Absolute calibration of SARAL-AltiKa and Jason-2 over Kavaratti Island in Arabian Sea

By

Space Applications Centre (ISRO)

List of authors:

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Objectives

- Is to calibrate AltiKa and Jason-2 over Indian region of the global ocean
- Global relative calibration of AltiKa with Jason-2 altimeter

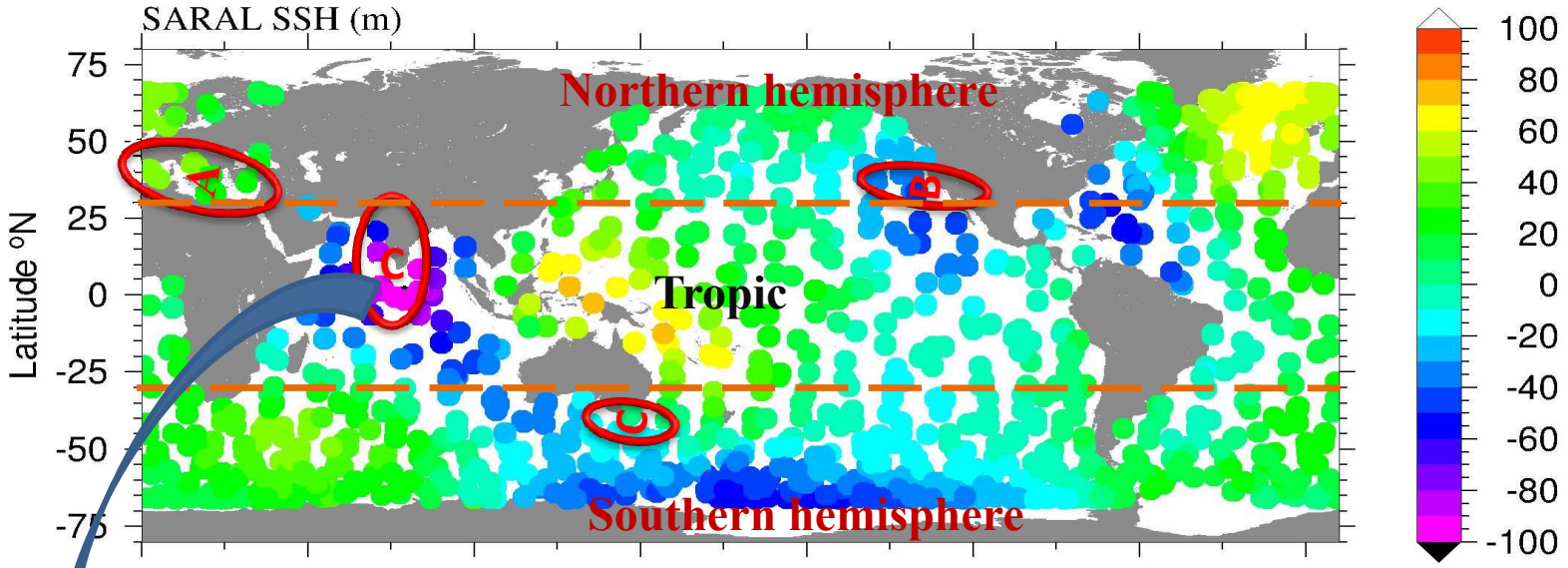
Collaborative Institutes:

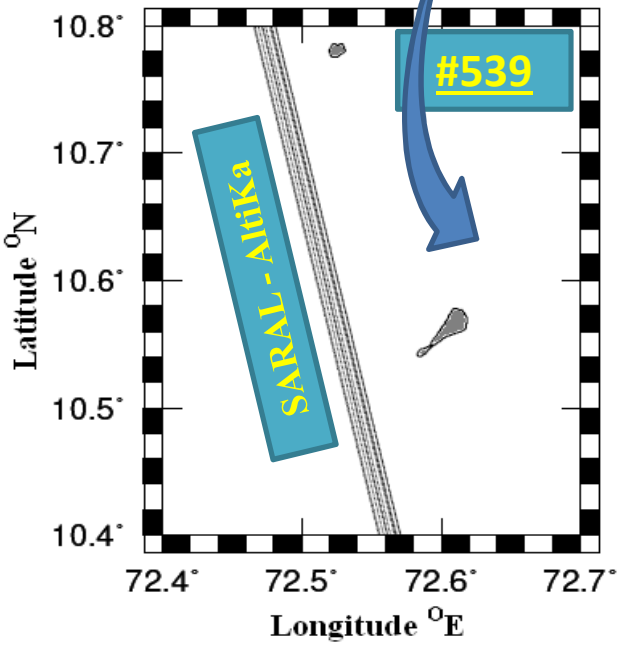
- National Institute of Oceanography, CSIR, Goa
- Department of Science and Technology, Kavaratti

Skylab	**1972**	**NASA**	**20m**
Geos-3	**1975**	**NASA**	**3m**
Seasat	**1978**	**NASA**	**2m**
Geosat	**1985**	**US Navy**	**30cm**
ERS-1	**1991**	**ESA**	**4-10cm**
ERS-2	**1995**	**ESA**	**4cm**

T/P	**1992**	**NASA/CNES**	**2-3cm**
GFO	**2000**	**US Navy**	**2-5cm**
Jason-1	**2001**	**NASA/CNES**	**2-3cm**
Envisat	**2002**	**ESA**	**2-3cm**
Jason-2	**2008**	**NASA/CNES**	**2-3cm**
AltiKa	**2012**	**ISRO/CNES**	**2-3cm**

Global sea surface height - AltiKa





Permanent altimeter calibration sites

A – Corsica, Ibiza, Gavdos (Northern hemisphere)

