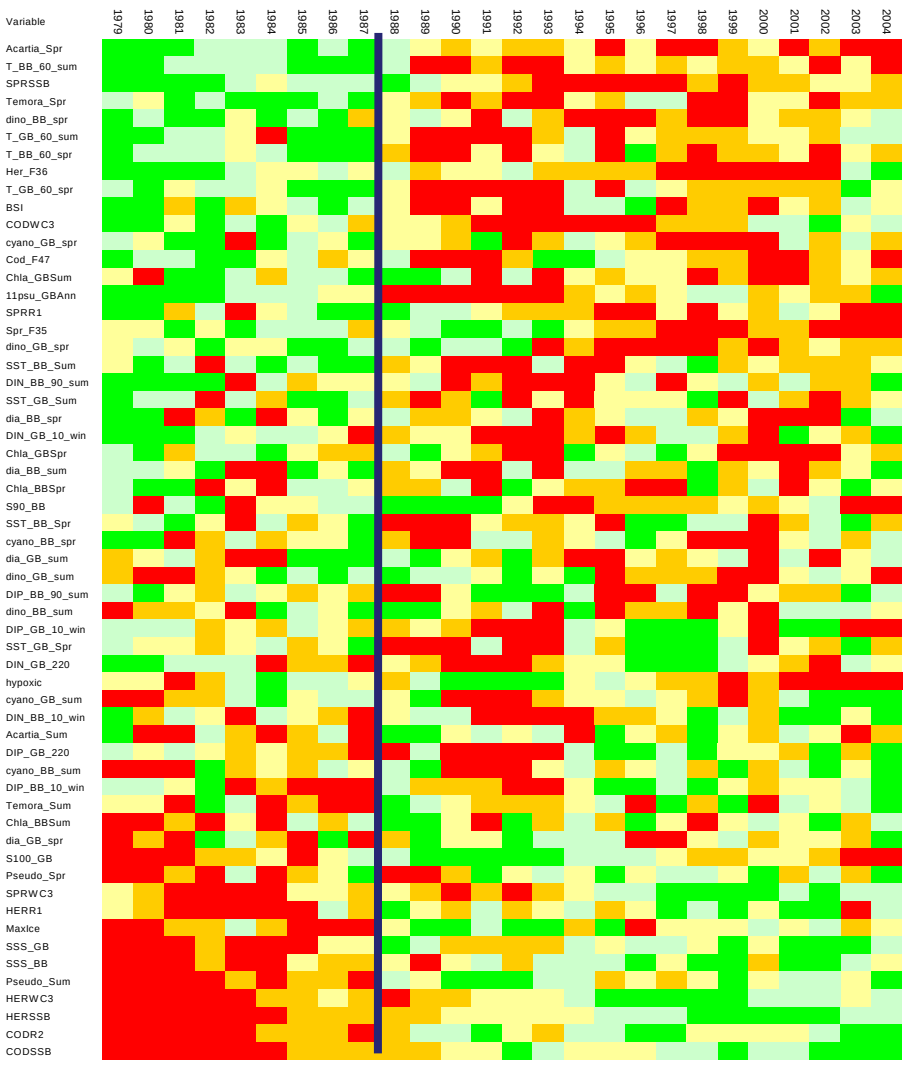


Shifts identified by chronological clustering at α=0.01

Traffic light approach (sorted according to PC1-scores)

Central Baltic Sea
58 variables

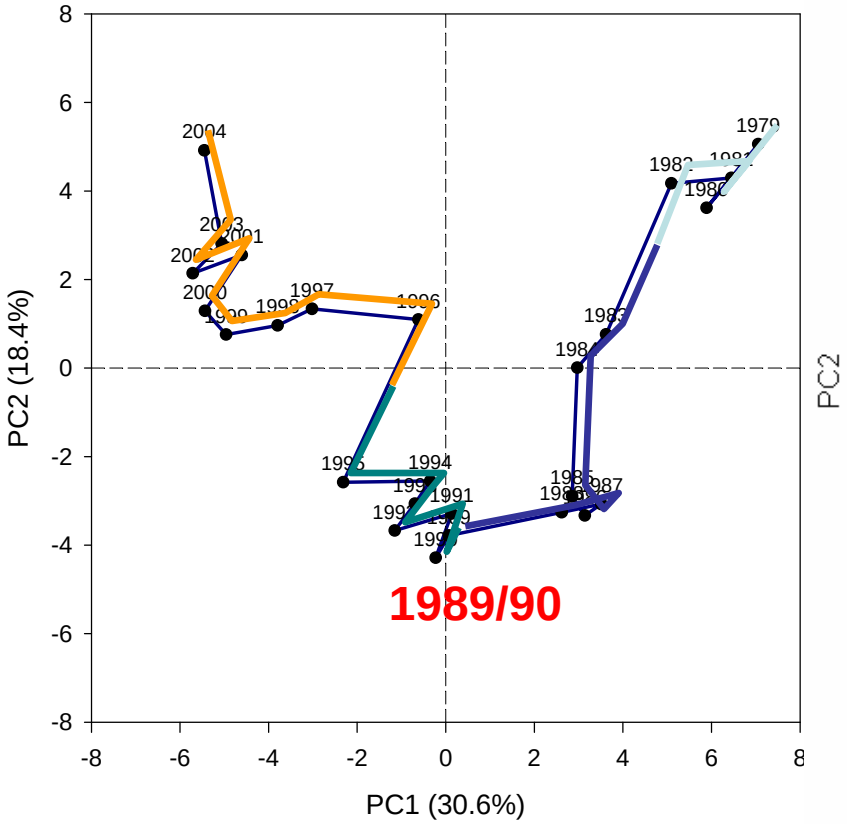
Courtesy of
R. Diekmann



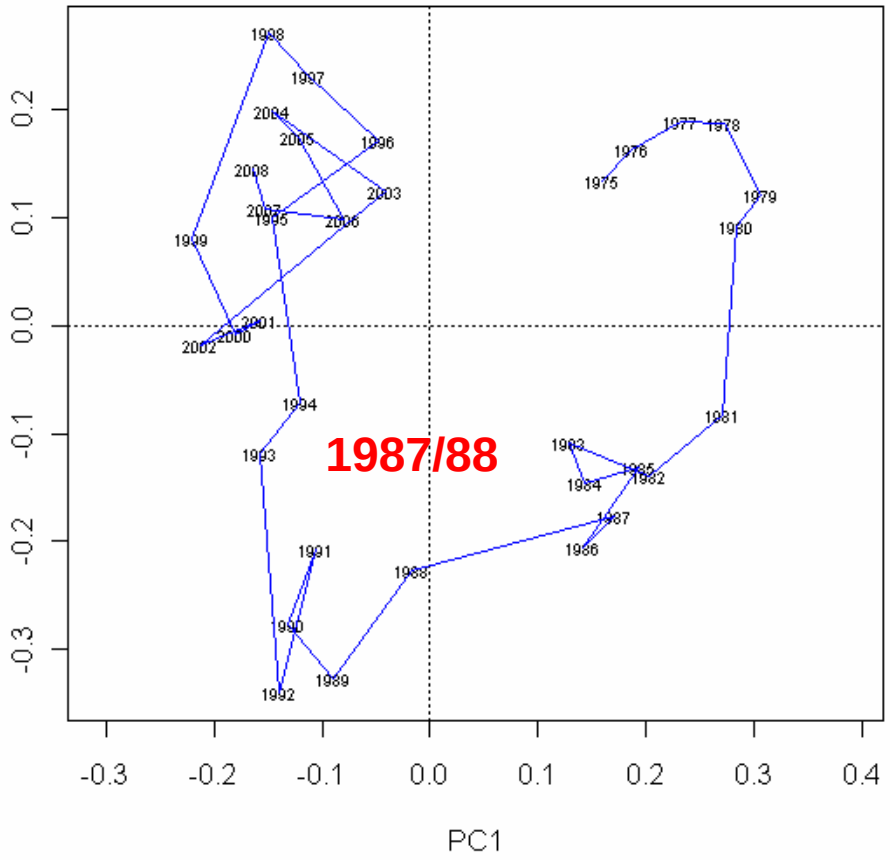
Shifts identified by chronological clustering at α=0.01

