Effects of Koshu Seamount on the Development of Baroclinic Instability Leading to the Kuroshio Large Meander

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It is well known that the Kuroshio south of Japan shows bimodal path fluctuations between the large meander (LM) path and the nonlarge meander (NLM) path. The transition from the NLM path to the LM path is triggered by a small meander which is generated off the southeastern coast of Kyushu and then propagates eastward to Cape Shiono-misaki while being amplified slowly through baroclinic interaction with a lower layer cyclone-anticyclone pair. This small meander thereafter amplifies rapidly over Koshu Seamount located about 200 km to the south of Cape Shiono-misaki, leading to the formation of the LM path. Although it is shown that the existence of Koshu Seamount is essential for the rapid amplification of the small meander, the underlying physical mechanism has not been fully understood yet.

In this study, the effects of Koshu Seamount on the development of baroclinic instability leading to the formation of the LM path of the Kuroshio are investigated using a two-layer quasi-geostrophic model taking into account the effect of bottom topography. Numerical experiments show that the transition processes from the NLM path to the LM path can be successfully reproduced only when the bottom topography mimicking Koshu Seamount is taken into account. In this case, the upper layer meander trough is amplified rapidly together with the lower layer cyclone-anticyclone pair during their passage over the seamount. This suggests that the transition from the NLM path to the LM path is caused by baroclinic instability enhanced over the seamount. A linear stability analysis with the bottom topography mimicking Koshu Seamount shows that baroclinic instability over the seamount is caused by a coupling between the upper layer Rossby wave propagating eastward in the background geostrophic flow and the lower layer topographically trapped wave propagating clockwise around the seamount. These two waves in the upper and lower layers propagate in the same direction with nearly the same speed so that they can resonantly interact with each other over the northern slope of the seamount. The spatial structure of the most unstable mode is shown to be close to that of the rapidly amplifying meander trough over the seamount reproduced in the numerical experiment.

Keywords: Large Meander of Kuroshio, Koshu Seamount, Baroclinic Instability, Topographically Trapped Wave, Two-Layer Quasi-Geostrophic Model, Linear Stability Analysis

Dynamics of the Atlantic meridional overturning circulation and Southern Ocean in an ocean model of intermediate complexity

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A steady-state, variable-density, 2-layer, ocean model (VLOM) is used to investigate basic dynamics of the Atlantic meridional overturning circulation and Southern Ocean. The domain consists of idealized (rectangular) representations of the Atlantic, Southern, and Pacific Oceans. The model equations represent the depth-averaged, layer-1 response.
A hierarchy of solutions is obtained in which forcings and processes are individually introduced. The complete solution set includes a wide variety of solution types: with sinking in the northern North Atlantic and with sinking near Antarctica; with and without wind forcing; with, without, and for two parameterizations of northern-boundary sinking that represent cooling external to and within the North Atlantic; for a wide range of mesoscale-eddy mixing strength and wind stress in the Antarctic Circumpolar region; and for different closures for mesoscale-eddy mixing. Novel aspects of the model and solutions include the following: use of VLOM, which allows buoyancy forcing to be introduced realistically; the aforementioned closure, which allows eddy-induced transport to be determined when layer 1 represents _both_ the surface mixed layer (h=h_m) and the depth of subsurface isopycnals (h>h_m); latitude where layer 1 outcrops in the Southern Ocean being _internally_ determined rather than externally specified; and a boundary layer, based on Gill's (1968) solution, that smoothly connects the Southern- and Atlantic-Ocean responses across the latitude of the southern tip of South America. Finally, some solutions in the set are comparable to solutions to idealized, ocean general circulation models (OGCMs); in these cases, our solutions provide insight into the underlying dynamics of the OGCM solutions, for example, pointing toward processes that may be involved in eddy saturation and compensation.

Keywords: Oceanic deep circulation, Layer model, Southern Ocean

Direct numerical simulation of deep-water waves in rotating frame

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The ratio of the periods of oceanic surface waves (wind waves and swells) and the inertial period is about 10^{-4}, and the earth's rotation does not greatly affect the orbital motion of fluid particles. Waves, however, do modify mean flow under the influence of Coriolis force. This is because the slight tilt of the orbital plane of fluid particle generates Reynolds stress. Hasselmann (1970) and Huang (1979) demonstrated that this Reynolds stress induced by waves can be expressed as the Coriolis force acting on the Stokes drift. The latter expression is called Coriolis-Stokes forcing. In ocean surface layer studies, Coriolis-Stokes forcing has been used as a standard formulation to incorporate the wave-stress effect. However, Coriolis-Stokes forcing is derived under several assumptions, and there has been no research that directly examined the appropriateness of the forcing.
Here we investigated the Coriolis-Stokes forcing, by performing direct numerical simulations of deep-water waves using a recently developed free-surface nonhydrostatic numerical model. The new scheme that this model adopts allows for the accurate simulation of the orbital motion and the dispersion relation of deep water waves, which could not be achieved by the conventional mode-splitting scheme.
Simulations were carried out under idealized conditions of x-z two dimensional domain with periodic horizontal boundaries. Waves were maintained by surface pressure perturbation. Reynolds stress was obtained from the velocity field, and the Coriolis-Stokes forcing was calculated using the Stokes drift, which we obtained from the on-line particle tracking.
Comparison of the two forces tells us that the Coriolis-Stokes forcing is nearly identical to the wave stress under the idealized condition. These forces induce a Eulerian response to the Stokes drift. In the existence of viscosity, this Eulerian flow generates the spiral current throughout the Ekman depth, even there is no net momentum input from the surface. By imposing a uniform stress on the surface, we also find that the mean current profile is described by Ekman-Stokes solution (Polton et al., 2005), which is obtained by considering Coriolis-Stokes forcing, rather than the classical Ekman solution. We will be presenting the results of further simulations under various conditions.

