MOS-P, GeoTASO, and Remote Sensing Data Products for KORUS-OC

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KORUS-OC Data Workshop, Portland, Oregon 19-21 May 2016

MOS-P Image Flying out of Seoul Across Incheon Bridge 2016-04-29

KORUS-OC Remote Sensing

Flights and Features

East Coast - Blooms; South East - Upwelling; South West South - Seaweed; South West - Tidal Flows; West - Mudflats

Navigating Environmental Conditions

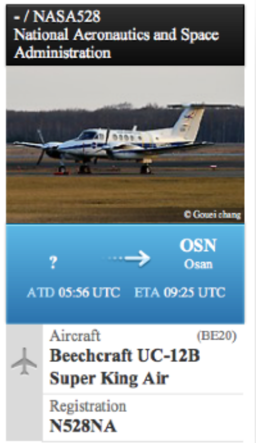
GOCI; VIIRS; Him-8

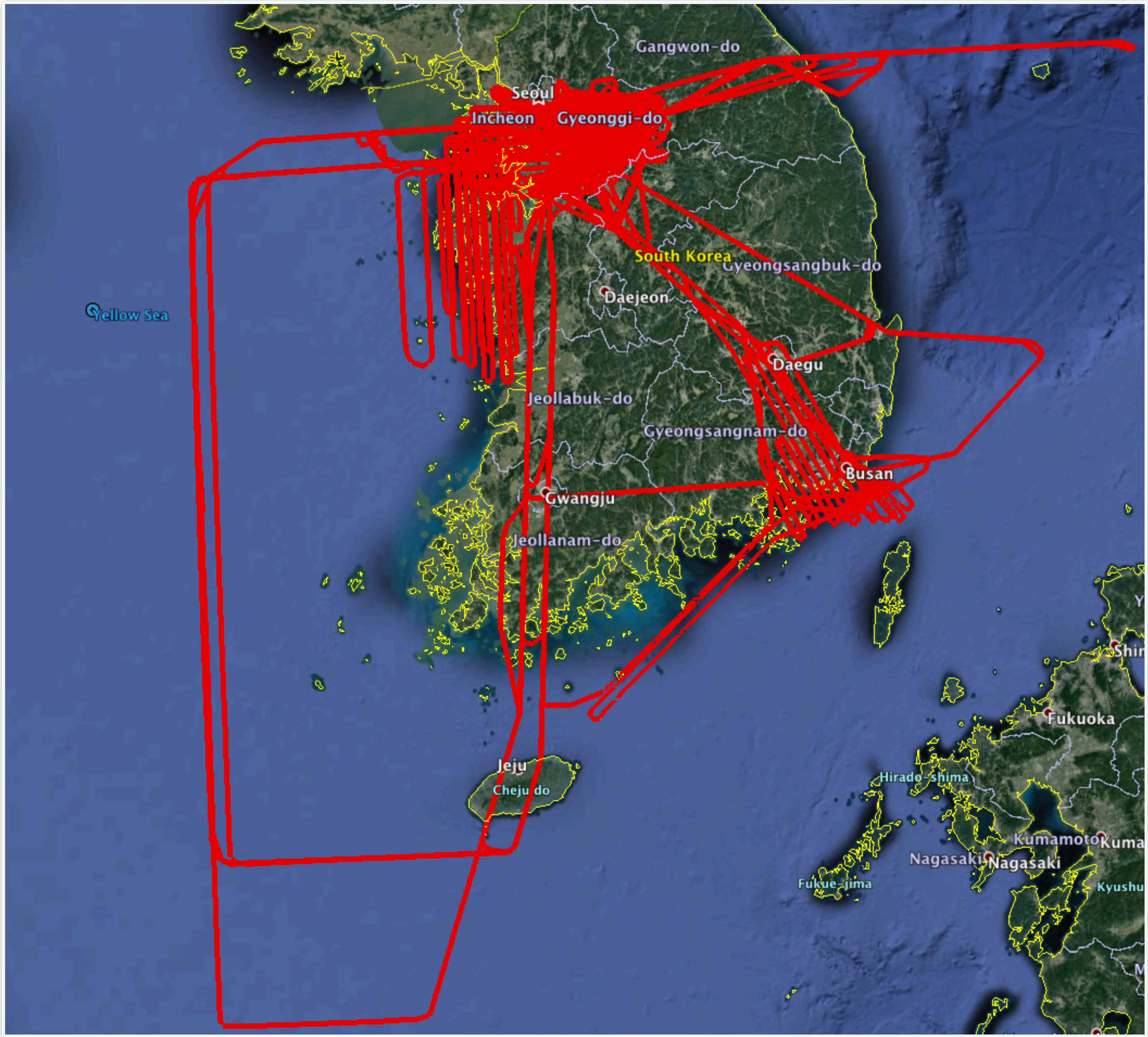
Processing and Data Sets

MOS-P - GEOTASO; Data Set Conventions; Processing Levels; Tools, Products, Issues; Web Page

KING AIR UC12 kmz flight paths at: https://www-air.larc.nasa.gov/missions/korus-aq/

King Air Over Flights





East Coast/Sea
Blooms
Onnuari
25 May AM
(Donghae/ Ulleung)

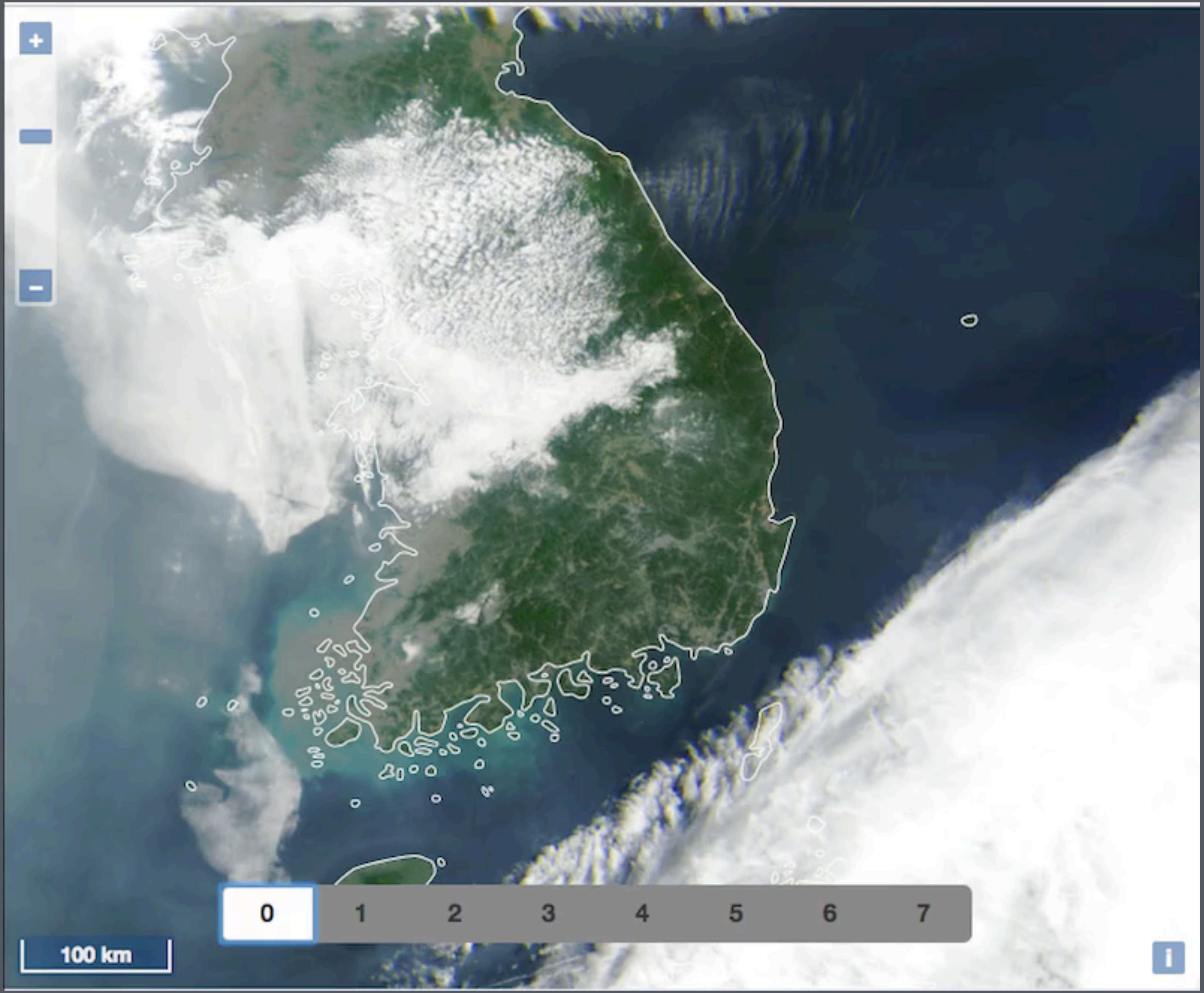
West
Mud Flats
Onnuari
30 May
(Han/Incheon/ Seoul)

South East
Upwelling
(Busan)