Integrated Ecosystem Assessments

North Sea



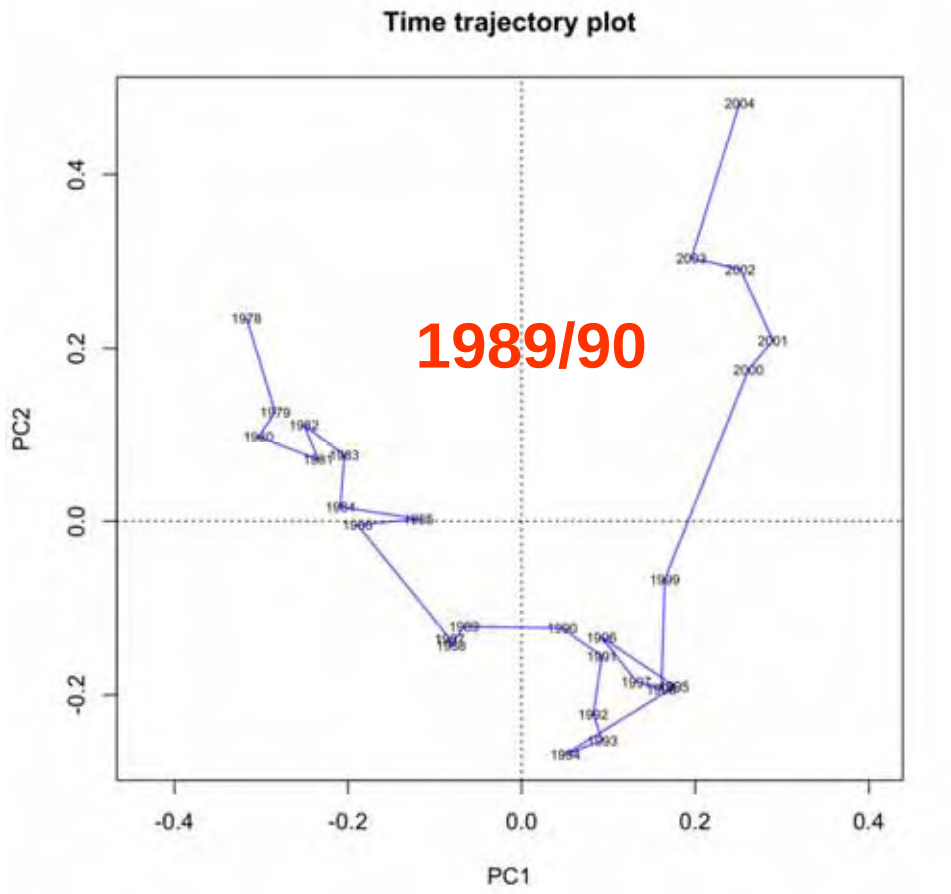
Central Baltic Sea



Time trajectory of full data set - Courtesy of R. Diekmann

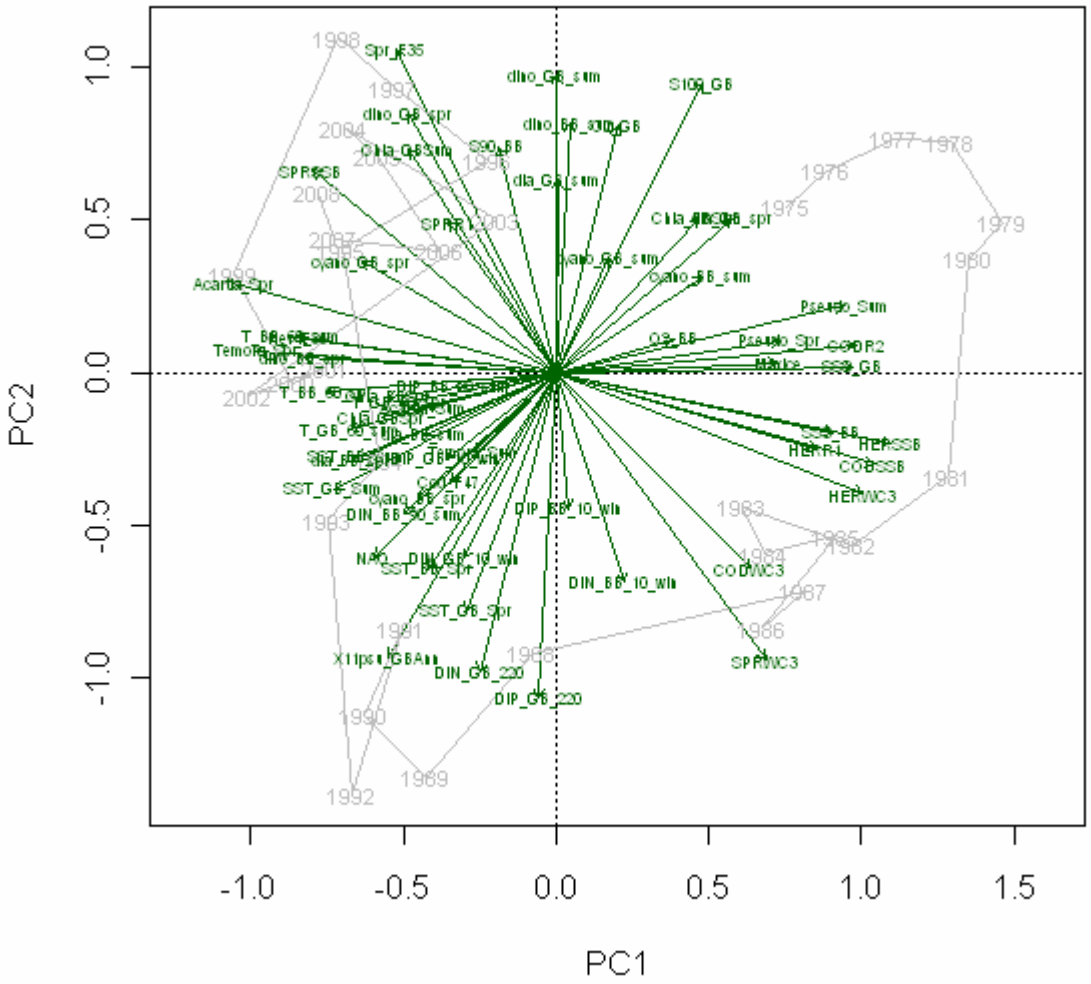
Japan/East Sea

Combined Data Set – Biotic Variables



Courtesy of
Y. Zuenko

Central Baltic Sea

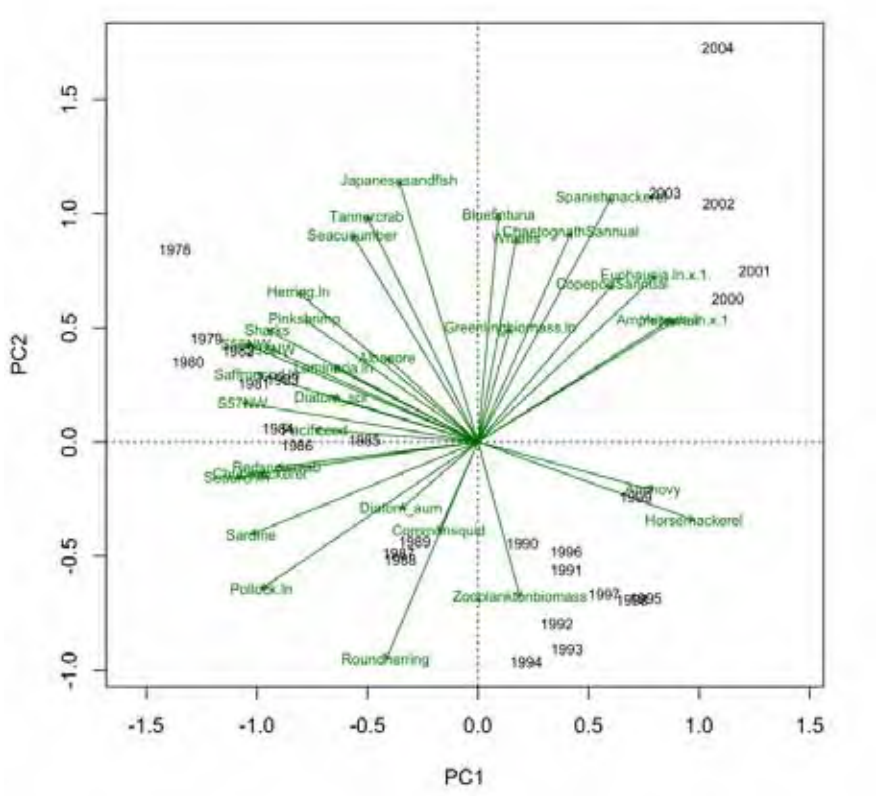


