WWlet: WAVELETS & APPLICATIONS

Numerical Methods for PDEs and Signal Processing

Summary

In the last few decades wavelets techniques have become an important research area in numerical analysis and an important tool in modern signal processing. Wavelets applied to the solution of partial differential equations can provide an alternative tool for developing adaptive methods, which enable an adaptive refinement of the solution according to its local regularity.

One of the main goals of these events are to explore concepts of wavelet analysis and its theoretical, numerical and computational aspects applied to the field of partial differential equations and signal processing.

We also have been organising a regular scientific group activity in São José dos Campos, São Paulo with CNPq and FAPESP financial support and a Thematic Committee in SBMAC (www.sbmac.org.br).

Material from the events are available at INPE library. Software are available at github. Please contact wwlet@inpe.br for more information.

XI WWlet 2019, main activities

- Wavelet Applications in Time Series, Signal and Image processing to be held in the XVIII Time Series and Econometrics Meeting - ESTE (redeabe.org.br/este2019), Gramado, Rio Grande do Sul, Brazil on Sep. 3rd. Program:

  A. Wavelet-based clustering and classification, Pedro A. Morettin (IME/USP, Brazil).

  B. Wavelet Statistical Analysis of Multitemporal SAR and Satellite Images, Aluísio Pinheiro (UNICAMP, Brazil).

  C. Partial Directed Wavelet Covariance, Kim Samejima (UFBA, Brazil).

  D. Multi-scale Identification of Dynamics in Chaotic Electrochemical oscillators, Luciano A. Magrini (IFSP, Brazil), Margarete Domingues (INPE, Brazil), Elbert E. N. Macau (Unifesp, Brazil).

  E. Geomagnetic disturbances in a local regularity point of view, Odim Mendes (Space Geophysics Division - DIDGE/INPE, Brazil) Margarete Domingues (INPE, Brazil).

  F. Evaluation of Genome Similarities: a Wavelet-Domain Approach, Telma Safadi (UFLA, Brazil).

  G. Wavelet Neural Networks for Prediction and Classification, Eniuce Menezes de Souza (UEM, Brazil).

WWlet 2017, main activities

Organizers: Margarete Domingues (INPE), Maria Teodora Ferreira (F. Bilac/UNIVAP), Cláudia Aline Mesquita UNIFESP).

- in the XXXVII Congresso Nacional de Matemática Aplicada e Computacional (CNMAC), São José dos Campos, SP, Brazil on Sep. $19 - 22^{\text{th}}$, 2017. Program:

  A. Ezequiel Echer (DGE/CEA/INPE), Multiresolution analysis of magnetic field fluctuations in the Jupiter's magnetotail.

B. Mariza Pereira de Souza Echer (PNPD/CAPES- GES/INPE), Study about spectral properties of the Global, hemispheric and latitudinal air surface temperature series from NASA/GISS database and Sunspot Number by wavelet analyses.

C. Eniuce Menezes de Souza (UEM), Forecasting with Wavelet Hybrid Models

D. On this occasion we pay posthumous homage to Dr. Daniel Nordeman for his achievements, conducted by Mariza Echer.

E. Ralf Deiterding (Univer. of Southampton, UK), Wavelet criteria in magnetohydrodynamics modelling using the parallel framework AMROC

F. Müller Moreira Lopes (CAP/INPE), High order time synchronisation in multiresolution adaptive models.

G. Gilcélia Regiane de Souza (Federal University of São João del-Rei), Jorge Stolfi (UNICAMP) Sampled irregularly functions approximation with tensorial elements compacts adaptive hierarchical bases

H. Multiscale Committee discussions

VIII WWlet 2016, main activities

1. **Regular seminars** (INPE): Wavelet Applied to Space Physics (WASP) Organizers: Margarete Domingues, Odim Mendes, and Renato Branco

2. **Short-Course** (INPE): Block-Structured Adaptive Mesh Refinement in C++: The AMROC Framework for Parallel AMR by Dr. Ralf Deiterding, University of Southampton 30th of June and 1st of July 2016, São José dos Campos, São Paulo, Brazil. Financial support: FAPESP-Newton Fund and British Council (grants 2015/50403-0 and 2015/25624-2) . Organizers: Celso Mendes Margarete Domingues, Odim Mendes, and Renato Branco.

WWlet 2015, main activities

1. **Regular seminars** (INPE): Wavelet Applied to Space Physics (WASP) Organizers: Anna Karina Fontes Gomes, Margarete Domingues, Odim Mendes, and Renato Branco.

