JPSS VIIRS Ocean Color Products Validation at NOAA CoastWatch

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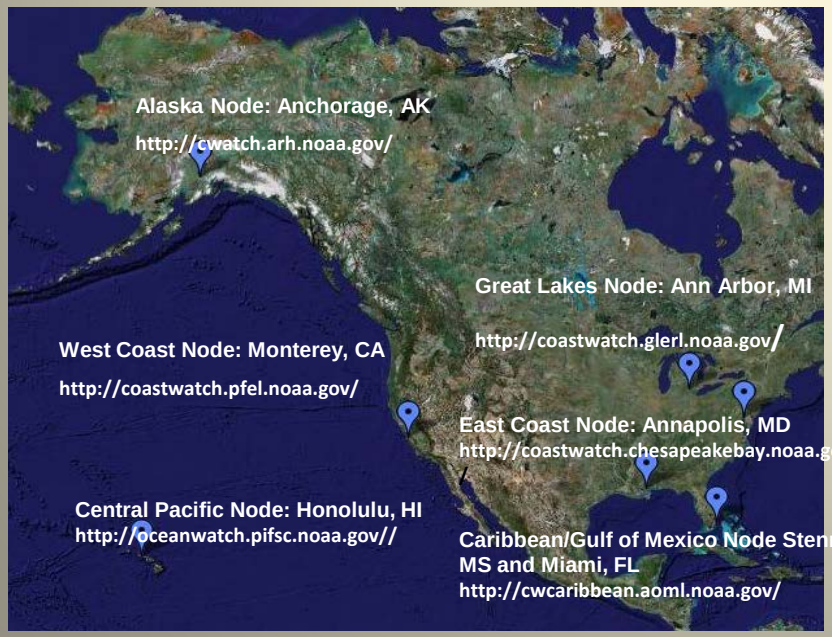
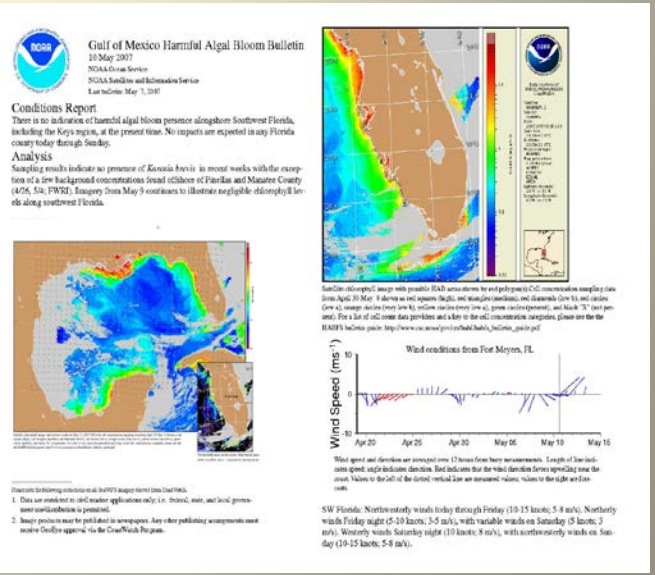
Background and Mission

BACKGROUND: CoastWatch began in 1987 by providing near real-time SST for the Mid-Atlantic following several outbreaks of Harmful Algal Bloom (Red Tide) along the coast of North Carolina. CoastWatch has evolved from providing high resolution data from the NOAA's Polar Orbiter satellites to providing data from multiple satellites from different government organizations. Regular funding (research) was established for CoastWatch in 1990 under the Coastal Ocean Program. NOAA CoastWatch became operational in 1991. Efforts are ongoing to expand CoastWatch into OceanWatch.

MISSION STATEMENT: to provide and ensure timely access to near real-time satellite data to protect, restore, and manage U.S. coastal ocean resources, and understand climate variability and change to further enhance society's quality of life. Our primary users include Federal, State, and local marine scientists, coastal resource managers, and the general public.





Harmful Algal Bloom Forecast System with NCCOS, distributed through CO-OPS

Why do this Analysis on VIIRS data ?

CoastWatch Users expressed dissatisfaction with the VIIRS IDPS algorithm.

STAR evaluated 6 months (Jul '13 to Dec '13) of retrospective chlorophyll-a products produced by the 'NOAA-MSL12' algorithm. In this comparison, GLOBAL and CONUS datasets were considered.

Stratification of the products were made using bathymetry and chlorophyll values (Low, Medium, High).

0:50m , 50-100m, 100-500m, > 500m

0.01 : 1.0, 1.0: 10.0, 10.0 : 100.00 mg/m^{-3}

The common reference for comparison is the NASA MODIS Climatology data.

Methodology

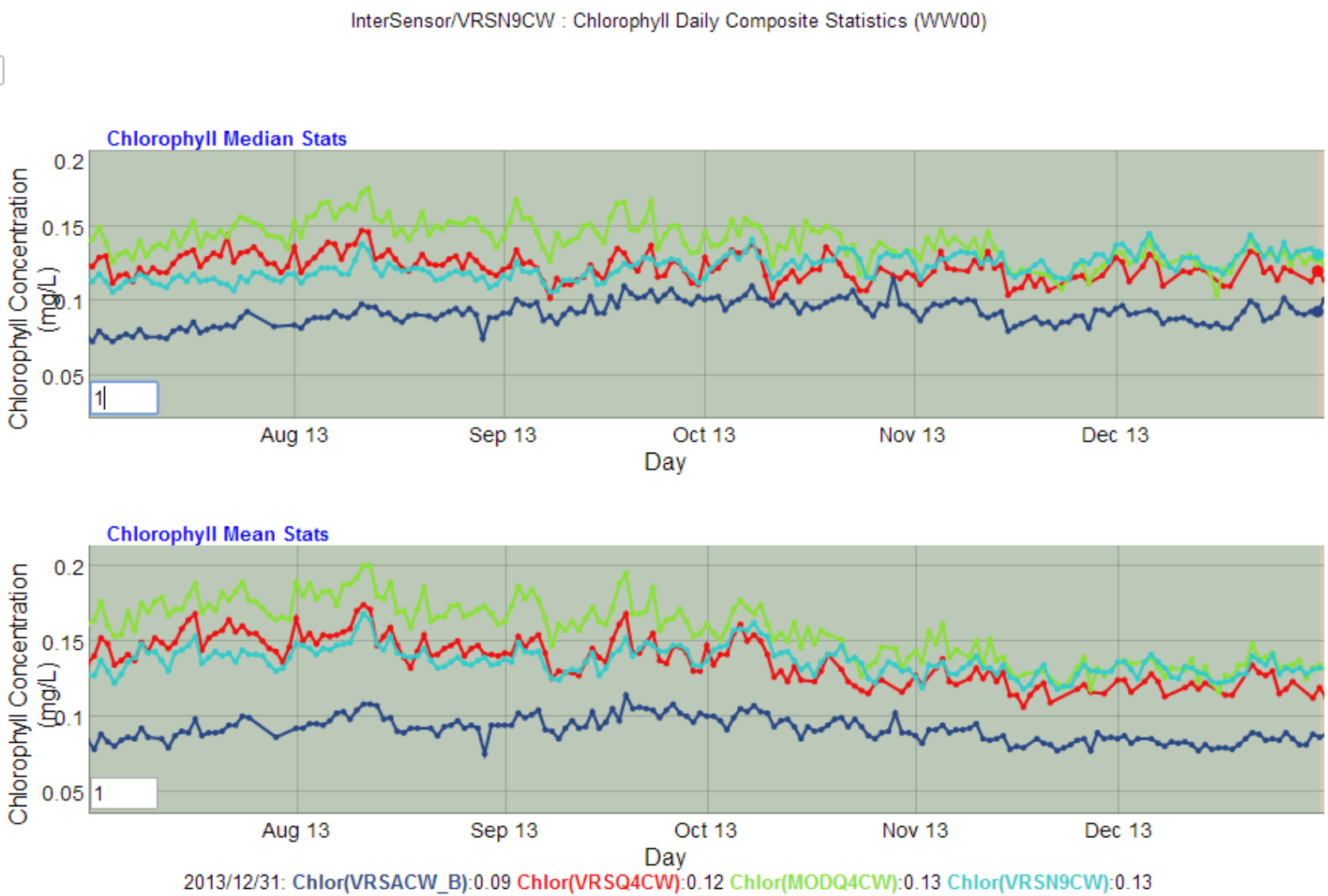
GLOBAL NOAA-MSL12 Comparisons

STAR/MECB provided mapped MSL12 products for July 2013 - December 2013. The 9km global products were remapped to 4km and then compared along with the following products (4km) to the MODIS NASA Monthly Climatology (multi-year):

