SST Quality Monitor (SQUAM)

www.star.nesdis.noaa.gov/sod/sst/squam/

In situ SST Quality Monitor (iQuam)

www.star.nesdis.noaa.gov/sod/sst/iquam/

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Yury Kihai, Xinjia Zhou

Thanks to: NOAA and GHRSST Colleagues

SST Quality Monitor (SQUAM)

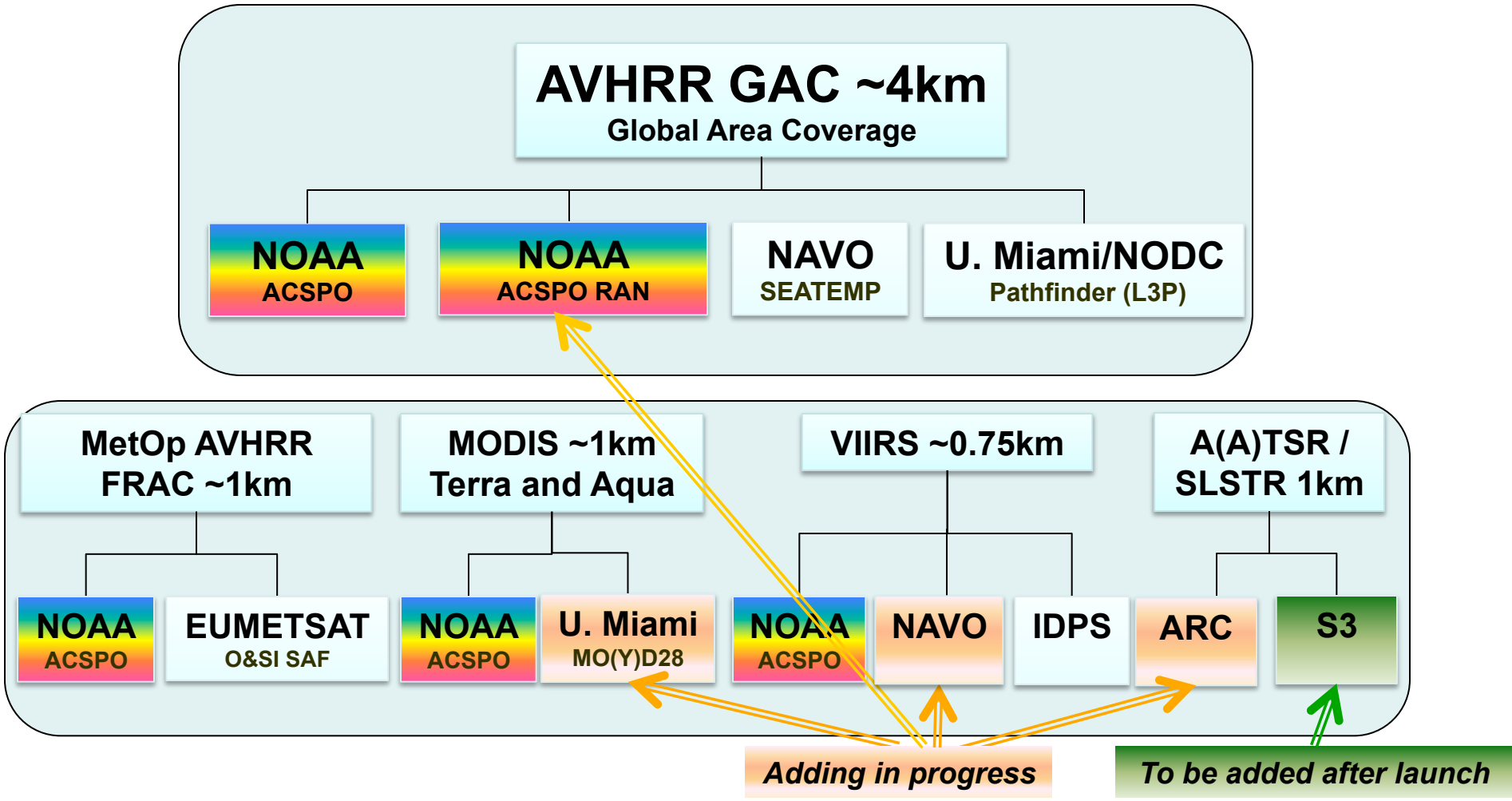
www.star.nesdis.noaa.gov/sod/sst/squam/

Dash, et al: SST Quality Monitor (SQUAM). JTech, 2010.

SST Monitoring in SQUAM

- **Key words**
  - Community resource, Automated, Near-Real Time, Global, Online, In situ validation, Consistency Checks
  - Google “SQUAM SST”
- **SST products in SQUAM**
  - Swath (**L2**), gridded (**L3**), analysis (**L4**) – 3 SQUAM modules
  - Commenced as a NOAA system but now monitoes many community Products – GRSST resource
- **Analyzed are deltas (deviations from reference SSTs)**
  - Centered at ~0? Small? Gaussian? no outliers?
  - Two reference SSTs
    1. ***Validation:*** *Against in situ SST (suboptimal quality, sparse and geographically biased, may not be available in real-time)*
    2. ***Consistency Checks:*** *Against L4 fields (more uniform quality, global coverage, large statistics, available in real-time)*

Polar L2 SST Products in SQUAM

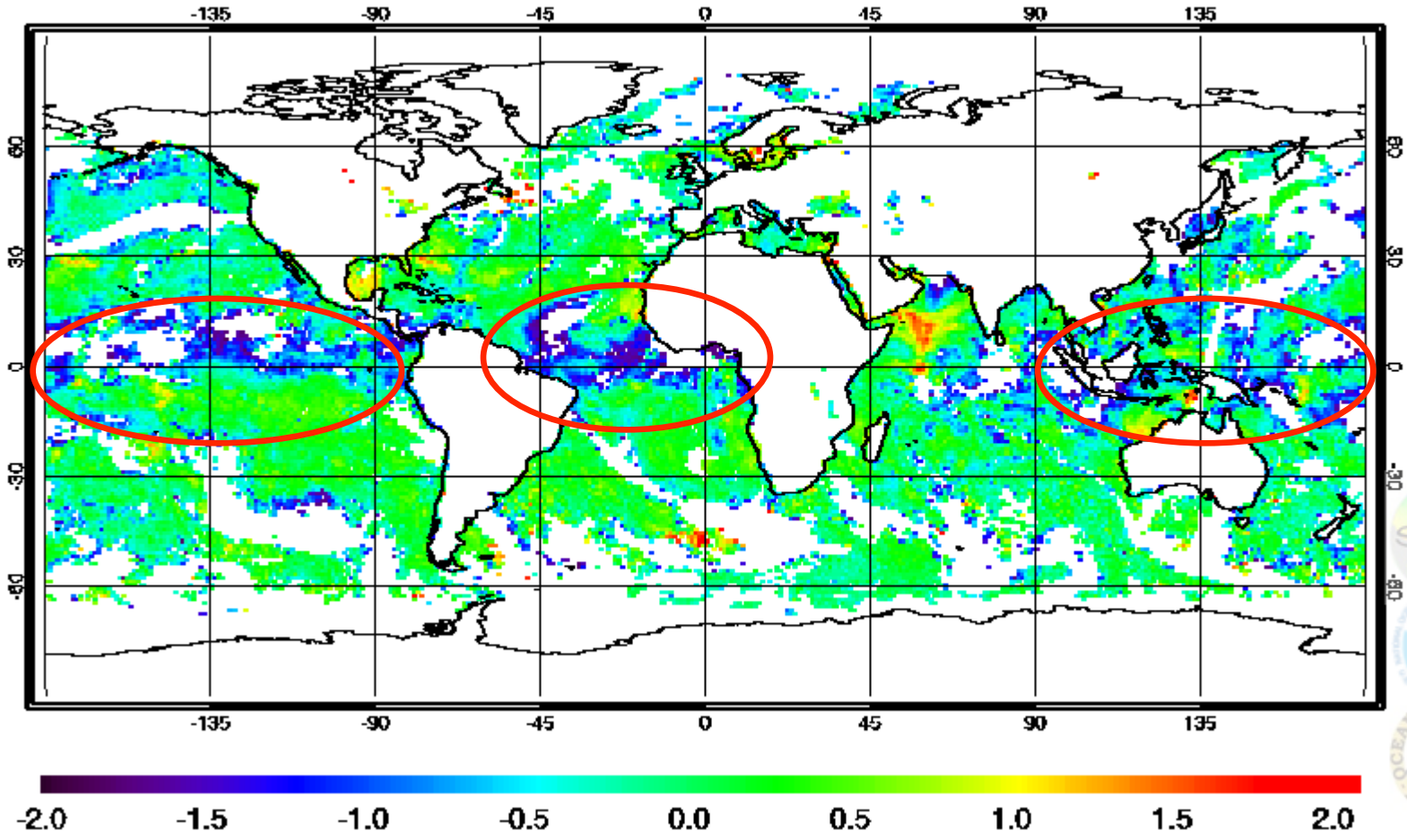


- *Current analyses in SQUAM are performed on a daily basis*
- *Several colleagues asked to add monthly analyses*

