SST Team Feedback to VCM

STAR - Sasha Ignatov, Prasanjit Dash, John Stroup,
Yury Kihai, Boris Petrenko, Xingming Liang

NAVOCEANO – Jean-Francois Cayula, Doug May

STAR Analyses

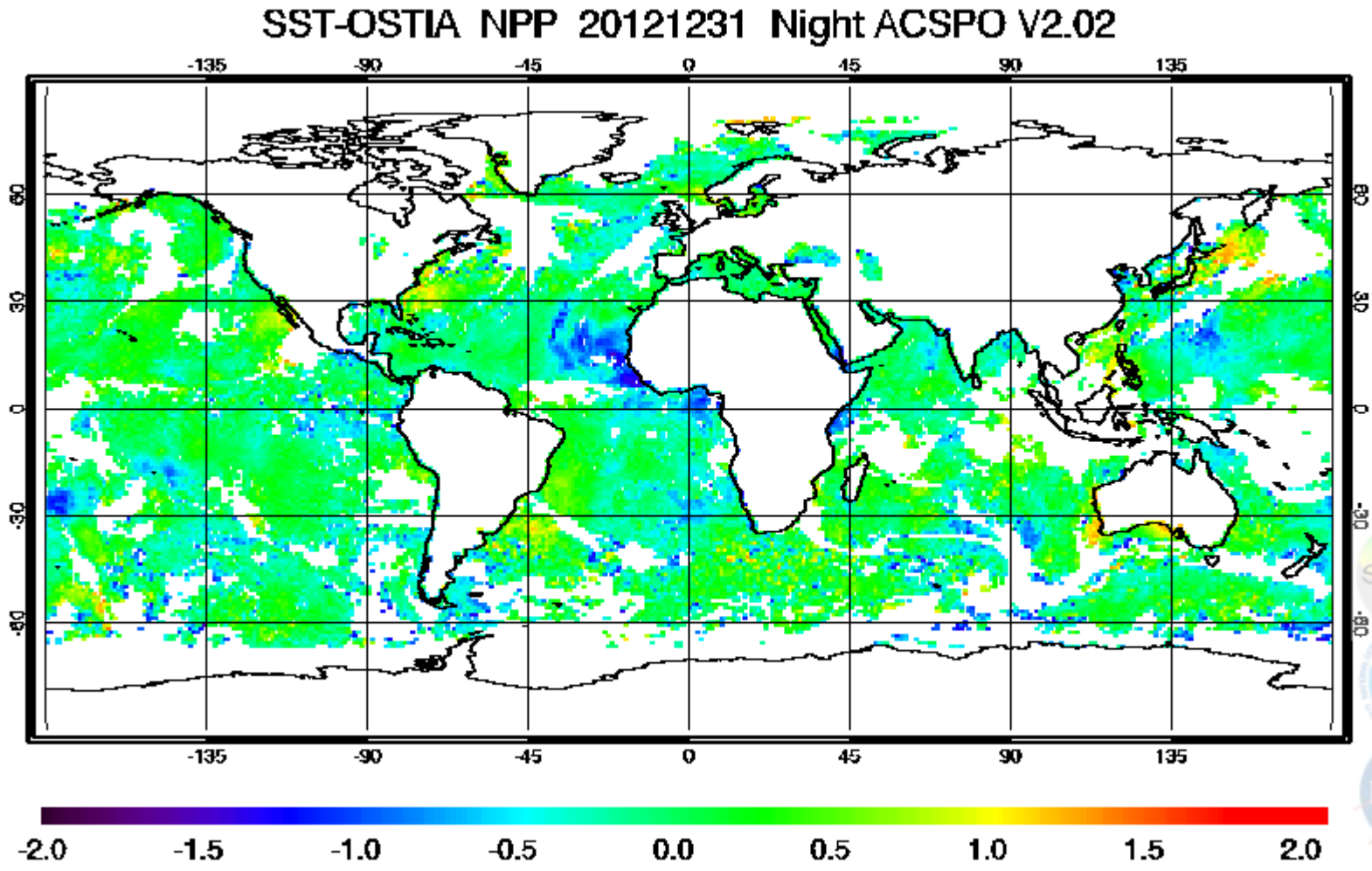
- STAR analyses use VCM Confidently Clear data only (consistent with VCM Beta Review Analyses, Apr'2012)
- SST QF have been analyzed & Discussed at several SST Telecons in Mar'2012
- Based on these analyses, SST QFs were found too restrictive and not used in SST Analyses

ACSPO (NOAA heritage) vs. IDPS SSTs

Objective: Ensure comparable SST performance in comparable SST domain

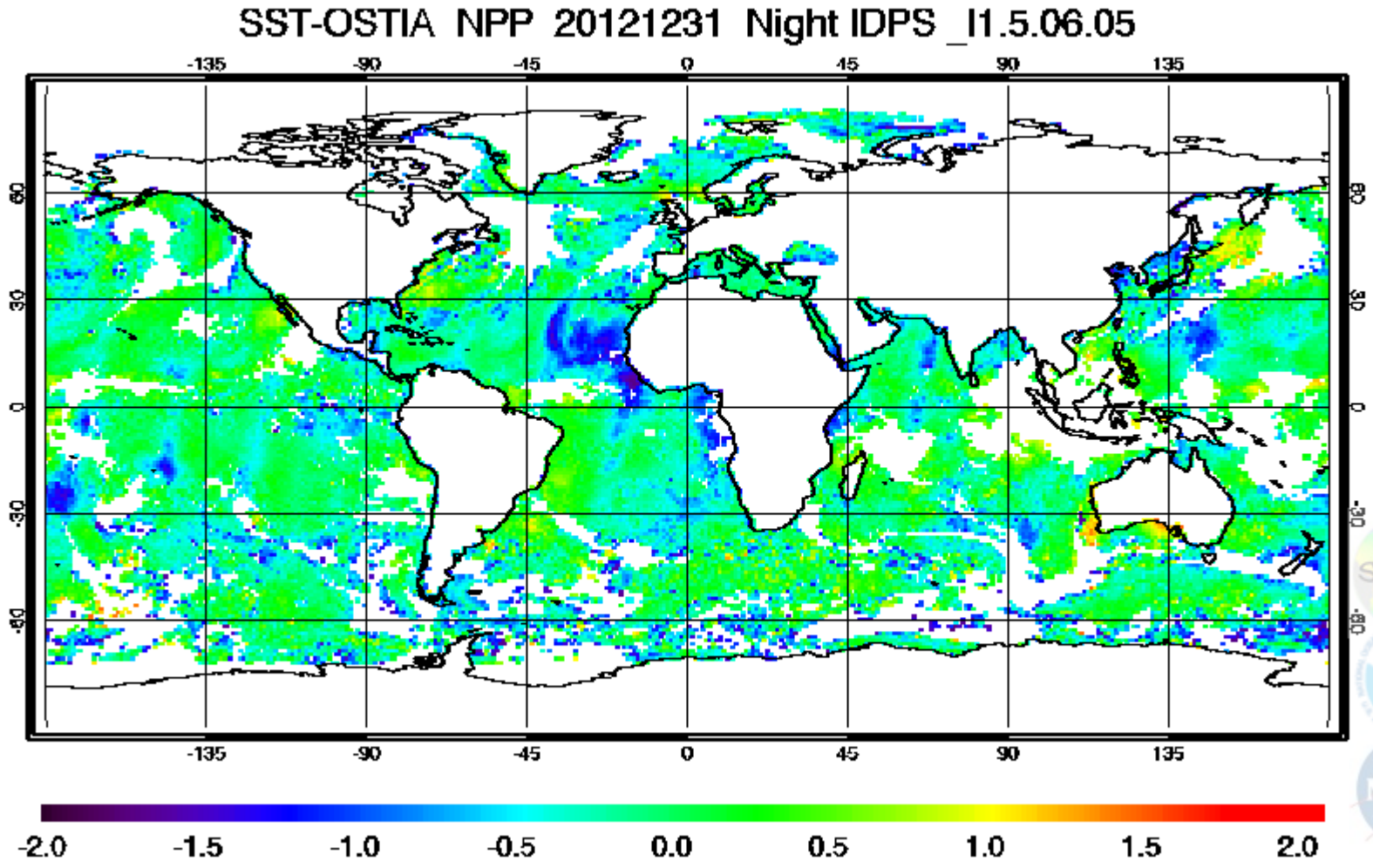
Analysis of one representative day of data
– 31 December 2012 in SST Quality Monitor (SQUAM)
www.star.nesdis.noaa.gov/sod/sst/squam/

NIGHT: ACSPO L2 minus OSTIA L4
31 December 2012



- *Deviation from Reference SST is flat & close to 0*
- *Residual Cloud/Aerosol leakages seen as cold spots*

NIGHT: IDPS L2 minus OSTIA L4
31 December 2012



- *More Cloud leakages in IDPS than in ACSPO*
- *"Limb Cooling" – due to IDPS SST equations*

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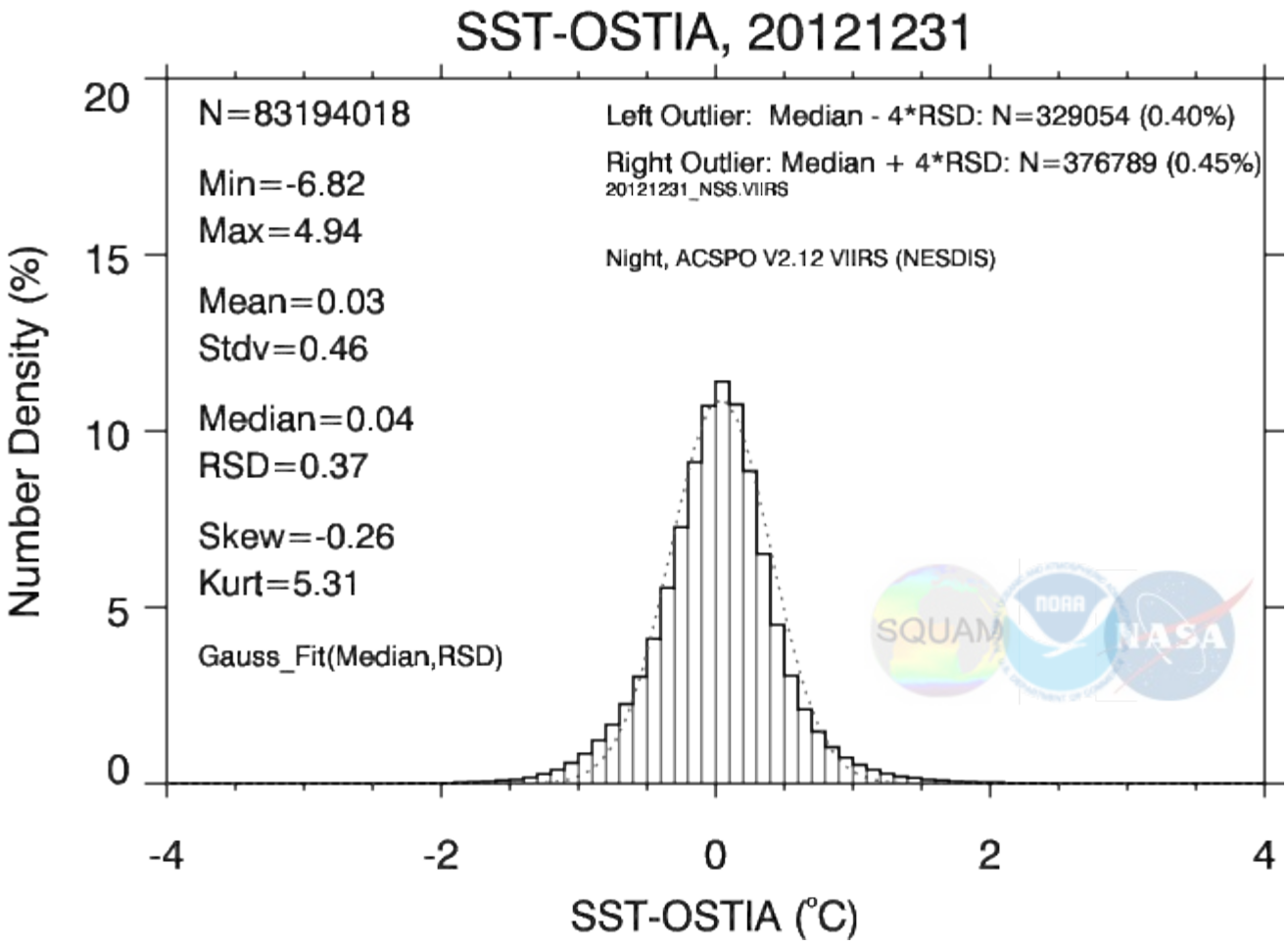

- ***Shape close to Gaussian***
- ***Domain & Performance Stats close to expected***

NIGHT: IDPS L2 minus OSTIA L4
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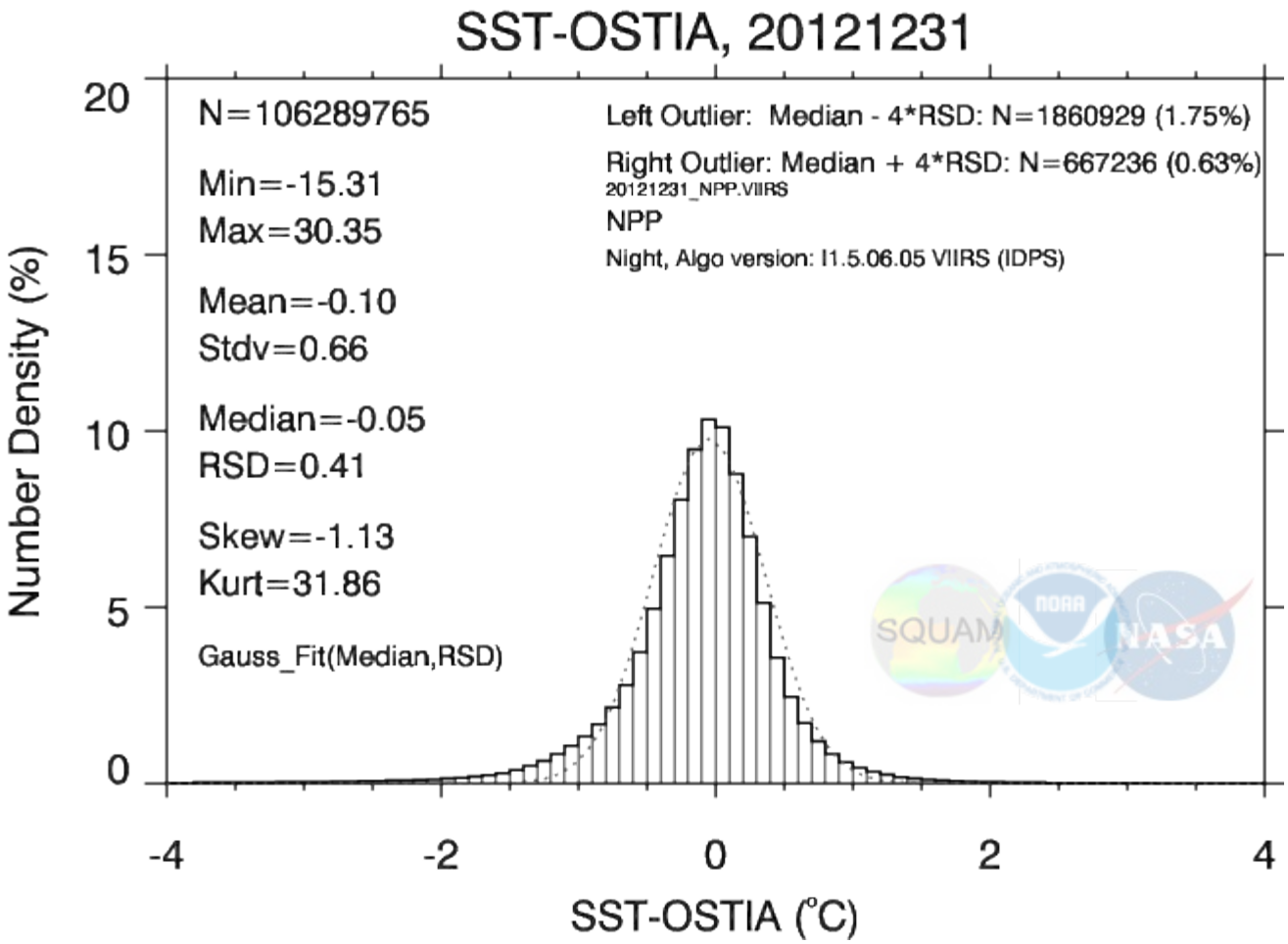

