Development of Two-Dimensional Lattice Boltzmann Code and Its Coarray parallelization

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Since LBM is already a matured technique, there exist several open source LBM codes. Although it would be easy to use one of them, we intentionally develop our own LBM code from scratch, because it will help us to firmly understand the basics of the method. We also expect that having our own LBM code and the development experience would provide us with indispensable skills for making of a LBM-based new techniques in future.

For this end, we have developed a fundamental two-dimensional computational fluid dynamics solver based on LBM and parallelized the code. For the parallelization, we have adopted coarray parallelization of Fortran 2008. The coarray parallelization is known to be effective for simulation method with simple grid configurations such as LBM.

We have found that the parallelization by coarray is much easier than that by MPI, which is widely used these days. We have also found that the parallelized code with coarray is much more concise and easy-to-read, compared with MPI-codes.

Conducting three quantitative tests, we have confirmed that calculation results by the LBM code developed in this study coincide well with analytical values.

Keywords: Lattice Boltzmann Method, Coarray parallelization , Fortran 2008

Preliminary results of linear stability analysis on the onset of convection in a thick rotating spherical shell with implications for a dynamo in an icy moon

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Convection in the fluid core of a terrestrial planet, which maintains its intrinsic magnetic field by dynamo action, is driven by thermal and/or chemical buoyancy. In case of the Earth, the former is fed by secular cooling of the core, latent heat release upon inner core solidification, and possibly decay of radioactive elements in the core, while the latter arises from light element ejection into the outer core at the front of inner core growth. On the other hand, let us consider a celestial body smaller than the Earth. In that case, compositional convection could occur in various ways due to different pressure-temperature conditions, strongly depending on bulk sulfur content in the core. Among them, we here focus on the iron snow process, which might drive the present Ganymede’ s dynamo.

In order to understand a basic flow structure of convection driven by the iron snow process, onset of thermal/compositional convection in rotating spherical shells is studied with linear analysis. First, we consider thermal convection of a Boussinesq fluid contained in a rotating spherical shell. We solve the linearized equations as an eigen-value problem, and then, check validity of our linear code by comparing the results with those in a literature (Ardes et al., 1997). Thus, the Ekman number adopted here is not very low, . Afterwards, linear stability problem of compositional convection driven by iron snow is examined. In this case, relative inner core size smaller than the Earth is given to mimic possible Ganymede’ s core geometry. Using the results, we then solve kinematic dynamo problem to gain some insights into dynamos driven by iron snow. We will report our preliminary results about these issues.

Keywords: thermal convection, compositional convection, kinematic dynamo, linear stability analisys, iron snow

Equatorial waves modified by the presence of a toroidal magnetic field within the stably stratified layer at the top of the Earth’s outer core

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A number of researches have suggested the existence of a stably stratified layer at the top of the Earth’s outer core (e.g. Buffett, 2014), including seismological evidence (e.g. Helffrich and Kaneshima, 2010). The stable stratification can make horizontal flow dominant at the top of the core. It is therefore expected that the hydrostatic approximation used in atmospheric and oceanic dynamics can be applied to fluid motion within this stratified layer provided that we include the influences of the magnetic field.
In this study, we investigated waves trapped in the equatorial region at the top of the liquid core. Our research is motivated by prominent geomagnetic fluctuations in the equatorial region. For example, Chulliat et al.(2015) found some standing waves with periods of about 6 years in secular acceleration data in the equatorial region. In addition, Finlay and Jackson (2003) and other scientists showed that the geomagnetic westward drift is most prominent in the low latitude region.
The governing equations we adopt are linearized non-dissipative Boussinesq-MHD equations. In addition, we use hydrostatic and equatorial beta plane approximations, and assumed that the background magnetic field has only toroidal (east-west) component. With these assumptions, the governing differential equations become separable, and can be divided into horizontal and vertical structure equations. It should be noted that the horizontal structure equations have the same form as the MHD (magnetohydrodynamics) shallow water equations (e.g. Gilman, 2000; Zaqarashvili et al., 2008).
We obtained a dispersion relation and eigenfunctions with both analytical and numerical approaches, and examined the effect of toroidal magnetic fields on equatorial waves.
Firstly, we considered the situation in which a uniform toroidal field is imposed. The frequencies of waves such as inertial gravity waves and Rossby waves are higher, and these waves decay more rapidly away from the equator than the non-magnetic situation. Moreover, MC Rossby waves, which can exist in the mid latitude, cannot be trapped in the equatorial region.
Next, we let the strength of imposed background field depend linearly on latitude. The spectrums of Alfven waves become continuous, and the resonance appears at the latitude where the east-west phase speed of an eigenmode coincides with the Alfven wave velocity.