ICES WGIAB Report 2010

Factor loadings on first two principal components

Japan/East Sea

Combined Data Set – Biotic Variables



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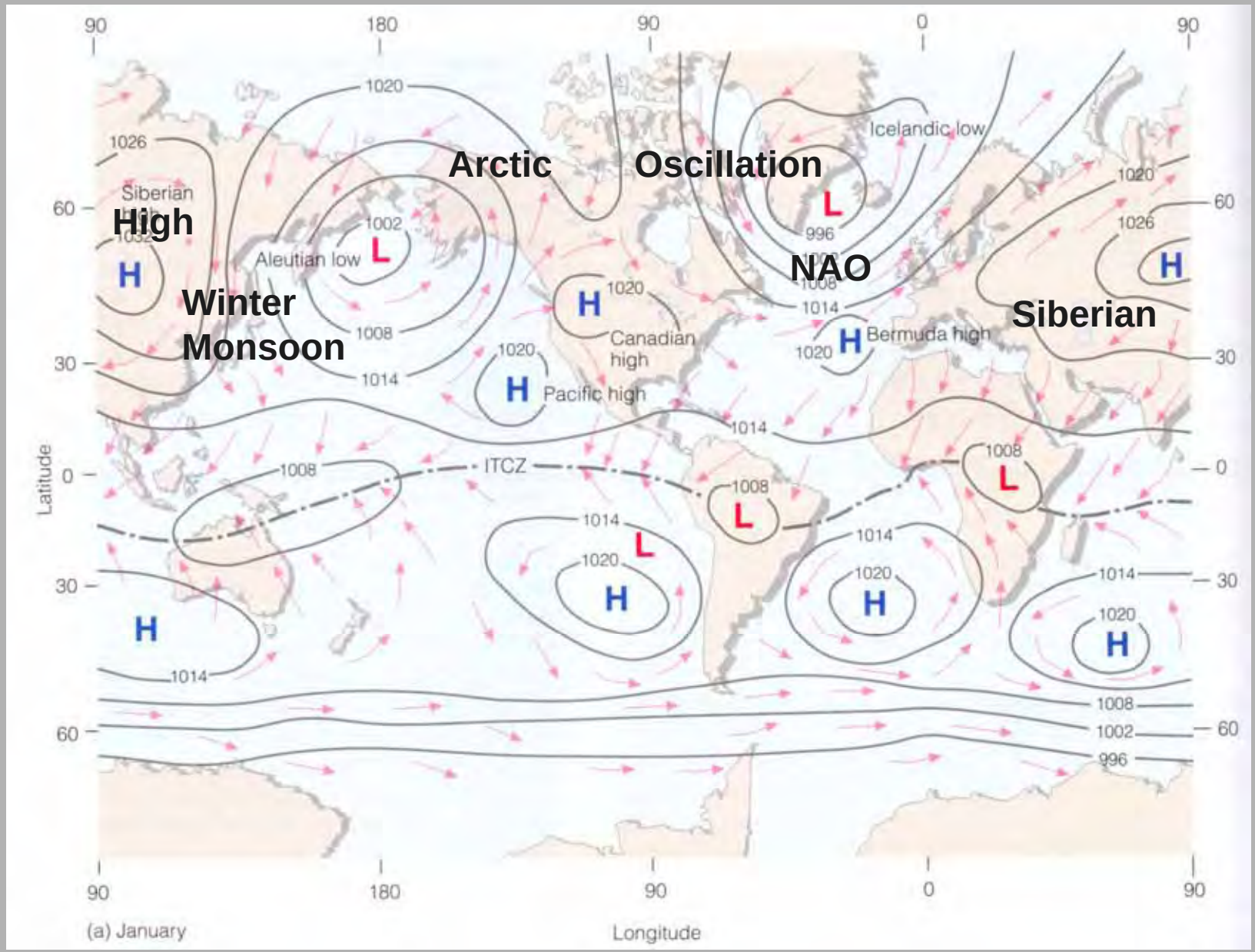
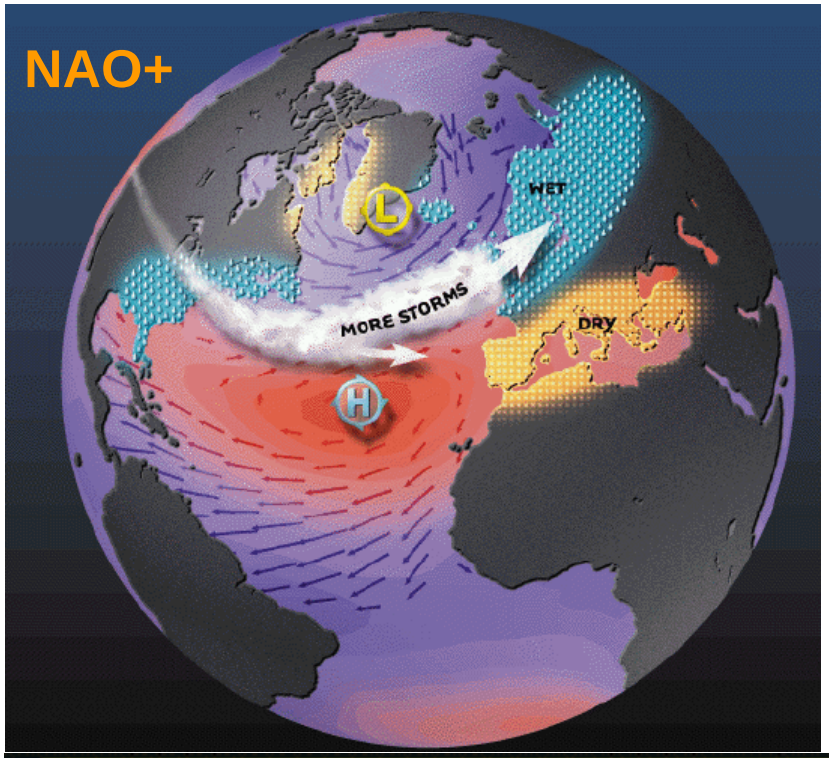
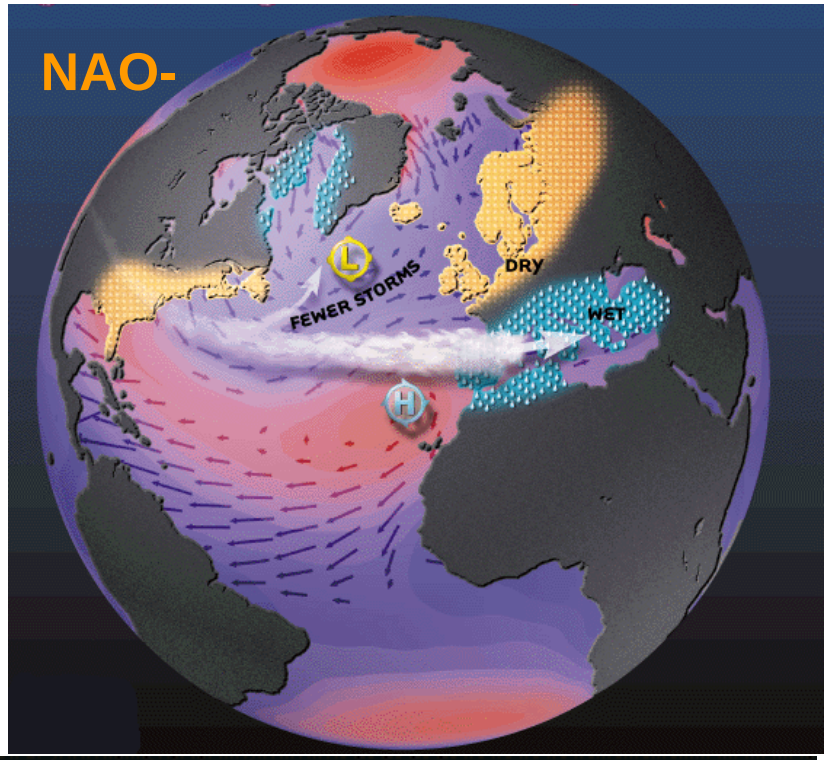
Factor loadings on first two principal components

