A NOTE TO SOLAR ECLIPS 2009

SATELLITE MONITORING OF SOLAR ECLIPTIC SHADOW ON THE EARTH PLANET SURFACE

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2009 September 20

Second Edition

人工衛星からみた日食2009

人工衛星可視画像からの2009年7月22日の日食の観測

中 村 重 久

2009年9月20日

Preface

This is the second edition of "a note on the satellite monitoring of the solar eclipse track on the earth planet".

A note could be taken as a part of the works in relation to the Shirahama Oceanographic Observatory settled by Kyoto University.

One of the project was started in Kyoto is " Researches on the Ocean Sciences". It was in 1960 when an offshore fixed tower for oceanographic observation. The leaders at that time were Professor Shoitiro Hayami of Geophysics and Profesor Denzaburo Miyadi of Marine Biology.

In advance of the 50years Anniversary of "the Shirahama Oceanographic Tower", we had a chance to meet the satellite monitoring of the solar eclipse.

On 22 July 2009, the solar eclipse track passed just neighbour of the Japanese Islands. This is the first time of the satellite monitoring of "the Solar Eclipse on the Planet Earth".

This solar eclipse might be a tiny impact to "the Geophysical Research" now, but the history of "Physics" tells us that the processes on the planet earth have been governed by The solar system.

Eşsentially, research on the "Solar Eclipse" has been promoted in the fields related to the section of "Astronomy". The 11yeras cycle of the solar polarity is one of the typical effects not only to the geophysical processes but to all of the existing lives on the earth.

This year might be in the year period of solar activity minimum, which could be understood one of the reported results in the European Geoscience 2008 in Vienna noticing a close correlation between the solar activity (referring to the sun spot number index) and the sea surface temperature variations off the Azores.

Professor Hayami, the founder of the Shirahama Oceanographic Tower, once ever had his chance to join a national observation the solar eclipse on an island in a mid of the Pacific to give a contribution in a form of the research paper.

Now, we know a little chance to meet ourselves to see the events of the solar eclipse on the earth surface. Even though, we have be aware that the solar impact is always strong for all of the lives on the earth even when the lives are in any environmental conditions.

The author wishes this note could give you some key to see the effect of the solar activity to the earth in your research.

Director (Last/ Retired)
Shirahama Oceanographic Observatory
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ま え が き

ここでは、惑星地球表面上の日食現象を人工衛星によって捉えた最近の例を紹介する。

本文は、表記の第二版として、初版に一部の加除訂正を加えたものである。

これは、1960年に発足した京都大学における学術的研究の延長線上にあると言ってよい。
この研究計画は、海洋に関する科学的研究を目的として、沖合いの固定した海洋観測塔を利用して、当時の、海洋物理学教授、速水頌一郎と海洋動物学教授、宮地伝三郎とによって、企画され、文部省の研究費をうけて、白浜海洋観測塔を利用して発足した。

白浜海洋観測塔による研究計画60周年を、来年の2010年という目前にして、今年、2009年7月22日に、皆既日食の観測が、日本列島付近のベルト状に延びた地表上および海洋上において可能であった。

この皆既日食が地球上で観測可能な時間および空間は、極めて限られた範囲であるが、長期的な太陽の地球表面の物理現象および社会現象に大きな関連があり、歴史的な視点で捉える必要のある面も認められている。

本来、日食は、天文学あるいは宇宙物理学のなかのひとつの分野であり、太陽物理学の一部であるが、これまでに、太陽活動が11年周期で変動していることが知られている。　さらに、地球上の現象のなかには、この11年周期で変動している例も多く知られている。

ちなみに、ヨーロッパ地球科学連合の2009年総会における、研究発表では、北東大西洋でも、アゾレス諸島沖の定点観測では、2008年までの海面水温の変動と太陽の11年変動周期との間に高い相関があることが指摘されているが、観測期間が数周期の期間に限られている。さらに、長期間にわたる観測の継続が望まれる。

白浜海洋観測塔の設置にかかわった、1960年当時の速水教授は、1900年代初期に、太平洋の赤道域付近のローソップ島における日食観測に参加し、その研究成果を発表している。

さて、われわれは、地球上で、日食現象を体験する機会は、地域的にも、時間的にも、非常に限られている。しかも、日食が太陽活動と深い関連がある現象であることもわかっている。

地球上のいろいろの現象が、この太陽活動の変動現象に密接にかかわっていることも、すでに、知られている。

ここでは、太陽について、最近の研究を述べるのではなくて、2009年の皆既日食の観測の例を契機にして、太陽活動と地球上の環境変動との関連について、これまでより、さらに研究を進展させることが大切である。2009年7月26日の初版の一部を改定して、第2版とした。

ここでは、太陽物理学のなかでも、とくに、日食時における地球表面に認められる月の影を、主題として、のその鍵となると考えられることを紹介して、今後の地球環境の理解への一助とすることにしたいと考えた。今後の関連分野の研究成果に期待をしたい。

元京都大学白浜海洋観測所長

2009年7月26日

Preface

This is prepared for giving a key to those who have interested in the solar activity in relation to the physical process on the surface of the planet earth.

First, a brief note is introduced about the sun-spot number index in relation to the solar activity in a historical review.

Following to this, a theoretical aspect of the solar activity is appears as an introduction to an application of Maxwell equations for a model of the solar activity. The 11 years cycle could be shown in a scope of a magneto-htdrodynamics. With a consideration of polarity, solar activity is demonstrated by the poloidal and troidal field of the sun in a theoretical model.

The main part of this text is the topics of the shadow of the solar eclipse in 2009. This shadow is monitored by a satellite to trace its track along the predicted track in the Northwest Pacific from India to the mid Pacific. Satellite monitoring by the sensor for visible band mounted on the satellite GMS2 was distributed on the Web-site at the courtesy of the Japanese Meteorological Agency. A brief note on the satellite monitoring of the solar eclipse track on the earth planet is given for the scientists who might eager to get the shadow of the solar eclipse 2009 on the predicted track.

The event of the solar Eclipse 2009 was just appeared in in the memorial time period of the international scientific research project in the year 2009 as the Solar Year 2009. The scientific data must be analyzed to find many phenomena and processes as advanced scientific contribution soon.

The author should be expecting this publication to be a key to see the Solar Eclipse 2009 and the related physical processes not only in the sun but on the planet earth.

Successively, satellite thermal monitoring of the ocean surface in the time period of the quiet daily processes is introduced. It was strange at first to find an ocean thermal plateau or an ocean thermal pinnacle in the foot print of the sensor for signal of the infrared band.

These ocean thermal plateau and ocean thermal pinnacle are well understood after an application of the Stefan-Boltzmann radiation theory for the planet earth as a black body.

What noted above should be taken as an extensive part of the scientific research works conducted as one of the projects promoted by using the Shirahama Oceanographic Tower as a offshore fixed station settled by Kyoto University in 1960.

The first stage of the operation at the offshore tower was to obtain the time series data in the ocean and in the atmospheric factors by using the instruments developed in the early age of the oceanography, meteorology and geophysics. The leaders at that time were Professor Shoitiro Hayami of Geophysics had ever joined to a solar eclipse observation in a small island located mid Pacific in the early age of 1900s.

The author has wishing that the many of the scientists surely get the key afte reading this and to waiting for the more advanced scientific contributions in near future.

Shigehisa Nakamura

2009 August 9

CONTENTS

SUN-SPOTS NUMBER AND SOLAR ACTIVITY

1. INTRODUCTION

Solar activity affects strongly to the solar radiation on the earth surface. Solar activity is symbolized to express by "Sun-Spots Number Index" on the bases of the specific observed trend of the sun-spots on the solar photosphere, nevertheless, the solar activity on the solar photo sphere is not so simple. There must be complicated reactions of nuclear energy transfer and of solar magnetic field.

