Giorgio Piccardi,
pioneer of space weather

Effects of space forces on chemical and biological systems

Giuseppe Bonacina

Florence, March 12, 2023

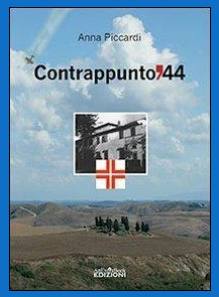
Anna Piccardi (1924-2022)

- Anna was the youngest Giorgio Piccardi's three daughters
- although without a chemistry background, Anna knew her father's work well
- I can say this because with Anna I curated the collection of Piccardi's works in the 70s and curated the museum placement of some of his instruments
- Anna maintained personal and epistolary relationships with scientific personalities such as Carmen Capel Boute (Brussels University) and the Russian scientist Alexander Tchijevski
- Anna wrote three books about her youth during World War II

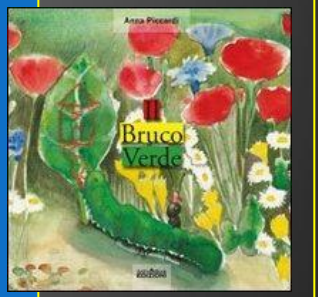
Carmen Capel Boute (1914-2003)

Alexander Tchijevski (1897-1964)

A Usigliano sotto le stelle

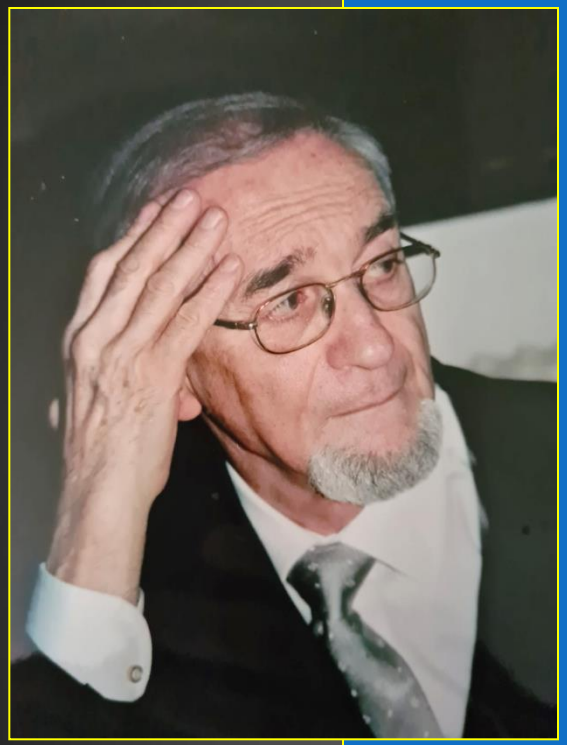


Contrappunto '44

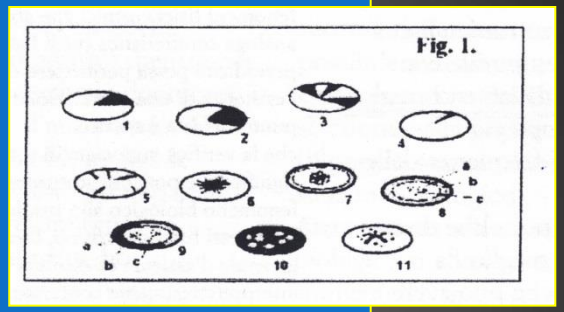


Il bruco verde

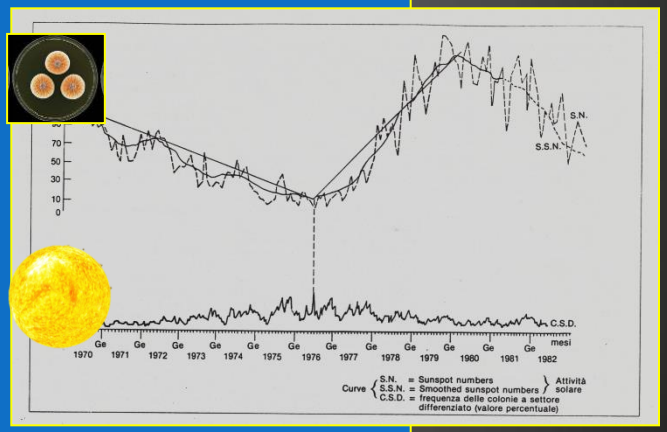
Piero Faraone (1931-2022)



- physician, researcher, poet, for me also a friend
- since 1970 Piero has carried out an original research with "differentiated sector colonies" consisting in counting, in bacterial cultures grown in standard laboratory conditions, how many colonies present sectors distinguished by colour, transparency, thickness etc.

