Climate Hazard and Mitigation Planning (CHaMP) Tool

Background and Guidance for Users

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RAND Social and Economic Well-Being
About This Tool

This user guide describes the motivation, structure, data, and outputs of Version 1.0 of an interactive website called the Climate Hazard and Mitigation Planning (CHaMP) Tool. CHaMP is designed to provide timely and clearly communicated information on place-specific past and projected climatic trends, weather-related hazards, and extreme events. CHaMP integrates climate-relevant information into a form that can be easily incorporated into hazard mitigation plans (HMPs), which are required for all grantees of the Federal Emergency Management Agency (FEMA). This report provides detailed information on the data provided in CHaMP and its limitations, as well as information about how to use CHaMP while writing HMPs or other climate-related plans. The online tool can be found at http://champ.rcc-acis.org/.

Three National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessments (RISA) teams—the Mid-Atlantic RISA (MARISA), the Carolinas RISA (CISA), and the Great Lakes RISA (GLISA)—and the NOAA-funded Northeast Regional Climate Center (NRCC) codeveloped CHaMP with the Urban Sustainability Directors Network (USDN).

The RISA and NRCC team anticipates that future versions of CHaMP will be released as the project team continues to improve and enhance the tool’s functionality based on feedback from users. Any comments or feedback on the tool can be sent to CHaMP@rand.org.

Mid-Atlantic Regional Integrated Sciences and Assessments and Community Health and Environmental Policy Program

The MARISA program was established in September 2016 with a five-year grant from the NOAA Climate Program Office (CPO) and received a second five-year grant in September 2021. It is one of a network of RISA teams across the United States and Pacific Islands funded by the NOAA CPO. MARISA supports integrated, flexible processes for building adaptive capacity to climate variability and change in diverse settings in the mid-Atlantic region. MARISA is led by the nonprofit RAND Corporation, in partnership with researchers at the Pennsylvania State University, Johns Hopkins University, Cornell University, the Virginia Institute of Marine Science, Carnegie Mellon University, and Morgan State University. MARISA is managed under the Community Health and Environmental Policy Program of RAND Social and Economic Well-Being, a division of RAND that seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. The program focuses on such topics as infrastructure, science and technology, community design, community health promotion, migration and population dynamics, transportation, energy, and climate and the
environment, as well as other policy concerns that are influenced by the natural and built
environment, technology, and community organizations and institutions that affect well-being.
For more information, email chep@rand.org.

Carolinas Integrated Sciences and Assessments

The CISA operated between 2003 and 2022, conducting applied research in North Carolina
and South Carolina that incorporated climate information into water, health, and coastal
management and decisionmaking. In its core activities, CISA sought to advance scientific
understanding of climate processes and impacts in the Carolinas, provided decision support
through the development of targeted and tailored information, advanced climate adaptation in the
region, and fostered climate information networks. The CISA team was based at the University
of South Carolina, with team members also located at the University of North Carolina at Chapel
Hill and the South Carolina Sea Grant Consortium. CISA established long-term partnerships and
collaboration with researchers at other universities; federal, state, and local government agencies,
nongovernmental organizations, and the private sector.

Great Lakes Integrated Sciences and Assessments Program

The GLISA was established in 2010 as a collaboration between the University of Michigan
and Michigan State University. As the Great Lakes RISA funded by the NOAA CPO,
GLISA serves the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio,
Pennsylvania, and Wisconsin (as well as the province of Ontario in Canada). GLISA works at
the boundary between climate science and decisionmaking while striving to enhance Great Lakes
communities’ capacity to understand, plan for, and respond to climate impacts now and in the
future. In its third phase, GLISA is a collaboration between the University of Michigan, the
Michigan State University, the College of Menominee Nation Sustainable Development Institute,
and the University of Wisconsin and is focusing on coproducing climate knowledge for scalable
and equitable adaptation action in the Great Lakes.

Northeast Regional Climate Center

Housed at Cornell University since 1983, the NRCC is one of six federally supported centers
established to meet regional needs for climate data products, research-based information, and
climate expertise. It is also a member of the MARISA team. NRCC users include businesses;
federal, state, and local governments; the media; and private citizens. The NRCC provides
climate information to users faced with responding to climate extremes, maximizing economic
gains through enhanced agricultural yields, optimizing energy usage, designing infrastructure,
and protecting the environment. Through experience, the NRCC has learned that effective
climate services require one-on-one interaction with stakeholders both to learn user needs and to
develop products that are relevant, usable, and up-to-date. Users typically require products and information that are dynamic, necessitating that new data be continually collected and incorporated into databases and products. The NRCC and Regional Climate Center (RCC) Program are at the forefront of developing operational data support systems. The Applied Climate Information System is the foundation of RCC data management and electronic information delivery. The system’s flexible modular design allows the NRCC to respond quickly and efficiently to requests for new products and services.

Urban Sustainability Directors Network

The USDN mission is to connect local government practitioners to accelerate urban sustainability in U.S. and Canadian communities. USDN’s work is member-led and member-driven. Members collectively determine what priorities they will focus on each year and lead the work to carry them out. USDN governments are leading the way to a sustainable, low-carbon future by developing, adopting, and sharing practices that create equitable and prosperous communities and a healthy environment. USDN has also been spearheading the development of a more robust and forward-looking approach to hazard mitigation planning.

