



SST Feedback to VIIRS SDR

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with inputs from STAR SST Team

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NOAA/NESDIS, CSU/CIRA, GST

Summary: VIIRS Performance for SST

Overall, VIIRS is a very good, state of the art sensor for SST

- ✓ Radiances are stable (critical for regression SST)
- ✓ Radiances consistent w/AVHRR/MODIS (critical for physical SST)
- ✓ VIIRS imagery comparable or better than Aqua MODIS
- ✓ VIIRS striping comparable or better than Aqua MODIS

Striping still affects SST

- ✓ Striping in VIIRS BTs is within specs. However, it
 - Affects VIIRS cloud mask
 - Gets amplified in SST
 - Affects SST downstream products (SST gradients)
- ✓ SST Team works with SDR to reduce striping based on 1st principles
- ✓ Also, SST Team explores destriping in BTs to improve SST EDR

Suggested Improvement

- ✓ Fill in radiances in bow-tie areas. (Currently, filled in with NaNs – suggest put real numbers, while keeping the “bow-tie” flag on)

VIIRS, MODIS, and AVHRR Radiance Monitoring in MICROS

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

Liang, Ignatov: Stability & Radiometric Consistency between AVHRR, MODIS, & VIIRS in SST bands. JGR, Jun 2013.

M-O Biases and Double Differences (“DD”)

Model minus Observation (“M-O”) Biases

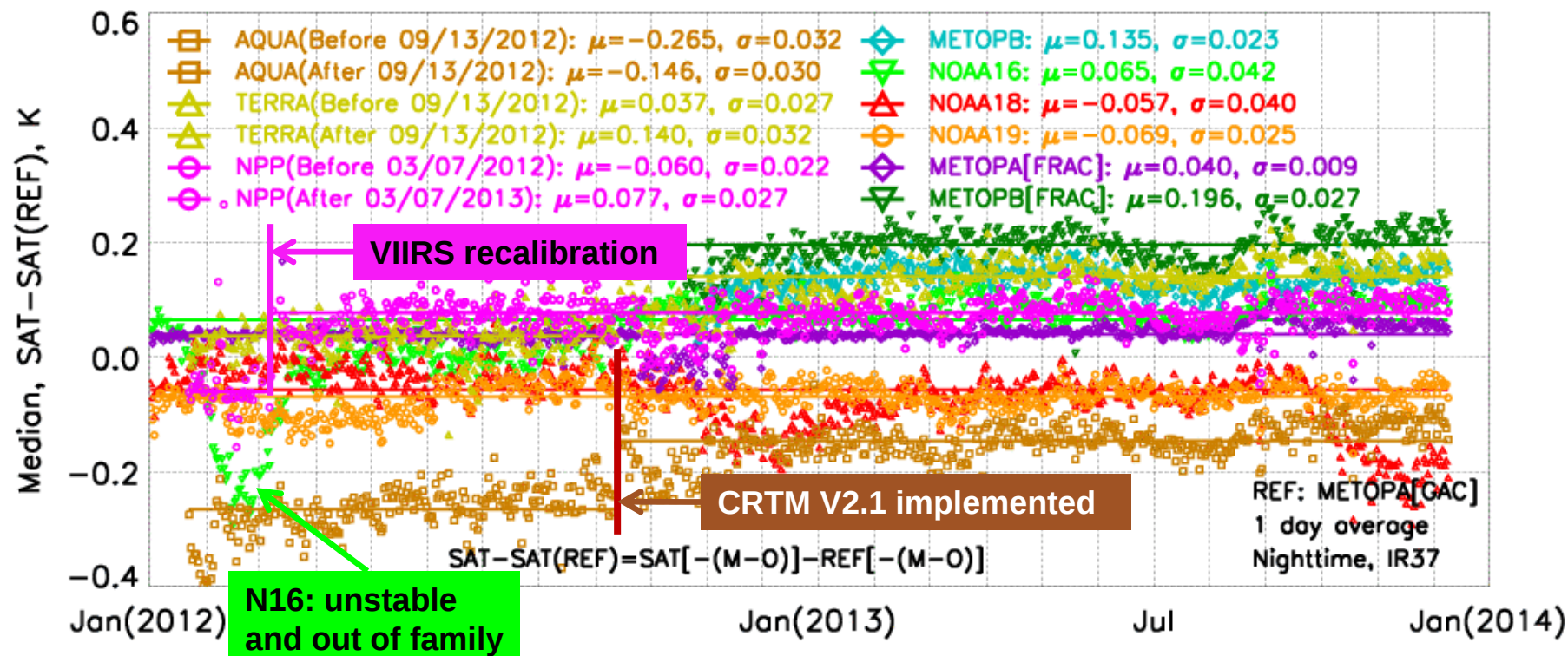
- **M (Model)** = Community Radiative Transfer Model (CRTM) simulated TOA Brightness Temperatures (w/ Reynolds SST, GFS profiles as input)
- **O (Observation)** = Clear-Sky sensor (AVHRR, MODIS, VIIRS) BTs

Double Differences (“DD”) for Cross-Platform Consistency

$$SAT - REF = SAT[-(M - O)] - REF[-(M - O)]$$

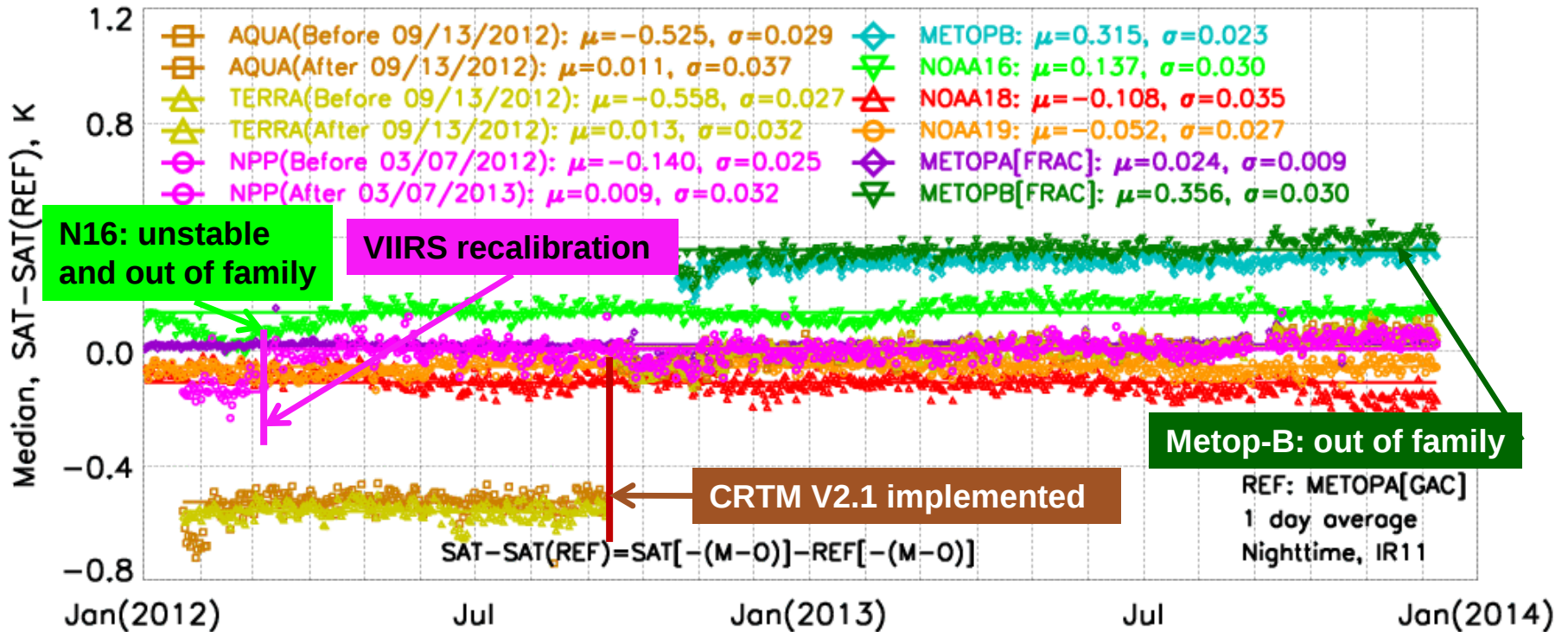
- “M” used as a “Transfer Standard”
- DDs cancel out/minimize effect of systematic errors & instabilities in BTs arising from e.g.
 - Errors/Instabilities in Reynolds SST & GFS
 - Missing aerosol
 - Possible systemic biases in CRTM
 - Updates to ACSPO algorithm