Daily Metop-A FRAC OSISAF

Maps | Histograms | Time-series | Dependencies | Hovmöller

Day: **Metop-A FRAC OSISAF** *minus* CMC L4, Apr-2014

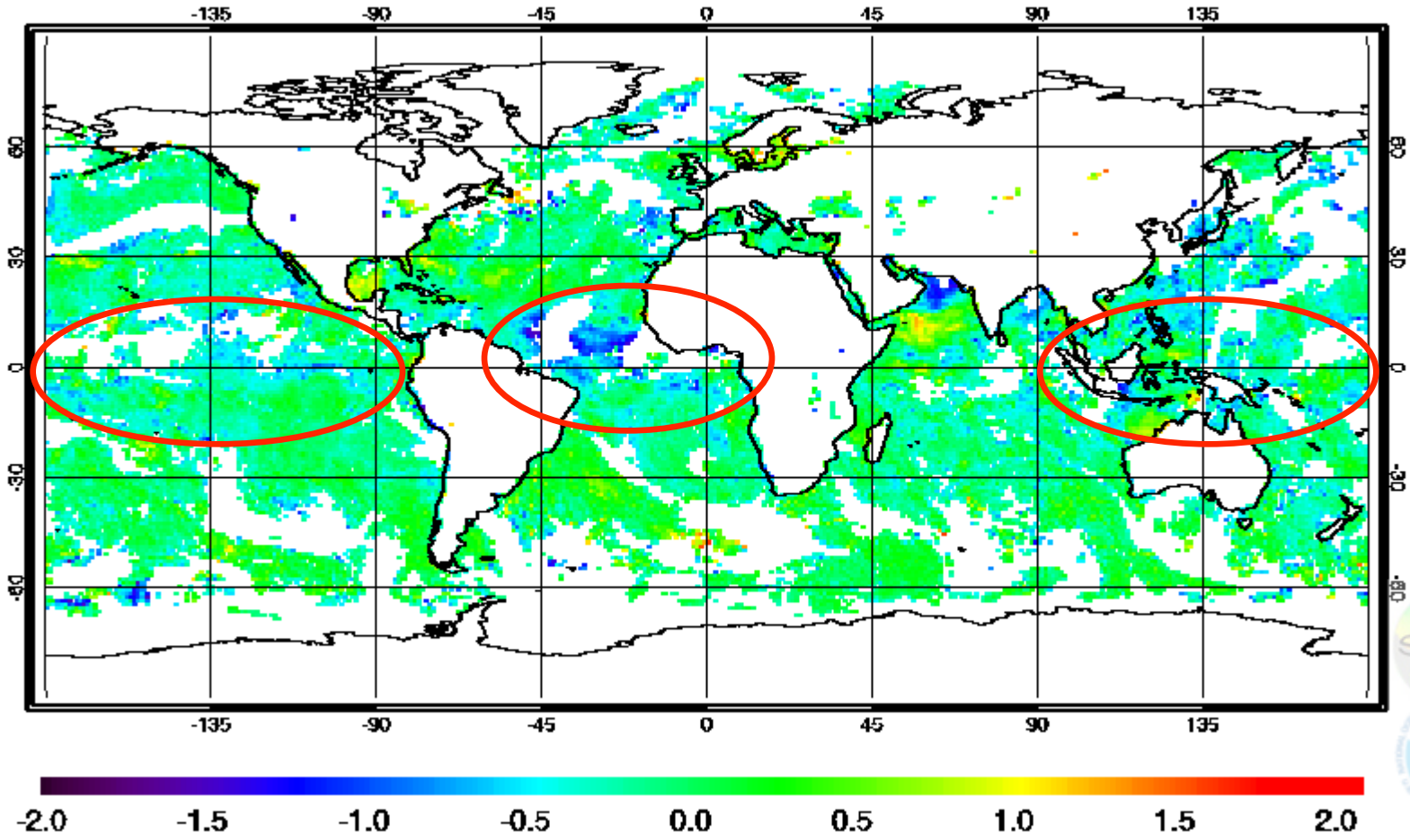


- *Cold spots in the tropics may be residual cloud/aerosol leakages*
- *Or they maybe due to use of regression SST algorithms*

Daily Metop-A FRAC ACSPO

Maps | Histograms | Time-series | Dependencies | Hovmöller

Day: **Metop-A FRAC ACSPO** *minus* CMC L4, Apr-2014

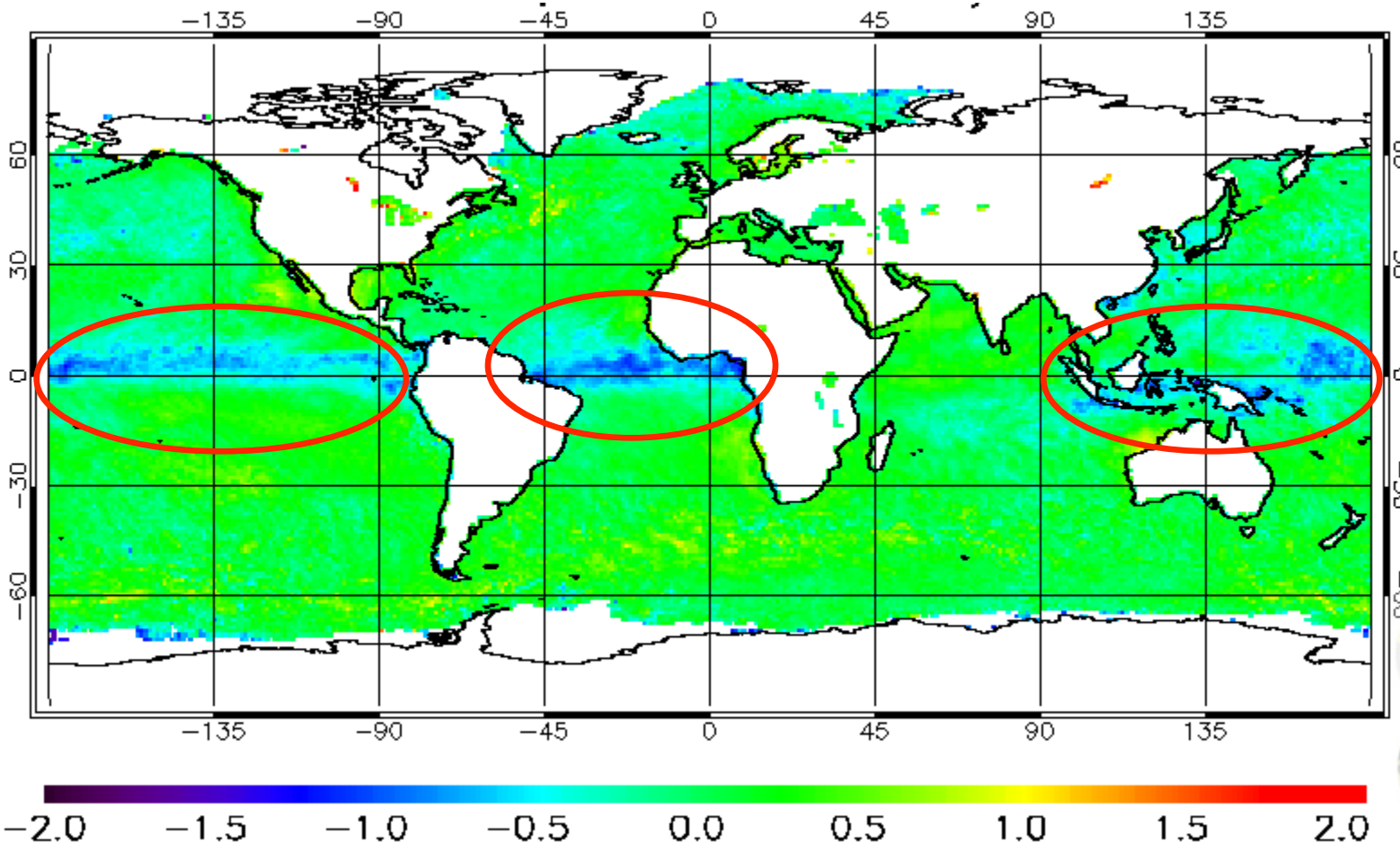


- *OSISAF SST equations now implemented in ACSPO (Petrenko et al, 2014)*
- *Nevertheless, ACSPO cold anomalies are fewer and of lesser magnitude*

