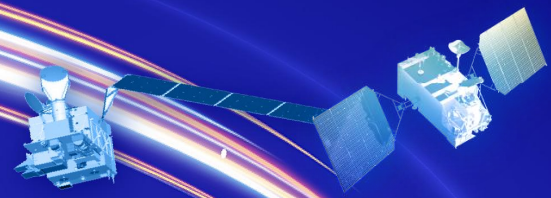
AOMSUC-15 FYSUC-2025
FIFTEENTH ASIA-OCEANIA METEOROLOGICAL SATELLITE USERS' CONFERENCE
THE JOINT 2025 FENGYUN SATELLITE USER CONFERENCE

Image correction and calibration verification of the MERSI-II/FY-3D radiometer for calculating marine bio-optical parameters

A.I. Aleksanin[1,2], G.S. Strelov[2]

1 Institute of Automation and Control Processes, Russian Academy of Sciences, Far Eastern Branch, Vladivostok, Russia

2 Far Eastern Federal University, Vladivostok, Russia



THE TASK

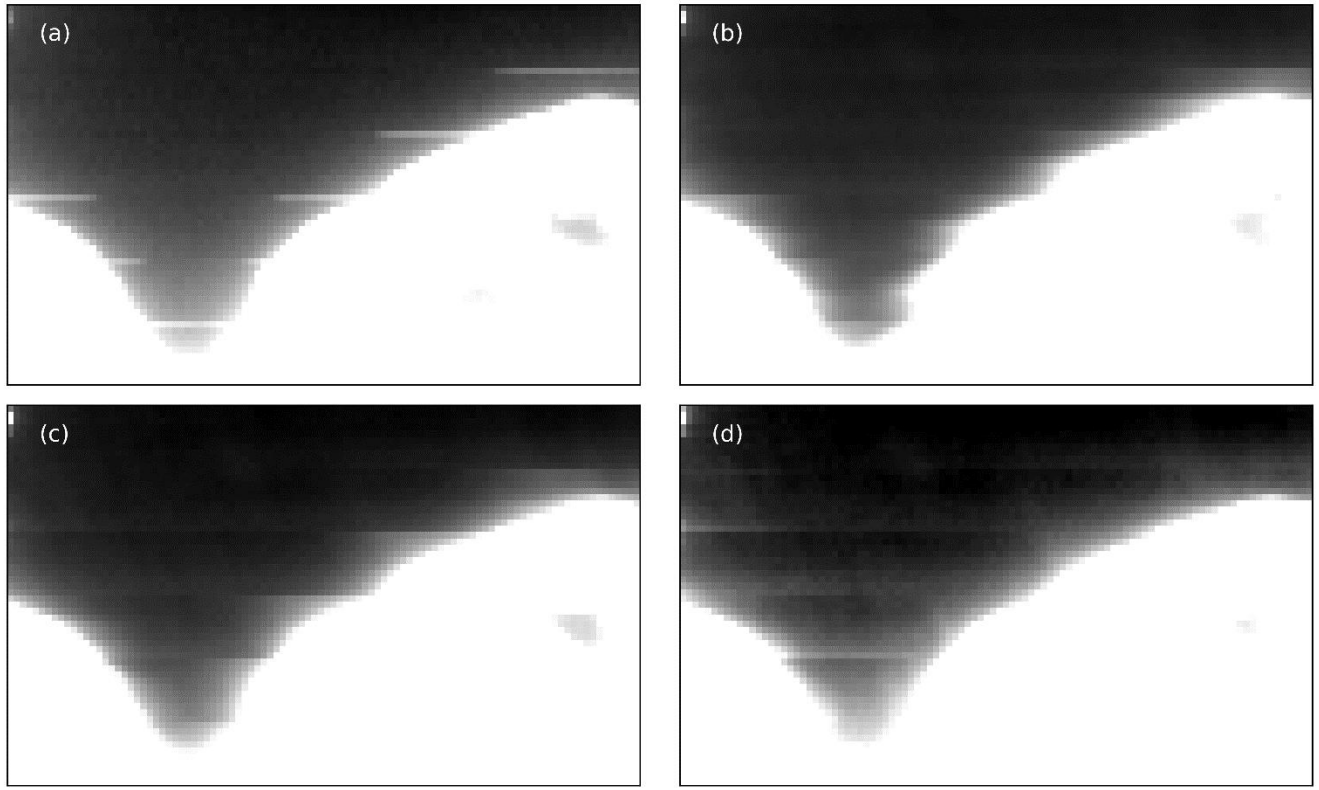
Data from the Chinese MERSI-II radiometer on the FY-3D satellite can be used to calculate marine bio-optical parameters, but they are not included in the product list of the National Satellite Meteorological Center (NSMC) of China.