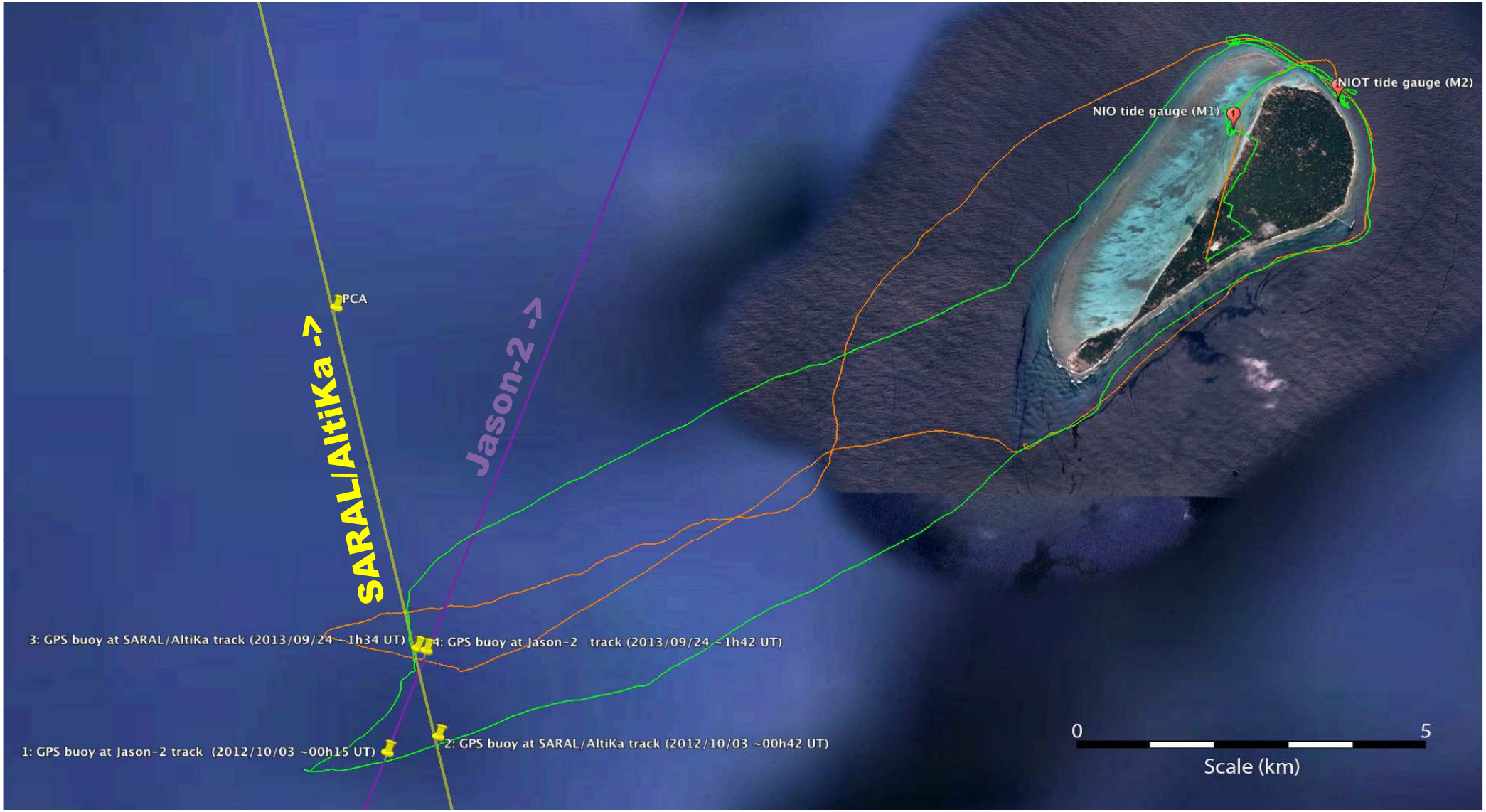
B – Harvest (Northern hemisphere)

* C – Kavaratti (Equatorial zone)

D – Bass strait (Southern hemisphere)

At Kavaratti site:

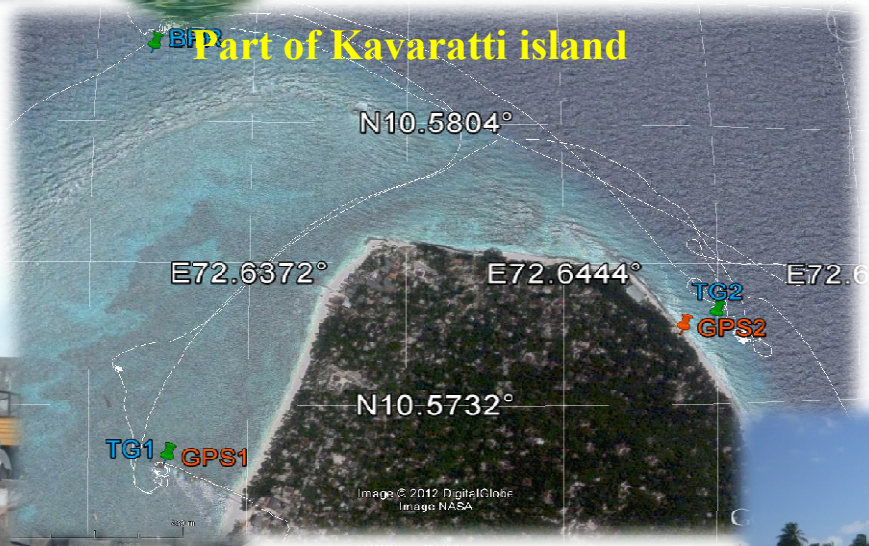
Pass #539 passes over west of Kavaratti site. The 11 cycles of AltiKa have spread over ~2Km along the altimeter track, and hence its absolute bias with respect to the in-situ observations.



