

Status of French balloon programme and possible cooperation with Canada

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**(input from Marie-Anne Clair,
director of the CNES balloon division)**

DECIDED MISSIONS

Commitment in planned missions...

- **ConcordIASI (with NCAR):** September 2010, flights up to Christmas or longer...
- **Kiruna/Esrangle (with SSC):** Spring 2010 and Spring 2011
- **Fireball (with USA):** scheduled in 2011, possible shift
- **Exomars (with ESA):** June 2011 and 2012 from Kiruna/Esrangle
- **Pilot:** Winter 2011/2012 from Kiruna/Esrangle
- **Bamed:** demonstration campaign in 2011, 1st scientific campaign in Fall 2012, 2nd scientific campaign in Spring 2013, possible continuation in Fall 2013 and Spring 2014 (TBC)
- **Strateole 2 (including Hamlet):** schedule to be confirmed, 1st technological flight in 2012 at earliest

... all missions have to be accomplished !

BALLOON VEHICLES

- **BPS (Ballon Pressurisé Stratosphérique):** Ongoing developments for **ConcordIASI** (solar panels, long distance control) based on existing flight trains
- **BSO (Ballon Stratosphérique Ouvert):** Existing flight trains are becoming obsolete and cannot be maintained (no parts available). No longer compatible with (new/enforced) safety rules. Necessary upgrade
- **Aeroclipper:** Flight readiness still to be confirmed. All sub-systems must be upgraded (envelope, guiderope, gondola, ground segment)
- **MIR (Montgolfière InfraRouge):** Possibly dangerous parts (polar pieces, envelopes, flight train) make this aerostat non compliant with present safety rules. Upgrade to be implemented similarly to BPS flight trains
- **BPCL (Ballon Pressurisé Couche Limite):** Ongoing developments for the mission **Bamed**

SAFETY

1. CNES requirements for non lethal balloon systems:

Critical safety functions shall remain compliant in case of single point failure. Flight elements, balloon/ground interfaces and ground segments shall be redundant (no single point failure) for critical parts (except for envelopes)

Waiver up to end 2011 for flights from Kiruna/Esrangle (BSO),
from Seychelles and from McMurdo (BPS)

2. Probability for casualty on ground:

The probability for a victim on ground shall be smaller than 3×10^{-5}

Impact of gondola and flight train forbidden in highly populated areas ($>$ a few inhabitant/km²)
Recovery in the vicinity of metropolitan areas no longer possible
with the existing CNES balloon system!

RETURN TO FLIGHT OBJECTIVES

- Return to flight for all types of aerostat
- The NOSYCA project aims at suppressing single point failure issues for BSO, BPS and MIR
- Priorities to be defined because of available human and budgetary resources



Work to be performed in phase with decided missions:

1. BPS (as they are): ConcordIASI in Fall 2010
2. BSO (new flight train): end 2011 for Pilot
3. Aeroclipper and BPCL: 1st mission within Bamed in Oct. 2012
4. BPS (new envelopes and flight trains) : Strateole 2 date TBD
5. MIR: no identified mission yet

