OS41R-03 0930h

Next Generation Digital Publishing - Journals as Living Literature Databases

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Publishing the results of scientific research in a purely digital environment is a relatively new paradigm that few publishers have fully embraced. Dependency on formats derived from print publications, albeit enhanced with links to the literature, does not take full advantage of the technology available.

We propose that the scientific journal should be a database of articles containing multiple data types alphanumeric, text, image, video and audio that are linked coherently within the database and to multiple external sources. Comprehensive indexing and classification of information enables one to publish a single multidisciplinary journal that links seamlessly to other databases in a federated search environment. In addition to articles, data, whether single reference values or large data sets, can be published with full credit to the author. Such a journal, integrated with the worlds scientific literature and factual databases provides an information resource that with the addition of search, data mining, visualization, interpretative and other tools provides the research scientist and the librarian with a rich information environment to extract the knowledge from the information base to improve the productivity and efficiency of the research and development processes.

As an example of what we propose, TheScientificWorldJOURNAL is a peer-reviewed digital journal for the Life Sciences and Environmental Sciences providing for online submission and immediate worldwide dissemination of accepted work. Authors retain copyright ownership of their work that, upon publication, may be accessed and purchased via the web site of TheScientificWorld. All articles are also deposited immediately in public online libraries where the content may be searched without charge. All articles published in TheScientificWorldJOURNAL may be obtained free of charge one year after their publication through either TheScientificWorld web site or through the public online libraries.

References cited in TheScientificWorldJOURNAL as well as author and title information are linked online to bibliographic databases including sciBASE, which incorporates data from PASCAL, CAB ABSTRACTS(R) and MEDLINE (R), as well as other leading sources to enable further bibliographic searches (e.g., author search); to provide abstracts of cited references; and, in addition, to link to document supply services that enable cited full text articles to be procured, by immediate pdf download or email delivery of copies. Articles can be dynamically updated through links to factual databases to retain the currency of the article.

OS41R-04 1000h

Marine Realms Information Bank, a Distributed Geolibrary for the Ocean

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The Marine Realms Information Bank (MRIB) is a prototype web-based distributed geolibrary that organizes, indexes, and delivers online information about the oceanic and coastal environments. The improvement of computer power and connectivity of the 1990s, by enabling very fast exchange of data online, has shown that effective information management does not automatically result from quicker connection or large broadband. Millions of web sites have been setup to provide information on every subject, and various information-gathering systems have been developed to locate information online. Unfortunately, these search engines often produce exhaustive bibliographic lists that mix first-quality scientific knowledge with irrelevant materials. To be really useful, information banks require not only quality control but also classification systems that integrate and organize the information.

In 1999 the National Research Council proposed the concept of distributed geolibraries, which are online digital libraries able to provide a simple mechanism for searching and retrieving information in response to topical and geographically defined needs. Distributed geolibraries are beneficial for various reasons, the most important of which is the authoritative role they would come to assume as subject gateways. To be referenced through a scientific geolibrary, information sources must meet quality standards set by the library gatekeeper. Another important benefit of a distributed geolibrary comes from its distributed attribute. Without the need to collect information in one physical location, local curators can serve and update online information without the requirement of maintaining consistency among multiple copies.

The MRIB prototype implements the distributed geolibrary concept to organize, index, and deliver online information about the oceanic and coastal environments. MRIB provides access to information, but it is not an information repository. It incorporates information that exists in remote sources, without modifying formats or content. This system succeeds by building a central index that consists of Electronic Index Cards containing metadata about the information sources, their geographical areas, and their network locations. The ontology of MRIB is expressed in the classification system through which users can explore the available information. MRIB currently classifies information with 13 types of categories (facets): Location, Geologic Time, Features, Biota, Discipline, Scientific Method, Hot Topics, Project Name, Agency Name, Author, Class, Format, and Audience. Classifying information is not automatic but is performed by a librarian, which is both the major benefit and the major operating cost of MRIB.

The significance of MRIB lies both in the utility of the information bank and in the implementation of the distributed geolibraries concept. Distributed information banks, such as MRIB, can be applied widely as unifying portals for extensive or rapidly developing information bases, for which a centralized repository would be impractical. In addition, MRIB has a modular structure that allows a classification system to be easily modified, to expedite the development and testing of suitable classification systems for existing information bases.