The goal – to correct images and verify the calibration of key spectral channels with central wavelengths of 412, 443, 490, 555, 670, 709, 746, 865 nm and to evaluate the use of data for calculating marine bioparameters.

IMAGE QUALITY CONTROL

Image distortions:

- systematic deviations (stripes) in readings,
- dependence of a specific sensor's readings on those of neighboring sensors,
- influence of previous measurements on current ones.



A samples of distortions. Images of ice/water edge. Spectral channels: a - 8, b - 12, c - 13, d - 15

IMAGE STRIPES

a) - a fragment of the Greenland image with the boundaries of the analyzed scan of channel 8; **b)** - variability of sequentially elongated sensor readings with the mean subtracted; **c)** - readings of the figure normalized to the mean modulus (b)

The stripes are present in all images and behave the same way.

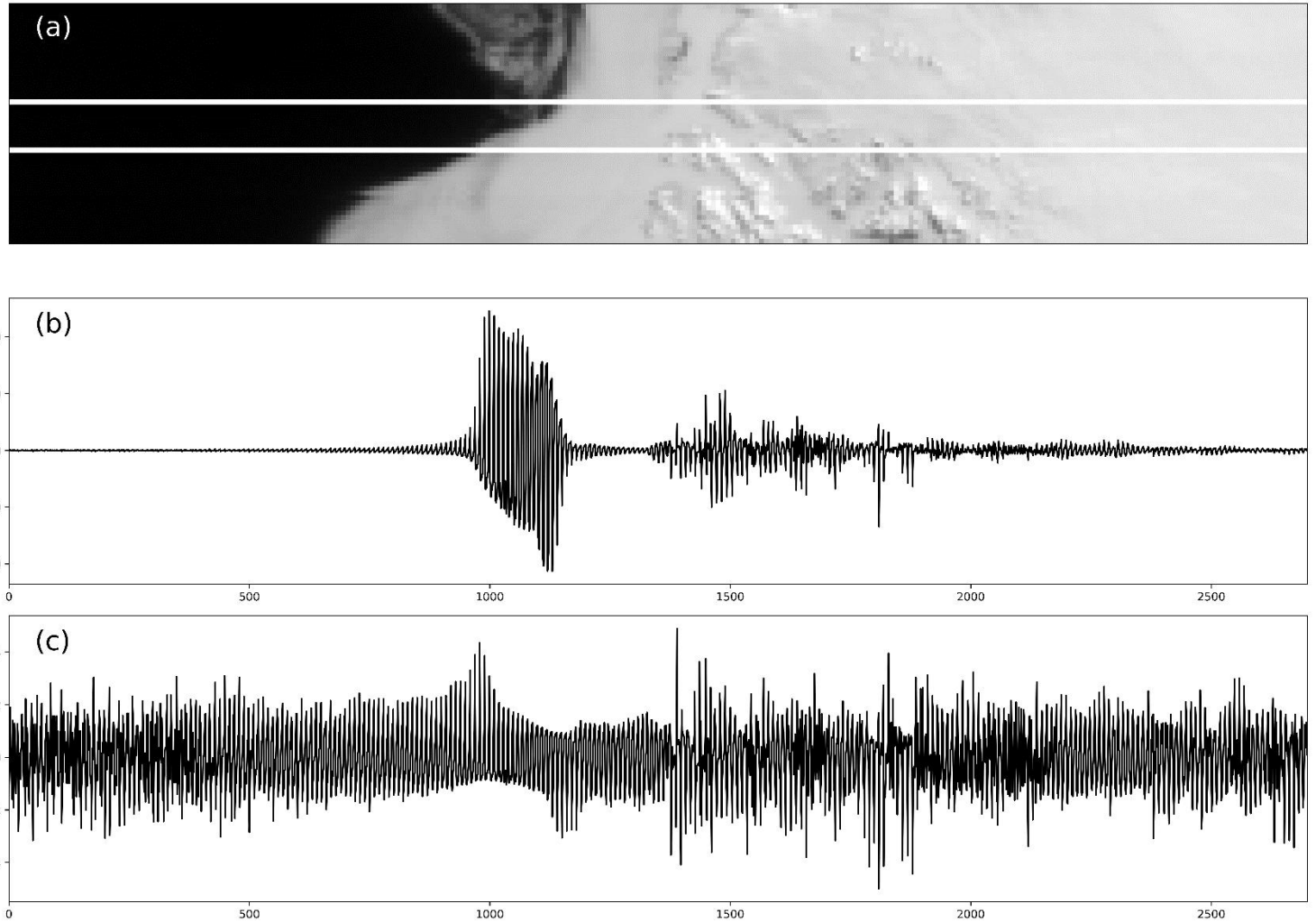


IMAGE CORRECTION

Three kinds of correction functions for a sensor:

Stripes: $dn_c(i,j)=dn(i,j) - (\overline{dn(i,j)} - dn(i,j)) \cdot a_s + b_s$.

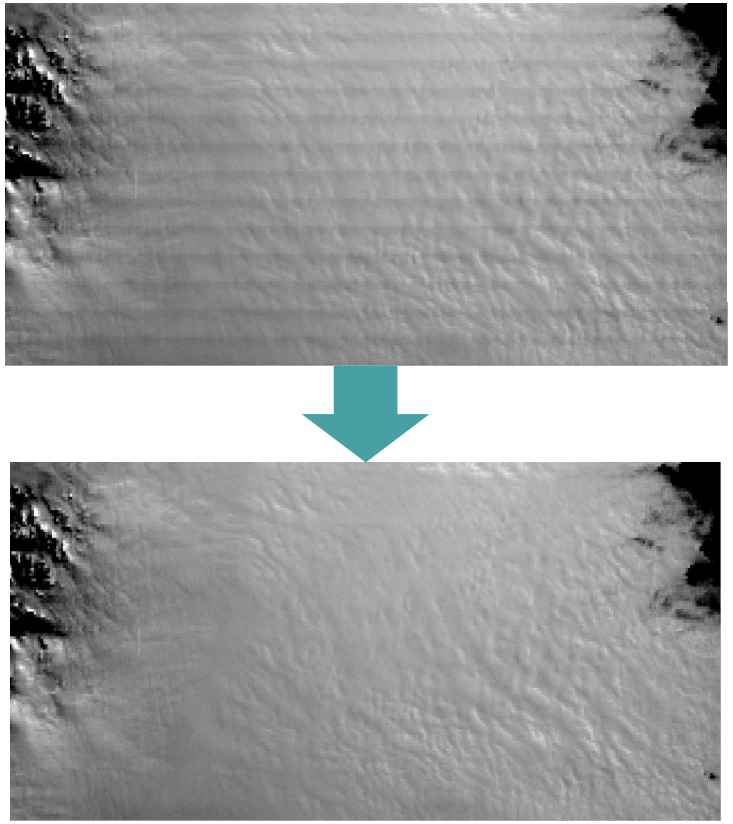
Dependence of a sensor's readings on a neighboring sensors:

$dn_c(i,j)=dn(i,j) - \varepsilon_{ij}^{p}$.

