The Chesapeake Bay Program C_a algorithm round robin

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http://seabass.gsfc.nasa.gov/eval/cbp_eval.cgi

ALGORITHMS

to start,

a brief description of the algorithms and their forms …

ALGORITHMS

<u>empirical (statistical) algorithms</u>

OC4 version 4	(operational SeaWiFS; *O'Reilly et al. 2000*)
OC4 version 5	(for next SeaWiFS reprocessing)
OC3 version 5	(operational MODIS)
OC2 version 5	
OC3-CB	(Old Dominion University; tuned to Bay)
Clark	(NOAA; tuned to Bay; full-band; OC2 analog)
Carder	(operational VIIRS; OC2 analog)

<u>semi-analytical algorithms</u>

GSM01	(*Maritorena et al. 2002*)
GSM01-CB	(tuned to Bay; *Magnuson et al. 2004*)

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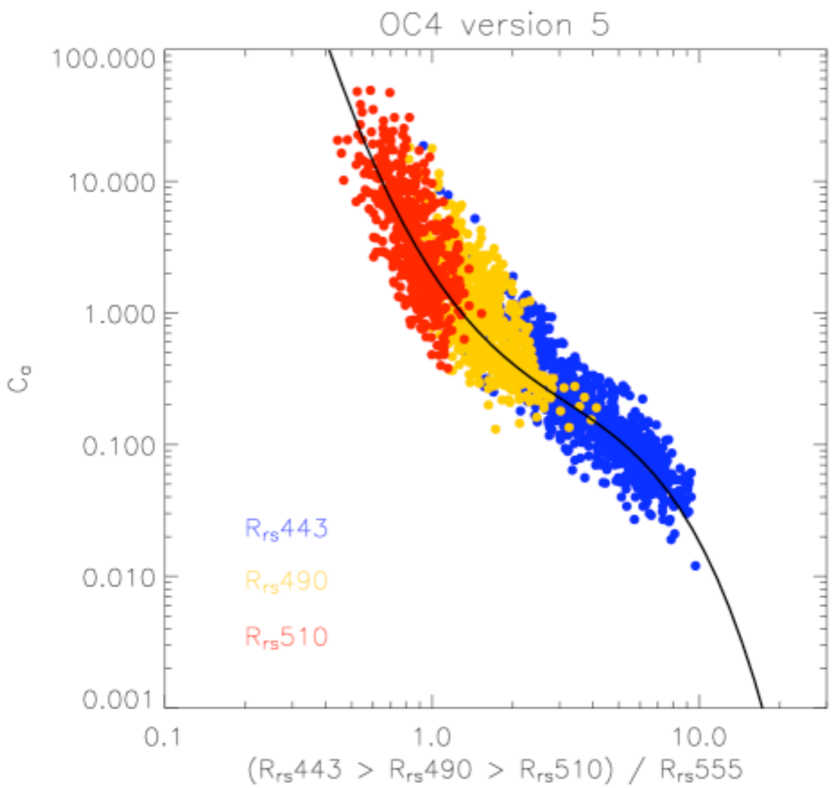
EMPIRICAL ALGORITHMS



general form of algorithm

$log_{10}(C_a) = (c_0 + c_1\ R + c_2\ R^2 + c_3\ R^3 + c_4\ R^4)$

where R is $log_{10}(R_{rs}\lambda\ /\ R_{rs}555)$

wavelengths used

OC4	= 443 > 490 > 510 / 555
OC3	= 443 > 490 / 555
OC2	= 490 / 555
Clark	= 490 / 555
Carder	= 490 / 555

principle differences

development data set (R_{rs} and C_a)

coefficients / regression

SEMI-ANALYTICAL ALGORITHMS

$$R_{rs} = g_0 \left(\frac{b_b}{a + b_b} \right) + g_1 \left(\frac{b_b}{a + b_b} \right)^2$$ (simplification of the radiative transfer equation)

R_{rs} == remote sensing reflectance

a == absorption coefficient

b_b == backscattering coefficient

g == constant

a separated into contributions by:

water (w) , dissolved + non-algal detrital material (dg), and phytoplankton (ϕ)

b_b separated into contributions by:

water (w), and particles (p)

