Regional Program MATH-AmSud
2017 Project Proposal (Research – Innovation)

Basic Form

- This form, and the associated CVs, must be filled **in English.** Before filling the form, please read carefully the bases published in the MATH-AmSud site (http://sticmathamsud.org/).
- This form must be sent by email in **.pdf** to the MATH-AmSud Secretariat (contacto@sticmathamsud.org) by the project's International Coordinator.

A. General Information

A1	Project title
	MATHematical methods for GEOphysical flows

A2	Acronym
	MATH-GEO

A3	Research domain
	Applied mathematics, Dynamical systems theory, Fluid mechanics, Topology of chaos, Manifold learning, Geophysical Sciences, Data Assimilation, Stochastic dynamical systems, Reduced-order models, Algebraic topology, Mathematical methods for studies of weather and climate.

A4	Project goals
	Development of new mathematical methods for Oceanographic and Atmospheric Applications, leading to innovating strategies for low-order modeling, with a potential application to short-term forecasting for wind-farm operation, atmosphere, ocean and climate dynamics research, and data analysis in the form of tracer trajectories.

A5	Abstract
	Nonlinear processes, such as advection and turbulent mixing, play a central role in geophysical sciences. The theory of nonlinear dynamical systems provides a systematic way to study these phenomena. Its stochastic extension also forms the basis of modern data analysis techniques, predictability studies and data assimilation methods. Contributions in the field of Topology and Dynamics of Chaos include methods conceived to unveil the structure organizing flows in phase space, building the gap between data and low-dimensional modeling. Low-order models in climate dynamics are highly desirable, since they can provide solutions in cases where high-resolution numerical simulations cannot be implemented, as in short-term wind forecasting. At the same time, the procedure provides a tool-kit for model validation, emulation or inter-model comparison, with interesting prospects in all fields of oceanographic and atmospheric sciences, including climate detection and attribution. The strategy constitutes an unprecedented and promising perspective, offering an original approach to the subject, with mathematical concepts that are not necessarily widespread in the geophysics scientific community.

	This proposal gathers specialists with a know-how in the most challenging aspects of the focused research field: coherent structure detection in fluid flows for the exploration and interactive visualization of scientific data (LIMSI France), data assimilation and fluid motion analysis from image sequences (INRIA Rennes), numerical models and data assimilation (CMM-Chile) stochastic models for climate dynamics with application to El Niño Ocean models (USIL-Peru), mathematical methods for weather and climate (CIMA-UBA & IMIT / IFAECI, Argentina), geophysical flows and dynamical systems (LMD France), mixing structures and Lagrangian analysis of multisatellite data (LOCEAN France), marine and estuarine hydrodynamic and water properties numerical models (INCO & IMFIA-Uruguay), in situ measurements of oceanographic conditions (CEBC France, in program with CNES France and CONAE Argentina), global modelling technique and topological characterization of flows (CORIA with CESBIO, France).

A6	**Scientific coordinators at each institution**			
	South America A		**South America B**	
	Institution	CIMA (Centro de investigaciones del mar y de la Atmósfera)[1], Universidad de Buenos Aires, Argentina	Institution	IMFIA: Instituto de Mecánica de los Fluidos e Ingeniería Ambiental, INCO: Instituto de Computación, Facultad de Ingeniería - Universidad de la República, Montevideo, Uruguay
	Project coordinator	Juan Ruiz	Project coordinator	Mónica Fossati
	Address	Intendente Güiraldes 2160 - Ciudad Universitaria - Pabellón II - 2do. Piso - (C1428EGA) Buenos Aires - Argentina	Address	Julio Herrera & Reissig 565, CP 11300 Montevideo, Uruguay
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	Email	jruiz@cima.fcen.uba.ar	Email	mfossati@fing.edu.uy
	South America C		**South America D**	
	Institution	USIL: Universidad San Ignacio de Loyola - Perú	Institution	CMM: Center for Mathematical Modeling- Chile
	Project coordinator	Alejandro Paredes	Project coordinator	Axel Osses
	Address	Universidad San Ignacio de Loyola Av. La Fontana 550 La Molina	Address	Beauchef 851, Edificio Norte – Piso 7 Santiago - CHILE

[1] See also IFAECI: Instituto Franco-Argentino sobre Estudios de Clima y sus Impactos (http://www.cima.fcen.uba.ar/UMI/)

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	France A		**France B**	
	Institution	LIMSI: Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur		
	Project coordinator	Denisse Sciamarella		
	Address	LIMSI-CNRS Rue John von Neumann Campus Universitaire d'Orsay Bât 508 91405 Orsay cedex		
	Tel/Fax	+33/0 1 69 85 80 69		
	Email	denisse.sciamarella@limsi.fr		

A7	**Other participating institutions**	
	In South America	**In France**
	In UBA: Universidad de Buenos Aires, Argentina: - Departamento de Ciencias de la Amósfera y los Océanos (DCAO), - Departamento de Matemáticas (DM) IFAECI (UMI 3351) Instituto Franco-Argentino sobre Estudios de Clima y sus Impactos, Buenos Aires Argentina IMIT: Instituto de Modelado e Innovación Tecnológica, Corrientes, Argentina (miembro de la UMI IFAECI, http://www.cima.fcen.uba.ar/UMI/)	CEBC : Centre d'Etudes Biologique de Chizé – CNRS, France CORIA : COmplexe de Recherche Interprofessionnel en Aérothermochimie, Rouen, France, with the Centre d'Etudes Spatiales de la BIOsphère (CESBIO) INRIA Rennes : Centre INRIA Rennes Bretagne Atlantique, Rennes, France LMD : Laboratoire de Météorologie Dynamique (UMR 8539), France LOCEAN: Laboratoire d'océanographie et du climat (UMR 7159-CNRS), France

A8	**List of expected participants (name and affiliation and status : junior, senior)**
	Seniors : - Christophe Guinet (project CEBC with CNES-CONAE) - Christophe Letellier (CORIA-Rouen) - Francesco D'Ovidio & Cédric Cotte (LOCEAN-Paris)

	- Gonzalo Panizo (USIL-Perú) - Joaquín Fontbona & Nicolás Hunneus (CMM-Santiago) - Luc Pastur & François Lusseyran (LIMSI-Orsay) - Manuel Pulido (Universidad Nacional del Nordeste, Argentina IMIT/IFAECI) - Martín Saraceno (CIMA/IFAECI-Buenos Aires) - Matthieu Jonckheere (Departamento de Matemática-UBA) - Michael Ghil (LMD-Paris) - Pablo Ezzatti (IMFIA/INCO-FING, Uruguay) - Sylvian Mangiarotti (IRD researcher, CORIA-CESBIO research team) Juniors : - Gisela Charo (PhD Student USA, CONICET granted) - Guillermo Scheffler (CIMA/IFAECI, Postdoc Student UBA, CONICET granted) - Lucía Curto (PhD Student UBA) - Manuel Jesús Arredondo Ruiz (Masther thesis, USIL, Perú) - María Ballesteros (Master thesis, Uruguay) - María Eugenia Dillon (Post-doc UBA, CONICET granted) - Natalia Tonti (DCAO-UBA, Post-doc Student UBA, CONICET granted) - Paula Maldonado (CIMA/IFAECI, PhD Student UBA, CONICET granted) - Ramiro Ferrari (Young researcher UBA) - Roberto Morales Ponce (PhD thesis, CONICYT granted)

A9	**International Project Coordinator (to be chosen among the Scientific Coordinators mentioned in A6)**
	Denisse Sciamarella

B. Project Details

B1. Project guidelines

The project concerns the development of innovative perspectives for nonlinear dynamical analysis of geophysical data. The goal is to develop, implement and apply mathematical tools to understand and model the fundamental processes at play in direct or indirect observations, and on a large span of time scales.

