Adding VIIRS HDF5 SDR (L1B) Import Ability to MSL12

Documented by Lide Jiang, Dec.20, 2010

I. VIIRS Proxy Data

The VIIRS Proxy Data were obtained from GRAVITE Data Portal on CasaNOSA through GTP client. For data types available on GTP, one can refer to GRAVITE Data Type Descriptions.

Data types used for test and validation in this MSL12 modification effort include "L1B1KM_AQUA" and "L1BGEO_AQUA" as MODIS-AQUA L1B and Geolocation data; "SVM??_AQUA" (?? from 01~16) and "GMODO_AQUA" as VIIRS SDR and Geolocation data.

The MODIS-L1B files on GTP were generated real-time from L0 granules using MODISL1DB. VIIRS proxy data were produced by mapping MODIS band to VIIRS band:

VIIRS Proxy SDR Band	MODIS L1B Band	MODIS L1B SDS: Array Index
M1	8	1 km Reflective: 0
M2	9	1 km Reflective: 1
M3	3	500m: 0
M4	4	500m: 1
M5	1	250m: 0
M6	15	1 km Reflective: 9
M7	2	250m: 1
M8	5	500m: 2
M9	26	1 km Reflective: 14
M10	6(Terra), or 7(Aqua)	500m: 3(Terra), or 500m: 4(Aqua)
M11	7	500m: 4
M12	20	1km Emissive: 0
M13	22	1km Emissive: 2
M14	29	1km Emissive: 9
M15	31	1km Emissive: 11
M16	32	1km Emissive: 12
I1	1	250m: 0
I2	2	250m: 1
I3	6(Terra), or 7(Aqua)	500m: 3(Terra), or 500m: 4(Aqua)
I4	20	1km Emissive: 0
I5	31	1km Emissive: 11
DNB		

In addition, spatial interpolation is also necessary in the production of the VIIRS proxy data. Swath-by-swath, MODIS data is fed into the algorithm. The coordinates for each pixel of the VIRS proxy data is then determined by bilinear interpolation or nearest neighbor.

II. Code Modification

According to the "NPOESS Common Data Format Control Book – External Volume III – SDR/TDR Formats" (Document Number: D34862-03, Revision: E), the VIIRS Sensor Data Records, or SDR are provided in HDF5 formats, with each SDR file contain just one band: there are 16 M-Band SDRs, 5 I-band SDRs, and 1 day&night band or DNB SDR. The previous version of MSL12 package does not have the ability to read HDF5 format files, nor does it handle multiple SDR files, since previous sensor L1B is a single file which consists of all the bands required for the L1 to L2 processing.

To add VIIRS SDR import ability to our MSL12 package, four files were added to the package: *l1_viirs_h5.h*, *l1_viirs_h5.c*, *h5_utils.h*, and *h5_utils.c*. Their usages are:

l1_viirs_h5.h: header for *l1_viirs_h5.c*, to include other headers and declare functions

l1_viirs_h5.c: functions to do the file I/O for VIIRS HDF5 SDR

h5_utils.h: header for *h5_utils.c*, to include other headers and declare functions

h5_utils.c: convenient functions for HDF5 file I/O to facilitate coding in *l1_viirs_h5.c*

Besides, several other files are modified to accommodate this change: *l1_io.c*, *l12_parms.h*, and *filehandle.h*, the changes are:

l1_io.c: add support for VIIRS SDR I/O

l12_parms.h: add sensor ID definition for VIIRS: #define VIIRS 6 (same as MODISA)

filehandle.h: add VIIRS info to file type definition, sensorName and sensorDir array.

Currently, after the VIIRS SDR are imported to the MSL12 program, the program recognizes the VIIRS data as if it were from MODIS-Aqua, because VIIRS is given the same sensor ID as MODIS-Aqua in *l12_parms.h*. This is done because currently there is no VIIRS-specific processing (such as atmospheric correction) in the program, and VIIRS sensor bears much resemblance to MODI-Aqua, and the most important reason is: we can compare the results from MODIS-Aqua L1B with those from Proxy VIIRS SDRs which were generated from MODIS-Aqua L1B data. Later on VIIRS will be definitely given a different sensor ID if VIIRS-specific

processing routines are coded in MSL12. Also, after VIIRS sensor file is made available, we need to update its location in sensorDir array in *filehandle.h*.

l1_viirs_h5.c is the major part of this effort. The code is based on *l1_modis_hdf_l1binput.c*. Major changes include replacing the old HDF4 I/O routines with HDF5 convenient functions defined in *h5_utils.c*. Also to read multiple input SDR, only one M-band SDR filename is passed as input parameter to the program, and the function openl1_viirs_h5() will search for and open all necessary files depending on what band is used to generate all the L2 product (including geo-location file) in the same directory as the input file, based on the time stamp string present in its name. readl1_viirs_h5() will read from all the opened files and closel1_viirs_h5() will close all the opened files.

For band mapping, the following table shows the 16 bands currently being used by MSL12 for processing MODIS Aqua L1B. Text in bold font shows the corresponding VIIRS proxy M-band SDRs that are generated using the MODIS-Aqua band. Note that only 10 MODIS bands made their way to VIIRS SDRs, while the rest 6 bands do not have corresponding VIIRS SDR files. However, since the current algorithm requires 16 bands, while VIIRS only have 9 bands to use (M1~M8, M10), some bands need to be duplicated to approximate the missing band. For example, VIIRS proxy M3 band is identical to MODIS 469nm band, and is also duplicated to be used as 488nm band, which does not have exact correspondence in VIIRS proxy SDRs. By referring to the 'Bindx' column and the sixth column (leftmost red column), one can see how the current band mapping is performed in *l1_viirs_h5.c*.

Bindx	Lamda	MODIS#	SDS Idx	VIIRS#			
0	**412**	**8**	**1km - 0**	**M1**	**M1**	**8**	**1km - 0**
1	**443**	**9**	**1km - 1**	**M2**	**M2**	**9**	**1km - 1**
2	**469**	**3**	**500m - 0**	**M3**	**M3**	**3**	**500m - 0**
3	488	10	1km - 2	N/A	M3	3	500m - 0
4	531	11	1km - 3	N/A	M4	4	500m - 1
5	551	12	1km - 4	N/A	M4	4	500m - 1
6	**555**	**4**	**500m - 1**	**M4**	**M4**	**4**	**500m - 1**
7	**645**	**1**	**250m - 0**	**M5**	**M5**	**1**	**250m - 0**
8	667	13	1km - 5&6	N/A	M5	1	250m - 0
9	678	14	1km - 7&8	N/A	M5	1	250m - 0
10	**748**	**15**	**1km - 9**	**M6**	**M6**	**15**	**1km - 9**
11	**859**	**2**	**250m - 1**	**M7**	**M7**	**2**	**250m - 1**
12	869	16	1km - 10	N/A	M7	2	250m - 1
13	**1240**	**5**	**500m - 2**	**M8**	**M8**	**5**	**500m - 2**
14	**1640**	**5**	**500m - 2**	**M8**	**M8**	**5**	**500m - 2**
15	**2130**	**7**	**500m - 4**	**M10&11**	**M10**	**7**	**500m - 4**

Table 1

III. Compiling and Linking

To build executables for the modified MSL12, one need to install HDF5-1.8 or later, and also ZLIB or SZLIB required by HDF5. Remember to include the include directories for HDF5, ZLIB and SZLIB after "-I" and library directories after "-L", and add -lhdf5 -lsz -lz during linking.

IV. Validation

To validate the current MSL12 program with added VIIRS capability, we perform several case studies to make comparisons between L2 files generated from MODIS-Aqua L1B and those generated from VIIRS proxy SDR. Note that since the mapping from MODIS-Aqua bands to proxy VIIRS M-bands is not total, we can only compare L2 products that involve exclusively the bands in bold fonts as listed in Table 1, since only these bands are identical in MODIS and VIIRS. The seven L2 products that can be compared are: nLw_412, nLw_443, nLw_469, nLw_555, nLw_645, nLw_748, and nLw_859. Chlorophyll-a concentration, K490 coefficient, and the rest of nLw products cannot be compared.

Also note that since NIR atmospheric correction algorithm uses 869nm, which does not have exact VIIRS M-band correspondence, it cannot be used for the case study. On the other hand, SWIR algorithm used 1240nm and 2130nm, both of which have exact VIIRS M-band correspondence, so it can be used in our comparisons. Besides, the polarization switch should be turn off in the input parameter file, because the polarization for VIIRS sensor has not been implemented in the current revision of MSL12 yet. Therefore, we want to process both MODIS and VIIRS data without polarization corrections.

V. Results

The following figures show comparison results using SWIR algorithm for atmospheric correction without performing polarization correction. No filtering were performed either.

