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## Gustavo Didier

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### Research Interests

- random processes and fields (fractional/self-similar, anomalous diffusion)
- wavelets
- high-dimensional time series analysis
- mathematical biology (nanobiophysics) and signal processing

### Education

- 2002 - 2007      **University of North Carolina at Chapel Hill, USA.**  
Ph.D. and M.S. advisor: Vladas Pipiras.
- 2000 - 2002      **Institute for Pure and Applied Mathematics, Brazil.**  
M.S. advisor: Aloisio Araujo.
- 1994 - 2000      **Federal University of Rio de Janeiro, Brazil.**  
B.A. and M.S. advisor: Jorge C. Batista.

### Professional Experience

- 2013/7 -            Associate professor. Mathematics Department, Tulane University.
- 2007/7 - 2013/6    Assistant professor. Mathematics Department, Tulane University.
- 2018/6 - 2018/7    CNRS invited visiting researcher. École Normale Supérieure de Lyon,  
Physics Lab.
- 2017/6 - 2017/7    CNRS invited visiting researcher. École Normale Supérieure de Lyon,  
Physics Lab.
- 2015/6 - 2015/7    CNRS invited visiting researcher. École Normale Supérieure de Lyon,  
Physics Lab.
- 2014/1 - 2014/8    Visiting researcher. École Normale Supérieure de Lyon, Physics Lab.
- 2013/9 - 2013/12   Visiting researcher. Department of Statistics and Probability, Michi-  
gan State University.
- 2011/1 - 2011/6    Visiting researcher. École Normale Supérieure de Lyon, Physics Lab.

- 2008/7 Visiting researcher. Institute for Pure and Applied Mathematics, Rio de Janeiro, Brazil.
- 2004/9 - 2007/6 Research assistant (with Vlas Pipiras). Stochastic processes and wavelet analysis. University of North Carolina at Chapel Hill.
- 2004/6 - 2005/5 Research assistant (with Robert Rodriguez). SAS-IML coding. SAS Institute Inc., Cary, NC.
- 2004/1 - 2004/5 Research assistant (with Harry L. Hurd). Time series analysis. University of North Carolina at Chapel Hill.
- 2002/4 - 2002/7 Visiting instructor. Department of Economics, Federal University of Rio de Janeiro.
- 1997/10 - 1998/3 Research assistant (with J. C. Batista). International Economics. Federal University of Rio de Janeiro.

## Support

- (co-PI: with John Fricks, Penn State University) “Forward and inverse methods for stochastic models of diffusing particles in complex biofluids”. Army Research Office, Biomathematics subdivision (2014–2017). Amount awarded: 25% of \$384,926.00.
- (co-PI: with John Fricks, Penn State University) “Statistical inference and stochastic simulation for microrheology”. Army Research Office, Short-Term Innovative Research (STIR) program, prime award no. W911NF-12-1-0512, Biomathematics subdivision (2012–2013). Amount awarded: 40% of \$50,000.
- (PI) “On multivariate long range dependence”. Louisiana Board of Regents award LEQSF(2008-11)-RD-A-23, Research Competitiveness Subprogram (2008–2012). Amount awarded: \$51,789.

## Preprints (journal and conference papers)

- [4] Boniece, B. C., Didier, G., Wendt, H. and Abry, P. (2019), ‘On multivariate non-Gaussian scale invariance: fractional Lévy processes and wavelet estimation’, pp. 1–5. *Under review*.
- [3] Didier, G. and Nguyen, H. (2019), ‘Asymptotic analysis of the mean squared displacement under fractional memory kernels’, pp. 1–33. *Under review*.
- [2] Boniece, B. C., Didier, G. and Sabzikar, F. (2018), ‘On fractional Lévy processes: tempering, sample path properties and stochastic integration’, pp. 1–46. *Under review*.
- [1] Boniece, B. C., Didier, G. and Sabzikar, F. (2018), ‘Tempered fractional Brownian motion: wavelet estimation, modeling and testing’, pp. 1–48. *Under review*.

