Monitoring Lightning Activity and Other Earth System Variables from Space Using Nanosatellite Technology

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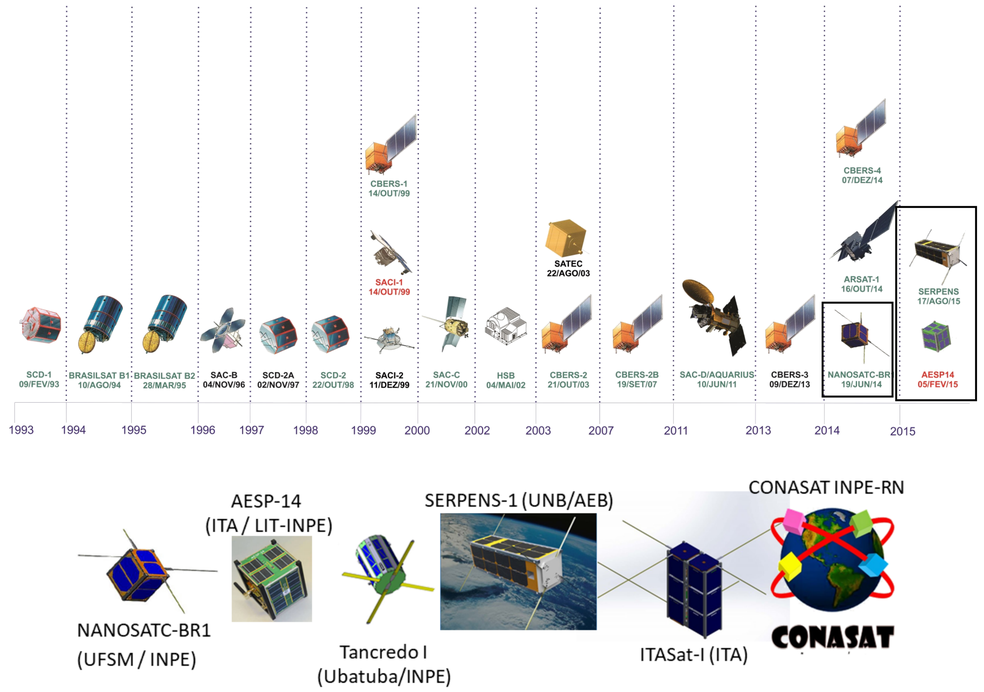
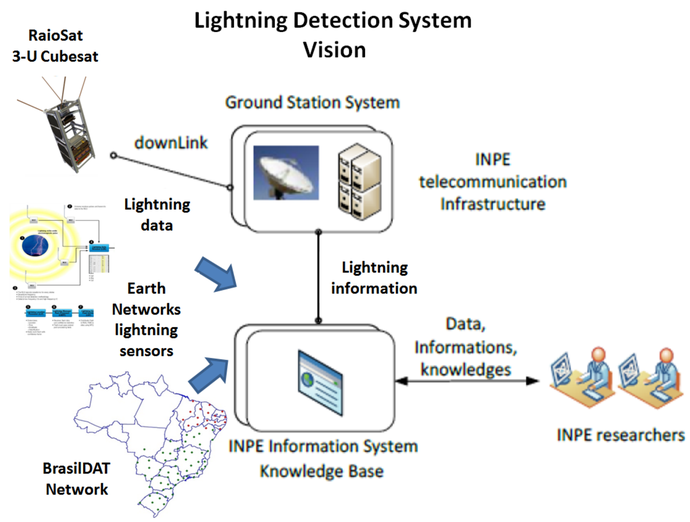
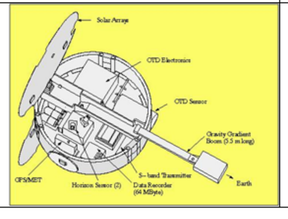
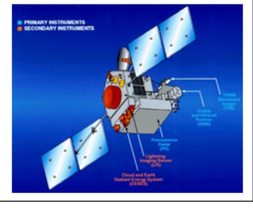
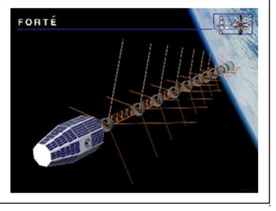
ABSTRACT: In many studies of sustainability and climate change, several types of measurements are required to understand earth system phenomena and/or environment variables. Nowadays, there is a significant amount of ground-based measurements of dozen types of environmental variables. However, observations from space can provide a more spatially uniform and time-continuous coverage, which is very important to any study of the earth system processes. As examples of the use of satellite measurements: (1) prediction of extreme weather events (one of the major features of climate changes) requires high-resolution numerical weather prediction (NWP) models and the maximum amount of observational data available; (2) remote observation of surface properties (both over land and sea) can be very useful for land use studies, deforestation impact assessment and interaction of the vegetation with the ground and sea (climatic conditions); (3) assessment of atmospheric gases from space (e.g. nitrogen and carbon dioxide) can provide biogeochemical traces to improve the studies of the greenhouse effect and global warming. Nowadays, in Brazil, there are several ground networks composed by different types of sensors that provide earth system measurements, including lightning and/or thunderstorm sensors, greenhouse gases, wind and solar potential for energy generation; however the Brazilian scientific community now demands new types of measurements that can be provided by satellite solutions, like for example the nanosatellites. Such data are important to expand the observational databases improving science and technology studies towards sustainable driven problem-solving researches. Brazil is now working to develop the RaioSat project which is a nanosatellite expected to operate in a 650 km LEO orbit using a 3U-CubeSat (10x10x30cm) aluminum structure to accommodate the bus, an optical camera with a spectral filter in the oxygen and nitrogen bands, and VHF antenna. This work addresses the current status of the RaioSat project and the future perspectives for expand the space observations to another environmental variables using possibly a constellation of cubesats.

