

Osservazioni di stato e tendenza del sistema climatico terrestre

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La scienza è fatta di dati come una casa di pietre.

Ma un ammasso di dati non è scienza più di quanto un mucchio di pietre sia una casa.

-Henri Poincaré-



definizioni e impostazione del problema;



evidenze della tendenza climatica;



problemi;

CLIMA E TEMPO METEOROLOGICO

diversa scala temporale

diversità di metodo, dati e formulazioni teoriche

tempo meteorologico stato di un sottosistema (in particolare dell'atmosfera) ad un preciso istante.

clima stato medio del sistema e sue variazioni nel tempo.

definizione dello stato e delle sue variazioni
monitoraggio **indicatori**

previsioni sull'evoluzione del sistema
modelli **parametrizzazioni**

temperatura dell'aria

altezza del mare

**precipitazione, vegetazione, insolazione,
estensione dei ghiacci,**

temperatura dell'aria ($h=2\text{ m}$)

termometri (tempi recenti < 200 anni):

- termometri a mercurio

- termometri a stato solido (termistori)

proxy data (paleoclima):

- anelli di accrescimento degli alberi

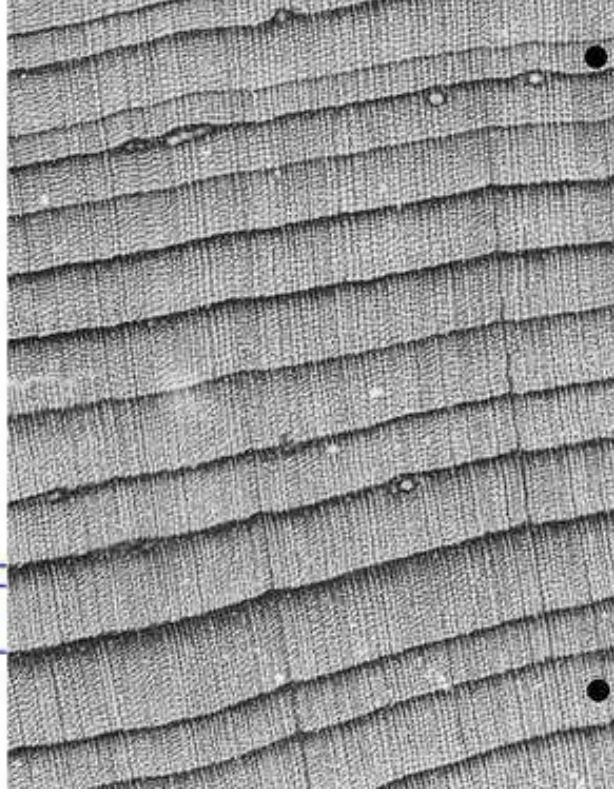
- forma delle foglie

- O^{16}/O^{18}

- cronache storiche



earlywood + latewood = annual ring



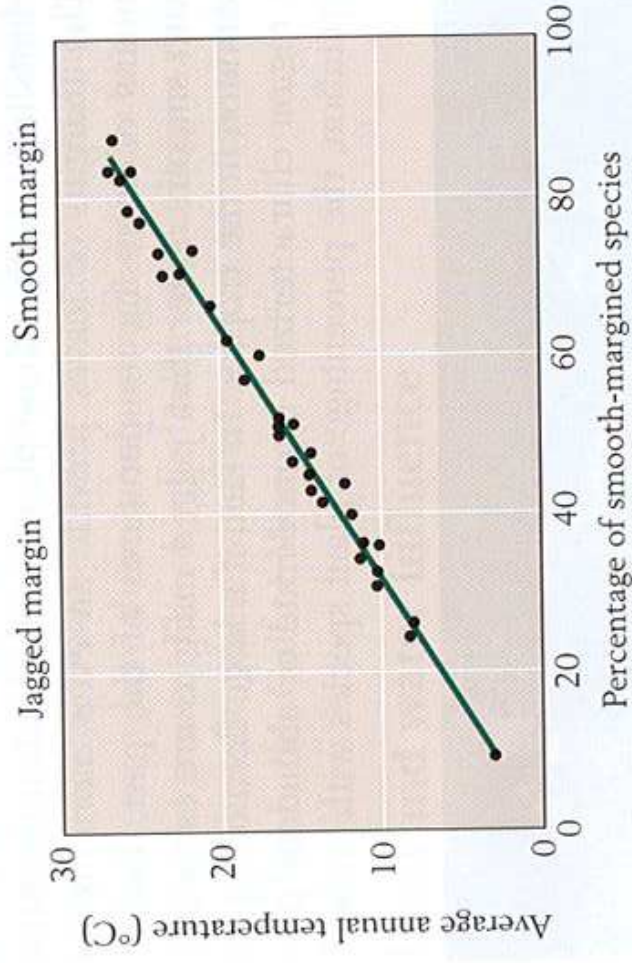
1770

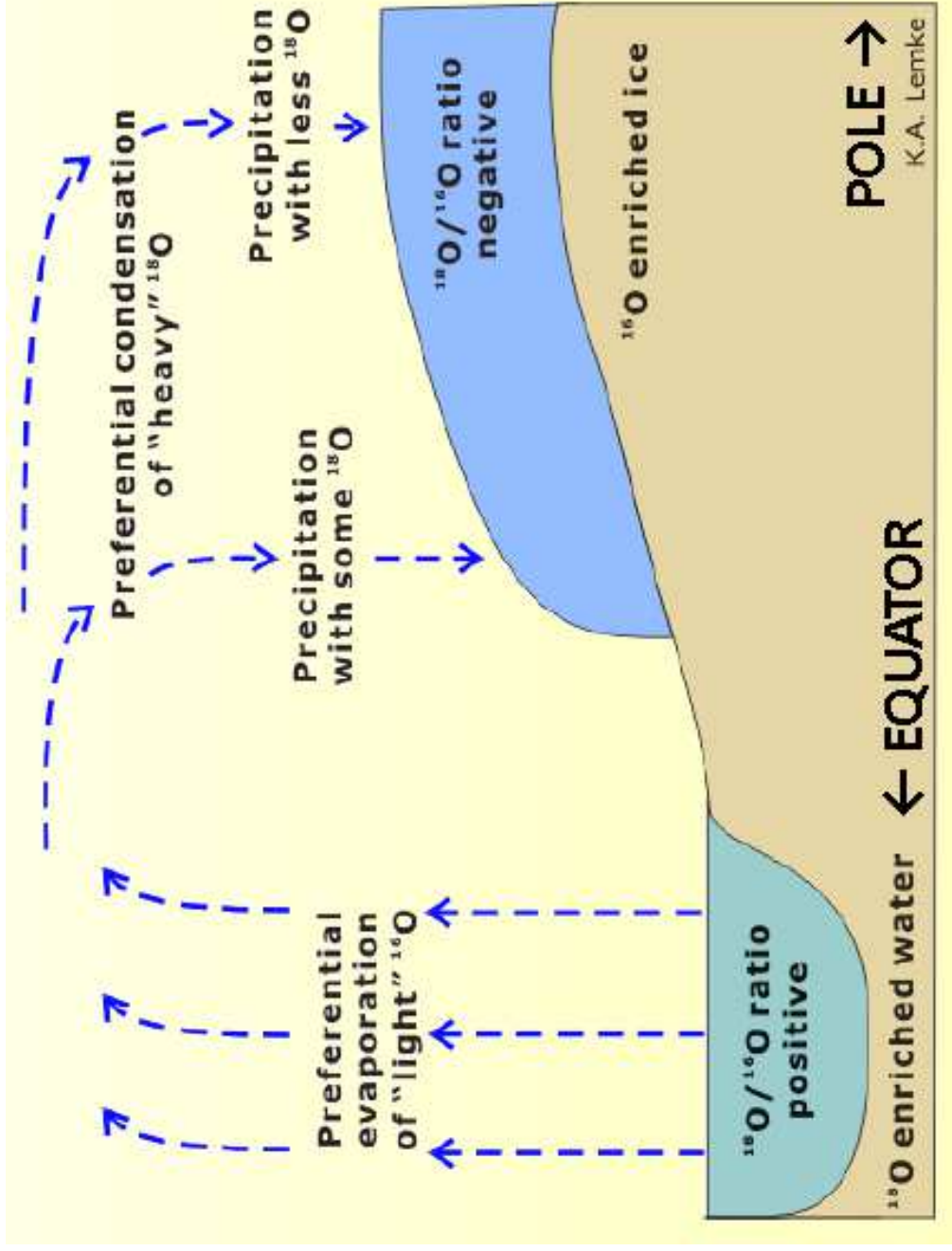
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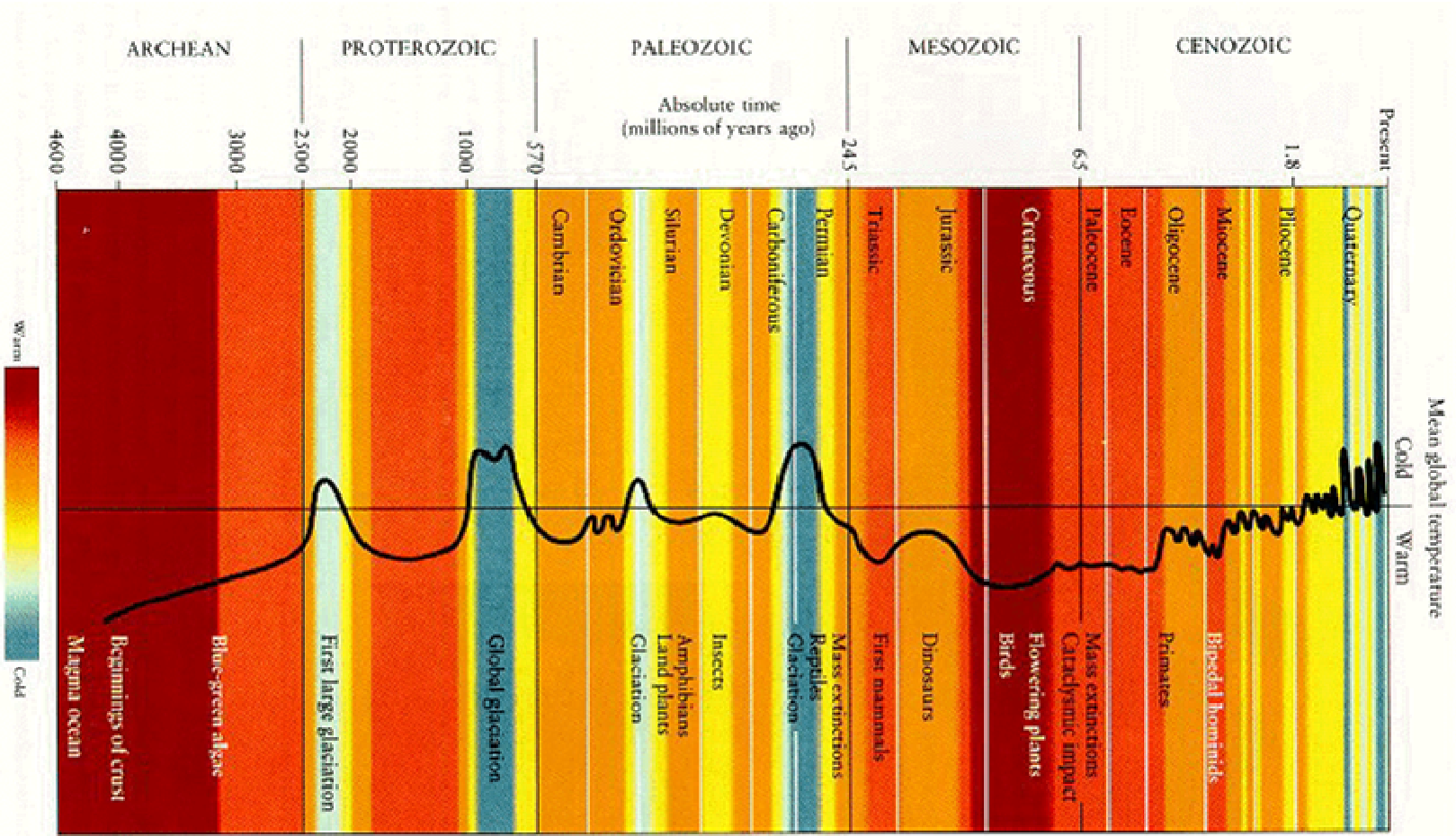
1783

