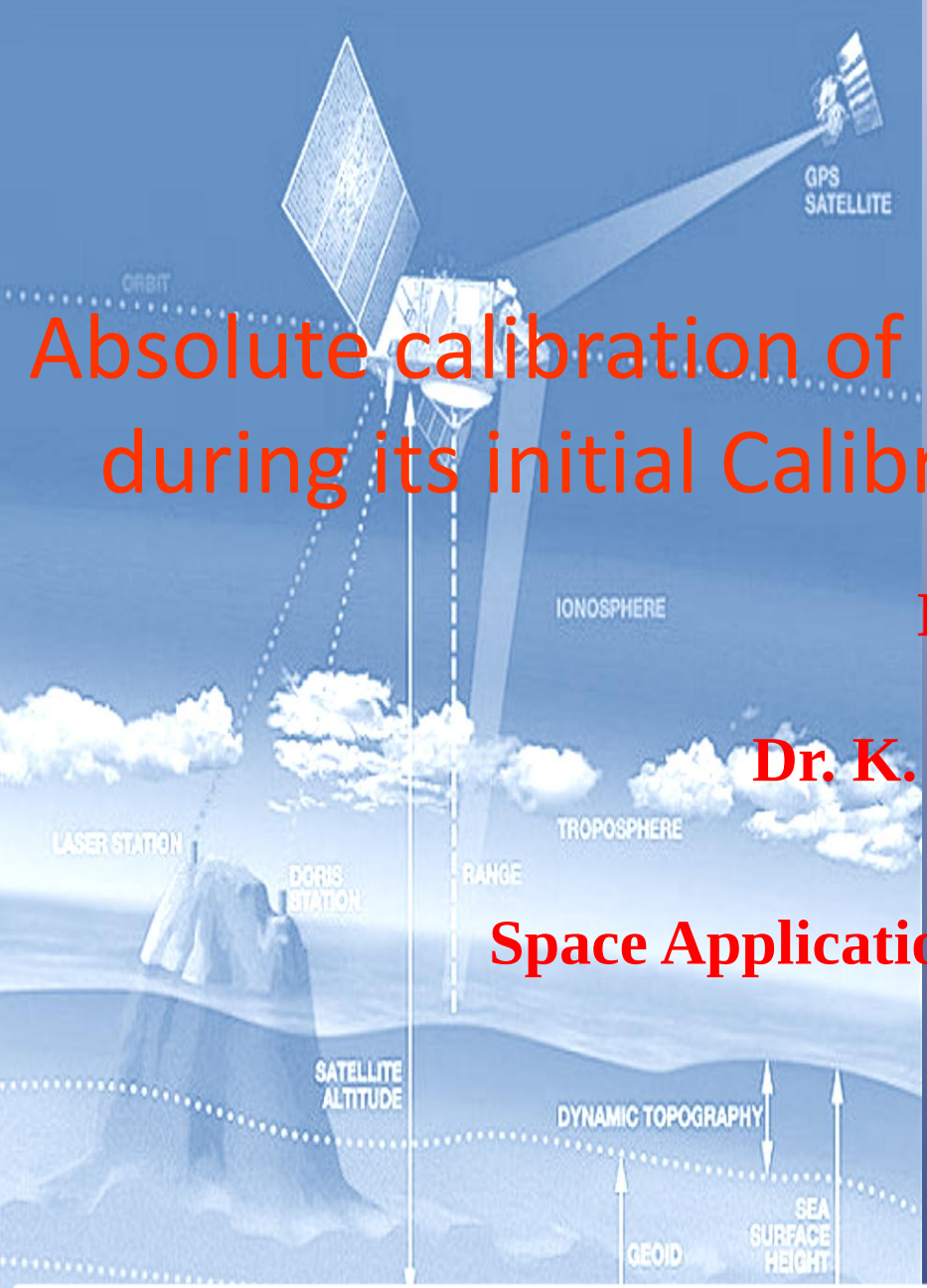

Absolute calibration of SARAL-AltiKa in Kavaratti during its initial Calibration-Validation phase

By

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List of contributors:

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Objectives

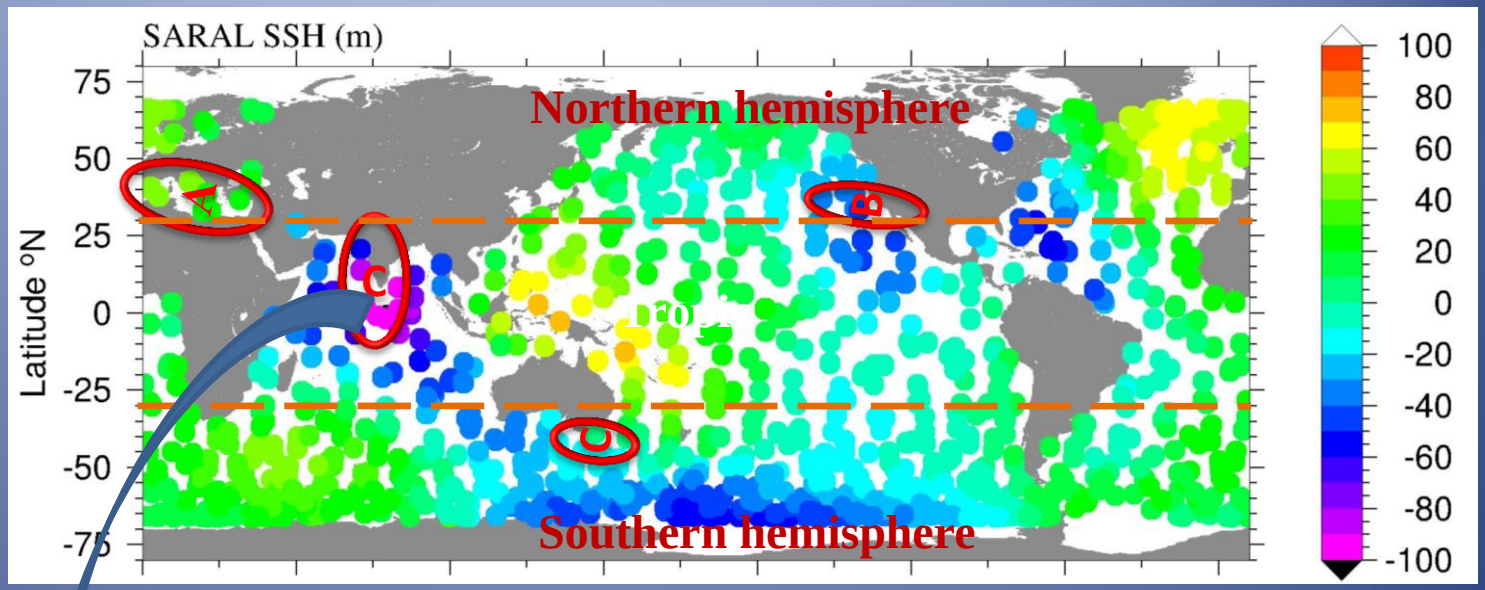
- Is to calibrate AltiKa over Indian region of the global ocean
- Identifying and qualifying Kavaratti Cal-Val site for Altimeter calibration
- Geodetic survey and leveling experiment
- Calibration of AltiKa using its 11 cycles of observations over Kavaratti
- Global relative calibration of AltiKa with Jason-2 altimeter