- *IDPS sample +28% larger compared to ACSPO*
- *Shape less Gaussian (negative Skew / increased Kurt)*
- *increased Min/Max, STDV/RSD & Larger fraction of outliers*

NIGHT: ACSPO L2 minus *in situ* SST
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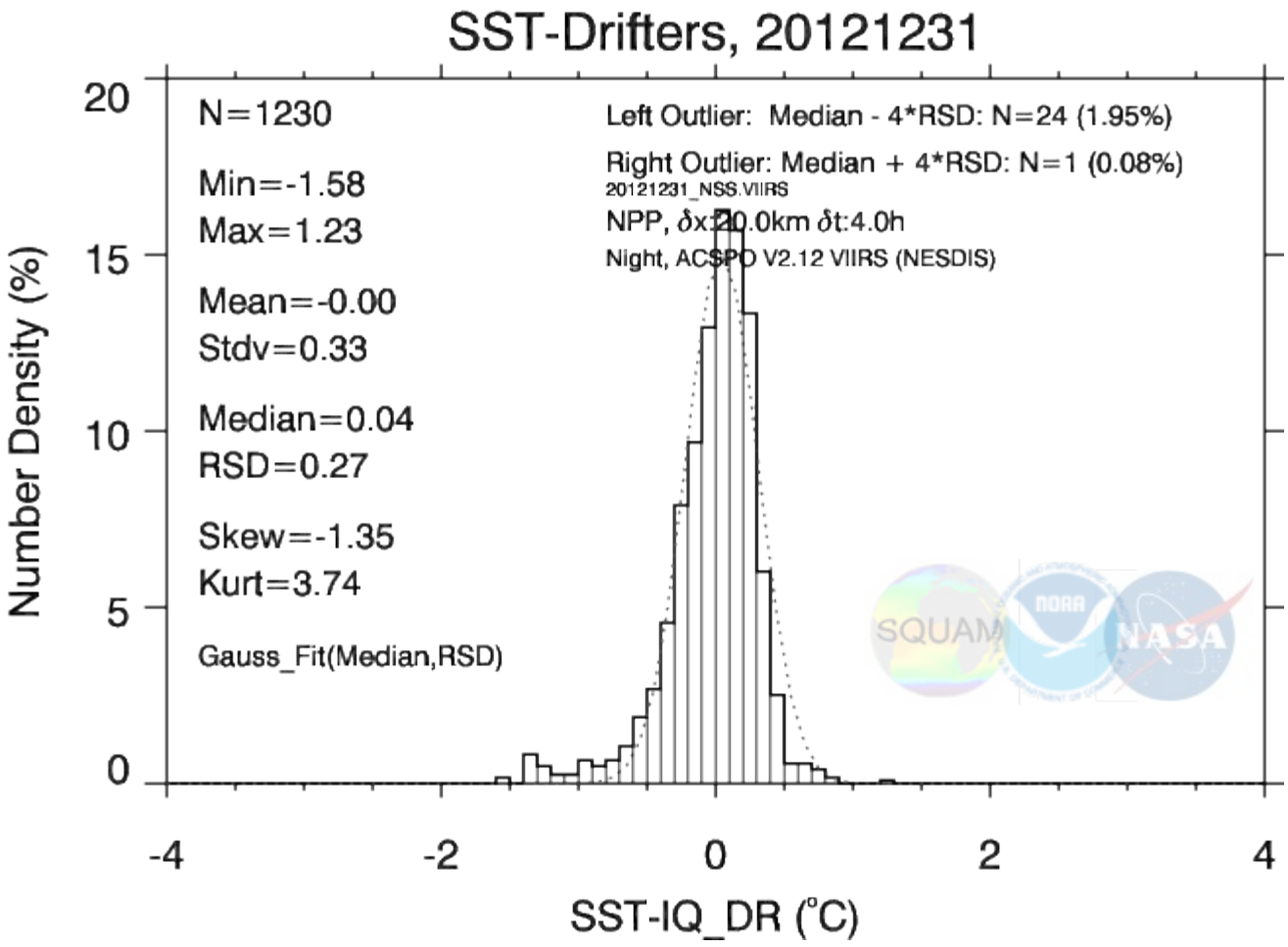

- ***Shape close to Gaussian***
- ***Performance Stats better than specs***

NIGHT: IDPS L2 minus *in situ* SST
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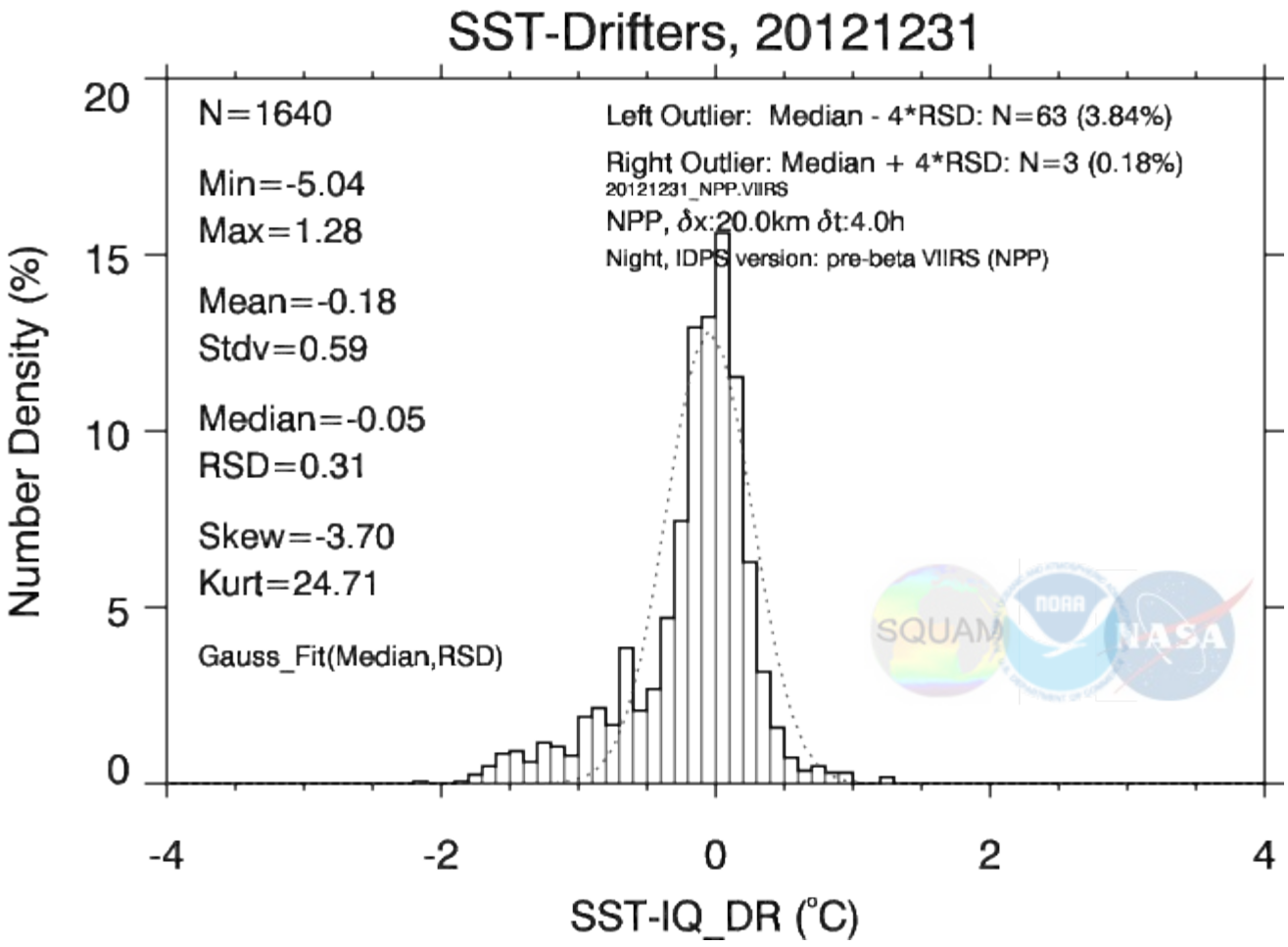


- *IDPS match-up data set +33% larger compared to ACSPO*
- *Shape less Gaussian (increased Skew / Kurt)*
- *increased Min/Max, STDV/RSD & Larger fraction of outliers*

NIGHT 31 December 2012 – Summary

ΔT = "VIIRS minus OSTIA" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	83.2M (100%)	-6.8/ +4.9	+0.03/0.46	+0.04/0.37	-0.3/ +5.3
IDPS	106.3M (128%)	-15.3/+30.4	-0.10/0.66	-0.05/0.41	-1.1/+31.9

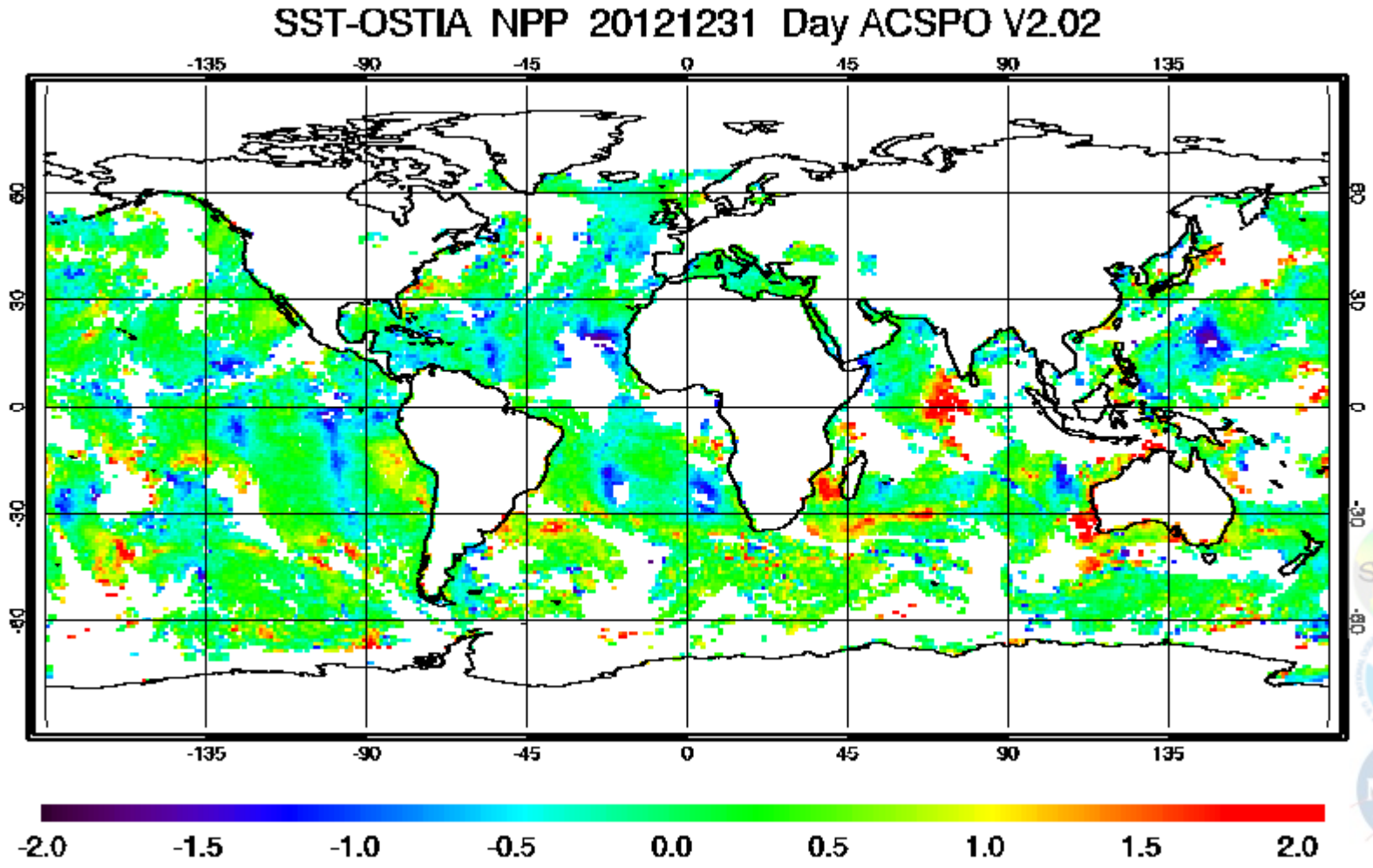
- *IDPS SST domain is +28% larger but all Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*

ΔT = "VIIRS minus in situ" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	1,230 (100%)	-1.6/ +1.2	-0.00/0.33	+0.04/0.27	-1.4/ +3.7
IDPS	1,640 (133%)	-5.0/+1.3	-0.18/0.59	-0.05/0.31	-3.7/+24.7

- *IDPS SST domain is +28% larger but all Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*