Keywords: wave-mean flow interaction, Coriolis-Stokes forcing, free-surface nonhydrostatic numerical model

A route to steady state of liquid fluidization

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When fluid is injected with low flux into the saturated packed bed of particles, fluid flows through interstitial spaces. This is known as a permeable flow. In this situation an empirical relationship, the Darcy law is known to exist in laminar flow, where the fluid flux is proportional to the applied pressure difference. When the applied pressure difference is increased and hence, the fluid flux is increased and both fluid and particles begin to flow together as a suspension. This gross flow called fluidization is important because it can drastically change efficiency of material transport. In the field of hydrology, for an example, this is related to an initiation of debris flow. In the field of volcanology, this process is related to the rejuvenation of a dormant magma chamber where the injection of new magma into the crystal mush causes the replenishment. In the field of chemical engineering, fluidization is well investigated for the engineering applications. The transition between a permeable flow and a gross flow is a kind of phase change; This critical superficial velocity is known as a minimum fluidization velocity (v_{mf}). The dynamics of the change from a permeable flow state to a gross flow state is more important in the initiation of such as debris flow and rejuvenation of magma chamber. The process of the initiation of fluidization is as follows; Water start to flow with high velocity enough to fluidize, both upper and fluidized front are lifted from top and bottom of particles bed, respectively(Slis et al. (1959)). Gibilaro et al. (1984) derived that upper front velocity has constant value until it reaches steady state and depends on water flux, and Thelen and Ramirez(1997) confirmed it experimentally. Upper front velocity is discussed like above, however, fluidized front velocity is not observed experimentally. In this presentation, we focus on the dynamics of the initiation process of the fluidization and present experimental approaches.

To observe the initiation process of the fluidization, we employed a vertical fluidizing bed. Transparent acrylic pipe (inside diameter:30 mm, length: 40~120 cm) is used, where particles are packed at the bottom of 12.5 cm. From water-saturated state, water is injected from the bottom at constant flux(the superficial velocity of 0.5~4.7 cm/s). The hydrostatic pressures are monitored at 3 different positions at 0,5,10 cm hight from bottom. Glass beads(diameter:0.8 mm, density:2.5 g/cm^3) and polystyrene beads(diameter:0.8 mm, density:1.03 g/cm^3) are used as particles. The all move of beads are filmed, and inside area of this pipe is divided into fixed, fluidized and no particle area by differential of particles density.

We found that top of the particle bed and the fluidization area propagates from bottom to upward when the injected velocity is above the critical value v_{mf}. Because fluidization front velocity is larger than upper front velocity, the thickness of fixed bed becomes gradually small, and after that all beads become fluidized. On checking pressure and movie of the same time, it is revealed that hydrostatic pressure gradient of fixed bed are larger than fluidized bed during rise. Propagation of fluidized bed is divided into two types by flux; In case injected velocity is slightly larger than v_{mf}, the propagation ends when both upper and fluidization front reach same hight. In case injected velocity is enough high compared with v_{mf}, rise lasts after a while that. Fluidized front velocity depends on injected flux when it is low, however, fluidized front velocity saturates when it is high. Porosity of propagating fluidized bed is kept nearly equal value to one of terminal fluidized bed.

We also compare the cases for soft gels are used as elastic particles and discuss the effect of modification of packing and particle shape during flow.