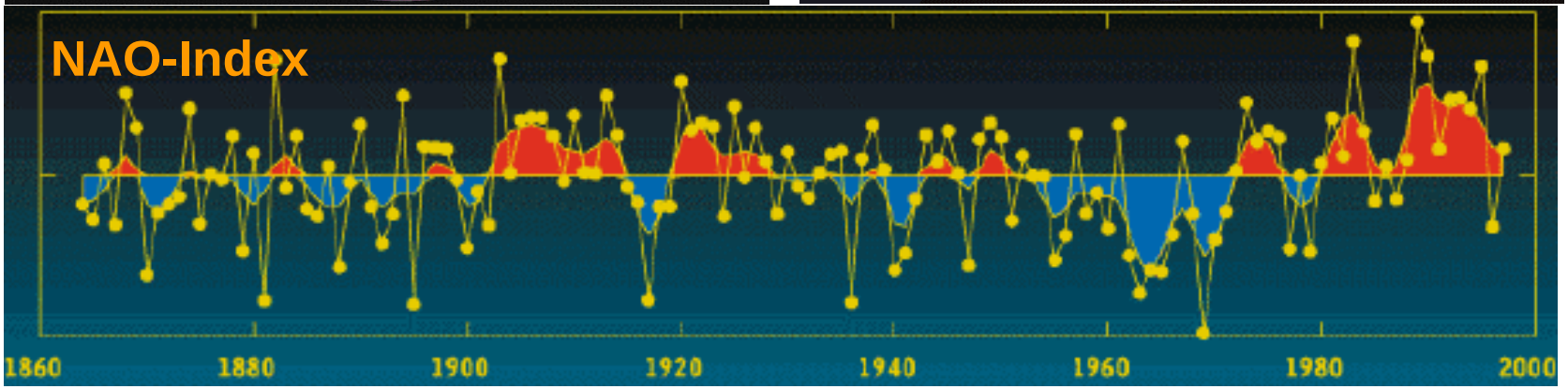


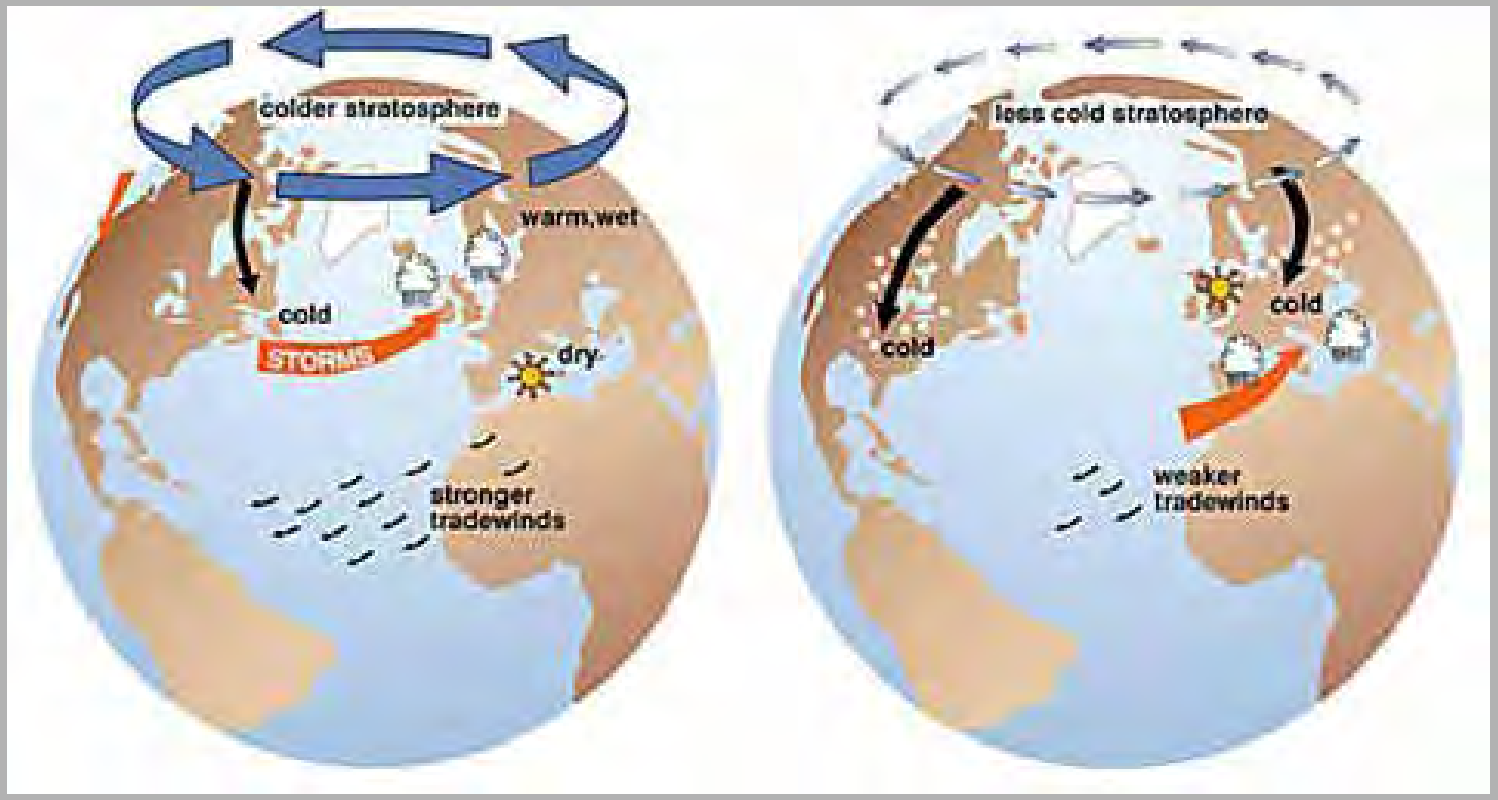
Ahrens: Meteorology Today

http://www.ldeo.columbia.edu/res/pi/NAO/





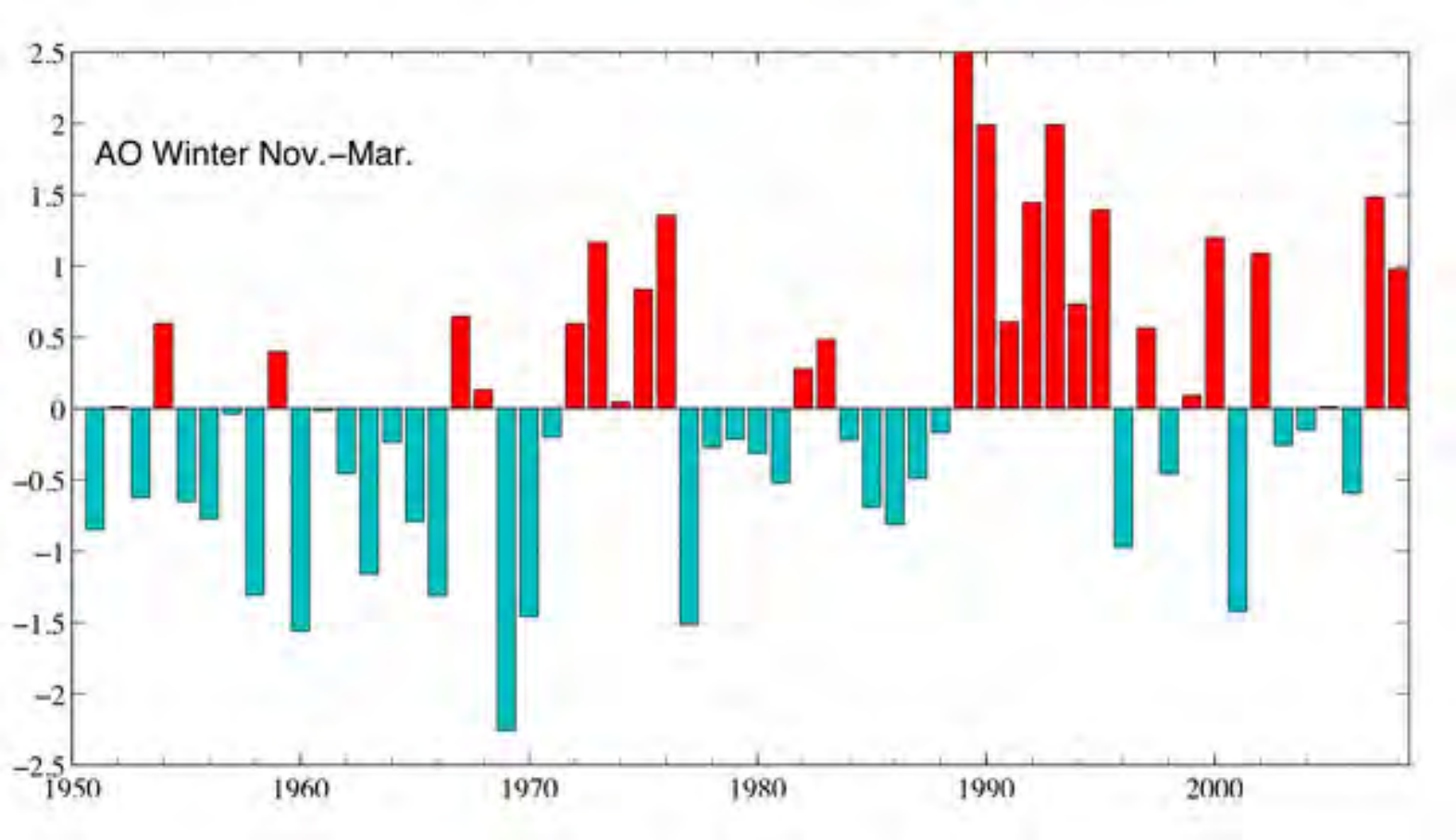




Effects of the Positive Phase of the **Arctic Oscillation** | Effects of the Negative Phase of the **Arctic Oscillation**