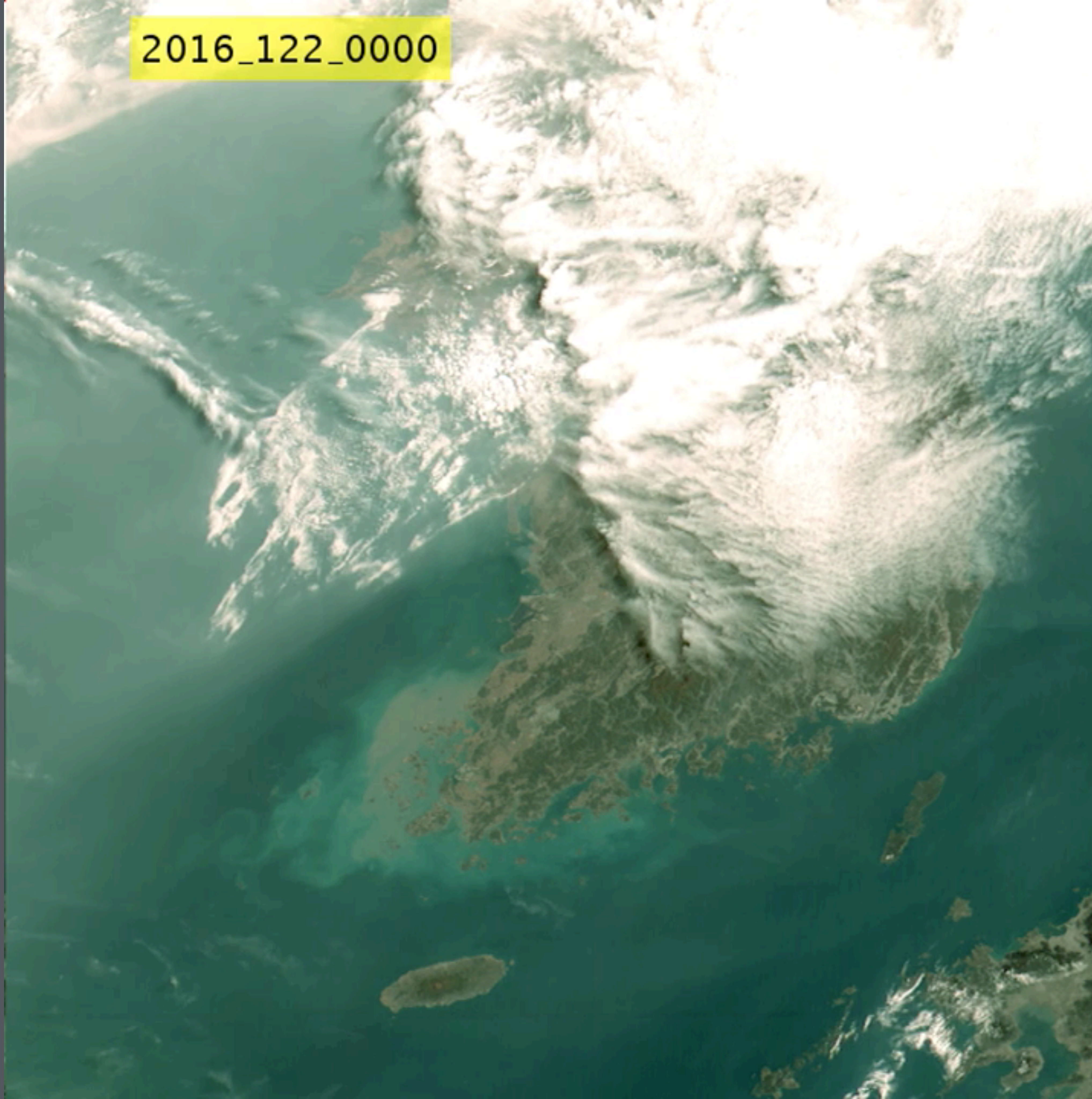
South West
Tidal Flows
(Jindo)

South
Aquaculture, Seaweed
(Jeju)

Daily Visibility from GOCI: East Sea 25 May 2016

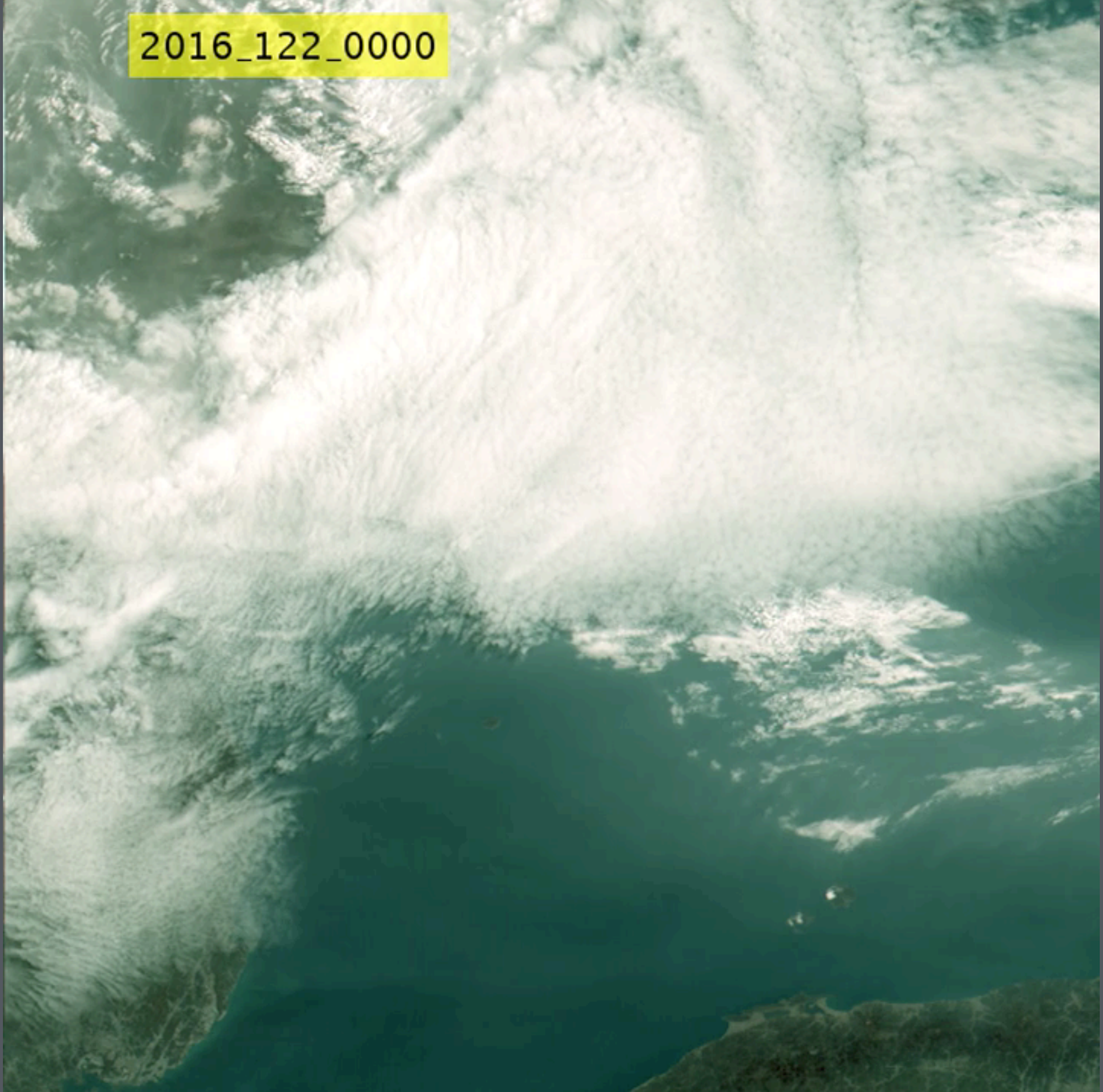


Korea Movie May 2016
Clear Days 125, 138 ...



Day 122 - 1 May : Day 152 - 31 May
Time: GMT - KST GMT + 9

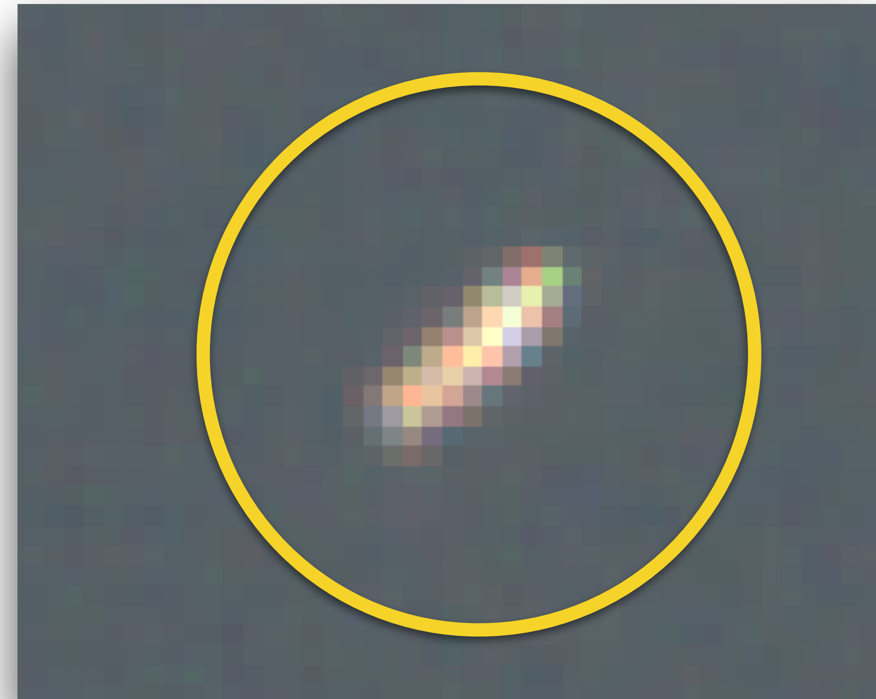
East Sea Movie May 2016
Day 149 - 25 May 2016
Onnuri Overpass

