River Runoff Effect on the Suspended Sediment Property in the Upper Chesapeake Bay Using MODIS Observations and ROMS Simulations

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Introduction

- Ocean color data derived from MODIS-Aqua from 2002–2012 and simulations from the Regional Ocean Model System (ROMS) are used to study the impact of the Susquehanna River discharge on the total suspended sediment (TSS) concentration in the upper Chesapeake Bay.
- The shortwave infrared (SWIR)-based atmospheric correction algorithm (Wang, 2007) is used to derive $nL_w(\lambda)$. The diffuse attenuation coefficient at the wavelength of 490 nm Kd(490) is derived using the algorithm proposed by Wang et al. (2009), and the TSS is derived using the algorithm proposed by Son and Wang (2012).
- The variations of MODIS-derived TSS climatology and monthly time series are compared with Susquehanna River discharge data at Conowingo Dam from USGS (http://waterdata.usgs.gov/usa/nwis/). Since Susquehanna River discharge is dominated by a few high-discharge events each year, ROMS sediment model is used to simulate the response of the upper Bay TSS to the Hurricane Sandy event.

Upper Chesapeake Bay TSS and Susquehanna River Discharge

- MODIS-Aqua-derived monthly climatology TSS concentration in the upper Chesapeake Bay and the Susquehanna River discharge data show similar pattern in seasonal variations: the TSS concentration is low in summer, reaches a peak in December/January, slightly drops in February, and then reaches a second peak in March/April (Fig. 1 and Fig. 2).
- The TSS monthly temporal variation in the upper Chesapeake Bay is also found in phase with the monthly averaged river discharge data (Fig. 3), which indicates strong correlation between the river discharge and the upper Chesapeake Bay TSS concentration.

