Currently available space technologies for Earth system study

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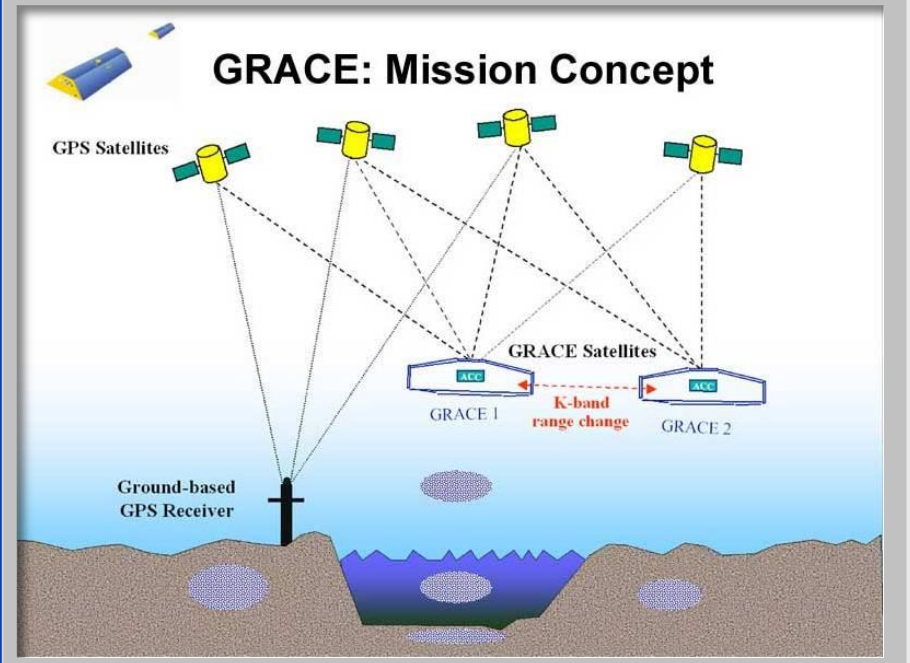
Possibilities for development of the Earth sciences through the advances and prospects in remote sensing relevant to the entire Earth system

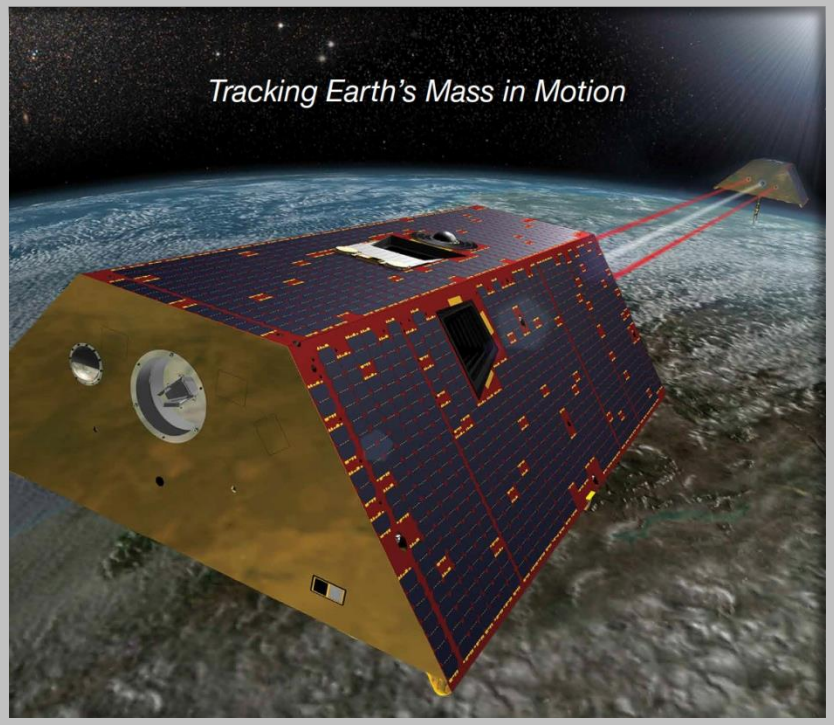
Measurements of the Earth gravity field and of the geoid by measuring intersatellite distance with K-Band range change



GRACE (Gravity Recovery and Climate Experiment) is designed to measure changes in gravitational pool that result from changes in mass on Earth.