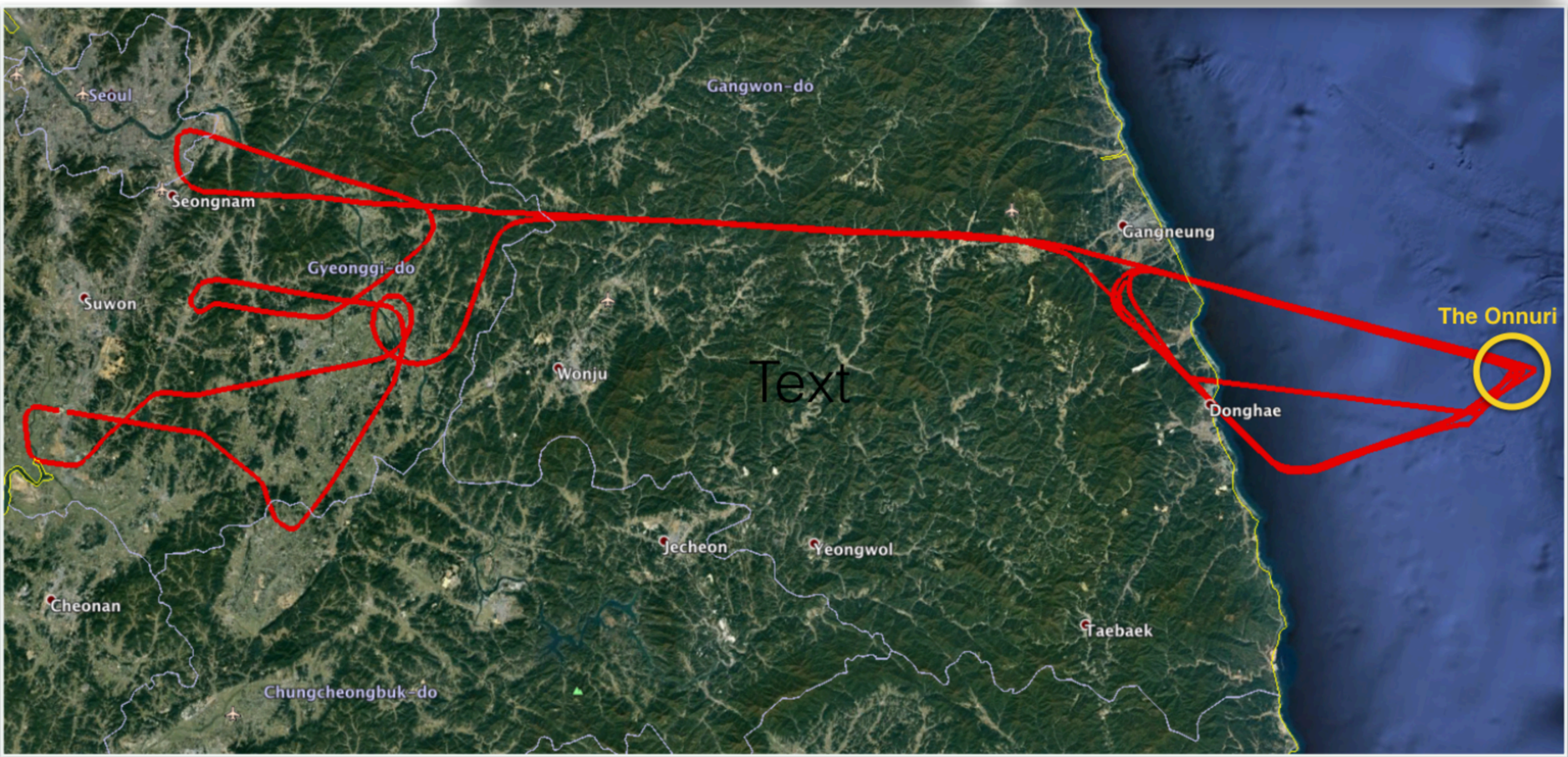


Day 122 - 1 May : Day 152 - 31 May
Time: GMT - KST GMT + 9

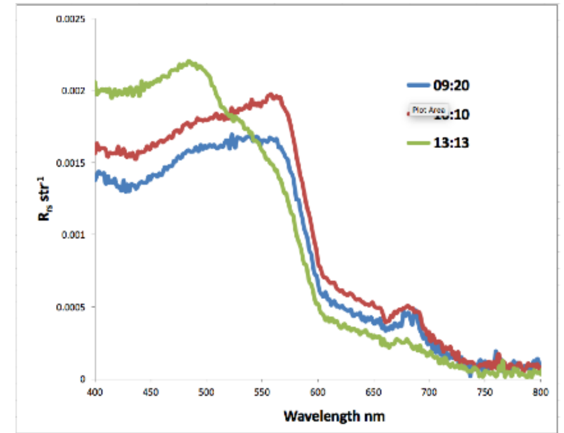
R/V Onnuri Overpass
East Coast - 25 May 2016

Context Camera
Glint
Flight Path





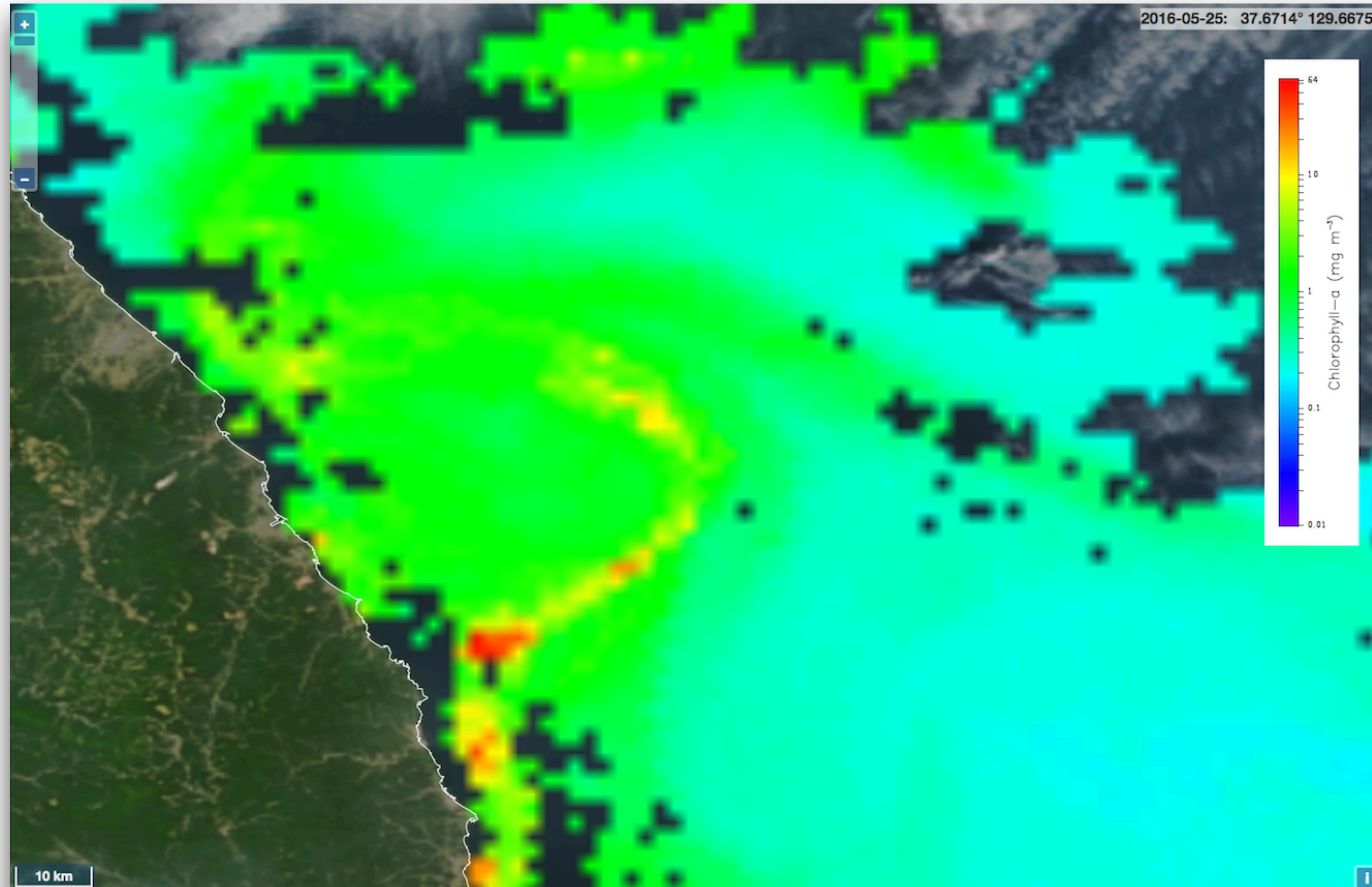
VIIRS CHL MAP AROUND ONNURI
East Coast - 25 May 2016