Double Differences in IR37 (VIIRS M12)



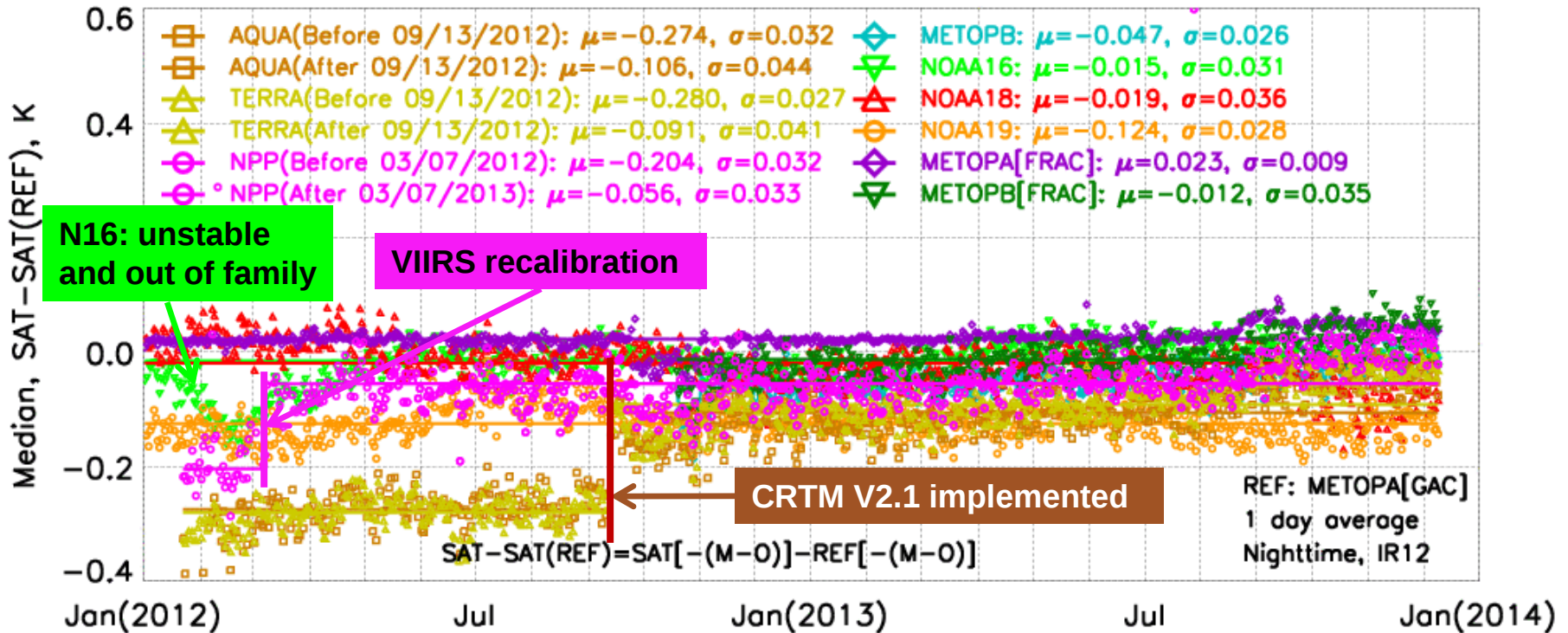
- All sensors are typically within $\pm 0.1K$ (except Metop-B and Terra/Aqua MODIS)
- VIIRS Cal change 7 Mar 2012 reset BT@M12 by $+0.14K$ – now better in family
- In Sep 2012, CRTM changed from V2.02 to v2.10 – affected DDs (N.B.: No change to sensors BTs)
- CRTM V2.1 implemented 13 Sep 2012: Two MODISs shifted up by $0.1K$, better bracket family now
- Metop-B out of family by $\sim +0.15 K$ (likely due to suboptimal CRTM coefficients used in CRTM V2.1)

Double Differences in IR11 (VIIRS M15)



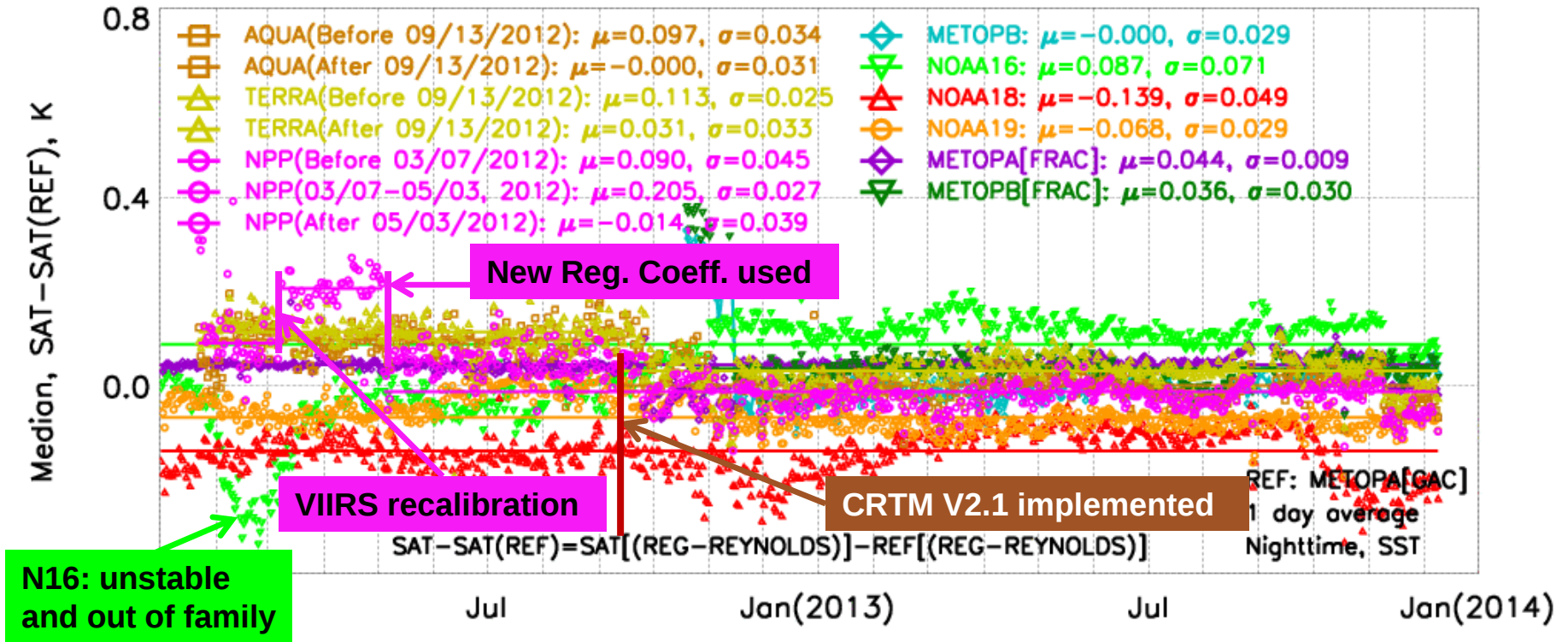
- All AVHRRs (except N16 and Metop-B), MODISs, and VIIRS are now consistent to within $\pm 0.1K$
- VIIRS Cal change 7 Mar 2012 reset BT@M15 by $+0.14K$ – now better in family
- Before 13 Sep 2012: Terra & Aqua/MODIS were biased by $-0.6K$ (suboptimal CRTM coeffs in v2.02)
- Both are back in family now, after CRTM V2.1 implemented on 13 Sep 2012
- Metop-B out of family by $\sim +0.3 K$ (likely due to suboptimal CRTM coefficients in CRTM V2.1)