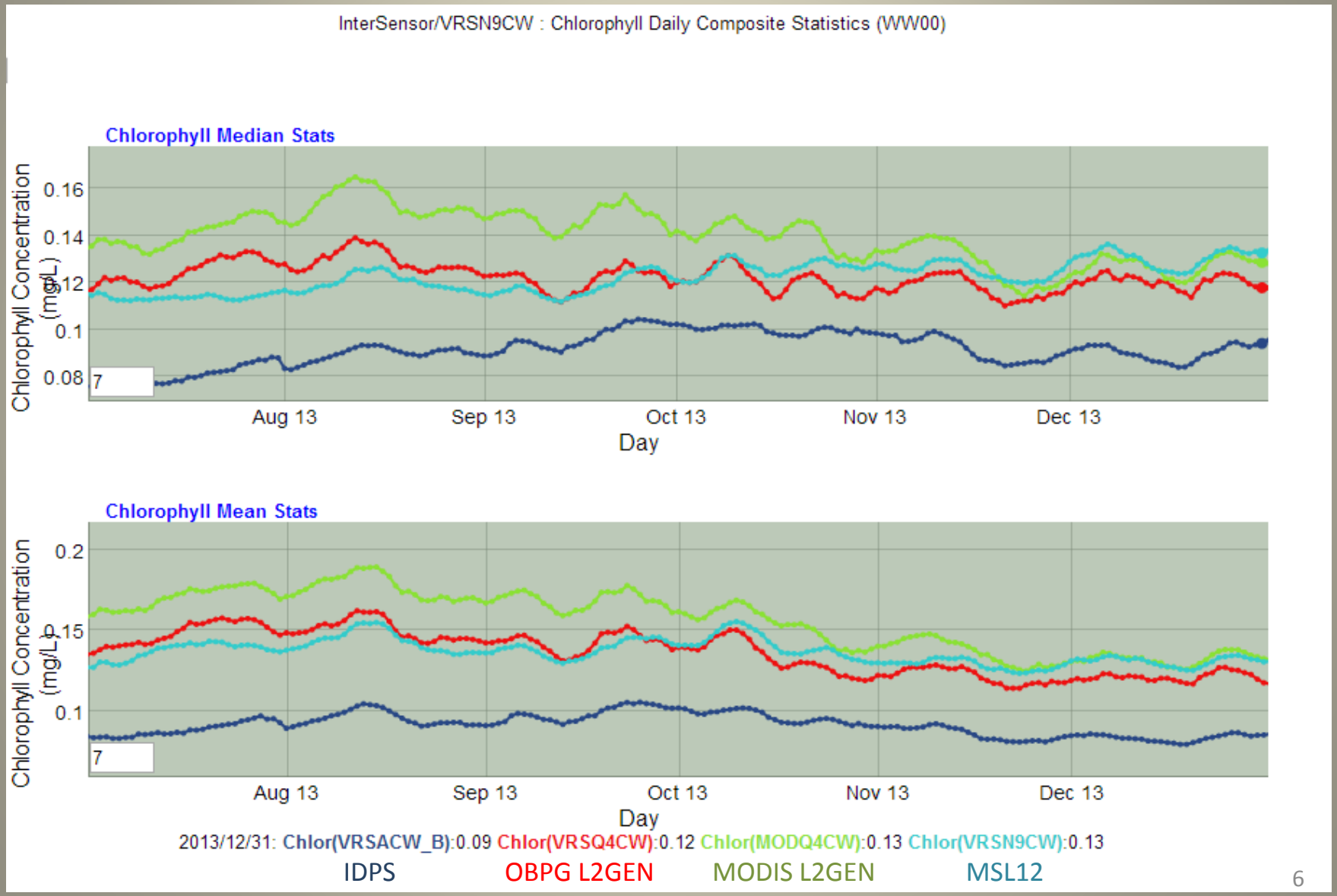
- VIIRS (4km) L3 CWHDF from NOAA-MSL12 NIR 9KM binned file inputs (VRSN9CW)
- VIIRS IDPS (VRSACW)
- VIIRS NASA L2gen (science quality) (VRSQ4CW)
- MODIS NASA L2gen (MODQ4CW)

MASKING used: LAND, CLOUD+ICE, SUNGLINT

Comparison of Daily Chlorophyll (Median, Mean)

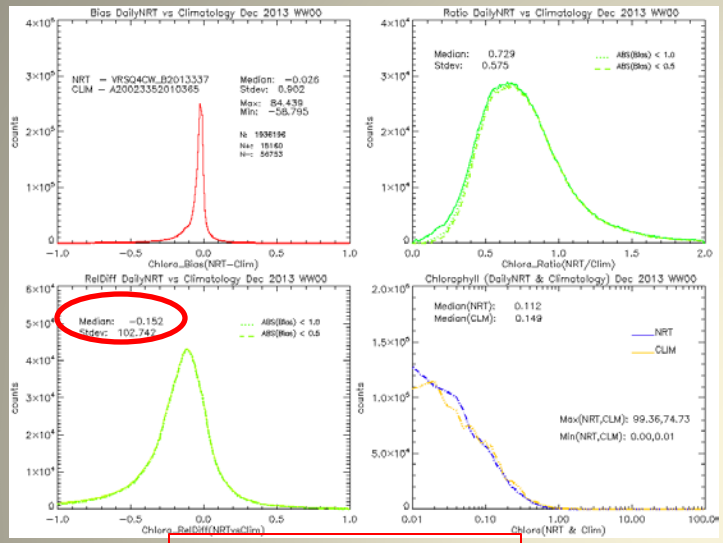


Comparison of 7-day Chlorophyll (Median, Mean)



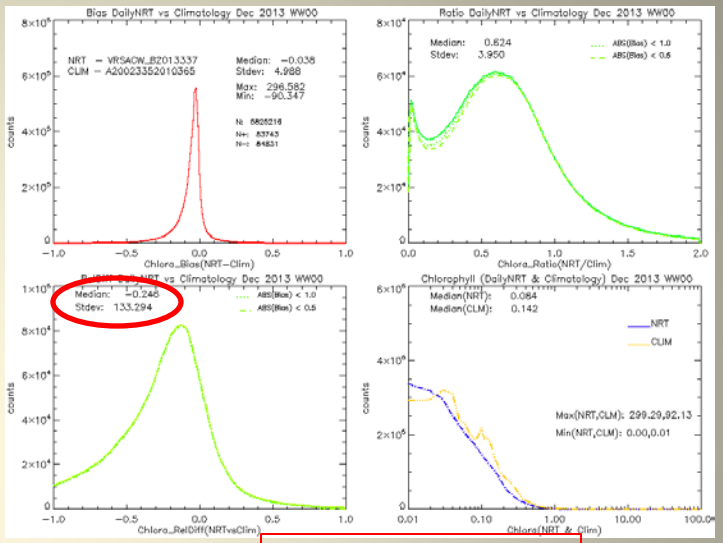
Example Daily Chlorophyll-Climatology Comparison Statistics for December 3, 2013

