



Thales Alenia Space instruments for climate

A technical overview



11/10/2017



PROPRIETARY INFORMATION

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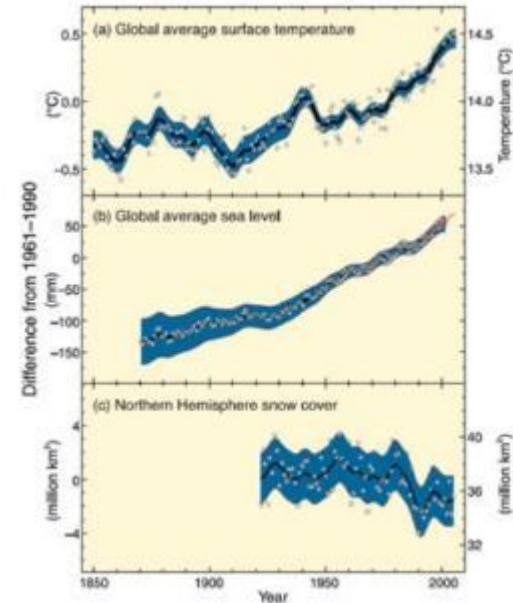
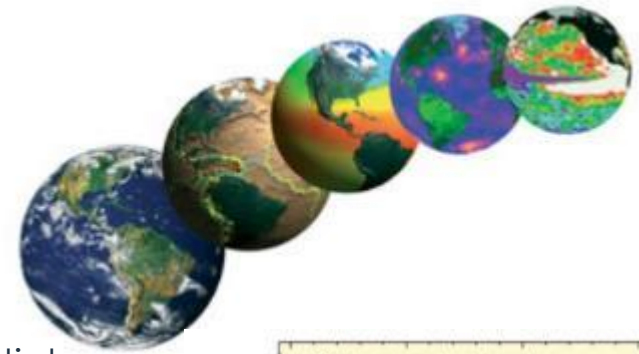


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THALES ALENIA SPACE INTERNAL

Introduction

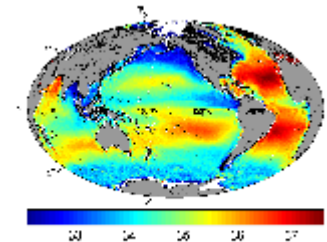
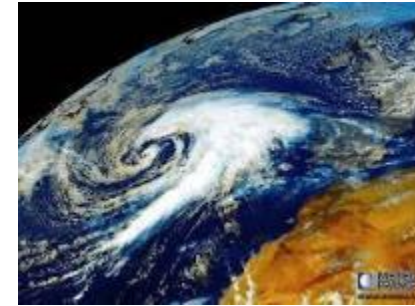
- 🌍 Earth System climate is undoubtedly changing well outside the range of natural variability
- 🌍 An improved understanding of the Earth System is essential
- 🌍 Long-term, sustainable and accurate observations are thus required, mandatorily through an international collaboration.
- 🌍 No single technology can provide all the necessary data, but satellites provide a vital means of obtaining observations from a global perspective



“a detailed global climate record for the future will not be possible without a major, sustained, satellite component” GCOS implementation plan

Essential Climate Variables

The Essential Climate Variables	
Domain	Essential Climate Variables
Atmospheric (over land, sea and ice)	Surface: Air temperature, precipitation, air pressure, surface radiation budget, wind speed and direction, water vapour.
	Upper air: Earth radiation budget (including solar irradiance), upper air temperature (including MSU radiances), wind speed and direction, water vapour, cloud properties.
	Composition: Carbon dioxide, methane, ozone, other long-lived greenhouse gases, aerosol properties.
Oceanic	Surface: Sea surface temperature, sea surface salinity, sea level, sea state, sea ice, currents, ocean colour (for biological activity), carbon dioxide partial pressure.
	Sub-surface: Temperature, salinity, currents, nutrients, carbon, ocean tracers, phytoplankton.
Terrestrial	River discharge, water use, ground water, lake levels, snow cover, glaciers and ice caps, permafrost and seasonally-frozen ground, albedo, land cover (including vegetation type), fraction of absorbed photosynthetically active radiation (fAPAR), leaf area index (LAI), biomass, fire disturbance, soil moisture.