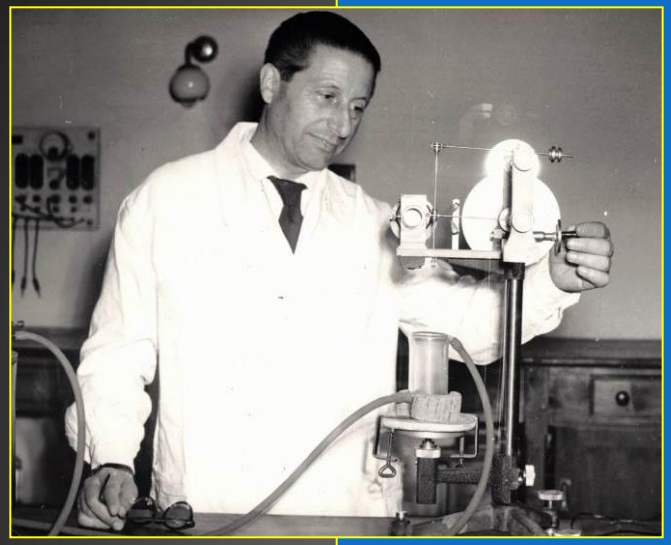


- he registered periodic fluctuations of CDS, especially according with the 11-year solar cycle

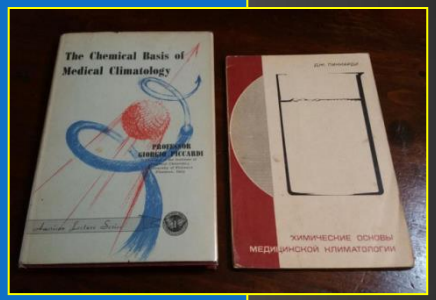


- Faraone's test is a «biological test» complementary to Piccardi's «chemical test»
- Piero was Vice President of CIFA (Comitee Internationale de Recherche ed d'Etude de Facteurs de l'Ambiance)

a natural philosopher



- 1895 born in Florence (13 October)
- 1922 graduated in Chemistruy from the University of Florence
- research on rare-earth separation and spectroscopy
- 1947 Director of Institute of Chemistry at Unversity of Florence
- 1951 start of routine chemical test
- 1957/1958 chemical test during IGY (International Geophysical Year)



1962 1967

- 1968 founder of CIFA (Comitee Internationale de Recherche ed d'Etude de Facteurs de l'Ambiance)
- author of more than 200 papers and in 1962 of he book *The chemical basisis of medical climatology* (translated into Russian in 1967)
- 1972 dead in Riccione (22 December)

Professor Enzo Frroni, his student and successor at the iInstitute of Physical Chemistry at the Univeristy of Florence, wrote of him:

> "Florentine by birth, a professor by vocation and a great gentleman of manners"

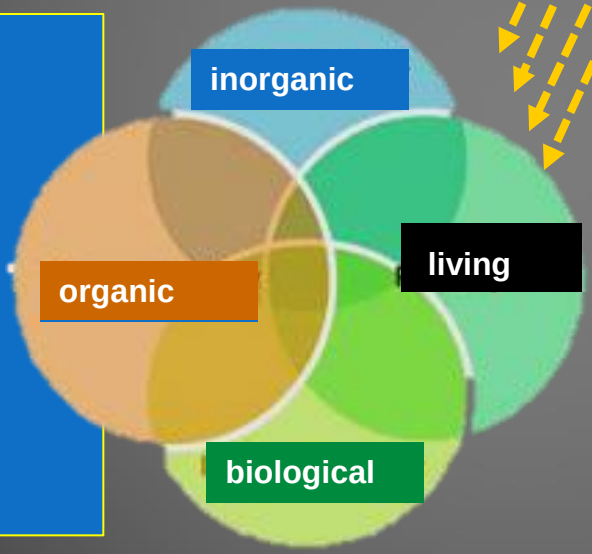
open systems and fluctuating phenomena

space forces

- electromagnetic, magnetic and corpuscular radiations that act incessantly and cannot be kept under control (primarily from the Sun)

