STEFAN BOLTZMANN RADIATION
FOR
SATELLITE THERMAL PATTERN
OF
GEOPHYSICAL PROCESSES

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2 0 0 8 JULY 4

PREFACE

PREFACE

This work concerns a finding in "Satellite Thermal Pattern of Geophysical Processes", which could be well to understood as "one of the possible physical processes" when we look at what is described in the "Stefan-Boltzmann's radiation theory".

The author has had continued his research work for updating "monitoring satellite hermal pattern on the sea surface".

This work is a part of the contributions in relation to a research project started at "Kyoto University". The author has had continued the research even after retirement of his official position in Kyoto University.

This work was first aimed to research for national project just after 1945.

Professors Shoitiro Hayami and Denzaburo Miyadi at Faculty of Science had take part of "Geophysical and Biological sections" of the research project in order to help for the national projects of "natural hazards", especially, of "Typhoon Hazards" and "Seismic Hazards including Tsunami Hazards" and of "Sustainable Food Supply".

Professors concentrated first for the urgent requested research works. That is to say, Profesor Hayami had engaged to a research on "ocean currents in coastal zone", and Professor Miyadi had engaged to a reearch on "primary product of marine life".

It was the initial stage of the satellite launching at that time in the world. In order to win the race to launch the first satellite, a heavy stress had been on the shoulders of the scientists to launch by the USA or/and Russia (at that time, the USSR).

At present, as every one knows well, there are many kinds of satellites in operation for various kinds of purpose.

Here, the author has utilized the satellite data directly receiving satellite signal at just passing above a settled station and by using an antenna and software-processing on a personal computer in order to real-time monitoring.

The project requested to the author to promote the research work in order to find what is a way to find a relation between the past ocean data in-situ and the satellite data of the ocean surface.

Now, this work is simply a part of the above noted project. With the time elapse, our research has been promoted to have an advanced knowledge. Nevvertheless, there have been left many problems to be solved for a long time.

The author feels this work as a fruit which as obtained for finding a key for us, though there had been an ambiguity at utilizing the satellite data for geophysical use.

The author appreciates for the NOAA's agreement and the JMA's permission and the related functions.

2008 July 4

Shigehisa Nakamura

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MONITORING OF SATELLITE THERMAL PLATEAU IN RELATION TO CONCENTRATION OF INFRARED BEAMS OUT OF SEA SURFACE WAVES

S.Nakamura
Kyoto University, Japan

Abstract—In order to have a physical understanding of a satellite thermal plateau found on the sea surface at a satellite monitoring, a model of an infrared beam concentration at a satellite out of the water wave facet on the sea surface.

In order to have a physical understand a satellite thermal plateau found on the sea surface at a satellite monitoring, a model of an infrared beam concentration at the satellite out of water surface wave facet is introduced in this work.

A problem is on a satellite detected some beam concentrating infrared beams out of a sea surface water wave facet. Assuming that the sea surface could be taken as a black body in a scope of thermodynamics to radiate a flux of some infrared beams, a sensor of the satellite might detect an anomalous signal. The interested beam could form a caustic (or a focus) at the sensor as an effect of a specific concave wave facet on the sea water surface when each beam is radiated normal to the sea water surface.

Thermodynamics tells us that a radiation follows the Stefan-Boltsmann's law, so that, the relation between an integrated intensity B of the radiation and the water surface temperature T (in Kelvin unit) is well formulated to show the following relation for a mall variations of $\mathrm{d}B$ and $\mathrm{d}T$, as follows:

$$\mathrm{d}B/B = 4\mathrm{d}T/T \quad \text{.......................................}(1)$$

This relation is independent of any frequency of the interested infrared beam radiated out of the sea surface as a black body.

When beams out of the sea surface water wave facet form a focusing point at the sensor mounted on a satellite, the value of $\mathrm{d}B$ should be infinity so that the value of t he $\mathrm{d}T$ is also infinity. In this case, the distance between the sensor mounted on the sat ellite and the wave facet is same to the altitude of the satellite above the sea surface.

When the beams form a caustic to hit the interested sensor of the satellite, and the value of $\mathrm{d}T$ is observed on a sea surface thermal pattern after a satellite monitoring, a degree of the caustic for the concentration of the infrared beams can be evaluated.

