OCI Flight CAL-1 GLAMR Spectral Results
OCI-65,66,67,68,69,72,73,74,75,76,82

OCI_REPORT_22_021

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V&V summary table:

	Requirement 1	Requirement 2	Requirement 3	Requirement 4	Requirement 5
OCI requirement ID	OCI-65	OCI-66	OCI-67	OCI-68	OCI-69
Pass/Fail	Pass	Pass	Pass	Pass	Pass with waiver OCI-DW-0174
Compliance shown on slides	25	26	28	29	33,34,35
WOA number(s)	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629
Test Plan(s)	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467
Test ID(s)	CAL-1 UV-VIS	CAL-1 UV-VIS	CAL-1 UV-VIS	CAL-1 UV-VIS	CAL-1 UV-VIS

V&V summary table:

	Requirement 6	Requirement 7	Requirement 8	Requirement 9	Requirement 10	Requirement 11
OCI requirement ID	OCI-72	OCI-73	OCI-74	OCI-75	OCI-76	OCI-82
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass
Compliance shown on slides	28	29	30	31	32	33,34
WOA number(s)	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629	WOA-OCI-THRM-2629
Test Plan(s)	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467	OCI-INT-PLAN-0467
Test ID(s)	CAL-SWIR	CAL-SWIR	CAL-SWIR	CAL-SWIR	CAL-SWIR	CAL-1 UV-VIS / SWIR

Absolute Cal – Test Data

Test data

October 05-16, 2022
OCI in TVAC at Nominal temperature.
GLAMR swept through wavelengths 310nm to 2400nm
~1386 GLAMR measurements used in analysis
(update Jan 06, 2023, manually selected best collects)

Laser	Wavelengths	Table
OPO_SWIR_4HG	310-339	OLAF-2
OPO_NIR_SHG	340-568	OLAF-2
OPO_SWIR_SHG	569-680	OLAF-2
OPO_NIR	681-1176	OLAF-2
OPO_SWIR	1171-1219	OLAF-2
OPO_NIR_IDLER	1220-2230	OLAF-2
ARGOS	2209-2400	OLAF-2

XINA marker Label	XINA marker ID	Wavelengths [nm]	Step Size [nm]	Description	Target Radiance
CAL-1 UV-VIS	**184000**	**310 – 899**	**1**	**Hyperspectral in-band**	Max (NTE 90% of Lmax/Lclip)
		342 – 352	0.2	Hyperspectral fine steps	Max (NTE 90% of Lmax)
		550 – 560	0.2	Hyperspectral fine steps	Max (NTE 90% of Lmax)
		615 – 625	0.2	Hyperspectral fine steps	Max (NTE 90% of Lmax)
		865 – 875	0.2	Hyperspectral fine steps	Max (NTE 90% of Lmax)
CAL-1 SWIR	**187000**	**900 – 2400**	**10**	**SWIR out-of-band**	GLAMR Max
		910 – 970	1	940 SWIR in-band	Max (NTE 90% of Lmax)
		990 – 1090	1	1038 SWIR in-band	Max (NTE 90% of Lclip)
		1219 – 1270	1	1250 SWIR in-band	Max (NTE 90% of Lclip 1250HG)
		1365 – 1391	1	1378 SWIR in-band	Max (NTE 90% of Lmax)
		1569 – 1670	1	1615 SWIR in-band	Max (NTE 90% of Lclip 1615HG)
		2090 – 2167	1	2130 SWIR in-band	Max (NTE 90% of Lmax)
		2201 – 2314	1	2260 SWIR in-band	Max (NTE 90% of Lmax)

Absolute Cal – Overview

OCI CPT Absolute Calibration

Source – integrating sphere with GLAMR at multiple wavelengths
Source radiance and wavelength monitored
Sensor response analyzed for Absolute Spectral Response

Analysis code flow – Absolute Calibration

1. Import OCI sensor response
2. Resample from L1A to L1B bands and multispectral bands
3. Subtract Dark View to get dn
4. Calculate centroid and average dn over scans and select pixels
5. Import GLAMR GSE
6. Convert raw GLAMR GSE to get wavelength and radiance
7. Calculate ASR
8. Screen collects by GLAMR stability and choose best repeated measurements
9. Combine ASR from all collects to calculate
10. For each OCI nominal L1B band with sufficient data, calculate
    RSR, gain, center, FWHM, integrated out of band response

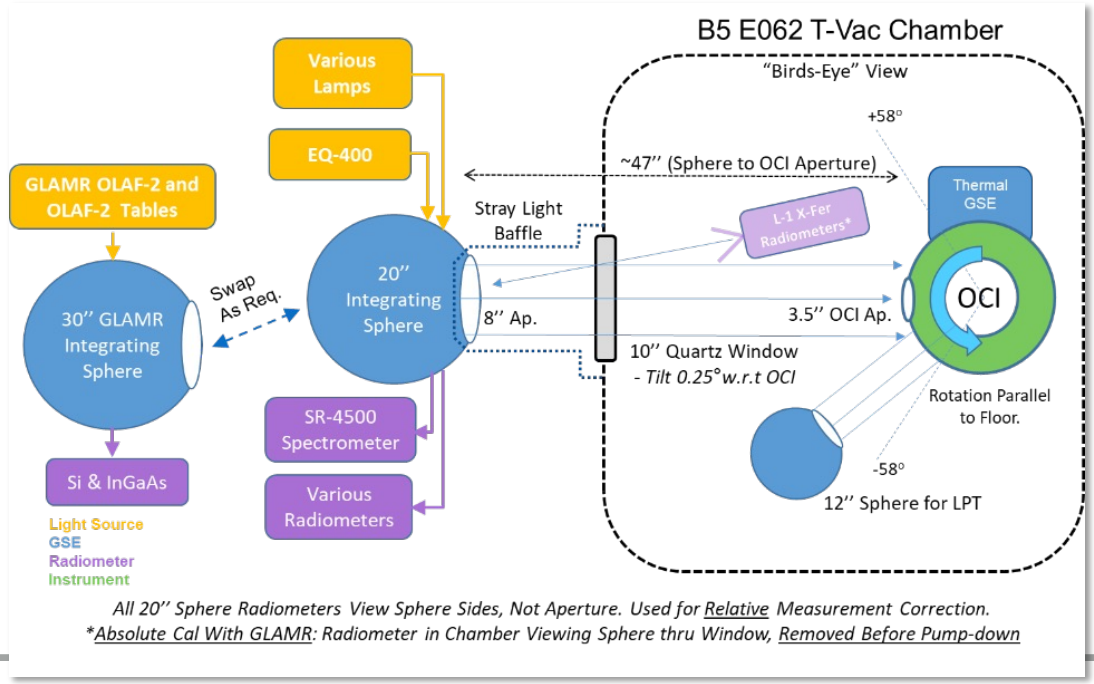
Current version of code has ~9000 lines in IDL

Absolute Cal – Test Setup

Test Setup

OCI in TVAC at Nominal temperature.

GLAMR 20” sphere placed at scan angle +0 deg.



Absolute Cal – Requirements

ID	Requirement
OCI-65	OCI shall have a visible spectral range of 342.5 nm - 887.5 nm (322.5 nm - 342.5 nm is a goal)
OCI-66	OCI shall have a wavelength difference of the center wavelengths for adjacent hyperspectral channels of 5nm ±0.5nm
OCI-67	The center wavelength of each 5nm band shall be characterized with an accuracy of 0.1 nm, pre-launch.
OCI-68	OCI visible spectral range bandwidth shall be 5 nm ± 1.0 nm FWHM
OCI-69	The ratio of the sum of all integrated out of band response to the integrated in band response shall be less than XX and measured with an uncertainty of YY for each multispectral band with center wavelengths: < 600nm: XX=2.5%, YY=0.25% >600nm and < 900nm: XX=1.0%, YY=0.25% 1) In Band Response is defined by FW1P (Full Width 1%). 2) Out of Band Response (total integrated out of band energy) is defined as 1% of the In-Band peak to 300nm and 1% of the In-Band peak to 2300nm. 3) 1% of the In-band peak shall occur in 10nm or less from the 50% points of the In-Band peak
OCI-DW-0174	The spectral out-of-band ratio uncertainties (YY) as described in OCI-69 for band 583nm shall be less than 0.4%, and less than 0.7% for 820nm.
OCI-72	OCI shall have the following SWIR bands: 940nm ± 4nm, 1038nm ± 2nm,1250nm ± 4nm, 1378nm ± 2nm, 1615nm ± 10nm, 2130nm ± 5nm, 2260nm ± 10nm
OCI-73	OCI SWIR bands shall have the following bandwidths Full Width Half Max (FWHM): 940nm: FWHM 45nm ± 4nm, 1038nm: FWHM 75nm ± 4nm, 1250nm: FWHM 30nm ± 4nm,1378nm: FWHM 15nm ± 2nm, 1615nm: FWHM 75nm ± 10nm, 2130nm: FWHM 50nm ± 5nm, 2260nm: FWHM 75nm ± 5nm
OCI-74	OCI SWIR bands shall have the following bandwidths Full Width 1% (FW1P), FW1P = FWHM * 2
OCI-75	The center wavelength of each SWIR band shall be characterized with an accuracy of 0.1 nm, pre-launch.
OCI-76	The integrated out of band response of the SWIR bands shall be less than 0.7% for 1378nm and less than 1.0% for 940nm, 1038nm 1250nm, 1615nm, 2130nm, and 2260nm. Out of band is defined by the FW1P
OCI-82	The pre-launch accuracy of the OCI absolute gain factor (1-sigma), K1 (see figure 2) shall be: 2.0% for bands between 340nm - 890nm, 5.0% for bands 940nm, 1038nm, 1250nm, 1615nm, 2130nm, 2260nm, 8.0% for band 1378nm

Data Selection – dn

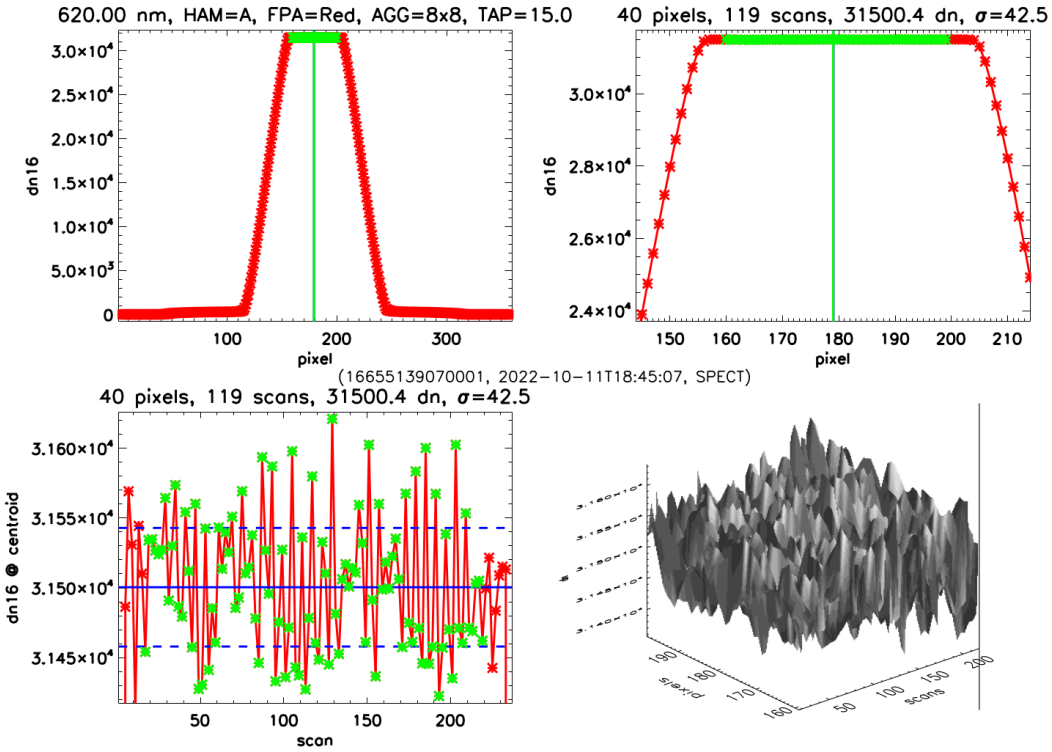
Data Selection – dn

- Build a scan profile of partial and full views of the sphere aperture using the **offset corrected** response.
- Determine the centroid of this profile for each band and HAM side (blue line).
- Average centroid over all bands and HAM sides (green line).
- Select 40 science pixels around the centroid for processing.
- Select scans to avoid GLAMR shutter transitions based on GLAMR telemetry.
- Process data in 8x1 and resampled 8x8 L1B bands

OCI Response and uncertainty

- Using selected pixels and scans and 3 sigma rejection, get the dn average and noise

$$\mathrm{dn} = \mathrm{DN} - \overline{\mathrm{DN}_{\mathrm{dark}}}, \qquad \sigma_{\mathrm{dn}} = \mathrm{STDDEV}(\mathrm{dn}),$$



Upper left: full EV scan averaged.
Upper right: plateau view scan average
Lower left: centroid pixels over all scans 1 HAM side
Lower right: all data selected pixels and scans
Note: green stars are selected pixels and scans

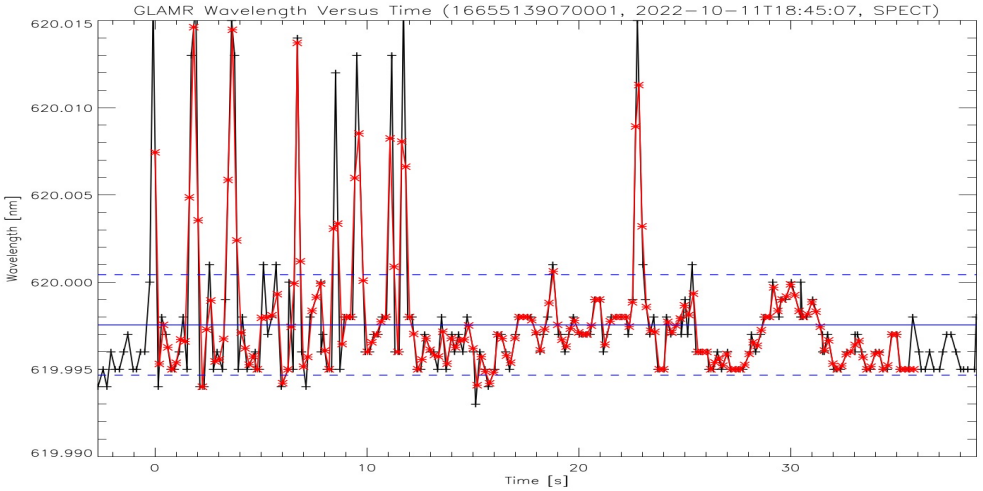
Data Selection – GLAMR

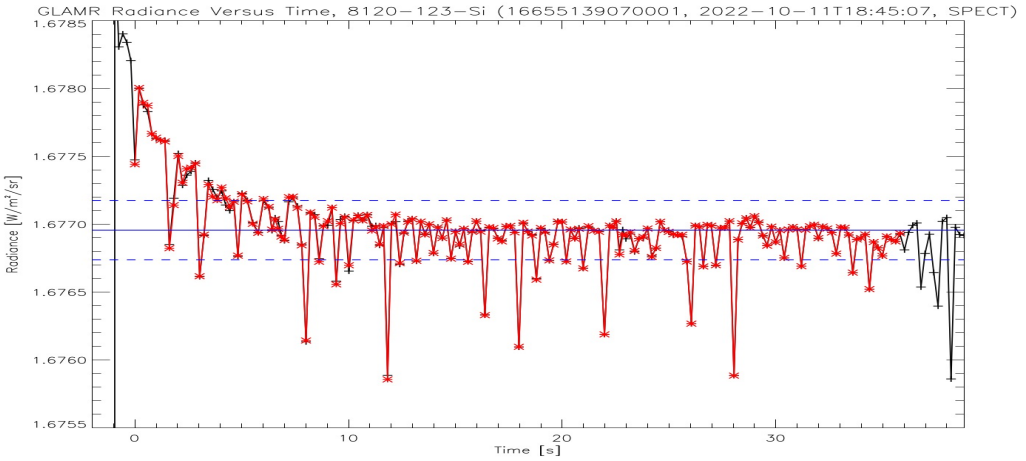
Data Selection – GLAMR

- GLAMR data processed by prescription provided by Julia Barsi.
- Wavelength and linewidth data screened for bad values.
- Data screened by shutter state.
- Voltage dark subtracted and then converted to radiance using gain and multiplier data, sphere calibration data, and transfer radiometer data.

$$L = \frac{(V - V_0)}{10^{g+m}} \frac{r_{TR/SM}}{G_{TR}}$$

- Wavelength, linewidth, and radiance reported. Uncertainties are taken as 1 standard deviation of the mean with 3sigma rejection of individual measurements during a collect.

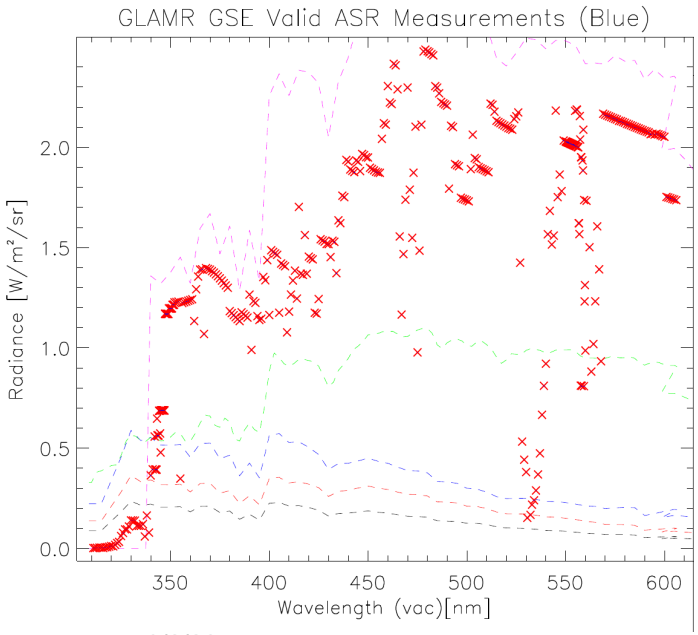


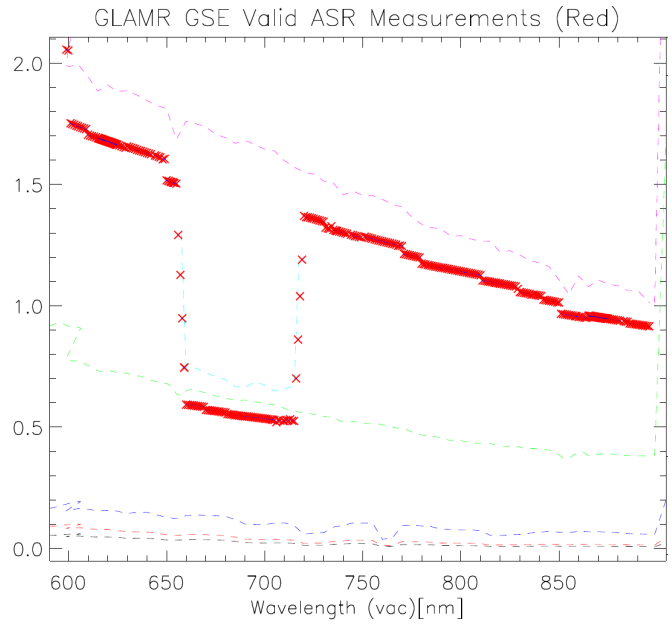


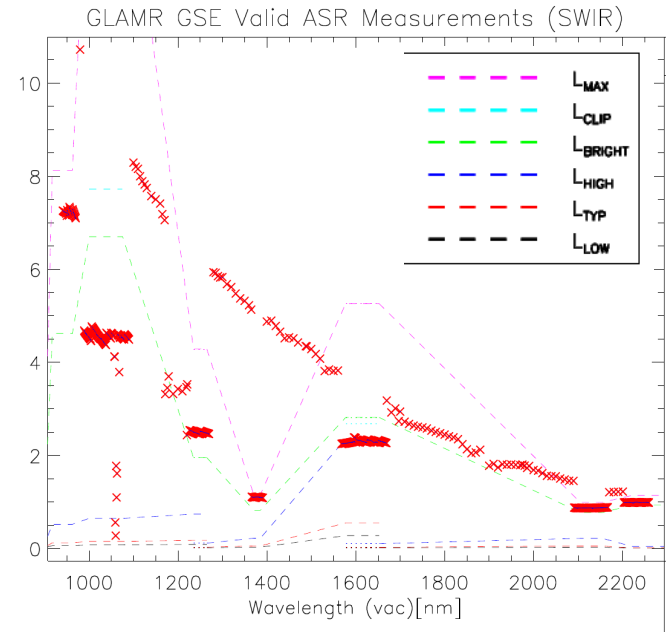
GLAMR GSE

Measured GLAMR GSE

- Plots show all CAL-1 valid GLAMR measurements used in spectral analysis.
- OCI radiance specs are over plot (adjusted from spectral radiance using bandwidth specs). Dashed dotted lines are L spec for HG bands.
- GLAMR collects screened for high instability. radiance $\sigma > 0.4\%$, wavelength $\sigma > 0.2nm$
- GLAMR collects screened so duration is > 25 seconds.
- Repeated collects screened to use the most stable collect.
- (update Jan 06, 2023, manually selected best collects)







Methodology - ASR

Absolute Spectral Response (ASR)

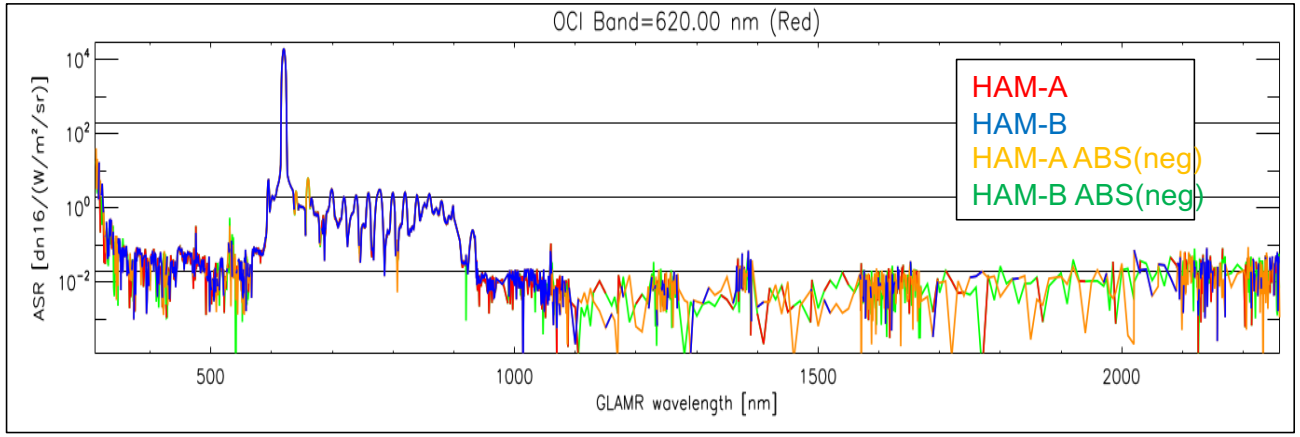
- Calculated per collect (per GLAMR wavelength per OCI band)

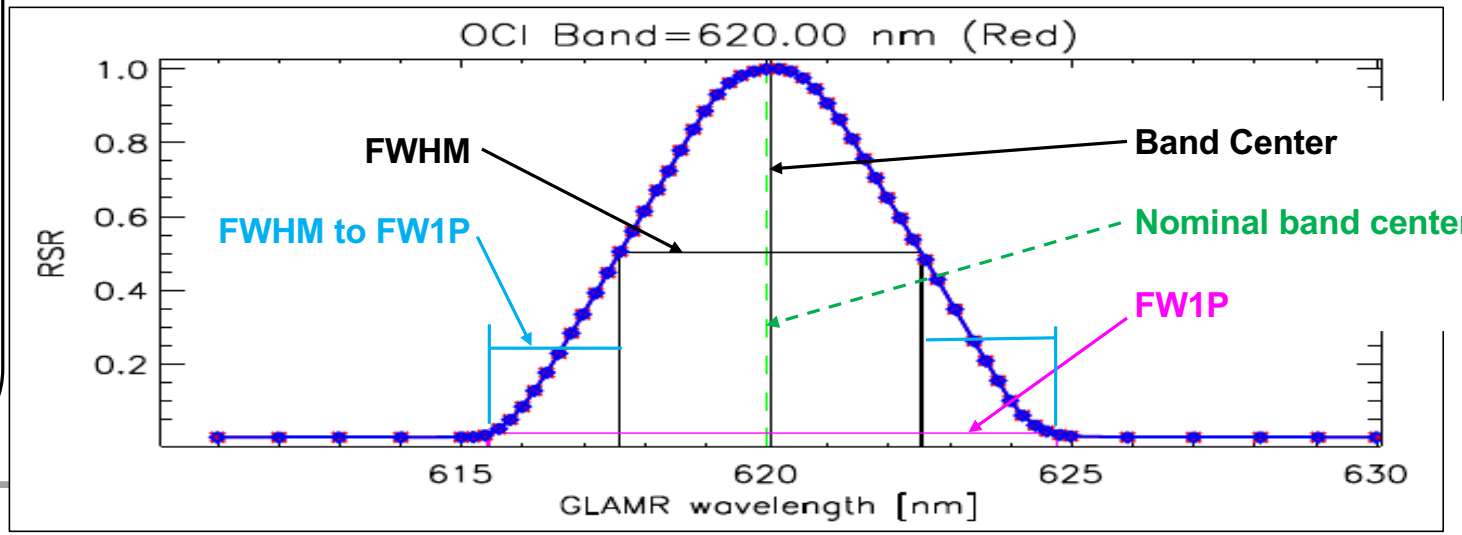
$$ASR(\lambda_o, \lambda_g) = \frac{dn(\lambda_o, \lambda_g)}{L(\lambda_g)}$$

- All valid GLAMR wavelength measurements combined to get the ASR for each OCI nominal band.
- OCI band ASR is used to calculate
  - FWHM
  - FW1P
  - Band center
  - RSR
  - OOB
  - K1, Gain

Relative Spectral Response (RSR)

$$RSR = \frac{ASR}{\max\{ASR\}}$$





ASR Uncertainty

Uncertainty inputs

σ_{dn}, OCI noise, 1-σ standard deviation of the mean *
σ_{λ}, GLAMR wavelength measurement noise, 1-σ standard deviation of the mean
σ_{L}, GLAMR radiance measurement noise, 1-σ standard deviation of the mean
$\sigma_{L_{tot}}/L$, GLAMR 1-σ total radiometric uncertainty**

* calculated considering the actual averaging efficiency
** from GLAMR_Uncertainty_Budget.OCI.20220711.delivered

Other terms

λ_c, OCI band center wavelength
λ, GLAMR wavelength measurement
L, GLAMR radiance measurement

ASR

RSS Radiance measurement uncertainty with GLAMR total radiometric uncertainty. Assume worst case covariance.

$$\sigma_{ASR}(\lambda_c,\lambda) = \left|\frac{dn(\lambda_c,\lambda)}{L(\lambda)}\right| \sqrt{\left(\frac{\sigma_{dn}(\lambda_c,\lambda)}{dn(\lambda_c,\lambda)}\right)^2 + \left(\frac{\sigma_L(\lambda)}{L(\lambda)}\right)^2 + \left(\frac{\sigma_{L_{tot}}(\lambda)}{L(\lambda)}\right)^2 + 2\left|\frac{\sigma_{dn}(\lambda_c,\lambda)\sigma_L(\lambda)}{L(\lambda)dn(\lambda_c,\lambda)}\right|}$$

Methodology – Band Metrics

Bandwidth is defined as the FWHM. Interpolate λ between two ASR points, (A_a, λ_a) and (A_b, λ_b) at point $A = 0.5\max[ASR(\lambda)]_\lambda$, for a lower and upper λ

Interpolation

$$\lambda = \lambda_a + \frac{(\lambda_b - \lambda_a)(A - A_a)}{(A_b - A_a)}, \qquad \sigma_\lambda = \sqrt{(\sigma_{\lambda_a})^2 + \left(\frac{\Delta A_a}{\Delta A}\sigma_{\Delta\lambda}\right)^2 + \left(\Delta\lambda\frac{\Delta A_a}{\Delta A^2}\sigma_{\Delta A}\right)^2 + \left(\frac{\Delta\lambda}{\Delta A}\sigma_{\Delta A_a}\right)^2}$$

FWHM and its uncertainty

$$FWHM = \lambda_{up} - \lambda_{low}, \qquad \sigma_{FWHM} = \sqrt{\sigma_{\lambda_{up}}^2 + \sigma_{\lambda_{low}}^2}$$

FW1P

$$FW1P = \lambda_{up-1p} - \lambda_{low-1p}$$

Band center is defined as the center of the FWHM and its uncertainty

$$\lambda_c = \frac{1}{2}(\lambda_{up} + \lambda_{low}), \qquad \sigma_{\lambda_c} = \frac{1}{2}\sqrt{\sigma_{\lambda_{up}}^2 + \sigma_{\lambda_{low}}^2}$$

Methodology - OOB

OOB

OOB is defined as the ratio of the integrated out of band (OB) to the integrated in band (IB) spectral response. Integrated using the trapezoid method.

$$OOB(\lambda_c) = \frac{\int_{OB} RSR(\lambda_c,\lambda)d\lambda}{\int_{IB} RSR(\lambda_c,\lambda)d\lambda}\times 100\% = \frac{\sum_{OB}(RSR(\lambda_c,\lambda_{i+1}))(\lambda_{i+1}-\lambda_i)}{\sum_{IB}\frac{1}{2}(RSR(\lambda_c,\lambda_{i+1})+RSR(\lambda_c,\lambda_i))(\lambda_{i+1}-\lambda_i)}\times 100\%$$

IB is in-band GLAMR wavelengths, λ_i where RSR > 0.01 and OB is out-of-band GLAMR wavelengths, λ_i where RSR < 0.01.

