

**Climate and Severe Weather Workshop
March 11-12, 2015**

**NOAA Center for Weather and Climate Prediction
College Park, MD**

Summary Report

1. Executive Summary

The Climate and Severe Weather Workshop (CSWW) was held at the NOAA Center for Weather and Climate Prediction (NCWCP) in College Park, MD on March 11-12, 2015. The workshop was designed to advance the goal of establishing long-range (i.e., > 1 week) operational severe weather outlooks by enhancing research and development activities, and strengthening partnerships for transitioning research to operations through a multi-institutional collaborative outlook process. The CSWW is the third in a series of workshops on long-range severe weather outlooks. It is the first to include specific discussion and recommendations of how scientific advances in climate and severe weather research may be brought to bear on long-range NOAA operations and applications.

Participants included those from various NOAA/NCEP and NOAA/OAR centers (SPC, CPC, and AOML), NOAA's Climate Program Office, and the academic research community. A key outcome is the recommendation that three severe weather outlooks be developed as a function of varying lead-times. These include separate outlooks for the seasonal, monthly, and weeks 1-4 time horizon. While the continued development of these outlooks will require additional resource commitments from NOAA and other funding agencies, it was widely agreed that experimental implementation could begin in FY 2016.

The first NOAA workshop on this topic was held in May 2012 in response to the record setting tornado activity of 2011. A central question at the 2012 workshop was whether there was a scientific basis for prediction of U.S. severe weather activity more than one week in advance. The 2015 CSWW made clear that there have been remarkable advances in the science since then. For example, two statistical methods for seasonal prediction of U.S. severe weather activity have been published in the peer-reviewed literature. On shorter time scales, numerical model guidance has been shown to have utility in anticipating severe weather activity for weeks 1 and 2. At the heart of this progress are recent improvements in the understanding of how severe weather activity is modulated by predictable climate signals such as ENSO and the MJO. To date, these scientific advances have yet to expand the suite of operational severe weather prediction products. The effort required for such an expansion is substantial, however many aspects are common to the overall weather/climate prediction endeavor. This workshop made clear that

existing NOAA products, activities, and successes, including the U.S. Hazards, Atlantic Hurricane, and Seasonal Climate Outlooks, provide valuable lessons for how scientific progress translates directly to operational capabilities, as well as practical strategies for format, timing, and institutional cooperation. For instance, with suitable resources and cross-NOAA input, week 2 of the U.S. Hazards could be expanded to include severe weather activity with tools similar to those currently used. A U.S. Spring Severe Weather Outlook could be patterned after the Atlantic Hurricane and Seasonal Climate Outlooks and employ the consensus methods developed at regional climate outlook forums. Nevertheless, outstanding challenges remain, many of which are not limited to severe weather, e.g., communication of uncertainty information, improving dynamical understanding, expansion into weeks 3 and 4, and relatively low seasonal predication skill. However, with the full range of capabilities within NOAA and beyond (and funding from the H.R. 1561 Weather Research and Forecasting Innovation Act of 2015), now is a moment of tremendous opportunity.

2. Workshop Goals

The CSWW organizing committee proposed 4 goals for consideration at the workshop. Research on the climate and severe weather connection has been rapidly advancing over the last few years. As such, these goals reflect the desire to assess the latest state-of-the-art science and develop a strategy for initiating and strengthening the R2O and O2R paradigms in the long-range severe weather context.

A. Goal 1: Science Updates

- Latest research on severe weather climatology from reanalysis and observational records.
- Updates on medium-range to seasonal severe weather prediction methods.

B. Goal 2: Toward developing long-range prediction products.

- Research Targets.
- Forecast Targets.
- Forecast Verification.

C. Goal 3: Discussion regarding the potential role of NCEP centers and partners with respect to future severe weather prediction products.

- This requires further action by NCEP management, particularly the leadership of CPC and SPC.

D. Goal 4: Developing a strategy to inform NOAA climate and weather interests and the greater community of our efforts.

3. Scientific Summary

The workshop featured four sessions, which included scientific presentations spanning numerous topics and timescales. Session 1 provided an overview of NOAA climate programs and examples of current operational climate outlook frameworks. Sessions 2 and 3 were oriented toward current understanding of sub-seasonal and seasonal variability of severe weather, respectively, including linkages to climate variability modes (i.e., MJO, GWO, ENSO) and modeling tools for their prediction. Session 4 targeted regional variability and high resolution modeling approaches. The CSWW agenda, list of attendees, and scientific presentations may be found here:

<http://www.spc.noaa.gov/misc/CSWW-2015/>

4. Outcomes and Recommendations

The participants discussed implementation planning for operational severe weather outlooks beyond week-1. In particular it is recommended that three severe weather outlooks be developed as a function of lead-time. These include separate outlooks for the seasonal, monthly, and weeks 1-4 time horizons. While some overlap in severe weather definitions and presentation format may occur, it was decided that some aspects will be unique to the particular lead time of the outlook, as summarized below.

A. Seasonal Severe Weather Outlook

- Severe weather refers only to large hail and tornadoes.
- Objective definition of severe weather season.
 - March, April, May, and June (MAMJ).
- We are forecasting activity.
 - Climatology is the long-term seasonal average of severe weather activity in a defined region.
- Forecast example: “This season is forecast to be in the upper/lower quartile of activity” as defined by event days, counts, and outbreaks. The outlook process will be patterned after the CPC seasonal climate forecast.
 - Commitment to hold a telecon in early 2016 to discuss tools.
 - Issue general severe weather activity outlook via spatial map.
- Experimental outlook will be issued annually on the Friday prior to March 1.
- Predictive tool development.
 - Continue to analyze and develop seasonal tools (e.g., ENSO, TNI, antecedent soil moisture, and other leading atmospheric modes on seasonal time scales).
 - Conduct teleconferences as needed to provide updates on new scientific advances (i.e., R2O).
- Resources required for continued development and integration of research tools into operations.
- CPC to host web tools for seasonal prediction.

B. Monthly Severe Weather Outlook

- Severe weather refers only to large hail and tornadoes.
- We are forecasting activity.
 - Climatology is the long-term monthly average of severe weather activity in a defined region.
 - Example: “The upcoming month is forecast to be in the upper/lower quartile of activity” as defined by event days, counts, and outbreaks.
- Forecast to be issued on the Friday before the 1st of the month.
- CPC to host web tools for sub-seasonal prediction.
- No distinct tools currently exist for this timescale.
 - Develop statistical model for monthly activity.
 - Dynamical guidance gaps are currently prohibiting development
 - Assessment
 - Parameters
 - Comprehensive reforecasts and case studies.
- Resources are required to develop tools and integrate into operations.

C. Weeks 1-4 Severe Weather Outlook

- Hazard Format based on total activity (i.e., not an anomaly forecast of above or below average activity).
- Some tools currently exist, including both dynamical and statistical-dynamical prediction models based on global high-resolution and/or nested regional downscaling approaches. CPC Operational Prediction Branch personnel are needed to integrate severe weather parameters into extended range hazards outlook.
- Necessary resources for scientific advances and to integrate research tools into operations.
 - Requires models with reforecasts.
 - Bias correction
 - Skill masks
 - More research needed to determine best prediction models (statistical-dynamical hybrid and dynamical-only) and methods to best use them on intraseasonal time scales.
 - Consolidate tools into a single website.
 - Tailor products to the target forecast parameters and relevant timescales.
- Access to NMME data.
 - Real time access to 3d sub-daily NMME data on a rotating archive. Even if only a once per month initialization.
 - NMME variables needed include: p, t, q, u, v, z, u10m, v10m, q2, t2, psl.

D. Partnerships for Scientific Research and Product Dissemination

A critical aspect to the success of this endeavor is to nurture shared activities among the NOAA/NCEP centers (i.e., CPC and SPC), NOAA/OAR labs (i.e., NSSL and AOML) and the academic research community. Despite the optimistic appraisal among the CSWW participants regarding the potential for skillful long-lead severe weather outlooks, it is paramount to understand that forecast improvements and related scientific advances ultimately depend on increased resource support from climate programs engaged in advancing scientific research and development activities. Given that gaps remain in understanding the climate and severe weather linkage and developing applied forecasting techniques, it is necessary that both basic and applied research continues in earnest, focusing on statistical and dynamical modeling, improved diagnostic understanding, and applied research on methods to blend models into useful guidance products.

5. Additional Information

CSWW Agenda and Presentations

<http://www.spc.noaa.gov/misc/CSWW-2015/>

2013 White Paper

http://www.cpc.ncep.noaa.gov/products/severe_weather/Climate.Severe.Weather.White.Paper.Apr2013.pdf

6. Definition of Terms

AOML	Atlantic Oceanographic and Meteorological Laboratory
CPC	Climate Prediction Center
CSWW	Climate and Severe Weather Workshop
ENSO	El Nino Southern Oscillation
GWO	Global Wind Oscillation
NCEP	National Centers for Environmental Prediction
NCWCP	NOAA Center for Weather and Climate Prediction
NMME	National Multi-Model Ensemble
NOAA	National Oceanic and Atmospheric Administration
NSSL	National Severe Storms Laboratory
OAR	Office of Oceanic and Atmospheric Research
O2R	Operations-to-Research
R2O	Research-to-Operations
SPC	Storm Prediction Center
TNI	Trans Nino