2. **Activities in Dynamic System Conference (DINCON)** at Natal, Rio Grande do Norte, Brazil

   A. **Mini-course**: Continuous Wavelet transform, by Margarete Domingues, and Odim Mendes

   B. **Technical section** in Wavelet Applications

WWlet 2014, main activities

1. **Regular seminars** (INPE): Wavelet Applied to Space Physics (WASP) Organizers: Anna Karina Fontes Gomes, Margarete Domingues, and Odim Mendes.

VII WWlet 2013, main activities

1. **In Dynamic System Conference (DINCON)** at Forlateza, Ceará, Brazil

   Organizers: Eniuce M. de Souza (State Univ. of Maringá) and Margarete Domingues (INPE)

   A. **Thematic group meeting**: Wavelet transform

   B. **Technical section** in Wavelet Applications

Organizers: José Eduardo Castilho (UnB of Planaltina), Margarete Domingues (INPE), Magda K. Kaibara (UFF), Odim Mendes (INPE), and Aylton Pagamisse (UNESP - Presidente Prudente)

1. XXXVI CNMAC, 17-21th Sep., Aguas de Lindóia, São Paulo, Minisimposium

   A. Reconstruction of tokamak plasma light emission from single images by wavelet-vaguelette decomposition. Romain Nugyen van yen, Freie Universität, Germany

   B. Wavelet analysis of intermittency in MHD turbulence. Marie Farge, ENS, Paris, France

   C. Dual-Tree Wavelets and their application to Vision Systems - introducing wavelet-based keypoint detectors and robust keypoint descriptors with rotation invariant properties. Nick Kingsbury, Cambridge University

   D. Dual-tree wavelet and new tecniques to phase determination in control systems. Elbert Macau, INPE

   E. A wavelet-based filtering of ensemble background-error variances. Olivier Pannekoucke, Meteo-France, France

   F. Adaptive multiresolution or adaptive mesh refinement? Kai Schneider, Aix-Marseille University, France

   G. Wavelets methods and applications to artificial satellite signals. Eniuce Menezes de Souza, Universidade Estadual de Maringá - PR

   H. Multiscale methods to solve differencial equations in visual computation. Jorge Stolfi, IC/UNICAMP

2. XXXVI CNMAC, 17-21th Sep., Aguas de Lindóia, São Paulo, Mini-course

   A. Introdução ao mundo das wavelets, José Eduardo Castilho (UnB), Margarete Domingues (INPE), Odim Mendes (INPE), Aylton Pagamisse (UNESP-Pres. Prudente)

   B. Complex-valued wavelets, the dual tree, and Hilbert pairs: why these lead to shift invariance and directional m-D wavelets? (3,5 hours), Nick Kingsbury, Cambridge University

3. XXXVI CNMAC, 17-21th Sep., Águas de Lindóia, São Paulo, Technical sections

4. Mini-courses and seminars, satellite events (at INPE, UFF, UFRJ, UNICAMP, 10-27th Sep.):

   A. UFF - Dual-Tree Complex Wavelets - their key properties and a range of image-processing applications Nick Kingsbury, Cambridge University (IC-UFF 12th Sep.)

   B. UFRJ - D'Alembert's paradox and the resistance of fluid flows in the fully-developed turbulent regime: still an open problem Marie Farge, ENS, Paris, France

   C. INPE - How wavelets are used to study turbulent transport in fluid and plasma flows Marie Farge, ENS, Paris, France Kai Schneider, Aix-Marseille University, France Romain Nugyen van yen, Freie Universität, Germany

   D. INPE - A wavelet-based filtering of ensemble background-error variances. Olivier Pannekoucke, Meteo-France, France (INPE, Cachoeira Paulista, 24th Sep).

V WWlet, 2011 main activities

Organizers: Margarete Domingues (INPE), Odim Mendes (INPE), and Aylton Pagamisse (UNESP - Presidente Prudente)

