

ALTIKA :
A Ka-Band Altimetry Payload
to Contribute in
Ocean and Ice Observing Systems



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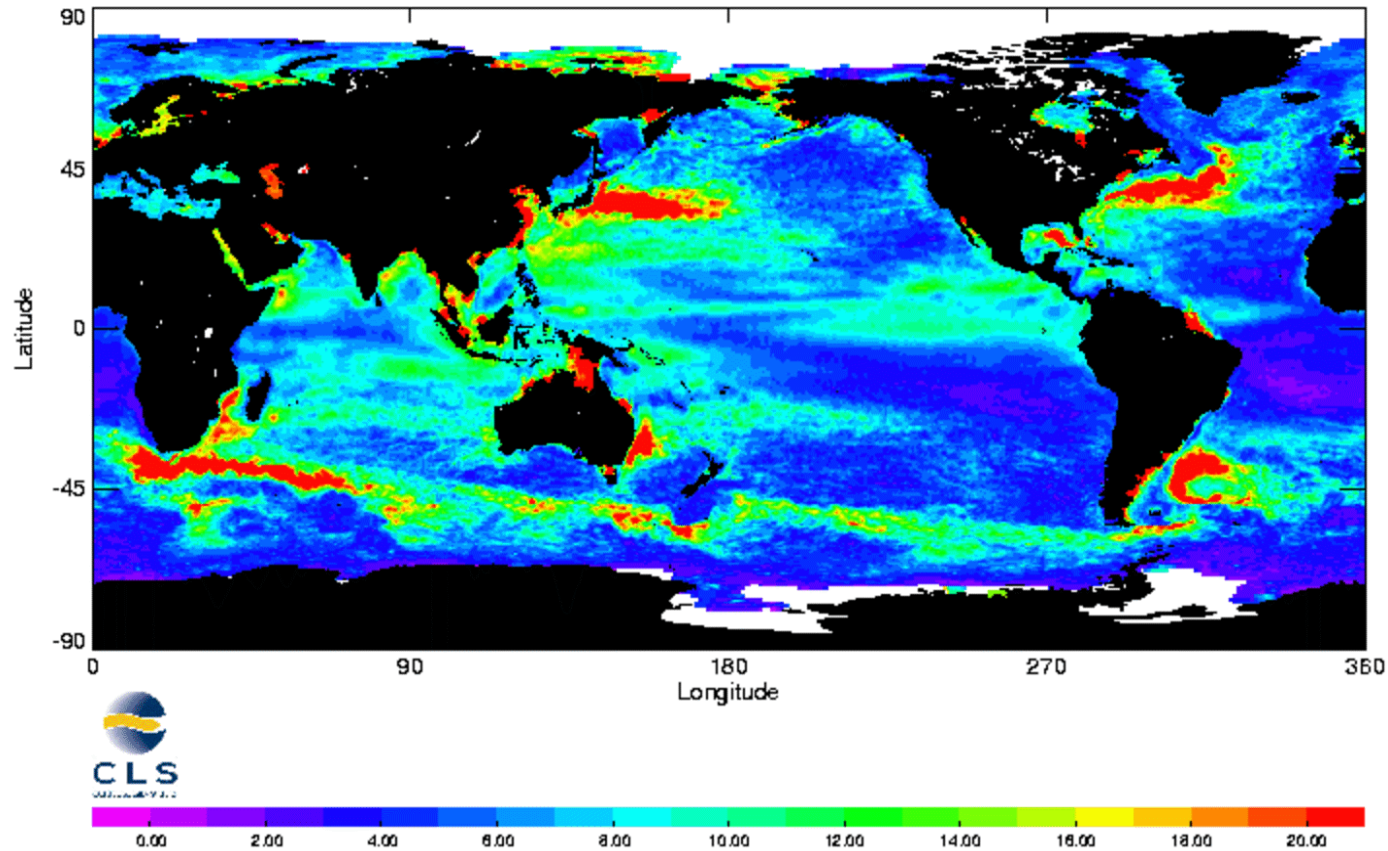
International Thematic Background