1. China East Coast: 1) nLw_412

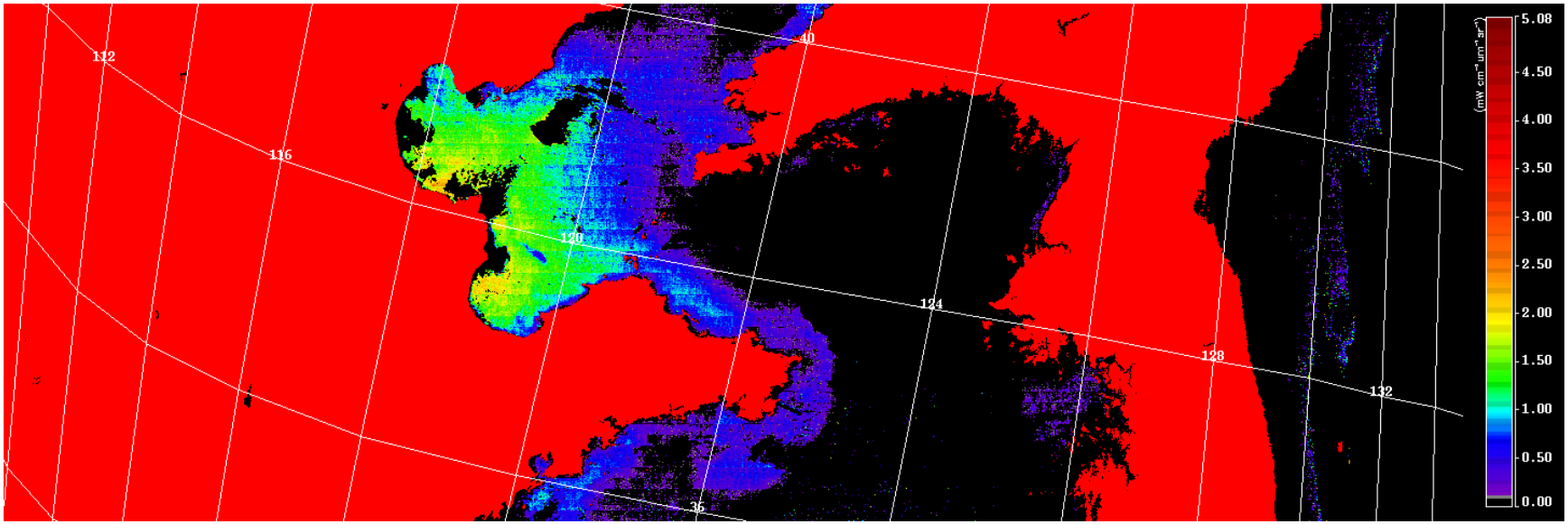

Figure 1-1a. MODIS-L1B

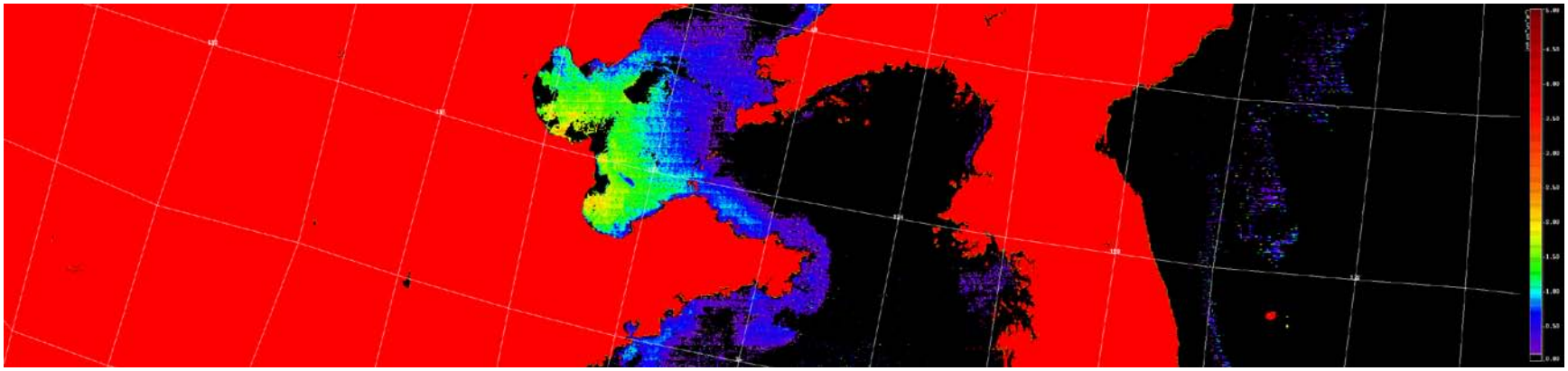

Figure 1-1b. VIIRS PROXY

2) nLw_443

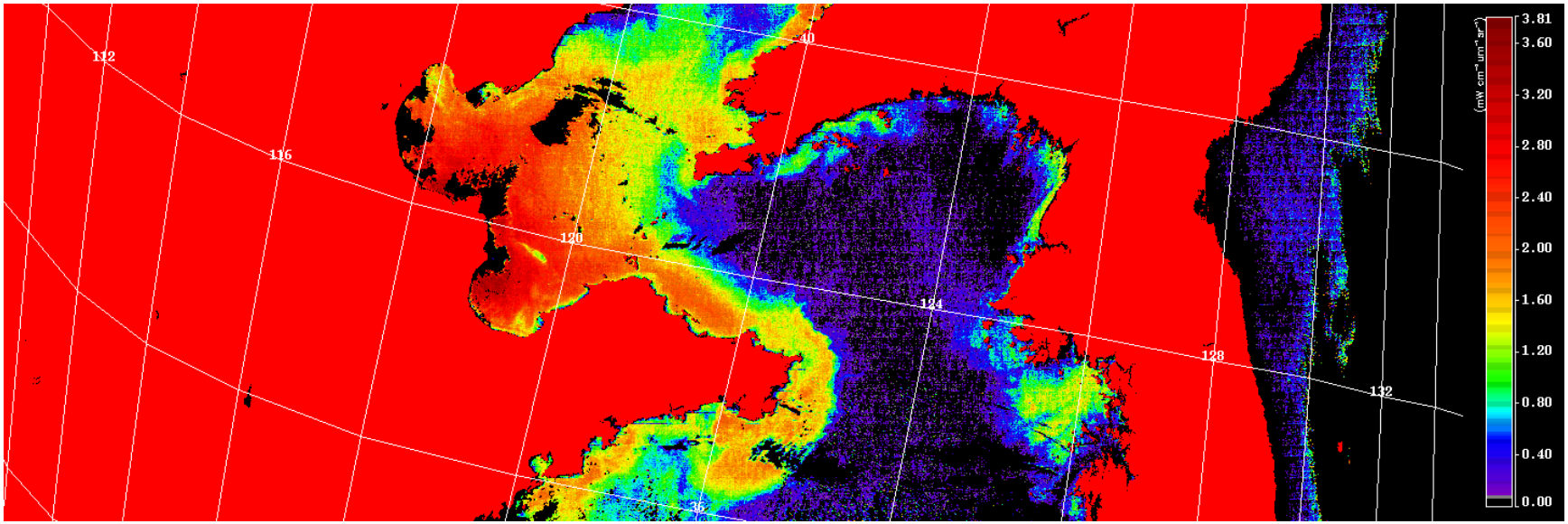

Figure 1-2a. MODIS-L1B

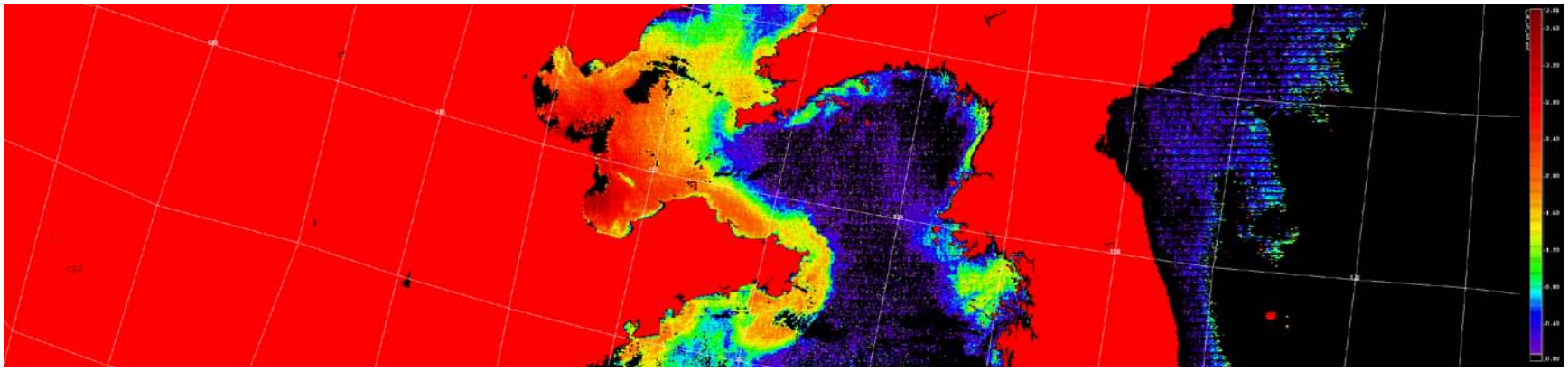

Figure 1-2b. VIIRS PROXY

3) nLw_469

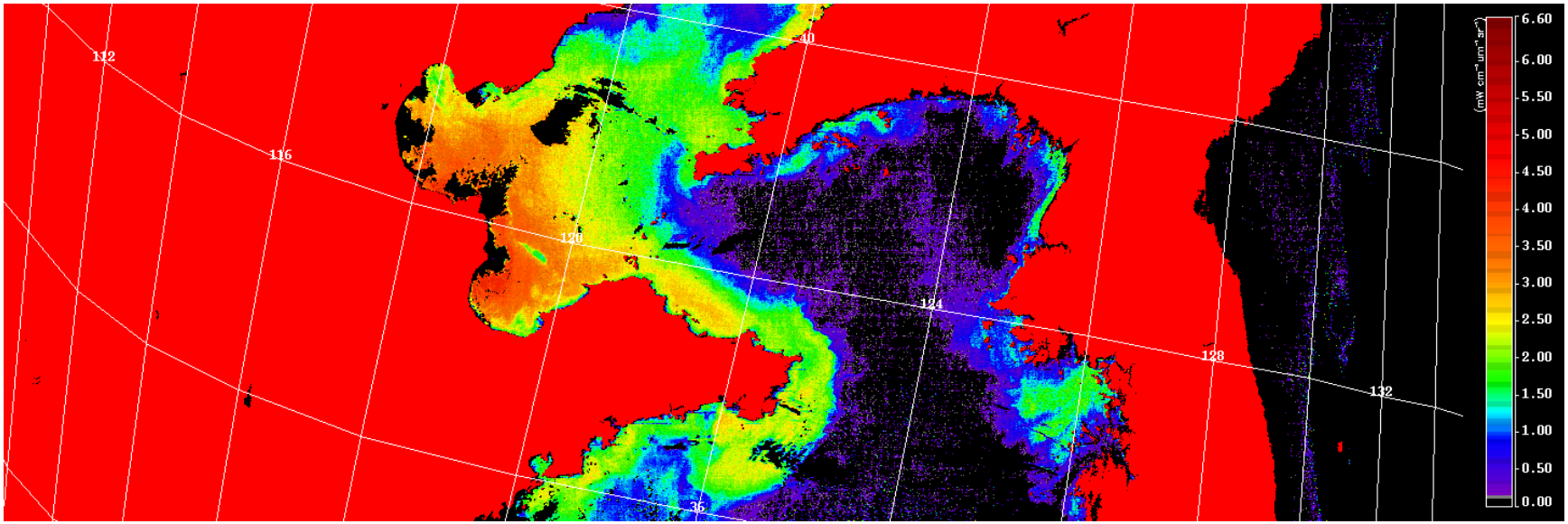

Figure 1-3a. MODIS-L1B

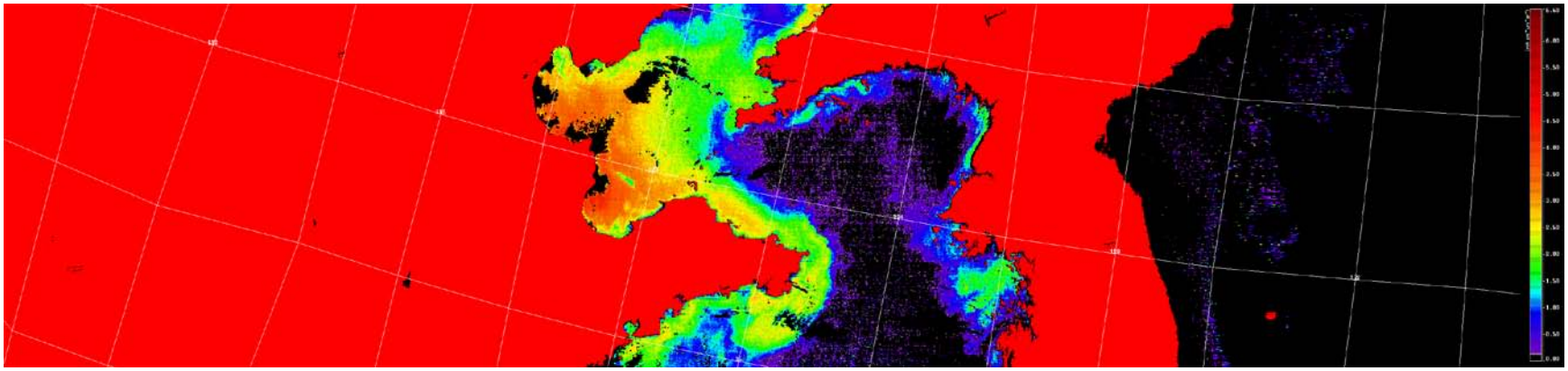