Monthly Metop-A FRAC OSISAF

Maps | Histograms | Time-series | Dependencies | Hovmöller

Day: **Metop-A FRAC OSISAF** *minus* **CMC L4, Apr-2014**

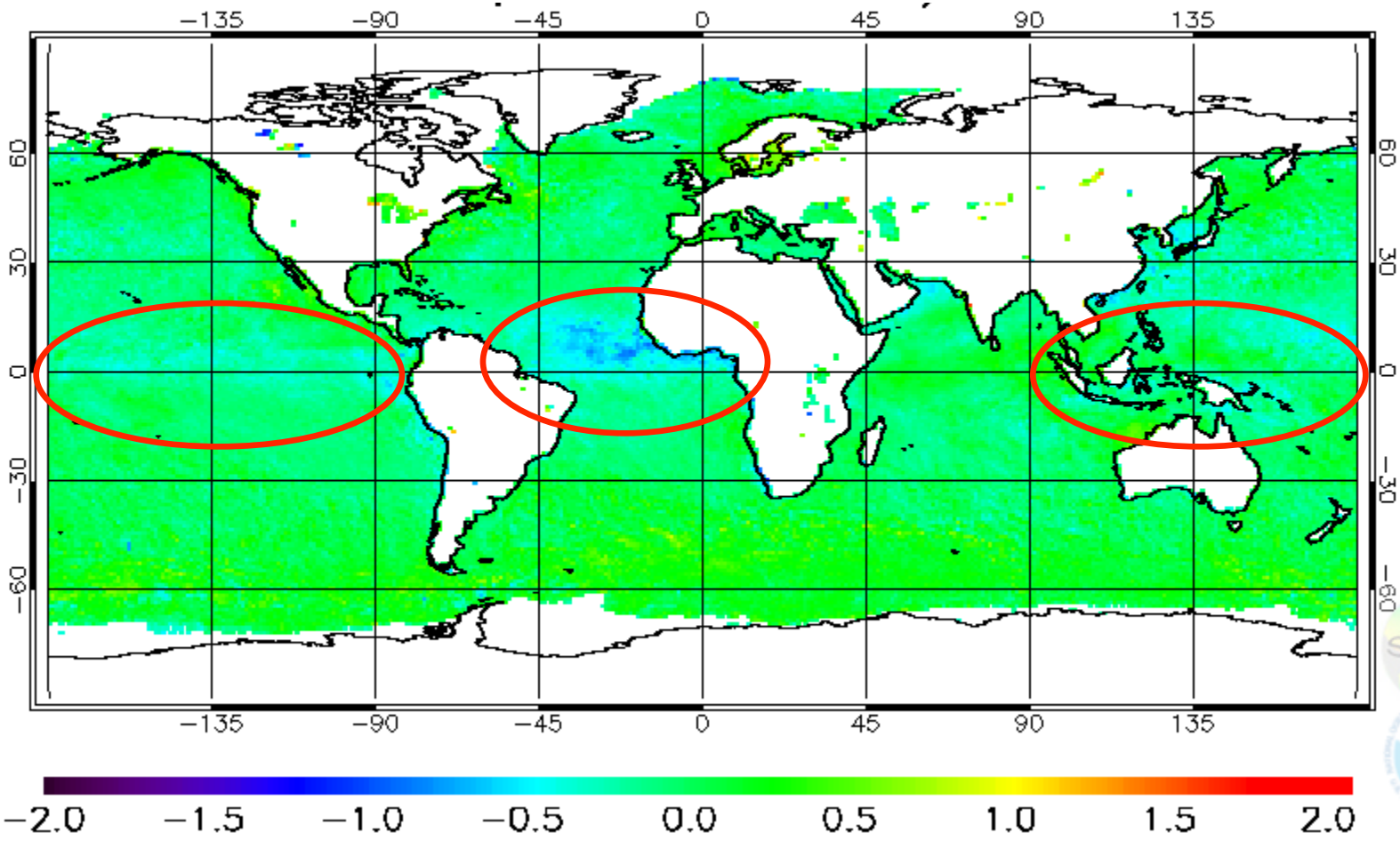


- ***Note that ACSPO uses OSISAF SST algorithms now***
- ***Cold spots may be cloud/aerosol leakages or SST algorithm biases***

Monthly Metop-A FRAC ACSPO

Maps | Histograms | Time-series | Dependencies | Hovmöller

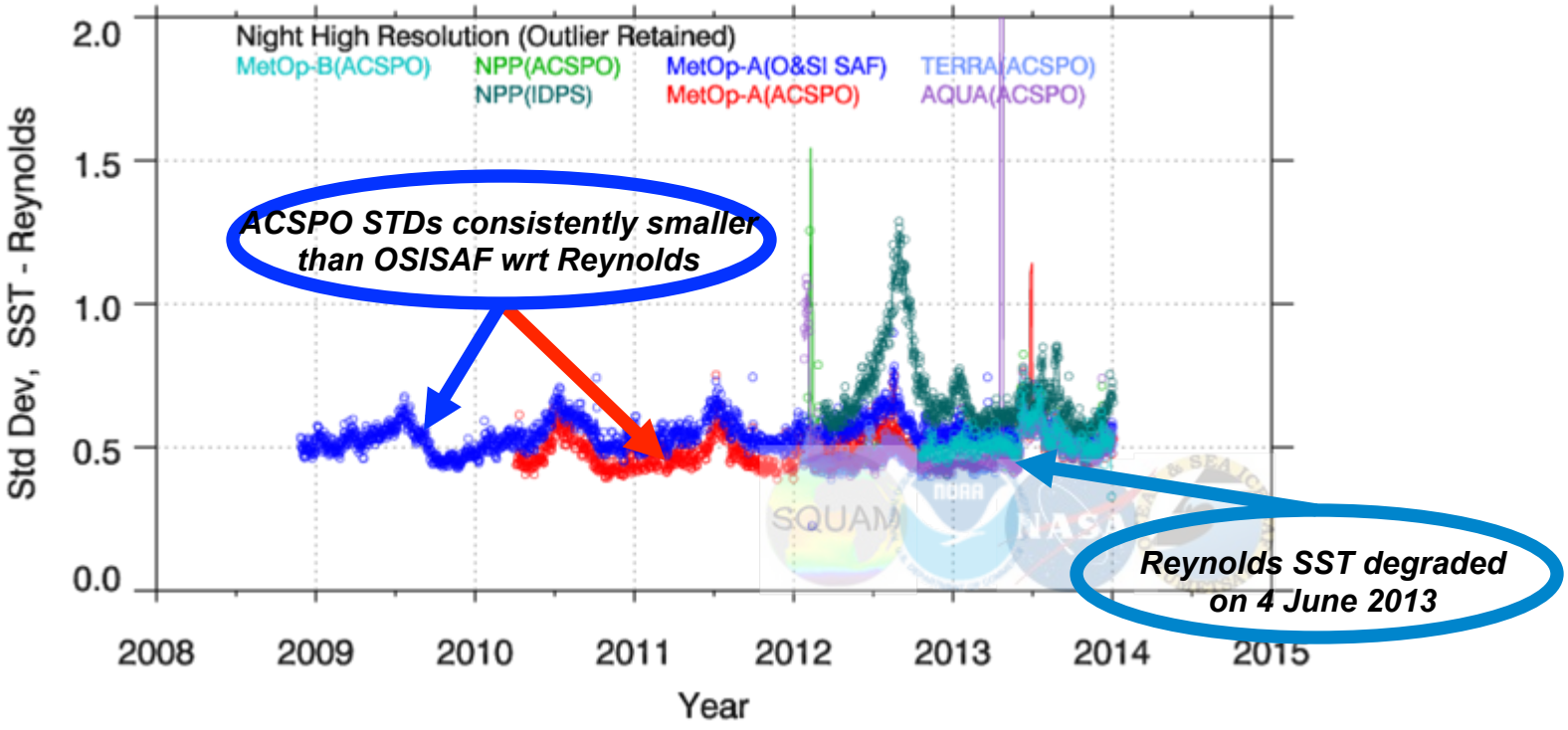
Day: **Metop-A FRAC ACSPO** ***minus*** **CMC L4, Apr-2014**



- ***ACSPO uses OSISAF SST algorithms now***
- ***Cold spots are likely residual cloud/aerosol leakages***

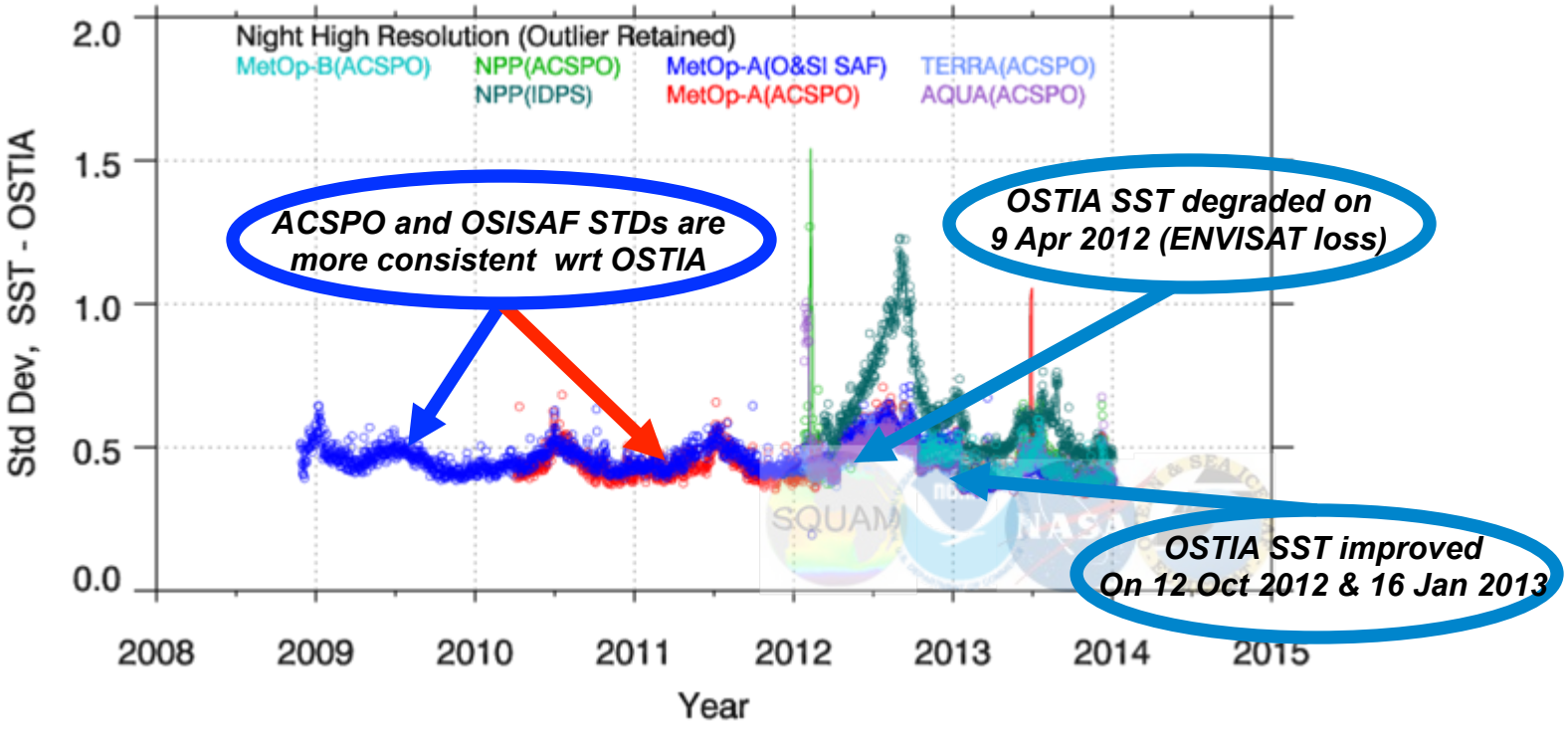
NIGHT STD DEV wrt. Reynolds L4

At night, OSISAF and ACSPO SSTs are more consistent



- **Neither ACSPO nor OSISAF L2s are assimilated in Reynolds L4**
- **Comparisons w/Reynolds should capture relative OSISAF/ACSPO performance**

