ANIMIKH BISWAS

Curriculum Vitae

MP440 Mathematics and Psychology Bldg.	*Ph: (410)455-3029 (Off)*
Dept. of Mathematics & Statsitics	*Ph: (704)458-1426 (Cell)*
University of Maryland, Baltimore County	*Email : abiswas@umbc.edu*
1000 Hilltop Circle, Baltimore, MD 21250.	*Webpage:* http://www.umbc.edu/~abiswas

EDUCATION

Ph.D.	2000	Indiana University, Bloomington, Mathematics
M.S.	1993	Indian Statistical Institute (India), Probability & Statistics
B.S.	1991	Indian Statistical Institute (India), Statistics

APPOINTMENTS

Year	Institution	Rank	Department
2016-	Univ. of Maryland, Baltimore County	Professor	Math. & Stat.
2013-2016	Univ. of Maryland, Baltimore County	Associate Professor	Math. & Stat.
2007-13	Univ. of North Carolina-Charlotte	Associate Professor	Math. & Stat.
2009-10	Univ. of Maryland, College Park	Visiting Scientist	CSCAMM.
2001-07	Univ. of North Carolina-Charlotte	Assistant Professor	Math. & Stat.
2000-01	Univ. of North Carolina-Charlotte	Visiting Assistant Professor	Math. & Stat.

PRIMARY RESEARCH INTEREST

Nonlinear Partial Differential Equations and Mathematical Fluid Dynamics

- Euler, Navier-Stokes and related equations: Well-posedness, Regularity Theory, Asymptotic Dynamics, Theory of Statistical Solutions and Turbulence.
- Geophysical, Astrophysical and Atmospheric Fluid Dynamics.
- Infinite Dimensional Dynamical Systems and Chaos.
- Data Assimilation and Inverse Problems
- Machine Learning for PDE and Data Assimilation

OTHER RESEARCH INTERESTS

- Functional Data Analysis.
- Systems Theory, Interpolation Theory and Robust Control.

HONORS AND AWARDS

- 1995, **William B. Wilcox Memorial Award** (Indiana University, Bloomington) in recognition of outstanding scholastic achievement in graduate studies.
- 1993, **P. C. Mahalanobis finalist** (Indian Statistical Institute), *Among top three graduating students for outstanding performance in Masters of Statistics.*
- 1991, **Gold Medal** in Bachelor of Statistics (Indian Statistical Institute).

RESEARCH SUPPORT/FELLOWSHIP

1. NSF DMS/Applied Mathematics Program, Determining map and its analysis, computation and applications to statistical data assimilation for geophysical fluid flows, *Pending.*
2. Simons Foundation (Collaboration grant for Mathematics), Statistical data assimilation for geophysical fluid flows, *Pending.*
3. 9/15/2015-8/31/2019, $173,121, NSF DMS/Applied Mathematics Program (DMS-1517027), "Collaborative Research: Deterministic and statistical relations between the Navier-Stokes equations and its determining forms", **Lead Principal Investigator.**
4. 11/18/2013-8/31/2015, $ 32,153 NSF DMS/Applied Mathematics Program) DMS 1425877, "Collaborative Research: Study of turbulence in physical systems through complex singularities and determining modes"; **Principal Investigator.**
5. 9/1/2011-11/17/2013, $ 38, 347 NSF (Applied Mathematics Program) DMS 1109532, "Collaborative Research: Study of turbulence in physical systems through complex singularities and determining modes", **Principal Investigator.**
6. 2/22/2010-2/26/2010, $3000 NSF travel funding to attend "Analysis and computation of incompressible fluid flow", Institute of Mathematics and Applications, Minnesota.
7. 4/12/2010-4/16/2010, $3000 NSF travel funding to attend "Transport and mixing in complex and turbulent flows", Institute of Mathematics and Applications, Minnesota.
8. 6/1/2003-5/31/2004, $6000 Junior Faculty Research Fellowship, University of North Carolina-Charlotte.

CAREER DEVELOPMENT

2012, ADVANCE Leadership Program (Univ. of North Carolina-Charlotte), Selected by the Dean to participate in this NSF funded program.