OOB uncertainty

$$\sigma_{RSR_{mi}} = \sigma_{ASRm_i}/\max(ASR)$$

$$\sigma_i(\lambda_c,\lambda_i) = |RSR_{mi}(\lambda_c,\lambda_i)\Delta\lambda_i|\sqrt{\left(\frac{\sigma_{RSR_{mi}}(\lambda_c,\lambda_i)}{RSR_{mi}(\lambda_c,\lambda_i)}\right)^2+\left(\frac{\sigma_{\Delta\lambda_i}}{\Delta\lambda_i}\right)^2+2\left|\frac{\sigma_{RSR_{mi}}\sigma_{\Delta\lambda_i}}{RSR_{mi}\Delta\lambda_i}\right|}$$

$$\sigma_{OB}(\lambda_c) = \sqrt{\sum_{OB}\left(\sigma_i(\lambda_c,\lambda_i)\right)^2}, \qquad \sigma_{IB}(\lambda_c) = \sqrt{\sum_{IB}\left(\sigma_i(\lambda_c,\lambda_i)\right)^2}$$

$$\sigma_{OOB}(\lambda_c) = \left|\frac{OB(\lambda_c)}{IB(\lambda_c)}\right|\sqrt{\left(\frac{\sigma_{OB}(\lambda_c)}{OB(\lambda_c)}\right)^2+\left(\frac{\sigma_{IB}(\lambda_c)}{IB(\lambda_c)}\right)^2}\times 100\% + \sigma_{\text{dRSR\_Ltyp}}(\lambda_c) + \sigma_{\text{dRSR\_impact}}(\lambda_c)$$

For multispectral bands, add uncertainty from non-linear RSR analysis (See OCI-SCI-RPT-0517).

Methodology - Gain

Gain

Gain is calculated as the integration of the absolute spectral response (ASR) over all GLAMR measured wavelengths. The trapezoid integration method is used as shown below.

$$Gain(\lambda_c) = \int ASR(\lambda_c, \lambda) d\lambda = \sum_{i=1}^{N-1} \frac{1}{2}[ASR(\lambda_c, \lambda_{i+1}) + ASR(\lambda_c, \lambda_i)][\lambda_{i+1} - \lambda_i]$$

λ_c, OCI band center wavelength
λ, GLAMR wavelength measurement

The gain parameter K1 is defined as radiance / count

$$L_t = \mathbf{K_1} * K_2(t) * (1 - K_3 * (T - T_{ref})) * K_4(q) * K_5(dn, T) * K_6(w) * dn$$

Therefore

$$K_1 = 1/Gain$$

Gain uncertainty

Trapezoid integration method where *i* are each of *N* GLAMR measurements.

$$Gain(\lambda_c) = \sum_{i=1}^{N-1} \frac{1}{2}[ASR(\lambda_c, \lambda_{i+1}) + ASR(\lambda_c, \lambda_i)][\lambda_{i+1} - \lambda_i] = ASR_{mi}(\lambda_c, \lambda_{i+1})\Delta\lambda_i$$

$$\sigma_{ASR_{mi}} = \frac{1}{2}\sqrt{\left(\sigma_{ASR}(\lambda_c, \lambda_{i+1})\right)^2 + \left(\sigma_{ASR}(\lambda_c, \lambda_i)\right)^2}, \qquad \sigma_{\Delta\lambda_i} = \sqrt{\left(\sigma_{\lambda_{i+1}}\right)^2 + \left(\sigma_{\lambda_i}\right)^2}$$

$$\sigma_{Gain_i}(\lambda_c, \lambda_i) = |ASR_{mi}(\lambda_c, \lambda_i)\Delta\lambda_i| \sqrt{\left(\frac{\sigma_{ASR_{mi}}(\lambda_c, \lambda_i)}{ASR_{mi}(\lambda_c, \lambda_i)}\right)^2 + \left(\frac{\sigma_{\Delta\lambda_i}}{\Delta\lambda_i}\right)^2 + 2\left|\frac{\sigma_{ASR_{mi}}(\lambda_c, \lambda_i)\sigma_{\Delta\lambda_i}}{ASR_{mi}(\lambda_c, \lambda_i)\Delta\lambda_i}\right|}$$

$$\sigma_{Gain}(\lambda_c) = \sqrt{\sum_{i=1}^{N-1}\left(\sigma_{Gain_i}(\lambda_c, \lambda_i)\right)^2}$$

$$\sigma_{K_1}(\lambda_c) = \frac{\sigma_{Gain}(\lambda_c)}{Gain(\lambda_c)^2}$$

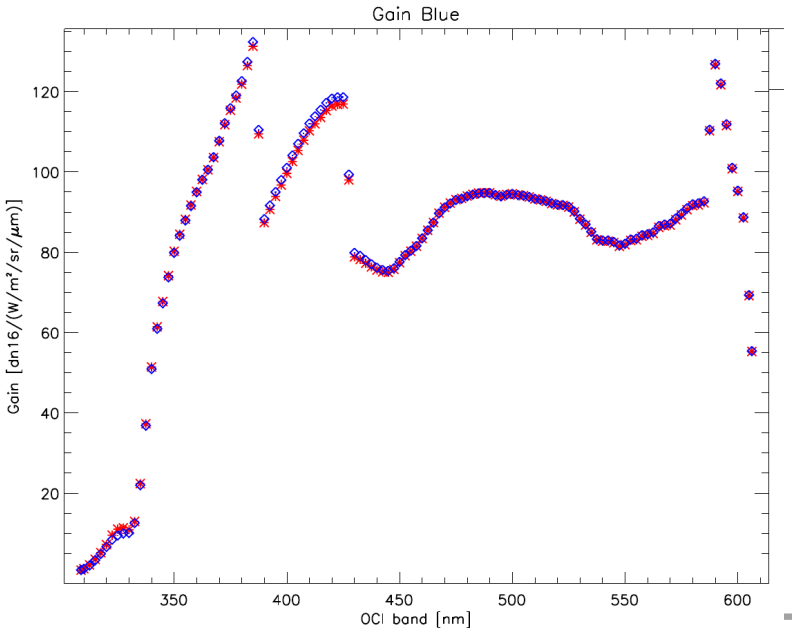
L3 Requirements

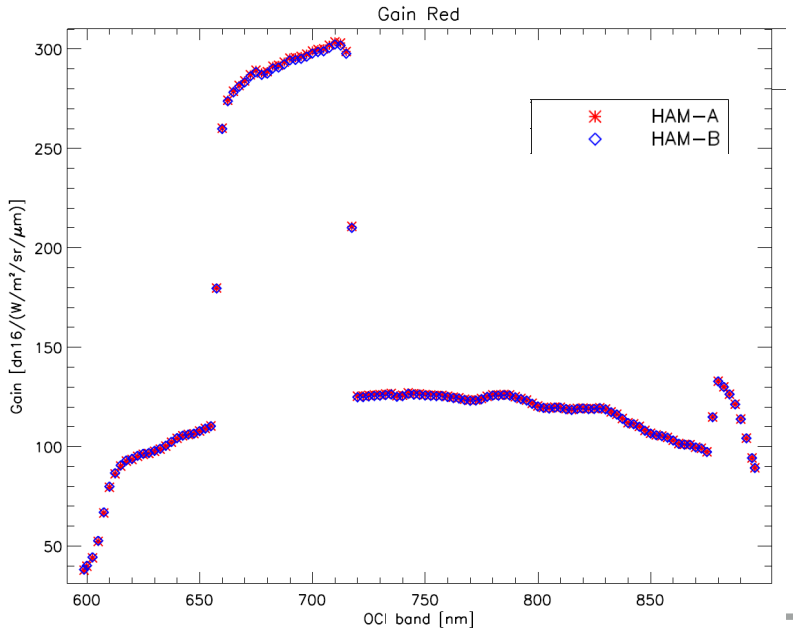
Spectral Response Range (OCI-65)

ID	Requirement
OCI-65	OCI shall have a visible spectral range of 342.5 nm - 887.5 nm (322.5 nm - 342.5 nm is a goal)

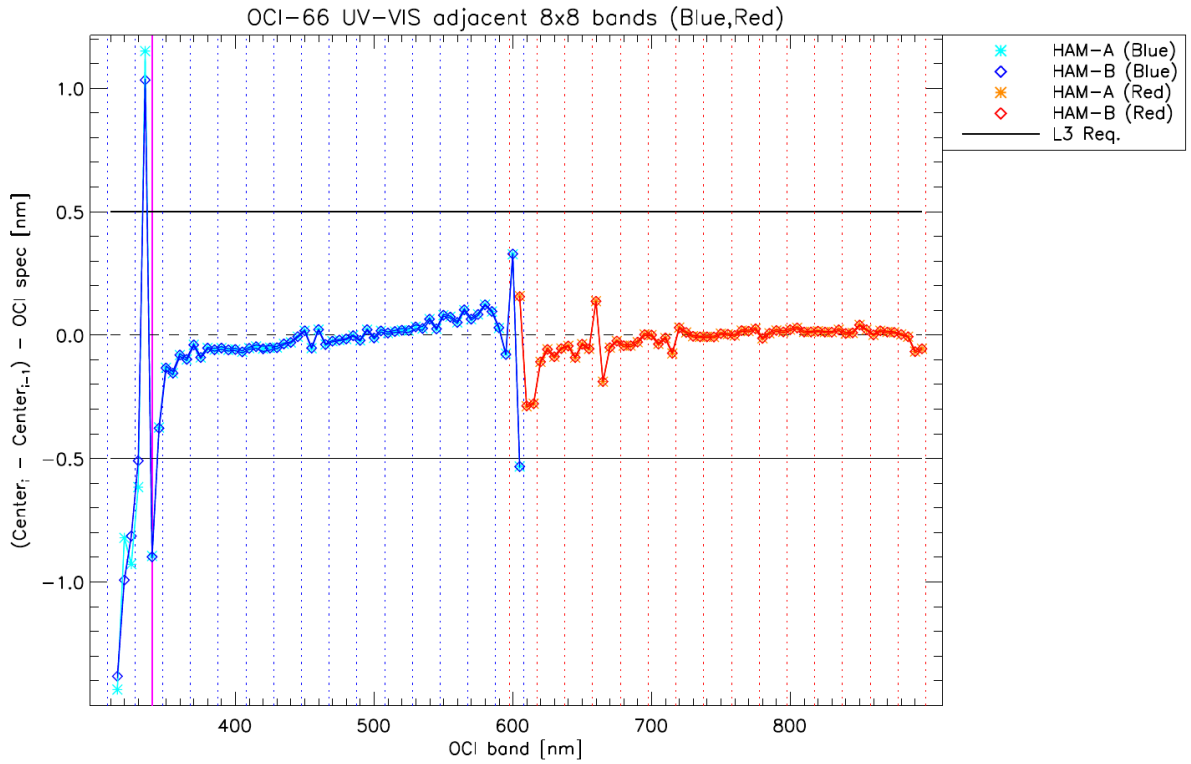
OCI shows signal in all hyperspectral bands, therefore OCI meets the requirement

- Shortest 8x4 band is 308.75 nm with a gain of 0.81082253 dn/(W/m²/sr/µm)
- Shortest 8x8 band is 310 nm with a gain of 1.1685679 dn/(W/m²/sr/µm)
- Longest 8x8 band is 895 nm with a gain of 94.261694 dn/(W/m²/sr/µm)
- Longest 8x4 band is 896.25 nm with a gain of 89.301627 dn/(W/m²/sr/µm)





Band Spacing (OCI-66)



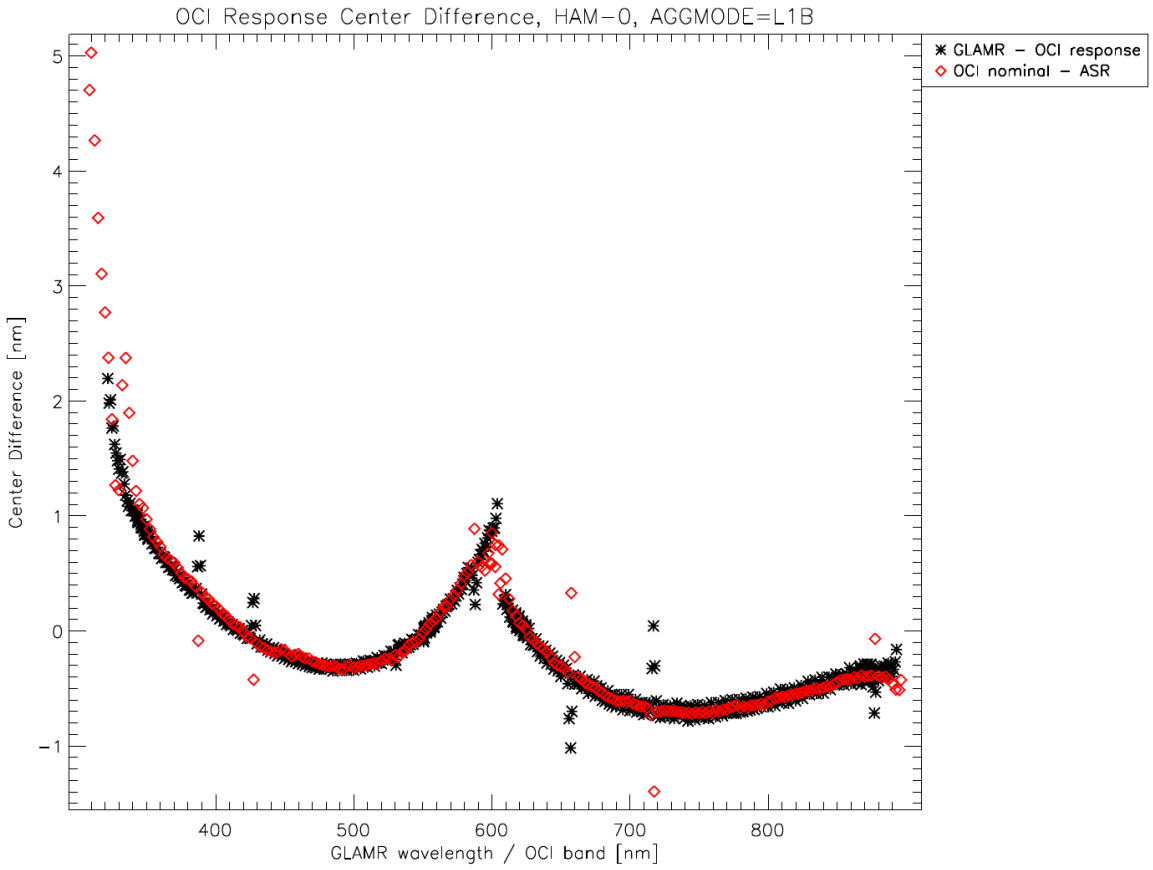
- Solid color lines that match the legend are uncertainty
- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- OCI meets the requirement for the blue channels for bands 340nm - 600nm
- OCI meets the requirement for the red channels for bands 600nm - 890nm

Blue Channel Fails
310 – 315 * worst HAM-A @ 3.55nm separation
315 – 320, 320 – 325, 325 – 330, 330 - 335
335 – 340, 600 – 605

ID	Requirement
OCI-66	OCI shall have a wavelength difference of the center wavelengths for adjacent hyperspectral channels of 5nm ±0.5nm

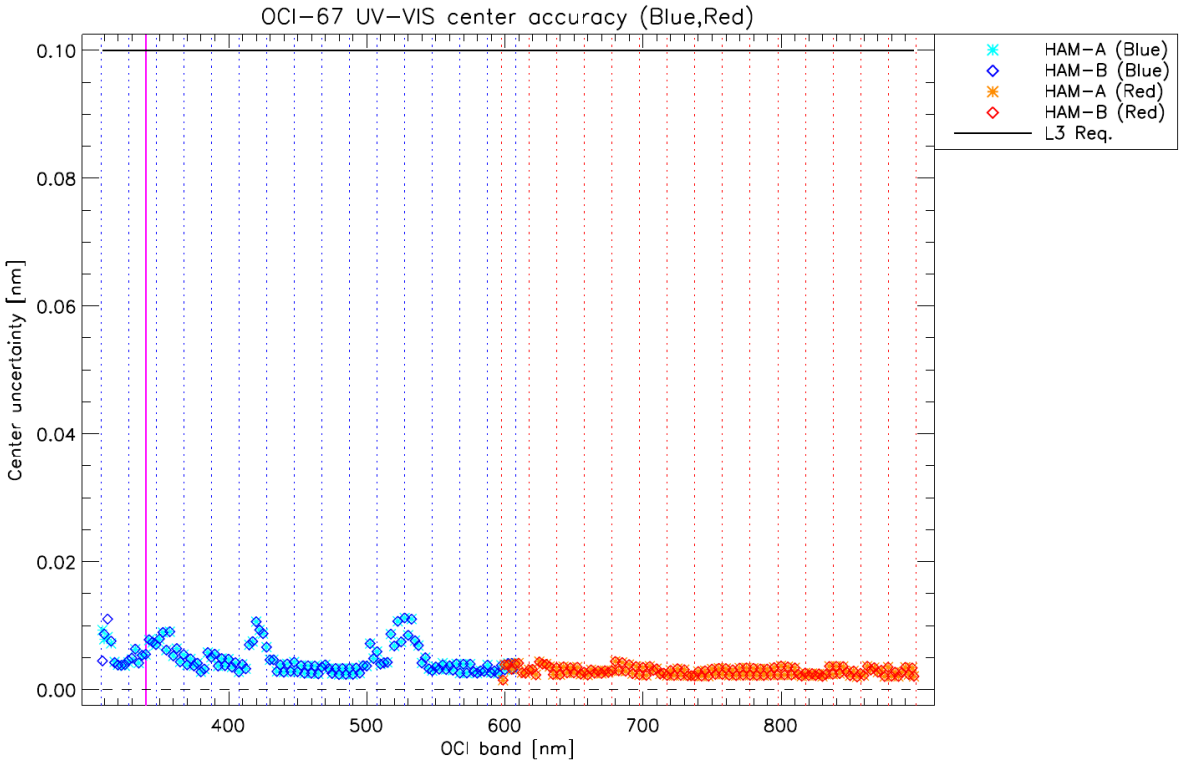
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

Spectral Results - Dispersion



Measured band center difference from the OCI nominal band center as calculated from FPA pixel map in OCI-FPA-SPEC-0087.

Band Center Accuracy (OCI-67)

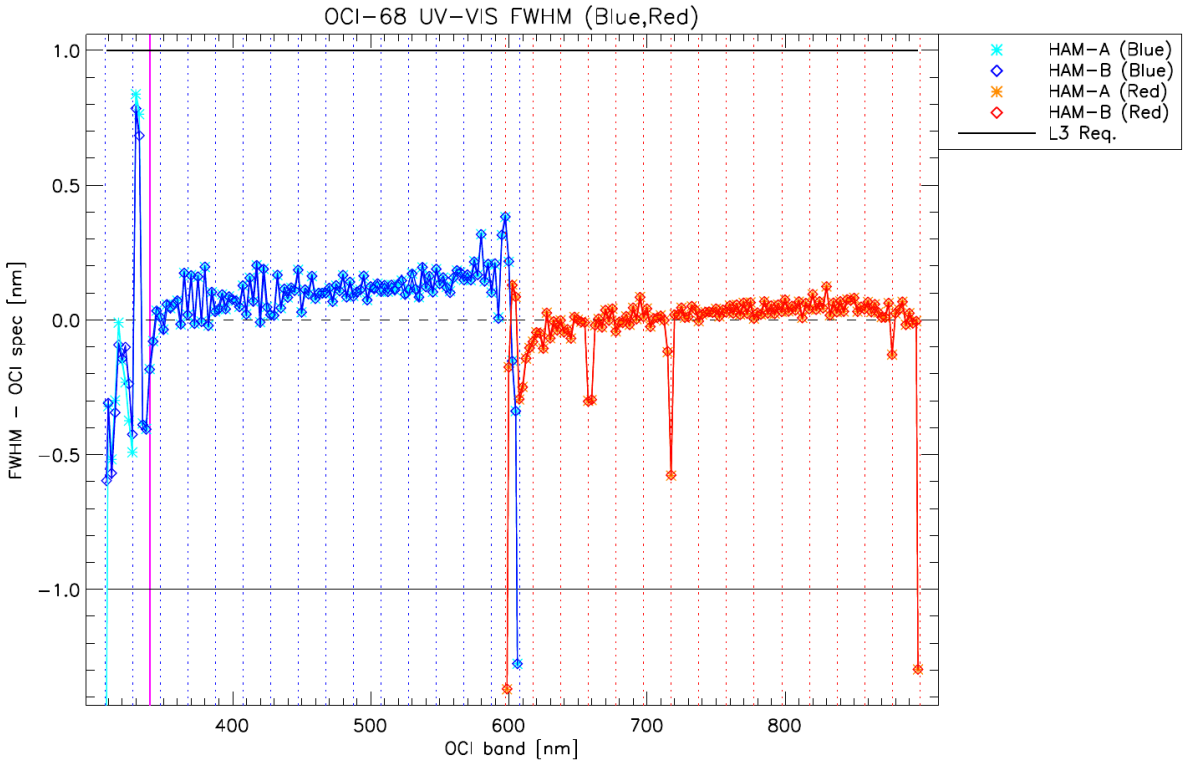


- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- All blue and red bands are below 0.1nm, therefore OCI meets this requirement

ID	Requirement
OCI-67	The center wavelength of each 5nm band shall be characterized with an accuracy of 0.1 nm, pre-launch.

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

Bandwidth (OCI-68)

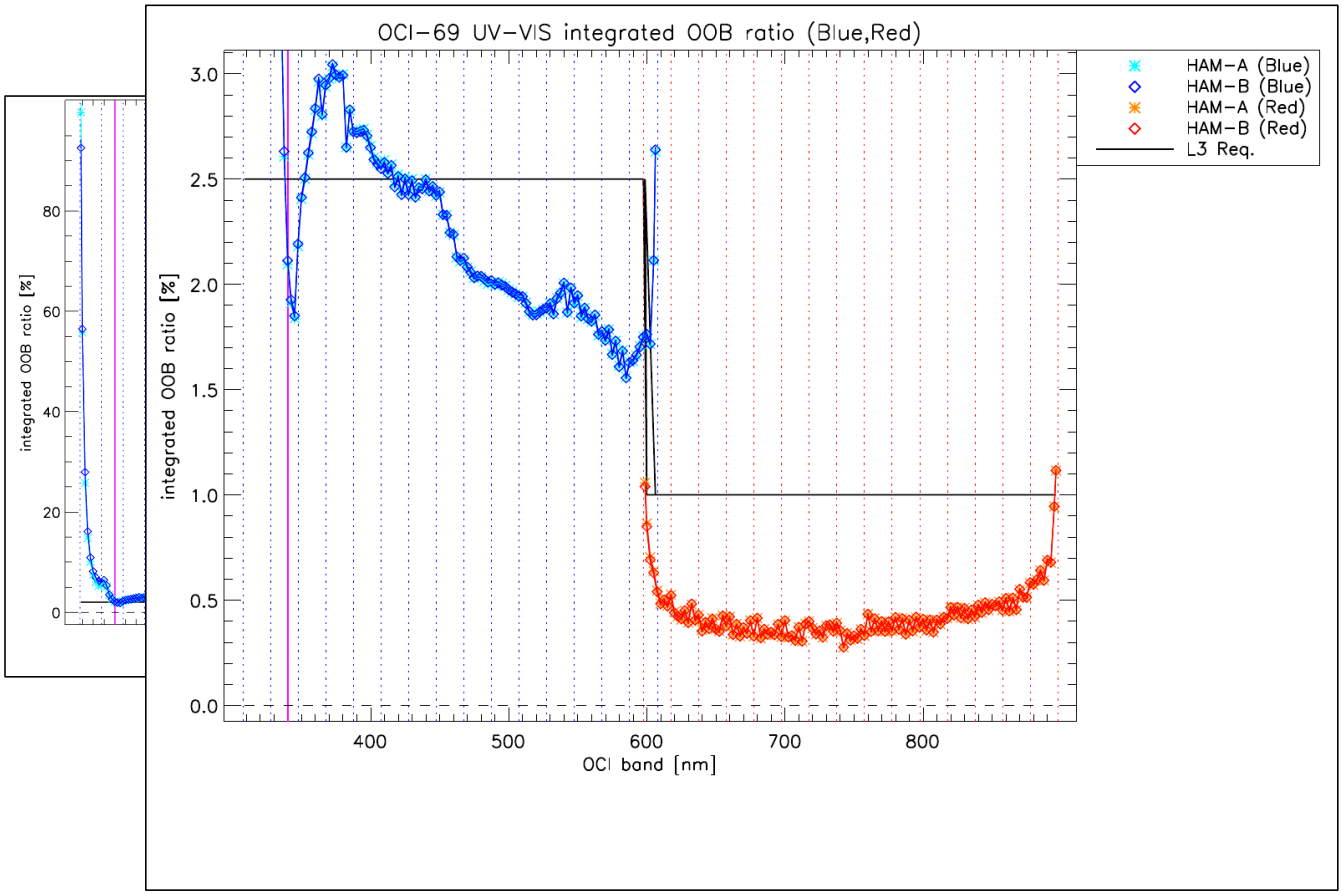


- Solid color lines that match the legend are uncertainty
- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- All 8x8 bands are within 1nm of spec, therefore OCI meets this requirement.
- All bands below spec line are 8x4 L1B bands.
- Low FWHM Red bands are cross tap bands at the edge of the high gain

ID	Requirement
OCI-68	OCI visible spectral range bandwidth shall be 5 nm ± 1.0 nm FWHM

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

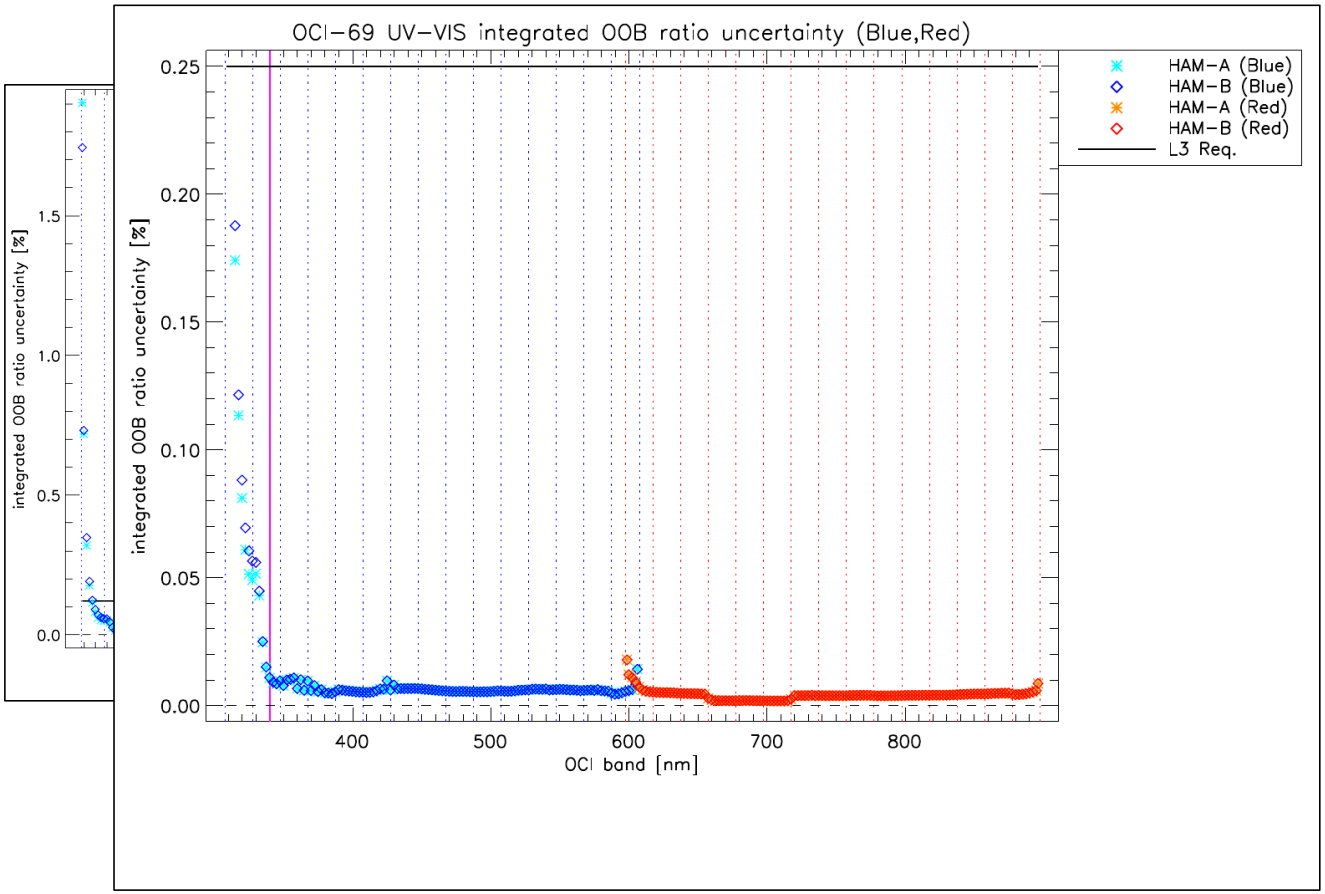
Integrated OOB ratio (OCI-69)



- **L1B bands**
  No longer used in L3
  Requirement
- Solid color lines that match the legend are uncertainty
- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- Far left plot insert shows full scale of OOB ratio below 340nm.

