Chesapeake Bay Satellite-derived Sea Surface Salinity Comparison to CBIBS Buoys

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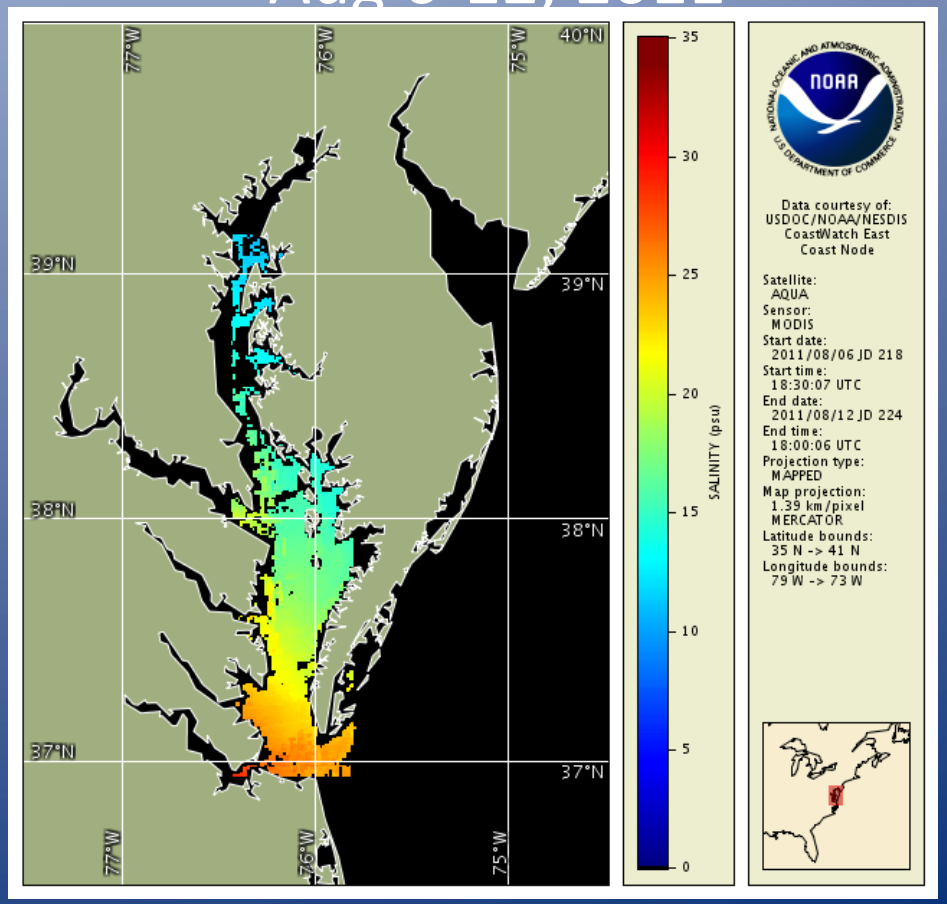
Satellite-derived Sea Surface Salinity
from NASA's Aqua satellite: MODIS sensor

7-Day Average:
Aug 6-12, 2011

WHY? **1km** salinity for hydrodynamic/ ecosystem models

WHAT? CDOM in freshwater runoff is measurable by satellite and is inversely proportional to salinity

HOW? NN algorithm (2003-2008; n= 1917); range 9.5 – 32.7 psu



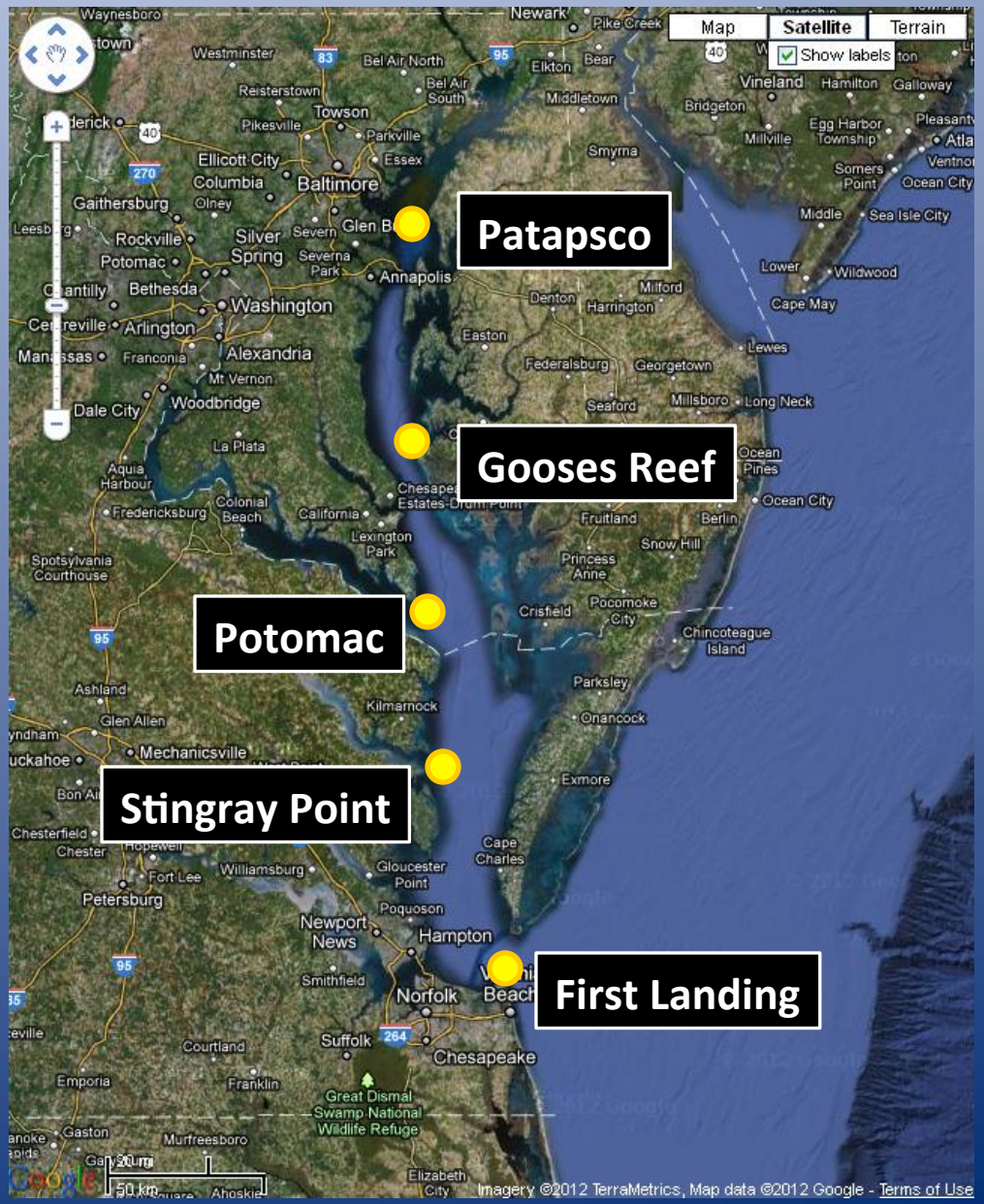
Geiger, et al., Continental Shelf Research

