Volume Transport from In-situ and Altimetry Data Over a Wide Continental Shelf

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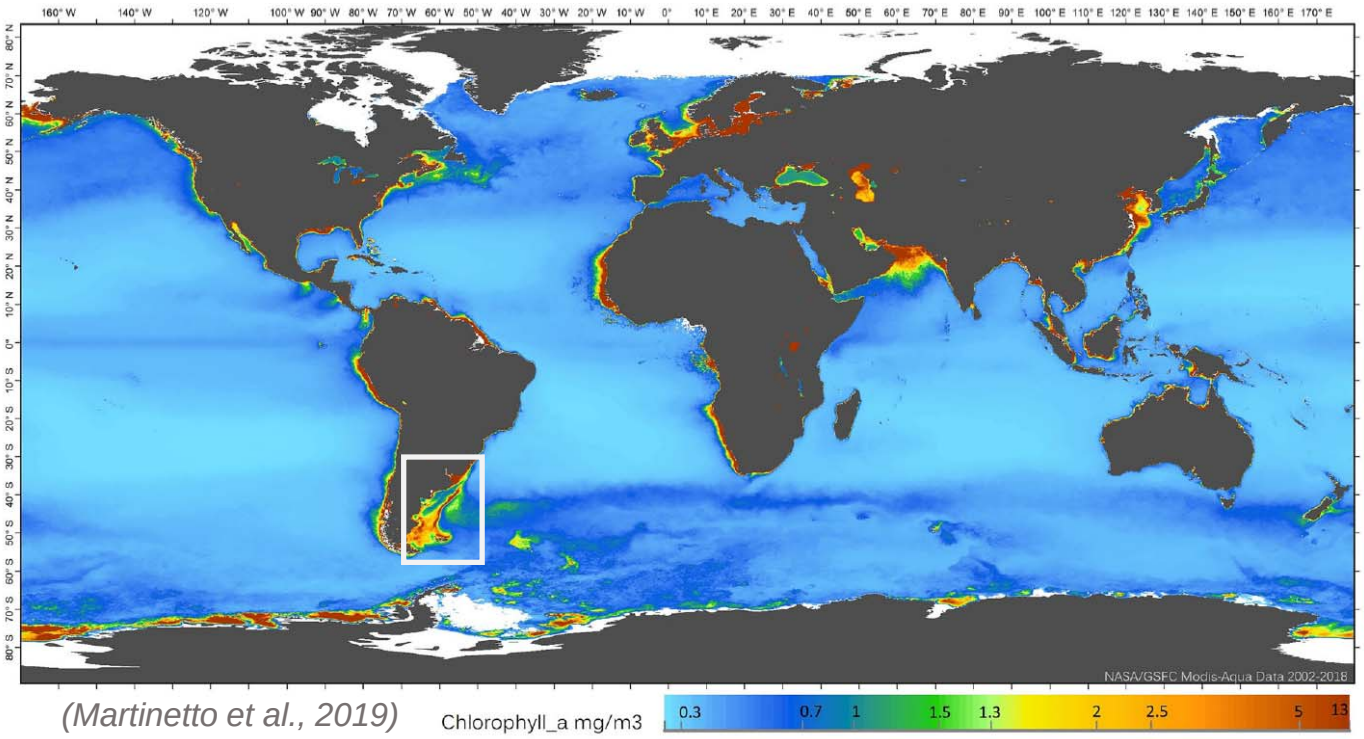
Argentine Continental Shelf: Ecological and Economic Importance

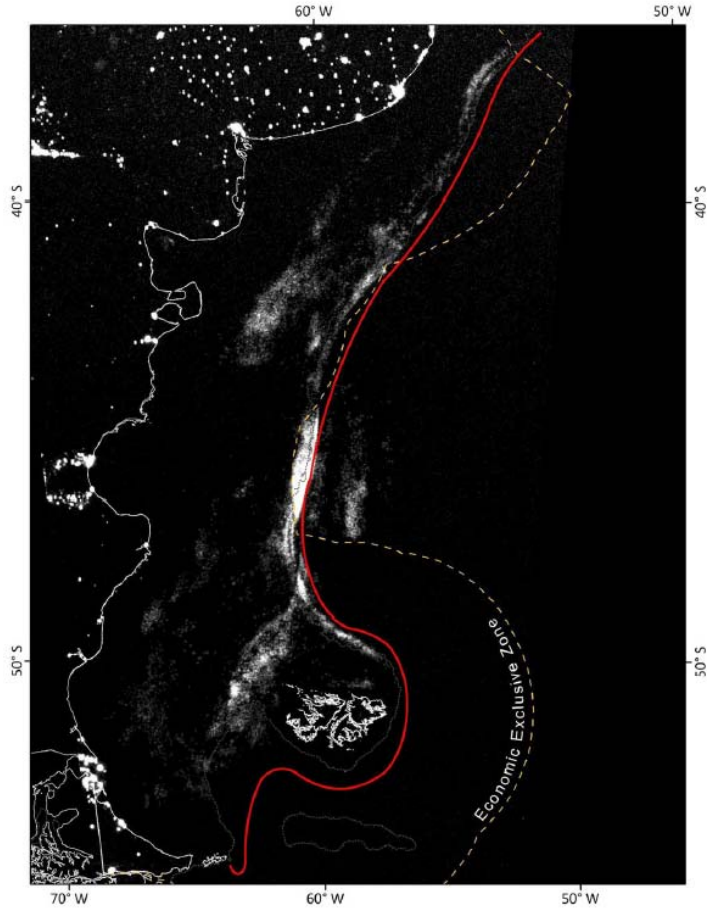


(Martinetto et al., 2019)

The Argentine Continental Shelf (ACS) is one of the most **productive ecosystems** of the world oceans

Argentine Continental Shelf: Ecological and Economic Importance

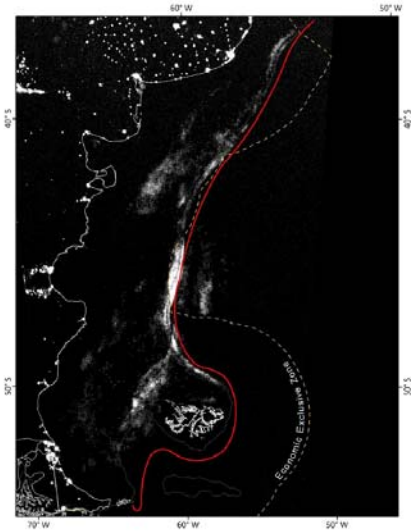
Light at night



Squid fishery

(Martinetto et al., 2019)

Argentine Continental Shelf: Ecological and Economic Importance



Squid (Martinetto et al., 2019)

Fishing resources of the ACS (INIDEP)

Not only squid: more tan 50 species!

