Resourcesat-2/2A Surface Reflectance Validation over RADCALNET & CEOS CAL/VAL sites

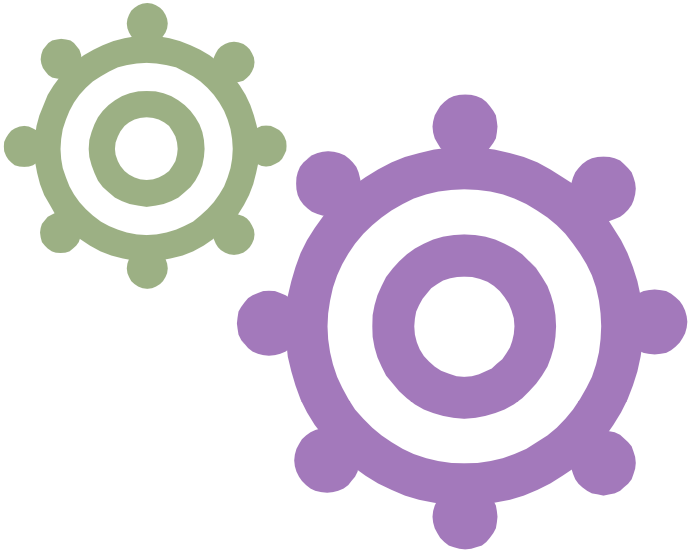
LSI-VC-14

10 Oct 2023

T.Radhika

NRSC/ISRO

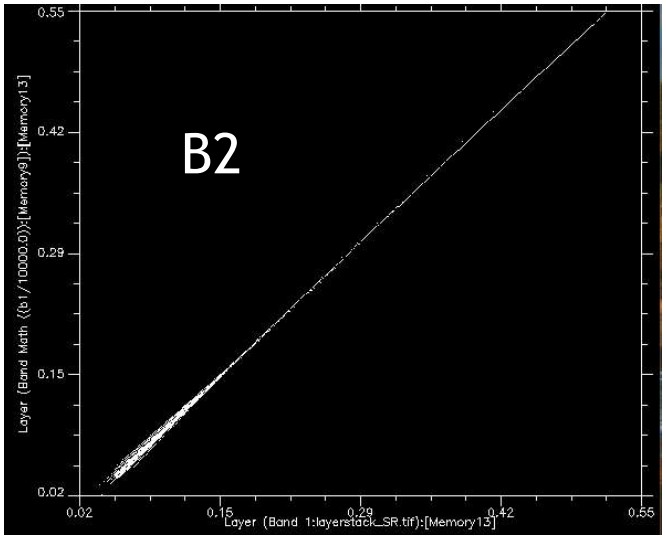
LSI-VC-13: QUICK RECAP..

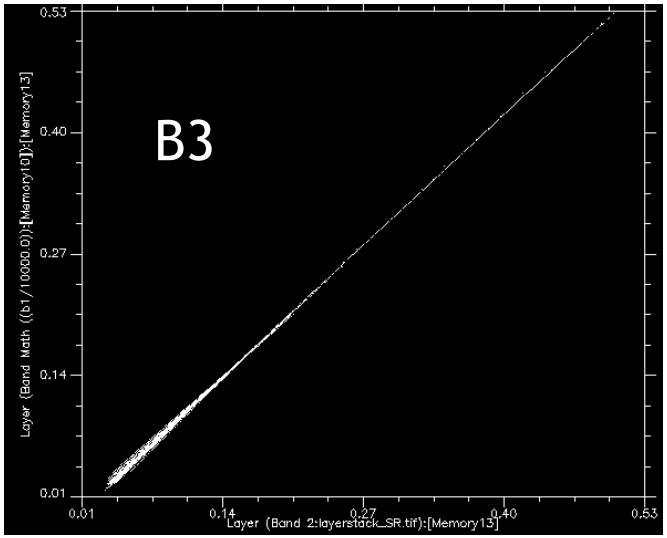


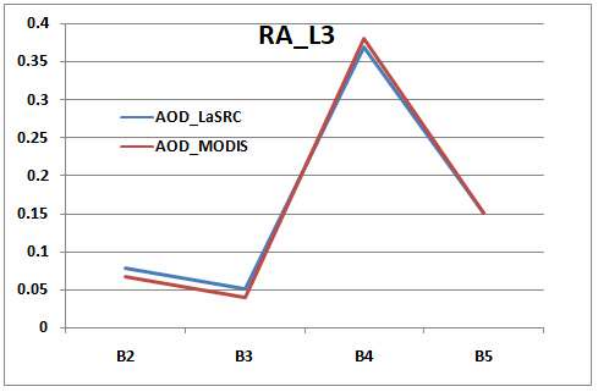
CONTROL & Confidence in Algorithms

- RS-2/2A SR generation is fully automated
- RS2 is harmonized with reference to RS2A
- Radiometric Accuracy is around 95 % - Validated with In-situ & OLI over Indian terrain
- Geometric accuracy is better than 1 pixel
- SR Products can be ordered from Bhoonidhi.
- ARD sets are generated over 3 sample areas from 2017 to 2022
- Requested LASRC-generated AOD datasets over Indian region-Received 10no.s
- SR Products over Global terrains would be provided for the endorsement

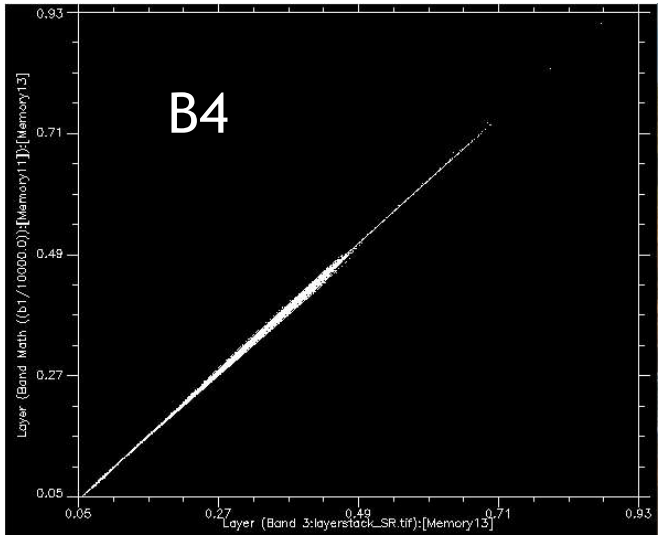
R2A-L3 : LASRC(AOD)- SR VS ACT-RS(AOD): SR