Satellite salinity comparison to CBIBS buoy salinity

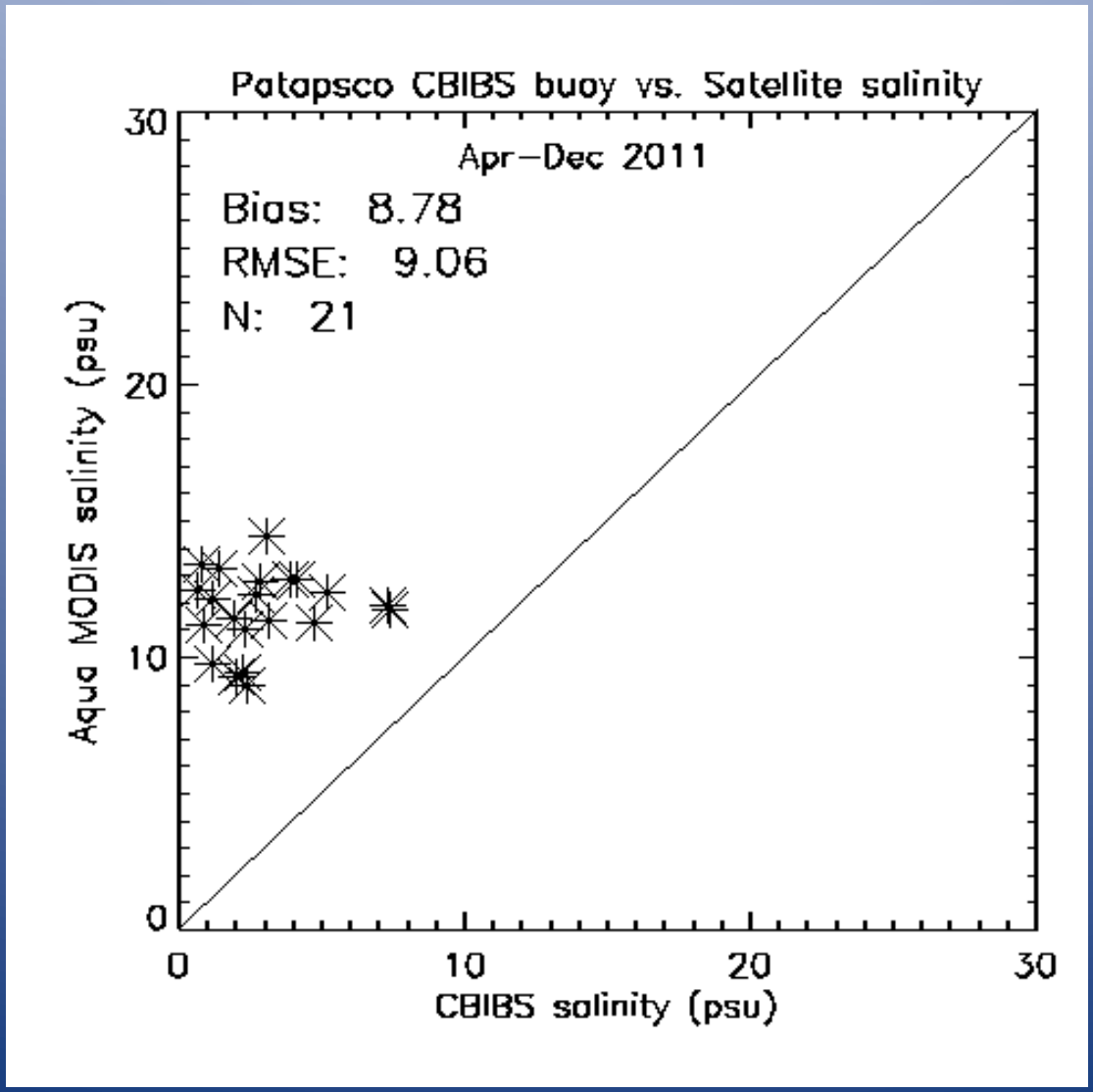
Apr 7 – Dec 31, 2011

Comparison method:

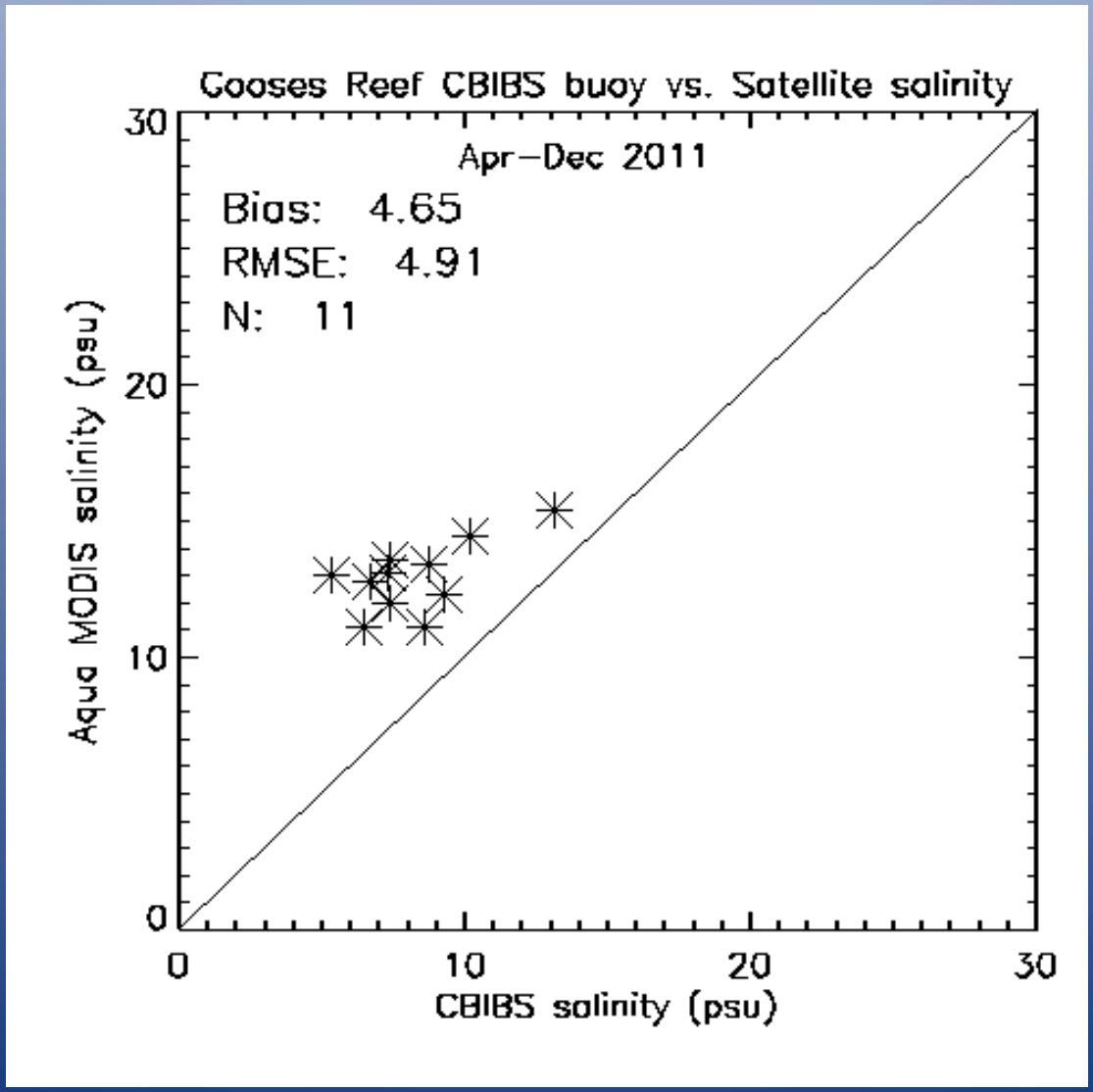
- Temporal: buoy salinity is within 2 hrs of satellite overpass
- Spatial: nearest-neighbor satellite grid cell to buoy's location (satellite data is in Mercator projection)



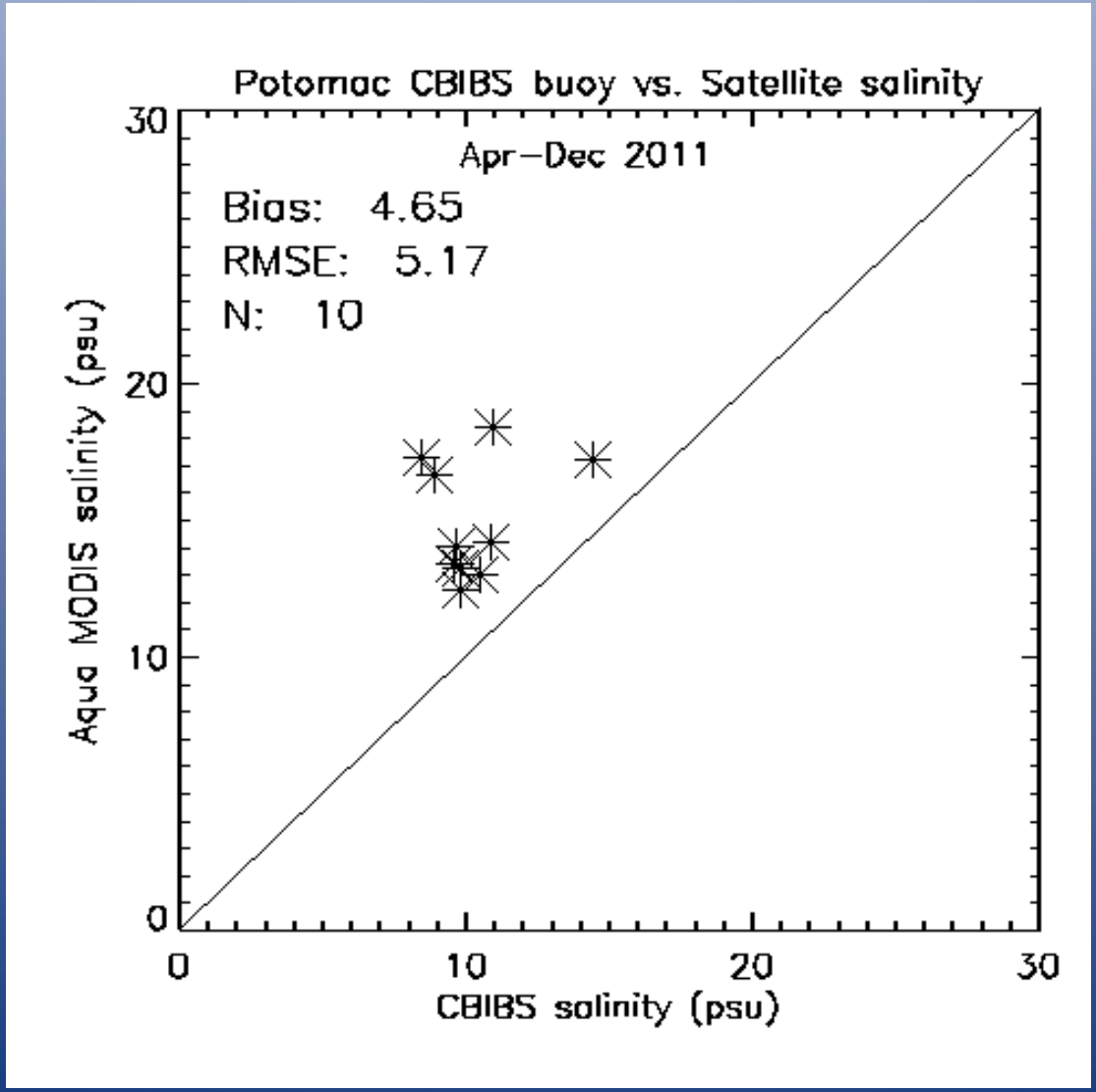
Patapsco


Patapsco CBIBS buoy vs. Satellite salinity
Apr–Dec 2011
Bias: 8.78
RMSE: 9.06
N: 21
Aqua MODIS salinity (psu)
CBIBS salinity (psu)
0
10
20
30