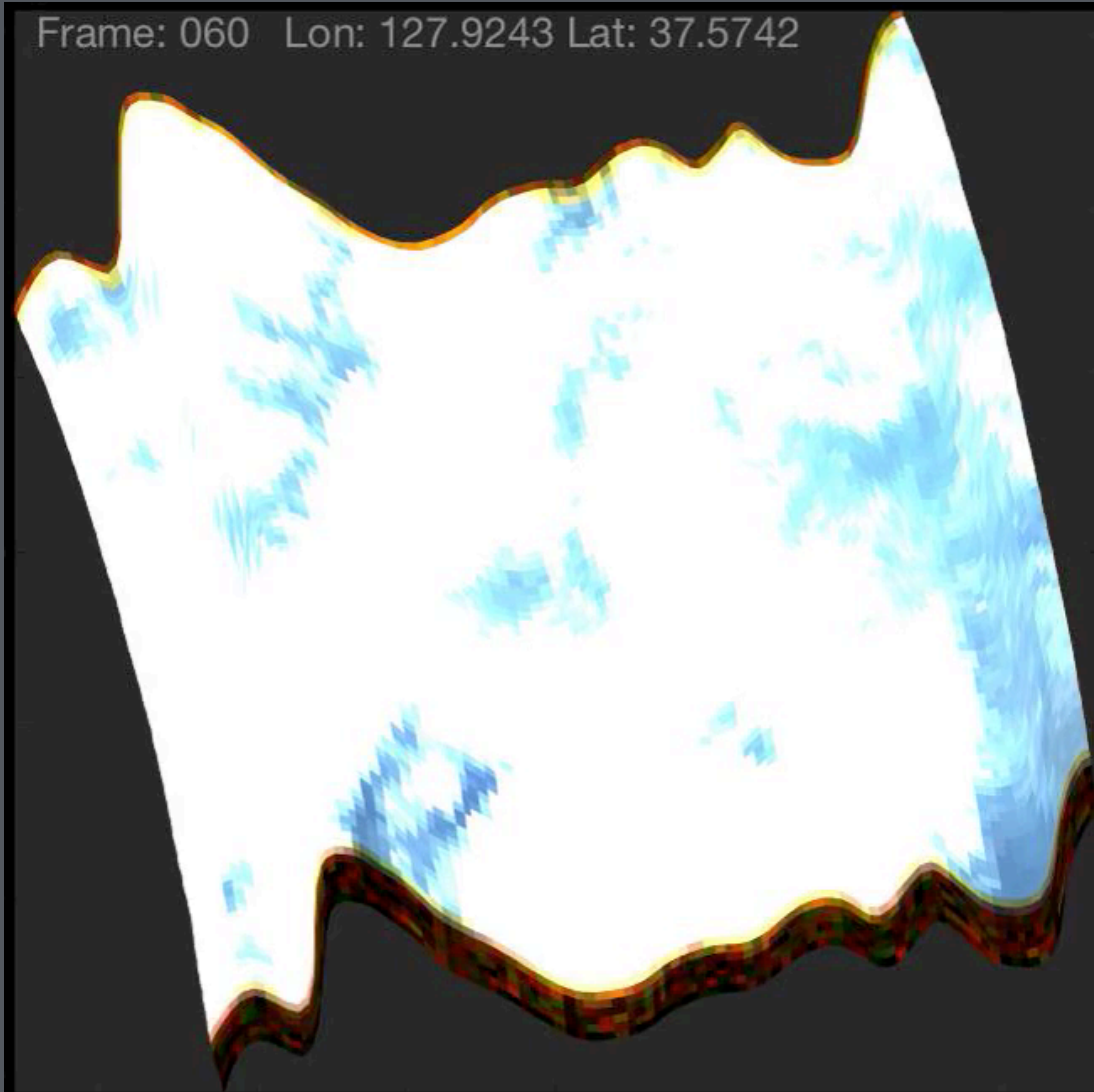
R/V Onnuri Positions

Time	Lat	Lon
5.5	37.6908	129.8021
7.5	37.7046	129.7836
9.3	37.6711	129.6670
9.7	37.6711	129.6670
10.17	37.6711	129.6670
12.22	37.7722	129.6417
15.5	37.8198	129.6028
18	37.8339	129.5406

Boat Data From Steve Ackleson, NRL



MOS-P Overflight
25 May 2016 AM



Frames:
Onnuri: 149,204, 254. Coast: 86, 135, 184, 235. Blue Roof: 73.

