Monitoring and validation of high-resolution Level 2 SSTs from AVHRR FRAC, MODIS, (A)ATSR and VIIRS in SQUAM

ST VAL breakout
GHRSST XV, 2014
3 Jun 2014, X:XX-X:XX AM

http://www.star.nesdis.noaa.gov/sod/sst/squam/HR/

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SQUAM objective: A global, web-based, community, quasi NRT, monitor for SST producers & users !

Acknowledgments

Level-2 SST: VIIRS/AVHRR/MODIS

- NESDIS SST Team : *ACSPO (GAC: 5 platforms, FRAC: Metop-A & B, VIIRS: NPP, MODIS: Terra/Aqua)*
- P. LeBorgne, H. Roquet : *O&SI SAF Metop-A FRAC*
- D. May, B. McKenzie : *NAVO SEATEMP*
- S. Jackson : *IDPS (NPP)*
- C. Merchant, Owen Embury: *L2P ARC* (ongoing effort as a prep for Sentinel-3 SLSTR)

Level-3 SST: AVHRR/(A)ATSR:

- K. Casey, R. Evans, J. Vazquez, E. Armstrong: *PathFinder v5.0*
- C. Merchant, Owen Embury: L3 ARC (*future work*)

Level 4 SSTs:

- R. Grumbine, B. Katz : *RTG (Low-Res & Hi-Res)*
- R. Reynolds, V. Banzon : *OISSTs (AVHRR & AVHRR+AMSRE)*
- M. Martin, J. R. Jones : *OSTIA foundation, GHRSST Median Product Ensemble, OSTIA Reanalysis*
- D. May, B. McKenzie : *NAVO K10*
- J.-F. Piollé, E. Autret : *ODYSSEA*
- E. Maturi, A. Harris, J. Mittaz : *POES-GOES blended*
- B. Brasnett : *Canadian Met. Centre, 0.2° foundation*
- Y. Chao : *JPL G1SST*
- H. Beggs : *ABOM GAMSSA*
- J Hoyer : *DMI OISST*
- M. T. Chin, J. Vazquez, E. Armstrong : *JPL MUR*

GHRSST support: Peter Minnett, Craig Donlon, Alexey Kaplan

Definitions of levels:
L2: at observed pixels (satellite)
L3: gridded with gaps (satellite)
L4: gap-free gridded, time-averaged

Major SST data providers:

CMC

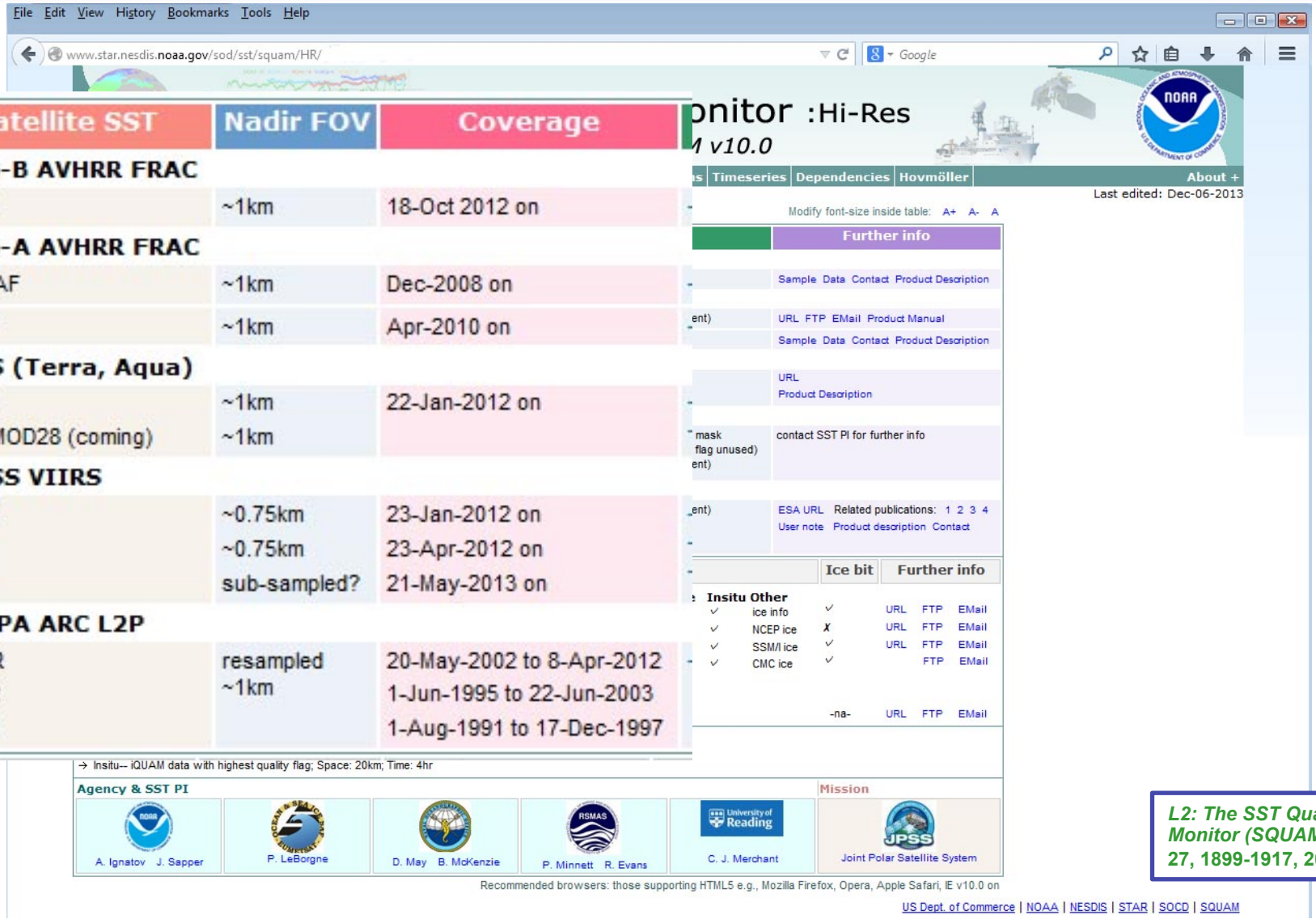
Projects and international group

Outline

11 slides

1. High-res (HR) SQUAM and SST products

Locate this website: Google: "SST + SQUAM + HR"



