SATELLITE THERMAL MONITORING
OF
SEA SURFACE

人工衛星直接受信地球表面温度の諸問題

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FOREWARD

In these ten years, a space station is under construction. This station could be act its function for our scientific interesting fact what have never been found by the past leading scientists. For the purpose of promoting an advanced scientific projects, the existing advanced technology is applied well and is utilized by the all of the boarding staff of the space shuttles which assist at construction of the space station.

Every one expecting to know what is the history of the earth including the birth of the earth. An extensive interest is the age of the cosmic space which might inform the origin of the whole of things around the earth.

Nevertheless, we, as the human being, are living on the earth even though we have had never aware of what environment has been existed around the human being. Old days, our ancestors had surely interested in finding their comfortable living, their food and fresh waters to drink, and what environment had been surrounded them. The nature of the earth might had been in harmony with the human being.

At present, we are receiving the invaluable gifts from the earth and the solar system. The galactic world has been in our dreaming imaginations. Though, we have to maintain our lives on the earth. Oly the earth is our place of the life.

Hence, we have to continue our scientific researches for everything of what concern to our life. The satellite systems are now one of the convenient tool for our activity on the earth. The satellites have given their advanced information and utility. Although, our scientific knowledge might be in a limited part of the actual nature's property. Scientists have been active to give us their findings for our application to satisfy our simple interest about what of any unknown things and to introduce a key to our comfortable life. At the same time, their findings have been resulted to apply for their negative activity on the earth.

At this stage, the author has worked about a problem of a monitoring of the earth's surface especially, of the sea surface by using the existing satellite signals which had been received directly. The author used a receiving system for the satellite signals just at the time of the satellites' passing above the station settled on a coast facing the ocean.

The author found some strange thermal patterns of the sea surface in the foot print of the satellites at the passage above the station even when the receiving system is working well without any wrong function. The author has took the apparently high temperature found in some thermal patterns might be understood if some physical processes are effective under some specific conditions.

This published part is only a part of the author's works, though the interesting result has been seen after the author's continued researches.

The author's finding may not soon be effective directly to our life, though the finding itself could be a key to stimulate our attention to a glimpse of "science".

Now, we would have to consider now about "science". We might have a key to what education and research are in need for a more advanced step for our scientific works.

2007 September 21

The last director, Shirahama Oceanographic Observatory,
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PREFACE

The author here introduces his recent contributions in a field of physical sciences.

He has continued his work even after retiring his university, Kyoto University. His major works are concerning mainly to the geophysical problems, especially, those related to oceanography and seismology.

He had joined a project in Kyoto University after finishing his educational courses for Batchelor of Science, for Mater of Science and for Doctor of Science(so-called as PhD). During his educational courses, just after 1945, most of the peoples had been forced to live their lives with their tolerant efforts under the condition of a limited food not sufficient for any active social works. The natural environments were severely out of natural stage as seen more than five years before the year of 1945. Various kinds of the natural hazards had been threat for their livings and their stable social constrictions.

What was the fact must be now noted here by the author in order to raise to those who are reading this for helping what we, human being, should consider about what they should do now.

The author had learned a one centimeter cubic material was made at the lecture for the highest class students in April 1945. Already, Japan had already completed what to control atomic energy for human kind though the representative scientists in Japan decided never to use it for solving purpose of any political application even under any extreme stage of the international environments. It was the scientists' decision in advance of about four months to have the atomic bombs ~~were~~ crushed the urban areas of Hiroshima on 6 August 1945 and of Nagasaki on 9 August 1945.

Since last half of August 1945, the leading scientists in Japan had understood soon the bombs in Hiroshima and Nagasaki were applications of the specific artificial radioactivity. It should be noted that the academic survey group of Kyoto University had hit by the severe storm at their surveying operation in Hiroshima. The Kyoto group had forced to get out of Hiroshima with no "Fruit" of their survey because the storm caused by the Makurazaki Typhoon". As for Nagasaki, the leading scientists of Rikagaku Kenkyusho had surveyed under the US control.

This experiences of the natural hazards was the trigger of an "unvisible research institute" settled in Kyoto University without no governmental financial support.

At present, this research institute is visible. The author has had his contributions in the physical scientific fields. In this writing, the author wishes to note what we should consider and act at this time for the human being in the twenty first century.

The author had found a broadcasting of a hot news that an epidemic research tells us an diffusion process of a single genetic element strongly affected by a intensive artificial radioactive beam, that is, an experiment for a rats' group have shown that thirty alternations of their generation gives us to find a completely defective genetic element established.

The author is now reporting on the utility of the electromagnetic waves for monitoring the earth's surface, especially, on the sea surface. Nevertheless, he has to notice that we have yet many things not only for us and for all of those living on the earth.

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The author

Shigehisa Nakamura

APPARENTLY ABNORMAL SATELLITE SIGNALS OF INFRARED BAND AS A THERMAL PLATEAU ON THE SEA SURFACE DIRECTLY MONITORED

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Abstract - The author has had studied about thermal pattern as a thermal plateau or a pinnacle which was obtained by a direct monitoring of the satellite signals. It is introduces a dynamical and physical model for helping an understanding about the apparently abnormal satellite signals of infrared band for the thermal pattern on the sea surface. Several typical examples are introduced for realizing what pattern is taken as an apparently abnormal case which was obtained under a normal operating condition of the directly monitoring system. A supporting example of the thermal plateau with a thermal pinnacle is introduced with a consideration about the meteorological factors measured in the interested ocean area. A note on the problem of spacial spectrum of sea surface waves is given in relation to the wave facet.

Monitoring Sea Surface Thermal Pattern Found by Directly Received Satellite Signal

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Abstract—Sea surface thermal pattern is studied by a system of directly receiving satellite signal for the beam of the infrared beam radiated on the sea surface. In the obtained result, thermal pinnacle or thermal plateau is found.

The author has continued to monitor a local sea surface thermal pattern, which is in the processed imagery of the satellite signal for the infrared band. This thermal effect is essentially caused by the radiation of a kind of beam in the infrared band, hence, this thermal pattern is completely different from the expected sun-glitter as a reflected beam of the visible band or an optical band.

Monitoring is practically undertaken by a satellite receiving system with an antenn a of cross-bar type and with a set of processing softwares. A permission of the signal receiving directly on the coast facing the northwestern Pacific has been given for the project started in Kyoto University.

The author has been found several cases of thermal pinnacle and thermal plateau in the ocean. The thermal pinnacle or plateau is appeared in a processed imagery as an abnormal high temperature, though the author has taken any one of the cases as a result of some proper physical and dynamical processes.

The author has references for only a limited several years data for this, and it is sure that the thermal pattern skipped by this time is useful for obtaining information of the sea surface.

One of the triggers is an effect of a distant storm offshore in the ocean. Another trigger is a very local agitated sea condition. Both of these cases can be well seen if an focusing effect of the infrared beam radiated on the water wave facet of the sea surface.

Several typical example could be introduced for the key to solving what physical and dynamical process is reasonable. The reasonable result should be utilised for some effective adjustment of the sea surface thermal pattern obtained in the past by this time.

MECHANISM OF SATELLITE THERMAL PLATEAU ON THE SEA SURFACE

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Abstract – This work concerns a mechanism of satellite thermal plateau on the sea surface at monitoring satellite signal, even when the signal is directly received at an station settled on the coast facing the ocean. Curvature of the water wave facet is one of the effective factors to concentrate the infrared beam out of the sea surface at the sensor mounted a interested satellite, when radius of the curvature of the wave facet is approximately equal to the distance between the sensor and the wave facet. A relation of the beam intensity at the sensor and the sea surface temperature helps to see what mechanism of the satellite thermal plateau on the sea surface found in practice.

Key Words: Sea Surface, Direct Satellite Monitoring, Infrared Band, Thermal Plateau. Wave Facet

INTRODUCTION

A possible mechanism of sea surface thermal plateau is introduced in order to see that an apparently abnormal infrared thermal pattern which can never be caused by a malfunction of an unidentified electronic processing system. An effective factors is curvature of the water wave facet to concentrate the infrared beam out of the sea surface at a thermal sensor mounted on an satellite, when radius of curvature of an wave facet is approximately equal to the distance between the sensor and the wave facet. Following the Stefan-Boltzman's criteria relating the two factors between the sea surface temperature and the radiation out of the wave facet, a reasonable mechanism is introduced for realizing the sea surface plateau found on the sea surface thermal pattern obtained after processing directly the satellite signal. A brief note is given on a spacial wave spectrum of the sea surface waves in the interested area of the ocean.

SEA SURFACE THERMAL PLATEAU

Nakamura(1995) reported some cases of a thermal pinnacle and a thermal plateau, which had been found during his monitoring of the sea surface pattern after directly directly received signals of a couple of the interested satellites.

Nevertheless, these thermal patterns has been simply noted phenomenologically with no physical or dynamical understanding. Hence, the similar thermal patterns surely be taken as some mal functioned cases of the related electronic system, though the author has considered that these thermal plateau and pinnacle must surely have some physical effect on the sea surface and the influence of the conditions between the sensor mounted on the satellite and the water wave facet of the sea surface waves.

WATER WAVE FACET

First of all, the author considered about what factor is the most effective for thermal plateau or thermal pinnacle. There might be several possible factors to be considered for understanding the thermal pattern.

Then, the author considered sea surface not only in a cope of hydrodynamics but also in a scope of thermodynamics. Every one has learned that thermodynamics tells that a black body radiates a radiation normal to the surface of an interested material. This radiation intensity is related to the surface temperature of the material in the formula that is known as Stefan-Boltzmann' criteria.

When the ocean surface can be taken as a black body approximately in a scope of thermodynamics, the sea surface can be taken as a radiator.

RELATION BETWEEN RADIATION AND TEMPERATURE

What the author should consider here is the infrared beam radiated out of the sea surface of a given temperature.

With what the author noted above, the problem to be considered now is on a satellite detected infrared beam out of the interested water wave facet. When the beam out of the sea surface is concentrated just neighbor the sensor mounted the satellite, the apparent increase of temperature dT (in Kelvin unit) can be evaluated as a degree of the beam concentration dB . That is,

$$dB/B = 4dT/T \quad \text{...(1)}$$

where, the notations B and T are for the integrated beam intensity of the infrared beam at the sensor and sea surface temperature on the concave water wave facet.

As far as the author concerns, Stefan-Boltzman's criteria hold for all of frequency so that it should be noted that the beam of the visible band has a short wave length with a strong decay in a short time and in a short time in the atmospheric column between the wave facet and the satellite.

In this case, the solar beam as electromagnetic wave reflected on the sea surface can be taken as a faint beam packet of the visible band so that the beam of the visible band is considered as a minor factor. The decaying and scattering processes should be out of sight in this wok.

As this work concentrates a problem of energy flux or energy transfer of the beam, no interest is about the phase difference or phase shift of the beam's wave form or about the wave amplitude. Then, there is no need of considering any interferometric process of the interested beam, and no SAR (Synthetic Aperture Rader) system is considered.

AMBIENT HIGH TEMPERATURE

Since a satellite was launched first for monitoring the sea surface thermal pattern, some ambiguity has been raised for the satellite sea surface temperature higher than the see-truth of the sea surface temperature about 5^0C (or 5K) in an interested area on the sea surface in the foot print of the sensor mounted on the satellite.

For example, a problem for this apparent difference of the sea surface temperatures obtained by the satellite monitoring and by the direct observation by the survey ship is considered here. That is, for a case of about 5K for a see-truth as 273K (or 0^0C) of the sea surface temperature, the thermal difference is dT=5 and T=273. Then, it is obtained that dT/T=5/273. Following the equation (1), the beam concentration degree is,

$$dB/B = 4dT/T = 4\text{x}0.018 = 0.073 \quad \text{...(2)}$$

This numerical result shows that an ambient condition of existing wave facet can be effective at understanding the ambiguity of the apparent high temperature directly monitored by the interested satellite signal.

BEAM CONCENTRATION AND THERMAL PLATEAU

In a case of an abnormally high sea surface temperature monitored by an antenna System of the interested satellite signal, following examples can be introduced on the bases of the author's monitored result of the satellite thermal patterns on the ocean surface.

Referring to the typical cases of the sea surface thermal plateau and pinnacle, it can be seen the relation between the sea surface temperature and the beam intemsity as shown below, i.e., in a case of the sea surface temperature 15°C (or 288K),

T	*dT*	*dT/T*	*dB/B*
288K	5K	0.017	0.069
288K	10K	0.035	0.139
288K	20K	0.069	0.278
288K	30K	0.104	0.417
288K	40K	0.139	0.556

The cases of *dT*=30K and *dT*=40K are appeared in the cases of swells propagated out of the distant storms(or typhoons in the Pacific) under a clear sky, the cases of wind induced waves seasonal in the coastal zone of the NW Pacific, and the cases of local small area of less than 100Km square at the mid of the Ocean.

In the summer season or the hot season in the northern hemisphere, the sea surface temperature get to about 24°C (or 297K). Then, we have the following relation, i.e.,

T	*dT*	*dT/T*	*dB/B*
297K	30K	0.101	0.404

This relation is often seen in the cases of the sea surface thermal plateau, though the duration time of this state is taken to be less than about six hours under the condition of a couple of satellites with each polar orbital motion of an about 100 minutes cycle. Similar cases have been found for the sea surface thermal pinnacle in the mid of the open ocean.

