Improvement and Validation of Version 2 GLI Ocean Products

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P-Y. Deschamps, and collaborators...

ADEOS-2 workshop, December 2004

0. Introduction

- We achieved minimum level of the ocean products to the first data release (version 1) in Dec. 2003
- In Nov. 2004, we released “version 2” products to catch up with today's other sensor products and have some advantages.
- This presentation includes;
  1. Characteristics of the Ver. 2 Algorithms
  2. Validation Results
  3. Summary and Plan

1. Ver.2 Algorithms

New features of the ver.2 ocean algorithms

- **Atmospheric correction (nLw, aerosol, and PAR)**
- **In-water algorithms (CHLA, SS, CDOM, and K490)**
- **Sea surface temperature**

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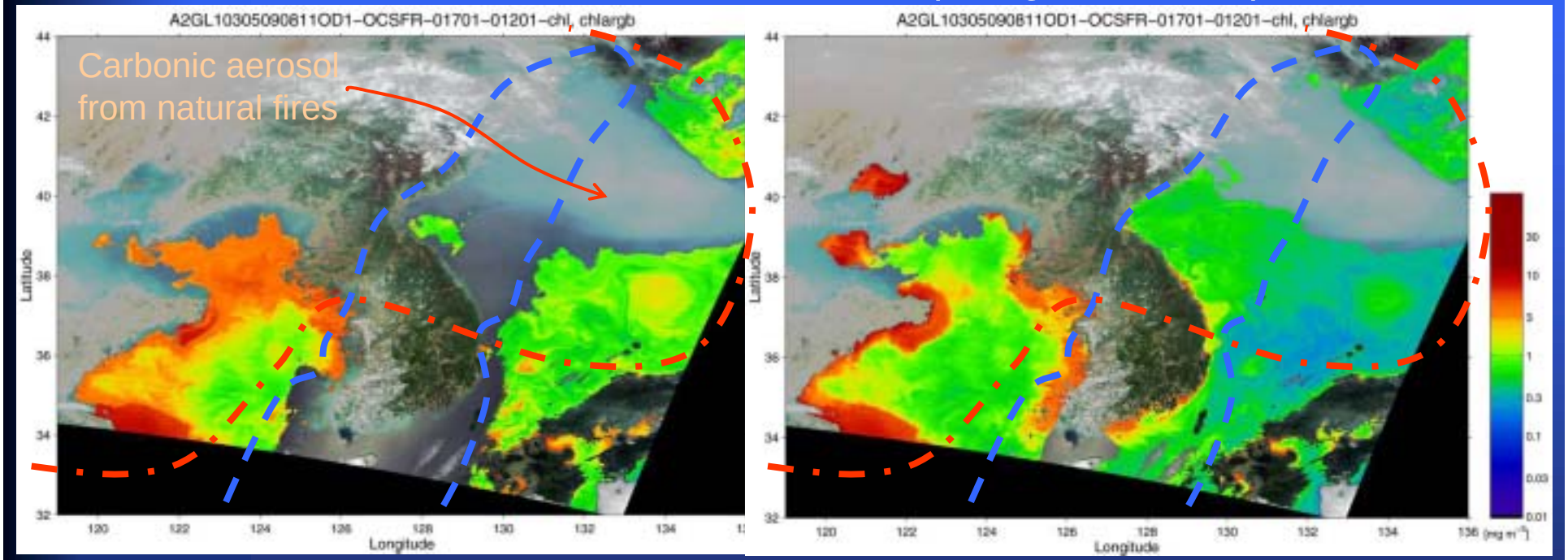
*[*1] atmospheric correction, [*2] SS, [*3] PAR, [*4] SST*
Analysis & integration: H. Murakami and K. Hosoda

1.1 Atmospheric Correction
(Sunglint and Absorptive Aerosol Corrections)

Ver.1 CHLA **Ver.2** (using same L1B)



2003/05/09 around the Korean Peninsula

1. **Sunglint correction** estimates surface reflectance using SeaWinds Level-3 wind speed data
2. **Absorptive aerosol correction** estimates aerosol absorption using CH1 (380nm) observation and simulated nLw _380 by in-water optical model

1.2 Suspended Solid Concentration (SS)

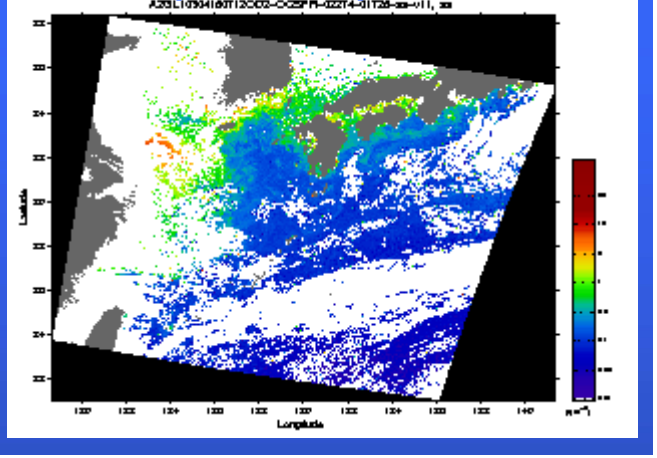
New features of Ver.2 SS (neural network)

1. **Parameters in the in-water optical model** are refined by newly collected in-situ measurements. The model makes training data for the neural network (NN).

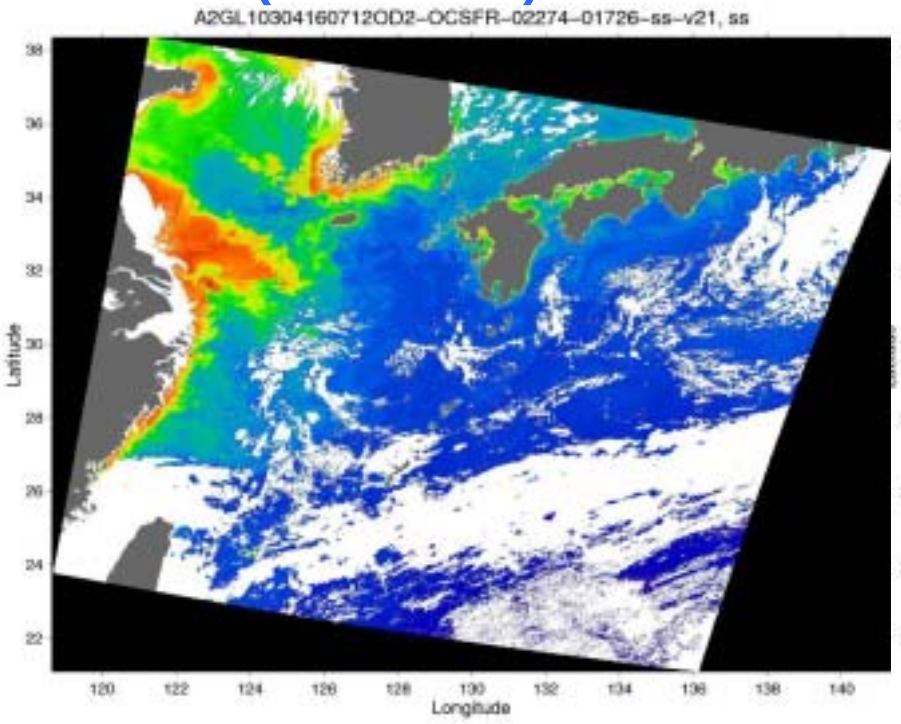
Ver.1 SS was lower than in-situ SS

Ver.2 SS improved the under estimation

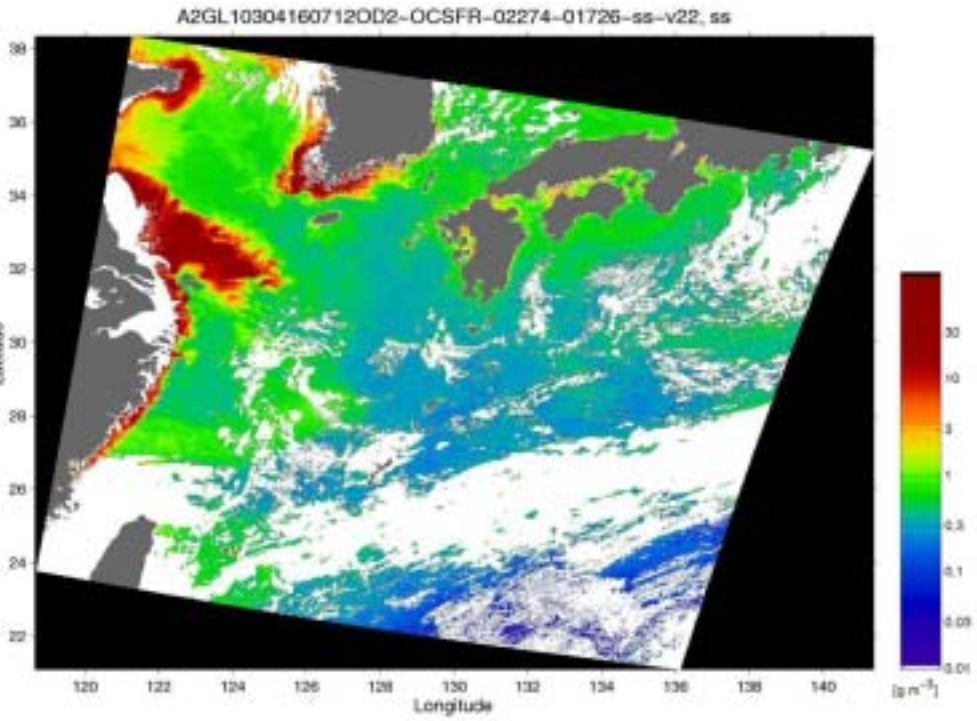
Ver.1 SS (Ver.1 nLw)



Ver.1 SS (Ver.2 nLw)



Ver.2 SS



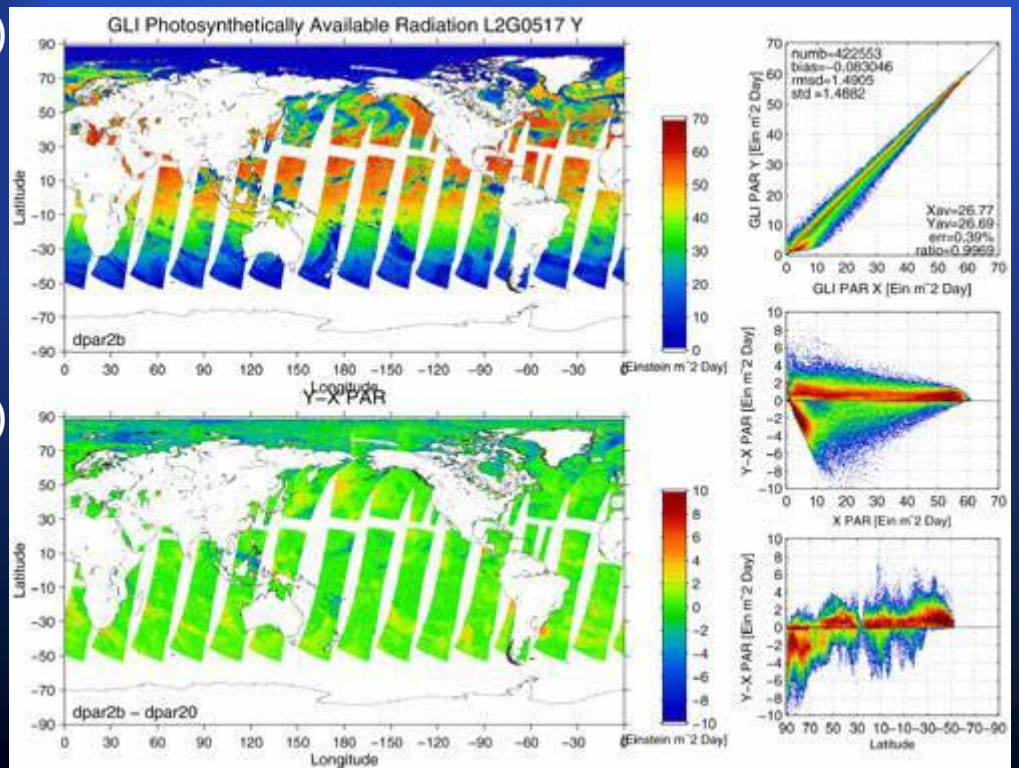
1.3 Potosynthetically Available Radiation (PAR)

New features of Ver.2 PAR algorithms:

1. **Diurnal variability of clouds** is considered statistically (using a regional diurnal albedo climatology based on 5 years of ERBS data; monthly, 2.5 degree resolution, 16 local times from 05:30 to 20:30)
2. **Surface albedo parameterization** is modified (as a function of sun zenith angle and fractions of direct and diffuse incoming sunlight)

(a)

(b)

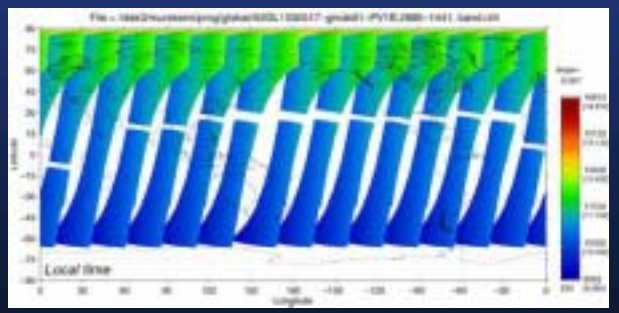


(a) Ver.2 PAR on 2003/05/17

(b) Ver.2 – Ver.1

(c) GLI observation local time

(c)