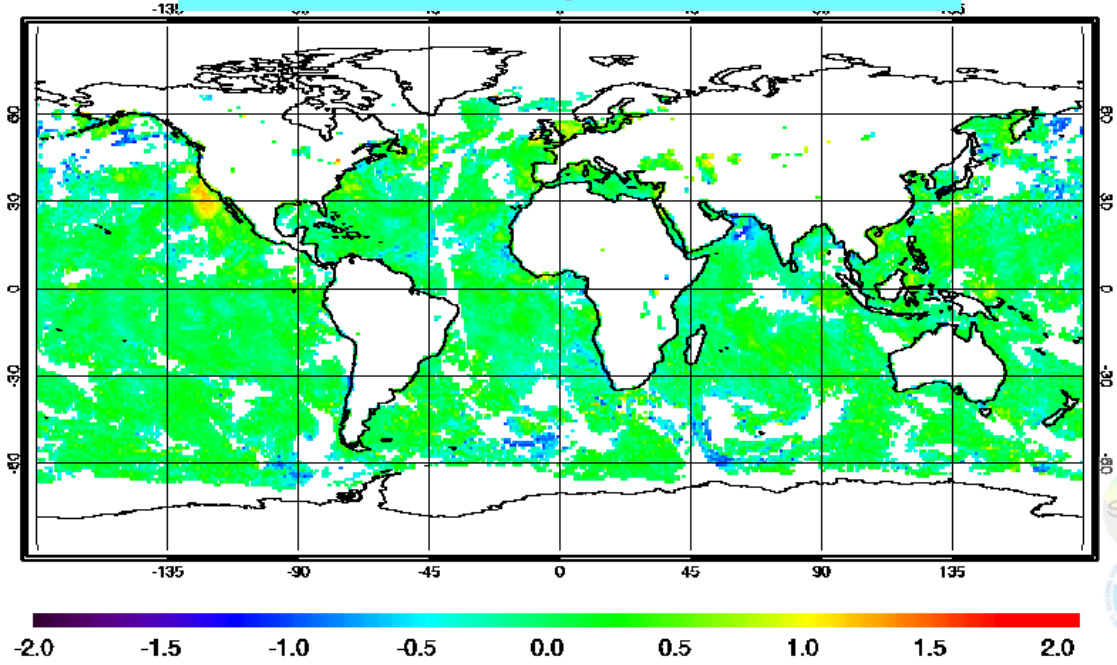
Satellite SST	Nadir FOV	Coverage
MetOp-B AVHRR FRAC		
ACSPO	~1km	18-Oct 2012 on
MetOp-A AVHRR FRAC		
O&SI SAF	~1km	Dec-2008 on
ACSPO	~1km	Apr-2010 on
MODIS (Terra, Aqua)		
ACSPO	~1km	22-Jan-2012 on
NASA MOD28 (coming)	~1km	
NPOESS VIIRS		
ACSPO	~0.75km	23-Jan-2012 on
IDPS	~0.75km	23-Apr-2012 on
NAVO	sub-sampled?	21-May-2013 on
ESA UPA ARC L2P		
A-ATSR	resampled ~1km	20-May-2002 to 8-Apr-2012
ATSR-2		1-Jun-1995 to 22-Jun-2003
ATSR-1		1-Aug-1991 to 17-Dec-1997

L2: The SST Quality Monitor (SQUAM), J.Tech, 27, 1899-1917, 2010

2. Monitoring in HR-SQUAM (Example 15 May 2014, Night)

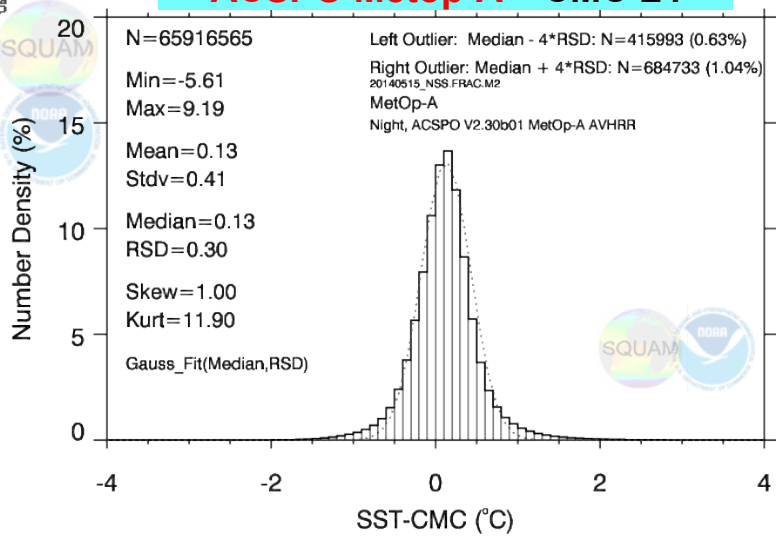
Maps | Histograms | Time-series | Dependencies | Hovmöller

