Value of space science and exploration for society

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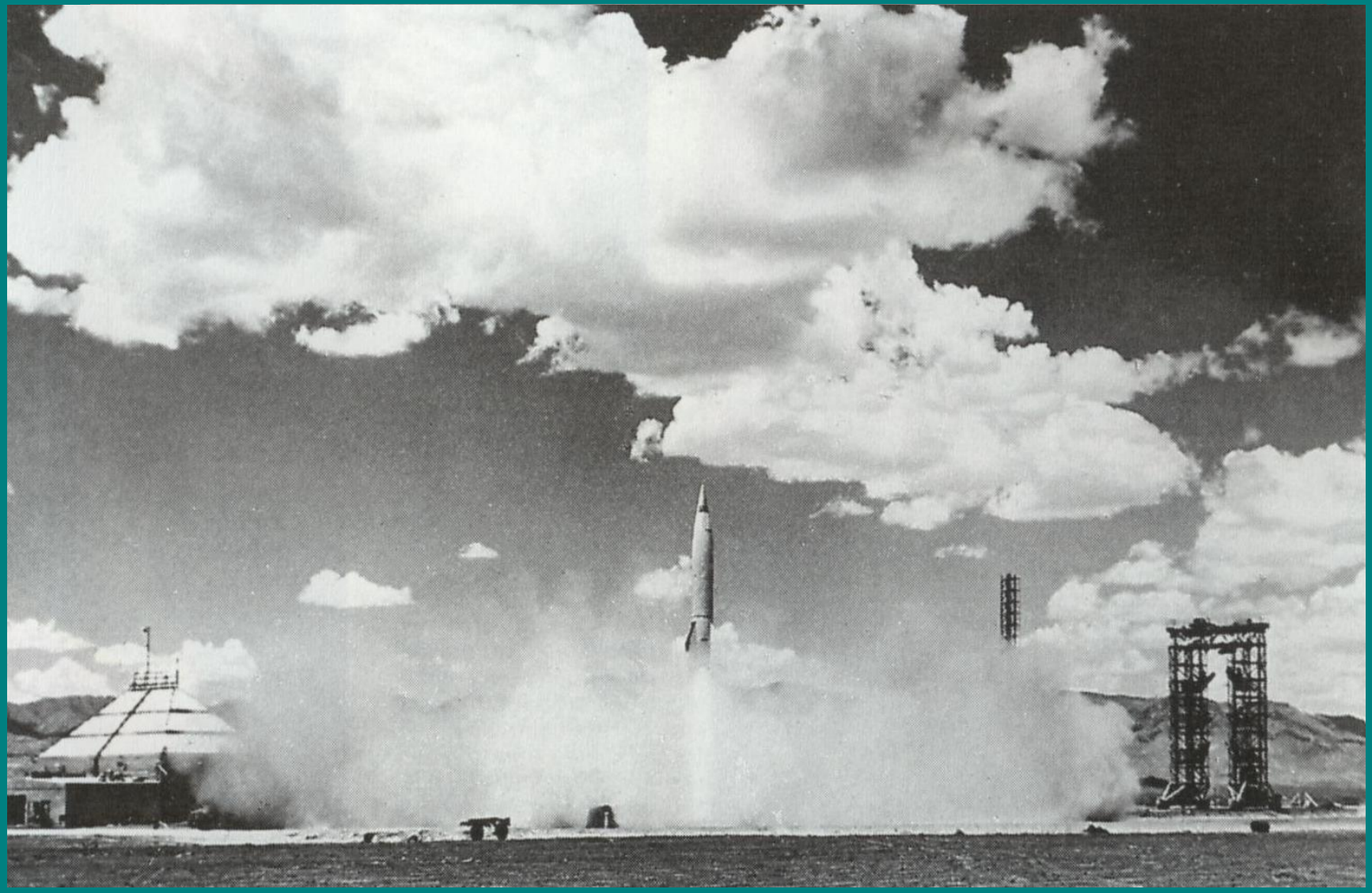
SPACE SCIENCE AND EXPLORATION 101

It started off rather badly…



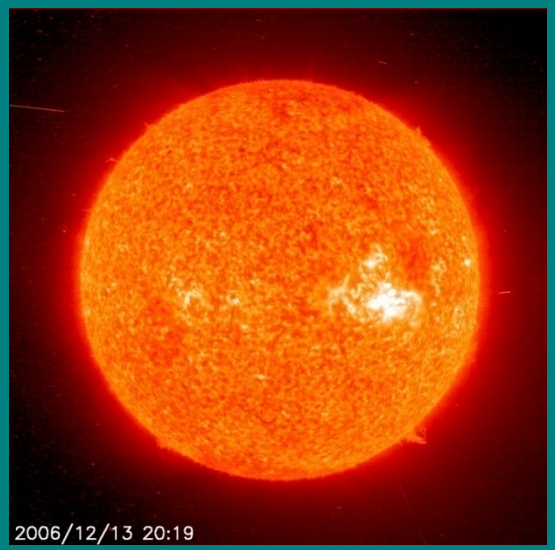
…but it's getting better all the time

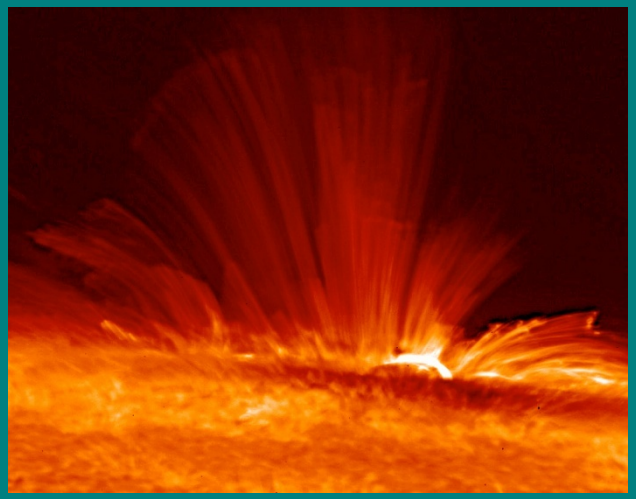
Space sciences

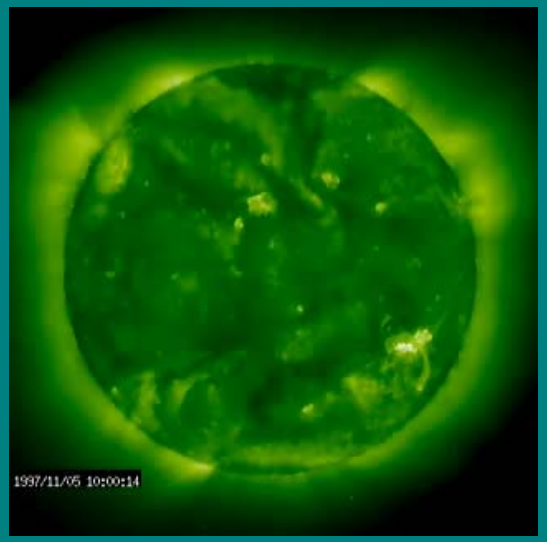
- Presence in space never faltered in the past 50 years or so
- Limited scientific experiments at the time of these pioneer years
- Space activities now span a broad spectrum of domains
  - astronomy, astrophysics, astrobiology, cosmology and fundamental physics
  - observation of exoplanets (494) **FREE I-Phone app !**
  - solar and heliospheric physics
  - exploration of the solar system
  - observation of the Earth
  - life and physical sciences in weightlessness

