Eliminating Surprises: Climate Change Impacts in the Chesapeakea Region Beyond Mid-Century

CBP Modeling July Quarterly Review

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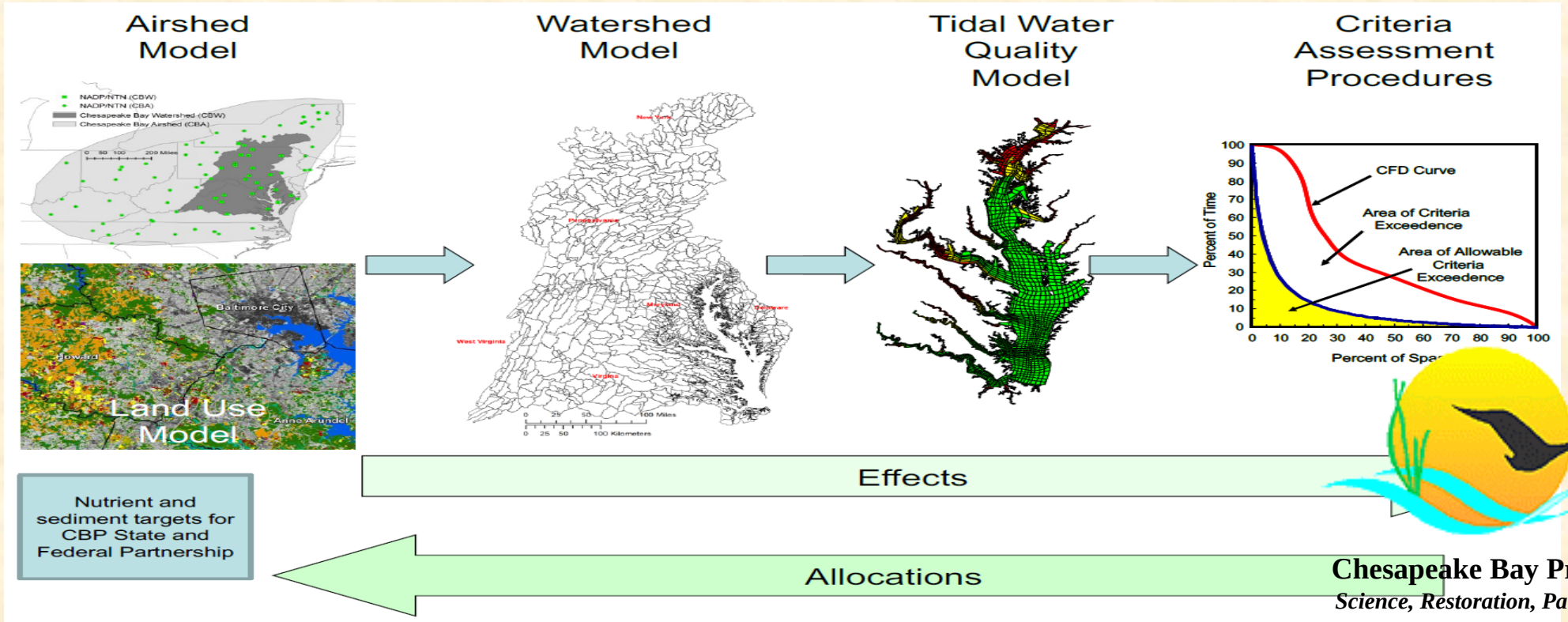
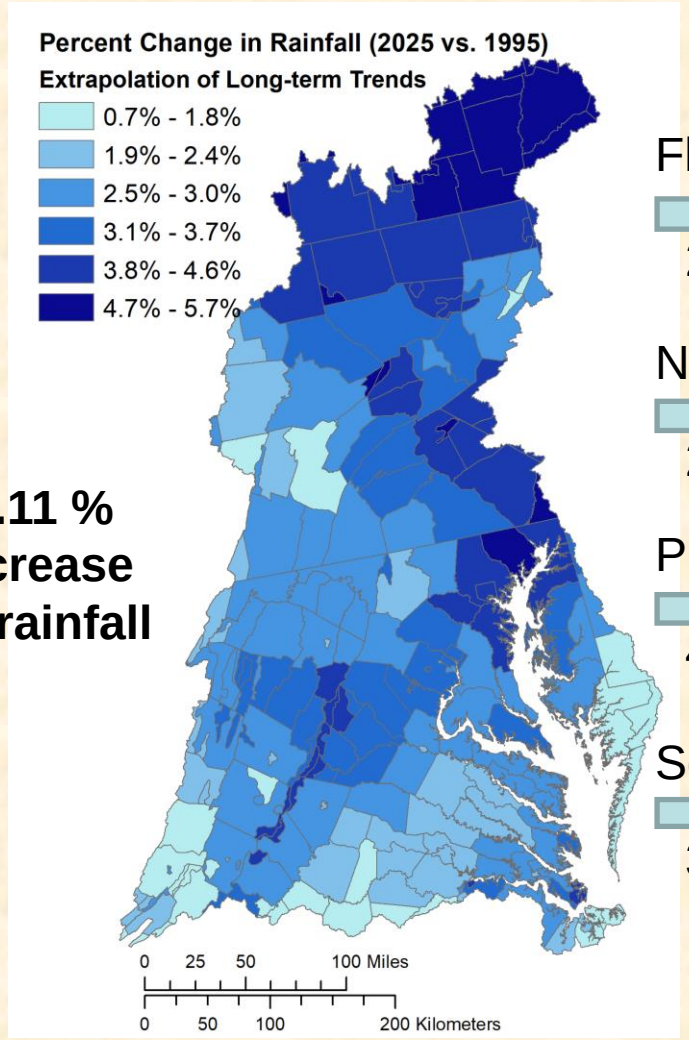


Chesapeake Bay Program
Science, Restoration, Partnership

Elements of 2025 Climate Change (1995-2025)



+3.11 % Increase in rainfall

Phase 6 Watershed Model

Flow → 2.4% Increase

Nitrogen Load → 2.6% Increase

Phosphorus Load → 4.5% Increase

Sediment Load → 3.8% Increase

Air-temperature increase: 1.06 °C

Sea Level Rise: 0.22m

Model: CH3D-ICM
400m-1km Resolution

Open boundary:
Temperature: +0.95 °C;
Salinity: +0.18 psu
(Thomas et al., 2017)

Elements of 2035 Climate Change (1995-2035)