When $\mathrm{d}T$ = 5K and T = 273K, then, we have 0.018 as $\mathrm{d}T/T$. This evaluation may be a helpful result that the value 0.018 by part could be caused the existence of the wave facets which are always found on the sea water surface. Any one of the facets should be concave upward. Then, this may give us an understanding of a discrepancy on the sea surface thermal pattern with a temperature parameter after the satellite monitoring of a local sea surface thermal pattern. This may a suggesting for adjusting the thermal pattern obtained after the satellite minitoring system since the starting date of satellite monitoring. The author unfortunately such a thermodynamical understanding has never been payed for attention at the correction of the sea surface thermal pattern obtained by the satellite monitoring.

When dT = 30K, the evaluated value of dT/T is approximately 0.0989 which means the radius of the water surface curvature is near tothe altitude of the satellite above the sea surface. This case is occasionally found under some conditions of the conditions related to meteorology on the interested sea surface.

For example, this case appears in the coastal zone in the northwestern Pacific. The thermal pattern of the sea surface looks like to be a thermal plateau when a distant storm in the subtropical zone is seen and the storm generated disturbances in form of the sea surface water waves are propagating out of the storm area to hit the coastal zone. This thermal plateau is found just under a foot print of a satellite with a clear sky condition. An uniformly atmospheric condition could be similar to find the storm induced sea surface waves on the apparently high temperature field taken to be as a thermal plateau. In the northwestern Pacific, the existence of the typhoon is effective.

The other case is for the cold season in the specific monsoon area. In winter of the northern hemisphere, a developing cold front of the atmosphere near the ground surface could be the most effective at finding the thermal plateau in the coastal zone in the northwestern Pacific.

With the above noted result, we should not yet take it as a convenient way for a detecting the sea surface wave field. At present, there are several factors controlling this appearance, and this problem has to be studied for a practical application to a demonstration of where the thermal plateau is appeared and of how about extent is possible to see a wave field by the satellite monitoring.

2. SATELLITE THERMAL PINNACLE

MONITORING SATELLITE THERMAL PINNACLE IN RELATION TO SPACIAL SPECTRUM OF SEA SURFACE WAVES

S.Nakamura
Kyoto University, Japan

Abstract—In order to realize a satellite thermal pinnacle and a satellite thermal Plateau found on the sea surface, a simple model of an infrared radiation out of the water wave facet on the sea water surface is introduced.

In order to realize a satellite thermal pinnacle and a satellite thermal plateau found on the sea surface, a model of an infrared radiation out of water surface wave facet is introduced in this work.

First, a frame of a modeling in this work is introduced. When a flat sea surface is on the co-ordinate x horizontally, a position of a satellite above the sea surface can be expressed as (x, z)=(0, H) in the orthogonal system of the co-ordinates with the axis z for the axis to be positive upward. In this work, for convenience, a two dimensional problem is considered. 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 a flat plane 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 a beam of an electromagnetic wave in the infrared band.

When a sensor mounted on the satellite is directed vertically downward, the sensor detects the beam radiated vertically out of the flat sea surface.

Assuming an arbitrary function of the sea surface,

$$F=F(x,\ z;\ t), \quad \text{..........} \quad (1)$$

then,

$$H = H\cos\theta + F, \quad \text{for } x = x, \quad \text{at an arbitrary time } t. \quad \text{..........} \quad (2)$$

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

$$(Z-z) = -(1/F')\ (X-x). \quad \text{..........} \quad (3)$$

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 of $Z \neq H$, the hitting beam can not be expected. When this pattern can be taken as a model for a beam radiated out of the sea surface, the beam can 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,

$$S_S = \int_0^{\infty} F(x,\ z;\ t)\ \exp(i\omega t)\ d\omega, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where, the notation ω is for frequency.

This spectral expression has been widely used for studying wave developing process at a fixed position at a time t. Though, this spectral form is not effective for 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, introducing a notation k for wave number,

$$S = \int_0^{\infty} F(x,\ z;\ t)\ \exp(ikx)\ dk, \qquad \text{at } t = t, \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Then,

$$F = \int_0^{\infty} S(k;\ t)\ \exp(-ikx)\ dx, \qquad \text{at} \quad t = t. \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Substituting (6) into (3), it is obtained that

$$(Z - z) = (X - x)\ \partial / \partial x \left[\int_0^{\infty} S(k;\ t)\ \exp(-ikx)\ dx \right]^{-1}. \quad \ldots\ldots\ldots\ldots (7)$$

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

$$(Z - H) = (X)\ \partial / \partial x[\int_0^{\infty} S(k;\ t)\ \exp(ikx)\ dx]^{-1}. \quad \text{(8)}$$

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,

$$(1/R) = (d\theta\ /ds), \quad \text{(9)}$$

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

$$(ds)^2 = (dx)^2 + (dz)^2, \quad \text{(10)}$$

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 (8).