Global Climate Observing System requires Atmospheric, Oceanic and Terrestrial observations

Satellites as one element of a consistent mission chain

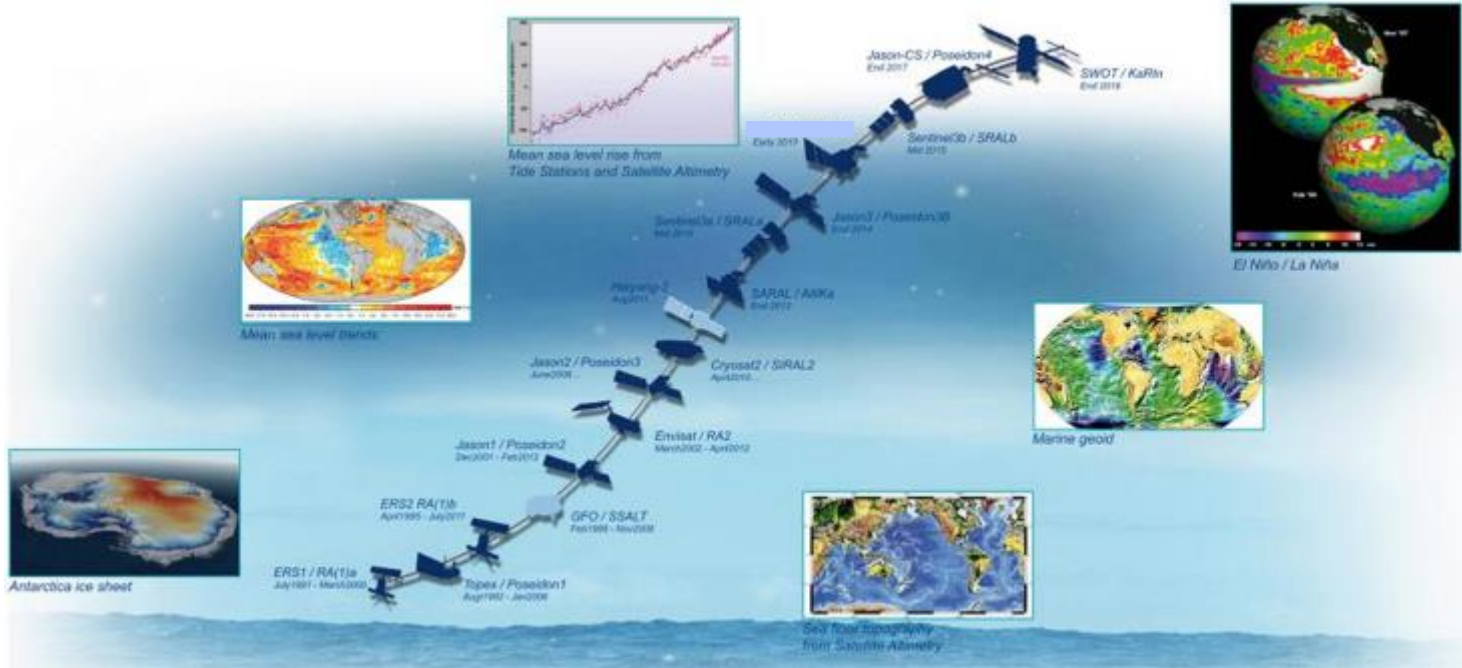
🛰️ To provide effective and indisputable climate changes information, the satellites shall be:

- 🛰️ Highly accurate,
 - 🛰️ Perfectly calibrated and characterized,
 - 🛰️ Stable along the years or with a known instability,
 - 🛰️ Designed as an element of a larger and consistent system,
 - 🛰️ Consistent with all the other elements of the mission chain (processing, applications, services...)
- 🛰️ Thales Alenia Space's vision is this is better achieved through the ability and willingness to interact with all the stakeholders and to understand the full mission chain



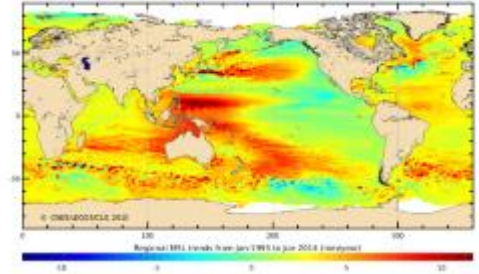
Climate change observations require the excellence that shall be achieved by a team work involving all the stakeholders

Altimeters product line consistent with the topography mission objectives



Unique instrument expertise for outstanding mission results

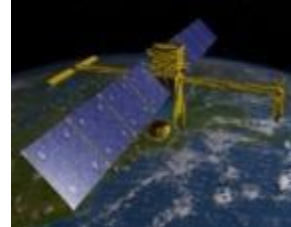
Examples of sustainable accurate observations: Altimetry