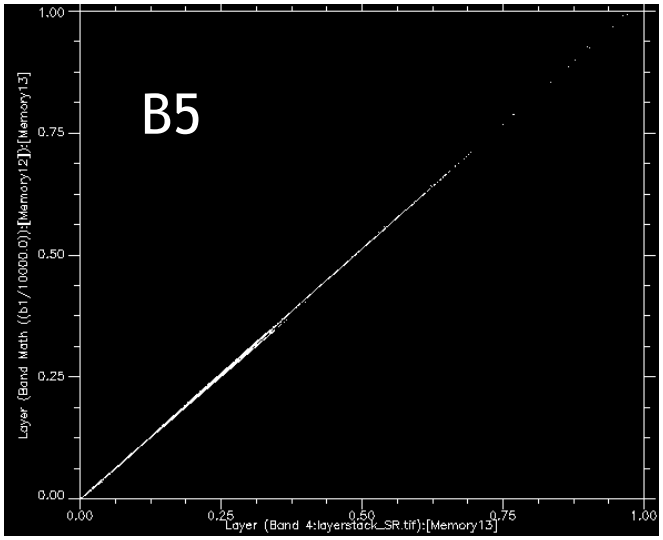






Vegetation Profile





X-axis: LASRC-SR Y-axis: ACT-RS

LASRC(AOD) & ACT-RS(AOD) Values are in good agreement over non-cloudy regions

OBJECTIVE -1 : ABSOLUTE VALIDATION WITH RADCALNET

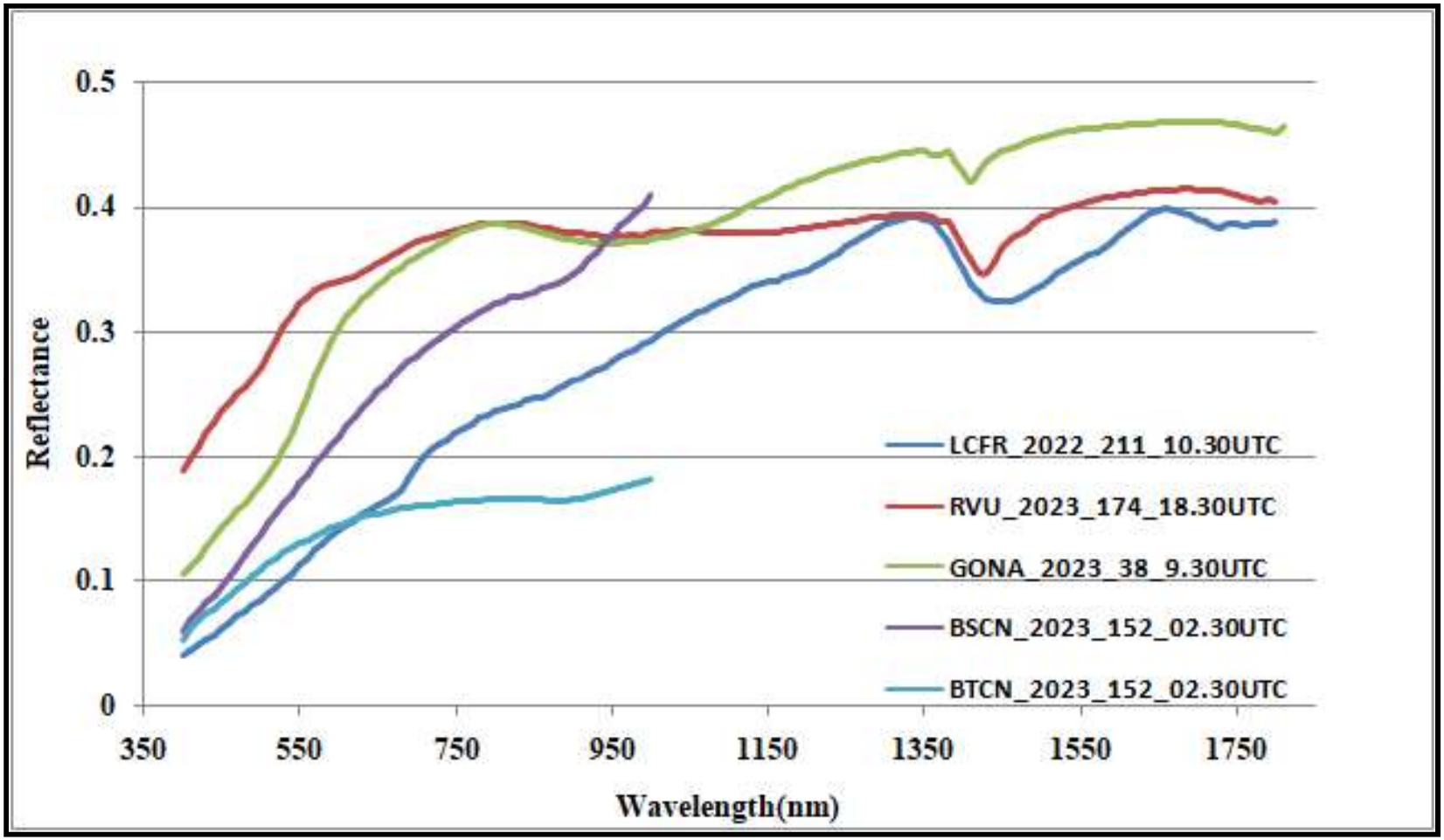
1. SR products from RS-2/2A L3 and AWiFS sensors over the sites since launch (2013 & 2017) are generated using 6S-RT code by using auxiliary information provided with Meta file and ancillary data sets from CAMS.
2. The Radcalnet provides the corrected reflectance values over four instrumented reference test sites namely Railroad Playa(USA), Baotou(China), La Crau (France) and Gobabeb(Namibia) at 30 minute intervals from 9am to 3pm.
3. Each site is equipped with automated ground-based radiometers and spectrometers that are used to measure surface and atmospheric parameters for the simulation of TOA reflectance.
4. The spectral range is 400-2500nm sampled at 10nm.
5. These sites can be used for validation of medium resolution sensors like L8/L9, Sentinel-2 MSI and L3.
6. Ground reflectance (BOA) from Radcalnet site is converted to R2/2A sensor's reflectance using spectral response function of the sensor's band as

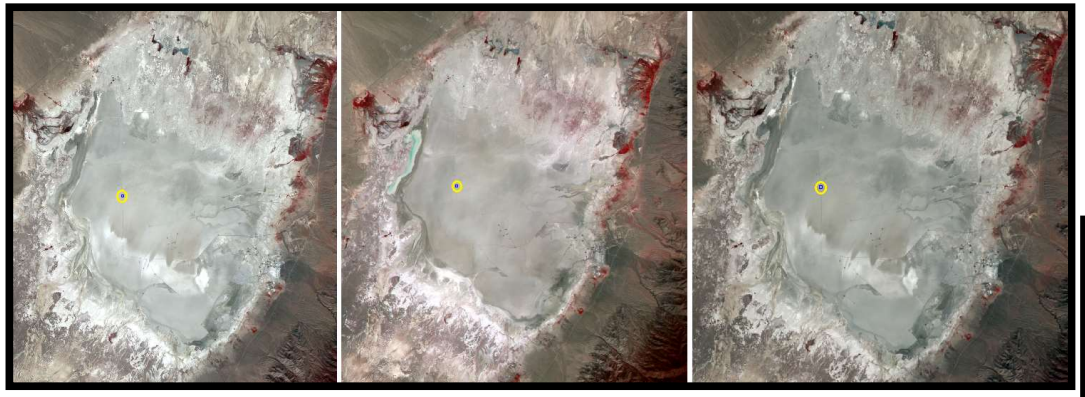
$$\rho(\lambda)_i = \frac{\int_{\lambda 1}^{\lambda 2} \rho(\lambda) S_i(\lambda) d\lambda}{\int_{\lambda 1}^{\lambda 2} S_i(\lambda) d\lambda}$$

Where $S_i(\lambda)$ is the sensors spectral response function and is spectral reflectance value.

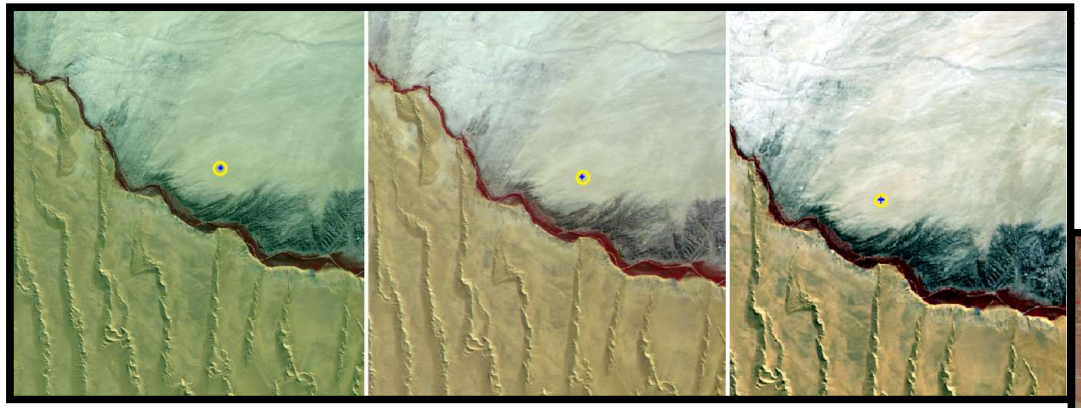
7. Data measured at satellite overpass local time is considered for the comparison.

Spectral profiles of five target sites



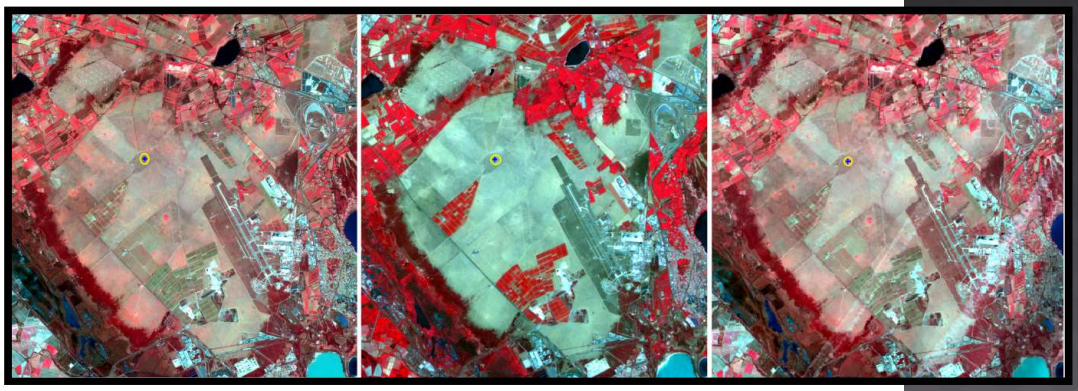


RVU- Left: RA -252/43, DOP: 14Oct2022, Centre: R2-252/53, DOP: 08Sep2022
Right: OLI L8-40/33, DOP: 04Sep2022