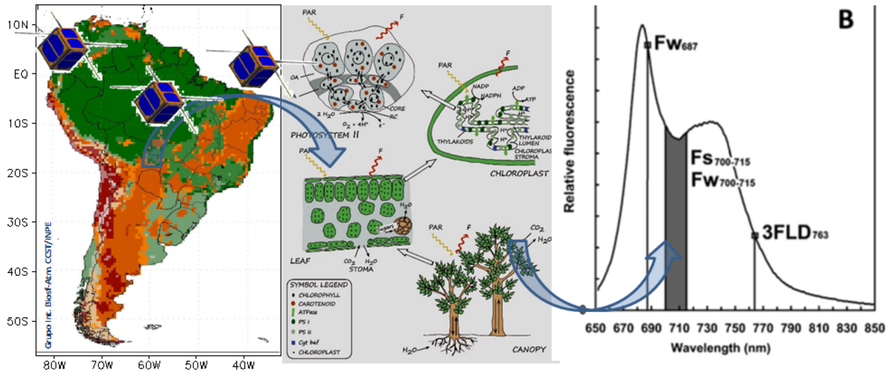
The Brazilian scientific community now demands these new types of measurements that could be provided by satellite solutions, like for example the nanosatellites as the one prospectively to be in operation using the RaioSat approach with its BrasilDAT ground sensor network. Typical examples of these types of data are:

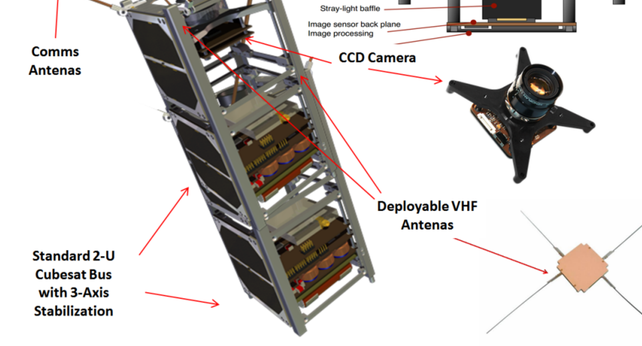
- Prediction of extreme weather events requires high-resolution NWP models and a great amount of observational data available such as atmospheric lightning discharges for instance;
- Remote observation of land and sea surface properties that can be fruitful for land use studies, deforestation impact analysis, forest healthy monitoring, land degradation, and vegetation-climatic systems interactions;
- Evaluation of atmospheric gases from space (e.g. N and CO2) can improve the greenhouse effect and global warming studies. The RaioSat nanosatellite and prospective BioMassSat constellations are examples further described hereafter.





Satellite	OrbView-1/ MicroLab	TRMM- Tropical Rainfall Measuring Mission	FORTE - Fast On-orbit Recording of Transient
Lightning Detecting Payload	OTD - Optical Transient Detector	LIS - Lightning Imaging Sensor	RF antenna OLS – Optical Lightning Sensor
Mass	74 kg	3620 kg	210 kg
Altitude	785 km	350 e 402 Km	800 Km
Inclination	70°	35°	70°
Launch Date	01/04/1995	27/11/1997	29/08/1997
End of Life	24/08/2015	08/04/2015	
Ilustration			





Resolution	Frame Rate	Column_Size	Row_Size	Shutter Width
2048 x 1536 QXGA	12 fps	2047	1535	<1552
1600 x 1200 UXGA	20 fps	1599	1199	<1216
1280 x 1024 SXGA	27 fps	1279	1023	<1040
1024 x 768 XGA	43 fps	1023	767	<784
800 x 600 SVGA	65 fps	799	599	<616
640 x 480 VGA	93 fps	639	479	<496