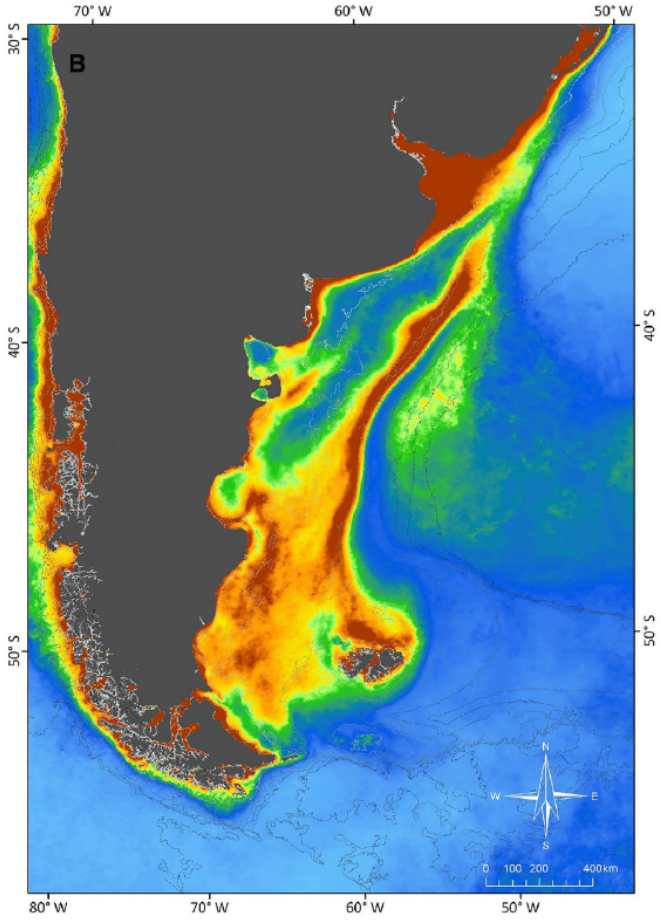
Hake

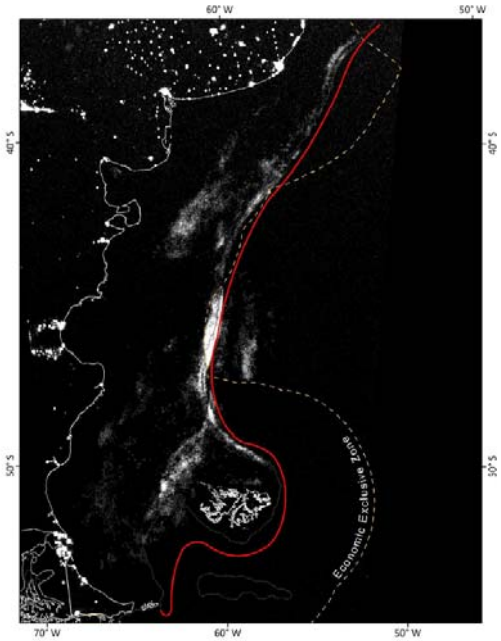
Argentine Continental Shelf: Ecological and Economic Importance

Fisheries are concentrated in frontal zones (Acha et al., 2005)

Physical processes influence primary production

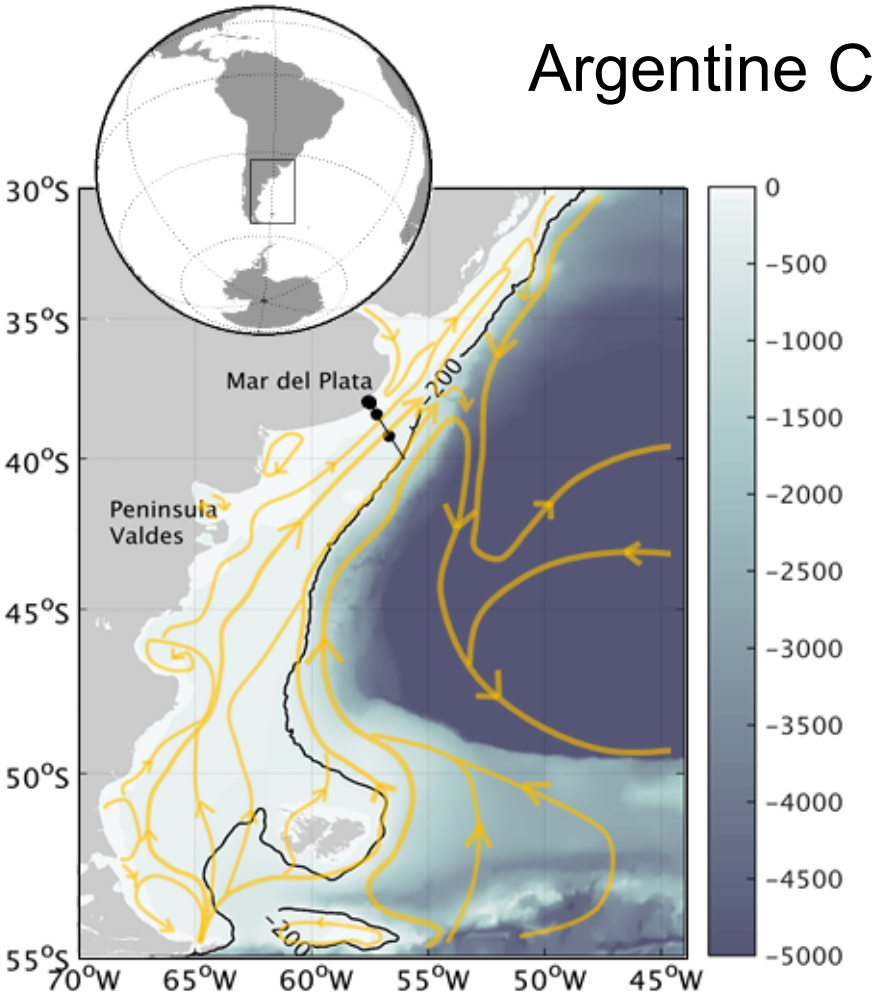
Understanding the regional circulation is essential for more sustainable fishing activities





(Martinetto et al., 2019)

Argentine Continental Shelf: A Challenge for Altimetry



General circulation in the Southwestern Atlantic (SWA) Ocean (Lago et al., 2019)

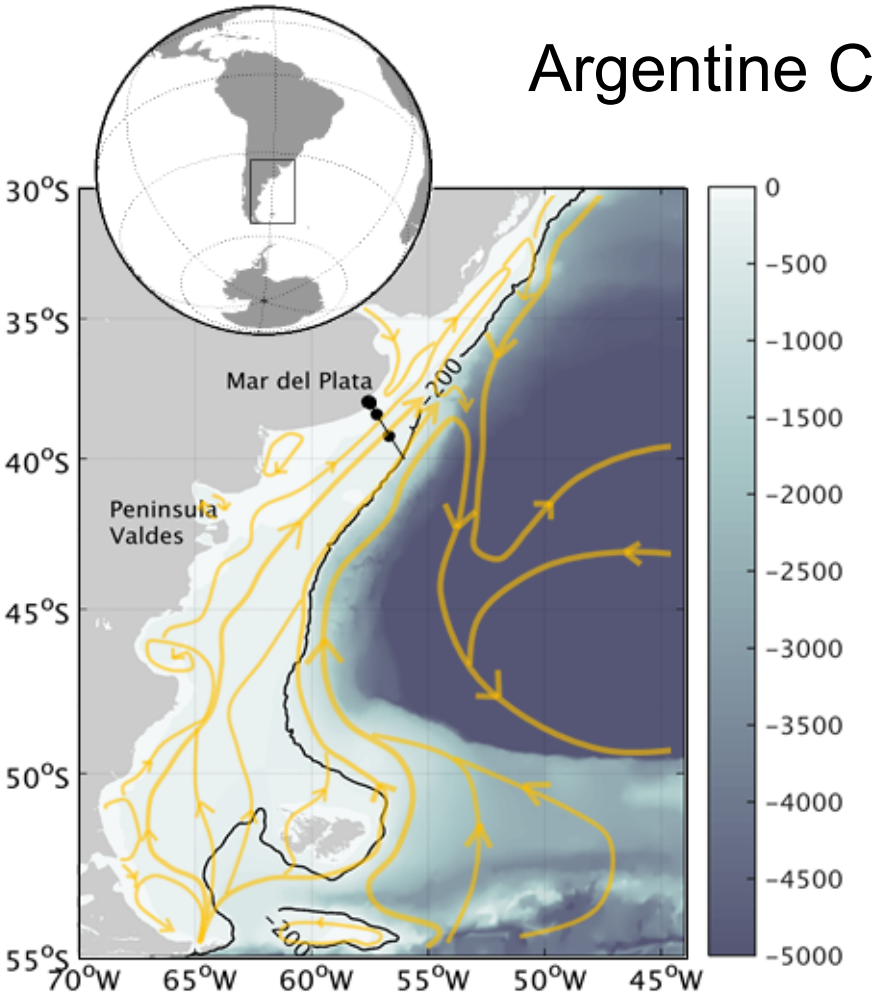
Area = 1 million m^2

Scarce in-situ data

Circulation

- From hydrographic observations
- From numerical models
- Mean flow to the NE
- Influenced by two western boundary currents (Brazil and Malvinas Currents)