SEMI-ANALYTICAL ALGORITHMS

$$R_{rs} = g_0\left(\frac{b_b}{a+b_b}\right) + g_1\left(\frac{b_b}{a+b_b}\right)^2$$

$$a(\lambda) = a_w(\lambda) + a_{dg}(443)\, e^{-S(\lambda - 443)} + \mathbf{a}_\phi^*(\lambda)\, Chl$$

$$b_b(\lambda) = b_{bw}(\lambda) + b_{bp}(443)\left(\frac{443}{\lambda}\right)^\eta$$

$R_{rs}(\lambda)$ from satellite(s)

S, η, g_0, g_1, & $\mathbf{a}_\phi^*(\lambda)$ are constants

$a_{dg}(443)$, $b_{bp}(443)$, & Chl are unknown

ALGORITHMS

next,

a review of SeaWiFS processing and evaluation protocols …

SUMMARY

<u>satellite data processing</u>

5,000 SeaWiFS MLAC files acquired

processed using MSL12 5.4.1 -- 3 runs per file

mapped and combined into single hdf files using SeaDAS

statistical and visual QC applied

900 final files considered, spanning 1998 through 2005

<u>comparison with *in situ* data</u>

data distributions via histograms

time-series of monthly averages

match-ups with level-2 data

<u>data stratification</u>

spatially: upper, middle, and lower Bay

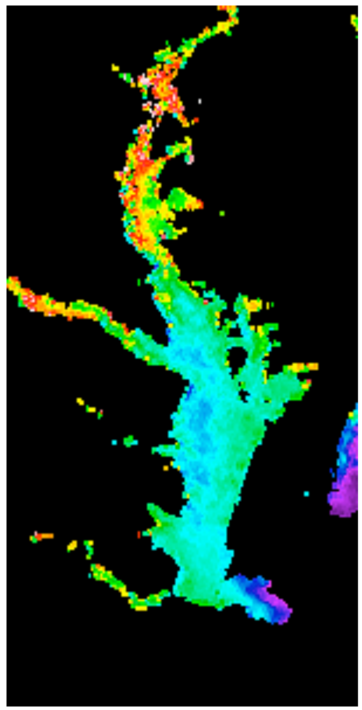
temporally: Winter, Spring, Summer, and Fall

SATELLITE QC METRICS

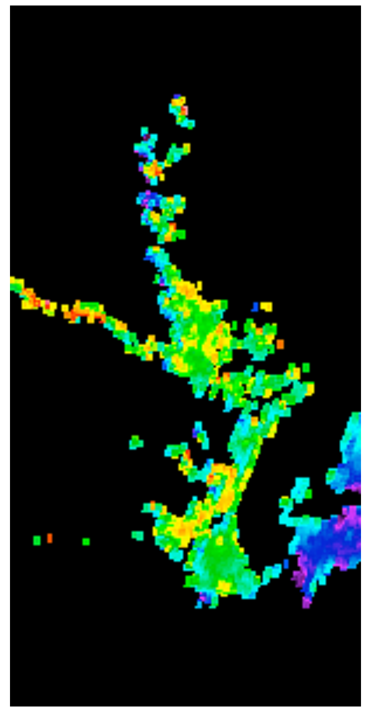
eliminate scenes with high satellite zenith angles in Bay

require > 25% of Bay ocean pixels to be cloud free

visual inspection:



good

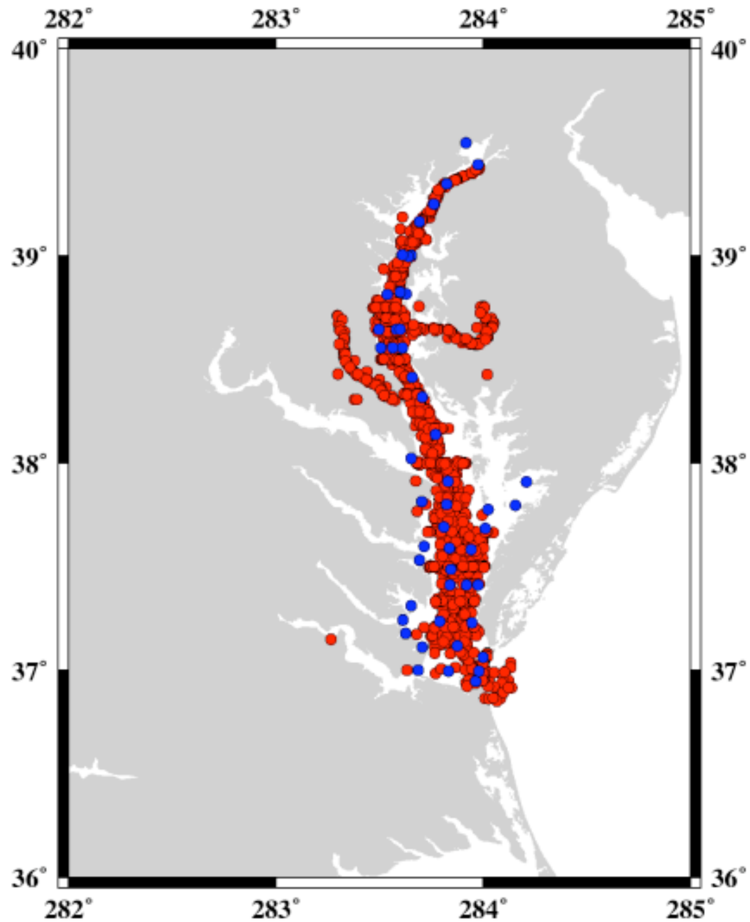


bad

consider only $0.1 \leq C_a \leq 100$ mg m^{-3}

require > 200 valid pixels per scene for regional analyses

IN SITU DATA



SIMBIOS/Harding

3,000 stations

CBP

15,000 stations

(fluorometrically derived)

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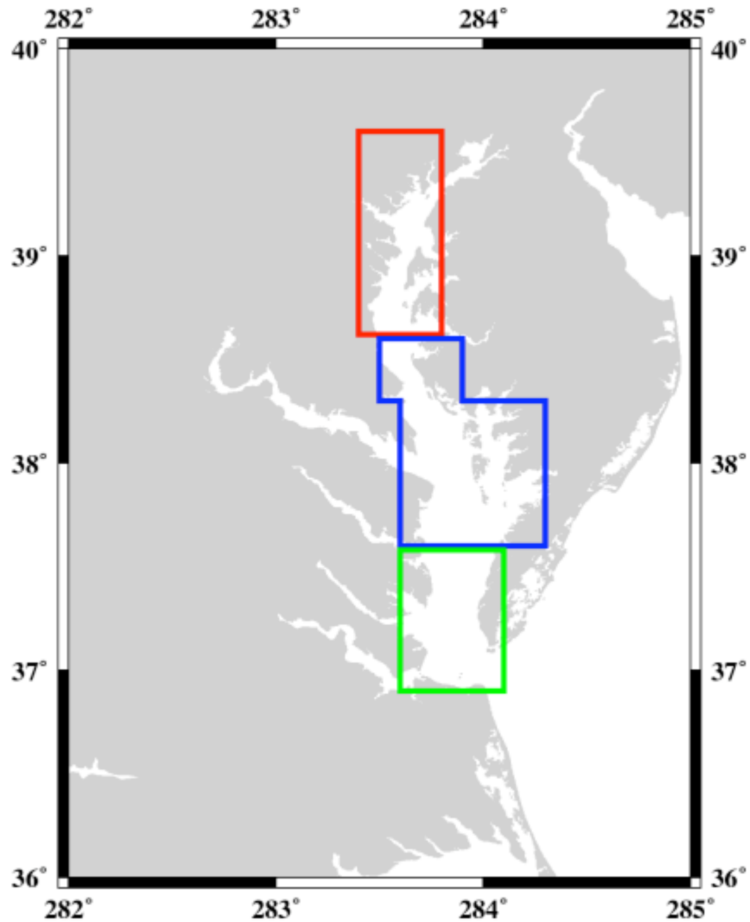
SPATIAL STRATIFICATION



upper

middle

lower

from *Magnuson et al. 2004*

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INTERMISSION

before we move on to the results …

let’s pause for a discussion on algorithm evaluation criteria

POSSIBLE EVALUATION CRITERIA

the histograms, time-series, and scatter plots convey comparative information in rather different ways

given pre-defined CBP requirements, certain analyses may prove more powerful than others