Funding

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Acknowledgments

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The CISA team would like to thank Gregory Sprouse and Guillermo Espinosa with the Central Midlands Council of Governments, and Leigh DeForth with the City of Columbia, South Carolina, as well as Katie Ellis, Jason McMaster, Nehemiah Stewart, and McCormick Taylor, for their time and thoughtful feedback during the CHaMP Tool development process.

The GLISA team would like to thank Joel Howrani Heeres, Donna Northern, and Robert Brown from the offices of the City of Detroit, Michigan, as well as Annabelle Wilkinson and Allison Farole from the offices of the City of Grand Rapids, Michigan, for their virtual user-testing of the CHaMP Tool. GLISA thanks Rachael Franks-Taylor and Laurie Smith-Kuyipers from NOAA and FEMA for their additional feedback and connections to various contacts from
federal agencies in the region. In addition to these practitioners, GLISA is grateful to Sara Smith and Dr. Casey Thornbrugh of the Northeast Indigenous Climate Resilience Network (NICRN) for their support in GLISA’s demonstration of the CHaMP Tool to NICRN.

The MARISA team would like to thank Carol Davis and Christy Straight from the New River Valley Regional Commission in Blacksburg, Virginia, for their ongoing feedback on the format and content of the tool. In addition, Saleem Chapman, Emma Giardina, and Carolyn Caton, employees from the offices of the City of Philadelphia, made helpful contributions to CHaMP’s development.

The authors would also like to acknowledge the input received via anonymous surveys that were distributed to planners in the mid-Atlantic and Great Lakes regions. We are also grateful to Adrien Zheng, who contributed to the early development for the online tool. Finally, we would like to thank Rachel Riley and Kelly Klima for their constructive suggestions for improving the guide’s content and usability.
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Chapter 1. Introduction

The Climate Hazard and Mitigation Planning (CHaMP) Tool is an interactive website that is designed to communicate potential vulnerabilities to residents and authorities responsible for allocating resources for mitigation activities and to help local hazard mitigation, infrastructure, and land use planners integrate climate information into their hazard mitigation planning efforts. The Federal Emergency Management Agency (FEMA) requires communities receiving FEMA grants for disaster mitigation and resilience actions to have up-to-date hazard mitigation plans (HMPs).\(^1\) Guidance for creating these plans can be found on FEMA’s website.\(^2\) Examples of HMPs can be found on communities’ websites. A few notable example plans that include a discussion of how climate change may affect their communities include the City of Baltimore’s Disaster Preparedness and Planning Project from 2018 and the Boulder County 2022–2027 HMP.\(^3\)

CHaMP provides users with a single point of access to county- and region-specific historical climate and hazard data and projected climate information. Organized around climate-hazard themes, the tool displays climate metrics, hazard data, and hazard impacts in a visual format with downloadable data visualizations and tables that are accompanied by explanatory text. CHaMP is intended to be a timely and durable resource for historical and future climate information linked to natural hazard data.

This guide provides users with contextual information and directions to support Version 1.0 of CHaMP. Although most of this information is included on the tool’s website, this guide offers a consolidated description of data sources and examples of how to use the tool. Drawing on user feedback and other sources of ideas for improvements, the CHaMP team aspires to continually refine and improve the tool, with subsequent releases anticipated.

Coproduction Process Used to Develop CHaMP

CHaMP was codeveloped through a partnership between the Urban Sustainability Directors Network (USDN) and community partners of three Regional Integrated Sciences and Assessments (RISA) teams, funded by the Climate Program Office (CPO), Office of Oceanic and Atmospheric Research, of the National Oceanic and Atmospheric Administration (NOAA).

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\(^1\) Public Law 106-390, Disaster Mitigation Act of 2000, October 30, 2000; Code of Federal Regulations, Title 44, Subchapter D, Chapter 1, Part 201.


The CHaMP team consistently sought feedback from community planners and other practitioners across each of the three RISA regions throughout the development process. This engagement resulted in several key adjustments to the tool, one example being switching from a metrics-based to theme-based approach to present the climate and hazard information.

Beginning in 2019, representatives of the Mid-Atlantic RISA (MARISA) and USDN met approximately monthly to discuss user needs and then plan and design the tool. After receiving funding from the NOAA CPO in 2020, MARISA, the Great Lakes Integrated Sciences and Assessments (GLISA), Carolinas Integrated Sciences and Assessments (CISA), and the Northeast Regional Climate Center (NRCC) began holding biweekly meetings to further advance the planning, design, and field-testing process.

Additional stakeholder and community partner input was crucial to the development and refinement of the tool. This outreach was conducted by each of the RISA teams individually with their partners and networks. MARISA met with representatives of Blacksburg, Virginia, three times in 2021 and representatives of Philadelphia, Pennsylvania, once in 2020 and twice in 2021 to showcase and receive feedback on the tool and assess its usefulness for hazard mitigation planning and other city- and county-level climate planning efforts. MARISA also received input via online surveys that were sent to hazard mitigation planners across the mid-Atlantic region.

GLISA presented CHaMP and solicited feedback from several representatives from the NOAA Office of Coastal Management (based in Traverse City, Michigan) and FEMA, and the discussion focused on the usefulness of the tool for hazard mitigation planning. GLISA also facilitated individual feedback sessions with city practitioners from the cities of Grand Rapids and Detroit, Michigan. In addition to these engagements, the Northeast Indigenous Climate Resilience Network hosted GLISA to present CHaMP to several tribal nations, organizations, and partners. Following these engagements, GLISA sent an online survey to these participants and additional practitioners from the Great Lakes Climate Adaptation Network for feedback on later versions of the CHaMP Tool.

