1st Look at VIIRS J-1 compared to S-NPP

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Topics

- No fundamental design changes
- Some development and implementation changes
- Much improved – optical crosstalk
  - At the cost of Vis polarization
  - Tungsten oxide optics contamination is not present on J1
- Worse performance on SWIR and DNB low-radiance linearity

- J1 launch more than year away
- Expect better quantitative performance description in CALCON 2016

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Fundamental Design & Manu-facturing Considerations S-NPP

- Primary concern was cross-talk (before launch)
  - Large optical component, also electrical components
  - Cross-talk effects captured in Relative Spectral Response curves
- Many researchers were wishing for fewer data compression strategies
- What is this thing called the Day-Night Band?
- On-orbit surprise – fore-optics contaminated with WOx in fabrication

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S-NPP to J1 Cross-talk

- Common (in-family) Relative Spectral Response (RSR) functions
- Essentially common electronic effects (small and unchanged)
  - Captured in Relative Spectral Response characterizations
- Polarization track-direction dependence still present
  - Ray Trace models now capture most of this variability
- Large improvement in optical cross-talk
  - Angle Resolved Scatter (ARS) largely eliminated with super-polished filer substrates, “higher density” coatings and out of band rejection tuned to filter side facing sensor aperture
  - Unintended consequence is larger degree of linear polarization sensitivity, mainly in Vis bands

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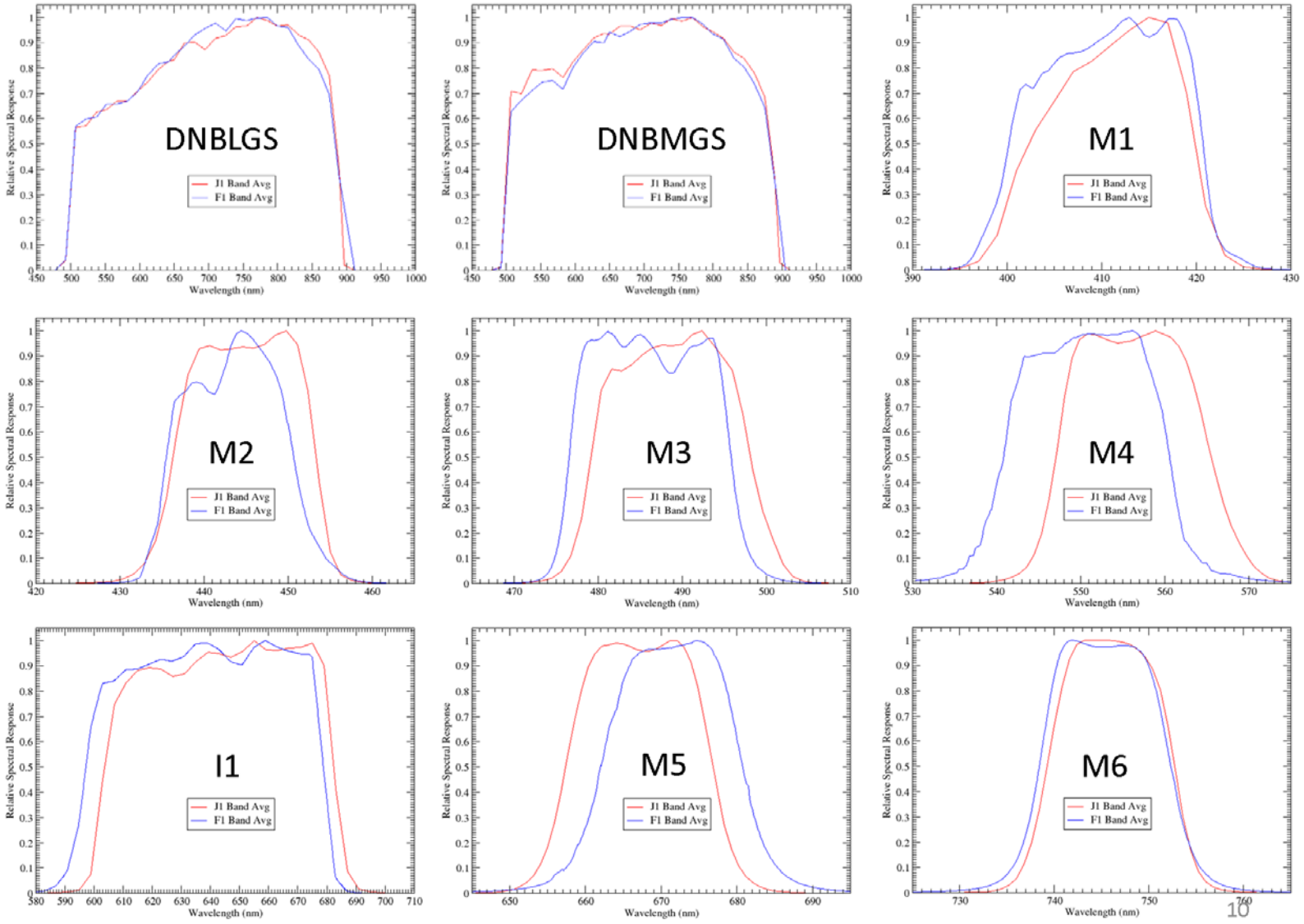
J1 VIIRS Band Average RSR: RSB (1 of 2)