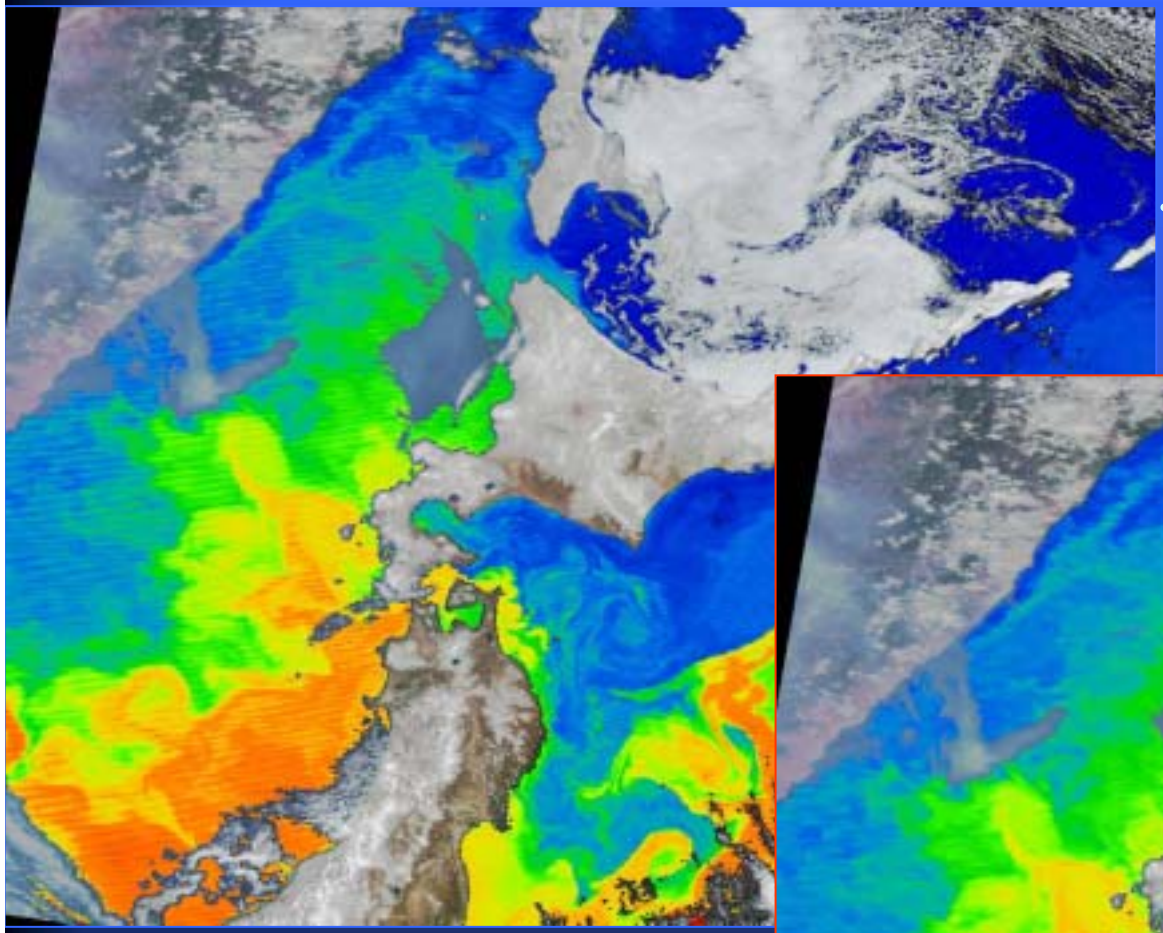
1.4 Sea Surface Temperature (SST)

New features of Ver.2 SST algorithm:

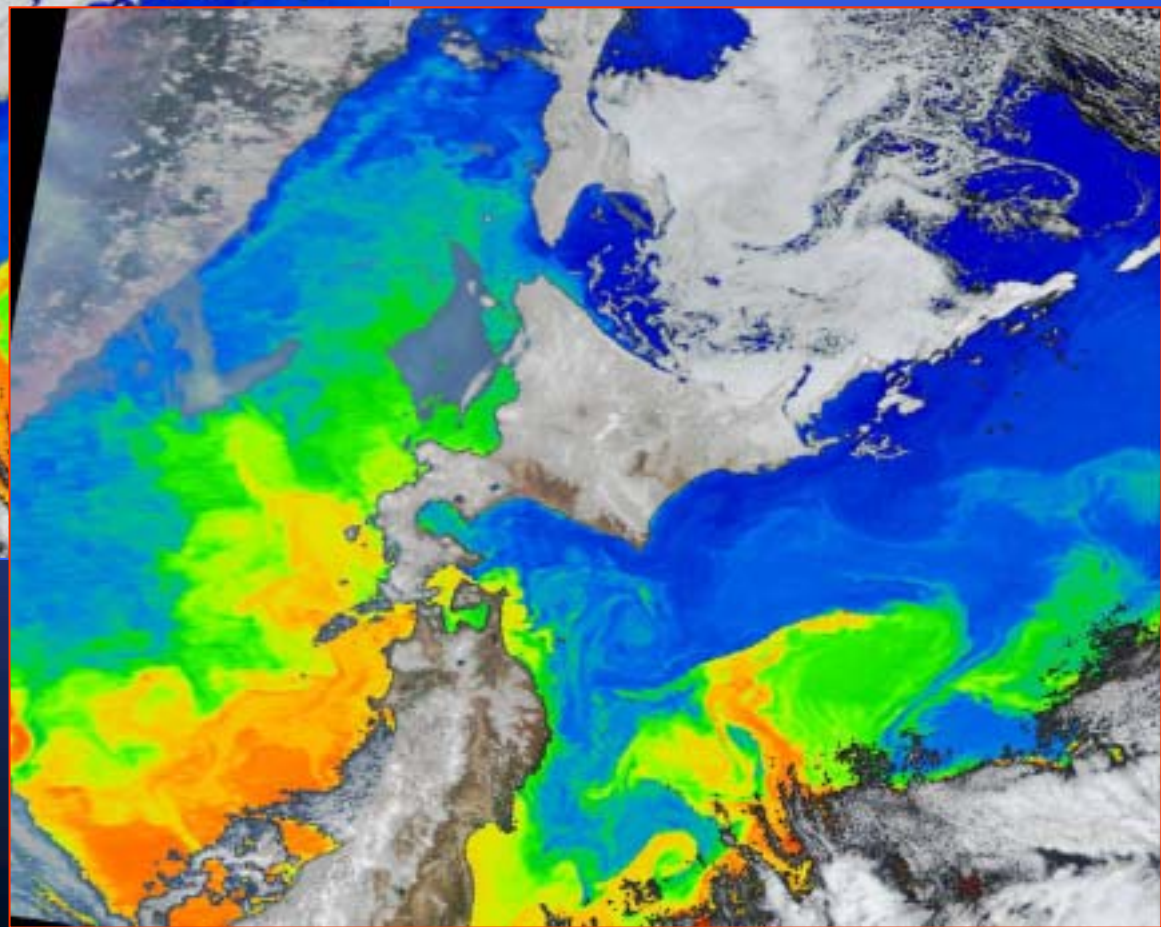
1. **MCSST coefficients was remade using new L1B :**
   - **stripe noise correction (simulate ver.2 radiance),**
   - **geometric correction (ver.1)**
2. **3.7μm (CH30) was included in the nighttime MCSST coefficients (separated for day and night)**
3. **Electric noise correction is applied to MTIR data**
4. **Cloud screening scheme was refined**

→ RMSE decreased from 0.83 to 0.66 K (0.74 to 0.70) in daytime (nighttime)

1.5 Electric Noise Correction (Version 2 SST)



Ver.1 SST



Ver.2 SST

2004/04/10 East Japan

2. Validation Results

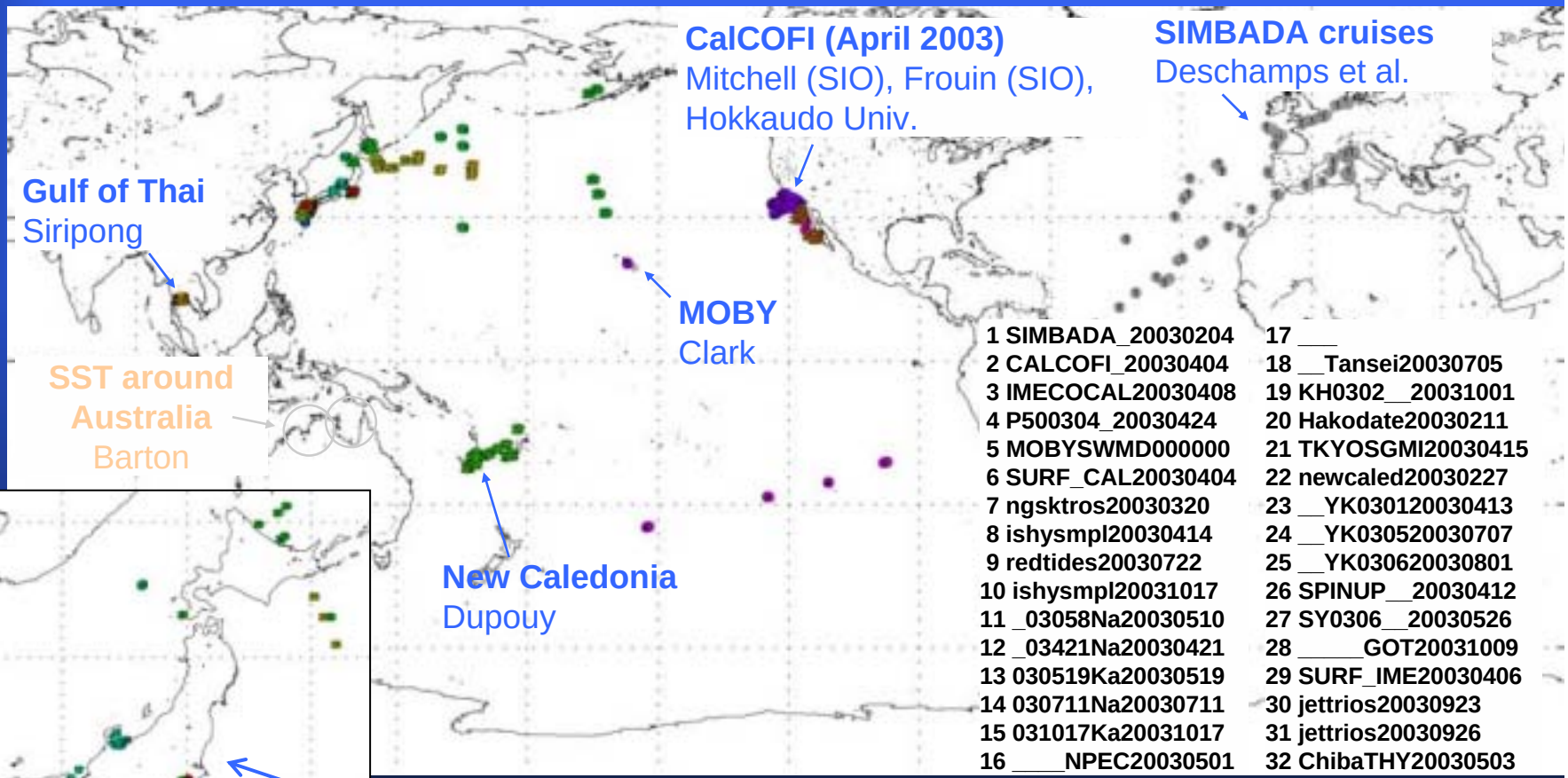
***Match-up analysis** and comparison with other satellite datasets:*

- **nLw and Tau_a**
- **In-water products**
- **PAR**
- **SST**

In-situ observation and data analysis:
Validation PI, Algorithm PI, GAIT, and collaborators

2.1 In-situ Observations (ocean color)

- *Available match up data was increased (about twice) after Ver.1*
- *Clear match-ups: 50~400 nLw (~300: SIMBADA), and 30-150 in-water parameters*



Japanese Univ. and Institutes
Ishizaka (Nagasaki), Kishino (Tokyo-Ocean), Saito (Hokkaido), NFRI (Seikai-ku, Tohoku), NPEC, JCG, JAMSTEC, EORC, etc.

2.1 In-situ Match Up Observations

instruments		*targets*	*wavelength nm*	*nLw*
	PRR600/610 under & above	•downward irradiance (Ed^+) •upward radiance (Lu^-) •sky irradiance (Es^-)	412, 443, 490, 520, 565, 670 and PAR	Calculate water leaving radiance (Lw) by upward radiance profile Lu. nLw is normalized by Lw, Ed and F0.
	MER2040/2041 under & above		412, 443, 465, 490, 510, 520, 555, 565, 625, 665,670,683 and PAR	
	Free Fall under & above		380, 400, 412, 443, 455, 490, 520, 555, 565, 620, 665, 683, 705 and PAR	
	TRIOS above only	•downward irradiance (Ed^+) •upward radiance (Lu^+) •downward radiance (Ls^+)	350-950nm 1nm intervals	normalize Lu by Ed, F0 and sea surface reflection factor.

2.2 Match-up Results (Version 1 nLw)

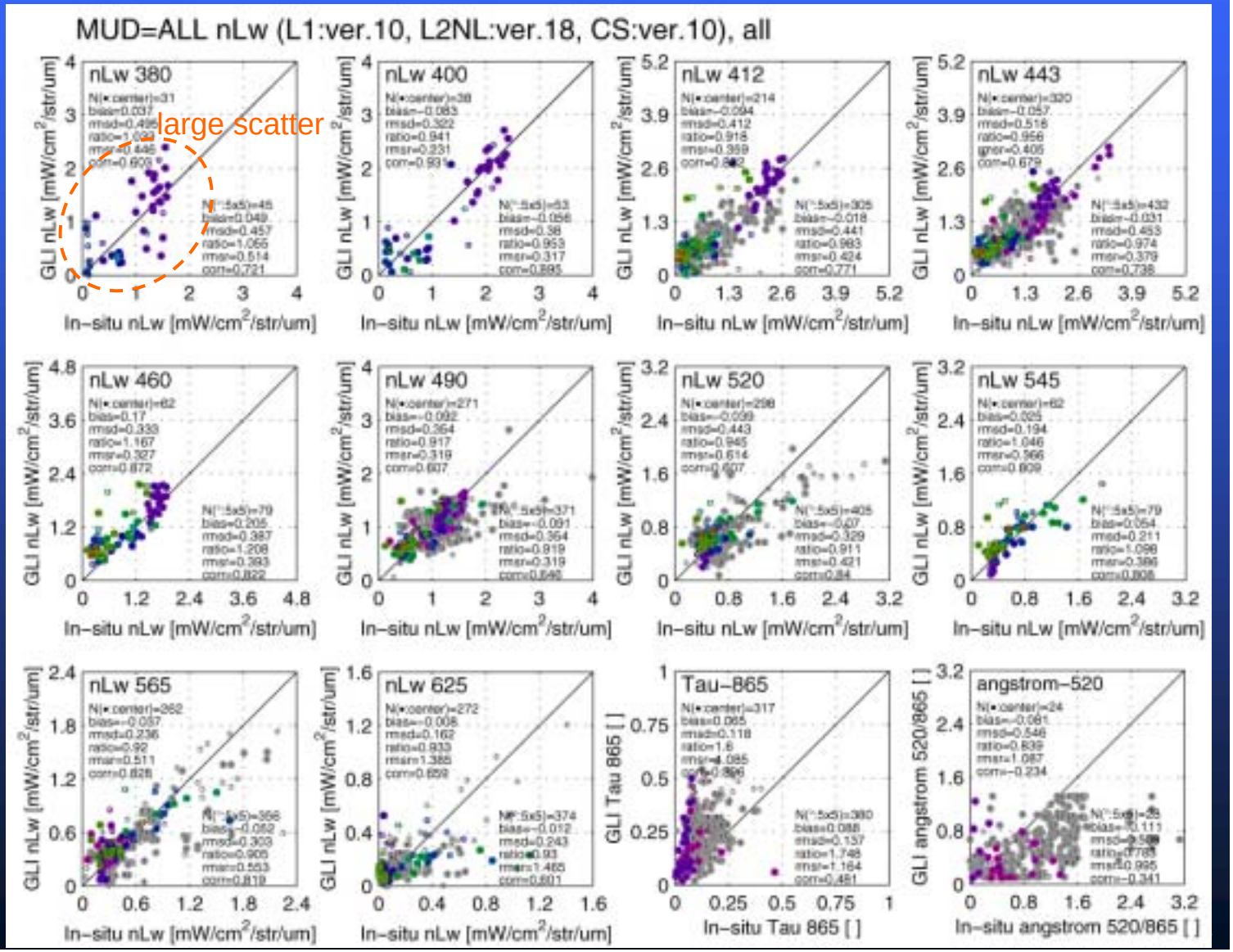
- *Problems of the Ver.1 nLw were large scatter at 380nm and negative nLw*

