SARAL PROJECT OVERVIEW

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SARAL PROGRAM

SARAL Program is a joint mission conducted by ISRO and CNES dedicated to the environmental, mainly oceanic, survey.

Two missions are on-board the SARAL satellite

- **ALTIKa** mission

  SARAL ↔ Satellite with ARgos and Altika

- **ARGOS-3** mission

**Scientific objectives of the ALTIKA mission**
- Ocean meso-scale variability study with an improvement in vertical and spatial measurement resolution thanks to Ka-band altimeter
- To provide geophysical data for assimilation in a global ocean model
- To contribute to:
  - coastal altimetry, continental waters and inland ice sheet monitoring, light rainfall and clouds climatology,
  - Geodetic reference system determination thanks to Doris and LRA

**Objectives of the ARGOS-3/SARAL mission**
- To improve and to expand the capabilities (availability, performance, data latency) of the ARGOS Data Collection System
  - ARGOS users segment: ~20,000 beacons spread all over the world
SARAL / ALTIKA MISSION OVERVIEW (1)

ALTIKA : First in-orbit altimeter in Ka band

**Orbit**
- Sun-synchronous (6/18)
- 800 km
- 35 days
- 98.55°
- Same orbit/ground-track than ENVISAT (< Oct 2010)

**AltiKa payload**
- Single frequency Ka-band altimeter (35.75 GHz)
- Dual-frequency radiometer (23.8 and 37 GHz)
- DORIS receiver
- Passive laser retroreflector array

**Single frequency Ka band altimeter with an enhanced bandwidth**
- Reduced ionosphere effects (authorizes mono-frequency altimeter)
- 480 MHz bandwidth: better vertical resolution
- Ka-band and increased PRF (4 KHz): improved spatial resolution and reduced 1Hz noise
- Smaller footprint
- Ka-band limitations: sensitivity to atmospheric water content
SARAL / ALTIKA MISSION OVERVIEW (2)

- **SARAL mission lifetime requirements**
  - ARGOS-3 / SARAL lifetime requirement : 5 years, **objective : 7 years**
  - AltiKa / SARAL lifetime requirement : 3 years, **objective : 5 years**

- **SARAL Flight Segment**
  - ISRO : SSB bus, PSLV, satellite operation : S/C CC, S-band station(s), *(X-band station : HKTM)*
  - CNES : PIM, polar X-band stations (IVK, KRN) for Payload TM retrieval

- **SARAL / AltiKa Mission Segment**
  - ISRO is responsible for providing Near Real Time (OGDR, IGDR, S-IGDR) and Off-Line (GDR, S-GDR) altimetry products to Indian users.
  - CNES is responsible for providing Near Real Time and Off-Line altimetry products to users outside India and for the precise determination of the orbit (POD).
    - According to CNES/EUMETSAT agreement, **EUM is in charge of SARAL data circulation between the mission centers and to compute and deliver OGDR to users outside India**
  - CNES is responsible for the coordination of AltiKa with the other altimetry missions (e.g. DUACS) and for the long term CALVAL.
SARAL SATELLITE : PIM & SSB

SARAL sat. characteristics
# Mass : 408.6 kg – Dec ‘12
- SSB platform : 244.8 kg
- Payload Module : 163.8 kg
404.916 kg – April ‘13

# Power : 570 W (end of life)
- SSB platform : ~ 205 W
- Payload Module: 250 w
(peak consumption < 300 W)

# Size
- ~ 1m x ~1m x 2.7 m
- Solar panels : 1.2m x 1.6m (x2)

ARGOS UHF ANTENNA
ARGOS L-BAND ANTENNA
SCBT
X-BAND ANTENNA
MAGNETOMETER
DORIS ANTENNA
TTC ANTENNA
LRA
ALTika ALTIMETER & RADIOMETER ANTENNA
STAR SENSORS
PIM : PAYLOAD INTEGRATED MODULE
SSB : SMALL SATELLITE BUS
THE SARAL SATELLITE IN SHAR FACILITIES
HISTORY : SOME MILESTONES OF THE SARAL PROGRAM

