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‘Aha Huliko’a Workshop Series

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LONG-TERM GOAL

The goal of the workshop series is to review the state-of-the-art, to identify areas of ignorance, and to make recommendations for future research on a topic or topics relevant to the Office of Naval Research.

OBJECTIVES

The subject of the 2007 workshop was “*Extreme Events*.” The participants were tasked to review observations of extreme events, identify the physical processes that lead to them, and assess their probability and predictability.

APPROACH

Conduction of workshop and publication of workshop proceedings and a meeting report in a professional journal.

WORK COMPLETED

A four-day workshop on “*Extreme Events”* was held from January 23th through 26th, 2007, in Honolulu, Hawaii. The workshop brought together about twenty five researchers from the fields of oceanography, meteorology and statistics. It was convened by the PI and Chris Garrett.

RESULTS

Extreme events are characterized by adjectives such as rare, exceptional, surprising, unexpected and catastrophic, and are often defined as “rare but influential” or “events on the tail of a probability distribution”. Extreme events occur in natural, technical and societal environments, and their description, understanding and prediction are of great importance. Extreme events may be studied as a statistical problem (with emphasis on their frequency of occurrence as a function of magnitude) or as a dynamical problem (with emphasis on the underlying mechanisms). The workshop brought together researchers from the fields of oceanography, meteorology and statistics to assess whether benefit can be obtained from combining the statistical and dynamical approaches in order to answer important questions such as:

- Do extreme events have special physics that occurs rarely in space and time?

- Are there "dynamical ceilings" that limit the magnitude of extreme events and prevent the reliable extrapolation of statistical results?

- To what extent and how far in advance can extreme events be predicted, either deterministically or statistically?

- When can we say with confidence that an increase in the occurrence or magnitude of extreme events is due to a shift in the underlying system rather than a statistical fluctuation?

The workshop addressed these and other questions, using examples from oceanographic and meteorological phenomena (such as hurricanes, waves, turbulence, rain fall, sea level, and storms). Some main results are:

- Extreme events can have different physics from normal events, though definitive examples of this, such as hurricanes, are rare.

- Dynamical ceilings that would invalidate simple extrapolation of statistical distributions can occur, but the ceilings are often too high to be particularly useful.

- The deterministic prediction of extreme events with a useful lead time is very dependent on the process. Statistical prediction, in the sense of a knowledge of the likely return period of a particular event, can be enhanced by recognition that events can arrive in clusters if there is a connection, either multiplicative or simply additive, between low and high frequency parts of the signal.

- Statements about the increased incidence of extreme events due to a shift in the underlying regime can only be probabilistic and are best treated within the framework of Bayesian statistics, which allows in a well-defined way for differing prior expectations.

IMPACT/APPLICATIONS

Review of the state-of-the-art of extreme event research, identification of major open problems and recommendations for future research.

RELATED PROJECTS

None