Figure 1-3b. VIIRS PROXY

4) nLw_555

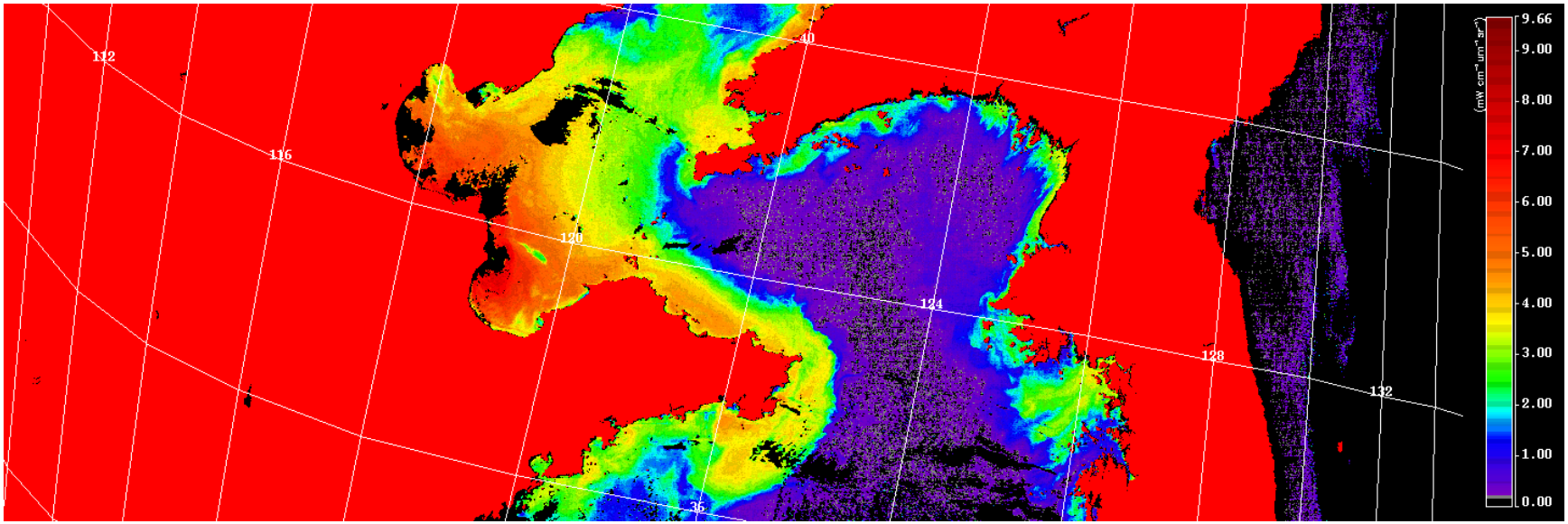

Figure 1-4a. MODIS-L1B

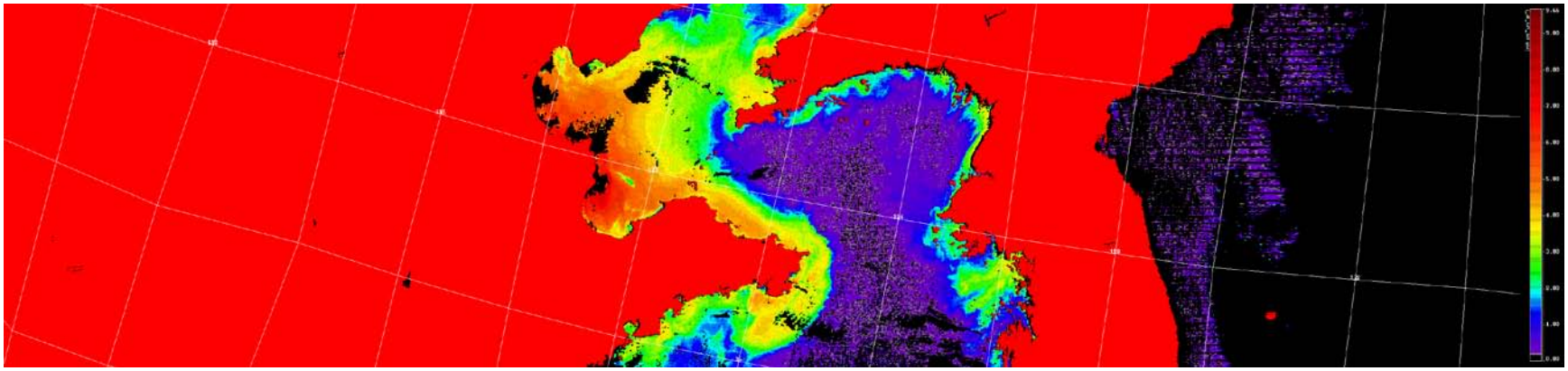

Figure 1-4b. VIIRS PROXY

5) nLw_645

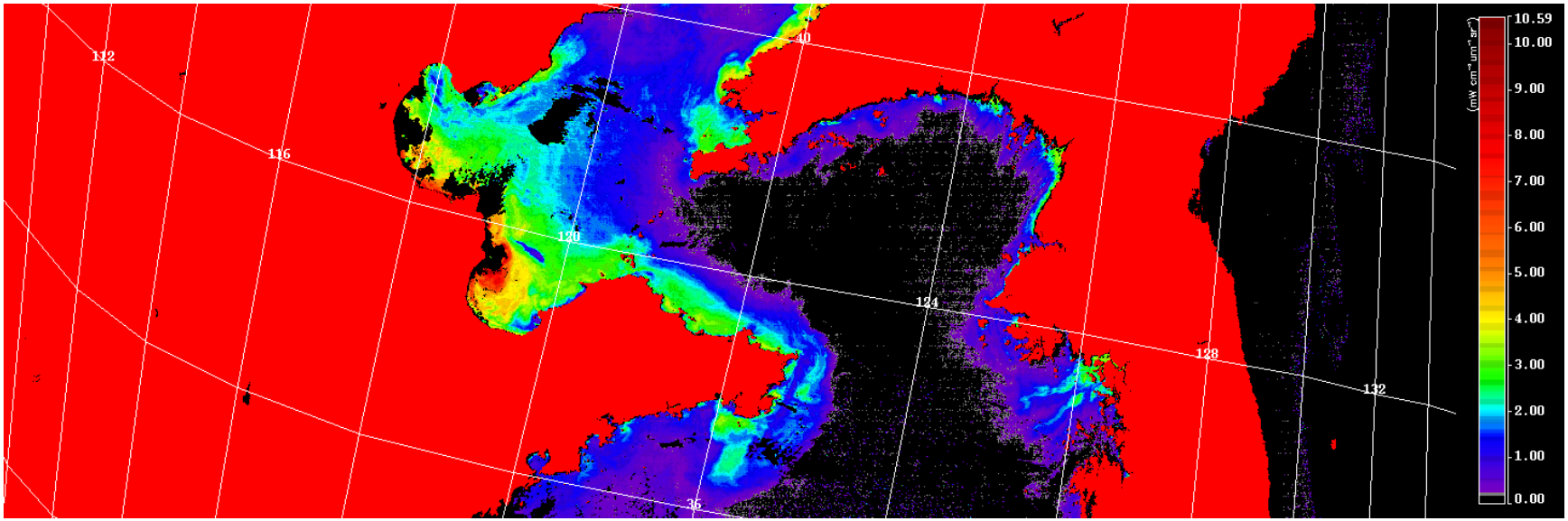

Figure 1-5a. MODIS-L1B

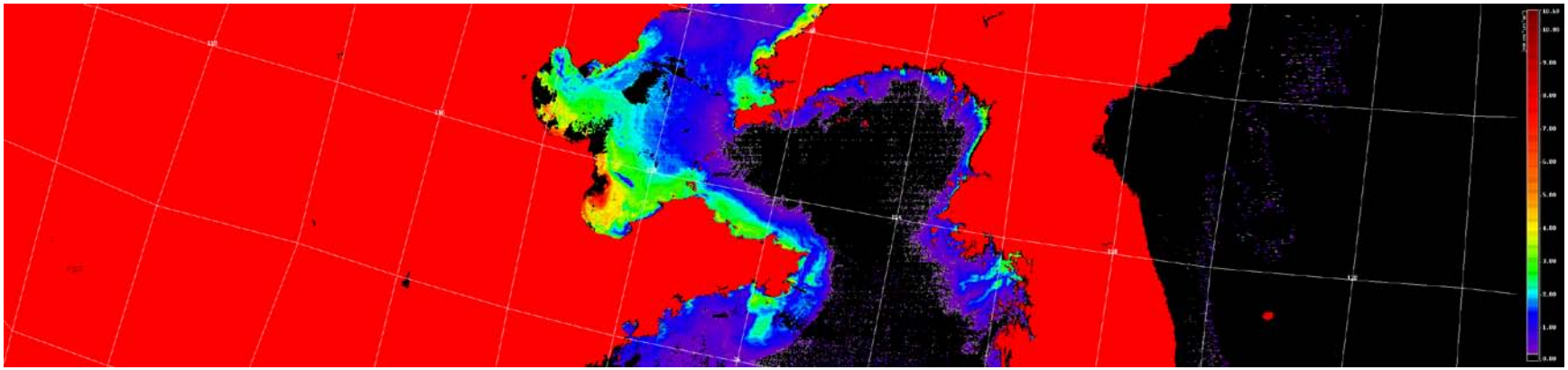

Figure 1-5b. VIIRS PROXY

6) nLw_748

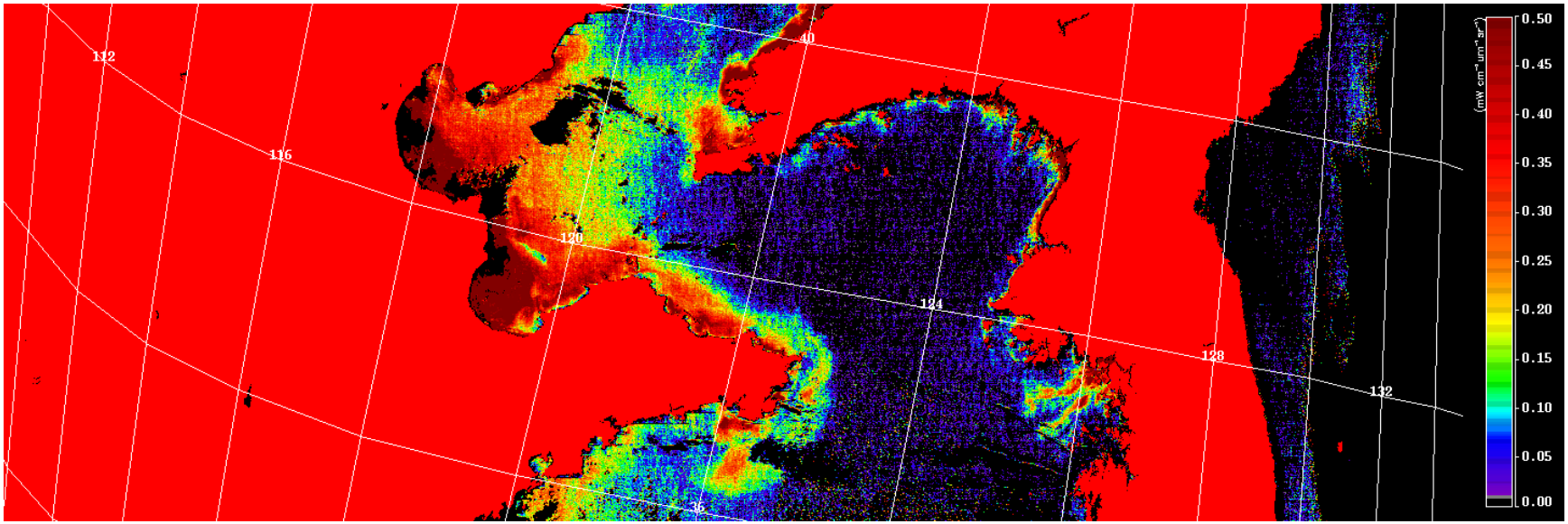

Figure 1-6a. MODIS-L1B

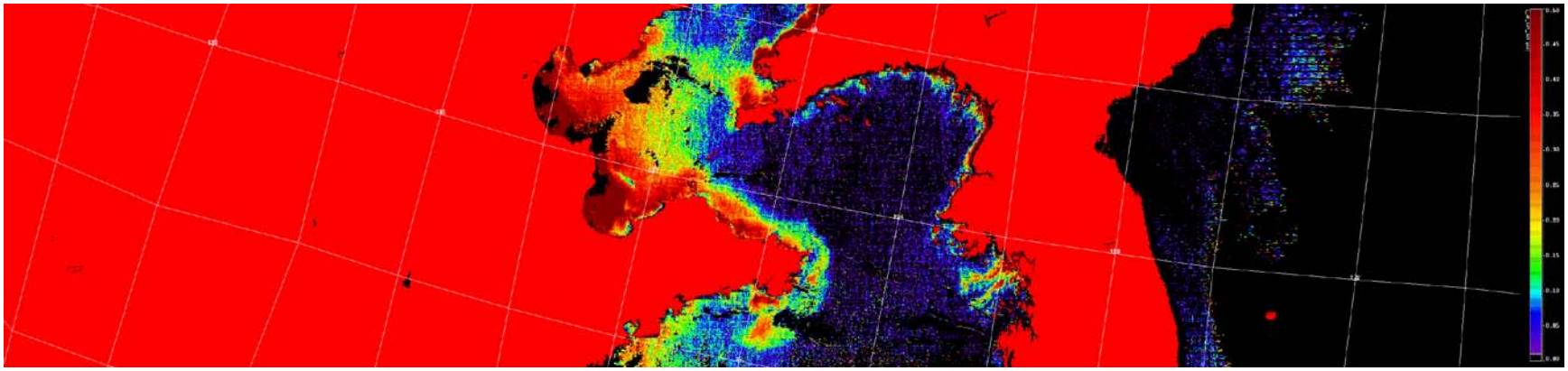

Figure 1-6b. VIIRS PROXY