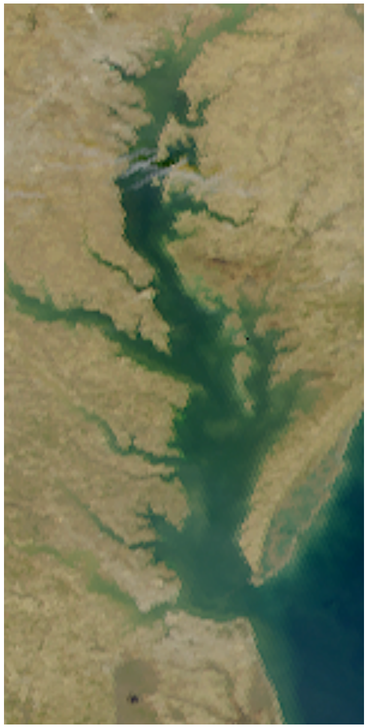
<u>possible considerations</u>

(1) geographic coverage (# of valid satellite pixels)

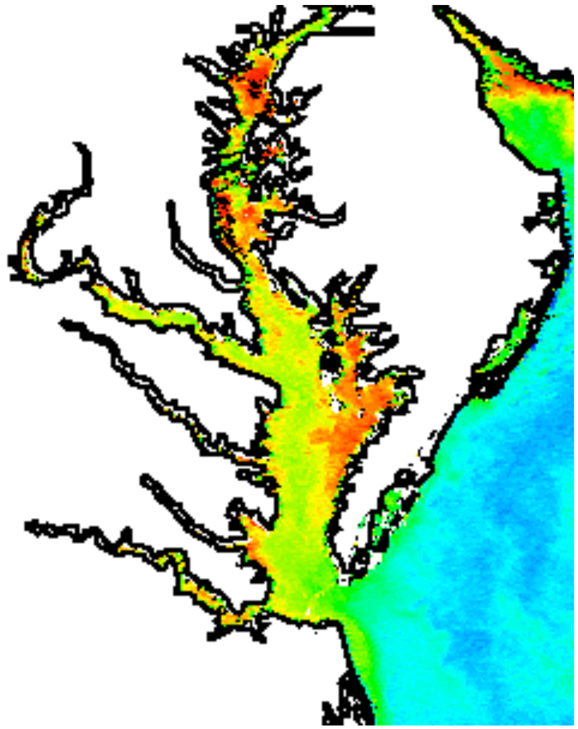
(2) absolute accuracy (quantitative evaluation?)

(3) reproduction of temporal features (qualitative evaluation?)