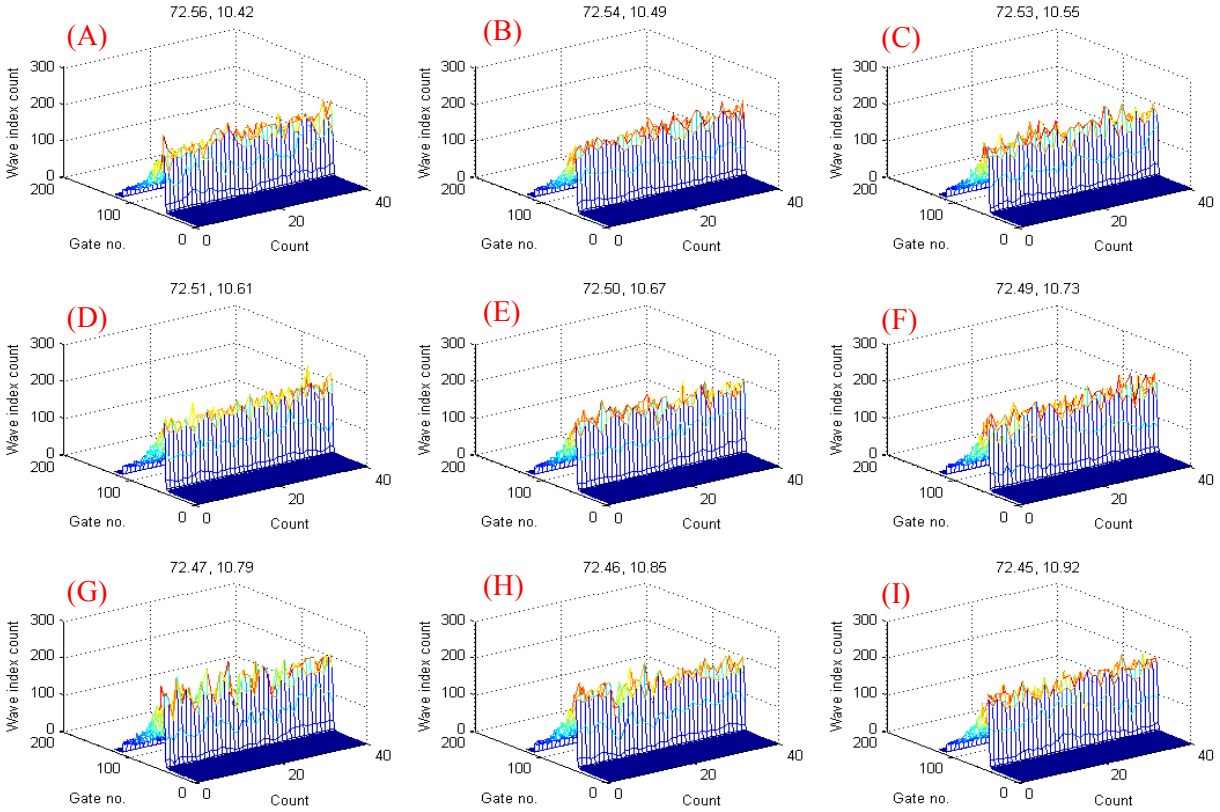
Geoid height difference (crossover->tide gauge) from EGM08: -9.1cm

Geoid height difference (crossover->tide gauge) from GPS-buoy: -17.2cm **=> value used**

Kavaratti calibration site



Kavaratti calibration site



Criteria for a good calibration site

- Altimeter should fly over the site
- The site should be located sufficiently far offshore so that the area of illumination should cover entirely by ocean when the satellite is directly overhead
- The data collection platform should be small enough so that it cannot influence the reflected radar signal
- Island stations are better, since they are away from the effects of shallow water
- Ultimately site at open ocean environment is best for these missions under which they are designed to best operate

