JPSS SST

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U. Wisconsin / CIMSS

Archive: Ken Casey, Sheekela Baker-Yeboah, Korak Saha, Ed Armstrong, Yibo Jiang
NCEI Silver Spring and PO. DAAC

L4 users of VIIRS SST: Dorina Surcel Colan, Bruce Brasnett, Andy Harris, Eileen Maturi, Emma Fiedler, Helen Beggs, Mike Chin, Masakazu Higaki, Toshiyuki Sakurai, Shiro Ishizaki
CMC; NOAA; Met Office; ABoM; JPL; JMA

Algorithm Cal/Val Team Members

Name	Organization	Tasks
Ignatov	STAR	JPSS Algorithm & Cal/Val Lead
Stroup Kihai Dash Liang Zhou, Xu Petrenko Ding	STAR – SGT STAR – GST STAR – CIRA STAR – CIRA STAR – CIRA & GST STAR – GST STAR – CIRA	Technical Liaison; ACSPO Development; ACSPO Reanalysis ACSPO code; Match ups with in situ; Destriping SST Quality Monitor (SQUAM) Monitoring IR Clear-sky Radiances Oceans for SST (MICROS) In Situ SST Quality Monitor (*i*Quam) ACSPO Clear-Sky Mask and SST Algorithm ACSPO Regional Val (high Latitudes); ACSPO L3 product
Gladkova Shahriar	STAR – CCNY, CREST & GST	Improved SST imagery; Pattern Recognition Improvements (Cloud Mask, Ocean Fronts); ACSPO Regional Monitor (ARM)
Arnone	U. Southern Mississippi	SST Cal/Val in coastal areas and from overlapping passes
May Cayula	NAVO	SST Consistency from overlapping orbits NAVO SEATEMP SST and Cal/Val
Minnett Kilpatrick	U. Miami	Improved SST retrievals in High latitudes and at swath edges
Roquet	Meteo France	VIIRS and Metop AVHRR Processing at EUMETSAT

JPSS SST Requirements

Attribute	Threshold	Objective
a. Horizontal Cell Size (Res)	1.6km[1]	0.25km
b. Mapping Uncertainty, 3σ	2km[1]	0.1km
c. Measurement Range	271 K to 313 K	271 K to 318 K
d. Measurement Accuracy[2]	0.2K	0.05K
e. Measurement Precision[2]	0.6K	0.2K (<55° VZA)
f. Refresh Rate	12 hrs	3 hrs
g. Latency	90 min	15 min
h. Geographic coverage	Global cloud and ice-free ocean; excluding lakes and rivers	Global cloud and ice-free ocean, plus large lakes and wide rivers

[1]Worst case scenario (corresponding to swath edge); both numbers are ~1km at nadir

[2]Represent global mean bias and standard deviation validation statistics against quality-controlled drifting buoys (for day and night, in full VIIRS swath, in full range of atmospheric conditions). Uncertainty is defined as square root of accuracy squared plus precision squared. Better performance is expected against ship radiometers.

S-NPP SST: Products, Progress, RAN, Users

- **Advanced Clear-Sky Processor for Oceans (ACSPO) Products**
  - Produced by NOAA ESPC/NDE; Archived w/GHRSST (PO.DAAC / NOAA NCEI)
  - L2 (swath projection; 10min granules; 27GB/day): May 2014-on
  - 0.02° L3U (Uncollated): May 2015-on (requested by ABoM, Met Office, JMA)
  - ACSPO code integrated into direct readout CSPP package at UW

- **Two ACSPO versions implemented (v.2.31/2.40) / Archived w/GHRSST**
  - Fixed warm low stratus cloud leakage
  - Produced new 0.02° L3U product (10min granules, 1 GB/day)
  - improved error characterization (facilitates data assimilation in L4 analyses)
  - Implemented destriping in the operations

- **ACSPO VIIRS SST Reanalysis (w/U. Wisconsin)**
  - Unfunded ‘demo’ effort w/UW L. Gumley’s group – need sustainable model

- **ACSPO VIIRS SST Users (L4 producers)**
  - Included in NOAA geo-polar blended & CMC L4s; Being explored in Met Office, BoM, NCEP, JMA, MUR, NCEI L4s

S-NPP SST: Cal/Val, Deficiencies, LTM

- **Status of ACSPO Cal/Val – Fully meet specs**
  - ACSPO L2 SST declared “Validated 3” in Sep 2014
  - ACSPO L3U SST (May 2015 – on) shows comparable performance

- **Known ACSPO Deficiencies**
  - Incomplete (May 2014 – on) & non-uniform record – RAN underway
  - Limited Regional Monitoring – ACSPO Regional Monitor for SST under development
  - Clear-Sky Mask in dynamic, coastal, hi-lat ocean has room for improvement – Future work
  - VAL time series show periodic (3-month) spikes of ~0.3 K, due to Warm-Up/Cool-Down exercises – Need SDR Team to fix the RDR-to-SDR code to minimize the effect on SST