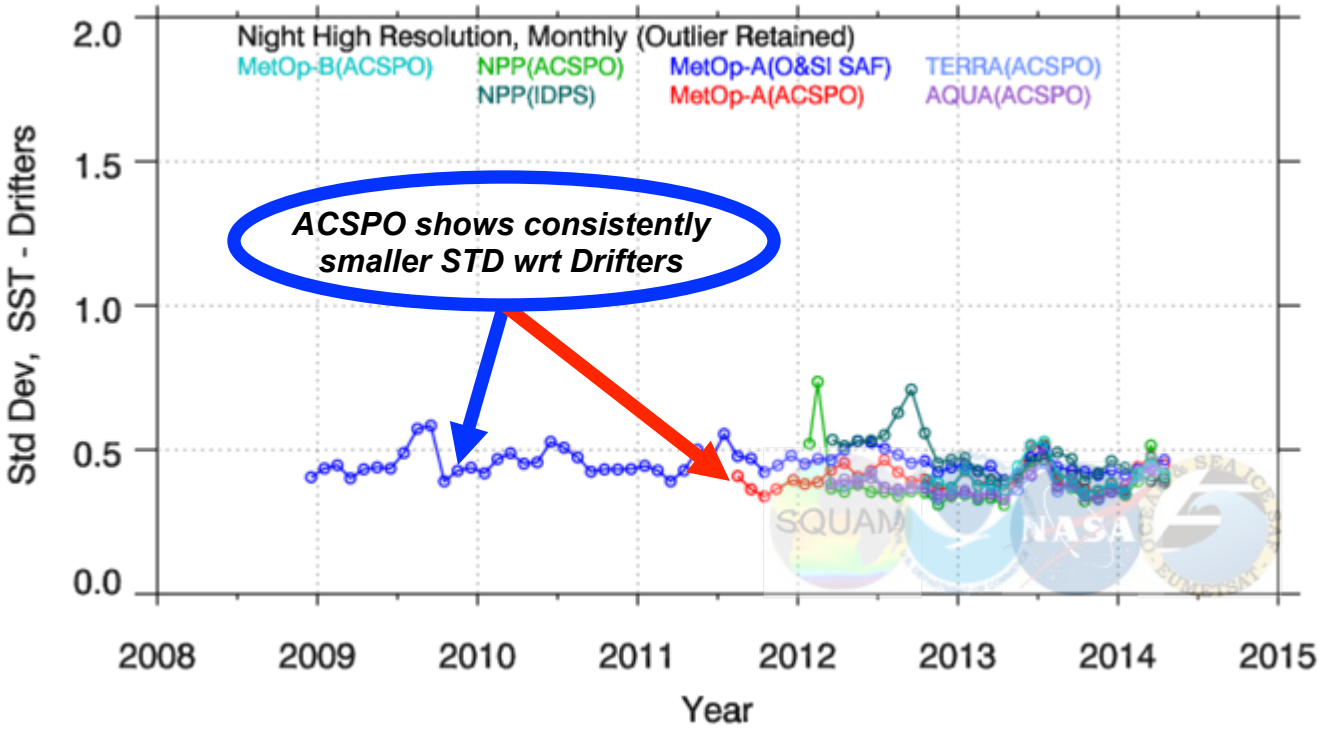
NIGHT STD DEV wrt. OSTIA L4



- Wrt. OSTIA SST, the pedestal is smaller– OSTIA "internal noise" smaller
- Both OSISAF and ACSPO STDs are reduced, but OSISAF to a greater extent. Recall that OSISAF L2 is assimilated in OSTIA L4 and ACSPO is not

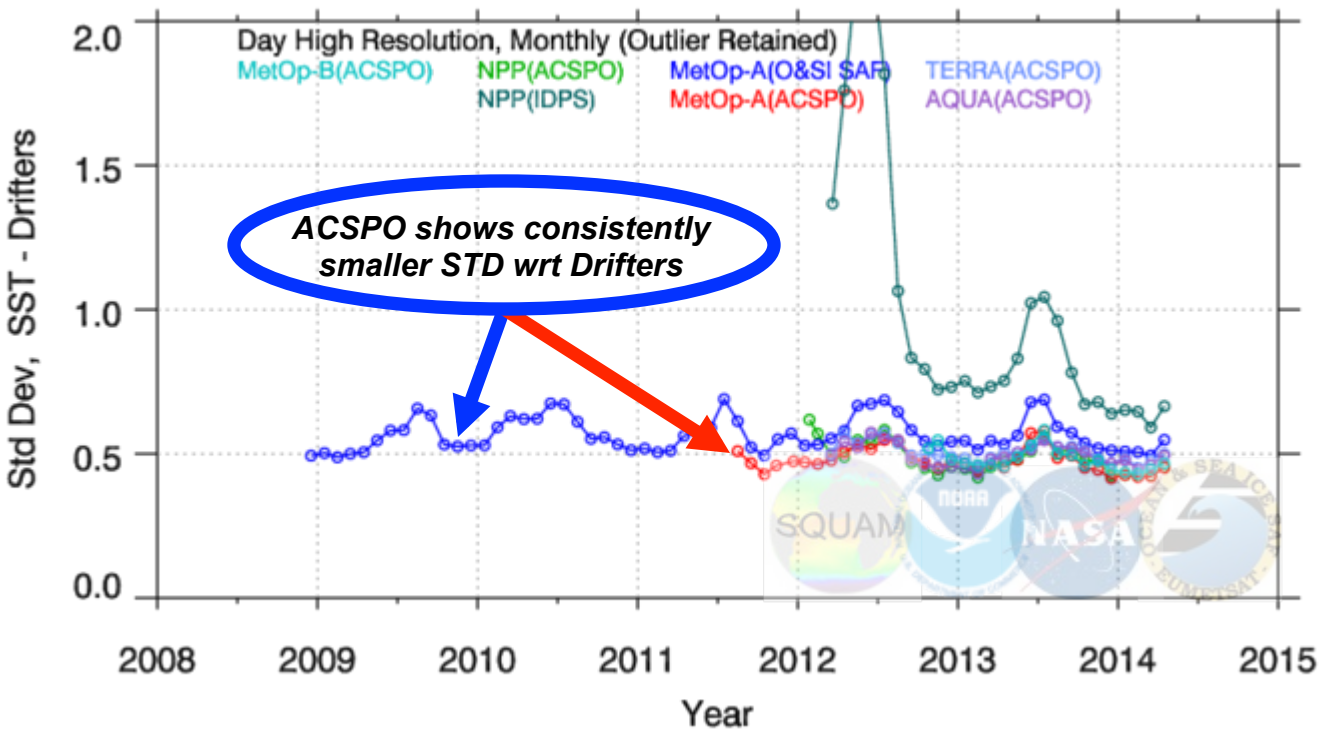
NIGHT STD DEV wrt. iQuam Drifters (Monthly)

Comparison with in situ drifters is the "golden standard"



- At night, both OSISAF and ACSPO show STDs <0.5K
- ACSPO STDs are slightly smaller than OSISAF
- Recently, OSISAF STDs became smaller and closer to ACSPO

DAY STD DEV wrt. iQuam Drifters (Monthly)



- Daytime STDs are larger than nighttime, for both OSISAF and ACSPO
- ACSPO STDs remain slightly smaller than OSISAF, for the full period

SQUAM Progress Summary

- Progress since GHRSST14
  - Improved stability, functionality, efficiency, fixed bugs
  - High-Res monitoring sustained (VIIRS, MODIS, AVHRR FRAC)
  - Progress made with monthly monitoring
  - ARC and NAVO processed (P. Dash' presentation)
  - ACSPO RAN processed
  - Processing MO/YD28 underway

- "Big Picture"
  - Improving SQUAM system
  - Filling in the remaining products

Move to new knowledge & understanding

- Ongoing work towards GHRSST16
  - Consolidate ARC, NAVO and ACSPO-RAN into main SQUAM
  - Complete MO/YD28 and consolidate into SQUAM
  - Uniformly implement monthly monitoring
  - Catch up with L4-SQUAM – stability has been suboptimal. Functionality is being restored & remaining products added
- "Big Picture"
  - Complete inventory of L4 and polar IR L2 products in SQUAM
  - Move to new knowledge and understanding
  - Start working on setting up geo-SQUAM

In situ SST QC & Monitoring in *i*Quam

www.star.nesdis.noaa.gov/sod/sst/iquam/

Xu, Ignatov: In situ SST Quality Monitor (iQuam). JTech, 2014.