This section is a brief note prepared for introduce a glance of the solar activity in a simple form. Using a simple expression in a form of "Sun-Spots Number Index", it is more convenient, for example, to see what correlation is between the monitored the index as a solar activity in relation to the sea surface temperature at a station in the ocean.

First of all, the author introduces a short note on the monitored solar cycle as a part of astronomy. It must be familiar to the scientists what the author notes as a briefing of the astronomical knowledge especially for realizing what should be considered about the relation between the sea surface temperature variations at Azores in the Atlantic Ocean and the sun spot number index variations during the time period of 1960 to 2007. A notice is given whether the fitting trends of the two factors could be possible to extend for the following several ten years.

2. SOLAR CYCLE

A convenient index of the solar cycle is the sun spot relative number, for example, Chapman ever written in his publication in 1964 [1] . As for the two types of "sun spot models", the first one is an empirical one. The second one is the magnetohydrostatic model. These models has been developed, for example, by Stix, 1989[2].

A part of solar cycle variation of sun spots is introduced in a diagram, for example, as found in Figure 1. So-called solar cycle of 11 years has been well known by the geophysical scientists though its dynamical mechanism has been extensively studied in the fields related to astronomy.

It could be noted here that the most interesting process is the latest solar minimum for a several years by the year of 2009. This is the topical happening to the leading scientists of the 11years cycle in the solar activity as a reference to the symbolic process of the bold solar activity. Some of the scientists has tended to refer to the Maunder minimum of the sun-spots number index.

This 11 year cycle was pointed out first by Schwabe in 1844. Hale had the first scientist of the magnetic field in one of the sun spots in 1908. Hale had observed them by 1923 and formulated his polarity rules on his bases of three consecutive cycles. That is to say, Hale's rules are so as that:

(1) the magnetic orientation of leader and follower spots in bipolar groups remains the same in each hemisphere over each 11-year cycle,
(2) the bipolar groups in the two hemispheres have opposite magnetic orientation,
(3) the magnetic orientation of bipolar groups reverses from one cycle to the next.

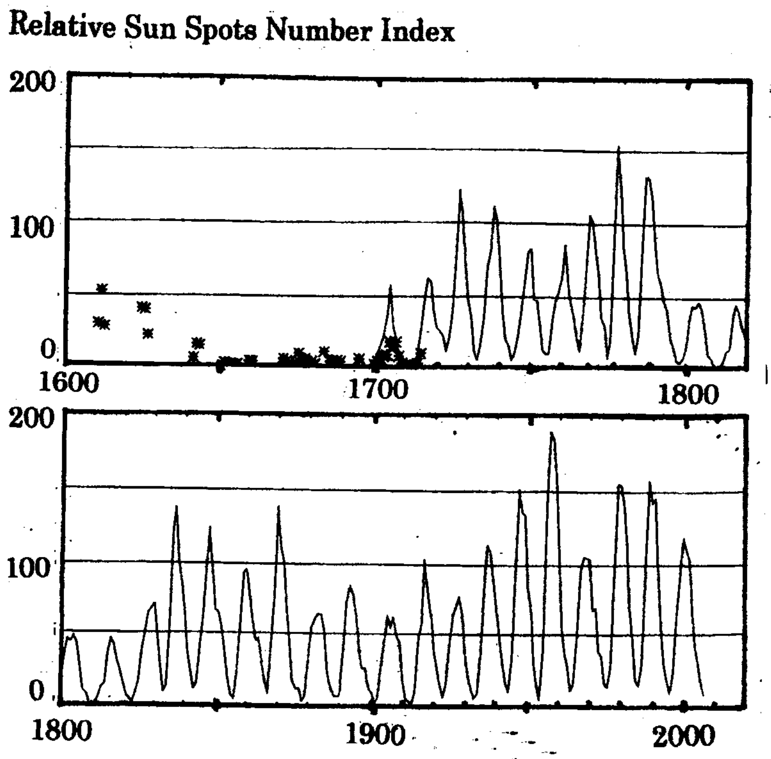


Figure 1 Solar cycle variation of sun spots

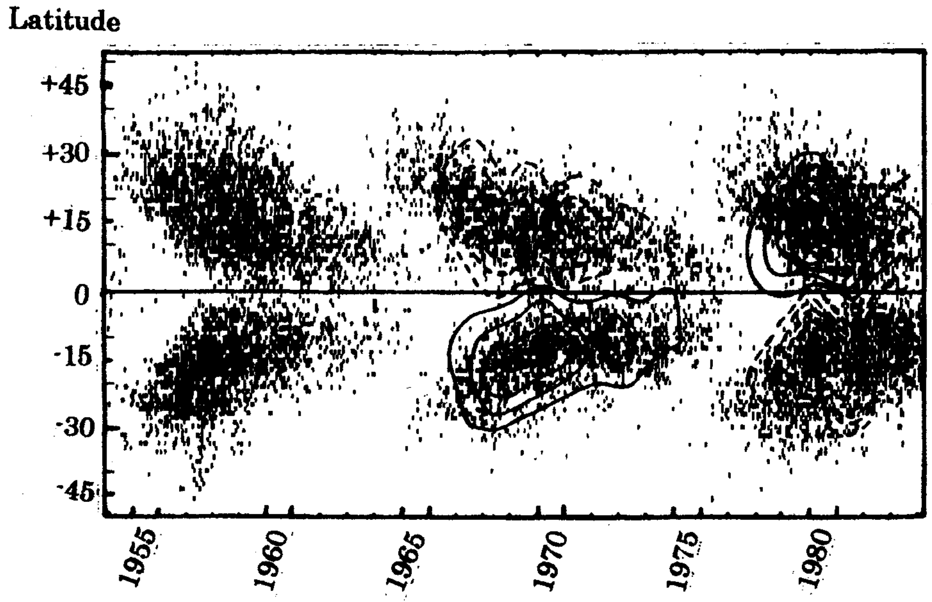


Figure 2 Butterfly diagram from Mt.Wilson Observatory
(courtesy R.Howard, National Solar Observatory)
Note:-(1) contours of radial mean field
(from Mt.Wilson and Stanford magnetograms)
(2) each vertical bar marks a sun spot
(3) the contours are (a) for solid positive 27 μT, 54 μT, ...,
(b) for dashed negative -27 μT, -54 μT, ...

Chapman[1] and Stix[2] had noted in his publication to a more detailed terms. For example, trends of the solar cycle variation of sun spots, prominences, and faculae. The numbers of northern and southern polar faculae are drawn with a sign in order to indicate the alternating magnetic polarity (which was published by Sheeley in 1964). Stix[1] had given the signs of plus or minus mark magnetic reversals at the poles in 1974.

3. BUTTTERFLY DIAGRAM

Another important result is known as butterfly diagram introduced by Maunder in 1922. The systematic behaviour of bipolar sun spot groups is readily understood in terms of a subsurface mean toroidal magnetic field, which is a field where lines of force are circles around the solar axis [1, 2]. A typical pattern of the batterfly diagram is shown as found in Figure 2.

In addition to the mean toroidal field there is a mean poloidal magnetic field. Cowling (1934) stated first the line-of-sight component of the magnetic vector field B. The mean field electrodynamics has been developed since 1955 by Parker and his followers.

4. SEA SURFACE TEMPERATURE

In 2007, the Azores Scientific Group showed that the observed sea surface temperature during the time period of 1960 to 2007 has shown a significant trend to fit the solar cycle variation of sun spots for four consecutive solar cycles.

The oceanographers in the University of Azores noticed that there is a high correlation between the sun-spots number index and the variations of the observed sea surface temperature at the station in Azores.