L2GEN



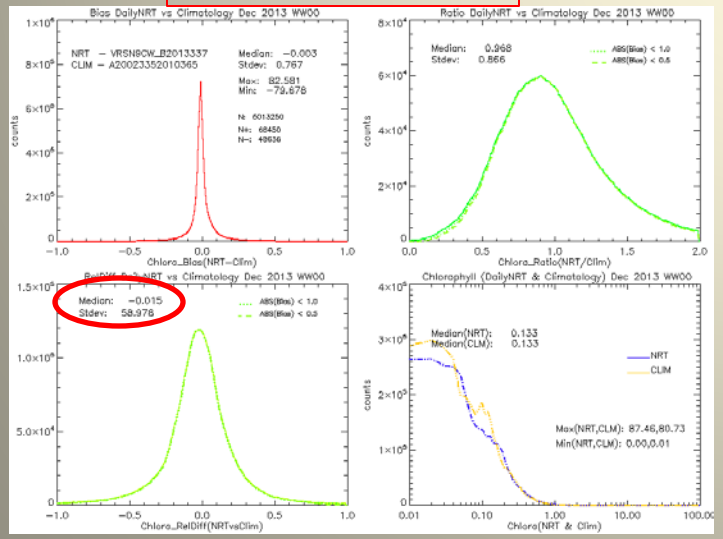
Median Relative Diff = -15.2 %

IDPS



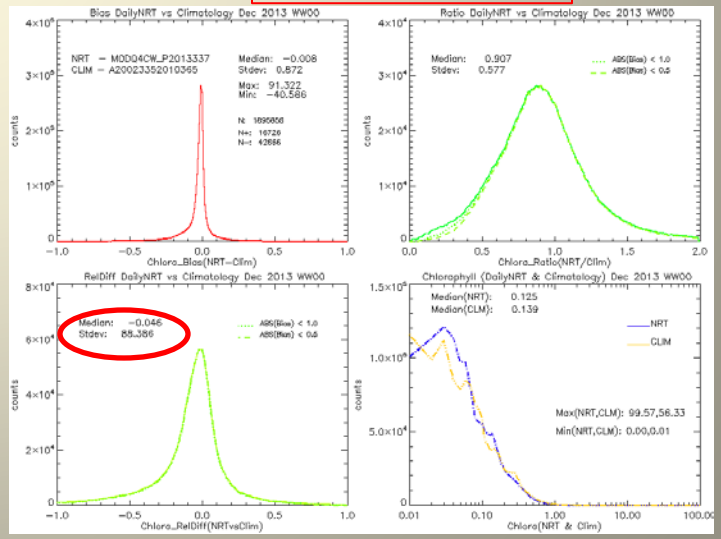
Median Relative Diff = -24.6 %

MSL12



Median Relative Diff = -1.5 %

MODIS

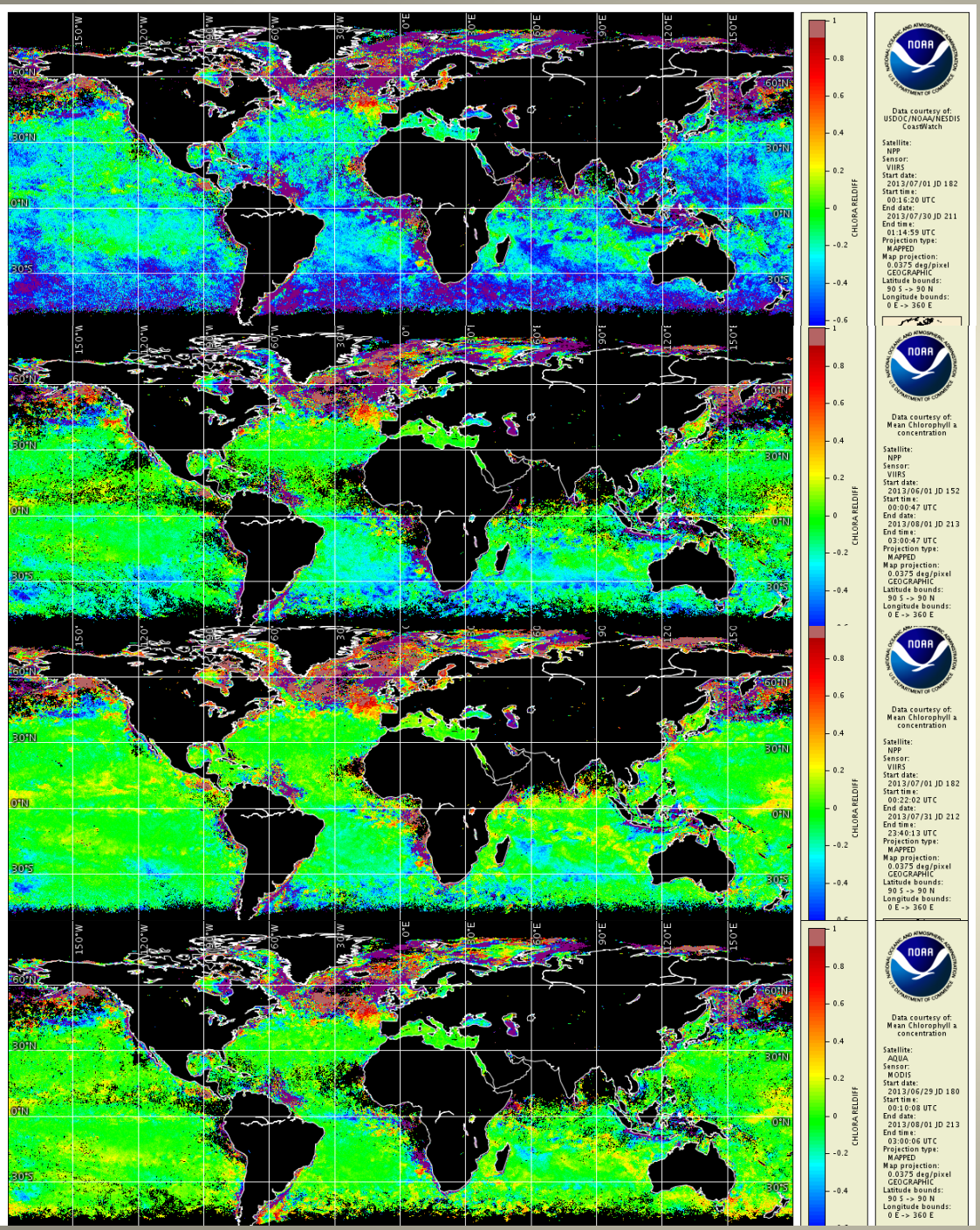


Median Relative Diff = -4.6 %

Comparison of Monthly Median Relative Difference with Climatology

Monthly Median Relative Difference (%) with Climatology for Global (WW00) - All pixels

Sensor Product	July	Aug	Sep	Oct	Nov	Dec
VRSACW(IDPS)	-33.7 %	-30.9 %	-28.0 %	-25.0 %	-25.0 %	-27.1 %
VRSQ4CW(NASA L2GEN)	-10.40 %	-11.10 %	-11.0 %	-9.20 %	-10.2 %	-10.1 %
VRSN9CW(MSL12)	**-4.10 %**	**-3.10 %**	**-1.80 %**	**0.01 %**	**-0.10 %**	**-0.90 %**
MODQ4CW(NASA)	-0.30 %	0.30 %	0.50 %	0.30 %	-1.3 %	-2.50 %



IDPS

Monthly Relative Difference with Climatology (July 2013)

OBPG L2GEN

MSL12

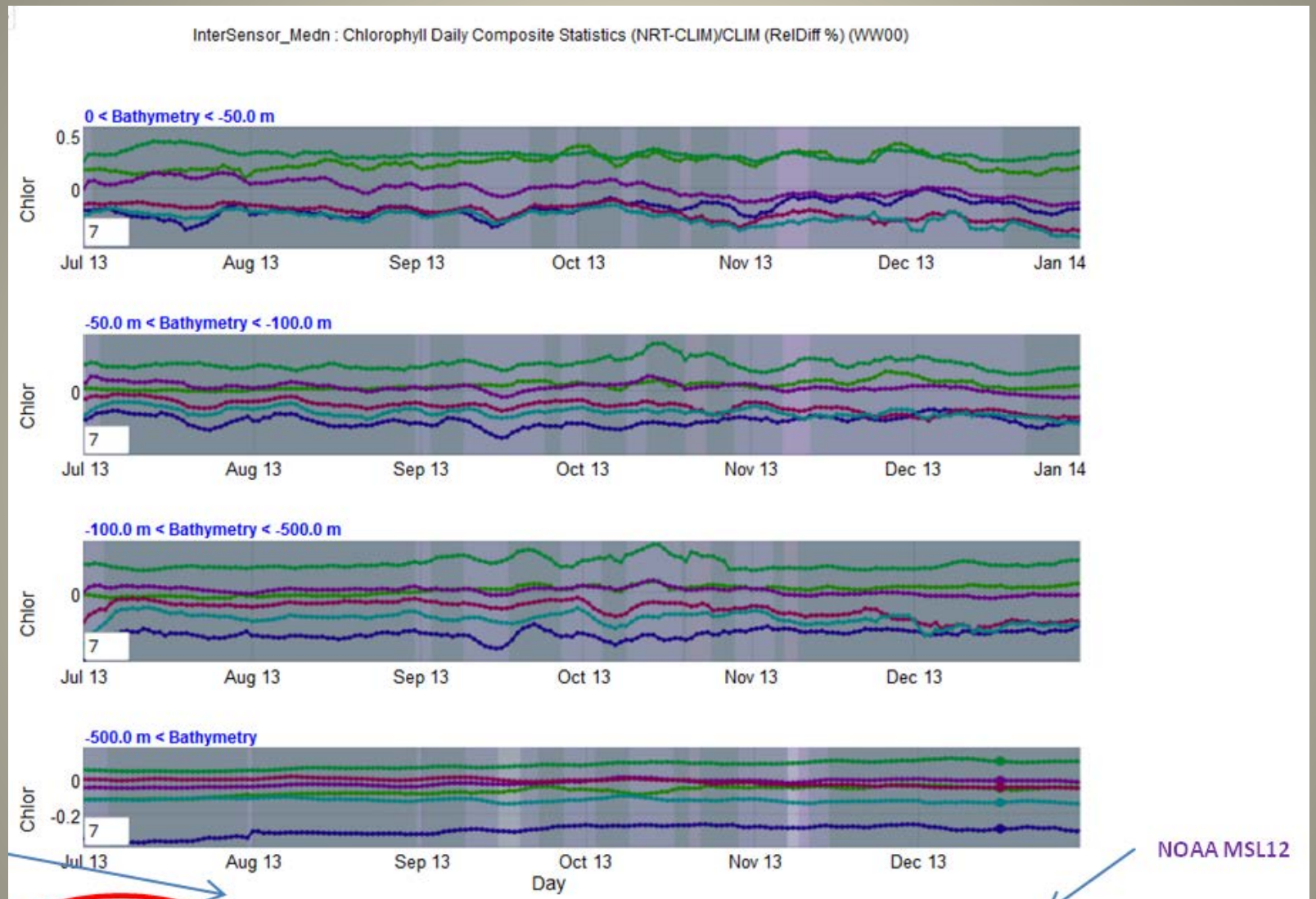
MODIS L2GEN

Global Summary

- Initial ‘all-pixel’ Global comparisons indicate NOAA-MSL12 does a very good job overall compared to other choices available.

- Next we discuss results from stratification based on bathymetry and chlorophyll value (both Global and CONUS)

Stratification by Bathymetry - global 4km Inter-sensor



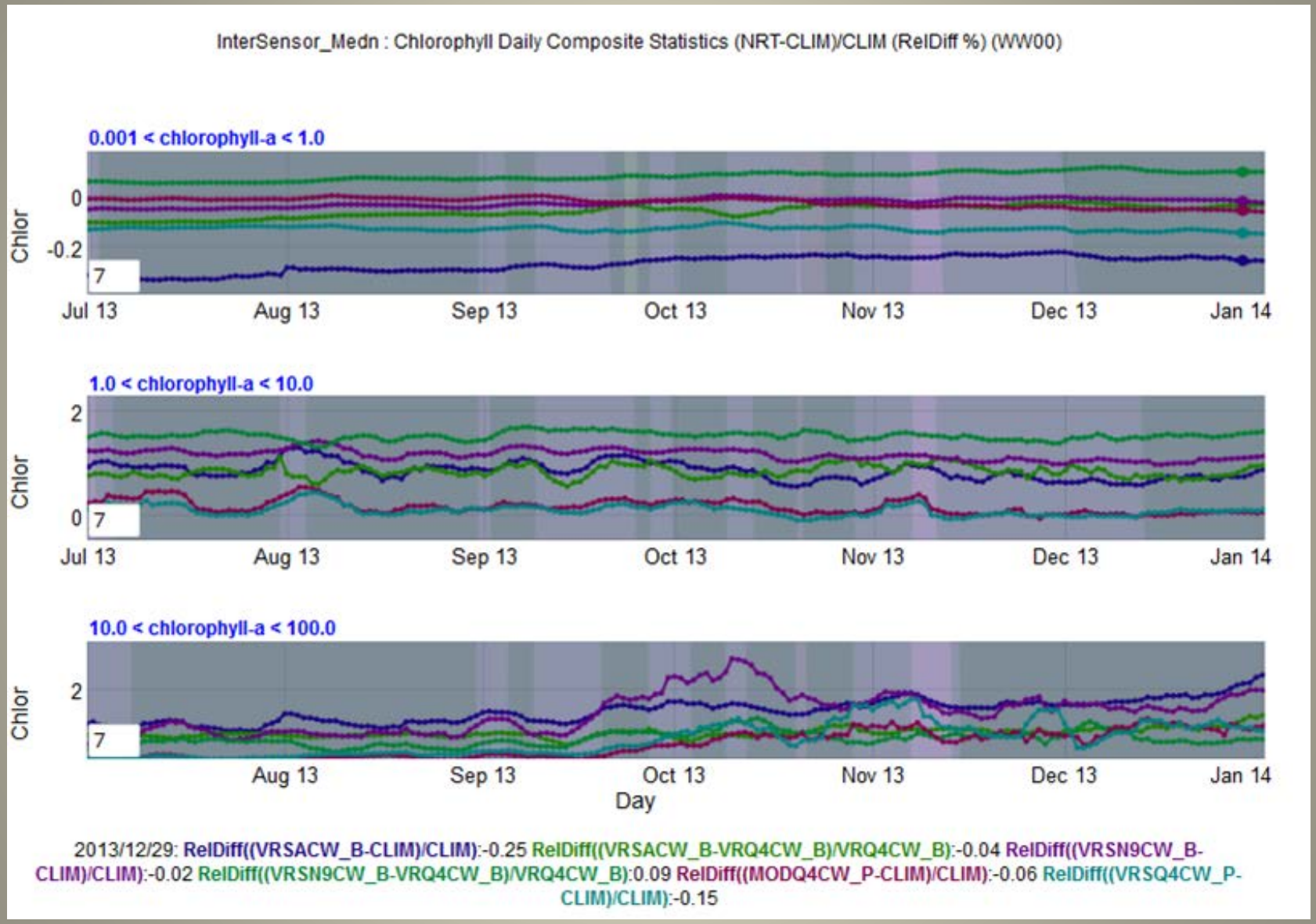
2013/12/16: RelDiff((VRSACW_B-CLIM)/CLIM):-0.28 RelDiff((VRSACW_B-VRSQ4CW_B)/VRSQ4CW_B):-0.05 RelDiff((VRSN9CW_B-CLIM)/CLIM):-9.00e-3 RelDiff((VRSN9CW_B-VRSQ4CW_B)/VRSQ4CW_B):0.1 RelDiff((MODQ4CW_P-CLIM)/CLIM):-0.05 RelDiff((VRSQ4CW_P-CLIM)/CLIM):-0.13