1790

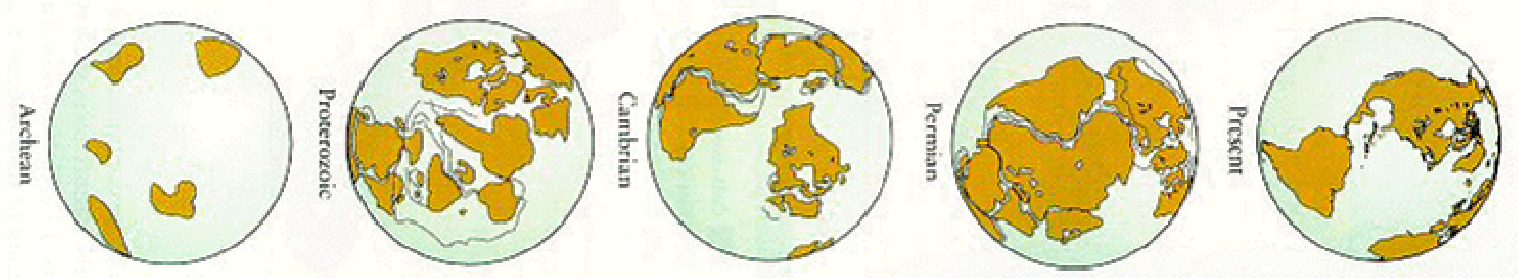
1800



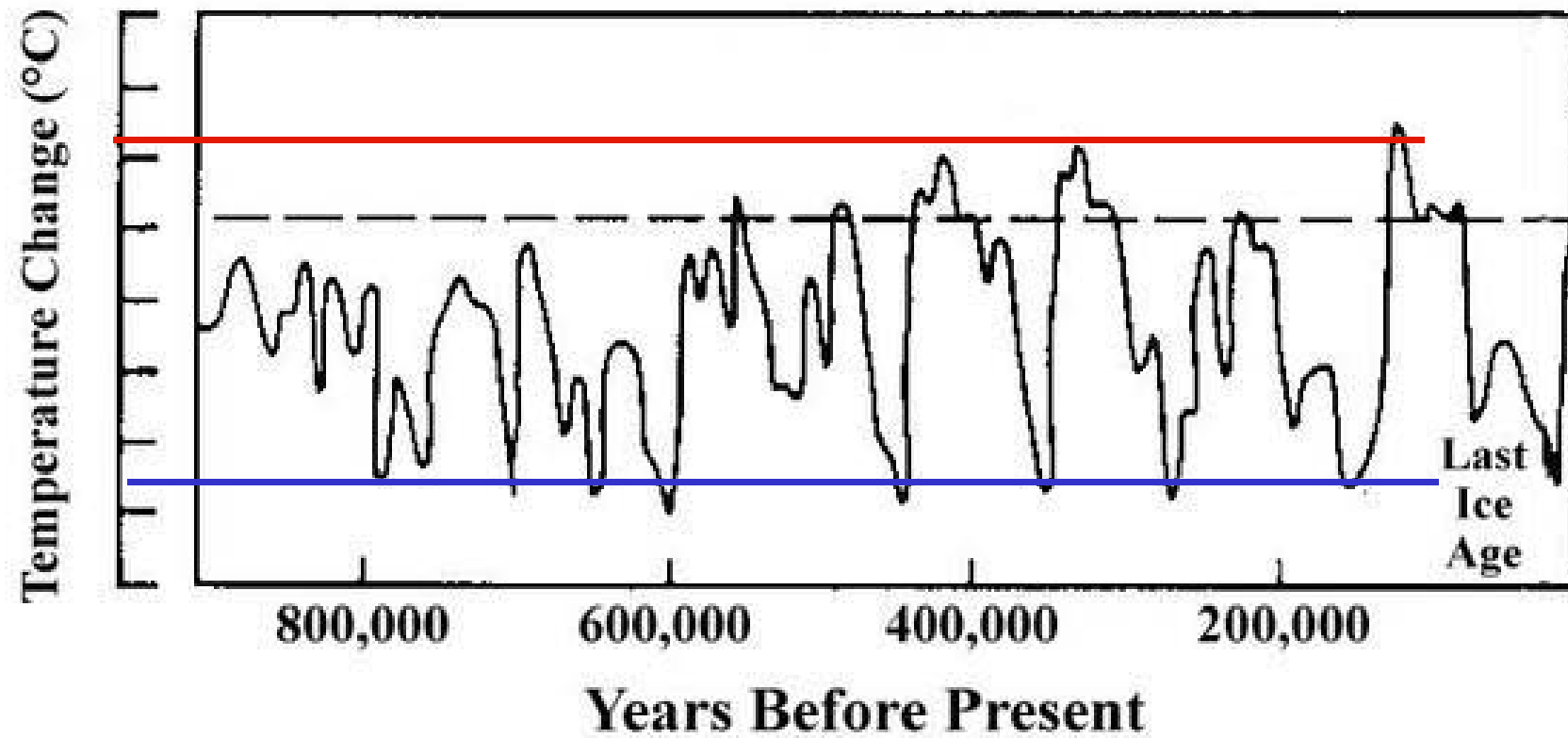




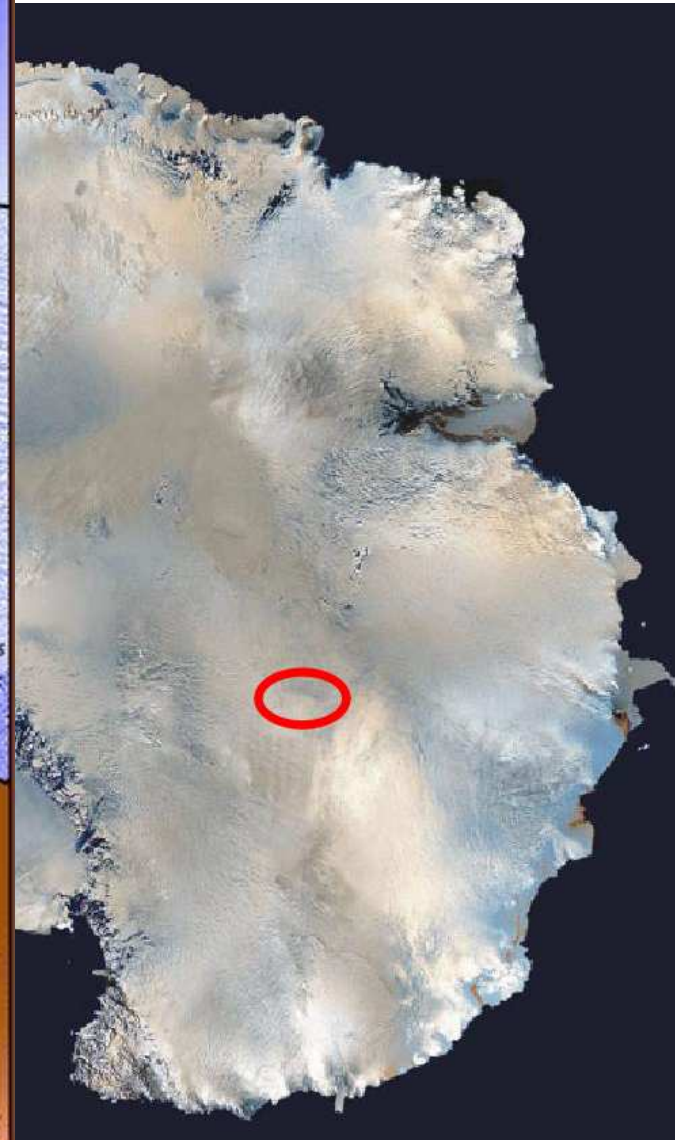
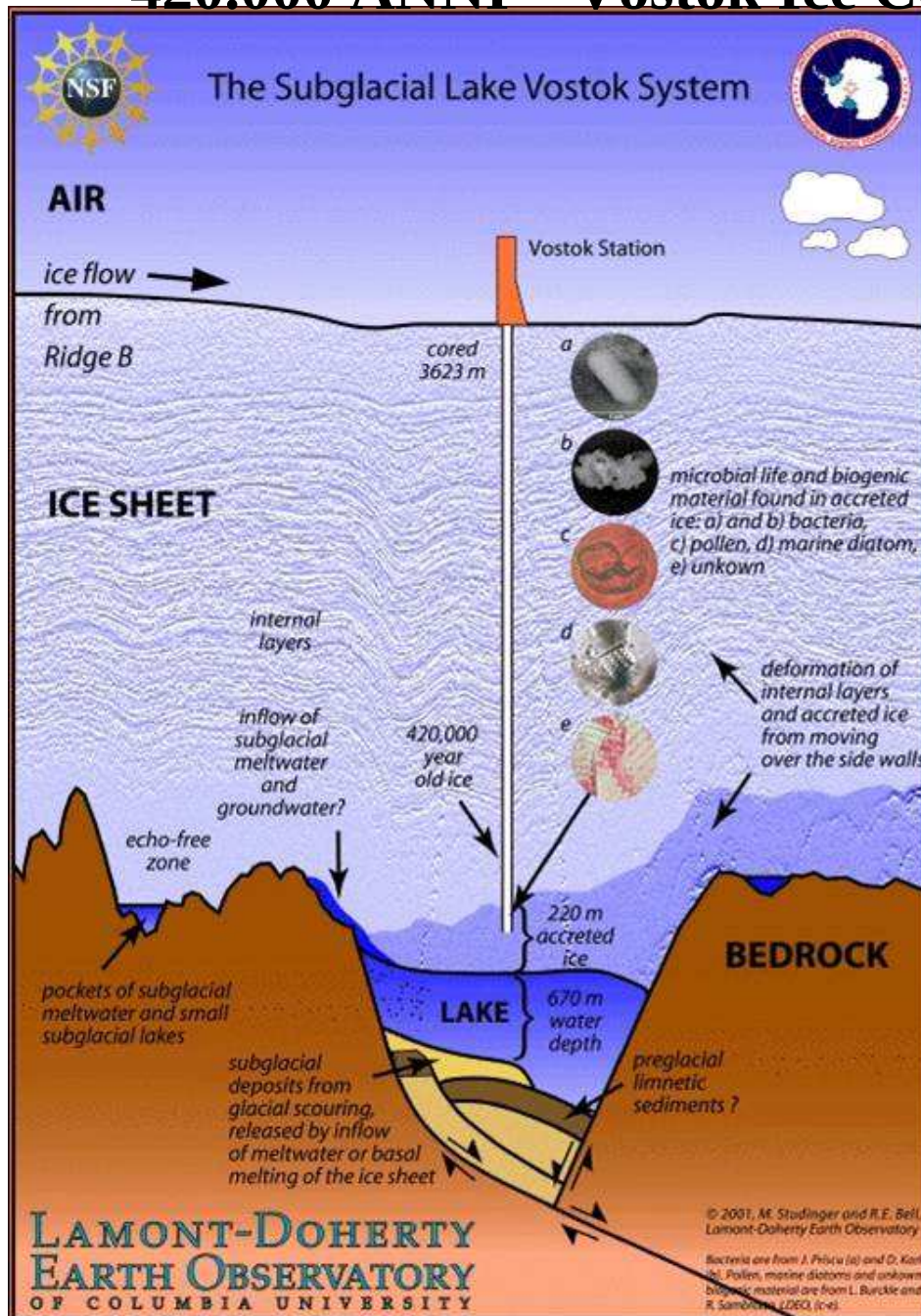
4.5 MILIARDI

