Statistic

Covariance (cross, auto)

$$\gamma(\Delta) = E\left((x(t) - \bar{x}) (y(t + \Delta) - \bar{y}) \right)$$

e.g. coral e.g. meteorol. data

Correlation (cross, auto)

$$\rho_{xy} = \frac{\gamma(\Delta)}{\text{normalized}}$$

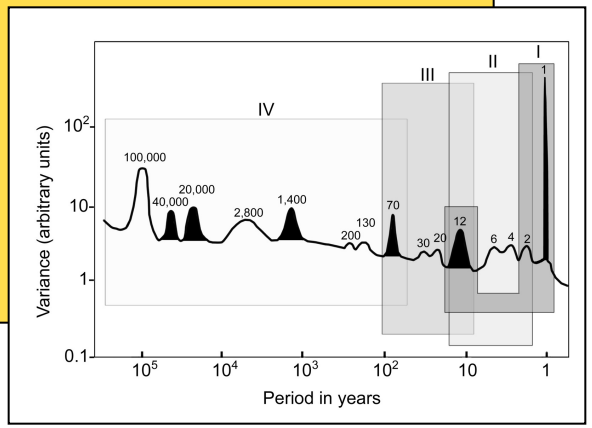
measures the tendency of x (t) and y (t) to covary

Spectrum (cross, auto)

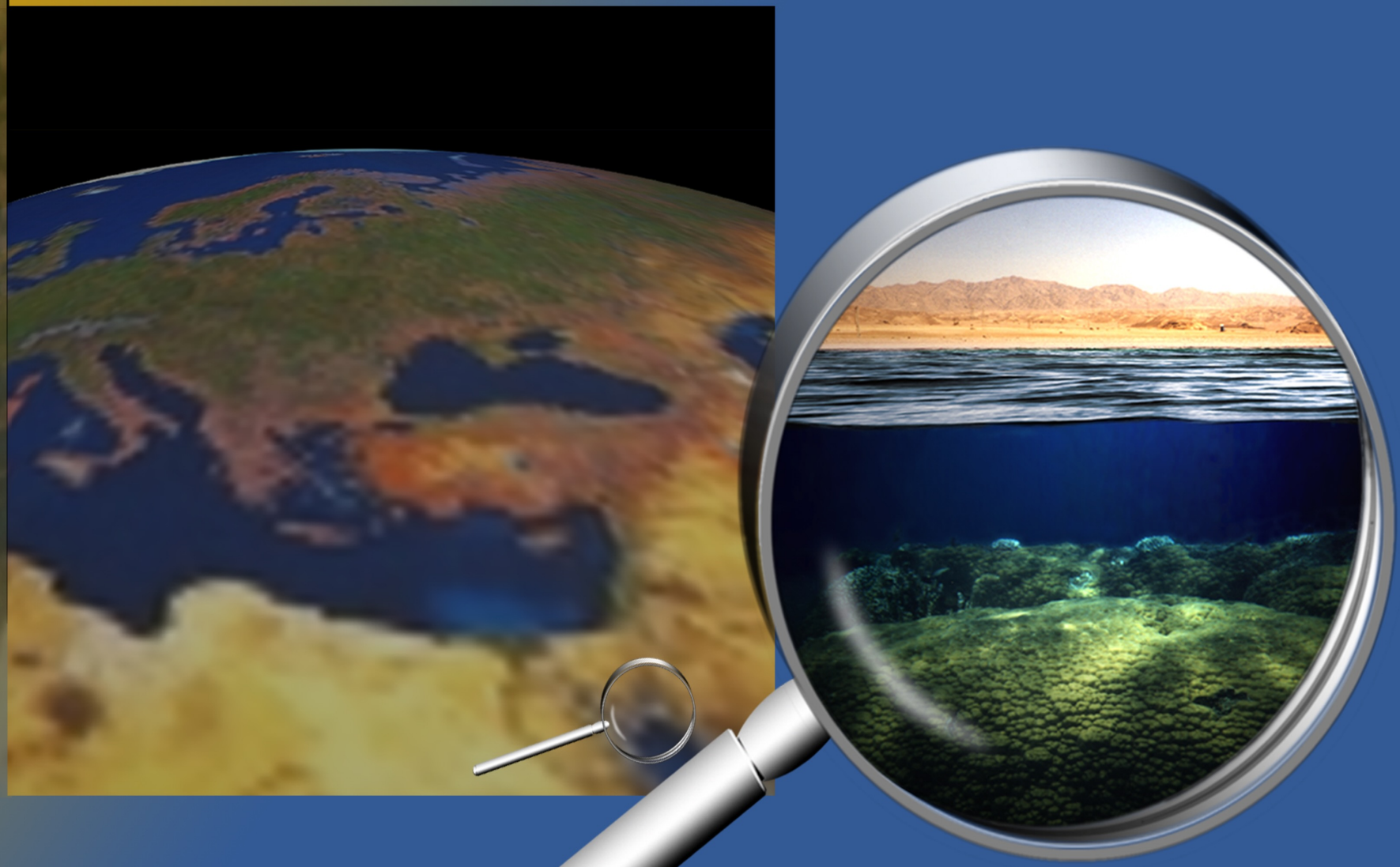
(spectral density)