SARAL AltiKa: Calibration

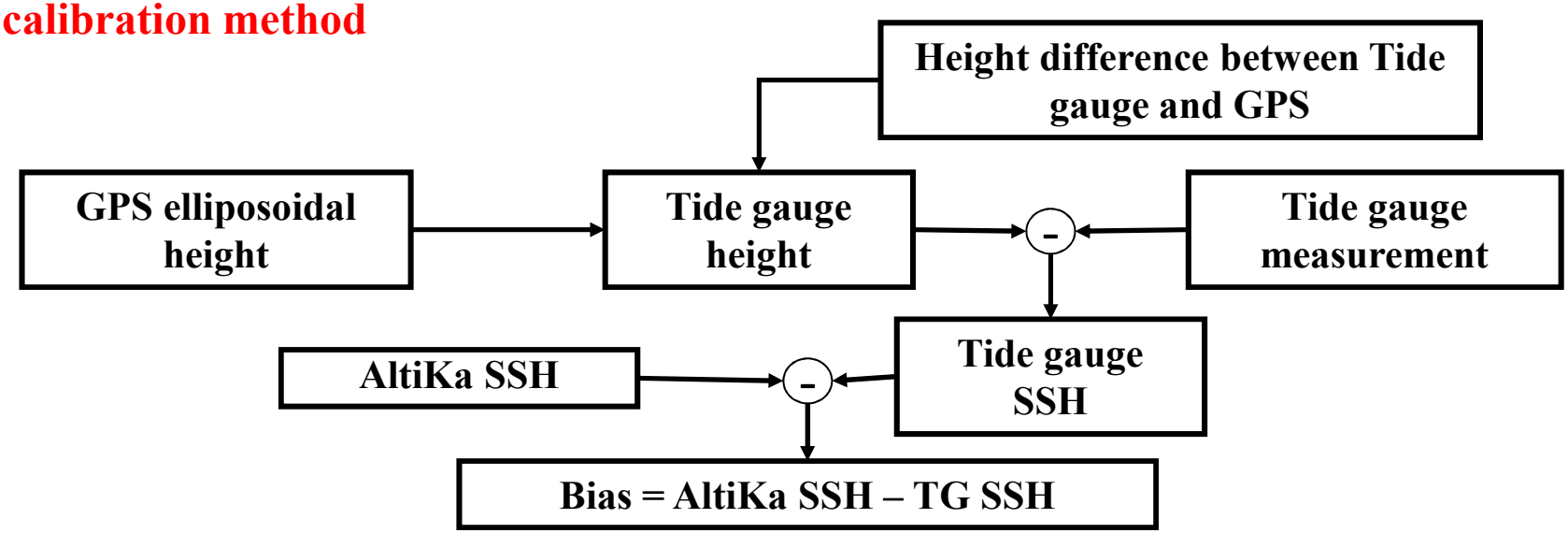
Level -2 Saral/AltiKa products

	OGDR	IGDR	GRD	GOALS
Sea surface height (cm)	30.5cm (req.)	5.3 cm(req.)	4.6 cm(req.)	2.8cm
Latency period	3 – 5 Hours	< 1.5 days	~40days	

Radar tide gauge specifications

Sensor	Range	Accuracy	Sampling interval	Data transfer
Radar level sensor (OTT, Germany)	1 – 30m	±1 cm	5 minutes	GSM modem

AltiKa calibration method

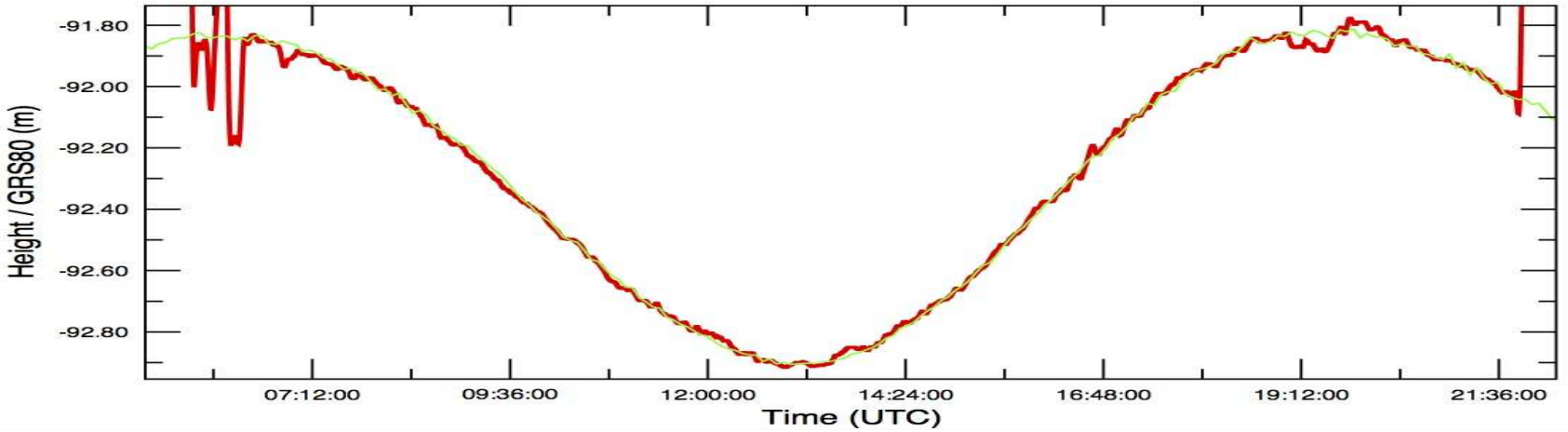


"The principal of the method is to estimate the bias by means of comparison of altimetric sea surface height information to adjacent tide gauge sea surfae height data located within the same geodedic reference frame".

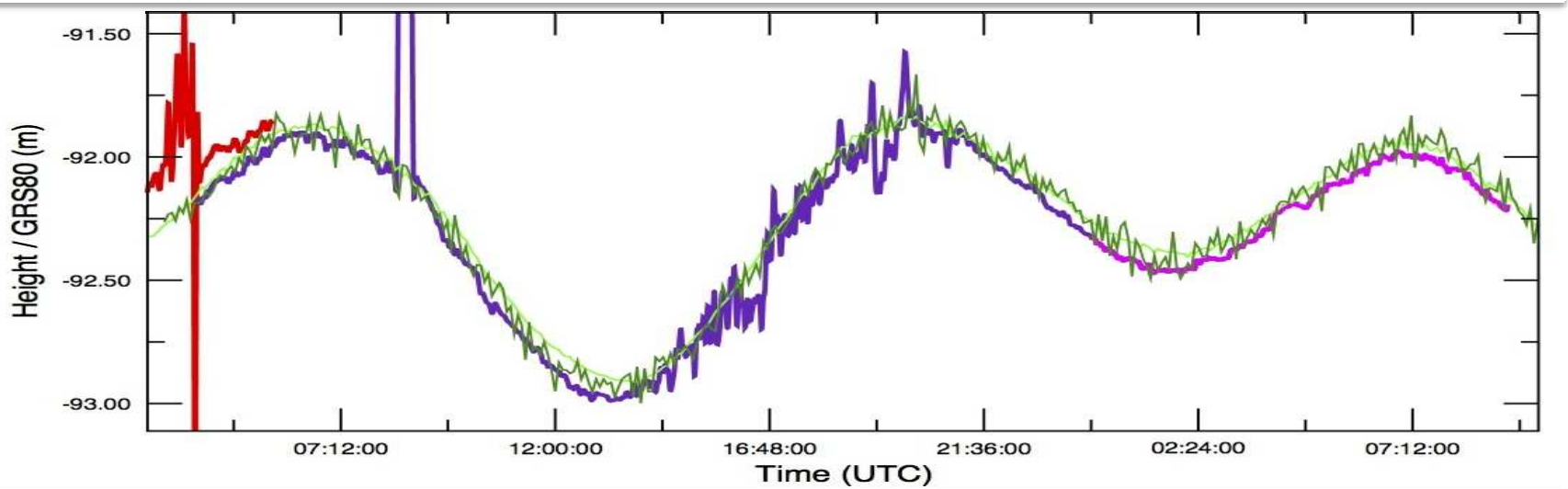
Interpolation schemes in absolute calibration (adapted from Bonnefond et al. 2011)