With what the author has studied above, The relation between X and Z is obtained in a simple form, and spacial spectral function at a time t is a function of wave number k in this case. Thence, the expression (8) 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 considers that this interferometry problem is outide of this work. The SAR system (Synthetic Aperture Rader) is for a faint thermal difference so that the author takes it also outside of his interest in this work.

3. WAVE FACET

Monitoring of Satellite Thermal Patch Formed by A Wave Facet Ocean Surface Water Waves

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Abstract— In a case of monitoring a satellite thermal patch, frequently found a wave facets on the sea surface. Assuming a concave facet of a part of the sea surface waves, a simple model is introduced in order to realize that the facet acts a infrared beam out of the ocean surface as a black body. Supporting satellite thermal patterns has been obtained by a direct receiving of the satellite signals. A note is given in relation to spacial spectrum of the sea surface waves.

Key words: Satellite monitoring, infrared radiation, thermal patch, water surface waves.

Introduction

In a case of monitoring a satellite thermal patch which is reduced from a satellite signal of a infrared band directly received at a station settled on the coast facing the oceam, it is frequently found a set of concave wave facets on the sea surface is formed by a coupling of the two water waves. When several conditions are satisfied, the wave facet on the sea surface can be a radiator of infrared beam out of the ocean as a black body. The beam is possible to have a radius of curvature approximately same to the distance between the sea surface of the interested area and the sensor mounted on a satellite.

In this work, a satellite thermal patch problem is concentrated to one case of coupling ocean surface wave facet which has a focusing point or a caustics formation of the infrared beam out of the wave just neighbor the satellite.

Supporting satellite thermal patterns has been obtained by a directly receiving of satellite signals at a station settled on the coast facing the ocean.

Assumption of Ocean Surface Waves

In order to realize a satellite thermal patch. It is assumed that an ocean surface water wave for convenience.

When an arbitrary reference is taken in a Cartesian co-ordinates on the still sea surface as a horizontal plane, it can be assumed to have the x and y co-ordinates on the plane and

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the z axis as vertical upward positive.

Then, it is possible to consider a coupling of two water surface waves to form a set of two waves crossing each other on the sea surface.

Now, the radiation beam out of the ocean surface as the black body can concentrate at a thermal sensor mounted on an interested satellite. And then, the height or altitude of the satellite above the reference H is given and the sensor axis θ referring to the vertical for a plane wave F=F(x; t), as follows cf. Figure 1),

$$H = H \cos \theta + F. \qquad \text{......(1)}$$

A simplest model of the wave facet as a part of the sea surface wave is to consider a water surface wave propagating only along or parallel to the x axis. The effect of the wave facet's curvature is expressed by the derivative of x for a function of the sea surface F'. That is,

$$(Z - z) = -[1/(F')] (X - x), \qquad \text{......(2)}$$

when F=F(x; t), and the orthogonal of the tangent F' at (X, Z)=(x, z) is given.

In the expression of (2), the function F can be written in a form of a spectral function. For example, a Fourier transform of F at t=t can be written by a function S as follow;

$$S = \int_{-\infty}^{\infty} F \exp(-ikx)\, dx \qquad \text{......(3)}$$

At considering a coupled effect of two crossing waves, it can be seen that the effective concentrated beam condition at the sensor of the satellite have to be satisfied the followin g relation, i.e.,

$$(Z - z) = -[1/(G')] (Y - y), \qquad \text{......(4)}$$

when G=G(y; t), and the orthogonal of the tangent G' at (Y, Z)=(y, z).

Physical Back Ground of Modeling

We have a systematic net work of the ocean in a global scale formed by the nations in order to monitor directly continuously by using the research vessels, ships and boats under an international co-operative operation projects.

The scientific oceanographers have learned about the ocean surface waves for more than

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one hundred years by this time. On the other hand, the field of "Hydrodynamics" has a theoretical knowledge about the water surface waves in the deep or shallow waters. This knowledge helps us to understand what is processes of the water surface waves in the sea.

This lead us to consider a concave facet of the sea surface waves which can radiate a infrared beam out of the ocean as a black body. That is, i.e., the ocean surface is assume as a radiator of infrared beam.