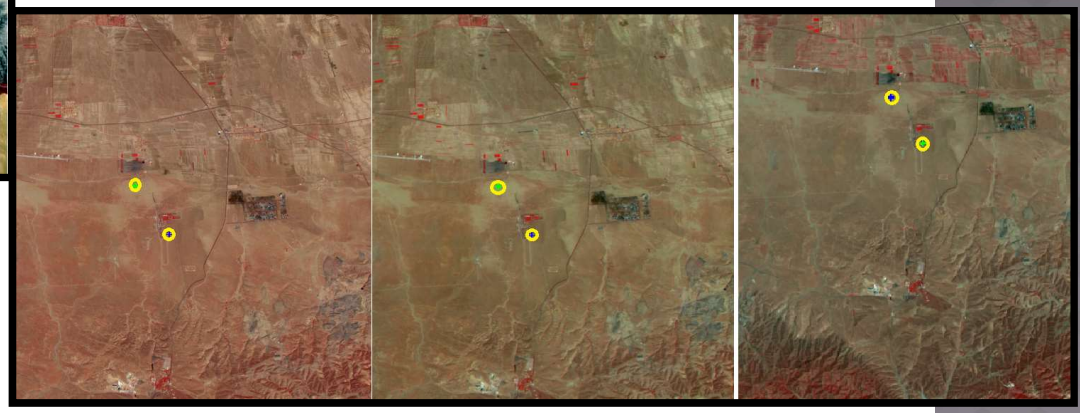


GONA- Left: RA -49/95, DOP: 05Jun2023, Centre: R2-49/95, DOP: 30Apr2023
Right: OLI L8-179/76, DOP: 01Jun2023

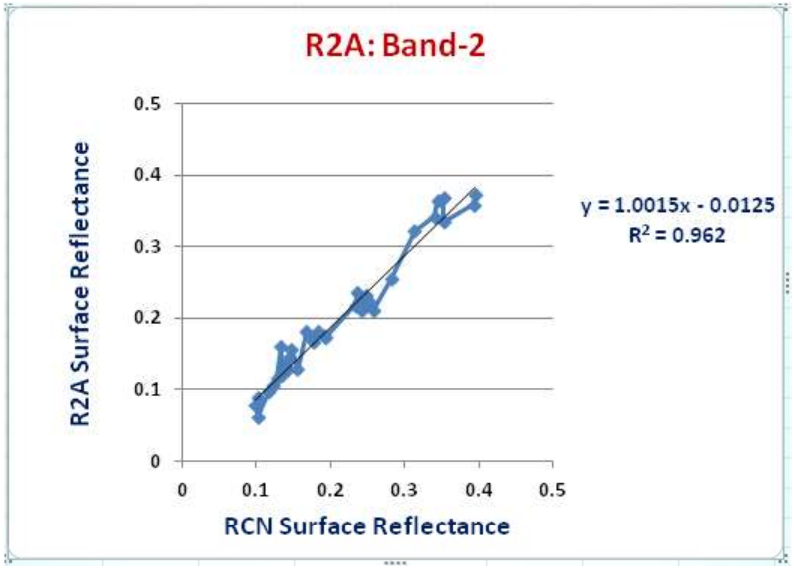
LFCR- Left: RA -23/38, DOP: 19Feb2023, Centre: R2-23/38, DOP: 30Jul2022
Right: OLI L8-196/30, DOP: 16Feb2023

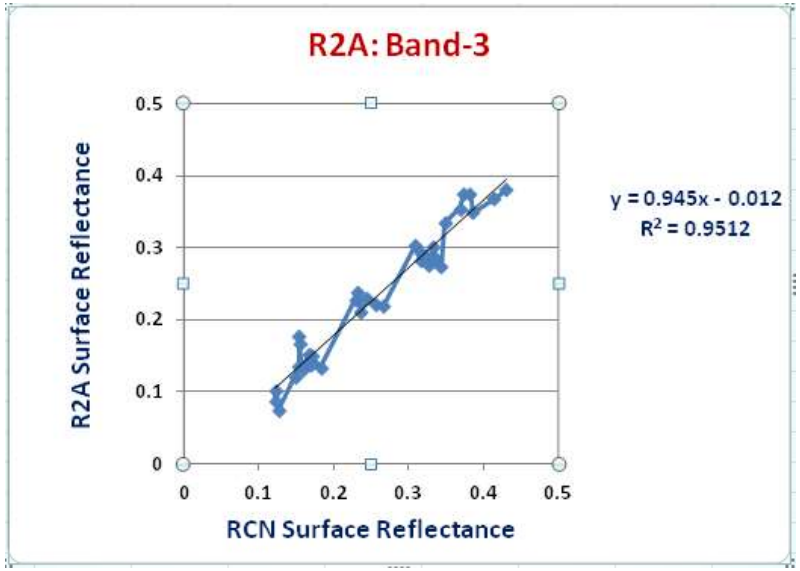


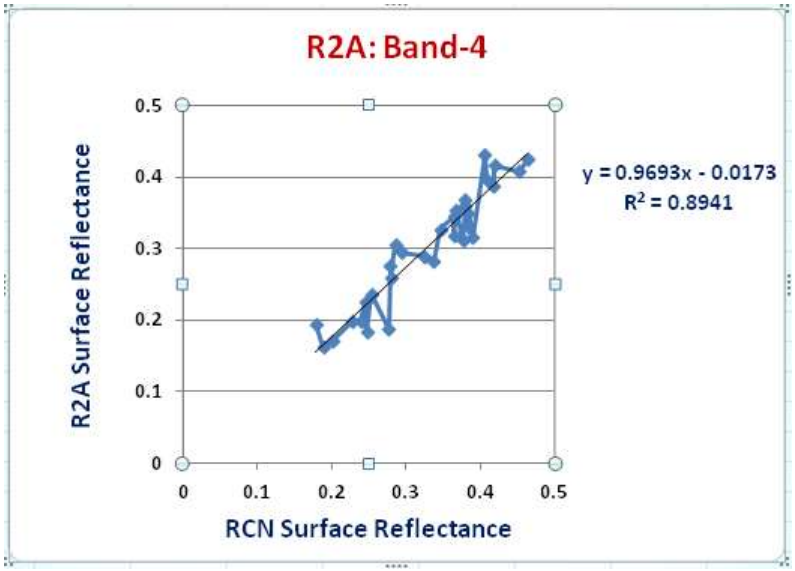
BSCN &BTCN-Left: RA -123/41, DOP: 22May2023, Centre: R2-123/41, DOP: 03Jun2023
Right: OLI L8-128/32, DOP: 12Jun2023

