2014 STAR JPSS Science Team Annual Meeting

OMPS CONOPS

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T.J.Kelly & G.Jaross

S-NPP & J-1 Data Rate Comparison

SNPP: 12/32NC

- "12" is rate (in Hertz) of number of S/C bus polls for OMPS TLM
- "32" is the max number of 64-byte buffers per polling interval
- "NC" is No Compression
- Data Rate:
  - Net TLM rate:12*32*64 = 24576 Bytes/sec, or
  - 196608 bits/sec (196.6 kb/s)

J1: 10/80C

- "10" is rate (in Hertz) of number of S/C bus polls for OMPS TLM
- "80" is the max number of 64-byte buffers per polling interval
- "C" is lossless Compression
- Data Rate:
  - Net TLM rate:10*80*64 = 51200 Bytes/sec, or
  - 409600 bits/sec
- *Above is an "NC" rate*
- Compression estimate: a factor of approximately 2, so
- Effective, estimated data throughput:
  - Net TLM rate: 2 x 51 kBps
    - = 100000 Bytes/sec, or
  - 820000 bits/sec (820 kb/s)

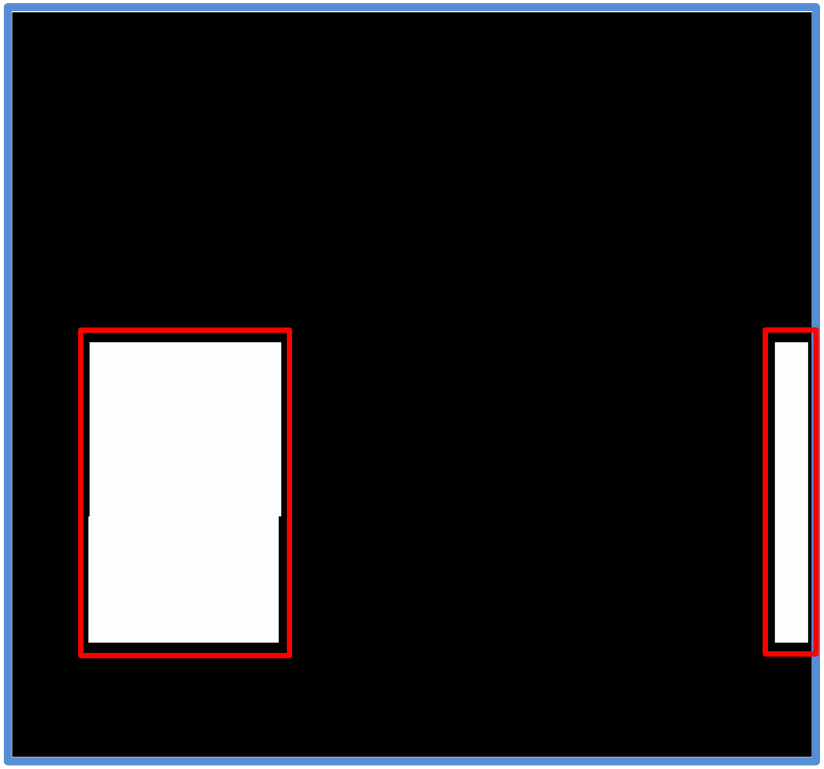
Reduced-Frame: New Capability

S-NPP: (a *first way* to run a TPG…)
- Read entire contents of CCD into memory
- Corresponds to area inside the blue frame
- Apply ST binning & Gain correction

J1: (a *second way* to run a TPG…*same* H/W)
- Read a select subset of pixels of CCD, shown as 2 red boxes, into memory
- Apply ST binning & Gain correction
- This is Reduced-Frame

Benefits of a Reduced-Frame:
- No time is spent reading out pixels that will only be discarded later
- Saves CCD read-out time
- Shortens along-track sampling for NM when NM and NP are read out together (every 6th frame)
- Apply mainly to Earth-View (Science Data)
- Other observations employ regular read-out