When all of the infrared beams out of a concave facet of the interested water surface waves concentrates at the sensor mounted on a satellite, the sensor on the satellite finds a concentrated beam signal to reduce an apparently high temperature on the sea surface. The satellite monitored beam signal and an anomary of the sea surface temperature can be well related at an applying Stefan-Boltzmann's criteria for a black body problem.

In this work, what is important is the following relation between total radiation intensity B and surface temperature T of a considering black body, i.e.,

$$B = \sigma T^4, \quad \text{(5)}$$

Where, the notation σ is a constant.

The following expression can be obtained what relation is between dB and dT;

$$dB/B = 4dT/T. \quad \text{(6)}$$

What above noted is useful for the author's model introducing in this work.

Supporting thermal patterns

There have been obtained several monitored sea surface thermal patters at a station on the coast facing the ocean. This station can only receive the satellite thermal signal at the time of the passage above the station on the polar orbit. Nevertheles, we have no data of the sea surface temperature at that time though a series of the routine observations gives us a collection of the directly observed result during the time period covering that time.

At present, it should be referred to the available data. In future, a data obtained by a more adanced technique. If so, we may expect a much more advanced reference might be taken as a reference.

Apparent Anomaly of Sea Surface temperature

In this work, the author introduces a model for a concave facet on the sea surface. This concave facet can be a part of the sea surface water waves. Asssuming the ocean surface

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as a black body, the facet can be a infrared beam radiator which has a focus just neighbor the sensor mounted on the interested satellite. When the concentrated infrared beam out of the facet with its focus just neighbor the satellite, the concentrated beam is related well related to an apparently high temperature which looked as an anomary in a thermal pattern on the sea surface. Then, this work tells that the concentration of the infrared beam out of the water surface wave is effectively controlled by the function F and G. In other word, the interested spectral pattern for the function F and G governs the curvature of the facet with a concave shape as a part of the sea surface waves.

Conclusions

The author notes what effect of a concave facet of the sea surface waves is. For this purpose, a simple model is introduced with some assumptions. The ocean surface is taken as a black body radiating infrared beam. The satellite polar orbital track hit just neighbor the focus of the facet of the sea surface waves. The curvature of a concave wave facet in a part of the sea surface waves can be described by a spacial derivative of the function F expressing the sea surface pattern. Then, it can be seen that the spectral pattern of the sea surface waves controls the wave facet's normal line to hit the satellite located near the focus of the wave facet. With the consideration of the curvature of the facet, the model in this work can be expressed by an application of Stefan-Boltzmann's criteria. That is, the infrared beam concentration controls the anomaly of the sea surface temperature in the satellite thermal pattern reduced from the directly monitored at a station on the coast.