DAY: ACSPO L2 minus OSTIA L4
31 December 2012



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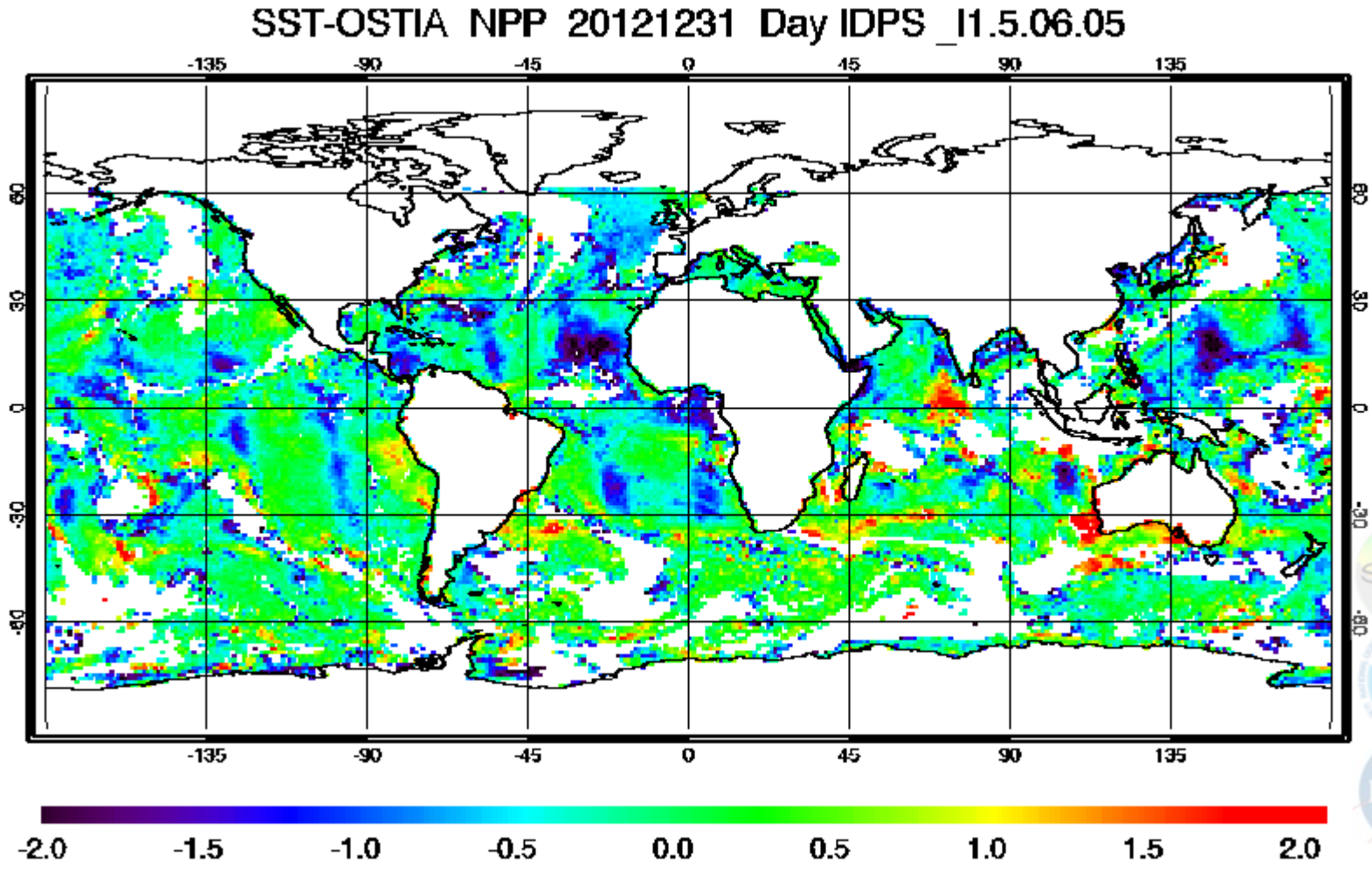

- ***More Cloud leakages in IDPS than in ACSPO***
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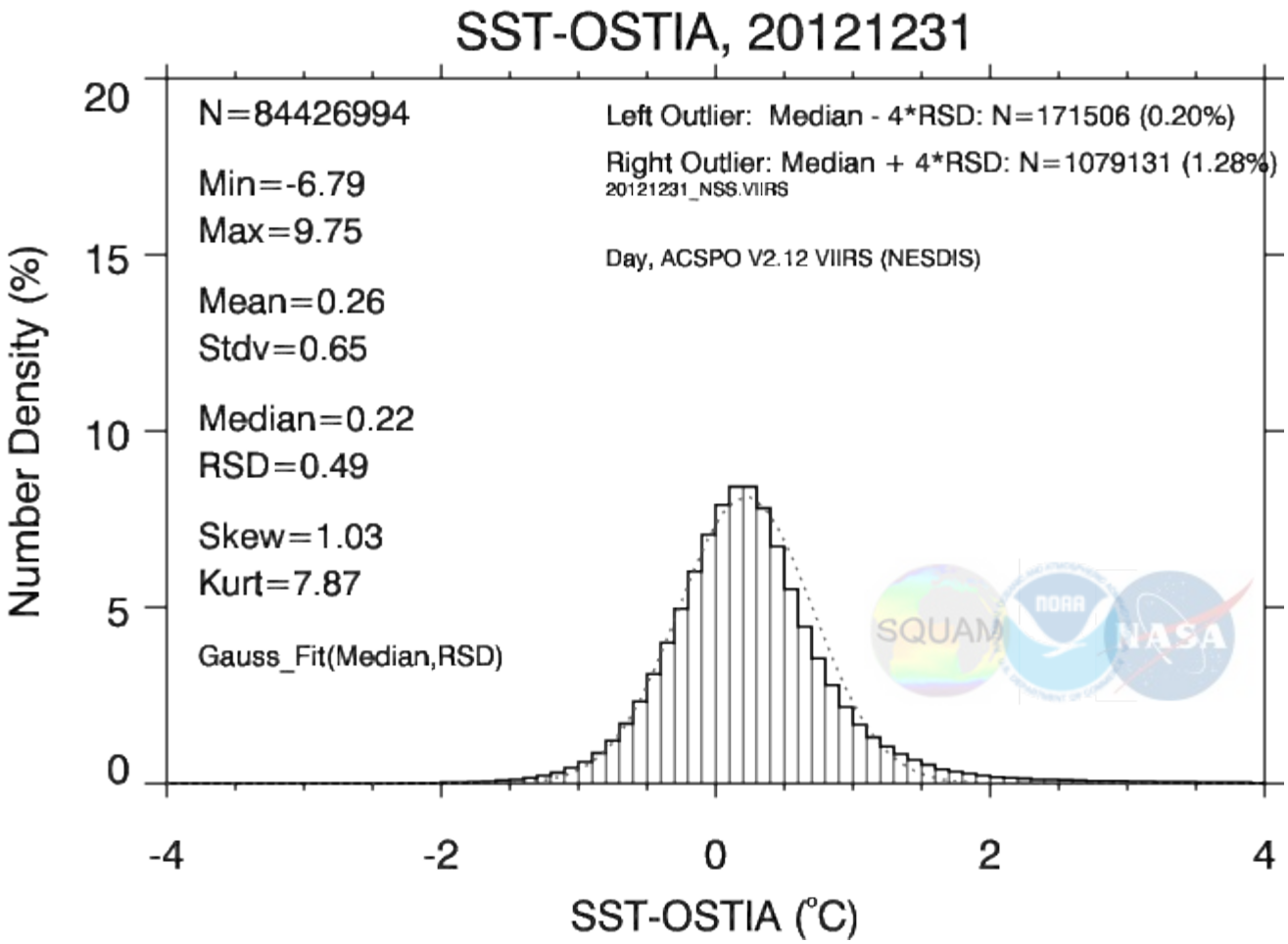

- ***Shape close to Gaussian***
- ***Domain & Performance Stats close to expected***

DAY: IDPS L2 minus OSTIA L4
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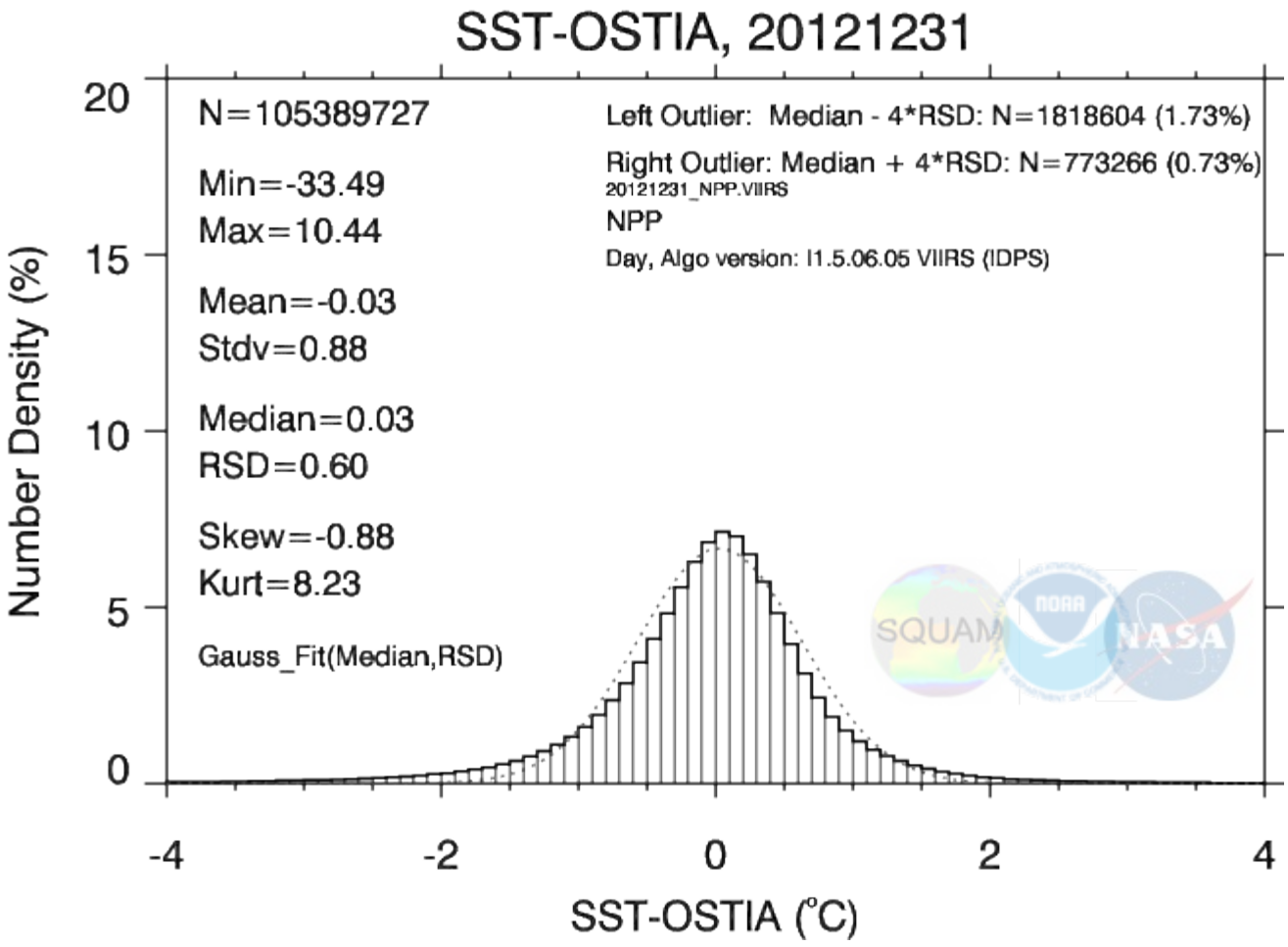

- *IDPS sample +25% larger compared to ACSPO*
- *increased Min/Max, STDV/RSD & Larger fraction of outliers*

DAY: ACSPO L2 minus *in situ* SST
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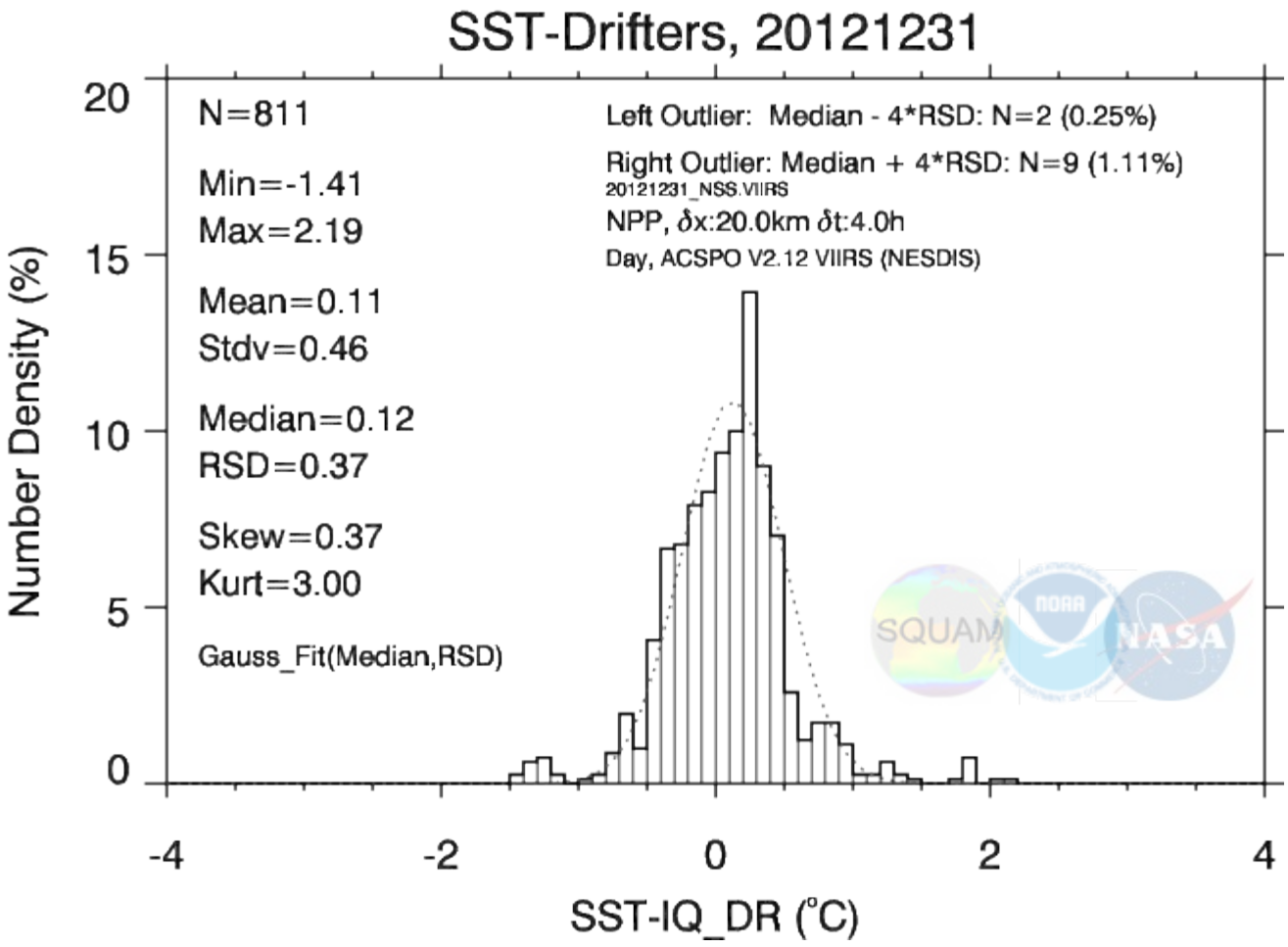