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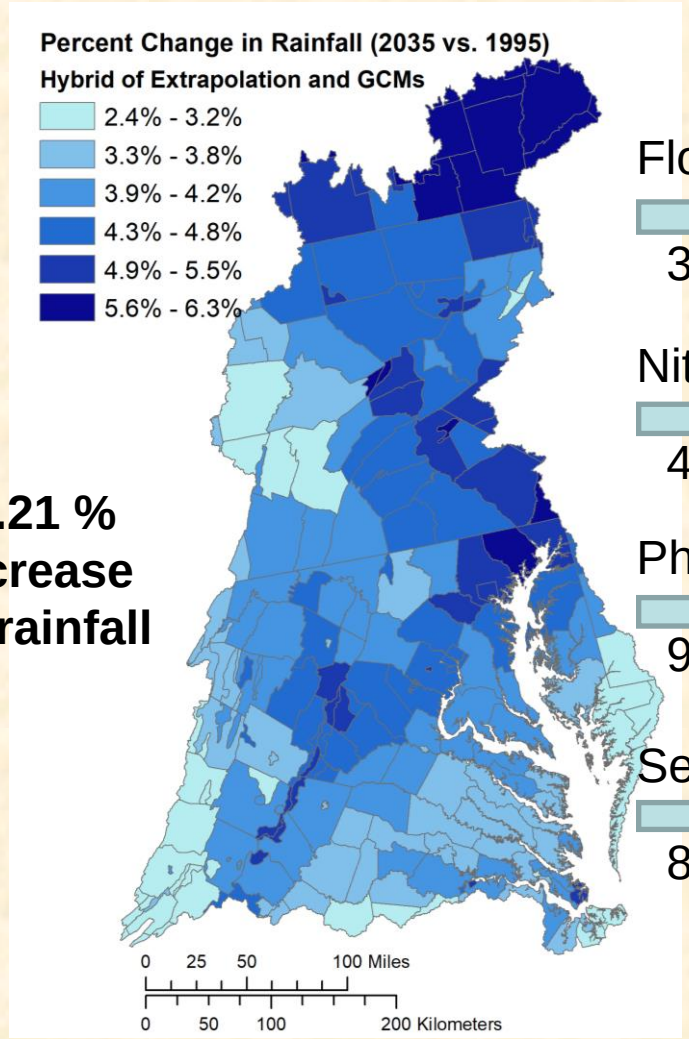
Air-temperature increase: 1.39 °C



+4.21 % Increase in rainfall

Flow → 3.7% Increase

Nitrogen Load → 4.7% Increase

Phosphorus Load → 9.9% Increase

Sediment Load → 8.5% Increase

Sea Level Rise: 0.31m

Open boundary:
Temperature: +1.32 °C;
Salinity: +0.25 psu
(Thomas et al., 2017)

Phase 6 Watershed Model

Model: CH3D-ICM
400m-1km Resolution

Chesapeake Climate Change Beyond Midcentury

There have been encouraging trends in the trajectory of observed and projected global fossil fuel emissions.