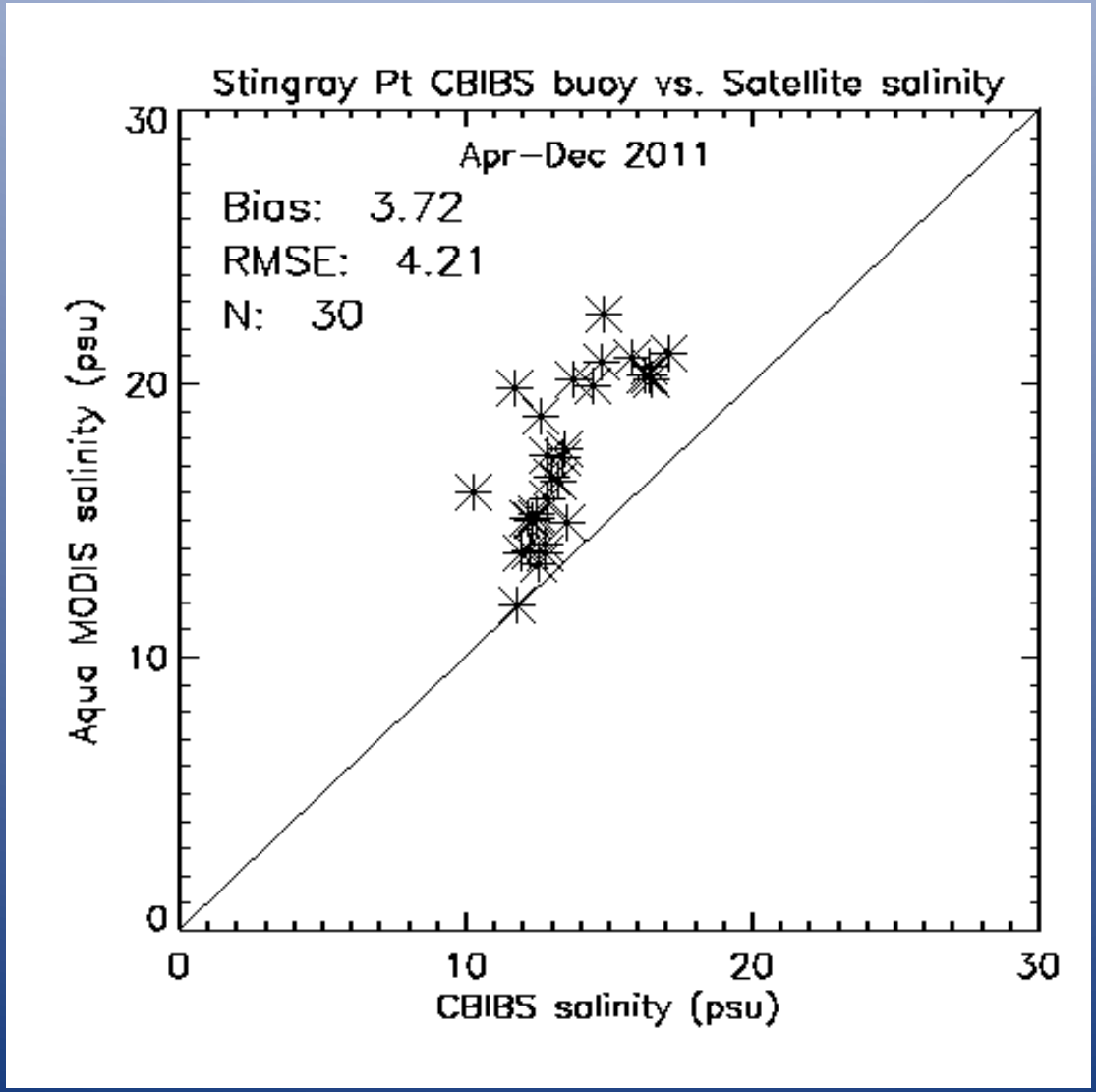
Gooses Reef


Gooses Reef CBIBS buoy vs. Satellite salinity
Apr–Dec 2011
Bias: 4.65
RMSE: 4.91
N: 11
Aqua MODIS salinity (psu)
CBIBS salinity (psu)
0
10
20
30