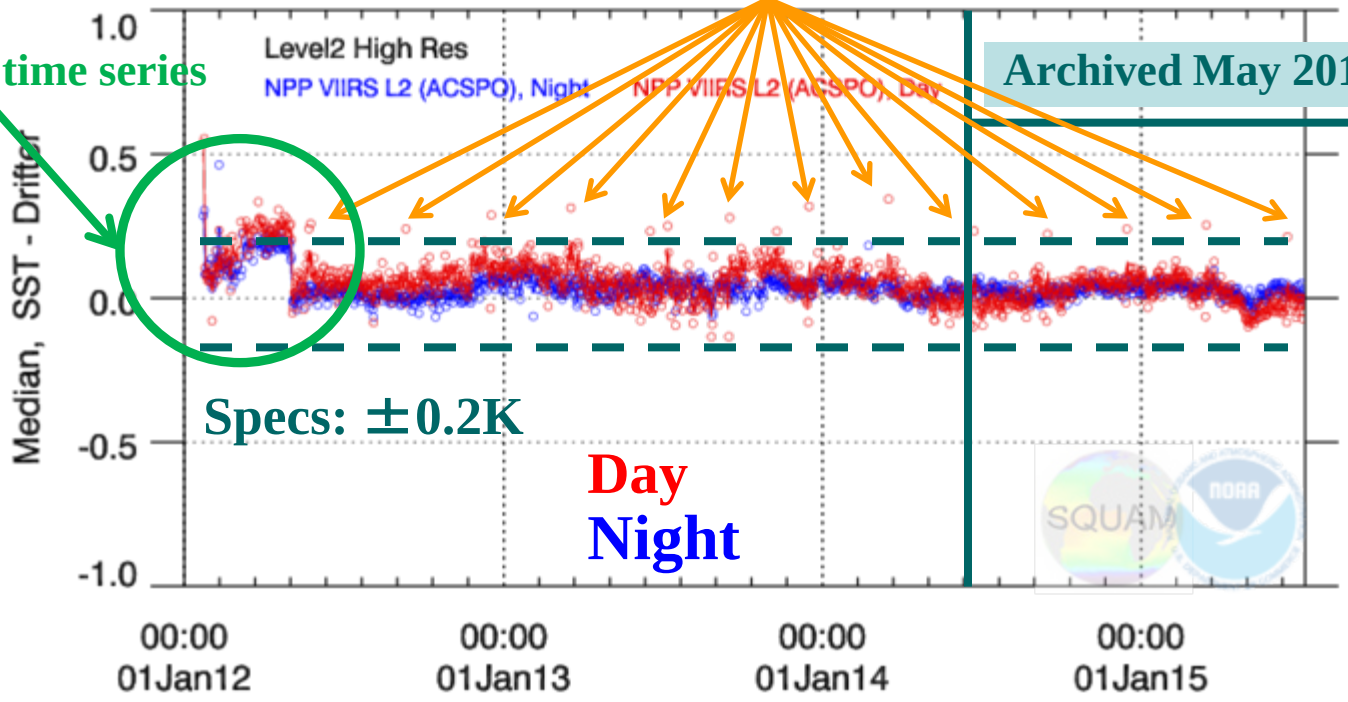
- **ACSPO Long-Term Monitoring**
  - SST Quality Monitor (SQUAM) www.star.nesdis.noaa.gov/sod/sst/squam/ - VIIRS SSTs
  - *In situ* Quality Monitor (*i*Quam) www.star.nesdis.noaa.gov/sod/sst/iquam/ - *in situ* SSTs
  - Monitoring IR Clear-Sky Radiances over Oceans for SST (MICROS) www.star.nesdis.noaa.gov/sod/sst/micros/ - VIIRS radiances associated with SST
  - ACSPO Regional Monitor for SST (ARMS) – development underway