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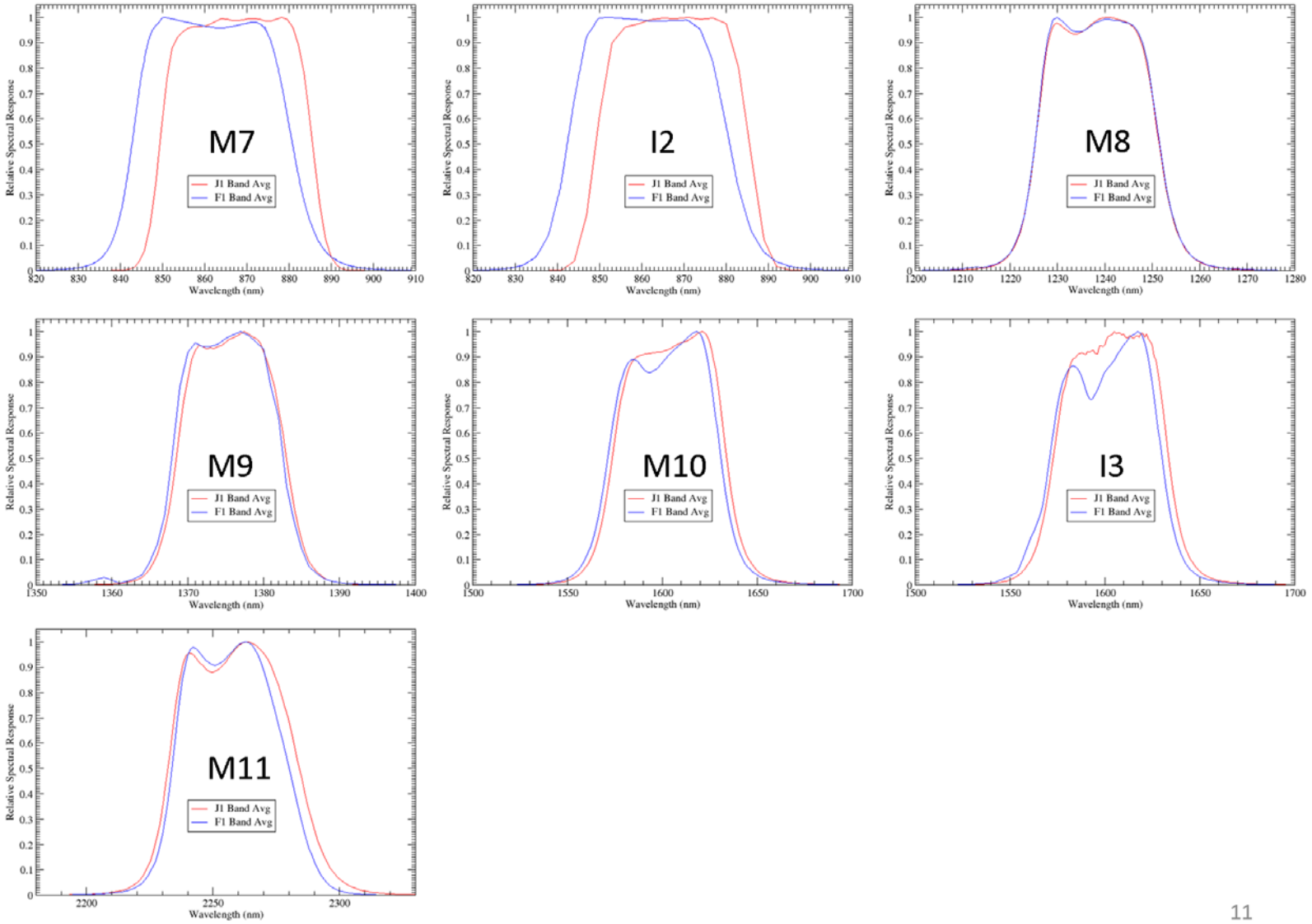
J1 VIIRS Band Average RSR: RSB (2 of 2)