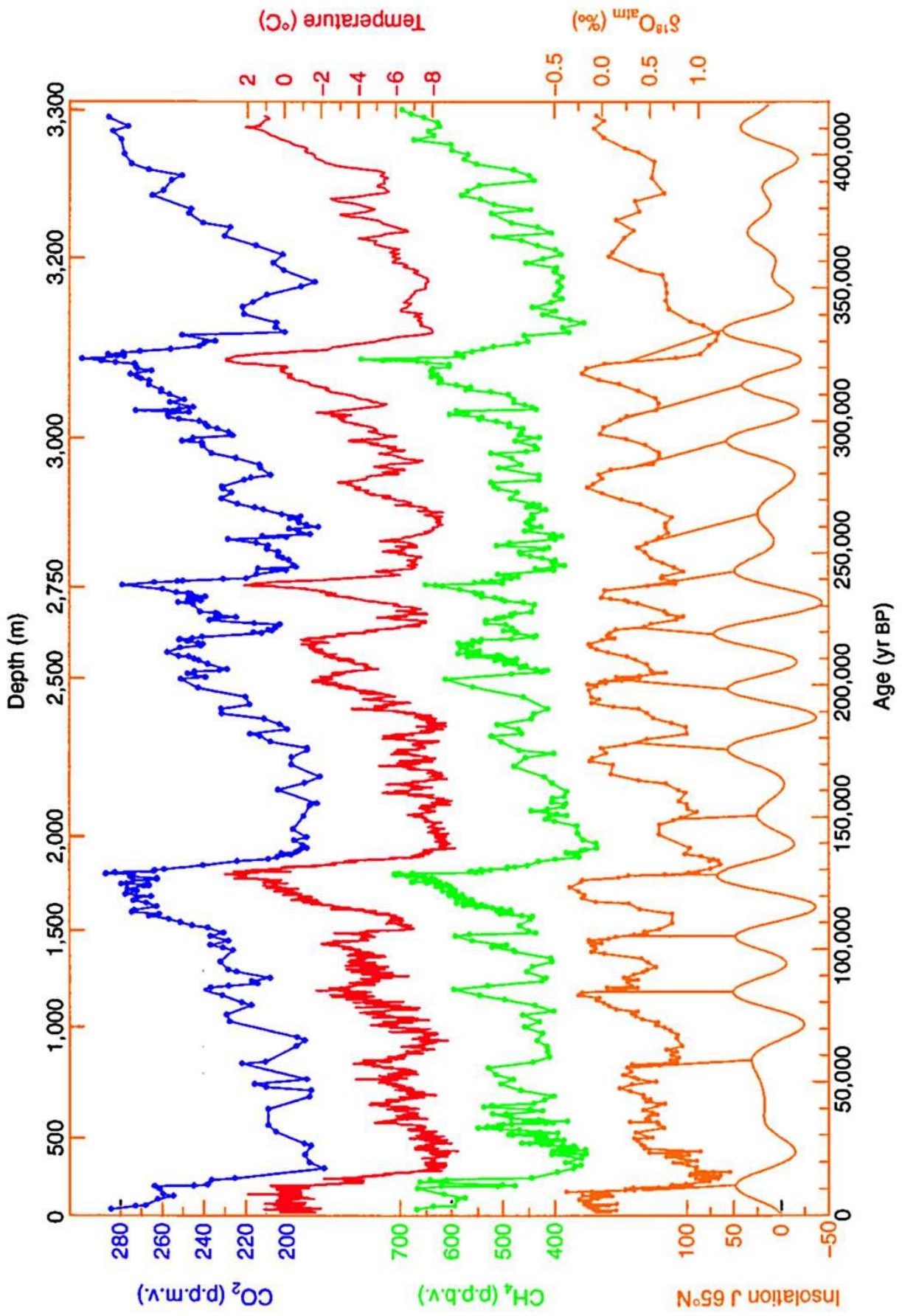


1 MILIONE DI ANNI

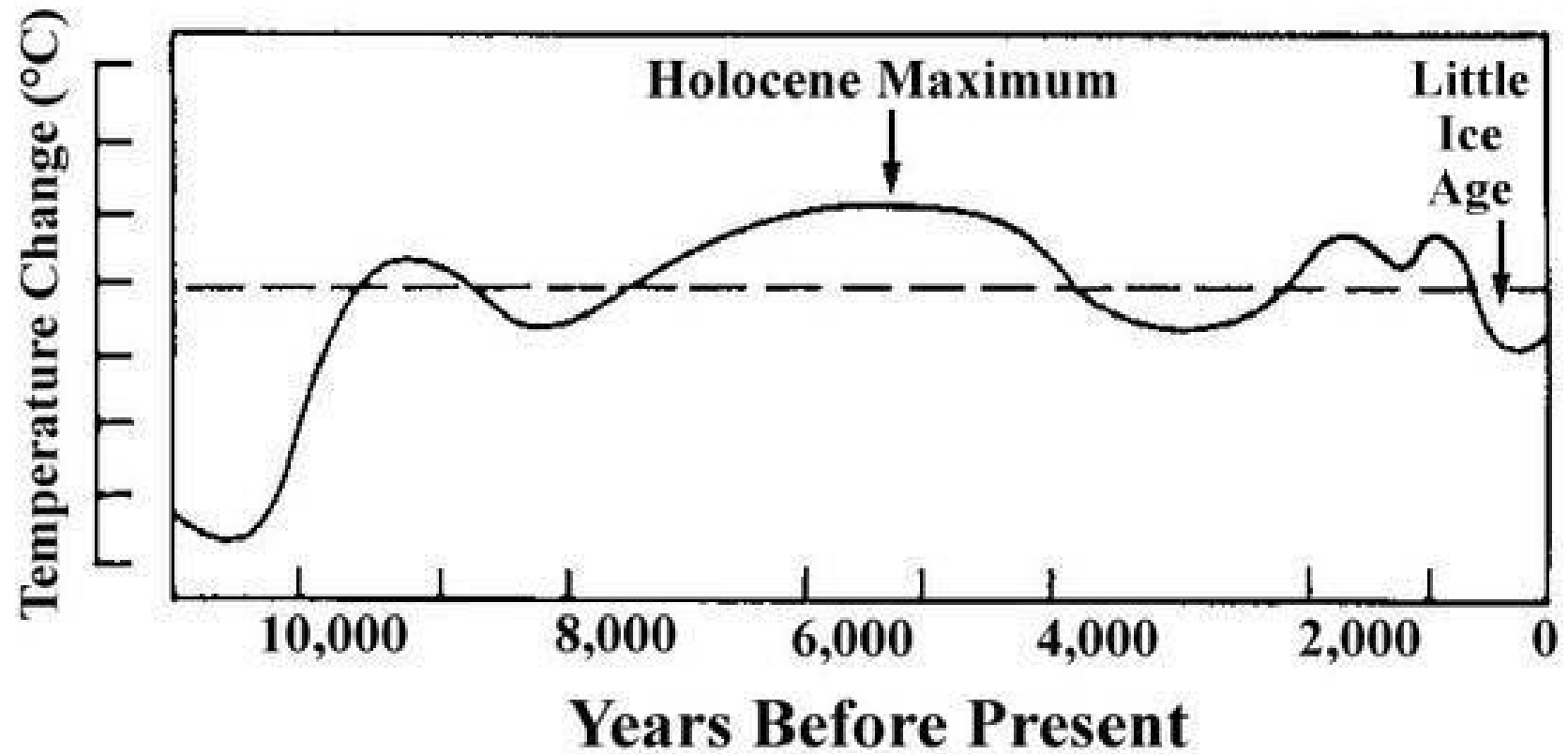


420.000 ANNI – Vostok Ice Core

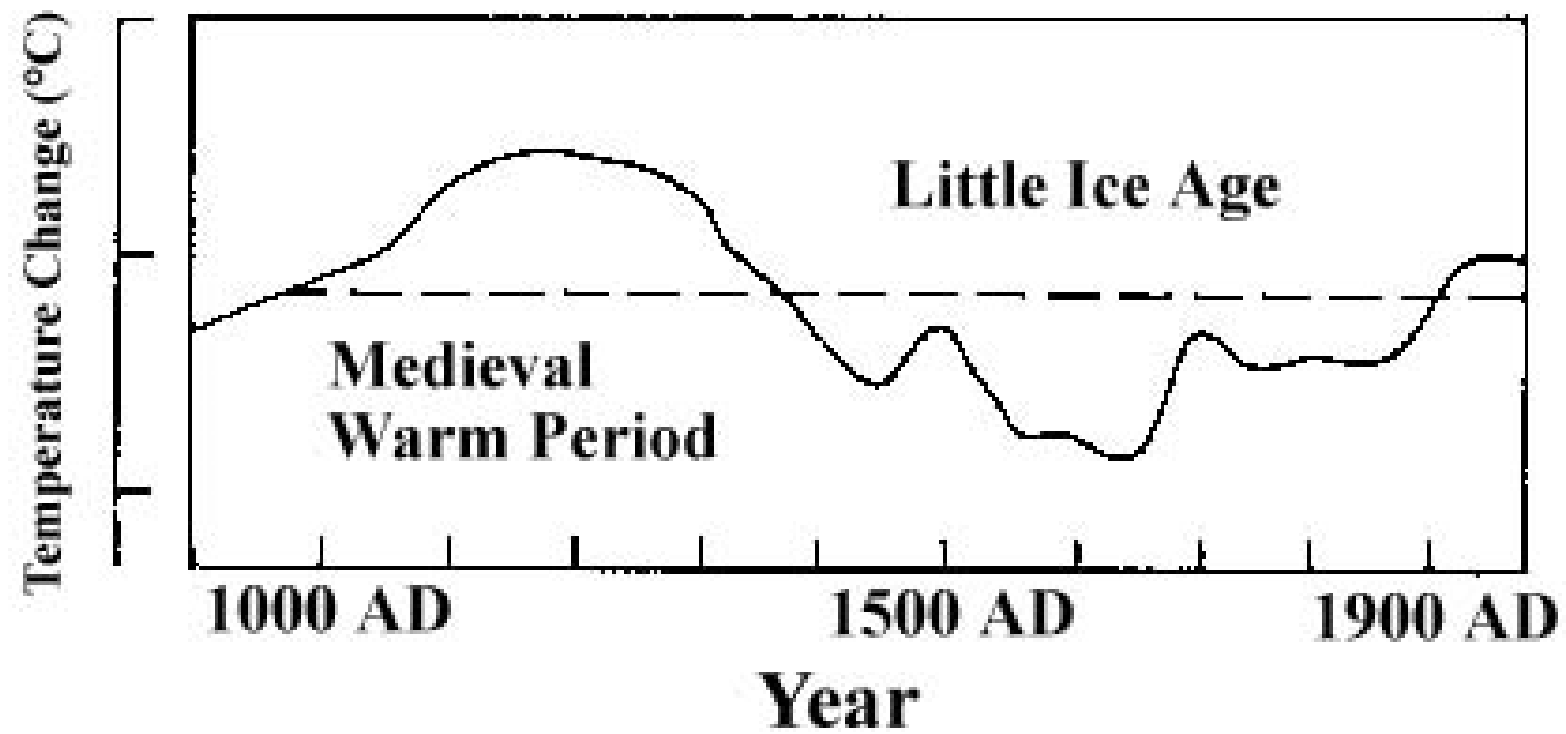




10.000 ANNI

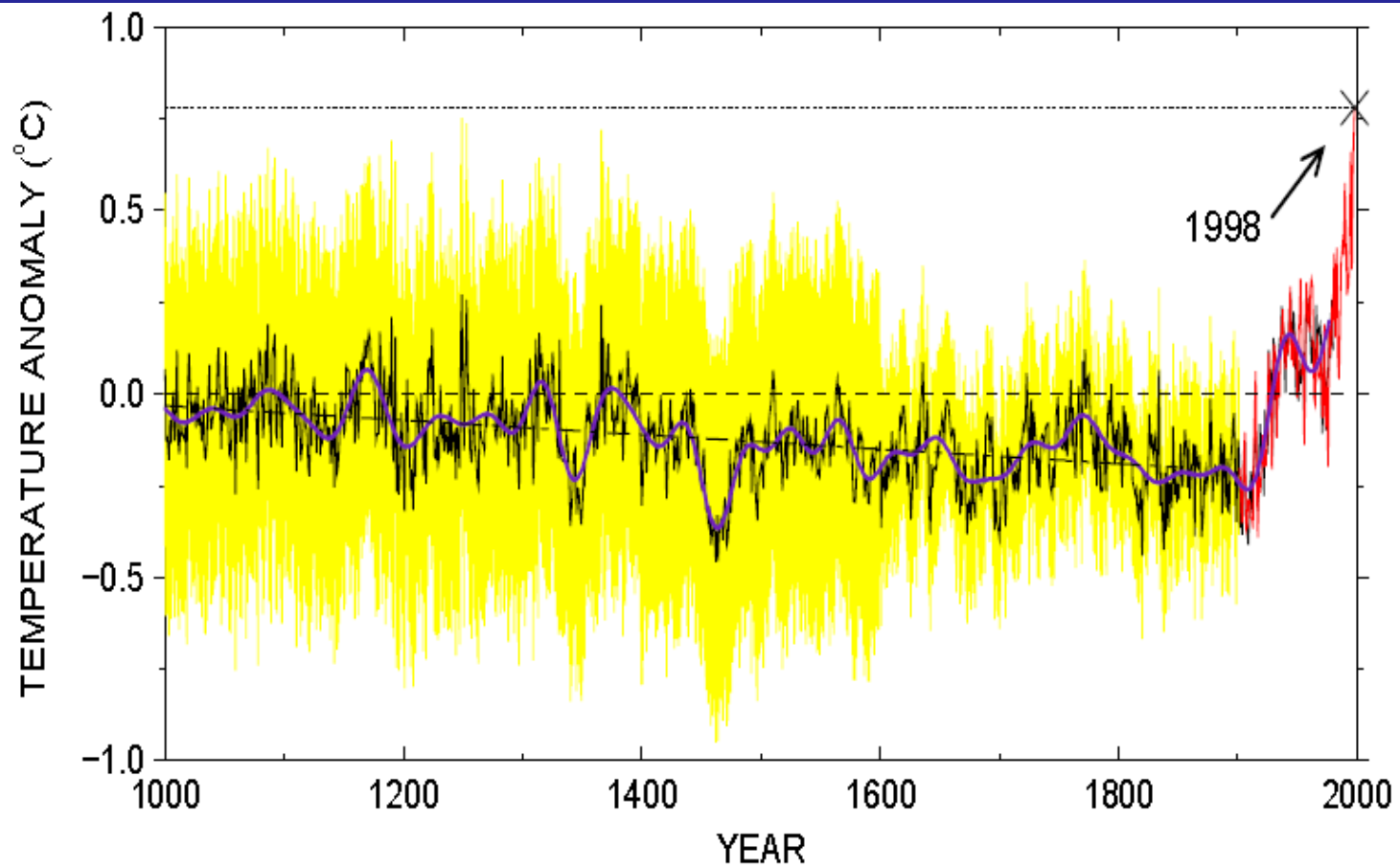


1.000 ANNI