SPACIAL SPECTRUM OF THE SEA SURFACE WAVES

As Nakamura (2007) noticed, one of the most important factors is spacial spectrum of the sea surface waves. Nevertheless, it should be aware of difficulty at obtaining the spacial spectrum of the sea surface waves or at obtaining the three dimensional sea surface topography. It should be considered to learn about this spacial spectrum as a function of space scale and time scale in order promote an advanced research.

CONCLUSIONS

A mechanism of the satellite monitored sea surface thermal plateau and pinnacle was realized with a consideration of water surface wave facet as a hydrodynamic process and with an assumption of the ocean surface as an black body radiating an infrared beam in a scope of thermodynamics. Stefan-Boltzmann's critera give us a consistent relation between the apparently abnormal high temperature found during monitoring the satellite thermal sea surface pattern and the expected effect of the existing water surface wave facet. This pattern was found only in the pattern for the infrared band but for the visible band. The thermal plateau appears after an atmospheric effect of a distant storm (or a typhoon) or after a strongly developing cold front monitored directly by an antenna system located on he coast. The thermal pinnacle is found in the mid of the ocean. What discussed by the author in this work was not considered some minor factors, for example, scattering and interferometry of the infrared beam.

ACKNOWLEDGEMENTS

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SATELLITE THERMAL PLATEAU ON THE SEA SIRFACE

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Abstract – The author has had studied about the thermal pattern as a thermal plateau or a pinnacle which was obtained by a direct monitoring of the satellite signals. The author introduces a dynamical and physical model for helping an understanding about the apparently abnormal satellite signals of infrared band for the thermal pattern on the sea surface. Several typical examples are introduced for realizing what pattern is taken as an apparently abnormal case which was obtained under a normal operating condition of the directly monitoring system. Another example of the thermal plateau with a thermal pinnacle is introduced with a consideration about the meteorological factors measured in the interested ocean area.

CONTENTS

1 INTRODUCTION

A possible mechanism of the sea surface thermal pinnacle and plateau is introduced in order to realize tat the infrared thermal pattern is not caused by a malfunction of an unidentified electronic processing system. A model has been introduced for a possibly reasonable one for realizing the thermal pinnacle and plateau. The first step is to have a model consistent to the knowledge of the existing scientific contributions. Physics is for the beam out of the sea surface and consideration is also in a scope of dynamical features of the sea surface waves which could be a black body radiating a beam. So, knowledge on optical physics, thermodynamics, statistical mechanics, electromagnetics, hydrodynamics and the related fields is synthetically considered. The author has taken a physical scope to see it as a problem of local focusing of sea surface infrared beam found in a set of the satellite thermal patterns which has been monitored by a simple system directly receiving the signals from the operation satellite.

The author has found frequently some suggestive patterns of the infrared beams out of the sea surface in the satellite thermal pattern. This led him to learn about what is a signal of the infrared band informing the sea surface thermal pattern are received directly by using an antenna of a cross bar type with a signal processing software system connected to a personal computer at a station located on a coast facing the ocean. Asignal is from any one of a couple of the NOAA satellites. The normal operation for directly receiving the satellite thermal signal has given a data set of several sea surface thermal pattern including several cases showing local hot areas in the foot prints of asatellite.

It is necessary to see what mechanism could be applied to the local focusing of the sea surface infrared beams. As for the sensor mounted on the interested satellite, signal of the infrared band from the sea surface must be a passive signal informing about the sea surface thermal condition. The sea surface thermal information is detected as a set of infrared beams emitted out of the sea surface when the ocean can be assumed as a black body in a scope of thermodynamics, therefore, there must be an effect of sea surface curvature which is formed as a facet on the sea surface cross wave generated on the sea surface. A combined effect of the beams and of the sea surface concaved wave facets could result to concentrate the focusing infrared beams near the sensor on the interested satellite. Then, a conceptual model is one step to see what is better at looking an apparently high temperature in a thermal pattern obtained by a directly receiving the satellite signal.

By this time, this focusing must be skipped or thrown away because this focusing is caused by a wrong signal of the satellite thermal data. A model introduced in this work may be a key to find an active notice to utilize any apparently high temperature in a thermal pattern obtained by a directly receiving system of the satellite signal.

2 REAL TIME MONITORING OF SATELLITE SIGNAL

As for the author's real time monitoring of satellite signal for about the infrared band, the author has been noted at a chance and repeated (for example, Nakamura [6]).

One of the reference texts was, for example, Stewart"s work [11]. The other edition is for a basic introduction on remote sensing [2]. One of the recent works is for related problems on the remote sensing [8].

Now, a brief note about the author"s direct monitoring of the satellite thermal pattern is introduced. In this work, any global pattern is considered. The author"s restricted condition forced to use a coarse scaling at directly receiving satellite signal by using a simple system with a personal computer, instead of scaling for the AVHRR (Advanced Very High Resolution Rader) [8]. The author also would not pay his consideration on sea surface salinity [5].

The signal for the purpose in this work has been monitored to reduce the sea surface thermal pattern after the directly received signal of the couple of the NOAA satellites. Each one of the satellites has a polar orbital motion. At a station settled on the coast facing the ocean, it is essentially possible to receive the satellite signal just at passing above the station in every 6 hours interval as an average.

The signal directly received is processed in about seven minutes to show a sea surface thermal pattern as a real time information just after a passage of a satellite above the station. The resolution of the sea surface temperature is 0.5 degree C (Celsius Unit).

In practice, the signal from the interested satellites is received at the station settled by Kyoto University on the coast facing the Pacific for the author's convenience.

3 APPARENT HIGH OF SEA SURFACE TEMPERATURE

First, one of examples is introduced in order to demonstrate why the author has been in the local problem instead of a global problem. What the author found once was an apparently high sea surface temperature in the area of the research project.

This apparently high sea surface temperature may be expressed as a sea surface therm al plateau or pinnacle which was appeared in the sea surface thermal pattern. The set of the satellite signals directly received is processed to get the thermal plateau or the thermal pinnacle.

The data of the satellite signal including the sea surface thermal information about the visible band and the infrared band. Our experience tells us that the electromagnetic wave as a signal out of the sea surface is a beam in an infrared band which decays rather gradually and scatters not so strongly in a certain distance between the sea surface and the sensor on the satellite, and it is known well that electromagnetic wave in a visible band decays in a short time and a short distance and scatters strongly. In a case of a pack of beams as the reflected electromagnetic waves of a solar beam on the sea surface, there may found a strong beam of the visible band. The difference of the two beams is understood as that caused by the difference of wave length of these two beams. The decaying and scattering processes of the beams affects not to concentr ate the beams. If these processes are effective to intensify the beam, these factors must be considered first in this work by the author.

A sensor on a satellite detects to get the sea surface thermal condition in every pixel. What the sensor finds is a level of a beam energy flux but any wave form. Then, any phase difference of the interested beams is outside of the interest and no effect is in need to consider any interferometric process of the interested beam.

A SAR (Synthetic Aperture Rader) system is effective to detect the sea surface waves. This SAR system is an application of interferomtry of the electromagnetic waves on the sea surface, nevertheless no energy level of a beam can be found by a simple use of the interferometry. This interferometry is fine when a small distance is aimed to see as a phase difference of the interested electromagnetic wave. For the SAR, it is important to know a phase difference of the two interested wave as the beams from the sea.

The above noted knowledge may be a key for us to develop an advanced model with a consideration of the related physical processes.

4 THERMAL PLATEAU AND TEMPERATURE

The author has worked to find a technique for prediction of an effect of distant storm which might threat to the human activity found in the coastal zones. There might be many factors to be considered and a specific sea surface thermal pattern is the one of the author's interest.

One of the specific sea surface thermal patterns is shown in Figure 1 (the local time is taken as a reference).

Looking at the top of Figure 1, an apparent sea surface temperature in the morning (at 0751-JST) in the ocean area is about five degree higher than that in the evening (at 1910-JST).

In the author understanding of the sea surface in the interested ocean, the temperature in the ocean area at the evening as shown in Figure 1 may be taken to be agreeable.

Now, a question is what physical effect should be caused to result shown as a thermal plateau in the interested ocean area in the morning as seen in Figure 1.

During the time period of the satellite thermal monitoring, an offshore station obtaine a continued measuring of the sea surface temperature in every one minute. This can be a reference to identify the temperature in the direct measurement (25 degree) and that in the thermal pattern obtained by direct satellite monitoring. The author has to takes it can be reasonable to see the thermal pattern in the evening in Figure 1.

Then, what should be the reason to have an apparently strange thermal pattern in morning in Figure 1. At any time of the satellite monitoring, there was no electronic or electric trouble in the monitoring system. The author has to take the pattern to be obtained under a regular operation of the monitoring system. There might be several physical factors actively affected to give the thermal pattern in the morning as shown in Figure 1.

One of the assistive information must be the weather chart of the surface on that day, that is, on 1993 October 4 (at 2100-JST) issued by the Japan Meteorological Agecny. A part of the weather chart is shown as in Figure 2. In this chart, two typhoons are found as a couple of the storm sources in the ocean. The maximum of the wind speed in the stormy zones may be about 50 m/sec or more, and the wind direction in each stormy zone was cyclonic (in the circular areas with a radius of about 100 km around each of the typhoon's center). In the stormy zones, the wind induces the sea surface waves to develop higher and higher. The wind induced sea surface waves in the storm zones were radiated out of the zones to propagate in a form of swells. The swells hit on the coasts facing the ocean under a calm and clear sky condition even at a distant location more than 1000 km. In a scope of hydrodynamics and physical oceanography, it must be possible to consider that a water wave packet generated by the two storms must propagate on the ocean surface out of the storm areas to agitate the local area of the ocean. Looking at the weather chart as shown in Figure 2, it can be seen that the typhoon T9319 (925 hPa of atmospheric pressure at the center) seems to be more effective than the typhoon T9320 (975 hPa) at considering a wave packet agitating the ocean surface.

The author has to note that the satellite signal informs us the sea surface information in a form of ATP(Automatically Transformed Picture) of the visible band and infrared band. The altitude of the sensor on each satellite is 850 km as an average and, is a distance to distinguish the decaying beam of the infrared and visible bands. The height of the satellite (altitude 850 km) is different from the height of the air craft flight, say, (10 km at most). An air craft was used for an optical monitoring of the sun glitter [1]. The satellite sun glitter is one of optical problems of photography which is studied by analyzing an imagery of the solar beam reflected on the sea surface (cf. Figure 3).

As for a case of the visible band, the directly monitored satellite at a station of a mid latitude on the coast facing the ocean informs that the pattern of the sun glitter as an elliptic bright zone on the ocean surface in the subtropical area at a passage of thesatellite at around 1300-JST of the local time at the station. The author confirmed that the satellite monitored pattern of the visible band was completely different from those of the sea surface thermal pattern directly monitored. The author concentrated his interest in the apparently high sea surface temperature which was obtained after a directly monitoring of the satellite signal.

5 INFRARED BEAMS OUT OF SEA SURFACE

Now, consider about radiation flux out of the sea surface on the earth. When the sea surface is assumed to be equivalent to a black body that is described in a formula of Kirchhoff's law, the radiation intensity out of the black body's unit surface is written by a function of the sea water surface temperature (degrees in Kelvin unit instead of degree C) with the parameters (Planck's constant, Boltzmann's constant, and the light beam's speed. The light is essentially a kind of electromagnetic waves in a visible band. Then, Stefan-Boltzmann's law tells that the integrated radiation flux of a beam out of an unit surface area is generally expressed by a function of temperature with Stefan's constant [3, 9, 10, 13].

As for the two cases of the satellite thermal patterns in the ocean shown in Figure 1, the difference of the apparent sea surface temperatures in the ocean is about 5 K (or 5C). When the refernce temperature of the sea surface water is taken as 300K, then, the difference of the integrated radiation fluxes can be about 0.07.

Exactly speaking, the integrated radiation flux out of the sea surface may be detected by using the sensor mounted on the satellite in this case for Figure 1. This means that the sensor on the NOAA satellite is well arranged to distinguish 0.5 degree C (or 0.5 K) at least in the directed thermal range. Then the sensor can find even a meaningful signal as an apparently abnormal signal. This apparently abnormal signal must be, by the time of the author's analysis, skipped or deleted away without any interest after as electing process of the data for the analyses at regulated normal processing operation of directly received satellite signals which was obtained under a condition without any electronic trouble in the system consisted by the set.

The relation between an integrated intensity B of radiation and a surface temperature T (in Kelvin unit) of a particle. When there are small deviations dB and dT, the above noticed law may be reduced to write as follows:

$$dB/B = 4dT/T.$$

This shows that the relation in the above form is independent of any frequency of the interested radiation beam as the electromagnetic waves.

This relation could be helpful at considering a focusing process of the radiation beam out of the concave wave facets in order to realize the satellite thermal patterns, which Have been usually obtained by the author after processing the satellite signals directly received at every passage of the interested satellite just above the settled station facing the ocean. Nevertheless, the author would not consider about that there might be the other physical or dynamical factors which could be a more effective key to understand the apparently high sea surface temperature on the ocean as shown in Figure 1.

6 CURVATURE OF WATER WAVE FACET

On the sea surface, there are always various kinds of water surface waves governed by the earth's gravity field. In relation to this work, the author's interest should be what property is in the water surface waves in the ocean. The theory of water surface wave tells us in the texts on classic hydrodynamics. For example, one of the old publications by Lamb [12] can be introduced for the author's convenience instead ofconsidering the advanced wave spectral pattern of the sea surface waves.

In this work, what the author considering now is to see whether the curvature of the wavy sea surface in a part is one of the most effective factors for understanding the apparently high sea surface temperature on the ocean as shown in Figure 3.