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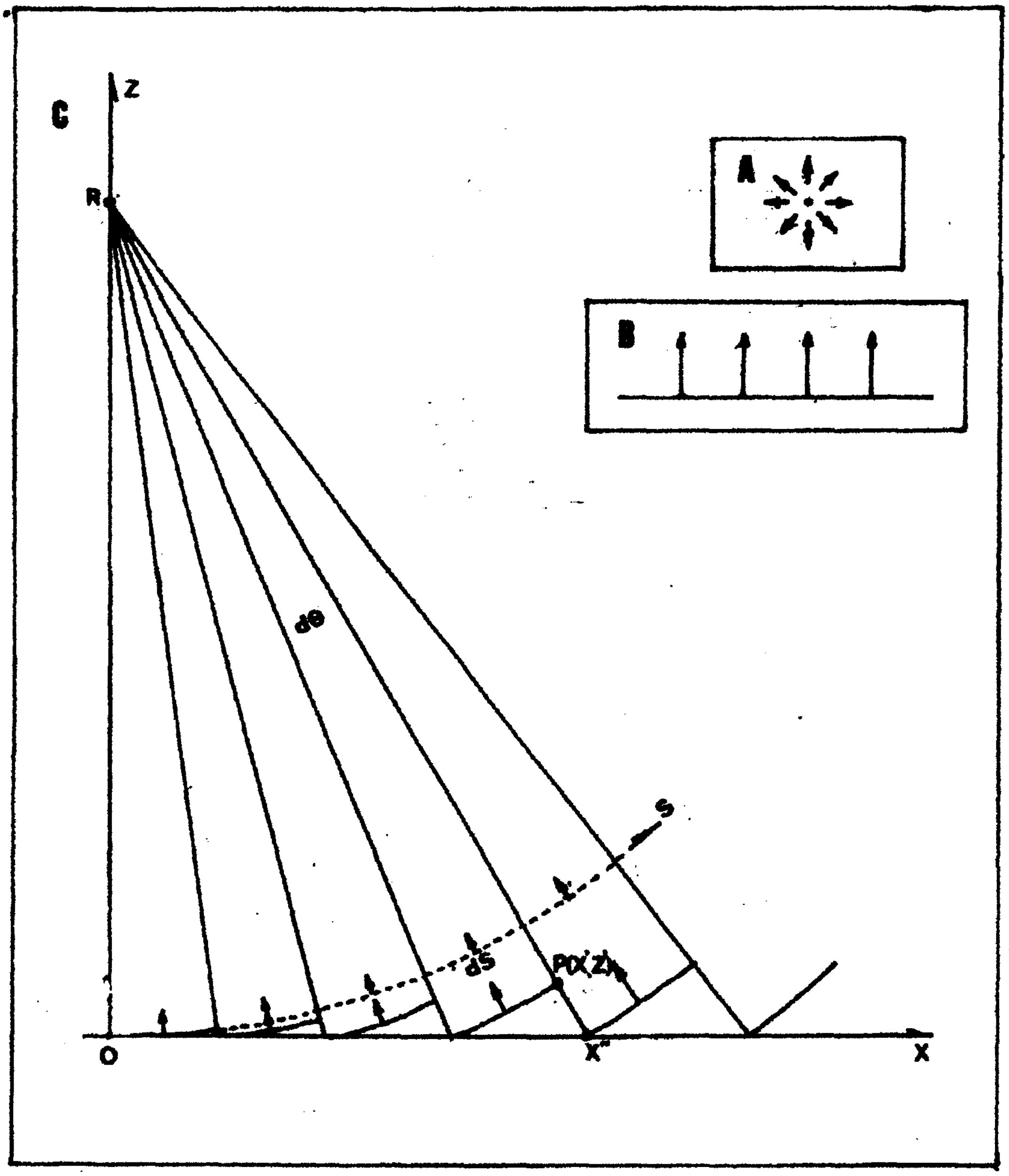

Figure 1 Model for concave facet of sea surface water wave (ds) and position of a satellite (R).

1) Inset A for a point black body,
2) Inset B for a flat surface of the black body,
3) Main frame C for concave facet of sea surface water wave.

4. STRONG WINDS IN MID-NIGHT

Monitoring of Satellite Thermal Patch on the Ocean Surface Generated by Strong Wind Duration in Mid-Night

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Abstract – This work concerns monitoring thermal plateau on the ocean surface generated by a strong wind duration in mid-night time of a cold season. This problem was raised first at a satellite thermal monitoring of a data set directly received signals at the satellite passing time just above the station of a system for receiving the satellite signal directly. There has been introduced a physical model for our understanding of a thermal high in a part of the reduced thermal pattern. The author has considered to introduce an application of Stefan-Boltzmann's criteria for a reasonable model with a radiation of an infrared beam out of the earth's surface.

Keywords: Satellite monitoring, infrared radiation, strong winds, water surface waves.

Introduction

A problem of a satellite thermal patch on the earth surface is introduced, especially, on the sea surface. One of the effective monitoring techniques is a satellite thermal monitoring of the earth's surface by using a polar orbital satellite. It seems in the author's understand that the recent scientific researches are strongly concentrated for the global processes of the earth's natural environmental factors as well as of the artificial factors reduced referring to the satellite monitored data set in a scale of a month or a year for "Climate Change".

For these twenty years, the author has reported about a sporadic satellite thermal pattern on the earth which have had been monitored by a simple system for receiving signals from a satellite directly at a station settled on the earth's surface.

Thermal pattern on the Sea Surface

In this work, the author introduces what had been found on the thermal patterns of the earth's surface which have been reduced by processing the satellite signal directly received.

Referring the data set of the earth's surface thermal pattern covering the station settled on the coast facing on the northwestern Pacific, it is easily found some apparently abnormal

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high temperature in some thermal pattern. The pattern has had been monitored even at a normal operation of the system.

Modeling and Stefan-Boltzmann's Criteria

The author has considered that there might be some physical conditions for reducing a patch of an apparently high temperature on the earth's surface in a thermal pattern reduced out of the directly received satellite signals processing.

The author here introduces a physical model for realizing these thermal patterns. These thermal patterns are, for example, thermal pinnacle, thermal plateau and thermal basin.