Ver.1 tests including the new match ups

nLw (380-625 nm) , Tau_865, and angstrom_520

X-axis: in-situ,

Y-axis: GLI



2.2 Match-up Results (New Vical + Ver.1)

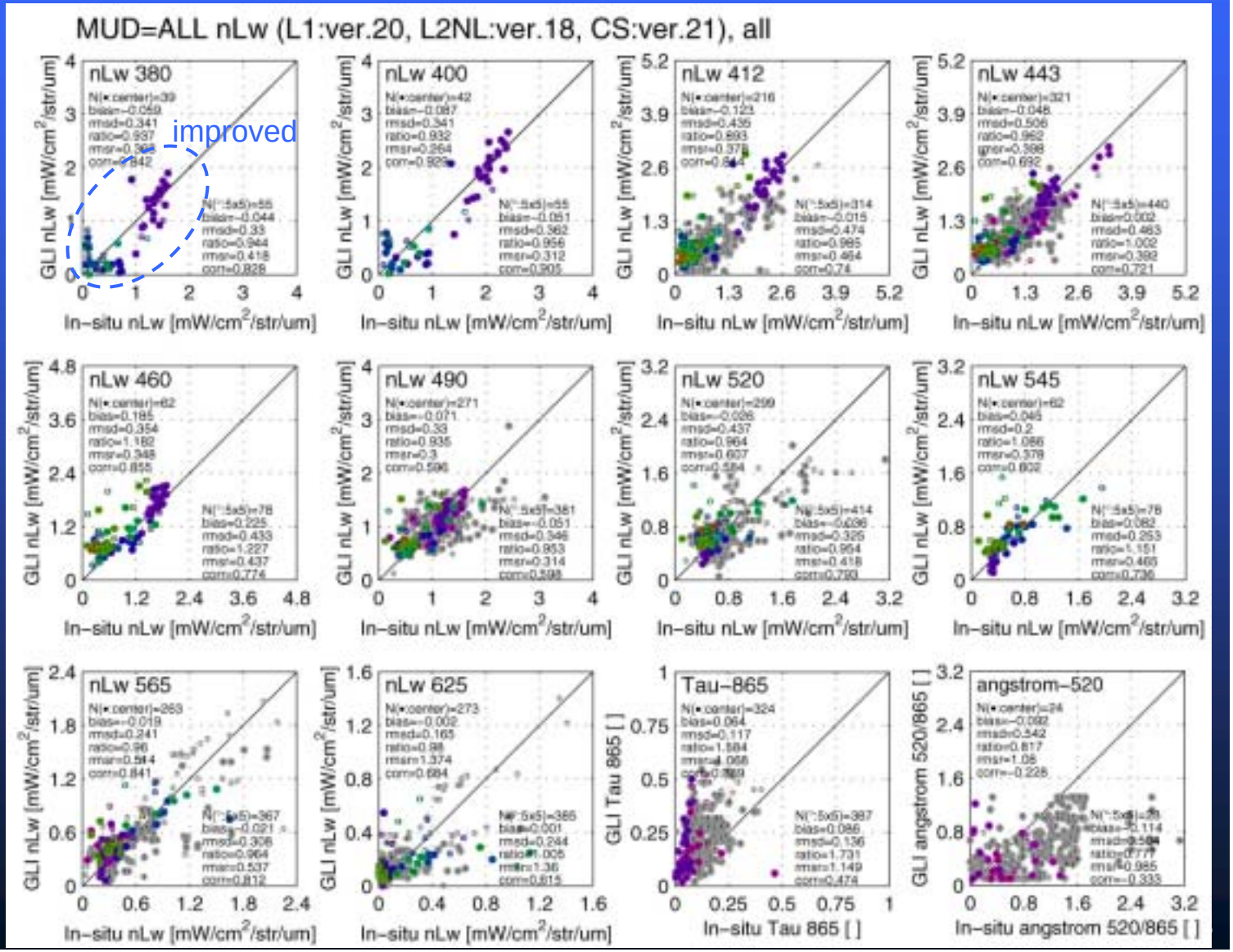
- **Large scatter of nLw 380nm is improved by vicarious calibration considering time and scan-angle.**

Ver.1 tests using new vical coefficients

nLw (380-625 nm) , Tau_865, and angstrom_520

X-axis： in-situ,

Y-axis: GLI



2.2 Match-up Results (Version 2 nLw)

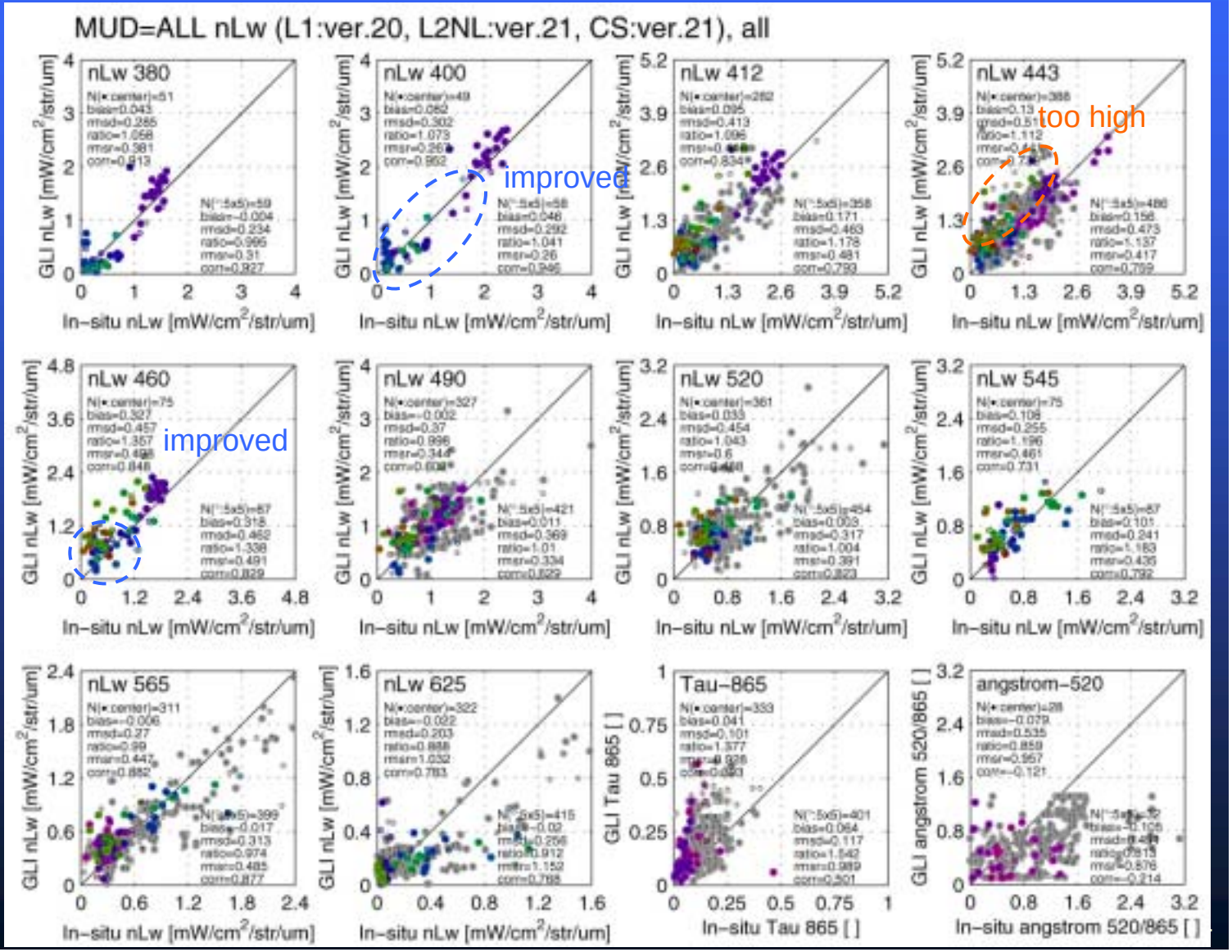
- **Negative nLw is improved by the absorptive aerosol correction (accuracy and available data number).**

Ver.2 tests using new vical coefficients

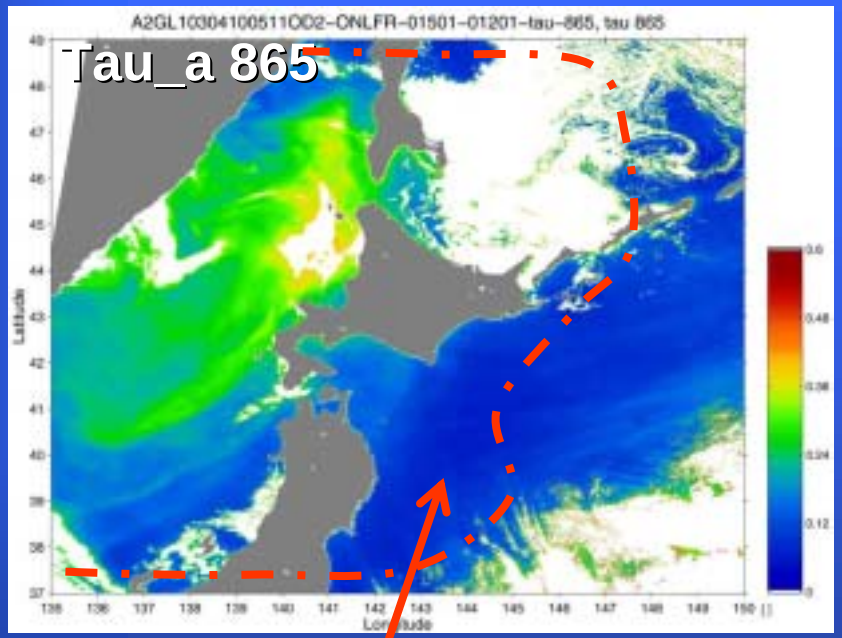
nLw (380-625 nm) , Tau_865, and angstrom_520

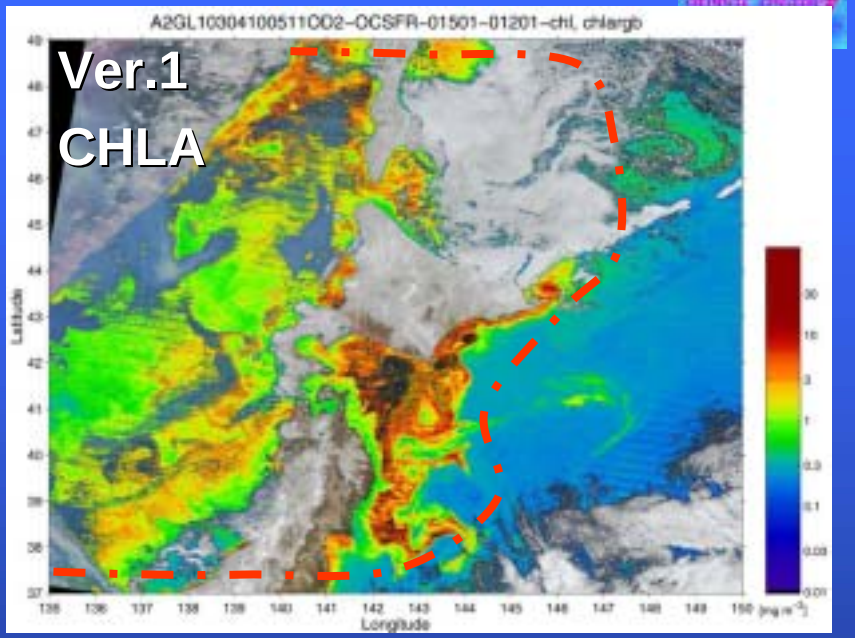
X-axis： in-situ,

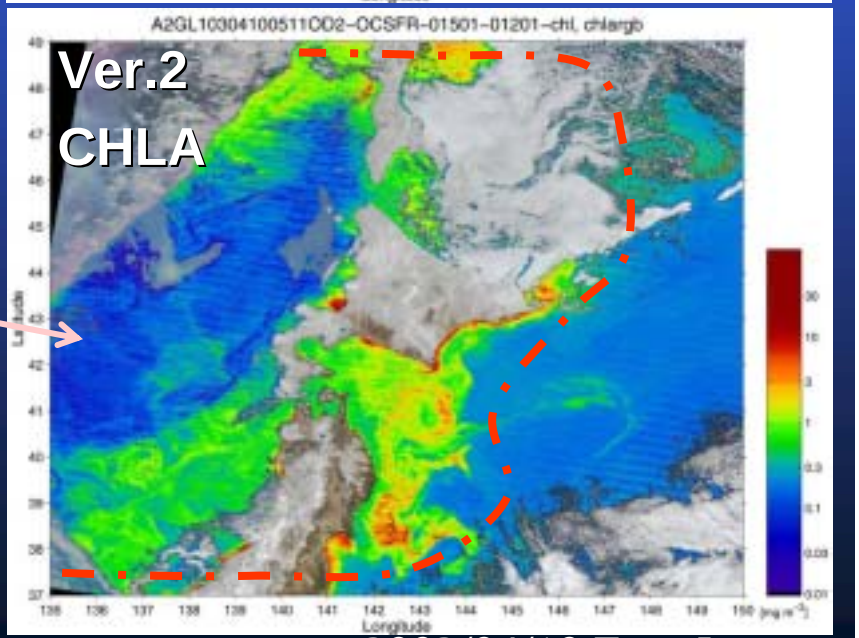
Y-axis: GLI



2.2 Absorptive Aerosol Correction







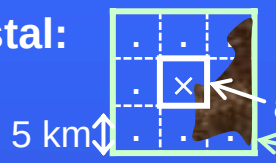
Absorptive aerosol influenced frequently around Japan

nLw in blue channel is too high

It makes better, but the absorptive factors and in-water model should be refined more.