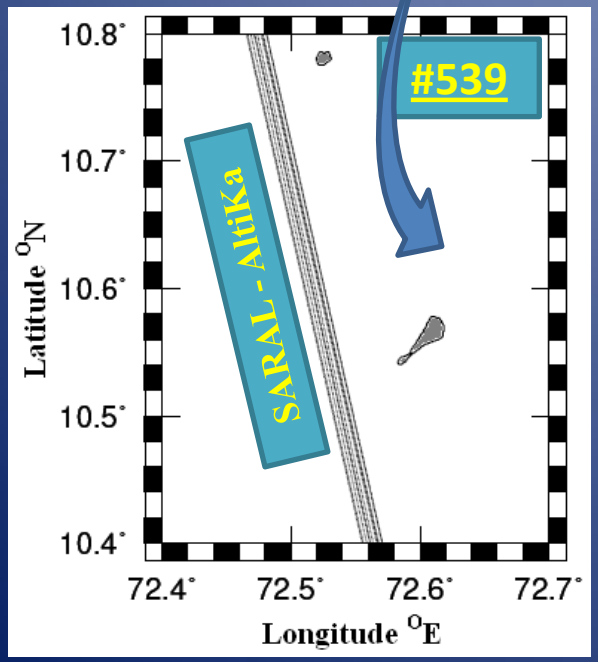
Collaborative Institutes:

- National Institute of Oceanography, CSIR, Goa

- Department of Science and Technology, Kavaratti

Global sea surface height - AltiKa





Permanent altimeter calibration sites

A – Corsica, Ibiza, Gavdos (Northern hemisphere)

B – Harvest (Northern hemisphere)

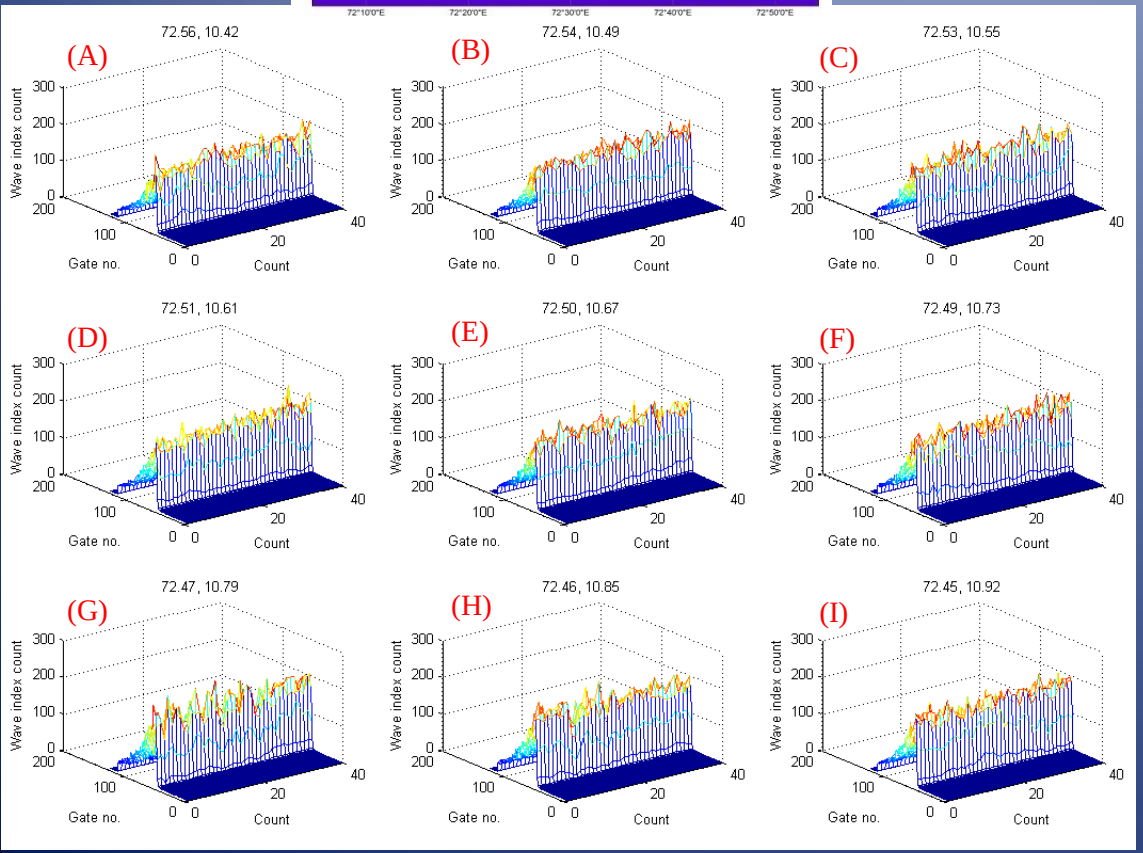
* C – Kavaratti (Equatorial zone)

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.