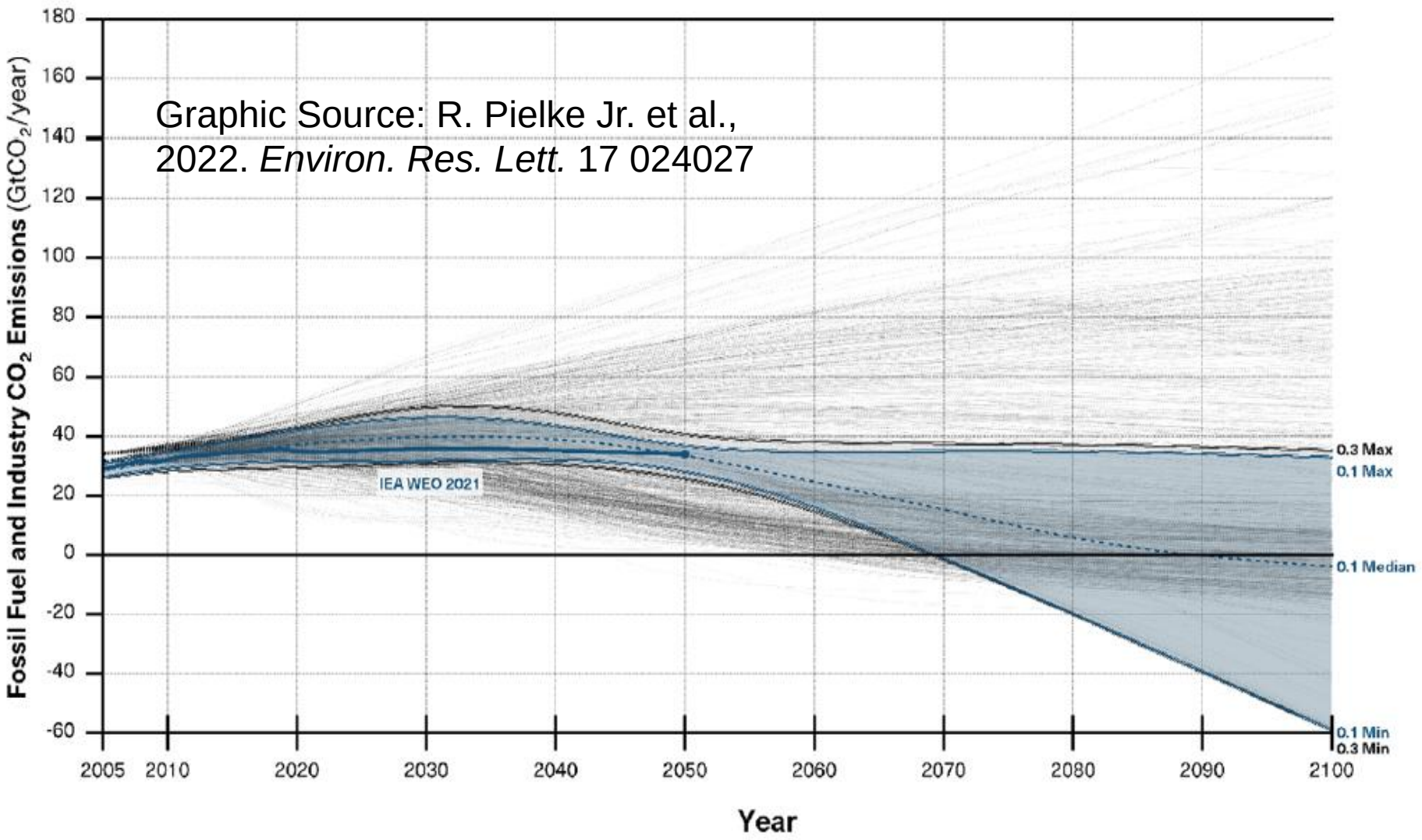
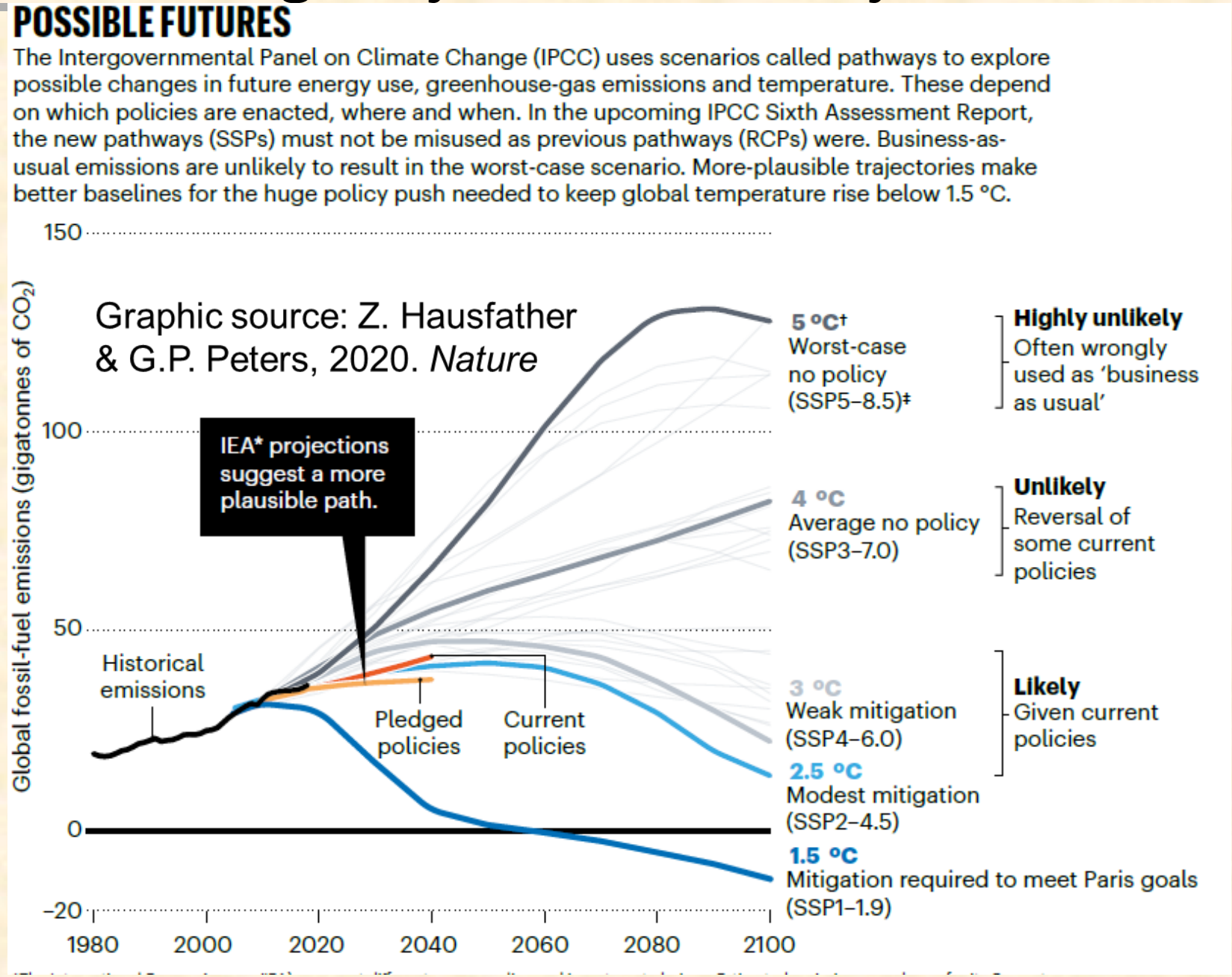


Figure 1. The trajectories of all fossil-fuel-and-industry (FFI) CO_2 emissions to 2100 among 1184 AR5 and 127 SSP scenarios (IPCC WGIII 2014b, Riahi *et al* 2017), along with the IEA STEPS to 2050 (IEA 2021). Shaded regions indicate envelopes of scenarios meeting ±0.1%/y (blue) and ±0.3%/y (gray) divergence tolerances in FFI CO_2 emissions (relative to observations and IEA projections). See also figure S1.