## Journal publications and forthcoming papers

- [18] Abry, P., Didier, G. and Li, H. (2018), ‘Two-step wavelet-based estimation for Gaussian mixed fractional processes’, pp. 1–60. To appear in *Statistical Inference for Stochastic Processes*.
- [17] Zhang, K., Crizer, K. P. R., Schoenfish, M. H., Hill, D. B. and Didier, G. (2018), ‘Fluid heterogeneity detection based on the asymptotic distribution of the time-averaged mean squared displacement in single particle tracking experiments’. *Journal of Physics A: Mathematical and Theoretical*, **51** 445601.  
[remark: paper selected for the *Journal of Physics A Highlights of 2018* collection]
- [16] Abry, P. and Didier, G. (2018), ‘Wavelet eigenvalue regression for  $n$ -variate operator fractional Brownian motion’, *Journal of Multivariate Analysis*, **168**, November, pp. 75–104.
- [15] Didier, G., Meerschaert, M. M. and Pipiras, V. (2018), ‘Domain and range symmetries of operator fractional Brownian fields’, *Stochastic Processes and their Applications*, **128**(1), pp. 39–78.
- [14] Abry, P. and Didier, G. (2018), ‘Wavelet estimation for operator fractional Brownian motion’, *Bernoulli*, **24**(2), pp. 895–928. [‘supplementary material’, published online by *Bernoulli*, pp. 1–15].
- [13] Wendt, H., Didier, G., Combrexelle, S. and Abry, P. (2017), ‘Multivariate Hadamard self-similarity: testing fractal connectivity’, *Physica D: Nonlinear Phenomena*, **356–357**, pp. 1–36.
- [12] Didier, G. and Zhang, K. (2017), ‘The asymptotic distribution of the pathwise mean squared displacement in single particle tracking experiments’, *Journal of Time Series Analysis*, **38**(3), May, pp. 395–416. [‘supporting information’, published online by *Journal of Time Series Analysis*, pp. 1–7.]
- [11] Didier, G., Meerschaert, M. M. and Pipiras, V. (2017), ‘Exponents of operator self-similar random fields’, *Journal of Mathematical Analysis and Applications*, **448**(2), pp. 1450–1466.
- [10] Frecon, J., Didier, G., Pustelnik, N. and Abry, P. (2016). ‘Non-linear wavelet regression and branch and bound minimization for the full identification of bivariate operator fractional Brownian motion’, *IEEE Transactions on Signal Processing*, **64**(15), pp. 4040–4049.
- [9] Baek, C., Didier, G. and Pipiras, V. (2014), ‘On integral representations of operator fractional Brownian fields’, *Statistics and Probability Letters*, **92**, pp. 190–198.
- [8] Didier, G. and Fricks, J. (2014), ‘On the wavelet-based simulation of anomalous diffusion’, *Journal of Statistical Computation and Simulation*, **84**(4), pp. 697–723.
- [7] Didier, G., Jaffard, S. and Pipiras, V. (2013), ‘On the Riesz property of  $L^2$ -unbounded transformations of orthogonal wavelet bases’, *Journal of Approximation Theory*, vol.176, December, pp. 94–117.

- [6] Didier, G. and McKinley, S. A., Hill, D. B. and Fricks, J (2012), ‘Statistical challenges in microrheology’, *Journal of Time Series Analysis*, **33**(5), September, pp. 724–743.
- [5] Didier, G. and Pipiras, V. (2012), ‘Exponents, symmetry groups and classification of operator fractional Brownian motions’, *Journal of Theoretical Probability*, **25**(2), pp. 353–395.
- [4] Didier, G. and Pipiras, V. (2011), ‘Integral representations and properties of operator fractional Brownian motions’, *Bernoulli*, **17**(1), pp. 1–33.
- [3] Didier, G. and Pipiras, V. (2010), ‘Adaptive wavelet decompositions of stationary time series’, *Journal of Time Series Analysis*, **31**(3), May, pp. 182–209.
- [2] Belloni, A. and Didier, G. (2008), ‘On the Behrens-Fisher problem: a globally convergent algorithm and a finite sample study of the Wald, LR and LM Tests’, *Annals of Statistics*, **36**(5), pp. 2377–2408.
- [1] Didier, G. and Pipiras, V. (2008), ‘Gaussian stationary processes: discrete approximations, adaptive wavelet decompositions and their convergence’, *Journal of Fourier Analysis and Applications*, **14**(2), April, pp. 203–234.