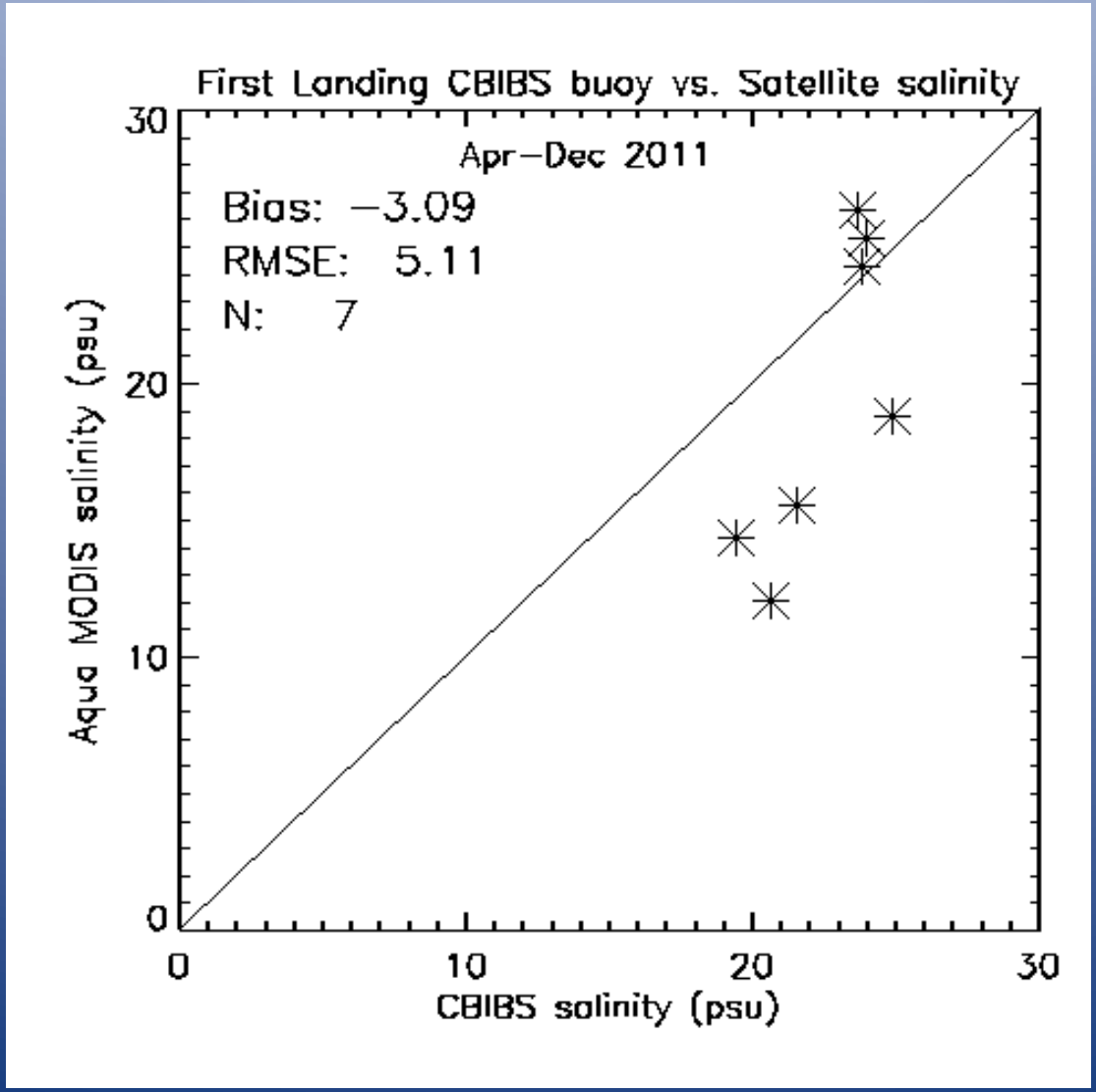
Potomac


Potomac CBIBS buoy vs. Satellite salinity
Apr–Dec 2011
Bias: 4.65
RMSE: 5.17
N: 10
Aqua MODIS salinity (psu)
CBIBS salinity (psu)
0
10
20
30

