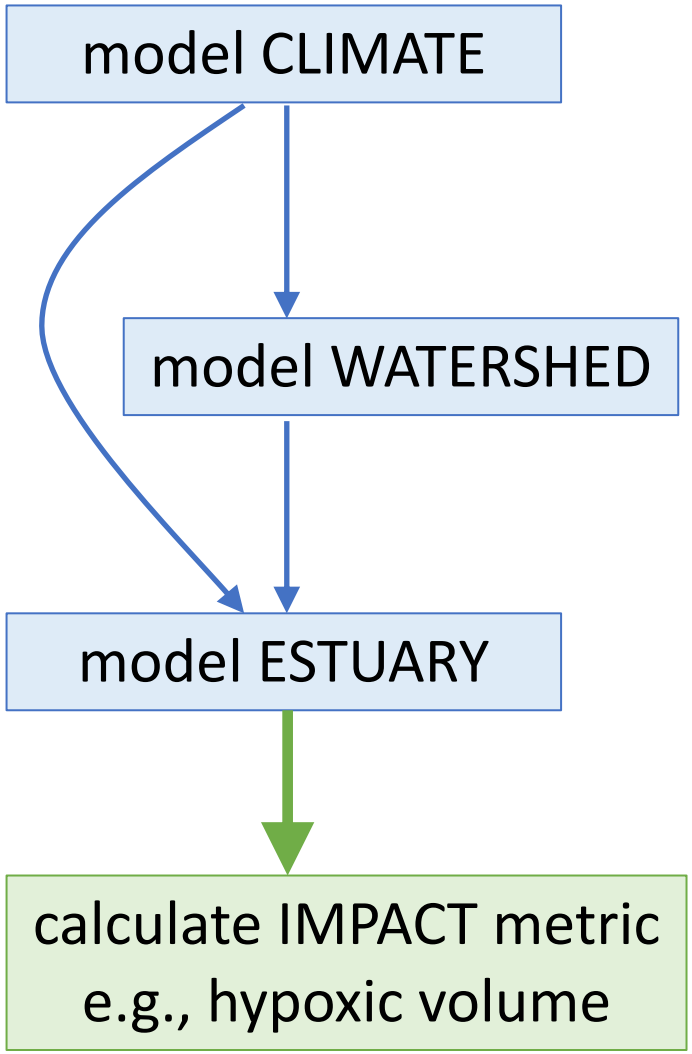
Are projected climate impacts sensitive to how we choose to apply climate forcing to the Chesapeake Bay?