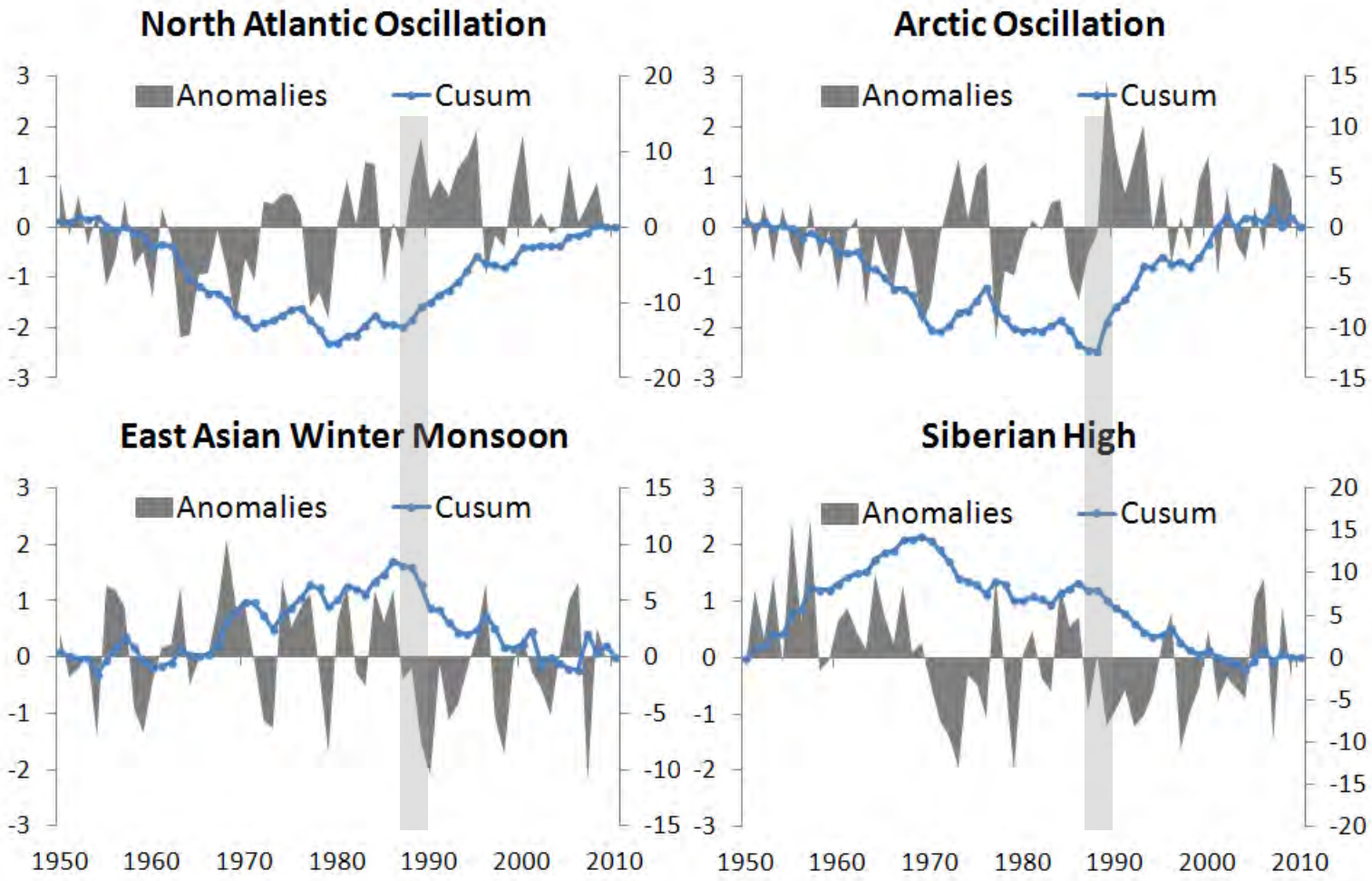
(Figures courtesy of J. Wallace, University of Washington)

http://nsidc.org/arcticmet/patterns/arctic_oscillation.html



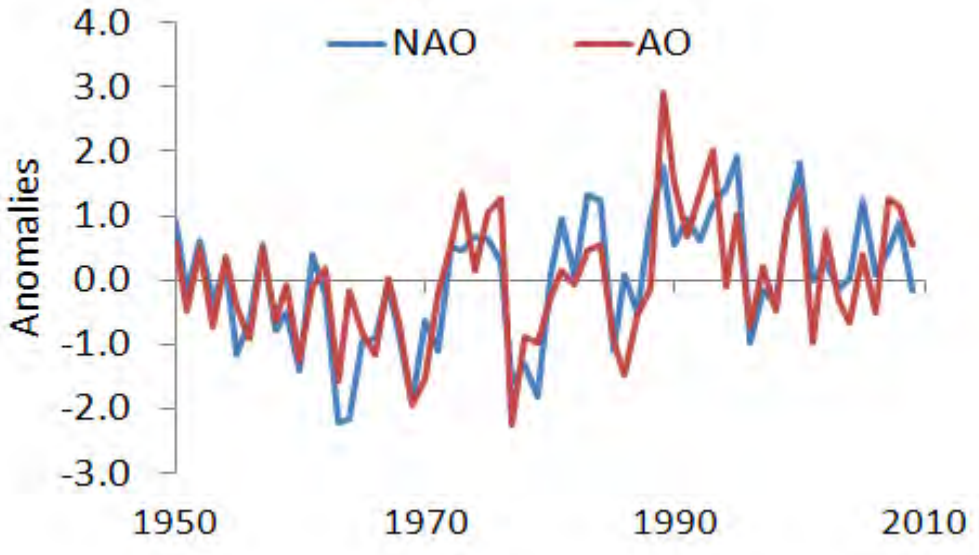
The Arctic Oscillation in Winter (November to March).
Data from NCEP.

