Summary of Recent Research on Effects of Climate Change on the Chesapeake Bay

Raymond Najjar
The Pennsylvania State University

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A brief update to:

Potential climate-change impacts on the Chesapeake Bay

Raymond G. Najjar[a,*], Christopher R. Pyke[b], Mary Beth Adams[c], Denise Breitburg[d], Carl Hershner[e], Michael Kemp[f], Robert Howarth[g], Margaret R. Mulholland[h], Michael Paolisso[i], David Secor[j], Kevin Sellner[k], Denice Wardrop[l], Robert Wood[m]

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Outline:

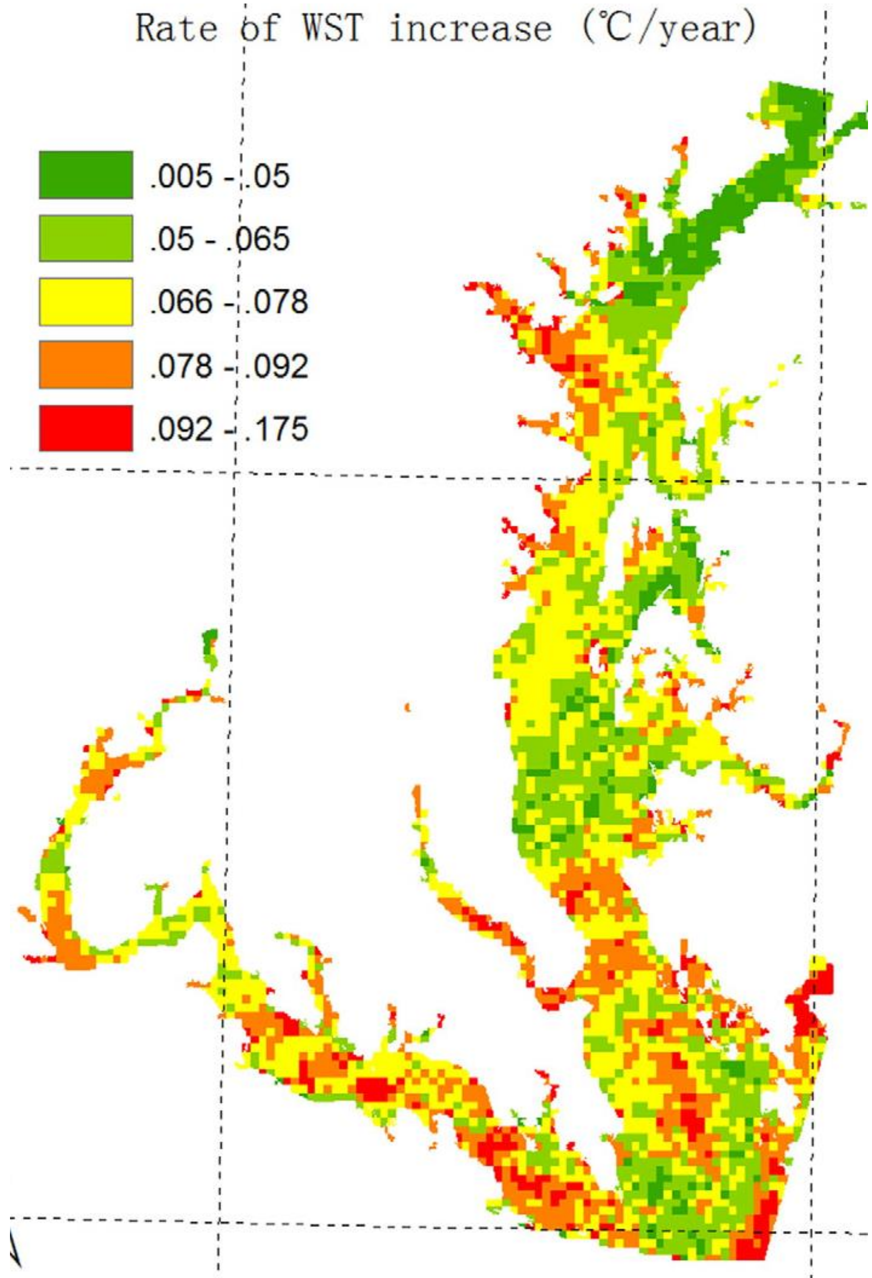
- 1. Climate and hydrological processes
- 2. Fluxes of nutrients and sediments from the watershed
- 3. Estuarine physical response
- 4. Estuarine biogeochemical response
- 5. Vascular plants
- 6. Fish and shellfish
- 7. Human systems