MSD-1 launch: Driftsonde + TSEN pre-ConcordIASI campaign 2010 February 8th

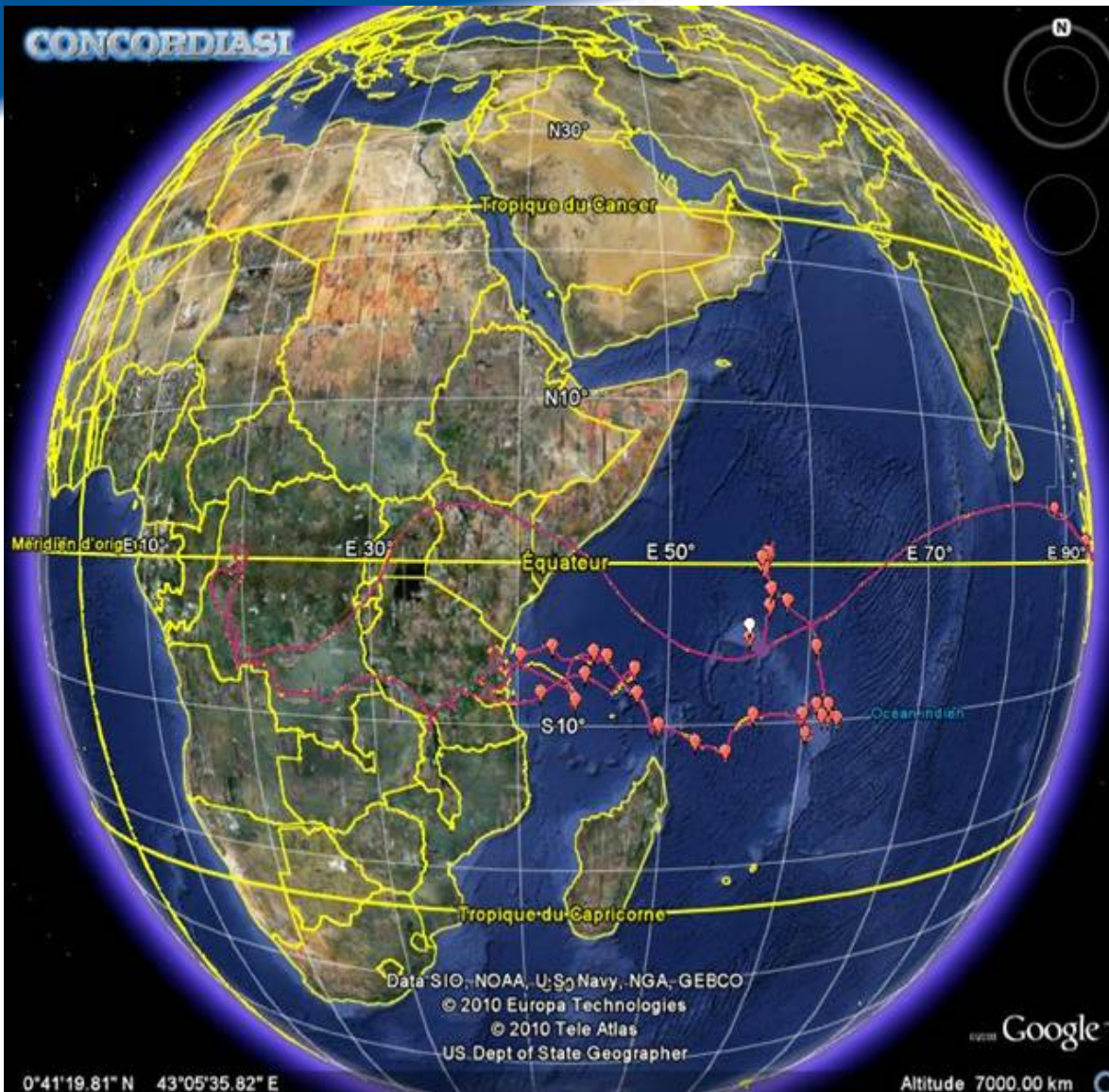


Reduced mass allocated
by CNES to Driftsonde
for this flight test

➤ 32 drop-sondes

Courtesy: P. Cocquerez,
CNES project manager of
the ConcordIASI project

MSD-1 flight trajectory (pre-ConcordIASI campaign)



Launches from
Seychelles
(pink marks:
dropsonde releases)

Courtesy: P. Cocquerez,
CNES project manager of
the ConcordIASI project

Roadmap for BSO (1)

- Authorized for flight up to end 2011 over less populated areas. Kiruna/Esrangle 2010 and 2011 are accepted (waiver).
- Forbidden for flight after 2011 except if compliant with single point failure