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

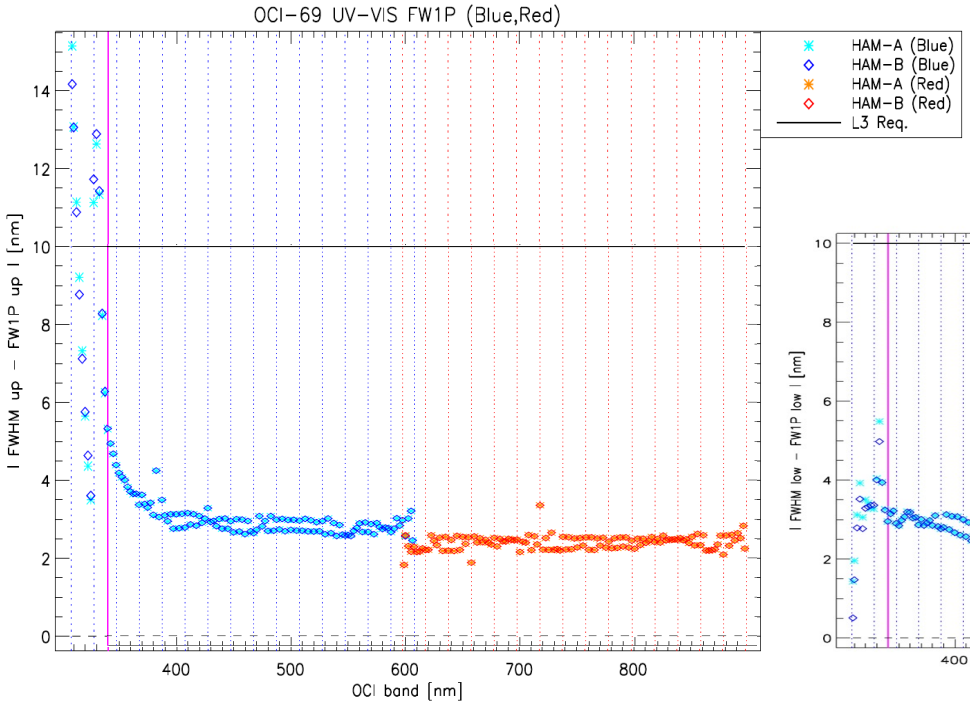
Integrated OOB ratio uncertainty (OCI-69)

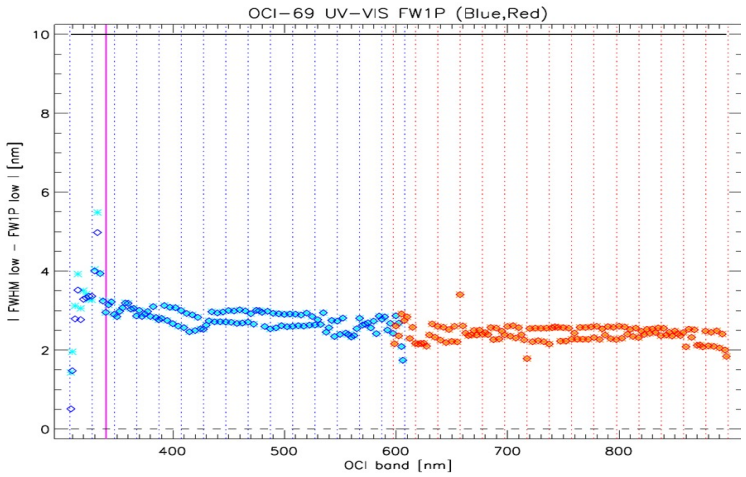


- **L1B bands**
  No longer used in L3
  Requirement
- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- Far left plot insert shows full scale of OOB uncertainty below 340nm.

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

FW1P (OCI-69)



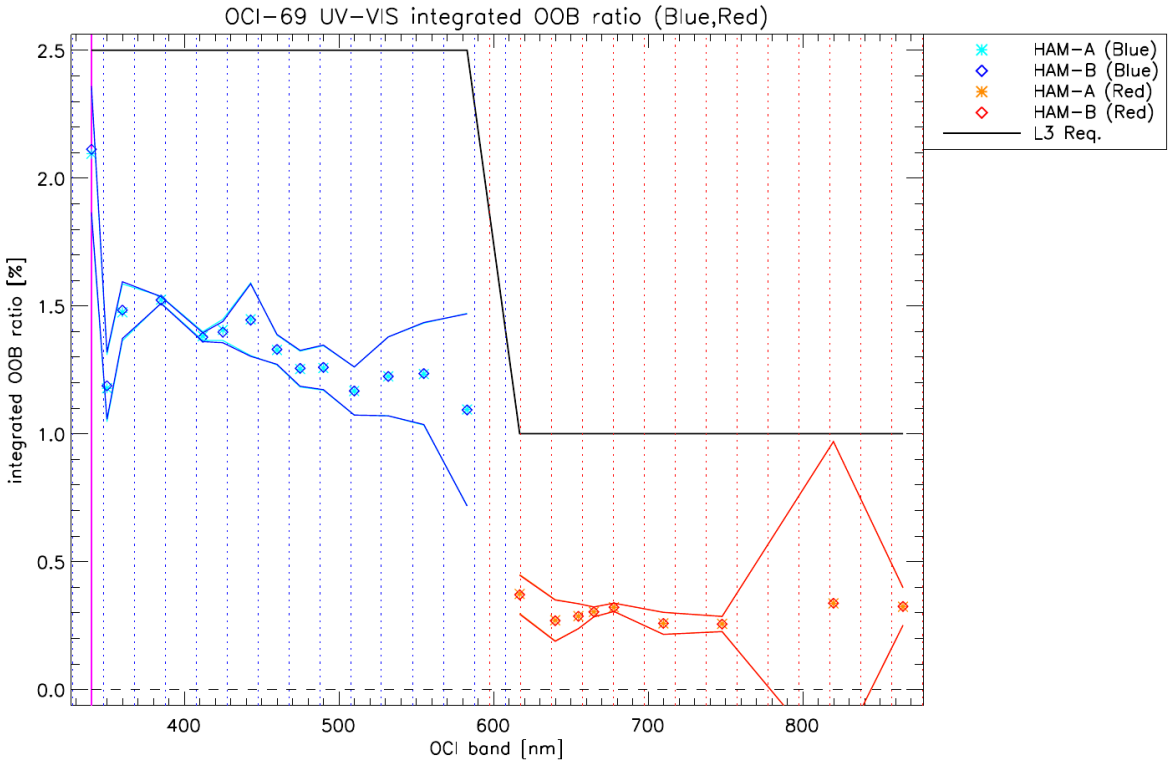


- **L1B bands**
  No longer used in L3
  Requirement

- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

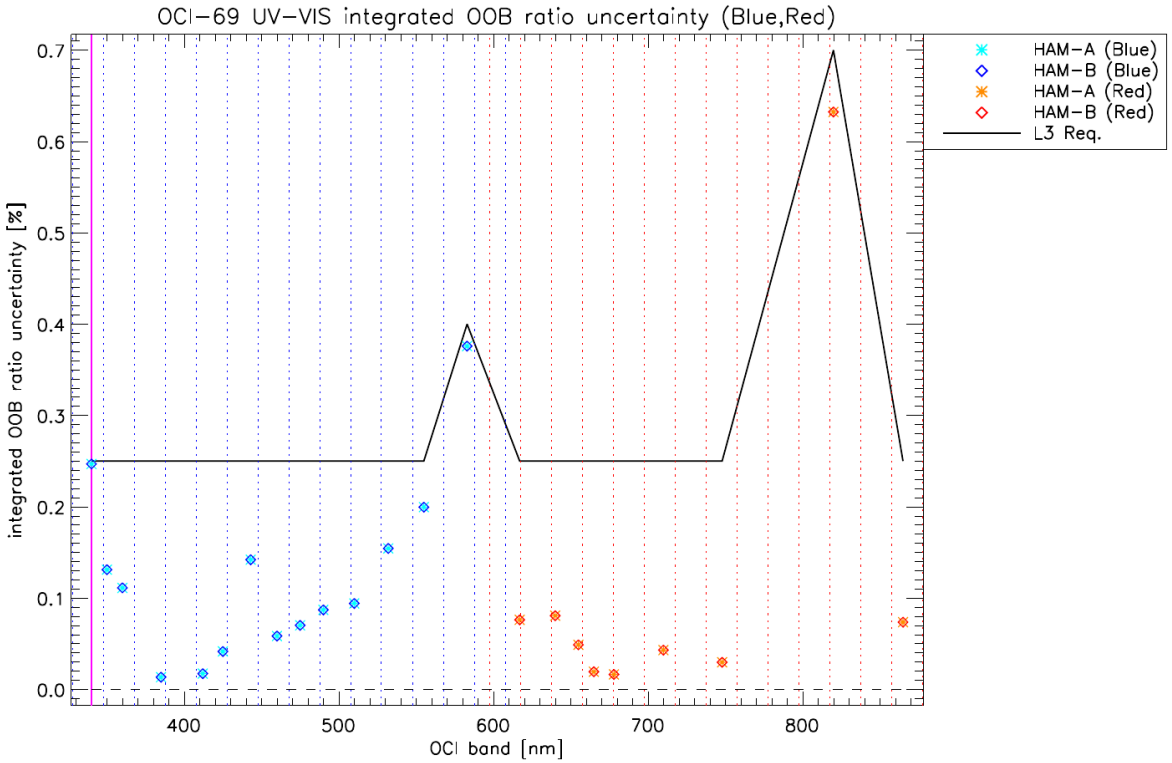
Integrated OOB ratio (OCI-69)



- **Multispectral bands**
  Now used in L3 requirement
- Magenta vertical marks 340nm.
- Solid color lines that match the legend are uncertainty
- All blue and red bands are less than the requirement.
  Therefore, OCI meets this requirement.

ID	Requirement
OCI-69	**The ratio of the sum of all integrated out of band response to the integrated in band response shall be less than XX** and measured with an uncertainty of YY **for each multispectral band with center wavelengths: < 600nm: XX=2.5%,** YY=0.25%, **>600nm and < 900nm: XX=1.0%,** YY=0.25% 1) In Band Response is defined by FW1P (Full Width 1%). 2) Out of Band Response (total integrated out of band energy) is defined as 1% of the In-Band peak to 300nm and 1% of the In-Band peak to 2300nm. 3) 1% of the In-band peak shall occur in 10nm or less from the 50% points of the In-Band peak

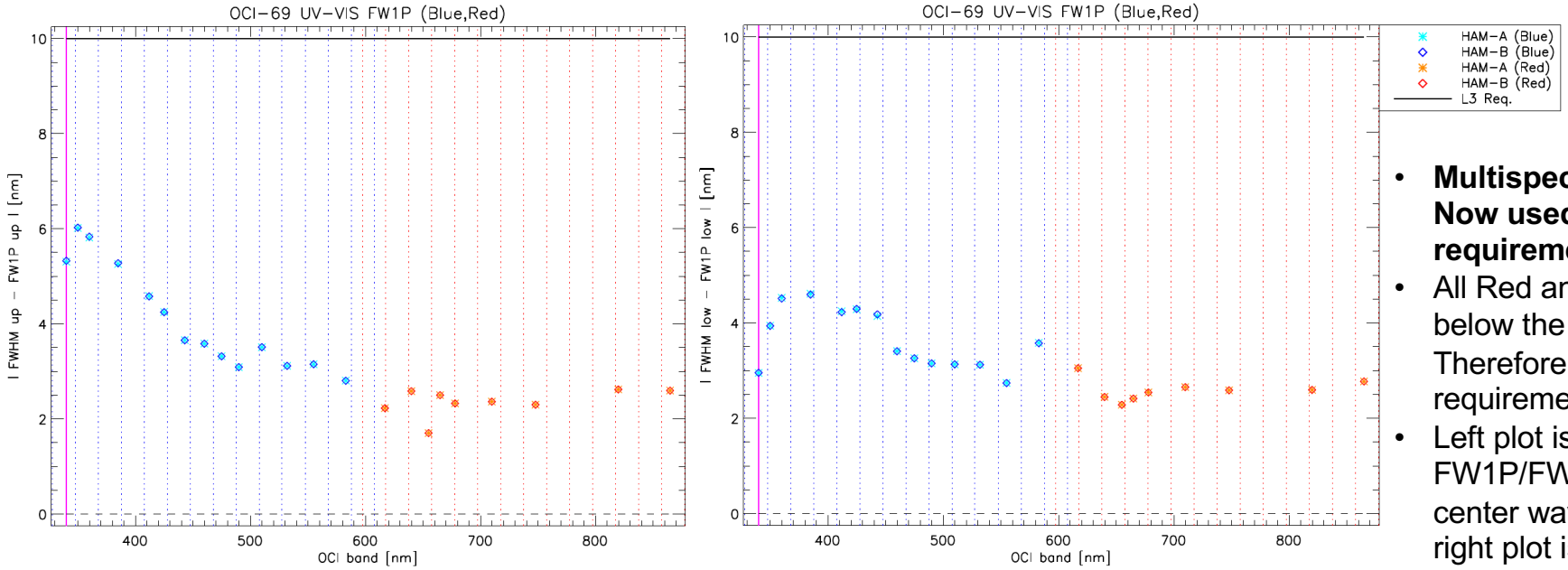
Integrated OOB ratio uncertainty (OCI-69)



- **Multispectral bands Now used in L3 requirement**
- Magenta vertical marks 340nm.
- All blue and red bands are less than the requirement. Therefore, OCI meets this requirement.

ID	Requirement
OCI-69	**The ratio of the sum of all integrated out of band response to the integrated in band response shall be** less than XX and **measured with an uncertainty of YY for each multispectral band with center wavelengths: < 600nm:** XX=2.5%, **YY=0.25%, >600nm and < 900nm:** XX=1.0%, **YY=0.25%** 1) In Band Response is defined by FW1P (Full Width 1%). 2) Out of Band Response (total integrated out of band energy) is defined as 1% of the In-Band peak to 300nm and 1% of the In-Band peak to 2300nm. 3) 1% of the In-band peak shall occur in 10nm or less from the 50% points of the In-Band peak

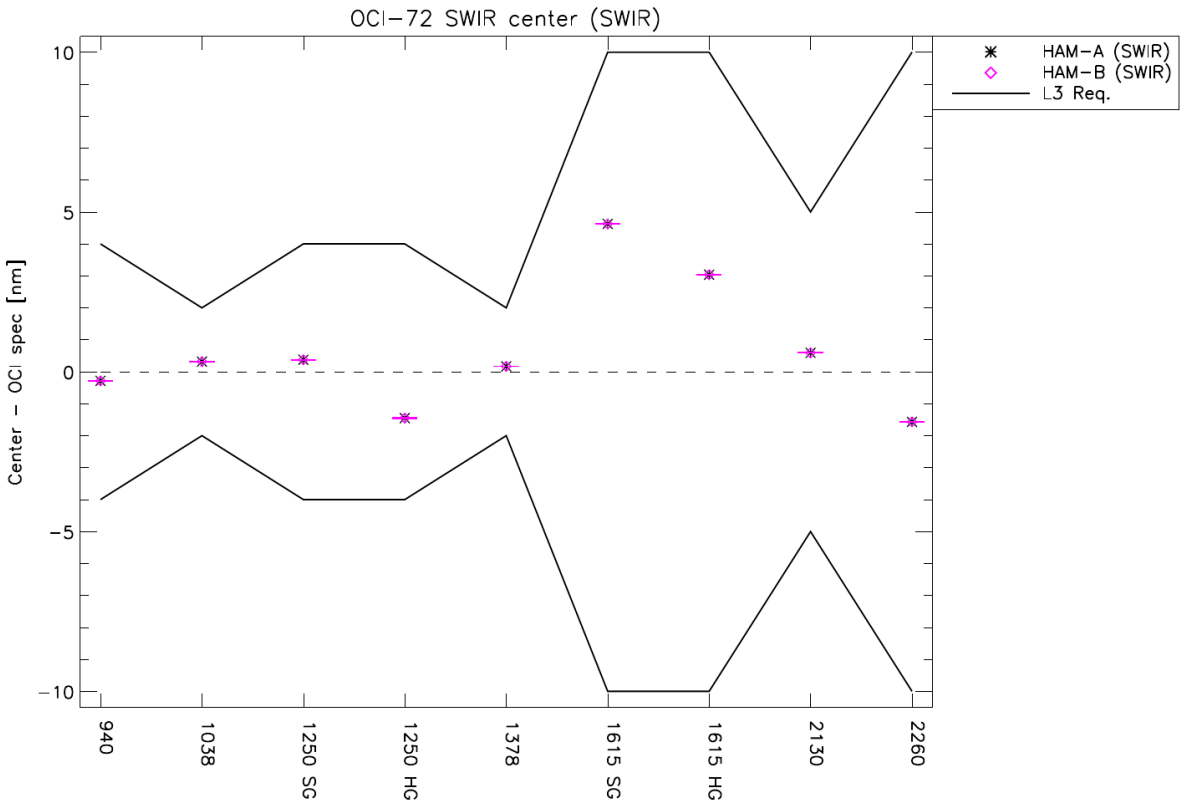
FW1P (OCI-69)



- **Multispectral bands Now used in L3 requirement**
- All Red and bands are below the spec line. Therefore, OCI meets this requirement.
- Left plot is for the FW1P/FWHM above the center wavelength and the right plot is for below the center wavelength.

ID	Requirement
OCI-69	The ratio of the sum of all integrated out of band response to the integrated in band response shall be less than XX and measured with an uncertainty of YY for each multispectral band with center wavelengths: < 600nm: XX=2.5%, YY=0.25%, >600nm and < 900nm: XX=1.0%, YY=0.25% 1) In Band Response is defined by FW1P (Full Width 1%). 2) Out of Band Response (total integrated out of band energy) is defined as 1% of the In-Band peak to 300nm and 1% of the In-Band peak to 2300nm. **3) 1% of the In-band peak shall occur in 10nm or less from the 50% points of the In-Band peak**

SWIR Center (OCI-72)



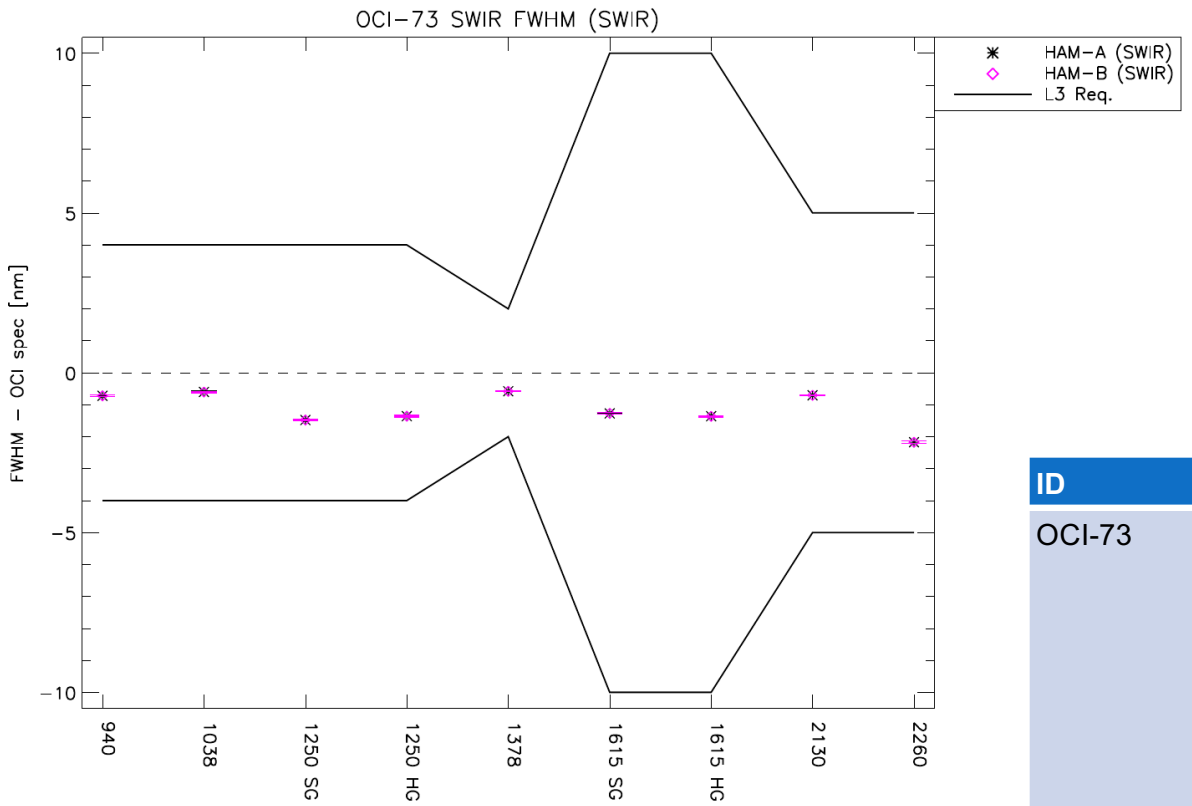
- Horizontal bars are uncertainty bars by HAM side color
- All SWIR bands are within the specified tolerance. Therefore, OCI meets this requirement.

- Worst is 1038nm at 0.33nm is closest to its 2nm requirement.

ID	Requirement
OCI-72	OCI shall have the following SWIR bands: 940nm ± 4nm, 1038nm ± 2nm, 1250nm ± 4nm, 1378nm ± 2nm, 1615nm ± 10nm, 2130nm ± 5nm, 2260nm ± 10nm

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

SWIR Bandwidth (OCI-73)



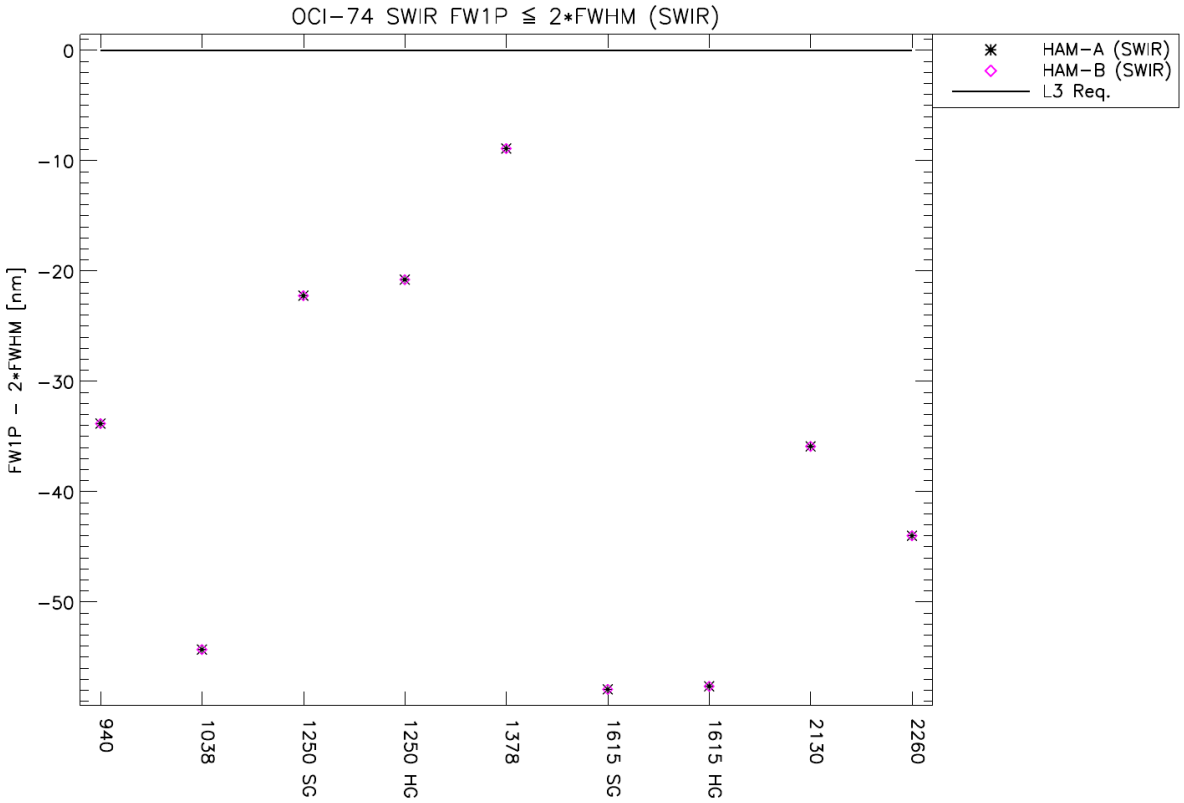
- Horizontal bars are uncertainty bars by HAM side color
- All SWIR bands are within the specified tolerance. Therefore, OCI meets this requirement.