From Appendix A in CBP Climate Management Strategy (2015)

1. Climate and hydrological processes

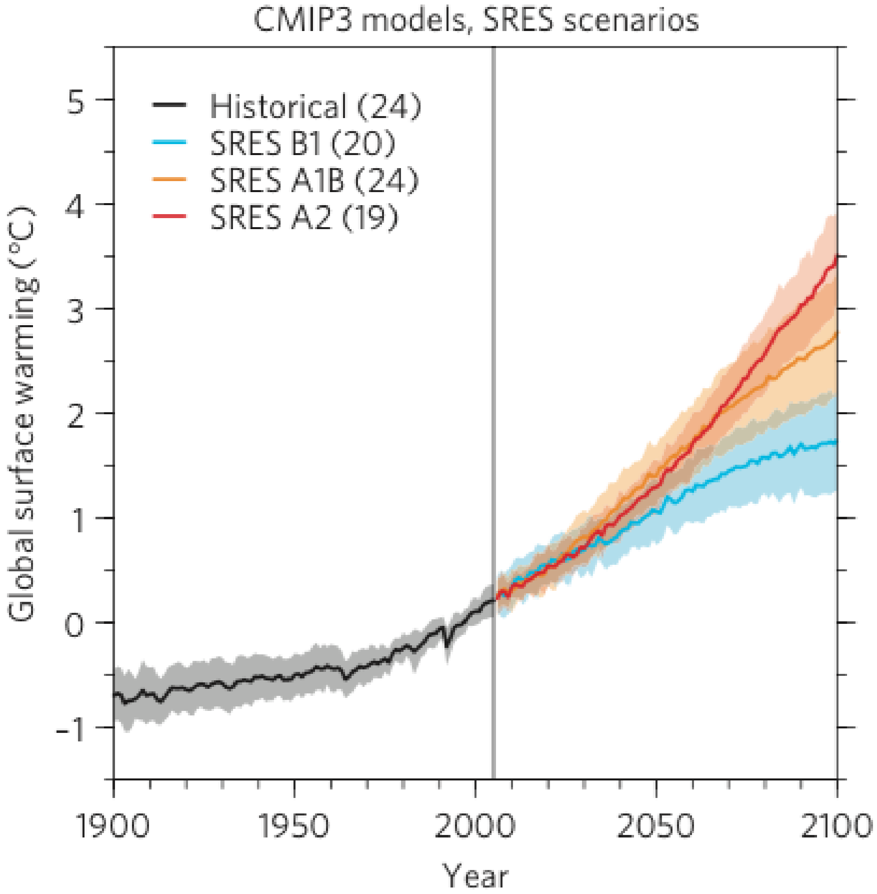
1960-2010 stream and air temperature trends of 0.23 and 0.28 deg C per decade, respectively (Rice and Jastram, 2014).

Ding and Elmore (2015) satellite analysis (1984-2011) shows 92% of bay is warming; water warming faster than air.