2.3 Match-up Results (Version 1 in-water parameters)

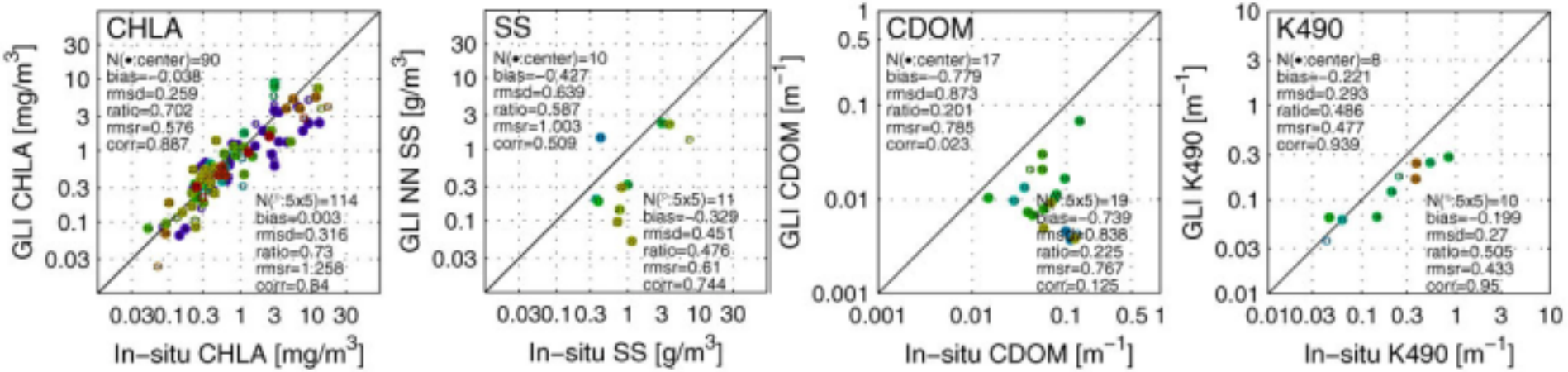
- Sample number is increased by collection and reanalysis of in-situ data
- Accuracy in the coastal area was not enough. (coastal: a>0.05 or b>0.1)



CHLA SS CDOM K490

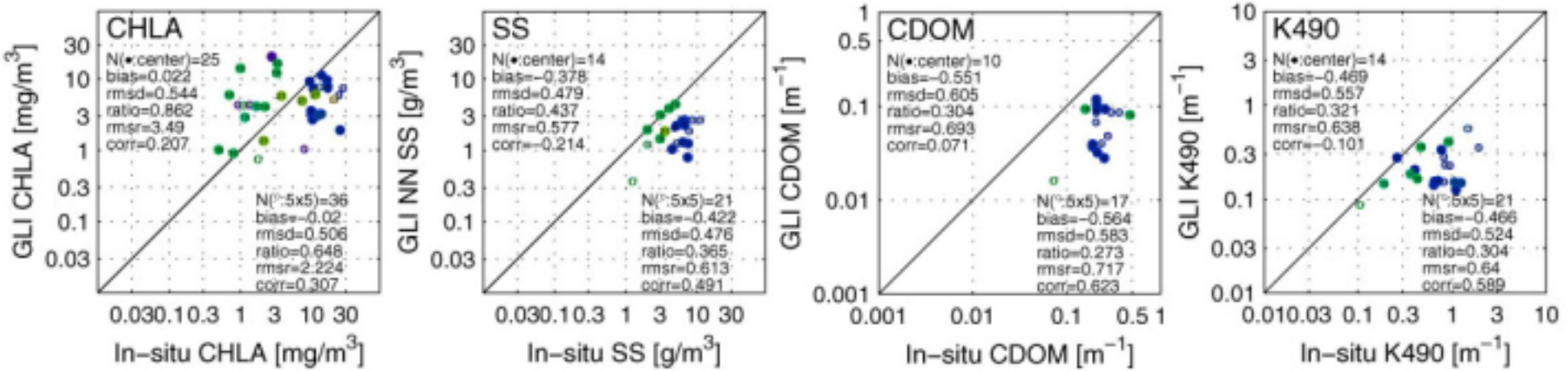
Ver.1 offshore

L:ver.18, CS:ver.10), offshore



Ver.1 coastal

.:ver.18, CS:ver.10), coastal



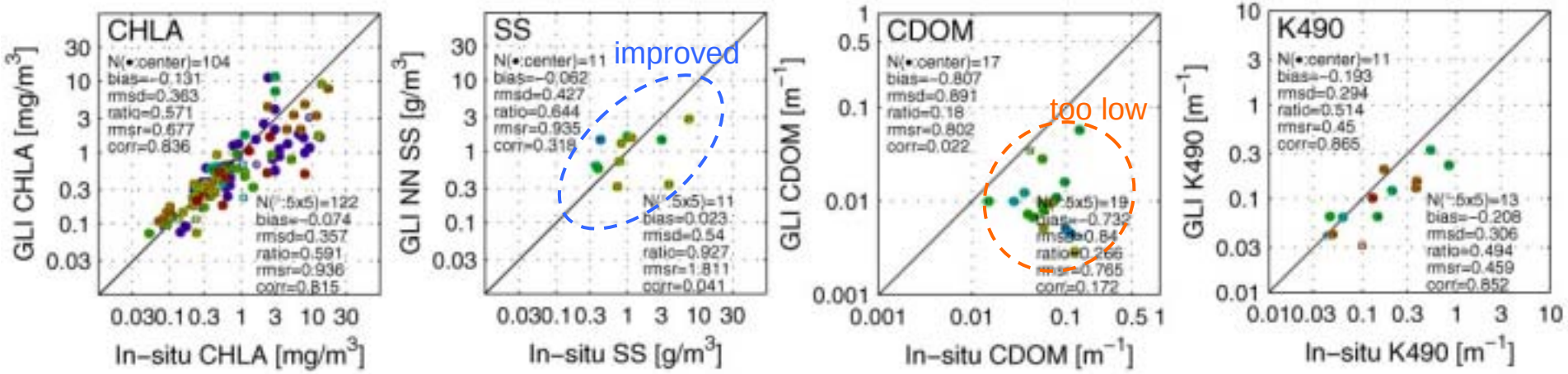
2.3 Match-up Results (Version 2 in-water parameters)

- Available data number is increased by the atmospheric correction algorithm
- SS algorithms are revised in Ver.2.
- Accuracy in the coastal area is still not enough.

CHLA SS CDOM K490

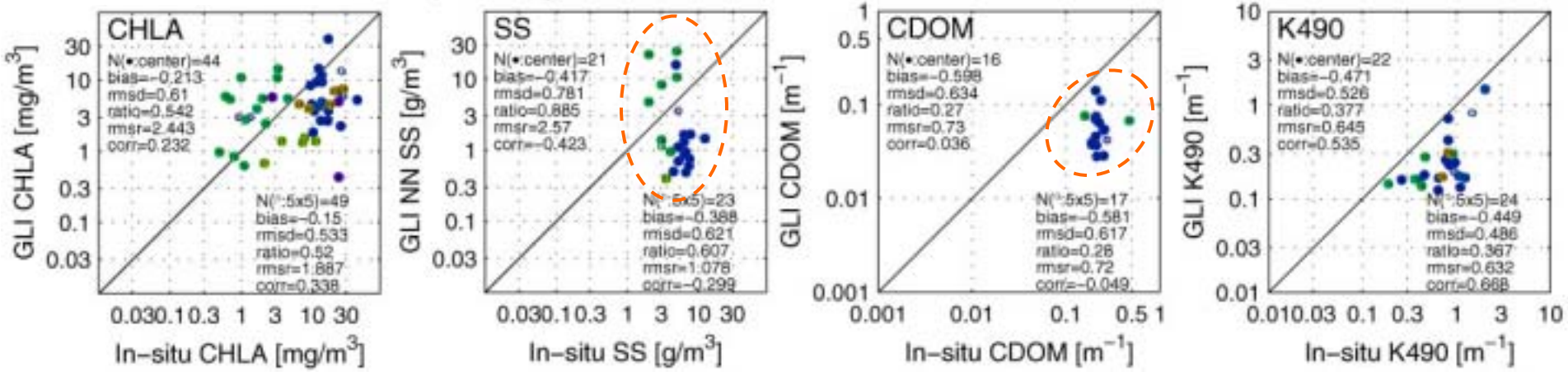
Ver.2 offshore

L:ver.21, CS:ver.21), offshore



Ver.2 coastal

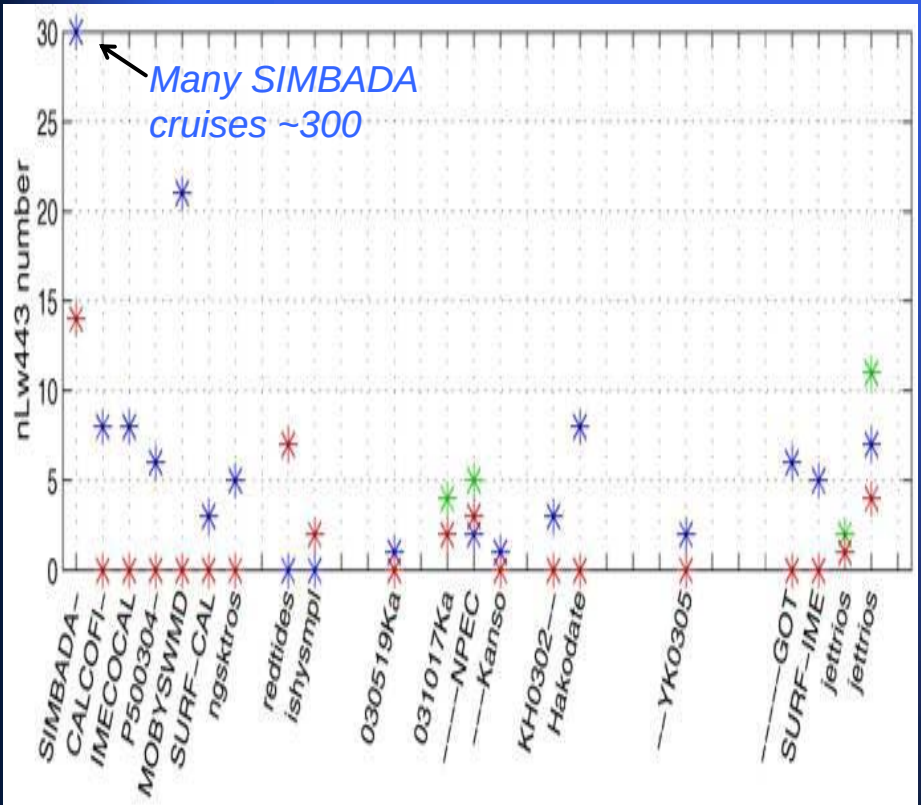
L:ver.21, CS:ver.21), coastal



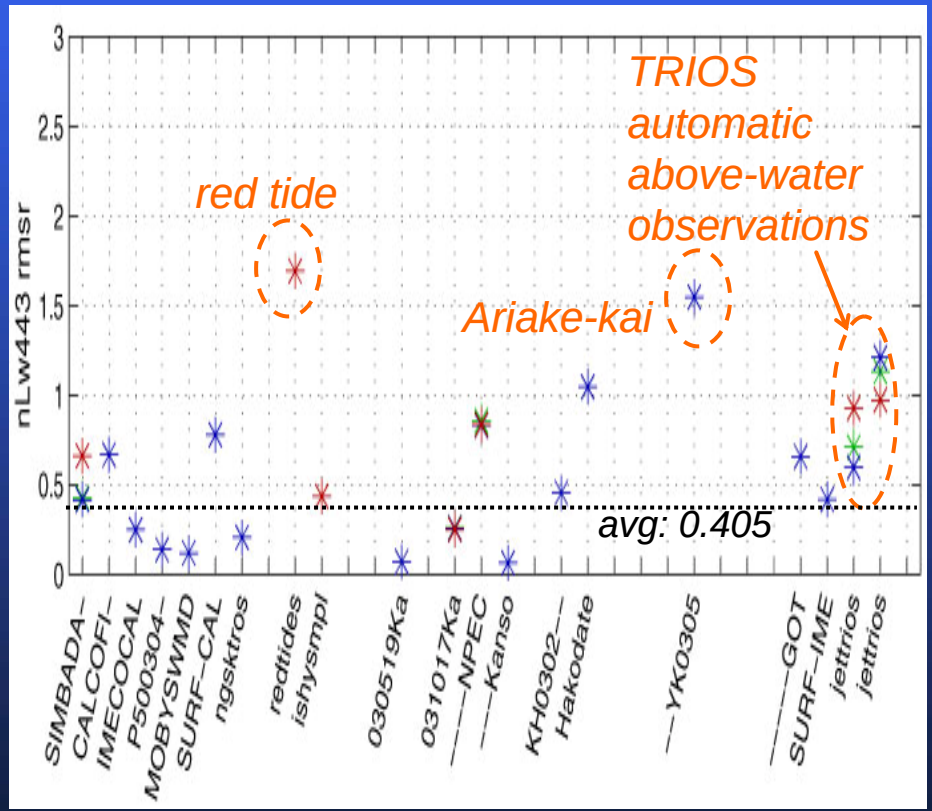
2.4 Results of Each Cruises (Version 1 nLw_443)

- nLw_443nm

Number



RMSR = RMSD / In-situ Average



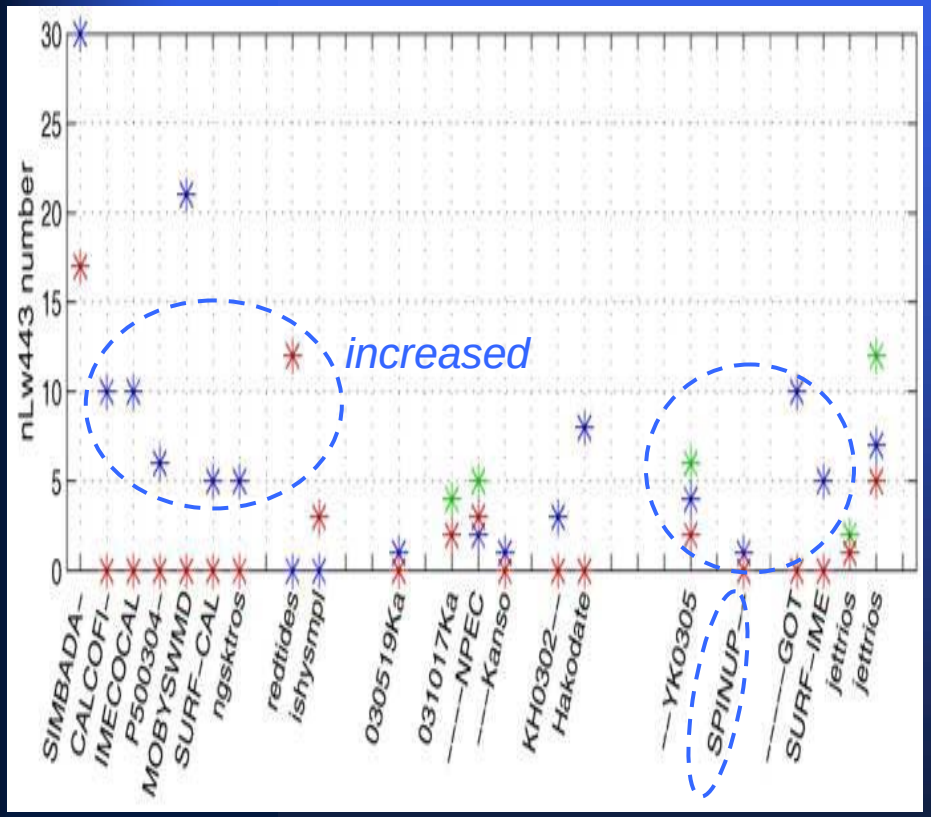
Green: all, Blue: Offshore, Red: Coastal