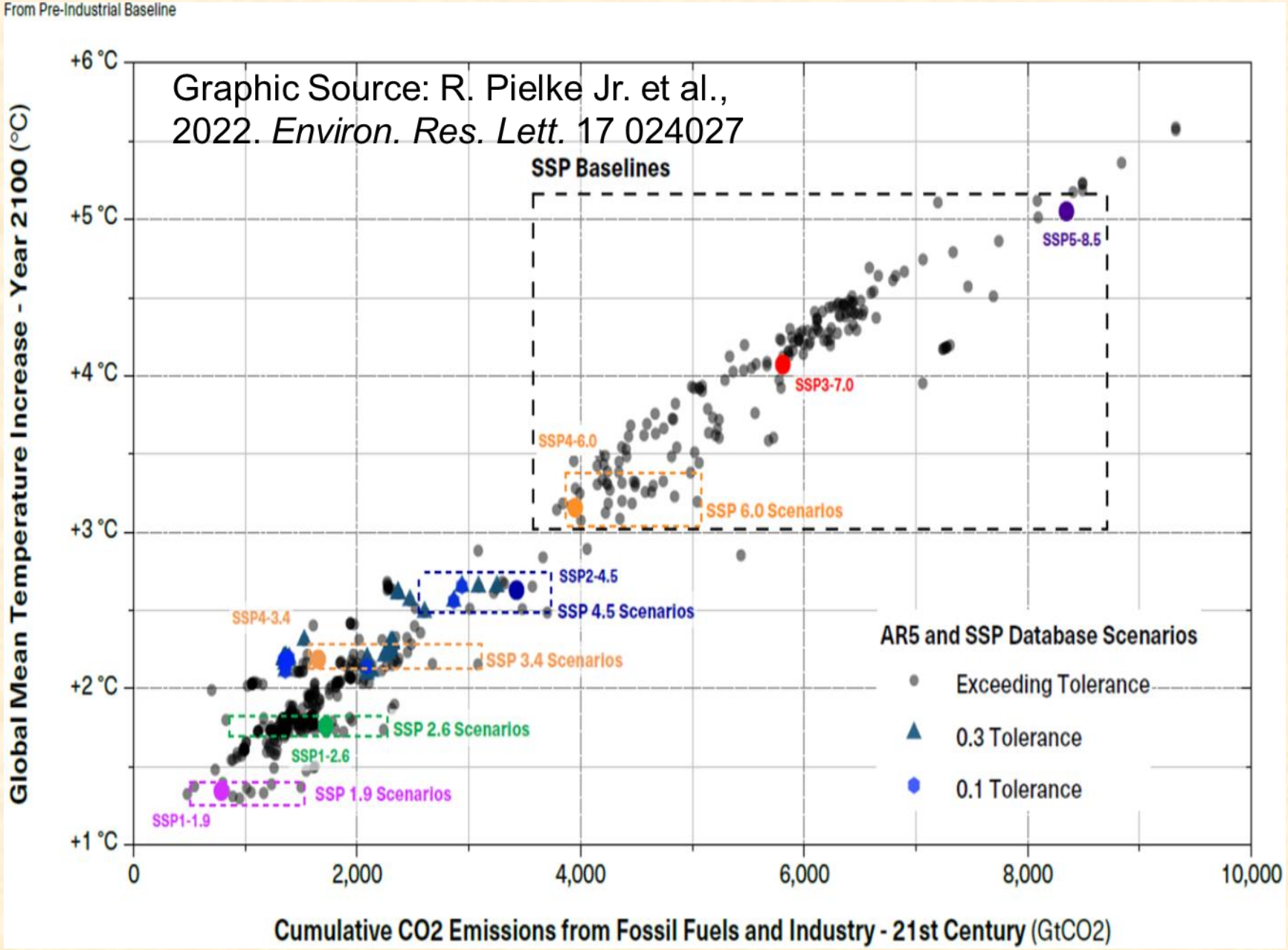
Chesapeake Climate Change Beyond Midcentury

The International Energy Agency (IEA) estimates of current observed global CO_2 emissions show climate mitigation policies tracking slightly higher and proposed mitigation policies slightly lower than the RCP 4.5 scenario (Pielke et al., 2022). The RCP 4.5 scenario is equivalent to the newer SSP2 scenario (Shared Socioeconomic Pathway 2) of the forthcoming CMIP6 scenarios. Both are plausible and consistent with current observed GHG emissions and both estimate a 2.5^{O} C increase in global temperature by 2100. This is compared to the implausible RCP 8.5 scenario which is tracking higher than the observed CO_2 emission estimates and projects a catastrophic 5^{O} C rise in global temperature by 2100.