- **1998 - 2002**: Exploratory studies and pre-developments related to Ka band altimetry
- **2003**: AltiKa instrument phase B
- **2003 - 2005**: Phase 0 (satellite) : AltiKa on-board a micro satellite
- **2005**: First discussions between CNES and ISRO: *ALTIKA on-board Oceansat3*
- **2006**: SARAL satellite is proposed : PIM (CNES) & SSB (Small Satellite Bus - ISRO)
  => ALTIKA and ARGOS-3 are integrated inside the Payload Module (PIM)
- **February 2007**: Signature of ALTIKA and ARGOS-3/SARAL MOU between CNES and ISRO
- **Aug. – Oct. 2009**: Delivery of Doris, ARGOS-3 package and ALTIKA FMs to THALES
- **December 2009**: formal agreement of EUMETSAT to take part to the SARAL mission
- **Jan. 2010 – July 2011**: PIM Integration & Qualification in France
- **July 2012**: PIM delivery to ISAC/ISRO in India (Bangalore)
- **Aug. 2012 – Feb. 2013**: Integration and Qualification of the SARAL S/C in ISRO facilities
  Launch campaign in Sriharikota
- **February 25th, 2013 at 12:31 UTC**: Take-Off !! from SHAR
- **27-29 Aug. 2013**: SARAL/ALTIKA 1st Verification Workshop in Toulouse
- **Oct. 2013**: Precise historical Envisat orbit and ground-track are reached
ICU turned ON on February 25th, 2013 at 15:36 UT. Since this date,

- No ICU switch OFF, no reset
- No anomaly detected in ICU operation
  - TC management and routing: OK
  - Payload TM acquisition and management : OK
  - ICU PPS distribution and time-tagging : OK
- ICU Currents, voltages and temperatures are nominal
- ICU FDIR (by SSB) and PIM ATC FDIR (by ICU) enabled on March 2nd, 2013 => no FDIR triggering

PIM – ICU status is nominal

PIM ACTIVE THERMAL CONTROL (performed by ICU) : OK

- Automatically enabled at ICU turned ON
- During payloads switch ON : 4 lines (Main) cycled as expected
- When all payloads ON : only 1 line (AMBIANT/Main) cycles as expected
- PIM equipments and aerials temperatures are nominal
- PIM ATC power consumption is nominal
DORIS STATUS

- Doris (chain 1) turned ON on February 25\textsuperscript{th}, 2013 at 23:40 UT. Since this date,
  - No DORIS switch OFF, no restart
  - No anomaly detected in DORIS operation
    - TC reception and processing: OK
    - TM generation: OK
  - Doris currents and temperatures are nominal
  - Jamming: no on-board jammer detected
  - DIODE (Doris embedded real-time navigator): OK
    - Auto-initialization: nominally achieved on February 26\textsuperscript{th}, 2013
  - 100\% availability and integrity during routine phases
    - \textit{Radial RMS \approx 3.3 cm}: on-board position accuracy is OK for OGDR
  - Accuracy of DORIS Off-line (ground processing) SARAL orbit restitution (MOE,POE): OK (see POD status presentation)

\textbf{\rightarrow DORIS status is nominal}
AltiKa STATUS

- AltiKa turned ON on February 26th, 2013 at 01:42 UT. Since this date,
  - No ALTIKA switch OFF, no restart
  - No anomaly detected in ALTIKA (altimeter & radiometer) operation
    - TC reception and processing: OK
    - TM generation: OK
  - ALTIKA (altimeter & radiometers) currents and temperatures are nominal
  - All acquisition/tracking modes (autonomous, Diode aided and DIODE+DEM) and both trackers (median and EDP) have been successfully tested and evaluated
  - Altimeter calibrations (routine calibrations: CAL1, CAL2, expertise calibrations) have been performed: instrument characteristics are very stable in orbit
  - Altimeter RF beam nadir pointing estimation (based on X-cross calibration maneuvers): better than 0.02 deg
  - Very few data are lost because of rain/clouds signal attenuation.

AltiKa altimeter and radiometer status is nominal
AFTER SLIGHTLY MORE THAN ONE YEAR IN ORBIT …

System and Operation

- All components of the SARAL/ALTIKA system are working properly
- Excellent stability of the instruments of the AltiKa mission
- Operations are run smoothly between CNES, ISRO and EUMETSAT
- An achievement of a very fruitful cooperation between ISRO and CNES with performances exceeding mission expectations!

Products: outcomes of ALTIKA 1st Workshop

(see SALP status presentation)

- Availability
  ✦ Easy to use, easy to fit in operational systems
  ✦ Products (OGDR, IGDR, GDR) made available to PI and to Users very fast
  ✦ Very high availability of data (despite the feared effects of rain) in a timely manner

- Quality
  ✦ All products quality is in line with mission requirements,
  ✦ Performance are similar to JASON2 (reference altimetry mission) and sometimes better

Setting-up a SARAL/ALTIKA follow-on mission would give the opportunity to ensure the continuity of the Ka-band altimetry survey of oceans, ice sheets, lakes and rivers while preparing and complementing the SWOT mission.
Thank you!