ANALYSIS OF THE OCEAN` AND ATMOSPHERE ROLES IN THEIR HEAT INTERACTION WITH USE OF SATELLITE AND VESSEL

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ABSTRACT. Special problem emphasized by specialists in the field of analyzing the heat interchanges in the system ocean-atmosphere (SOA) is a necessity of determination of the *near-surface* atmospheric temperature, which can be only *indirectly* connected with characteristics of the SOA natural microwave radiation measured from satellites. That is why, the following dilemma is not obvious, but interesting and promised: what is better - to use the satellite methods for retrieving the *partial* parameters of the SOA or for analysis its state as *a whole*. To our opinion, this task is similar to the idea recognized by specialists engaged in the *heat* infrared region (8-12 *mcm*) of electromagnetic spectrum and its applications, where an intensity of natural infrared radiation (effective radiation) is used as the inherent property (the *attribute*) of the SOA heat balance.

Here we studied important aspects of this problem: a) what medium *initiates* a heat transfer in the SOA and disturbs its heat balance - the *ocean* or the *atmosphere*; b) what SOA parameters *directly* influence on its natural microwave radiation intensity (brightness temperature) measured from satellites? We relate these processes mainly to the *synoptic* range of time scales enriched by various events in the SOA interface such as the *mid-latitude* and *tropical cyclones*.

KEY WORDS: Ocean and Atmosphere, Heat Interaction, Microwaves, Earth Satellites

INTRODUCTION. The problem of using the satellite passive microwave radiometric methods for the analysis of the roles of the ocean and atmosphere (in respect of their priority) in heat interaction over various space and time scales is considered. This problem is long attracts the specialists engaged in the oceanology, meteorology, atmospheric sciences, etc. Some data of measurements from the METEOR-3M MTVZA device (Module of Temperature and Vlazhnost (humidity) Zonding of the Atmosphere), data of the DMSP (SSM/I) and EOS-Aqua (AMSR-E) radiometers can be used for solving this problem. We do not know results of any similar researches of this profile, at least, in Russia.

We analyzed those processes in the system ocean-atmosphere (SOA), which can be serve as *initial sources* of it heat balance and, at the same time, of influence on the SOA brightness temperature measured from satellites. We will consider the *time advancing* of any given parameter of the SOA in comparison with other parameters as the quantitative criterion of their priority as a *first step* in this study. That is, the advance parameter is seen as the *source* of disturbances in the SOA, and a behavior of other parameters is rated as the *response*. This indicator is more reliable in comparison with the estimates based on the measurements of an *intensity* of microwave radiation, which are sensible to the errors of their calibration.

This approach is used in a *narrow sense* when an influence of the sources of heat perturbations in the SOA are considered as some factors acting in some *local* areas of the ocean. More complex task is an investigation of generalized (global) relations between the SOA brightness temperature and its geophysical parameters, whereas the vast data of satellite and other information have to be used.

The results given are concerning the study of some events related to the ocean-atmosphere interaction in zones of an activity of the mid-latitude cyclones in the North Atlantic (1988, 1990) and partially in the area of an activity of the typhoon Katrina (2004).

We will differentiate these effects over different time scales such as the *mesoscale*, *synoptic*, and *climatic* ones.

Mesoscales. The theoretical method of artificial excitation of the fluxes of sensible (latent) heat in the SOA is used: correlation between near-surface atmosphere temperature and humidity and natural microwave (MCW) radiation of the SOA is analyzed during their relaxation; the relationships between spectral characteristics of MCW radiation and heat fluxes in the range of synoptic time scales are in the focus [1-3]. The excitation-induced evolution of the SOA is accompanied by significant changes in the water surface temperature, as well as in temperature and humidity of atmospheric layer, i.e., parameters that make a critical contribution to the formation and transfer of vertical electromagnetic and thermal fluxes - this circumstance is a prerequisite for its joint analysis.

The important result of this study observed first is the fact of the time delay (~12 hours) between the SOA brightness temperature and the heat fluxes observed during the experiment ATLANTEX-90 of the SOA

natural MCW radiation measured from the satellite F-08 (DMSP).

Synoptic scales. We analyzed the phenomena of a time delay of the SOA brightness temperature response in the resonant spectral domains 0.59 cm and 1.35 cm on the variations of surface heat fluxes resting upon the results adjusted above. The Duamel's integral equation let us to calculate the function $r(t)$ of the brightness temperature T^b response (sensitivity) to the total heat fluxes q_{he} variation were examined. Some example of this analysis is presented in the Fig.1. Let's estimate the time shift between the SOA brightness temperatures the wavelengths at the wavelengths 5.9 mm and 1.35 cm calculated from the oceanographic, meteorological, and aerological data, observed in the experiment and their connections with the heat fluxes in the experiment with ATLANTEX-90 synchronized with use of the DMSP F-08 heat fluxes data q_{he} obtained from the vessel *Victor Bugaev* during the cyclone of 9-13 April 1990) Theoretically, this dependence is described with the Duamel's integral (Fig. 1).

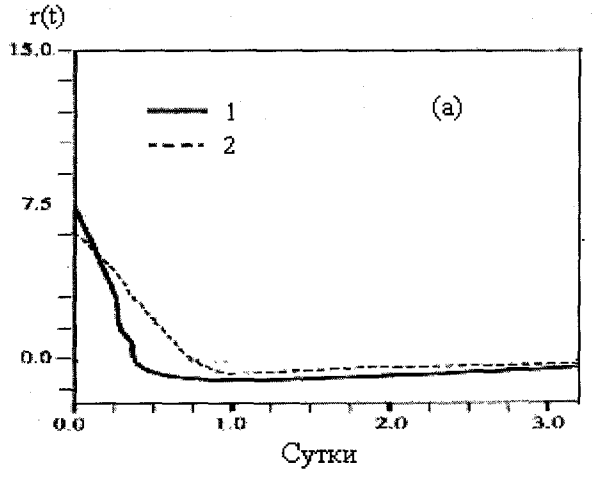

Fig.1. Response of the SOA brightness temperature $r(t)$ at the wavelengths 1.35cm (1) and 0.59 cm (2) to the total heat fluxes q_{he}, estimated from the vessel *V. Bugaev* in K Wt m^{-2} per 24 hours.

Climatic scales. We have revealed that the SSM/I-derived brightness temperatures of the SOA are responsive to intra- and interannual variations of sensible, latent and total heat fluxes in the points D, H of the North Atlantic (rather, in areas 0.5 by 0.5^0 covering these points and being in line with the SSM/I spatial resolution). For example, Fig. 2 demonstrates a noticeable relation between long-term variability of monthly mean total heat flux and SSM/I brightness temperature at the wavelength 1.35 cm measured in the channel 22V of the radiometer (available gaps in the brightness temperature data are caused by troubles in processing of initial SSM/I data). This Figure shows some results of comparison between the total heat fluxes and their estimates represented as a linear combination of brightness temperatures T^b_22V, T^b_1.55V and T^b_1.55H.

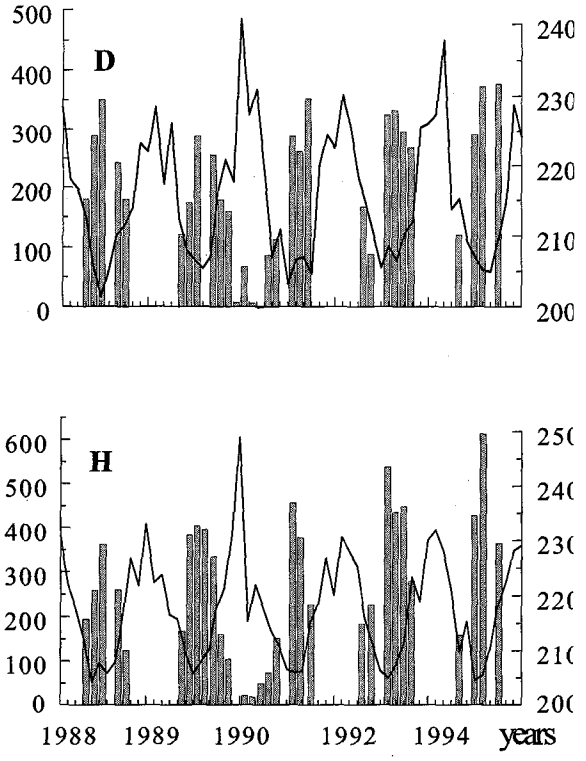

Fig. 2. Comparison of monthly mean heat fluxes q_{he} (1) and brightness temperature T^b_1.35 (2) in the points D, H during 1988-1994.

Also we have studied the processes of the air-sea heat interaction observed in the tropical latitudes of the Atlantic during the activity of the hurricane Katrina in 2005. Here we can see the anomalies of typical relations between such parameters as the atmosphere temperature and humidity, as well as the near-surface wind speed and the atmospheric pressure. In details these results will be reported at the conference.

References

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