#### Conference papers (peer-reviewed)

- [8] Didier, G., Wendt, H. and Abry, P. (2019), ‘Detection and estimation of delays in bivariate self-similarity: bootstrapped complex wavelet coherence’. To appear in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brighton, U.K., pp. 1–5.
- [7] Wendt, H., Abry, P. and Didier, G. (2019), ‘Bootstrap-based bias reduction for the estimation of the self-similarity exponents of multivariate time series’. To appear in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brighton, U.K., pp. 1–5.
- [6] Abry, P. and Wendt, H. and Didier, G. (2018), ‘Detecting and estimating multivariate self-similar sources in high-dimensional mixtures’, *IEEE Statistical Signal Processing Workshop*, Freiburg, Germany, pp. 1–5.
- [5] Boniece, B. C., Sabzikar, F. and Didier, G. (2018), ‘Tempered fractional Brownian motion: wavelet estimation and modeling of turbulence in geophysical flows’, *IEEE Statistical Signal Processing Workshop*, Freiburg, Germany, pp. 1–5.
- [4] Wendt, H., Abry, P. and Didier, G. (2018), ‘Wavelet domain bootstrap for testing the equality of bivariate self-similarity exponents’, *IEEE Statistical Signal Processing Workshop*, Freiburg, Germany, pp. 1–5.
- [3] Combrexelle, S., Wendt, H., Didier, G. and Abry, P. (2017), ‘Multivariate scale-free dynamics: testing fractal connectivity’, *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, New Orleans, USA, pp. 1–5.

- [2] Frecon, J., Fontugne, R., Didier, G., Pustelnik, N., Fukuda, K. and Abry, P. (2016), ‘Non-linear regression for bivariate self-similarity identification – application to anomaly detection in Internet traffic based on a joint scaling analysis of packet and byte counts’, *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Shanghai, China, pp. 1–5.
- [1] Didier, G., Helgason, H. and Abry, P. (2015), ‘Demixing multivariate-operator self-similar processes’, *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Brisbane, Australia, pp. 1–5.

## Other publications

- [3] “Studies in stochastic processes: adaptive wavelet decompositions and operator fractional Brownian motions”. *Ph.D. thesis, University of North Carolina at Chapel Hill*. Advisor: V. Pipiras. (2007).
- [2] Batista, J. C. and Didier, G. (2001), ‘Real and effective exchange rates with double-weighting scheme for Brazilian manufactured products’, *Boletim de Conjuntura*, vol. 20, no. 3, p. 59–66. Rio de Janeiro, Brazil.
- [1] “The geography of Brazilian competition patterns and the effects of changes in relative prices on Brazilian exports”. *M.S. thesis, Federal University of Rio de Janeiro*. Advisor: J. C. Batista. (2000).

## Presentations

- 2018/07 “Tempered fractional Brownian motion: wavelet estimation, modeling and testing”. Séminaire de traitement du signal, Physics Lab, ENS-Lyon, France.
- 2018/06 “Tempered fractional Brownian motion: wavelet estimation and modeling of turbulence in geophysical flows” [poster]. IEEE Statistical Signal Processing Workshop, Freiburg, Germany.
- 2018/04 “On multidimensional scaling”. Statistics seminar, Iowa State University, Ames, IA.
- 2018/04 “On multidimensional scaling”. Mathematics colloquium, University of Tennessee, Knoxville, TN.
- 2017/11 “On multidimensional scaling”. Statistics seminar, Arizona State University, AZ.
- 2017/03 “Multivariate scale-free dynamics: testing fractal connectivity”. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), New Orleans, LA.
- 2016/09 “Scaling laws and asymptotics in single particle modeling”. Statistics colloquium, University of Virginia, VA.