open systems

- heterogeneous systems in evolution (especially colloidal systems) and out of equilibrium
- sensistive to space forces



fluctuating phenomena

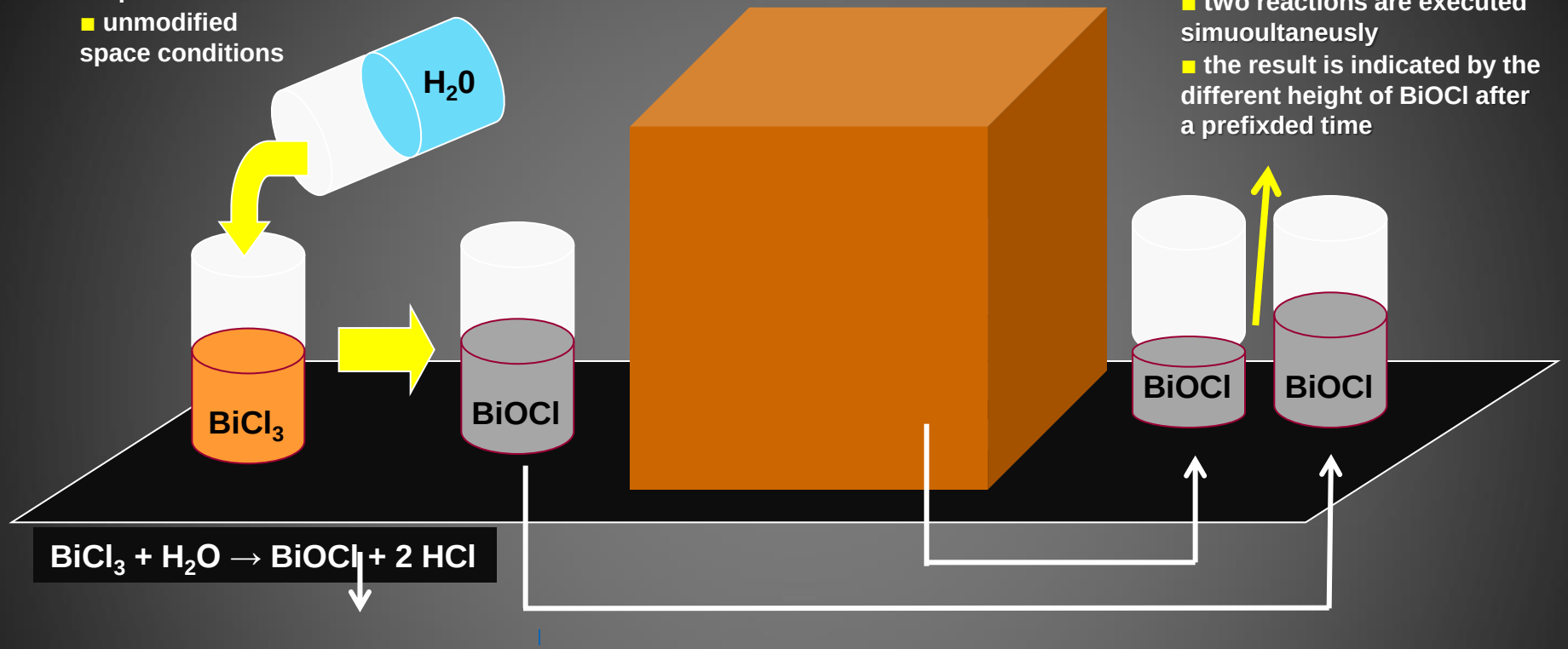
- non reproducibile but not casual
- effects may be greater than causes
- heterogenous systems complex enough and out of equilibrium, as many chemical and biologivcal systems, are sensitive to fluctuating space conditions

the chemical test P (the simplest test)