URL: http://mrib.usgs.gov

OS41R-05 1050h INVITED

Electronic Journals: A Work in Progress

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Despite the fact that journals have been distributed electronically for >5 years, the electronic journal is in the very early stages of development. How quickly it will change and what it will change to depend on the imagination of authors as they exploit the medium to convey their results. AGU's goal from the beginning has been to go beyond a flat page reproduced on a screen. Providing members the means to customize their AGU information packages was also a critical part of the AGU plan. Starting 1 Jan. 2002, the SGML files in the AGU archive will constitute the journal of record; the html will be the online rendition of the journal of record and will contain material that will not be in the printed journal. Thus, the printed journal can no longer serve the archival role it has in the past. The responsibility for maintaining and upgrading the archive for electronic journals must lie with the publisher; libraries and other entities are unlikely to have the means to do the job. Seemingly mundane things are also changing: how to cite articles in a persistent way; how to maintain the integrity of the literature while making it easy to find the errata. Adjusting the economic model is another aspect of this work in progress. To what extent can societies continue to rely on three traditional revenue streams: member subscriptions, institutional subscriptions, and author fees? The terms under which access will be granted are also likely to change as there is more experience. There are many unknowns, but it is clear that change will be the norm for electronic journals for a long time.

OS41R-06 1120h

Deep-Sea Research: A Classic Journal Enters the Digital Millennium

Name TBD (508-289-7665; euhlinger@mbl.edu)

Elsevier Science, Molenwerf 1 1014 AG Amsterdam The Netherlands, Netherlands

Elsevier Science, publisher of a number of highly respected oceanography journals, continues to be a leader in the rapid evolution from print to electronic journals. The process of taking a journal such as Deep-Sea Research into the electronic era, the impact on the journal, and the emerging issues for scholarly scientific communication in the ocean sciences will be discussed.

OS41S HC: 317 B Thursday 0830h

Ocean Dynamics and Instabilities II

Presiding: **D P Marshall,** University of Reading**; R A de Szoeke,** Oregon State University

OS41S-01 0830h

Destabilisation of barotropic flows by small-scale topography

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We examine the stability of a zonal jet on the beta-plane with bottom topography (such that the isobaths are zonal). It is assumed that the horizontal scale of topography is much smaller than the width of the jet. The attention is mostly focussed on linear, normal-mode disturbances.

Two types of disturbances are considered: *long* disturbances, the length of which is comparable to the width of the jet; and *short* disturbances, the length of which is comparable to the spatial scale of topography. The former have been examined by Benilov (2000), who demonstrated that topography is, generally, a stabilizing influence for them. The latter are the subject of the present work: using analytical methods and direct numerical integration of the eigenvalue problem for normal modes, it is argued that they are always unstable.

OS41S-02 0845h

Effects of Bottom Friction on a Baroclinically Unstable Oceanic jet

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Bottom friction is an important sink of energy in the ocean. Indeed, high resolution ocean models need bottom friction to achieve a satisfactory kinetic energy level at the equilibrium.

In this study we reexamine the effects of bottom friction on the non-linear equilibration of an unstable baroclinic jet using a PE model. As in previous studies using QG models (Panetta, 1993) we have found that the bottom friction strongly affects the barotropic mode whereas the baroclinic modes are weakly changed. The new result is that the bottom friction can yield a significant space scale selection, either in QG or PE model. A comparison between PE and QG solutions reveal that the characteristics of the PE eddy field differ from that of the QG eddy field in the upper layers.

The "barotropic governor" of James (1987) cannot explain the effects of the bottom friction for this oceanic eddy field. A rationalisation of these results is proposed.

OS41S-03 0900h

Instability of vortices in a two-layer ocean with thin upper layer

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We examine the stability of a quasigeostrophic vortex in a two-layer ocean with *thin* upper layer on the f-plane. It is assumed that the vortex has a sign-definite swirl velocity and is localised in the upper layer, whereas the disturbance is present in both. The stability boundary-value problem admits three types of normal modes: *fast* (upper layer dominated) modes, responsible for *equivalent-barotropic* instability, and two *slow baroclinic* types (mixed and lower layer dominated modes). The growth rate of unstable fast modes is the largest of the three, however, they exist only for unrealistically small vortices (with a radius smaller than

half of the deformation radius), and the attention is focussed on the slow modes. Those are examined by expanding the stability boundary-value problem in powers of the (small) ratio of the upper layer's depth to the lower layer's depth.

(i) It has been demonstrated that the instability of slow modes, if any, is associated with critical levels, which are located at the periphery of the vortex.