When radius of curvature of the radiated beams normal to the concave wave facets on the sea surface and this radius is approximately equal to the distance between the sea surface and the sensor on the satellite, and when the radiation flux on the sea surface is directed normal at hitting the sensor, then, the radiation flux of the infrared band out of the sea surface concentrate to focus at the sensor which finds the thermal signal on the sea surface. This model for a signal detected by a passive sensor help us to see what physical process is effective for the author's interest in this work. Now, what is necessary is the sea surface temperature simultaneously measured directly at the site in the itrested sea area. Nevertheless, it is unfortunate that the author has no available data of the sea surface temperature measured simultaneously at the passage time of the satellite just above the interested sea area in the morning on the day when the signalf or the apparently high sea surface temperature was found as shown in Figure 1.

The author has considered to identify the satellite thermal pattern by referring to the sea surface temperature directly measured on the sea surface, for example, by a survey ship at the time of each satellite passage, though no reference data is found any where in the author's sight of seeking. Thence, the author is now not to be able to find any techniques and tools to see and to assure what is true except the author's concept with his belief about his model.

7 ALTITUDE OF SATELITE ABOVE SEA SURFACE

As is already known, each of the NOAA satellites is in a polar orbital motion, and the altitude of this orbit is above the sea surface in a range of 870 to 833 km.

When a wavy sea surface field can be taken as an ensemble of concave wave facets, and the radius of curvature of each wave facet is corresponding to the altitude about 850 km of the interested satellite, each of concave wave facets may act as if it were a mirror to focus a radiated beam out of the sea surface at the pixel position. This may be the necessary condition for a possible mechanism at considering that the signal hit the sensor in a form of concentrated beams in the infrared band out of the interested facet.

As for the case of ATP (Automatically Transformed Picture), which can be received by a simple system with an antenna of a cross bar type and a personal computer, the size of one pixel should be about 4 km square in this work, instead of the pixel size for AVHRR as about 1 km square. This means that the pixel size restrict for a system for directly receiving of a satellite signals by using a simple antenna and a personal computer.

Now, it is necessary to consider an application of what we know about water surface waves [4, 12] for our convenience. It may be possible to consult to the recent works as an easy way to see about the sea surface waves found in the ocean. The recent works are mostly concerned for problems of ocean wave spectra as a function of frequency in order to have a mathematical linear transform. A linear process can be expressed by a linear formulation. This linear process is taken as a reversible process, nevertheless we know that the actual processes in the natural fields are irreversible. A linear process is our simplified form in order to describe our interested process in our conceptual field. The author would consider if a convenient formulation was found for describing what of his interested problems in nature, though any mathematical transform can show us simply a linear spectral pattern of a nonlinear water wave without new dynamical key. In the case of the author's work introduced here, the author tends to consider that a doubt is left at a reversal reduction can not reproduce the interested problem noted in this work.

When we look at the sea surface, it is easily found that there are always various kinds of water surface waves with various wave length and various wave periods on the sea surface. Then, it would let us tend to consider what relation is between the interested concave wave facets and the wave spectrum. Nevertheless, as stated above, the author has unfortunately has no information about any direct measurement of the sea surface waves at the focusing wave facets were expected to be found in the sea surface area in the foot print of the interested satellites.

With the author's understanding what above noticed, an essential model is introduced by the author for convenience in order not to miss at establishing a more advanced model which might be applied for a practice of the sea state prediction on the basis of the satellite thermal pattern on the sea surface which could be obtained by a system with a simple antenna and a personal computer.

In a case of wind waves with a wave period of about 5 or 6 sec, the wave could be taken as a wave of a deep water for the water depth more than 200 meters. Then, a wave length is approximately 50 meters under the gravity effect so that there must be about 80 crests of the wind waves in a pixel of a 4 km square size. When there were two kinds of wind waves forming a cross wave packet, the wave facets must be found about 6400 concave wave facets (this corresponds to a square of 80 crests).

In a case of swells with a period of about 1 or 12 sec, the waves are in a stage of a decaying to form rounded crests. In this case, swell has a wave length of about 200km so that there may be about 20 crests of the swells in a pixel with a 4 km square, and there must be about 400 concave wave facets at most if there were cross wave packet formed by the plural swells propagating out of the strong wind areas of the typhoons, for example, as noted for the weather chart shown in Figure 2.

The propagation pattern of swells out of stormy zone of a typhoon is considered quite similar to the case of swells out of stormy zone of hurricane in the north Atlantic.

The number of the concave wave facets could be an index for the necessary conditions to notice about an intensifying factor for the focusing effect of the infrared beams out of the sea surface at the sensor on the satellite.

In any one of the above noted cases, wind waves and swells, a part of each one wave as a concave wave facet must have a radius of curvature corresponding to the distance between the sea surface and the sensor on the satellite.

When it is taken to be acceptable what noted above, a hydrodynamic model could be here introduced as a theoretical background in a scope of classic theory of water wave. There have been many researches on the ocean waves which are taken to be outside of the author's interest in this work. This does not mean that the recent researches on the ocean waves are not to be evaluated by the author. The author here is considering a simplified model only for his purpose in this work with the author's understanding of various kinds of waves on the sea surface in the ocean.

8 FOCUSING CONCAVE OCEAN WAVES FACETS

When what was noted as seen above, the author considered that a hypothetical model of thermal pinnacle is taken to be acceptable. In this section, some other patterns are introduced. What patterns introduced here may called as thermal pinnacle in the sea. These patterns are shown as seen in Figure 4. The author trust the processing system of the directly received satellite signals so that these thermal patterns should be found by some navigators of a sailing boat or some officers of some vessels. The author is now considering that there might be no oceanographic survey line for any project just neighbor any one of the thermal pinnacles introduced as in Figure 4. Then, a thermal pinnacle in the ocean is found in each case of Figure 4 though there is no reference data of oceanographic measurement.

Specific profile of the thermal pinnacles shown in Figure 4 can be taken as a conical thermal pattern of the sea surface temperature in the ocean. At the peak of the cone, the highest sea surface temperature is found and the temperature in the side robe on the sea surface is taken to be normal.

In each case that shown in Figure 4, the sea surface temperature 30 degree C at the peak is higher ten degree C than that found in the surrounding side robe sea area. The thermal pinnacle has a thermal side robe with a radial extent of several ten km. In some case, a diameter of the thermal side robe is in the range of 10 to 20 km.

At this time, the author is considering to confirm this to be a physical process and to construct a model in a scope of thermodynamics and geophysics. Now, it is necessary to get a key for a more advanced research. Then, the author tends to consider some similar model to that shown in Figure 3 for realizing the thermal pinnacles shown in Figure 4 for his convenience without any other reference data.

9 A SEA SURFACE WAVE TRAIN MODEL

In this section, a wave train model is introduced for a more advanced modeling for a Thermal plateau with a thermal pinnacle on the sea surface (cf. Figure 5).

A particle as a black body radiates beams all of the direction on the surface. This is well understood by Stefan-Boltzmann's law as noted above in this work. This is shown as the case A in Figure 5.

As for a case of radiation out of a flat surface of a black body, each of the beams is radiated normal to the flat surface as shown in the case B in Figure 5.

A wave train model is introduced as the case C in Figure 5 with some assumption. In this case, a flat surface is taken as a horizontal axis OX and a sensor mounted on a satellite is assumed to be located at a location of (x, z)=(0, R). The sensor's height on the earth's surface is expressed by R. The vertical axis OZ is taken to pass a line of x=0.

Each of the concave wave facets ds on the sea surface S is considered and assumed to have its axis normal to the surface of the facet on the direction to point the position (x, z)=(0, R). The angle θ is referred to the location (x, z)=(0, R) so that the angle of $d\theta$ for the wave facet of ds can be assumed for a convenience to consider a focusing beams out of the surface of the concave wave facet. Then, it can be written as

$ds = Rd\theta$, for a facet $x'' < x < R\tan(\theta + d\theta)$,

where $x = x'' = (R\tan\theta)$ in Figure 5.

In this model, a wave in form of a concave facet is on the foot at the locations of

$x = x''$ and $x = R\tan(\theta + d\theta)$,

and the crest height of this wave is positioned at (x, z) expressed as

$z' = R[1 - \cos(\theta + d\theta)]$, at $x = R\sin(\theta + d\theta)$.

With the wave train model, there may be expected a possible set of wave facets acting to concentrate the radiated beams at the location (x, z)=(0, R).

In Figure 6, an example of the thermal plateau (P) found at a windy condition which was caused by a passage of an atmospheric cold front mid night. Now, it can be seen a typical case of a thermal plateau(30 degree C on the sea area around P in Figure 6) with a thermal pinnacle (33 degree C at M in Figure 6).

In Figure 8, a set of several meteorological factors during the time period covering The time is shown in order to show what meteorological variations was effective to form a thermal plateau with a thermal pinnacle. The time for the author's interest is that at 0247-JST on 1996 December 19.

Now, it can be seen easily that the thermal plateau was found mid night at the time marked by H in Figure 8. The weather chart in Figure 7 is for the time mark S in Figure 8.

During the time from the mark S to the mark H in Figure 8, an increase of the wind speed was seen. This increase of the wind speed at a station near the interested sea area is taken as a trigger for growth of the wind induced waves.

The author here considers that these meteorological factors are suggesting a growth of the winds at the passage of the atmospheric cold front which should be one of the effective factors for the thermal plateau with a pinnacle mid night. This must surely be a key for the thermal plateau and thermal pinnacle what the author introduced for a physical understanding. This seems to support what the author introduced is to be acceptable when we see what tells us the knowledge of physical oceanography.

The passage of a atmospheric cold front can be understood by referring to the weather chart (cf. Figure 7) given as an issue by the Japan Meteorological Agency. The wind peed is the most effective at realizing the thermal plateau found at that time shown in Figure 6.

The author has shown the sea surface temperature of 15 degree C at T (the offshore tower station in Figure 6. In the author's experience, it is frequent for the author to see similar pattern to the case as in thermal pattern in the evening that is shown at the bottom of Figure 6. Nevertheless, the thermal plateau mid night of cold season as shown in Figure 5 looks yet strange though it is found frequently. This suggests us to compile similar case in relation to the physical processes.

With what the author has studied, the author considers that the author's model for a thermal plateau may be supported by an example of the thermal plateau including a thermal pinnacle, for example, found on 1996 December 19 as seen in Figure 6.

10 DISCUSSIONS

For a more detailed understanding of the satellite thermal plateau on the sea surface, a note should be what about a spacial spectrum of the sea surface waves in relation to the curvature of the concave wave facet in the gravity field in the interested area. In this case, it is necessary not to see a frequency spectrum but a frequency spectrum of the sea surface waves.

Now, again, it should be noticed that the thermal beam radiated out the sea surface is a kind of the electromagnetic wave in the infrared band propagating in the medium of atmospheric layer between the sea surface and the sensor mounted on the interested satellite, and it should be reminded that any waves on the sea surface is propagating on the interface of the atmosphere and ocean under the earth's gravity field.

A simplified model should be introduced in order to help an understanding of a beam radiated out of the sea surface in relation to the thermal plateau. Here, it should be referred to what noted in the appendix for a simplified model. Then, it could be seen that the special spectrum of the sea surface waves should be considered but any one of the frequency spectra of the sea surface waved in order to see what is effective at considering a beam out of the concave wave facets on the sea surface which hit the sensor mounted on the satellite.

11 CONCLUSIONS

A satellite thermal pattern as a thermal plateau or a thermal pinnacle is studied after a direct monitoring of the NOAA satellites' signals for the detected beams out of the sea surface. A dynamical and physical model is introduced for getting an understand about the apparently abnormal satellite signals. Several typical examples are introduced For helping what pattern of a thermal plateau or a thermal pinnacle is taken as an apparently abnormal case under a normal operating condition of a directly monitoring system. A meteorological data for the thermal plateau is shown for considering what is an active supporting factor, though scattering is taken as a negative factors for this work. For simplicity, a consideration is given about a spacial pattern of sea surface wa ves controlled by the earth's gravity in the ocean in relation to an infrared beam out of the concave wave facet on the sea surface.

ACKNOWLEDGEMENTS

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APPENDIX SPACIAL SPECTRUM AND CONCAVE WAVE FACET

First, a frame of a modeling in this work is introduced as following for a convenience. A reference of the previous note (for example, by Nakamura, 2006) may be helpful at an establishment of this frame.

When a flat sea surface is taken as the co-ordinate x horizontal, a satellite at a height H above the sea surface can be taken to be at z=H and x=0 in the orthogonal system of the co-ordinates, where the vertical axis z is taken to be positive upward.

In the actual sea surface, any problems are generally to be three dimensional though a two dimensional frame is assumed.

This frame can be taken as an approximation at considering a small sea area under a satellite in a polar orbital motion, then, it can be taken to be acceptable to consider one pixel size of 4km square in a satellite thermal pattern to be flat in the foot print comparing to the radius of the Earth.

If the sea surface on the earth everywhere could be taken to be as a black body, then, it can be a case of thermodynamics which tells us a radiation out of the sea surface as an electromagnetic wave.

When a sensor mounted on the satellite is directed vertically downward, the sensor can detect the beam radiated vertically out of the flat sea surface though it can not detect any signal without scanning function.

Assuming an arbitrary function

$$F=F(x,\ z;\ t) \quad \cdots\cdots \quad (A1)$$

for expressing the sea surface pattern, then,

$$H = H\cos\theta + F, \quad \text{for } x = x, \quad \text{at an arbitrary time } t. \quad \cdots\cdots \quad (A2)$$

This could be a most simplified model of a satellite thermal pinnacle.