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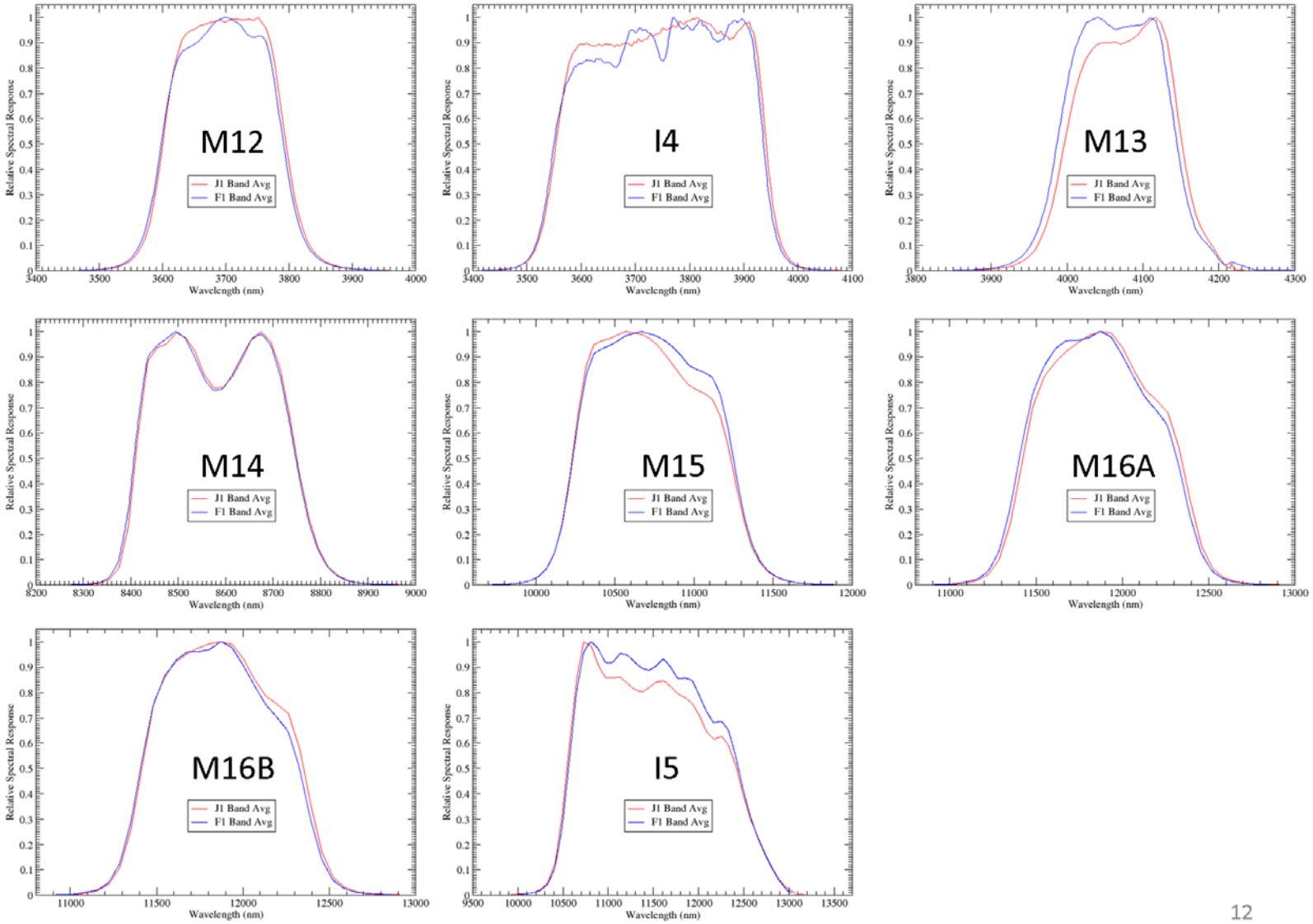
J1 VIIRS Band Average RSR: TEB



