International Ocean Colour Science Meeting 2013

CNES OCEAN PROGRAMS

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Wednesday, May 8th, 2013

Darmstadt, Germany
• CNES OCEAN PROGRAMS OUTLOOK
• OCEAN COLOR MISSIONS
• OCEAN COLOR DEVELOPMENTS
Ocean sciences are one of the major interests of CNES Earth observation programs

Supporting (and supported by) a strong scientific community through dedicated research funding

Supporting several larger scope projects and initiatives (e.g. Mercator-Ocean, CORIOLIS and bioArgo, Boussole, GIS COOC…)

Strong support to R&D (Instrument, mission concepts, data processing…)

In terms of satellites missions, the heavy weight is still on physical ocean observation

altimetry (Jason-1/2/3/CS, SARAL/AltiKa, SWOT, Sentinel-3, Hy-2A, )
salinity (SMOS)
wind/waves (CFOSAT),
ocean color: PARASOL, Sentinel-3, “GEOCAPI”
Ocean missions @ CNES (various levels of contributions)

- **Jason-1** France/USA (12/01)
- **Jason-2** Europe/USA (06/08)
- **ENVISAT** Europe (3/02)
- **CRYOSAT-2** Europe
- **SARAL** Fr./India
- **HY-2A** China
- **SMOS** Europe
- **PARASOL/POLDER** France (12/04)
- **Sentinel-3A** Europe
- **Sentinel-3B** Europe
- **Sentinel-3A-B** Europe
- **Sentinel-3A** Europe
- **Jason-3** Europe/USA
- **Jason-CS A and B** Europe/USA
- **SWOT** USA/France
- **OCAPI** ???

**Operational**, **Validation**, **Being developped (C/D)**, **Proposed (A/B)**, **Concept (O)**
PARASOL STATUS

Main objective is to monitor clouds and aerosols… with an ocean color observing capability (and polarimetry)

- in the A-Train from Dec 04 to Dec 09, then moved to a lower orbit (collision risks avoidance)
- « mission extension review » held successfully in 2011 => mission extended up to 2013
- Level 1b through ICARE thematic center (atmosphere)

- Some OC level-2 products are generated by CNES, but distribution is on request: any request to have them more widely available is welcome!
There is some strong French involvement in GMES Ocean component at all levels

On Space component
- Cooperation with ESA on Sentinel-3 development: system support for the altimetry mission payload and ground system
- CNES in-kind contribution: DORIS, orbitography processing, part of ground segment prototyping

On Core Services
- Support to Mercator-Ocean (leader of MyOcean/MyOcean-2)
- In-kind contributions and upstream R&D support

On “Collaborative Ground Segment”
- Structuration of a Marine Collaborative Ground Segment => institutional and private funding of prototyping activities
- Balance between ocean color, altimetry, and sea state

Science support (TOSCA program, S3VT)
⇒ OCAPI « Ocean Color Advanced Permanent Imager »
Recommended by the science prospective seminar (Biarritz 2009)
⇒ Decision to start a “phase 0” study at CNES PASO

Quite long « phase 0 » study at CNES (~2 years), but we are getting close to the end
« Key point 2 » end of Feb’13: concludes the phase 0 study (assesment of the different scenarii)
Mission Definition Review planned for April: prepare transition to phase A (selection of the baseline scenario)

Phase A not funded yet, but 1st on the waiting list: could start in 2014
A new round of « science prospective » exercice on-going at CNES, and OCAPI is still a high priority for ocean community: keep pushing for it…
International cooperation needed: CNES is unlikely to do it alone
### GEO-OCAPI: MISSION REQUIREMENTS (1/3)

| Band | \(\lambda\) (nm) | \(\Delta \lambda\) (nm) | \(L_{mm}\) | \(L_{ref}\) | \(L_{max,\text{ocean}}\) | SNR at 250 m
& \(L_{ref}\) |
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- From 395 to 740 nm thematic needs
- From 750 to 1040 nm atmospheric corrections

\(\Rightarrow\) 16 spectral bands minimum.