Specifications of correction representation	
Ionospheric	Mean over -11sec to 11sec around the TCA
Dry tropospheric	Linear fit over -2sec to 2sec around the TCA interpolated at the TCA
Wet tropospheric	Linear fit over -5sec to 5sec around the TCA
Sea state bias	Cubic polynomial fit over -4sec to 4sec around the TCA
Tide gauge	Linear fit over 30min centered on TCA (5min sampling
Geoid (EGM08)	-3 to +17Km

Verification of tide gauges using GPS buoy



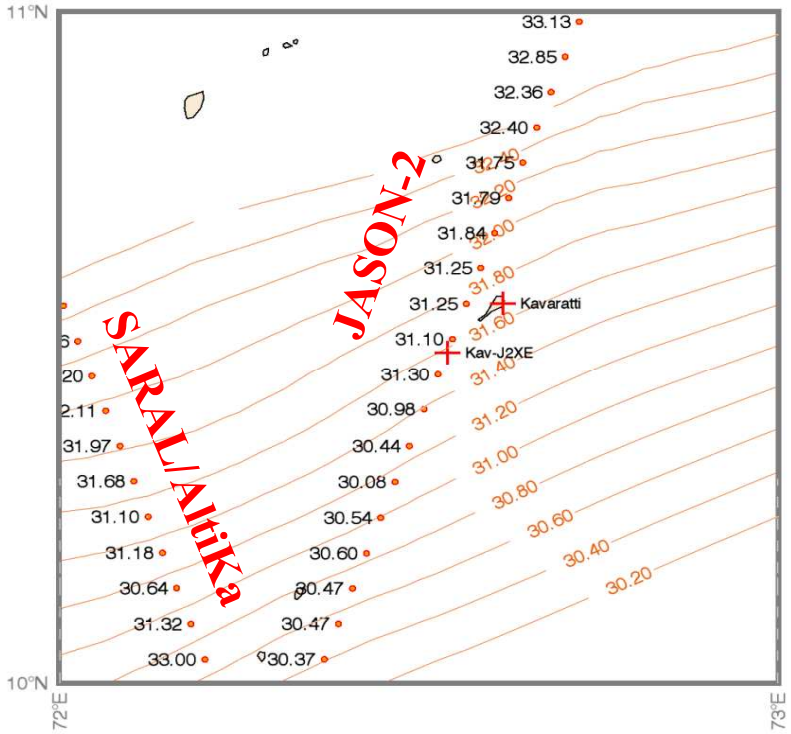
Sea surface height from GPS buoy solution (red line), tide gauge (light green) at Kavaratti main jetty



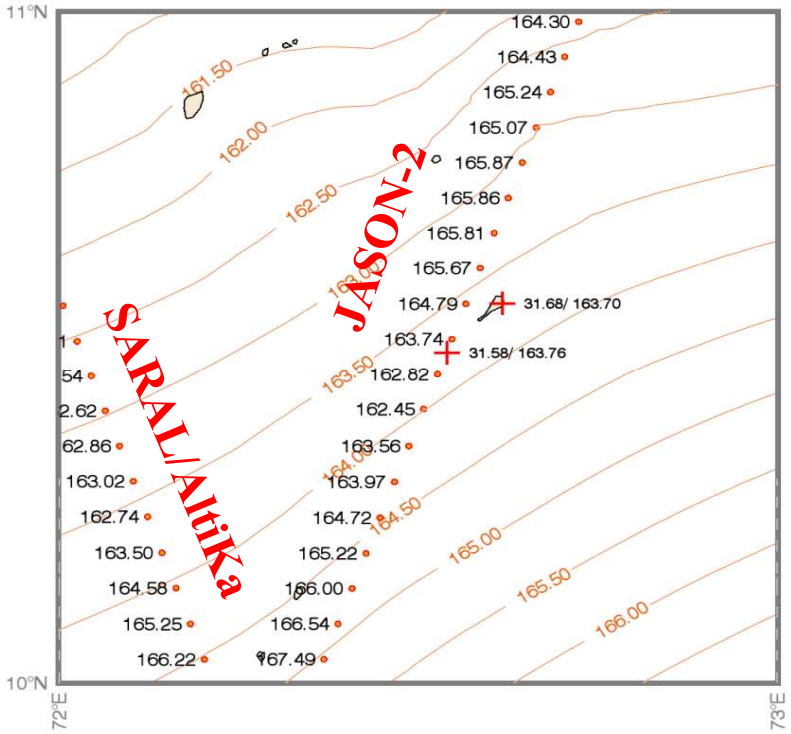
Sea surface height GPS buoy (red, purple, magenta), main jetty tide gauge (light green) and NIOT tide gauge (dark green)