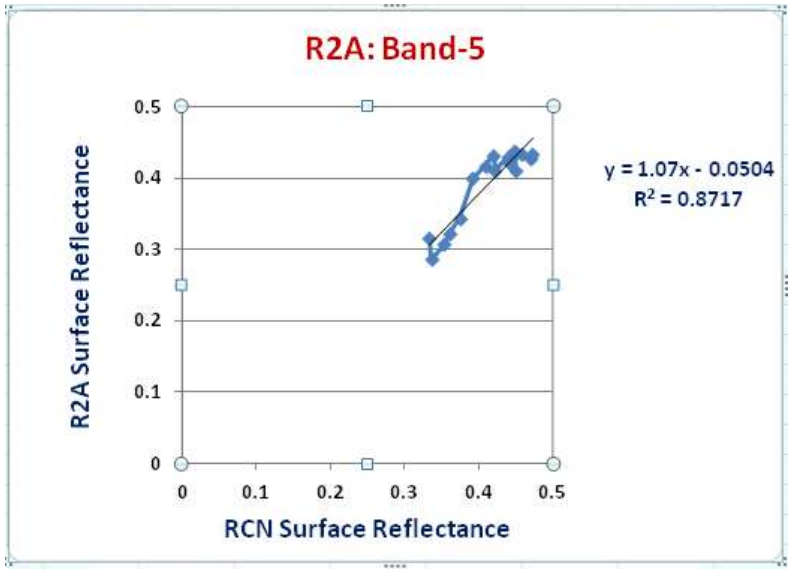


RCN VS R2A-L3 : ALL SITES SINCE 2017

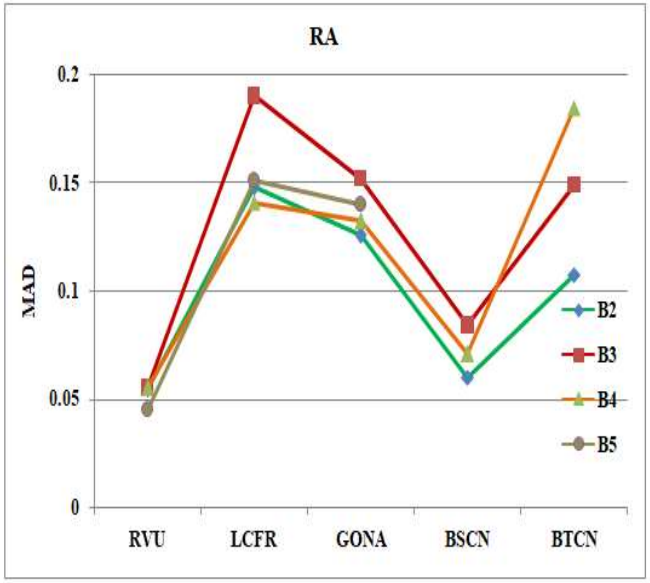




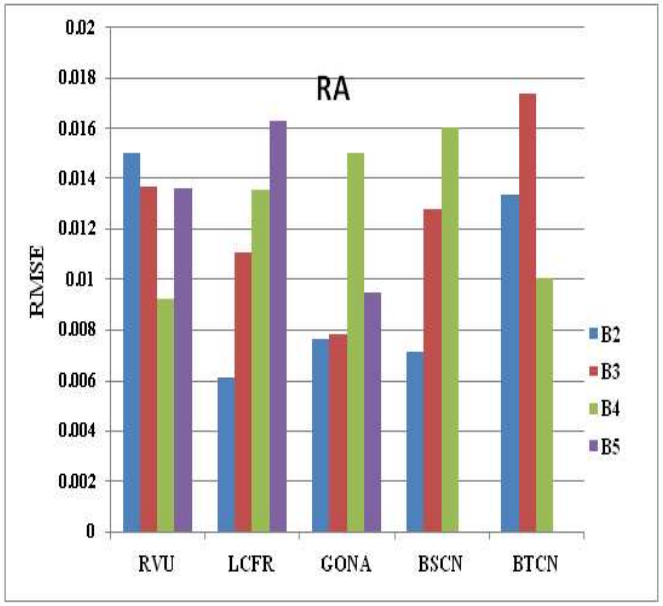




R2A-L3 WITH RCN

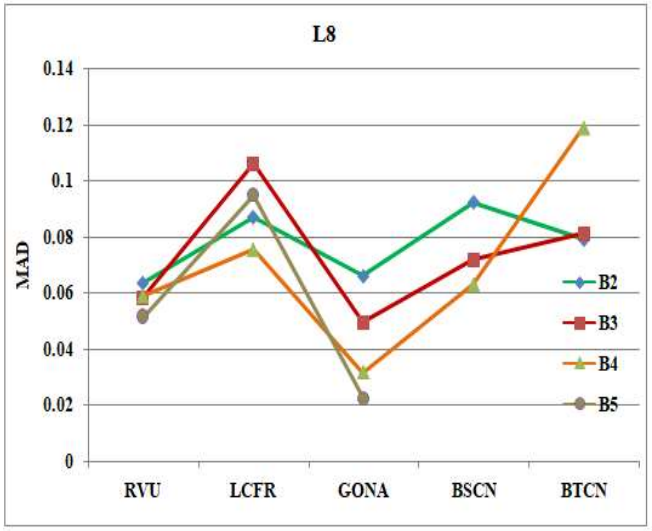


MAD-RS2A

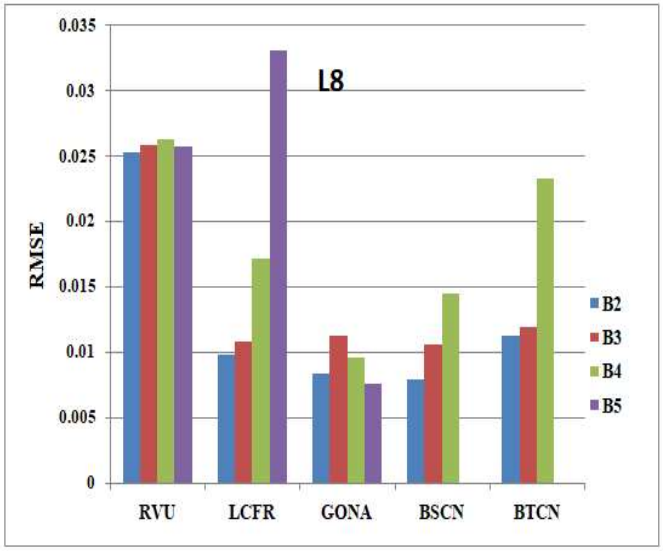


RMSE-RS2A

MAD-L8



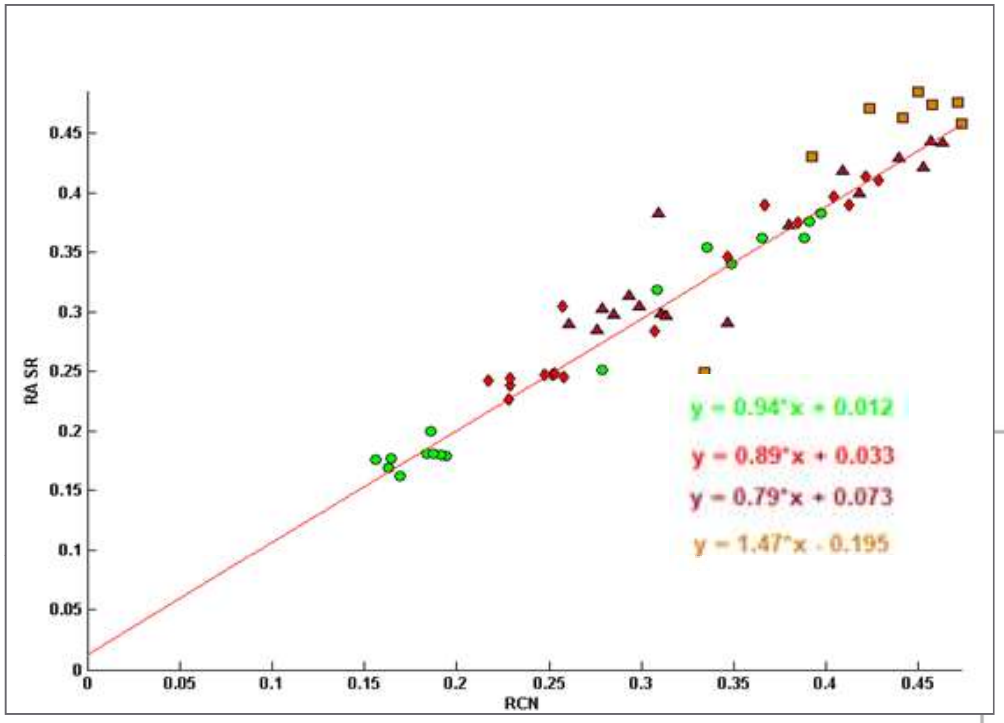
RMSE - L8



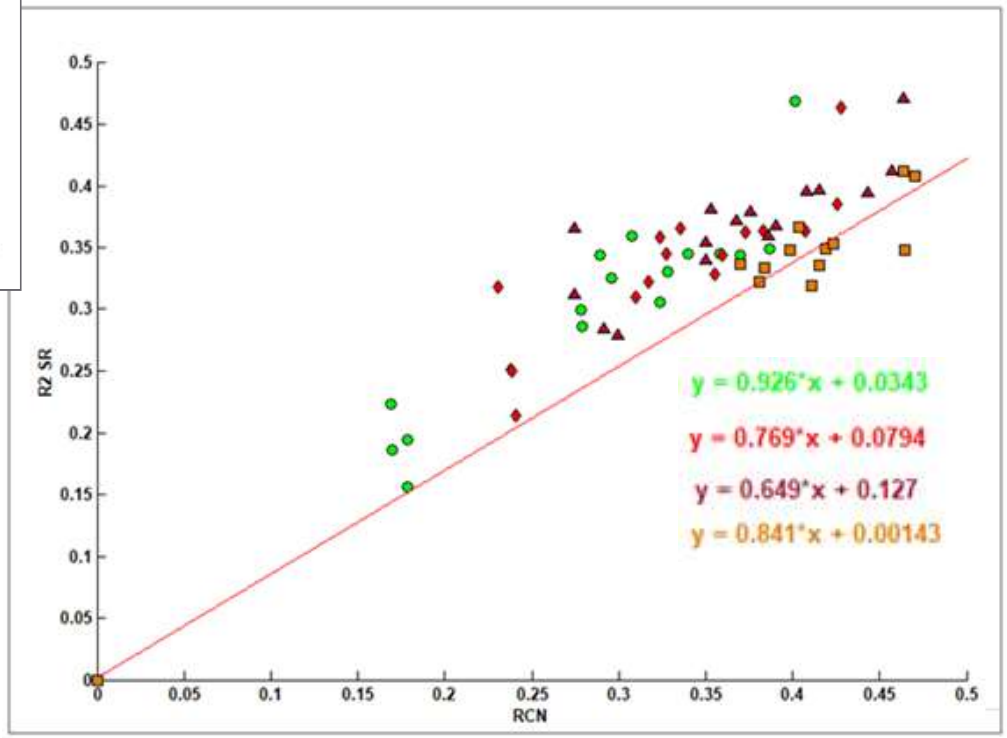
L3-Accuracy metrics over RCN : from all the observations for R2/RA/L8 over five sites

RS-2	SSIM	RMSE	slope	offset	R^2	SMAPE
B2	0.809	0.018	0.702	0.007	0.945	15.009
B3	0.819	0.021	0.748	0.006	0.943	12.802
B4	0.778	0.030	0.589	0.081	0.877	9.383
B5	0.806	0.037	0.576	0.083	0.585	12.232
RS-2A						
B2	0.908	0.015	1.001	-0.012	0.962	5.247
B3	0.871	0.017	0.945	-0.012	0.951	6.874
B4	0.792	0.019	0.863	0.021	0.868	5.898
B5	0.728	0.025	1.046	-0.051	0.787	5.555
L8-OLI						
B3	0.8423	0.020	0.932	0.01	0.941	3.748
B4	0.8442	0.022	0.972	0.008	0.944	3.477
B5	0.813	0.024	0.884	0.043	0.898	3.621
B6	0.8348	0.027	1.010	-0.008	0.781	2.527

