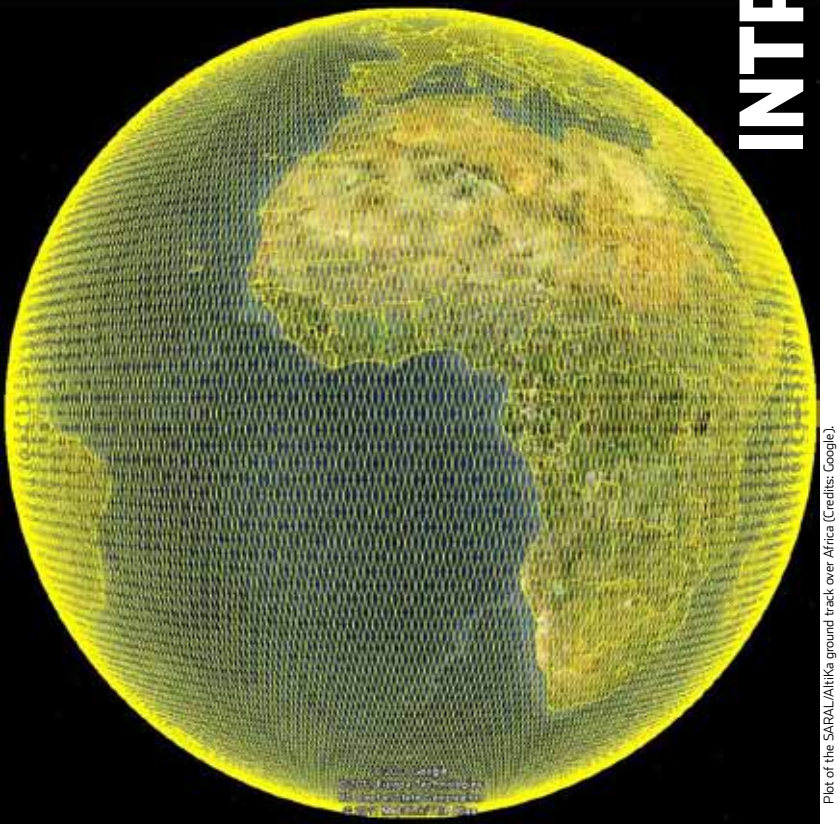

cnes
इसरो isro
SARAL
AltiKa

INTRODUCTION



Plot of the SARAL/AltiKa ground track over Africa (Credits: Google).

SARAL/AltiKa is a new mission in cooperation between CNES and ISRO (Indian Space Research Organization), conducted with the collaboration of EUMETSAT. In Hindi, "SARAL" means "simple"; in English, "SARAL" stands for SAtellite for ARgos and ALtiKa. Carrying in particular a new-generation altimeter, the satellite will follow the same ground tracks as Envisat (ESA). This mission renews the series of successful altimetric missions such as TOPEX/Poseidon and Jason missions, conducted in cooperation between CNES, NASA, EUMETSAT and NOAA.

All altimeters previously launched operated in Ku-band (13.6 GHz) coupled with S or C band. The idea of using Ka-band (35 GHz) is that the altimeter would be much less affected by the ionosphere than one operating at Ku-band, and would have enhanced performance in terms of vertical resolution, time decorrelation of echoes, spatial resolution and range noise. With the design of an adapted tracker algorithm, near-continuous altimetric tracking above all kinds of surface could be performed, which is especially important when approaching or leaving coasts. Among the expected advantages, a better observation of ice, rain, coastal zones, lakes, rivers and wave heights is foreseen.

The SARAL/Altika satellite will be launched by a PSLV vehicle from India in 2012. It is planned to operate for a nominal period of 5 years, with an objective at 7 years.

ISRO / CNES RESPONSIBILITIES

ISRO responsibilities	CNES responsibilities
Project Management, shared with CNES	Project Management, shared with ISRO
SARAL satellite engineering	Overall SARAL system engineering
Small Satellite Bus/Indian Mini Satellite - 2 Platform	Integrated Payload Module including • AltiKa mission payload • ARGOS-3 mission payload
SARAL Satellite Integration and Tests	Support for SARAL Payload Module Integration and Tests
PSLV Launch vehicle and services	
Ground System & Operations • Flight Operations Control Center • S-band network stations • X-band Hyderabad station • Data communication network • NRT and OFL products processing and distribution to users within India • Archiving of all telemetry and products and auxiliary data	Ground System & Operations • 2 Polar X-band stations [Swedish Space Corp.] • Compatibility of L-band stations network required for the ARGOS-3/SARAL mission • Data communication network • AltiKa Mission Center • NRT and OFL product processing software development, installation, training and support to operations (ISRO and EUMETSAT) • NRT product processing, archiving, distribution to users outside India with the support of EUMETSAT • OFL product processing and distribution to users outside India • DORIS products processing and distribution • Data providing to the ARGOS Global Processing Centers • Archiving of all telemetry and products and auxiliary data
User services	User services
	ALTIKA System Coordination with other altimetry missions; expertise and long term CALVAL