ACSPO Metop-A – CMC L4



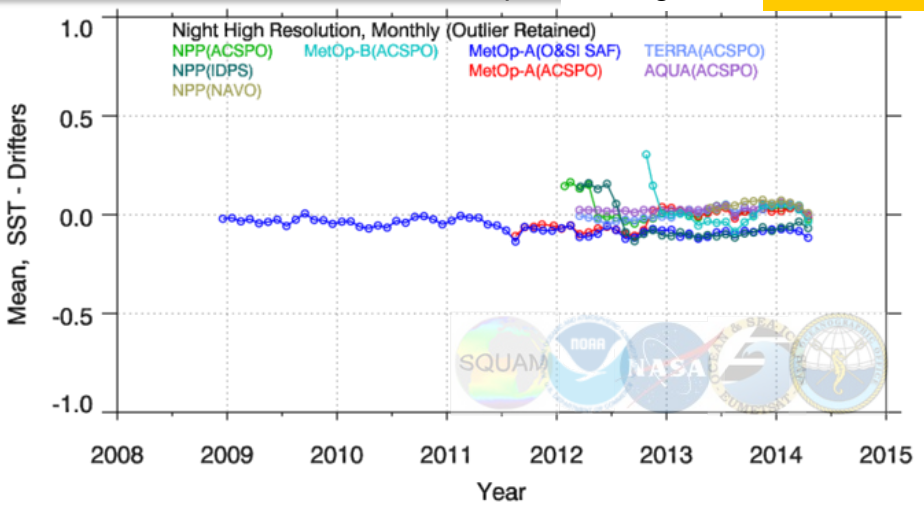
- *Some -ve residuals suggesting possible cloud leakages*
- *Maps used to check cloud leakage, coverage, and other anomalous situations*