Argentine Continental Shelf: A Challenge for Altimetry



General circulation in the Southwestern Atlantic (SWA) Ocean (Lago et al., 2019)

Area = 1 million m^2

Scarce in-situ data

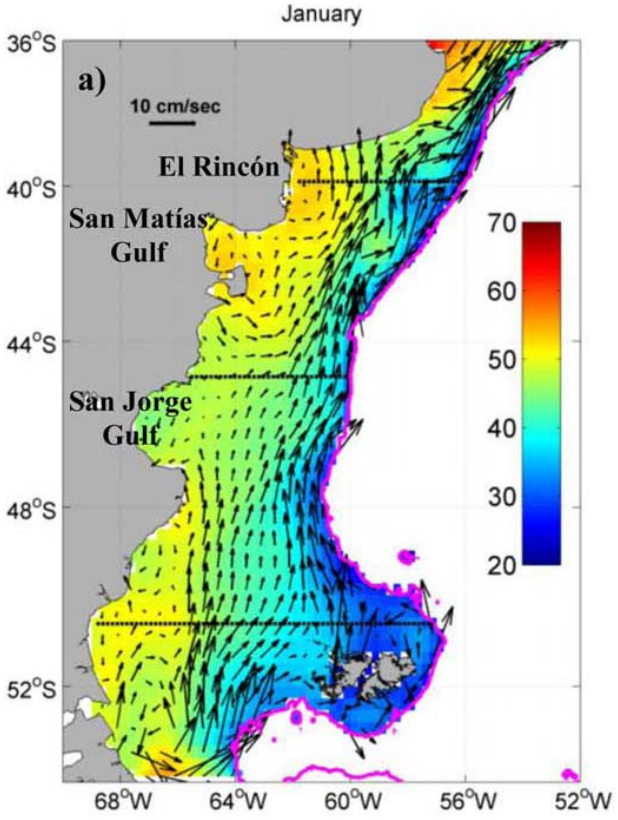
Circulation

- From hydrographic observations
- From numerical models
- Mea
- Inf

Complex circulation patterns

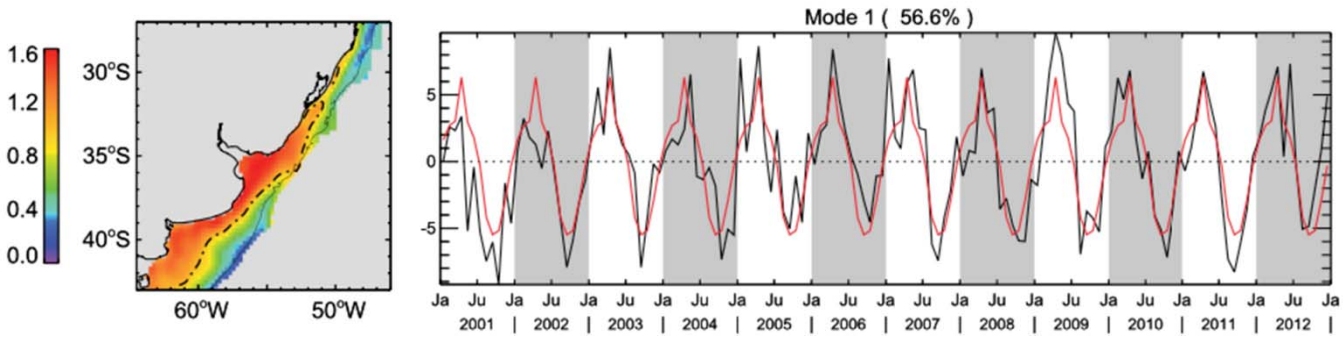
- strong winds
- Macrotidal regime in the southern region
- Complex bathymetry

Can We Use Satellite Altimetry in the Argentine Continental Shelf?



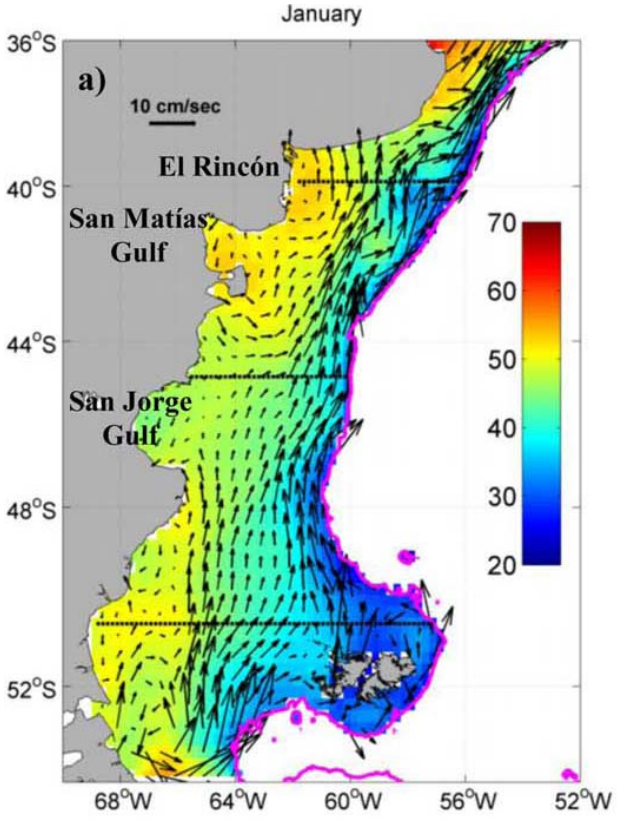
SLA + MDT and associated geostrophic velocities (Ruiz-Etcheverry et al., 2016)

- Successfully used to study the **seasonal** circulation patterns
- Consistent with numerical models and available in-situ data
- Marked seasonal cycle



SLA first EOF mode, associated time series (black) and seasonal cycle (red) (Strub et al., 2015)

Can We Use Satellite Altimetry in the Argentine Continental Shelf?