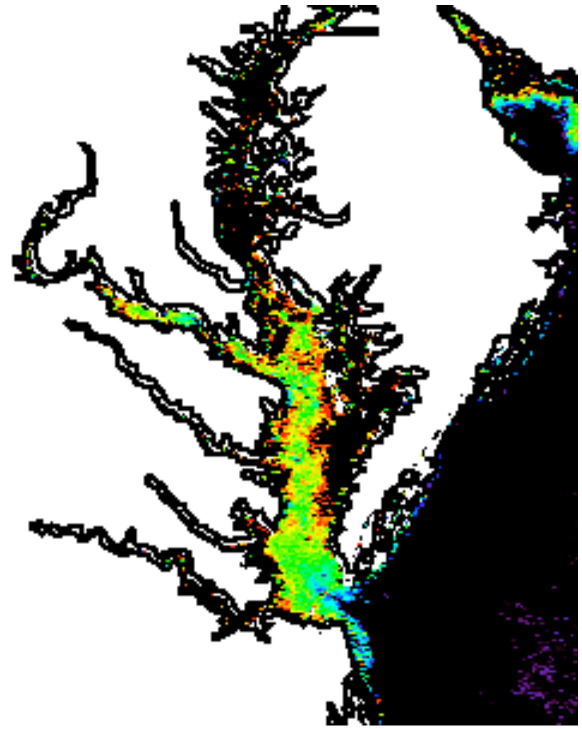
COVERAGE ISSUES



OC4v4



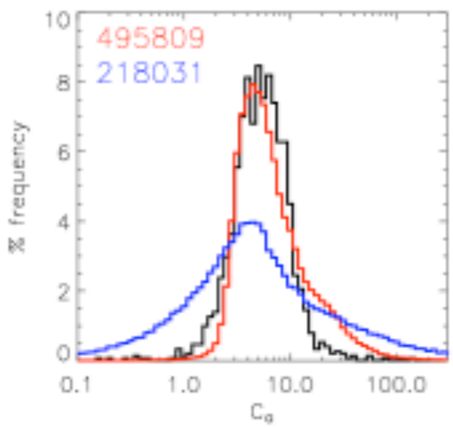
GSM01-CB



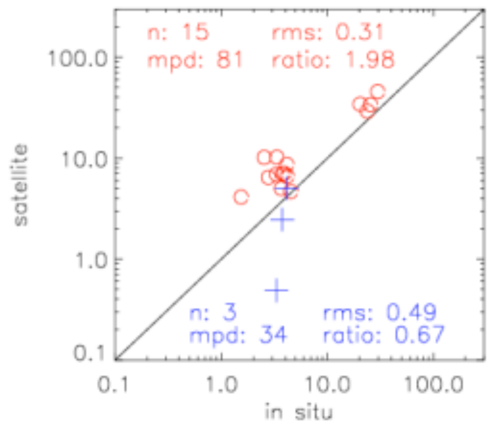
Scene from Spring 2005; C_a from 0.1 to 100 mg m^{-3} shown

EXAMPLE ANALYSES

distributions



match-ups



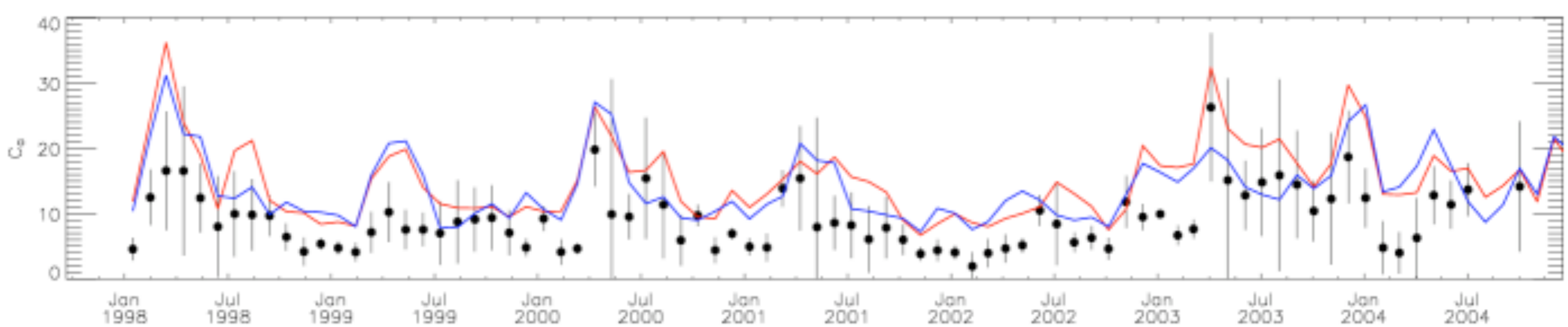
results generated

for each algorithm

for each region

for each season

time-series



EXAMPLE RESULTS

distributions

Winter			Spring			Summer			Fall		
low	mid	upper	low	mid	upper	low	mid	upper	low	mid	upper
OC4	OC4	OC4	OC3	OC4	OC4	OC4	OC4	X	OC2	OC4	OC4
OC3	Carder	Carder	OC3-CB	OC3-CB	Carder	OC3	GSM-01	X	Clark	Carder	Carder

match-ups

Winter			Spring			Summer			Fall		
low	mid	upper	low	mid	upper	low	mid	upper	low	mid	upper
OC3-CB	OC3-CB	X	OC4	Carder	Carder	OC4	OC3	Carder	OC4	OC4	Clark
GSM-CB	GSM-CB	X	GSM-CB	GSM-CB	OC4	GSM-CB	OC2	OC2	OC3	OC3	X

time-series

low	mid	upper
OC4	OC4	OC4
OC3-CB	OC3-CB	Carder

first attempt to identify
top 2 performers for each analysis

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INTERMISSION

rather than delve into results for each algorithm,

here are example results for OC4v5 and GSM-CB

(one empirical, one semi-analytical)