NOAA MSL12

NASA L2gen

NASA MODIS L2gen

Stratification by Chlorophyll value - global 4km Inter-sensor



Global (4km) statistics compared to MODIS Climatology

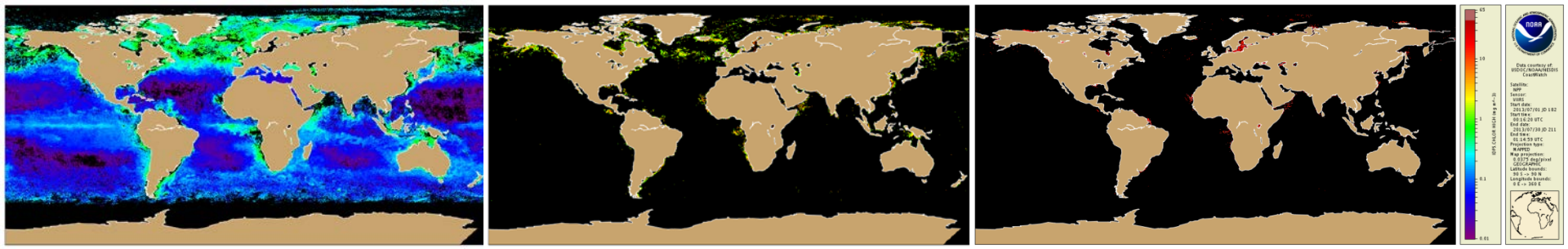
Median Relative Difference (%) with Climatology for Global (WW00) Stratified by Bathymetry

Sensor Product	< 50m	50m to 100m	100m to 500m	>500m
VRSACW(IDPS)	-16.6 %	-38.4 %	-45.4 %	-28.0 %
VRSQ4CW(NASA)	-22.6 %	-26.3 %	-27.5 %	-11.8 %
VRSN9CW(MSL12)	**-0.05 %**	**5.3 %**	**2.30 %**	**-2.0 %**
MODQ4CW(NASA)	-17.5 %	-17.5 %	-14.0 %	-0.80 %

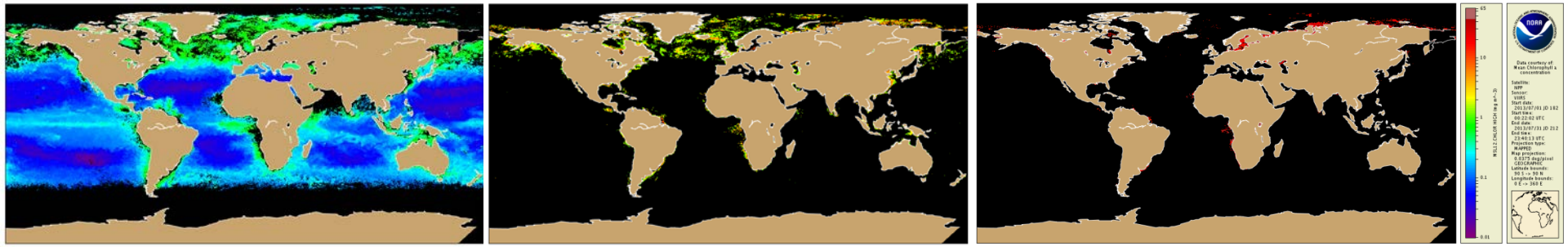
Median Relative Difference (%) compared with MODIS Climatology for Global (WW00) Stratified by Chlorophyll

Sensor Product	0.01 < chlor < 1.0	1.0 < chlor < 10.0	10.0 < chlor < 100
VRSACW(IDPS)	-25.5 %	85.8 %	148.80 %
VRSN9CW(MSL12)	**-2.50 %**	116.30 %	133.20 %
VRSQ4CW(NASA)	-12.9 %	7.8 %	**45.70 %**
MODQ4CW(NASA)	-1.80 %	14.0 %	**37.2 %**

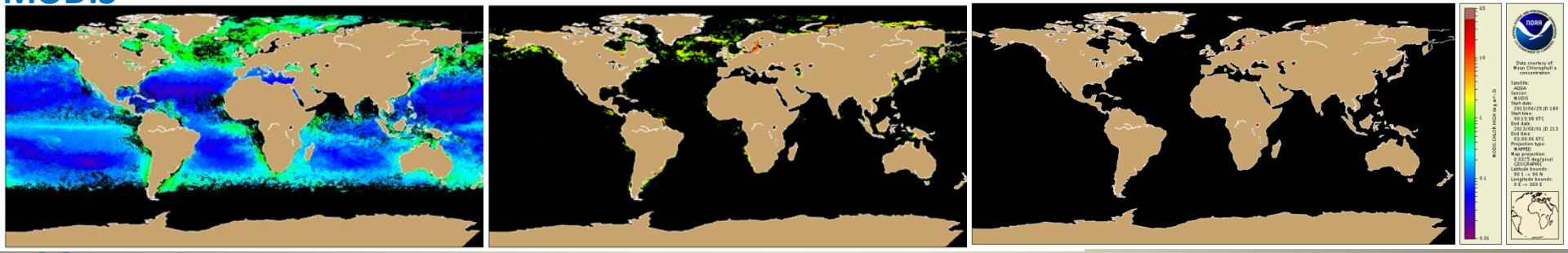
0 < chl < 1. **IDPS** 1. < chl < 10. 10. < chl



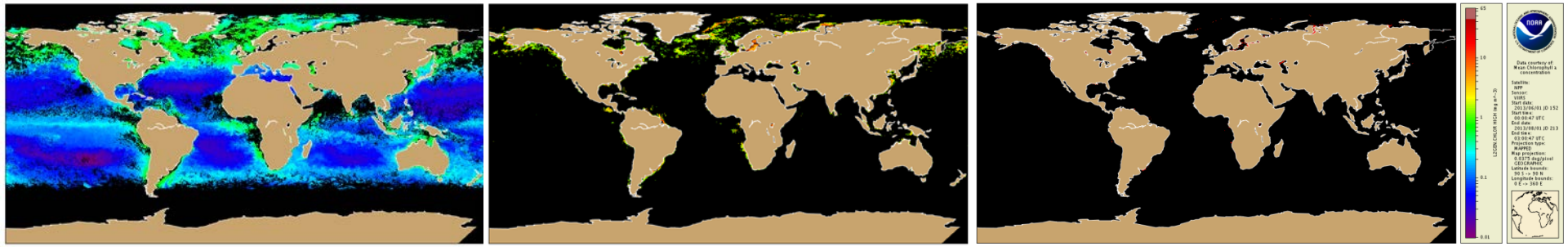
MSL12



MODIS



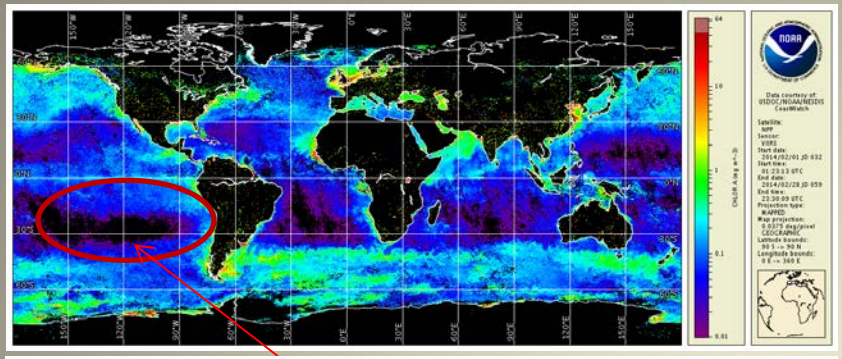
L2GEN



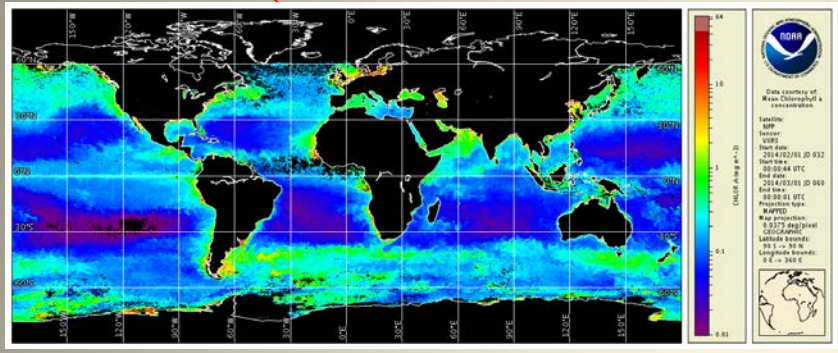
Summary of chlorophyll retrievals and value-stratification for July 2013 composite