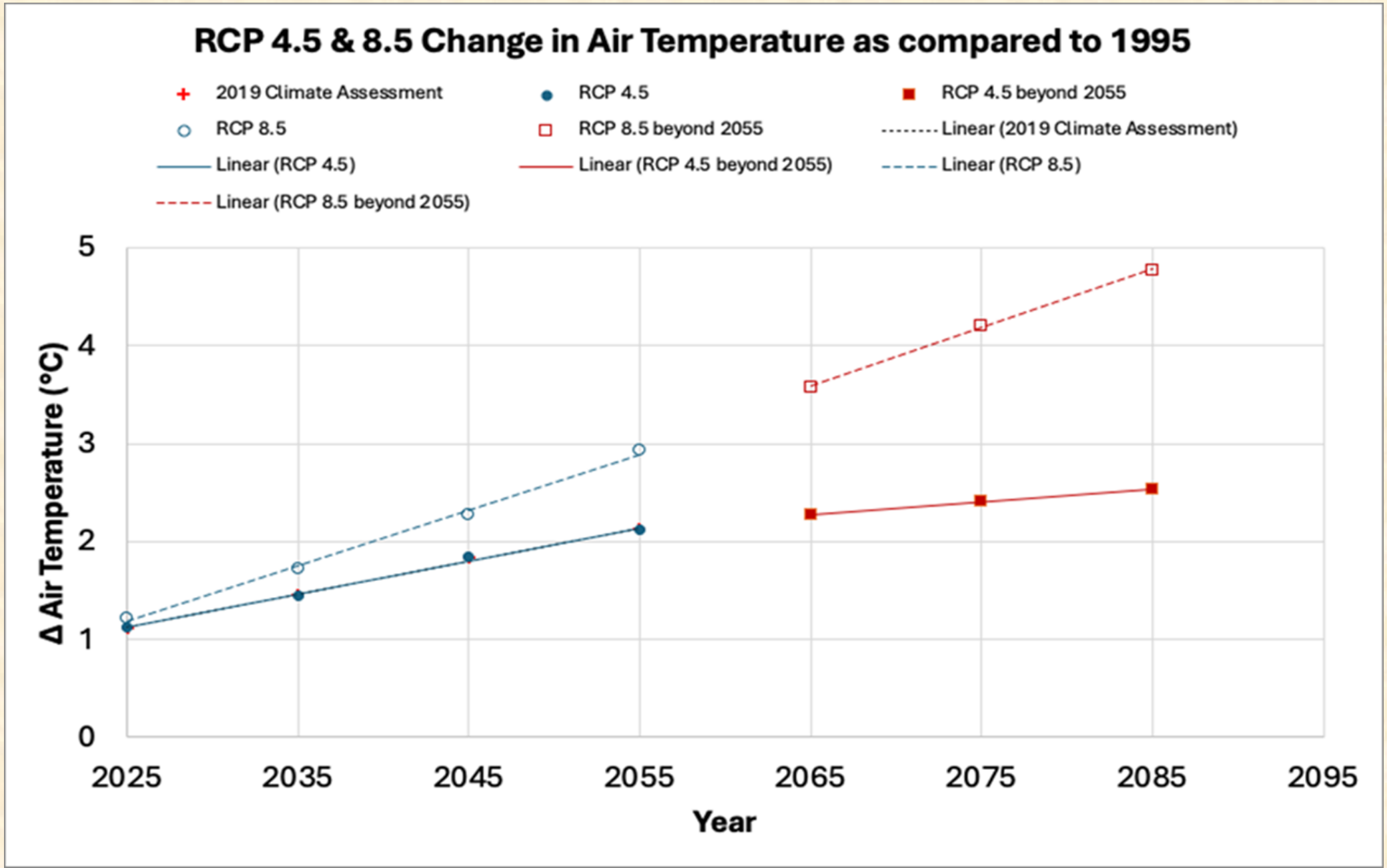


Chesapeake Climate Change Beyond Midcentury

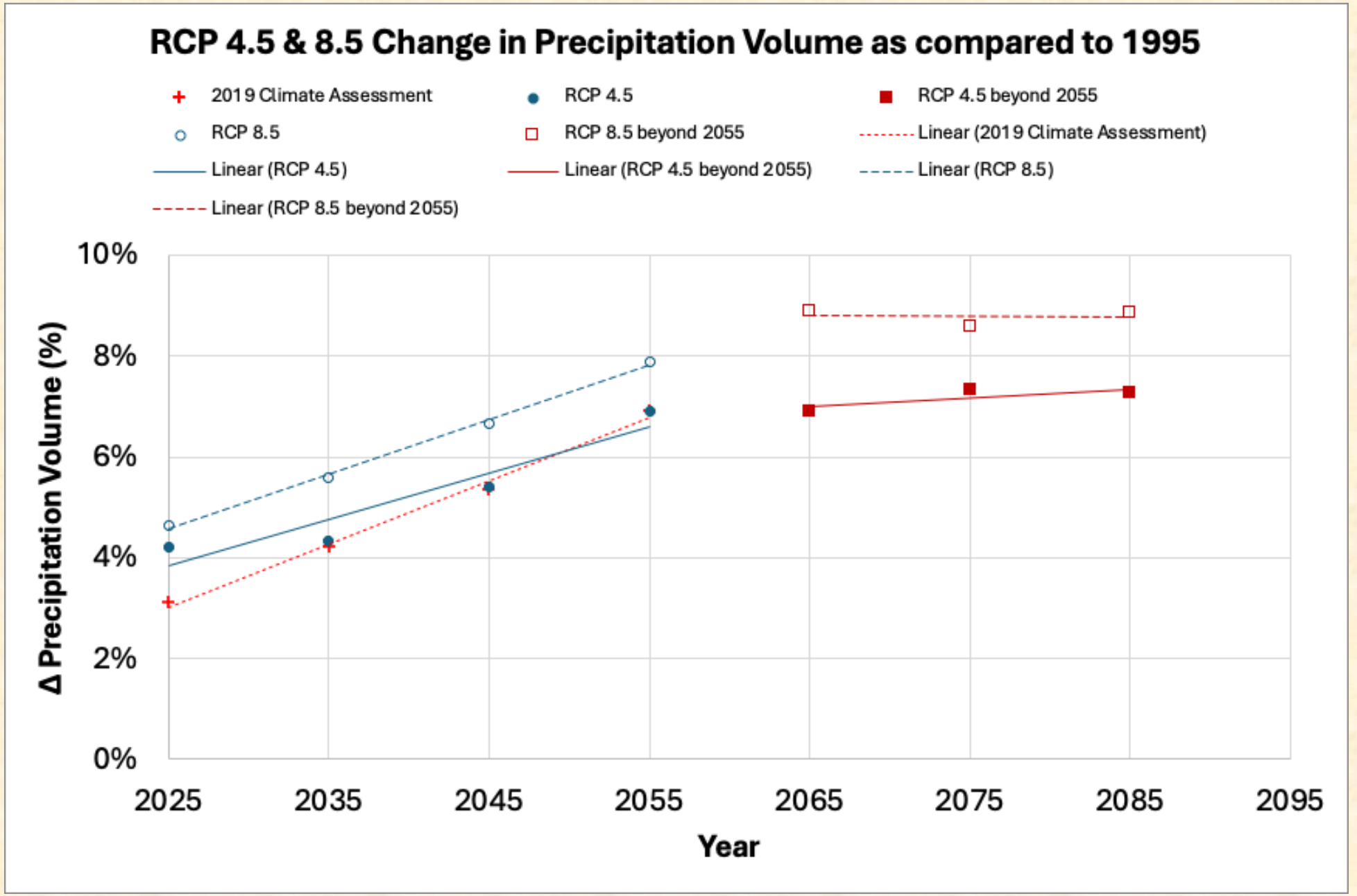
Recent growth in low CO_2 emission renewable sources coupled with renewable energy sources becoming less expensive and ongoing greenhouse gas mitigation policies have contributed to the trend of GHG emissions leveling off with a long plateau to midcentury (Hausfather and Peters, 2020a; 2020b).



Chesapeake Climate Change Beyond Midcentury - Temp



Chesapeake Climate Change Beyond Midcentury - Precip.



CCC Beyond Midcentury - Precip. & Temp.

