Subcommittee on Disaster Reduction – Heat Wave Implementation Plan
CDC, EPA, and NOAA Responses Marking Progress on the Grand Challenges

The White House National Science and Technology Council Subcommittee on Disaster Reduction (SDR) identified a set of challenges that, when addressed, would reduce community vulnerability to disasters and thus create a more disaster-resilient Nation. These were set forth in a 2005 report, *Grand Challenges for Disaster Reduction*,[1] which formulated a ten-year strategy for disaster reduction through science and technology. The six broad challenges were:

1) Provide hazard and disaster information where and when it is needed.
2) Understand the natural processes that produce hazards.
3) Develop hazard mitigation strategies and technologies.
4) Recognize and reduce vulnerability of interdependent critical infrastructure.
5) Assess disaster resilience using standard methods.
6) Promote risk-wise behavior.

The SDR *Grand Challenges for Disaster Reduction* report acknowledged that addressing these challenges would require sustained Federal investment as well as collaborations with state, local, and tribal governments, professional societies and trade associations, the private sector, academia, and the international community in order to successfully transfer disaster reduction science and technology into common use.

The SDR subsequently developed a series of 15 hazard-specific Implementation Plans – released in 2008, 2009, and 2010 – that contained priority science and technology interagency strategic actions to improve the Nation's capacity to mitigate, respond to, and recover from disasters. An ad hoc SDR task force was spun up earlier this year to assess progress on addressing the 17 short-, medium-, and long-term strategic actions contained in the SDR *Grand Challenges for Disaster Reduction Heat Wave Implementation Plan*.[2]

Grand Challenge #1: Provide hazard and disaster information where and when it is needed.
To identify and anticipate the hazards that threaten communities, a mechanism for real-time data collection and interpretation must be readily available to and useable by scientists, emergency managers, first responders, citizens, and policymakers.

- Through advanced communication technology, improved reporting timeliness and accessibility to surface meteorological observations essential to monitoring and forecasting heat wave severity in urban and rural areas of the country;

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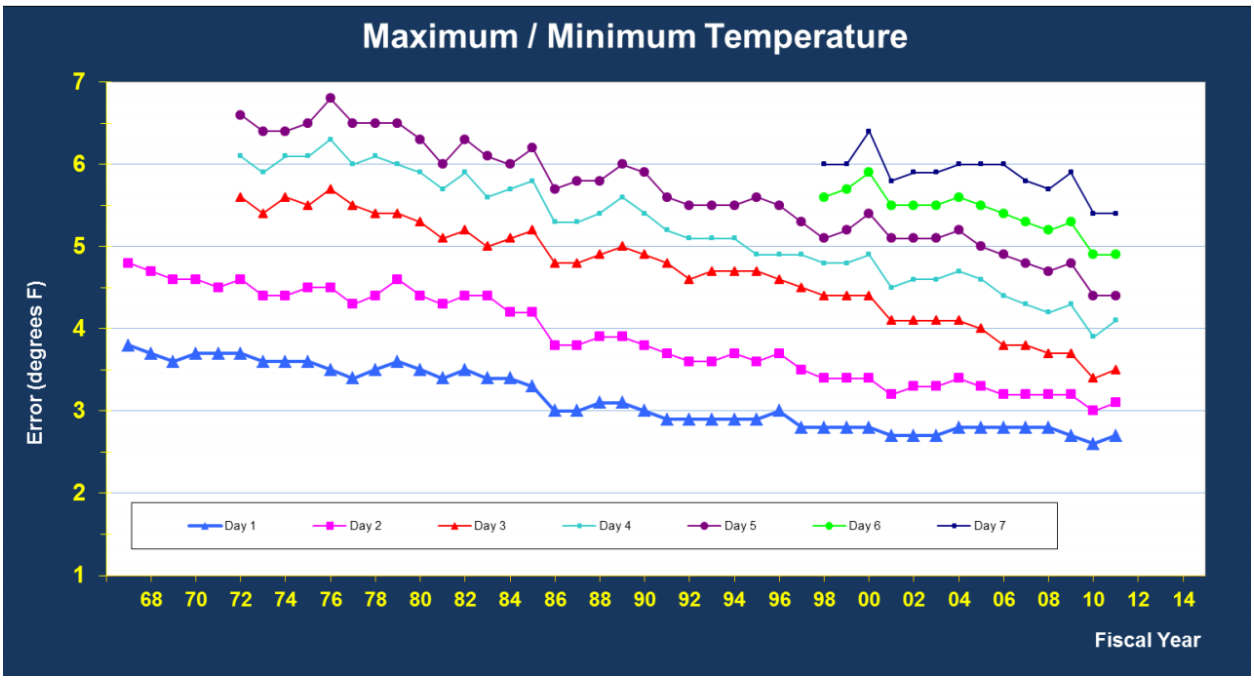
[1] National Science and Technology Council, Committee on Environment and Natural Resources, *Grand Challenges for Disaster Reduction: A Report of the Subcommittee on Disaster Reduction,* June 2005. http://www.sdr.gov/docs/SDRGrandChallengesforDisasterReduction.pdf