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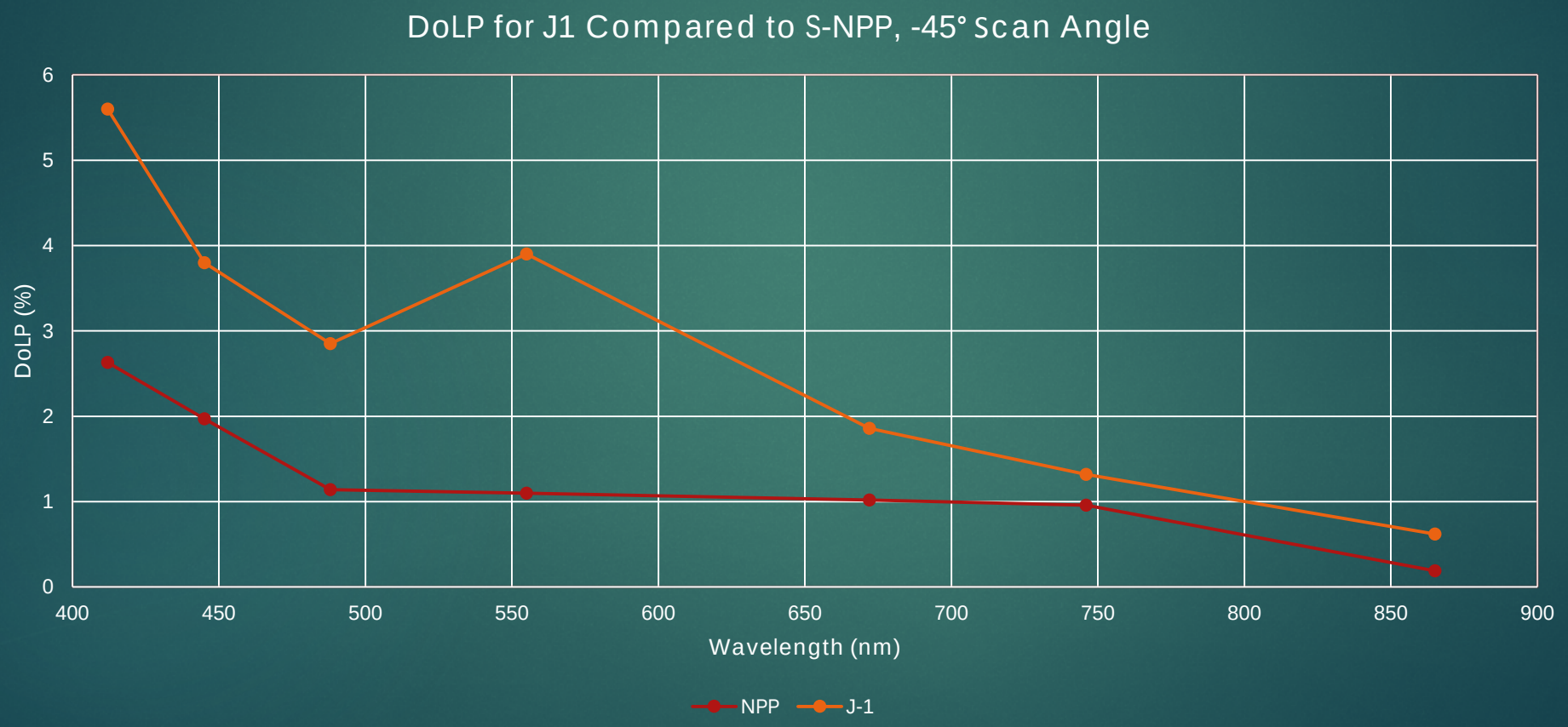
Polarization Comparison (peak) at -45° Scan Angle