VAL BIAS: Real Time ACSPO VIIRS L2

WUCD Events – ~0.3K spikes every 3 month

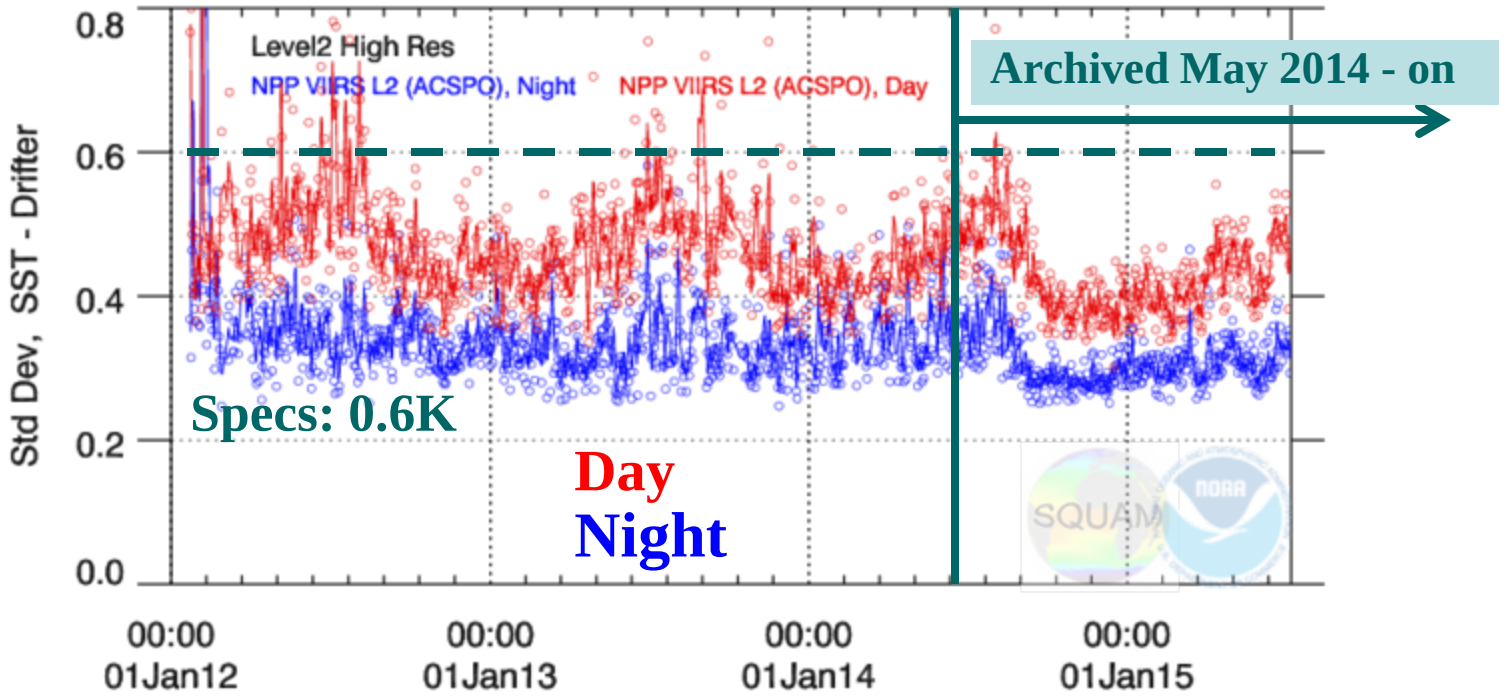
Artifacts in time series

Archived May 2014 - on



- ACSPO SST only archived from May 2014 – pr
- SST gradually improved due to SST algorithms improvements
- Every 3 month, “global warming” of ~0.3 K occurs, due to WUCDs
- Reprocessing with UW will produce uniform time series (except WUCD)

VAL STD: Real Time ACSPO VIIRS L2



- STD gradually improved with time as ACSPO SST algorithms matured
- Current STDs ~0.35 K (Night); ~0.45K (daytime) are well within specs
- STD smaller at night (VIIRS skin SST being closer to bulk buoy)
- Reprocessing with UW underway to produce uniform time series

ACSPO SST Users (L4 producers)

- **Active Users (assimilate in L4 analyses)**
  - Canadian Met Centre, CMC02 L4 SST (Dorina Surcel-Colan, Bruce Brasnett)
  - NOAA geo-polar blended L4 SST (Andy Harris, Eileen Maturi)

- **Advanced Users (testing)**
  - Met Office, OSTIA L4 SST (Emma Fiedler)
  - Australian Bureau of Meteorology, GAMSSA/RAMSSA L4 SSTs (Helen Beggs)

- **Users who established access to data (exploring)**
  - NCEP MMAB, RTOFS and RTG SST (Carlos Lozano, Avichal Mehra, Bob Grumbine)
  - JPL, MUR L4 SST (Mike Chin)
  - JMA, MGDSST L4 (Masakazu Higaki, Toshiyuki Sakurai, Shiro Ishizaki)
  - NCEI, Reynolds SST (Viva Banzon)

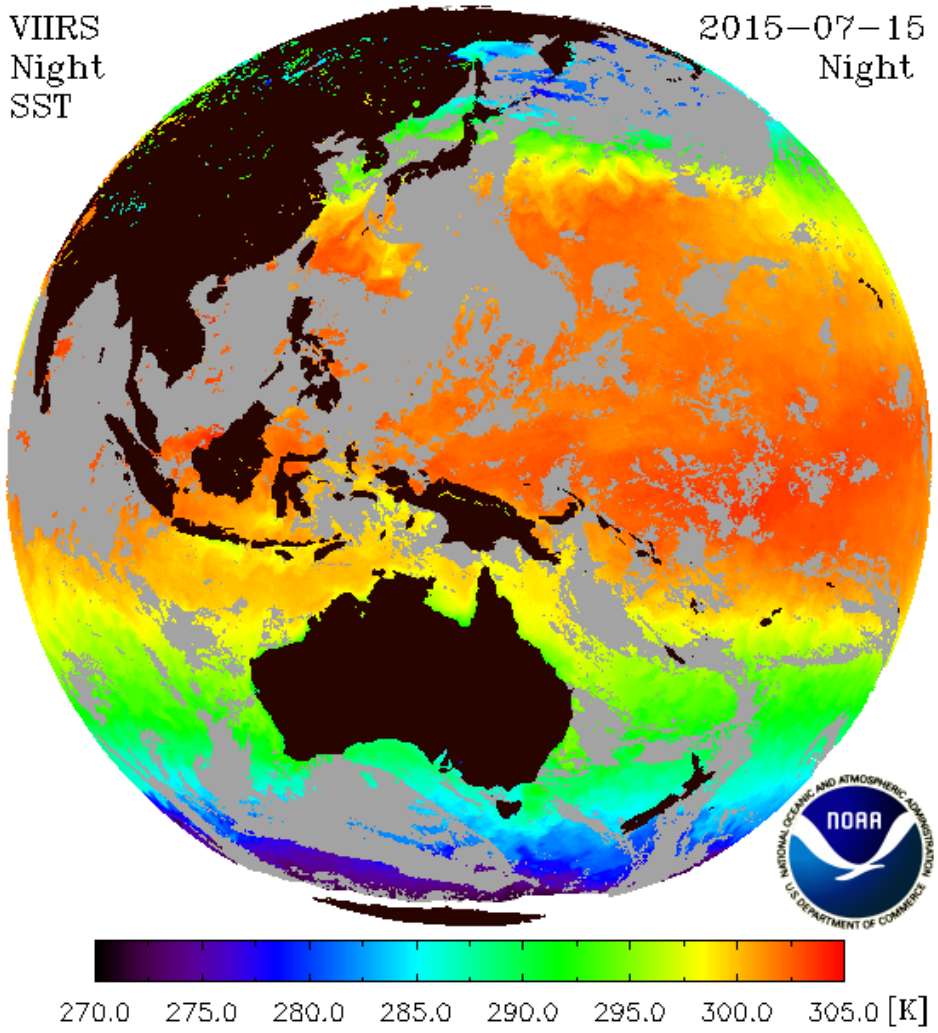
- **Tasks in 2015-2017**
  - Work with current users (to evaluate L3U product, and new error characterization)
  - Work with emerging users, to assess the impact of VIIRS SST on L4 analyses

