

# The Assessment of Marine Oil Spills with Lagrangian Descriptors and Remote Sensing

V. J. García-Garrido<sup>\*1</sup>, A. Ramos<sup>2</sup>, A. M. Mancho<sup>1</sup>, J. Coca<sup>2</sup>, and S. Wiggins<sup>3</sup>

<sup>1</sup>Instituto de Ciencias Matemáticas, CSIC-UAM-UC3M-UCM, C/ Nicolás Cabrera 15,  
Campus Cantoblanco UAM, 28049, Madrid, Spain.

<sup>2</sup>División de Robótica y Oceanografía Computacional, IUSIANI, Universidad de Las  
Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain.

<sup>3</sup>School of Mathematics, University of Bristol, Bristol BS8 1TW, United Kingdom.

## Abstract

In this talk we will describe how an interdisciplinary approach that combines techniques both from Dynamical Systems Theory and satellite Remote Sensing could greatly contribute to the effective assessment of marine oil spills and the future development of contingency strategies. This work focuses on the sinkage of Oleg Naydenov fishing trawler ship, an environmental crisis that took place in the Canary Islands on April 2015.

From the context of Dynamical Systems, our analysis is based on Lagrangian Descriptors (Madrid and Mancho, 2009; Mancho *et al.*, 2013). This technique, which has the capability of revealing the dynamical barriers within a fluid flow that govern transport and mixing processes, allows for the assessment in almost real-time of the potential danger of the sinking point regarding the possible fuel arrival to the coast. Concerning the spill evolution, we have applied contour advection tools (Dritschel, 1989; Mancho *et al.*, 2003) to track fuel slicks. The results obtained remarkably reproduce the fuel sightings during the event. Undoubtedly, all this valuable information could have been of great help to the emergency services for the effective management of the catastrophe.

In the framework of satellite detection of oil spills, this work benefits from the application of Remote Sensing tools to analyze the reflectance spectra of ocean regions (Bulgarelli and Djavidnia, 2012) in order to address the presence of fuel, helping the sea/air operatives in their real-time monitoring and cleaning tasks during the crisis.

## References

- Bulgarelli, B. and Djavidnia, S. (2012). On MODIS retrieval of oil spill spectra properties in the marine environment. *IEEE Geosci. Remote S.*, **9**(3), 398–402.
- Dritschel, D. G. (1989). Contour dynamics and contour surgery: Numerical algorithms for extended, high-resolution modelling of vortex dynamics in two-dimensional, inviscid, incompressible flows. *Comput. Phys. Rep.*, **10**(3), 77–146.
- Madrid, J. A. J. and Mancho, A. M. (2009). Distinguished trajectories in time dependent vector fields. *Chaos*, **19**, 013111.
- Mancho, A. M., Small, D., Wiggins, S., and Ide, K. (2003). Computation of stable and unstable manifolds of hyperbolic trajectories in two-dimensional, aperiodically time-dependent vectors fields. *Physica D*, **182**(3), 188–222.
- Mancho, A. M., Wiggins, S., Curbelo, J., and Mendoza, C. (2013). Lagrangian descriptors: A method for revealing phase space structures of general time dependent dynamical systems. *Commun. Nonlinear Sci.*, **18**(12), 3530–3557.

---

\*victor.garcia@icmat.es