		Pixels occurring in Chlorophyll Ranges (July 2013 monthly composite)						
	Total Pixels	**chl < 1.0 (#)**	**chl < 1.0 (%)**	**1.0 < chl < 10.0 (#)**	**1.0 < chl < 10.0 (%)**	**10.0 < chl (#)**	**10.0 < chl (%)**	**+/- Pixels over MODIS**
IDPS	22824058	21709570	**95.12%**	912660	**4.00%**	201827	**0.88%**	5123256
MSL12	19977855	18426575	**92.24%**	1244667	**6.23%**	306613	**1.53%**	2277053
L2GEN	17505885	16432788	**93.87%**	983110	**5.62%**	89977	**0.51%**	-194917
MODIS	17700802	16691019	**94.30%**	933924	**5.28%**	75834	**0.43%**	0

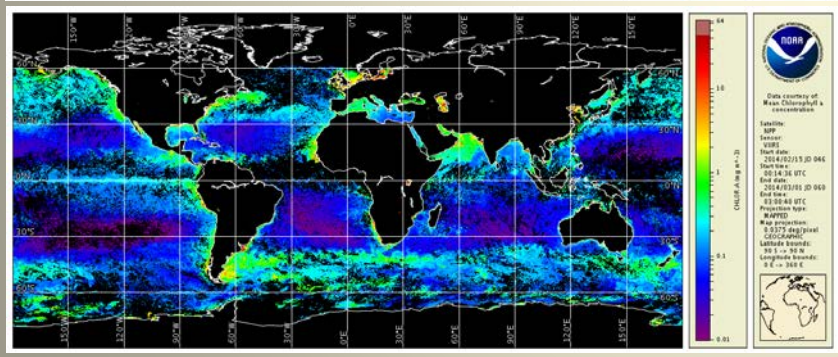
Feb 2014



VIIRS IDPS 4km (VRSACW)

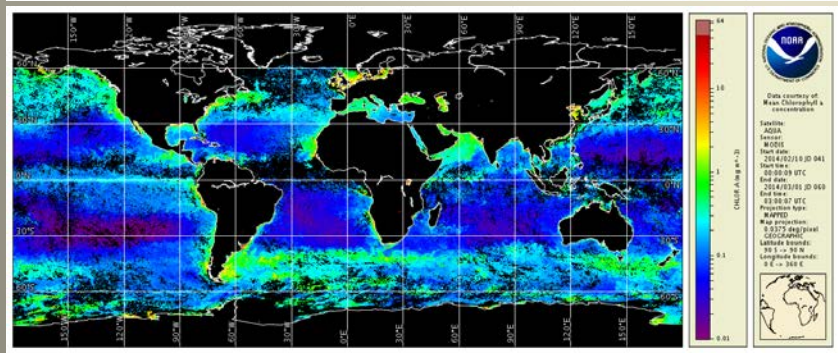


VIIRS **NOAA-MSL12** 9km (VRSN9CW)



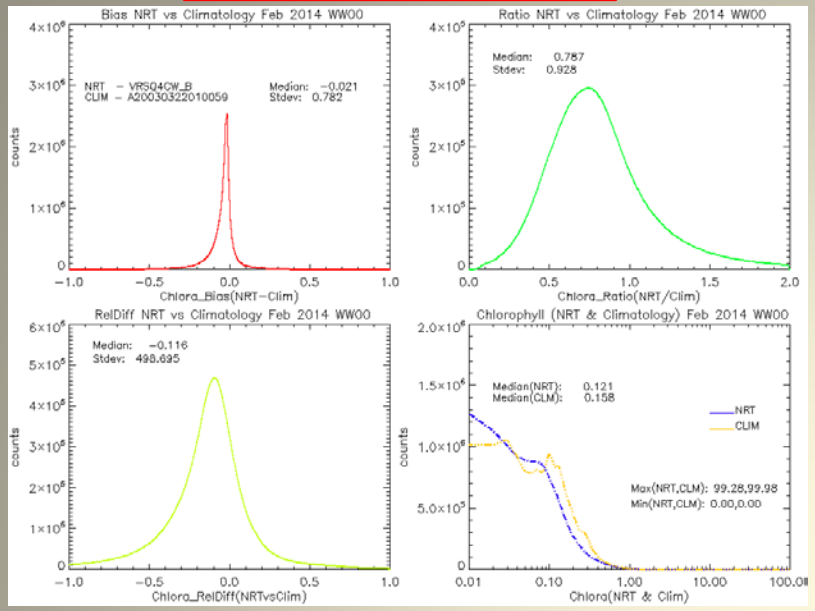
VIIRS NASA-OBPG 4km (VRSQ4CW)

Note that NASA uses their own SDR and not IDPS SDRs

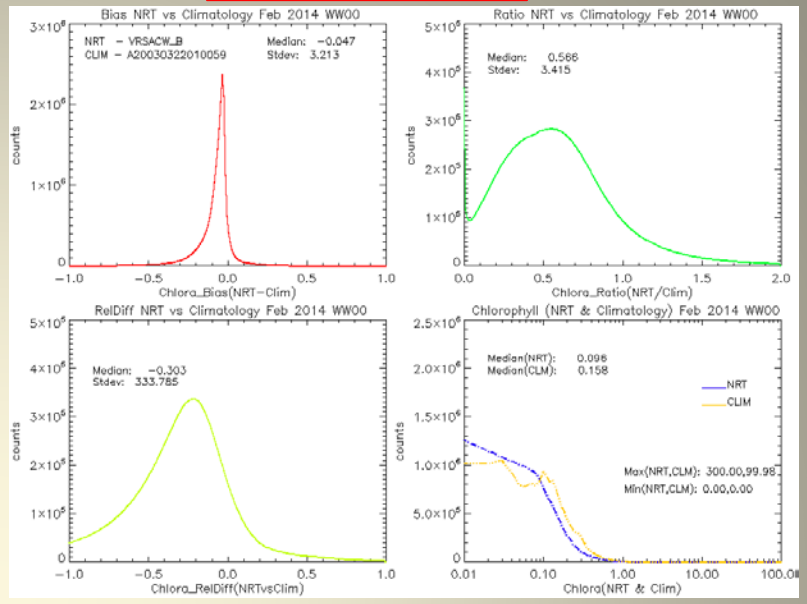


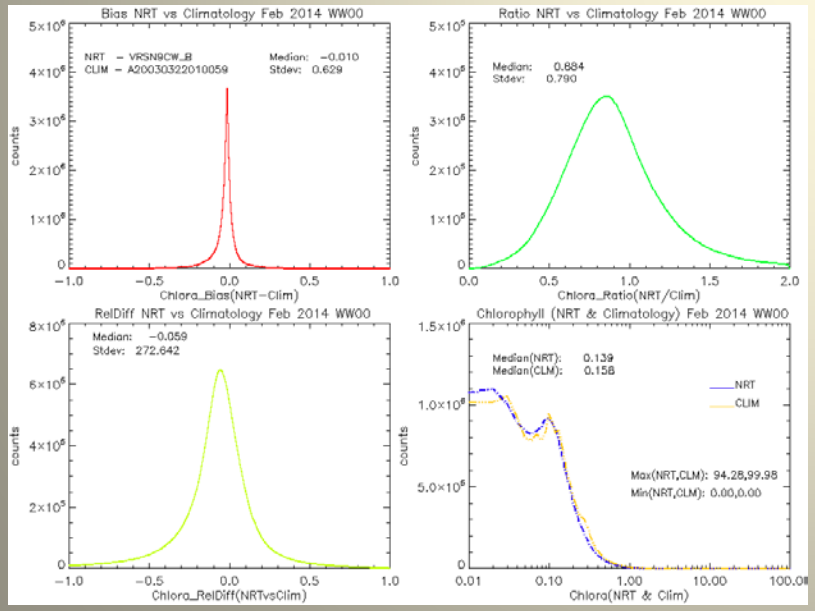
MODIS NASA-OBPG 4km (MODQ4CW)