(ii) The complete (sufficient and necessary) stability criterion with respect to slow modes has been derived: the vortex is stable if and only if the potential-vorticity gradient at the critical layer and swirl velocity are of the same sign.

Several vortex profiles have been examined, and it has been shown that vortices with slow-decaying periphery are more unstable *baroclinically* and less *barotropically* than those with fast-decaying periphery, with the Gaussian profile being the most stable overall.

The asymptotic results have been verified by numerical integration of the exact boundary-value problem, and interpreted using oceanic observations.

OS41S-04 0915h

The Role of Sloping Sidewalls in Forming Potential Vorticity Contrasts in the Ocean Interior

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Given the adiabatic nature of the interior ocean, the potential vorticity (PV) distribution is principally determined by a competition between PV sources from boundaries and stirring by geostrophic eddies. For example, over the upper thermocline, the PV distribution is determined by a combination of ventilation from the diabatically-forced, surface mixed layer and eddy stirring. Following Hallberg and Rhines (2000), we investigate the role of sloping sidewalls in determining the PV in the ocean interior, which might be particularly relevant for the deep ocean. We conduct eddy-resolving (1/16 degree), isopycnic experiments for a double wind-driven gyre with either vertical or sloping sidewalls. If there are vertical sidewalls, eddy stirring leads to PV homogenization within interior density layers. If there are sloping sidewalls, frictional torques lead to bands of low and high PV being formed along the western boundary of the subpolar and subtropical gyres respectively. These regions of low and high PV are transferred into the interior by a separated jet at the intergyre boundary. This injection of the PV contrast along the boundary can prevent eddy homogenization occurring over the interior of the basin. In these integrations, the boundary injection of the PV contrast weakens with depth. Hence, the relevance of this process to the real ocean depends on whether the background circulation is sufficiently strong to transfer these PV contrasts formed along the boundary into the interior. In addition, including enhanced diabatic mixing along the sloping sidewalls can lead to the preferential formation of low PV for intermediate layers.

Reference: Hallberg, R. and P.B. Rhines, 2000: Boundary sources of potential vorticity in geophysical circulations. Developments in Geophysical Turbulence, R.M. Kerr and Y. Kimura (Eds.), Kluiver

OS41S-05 0930h

Flow Past a Cylinder on a β-Plane and Gulf Stream Separation

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The classical problem of flow past a cylinder is revisited in the context of understanding the separation of the Gulf Stream at Cape Hatteras. Numerical solutions are presented for eastward, barotropic flow past a cylinder in a β-plane channel. The solutions are dependent on two nondimensional parameters: the Reynolds number and a β-parameter (or Rhines number). Downstream separation requires both high Reynolds number and moderate β; in constrast separation is inhibited downstream of the cylinder in the limit of large β. The relevance of these results to boundary current separation will be demonstrated. The mechanism through which separation occurs is the generation of an adverse pressure gradient along the boundary. A formula will be derived relating downstream pressure variations to three dynamical processes: (i) the beta-effect, (ii) changes in coastline curvature, and (iii) vortex stretching. The relation of this formula to the numerical results will be discussed.

URL: http://www.met.rdg.ac.uk/~ocean/pub/tm01b.html

OS41S-06 0945h

Assessing Turbulence's Role in Westward Intensification Using Inhomogeneous Viscosity

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The behavior of the single-gyre homogeneous density ocean model at large Reynolds number is quite unlike the behavior exhibited by the ocean. At relatively modest Reynolds number, the dynamics of the single-gyre model are dominated by inertia throughout the basin, a situation known as inertial runaway. The Sverdrup relation does not apply anywhere in inertial runaway. We have shown that inhomogeneous horizontal viscosity in an eddy-resolving homogeneous model can prevent runaway even with small viscosity in most of the basin.

Processes which do not conserve barotropic vorticity–such as tidal and wave interaction with topography–are presumably enhanced near the basin margins, so increased viscosity near the basin boundary may be considered to represent such phenomena in a simplified way. The basin-wide circulation constraint also suggests that increased viscosity near the boundary will be necessary, as the lateral friction vorticity flux through the basin boundary must balance the wind stress input. We performed barotropic eddy-resolving numerical calculations increasing the viscosity in different regions. In the model eddies deliver vorticity (by Reynolds flux) to the regions where the viscosity is large near the basin boundary. The vorticity is then removed by the friction in this area. The viscosity away from the boundary does not appear to have a large role in determining the global structure of the solution.