Nevertheless, it is hard to accept what has introduced by the Azores Group for helping to understand any global trend of the sea surface temperature on the planet earth. The scientists for dynamics of the ocean and atmosphere have found already any dynamical processes of the geophysical fluid motions are not so simple to see on a basis of a limited data observed on the earth surface. The Azores Group must have had a lucky position of their station for obtaining their interesting finding.

5. DISCUSSIONS

The author here has to note whether the Azores Scientific Group could show a same trend for their extensive observation of the sea surface temperature in relation to solar spots for about several ten years trends of the two physical factors.

The ocean scientists have learned that the sea surface thermal pattern on the earth is not so simple that it is hard to take it easy to relate the sea surface temperature variations even at Azores in the Northeast Atlantic Ocean to the sun spots number variations as an index of the solar activity.

The ocean water has a complicated system of the ocean water motion between the earth crust surface and the atmospheric layer under an affect of the solar radiation. So that, a global understanding of the ocean thermal transferring system should be taken into consideration at discussing on the sea surface temperature variations for obtaining a more reasonable understanding in a physical scope.

Finally, it is expected that a more advanced research should be promoted for a dynamical understanding of the various processes appear on the earth under the effect of the solar radiation.

REFERENCES

[1] Chapman, S. 1964 Solar plasma, geomagnetism, and aurora, Gordon and Breach, New-York, 141p.
[2] Stix, M. 1989 The Sun-An introduction, Springer-Verlag, 390p.

SOLAR CYCLE IN MAGNETO-HYDRODYNAMICS

1. INTRODUCTION

In this section, a brief note is introduce about solar cycle in magnet-hydrodynamics in order to help a significant trend of the 11 year cycle in the solar activity. There have been developed various kinds of solar cycle models by this time, for example, models on the basis of Maxwell equations and models in a scope of magnet-hydrodynamics.

The solar cycle for about 100 years is studied by an approximated model in order to understand a specific property of solar activity in a scope of dynamical electromagnetism. Chapman[1, 2] and Stix[3], for example, noted the early state of the researches related to the solar cycle and solar activity specified by the sun spots number index in an annual time unit. This solar cycle model could be a key to an answer at considering any one of the geophysical processes on the earth as a planet in the solar system.

2. MAXWELL EQUATIONS

In order to start for studying solar cycle, Maxwell equations are introduced first for the magnetic field B, the electric field E, and the electric current density j, i.e.,

$$\mathrm{div}\, B = 0\,, \qquad \ldots\ldots (1)$$

$$\mathrm{curl}\, B = \mu\, j\,, \qquad \ldots\ldots (2)$$

$$\mathrm{curl}\, E = -(\partial / \partial t) B\,, \qquad \ldots\ldots (3)$$

where, the mark μ is the magnetic permeability (for free space, in this case). In equation of (2), an approximation is assumed for non-relativistic, or slow phenomena (neglected the displacement current).

When the field is in a material with electric conductivity σ, the current is σ times the electric field (known as Ohm's law). When the material is in motion, it is taken into account of that the law valid in the co-moving frame of reference (i.e.,$j = \sigma E$). In a case of motion (say, v for $v \ll c$), transformation to the frame at rest is as $j = j$ and E=E+vxB. Then, $J = \sigma (E + v\mathrm{x}B)$. Eliminating E and j in the above equations, the induction equation is written as

$$(\partial / \partial t) B = \mathrm{curl}(v\mathrm{x}B) - \mathrm{curl}(\eta\, \mathrm{curl}\, B), \qquad \ldots\ldots (4)$$

where, magnetic diffusivity is $\eta = 1/(\mu\ \sigma)$.

3. MEAN-FIELD ELECTRODYNAMICS

The solar cycle could be solved referring essentially to the Maxwell equations for the magnetic field B, the electric field E, and the electric current density j [1]. Then, an induction equation is reduced. Electric conductivity of the sun could be determined as that of the ionized gas (or plasma) following to Spitzer(1962). For the case of the dynamo problem in terms of a mean magnetic field, $B=[B]+b$, where $[B]$ may be understood as an average over longitude or, more generally, as an ensemble average. Then, $[b]=0$. In a same way, $v=[v]+u$. Substituting these two into the induction equation, fluctuating part is obtained after separating the mean part.

Following Moffatt(1978) with some assumptions, the mean part $[B]$ and the fluctuating part b can be separately described, i.e.,

$$(\partial / \partial t)[C] = \mathrm{curl}([v]\times[B]+\varepsilon - \eta\, \mathrm{curl}[B]), \quad \text{.........(5)}$$

$$(\partial / \partial t)b = \mathrm{curl}([v]\times b+u\times[B])+G-\eta\, \mathrm{curl}\, b), \quad \text{.........(6)}$$

where, $\varepsilon = [u\times b]$, and $G= u\times B-[u\times b]$.

Under some specific condition, the value of ε is shown as following, i.e.,

$$\varepsilon = \alpha [B] - \beta\, \mathrm{curl}[B]+\ldots, \quad \text{.........(7)}$$

where,

$$\alpha = -(1/3) \int_0^\infty [u(t)\, \mathrm{curl}\; u(t-t')]\mathrm{d}t', \text{ and } \beta = (1/3) \int_0^\infty [u(t)\; u(t-t')]\mathrm{d}t', \quad \text{.........(8)}$$

One of the way to describe feature of the mean-field induction eqution is the term involving α (that is called as the α effect).

Following to Knause (1967), $\alpha \simeq +l\Omega$ (or $-l\Omega$) is the mean angular velocity of the Sun. The sign of α depends on helicity of the flow in the solar convection.

Stix(1976) has shown the meridional cross sections for contours of constant toroidal field strength and poloidal lines of force (cf. Figure 1). The arrows are indicating strength and sign of polar field. An illustration is given in an adjusted time scale for 11 years for each half-cycle.

Theoretical butterfly diagram (contours of constant toroidal field) in an oscillatory kinematic $\alpha\ \Omega$ dynamo is shown by Steenbeck and Krause in 1969 (cf. Figure 2).

The numerical results noted above is obtained under several assumption with some conditions, so that specific patterns could be demonstrated on the bases of the dynamical theory in an approximated forms as introduced by Stix [1].

The author here has to notice that the scientists should have their understanding of the specific pattern in the solar activity at considering the geophysical processes on the planet earth.

4. CHAOTIC DYNAMO

As a dynamic system, the magnetohydrodynamic dynamo is capable of chaotic behaviour. Such can be seen from the numerical integrations mentioned, for example, by Stix [1]. In this section, expression in formulation is in a simplified form, so that, to the deails, it