7) nLw_859

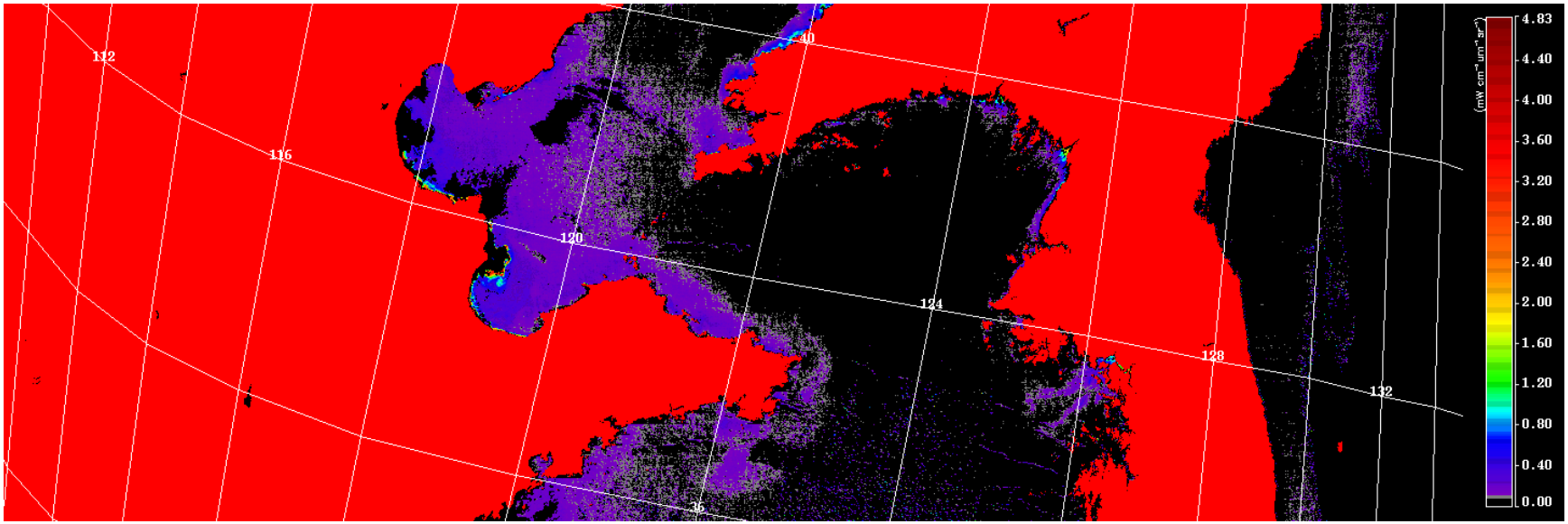

Figure 1-7a. MODIS-L1B

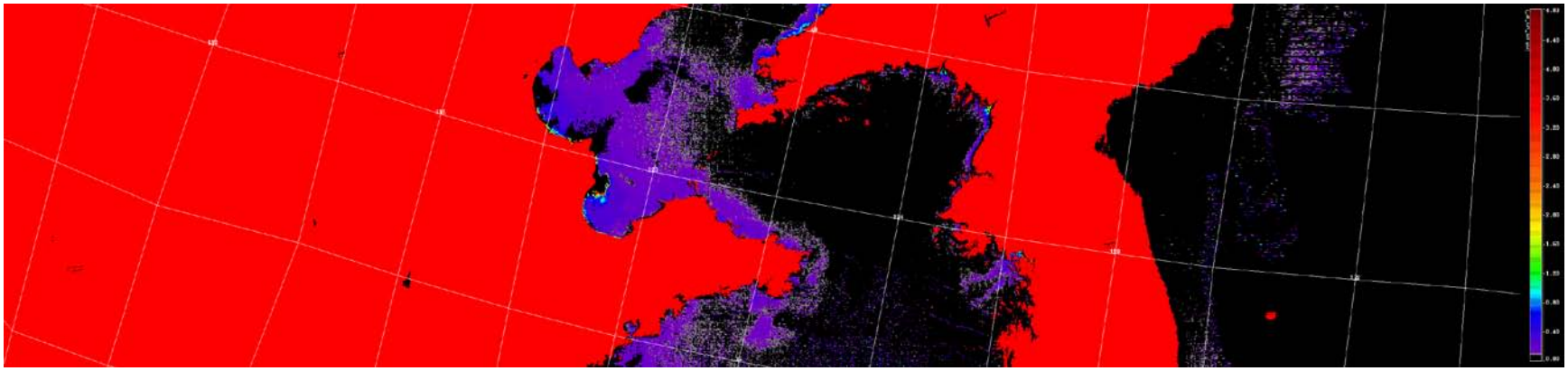

Figure 1-7b. VIIRS PROXY

2. New Zealand: 1) nLw_412

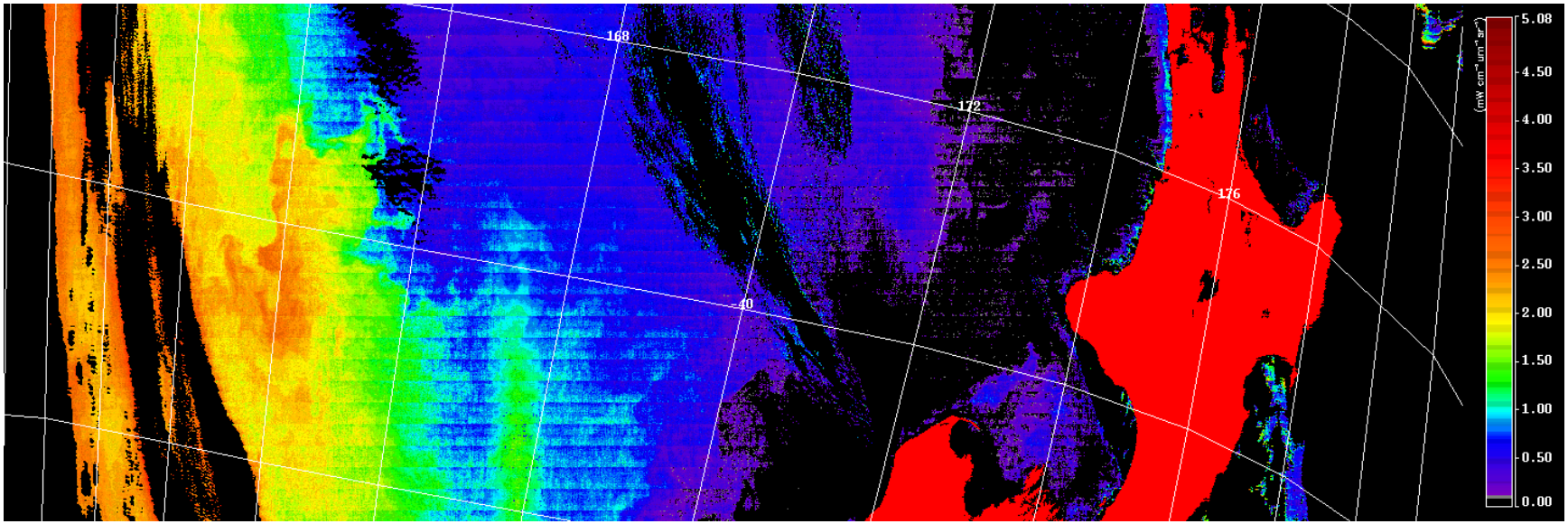

Figure 2-1a. MODIS-L1B

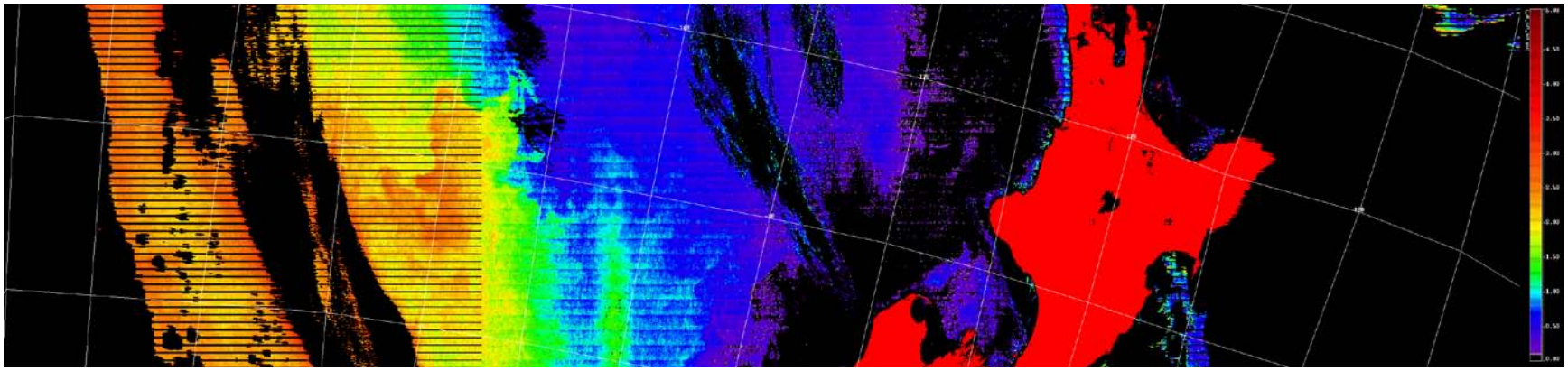

Figure 2-1b. VIIRS PROXY

2) nLw_443

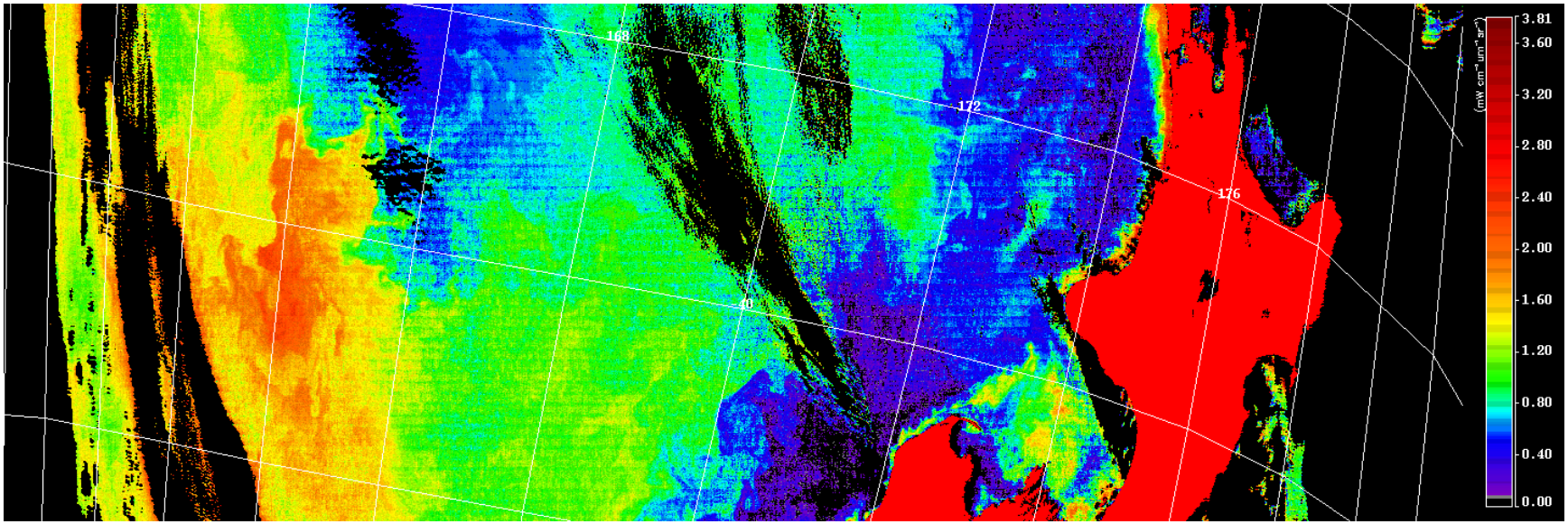

Figure 2-2a. MODIS-L1B

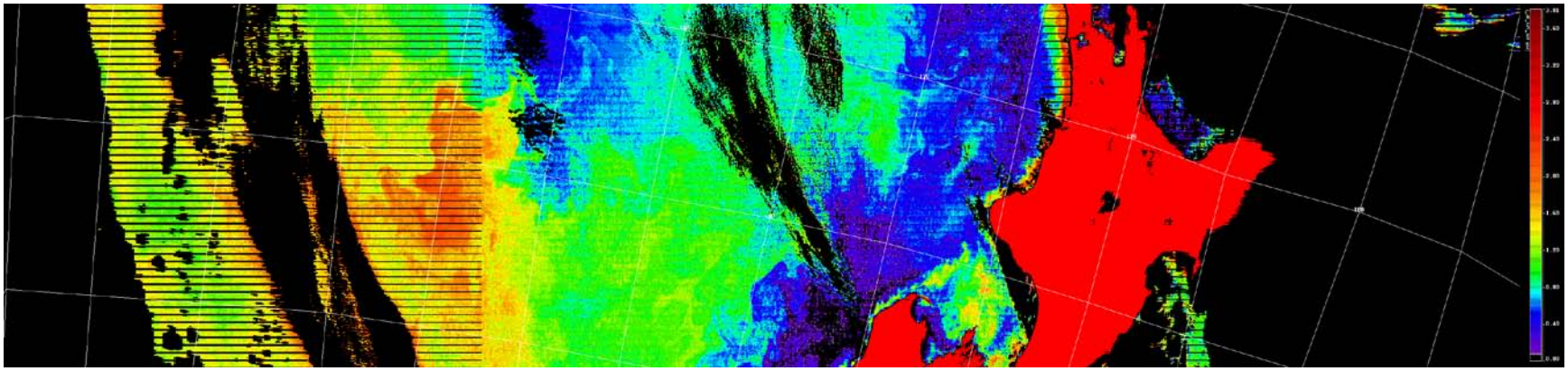