Data provided by Jeff McIntire, SSAI

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Data Compression Strategies

- Same on J1 as S-NPP
  - Bow-tie deletion
  - Predictor band
  - On-board aggregation of single gain bands
  - On-board track aggregation to reduce track-direction spatial resolution
  - Rice Compression
- Evolution of Direct Broadcast content to optimize system utility
  - No changes on J1 compared to S-NPP

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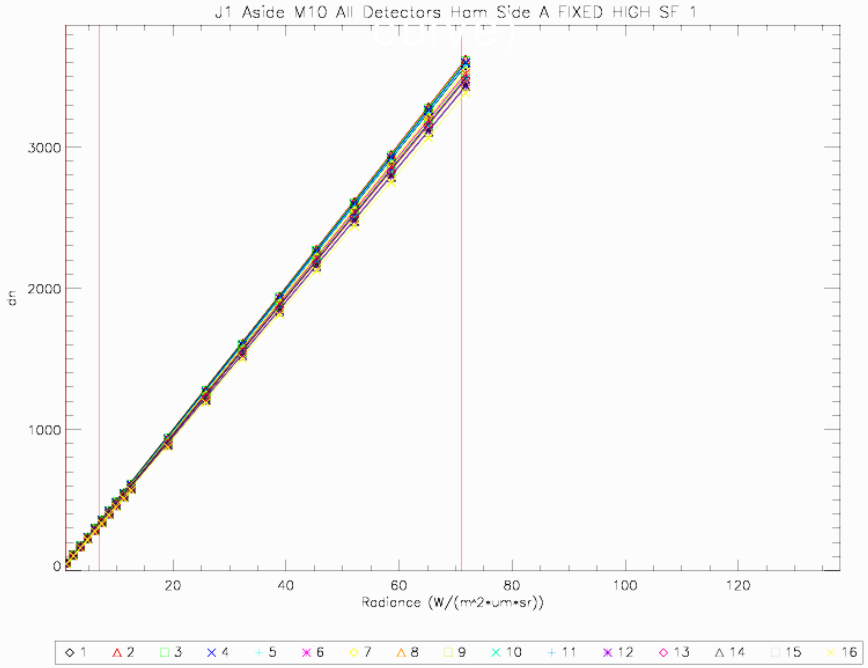
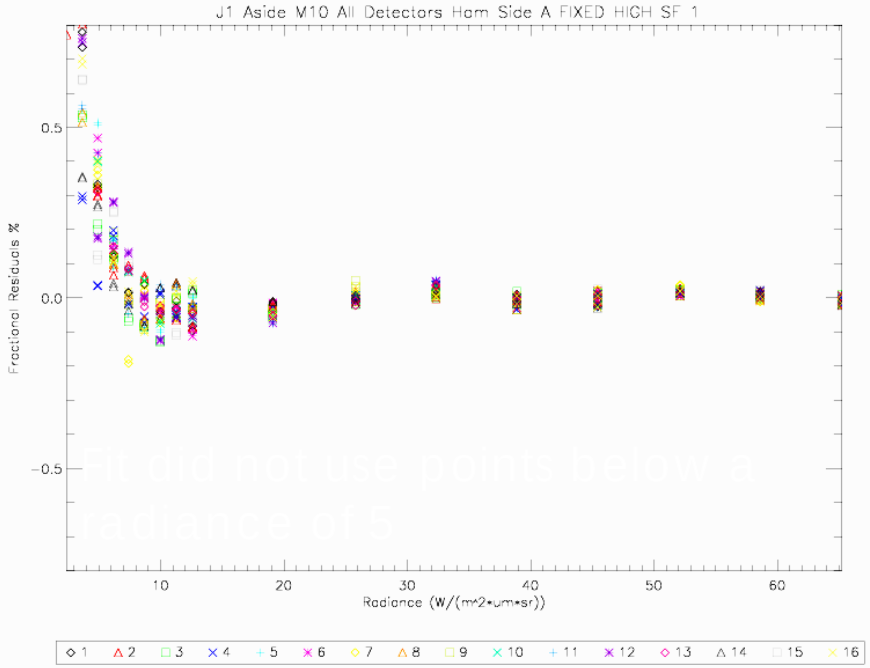
J1 M10 (1610 nm) Nominal Performance Aside 2nd Order Fit

