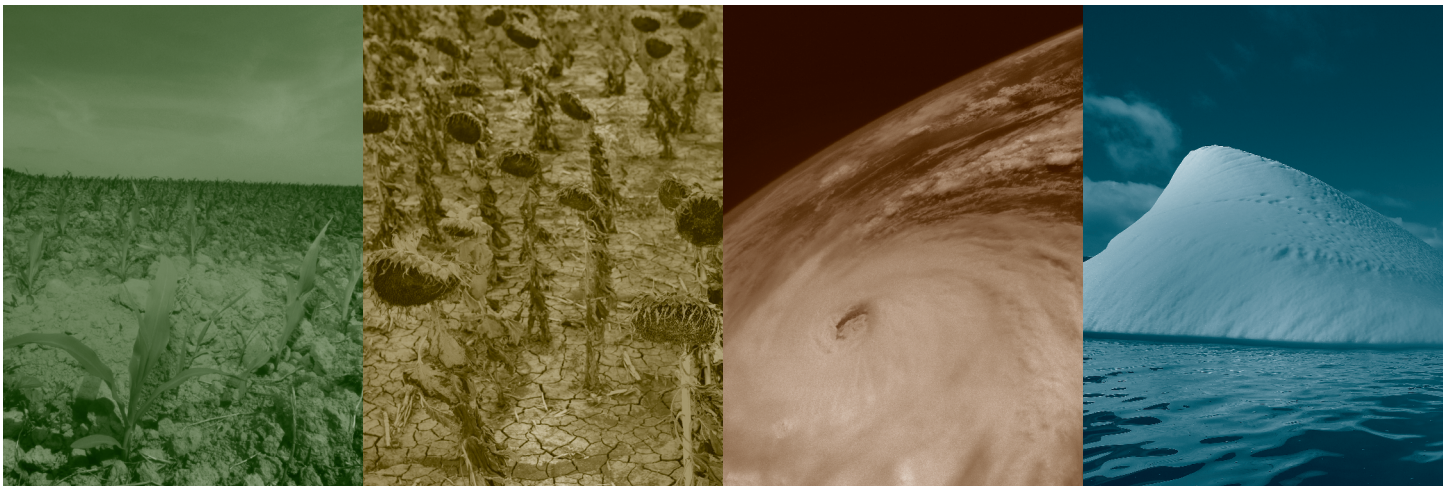
Climate Models and the Use of Climate Projections:

A Brief Overview for Health Departments



Climate and Health Technical Report Series

Climate and Health Program, Centers for Disease Control and Prevention

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Summary

When assessing and preparing for the human health effects of climate change, public health practitioners will likely need to access climatological information. Projected climate data, such as future temperature and precipitation, can be used to assess vulnerability and project disease burden. However, state and local health departments often do not have the capacity to utilize climate data or climate projections. This document provides a definition for climate outlooks and climate models and describes particular outlooks and models that may be useful in anticipating the human health effects of climate change. It also includes a topic overview and some suggested initial methods for state and local health departments. This guidance is in accordance with Step 1 of CDC's Building Resilience Against Climate Effects (BRACE) framework.

Climate models

Models are fundamental tools for studying the potential impacts of climate change, including changes in temperature, precipitation, and sea level. The National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center defines a climate model as a "mathematical model for quantitatively describing, simulating, and analyzing the interactions between the atmosphere and underlying surface (e.g., ocean, land, and ice)." A Global Climate Model (GCM) combines a series of models of the Earth's atmosphere, oceans, and land surface. GCMs divide the earth into many layers and thousands of three-dimensional gridded spaces. These models are skilled at replicating past and current climate. For example, GCMs accurately reproduce observed temporal warming trends, sea ice dynamics, and extreme weather events.

The climate models project possible future climate shifts under the conditions of the specific scenarios. These models are run multiple times using various scenarios of future conditions, such as population levels and anticipated emissions of carbon dioxide (CO_2) or other greenhouse gases. Each GCM is distinct and has a different sensitivity to greenhouse gas emissions. This range, taken as a whole, is important to researchers for providing a sense of the uncertainty surrounding possible future events given a particular scenario and period. To capture this range and make use of the complement of projections, ensembles of multiple global climate model simulations are often used.