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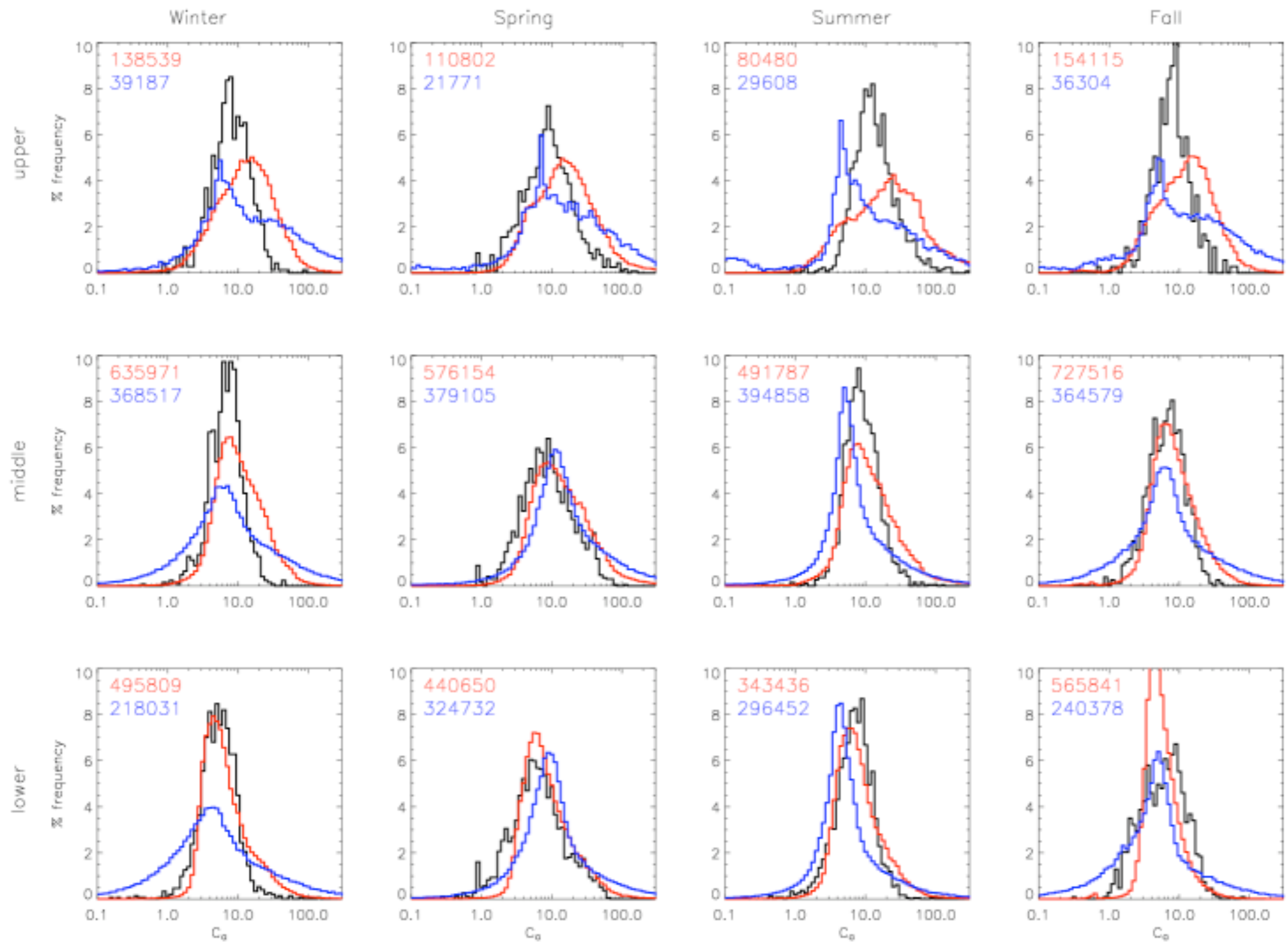
DATA DISTRIBUTIONS