- Worst is 1378nm at -0.59nm is closest to its 2nm requirement.

ID	Requirement
OCI-73	OCI SWIR bands shall have the following bandwidths Full Width Half Max (FWHM): 940nm: FWHM 45nm ± 4nm, 1038nm: FWHM 75nm ± 4nm, 1250nm: FWHM 30nm ± 4nm, 1378nm: FWHM 15nm ± 2nm, 1615nm: FWHM 75nm ± 10nm, 2130nm: FWHM 50nm ± 5nm, 2260nm: FWHM 75nm ± 5nm

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.band_l3_specs.glamr.pdf

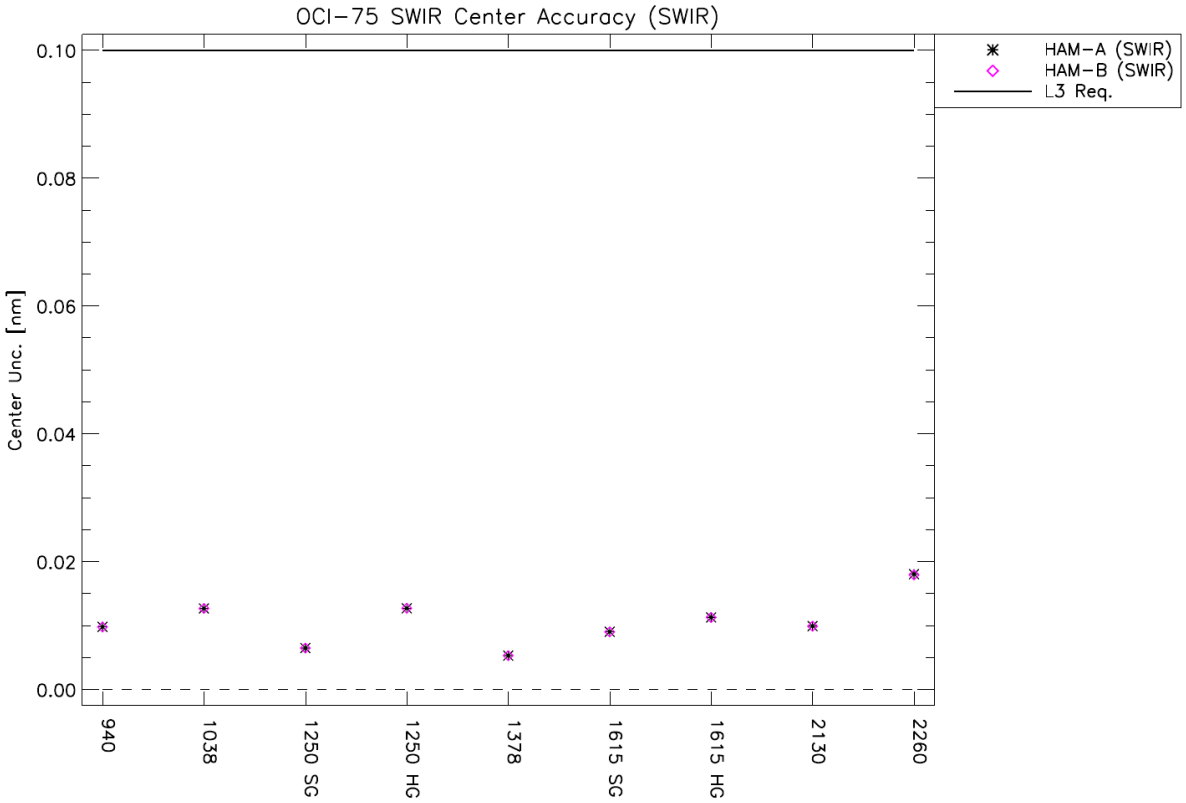
SWIR FW1P (OCI-74)



- The measured FW1P are all less than 2*FWHM.
- Therefore, OCI meets the OCI-74 requirement.
- Worst is 1378nm at FW1P = 21.1nm is closest to its 30nm requirement.

ID	Requirement
OCI-74	OCI SWIR bands shall have the following bandwidths Full Width 1% (FW1P), FW1P = FWHM * 2 *Taken as FW1P ≤ FWHM * 2*

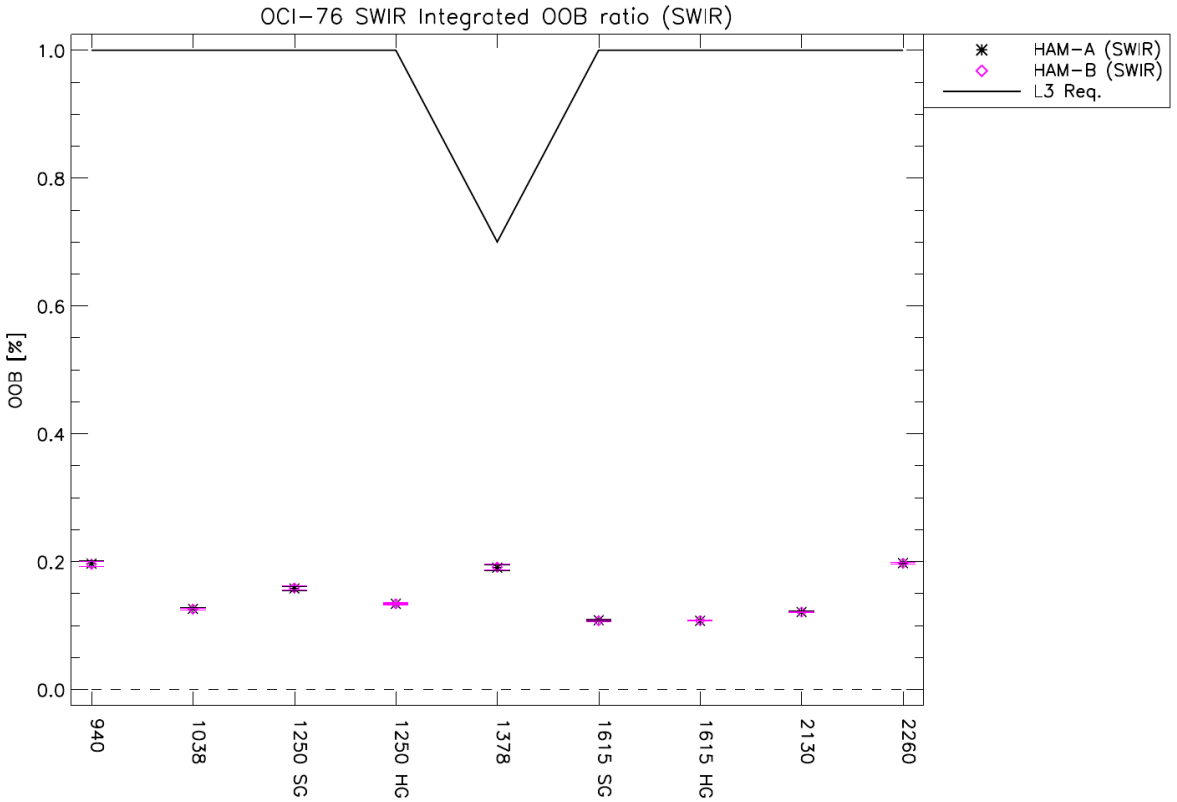
SWIR Band Center Accuracy (OCI-75)



- The measured center uncertainty are all less than 0.1%.
- Therefore, OCI meets the OCI-75 requirement.
- Worst is 2260nm at 0.018%.

ID	Requirement
OCI-75	The center wavelength of each SWIR band shall be characterized with an accuracy of 0.1 nm, pre-launch.

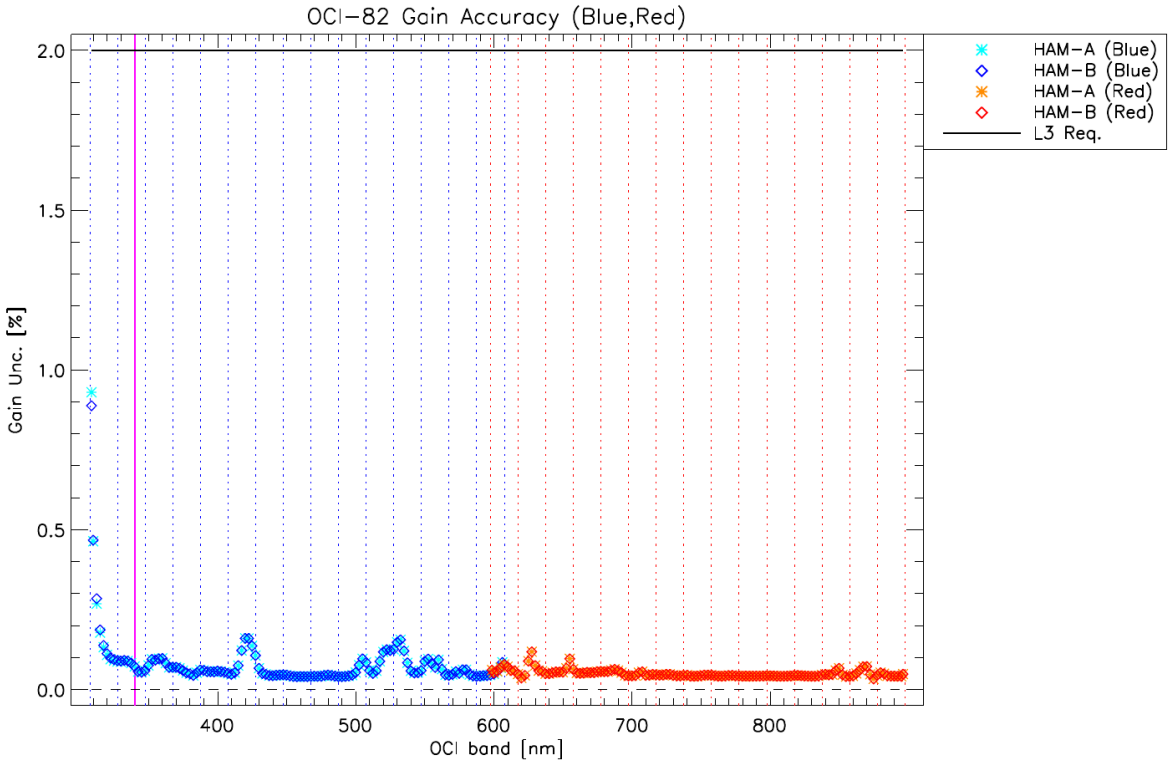
SWIR Integrated OOB (OCI-76)



- Horizontal bars are uncertainty bars by HAM side color
- The measured integrated OOB ratio +/- uncertainty less than the requirement.
- Therefore, OCI meets the OCI-76 requirement.
- The worst is 1378nm at 0.20% closest to its 0.7% requirement.

ID	Requirement
OCI-76	The integrated out of band response of the SWIR bands shall be less than 0.7% for 1378nm and less than 1.0% for 940nm, 1038nm 1250nm, 1615nm, 2130nm, and 2260nm. Out of band is defined by the FW1P

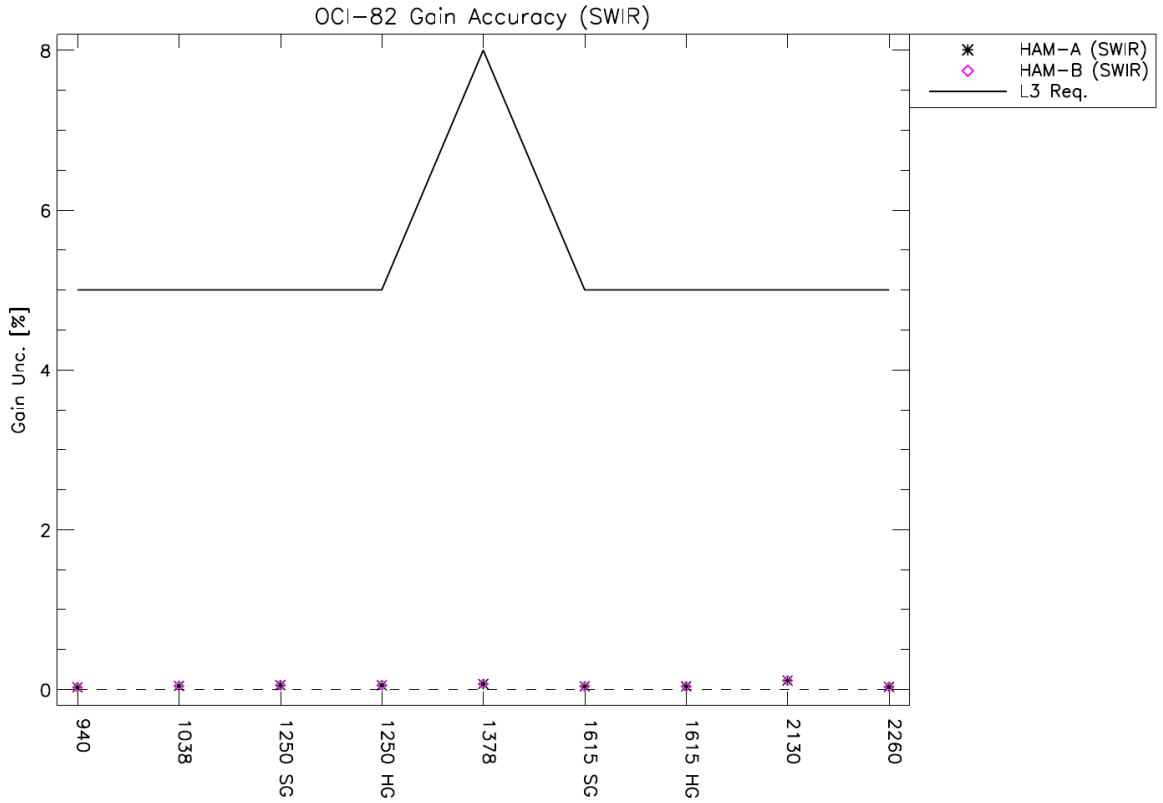
Gain Accuracy (Blue & Red) (OCI-82)



- Magenta vertical marks 340nm. Uncertainty below 340nm is high. GLAMR radiance below 340nm was below L_{low}.
- All Blue and Red bands are below 2%. Therefore, OCI meets this requirement.

ID	Requirement
OCI-82	The pre-launch accuracy of the OCI absolute gain factor (1-sigma), K1 (see figure 2) shall be: **2.0% for bands between 340nm - 890nm**, 5.0% for bands 940nm, 1038nm, 1250nm, 1615nm, 2130nm, 2260nm, 8.0% for band 1378nm

Gain Accuracy (SWIR) (OCI-82)



- All SWIR bands are the spec line. Therefore, OCI meets this requirement.

ID	Requirement
OCI-82	The pre-launch accuracy of the OCI absolute gain factor (1-sigma), K1 (see figure 2) shall be: 2.0% for bands between 340nm - 890nm, **5.0% for bands 940nm, 1038nm, 1250nm, 1615nm, 2130nm, 2260nm, 8.0% for band 1378nm**

Conclusions

Updates

- Completed a comprehensive check to use the most accurate measurements. In this report as of Jan 6, 2022

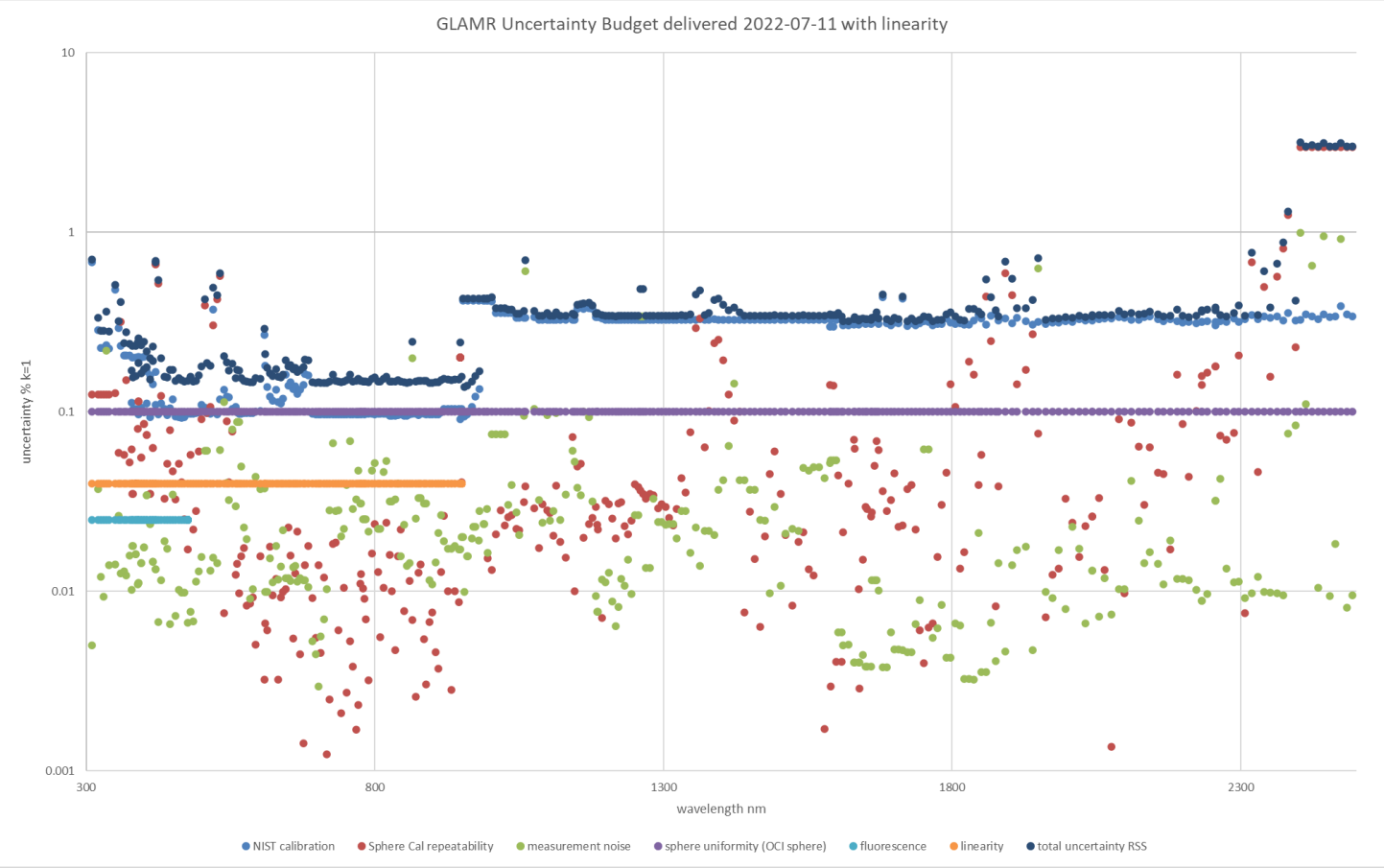
Future work

- Remove the bias in the 2260 and 2130 bands due to the temperature difference in the TVAC window to the dark target.
- Do a comprehensive check that all measurements were processed in the most accurate way.
- Incorporate the GLAMR measurements taken with the LSF sphere and the 7-science pixel mask that has a higher source radiance in the UV to help characterize the OOB response in the UV.
- Use the fine stepped in-band RSR profiles as a model to interpolate the non fine stepped bands. This will increase the accuracy of the band centers and FWHM
- Account for the GLAMR sphere fluorescence correction in the OCI response.
- Use updated GLAMR calibration tables so the table transition does not occur in-band of 1615nm.
- Calculate the actual standard deviation of the mean for all bands in all measurements. This will improve the uncertainty calculations over using a single correction factor for the OCI response standard deviation of the mean.

- These changes will improve the accuracy of the results but should not change the results significantly as to change the current Pass/Fail results of the L3 requirements in this report.

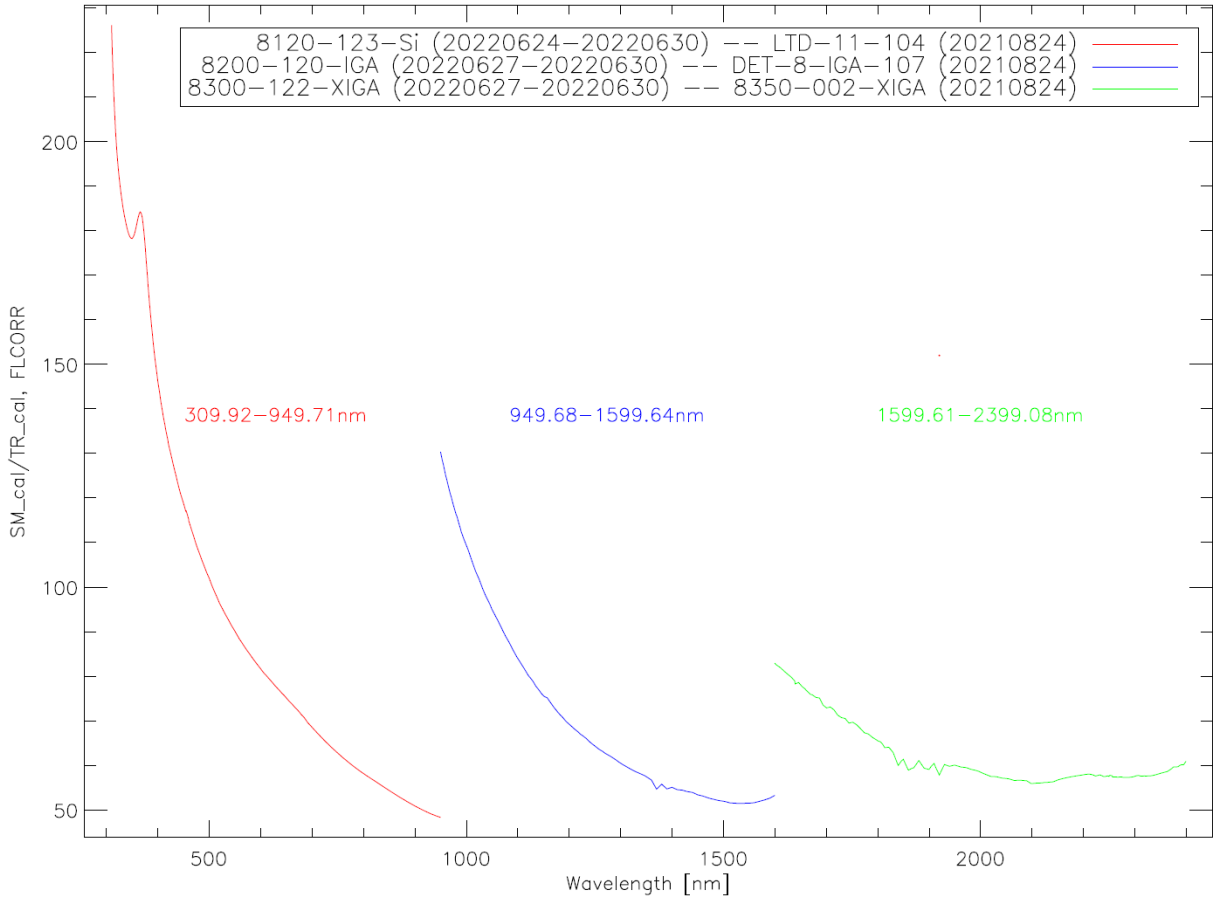
Back up slides

GLAMR total uncertainty

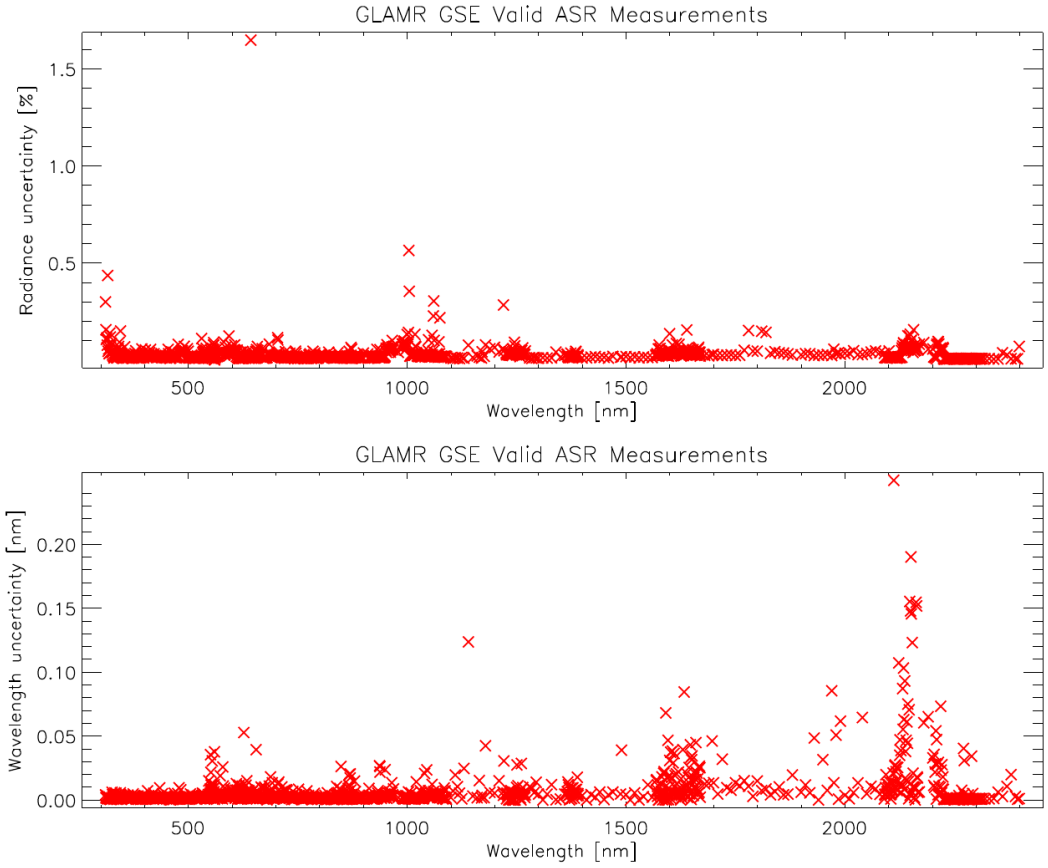


- Look up table contains the total uncertainty of GLAMR at each wavelength that is incorporated into the final OCI uncertainties.

GLAMR calibration tables used



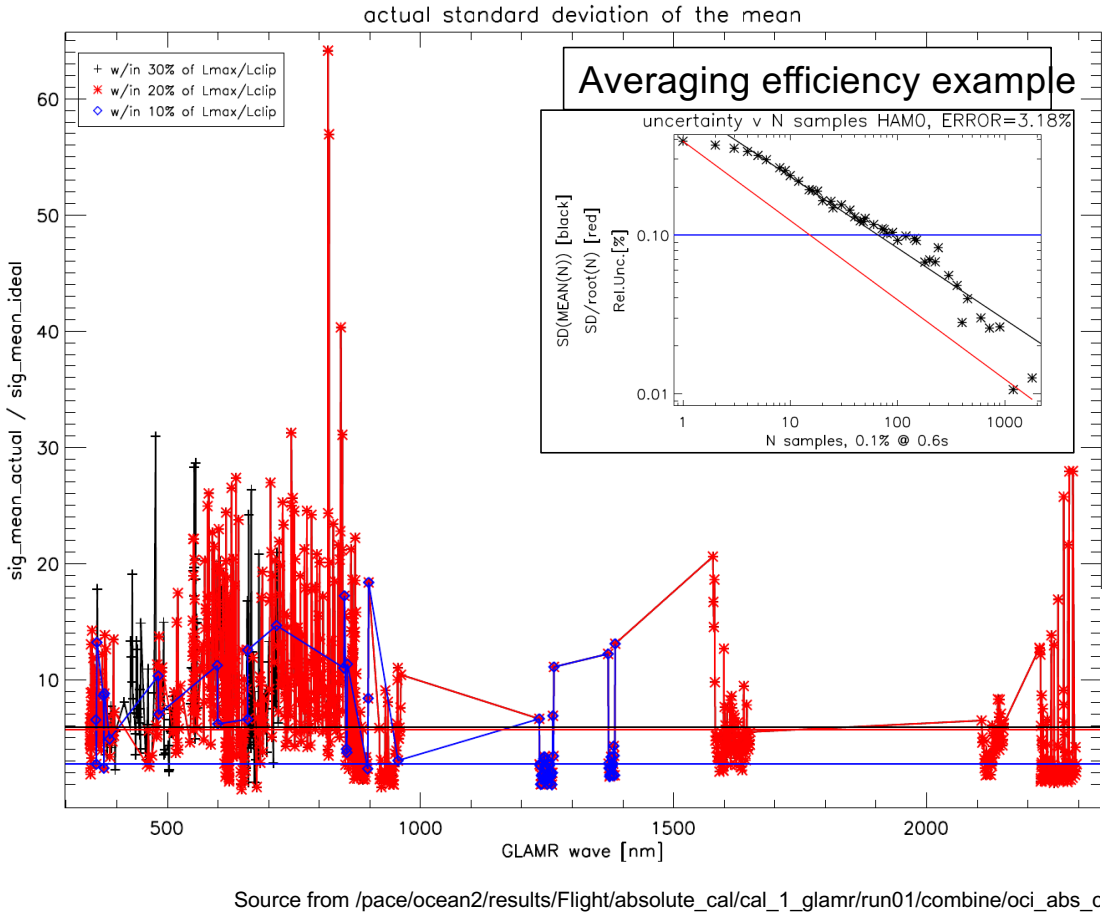
GLAMR measurement uncertainty



- Standard deviation with 3 sigma rejection of the GLAMR radiance and GLAMR wavelength shown for each measurement used in the analysis. This is used was used as source stability to filter measurements.