Stingray Point



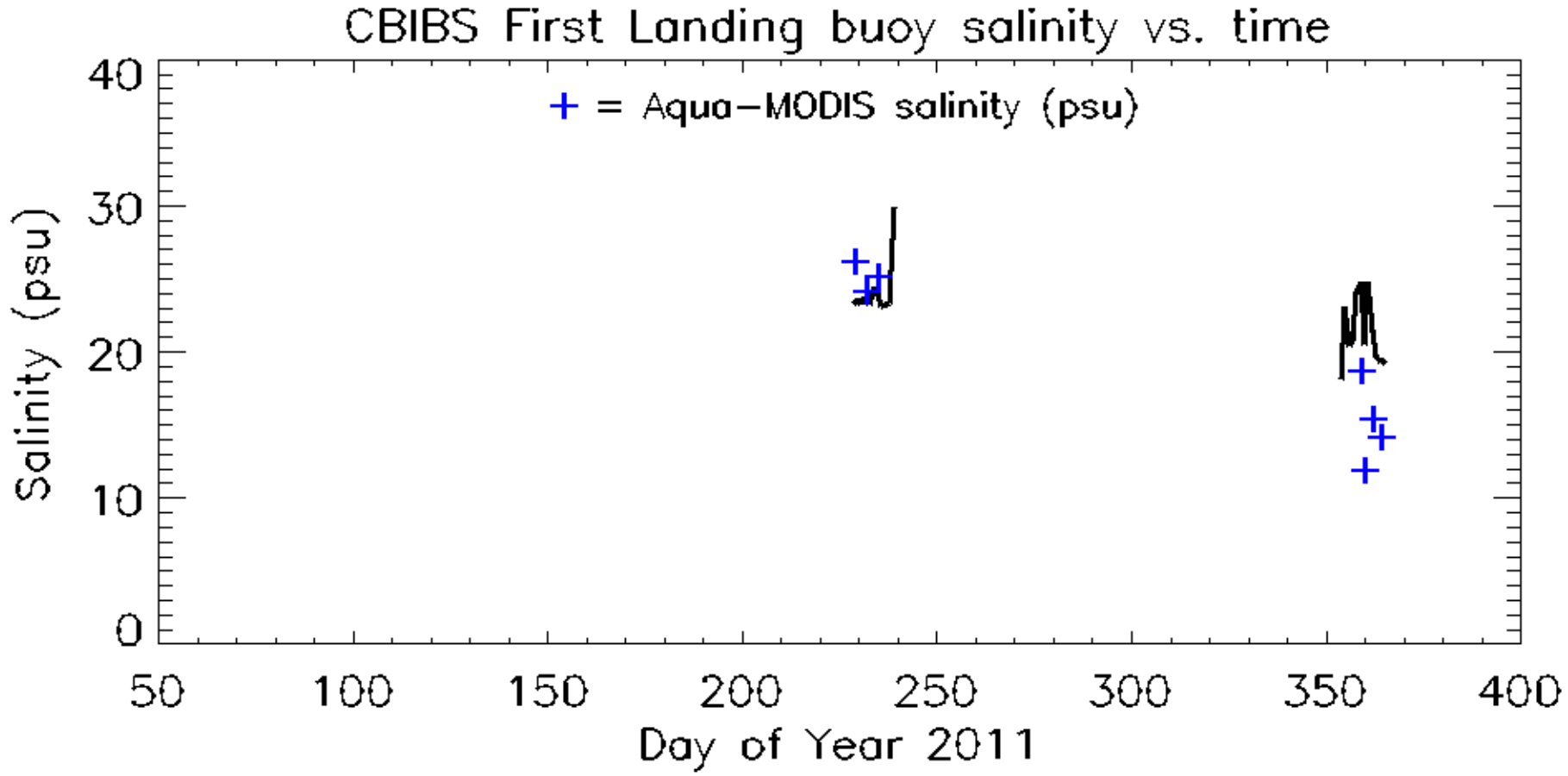
First Landing



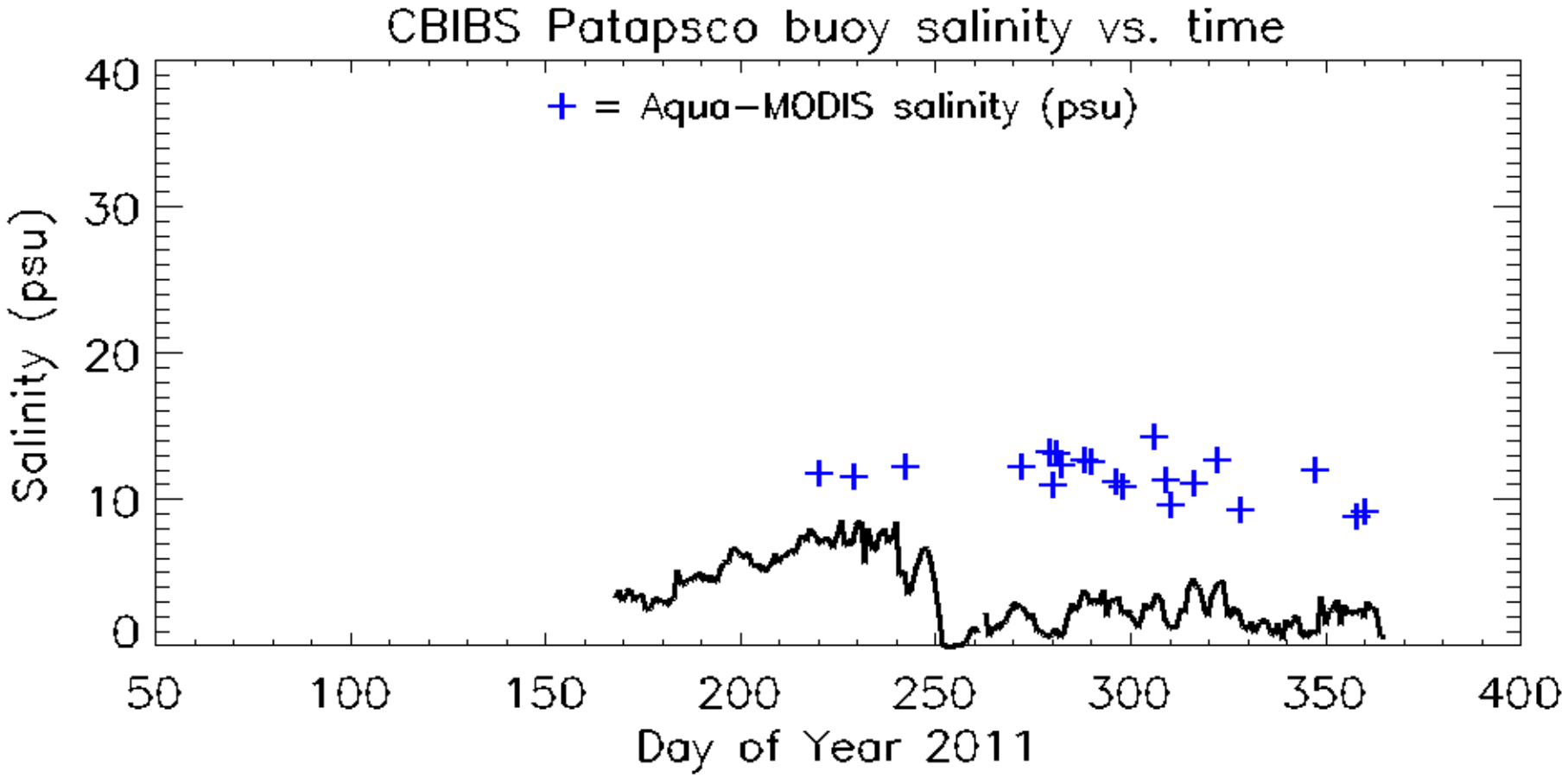
Evaluation with CBIBS helped us learn:

- Algorithm is overpredicting salinity:
  - **Rerun algorithm training with in-situ data representative of the entire mainstem bay.**
- Small number of match-up points:
  - Algorithm is very conservative: high zenith angle & coastal aerosol contamination
    - **Perhaps relax rejection criteria to obtain more data**
- High quality CBIBS measurement is essential **over time**
  - Frequent instrument swaps to maintain consistency of quality
  - CBIBS data QC