in situ **OC4v5** **GSM-CB**

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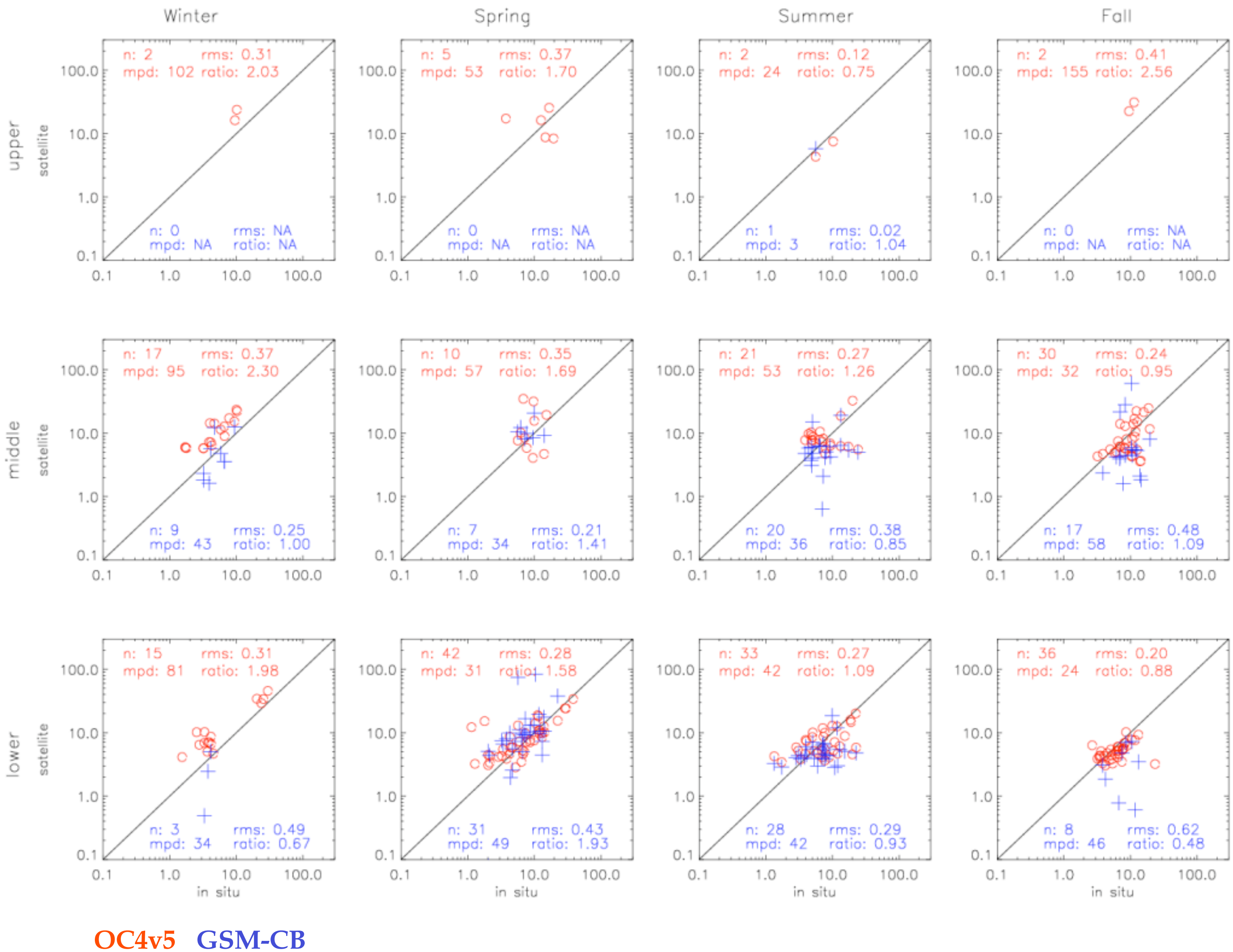
SATELLITE MATCH-UPS