FES2012 – 1/36º

Amplitude



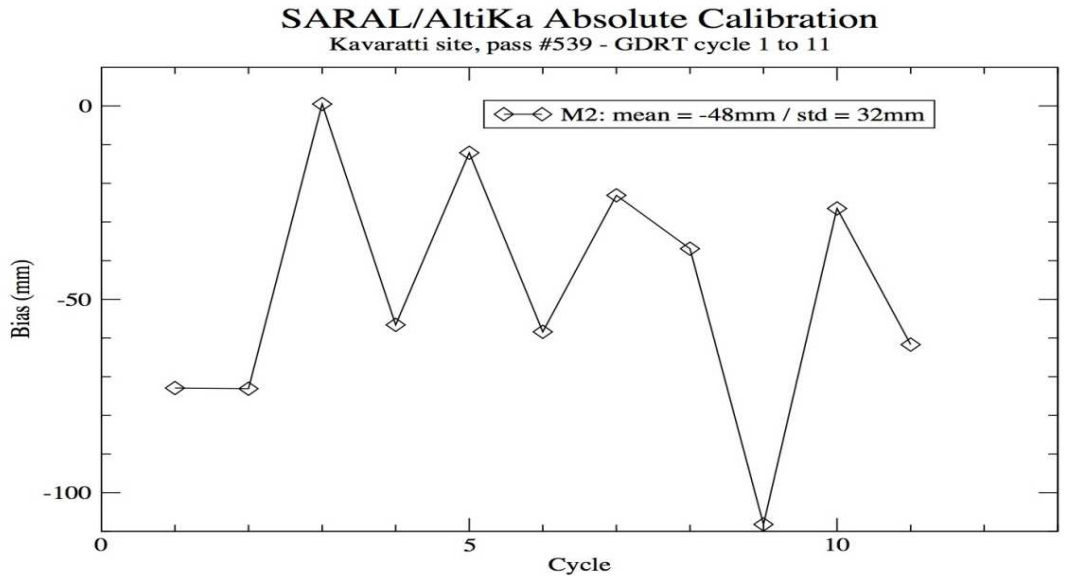
Phase



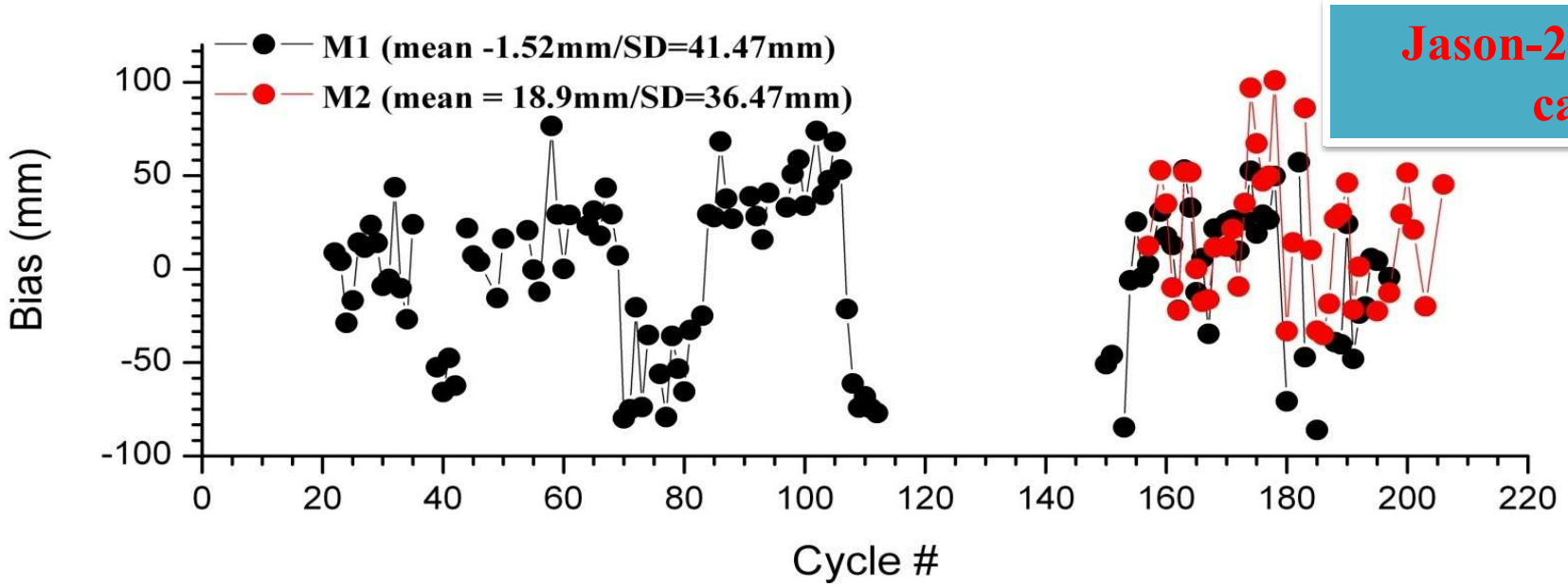
Similar results are found when we used FES2004, GOT4.7 and TPXO7.2 models. The difference both in magnitude and phase are ~2mm/~1º for the distance of 12km at this site.