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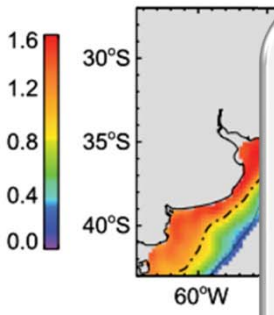
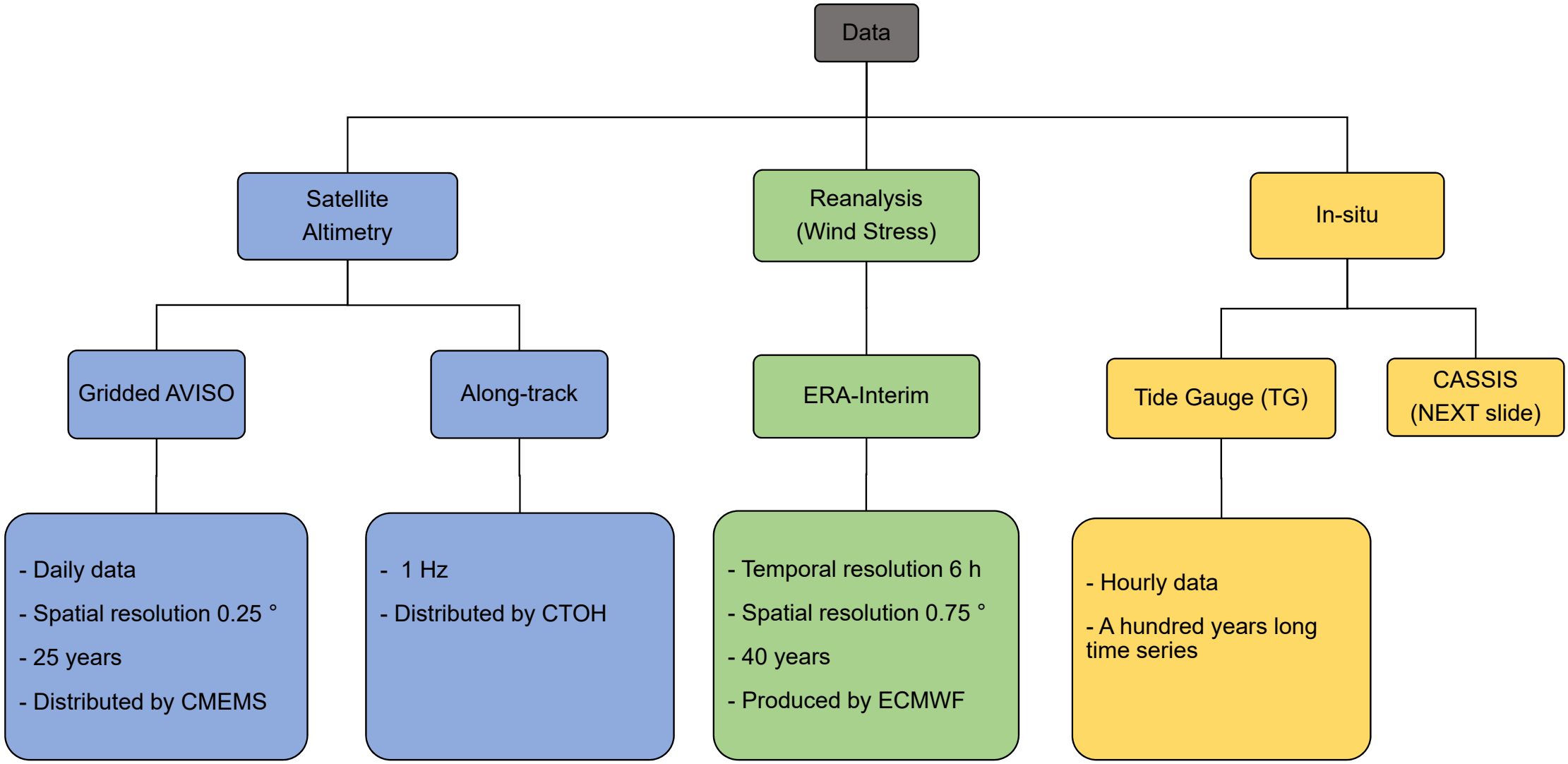


SLA first EOF mod

What about the sub-seasonal component?

11 months-long velocity observations in the ACS are used to evaluate sub-seasonal satellite products and to compute transport.

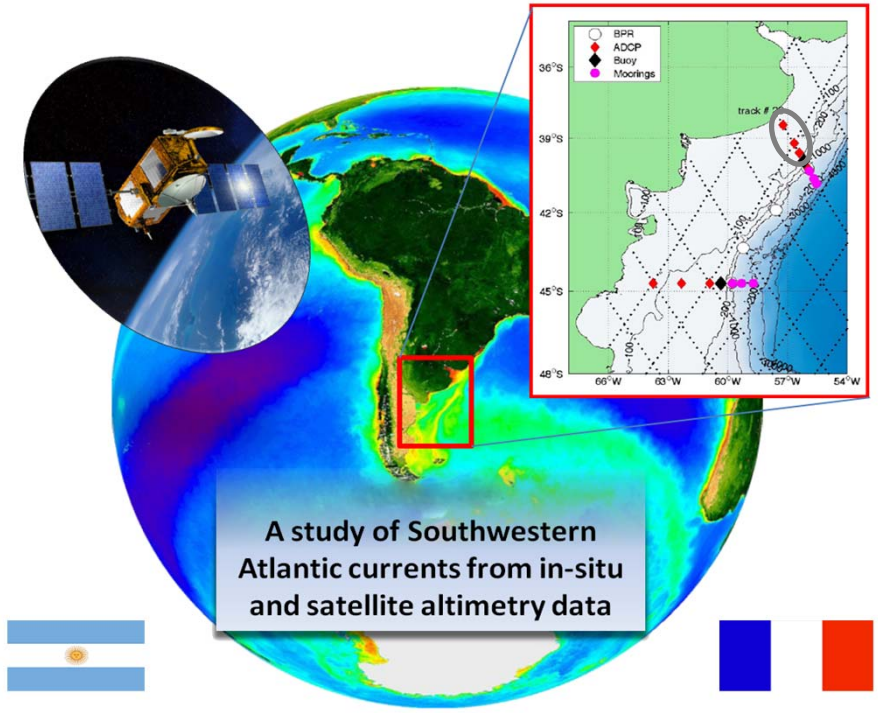

Data
Satellite Altimetry
Reanalysis (Wind Stress)
In-situ
Gridded AVISO
Along-track
ERA-Interim
Tide Gauge (TG)
CASSIS (NEXT slide)
- Daily data
- Spatial resolution 0.25 °
- 25 years
- Distributed by CMEMS
- 1 Hz
- Distributed by CTOH
- Temporal resolution 6 h
- Spatial resolution 0.75 °
- 40 years
- Produced by ECMWF
- Hourly data
- A hundred years long time series

