



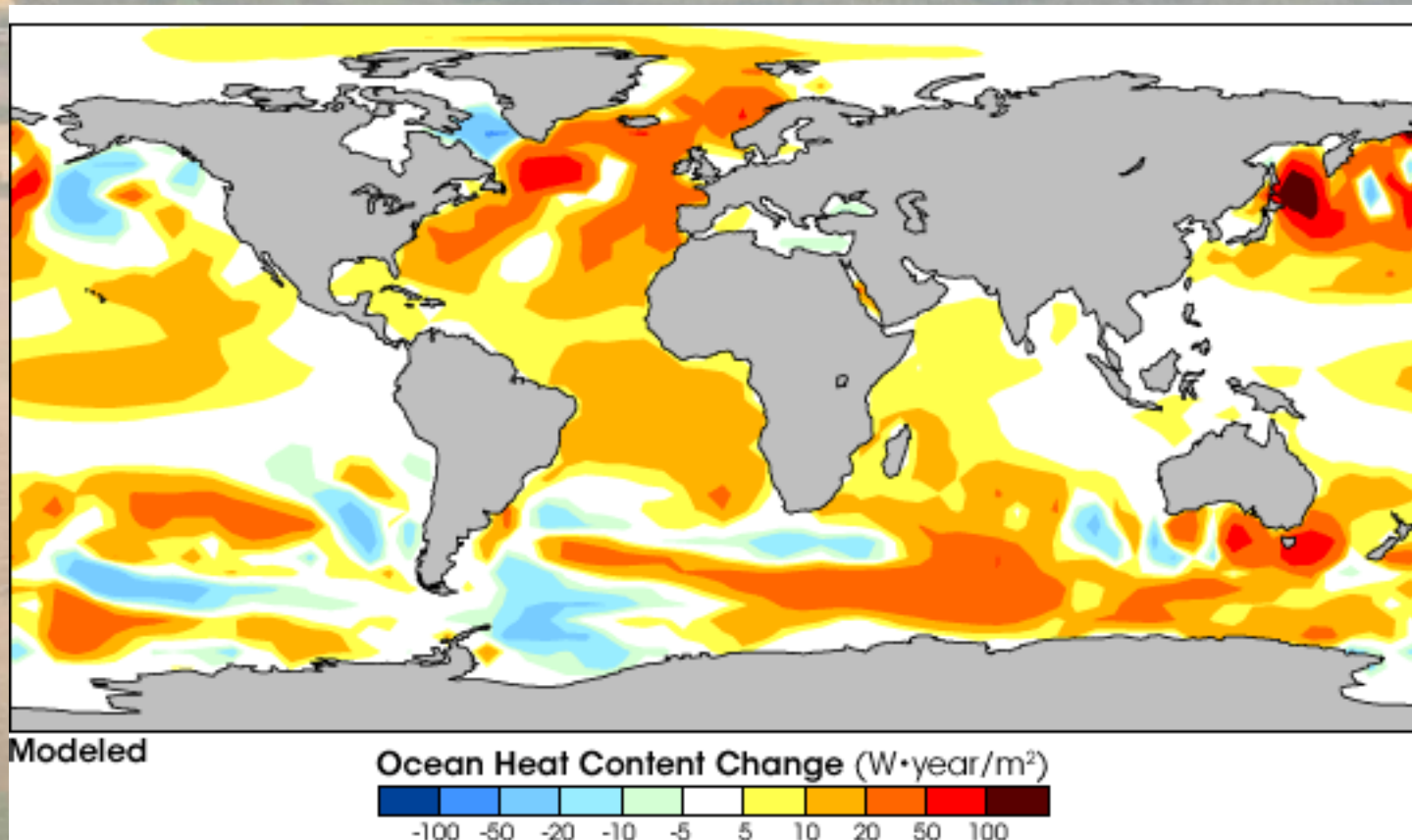
Cambiamenti climatici , risorse idriche e siccità

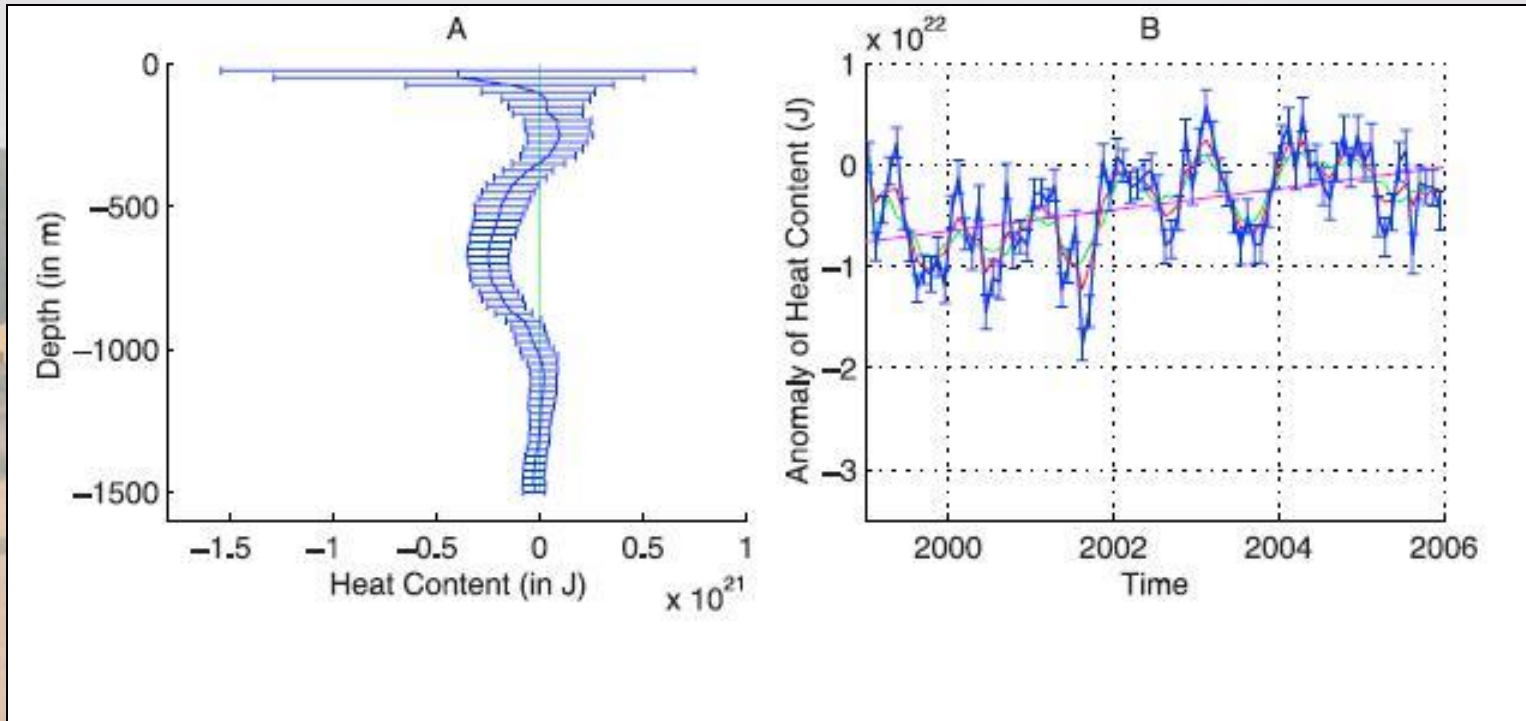
**Giampiero Maracchi
Accademia dei Georgofili**

La tesi :

- **Aumenta la temperatura del mare**
- **Si modifica il contenuto in vapor d'acqua dell'atmosfera**
- **Si modifica il bilancio energetico**
- **Cambia la nuvolosità**
- **Cambia la circolazione generale**

Modifica del contenuto energetico (W.year/m²) degli oceani 1993-2003

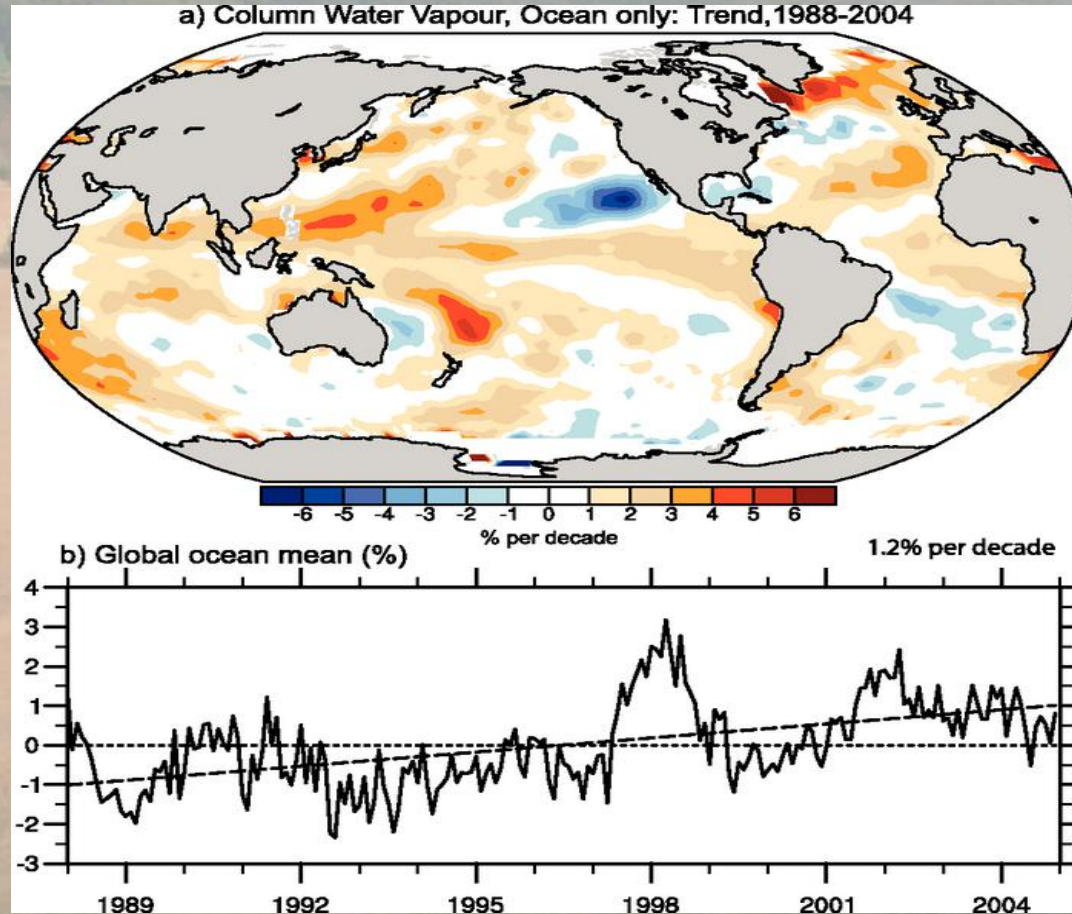




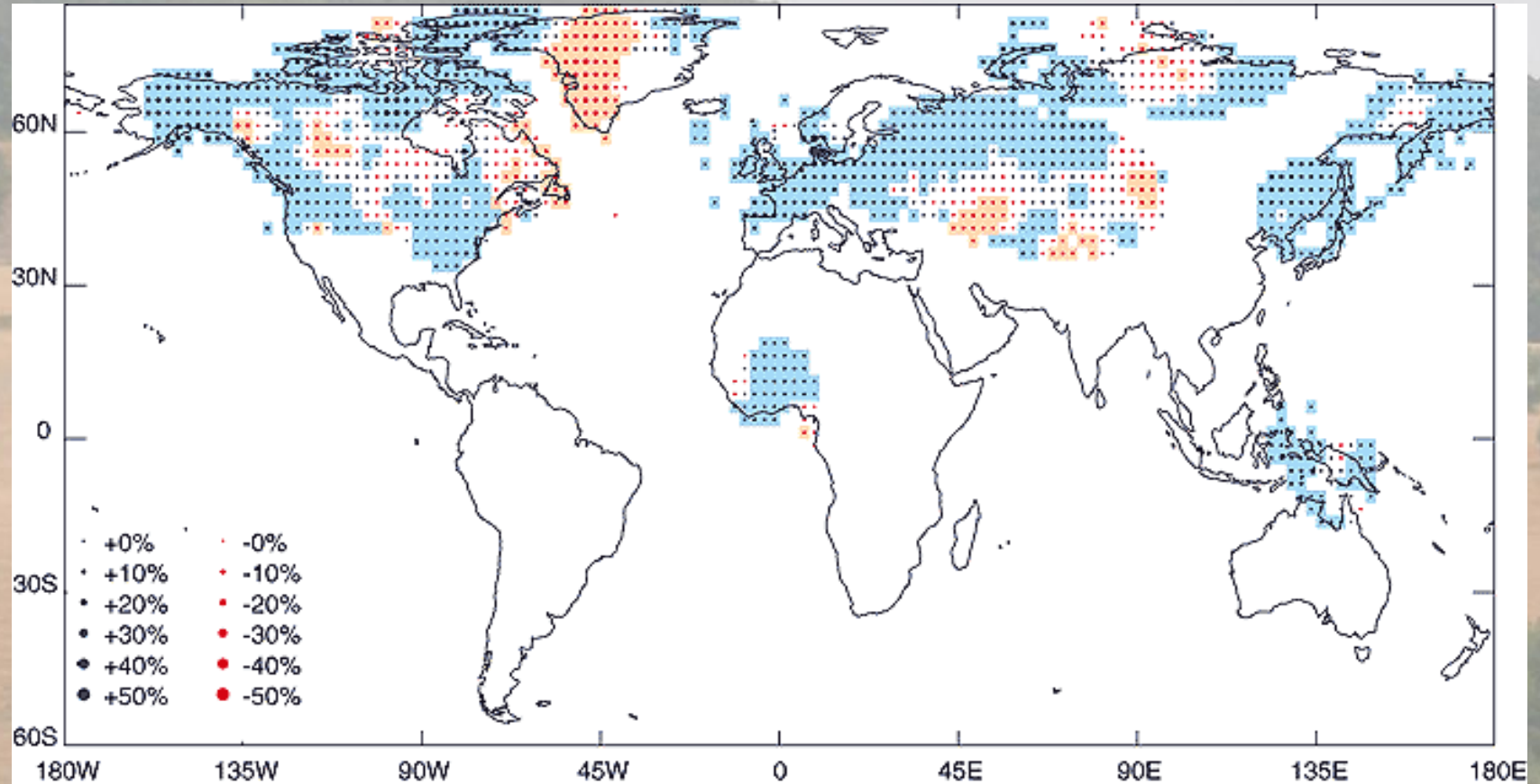
**VARIAZIONI NEL CONTENUTO
ENERGETICO (J) dell'Oceano
Atlantico del Nord
IN BASE ALLA PROFONDITA'**