Keywords: Fluidization, Bed of particles, Substance transportation, Suspension, Laboratory experiment

Height structure of solar surface convective velocity from absorption line profile

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Convection phenomenon in the star is responsible for a energy carrier in the interior and its atmospheric activity. The internal structure of stars depends on how the energy created by nuclear fusion is transported toward outer space. The sun, the nearest star for us, is a good target in terms of understanding the convection phenomenon of the star. In the case of the sun, the energy created in the core part is carried by radiative effect. In the outer part of 30 % of the radius, energy transport mechanism changes to convective motion. The convective motion penetrates to the solar surface, which is seen with visible light. It is the important energy source of the upper atmospheric heating and its dynamics. The solar surface convection is considered as a energy carrier for the outer atmosphere, however we are still lack of understanding it. The solar surface, the photosphere, is covered with numerous bright ”granules”, which are separated dark ”intergranular lanes”. The granular regions show going upward materials coming from the interior, while the intergranular regions represent going downward gas. Some authors have been tested the phenomenon with their numerical simulations, while an actual process to decelerate the gas motion is still unclear observationally. It is important to derive the height structure of velocity field because the deceleration is being caused during ascending gas motion. Nevertheless we are lack of observational velocity field with enough time- and spatial-resolution for this analysis.In this study, we investigated the height structure of velocity field, using the spectral data for the analysis of absorption line shape acquired with the Spectro-Polarimeter (SP) of the Hinode / Solar Optical Tele- scope (SOT). It is possible to derive the velocity field for continuous height in the photosphere, calculating Doppler velocity for each intensity in the absorption line. This method is based on the fact that observed light at each intensity reflects different height. Hinode/SP is suited to this analysis because it provides high signal-to-noise data contributing to good accuracy for shape of absorption line with high spatial resolution. Our result, focusing on the height structure difference between on granules and intergranular lanes, shows that materials going upward accelerate with height until a certain level and decelerate in the higher layer, while submerging materials accelerate with depth. The latter accelerating process is cannot explained by the conventional 1-dimensional steady model. We are going to discuss some candidates to solve it in my talk.

Keywords: convection, the sun

Why always so cold the forests is?

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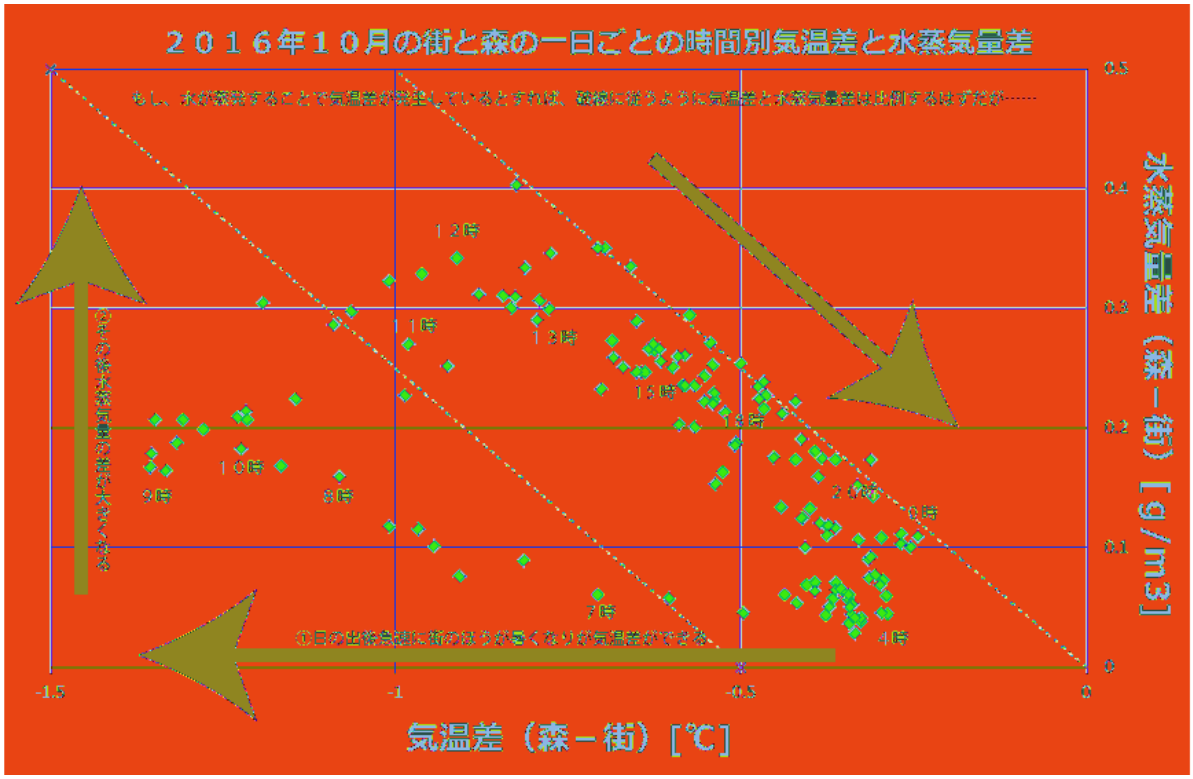
Location of forest cool. Even in a park surrounded by trees that are in the city also it is the same. In not been thorough investigation about the fact that why cool to do. Vague, more of the forest is low temperatures in the city and the forest, the relative humidity was only has been found that high. Also from the fact that make the plant transpiration, to measure the transpiration rate of the plant it has been actively carried out from diversified direction, such as for the interest and urban greening to the ecology of the plant. So