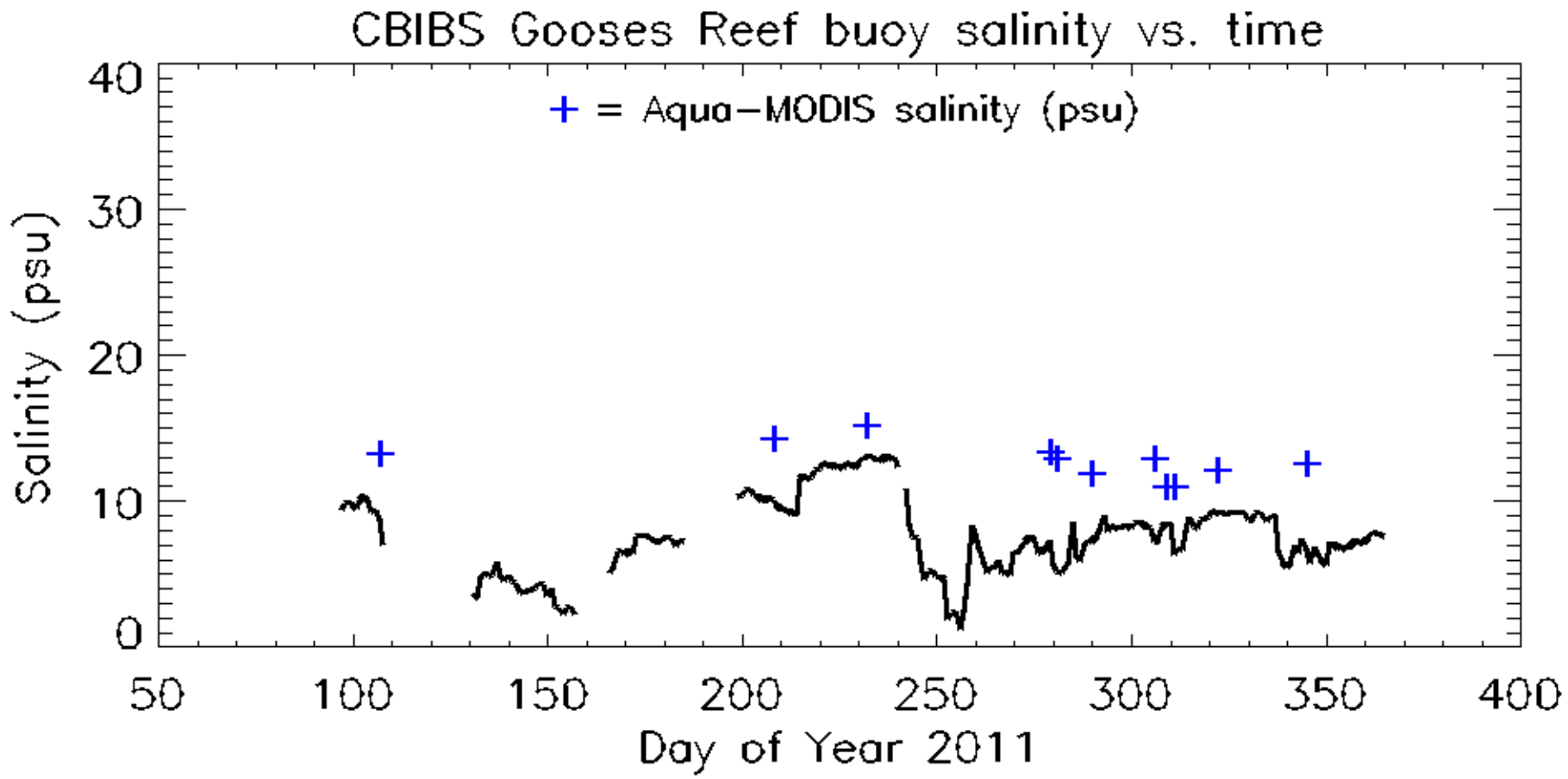
CBIBS vs. Satellite salinity time series, First Landing



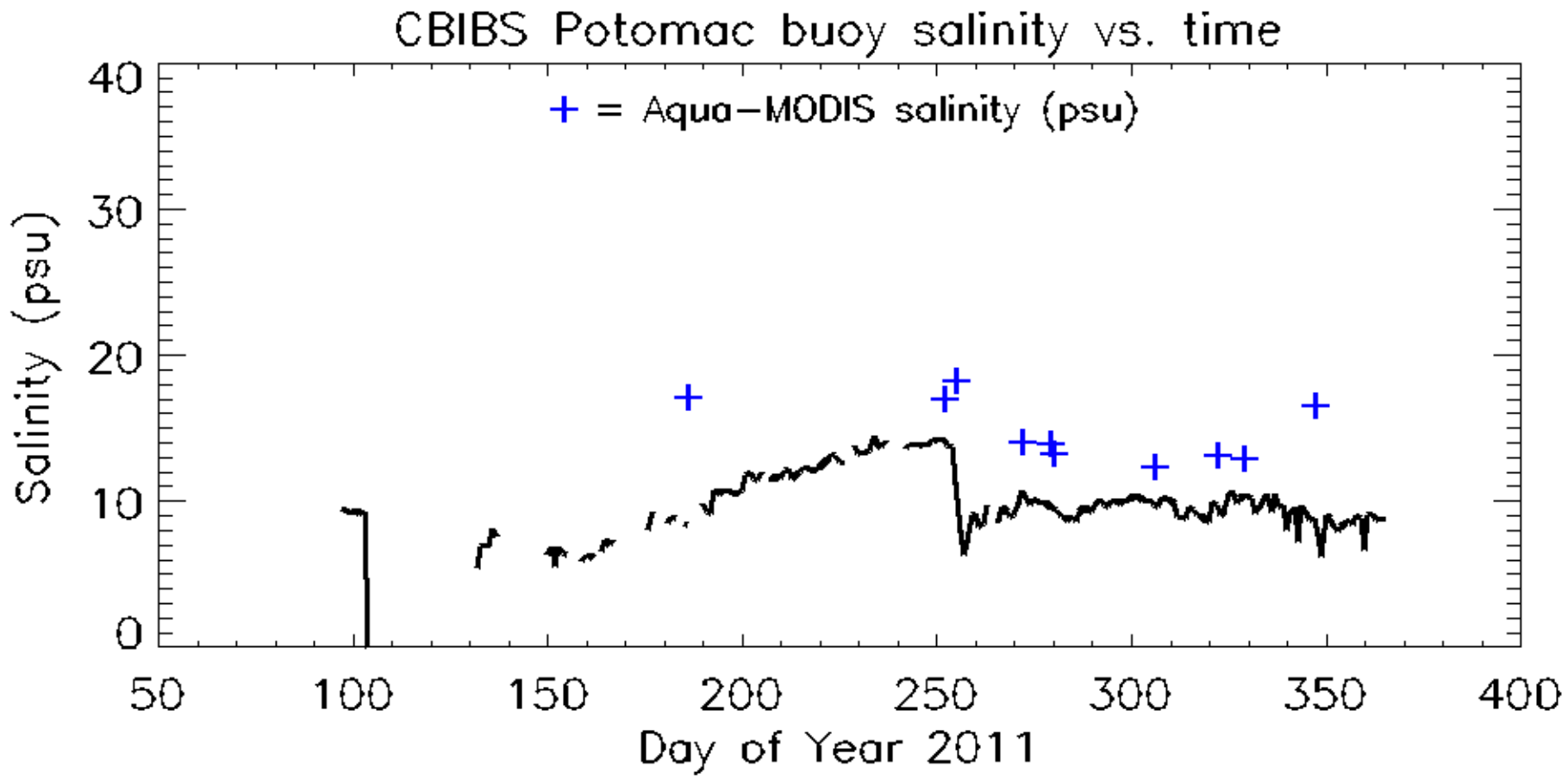
CBIBS vs. Satellite salinity time series, Patapsco