PAYLOAD OVERVIEW

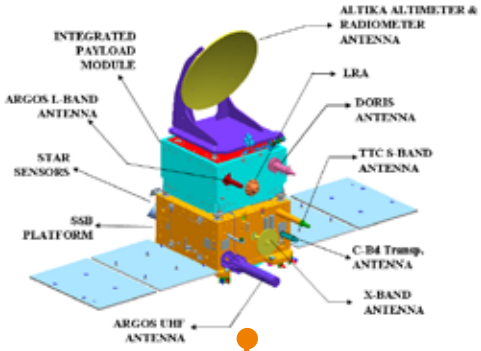
The SARAL payload includes the following instruments:

- An **altimeter,** provided by CNES (the main mission instrument) and a **dual frequency microwave radiometer,** provided by CNES (to correct the altimeter measurement for atmospheric range delays induced by water vapour).

The **AltiKa** instrument consists of a Ka-band altimeter and an embedded dual frequency radiometer (23.8 GHz / 37 GHz), both sharing the same antenna.

- The radiopositioning **DORIS system,** provided by CNES (for precise orbit determination using dedicated ground stations).
- **A Laser Reflector Array (LRA),** provided by CNES (to calibrate the orbit determination system).
- **And the ARGOS-3 instrument** (and associated components) that has its own mission on-board the SARAL satellite as part of the ARGOS system.

View of the SARAL satellite
(AltiKa & Argos-3 payloads accommodation on the platform)



SARAL satellite in integration / © CNES/JALBY Pierre, 2010

The AltiKa payload is based on a Ka-band altimeter (35.75 GHz), 1st oceanographic altimeter using such a high frequency. At this frequency, **the ionospheric attenuation can be considered as low** and can be corrected by model, including in NRT processing. This feature eliminates the need for a dual-frequency altimeter.

The use of Ka-band induces a **reduced altimeter footprint** that leads to a better spatial resolution (8 km footprint diameter).

The decorrelation time of sea echoes at Ka-band is shorter than at Ku-band. So the number of independent echoes per second measured per second can be significantly increased to provide a **high pulse repetition frequency (4 kHz).**

Thanks to the use of Ka-band, **a larger bandwidth** is available compared to other altimeters. The **500 MHz** bandwidth can provide a **high vertical resolution (0.3 m).**

Compared to Ku-band, a lower signal penetration of snow and ice is expected. The altimetric observation and height restitution thus correspond to a thin subsurface layer. This should improve measurements of snowpack with respect to ice aging in the surface layers of the polar ice caps. Moreover, ice grain size would also be measurable. Combined with better spatial resolution, Ka-band would therefore allow closer monitoring of sea and continental ice.

Artist view of the SARAL satellite / © CNES/ill./SATTLER Oliver, 2010

The AltiKa instrument
has the main following characteristics:

Parameter	Value
Altimeter band	35.75 GHz +/- 250 MHz
Pulse bandwidth	500 MHz
Pulse duration	110 µs
Altimeter pulse repetition frequency	~3.8 kHz (automatically adjusted)
Echo averaging (altimeter)	~25 ms
Spectrum analyser (altimeter)	128 points
Altimeter link budget	11 dB (sigma naught = 6.5 dB)
Antenna diameter	1000 mm
Focal length	700 mm
Offset	100 mm
Radiometer band	23.8 GHz +/- 200 MHz 37 GHz +/- 500 MHz
Radiometric sensitivity	< 0.3 K
Radiometric bias	< 1 K
Radiometric averaging	200 ms
Data rate	38 kbits/s
Mass (altimeter+radiometer)	< 42 kg
Power consumption (altimeter+radiometer)	< 100 W

THE SARAL / ALTIKA ORBIT

The SARAL / AltiKa satellite flies on the same ground-track as Envisat with a 501-pass, 35-day exact repeat cycle on a sun-synchronous orbit.

The mean classical orbit elements are given in the table below:

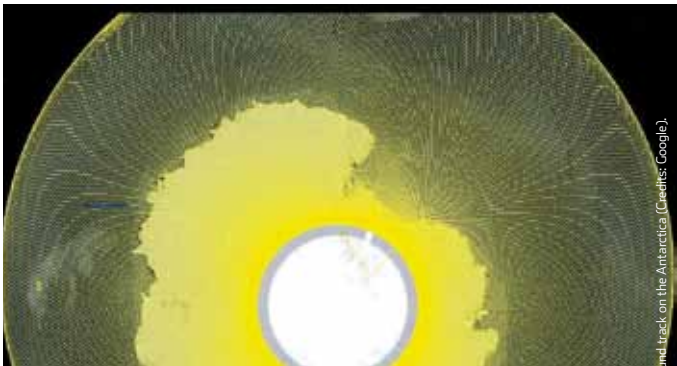
Orbit element	Value
Repeat period	35 days
Number of revolution within a cycle	501
Apogee altitude	814 km
Perigee altitude	786 km
Inclination	98.55 deg
Argument of perigee	90.0 deg
Local time at ascending node	06:00 AM
Earth Longitude of equator ascending crossing of pass1	0.1335 deg
Ground track control band	+/- 1 km

Zoom on the French/Italian/Corsican coasts (Credits: CLS / Google).