Ph.D. STUDENT

- Jared Praniewicz, *in progress,* Dissertation Advisor.
- Randy Price, *in progress*, Dissertation Co-Advisor.
- Joshua Hudson, Defended 4/25/2018, Dissertation Advisor, University of Maryland-Baltimore County.
- Vincent Martinez, Defended 4/23/2014, Co-Mentor and Thesis Committee Member, Indiana University.
- Jonathan McHenry, Defended 11/21/2014, Thesis Committee Member, University of Maryland-Baltimore County.
- Serap Tay, June, 2016, Thesis Committee Member, University of Maryland-Baltimore County.
- Kannan Subramanian, University of North Carolina-Charlotte, Defended 2007, Thesis Committee Member.
- John Herron, University of North Carolina-Charlotte, Defended 2005, Thesis Committee Member.
- Yang Cao, University of North Carolina-Charlotte, Defended 2001, Thesis Committee Member.

MASTER'S (THESIS/ORAL)

- Tracy Cronin, 2007, Committee Chair, University of North Carolina-Charlotte.
- John Herron, 2004, Committee Member, University of North Carolina-Charlotte.
- Neha Shah, 2001, Committee Member, University of North Carolina-Charlotte.

UNDERGRADUATE STUDENT

- Patrick Ellsworth, Oberlin College, Summer Intern at NIH; co-mentored with Dr. R. Sundaram (*Eunice Kennedy Shriver National Institute of Child Health*, NIH); poster presented at NIH research fair: *A Mathematical Modeling of Progression of First Stage of Spontaneous Labor;* manuscript is in preparation.

- Rohiel Ahmad, University of Maryland-Baltimore County, Parameter Identification Problem in Neuronal Dendritic Trees, Independent Study.
- Adam Reddan, University of Maryland-Baltimore County, Parameter Identification Problem in Neuronal Dendritic Trees, Independent Study.
- Christopher Turner, University of Maryland-Baltimore County, Parameter Identification Problem in Neuronal Dendritic Trees, Independent Study.

TEACHING

University of Maryland-Baltimore County

- Math/Stat 365 (Financial Mathematics for Actuaries)
- Math 221 (Linear Algebra)
- Math 225 (Introduction to Differential Equations)
- Math 612 (Ordinary Differential Equations)
- Math 611 (Applied Analysis)
- Math 710 (Topics Course in Fluid Dynamics)
- Math 898 (Pre-Candidacy Doctoral Research)
- Math 301 (Mathematical Analysis I)
- Math 614 (Partial Differential Equations)
- Math 499 (Independent Study in Mathematics)
- Math 898 (Pre-Candidacy Doctoral Research)
- Math 302 (Mathematical Analysis II)
- Math 898 (Pre-Candidacy Doctoral Research)
- Math 251 (Multivariable Calculus)

University of North Carolina-Charlotte

Undergraduate Courses

- Math 1241 (Calculus-I, Math 151 UMBC equivalent)
- Math 1242 (Calculus-II, Math 152 UMBC equivalent)
- Math 2241 (Calculus-III, Math 251 UMBC equivalent)
- Math 1100, (College Algebra, Math 106/150 UMBC equivalent)

- Math 2164 (Matrices and Linear Algebra, Math 221 UMBC equivalent)
- Stat 1222 (Introduction to Statistics, STAT 121 UMBC equivalent)
- Stat 1220 (Elements of Statistics I (BUSN), STAT 351 UMBC equivalent)

Graduate Courses

- Math 5174 (Partial Differential Equations, Math 404 UMBC equivalent)
- Math 7143 (Real Analysis I, Math 601(Measure Theory) UMBC equivalent)
- Math 7144 (Real Analysis II, Math 601(Measure Theory) UMBC equivalent)
- Math 5143 (Analysis I, Math 600 UMBC equivalent)
- Math 5144 (Analysis II, Math 600 UMBC equivalent)
- Co-taught research topics course on Mathematical Fluid Dynamics
- Several Independent studies and research seminars on
  – Continuum Mechanics and Fluid Dynamics
  – Infinite Dimensional Dynamical Systems
  – Quantum Computation

PUBLICATIONS (Peer Reviewed Articles)

1. Animikh Biswas, Ciprian Foias, Cecilia F. Mondaini and Edriss S. Titi, Downscaling data assimilation algorithm with applications to statistical solutions of the Navier-Stokes equations, *Annales d'lInstitut Henri Poincaré Analyse non lineaire,* **36** (2019), no. 2, 295–326.