The CISA team held webinar discussions with community planners from the Central Midlands Council of Governments, the City of Columbia, and the consulting firm McCormick Taylor. These stakeholders completed brief online surveys to help familiarize themselves with the CHaMP Tool in advance of the webinar and to test the tool’s usability. The CISA team used the same survey questions distributed to Great Lakes and mid-Atlantic stakeholders during the webinar discussions.

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4 The project team did not collect demographic or identifying information from these stakeholders and community partners due to concerns related to human-subject protection practices. Generally, we targeted our outreach to planners and emergency managers in states in each of the RISA regions that are included in this version of the CHaMP Tool to get feedback on usability. We provide a summary of the more specific information that we have for the people we spoke with in these interactions in the acknowledgments section.
In total, members of each of the RISAs spoke with more than 20 individuals involved in hazard mitigation planning to gain feedback on the tool. The survey, which was intended to further test the usability of CHaMP for county-level hazard mitigation planning, was completed by eight respondents across the mid-Atlantic and Great Lakes regions.5

**Intended Audience**

The intended audience for the tool includes but is not limited to planners, emergency managers, engineers, consultants, other climate service providers, and community leaders and members interested in integrating climate, hazard, and impact data and information into planning, public education, and other documents. As its primary focus, CHaMP is intended to address recurring climate, hazard, and impact information needs of state, local, tribal, and territorial government officials contributing to HMPs, which are an eligibility requirement for FEMA disaster mitigation grants.

**Key Features of CHaMP**

CHaMP was specifically designed to meet the needs of community-based planners responsible for producing HMPs that meet FEMA’s requirements for grantees, and it was coproduced with USDN for this purpose. But the tool can also be used to help inform the development of various other kinds of adaptation and resilience plans, as well as inform local decisionmaking on hazard mitigation and adaptation priorities based on the best available data.

CHaMP also presents a broad range of climate metrics, as well as metrics and information that are region-specific. CHaMP’s climate metrics go beyond temperature and precipitation by providing information on a wider range of climate phenomena of interest to planners, such as severe weather events and wildfires. Building on the regional expertise of each of the RISA teams, CHaMP provides regionally relevant information on hazards, such as Great Lakes hazards and coastal hazards. Additionally, CHaMP provides users with interpretive text that is customized for each county and region and includes descriptions of trends. This text can be incorporated directly into HMPs via CHaMP’s copy and paste function.

Finally, the climate and hazard data in the CHaMP Tool are current and will stay current over time due to the tool being linked to databases through the NRCC that are updated monthly. Due to the current, temporal resolution in CHaMP, these monthly updates will be seen only at the close of each calendar year. This linkage with NRCC databases allows users to refer to CHaMP any time they need to update their HMPs or climate adaptation plans, knowing that they will have continued access to the most-recent annual data. Additional information about the sources of the data presented in the CHaMP Tool is included in Chapter 2.

5 This survey was not intended to be used for research analysis, and the RISA teams did not collect demographic or other data on respondents.
Chapter 2. Data Sources

CHaMP incorporates and integrates observational data related to climate hazards and impacts, as well as projections of future climate and impacts. The sources of these data and projections and their limitations are described in this chapter. In CHaMP, climate data are metrics that relate to historical and future temperature and precipitation, such as “days with precipitation greater than one inch” or “highest summer temperature,” while *hazard* refers to specific storm or other significant weather events that have the potential to “cause loss of life, injuries, significant property damage, and/or disruption to commerce,” as documented in the NOAA National Centers for Environmental Information (NCEI) Storm Events Database.6

**Climate Data**

The climate data provided in the CHaMP Tool comes from the Applied Climate Information System (ACIS) through the NRCC. ACIS is “a system that delivers operational information derived from historical archives and near real-time climate data.”7 The climate data that are “available in ACIS consist of in-situ observations collected from a variety of federal, regional, state, and local networks.”8 ACIS also includes gridded datasets, such as regionally downscaled climate model outputs and daily and monthly gridded historical data. Specifically, the historical climate data from ACIS that we provide in the CHaMP Tool comes from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Spatial Climate Datasets, specifically from the “recent years” gridded dataset.9 This dataset provides climatological data (e.g., precipitation and temperature) from January 1981 to December 2021 and is updated annually.

Future climate projections in the CHaMP Tool are drawn from ACIS and originate from the localized constructed analogs (LOCA).10 LOCA is a statistically downscaled climate data product with 6-km resolution over the entire continental United States and includes all 32 climate models from the Coupled Model Intercomparison Project 5 (CMIP5) archive.11

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6 National Oceanic and Atmospheric Administration, National Centers for Environmental Information, Storm Events Database, undated-a.
9 PRISM Climate Group, Oregon State University, homepage, undated.
The low-emission projections in the tool are the LOCA results for Representative Concentration Pathway (RCP) 4.5, and the high-emission projections are the results from LOCA for RCP 8.5. Both RCPs were developed as inputs for climate models leading up to the Intergovernmental Panel on Climate Change’s Fifth Assessment Report. The RCPs “describe future pathways of emissions and concentrations of greenhouse gases, aerosols, chemically active gases, and land use/cover change.” GLISA recently published a guide on climate model scenarios that might be of interest to users wanting to better understand RCPs and scenarios.

