

The Gulf of Maine in 2050

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The year 2050 seems like a long way in the future, so why are we making such a big deal about a year 30 years from now? Beyond the usual human fascination with multiples of 10, there is a clear scientific reason for selecting 2050: 2050 marks the threshold between the inevitable changes the climate system that we must prepare for and the even more challenging conditions that we will hopefully avoid.

One of the insidious aspects of climate change is that it takes several decades for the climate system to fully respond to a change in CO₂. This means that we are only now feeling the effects of CO₂ that was released when Bill Clinton was president and Jean Chrétien was prime minister. For the next 30 years, we will experience the changes in weather patterns, ocean temperatures, ocean chemistry, and sea level as the Earth adjusts to the CO₂ emitted up until today (408.54 ppm on 11/1/19).

While it may be depressing to think that change is inevitable, the presence of strong climate change actually makes some things more predictable. The purpose of this document and the Gulf of Maine 2050 Symposium is to clearly identify what we know about the future and what we can do about it. The steps that we take in the next few years will determine how successful we are at adapting to changes in the climate system and whether we avoid the even more challenging conditions if CO₂ conditions continue to rise.

What can we say about 2050?

Carbon dioxide (CO₂) is a greenhouse gas. It makes it harder for heat to escape the surface of the earth. This means that increasing CO₂ in the atmosphere by burning coal, oil, and natural gas makes the earth warmer. This is global warming.

Global warming causes other changes in the climate system. The amount of ice in the Arctic decreases, glaciers in Greenland and Antarctica melt, weather patterns and ocean currents shift. Changes like these go beyond simple warming and are why scientists prefer to talk about climate change rather than merely global warming.

Climate scientists have developed sophisticated computer models that represent the interaction between carbon dioxide in the atmosphere, heating at the earth's surface, warming in the ocean, changes in ice, and shifts in weather patterns and ocean currents. When these models are run with observed concentrations of CO₂, they can reproduce the warming trends that we have observed. Our current global mean temperature of 0.5°C above the 1976-2005 average is consistent with predictions made 30 years ago. This gives us confidence that we can use these models to predict conditions 30 years in the future.

While the current generation of global climate models has a higher resolution than their predecessors, they still cannot fully capture the complex currents in the ocean and atmosphere over a small place like the Gulf of Maine. To get a clearer look at how conditions might change by 2050, scientists in the US and Canada took output from the global models and used it to drive high resolution ocean models. These models “downscale” from the coarse view provided by the global models to a more detailed view of our conditions in our region.

To support the discussions at Gulf of Maine 2050, we asked scientists from around the Gulf of Maine to review what we know about expected conditions in 2050 and how these might impact ecosystems and people. We organized these “scenario papers” around three drivers of change: sea level rise and storms, ocean temperature and circulation, and ocean and coastal acidification. These papers are available at <https://www.gulfofmaine2050.org/home-2/program/papers/> and will be refined based on input at the symposium. Here are some highlights of what we can say about 2050

Atmospheric temperature: we expect that the Gulf of Maine region will be warmer—likely 2-3.4°C above the current average. This will lead to a longer growing season but an extended spring frost period and an increase in extremely hot days.

Precipitation and storms: precipitation is likely to increase over the Gulf of Maine, but some models suggest drier conditions (decline of 3.2% to a 13.2% increase). The frequency of tropical and winter storms is hard to predict, but it is likely that storm intensity will increase.

Sea level: in the western Gulf of Maine (Massachusetts to New Brunswick), water levels in 2050 will be 19-27 cm higher. Levels in Nova Scotia will be higher: 24-32 cm.

Ocean temperature: the surface waters of the Gulf of Maine will continue to warm, from 1° to as much as 2.4°C above 1975-2006 average. Note that these conditions represent the baseline climate around 2050. Individual years could be as much as 0.5° cooler or warmer than these projections.

Ocean salinity: the models suggest that surface waters of the Gulf of Maine are likely to be slightly fresher. Salinity varies with temperature: the cooler projections have lower salinities.

Ocean acidification: the Gulf of Maine will be more acidic, but predictions are more uncertain. Unlike temperature, ocean acidification responds quickly to CO₂, so there is a bigger difference between emissions pathways. Interestingly, the scenarios with less warming and more freshening are likely to be more acidic.

Ecosystem conditions: the Gulf of Maine ecosystem will become more temperate, with subarctic species like *Calanus finmarchicus*, cod, and lobster declining and mid-Atlantic species like longfin squid becoming more prominent.

Human impacts: declines in traditional fisheries like those for cod and lobster will impact coastal communities. Ocean acidification will become an increasing challenge for shellfish aquaculture. Rising sea levels will cause more frequent flooding of coastal infrastructure and increased saltwater intrusion into aquifers.

Looking beyond the physics

All of the figures above were taken from climate projections that used “business as usual” carbon emission scenarios. Under these scenarios, emissions continue to rise. Because of the delays in the climate system, the difference between the high CO₂ and low CO₂ scenarios in 2050 is small. Beyond 2050 the world’s depicted under high and low emissions are stark: by 2100 under high emissions, lobster fishing would not be viable, shell-forming organisms would be severely stressed, and sea levels would be more than 1 m higher.

The stark 2100 predictions are not inevitable—these conditions can be avoided if the world shifts rapidly away from fossil fuels. If this shift happens, it would alter another important driver on the Gulf of Maine: the economic and policy environment. The states and provinces around the Gulf of Maine have all embraced ambitious goals to reduce carbon emissions, and New Brunswick and Nova Scotia are currently implementing carbon taxes. As these policies evolve, they will impact how people interact with the Gulf of Maine. For example, it is likely that the Gulf of Maine region will have a viable lobster fishery in 2050, but imagining a fishery prosecuted using diesel-powered boats would be inconsistent with a world trying to avoid catastrophic global warming.

Whatever the scenario it represents major change from the conditions of the past, so we must accept a context of change. This includes ecological change but also social, economic and institutional change. We are witnessing increased attention to climate change around the world, and we can expect this to impact our the national and international context for our activities.

Moving forward

We are used to thinking about the future, especially far-off dates like 2050, as unpredictable. One of the main messages from modern climate science is that we actually can make reliable projections about our warmer, wetter, more acidified future. The purpose of the 2050 project is to realistically envision what our future could look like, and then identify the pathways that we need to take to get there. The scenario papers and other presentations have been selected to provide a sound basis for panels, discussions and real insightful deliberation on climate change adaptation. We are facing an enormous challenge, but we also have incredible resources in the knowledge, experience, and creativity of the people living and working around the Gulf of Maine. When our successors meet in 2050, we hope they will look back at the Gulf of Maine 2050 Symposium as an important step toward building a vibrant, productive, and resilient community.