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

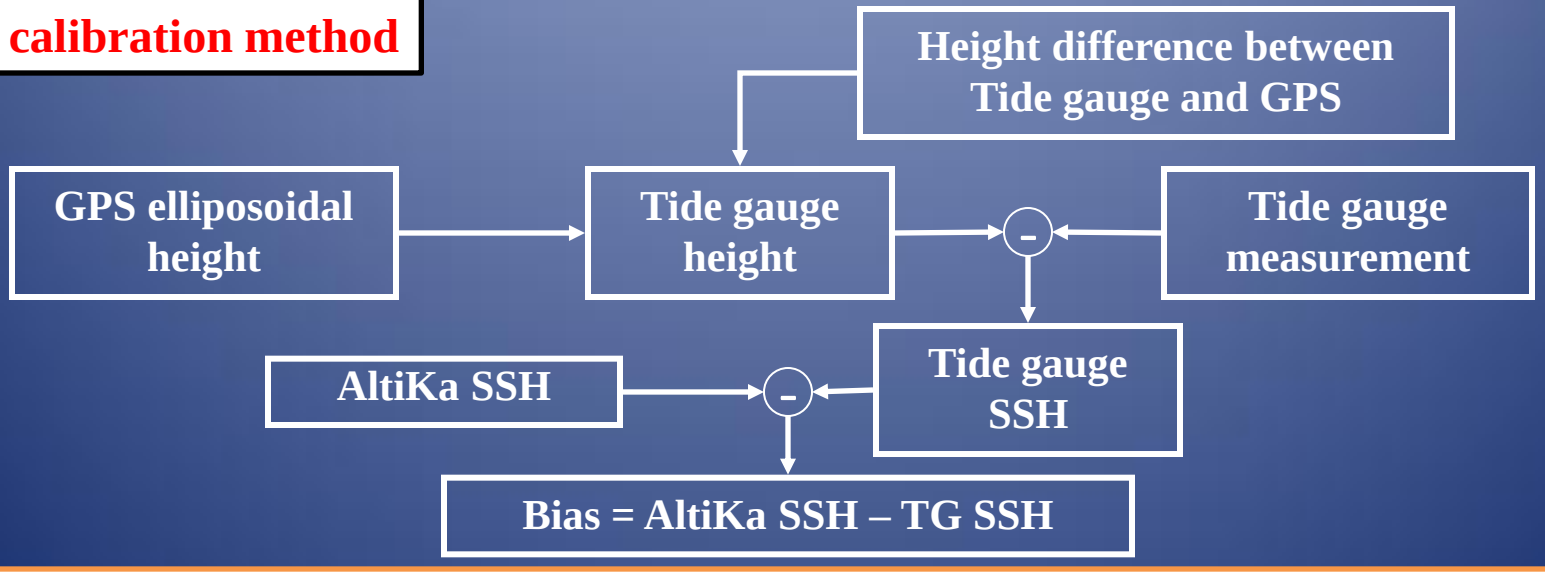
Level -2 Saral/AltiKa products

	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

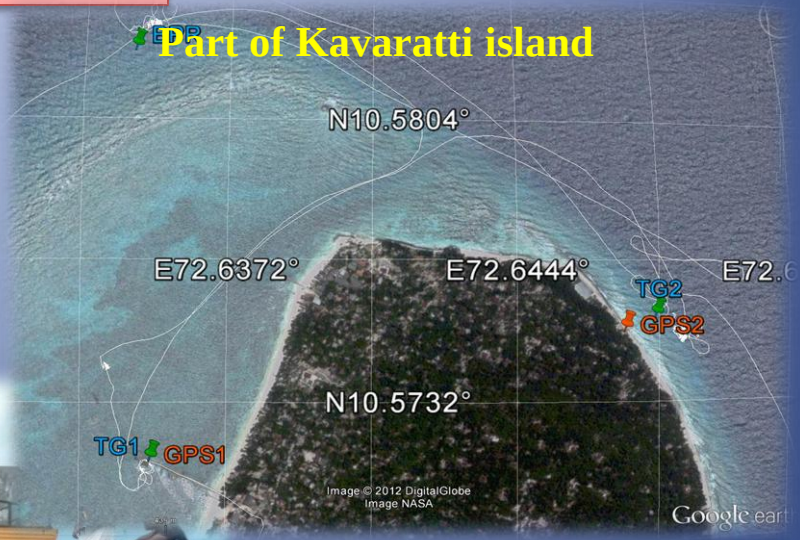


"The principal of the method is to estimate the bias by means of comparison of altimetric sea surface height information to adjacent tide gauge sea surfae height data located within the same geodedic reference frame".

Geodetic survey and leveling experiment

Kavaratti main jetty

GPS (72.63536°E / 10.57171°N / H=-87.026m)



Kavaratti main jetty

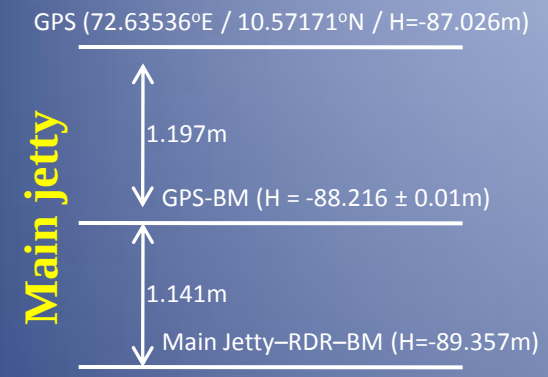
GPS (72.64705°E / 10.57493°N / H=-86.978m)

Kavaratti NIOT jetty

Kavaratti NIOT jetty

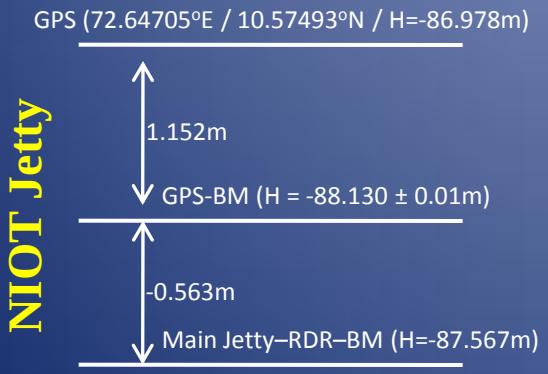
Kavaratti NIOT jetty

Summary: Leveling experiment



D_tg_gps = 1.141m - 0.02m
D_tg_capt = 0.0 (additional offset of the sensor)
hwgs84 = -88.216m (from GAMIT)
delta_ellips = 0.701m

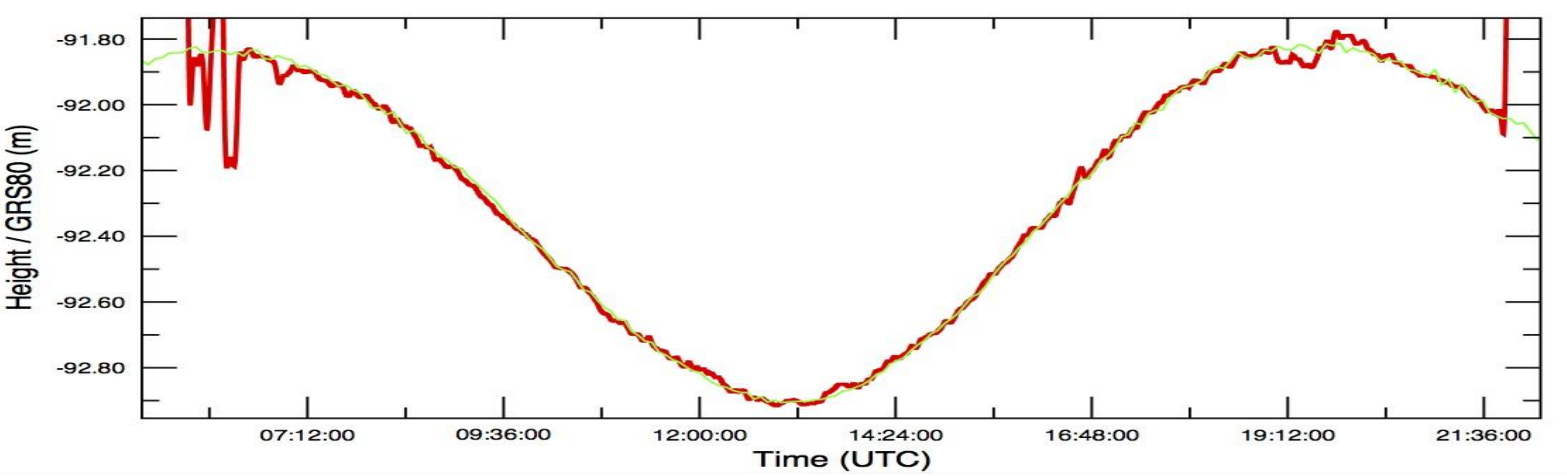
Absolute_SSH_RDR = hwgs84 + delta_ellips - (D_tg_gps - D_tg_capt) - hraw*$1e^{-2}$



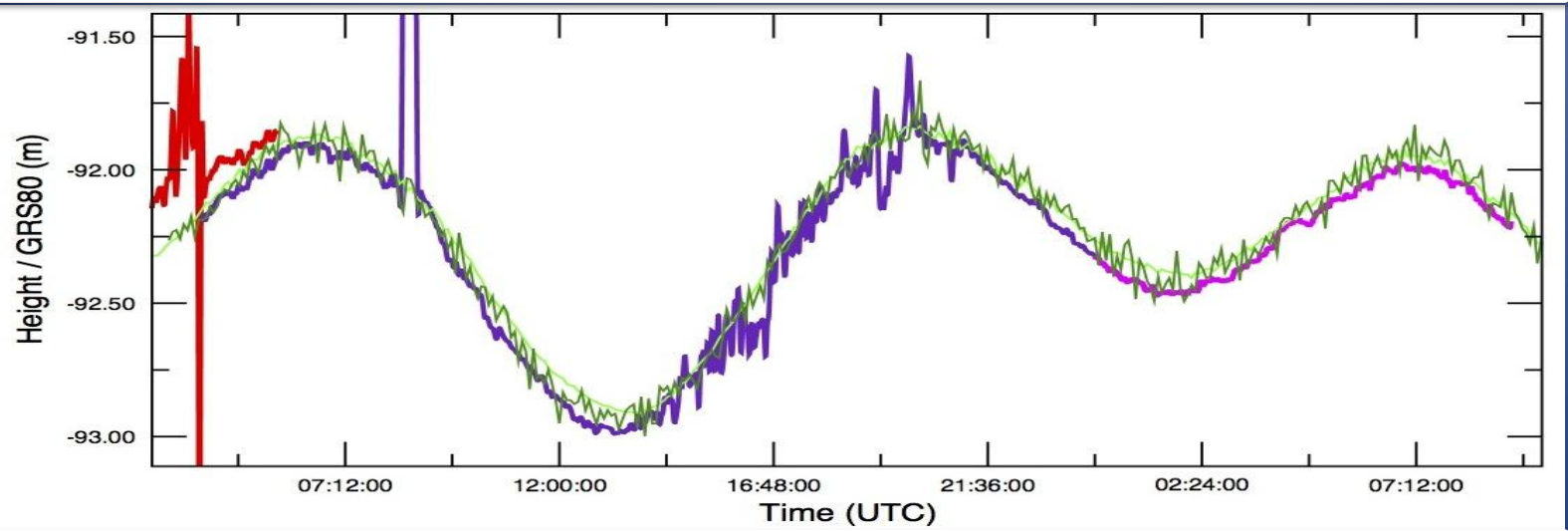
D_tg_gps = – 0.563 - 0.02
D_tg_capt = 0.0 (additional offset of the sensor)
hwgs84 = -88.216m (from GAMIT)
delta_ellips = 0.701

absolute_SSH_TP = hwgs84 + delta_ellips - (D_tg_gps - D_tg_capt) - hraw*$1e^{-2}$

