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Understanding Severe Hurricanes

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Hurricanes are complex phenomena, whose understanding involves many facets, of which my presentation will provide an overall flavor and review. Understanding the physical hurricane involves a complex amalgam of fluid dynamics, thermodynamics and scale interactions. The basic structure is one of a fluid vortex, which dictates everything from the characteristic spiral shape to the clear eye region. Energetically, once formed a hurricane is a self sustaining heat engine, one that extracts energy from the enthalpy difference between the warm ocean surface and the cold upper atmosphere, and one that will continue its merry way until it is destroyed by some external influence (such as landfall). Hurricanes also are a response to the global climate in which they develop and can feed back to influence and perhaps even change that climate. For example a series of hurricanes moving into the higher latitudes in the Pacific can set off a train of events that are still affecting European weather a year later. From a societal perspective they are the most dangerous and deadly of all natural atmospheric systems, capable of causing widespread destruction and long-term disruptions to entire societies. The damage wreaked by Katrina in New Orleans provides a canonical example, but this was by no means the worse cyclone in history. Even lesser damage on a small island nation can be much more catastrophic and exceed their entire gross domestic product. This capacity for disruption arises from three main mechanisms: the high surface winds, the response of the ocean to these winds, and the intense rainfall. These have widely different contributions in different storms: the extended region of high winds and particularly the storm-surge response were dominant factors in Katrina; whereas the >10,000 deaths by Hurricane Mitch arose entirely from rainfall and the associated flooding and landslides. Societal response to this danger involves complex interplays of warning, communication culture, previous experiences and perceptions, interplays that are neither well understood nor adequately predictable.