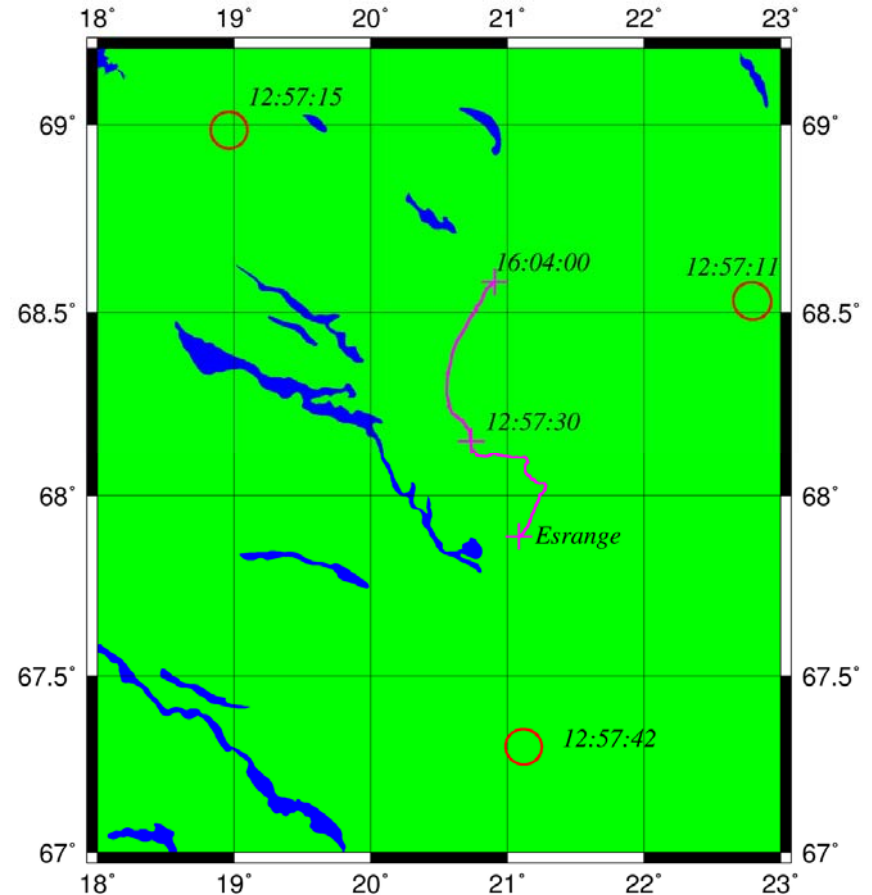
The BSO version using NOSYCA must be available for the Pilot flight by the end of 2011 and for BSO flights after 2011 !!!

- High priority to the qualification of NOSYCA for BSO flights in 2011
- The timing for scientific campaigns from Kiruna/Esrangle in 2011 will be phased depending on the progress in the development of NOSYCA

Example of recent BSO flight from Kiruna/Esrange



Final launch operation of the payload SWIR-balloon on 14 August 2009 from Esrange (Credit: LPMAA)



SWIR01 flight trajectory (pink line) and coincident IFOVs of TANSO-FTS (red circle).

Example of recent BSO flight from Kiruna/Esrange



SWIR-balloon payload on the recovery site. The azimuth control system of the gondola (pivot) is clearly seen on the top of the gondola (lying on its side in this case)

Roadmap for BSO (2)

Then:

1. **Re-flight from Teresina in 2013 with BSO version NOSYCA**
2. **Re-flight from Aire-sur-l'Adour (ASA) and/or Gap in 2013 or 2014.**
Options under study at CNES:
 - Sea recovery: discussions with scientific teams, integrated partnership between CNES and scientist to develop gondola suitable for sea recovery
 - Recovery by helicopter of all parts of the aerostat (gondola and envelope)
3. **Study and development of a flight simulator** for predicting/optimizing the trajectory and determining appropriate landing zones (safety authorities to validate this option, date TBD)
4. **Incremental extension of flight duration (dates TBD):**
 - **3 days in 2014,**
 - **5 days in 2015: flight Kiruna/Esrangle-Canada**
 - **2 weeks in 2016: circum-polar flight from Kiruna/Esrangle**
 - **4 weeks in 2017: circum-equatorial flight from Teresina or Kourou**

Roadmap for BPS

ConcordIASI to be successful in Fall 2010 !!!

