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## From COP 21 to COP 22, new challenges for space agencies on climate: greenhouse gasses and water resources measurements from space



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## **Objectives of EO : Advanced Earth Sciences**



# Objectives of EO: Inform decision (societal benefit)







Mauna Loa, Hawaii



Source: Dave Keeling and Tim Whorf (Scripps Institution of Oceanography)



Concentration (ppmv)

 $\tilde{c}_{0}$ 





















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## **Success stories**

Some examples...

# Numerical weather prediction







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## **IASI and IASI-NG**

(Infrared Atmospheric Sounding Interferometer) Breakthroughs for meteorology and determining the composition of the atmosphere

#### A CNES/EUMETSAT programme

- An essential instrument in the payload of the 3 European polarorbiting meteorological satellites, MetOp (A & B) and MetOp-SG, due to its Fourier transform interferometer.
- Has resulted in improved 6-day weather forecasts. Provides airpollution alerts 1 or 2 days in advance.
- First flight model launched in October 2006 on MetOp-A. Second model launched on MetOp-B in September 2012.
- The three IASI-NG models are under development.

Launch of the third IASI model in 2018 and of the first IASI-NG model in 2021

## **Observation** Atmosphere/Weather



#### Seasonal variations El Niño/La Niña using altimetry data

Monthly averages maps (in cm) on Novembers each year since 1993, over the Equatorial Pacific from the El Niño Bulletin. The time series of the standardized Sea Level Anomalies is also displayed and updated on the Indicator page. Credits CLS/CNES



-20

0

-10

10

20



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## Observation Oceanography

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#### The Jason series Towards operational oceanography

A CNES/NASA project (expanded to include NOAA and EUMETSAT).

- Following on from operational meteorology, Jason 2 was able to demonstrate operational oceanography.
- The programme is being continued with Jason 3, which shares many of Jason 2's characteristics.
- The follow-up to Jason 3 is already planned. This will be Jason CS (for "Continuity of Service"), the sixth Sentinel satellite of the Copernicus programme.



Jason 3 was launched on 17 January 2016



## New challenges : climate

## **UN Sustainable Development Goals**



Cones



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# 1) Greenhouse Gases observation from Space

**CEOS EARTH OBSERVATION HANDBOOK FOR COP21** 



Domain	Essential Climate Variables
Atmospheric (over land, sea and ice)	Surface: Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget Upper-air: Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance) Composition: Carbon dioxide, Methane, and other long-lived greenhouse gases, Ozone and Aerosol, supported by their precursors
Oceanic	Surface: Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture

The ECVs – satellite observations make a major contribution to the ECVs shown in bold



# MICROCARB & MERLIN



MERLIN : CH4 Active measurement Accuracy< 27 ppb Bias < 3,7 ppb

- DIAL Lidar at 1,67 μm
- Horizontal sampling accumulation: 50 km
- To be launched in 2021





MICROCARB : CO2 Passive measurement Accuracy< 1 ppm Bias < 0,1 ppm

- XCO2 spatial gradients are small (< 10 ppm)
- Error on measurement (regional bias) implies
   wrong flux computation
- To be launched in 2020

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# Growing interest in $CO_2$ and $CH_4$ Observations from



#### Japan:

- GOSAT (JAXA/NIES/MoE), launched in 2009.
- GOSAT-2 (JAXA/NIES/MoE), planned for 2018.



space

COPS



#### USA:

- OCO-2 (NASA), launched in 2014.
- OCO-3 (NASA), planned in or after 2018.
- GEOCARB (NASA), planned for ?
- ASCENDS (NASA), under study (2023+).





#### China:

• TanSat (CAS, MOST, CMA) launched in 2016.

### Europe:



- COPERNICUS/Sentinel 5P (ESA) & 5 (UE), planned for 2017 & 2021.
  MERLIN (CNES-DLR), planned for 2021.
- MICROCARB (CNES), planned for 2020.
- General presentation of CNES Sentinel 7 (ESA/UE), TBC, for 2025



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# 2) Water cycle and fresh water resources from Space

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## **Observation**

## **Oceanography/Hydrology**

## **SWOT** (Surface Water Ocean Topography Mission )

Monitoring the level of oceans and inland waters



- CNES is providing the platform and co-operating with NASA on the instruments, in particular the highly-innovative KaRIn wideswath altimeter.
- CNES is also in charge of the satellite's ground control segment and is developing (jointly with NASA) a mission ground segment for data processing.
   The French contribution is partly financed by the French future investments programme (PIA).



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Launch scheduled for 2021



### Going from large scale to smaller scale monitoring New generation of altimetry measurements for oceanography

Example: Ocean dynamics in the Gulf of Mexico

- The colored map depicts the ocean circulation as it is monitored by current satellite altimetry
- Yellow lines shows the actual trajectory or surface drifters





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## SWOT Coverage Leap - from local altimetry to topography



SWOT mission will address challenges and shortcomings of conventional altimetry (e.g., spatial coverage and resolution) in both oceanographic and hydrologic applications and will enable a wide range of research opportunities in oceanography and land hydrology.

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## International cooperation



## From COP 21 to COP 22





HEADS OF SPACE AGENCIES DECIDE TO JOIN EFFORTS IN SUPPORT OF COP 21 DECISIONS

- MAY 2016 -

Marrakech Declaration – Water cycle and fresh water resources



# Thank you for your attention