An ensemble set of global climate model simulations referred to as the Climate Model Intercomparison Project phase 3 (CMIP3) was used for the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report. CMIP3 was also used for the third U.S. National Climate Assessment (NCA) report. An updated ensemble, the Coupled Model Intercomparison Project phase 5 (CMIP5), was used for the IPCC 5th Assessment Report. CMIP5 promotes a standard set of model simulations and will provide projections of future climate change on both near term (through 2035) and long term (out to 2100 and beyond) scales. Compared to CMIP3, the updated CMIP5 models produce higher resolution projections and use an updated set of greenhouse gas emission scenarios. The model output is freely available to researchers. More information and access to CMIP5 data is available at http://cmip-pcmdi.llnl.gov/cmip5/.

An in-depth description of the development of CMIP 5 is available in the Bulletin of the American Meteorological Society:
Karl E. Taylor, Ronald J. Stouffer, Gerald A. Meehl, 2012: An Overview of CMIP5 and the Experiment Design. Bull. Amer. Meteor. Soc., 93, 485–498

In general, the U.S. CMIP3 and CMIP5 projections are fairly consistent. However, important differences exist for specific geographic areas (e.g. California, Southern United States) and processes (precipitation). Because a variety of climate products (projections and outlooks) have already been created using CMIP3, this data will be the most accessible and easy to use for health departments. Thus, if capacity and/or capability are limiting factors, the existing materials using CMIP3 should be utilized. If modeling capacity exits, state and local health departments should use CMIP5 when applicable, because CMIP3 studies will soon become dated and CMIP5 is the most up-to-date set of widely used climate models. Some public health outcomes may require more precise climate projections provided by a complimentary set of downscaled (high geographic resolution) climate models. In these cases, health departments may need to use a regional climate model or statistically downscaled projections based on CMIP3 or other climate models. Health departments using CMIP5 will need to have the technical capability to work with, understand, and utilize climate model outputs. This may require collaboration with universities, state climatologists, NOAA Regional Integrated Sciences and Assessment (RISA) programs, or other relevant organizations.

Climate outlooks

A climate outlook is a series of climate-related outcomes for a future timeframe that gives probabilities that conditions, averaged over a specified period, will be below normal, normal, or above normal. For example, a climate outlook might project that the average summer high temperature will be above normal for a certain region in the year 2040. Climate outlooks are based on results from running climate models. These outlooks may be useful to state and local health departments for anticipating the health impacts of climate change.

A benefit of using climate outlooks is that they do not require knowledge of how to construct or run climate models or interpret outputs from climate model runs. Health departments without staff capable of running climate models can still use climate outlooks. However, small-scale (downsized) climate outlooks that would be more useful for city and county health departments may not be available.

Health departments can use the climate outlooks developed by NOAA for the NCA. These technical reports were released in January 2013 and are available in PDF form on the U.S. Global Change Research Program's website at http://scenarios.globalchange.gov. Nine reports are currently available in this climate scenario series—one for each of the eight regions defined by the NCA and one for the contiguous U.S. The eight NCA regions are the Northeast, Southeast, Midwest, Great Plains, Northwest, Southwest, Alaska, and Hawaii/Pacific Islands. In addition, a national sea-level rise scenario has been developed for use by coastal regions.

Reports for each region are available under the "Regions" tab at
http://scenarios.globalchange.gov/regions.
The reports are titled "Regional Climate Trends and Scenarios for the U.S. National Climate Assessment," and have associated images which can be downloaded separately. In addition, the Environmental Protection Agency hosted a webinar describing several of these climate outlooks titled "Regional Climate Scenarios and Projections of Sea Level Rise." The webinar materials can be found at http://www.epa.gov/climatechange/impacts-adaptation/adapt-tools/Jan2013-webcast.html.

The regional outlook reports have useful information on projected average climate, such as number of days over 95 degrees and change in annual precipitation. The outlooks can also be combined with

existing health and vulnerability data to project the future disease burden attributable to climate change.

Use of other models or outlooks

In addition to CMIP3, CMIP5, and NOAA's climate outlooks developed for the NCA, state and local health departments can access other available state and local climate data through partnerships. For example, a health department may want to utilize a model developed by a state climatologist, a local university, or a NOAA Regional Integrated Sciences and Assessment: http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram.aspx

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