B2. Project description

Goals, motivation, methodology and contribution of each participating institution

The project's goal is creating a scientific consortium on mathematical methods for studies of ocean and atmospheric dynamics, with a focus upon innovating approaches that remain under-explored. The motivation is to conceive mathematical methods to analyze data that is available in the form of tracer trajectories, and to provide solutions in cases for which high-resolution numerical simulations cannot be implemented. From a theoretical perspective, the strategies include adapting geometrical, topological and/or differential constructions from Topology and Dynamics of Chaos for time series analysis, as well as exploring systems built from large-scale stochastic representations. Concerning applications, the strategy to test the new methods is to run heuristic diagnostics on flow data, and point out similarities between features of the diagnostics and observed flow patterns. Data from idealized flows, direct numerical simulations and experimental facilities will be considered, before analyzing true data. Each participating institution provides specific know-hows, either in mathematical techniques or in collecting and analyzing data. Contributions encompass theoretical procedures to extract Lagrangian Coherent Structures from trajectory data, measurement campaigns combining in situ and satellite data, high resolution computing, the application of nonlinear dynamical systems theory on direct Lagrangian measurements, and the development of original stochastic frameworks to represent large-scale flow dynamics or low-dimensional deterministic models. Because different dynamical variables do not provide the same level of information of the underlying dynamics, the specific problem of designing an appropriate space to represent the dynamics will be addressed. Ongoing PhD theses in the associated countries will particularly benefit from the exchanges and transfer of expertise that will result from the mobility of the involved researchers.

Project scope

The project scope is improving the mathematical frameworks that are available to deal with the complex processes involved in atmospheric and ocean flows, with applications to concrete case studies, and with a potential for technological transfer.

Expected results

The new mathematical procedures are expected to provide an alternative tool-kit for modelling, model validation, emulation, refutation and comparison, providing a back-and-forth route between conceptual models and data. The analysis of geophysical time series will be carried out using methods that have been applied in other research areas, but that are not necessarily widespread in the climate scientific community. Specific theoretical developments to address the specific needs for data analysis in geophysical studies (e.g. under the Lagrangian perspective) will be proposed. Concrete applications of such methods are expected to provide answers to the specific questions motivating the observations/experiments.

B3. Schedule, with main execution stages

Stage 1 (2018)

- Kick-off meeting in Buenos Aires, boosting the interaction of project participants.
- School dictated by the experts travelling to take part of the kick-off meeting.
- Designing an appropriate space from the measurements to investigate the underlying dynamics.
- Towards an implementation of nonlinear methods: the role of observability.
- Evaluation of the best datasets for the applications from experiments/observations.

Stage 2 (2019)

- Running heuristic diagnostics on data from idealized flows or numerical experiments.
- Analysis of results from 'real' data, in particular from IFAECI campaigns.
- Developments of large-scale stochastic approaches for Lagrangian Coherent Structure identification
- Getting low-dimensional deterministic models from the measured data
- Research articles reporting methodology/applications.

B4. Contributions

Present contributions so as to highlight the role of each partner and the integration among partners.

Contributions from LIMSI (Orsay) focus on the development of new strategies for the detection and identification of Lagrangian Coherent Structures. This subject has a trajectory that has led to a previous thesis (https://tel.archives-ouvertes.fr/tel-00947413). A PhD thesis on this subject is in progress in co-direction between LIMSI and the University of Buenos Aires. In this field, Michael Ghil (LMD) and co-workers have made important contributions, particularly in Geophysical Fluid Dynamics in relation with Dynamical and Complex Systems Theory.

In Buenos Aires, CIMA/IFAECI is collecting oceanographic data in campaigns to feed these developments. In particular, an ONR proposal on the permeability of the Malvinas Current (MC) has been approved in view of applying nonlinear dynamical systems techniques on altimetry-derived velocity and using direct Lagrangian measurements. In atmospheric research, high resolution numerical simulations of the atmospheric flow are generated to better understand atmospheric dynamics at different spatio-temporal scales and to improve forecasting capabilities.

The work in IMIT/IFAECI group has been focused on the development of data assimilation techniques based on ensemble Kalman filter and variational assimilation for improving geophysical models, including model error treatment, resolved-subgrid parametrization interactions and stochastic subgrid parametrization development. The topic is being developed in collaboration with colleagues at LMD, Institut Mines-Telecom Atlantique and Université Paris-Est. On the other hand, research groups from DCAO and DM of the UBA include ongoing PhD thesis on related subjects.

CORIA has been collaborating with CESBIO for more than six years on techniques borrowed from the nonlinear dynamical systems theory. In particular, they developed a specific technique for assessing the observability of a dynamics from given measurements which could help to choose the best variable to measure for investigating a given system. They are also developing a global modeling technique – getting a set of ordinary differential equations from experimental data – that they applied on various cases, including data recorded by satellites. In order to validate the obtained global models, they also developed a topological analysis of flows. They recently studied the potential effects that assimilation technique may have on the quality of the global model.

Data Assimilation concerns the estimation of the tracking along time of features transported by the flow, the setup of large-scale stochastic dynamical models, the identification of reduced order dynamical models, and the devise of dedicated flow measurement techniques. This subject is within the scope of a long-standing research by the INRIA Rennes research group in France. A recent research stay of a PhD student LIMSI-UBA was carried out in 2016, to work on the calculation of Finite Time Lyapunov Exponents (FTLE) on stochastic flows upon numerical data. The aim in this franco-argentinian work is to connect probabilistic and geometric descriptions of coherent structures in flows.

INRIA Rennes is also sharing strategies with USIL in Peru, where a new research team is being settled to

address the problem of multiple error and uncertainties sources handling, when modeling and simulating geophysical flows. All these errors and uncertainty sources, that can only be described in a statistical way, are often neglected or over-simplified on heuristic grounds, even if they have a real influence on the final prediction of the model. The error and uncertainties sources handling can be achieved with stochastic versions of the Navier-Stokes equations, as proposed by the team at INRIA Rennes. The models emerging from it are called fluid flow dynamics models under location uncertainty. The USIL-INRIA project aims at expanding the knowledge of fluid flow dynamics models under location uncertainty using numerical tools and appliying it to relevant 'El Niño' based oceanic models. The USIL team brings up a strong experience in computational fluid dynamics to build an efficient accurate and parallel code to study this new stochastic approach of fluid dynamics.

In parallel, a franco-argentine consortium with LOCEAN and CEBC has been formed around a project involving CNES and CONAE in Argentina. This program will be developed during 2017-2019 to study oceanographic conditions obtained both, from in situ measurements by elephant seals and from satellite data CFOSAT (2018). This includes sea surface temperature and sea surface color (SENTINEL) to quantify the spatio-temporal structuring of phytoplankton fields and of elephant seals' prey. The studied zone will concern the South-Argentinian continental shelf, a marine environment that is governed by the complex interactions between the warm poleward flowing Brazil Current and the cold equatorward flowing Malvinas Current, as well as the action of strong continental winds. The Malvinas Current is actively studied at CIMA/IFAECI. This program is in need of analytic efforts to better understand and describe the dynamics linked to the collection of oceanographic data, one of the main objectives of the present proposal.

In Santiago, the CMM has a long trajectory developing modeling techniques and complex problem analyses with a strong expertise on numerical simulations and data assimilation. It is developing research on Inverse problems for the Stokes system with missing components, on Partial Differential Equation control, and applications of inverse problems to geophysics. Partial and global cooperation with the other teams is expected.

During several years the IMFIA has studied sea levels, tidal currents and waves in the Río de la Plata estuary and the Atlantic Ocean. Numerical models validated for the area are available, linked to many research publications with its results and applications. The development and evaluation of a forecast tool to determine short-term flow characteristics in the Uruguayan sea of the Río de la Plata and Maritime Front (RPFM) is being developed. The institute will provide geophysical data from in situ measurements as well as from models of the "Río de la Plata" dynamics or of the South Atlantic Ocean, that may serve as input for the application of the developed methods. It also has an expertise in computational issues related with data analysis.

B5. Regional Aspects

Indicate how the activities will stimulate effective scientific interactions between all the participants.

Data analysis will gather scientific partners around the mathematical frameworks that will be developed within the project. The different mathematical frameworks (deterministic, stochastic, mixed) will offer possibilities awaking interest and applicability in a variety of contexts and demands. To provide a few examples of the expected synergy, LIMSI, CORIA and CIMA/IFAECI will actively collaborate around methods based on the Topology of Chaos, in a fluid communication with alternative methodologies used in LOCEAN and LMD. This is expected to be applied to wind forecast for wind farms operation, to describe mechanisms underlying the dynamics of eddies in the South Atlantic, as well as predicting changes in Atmospheric Circulation. INRIA will cooperate with CIMA/IFAECI, IMIT/IFAECI and CMM in data analysis using assimilation techniques. USIL and INRIA Rennes will launch a program of numerical studies of fluid flows under location uncertainty with an Application to El Niño oceanic models. Specific techniques conceived to analyze data obtained in the CEBC campaign involving CONAE and CNES are also expected to be developed, providing an oceanographic consortium for data analysis. Exchanges in the frame of ongoing PhD Thesis and Post-Docs are expected.

