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this book originated from our interest in sea surface temperature variability our initial though entirely pragmatic goal was to derive adequate mathemat ical tools for handling certain oceanographic problems eventually however these considerations went far beyond oceanographic applications partly because one of the authors is a mathematician we found that many theoretical issues of turbulent transport problems had been repeatedly discussed in fields of hy drodynamics plasma and solid matter physics and mathematics itself there are few monographs concerned with turbulent diffusion in the ocean csanady 1973 okubo 1980 monin and ozmidov 1988 while selecting material for this book we focused first on theoretical issues that could be helpful for understanding mixture processes in the ocean and sec ond on our own contribution to the problem mathematically all of the issues addressed in this book are concentrated around a single linear equation the stochastic advection diffusion equation there is no attempt to derive universal statistics of

turbulent flow instead the focus is on a statistical description of a passive scalar tracer under given velocity statistics as for applications this book addresses only one phenomenon transport of sea surface temperature anomalies hopefully however our two main approaches are applicable to other subjects unique book on reaction advection diffusion problems bennett s transport by advection and diffusion provides a focused foundation of the principles of transport at the undergraduate level with illustrations from a wide range of topics the text uses an integrated approach to teaching transport phenomena but widens coverage to include topics such as transport in compressible flows and in open channel flows it helps students develop the requisite math skills as well as the conceptual understanding needed to succeed in research and education it presents analytical and numerical tools to aid problem solving in each topic area the text is designed for senior or graduate level courses for chemical and mechanical engineering environmental studies earth science materials science and physics but it will also appeal to practitioners this text deals with the applications of the finite element method to incompressible flows volume one addresses the theoretical background and the methods development to the solution of a wide range of

incompressible flows volume two due may 1997 will be practice orientated and will address the simulation of the numerical solutions of the navier stoke equations via the finite element method das umfangreiche handbuch zur anwendung finiter elemente auf die inkompressible strömung jetzt neu als preiswerte paperback ausgabe ausgehend von einer ausführlichen erläuterung der theoretischen grundlagen werden geeignete numerische methoden zur lösung vielfältiger strömungsprobleme abgeleitet die in der praxis außerordentlich wichtigen anfangs und randbedingungen werden besonders sorgfältig behandelt nicht zuletzt finden sich angaben zur bisher oft kontrovers diskutierten rolle des druckes 06 00 many physical problems involve diffusive and convective transport processes when diffusion dominates convection standard numerical methods work satisfactorily but when convection dominates diffusion the standard methods become unstable and special techniques are needed to compute accurate numerical approximations of the unknown solution this convection dominated regime is the focus of the book after discussing at length the nature of solutions to convection dominated convection diffusion problems the authors motivate and design numerical methods that are particularly suited to this class of problems at first they examine finite

difference methods for two point boundary value problems as their analysis requires little theoretical background upwinding artificial diffusion uniformly convergent methods and shishkin meshes are some of the topics presented throughout the authors are concerned with the accuracy of solutions when the diffusion coefficient is close to zero later in the book they concentrate on finite element methods for problems posed in one and two dimensions this lucid yet thorough account of convection dominated convection diffusion problems and how to solve them numerically is meant for beginning graduate students and it includes a large number of exercises an up to date bibliography provides the reader with further reading the book is divided into two parts first we present two finite volumes schemes for the discretization of convection diffusion reaction problems on moving surfaces the first scheme extends the two points flux approximation finite volumes on moving surfaces the second scheme presents a finite volume scheme of type o method here we construct around the mesh vertices a linear approximation of the solution to the given problem using the unknowns located at cells centers a suitable flux continuity on cells interfaces in incorporated the method allows also the construction of a second order upwind for convection operators which makes the

overall scheme second order in space next we model the flow of a surfactant driven thin film here the use of tensor theory combined with lubrication approximation helps to reduce the navier stokes equations describing the flow of the thin film in three dimensions to a fourth order equation stated on the moving curved surface whose unknown is the film height the surfactant assumed to be insoluble is modeled by a convection diffusion equation on the fluid air interface we simulate the coupled system using an interface tracking method the effects of weak and strong advection on the dynamics of reaction diffusion models have long been studied in contrast the role of intermediate advection remains poorly understood for example concentration phenomena can occur when advection is strong providing a mechanism for the coexistence of multiple populations in contrast with the situation of weak advection where coexistence may not be possible the transition of the dynamics from weak to strong advection is generally difficult to determine in this work the authors consider a mathematical model of two competing populations in a spatially varying but temporally constant environment where both species have the same population dynamics but different dispersal strategies one species adopts random dispersal while the dispersal