Climate model data are best used to consider the overall amount and rate of change of climate metrics, such as average annual temperature and annual precipitation totals, over time rather than as a forecast for a single year. The climate model scenarios (for example, RCPs) are representations of possible future concentrations of greenhouse gases, aerosols, other gases, and changes in land use and cover. The data represented in these charts show the range of possible changes in climate from 32 climate models that were each run under the same RCP. No single model is a best estimate of the future. Therefore, it is important to consider the full range of model results, rather than a single projection, to understand what each region, state, or county could expect in a changing climate. It should be noted, however, that actual future conditions may be outside the range of the model data.

Hazard and Impacts Data

The data on climate hazards and impacts come from the NOAA NCEI Storm Events Database. This database “is an official publication of . . . NOAA which documents the occurrence of storms and other significant weather phenomena having sufficient intensity to...”

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15 GLISA performs ongoing evaluation of global and regional climate models to determine which ones best represent the climate of the region due to the poor representation of the lakes themselves and lake-land-atmosphere dynamics in many models. Users in the Great Lakes region who would like to make use of future climate projections that best account for the lakes themselves (i.e., lake-land-atmosphere interactions) can email glisainfo@umich.edu for more information. MARISA and CISA have not completed a similar analysis for their regions.

16 National Oceanic and Atmospheric Administration, National Centers for Environmental Information, undated-a.
cause loss of life, injuries, significant property damage, and/or disruption to commerce. In addition, it is a partial record of other significant meteorological events.” The database contains information, as entered by personnel from the National Weather Service (NWS), on 48 event types from 1996 to the present.

The CHaMP Tool provides data on a subset of the 48 event types tracked by the NWS and included in the Storm Events Database. This subset was chosen to represent the hazards that were most relevant for the regions covered by the CHaMP Tool and for hazard mitigation planning. All the events tracked in the database are defined and detailed in NWS Instruction 10-1605. We have included summarized versions of these definitions in the text accompanying the Hazard and Impacts data within the tool and in the “Hazards Definition” box on the next page. Example thresholds for these events are included in the definitions where applicable; however, as these thresholds vary according to individual locations, it may be useful to refer to regional maps. The NWS station in Blacksburg provides regional maps for snow, ice storm, wind chill, and heat index events that are relevant for much of the area currently covered by the CHaMP Tool.

It should be noted that the NWS does not guarantee the accuracy, validity, or completeness of the event data in the Storm Events Database. This is because some of the information included in the database has been collected and reported by non-NWS personnel (for example, government agencies, the media, individuals). NWS is unable to validate all the data collected from these varied sources due to resource and time constraints.

Hazard Definitions

- **Blizzard:** A winter storm that has both sustained 35-mph winds or frequent gusts of wind, along with snow (falling or blowing) that reduces visibility to less than a quarter of a mile for a minimum of three consecutive hours.

- **Coastal flood event:** A rise in sea level to above normal levels due to high tides, onshore winds, and/or low atmospheric pressure (but not a tropical storm) on land that is adjacent to the ocean or its connected bays and estuaries. For example, thresholds for coastal flood events for the tidal gauge in Rehoboth Bay at Dewey Beach, Delaware are 3.3 feet above normal levels for minor flooding, 4.3 feet above normal for moderate flooding, and 5.3 feet above normal for major flooding. These thresholds are highly localized, as similar flood thresholds for the tidal gauge in Delaware Bay at Lewes, Delaware which is less than 8 miles away, are 6.0 feet (minor), 7.0 feet (moderate), and 8.0 feet (major). Additional information on flooding thresholds for tide gauges across the country can be found at the NOAA Advanced Hydrologic Prediction Service webpage.

- **Coastal/wind chill event:** A "period of low temperatures or wind chill temperatures reaching or exceeding locally/regionally defined advisory . . . conditions." For example, for portions of New York, this threshold is –15 to –24 degrees Fahrenheit, while in portions of Maryland and Virginia, the threshold is –5 to –19 degrees Fahrenheit.

- **Dense fog:** Fog that has reduced visibility to approximately a quarter of a mile or less.

- **Excessive heat:** A combination of high temperatures and high humidity (which together form a heat index) that can affect human health. An excessive heat event is recorded or reported when heat indexes "meet or exceed locally/regionally established excessive heat warning thresholds." In most of Maryland and Virginia, the threshold for an excessive heat warning is when heat indexes are expected to reach 110 degrees Fahrenheit or higher for two consecutive days, while in parts of New York, the threshold is a heat index of 105 degrees Fahrenheit or more for over two hours. A heat advisory may be issued below these thresholds if it is early in the spring or summer or as part of a multiday event.

- **Extreme cold/wind chill event:** Occurs when "temperatures or wind chill temperatures reach or exceed locally/regionally defined warning criteria." While this varies regionally, it usually occurs when temperatures reach –35 degrees Fahrenheit or colder.

- **Flash flood event:** The inundation by water, either pluvial or fluvial, of a normally dry area that has the potential to cause damage.

- **Frost/freeze:** When the surface air temperature reaches 32 degrees Fahrenheit or colder, or when ice crystals (frost) form on a surface for long enough that it causes an impact during the local growing season.