Our numerical results demonstrate that basin-wide behavior is affected by changing the boundary current structure only in the frictional sublayer. As viscosity is raised in the sublayer, a visco-inertial western boundary layer forms where interior fluid enters, and a turbulent western boundary layer forms where the boundary layer fluid exits. The strength of the recirculation gyre typical of single-gyre solutions is controlled non-locally by the viscosity in the frictional sublayer.

URL: http://web.mit.edu/baylor/www/main.htm

OS41S-07 1020h

Baroclinic Modes of a Two-Layer Basin

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We examine large-scale baroclinic eigenmodes of a two-layer rectangular basin forced by surface wind-stress in the limit of small dissipation. Low-frequency oscillatory modes with small decay rates independent of friction result when the constraint of mass conservation is enforced.

We found the magnitude of the wind-stress to be critical to the eigenspectrum. For forcings with blocked geostrophic contours, and non-zero long baroclinic Rossby wave speeds, modes with decay rates independent of friction emerge. For forcings with closed geostrophic contours two classes of eigenmodes with comparable decay-rates emerge: purely decaying modes confined to the region of closed contours and oscillatory modes confined to the separatrix between blocked and closed contours. The purely decaying mode exists without the constraint of total mass conservation, but their decay rate depends on dissipation to leading order.

OS41S-08 1035h

A Theory for the Response of the Thermohaline Circulation to Variability in Forcing

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The response of the upper, warm, limb of the thermohaline circulation to an abrupt change in deep water formation at high latitudes is investigated using a reduced-gravity ocean model. Kelvin waves are initiated which propagate along the western boundary to the equator, on a timescale of months. Adjustment in the North Atlantic is therefore rapid. Response in the southern hemisphere, governed by westward Rossby wave propagation in the interior, is much slower.

Through a mechanism we term the "equatorial buffer", the equator acts to limit the size of the response in the South Atlantic. The equator behaves as a low-pass filter, confining variability on decadal and shorter timescales to the hemisphere in which it is forced.

We develop a new quantitative theory, based on a single variable - the thermocline thickness on the eastern boundary - to describe this surface ocean response. The theory agrees well with the numerical results, and has important implications for abrupt climate change, the spatial extent of anomalies in overturning, and the monitoring of thermohaline variability.

OS41S-09 1050h

Thermobaric Effects on Planetary Wave Propagation

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The equations of motion and thermodynamics are shown in orthobaric density coordinates. Orthobaric density is a way of empirically correcting in situ density for pressure. Because orthobaric density is not a material variable, there is an adiabatic, reversible diapycnal flux, which is proportional to the thermobaric coefficient in the seawater equation of state, the anomaly of salinity from the standard T-S relation, and the apparent vertical motion of the orthobaric isopycnals. This complicated term is propagated through the otherwise conventional derivation of the quasigeostrophic equations. As an example of the effect of this term, it is shown how baroclinic Rossby waves are modified by propagation through an ocean with spatially variable T-S relation. Because the thermobaric term is essentially nonlinear, an effect can only occur at finite amplitude. A Korteweg-de Vries equation is obtained for the long-time amplitude evolution of Rossby waves due to this effect. An assessment will be made of its importance to time-dependent circulation.

OS41S-10 1105h

Asymptotic Solutions for Groups of Long Planetary Waves in a Two-and-a-half Layer Model with Nonzonal Mean Flow

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We consider long planetary waves linearised about a steady wind-driven non-zonal spatially homogeneous upper layer flow that qualitatively models different locations in a subtropical gyre.

Waves are generated by a localised wavemaker impulsively switched on and oscillating thereafter at a fixed frequency. An asymptotic (stationary phase) far field solution at large time consists of a travelling pulse that leaves in its wake a sympathetic oscillation at the forcing frequency. The sympathetic part of the solution shows spatial growth due to baroclinic instability. The translating form of the pulse acquires an anisotropic shape due to the dynamical characteristics of Rossby waves.

OS41S-11 1120h

Climate Oscillations in a Hybrid Coupled Ocean–Atmopshere–Sea-Ice Model

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A hybrid coupled ocean–atmosphere–sea-ice model has been set up to investigate low-frequency variability in the climate system. The model's atmospheric component is a Budyko-Sellers-North, two-dimensional energy-balance model (EBM) that is used both with and without a diagnostic hydrologic cycle. The oceanic component is an idealized general circulation model, in which buoyancy fluxes depend on the presence of the hydrologic cycle in the EBM, while the sea-ice component is a thermodynamic sea-ice model.