Double Differences in IR12 (VIIRS M16)



- All AVHRRs, MODISs, and VIIRS are now consistent to within $\pm 0.1K$
- VIIRS Cal change 7 Mar 2012 reset BT@M16 by $+0.14K$ – now better in family
- Terra and Aqua/MODIS were out of family by $-0.3K$, due to suboptimal CRTM coefficients in V2.02
- Both are back in family now, after CRTM V2.1 implemented on Sep. 13, 2012
- Metop-B in family, but this may change once CRTM coefficients used in CRTM V2.1 are updated

Double Differences in SST



- All AVHRRs, MODISs and NPP/VIIRS SSTs are consistent to within $\pm 0.1K$
- As a result of VIIRS Cal Change on 7 Mar 2012, VIIRS SST went out of family
- Was brought back in family when new SST coefficients implemented 3 May 2012
- CRTM update resulted regression SSTs more noise, and the new coefficients have been implemented since Dec. 2012. More data is needed to understand their performance

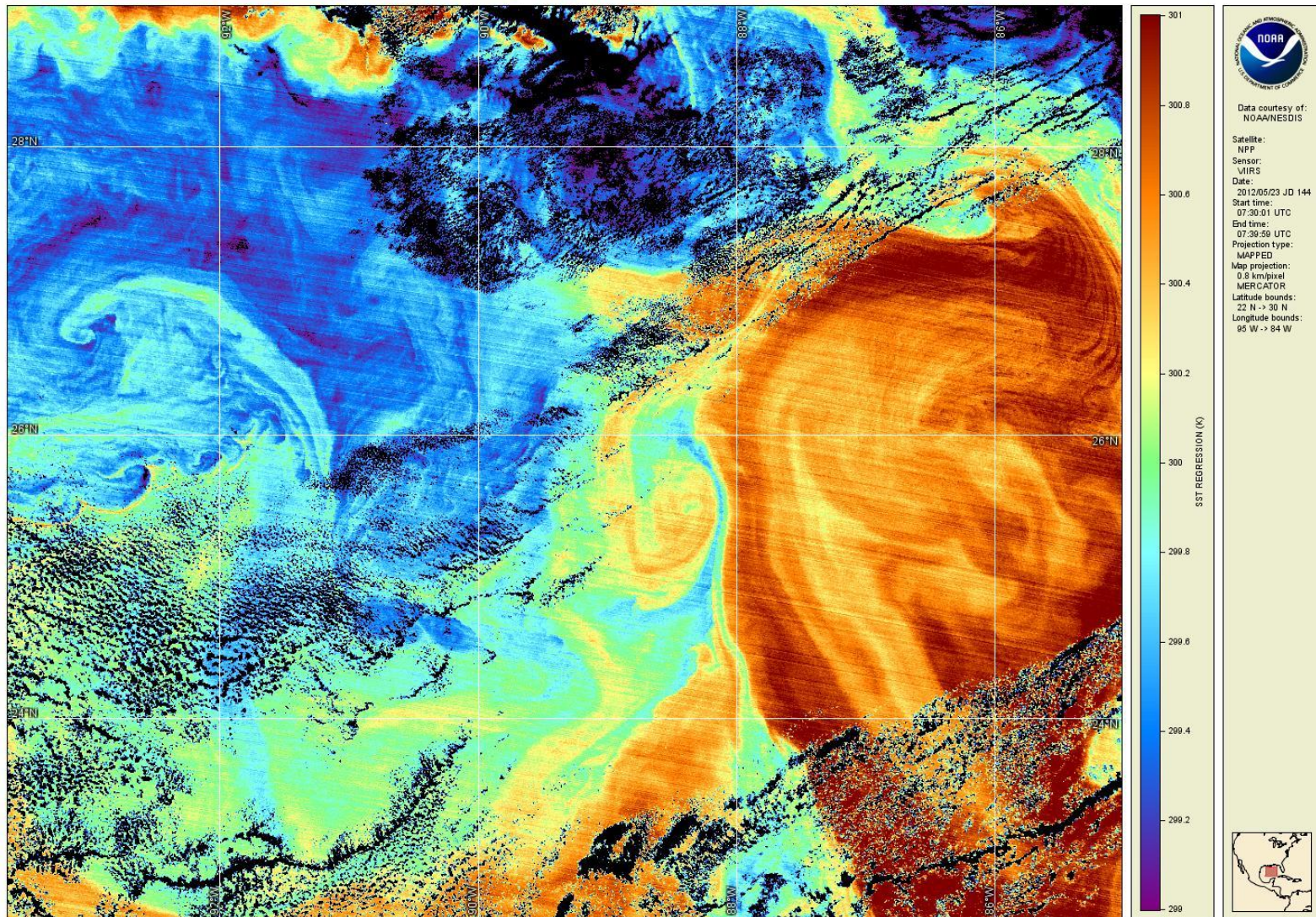
**Quality of VIIRS SST
imagery is very good**