Climate Indices – Longterm trends and CuSums

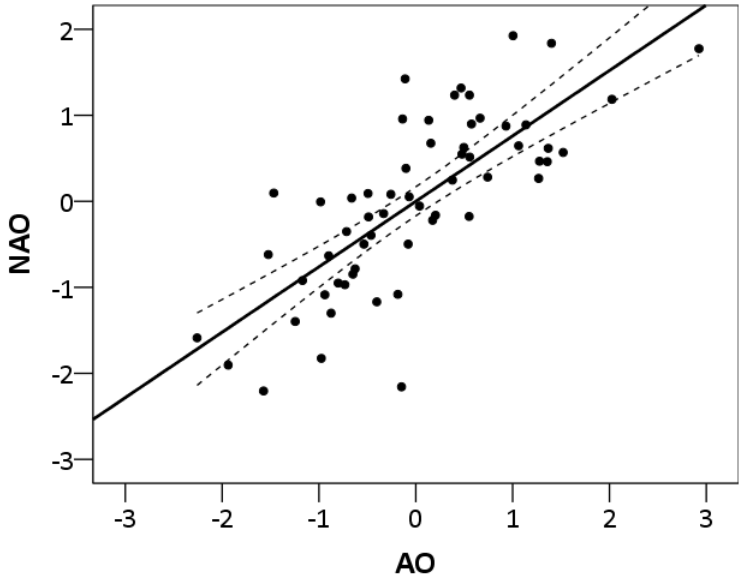


NAO – AO

Long-term trend



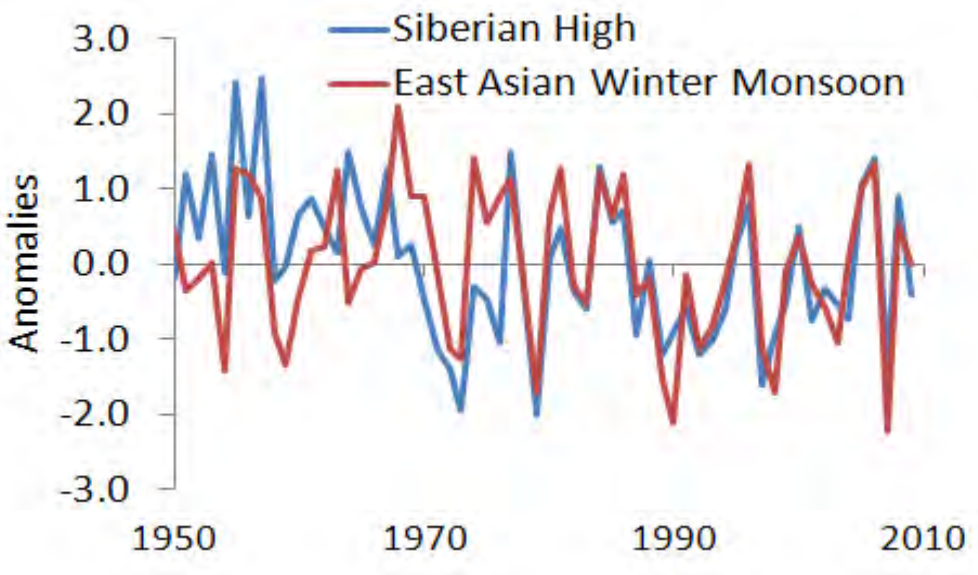
Regression



X	Y	R^2	Sign. Influence	Coefficient
AO	**NAO**	**57.9%**	**P<0.01**	**0.761**
Siberian High	EAWM	39.5%	P<0.01	0.624

Siberian High – EAWM

Long-term trend



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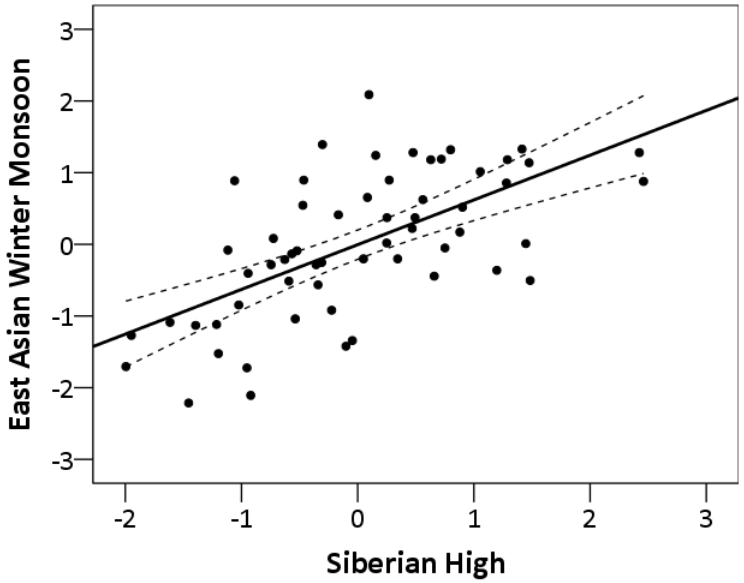

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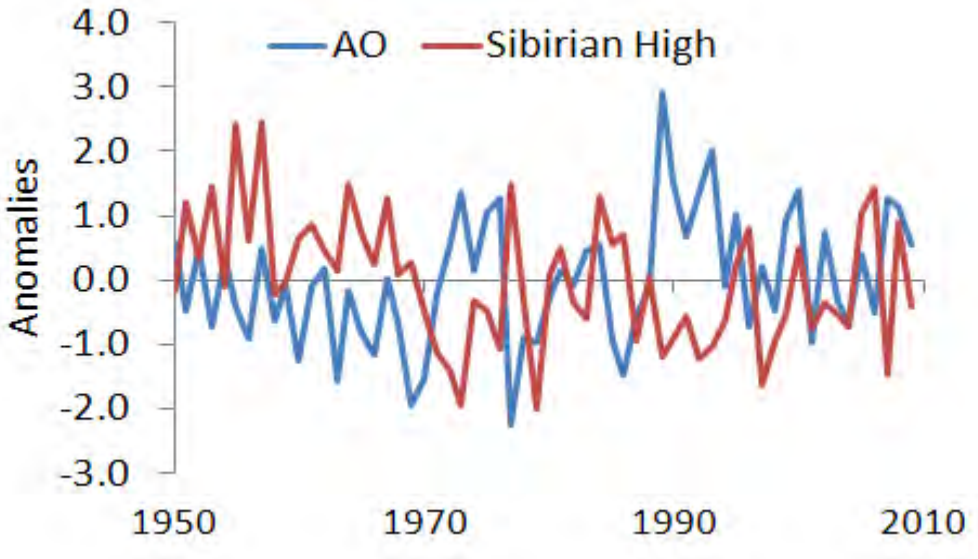
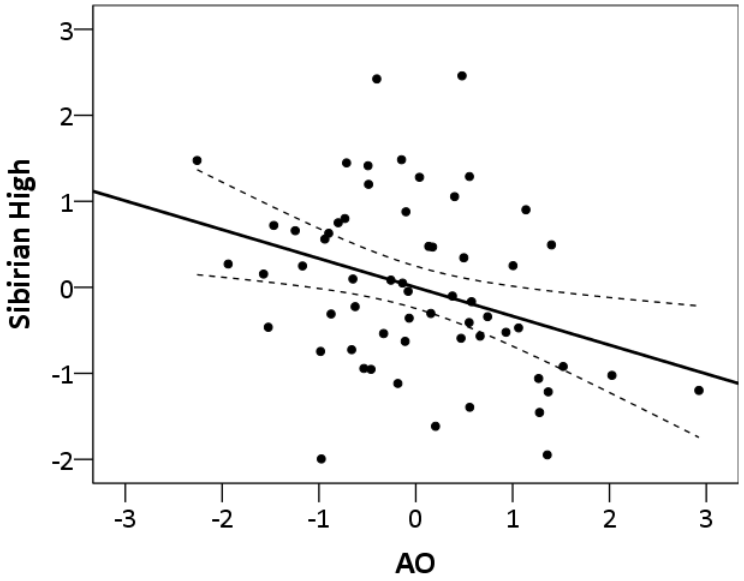
AO – Siberian High

Long-term trend



Regression



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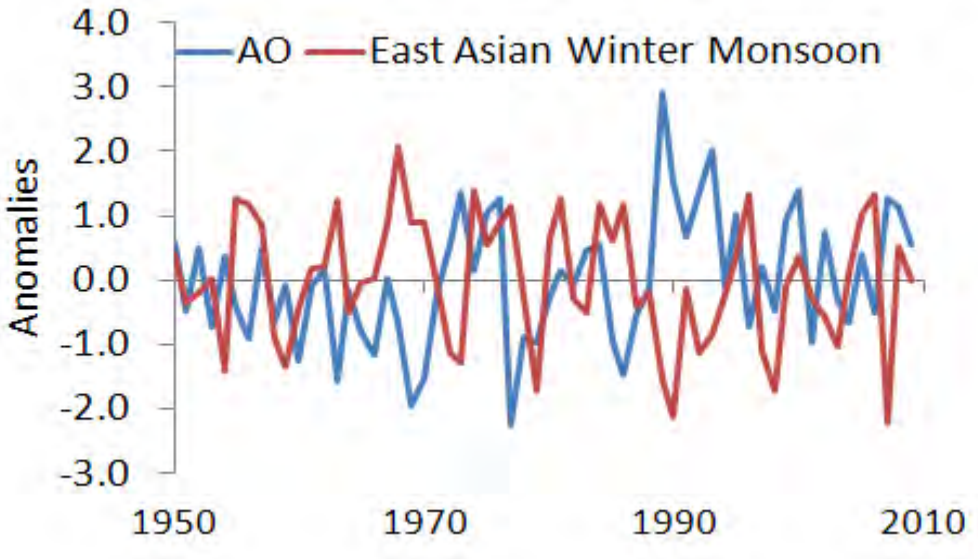
NAO	Siberian High	2.8%	n.s.	
NAO	EAWM	1.1%	n.s.	
AO	**Siberian High**	**11.2%**	**p=0.009**	**-0,335**
AO	EAWM	14.3%	p=0.003	-0,376