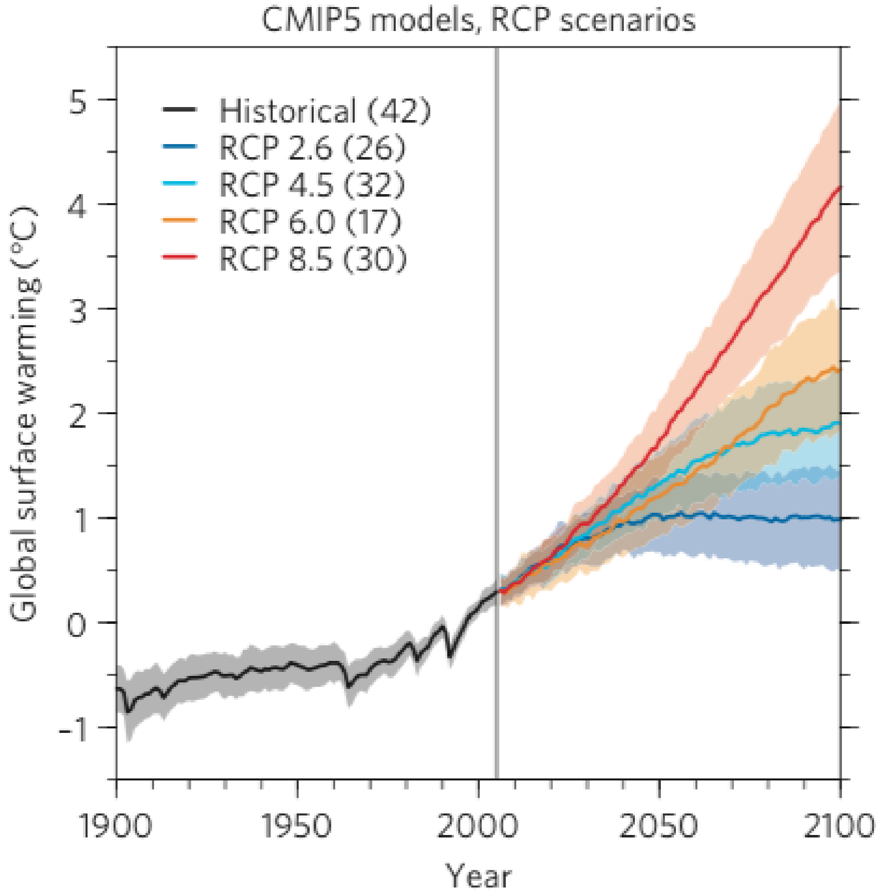


New, broader set of emissions scenarios: Representative Concentration Pathways (RCPs)