J1 Readiness: Algorithm, Cal/Val Plans

- ✓ **J1 Algorithm**
  - ACSPO code available by J1 launch will be implemented with J1 VIIRS
- ✓ **Pre-launch Cal/Val**
  - Analyze proxy data: S-NPP VIIRS, AVHRR (FRAC and GAC), MODIS, AHI/ABI
  - Continue ACSPO development: Release ACSPO v2.50/2.60 in 2016
  - Sustain SST Cal/Val Tools: SQUAM, MICROS, *i*Quam
- ✓ **Post-launch Cal/Val**
  - Early Orbit Checkout (EOC): Emphasis on sensor performance / Work w/SDR to resolve
  - Intensive Cal/Val Phase (ICV): Emphasis on SST performance
  - Long-Term Monitoring (LTM): Create match-ups w/iQuam; Add J1 to SQUAM/MICROS
  - Based on evaluation and monitoring, refine SST algorithms (recalculate coefficients, etc)
- ✓ **Cal/Val Timelines (cryoradiator doors open at T0)**
  - Assuming that performance of J1 VIIRS is comparable to that on S-NPP:
    Beta: T0+3mo; Provisional: T0+6mo; VAL: T0+12mo

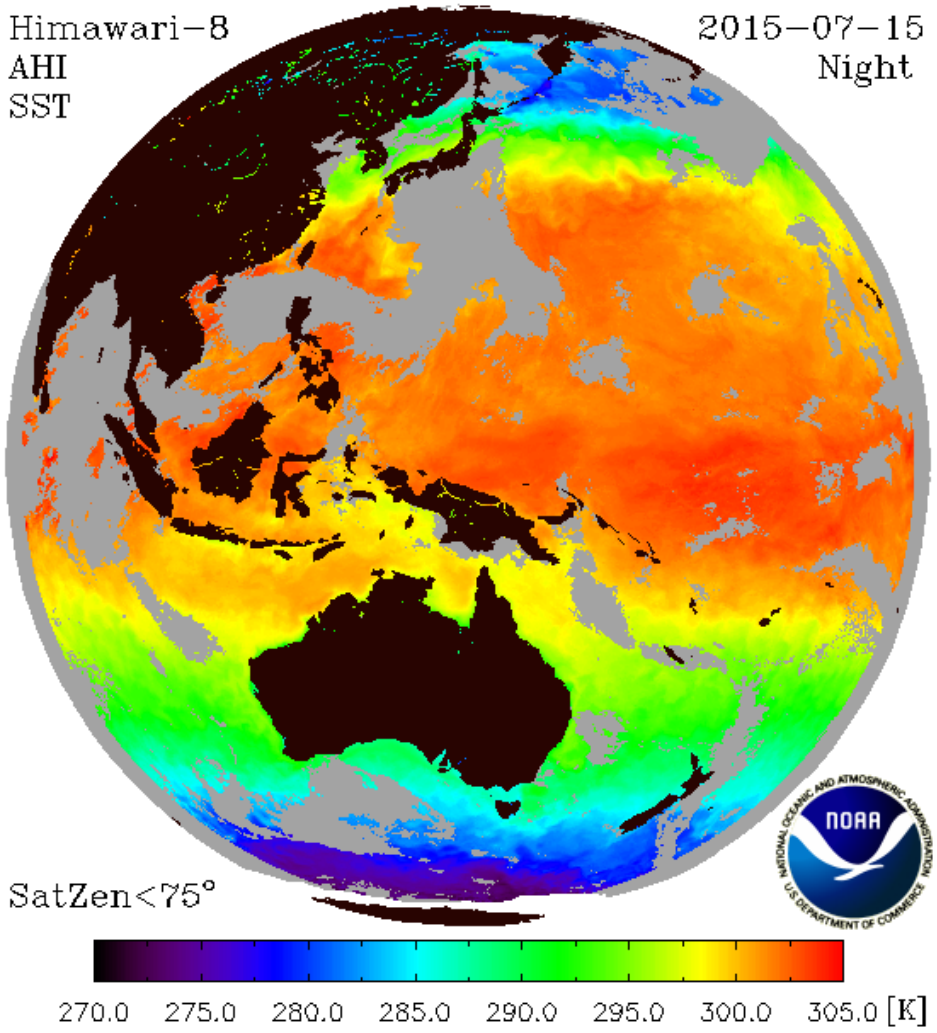
VIIRS Night SST Composite in Himawari-8 Domain