Maria Herrmann and Ray Najjar

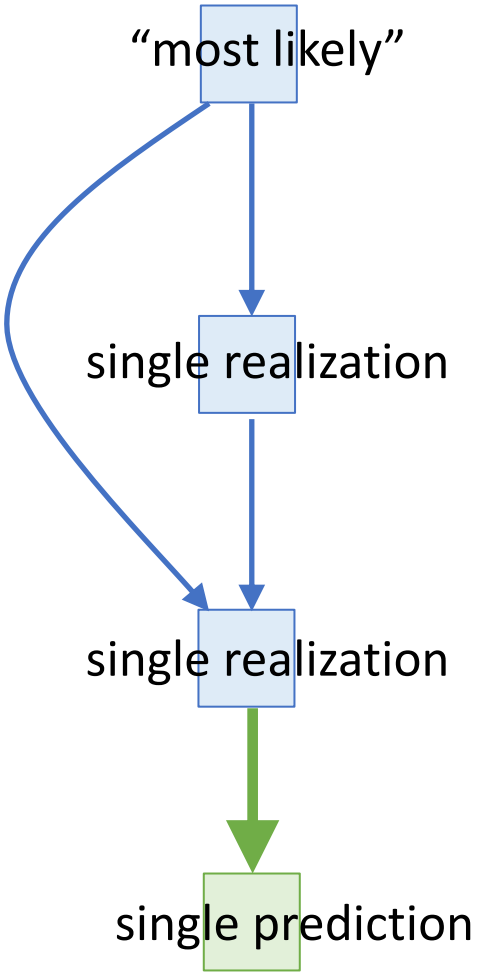
CHAMP project meeting

2021-06-24

OUTLINE of the Chesapeake climate impact assessment



DETERMINISTIC assessment



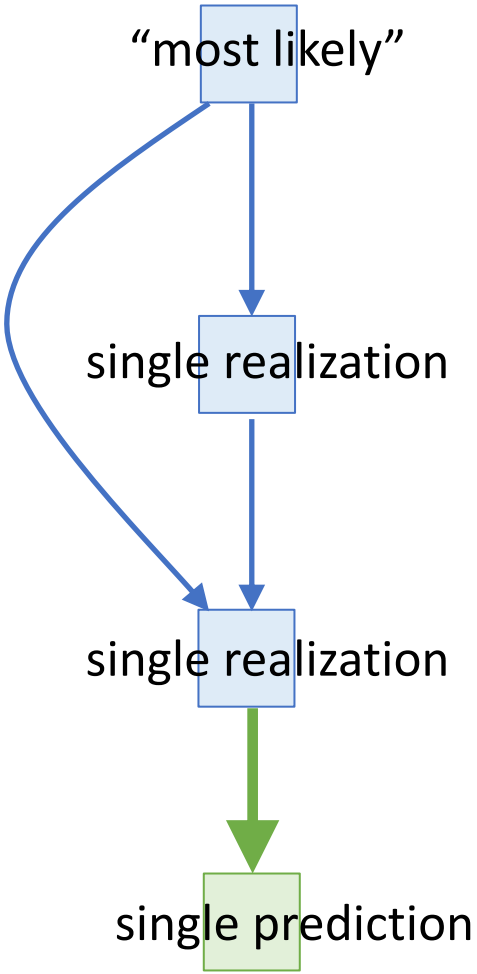
CLIMATE

WATERSHED

ESTUARY