**Example: Gulf of Mexico
23 May 2012 (Mapped)**

NPP/VIIRS ACSPO SST 23 May 2012

0730-0740 UTC – Night – Mapped onto 0.8km grid

ACSPO_V2.10_NPP_VIIRS_2012-05-23_0730-0740_20120526.053954.hdf

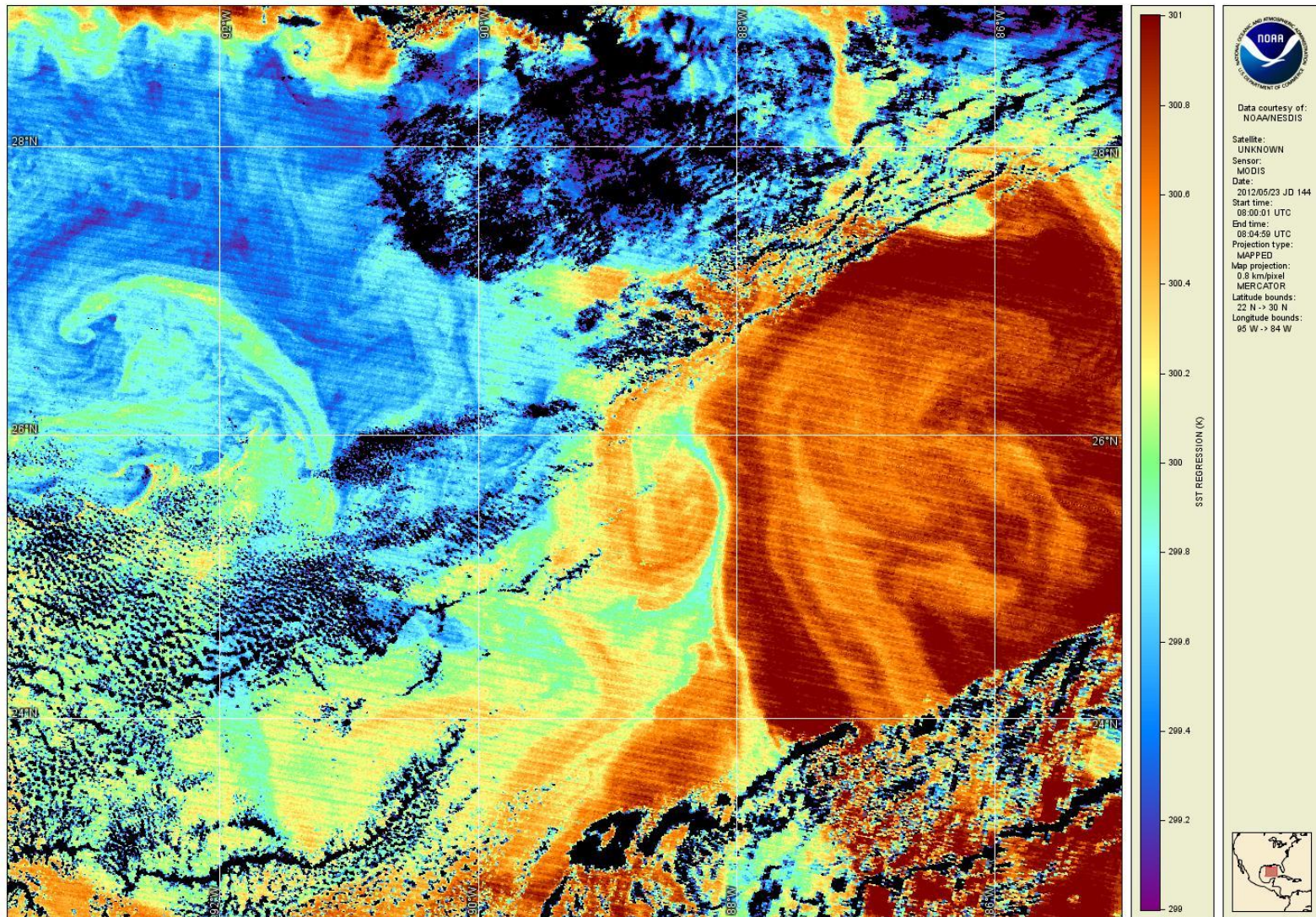


19 December 2013

Aqua/MODIS ACSPO SST 23 May 2012

0800-0805 UTC – Night – Mapped onto 0.8km grid

ACSPO_V2.10_AQUA_MODIS_2012-05-23_0800-0805_20120527.093405.hdf



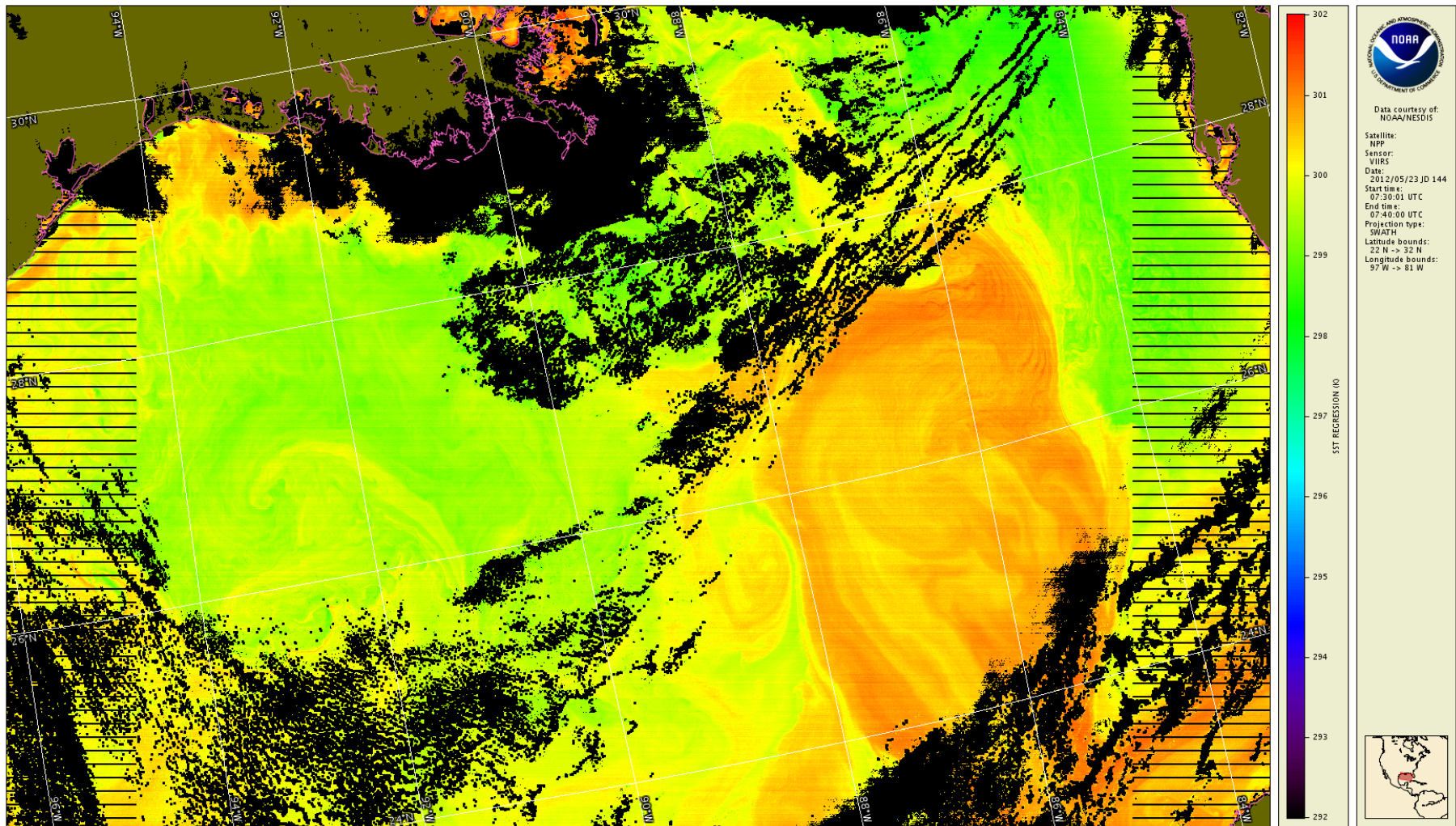
19 December 2013

Swath imagery affected by bow-tie

NPP/VIIRS ACSPO SST 23 May 2012

0730-0740 UTC – Night – Swath Projection

ACSPO_V2.10_NPP_VIIRS_2012-05-23_0730-0740_20120526.053954.hdf



Bow-ties in VIIRS imagery require pre-processing before standard swath display SW can be used