2. Animikh Biswas, Ciprian Foias and Basil Nicolaenko, Existence time for the 3D Navier-Stokes equations in a generalized Gevrey class, *Physica D*, **376/377** (2018), 5–14.

3. Animikh Biswas, Joshua Hudson, Adam Larios and Yuan Pei, Continuous data assimilation for the 2D magnetohydrodynamic equations using one component of the velocity and magnetic fields, *Asymptotic Analysis,* **108** (2018), no. 1-2, 1-43.

4. Animikh Biswas and Vincent Martinez, Higher-order synchronization for a data assimilation algorithm for the 2D Navier-Stokes equations, *Nonlinear Analysis: Real World Applications,* **35** (2017), 132-157.

5. A. Biswas, C. Foias and A. Larios, A generalized notion of attractor for the semi-dissipative Boussinesq equations, *Annales d'lInstitut Henri Poincaré Analyse non lineaire,* **34** (2017), no. 2, 381-405.

6. Animikh Biswas, Vincent Martinez and Prabath Silva, On Gevrey regularity of the super-critical SQG equation in critical Besov spaces, *Journal of Functional Analysis,* **269**, (2015), no. 10, 3083-3119.

7. Hantaek Bae and Animikh Biswas, Gevrey regularity for a class of dissipative equations with analytic nonlinearity, *Methods and Applications of Analysis,* **22** (2015), no 4. 377-408.

8. A. Biswas, M. S. Jolly, V. Martinez and E. S. Titi, Dissipation length scale estimates for turbulent flows: A Wiener algebra approach, *Journal of Nonlinear Science,* **24** (2014), no. 3, 441-471.

9. A. Biswas, Gevrey regularity for the supercritical quasi-geostrophic equation, *Journal of Differential Equations*, **257** (2014), 1753-1772.

10. A. Biswas and E. Tadmor, Dissipation vs quadratic nonlinearity: From *a priori* energy bound to higher-order regularizing effect, *Nonlinearity*, **27** (2014), no. 3, 545-562.

11. A. Biswas and C. Foias, On the maximal spatial analyticity radius for the 3D Navier-Stokes equations and turbulence, *Annali di Matematica Pura et Applicata (4),* **193** (2014), no. 3, 739-777.

12. H. Bae, A. Biswas and E. Tadmor, Analyticity and decay estimates of the Navier-Stokes equations in critical Besov spaces, *Archives for Rational Mechanics and Analysis,* **205** (2012), 963-991.

13. A. Biswas, Gevrey regularity for a class of dissipative equations with applications to decay, *Journal of Differential Equations,* **253** (2012), 2739-2764.

14. A. Biswas, D. Swanson, Navier-Stokes equations and weighted convolution inequalities in groups, *Communications in Partial Differential Equations*, **35** (2010), 559-589.

15. J. Ball, A. Biswas, Q. Fang, S. ter Horst, Multivariable generalizations of the Schur class: positive kernel characterization and transfer function realization, *Recent advances in operator theory and related topics, Operator Theory: Advances and Applications, Birkhäuser, Basel,* **187** (2008), 17-79.

16. A. Biswas, A. Lambert, S. Petrovic, B. Weinstock, On spectral radius algebras, *Operators and Matrices*, **2** (2008), 167-176.

17. A. Biswas and D. Swanson, Existence and generalized Gevrey regularity of solutions to the Kuramoto-Sivashinsky equation in $\mathbf{R}^n$, *Journal of Differential Equations,* **240** (2007), 145-163.

18. A. Biswas and D. Swanson, Gevrey regularity of solutions to the 3-D Navier-Stokes equations with weighted ℓ_p initial data, *Indiana University Mathematics Journal,* **56** (2007), 1157 - 1188.

19. A. Biswas and D. Swanson, Gevrey regularity of solutions to the 3-D Navier-Stokes equations, *Contemporary Mathematics*, **440** (2007), 83-90.

20. A. Biswas, A. Lambert and S. Petrovic, On spectral radius algebras and normal operators, *Indiana University Mathematics Journal,* **56** (2007), 1661-1674.