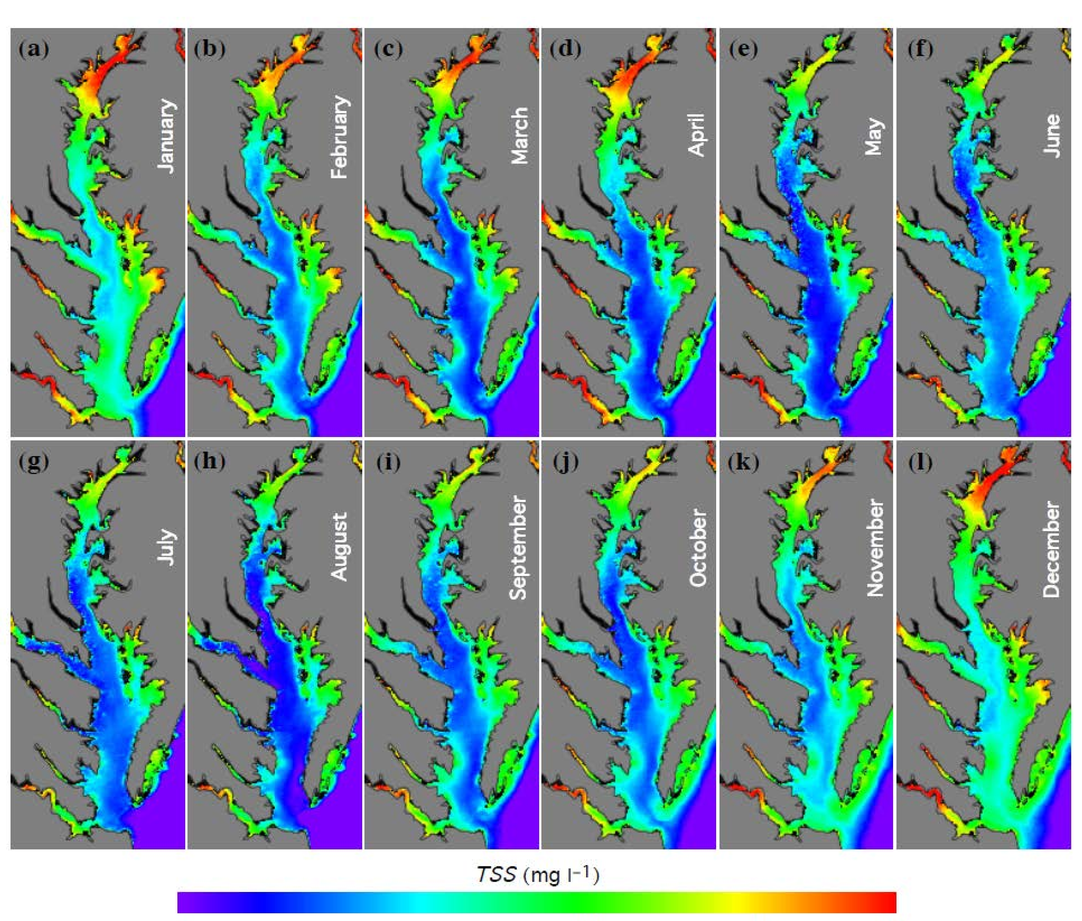

Figure 1. MODIS-Aqua-derived monthly climatology images (2002–2012) of TSS concentration for (a)–(l) as the month of January to December.

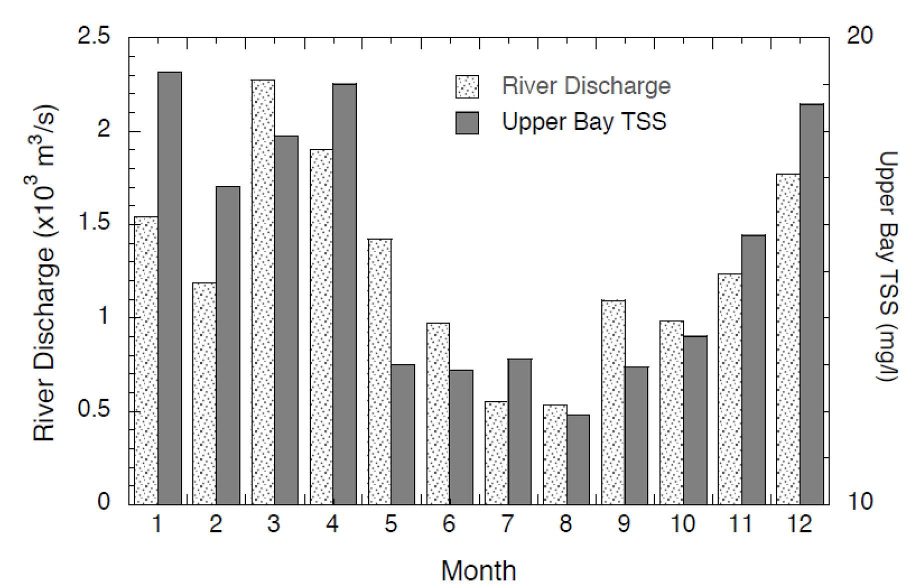

Figure 2. Comparison of the Susquehanna River discharge from year 2002 to 2012 averaged by month (light bars) and MODIS-Aqua-derived monthly climatology TSS concentration in the upper Chesapeake Bay (dark bars).

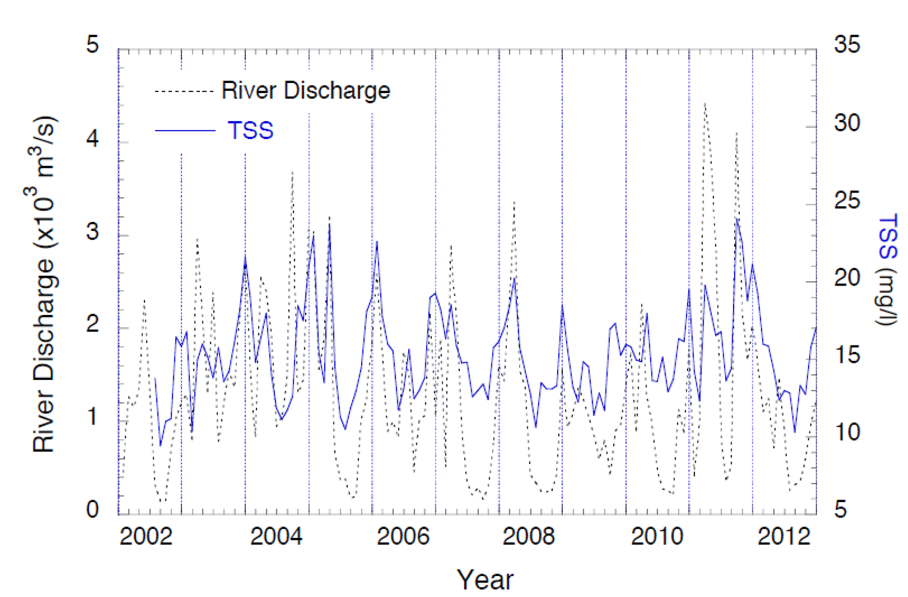

Figure 3. Comparison of time series of monthly averaged Susquehanna River discharge from year 2002 to 2012 (dotted line, scale in left) and time series of monthly averaged MODIS-measured TSS concentration from 2002 to 2012 in the upper Chesapeake Bay (solid line, scale in right).