- open air
- unmodified space conditions

- under a copper screen
- modified space conditions

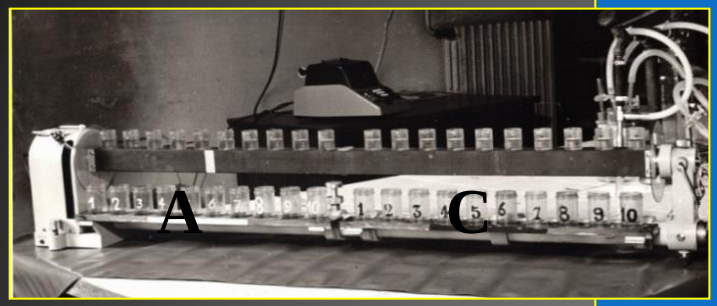
- two reactions are executed simuoultaneusly
- the result is indicated by the different height of BiOCl after a prefixded time

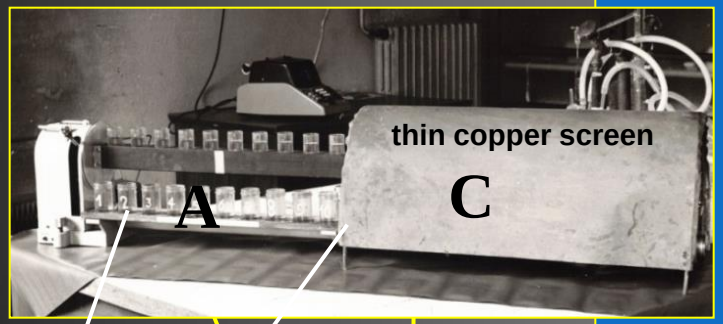


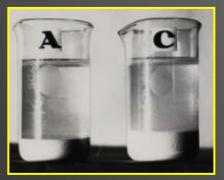
$$BiCl_3 + H_2O \rightarrow BiOCl + 2\,HCl$$

- the different result of the reactions in the two sets is evaluated by the different height of the precipitates after a fixed time (in practice, by the different precipitation speed of the BiOCl)
- test P is the simplest test of the three types of Piccardi's test

routine test research (syncrhronous mixer)

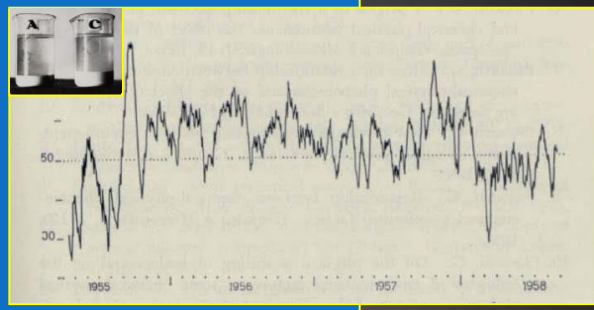






10 pairs

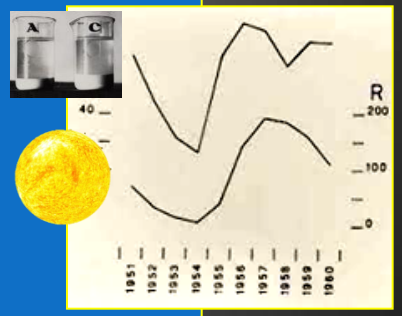
- two sets of 10 beakers (A and C) permits 20 BiOCl precipitations simultaneously, but with one set under a thin copper screen (that modifies space conditions)
- the resullt is
  - differential (independent from traditional physical forces)
  - quantitative (% on 10 couples)
  - statistical (on long periods)
- registered variations: annual, secular, latidude, altitude etc.
- a very commonplace chemical operation is a mean to discover whether important phenomena are taking place in surrounding space (above all on the Sun)