As the tangent of F for the position (X, Z) = (x, z) at time t is to be $F' = \partial F/\partial x$, the orthogonal of the tangent is described as

$$(Z-z) = -(1/F')\ (X-x). \quad \ldots\ldots \quad (A3)$$

This normal line is taken to be corresponding to the direction of the beam radiated at (x, z).

When this normal line hits the point (X, Z) = (0, H), the sensor catches the beam as a signal from the sea surface. At any other cases, $Z \neq H$, the other hitting beam can not be expected.

When this pattern is taken as a model for a beam radiated out of the sea surface, the beam in the infrared band could be found only at a single pixel in a thermal pattern which was reduced after directly receiving of an interested satellite's signals related to the sea surface thermal pattern.

The function F introduced above can be transformed mathematically to express it in a form of spectral function $S_S = S_S(\omega;\ t)$ at a fixed position x. That is,

$$S_S = \int_0^{\infty} F(x,\ z;\ t)\ \exp(i\omega t)\ d\omega, \quad \ldots\ldots \quad (A4)$$

where, the notation ω is for frequency.

This spectral expression has been widely used for studying wave developing process at a fixed position, though this can not show any spacial pattern of the sea surface waves as a sea surface pattern at a time t. Nevertheless, this spectral form is not effective at studying a spacial pattern of the waves or of a wave facet on the sea surface.
Then, it should be introduced a spacial spectral function S, which is expressed as

$$S = S(k;\ t), \qquad \text{at} \quad t = t,$$

and,

$$S = \int_0^{\infty} F(x,\ z;\ t)\ \exp(ikx)\ dk, \qquad \text{at } t = t, \quad \ldots\ldots \quad (A5)$$

where, the notation k is for wave number.

Then,

$$F = \int_0^{\infty} S(k;\ t)\ \exp(-ikx)\ dx, \qquad \text{at} \quad t = t. \quad \dots\dots \quad (A6)$$

Substituting (A6) into (A3), then,

$$(Z - z) = (X - x)\ \partial / \partial x\left[\int_0^{\infty} S(k;\ t)\ \exp(-ikx)\ dx\right]^{-1}. \quad \dots\dots \quad (A7)$$

When this normal line to the tangent at (x, z) hits the position (x, z) = (0, H),

$$(Z - H) = (X)\ \partial / \partial x\left[\int_0^{\infty} S(k;\ t)\ \exp(ikx)\ dx\right]^{-1}. \quad \dots\dots \quad (A8)$$

This shows a single beam hitting at the point (x, z) = (0, H) for an arbitrary form of the spectral function S(k; t).

When this is taken as a model for a infrared beam radiated to hit at a sensor for the sea surface thermal pattern, a single pixel in a sea surface thermal pattern could be as a thermal pinnacle of an impulse form. Nevertheless, this model is hard to be even a simplified model for help to see any one of the sea surface thermal pinnacles actually found in the satellite sea surface thermal pattern.

Following what tells us the geomery for a plane, the radius of curvature in this work is for the wave facet on the sea surface. That is, expressed as follows referring to the sensor's position (x, z) = (0, H) which stated above. Then,

$$(1/R) = (d\theta\ /ds), \quad \dots\dots \quad (A9)$$

where, the notation R is the radius of curvature of the wave facet, and the notation $d\theta$ is for the angle length of the wave facet at the sensor. The length segment ds is;

$$(ds)^2 = (dx)^2 + (dz)^2, \quad \dots\dots \quad (A10)$$

where, dz and dx are for the wave facet at the position (X, Z). The relation of X and Z is described as shown in a form of (A8).

With what the author has studied above, The relation between X and Z is taken to be a simple form, and spacial spectral function at a time t is a function of wave number k in this case. Thence, the expression (A8) should be rewritten for the problem on the energy flux or energy transfer of the beam out of the facet concentrates just near at the sensor where the beam is focusing as an electromagnetic wave with a consideration. The factor of interferometry is simply effective at decaying of the beam intensity, then, the author considered that this problem was to be taken at this case as that outside of the existing and working SAR system (Synthetic Aperture Rader)'s interest.

CAPTIONS

Figure 1 Sea surface thermal patterns obtained by directly satellite nonitoring.
Top: at 0751-JST on 1993 October 3 (NOAA-12),
[showing a thermal plateau of the beams in the infrared band].
Bottom: at 1910-JST on 1993 October 4 (NOAA-12).
[note: the local time JST = GMT(UT)+9 hours].

Figure 2 Weather chart(surface) at 2100-JST on 1993 October 4.
[Two typhoons, T9319(925hPa) and T9320(975hPa) are in the chart].

Figure 3 A model for emitted infrared beam radiation focusing after radiating out of a concave wave facet.
(A) Radiation beam E on wave facet of the sea surface,
(B) Radiation beam V focusing of reflected solar beam of the visible band on the wavy sea surface between a satellite and the sea surface.

Figure 4 Specific thermal pinnacle patterns on the sea surface
on the sea surface.

Figure 5 Wave train model with wave facets.
(A) Radiation out of a particle as a black body,
(B) Radiation out of a flat surface of a black body,
(C) Radiation model out of a water surface wave facet (dS) on the sea surface to focus at a sensor (R).

Figure 6 Specific thermal plateau with a thermal pinnacle on the sea surface.
Top: at 0247-JST on 1996 December 19 (NOAA-14) [mid night],
Bottom: at 0710=JST on 1996 December 19 (NOAA-14) [in morning].

Figure 7 Weather chart(surface) at 1800-JST on 1996 December 18.
[A typical meteorological condition of the seasonal northwestern winds at the passage of the atmospheric cold front, which caused to grow up the wind induced water surface waves].

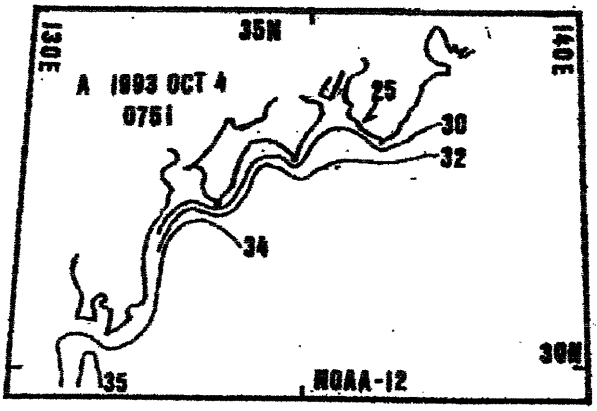
Figure 8 Meteorological evolution of the factors in the time period covering the thermal pattern at 0247-JST on 1996 December 19 (cf. Figure 6).

over

Fig. 1 (X 1/1)

S. NAKAMURA

Fig. 1



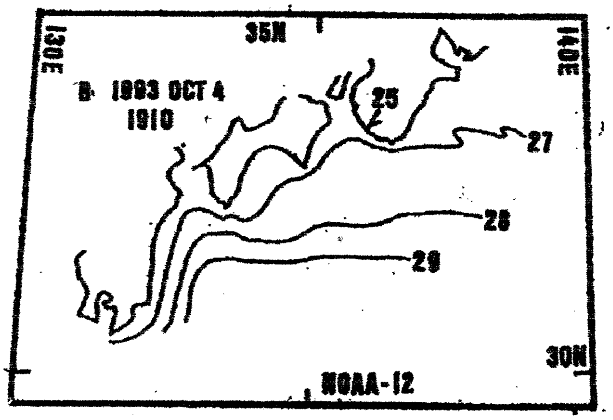
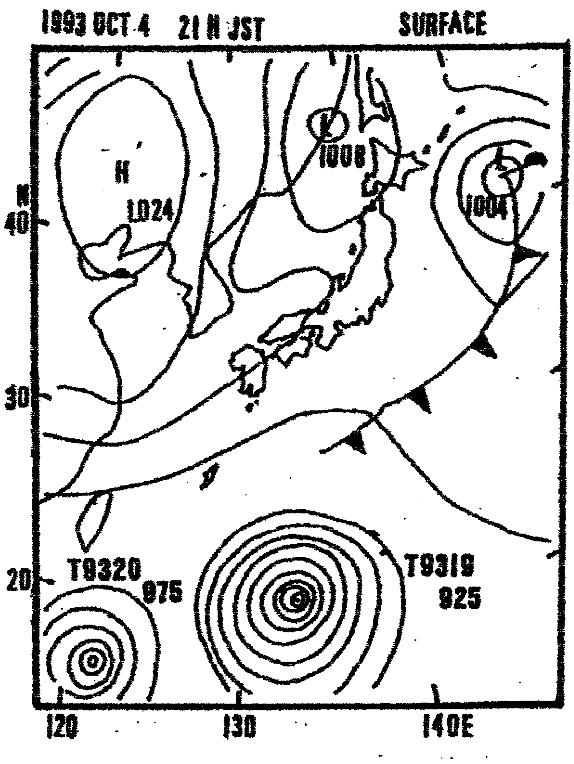


Fig. 2 (× 1/1)
S. NAKAMURA
Fig. 2



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~~Fig. 1~~

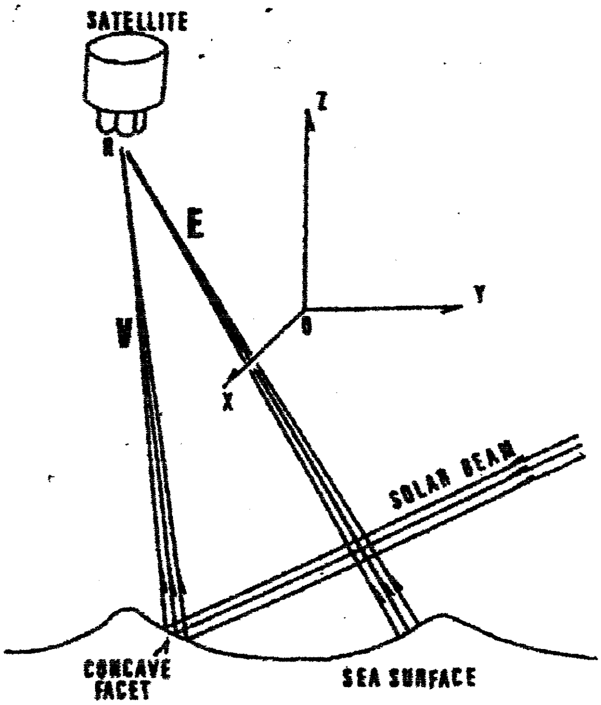

Fig. 4 (× 1 × 1)

