EARLY DETECTION OF HURRICANES ORIGIN IN OCEANS WITH REMOTE SENSING METHODS AND INFORMATION MODELING TECHNLOGIES

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1. INTRODUCTION

The satellite microwave (MCW) radiometric methods serve as the important tool of analysis of the affecting on energetic processes in ocean-atmosphere system such its oceanographic and meteorological parameters as the water surface temperature, wind speed, total water vapor content of the atmosphere, integral content of liquid water in clouds, intensity of precipitations as well as the vertical turbulent fluxes of heat, water and impulse which are important in studies of cyclonic areas of the ocean. A knowledge of these parameters lets us to solve the tasks related to premises of the tropical hurricane appearance and their beginning as well as the mid latitude cyclones dynamics.

2. GENERAL APPROACH

Analysis of hurricanes and search of methods for their earlier detection require novel approaches based at the taking into consideration all diversity of correlation dependencies between natural processes involved. One of such approaches is currently developed in the Institute of Radioengineering and Electronics of Russian Academy of Science (IRE RAS) [1,2]. It can be generally outlines as follows:

1. At spacious territories of Far East, Pacific, many countries the Pacific region and North America tropical hurricanes cause severe economic losses and result in human sacrifices. Development of satellite and other methods of regular analysis of the factors promoting the tropical hurricane beginning and their development in the early stages will let us, in perspective, to reduce risks of this dangerous natural phenomenon.
2. The satellite radiophysical methods serve as the important tool for definition of oceanographic and meteorological parameters, influencing at the interaction energy of ocean-atmosphere system such as the water surface temperature, wind speed, total water vapor content of the atmosphere, integral content of liquid water in clouds, intensity of precipitations as well as the vertical turbulent fluxes of heat, water and impulse which are especially important in studies of cyclonic areas of the ocean. [3,4] The data of satellite measurements can also give indirect information on important from the point of view of the tropical hurricane forming geochemical and biophysical processes in the ocean and its floor. Also data from vessel and buoy measurements, in common with the means of mathematical modeling are analyzed.
3. Knowledge of the parameters listed lets us to study the conditions of the tropical hurricane origin and their development at the early stages.

The basic concept of work consists in: a) search of primary sources exciting activity of geochemical, biophysical factors in ocean column and its bottom inaccessible for direct vision by means of radiophysical remote sensing, b) analysis of intermediate relations of these factors with oceanographic parameters of ocean surface (primary, with its temperature) and meteorological parameters of atmosphere; c) analysis of processes at the interface of ocean and atmosphere, which are concerned with its thermal and dynamic interaction characterizing by the vertical turbulent fluxes of sensible, concealed (latent) heat and impulse (momentum) as well as to horizontal (circulation) movements in the atmosphere; d) an analysis of *direct* and *indirect* bonds these geophysical characteristics with an intensity of natural microwave radiation of the ocean-atmosphere system (the brightness temperature) in the range of millimeter and centimeter wavelengths traditionally used in modern meteorological and oceanological satellites. In this way we suppose to study the bound between links of the chain: “original (initial) events in the system ocean-boundary layer of the ocean and atmosphere - atmosphere-brightness temperature measured from satellites” in areas of the *tropical* hurricane origin taking into account an experience of such studies in zones of performance of midlatitude cyclones in the North Atlantic.

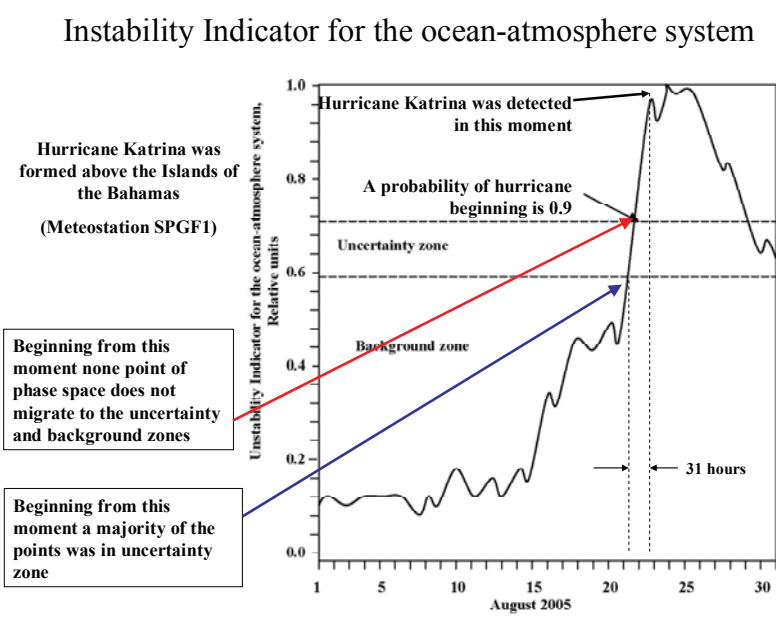

Fig. 1 Dynamics of non-dimensional parameter *p*, calculated from the near- surface atmosphere characteristics (temperature, humidity and pressure of the air) and wind speed (NOAA TAO/TRITON Array) and EOS Aqua data, for the hurricane Katrina case (in the August 2005)

3. EXAMPLES

The Ocean-Atmosphere System instability model was developed for early detection of hurricanes. This model gives a possibility to detect a moment of transition of the ocean-atmosphere system from the background (quasistationary) state to the hurricane beginning state. Model will be described in the presentation.
Proposed instability indicator allowed making more precise the time of the hurricane beginning. So, for example, delay time equals 31 hours in the case of hurricane Katrina. (Look at the Figure 1). Another indicators were analyzed [2].

4. APPLICATION

Results of this study are important for:
- model development of "ocean-atmosphere" system behavior at the different stages of the tropical hurricanes forming, specifically for development of operative version of model WRF (Weather Research and Forecasting) with the purpose of numerical experiments conducting on reproduction life cycle of tropical hurricanes, comparison of modeling results basing on model WRF with other numerical experiments;
- understanding processes taking place in the zones of tropical hurricanes birth at the different stages of its genesis;
- development of methods for statistical assessment of correlations between parameters that are determined on a basis of satellite microwave data in the zones where tropical hurricanes are formed;
- search for the most reliable indicators - precursors that give most high probability of hurricane detection at the early stages;
- development of methods for satellite microwave monitoring of the World Ocean water areas in the zones of the most probable hurricane beginning.

5. REFERENCES

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