multiannual trend of chemical test

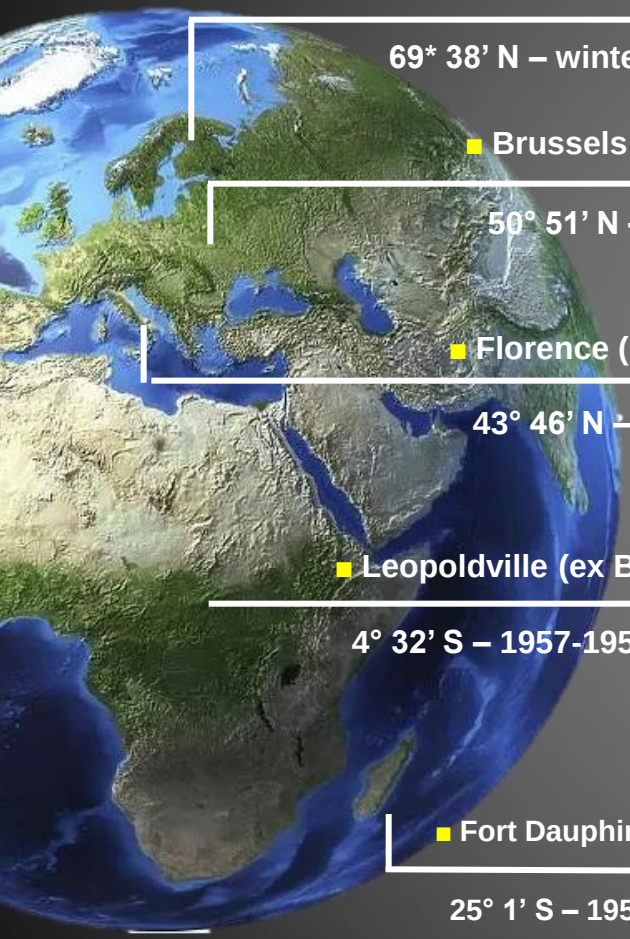
problems of Piccardi's chemical test

- a complex and imperfect experimental protocol
- relationship between qualitative and quantitative data
- absence of physical mechanisms between the parallelism of test and solar activity long-term trends: correlation does not necessarily imply causation



multiannual trend of chemical test and solar activity

execution of test P worldwide (effect of latitude)



- Tromsoe (Norway)

69* 38’ N – winter 1960

- Brussels (Belgium)

50° 51’ N – 1952-1978

- Florence (Italy)

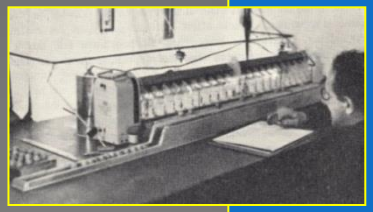
43° 46’ N – 1951-1972

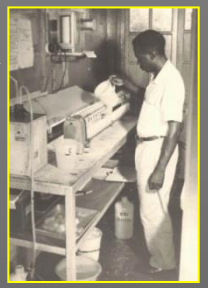
- Leopoldville (ex Belgian Congo)

4° 32’ S – 1957-1958

- Fort Dauphin (Madagascar)