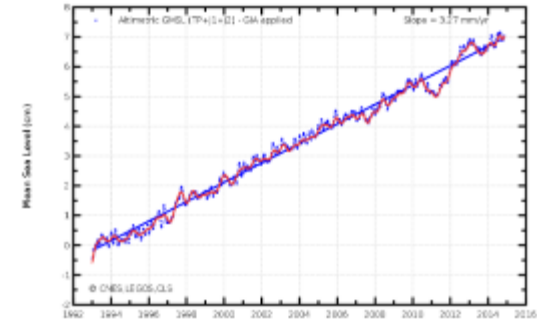
TOPEX



JASON 1/2/3



POS3C-SWOT



Poseidon 1-3 : the reference altimeter for more than 20 years

Examples of sustainable accurate observations: Meteosat & Copernicus



METEOSAT series provides remote sensing data key for several atmospheric Essential Climate Variables



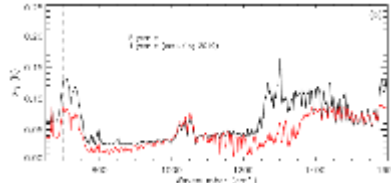
Sentinel-3 provides Remote Sensing Data key for several Oceanic, Terrestrial and even Atmospheric Essential Climate Variables



Sentinel-1 provides Remote Sensing Data for key Oceanic, Terrestrial Essential Climate Variables

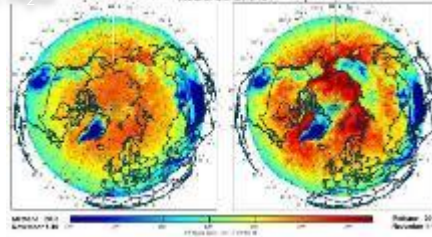
IASI a breakthrough for operational weather forecast, climate & air quality

IASI stability is paramount for climate long trend analysis : temperature, CO₂, CH₄,

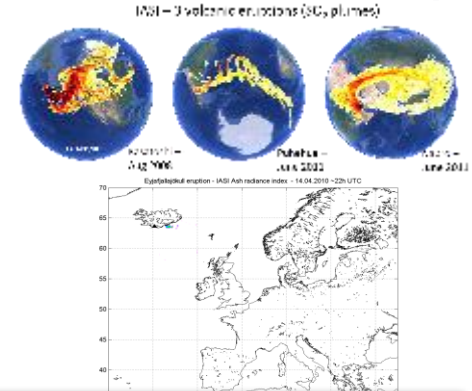


Standard deviation in global annual mean IRR brightness temperatures for all 5 yr (black) and excluding 2010 (red). HELEN BRINDLEY, & all Imperial College London

H₂O, N₂O

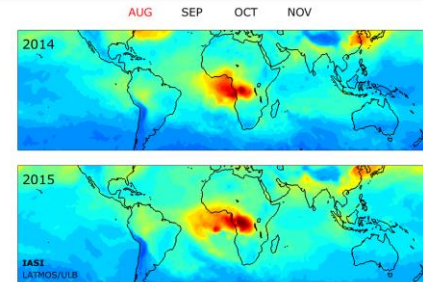
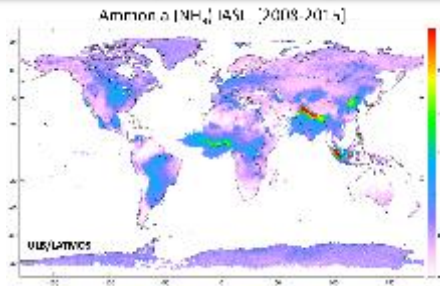
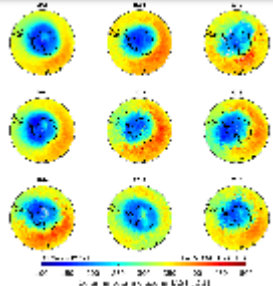


Ashes, fire plumes monitoring



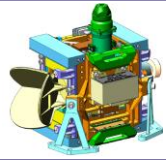
Courtesy CNES

IASI a precursor of operational Air Quality services: O₃, NH₃, CO, SiO₂, HCOOH, fires, ashes & others aerosols monitoring




Operational Weather Forecasting, Climate & Air quality success
Rewarded by the AAE 2015 1st price