Keywords: the uppermost outer core, stable stratification, equatorial waves, MHD shallow water equations

A Marine-field Optical Particle Counter for Sea-Spray Measurements: Understanding the Relationship Between Surface Wave Breaking and Aerosol Generation

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For understanding the phase relationship between the breaking of wind waves and the generation of marine-aerosol at the sea surface, we use an experimental opticle particle counter for sea spray (OPC-SS) which is able to measure particle concentrations at a rate of 10 Hz in 8 size bins between 0.3 and 30 micro-meters . The OPC-SS is also equipped with triaxial accelerometer at a rate of 10 Hz for measuring the movement of a buoy. In this year, we are planning to test the OPC-SS at the Shiramaha Oceanographic Observatory Tower (Kyoto Univ.) and also in the Otsuchi Bay in front ot the International Coastal Research Center (the Univ. of Tokyo).

Keywords: Sea spray measurment, Air-sea surface wave boundary layer, Marine aerosol

On the mathematical properties of non-linear atmospheric flows counting with heat conductivity, vertically stratified density, rotation of the Earth, humidity and moisture content in the clouds.

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We construct an explicit solution of a non-linear Navier-Stokes type system of partial differential equations which describes the behavior of the Atmosphere of the Earth taking into account various simultaneous parameters; such as rotation, initial exponentially decreasing vertical stratification of density, heat conductivity, humidity and moisture content in the clouds. To construct the explicit algorithm of the solution, we use the Galerkin method.
We prove the existence and uniqueness of the solution for a limited interval of time.
For the linearized model, we find the structure and localization of the spectrum of internal vibrations of the Atmosphere.
The results may find theoretical application in Atmosphere fluid dynamics, as well as more practical application in weather forecasting.

Keywords: atmosphere flows, explicit numerical solution, humidity and moisture content in the clouds, vertical stratification of density, existence and uniqueness of solutions of PDE systems, spectrum of internal waves

Origin of plate tectonics, Ocean floor, Pacific arcuate rchipelago, nclination of the Earth's axis, Van Allen eccentricity and Drivie force Plate tectonics
--Everything is unified with a multi impact hypothesis using abduction--

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Elucidation of the Origin is impossible in terms of cost and time in reproduction experiments in solar system physics. Furthermore, since the initial condition is also unknown, it is difficult to elucidate by Induction method and Deductive method. *However, the use of Aabduction, can verify the Hypothesis by using the results of the evolution of only one time from the Origin of the solar system.*
Assuming a physically meaningful Hypothesis, *evolution matching the initial condition with the Origin of the solar system, if you can explain several current situations using Abduction increase the veracity of verification.* In abduction, reliability increases as much as the Hypothesis can explain much of the current situation, but unless it can explain it is useless.

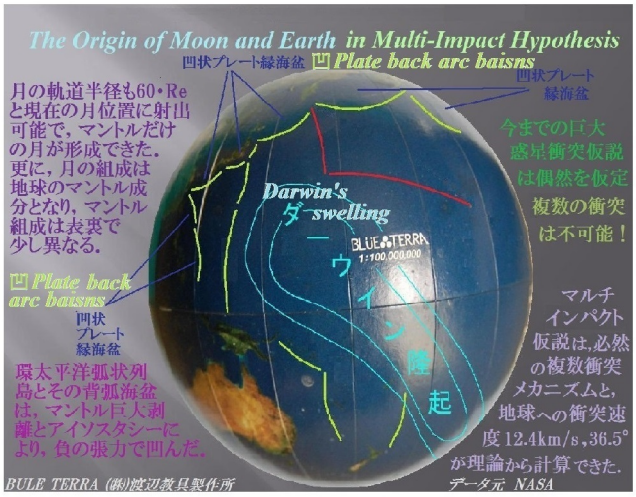
In the Multi Impact Hypothesis, *we were able to describe everything such as Origin of plate tectonics, deep sea ocean floor and the Pacific arcuate archipelago, sudden change of earth's axis inclination and movement direction, Van Allen eccentricitynew and driving force of plate tectonics.* With the Multi Impact Hypothesis, we can verify everything uniformly by abduction using the current state of evolution of the earth only once. In addition, **the Multi Impact Hypothesis can explain *the Origin of the Moon, the Pluto, the Asteroid belt, the differentiated meteorite, Jupiter Great Red Spot, and the inclination of Neptune's axis, the Mercury Core-Mantle ratio is large.***
In this way you can explain not only the Earth but also the Origin and evolution of the solar system in a unified way. On the contrary, the simulation **result of the unfounded Hypothesis** is **less successful and more contradictory.**