In-Situ Measurements

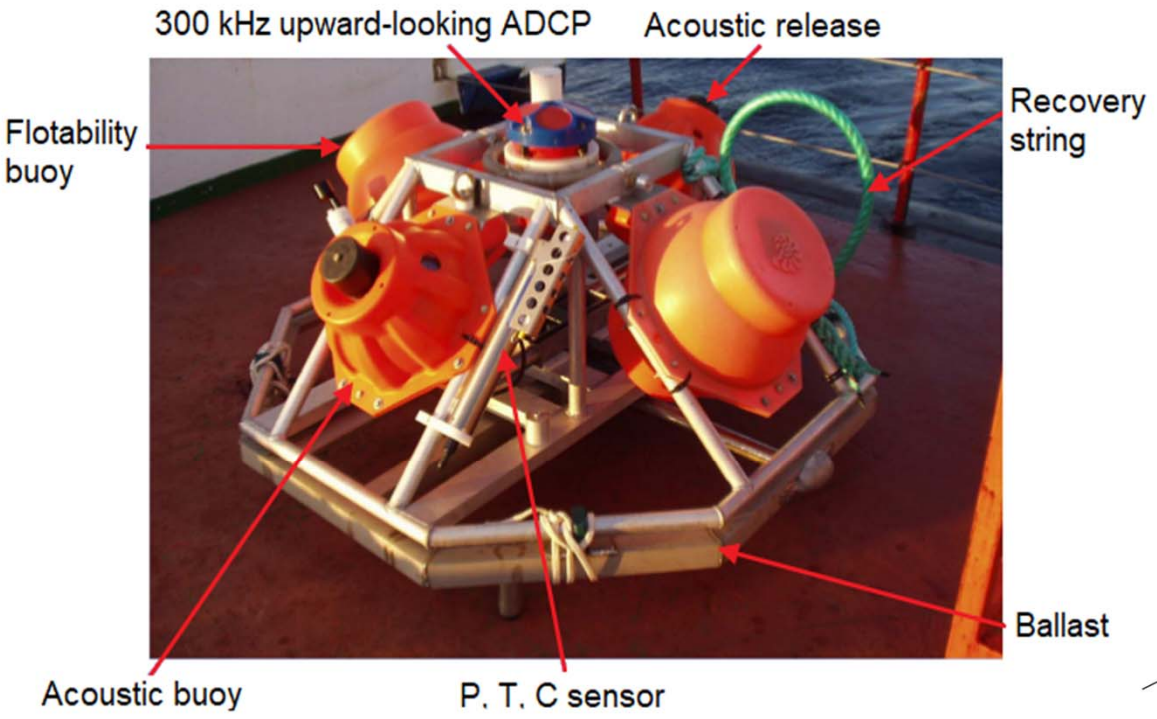
CASSIS Project
http://www.cima.fcen.uba.ar/malvinascurrent/es/

Unité Mixte Internationale - Instituto Franco-Argentino sobre Estudios de Clima y sus Impactos (UMI- IFAECI)

11 month-long time series
(Nov 2014 – Dec 2015)



In-Situ Measurements



Cage with mounted ADCP and T, C and P sensor.

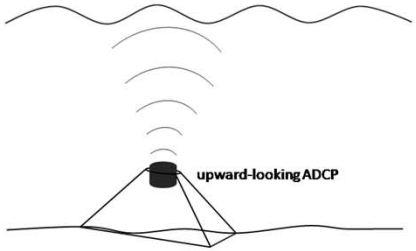
11 month-long time series
(Nov 2014 – Dec 2015)

Bottom

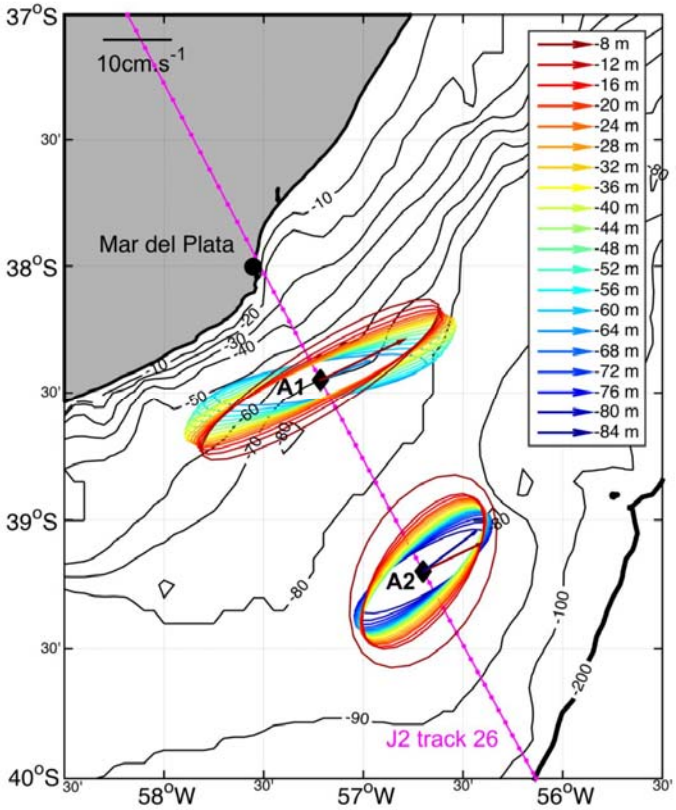
- P
- T
- S

Every 4 m in the vertical

- Zonal velocity
- Meridional velocity



In-Situ Measurements



Variance ellipses of in-situ currents at all depth levels. Mean velocity vector of the shallowest and deepest levels.

JGR Oceans

Research Article | Full Access |

On the wind contribution to the variability of ocean currents over wide continental shelves: a case study on the northern Argentine continental shelf

L.S. Lago, M. Saraceno, P. Martos, R.A. Guerrero, A.R. Piola, G.F. Paniagua, R. Ferrari, C.I. Artana, C. Provost

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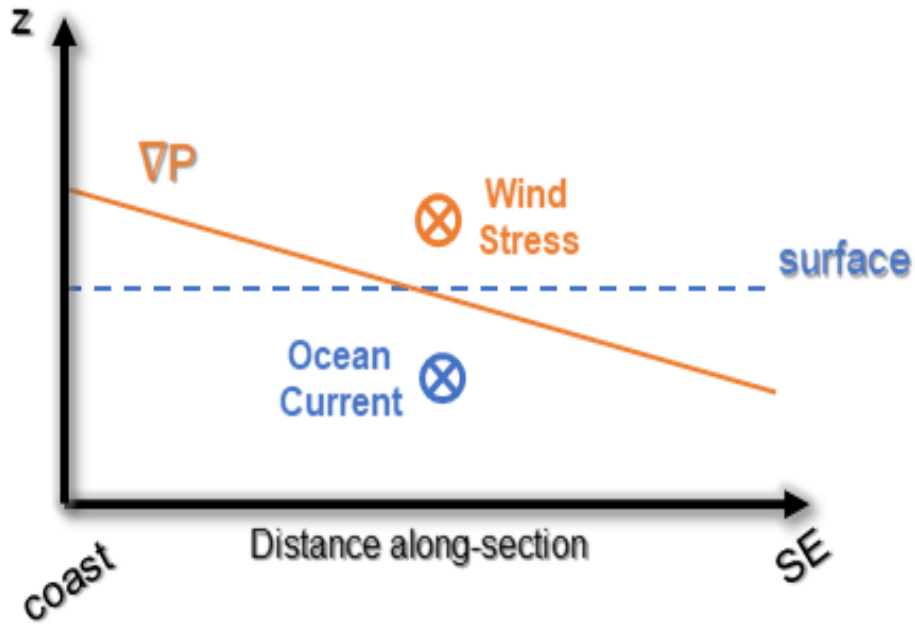
- Flow on average to the NE
- Maximum variability along-shore, aligned with local bathymetry
- **Mostly barotropic (**83% explained variance)
- High correlation between A1 and A2 (0.9)
  - **Uniform variability in this portion of the ACS**

In-Situ Measurements



High correlation between along-shore wind stress and along-shore currents (0.7)

MECHANISM

Wind stress to the NE → Generates a cross-shore pressure gradient → Water is piled-up near the shore → Ocean currents to the NE

(Lago *et al.*, 2019)

In-Situ Measurements

Along-shore circulation is

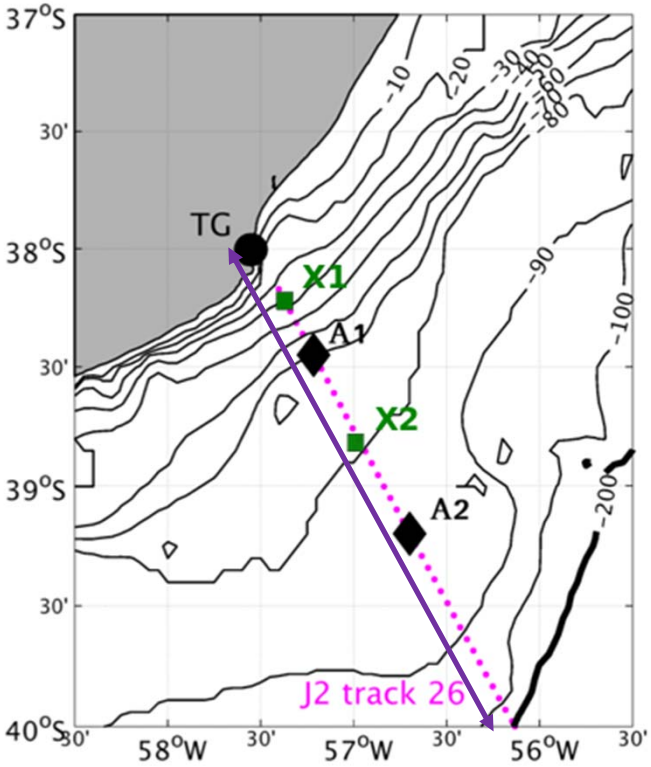
- mainly barotropic
- responds to geostrophy
- shows similar variability over the whole region of study

We can estimate the along-shore transport with direct measurements of currents despite having only 2 points

Transport Estimation

Three methods:

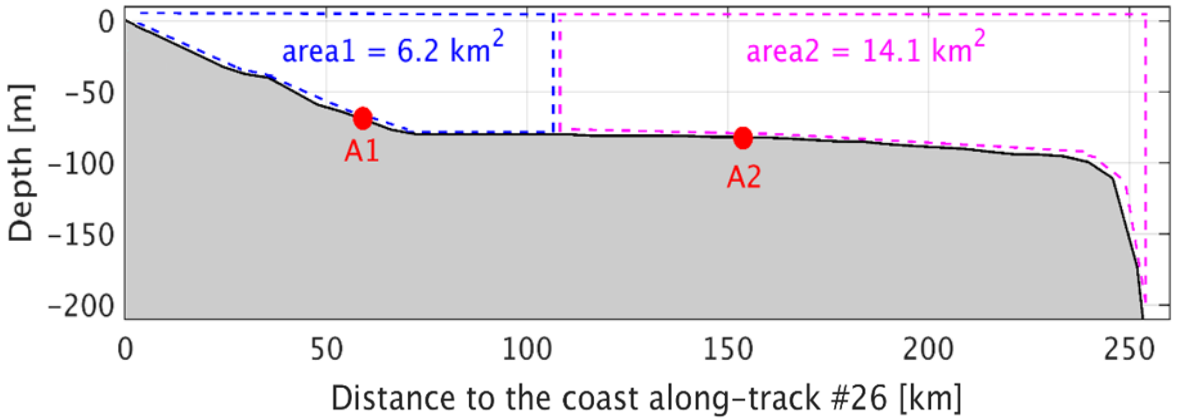
1. From direct observations of currents (direct method).
2. From pressure measurements (indirerct method).
3. From currents inferred from satellite altimetry data.

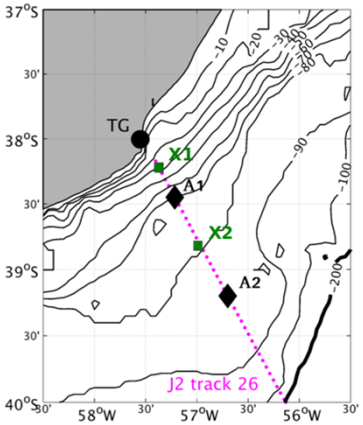


Location of instruments. Contours show local bathymetry.

Transport Estimation: In-Situ

1 From direct observations of currents (direct method)



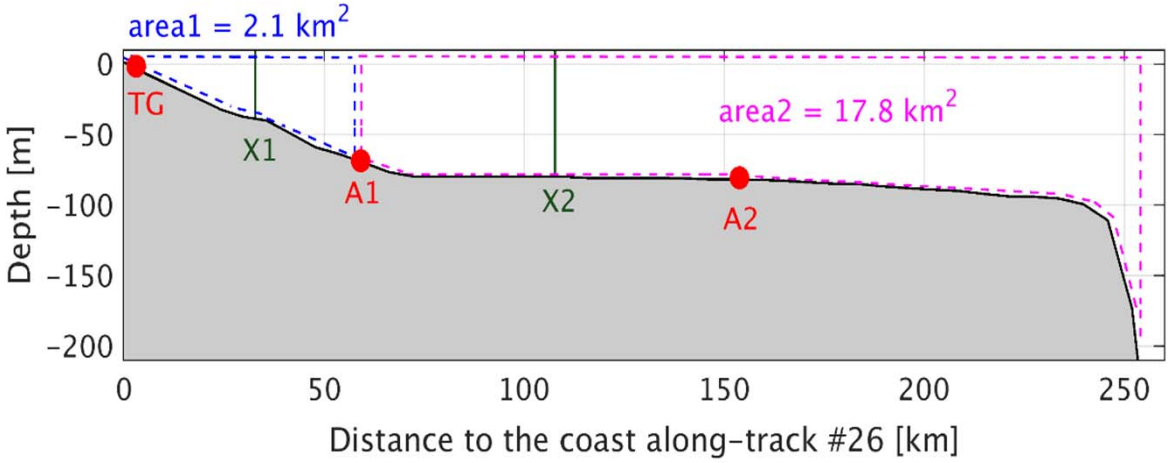


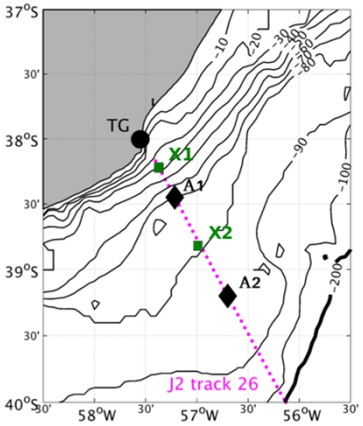
From Lago *et al.* (2019)

- Barotropic velocity from direct observations (explains 84% of the total variance) → barotropic transport
- The dominant response of the circulation to the wind is geostrophic → Transport without considering the Ekman layer