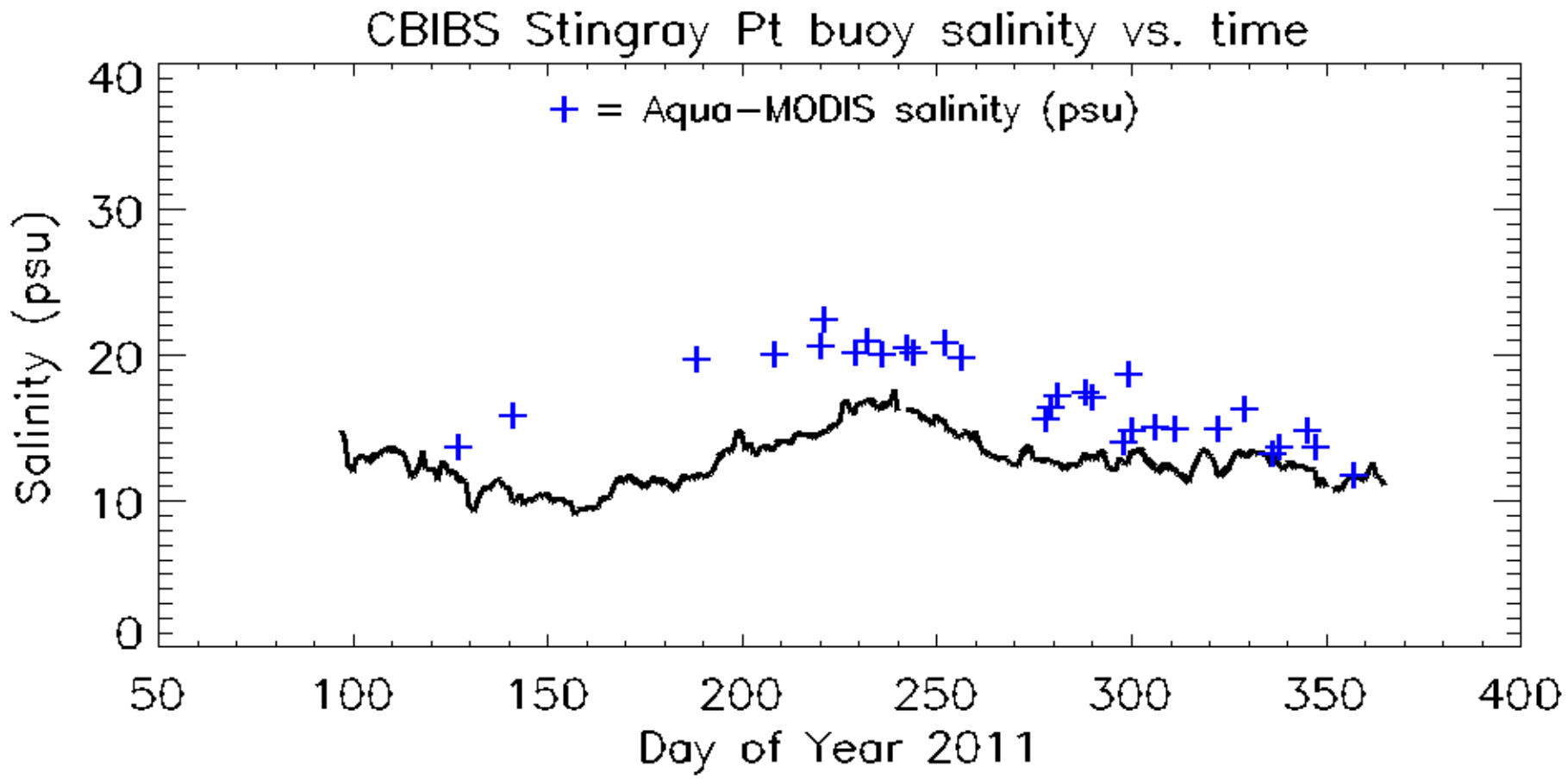
CBIBS vs. Satellite salinity time series, Gooses Reef



CBIBS vs. Satellite salinity time series, Potomac



CBIBS vs. Satellite salinity time series, Stingray Point



Evaluation with CBIBS helped us learn:

- Algorithm is overpredicting salinity due to:
  - Lack of freshwater samples in training data.
    - CBIBS-Satellite Bias improves toward more saline water.
    - ➢ **Rerun algorithm training with in-situ data representative of the entire mainstem bay.**
  - MODIS instrument is nearly 10 years old: degradation shows INCREASE in radiometric response since 2010 (uncorrected), notably in wavelength bands that estimate CDOM.
    - Higher sensor reflectance (less CDOM absorption) translates to higher salinity.
    - ➢ **Utilize data from new satellite sensor (NPP/VIIRS) after it is calibrated.**
- Small number of match-up points due to:
  - Algorithm is very conservative: satellite data rejected when not in training range
    - ➢ **May be appropriately rejecting data** (high zenith angle & coastal aerosol contamination)
    - ➢ **Perhaps relax rejection criteria to obtain more data**
  - Cloud coverage
  - Buoy data outages (esp. First Landing buoy)
- High quality CBIBS measurement is essential **over time**
  - Continue frequent instrument swaps to maintain consistency of quality (instrument fouling is episodic)
  - Perform CBIBS data quality control to remove outlier values

Satellite Sea Surface Salinity Algorithm

- Ocean Color Radiometry (OCR) Sea Surface Salinity algorithm concept: Colored Dissolved Organic Matter (CDOM) is measurable by satellite and is inversely proportional to salinity
- MODIS instrument on NASA Aqua satellite: bands specific for ocean optical radiance retrieval at blue and green wavelengths (CDOM absorbs in UV-to-blue region)
- Neural network algorithm relates input parameters to salinity:
  - Rrs @ 412nm, 443nm, 412/547, 443/547, 488/547
  - SST, latitude, longitude
- Neural net training based on matched MODIS data and in-situ salinity for years 2003-2008 with range 9.58 – 32.71 psu (1,917 matchup points)
- Error of ±1.12 psu (rms) based on comparison of algorithm results with ½ of satellite-insitu matchups NOT used in training
- Algorithm very conservative: rejects satellite data not falling within training range of input data (Rrs's, SST, lat, lon)
- Algorithm Reference: Geiger, E. F., Grossi, M. D., Trembanis, A. C., Kohut, J. T., Oliver, M. J., 2011. Satellite-derived Coastal Ocean and Estuarine Salinity in the Mid-Atlantic. Continental Shelf Research. doi:10.1016/j.csr.2011.12.001