The orbit auxiliary data are given in the table below:

Auxiliary Data	Values
Semi major axis	7159.496 km
Eccentricity	1.165 10-3
Nodal period	100.59 mn
Number of orbits per day	14+11/35
Equatorial cross track separation	75 km
Inertial nodal rate	0.9856 deg/ day
Mean Orbital speed	7.47 km/s

Due to the orbit eccentricity and Earth' shape, the altimeter is designed to cover altitude range of +/- 25 km max.


Plot of the SARAL/AltiKa ground track on the Antarctica (Credits: Google).

SARAL / AltiKa MISSION OBJECTIVES

SARAL/AltiKa main scientific objective is divided in sub-themes including:

- Intrinsic **scientific studies of ocean at meso-scale dynamics:** observations, theoretical analyses, **modelling, data assimilation, parameterization,** etc.
- Improvement of our **understanding of the oceanic component in the climate system:** investigation of local processes at small or medium scale poorly known and understood at present, but which have an impact on the modelling of climate variability at large spatial and temporal scales.
- Contribution **to the study of coastal dynamic processes,** especially small or medium scale phenomena, whose retrieval will enable to anticipate many downstream applications.
- Contribution to **operational oceanography** which requires large amounts of in situ and space observation data.

SARAL/AltiKa secondary **objectives** are notably the monitoring of the main **continental waters level** (lakes, rivers, closed seas), the monitoring **of mean sea level** variations, the observation of **polar oceans,** the analysis and forecast of **wave and wind fields,** the study of **continental ices** and **sea ices** (thanks to improved performances of Ka-band over this kind of surfaces), the access to low rains climatology (enabled in counterpart to the sensitivity of Ka-band to clouds and **low rains**) and the **marine biogeochemistry** (notably through the role of the meso and sub-meso-scale physics).

SARAL satellite in integration / © CNES/JALBY Pierre, 2010

The SARAL/AltiKa Level-2 products

The SARAL/AltiKa products will follow the same logic and scheme than Jason-2, with three latencies and three complexities.

Note, however, that the high rate data will be 40 Hz (instead of 20 Hz classically).

	OGDR family	IGDR family	GDR family
Reduced: 1 Hz	OGDR-SSHA	IGDR-SSHA	GDR-SSHA
Native: 1 Hz + 40 Hz	OGDR	IGDR	GDR
Sensor: 1 Hz + 40 Hz + waveforms	-	S-IGDR	S-GDR
Latency	3 - 5 Hours	< 1.5 days	~40 days

The products will be given in NetCDF standard to be consistent with other altimetric missions and altimetry toolbox such as BRAT (Basic Radar Altimetry Toolbox), developed by CNES & ESA. The Near Real Time products are also available in BUFR format for meteorological users.

Auxiliary Data	Impacted Parameter	OGDR	IGDR	GDR
Orbit	Satellite altitude, Doppler correction	DORIS Navigator	Preliminary (DORIS MOE)	Precise (DORIS+Laser POE)
Meteo Fields	Dry/wet tropospheric corrections, U/V wind vector, Surface pressure, Inverted barometer correction	Predicted	Restituted	
Pole Location	Pole tide height	Predicted		Restituted
Mog2D	HF ocean dealiasing correction	Not available	Preliminary	Precise
GIM	Ionosphere correction	Available		

FOR FURTHER INFORMATION > **AVISO website** (http://www.aviso.oceanobs.com) & **AVISO Users Service** (aviso@oceanobs.com)
• **French Scientific Missions of the French National Space Agency** (http://smsc.cnes.fr/SARAL/index.htm) • **CNES website** (http://www.cnes.fr) & **ISRO website** (http://www.isro.org).

ACCESS TO NRT DATA

The OGDR files are produced at ISRO and EUMETSAT. The official NRT products release will occurred about 6 months after launch, after the NRT verification phase. In near real time, EUMETSAT disseminates OGDR files on EUMETCast or via ftp (UMARF **http://archive.eumetsat.org/umarf**) and ISRO disseminates OGDR files via ftp (MOSDAC **http://www.mosdac.gov.in**).

ACCESS TO OFF-LINE DATA

The official OFL products release will occur about 10 months after launch, after the OFL verification phase. The IGDR family is produced solely by CNES while GDR families are produced by CNES and ISRO. They are available on the AVISO ftp server (**http://www.aviso.oceanobs.com**) and on MOSDAC (**http://www.mosdac.gov.in**).

CNES and ISRO archival facilities also provide a variety of auxiliary files used to produce the O/I/GDR datasets.

Réalisation ACM 2012-266 - CNES Toulouse - couverture Artist view of the SARAL satellite © GEKO / CNES / Impression Messages

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