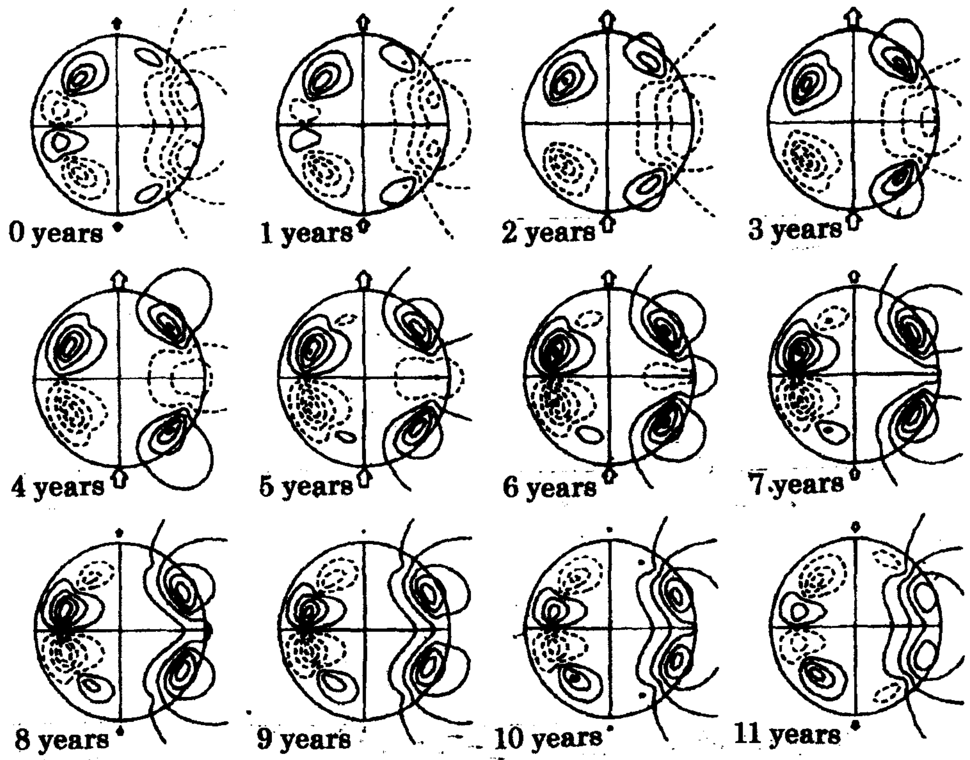


Figure 1 Oscillatory kinematic $\alpha\ \Omega$ dynamo model
In each illustration in every year, the meridional cross section is shown as (1)
(1) on the right-contours of constant toroidal field strength,
(2) on the left-contours of constant poloidal lines of force.
(3) arrows indicate strength and sign of the polar field,
(4) time scale is adjusted to 11 years for each half-cycle.
(5) refer to Stix (1976)

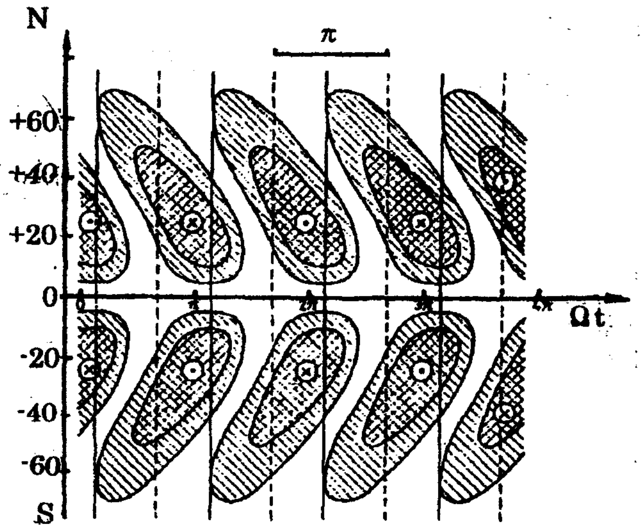


Figure 2 Theoretical butterfly diagram (contours of constant toroidal field) in an oscillatory kinematic $\alpha\ \Omega$ dynamo model (cf. Steenbeck and Krause, 1969).

should be referred to the original descriptions on this processes.

A simplified expression of the model can be written as follow, i.e.,

$$(\partial/\partial t)A = 2DB - A, \qquad (9)$$

$$(\partial/\partial t)B = iA - (1/2)i\Omega A' \cdot B, \qquad (10)$$

$$(\partial/\partial t)\Omega = -iAB - \nu\,\Omega\,. \qquad (11)$$

where, A' is complex conjugate of A.

System (9) to (11) is a complex generalization of a system first studied by Lorenz in 1963 as a model of turbulent convection. The system in this work likes to the Lornz system. It has chaotic solutions but also has solutions which are periodic in time.

5. DISCUSSIONS

A theoretical background is introduced in a form of shortened expression. This might be helpful for realizing the monitored solar activity or the 11 year cycle of the sun spots number index. This work might be well related to the various geophysical processes found on the planet earth. Nevertheless, it is yet necessary to consider how complicated processes appear in the earth as well as in the sun.

It should be aware of an advanced research to be promoted even at present for our dynamical understanding of the sun as well as the planet earth where we are living.

REFERENCES

[1] Chapman, S., and J. Bartels 1940 Geomagnetism, Oxford University Press, London, 1049p.

[2] Chapman, S. 1964 Solar plasma, geomagnetism, and aurora, Gordon and Breach, New-York, 141p.

[3] Stix, M. 1989 The Sun-an introduction, Astronomy and Astrophysics Library, Springer-Verlag, 390p.

NOTE TO SOLAR ECLIPSE 2009

It was one of the great events in the natural environment on the planet earth.

In the field of Astronomy, there have been many researches published by this time.

Now, the author has to give a remark that the solar eclipse 2009 this time was the first event of the satellite monitoring of the solar eclipse tracking.

It is well understood that the solar activity is strongly effective to all of those living on the earth surface. Human activity has been under effects of the solar activity.

This solar activity reflects directly to the earth surface as has have been well understood.

One of the typical effects might be the 11 years cycle of solar polarity. A theory of magneto-hydrodynamics could be described referring to Maxwell equation, though it can be seen simply an approximated solar activity processes.

The event of the solar eclipse might be a chance to find a more detailed key to understand the solar activity in relation to the earth.

The solar eclipse 2009 had been monitored by the scientists on the surface of the earth. Adding to this, it should be noticed that one of the satellites had well monitored the solar eclipse tracking.

The satellite monitored was the satellite GMS-2 under the regular operation on the synchronized orbital motion above about 800 km above the earth surface.

The monitored solar eclipse on 22 July 2009 had been predicted officially, for example, by the National Astronomical Observatory in Tokyo (cf. Figure 1).

The Japan Meteorological Agency has distributed the data of the monitored result by using the Website, so that it is easy to see the monitored imagery at every 15 minutes step of the satellite GMS-2 monitoring in the visible band.

A more advanced research might be promoted and presented after every one of the scientists in the related fields to the solar eclipse 2009 monitoring.

This time, the author would not introduce any directly monitored data of available.

The author is expecting that this note could be a key to find an advanced knowledge for our human activity.