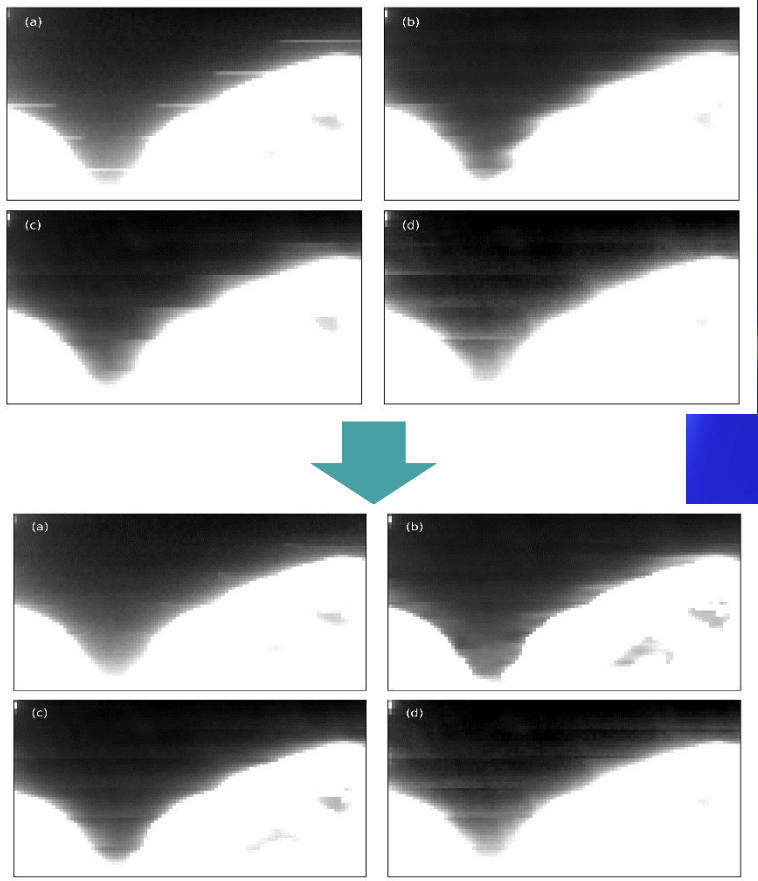
Influence of previous measurements on current ones:

$dn_c(i,j)=dn(i,j) - \beta_j\Delta_j$, $\Delta_j = (dn_{i,(j-1)} - dn_{i,j})$, if $\Delta_j > 0$ and 0 otherwise