The difference of interpolated mean dynamic topography between the tide gauge locations (M1/M2) and crossover point is 1.4mm/1.1mm

Absolute calibration bias results for SARAL/AltiKa and Jason-2



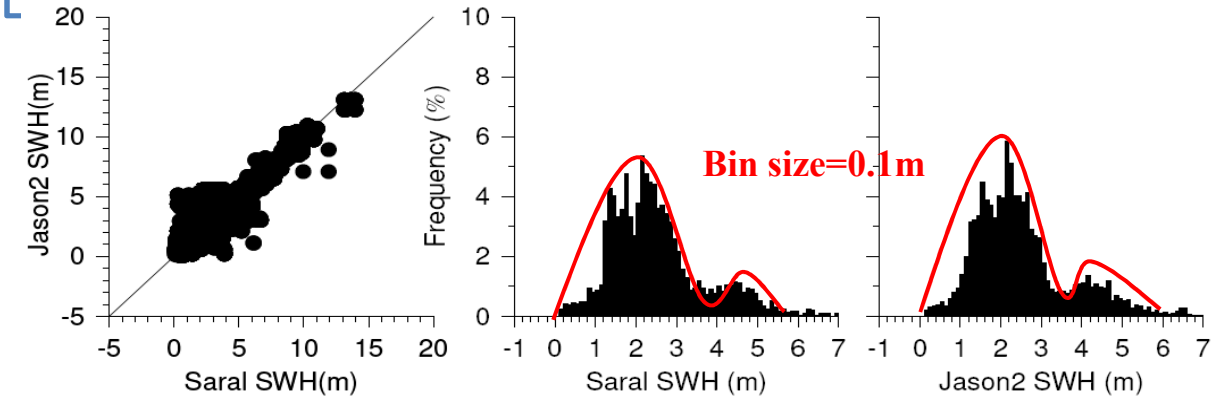
AltiKa absolute calibration



Jason-2 Absolute calibration

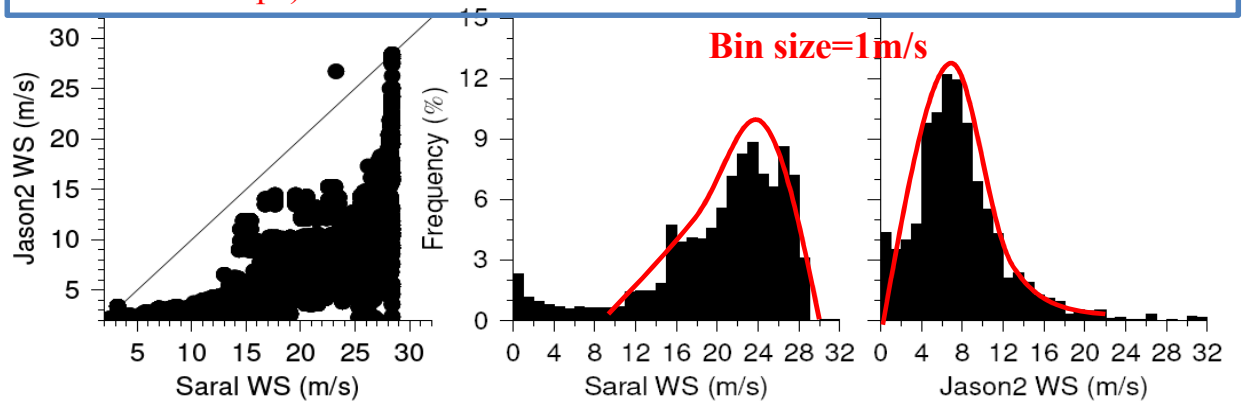
Relative performance of SARAL/AltiKa Vs Jason-2 over global oceans

Scatter & frequency histogram of the global SWH (25 km × 25 km grid & 30 minutes time laps)



Parameter	IGDR specification	
	Jason-2	AltiKa
Significant wave height	10% or 0.4m	10% or 0.4m
Wind speed	1.5m/s	1.7m/s
Sea surface height	3.9cm	5.3cm

Scatter & frequency histogram of the global WS (25 km × 25 km grid & 30 minutes time laps)