**VARIAZIONI NEL CONTENUTO
ENERGETICO (J) dell'Oceano
Atlantico del Nord
DAL 1999-2006**

Cambia il contenuto in vapor d'acqua

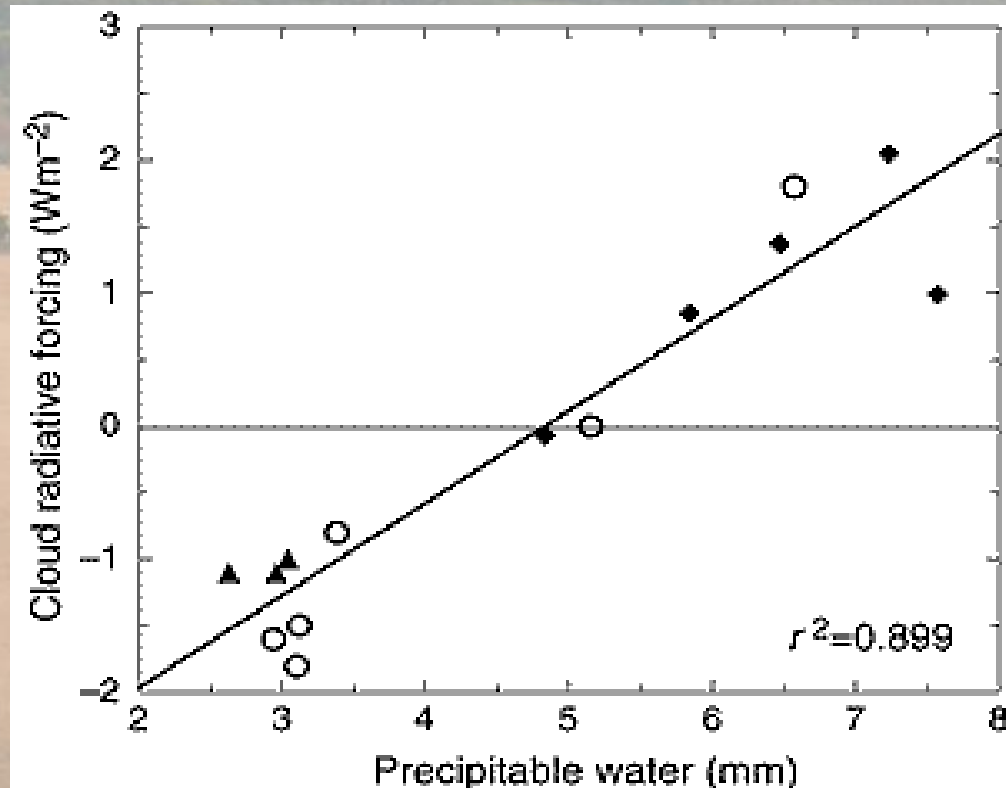


TREND NEI VALORI MEDI ANNUI DELLA PRESSIONE DI VAPORE SUPERFICIALE 1975-1995

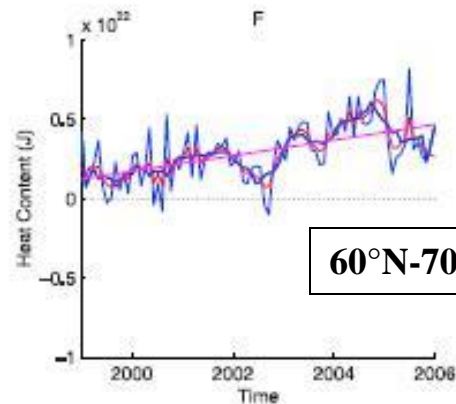
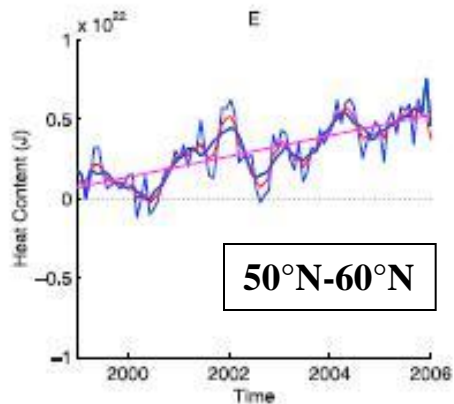
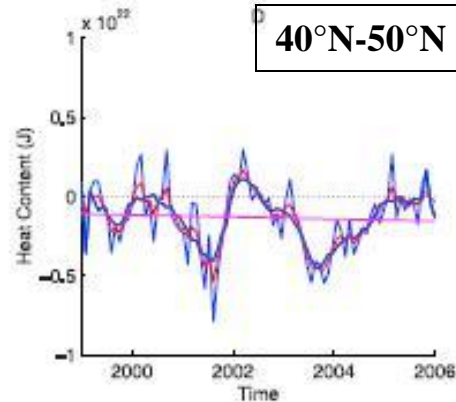
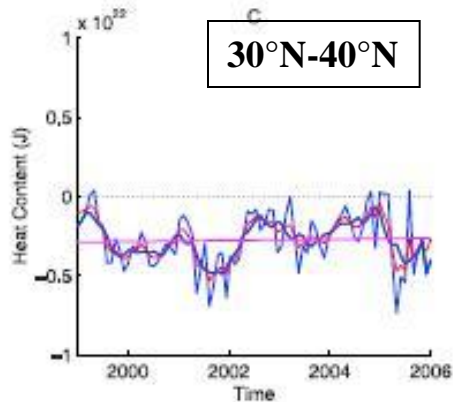
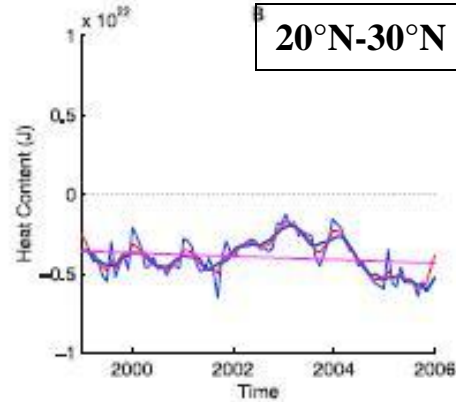
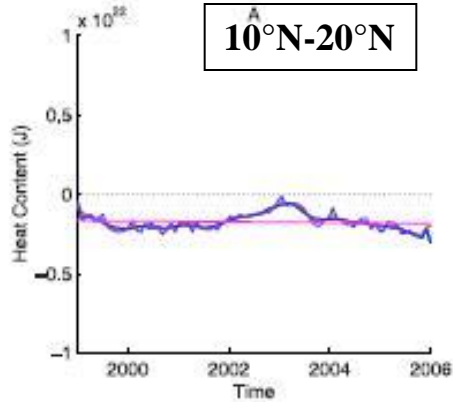