B6. Institutions and CVs of coordinators

Description of each participating institution, and curriculum vitae of each coordinator (maximum 2 pages per coordinator).

CEBC: The laboratory at the Chizé Centre for Biological Studies belongs to the Institut Ecologie et Environnement (INEE), department of the CNRS, carries out interdisciplinary research to study the effects of time and space variations in available resources, in particular due to global climate change and anthropogenic activities (agriculture, fisheries etc.), on vertebrate populations and communities. The above mentioned research program to study oceanographic conditions from in situ measurements by elephant seals and from satellite data is at the heart of the CEBC participation in this project.

CIMA/IFAECI: This "Unité Mixte International" from CNRS, located in Buenos Aires, is focused in promoting a large and multidisciplinary array of scientific interactions between France and Argentina, in order to increase knowledge of physical processes driving climate variability and change at regional scale (South America and South Atlantic). It fosters studies addressing how climate variability and change will impact population, biodiversity, production and vulnerability and how to generate climate information for application and adaptation. IFAECI gathers researchers from the CIMA (Centro de Investigaciones del Mar y la Atmósfera) as well as other institutions from CONICET, including IMIT (Instituto de Modelado e Innovación Tecnológica), and research groups from DCAO (Departamento de Ciencias de la Atmósfera y los Océanos, FCEN-UBA) and the SMN (Servicio Meteorológico Nacional).

CMM: The "Centro de Modelado Matemático" of the FCFM Universidad de Chile was created in 2000 with the scope of creating new mathematics and of applying them to the comprehension and solution of complex problems coming both from the production sectors or from other sciences. The CMM develops modeling techniques, and complex problem analyses to provide an answer to local needs. The CMM will participate in this project through subjects connected to control and inverse problems in partial differential equations. It is an institute that continues to attract young researchers with capacities to innovate in mathematical applications in the region. Geophysics is one of the main interdisciplinary subjects that is being developed between high level and active groups.

CORIA: CORIA is a Unité Mixte de Recherche (UMR) in Rouen. Its research domains include fundamental and applied studies on flow dynamics and turbulent mixing as well as the nonlinear dynamical systems theory applied to various fields (fluid mechanics, biomedicine, plasma physics, etc.). Its priority axes focus on the modeling of mechanisms and procedures regarding pollutant transport. CORIA proposes the development of simulation techniques, of diagnostics procedures with numerous international collaborations in the domains of fluid mechanics and combustion. These research activities involve industrial groups such as ERT with GDF-Suez for instance, as well as with CEA, IFP, IRSN, CNES, ONERA, etc. In collaboration with CESBIO, CORIA will participate in the data analysis with the double objective to model and characterize the dynamics.

CESBIO is the UMR 5126 between several institutions including the 'Institut de Recherche pour le Développement' IRD. It attempts to contribute to the progress of knowledge towards the interaction of continental surfaces, the climate and the human factor, on the basis of satellite data, developing models. It is involved in this proposal through the above mentioned collaboration with CORIA.

IMFIA/INCO-FING: The "Instituto de Mecánica de los Fluidos e Ingeniería Ambiental" (IMFIA) develops research activities in subjects related to Fluid mechanics and environmental engineering. IMFIA and INCO (Instituto de Computación) are Institutes of the Engineering School of Universidad de la República (FING), the main research and higher education institution in Uruguay. Being a public institution itself, FING has strong links with both private and public institutions, providing advice and applied research services in a wide field of subjects, including but not limited to: Environmental Hydraulics, Water Treatment, Water Management, Early Warning Systems, Natural Hazards Risk Analysis, Climate Change, Renewable Energies and Energy Efficiency.

INRIA Rennes: The INRIA Fluminance group located in Rennes works on the field of fluid motion analysis from image sequences. This concerns essentially the study of methodologies for the estimation or the tracking along time of characteristic features transported by fluid flows and observed through image sequences. The aim is devising estimation techniques that take more properly into account the dynamics or the physics of the observed phenomena. This group will participate in this project with data processing and assimilation techniques.

LIMSI: The LIMSI is a CNRS laboratory with a team devoted to the simulation of realistic flows and analysis of experimental or numerical databases for geophysical, industrial, biological and technological applications. LIMSI develops fundamental research on advanced numerical methods in the context of high performance computing (HPC) as well as applied studies to the concerned domains. A PhD student in co-direction with the University of Buenos Aires is being devoted to the development of mathematical methods applied to the detection of coherent structures. A new collaboration axis is being established between LIMSI and IFAECI in Buenos Aires.

LMD: The "Laboratoire de Météorologie Dynamique" is one of the main CNRS laboratory devoted to climate and weather research. LMD developed the LMDZ global climate model which is the atmospheric component of the IPSL coupled Earth system model involved in the CMIP5 exercise. Besides, the LMD and especially the FST (Fluide Stratifié Tournant) group have a strong expertise on geophysical fluid dynamics.

LOCEAN: Research at LOCEAN focuses on the study of the physical and biogeochemical processes controlling global ocean dynamics and climate variability over a large range of temporal and spatial scales for a better understanding of the climate system and its past, present and future behavior. LOCEAN has a specific expertise in ocean observation including field work, remote sensing and development of marine instrumentation, numerical modeling and analysis of oceanic parameters and proxies of climate change.

USIL: The San Ignacio de Loyola University (USIL) philosophy is supported on four institutional pillars: Entrepreneurship, Research and Development, Social Responsibility and Globalization. The Research and Development pillar concerns the support of new science related initiatives that address Peruvian reality problems. In this sense, USIL is working to attract young Peruvian researchers to open cutting edge research lines with direct application to local problems. At the same time, USIL wants to strengthen collaborations with South American partners and develop new ones with European research institutions.

Curriculum vitae of each coordinator:

Scientific Coordinator France A, International Coordinator:

D. SCIAMARELLA

1/ Personal data

Name: Sciamarella Denisse
Birth date: 31/12/1971
Professional address (with telephone and e-mail):
LIMSI-CNRS, BP 133, F-91403 Orsay CEDEX, France.
Tel. +33 1 69 85 80 69
E-mail: sciamarella@limsi.fr
Current job title and size of the research group:
CNRS 1st class Researcher
Groupe AERO : 11 permanent researchers, 6 Ph.D. students, 1 post-doc

2/ Highest obtained degree (with indication of place and date)

PhD in Physics, Universidad de Buenos Aires, Argentina, 2001

3/ Professional activity (the last 5 years)

CNRS researcher (CR2 2002-2006, CR1 since 2007)
CNRS researcher with "Mise à disposition" at LFD-FIUBA (2007-2009)
CNRS visiting researcher at LIA PMF (since 2010)

4/ Other duties/ positions

Member of the Société Française d'Acoustique
Responsible of Axis 3 at LIA PMF (www.liaflu.com)

5/ Awards, fellowships and external recognition

Fellowships at Ecole Normale Supérieure, DAAD (Germany), Ministère de la Recherche (France)
Member of the Jury for PhD Thesis at FIUBA, 2007/2009
Ad-hoc reviewer for: Acta Mechanica, Acustica united with Acta Acustica, Speech Communication, Computers and Fluids, Canadian Review of Physics, Journal of the Acoustical Society of America, Experiments in Fluids, European Journal of Fluid Mechanics, Journal of Mathematical Analysis and Applications, PLoS ONE.

6/ Ongoing funded research projects with dates, titles, sources of funding

LIA PMF, dates: 2010-2018, sources of funding: CNRS, CONICET. Director Axis Three.
MoSiME – CAFCI, dates: 2016-2017, sources funding: CNRS, CONICET. Co-director.

7/ Projects approved in the last 5 years

MoSiME – CAFCI, dates: 2016-2017, sources funding: CNRS, CONICET. Co-director.
LIA PMF, dates: 2010-2018, sources of funding: CNRS, CONICET. Director Axis Three.
SticAmSud 13-STIC-08 (in a scientific field without link to the present proposal). International Coordinator
VOFOCAM - ANR-12-PDOC-0018. Director in one thematic axis.