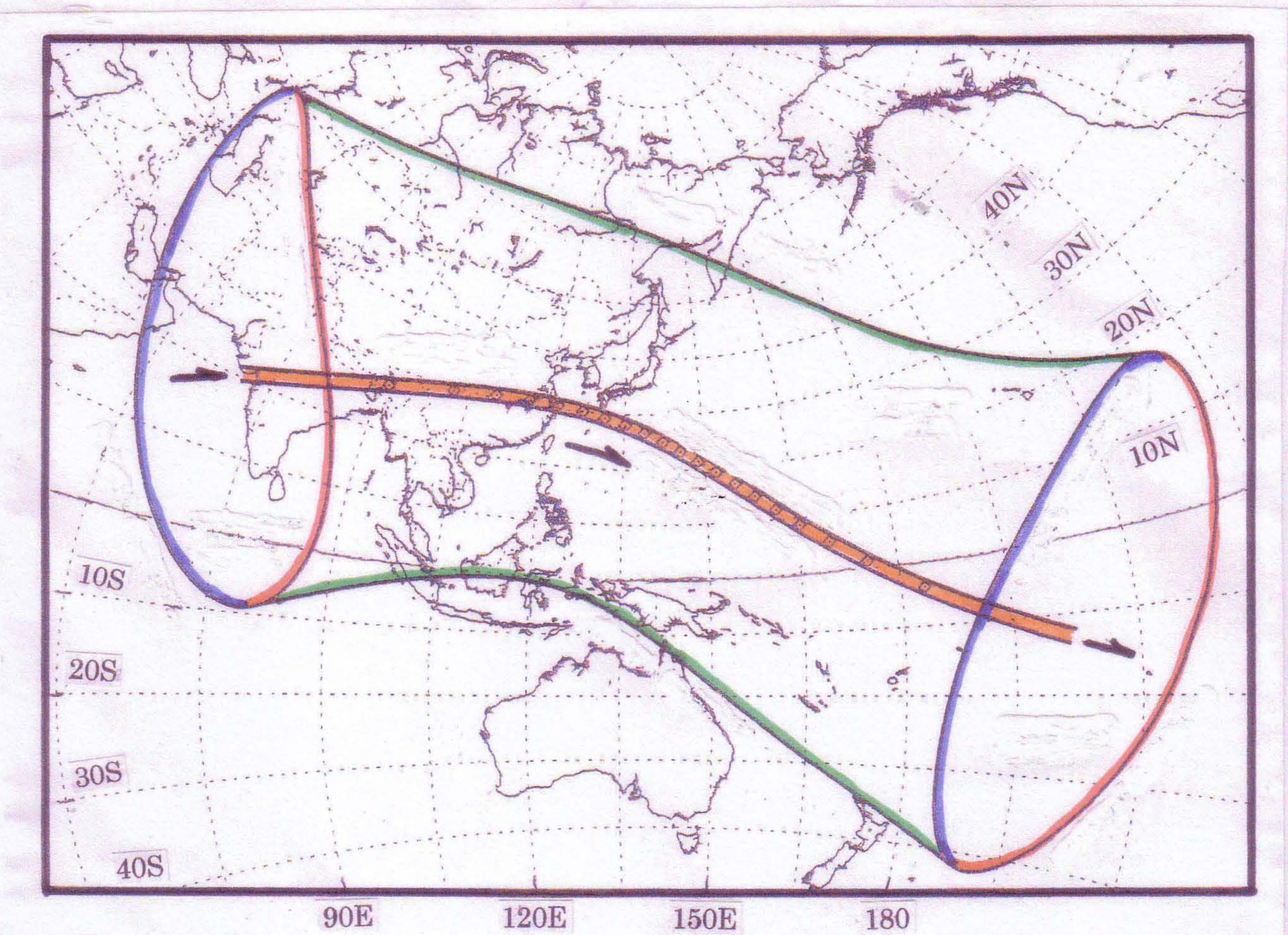


Figure 1 Solar eclipse shadow belt on the earth surface
On 2009 July 22.
(Refer to the National Astronomical Observatory)

1. Orange color line for the main shadow belt zone
2. Red color line at each case of the west and east parts for the start of the solar eclipse at sun rise and at sun set
3. Blue color line at each case of the west and east parts For the end of the solar eclipse at sun rise and at sun set
4. Green color lines for the northern and southern limits of the sub-shadow belt centering the main shadow zone
5. Arrows (in black color mark) shows the shadow movement with the time elapse.

SUPPLEMENT – TRACKING THE 2009 SOLAR ECLIPSE

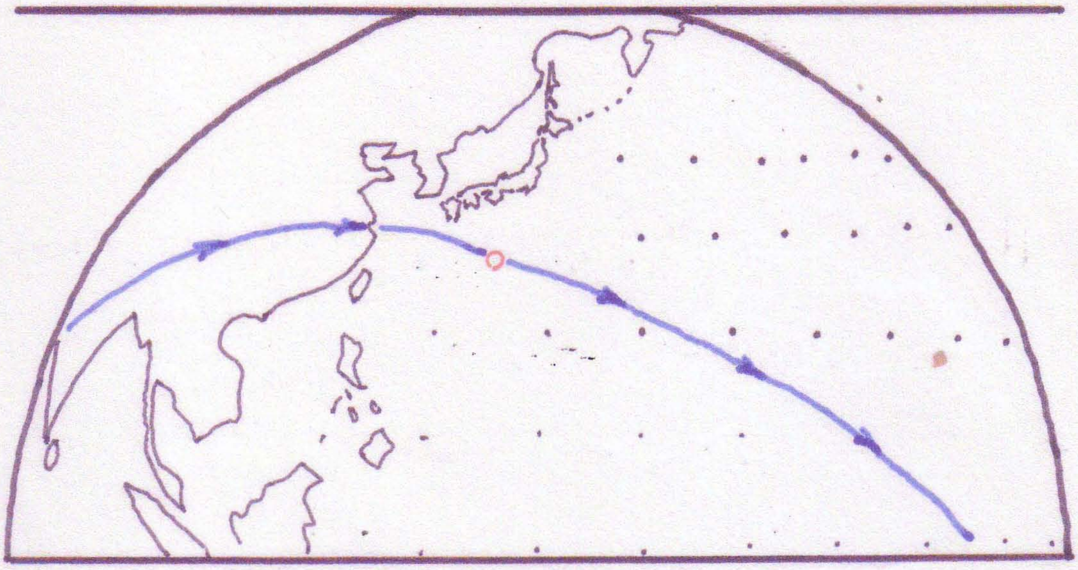


Figure 1. Tracking of The 2009 Solar Eclipse

Tracking the shadow zone axis of the 2009 Solar Eclipse
On 2009 July 22 during the time between 0900 to 1400JST.
(1) Track of the shadow zone axis is shown by a "blue line".
(2) Red mark is the location of the Io Island, where
the shadow zone started at 1103JST to cover the Island,
(3) It was about 6 minutes to pass a location
on the shadow zone.
(4) To the details, the successive works should be followed.

Data source is based on the issue through the Web-site
Of the Japanese Meteorological Agency.

SATELLITE THERMAL PINNACLE IN OCEAN

1. INTRODUCTION

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.

2. SEA SURFACE WAVE FACET MODEL

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,

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

then,

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

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 written as $F' = \partial F / \partial x$, 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,

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

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,

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

Then,

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

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

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

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

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

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

3. SATELLITE THERMAL PINNACLE

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.

4. SATELLITE THERMAL PLATEAU

When a certain domain of a wide area in the satellite foot print is fully filled up and covered by the thermal pinnacle, the interested domain might be possibly seen as a thermal plateau.

4. CURVATURE OF SEA SURFACE WAVE FACET

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,

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

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;

$$(ds)^2 = (dx)^2 + (dz)^2, \quad \ldots\ldots \quad (10)$$

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 shown above, The relation between X and Z is obtained in a simple form, and spacial spectral function at a time t should be a function of wave number k in this case. Then, the expression (8) can 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 consi deration.

5. EVALUATION OF INFRARED BEAM OUT OF OCEAN

The author has take it reasonable the above noted modeling for the ocean existing sea surface wave facets effective to form a concentrated beam or a beam ensemble at t he position of the monitoring sensor mounted on the satellite.

This effect of the beam concentration out of the ocean surface is so significant that any other effects of interferometry might be taken as a minor factor to be negligible.

In this condition, the factor of interferometry is simply effective at decaying of the beam intensity, then, the author considers that this interferometry problem is out-side of his interest in this work.

The SAR system (Synthetic Aperture Rader) should be highly evaluated when it is properly applied for the physical processes or the other related processes, nevertheless, it is for a faint thermal difference in the author's interest in this work so that he is tending to takes the SAR system also outside of his interest in this work.

Nevertheless, it should be reminded that what are noted above by the author does not mean that any one application of interferometry and SAR system should be taken to be meaningless. The author has to notice here it is necessary to consider a problem should be solved by a most proper technique without any prejudice.

SATELLITE THERMAL PLATEAU IN OCEAN

1. INTRODUCTION

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.

2. MODEL OF SATELLITE THERMAL PLATEAU IN OCEAN

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.