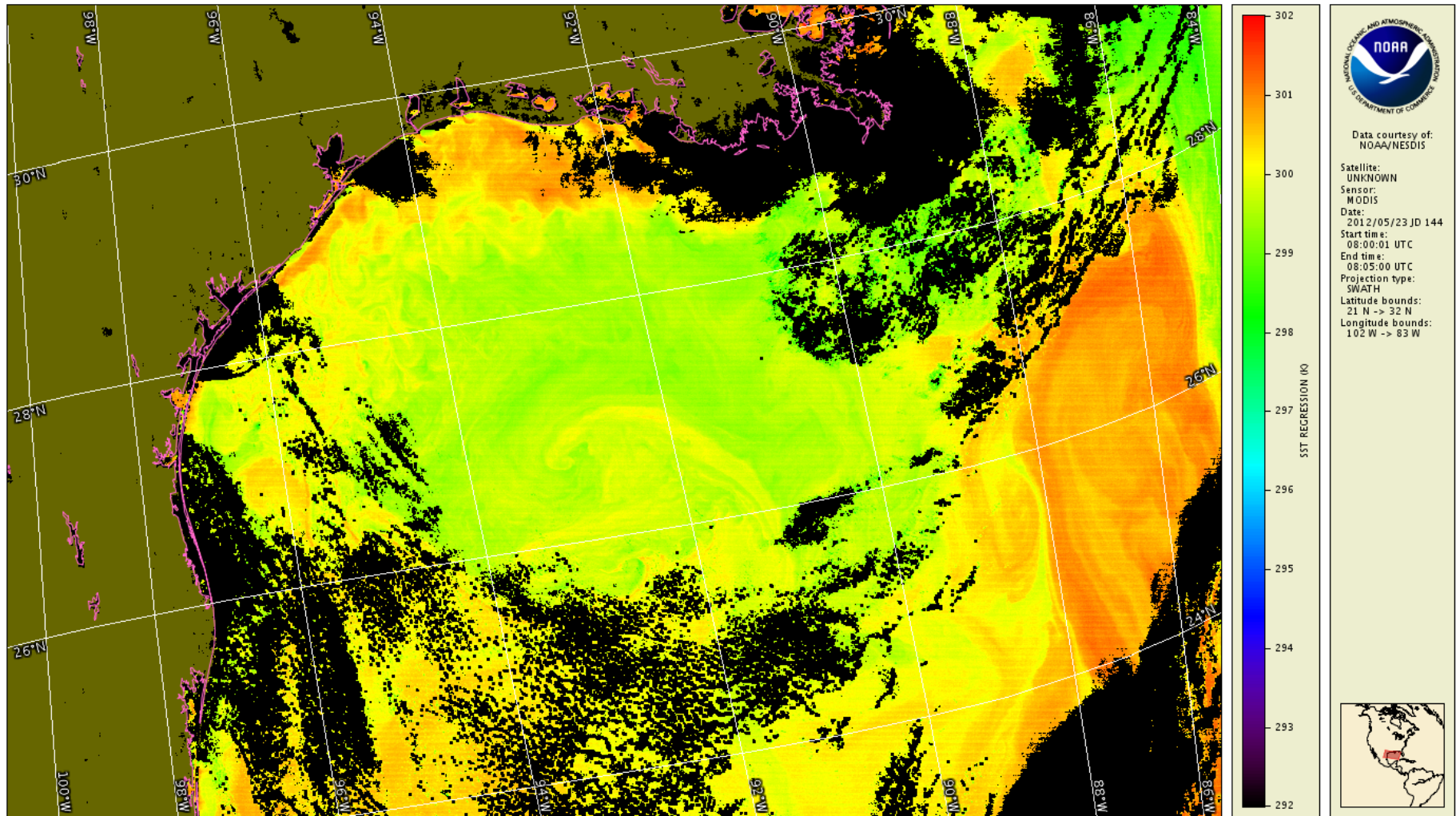
19 December 2013

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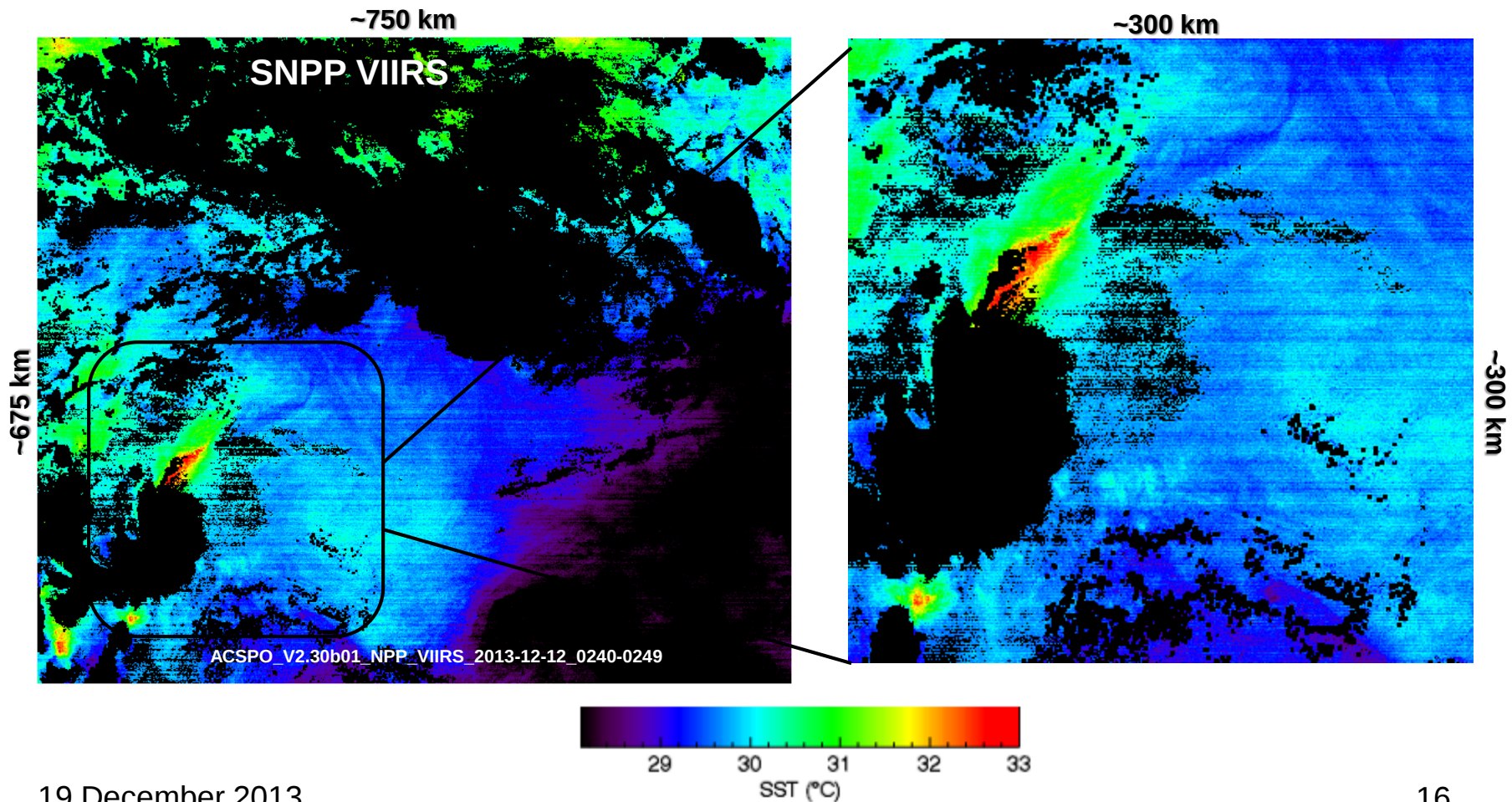