Impact of High River Discharge Events on the Upper Bay TSS

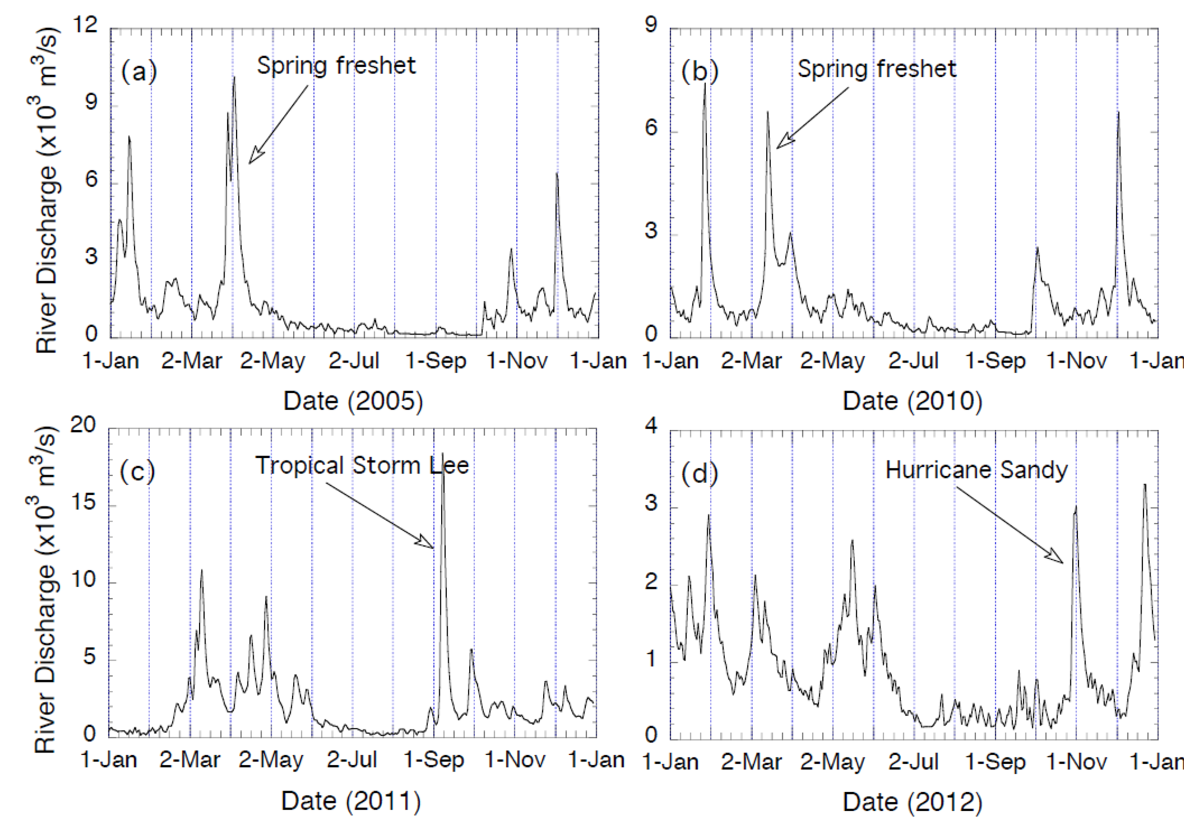

Figure 4. Daily time series of the Susquehanna River discharge in the year of (a) 2005, (b) 2010, (c) 2011, and (d) 2012.