IMPACT

DETERMINISTIC assessment



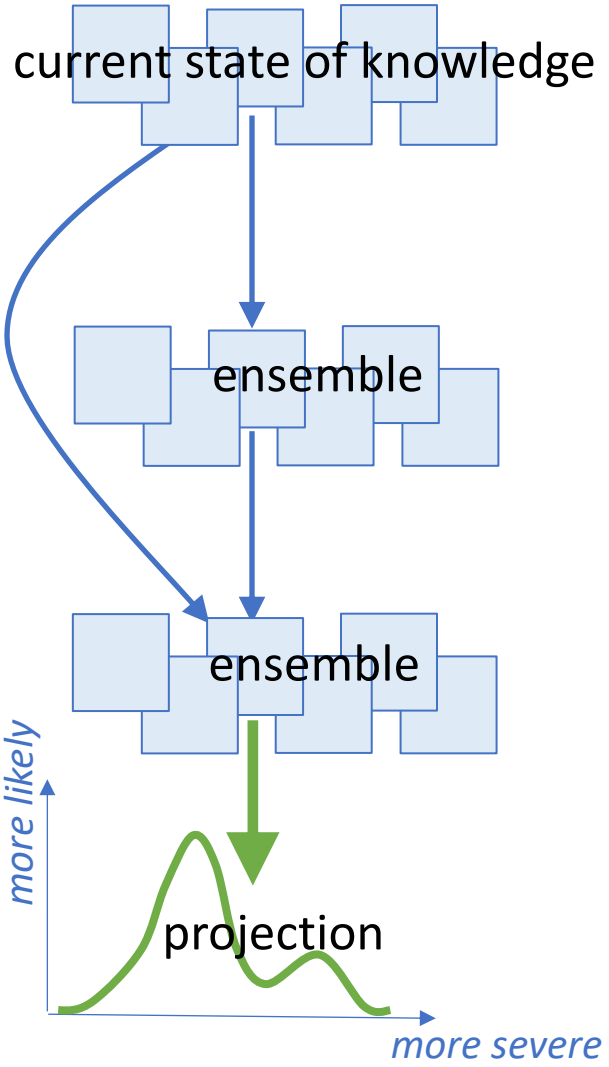
CLIMATE

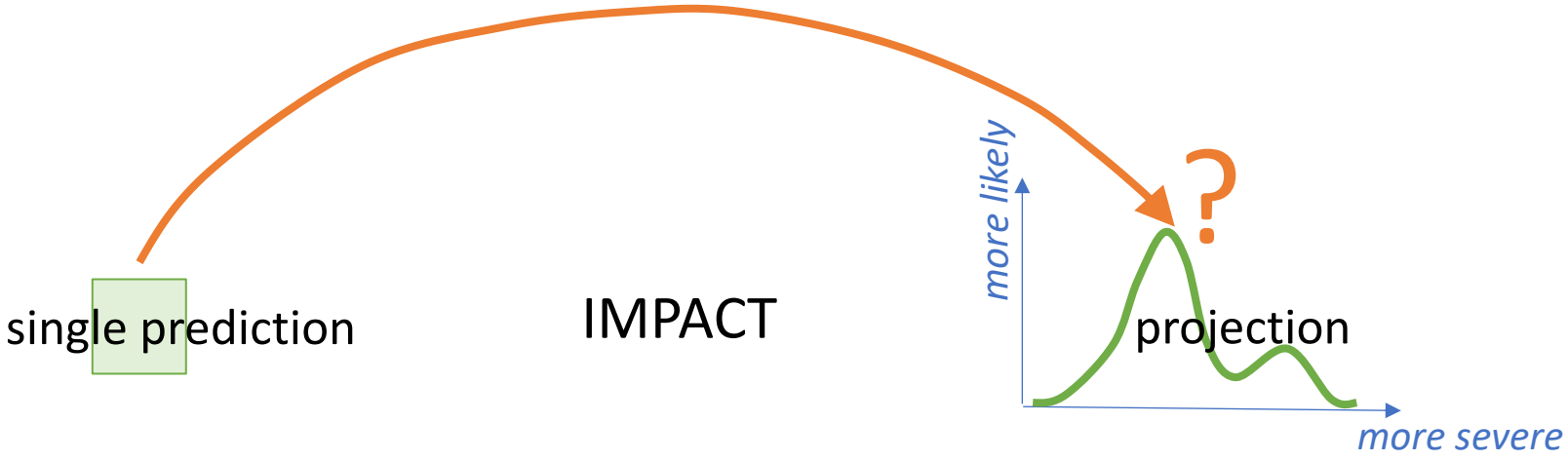
WATERSHED

ESTUARY

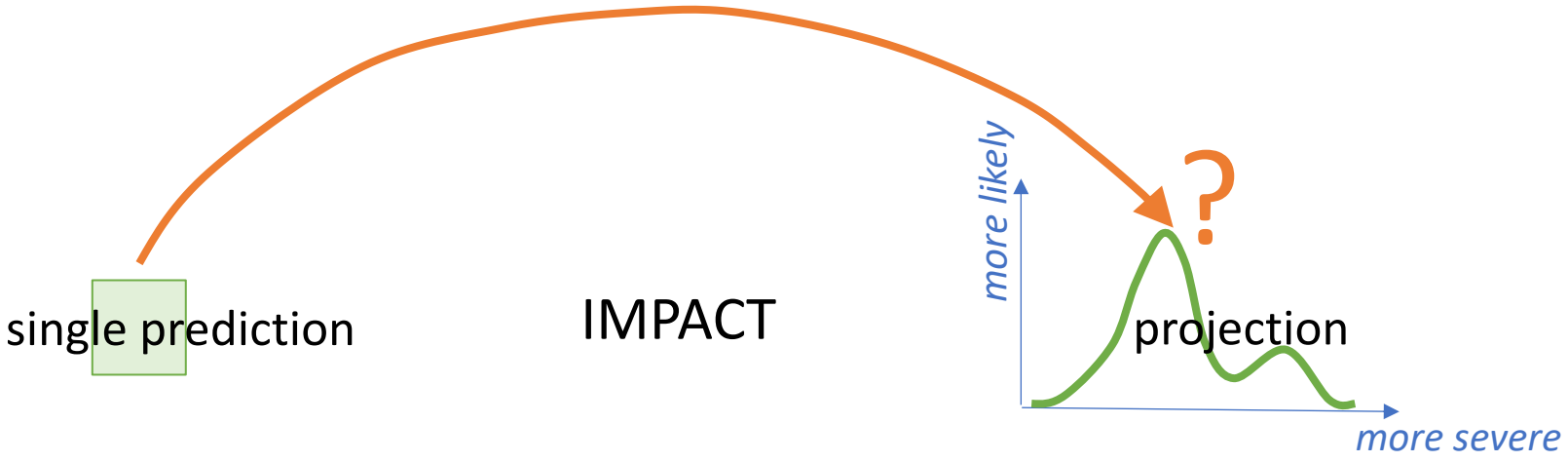
IMPACT

PROBABILISTIC assessment




single prediction
IMPACT
?