Objectives of iQuam

In situ Quality Monitor (*iQuam*) performs the following functions

- **QC:** Accurate/flexible QC of *in situ* SSTs, consistent with wider Meteorological and Oceanographic communities
- **Monitoring:** Report statistical summaries of *in situ* minus reference L4 SST online, stratified by ships, drifters, tropical & coastal moored, ARGO floats; and individual platforms
- **Data Serving:** Serve QCed *in situ* SST data online for SST community.

iQuam Data Usage: L2, L3, L4 SST products are matched up with in iQuam SSTs, and displayed in SQUAM

- ***iQuam version 1 was implemented in 2009***
- ***iQuam version 2 to be implemented in 2014***

Quality Control – Consistent with UK MO

Category	Check	Type of error handled	Physical basis
Preprocessing	Duplicate Removal	Duplicates arise from multiple transmission or data set merging	Identical space/time/ID
Plausibility	Plausibility checks	Unreasonable field values	Range of single fields & Relationships among them
Internal consistency	Tracking	Points falling out of track	Travel speed exceeds limit
	Spike check	Discontinuities in SST time series	SST gradient exceeds limit
External consistency	Reference Check	Measurements deviating far away from reference	Bayesian approach (*) (Ref. SST: Daily OI SST v2)
Mutual consistency	Cross-platform Check	Mutual verification with nearby measurements ("buddies check")	Bayesian approach (*) based on space/time correlation of SST field (Correlation model: 2-scale SOAR, Martin et al., 2002)

(*) Lorenc and Hammon, 1988; Ingleby and Haddleston, 2007

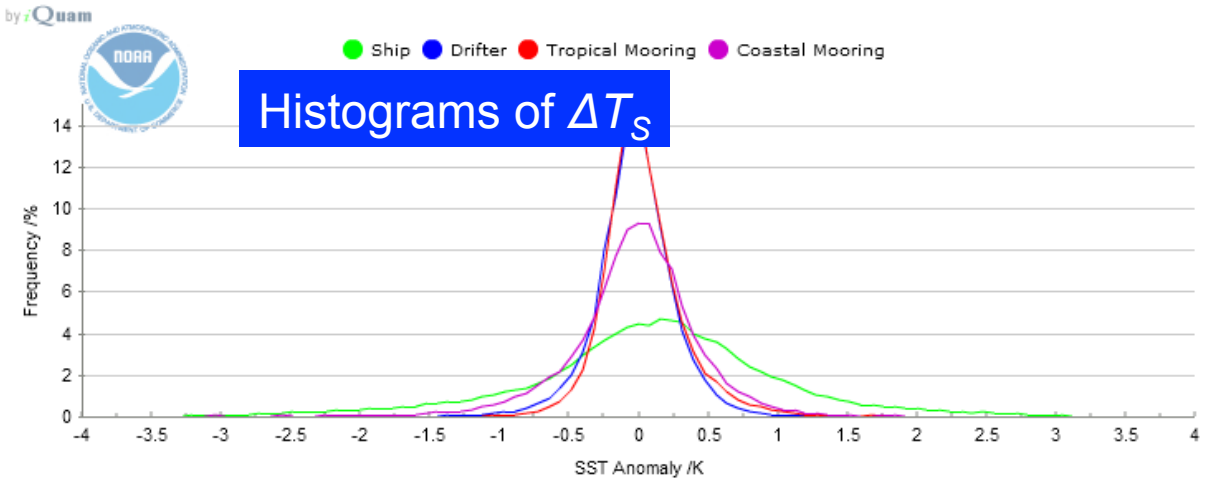
Monthly Statistical Summaries

QC Statistics — Outliers detected by each QC check

Platform	N_Obs	N_QC	DR	TC	SC	RC	XC
Ship	78,661	66,072	164	7,409	150	11,626	12,087
Drifter	1,048,270	939,558	84,745	3,197	870	15,257	23,878
Tropical Mooring	33,566	32,994	212	140	17	314	351
Coastal Mooring	187,319	174,938	6	1,354	426	6,313	12,180

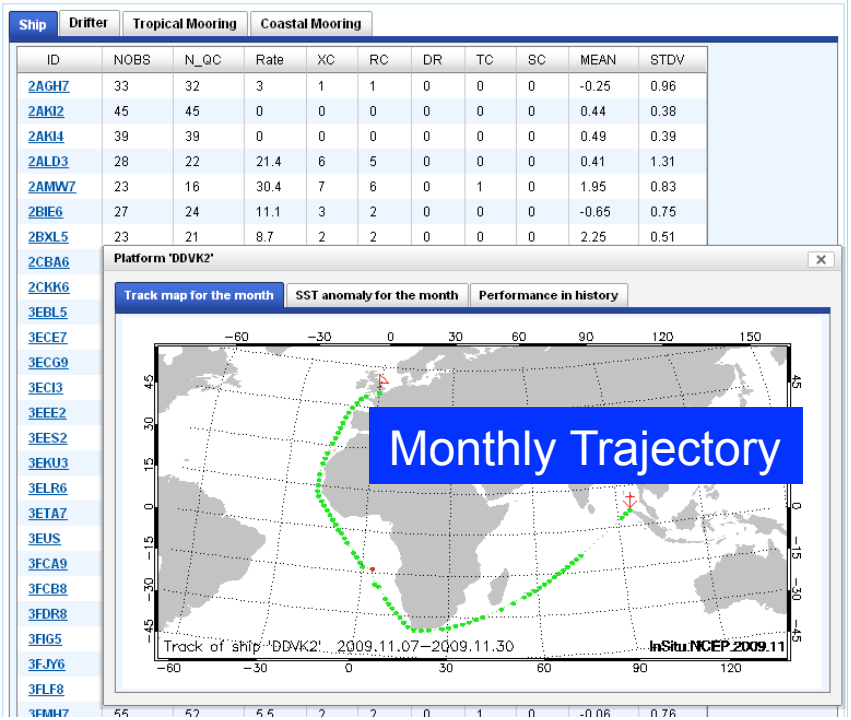
SST Statistics — Moments of $\Delta T_S = T_{in\ situ} - T_{Reynolds}$

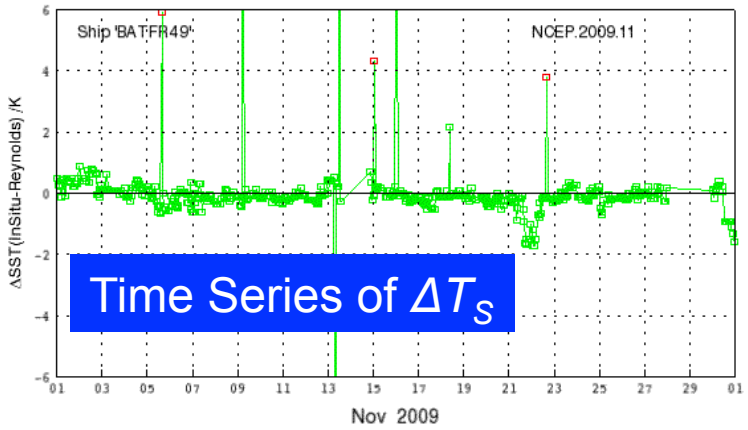
Platform	BIAS	SD	SKEW	KURT	MED	RSD	N_Mtchp
Ship	0.14	0.94	-0.32	1.77	0.17	0.73	60,687
Drifter	0.02	0.29	-0.29	4.43	0.02	0.23	937,136
Tropical Mooring	0.07	0.29	0.79	3.39	0.04	0.22	32,947
Coastal Mooring	0	0.5	-1.24	7.32	0.04	0.35	148,818