2.4 Results of Each Cruises (Version 2 nLw_443)

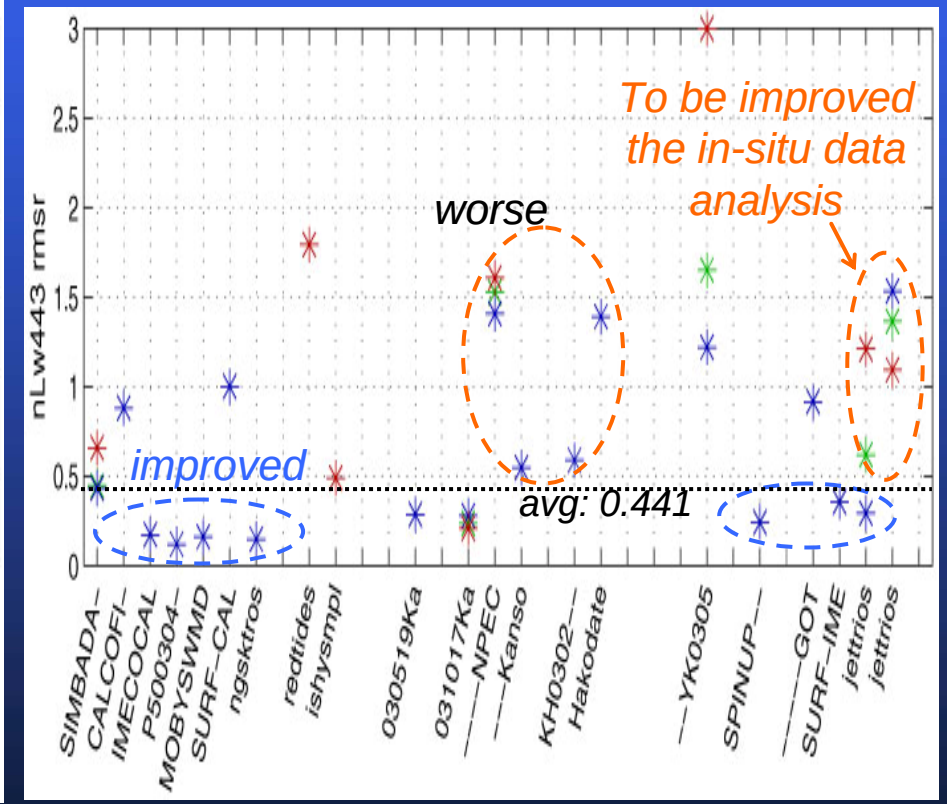
- Available data number is increased by the level-2 algorithm
- Some cases better, and some cases worse.

(X: in-situ, Y: GLI)

Number



RMSR = RMS(Y-X) / X-average



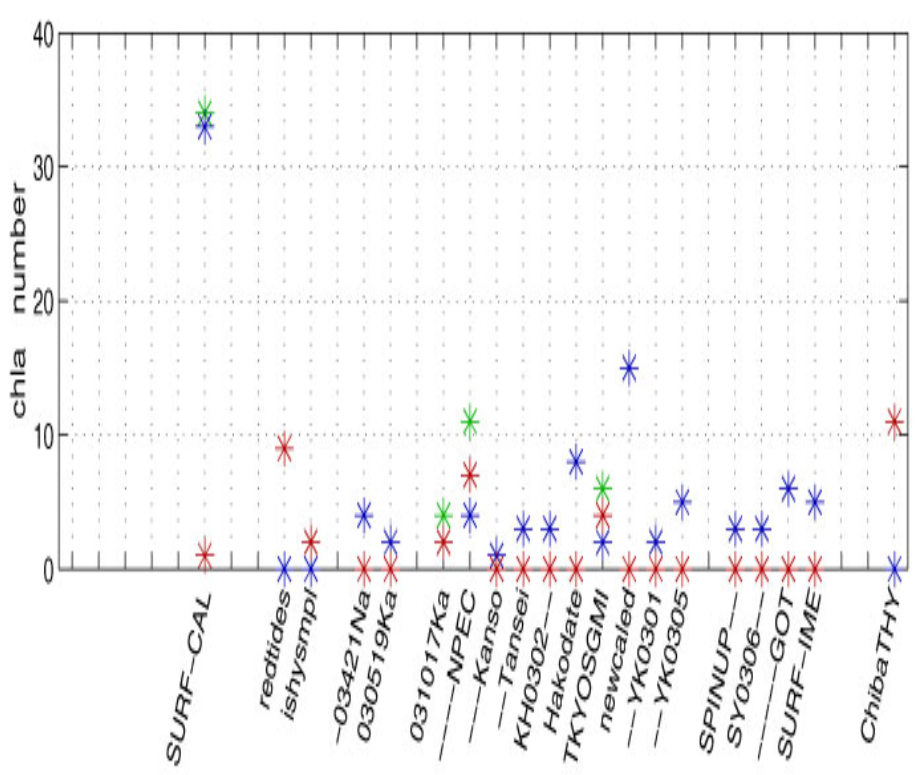
Green: all, Blue: Offshore, Red: Coastal

2.4 Results of Each Cruises (Version 1 CHLA)

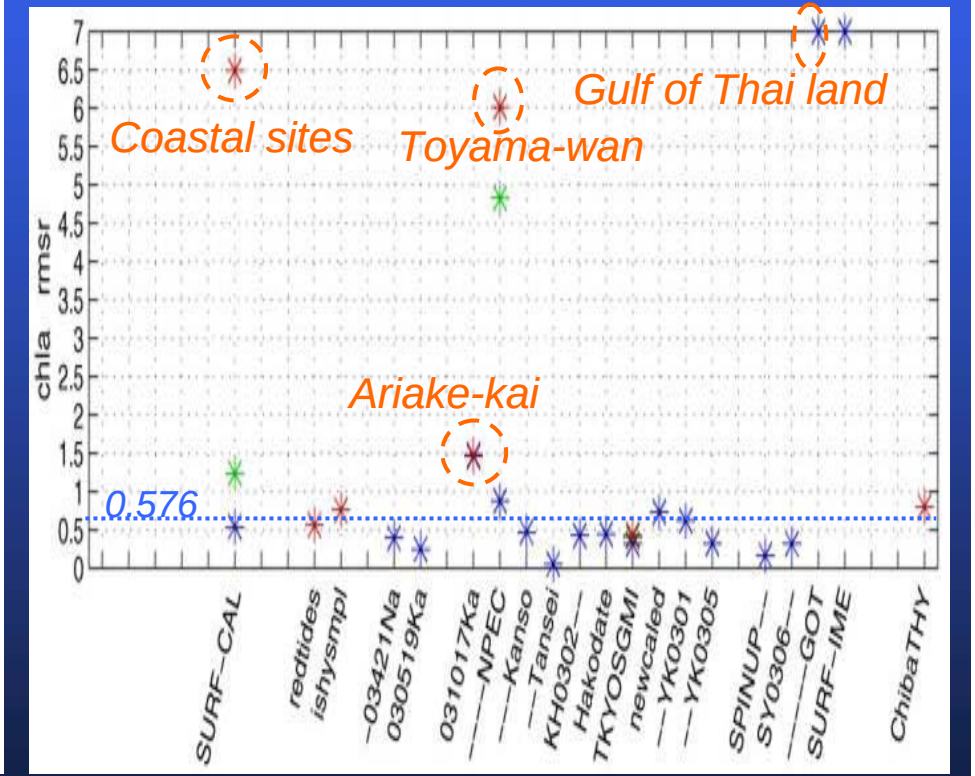
- CHLA

(X: in-situ, Y: GLI, linear scale)

Number



RMSR = RMS((Y-X)/X)

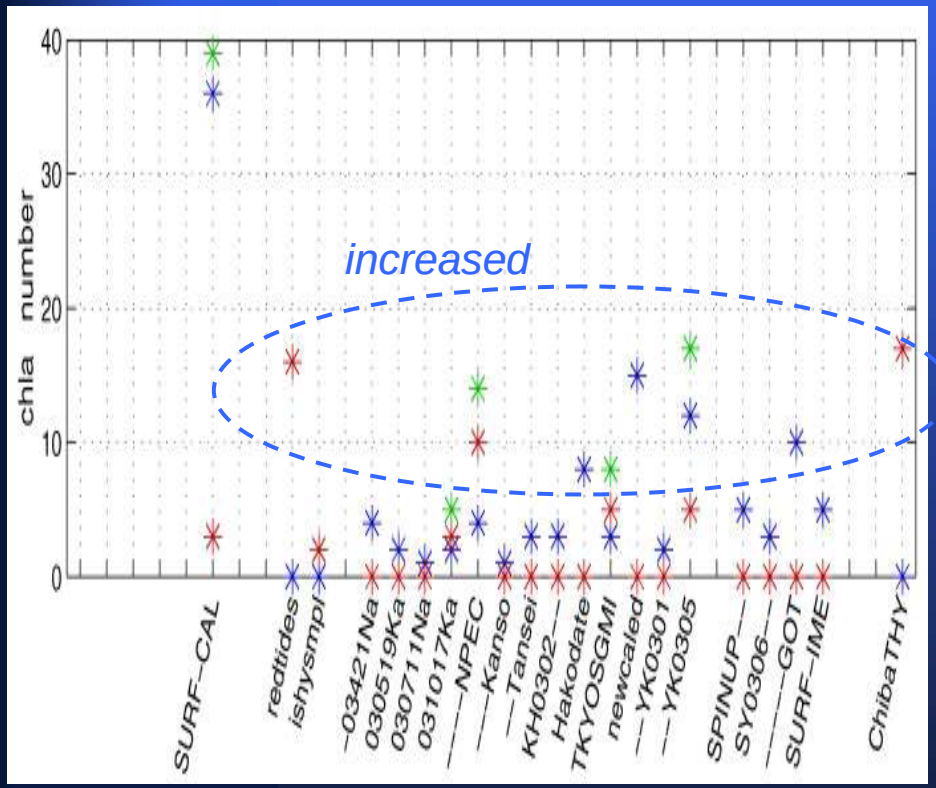


Green: all, Blue: Offshore, Red: Coastal

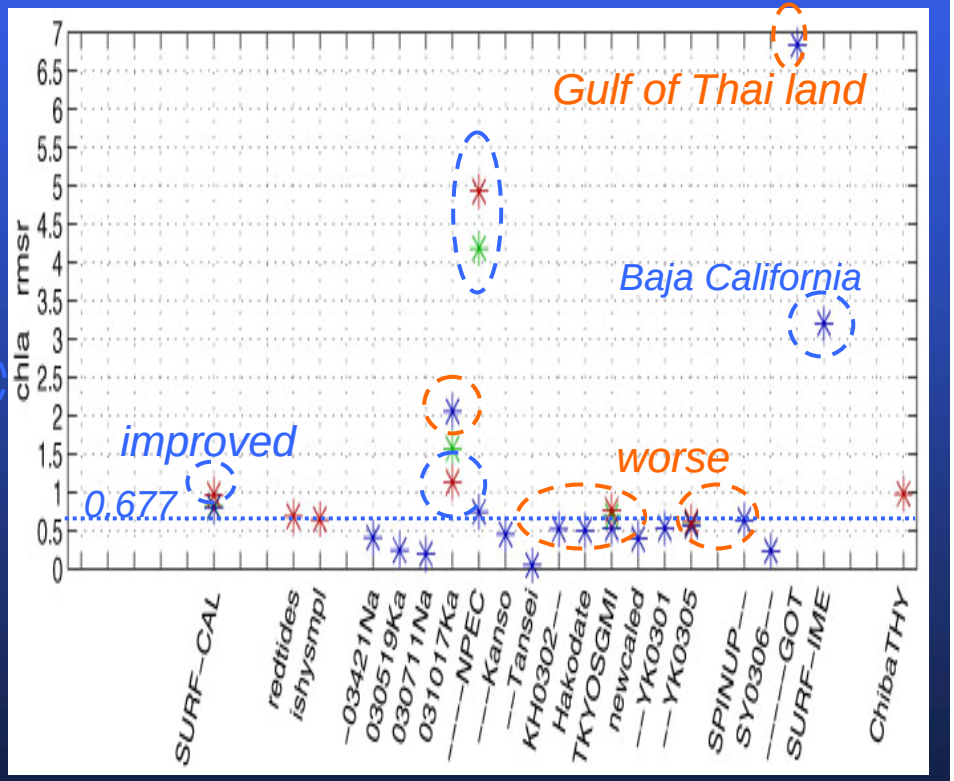
2.4 Results of Each Cruises (Version 2 CHLA)

- Available data number is increased by the level-2 algorithm
- Some cases better, and some cases worse.