$$\Gamma(\omega) = \sum_{\Delta=-\infty}^{\infty} \gamma(\Delta)\, e^{-2\pi i \Delta}$$

measures variance

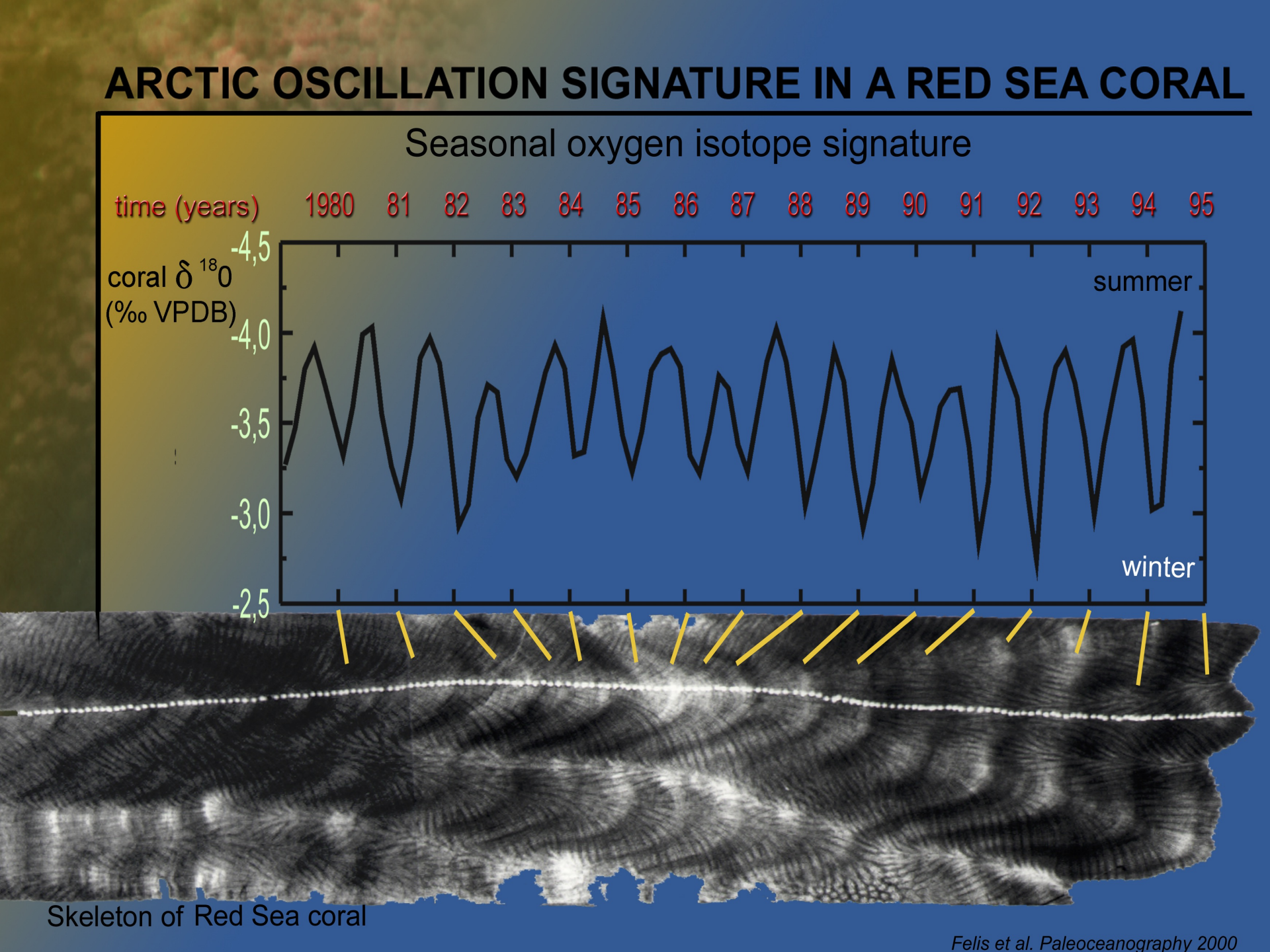


Climate Modes from Proxy Data



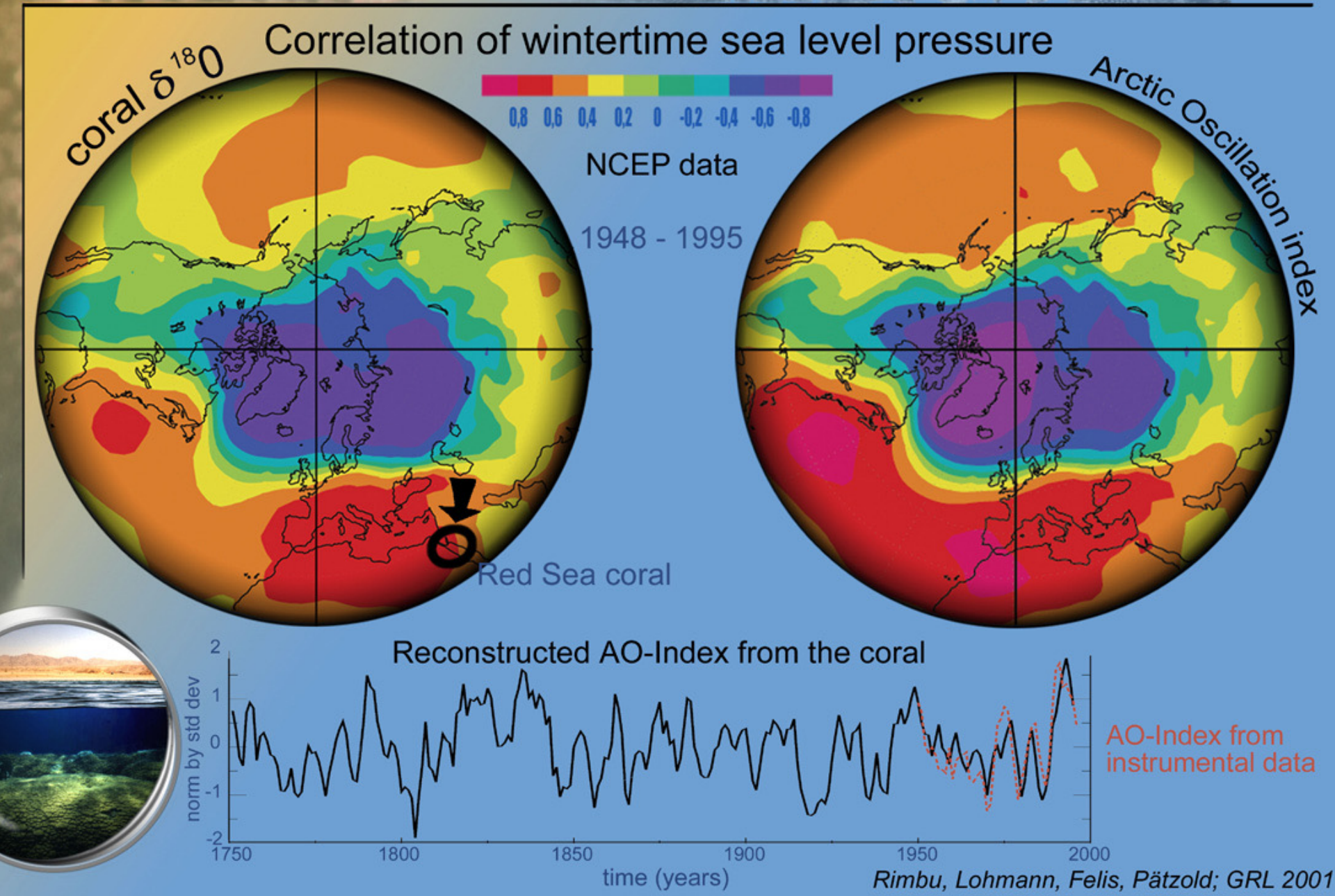