8/ Publications

8.1– Highlight the most important publications related to the project theme
Audier, Sciamarella, Artana. Physics of Fluids 28(1) (2016)
Sciamarella, Silva, G. Artana. Exp Fluids (2012) Experiments in Fluids, 53(3), 765–776 (2012)
Chisari, Artana, Sciamarella, Exp Fluids 50(2):397-406 (2011)
Pomeau, Sciamarella, Physica D 205 (2005) 215–221
Sciamarella, Pomeau, Journal of Low Temperature Physics, Vol. 123, Nos. 12 (2001)
Sciamarella, Mindlin, PRL 82, 7 (1999)
Sciamarella, Mindlin, PRE 64, 036209 (2001)

8.2 – Publications in cooperation with the project partners
Tuerke, Pastur, Sciamarella, Lusseyran, Artana. Experiments in Fluids in press. EXIF-D-17-00008R2 (2017)
Tuerke, Pastur, Fraigneau, Sciamarella, Lusseyran, Artana. Journal of Fluid Mechanics, Vol. 813, pp. 1-22 (2017)
Tuerke, Sciamarella, Lusseyran, Pastur, Artana. Physical Review E 91(1-1):013005 (2015)

9/ Theses oriented and post-doctoral fellows supervised

9.1– Finished/defended in the last 5 years

F. Tuerke. PhD Thesis. Co-tutelle entre l'Université de Paris-Saclay et l'Université de Buenos Aires CONICET Ph.D. scholarship. Defended April 7th, 2017
P. Audier: Post-doc Bernardo Houssay (2014-2015)

9.2 – Ongoing

G. Charo : Identification de structures cohérentes lagrangiennes. PhD Thesis LIMSI(CNRS) and UBA (2017-2020)
D. Alviso: Pos-doc CONICET (2017-2018)

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Scientific Coordinator South America A

JUAN RUIZ

1/ Personal data
Name: Ruiz Juan José
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Current job title and size of the research group: Researcher at CONICET (since 2011) and part time lecturer at the University of Buenos Aires (since 2011). The research group is currently composed by 2 PhD fellows and 2 post-doctoral fellows.

2/ Highest obtained degree (with indication of place and date): Licensure in Atmospheric Sciences (School of science, Universidad de Buenos Aires, 2004), PhD in Atmospheric Sciences (Universidad de Buenos Aires, 2009)

3/ Professional activity (the last 5 years):

4/ Other duties/ positions: Invited researcher at the Advanced Centre for Computational Science (RIKEN-AICS, Japan, since 2013), Member of the WMO working group on Data Assimilation (since 2017).

5/ Awards, fellowships and external recognition
-PhD fellowship at CONICET (Argentina), April 2004-April 2009. Universidad de Buenos Aires.
-Post-doctoral fellowship at CONICET (Argentina) April 2009-April 2010 Universidad Nacional del Nordeste Corrientes, Argentina,
-Bernardo Houssay fellowship march 2011-July 2011 Laboratoire de Meteorology Dynamique, Paris, France.
-World Meteorological Organization Research Award for Young Scientists 2010.

6/ Ongoing funded research projects with dates, titles, sources of funding
UBACYT 2014: Ensemble based data assimilation for regional models as co-PI. Universidad de Buenos Aires
PICT 2014 2014-2017 Ensemble based radar data assimilation as PI. National Agency for the Promotion of Science and Technology, Argentina.
PIDEFF 2014-2017 Data Assimilation and ensemble forecasting for high impact weather events in South America as co-PI Ministry of Defense of Argentina.

7/ Projects approved in the last 5 years
UBACYT 2011-2012: Parameter estimation using the Ensemble Kalman Filter.. As PI. Universidad de Buenos Aires.
PYCT 1986 2011-2012: Parameter estimation in numerical weahter prediction models based on the Ensemble Kalman Filter as PI. National agency for the promotion of Science and Technology, Argentina.
PIP 2013-2016: Model error treatment and parameter estimation in the Ensemble Kalman filter as Co-PI. CONICET

8/ Publications
8.1 Highlight the most important publications related to the project theme
-Pulido M., Scheffler G., Ruiz J., Luccini M. and Tandeo P., 2016: Estimation of the functional form of subgrid-scale parametrization using ensemble-based data assimilation: a simple model experiment. Quaterly Journal of the Royal Meteorological Society. 2016 in press. (*)
-Miyoshi T., Kunii M., Ruiz J., Lien G-Y, Satoh S., Ushio T., Bessho K., Seko H., Tomita H., Ishikawa Y, 2016: "Big Data Assimilation" revolutionizing severe weather prediction. Bulletin of the American Meteorological Society. 2016, ,97, 1347–1354, doi: 10.1175/BAMS-D-15-00144.1.
-Dillon M. E., García Skabar Y., J. Ruiz, Kalnay E., Collini E., Echevarría P., Saucedo M., Miyoshi T. and Kunii M.: Application of the WRF-LETKF Data Assimilation System over Southern South America:

Sensitivity to model physics. Weather and Forecasting, doi: http://dx.doi.org/10.1175/WAF-D-14-00157.1, 2016. (*)
-Alexis Hannart, A. Carrassi, M. Bocquet, M. Ghil, P. Naveau, M. Pulido, J. Ruiz and P. Tandeo, 2016: DADA: Data Assimilation for the detection and attribution of weather and climate-related events. Climatic Change, 2016, 136, 155. doi:10.1007/s10584-016-1595-3 (*)
-Ruiz, J. and M. Pulido, 2015: Parameter estimation using ensemble-based data assimilation in the presence of model error. Monthly Weather Review, 143, 1568-1582. (*)
-Ruiz, J. J., M. Pulido, and T. Miyoshi, 2013: Estimating model parameters with ensemble-based data assimilation: Parameter covariance treatment. J. Meteorol. Soc. Japan, 91, 453-469. doi:10.2151/jmsj.2013-403. (*)
-Ruiz, J. J. and Celeste Saulo, 2012: How sensitive are probabilistic precipitation forecasts to the choice of calibration algorithms and the ensemble generation method? Part I: Sensitivity to calibration methods. Meteorological Applications. Wiley, 19, 302-313.
-J. Ruiz, C. Saulo y E. Kalnay, 2009: Comparison of methods to generate probabilistic quantitative precipitation forecast over South America. Weather and Forecasting, 24, 319-336.

8.2 Publications in cooperation with the project partners (*)

9/ Theses oriented and post-doctoral fellows supervised
9.1– Finished/defended in the last 5 years
Marcos Saucedo, Data Assimilation for short range forecast improvement over South America. Co-advisor. PhD Thesis, Universidad de Buenos Aires
9.2 – Ongoing
-Paula Maldonado, High resolution radar data assimilation. Advisor. PhD Universidad de Buenos Aires.
-Hernan Bechis, Dry line climatology and dynamics over central Argentina. Co-advisor. PhD Universidad de Buenos Aires.
-Cyntia Matsudo, High resolution ensemble forecast strategies over Argentina. Co-advisor. PhD Universidad de Buenos Aires
-Felix Carrasco, Data assimilation and parameter estimation for air quality applications. Advisor, PhD Universidad de Buenos Aires.
-Soledad Osores, Ash dispersion forecast, evaluation of different methodologies. Advisor, PhD Universidad de Buenos Aires.
-Guillermo Scheffler: Optimization of stochastic parameters in a general circulation model of the atmosphere using Data Assimilation. Post-doctoral fellow.
-Maria Eugenia Dillon: Hybrid EnKF-Variational Data Assimilation. Post-doctoral fellow.

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Scientific Coordinator South America B

MONICA FOSSATI

1/ Personal data
Name: Mónica Fossati Piñeyrúa
Birth Date: 10 July 1978
Email: mfossati@fing.edu.uy
Professional address: Facultad de Ingeniería (Engineer Scohol) Universidad de la República. J. Herrera & Reissig 565, Montevideo, Uruguay. +59827115276 / 218
Current job title and size of the research group:
Associate Professor (Gr.4, tenure, Full Time) at the Fluid Mechanics and Environmental Engineering Institute of the Engineering Faculty (IMFIA – Facultad de Ingeniería). National Research System member Level 1 (SNI-ANII). The research group is currently composed by 3 full professors, 1 PhD student, 1 Master Student and 2 degreees students.