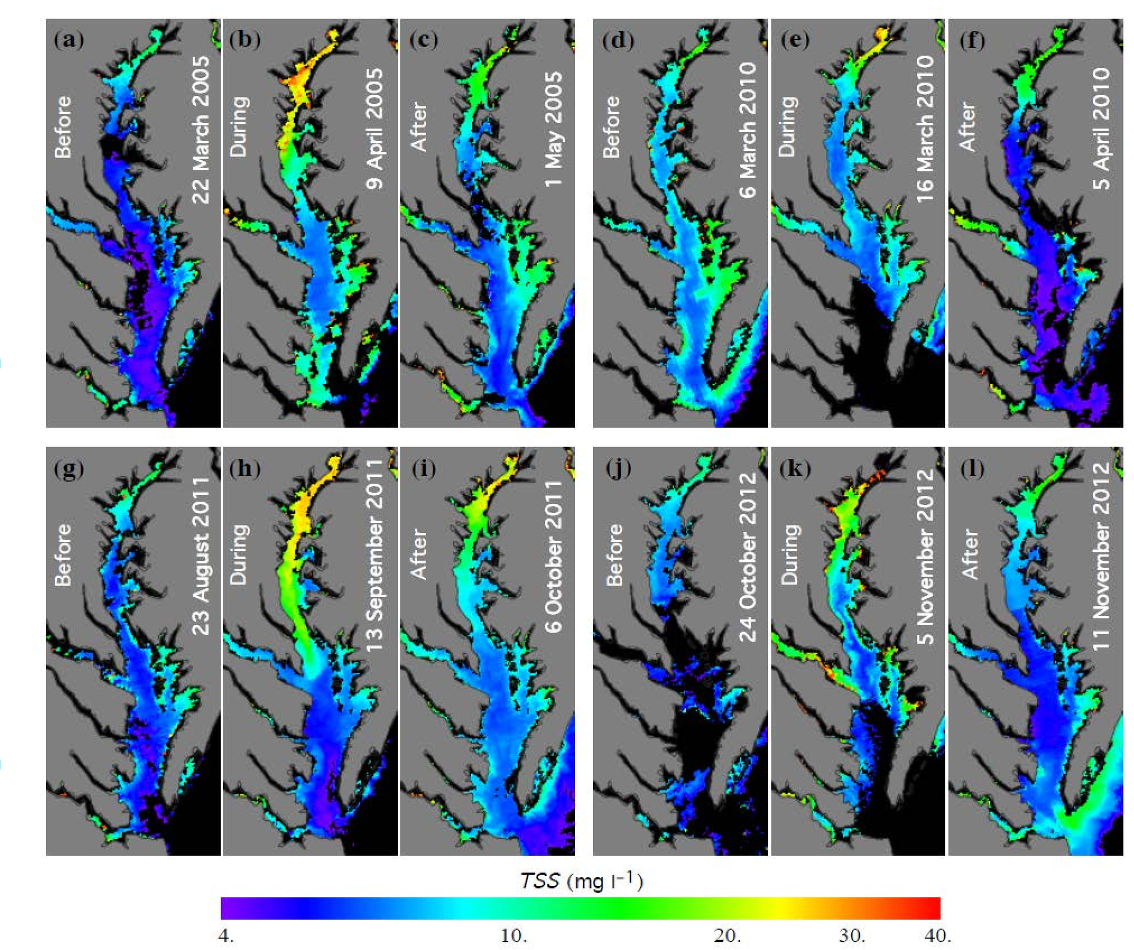

Figure 5. MODIS-Aqua-derived TSS concentration images before, during, and after four high discharge events of the Susquehanna River for the case of (a–c) April 2005, (d–f) March 2010, (g–i) September 2011, and (j–l) November 2012, respectively.

ROMS Simulations

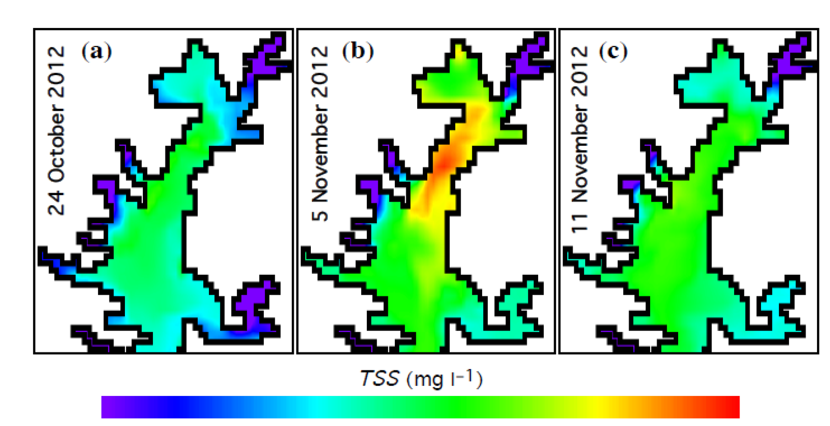

Figure 6. Model simulated TSS concentration in the upper Chesapeake Bay on (a) 24 October, (b) 5 November, and (c) 11 November 2012.