Verification of tide gauges using GPS buoy

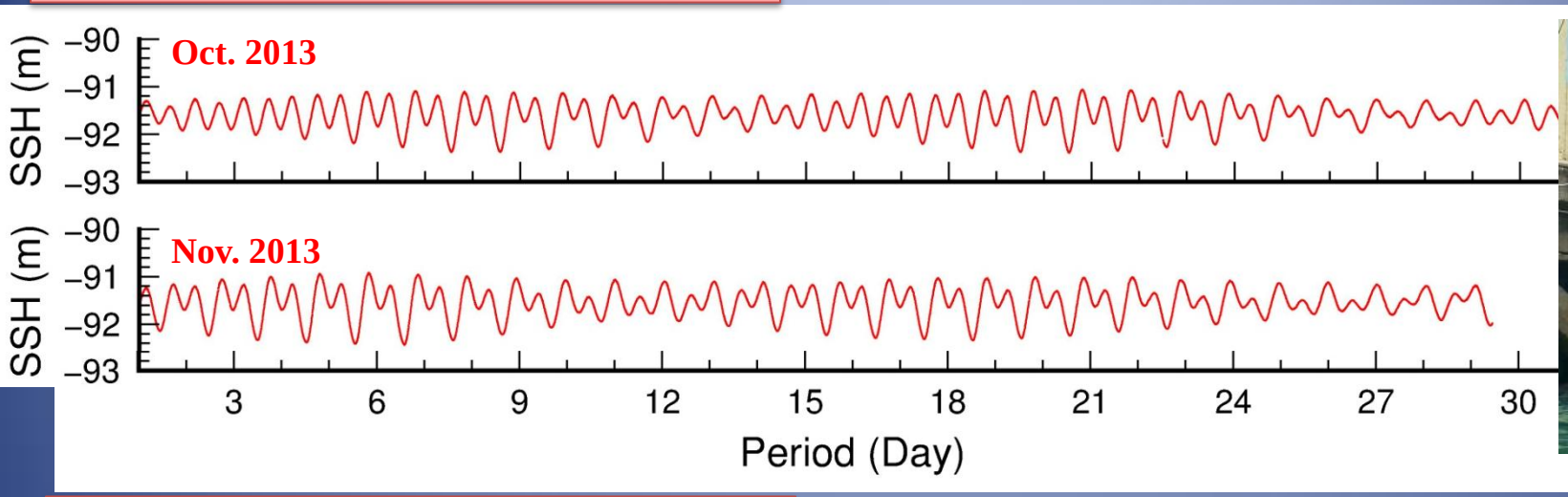


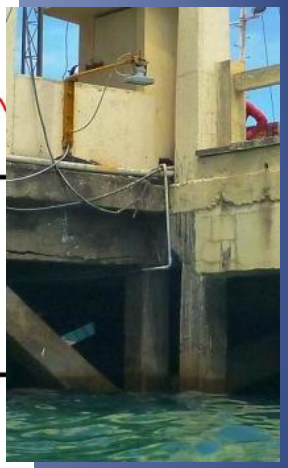
Sea surface height from GPS buoy solution (red line), tide gauge (light green) at Kavaratti main jetty



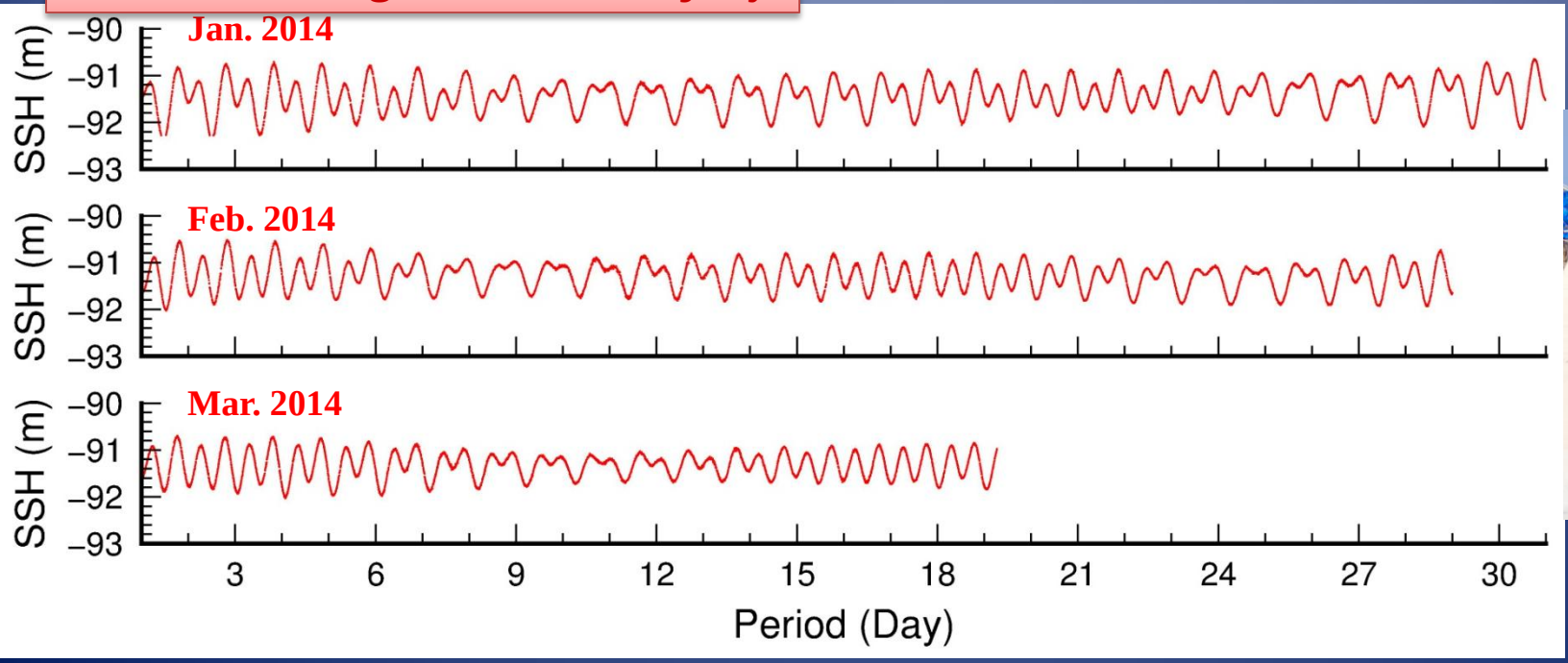
Sea surface height GPS buoy (red, purple, magenta), main jetty tide gauge (light green) and NIOT tide gauge (dark green)

