Characterization of the Data Volume Generated by the S-NPP Mission to Support Decisions Regarding Data Downlink Resource Management

Laura Ellen Dafoe
Jeffries Technology Solutions, Inc

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Background for the Work

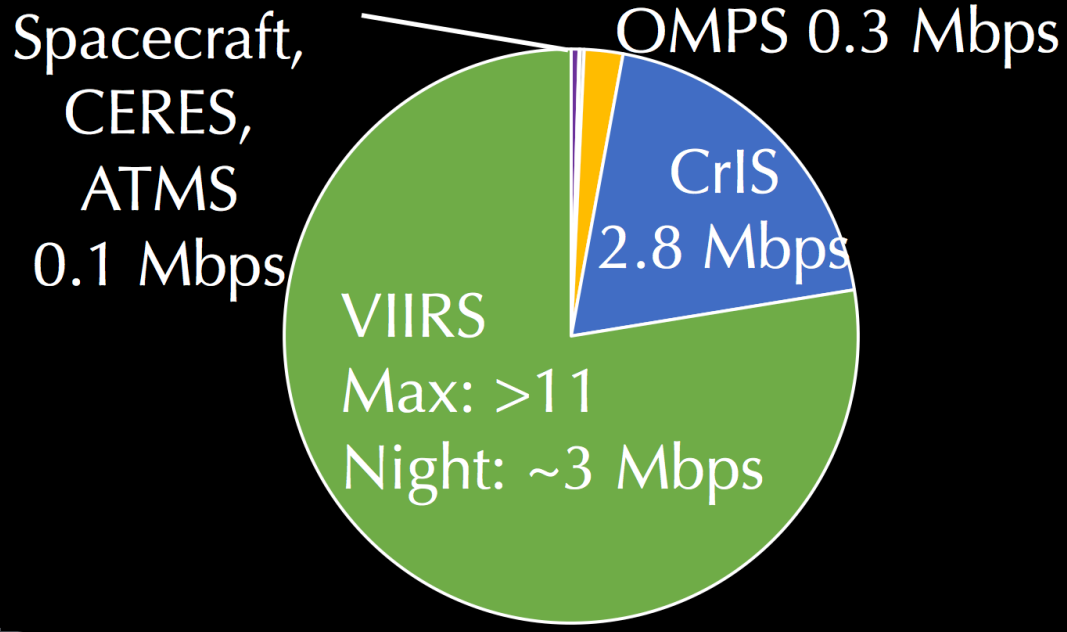
- Proposed Sensor Improvements (J3/4) Require Additional Downlink Bandwidth Than Current Specs.
- How Much Data Does SNPP Actually Generate?
- SNPP Design Favors Conservative Data Management.
  - SNPP Has Fixed Downlink Capability, AND
  - Variable Data Generation Due to VIIRS Data Compression (Compression varies with scene, time of day, season)

We Now Understand the SNPP Data Generation
So That We Can Strategically Manage the Downlink