Red Sea coral

ARCTIC OSCILLATION SIGNATURE IN A RED SEA CORAL



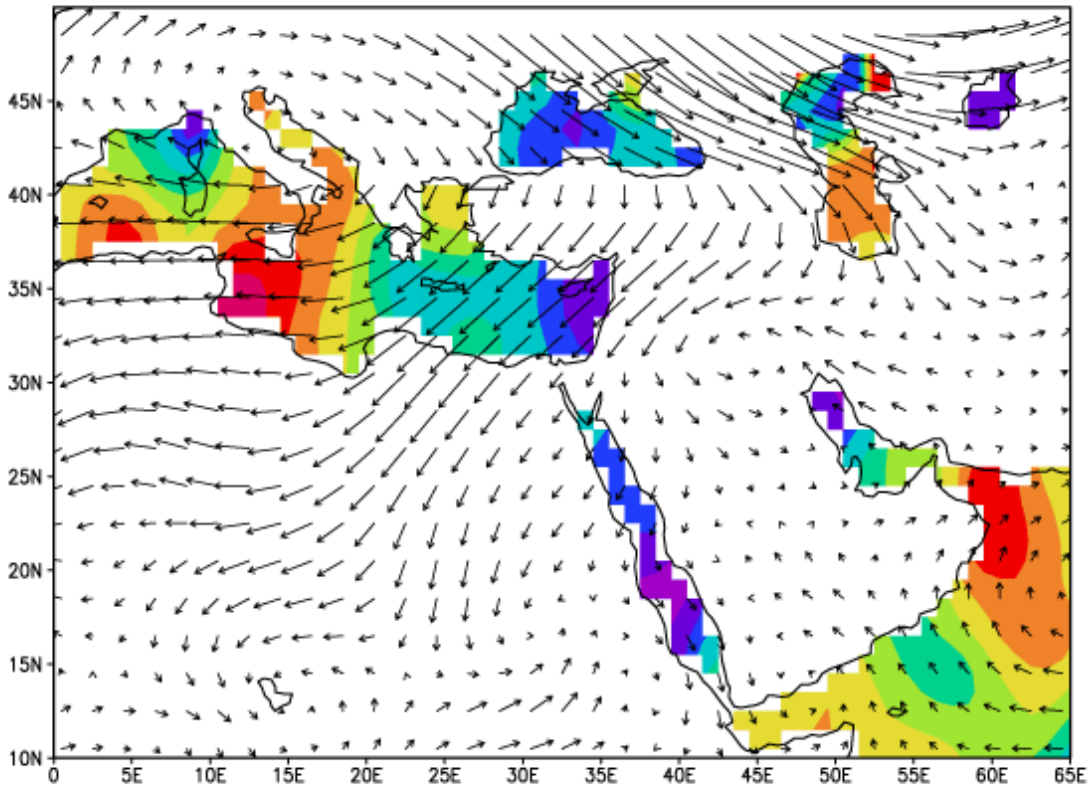
Felis et al. Paleoceanography 2000

ARCTIC OSCILLATION SIGNATURE IN A RED SEA CORAL



Rimbu, Lohmann, Felis, Pätzold; GRL 2001

ARCTIC OSCILLATION SIGNATURE IN A RED SEA CORAL



Composite Map of SST [°C] and 925 hPa wind [m/s] for 1948 -1995, January - February

mechanistic understanding

ARCTIC OSCILLATION SIGNATURE IN A RED SEA CORAL