- 2016/09 “Scaling laws and asymptotics in single particle modeling”. Statistical Science and Operations Research seminar, Virginia Commonwealth University, VA.
- 2016/07 “Scaling laws and asymptotics in single particle modeling”. SIAM Conference on the Life Sciences, Boston, MA.
- 2016/02 “Scaling laws in biodiffusion” [poster]. Current topic workshop: *Modeling and inference: from single molecules to cells*, Mathematical Biosciences Institute, Columbus, OH.
- 2015/09 “Modeling operator self-similarity”. Biostatistics seminar, LSUHSC, New Orleans, LA.
- 2015/06 “Modeling operator self-similarity”. *Séminaire Cristolien d’Analyse Multifractale*, Université Paris XII – Val de Marne, Créteil, France.
- 2014/03 “Self-similarity, symmetry and anisotropy in the multivariate and multiparameter settings” *Séminaire Cristolien d’Analyse Multifractale*, Université Paris XII – Val de Marne, Créteil, France.
- 2014/04 “Time and spectral domain analysis of biodiffusion”. Séminaire des mathématiques, Université Bretagne-Sud, Vannes, France.
- 2014/02 “Self-similarity, symmetry and anisotropy in the multivariate and multiparameter settings”. Workshop *Multifractal Analysis: From Theory to Applications and Back*, Banff International Research Station, Canada.
- 2013/11 “Probabilistic and inferential aspects of self-similarity in the multivariate and multiparameter settings”. Statistics and Probability colloquium, Michigan State University, East Lansing, Michigan.
- 2013/09 “Time and spectral domain analysis of biodiffusion”. Probability seminar, Michigan State University, East Lansing, Michigan.
- 2013/08 “Time and spectral domain analysis of biodiffusion” [poster]. Workshop for Young Researchers in Mathematical Biology, Mathematical Biosciences Institute, Columbus, Ohio.
- 2012/12 “Time and spectral domain analysis of biodiffusion”. Louisiana ASA Chapter Meeting, Baton Rouge, LA.
- 2012/10 “Probabilistic and inferential aspects of self-similarity in the multivariate setting”. AMS Fall Southeastern Section Meeting, New Orleans, LA.
- 2012/07 “Probabilistic and inferential aspects of self-similarity in the multivariate setting”. 8<sup>th</sup> World Congress of Probability and Statistics, Istanbul, Turkey.
- 2012/04 “Statistical challenges in Biophysics”. Louisiana ASA Chapter Meeting, New Orleans, LA.