Keywords: HEAT ISLAND, HUMIDITY, TEMPERATURE, WATER VAPOR, FOREST



Wind stress for ocean circulation as given by the dissipation rate of surface waves

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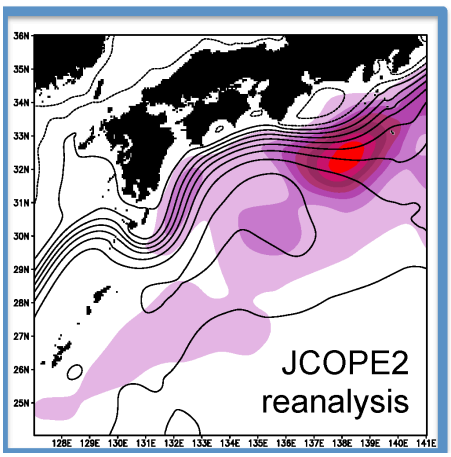
Recent studies have shown that mesoscale eddies and recirculation around western boundary currents are better simulated with a moderate magnitude in high-resolution OGCMs when relative wind speed (difference between the speeds of wind and surface circulation) is used in the bulk formula for wind stress. However the drag coefficient for wind stress might be better parameterized using quantities associated with surface gravity waves, such as significant wave height, wave age, and the direction of waves. Many studies in the surface wave community suggest that the net momentum flux from air (i.e. wind) to water (i.e. ocean circulation and surface waves) is given by the sum of skin stress and wave stress, the latter of which is associated with the generation of surface waves. Meanwhile, the net momentum flux to ocean circulation is given by the sum of the skin stress and dissipation-induced stress, the latter of which is associated with the breaking of surface waves. In order to investigate the utility of this mechanism, we have developed a coupled atmosphere ocean surface-wave model and performed sensitivity experiments associated with three types of wind stress. The first type of wind stress is given by the traditional formula with absolute wind speed. The second type of wind stress is given by the traditional formula with relative wind speed. The third type of wind stress is given by the surface wave model based on the dissipation rate of surface waves. The sensitivity experiments have been performed to examine the strength of mesoscale eddies in the Kuroshio Extension region, the small Kuroshio meander south of Japan, and the interaction between the Kuroshio Current and coastal upwelling associated with the landing of tropical cyclones.

Keywords: Wind stress, Wind waves, Ocean circulation surface-wave coupled model

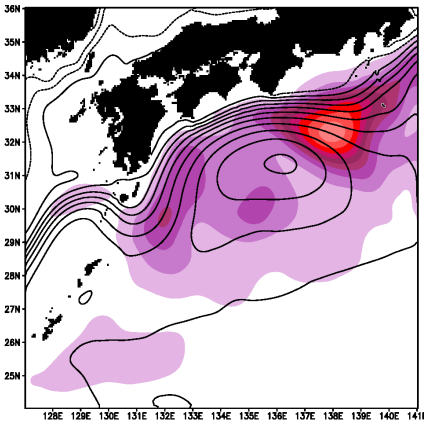
sensitivity of Kuroshio Small Meander to wind forcing

Color:
7-yr variance of SSH

Contour:
7-yr mean of SSH



#1: Absolute Wind Velocity



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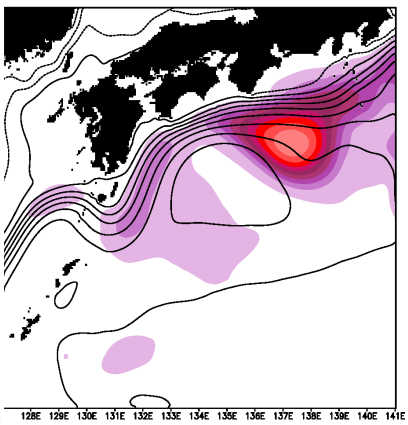
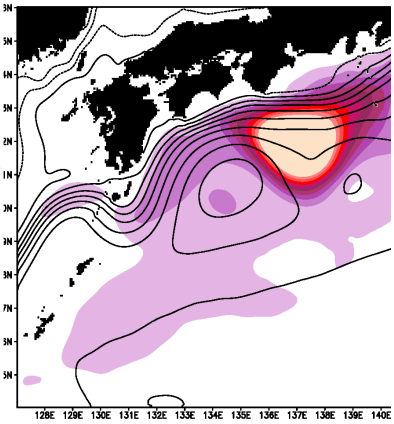
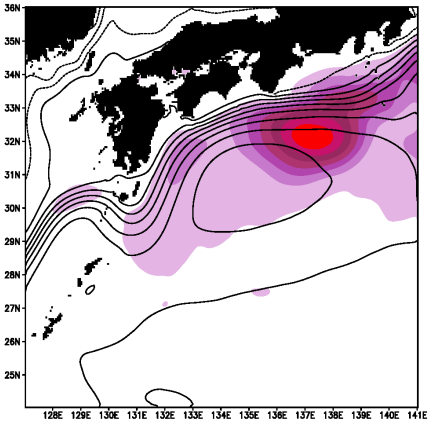