MOS-P Overflight

Frame 149: 25 May 2016 AM Time 10:12 KST

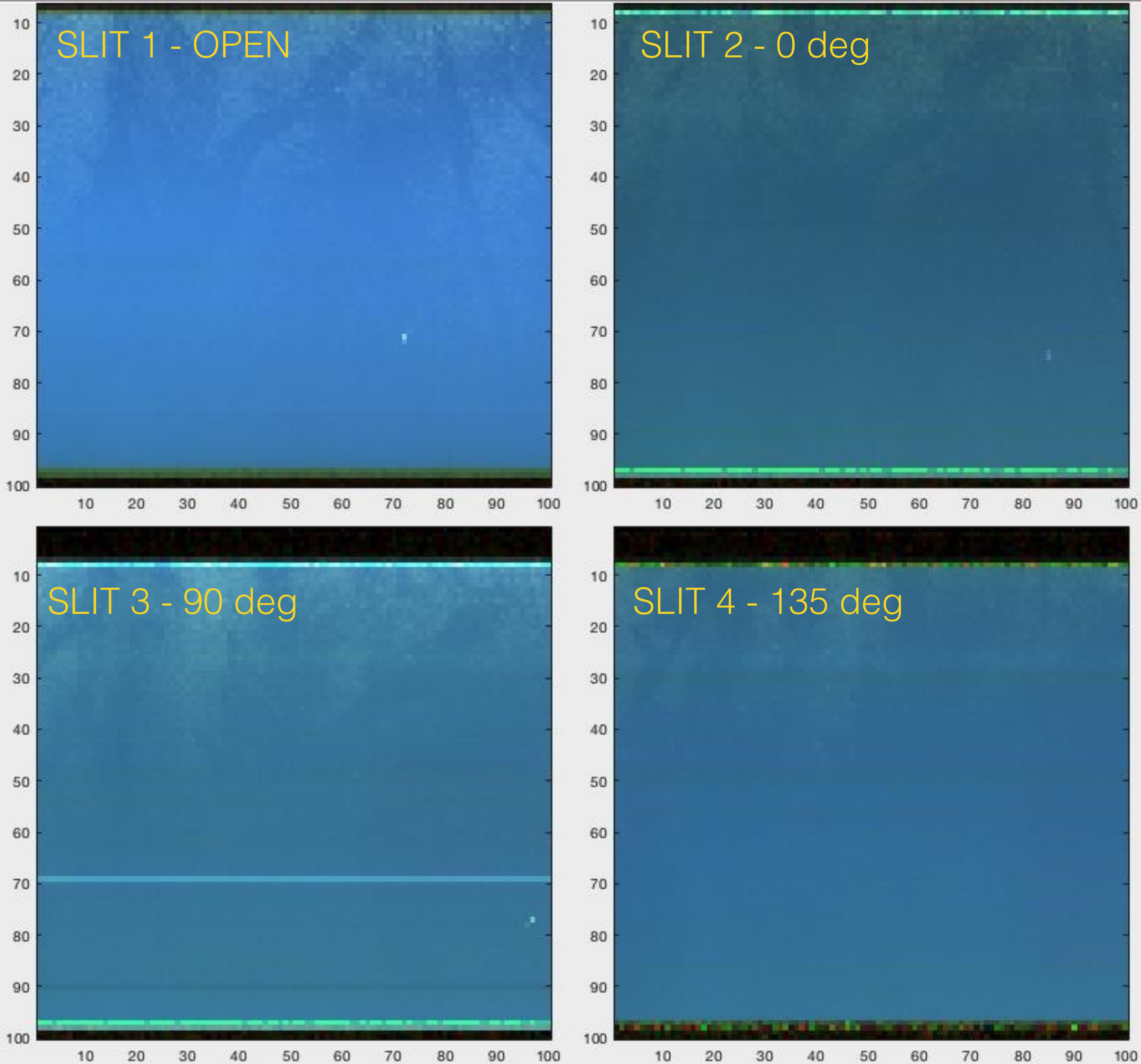


Image: 149 ITOW: 263549.9 Time: 738292349.9 UTC: 20160525T011229.854Z

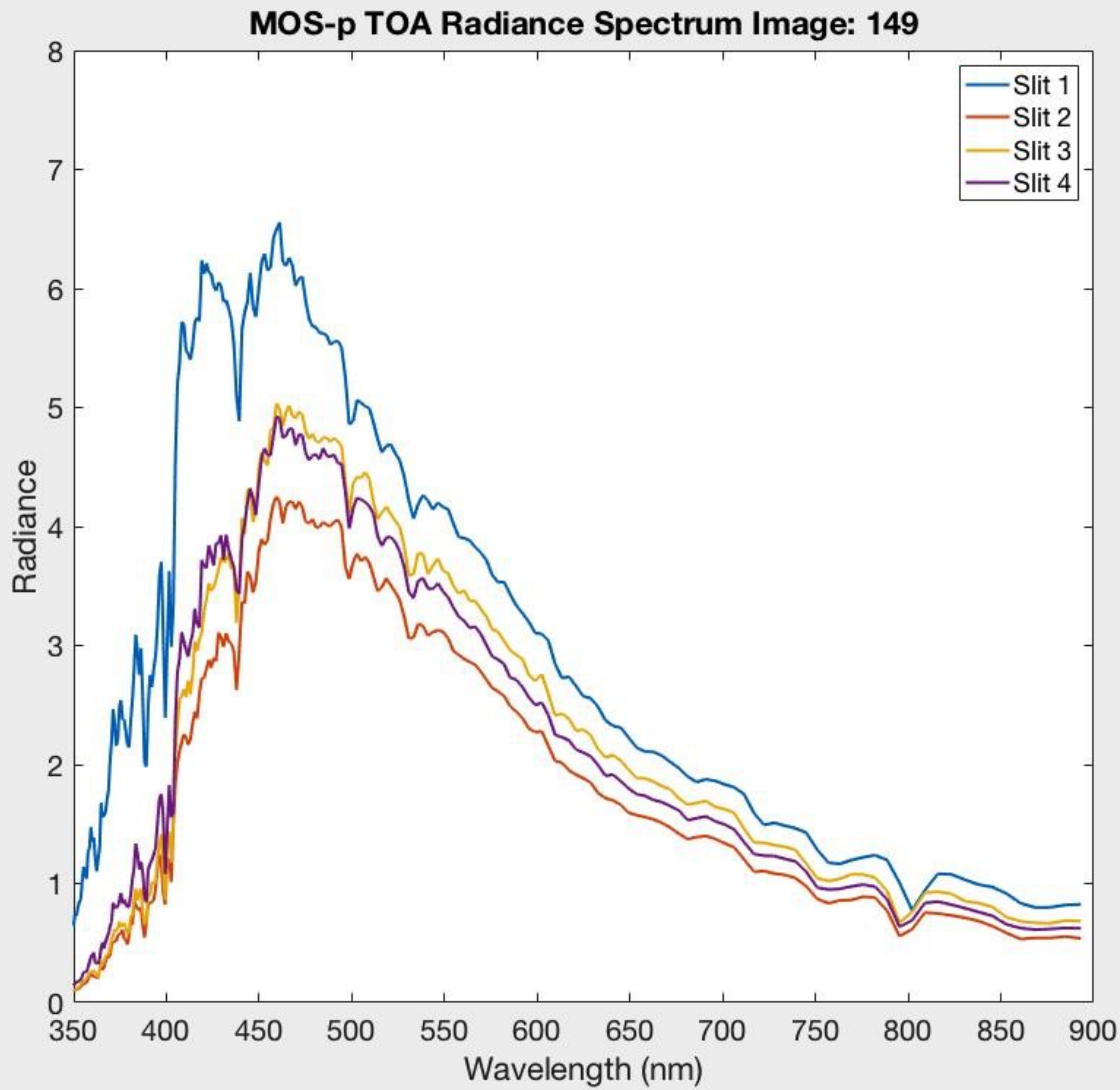
Altitude: 7579 Lat: 37.671 Lon: 129.650

Radiance: 1.8064 3.4711 4.5141

Image at FPA - Focal Plane Array

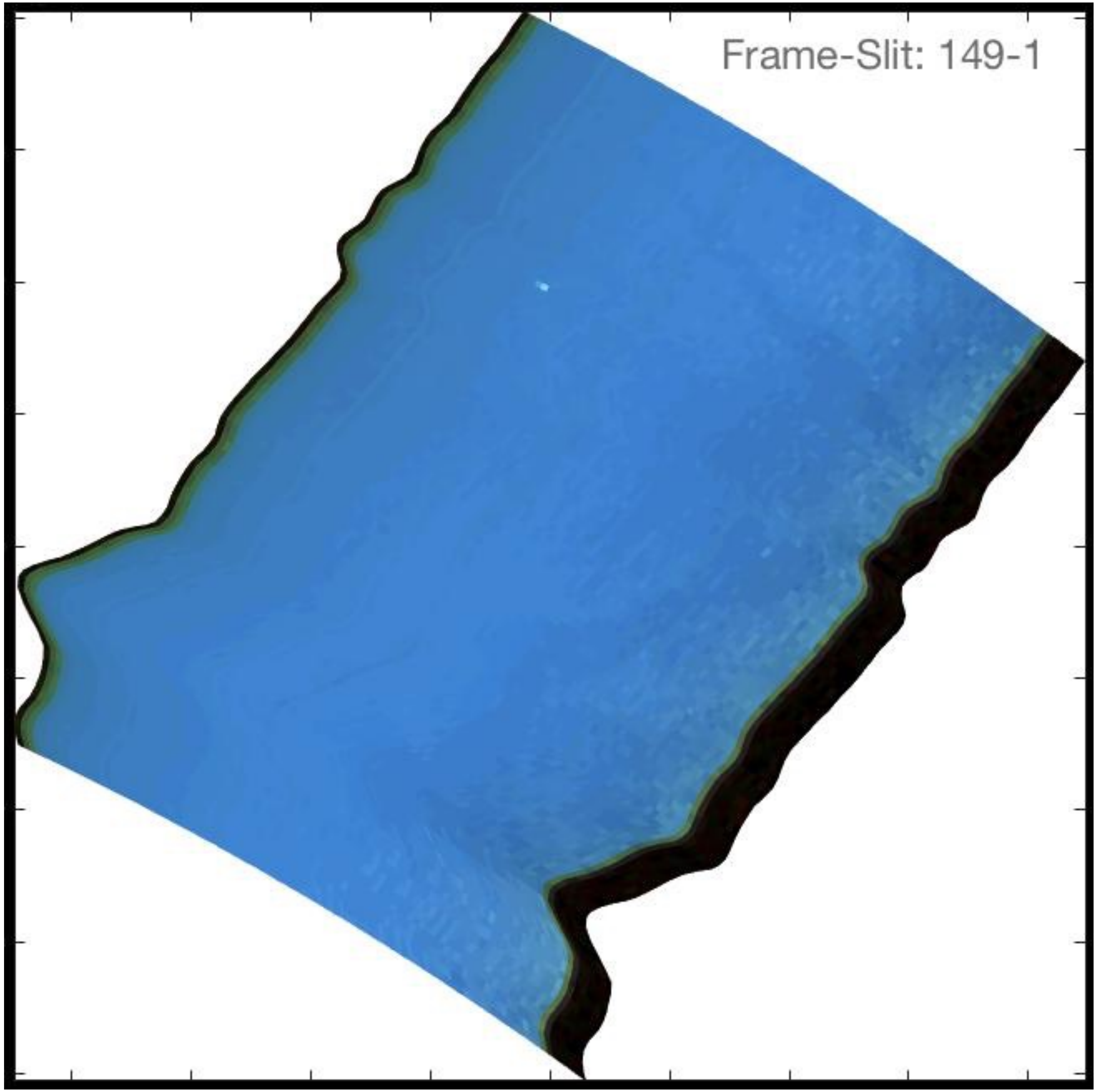
Onnuri is 'white dot' in Slit-1

Horizontal Stripe in Slit-3 is FPA defect (in all data)



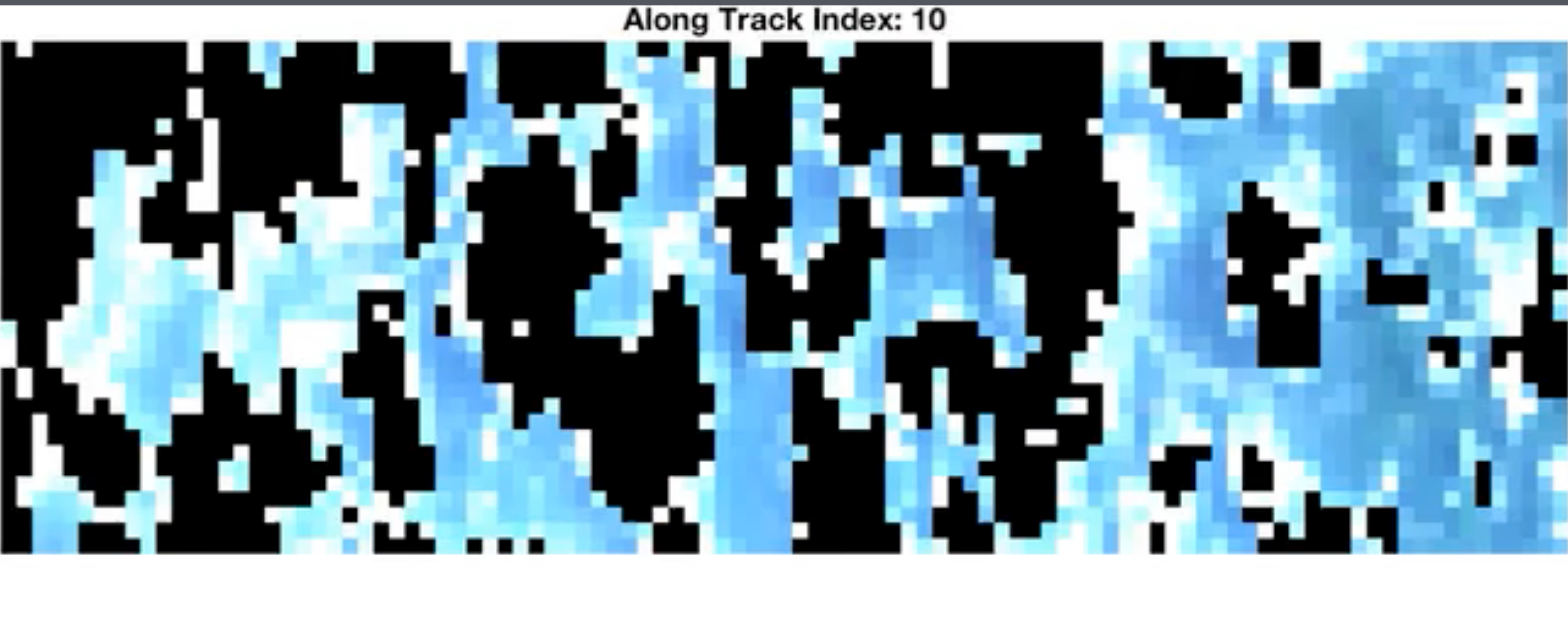
MOS-P Spectra at Plane (L1b)
Frame 149: 25 May 2016 AM Time 10:12 KST