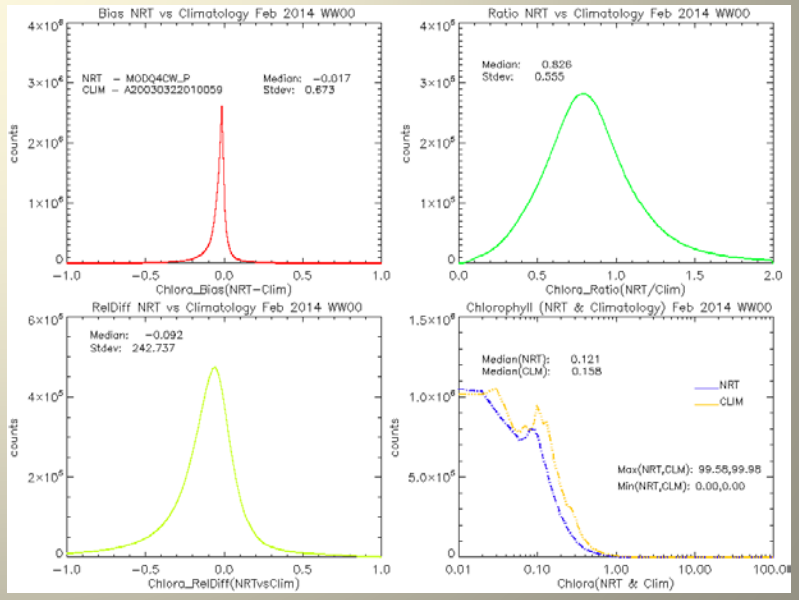
NASA VIIRS L2gen ~ -11.6 %



IDPS VIIRS ~ -30.3 %







NOAA MSL12 ~ -5.9 %

NASA MODIS L2gen ~ -9.2%

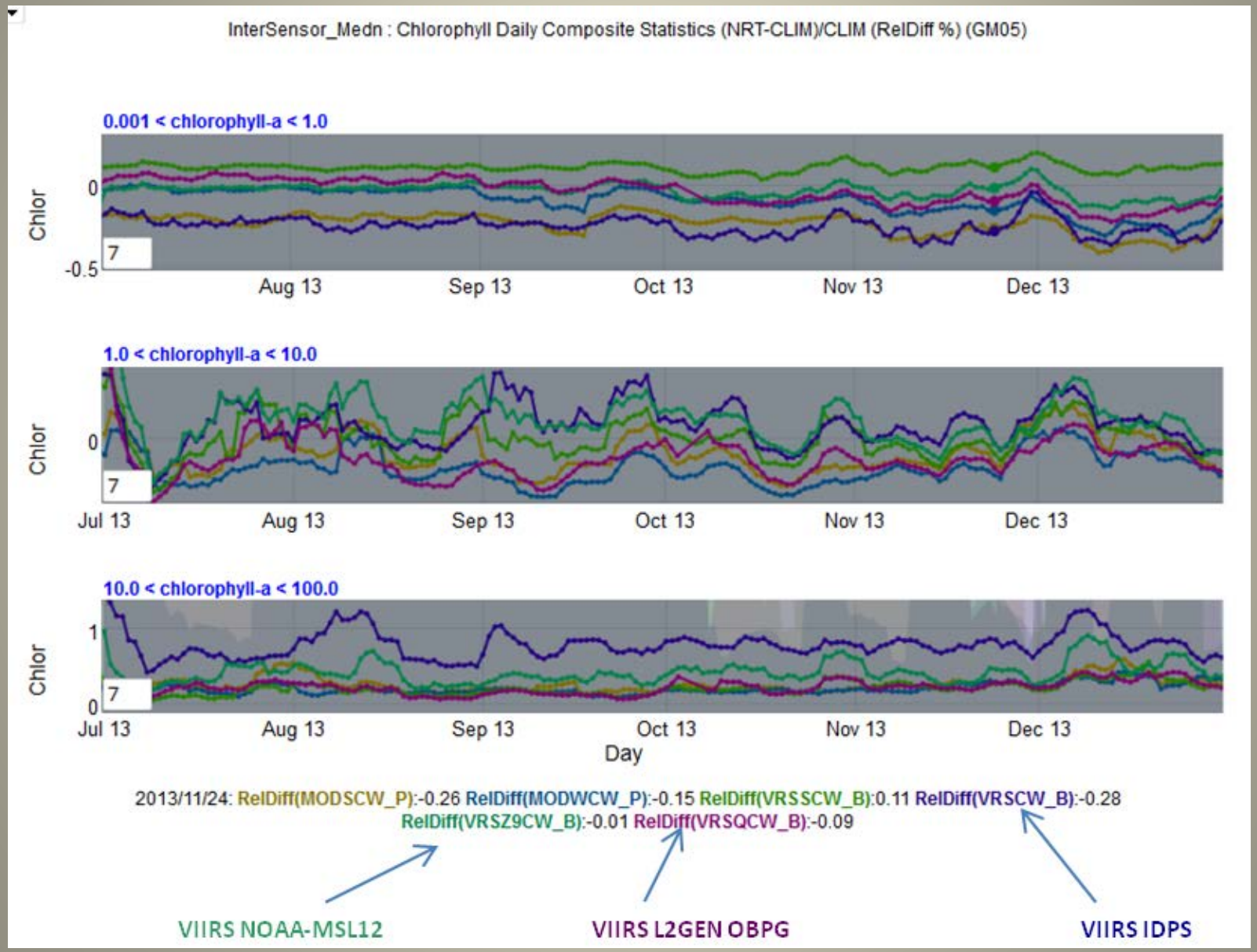
CONUS

Gulf of Mexico

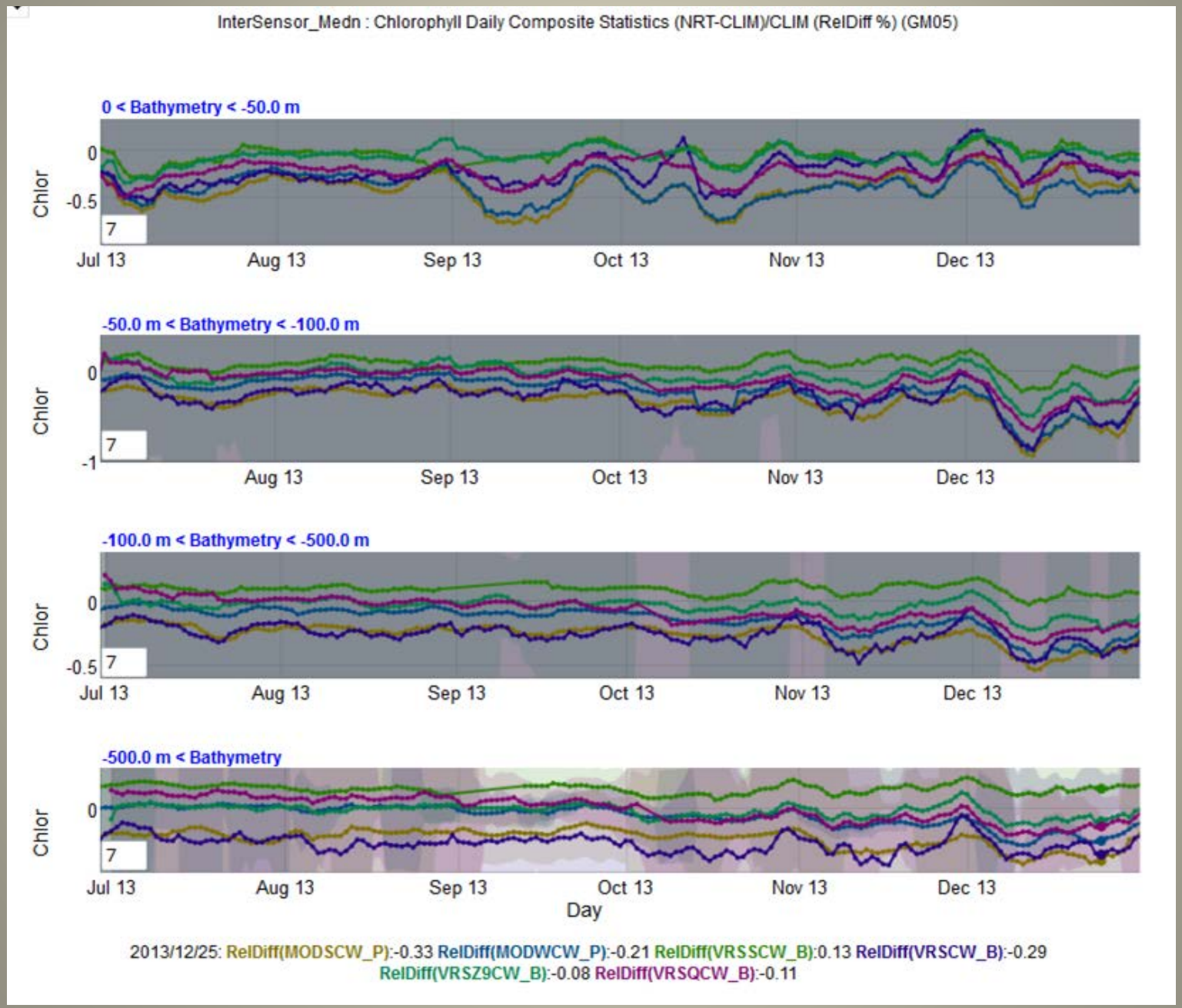
- VIIRS (750m) L2 CWHDF from NOAA-MSL12 NIR file inputs (VRSZ9CW)
- VIIRS IDPS L2 CWHDF 750m(VRSCW)
- VIIRS NASA L2gen (science quality) (VRSQCW)
- VIIRS NOAA L2gen with IDPS SDR (VRSSCW, VRSZ1CW)
- MODIS NOAA L2gen (MODSCW)
- MODIS NOAA SWIR (MODWCW)

MASKING used: LAND, CLOUD+ICE, SUNGLINT

Stratification by Chlorophyll values - Gulf of Mexico



Stratification by Bathymetry - Gulf of Mexico



Gulf of Mexico statistics compared to MODIS Climatology

Median Relative Difference (%) compared with MODIS Climatology (GM05)

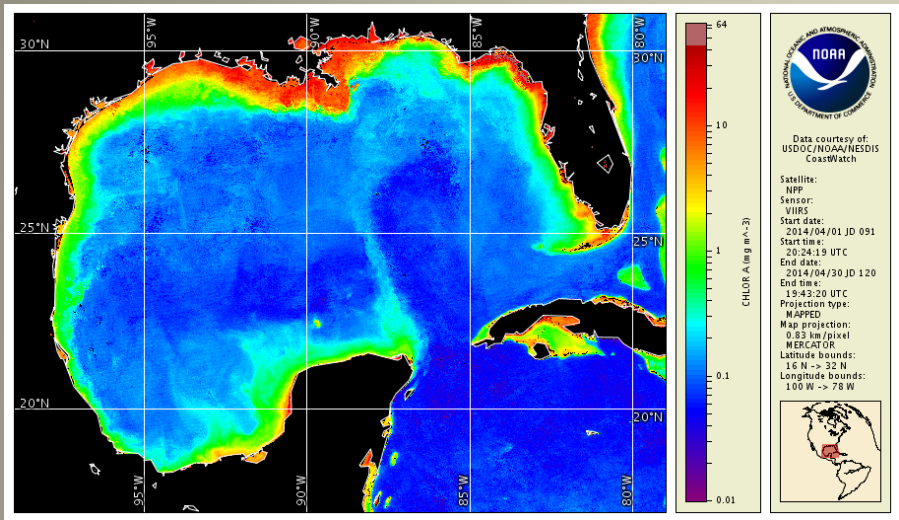
Sensor Product	0.01 < chlor < 1.0	1.0 < chlor < 10.0	10.0 < chlor < 100
VRSCW(IDPS)	-23.00 %	2.00 %	74.00 %
VRSSCW (NOAA)	11.00 %	-5.50 %	19.00 %
VRSQCW(NASA)	-1.00 %	-18.00 %	20.50 %
VRSZ9CW(MSL12)	**-2.00 %**	**3.00 %**	**35.00 %**
MODSCW(NOAA)	-22.00 %	-15.0 %	22.00 %
MODWCW(NOAA)	-7.00 %	-22.0 %	19.00 %