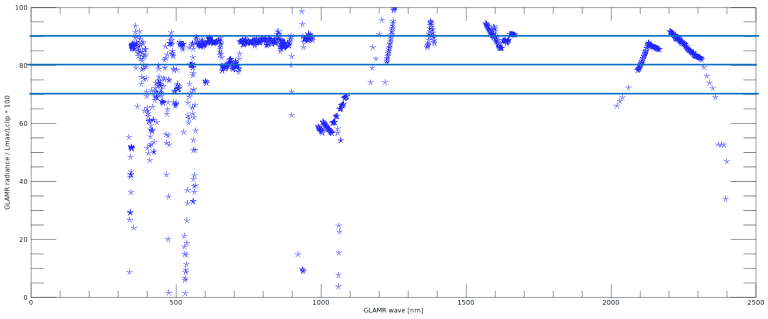
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/combine/oci_abs_cal_run01.8x8.gse_radiance.glamr.pdf

dn measurement uncertainty

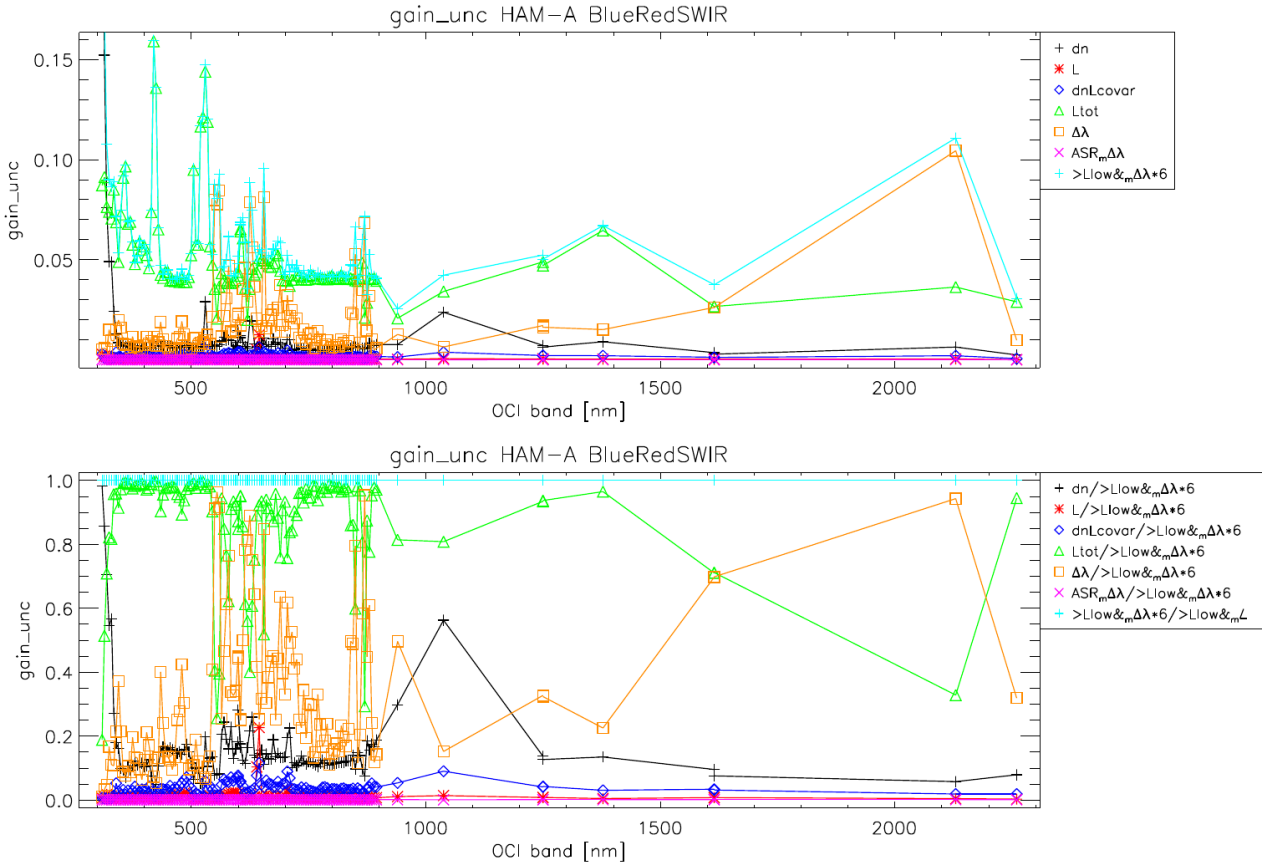


Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/combine/oci_abs_c

- This plot shows the calculated standard deviation of the mean ratioed to the ideal standard deviation of the mean for all GLAMR measurements using the OCI response of peak 8x8 band.
- The median of all the measurements shows that the actual uncertainty of the OCI response is 6 times the ideal standard deviation of the mean
- This factor of 6x was used for all bands for all measurements

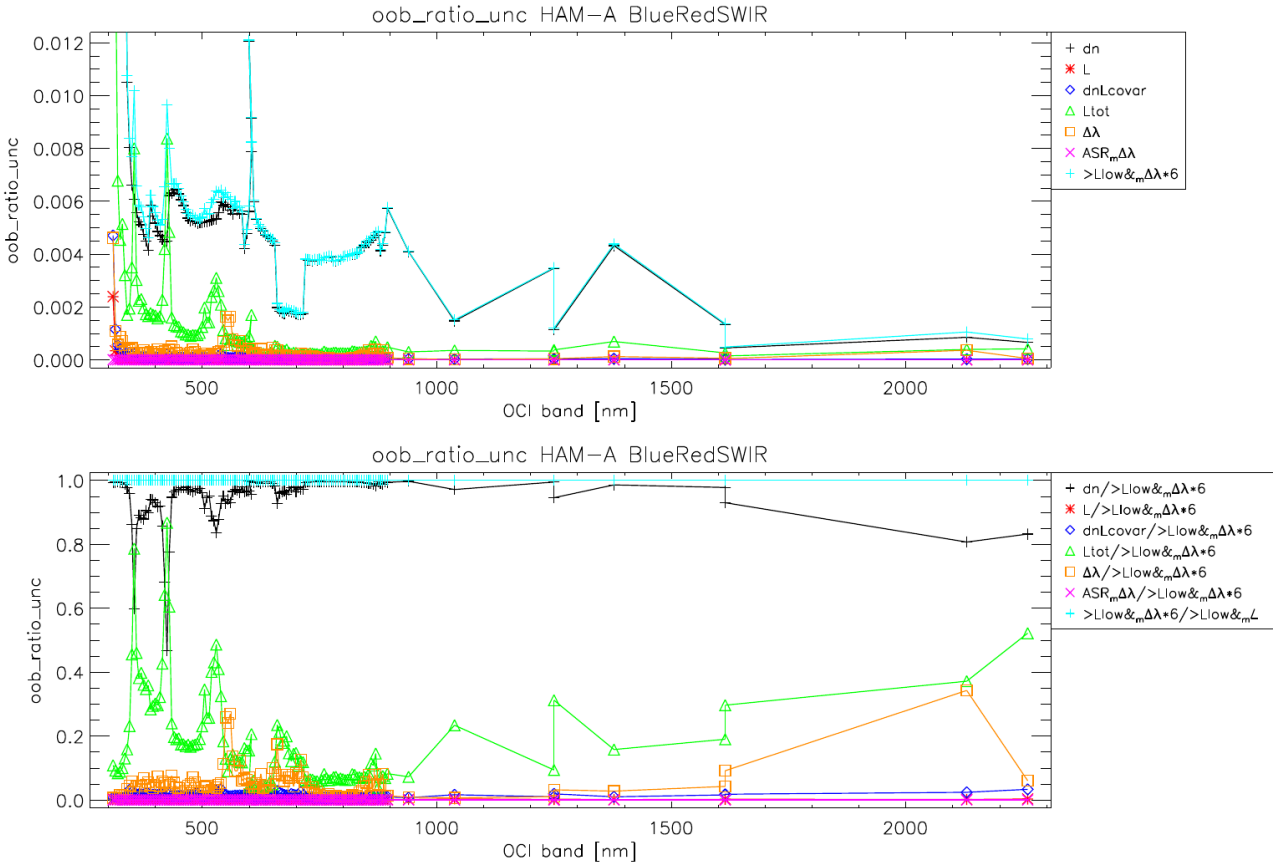


Gain Uncertainty breakdown



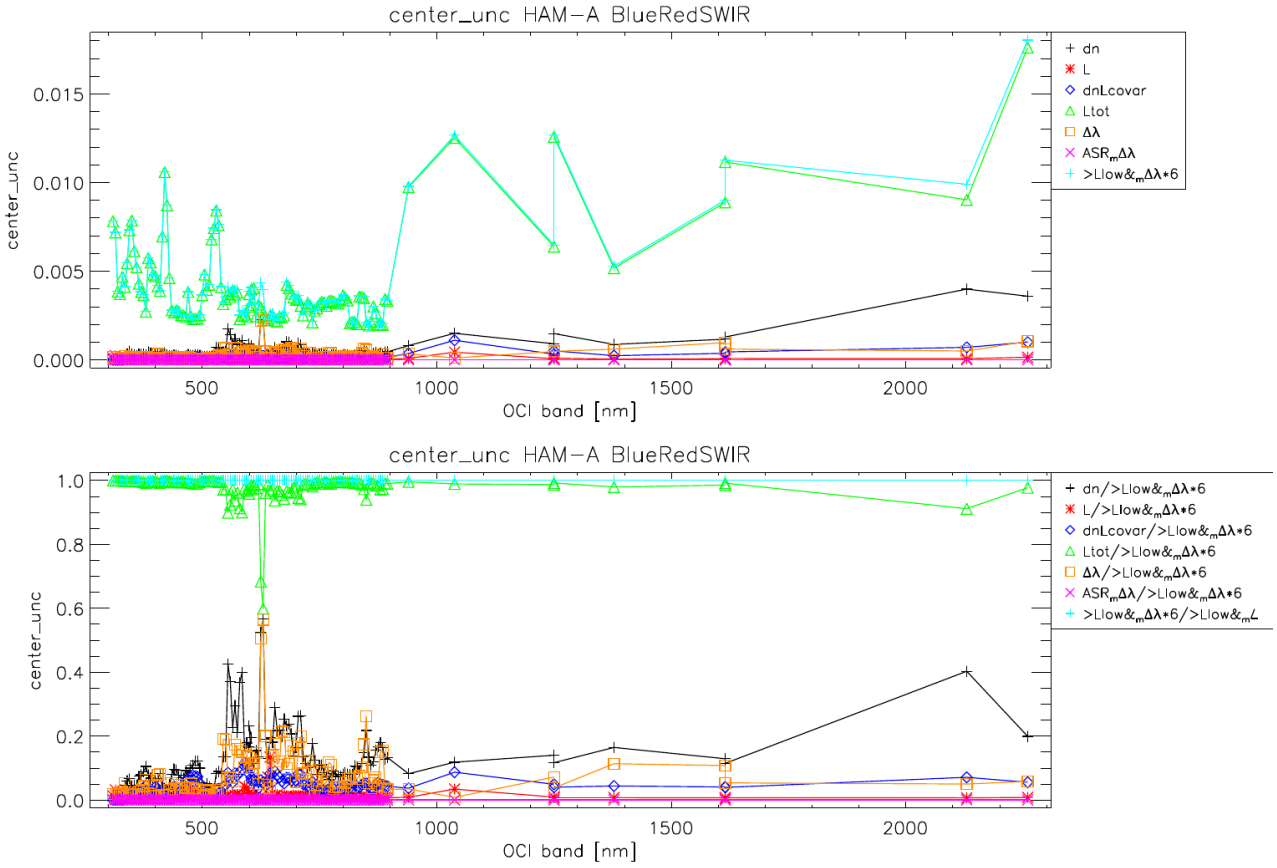
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

OOB Uncertainty breakdown



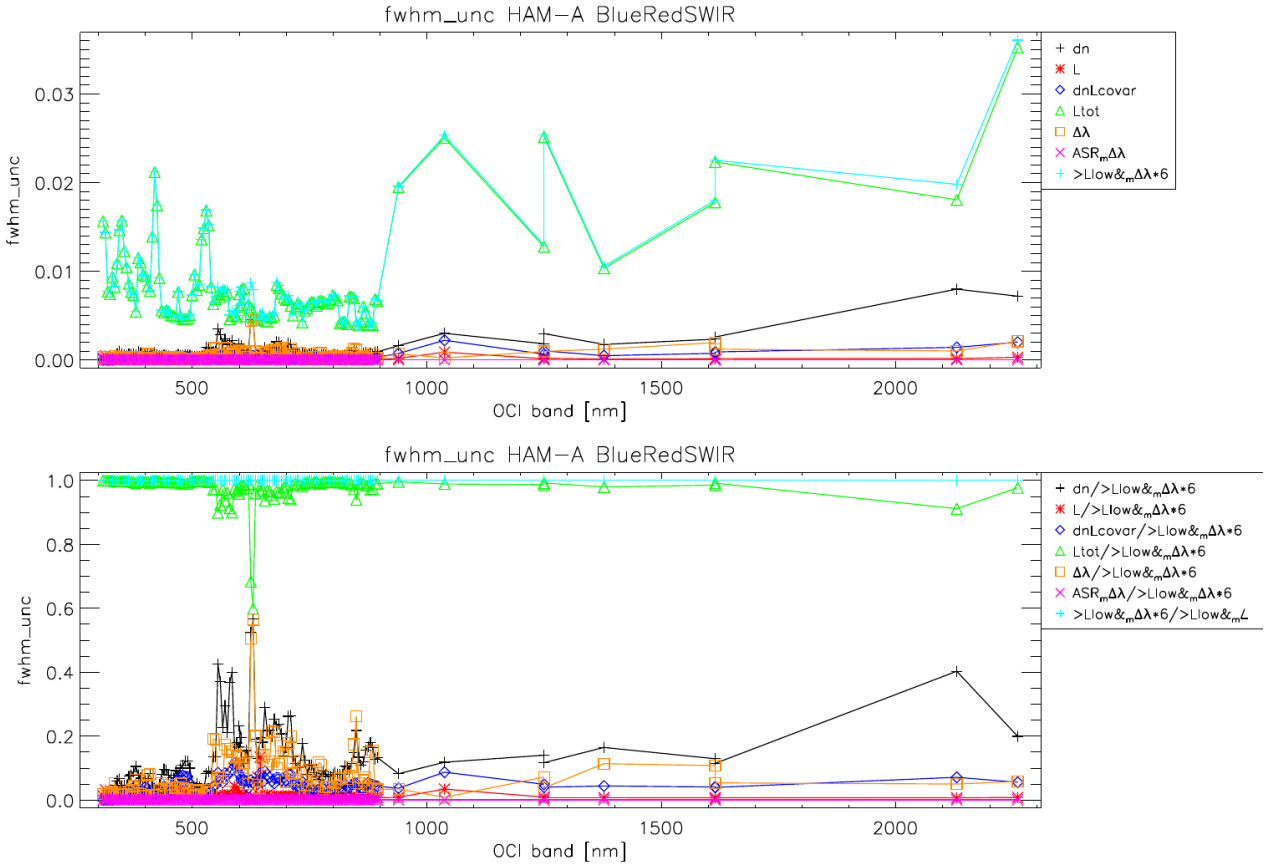
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

Band Center Uncertainty breakdown



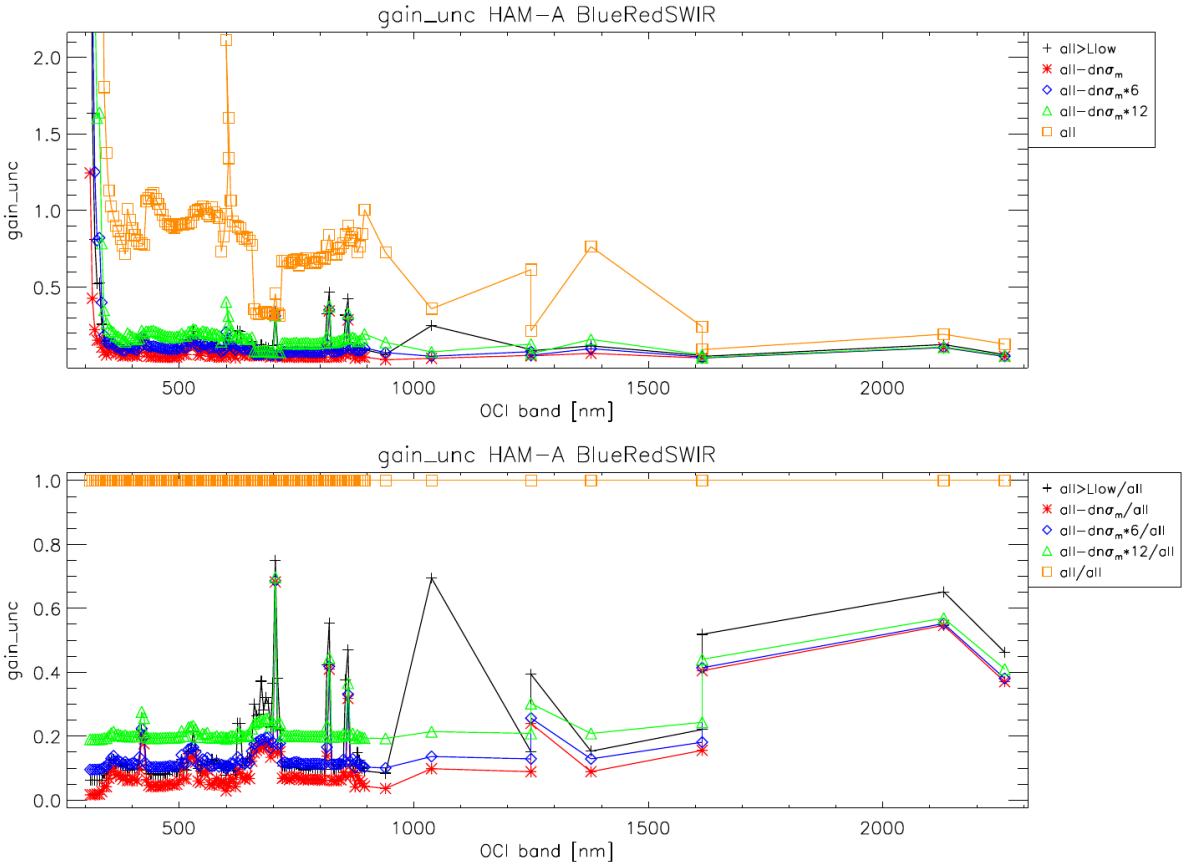
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

FWHM Uncertainty breakdown



Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

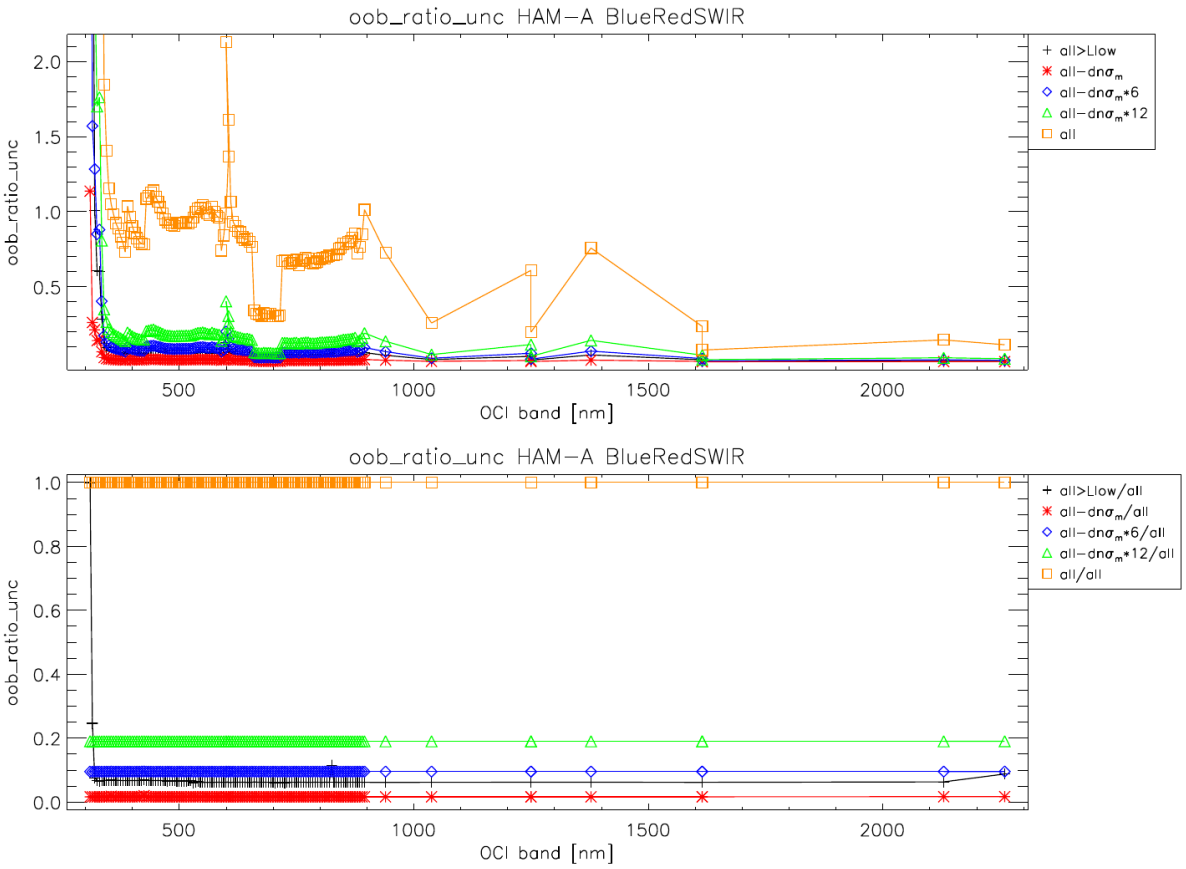
Gain Uncertainty options



- all>Llow shows the uncertainty when removing the uncertainty contribution of out-of-band measurements with GLAMR radiance measured below L_low, and using the OCI response uncertainty as the standard deviation.
- All-dn σ_m shows the uncertainty using all the measurements and using the OCI response uncertainty as the ideal standard deviation of the
- All-dn σ_m x6 and x12 shows the uncertainty using all the measurements and using the OCI response uncertainty as the ideal standard deviation of the mean times 6 or 12.
- All shows the uncertainty using all the measurements and using the OCI response uncertainty as the standard deviation.

Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

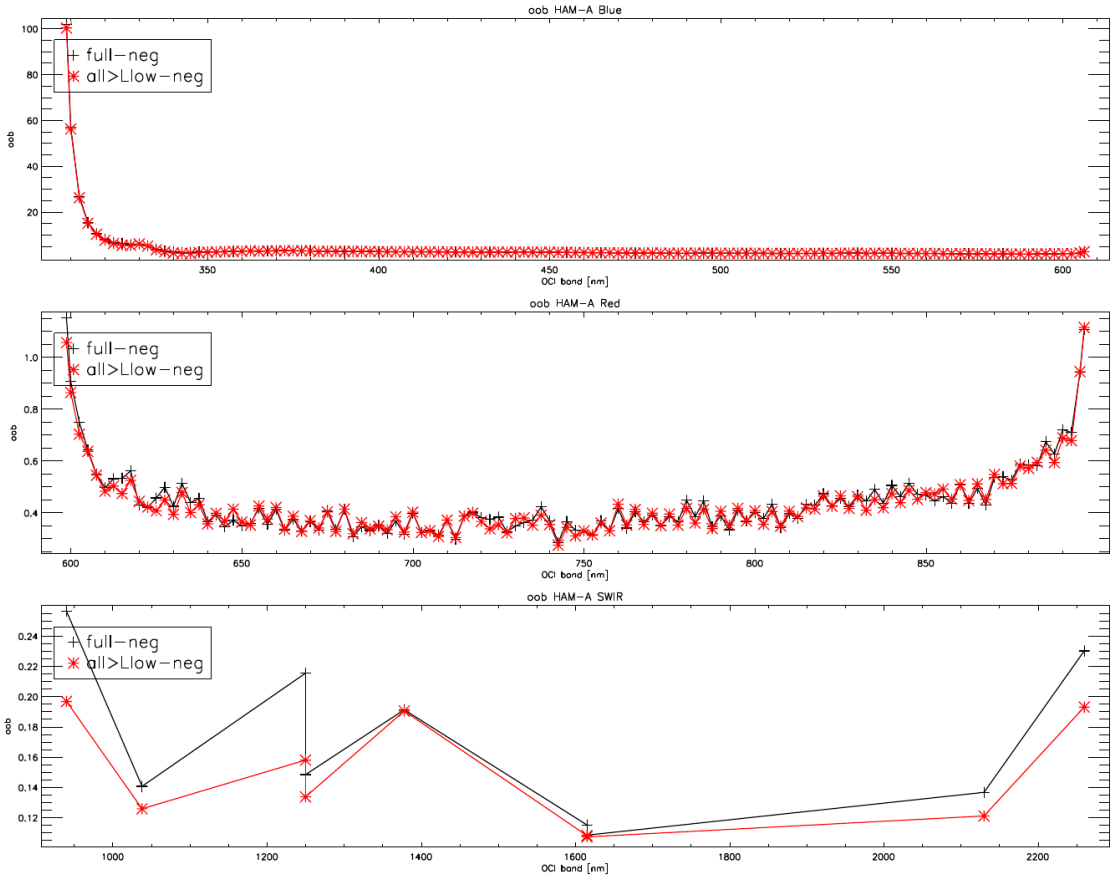
OOB uncertainty options



- all>Llow shows the uncertainty when removing the uncertainty contribution of out-of-band measurements with GLAMR radiance measured below L_low, and using the OCI response uncertainty as the standard deviation.
- All-dn σ_m shows the uncertainty using all the measurements and using the OCI response uncertainty as the ideal standard deviation of the
- All-dn σ_m x6 and x12 shows the uncertainty using all the measurements and using the OCI response uncertainty as the ideal standard deviation of the mean times 6 or 12.
- All shows the uncertainty using all the measurements and using the OCI response uncertainty as the standard deviation.