- **Hail:** A form of frozen precipitation. A hail event occurs when hail that is three-quarters of an inch falls in a given area or when smaller hailstones "result in fatalities, injuries, or significant damage." When "snow accumulation meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria." The particular amount of snowfall for these warning criteria varies by location.

- **Heat event:** A "period of heat resulting from the combination of high temperatures (above normal) and relative humidity" (also termed a heat index) and is reported/recorded "whenever heat index values meet or exceed locally/regionally established advisory thresholds." In most of Maryland and Virginia, the threshold for a heat event is a heat index of 105–109 degrees Fahrenheit for two consecutive hours, while in much of New York the threshold is heat indexes of 95 degrees Fahrenheit or higher for at least two consecutive hours.

- **Heavy rain event:** An "unusually large amount of rain which does not cause a flash flood event, but causes damage." When "snow accumulation meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria." The particular amount of snowfall for these warning criteria varies by location.

- **High surf event:** The occurrence of large waves, caused by a distant storm or by strong onshore winds, that break either on or near the shore and cause fatality, injury, or other damage. For Maryland coastal waters, the threshold for a high surf advisory is surf with a height of eight feet near shore, for Virginia it is ten feet with a ten-second period, and for North Carolina it is 12 feet with a ten-second period, all with durations of at least 12 hours.

- **High wind event:** Sustained winds of 40 mph or greater for a minimum of one hour or the occurrence of 58-mph winds (or a different windspeed that is defined locally) for any duration. This classification is not used for "severe local storms or winter storm events."

- **Hurricane:** A tropical storm with sustained surface winds that are 74 mph or greater.

- **Ice storm:** Ice accumulations from freezing rain that meet or exceed locally/regionally defined warning criteria, typically a quarter to a half an inch. This event does not get reported/recorded if additional forms of precipitation (such as snow) are mixed in with freezing rain.

- **Lake-effect snow:** Cold air that travels over a comparatively warm, large body of water, resulting in a convective snow band along the leeward side of the body of water. A lake-effect snow event is recorded
when this phenomenon causes snow accumulations that meet or exceed locally defined 12- and/or 24-hour warning criteria, typically about six to eight inches in 12 hours or eight to ten inches in 24 hours.

- **Lakeshore flood event:** A rise of water above normal levels along a lakeshore due to a "strong, persistent onshore wind and/or atmospheric pressure, resulting in damage . . . fatalities, or injuries."⁶
- **Rip current:** "A narrow channel of water that flows away from the beach, through the surf and dissipates beyond the breaking waves."⁷ A rip current can form in any body of water that has breaking waves. Rip current events are reported/recorded only when they necessitate one or more rescues, cause a drowning or near drowning, or cause any damage to watercraft.
- **Sleet:** Precipitation that becomes frozen while falling. This is different from freezing rain, which freezes only once it hits a surface. A sleet event occurs when sleet accumulations meet or exceed locally or regionally defined warning criteria, which is typically a half inch or greater.
- **Storm surge/tide event:** When coastal and lakeshore areas experience a rise in water above normal levels that is "associated with a storm of tropical origin (e.g. hurricane, typhoon, tropical storm, or subtropical storm)" that results in injuries, fatalities, or other damage.⁸
- **Strong wind event:** "Non-convective winds" that gust at less than 58 mph or when sustained winds less than 40 mph result in "fatality, injury, or damage."⁹ These thresholds may change depending on location.
- **Thunderstorm wind event:** When "winds, arising from convection (occurring within 30 minutes of lightning being observed or detected)" have speeds that are 58 mph or greater or winds that are less than 58 mph result in fatality, injury, or other damage.⁹
- **Tornado:** A "violently rotating column of air [that extends to and from] a cumuliform cloud or underneath a cumuliform cloud to the ground." A tornado should also produce visible effects, "such as dust/dirt rotational markings/swirls, or structural or vegetative damage or disturbance."⁹
- **Tropical storm:** A tropical cyclone that has winds between 39 and 73 mph.
- **Wildfire:** Any fire that "consumes the natural fuels and spreads in response to its environment" and "causes one or more fatalities, one or more significant injuries, and/or property damage." "In general, forest fires smaller than 100 acres, grassland or rangeland fires smaller than 300 acres, and wildland use fires not actively managed as wildfires" are not reported/recorded as wildfire events.⁸
- **Winter storm event:** A "winter weather event that has more than one significant hazard (for example, heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet, and ice) and meets or exceeds locally/regionally defined 12- or 24-hour warning criteria for at least one of the precipitation elements."⁸
- **Winter weather event:** A "winter precipitation event that causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria."⁹

**SOURCES:**

Limitations

The CHaMP team has conducted extensive testing with the Storm Events Database throughout the development of the online tool. There are significant limitations that we have observed, particularly the incomplete and inconsistent reporting of hazard events and impacts. For example, one coastal county can report that it was significantly affected by a tropical storm event and a neighboring coastal county may have no reported data from that same storm event, despite the storm having passed over that county. An additional limitation of this database is that it provides data from only 1996 to the present. This is a relatively limited period and, therefore, the database may not contain information on rare but potentially effective hazards. Unfortunately, the CHaMP team was unable to identify a database that has a more complete dataset for similar hazards and their impacts that was available across each of the regions included in the tool, and the team did not have the resources to fill in these data gaps. Therefore, the CHaMP team recommends using the hazard and impacts data within CHaMP with caution and to supplement with additional local or state-level databases whenever possible.20