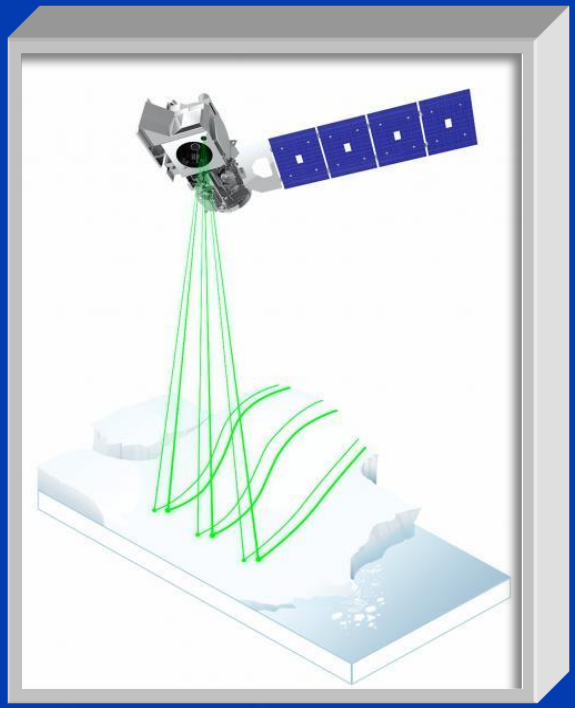
GRACE twin satellites were making detailed measurements the distance between its twin satellites over 15 years from March 2002. The science mission lies in tracking the continuous movements of liquid, water, ice and solid Earth.

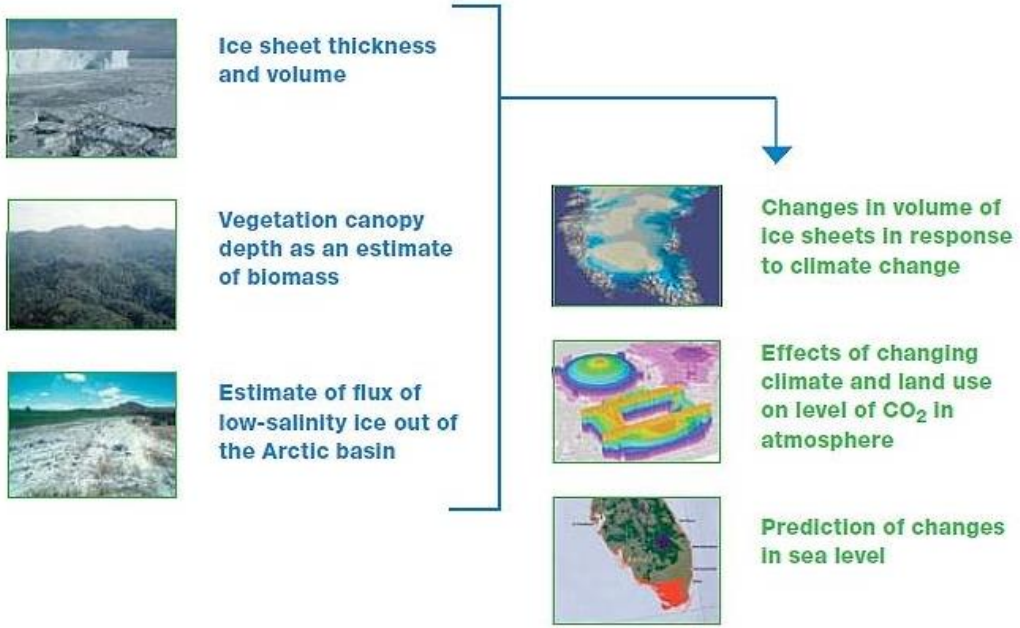
Measurements of the Earth gravity field and of the geoid by measuring intersatellite distance with microwave and new laser interferometer



GRACE-FO twin satellites launched 25.05.2018 by Falcon-9 circling the Earth separated by 220 km in the same orbit 490 km above ground. The changes in mass below change the distance very slightly. The record of this changes is analyzed to create monthly global maps of changes and redistribution of Earth mass near the surface, f.e. water moves continually everywhere. From GRACE mission total water storage estimates.

