La sfida della scienza del clima

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However, all the mouths of the Nile, with the exception of the branch at Canopus, are obviously artificial and not natural. And Egypt was nothing new, though he is in relation to such changes.

(…)
This happened to the land of Argos and Mycenae. In the days of the Trojan wars the Argive land was marshy and could only support a small water plant; but at the time of the seventh Olympiad the land of Mycenae was in good condition. But now the opposite is the case, for the marshy land is completely dry and barren, while the Argive land has become fruitful. Now the same process this year is going on over whole countries and on a large scale.

(…)
So it is clear, since there will be no end to the argument, that neither the Tanais nor the Nile has always been flowing, but that the region which they water has been once dry: for their effect may be fulfilled, but time cannot. And this will be equally true of all other rivers. But if rivers come into existence and perish and the same parts of the earth were not always moist, the sea must needs change correspondingly. And if the sea is always advancing in one place and receding in another it is clear that the same parts of the whole earth are not always either sea or land, but that all this changes in course of time.
The Climate Machine

Solar Radiation

Earth Radiation
Una serie di carestie senza precedenti, i cui effetti furono moltiplicati dal regime coloniale, colpì l’India nella seconda metà del XIX secolo. (1861, 1866, 1876-1878, 1897-1901). L’inserimento dell’agricoltura tropical nel sistema europeo mise in rilievo che la carestia, prodotti dai fallimenti della stagione delle piogge, non erano solo limitati all’India, ma si erano verificate anche in Cina e in Brasile.

Lo sforzo di comprendere si allarga’. Jevons, economista e statistico, elaborò una teoria secondo la quale i cicli delle macchie solari influenzavano i cicli economici e in special modo un ciclo di undici anni tra crisi finanziarie che aveva appena scoperto.

Sir Gilbert Walker, direttore del servizio meteorologico indiano nel … cercò di prevedere le variazioni interannuali dei monsoni collegate ai disastri. Si imbarcò in una colossale fishing expedition per cercare di trovare relazioni che collagassero i monsoni indiani ad altri fenomeni climatici, coordinando uno sforzo di raccolta dati senza precedenti. Analizzando i dati che gli arrivavano da tutto l’impero fu in grado di individuare una serie di relazioni a lunga distanza tra la pressione al suolo, di cui la più famosa e la più importante è l’Oscillazione Meridionale.
The interactions between atmosphere and oceans in the tropics dominate the variability at interannual scales. The main player is the variability in the equatorial Pacific. Wavetrains of anomaly stem from the region into the mid-latitudes, as the Pacific North American Pattern (PNA). The tropics are connected through the Pacific SST influence on the Indian Ocean SST and the monsoon, Sahel and Nordeste precipitation. It has been proposed that in certain years the circle is closed and a full chain of teleconnections goes all around the tropics. Also shown is the North Atlantic Oscillation a major mode of variability in the Euro_atlantic sector whose coupled nature is still under investigation.
A scientific consideration of climate (I)

Crucial experiments like the famous experiment of Michelson and Morley are not possible in climate science.

How is it possible a scientific investigation of climate?
We can make experiments if we represent the climate system via a set of mathematical relations: the equation of climate.

The equation of climate are very difficult, but they can be solved by numerical methods.

We can then treat very complex mathematical equations, paying the price of a enormous number of elementary operations.
Every generation of numerical models is like a new, more powerful, telescope or particle accelerator and they will allow us to look further into the working of the Earth climate more accurately, extensively and reliably.
Numerical Methods

Discretize the atmosphere

Fig. 2. Horizontal grid and geographical coverage.
Meteorologists in front of the Electronic Computer Project at the Institute for Advanced Study (Princeton)

Bolin Davies Charney Rossby Smagorinsky
Sort of crowded at the pole
L’anidride carbonica

Valori massimi di anidride carbonica
Global Temperature

Jan-Dec Global Mean Temperature over Land & Ocean

Anomaly (°C) relative to 1901-2000

1880 1900 1920 1940 1960 1980 2000

NCDC/NESDIS/NOAA
The climate in 2012: the Arctic

Average Monthly Arctic Sea Ice Extent
October 1979 - 2012

Sea Ice Extent
Oct 2012

Total extent = 7.0 million sq km

median
ice edge
A dark Greenland

The map above shows the percent of incoming sunlight Greenland reflected during June through August 2012 compared to the average of summers from 2000-2011. Blue indicates less sunlight reflected than average, with dark blue indicating nearly 20 percent less sunlight than average reflected back into space. (http://www.climatewatch.noaa.gov)
Ocean reanalysis

Sea Level 1987-2007 (m) estimated by Circe reanalyses
Ocean reanalysis

Temperature in °C

Whole Mediterranean

Western Basin

Eastern Basin

surface

1000 m

1400 m

Assimilation only sfc-1000 m
Salinity in practical salinity units

Ocean reanalysis

Whole Mediterranean

Western Basin

Eastern Basin
The IPCC has been associated with four generations of emission scenarios:

- SA90 (1990-1992, not shown)
- SRES (2000-2012)
- RCPs (2012+)


Source: Peters et al. 2012a; Global Carbon Project 2012
Emissions are heading to a 4.0-6.1°C “likely” increase in temperature. Large and sustained mitigation is required to keep below 2°C.

Linear interpolation is used between individual datapoints.

Source: Peters et al. 2012a; Global Carbon Project 2012;
Section 2.2 and Section 2.3: SIMULATIONS OF THE MEDITERRANEAN CLIMATE AND FUTURE PROJECTIONS

T2m and Precipitation projected trends
Ci sono dei limiti all’adattamento?

Mucche olandesi, 2100 circa
La Struttura del CMCC

Calcolo Scientifico e Operazioni

Scenari Energetici

Politiche di Adattamento e Mitigazione

Impatti Economici

Esperimenti Numerici e Scenari

Impatti sull’Agricoltura

Impatti sul Suolo e sulle Coste

Servizio Climatico
Climate Change Impacts on GDP

% change of GDP wrt no CC baseline

- Italy
- Spain
- France
- Greece
- Malta
- Cyprus
- Slovenia
- Croatia
- FYug
- Albania
- Turkey
- Tunisia
- Morocco
- RoNAfrica
- RoMdEast
- RoNME
- RoA1
- ChInd
- RoW
- World
- RoW
- Med
Ottimisti ma preoccupati

A volte, sfidare la natura porta a risultati tremendi, vecchio mio!

D'accordo con te, Satanasso! Roba da farti accapponare la pelle!