20 The CHaMP team is considering including a functionality where users can upload their own information on hazard events in a future version of the tool. The intention of this would be to help supplement data from the Storm Events Database. The CHaMP team welcomes any additional suggestions for supplementing this database within CHaMP, these suggestions can be sent to CHaMP@rand.org.
Chapter 3. How to Use CHaMP

In this chapter, we provide users with an overview of CHaMP’s structure. We also provide an example of how users might explore CHaMP’s offerings and select climate and hazard measures of greatest interest to their community. We also describe how and where to find documentation within the tool. Instructions on how to use the tool are guided by screenshots of Version 1.0 that were taken in April 2022.

Getting Oriented in the Tool

Figure 3.1 shows a screenshot of the view users see when landing on CHaMP’s homepage (https://champ.rcc-acis.org). When entering the tool, users will see a map of the United States along with the highlighted states for which CHaMP currently has data: New York, New Jersey, Pennsylvania, Maryland, Delaware, Virginia, North Carolina, South Carolina, West Virginia, Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota, as well as Washington, D.C. There are several panels visible from the homepage along the outer edges of the map. Along the top of the map is the selection panel and time range selector. These allow the user to select the climate and hazard information that they wish to visualize and the time period that is relevant to their analysis. More information about how to use the selection panel and time selector is included in the next section.

On the left side of the homepage is a white panel, which has information about how to get started using the CHaMP Tool. The panel on the left side of the page is also where interpretive text describing plots and trends will appear once the user selects a climate metric or hazard.

On the right side of the homepage, there is a circular icon and a question mark icon. Users can click on the circular icon to search for a particular location. This search will provide results only for locations within the states included in Version 1.0 of the tool. Clicking on the question mark icon will bring up a menu where users can find additional documentation on the purpose of the tool, how to use the tool, and data and technical resources (including this guide). Finally, a legend and zoom controls can be found at the bottom-right corner of the homepage.
Selection of Time Range, Climate-Hazard Themes, and State and County

**Time Range**

One option relates to the time range for data presentation. In the time range selector (located at top right of the map and indicated with a yellow arrow in Figure 3.2), the slider bars can be used to select the beginning and end years of interest. The range is initially set at 1981 to 2021 but could be constrained to a shorter time interval of, say, 20 years rather than 40. The tool allows a minimum period of 20 years to be selected: Shorter time periods could give a deceptive view of trends because of the magnitude of annual variability.
Climate-Hazard Themes

Users also may select and change themes and hazards on the selection panel using the drop-down menus indicated by the red and blue arrows in Figure 3.2, respectively. The CHaMP Tool divides the data into nine themes that users can select to gather data on a particular hazard or climate metric. Available themes are coastal hazards, extreme rainfall/flooding, fog, Great Lakes hazards, severe weather, tropical storms/hurricanes, extreme heat, wildfire, and winter weather. Each theme has corresponding hazards associated with it, which can be selected using the drop-down menu indicated by a blue arrow in Figure 3.2. Within the “Hazards” menu, there are two categories: “Climate Metrics and Projections” and “Hazard Types.”

Using the options panel at the top of the map, one may use the first drop-down menu labeled “Theme” (indicated by a red arrow in Figure 3.2) to select a category of climate hazards. This will populate a list in the climate metric/hazard type drop-down menu (indicated by a blue arrow in Figure 3.2) that lists available climate metrics and/or hazard types relevant to the selected theme. If the user has selected a hazard type, additional metrics can be selected under the drop-down labeled “Impacts.” Once either a climate metric or an impact has been selected, the associated data will be shown on the map, and general trend information can be found by hovering over a state of interest. Table 3.1 shows the hazard types and climate metrics that are associated with each theme.
<table>
<thead>
<tr>
<th>Themes</th>
<th>Hazard Types</th>
<th>Climate Metrics and Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal hazards</td>
<td>• Coastal flood</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td></td>
<td>• High surf</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rip current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Storm surge/tide</td>
<td></td>
</tr>
<tr>
<td>Extreme rainfall/flooding</td>
<td>• Coastal flood</td>
<td>Days with precipitation &gt; 1 in</td>
</tr>
<tr>
<td></td>
<td>• Flash flood</td>
<td>Days with precipitation &gt; 2 in</td>
</tr>
<tr>
<td></td>
<td>• Flood</td>
<td>Total spring precipitation</td>
</tr>
<tr>
<td></td>
<td>• Heavy rain</td>
<td>Total summer precipitation</td>
</tr>
<tr>
<td></td>
<td>• Lakeshore flood</td>
<td>Total fall precipitation</td>
</tr>
<tr>
<td></td>
<td>• Days with precipitation &gt; 1 in</td>
<td>Total winter precipitation</td>
</tr>
<tr>
<td></td>
<td>• Days with precipitation &gt; 2 in</td>
<td>Total annual precipitation</td>
</tr>
<tr>
<td>Fog</td>
<td>• Dense fog</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td>Great Lakes hazards</td>
<td>• Lake-effect snow</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td></td>
<td>• Lakeshore flood</td>
<td></td>
</tr>
<tr>
<td>Severe weather</td>
<td>• Flash flood</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td></td>
<td>• Hail</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Heavy rain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• High wind</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strong wind</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Thunderstorm wind</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tornado</td>
<td></td>
</tr>
<tr>
<td>Tropical storms/hurricanes</td>
<td>• Hurricane (typhoon)</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td></td>
<td>• Tropical storm</td>
<td></td>
</tr>
<tr>
<td>Extreme heat</td>
<td>• Excessive heat</td>
<td>Days with high &gt; 90°F</td>
</tr>
<tr>
<td></td>
<td>• Heat</td>
<td>Days with high &gt; 95°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Days with high &gt; 100°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summer maximum temperature</td>
</tr>
<tr>
<td>Wildfire</td>
<td>• Wildfire</td>
<td>No climate data or projections available for this theme</td>
</tr>
<tr>
<td>Winter weather</td>
<td>• Blizzard</td>
<td>Days with low &lt; 0°F</td>
</tr>
<tr>
<td></td>
<td>• Cold/wind chill</td>
<td>Days with low &lt; 20°F</td>
</tr>
<tr>
<td></td>
<td>• Extreme cold/wind chill</td>
<td>Days with low &lt; 32°F</td>
</tr>
<tr>
<td></td>
<td>• Frost/freeze</td>
<td>Winter minimum temperature</td>
</tr>
<tr>
<td></td>
<td>• Heavy snow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ice storm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sleet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Winter storm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Winter weather</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: F = Fahrenheit.
**Location by State and County**