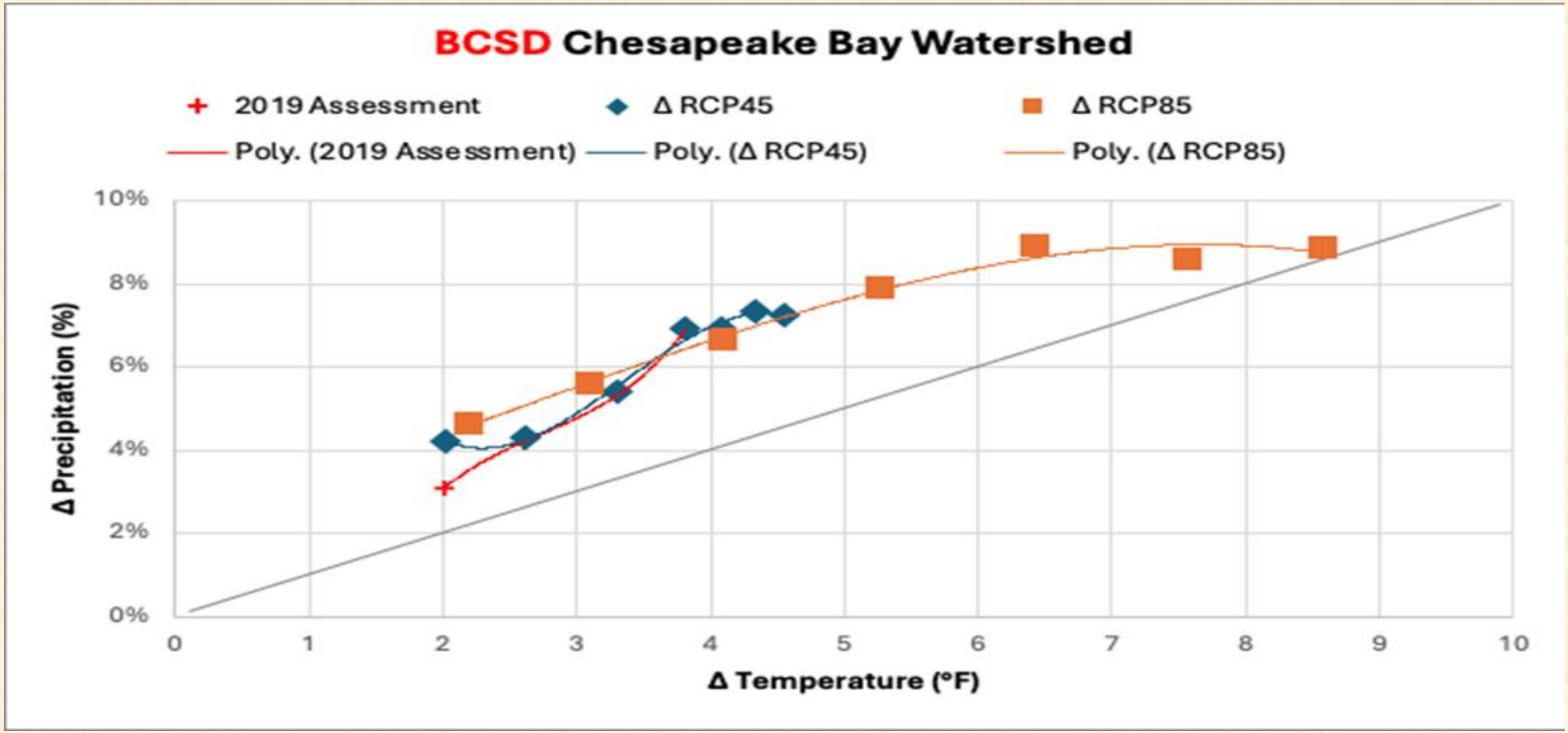


FIGURE V. Change in air temperature and precipitation volume relative to 1995 for CMIP5 RCP 4.5 and RCP 8.5 ensemble for the years 2025, 2035, 2045, and 2055 (Bhatt et al., 2023) and for 2065, 2075, and 2085 (this analysis).

Chesapeake Climate Change Beyond Midcentury - SLR

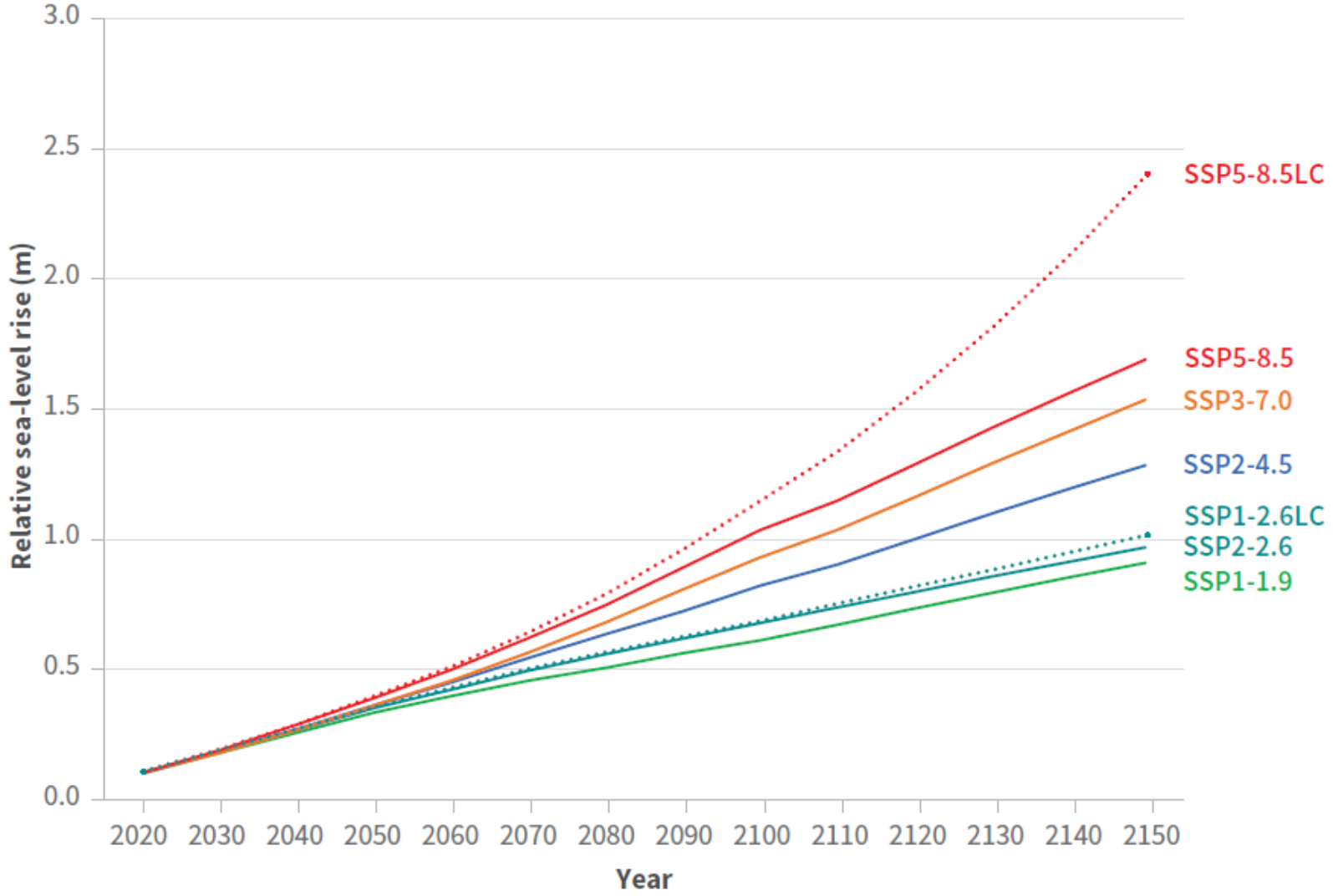
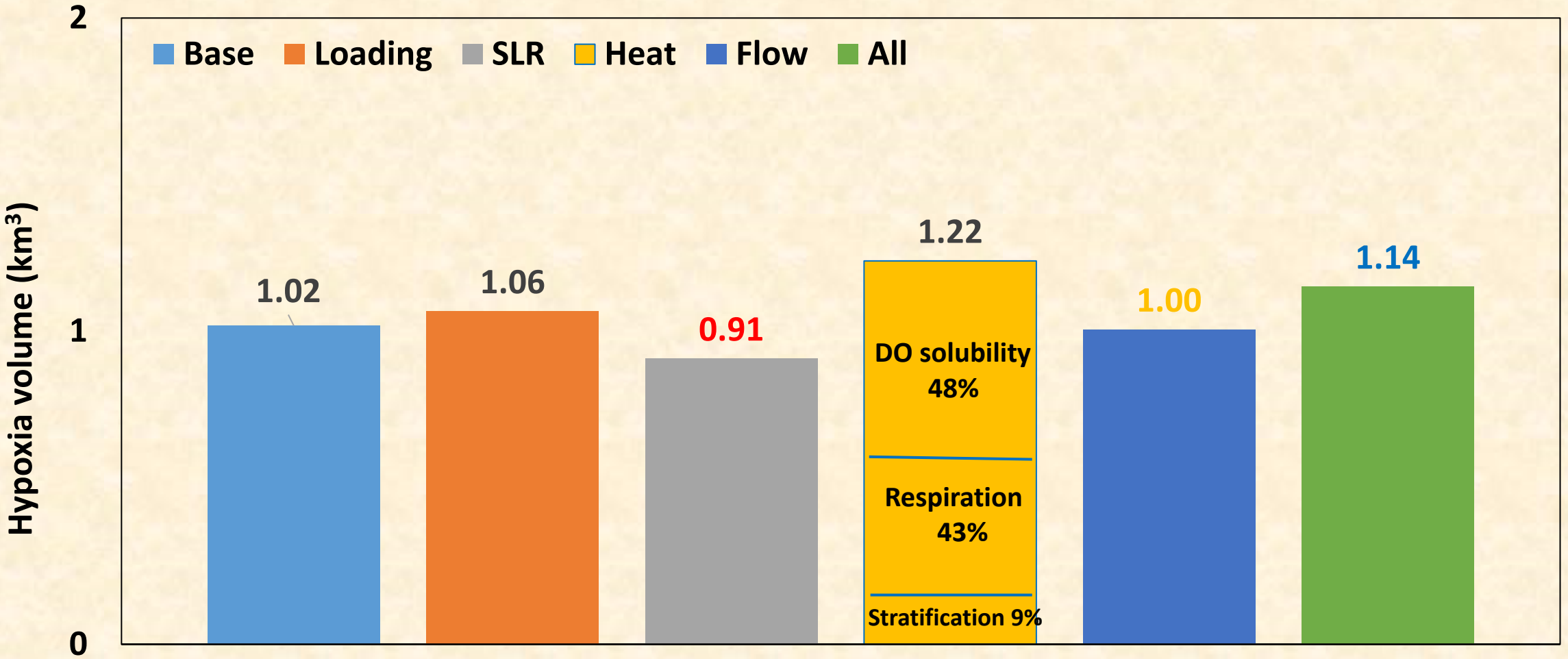