Figure 2-2b. VIIRS PROXY

3) nLw_469

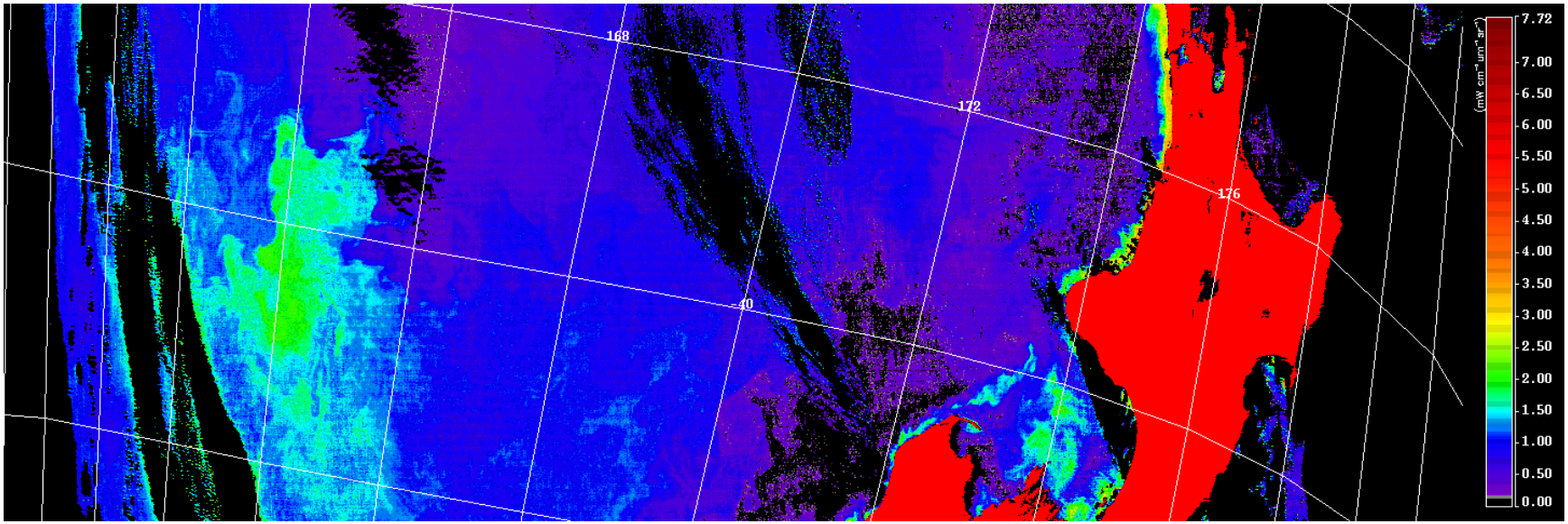

Figure 2-3a. MODIS-L1B

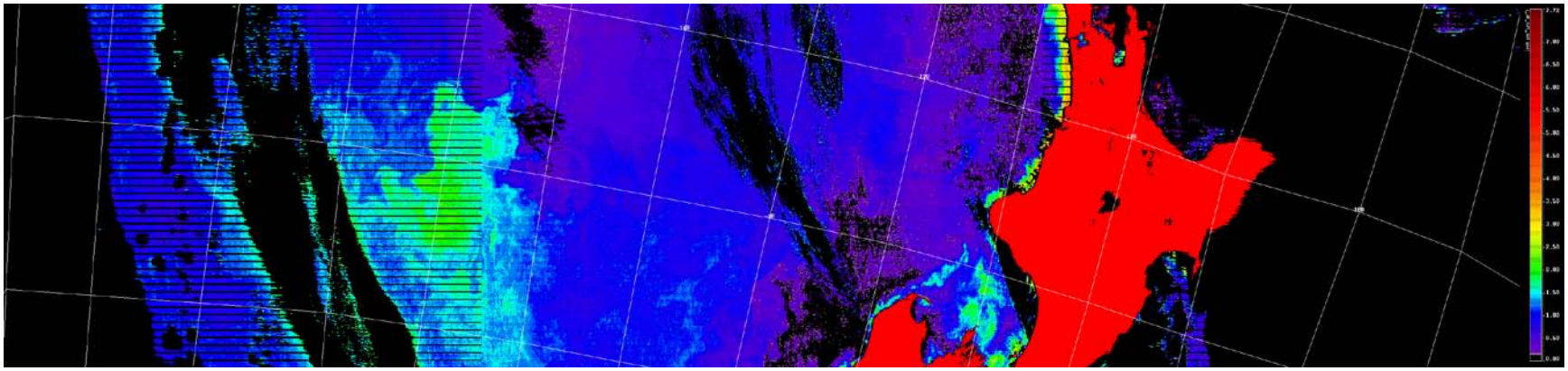

Figure 2-3b. VIIRS PROXY

4) nLw_555

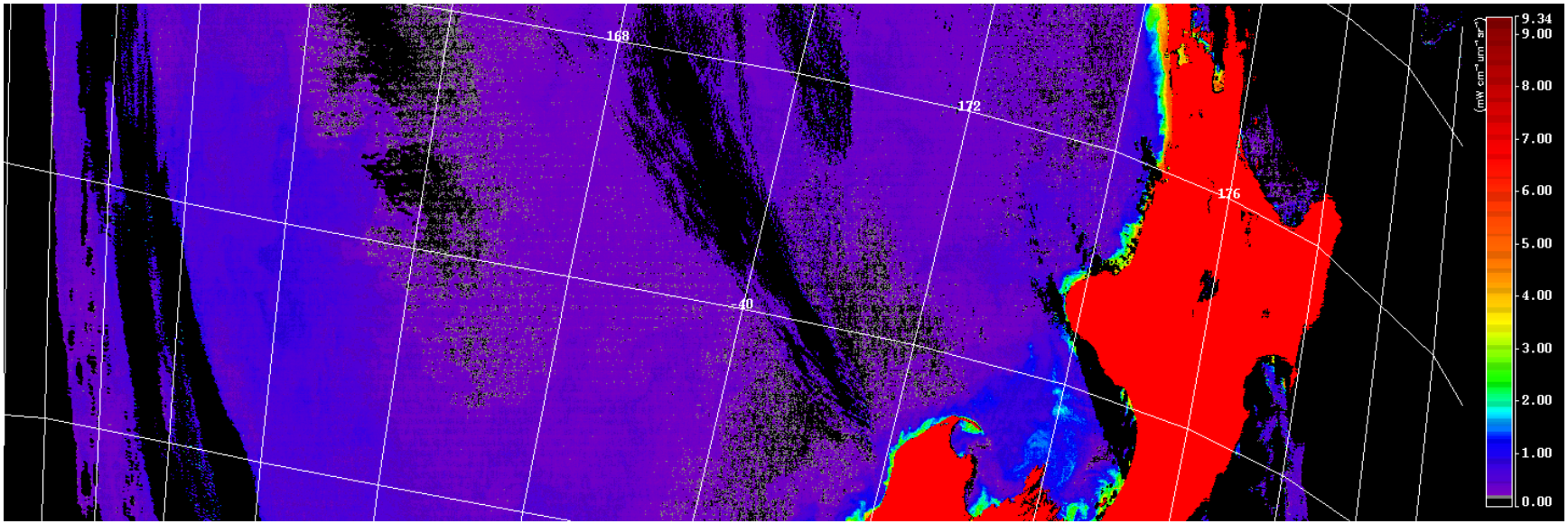

Figure 2-4a. MODIS-L1B

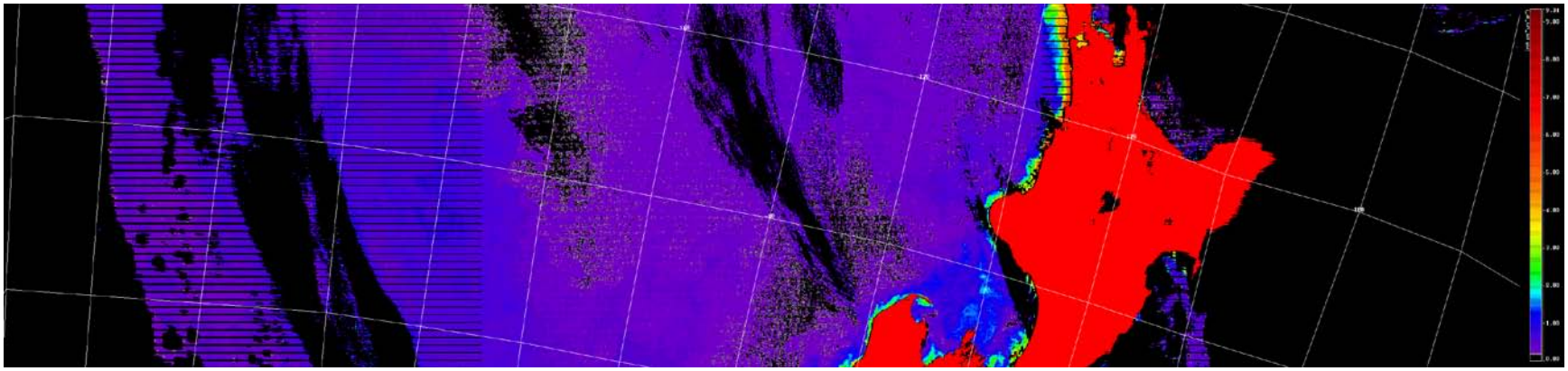

Figure 2-4b. VIIRS PROXY

5) nLw_645

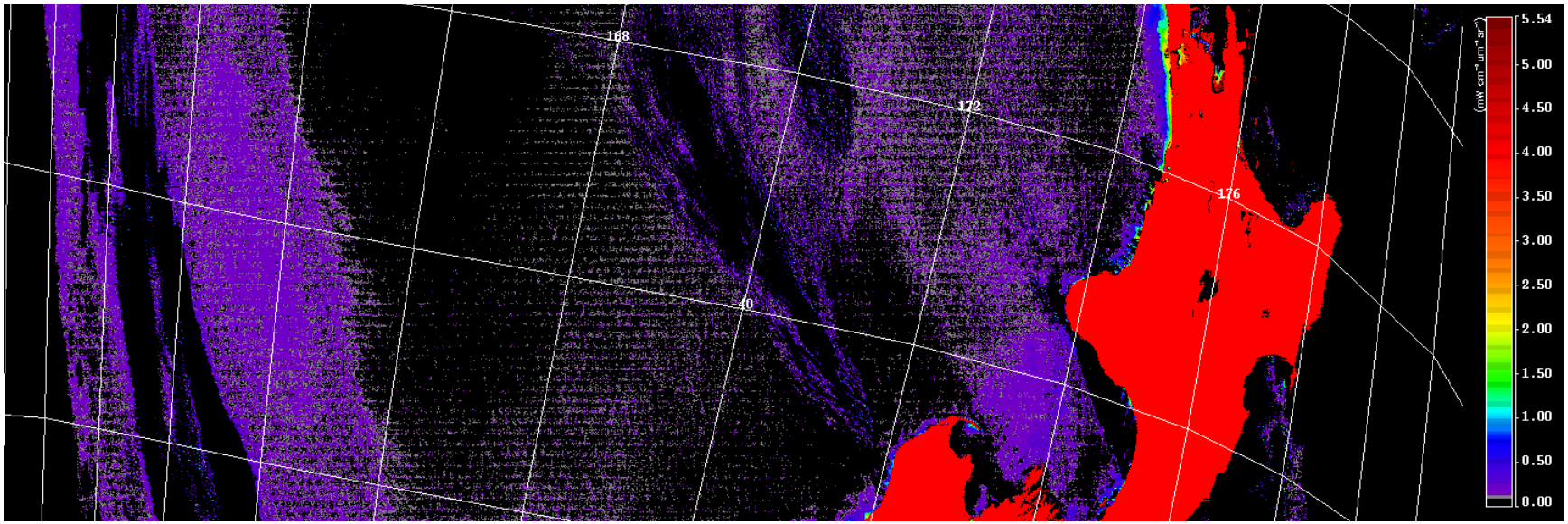

Figure 2-5a. MODIS-L1B

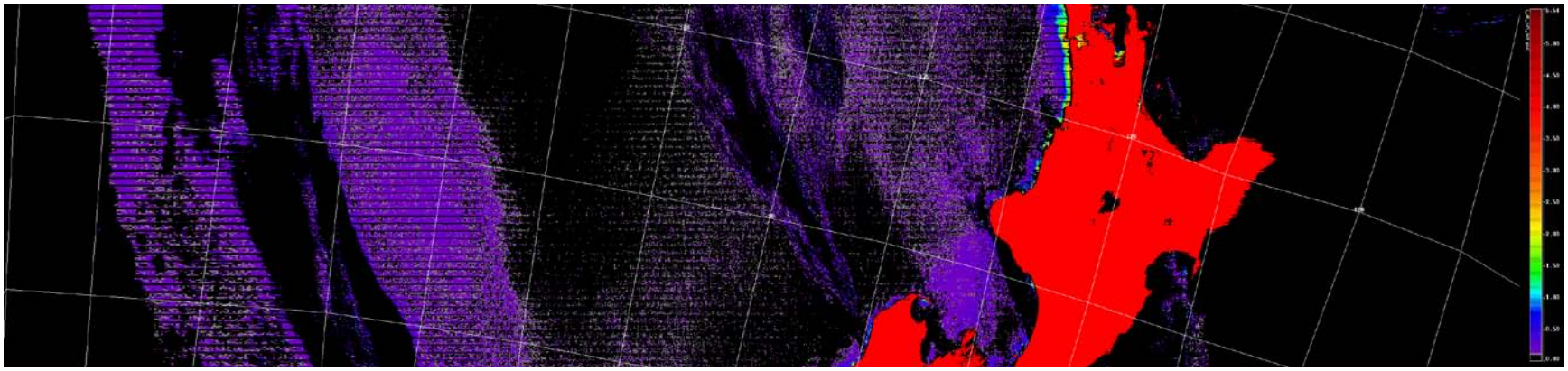

Figure 2-5b. VIIRS PROXY