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DAY: IDPS L2 minus *in situ* SST
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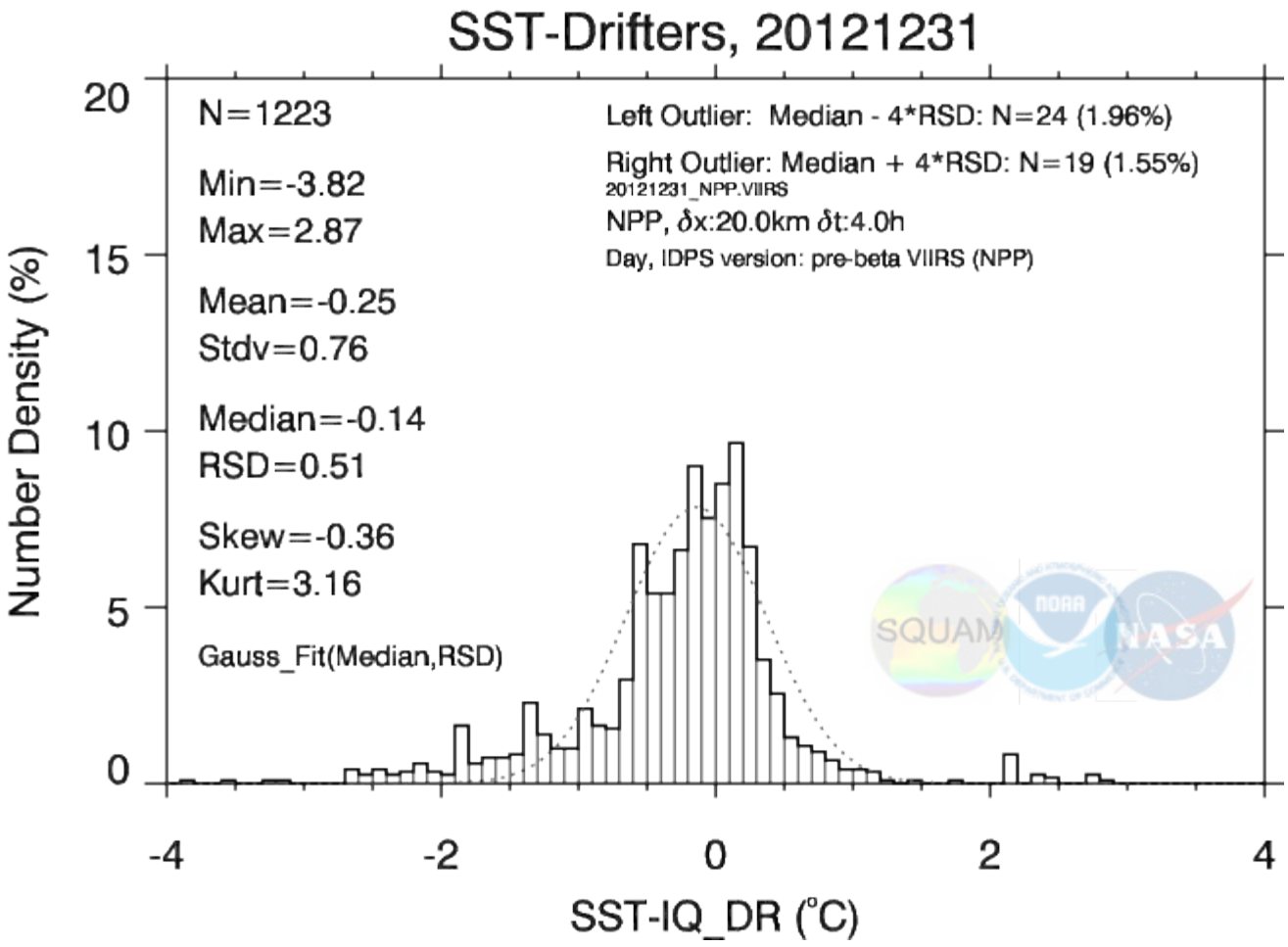


- ***IDPS sample +51% larger compared to ACSPO***
- ***increased Min/Max, STDV/RSD & Larger fraction of outliers***

DAY 31 December 2012 – Summary

ΔT = "VIIRS minus OSTIA" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	84.4M (100%)	-6.8/ +9.8	+0.2[illegible]/0.65	+0.2[illegible]/0.49	+1.0/ +7.9
IDPS	105.4M (125%)	-33.5/+10.4	-0.03/0.88	+0.03/0.60	-0.9/+8.2

- *IDPS SST domain +25% larger but all Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*

ΔT = "VIIRS minus in situ" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	811 (100%)	-1.4/ +2.2	-0.11/0.46	+0.12/0.37	+0.4/ +3.0
IDPS	1,223 (151%)	-3.8/+2.9	-0.25/0.76	-0.14/0.51	-0.4/+3.2

- *IDPS SST domain is +51% larger but all Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*

STAR Conclusion and Work in Progress

- VCM performance for SST remains suboptimal
  - IDPS domain larger than ACSPO, but SST statistics degraded
  - SST specs are not met (including revisited in new L1RD)
  - Part of SST performance is due to SST algorithms (e.g., limb cooling at swath edges) – work underway to revisit
  - Improvements are needed during both day and night

- STAR work underway to improve VCM for SST
  - With U. Wisconsin Andy Heidinger and Denis Botambekov, to replicate SQUAM global analyses and fine-tune VCM, globally

NAVOCEANO Analyses

- NAVO analyzed VCM Mask and SST Quality Flags
- Analyses stratified by Day and Night
- NAVO also compared VCM with NAVO Cloud Mask (NCM)

SEATEMP (NAVO heritage) vs. IDPS SSTs

Objective: Ensure comparable SST performance in comparable SST domain

Analysis of 25 days of global data from 10 Dec 2012 – 06 Jan 2013

Daytime EDR SST Statistics

- 25 km / 4 hour match-up, 25 days, global coverage.

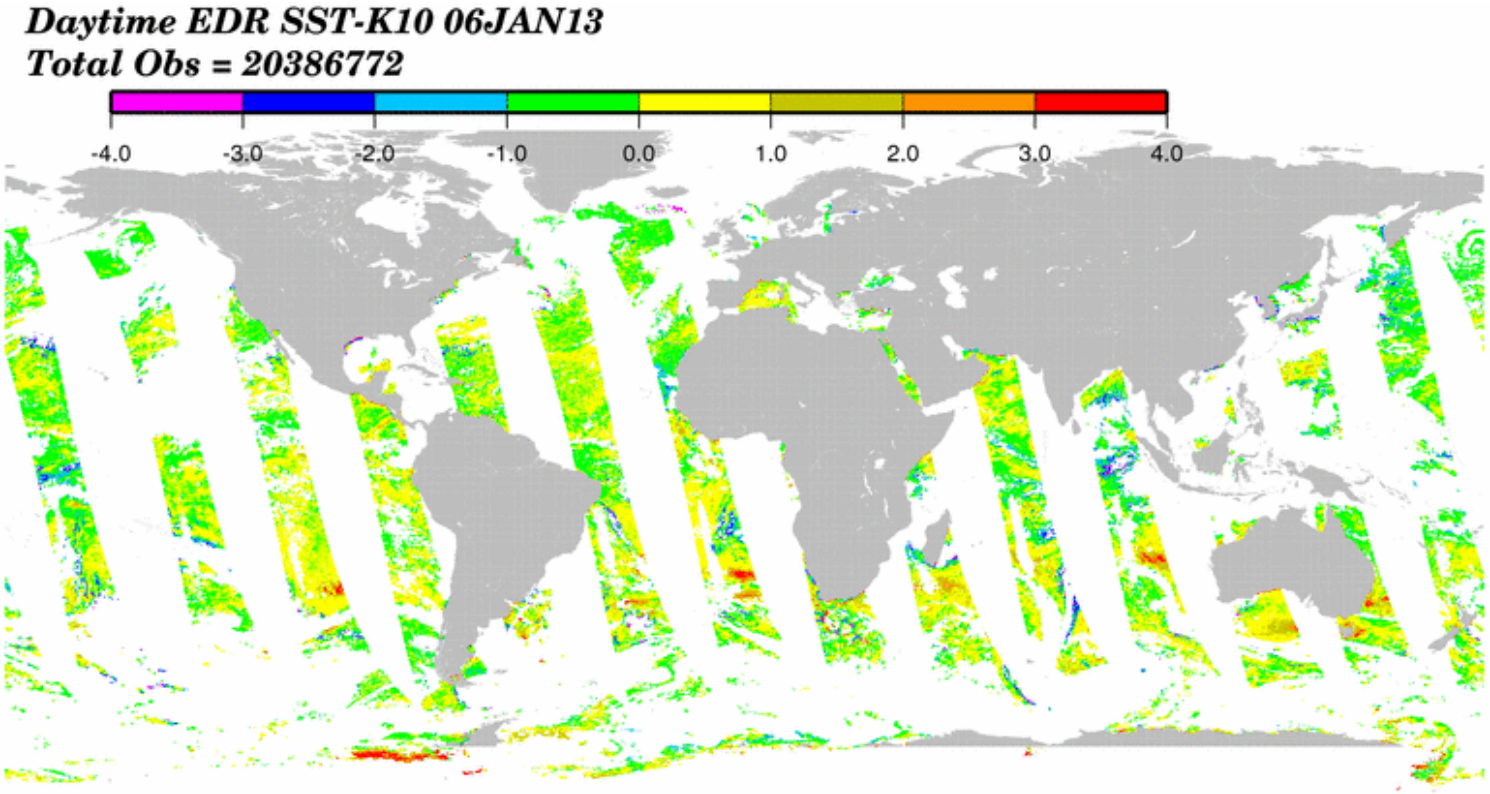
Quality	Buoy Matches	RMS error	bias
High	6038	0.45	-0.02
Degraded	20225	0.80	-0.27
Excluded	33921	1.78	-1.30

- For comparison VIIRS Seatemp statistics

Quality	Buoy Matches	RMS error	bias
Clear	15330	0.44	0.02
Prob. Clear	2925	0.76	0.05
Prob. Cloudy	514	1.54	-0.48

Daytime EDR SST Statistics

- **Comparison graphics: High quality EDR SST - K10**



Observations from Daytime Data

- SST statistics wrt. in situ data (mean and STD) for the best quality data are remarkably similar between EDR and Seatemp
- For the best quality data a standard deviation of about 0.45^{o}C is acceptable.
- However, the number of buoy match-ups which reflects the number of retrievals is low for best quality IDPS SSTs
- Also, graphics of best quality EDR SST – K10 field show some potential problems
- Best quality EDR SST is limited to a view zenith angle 40° (3 to 1 aggregation) compared with 53° VZA for Seatemp

Nighttime EDR SST Statistics

- 25 km / 4 hour match-up, 25 days, global coverage.

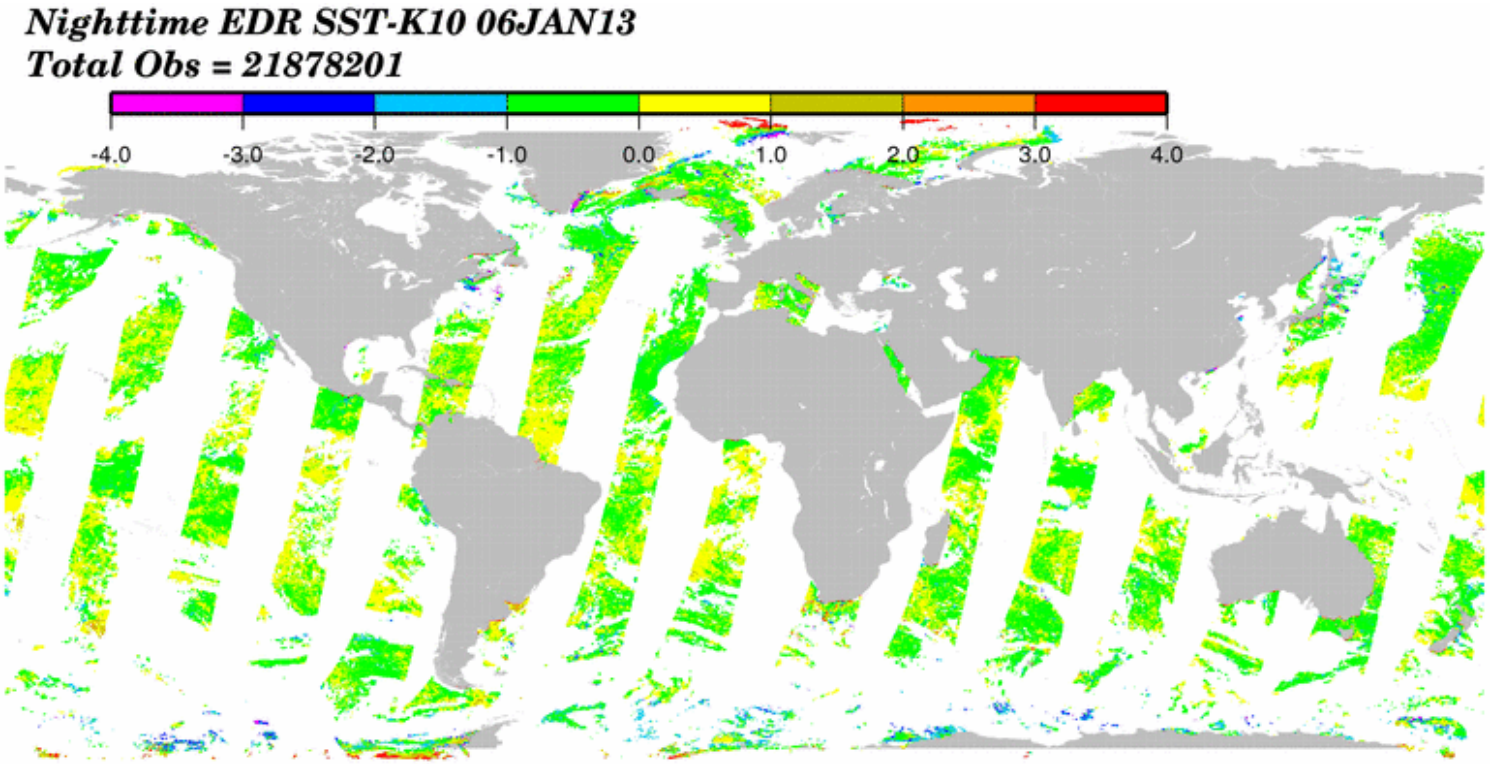
Quality	Buoy Matches	RMS error	bias
High	6154	0.35	-0.09
Degraded	17083	0.50	-0.15
Excluded	29715	2.05	-1.69

- For comparison VIIRS Seatemp statistics.