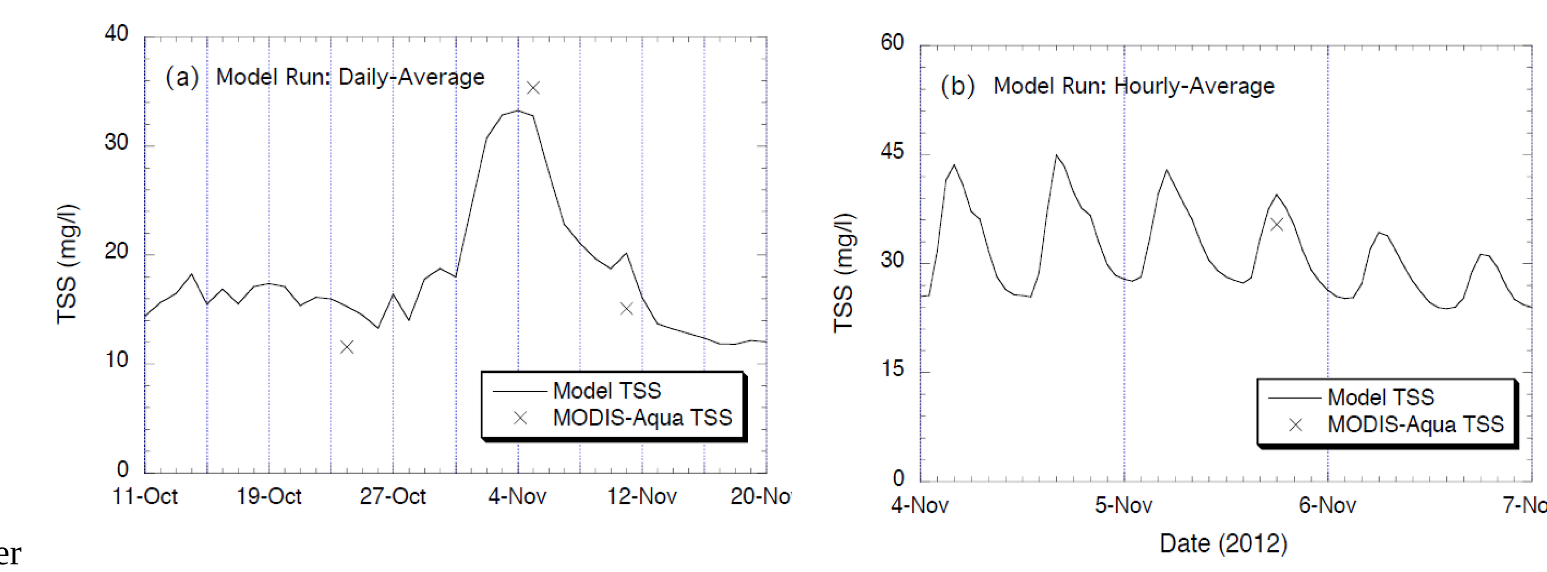

Figure 7. Model-simulated vs. satellite-measured TSS comparison near the center of the ETM zone (39.35°N, 76.14°W) for (a) daily averaged TSS concentration from 11 October 2012 to 20 November 2012 and (b) hourly averaged TSS concentration from 4 November 2012 to 7 November 2012.

Conclusions

- MODIS-Aqua-derived TSS data indicate that the Susquehanna River discharge has strong and direct impact on the variation of TSS concentration in the upper Chesapeake Bay.
- The effect of the Susquehanna River discharge on the upper Bay TSS is mainly through a few high river discharge events in each year, and the TSS is generally low in low river flow conditions.
- Both MODIS-derived TSS data and ROMS simulations show that the Susquehanna River discharge is the dominant factor for the variations of TSS concentration in the upper Chesapeake Bay.

Acknowledgements

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