We suggest that bow tie areas be filled with radiances in SDRs, keeping the bow-tie flag “on”

Effect of VIIRS Striping on Cloud Mask, SST, and downstream products (gradients)

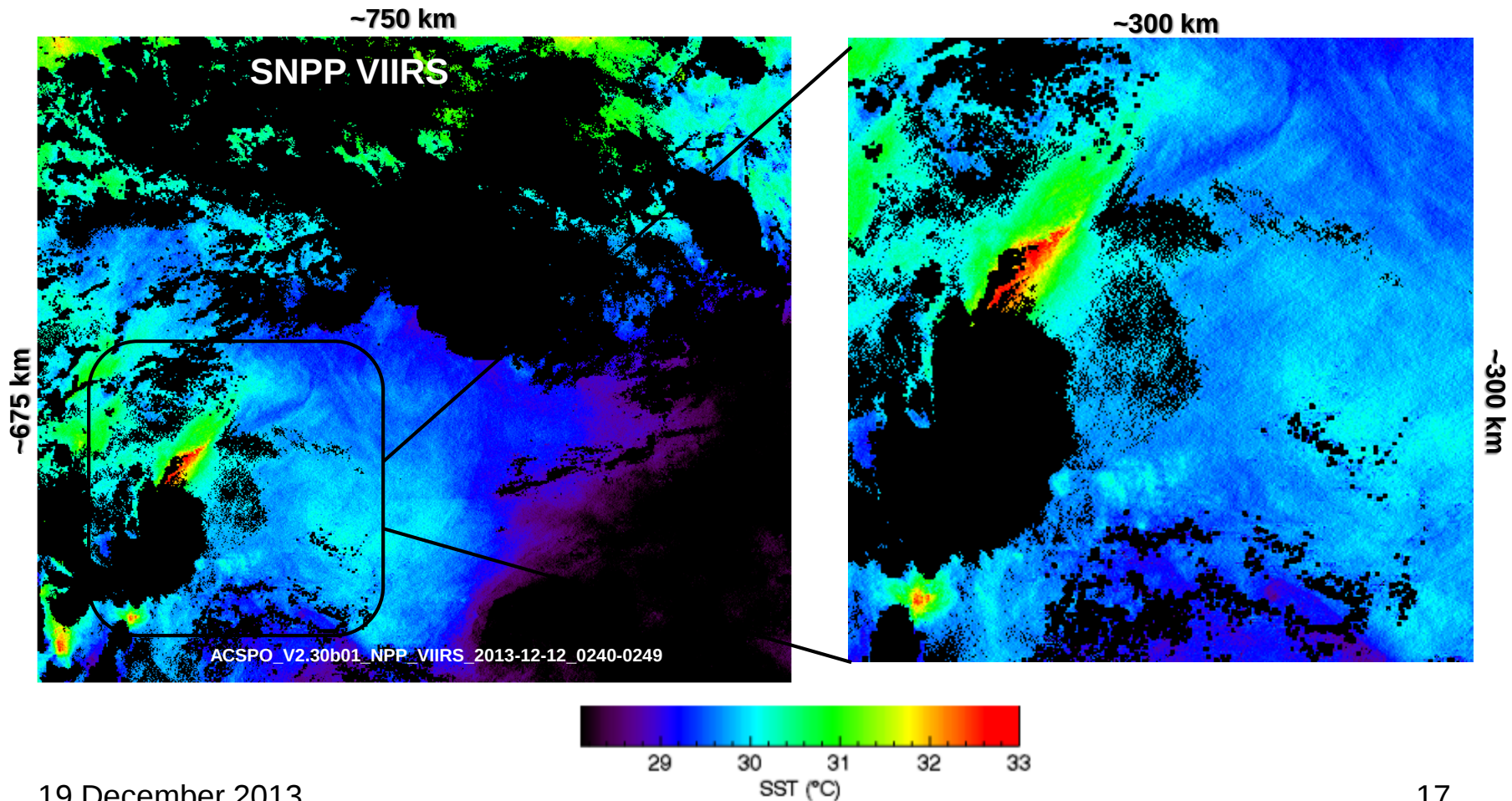
Cloud Mask from original SDR

South Pacific Ocean (Lat = 10-17S, Lon = 159-168E)



Cloud Mask from destriped SDR

South Pacific Ocean (Lat = 10-17S, Lon = 159-168E)