\(\Rightarrow\) SNR (*) < 400

\(\Rightarrow\) Spectral resolution from 10 to 40 nm (depending of the spectral domain and uses)

\((*)\) SNR = Signal-to-Noise Ratio
Ground Spatial Resolution (GSR) - 3 classes of needs are identified for the VNIR domain (0.4 – 1.1 μm):

- Threshold: 500 meters and larger for Open Ocean (Case-1 waters)
- Goal: 100 meter for Coast and inland observation (Case-2 waters)
- Breakthrough: 250 meters as well Case-1 than Case-2 waters

Coverage:
- Global disk
- Coastal area should be the goal at the better resolution

Satellite’s revisit frequency is the main design driver
- from ½ to 1 hour (diurnal)
- A daily mosaïc is required after clouds and glitter correction
Two main challenges:

**IMAGE QUALITY**, an image is considered exploitable if:
- Solar zenithal angle ($\theta_s$) < 80 deg
- Incidence angle ($\theta_v$) < 60 deg
- Glint < 0.0005 (assuming a wind speed of 7 m/s)
- Air mass fraction ($f$) < 4

**RADIOMETRY AND GEOMETRY QUALITY**, depends also on platform stability
- The a priori pointing error < 5% of the field of view
- The geolocation error -> ½ pixel
MAIN TRADE OFF FOR GEOOCAPI: RESOLUTION VS REVISIT

“Breakthrought” scenario: GeoOCAPI 250
- The main challenge for this mission was to design a satellite able to cover all the disk, every hours, at 250m of resolution with 16 narrow bands on a mini satellite (500 kg -> 1 ton class)
- Preliminary studies lead by CNES with industrial support show that this challenge can be taken to space before 2021.

“Goal” scenario: GeoOCAPI 100
- The challenge for this mission is to design a very high-resolution (100 m class) superspectral (16 bands) system, able to cover all the Atlantic + Mediterranean coasts every ½ or 1 hour.
- Specifications are more difficult to reach and may require additional analysis to definitively demonstrate the feasibility of the concept

⇒ Feasibility and Cost studies favour the GeoOCAPI 250 design
Commits with all the performance requirements:

- Pupil diameter: 160 mm
- Dimensions: 1.2m*1m*1m
- Mass: 140kg
- Power: 300W
- Data rate ~100 Mbps per day (<25 Mbps after compression)
- Ka band strongly recommended
- (Operational congestion of X Band)

(1) TMA telescope (Three-Mirror Anastigmat)
(2) 2-axes pointing mechanism (pointing mirror)
(3) Filter Wheel (16 filters+1 black)
(4) Focal plane: 2D CMOS new detector
<table>
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<td><strong>Altitude</strong></td>
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| **Payload**     | TMA telescope \( \phi 160 \) mm  
Detector VNIR CMOS 4000 x 356 pixels  
(to be developed) |
| **Resolution/Swath** | 250 m / 1000*750 km |
| **Spectral bandwidth** | 350 – 1050 nm / 10 to 40 nm |
| **Nb of bands** | 16 2 (in option) |
| **Heure locale** | 6H-18H |
| **Payload budget** | Mass 140 kg/Power 300 W (imaging), |
| **Satellite budget** | 700 kg (dry ass) – 1100 kg (at launch)/ 1500W |
| **Geolocalisation/ Co-registration** | 130m / 2 pixels en 36s |
| **Revisit period** | 1 Hour |
| **Imaging capacity** | \(~ 750 000\)km2 per image / 1200 images by day |
| **Data rate** | 100 Mbps (25 Mbp after compression) |
| **Link to Ground** | Ka-band (with ground stations) |
| **Launcher compatib.** | Soyuz direct GEO |
| **Expected lifetime** | 10 years (incl. end-of-life operations) |
GeoOCAPI introduces the next Ocean Color generation with:

- high spatial resolution of 250 m, 16 spectral channel, a swath of 1000 km2 compatible with LEO data (MODIS, SENTINEL 3, …);
- thanks to his GEO position, the disk is revisit 1 time by hour and Near Real Time observation (NRT) is possible;
- technological miniaturization which allows an innovative mini-satellite less than 700kg (dry, marged);
- lifetime is 10 years.

The GeoOCAPI phase A should take place in CNES in 2014. Phases B/C/D/E1 (for 7 years) should be decided for a launch in 2020/2021.

This program is strongly depending on the development of critical technologies (like specific detectors) and international cooperation interest.