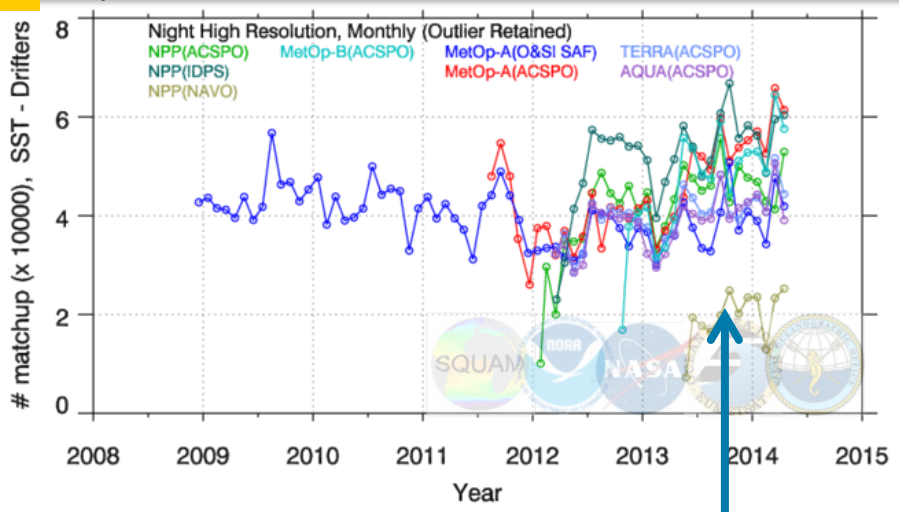
ACSPO Metop-A – CMC L4

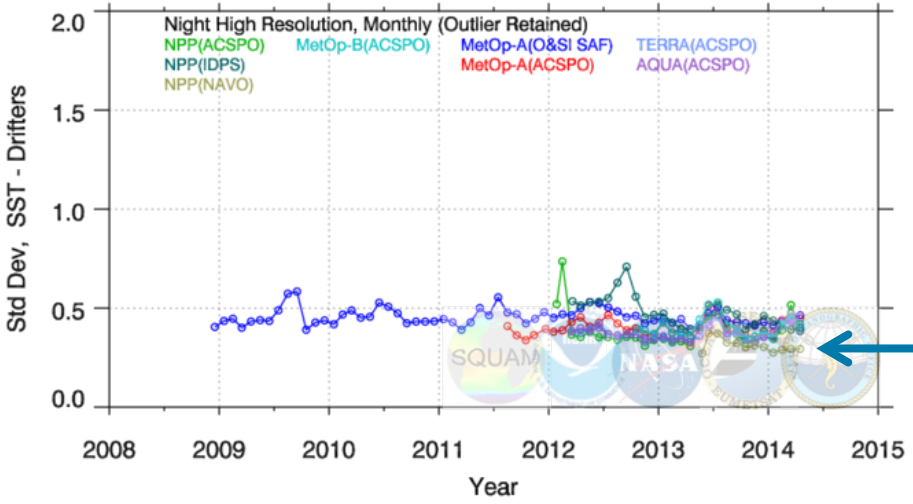


3. Monthly Nighttime VAL vs. iQuam Drifters (20km × 4hr)

Maps | Histograms | **Time-series** | Dependencies | Hovmöller



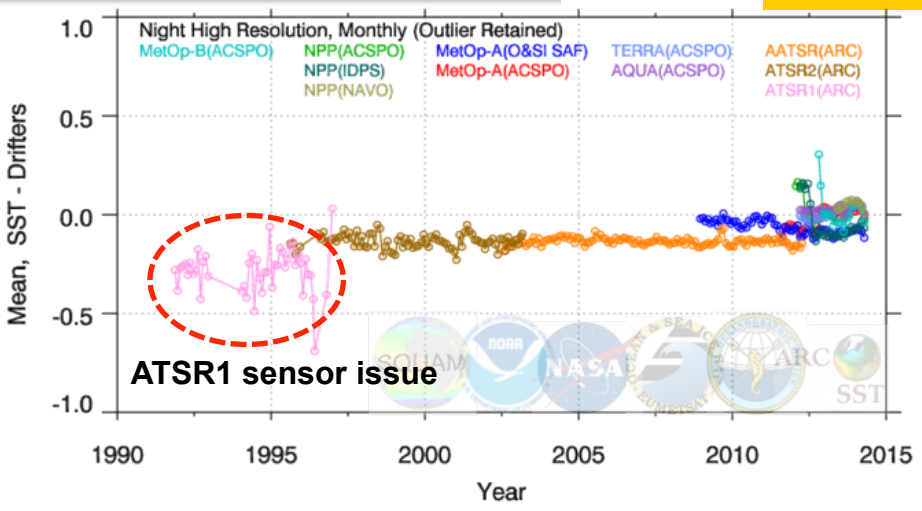


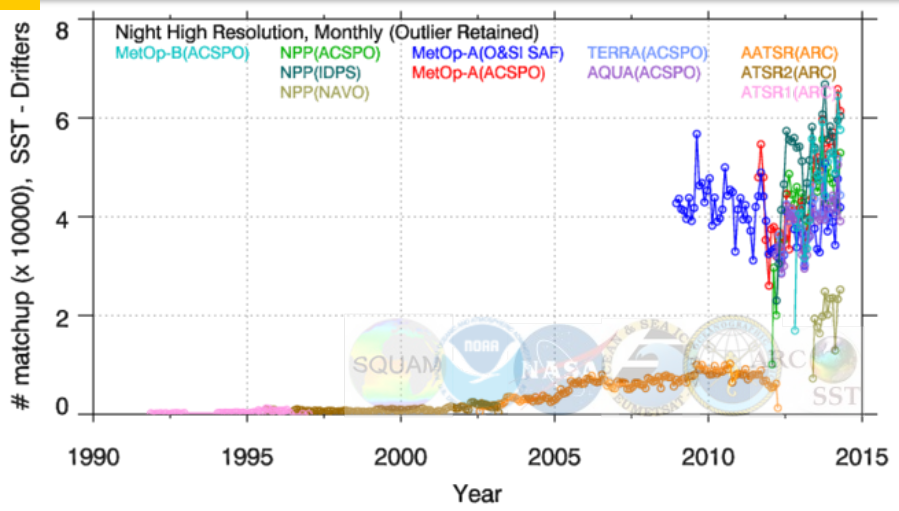


NAVO:
Smaller Domain
Improved Std Dev

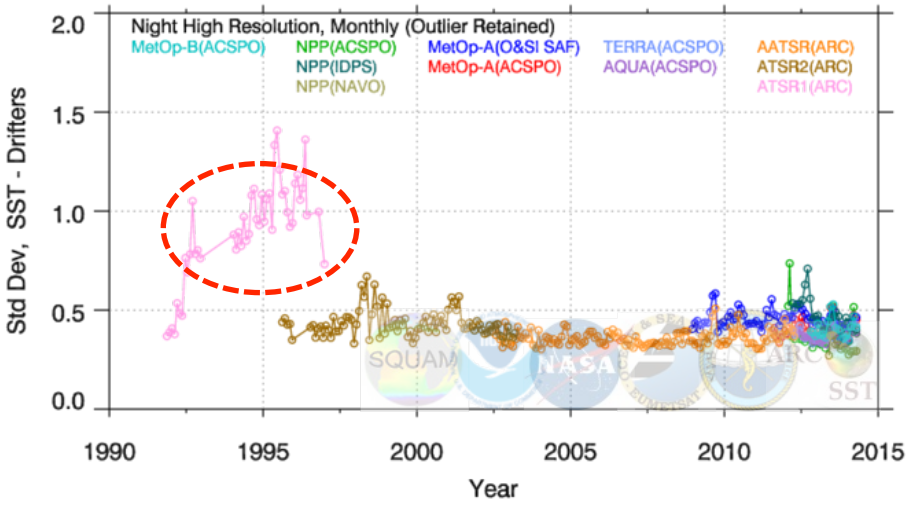
3. Monthly Nighttime VAL vs. iQuam Drifters (20km × 4hr)