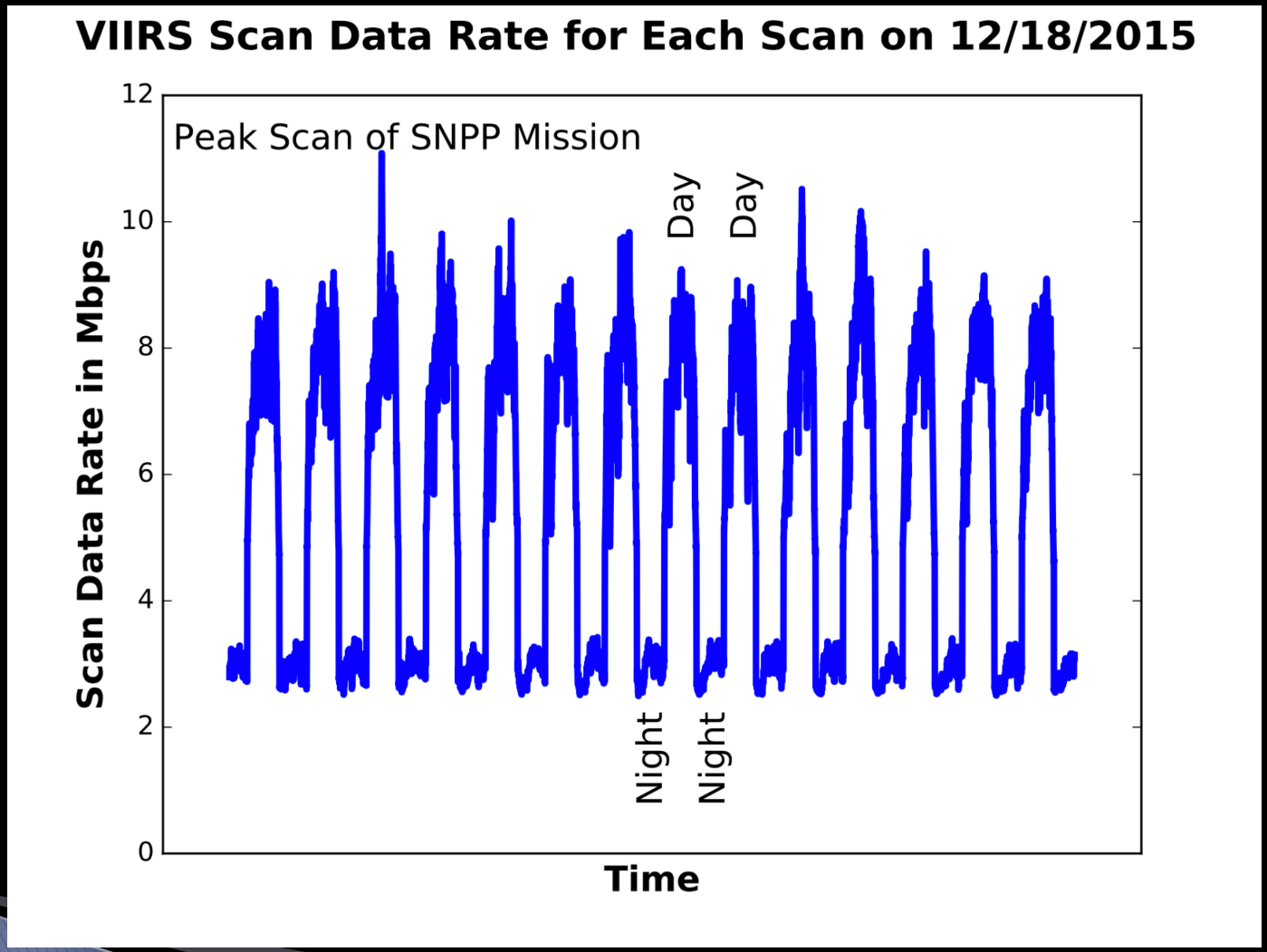
SNPP Data Generation

- Data Generated from the SNPP Spacecraft and Four of Its Instruments Is Effectively Constant.
- VIIRS Generates the Largest and Most Dynamic Data.