Quality	Buoy Matches	RMS error	bias
Clear	21074	0.36	0.01
Prob. Clear	1235	0.82	-0.11
Prob. Cloudy	112	2.21	-1.70

Nighttime EDR SST Statistics

- **Comparison graphics: High quality EDR SST - K10**



Observations from Nighttime Data

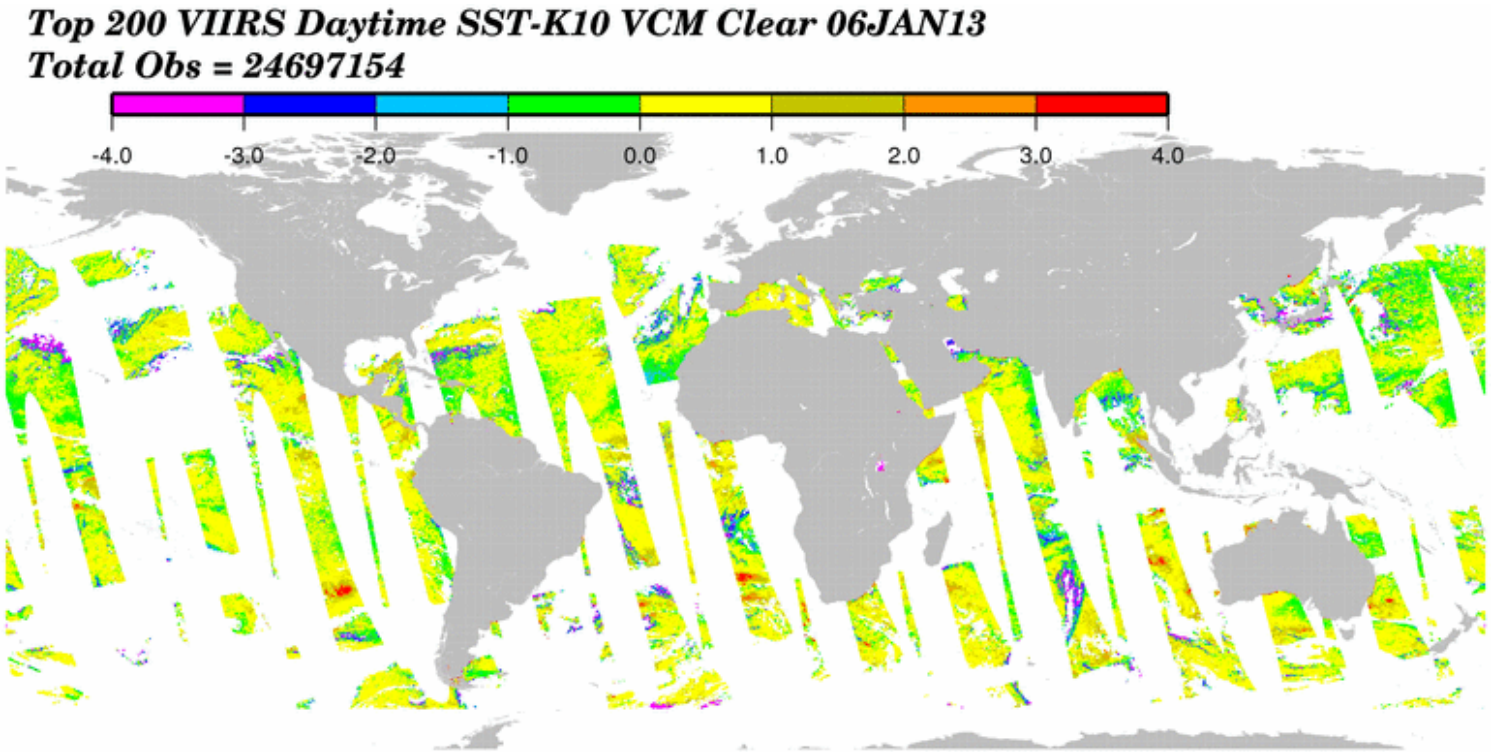
- Statistics for the best quality EDR data are similar to Seatemp
- For the best quality data a RMS error of about 0.35 ^{o}C is very good
- However, the number of buoy match-ups which reflects the number of retrievals is low for best quality data
- Graphics of EDR SST – K10 field show a few potential problems
- Best quality EDR SST is limited to a satellite zenith angle 40° (3 to 1 aggregation) compared with 53° for Seatemp

VIIRS Cloud Mask

- For this evaluation, “VCM clear” means that VCM is “confidently clear” and all VCM tests were performed successfully, in other words, “confidently confidently clear.”
- The purpose of VCM is to detect clouds. NCM is the NAVOCEANO Cloud mask. The purpose of NCM is to produce clean SST retrievals.
- The evaluation is conducted on the “best” 200 daytime granules and the “best” 200 nighttime granules, where “best granules” are defined as the ones for which Seatemp produced the highest number of cloud-free SST retrievals
- Underlying SST field is computed at full resolution with the expanded NL SST equations.
- 25 km / 4 hour match-up, 25 days, partial coverage.

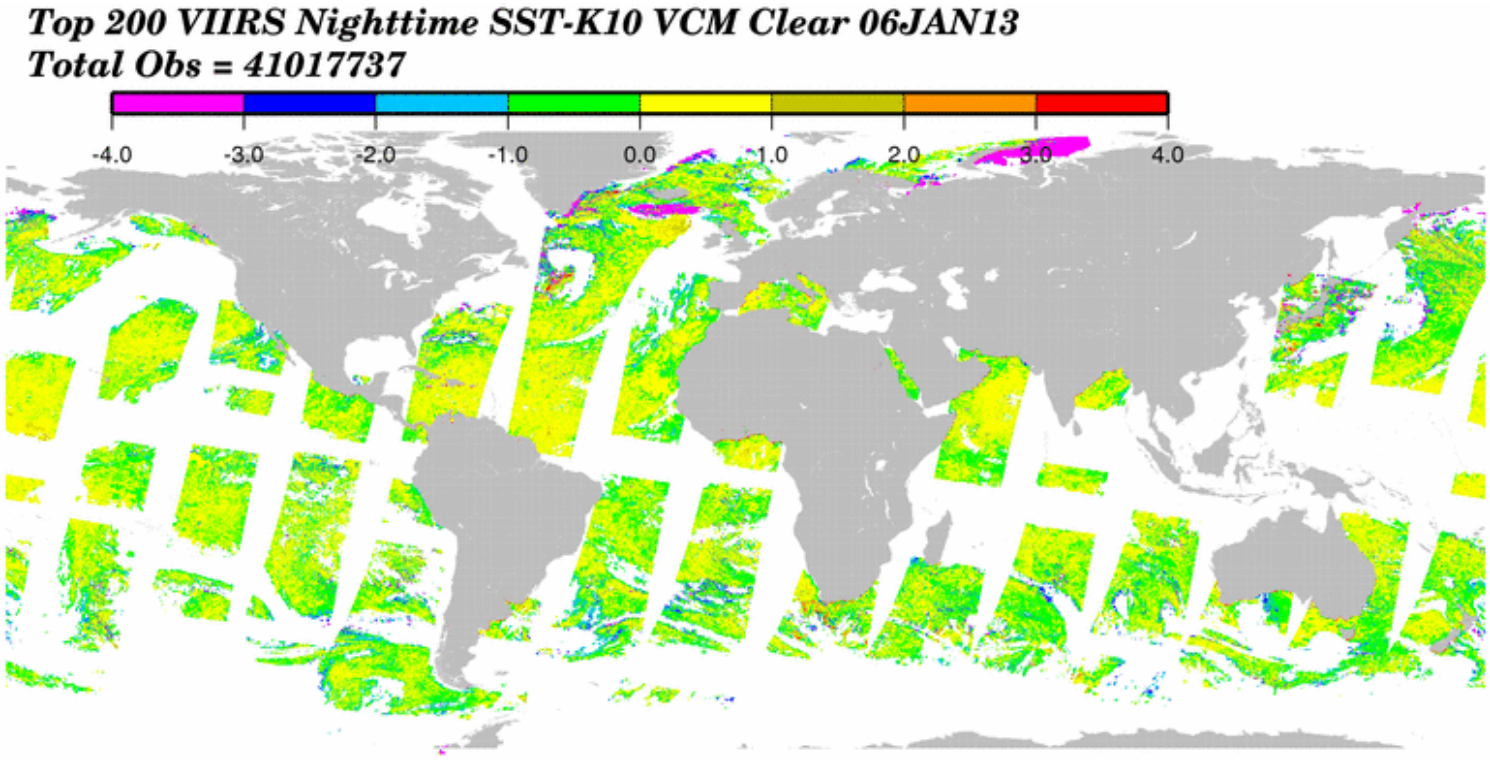
IDPS Day SST - K10 (VCM=Confidently Confidently Clear)

- Daytime, VCM clear SST – K10



IDPS Night SST - K10 (VCM=Confidently Confidently Clear)

- Nighttime, VCM clear SST – K10



VCM vs. NCM

- Daytime statistics VCM / NCM

	Buoy matches	RMS error	bias
NCM clear / VCM clear	6837	0.48	0.10
NCM cloud / VCM clear	9863	1.03	-0.38
NCM clear / VCM cloud	2635	0.63	0.02

- Nighttime statistics VCM / NCM

	Buoy matches	RMS error	bias
NCM clear / VCM clear	7063	0.31	0.07
NCM cloud / VCM clear	20091	0.82	-0.33
NCM clear / VCM cloud	547	1.07	-0.49

VCM vs. NCM Conclusions

- NCM detects all sources of SST corruption.
- VCM “confidently clear” has more cloud leakages although next update may correct some problems.
- VCM confidence level flag must be used with the cloud mask quality flag to make decisions.
- The VCM flag defaults to clear.
- VCM quality level flag is always lower in sun glint regions even if the confidence flag is clear.
- Reducing the quality criteria to “medium” to obtain clear sun-glint pixels has a cost of obtaining other problems that contaminate SST.

NAVO EDR/VCM Summary

- Best category EDR SST is of good quality with little cloud corruption.
- Best category EDR SST produces too few retrievals for our applications.
- Suggest at least removing satellite zenith angle, which is deterministic, as input to quality flag.

STAR/NAVO Summary & Work in Progress

- VCM performance for SST
  - VCM confidently clear domain larger than in ACSPO and SEATEMP, but SST statistics degraded and unacceptable
  - Using SST “highest quality” flags results in SST performance statistics comparable with ACSPO and SEATEMP, but in a much smaller domain

- Work underway to improve VCM for SST
  - STAR to work with U. Wisconsin Andy Heidinger and Denis Botambekov to fine-tune VCM, globally
  - NAVO to work with AEROSPACE Tom Kopp, to identify problem cases / areas, and fix
  - SST Team to redefine SST Algorithms and Quality Flags (currently, both are suboptimal)

Back Up Slides

Another day of data – 25 September 2012
In SST Quality Monitor (SQUAM)

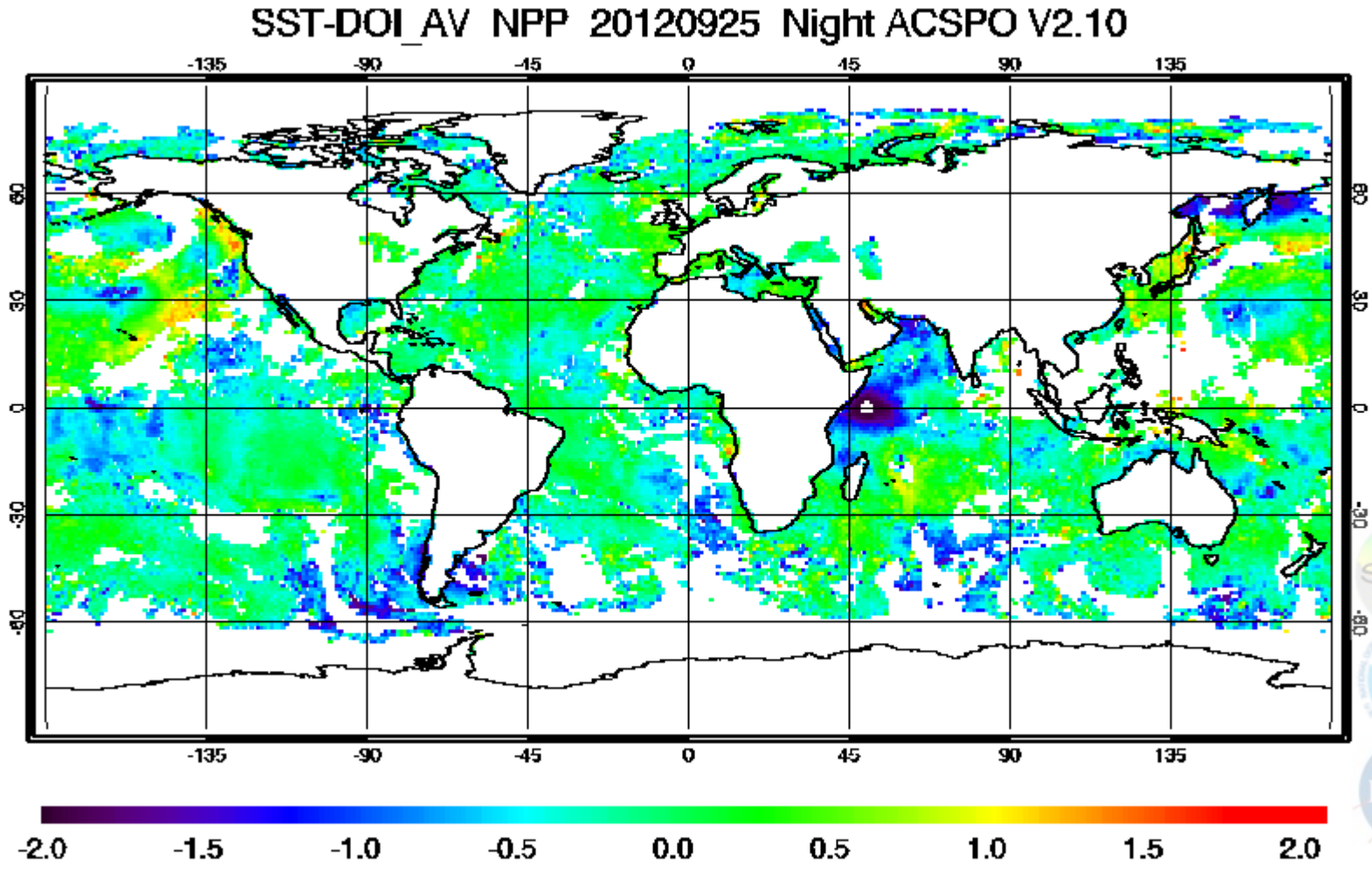
www.star.nesdis.noaa.gov/sod/sst/squam/

Monitoring of ACSPO and IDPS SSTs in SST Quality Monitor (SQUAM)