- 2011/10 “On the simulation of anomalous diffusion”. Sandia National Labs, Albuquerque, NM.
- 2011/9 “Self-similarity and long range dependence: some recent developments for the multivariate setting”. Penn State Department of Statistics colloquium, University Park, PA.
- 2011/7 “On the simulation of anomalous diffusion”. 7<sup>th</sup> International Congress on Industrial and Applied Mathematics, Vancouver, Canada.
- 2011/6 “Self-similarity and long range dependence: some recent developments for the multivariate setting”. 35<sup>th</sup> Stochastic Processes and their Applications, Oaxaca, Mexico.
- 2011/1 “Self-similarity and long range dependence: some recent developments for the multivariate setting”. Joint Mathematics Meetings, New Orleans-LA, USA.
- 2010/11 “Subdiffusions in microrheological experiments”, with J. Fricks. LSU Biostatistics Seminar, New Orleans-LA, USA.
- 2010/10 “Self-similarity and long range dependence: some recent developments for the multivariate setting”. Joint Mathematics and Statistics Seminar, Iowa State University, Ames-IA, USA.
- 2010/8 “Exponents and symmetry groups of operator fractional Brownian motions”, with V. Pipiras. 73<sup>rd</sup> Annual Meeting of the Institute of Mathematical Statistics, Gothenburg, Sweden.
- 2010/3 “Subdiffusion detection in microrheological experiments”, with J. Fricks. ENAR 2010 Spring Meeting, New Orleans-LA, USA.
- 2010/3 “Exponents and symmetry groups of operator fractional Brownian motions”, with V. Pipiras. Seminar on Stochastic Processes 2010, Orlando-FL, USA.
- 2009/11 “Self-similarity and LRD: some basic connections and recent developments for the multivariate setting”. LSU Biostatistics Seminar, New Orleans-LA, USA.
- 2009/8 “Multivariate long range dependence and operator self-similarity”, with V. Pipiras. Joint Statistical Meeting 2009, Washington-DC, USA.
- 2009/7 “On operator fractional Brownian motions”, with V. Pipiras. 33<sup>rd</sup> Conference on Stochastic Processes and Their Applications, Berlin, Germany.
- 2008/8 “On operator fractional Brownian motions”, with V. Pipiras. 11<sup>th</sup> Meeting of New Researchers in Statistics and Probability. University of Colorado and NCAR, Boulder-CO, USA.

- 2008/7 “On operator fractional Brownian motions”, with V. Pipiras. Stochastic Processes Seminar. Institute for Pure and Applied Mathematics, Rio de Janeiro, Brazil.
- 2006/8 “Adaptive wavelet decompositions of stationary time series”, with V. Pipiras. 69<sup>th</sup> Annual Meeting of the Institute of Mathematical Statistics, Rio de Janeiro, Brazil.
- 2006/6 “Adaptive wavelet decompositions of stationary (Gaussian) processes” [poster], with V. Pipiras. Graybill Conference, 2006, Fort Collins-CO, USA.
- 2005/6 “Gaussian stationary processes: discrete approximations, special wavelet decompositions and simulation”, with V. Pipiras. 30<sup>th</sup> Conference on Stochastic Processes and their Applications, 2005, Santa Barbara-CA, USA.
- 2001/8 “Relative prices and Brazilian exporting performance”, with J. C. Batista. 9<sup>th</sup> Brazilian School of Time Series and Econometrics, 2001, Belo Horizonte, Brazil.

## Service

- 2015/8 - 2018/7 TU Graduate Council.
- 2014/8 - 2015/7 TU Mathematics Department graduate studies committee.
- 2009/8 - 2010/7 TU Mathematics Department undergraduate studies committee.
- 2018/10 - 2019/2 TU Mathematics Department hiring committee in Statistics.
- 2017/10 - 2018/2 TU Mathematics Department hiring committee in Statistics.
- 2014/10 - 2015/2 TU Mathematics Department hiring committee in Statistics.
- 2012/1 - 2012/3 TU Mathematics Department hiring committee in Analysis.
- 2015/8 - 2019/5 TU Mathematics Department colloquium coordinator.
- 2012/8 - 2013/5 TU Mathematics Department colloquium coordinator.
- 2016/7 Co-organizer (with John Fricks, Penn State) of the special session “Linking single particle tracking experiments to stochastic diffusion models”, SIAM Conference on the Life Sciences, Boston, MA.
- 2012/10 Co-organizer (with Greg Forest, UNC-Chapel Hill) of the special session “Diffusion in Biology”, AMS Fall Southeastern Section meeting, Tulane University, New Orleans, LA.

## Honors and awards

2006	IMS Laha travel award for the paper “Gaussian stationary processes: discrete approximations, adaptive wavelet decompositions and their convergence”, with V. Pipiras.
2006	NSF Travel Funding for the 69 <sup>th</sup> Annual Meeting of the IMS.
2005	30 <sup>th</sup> Conference on Stochastic Processes and Their Applications travel award.
1998/3 - 2000/2	CAPES (Brazilian federal funding agency) M.S. Fellowship.
1997	Honors Degree, B.A., Federal University of Rio de Janeiro.

