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HURRICANE RISK IN HAWAII
PART I: STEERING FLOW ANALYSIS IN THE CENTRAL NORTH PACIFIC

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1. INTRODUCTION

In the first part of this work, Central Pacific tropical cyclone tracks are investigated with an emphasis on the satellite era. Our purpose is to better understand the environmental influences and climatology of hurricane risk over the Hawaiian region and to apply this knowledge in seasonal and short-term outlooks if possible. The relative paucity of events increases the challenge, making inferences from observational studies difficult (e.g., Chu and Clark 1999).

2. METHODOLOGY

We divide this project in two stages. In Part I, we investigate the behavior of tropical cyclones and the relation of their tracks to the environmental steering flow . Using NWS best track data and NCEP/NCAR reanalysis fields, we seek to determine an optimal layer mean environmental steering flow for the Central North Pacific (e.g., Chan 1985). In Part II, we will apply our empirical layer mean concept to a set of virtual storms in the Central North Pacific using backward trajectories to develop risk dependencies for the residents of Hawaii. We consider sensitivity to initial position, track bifurcations, and possibly in the near future the beta gyre effect. Dependence of intensity on sea surface temperature and vertical shear are also investigated. The preliminary results reported here are from Part I only.

3. DATASET

Wind data were obtained from the NCEP/NCAR reanalysis project. Daily averages of westerly (u) and southerly (v) wind components at 8 pressure levels (850, 700, 600, 500, 400, 300, 250, and 200 mb) are vertically averaged (mass-weighted) to 36 candidate Environmental Steering layers (ESL) among them (e.g., Carr and Elsberry 1990). Levels below 850 mb and above 200 mb are not considered. Best track data from the NWS provide 6 hourly data of storm position and intensity. A daily average value for storm speed and direction is calculated.

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4. ANALYSIS PROCEDURES

Fifty storm cases were selected for this initial analysis, with emphasis on the satellite era (1980 and later). A storm displacement vector was produced from the observed storm motion in a 24 hour period. For each ESL, a parcel displacement vector for the same time period was also produced. Interpolation of the environmental wind on an 8 point window surrounding the 1200 Z storm position provided the environmental wind vector which was compared to the storm vector in order to determine angle and speed errors among them. At this stage, we composite the results of daily absolute average angle and speed errors for all the storms rather than analyzing each case separately. It is our intention to stratify the data by direction, intensity and recurvature occurrences. A total of 225 storm days were analyzed.

5. RESULTS

After calculating the speed and angle error between the storm vector and each ESL vector, we found that in general the deepest layers (450-500 mb deep) showed the smallest errors in both direction and speed (see fig.1). Layers 1, 2, 3, and 4 correspond to the deep-layer ESLs 850-200 mb, 700-200 mb, 600-200 mb, and 850-300 mb respectively.

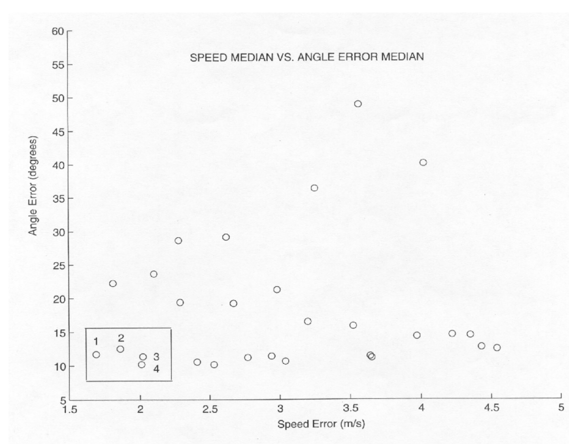

Figure1. Speed vs. Angle absolute errors for all 36 ESL. The rectangular area indicates the ESL with lower absolute error in both angle and speed.

The ESLs with bases at middle to upper levels (500 mb and higher) show the worst errors between both parameters.

By plotting each storm day on a geographical chart for the Central North Pacific centered at the Big Island of Hawaii (see fig 2) we can also see that most storm days occurred on the south east quadrant, followed by the south west quadrant. We are currently analyzing the ESL concept on each quadrant separately to investigate if its approximation is better on a specific quadrant(s). It is clear that tropical cyclones are more frequent in the southeastern portion of the Central North Pacific and south of Hawaii.

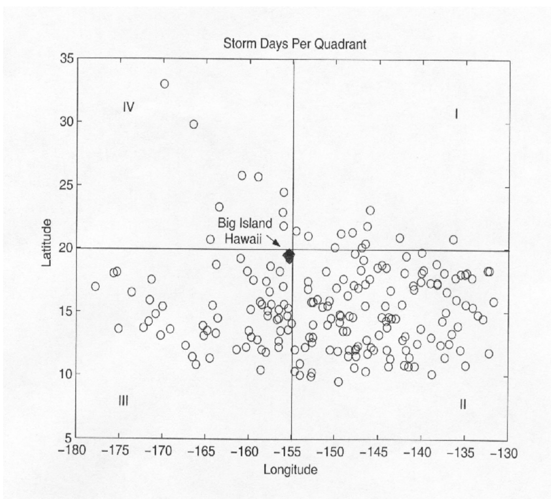

Figure 2. Storm days per quadrant of the Central North Pacific surrounding Hawaii.

6. SUMMARY

Thirty six alternative steering layers for a data set of storms have been analyzed. The deepest layers are observed to have smallest absolute error values for both angle and speed. The middle-higher ESLs do not perform well for the general case study. They show the highest absolute errors.

Also, the risk for tropical cyclones to be steered towards the Hawaiian Islands according to the ESL concept might be greater if the storms form or move into the south eastern quadrant relative to the island of Hawaii in the Central North Pacific. Hurricane Iniki, which made landfall on the island of Kauai in 1992, is a good example of such a scenario. Part II of this project is now being developed.

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