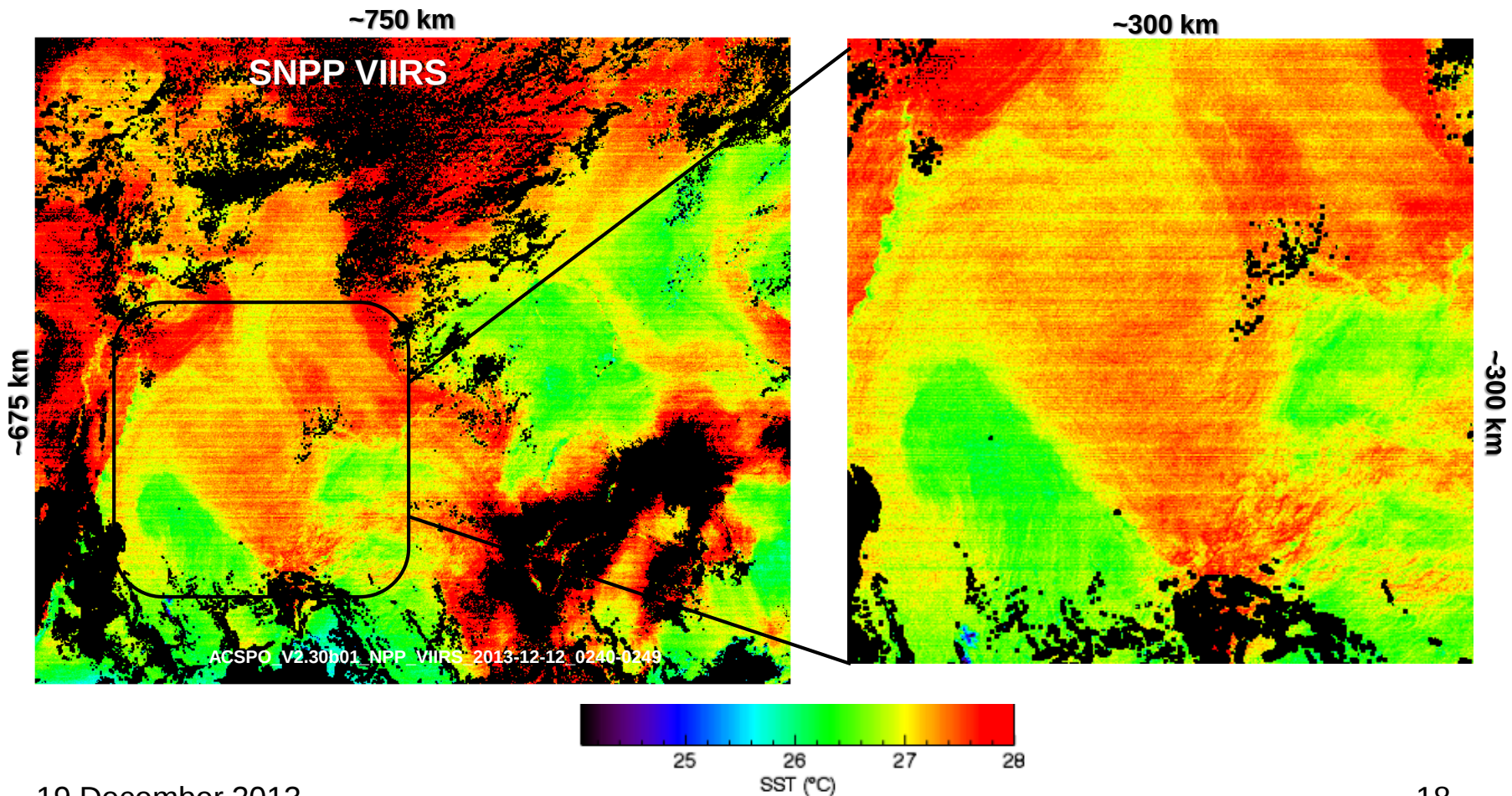


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SST from original SDR

South Pacific Ocean (Lat = 15-23S, Lon = 155-165E)