Briefly, an application of Stefan-Boltzmann's theoretical criteria for electromagnetic beam radiation out of a black body is introduced in order to demonstrate that this criteria can be helpful at physical understanding of the thermal pattern on the earth surface.

The application of Stefan-Boltzman's criteria for the considering thermal pattern should be effective for the earth's surface to be assumed as a black body, when a coupled effect of a concave earth's surface which concentrates the beam radiation out of the earth surface, i.e., the sea surface or the land surface at a sensor mounted on a satellite.

Reflection of the solar beam in the infrared band out of the earth is effective for this work, and the beam in the visible band is not effective in fact.

Stefan-Boltzmann's Criteria for Radiation

When the earth's surface can be assumed to be a black body, the surface of the black body radiates a electromagnetic radiation beam normal to the surface.

An application of Kirchhoff's physical criteria for radiation is helpful us to realize the model at our physically reasonable understand.

Planck's radiation law tells us that several physical factors help to formulate the law to describe the relation between the intensity of radiation out of the black body's surface in a unit time for a unit area. The specific factors are Planck's constant h, propagation speed c of electromagnetic ray as a wave, Boltzmann constant k and absolute temperature T of the black body. Then, Planck's formula gives a relation for a interested wave length λ of the wave length and the radiation intensity B_1, that is,

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

where,

$$F_1 = [hc(\lambda kT)^{-1}]. \qquad \cdots\cdots(2)$$

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Total radiation intensity B is obtained by integration of B1 for $0 > \lambda < \infty$.

Considering $\lambda \nu = c$(the notation ν is frequency of the interested beam), total radiation flux B is obtained as follow;

$$B = \pi B_1 = \sigma T^4 \quad \ldots\ldots (3)$$

This relation of B and T is called as Stefan-Boltzmann's law for what the author interested in is simply expressed as noted above process, the relation of B and T is written a simple form.

Now, for the author's interested problem, what is important is to know a relation of dB and dT. This relation can be reduced easily and written as,

$$dB/B = 4dT/T \quad \ldots\ldots (4)$$

Concave Facet of Sea Surface Wave

On the ocean(Oxy), it is observe usually a complicate form of the sea surface waves. Assuming an arbitrary function of the sea surface at time t as,

$$F = F(x,\ y;\ t), \quad \ldots\ldots (5)$$

where, the sea surface height above a reference is expressed by the notation z.
Then, a mathematical manipulation gives what the author aimed to get the spectral form.
Assuming a Fourier transform of the Function F, as written following form,

$$F = F_x(x,\ k_x;\ t)\ F_y(y,\ k_y;\ t), \quad \ldots\ldots (6)$$

with wave number k_x and k_y for the x and y component respectively, and,

$$[S_x,\ S_y] = \int_0^\infty F_x(x,\ k_x;\ t)\ \exp(ik_x)\ dx \int_0^\infty F_y(y,\ k_y;\ t)\ \exp(ik_y)\ dy. \quad \ldots\ldots (7)$$

Then, the spectral expression S of the sea surface pattern can be described, i.e.,

$$S = \int_0^\infty \int_0^\infty S_x(x,\ k_x;\ t)\ S_y(y,\ k_y;\ t)\ \exp(-ik_x)\ \exp(-ik_y)\ dx\ dy, \quad \text{at } t = t \ldots\ldots (8)$$

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Now, the radiation beam out of the black body as the ocean surface can concentrate at a thermal sensor for the infrared band, when the height of the satellite above the reference H is given and the sensor axis angle is θ and $F=F(x; t)$ for a plane wave,

$$H = H \cos\theta + F \quad \text{......(9)}$$

Considering a radius of geometrical curvature for a concave sea surface facet as a part of the interested sea surface water waves in the thermal pattern, here, the concave facet of the sea surface at (x, z) in an orthogonal frame of OZX can be expressed as a function of F' (writing $F' = \partial F/\partial x$), and can be expressed in the frame of OZX as following:

$$(Z - z) = -[1/(F')] [X - x] \quad \text{......(10)}$$

for a simplest case of $F = F(x; t)$ instead of the case of (5).

This helps us to realize that a concave facet of sea surface water wave is effective to concentrate the infrared beam radiated out of the sea surface as a black body at the sensor mounted on the satellite.

This concave wave facet was introduced first for a pixel at a thermal pinnacle. Thermal patch group in a satellite thermal pattern is found as a thermal plateau or a thermal basin in a satellite thermal pattern under a natural condition.