Caveats:
- Sample and Gain correction Tables must be sized for reduced-frame
- Reduced-Frame TPG is tied to ST and GT



APID will tell you whether Compressed &/or Reduced-Frame applies

On the Ground:
- Reduced-Frame looks no different in raw data
- Nothing needed in Ground SW to account for it

Interchangeability: Product Sets

- In all, BATC created 4 Data Rate/Compression packages, known as "Product Sets"
  - Not all OMPS tables are affected
  - Tables included are CBM, Image Profile, Gain, ST & TP, and a Global Config

- KEY POINT: Each Product Set works with the same version of FSW
  - A Product Set essentially configs just the necessary FSW parms

- Reason: Kind of a *Plug 'n Play* approach
  - Minimize risk in case S/C couldn't handle max data rate, etc.
  - 2 with compression, 2 without
  - Same polling rate (10 Hz)
  - Lower numbers of 64 byte buffers per S/C poll

Data Compression Testing

- Compression Studies
  - Tested several compression methods
    - COTS products
    - Included the “zlib” & “szip” packages
    - Tested on actual data from S-NPP/OMPS: EV, SCAL, LED and Darks
    - General Compression Results:
      - zlib compression of ~ 2.0X
      - szip compression of ~2.5X
  - Selected “szip”, which uses extended Rice compression algorithm
- FYI: On-board CPU demand for data compression is ~3%
  - Plenty of CPU resources available
  - No problems expected to perform data compression in existing H/W
- 2x compression is conservative for EV HiRes
  - Even though results suggests 2.5X
  - Only accounts for register under-utilization (14 bits for one coadd vs. 32-bit word/pixel).
- Dark Current data achieve up to 10x compression.
- Use LEO&A to improve compression estimates
  - And improve/refine ST too
  - Enhance wavelength selection in EV ST

J1 Flight ConOps: Calibration Plans

- Solar Cals: 2 methods
  - 1-orbit and 3-orbit varieties, as with S-NPP/OMPS
    - TP and IT characteristics convey
  - Evaluate new QVD Diffuser
    - Less diffuser features than Aluminum Diffuser on S-NPP/OMPS
    - Compare performance diffs of 2 types of Solar Cals (1 vs 3-orb)
  - Desire is to utilize 3-orb solars
    - Reduces effect of Goniometry errors, incl. diffuser features
    - However … need to factor in Mech. moves over lifetime of mission
- Dark Cals with door closed
  - Performed weekly
  - Much like S-NPP/OMPS: Full-Frame (FF) images
  - Separate Image and Storage Region Darks
  - Include short-IT and medium-IT darks
- LED Cals with door closed
  - Performed every 4 weeks
  - Upgraded: FF images due to data compression
  - Collect LED Warm-up, Linearity and FF image data

J1 Flight ConOps: Special EV Plans

- Special EV data collection activities
  - Door open Dark Cals
    - Just like door closed Darks
    - Provides orbit-by-orbit updates
  - EV FF data collection for NM & NP
    - Separate orbits for each, as with S-NPP
    - ~4X increase in number of images
    - Good for straylight obs., very-fine imaging, etc.
  - PNRU obs. for NM
    - Increased wavelength range
    - over Antarctica & Greenland
    - In season: Centered on a Summer Solstice
  - EV_360
    - Essentially an extended version of EV_Hi_Res
    - NOM APIDs: Compressed & reduced-frames

J1 Flight ConOps: Science Data Plans

- EV_Hi_Res default Science Data (EV) activity
  - Timing pattern enhancements : No coadds
    - **Was** 6 coadds (of 1.25 s) for NM and 3 coadds (of 12.5 s) for NP on S-NPP/OMPS
    - **Will be**
      - NM: IT = 1.25 sec
        - » Shorter than 1.76 sec that's run on S-NPP/OMPS with CBM: EV_HiRes_O3
      - NP: IT = 7.5 sec
        - » as was tested on S-NPP/OMPS with CBM: EV_TCres_NP
    - Better along-track resolution
      - NM resolution = ~10 km "6X"
      - NP resolution = ~49 km "5X"
  - Wavelength range enhancements:
    - J1 NM available wavelength range increased
      - 298 to 423 nm
      - Marginal sensitivity from 392 to 413 nm
    - J1 NP wavelength range unchanged
      - 252.0 nm to 305.87 nm