### Teaching experience (instructor with full course responsibility)

(**U**: undergraduate; **G**: graduate)

- Federal University of Rio de Janeiro:

*Calculus II* (**U**, 2002).

- Tulane University:

*Statistics for Business and Economics* (**U**, Fall 2007);

*Introduction to Probability Theory* (upper-level **U**, Fall 2010, Fall 2011, Fall 2014);

*Introduction to Statistical Inference* (upper-level **U**, Spring 2009, Spring 2013);

*Analysis I [Measure Theory]* (**G**, Fall 2008);

*High-Dimensional Probability Theory* (**G**, Spring 2019).

*Mathematical Statistics* (**G**, Fall 2009, Fall 2010, Fall 2011, Spring 2015, Spring 2016, Spring 2017, Spring 2018, Spring 2019);

*Probability Theory I* (**G**, Fall 2014, Fall 2015, Fall 2016, Fall 2017, Fall 2018);

*Time Series Analysis* (**G**, Spring 2008, Spring 2013).

*Stochastic Processes* (**G**, Spring 2010, Spring 2012);

- University of North Carolina at Chapel Hill:

*Basic Statistics* (**U**, Fall 2005, Spring 2006, Fall 2006, Spring 2007).

### Students mentored (with month and year of graduation)

Ph.D.:

- Villamarín-Gomez, Sergio N. (expected graduation: May 2022)
- Benjamin Cooper Boniece (expected graduation: August 2019).

- Hui Li (August 2017). Thesis title: *Wavelet-based estimation for Gaussian and non-Gaussian mixed fractional processes.*
- Kui Zhang (May 2017). Thesis title: *Asymptotic theory for the statistical analysis of anomalous diffusion in single particle tracking experiments.*

M.S:

- Binqi Huang (May 2016), Renyue Tan (May 2016), Yujie Suo (December 2014), Jianning Zhao (May 2013), Peter Bierhorst (May 2012), Andrea Hebert (jointly with Chad Bhatti; May 2008).

Honors thesis:

- Shengying Wang (second and third readers: Damir B. Khismatullin - Biomedical Engineering, Kathleen Carlin - English; Spring 2013).

Senior seminar project:

- Linhui He (May 2017), James Bernazzani (May 2016), Robert McKay (May 2015), Rachel Christoph (December 2014), Jessica Feagles (jointly with John Liukkonen; May 2013), Stefan Schembor (May 2013), Lu Liang (May 2012), Matthew Roser (May 2010), Richard J. Hayes (December 2007).

## Professional activities

- Referee for *Applied and Computational Harmonic Analysis*, *Australian and New Zealand Journal of Statistics*, *Bernoulli* (4), *Canadian Journal of Statistics*, *Computational Statistics and Data Analysis*, *Electronic Communications in Probability*, *Frontiers of Mathematics in China*, *IEEE Transactions on Signal Processing* (2), *2016 IEEE Workshop on Statistical Signal Processing*, *International Journal of Biomathematics*, *Journal of Business and Economic Statistics*, *Journal of Statistical Computation and Simulation* (2), *Journal of Applied Probability*, *Journal of the Korean Statistical Society*, *Journal of the Royal Statistical Society - Series B*, *Journal of Mathematical Physics*, *Journal of the American Statistical Association*, *Journal of Mathematical Research with Applications*, *Journal of Statistical Physics*, *Journal of Theoretical Probability*, *Journal of Time Series Analysis*, *Journal of Wavelet Theory and Applications*, *Mathematical Methods in the Applied Sciences*, *Physics Letters A*, *Séminaire et Congrès – Société Mathématique de France*, *Statistics and Probability Letters*, *Stochastic Models*, *Stochastic Processes and their Applications* (2).
- Member of the Institute of Mathematical Statistics, American Mathematical Society.