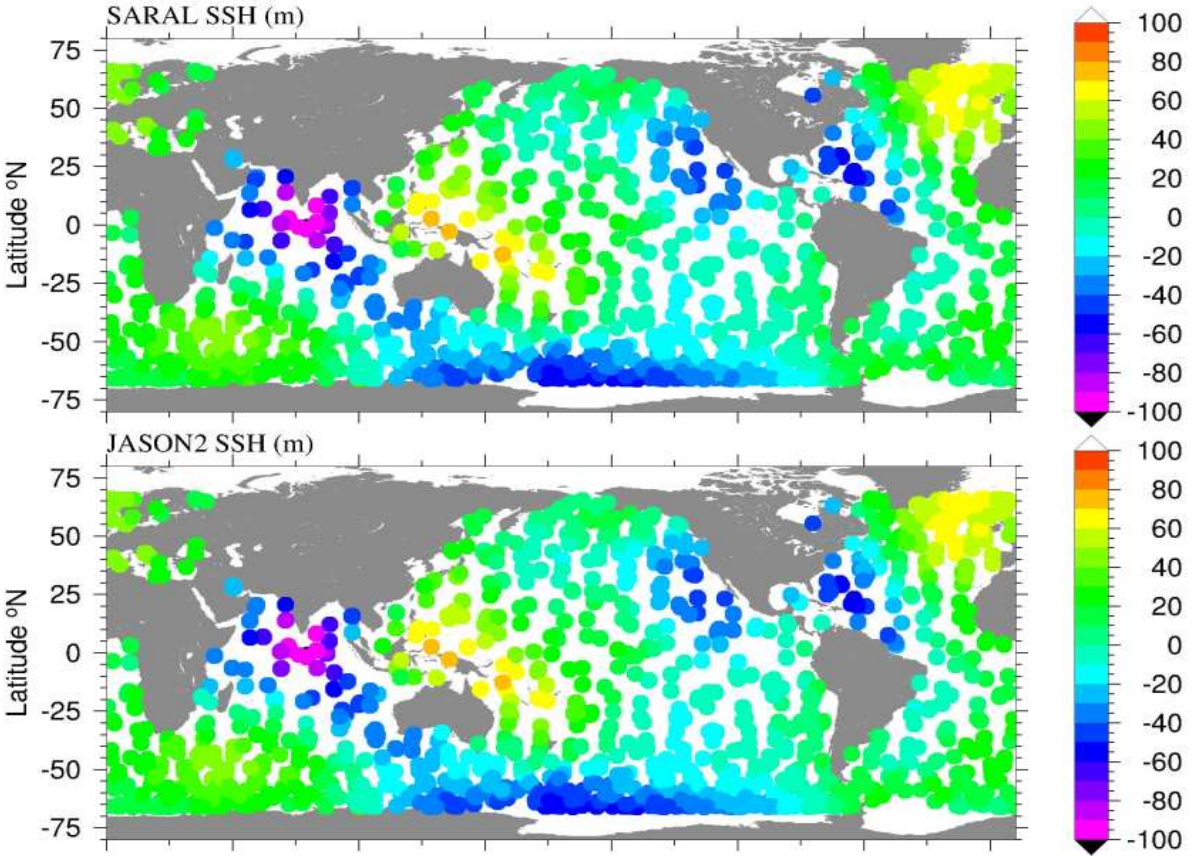


Statistics among SARAL/AltiKa and Jason-2 derived SWH correction

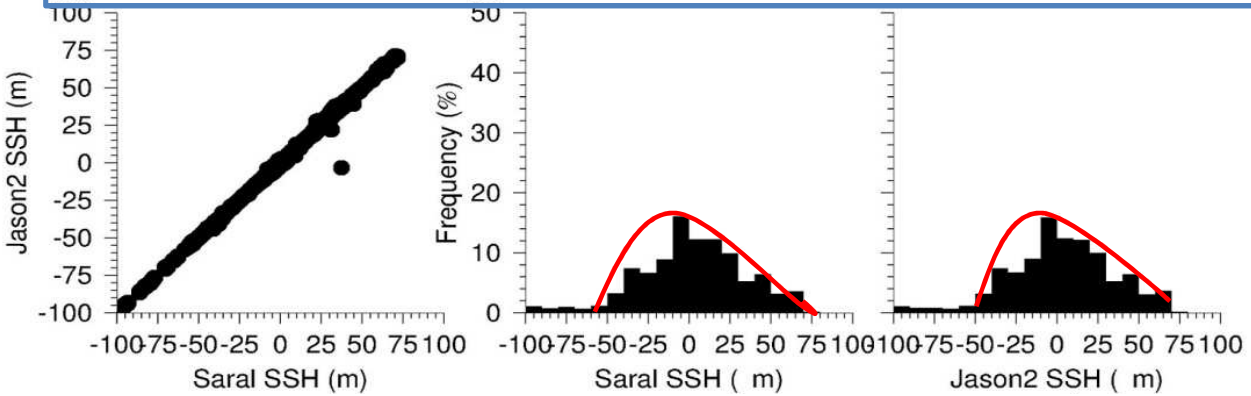
	1 km × 1 km	10 km × 10 km	25 km × 25 km
No. of points	36	17803	272331
CC	0.60	0.78	0.71
RMSE (m)	9.28	0.64	0.79
Slope	0.33	0.89	0.92
Bias (m)	2.13	0.26	0.19
RMSE (m)	0.43 (24)	0.22	0.23
1Sigma		(11289)	(179944)

Statistics among SARAL/AltiKa and Jason-2 derived WS

	1 km × 1 km	10 km × 10 km	25 km × 25 km
No. of points	36	17992	275473
CC	0.76	0.72	0.71
RMSE (m/s)	13.59	13.99	13.98
Slope	0.45	0.47	0.48
Bias (m/s)	-1.51	-2.45	-2.75
RMSE (m/s)	15.06 (29)	14.79	14.73
1Sigma		(13986)	(210323)



Scatter & frequency histogram of the global SSH (25 km × 25 km grid & 30 minutes time laps)



Statistics among SARAL/AltiKa and Jason-2 derived SSH correction

	1 km × 1 km	**10 km × 10 km**	**25 km × 25 km**
No. of points	36	17871	273389
CC	0.99	0.99	0.99
RMSE (m)	0.06	0.27	0.36
Slope	1.00	1.00	1.00
Bias (m)	**0.036**	**0.053**	**0.04**
RMSE (m) 1Sigma	0.06 (26)	0.27 (12311)	0.26 (188165)

Errors in estimation of the absolute bias of SARAL/AltiKa and Jason-2

	SARAL/AltiKa	Jason-2
Parameter	Error	Error
Geodetic reference	±13mm	±13mm
Optical leveling	±1mm	±1mm
Tide gauge	29.6mm	29.6mm
Absolute bias	-48±32mm (M2)	-1.52±41mm(M1) 18.9±36mm(M2)

Conclusion

1. The Kavaratti calibration site measurements are used to do absolute calibration of Jason-2 and SARAL/AltiKa altimeters
2. The variations in tide and mean dynamic topography are very less though, the island is situated on a seamount
3. The absolute SSH bias of AltiKa GDRT product is -48±32mm (M2) and Jason-2 (GDR) is -1.52±41mm(M1)/18.9±36mm(M2)
4. The global bias of AltiKa against Jason-2 in IGDR product is 5.3/4.0cm in its 10/25km collocation