6) nLw_748

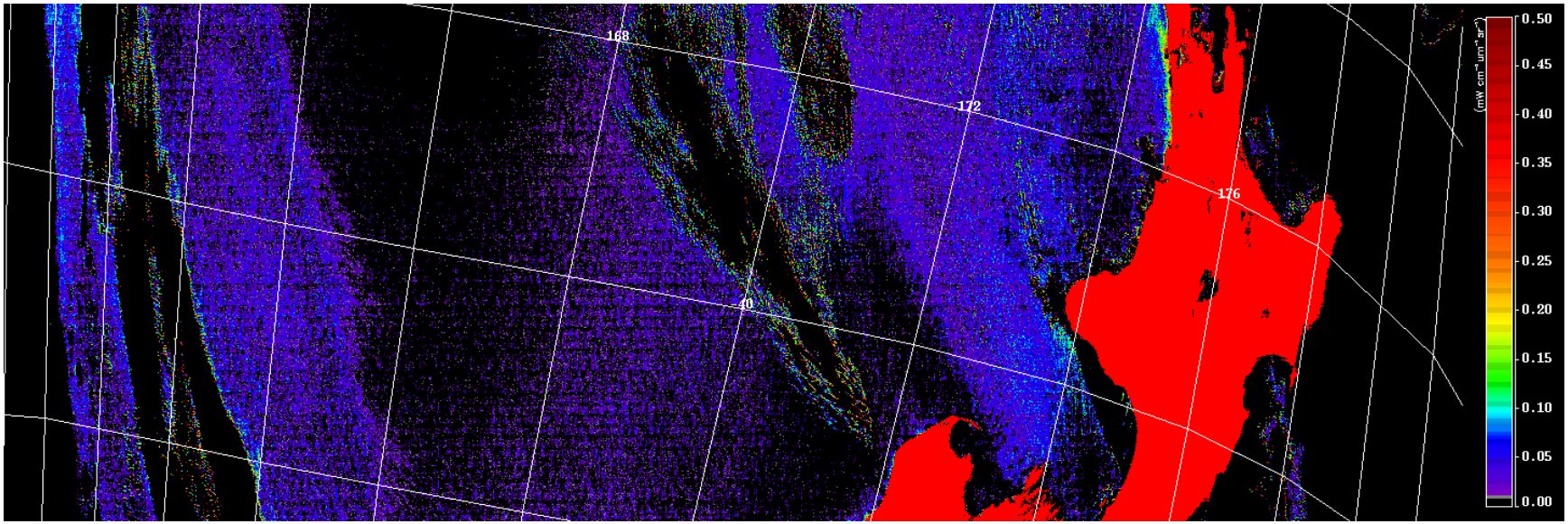

Figure 2-6a. MODIS-L1B

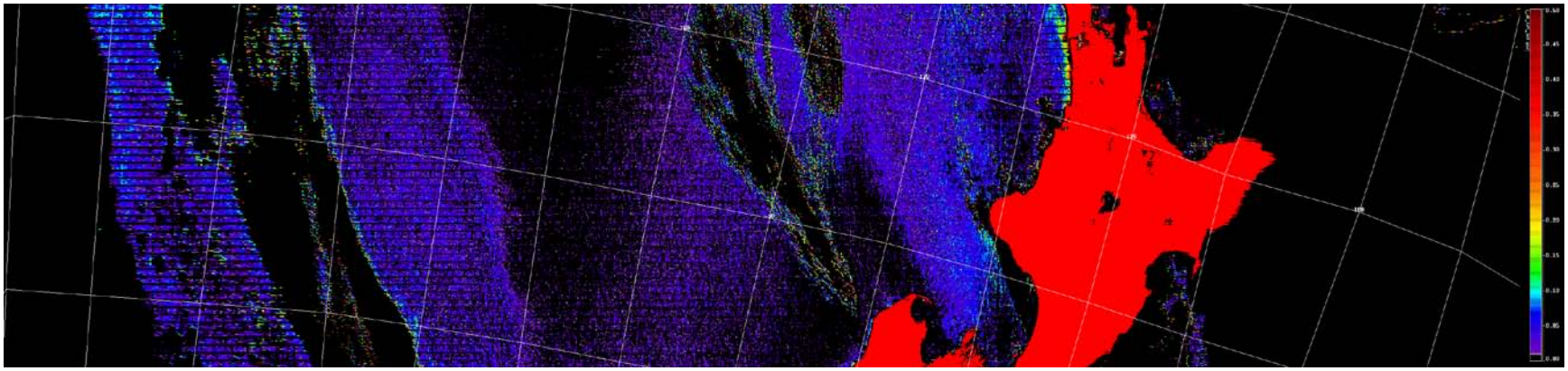

Figure 2-6b. VIIRS PROXY

7) nLw_859

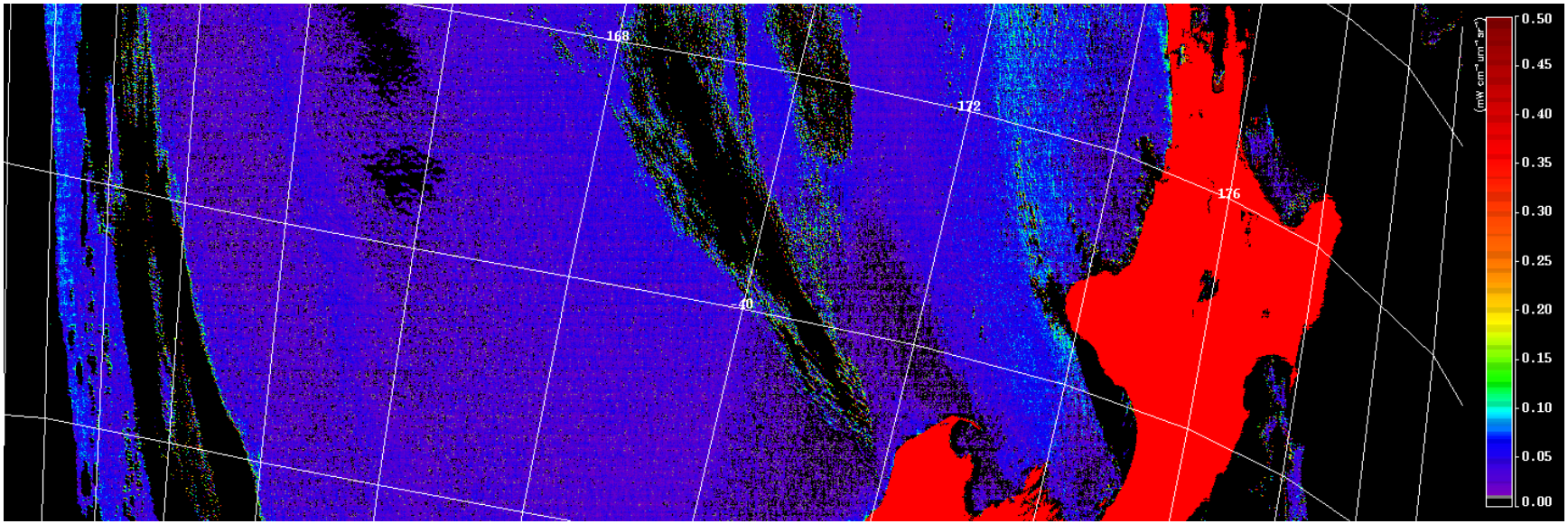

Figure 2-7a. MODIS-L1B

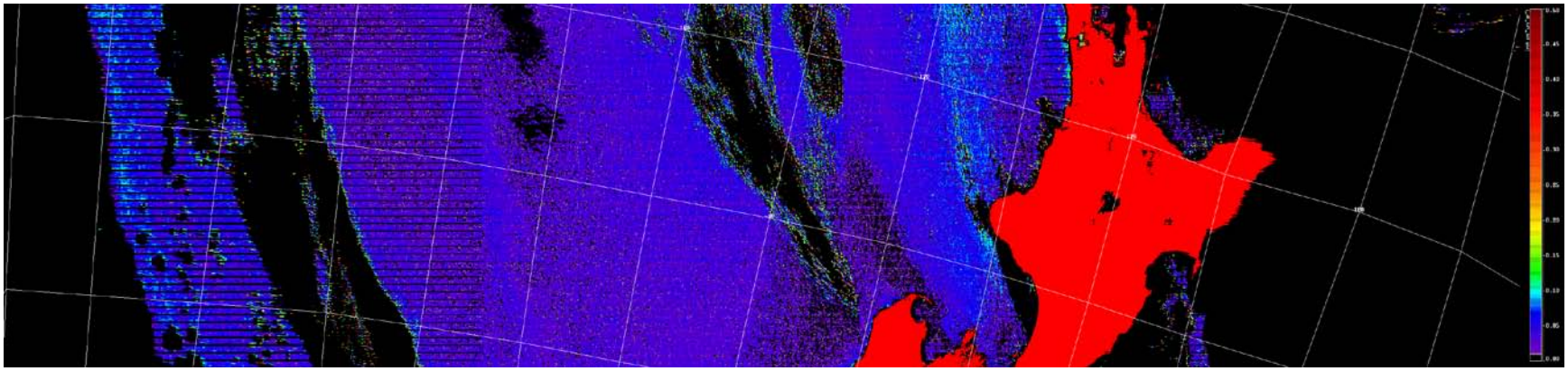

Figure 2-7b. VIIRS PROXY

3. US East Coast: 1) nLw_412

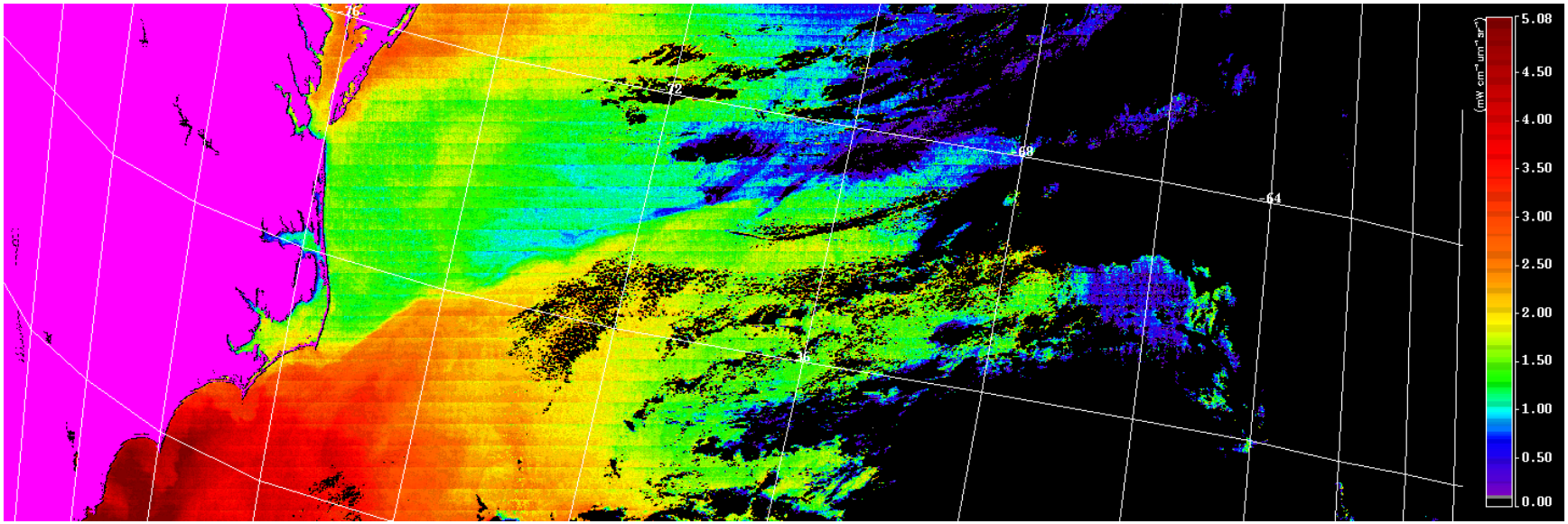

Figure 3-1a. MODIS-L1B

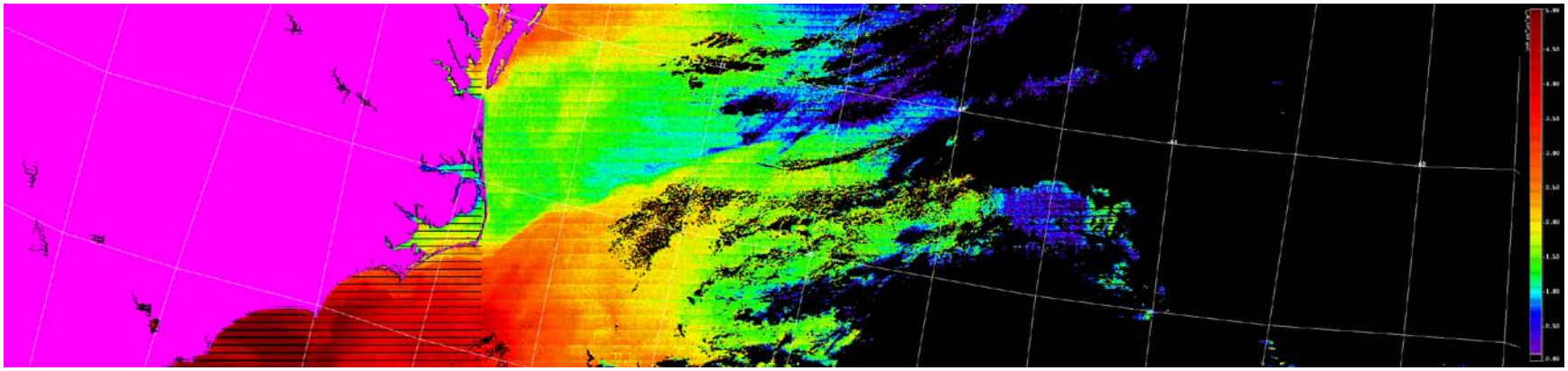