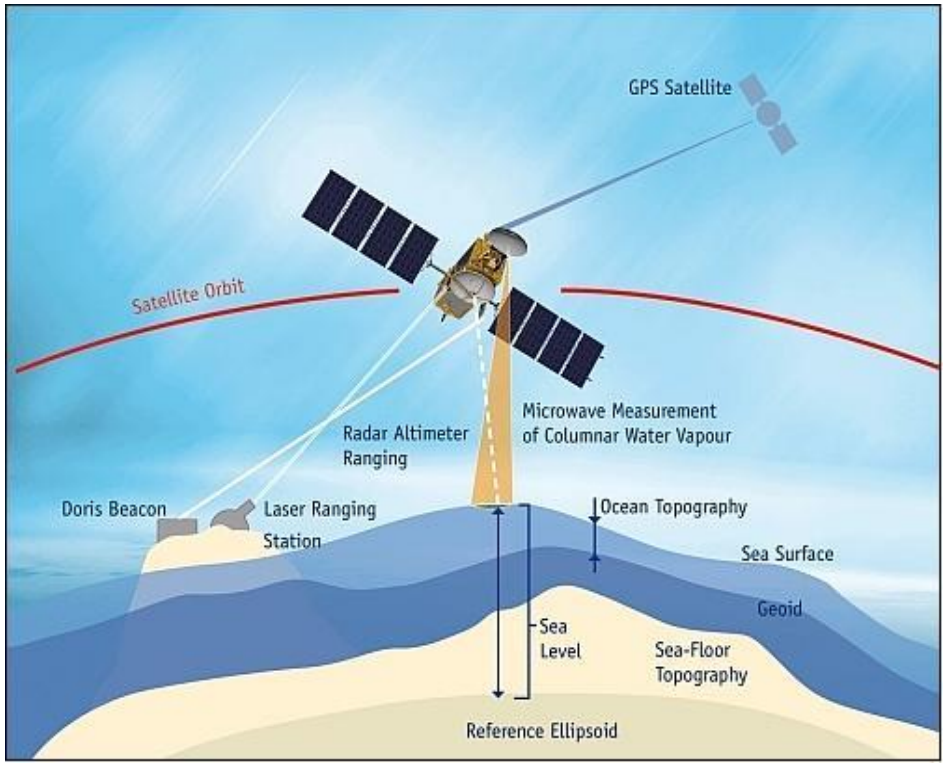
New satellite mission NASA ICESat-2 (Ice, Cloud and Elevation Satellite-2)





ICESat-2 will be launched in September 2018; this observatory contains a single instrument, an improvement laser altimeter called ATLAS (Advanced laser altimeter system). ATLAS is designed to measure ice-sheet topography, sea, ice, freeboard as well as cloud and atmospheric properties and global vegetation.