BLU: INCREMENTO
MARRONE : DECREMENTO

L'acqua precipitabile modifica la forzante radiativa



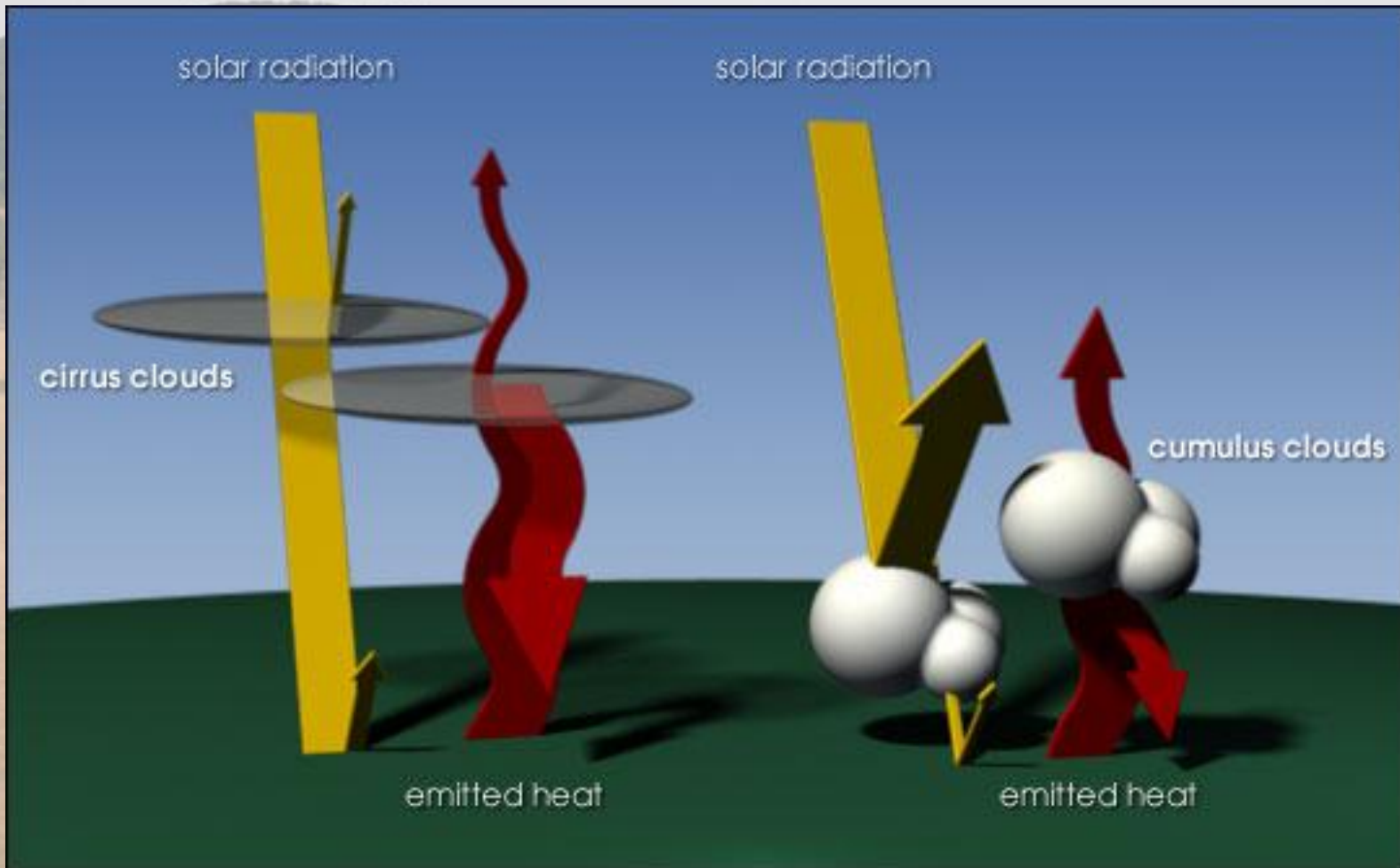
LATITUDINE



**VARIAZIONE
DELL'ENERGIA
TERMICA ALLE
DIVERSE LATITUDINI**

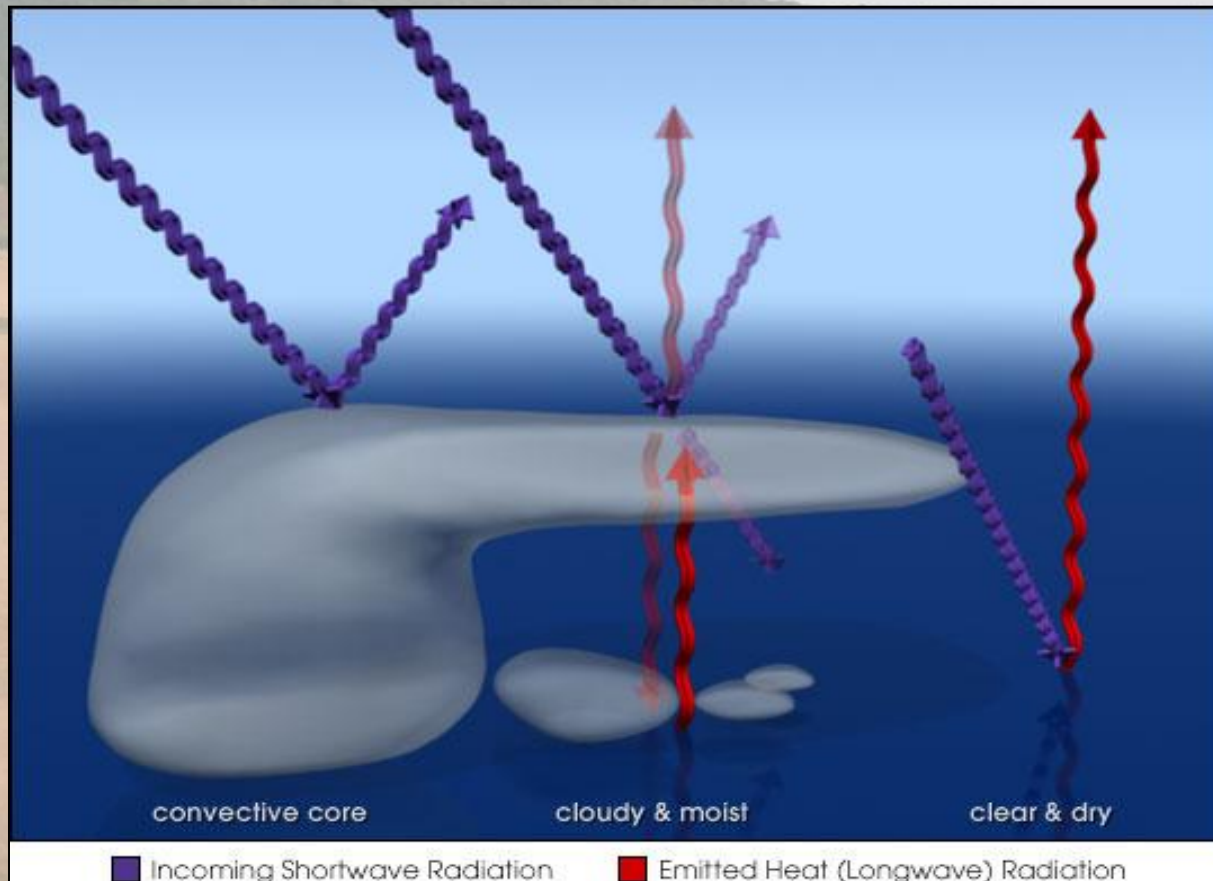
INCREMENTO NELL'ENERGIA TERMICA

EFFETTO DEI DIVERSI TIPI DI NUVOLE SUL BILANCIO TERRESTRE

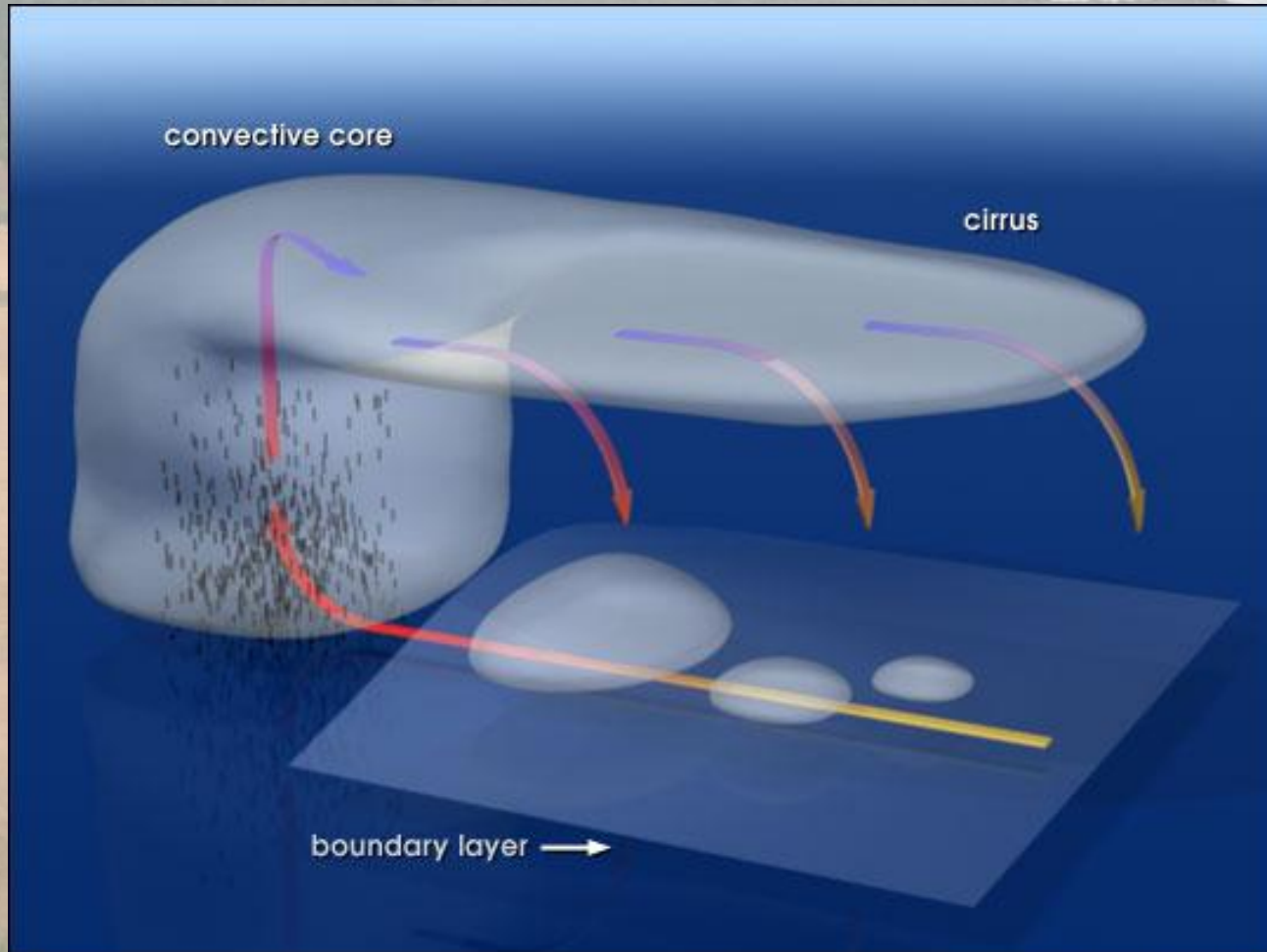


I diversi tipi di nuvole hanno un ruolo diverso nel bilancio di energia

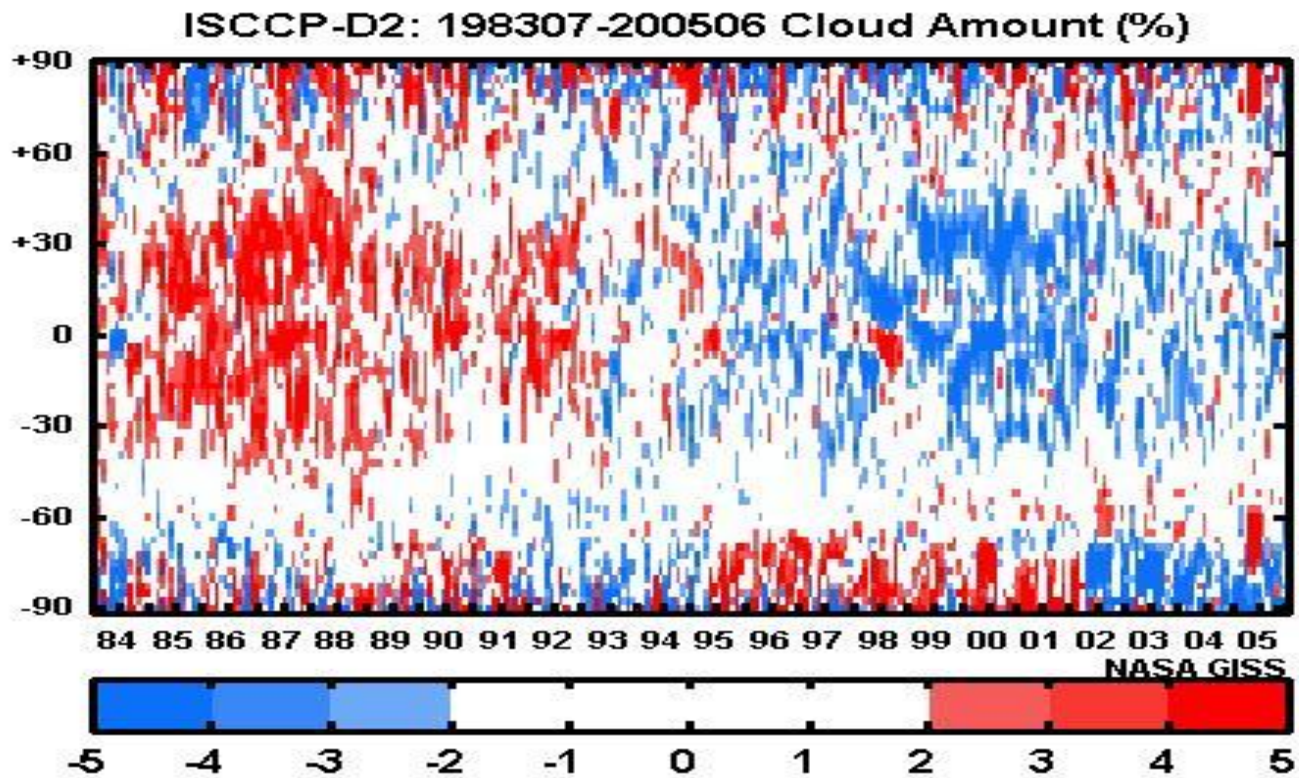
RUOLO DELLA COPERTURA NUVOLOSA NEL TRASFERIMENTO DI ENERGIA



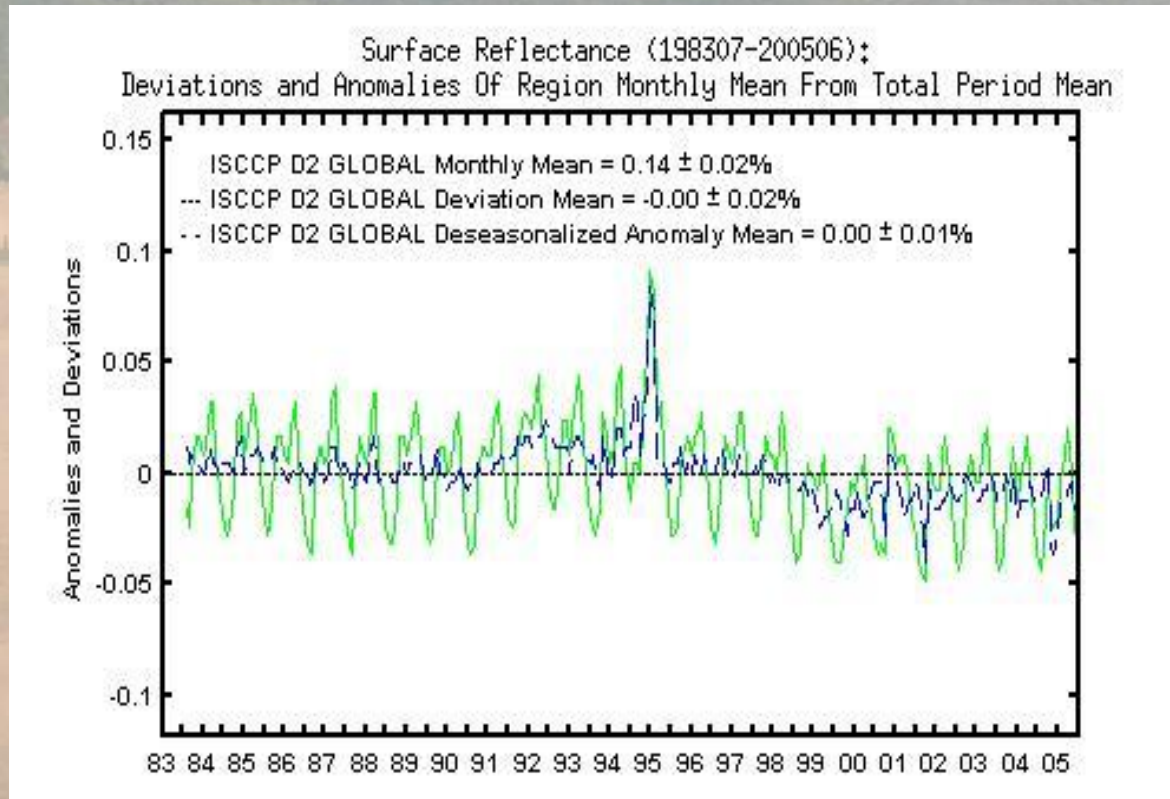
RIDISTRIBUZIONE DI CALORE ED UMIDITÀ NELL'ATMOSFERA PROVOCATO DALLA CONVEZIONE



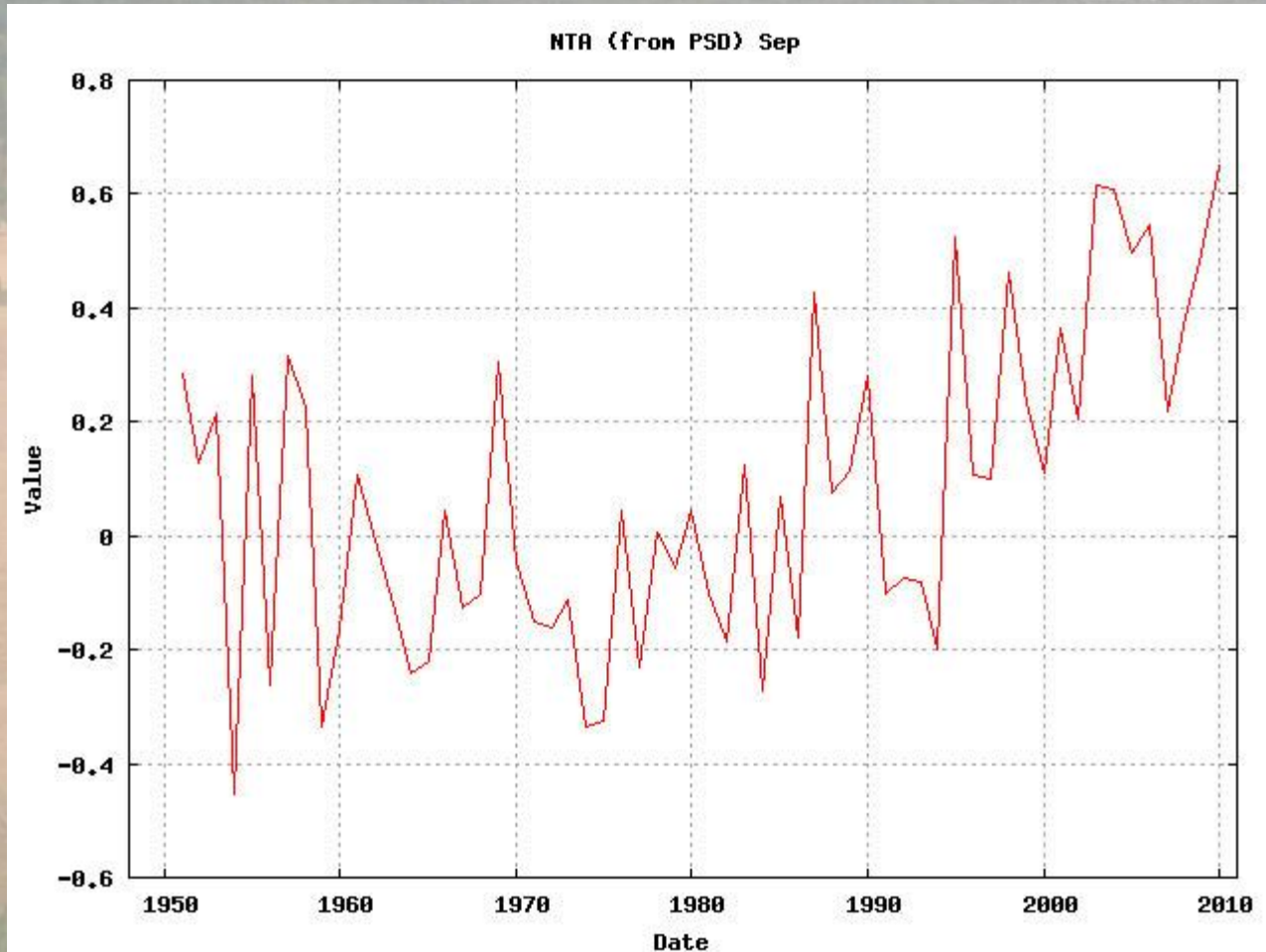
Diminuzione nuvolosità ai tropici