Figure 3-1b. VIIRS PROXY

2) nLw_443

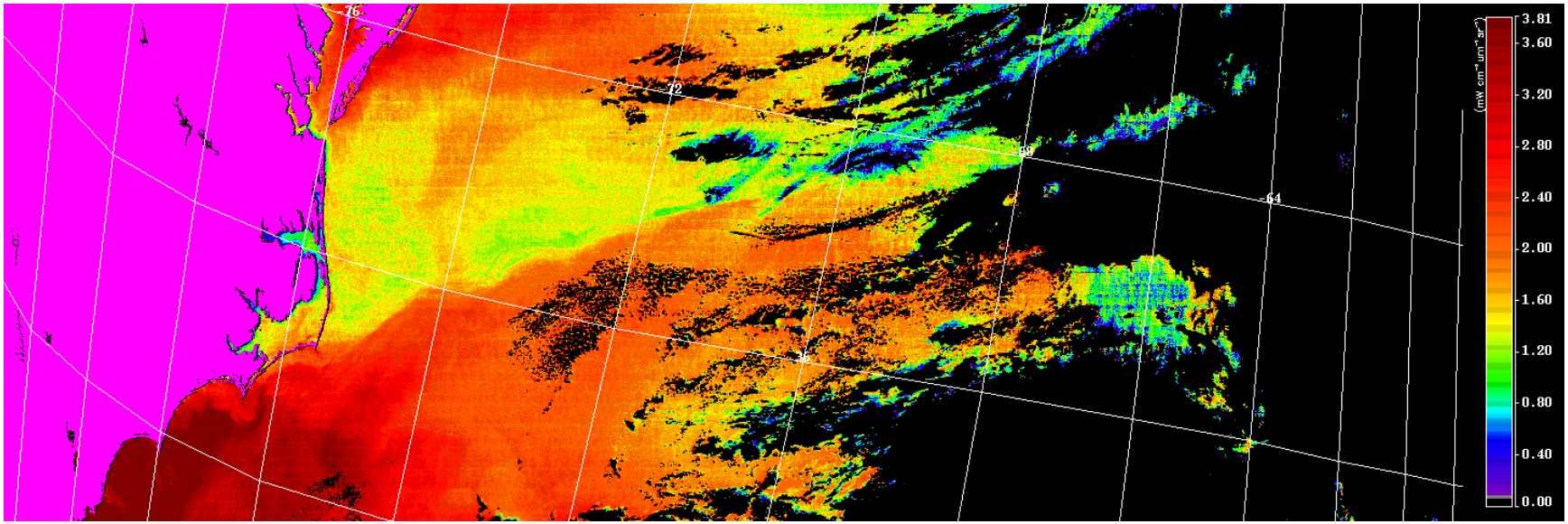

Figure 3-2a. MODIS-L1B

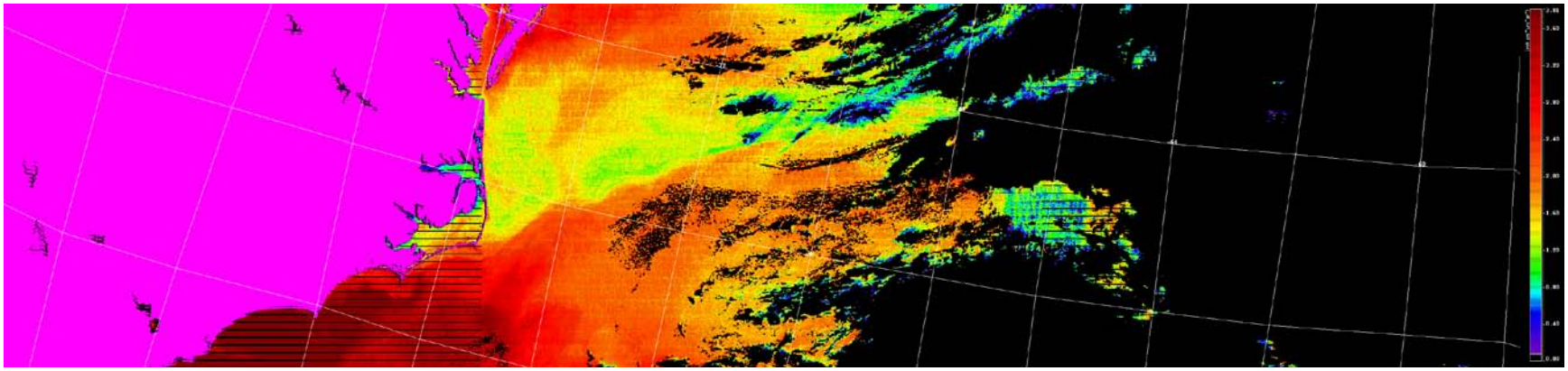

Figure 3-2b. VIIRS PROXY

3) nLw_469

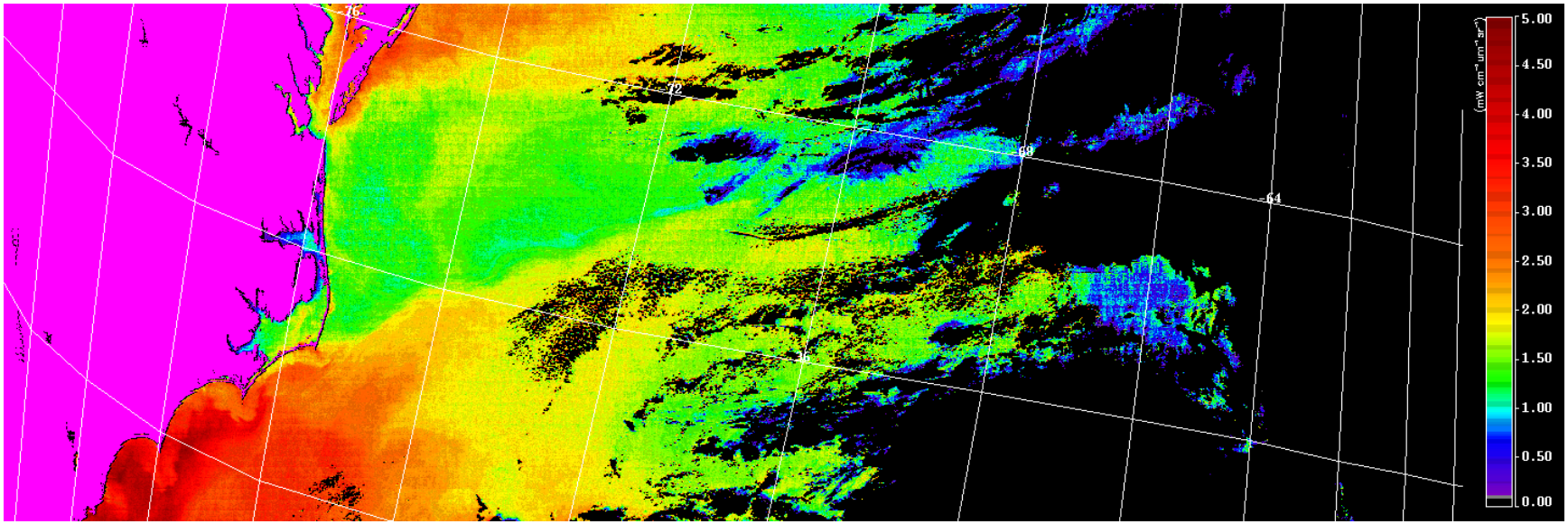

Figure 3-3a. MODIS-L1B

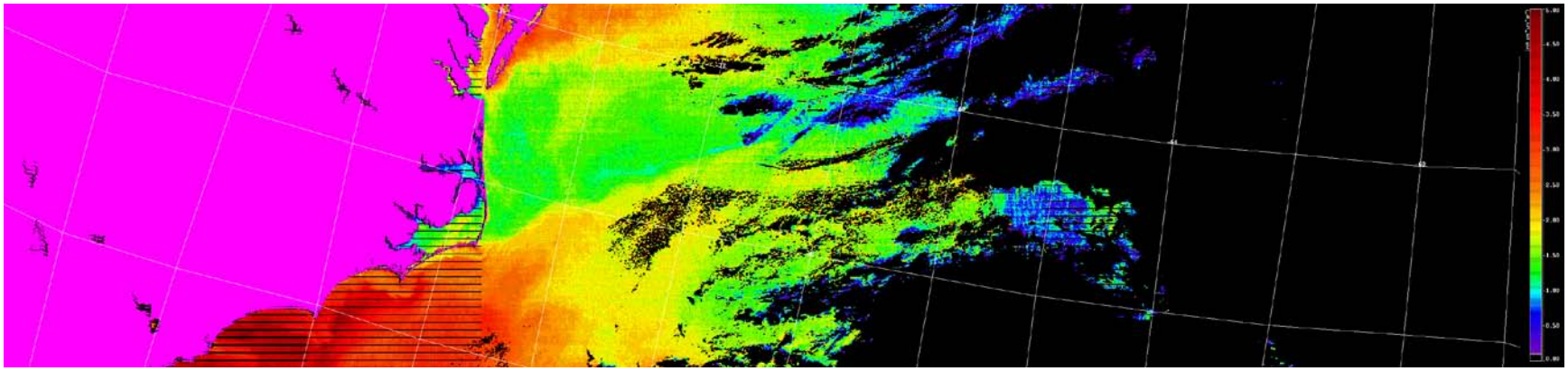

Figure 3-3b. VIIRS PROXY

4) nLw_555

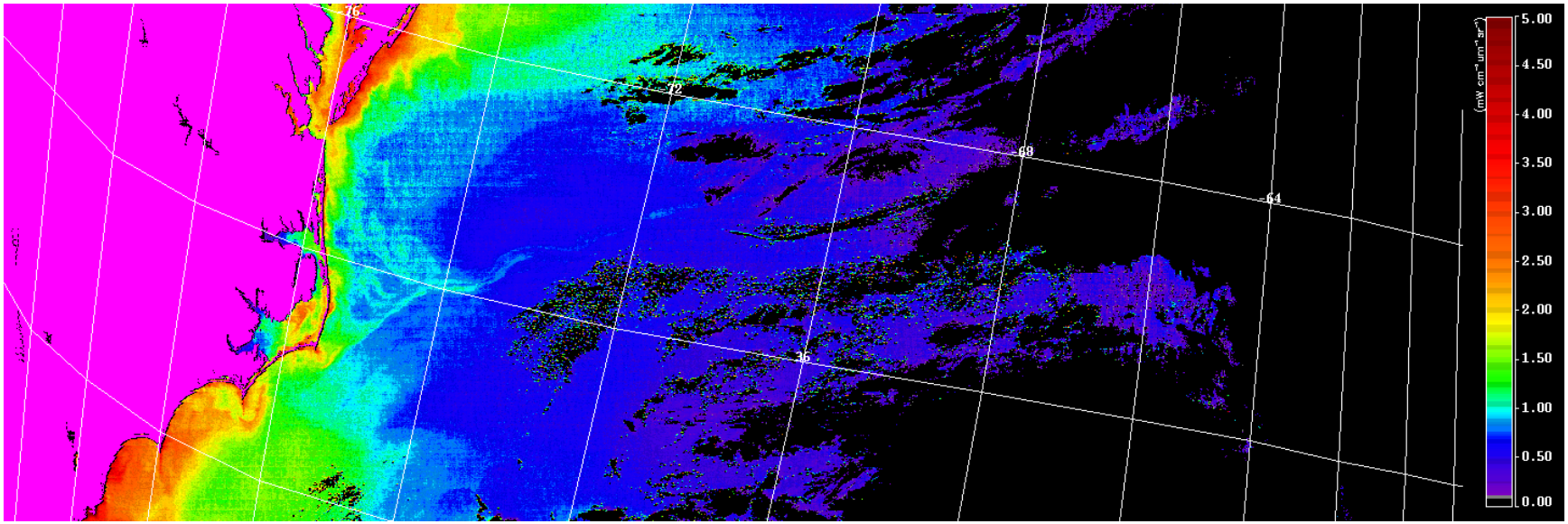

Figure 3-4a. MODIS-L1B

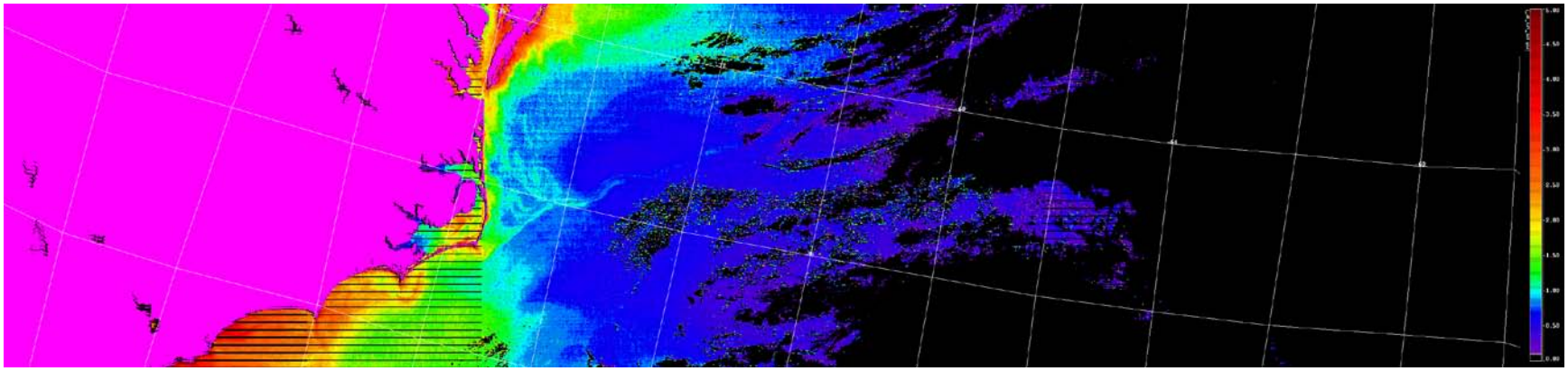

Figure 3-4b. VIIRS PROXY