- VIIRS SST composite in H8 domain
- Large areas are cloudy during S-NPP overpass @ 1:30 am



Himawari-8 Night SST Composite

- Enterprise ACSPO algorithm applied to H8
- AHI composite covers larger domain, due to 10min refresh rate
- SST Team will be ready for J1 and GOES-R launch



ACSPO Priorities in FY16

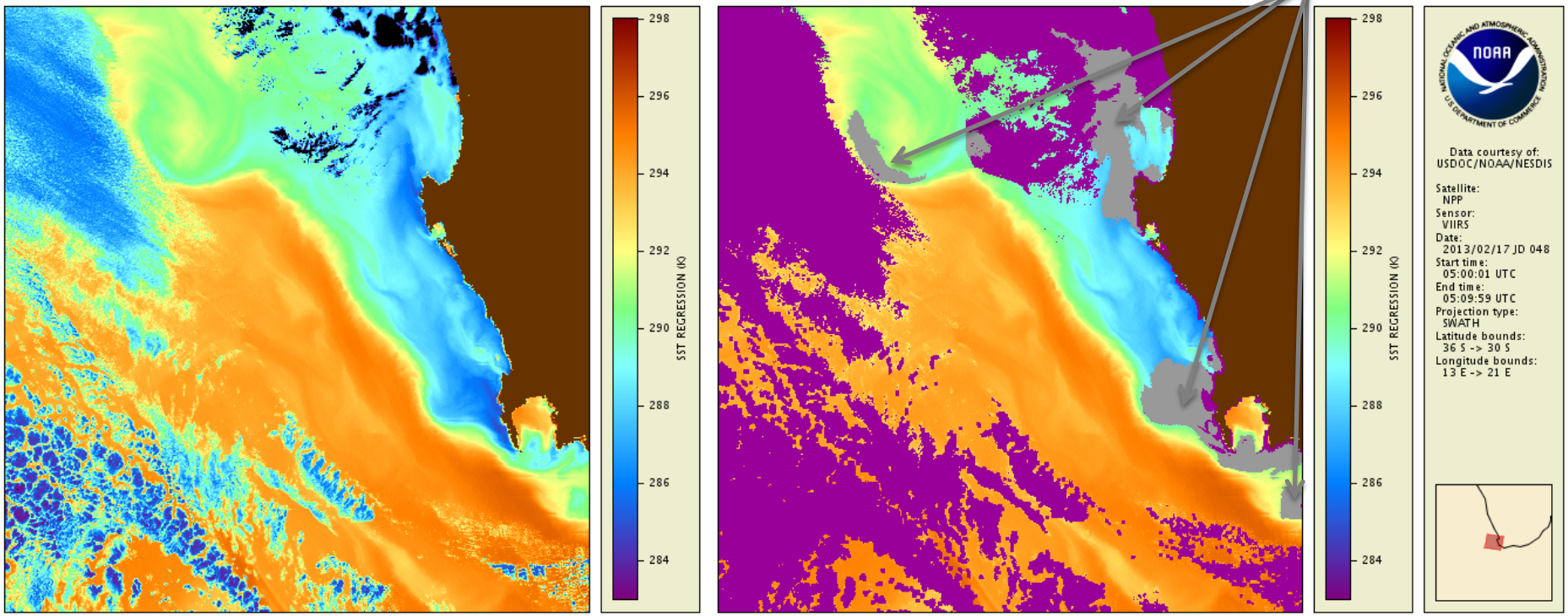
1. (Prerequisite for tasks 2-3) Improve BT and SST Imagery: resample (“de-bowtize”) and restore pixels in bow-tie areas deleted onboard – ACSPO v2.50 (Mar 2016)
2. (Main Objective) Improve clear sky mask based on pattern recognition approach: Focus on dynamic, coastal, and high-latitude areas – ACSPO v2.60 (Dec 2016)
3. (By-product of pattern recognition) Produce Ocean Thermal Fronts – ACSPO v2.60 (Dec 2016)

Why Pattern Recognition is Important?

1. All current “in-pixel” IR clear-sky masks tend to be overly conservative. ACSPO is on a less conservative side, but still produces quite a few “false alarms” (especially in the dynamic, coastal, and high-latitude areas)
2. As a result, some areas (with variable SST, or colder than surrounding waters, or colder than expected “L4” SST) may remain unobserved for extended periods of time
3. These areas are most interesting to users – in particular, producers of hi-res L4 analyses (which may rely on climatological SSTs here)
4. VIIRS imagery has excellent potential. We plan to fully realize it, to satisfy wide range of SST users