2. STEFAN-BOLTZMANN RADIATON

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 dB and dT, as follows:

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

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 dB should be infinity so that the value of the dT is also infinity. In this case, the distance between the sensor mounted on the satellite and the wave facet is same to the altitude of the satellite above the sea surface.

3. APPLICATION OF MODEL

When the beams form a caustic to hit the interested sensor of the satellite, and the value of dT 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 dT = 5K and T = 273K, then, we have 0.018 as dT/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.

4. SATELLITE THERMAL PLATEAU

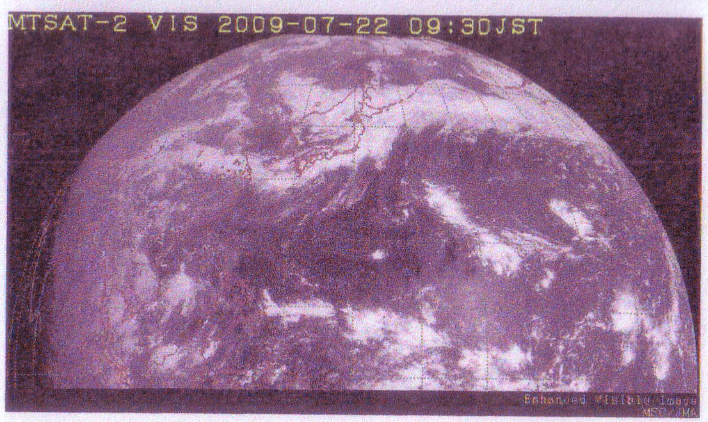
For example, this case appears in the coastal zone in the northwestern Pacific. The the rmal pattern of the sea surface looks like to be a thermal plateau when a distant stor m in the subtropical zone is seen and the storm generated disturbances in form of the sea surface water waves are propagating 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 assumed to be similar to that found 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.

Appendix -1 Solar Eclipse 2009 Shadow Monitored by GMS-2 in Visible Band
[気象衛星 GMS-2 からみた地球上の日食 2009 の画像－可視光波長帯]