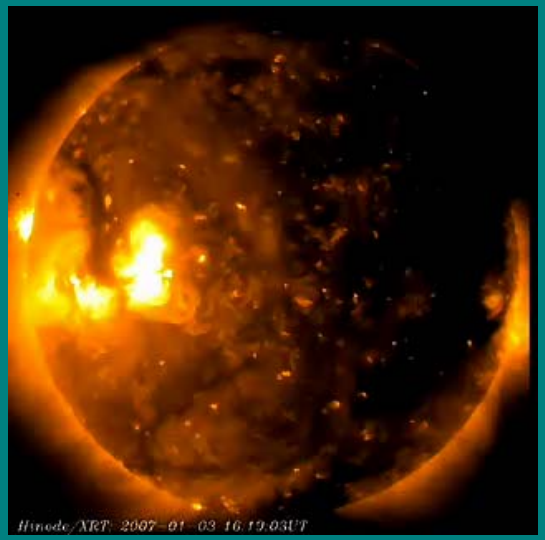

Astronomy & astrophysics

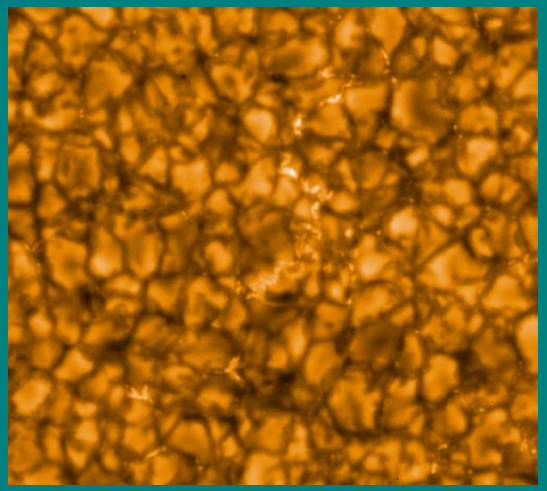
Here comes the Sun…



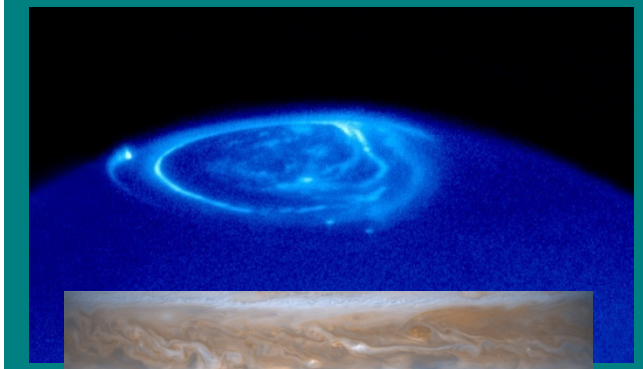


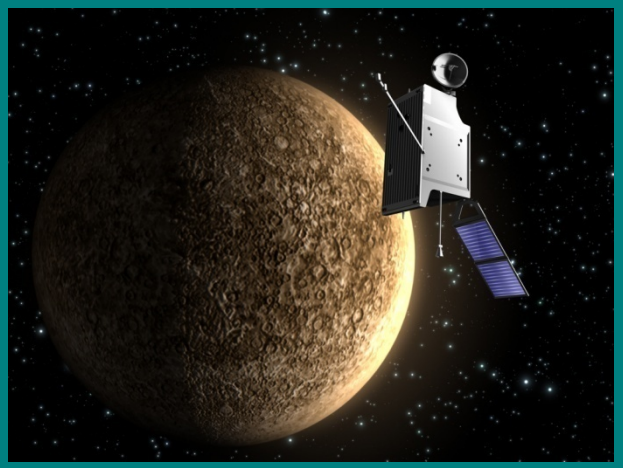




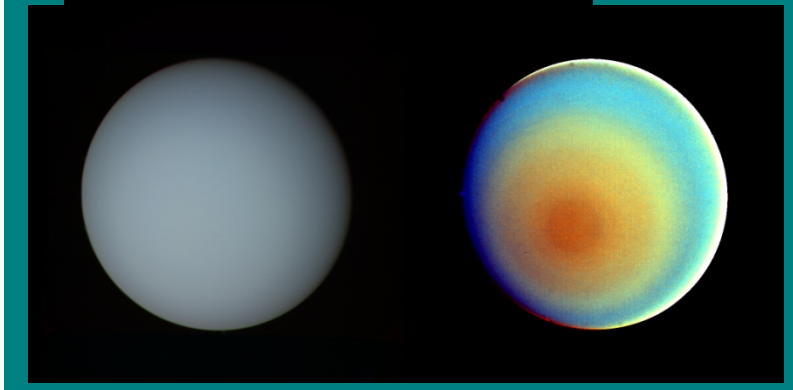


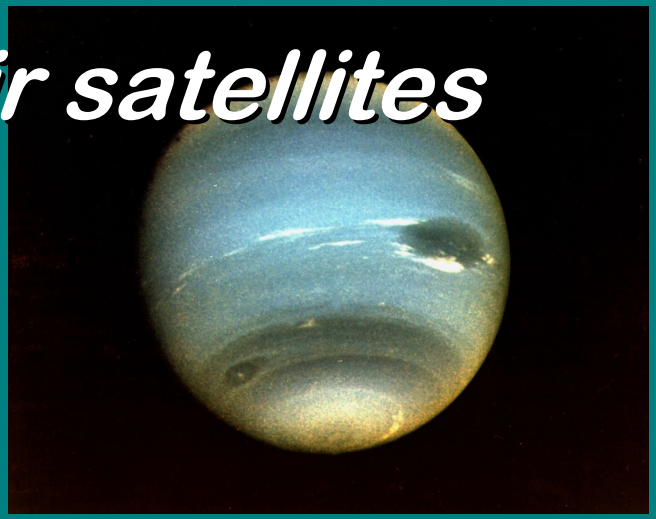
All planets were visited !