more likely
projection
more severe

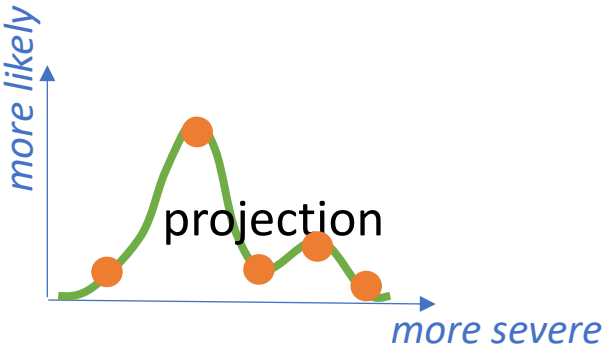
The prediction based on “most likely” inputs might match the “most likely” projection only in a rare case when the system is linear.



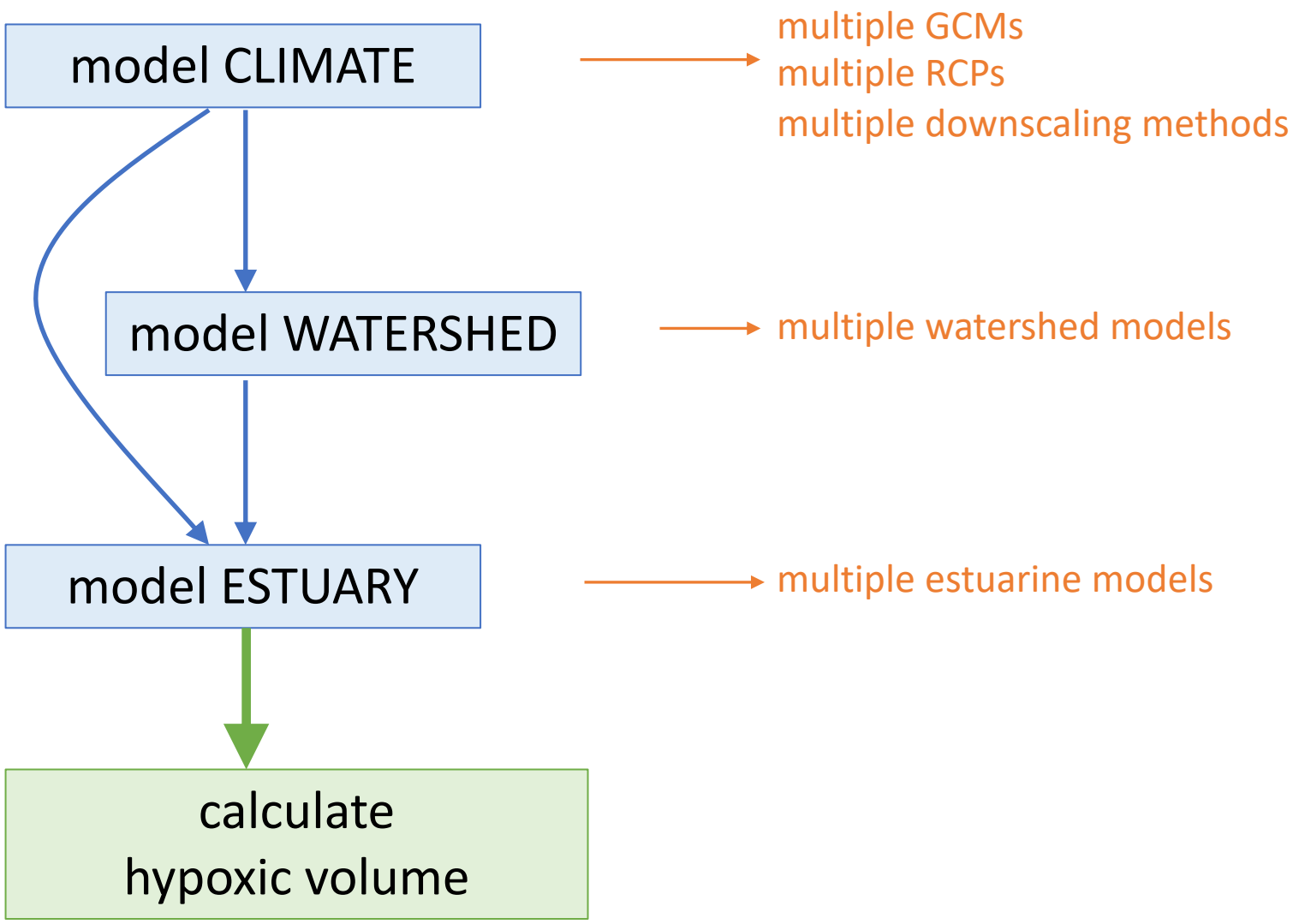
To get the full probability distribution of potential impacts is an enormously complex problem, but a well-designed ensemble of model runs can “sample” the distribution and provide some sense of its shape, i.e., reflect more truthfully the current state of knowledge.