[2] http://www.sdr.gov/docs/185820_Heatwave_FINAL.pdf

    - All NWS Weather Forecast Offices (WFOs) generate "hourly weather roundups" which are openly available at 10 min past each hour and which provide the latest information on air temperature, relative humidity, and when above certain thresholds, the heat index.
    - Most WFOs routinely monitor social media to collect information about extreme events from their area of responsibility, which would include information about extreme heat. These offices provide Impact-based Decision Support Services (IDSS) directly to core government decision makers when conditions warrant.
    - The NWS created a new program called Weather-Ready Nation Ambassadors, which welcomes organizations from across America to raise awareness to weather, water and climate issues affecting the nation. Currently, there are over 2800 Ambassador organizations around the country, which help to spread the word about weather preparedness.
    - NOAA has a Memorandum of Understanding with the Centers for Disease Control (CDC) to collaborate on the issuance of CDC's health-related safety messages to the public via NWS' vast dissemination network.
    - NWS has a Memorandum of Understanding with the Occupational Safety and Health Administration (OSHA) to jointly raise the awareness of heat safety for outdoor workers. The heat campaign website is at https://www.osha.gov/SLTC/heatillness/index.html.
- Assess and fill gaps in observations, training, technology, capacity, and organization that may prohibit efficient communication of heat wave forecasts;
    - The NWS has embarked on a multi-year plan to assess and evaluate the effectiveness of their Watch, Warning, Advisory (WWA) program, which is the main way that awareness and threats are conveyed to the nation.
    - The NWS currently uses a combination of Heat Watches, Advisories, and Excessive Heat Warnings, which are coordinated with local governmental authorities and tailored to regional climates.
- Provide near real-time reporting of weather conditions to support heat wave monitoring and forecasting through a fully integrated Federal-to-local network of surface observing systems;
    - Working with our sister NOAA line office, NOAA's Office of Oceanic and Atmospheric Research (OAR), the NWS developed a system to collect observations from hundreds of weather sensing networks that span the nation and the breadth of the weather community. These observations are provided by Federal partners (FAA, DoD), State transportation departments (aviation and surface transportation), and privately operated weather networks (called "mesonets"), which include observations from academia, private networks and even weather enthusiasts. This information is openly available via a new system called MADIS, the Meteorological Assimilation Data Ingest System (www.madis.noaa.gov).
    - The NWS continues to operate and modernize its Cooperative Observation (COOP) network, which has more than 9,000 members providing daily observations of temperature and precipitation.

- Information from weather networks can be obtained from NOAA's National Center for Environmental Information (NCEI) (www.ncei.noaa.gov).

- Improve forecast accuracy of daily maximum temperature by 0.6□C (1.0^0 F) to support energy production and delivery;
  - The accuracy of nationwide temperature forecasts produced by the NWS continues to improve as seen by the graphic below. For example, the accuracy of a Day 2 temperature forecast in 2012 was 1.4 Degrees (F) more accurate than in 1980 (67 percent improvement).
  - The steady improvement in forecast accuracy can be used in sectors across the country to improve decision making for both the protection of life and property, and to support the economy.