Maps | Histograms | Time-series | Dependencies | Hovmöller



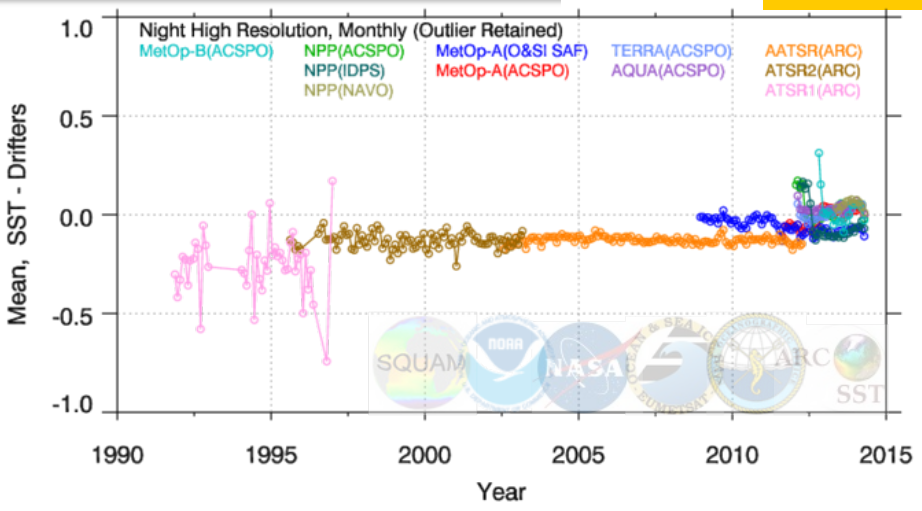


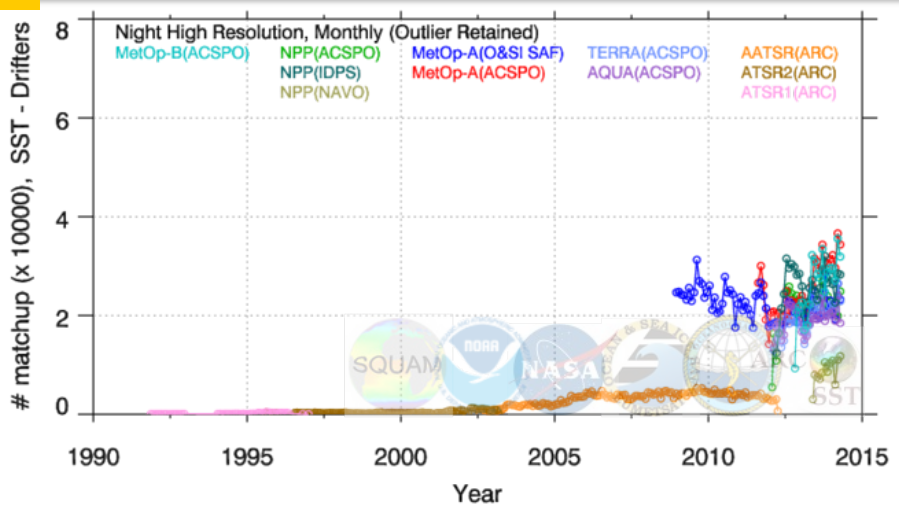
Now including ARC (QF GE 3)