25° 1’ S – 1957-1958





other stations during IGY (International Geophysical Year) 1957/1958

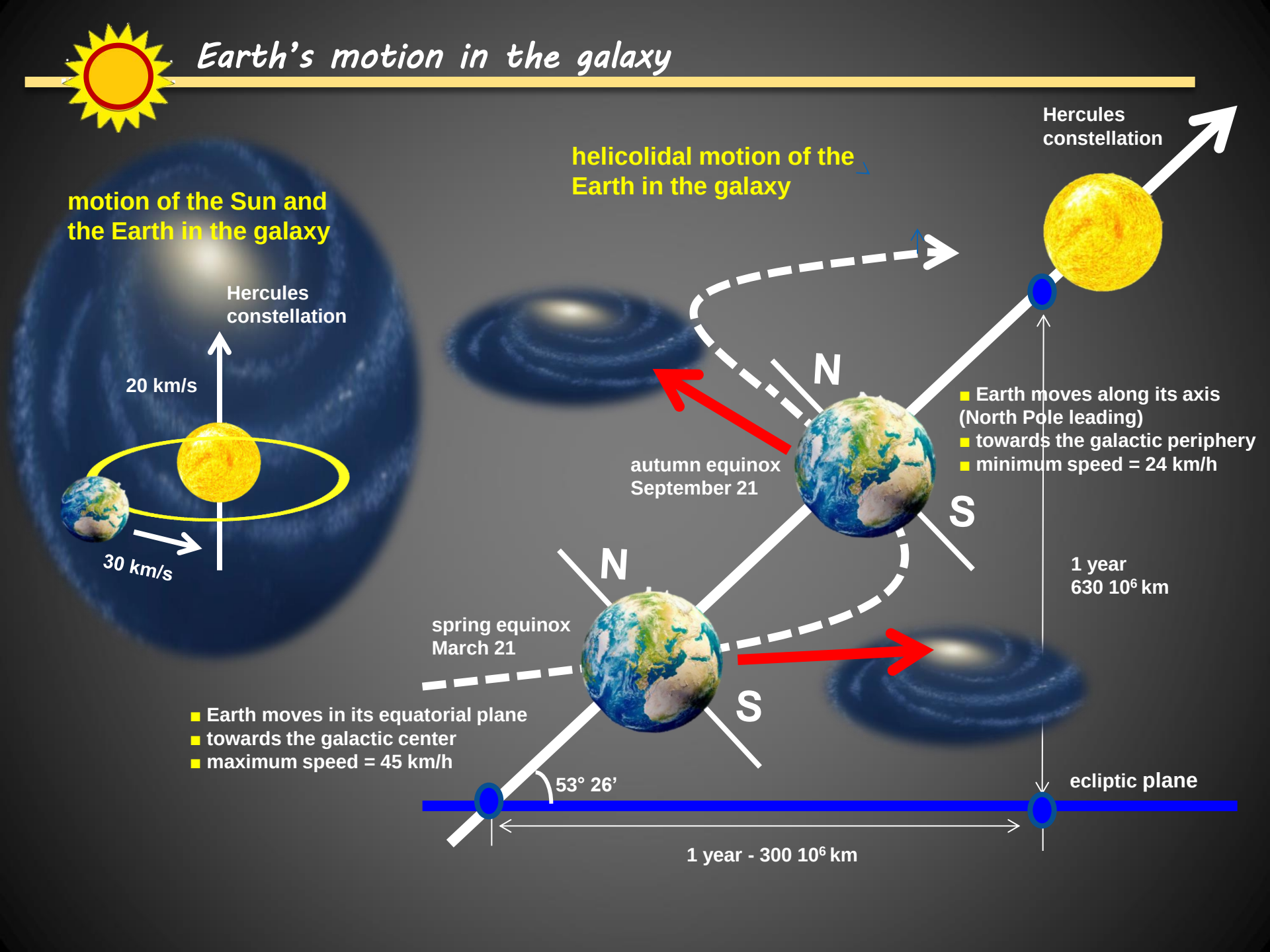
- Vienna (Austria)
- Trieste (italy)
- Genova (italy)
- Grotte Castellana – Bari (Italy)
- Sopporo (Japan)
- Kumamoto (Japan)

N equator

S

- Libreville (ex Belgian Congo)
- Kerguelen Island (Indian Archipeol, France)

Earth's motion in the galaxy



the «solar hypotheiis»

Piccardi with the dynamic model of the solar hypothesis

- The displacement of the Earth (a body surrounded by a magnetic field) in one direction or another of the galaxy (filled with gas, dust and plasma) is not without consequences.

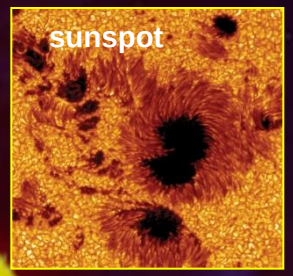
- Earth's general physical conditions must vary in the course of a year.

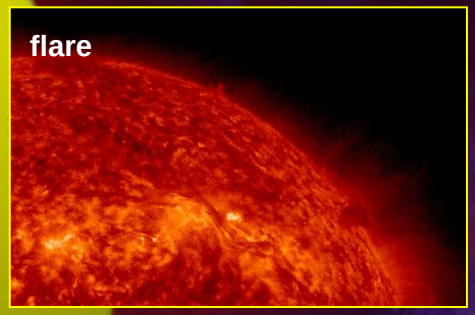
space weather

Space weather

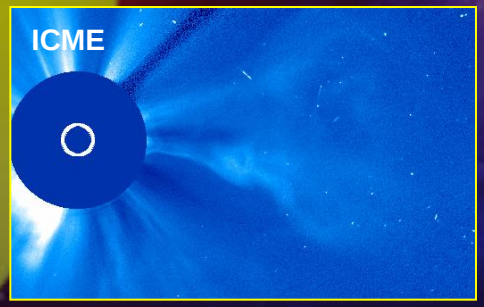
- Space Weather is a new branch of science (defined in '90) that refers to variations in the space environment that are a consequence of charged particles (H^+, He^{++} etc.) and electromagnetic radiation (from IR to X-rays) with a «frozen» magnetic field
- the main source of space forces is the Sun

quiescent activity phenomena





impulsive activity phenomena (solar storms)