dn – count, dn_c - count corrected, s - sensor number of a scan

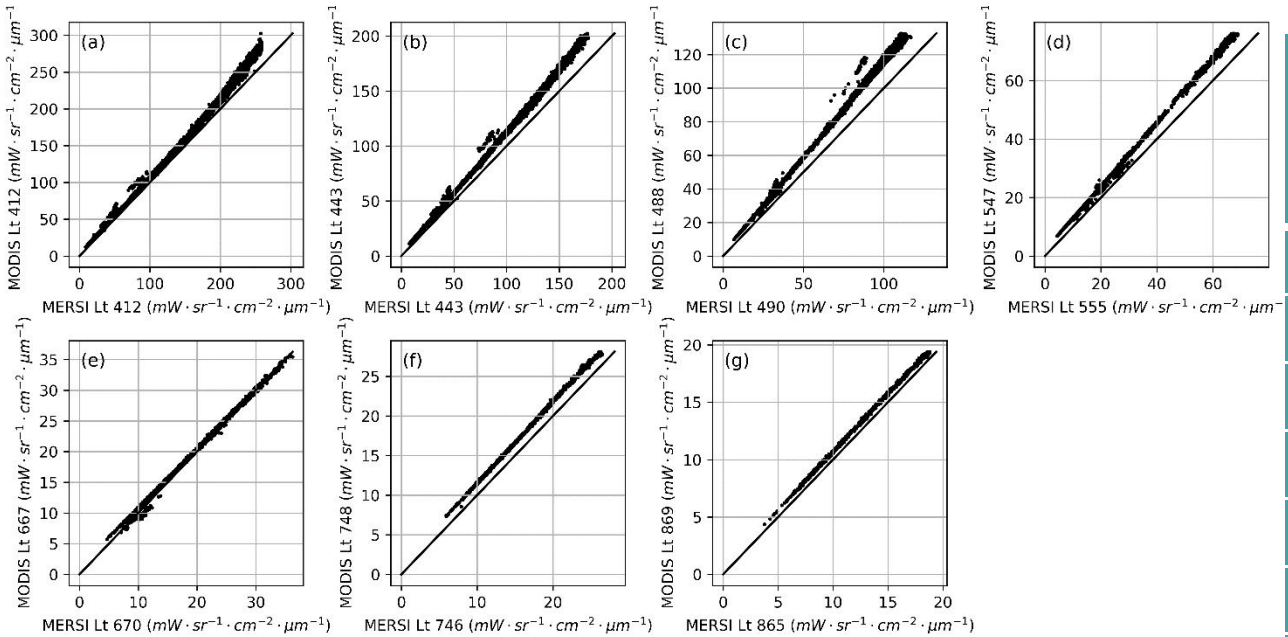


Ice, channel 8



Images of ice/water edge. Spectral channels: a - 8, b - 12, b - 13, d - 15

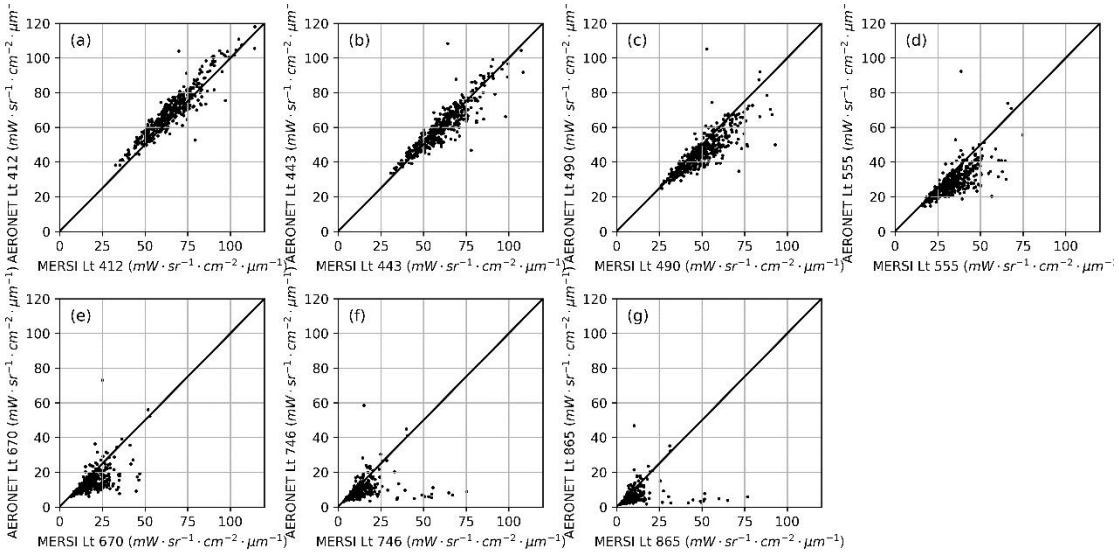
CROSS-CALIBRATION



λ (MERSI) nm	λ (MODIS) nm	Slope	Intercept (mW•sr^{-1}•cm^{-2}•nm^{-1})	R^2
412	412	1.0743 ± 0.0001	-0.7629 ± 0.0125	0,99786
443	443	1.1175 ± 0.0001	1.4862 ± 0.0079	0,999075
490	488	1.146 ± 0.0001	1.7191 ± 0.0081	0,999136
555	547	1.0947 ± 0.0002	1.7666 ± 0.0063	0,998956
670	667	0.9879 ± 0.0005	0.541 ± 0.0095	0,995723
746	748	1.0271 ± 0.0003	1.2432 ± 0.0042	0,999473
865	869	1.0054 ± 0.0004	0.6551 ± 0.0044	0,999273

Scatter plots of calibrated data of MERSI-II and MODIS radiometers for spectral channels with numbers: a - 8, b - 9, c -10, d – 11, e – 12, f – 14, g -15.

CALIBRATION VERIFICATION ON AERONET OC DATA



Scattering diagrams of Lt radiometer MERSI-II and Lt calculated from data of AERONET OC stations for spectral channels with numbers: a - 8, b - 9, c - 10, d – 11, e – 12, f – 14, g - 15.