Sea surface height from main jetty





Sea surface height from NIOT jetty



Data preparation

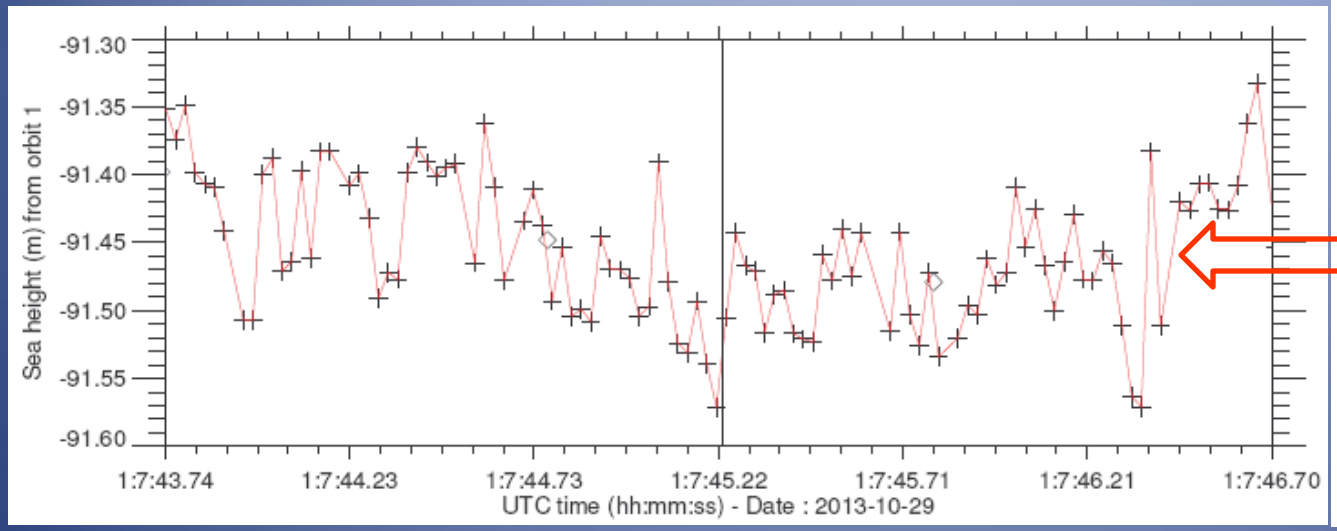
Sea surface height is the height of the sea surface above the reference ellipsoid. It is calculated by subtracting the corrected range from the altitude:

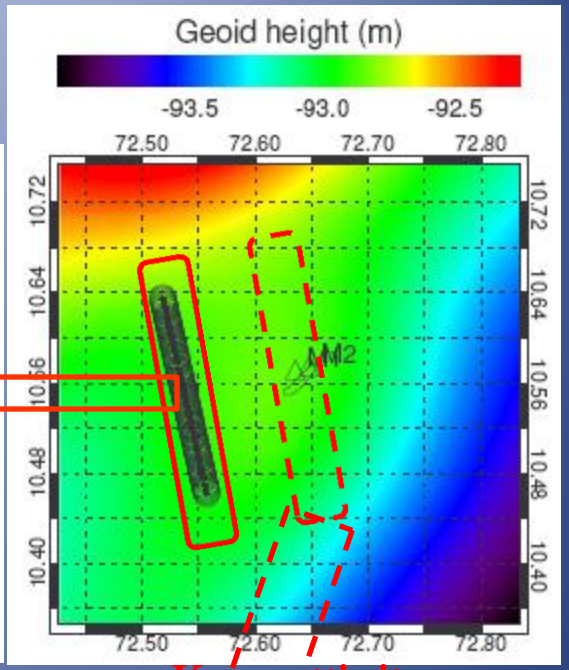
Corrected range = $_1$Range + $_2$WTC + $_2$DTC + $_2$IC + $_2$SSBC
SSH = Altitude – Corrected range

$_1$ 40Hz altimetric data sets
$_2$ 1Hz correction terms

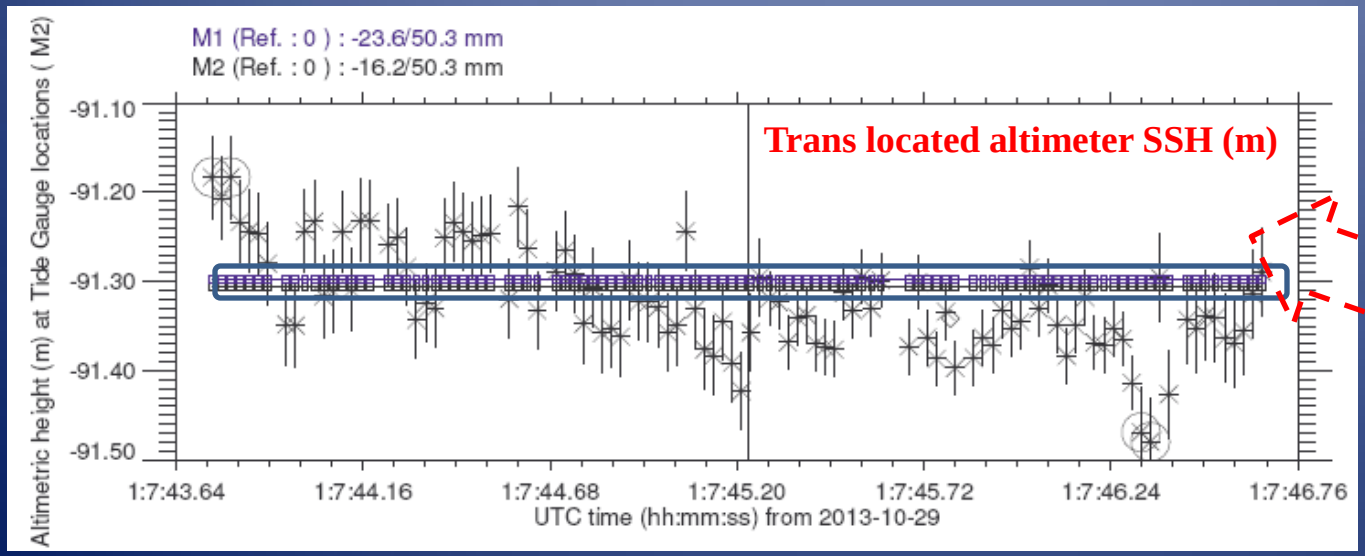
Specifications of correction	
Range (0.025sec, 40Hz)	
Hence the followings are to be modeled to 40Hz time interval	
Ionospheric correction (1sec)	Mean over -11sec to 11sec around the TCA
Dry tropospheric correction (1sec)	Linear fit over -2sec to 2sec around the TCA interpolated at the TCA
Wet tropospheric correction (1sec)	Linear fit over -5sec to 5sec around the TCA
Sea state bias correction (1sec)	Cubic polynomial fit over -4sec to 4sec around the TCA
Tide gauge (5min)	Linear fit over 30min centered on TCA (5min sampling