Diminuzione della riflessione ai tropici

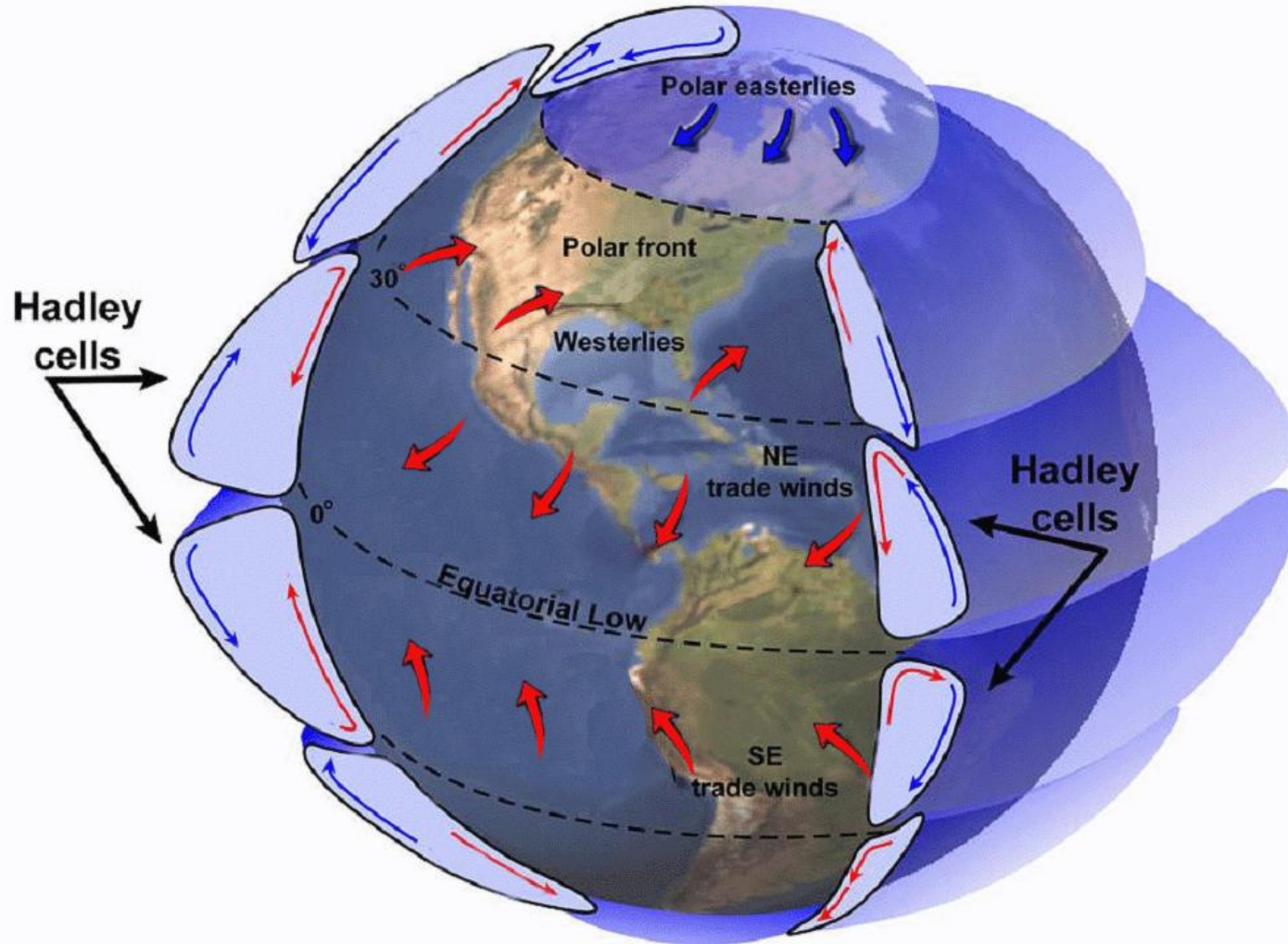


Aumenta la Ts dell'Atlantico tropicale

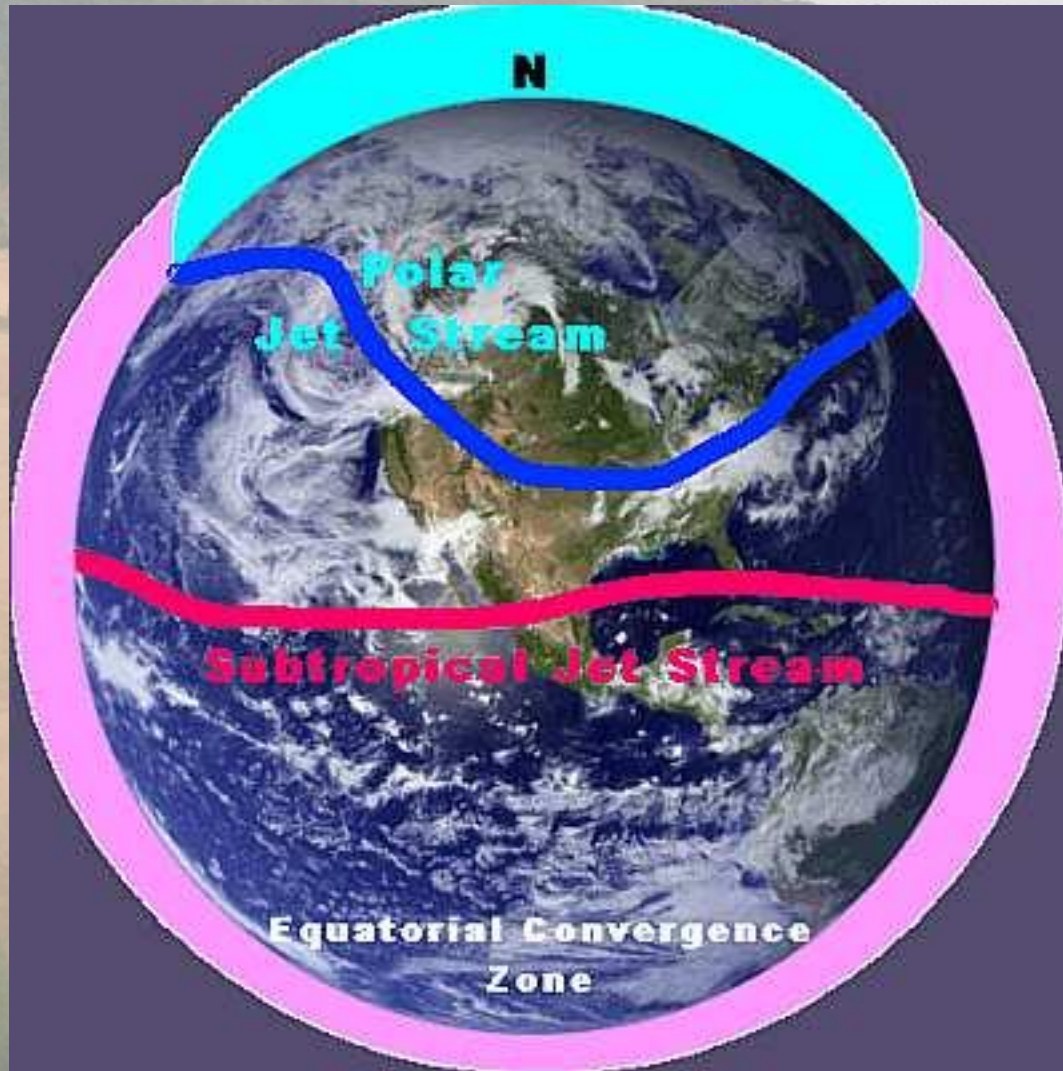


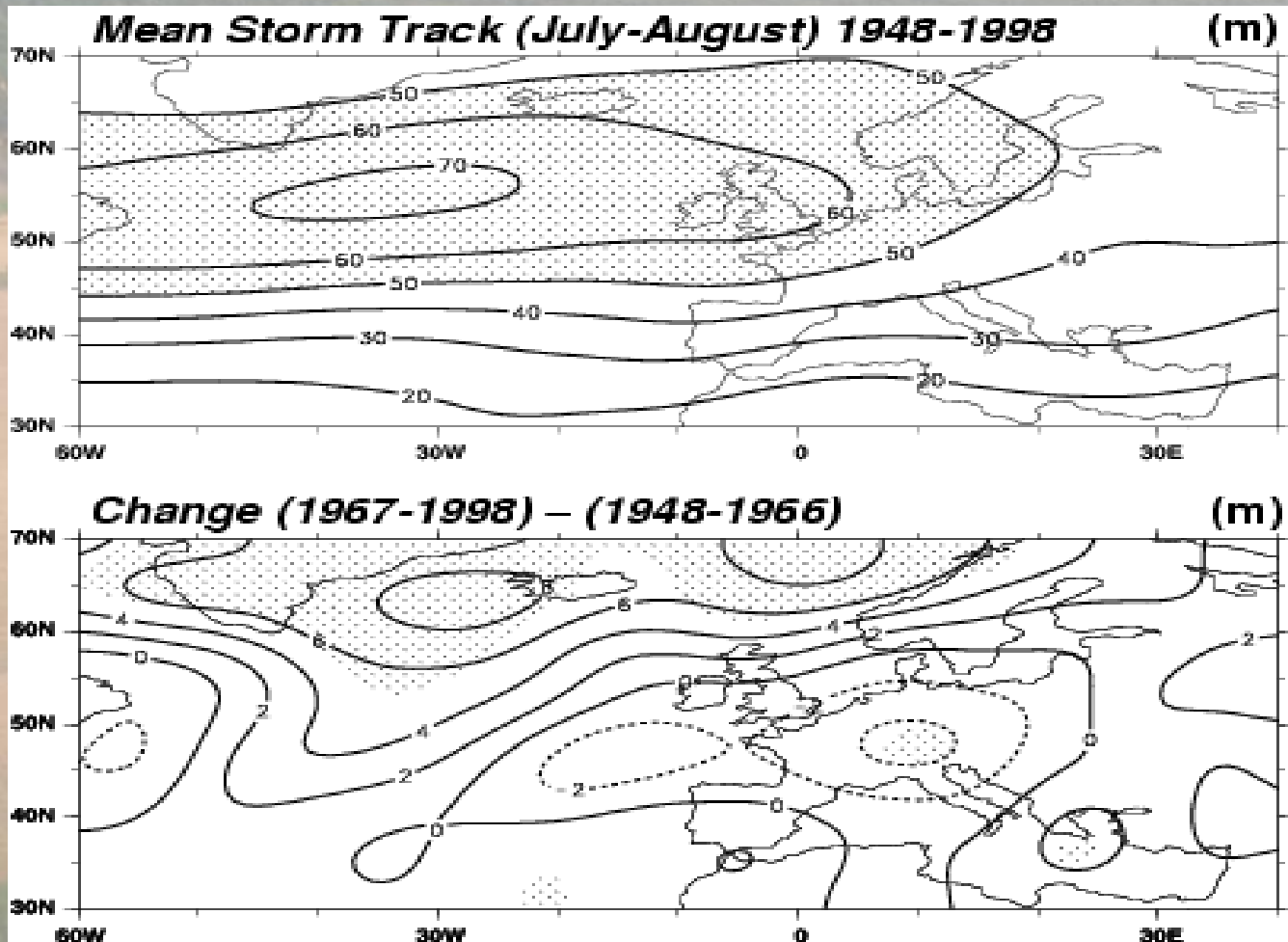
La circolazione globale è interessata dai cambiamenti

Hadley Cell



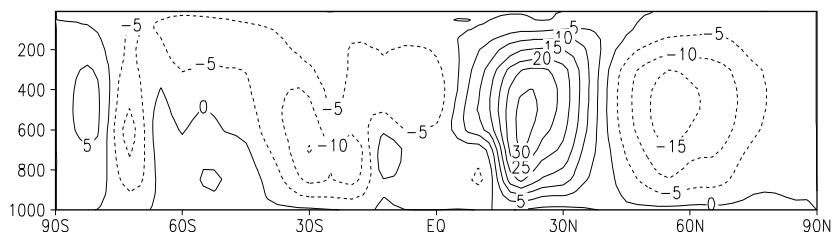
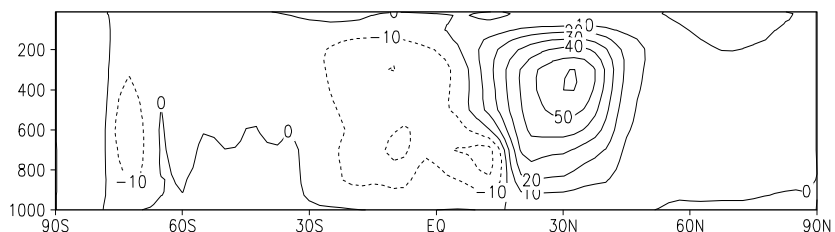
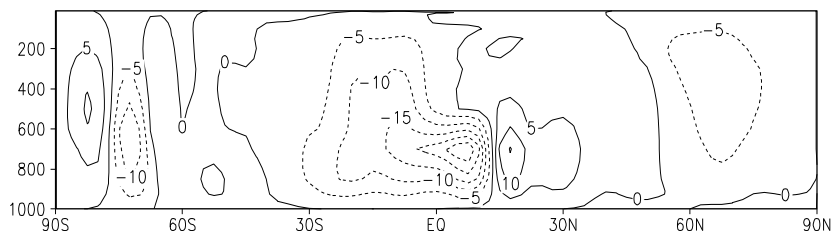
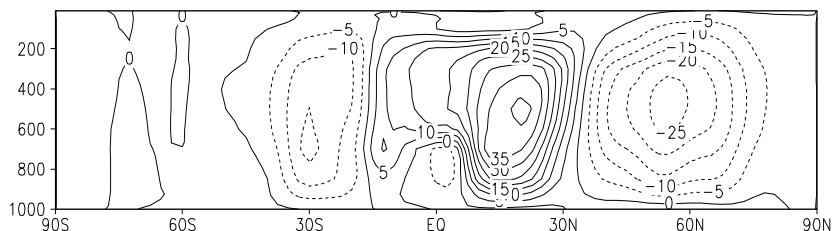
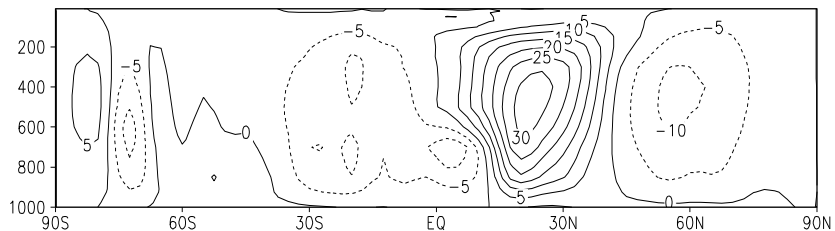
Jet Stream





Mass streamfunction [$1E10$ kg/s]
(NCEP/NCAR Reanalysis 1971-2002)

Africa



La circolazione dell'emisfero Nord è più intensa rispetto alla media zonale



Inverno

Bacino del Congo => circolazione anomala all'Equatore



Estate

La cella di Hadley si estende fino a 45°N (Mediterraneo)