strategy for the other species is a combination of random dispersal and advection upward along the resource gradient for any given diffusion rates the authors consider the bifurcation diagram of positive steady states by using the advection rate as the bifurcation parameter this approach enables the authors to capture the change of dynamics from weak advection to strong advection the authors determine three different types of bifurcation diagrams depending on the difference of diffusion rates some exact multiplicity results about bifurcation points are also presented the authors results can unify some previous work and as a case study about the role of advection also contribute to the understanding of intermediate relative to diffusion advection in reaction diffusion models le travail presente dans cette these est principalement une contribution a l analyse d approximations stabilisees pour des problemes de convection diffusion lineaires une etude numerique d un probleme d interaction fluide structure est egalement presentee pour une equation de convection diffusion stationnaire on analyse la precision d un schema elements finis comportant un terme de stabilisation sous forme de dissipation du quatrieme ordre dans une premiere partie on se restreint a une analyse pour des maillages simpliciaux reguliers au sens des esempnts

finis pour un probleme dans ir n avec n 3 on obtient des estimations de l erreur d approximation dans l 2 et dans h 1 pour une dissipation sous forme variationnelle dans le cas bidimensionnel on etudie plus particulierement un schema de type jameson compose d une partie centree de type mixte elements finis volumes finis et d une dissipation en differences quatriemes non consistante dans une deuxieme partie on considere l approximation d un probleme de convection diffusion dont la solution presente des couches limites on obtient des estimations d erreur dans la norme de l energie pour un schema elements finis avec une dissipation du quatrieme ordre consistante pour des maillages triangulaires localement anisotropes dans les couches limites le schema etudie est compare a des schemas volumes finis du second ordre dans une troisieme partie on analyse la consistance locale des schemas ayant la propriete de preservation de la linearite sur des maillages non structures une quatrieme partie est consacree a l etude numerique d un schema implicite linearise dans le cadre de l analyse du flottement d un profil d aile dans un ecoulement the role of double diffusive mixing in the north atlantic thermocline is considered mixing observations are analyzed in terms of the stability parameters for shear and double diffusive convection andshop manual

nondimensional ratio of dissipation rates while the model for turbulence describes most dissipation occurring in high shear dissipation in low shear is better described by the salt finger model and a method for estimating the salt finger enhancement of the diapycnal haline diffusivity over the thermal diffusivity is proposed these calculations suggest that salt finger driven haline flux drives diapycnal downwelling in the upper thermocline the role of turbulence occurring above rough bathymetry in the abyssal brazil basin is also considered the mixing levels along sloping bathymetry exceed the levels observed on ridge crests and canyon floors additionally mixing levels modulated in phase with the spring neap tidal cycle a model of the dissipation rate is derived and used to specify the turbulent mixing rate and constrain the diapycnal advection in an inverse model for the steady circulation the inverse model solution reveals the presence of a secondary circulation with zonal character these results suggest that mixing in abyssal canyons plays an important role in the mass budget of antarctic bottom water in probability theory and statistics a diffusion process is a solution to a stochastic differential equation it is a continuous time markov process with almost surely continuous sample paths brownian motion reflected

brownian motion and ornstein uhlenbeck processes are examples of diffusion processes a sample path of a diffusion process models the trajectory of a particle embedded in a flowing fluid and subjected to random displacements due to collisions with other particles which is called brownian motion the position of the particle is then random its probability density function as a function of space and time is governed by an advection diffusion equation in the last few years there has been a growing interest in the development of numerical techniques appropriate for the approximation of differential model problems presenting multiscale solutions this is the case for instance with functions displaying a smooth behavior except in certain regions where sudden and sharp variations are localized typical examples are internal or boundary layers when the number of degrees of freedom in the discretization process is not sufficient to ensure a fine resolution of the layers some stabilization procedures are needed to avoid unpleasant oscillatory effects without adding too much artificial viscosity to the scheme in the field of finite elements the streamline diffusion method the galerkin least squares method the bub ble function approach and other recent similar techniques provide excellent treatments of transport equations of elliptic type with small

