10 e 11 de novembro de 2021
São José dos Campos - SP

Scientific Committee:
Margarete Domingues (INPE)
Eniuce Menezes de Souza (UEM)

Organizers:
Margarete Domingues (INPE)
Luciano Magrini (IFSP)
Gilcélia de Souza (UFSJ)
Odim Mendes (INPE)

SBMAC

X WWlet Wavelets & Aplicações

- The use of wavelet technique for Pc5-pulsation electrodynamical characterization analysis at low-latitude conjugate stations
  Camacho E.; Benyosef L.; Mendes O.; Domingues M.

- Identificación de la inestabilidad eléctrica cardíaca en pacientes con infarto de miocardio mediante el uso de cuantificadores basados en la Transformada Wavelet
  Clemente G.; Vampa V.; Valverdea E.; Arini P.

- Adaptive multiresolution simulation of resistive magnetohydrodynamics equations
  Gomes A. K. F.; Domingues M.; Mendes O.; K. Schneider

- Multiscale approximations and applications
  Liandrat J.; Kui Z.; Garcia E.

- Adaptive global magnetic-hydrodynamic simulations using sparse point representation
  Sierra-Lorenzo M.; Domingues M.; Mendes O.; León-Mecías A.

- A case study of a gravity wave induced by Amazon forest orography and low level jet Generation
  Martins H. S.; Polari B.; Corrêa A,; Dias-Júnior C. Q.; Manzi A. O.; Martins H. S., et al

- Alternatives to build wavelet bases adapted to one-dimensional pattern
  León-Mecías A.; Santiago D. V.; Díaz-Romañach M. L. B.

- Establishing a methodological approach to characterize South America Geomagnetic Disturbances
  Mendes O.; Bilibio A. V.; Silva M. R.; Domingues M.

- Adaptive Solution Of Initial Value Problems By A Dynamical Galerkin Scheme
  Pereira R. M.; Nguyen nan yen N.; Schneider K.; Farge M.

- Recurrent Wavelet Neural Network for time series prediction
  Souza E. M.; Leme M.

The use of wavelet technique for Pc5-pulsation electrodynamical characterization analysis at low-latitude conjugate stations

Camacho E. [1]
Benyosef L.[2]
Mendes O. [3]
Domingues M.[4]

Abstract: Understanding the effects of the space environment upon the Earth's atmosphere is of significant importance to the high technological society daily life. The solar-terrestrial electrodynamical interaction creates geomagnetic disturbance affecting installation and services from the near-space to the surface. There are geomagnetically conjugate areas in both hemispheres linked by magnetic flux tubes. Examination of the Pc5 pulsations (ultra low-frequency waves, 1-7 mHz) at the conjugate areas could explore essential characteristics of the physical processes. The main objective of this work is to apply a wavelet technique to characterize the frequency band based on evolution and the inter-relationship between conjugated signals. Datasets are composed of the horizontal geomagnetic component from available magnetograms obtained at the Asia-Pacific region in middle-to-low latitude. As a methodology, the Continuous Wavelet Transform performs a time-scale analysis of the filtered signal, followed by a signal coherence wavelet analysis. Some results already reached illustrate the geophysical importance of the technique and build an exploratory characterization of the complex process existing in the magnetosphere-ionosphere system coupling effects.

[1]National Observatory, Brazil,
edwinlinares@on.br
[2]National Observatory, Brazil,
benyosef@on.br
[3]National Institute for Space Research, Brazil,
odim.mendes@inpe.br
[4]National Institute for Space Research, Brazil,
margarete.domingues@inpe.br

Identificación de la inestabilidad eléctrica cardíaca en pacientes con infarto de miocardio mediante el uso de cuantificadores basados en la Transformada Wavelet

Clemente G. [5]
Vampa V.[6]
Valverdea E.[7]
Arini P.[8]

Abstract:

Those individuals who have suffered a myocardial infarction (MI) have been shown to have a high probability of developing malignant ventricular arrhythmias and/or sudden cardiac death. Electrical conduction abnormalities that appear in the infarcted region of the myocardium are reflected on the electrocardiogram (ECG) as fragmentation of the QRS-complex (fQRS). Such fragmentations are not always possible to detect visually. Although it may happen that patients do not develop tachycardia and/or venticular fibrillation (VT/VF), they are potentially risky because they can develop it unexpectedly and without previous symptoms. There are few non-invasive techniques to capture these electrical instabilities, such as the signal averaged electrocardiogram technique, and the spectral variance of the QRS-complex, among others. In a previous work by the authors, good results were obtained with the calculation of the Entropy and Shannon Complexity from the coefficients provided by the Continuous Wavelet Trans- Form. The objective of this work is to analyze and compare other measures of Entropy and Complexity in order to quantify abnormal alterations in cardiac electrical activity in post MI patients who do not present VT/VF, in a more efficient way. For this, the Entropy and Complexity of Renyi and Tsallis are calculated; and the Entropy of Amplitudes and the Sensitivity and Specificity values are analyzed for each case.

[5]Faculty of Engineering - UNLP, Argentina
investigar1matematica@gmail.com
[6]National University of La Plata, Argentina
victoriavampa@gmail.com
[7]University of Buenos Aires, Argentina
[8]National Scientific and Technical Research Council, Argentina

Adaptive multiresolution simulation of resistive magnetohydrodynamics equations

Gomes A. K. F. [9]
Domingues M.[10]
Mendes O. [11]
Schneider K. [12]

Abstract: In this work, it is presented a fully wavelet adaptive computation of the magnetohydrodynamics equations in two and three dimensions, performed with CARMEN-MHD code. The cell-averaged adaptive multiresolution technique allows the automatic adaptation of the grid and ensures the precision of the computations while reducing CPU time and memory requirements. This approach is recent to the magnetohydrodynamic model and it is shown to be promising. To illustrate its precision and efficiency different benchmark computations are presented and discussed.

References

[1] Gomes et al. *Adaptive multiresolution simulation of resistive magnetohydrodynamics equations* Advances in Computational Mathematics volume 47, Article number: 22 (2021)

[9]Federal Institute of São Paulo (IF-SP), Cubatão Campus, Brazil,
annakfg@gmail.com
[10]National Institute for Space Research, Brazil,
margarete.domingues@inpe.br
[11]National Institute for Space Research, Brazil,
odim.mendes@inpe.br
[12]Aix-Marseille University, France
kai.schneider@univ-amu.fr

Multiscale approximations and applications

Liandrat J. [13]
Kui Z.[14]
Garcia E. [15]

Abstract: Subdivision schemes introduced in the 90th in parallel with wavelets are workhorses for many developments in the framework of approximation. They have been developed in many directions and they can be (or not be) linear, interpolatory, data dependent, position dependent, stationary, and manifold stable. Often, to fully exploit their power, subdivision schemes must be plugged in a multiresolution framework (of the same type as multiscale analysis for wavelets). We will consider the construction of this framework and exhibit some of its properties in different situations. Classical applications deal with data compression. We will moreover consider some applications devoted to regularity recovery with applications to friction coefficient reconstruction into a pipe.

References

[1] Z. KUI, J. BACCOU, J. LIANDRAT *On the construction of multiresolution analyses associated to general subdivision schemes*. Maths. Comp. 90 (2021), 2185-2208.

[2] E. GARCIA, J. LIANDRAT *Enforcing convergence of derivatives for uniform approximation of a regular curve*. Comput. Aided Geom. Design 87 (2021) 101982.

[13]Aix-Marseille University, France,
jliandrat@centrale-marseille.fr
[14]Aix-Marseille University,
zhiqing.kui@centrale-marseille.fr
[15]Aix-Marseille University,
egarcia@exlog.com

Adaptive global magnetic-hydrodynamic simulations using sparse point representation

Sierra-Lorenzo M. [16]
Domingues M.[17]
Mendes O. [18]
León-Mecías A.[19]

Abstract: Global magneto-hydrodynamic (MHD) models are important tools to study solar wind–magnetosphere interactions. In regular meshes, MHD models demand a huge amount of CPU time. To bypass these constraints we combine a well known 3D global MHD code that uses finite difference methods in space discretization with the interpolating wavelet technique Sparse Point Representation. We significantly reduce the CPU time preserving the accuracy of the model. We claim that this combination can be also useful to other finite difference models.