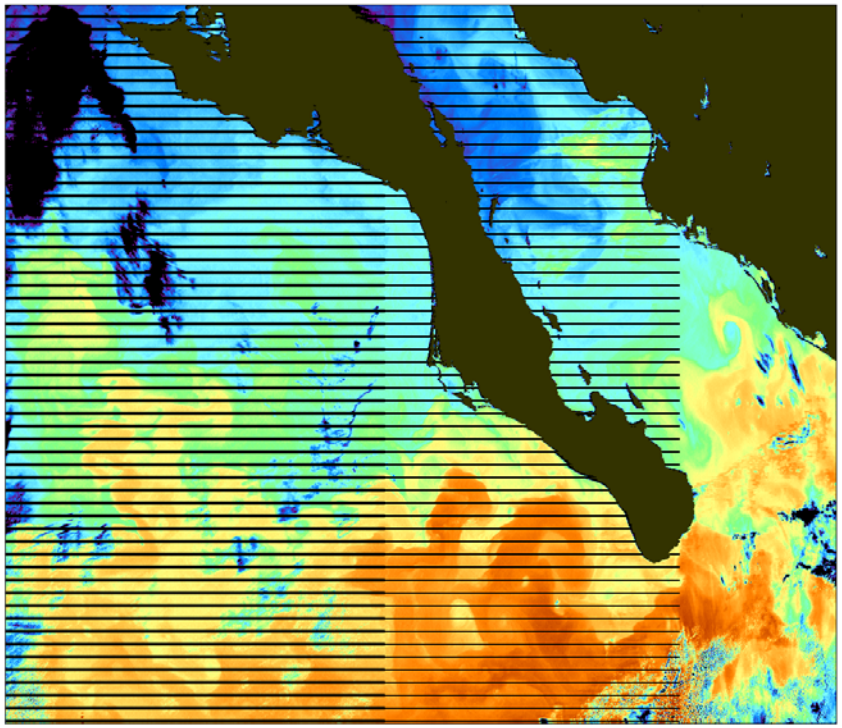
ACSPO v2.60: Improved Clear-Sky Mask

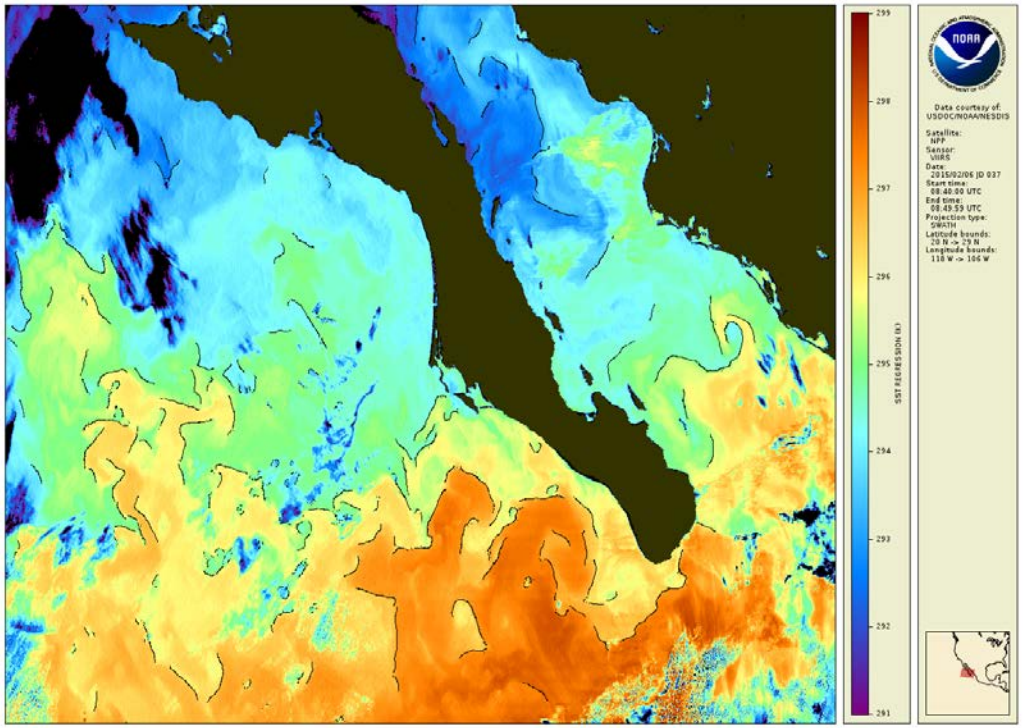
S. Africa, 02/17/2013 (day pass)



Cold upwelling and some other dynamic and coastal areas (shown in grey) are misclassified by the current ACSPO as cloud