osservazione delle tendenze I

hockey stick

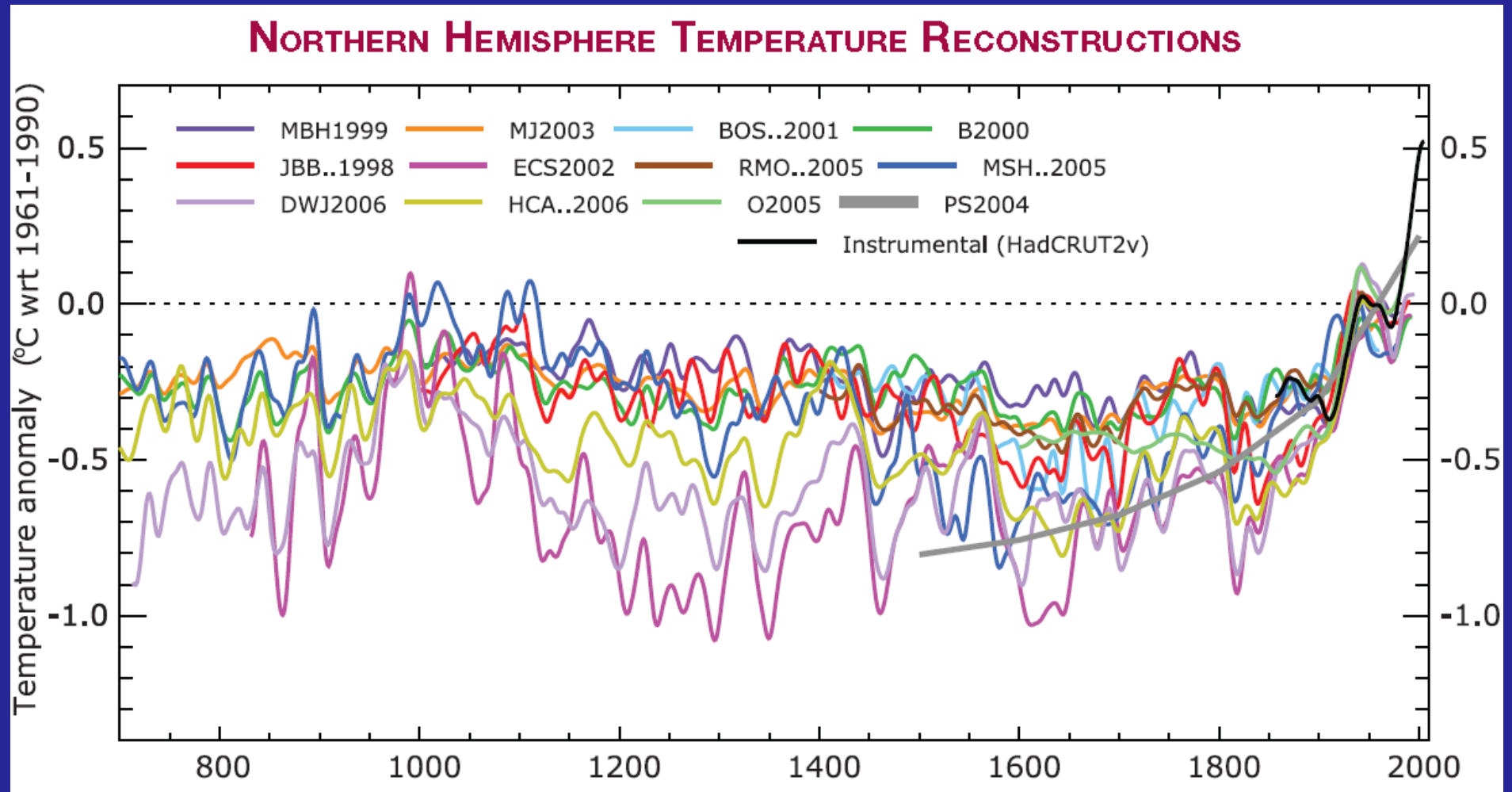


(a)

- reconstruction (AD 1000–1980)
- raw data (AD 1902–1998)
- calibration period (AD 1902–1980) mean
- reconstruction (40 year smoothed)
- linear trend (AD 1000–1850)