Dynamic Range (line is fit equation)



Fit Residual Error



Fit did not use points below a radiance of 5

Analysis and Slide by Dave Moyer, Aerospace, Inc.

SWIR Non-Linearity for Low Radiance Scenes

- All 4 SWIR bands (1240 – 2250 nm) show similar behavior
  - Low radiance departure from smooth curve at higher radiance values
  - Appears best served with a split range pair of quadratic equations
  - Break for dual fitting range such that virtually all ocean scenes near coast need split range quadratic fitting range
  - At-launch status is that split range will not be applied in operational (IDPS) code and data product
    - Split range may be applied in Oceans team
    - Turbid waters (common to coastal zone) fail the traditional NIR assumptions required for atmosphere correction over ocean (ACO)
    - Common alternate ACO uses SWIR bands needed to distinguish aerosol and Rayleigh components

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DNB non-linearity at low radiance

- Sampling strategy involves 32 aggregation zones from Nadir to edge of scan, multiple frames used in each agg zone
- Non-linear responses found in final 250 km toward edge of scan
  - See next chart for one agg zone (~worst case)
- Effects minimized with extending agg zone at ~251 Km from edge to the edge
  - Non-linear response minimized with alternate CONOPS
  - Size of image pixel grows by about 2X in scan, less in track
- Improved radiometry possible with split range calibration equation and that is NOT planned for the J1 at-launch algorithm

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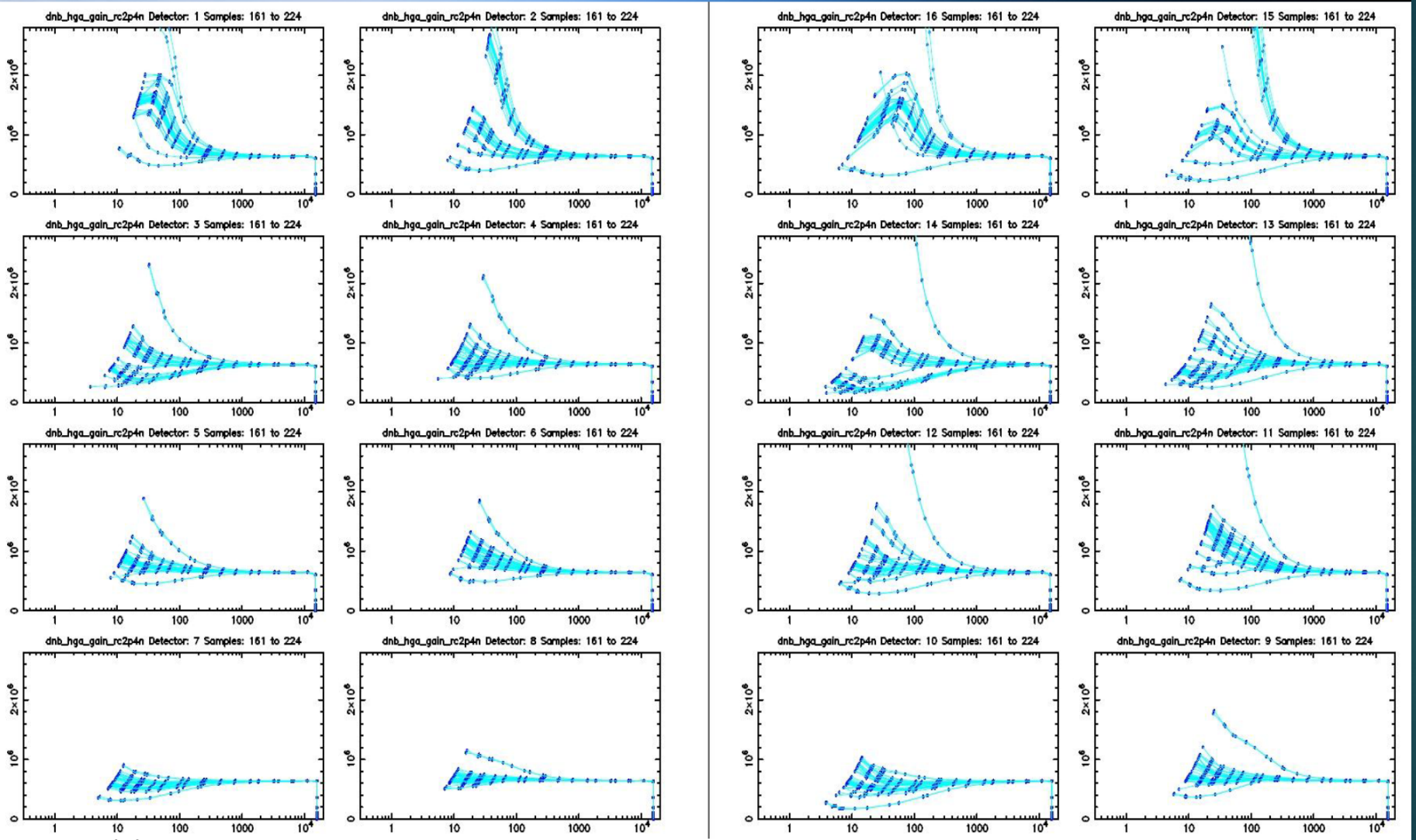
Gain G(x,y,t) Plotted vs. dn Z(x,y,t) for Single Detectors in Agg Mode 29