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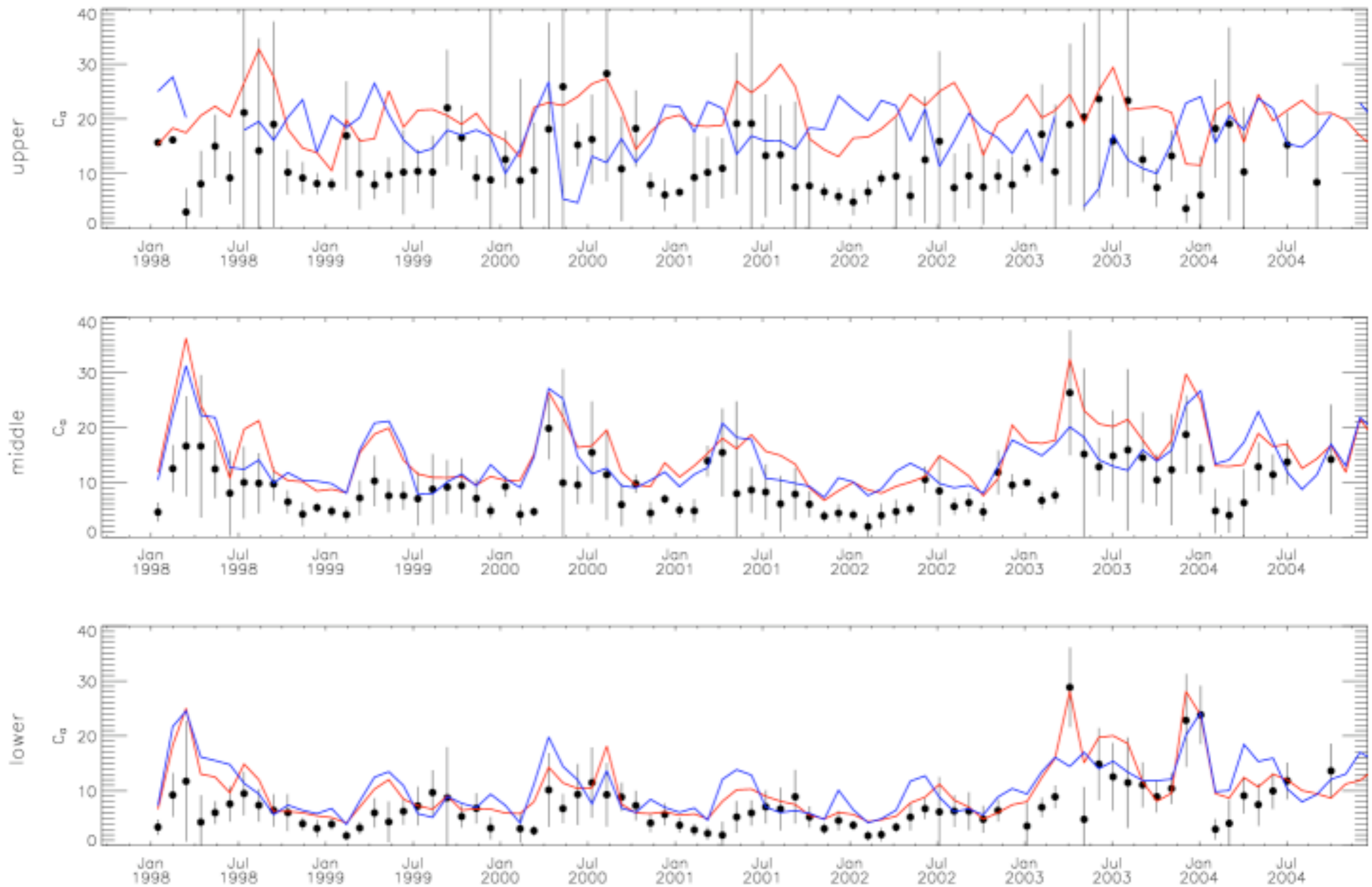
TIME-SERIES



in situ **OC4v5** **GSM-CB**

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KNOWN ISSUES WITH ANALYSES

varying statistical approaches (e.g., median vs. mean in time-series)

additional statistical approaches (e.g., K-S tests for distributions)

alternative satellite and *in situ* exclusion criteria

alternative satellite flagging and masking schemes

alternative averaging approaches for match-ups and time-series

nuances of semi-analytical algorithms

NEXT STEPS

considering what was presented in the preceding slide,

this meeting provides an introduction to the activity …

in the coming months, this group should focus on:

(1) review and discussion of existing results

(2) implementation of alternative analyses

(3) selection of algorithm(s)

(4) transition to CoastWatch

(5) MODIS