THEN:

- **Suppress single point failure: adapt « NOSYCA BSO » to BPS.
Start activities after ConcordIASI (availability of the BPS team)**
- **Increase the diameter of envelopes from 12 m to 16 m (ongoing) in order to:**
 - **Increase mass for the payload**
 - **Increase float altitude**
- **Choice of an industry contractor for a gondola production line**

Strateole 2 mission:

Date to be defined according to available resources at CNES and in the concerned scientific laboratories

Roadmap for Aeroclippers

- Generic mission specification available
- Ongoing work for prototypes of envelope and guiderope
- Ongoing system definition including ground segment
- **System Definition Review in June 2010**
- Design in 2nd half of 2010
- Assembly and test of prototype during 1st half of 2011
- Detailed technical specification of aerostat production line for Bamed demonstration campaign : June 2011



Tight schedule but compatible with Bamed planning,... TBC

THEN: prepare other missions: possibly SWICE

Roadmap for MIR

- Suppress dangerous parts (ongoing)
- Study of the envelopes (from the safety point of view)

To be continued:

- Suppress single point failure issues by adapting the NOSYCA version for BPS to MIR
- Improve trajectory forecast for controlling impact zones
- Analyze double envelope concepts for better over flight of cold clouds

No pressing mandate since no decided mission

Search for new launching/landing sites (1)

■ Criteria

- ◆ scientific interest (enhanced latitude coverage)
- ◆ capacity for logistics and operations
- ◆ costs

■ Questionnaire toward scientists in July 2009 on areas of interest (as a function of latitude)

■ Presentation of results in January 2010

Search for launching/landing sites (2)

- **5 sites will be examined (by order of priority):**
 - ◆ **Canada for ~ mid-latitudes: Vanscoy 52° N (?)**
 - ◆ **Kourou for equatorial zones 5° N**
 - ◆ **Brazil: Bauru and Teresina (reactivate cooperation with INPE)**
 - ◆ **Australia with option to launch from Nouméa 23° S**
 - ◆ **Mediterranean (Sicily-Spain flights about 20 years ago, “chantier Méditerranée”)**
 - ◆ **USA: ongoing cooperation on “bigger” astronomy/astrophysical payloads**
- **Including the « classic sites »:**
 - Kiruna/Esrange, McMurdo,**
 - or Gap, and ASA (possibly reactivated for payloads ~ 100 kg)**

Summary

- **Current CNES balloon capabilities**
 - ◆ **BSO**: 500 kg, 5 hPa, 35 km, 4-12 hr, possible azimuth control
 - ◆ **PB**: 40 kg, 50 hPa, 20 km, 3 weeks
 - ◆ **NOSYCA** is key for future balloon operations: compliance with enforced safety rules and operative for long distance flights. Workhorse for future (French) balloon operations
 - ◆ Proposed study for optimizing BSO trajectories in real time (ballast/valve) to reach a target site or a “safe” area for recovery
 - ◆ New “**unique counter**” for scientific ballooning proposals:
Comité Scientifique et Technique Ballon (CSTB)
 - ◆ International cooperation welcome (possible piggy-back, possible accommodation on **gondola with azimuth control**)
- Major concern of CNES director with **safety issues**
(comply with the written “doctrine” to reduce risks of casualties)
- Ongoing discussions in Europe on balloon infrastructures (SSC, DLR, ...)

Outlook

- CNES balloon programme is in a **transition state**
 - ◆ Kiruna/Esrange campaigns in 2010 and 2011 are “enacted”
 - ◆ ConcordIASI mobilizing energies in between these two campaigns
 - ◆ Years 2012 and 2013 for qualifying NOSYCA in its various versions
 - ◆ Search for new partners/sites for enhanced capabilities at different latitudes
 - ◆ Ongoing studies for recovery of balloon payloads at sea to circumvent safety issues over land
 - ◆ International cooperation could benefit from the synergy between **balloon** and **satellite** projects (demonstration of new instrument concepts, calibration/validation, data exchange, compatibility of equipments and procedures, training...)
- CNES is interested in flying BSO **to or from Canada** with a possible support/cooperation of the French balloon launching and operation team to/with a new CSA scientific balloon capacity.

Thanks to all
Merci de votre attention