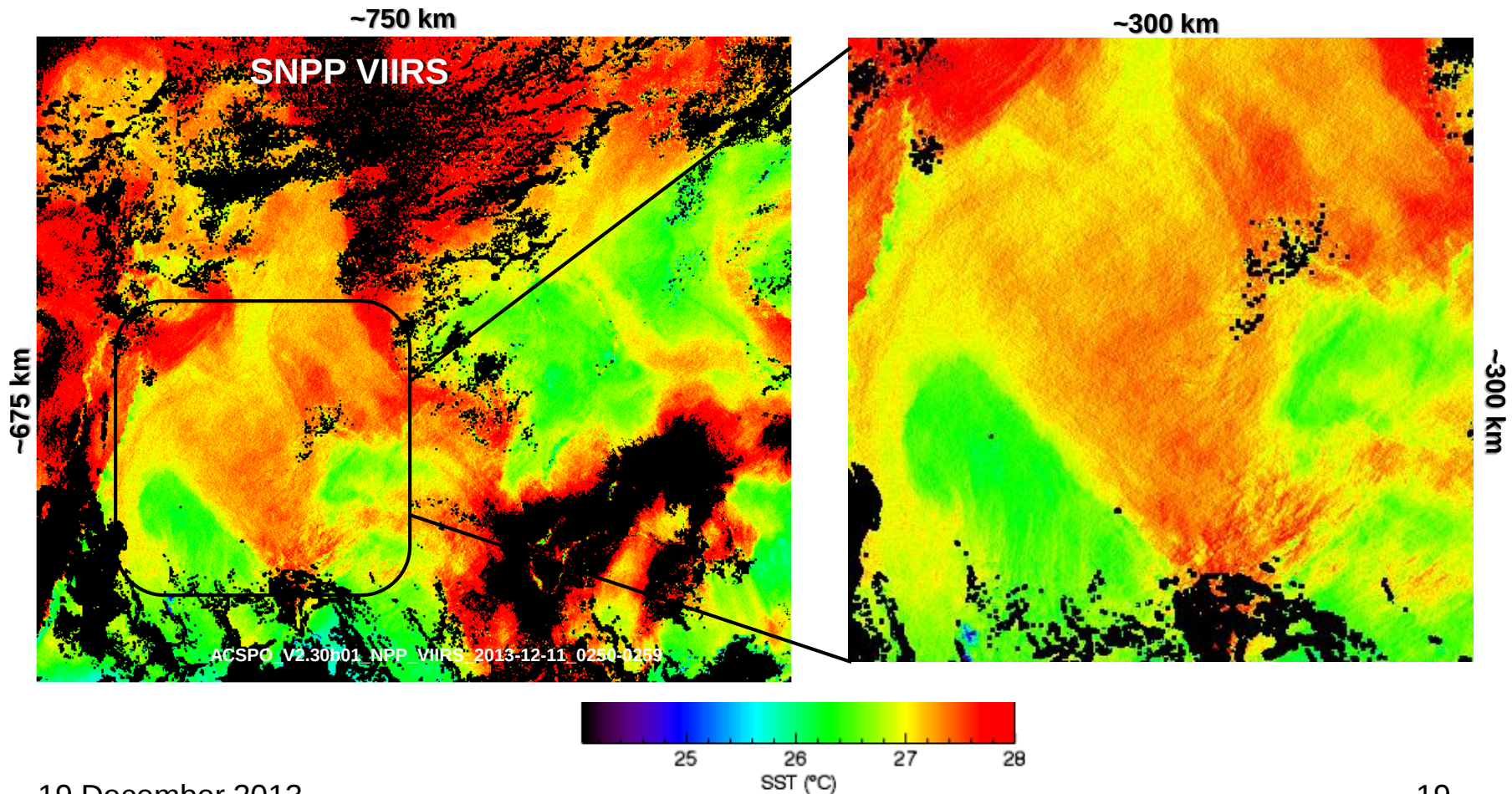


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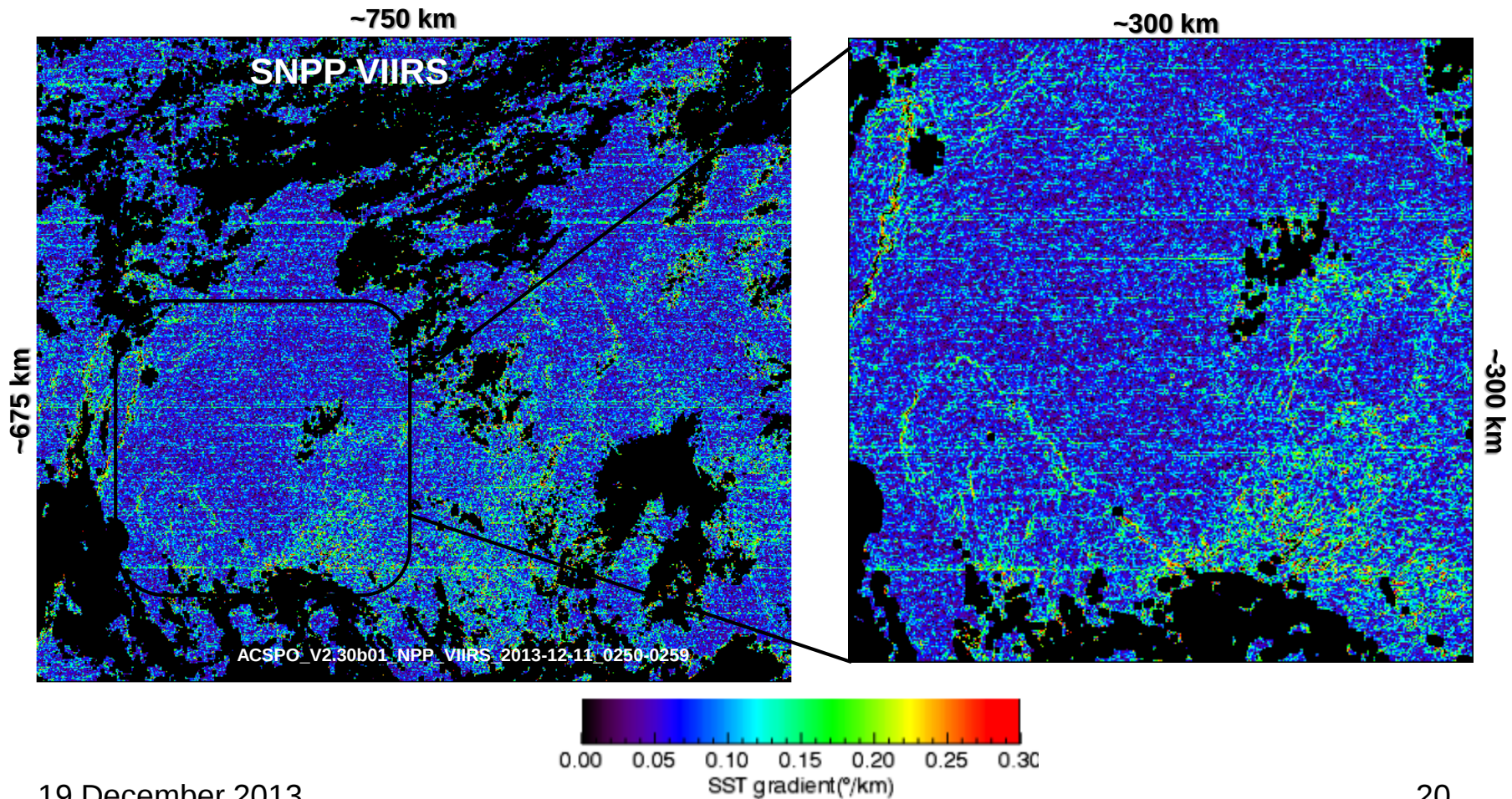
SST from destriped SDR

South Pacific Ocean (Lat = 15-23S, Lon = 155-165E)



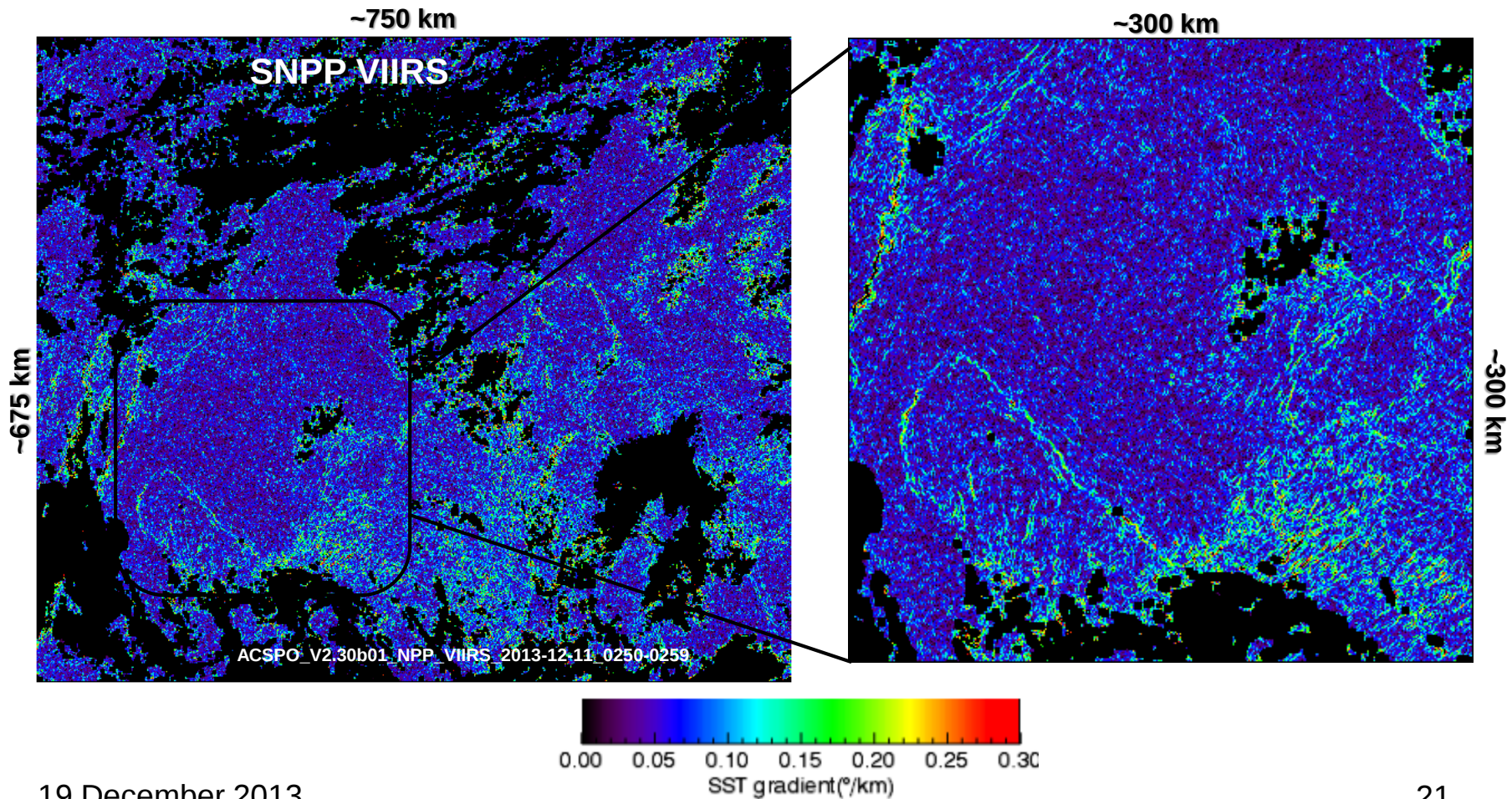
SST gradients from original SDR

South Pacific Ocean (Lat = 15-23S, Lon = 155-165E)



SST gradients from destriped SDR

South Pacific Ocean (Lat = 15-23S, Lon = 155-165E)



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Conclusion

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