- Create monitoring and assessment tools for identifying location-specific conditions that are likely to be life threatening to at-risk individuals (e.g., Operational Heat Health Warning System for every National Weather Service forecast area in the United States, increasing the number of Weather Forecast Offices with the capability to use this system from the current 16 to over 120).
  - NOAA and the CDC are working together to build a National Integrated Heat Health Information System that will identify and harmonize existing capabilities and deliver research, observations, prediction, and vulnerability information and operational decision support services to reduce health-related risk during heat waves.

- The NWS has developed a data analysis and visualization tool called LCAT, the Local Climate Analysis Tool. LCAT can be accessed by anyone on the Internet (after registration) and provides the ability to visually mine years of data to show local climate trends, such as the frequency of excessive heat.
- CDC Environmental Public Health Tracking Network (Climate Portal): The Tracking Network includes data on extreme heat to better evaluate the number of heat-related deaths, hospitalizations, and emergency department visits at the national level, while allowing for comparisons across states. These data can help local communities in evaluating past extreme heat days and events and predicting future extreme heat days/events; understanding the possible health effects and risks to specific groups of people; and designing interventions. http://ephtracking.cdc.gov/.

Grand Challenge #2: Understand the natural processes that produce hazards.
To improve forecasting and predictions, scientists and engineers must continue to pursue basic research on the natural processes that produce hazards and understand how and when natural processes become hazardous. New data must be collected and incorporated into advanced and validated models that support an improved understanding of underlying natural system processes and enhance assessment of the impacts.

- Develop heat wave climate indices that can be used in anticipating future heat wave events and monitoring long-term heat wave event changes based upon climate;
  - The NWS' Climate Prediction Center (CPC) provides operational, diagnostic and monitoring products and services on both national and international scales.
  - CPC has developed an experimental week-2 excessive heat outlook, which will provide advanced notification for the conditions that produce heat waves in the U.S.
  - CPC has developed an experimental week 3-4 temperature and precipitation outlook that provides advance notice of potential large-scale pattern changes to further assist decision makers on weather and climate sensitive activities.
  - CPC issues monthly and seasonal outlooks for precipitation and temperature. Monthly outlooks are for the first month lead and seasonal outlooks extend out for several seasons.
- Identify the amplification of high pressure areas, the roles of phenomena such as the El Nino-Southern Oscillation, and micro-scale influences that can moderate or exacerbate the severity of a heat wave;
  - CPC issues outlooks on the El Nino – Southern Oscillation (ENSO) that can provide predictive signals as to temperature and precipitation trends that may impact global weather for months or seasons.
- Improve mid- and long-range models and the accuracy of forecasted conditions that affect human health, agriculture, transportation and power distribution.
  - In 2011, the NWS Environmental Modeling Center developed the Climate Forecast System (version 2), which is a global climate prediction model.

- In the fall of 2015, the NWS introduced the North American Multi-Model Ensemble (NMME) that uses climate models from six North American centers to improve seasonal climate prediction.

Grand Challenge #3: Develop hazard mitigation strategies and technologies.
To reduce and prevent damage, scientists and engineers must invent – and communities must implement – more affordable and effective hazard mitigation technologies such as disaster resilient building materials and architecture and smart structures that respond to changing conditions.

- Identify at-risk individuals, establish responsive health surveillance and alert systems, create a network of social service and support volunteers, establish infrastructure such as cooling locations/shelters and telephone help-lines, and institute other response mechanisms to ensure essential life-saving actions are provided when needed;
  - Heat waves may be accompanied by episodes of unhealthy air quality. The EPA AirNow website and app inform the public of air quality in their community.
    - EPA established the Air Quality Index (AQI) in 1999 to enhance public understanding of air pollution across the country and allow people to take actions to reduce exposure, if necessary.
    - Metropolitan areas with populations of more than 350,000 are required to report the AQI daily, but many more areas voluntarily report the AQI as a public service.
    - For ozone and particle pollution – two of the most prevalent pollutants in the U.S. – state and local air agencies provide information on the current ozone and particle pollution AQI and next day forecasts for nearly 400 U.S. cities. EPA provides the forecasts through its AirNow.gov website, and the free AirNow app for iPhone and Android phones.
    - To access AirNow on the Web, go to: https://airnow.gov/index.cfm?action=airnow.main
- Use meteorological thresholds for each community that identify conditions conducive to the deterioration of human health by applying the synoptic air mass classification approach for heat wave assessment and forecasting.
  - WFOs have established partnerships with their state/city health departments, and collaborated on the development of revised warning criteria for heat watch, warnings and advisories.
  - As previously discussed, NOAA/NWS has Memorandum of Understanding with both OSHA and CDC to help with reaching the population with heat health-related information.
  - The NWS is also working with Environment and Climate Change Canada to ensure that warning thresholds at border states are consistent between the U.S. and Canada.