3. Monthly Nighttime VAL vs. iQuam Drifters (10km × 2hr)

Maps | Histograms | Time-series | Dependencies | Hovmöller

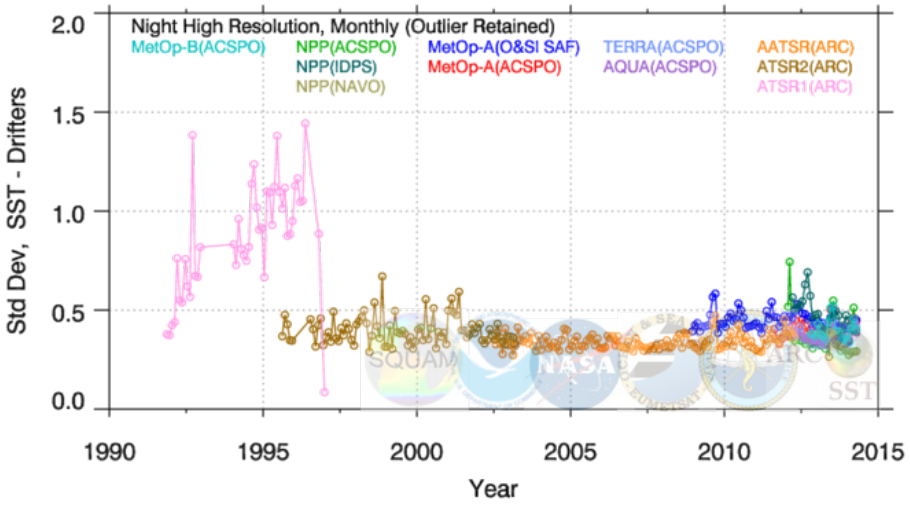




Reduced window size ×½ space ×½ time

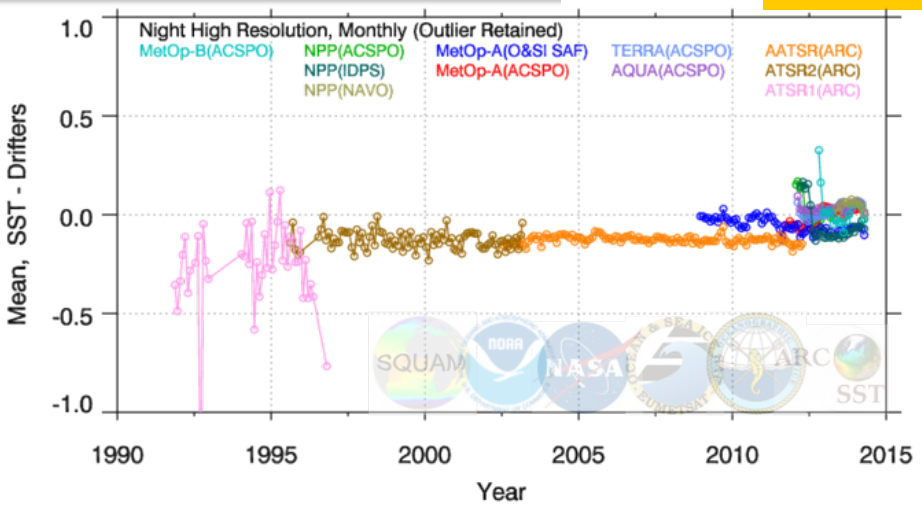
Sample size reduced by ×½

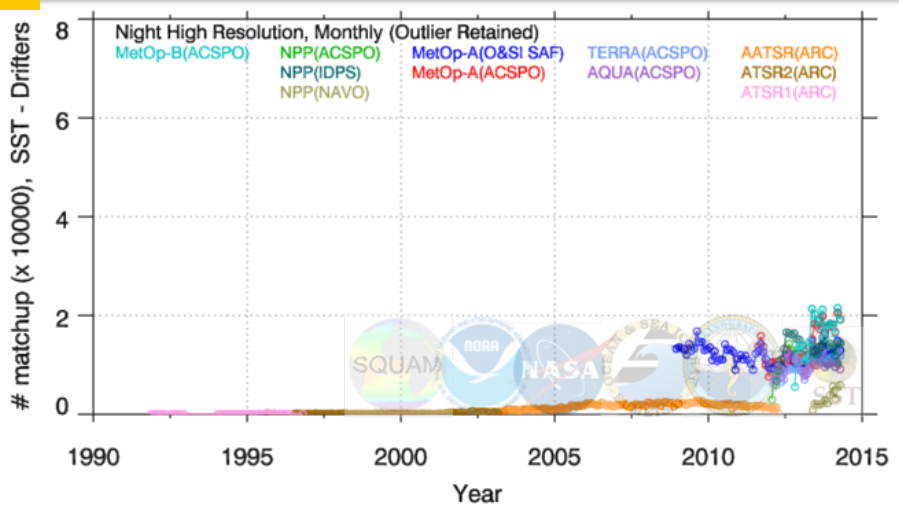
Std Dev reduced but not significantly



3. Monthly Nighttime VAL vs. iQuam Drifters (5km × 1hr)

Maps | Histograms | Time-series | Dependencies | Hovmöller

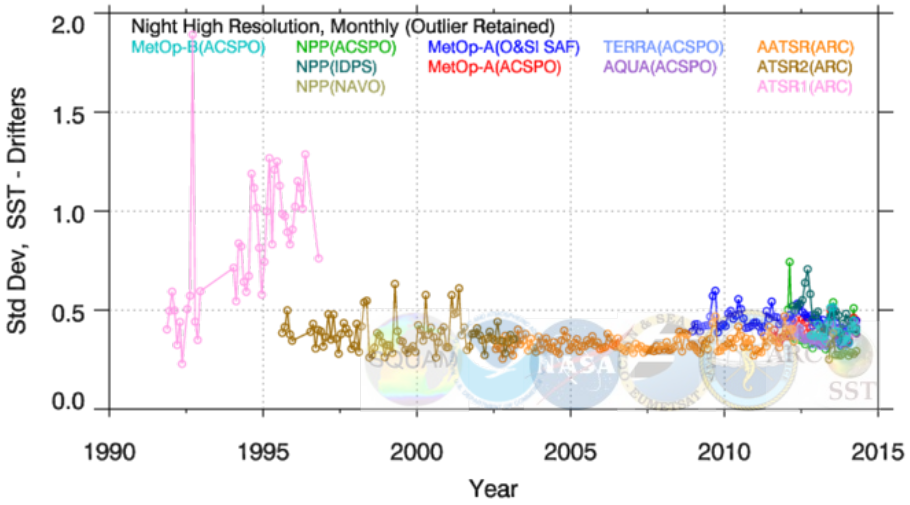




Reduced window size ×¼ space ×¼ time

Sample size reduced by ×¼

Std Dev reduced not significantly



3. Validation (20 km 4 hr, Mar 2014) : Summary**

Products	~ECT	# of matches	Min / Max (°C)	Mean / Median	Std Dev / RSD	Skew / Kurt
ACSPO NPP	13:30	42917 (night) 42586 (day)	-2.61 / 5.92 -2.82 / 4.12	-0.03 / 0.04 0.06 / 0.06	0.39 / 0.25 0.42 / 0.33	2.77 / 35.04 0.35 / 4.46
NAVO NPP		12912 10063	-2.58 / 2.20 -1.80 / 4.31	0.06 / 0.09 0.05 / 0.03	0.29 / 0.22 0.38 / 0.32	-0.97 / 7.51 0.58 / 5.89
IDPS NPP		48638 46208	-6.62 / 2.83 -8.04 / 6.43	-0.06 / 0.00 -0.07 / 0.02	0.42 / 0.26 0.65 / 0.42	-2.00 / 15.51 -1.68 / 11.23
ACSPO Aqua		40728 42083	-3.18 / 6.07 -3.18 / 3.91	0.05 / 0.06 0.12 / 0.10	0.41 / 0.28 0.44 / 0.38	2.22 / 24.69 0.28 / 2.76
ACSPO Metop-A	9:30	52591 46594	-2.33 / 6.60 -2.43 / 4.99	0.03 / 0.04 0.00 / 0.01	0.44 / 0.28 0.42 / 0.37	2.84 / 31.62 -0.10 / 2.91
OSISAF Metop-A		34215 40430	-4.24 / 5.60 -3.68 / 5.13	-0.08 / -0.01 0.10 / 0.16	0.43 / 0.29 0.51 / 0.39	-1.19 / 10.79 -0.63 / 4.12
ACSPO Metop-B	9:30	48837 44574	-2.83 / 7.21 -2.39 / 4.71	0.05 / 0.06 0.03 / 0.04	0.42 / 0.29 0.43 / 0.38	2.09 / 27.67 0.11 / 2.56
ACSPO Terra	10:30	40285 39385	-2.19 / 5.84 -2.29 / 4.46	0.06 / 0.06 0.06 / 0.06	0.41 / 0.28 0.45 / 0.41	1.94 / 22.74 0.28 / 3.54
ARC AATSR	10:00	5533 7446	-4.04 / 2.19 -3.93 / 2.28	-0.16 / -0.12 -0.12 / -0.10	0.41 / 0.25 0.49 / 0.34	-1.89 / 14.16 -1.22 / 8.89
ARC ATSR2	10:30	1591 1957	-3.11 / 1.63 -4.88 / 2.38	-0.11 / -0.12 -0.18 / -0.16	0.36 / 0.27 0.52 / 0.39	0.04 / 5.39 -0.74 / 6.17