Figure 3. Median projections for sea-level rise at Baltimore under emissions scenarios included in the IPCC AR6. Projections labeled "LC" also include estimates of additional polar ice sheet losses that AR6 regarded with *low confidence*. Source: NASA Sea Level Projection Tool.

Summer (Jun.-Sep.) Hypoxia Volume (<1 mg/l) 1991-2000 in the Whole Bay Under 2025 WIP3 Condition



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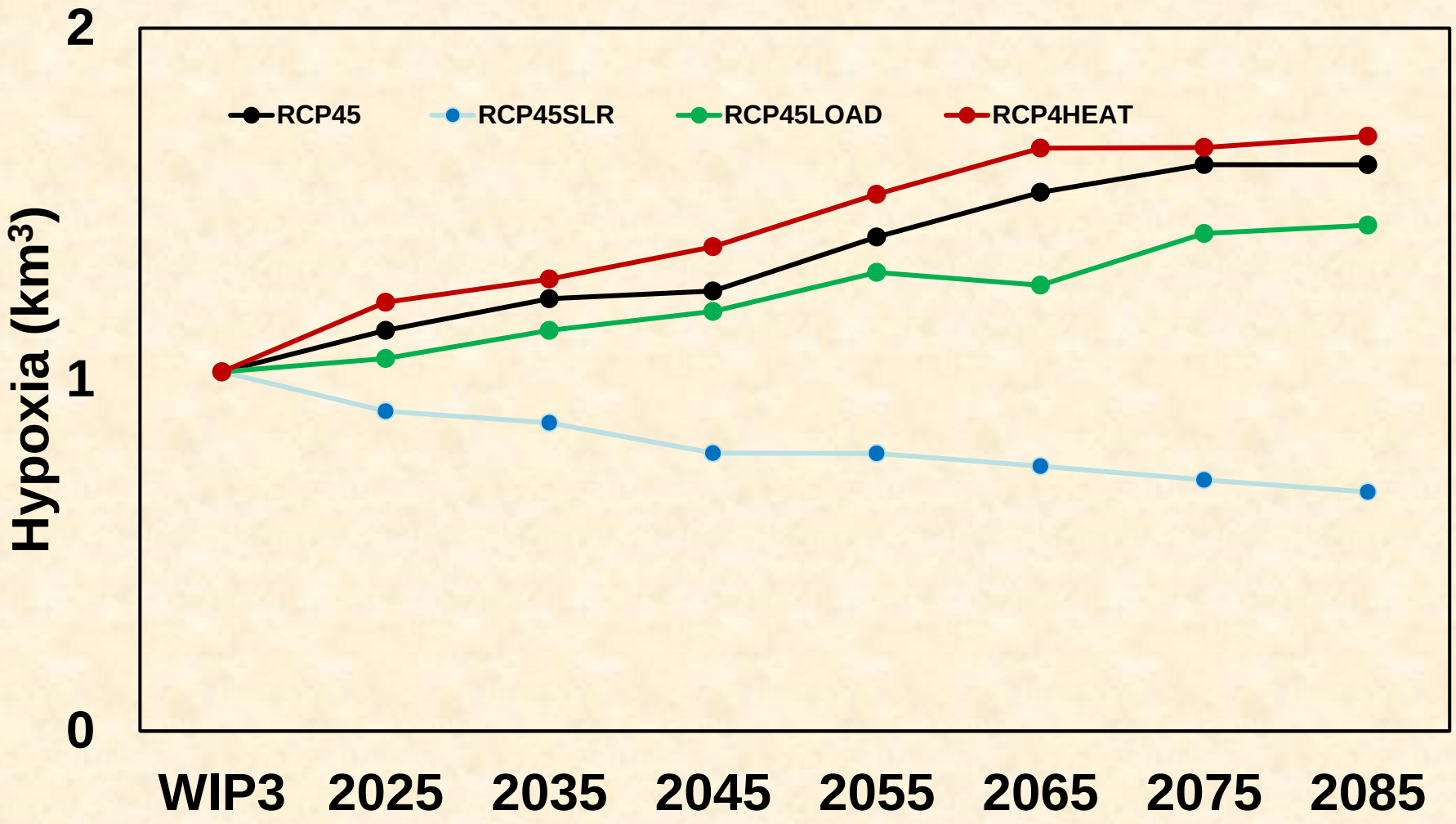
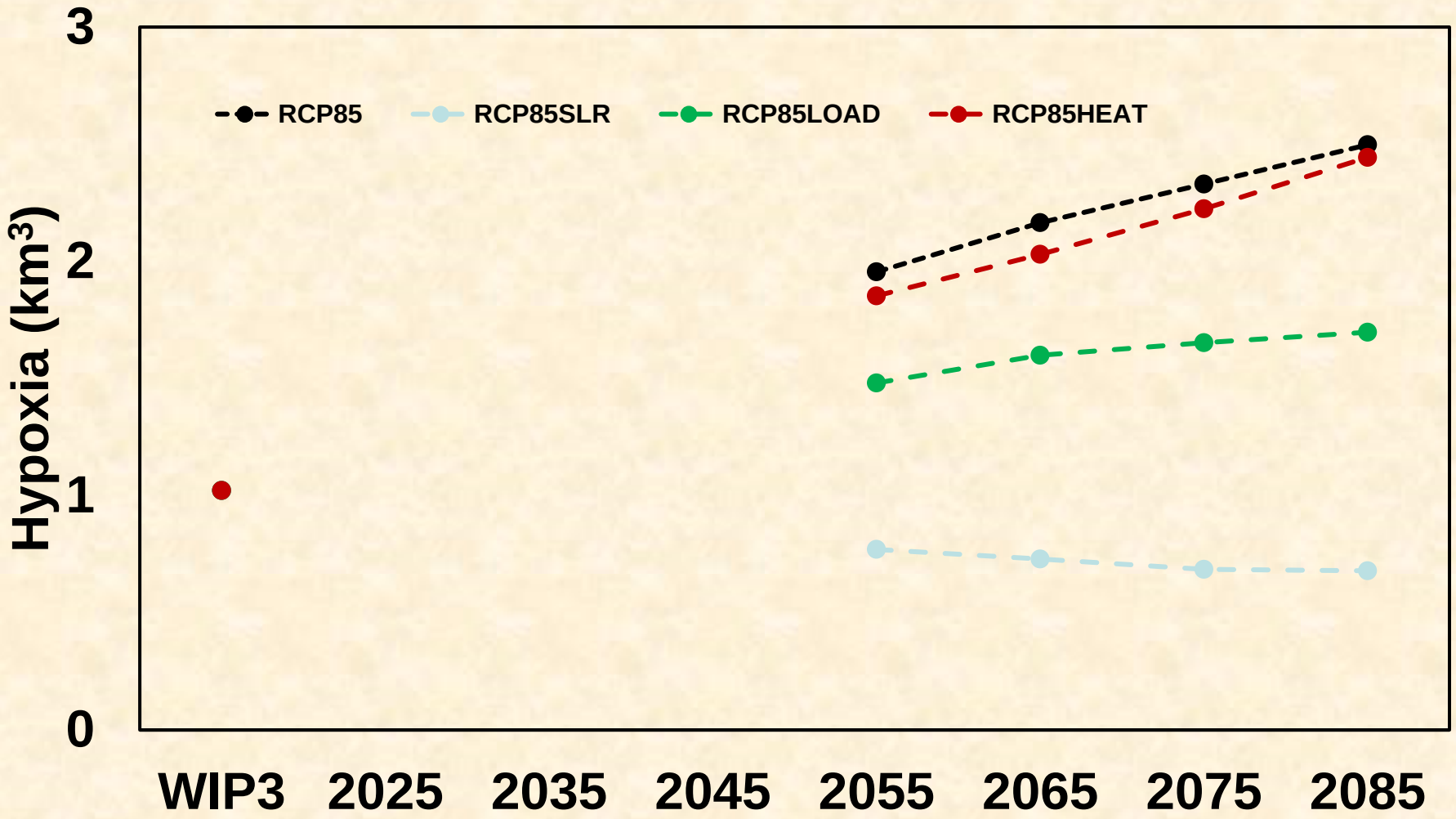
Chesapeake Climate Change Beyond Midcentury



Chesapeake Climate Change Beyond Midcentury



Conclusion: Except from conclusion of Linker et al., 2023

- "Climate change is a multi-generational challenge for Chesapeake Bay restoration. **TRUE**
- The impacts of climate change on Chesapeake water quality are inevitable over the century regardless of future paths of higher or lower CO_2 emission reductions because of slow rates of global processing and clearing of CO_2. **SORT OF (but needs modifier)**
- Flow, nutrient, and sediment loads from the watershed and tidal Bay hypoxia are estimated to continue to increase from 1995 to 2055 from climate change. **TRUE**
- **[However, there is growing evidence that that by midcentury rates of increased temperature, precipitation, nutrient loads, and hypoxia will begin to abate.]**
- In response, the Chesapeake Bay Program is developing better management tools combined with an ongoing multi-decadal plan of adaptation to climate change to maintain the Chesapeake TMDL and restoration objectives for the Chesapeake. The assessment of climate change impacts on the Chesapeake TMDL is an iterative process and reassessments each decade are currently planned." **TRUE**