J1 Flight ConOps: Science Data Plans

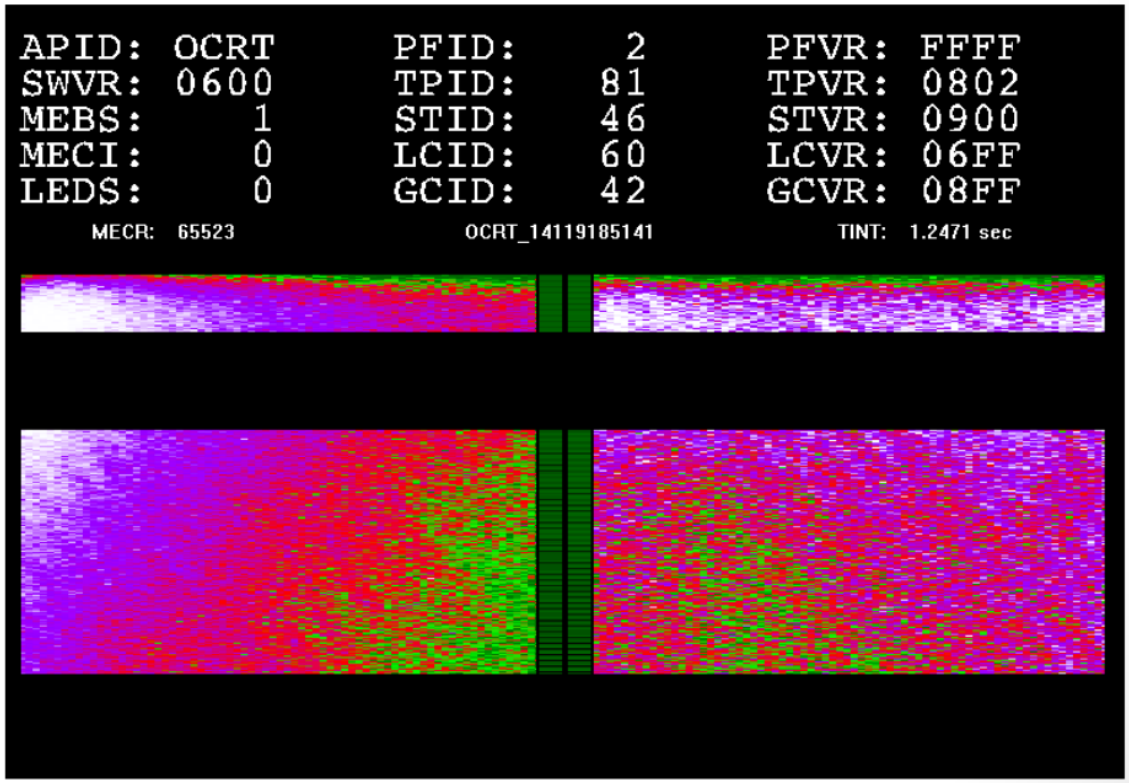
- EV_Hi_Res (continued)
  - Sample Table enhancements: Finer Binning
    - For NM: How best to distribute?
    - Option 1: BATC delivered an NM ST with BF=5
      - 210 spectral pixels (170 + 40)
      - The 170: Spectral range covers PRD wavelengths from 307.6 to 378.2 nm
      - Extra 40: 407.0 to 423.4 nm
    - Option 2: May reduce to BF=4 with 170 wavelengths
      - Done on S-NPP: Early version of ST for EV_HiResO3
    - Option 3: May use variable binning
      - Done on S-NPP: EV_HiResO3 run on Saturdays
      - Reduces off-nadir swell
      - If select BF=4:3:2, can collect 80 to 100 wavelengths
    - For NP: BATC-delivered ST
      - 5X spatial resolution
      - Has been tested on S-NPP: EV_Tcres_NP & nomEV_Tcres_NP
      - 150 spectral pixels (as mentioned on prior slide)
  - FOVs of BATC delivered J1 EV STs:
    - NM: approximately **13** km wide x **10** km along-track at nadir "4X x 6X"
    - NP: approximately **50** km wide x **55** km along –track "5X x 5X"