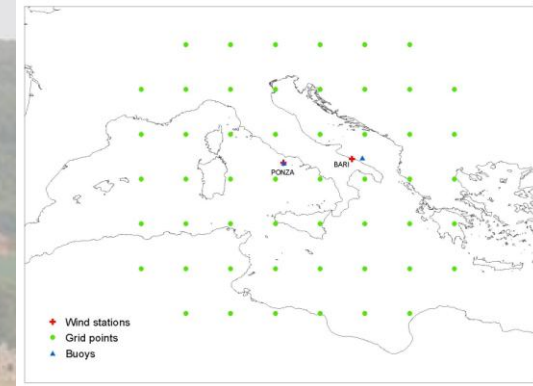
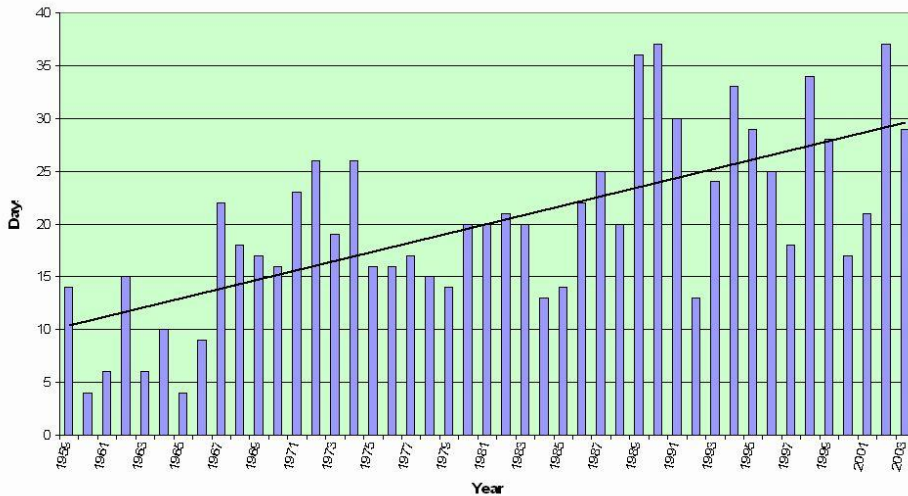
Meccanismi di Charney => intensità anomala della cella di Hadley

Tendenza dei tipi di tempo (WT)

L'anticiclone delle Azzorre si indebolisce

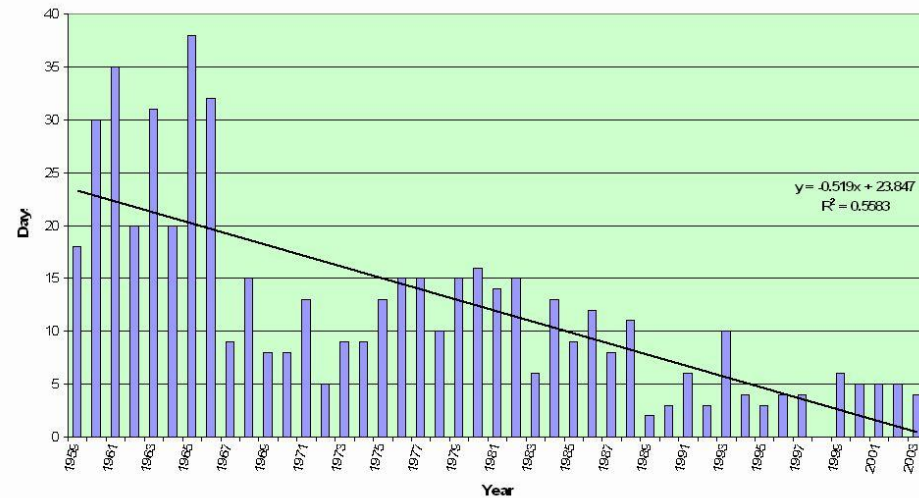
Days with Cyclonic WT - Season: Summer

$$y = 0.4368x + 9.9323$$
$$R^2 = 0.4601$$



Days with Anticyclonic WT - Season: Summer

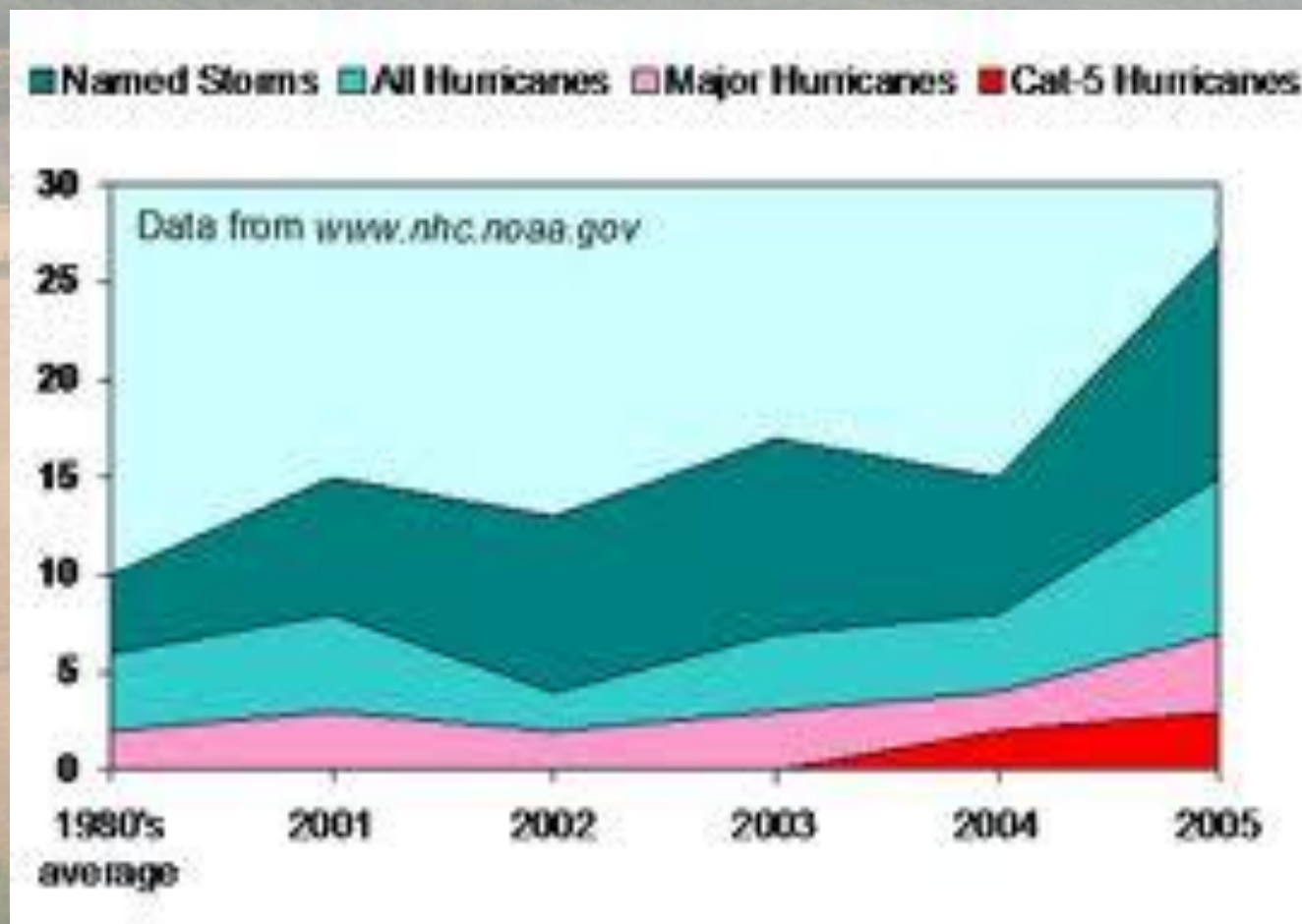
$$y = -0.519x + 23.847$$
$$R^2 = 0.5683$$



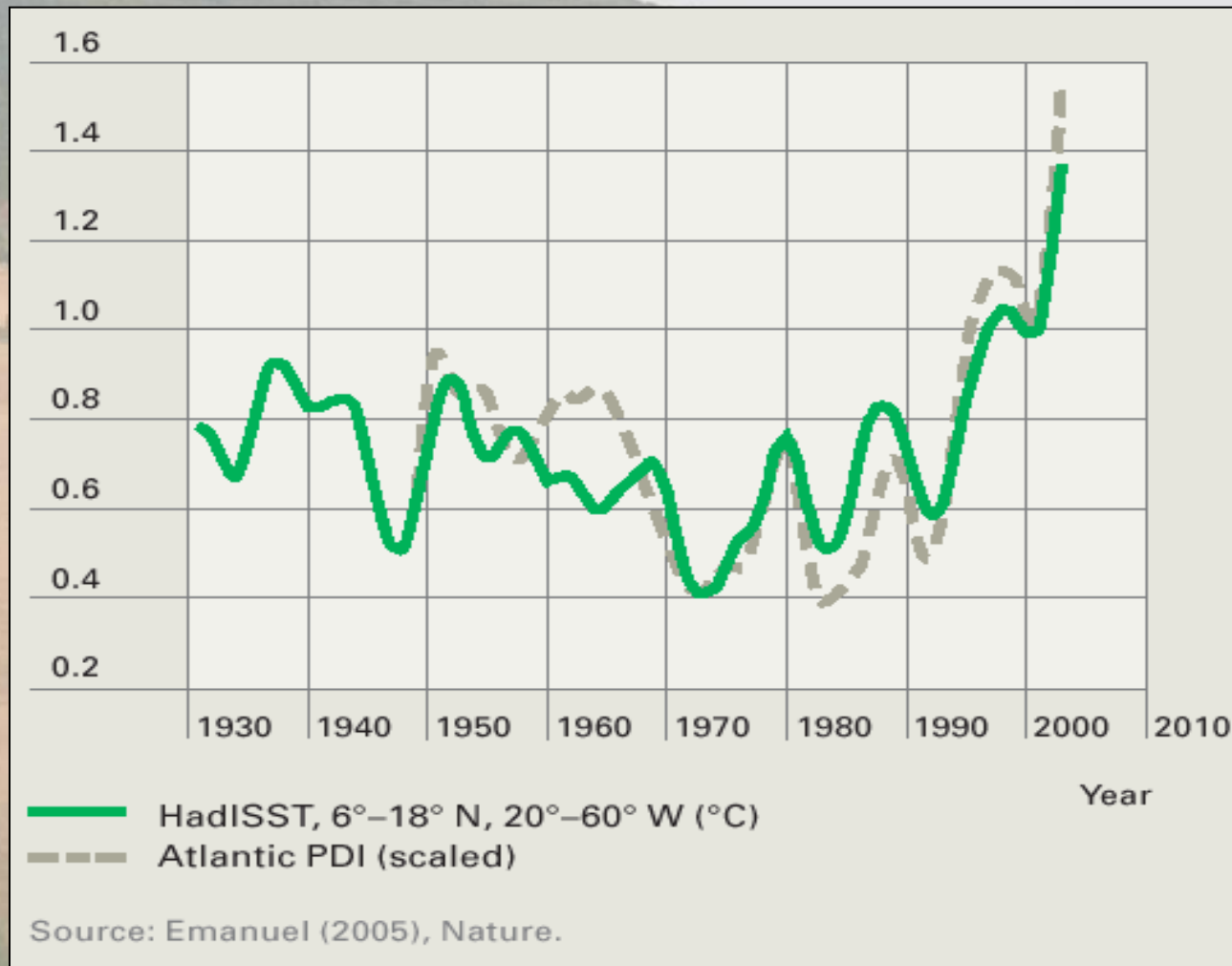



Le conseguenze

Aumentano gli eventi ciclonici importanti



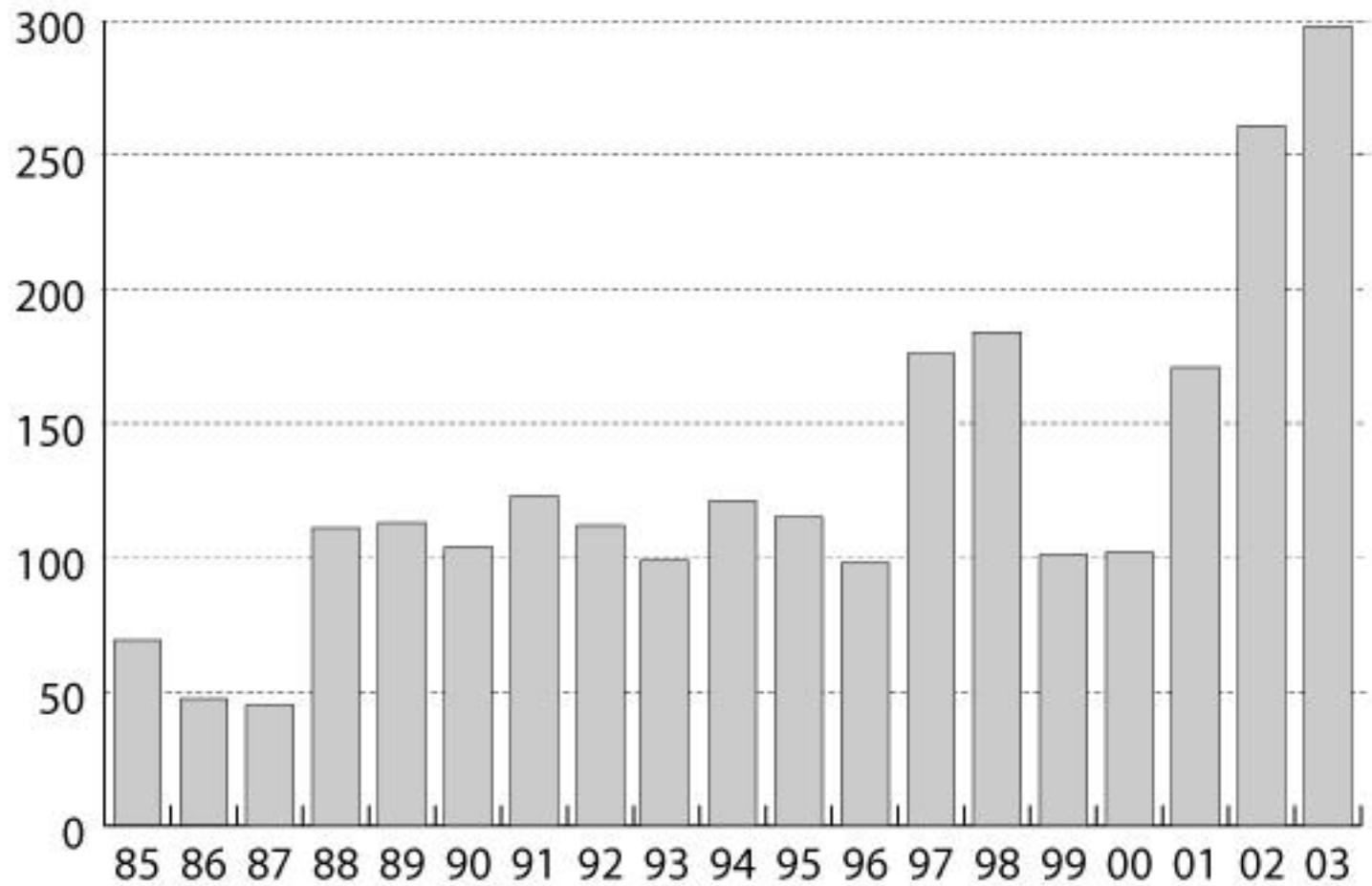
Incremento degli indici globali di energia