2/ Highest obtained degree:
PhD Engineer – Applied Fluid Mechanics (FING - UdelaR, 2013).

3/ Professional activity in the last 5 years

Professor (Agregado, Grado 4, since april 2015; Adjunto, Grado 3, 2011-2015; Asistente, Grado 2, 2007-2011).
Universidad de la República, URUGUAY. Facultad de Ingeniería. IMFIA: Instituto de Mecánica de los Fluidos e Ingeniería Ambiental.
From 2009 : Member of the National System of Researchers (ANII, Uruguay).

4/ Other duties/ positions
Teaching activities
2008-2009, 2012-2013, 2014-2015: 'Applied Hydraulic and Hydrology' course for Civil Engineers.
2009-2015: Hydraulic Engineering for Coastal zone management. Postgraduate course (MCISur program)

5/ Awards, fellowships and external recognition
Academic internships:
2015-2016 (15 days each year). Laboratoire d'Hydraulique Saint Venant (Equipe Dynamique Sédimentaire). Paris – France.
2012 (15 days). UFRJ - COPPE, Laboratorio de SEdimentos Cohesivos. Río de Janeiro. Brasil.
2011 (5 months). IFREMER. DYNECO/PHYSED. Laboratoire des physique hydrodynamique et sédimentaire. Brest. France.
2010 (2 months). IFREMER. DYNECO/PHYSED. Laboratoire des physique hydrodynamique et sédimentaire. Brest. France.

6/ Ongoing funded research projects with dates, titles, sources of funding
2017-2019: 'Real time forecast of water levels and currents for the Rio de la Plata estuary'
Counterparty and financing: CSIC, Universidad de la República. Co-director of the project.
2015-2017: 'OSMOSE: Open Source Modelling on the fine sediment dynamic's in Estuaries and bays' ECOS-SUD Program – IMFIA (Uruguay) and LHSV (France). Uruguayan director.

7/ Projects approved in the least 5 years
2015-2017: 'OSMOSE: Open Source Modelling on the fine sediment dynamic's in Estuaries and bays' ECOS-SUD Program – IMFIA (Uruguay) and LHSV (France). Uruguayan director.
2014-2016: 'Tidal Currents energy extraction viability in Uruguay'. ANII. Co-director.
2013-2015: 'Development of a long term simulation system of the Río de la Plata flow dynamic'. CSIC I+D. Co-director.

8/ Publications
8.1 Highlight the most important publications related to the project theme
Alonso, R., Jackson, M., Santoro, P., Fossati, M., Solari, S., Teixeira, L., "Wave and tidal energy resource assessment in Uruguayan shelf seas", Renewable Energy, 2017 accepted.
PABLO SANTORO; FOSSATI M.; P. TASSI; DAMIAN PHAM VAN BANG; N. HUYBRECHTS; M. BENOITE; PIEDRA-CUEVA I. Hydrodynamic and fine sediment transport numerical modelling, application to the Río de la Plata and Montevideo Bay, 2015. XXIInd TELEMAC-MASCARET conference, Liverpool, England, 2015.
PABLO SANTORO; FOSSATI M.; JUAN PABLO SILVA; DUFRECHOU E.; EZZATTI P.; PIEDRA-CUEVA I. Towards a 3D Hydrodynamic numerical modeling system for long term simulations of the Río de la Plata, 2015. 36th IAHR World Congress, La Haya, 2015.
FOSSATI M.; PABLO SANTORO; RODRIGO MOSQUERA; C. MARTINEZ; GHIARDO F.; PABLO EZZATTI; FRANCISCO PEDOCCHI; ISMAEL PIEDRA-CUEVA. Dinámica de flujo, del campo salino y de los sedimentos finos en el Río de la Plata. RIBAGUA - Revista Iberoamericana del Agua, v.: 1 1, p.: 48 - 63, 2014.
Fossati, M.; Cayocca, F.; Piedra-Cueva, I. Fine Sediment dynamics in the Río de la Plata. Advances in Geosciences, v.: 39, p.: 75 - 80, 2014.
Santoro, P.; Fossati, M.; Piedra-Cueva, I. Characterization of Circulation Patterns in Montevideo Bay (Uruguay). Journal of Coastal Research, v.: 29 4, p.: 819 - 835, 2013.
Fossati, M.; Piedra-Cueva, I. A 3D hydrodynamic numerical model of the Río de la Plata and Montevideo's coastal zone. Applied Mathematical Modelling, v.: 37 3, p.:1310 - 1332, 2013.
Santoro, P.; Fossati, M.; Piedra-Cueva, I. Study of the meteorological tide in the Río de la Plata. Continental Shelf Research, v.: 60, p.: 51 - 63, 2013.

Santoro, P.; Fernández, M.; Fossati, M.; Cazes, G.; Terra, R.; Piedra-Cueva, I. Pre-operational forecasting of sea level height for the Río de la Plata. Applied Mathematical Modelling, v.: 35 5, p.: 2462 - 2478 , 2011.
Fossati, M.; Santoro, P.; Urrestarazu, S.; Piedra-Cueva, I. Numerical Study of the Effect of a Power Plant Cooling Water Discharge in the Montevideo Bay. Journal of Applied Mathematics, v.: 2011.
Ezzatti, P.; Fossati, M.; Piedra-Cueva, I. An efficient version of the RMA-11 model. C L E I Electronic Journal, v.: 14, 2011.
Fossati, M.; Piedra-Cueva, I. Numerical modelling of residual flow and salinity in the Rio de la Plata. Applied Mathematical Modelling, v.: 32 6, p.: 1066 - 1086, 2008.
Piedra-Cueva, I.; Fossati, M. Residual currents and corridor of flow in the Rio de la Plata. Applied Mathematical Modelling, v.: 31 3, p.: 564 - 577, 2007.

8.2 Publications in cooperation with the project partners (*)

9/ Theses oriented and post-doctoral fellows supervised
9.1– Finished/defended in the last 5 years
Pablo Santoro. Numerical study of the Montevideo Bay hydrodynamics and fine sediment dynamic. PhD Engineer (Applied Fluid Mechanics) FING – UdelaR – 2017.
9.2 – Ongoing
Agustin Ríos. 'Santa Lucia river water quality modeling'. Master Engineer. FING-UdelaR.

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Scientific Coordinator South America C

ALEJANDRO PAREDES

1/ Personal data

Name: Paredes Cabrel, Alejandro

Birth date: 20.03.1980

Professional address (with telephone and e-mail):
Universidad San Ignacio de Loyola.
Address: Av. La Fontana 550. La Molina
Phone: (511) 317-1000 Ext. 3996

Current job title and size of the research group:
Research Professor
Size research group: 3 people

2/ Highest obtained degree (with indication of place and date)

PhD Mechanics and Physics of Fluids

Marseille- France 12.09.2013

3/ Professional activity (the last 5 years)

- Research professor at Univerisdad San Ignacio de Loyola 2017-now.
- Post-Doctoral Researcher 2013 – 2016

  Institute for Astrophysics Potsdam (AIP)- Magnetohydrodynamics and Turbulence Dept.

  Research on liquid metal magnetorotational instabilities in a Taylor-Couette configuration using a MPI FSEM FORTRAN in-house code.
- Assistant professor at Université de Toulon 2012-2013.

