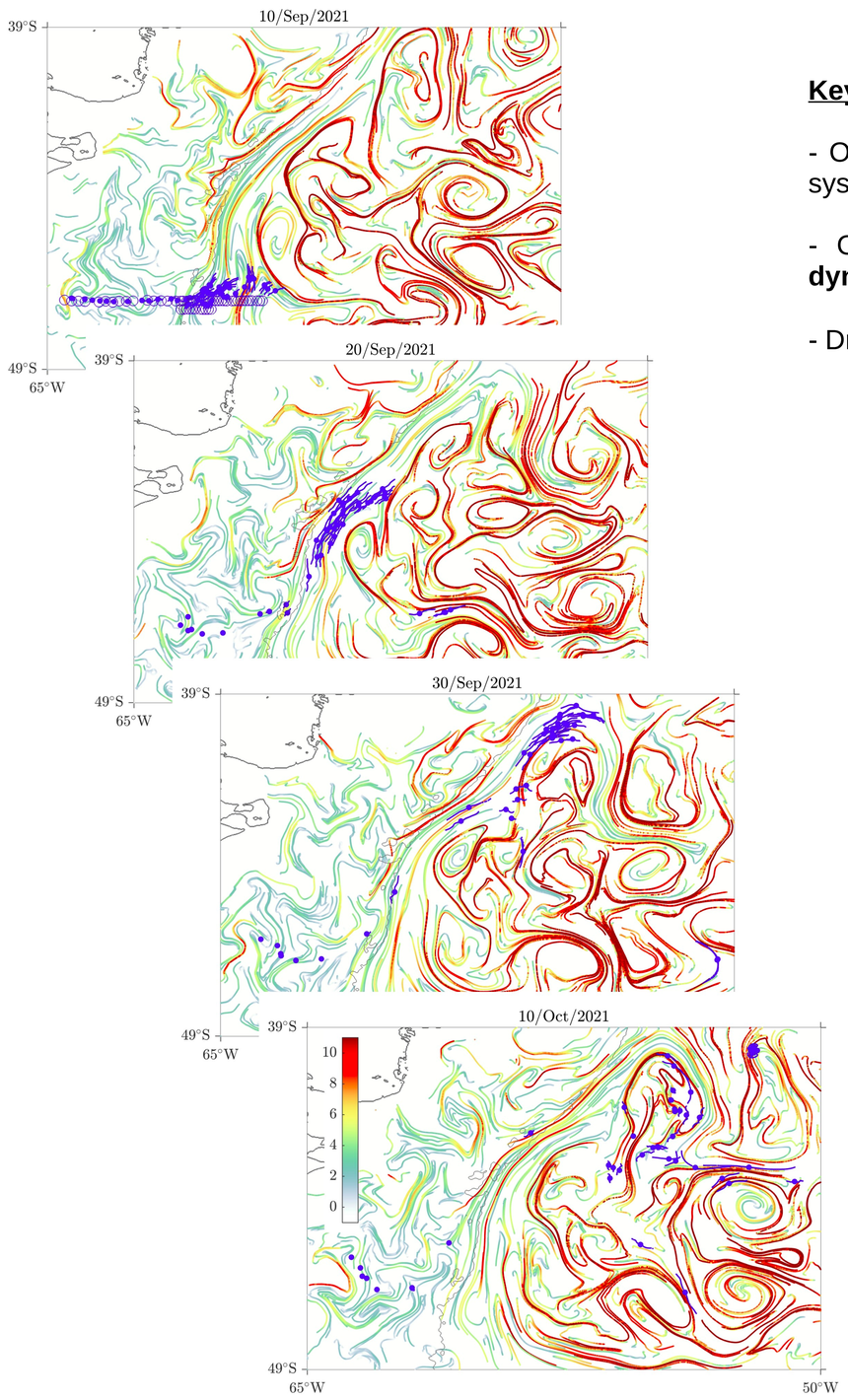
Multiple Lagrangian jet-core structures in the Malvinas Current

N. Bodnariuk (1,2,3), M. Saraceno (1,2,3), L.A. Ruiz-Etcheverry (1,2,3), C. Simionato (1,2,3), F. Andrade-Canto (4), F.J. Beron-Vera (5) and M.J. Olascoaga (6)