RCN VS AWIF : ALL SITES SINCE 2017



RS-2A

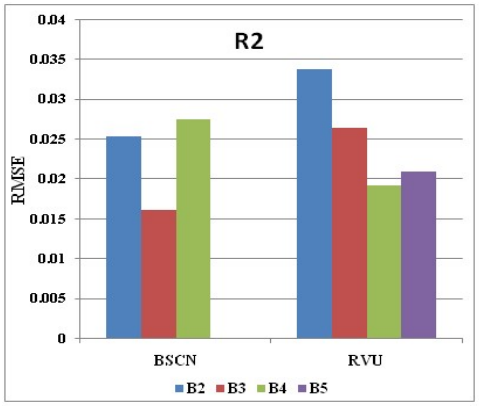


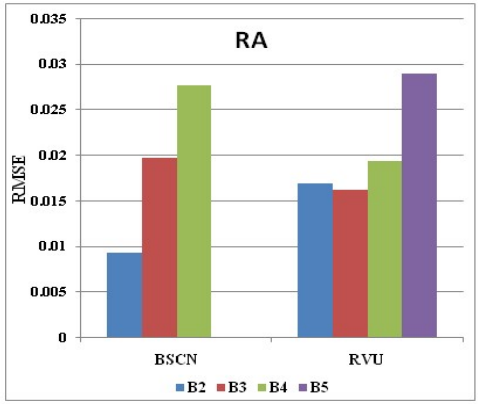
RS-2

B2-Green
B3-Red
B4-NIR
B5-SWIR

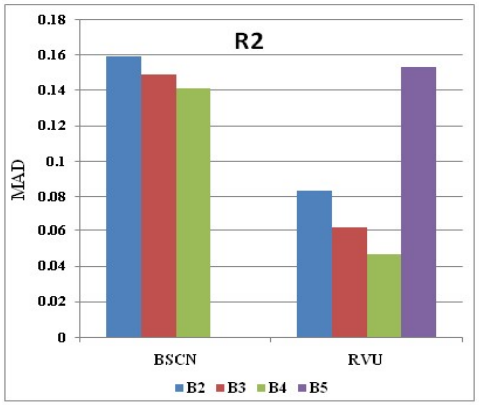
AWIF-Accuracy metrics over RCN

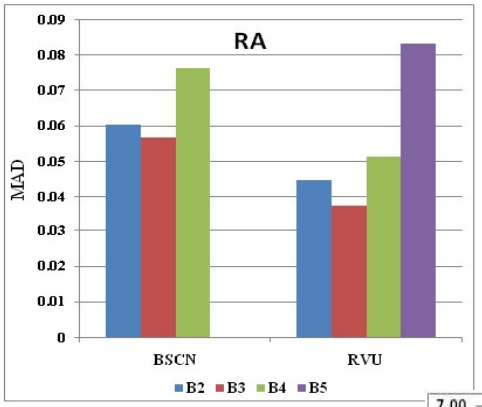
RMSE



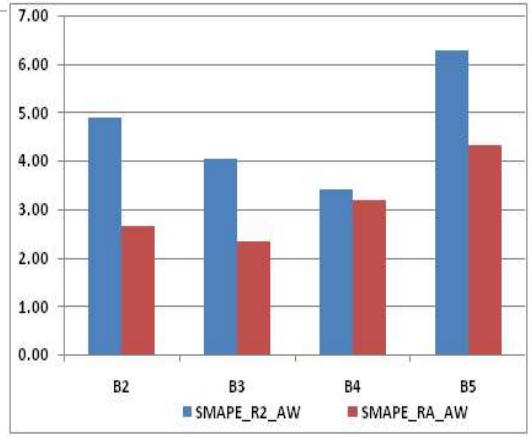


MAD

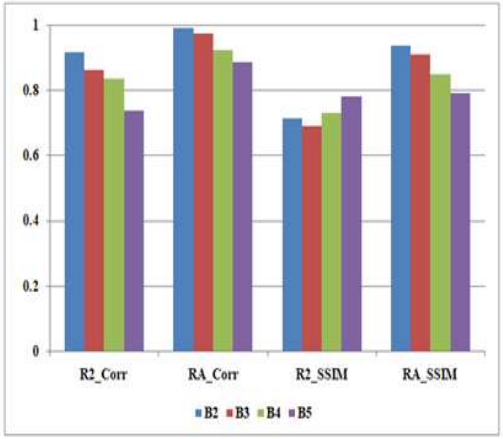




SMAPE



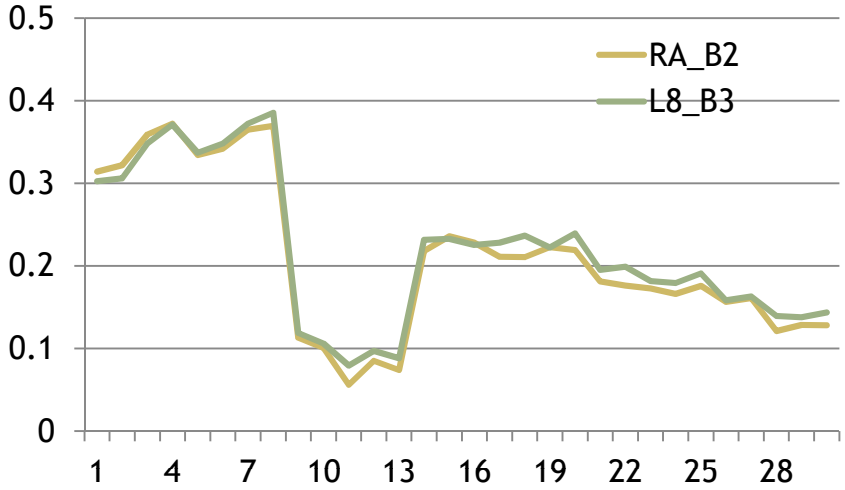
CORRELATION & SSIM

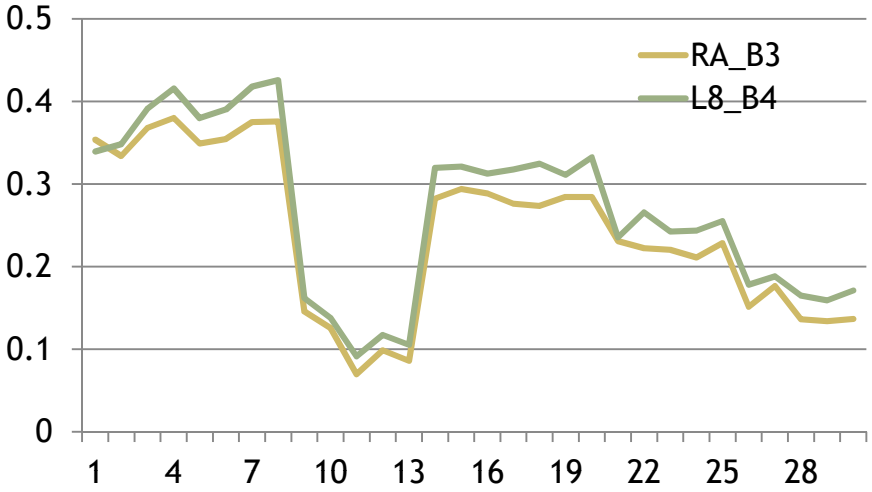


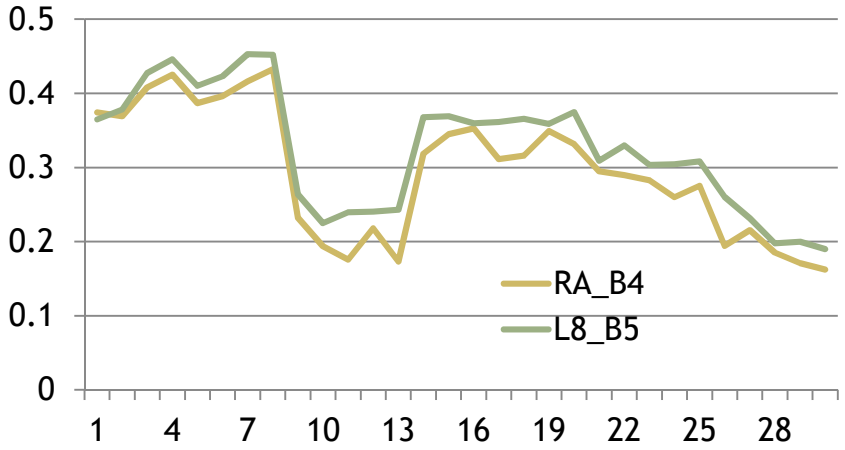
OBJECTIVE -2 : RELATIVE VALIDATION WITH OLI OVER RCN & CEOS SITES