1. Minisimposium 6 Program: Aug. 29th
   A. Transformada wavelet e super-resolução de imagens, Aylton Pagamisse, Marco Antonio Piteri
   B. Multiscale of geomagnetic disturbances: Case study in South Athantic anomaly region, Odim Mendes, Marize Correa Simões, Margarete Oliveira Domingues, Varlei E. Menconi
   C. Wavelet de Meyer como regularizadora de equações tipo Caichy-poisson de interesse da física de plasma espacial, Margarete Domingues, Magda Kaibara, Odim Mendes
2. Minisimposium 6 Program: Aug. 30th
   A. Esquemas Lifiting-wavelet interpolador para equações diferenciais parciais, José Castilho
   B. Detecção da sincronização de fase entre sistemas com dinâmica caótica empregando a transformada wavelet complexa dual-tree, Maria Teodora Ferreira, Elbert E. N. Macau, Rosângela Follmann Bageston, Margarete Oliveira Domingues
3. Other Activities:
   A. Discussion on a proposal to a thematic group for the Brazilian Applied Mathematics and Computational Society (SBMAC).
   B. Presentation of master and PhD proposals Coordinators: Aylton Pagamisse, Magda Kaibara, Odim Mendes. Financial support CAPES, CNPq, FAPESP

IV WWLET, 2010 main activities

Organizers: Margarete Domingues (INPE),Magda K. Kaibara (UFF), and Odim Mendes (INPE)

1. IV WWLET, in DINCON, Serra Negra, SP, Brazil on June 7th to 11th, Program:
   A. On the use of Harmonic Wavelets for the solution of some PDE's and an application to a precipitation front propagation model, Saulo R. M. Barros, Pedro da Silva Peixoto, Universidade de São Paulo, São Paulo, Brazil
   B. Wavelet based Faraday Rotation Measure Synthesis, Peter Frick, Rodion Stepanov Institute of Continuos Media Mechanics of Ural, Branch of the Russian Academy of Sciences, Perm, Russia, Dmitry Sokoloff, Department of Physics, Moscow State University, Moscow, Russia
   C. Wavelet analysis of bioimpedancometric data, Peter Frick, Rodion Stepanov, Institute of Continuos Media Mechanics of Ural, Branch of the Russian Academy of Sciences, Perm, Russia, Sergey Podtaev Department of Physics, Perm State University, Bukireva str. 15, Perm, 614990, Russia, Andrew Dumler, Perm State Medical Academy
   D. Revealing Physical Process in Space Plasma Disturbances with Wavelet Analysis, Anthony T. Y. Lui, Johns Hopkins University (JHU/APL), Laurel, MD 20723-6099, USA
   E. Application of multi-scale analyses on solar images from SOHO and STEREO, Guillermo Adrián Stenborg, Interferometrics, Inc., USA.
   F. Image Analysis Based on Wavelet Transforms, Helio Pedrini Instituto de Computação, UNICAMP, Campinas, Brazil

2. Working Groups, INPE, Jun. 2nd - 6th:

   A. Wavelet applied to MHD-turbulence, Organizers: Margarete Domingues, Peter Frick, Magda Kaibara, Odim Mendes

   B. Wavelet applied to Quasar dataset, Organizers: Luis Botti, Margarete Oliveira Domingues, Peter Frick, José Soto

   C. Wavelet applied to solar physics. Organizers: Guillermo Adrián Stenborg, Alisson Dal Lago

3. Working groups, in DINCON, Serra Negra, SP, Brazil on Jun. 7-11th

   A. Wavelet applied to Geomagnetic analysis, Margarete Oliveira Domingues, Peter Frick, Odim Mendes, Virginia Klausner

   B. Wavelet applied to solar physics. Organizers: Guillermo Adrián Stenborg, Alisson Dal Lago

4. Working Group : Serra Negra and INPE, Jun. 12-13th Wavelet applied to reconnection problems. Organizers: Margarete Domingues, Magda Kaibara, Anthony Lui, Odim Mendes, Arian Gonzalez

5. Short-course:in DINCON, Serra Negra, SP, Brazil on Jun. 11th

   Shell models - a dynamical systems approach to fully developed turbulence, Dr. Peter Frick, Institute of Continuous Media Mechanics of Ural, Branch of the Russian Academy of Sciences, Perm, Russia

Financial support CAPES, CNPq, FAPESP

III WWLET, 2009 main activities

Organizers: Margarete Domingues (INPE),Magda K. Kaibara (UFF), and Odim Mendes (INPE), Alice de Jesus Kozakevicius (Univ. Santa Maria), Technical support: Thiago Pedro Donadon Homem (Pós-graduação Engenharia Elétrica Faculdade de Engenharia - FEB Universidade Estadual Paulista - Unesp)

- Minisymposium - May 19th. Program:

  A. Double Wavelet Analysis - method for recognising stellar activity peculiarities Peter Frick, Institute of Continuous Media Mechanics of the Ural Branch of the Russian Academy of Sciences, Perm, Russia.

  B. Wavelets to compute turbulence: Burgers, Euler, Navier-Stockes Equations Marie Farge, Ecole Normale Superieur, Paris, France.