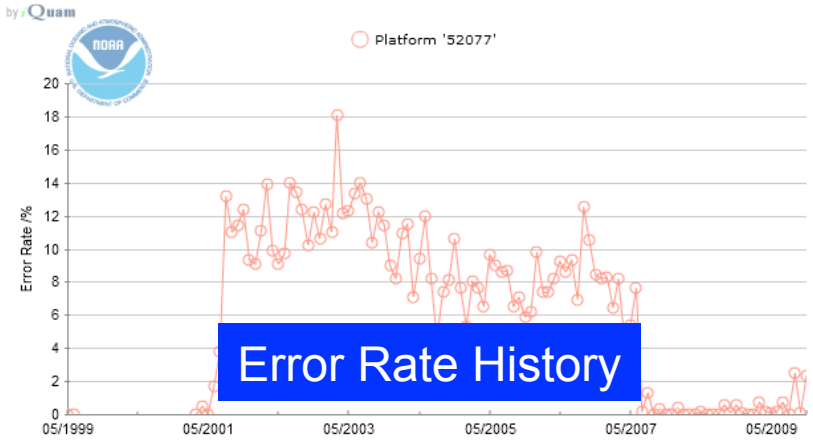


Monitoring Individual Platforms

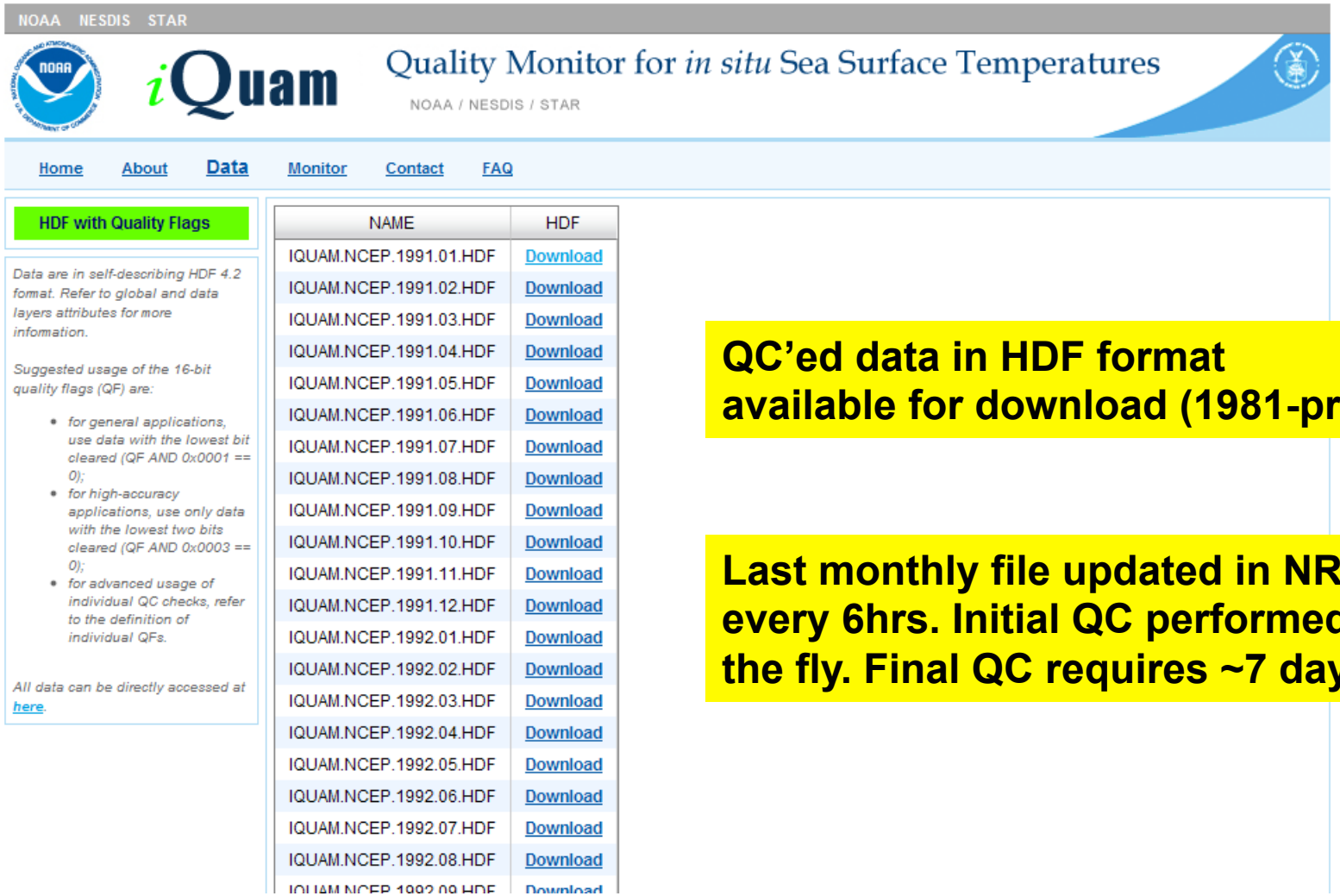
List of platforms & individual statistics







Data for Download



QC'ed data in HDF format available for download (1981-pr)

Last monthly file updated in NRT every 6hrs. Initial QC performed on the fly. Final QC requires ~7 days.

iQuam2 Enhancements

- **Add ARGO floats**
- *Extend time series back to 1980. Use ICOADS data with their heritage QFs, add iQuam QFs, compare two QFs*
- *Add CMS buoy blacklist as an additional QF*
- *Add trackob ships (work with BoM Helen Beggs)*
- *Add GHRSST Buoys*
- *Add Min/Max to monitoring – focus on outliers*
- *Perform sensitivity analyses to reference SST*

New interface of iQuam v2

NOAA NESDIS STAR

iQUAM *in situ* SST quality monitor v2.0

NOAA / NESDIS / STAR

Monitor Data About

ARGO: Uniform global coverage

Maps
Statistics
Time Series
Platforms

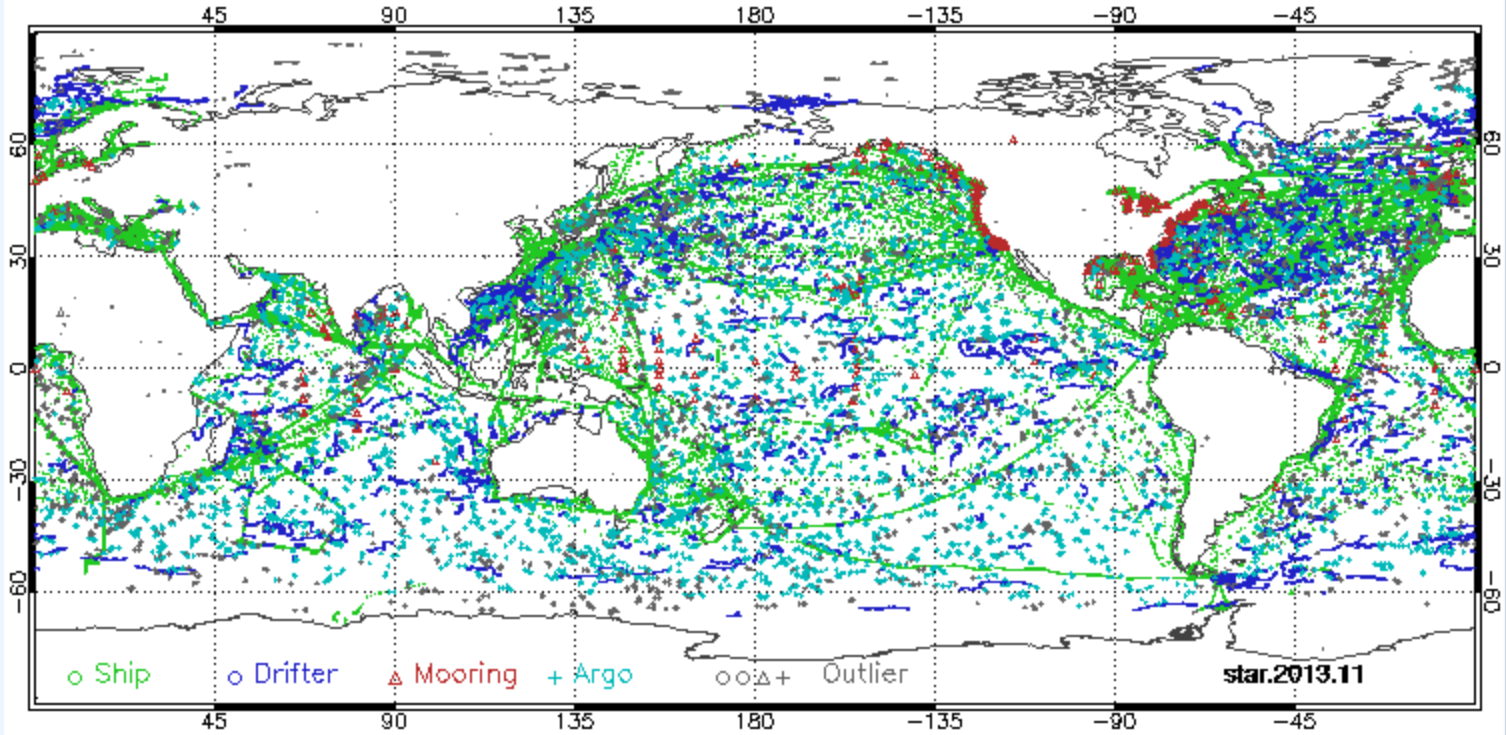
11 2013

Different platform types are shown in different colors, with obs detected by QC shown in gray. Each symbol stands for one observation.

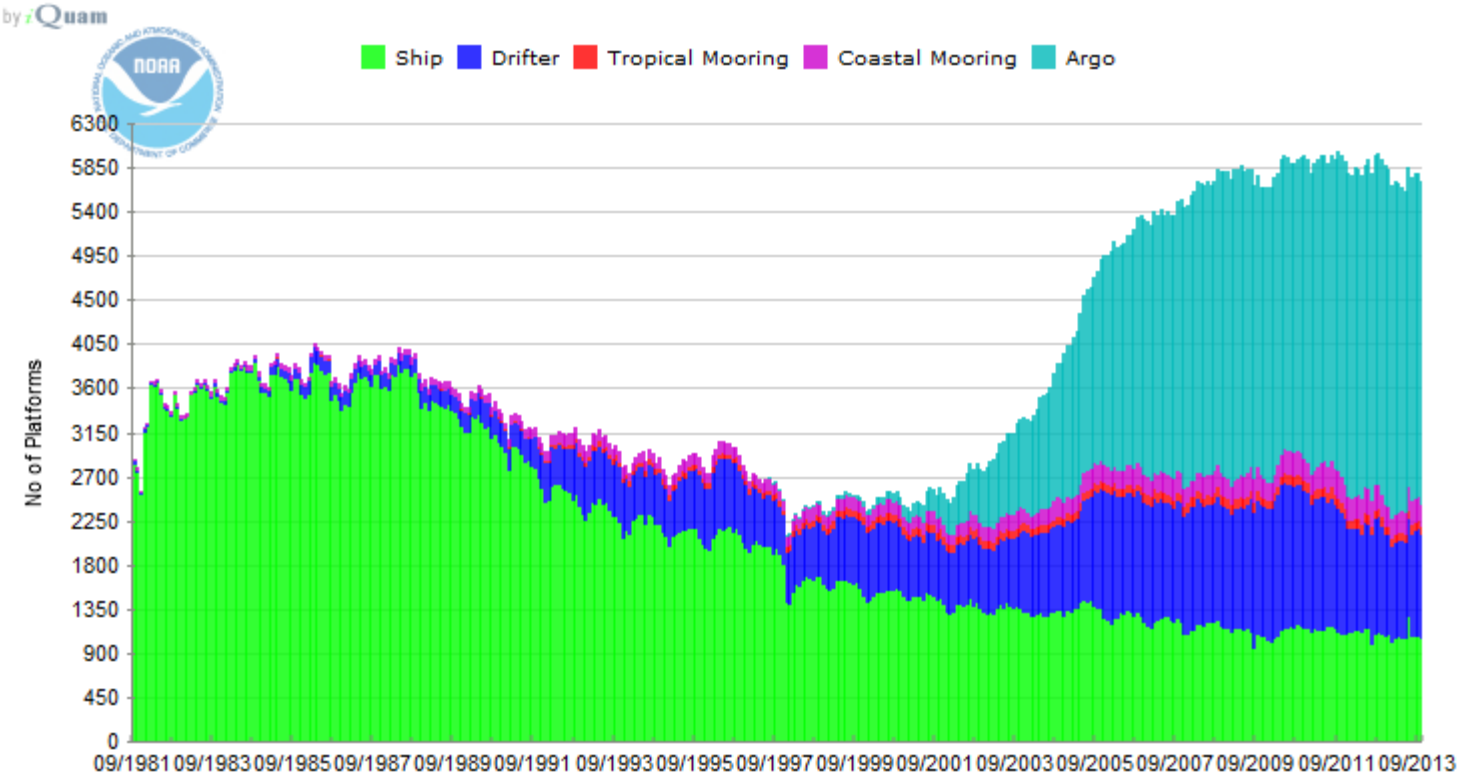
Tropical moorings include TAO/TRITON, PIRATA, RAMA etc. Coastal moorings are all other moorings.