Transport Estimation: In-Situ

2 From pressure measurements (indirect method)

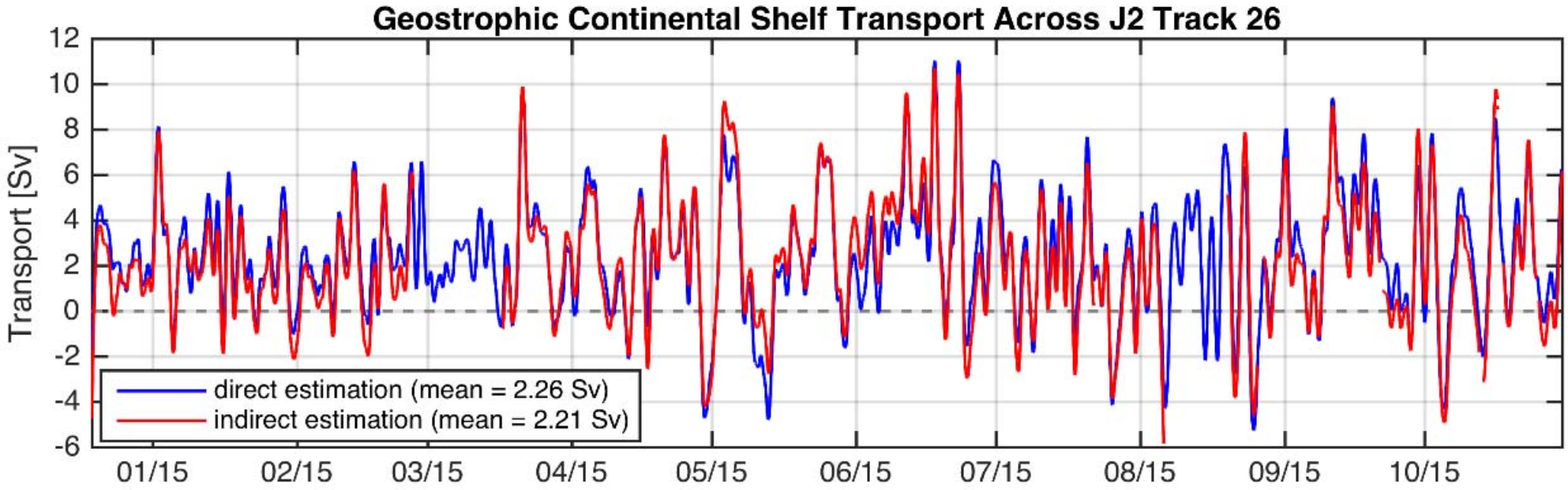




- Velocity inferred from P measurements (relative)
- Geostrophic component only

Transport Estimation: In-Situ

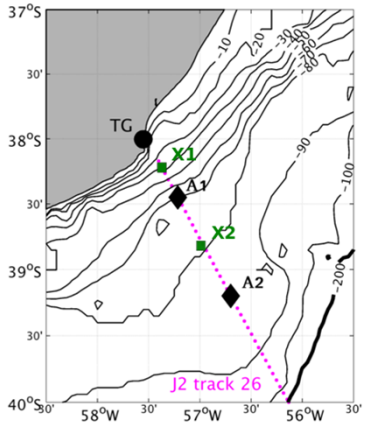
corr coeff = 0.95



Transport Estimation : Satellite

3 From currents inferred from satellite altimetry data

How does satellite velocities compare with in-situ data?
Gridded or along-track?



	X1	A1	X2	A2
AVISO GRIDDED	0.4	0.7	0.8	0.7
CTOH ALONG-TRACK	0.2	0.6	0.6	0.7

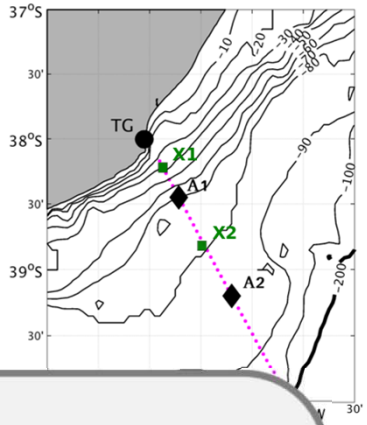
Correlation coefficient between along-shore in-situ velocities and satellite velocities

Highest correlation with gridded data

Transport Estimation : Satellite

3 From currents inferred from satellite altimetry data

How does satellite velocities compare with in-situ data?
Gridded or along-track?



	AVISO GRIDDED
	CTOH GEBCKO ALONG-TRA

Correlation coefficient between along-s

Highest correlation with gridded data

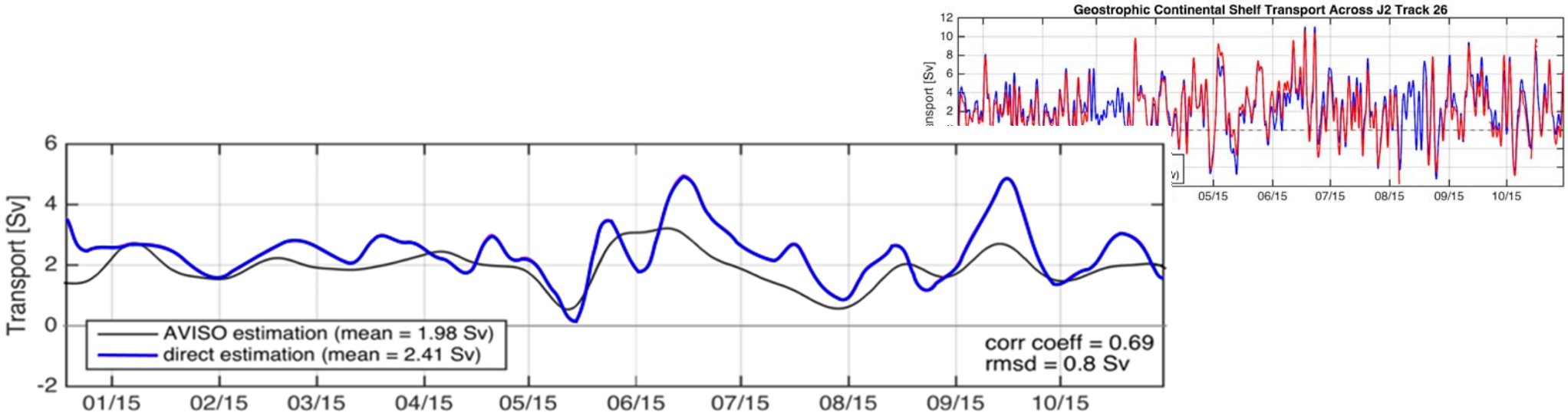
Why?

In this area, geostrophic velocities:

- High temporal variability
- low spatial variability

the gridded product combines multiple satellite data and thus provides time series with higher temporal resolution than along-track products

Transport Estimation : Satellite



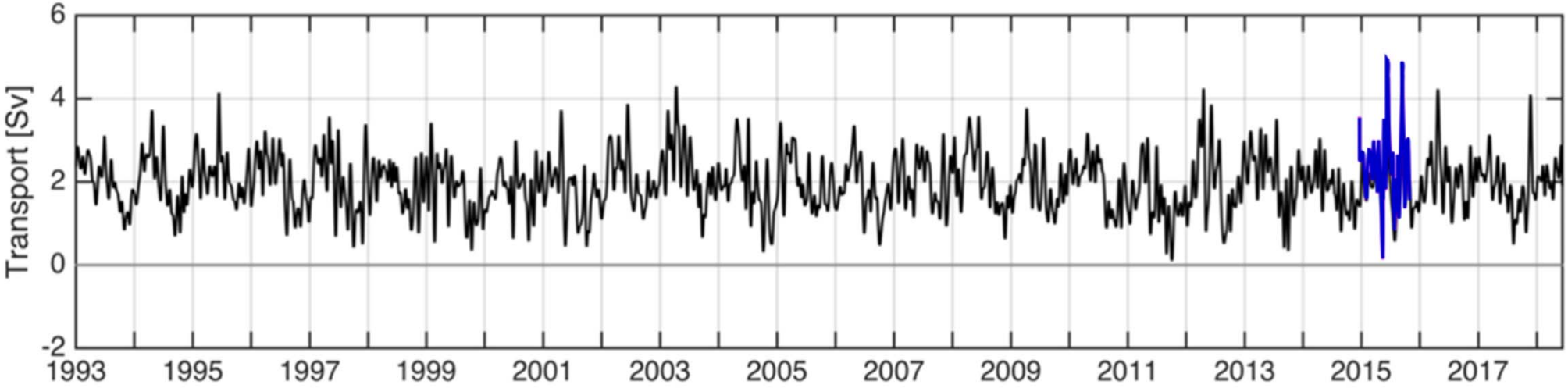
Along-shore direct transport estimation for the period with in-situ observations (magenta) and satellite transport (black)

Satellite transport represented in-situ transport successfully during the period of measurements.