Various oscillations with interannual and longer periods are found, depending on model parameter values and the physical processes allowed to operate in the model. We perform an extensive study of the model's

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parameter regimes and identify essential physical processes instrumental in maintaining different types of low-frequency variability.

These results are used to study predictable climate modes that can be detected at the ocean's surface in an optimal way, by distinguishing between surface signatures of the model's oscillatory solutions.

OS41S-12 1135h

A new approach to parameterising geostrophic eddies

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We revisit the problem of parameterising geostrophic eddies from the perspective of geostrophic turbulence theory. A key aspect is that energy cascades to larger spatial scales and is approximately conserved, whereas potential enstrophy cascades to smaller spatial scales where it is dissipated. Results are presented from an eddy-resolving, one-and-a-half layer model of abyssal recirculations. Using these results, we develop a new parameterisation that successfully reproduces aspects of the eddy-resolving integrations.

Extensions of these calculations to multiple layers will be presented, in particular focussing on which properties are conserved and dissipated, with an emphasis on interior layers that are not directly in contact with the upper or lower boundaries.

OS41T HC: 316 B Thursday 0830h

Mixing and Doubly Diffusive Processes

Presiding: **F G Jacobitz,** University of California**; B R Ruddick,** Department of Oceanography

OS41T-01 0830h

Differential Diffusion of T and S in Bi-stable Conditions

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Double diffusive phenomena resulting from the factor of 100 difference in the molecular diffusivities for T and S are widely known and studied. Less well recognized is the potential for preferential diffusion of T relative to S in conditions where both mean gradients are stabilizing, conditions common in estuarine and coastal environments. This phenomenon, termed differential diffusion, has been explored in a series of fully three-dimensional direct numerical simulations of decaying turbulence, using molecular coefficients consistent with T in seawater, and a "salt" scalar S which is 10 times less diffusive than T. The simulations exhibit differential diffusion, in the expected sense of larger flux of T than of S : the maximum flux differential is of order 20%, and is associated with the largest observed mixing efficiency. Since T and S made equal contributions to the mean density gradient in the simulations, the observed flux differences imply that T has a larger turbulent diffusivity than S. Although the physical scale range of the simulations is restricted by computer limitations, available comparisons with oceanographic data, including values of turbulence Re and temperature Cox numbers, as well as velocity and scalar spectral shapes, all suggest that the numerical results are indistinguishable from direct observations of sporadic turbulence in the stratified ocean interior. Since these simulations will underestimate the degree of differential diffusion between T and true salt (with molecular diffusivity 100 times less than T), we conclude that the sporadic turbulence characteristic of stratified ocean water columns will normally exhibit significant differential diffusion, in the sense of a vertical diffusivity of T exceeding that of salt. Equal turbulent diffusivities of T and S is a basic tenent of our beliefs about the effects of "ordinary" turbulence in the stratified interior of the ocean, underlying both the "theory" used to derive density flux (diffusivity) from measurement of T microstructure, and the alternate method using observations of the vertical diffusion of a dye (which generally has the molecular diffusivity of neither T nor S). Acceptance of the reality of differential diffusion thus impacts much of what we "know" about the magnitude of turbulent fluxes in stratified regions of the ocean. Accounting for differential diffusion may be particularly important in settings, such as high latitude oceans and estuaries, where density structure is dominated by salinity.

OS41T-02 0845h

Laboratory Experiments on Continually Forced 2D Turbulence

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There has been much recent interest in the advection of tracers by 2D turbulence in geophysical flows. While there is a large body of literature on decaying 2D turbulence or forced 2D turbulence in unbounded domains, there have been very few studies of forced turbulence in bounded domains. In this study we present new experimental results from a continuously forced quasi 2D turbulent field.

The experiments are performed in a square Perspex tank filled with water. The flow is made quasi 2D by a steady background rotation. The rotation rate of the tank has a small ($< 8\%$) sinusoidal perturbation which leads to the periodic formation of eddies in the corners of the tank. When the oscillation period of the perturbation is greater than an eddy roll-up time-scale, dipole structures are observed to form. The dipoles can migrate away from the walls, and the interior of the tank is continually filled with vortexs. From experimental visualizations the length scale of the vortexs appears to be largely controlled by the initial formation mechanism and large scale structures are not observed to form at large times. Thus the experiments provide a simple way of creating a continuously forced 2D turbulent field. The resulting structures are in contrast with most previous laboratory experiments on 2D turbulence which have investigated decaying turbulence and have observed the formations of large scale structure. In these experiments, decaying turbulence had been produced by a variety of methods such as the decaying turbulence in the wake of a comb of rods (Massen et al 1999), organization of vortices in thin conducting liquids (Cardoso et al 1994) or in rotating systems where there are sudden changes in angular rotation rate (Konijnenberg et al 1998).