Rem- Referring to the data issued by JMA on the Web site
(注：日本の気象庁がインターネット上に公開したデータを参照)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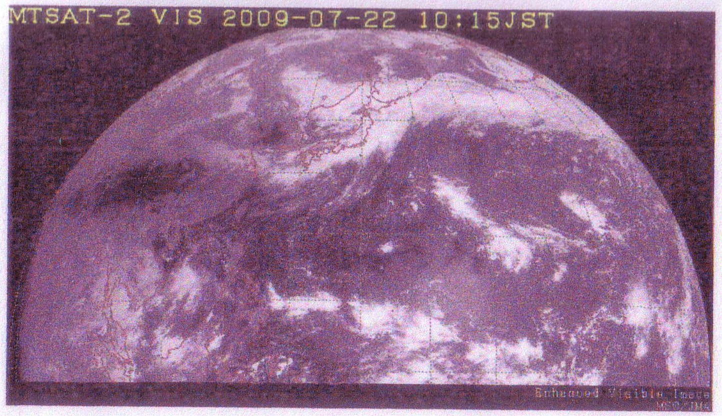
MSC/JMA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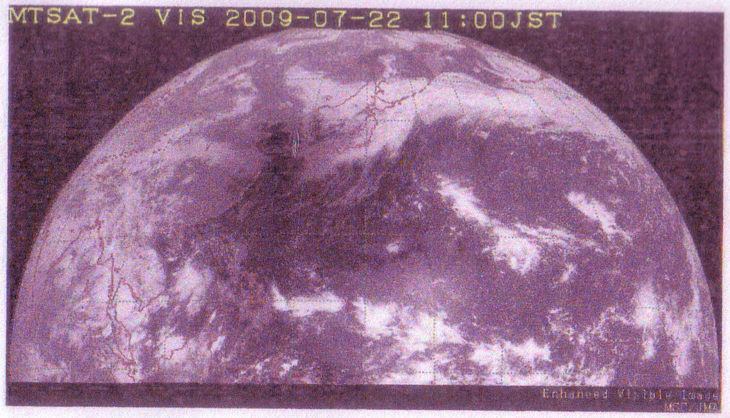
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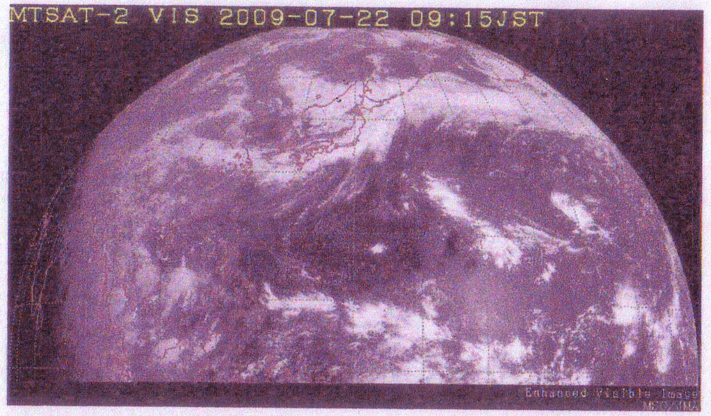
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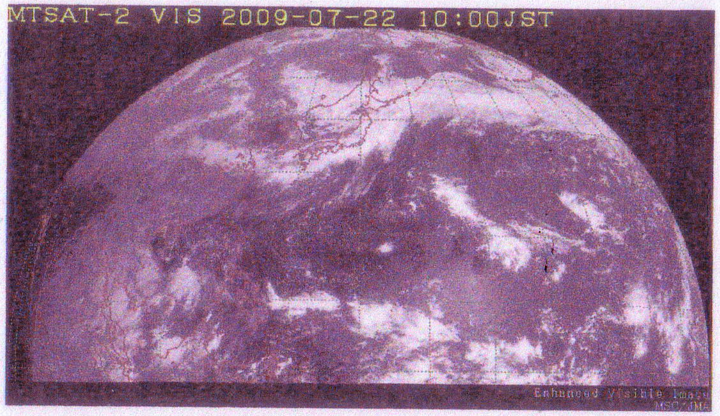
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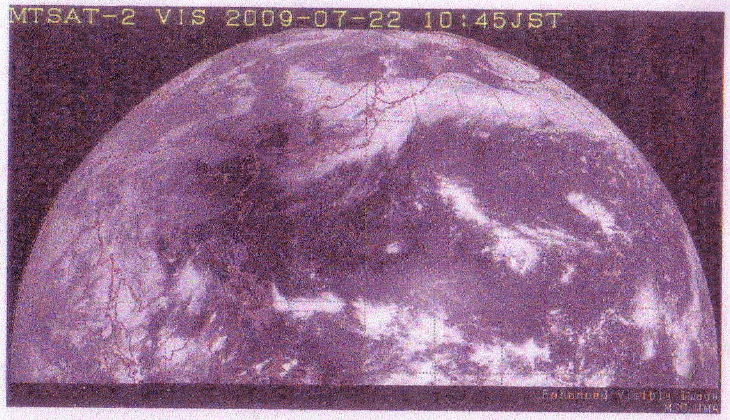
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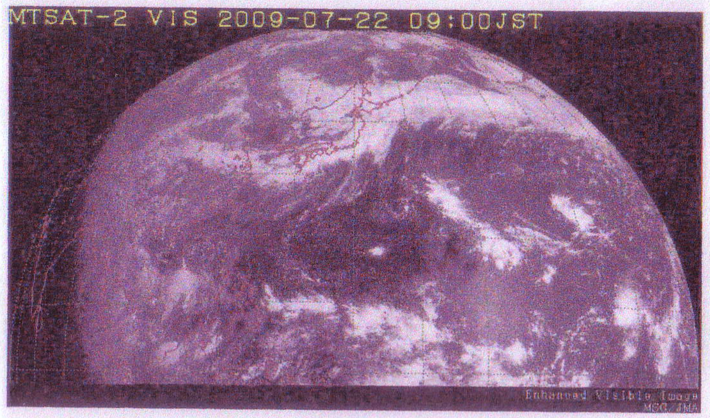
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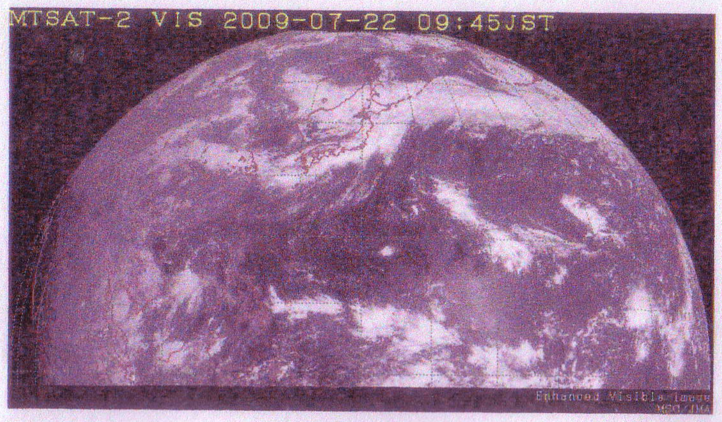
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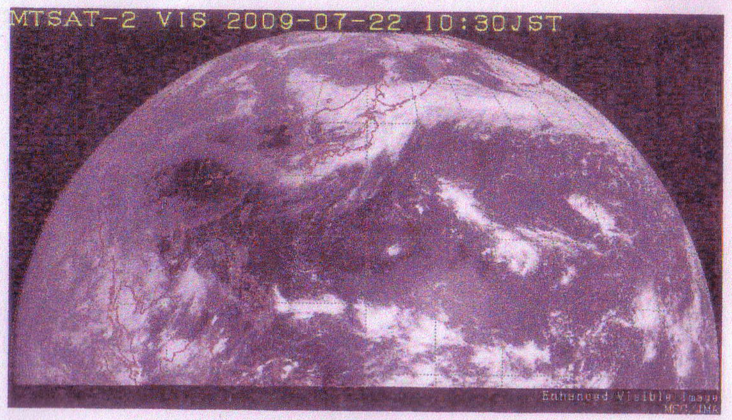
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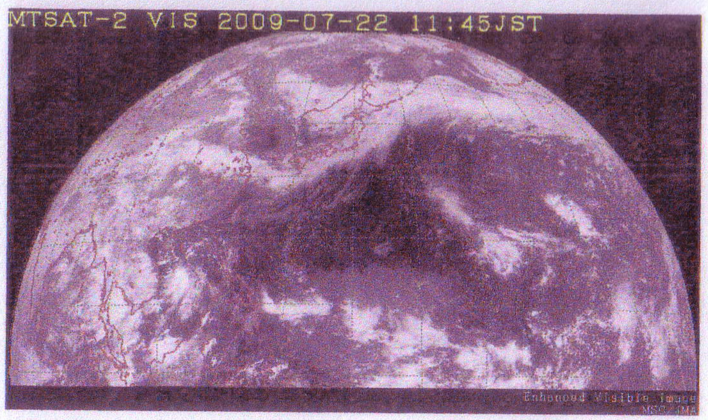
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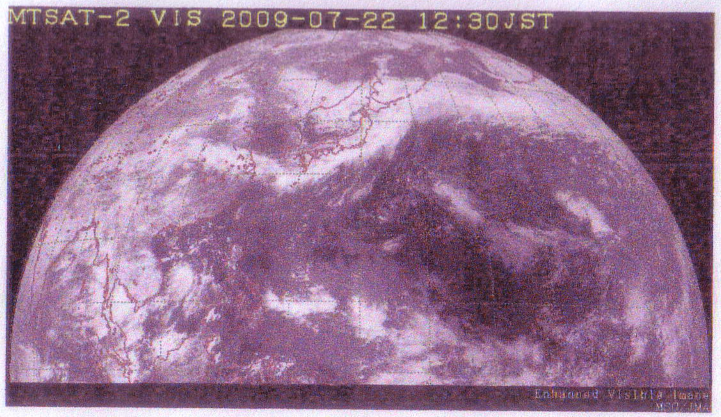
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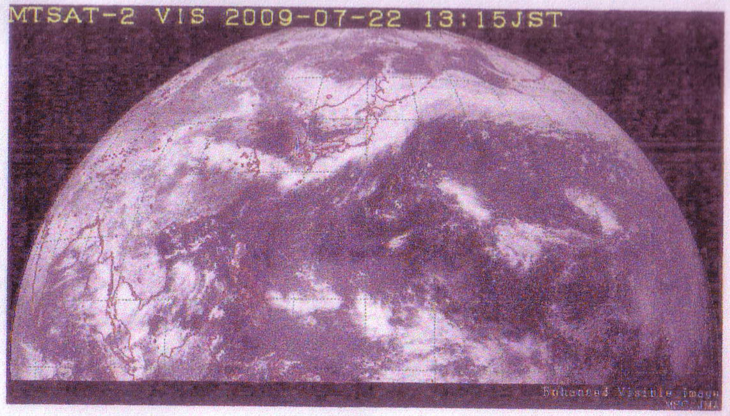
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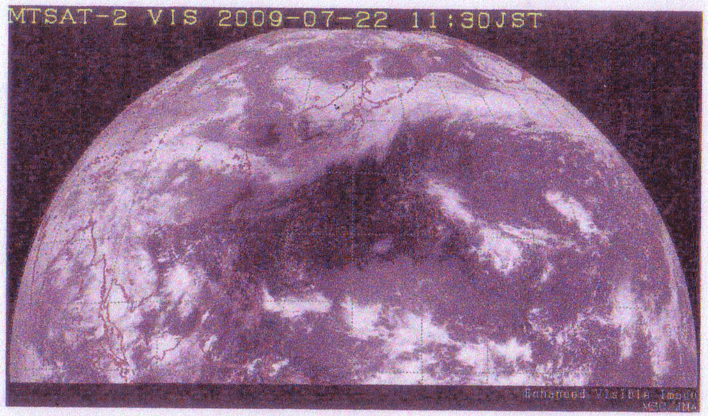
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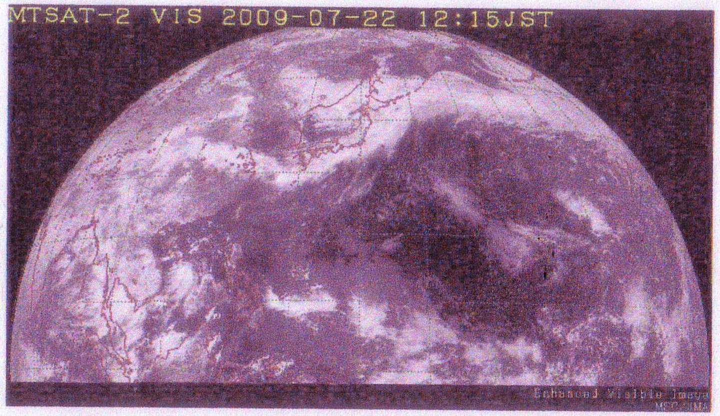
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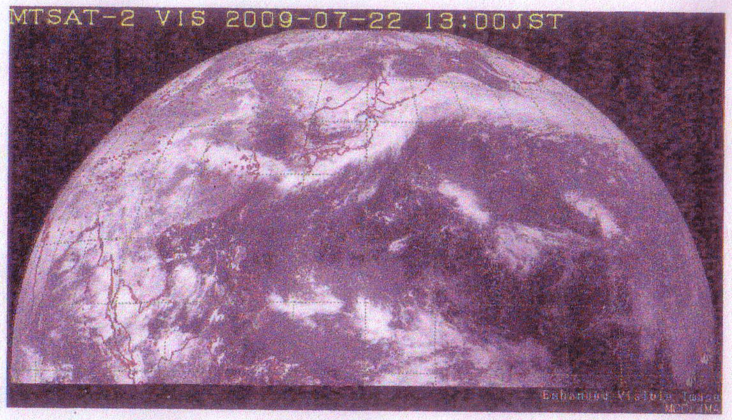
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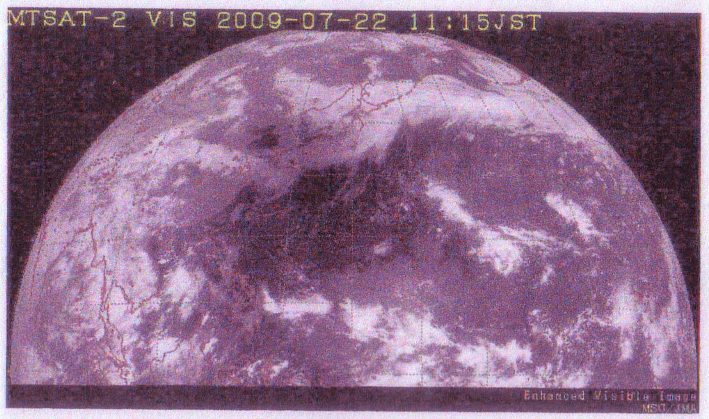
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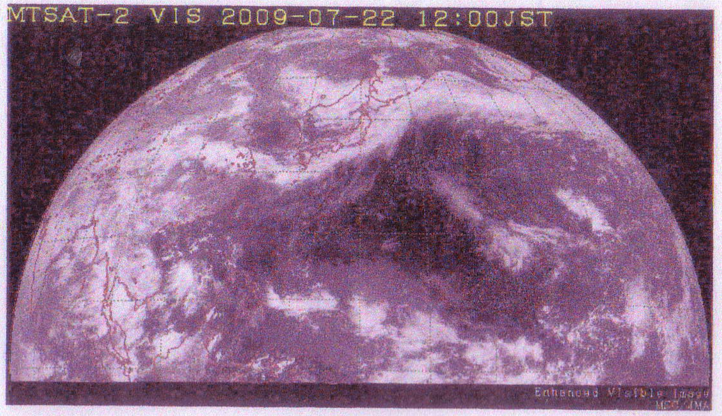
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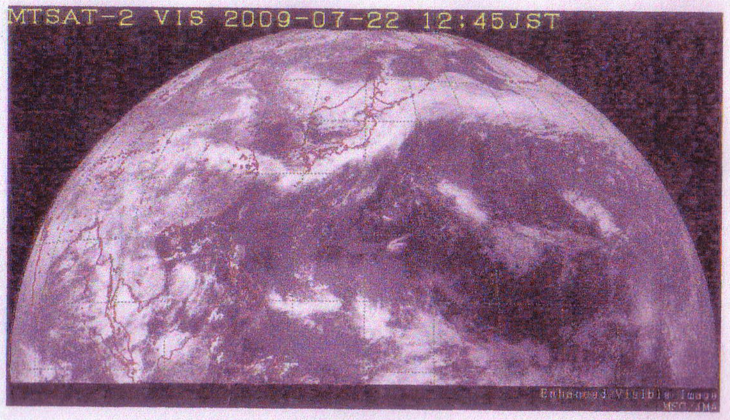
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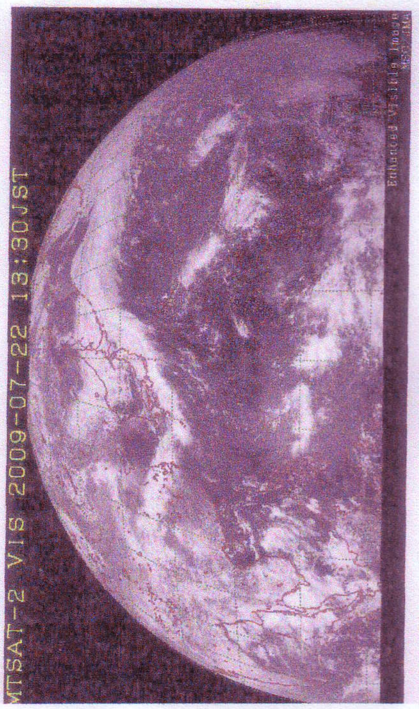
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Appendix -2 – Outline of Solar Physics