Agg Mode 29

Chart provided by Jim McCarthy, Stellar Soltuions

Summary and Conclusions

- Fundamentally degradations in performance for J1 compared to S-NPP are
  - Polarization correction larger for oceans (low surface reflectance) scenes in Vis
    - Polarization may be needed to optimize aerosol computations
      - Particularly when working in deep blue
  - SWIR scenes for Ocean Color (atmosphere correction) will need be handled with non-linear algorithm
    - And this will not be done in IDPS code and production
  - DNB edge of scan spatial resolution slightly degraded
- Expect further tuning of Direct Broadcast content to optimize operational and research applications of the J1 data set

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Acronyms

Acronym	Meaning	Acronym	Meaning
ACO	Atmospheric Correction over Ocean	MODIS	Moderate Resolution Imaging Spectroradiometer
Agg	Aggregation	NASA	National Aeronautics and Space Administration
ARS	Angle-Resolved Scatter	NICST	NASA Instrument Characterization Support Team
CALCON	Calibration Conference, SDL, USU, Logan UT	NIR	Near Infrared Bands
CONOPS	Concepts of Operation	NIST	National Institutes of Standards and Technology
Dn (also called little dn)	Digital number sensor response adjusted for dark response	nm	Nanometers
DNB	Day-Night Band	RSB	Reflected Solar Bands
DoLP	Degree of Linear Polarization	RSR	Relative Spectral Response
I (also I-Band)	Imagery Band (375 Km resolution at Nadir)	S-NPP	Suomi-National Polar Partnership
IDPS	Interface Date Processing Segment	STAR	Center for Satellite Applications and Research
J1	JPSS 1 (Mission or Spacecraft)	SWIR	Shortwave Infrared
JPSS	Joint Polar Satellite System	TEB	Thermal Emissive Bands
LGS	Low Gain Stage (daytime operations, DNB)	T-SIRCUS	Traveling-Spectral Irradiance and Radiance responsivity Calibrations using Uniform Sources
M (also M-band)	Moderate Resolution Band	VIIRS	Visible/Infrared Imaging Radiometer Suite
MGS	Mid Gain Stage (transition between day and dark night operations, DNB)	Vis	Visible (wavelength) bands