Monitored Thermal Patterns

Now, the author introduces an example of the sea surface thermal patterns obtained by the author's directly monitored sea surface thermal patterns at the couple of the NOAA satellite passage above the monitoring station.

In Figure 1, the pattern at the top shows a thermal plateau (30°C at "P") appeared just after the sea surface waves grown or matured after several hours strong winds. The sea surface waves were generated by the wind effects on the sea surface water. In other words, the winds caused to make an ensemble of the concave facets of the sea surface waves. This must be a key to form a thermal plateau in the thermal pattern on the sea surface. One of the thermal pinnacles was at the location of the red mark off the Offshore Tower settled for the operation of Oceanographic Observation of Kyoto University.

A reference of the sea surface temperature 15°C was obtained at "T". This is surely a main cause to form the thermal plateau even in the mid-night of the cold season.

As for the case shown at the top of Figure 1, the relation $dB/B=4dT/T$ is for $dT=30-15$ and $T=273+15$, then, $dB/B=4x(15/288)=0.208$. This means that the concentration rating of the infrared beam out of the ocean surface is evaluated as 0.208, or that the value of the

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beam intensity exceeds as much as 0.208 than that of the reference. This means 1.208 time at the sensor mounted on the satellite comparing to the beam intensity on the sea surface.

In the case of Figure 1, decay of the sea surface water waves might be several hours. The thermal pattern sown at the bottom is normal, so that the next satellite thermal pattern in morning could be taken to be consistent to the sea surface temperatures observed by the research ships in the interested ocean area.

In Figure 1, the atmospheric conditions on the sea surface were caused to find patches of the thermal pattern on the sea surface, even though it is understood that the coast of the northwestern Pacific can be demonstrated as a thermal boundary in the thermal pattern of the coastal zone.

The monitored satellite thermal pattern after the direct receiving of the satellite signals is one of the supporting example for the model introduced in this work. Even though, there are left many problems to be solved at considering a more detailed evaluation of a thermal pattern on the sea surface in the shadow side zone as well as that in the sunny side zone.

The model supports well the satellite thermal plateau under a condition of a strong wind duration mid-night in cold season, when the atmospheric column between the ocean surface and the sensor mounted on the satellite. In this work, no interest of polarity or interferrometric problem is for the beam radiated out of the ocean surface. The author has taken that polarity and interference as the minor factors of considered. Hence, no consideration is in the sight of the author for a system or a problem as seen for SAR data.

Conclusions

Monitoring of satellite thermal pattern, especially a thermal plateau found mid-night in, a cold season is introduced. A model introduced in this work is a model of radiation out of the sea surface which is assumed as a black body with an assumed condition of curvature of a concave wave facet on the sea surface water. Combined effect of radiation out of the ocean and the wave facet curvature on the sea surface water, it easy to see that a satellite thermal plateau monitored directly is well supported by the model even when the thermal plateau is found under a condition of a strong wind duration mid-night in cold season.

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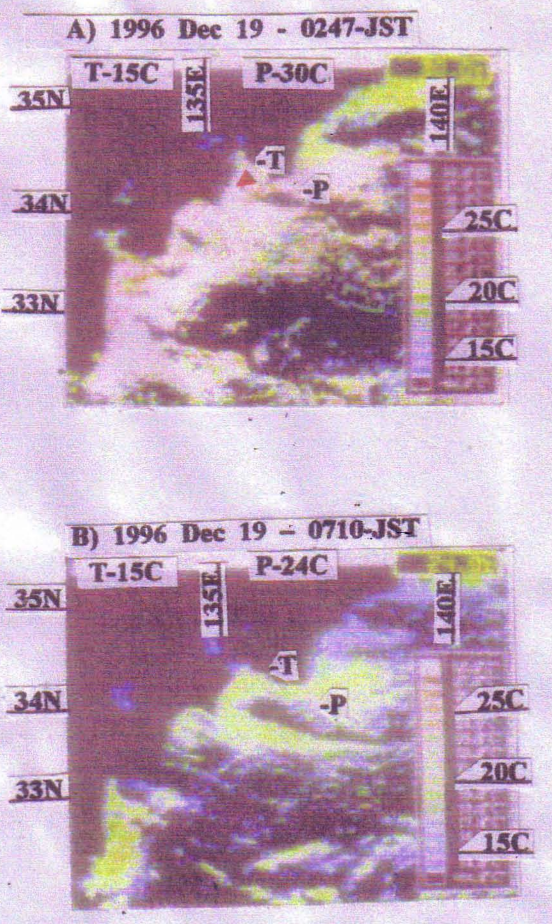

Figure 1 Sea surface thermal patterns obtained by directly satellite nonitoring.
Top: at 0247-JST on 1996 December 19 (NOAA-14),
[showing a thermal plateau of the beams in the infrared band].
Bottom: at 0710-JST on 1996 December 19 (NOAA-12).
[showing a thermal pattern found usually in the infrared band].
Note: the local time JST = GMT(UT)+9 hours].