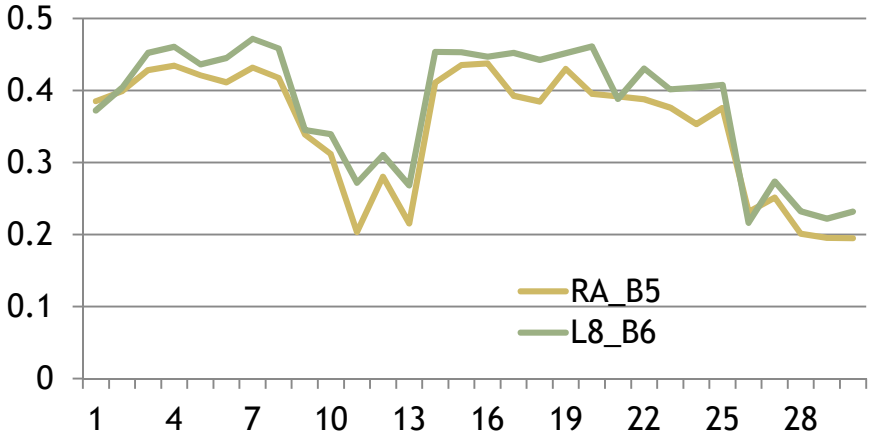
1. L8/9 OLI SR products were aggregated using nearest neighbour interpolation techniques to match the resolution of L3 and AWIFS.
2. ROIs (2 to 4km area) are extracted from near synchronous L8/9 and L3 datasets on the site location.
3. Band wise Standard least squares linear regression was then used to represent the differences in surface reflectance between OLI and RS-2/2A pixels.
4. Parameters such as MAD, RMSE, SMAPE,SSME were computed to quantify the agreement

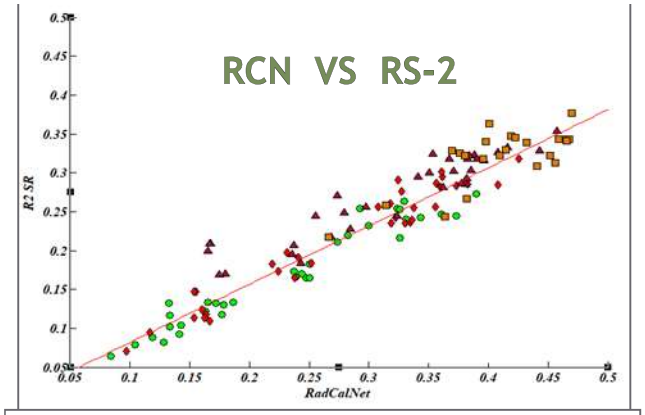
RS-2A:L3 VS L8-OLI over RCN sites

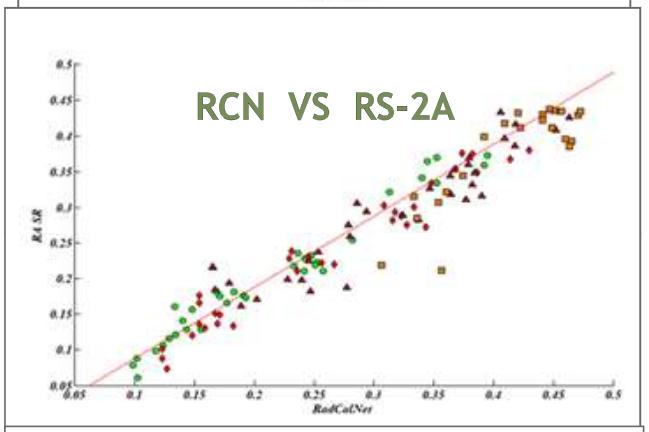


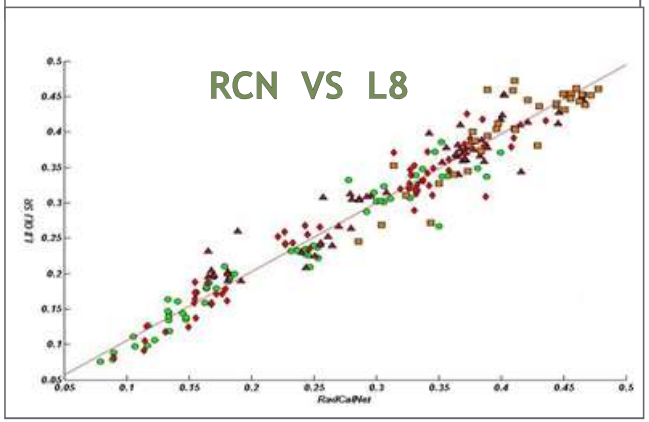










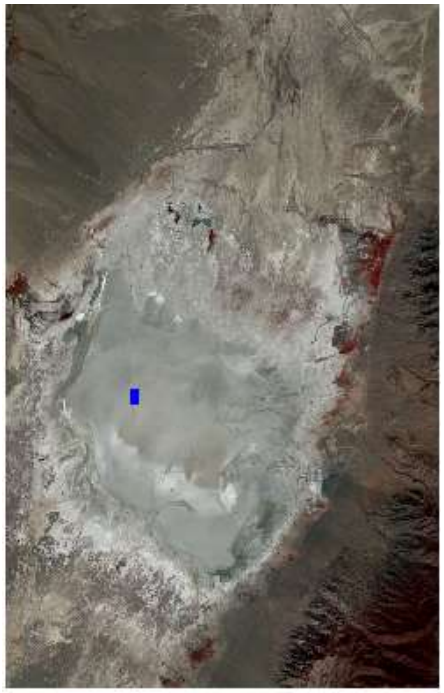


SR: Relative validation with OLI over RCN

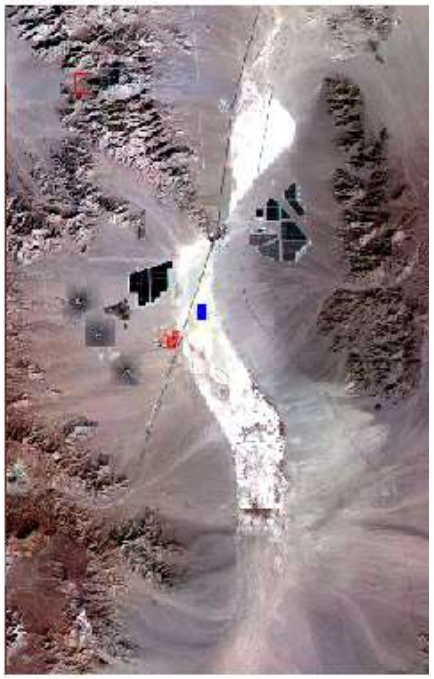
R2 vs L8	slope	offset	R^2	SSIM	corr	RMSE	SSE	MAD
B2	0.817	-0.012	0.881	0.819	0.939	0.024	0.019	0.025
B3	0.827	-0.013	0.906	0.850	0.951	0.024	0.018	0.022
B4	0.729	0.035	0.848	0.835	0.921	0.023	0.017	0.016
B5	0.649	0.049	0.807	0.842	0.898	0.024	0.019	0.021
RA vs L8								
B2	1.046	-0.018	0.989	0.971	0.994	0.009	0.002	0.008
B3	0.947	-0.013	0.982	0.942	0.990	0.013	0.004	0.012
B4	1.046	-0.045	0.956	0.913	0.977	0.018	0.009	0.010
B5	0.963	-0.015	0.938	0.891	0.968	0.021	0.012	0.009