#3: Wind Stress in JRA55



#4: Surface Wave Model



A seamlessly diagnosable expression for the energy flux of all waves at all latitudes with equatorial and coastal waveguides

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Some of Rossby waves in the mid-latitude regions of the ocean originate from waves propagating poleward along the eastern boundaries, that may be traced back to the arrival of equatorial Kelvin waves. This kind of interaction between the various types of free waves in the equatorial and mid-latitude regions is fundamental for understanding tropical climate systems, and has sometimes been explained using the concept of equatorial basin mode. In previous studies, the interaction of equatorial and mid-latitude waves has been little mentioned in terms of the transfer of wave energy. The present study provides a formula to calculate the energy flux, from model outputs without relying on a Fourier analysis. The expression of the energy flux of the present study has been determined from the analysis of the group velocity of equatorial Rossby, mixed Rossvy-gravity, and inertia-gravity waves. The result is that the energy flux is written as the sum of the pressure flux and the additional rotational flux. The expression of the additional rotational flux reduces, under the approximation of mid-latitude Rossby waves, to that has been derived in previous studies and, under the approximation of mid-latitude inertia-gravity waves, to zero. Thus the expression of the energy flux, as given by the present study, may be used for a seamless diagnosis of waves in both equatorial and mid-latitude regions.

Keywords: group velocity, equatorial waves

Heat transport associated with gravitational sedimentation of condensed particles in cloud layers where convection is suppressed

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In Earth’s atmosphere, condensation of H2O enhances convection by the release of latent heat. However, in planetary atmospheres in general, there are cases where convection is suppressed in the condensing layer. For example, in the case when major constituent condenses, buoyancy can hardly be allowed because density of condensing parcel is constrained by the saturation relation between pressure and temperature (Colaprete et al 2003; Yamashita et al, in revision). We propose that, even where convection is suppressed in association with condensation, gravitational sedimentation of condensed phase can contribute to vertical heat transport; the combination of the downward gravitational sedimentation of lower entropy condensed phase and the mean upwelling of higher entropy gas phase can result in the net upward transport of entropy without convective motion in gas phase. In this presentation, we demonstrate the plausibility of the above mechanism in numerical experiments. Possible application of the same mechanism to H2O, NH3, or NH4 condensation layer in hydrogen rich atmospheres of gas giant planets, where convection tends to be suppressed due to heavier molecular weights of the condensible components (Guillot, 1995), will also be discussed.

Keywords: convection, cloud microphysics, planetary atmospheres, moist convection, Mars, Jovian planets

Penetration of mean zonal flows into an outer stable layer excited by MHD thermal convection in rotating spherical shells

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Recent seismological observations and their analyses suggest the existence of a stably stratified layer just below the core-mantle boundary of the Earth, whose thickness is O(100km). The extent of penetration of the deep convective motion
into the outer stable layer is one of the important key issue for considering magnetic field generation through the dynamo process as well as origin of the magnetic secular variation of the Earth. Takehiro and Lister (2001) theoretically derived the scaling of penetration thickness of the columnar convection into the stable layer in the case of no magnetic field, and showed that the penetration thickness is in proportion to the ratio of the angular velocity of the planet to the Brunt-Vaisala frequency of the stable layer and to the horizontal wavenumber of the disturbance. Takehiro (2015) considered the effect of magnetic field and obtained the penetration thickness when the stable stratification is sufficiently strong. The penetration thickness is proportion to the ratio of Alfven wave speed and inverse proportion to the ``arithmetic'' average of viscous and magnetic diffusion coefficients and to the total wavenumber of the disturbance. However, these scalings of penetration thickness can be applied when the disturbance under the stable layer is time-dependent. The extent of penetration of steady fluid motions, such as mean zonal flows induced by MHD rotating convection, should be examined separately. Takehiro and Lister (2002) investigated penetration of mean zonal flows excited by non-magnetic columnar convection into an upper stable stratified layer in a rotating spherical shell. They showed that penetration extent can be explained by the formula of Takehiro and Lister (2001) in the initial stage of the time development of mean zonal flows, whereas in the final stage, penetration extent becomes similar to the horizontal scale of zonal flows due to viscosity. In contrast, penetration of mean zonal flows into an upper stable layer under effects of magnetic field is not yet investigated. Here we theoretically examine the characteristics of mean zonal flows in the outer stable layer induced by the MHD convective motions below the layer.
We reexamine the theoretical model proposed by Takehiro (2015) in the case of steady fluid motion below the bottom boundary. Steady disturbances penetrate into a density stratified MHD fluid existing in the semi-infinite region in the vertical direction. The axis of rotation of the system is tilted with respect to the vertical. The basic magnetic field is uniform and may be tilted with respect to the vertical and the rotation axis. Linear dispersion relation shows that the penetration distance with zero frequency depends on the amplitude of Alfven wave speed. When Alfven wave speed is small, viscous diffusion becomes dominant and penetration distance is similar to the horizontal scale of the disturbance at the lower boundary. In contrast, when Alfven wave speed becomes larger, disturbance can penetrate more deeply, and penetration distance becomes in proportion to the Alfven wave speed and inverse proportion to the ``geometric'' average of viscous and magnetic diffusion coefficients and to the total horizontal wavenumber.
In order to validate the theoretical scaling of propagation distance, we perform numerical time integration of finite amplitude MHD thermal convection in a rapidly rotating spherical shell with an upper stably stratified layer embedded in the axially uniform basic magnetic field. The numerical results show that mean zonal flows trapped below the stable layer gradually penetrate into the stable layer as the basic magnetic field is strengthened, which is quantitatively