S. NAKAMURA

~~Fig. 2~~

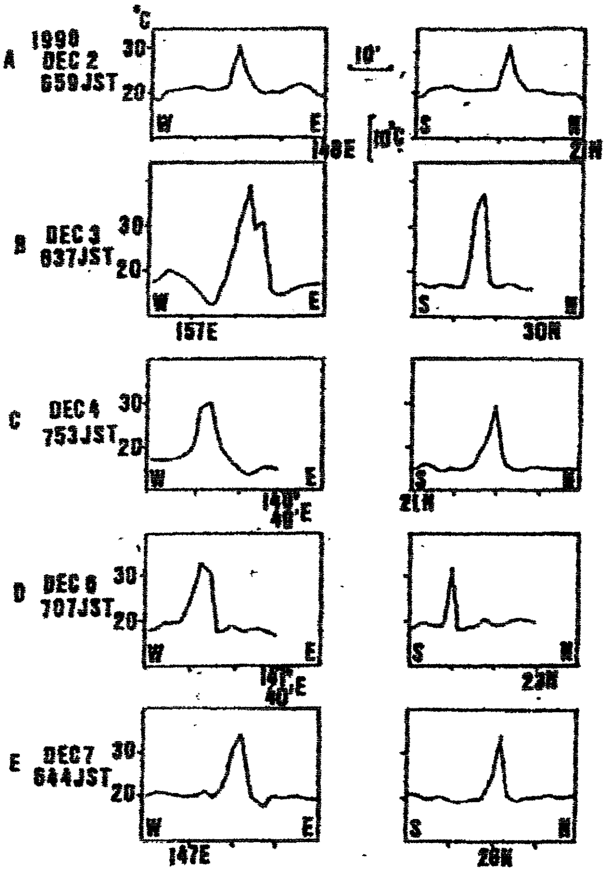

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Fig. 5

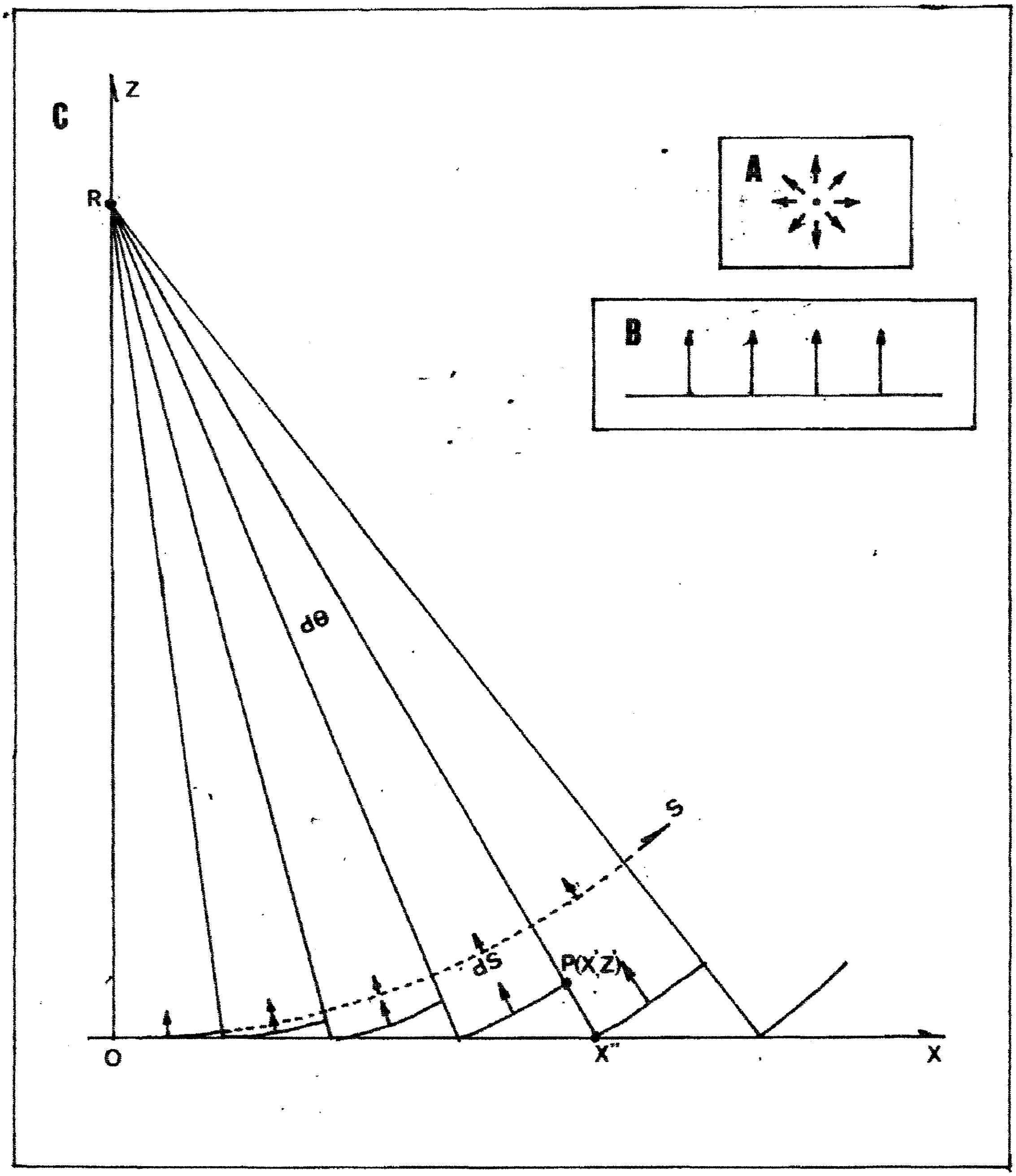

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Fig 6

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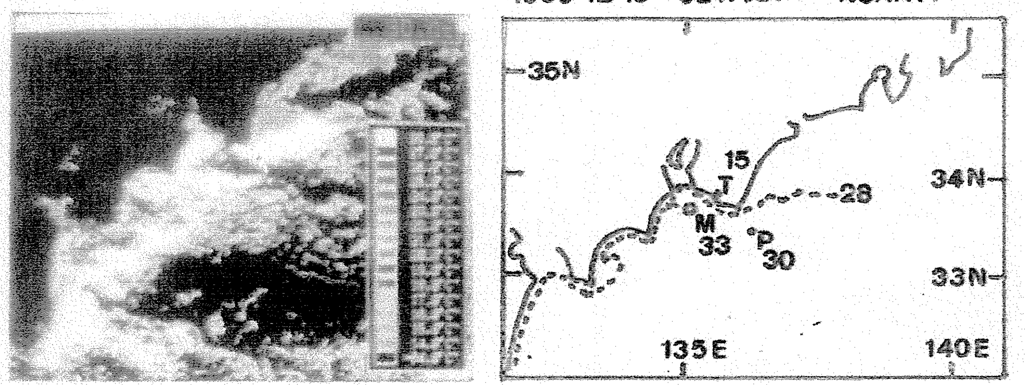

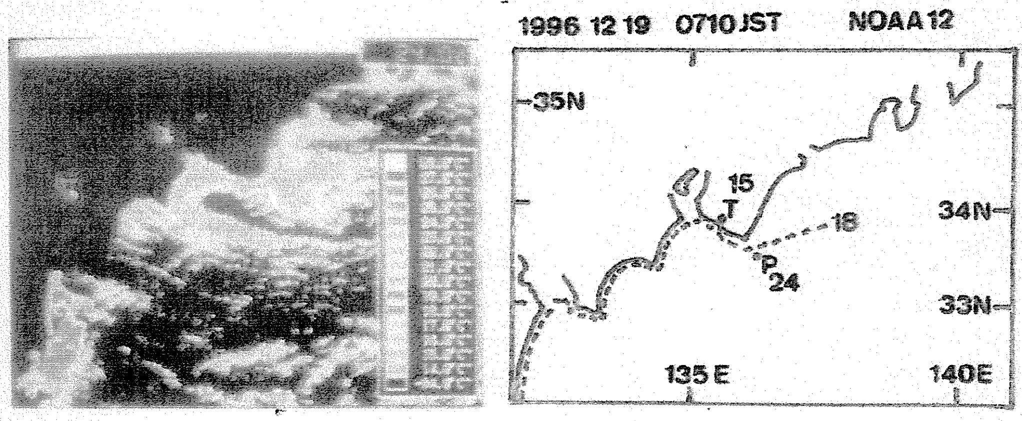

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Fig. 7

1996 12 18 1800 JST SURFACE

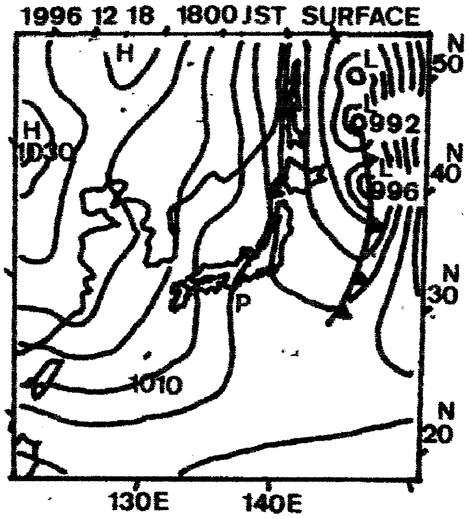

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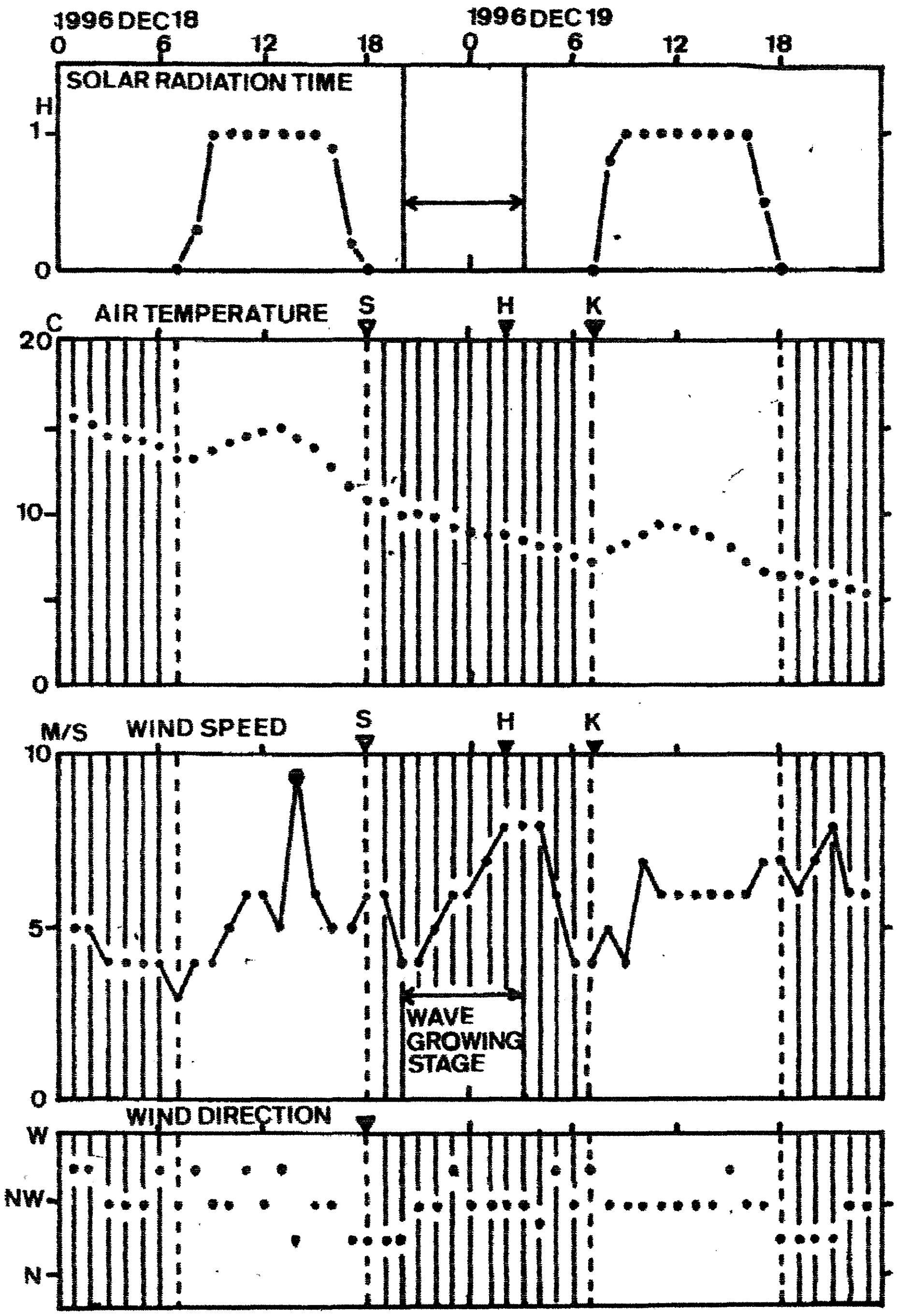
Fig. 8



TIME SPACE SCALING OF OCEAN FRONT EVOLUTIONS IN SATELLITE THERMAL PATTERNS DIRECTLY MONITORED

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ABSTRACT

This study concerns on a problem of time space scaling of ocean front evolutions. A theoretical solution of the ocean front model has suggested that the front can be classified by several categories, though the author here considers three typical categories which may be well related to a dynamical understanding of the interested ocean front. The patterns of the oceanic front have been obtained by direct monitoring of the satellites' signals of the infrared band at a station. A set of the signals at an every satellite passage just above the station in the foot print gives the real time sea surface thermal pattern. Several thermal patterns are introduced in order to demonstrate the three categories with some dynamical notes referring to the existing geophysical hydrodynamics. These patterns help us to have our understanding of a linear process, or a weakly nonlinear process, or a strongly nonlinear process corresponding to the monitored patterns of a meandering, or a filamentation, or a gyre formation, For this work, the motions of the waters in the ocean are formulated in a non-dimensional form.

INTRODUCTION

In this work, a part of the author's study on a problem of time space scaling of ocean front evolutions. First, a brief review is noted about the history of the oceanographic observation. Then, a note is given on time space scaling of the intensified current in a western boundary ocean current. The satellite monitoring of the sea surface is the most advanced technique at present to find a variations of the ocean current. On the other hand, there have been developed several theories of the ocean front. The front formed between the coastal water and the ocean water may be seen around the intensified geostrophic ocean current in the area of the western part of an ocean. Directly received signals of the infrared band for detecting the sea surface thermal pattern have been obtained at a fixed station on the coast facing the Pacific by Kyoto University. Some one of the patterns shows a linear process of the ocean front, and the other one shows a weakly nonlinear process or a strongly nonlinear process. This strongly nonlinear process may help us to realize what dynamical process is appeared in the ocean front evolution in the interested sea area where the effects of the coast line and bathymetry are effective to give a meandering, or a filamentation, or a gyre formation. With these study, it should be awared that the ocean front evolution surely be a part of the global resultant process of the waters' motion of the ocean covering about the 70 per cent of the earth's surface.

A BRIEF REVIEW OF OCEAN OBSERVATION

In this work, the satellite data directly received at a station is introduced. Here, it is necessary to give a review of the ocean observation in order to realize what we should evaluate the value of the satellite monitoring of the sea surface thermal pattern.

Several specific ships had been undertaken their scientific expeditions of the ocean as the pioneers. The one, for example, was the RV Challenger (2306ton-UK) in the period from 1873 to 1876. The reports of the RV Meteor(1,178ton-Germany) expeditions during 1929 to 1938 were the detailed descriptions of the Atlantic Ocean at that time. Nevertheless, each one of the diagrams or the charts was a collection of the data obtained not at the same time along the survey lines. Hence, they had forced simply to get an image of a steady pattern of the ocean (for example, Sverdrup et al., 1942; Dietrich,1957). The RV Fram (530ton-Norway), observed what was identified later as one specific data of the ocean internal waves in the polar sea area. There have been built many ships for oceanographic observations since the 19 century. The RV Meteor was the one of them (A picture of the RV Meteor is shown in Figure 1). In the recent years, for example, a quick report issued bimonthly notices to show how fluctuating is the oceanographic patterns in the northwestern Pacific. The author has to notice that each one of the report has contents of flow patterns reduced referring the observed results obtained in the two weeks by the time of each issue. Hence, it is hard to see what dynamical process is appeared in the ocean for the author.

[Figure 1 goes here]

The interested satellites help us to show a global pattern of the meteorological or oceanographical processes. For example, a couple of the NOAA satellite gives information at an every interval of 102 minutes with a certain resolution, for example, in a specific form of about seven minutes signals for ATP-Automatically Transformed Picture. As for the several specific factors oabout each one of the NOAA satellites, for example, (1) orbital altimetry is about 850 km above the earth's ground surface or sea surface, (2) orbital cycle is about 102 minutes (a orbit passing the earth's polear zones), (3) coverage area is about 3200 km square (at passing just above the settled station), (4) resolutions are about 4km of a one pixel size and 0.5 degree of sea surface temperature, and (5) frequency bands are (a) visible band [725-1,000 nm] and (b) infrared band [3,550-3,930 nm]/thermal band [10,566-11,500 nm].

At a station settled on land as a fixed station, it is possible to obtain a set of the real time data in form of signals in the foot print of the satellite covering the station. The GPS system can be used for positioning of a station on bord in the sea. So that, this real time data is useful to see the interested local sea surface thermal pattern at an interval of about 6 hours when the signals are directly received from the couple of the NOAA satellites (cf. Nakamura, 1993; 2000; 2003a; 2003b). Exactly speaking, it takes about 7 minutes for directly receiving of the signals as a set of data in the foot print of a satellite for the author's interested area in order to get a sea surface thermal pattern just at the time passing the satellite after the author's trimming process of the signals. Hence, exactly speaking, the thermal pattern from the satellite even in the interested area is not formed by the simultaneously obtained data. So that, it is only a way to study at present after taking the pattern, for the author's convenience, as a shot obtained at once.

DYNAMICAL CLASSIFICATION OF OCEAN FRONT

There might be various kind of fronts in the ocean (cf. Fedrov, 1986). One of these fronts show, for example, a gap of water temperature, salinity, water density and horizontal shear. These front is exactly to be the location of the maximum gradient of the water temperature and the other factors. Three specific satellite thermal patterns of the sea surface are shown in Figure 3 in a form of a pseudo-colored illustration, and specific patterns of the isotherms for each maximum of thermal gradient are also shown.

Theoretical models have been developed and introduced by this time (for example, Stommel, 1948; 1965). Munk(1950) had developed a dynamical theory for realizing the wind driven circulation on the ocean surface in the Pacific in his synoptic concept. These suggest us to have a key for a dynamical understanding of the ocean current charts. On the otherhand, it is hard yet to establish any theoretical model for a more advanced understanding for helping our present images about what is essential as the trigger of the undulation. A reasonable dynamical background of our understanding could be obtained at watching the satellite thermal pattern of the ocean front obtained from the directly received satellite signals even if the specific ocean current could be assumed to be a geostrophic current which would be just neighbor the ocean front where the maximum of the thermal gradient was found. The author has introduced three categories to classify the ocean front pattern in a scope of geophysical hydrodynamics (for example, Nakamura, 1995; 1996;1998;2000a;2000b).

The patterns in Figure 2 are taken in this work for the author's convenience of his dynamical understading, and these cases may help that the specific isotherm (S – S) or (T – T) illustrated can be realized in a scope of geophysical hydrodynamics. At this time, the author should consider that the ocean front is only a part of the global water motions in the ocean covering the earth's surface.

That is to say, the first category (1) is a linear process that is found at an initial stage of a horizontal undulation of the ocean front induced by a small dynamical disturbance. The trigger of the disturbance possibly (a) meteorological impacts, (b) climatological effects, (c) shearing effects in the ocean waters, (d) bathymetric condition of the crusts

[Figure 2 goes here]

under the sea surface and around the ocean. This linear process can be mathematically approximated by a sinusoidal undulation of a small amplitude. This undulation in the rectangular co-ordinate on the sea surface may be distorted to be a oblique co-ordinate with a time elapse. Hence, the undulation in a rectangular formed area changes its form into that in a rhombic formed area keeping its symmetric property (for example, Nakamura, 2000b). One case of this category is seen at the top of Figure 2.

The second category (2) is a weakly nonlinear process under an effect of shearing force between the coastal water and the ocean water. This can be modeled by a theoretical model of a propagating wave on the ocean front as a densimetric front after applying the perturbation method at reducing the solution in a mathematical form (cf. Nakamura, 1995). One case of this category may be seen at the mid of Figure 2.

The third category (3) is mathematically solved by applying a specific technique to obtain an asymptotic solution of an integral equation (cf. Nakamura, 1998). For this category, a semi-infinite ocean model is introduced with an assumed exponential bathymetry as an approximated continental shelf. An assumption of a two dimensional non-viscous fluid is also for the vorticity equation in an f plane ocean model. The solution shows that the frontal pattern is controlled by the various kinds of the parameters (for example, Grimshaw and Yi, 1990; 1991; Viera,F. and Grimshaw, 1994; Nakamura, 1995; 1996; 1998; Send, 1989). When a case of very small time variations is the equation of motion for the category (3) can be written as same form to the equation for a geostrophic current which has been well known as an elementary factor in oceanography.

The case of the above third category suggests what factors could be effective at considering about the problems related to time space scaling of the thermal patterns which were found in the infrared imageries of the interested thermal pattern.

Each one of the above categories is found in various time scales and specific special scales. The theoretical model gives the solution as a frontal pattern that could be taken an equivalent pattern for the maximum of thermal gradient or a thermal front between the coastal water and the ocean water.

What is shown in Figure 2 is a typical case that an initial stage of the thermal frontal undulations can be approximated by a sinusoidal pattern in the satellite thermal pattern and this approximated dynamical understanding can be supported by a linear dynamical model. Adding to the above, a timely evolution of the thermal pattern shown in Figure 2 can be an illustration of that the initial stage of an frontal undulation (as shown at the top of Figure 2) as a linear process is possible to evolve to a weakly nonlinear process (as shown at the mid of Figure 2) in a time scale of a day or a time scale of 20 hours with a special scale of 100 km. This weakly nonlinear process can be evolved into a strongly nonlinear process of the thermal front as shown at the bottom of Figure 2 in a time scale of a day or a time scale of about 24 hours.

It is sure that there are a minor time and space structure of the thermal front evolution in the actual process which can be understood in a scope of a linearized dynamical model. The weakly nonlinear process (for example, Nakamura, 1995) are frequently found in an any one of the thermal patterns obtained by a directly receiving the satellite signals at a fixed station settled on the coast facing the northwestern Pacific. The nonlinear process as shown in Figure 2 can be understood in a scope of geophysical hydrodynamics (for example, Viera and Grimshaw, 1994; Nakamura, 1996; 1998; 2000b; 2003).

The author has introduced a specific example of the thermal front above. Though, Stommel(1948) has shown what is essential to see the western intensified current in the western boundary of an ocean referring to the synoptic chart of the ocean currents. Munk (1950) has given a model of a wind driven ocean circulation, for example, in the northern Pacific to get a synoptic pattern of the ocean currents. Now, we need it to see what is synoptic. In the cases introduced in work, one shot of the satellite thermal pattern can be directly received and processed in a time scale of about 7 minutes. In Figure 2, each one of the satellite thermal patterns is a trimming obtained out of the foot print of the original satellite thermal pattern. So that, the author here feels that it is necessary to raise a problem about time and special scales of the ocean thermal front evolution in relation to the ocean flow pattern.

Now, the author thinks it necessary to remind that a solution of the equation of motion described by the dynamical factors in a form of non-dimensional expression for each category classified as above. This may help us to consider a dynamical similarity of the ocean front undulation processes in a scope of the non-dimensional analysis. In other words, non-dimensional analysis may give us an understanding of similarity for any scale of the ocean front process, for example, the Kuroshio meandering found in the northwestern Pacific. With the above noted result, he believes that a specific solution for the strongly nonlinear process must be possible to specify some observed process with a scale of several months or several years. It is here essential to remind that the equation for the strongly nonlinear process is formulated in a non-dimensional form (for example, Viera and Grimshaw, 1994). This makes us to believe that any possible dynamical process surely holds the similarity under the assumption. Here, it must be reminded that the interested formulation referred in this work is undertaken on an assumed f-plane instead of the spherical earth's surface as an approximation for a convenience. A more bold approximation might be to take that the ocean currents in the ocean are steady. A simplest formulation for the steady state of the ocean currents can be an approximation to the formulation of the geostrophic current. This steady ocean current has helped to give the starting point of the hydrodynamics of the ocean current as shown, for example, by Sverdrup et al. (1942), without any consideration of the time factor or with an assumption of negligible time derivative of the current velocity in the equation of motion.

It should be here noted that a dynamical solution must be given also for the Kuroshio mandering with a time scale of several months or several years as a successive and extensive work in the next new age. Now, it is necessary to see that the interested ocean front in this work is only a glimpse of the whole of the ocean water motion covering about two thirds of the earth's surface. The author has understanding about what have been developed an advanced numerical techniques for analyzing the ocean in a scope of a global scale, an intermediate scale or a small scale in order to see a more detailed profile of the ocean as a total for application to see the ocean yet it should be promoted much more at present. Each one of the dynamical factors is expressed in a form of non-dimensional expression at describing the equation of motion for the interested ocean front, though the factors are assumed not to be dependent from the time. This technique of non-dimensional expression could be a way to obtain a solution which is applicable to all cases of the ocean front evolution. Then, a more advanced hydrodynamics might be developed for a promoted understanding of what climate change might be closely related to the ocean front or to the ocean current in the world.

CONCLUSIONS

Time space scaling of the ocean front evolution was noted referring to the sea surface thermal patterns obtained by directly received satellites signals at a fixed station settled on the coast facing the ocean. The satellite thermal patterns observed can be well understood in the scope of geophysical hydrodynamics and can be classified into three categories, i.e., (1) linear process, (2) weakly nonlinear process, and, (3) strongly nonlinear process (filamentation or gyre formation). The ocean front should be a glimpse of the water motion in the global scale. The geophysical hydrodynamics should be formulated in terms of the dynamical factors expressed in non-dimensional expressions under some assumed conditions. A notice is that some extensive works should be promoted for a more advanced understanding on the climate of the ocean.

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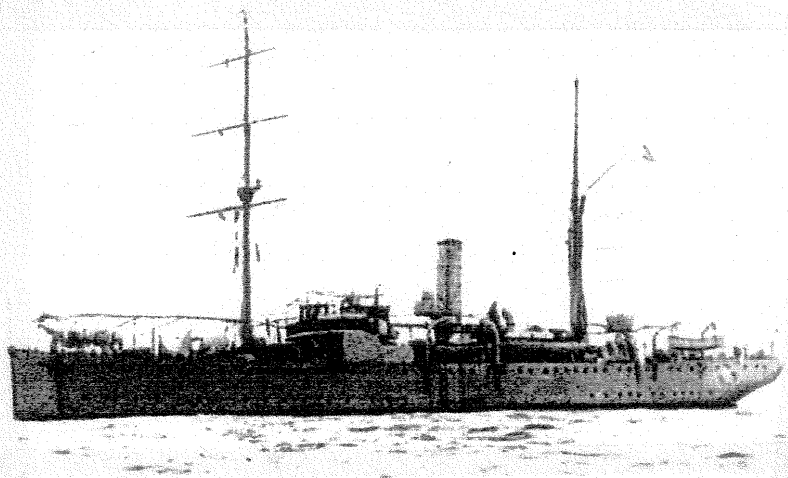

Figure 1. RV Meteor (Germany) in 1927 [cf. Dietrich, 1957]

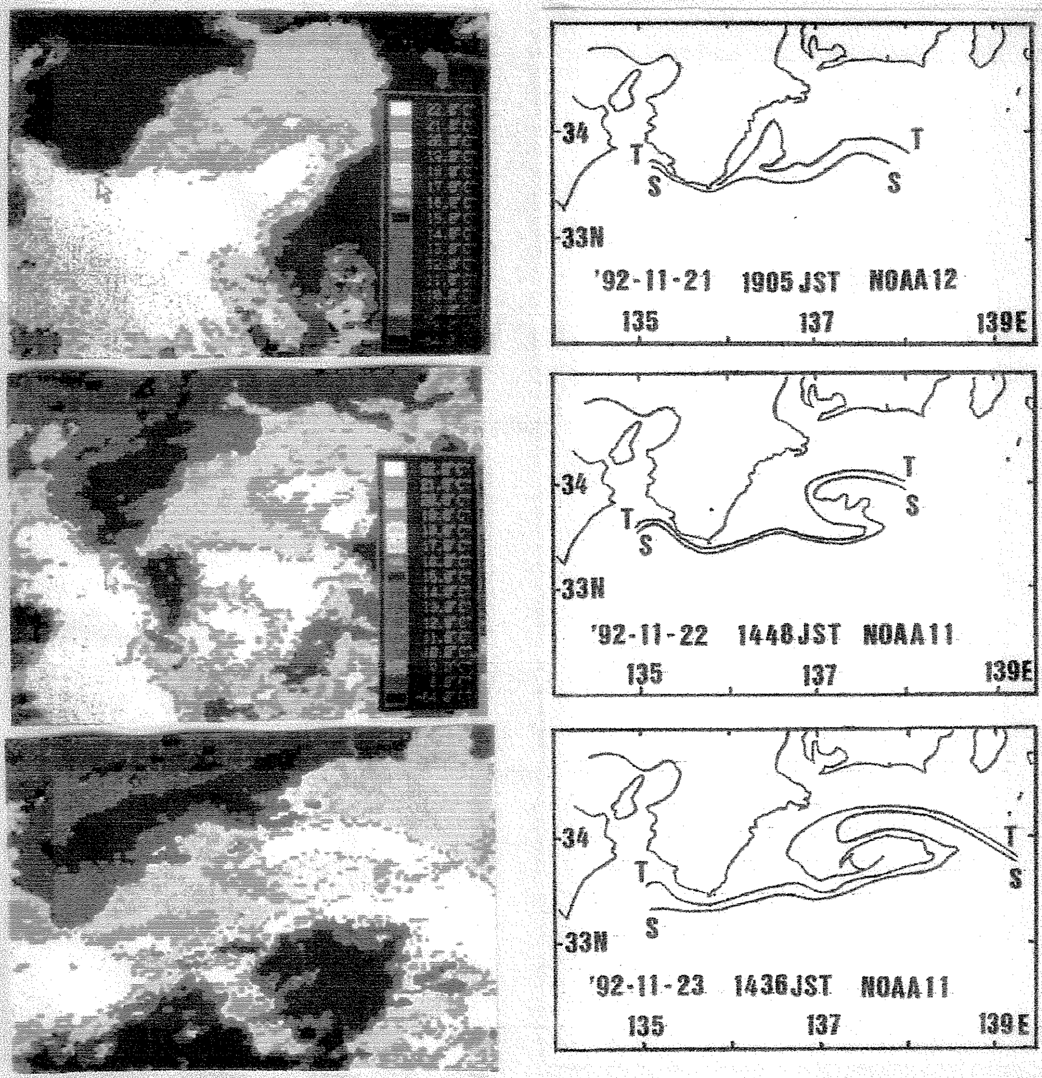

Figure 2. Satellite thermal patterns around the ocean front directly monitored.