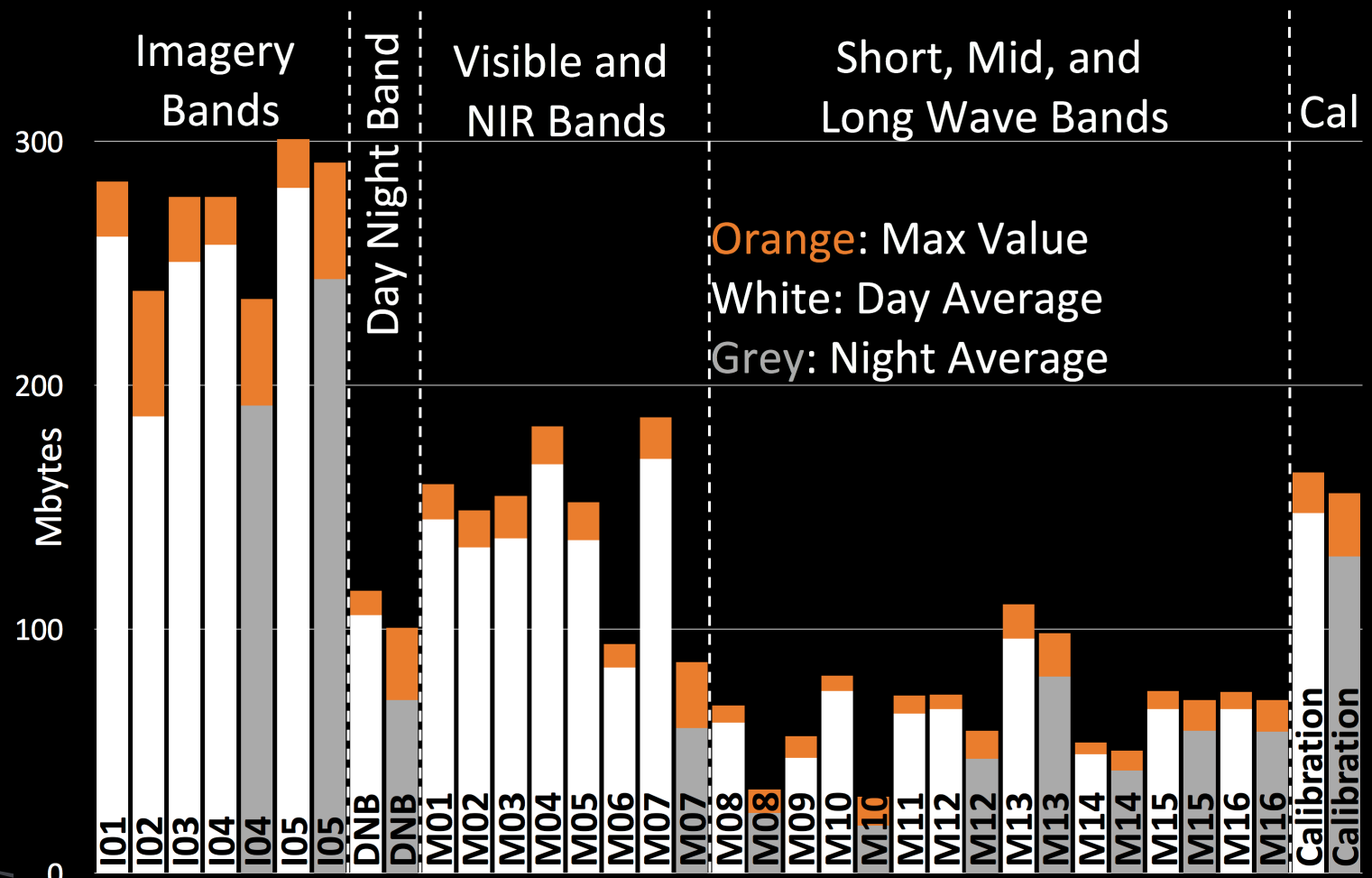
SNPP Data Generation Rate by Source



VIIRS Data Generation Is Dynamic – Day/Night, Scene



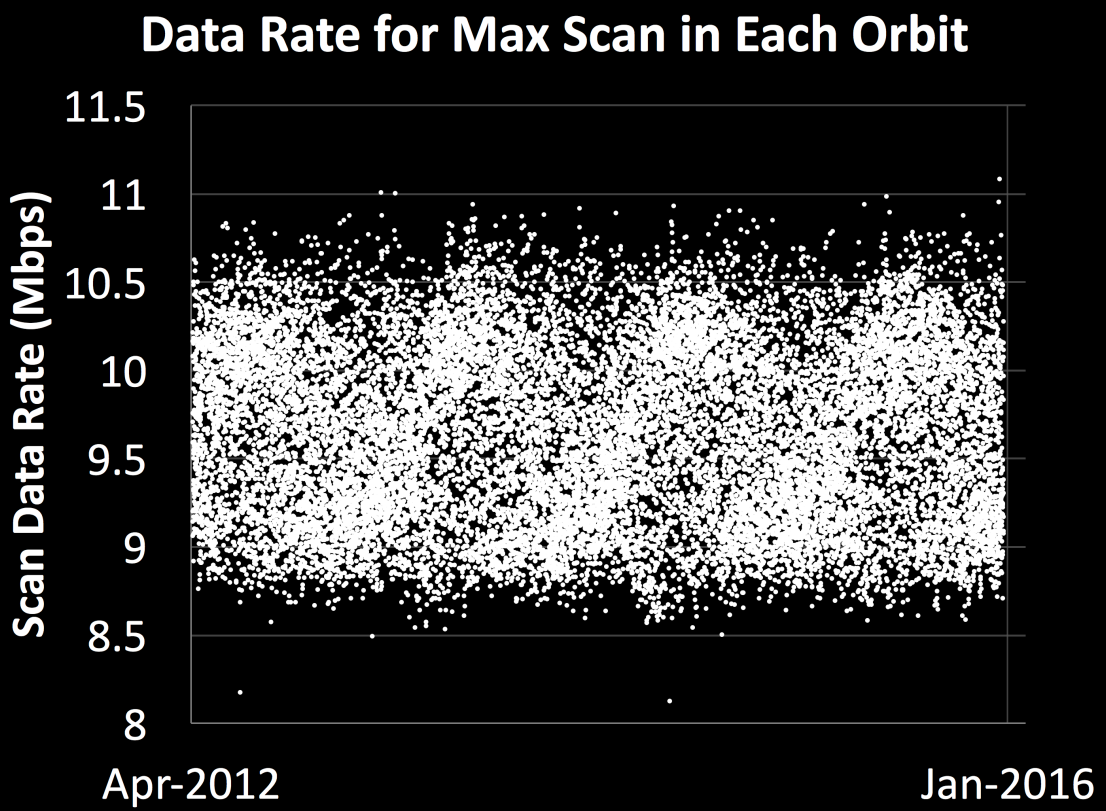
VIIRS Orbital Volume by Channel



Every VIIRS Packet Analyzed: Apr 2012 – Dec 2015

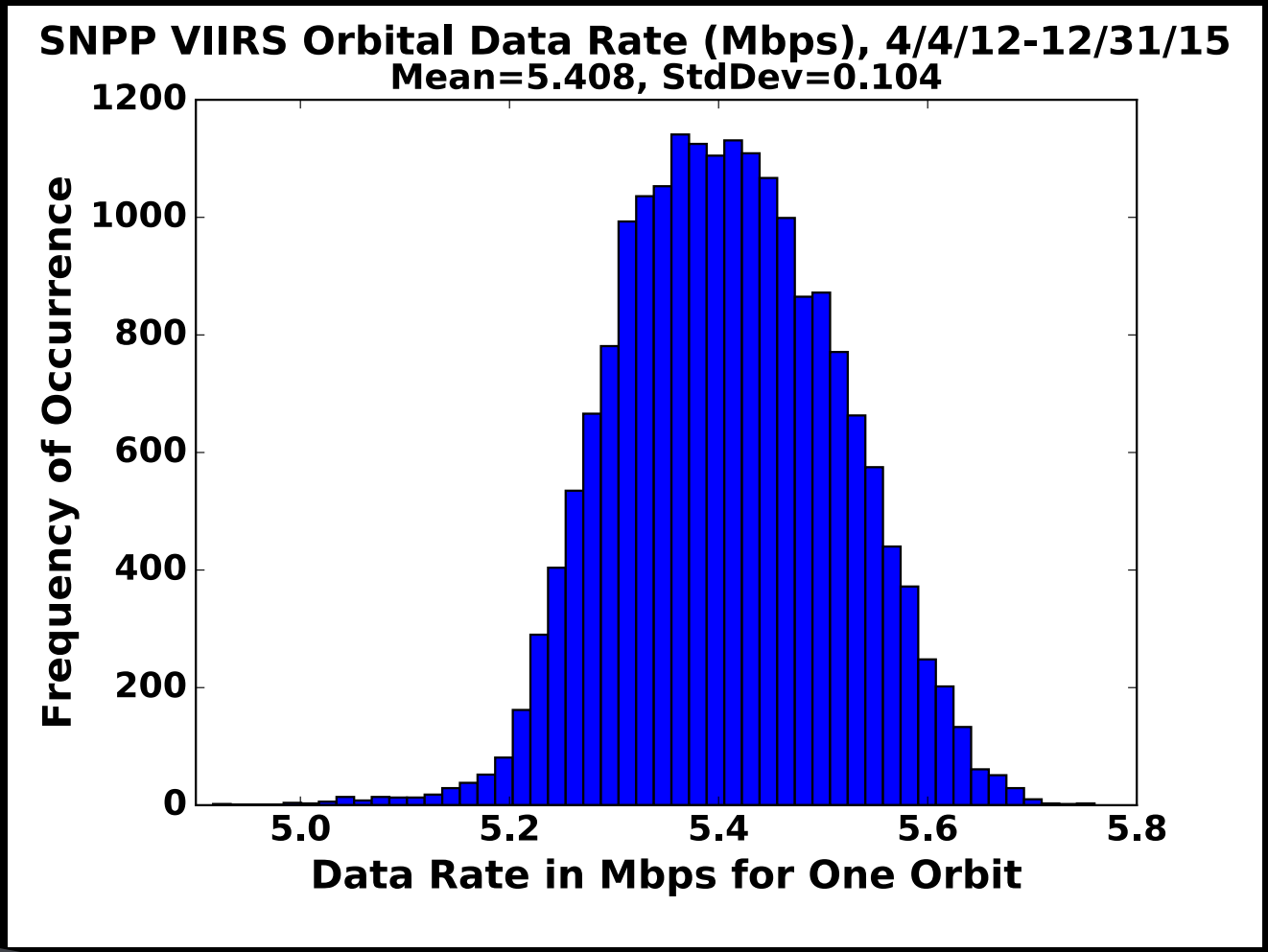
VIIRS Peak Data Rate