太陽物理学におけるいろいろな課題
[太陽物理学入門－講義用目次題目－]

1. Outline of The Sun
Distance-
Mass-
Radius-
Luminosity-
Spectral Energy Distribution
Energy Flux and Intensity
The Visible (VS)
The Infrared (or IR)
The Far-Infrared (or FIR)
The Radio Spectrum
Extreme Ultraviolet and X-Rays
Color Indices
2. Internal Structure of the Sun
Construction of Model
Evolution Sequence
The Standard Model
Age and Pre-Main-Sequence Evolution
Model Formulation
Conservation Laws
Energy Transport
The Equation of State
The Entropy
Nuclear Energy Sources
Opacity
Boundary Conditions and Solution
Results for a Standard Solar Model
General Evolution
Neutrinos
Non-Standard Models
The Low-Z Model
Rapid Rotating Core
Internal Mixed Model
3. Instrumentation for Observation
Limitations
General Difficulties
Description and Definitions
High Resolution Telescope
Image Scale
Mirrors for Fixed Telescopes
Telescopes with Long Primary Focus
Telescopes with Short Primary Focus
Spectrographs and Spectrometer
Grating Spectrograph
Fourier Transform Spectrograph
Measurement of Line Shifts

Filters and Monochromators

The Lyot Filter

Tuning – the Universal Filter

A Double Monochromator

Spectrohelioscope

Magnetic Fields and Polarimetry

Zeemann Splitter

Polarized Light

Unno's Equations

Solar Polarimeters

Special-Purpose Instruments

The Pyrheliometer

Neurino Detector

The Coronagraph

4. Atmosphere of the Sun

Radiative Transfer – Local Thermodynamical Equilibrium (LTE)

Equation of Transfer

Various Equiribria

Absorption Lines in LTE

Radiative Transfer – Statistical Equilibrium

Assumptions for Model

Line Radiation and Einstein Coeficients

Continuum Radiation

Collisions

The Source Function

The Equations of Statistical Equilibrium

Atmospheric Models

Limb Darkening

Model Calculations in LTE

Models with Departures from LTE

Chemical Composition of the Sun

Spectrum Synthesis

The Light Elements Li, Be, B

Helium

5. Oscillations

Observations

Five-Minute Oscillations

The p-Mode Ridge

Low-Degree p Modes

Linear Adiabatic Oscillations of a Non-Rotating Sun

Basic Equations

Spherical Harmonic Representation

The Cowling Approximation

Local Adjustment – Local Treatment

Boundary Conditions

Asymptotic Solutions

Helioseismology

Direct Modeling – Normal Approach to Solution

Inverse Theory-Internal Structure – Technique to find Trigger from Solution

Inverse Theory-Rotation – Solution for a Rotating Solar Motion

Excitation and Damping

The κ Mechanism

Stochastic Excitation by Convection

[cf. "The Sun" written by "Michael Stix"
(Kiepenheuer-Institut fur Sonnenohysik, Freiburg)
published in 1939&1989]

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