consistent with the theoretical scaling.

* References

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Takehiro (2015) PEPI, 241, 37.

Keywords: Earth's outer core, Mercury's outer core, core mantle boundary, dynamo, secular variation of geomagnetic field, Alfven waves

Spherical MHD dynamo in a thin convection layer above a thick resistive core

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We performed magnetohydrodynamics (MHD) simulations in a sphere of radius r=1 with a thin convection layer between r=0.9 and r=1, with relatively slow rotation rates. The inner sphere of radius r=0.9 is a stable (rigid) region with the same resistivity as the convection layer. The dynamo-generated magnetic field, therefore, diffuses into the inner resistive sphere. Since the convection layer is such thin, the convection pattern and its dynamo action are very different from those observed in the standard geo- or solar dynamo simulations. For these simulations, we applied a newly developed global grid, Yin-Yang-Zhong grid [Hayashi & Kageyama, JCP (2016)] by which we can solve equations on the coordinate singularity at r=0.

Keywords: MHD dynamo, spherical convection, Yin-Yang-Zhong grid

Transition to turbulence in liquid metal convection under a horizontal magnetic field

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Transition of flow pattern from laminar to turbulent is one of the most interesting problems in fluid dynamics. We performed both laboratory experiments and numerical simulations of Rayleigh-Benard convection of liquid metals under a uniform horizontal magnetic field. Fluids with low-Prandtl number like liquid metals are easy to be turbulent above the critical Rayleigh number. On the other hand, flow pattern can be laminar under a strong magnetic field when the fluid is electrically conductive, and the axes of convection rolls tend to be aligned in the direction of the magnetic field. Rayleigh-Benard convection of liquid metals under a uniform horizontal magnetic field is an appropriate system for a systematic study of flow transitions. Ultrasonic measurement of flow velocity profile is suitable for this setting of liquid metal convection, because it can grasp quasi-two-dimensional structure with its time variations. The process to turbulence is as follows; from steady laminar roll-structure to oscillatory rolls, to time dependent roll-numbers, and to vessel-scale circulation with turbulence. These are clearly observed with the decrease in the magnetic field. Repetition of the change of roll-numbers occurs when the magnetic field has moderate intensity for a given Rayleigh number. By analyzing the results of both laboratory experiments and numerical simulations, we clarified the decrease in mean roll-numbers as well as their mechanism. The process can be regarded as an interaction between aligned convection rolls and global-scale flow. The occurrence of global circulation bends the aligned rolls in a style of the skewed-varicose instability and induces roll number reduction. In the other point of view, the transitions can be regarded as a competition among several flow modes having different roll-numbers. To extract the fundamental flow structures and to quantify the mean roll-number existing in time varying flow patterns, we utilize the proper orthogonal decomposition (POD) analysis. We succeeded in identifying competitive modes with time variations of their amplitudes. Convective flow regimes seen in the present setting are clearly classified by a few fundamental flow modes and variations of their relative intensities.