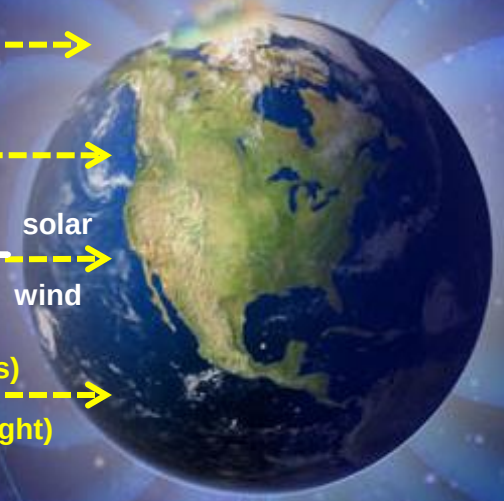
according with 11-year solar cycle

- cosmic rays
- electromagnetic (IR - X-rays)
- charged particles (plasma)
- «frozen» magnetic field

solar wind

SEP (Solar Enrgetic Particles)

(> 100 MeV – ~ 80% speed light)



flares

- powerful surge of X-rays and energy that shine in all direction

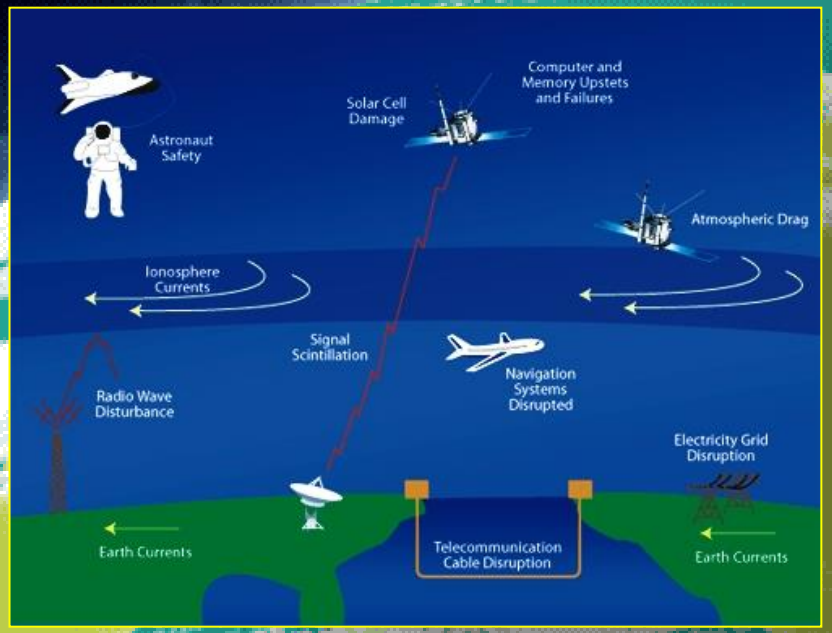
ICME (Interplanetary Coronal Mass Ejection)

- explosions of charged particles that erupt and expand into interplanetary space in a particular direction

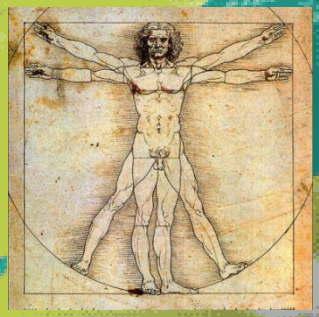
solar storms impacts

geophysical
(polar aurorae, magnetic storms and climate)

technological
(installations and infrastructures in space and on the ground)



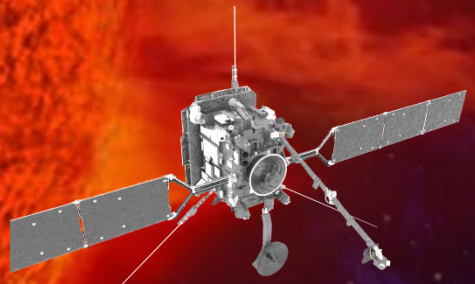
biological
(human health)
(no scientific consensus)