- Largest Scan in Orbit Stays in the Range of 8.8-10.5 Mbps.
- Top 20 Scans Include Almost Every Continent and Month.
- Four of the Five Largest Scans Were Over Australia.

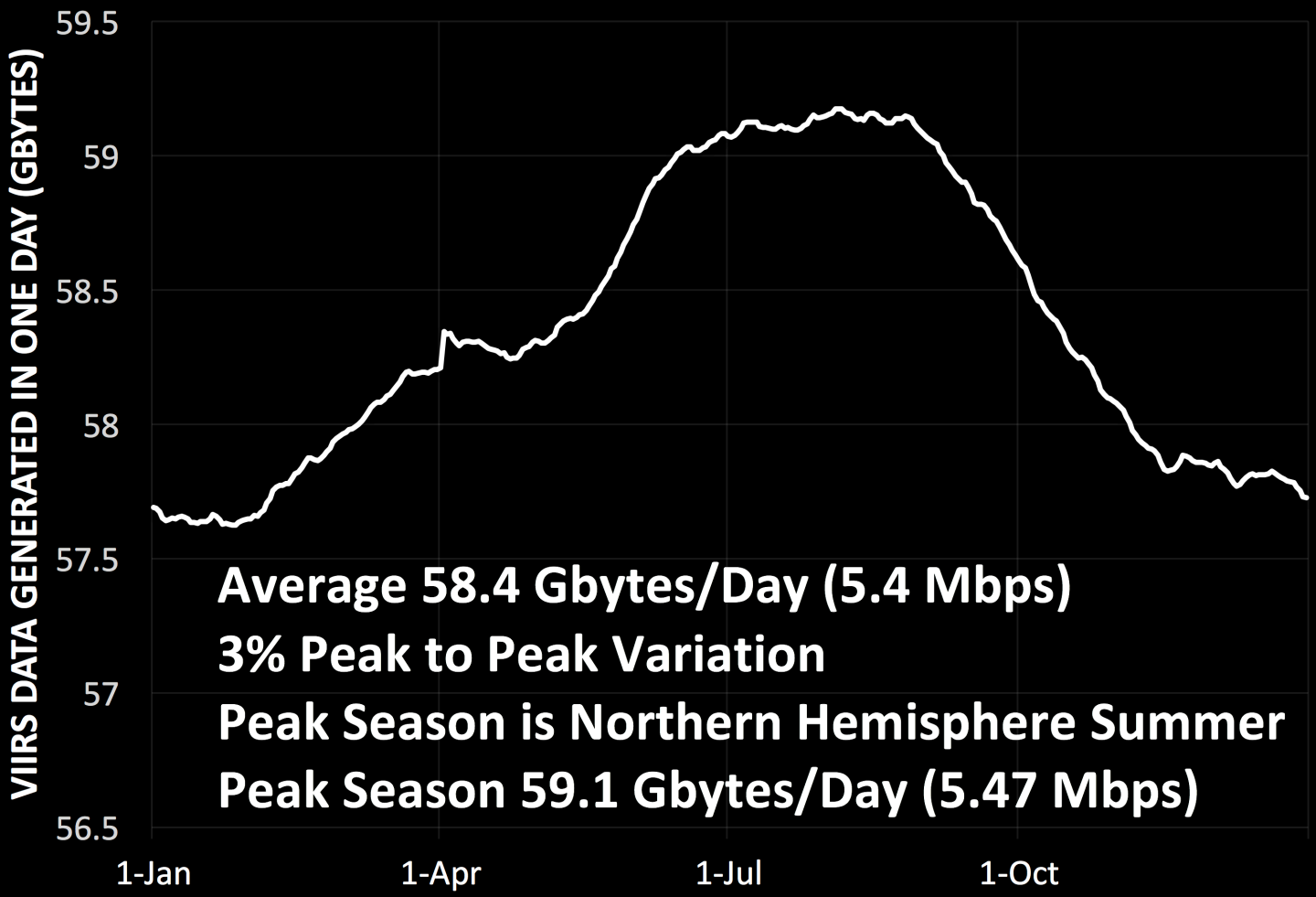


- Northern Hemisphere Summer Yields More Large Scans, but Southern Hemisphere Summer Yields Largest Scans.