Analysis of one day of data – 25 September 2012
Presented at SST Telecon 10/03/12

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

NIGHT: ACSPO L2 minus Reynolds L4
25 September 2012



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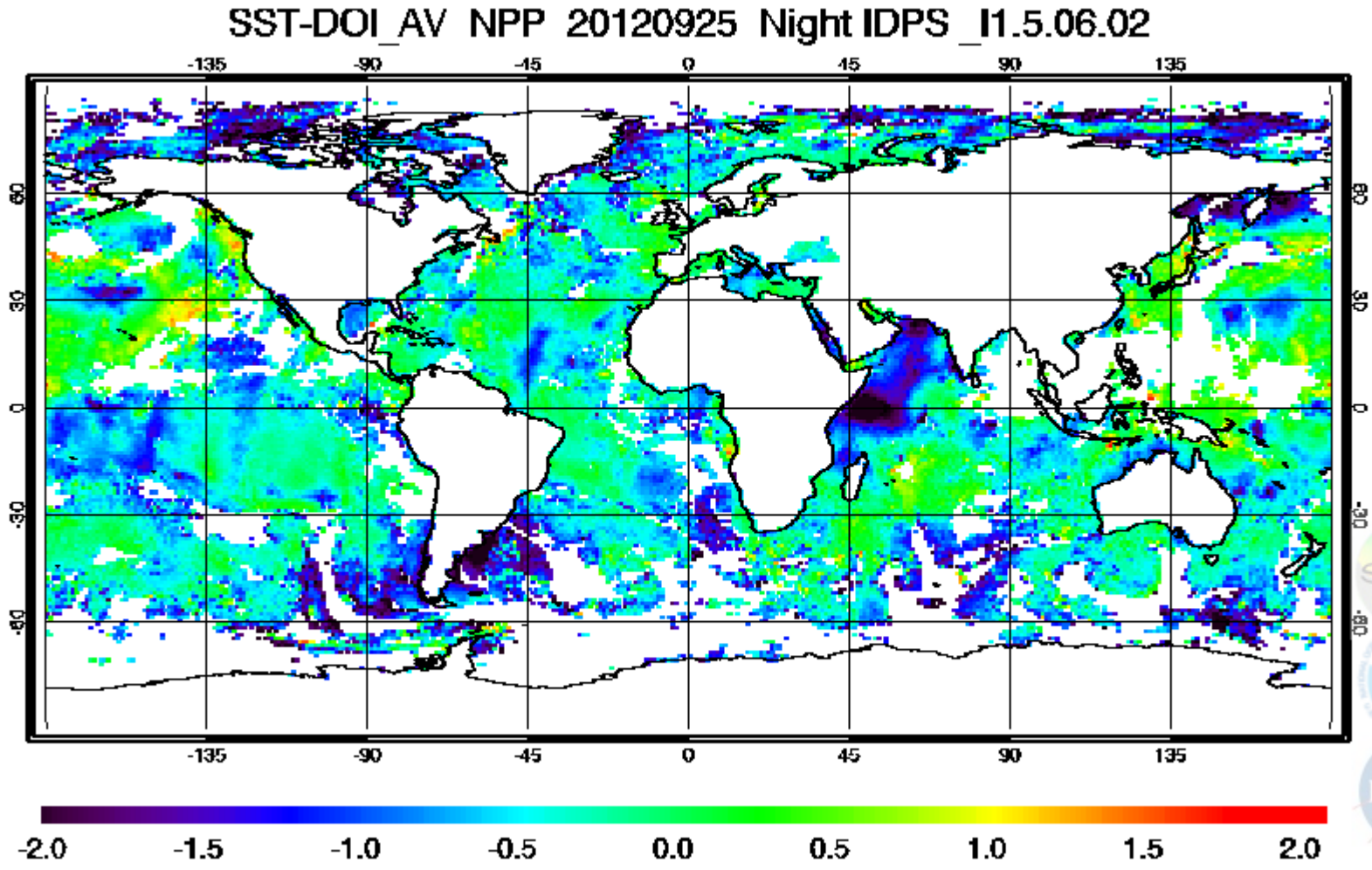

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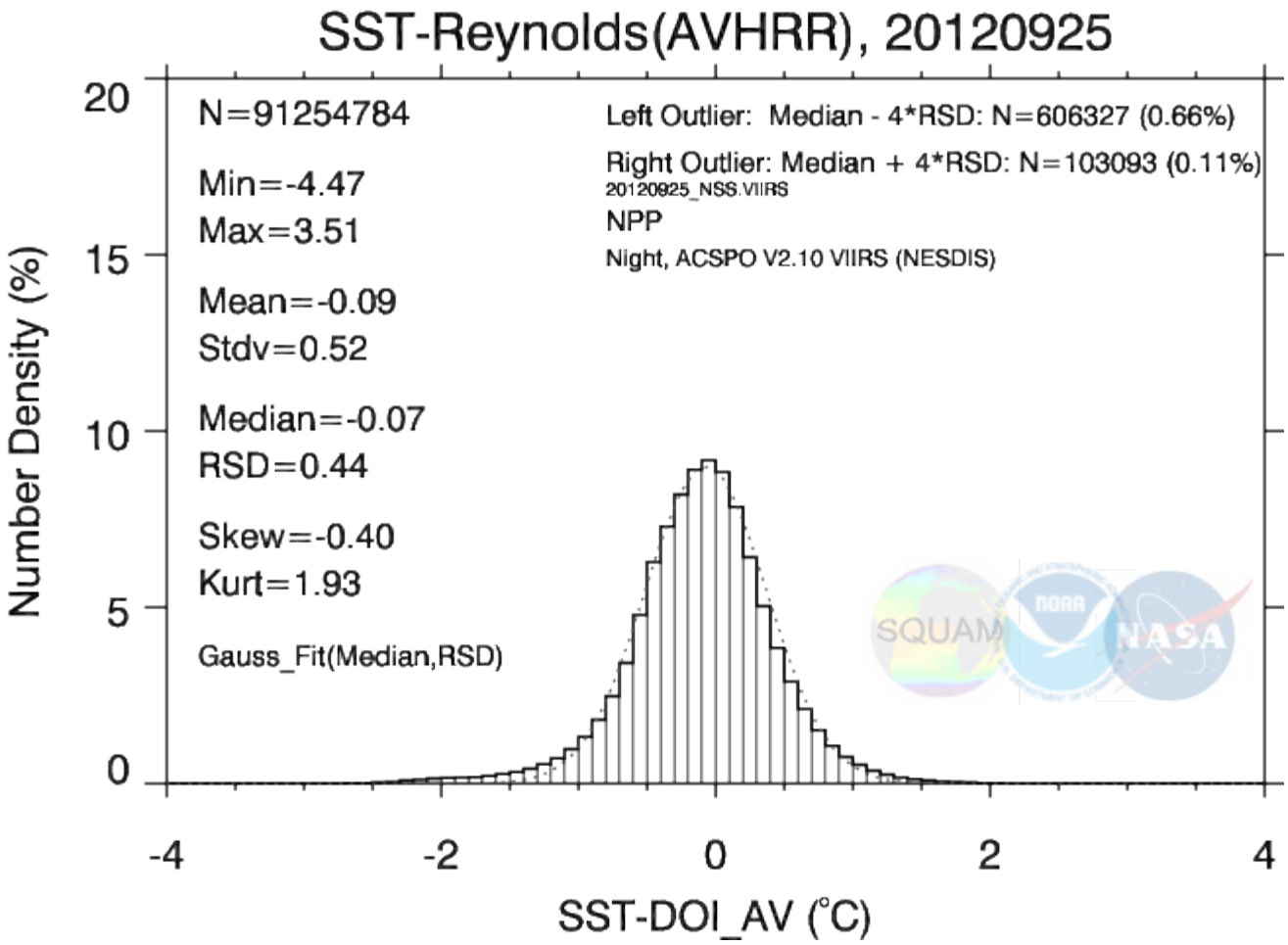

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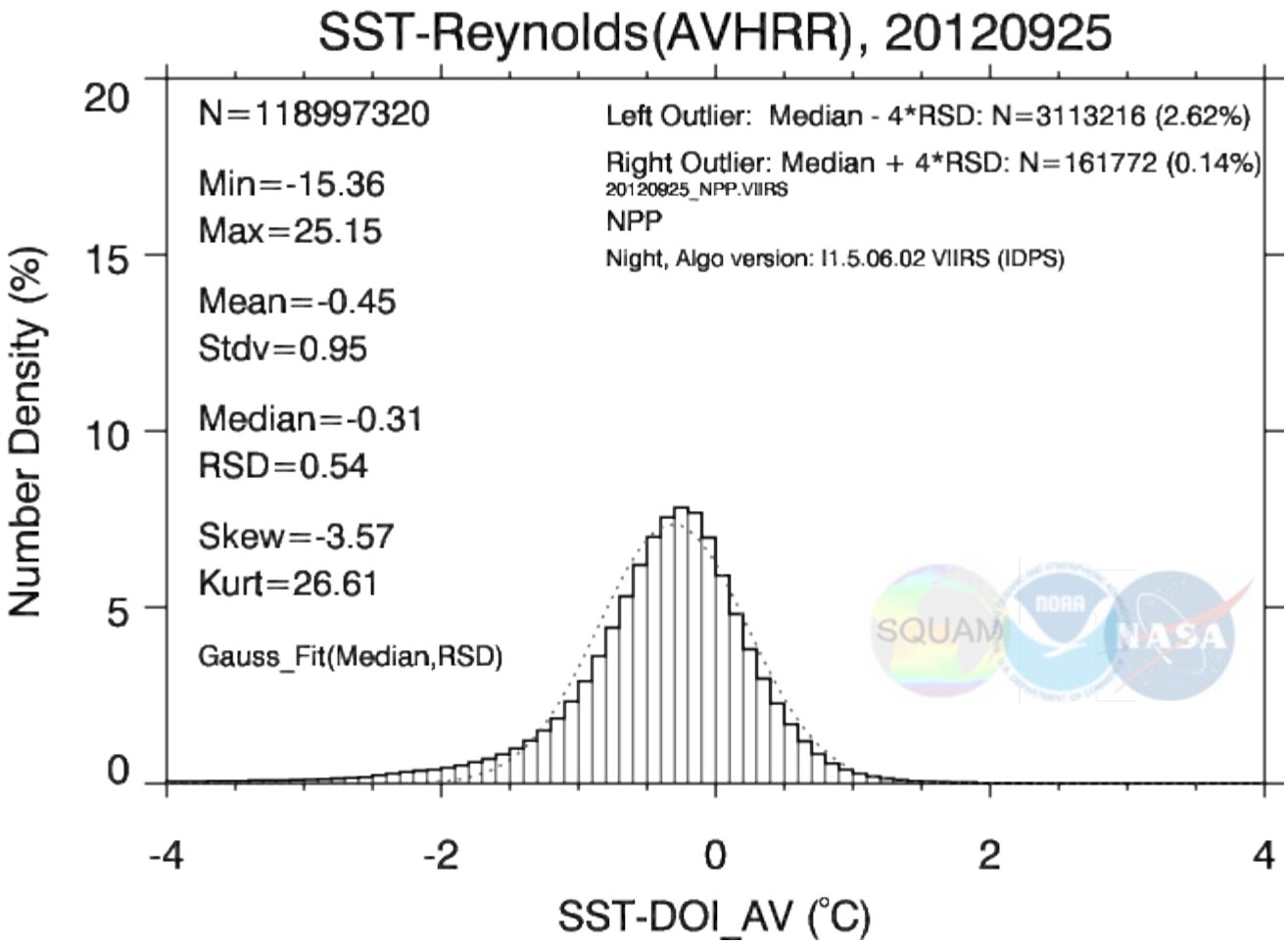

- *IDPS sample +30% larger compared to ACSPO*
- *Shape less Gaussian (negative Skew / increased Kurt)*
- *Negative bias, increased Min/Max, STDV/RSD, fraction of outliers*

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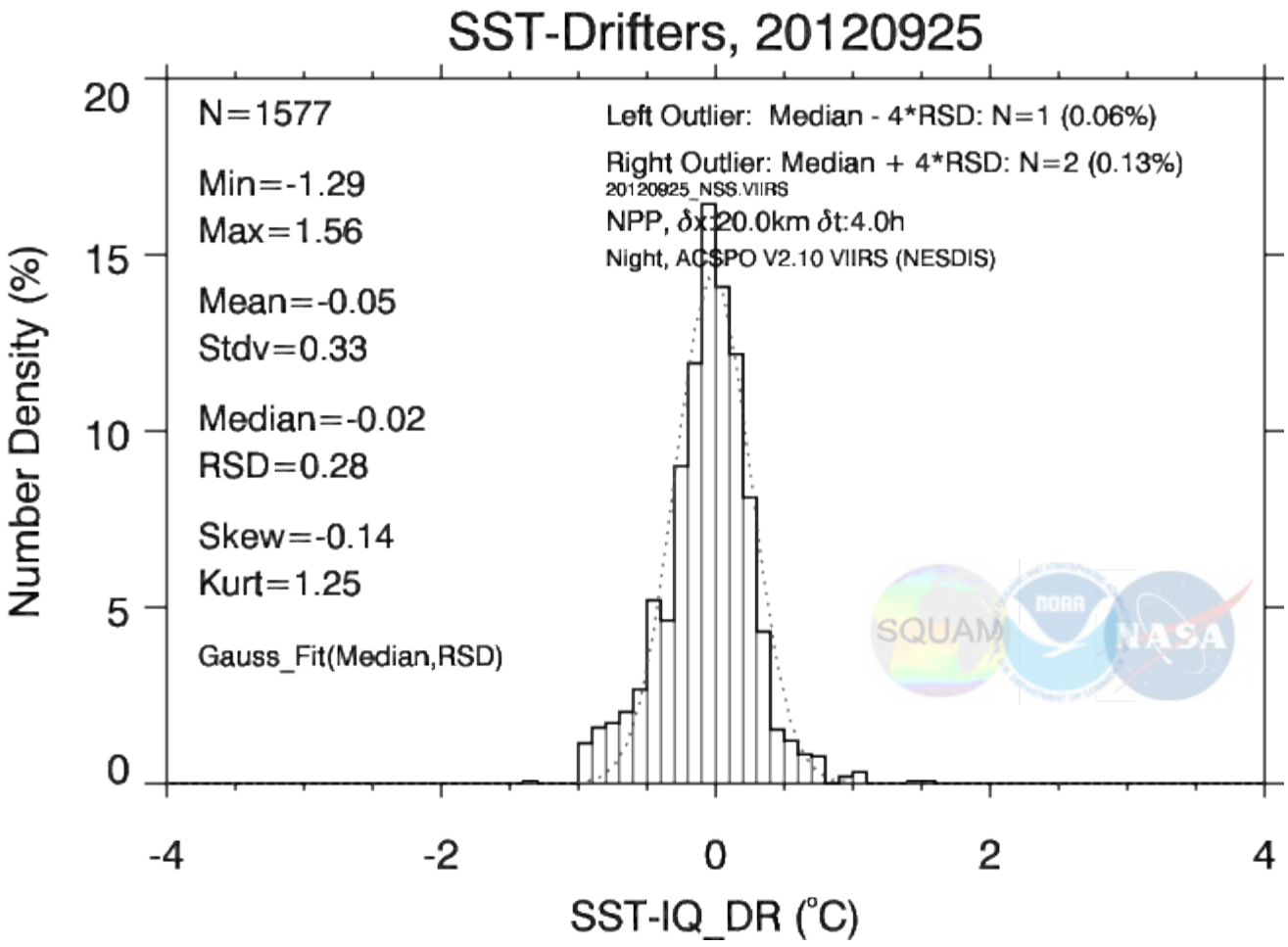