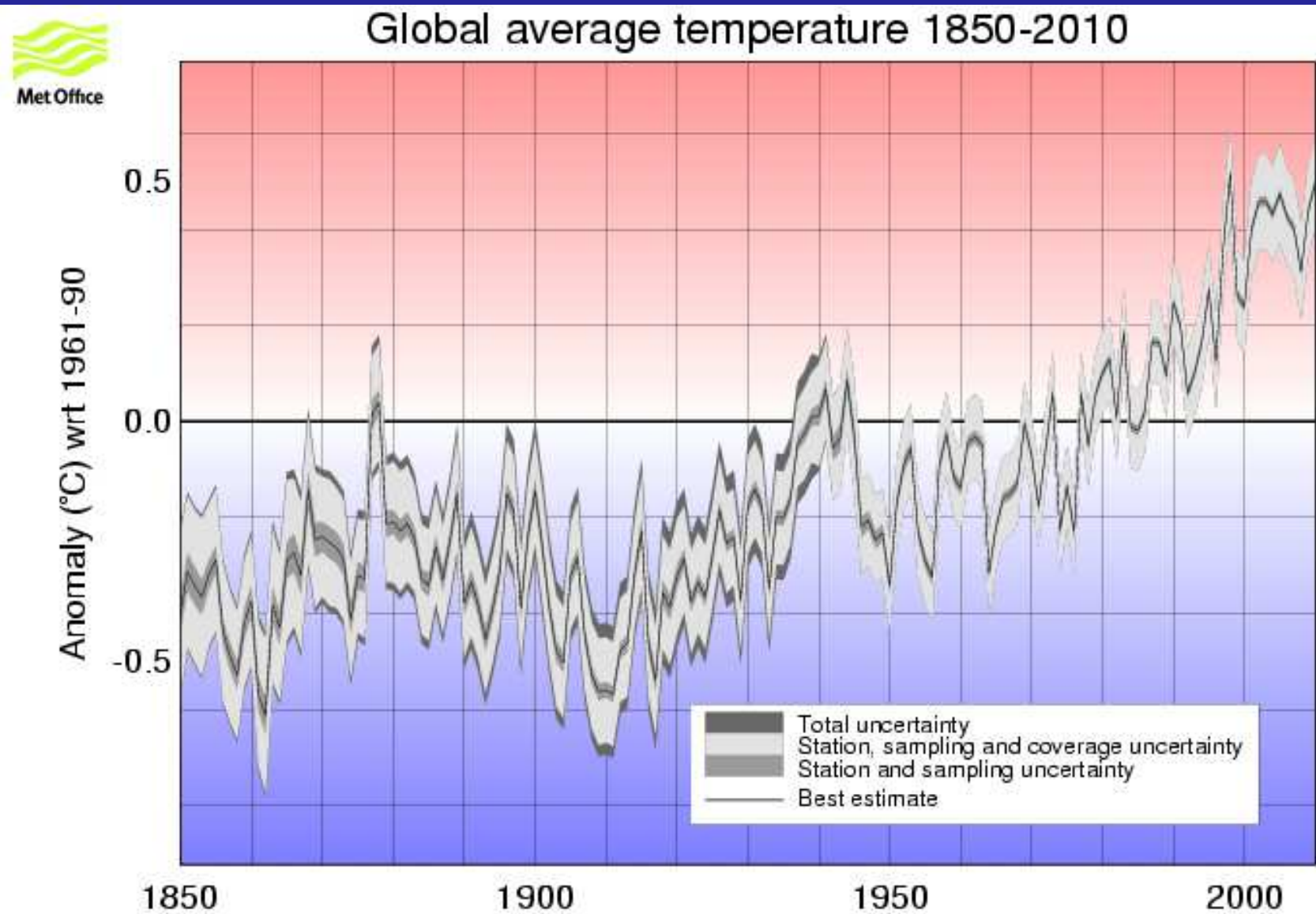
osservazione delle tendenze II

stime della temperatura media dell'emisfero nord



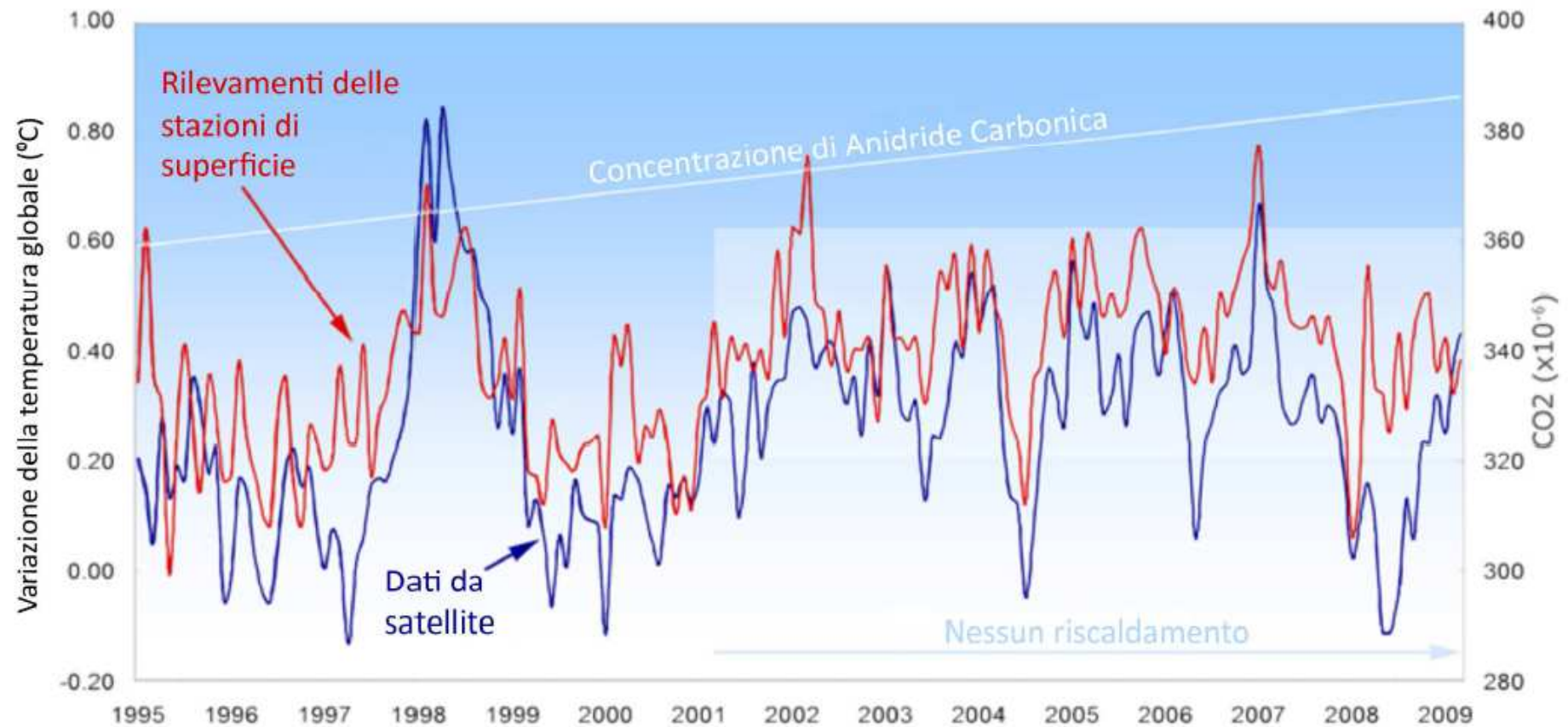
osservazione delle tendenze III

ultimi anni



osservazione delle tendenze III