**Aumentano gli eventi
alluvionali**

ALLUVIONI NEL MONDO

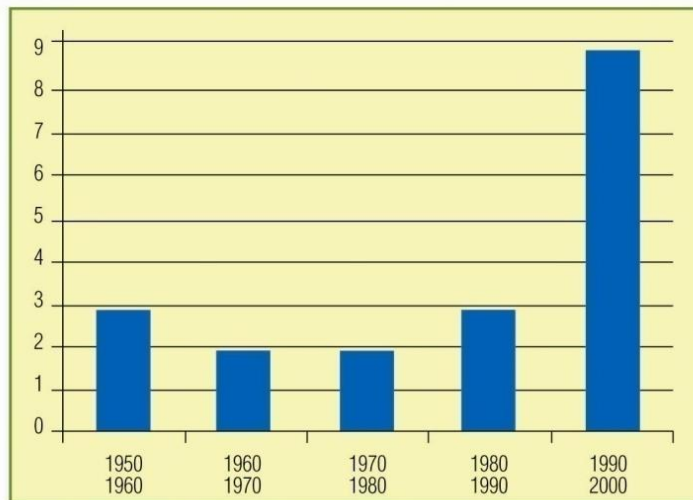


Aumento delle piogge intense

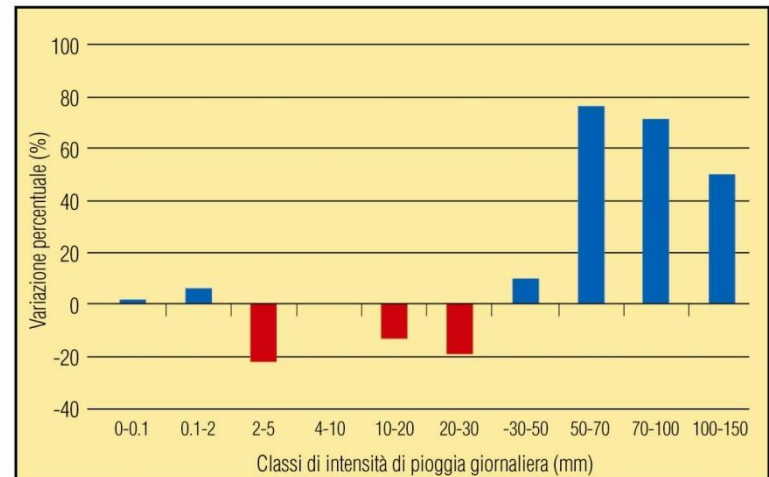
Aumento di eventi estremi di precipitazioni in Italia (1950-2000)

Aumento dell'intensità delle precipitazioni in Italia (%) negli ultimi 20 anni

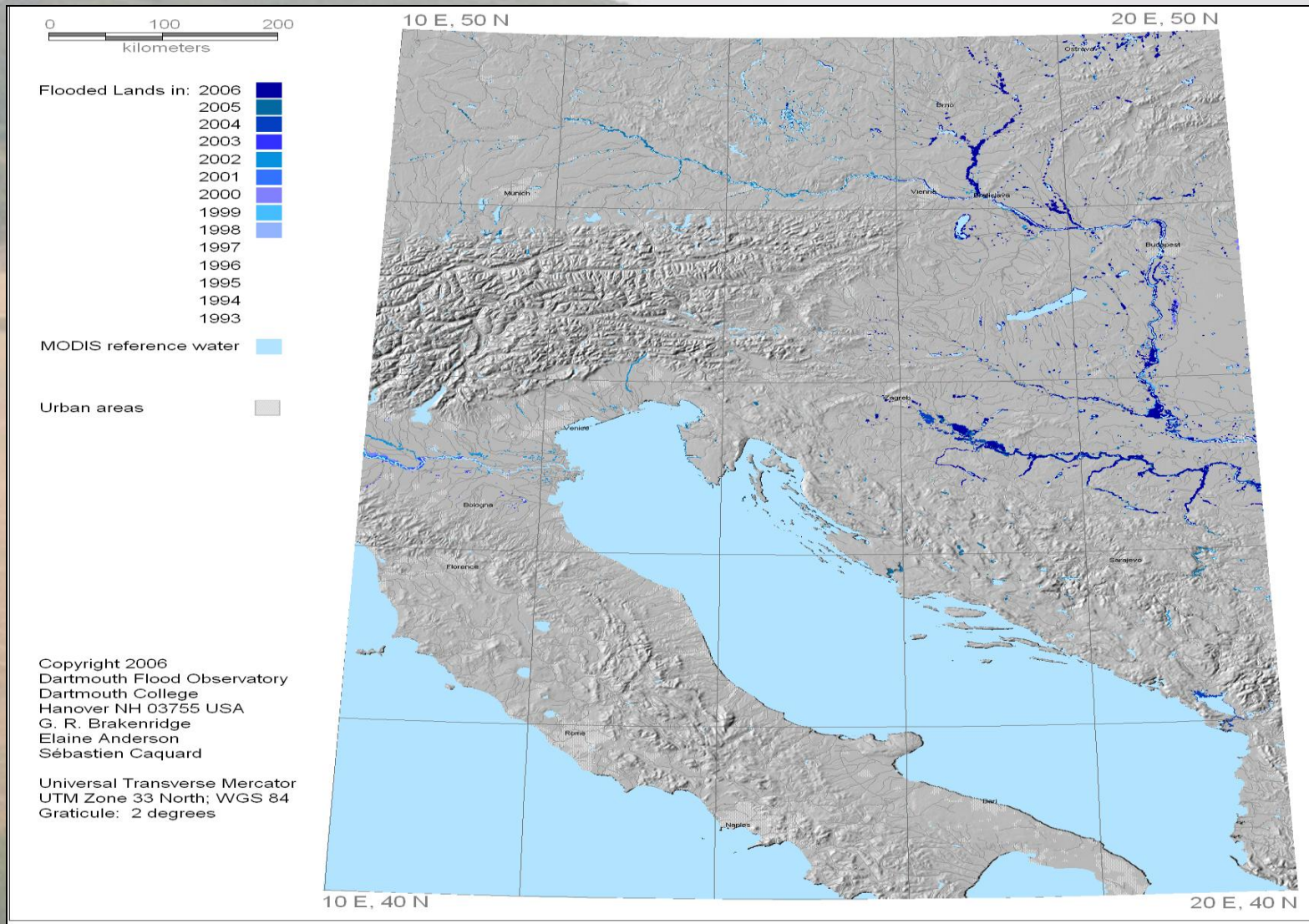
Aumento eventi estremi in Italia



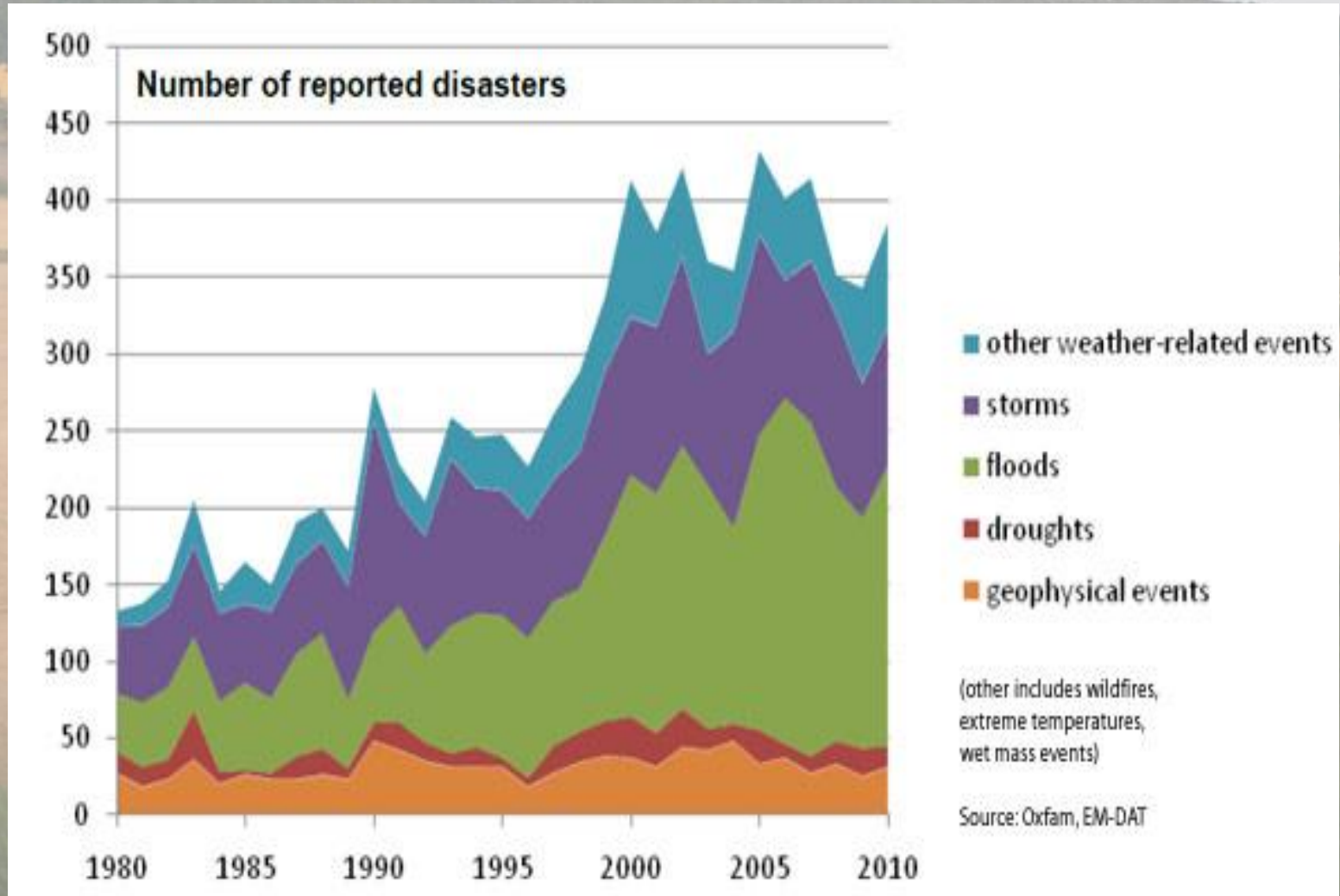
Variazione % della precipitazione giornaliera per classi di intensità
(1981/2000 - 1961/1980)