Number



CHLA



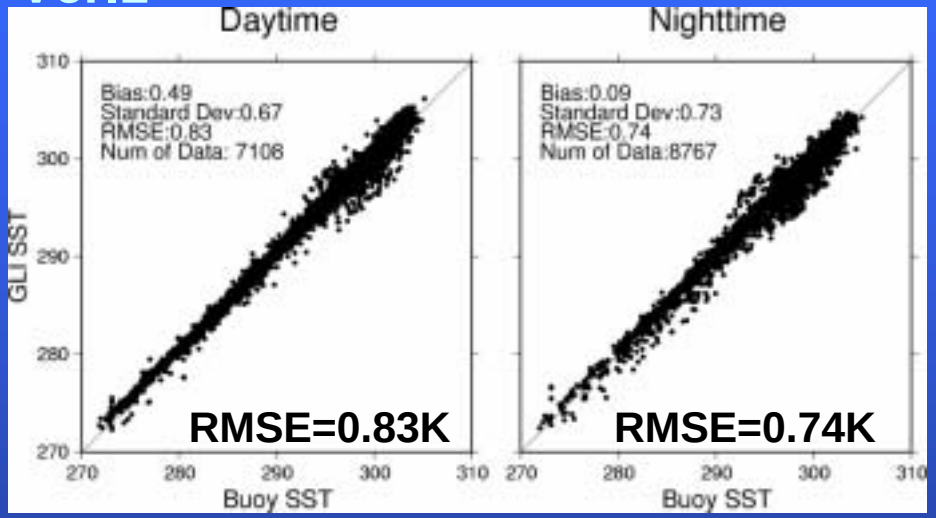
Green: all, Blue: Offshore, Red: Coastal

2.5 In-situ Match-ups (Version 1 & 2 SST)

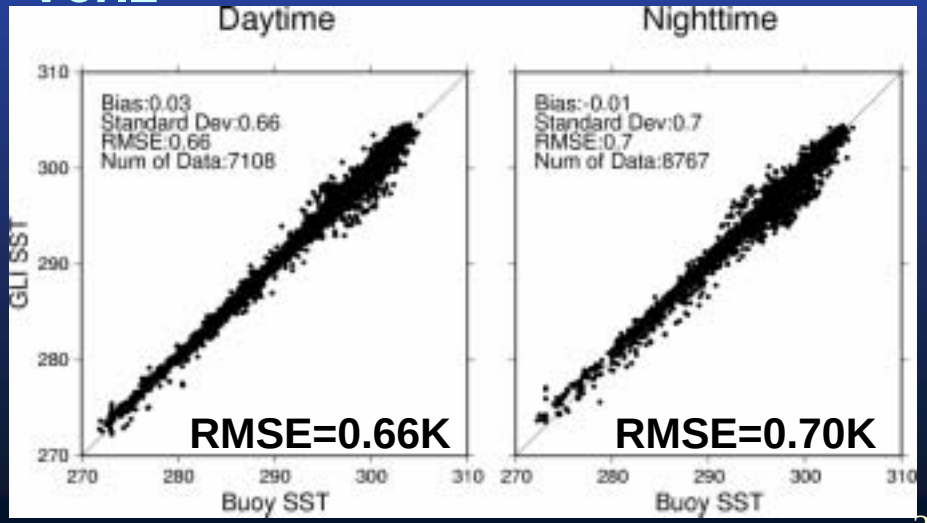
1. GTS data (buoys) is used for the match up.
2. New SST coefficients are derived using new L1B:
   - Stripe noise correction (simulate ver.2 radiance),
   - Geometric correction (ver.1)
3. 3.7μm (CH30) is used for nighttime SST
4. Cloud screening

→improved by 0.04~0.17K

Ver.1

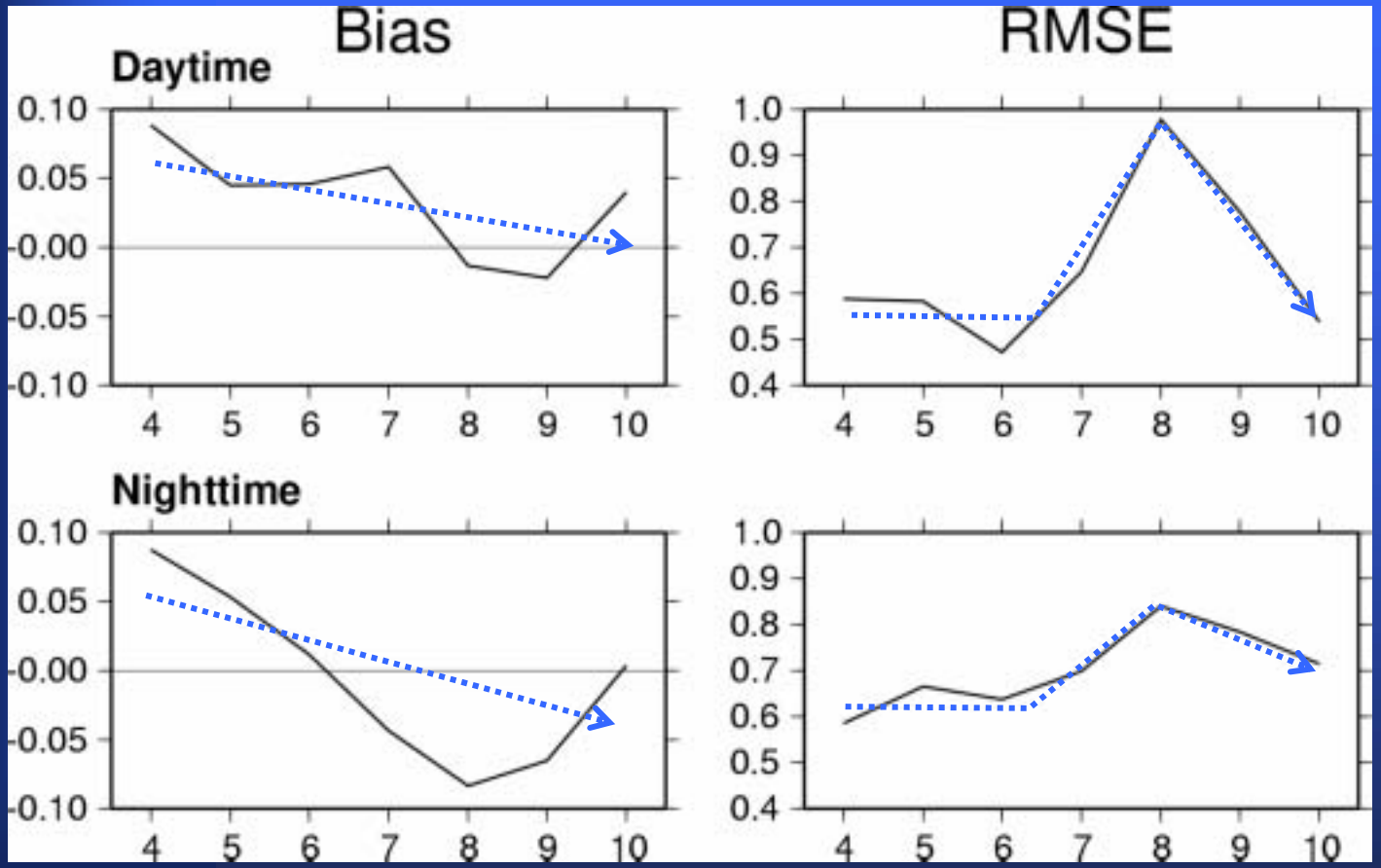


Ver.2



2.5 In-situ Match-ups (Version 2 SST)

Temporal change of estimation error of the SST



Bias and RMSE from April to Octover 2003

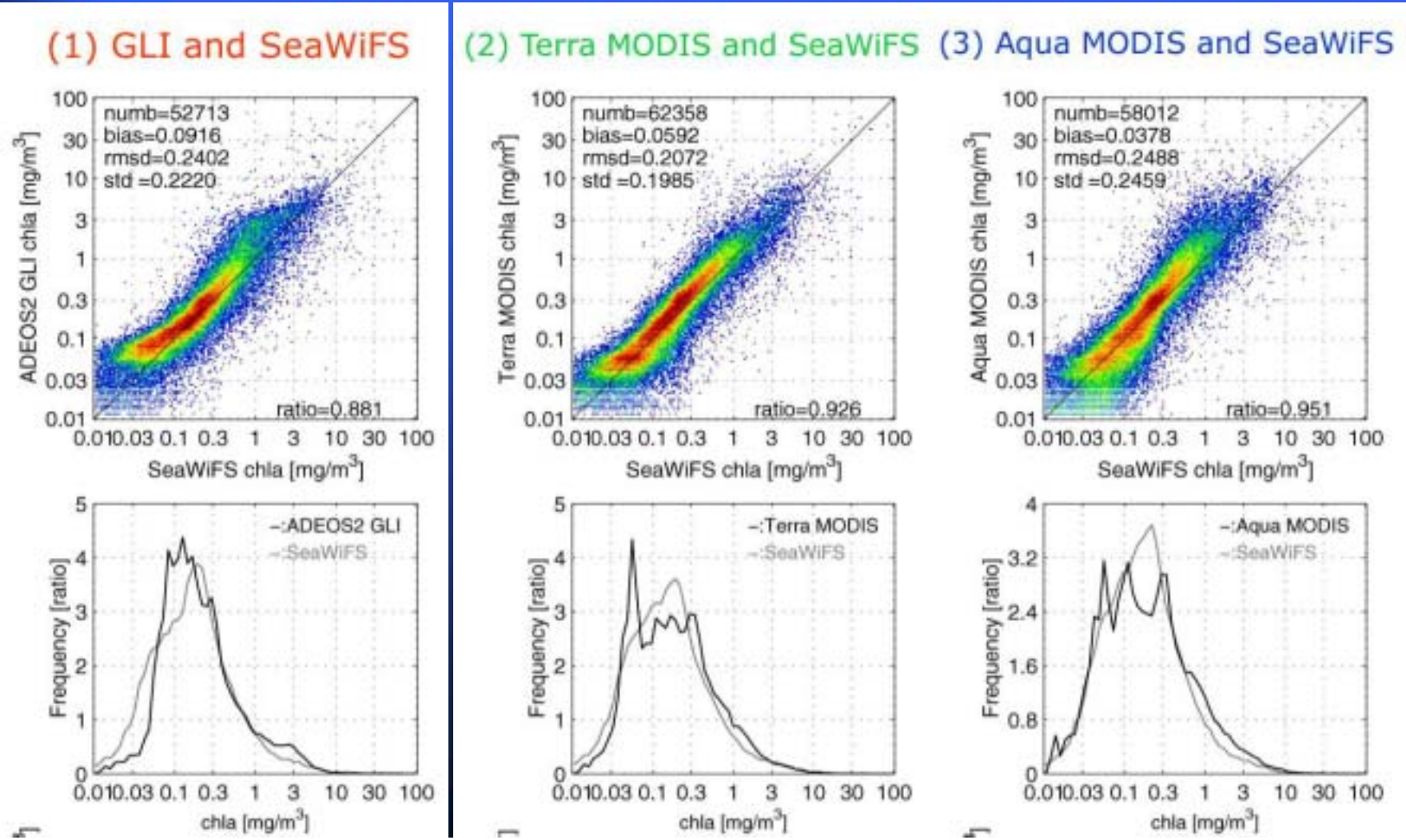
Unit: °C

Bias decreased by 0.05~0.1K during 6 months, RMSE changed and peaked in August 2003.

The reasons may be temporal changes of MTIR channel sensitivity and noise characteristics

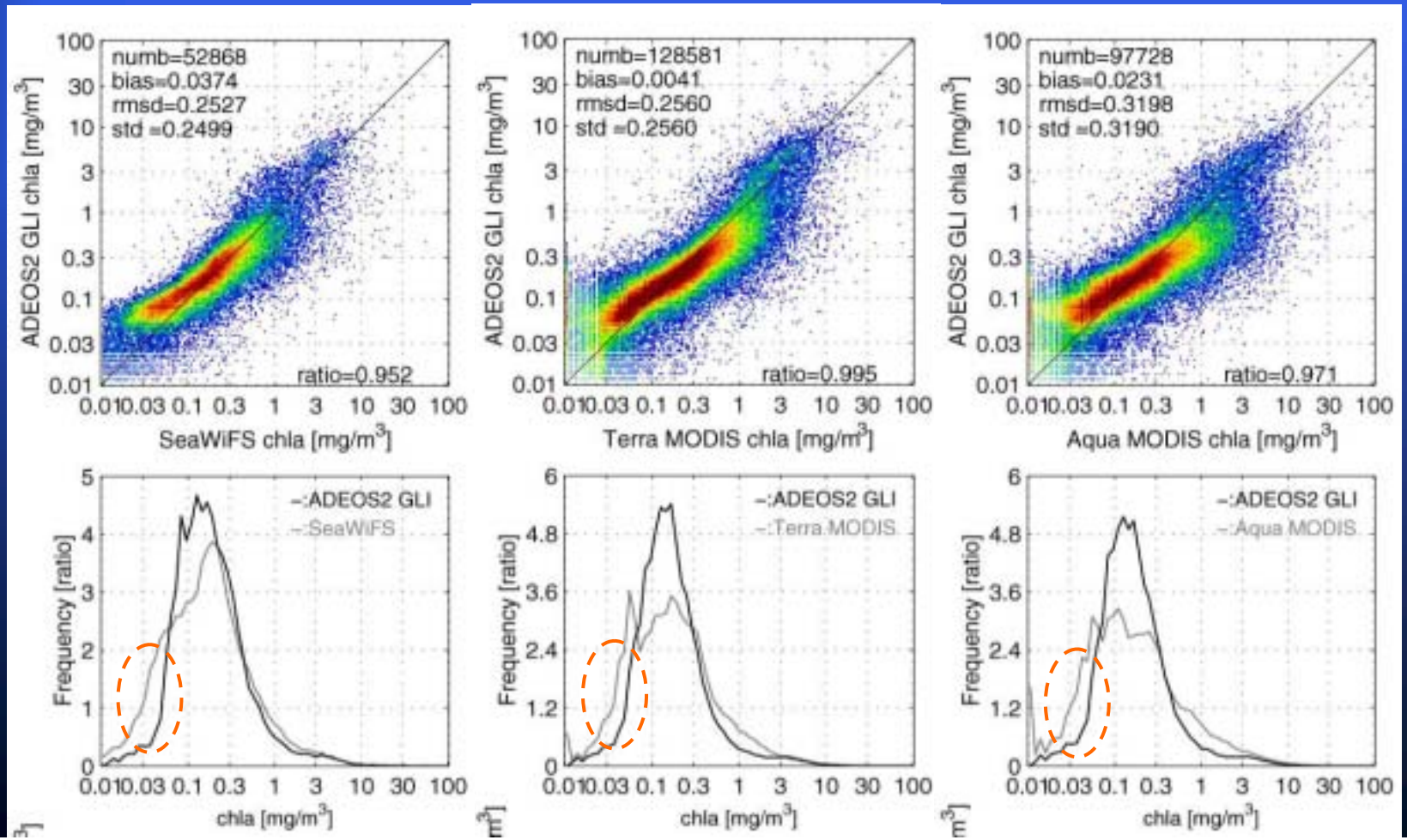
2.6 Comparison with Other Satellite (CHLA)

- **GLI, Terra MODIS and Aqua MODIS on 17 Oct. 2003**
- CHLA by SeaWiFS, Terra and Aqua MODIS are different In high and low ranges.
- After this vical, Terra & Aqua MODIS CHLA are agreed well with SeaWiFS one.