diffusive terms referred to in fluid dynamics as advection diffusion or convection diffusion equations goals this book is an attempt to guide the reader in the construction of a computa tional code based on the spectral collocation method using algebraic polyno mials the main topic is the approximation of elliptic type boundary value par tial differential equations in 2 d with special attention to transport diffusion equations where the second order diffusive terms are strongly dominated by the first order advective terms applications will be considered especially in the case where nonlinear systems of partial differential equations can be re duced to a sequence of transport diffusion equations transports in fluids can be approached from two complementary perspectives in the eulerian view of mixing the focus is on the concentration field in the langrangian view fluid parcels are followed around as they move with the flow experiencing chaotic or stochastic motion this book examines both pictures presenting a number of theoretical and experimental lectures on various aspects of transport and mixing of active and passive particles in geophysical flows the accurate and efficient discretization of singularly perturbed advection diffusion equations on arbitrary 2d and 3d domains remainsshopmanual

problem an interesting approach to tackle this problem is the complete flux scheme cfs proposed by g d thiart and further investigated by j ten thije boonkkamp for the cfs uniform second order convergence has been proven on structured grids we extend a version of the cfs to unstructured grids for a steady singularly perturbed advection diffusion equation by construction the novel finite volume scheme is nodally exact in 1d for piecewise constant source terms this property allows to use elegant continuous arguments in order to prove uniform second order convergence on unstructured one dimensional grids numerical results verify the predicted bounds and suggest that by aligning the finite volume grid along the velocity field uniform second order convergence can be obtained in higher space dimensions as well in this thesis we study partial differential equations with random inputs the effects that different boundary conditions with random data and uncertain geometries have on the solution are analyzed further comparisons and couplings between different uncertainty quantification methods are performed the numerical simulations are based on provably strongly stable finite difference formulations based on summation by parts operators and a weak implementation of boundary and interface conditions the first part of this thesis

treats the construction of variance reducing boundary conditions it is shown how the variance of the solution can be manipulated by the choice of boundary conditions and a close relation between the variance of the solution and the energy estimate is established the technique is studied on both a purely hyperbolic system as well as an incompletely parabolic system of equations the applications considered are the euler maxwell s and navier stokes equations the second part focuses on the effect of uncertain geometry on the solution we consider a two dimensional advection diffusion equation with a stochastically varying boundary we transform the problem to a fixed domain where comparisons can be made numerical results are performed on a problem in heat transfer where the frequency and amplitude of the prescribed uncertainty are varied the final part of the thesis is devoted to the comparison and coupling of different uncertainty quantification methods an efficiency analysis is performed using the intrusive polynomial chaos expansion with stochastic galerkin projection and nonintrusive numerical integration the techniques are compared using the non linear viscous burgers equation a provably stable coupling procedure for the two methods is also constructed the general coupling procedure is exemplified using a

hyperbolic system of equations a discontinuous enrichment method dem for the efficient finite element solution of advection dominated transport problems in fluid mechanics whose solutions are known to possess multi scale features is developed attention is focused specifically on the two dimensional 2d advection diffusion equation the usual scalar model for the navier stokes equations following the basic dem methodology 1 the usual galerkin polynomial approximation is locally enriched by the free space solutions to the governing homogeneous partial differential equation pde for the constant coefficient advection diffusion equation several families of free space solutions are derived these include a family of exponential functions that exhibit a steep gradient in some flow direction and a family of discontinuous polynomials a parametrization of the former class of functions with respect to an angle parameter is developed so as to enable the systematic design and implementation of dem elements of arbitrary orders it is shown that the original constant coefficient methodology has a natural extension to variable coefficient advection diffusion problems for variable coefficient transport problems the approximation properties of dem can be improved by augmenting locally the enrichment space with a

higher order enrichment function that solves the governing pde with the advection field a x linearized to second order a space of lagrange multipliers introduced at the element interfaces to enforce a weak continuity of the solution and related to the normal derivatives of the enrichment functions is developed the construction of several low and higher order dem elements fitting this paradigm is discussed in detail numerical results for several constant as well as variable coefficient advection diffusion benchmark problems reveal that these dem elements outperform their standard galerkin and stabilized galerkin counterparts of comparable computational complexity by a large margin especially when the flow is advection dominated