B2
B3
B4
B5

SR: Relative validation with OLI over CEOS CAL sites

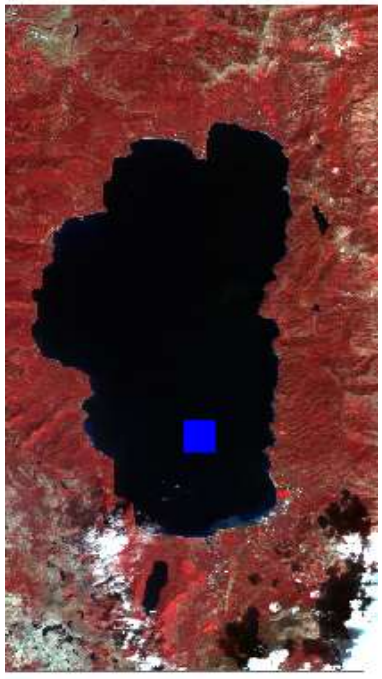


Rail Road Playa

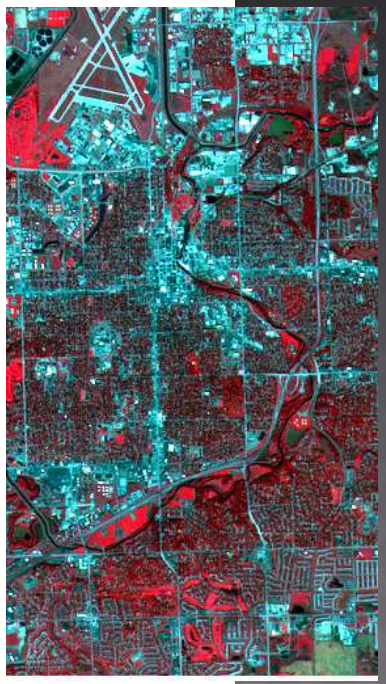


Ivanpah Playa

Libya-4



Lake Tahoe



Sioux Falls

AWIFS : CEOS TARGETS & DATA SETS

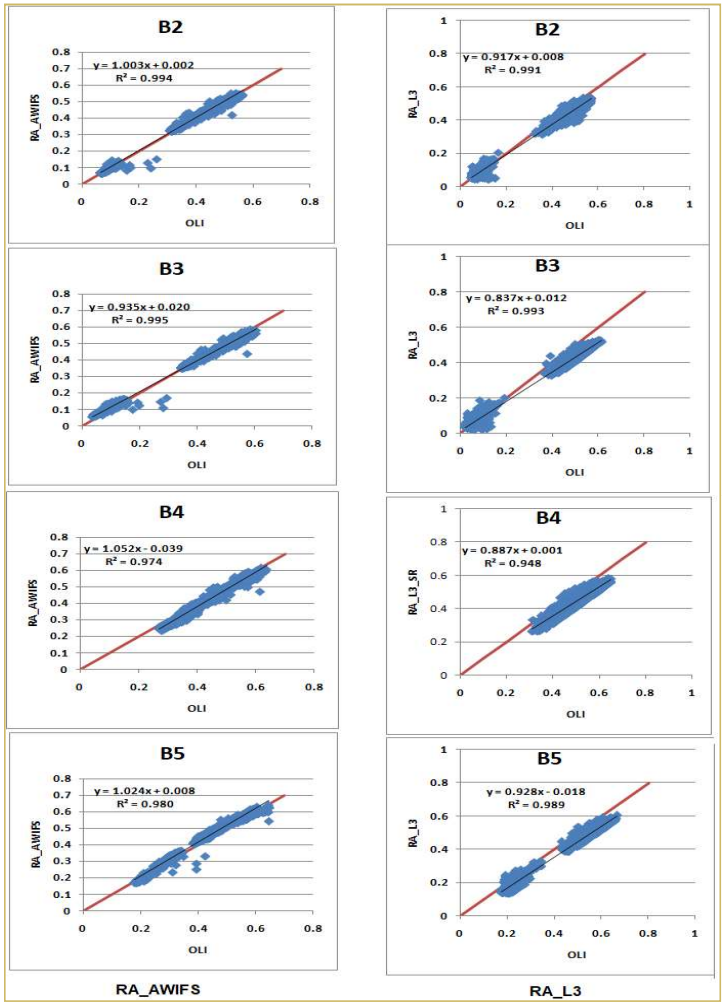
Sl.No	CEOS site	RS2/2A path/Row	Date of Pass	L8/L9 path/row	Date of Pass
1.	Ivanpah Playa (USA)	RS2_253/45 RA_253/45	04Feb2023 29Apr2023	L9_39/35 L8_39/35	04Feb2023 25Apr2023
2.	Rail Road Playa (USA)	RS2_252/43 RA_252/43	260Oct2022 14Oct2022	L9_40/33 L9_40/33	30Oct2022 14Oct2022
3.	Sioux Falls (USA)	RS2_267/38 RA_268/38	11Sep2022 28Sep2022	L8_29/30 L9_29/30	07Sep2022 01Oct2022
4.	Lake Tahoe (USA)	RS2_247/42 RA_247/42	07Sep2022 26Jun2019	L9_43/33 L9_43/33	01Sep2022 29Jun2019
5.	Libya-4 (Africa)	RS2_45/51 RA_45/51	17Mar2023 03Apr2022	L9_181/40 L8_181/40	19Mar2023 09Apr2022

L-3 : TARGETS & DATA SETS ..

Sl.No	CEOS site	RS2/2A path/Row	Date of Pass	L8/L9 path/row	Date of Pass
1.	Ivanpah Playa (USA)	RS2_253/45 RA_253/45	04Feb2023 29Apr2023	L9_39/35 L8_39/35	04Feb2023 25Apr2023
2.	Rail Road Playa (USA)	RS2_252/43 RA_252/43	260Oct2022 14Oct2022	L9_40/33 L9_40/33	30Oct2022 14Oct2022
3.	Sioux Falls (USA)	RS2_267/38 RA_268/38	11Sep2022 28Sep2022	L8_29/30 L9_29/30	07Sep2022 01Oct2022
4.	Lake Tahoe (USA)	RS2_247/42 RA_247/42	07Sep2022 26Jun2019	L9_43/33 L9_43/33	01Sep2022 29Jun2019
5.	Libya-4 (Africa)	RS2_45/51 RA_45/51	17Mar2023 03Apr2022	L9_181/40 L8_181/40	19Mar2023 09Apr2022