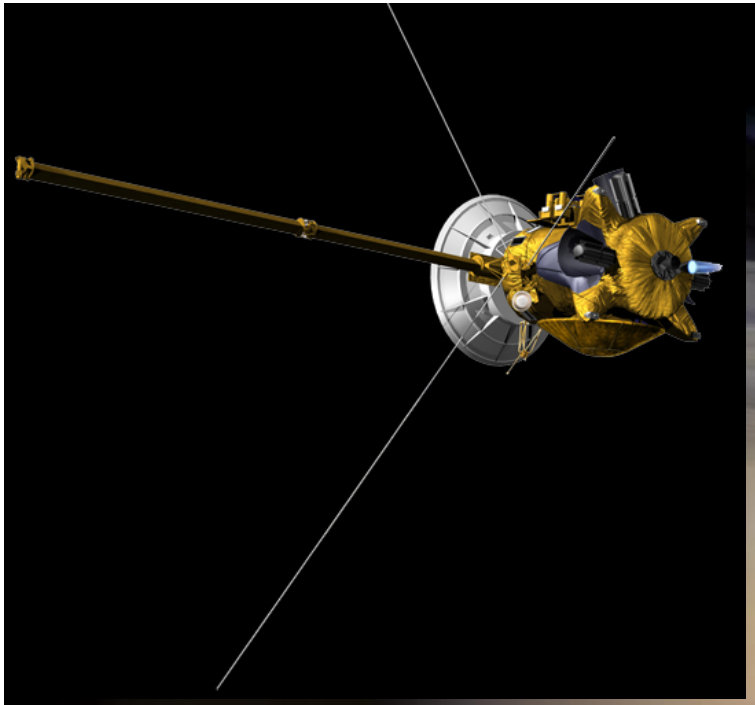


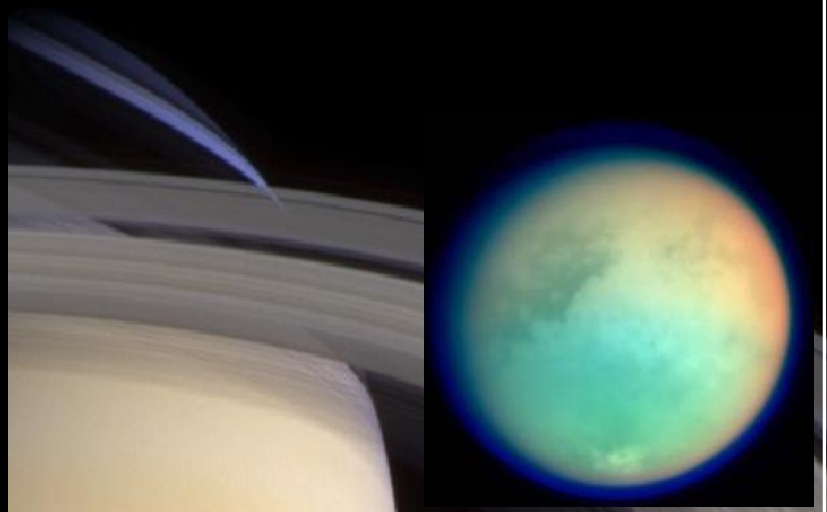


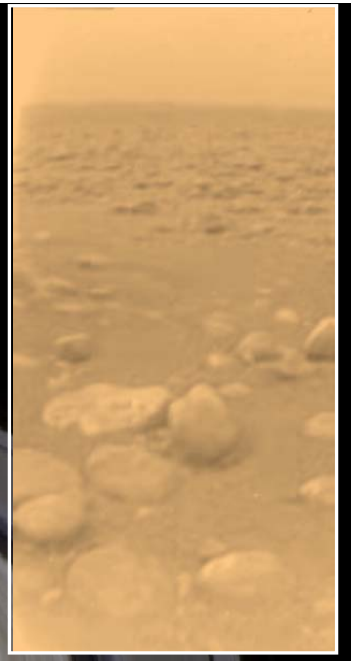
Not mentioning their satellites

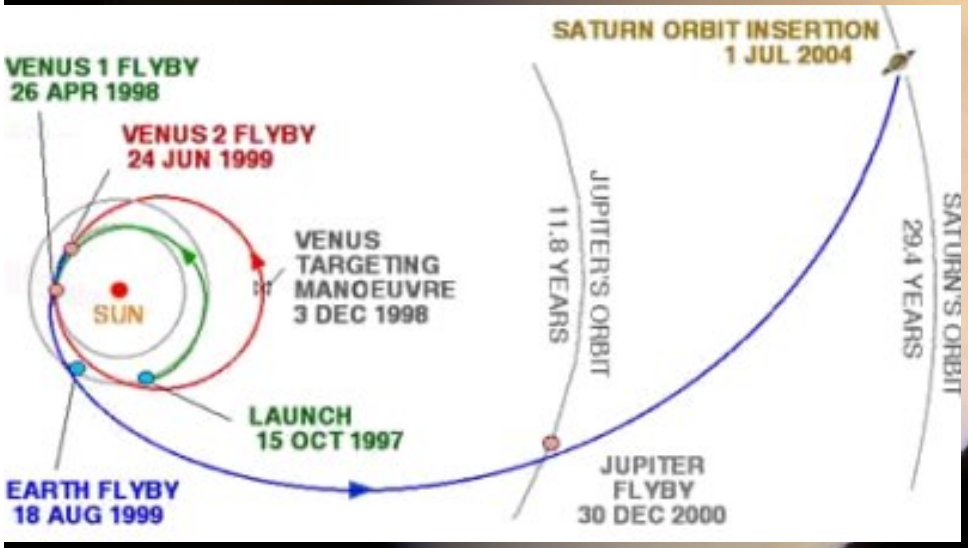






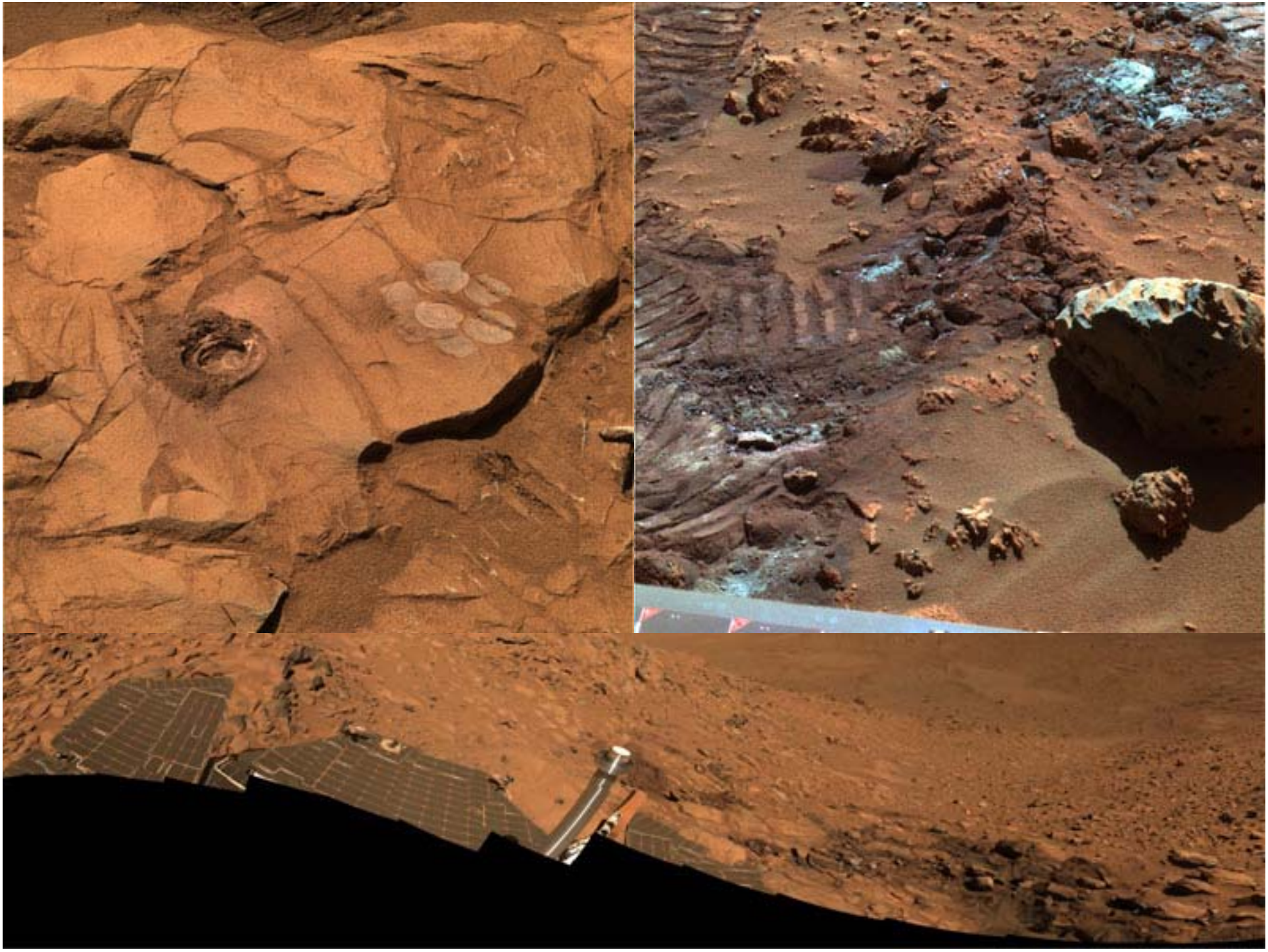




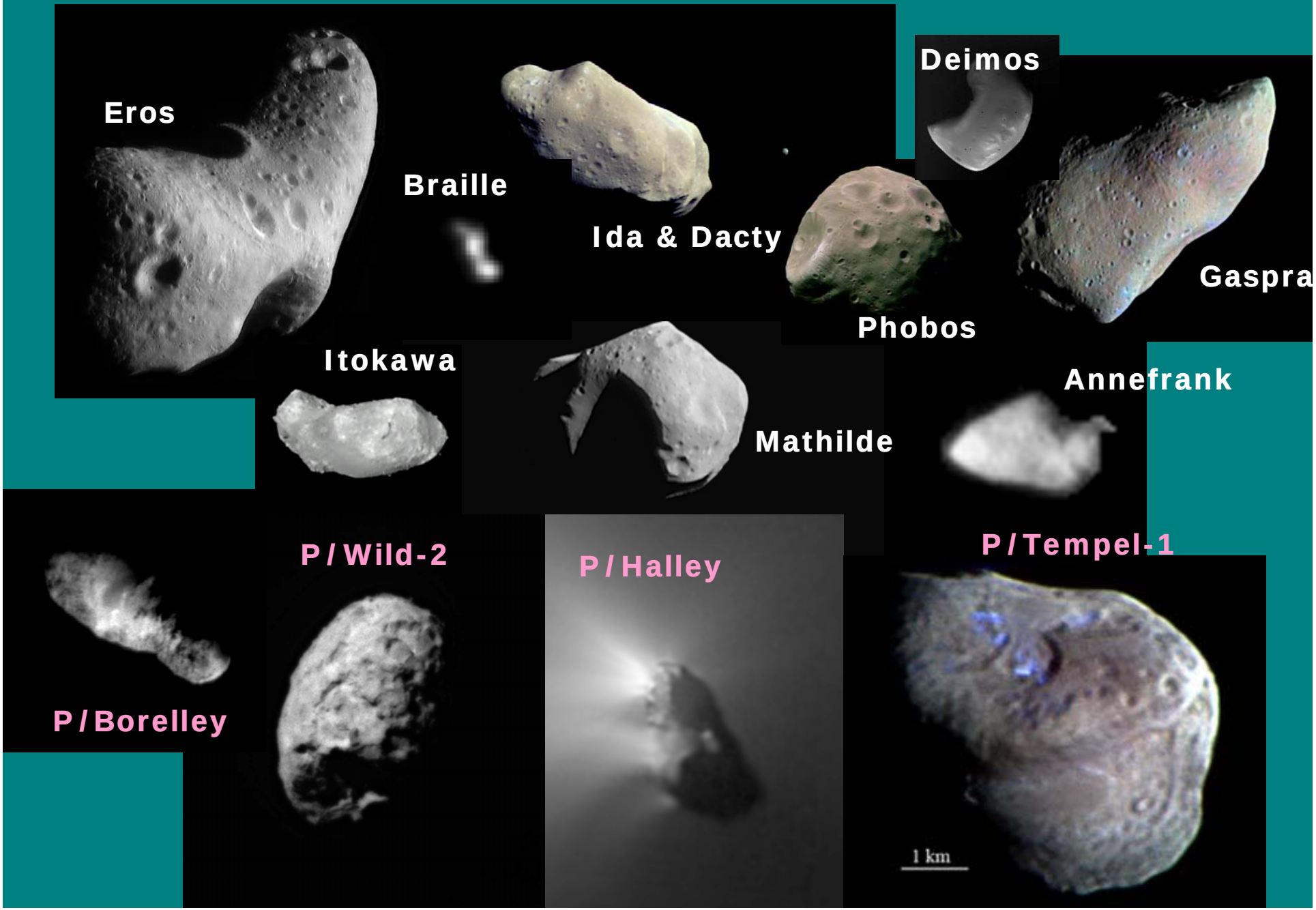