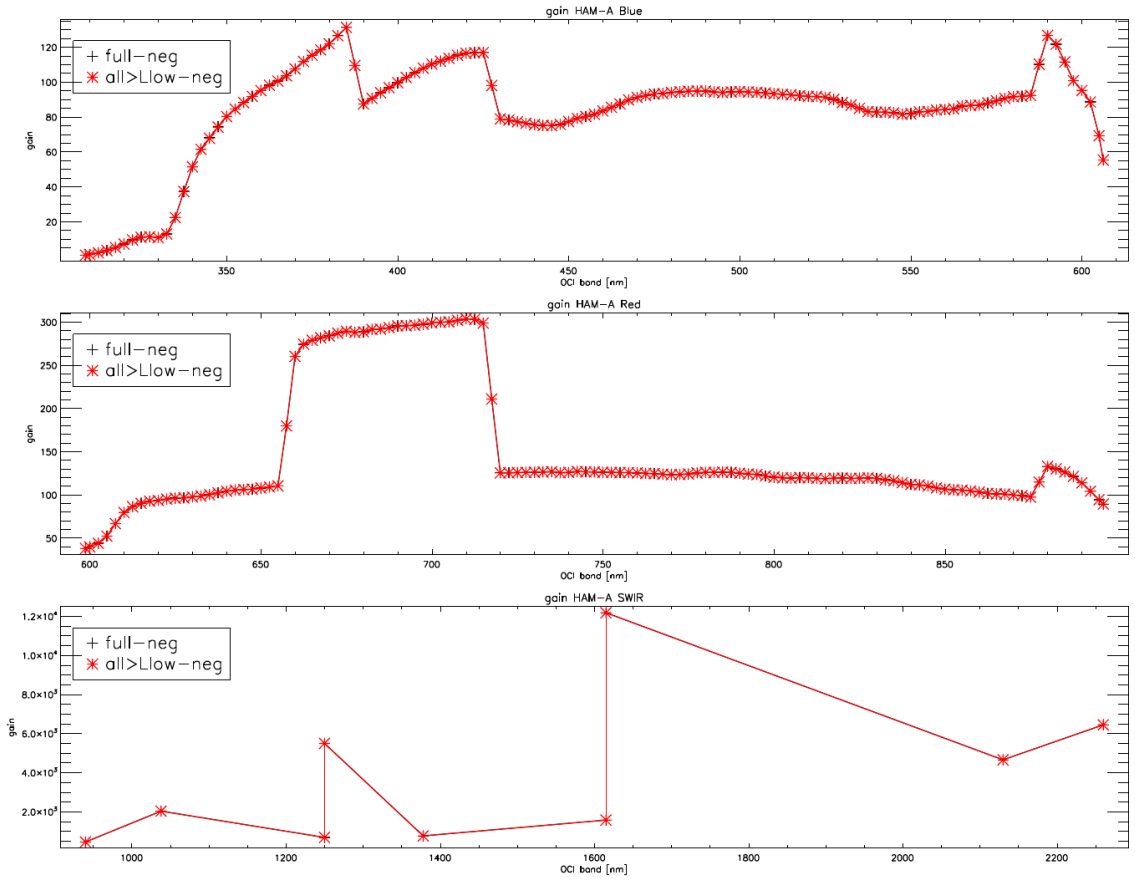
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results_uncertainty.glamr.pdf

OOB options



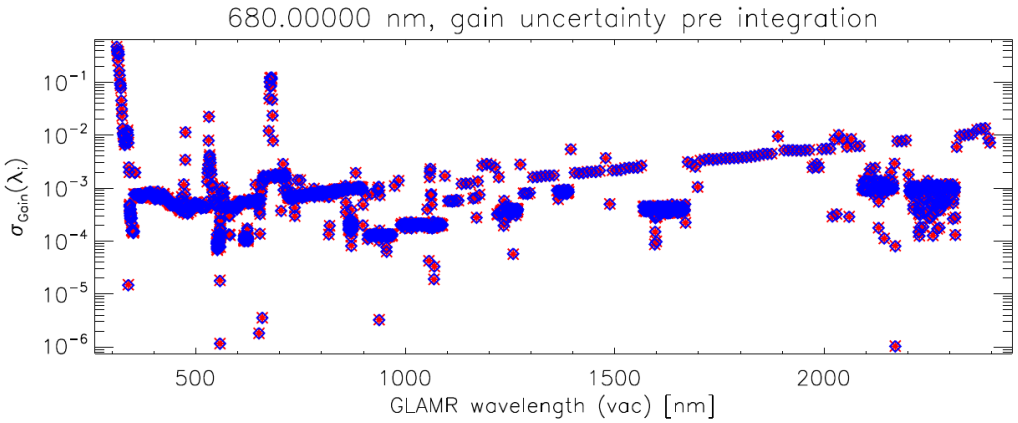
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results.glamr.pdf

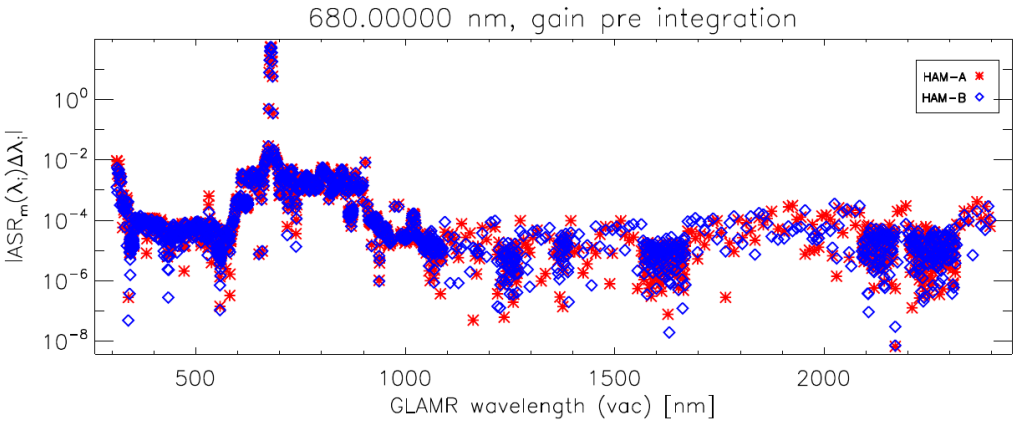
Gain options



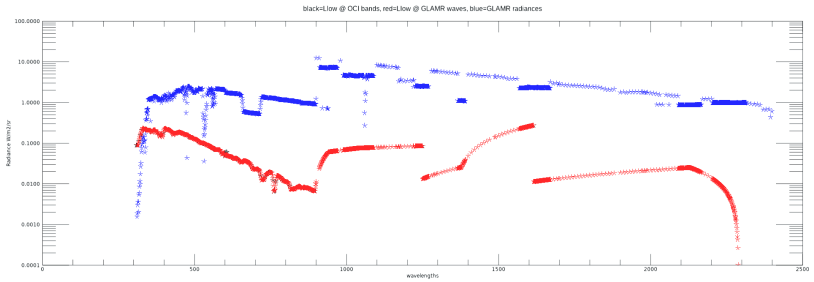
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.spectral_results.glamr.pdf

Gain & Unc. pre integration



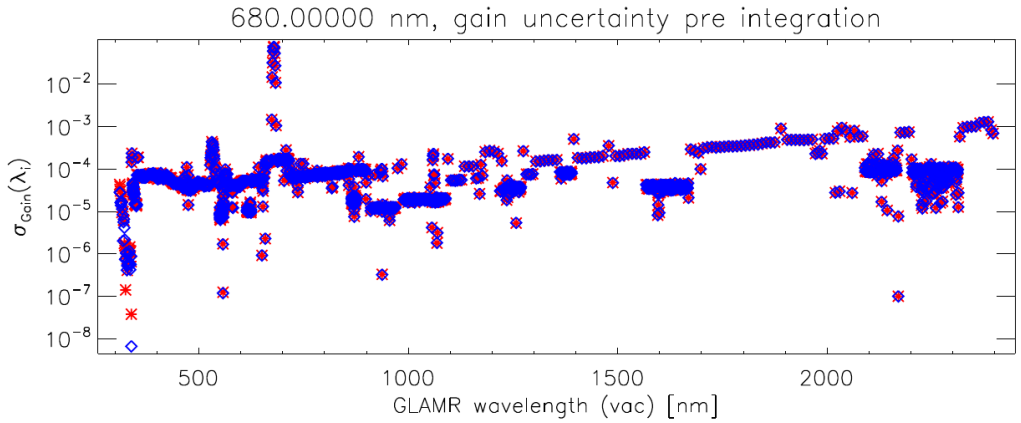


Pre Llow filter

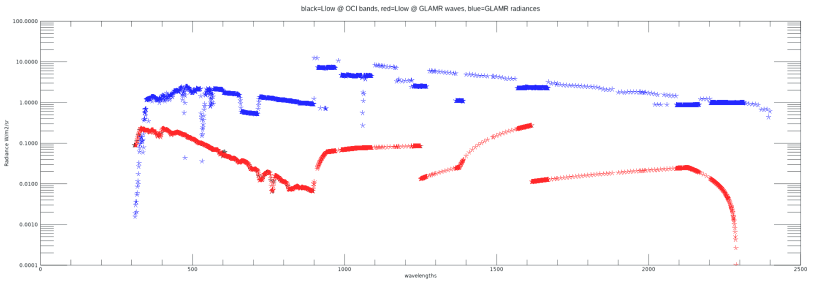


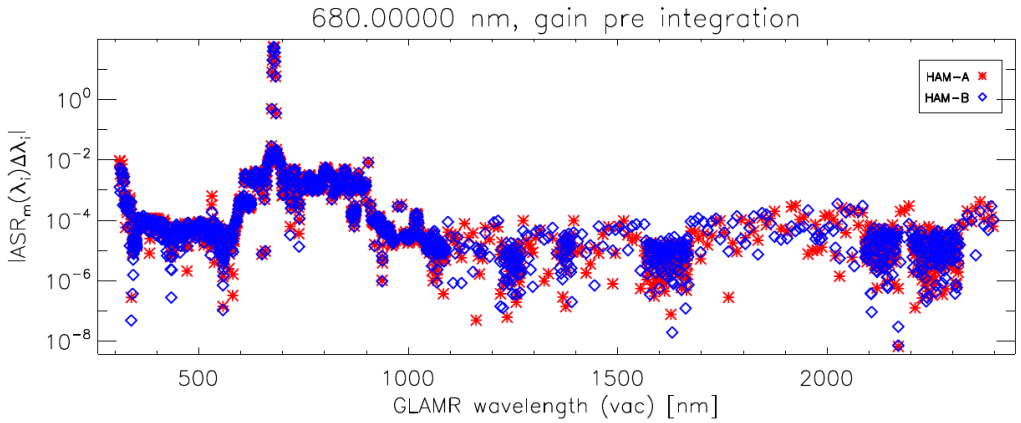
Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.gain_pre_integration.glamr.pdf

Gain & Unc. pre integration



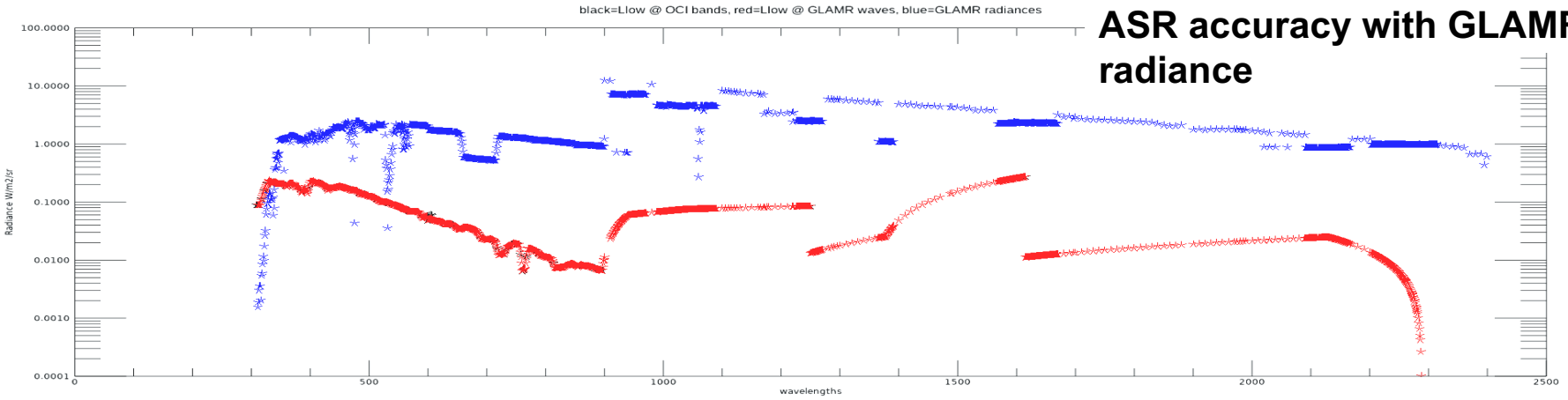
Post Llow filter



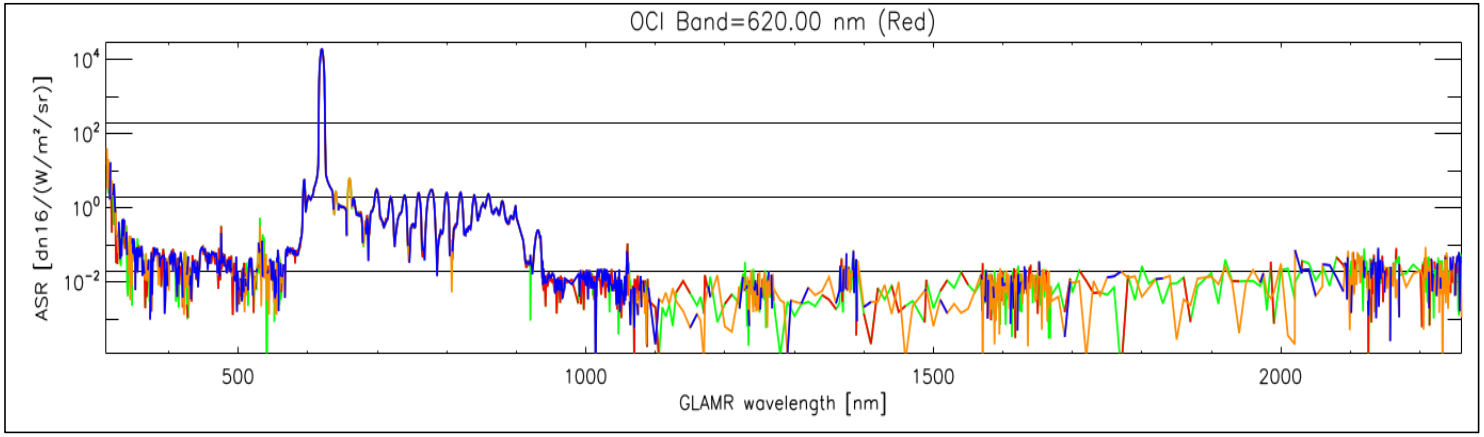


Source from /pace/ocean2/results/Flight/absolute_cal/cal_1_glamr/run01/main_output/oci_abs_cal_run01.8x8.gain_pre_integration.glamr.pdf

Removing Unc below Llow justification plots

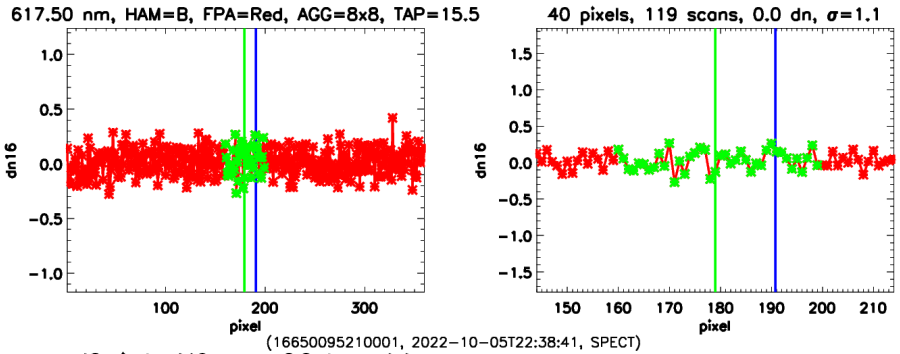


ASR accuracy with GLAMR radiance



Removing Unc below Llow justification plots

620 band response to 340nm source



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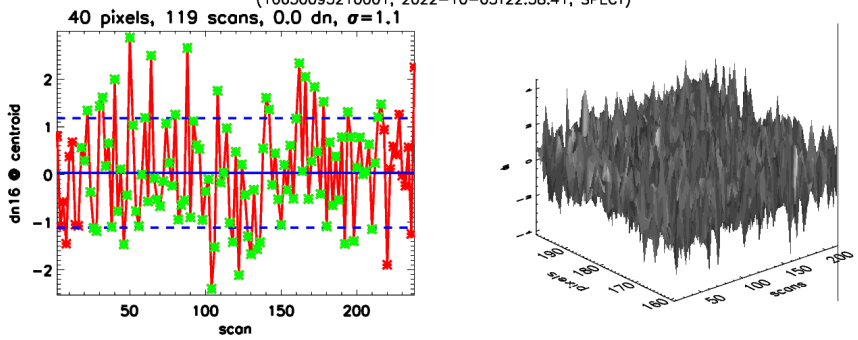
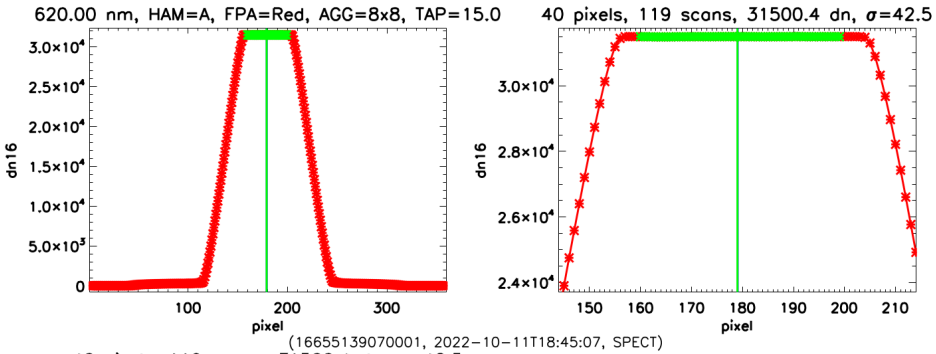


620 band response to 620nm source



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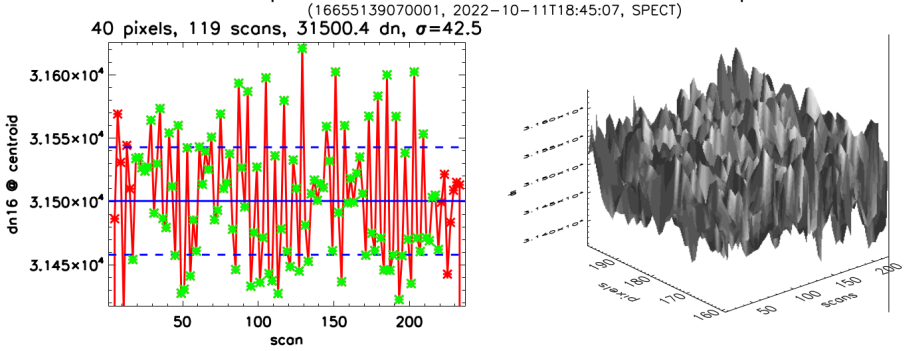
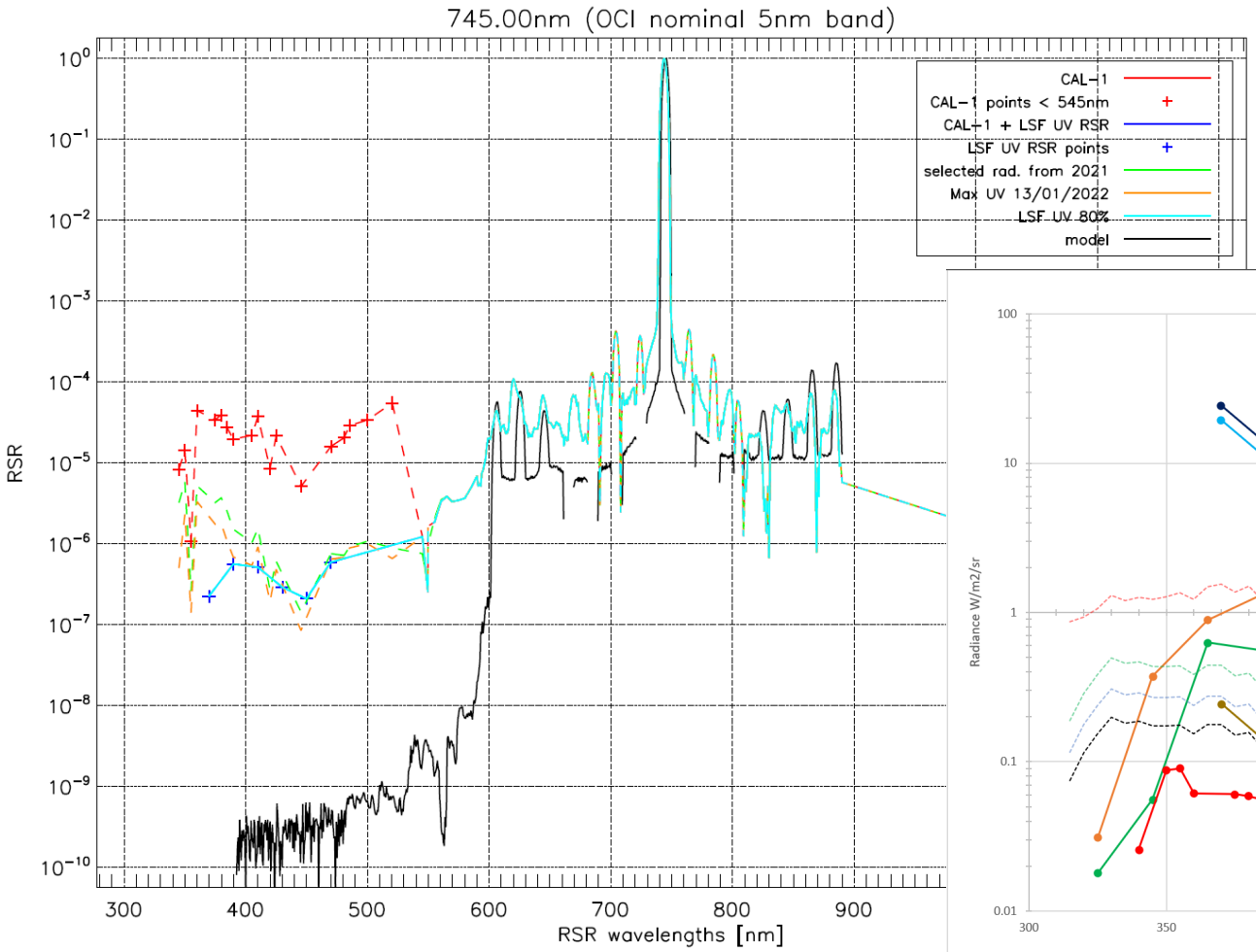
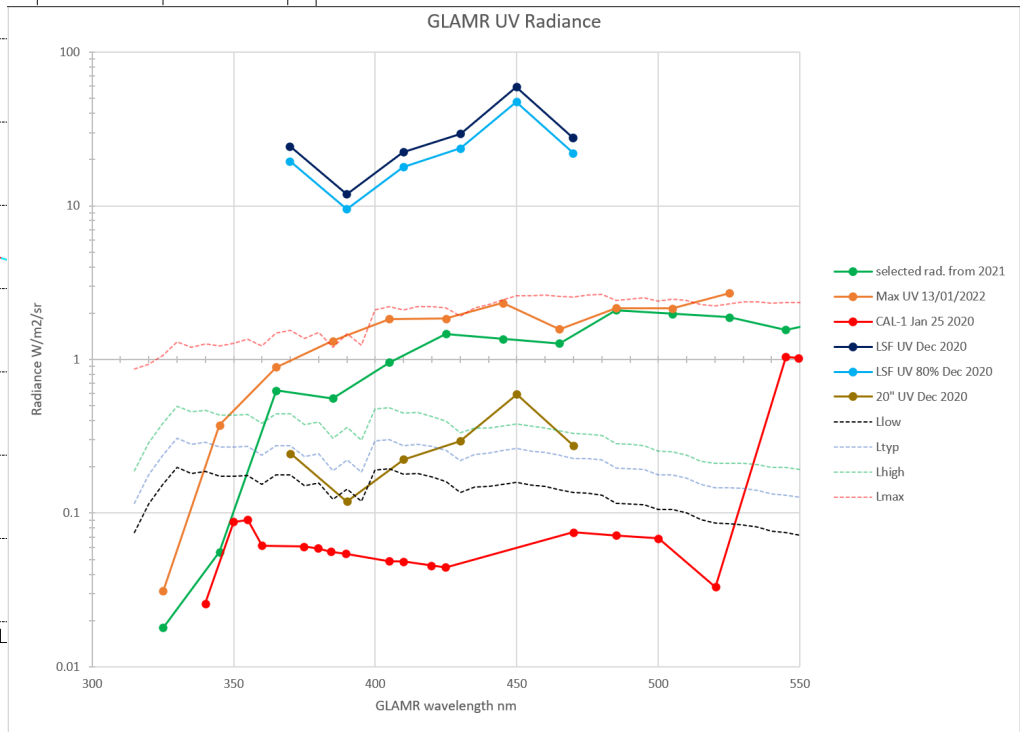


Removing Unc below Llow justification plots

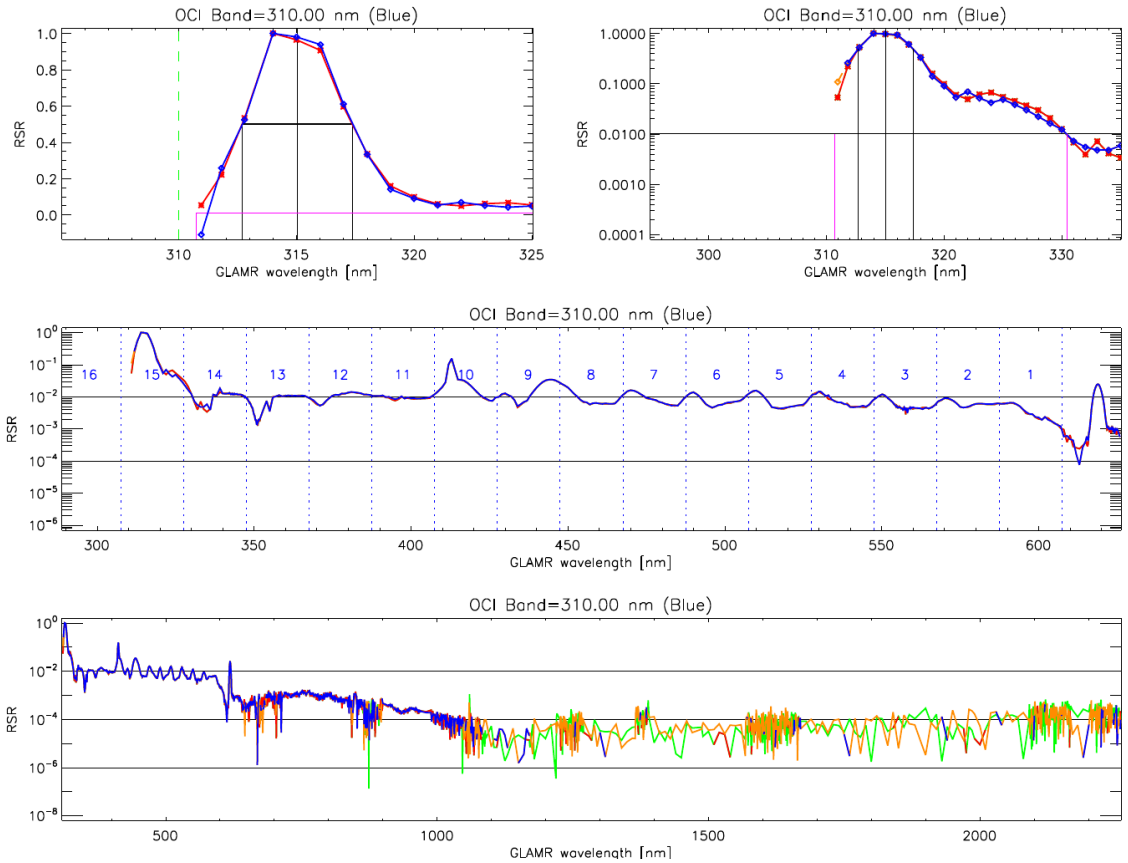


ETU results comparing RSR OOB with different UV radiance levels.