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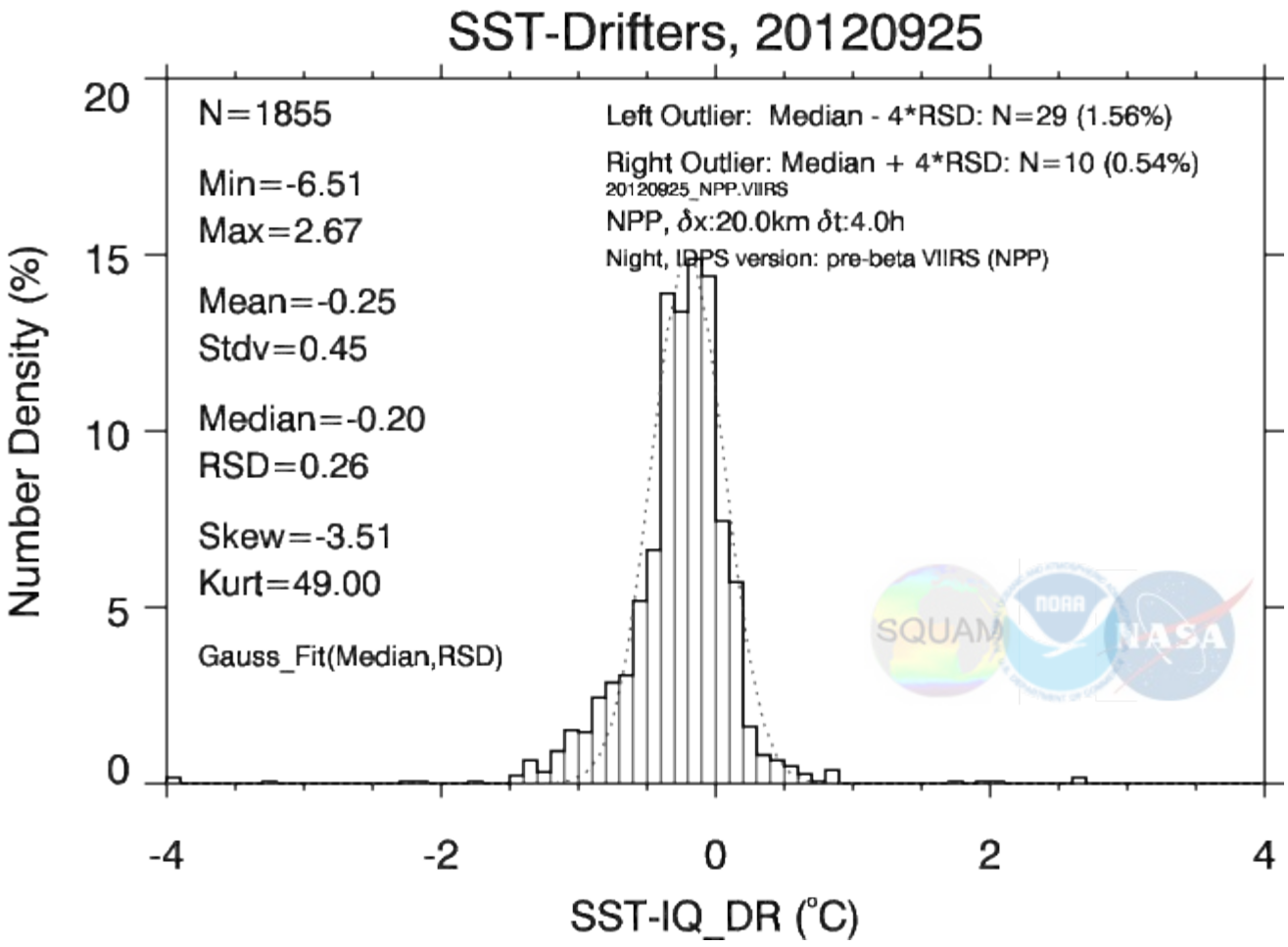

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NIGHT 25 September 2012 – Summary

ΔT = "VIIRS minus Reynolds" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	91.3M (100%)	-4.5/ +3.5	-0.09/0.52	-0.07/0.44	-0.4/ +1.9
IDPS	119.0M (130%)	-15.4/+25.2	-0.45/0.95	-0.31/0.54	-3.6/+26.6

- *IDPS SST domain +30% larger & Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*

ΔT = "VIIRS minus in situ" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	1,577 (100%)	-1.3/ +1.6	-0.05/0.33	-0.02/0.28	-0.1/ +1.3
IDPS	1,855 (118%)	-3.7/+4.4	-0.11/0.55	-0.04/0.32	+0.8/+21.9

- *IDPS SST domain is +18% larger but all Stats degraded, compared to ACSPO*
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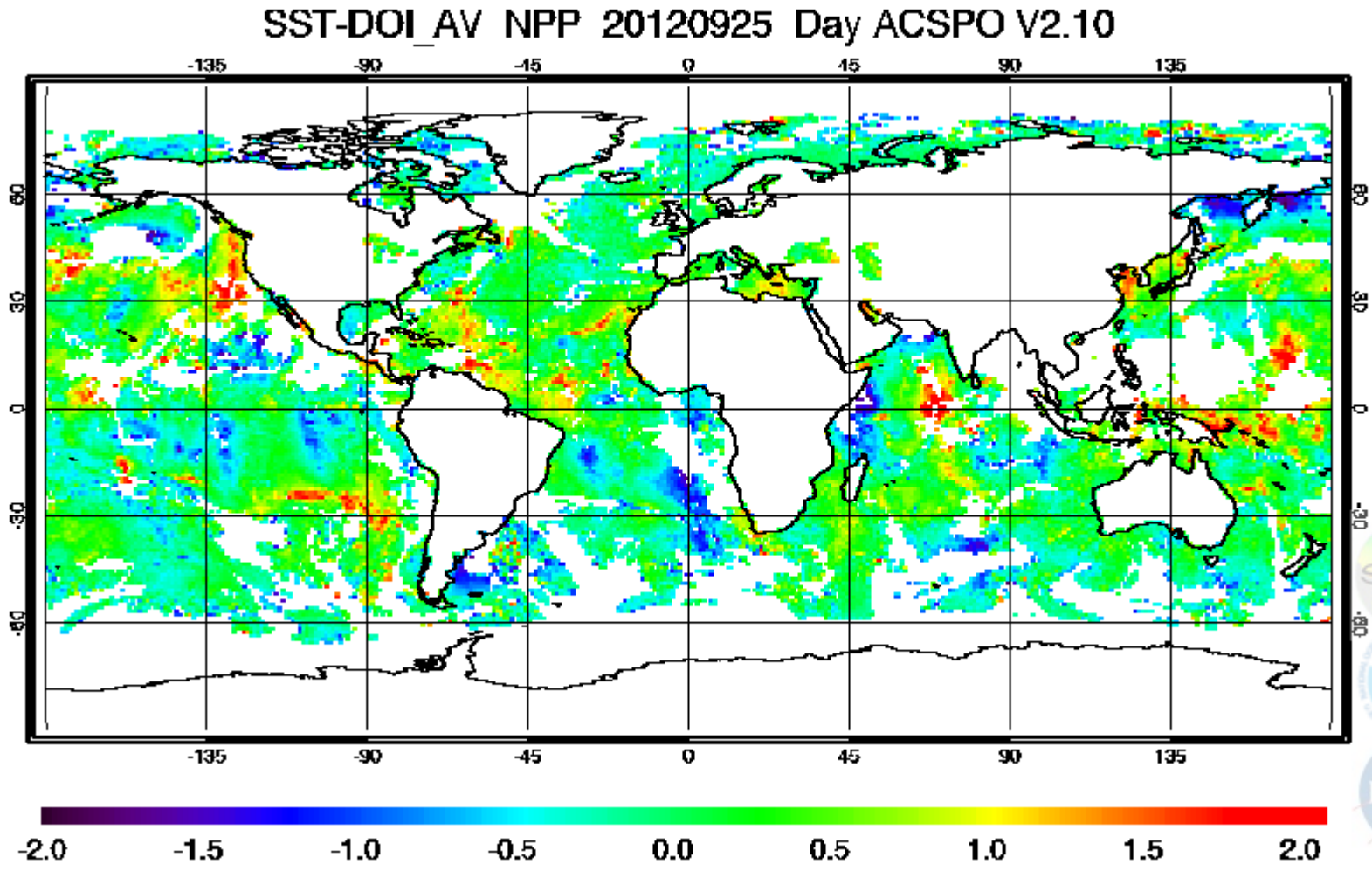
DAY: ACSPO L2 minus Reynolds L4
25 September 2012



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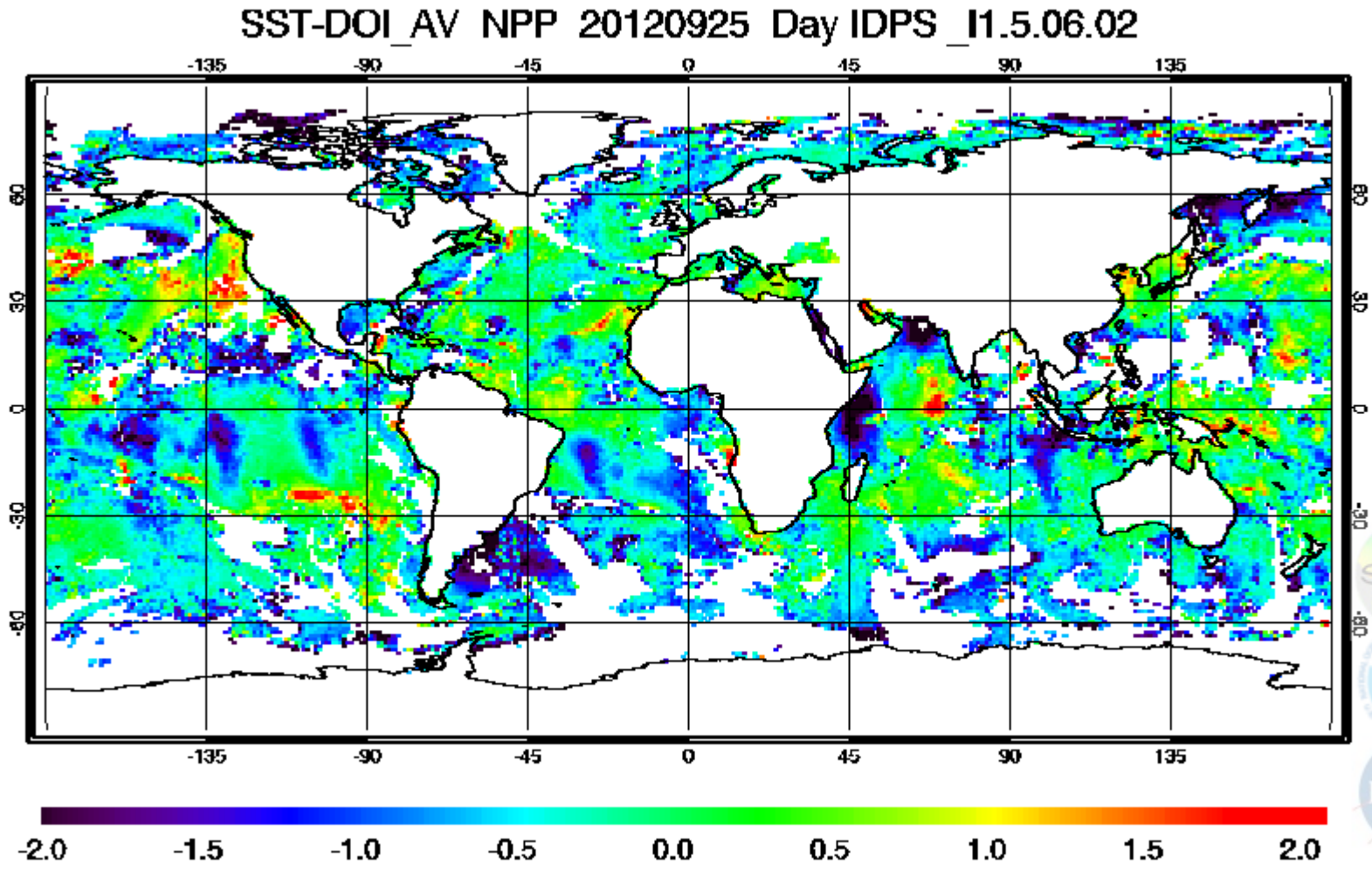