- **GODAE (Global Ocean Data Assimilation Experiment) Requirement (GODAE Report N 6 - Dec. 2000), IGOS Ocean Theme report (Integrated Global Observing Strategy, 2000):**
 - « Continuity of high accuracy, high resolution near-real time observations of the ocean surface topography is required. At least, 2 simultaneous altimetric missions are required (including one of the Jason reference class) »
- **To fill in the gap after the 5-year ENVISAT mission:**
 - The concept of the AltiKa payload is based on the TOPEX/POSEIDON and Jason-1 heritage.
 - It also has a number of technological improvements needed to answer the post-GODAE and IGOS requirements in terms of performances

What are we looking for?

Oceanic mesoscale circulation and variability

Standard-deviation of sea level derived from 5 years of observations by TOPEX/POSEIDON and ERS-1/2 (From Ducet & Le Traon, 1999). Units are in cm



OCEAN OBJECTIVE

- ◆ Observe and determine the global meso-scale ocean circulation in order to:
 - ↳ operationally analyze and forecast the global meso-scale ocean circulation
 - ↳ study « the climate of the ocean » (in particular through the continuous monitoring of the sea-level parameter) and improve seasonal forecasting
 - ↳ finally, understand the major physical component of the forecasting systems of the marine ecosystems through physico-biogeochemical coupling processes

The compact combined Altimeter / Radiometer composing the AltiKa PAYLOAD

◆ Part A : the Ka-band altimeter

↪ ionospheric effects are negligible

1. Improved technological capability:

* 500 MHz Bandwidth allowed by the ITU,
instead of 320 MHz in the classical Ku-band

Performance feature improved:

* *higher vertical resolution (30 cm vs 48 cm in
Ku-band)*

2. Improved technological capability:

* 4 KHz PRF that may be adjusted along the
orbit.

Performance feature improved:

* *shorter decorrelation time of sea echoes*

3. Improved Antenna Gain and Signal to Noise ratio for a given antenna size.

ALTIMETER REQUIREMENTS	Micro-satellite	Poseidon 2
Orbit	~800 km	1347 km
Inclination	~98.6°	66°
Mission lifetime	2 years	5 years
Frequency	35.75 GHz	5.3/13.6 GHz
Bandwidth	480 MHz	320 MHz
Pulse Repetition Frequency	4 kHz	2 kHz
Backscattering coefficient σ_0	6.5 dB	8 dB (Ku)
Signal to Noise Ratio (SNR)	≥ 7 dB ($H_{1/3}=0m$)	>10 dB
Spectrum analyser	128 points	128 points
Echo averaging	25 to 50 ms	50 ms
Mass (without antenna)	< 20 kg	24 kg
Power consumption	35 W (goal)	72 W

The compact combined Altimeter / Radiometer composing the AltiKa PAYLOAD (2)

◆ Part B: Dual-frequency radiometer (24/37 GHz)

↳ required for tropospheric correction

RADIOMETER REQUIREMENTS	
Frequency	23.6-24 GHz & 36.6-37 GHz
Pointing	Nadir
Polarisation	linear
Beam efficiency	> 90 %
Antenna	shared with altimeter
Sensibility	< 0.5 K
Accuracy	< 3.0 K
Integration time	~ 100 ms
Dynamic range	120 to 300 K

◆ *A simple Total Power Dicke Dual Frequency Radiometer is combined with the Ka-band altimeter so that it can operate on micro-platforms*