Distribution of VIIRS Orbital Average Data Rate



Daily VIIRS Volume for Year



Data Rate Tables for Ops

Data Type	Suomi NPP Nominal Configuration 8/19/15-Present CrIS Full Spectral, remove FOVs 4 and 6 and *italicized* from HRD			Proposed JPSS-1 Full Spectrum Configuration Put It All Back Into HRD		
	Mbps	Data Rate to HRD	Data Rate to SMD	Mbps	Date Rate to HRD	Date Rate to SMD
Spacecraft Attitude & Ephemeris	0.0057	0.0639	0.0639	0.0057	0.0639	0.0639
Spacecraft Telemetry	0.0582			0.0582		
CERES Science	*0.0085*	0.0006	0.0091	0.0085	0.0091	0.0091
CERES Housekeeping	0.0006			0.0006		
ATMS	0.0204	0.0204	0.0204	0.0204	0.0204	0.0204
OMPS Science Limb	*0.1250*	0.1903	0.3153	N/A	N/A	N/A
OMPS Science Nadir	0.0400			0.4096	0.4096	0.4096
OMPS Housekeeping/Reserved	0.0253					
OMPS Reserved (Diagnostic Data)	0.1250					
VIIRS DNB	0.2620	7.2041	7.6251	0.2620	7.6576	7.6576
VIIRS I1	0.6460			0.6460		
VIIRS I2	0.4640			0.4965		
VIIRS I3	0.6210			0.6210		
VIIRS I4	0.6380			0.6380		
VIIRS I5	0.6960			0.6960		
VIIRS M1	0.3590			0.3590		
VIIRS M2	0.3300			0.3510		
VIIRS M3	0.3400			0.3400		
VIIRS M4	0.4150			0.4150		
VIIRS M5	0.3380			0.3380		
VIIRS M6	0.2090			0.2090		
VIIRS M7	*0.4210*			0.4210		
VIIRS M8	0.1530			0.1530		
VIIRS M9	0.1170			0.1170		
VIIRS M10	0.1850			0.1850		
VIIRS M11	0.1620			0.1620		
VIIRS M12	0.1670			0.1670		
VIIRS M13	0.2380			0.2380		
VIIRS M14	0.1210			0.1210		
VIIRS M15	0.1670			0.1670		
VIIRS M16	0.1660			0.1660		
VIIRS Engineering	0.0420			0.0420		
VIIRS Calibration	0.3660			0.3660		
VIIRS Housekeeping	0.0021			0.0021		
CrIS LWIR	0.9756	2.1262	2.8254	0.9756	2.8254	2.8254
CrIS MWIR	1.0865			1.0865		
CrIS SWIR	0.6703			0.6703		
CrIS Other Telemetry	0.0930			0.0930		
Total Application Packet Rate		9.6055	10.8592		10.9860	10.9860
Total Packet Rate with CCSDS Overhead		**11.1268**	**12.5790**		**12.7259**	**12.7259**
HRD Threshold		15.0000	N/A		15.0000	N/A
HRD Margin Relative to Threshold		**3.8732**	**N/A**		**2.2741**	**N/A**

Data Type	*italicized* from HRD		
	Mbps	Data Rate to HRD	Data Rate to SMD
Spacecraft Attitude & Ephemeris	0.0057	0.0639	0.0639
Spacecraft Telemetry	0.0582		
CERES Science	*0.0085*	0.0006	0.0091
CERES Housekeeping	0.0006		
ATMS	0.0204	0.0204	0.0204
OMPS Science Limb	*0.1250*	0.1903	0.3153
OMPS Science Nadir	0.0400		
OMPS Housekeeping/Reserved	0.0253		
OMPS Reserved (Diagnostic Data)	0.1250		
VIIRS DNB	0.2620		
VIIRS I1	0.6460		

- Tables Quantifying Each Data Source Are Available.
  - Day Expected, Peak, Night Expected
- More Informed Downlink Decisions Are Possible.

Potential Downlink Options

- TDRSS Used as a Downlink Option Twice an Orbit
- Schedule Less TDRSS Time for Night Portion of Orbit
- Transmit Only Specific Bands Over TDRSS

Case	Content	TDRSS Time for 150 Mbps (minutes)
1	Only ATMS, CrIS, Health/Geo	00:59.5
2	Only ATMS, CrIS, Health/Geo, VIIRS Key Performance Param.	02:17.4
3	Only ATMS, CrIS, Health/Geo, VIIRS Fire, Cloud, Ice Bands	01:48.5

Conclusions

- SNPP Data Generation Has Been Characterized – Instrument, Day/Night, Season, Waveband.
- The Characterization Will Facilitate Creation of Downlink Concepts That Optimize Latency, Resource Management, Cost.