(1) Departamento de Ciencias de la Atmósfera y los Océanos, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (DCAO, FCEN-UBA). Buenos Aires, Argentina.
(2) Centro de Investigaciones del Mar y la Atmósfera (CIMA/CONICET-UBA)
(3) Instituto Franco-Argentino para el Estudio del Clima y sus Impactos (IRL-IFAECI/CNRS-CONICET-UBA)
(4) Departamento de Observación y Estudio de la Tierra, la Atmósfera y el Océano, El Colegio de la Frontera Sur, Chetumal, Quintana Roo, Mexico.
(5)Department of Atmospheric Sciences, Rosenstiel School of Marine, Atmospheric & Earth Science, University of Miami, Miami, Florida, USA.
(6)Department of Ocean Sciences, Rosenstiel School of Marine, Atmospheric & Earth Science, University of Miami, Miami, Florida, USA

nicolas.bodnariuk@cima.fcen.uba.ar



Drogued drifter trajectory segments (blue) overlaid on attracting LCS (colored according to stretching rate) as extracted from altimetry-derived currents on each date t_0 indicated from a backward-time geodesic LCS analysis with T= -30 days. The circles in each panel indicate deployment positions on 8 and 9 September 2021. The drifter trajectory segments are 2-day-long, centered at t_0, with the corresponding position indicated by a dot.

Surface drifters

62 drogued drifters were deployed on 8 and 9 September 2021 along 47°S and 47.25°S (drogued at 15-m depth)

55 drifters were custom-made, with satellite-tracked positions recorded every 10 minutes. The remaining 7 drifters, provided by the NOAA Global Drifter Program, record positions hourly.

Trajectory data underwent a quality control process to determine drogue presence (Lumpkin *et al.;* 2012).

Color images

We considered satellite-derived surface chlorophyll-a concentration data (Hu *et al*., 2019). L2 images acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Aqua satellite.

Altimetry

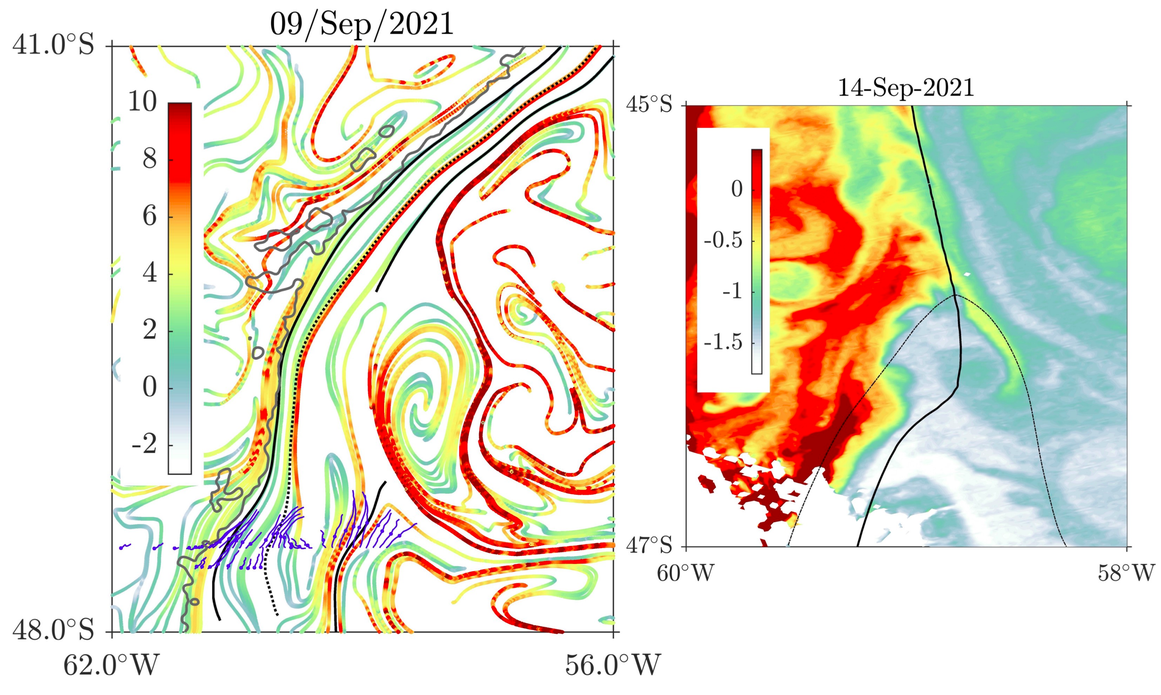
Surface velocities derived geostrophically from sea surface height anomaly were obtained from the combined processing of data collected by altimeters on the constellation of available satellites (LeTraon *et al.*, 1998).