8/ Publications

Most relevant publications:
A. Paredes et al. Mixing of a passive scalar by the instability of a differentially rotating axial pinch. A&A, 588, 2016
A. Paredes et al. A penalization technique to model plasma facing components in a tokamak with temperature variations. J. Comput. Phys., 274:283 – 298, 2014

Other Publications:
A. Paredes et al. Numerical Fluid Modelling of the Plasma Edge Response to a 3D Object and Application to Mach Probe Measurements. CPP, 54(4-6):373–377, 2014
A. Paredes et al. Penalization technique to model wall-component impact on heat and mass transport in the tokamak edge. J. Nucl. Mater., 438, Supplement:S625 – S628, 2013
E. Serre et al. Numerical Modeling of the Impact of Geometry and Wall Components on Transport in the Tokamak Edge. CPP, 52(5-6):401–405, 2012
Ph. Ghendrih et al. Transition to supersonic flows in the edge plasma. PPCF, 53(5):054019, 2011
F. Schwander et al. Parallel shear flow instability in the tokamak edge. J. Nucl. Mater., 415(1, Supplement):S601 – S604, 2011
A. Paredes et al. Boundary conditions at the limiter surface obtained in the modelling of plasma wall interaction with a penalization technique. J. Nucl. Mater., 415(1, Supplement):S579 – S583, 2011

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Scientific Coordinator South America D

AXEL OSSES

1/ Personal data

Name: Axel Osses
Birth date: 1/7/1968
Professional address (with telephone and e-mail):
DIM/CMM Beauchef 851, Piso 5, Santiago Chile tel: 56-2 29 78 49 94 e-mail: axosses@dim.uchile.cl
Current job title and size of the research group: Prof. Titular. Departamento de Ingeniería Matemática, Universidad de Chile

2/ Highest obtained degree (with indication of place and date)

PhD Applied Mathematics, Ecole Polytechnique, Palaiseau, France, 1998

3/ Professional activity (the last 5 years)

2016—2018 Consejero de Facultad, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile.
2014—2016 Director, Departamento de Ingeniería Matemática, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile.
2013 Profesor Titular, Departamento de Ingeniería Matemática, Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile.

4/ Other duties/ positions

2013-2016 Associated Editor, Mathematical Control and Related Fields MCRF, American Institute of Mathematical Sciences.

5/ Awards, fellowships and external recognition

6/ Ongoing funded research projects with dates, titles, sources of funding

2009—2019 Basal Center for Mathematical Modeling CMM. Associate Member.
2013—2017 Fondap Center for Climate Change and Resilience CR2. Assistant Member.
2015—2018 Fondecyt-CONICYT 1151512 Inverse Problems in Physical Sciences and Engineering. Director.
2016-2017 Ecos C14U01 Estimating black carbon emissions by assimilating aerosol absorption optical depth. Member.

7/ Projects approved in the last 5 years

2015—2016 Math-Amsud SOCDE 15MATH-02 Sparse Optimal Control of Differential Equations: Algorithms and Applications. Member.
2014—2015 Math-Amsud COSIP 14MATH-03 Control Systems and Identification Problems. Associated Member.
2013—2015 Anillo-ACPA Analysis of Control Problems and Applications. Associated Member.
2011—2014 FONDECYT-CONICYT 1110290. Inverse Problems in Partial Differential Equations with Applications. Director.

8/ Publications (last five years)

8.1– Highlight the most important publications related to the project theme

2016 P. Moisset de Espanés, A. Osses, I. Rapaport. Fixed-points in Random Boolean Networks: The impact of parallelism in the Barabási-Albert scale-free topology case. To be published in Biosystems 150, 167—176.
2015 A. Henriquez, A. Osses, L. Gallardo and M. Diaz Resquin. Analysis and optimal design of air quality monitoring networks using a variational approach. Tellus B, 67, 1—13.
2015 M. Courdurier, F. Monard, A. Osses And F. Romero. Simultaneous source and attenuation reconstruction in SPECT using ballistic and single scattering data. Inverse Problems 31(9), 1—30.
2015 L. Baudouin, S. Ervedoza, A. Osses. Stability of an inverse problem for the discrete wave equation and convergence results. J. Math. Pures Appl. 103, 1475—1522.
2014 P. Manriquez, E. Contreras, A. Osses. Lithospheric 3D flexure modelling of the oceanic plate seaward of the trench using variable elastic thickness. Geophys. J. Int. 196, 681—693.
2013 R. Briceno, P. Moisset, A. Osses, I. Rapaport. Solving the density classification problem with a large diffusion and small amplification cellular automaton. Physica D 261, 70—80.
2013 G. Garcia, A. Osses, M. Tapia. A heat source reconstruction formula from single internal measurements using a family of null controls. Journal of Inverse and Ill-posed Problems, Vol. 21(6), 755—779.
2013 A. Osses, T. Faundez, L. Gallardo. Analysis and evolution of air quality monitoring networks using combined statistical information indexes. Tellus B, 65.
2013 B. Palacios, A. Osses, Potential recovery for Reissner-Mindlin and Kirchhoff-Love plate models using global Carleman estimates. Inverse Problems 29(7), 75009—34.

8.2– Publications in cooperation with the project partners

2008 L. Baffico, C. Grandmont, Y. Maday, A. Osses, Homogenization of an elastic media with gaseous bubbles, SIAM Multiscale Modeling & Simulation 7(1), 432—465.

9/ Theses oriented and post-doctoral fellows supervised

9.1– Finished/defended in the last 5 years

2013—2016 (PhD) Cristhián Montoya. Inverse problems for the Stokes system with missing components. Doctorado en Ciencias de la Ingeniería con Mención en Modelación Matemática, U. de Chile. Director. Graduated. Conicyt granted.

2014—2015 (MsC) Francisco Reyes. Electrical Engineering Thesis and MsC in Electrical Engineering. Simulation tool development for semiconductor devices based on drift-diffusion and Monte Carlo. Co-Directed with M. Díaz from Electrical Engineering Department.

2013—2014 (MsC) Paula Manríquez. MsC in Geophysics. Modelamiento tridimensional de placas litosféricas y aplicaciones a la identificación de su espesor. Co-directed with E. Contreras, Geophysics Department, U. de Chile.

2015—2016 (MsC) Felipe Salas Bravo. Robust control in copper injection refinement. Director. Graduated. CODELCO disruptive thesis award.

2015—2016 (MsC) Rodolfo Núñez. Mathematical Engineering Thesis and MsC in Mathematical Modeling. Estimation of relative pressure from velocity measurements in blood flows: state-of-the-art and new approaches. Co-Directed with C. Bertoglio from CMM, U. de Chile.

2015—2016 (MsC) Nicolás Molina. Mathematical Engineering Thesis and MsC in Engineering Sciences with mention in Mathematical Modeling. Control of a shallow water tank. Co-directed with E. Cerpa from UTFSM, Santiago. CMM granted. Doing PhD U. Paris 9 Dauphine.

2014 (pregadute) Francisco Romero. Mathematical Engineering Thesis, U. de Chile. An energy level SPECT method using attenuated Radon transform}{Co-Director with M. Courdurier, PUC, Santiago. Doing PhD in Applied Mathematics, LHZ, Swizerland.

2013—2014 (MsC) Adolfo Henríquez. Mathematical Engineering Thesis and MsC. Atmospheric Sciences. Algunos problemas de optimización de redes y clasificación en ciencias atmosféricas. Co-directed with L. Gallardo, Geophysics Department, U. Chile.

2013—2014 (pregraduate) Benjamín Palacios. Mathematical Engineering Thesis, U. de Chile. Problemas inversos en ecuaciones de placas y aplicaciones. Director. Doing PhD in Applied Mathematics, UW, Seattle.

9.2 – Ongoing

2016-2017 (Postdoc) Jéremy Dalphin. Postdoc at Center for Mathematical Modelling.
2016- (PhD) M. Soledad Gutiérrez. Starting. Doctorado en Ciencias de la Ingeniería con Mención en Modelación Matemática, U. de Chile. Director. Conicyt granted.

2016- (PhD) Evelyn Cueva. Starting. Co-direction with M. Courdurier (PUC). Doctorado en Ciencias de la Ingeniería con Mención en Modelación Matemática, U. de Chile. Director. Conicyt granted.

2016- (PhD) Hugo Carrillo. Starting, co-direction with C. Bertoglio. Doctorado en Ciencias de la Ingeniería con Mención en Modelación Matemática, U. de Chile. Director. Conicyt granted.

2016- (PhD) David Nolte. Starting, co-direction with C. Bertoglio (CMM). Doctorado en Ciencias de la Ingeniería con Mención en Fluido-dinámica, U. de Chile. co-Director. Conicyt granted.

2016- (PhD) Félix Carrasco. co-direction with J. Ruiz (UBA). Doctorado en Ciencias Atmosféricas, UBA. co-Director. Conicet granted.

2015- (PhD) Roberto Morales Ponce. Stability results on inverse problems of hyperbolic equations. Doctorado en Ciencias de la Ingeniería con Mención en Modelación Matemática, U. de Chile. Director. Grade expected in 2018. Conicyt granted.

2016- (MsC) Roberto Rojas. Electrical Engineering Thesis and MsC in Electrical Engineering. Compressed sensing in interferometry. Co-Directed with J. Silva, Electrical Engineering Department, U. de Chile.