Absolute bias estimation

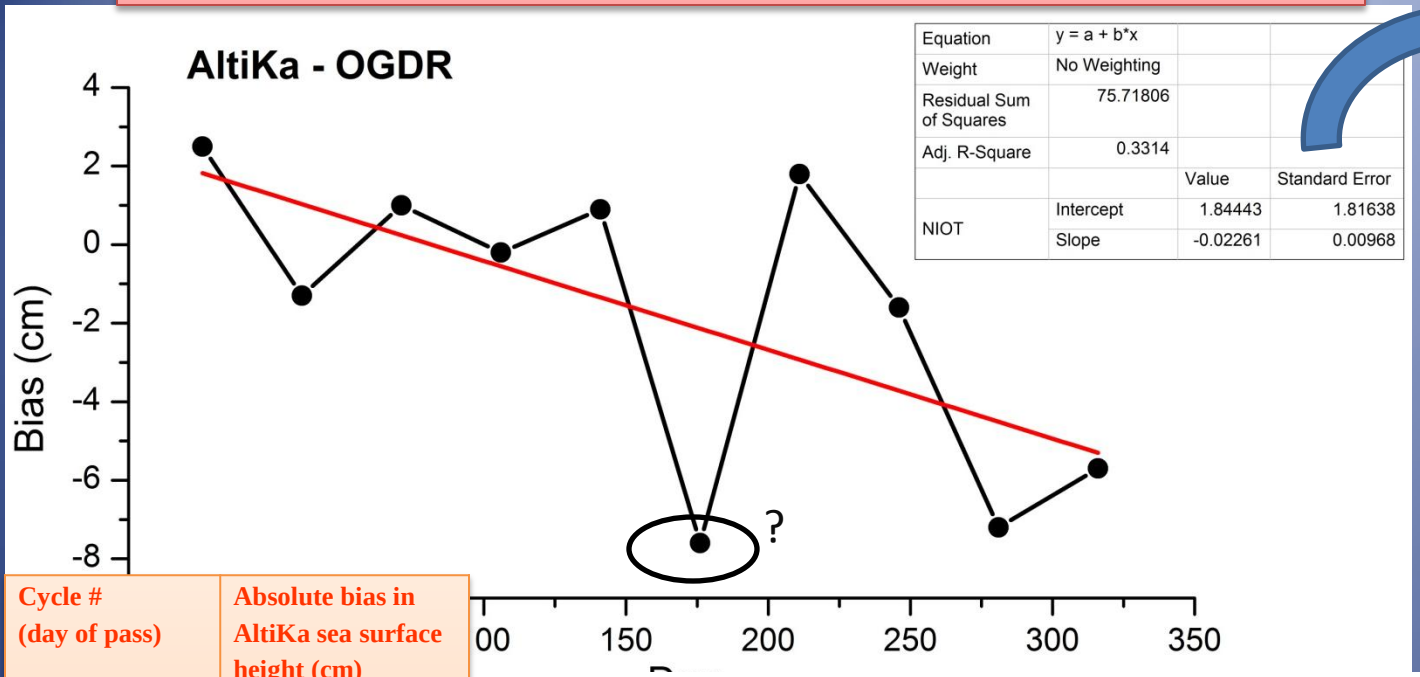




Kavaratti site



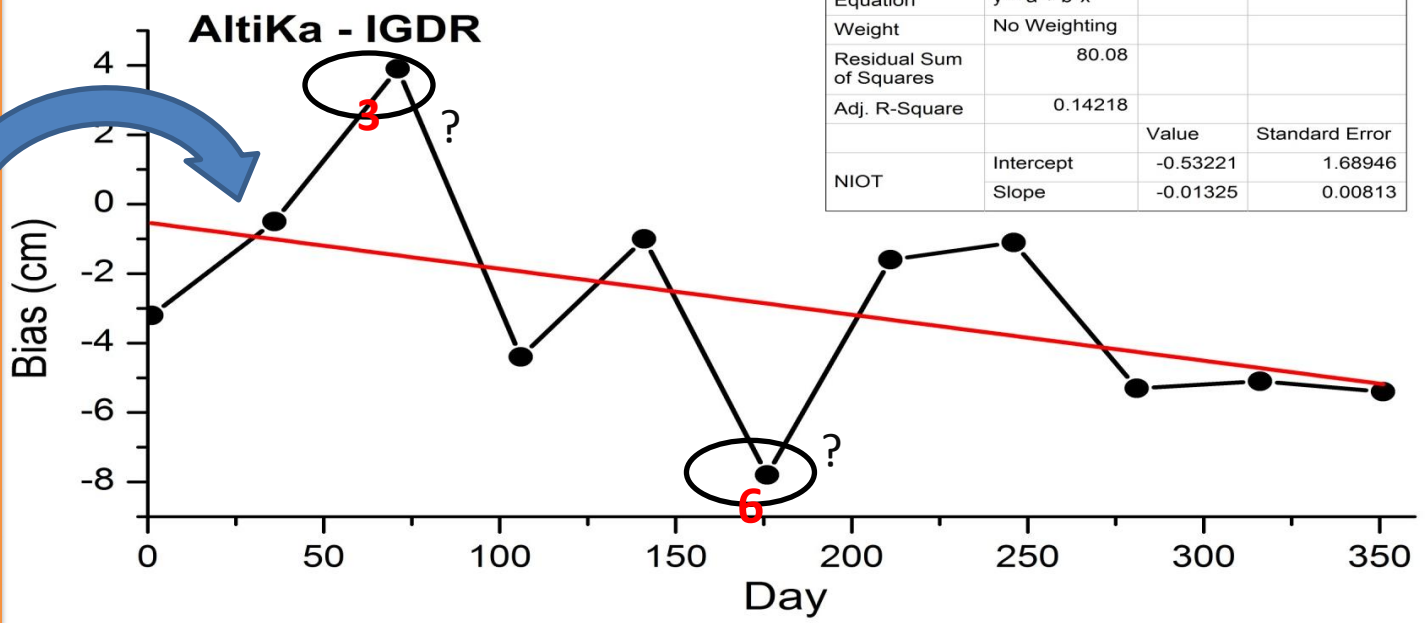
Absolute bias (Altimeter SSH – Tide gauge SSH)



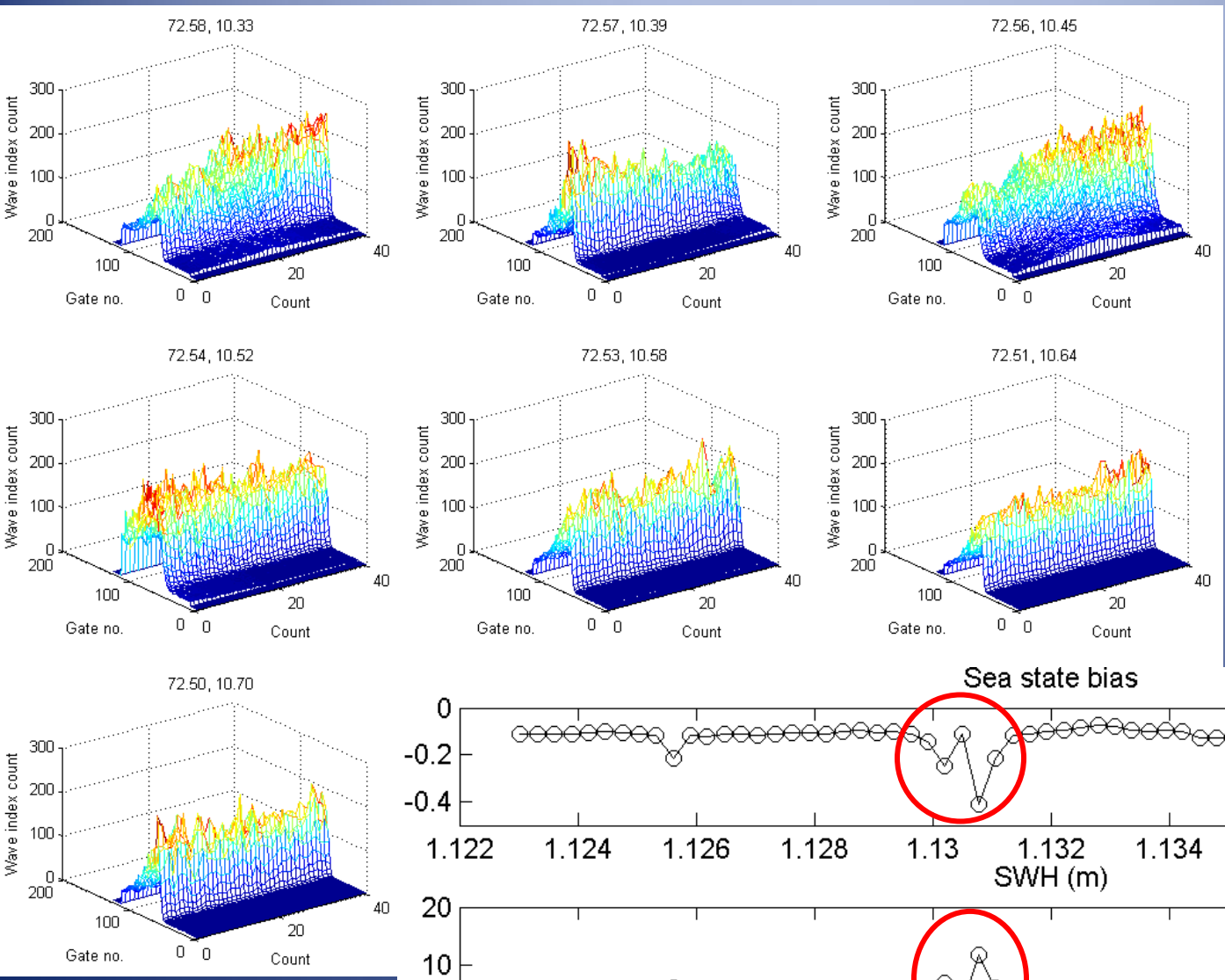
Equation	y = a + b*x		
Weight	No Weighting		
Residual Sum of Squares	75.71806		
Adj. R-Square	0.3314		
		Value	Standard Error
NIOT	Intercept	1.84443	1.81638
	Slope	-0.02261	0.00968