ACSPO v2.60: Ocean Fronts





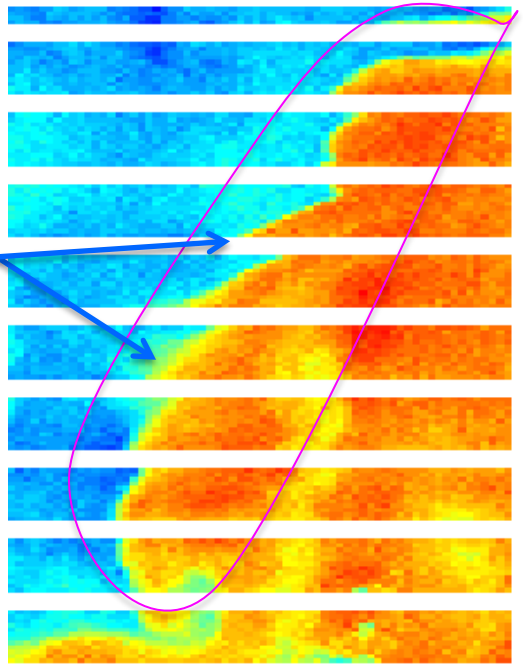
Original VIIRS SST imagery

Resampled imagery with oceanic thermal fronts superimposed

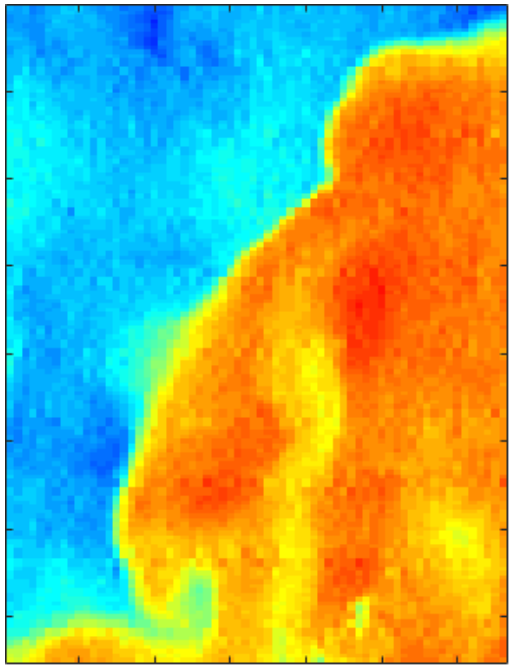
ACSPO v2.50: Prerequisite to v2.60

- VIIRS swath data have bow-tie distortions, onboard deletions and aggregations
- This creates spatial discontinuities and artifacts in the gradient fields, and prevents implementation of pattern recognition algorithms
- ACSPO v2.50 will fix these artifacts as best as we can but.. **we strongly recommend against bow-tie deletions on J1 & beyond!!**