21. A. Biswas and R. Sundaram, Kernel survival function estimation with doubly censored data, *Communications in Statistics: Theory and Methods*, **35** (2006), 1293 - 1307.

22. A. Biswas and S. Petrovic, On extended eigenvalues of operators, *Integral Equations and Operator Theory* **55** (2006), 233-248.

23. A. Biswas and C. Foias, On the general intertwining lifting problem. I, *Acta Sci. Math. (Szeged)*, **72** (2006), 271 - 298.

24. A. Biswas, Local existence and Gevrey regularity of 3-D Navier-Stokes equations with ℓ_p initial data, *Journal of Differential Equations*, **215** (2005), 429-447.

25. A. Biswas, C. Foias, A. E. Frazho, An intertwining property of positive Toeplitz operators, *Journal of Operator Theory*, **54** (2005), 301-322.

26. A. Biswas, A. Lambert, S. Petrovic, Extended eigenvalues and the Volterra operator. *Glasg. Math. J.* **44** (2002), 521 - 534.

27. A. Biswas, C. Foias, A. E. Frazho, Weighted variants of the three chains completion theorem. *Recent advances in operator theory and related topics, Operator Theory: Advances and Applications, Birkhäuser, Basel,* **127** (2001), 127 - 144.

28. A. Biswas, A harmonic-type maximal principle in the three chains completion problem, *Integral Equations and Operator Theory* **36** (2000), 396 - 408.

29. A. Biswas, C. Foias, A. E. Frazho, Weighted commutant lifting, *Acta Sci. Math. (Szeged)* **65** (1999), 657 - 686.

30. A. Biswas, A harmonic-type maximal principle in commutant lifting, *Integral Equations and Operator Theory* **28** (1997), 373 - 381.

PUBLICATIONS (Refereed Conference Proceedings)

N. Pathak, N. Roy and A. Biswas, Iterative signal separation assisted energy disaggregation, *Green Computing Conference and Sustainable Computing Conference (IGSC), 2015 Sixth International, Las Vegas, NV* (2015), pp. 1–8.
http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=7386533

PUBLICATIONS (Non-Peer Reviewed Book Chapter)

Chapter VI.5, pages 284 - 288 are an extract of my thesis in *Metric constrained interpolation, commutant lifting and systems* by C. Foias, A. E. Frazho, I. Gohberg and M. A. Kaashoek, Operator Theory: Advances and Applications **vol. 100**, (1998), Birkhauser.

SUBMITTED/UNDER PREPARATION

- Animikh Biswas and Joshua Hudson, Space and time analyticity for inviscid equations of fluid dynamics, *submitted, arxiv:1712.02720v1*
- J. Bell and A. Biswas, Cross-chemotaxis system derived from an atherosclerotic plaque model, Preprint, *arxiv:1511.02304v1* .
- A. Biswas and S. Ulusoy, Error analysis of machine learning algorithms for certain linear and nonlinear PDEs, *in preparation.*
- A. Biswas, R. Price and E. S. Titi, Downscaling data assimilation algorithms for the Navier-Stokes equations with stochasic observational and model errors, *in preparation.*
- A. Biswas and R. Price, Statistical data assimilation for the 3D Charney-Stommels ocean circulation model, *in preparation.*
- Animikh Biswas and Thomas I. Seidman, Periodic longitudinal vibrations of a viscoelastic rod, *in preparation.*
- A. Biswas, An inertial delay differential form for the 2D Navier-Stokes equations, *in preparation.*
- A. Biswas, J. Hudson and J. Tian, On the rate of blow-up for the 3D Navier-Stokes equations in analytic Gevrey classes, *in preparation.*

BOOK (UNDER PREPARATION)

Animikh Biswas and Ciprian Foias, *An elemenary introduction to the mathematical theory of the Navier-Stokes equations and turbulence* (tentative title).

INVITED CONFERENCE PRESENTATIONS (SELECTED)

- *Determining map for statistical data assimilation and applications,* AMS National Meeting, Baltimore, 2019.
- *Determining quantities for statistical solutions of the Navier-Stokes equations,* AMS Fall Southern Sectional Meeting, University of Arkansas, Fayetteville, November, 2018.