J1 Flight ConOps: Routine Data Collection

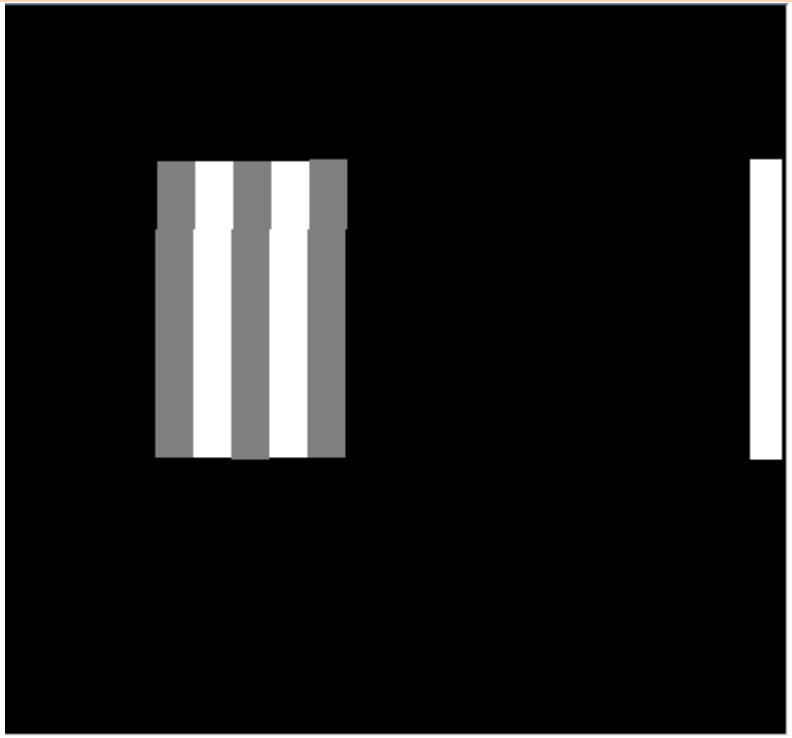
- EV_Hi_RES is default activity
- Solar Working Cal every other week
- LED Cal every 4th week
- Dark Cals
  - Door closed once a week
  - Door open is default nightside activity
- Solar Ref Cal approx'ly semi-annually
  - Maintain constant Solar Azimuth/β Angles as S-NPP

J1 Routine Science Data: BATC NM Test ST

Sample/Bin TC "Hi-Res" EV



J1 Routine Science Data: NP Test ST



- J1 NP Test EV ST
  - 5X spatial resolution

Planned NPP Improvements

- Load J1 FSW6.0 on S-NPP
  - After all … same hardware!
  - LP inactive during test
  - Concurrent with Block2.0 changes
  - Must wait due to changes in OMPS header
  - Incremental Approach: Operate under a 12/32NC ConOps
    - Duplicate existing S-NPP config
    - Need new product set (can't re-use J1)
  - Next Increment: 12/32C ConOps
    - Supports Reduced-Frames
    - Expect performance to be similar to J1's *10/80NC* ConOps
      - OMPS-to-S/C data rate is a "32" and not an "80"
      - Lessen ST loads if necessary, i.e, adjust wavelength range
    - Science Data Options:
      - EV_LOW_RES CBM (same as currently on S-NPP)
      - EV_MED_RES: Enhanced resolution
        - » NM: 2X cross-track and 3X along-track (25 km x 16 km Nadir FOV, resp)
        - » NP: 5X5
- Table changes needed:
  - FSW, Global_Config, Mech_Options, Fault, CBM, CSM, ProfileID, Gain, ST, TPGs
  - Need a day to get all uploaded
- BATC would outline and test all transition steps in advance
- Provide data for ground system use