Cycle # (day of pass)	Absolute bias in AltiKa sea surface height (cm)
	OGDR
	NIOT Jetty
1 (02/04/13)	2.5
2 (07/05/13)	-1.3
3 (11/06/13)	1
4 (16/07/13)	-0.2
5 (20/08/13)	0.9
6 (24/09/13)	-7.6
7 (29/10/13)	1.8
8 (03/12/13)	-1.6
9 (07/01/14)	-7.2
10 (11/02/14)	-5.7
RMSE = 3.97cm	

Cycle # (day of pass)	Absolute bias in AltiKa sea surface height (cm)
	IGDR
	NIOT Jetty
1 (02/04/13)	-3.2
2 (07/05/13)	-0.5
3 (11/06/13)	3.9
4 (16/07/13)	-4.4
5 (20/08/13)	-1
6 (24/09/13)	-7.8
7 (29/10/13)	-1.6
8 (03/12/13)	-1.1
9 (07/01/14)	-5.3
10 (11/02/14)	-5.1
11 (18/03/14)	-5.4
RMSE = 4.06cm	

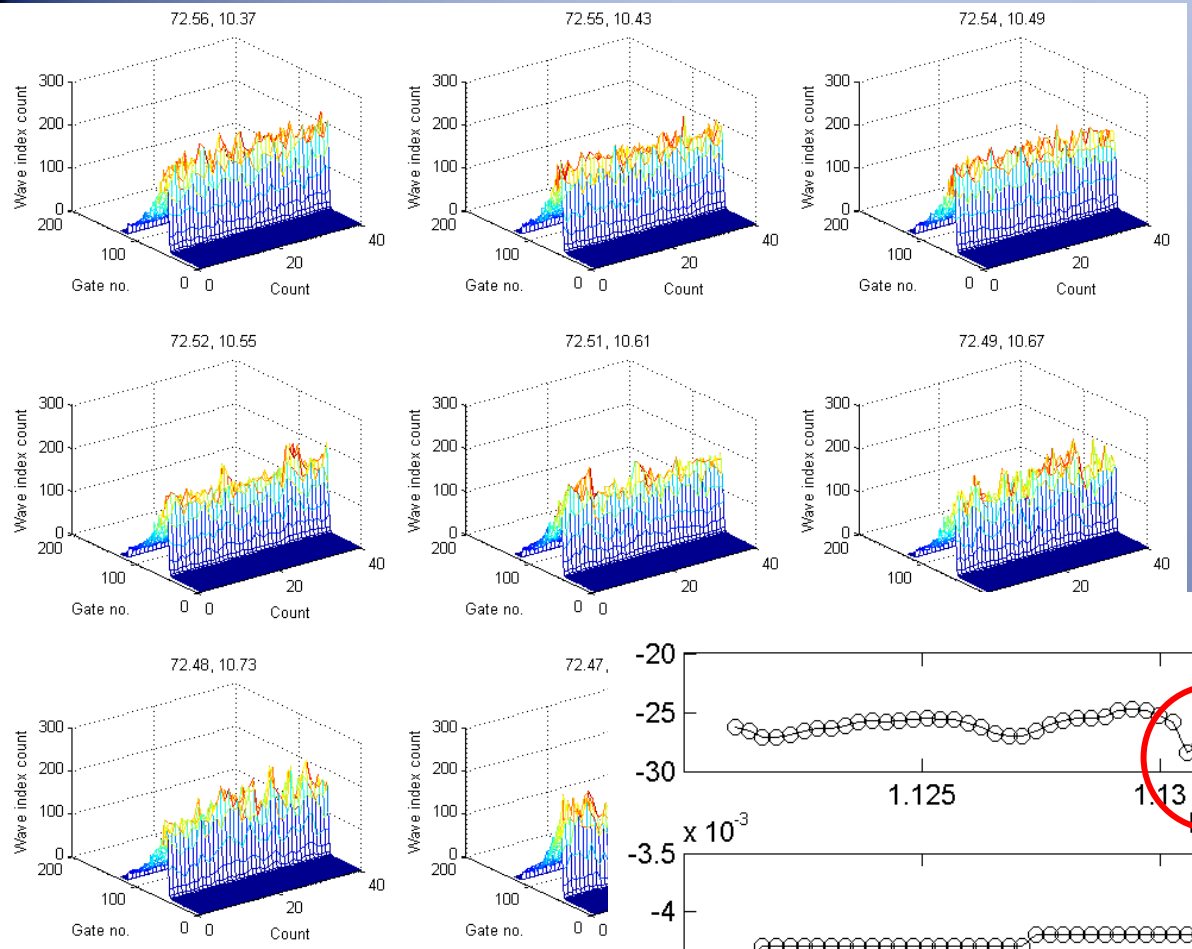


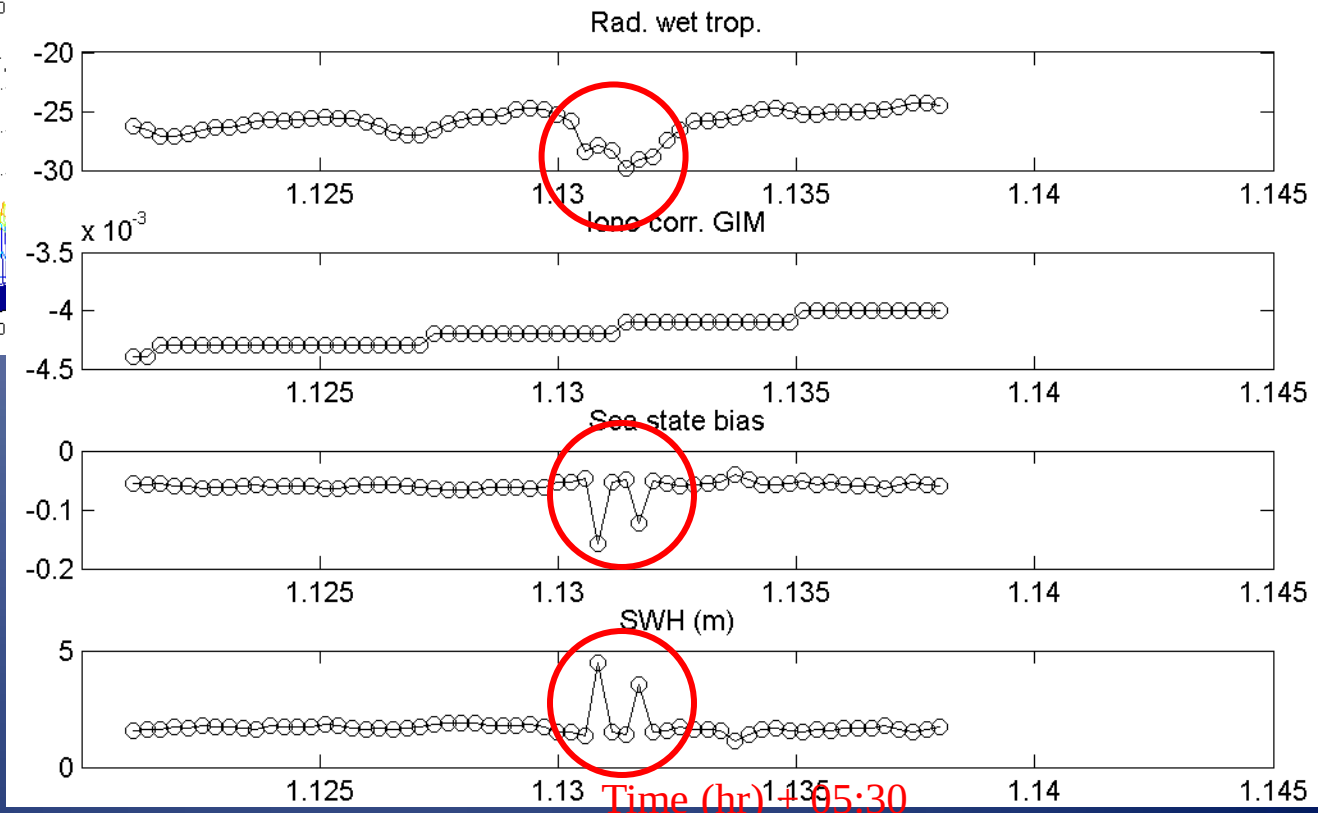
Equation	y = a + b*x		
Weight	No Weighting		
Residual Sum of Squares	80.08		
Adj. R-Square	0.14218		
		Value	Standard Error
NIOT	Intercept	-0.53221	1.68946
	Slope	-0.01325	0.00813



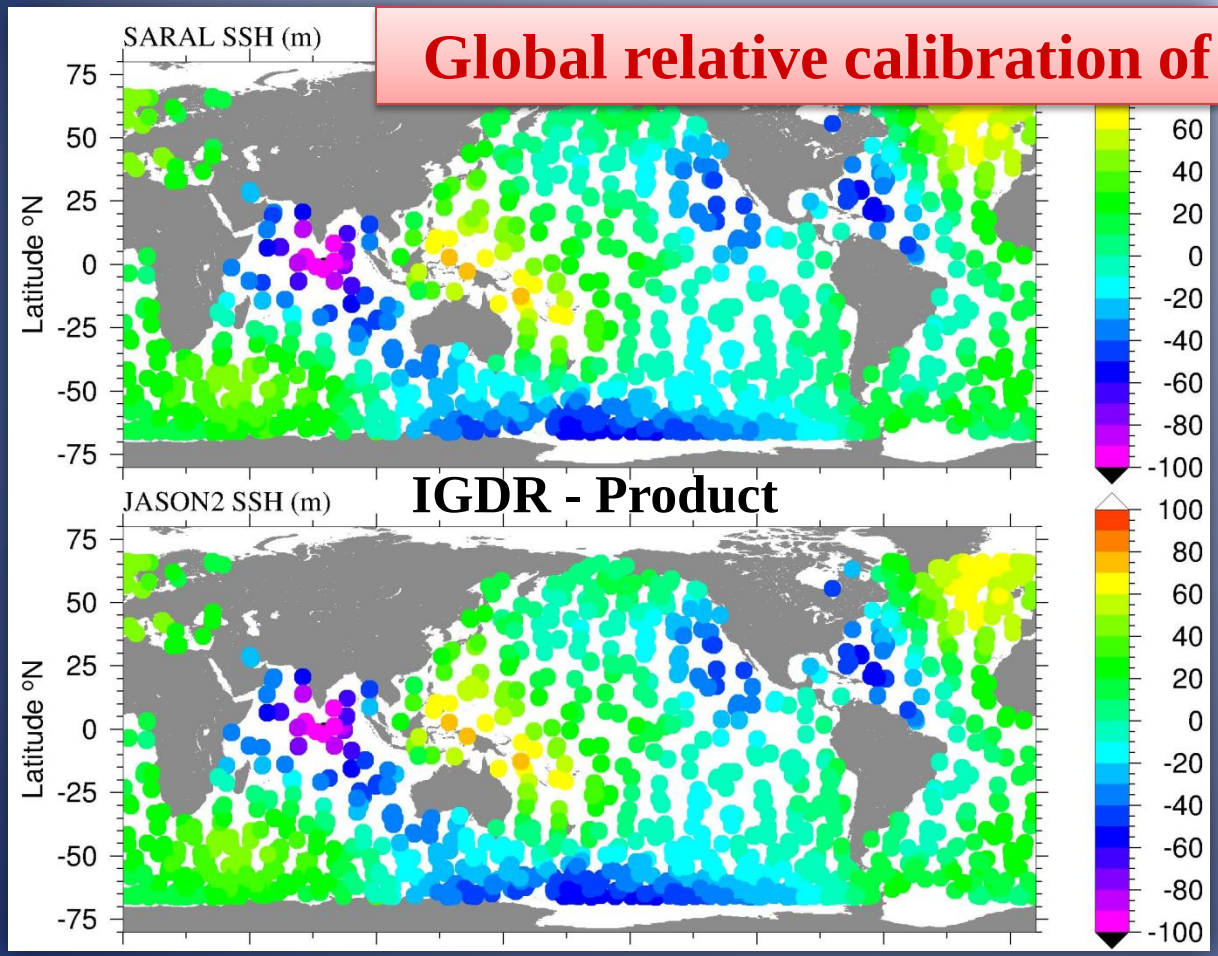
AltiKa cycle #3 (11/06/2013)