- *Navier-Stokes equations in Gevrey classes,* AMS Fall Southern Sectional Meeting, University of Arkansas, Fayetteville, November, 2018.
- *Downscaling data assimilation algorithm with applications to statistical solutions,* AMS Spring Central Sectional Meeting, Columbus, Ohio March, 2018.
- *Downscaling data assimilation algorithm with applications to statistical solutions,* SIAM Conference on Analysis of Partial Differential Equations, Baltimore, MD, December, 2017.
- *Downscaling data assimilation algorithm with applications to statistical solutions,* SIAM Central States Section Meeting, Boulder, CO, September, 2017.
- *Navier-Stokes equations in a generalized Gevrey class,* Conference on Equations of Fluid Dynamics, University of Virginia, May 2017.
- *Abridged Determining Parameters and Data Assimilation for the MHD Equations in 2D,* The 11th AIMS Conference on Dynamical Systems, Differential Equations and Applications, July 1-5, 2016, Orlando, Florida, USA.
- *Determining modes for the statistical solutions of the Navier-Stokes equations,* International Conference on Evolutions Equations, Vanderbuilt University, Nashville, Tennessee, May 16-20, 2016.
- *On the attractor for the semi-dissipative Boussinesq Equations,* SIAM (Society for Industrial and Applied Mathematics) Conference on Analysis of Partial Differential Equations, 12/2015, Scottsdale, Arizona.
- *Generalized Gevrey Norms with applications to Dissipative Equations,* SIAM Conference on Analysis of Partial Differential Equations, 12/2015, Scottsdale, Arizona.
- *Navier-Stokes equations in a Constantin-Chen class of functional spaces,* AMS (American Mathematical Society) Conference, Georgetown University, 3/2015.
- *Gevrey regularity for quasi-geostrophic equations with applications to decay,* AMS Conference, Lubbock, Texas, 4/2014.
- *Generalized Gevrey norms with applications to dissipative equations,* SIAM Conference, Lake Buena Vista, Florida, 12/2013.
- *Gevrey regularity for dissipative equations with applications to decay*, American Institute of Mathematical Sciences (AIMS) International Conference on Dynamical systems, Differential Equations and Applications, Orlando, Florida, 7/2012.
- *Maximal analyticity radius for the Navier-Stokes equations with connections to turbulence*, AIMS International Conference on Dynamical systems, Differential Equations and Applications, Orlando, Florida, 7/2012.

- *Spatial analyticity and turbulence in fluids,* SIAM Conference, San Diego, California, 11/2011.
- *Spatial analyticity, Gevrey regularity and its applications in fluid dynamics,* International Fluid Dynamics Conference, Campinas, Brazil, 6/2011.
- *Navier-Stokes equations in geometrically based regularity spaces,* The sixth IMACS (International Association for Mathematics and Computers in Simulation) international conference, University of Georgia, Athens, 7/2009.
- *Relaxed Commutant Lifting for Correspondences,* Mathematical Theory of Networks and Systems, Blacksburg, Virginia 6/2009.
- *Multivariable generalization of the Schur class*, International Workshop in Operator Theory, Williamsburg, Virginia 6/2009.
- *Convolution inequalities and Navier-Stokes equations,* AMS Conference, Bloomington, Indiana (2008).

INVITED COLLOQUIUM/SEMINAR PRESENTATIONS (SELECTED)

- *On the attractor for the semi-dissipative Boussinesq Equations,* PDE and Functional Analysis Seminar, Texas A&M University, College Station, Texas, 10/2015.
- *Navier-Stokes equations in a generalized Gevrey class,* Seminar at the Institute for Scientific Computing and Applied Mathematics, Indiana University, Bloomington, IN, 3/2015.
- *Navier-Stokes equations in a Constantin-Chen class of functional spaces,* Institute of Pure and Applied Mathematics *(IPAM)*, UCLA; 10/2014.
- *Maximal spatial analyticity radius, intermittency and energy cascades in 3-D Navier-Stokes equations,* Mathematics Department Colloquium talk, Indiana University, Bloomington, IN, 2/2012.
- *Navier-Stokes equations in geometrically based regularity spaces,* University of Maryland, Mathematics Department, Seminar talk, 3/2010.
- *Analyticity and Gevrey class technique for Navier-Stokes and related equations,* University of Maryland, Mathematics Department, Seminar talk, 10/2009.
- *Gevrey regularity of Navier-Stokes equations with rough initial data,* Colloquium talk, University of Virginia, Charlottesville, 10/2008.
- *Commutant lifting in univariate and multivariate set-up,* Colloquium talk, Indian Statistical Institute, Bangalore, India, May 2006.