5) nLw_645

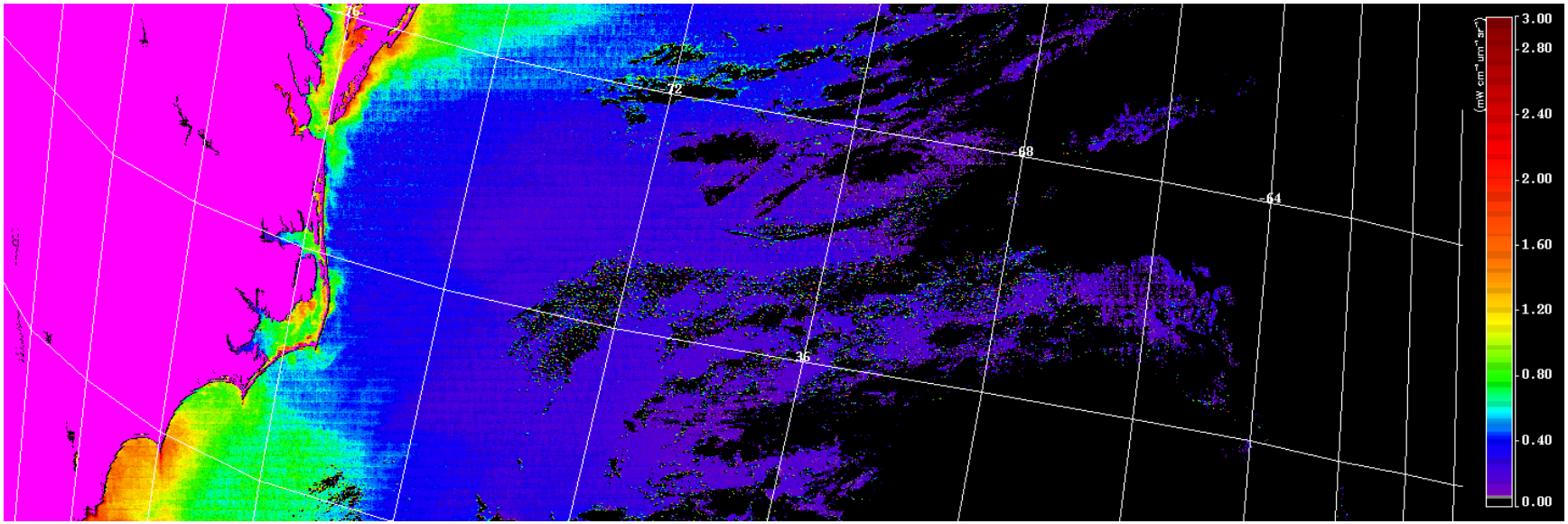

Figure 3-5a. MODIS-L1B

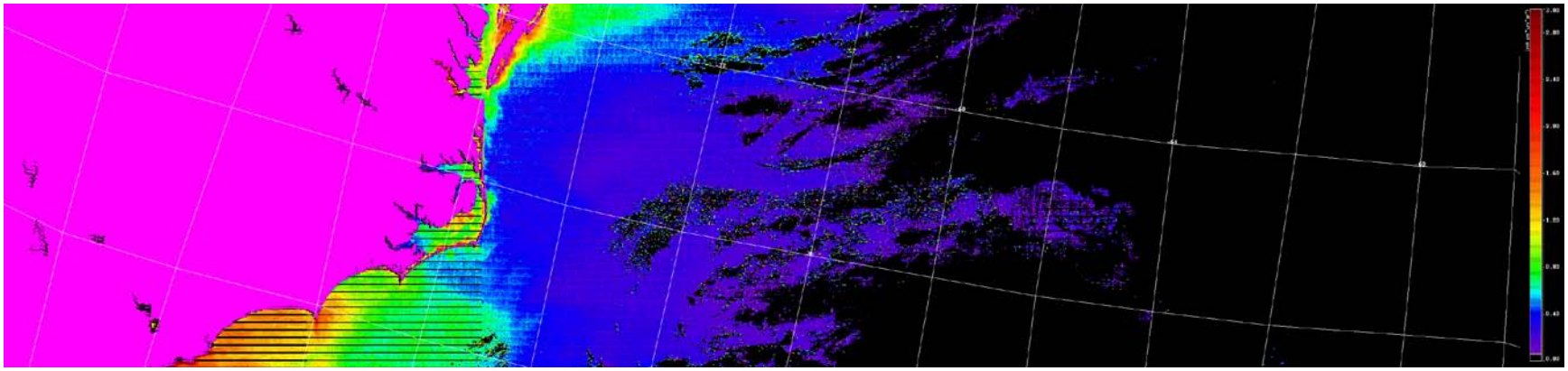

Figure 3-5b. VIIRS PROXY

6) nLw_748

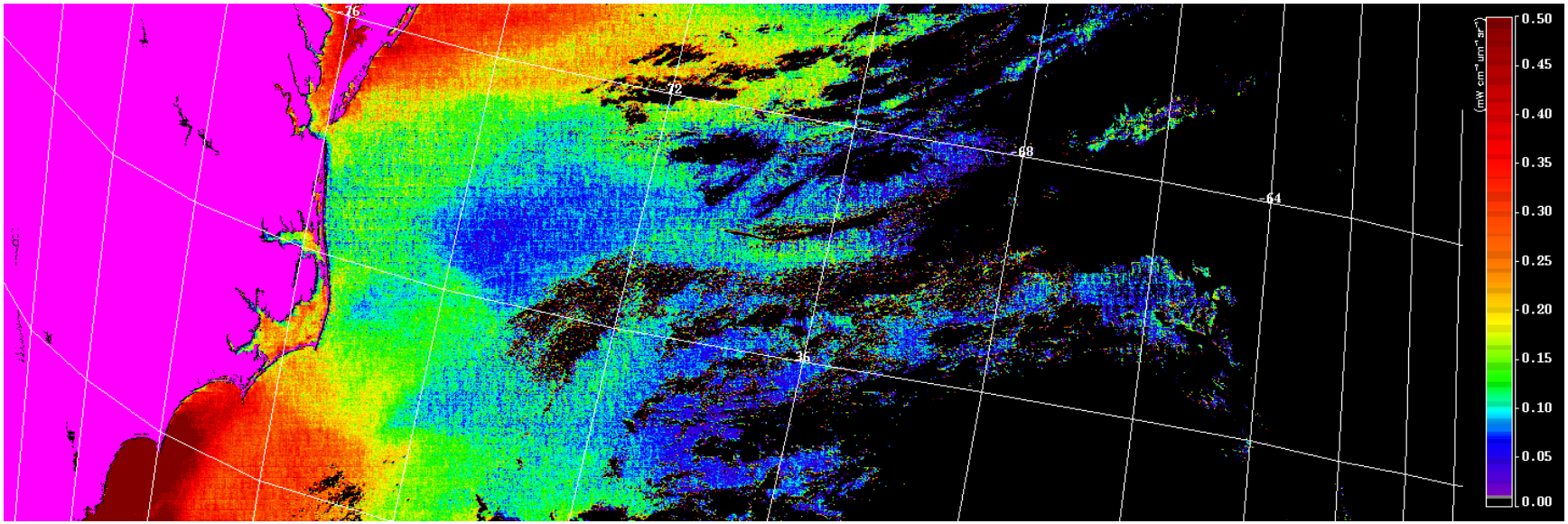

Figure 3-6a. MODIS-L1B

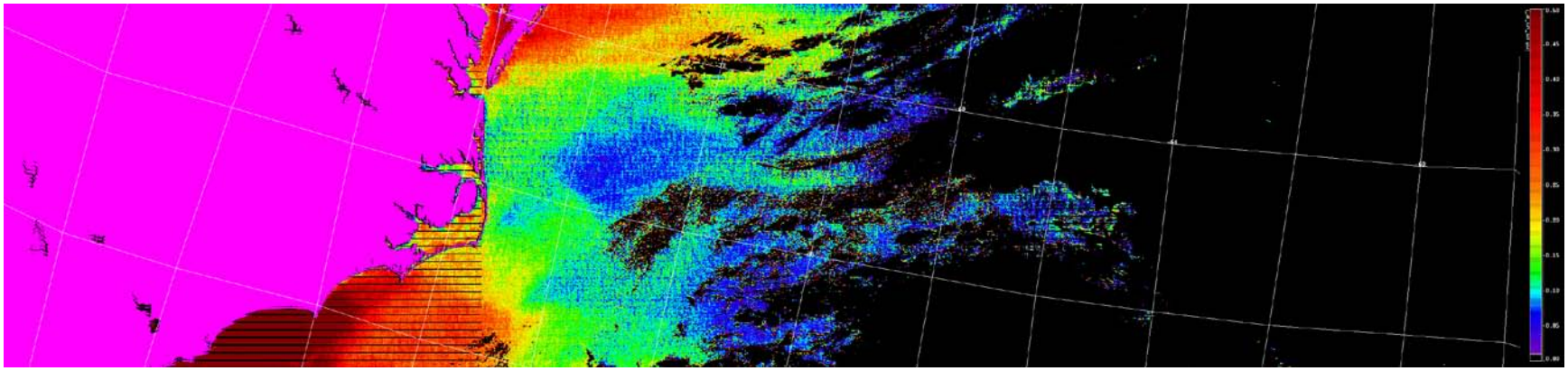

Figure 3-6b. VIIRS PROXY

7) nLw_859

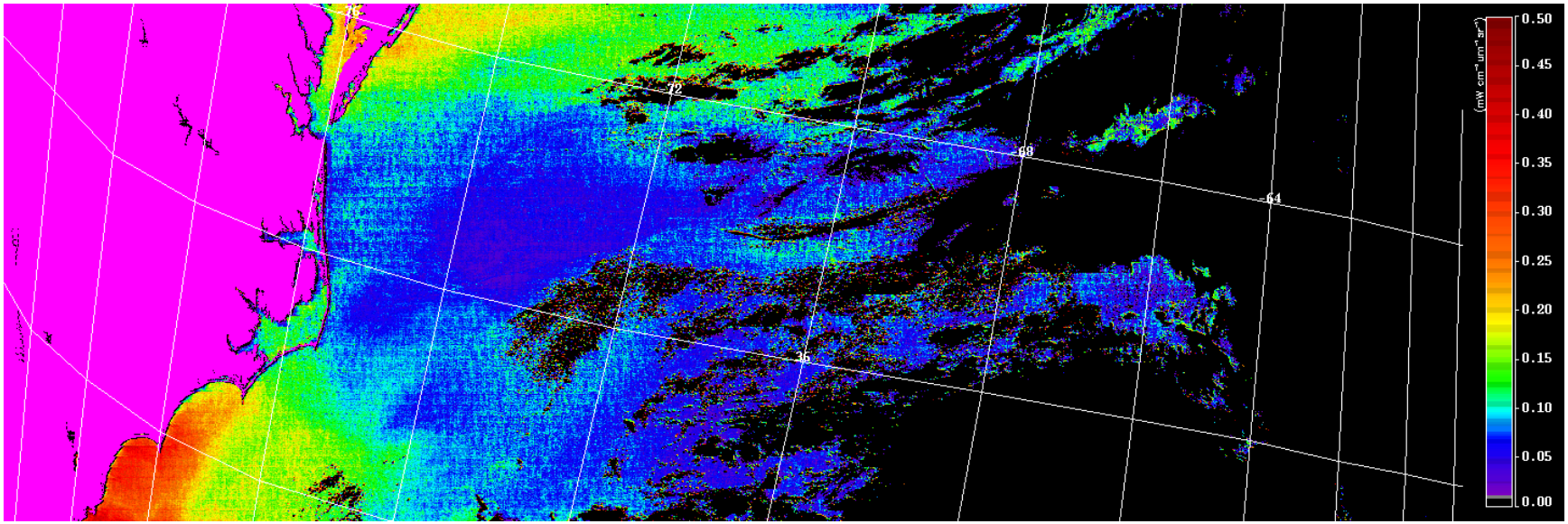

Figure 3-7a. MODIS-L1B

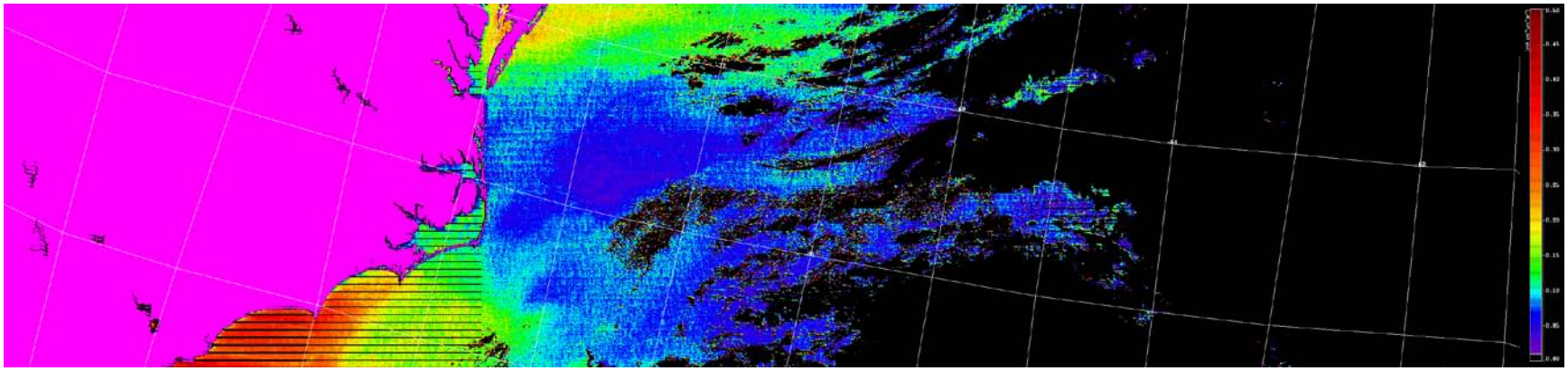

Figure 3-7b. VIIRS PROXY