Median Relative Difference (%) with Climatology for CONUS (GM05) Stratified

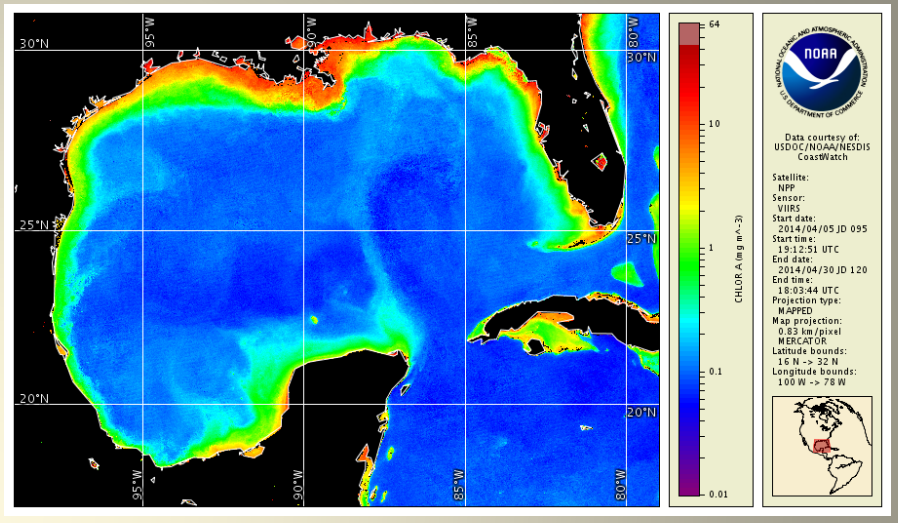
Sensor Product	< 50m	50m to 100m	100m to 500m	>500m
VRSCW(IDPS)	-22.00 %	-27.00 %	-24.70 %	-21.10 %
VRSSCW (NOAA)	-2.35 %	7.45 %	10.20 %	13.40 %
VRSQCW(NASA)	-21.20 %	-6.60 %	-5.00 %	1.55 %
VRSZ9CW(MSL12)	**-5.05 %**	**-3.90 %**	**-2.40 %**	**-0.80 %**
MODSCW(NOAA)	-37.30 %	-29.70 %	-23.90 %	-17.90 %
MODWCW(NOAA)	-35.70 %	-15.50 %	-11.90 %	2.10 %