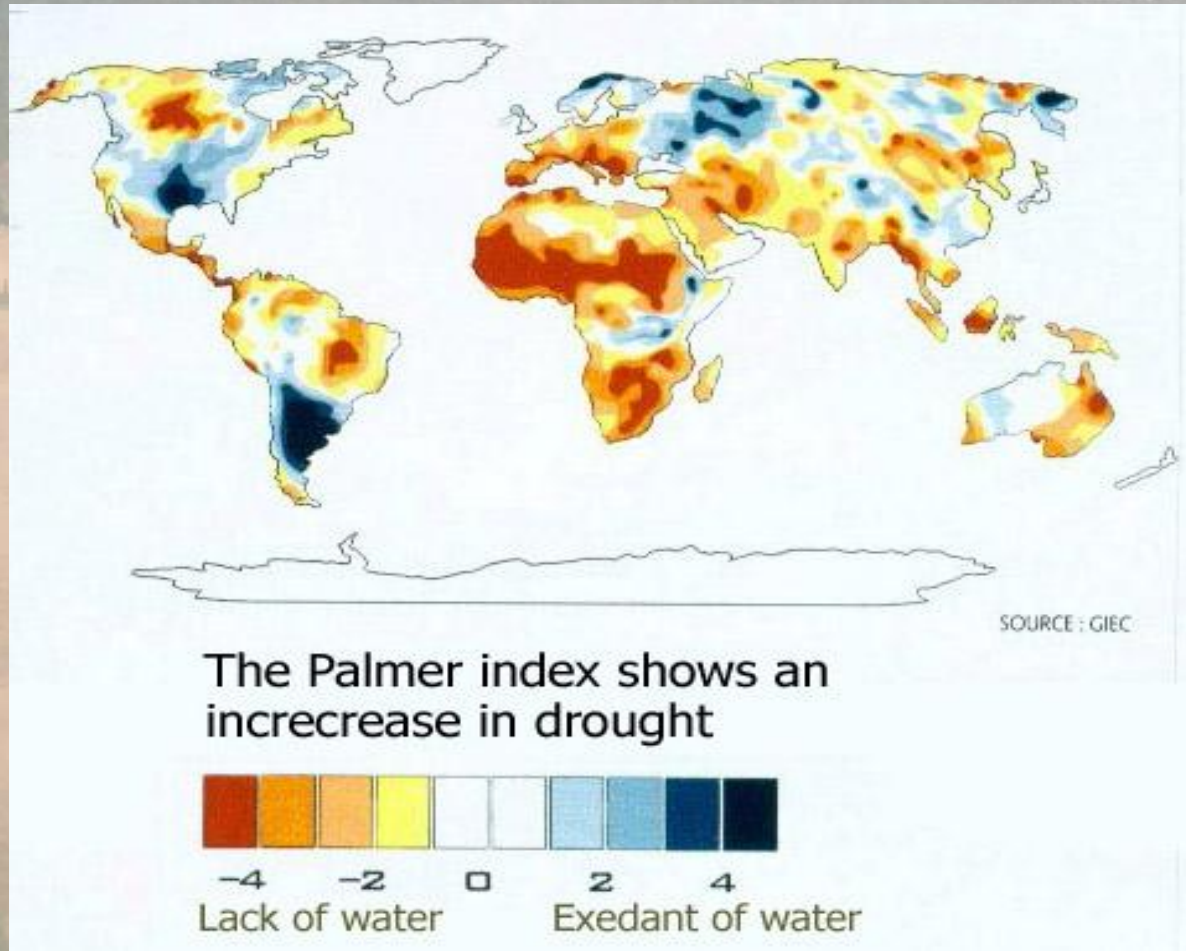
ALLUVIONI DAL 1993-2006 in nord europa



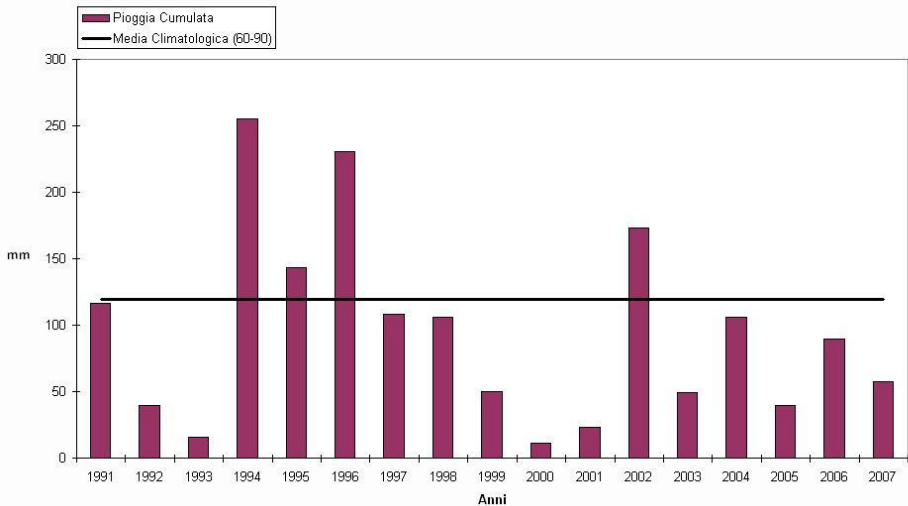
Aumenta il numero di eventi estremi



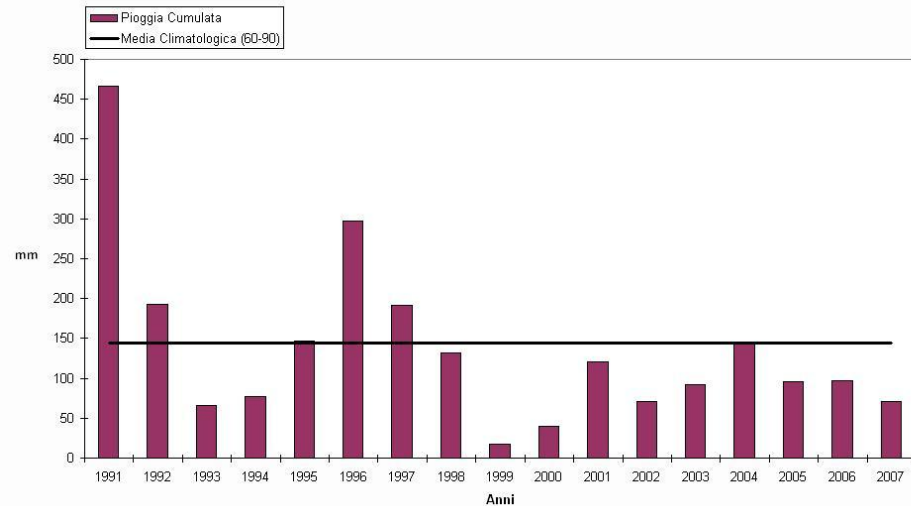
Anche la siccità aumenta



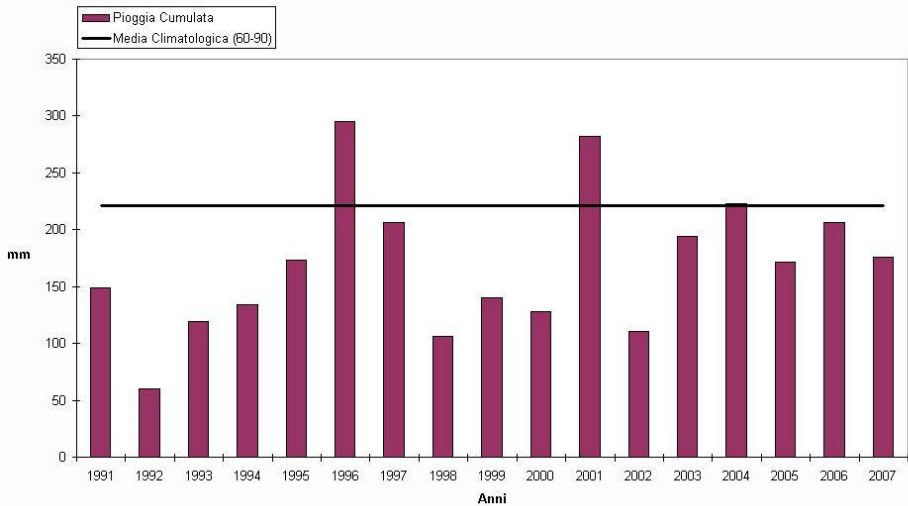
Pioggia cumulata (Dic-Feb)
TORINO



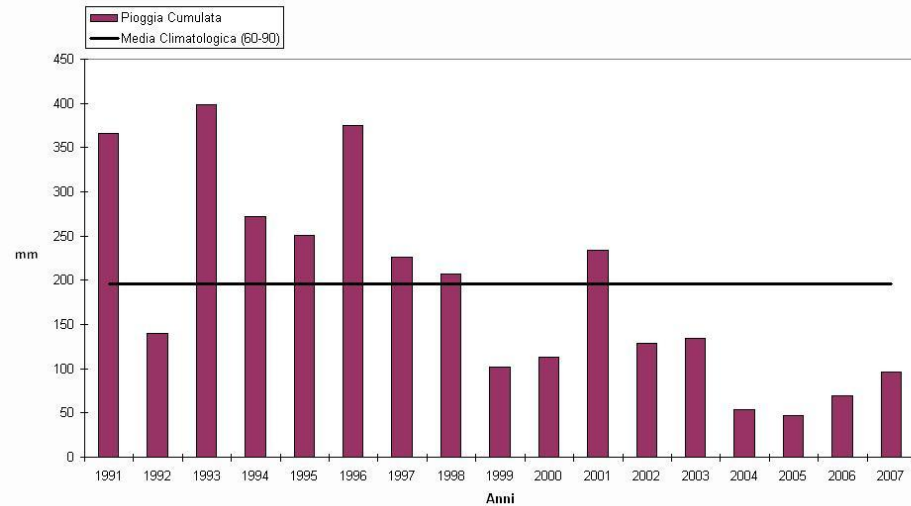
Pioggia cumulata (Dic-Feb)
VERONA



Pioggia cumulata (Dic-Feb)
FIRENZE

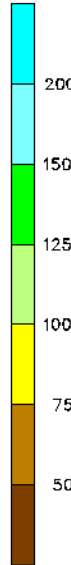
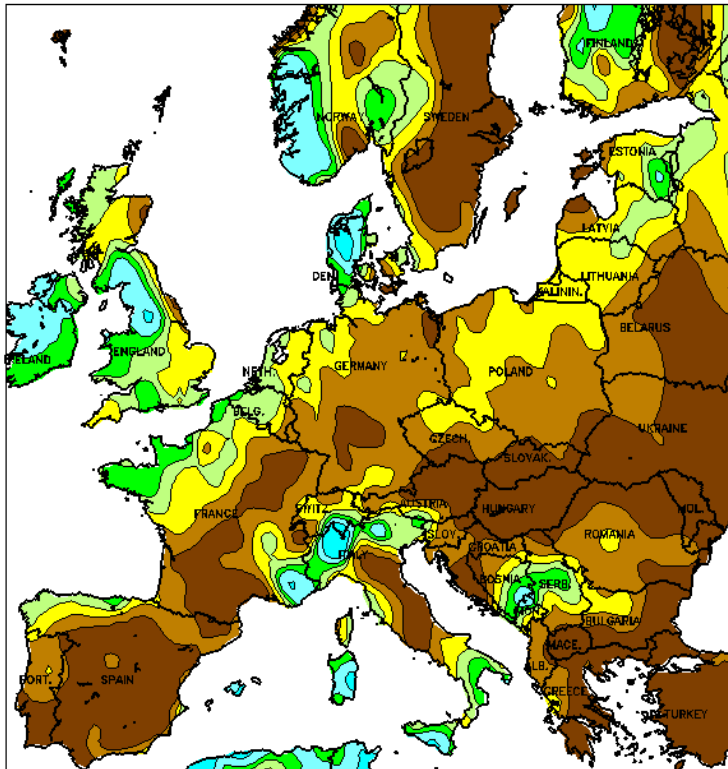


Pioggia cumulata (Dic-Feb)
PALERMO



Dicembre 2006

EUROPE
Percent of Normal Precipitation
December 2006

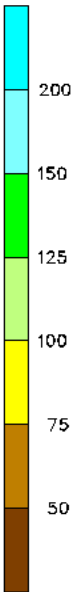
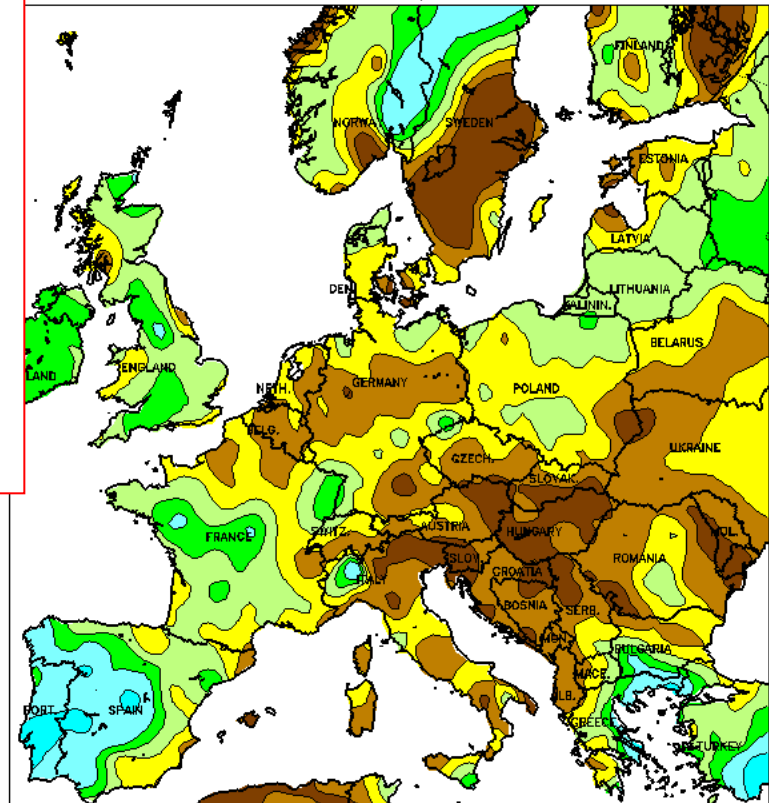


CLIMATE PREDICTION CENTER, NOAA
Computer generated contours
Based on preliminary data



Settembre-novembre 2006

EUROPE
Percent of Normal Precipitation
SEP 1 - NOV 30, 2006

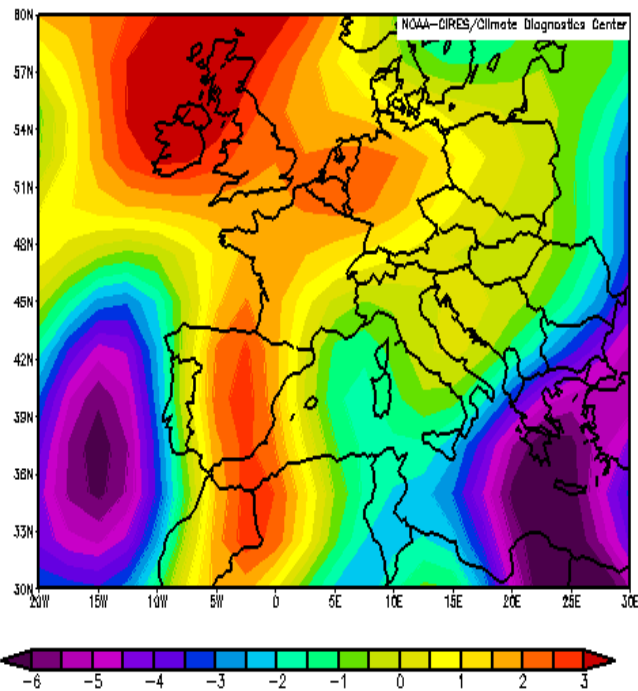


CLIMATE PREDICTION CENTER, NOAA
Computer generated contours
Based on preliminary data