Select RSR plots

RSR



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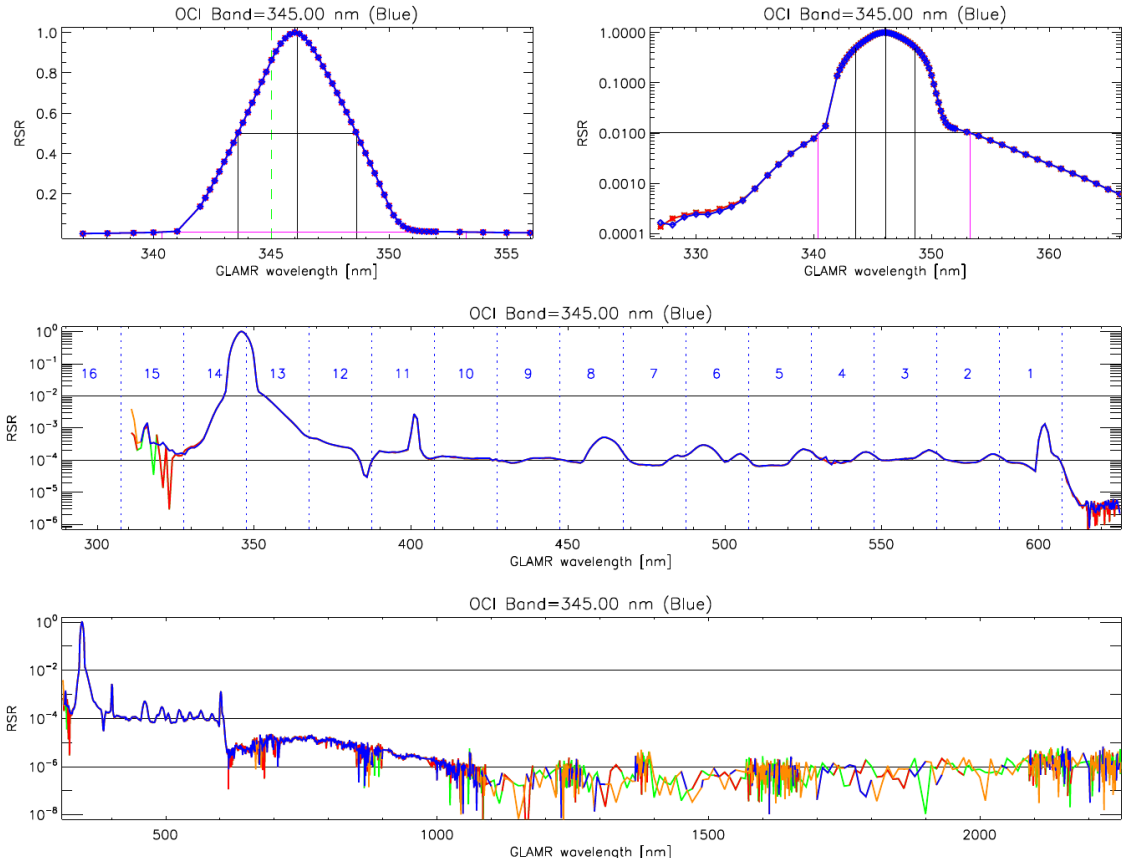
RSR



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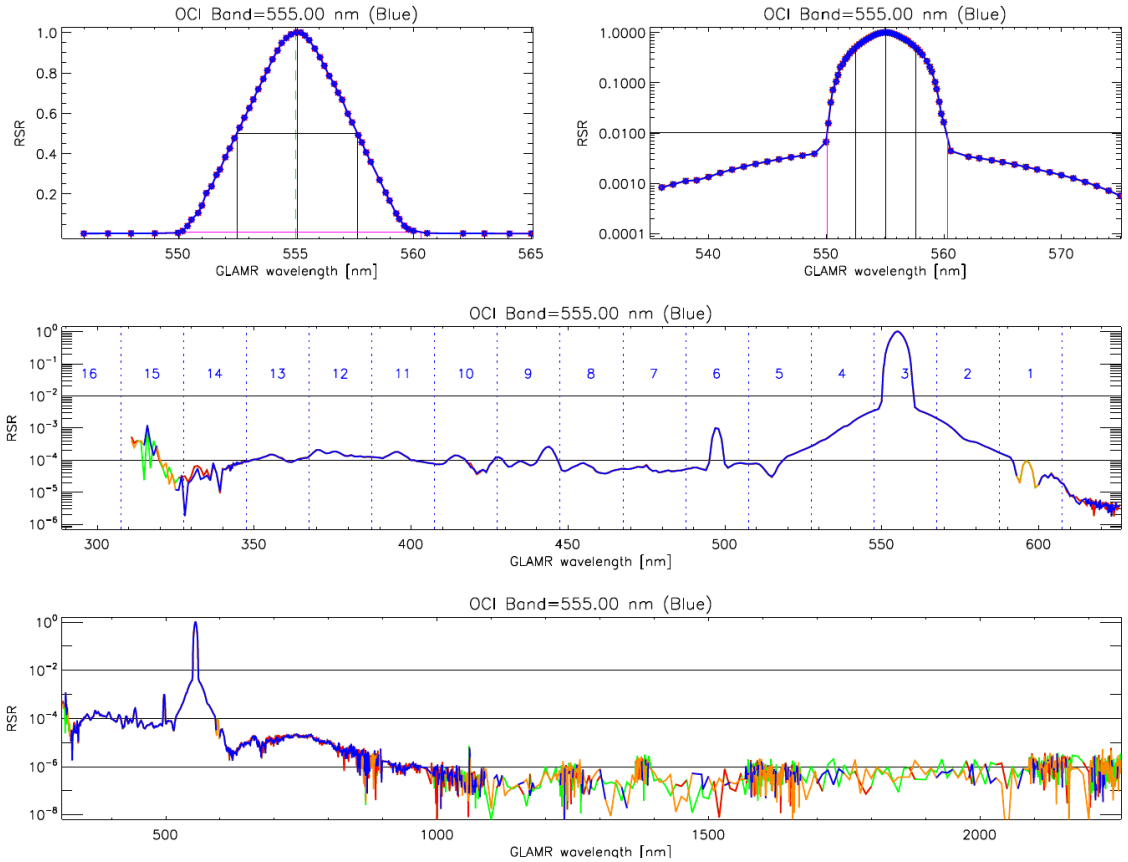
RSR



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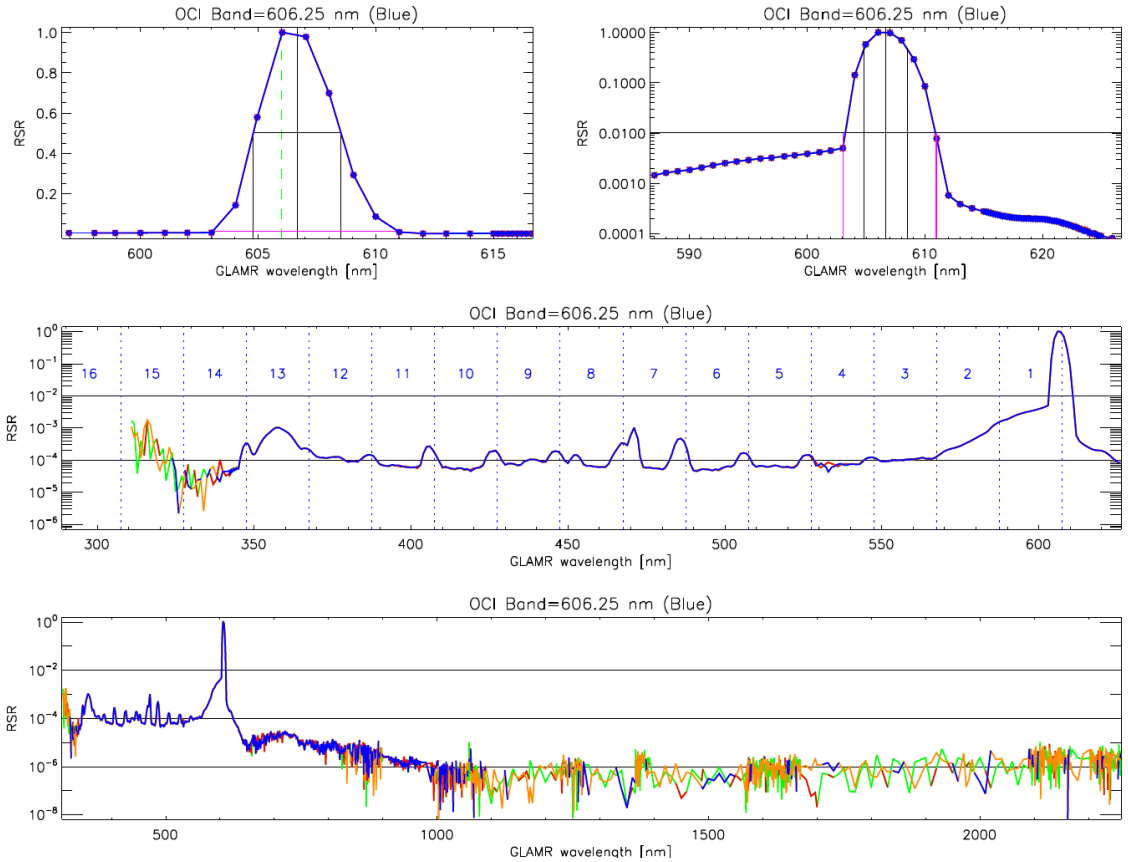

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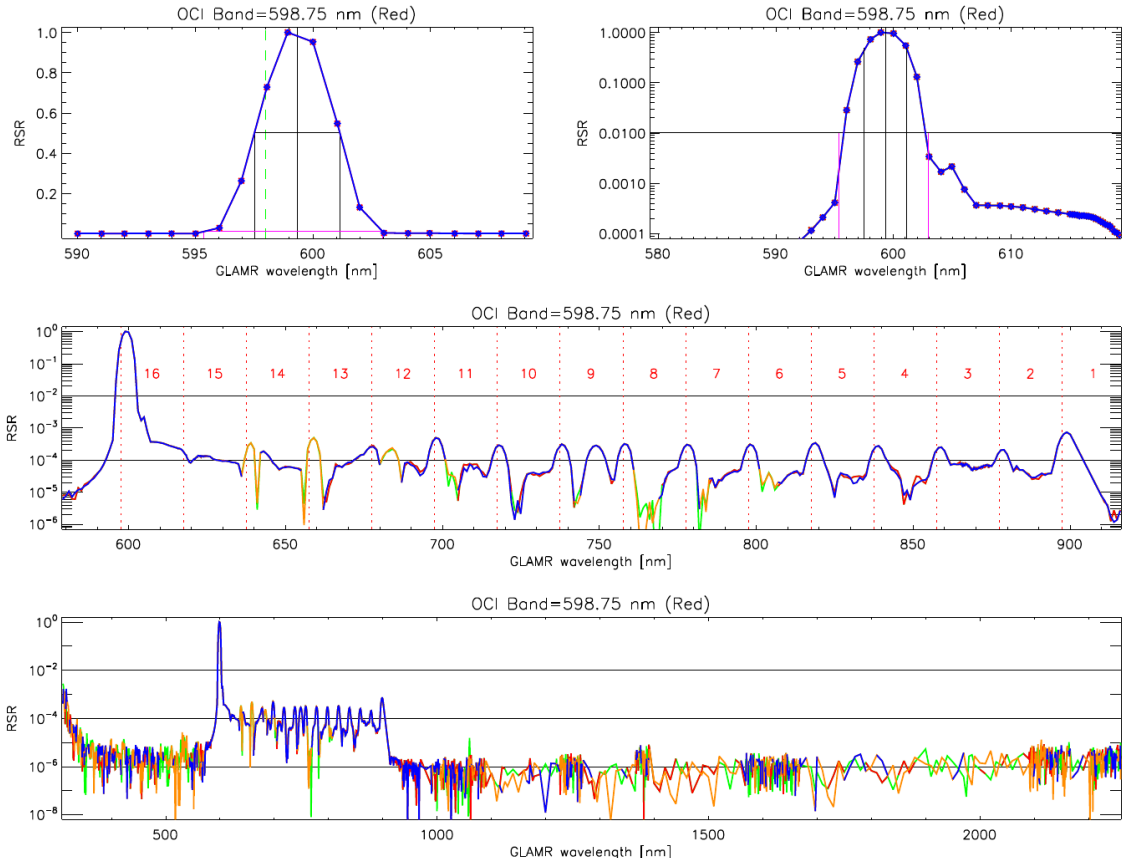

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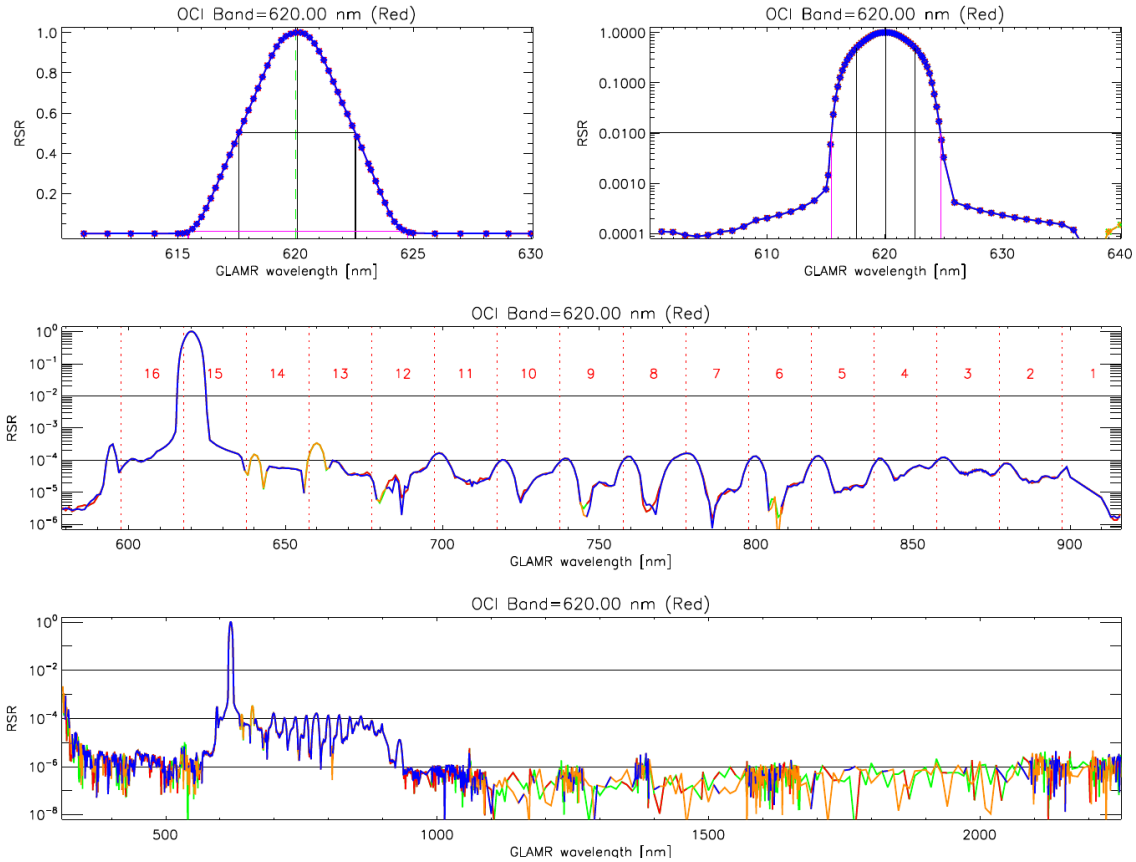

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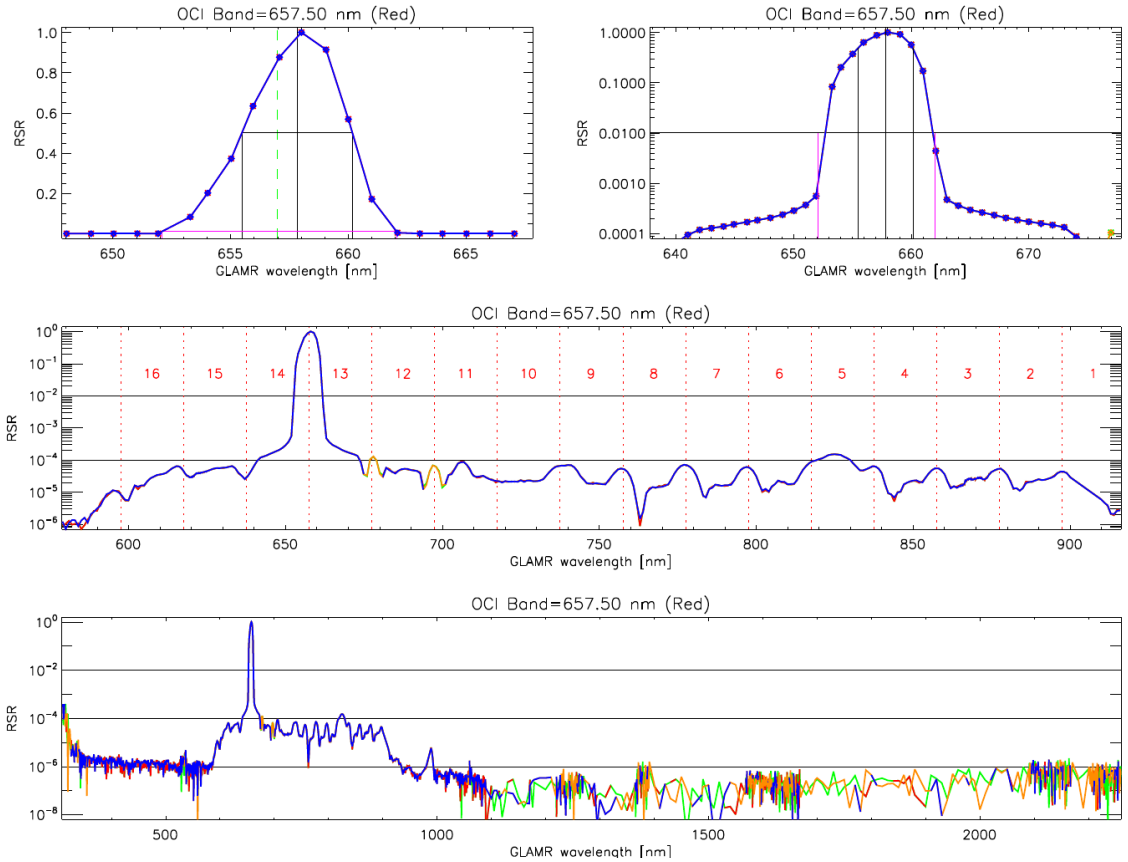
RSR



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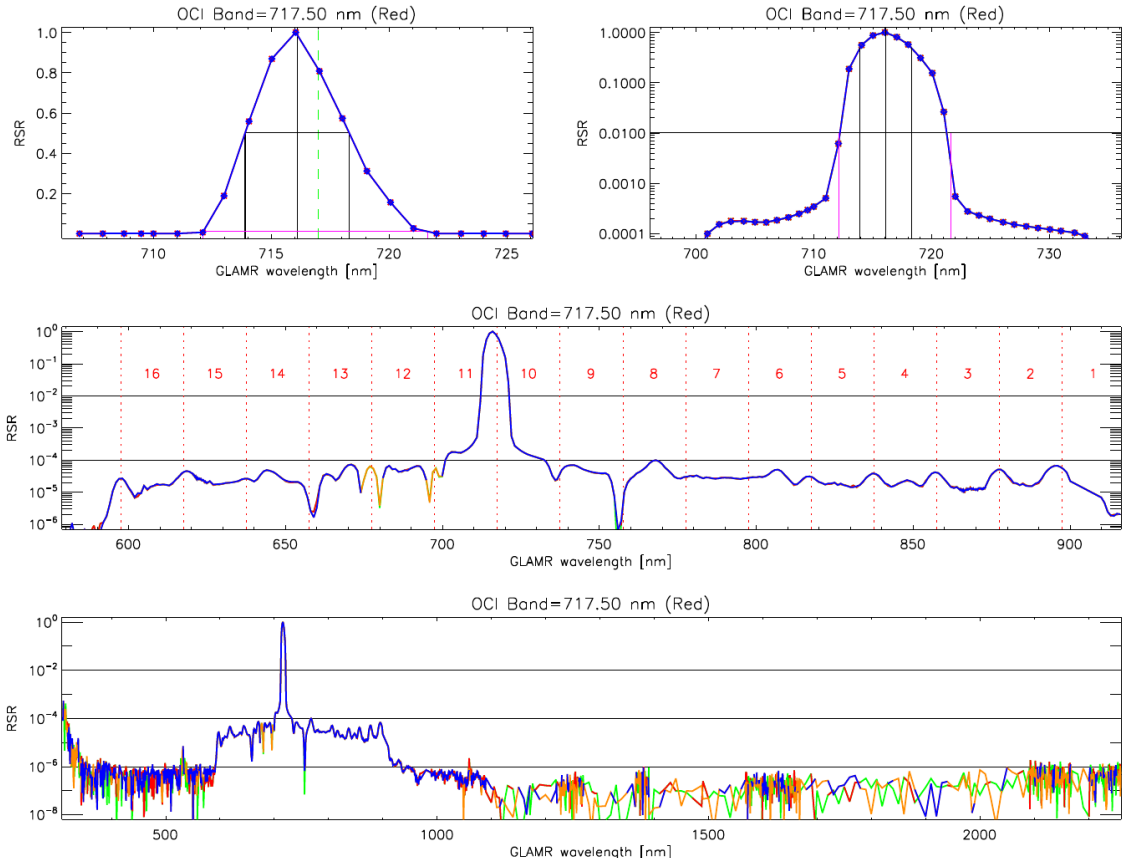

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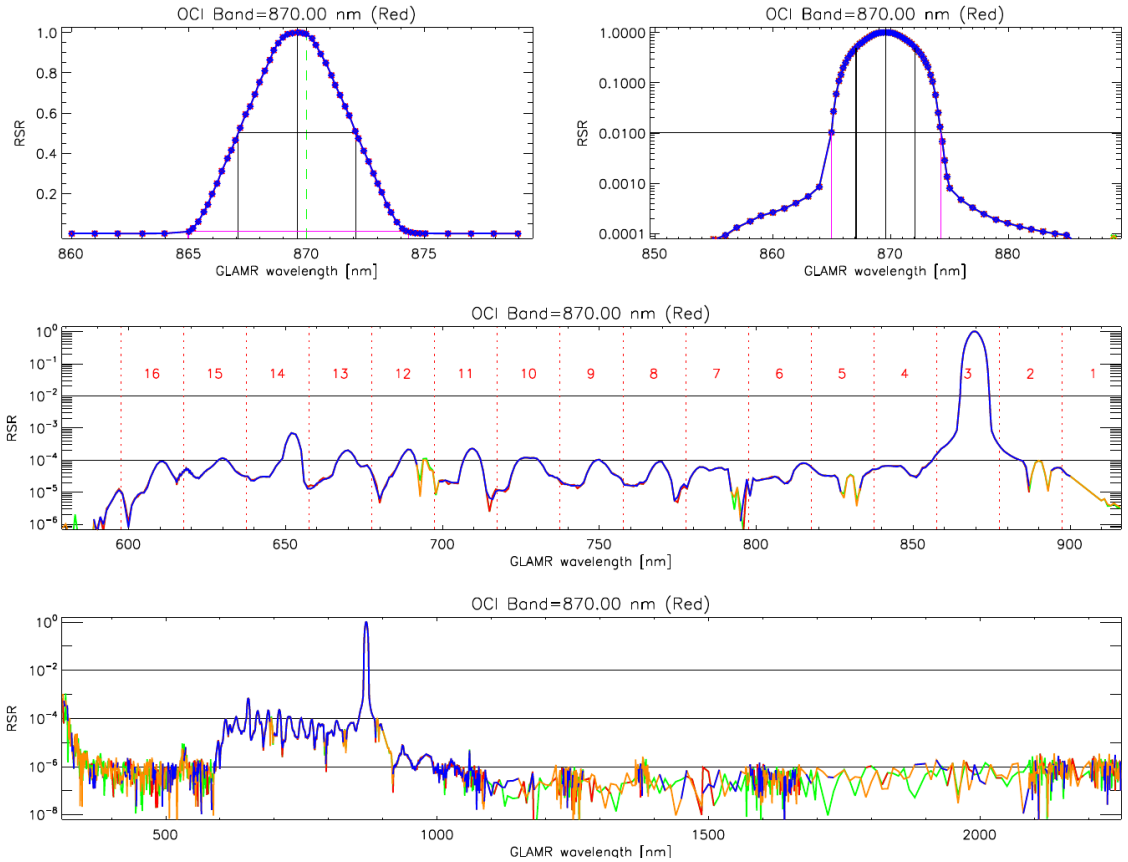
RSR



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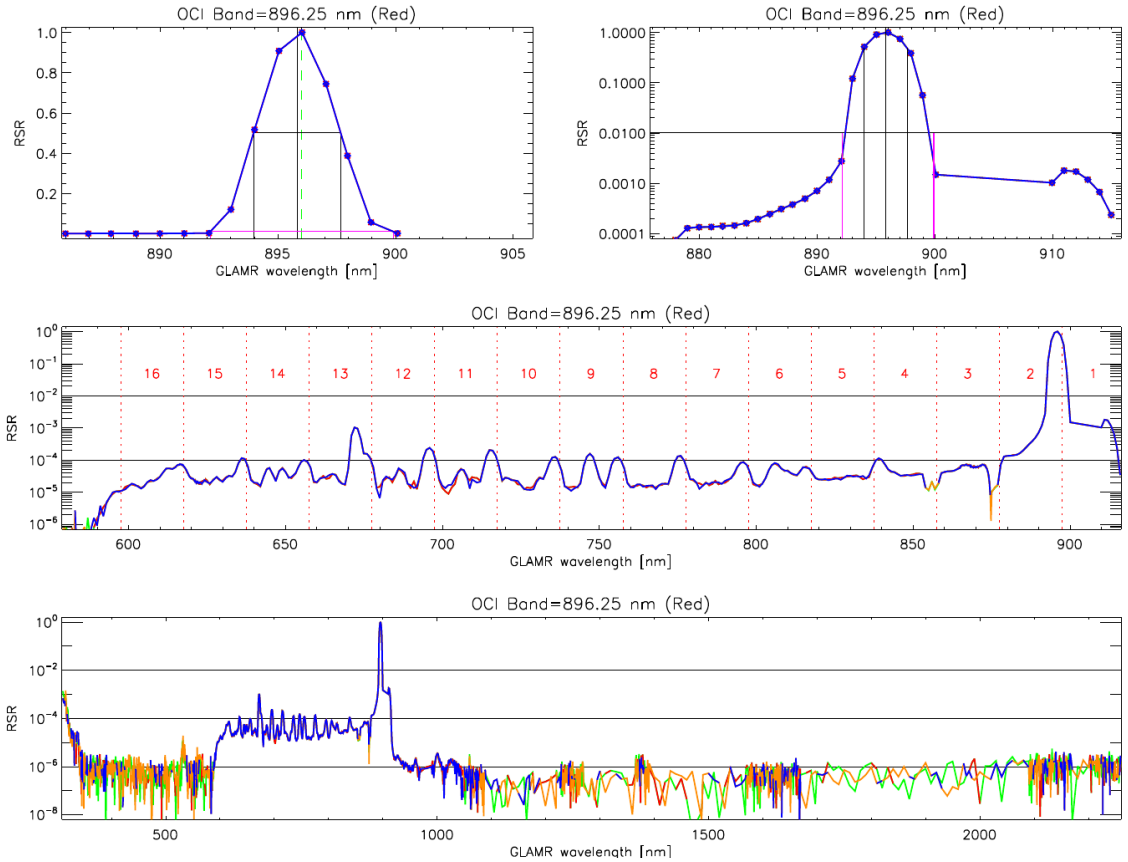
RSR