April 2014

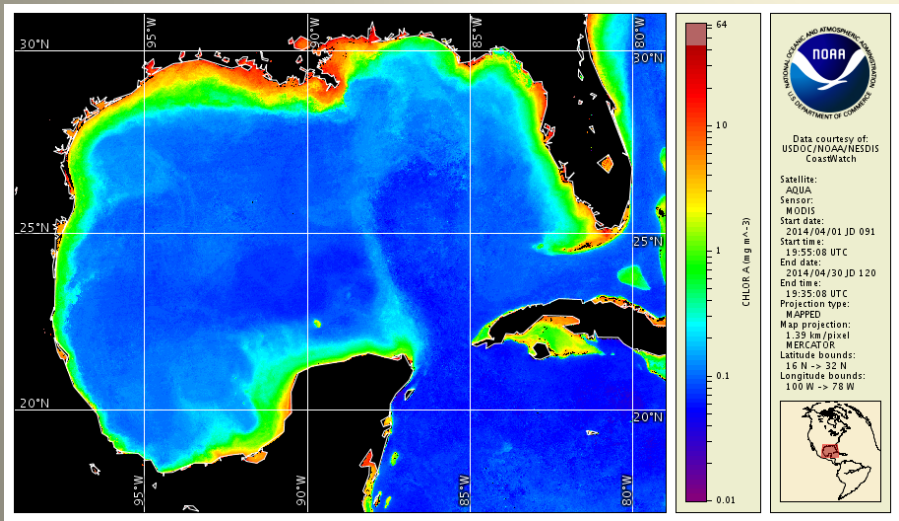
VIIRS NOAA-MSL12



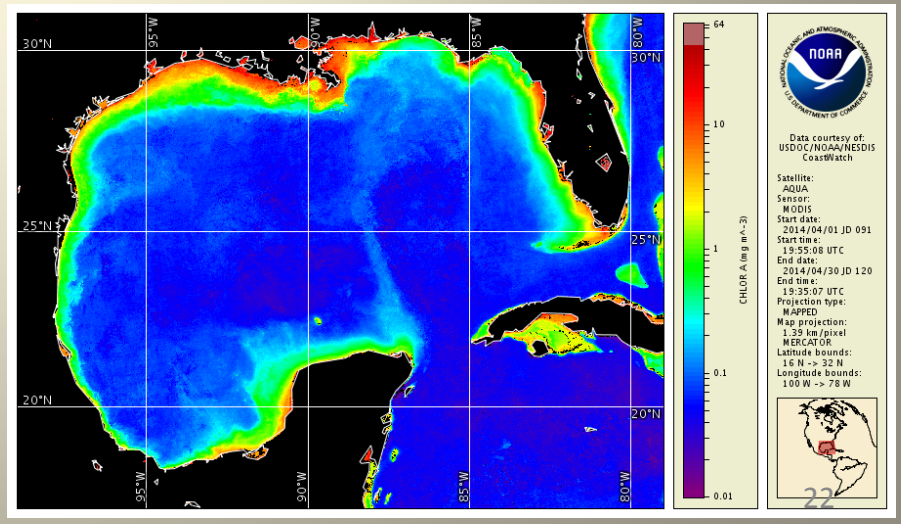
VIIRS NASA-OBPG



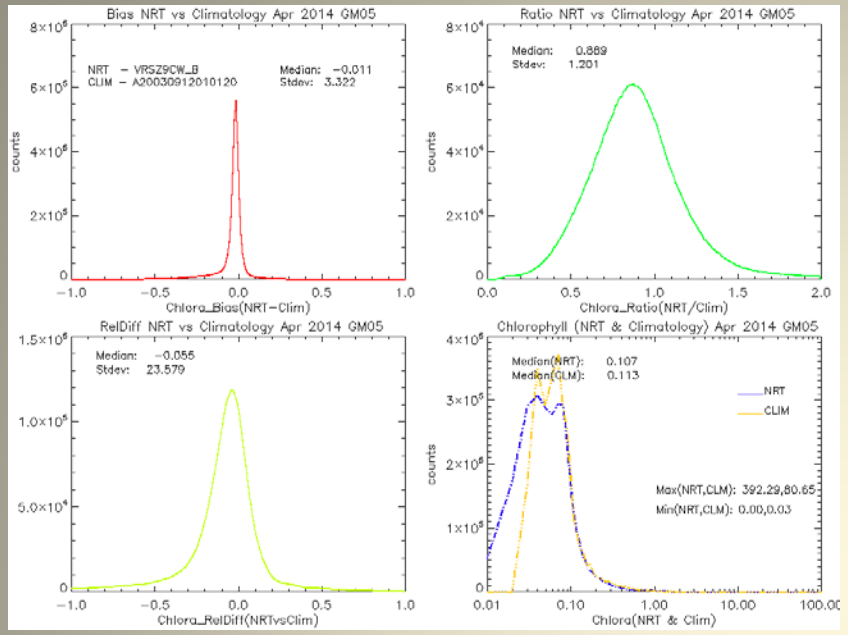
MODIS NOAA-MSL12-SWIR



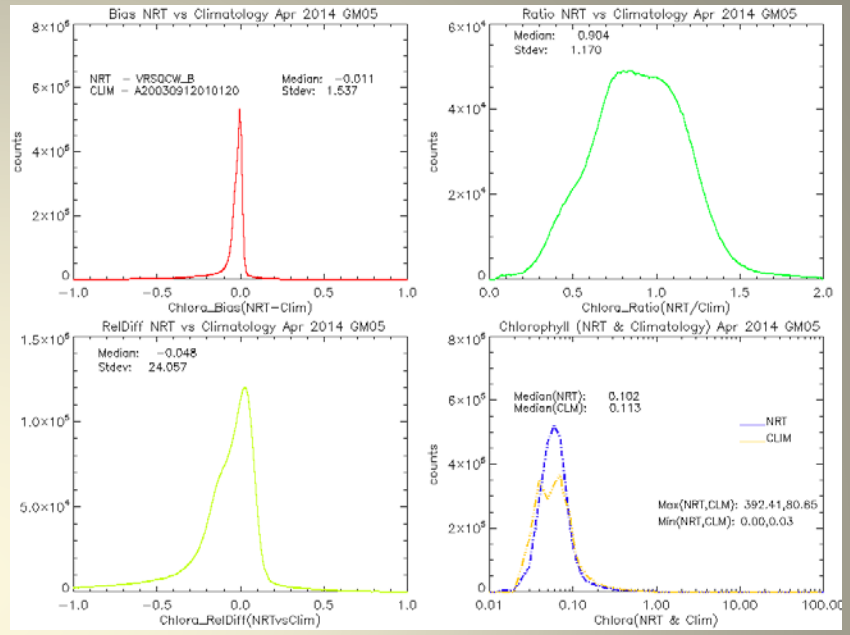
MODIS NOAA-L2gen



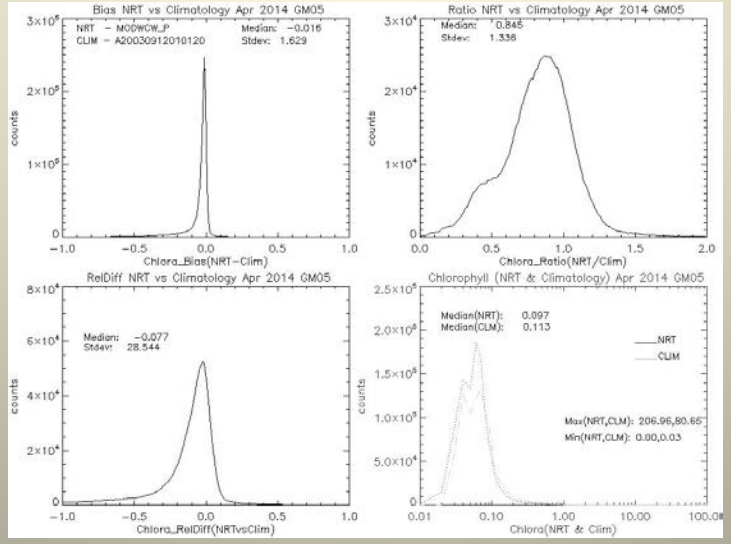
Gulf of Mexico April 2014 Monthly Chlorophyll



VIIRS NOAA MSL12 - MECB ~ - 5.5 %

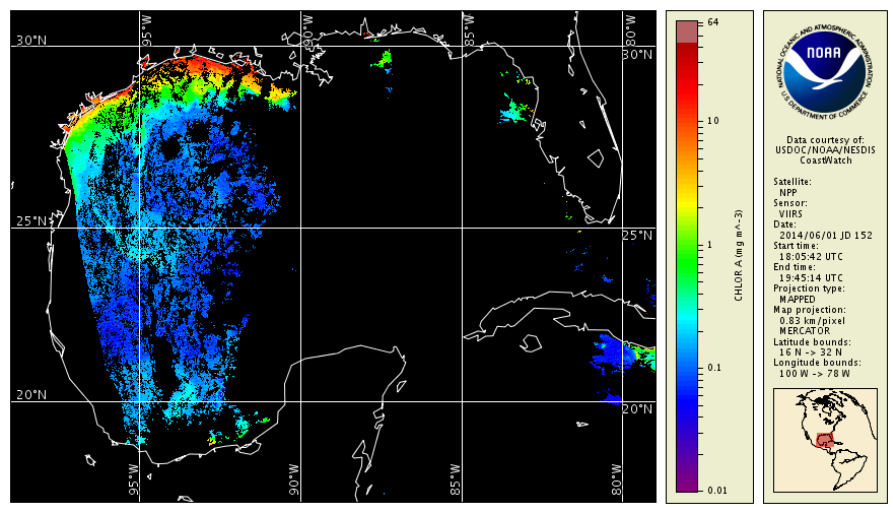


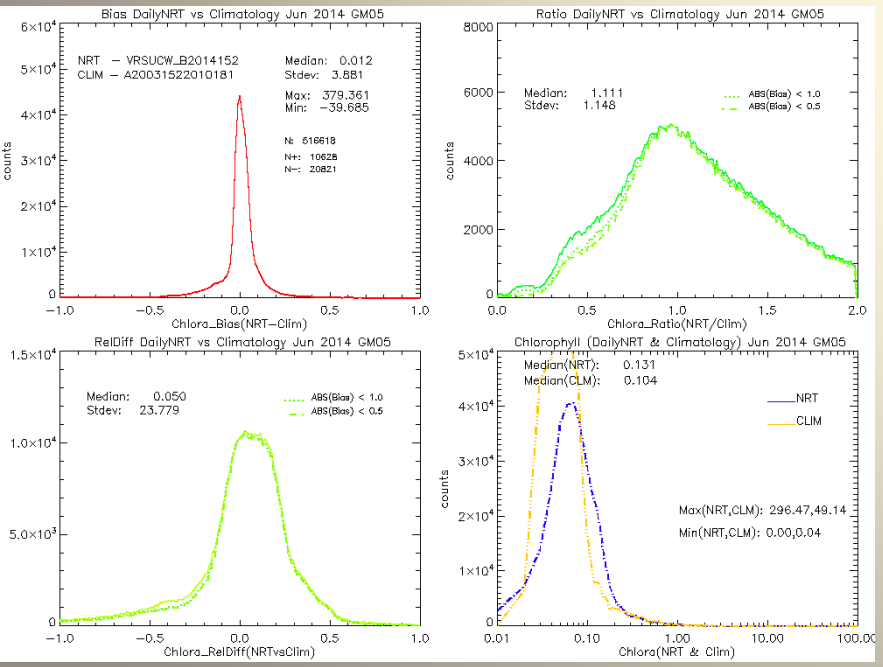
VIIRS NASA L2GEN - OBPG ~ - 4.8%



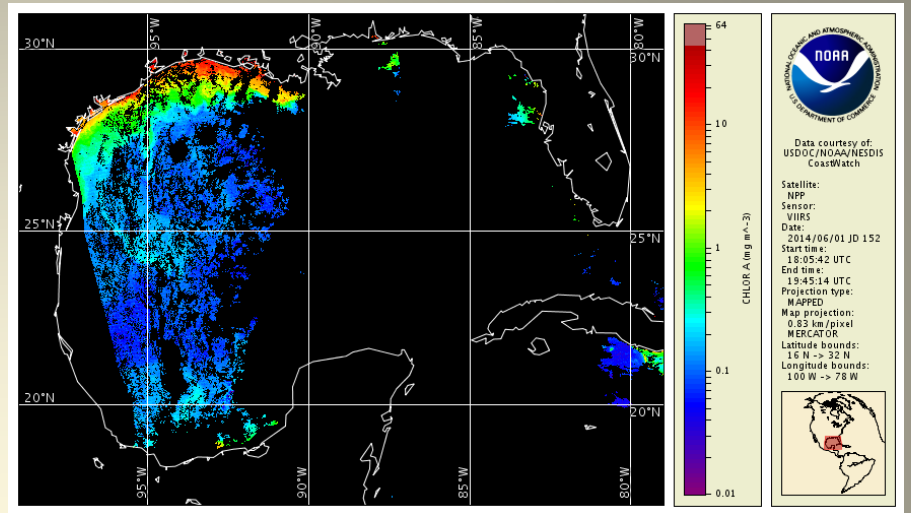
MODIS SWIR NOAA ~ - 7.7 %

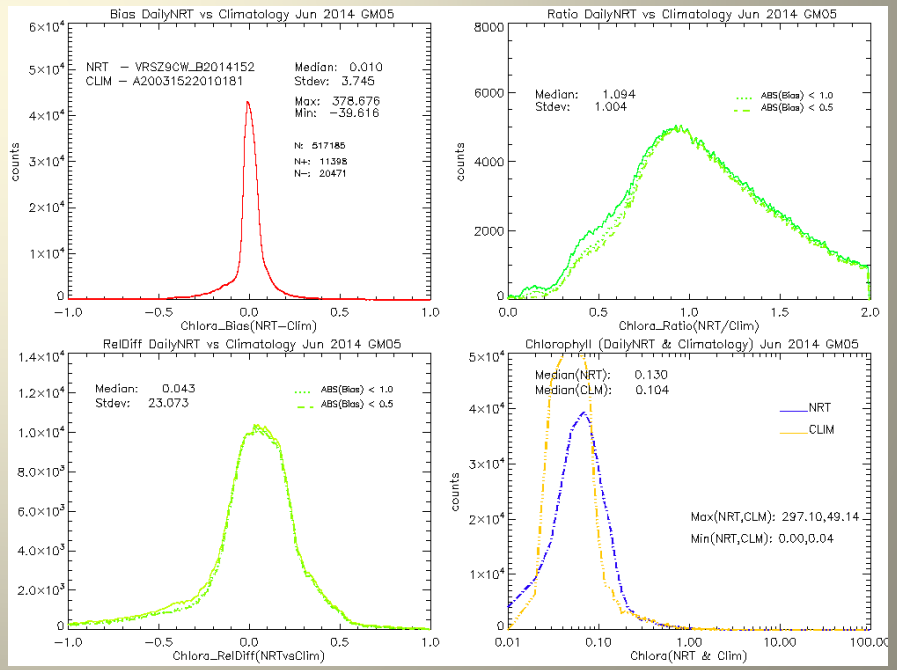
VRSUCW NOAA-MSL12 CW





VRSZ9CW NOAA-MSL12 MECB





NOAA-MSL12 NRT product

NOAA-MSL12 Science product

SUMMARY

- NOAA MSL12 does a better job than other contending algorithms like IDPS and NASA-L2gen. In addition it meets the L1 Accuracy requirements set in the JPSS Requirements document for open ocean waters. Further improvements in the algorithm for case-2 waters is anticipated in the future.

- NASA uses a tuned SDR to run their L2gen algorithm which is different from the IDPS SDRs that NOAA plans to use.
  - Lack of Vicarious Calibration when using L2gen with the IDPS SDR at NOAA rules out usage of L2gen for VIIRS to keep product quality high and consistent.
  - NASA's calibration activity for VIIRS is not completed either.

- NOAA Ocean Color Team is expected to do mission reprocessing of VIIRS
  - Hence using the NOAA-MSL12 in Near Real Time is advantageous versus the other options on the table.
  - Any user feed back on product quality issues related to the algorithm can be addressed in house at NOAA by the Ocean Color Team at STAR.

- JPSS has recently selected the NOAA-MSL12 as the algorithm of choice to run in operations at NOAA.