Argo floats data are from USGODAE GDAC ftp site. The shallowest good measurement in 3-8dbar depth range is extracted from each profile.

Global map of measurements

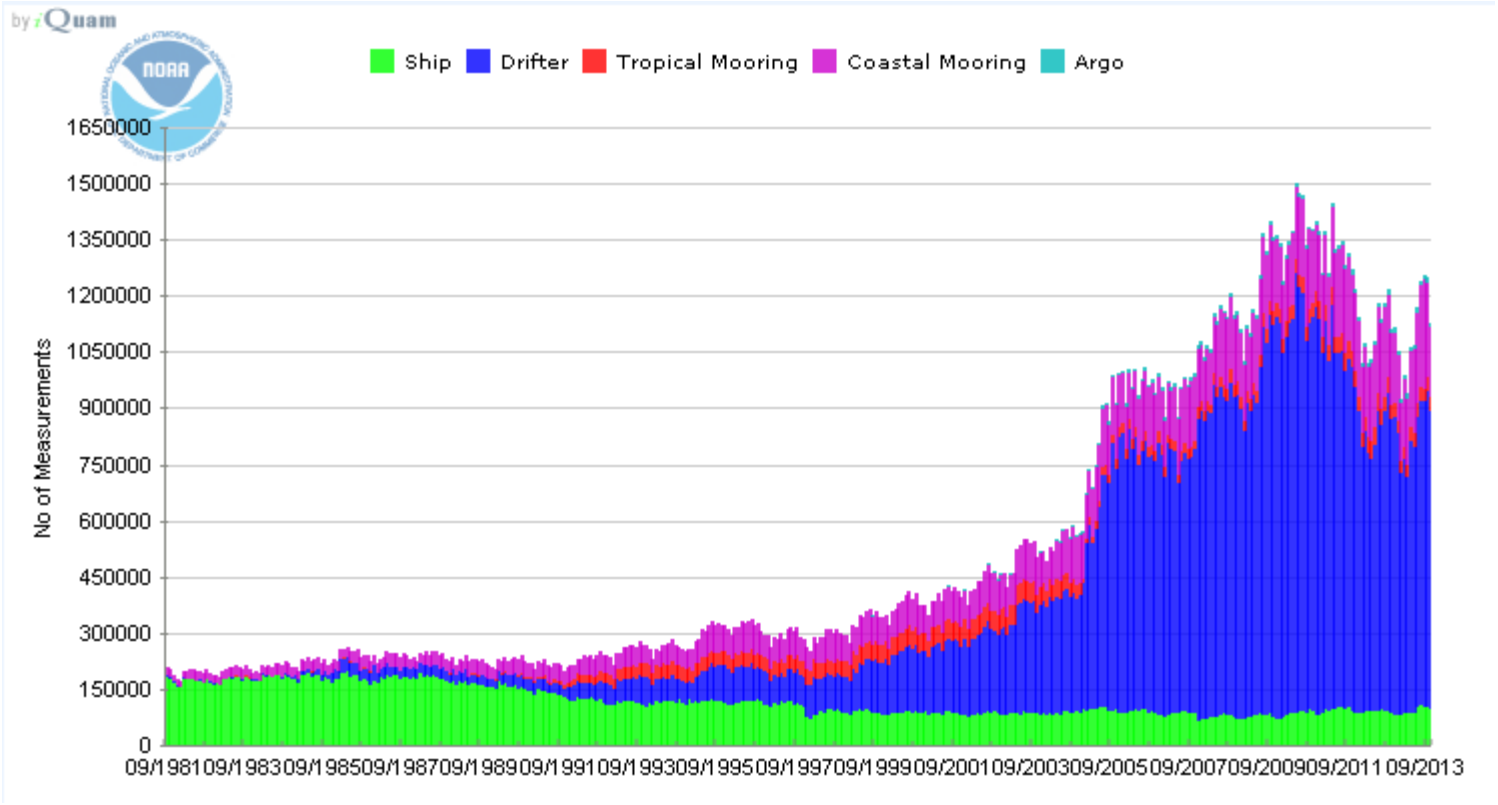


Number of Unique IDs



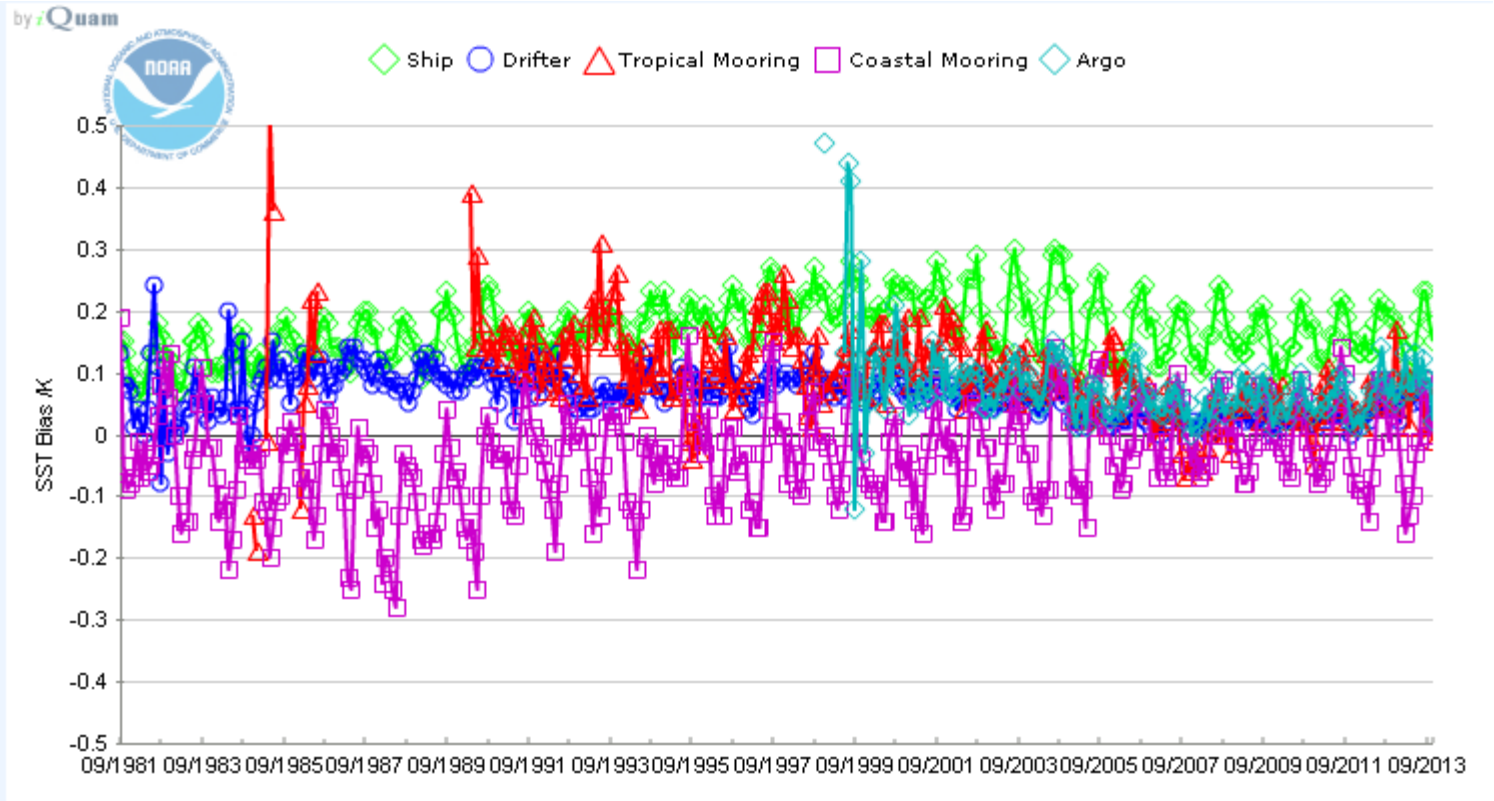
ARGO: Rapid deployment after 2000

Number of Observations



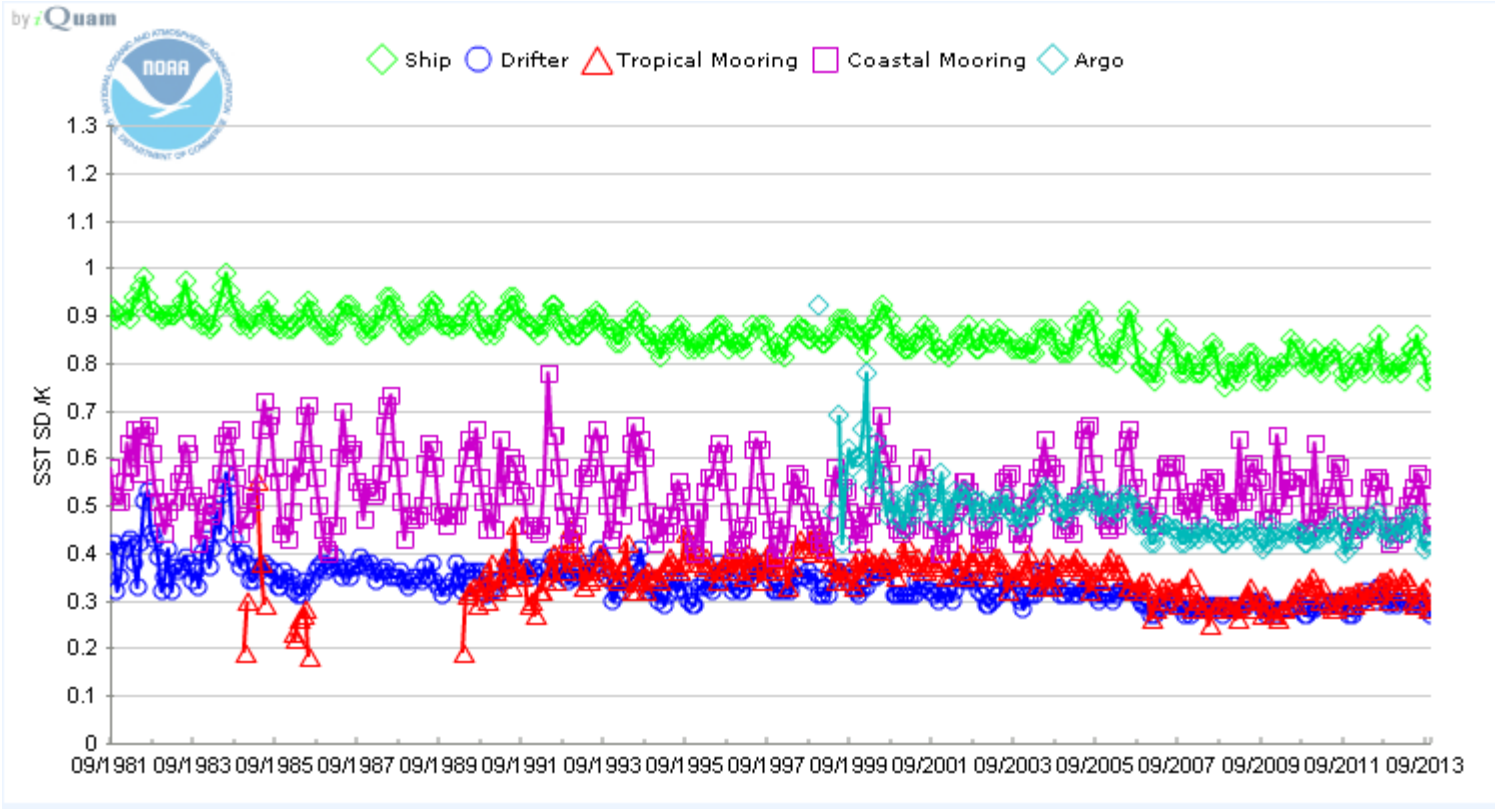
ARGO: 10day profiling period results in only 3 obs per month

Mean Bias "In situ minus Reynolds"



Bias wrt. Reynolds: ARGO comparable with Drifters & Tropical Moorings

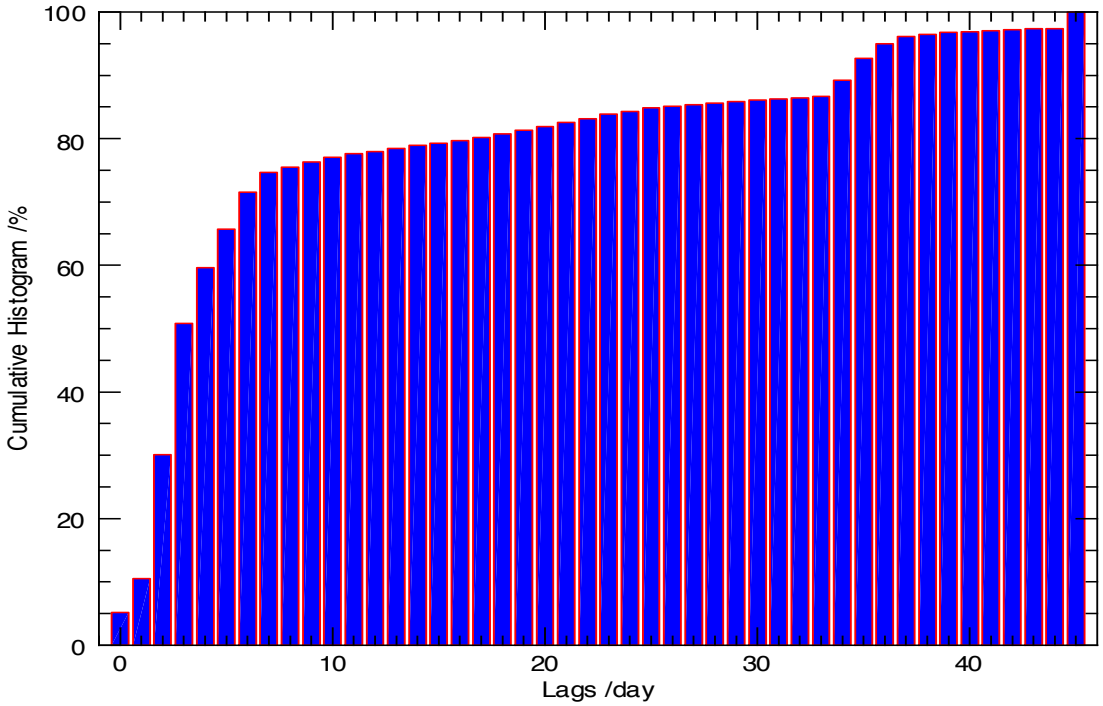
Std Dev "In situ minus Reynolds"



- **STD wrt. Reynolds is ~0.45K for ARGO floats and ~0.3K for Drifters and Tropical Moorings**
- **Drifters & TMs have been assimilated into Reynolds analyses**

ARGO Floats Data Source

- Real-Time ARGO from GTS to be incorporated into iQuam in the future
- Currently ARGO data are from USGODAE with processing lags



- **50% of QCed data come in 4days, 75% in 7days, 85% in 4weeks**
- **Comparison with iQuam QC is underway, to improve latency**

ARGO Floats – Heritage QC

- USGODAE reports ARGO with 3 levels of inherited QC
  1) Real time system performs a set of STANDARD automatic checks on all float measurements. Real-time data with assigned QFs are available to users within 24-48hrs timeframe
  2) Delayed-mode system
  3) Regional scientific analyses of all float data with other available data. The procedures for regional analyses are still TBD
- QC'ed are Time, Lat/Lon, and Data (Temp/Pres/PSAL)

In iQuam, ARGO data are subject to additional independent QC

Results of both inherited and iQuam QC are retained in iQuam data files

ARGO Floats – Heritage QC

##	Test	Description
1	Deepest Pressure Test	Check if pressure exceeds the deepest possible pressure of that float
2	Platform Identification	WMO allocated number
3	Impossible Date Test	
4	Impossible Location Test	−90 to 90 ; −180 to 180
5	Position on Land Test	
6	Impossible Speed Test	Drifting speed <3m/s
7	Global Range Test	a gross filter on observed values for pressure, temperature and salinity : •Pressure cannot be less than −5 dbar •Temperature in range −2.5 to 40.0°C •Salinity in range 2 to 41.0 PSU
8	Regional Range Test	specific ranges for observations from the Mediterranean and Red Seas further restrict what are considered sensible values