ultimi anni

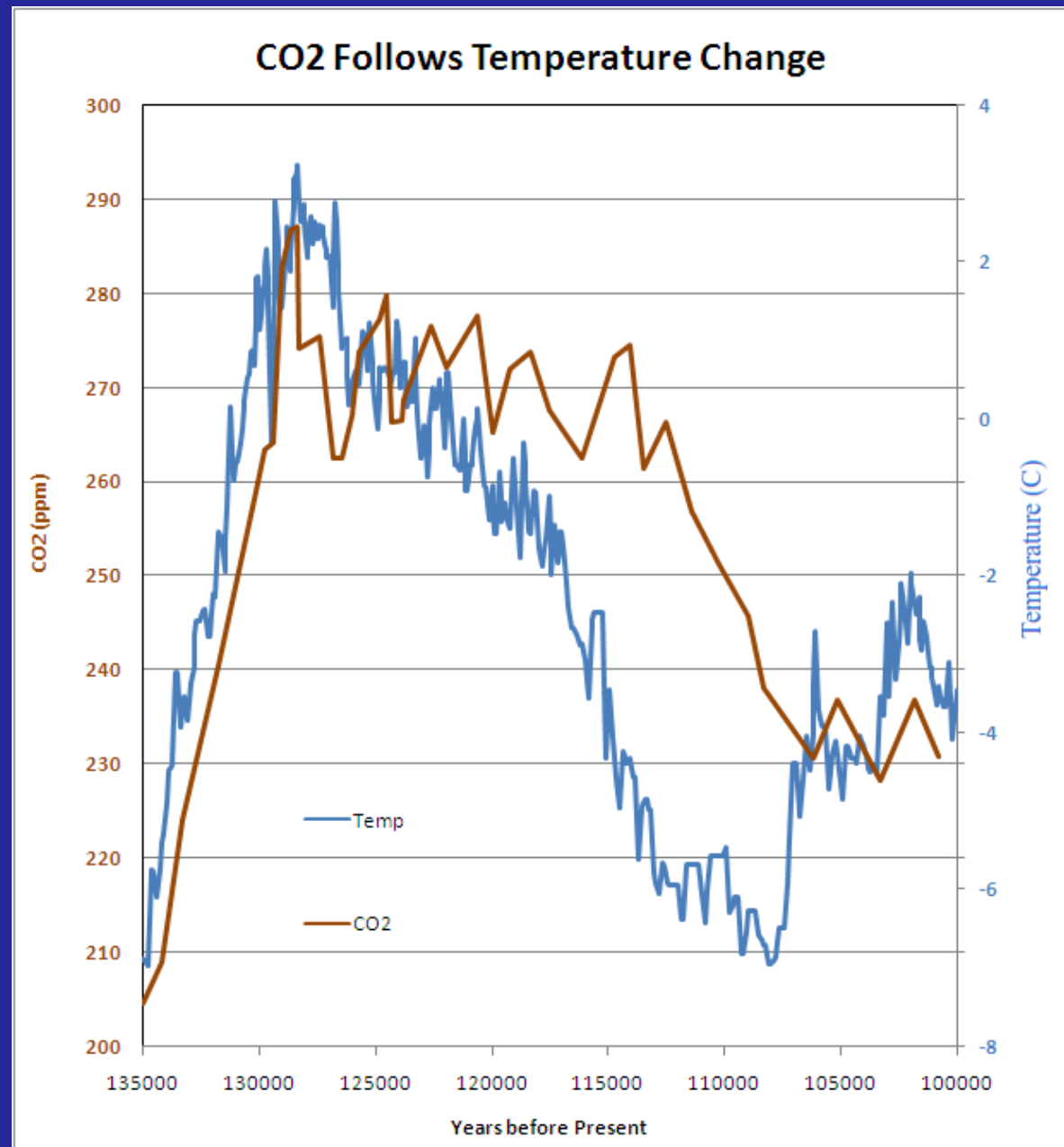


osservazione delle tendenze IV

relazione $GHG/\Delta T$

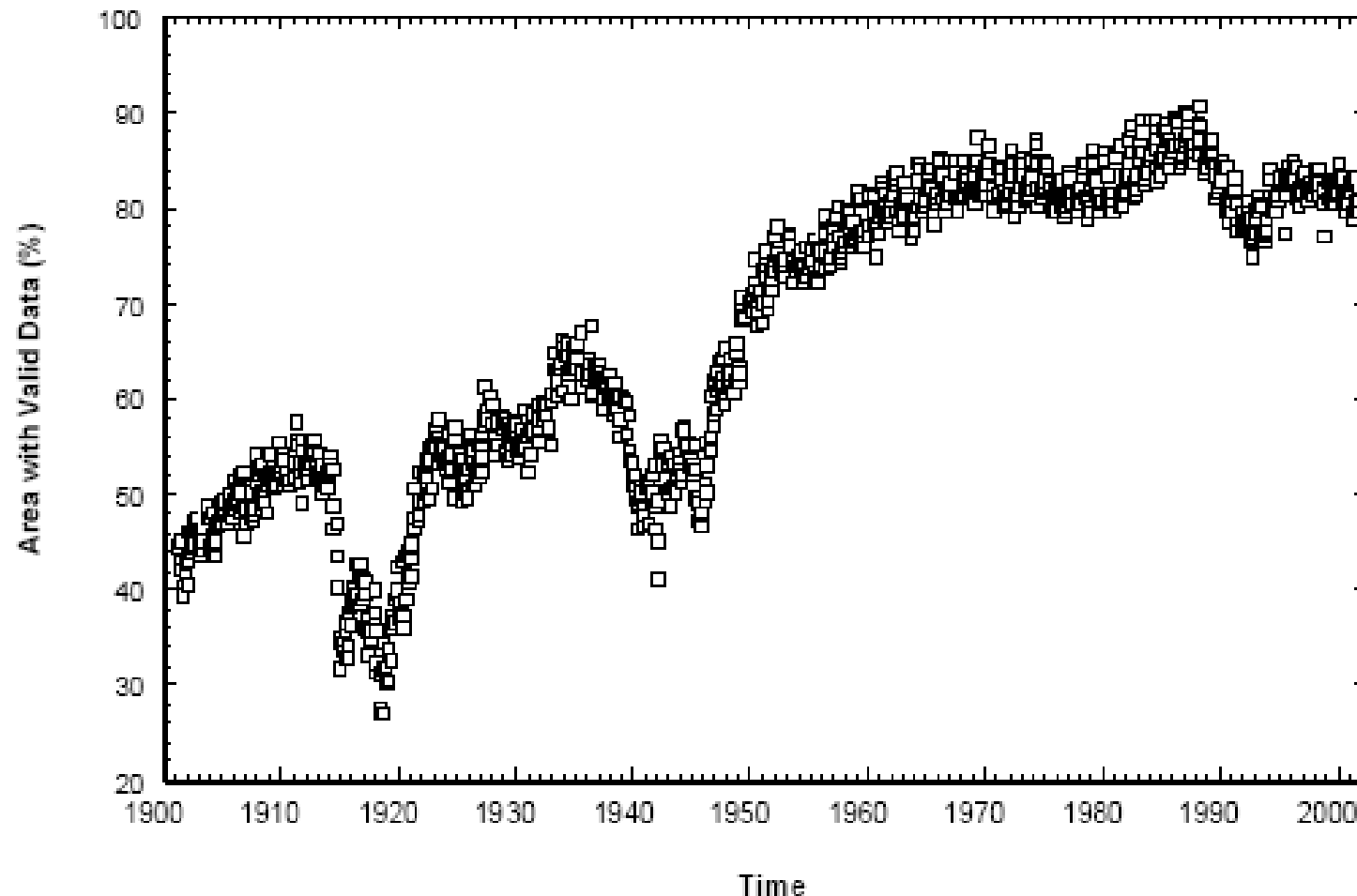
le variazioni di
contenuto di CO_2
seguono di circa 800
anni le variazioni
della temperatura