Available Resources

- EXECUTIVE SUMMARY:
  All Six Data Sources, Data Rate Tables, 16 pages
- TECHNICAL MANUAL:
  Detailed Characterization of VIIRS, 144 pages

LauraEllen.Dafoe@JeTSI.com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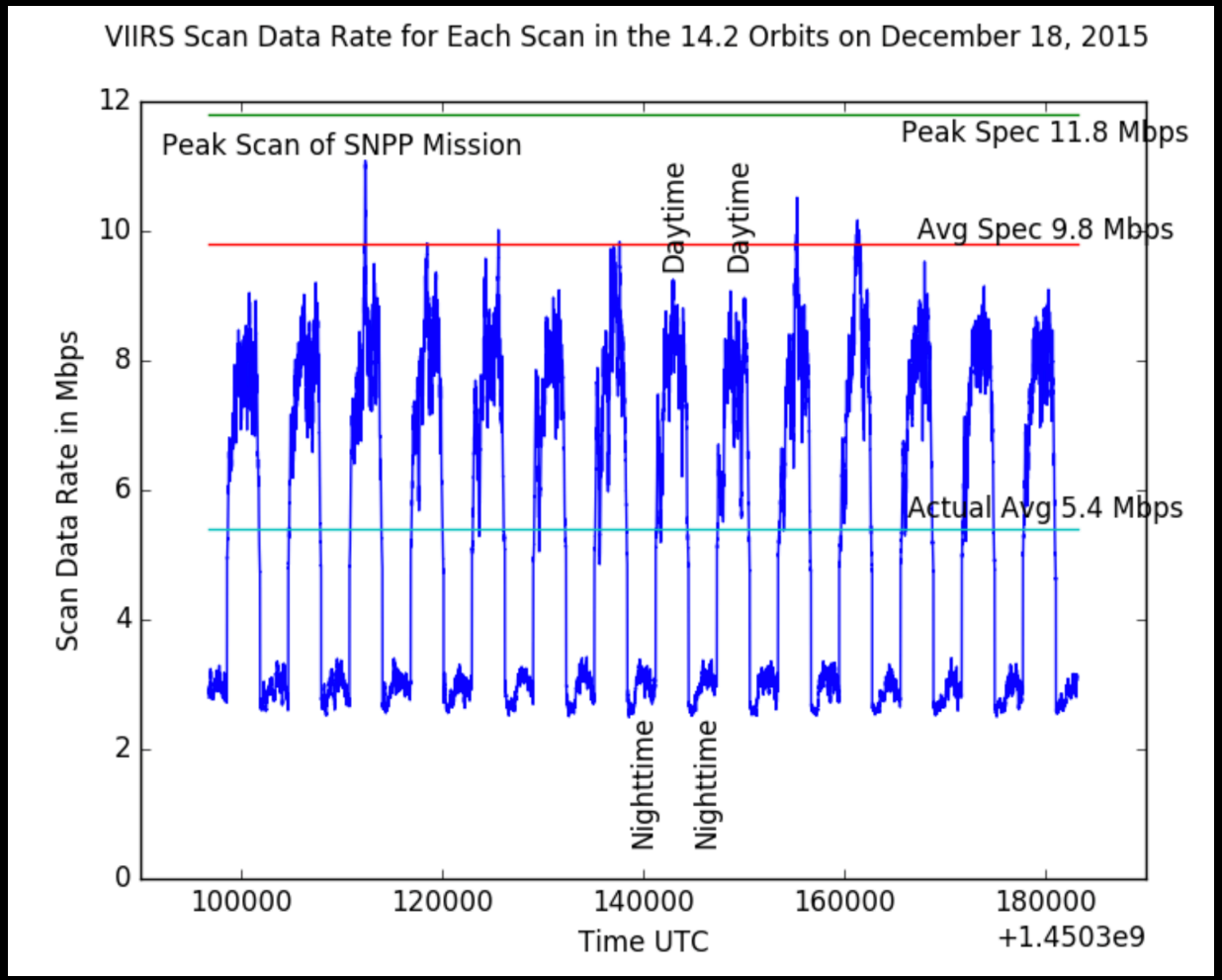
Questions?