9	Pressure Increasing Test	requires that the profile has pressures that are monotonically increasing
10	Spike Test	Difference between sequential measurements, where one measurement is quite different than adjacent ones, is a spike in both size and gradient

ARGO Floats – Heritage QC

##	Test	Description
11	Top and Bottom Spike Test	obselete
12	Gradient Test	Check if difference between vertically adjacent measurements is too steep
13	Digit Rollover Test	Check digit rollover and correct it
14	Stuck Value Test	Check all measurements of temperature or salinity in a profile being identical
15	Density Inversion	compares potential density between measurements in a profile
16	Grey List	The decision to insert a float parameter in the grey list comes from the PI or the delayed-mode operator.
17	Gross salinity or temperature sensor drift	detect a sudden and significant sensor drift: average temperature of last 100dBar vs. previous profile, difference < 1deg
18	Frozen profile	detect a float that reproduces the same profile (with very small deviations) over and over again.
19	Visual QC	Subjective visual inspection of float values by an operator

iQuam2 Summary and Ongoing Work

- iQuam2 enhancements include
  - Extended time-series back to 1981 using ICOADS
  - Added ARGO floats, with both heritage QC and iQuam QC
  - Incorporated CMS buoy black list as an additional iQuam QF
  - Adding trackob ships and GHRSST buoys underway

- Ongoing work
  - Evaluate relative merit of heritage and iQuam ARGO QFs
  - Evaluate relative merit of ICOADS and iQuam QFs
  - Evaluate trackob ships and GHRSST buoys
  - Consider implementing CMC in addition to Reynolds, evaluate additional merit (CMC only goes back to 1991)
  - Implement iQuam2, present at CLIMAR4, document in Int. J. Clim.

SQUAM/iQuam Resources at the Meeting

- Tuesday, 3 June
  - STVAL, 8-10am, “Monitoring and Validation of Hi-Res L2 SSTs in SQUAM – Prasanjit Dash
  - AUSTG, 10:30-12:30, “What product to use: NAVO vs. ACSPO case study” – Prasanjit Dash
  - HLTAG, 13:30-15:30, “VIIRS Algorithm Performance at High Latitudes” – Sasha Ignatov

- Thursday, 5 June
  - 14:20, “Update on VIIRS” – Sasha Ignatov
  - 16-18, “SQUAM and iQuam interactive display”
  - 16-18, “VIIRS Breakout”

Thank You!