AO – EAWM

Long-term trend



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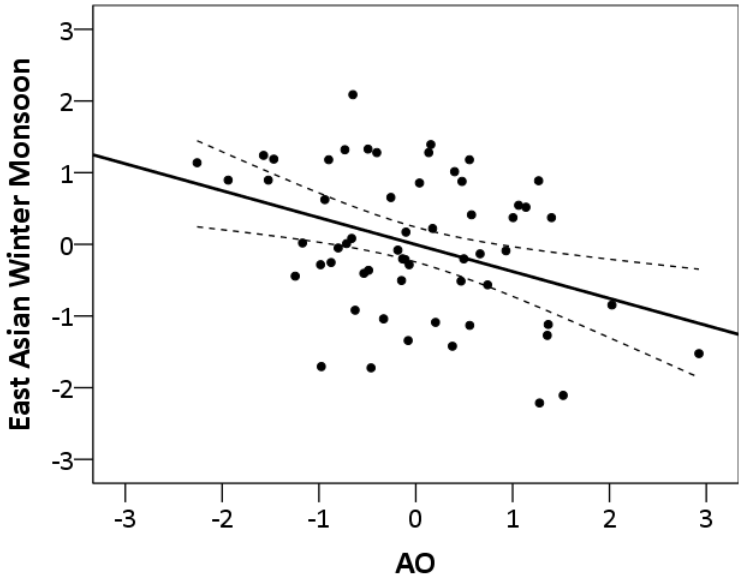

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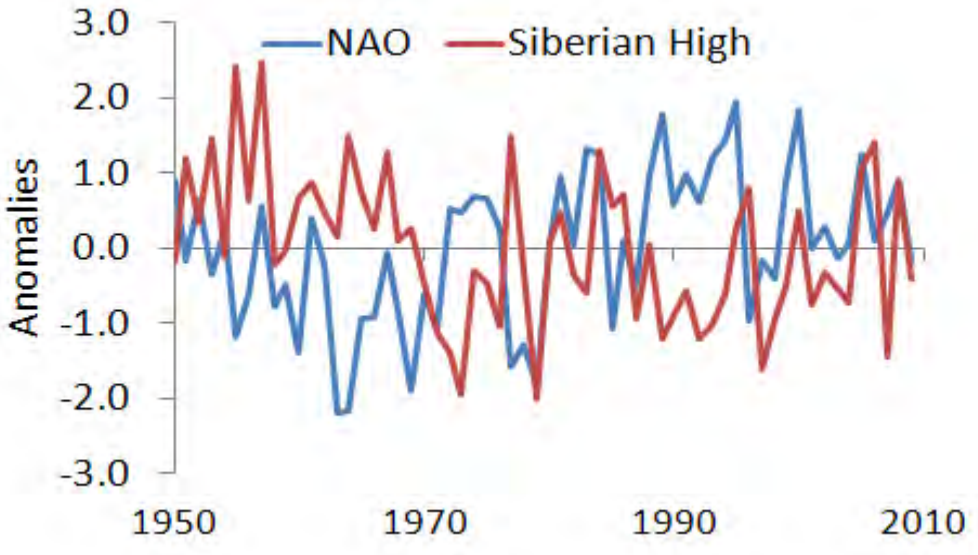
NAO – Siberian High

Long-term trend



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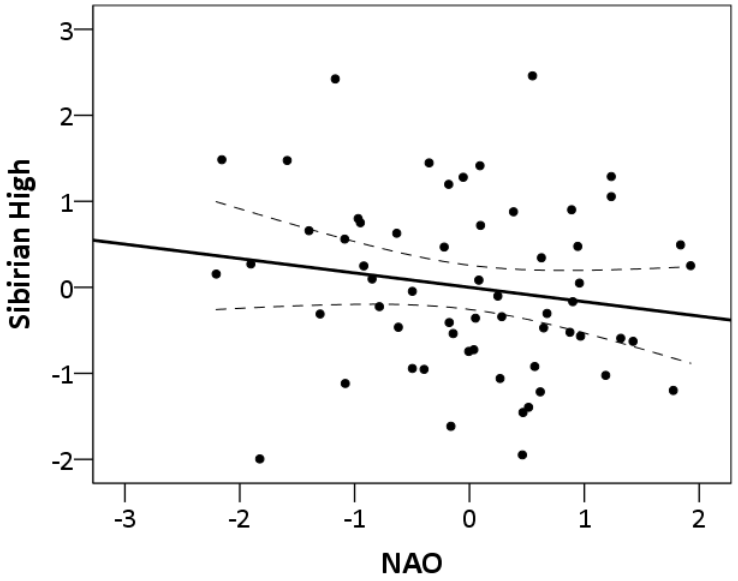

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NAO – EAWM

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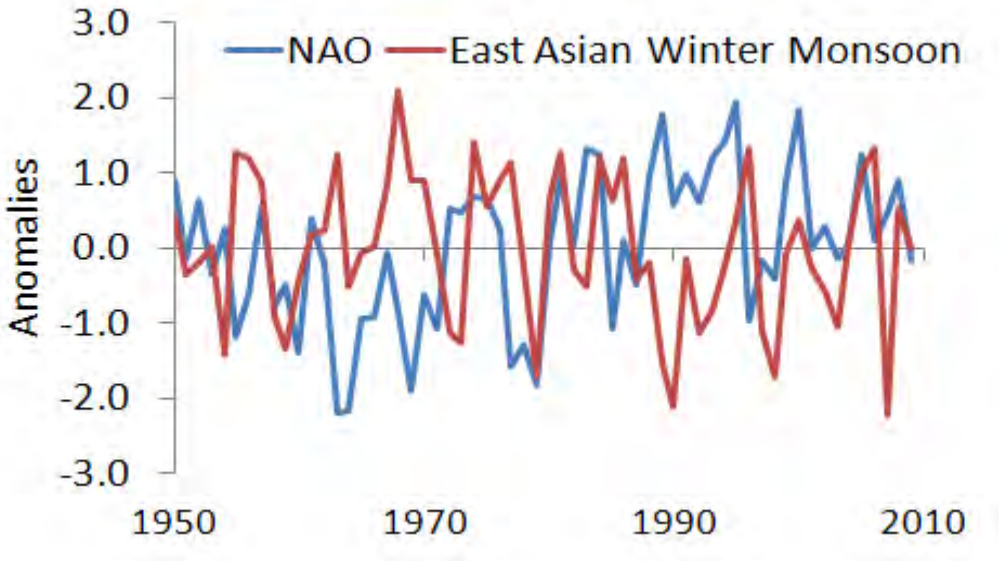

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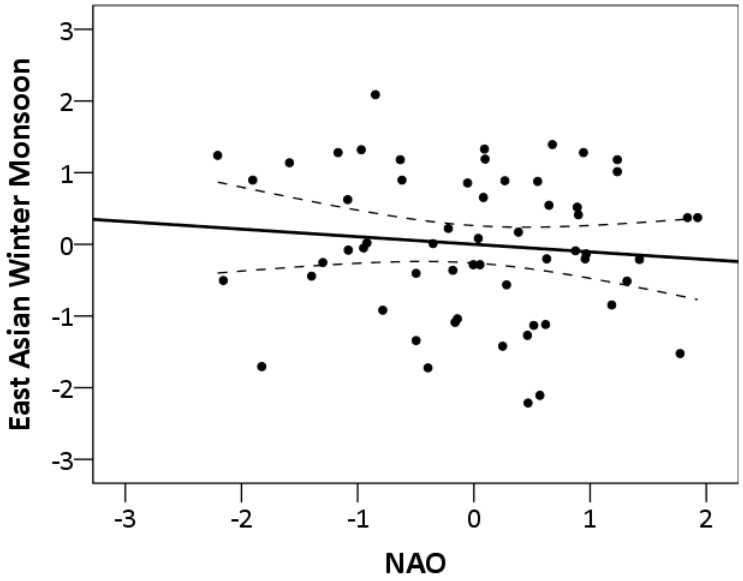