MOS-P Georectified Image using L1b RGB
Frame 149: 25 May 2016 AM Time 10:12 KST



Onnuri is 'white dot' at near top
Frame is 100 x 100 pixels

GeoTASO 25 May 2016 AM Flight
~ 250 m pixels L1b RGB



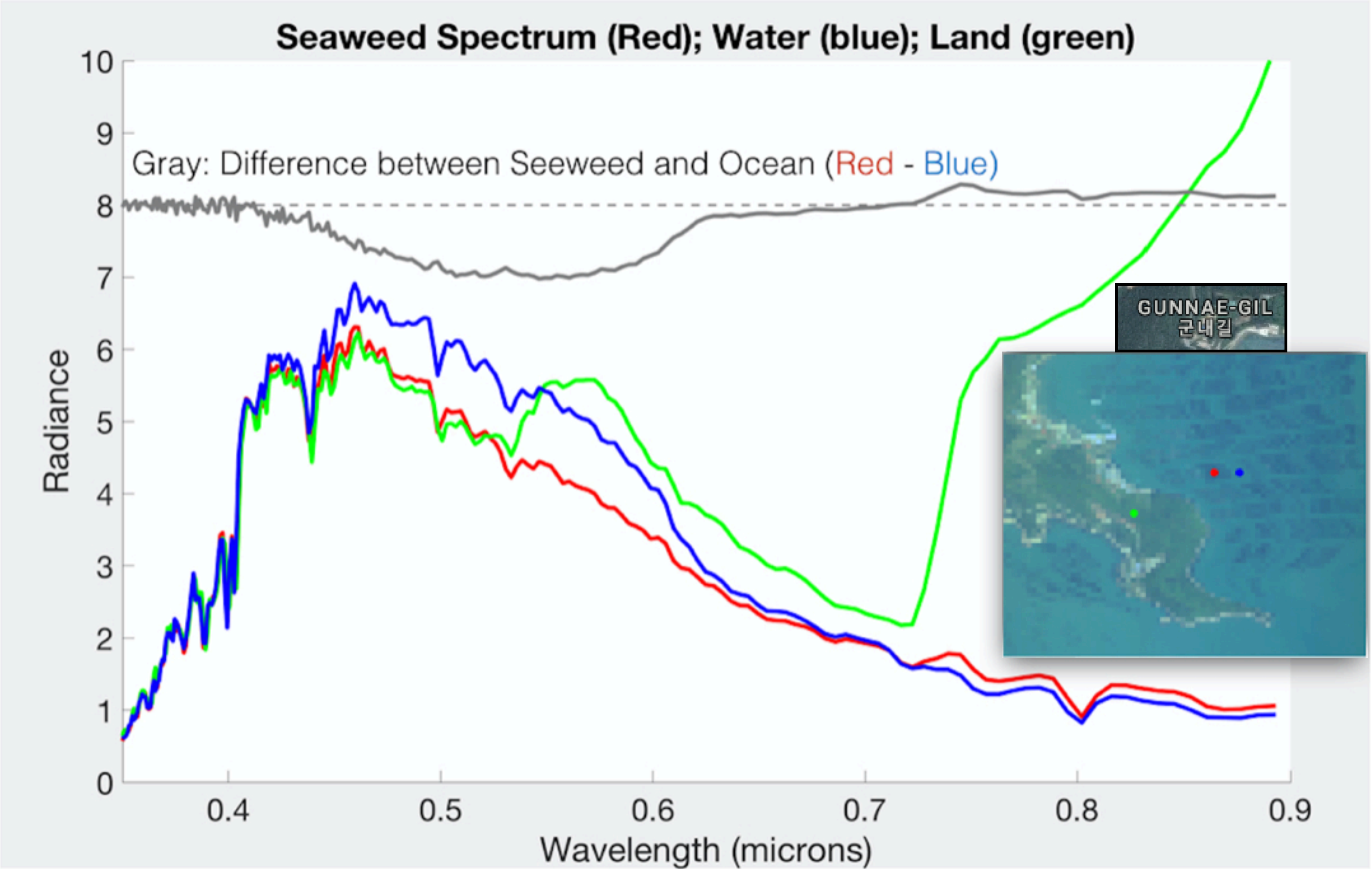


Figure 5. A MOS-P image taken on 29 April 2016 showing the spectral signature of a Seaweed Farm along the Southern most coast of South Korean. Seaweed beds are grown on ropes in shallow waters and provide 90% of the country's seaweed crop. Red Pixel - Seaweed; Blue - Open Ocean; Green - Land.

Flight Information

- Speed: ~100 - 120 m/s
- Altitude: ~ 7500 - 9000 m
- Instantaneous Field of View (IFOV)
    - MOS-P: ~0.013°
    - GEOTASO: ~0.044°

KORUS-OC Remote Sensory Variable Conventions

MOS-P

z	x	y	s	f
spectra	cross-track	along track	slit	frame number

GEOTASO

z	x	y	f
spectra	cross-track	along track	frame number

KORUS-OC Data Levels

	L0 native		L1 binned		L2 binned	
	MOS-P	GEOTASO	MOS-P (Ball)	GEOTASO (NASA)	MOS-P (OSU)	GEOTASO (OSU)
#z (nm)	1344 (330-925)	1056 (410-699): ~0.28	256 (330-925: ~1-8	1056 (410-699): ~0.28	64 (350-900: ~10)	64 (420-690: ~5)
#x (m)	2016 (~2)	1033 (~7)	2016 (~2)	33 (~250)	100 (~50)	33 (~250)
#y (m)	1 (~50)	1 (~25)	100 (~50)	# (~50)	100 (~50)	33 (~250)
t (s)	1/4	1/3	~2 1/2	~3 1/3	~2 1/2	~3 1/3

approximately square image

Data Formats
HDF5
ENVI Standard (binary data cubes with ascii header filers)

Products
CHL (OC4), TSS, nLw, Rrs, IOP's (QAA)
DOLP (Degree of Linear Polarization for MOS-P)

Complementary Data Sets
GOCI
VIIRS/MODIS
Him-8

Tools for searching, interpolating and displaying data
MATLAB

Data Samples: dp.homeunix.net/kor

Workshop discussions:

Preferred data bundling
Products
Sampling (z, x, y …)

Tools for searching, displaying data
Initial data matchups
…

Issues: Pixel based atmospheric corrections

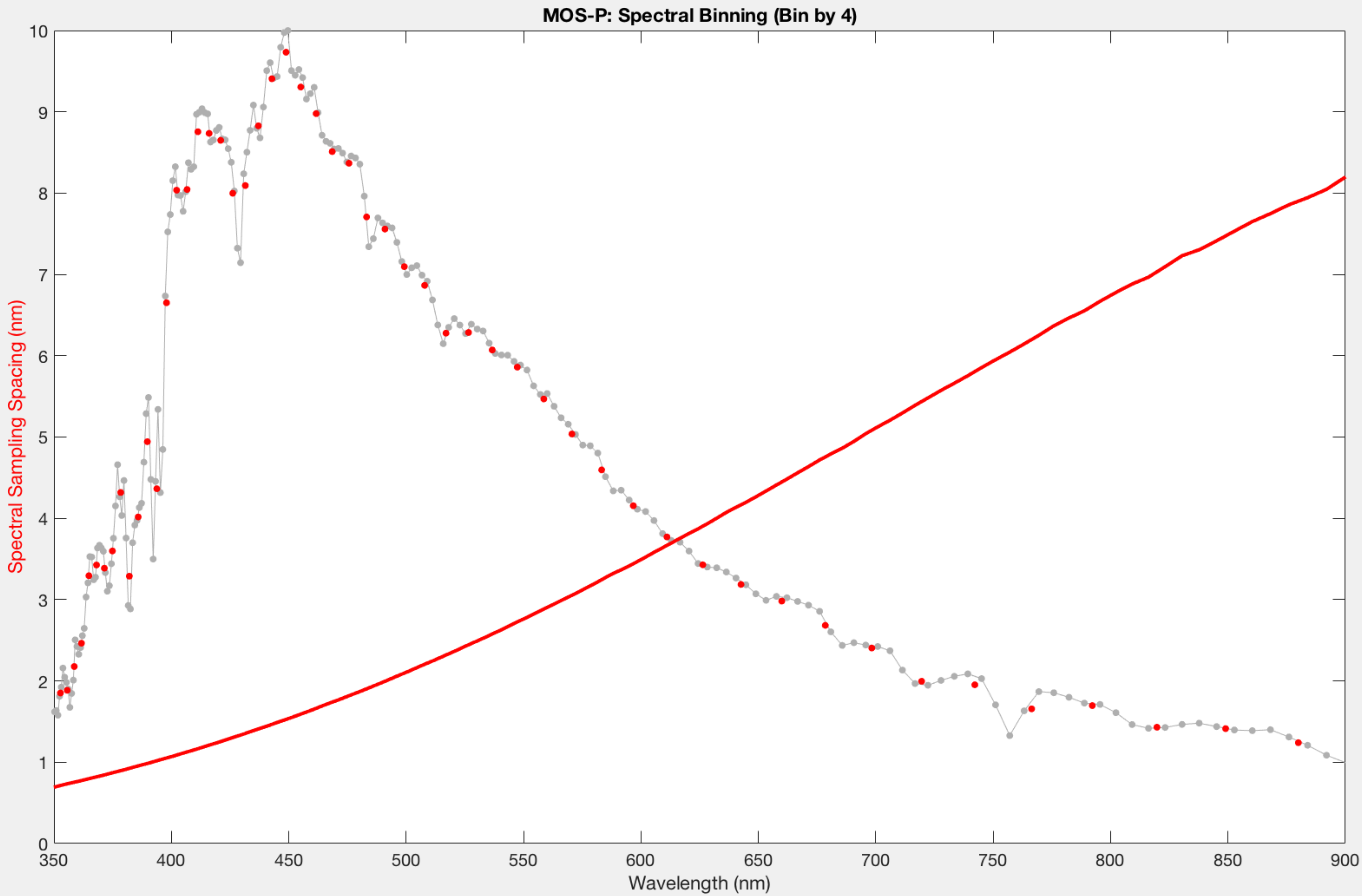
Use of GeoTASO for Atm. Corr. of Ocean Color
Use of Polarization for Glint Removal
Enhance SNR of Ocean Products
…