[16]Center for Atmospheric Physics, Meteorology Institute of Cuba, Cuba,
maibys.lorenzo@insmet.cu
[17]National Institute for Space Research, Brazil,
margarete.domingues@inpe.br
[18]National Institute for Space Research, Brazil,
odim.mendes@inpe.br
[19]University of Havana, Cuba,
angela@matcom.uh.cu

A case study of a gravity wave induced by Amazon forest orography and low level jet Generation

Martins H. S.
Polari B.
Corrêa A.
Dias-Júnior C. Q.[20]
Manzi A. O., et al[21]

Abstract: The role of turbulent coherent structures (CS), gravity waves (GW) and low-level jet (LLJ) propagation in the flow dynamics of the Nocturnal Boundary Layer (NBL) within and above a forest canopy at the Amazon Tall Tower Observatory (ATTO), in Central Amazon was investigated. Seven levels of wind velocity and temperature measurements allowed the study of the flow structure below and above the surface layer. We analyzed one dynamically rich night in 2015, which includes three distinct periods. In the first one, the NBL is characterized by CS generated at the canopy top. In the second period, the change in wind direction triggers the onset of a orographic GW above the roughness sublayer. The wave, suppressing the propagation of CS, strongly influences the boundary layer structure, both above and below the canopy. In the third period, low turbulence intensity at the canopy top enables the development of a LLJ. As the jet shear layer propagates upward, it disrupts the wave oscillations, while LLJ dominates the flow dynamics. The wavelet analyses identified i) turbulent and non-turbulent structures with different length and time-scales; ii) coupling of the flow at different levels and the vertical propagation of turbulent and wave motions; and iii) the ability of turbulent and low frequency processes associated with the orographic GW to penetrate within the canopy. Further, scalar measurements of methane, carbon monoxide and carbon dioxide identified the LLJ nose as upward limit for how far scalars can be transported.

[20]Federal Institute of Education, Science and Technology of Pará,
cleo.quaresma@ifpa.edu.br
[21]National Institute for Space Research, Brazil,
antonio.manzi@inpe.br

Alternatives to build wavelet bases adapted to one-dimensional pattern

Santiago D. V.
León-Mecías A. Díaz-Romañach M. L. B.[22]

Abstract: Wavelet bases have shown their efficiency in signal representation, achieving a better time-frequency localization with respect to other basis functions such as trigonometric ones. Several methods are reported in the literature to construct wavelet bases by optimizing properties such as regularity, null moments, time-frequency localization and frequency response. When using the Discrete Wavelet Transform to detect a certain pattern in a signal, the choice of the mother wavelet is fundamental. There are several criteria for this, the most frequent is to take the wavelet with the highest correlation with the pattern. This method presents some difficulties and therefore the so-called adapted wavelet approach is proposed. In this contribution a critical review of the methods used to construct adapted wavelet bases is presented as well as the results of experiments using the Discrete Shapelet Transform. The experiments include several numerical algorithms to solve the non-linear system determined by the coefficients of the wavelet filter and the evidence of the detection of the pattern and dilated versions of it.

[22]Havana University, Cuba
{angela,mbaguer}@matcom.uh.cu, dvs89cs@gmail.com

Establishing a methodological approach to characterize South America Geomagnetic Disturbances

Mendes O.
Bilibio A. V.
Silva M. R.
Domingues M.[23]