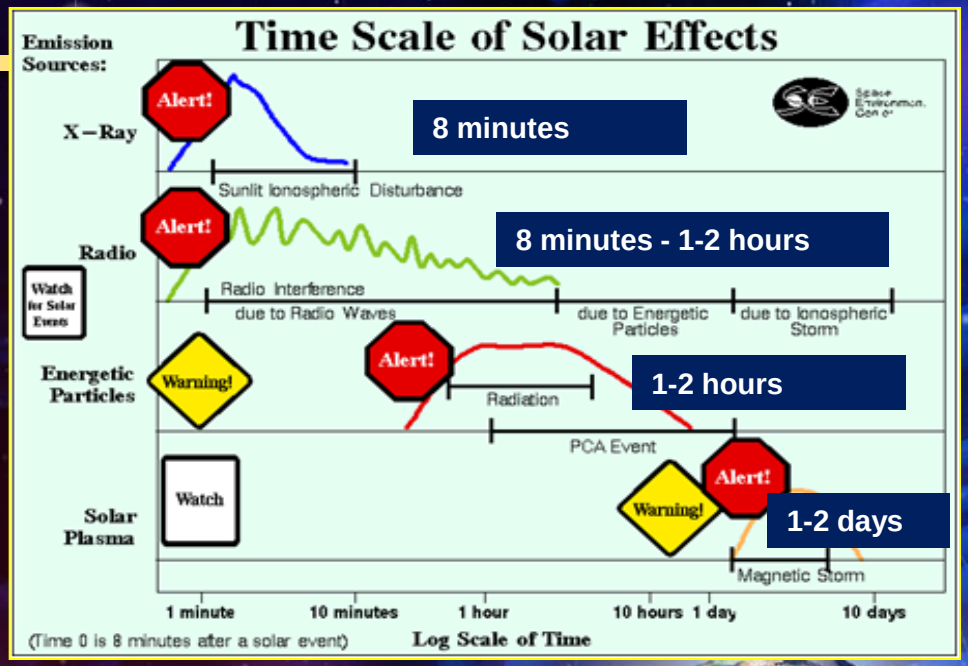
space weather alert

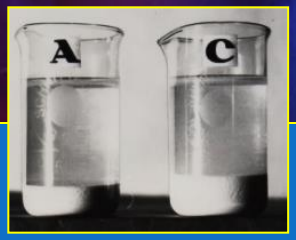
SOHO (SOlar and Heliospheric Observatory), 1985

SDO (Solar Dynamics Observatory), 2012



SOLO (Solar Orbiter), 2020

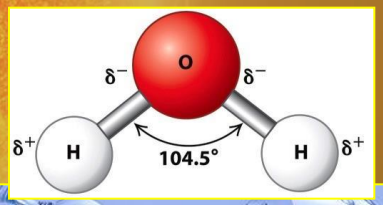


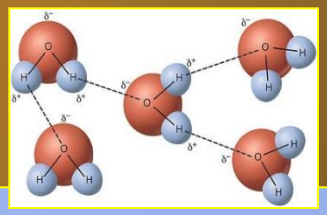


- the chemical test can be used as an indicator of the actual situation of space weather, so a warning of potentially distructive terrestrial events
- it is important to find a simpler, faster and more reliable reaction and an objective and quantitative protocol (possibly automated and worldwide)

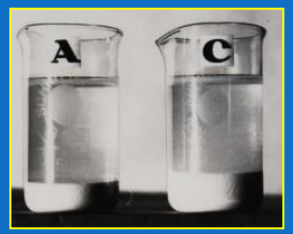
an «antenna» of space forces

space forces

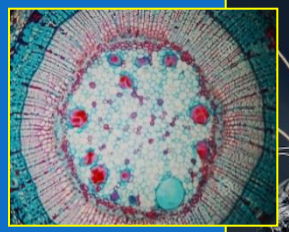




- water is the more common and strangest liquid on Earth
- water is the solvent of a great number of biologival and chemical systems
- water is a liquid sensible to space fluctuating conditions through the «hydrogen bond» (a sort of «antenna» of space forces)
- water is the medium of fluctuating behaviour of complex biological and chemical sytems out of equilibrium («open systems»)



open chemical system (Piccardi's test)



open biological system (Faraone's test)

Giorgio Piccardi's legacy'

Giorgio Piccardi (1895-1972)

- Piccardi intuited, since the 50s, that space variables could influence some terrestrial «open systems», anticipating the concepts of space weather
- Piccardi was a chemisti, so he tried to prove this space influence with a chemical test
- in this way Piccardi was truly a prioneer of space weather (formally defined in the 90s)

> *"Nothing escapes sensitive inorganic and living systems: what the Sun does can therefore also be felt by looking down towards the Earth."*

Thank you