Another option for viewing climate and hazard data in CHaMP is to zoom in on a particular state or county. Once a hazard type or metric is selected in the options panel, the map will initially display this hazard or metric data aggregated at the state level. Users can then click a specific state on the map. The tool will then zoom in on that state with county-level trends shown on the map and a written summary of state-level trends shown in the left side panel. Figure 3.3 gives an example of a state-level view. Users can select a county by clicking it on the map. In a county view, the left panel updates to describe county-level trends. More information about how to view the underlying data that went into calculating these trends is provided in the following section.

**Figure 3.3. Zoomed-In View of the State of Virginia**

![Zoomed-In View of the State of Virginia](image)

Viewing and Downloading Climate and Hazard Data and Plots

**Historical and Projected Climate Data**

Once a climate metric is selected and the user has zoomed in on either a state or county, the left panel will show two buttons along the bottom—“Show Historic Data” and “Show Projected Data.” These buttons are circled in the bottom left corner of Figure 3.3. To see a plot of the annual historical observational data used to determine the trends described in the text in the left panel, users can select the “Show Historic Data” button to view the state- or county-level historical climate metric data as a time series. Climate projections can be viewed either by selecting the “Show Projected Data” button in the left panel or, if the user has already selected the historical data and is viewing the chart, by using the tabs at the top of the chart to choose one of two future greenhouse gas emission scenarios (see “Climate Data” in Chapter 2 for more details). Users may then choose “High Emission Future” or “Low Emission Future” to view
future climate projections for the metric of interest for either of these two future greenhouse gas emissions scenarios. When viewing projected data, the left panel will update to show a description of the trends seen in the projections. Information about the source of the climate projections and guidance about how to use climate projections are also provided in the left panel. Figure 3.4 shows a screenshot of the climate projections under a “High Emission Future” scenario in Virginia for the extreme heat climate metric, days with highs above 90 degrees Fahrenheit.

**Figure 3.4. Virginia Extreme Heat Projections (High-Emission Future)**

![Figure 3.4. Virginia Extreme Heat Projections (High-Emission Future)](image)

**Hazard Data**

Users can also view hazard data when zoomed into the state or county level. As an example, Figure 3.5 shows the hazard data view of flash flood events for the state of Pennsylvania. The left panel provides a summary of the number of events and their impacts in terms of reported property damage, reported crop damage, reported deaths, and reported injuries. The side panel also provides a citation for the source of the hazard data, the NOAA NCEI Storm Events Database.
Figure 3.5. Pennsylvania Total Reported Episodes of Flash Floods

From this view, the user can select the “Show Annual Data” button at the bottom of the left panel to view the time series for the selected hazard data. Figure 3.6 shows what the annual data for flash flood events look like for Allegheny County, Pennsylvania.

Figure 3.6. Allegheny County Annual Reported Flash Flood Events

It is possible for the user to get more information about specific hazard events by clicking on one of the bars in the bar chart of the annual data. This will cause the left panel to update and to show the dates of specific hazard events, as well as any narrative information that was reported to the NOAA NCEI Storm Events Database. Figure 3.7 shows this view for flash floods in Allegheny County for 2018. Users should be aware that not all events in the Storm Events Database have detailed, or any, narratives. However, when available, these narratives can provide quite detailed information on the impacts of the particular event, such as amount of rainfall and specific roads affected.
Copy, Paste, Print, and Download Charts and Text

Users can copy and paste descriptive text from any part of the tool for use in climate- or hazard-related plans, public education materials, and other documents. Charts can be downloaded in a variety of formats by clicking on the three-barred icon (“hamburger”) in the upper-right corner, just below the X that is used to exit out of the chart. Users can also download the data in a .csv file by selecting the same hamburger icon.