Additional required elements for a consistent altimetry system

◆ Laser Retro-reflector Array

↪ minimum for orbitography and system calibration

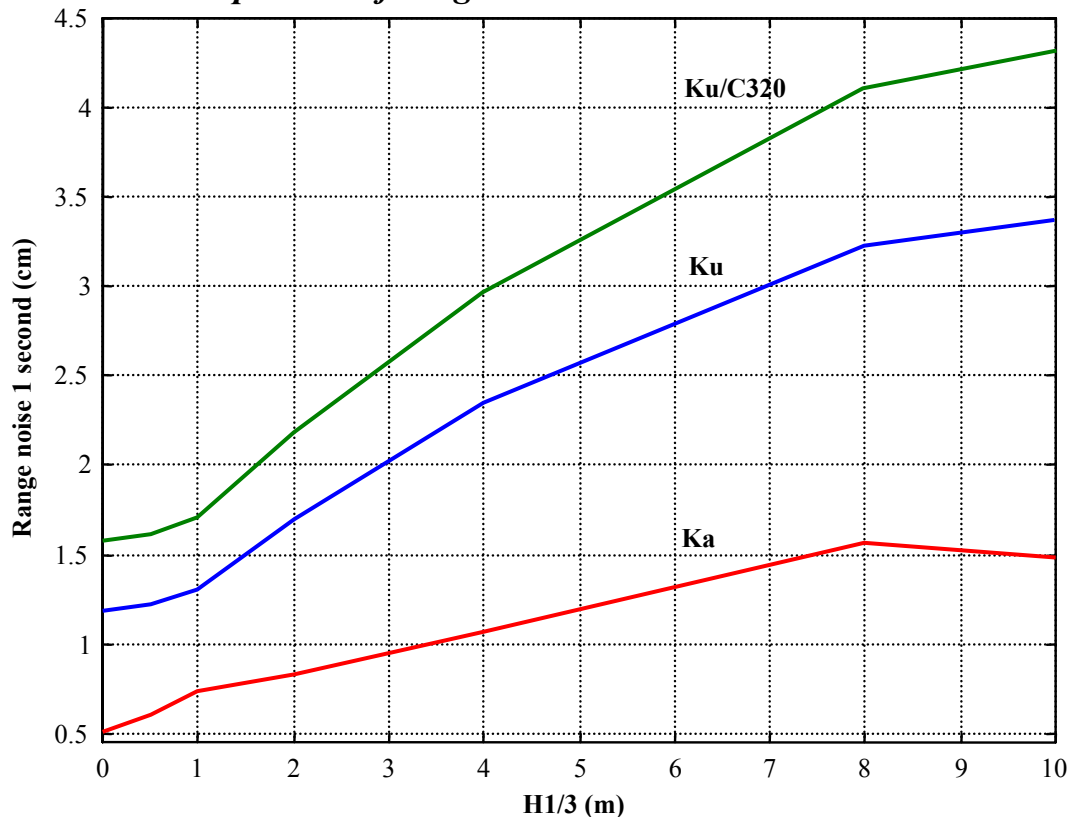
◆ A Precise Orbitography system such as DORIS

↪ to achieve adequate orbitography performances in low Earth orbits (oceanography need)

↪ to have consistent reference systems through T/P, JASON, ENVISAT and future missions embarking the AltiKa payload, which is required for mean sea-level analysis

Improved Error Budget: ALTIMETRIC PERFORMANCE in terms of NOISE

Comparison of range noise POSEIDON2 and AltiKa



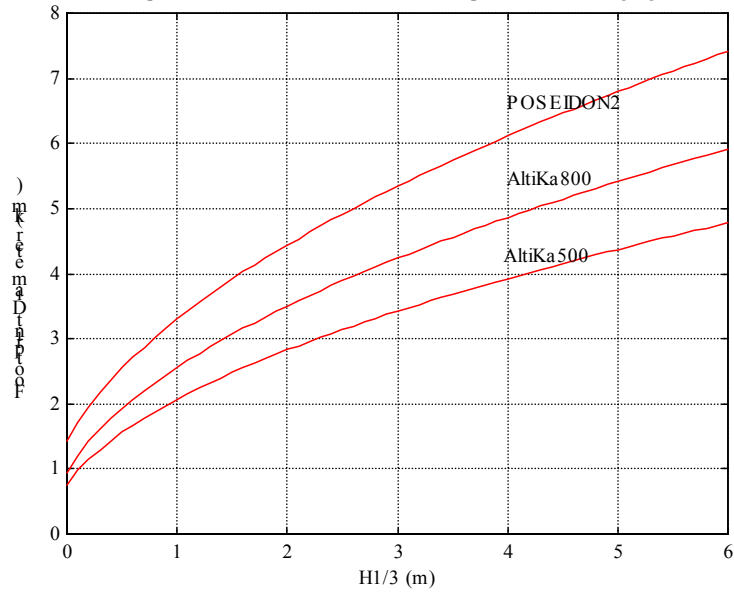
↪ A priori 1 Hz range noise performance much better than for any past altimeter instrument