Keywords: flow pattern, transition, magnetic field

Structure of thermal turbulence confined by moderate aspect ratio box

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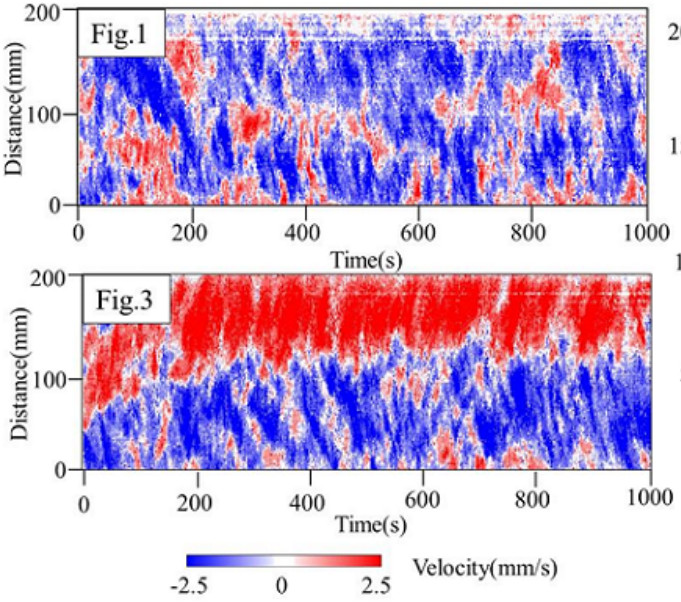
Spontaneous flow reversals occur in buoyancy-driven fluid dynamical systems, e.g. the ocean, the atmosphere and the inner core of planets. Behaviors of large scale flow structures in these systems have attracted many interests and a typical example is reversals of geo-magnetic polarity. The most fundamental flow configuration for these systems is the Rayleigh-Bénard convection, convections in a fluid-filled cell heated from below and cooled from above. In this system, flow reversals of large scale flow in thermal turbulence regime are detected and statistically analyzed in the particular case of the two-dimensional (2-D) rectangular geometry with aspect ratio of unity. The occurrence of reversals sensitively depends on the aspect ratio and thus there is great importance to investigate behaviors of the large scale flows in 3-D rectangular geometry with larger aspect ratios.
We performed laboratory experiments of Rayleigh-Bénard convection with a moderate aspect ratio box filled with water. The box has horizontal cross section of 200 ×200 mm^2 and 40 mm in height giving the aspect ratio five. The wall of this box assumes thermal insulation and the boundary conditions are isotropic in the horizontal cross sections. Ultrasonic Velocity Profiling (UVP) was used to visualize the spatiotemporal structure of flows on a measurement line and predicted the 3-D structure of the flows all over the box. We fixed Rayleigh number Ra = 6.4 ×10^6 and Prandtl number Pr = 5.3 at which thermal turbulence regime is expected. Fig.1 shows the spatiotemporal velocity map obtained in the measurement, where horizontal and vertical axes indicate time and distance, color represents velocity. We can observe flow keeping its direction over the measurement line and this is regarded as large scale flow in thermal turbulence. Besides there are several smaller scale flows accompanying the large scale flow with the size of about tens of millimeters which repeats appearance and disappearance everywhere on the line. We calculated spatial spectra from the velocity map and flow structures were objectively classified as large or small scale structures. Wavelength of the large one is the same with length of the box and that for the small ones corresponds to tens of millimeters we expected. This result agrees with past studies of numerical simulations. We also identified these 3-D structures by making instantaneous path line images at the same aspect ratio box with the grass cover. Fig.2 shows an example of path line images and some convective cells and rolls with the size of about tens of millimeters are identified. In addition, calculating power spectra of the velocity map indicates existence of a dominant frequency of the velocity oscillation in the order of 10^{-3} Hz. This oscillation is caused by periodic appearance of thermal plumes in a closed cell or roll that organize themselves both in space and time, and these generate coherent oscillations in thermal turbulence at any finite aspect ratio box. Finally we performed UVP measurement at the same aspect ratio box with the grass cover, where we can expect anisotropic large scale flows by non-uniform side wall thermal conditions. Fig.3 is the spatiotemporal velocity map of this measurement. There are two large scale structures of the flow having opposite flow directions, and corresponding instantaneous path line images tell us corresponding 3-D structures. These flow directions were kept for several thousand seconds and changed suddenly and spontaneously. This change resembles flow reversals in its time scale. There is also dominant velocity oscillation frequency in the same order as the box having uniform horizontal thermal condition at the wall on the power spectra calculated from the velocity map.

Keywords: Natural convection, Thermal turbulence, Large scale flow, Flow reversals



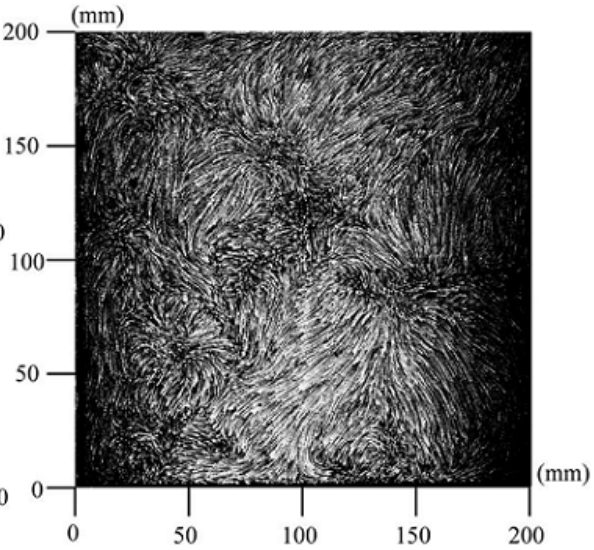


Fig.2

An axisymmetric flow in a cylindrical tank with a rotating bottom: comparison with experimental data in preceding studies and corrections around sidewall