View Source Documents

Sources are cited throughout the CHaMP Tool via hyperlinked text, which can be identified as underlined text and footnotes. Clicking on either the hyperlinked text or the footnote will take users directly to the citation for the source document.
Chapter 4. Maintenance, Feedback, and Potential Future Work

In this chapter we discuss the CHaMP team’s plans for maintaining the tool and its data, incorporating future user feedback into CHaMP, and building on and improving Version 1.0 of the tool.

Procedures for Maintaining CHaMP

The CHaMP Tool was designed with the knowledge that communities and planners will need to update their HMPs and other climate-related plans on a regular basis and that having up-to-date climate and hazard information is vital for properly responding and building resilience to a changing climate. By linking the CHaMP Tool to the NRCC’s databases, the project team has ensured that all data within CHaMP will be updated on at least an annual basis. Although the databases themselves are updated more frequently, often on a monthly basis, users will see updates in the tool itself on an annual basis because CHaMP is set up to provide yearly data resolution. The NRCC’s support for maintaining CHaMP comes from a combination of MARISA funding and long-term support via the NRCC’s portfolio of tools, which is supported by the NOAA Regional Climate Center funding.

The MARISA and GLISA teams will collaborate regularly to conduct informal reviews of the tool and assess its relevance to users to ensure that it continues to meet the needs of state and local planners as part of their continuing activities in their existing grants. More-formal reviews of CHaMP will be completed whenever substantial updates are completed and published.

Importance of User Feedback to Support Continuous Improvement of CHaMP

Version 1.0 of the CHaMP Tool was developed through a coproduction process that centered on potential user data requirements and feedback. The CHaMP team will continually respond to the needs of the communities and planners in the mid-Atlantic, Great Lakes, and Carolina regions. This durability is a core feature of the RISA program. In addition, the project team will continue to collaborate with USDN and its members to ensure that the data and how they are presented are relevant and easily incorporated into HMPs and other climate-related planning documents.

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21 MARISA and GLISA received five-year grants in 2021 and will be funded at least until September 2026.
Users may contact CHaMP@rand.org to provide the project team with feedback at any time. This email address will be continually monitored, and all feedback will be considered by the project team and, if appropriate, incorporated into subsequent updates of the tool.

**Aspirations for Improvements on Version 1.0 of CHaMP**

Several desirable features and functions were not incorporated into Version 1.0 of CHaMP due to time and funding constraints, despite hearing from user communities that they were of interest. The features and functions that the team would like to attempt to include in the next version of CHaMP are

- integrating station-level data into the tool
- developing detailed training materials for incorporating CHaMP data visualizations and interpretive text into HMPs and other planning efforts
- incorporating a form, or other mechanism, where users can upload data to be included in the databases that feed the CHaMP Tool.

Additionally, the team hopes to identify communities and opportunities where we can integrate higher-resolution datasets, at a finer-than-county scale. Our plan is to start with datasets that would be of interest to planners, with an initial focus on addressing environmental justice and equity data needs.

For potential future versions of CHaMP, the team would like to incorporate updated information. For example, these could include updating the explanatory text in the tool and future climate projections to reflect the latest science (e.g., CMIP6 data and the Intergovernmental Panel on Climate Change’s Fifth Assessment Report) and identifying datasets that provide more-complete hazard and impact information. In the longer term, the team aspires to see the tool expanded to cover the entirety of the continental United States. These updates are dependent on the availability of necessary funding.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACIS</td>
<td>Applied Climate Information System</td>
</tr>
<tr>
<td>CHaMP</td>
<td>Climate Hazard and Mitigation Planning</td>
</tr>
<tr>
<td>CISA</td>
<td>Carolinas Integrated Sciences and Assessments</td>
</tr>
<tr>
<td>CMIP</td>
<td>Coupled Model Intercomparison Project</td>
</tr>
<tr>
<td>CPO</td>
<td>Climate Program Office</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>GLISA</td>
<td>Great Lakes Integrated Sciences and Assessments</td>
</tr>
<tr>
<td>HMP</td>
<td>hazard mitigation plan</td>
</tr>
<tr>
<td>LOCA</td>
<td>localized constructed analogs</td>
</tr>
<tr>
<td>MARISA</td>
<td>Mid-Atlantic Regional Integrated Sciences and Assessments</td>
</tr>
<tr>
<td>NCEI</td>
<td>National Centers for Environmental Information</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NRCC</td>
<td>Northeast Regional Climate Center</td>
</tr>
<tr>
<td>NWS</td>
<td>National Weather Service</td>
</tr>
<tr>
<td>RCP</td>
<td>Representative Concentration Pathway</td>
</tr>
<tr>
<td>RISA</td>
<td>Regional Integrated Sciences and Assessments</td>
</tr>
<tr>
<td>USDN</td>
<td>Urban Sustainability Directors Network</td>
</tr>
</tbody>
</table>
References


Code of Federal Regulations, Title 44, Subchapter D, Chapter 1, Part 201.


https://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=dewd1

https://www.weather.gov/rnk/criteria

https://www.weather.gov/aly/preparedness

https://water.weather.gov/ahps/

https://www.weather.gov/media/akq/miscNEWS/criteria.pdf

https://www.weather.gov/lwx/WarningsDefined

https://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf


PRISM Climate Group, Oregon State University, homepage, undated. As of September 30, 2022:
https://prism.oregonstate.edu

Public Law 106-390, Disaster Mitigation Act of 2000, October 30, 2000. As of September 30, 2022:
https://www.govinfo.gov/app/details/PLAW-106publ390

