

Scientific report of the STSM by

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This Short-term Scientific Mission was held at Nansen Environmental and Remote Sensing Center (NERSC) in Bergen (Norway) from Monday 6th March until Friday 10th March 2017, for a total term of 5 days.

Assistants to the meeting

- Francisco Balibrea-Iniesta (ICMAT)
- Ana Mancho (ICMAT)
- Stephen Wiggins (University of Bristol)
- Laurent Bertino (NERSC)
- Jiping Xie (NERSC)
- Satoshi Kimura (NERSC)

Purpose of the STSM

The objective of this meeting was establishing a collaboration between the research group of geophysical fluid flows at ICMAT (led by Ana Mancho) and the research group of data assimilation at NERSC. Our initial intention was starting an interdisciplinary project where mathematical techniques could be applied to data sets measured in the Arctic Ocean in order to understand some insights of ocean circulation from a new perspective. Therefore this meeting could serve as an exchange of knowledge and information between researchers coming from different disciplines such as mathematics and oceanography, and eventually this collaboration could lead to the publication of some results analysed and interpreted from different points of view.

Work carried out during the STSM and main results

The working plan started by the presentations of the last results from both research groups. Laurent Bertino from NERSC first exposed their improvements on data assimilation of TOPAZ4 oceanographic model, which supplies them in a very successful way the velocity fields and physical parameters of the Arctic waters at several layers of depth. The presentation from IC-MAT group was carried out by Francisco Balibrea-Iniesta, who exposed the method of Lagrangian descriptors applied to the data supplied by NERSC as well as some simulations where this method clearly described the motions of the currents within the Arctic Ocean. After these two presentations a large discussion followed about the capability of this mathematical technique on describing the main geophysical phenomena in the Arctic Ocean. All the comments, suggestions and references of previous works served to create a nice atmosphere of working where all the assistants to the meeting were involved. Very remarkably professor Stephen Wiggins provided the needed framework of dynamical systems theory, which is the basis of the method of Lagrangian descriptors. Moreover on Tuesday 7th Ana Mancho gave a talk at NERSC where she exposed the formal insights of the method and a practical example where the method was applied in a very successful way (see *A Real-Time Response to a Marine Oil Spill: an Interdisciplinary Approach*, García-Garrido *et al.*, 2016).

On forward days the discussions turned around the reliability of the simulations based on the method of Lagrangian descriptors in order to detect some concrete and well-reported phenomena. These simulations obviously needed to be supported by previous articles dealing with Arctic oceanic circulation patterns and the evolution of water properties such as temperature and salinity. Among all the circulation events taking place in the Arctic seas, we focused our discussion on two particular currents: the Transpolar Drift which is a main jet crossing transversely the Arctic basin carrying the largest amount of water out to the North Atlantic and also the Beaufort Gyre. This last current conforms the largest storage of fresh water throughout the Arctic and its complex dynamics still keep partially unknown by the scientific community. Any possible change on its motion may lead to dramatic changes in the Arctic circulation scheme and more importantly to disturbances on global climate by means of several processes. Once we established the preference on these matters, all the assistants put the effort on interpreting the simulations and relating them to already reported results in the literature.

Future collaboration with the host institution and foreseen publications

In view of the conclusions reached after the discussions and all the available material, the assistants to the meeting agreed to continue collaborating in order to publish the results. This eventually will lead to an article where all the mathematical concepts around the method of Lagrangian descriptors are explained and applied to the data supplied by NERSC. Our intention is publishing the results in a journal on geophysical sciences as geophysicists and specially oceanographers may find our conclusions very inspiring and of very much interest.

Confirmation by the host institution and the applicant to the COST Action grant

Laurent Bertino from the research group of data assimilation at Nansen Environmental and Remote Sensing Center, and Francisco Balibrea-Iniesta from the research group of geophysical fluid flows at Instituto de Ciencias Matemáticas, confirm the successful execution of the Short-term Scientific Mission held in NERSC from 6th March 2017 until 10th March 2017.

Signatures:



Francisco Balibrea-Iniesta