Mudelsee, 2001



osservazione delle tendenze V
copertura globale dei sensori

la frazione di superficie globale monitorata varia
 $5^\circ \times 5^\circ \sim 550 \times 400 \text{ km}^2$

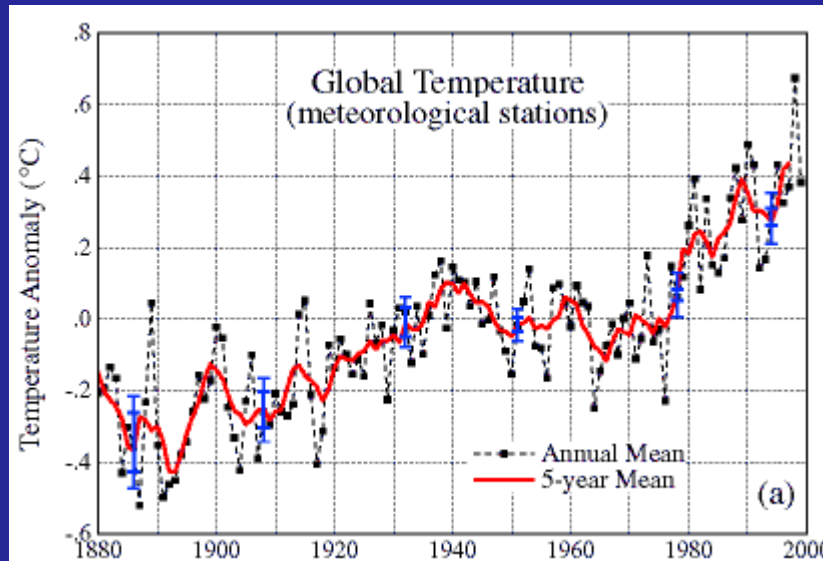


osservazione delle tendenze VI modiifica dei siti di misura



osservazione delle tendenze VII

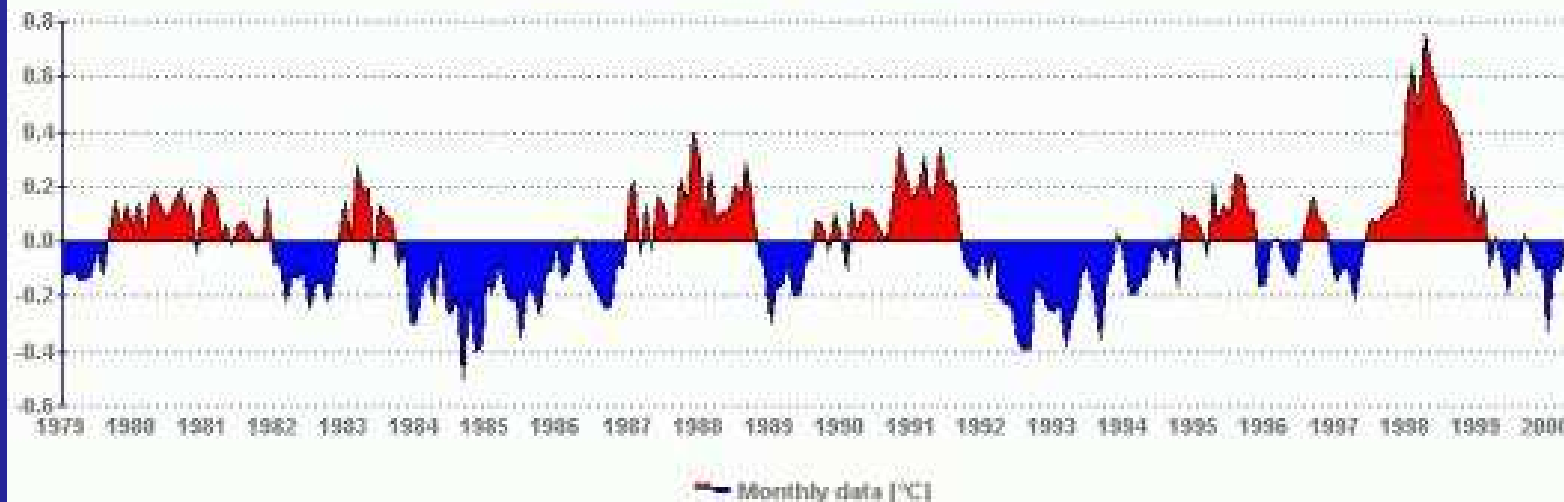
osservazioni dallo spazio



0,2 K/decade

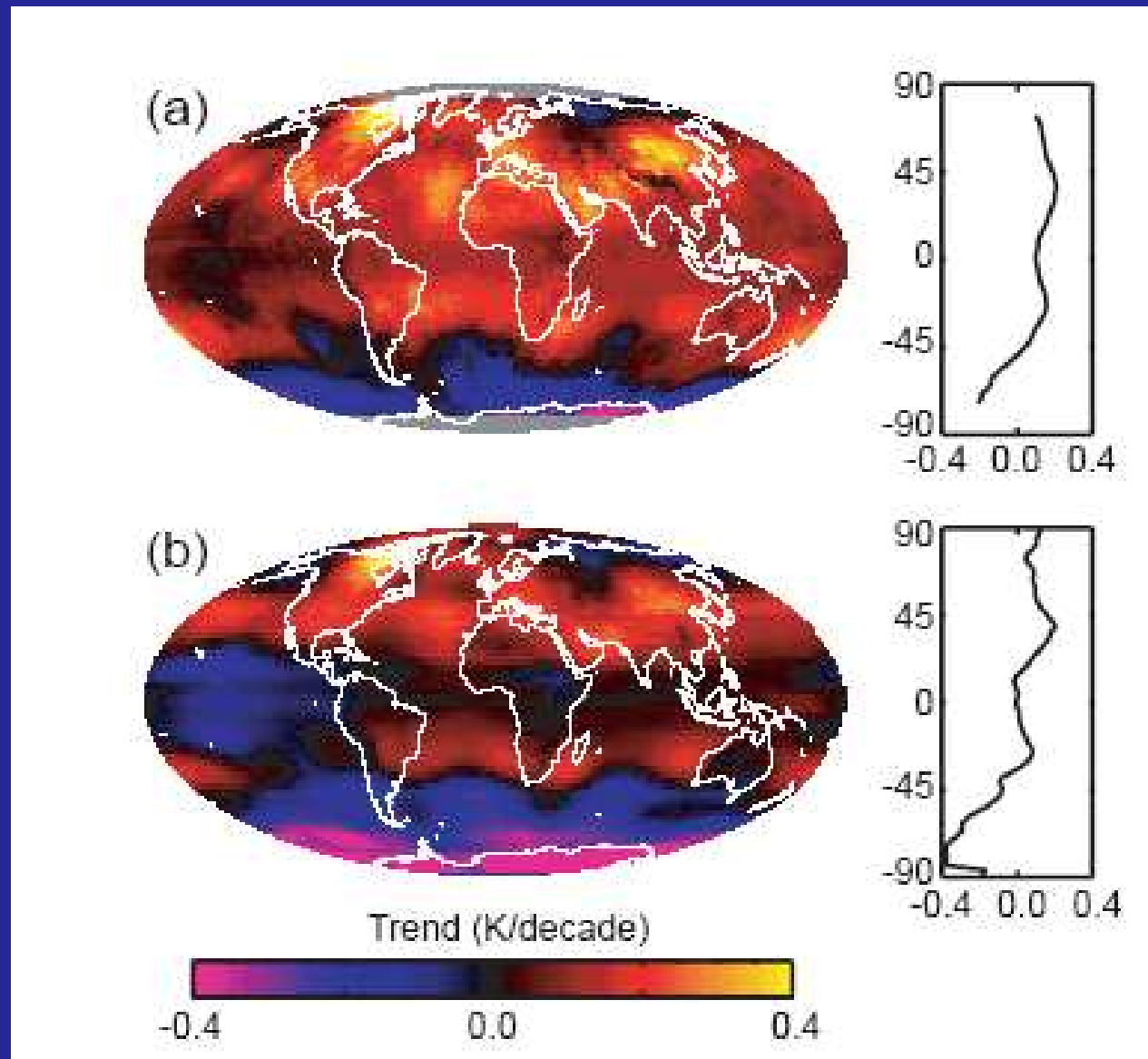
0,09 K/decade

Lower Troposphere Temperature
Satellite Measured [anomalies °C]