KORUS-OC Workshop - Remote Sensing Extra Slides

Discussion of Spectral Binning in MOS-P and GeoTASO

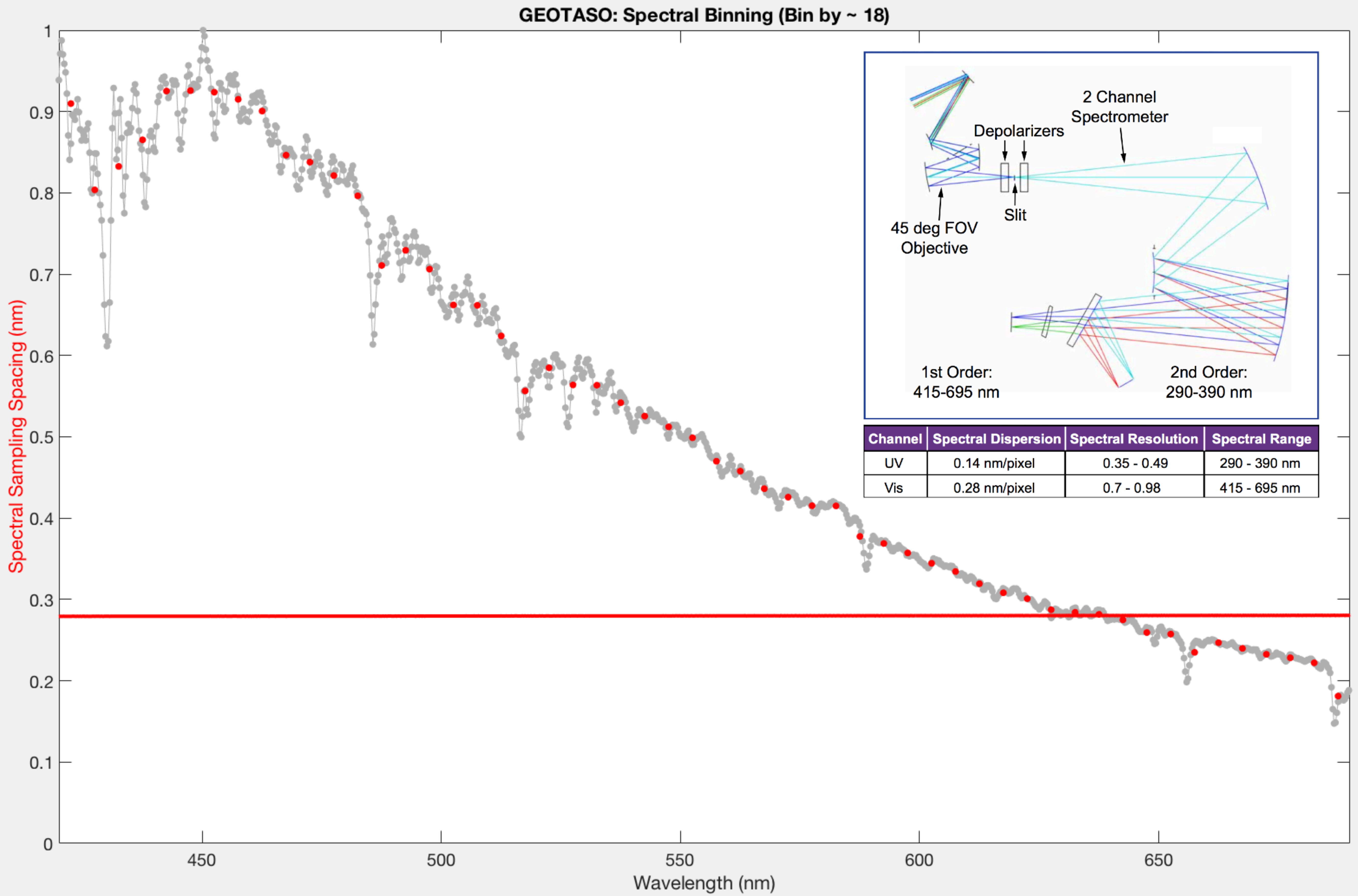
MOS-P Spectral Binning

(PRISM Spectrometer, Bin by 4, nominally 10 nm)



GeoTASO Spectral Binning

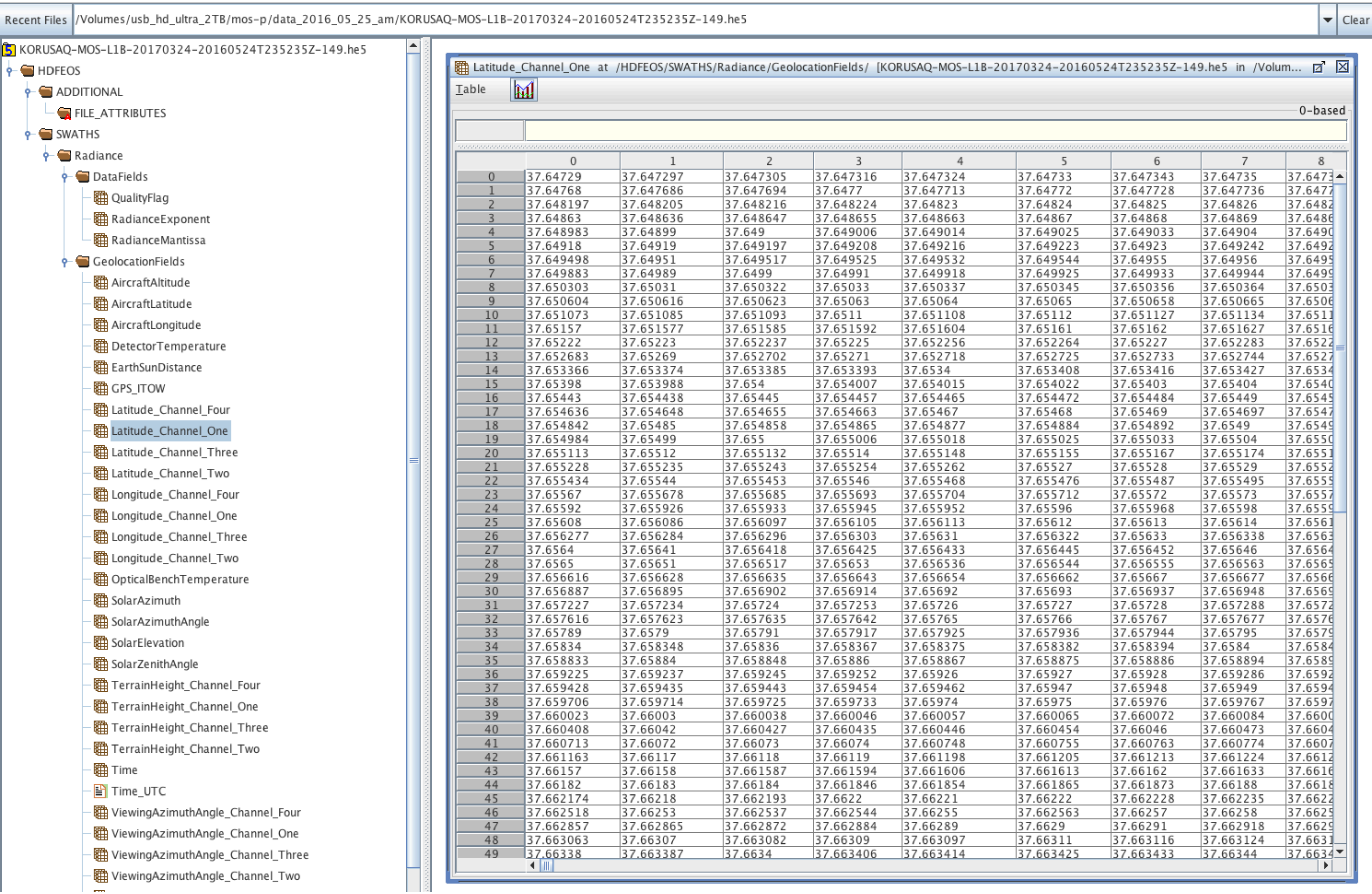
(Bin by 18, ~ 5 nm)



Channel	Spectral Dispersion	Spectral Resolution	Spectral Range
UV	0.14 nm/pixel	0.35 - 0.49	290 - 390 nm
Vis	0.28 nm/pixel	0.7 - 0.98	415 - 695 nm