IASI: a technological success for a successful mission



1 580 000 000 cycles of acquisition

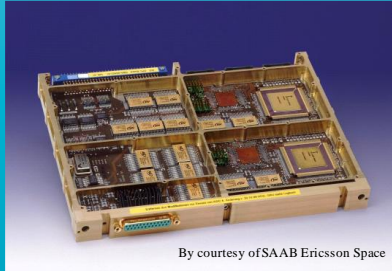


$10^{-7} \lambda/\Delta\lambda$ stabilisation of LASER source



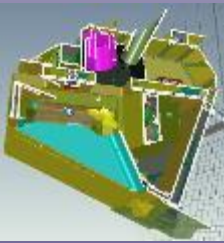
Cold optics & Focal Planes cool down @ -180°C
with a 3 stage Passive Cooler.
Corner Stone of high radiometric performance & free of vibration IASI data

On board processing chain : 8 processing chains based on 200 Mips μ PROCESSORS



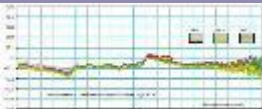
By courtesy of SAAB Ericsson Space

Interferograms 45 Mb/s
↓
Interferograms correction
↓
FFT
↓
Radiometric calibration
↓
Variable coding
↓
1,5 Mb/s Calibrated Spectra in engineering units ready for model assimilation by users



Less than 50 mK Absolute Error between the 12 pixels of the 3 IASI flight models

Absolute calibration error almost insensitivity to environmental variations such as input and output eclipse proven by testing on ground



80 000 Atmospheric spectra provided by IASI on METOP A & B in 20'

IASI design and key technologies provide to users numerous highly stable and reliable information on atmospheric states from beginning of 2007 year

IASI's success lies in an exceptional team work between scientists, CNES and industry understanding Atmospheric Remote Sensing measurement & processing chain stakes

Future: Greenhouse gases monitoring and Copernicus

- 🌐 Greenhouse gases measurements both for natural and anthropogenic fluxes monitoring
 - 🌐 CO2 Human Emissions H2020 project to prepare a European capacity to monitor CO2 anthropogenic emissions
 - 🌐 TRACE industrial chaire to analyze innovative observations solutions and mission chain optimization
 - 🌐 Microcarb
 - 🌐 CO2 Sentinel



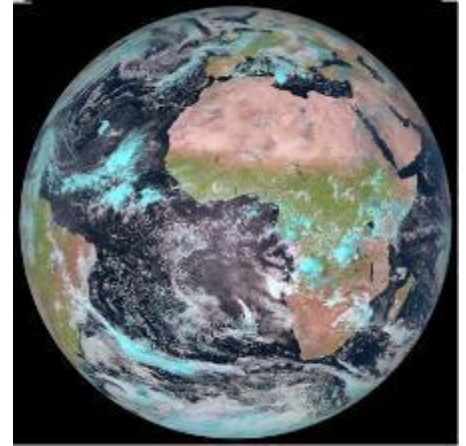
- 🌐 Copernicus expansion and extension



Credit CNES

Future: MTG next operational mission breakthrough from GEO orbit

- 🛰️ Thales Alenia Space continues to innovate in favor of expanding horizons in Atmospheric Remote Sensing with the 6 Meteosat Third Generations satellites
 - 🛰️ First European 3 stabilized platforms for Operational Weather Forecasting
- 🛰️ MTG imagers and sounders will provide high frequency images of Earth Disk
 - 🛰️ 144 per day Visible to TIR high resolution images
 - 🛰️ 24 per day MWIR to TIR high spectral resolution image of H₂O and CO₂
- 🛰️ In continuity of MSG and IASI in orbit performance, MTG will provide, high performance data with emphasis on the quality, the reliability and the availability of data:
 - 🛰️ Innovative sun radiance entrance management @ eclipse
 - 🛰️ Image quality and navigation inherited from Thales Alenia Space long series of METEOSAT
 - 🛰️ Highly stable radiometric & spectral calibration inherited from Thales Alenia Space long series of Thermal Infrared Instruments



Conclusion

- 🌐 Thales Alenia Space DNA fully corresponds to climate change needs and success criteria
 - 🌐 Sustainable, accurate, stable and characterized satellites
 - 🌐 international collaboration
 - 🌐 Satellite designed as an element of a larger and consistent system,
 - 🌐 Satellite consistent with all the other elements of the mission chain (processing, applications, services...)
 - 🌐 Capacity to interact with all the stakeholders and to understand the full mission chain



Thank you for your attention

Thales Alenia Space is ready to accompany you
to sustain the climate change challenge