  C. Numerical simulations of the Stefan problem using wavelets Jacques Liandrat, Centrale Marseille, France

  D. Detection of convective rolls using continuous wavelets transform Angela Leó Meciás, Facultad de Matemática y Computación, Havana, Cuba.

  E. Error map technique in dyadic meshes Jorge Stolfi, Instituto de Computação, UNICAMP

  F. Multiresolution and Adaptive Mesh Refinement schemes: a comparative study Ralf Deiterding, Margarete O. Domingues, Sônia M. Gomes, Olivier Roussel and Kai Schneider, Departamento de Matemática Aplicada, IMECC-UNICAMP

  G. An adaptive multiresolution method for the Coherent Vortex Simulation (CVS) of compressible turbulent flows Olivier Roussel and Kai Schneider FAPESP Visiting researcher at Departamento de Matemática Aplicada, IMECC-UNICAMP

H. The use of Daubechies bases in Wavelet-Galerkin method Maria Tereza Martins and Victoria Vampa, Departamento de Matemática, Facultad de Ciencias Exactas, Universidad Nacional de La Plata, Argentina

- Roundtable: Applications. Odim Mendes (Chair)

A. Wavelets in Wannier functions Alexys Bruno Alfonso (UNESP/Bauru)

B. Improving the estimation of daily rainfall from NDVI using the wavelet transform Adolfo Nicolas Posadas Durand(Visiting researcher at Embrapa Instrumentação Agropecuária, International Potato Center -CIP)

C. Image segmentation challenges and possible solutions with wavelets Rafael Santos (INPE)

D. The wavelet transform applied to bifurcation in the dynamic population models Matheus Alvarez and José Raimundo de Souza Passos(UNESP/Botucatu)

Financial support Capes, CNPq, FAPESP

II WWlet, 2008 main activities

1. in CNMAC, Belém/PA, Sep. 11th 2008, in 31th Congresso Nacional de Matemática Aplicada e Computacional

2. Program:

A. Sparse point representation techniques with time step control, Sônia Gomes(UNICAMP), Andrielbe Oliveira, Anamaria Gomide(UNICAMP), Margarete Domingues(INPE), Paulo Jorge Gonçalves Ferreira(Univ. Aveiro, Portugal), José Rocha Pereira (Univ. Aveiro, Portugal), Pedro Renato Tavares Pinho (inst. Lisboa, Portugal).

B. Application of PML absorbing boundaries in the SPR method, Pedro Renato Tavares Pinho(Inst. Lisboa, Portugal), Paulo Jorge Gonçalves Ferreira, José Rocha Pereira(Univ. Aveiro, Portugal), Sônia Maria Gomes(UNICAMP), Andrielber Oliveira(UNICAMP), Anamaria Gomide(UNICAMP), Margarete Domingues(INPE).

C. Numerical solution of hiperbolic-elliptic systems of conservation laws by multiresolution schemes, Alice de Jesus Kozakevicius(USM), Stefan Berres(USM), Raimund Bürgers(Univ. Concepcion, Chile)

D. Algorithms on adaptive dynamic grids, Jorge Stolfi (UNICAMP)

E. Adaptive multiresolution methods for evolutive PDEs, Margarete Domingues(INPE), Sônia Maria Gomes(UNICAMP), Olivier Roussel (Unv. Klaushe, Germany), Kai Schneider (Univer. Aix-Marseille). 6. Numerical methods for generalized KDV equations, Mauricio Sepulveda Cortes (Univer. Concepción, Chile), Octavio Vera Villagran(Univer. Bio-Bio, Chile).

F. Discussions: Magda Kaibara (chair)

Financial support CAPES, CNPq, FAPESP

I WWlet 2007, main activities

Organizers: Chou Sin Chan (INPE), Elbert Macau (INPE), Margarete Domingues (INPE), and Odim Mendes (INPE). Techinical staff: Maria Cristina Peloggia de Araújo (Secretary), Marize Simões (Engineer), and Varlei Menconni (Enginner)

- at INPE São José dos Campos, Brazil, from Nov. $5 - 7^{\text{th}}$

  A. Lectures: Sônia Gomes (IMECC/Unicamp), Anamaria Gomide (IC/Unicamp), Alice Kozakevicius(UFSM)

  B. Technical discussions: Sônia Gomes, Anamaria Gomide, Elbert Macau, Margarete Domingues, Odim Mendes.

Promotion: INPE. Co-sponsors ApLBA, CAPES, CNPq

Snapshots: