

Modelling the Potential for Correlations between Atlantic Hurricanes

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Project Outline and Objectives

The 2005 Atlantic hurricane season is famous as the most active and expensive Atlantic hurricane season since records began. In addition to thousands of deaths, damage to property and infrastructure was estimated at about of about 130 billion (2005 USD). The Mexican states of Quintana Roo and Yucatán and the U.S. states of Florida and Louisiana were each struck twice by major hurricanes including Katrina, the most expensive natural disaster in the history of the United States. The insurance industry is naturally interested in the question of whether this is mere coincidence or whether there are correlations between the tracks of intense hurricanes. Risk estimation models used in the industry apparently treat the probability of a hurricane making landfall in a particular area as independent Poisson processes characterised by their historical mean. The possibility of even weak correlations, particularly between large storms, may be an important source of systematic error in these models.

This question was posed by Lloyds and explored during the 73rd European Study Group with Industry which took place at Warwick in April 2010. Statistical analysis of the historical data was done which did not prove conclusive. In tandem with this statistical analysis a more foundational question was studied: how do the pairs of vortices embedded in a larger scale “steering flow” influence each other when their separations are large? The preliminary work done during the study group on the interactions between point vortices in two-dimensional flows has since has been extended by Connaughton and Ockendon to take into account the important role played by the Earths rotation in the motion of large atmo-

spheric vortices. Preliminary numerical investigations of this model suggest the interactions between vortices in the presence of rotation decay exponentially with separation (in contrast to the non-rotating case where this interaction decays inversely proportional to the separation).

Required Background and Methodology

This project requires an interest in geophysical fluids dynamics. The reduced model mentioned above is a set of nonlinear ordinary differential equations which, for the most part require numerical treatment. One possible avenue of research is to compare the results of the model to the barotropic potential vorticity equation, the simplest partial differential equation model of atmospheric dynamics. A code already exists to facilitate this. A second avenue of research would be to attempt to correlate the model with historical observations.

Research Outcomes

We aim to quantify definitively (within the context of deterministic models) the extent to which atmospheric vortices correlate. A more ambitious outcome would be to understand how these models are relevant to the original real world problem as posed by Lloyds. Connaughton and Ockendon have already committed to contributing a publication on this topic to the journal *Discrete and Continuous Dynamical Systems* by the summer. A successful student could contribute to this article.

PhD prospects

If this MSc project gives valuable new insights, there is the possibility of a more extensive follow-up PhD project in conjunction with Lloyds and possibly Prof. L. Smith (LSE).