Old global temp. change



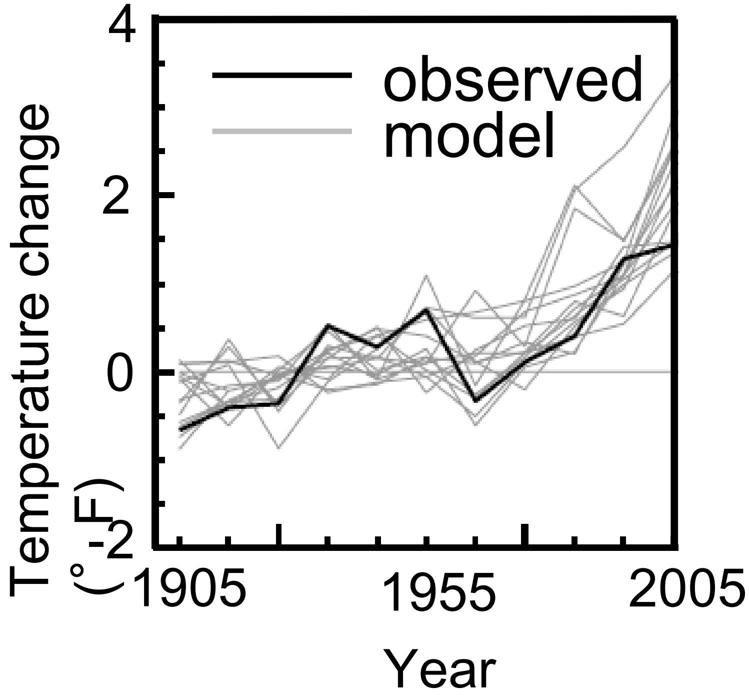
New global temp. change

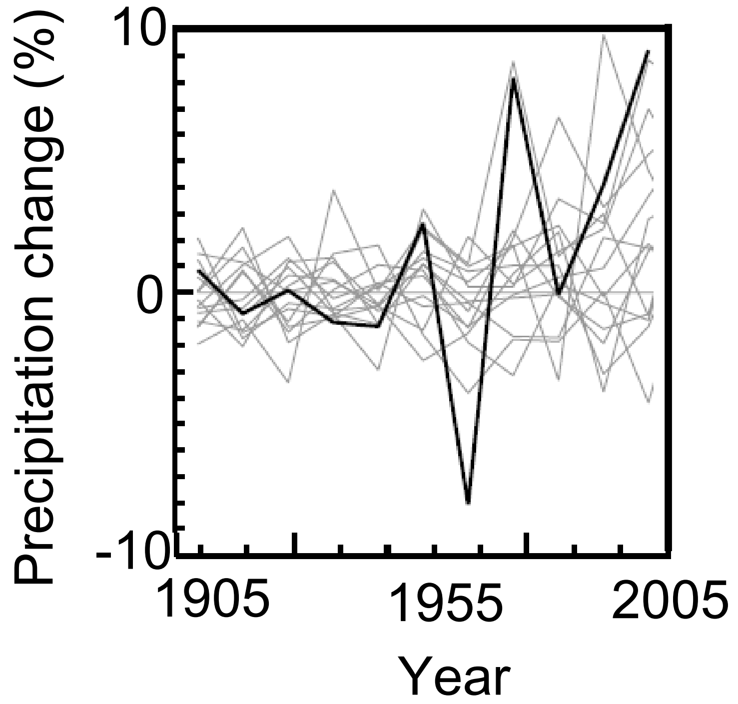


Temperature and precipitation projections

- New set of climate model simulations contains more models, has higher spatial resolution, and includes a variety of downscaled products.
- More confidence in newer set: they now reproduce historic temperature change and bracket historic precipitation change in northeast US (Kunkel et al., 2013).
- Basic temperature results in northeast US unchanged.
- Consensus in summer shifting to precipitation declines and winters getting even wetter than before.
- Jury still out on changes in winter extremes (Cohen et al., 2014).

Observed and simulated temperature and precipitation change in the Northeast U.S.





Decadal averages; deviation from 1901-1960 average

Kunkel et al. (2013)

Streamflow change

- Have high streamflows in Chesapeake watershed increased? Some now say no (Rice and Hirsch, 2014) whereas others say yes (Armstrong et al., 2014).
- Projected changes continue to show a wide range, though most studies indicate annual increases.

Sea level change

- Increase in consensus that global mean sea level is greatly accelerating (Hay et al., 2015).
- Chesapeake Bay sea level is also accelerating, possibly due to a weakening Gulf Stream (Sallenger et al., 2012).
- Better constraints on land subsidence and its causes; half of subsidence in southern Bay due to aquifer system compaction (Eggleston and Pope, 2013)
- More evidence of increases in nuisance flooding)(Sweet et al., 2014).

2. Fluxes of nutrients and sediment from watershed

- High-flow events deliver more nutrients and sediment than they used to because Conowingo Dam is filling up (Hirsch, 2012; Zhang et al., 2013).
- Johnson et al. (2012) and US EPA (2013) project median increase in sediment, P, and N loads from Susquehanna of 12, 13, and 49% by mid-century.

3. Estuarine physical response

- Additional studies simulating future increases in sea level conclude that bay will become saltier (Hong and Shen, 2012; Rice et al., 2012).
- Other physical changes: increased stratification, exchange flow, and tidal currents (Hong and Shen, 2012).

4. Estuarine biogeochemical response

- Harding et al. (2015) analysis of historical data suggests higher flows and higher nutrients lead to increases in diatom abundance.
- Numerous studies elucidate controls on hypoxia and its trends with new evidence on impacts of winds Scully (2010) and stratification (Murphy et al., 2011).

5. Vascular plants

- Kirwan et al. (2013): Sea-level rise does not reduce organic matter decay rates in tidal wetlands (no negative feedback on submergence).
- Net ecosystem production in tidal wetland decreases with warming (Drake, 2014) but increases with CO_2 (Erickson et al., 2013).

6. Fish and shellfish

- Hines et al. (2010) show mixed effects of warming on blue crab.
- Two studies emphasize importance of salinity to changes in oyster abundance (Levinton et al., 2011; Kimmel et al., 2012).
- Waldbusser et al. (2010a, b) show lower calcification and higher dissolution of oyster juveniles under reduced pH.

7. Human systems

- Paolisso et al. (2012): African-American communities on the eastern shore of the Chesapeake Bay are organized through their churches to address some climate impacts.
- Miller Hesed & Paolisso (2015): Social and political isolation inhibits access to sources of adaptive capacity, thereby exacerbating local vulnerability.

Thank you

References

Ding, H., Elmore, A.J., 2015. Spatio-temporal patterns in water surface temperature from Landsat time series data in the Chesapeake Bay, U.S.A. Remote Sensing of Environment 168, 335-348.

Miller Hesed, C.D., Paolisso, M., 2015. Cultural knowledge and local vulnerability in African American communities. Nature Climate Change 5, 683-687.

For others, see Appendix A in CBP Climate Management Strategy (2015)