↪ Important for ocean meso-scale recovery

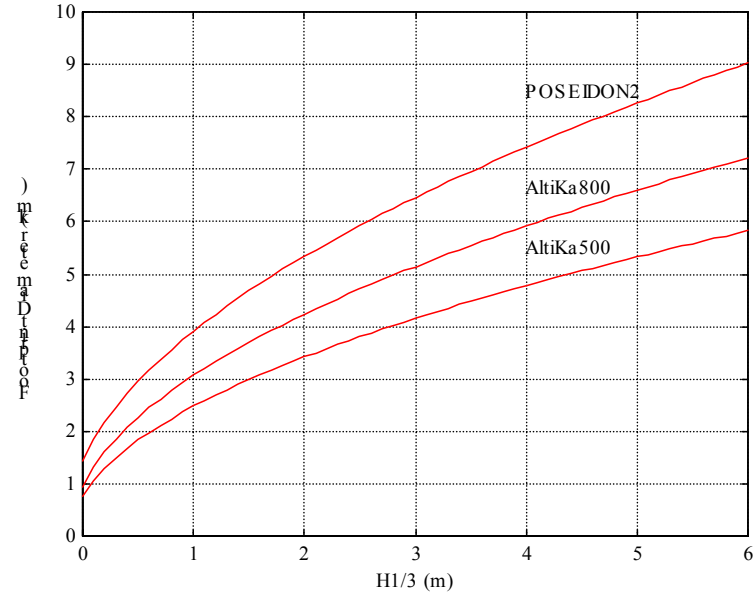
↪ question in progress:
↪ evaluate level of operability for rain rates > several mm/h (5 to 10% of time depending on the geographic area)

FOOTPRINT CHARACTERISTICS

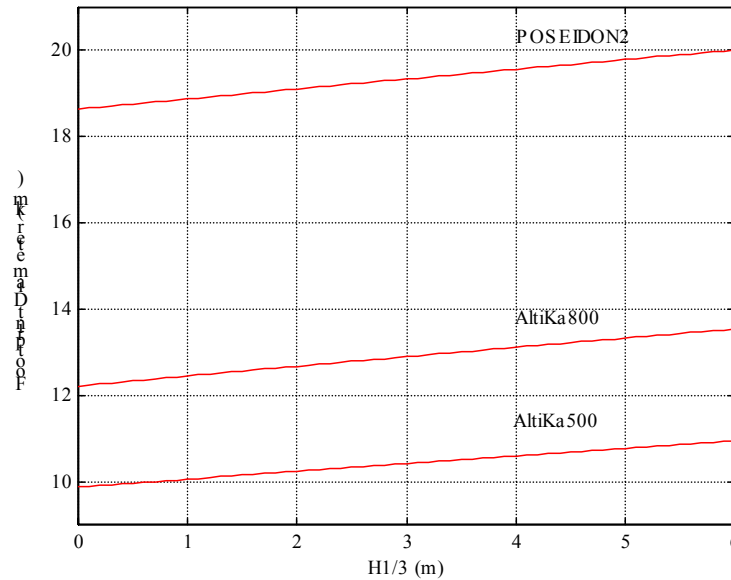
Comparison of POSEIDON2 & AltiKa footprints for first range gate