Top: for a linear process of the front (S-S) – category 1 at 1905 JST on 21 November 1992 [NOAA-12].

Mid: for a weakly non-linear process of the front (T-T) – category 2 at 1448 JST on 22 November 1992 [NOAA-11].

Bottom: for a strongly non-linear process of the front (S-S) – category 3 at 1436 JST on 23 November 1992 [NOAA-11]

A GEOPHYSICAL HYDRODYNAMIC UNDERSTANDING OF OCEAN FRONT DIRECTLY MONITORED AS SATELLITE THERMAL PATTERN

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ABSTRACT

This work concerns on a geophysical hydrodynamic understanding of an ocean front which has been found after a directly monitored ATP (Automatically Transformed Picture) signal as a real time satellite monitored thermal pattern of the sea surface at each passage just above a station settled on the coast facing the ocean. For the author's convenience, his interest is concentrated to the directly monitored ocean front about the Kuroshio in the northwestern Pacific. The set of the reference data has been obtained by a system with an antenna of a cross bar type and a simple personal computer of a desk-top type. The monitored thermal pattern on the sea surface in the ATP leads to see a timely and spacial evolution of the Kouroshio front as an ocean front. Each of the monitored thermal patterns of the sea surface in the western Pacific is consistent to what is a linear or weakly nonlinear or a strongly nonlinear process as a solution of hydrodynamical geophysics. Some notices are given for a more advanced research expected in future.

INTRODUCTION

A real time satellite monitoring of thermal pattern of the sea surface has been seen for realizing the various processes in the ocean. In this work, a geophysical understanding of the ocean front is the focus of the interest.

The author has studied the sea surface thermal pattern around the ocean front monitored as a series of a set of the real time signals for ATP from a couple of the NOAA satellites, especially in an area covering the northwestern Pacific. Even though, there have been seen many works of satellite oceanography by using the AVHRR (Advanced Very High Resolution Rader). Here, it should be noted why the author has monitored the ATP signals instead of the AVHRR signals. That is, this work was started first to monitor some specific hazardous signals by utilizing a real time monitored signal from the satellite after directly receiving of the satellite signals at the passage of a station settled on the coast facing an ocean, for example, the Pacific. The signals which are directly received are processed for visualizing the sea surface thermal pattern just after several minutes of the satellite passage above the settled station. This makes us possible to see the other related processes just at each passage of the satellites. This technique is now possible for personal or public uses with an easy operation.

Theoretical studies has been promoted especially on the ocean front in relation to the boundary condition of the coast, bathymetry, vorticity or of the shear found just around the front formed between the coastal water and the oceanic water in a scope of geophysical hydrodynamics. These studies make us possible to consider a classification of the evolution of the ocean front with a theoretical background of dynamical geophysics.

DIRECT SATELLITE MONITORING OF SEA SURFACE IR DATA

In order to monitor the ocean front referring to the thermal pattern obtained by the directly received APT signals. The signal processing is undertaken by a system consisted by an antenna, converter, infrared signal transform software, transformed signal processing software for a display of the thermal pattern on the sea surface in the foot print of the sensor mounted on each of the satellites. With some specific skipping procedure, the reduced ATP can be well processed for the purpose by a simple system with a personal computer of a desk top type. This system is essentially possible to obtain the signals every six hours at each passage of any one of the couple of the NOAA satellites.

As for direct monitoring of the sea surface thermal pattern, the author has been presented and published for these years referring to the data obtained directly from the couple of the NOAA satellites at a station fixed on the coast facing the NW Pacific.

The system has introduced first by the author(Nakamura, 1990), and then, his extensive works has been presented(for example, Nakamura, 1990; 1992; 1993a; 1993b; 1995; 1996;1998a; 1998b;1999; 2000a, 2000b; 2001, 2002).

As for the studies on the signals of the visible band, it can be taken as a problem, at present well known as that, the sun glittering on the sea surface which was first monitored by an air cruft and studied by Cox and Munk (1954a, 1954b). There have been presented many works as extensdive contributions by the successive scientists since then. The author now has interested in the problems on the sea surface thermal patterns which have been monitored on the basis of a set of the directly monitored satellite signals at a fixed station after processing the satellite data for the signals of the infrared band.

Hereafter, the author gives his interest to the cases of the infrared band.

CLASSIFICATION OF OCEAN FRONT PATTERNS

A frontal line is formed between the coastal water and the ocean water (cf. Fedrov, 1986). This front shows the gap of water temperature, salinity, water density and horizontal shear. This front changes time to time and it is at present hard to predict any dynamical processes what have been seen in the evolution of the front. For the author's convenience, he names it as the ocean front where each of the thermal and haline gradients on the sea surface is the maximum. That is a densimetric front. This suggests that the intensified current near the western boundary of the ocean is expected just neighbor the ocean front if the current can be taken as a geostrophic current (cf. Stommel, 1948; 1965). With the above assumption, it may be possible to consider a classification of the ocean fronts found out of the thermal pattern obtained by the satellite signals directly received just at passing above the station settled on the coast facing the ocean. The ATP could be one of the convenient data sources.

There might be various criteria to classify the ocean fronts or the ocean currents. Now, the author introduces three categories which can be well understood mathematically. That is, (1)a linear process, (2)a weakly nonlinear process and (3)a strongly nonlinear process(for example, Fedrov, 1986; Nakamura, 2000b).

LINEAR SHEARING PROCESS OF OCEAN FRONT

A linear process is found at an initial stage of a horizontal undulation of the ocean front induced by a small dynamical disturbance. In this case, a pattern of a small amplitude of a sinusoidal undulation becomes a spacially distorted pattern just similar to a linear distorting process of an elastic body under an simple shearing effect, then, a rectangular segment of the sea surface patch is distorted its shape with a time elapse to be a rhombic segment(for example, Nakamura, 2000b).

WEAKLY NONLINEAR PROCESS AND HORIZONTAL SHEAR

Garvin(1984) has developed a theoretical model of a propagating waves on the oceanic densimetric front by applying the perturbation method. This model can be helpful to realize an undulation of the front as an approximated solution of a meandering oceanic front. The application of the perturbation method gives an one value function as the solution, for which the nonlinear equation of motion is solved essentially by techniques for the linear problems. The solution demonstrate the relation of the wave length of the undulation and the propagation speed of the wave as the disturbance of the front(cf. Nakamura, 1995).

STRONGLY NONLINEAR EVOLUTION OF OCEAN FRONT

The meandering process of the ocean current, for example, that of the Kuroshio in the northwestern Pacific, has been known on the bases of the observations by the survey ships. This process is understood as a nonlinear process which is described by a nonlinear equation of motion in a scope of geophysical hydrodynamics. A semi-infinite ocean model is introduced with an assumed exponential bathymetry as an approximate continental shelf. An assumption of a two dimensional non-viscous fluid is also for this problem, then, a reduced form of a vorticity equation of an f plane is obtained (cf. Grimshaw and Yi, 1990; 1991; Nakamura, 1998b). Then, the vorticity front can be corresponding to the ocean front formed between the coastal water and the ocean water with an assumption of hydrodynamical continuity about the front. Adding to the above, this front can be taken as the thermal discontinuity between the two waters in the ocean which is found as a thermal track of the maximum of the sea surface temperature in the thermal pattern obtained by a set of the directly receiving signal from the satellites.

Using an equivalent Lagrangean equation under the given condition for the front, a solution is obtained to see about the control factors for the front, those are, coastline, speed of the flow on both sides of the front bathymetric and boundary conditions (cf. Send, 1989).

In order to obtain a mathematical solution it is more convenient to solve the reduced vorticity equation rather than to solve the primitive equation of motion even under some given conditions.

The equation is expressed by an approximated expression in a form of a differential equation. This equation can be rewritten when a Green function for a elmholtz operator is introduced. Then, the solution is written in a form of that including the terms of some double integrals after applying the Green's integral theorem. This solution is consited by the two terms of the vorticity anomary and of topographic effect. In order to have the final form of the solution, the two double integrals what are above noted should be solved by an application of a mathematical technique for obtaining an asymptotic solution.

In order to get a numerical solution, a contour integral is considered as an approximation in a form of a set of the connected line segments along the contour. The contour is taken to avoid the logarithmic singularity which is troublesome during the mathematical process for obtaining the solution (cf. Viera and Grimshaw, 1994; Nakamura, 1998b; 2000a; 2000b).

EVOLUTION OF FRONT AND NONUNIFORM BATHYMETRY

Looking at the solution of the above vorticity equation (cf, Viera and Grimshaw, 1994; Nakamura, 1998b; 2000b), a significant effect of a non-uniform bathymetry can be seen.

In this case, (1)the bathymetric cross section of the continental shelf is assumed to be given by a Gaussian function. For a convenience, (2)the water depth on the coast is not to be zero. (3)Distance of the front from the coastline is also one of the most effective factors at considering about what is governing the meandering of the Kuroshio front as a vorticity front or a thermal ocean front. (4) Water mass transports on both sides of the front should be here introduced as one of the important factors. (5) Difference of the two water masses is also important at realizing the evolution process of the vorticity front in the scope of geophysical hydrodynamics or the thermal front in the sea surface infrared pattern obtained by the satellite. These factors should be well considered to realizing what the solution is demonstrating for the evolution of the Kuroshio front.

CONSISTENCY BETWEEN SATELLITE THERMAL PATTERN AND GEOPHYSICAL HYDRODYNAMICS

First, a linear process expected theoretically is found and is taken to be consistent in the thermal patterns of a scales of about 10 km and of several hours for the dilectly monitored satellite signals, for example, in the Kuroshio flow area in the northwestern Pacific. Secondly, a weakly nonlinear process reduced by a solution applying a perturbation method for the equation of geophysical hydrodynamics is understood to be consistent to some cases of the satellite thermal patterns of the ocean front as the Kuroshio front undulating in a special scale of several tens kilometers with a time scale of several hours. Thirdly, a strongly nonlinear process as a solution obtained by applying an asymptotic integral gives us some satellite thermal patterns, for example, in the Kuroshio area. This solution for the strongly nonlinear process suggests a possible process actually expected to be found in a case of the directly monitored stelite thermal patterns. This shows that some possible processes can be seen various cases of frontal undulations to form some filamentation. This filamentation is controlled by the vorticity on both side of the front, the volticity difference, the distance of the front from the coast, the bathymetric pattern on the continental shelf, and some other factors. A case of these factors gives a consistent to give an understanding of a counter-clockwise eddy formation which can be seen in the satellite thermal patterns. This eddy formation are in a special scale of several hundred kilometers with a time scale of about several days or several weeks in the satellite thermal data. In the south of the Japanese Islands, this eddy formation is frequently found in a year. Some other case suggests a formation of a clock-wise eddy, which could be appeared as a strong effect of a conical pattern of the continental shelf.

Lastly, a more advanced dynamical study should be promoted for realizing exactly the interested thermal pattern based on the bases of the infrared satellite signals. Adding to that, the frontal activity should be understood the factors which are controlling the ocean water motions in a globalscale.

Then, we could have understanding the dynamical pattern in relation to the related problems of the other scientific fields and to find what application can be possible for helping the human activity.

CONCLUSIONS

This work is a notice to consider about an geophysical hydrodynamic understanding of the directly monitored satellite thermal patterns of the ocean front. The solution of the vorticity equation for the vorticity front is introduced in order to what processes found in the satellite thermal patterns could be taken to be consistent. First, a linear process is considered for some cases of small scale undulation of the interested front. Secondly, a weakly nonlinear process is introduced for a possible key of filamentation. Thirdly, strongly nonlinear process is introduced for a dynamical understanding of some processes at formation of eddy under some strong effects of the continental shelf. Vorticity of the ocean water off the vorticity front is, naturally, effective at considering any processes of the Kuroshio meandering as the ocean front undulations.

An advanced study should be promoted for a more exact understanding of the ocean front. An application of the advanced study should be for helping the human activity.