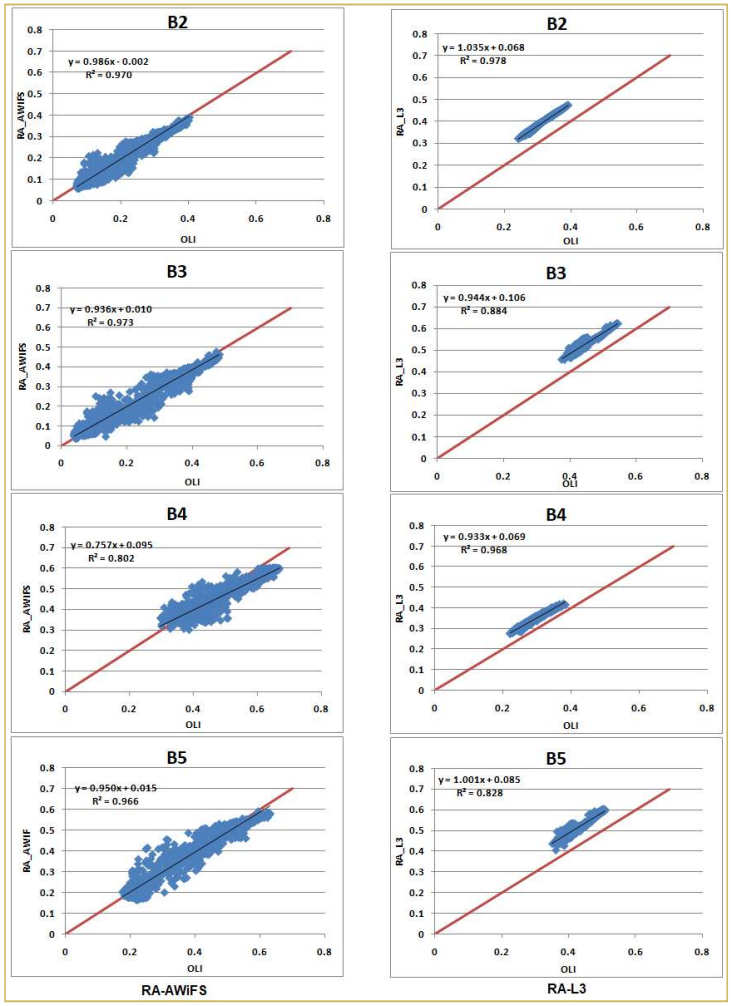
RS2A : RESULTS

RUV



AWIF L3

IVP

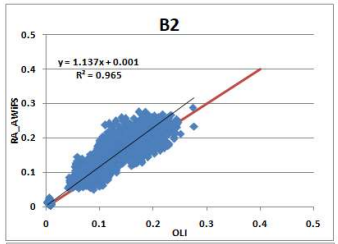


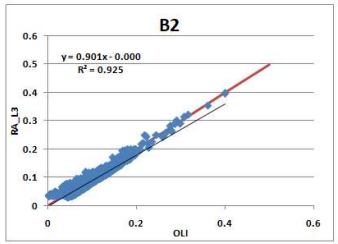
AWIF L3

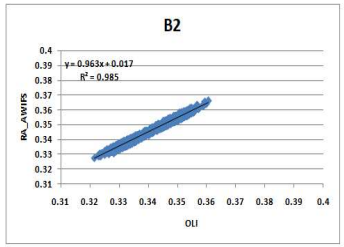
LT

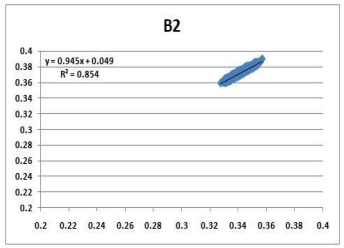
LIB

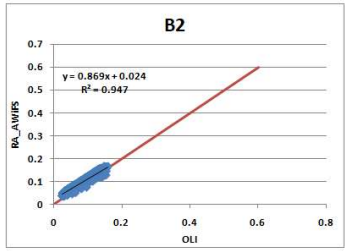
SF

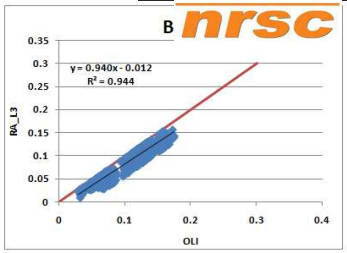


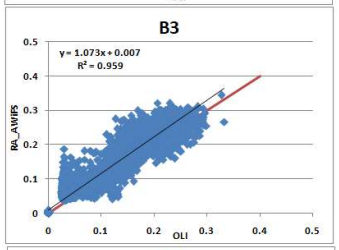


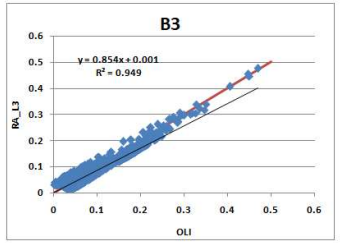


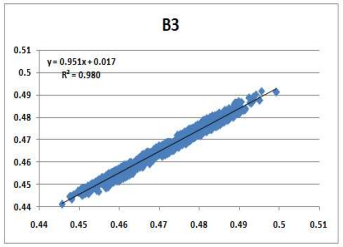


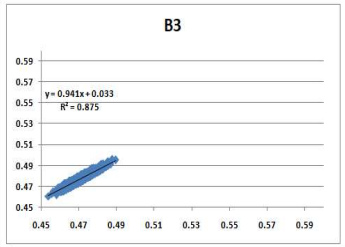


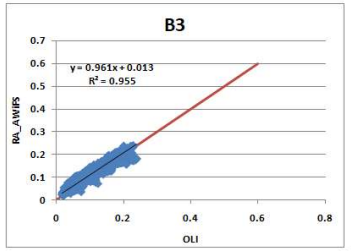


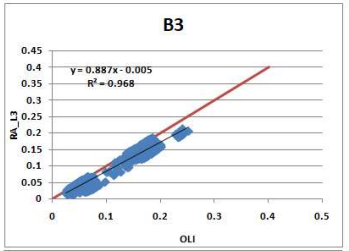


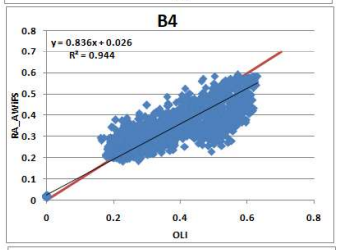


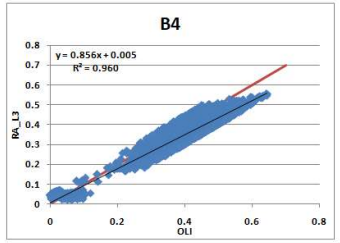


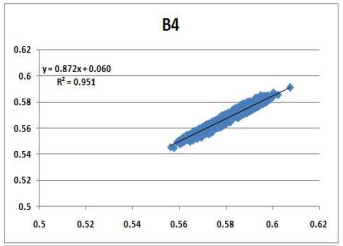


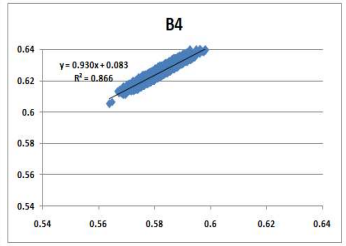


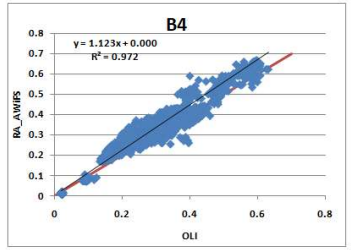


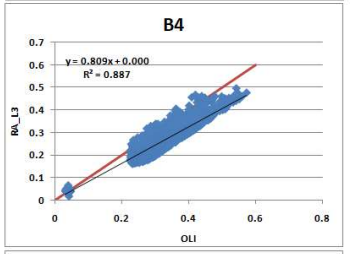


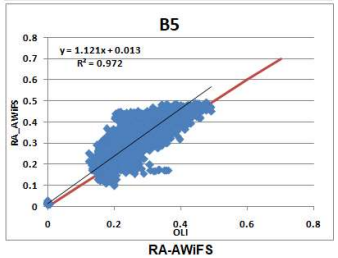


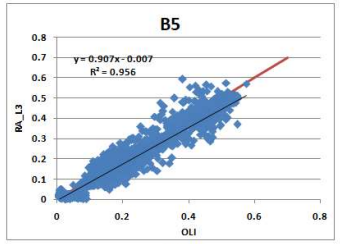


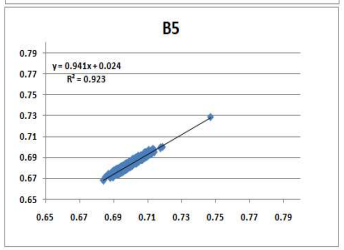


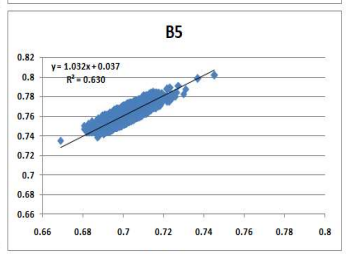


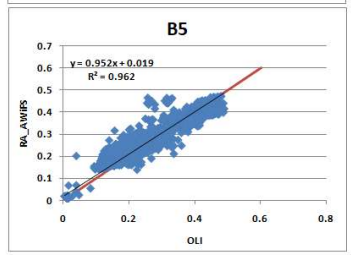


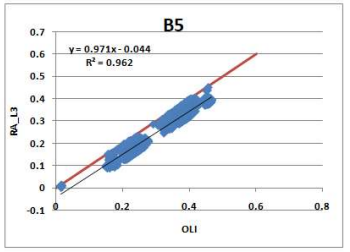












RA-AWiFS

RA-L3

RA_AWiFS

RA-L3

RA_AWiFS

RA-L3

AWIF

L3

AWIF

L3

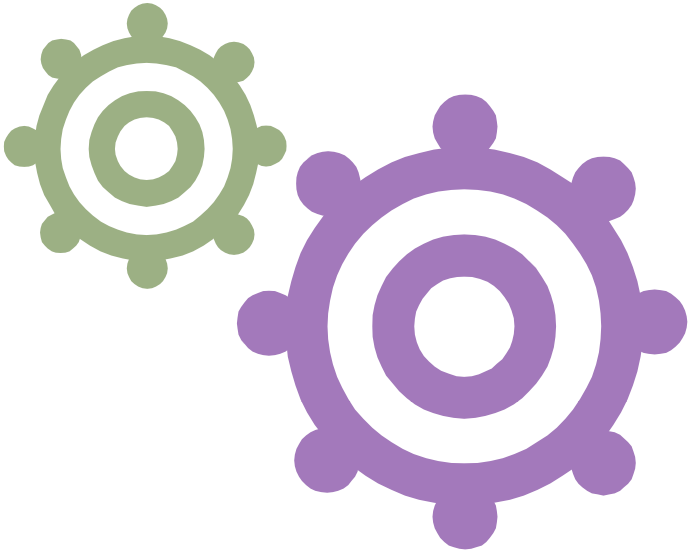
AWIF

L3

Over all agreement with L8_SR

	Green Band(B2)			Red band (B3)			NIR band(B4)			SWIR band(B5)		
AWiFS	Slope	Offset	R^2	Slope	Offset	R^2	Slope	Offset	R^2	Slope	Offset	R^2
IVP	0.986	-0.002	0.968	0.936	0.01	0.971	0.756	0.095	0.799	0.95	0.014	0.965
RUV	1.003	0.002	0.994	0.935	0.02	0.995	1.052	-0.039	0.974	1.024	0.008	0.98
LIB	0.963	0.017	0.985	0.951	0.017	0.98	0.872	0.06	0.951	0.941	0.024	0.923
SF	0.869	0.024	0.947	0.961	0.013	0.955	1.123	0	0.972	0.952	0.019	0.962
LT	1.137	0.001	0.965	1.073	0.007	0.959	0.836	0.026	0.944	1.121	0.013	0.972
L3	Slope	Offset	R^2	Slope	Offset	R^2	Slope	Offset	R^2	Slope	Offset	R^2
IVP	1.035	0.068	0.978	0.944	0.106	0.884	0.933	0.069	0.968	1.001	0.085	0.828
RUV	0.917	0.008	0.991	0.837	0.012	0.993	0.887	0.001	0.948	0.928	-0.018	0.989
LIB	0.944	0.049	0.854	0.943	0.033	0.875	0.929	0.084	0.866	1.032	0.037	0.93
SF	0.94	-0.012	0.944	0.887	-0.005	0.968	0.809	0	0.887	0.971	-0.044	0.962
LT	0.901	0	0.925	0.854	0.001	0.949	0.856	0.005	0.96	0.907	-0.007	0.956

LSI-VC-14: Summary..



Confidence in accuracies

- SR Product accuracy is around 95% with ground measurements & OLI
- Accuracy is consistent since launch
- ARD Products are ready for endorsement

Thank you..