Grand Challenge #4: Reduce the vulnerability of infrastructure.
Protecting critical infrastructure systems, or lifelines, is essential to developing disaster-resilient communities. To be successful, scientists and communities must identify and address the interdependencies of these lifelines at a systems level (e.g., communications, electricity, financial, gas, sewage, transportation, and water).

- Provide a technical basis for revised standards and codes that integrate local climatological and meteorological knowledge to improve standards for the built environment, improve safety and increase power distribution infrastructure, railway, roadway and pipeline resistance to excessive heat.
    - The SDR agencies that participated in this progress assessment did not list any specific activities under this Grand Challenge strategic action.

Grand Challenge #5: Assess disaster resilience.
Federal agencies must work with universities, local governments, and the private sector to identify effective standards and metrics for assessing disaster resilience. With consistent factors and regularly updated metrics, communities will be able to maintain report cards that accurately assess the community's level of disaster resilience.

- Study outcomes of past heat waves to distinguish effective and ineffective mitigation and response strategies and technologies;
    - The SDR agencies that participated in this progress assessment did not list any specific activities under this Grand Challenge strategic action.
- Complete risk assessments for at-risk populations in each community.
    - The SDR agencies that participated in this progress assessment did not list any specific activities under this Grand Challenge strategic action.

Grand Challenge #6: Promote risk-wise behavior.
To promote "risk-wise" behavior, develop and apply principles of economics and human behavior to enhance communications, trust, and understanding within communities.

- Expand the forecast areas for heat warning systems (e.g., Heat Health Warning System);
    - See the Appendix (pages 9-10) for a partnership between NOAA and CDC on the development of a National Integrated Heat Health Information System.
- Improve individual, community, state and Federal understanding of the serious risks associated with excessive heat and the potential for human health crises when extreme heat events occur;
    - Building Resilience Against Climate Effects:
        - The Building Resilience Against Climate Effects (BRACE) framework is a five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change. Sixteen of 18 grantees that CDC is funding to implement the

BRACE framework are addressing extreme heat. Arizona, Michigan, Minnesota, and San Francisco have developed extreme heat response plans. http://www.cdc.gov/climateandhealth/brace.htm.

- Extreme Heat and Your Health: Website
  - Based on the theme of "Stay Cool, Stay Hydrated, Stay Informed," this website provides easily accessible heat resources for members of the general public, including specific information for elderly populations, infants and children, people with chronic medical conditions, outdoor workers, athletes, and low income populations. http://wwwdev.cdc.gov/extremeheat/index.html
- Climate Change and Extreme Heat Events Guidance
  - This guidance document describes extreme heat events, how extreme heat events threaten public health, and how communities can prepare for and respond to these events. Links to local programs and real-world examples from across the country are provided as additional resources for use in extreme heat planning. http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf
- CDC Health Studies Branch -- Preparedness for and Responding to Extreme Heat and Cold Events: http://www.cdc.gov/nceh/hsb/disaster/heatandcold.htm

- Emphasize the danger signs for heat-related illnesses;
  - Recognizing, Preventing and Treating Heat-Related Illness: An e-learning course:
    - CDC developed training course aimed at teaching and reinforcing heat-related illness awareness among coaches, athletic trainers, students, school nurses, parents, and teachers. It also promotes the development and implementation of guidelines by these participants. Nurses receive continuing education credits for completing this course. http://www.cdc.gov/nceh/hsb/extreme/heat_illness_training.htm
  - CDC Extreme Heat Media Toolkit:
    - Messaging resources provided in this toolkit include logos, web resources, media materials, and outreach letters that can be used to reach diverse audiences. http://wwwdev.cdc.gov/extremeheat/materials.html
  - Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments:
    - This 2013 revision includes additional information relating to the physiological changes that result from heat stress; updated information from relevant studies, such as those on caffeine usage; evidence to redefine heat stroke and associated symptoms; and updated information on physical monitoring and personal protective equipment and clothing that can be used to control heat stress. http://www.cdc.gov/niosh/docket/review/docket266/pdfs/heatHotEnvironmentsCritDoc-ExtRev-120913.pdf