Titan landing
10 Jan 2005

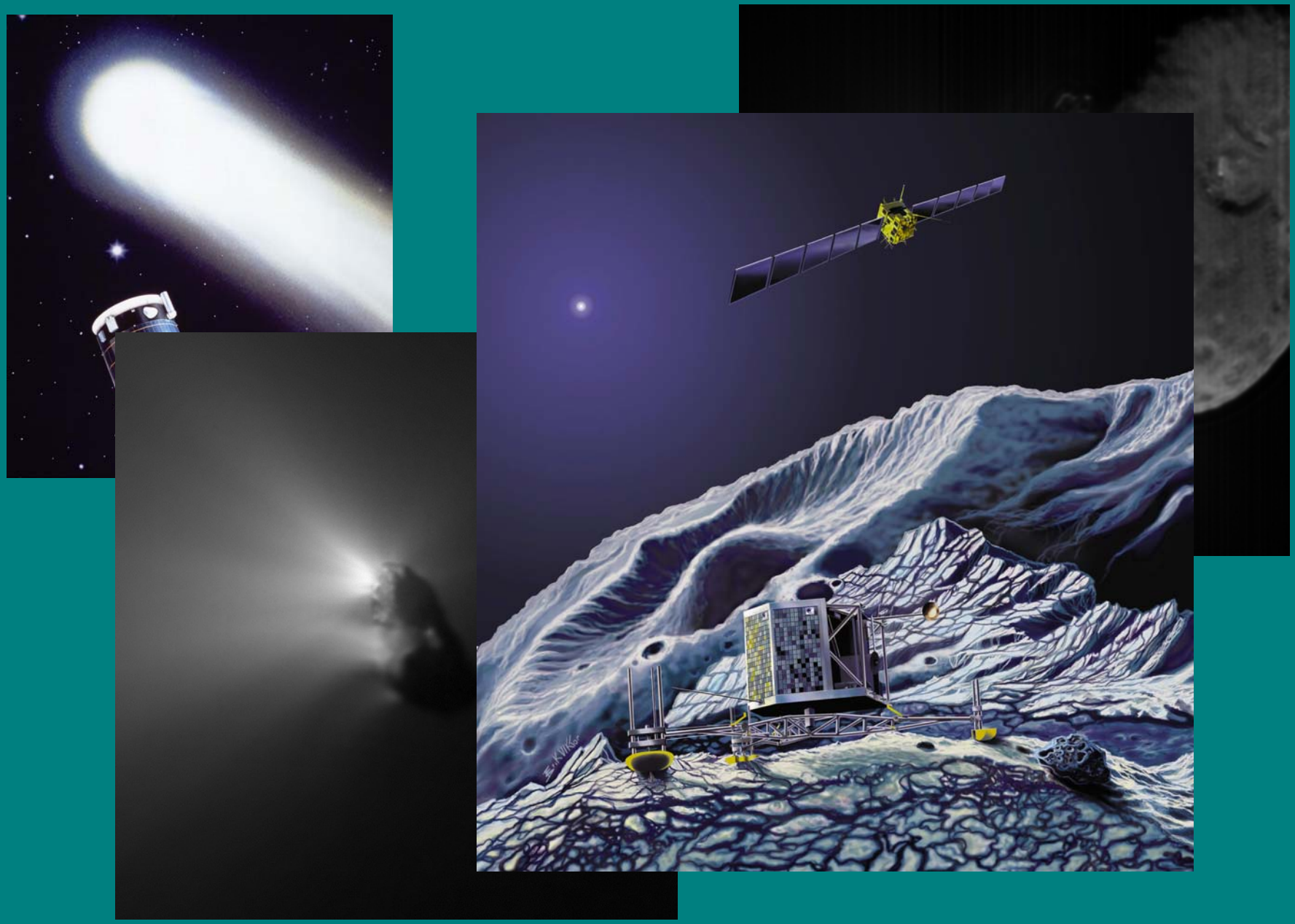
Cassini-Huygens



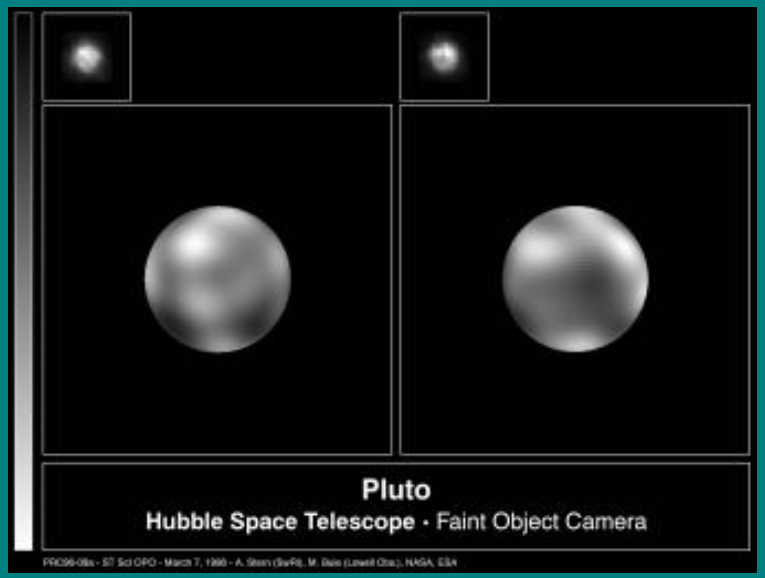
Visits to small bodies

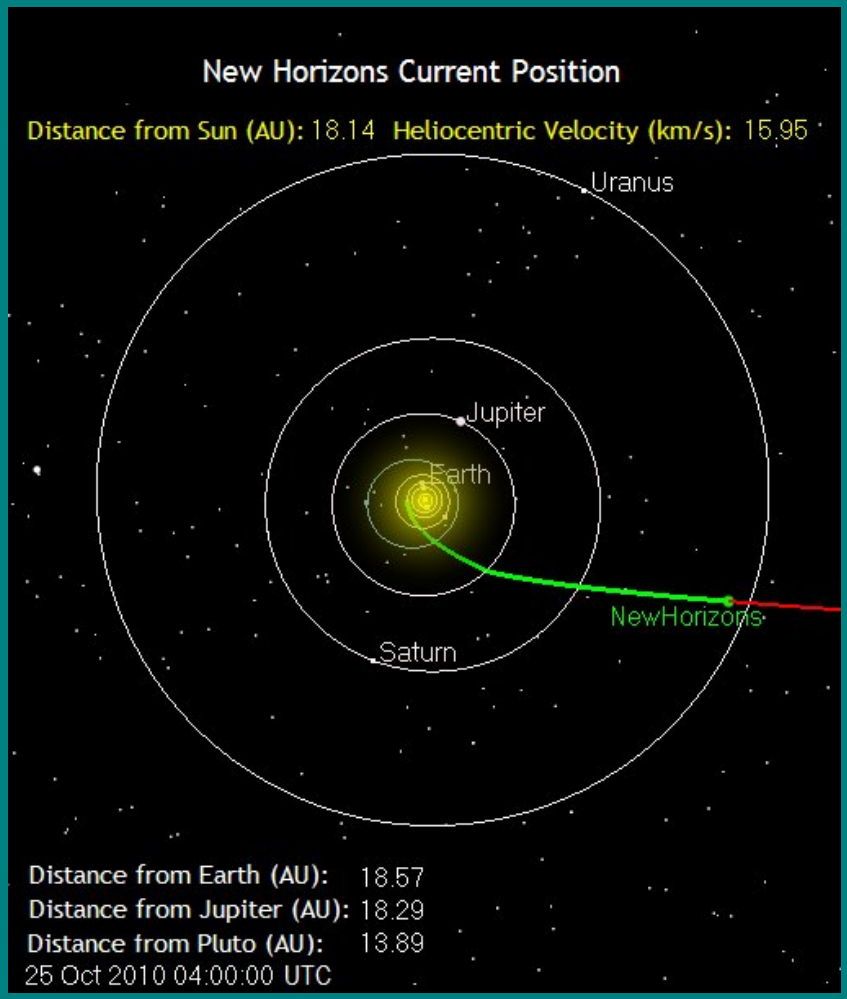


Comets !



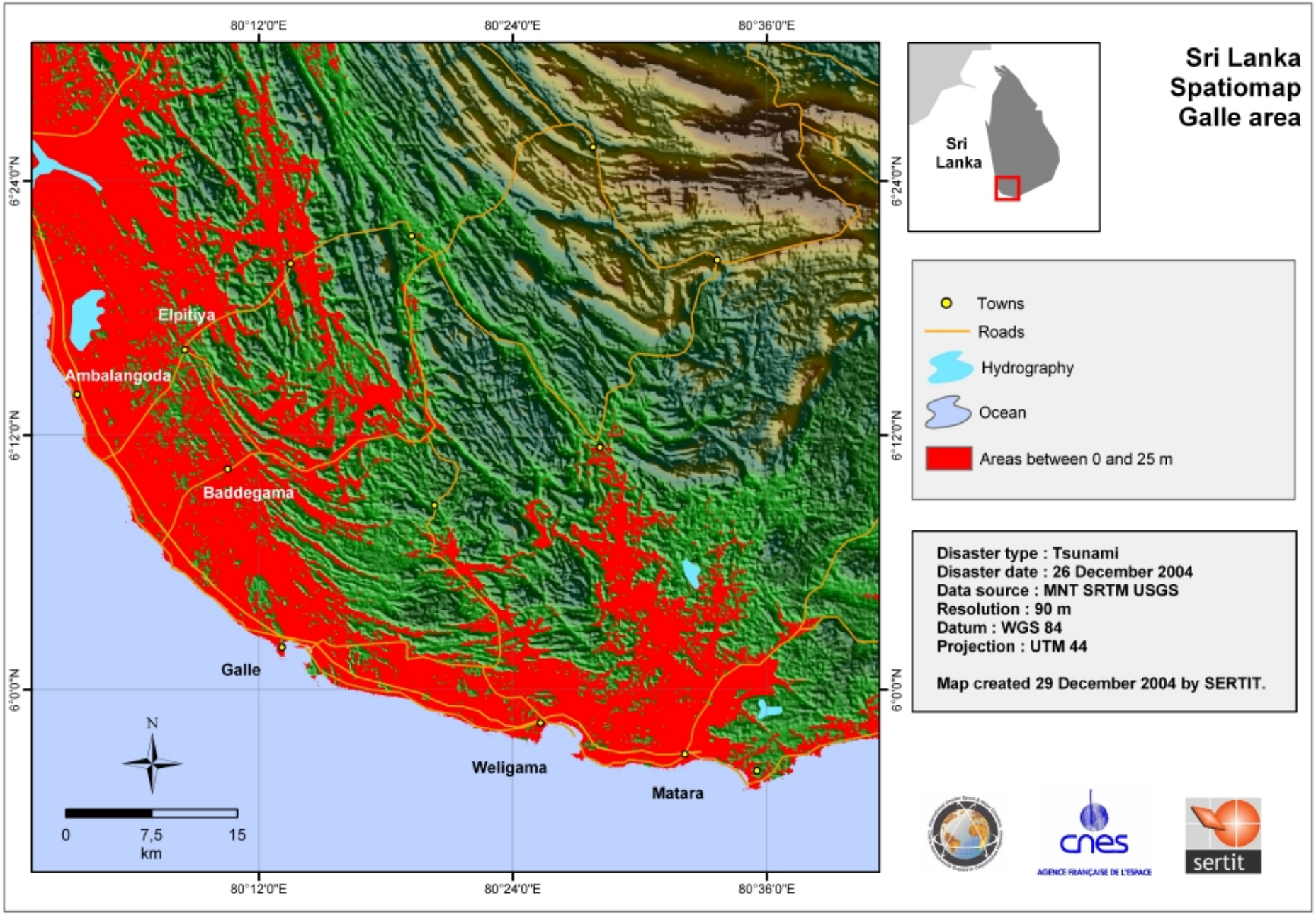
Even poor Pluto…





And beyond…


Sedna
800-1100 miles
in diameter
Quaoar
(800 miles)
Pluto
(1400 miles)
Moon
(2100 miles)
Earth
(8000 miles)


Sri Lanka Spatiomap Galle area
80°12'0"E
80°24'0"E
80°36'0"E
6°24'0"N
6°12'0"N
6°0'0"N
Elpitiya
Ambalangoda
Baddegama
Galle
Weligama
Matara
Sri Lanka
Towns
Roads
Hydrography
Ocean
Areas between 0 and 25 m
N
0
7,5
15
km
Disaster type : Tsunami
Disaster date : 26 December 2004
Data source : MNT SRTM USGS
Resolution : 90 m
Datum : WGS 84
Projection : UTM 44
Map created 29 December 2004 by SERTIT.
cnes
AGENCE FRANÇAISE DE L'ESPACE
sertit