single prediction

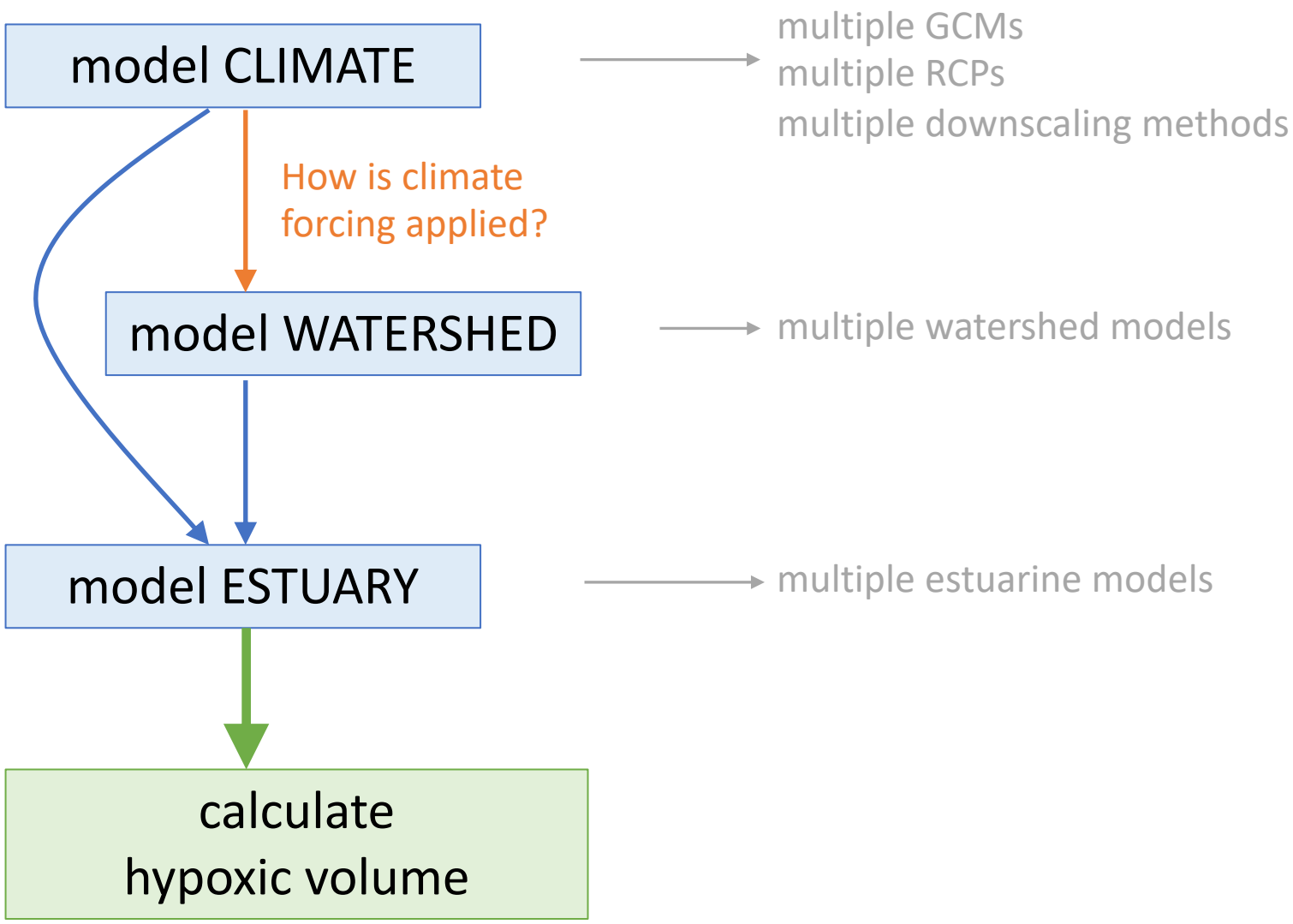
IMPACT



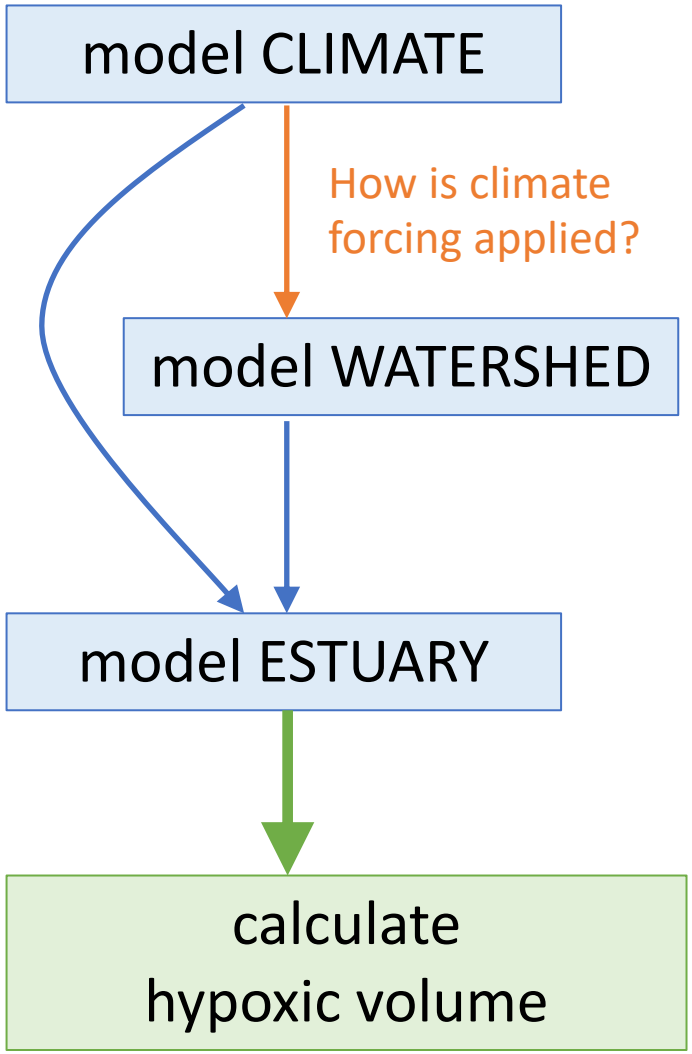
Probabilistic approach in CHAMP



Potential additional influence on projected hypoxia



Summary of planned work

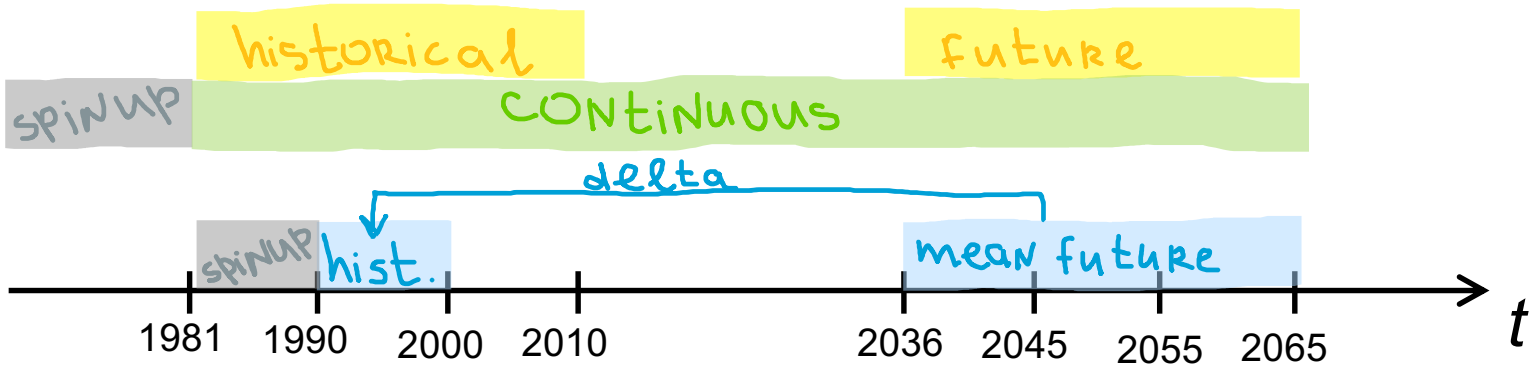


Conduct additional simulations of the DLEM model and use the output to quantify hypoxia in the Bay to answer the following question:

Are projections of hypoxia sensitive to how we choose to apply climate forcing to the Chesapeake Bay?

The “delta method”, which has been the method of choice due to its relative ease of application, averages out all variability except seasonal. Using continuous daily forcing preserves information on variability but is more challenging to implement.

Planned additional DLEM simulations



Run nu.	Run long name	Climate forcing	Spinup period	Analysis period
1	Historical delta run	OBS 1981–2000	1981–1990	HIST 1991–2000
2	Future delta run	OBS 1981–2000 + DELTA	2036–2045	FUTU 2046–2055