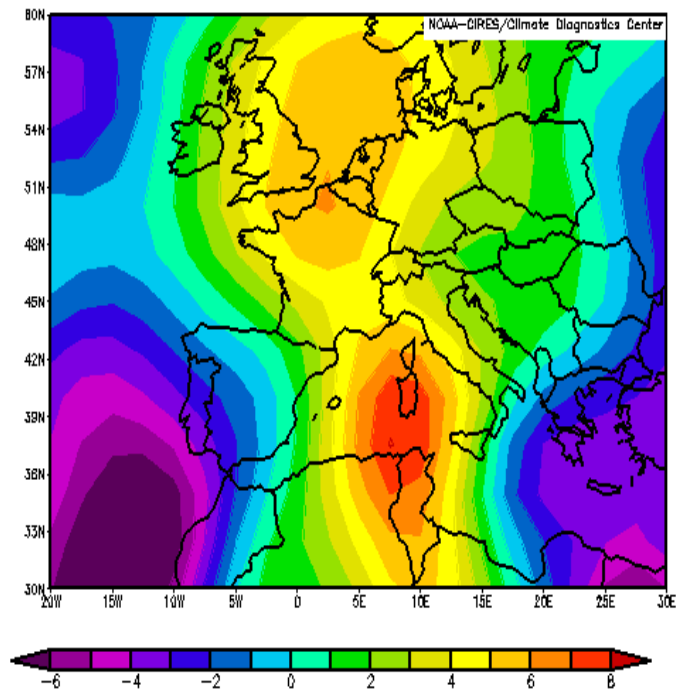


Variazioni delle
precipitazioni

Aumento eventi di “heat waves” / “Ondate di calore” estive



**9 giorni consecutivi
nel giugno 2002
con $T_{max} > 34^\circ$
Firenze - Estremo secolare**



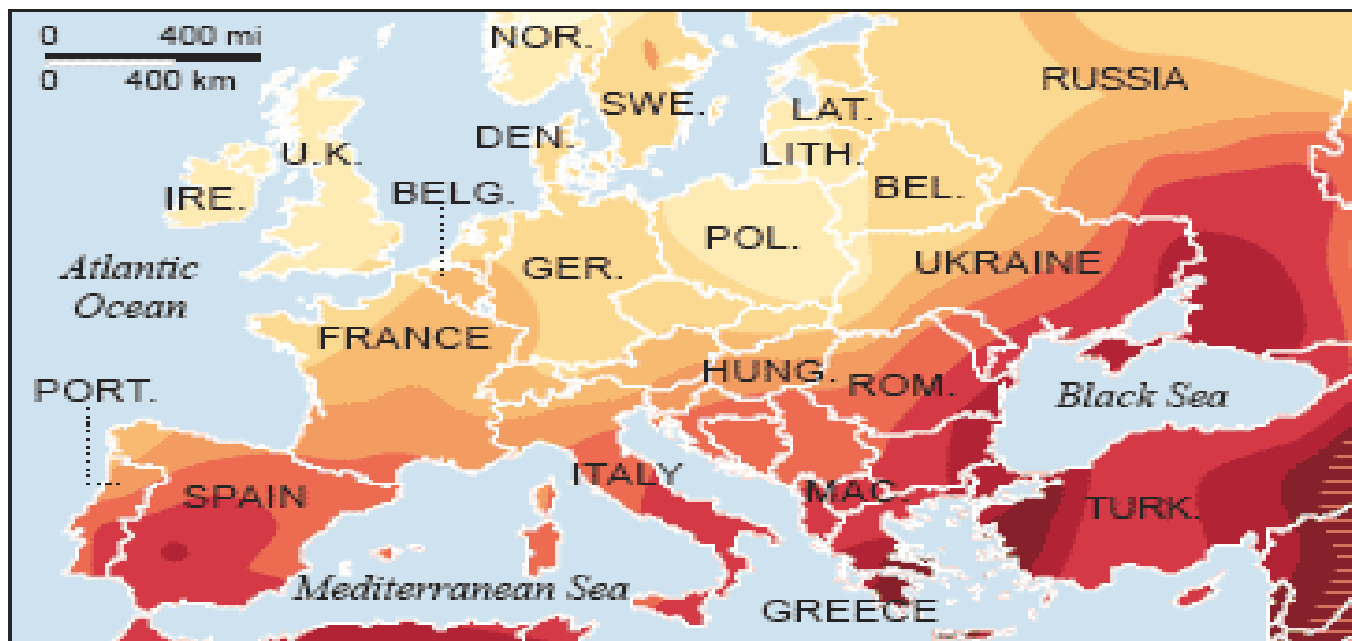
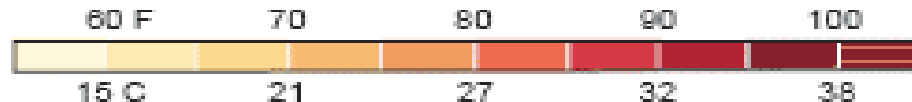
**5 giorni consecutivi
nel maggio 2003
con $T_{max} > 30^\circ$
Firenze - Estremo secolare**

Conseguenza : le ondate di calore

Oppressive heat settles in Europe

Officials warned citizens, especially the elderly, to stay indoors and drink plenty of water during the summer's second major heat wave.

Temperature,
Wednesday,
10 a.m. EDT



NOTE: Average temperatures from highest to lowest elevation

SOURCE: Weather Underground

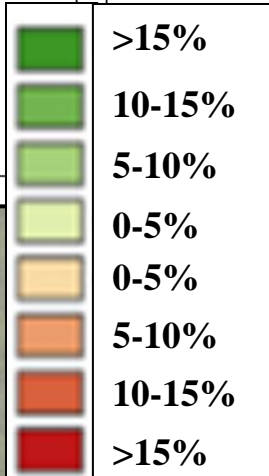
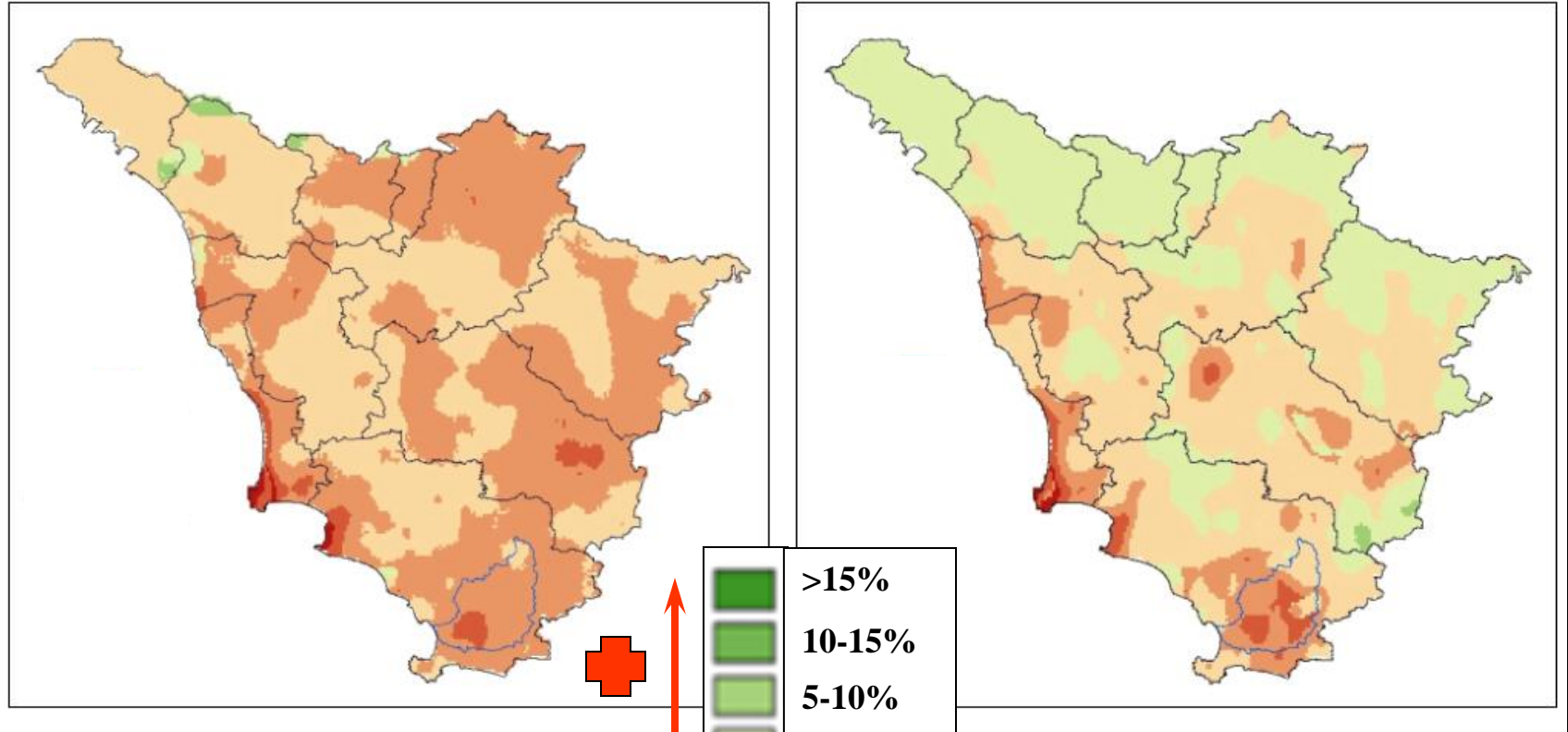
AP

Aumento della siccità

Variazione NDVI (1986-2003)

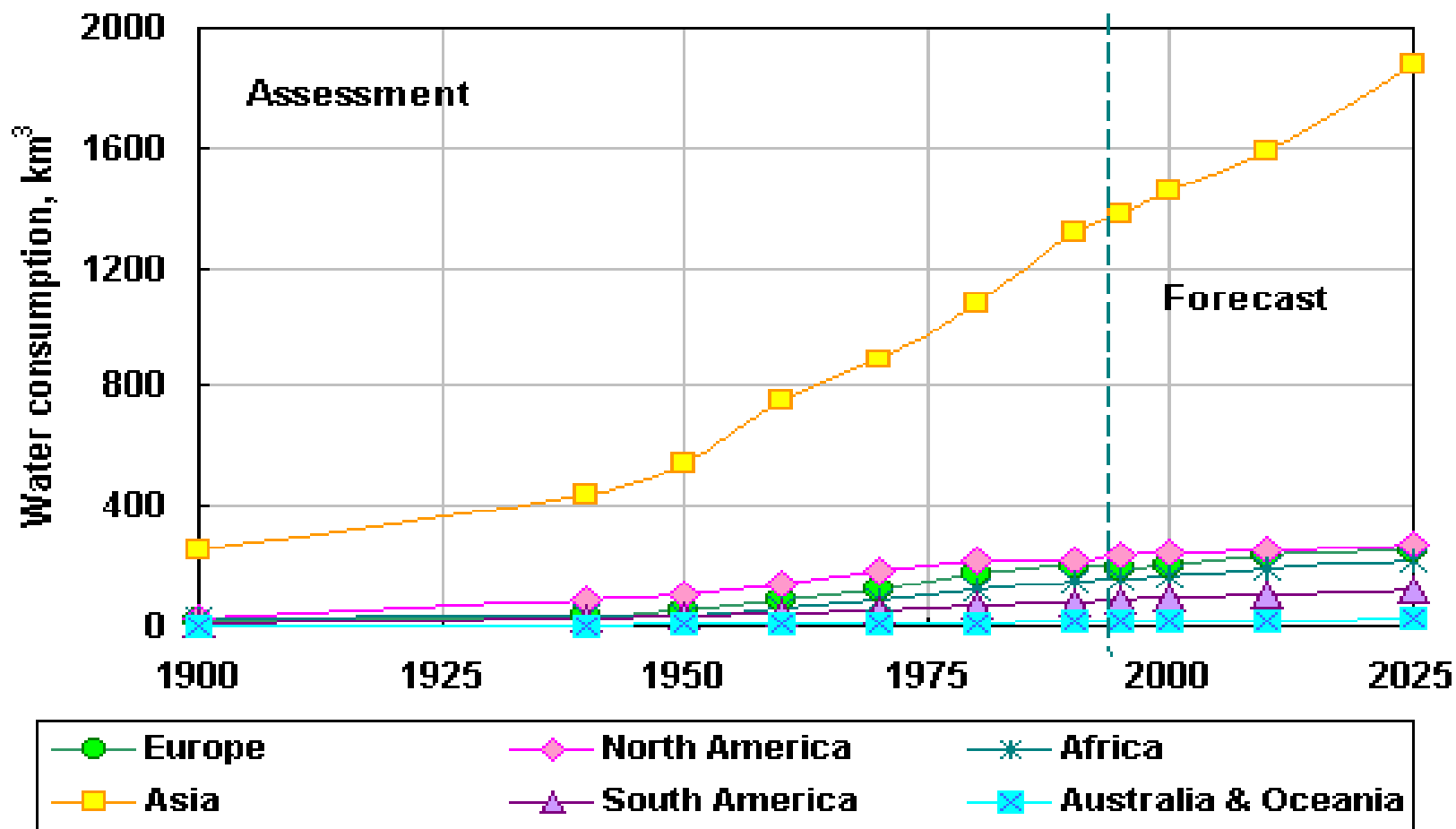
ESTATE

PRIMAVERA

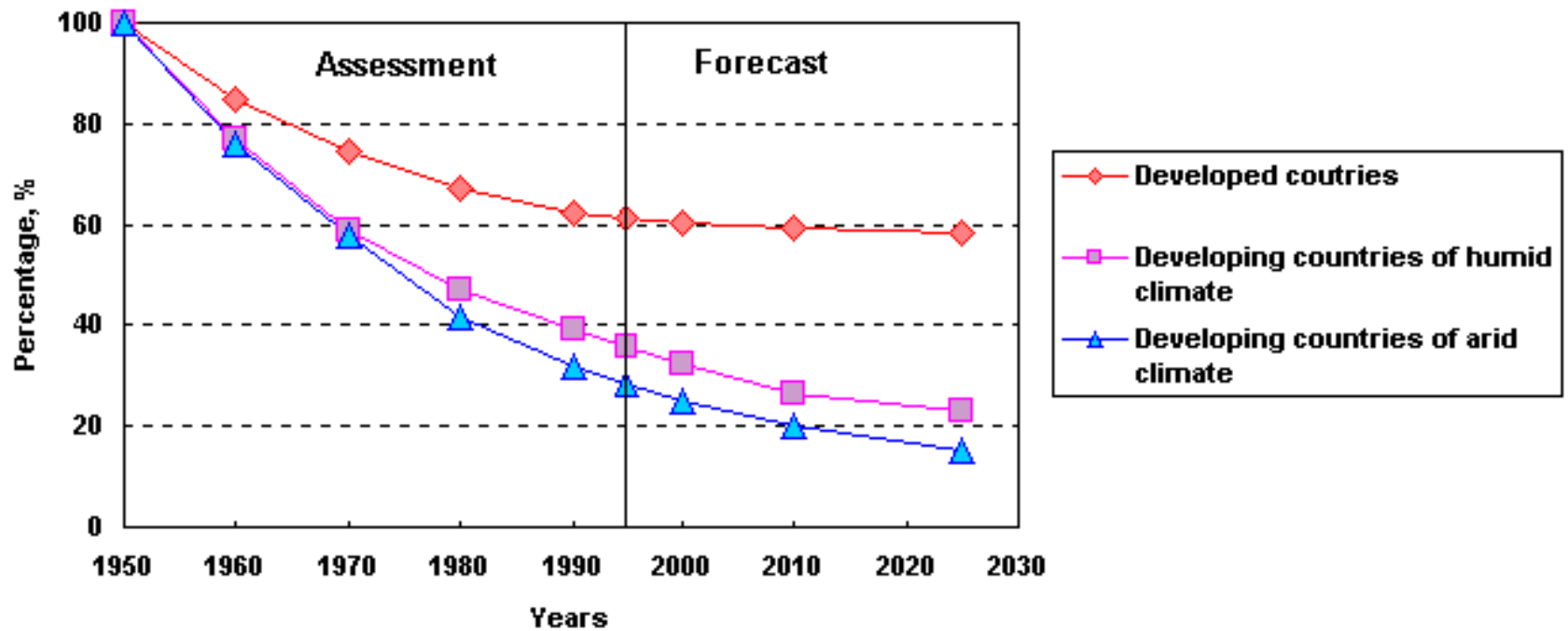


CONSUMI MONDIALI DI ACQUA

World



TREND TEMPORALE delle disponibilità idriche



Conclusioni

- **Le modifiche del clima si possono riassumere nell'aumento :**
 - **delle piogge intense**
 - **della siccità**

Pertanto è necessario :

- **rivedere la progettazione dei sistemi di smaltimento delle acque**
- **creare degli invasi per le risorse idriche**