Research in space

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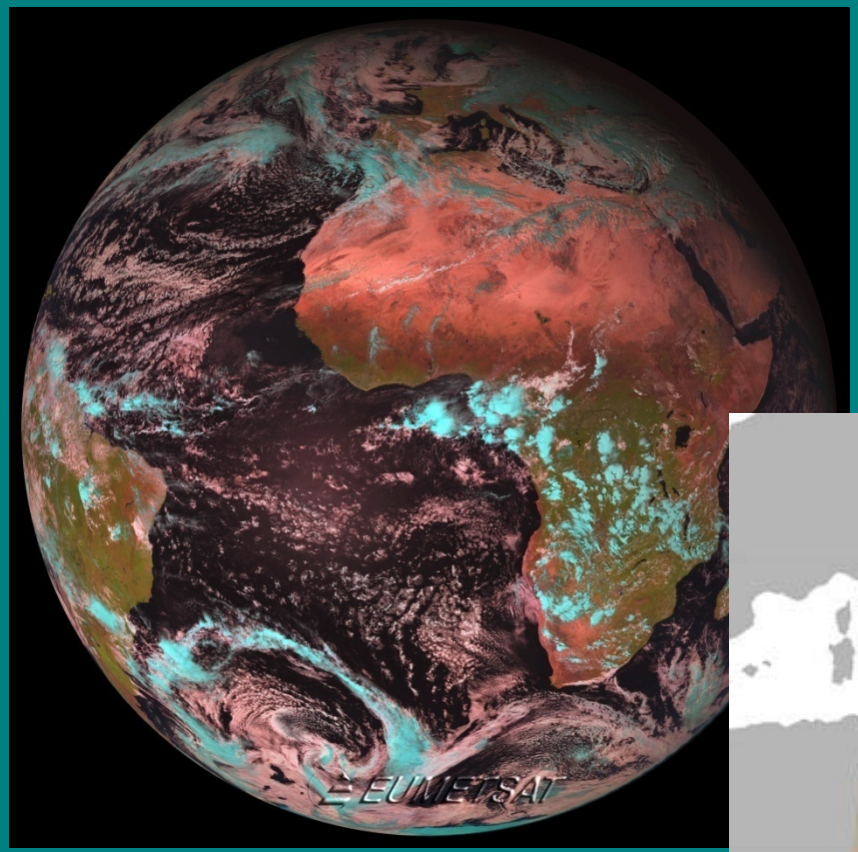
…and applications

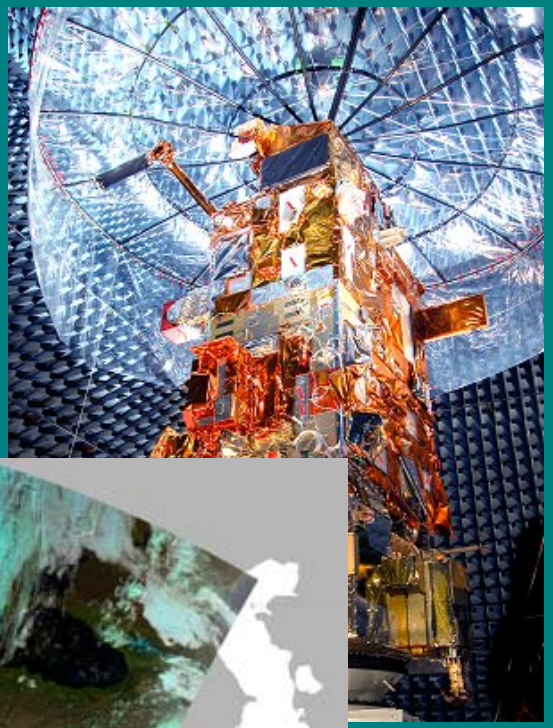
- Space assets deliver the citizen with services just as pervasive as quantum physics pervade today's technology
  - meteorology
  - observation and monitoring of the Earth resources
  - climate, weather and natural events
  - satellite telecommunications and broadcasting
  - navigation
  - weather forecast is being extended to space weather forecast (prediction of outbursts of solar activity), of prime importance to
    - satellite operators and ground-based power grid controllers
    - or, e.g. future astronauts en route to Mars

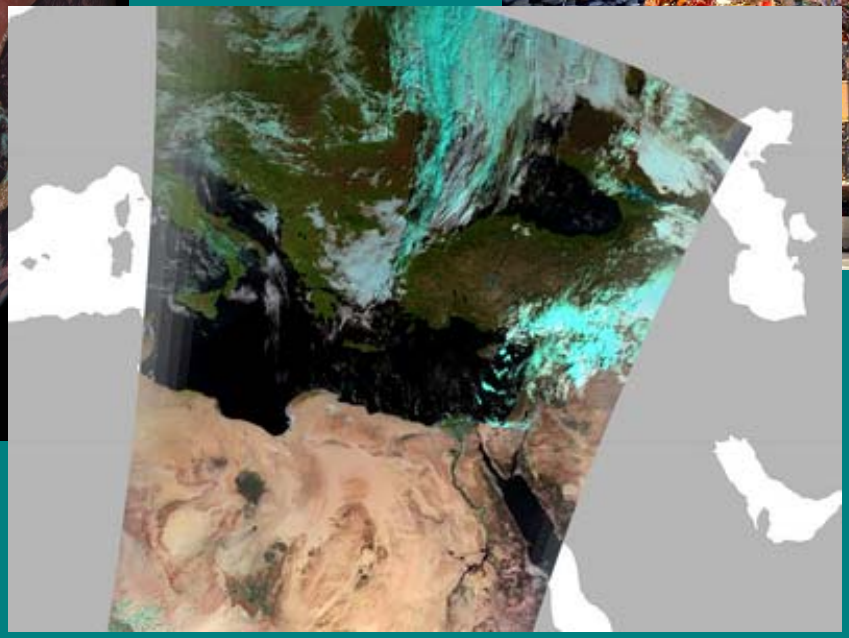
Looking everywhere from high above

- Global satellite coverage enables almost instant access to a variety of images and other data and satellites have therefore proven essential in developing a global database to describe the Earth system and its evolution
- Satellites also remain in orbit sufficiently long to monitor gradual environmental changes
- This global coverage also challenges traditional notions of individual privacy and this will need to be re-evaluated by citizens and societies