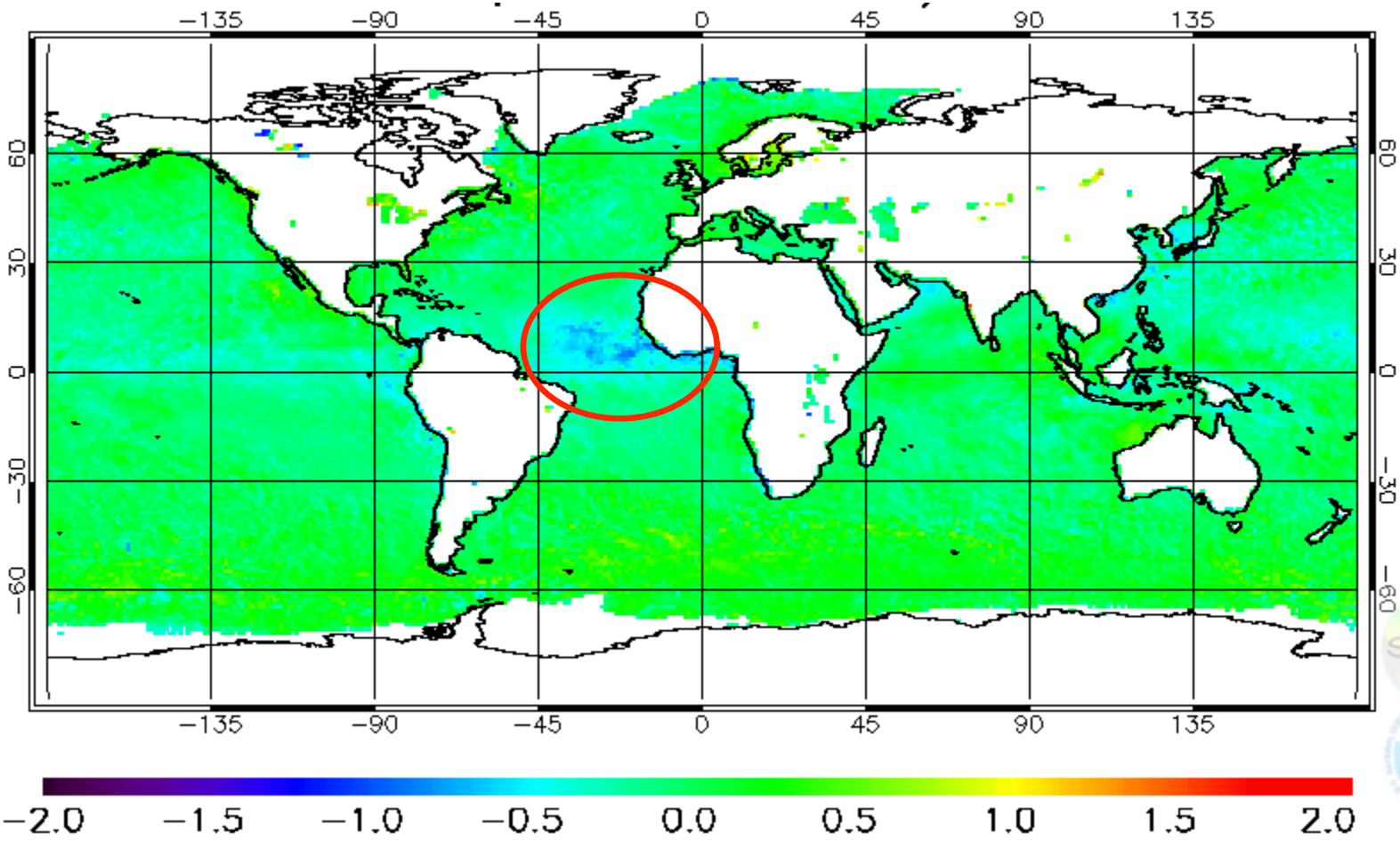
* QC'ed drifters from iQuam: *www.star.nesdis.noaa.gov/sod/sst/iquam/; outliers not removed*