JeTSI

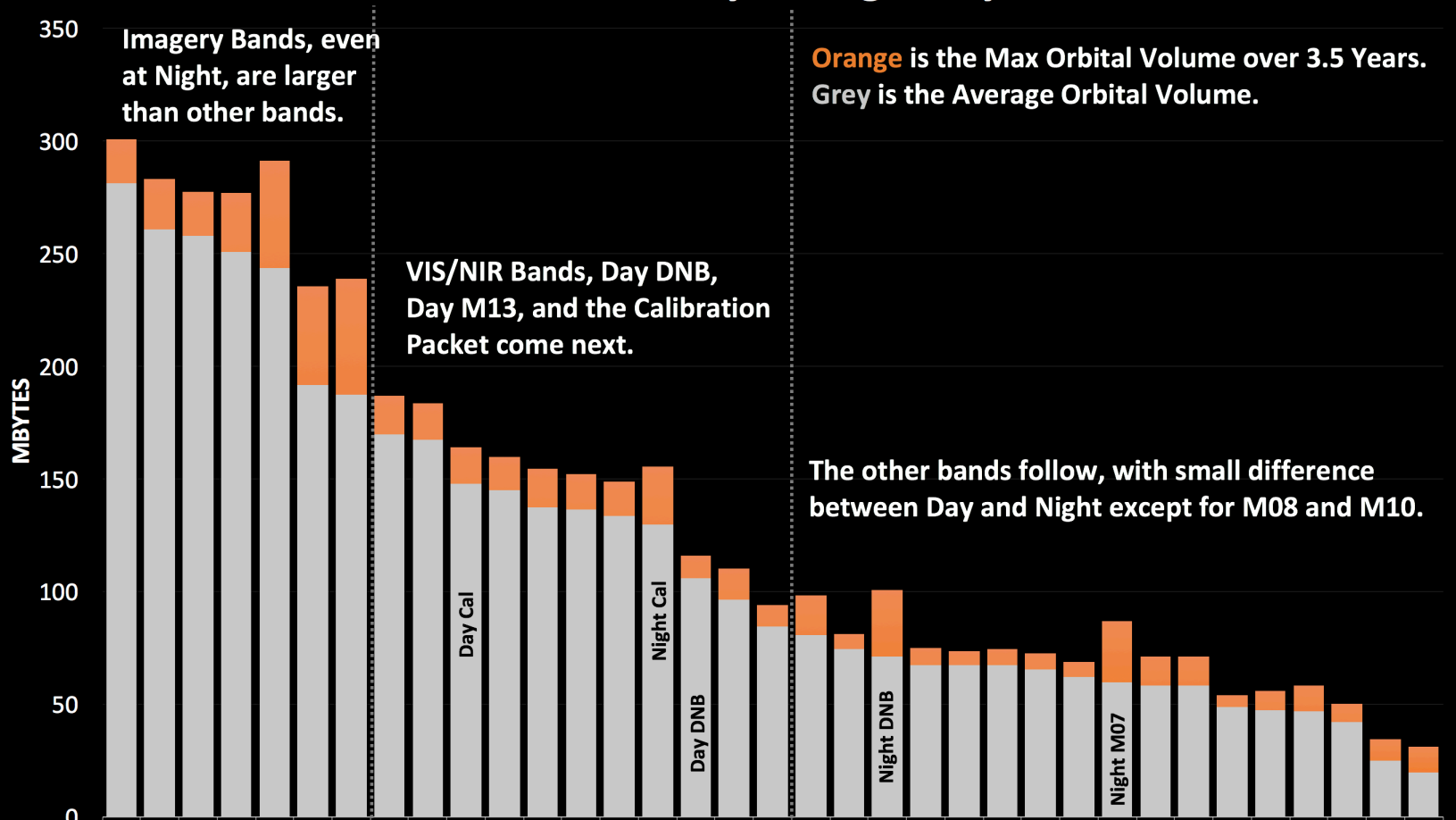
Backup

VIIRS Specs vs Actual



VIIRS Band Specific Volume

VIIRS Orbital Volume, Day or Night, By Waveband



	Day I05	Day I01	Day I04	Day I03	Nite I05	Nite I04	Day I02	Day M07	Day M04	Day Cal	Day M01	Day M03	Day M05	Day M02	Nite Cal	Day DNB	Day M13	Day M06	Nite M13	Day M10	Nite DNB	Day M15	Day M12	Day M16	Day M11	Day M08	Nite M07	Nite M15	Nite M16	Day M14	Day M09	Nite M12	Nite M14	Nite M08	Nite M10
Max	301	283	277	277	291	235	239	187	183	164	160	155	152	149	155	116	110	94	98	81	100	75	73	74	73	69	87	71	71	54	56	58	50	34	31
Avg	281	261	258	251	244	191	187	170	167	148	145	137	136	133	130	106	96	84	81	75	71	67	67	67	65	62	59	58	58	49	47	47	42	25	20