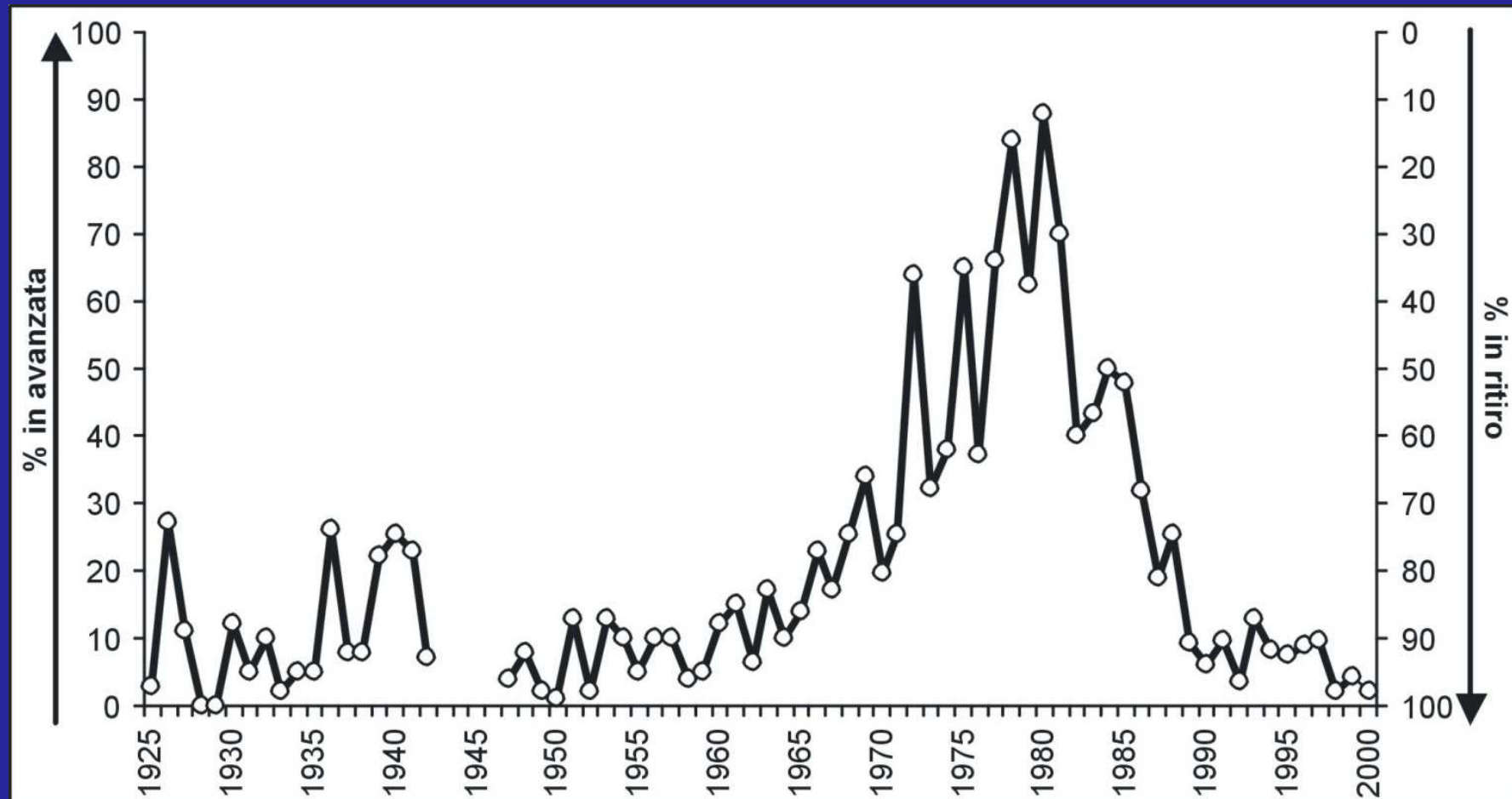
osservazione delle tendenze VIII

Microwave Sounding Unit (MSU)



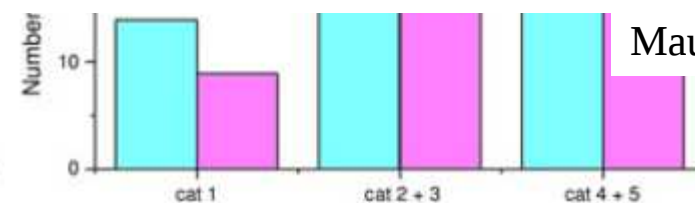
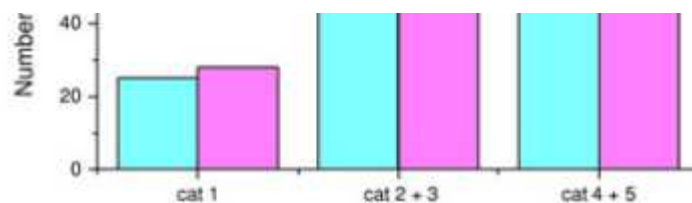
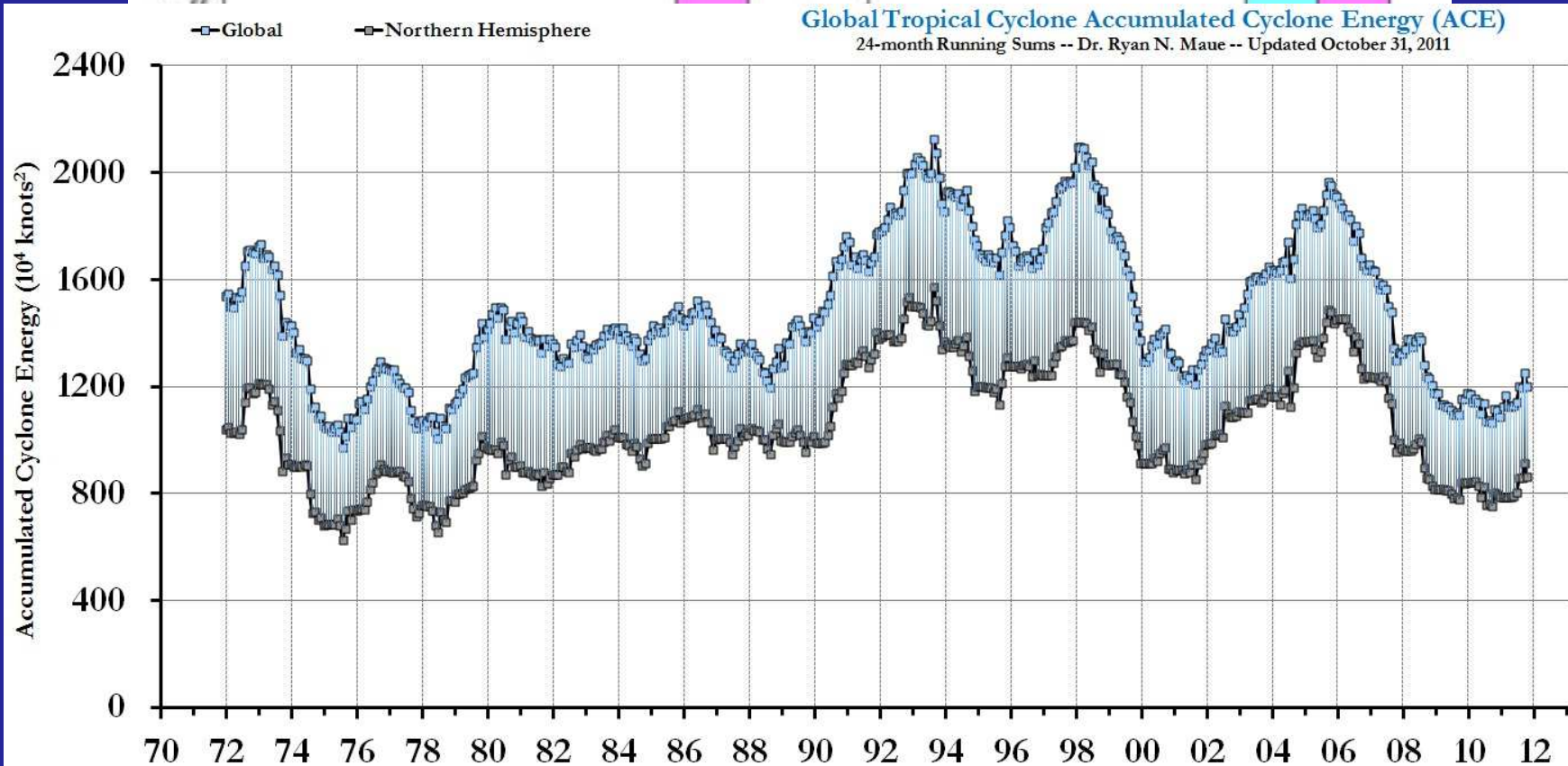
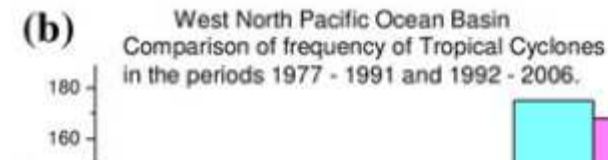
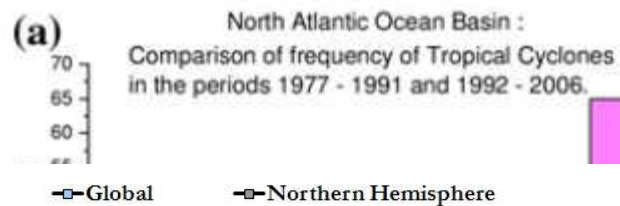
osservazione delle tendenze IX

ritiro dei ghiacciai



osservazione delle tendenze X eventi estremi: cicloni tropicali

Deo et al., 2011



Maue, 2011

osservazione delle tendenze XI

*impatto sui
sistemi fisici e
biologici*