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Monitoring of Satellite Thermal Basin in a Slope of Mountain Range

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Abstract - A satellite monitoring of thermal pattern in a basin of a mountain range and its model are introduced in order to show a thermal patch in the basin. In a scope of radiation of infrared beam as a problem of thermodynamic process for the thermal patch found on the land surface, a simple model is introduced with an assumption of the earth's surface as a black body. This model helps us to see what physical factors can be effective for the hot area of the patch in the thermal pattern directly monitored by the author.

Keywords: Satellite monitoring, infrared radiation, land surface, black body, thermal basin.

Introduction

In order to realize a hot area of a patch in a basin on a slope of a mountain range, a simple model is introduced. This is raised by the author when he had been monitoring a series of satellite thermal pattern on the land surface. A hot area in the interested basin was once found in the thermal pattern found after processing the directly received signals of a satellite. The author introduces a model for a radiation out of the land surface as a black body. This model is supported by the monitored thermal pattern of the interested area.

Concept of Modeling

In this work the author notes on a problem of a satellite thermal basin in a slope of mountain, especially, snow-covered concave area in a basin on a slope of a mountain range. The author has had his physical understanding of this apparently abnormal pattern. In some other similar cases were the thermal plateau and thermal pinnacle on the ocean surface which had been reduced after processing the author's directly received satellite signals for monitoring the sea surface pattern. Then, the author has his idea to introduce a model for a problem of infrared radiation out of a black body as the earth's surface.

The author unfortunately has never heard of any other scientific work related to this problem in relation to thermodynamics of infrared radiation out of the earth as a black body in order to realize any physical processes on the sea surface.

Monitoring of Thermal Patch on Land

First, a model is introduced in a simple geometrical model for a basin in a slope of mountain range. It is necessary to consider a combined effect of several factors which are infrared radiation out of a slope of mountain range as an assumed black body. The infrared radiation transfers its energy as a form of radiated beam normal to the surface of the model basin. When the beam out of the basin concentrates just neighbor the thermal sensor mounted on a satellite with a polar orbit, the thermal pattern covering the area of the interested basin shows an unexpected abnormal high temperature.

This abnormal high temperature is a result of monitoring the thermal pattern on the land and the ocean. As for the problems on the ocean, the author has had reported and noted by this time. These apparently abnormal thermal patterns must have been taken not to be obtained under a correct operational condition, though the author has found that such the thermal pattern has been monitored under the normal operation for the direct receiving of the satellite signal at the station settled on the land just neighbor the ocean.

Radiation out of Black Body

For this problem, it is considered to be effective at understanding a thermal patch of a high temperature in a basin in a slope of mountain range on land. Then, an application of the physical criteria for radiation could be introduced for the considering problem. That is, an application of Kirchhoff's law.

Planck's radiation law tells us that the intensity of radiation out of the surface of the black body in a unit time for a unit area is well related to the factors, that is, Planck's constant $h=6.55x10^{-27}$ ergsec, propagation speed of electromagnetic ray c as$3x10^{10}$ cm/sec, Boltzmann constant $k=1.37x10^{-16}$ erg/deg, and the absolute temperature T of the interested material of the black body. Then, Planck's formula for the interested radiation between the intensity B_1 and wave length of radiation λ as follow;

$$B_1 = [2hc^2/\lambda^5]\,[(\exp(F_1) - 1)^{-1}] \quad \ldots\ldots (1)$$

Where,

$$F_1 = [hc\,(\lambda kT)^{-1}] \quad \ldots\ldots (2)$$

Total radiation intensity B is obtained by integration B_1 for $0<\lambda<\infty$. After integration, It is reduced the following form with the relation $\lambda\,\nu = c$ (where, ν is frequency of the interested electromagnetic beam.

Then, total radial radiation flux **B** is described as

$$\mathbf{B} = \pi B = \sigma T^4 \quad \cdots\cdots (3)$$

This relation of **B** and T is called generally as Stefan-Boltzmann's law for what the author interested in is expressed as $\mathbf{B} = \sigma T^4$ with $\sigma = 5.70 \times 10^{-5}$ erg/cm^2/sec/deg.

Concentration of Beam

Then, the total radiation flux in the author's interest is proportional to T^4, and, then an important relation is reduced as follows, i.e.,

$$d\mathbf{B}/\mathbf{B} = 4dT/T \quad \cdots\cdots (4)$$

This relation is independent of the wave length of the beam.

When the satellite monitored thermal pattern includes a hot area of 40^{o}C (or 313K), and the ambient area of 0^{o}C (or 273K), then, a numerical application of the above case is read as that "When dT=40K and T=273K, then, dT/T=0.146, and **dB/B**=0.584." This means that the beam out of the interested basin concentrated at the rate of 0.584 at one of the pixels in the directly monitored satellite thermal sea surface pattern.

In a case of the beam focusing at the sensor mounted on the satellite, it is evaluated Numerically though it is hard to realize under the natural state around the actual earth. In this work, simply the case of the satellite monitoring of the land surface but of any area in the planetary space.

This thermal anomaly of 40K had been supported by the practical satellite monitoring of the thermal pattern covering a snow covered basin in a slope of mountain range, when the author has directly monitored the earth's surface to find what noted first under a normal operation. One of the typical examples is shown in Figure 1, which was obtained after processing the directly received signal of the satellite NOAA-14 at the time passing the station on the coast facing the Pacific. At the same time, the signal for the visible band was processed to obtain simply to show a topographic pattern.

Specific Thermal Basin

The thermal basin in a slope of a mountain range might have been taken as a thermal pattern which should be skipped not to be a normal result from a satellite signal, though the author has shown a physical illustration of this thermal pattern as noted as above in this work. The model introduced here shows that this apparently abnormal high temperature distribution in a part of a basin in a slope of mountain may appear as a thermal patch in the satellite thermal monitoring of the infrared beam. This apparent abmormal hot area is outside of the scope of radiated beams' intereferometric process. So that, for example, a SAR(Side-Scan Aperture Rader) system might skip or kill an apparently strange thermal Pattern even though this infrared thermal pattern out of the data set at monitoring by a satellite or by an aircraft even though what valuable information is in the thermal pattern.

Conclusions

A simple model was introduced in order to have a physical understanding about what was found during the author's satellite thermal monitoring of the infrared beam. As for the case of a thermal hot patch in a basin on a slope of a mountain ridge, the model is more helpful for illustrating possible mechanism after introducing a model of an infrared beam radiated out of the land surface as a black body. Even in a case of a snow covered basin as a hot patch in a satellite monitored thermal pattern, the model and the monitored result is well supported each other to demonstrate both of them as the consistent illustration. For practical applications, it is necessary to promote this work for a more advanced stage.

Lastly, the author has to express his appreciation as that this is a part of the extensive contributions of the research project which started in Kyoto University.

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Note: Full length paper (Five pages at most) – Deadline-20April 2007.

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Contents:

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2. one figure sheet with a caption as a part of the text file in the format of PDF.

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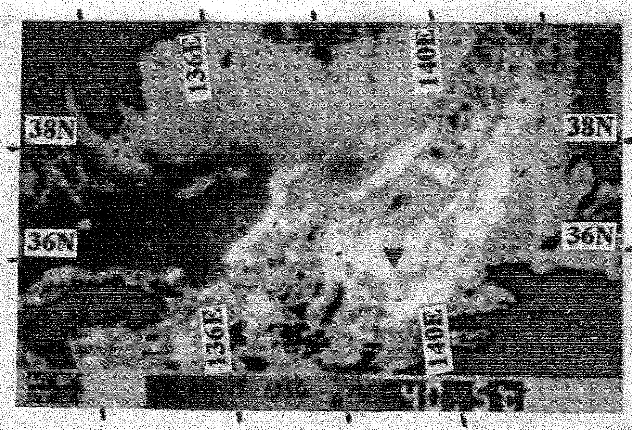

Figure 1 An example of a thermal basin in a slope of mountain range covered by snow sheet, which was obtained by a directly monitoring of the satellite signal out of the earth surface in the infrared band at 0454-UT on 1996 April 15.

(1) A hot spot of 40.5^{0}C in the thermal basin is at the location of a red triangle.

(2) A thermal basin (higher than 40^{0}C) is shown by a white patch on land (in the range of 20 to 40^{0}C).

(3) The sea area lower than 20^{0}C (blue) around the land is partly covered by the clouds (black).

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INTERNATIONAL ACTIVITY – Shigehisa Nakamura 2007 Sept 10

1. 71Aug01-71Aug19 IUGG General Assembly, Moscow, USSR
2. 72Aprx1-72Aprx2 Congress on Ocean Development, Keidanren, Tokyo#
3. 74Jan25-74Feb03 IUGG Tsunami Symposium, Wellington, NZ
4. 77Mar21-77Apr01 IUGG Tsunami Symposium Ensenada, Mexico
5. 78Jun10-78Oct10 *Visiting Senior Fellow, Hawaii Univ., HIG, Hon, HI
6. 79Aug24-79Sep05 Pacific Science Congress, Khabarovsk, USSR
7. 80Jul26-81Jan21 *Visiting Scientist, CSIRO Perth(Div.LRM), Australia
8. 82Aug15-82Aug22 Tsunami Soc., Honolulu, Hawaii, USA
9. 83Aug13-83Aug28 IUGG General Asembly, Hamburg, West Germany
10. 84Dec09-84Dec15 Seminar/Workshop on Preparedness for Geologic Disasters in Southeast Asia and the Pacific Region, Manila, Philippines
11. 85Aug03-85Aug09 Joint Assembly IAMAP/IAPSO, Honolulu, HI, USA
12. 87Aug16-87Aug24 IUGG General Assembly, Vancouver, Canada
13. 88Mar18-88Mar25 EuropeanGeopysicalSociety(EGS) General Assembly, Bologna, Italy
14. 88Nov14-88Nov21 NOAA Int.Conf.on Tidal Hydrodynamics(NBS/NIST) Gaithersburg, MD, USA
15. 91Aug17-91Aug24 IUGG General Assembly, Wien, Austria
16. 91Sep20-91Oct05 Int.Workshop 'Waves and Vortices in the Ocean and their Laboratory Analogues, Vladibostok, Russia
17. 92Apr06-92Apr10 EGS General Assembly, Edinburg, UK
18. 92Jun01-92-Jun05 Pacific Congress on Marine Science and Technology, (PACON), Kona, Hawaii, USA
19. 93Jun13-93Jun18 PACON93 China Symposium, Beijing, China
20. 94Jul02-94Jul09 PACON94, Townsville, Queensland, Australia
21. 94Sep20-94Sep27 InternationalSymposium on Marine Positioning 1994 (INSMAP94), Hannover, Germany
22. 95Apr02-95Apr09 EGS General Assembly, Hamburg, Germany
23. 95Jun05-95Jun10 Int.Workshop 'Boundary Effects in Stratified and/or Rotating Fluids', Sankt-Peterburg(Pushkin-Tsarskoi Selo), Russia
24. 95Aug09-95Aug14 IAPSO(IUGG) General Assembly, Hon, HI, USA
25. 96Mar04-96Mar10 Oceanology International 96, Brighton, UK
26. 96Jun17-96Jun23 PACON96, Honolulu, Hawaii, USA
27. 96Jul20-96Jul26 AGU-WPGM'96, Brisbane, Australia

28.96Aug12-96Aug18 Pacific Ocean Remote Sensing Conf.(PORSEC96), Victoria, BC, Canada
29.97May10-97May14 Oceanology International 97 Pacific Rim, Singapore
30.97Jun30-97Jul04 Joint Assembly IAMAS/IAPSO, Melbourn, Australia
31.98Jul21-98Jul24 AGU-WPGM'98, Taipei, Taiwan
32.98Jul27-98Jul31 PORSEC98, Quindao, China
33.98Oct12-98Oct15 ICHD98, Seoul, Korea
34.99Mar22-99Mar26 PIERS1999, Taipei, Taiwan
35.99Jul19-99Jul24 IUGG99 General Assembly, Birmingham, UK
36.00Mar25-00Apr01 ISRE(Int.Sym.Remote Sensing Env.), Cape Town, SA
37.00Dec03-00Dec08 PORSEC2000, Panaji, Goa, India
38.01Jul08-01Jul12 PACON2001(Jul8-11), Burlingame, Calif., USA
39.01Jul15-01Jul19 IAMAS2001(Jul.10-18), Innsbruck, Austria
40.02Feb11-02Feb15 AGU-Ocean Sciences 2002, Honolulu, Hawaii, USA*
41.02Jul01-02Jul05 PIERS2002, Cambridge, MA, USA
42.02Jul21-02Jul26 PACON2002, Makuhari, Chiba#
43.03Jun30-03Jul11 IUGG2003, Sapporo, Hokkaido#
44.03Oct12-03Oct16 PIERS2003, Honolulu, Hawaii, USA
45.03Nov30-03Dec03 PACON2003, Kaoshiung, Taiwan
46.04May30-04Jun04 PACON2004, Honolulu, Hawaii, USA
47.04Aug15-04Aug21 ICTAM2004, Warsaw, Poland
48.04Aug28-04Aug31 PIERS2004, Nanjing, China
49.05May23-05May27 AGU Joint Assembly, New Orleans, LA, USA*
50.05Aug23-05Aug26 PIERS2005, Hangzhou, China
51.06Mar26-06Mar31 PIERS2006, Cambridge, MA, USA
52.06Jul24-06Jul27 AGU-WPGM, Beijing, China*
53.07Mar26-07Mar30 PIERS2007, Beijing, China
54.07Aug27-08Aug30 PIERS2007, Prague, Czech
55.08Mar24-08Mar28 PIERS2008, Hangzhou, China##

Note: *xxx – Long Term Visitor abroad

xxx# —served by the Japan National Science Academy

xxx* —visited and participated without presentation

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