VIIRS J1 - J4 status update

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VIIRS reminder

Provides visible and infrared imagery and global observations of land, atmosphere, cryosphere and oceans

- Generates critical environmental products about snow and ice cover, clouds, fog, aerosols, fire, smoke plumes, dust, vegetation health, phytoplankton abundance and chlorophyll
- Extends and improves measurements initiated by AVHRR and MODIS
  - Better spatial resolution
  - Larger swath
  - Day/Night Band
What you should get from this talk

- VIIRS is primarily an operational sensor but is also part of a legacy of sensors to understand earth-atmosphere system

- S-NPP, J1, J2, J3, J4 have same basic design but will not be identical

- The more sensors we build, the more we learn about behavior of current systems and the future builds

- J1 VIIRS is well understood and should provide a worthy follow-on to S-NPP VIIRS

- J2 is on its way to being as well understood as J1

- J3 and J4 have already begun component-level hardware assembly
Overview of pre-launch testing objectives

Characterize overall performance and identify potential noncompliance issues

- Testing includes radiometric, geometric, and spectral performance
- Component and Sub-system Level
- Sensor Level ambient, pre-thermal vacuum (TVAC), TVAC, and post-TVAC
- Observatory Level
- Ensure sensor performance meets design requirements
- Check that sensor data quality will achieve overall science objectives
- Allows key sensor performance parameters to be derived for on-orbit operation and calibration
- Support mitigation strategies to address noncompliance issues
Pre-launch characterization/calibration

Tests also include evaluation of the full system including onboard calibrators

- Radiometric - SNR/NEdT, detector gains and dynamic range
- Spectral - In-band and out-of-band relative response
- Spatial and geometric including band-to-band registration, modulation transfer function, and pointing
- Thermal testing
- Electromagnetic interference
- Response versus scan angle
- Vibration testing

- Solar diffuser BRDF and diffuser monitor screen transmission function
- Polarization sensitivity
- Blackbody emissivity
- Stray light
Test data evaluation is a team effort

Collaborative and independent assessments by sensor vendor (Raytheon SAS) and government teams

- Government Team includes Aerospace Corp., U. of Wisconsin, NASA, NOAA
- Periodic reviews
  - Data Review Boards to evaluate results presented by sensor team
  - Data Analysis Working Group to evaluate results primarily from government team
  - Special technical interchange meetings
  - Regular briefing at NOAA VIIRS SDR meetings
J1 VIIRS

Initial J1 observatory-level thermal vacuum (TVAC-1) testing showed no issues for VIIRS

- TVAC-2 indicated cryoradiator thermal margin was lower than expected based on J1 Sensor TVAC test data
  - Led to added testing for other plateaus within the TVAC-2 testing
  - Radiometric performance is met at the 3 temperature setpoints but predicted M14 SNR margin at end of life does not meet requirement

- VIIRS is bagged and ready for shipment to Vandenburg
Reminder – key changes to J1 relative to S-NPP

Lessons learned in the testing and evaluation of S-NPP VIIRS led to several modifications to J1 VIIRS including:

- **RTA Mirrors Changed from nickel coated to VQ**
  - Improved spatial stability with temperature

- **Dichroic 2 Coatings Redesigned**
  - Improved spatial performance between SMWIR & LWIR

- **Eliminated Throughput Degradation Due to Tungsten**
  - Improved radiometric sensitivity

- **Enhanced VisNIR Integrated Filter Coating Change**
  - Improved crosstalk, out-of-band performance
  - But, led to higher polarization sensitivity for Bands M1 – M4

- **Build variations between J1 and S-NPP led to several performance differences between the two including 15 performance waivers and their associated mitigation plans or impact evaluations**
J2 VIIRS currently in TVAC testing

Performance testing and evaluation is following similar path as done for S-NPP and J1

- Evaluating J2 relative to J1
- Pre-TVAC testing with GLAMR (GSFC Laser for Absolute Measurement of radiance tunable laser)
- PER took place last fall followed by vibration, electromagnetic interference and compatibility (EMI/EMC), pre-TVAC
- TVAC testing began earlier this summer
Reminder – key changes to J2 relative to J1

JPSS-2 VIIRS similar to predecessors, with multiple performance improvements including:

- Redesign of VisNIR integrated filter assembly (IFA) filter to reduce polarization sensitivity
- Changes to aft optics assembly (AOA) fold mirror #2
- Eliminated SWIR and DNB non-linearity issues seen in J1
- J2 test program includes lessons-learned:
  - Better efficiency
  - Cost reductions
  - Enhanced stray light testing
  - Shorter crosstalk testing
- Early results indicate no major issues with J2 VIIRS
J2 VIIRS is performing well