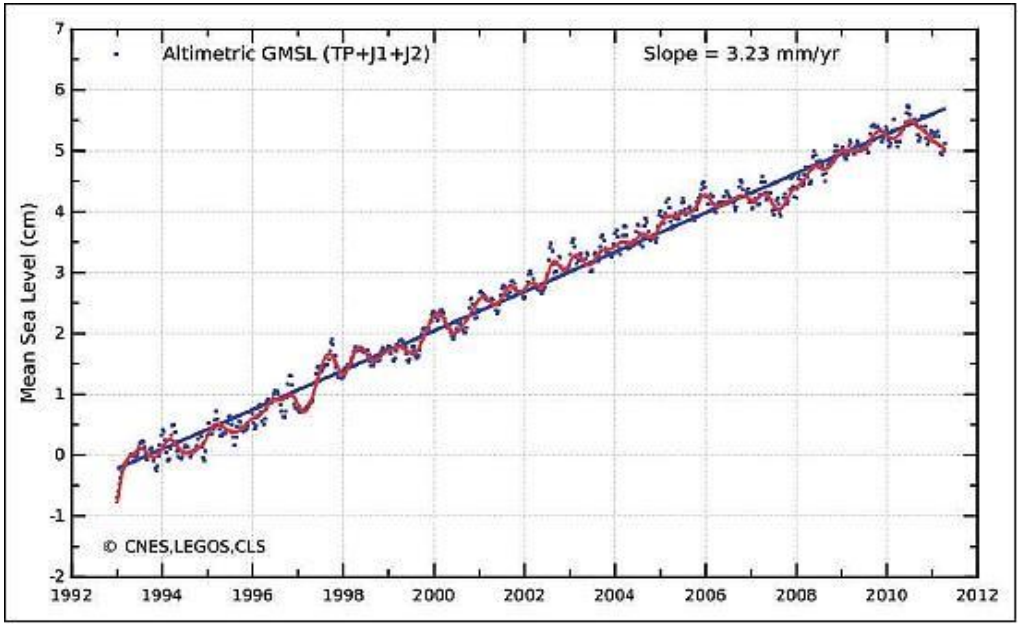
The Ocean surface topography

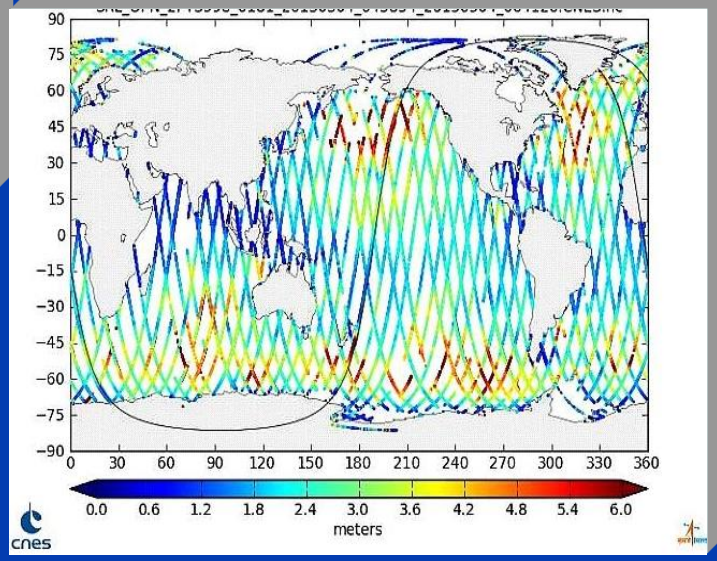


The extended time series of ocean surface topography measurements with altimeter Poseidon-3 and advanced microwave radiometer are intended for:

- *Obtain a continuous record observations.*
- *To determine the variability of ocean circulation at decadal time scales*
- *Improve the measure of the time-averaged ocean circulation.*
- *Improve the measure of global sea-level change.*

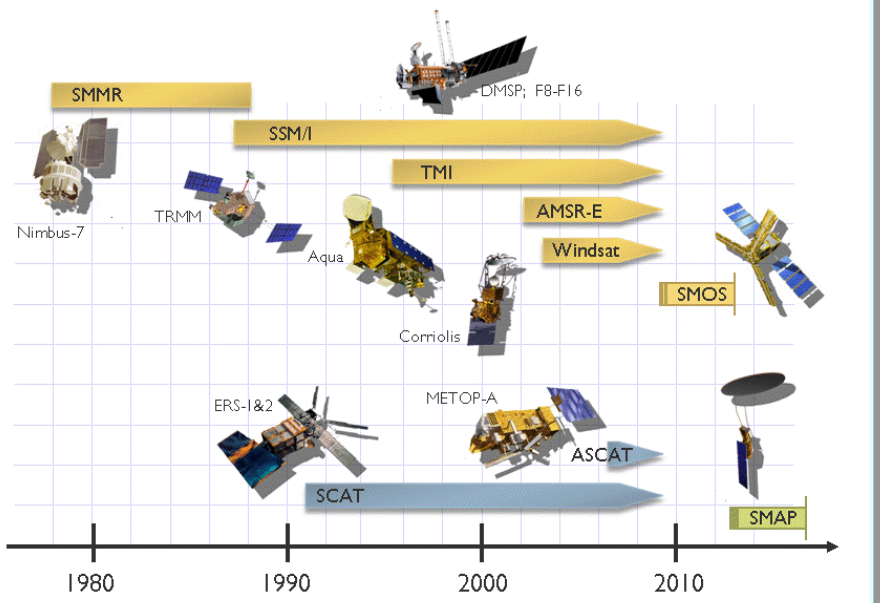
The Ocean level changes





Ka-band significant Wave height

Observations of Soil Moisture and freeze-thaw processes



Soil moisture was recognized as an Essential Climate Variable (2010). The soil moisture data record was generated by merging two soil moisture data sets, one derived from active microwave observation from board of ERS-1,-2 и METOP –A, and the other from passive microwave observation.