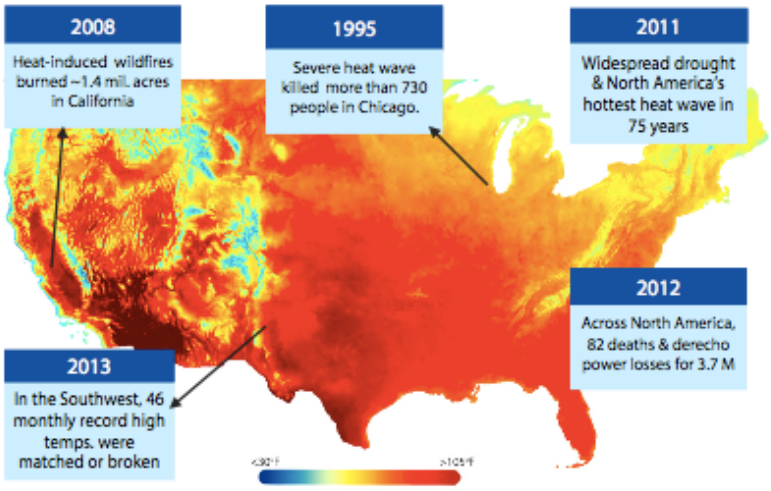
- Deploy a seamless suite of reliable and accurate heat wave forecast products to support 10 to 14 day advance notification.
    - The SDR agencies that participated in this progress assessment did not list any specific activities under this Grand Challenge strategic action.

Appendix: NOAA and CDC Partnership: National Integrated Heat Health Information System

A National Integrated Heat Health Information System

Extreme weather or climate events such as heat waves, drought, or derechos can profoundly affect society and the environment, resulting in loss of life, productivity, property, and natural habitat.

From 1979-2003, **excessive heat exposure caused 8,015 deaths** in the U.S. During that period, more people died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

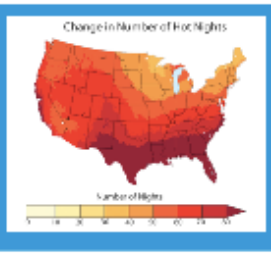


The base map shows projected average maximum temperatures for July 2030 in degrees Fahrenheit under a low emissions scenario (best case scenario). Call out boxes detail devastating effects of past heat waves across the country.

Integrated heat information systems can be **effective tools for reducing illness, death, and loss of productivity** associated with heat waves.

Heat affects urban and rural populations, outdoor workers, pets, the elderly, and events and activities that take place outside.

The latest National Climate Assessment (NCA) found that **extreme heat events will be more frequent, more intense, and longer in duration in the future.** "What now seems like an extremely hot day will become commonplace."



Projected increase in the number of hot nights - when body temperatures would otherwise recover from hot days - for the end of the century (2070-2099) compared to 1971-2000.

Source: CICS-NC RISA, prepared for NCA3

cpo.noaa.gov/NIHHIS

NIHHIS

NATIONAL INTEGRATED HEAT HEALTH INFORMATION SYSTEM

A YEAR OF PROGRESS

Launched by **NOAA** and the **CDC** in the summer of 2015, NIHHIS facilitates an **integrated approach to providing a suite of decision support services that** reduce heat-related illness and mitigate other effects of extreme heat.

In July 2015 a kick-off workshop in Chicago strengthened collaboration between domestic and international partners – to understand the **future risk** of extreme heat, **current capabilities** for addressing this risk, and **opportunities to improve preparedness.**

Additional activities spurred learning networks and partnerships with countries such as **India** and **Germany**, NGOs such as the **National Healthcare Coalition** and the **Natural Resources Defense Council**, and interagency partners such as **OSHA** and the **State Department.**

A National Integrated Heat Health Information System

CDC researchers are conducting a comprehensive national assessment of health risks associated with extreme heat. This research will identify the range of high temperatures at which excess deaths and illness are observed for different locations in the U.S. NOAA is improving observations, understanding, and predictions of extreme heat and its consequences at all time scales--from early warning to climate resilience. **NIHHIS will deliver information to help the nation understand, anticipate and respond to extreme heat.**

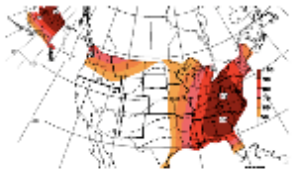
Define Demand

NOAA and the CDC sustain continuous engagement between climate and health communities to **identify needs, develop and evaluate solutions, and inform decisions**.