2015- (MsC) Jeremías Garay Labra. MsC in Geophysics. Modeling of contact problems for tectonic plates. Co-Directed with E. Contreras-Reyes from Geophysics Department, U. de Chile. Conicyt granted.

B7. Additional information

List all the complementary fundings expected or already obtained.

Complementary fundings are available at each institution to reinforce the research actions that will result from this project.

- 2015-2018 Fondecyt-CONICYT 1151512 Inverse Problems in Physical Sciences and Engineering. Director: Axel Osses. In this project applications of inverse problems to geophysics are included.

- 2017-2019: 'Real time forecast of water levels and currents for the Rio de la Plata estuary' Counterparty and financing: CSIC, Universidad de la República. Co-director: Mónica Fossati.

- CEBC campaign involving CONAE and CNES (Christophe Guinet).

For reference, the above mentioned projects can finance 4 research missions (air ticket + per diem) per year.

Missions coupled to other projects will be possible with sources from:

- INRIA associate team between the Fluminance Inria group and the Buenos Aires university (http://www.irisa.fr/prive/memin/LFD-FLU/), Director: Etienne Mémin

- LIA PMF, dates: 2010-2018, sources of funding: CNRS, CONICET.

- Modeling and Simulation in Multidisciplinary Engineering, acronym MoSiME within CAFCI project (http://laboratorios.fi.uba.ar/lfd/pdfs/Project_CAFCI_MoSiME.pdf). Co-director: Denisse Sciamarella

For the school by experts coming for the kick-off meeting, complementary fundings are expected by programs such as CELFI.

Experience of the coordinators in similar projects.

- Denisse SCIAMARELLA: LIMSI-CNRS researcher. She has an expertise in non-linear topological methods for time series data analysis and in general fluid mechanics. She has played the role of international coordinator in two previous editions of the SticAmSud Program (SticAmSud 13-STIC-08 and 07-STIC-05) devoted to physics-based voice production. She is a founding member and directs one of the axes of the LIA PMF (Laboratoire International Associé en Physique et Mécanique des Fluides CNRS/CONICET). She has taken part in several National and European programs (e.g. TMR Intermittency Network, ANR-12-PDOC-0018) and has participated in several bilateral actions involving France and Argentina (i.e. supervising post-docs in the 'Bernardo Houssay' Program). She has been in charge of the Red Fluidos en Física y Mecánica de Fluidos from Programa Raíces (MINCYT, Argentina).

- Alejandro Paredes: USIL researcher. In collaboration with the FLUMINANCE team at INRIA, he is currently launching a new research line in Peru at USIL on numerical methods for a stochastic approach of fluid dynamics with application to El Niño oceanic models.

- Juan Ruiz: CIMA-IFAECI researcher: He has an expertise in numerical simulation of the atmospheric dynamics and data assimilation techniques. He is participating in international projects like ANR-13-JS06-0007 (Detection and Attribution of Climate Change based on Data Assimilation – DADA) and Innovating "Big Data Assimilation" technology for revolutionizing very-short-range severe weather prediction (founded by CREST). He also coordinates Argentinean research projects (Founded by CONICET, ANPCyT and Universidad de Buenos Aires) as PI and co-PI.

- Mónica Fossati: IMFIA-FINNG researcher is the Uruguayan director of an ECOS-SUD Program between IMFIA (Uruguay) and LHSV (France) 'OSMOSE: Open Source Modelling on the fine sediment dynamic's in Estuaries and bays' developed between 2015 and 2017 (three years).

- Axel Osses: DIM-CMM researcher. He has experience in inverse problems and data assimilation. He is participating in mathematical research for climate projects like CR2 (Fondap Center for Climate Change and Resilience, U. de Chile) and Ecos C14U01 (Estimating black carbon emissions by assimilating aerosol absorption optical depth). He also is conducting general fundamental mathematical research in inverse (CMM Basal Center for Mathematical Modeling and Fondecyt-CONICYT 1151512 Inverse Problems in Physical Sciences and Engineering).

Present main activities and their relationship with the project's main goal.

- Denisse SCIAMARELLA is a researcher at the interface between fluid mechanics and nonlinear dynamics, devoted to modeling the mechanisms at work underlying numerical and experimental data. She has applied these methods to the study of fluid flows encountered in nature. Applications include dipolar structures generated in stratified flows, fluid flow instabilities in finite domains, similarity properties in relation with invariance, time-delay feedback mechanisms, and mathematical studies concerning turbulence issues. Her expertise on the topology of chaos to analyze short and noisy time series has turned her attention towards the application of these techniques to the identification of Lagrangian Coherent Structures from trajectory data, a subject that is central where data is available in the form of tracer trajectories, as in oceanographic floats or atmospheric balloons. She is currently supervising a PhD thesis at the University of Buenos Aires on this subject. It is expected that these methods will be applicable to model validation, emulation, inter-model comparison and short-term forecasting.

- Alejandro Paredes has an expertise on CFD and a six years' research experience on numerical simulations of compressible and incompressible flows with applications to nuclear fusion devices and astrophysics. He has worked on hyperbolic systems of conservation laws for a fusion plasma in a fluid formalism and on magneto rotational instabilities of liquid metals in a Taylor-Couette configuration.

- Juan Ruiz has an expertise in numerical weather prediction and uncertainty quantification in weather forecasts for different applications, including high resolution numerical weather prediction and ensemble forecasting techniques. In the recent years he has been applying data assimilation methods to the problem of model optimization via parameter estimation. In particular, he has experience in the application of ensemble based data assimilation to models of different complexity ranging from toy low dimensionality models to state-of-the-art mesoscale numerical weather prediction models. It is expected that this expertise can be used to generate numerical simulations of the atmospheric flow that can be used to test and validate the implementation of the techniques developed within the project, in particular those that can be applied for short-term forecasting.

- Mónica Fossati has experience in marine, estuaries and coastal hydrodynamics modeling studies related with engineering projects located in the Río de la Plata and Maritime Front. Tidal propagation, storm surge, water properties transport and diffusion, sediment dynamics are the main processes studied. She is leading the development of a forecasting water level system based on a circulation model for the Río de la Plata. The mathematical methods developed during the project will be applied in selected modelled time series.

- Axel Osses has expertise in inverse problems for Partial Differential Equations and his research is related with applications in geophysics, both in Atmospheric Sciences and in Solid Earth. In the atmospheric sciences part, he did research about a) the evaluation of air quality monitoring networks using information theory from data (Tellus B 2013) or physical models (Tellus B 2015), b) air-pollution model based weather forecast in Santiago de Chile (Atmospheric Environment 2011), c) new data assimilation methods for air quality (multi scale data assimilation, Tellus B 2011) or in oceanography (controllability data assimilation method, M2AN 2011). His interests concern also Kalman filtering and optimal control as can be seen from his research. It is expected that his expertise, combined with the local Chilean team (that includes an expert in probability and another in numerical analysis) and with the international team (including also experts in numerical simulation of nonlinear flows, stochasticity and data assimilation) will be a great opportunity to the development and application of new methods to the development of climate dynamics and data analysis.

Perspectives of continuing collaboration after project financing is over.

The project will provide a framework to create new partnerships with long term aims that will naturally go beyond the two-year project proposed by MathAmSud. Network exchanges, engagement of students,

new research lines and data treatment issues will keep bi- and multilateral cooperations active. The synergy will be strong thanks to the complementary skills of the different participants.

B8. International referees

Suggest names of at least 3 international referees to evaluate the project. These researchers should not be connected to people in the project.

1- Hervé Le Treut (Université Pierre et Marie Curie, France)
2- Robert Gilmore (Department of Physics and Atmospheric Science, Drexel University)
3- Nicholas Tufillaro (College of Earth, Ocean, and Atmospheric Sciences, Oregon State University)
4 - Lars Nerger (Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany)

Names of referees who should not review this project in your opinion (optional)

1-
2-

B9. Public and private support obtained related to the project:

Previous project STIC AMSUD / MATH AMSUD?
NO

Other public or private support in the past:

Support received *in connection with* the subject addressed in this proposal
- Geophysical sciences constitute a priority axis both for CNRS and CONICET, that has led to the creation of the 'unité mixte international' UMI-3351.
- Inria associate research team LFD-FLU between Inria and UBA is another project in connection with this proposal that has been maintained during the years.
- 2006-2010 SAEMC-IAI, South American Emissions, Megacities and Climate: Bogotá, Buenos Aires, Rio de Janeiro, Santiago, Sao Paulo, IAI Inter American Institute for Global Change.
- PICT 2014 2014-2017 Ensemble based radar data assimilation as PI. National Agency for the Promotion of Science and Technology, Argentina.
- PIDEFF 2014-2017 Data Assimilation and ensemble forecasting for high impact weather events in South America with the Ministry of Defense of Argentina.
- 2013-2017 Fondap Center for Climate Change and Resilience CR2. Associate Member from this year. Data assimilation of aerosols.