5. MONUNTAIN RANGE

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 $h=6.55 \times 10^{-27}$ ergsec, propagation speed of electromagnetic ray c as 3×10^{10} cm/sec, Boltzmann constant $k=1.37 \times 10^{-16}$ 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_l and wave length of radiation λ as follow;

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

Where,

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

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

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interested electromagnetic beam.

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

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

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 $\sigma = 5.70\times10^{-5}$ 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.,

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

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

When the satellite monitored thermal pattern includes a hot area of 40°C (or 313K), and the ambient area of 0°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 d**B**/**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:

1. a manuscript in a form of text file in the format of PDF as (xxx.text or xxx.doc).
2. one figure sheet with a caption as a part of the text file in the format of PDF.

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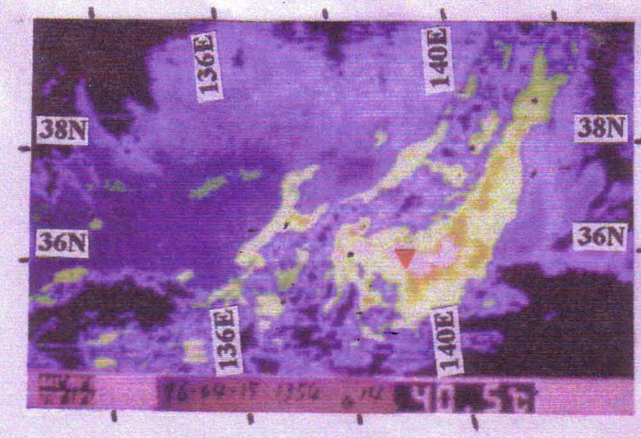

Figure 1 An example of a thermal basin in a slope of mountain range covered by snow sheet, which was obtained by a directly monitoring of the satellite signal out of the earth surface in the infrared band at 0454-UT on 1996 April 15.

(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).

APPENDICES

1. A list of the author's international contributions

2. The author's brief note to background

INTERNATIONAL ACTIVITY – Shigehisa Nakamura

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
55.07Aug27-08Aug30 PIERS2007, Prague, Czech
56.08Mar24-08Mar28 PIERS2008, Hangzhou, China
57.08Apr13-08Apr18 EGU2008 General Assembly, Vienna, Austria

2008 June 29

Autobiography and Curriculum Vitae

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Education

1958 Batchelor of Science, Faculty of Science(Geophysics-Geoelectromagnetism), Kyoto University, Japan
1960 Master of Science, School of Geophysics(Physical Oceanography), Kyoto University, Japan
1963 Finished Doctor Course, School of Geophysics(Physical Oceanography), Kyoto University, Japan [Candidate of PhD as Doctor of Science]
1976 Doctor of Engineering-Civil and Ocean Engineering(PhD), Kyoto University

Affiliation

1963-1997- Disaster Prevention Research Institute, Kyoto University, Japan
1978 - Visiting Senior Fellow, Hawaii University at Manoa, Honolulu, HI, USA
1980-1981- Visiting scientist, CSIRO at Perth, Western Australia, Australia
1992-1996- Director, Shirahama Oceanographic Observatory, Kyoto University

1992- Fellow, Royal meteorological Society, UK
2004- Fellow, PACON International, Honolulu, Hawaii, USA
2007- Fellow, Electromagnetics Academy, Cambridge, Massachusetts, USA
2008-Gratis Member, European Geoscience Union

Prize and Honours:

1983- Prix de la Franco-Japonaise Societe de Oceanographie, Tokyo, Japan

Published materials: Academic papers in Scientific Journals, Proceedings, and others
Scientific Books(Japanese and/English) including "e-Books"
[search Nakamura through the following window, please
->>hhtp:www.piers.org
and/or
->>http://repository.kulib.kyoto-u.ac.jp/dspace]

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I, as Shigehisa Nakamura, declare that my curriculum vitae are correct as seen above.

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