

# **Diagnostics, Trends and Climate Model Projections of U.S. Summer Heat Waves**

**Anthony G. Barnston<sup>1</sup> Bradfield Lyon<sup>1</sup>** (Co-PI)

<sup>1</sup>International Research Institute for Climate and Society (IRI), Palisades, NY

## **ABSTRACT**

Consecutive days with extreme summer temperatures – heat waves – can cause myriad impacts ranging from adverse effects on human health, to a marked increase in energy and water demand, to deleterious consequences for agriculture. While several investigators have studied various aspects of heat waves in the United States (US), the approach has typically been to focus either on a particular extreme event (e.g., the 2011 Texas heat wave) or on a temperature-only based definition or definitions that include humidity. While progress has been made on connecting US heat waves to anomalous regional and large-scale atmospheric circulation features, our current understanding of the linkages between regional climate extremes and large-scale climate variations is far from complete. For example, the relationship between extreme summer temperatures and concurrent high humidity (an important consideration for impacts on human health) has not been thoroughly examined in observations or climate model projections.

Here we propose to undertake a comprehensive study of US summer heat waves and develop related products for display via a Web-based interactive analysis and display tool. We will consider multiple heat wave definitions by varying the intensity and duration thresholds required for identifying an event and will also consider heat wave definitions that include atmospheric moisture. Using quality controlled daily station data covering roughly the last eight decades, we will first evaluate the geographical occurrence and persistence characteristics of heat waves as a function of their definition. We will compare these results with model simulations of the recent observed climate from the Climate Model Intercomparison Project phase 5 (CMIP5), and for a shorter period, in the North American Regional Reanalysis (NARR). Recurrent and anomalous atmospheric circulation features will be examined on a regional basis, investigating whether they are in turn associated with large-scale circulation patterns possibly forced by anomalous sea surface temperatures (SSTs) offering some potential predictability. Conditional probabilities of heat waves given pre-existing land surface condition (e.g., drought) will be evaluated as a function of location and heat wave definition and an associated “joint extreme index” will be developed. Finally, secular trends in heat wave characteristics in observations and CMIP5 climate projections will be analyzed. The Web-based tool to be developed will allow users to select a region and period of interest, heat wave definition and desired heat wave characteristics in order to display associated time series and other statistics.

The proposed work directly addresses the COM FY14 focus on data sets for weather/climate extremes. Our analyses map onto program element 1, “Data sets and indicators”, sub-element (a). In addition, our diagnostic analysis will address the program’s objective of discerning “...new insights of underlying processes of weather/climate extremes” while our Web-based analysis and display tool will meet the desired goal of transforming climate-related observations into informative products that will be made publically available. Via the IRI’s Data Library all data sets and derived products from this work will also be downloadable in multiple formats suitable for use in other display platforms.