For further information, see coordinators' CV.

Prospects for public or private support in the future:

Being these subjects the heart of active research between France and the South American region, public and private support will certainly accompany projects in connection with this proposal. An example is the project between CONAE and CNES to be developed during 2017-2019.

C. Project Budget

Project title: MATHematical methods for GEOphysical flows
Participating institutions: CEBC, CIMA/IFAECI, CMM, CORIA, IMFIA, INRIA, LIMSI, LMD, LOEAN, USIL
The MATH-AmSud program **funds travel expenses** (air tickets and *per diem*) to researchers in research missions and workshops.

C1. First year (2018)

Planned missions – Year 1

Researcher	Status (student, junior, senior)	Institution	Origin	Destination	Planned date	Duration (max. 30 days)	Estimated cost of the trip (€)	Estimate of total *per diem* (€)	Trip and Mission funding institution[2]	Mission objectives
Michael Ghil	Senior	LMD	Paris	Buenos Aires	April 2018	10	1.500	1.000	CNRS	Kick-off meeting
Etienne Mémin	Senior	INRIA	Rennes	Buenos Aires	April 2018	10	1500	1000	INRIA	Kick-off meeting
Christophe Letellier	Senior	CORIA	Rouen	Buenos Aires	April 2018	10	1500	1000	CNRS	Kick-off meeting
Axel Osses	Senior	CMM	Santiago	Buenos Aires	April 2018	10	300	1000	CMM	Kick-off meeting
Alejandro Paredes	Senior	USIL	Lima	Buenos Aires	April 2018	10	700	1000	CONCYTEC	Kick-off meeting
Mónica Fossati	Senior	IMFIA	Montevideo	Buenos Aires	April 2018	5	250	500	ANII	Kick-off meeting
Francesco D'Ovidio	Senior	LOCEAN	Paris	Buenos Aires	April 2018	10	1500	1000	CNRS	Kick-off meeting
Manuel Pulido	Senior	IMIT	Corrientes	Buenos Aires	April 2018	5	400	500	MINCYT	Kick-off meeting

[2] **Each institution will pay for the trip and per diem of its own researchers.**

Sylvain Mangiarotti	Senior	CESBIO (with CORIA)	Toulouse	Buenos Aires	April 2018	10	1500	1000	MAEDI	Kick-off meeting
Luc Pastur	Senior	LIMSI	Paris	Buenos Aires	April 2018	10	1500	1000	CNRS	Kick-off meeting

CONSOLIDATED BUDGET: Year 1
Funding requested to the MATH-AmSud Program
Estimated costs (€)

	A. Travel costs (air tickets)	B- Maintenance costs (*per diem*)	TOTAL
MAEDI France	1500	1000	2500
CNRS France	6000	4000	10000
INRIA France	1500	1000	2500
MINCYT Argentina	400	500	900
CONICYT Chile	-	-	-
CMM Chile	300	1000	1300
Faculty of Mathematics (PUC – Chile)	-	-	-
CONCYTEC Peru	700	1000	1700
IMCA Peru	-	-	-
ANII Uruguay	250	500	750
Total requested funding to MATH-AmSud	10650	9000	19650[3]
Other funding[4]	6000	4000	10000
TOTAL	16650	13000	29650

Do you have additional funding sources for this project[5]? (if so please specify the amount and source (s)):

All additional funding sources are detailed in B7. As reference, these sources represent a contribution equivalent to four research trips per year.

[3] E-mail communication with Antonia Alcaraz : "La limite [de référence de 15000 eur] vient du fait que les projets présentés proposent entre deux et trois pays impliqués en Amérique latine plus la France : vous pouvez demander un budget un peu plus conséquent du fait du nombre des pays impliqués mais pas très au-delà, 20000 eur semble judicieux."

[4] Fundings in connection with the present proposal are listed in B7. As reference, these sources can add four research trips per year.

[5] Reserved for CNRS researchers

C2. Second year (2019)

Second year funding depends on approval of intermediate progress report.

Planned missions – Year 2

Researcher	Status (student, junior, senior)	Institution	Origin	Destination	Planned date	Duration (max. 30 days)	Estimated cost of the trip (€)	Estimate of total *per diem* (€)	Trip and Mission funding institution[6]	Mission objectives
Lucía Curto	Junior	UBA	Buenos Aires	LIMSI Paris	March 2019	30	1.500	1200	MINCYT	Research stay
Gisela Charo	Junior	UBA	Buenos Aires	LIMSI Paris	March 2019	30	1500	1200	MINCYT	PhD Thesis en co-tutelle
Guillermo Scheffler	Junior	CIMA	Buenos Aires	INRIA Rennes	February 2019	30	1500	1200	MINCYT	Research stay
Cédric Cotte	Senior	LOCEAN	Paris	Buenos Aires	Juin 2019	10	1500	1000	CNRS	Research visit
Manuel Jesús Arredondo Ruiz	Junior	USIL	Lima	Rennes	March 2019	30	1500	1200	CONCYTEC	Research visit
Roberto Morales Ponce	Junior	CMM	Santiago	Buenos Aires	Juin 2019	10	300	500	CMM	Research visit
María Ballesteros	Junior	IMFIA	Montevideo	Buenos Aires	Juin 2019	10	250	500	ANII	Research stay
Gonzalo Panizo	Senior	USIL	Lima	Rennes	March 2019	30	1500	1200	CONCYTEC	Research stay

[6] **Each institution will pay for the trip and per diem of its own researchers.**

CONSOLIDATED BUDGET: Year 2
Funding requested to the MATH-AmSud Program
Estimated costs (€)

	A. Travel costs (air tickets)	B- Maintenance costs (*per diem*)	**TOTAL**
MAEDI France	-	-	-
CNRS France	1500	1000	2500
INRIA France	-	-	-
MINCYT Argentina	4500	3600	8100
CONICYT Chile	-	-	-
CMM Chile	300	500	800
Faculty of Mathematics (PUC – Chile)	-	-	-
CONCYTEC Peru	3000	2400	5400
IMCA Peru	-	-	-
ANII Uruguay	250	500	750
Total requested funding to MATH-AmSud	9550	8000	17550[7]
Other funding[8]	6000	4000	10000
TOTAL	15550	12000	27550

Do you have additional funding sources for this project[9]? (if so please specify the amount and source(s))

All additional funding sources are detailed in B7. As reference, these sources represent a contribution equivalent to four research trips per year.

[7] E-mail communication with Antonia Alcaraz: "La limite [de référence de 15000 eur] vient du fait que les projets présentés proposent entre deux et trois pays impliqués en Amérique latine plus la France : vous pouvez demander un budget un peu plus conséquent du fait du nombre des pays impliqués mais pas très au-delà, 20000 eur semble judicieux."
[8] Fundings in connection with the present proposal are listed in B7. As reference, these sources can add four research trips per year.
[9] Reserved for CNRS researchers

C3. BUDGET TOTALS

	Year 1	Year 2	Total
Funding requested to MAEDI (France)	2500	-	2500
Funding requested to INRIA (France)	2500	-	2500
Funding requested to CNRS (France)	10000	2500	12500
Funding requested to MINCYT (Argentina)	900	8100	9000
Funding requested to CMM (Chile)	1300	800	2100
Funding requested to Faculty of Mathematics (PUC – Chile)	-	-	-
Funding requested to CONICYT (Chile)	-	-	-
Funding requested to CONCYTEC (Peru)	1700	5400	7100
Funding requested to IMCA (Peru)	-	-	-
Funding requested to ANII (Uruguay)	750	750	1500
Matching funds from the partners	19650	17550	37200
Other sources	12000	8000	20000
TOTAL	**31650**	**25550**	**57200**