3	Continuous run with daily GCM forcing	OBS prior to 1981 GCM 1981–2065	prior to 1981	HIST 1981–2010 FUTU 2036–2065

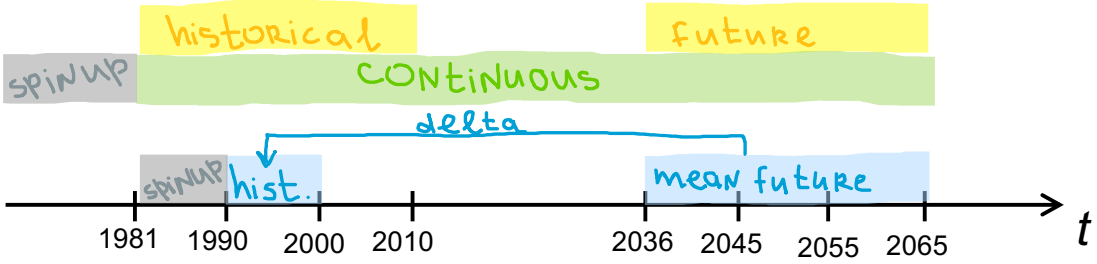
Key:
OBS = observations
DELTA = monthly climatological 30-year delta added to GCM = daily GCM output
HIST = historical
FUTU = future

The non-climate forcing is fixed at the 1995 level at the beginning of the spinup and does not change through the end of each run

Planned analysis steps

Proposed metrics (change = future minus historical)

- climate change: change in temp. and precip.
- climate impact on the watershed: change in nitrogen and sediment loads
- climate impact on the bay: change in hypoxic volume



Step 1. The difference between delta future and delta historical runs will quantify the metrics according to the delta method;

Step 2. The difference between the future and historical periods in the continuous run will quantify the metrics according to the continuous method;

Step 3. By comparing Step 1 and Step 2 metrics we will be able to quantify how sensitive the projections are to the choice of the method.