Meteorology







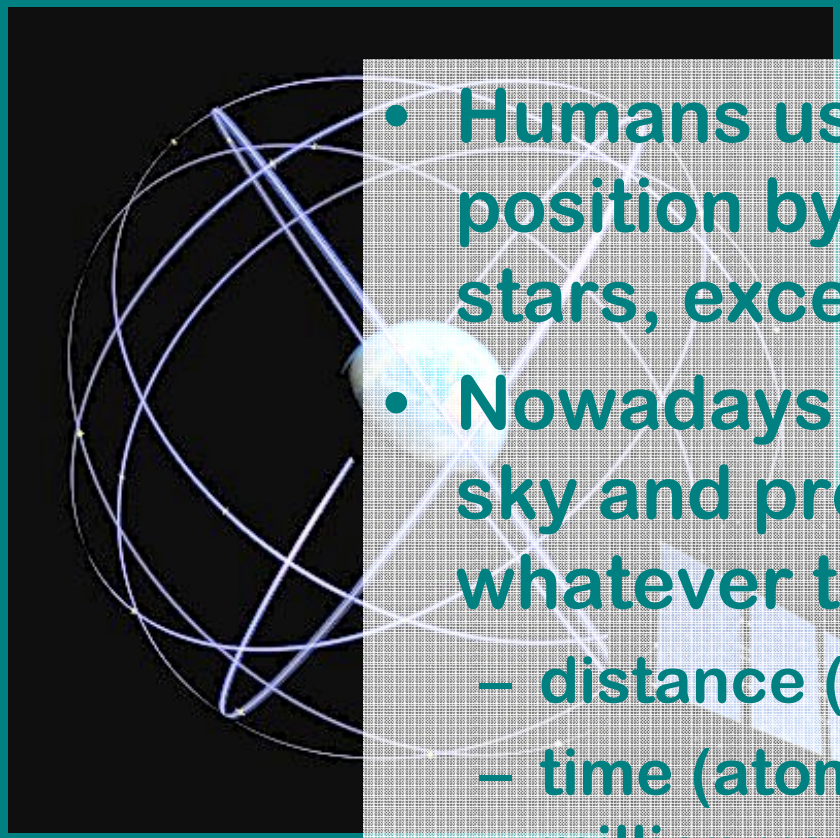
The Weather Channel

- The ability provided by space to observe and predict the environment, weather and climate, has increased the importance and value of these observations and predictions for modern societies
- It is for example estimated that as much as 40% of the $10 trillion U.S. economy is affected by weather and climate annually
- Approximately 90% of the presidentially declared disasters in the US are weather-related
- The space component of this observation and prediction system requires accurate information as well as high-resolution information in both space and time

Telecommunications

- 2 intercontinental phone conversations were already relayed by satellite a few years ago
- Today more powerful satellites and frequencies allow direct reception of signals from space
- Over 70 million European homes receive satellite or cabled television
- Do we know that
  - Radio: signals are often broadcast by satellite from the studio
  - Newspapers: production centralised and relayed by satellite
  - Sports: even for local events…
  - Internet: using satellites in many countries
  - etc…

Navigation



- Humans used to determine their position by looking at the sky and stars, except in case of rain
- Nowadays our machines sit in the sky and provide references whatever the weather:
  - distance (a few m to a few cm)
  - time (atomic clocks, 1 second in100 million years)

Watching the skies

- Should our species' "cosmic fate" become endangered by a "killer" asteroid, as perhaps were the dinosaurs 65 million years ago, space (science and technology) would remain the only tool of salvation
- Our society is therefore and more than ever "watching the skies" in many different ways in order to sustain its development

REMOVING THE LIMITS TO GROWTH, OR USING SPACE ASSETS IN SUPPORT OF EARTH'S SUSTAINABILITY ?

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Space colonies?

- Will humans reach and settle on other habitable planets?
- The obstacles that pile up before us are immense: stellar distances and constraints imposed by relativity seem to forbid such trips, at least when compared to the span of a human life
- Short of the possibility to effectively 'terraform' Mars, it looks as if human settlements remain a very distant possibility in the future, and perhaps even a downright physical impossibility
- Even assuming these obstacles would somehow be overcome, there remains the fact that presenting space colonisation as the possibility to offer new perspectives to billions of impoverished human beings is impractical and illusory

Space colonies?

- The mere scale of the enterprise would defeat any society, government or alliance of nations
- If 'colonisation' of other planets is to happen in the future, it can probably be only conceived initially as the bold endeavour of a few daring scientists, entrepreneurs, miners, or even misfits of our societies → space "tourism" a sign?
- "Cosmic salvation" will not occur for today's starving billions; that can only come from us, down here and now

A toy for scientists, or part of society's future?

- Space provides invaluable support for society's sustainability for resources, energy, demography, international relations, security, education, and the preservation of Earth as habitat for the human genus
- Multiple foreseeable threats such as global warming have indeed been identified → space science can offer tools to help dealing with them through observation, prediction and management
- Mitigation needs more than space assets and also requires ground-based efforts, public resources and, above all, political will
- Space data can help reduce these threats and represent unprecedented opportunities to evaluate a situation and quantify an issue from a global perspective

EXPLORATION IN OUR GENES: NUTS, BOLTS AND HUMANS

Humans in space

- European exploration programme in the making → Flagship programme of Europe?
  - SAG report
  - XIIth EISC declaration, § 3.3.2
- A strong driver of any exploration programme is to advance the presence of humans in space
- Advantages of humans in exploration have been documented elsewhere
- Interdisciplinary assessment of the human dimension of exploration (humanities and social sciences)
- ESF-ESPI initiative, with support from ESA

COOPETITION !

Cooperation

- international cooperation will be essential for accomplishing advanced missions (such as Mars Sample Return)
- Europe's strengths is its large number of Member States and its habit of conducting projects in a cooperative manner which makes it naturally open to international cooperation
- Emerging actors (China, India, Brazil, S. Korea, etc) offer new opportunities but also increase the need to reduce duplication
- Internationally-coordinated programme to which all partners could bring their own assets and modules without compromising their predefined priorities

…but also competition

- to strengthen the non-dependence of Europe, several critical technologies must be developed, e.g.
  - new sensors for different spectral windows (astronomy)
  - new sources of energy and reduced power consumption to enable solar system exploration (RTGs)
  - MEMS-based sensors and actuators with improved long-term reliability and radiation hardness
  - technologies allowing new types of observation: formation flying, interferometer systems, measurement and relative positioning control, high-precision timing
  - specific laser sources, low-frequency radars, synthetic aperture optics for observation from GEO
  - Launchers?
- Europe should become more "ITAR-independent"

In conclusion

- Space sciences have proven enormously useful in various domains that are of direct relevance to Earth's sustainability
- Many operational services have come to fruition
- Research creates applications and products in an essentially unpredictable way, and applications generate in turn further scientific needs and projects
- To support this virtuous circle basic science needs to be supported adequately
- Other aspects are mandatory, such as the continuity of data acquisition, its standardisation and proper archiving, access and distribution for end-users
- ESA and national space agencies are playing their role but there is an increased need for direct support emanating from the European Union, hence the role of Parliaments, with support from various actors, including the science community

Citizen's space

- Return on investment (5€ per year per capita for space sciences) to be communicated
- More visibility to promote better PR on space
  - For citizens: web portal
  - For decision-makers: MIT model

THANK YOU VERY MUCH