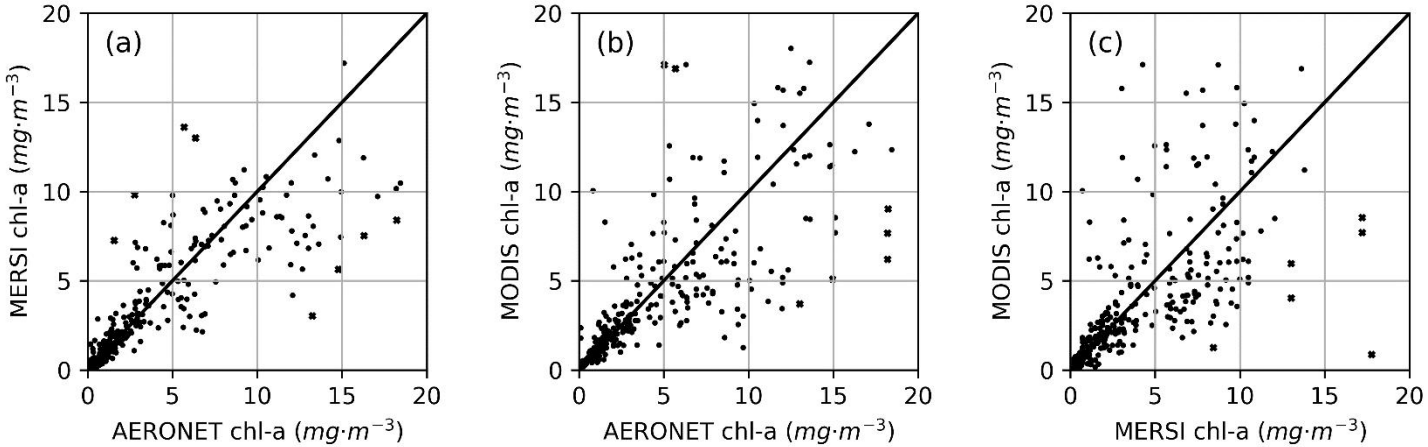
6SV model used for computation the top of atmosphere radiance (Lt)

	MERSI-II				MODIS			
channels MERSI-II / MODIS	Slope	R^2	ME	RMSE	Slope	R^2	ME	RMSE
8 / 8	1.05±0.01	0,997	3,75	3,94	0.96±0.01	0,994	-3,02	5,79
9 / 9	0.99±0.01	0,996	-0,36	4,01	0.92±0.01	0,992	-5,60	5,95
10 / 10	0.91±0.01	0,991	-4,39	4,39	0.88±0.01	0,986	-6,60	5,94
11 / 12	0.82±0.01	0,978	-5,58	4,35	0.82±0.01	0,972	-6,17	5,48
12 / 13	0.76±0.02	0,94	-3,87	3,53	0.84±0.02	0,938	-2,43	3,80
14 / 15	0.7±0.02	0,882	-2,85	3,17	0.82±0.02	0,901	-1,69	3,07
15 / 16	0.63±0.03	0,83	-2,46	2,44	0.87±0.03	0,848	-0,61	2,29

Linear relations between Lt MERSI and Lt AERONET, Lt MODIS and Lt AERONET ($mW \cdot sr^{-1} \cdot cm^{-2} \cdot nm^{-1}$)

CALCULATION OF CHLOROPHYLL-A CONCENTRATION

6SV model was used for computation of remote sensing reflectances (**Rrs**) for both MERSI-II and MODIS data



The chlorophyll-a concentration scattering diagram. The x-axis represents AERONET measurements, and the y-axis represents MODIS and MERSI-II measurements. OC3M algorithm used for MODIS data. Optimal parameters of OC3 were used for chlorophyll-a concentration on MERSI-II data.

OC3:

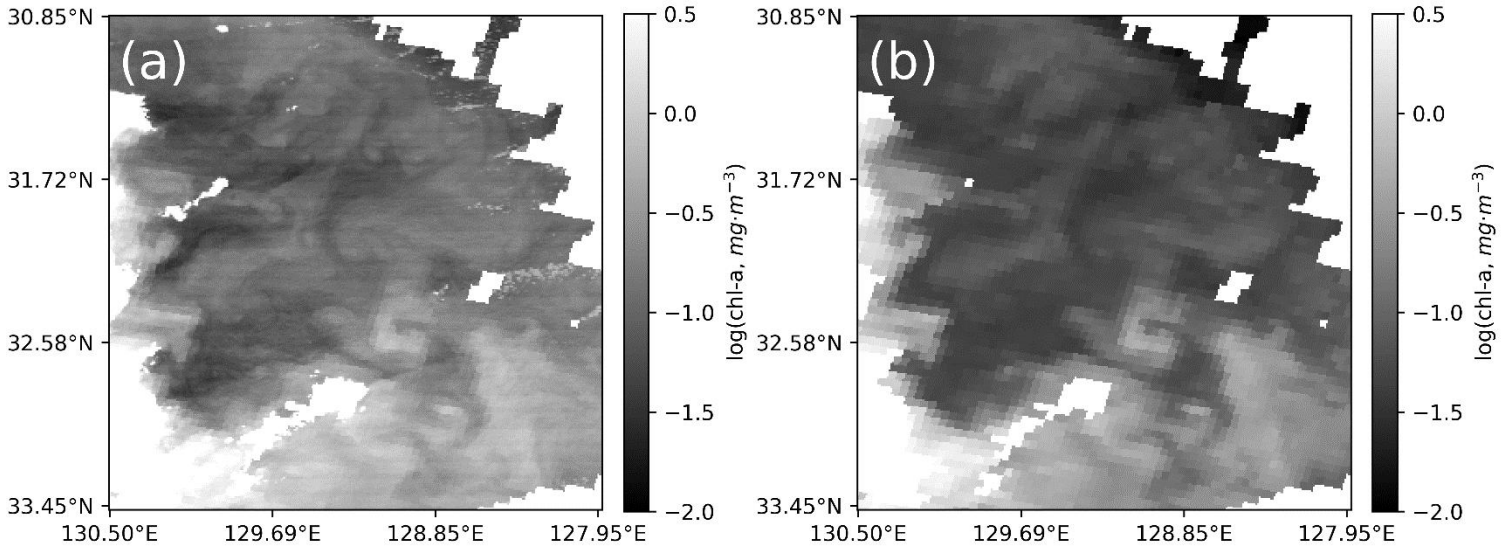
log10[$c\ \hbar\ l\ -a\ ]=a\ 0+a\ 1X\ +a\ 2X\ 2+a\ 3X\ 3+a\ 4X\ 4$,

where $X\ =l\ \ o\ \ g$ [max($R\ r\ \ s\ $ (443),$R\ r\ \ s\ $ (490))/$R\ r\ \ s\ $ (555)].

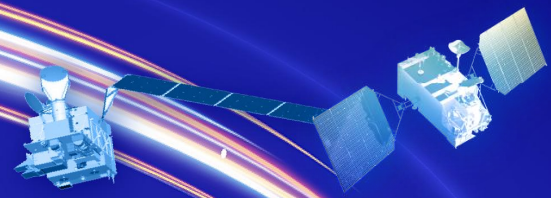
CALCULATION OF CHLOROPHYLL-A CONCENTRATION

Comparison of chlorophyll-a concentrations of two radiometers

	Slope	R^2	ME	RMSE	RMSD
AERONET-MERSI	0.85±0.03	0,931	-0,41	1,74	2,08
AERONET-MODIS	0.91±0.04	0,874	-0,22	2,59	2,67
MERSI-MODIS	0.97±0.06	0,756	0,14	3,09	3,10



Chlorophyll-a concentration in the vicinity of the Ariake Tower station in Tokyo Bay, computed using MERSI-II (a) and MODIS/AQUA (b) data on October 20, 2020



Conclusions

- The MERSI-II radiometer has a large number of deviations, the correction of which requires significant effort in selecting the appropriate functions.
- The calibration of the visible spectral range channels is good.
- Using AERONET OC data for atmosphere correction images allows to calculate the sea bio-parameters. The accuracy of the bio-parameters is comparable to that of the MODIS/AQUA radiometer.
- The sensor noise is not high, the brightness resolution is good and the sensor readings are relatively stable over time, which allows them to be calibrated to existing accuracy standards (the sensors of the visible and near infrared radiometers MERSI-II and infrared MERSI-LL were tested).


Thank you for your attention!
FY-1D/CHRPT