Keypoints:

- Original evidence derived from a **dedicated drifter experiment** characterizes the Malvinas Current as a system of multiple **Lagrangian jets**

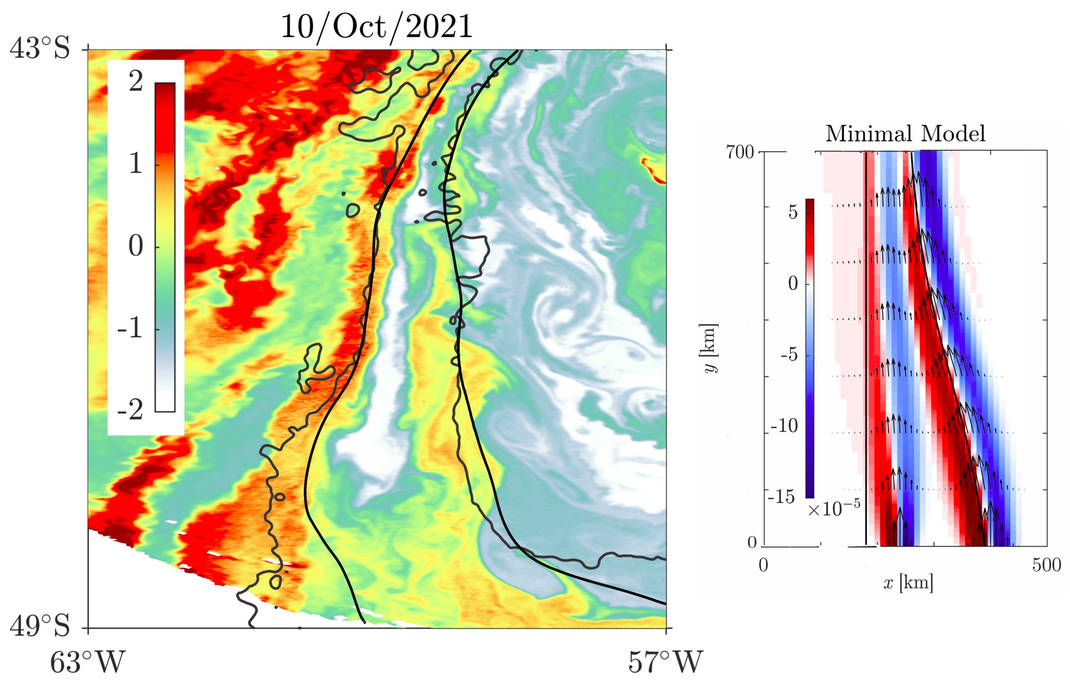
- Ocean color suggests upwelling along Malvinas jets, consistent with **arrested topographic wave dynamics**.

- Drifter data analysis confirms theoretically predicted **boomerang-shaped features** straddling jet-cores.



Left panel: Drifter trajectory pieces (blue) centered on t_0 as indicated (a dot corresponds to position on t_0), overlaid on attracting LCSs (colored according to pointwise stretching rate) and jet-cores (black curves and dashed curve) extracted from altimetry flow by applying geodesic LCS analysis.

Right panel: a jet-core (black curve) and two attracting LCSs (dashed curves) overlaid on surface chlorophyll-a concentration (logarithmic scale). The time window for the spLCS extraction was set to T=-15 days, a timescale representative of the chlorophyll path time span.



Overlaid on satellite-derived surface chlorophyll-a concentration (logarithmic scale), two jet-cores extracted from altimetry (black curves). The gray curves are the 200 and 1500 m isobaths (right panel) Arrested topographic wave (minimal) model solution revealing upwelling on the western flanks of the upstream-merging jets. Black curves represent the 200 m (shelfbreak) and 1500 m isobath. Vertical velocity units are m s^{-1}.

Methodology: Lagrangian Coherent Structures Theory

The surface ocean flow ehibits complex multi-scale dynamics. Despite this complexity, surface ocean motions are organized along distinguished material curves known as Lagrangian Coherent Structures (LCSs). These structures may represent the centerpieces of passive tracer filaments, they may delineate the axes of Lagrangian jets, or they may provide boundaries to material eddies. In this work, we apply LCS methods to extract the organizing structure of the Malvinas Current flow.

Acknoledgements: This study is a contribution to EUMETSAT/CNES OSTST SABIO and ONR Global under Grant No. 12275382.