Results of dye visualizations, particle tracking experiments and a direct numerical simulation will be presented and discussed in terms of their oceanographic application.

URL: http://www.fluid.tue.nl/users/mathew/

OS41T-03 0900h

Vertical Mixing and Transports Through a Stratified Shear Layer

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A stratified shear layer was generated in the laboratory by driving a turbulent mixed layer over a quiescent, deep dense layer. As a result, a density was formed between the upper and lower layers. This density interface was embedded in a velocity shear layer. Detailed velocity, density, and average local Richardson number Ri measurements were made through the stratified shear layer, from which the fluxes of momentum and density through the interface as well as energetics of the stratified shear layer were evaluated as a function of Ri. The quantities measured included the flux Richardson number, the dissipation flux coefficient, and the eddy diffusivities of momentum and density averaged across the shear layer. The results were compared with various deep and coastal oceanic data as well as common oceanic eddy diffusivity and flux parameterization schemes.

OS41T-04 0915h

Shear Diffusion in Plumes

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The hot fluid issuing from hydrothermal vents supports communities comprising animals that can only survive close to the vents. Vent activity appears to be ephemeral with a time scale of decades, and the only way for stationary benthic species to survive on evolutionary time scales is to colonize other active vent habitats. Kim, Mullineaux & Helfrich (1994) have measured larval abundances near hydrothermal vents and have combined these measurements with standard plume models to provide estimates of vertical larva fluxes. The larvae entrained into the plume are transported a considerable distance vertically into regions of faster horizontal motion which may lead to dispersal into habitats unreachable by larvae in near-bottom flows.

We investigate the dispersion of particles disperse inside a plume is modelled. The particles are viewed as a passive tracer that is advected by the velocity field of a line or axisymmetric plume. This velocity field is different from the usual Poiseuille flow of shear dispersion. Nevertheless, shear dispersion occurs and we develop a convection-diffusion equation is developed for the particle density. The effect of entrainment is discussed.

OS41T-05 0930h

Experiments on Differential Diffusion in a Diffusively-Stable, Turbulent Flow

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If temperature and salinity are mixed at different rates, the mixing efficiencies in flows with the same relative stratification strength can vary if the contributions of temperature and salinity to the density differ. We performed laboratory experiments to evaluate the conditions under which differential diffusion of heat and salt occurs and its effect on the mixing efficiency. A linearly stratified system that is stably stratified with both heat and salt is stirred with horizontally-oscillating vertical rods. This configuration isolates effects of molecular diffusivity by ensuring that both scalars experience the same stratification and turbulence strengths. Eddy diffusivities are equal for $\epsilon_a/\nu N^2 > 300$, where ϵ_a is an average dissipation, and the eddy diffusivity of heat exceeds that of salt for lower values. The effect of differential diffusion on the mixing efficiency was evaluated by allowing the initial density ratio $\alpha\Delta T/\beta\Delta S$ to vary. For weak stratification, the efficiency does not depend on density ratio, but for strong stratification, the efficiency increases with increasing density ratio.

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Measuring Intrusive Heat Flux Across a Front

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The lateral heat flux <uT> across intrusive thermohaline fronts is nearly impossible to measure directly because the intrusion velocities are small, O(1 mm/s). These velocities are almost completely masked by instrument errors and by internal wave velocities. We present a model that relates the intrusive-scale motions to the thermal microstructure, resulting in a simple parameterization for the cross-frontal heat flux. This model, a combination of Joyces intrusion model and the microstructure model of Osborne and Cox, shows that the cross-frontal heat flux results in intrusive-scale temperature variance, which must be erased by diapycnal mixing, and then dissipated by molecular heat conduction. The specific intrusive driving mechanism doesnt matter to this method.

The method is tested using hydrographic and microstructure observations from Meddy "Sharon. Three sets of hydrographic observations over a one-year period showed inward erosion of the Meddy by thermohaline intrusions, and consequent decrease in radius of the