Comparison of POSEIDON2 & AltiKa footprints for leading edge



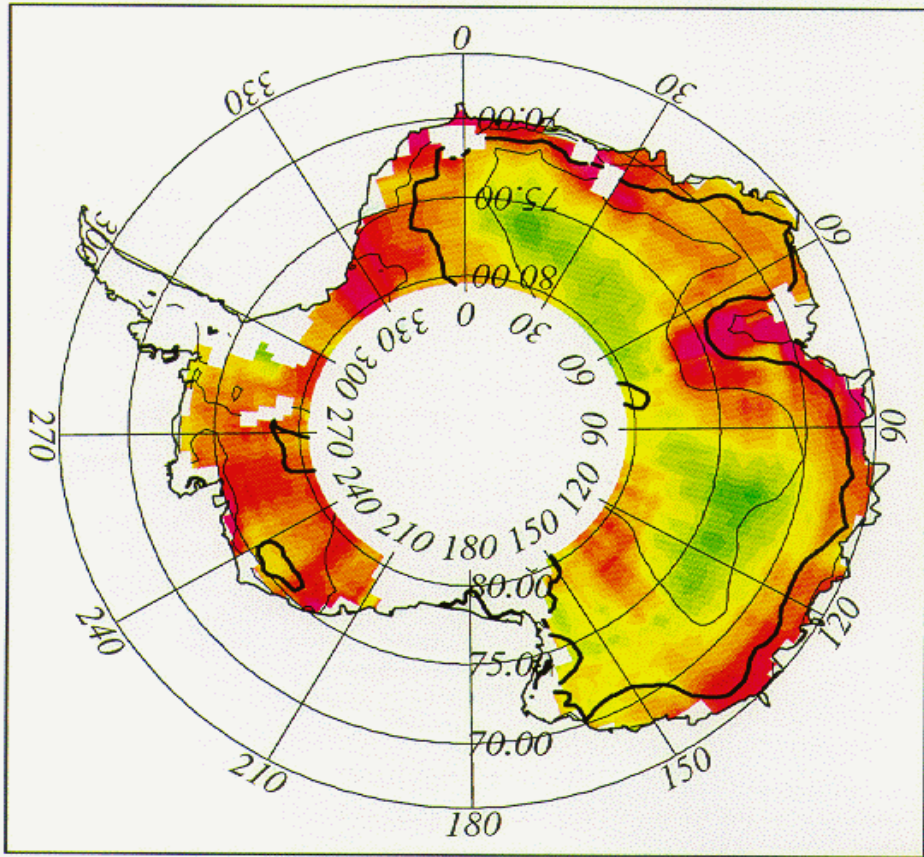
Comparison of POSEIDON2 & AltiKa footprints for gate #128



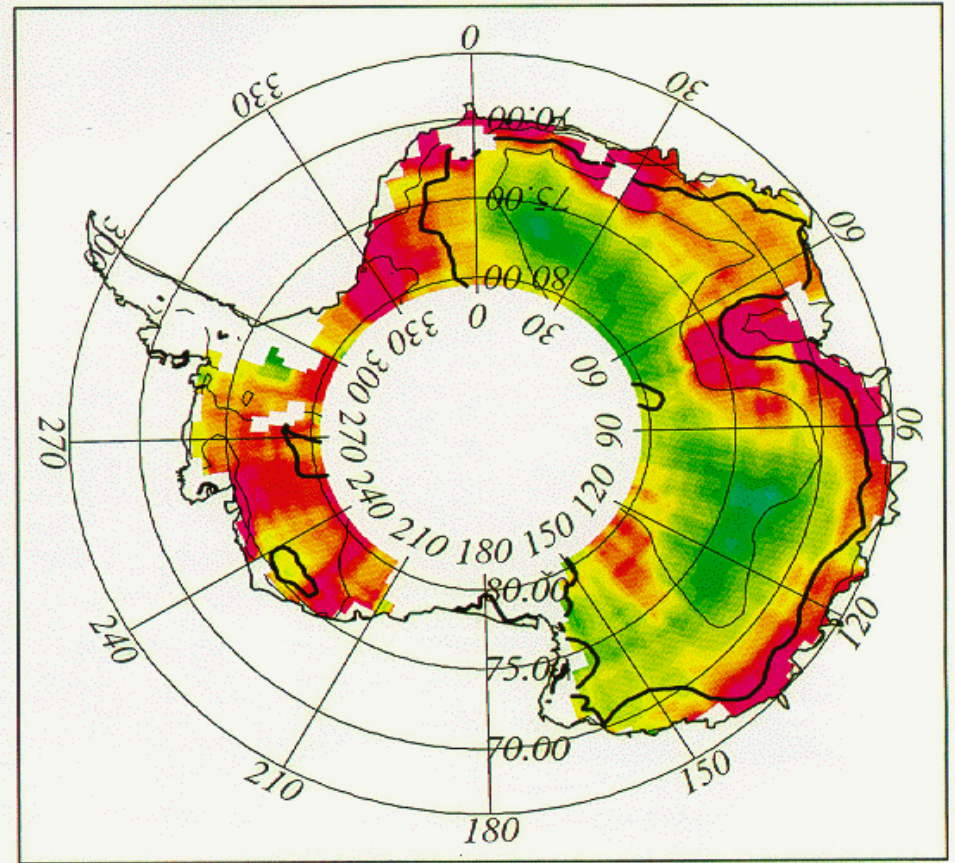
The design/compactness and performances of the AltiKa Payload allows:

- ◆ To embark it on micro-, mini-, or even large platforms
- ◆ To better monitor continental ice areas thanks to the specific technical improvements due to the use of the Ka-band instead of the classical Ku-band.
- ◆ Contribute in a series of other types of science or prospective studies:
 - ↳ Sea-state analysis & forecast,
 - ↳ Inland waters,
 - ↳ Rain applications,
 - ↳ Applications benefiting from having simultaneous active (altimeter) and passive (radiometer) measurements at the same frequency (Ka-band) for the first time,
 - ↳ Contribution of the Ka-band observations in the altimetry over media that are highly sensitive to penetration such as *canopy, forest, ice sheet*

The AltiKa payload improves the observation of continental ice



ku-band penetration (m)



ka-band penetration (m)

THE ALTIKA PAYLOAD IMPROVES THE PERFORMANCES OF ALL PREVIOUS ALTIMETRY MISSIONS IN COASTAL AREAS

Performance of altimeters for coastal applications depends :

- (i) on waveform / footprint relationship*
- (ii) on antenna diagram / footprint relationship (to obtain attenuation of land contribution to echo)*
- (iii) on tracking performance for complex echoes*

◆ *AltiKa characteristics have been optimized for these 3 issues :*

- ◆ *Ka-band altimeter close to a beam limited altimeter*
- ◆ *refer to previous slide on footprint characteristics*
- ◆ *altimeter tracking loops designed at the same time as ESA CRYOSAT/SIRAL altimeter*
 - => continuous tracking in ocean/land/ice conditions*
 - => acquisition/locking phase shorter than 500 ms*

CONCLUSION: The AltiKa Payload as a candidate key-element of future altimetry systems

- ☞ To fill in the Post-ENVISAT gap and reach the Main Mission Objective derived from post-GODAE/IGOS requirements:
 - ◆ Design a simple dedicated (Micro-)satellite mission in complement to the operational Jason-2 (2006-)
- ☞ At a longer time scale, make the AltiKa payload the basics of a permanent altimetry system:
 - ◆ conceive a « Robust Dual-Technique Altimetry System based on Ka-band altimeters and Wide Swath Altimeters » that would be robust to the loss of one element, for meso-scale applications
 - ◆ conceive a « constellation of (micro-)satellite systems, several of which embarking the AltiKa payload », for high resolution altimetry applications
 - ◆ conceive a dual frequency high accuracy « Ocean - Ice payload » by simultaneously embarking a follow-on of the Ku-band SIRAL SAR/Interferometric altimeter and a Ka-band payload on a platform

A combined Jason-2 + « AltiKa single microsatellite » sampling

*AltiKa assumed to fly on a sun-synchronous orbit
(ERS / ENVISAT type) - 800 km, 98.5 degrees, 35 days*