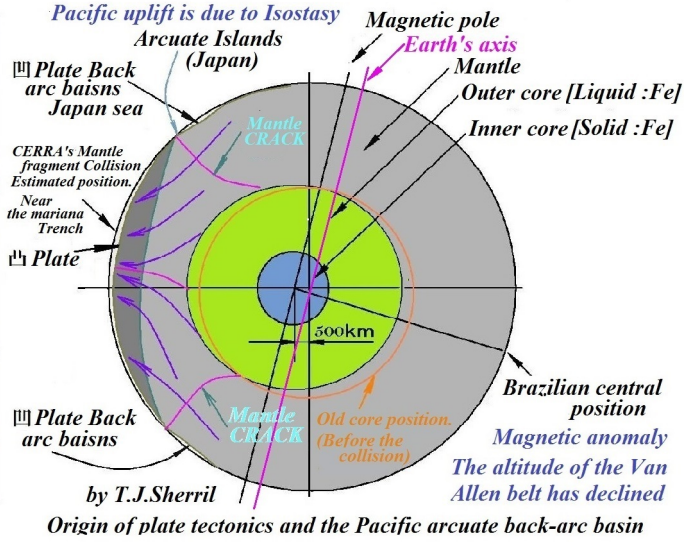
In the simulation of the Giant Impact Hypothesis, the moon formation of the mantle alone can be calculated, but the moon orbital energy was **only 1/20 of the actual.** Furthermore, in the Giant Impact Hypothesis, we can not explain **the difference in density between the front side and the back side of the moon** and **the Origin of the meteorite heavy bombing period and the feeding zone.**

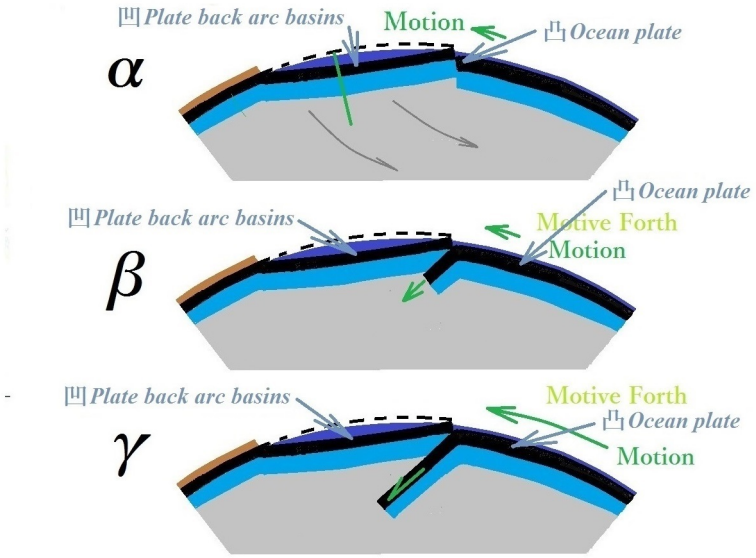
In this way, all Origins can easily be elucidated by Abduction, but other proofs are difficult.

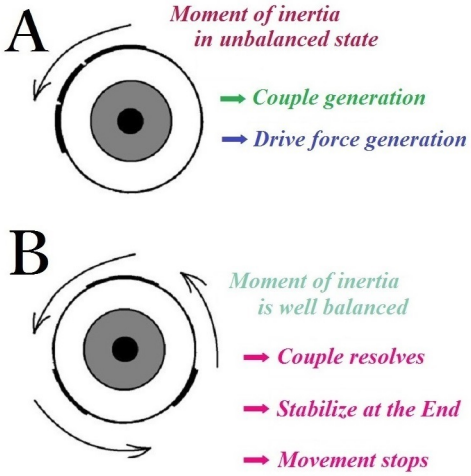
Keywords: Origin of plate tectonics, Origin of Ocean floor and Pacific arcuate rchipelago, Driving force of plate tectonics, Origin of sudden change of movement direction, Reason for inclination of the Earth rotation axis, Examination of multi impact hypothesis by abduction

Origin of the Earth,Plate-tectonics,Ocean-floor, by Abduction in Multi-Impact Hypothesis CERRA









The Great Kanto(1923) Earthquakeand YOKOHAMA (2)

*Masaru Nishizawa[1]

1. none

Abstruct:
(1) The focus of the great Kanto (1923) earthquake was located SAGAMI trough. Sagami bay and Suruga bay is very important and interest region to biological oceanography and seismology.
(2) In recent years, many deep-sea creatures was discovered in the deep sea of their Sagami and Suruga bay

(3) This deep-sea creatures can live by the existence of “S” component.