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Non-axisymmetric flows are often realized in the terrestrial and planetary atmospheres even when their environments are axisymmetric. Such non-axisymmetric flows are observed in a very simple laboratory experiment using a cylindrical container filled with water by rotating a disk at the bottom rapidly. In order to investigate the mechanism of such symmetric breaking, we need to know axisymmetric flow as the basic state. We obtained the parameter of the basic axisymmetric flow by solving analytically the boundary layers, and showed that we can predict the basic state theoretically.
In order to verify the theory, we compared the theoretical prediction with the results which appeared in preceding researches on similar laboratory experiments. Although most preceding studies focus on non-axisymmetric phenomena, some data on axisymmetric regime are documented. Through this comparison with experimental data, the validity of the theory is confirmed. However, it is also found that the water surface around sidewall tends to be raised higher than theoretical prediction. The behaviour of the sidewall boundary layer is re-examined. We found that it has an effect to raise the water surface, whose specific value we estimated. The theory including this correction gives a good prediction including the region close to the sidewall.

Keywords: rotating flow, boundary layer, axisymmetric flow, laboratory experiment

Titius-Bode's law, the formation mechanism of the month, to explain the driving force of plate tectonics unified manner of "multi-impact hypothesis", elucidate the Earth evolution in Abduction, Approaching the mystery of the diamond formation

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Efficacy of abduction is determined all in the selection of "physically meaningful hypothesis". "That multiple conclusions can be explained systematically without contradiction to each other the current situation" is the proof.
The "Multi-Impact Hypothesis," to give the hypothesis with the following "Linking the moon and the earth of the Missing Link," a unified reasoning of (A) and (B).
(A)Differentiated protoplanetary CERRA of Mars size formed in the asteroid belt position of the solar system,by the perturbation of the most recent of Jupiter (giant mass), orbit is flattened to Jupiter near point side.
(B)Immediately before the CERRA to Jupiter collision, ruptured at a tension of Jupiter and the sun, the mantle piece collide intersects the Earth orbit.
by Abduction * : The flow of origin relationship of plate tectonics +: the origin and flow of the kimberlite pipe, diamond formation,Formation mechanism
(1)Moon of origin: collision mantle piece to Earth (12.4km /s, 36.5 degrees: from theoretical calculation), and formed in the orbit radius 60Re position,Formation mechanism
*(2)Pacific Rim arc-shaped archipelago marginal origin: In the Pacific Ocean position collision at the time of moon formation, Depression marginal sea forming in all directions
*(3)By a large amount of mantle deficient moon formation collision, Van Allen belt of Brazil of core eccentricity (about 10 percent) was reduced.
*(4)CERRA it takes about 5-6 million years until the track flat torn in Jupiter perturbation, had already differentiated cooling.
*(5)Multiple of mantle piece collide to Eartht by peeling off the mantle , 70 percent of the sea surface of the earth -5km was formed by isostasy.
*(6)Origin of plate tectonics PT , minimization of the eccentric and the moment of inertia caused by the collision as the driving force.
*(7))Origin of plate boundary, Crust peeling due to the mantle piece collision and crack formation.
*(8)Origin of arc-shaped archipelago and Marginal basin plate : Mantle deficit by collision and plate concave formed by isostasy
*(9)The origin of the start of subduction convex plate : When the concave plate and the convex plate each other press by the driving force , cause the convex crawl under concave.
+(10)Why diamond pipe has been formed in the South African Premier and Russian Mirunui district?
:Collision of Hawaii position, the collision energy was jetting pipe becomes a pressure concentrated on the opposite side of the Earth, and then continental drift.
+(11)Collides with the opposite side of the Drake Passage of Mirunui mine, Antarctica has been stabilized to move.
+(12)Why earth's axis is tilted even 23.5 degree from the revolution surface ?
:The Drake (high latitudes) was estimated to collision of CERRA division pieces to the position.
(13)Fragments at break of CERRA is the origin of the asteroid belt. Understood in the distribution of long radius (kinetic energy)
(14)The meteorite, but differentiated stony, stony-iron and iron meteorites are mixed , it can be understood with the fragments of CERRA.

(15)There are several fragments of CERRA, large species extinction repeated happened with sequentially collision.
(16)Core and part of the mantle of CERRA , the mass is large energy such as distribution, It became a low orbital energy Mercury with law of equipartition of energy.
(17)The fragments of CERRA that has collided to Jupiter, was the origin of the Great Red Spot.
cf. Shoemaker Levy No.9 comet collide with Jupiter in July 1997, collision marks remained about half a year as small red spots.
If large Serra of debris from the comet, it is possible to maintain the Great Red Spot without disappear from the hundreds of millions of years ago. Is this in the finished demonstration experiment?
What to elucidation of purposes in the sample return plan is made clear.

Keywords: Titius-Bode's law, the formation mechanism of the moon, the driving force of plate tectonics, Multi-Impact Hypothesis, Abduction