Summary

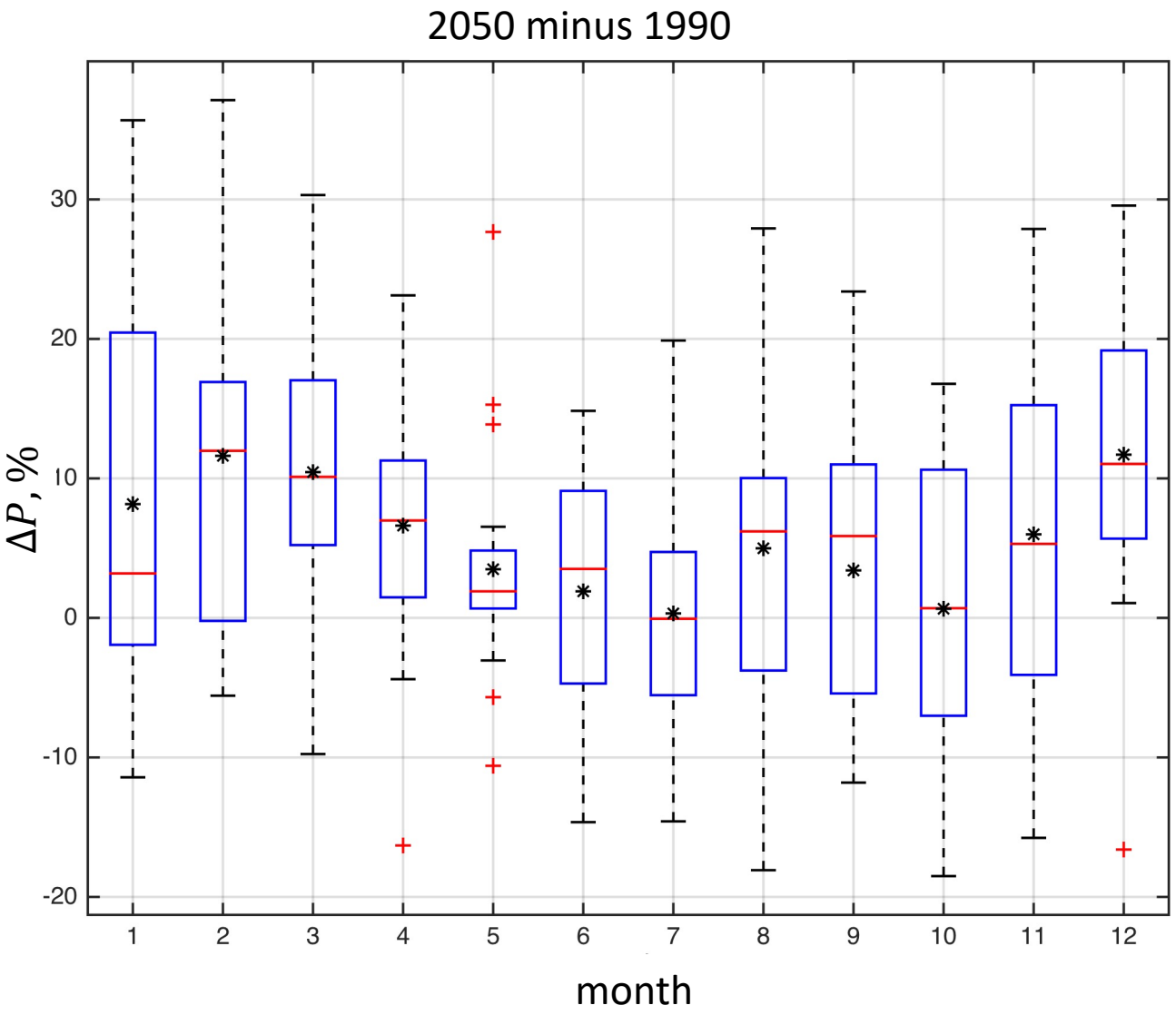
- To get the full probability distribution of the potential impacts is an enormously complex problem. A well-designed probabilistic approach can "sample" the distribution and provide some sense of its "true" shape, giving more confidence that the results reflect as much as possible the current state of knowledge.

- The CHAMP team is addressing multiple factors to evaluate how strongly they influence hypoxia projections, e.g., structural differences in the climate models, the fact that future emissions are unknown, and the errors introduced when coarse resolution climate projections are downscaled to finer spatial resolution, and structural differences in watershed and estuarine models.

- Additional CHAMP work will evaluate whether climate impact projections are sensitive to the choice of how climate forcing is applied to the Chesapeake modeling system.

Extras

Relative precipitation change in 2050



Temperature change in 2050