(4) The hot water well out from this deep-sea. This hot water containing “S” bring up many deep-sea creatures. See Fig-2: many troughs, many trenches, many bay and the relationship.

(5) The last :Most important obvious fact: The lain of most biggest earthquakes of the world under the Japanese (islands) are packed(jumed). “We must guard the nature enviroomentfor the young.”

Keywords: SAGAMI trough, the deep-sea creatures, Gravitation, The sink of Japan

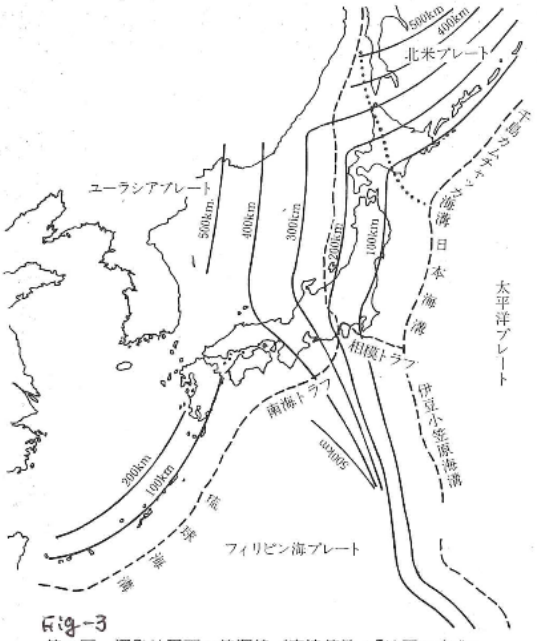


Fig-3
第二図 深発地震面の等深線（宇津徳治：「地震の事典」, P. 147, 朝倉書店, 1987）
和達清夫著「地震」中公文庫
1933, 1993, P229

長沼毅著「深海生物学への招待」
NHK Books, 1996, P126

Fig-2
図2 日本周辺の海底におけるチューブワームの分布。●は既発見地。○は候補地。

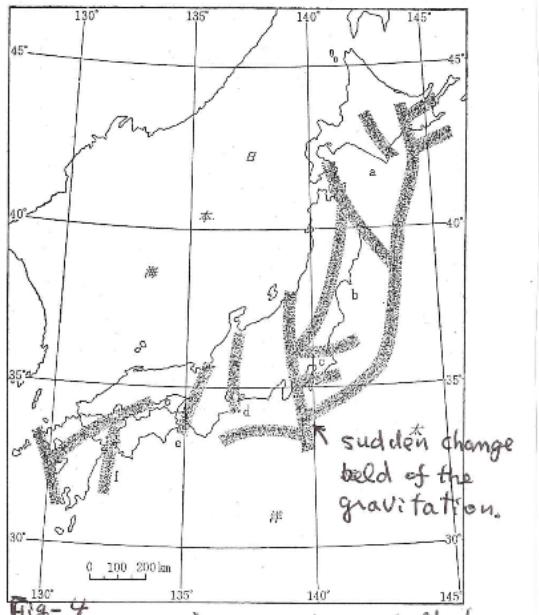
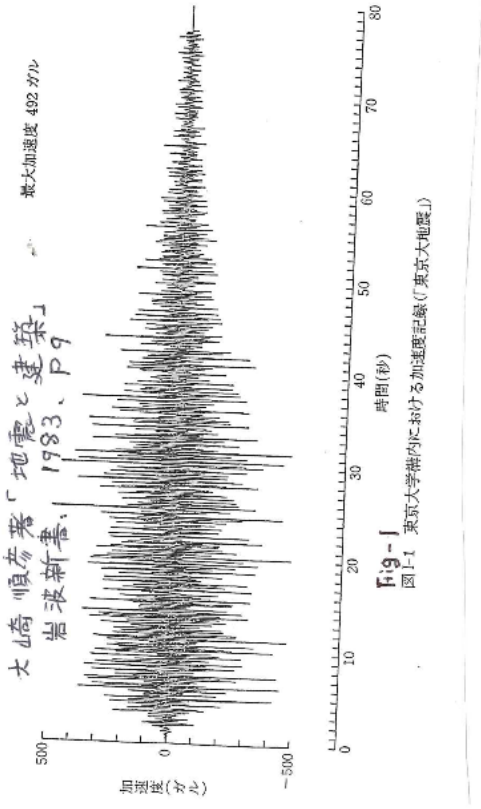


Fig-4
重力異常の急変帯（Sudden change belt of the Gravitation.
坪井忠二著「新・地震の話」岩波新書, 1957, P42



大崎順彦著「地震と建築」岩波新書, 1983, P9

Fig-1
図1-1 東京大学構内における加速度記録（「東京大地震」）