Bow-tie distortions and deletions



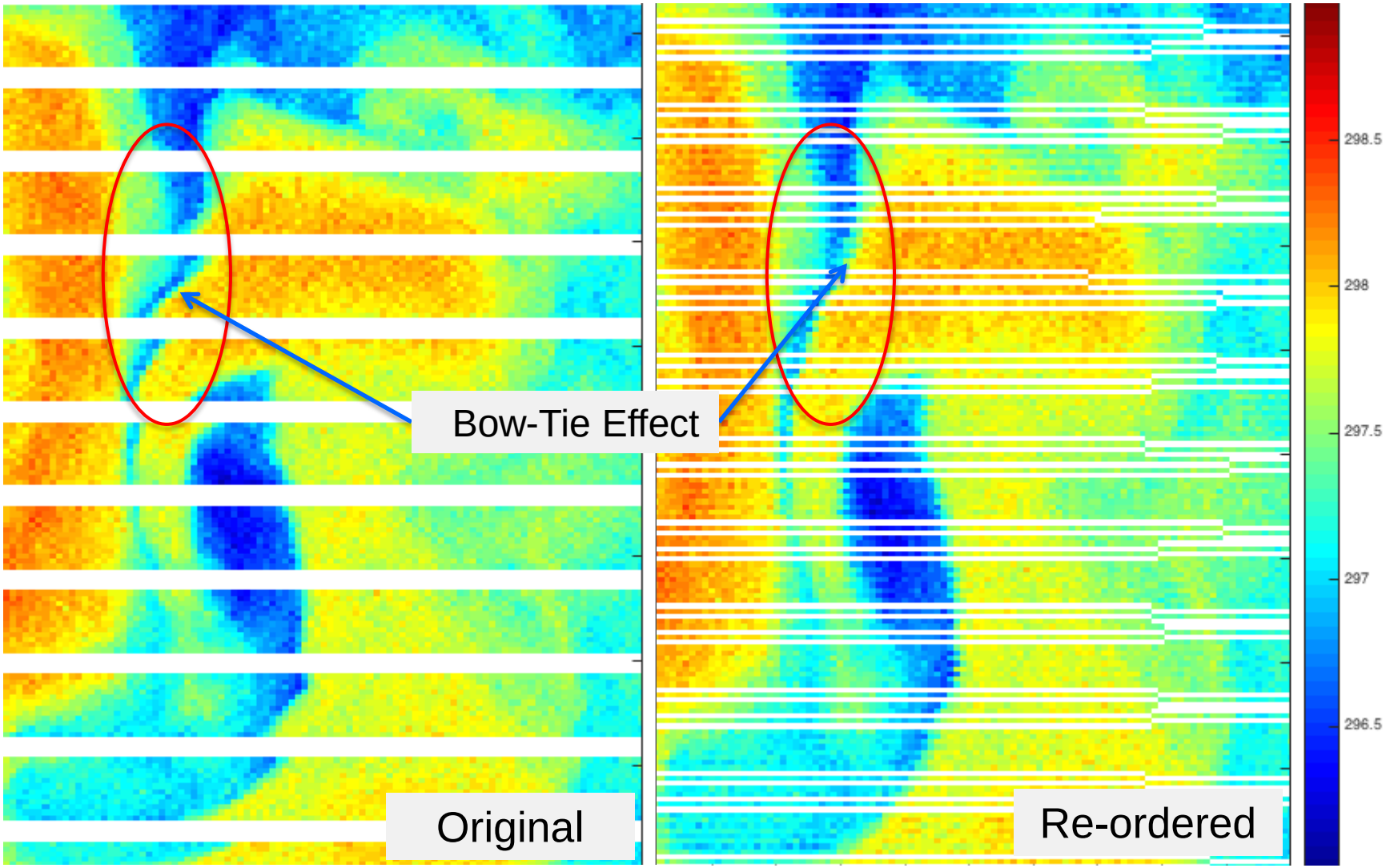
Current SST



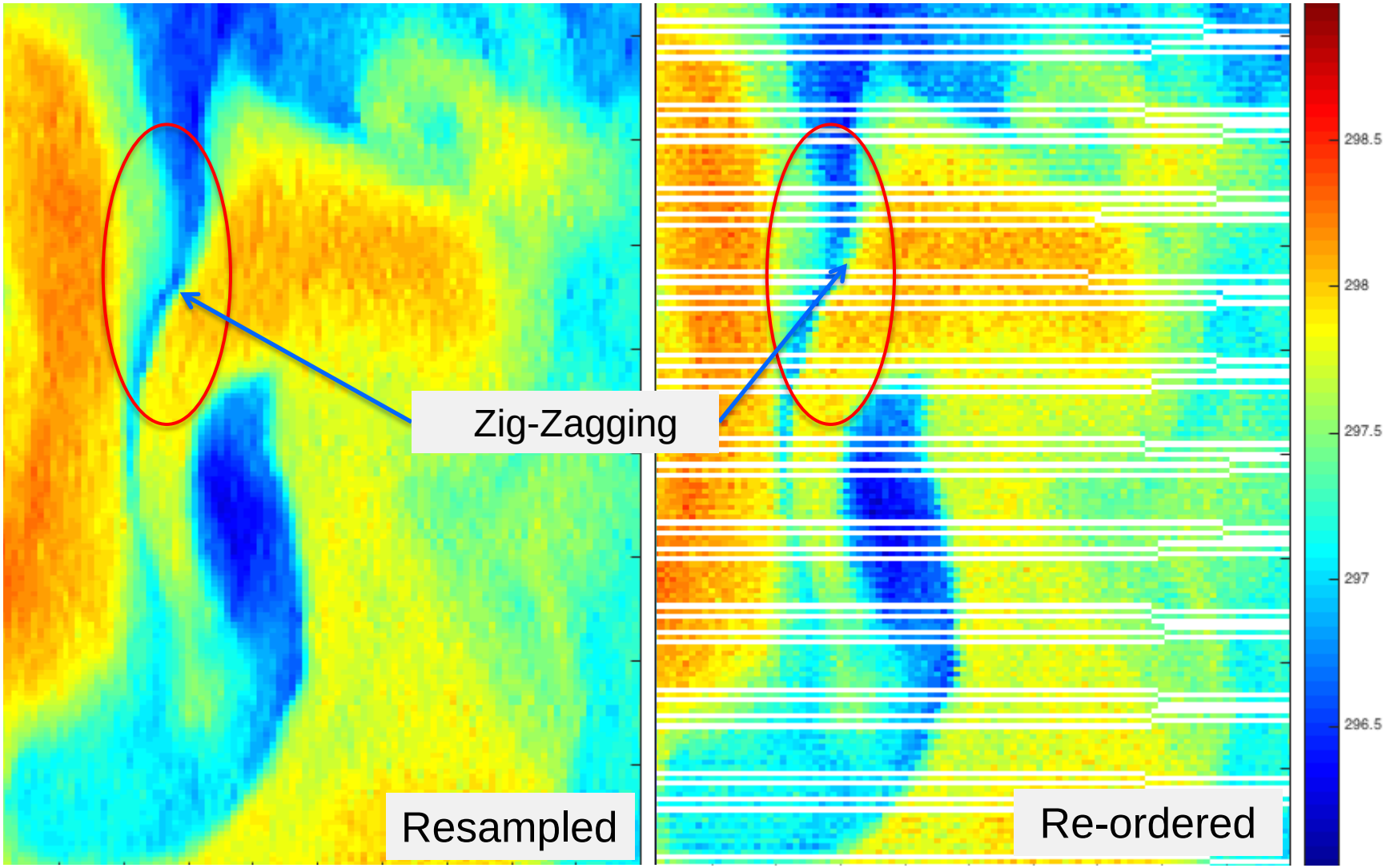
SST in ACSPO 2.50

JPSS SST

ACSPO v2.50



ACSPO v2.50



Other SST Tasks in 2016

Complete VIIRS RAN1

- ✓ Display online in SQUAM and MICROS, QC, fix remaining issues
- ✓ Archive with NCEI Silver Spring

Sustain near-real time global VAL/Monitoring online

- ✓ Sustain match-ups with in situ SSTs (*i*Quam)
- ✓ Monitor in SQUAM and MICROS

Focus on Regional Validation

- ✓ Recommended by JPSS PO at Validated Review (Sep 2014)
- ✓ ACSPO Regional Monitor for SST (ARMS) is being developed

Work with VIIRS SST Users (L4 producers)

- ✓ Established users: Test improvements (L3U, error characterization)
- ✓ New/Emerging Users: Test improvements from assimilating VIIRS SST

Issues to Discuss at the Meeting

VIIRS Warm-Up / Cool-Down exercises affect SST

- ✓ Fix RDR to SDR code, to minimize the ~0.3K “global warming” artifacts
- ✓ Discuss with JPSS PO, STAR JPSS Management, SDR Team

ACSPO VIIRS Reanalysis (RAN)

- ✓ Unfunded “demo” RAN-1 underway with UW group (L. Gumley)
- ✓ Results look promising, need a sustained support
- ✓ Discuss with JPSS PO, UW, STAR JPSS Management

VIIRS L1.5 product? (bow-ties filled in, geo-rectification applied)

- ✓ SST will “fix” SDR in ACSPO v2.50 for pattern recognition analyses
- ✓ If you are a VIIRS data producer or user, interested in a L1.5 – please provide feedback to SST/SDR/Imagery/JSTAR Leads
- ✓ SST Team plans discuss w/JPSS PO, JSTAR, SDR, Imagery and other EDR Teams during the meeting