** All Data for Feb 2014, except: ARC AATSR (Feb 2012), ARC ATSR2 (Feb 2003); ARC ATSR1 not shown (sensor issues)

4. Persistent features (monthly aggregated)

Maps | Histograms | Time-series | Dependencies | Hovmöller

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

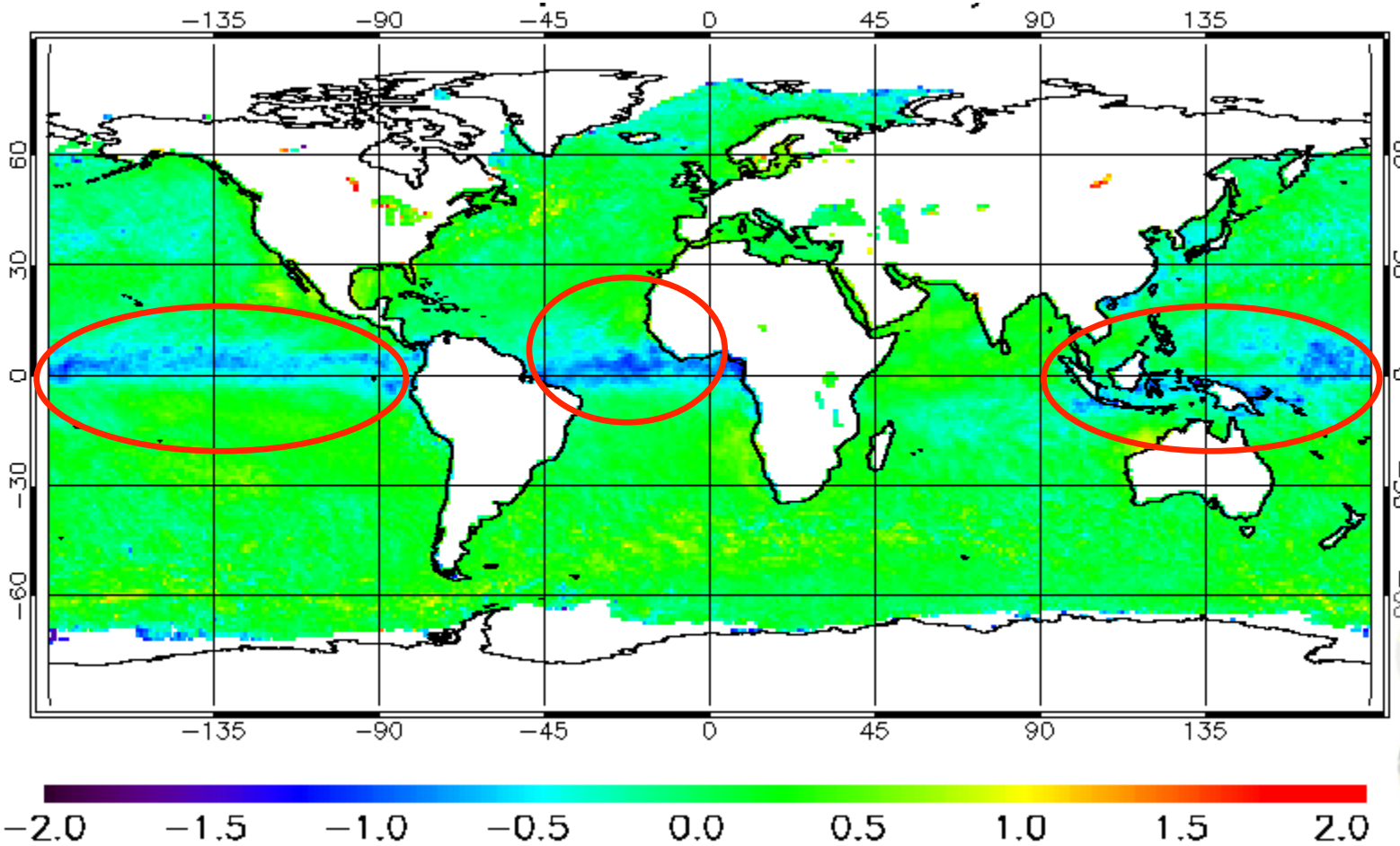


- *Negative residuals possibly suggest cloud/aerosol leakages*

4. Persistent features (monthly aggregated)

Maps | Histograms | Time-series | Dependencies | Hovmöller

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



- *More negative residuals possibly suggesting more cloud/aerosol leakages*
- *Coverage similar to ACSPO (at grid-level; # obs different)*

5. Drifter error using Triple Collocation Method (TCM; O'Carroll et al., 2008) and correlation of residuals (Apr 2014)

Combinations for TCM	Avg. Error in Drifters* (1x1 deg; may be an underestimate)	
OSISAF Metop-A, ACSPO Terra, Drifters	0.18 (Night)	0.27 (Day)
ACSPO Metop-A, ACSPO Terra, Drifters	0.19	0.26
OSISAF Metop-A, ACSPO Metop-B, Drifters	0.18	0.27
NAVO VIIRS, ACSPO Aqua, Drifters	0.18	0.24

* Drifter errors from different TCM combinations are close but not exactly same – may be due to some correlated errors. The table below shows correlation between residuals.

Residuals (SST – Drifters)	~ECT	ACSPO NPP	IDPS NPP	NAVO NPP	ACSPO Metop-A	OSISAF Metop-A	ACSPO Metop-B	ACSPO Terra	ACSPO Aqua
ACSPO NPP	13:30	1.00 (Night) 1.00 (Day)	0.69 0.67	0.49 0.41	0.24 0.21	0.13 0.15	0.22 0.20	0.27 0.21	0.36 0.38
IDPS NPP			1.00 1.00	0.54 0.37	0.21 0.20	0.17 0.19	0.28 0.19	0.25 0.19	0.31 0.32
NAVO NPP				1.00 1.00	0.22 0.18	0.18 0.10	0.21 0.15	0.24 0.15	0.29 0.23
ACSPO Metop-A	9:30				1.00 1.00	0.47 0.46	0.31 0.38	0.27 0.31	0.18 0.19
OSISAF Metop-A						1.00 1.00	0.20 0.27	0.19 0.22	0.09 0.13
ACSPO Metop-B	9:30						1.00 1.00	0.16 0.19	0.25 0.33
ACSPO Terra	10:30							1.00 1.00	0.28 0.27
ACSPO Aqua	13:30								1.00 1.00

Correlation higher for different products from the same sensor

Correlation lower for the same product from different sensors

6. Summary

- Monitoring/Validation against L4 fields and QC'ed *iQuam* drifters shows:
  - Most products show comparable performance
  - In preparation for SLSTR, ARC AATSR (QF GE 3) retrievals are evaluated: Domain is ~6-9 smaller than from Metop, performance statistics comparable
  - NAVO VIIRS has better VAL stats than ACSPO, but in a ~1/3 retrieval domain
- Sensitivity to space-time window on monthly matchup shows:
  - At night, 20km/4hr, 10km/2hr, 5km/1hr, reduces # of matches but does not result in measurable improvements in VAL std dev
- Triple-Collocation analysis and residual correlation
  - Random errors in 1°×1° drifter data ~0.18°C(night)/0.26°C(day), globally
  - Many products show a high degree of correlation in residuals (SST – drifters). The L4 producers may use this to minimize redundancy in input L2Ps

THANK YOU!