LINKS AND RESOURCES

- **RISA and Heat Health**
  - **In New York City:** www.CCRUN.org
  - **In the Great Lakes:** www.GLISA.umich.edu
  - **In Arizona:** www.CLIMAS.arizona.edu
- **CDC Climate and Health Program:** www.CDC.gov/climateandhealth
- **NWS Early Warning Coordination Meteorologists:** www.stormready.noaa.gov/contact.htm

Enhance Forecasts



6-10 day forecast from NCEP

NOAA works to **enhance current heat forecasts** based on user need and epidemiological requirements to extend heat projections from weeks to months and beyond.

LINKS AND RESOURCES

- **Local Temperature Forecasts:** www.weather.gov
- **Modeling, Analysis, Predictions, & Projections Program (MAPP):** bit.ly/MAPPprojects
- **Madden-Julian Oscillation:** bit.ly/MJOandTemp
- **Climate Prediction Center Temperature Outlooks:** www.CPC.NCEP.NOAA.gov

Observe & Monitor

NOAA and the CDC work to sustain Earth observations and biosurveillance that support **improved understanding of the role of climate on extreme heat** and enhance operational efforts.

LINKS AND RESOURCES

- **Climate Observations and Monitoring (COM):** bit.ly/ClimateObs
- **Climate Variability & Predictability Program (CVP):** bit.ly/AboutCVP
- **CDC National Environmental Public Health Tracking Program:** bit.ly/CDC-NEHTP

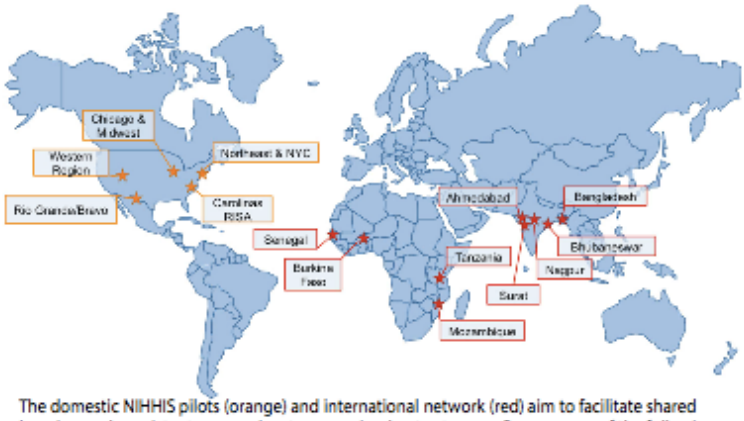
Understand & Communicate

NOAA and the CDC **enhance understanding** and impact of extreme heat events across time scales, **builds capacity** across climate and public health communities, and develops timely and accessible communication tools **to inform preparedness and adaptation**.

LINKS AND RESOURCES

- **U.S. Climate Resilience Toolkit - Human Health:** toolkit.climate.gov/topics/human-health
- **Regional Integrated Sciences and Assessment (RISA):** bit.ly/CPORISA
- **Coastal and Ocean Climate Applications Program (COCA):** bit.ly/CPO-COCA
- **Summer Weather Safety Campaigns:** www.weather.gov/heat
- **Global Framework for Climate Services:** gfcs.wmo.int/health

NIHHIS Pilots and Network



The domestic NIHHIS pilots (orange) and international network (red) aim to facilitate shared learning and consistent approaches to managing heat extremes. One or more of the following outcomes are anticipated from each pilot system:

Heat Action Plans detailing responsibilities and processes	Improved early warning & surveillance products customized for regional risks
Sectoral decision-making calendars and improved long-term heat outlooks	Communications strategies for and analysis of all vulnerable populations

National Oceanic and Atmospheric Administration — cpo.noaa.gov/nihhis