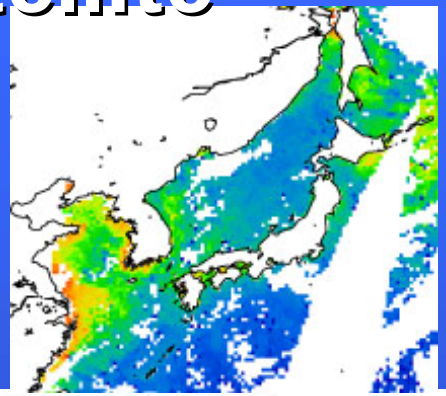
2.6 Comparison with Other Satellite (CHLA)

- **GLI with SeaWiFS, Terra MODIS and Aqua MODIS on 17 Oct. 2003**
- GLI CHLA in low CAHL range has a problem ? Or due to channel difference used in in-water algorithm ?

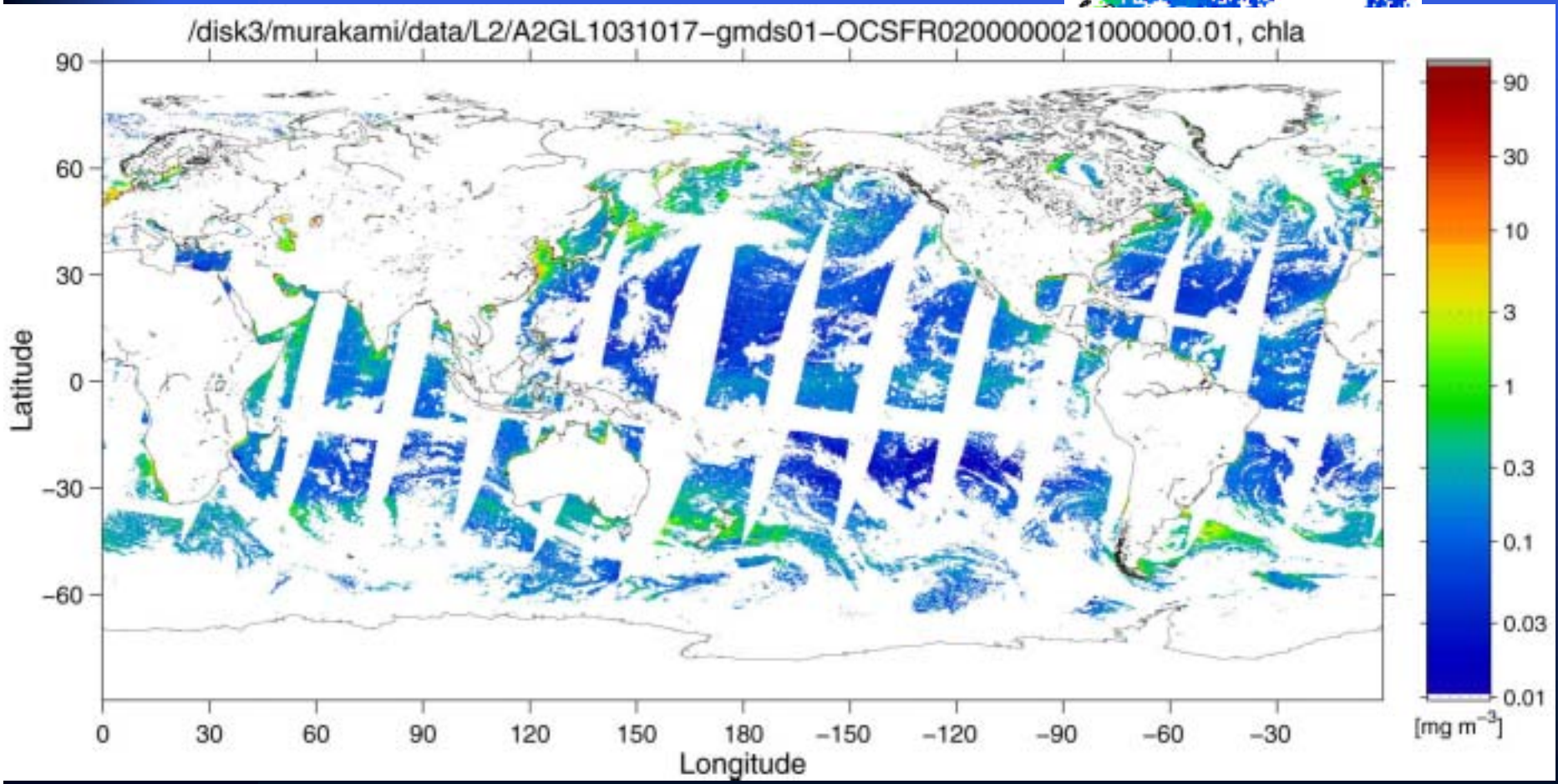


2.6 Comparison with Other Satellite

- **GLI CHLA 17 Oct. 2003**

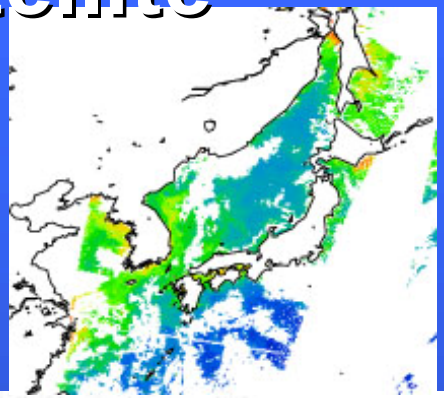


Zoom around Japan

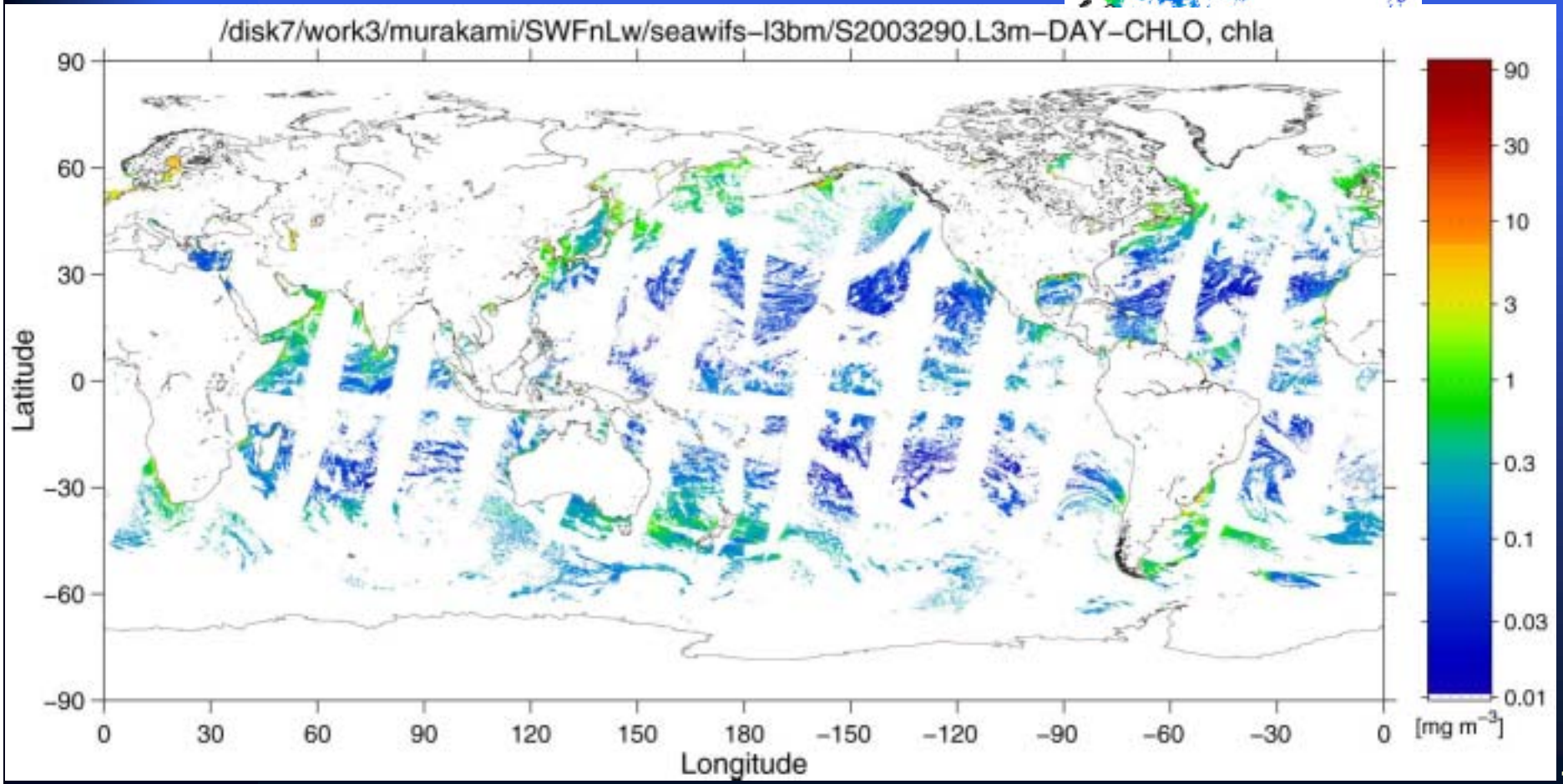


2.6 Comparison with Other Satellite

- SeaWiFS 17 Oct. 2003

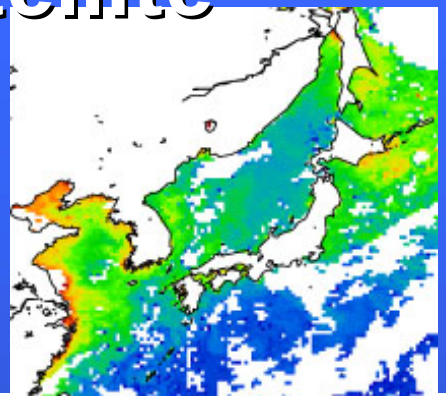


Zoom around Japan

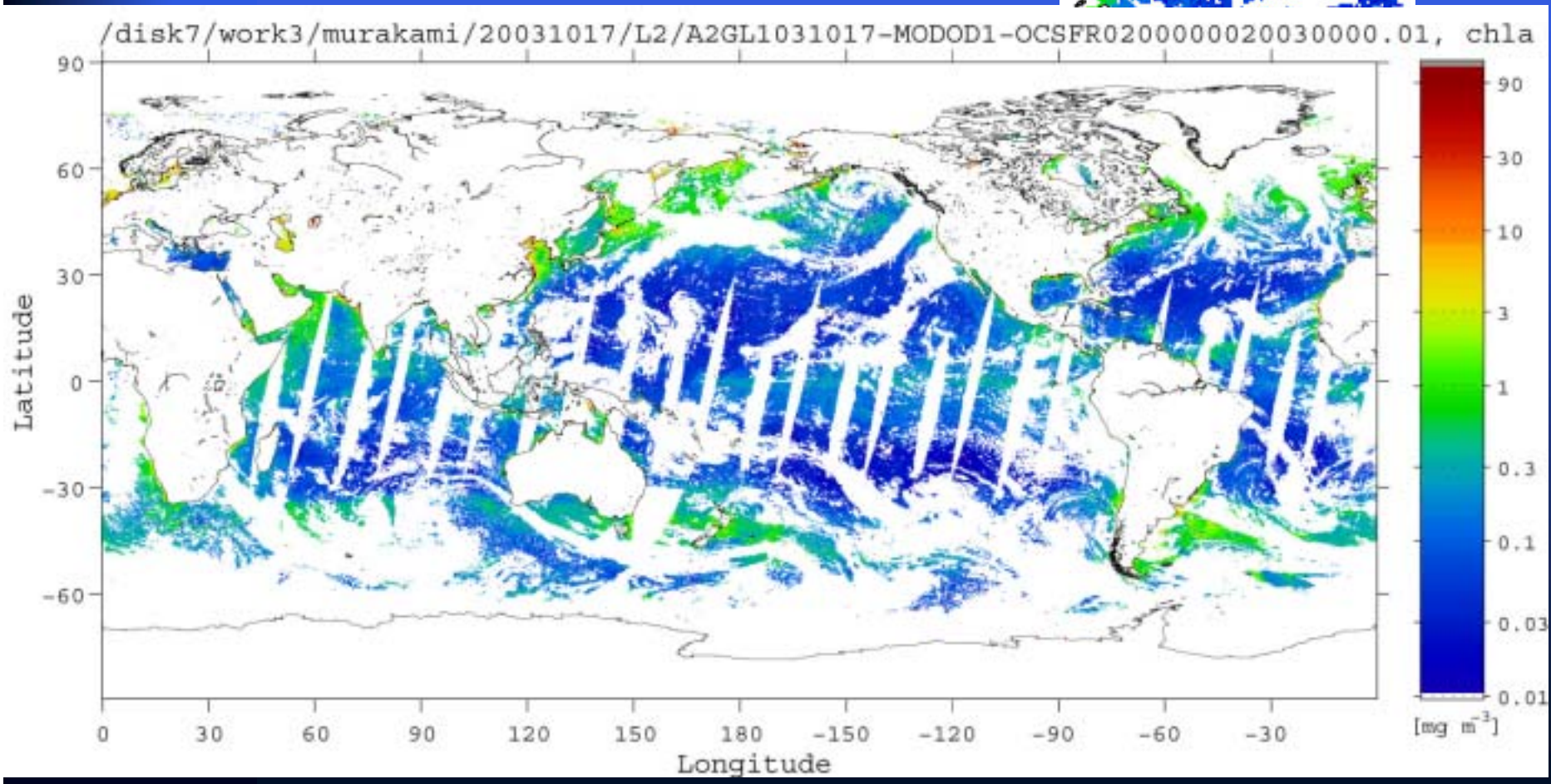


2.6 Comparison with Other Satellite

- **Terra MODIS CHLA (calibrated by the GLI vical scheme) 17 Oct. 2003**

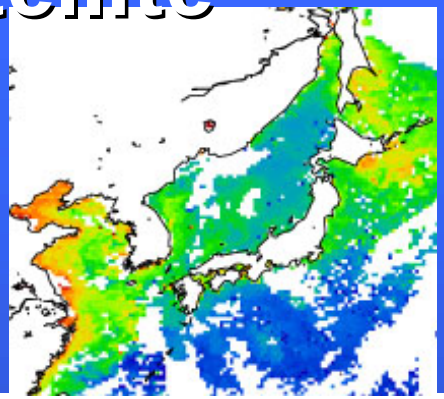


Zoom around Japan

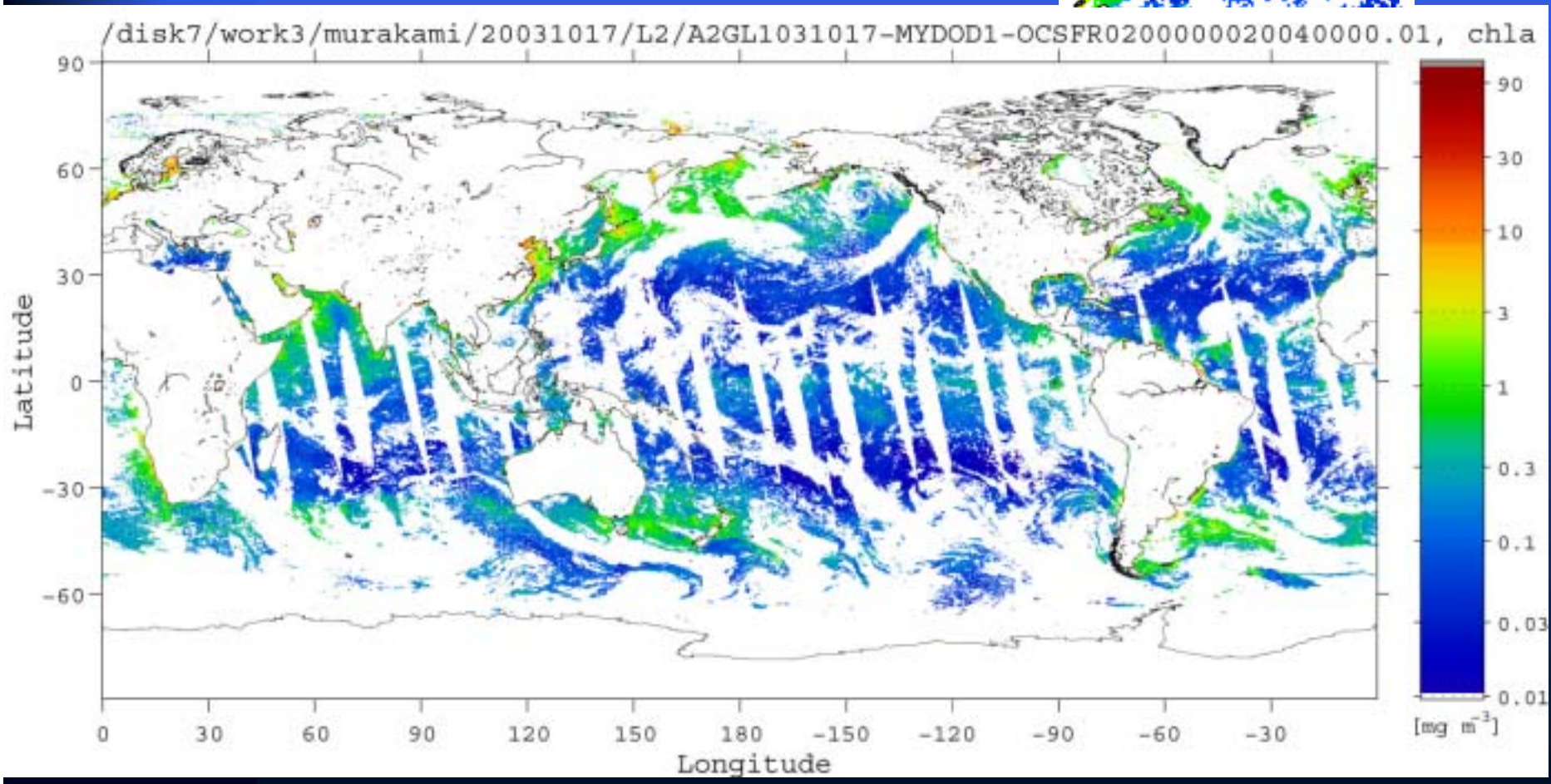


2.6 Comparison with Other Satellite

- **Aqua MODIS CHLA (calibrated by the GLI vical scheme) 17 Oct. 2003**

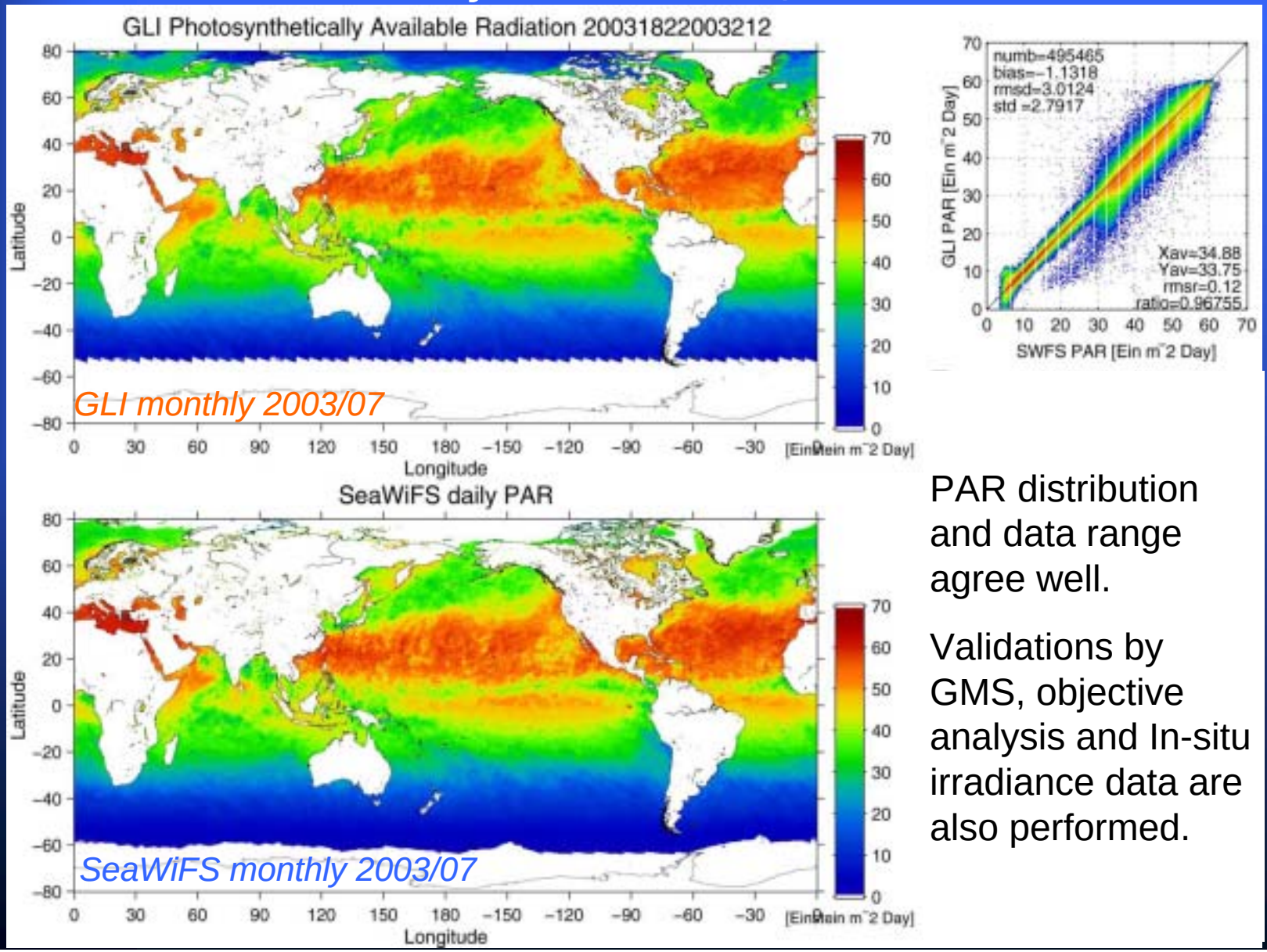


Zoom around Japan



2.7 Comparison with Other Satellite (PAR)

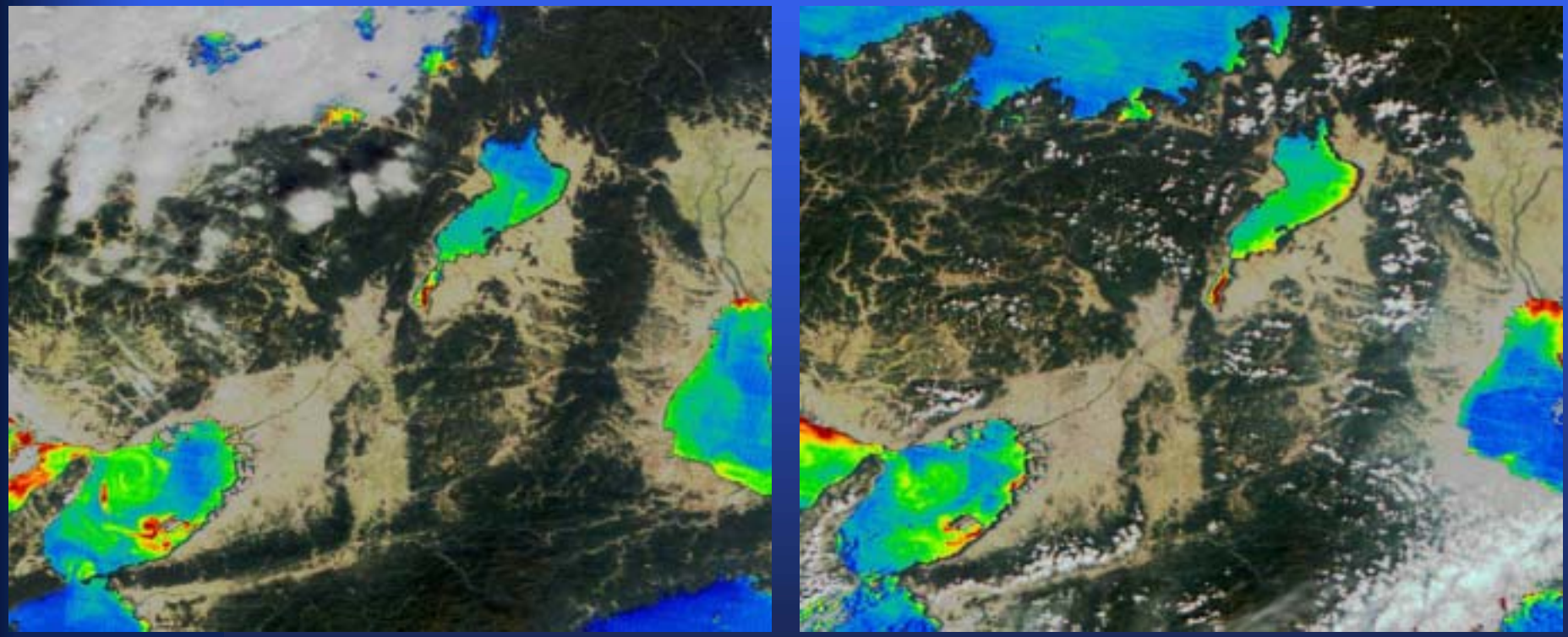
- **GLI PAR was validated by SeaWiFS PAR, TAO and GMS irradiance**



PAR distribution and data range agree well.

Validations by GMS, objective analysis and In-situ irradiance data are also performed.

3. Summary and Plan



Future products: GLI 250m nLw_543 Kinki area Japan, 1 (left) and 9 (right) Oct. 2003

H. Murakami, K. Sasaoka, K. Hosoda, and Ocean PIs
ADEOS-2 workshop, December 2004

3.1 Ver.2 Validation Summary

- By the ver.2 revisions of vical and ocean algorithms, accuracy of nLw, CHLA (coastal area), SS (offshore) and SST is improved.
- Coastal retrieval should be investigated further.

Parameter	target	Ver. 1	Ver. 2	Note
Normalized water leaving radiance (NWLR)	–35~+50% /–50~+100% offshore/coast	CH01-09 40 /70%, CH10-12 160 /110% (offshore/coast)	CH01-09: 40 /80% CH10-12 120 /90% (offshore/coast)	●380nm is improved by ~15% by the new vical. ●Available data is increased by 10 /60% (offshore/coast) ●Low signal in >600nm causes large error. ●Absorptive aerosol is corrected. Problem in absorption rate
Photo synthetically available radiation (PAR)	–10~+10% (10km monthly)	11%	~12%	●Comparison to TAO buoy and SeaWiFS ●difference from SeaWiFS was increased due to considering diurnal cycle in GLI Ver.2