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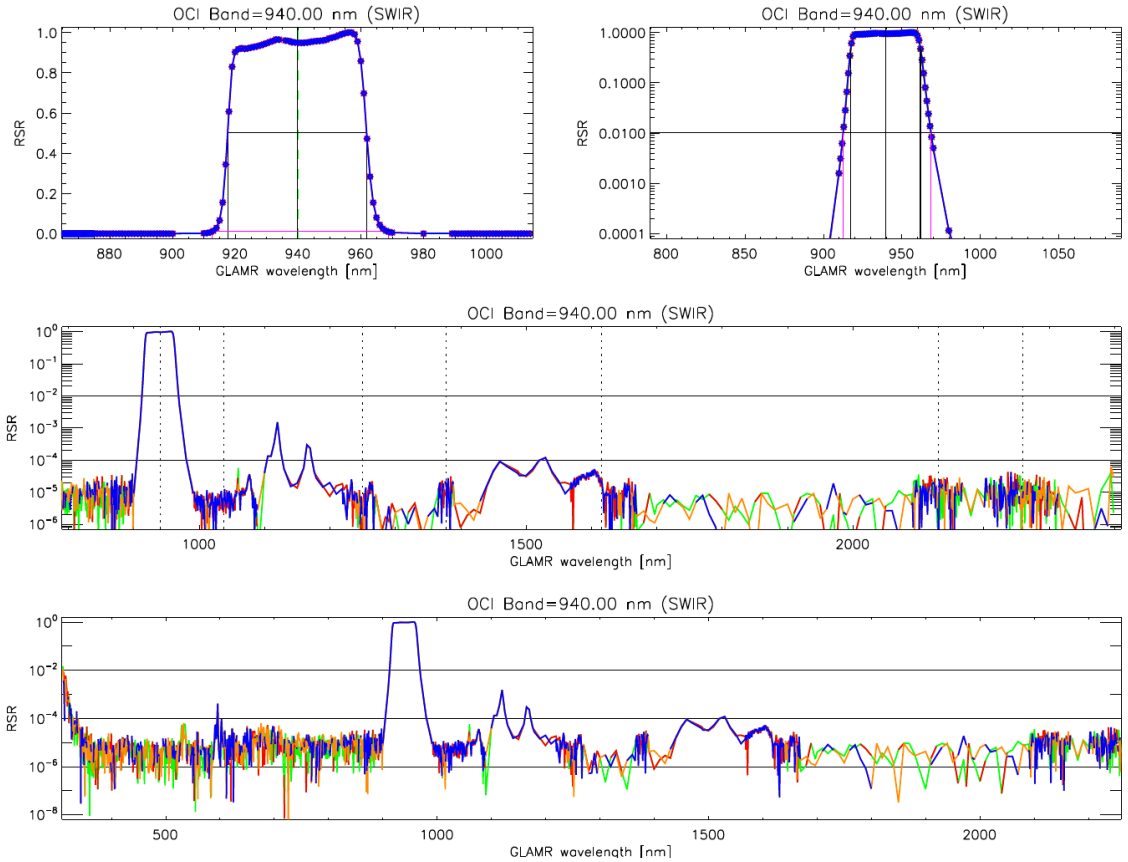
RSR



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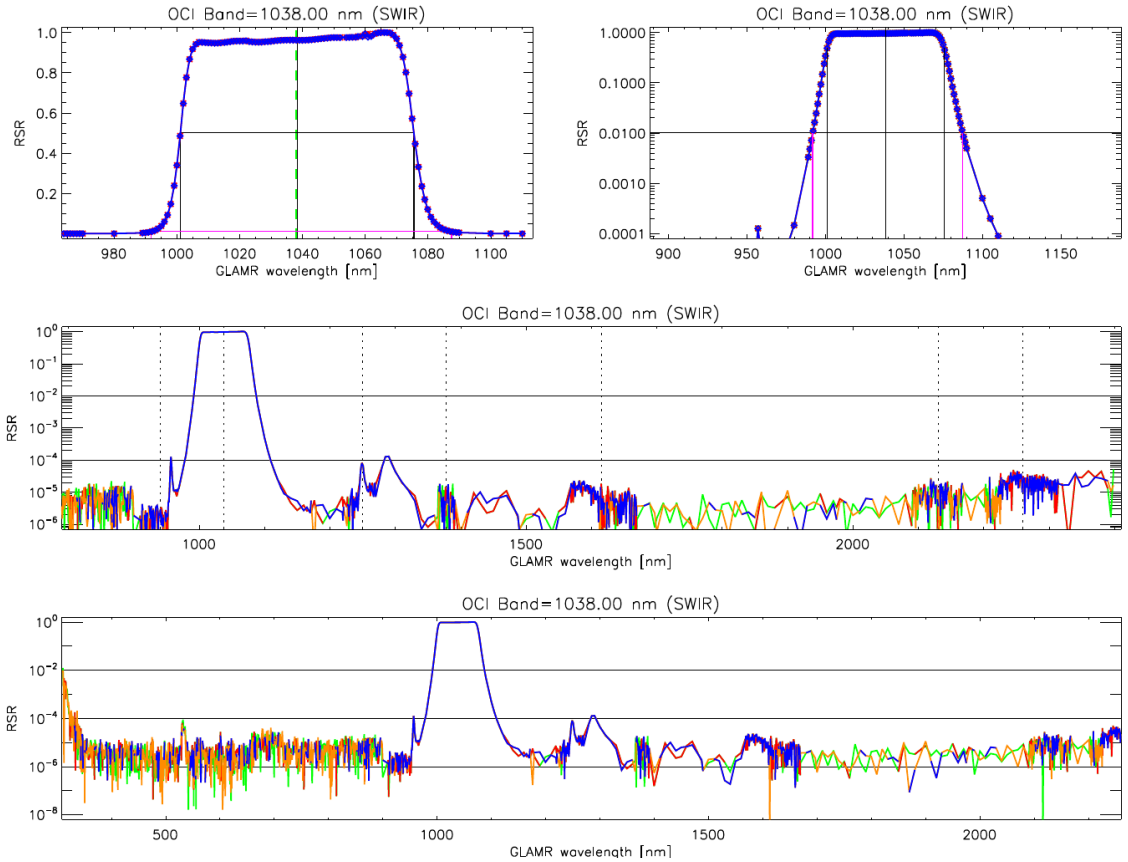

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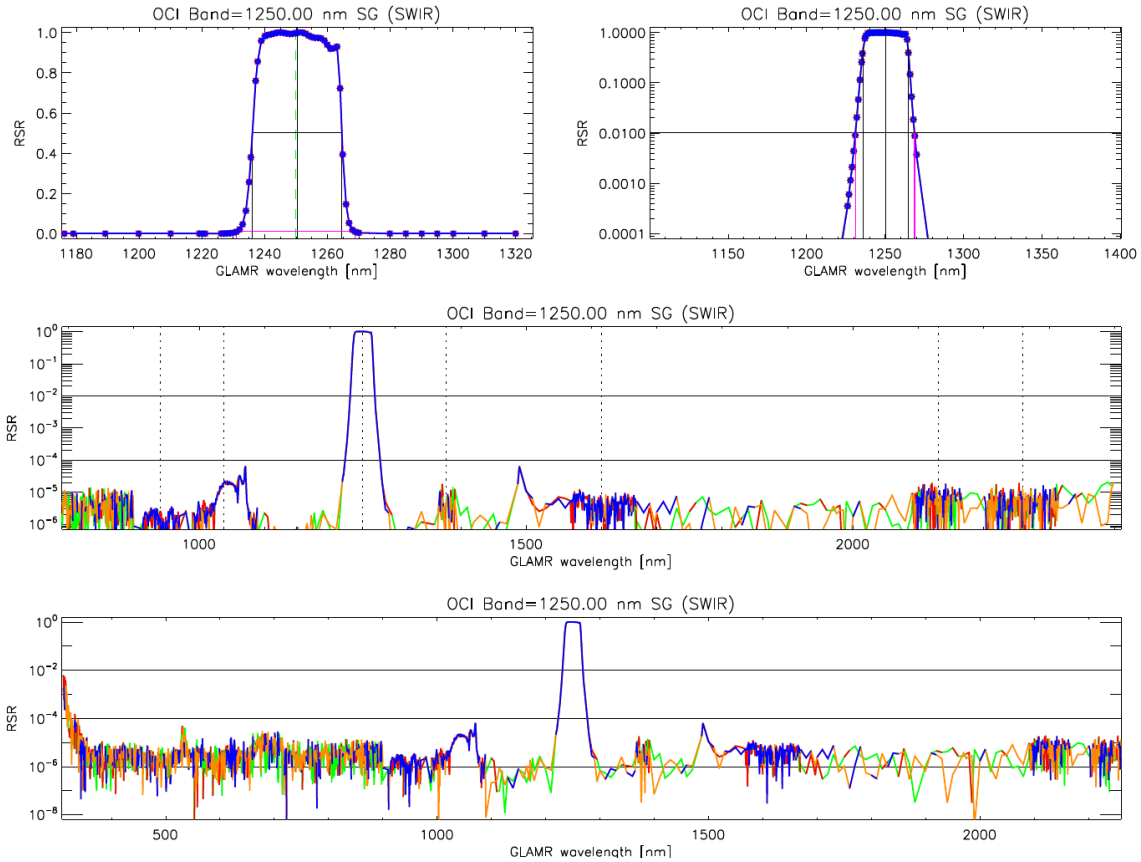
RSR



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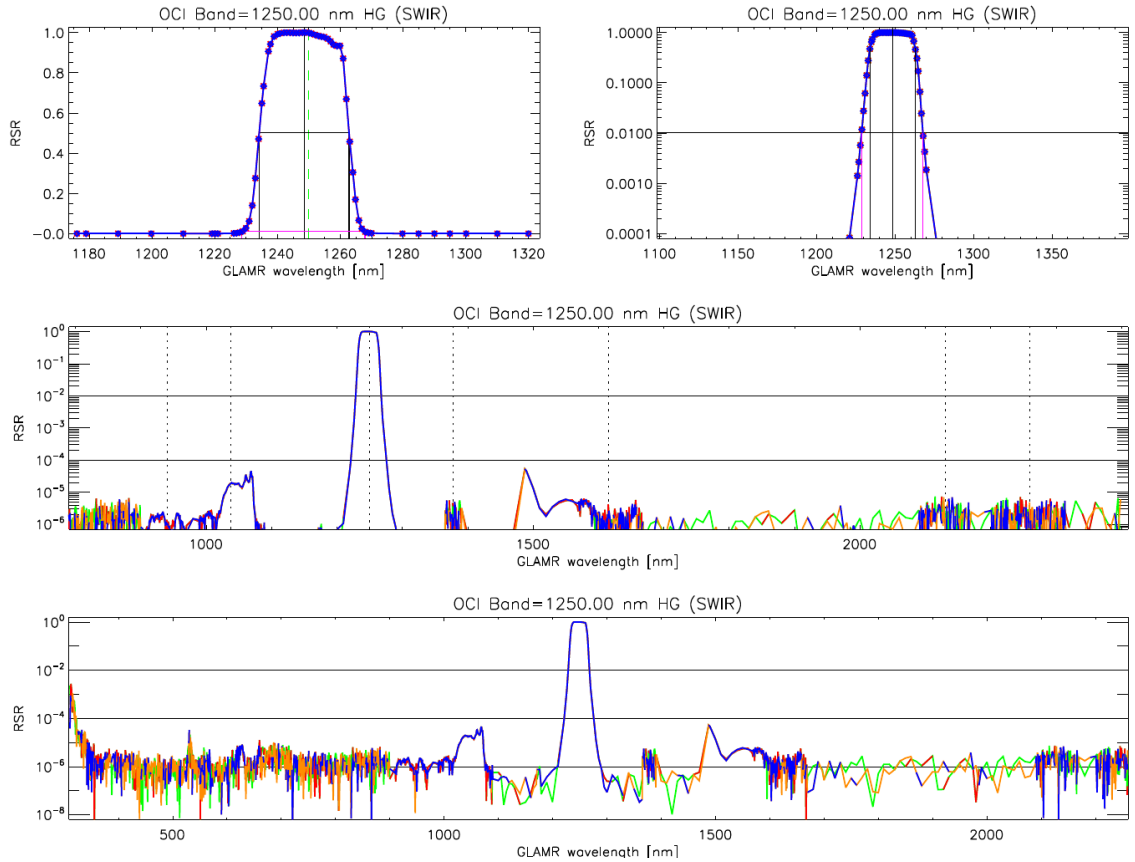

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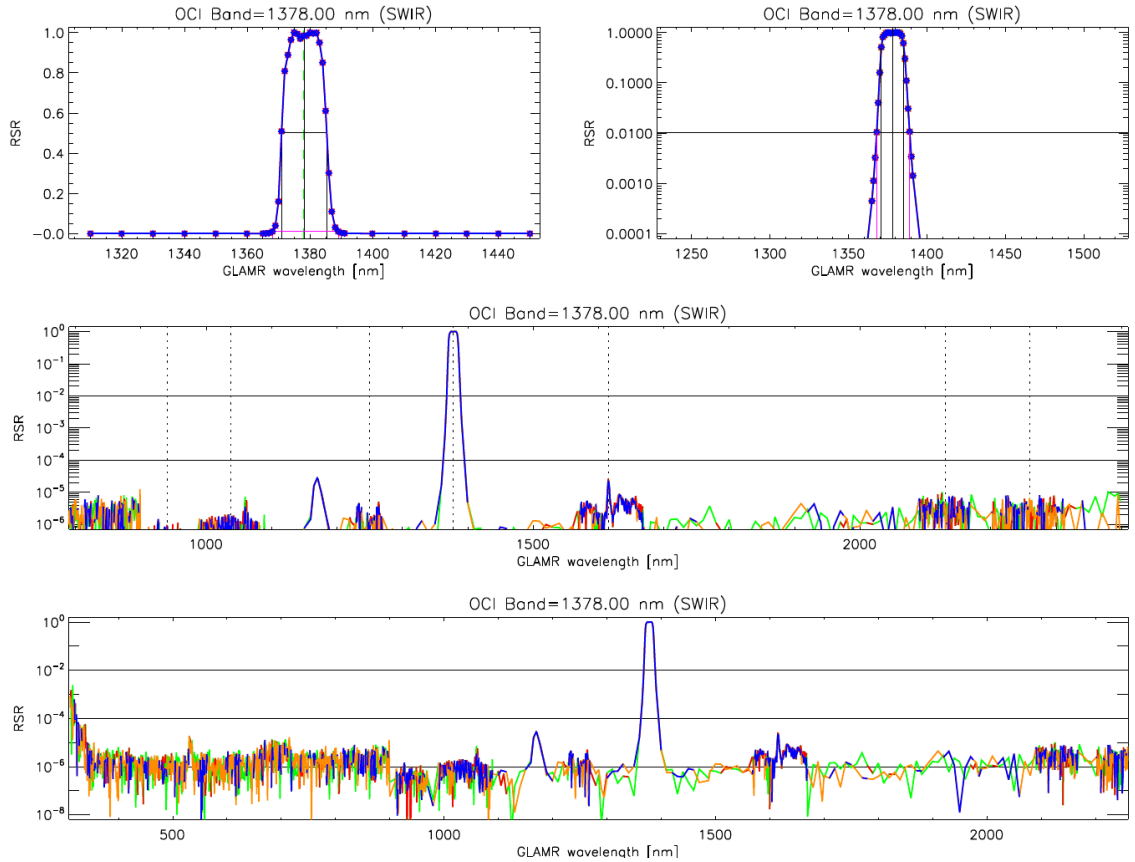

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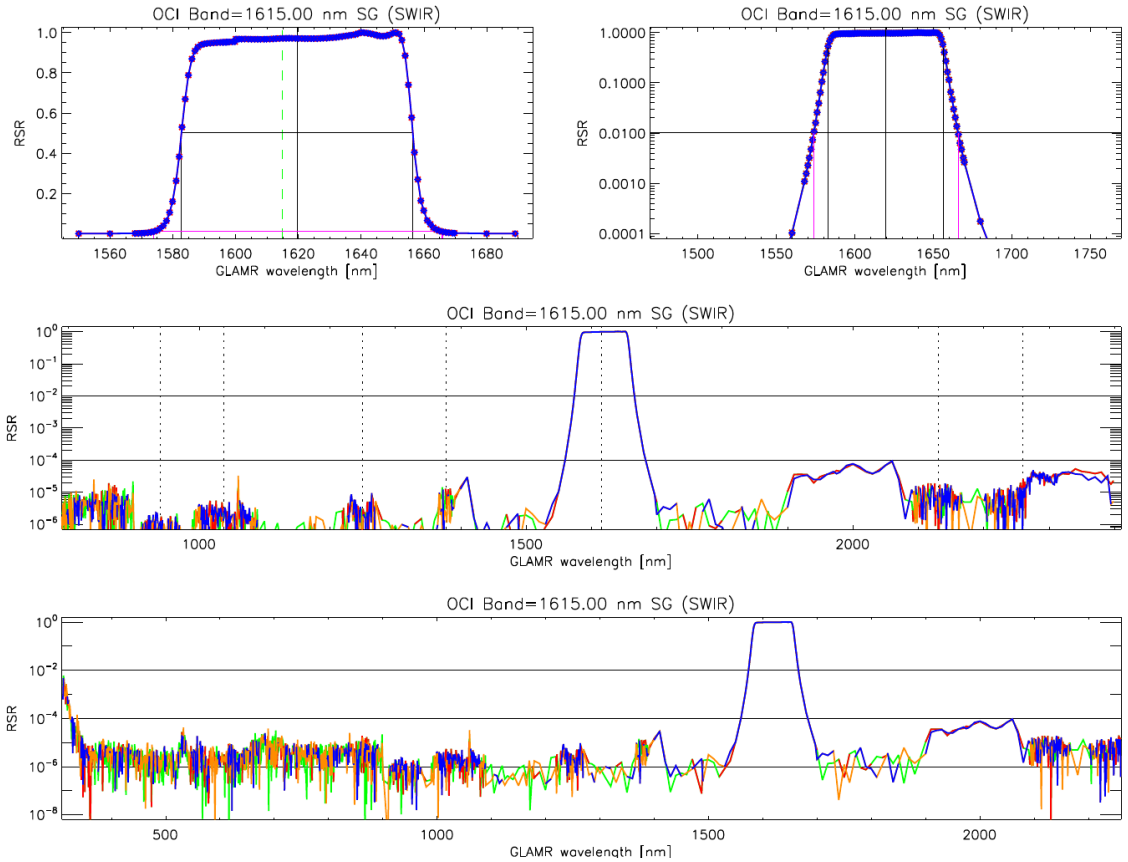

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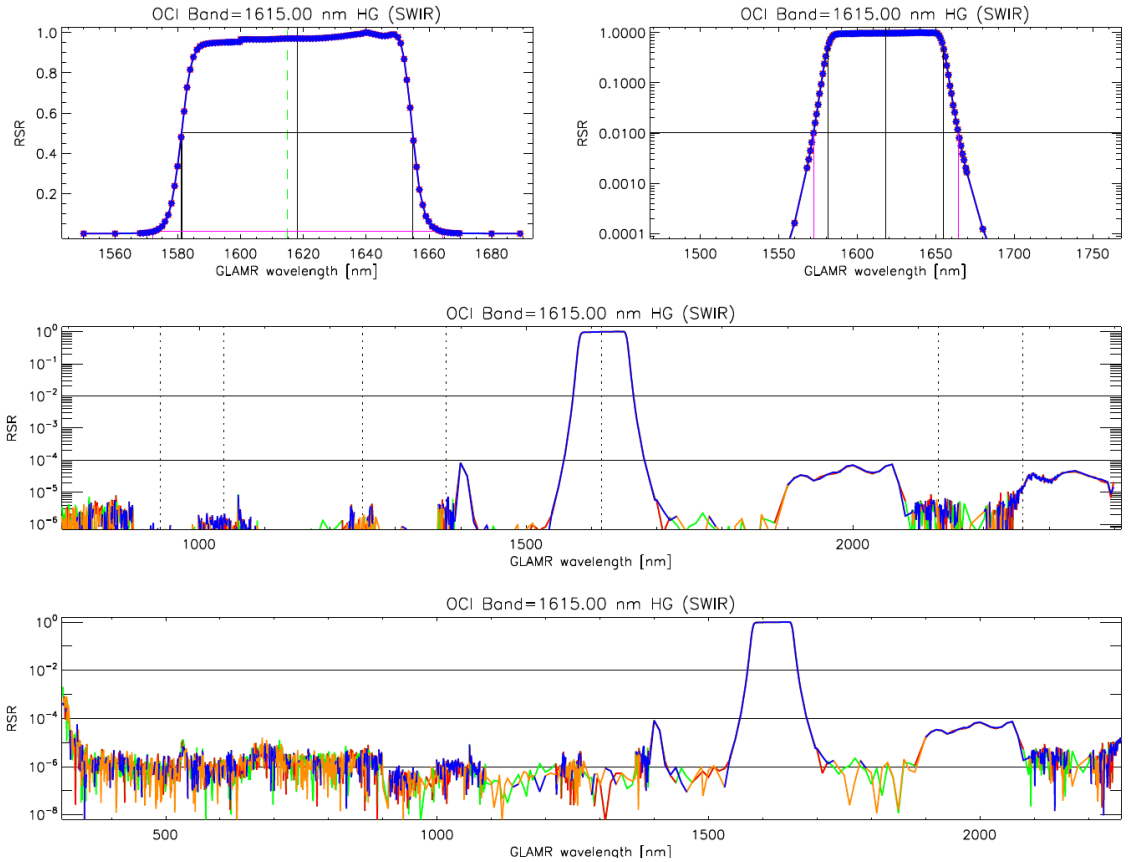

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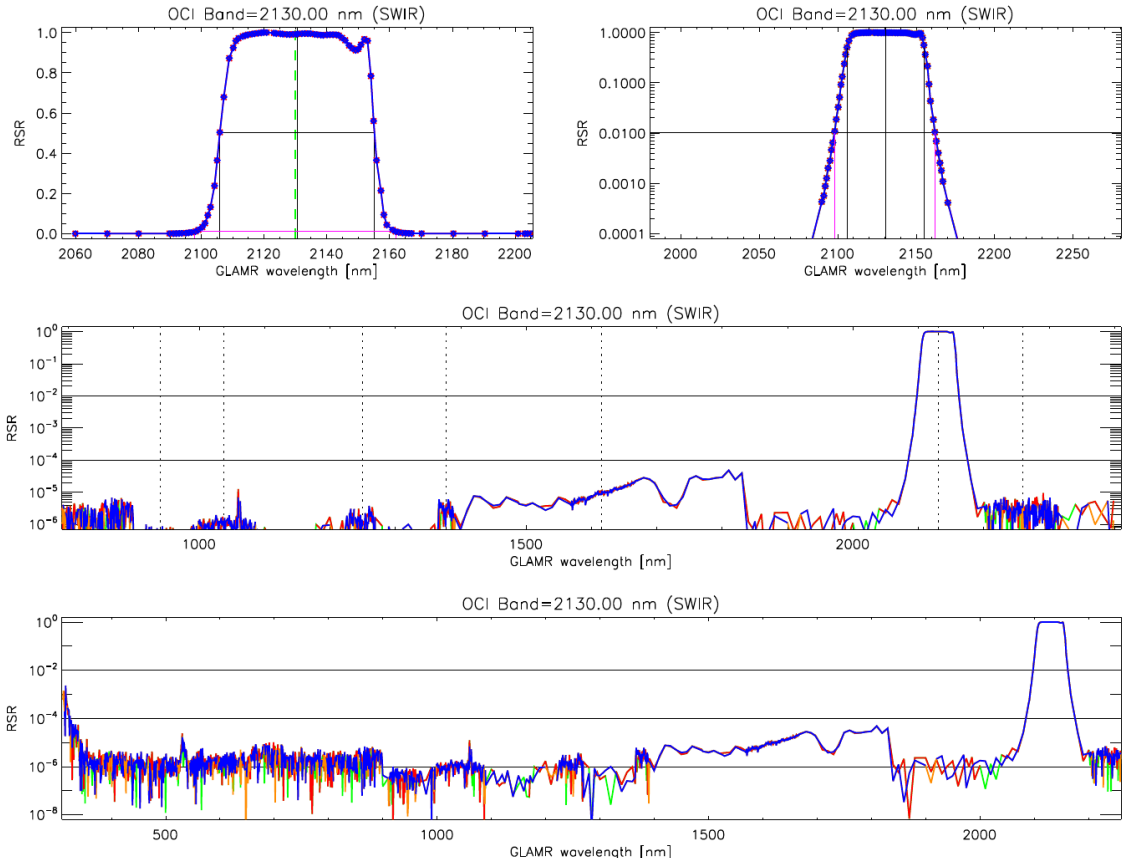

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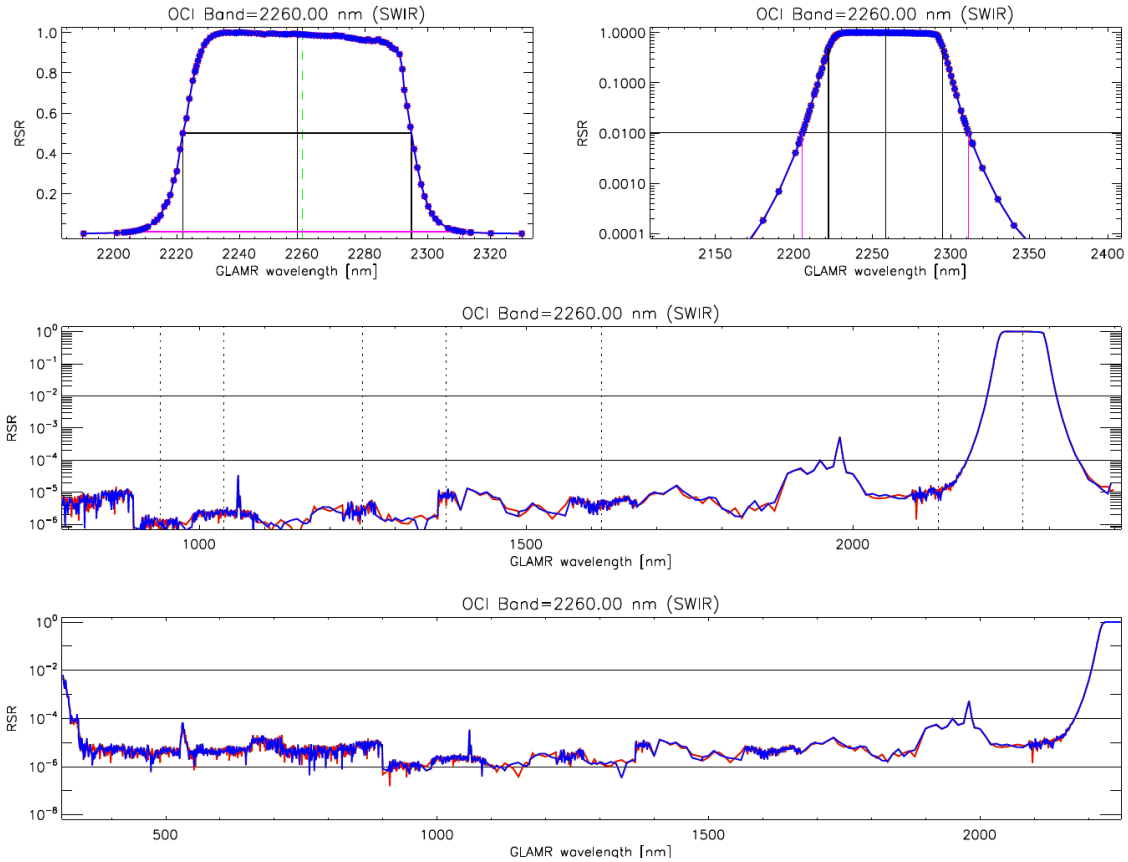

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