Back-Up Slides

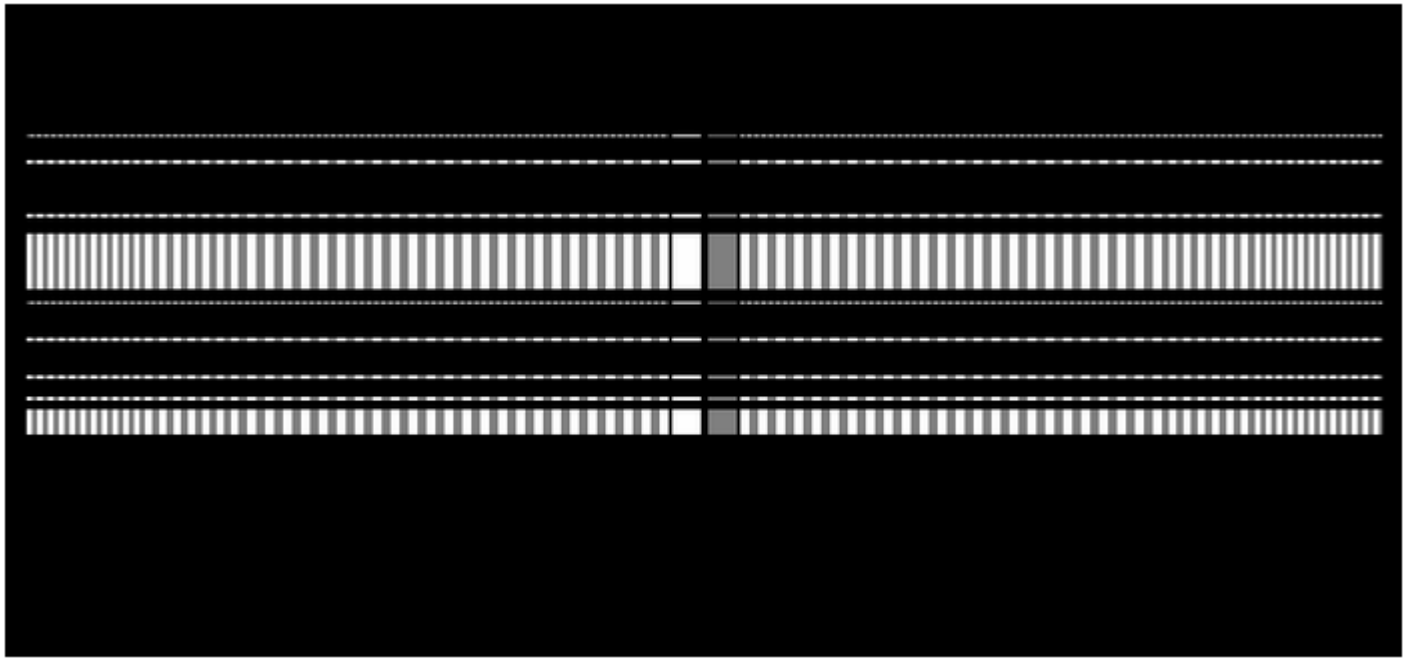
OMPS H/W on S-NPP & J-1

- The addition of both Data Compression and Reduced-Frame is built into the Flight Software (FSW)
- Hardware for S-NPP and J1 are identical
  - Except for omission of LP
  - Better “same-ness” between S-NPP and J2 !
- Upshot: Data Compression and Reduced-Frame could work for S-NPP too
  - Not impossible to test on S-NPP

Facts & Info

- OJ1 is capable of producing at a 40X rate greater than the OMPS 1553 bandwidth allocation.

S-NPP/OMPS EV_HiRes_O3 ST



- Not J1 High-Res EV ST, but …
  - Similar spatial resolution (horizontal)
  - S-NPP case has reduced wavelength coverage (data rate limit)