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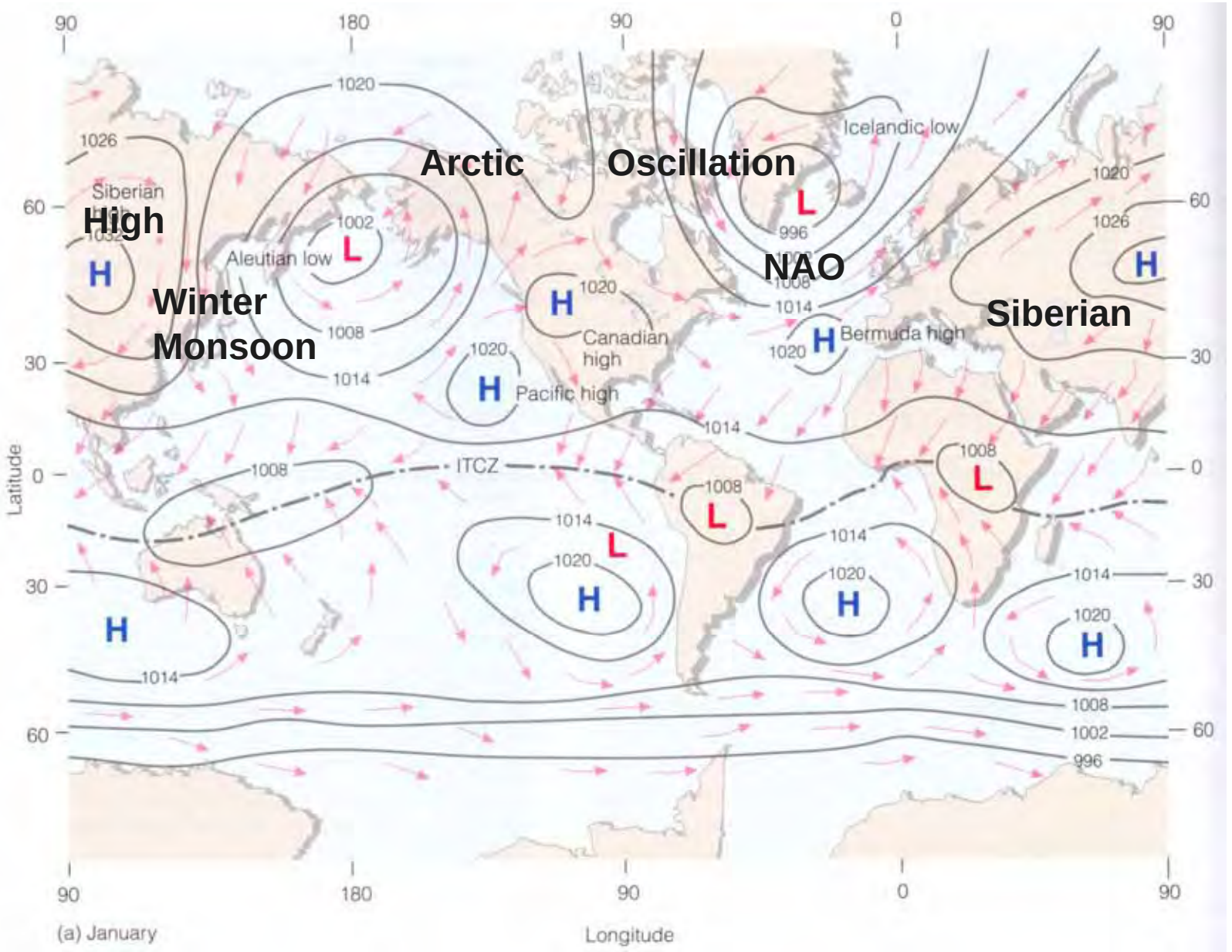

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Sequence of Events in late 1980s

NAO negative – positive

→ warming of North and Baltic Sea

AO negative – positive

↕

SH strong – weak

↓

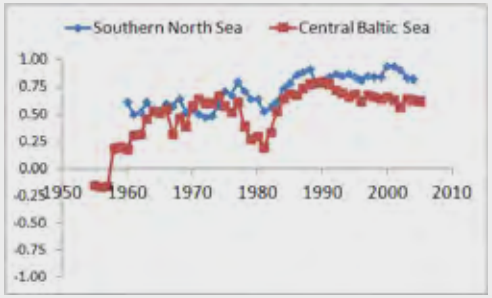
→ warming of Japan/East Sea and Kuroshio Current

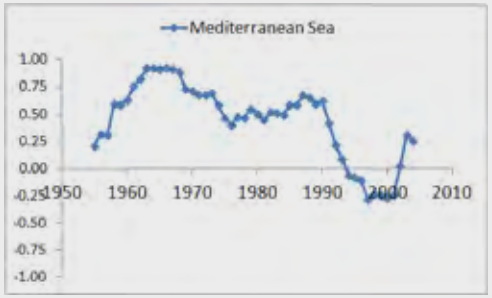
EAWM strong – weak

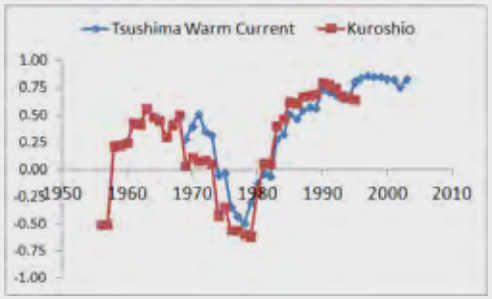
Result: Atmospherically teleconnected Ecosystem Regime Shifts

Moving correlations between water temperatures of

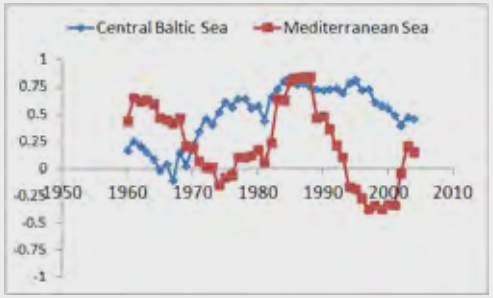
Northern North Sea and

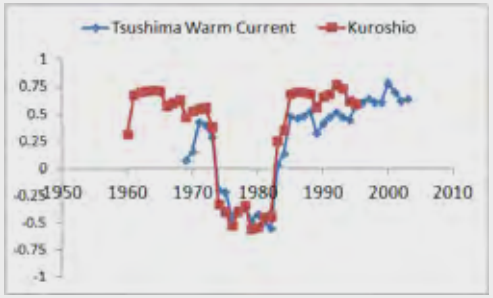




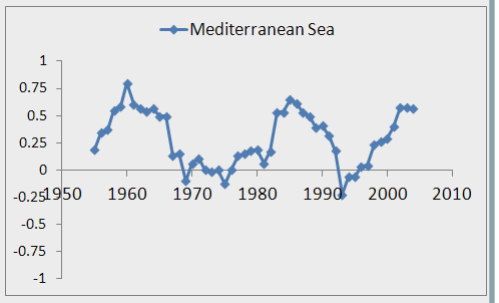


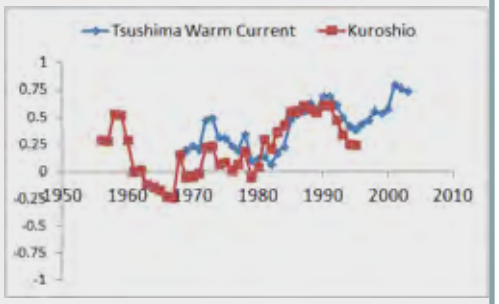
Southern North Sea and



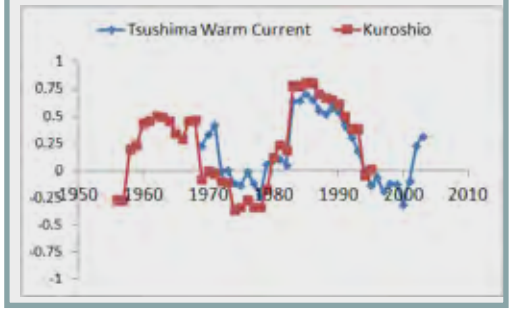


Baltic Sea and





Mediterranean and



Tsushima Warm Current and