Water exchange between atmosphere, soil and ground water is one of the determining factors in hydrological cycle and the carbon cycle. Heat and moisture flows in the surface layer of the atmosphere are significantly dependent on soil moisture.

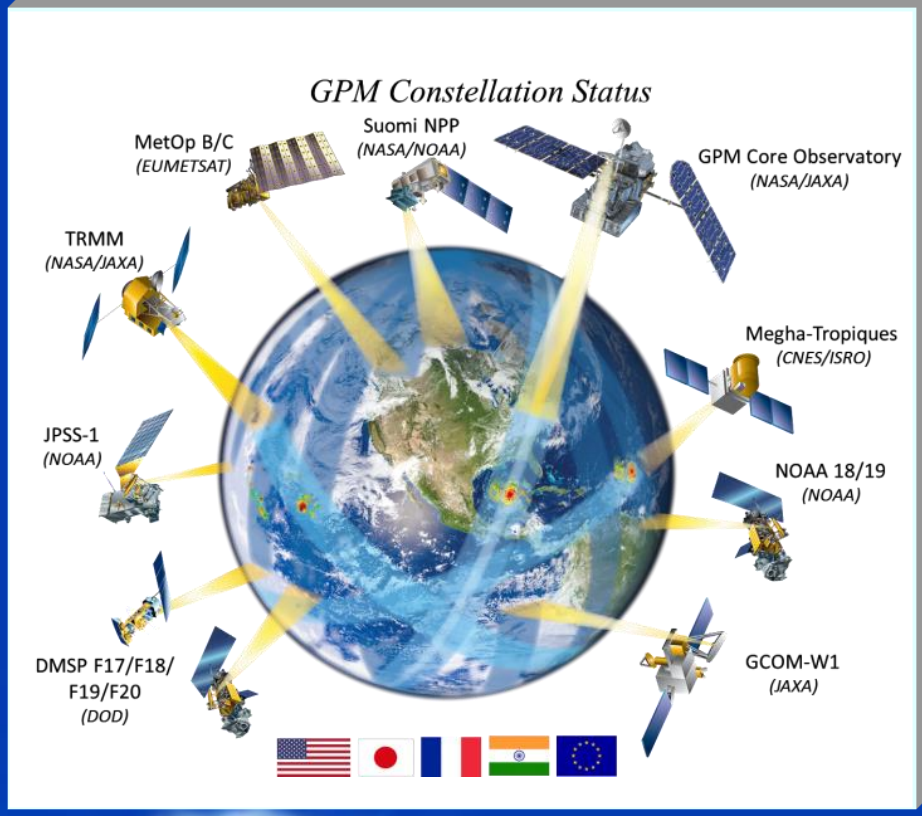
The measured emissivity of land or water surface is equally affected by soil moisture or ocean salinity.

The data SMOS allow to form maps of soil moisture averaging for three days and once a month maps of salinity of the World Ocean.

SMOS will improve our understanding of Earth's water cycle, providing much-needed data for modeling of weather and climate

SMOS mission has gone beyond its original scientific brief of delivering critical information for understanding water cycle-this satellite is now being used to predict drought and improve crop yield and also to measure thin ice floating in polar seas accurately enough for forecasting and ship routing