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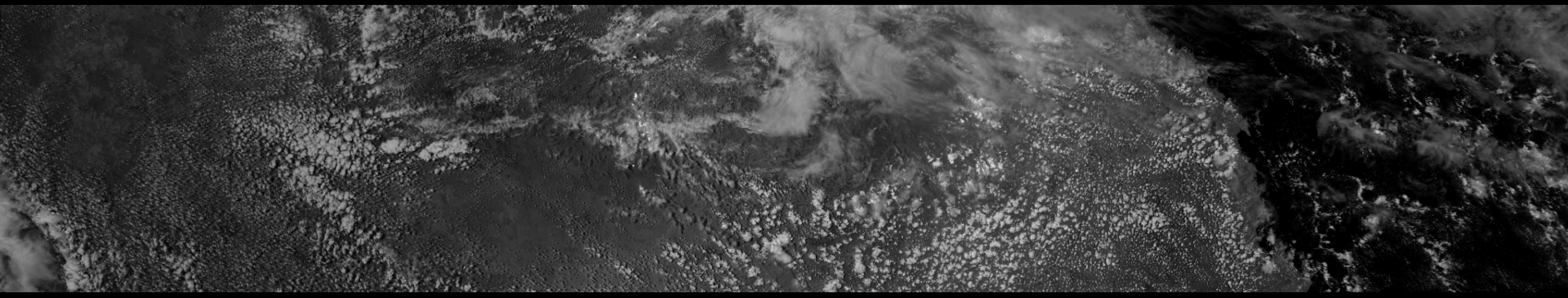
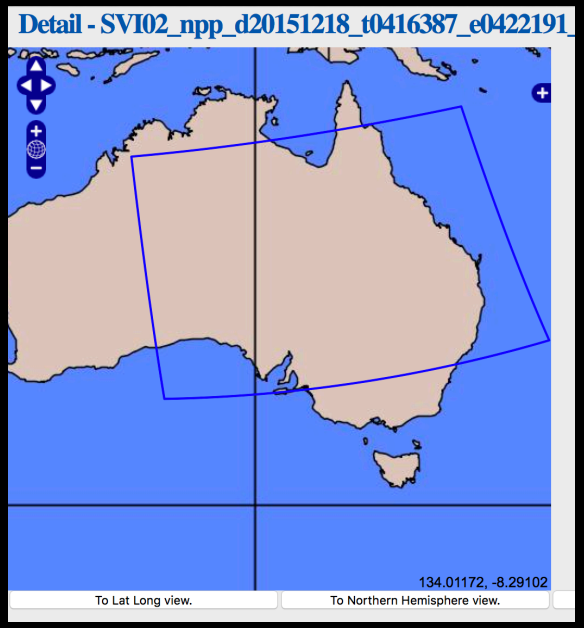
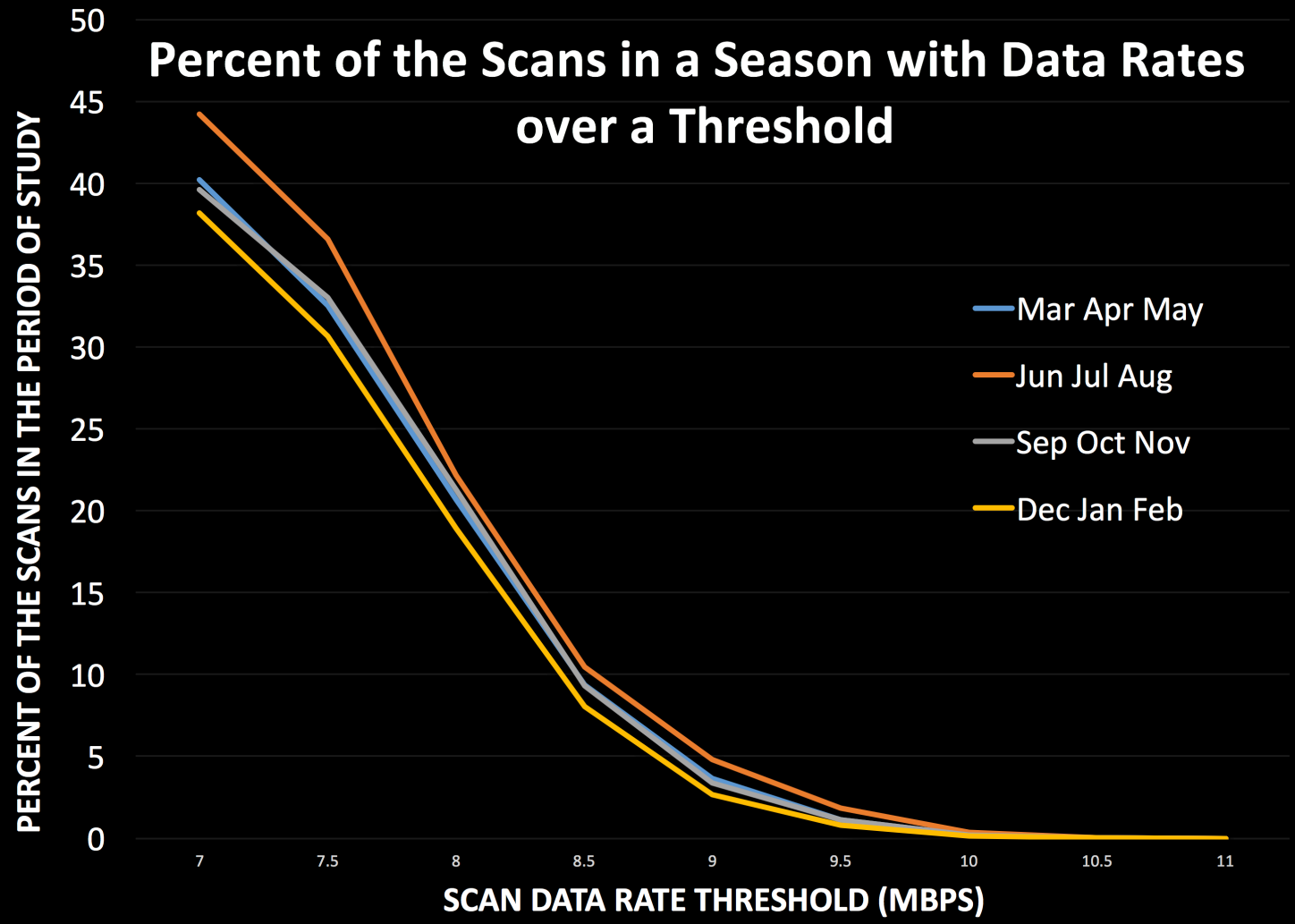
Peak Scan on 12/18/2015



- Near the Top of This I01 EDR Image.
- Near the Middle of the Highlighted Region on the Map.



VIIRS Peak Data Generation



Potential Downlink Options

- Downlink Overhead 17.4%
- VC0: State of Health, incl. Geo
- Key Performance Parameter (KPP): I01-05, M12, M14-16, DNB, incl. Cal/Eng
- Latency Critical: Fire, Cloud, Ice
- Hybrid 3:4 Case
- Buy More TDRSS Time If Needed

Case	Concept, Content and Conditions	Portion of an Orbit to Downlink	Information Data Volume (Gbytes)	Downlink Data Volume (Gbytes)	TDRSS Time if 150 Mbps (minutes)	TDRSS Time if 300 Mbps (minutes)
1	All SMD, Max VIIRS	Full orbit	9.12	10.71	09:31.0	04:45.5
2a	All SMD, Max Day VIIRS	One-third orbit	3.41	4.00	03:33.5	01:46.7
2b	All SMD, Nighttime VIIRS	One-third orbit	2.17	2.54	02:15.7	01:07.8
3	ATMS, CrIS, VC0 Only	One-third orbit	0.95	1.12	00:59.5	00:29.8
4a	ATMS, CrIS, VC0, VIIRS KPP Only, Max	One-third orbit	2.19	2.58	02:17.4	01:08.7
4b	ATMS, CrIS, VC0, VIIRS KPP Only, Min	One-third orbit	1.59	1.86	01:39.4	00:49.7
5	ATMS, CrIS, VC0, Latency Critical Bands, Max	One-third orbit	1.73	2.03	01:48.5	00:54.2