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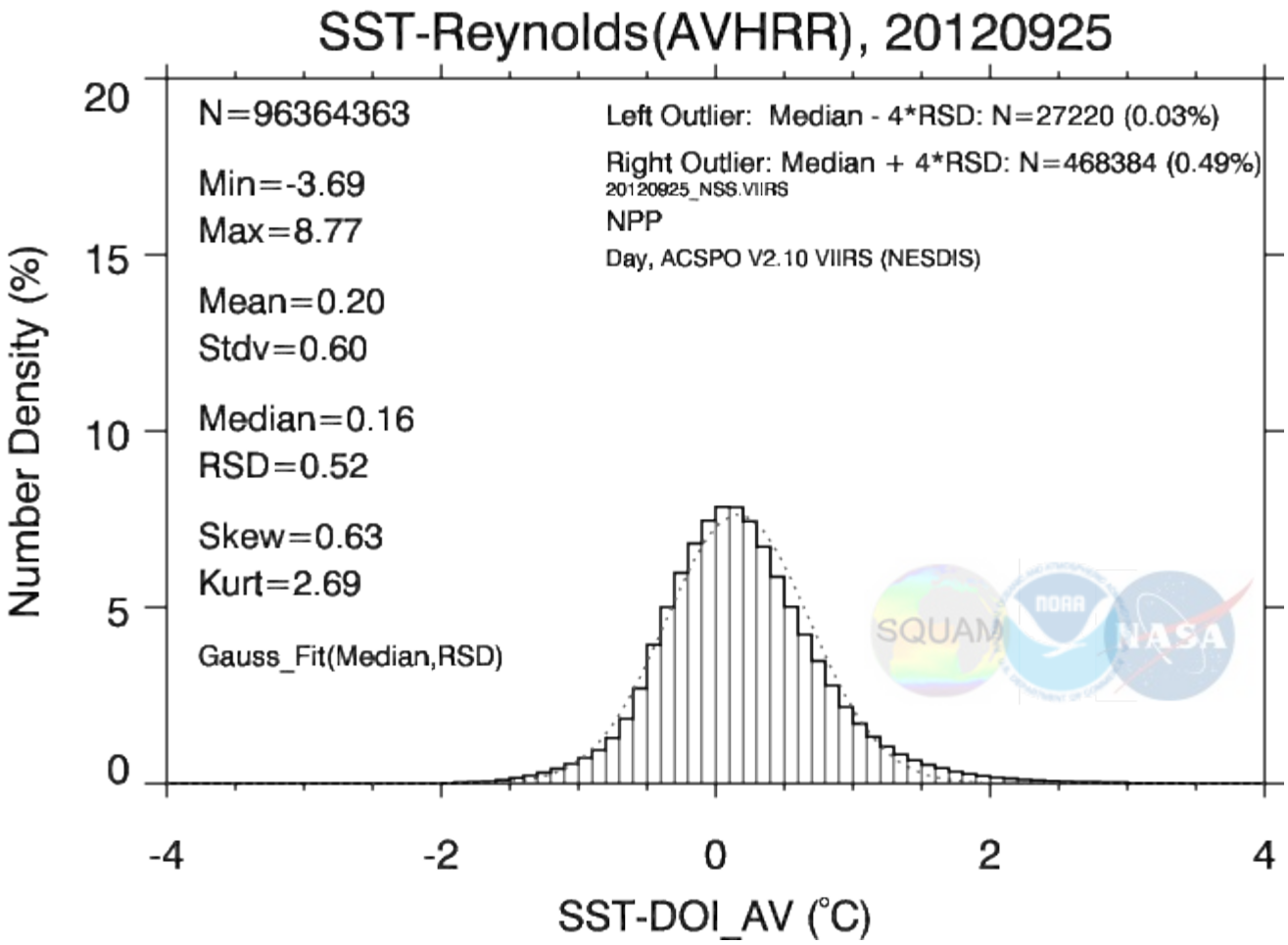

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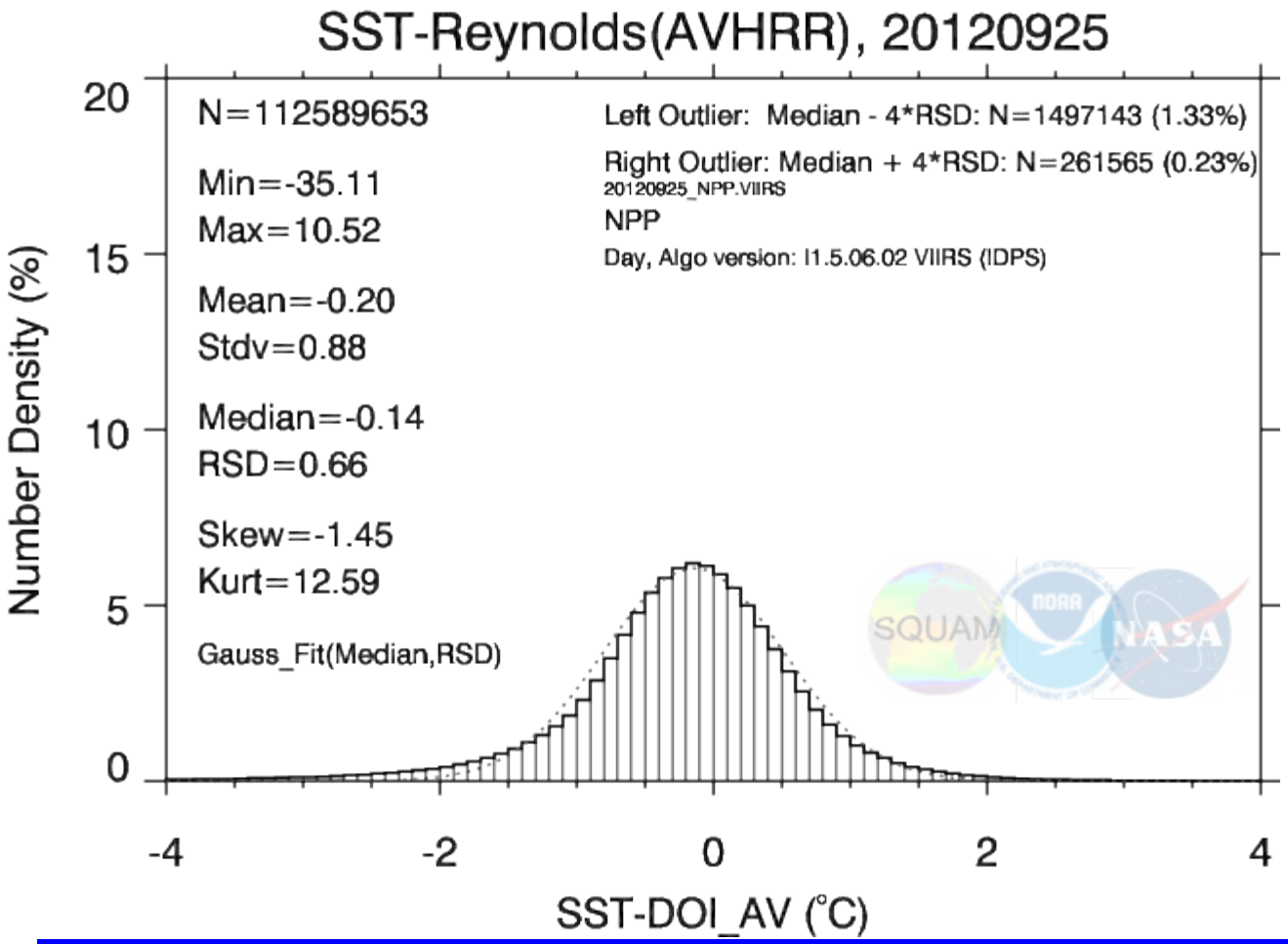
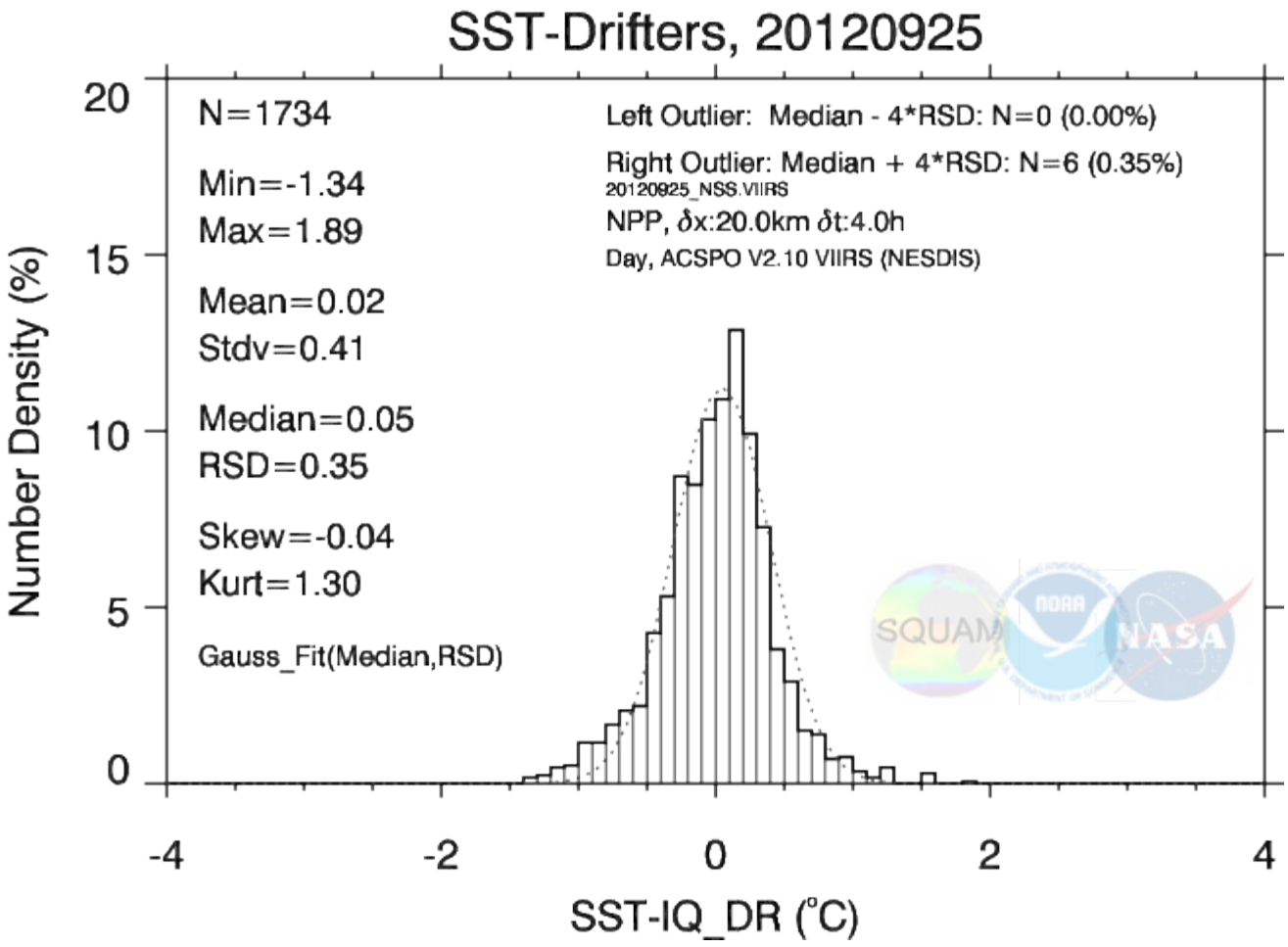


- *IDPS sample +17% larger compared to ACSPO*
- *Shape less Gaussian*
- *Negative bias, increased Min/Max, Mean, STDV/RSD, % outliers*

DAY: ACSPO L2 minus *in situ* SST
25 September 2012



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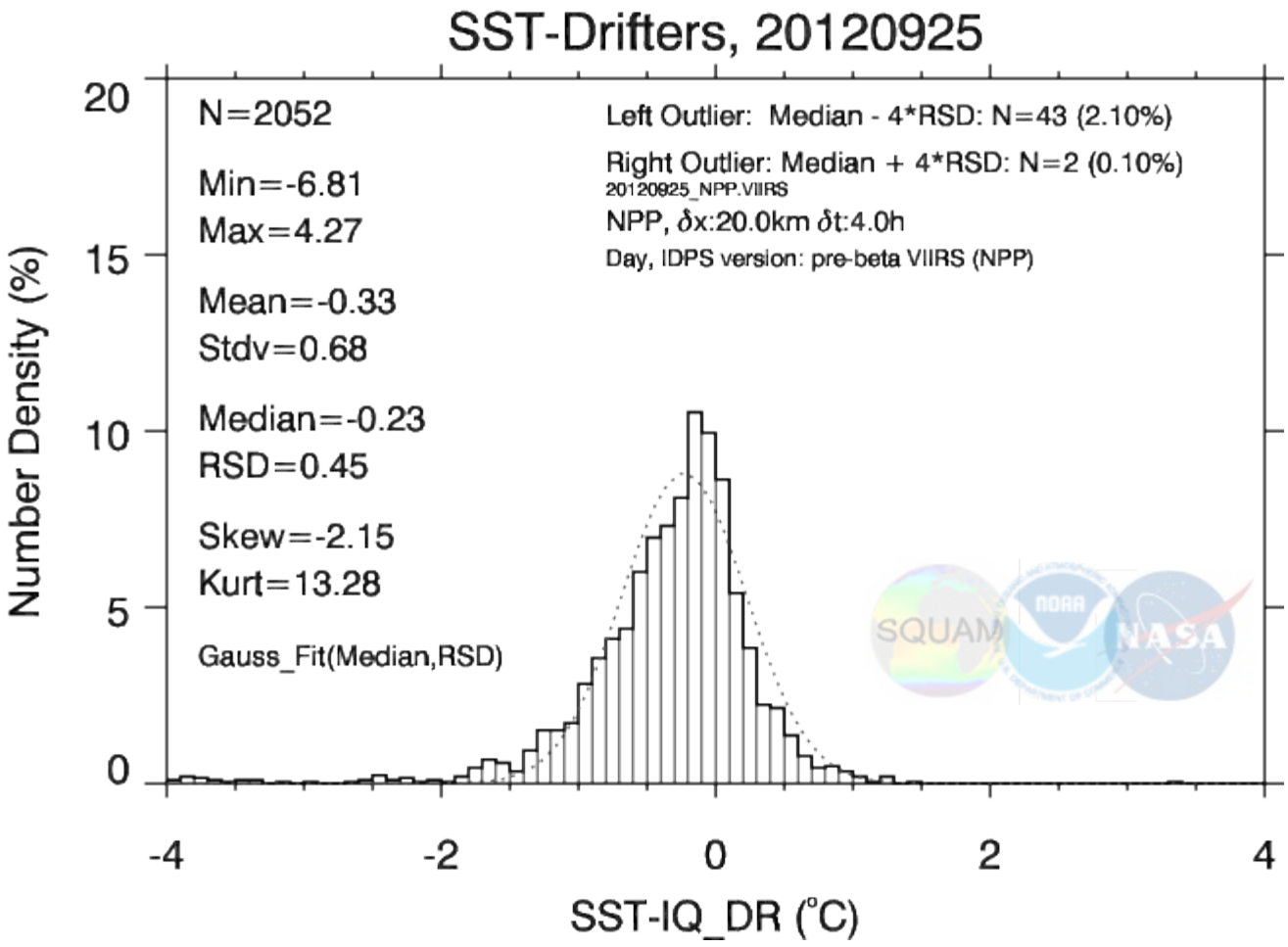

- ***IDPS sample +18% larger compared to ACSPO***
- ***Negative bias, increased Min/Max, STDV/RSD, % outliers***

DAY 25 September 2012 – Summary

ΔT = "VIIRS minus Reynolds" SST (expected ~0)

	NOBS (%ACSPO)	Min/ Max	Mean/ STD	Med/ RSD	Skew/ Kurt
ACSPO	96.4M (100%)	-3.7/ +8.8	+0.20/0.60	+0.10/0.52	+0.6/ +2.7
IDPS	112.6M (117%)	-35.1/+10.5	-0.20/0.88	-0.14/0.66	-1.5/+12.6

- *IDPS SST domain +17% larger & Stats degraded, compared to ACSPO*
- *Gap between Conventional and Robust stats wider in IDPS - More outliers*