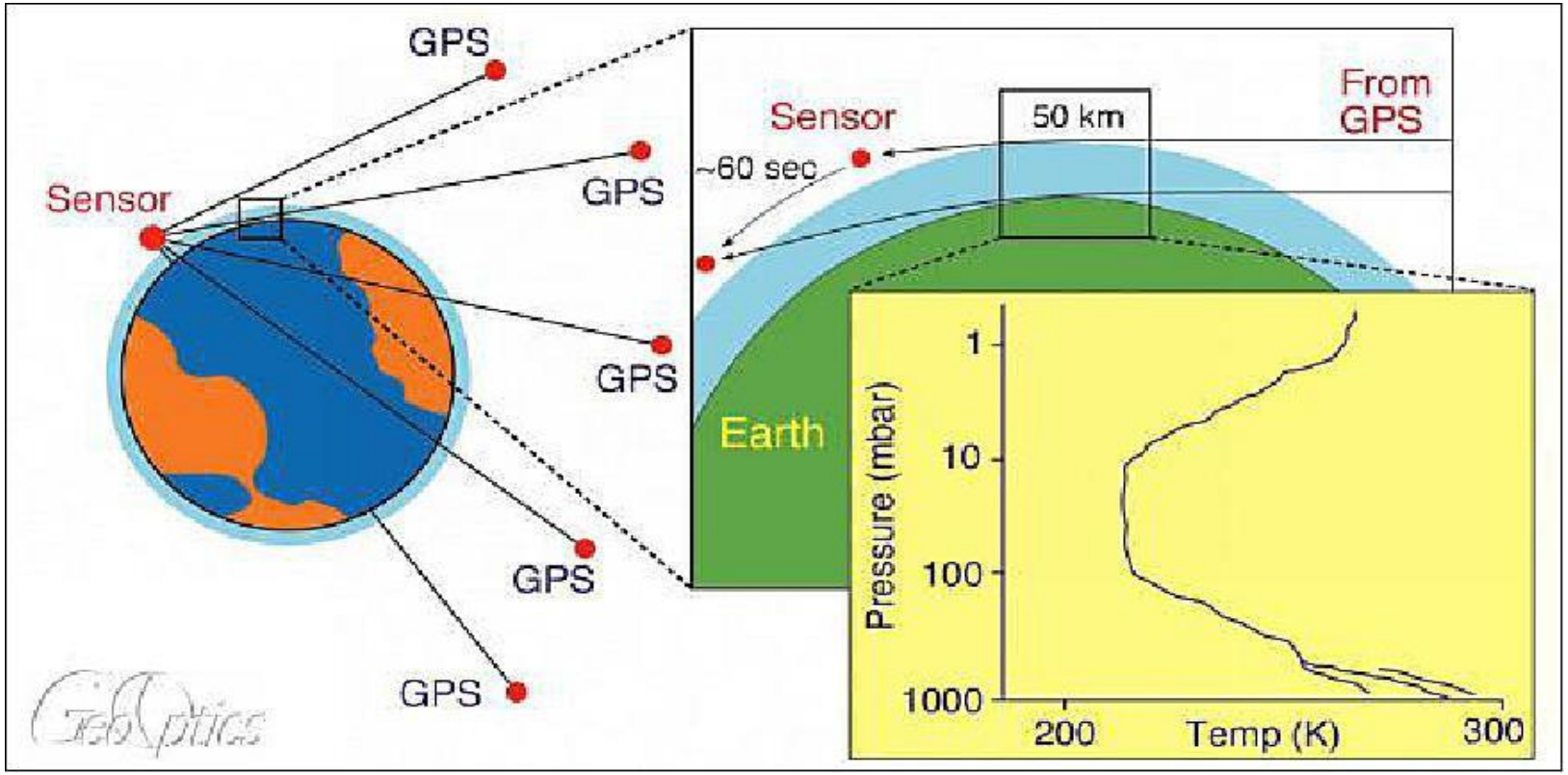
Global Precipitation Measurement Mission



Each member country with satellites with their own scientific and practical tasks provides data for measuring precipitation intensity, water content of clouds, temperature and humidity profile of the atmosphere for use in the program. The combination of capabilities allows measurements to be taken several times a day throughout the Earth.

The GPM mission data will advance our understanding of the water and energy cycle.

CICERO Project: the pass of the beam in the troposphere depends on the refractive index along it, that is fields of temperature, pressure and humidity



The CICERO projects includes the deployment of low-orbit constellation of 24 or more smaller satellites in different orbital planes for regular observations of the signal navigation satellites GPS an Galileo passing through the atmosphere.

Thanks for watching