But, as with all sensors, there are features that will affect the quality of the data

- Studies of the optical results from J2 VIIRS indicated a scan underlap
  - Present in J1 VIIRS
  - Build variations in optics means that S-NPP VIIRS data minimally affected
  - Modifications to J2 VIIRS optical system and sampling approach has mitigated this issue
  - Effect on science should be limited

- Testing of the onboard blackbody uniformity returned a value that exceeds the subsystem uniformity requirement
  - Still in the early stages of determining possible cause
  - Unclear at this point whether it will impact J2 VIIRS performance
Other J2 features

- J2 testing has included added thermal tests to gain better understanding of the cryoradiator model.
- Polarization characterization has a requirement that uncertainty is to be less than 0.5% (1 sigma) for scan angles less than 55.84 degrees.
  - VIIRS instrument level polarization test uses a lamp-based, spherical integrating source (SIS).
  - On orbit VIIRS sees top of atmosphere (TOA) radiance based on solar illumination.
  - Polarization model now has a better model for SIS-TOA uncertainty.
  - Band M1 is most sensitive to SIS-TOA uncertainty.
  - Issue found while attempting to determine the best optical elements to use for the J3 instrument.
  - Possible additional testing after TVAC is being weighed that would better simulate the expected on-orbit solar spectrum.
J3/J4 lessons learned

Instrument Heritage Review took place last year to determine possible modifications for J3/J4 relative to J2

- Decreased polarization sensitivity of M1 through appropriate selection and characterization of dichroic beamsplitters
- Eliminating near-IR out-of-band leak in solar diffuser stability monitor (SDSM) filters
- Satisfy end-user/science need to minimize scan-to-scan underlap
- Identifying methods to ensure system performance for J3/J4 after an expected 10+ years on the shelf
- J1+ Test & Verification Lessons Learned under evaluation for J3+
J 3/J 4 VIIRS is already beginning assembly

- Electronics Module circuit card assemblies (CCAs) in build+test, focal plane arrays (FPAs) in work (J 2 Spares), opto-mechanical module procurements
- J 3 DNB/FPIE Testing
- Raytheon exploring options for dichroic beamsplitter (DBSP-1) to reduce band M1 polarization
- Raytheon determined method to select solar diffuser panels with reduced susceptibility to on-orbit UV degradation
- Near-term future efforts
  - OMM lower level assembly builds
  - Continue EM and OMM electronic CCA builds
  - Start FPIE/DNB TVAC Test
- Work on the final integration of the J 4 Spare DNB build
Getting ready for J1 launch - Post-launch tests - PLTs

J1 VIIRS has a clearer idea of how the sensor will be tested and evaluated during commissioning

- Thanks to the efforts from the JPSS flight team at GSFC, members of STAR at NOAA, and Raytheon
- PLTs based on the lessons learned during S-NPP testing
- Tailored toward the lessons learned during pre-launch tests
- Balance of
  - Vendor has to verify requirements for sell off
  - Early data points for instrument trending
  - One-off collections for sensor understanding
  - Early characterizations that can only be done shortly after launch

Example Post Launch Tests (PLTs)
- Pitch Offset (Backflip) for Instrument Calibration
- Spacecraft Jitter Characterization Post Launch
- Consolidated SEU Trending
- VIIRS Compressed Emissive Band Calibration
- VIIRS Solar Diffuser Characterization Maneuver
- VIIRS Lunar Roll Calibration and Sector Rotation
- CERES Solar Calibration/ Interference/ Glint Evaluation, & OMPS Solar Diffuser Goniometric Calibration Maneuver
- VIIRS Activation
- VIIRS Dynamic Range and Linearity Verification
- VIIRS Solar Diffuser Calibration
Conclusions

A five sensor development program for operational measurements is a challenge

- Lessons learned from S-NPP to J1 to TVAC testing of J2 have led to improvements along the way
  - Sensors will always have build-to-build variations
  - Collaboration between all groups involved has improved and led to better understanding of each subsequent sensor
- J1 VIIRS is bagged and ready for its post-launch testing
- J2 has been baked, shaken, irradiated, and is now in a cold, dark, airless place
- J3 and J4 are progressing through subsystem builds
- J1 and J2 both show differences from S-NPP but all indications are the data from both will be readily incorporated into the operational processing as well as fit within the longer history of previous sensors