Navigating MOS-P HDF Files

https://support.hdfgroup.org/products/java/hdfview/



	0	1	2	3	4	5	6	7	8
0	37.64729	37.647297	37.647305	37.647316	37.647324	37.64733	37.647343	37.64735	37.6473
1	37.64768	37.647686	37.647694	37.6477	37.647713	37.64772	37.647728	37.647736	37.6477
2	37.648197	37.648205	37.648216	37.648224	37.64823	37.64824	37.64825	37.64826	37.6482
3	37.64863	37.648636	37.648647	37.648655	37.648663	37.64867	37.64868	37.64869	37.6486
4	37.648983	37.64899	37.649	37.649006	37.649014	37.649025	37.649033	37.64904	37.6490
5	37.64918	37.64919	37.649197	37.649208	37.649216	37.649223	37.64923	37.649242	37.6492
6	37.649498	37.64951	37.649517	37.649525	37.649532	37.649544	37.64955	37.64956	37.6495
7	37.649883	37.64989	37.6499	37.64991	37.649918	37.649925	37.649933	37.649944	37.6499
8	37.650303	37.65031	37.650322	37.65033	37.650337	37.650345	37.650356	37.650364	37.6503
9	37.650604	37.650616	37.650623	37.65063	37.65064	37.65065	37.650658	37.650665	37.6506
10	37.651073	37.651085	37.651093	37.6511	37.651108	37.65112	37.651127	37.651134	37.6511
11	37.65157	37.651577	37.651585	37.651592	37.651604	37.65161	37.65162	37.651627	37.6516
12	37.65222	37.65223	37.652237	37.65225	37.652256	37.652264	37.65227	37.652283	37.6522
13	37.652683	37.65269	37.652702	37.65271	37.652718	37.652725	37.652733	37.652744	37.6527
14	37.653366	37.653374	37.653385	37.653393	37.6534	37.653408	37.653416	37.653427	37.6534
15	37.65398	37.653988	37.654	37.654007	37.654015	37.654022	37.65403	37.65404	37.6540
16	37.65443	37.654438	37.65445	37.654457	37.654465	37.654472	37.654484	37.65449	37.6545
17	37.654636	37.654648	37.654655	37.654663	37.65467	37.65468	37.65469	37.654697	37.6547
18	37.654842	37.65485	37.654858	37.654865	37.654877	37.654884	37.654892	37.6549	37.6549
19	37.654984	37.65499	37.655	37.655006	37.655018	37.655025	37.655033	37.65504	37.6550
20	37.655113	37.65512	37.655132	37.65514	37.655148	37.655155	37.655167	37.655174	37.6551
21	37.655228	37.655235	37.655243	37.655254	37.655262	37.65527	37.65528	37.65529	37.6552
22	37.655434	37.65544	37.655453	37.65546	37.655468	37.655476	37.655487	37.655495	37.6555
23	37.65567	37.655678	37.655685	37.655693	37.655704	37.655712	37.65572	37.65573	37.6557
24	37.65592	37.655926	37.655933	37.655945	37.655952	37.65596	37.655968	37.65598	37.6559
25	37.65608	37.656086	37.656097	37.656105	37.656113	37.65612	37.65613	37.65614	37.6561
26	37.656277	37.656284	37.656296	37.656303	37.65631	37.656322	37.65633	37.656338	37.6563
27	37.6564	37.65641	37.656418	37.656425	37.656433	37.656445	37.656452	37.65646	37.6564
28	37.6565	37.65651	37.656517	37.65653	37.656536	37.656544	37.656555	37.656563	37.6565
29	37.656616	37.656628	37.656635	37.656643	37.656654	37.656662	37.65667	37.656677	37.6566
30	37.656887	37.656895	37.656902	37.656914	37.65692	37.65693	37.656937	37.656948	37.6569
31	37.657227	37.657234	37.65724	37.657253	37.65726	37.65727	37.65728	37.657288	37.6572
32	37.657616	37.657623	37.657635	37.657642	37.65765	37.65766	37.65767	37.657677	37.6576
33	37.65789	37.6579	37.65791	37.657917	37.657925	37.657936	37.657944	37.65795	37.6579
34	37.65834	37.658348	37.65836	37.658367	37.658375	37.658382	37.658394	37.6584	37.6584
35	37.658833	37.65884	37.658848	37.65886	37.658867	37.658875	37.658886	37.658894	37.6589
36	37.659225	37.659237	37.659245	37.659252	37.65926	37.65927	37.65928	37.659286	37.6592
37	37.659428	37.659435	37.659443	37.659454	37.659462	37.65947	37.65948	37.65949	37.6594
38	37.659706	37.659714	37.659725	37.659733	37.65974	37.65975	37.65976	37.659767	37.6597
39	37.660023	37.66003	37.660038	37.660046	37.660057	37.660065	37.660072	37.660084	37.6600
40	37.660408	37.66042	37.660427	37.660435	37.660446	37.660454	37.66046	37.660473	37.6604
41	37.660713	37.66072	37.66073	37.66074	37.660748	37.660755	37.660763	37.660774	37.6607
42	37.661163	37.66117	37.66118	37.66119	37.661198	37.661205	37.661213	37.661224	37.6612
43	37.66157	37.66158	37.661587	37.661594	37.661606	37.661613	37.66162	37.661633	37.6616
44	37.66182	37.66183	37.66184	37.661846	37.661854	37.661865	37.661873	37.66188	37.6618
45	37.662174	37.66218	37.662193	37.6622	37.66221	37.66222	37.662228	37.662235	37.6622
46	37.662518	37.66253	37.662537	37.662544	37.66255	37.662563	37.66257	37.66258	37.6625
47	37.662857	37.662865	37.662872	37.662884	37.66289	37.6629	37.66291	37.662918	37.6629
48	37.663063	37.66307	37.663082	37.66309	37.663097	37.66311	37.663116	37.663124	37.6631
49	37.66338	37.663387	37.6634	37.663406	37.663414	37.663425	37.663433	37.66344	37.6634

Modeling polarized solar radiation from the ocean–atmosphere system for CLARREO inter-calibration applications

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[2]NASA Langley Research Center, Hampton, VA, 23681, USA

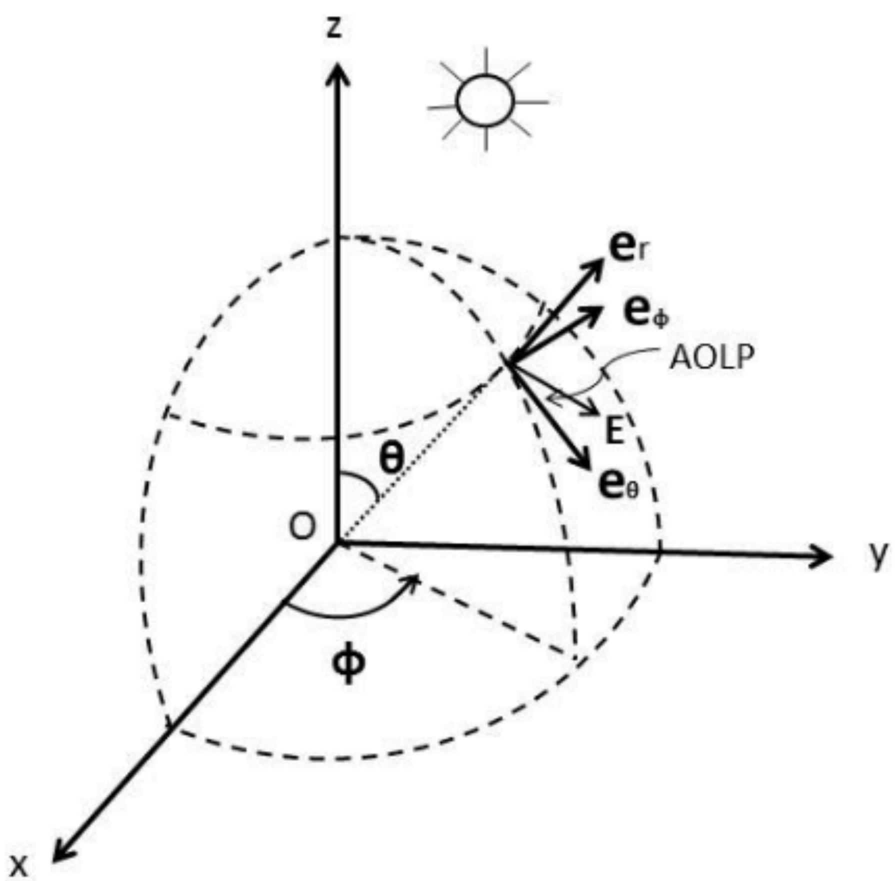

Fig. 1. Geometry of light's reflection in the ocean–atmosphere system.

time. It is well known that any arbitrarily polarized incoherent radiation denoted by Stokes parameters I, Q, U, and V can be represented by a sum of an unpolarized part and a 100 % polarized part as

$$\begin{bmatrix} I \\ Q \\ U \\ V \end{bmatrix} = \begin{bmatrix} I-\sqrt{Q^2+U^2+V^2} \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} \sqrt{Q^2+U^2+V^2} \\ Q \\ U \\ V \end{bmatrix}. \quad (2)$$

Since the circularly polarized radiance from the ocean–atmosphere system is negligible ($V \approx 0$) (Coulson, 1988), only the total radiance I and linearly polarized radiance Q and U need to be calculated in this study. Without considering the circularly polarized radiance ($V \approx 0$) at TOA, the DOP and AOLP are defined in terms of Stokes parameters, respectively, as

$$\mathrm{DOP} = \frac{\sqrt{Q^2+U^2}}{I} \quad (3)$$

and

$$\mathrm{AOLP} = \frac{1}{2}\tan^{-1}\left(\frac{U}{Q}\right) + \alpha_0, \quad (4)$$

where $\alpha_0 = 0°$ if $Q > 0$ and $U \geq 0$; $\alpha_0 = 180°$ if $Q > 0$ and $U < 0$; $\alpha_0 = 90°$ if $Q \leq 0$. The physical meaning of AOLP is illustrated in Fig. 1. When both DOP and AOLP of the radiance are known, the sensor-measured intensity counts of light can be expressed as

$$C_\mathrm{m} = G_0 \cdot (1 - DOP) \cdot I + G_\mathrm{p}(\mathrm{AOLP}) \cdot \mathrm{DOP} \cdot I, \quad (5)$$

Coulson, K. L.: Polarization and Intensity of Light in the Atmosphere, A. Deepak, Hampton, VA, 1988.