AltiKa cycle #6 (24/09/2013)





Global relative calibration of AltiKa with J2

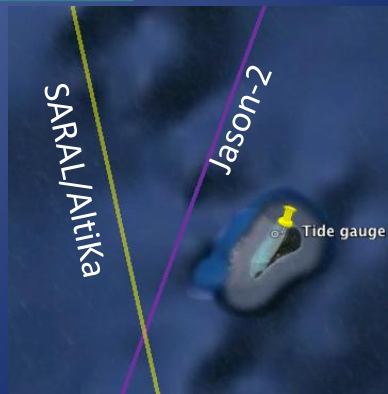


SARAL-AltiKa (cycle #001 to 003)
JASON-2 (cycle #173 to 180)

	10 km × 10 km	25 km × 25 km
No. of points	17871	273389
Correlation coefficient	0.99	0.99
Slope	1.00	1.00
Bias RMSE (cm)	**5.3** (12311)	**4.0** (188165)

Conclusion

1. Kavaratti calibration and validation site is found to be suitable of Altimeter calibration
2. The absolute bias for OGRD/IGRD products of AltiKa is -3.9/-1.7 cm
3. The higher bias found in few cycles over this site is often due to sea state bias & wet tropospheric correction
4. The global bias of AltiKa against Jason-2 in IGDR product has a RMSE 5.3/4.0cm in its 10/25km collocation
5. Future altimetric mission also should be planned to fly over Karavatti site so that this Equatorial site can be for its calibration



Future initiatives

Thank you all