Advection and Diffusion in Random Media 2013-11-11 this book originated from our interest in sea surface temperature variability our initial though entirely pragmatic goal was to derive adequate mathemat ical tools for handling certain oceanographic problems eventually however these considerations went far beyond oceanographic applications partly because one of the authors is a mathematician we found that many theoretical issues of turbulent transport problems had been repeatedly discussed in fields of hy drodynamics plasma and solid matter physics and mathematics itself there are few monographs concerned with turbulent diffusion in the ocean csanady 1973 okubo 1980 monin and ozmidov 1988 while selecting material for this book we focused first on theoretical issues that could be helpful for understanding mixture processes in the ocean and sec ond on our own contribution to the problem mathematically all of the issues addressed in this book are concentrated around a single linear equation the stochastic advection diffusion equation there is no attempt to derive universal statistics for turbulent flow instead the focus is on a statistical description of a passive scalar tracer under given velocity statistics as for applications this book addresses only one phenomenon transport of sea surface

temperature anomalies hopefully however our two main approaches are applicable to other subjects

Numerical Solution of Time-Dependent Advection-Diffusion-Reaction Equations 2013-04-17 unique book on reaction advection diffusion problems

Transport by Advection and Diffusion 2012-10-16 bennett s transport by advection and diffusion provides a focused foundation of the principles of transport at the undergraduate level with illustrations from a wide range of topics the text uses an integrated approach to teaching transport phenomena but widens coverage to include topics such as transport in compressible flows and in open channel flows it helps students develop the requisite math skills as well as the conceptual understanding needed to succeed in research and education it presents analytical and numerical tools to aid problem solving in each topic area the text is designed for senior or graduate level courses for chemical and mechanical engineering environmental studies earth science materials science and physics but it will also appeal to practitioners

Numerical Methods for Advection--diffusion Problems 1993 this text deals with the applications of the finite element method to incompressible flows volume one addresses the

theoretical background and the methods development to the solution of a wide range of incompressible flows volume two due may 1997 will be practice orientated and will address the simulation of the numerical solutions of the navier stoke equations via the finite element method

An Advection-diffusion Theory of Contaminant Transport for Stratified Porous Media [microform] 1983 das umfangreiche handbuch zur anwendung finiter elemente auf die inkompressible strömung jetzt neu als preiswerte paperback ausgabe ausgehend von einer ausführlichen erläuterung der theoretischen grundlagen werden geeignete numerische methoden zur lösung vielfältiger strömungsprobleme abgeleitet die in der praxis außerordentlich wichtigen anfangs und randbedingungen werden besonders sorgfältig behandelt nicht zuletzt finden sich angaben zur bisher oft kontrovers diskutierten rolle des druckes 06 00

Incompressible Flow and the Finite Element Method 1997-01-01 many physical problems involve diffusive and convective transport processes when diffusion dominates convection standard numerical methods work satisfactorily but when convection dominates diffusion the standard methods become unstable and special techniques are needed to compute accurate numerical approximations of the unknown

solution this convection dominated regime is the focus of the book after discussing at length the nature of solutions to convection dominated convection diffusion problems the authors motivate and design numerical methods that are particularly suited to this class of problems at first they examine finite difference methods for two point boundary value problems as their analysis requires little theoretical background upwinding artificial diffusion uniformly convergent methods and shishkin meshes are some of the topics presented throughout the authors are concerned with the accuracy of solutions when the diffusion coefficient is close to zero later in the book they concentrate on finite element methods for problems posed in one and two dimensions this lucid yet thorough account of convection dominated convection diffusion problems and how to solve them numerically is meant for beginning graduate students and it includes a large number of exercises an up to date bibliography provides the reader with further reading

An Advection-diffusion Model of the DOMES Turbidity Plumes 1976 the book is divided into two parts first we present two finite volumes schemes for the discretization of convection diffusion reaction problems on moving surfaces the first scheme extends the two points flux approximation finite volumes on moving

surfaces the second scheme presents a finite volume scheme of type o method here we construct around the mesh vertices a linear approximation of the solution to the given problem using the unknowns located at cells centers a suitable flux continuity on cells interfaces in incorporated the method allows also the construction of a second order upwind for convection operators which makes the overall scheme second order in space next we model the flow of a surfactant driven thin film here the use of tensor theory combined with lubrication approximation helps to reduce the navier stokes equations describing the flow of the thin film in three dimensions to a fourth order equation stated on the moving curved surface whose unknown is the film height the surfactant assumed to be insoluble is modeled by a convection diffusion equation on the fluid air interface we simulate the coupled system using an interface tracking method

Lattice Boltzmann Modeling of Advection-Diffusion-Reaction Equations in Non-equilibrium Transport Processes 2013 the effects of weak and strong advection on the dynamics of reaction diffusion models have long been studied in contrast the role of intermediate advection remains poorly understood for example concentration phenomena can occur when advection is strong providing a

mechanism for the coexistence of multiple populations in contrast with the situation of weak advection where coexistence may not be possible the transition of the dynamics from weak to strong advection is generally difficult to determine in this work the authors consider a mathematical model of two competing populations in a spatially varying but temporally constant environment where both species have the same population dynamics but different dispersal strategies one species adopts random dispersal while the dispersal strategy for the other species is a combination of random dispersal and advection upward along the resource gradient for any given diffusion rates the authors consider the bifurcation diagram of positive steady states by using the advection rate as the bifurcation parameter this approach enables the authors to capture the change of dynamics from weak advection to strong advection the authors determine three different types of bifurcation diagrams depending on the difference of diffusion rates some exact multiplicity results about bifurcation points are also presented the authors results can unify some previous work and as a case study about the role of advection also contribute to the understanding of intermediate relative to diffusion advection in reaction diffusion models

Incompressible Flow and the Finite Element Method, Volume 1 2000-06-22 le travail presente dans cette these est principalement une contribution a l analyse d approximations stabilisees pour des problemes de convection diffusion lineaires une etude numerique d un probleme d interaction fluide structure est egalement presentee pour une equation de convection diffusion stationnaire on analyse la precision d un schema elements finis comportant un terme de stabilisation sous forme de dissipation du quatrieme ordre dans une premiere partie on se restreint a une analyse pour des maillages simpliciaux reguliers au sens des elements finis pour un probleme dans ir n avec n 3 on obtient des estimations de l erreur d approximation dans l 2 et dans h 1 pour une dissipation sous forme variationnelle dans le cas bidimensionnel on etudie plus particulierement un schema de type jameson compose d une partie centree de type mixte elements finis volumes finis et d une dissipation en differences quatriemes non consistante dans une deuxieme partie on considere l approximation d un probleme de convection diffusion dont la solution presente des couches limites on obtient des estimations d erreur dans la norme de l energie pour un schema elements finis avec une dissipation du quatrieme ordre consistante pour des maillages triangulaires localement anisotropes dans les

couches limites le schema etudie est compare a des schemas volumes finis du second ordre dans une troisieme partie on analyse la consistance locale des schemas ayant la propriete de preservation de la linearite sur des maillages non structures une quatrieme partie est consacree a l etude numerique d un schema implicite linearise dans le cadre de l analyse du flottement d un profil d aile dans un ecoulement

Convection-Diffusion Problems: An Introduction to Their Analysis and Numerical Solution

2018-11-21 the role of double diffusive mixing in the north atlantic thermocline is considered mixing observations are analyzed in terms of the stability parameters for shear and double diffusive convection and a nondimensional ratio of dissipation rates while the model for turbulence describes most dissipation occurring in high shear dissipation in low shear is better described by the salt finger model and a method for estimating the salt finger enhancement of the diapycnal haline diffusivity over the thermal diffusivity is proposed these calculations suggest that salt finger driven haline flux drives diapycnal downwelling in the upper thermocline the role of turbulence occurring above rough bathymetry in the abyssal brazil basin is also considered the mixing levels along sloping bathymetry exceed the levels

observed on ridge crests and canyon floors additionally mixing levels modulated in phase with the spring neap tidal cycle a model of the dissipation rate is derived and used to specify the turbulent mixing rate and constrain the diapycnal advection in an inverse model for the steady circulation the inverse model solution reveals the presence of a secondary circulation with zonal character these results suggest that mixing in abyssal canyons plays an important role in the mass budget of antarctic bottom water

A Domain Decomposition Method for the Advection-diffusion Equation 1994 in probability theory and statistics a diffusion process is a solution to a stochastic differential equation it is a continuous time markov process with almost surely continuous sample paths brownian motion reflected brownian motion and ornstein uhlenbeck processes are examples of diffusion processes a sample path of a diffusion process models the trajectory of a particle embedded in a flowing fluid and subjected to random displacements due to collisions with other particles which is called brownian motion the position of the particle is then random its probability density function as a function of space and time is governed by an advection diffusion equation

Multi-dimensional Asymptotically Stable Finite

Difference Schemes for the Advection-diffusion Equation 1996 in the last few years there has been a growing interest in the development of numerical techniques appropriate for the approximation of differential model problems presenting multiscale solutions this is the case for instance with functions displaying a smooth behavior except in certain regions where sudden and sharp variations are localized typical examples are internal or boundary layers when the number of degrees of freedom in the discretization process is not sufficient to ensure a fine resolution of the layers some stabilization procedures are needed to avoid unpleasant oscillatory effects without adding too much artificial viscosity to the scheme in the field of finite elements the streamline diffusion method the galerkin least squares method the bub ble function approach and other recent similar techniques provide excellent treatments of transport equations of elliptic type with small diffusive terms referred to in fluid dynamics as advection diffusion or convection diffusion equations goals this book is an attempt to guide the reader in the construction of a computa tional code based on the spectral collocation method using algebraic polyno mials the main topic is the approximation of elliptic type boundary value par tial differential equations in 2 d with special

attention to transport diffusion equations where the second order diffusive terms are strongly dominated by the first order advective terms applications will be considered especially in the case where nonlinear systems of partial differential equations can be re duced to a sequence of transport diffusion equations

Numerical Study of Advection-diffusion-reaction Processes in Microfluidic Systems 2022 transports in fluids can be approached from two complementary perspectives in the eulerian view of mixing the focus is on the concentration field in the langrangian view fluid parcels are followed around as they move with the flow experiencing chaotic or stochastic motion this book examines both pictures presenting a number of theoretical and experimental lectures on various aspects of transport and mixing of active and passive particles in geophysical flows

Model of Advection, Diffusion and Chemistry of Air Pollution (MADCAP) Evaluated at San Diego Air Basin 1978 the accurate and efficient discretization of singularly perturbed advection diffusion equations on arbitrary 2d and 3d domains remains an open problem an interesting approach to tackle this problem is the complete flux scheme cfs proposed by g d thiart and further investigated by j ten thije boonkkamp for the cfs uniform second order

convergence has been proven on structured grids we extend a version of the cfs to unstructured grids for a steady singularly perturbed advection diffusion equation by construction the novel finite volume scheme is nodally exact in 1d for piecewise constant source terms this property allows to use elegant continuous arguments in order to prove uniform second order convergence on unstructured one dimensional grids numerical results verify the predicted bounds and suggest that by aligning the finite volume grid along the velocity field uniform second order convergence can be obtained in higher space dimensions as well

Mathematics: Numerical Analysis and Scientific Computing 2012 in this thesis we study partial differential equations with random inputs the effects that different boundary conditions with random data and uncertain geometries have on the solution are analyzed further comparisons and couplings between different uncertainty quantification methods are performed the numerical simulations are based on provably strongly stable finite difference formulations based on summation by parts operators and a weak implementation of boundary and interface conditions the first part of this thesis treats the construction of variance reducing boundary conditions it is shown how the variance of the solution can be

manipulated by the choice of boundary conditions and a close relation between the variance of the solution and the energy estimate is established the technique is studied on both a purely hyperbolic system as well as an incompletely parabolic system of equations the applications considered are the euler maxwell s and navier stokes equations the second part focuses on the effect of uncertain geometry on the solution we consider a two dimensional advection diffusion equation with a stochastically varying boundary we transform the problem to a fixed domain where comparisons can be made numerical results are performed on a problem in heat transfer where the frequency and amplitude of the prescribed uncertainty are varied the final part of the thesis is devoted to the comparison and coupling of different uncertainty quantification methods an efficiency analysis is performed using the intrusive polynomial chaos expansion with stochastic galerkin projection and nonintrusive numerical integration the techniques are compared using the non linear viscous burgers equation a provably stable coupling procedure for the two methods is also constructed the general coupling procedure is exemplified using a hyperbolic system of equations

The Role of Advection in a Two-Species Competition Model: A Bifurcation Approach

2017-01-18 a discontinuous enrichment method dem for the efficient finite element solution of advection dominated transport problems in fluid mechanics whose solutions are known to possess multi scale features is developed attention is focused specifically on the two dimensional 2d advection diffusion equation the usual scalar model for the navier stokes equations following the basic dem methodology 1 the usual galerkin polynomial approximation is locally enriched by the free space solutions to the governing homogeneous partial differential equation pde for the constant coefficient advection diffusion equation several families of free space solutions are derived these include a family of exponential functions that exhibit a steep gradient in some flow direction and a family of discontinuous polynomials a parametrization of the former class of functions with respect to an angle parameter is developed so as to enable the systematic design and implementation of dem elements of arbitrary orders it is shown that the original constant coefficient methodology has a natural extension to variable coefficient advection diffusion problems for variable coefficient transport problems the approximation properties of dem can be improved by augmenting locally the enrichment space with a higher order enrichment function that solves

the governing pde with the advection field a x linearized to second order a space of lagrange multipliers introduced at the element interfaces to enforce a weak continuity of the solution and related to the normal derivatives of the enrichment functions is developed the construction of several low and higher order dem elements fitting this paradigm is discussed in detail numerical results for several constant as well as variable coefficient advection diffusion benchmark problems reveal that these dem elements outperform their standard galerkin and stabilized galerkin counterparts of comparable computational complexity by a large margin especially when the flow is advection dominated

Fast Numerical Algorithms for Advection-Diffusion Equations and Applications in Particle Dynamics 2012

Optimal Sampling Strategies Using Spatially Averaged Advection-diffusion Parameter Estimation 2008

FOURTH-ORDER VISCOSITY MODELS FOR ADVECTION DIFFUSION PROBLEMS ON UNSTRUCTURED MESHES 1996

Journal of the College of Marine Science and Technology, Tokai University 1983

Diapycnal Advection by Double Diffusion and Turbulence in the Ocean 1999

Stability and Error Analysis for a Diffuse Interface Approach to an Advection-diffusion

Equation on a Moving Surface 2016
Partial Differential Equations and Diffusion Processes 2018-11-22
Spectral Elements for Transport-Dominated Equations 1995
Schwarz and Schur 2007-11-30
Transport and Mixing in Geophysical Flows 1994
An Operator Splitting Algorithm for the Three-dimensional Advection-diffusion Equation 2004-04
Journal of Physical Oceanography 2004
Use of Neural Networks with Advection-diffusion-reaction Models to Estimate Large-scale Movements of Skipjack Tuna from Tagging Data 1996
Applying Dynamic Alternating Direction Implicit Techniques on Advection-diffusion Partial Differential Equations 1996
One Level Krylov-Schwarz Domain Decomposition for Finite Volume Advection-diffusion 1993
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Advection-diffusion-reaction Modeling of Bacteroidales in Estuaries with a Specific Application to the San Pablo Bay 1995
The Influence of Interface Conditions on Convergence of Krylov-Schwarz Domain Decomposition for the Advection-diffusion Equation 2016
Uniform Second Order Convergence of a Complete Flux Scheme on Unstructured 1D Grids for a Singularly Perturbed Advection-diffusion

Equation and Some Multidimensional Extensions 1998
Numerical Methods for Advection-dominated Problems 2018-04-09
Uncertainty quantification for wave propagation and flow problems with random data 1974
Symposium on Atmospheric Diffusion and Air Pollution of the American Meteorological Society 2011
The Discontinuous Enrichment Method (DEM) for Multi-scale Transport Problems 2004
Journal of Ocean Science and Technology

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