# Using M-AERI and ISAR to validate MODIS and VIIRS data

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# M-AERI deployments

- M-AERIs now operate autonomously over satellite internet link.
- Three M-AERI Mk2's have been on long-term deployments on 3 RCCL cruise ships: *Celebrity Equinox, Allure of the Seas, Adventure of the Seas.*
- M-AERI Mk3 completed a global circumnavigation on NOAA S *Ronald H. Brown*: USA – South Africa – India – Australia – Hawaii – Panama – USA.
- M-AERI Mk3 currently deployed on NOAA S *Ronald H. Brown* for this year's PNE cruise off W. Africa.







## **Explorer of the Seas**



*Explorer of the Seas: near continuous operation December 2000 – December 2007.* 



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#### **Current Cruise Ship Deployments**



Track of the *Celebrity Equinox* for nine-months of 2016, colored by the skin SST derived from M-AERI Mk2 unit B. The temperature scale is at right in K.



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#### M-AERI Mk2 installed on the Adventure of the Seas.



## **Research Ship Radiometer Deployments**





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#### **M-AERI Research Ship Cruises**





There are 194,597 data points.



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## M-AERI Mk3 on Ronald H Brown.





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# M-AERI on *Ronald H Brown* circumnavigation





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# ISAR deployments



al52, FROM 2017-10-04 (277) 17:20:00.0 TO 2017-11-17 (321) 06:50:00.0 45<sup>°</sup>N 32 288 36<sup>0</sup>N STA 24 298 303 27<sup>°</sup>N 16 18<sup>°</sup>N 8 Transmitted = 2092 9°N Received # 78% Rain = 3% 180°W  $150^{\circ}W$ 120°W  $90^{\circ}W$ 150°E

Track of the M/V *Andromeda Leader* from 4 October to 17 November 2017. The colors indicate the skin SST derived from ISAR measurements, in °C, given on the scale at right.



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# ISAR deployments

ISAR 6 Jun 2004 - 29 Mar 2017



ISARs first deployed on NYK ships on July 11, 2005.

Terminated May 15, 2018, because of lack of funds.



Peter J. Minnett, RSMAS. Mon Aug 14 22:21:53 2017 E:\ISAR\Andromeda Leader\ISAR 6 Jun 2004 - 29 Mar 2017.ps



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#### MODIS & VIIRS SSTs vs Ship Radiometers

MODIS Skin SST vs M-AERI and ISAR Skin SST. Temperatures in K

Terra SST Day $0.082$ $0.080$ $0.567$ $0.409$ $1025$ Terra SST Night $0.048$ $0.034$ $0.467$ $0.337$ $2454$ Terra SST4 Night $0.016$ $0.023$ $0.339$ $0.244$ $2467$ Aqua SST Day $0.105$ $0.107$ $0.666$ $0.480$ $910$ Aqua SST Night $0.020$ $0.027$ $0.489$ $0.353$ $1752$ Aqua SST4 Night $0.010$ $0.016$ $0.396$ $0.285$ $1858$ VIIRS $0.030$ $0.009$ $0.196$ $0.142$ $81$	Satellite and Algorithm	Mean	Median	Standard Deviation	Robust St. Deviation	Number
Terra SST Night $0.048$ $0.034$ $0.467$ $0.337$ $2454$ Terra SST4 Night $0.016$ $0.023$ $0.339$ $0.244$ $2467$ Aqua SST Day $0.105$ $0.107$ $0.666$ $0.480$ $910$ Aqua SST Night $0.020$ $0.027$ $0.489$ $0.353$ $1752$ Aqua SST4 Night $0.010$ $0.016$ $0.396$ $0.285$ $1858$ VIIRS $0.030$ $0.009$ $0.196$ $0.142$ $81$	Terra SST Day	0.082	0.080	0.567	0.409	1025
Terra SST4 Night $0.016$ $0.023$ $0.339$ $0.244$ $2467$ Aqua SST Day $0.105$ $0.107$ $0.666$ $0.480$ $910$ Aqua SST Night $0.020$ $0.027$ $0.489$ $0.353$ $1752$ Aqua SST4 Night $0.010$ $0.016$ $0.396$ $0.285$ $1858$ VIIRS $0.030$ $0.009$ $0.196$ $0.142$ $81$	Terra SST Night	0.048	0.034	0.467	0.337	2454
Aqua SST Day $0.105$ $0.107$ $0.666$ $0.480$ $910$ Aqua SST Night $0.020$ $0.027$ $0.489$ $0.353$ $1752$ Aqua SST4 Night $-0.010$ $0.016$ $0.396$ $0.285$ $1858$ VIIRS $0.030$ $0.009$ $0.196$ $0.142$ $81$	Terra SST4 Night	0.016	0.023	0.339	0.244	2467
Aqua SST Night0.0200.0270.4890.3531752Aqua SST4 Night-0.0100.0160.3960.2851858VIIRS0.0300.0090.1960.14281	Aqua SST Day	0.105	0.107	0.666	0.480	910
Aqua SST4 Night-0.0100.0160.3960.2851858VIIRS0.0300.0090.1960.14281	Aqua SST Night	0.020	0.027	0.489	0.353	1752
VIIRS 0.030 0.009 0.196 0.142 81	Aqua SST4 Night	-0.010	0.016	0.396	0.285	1858
	VIIRS	0.030	0.009	0.196	0.142	81



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## But, radiometers are not numerous





temperature measurements

#### Aqua MODIS SST4 Median and RSD vs drifters





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## Saildrone deployments.

- In the NOPP MISST-3\* (Multi-sensor Improved SST) project, we will deploy Saildrones in the icefree summer Arctic to provide data for improving SSTs from IR radiometers on satellites.
- Although Saildrones have a simple IR radiometer, its absolute accuracy is questionable and the reflected sky radiance correction is not feasible.
- In a pilot project we deployed a Saildrone off the West Coast, 11 April – 10 June 2018, we added a subsurface CTD thermometer at ~30 cm.

\* PI: Chelle Gentemann, Earth & Space Research CoIs: Mike Steele, APL, U Washington Peter Minnett, RSMAS, U. Miami



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#### Saildrone: Aqua MODIS comparisons





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Night best quality a	ll records – multiple
Saildrone temperati	ares in MODIS pixel

Median	St Dev	RSD	Ν
0.092	1.096	0.399	526

Night best quality unique – closest Saildrone temperature in MODIS pixel.

0.154	0.87	0.248	39

#### Preliminary results



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## But, bear in mind....

#### "God made the bulk; surfaces were invented by the devil."

Wolfgang Pauli







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