Abstract: Emitted by the Sun, the electromagnetic and high-energetic corpuscular radiations ionize the Earth's atmosphere, which is permeated by a magnetic field from a dynamo mechanism in the inner core, defining a surrounding region known as the magnetosphere-ionosphere system. By the electrodynamical coupling between solar wind plasma structures and this Earth's plasma environment, complicated electrical current systems are structured involving the planet. On the surface, magnetometers measure fluctuations, known as geomagnetic disturbances, useful as a powerful tracer that can monitor and help unravel complex dynamics in a global scenario. Analyses of those disturbances help to identify and quantify electrodynamical processes and provide understanding to mitigate potential deleterious effects. Nevertheless, the scenario in South America is much more complicated due to some peculiar existing phenomena, like the South Atlantic Magnetic Anomaly, a tilt of the magnetic equator, the ionospheric plasma bubbles, the equatorial electrojet, and a vertical-drift plasma equatorial source.The examination of magnetic station records in this region could distinguish in a certain way the specific answers and identify magnetic patterns compared with global ones.This work aims to explore the time-scale analysis from wavelet technique to find an acceptable intermediate frequency range, avoiding frequency contributions below thresholding value (referring to know long-term patterns) and above a limit that defines a correct noise interpretation (acceptable to the physical interests). The datasets are composed of horizontal geomagnetic components from selected stations in South America and global-reference behaviour stations.The study result and its interpretation will be used in a predeveloped wavelet tool, which, by its time, can aid to categorize the magnetometers and develop a geomagnetic descriptor sensitive to the regional peculiarities.

[23]National Institute for Space Research, Brazil,
{odim.mendes, anderson.bilibio,marlos.silva,margarete.domingues}@inpe.br

Adaptive Solution Of Initial Value Problems By A Dynamical Galerkin Scheme

Pereira R. M. [24]
Nguyen nan yen N. [25]
Schneider K. [26]
Farge M.[27]

Abstract: We study dynamical Galerkin schemes for evolutionary partial differential equations (PDEs), where the projection operator changes over time. When selecting a subset of basis functions, the projection operator is non-differentiable in time and an integral formulation has to be used. We analyze the projected equations with respect to the existence and uniqueness of the solution and prove that non-smooth projection operators introduce dissipation, a result which is crucial for adaptive discretizations of PDEs, e.g. adaptive wavelet methods. For the Burgers equation, we illustrate numerically that thresholding the wavelet coefficients, and thus changing the projection space, will indeed introduce dissipation of energy. We discuss consequences for the so-called 'pseudo-adaptive' simulations, where time evolution and dealiasing are done in Fourier space, whilst thresholding is carried out in wavelet space. Numerical examples are given for the inviscid Burgers equation in 1D and the incompressible Euler equations in 2D and 3D.

[24]Federal Fluminense University, Brazil,
rpereira at mail.if.uff.br
[25]Doctor in Physic,
[26]Aix-Marseille University, France
kai.schneider@univ-amu.fr
[27]ENS, Paris, France
marie.farge@ens.fr

A Wavelet-AdaptiveMethod for Multiscale Simulation of Turbulent Flows in Flying Insects

Schneider K. [28]
Engles T.[29]
Reiss J. [30]
Farge M.[31]

Abstract: To appear in Communications in Computational Physics (in press).

[28]Aix-Marseille University, France
kai.schneider@univ-amu.fr
[29]ENS, Paris, France
[30]Technical University Berlin,
[31]ENS, Paris, France
marie.farge@ens.fr

Recurrent Wavelet Neural Network for time series prediction

Souza E. M. [32]
Leme M.[33]

Abstract: Artificial neural networks have been shown to be a very efficient method in several applications, including times series. However, its recurrent version is more suitable for time series, since it is possible to aggregate information from past instants to the network, facilitating learning/modeling and making forecasting of temporal sequences more efficient. Furthermore, another approach that stands out to study the behavior of time series is wavelet analysis, because its simultaneous analyzes in time and frequency. Through the union of these two approaches, a more efficient alternative emerges for the same purposes, called recurrent wavelet neural networks. In this sense, a recurrent wavelet neural network will be presented, which is composed by a context layer responsible for the recurrence of the network, which sends information to the hidden and output layers. In addition, the network also contains a weighted linear connection between the input and output layers. To analyze the performance of adjustment and prediction of this network, examples involving time series from real data will be presented. The results for both modeling and forecasting even for non-stationary time series showed to be very promising.

[32]State University of Paraná, Brazil
emsouza@uem.br
[33]State University of Maringá, Brazil
matheus_a46@hotmail.com