- *Commutant lifting in univariate and multivariate setting,* Colloquium talk at Institute of Mathematical Sciences, Chennai, India, May 2006.
- *The geometry of $*$-regular dilation,* Seminar talk, Virginia Tech, Blacksburg, March 2006.

SERVICE

- **Department Service (University of Maryland-Baltimore County)**
  - Graduate Program Director, January 2015–.
  - Graduate Committee (Member) 2013-14.
  - Applied Math. Hiring Committee (Member), 2013-14.
- **Department Service (University of North Carolina-Charlotte)**
  - Undergraduate Research Symposium liaison (Math and Stat Department)
  - Graduate TA Recruitment Committee
  - High school mathematics contest committee
  - Putnam Committee
  - Computer Advisory Committee (Chair)
  - Webwork Committee (Chair)
  - Undergraduate Curriculum Committee
  - Library Committee
  - Mathematics Tutorial Committee
  - Graduate Curriculum Committee
  - Computer/Calculator Lab Committee
  - Department Advisory Committee
- **College Level (UNC-Charlotte)** Served in committee for designing Award for integration of undergraduate teaching and research in the College of Liberal Arts and Sciences, 2012-13.
- **Professional Service**
  - Reviewer for the following journals:
    - *AMS Mathematical Reviews*
    - *Biometrics*
    - *Communications in Information Systems*
    - *Discrete and Continuous Dynamical Systems*

  - * *Electronic Journal of Differential Equations*
  - * *Journal of Differential Equations*
  - * *Journal of the Indian Institute of Science*
  - * *Journal of Mathematical Analysis and Applications*
  - * *Journal of Mathematical Physics*
  - * *Journal of Operator Theory*
  - * *Nonlinearity*
  - * *Numerical Functional Analysis*
  - * *Proceedings of the American Mathematical Society.*
- Reviewer for NSF Grant (DMS Computational Mathematics Program).
- Organization of Conference and workshops
  - * Minisymposium organizer, *Fluid Models, Turbulence and Data Assimilation,* SIAM Conference on Analysis of Partial Differential Equations, Scottsdale, Arizona, 12/2015.
  - * Minisymposium organizer at UMBC, *Analysis of Nonlinear PDEs and Fluid Flows,* 1/2014.
  - * Symposium organizer and chair, *Turbulence and Mixing in Fluids: Analysis and Applications,* Joint Mathematics Meeting, Baltimore, 1/2014,
  - * SIAM Minisymposium organizer and chair, *Global attractors, dissipative dynamical systems and turbulence,* Orlando, Florida 9/2013.
  - * SIAM Conference on Analysis of Partial Differential Equations, San Diego, November 14 17, 2011 (about 500 participants in the conference). Organized Minisymposiums: *Turbulence and Statistical Solutions in Incompressible Flows-I and II (8 speakers),* Sponsored by SIAM activity group Analysis of PDE.
  - * Co-organizer of NSF funded workshop (part of joint collaborative NSF grant) on fluid dynamics, Title: Incompressible Fluids workshop, February 16-20, 2012, College Station, Sponsor: NSF grant and Texas A & M University, Mathematics Department. (25 participants including graduate students and Post Docs from Texas A & M, Indiana University, University of California-Irvine and Weizmann Institute, Israel.
  - * Organized session titled Fluids and Turbulence (18 participants) at the AIMS (American Institute of Mathematical Sciences) International Conference on Dynamical Systems and Differential Equations (held in Arlington, Texas in 2008). This is a major conference in the discipline with 700 international participants
    (http://aimsciences.org/AIMS-Conference/2008/). The session was partially sponsored by American Institute of Mathematical Sciences. The goal of the session was to bring together leading scientists as well as young researchers in the field. The main focus was on (i) existence, uniqueness and regularity results for equations of fluid dynamics (ii) long time behavior of

solutions (iii) study of the global attractor in relation to turbulence (iv) qualitative behavior of solutions (v) computational aspects of fluid dynamics.