Chlorophyll-a concentration (CHLA)	–35~+50% /–50~+100% offshore/coast	60 /350% (offshore/coast)	70/ 240% (offshore/coast)	●Available data is increased by 10 /60% (offshore/coast) ●QC of in-situ data should be refined ●Still problems in coastal areas ●CDOM is under estimated ●SS by NN is improved offshore but scattered in coastal areas
Absorption of colored dissolved organic matter (CDOM)	–50~+100%	80 /70%	80 /70%	
Suspended solid concentration (SS)	–50~+100%	100 /60%	90 /260%	
Attenuation coefficients at 490nm (K490)	–35~+50%	50 /60%	50 /60%	
Bulk sea surface temperature (SST)	0.6K	0.83/0.74K	0.66/0.70K (day/night)	●Match up data number is increased ●Error was temporally changed by MTIR Cal ?

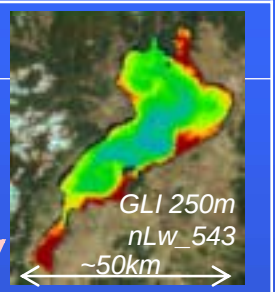
3.2 Status of Action Items for Ver.2

date	*items*
From Ver.1 (2003/12) to Ver.2 (2004/11)	•**Reanalyze MUD using reprocessed (geo/radiometric) L1B→Done** •**Consider vical coefficients and their temporal change→Done** •**Improve absorptive aerosol →Done** •**Further study of in-water optical model in the coastal area (absorption, scattering, surface reflection coefficients) →Revised SS but still problems** •**Improve cloud detection →Done (SST and OC)** •**Applying the latest GLI algorithms to the MODIS NRT processing →test was done, continue to be operational** •Improve sunglint correction using AMSR wind speed →**Done (SeaWinds)** •Switching saturation alternative bands, and try to use 710nm →**Cancel** •Consider diurnal cycle of cloud amount (PAR) →**Done** •Evaluate SS and CDOM algorithm in global coastal area →**continue** •Improve water vapor correction for SST →**3.7um in nighttime SST**

→ ***Most of the items were realized in the Ver.2, but still have coastal problems***

3.3 Next Targets and Action Plan

date	*items*
after Ver.2 to the mission goal	•**Improve spectral characteristics of absorptive aerosol** •**Improve parameterization of in-water optical model in the coastal area** •**Investigate Atmos.Corr. and CHLA estimation using 250m data** •**Investigate combined use of multi-sensor/satellite datasets (SST and others)** •Evaluate primary production algorithms (research product) •Study of fluorescence algorithm and its application (research product)



For the next mission (SGLI) target: "Coastal area research and monitoring"

1. Construct coastal-area optical algorithms until SGLI launch.

← Make database of optical and CHLA observations in the coastal area

2. Describe and parameterize physical + biological processes in the coastal area

3. Encourage science and data-user communities

← Demonstration of coastal data application and study using GLI and other satellite data