→ We extended the satellite transport time-series since 1993 to present

Ongoing work: What happens during the periods of maximum difference between in-situ and satellite transport?

Transport Estimation : Satellite



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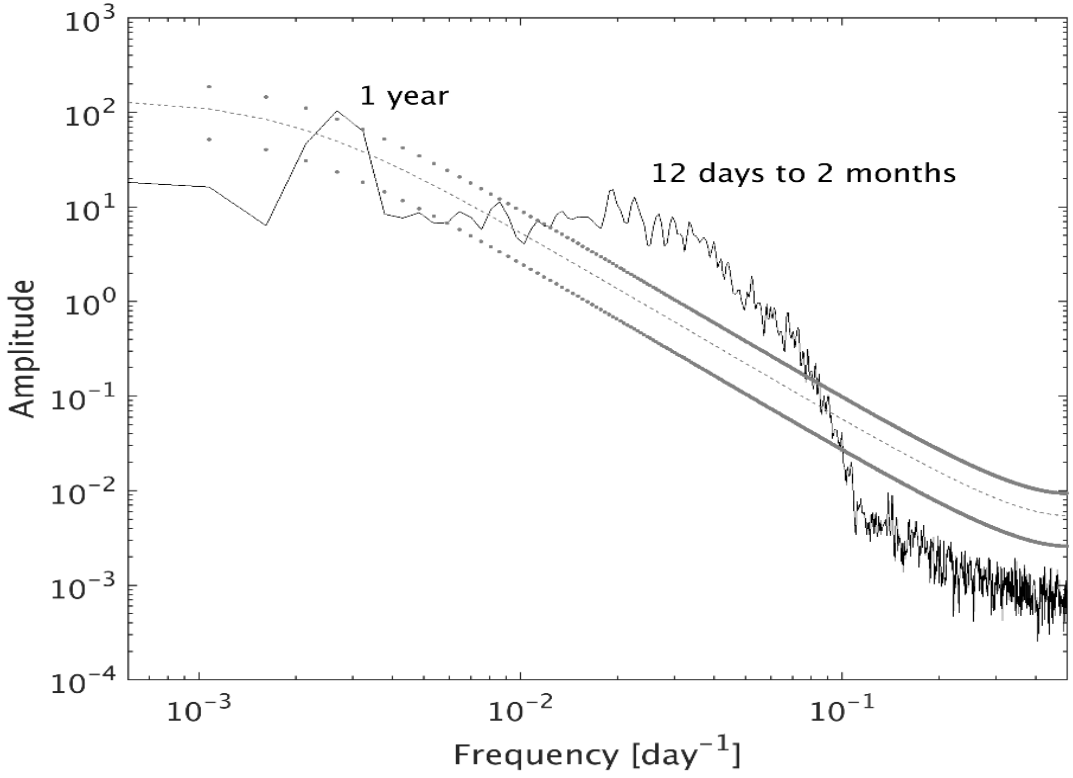
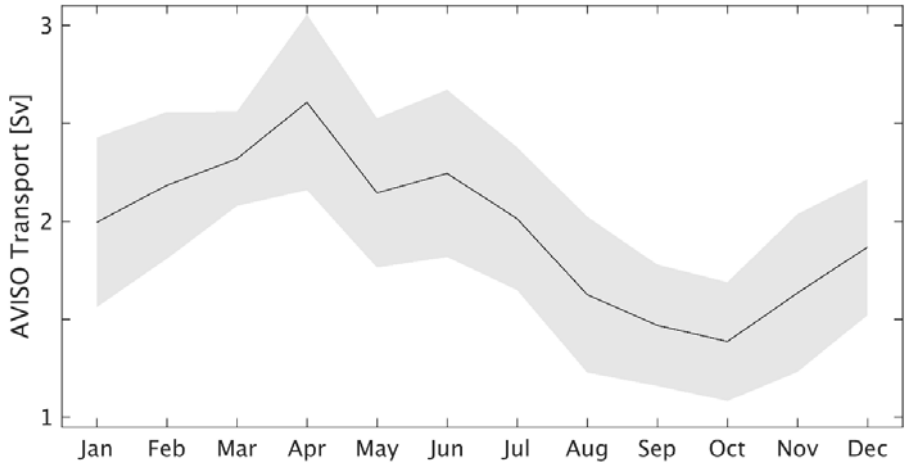


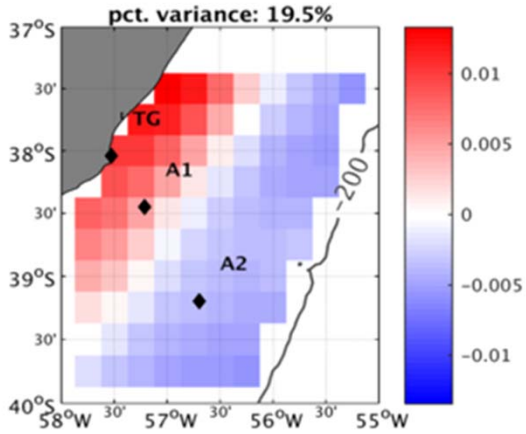
Spectral analysis of the 25-year long time series of satellite transport.

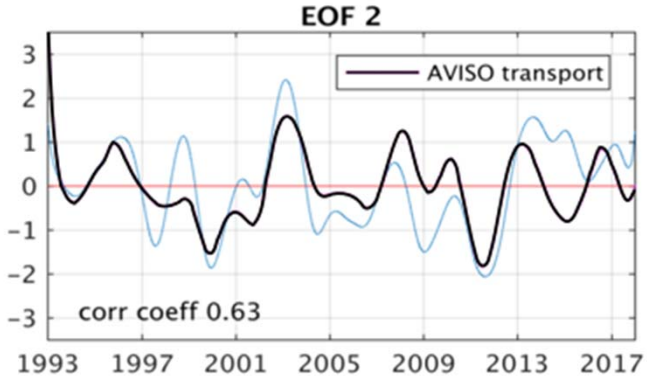
- strong annual cycle
- marked variability for the synoptic scale



Satellite transport climatology from 1993 through 2017.

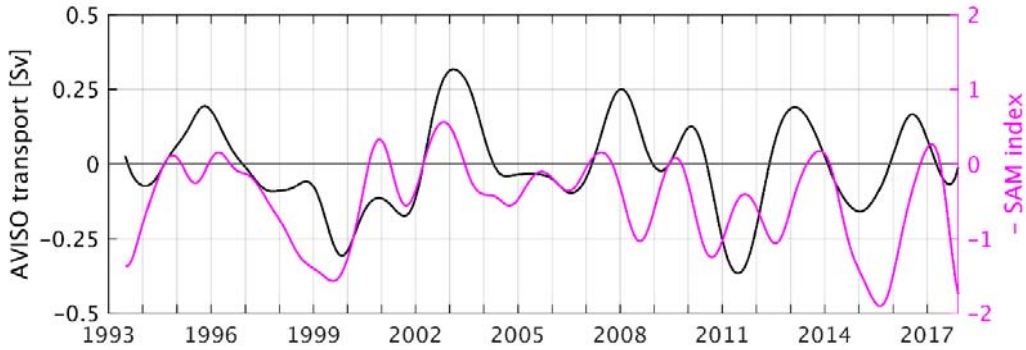
Transport Estimation : Satellite





2nd EOF modes of SLA [m] in the region of study, and associated time series (blue).

What About the Interannual Signal?



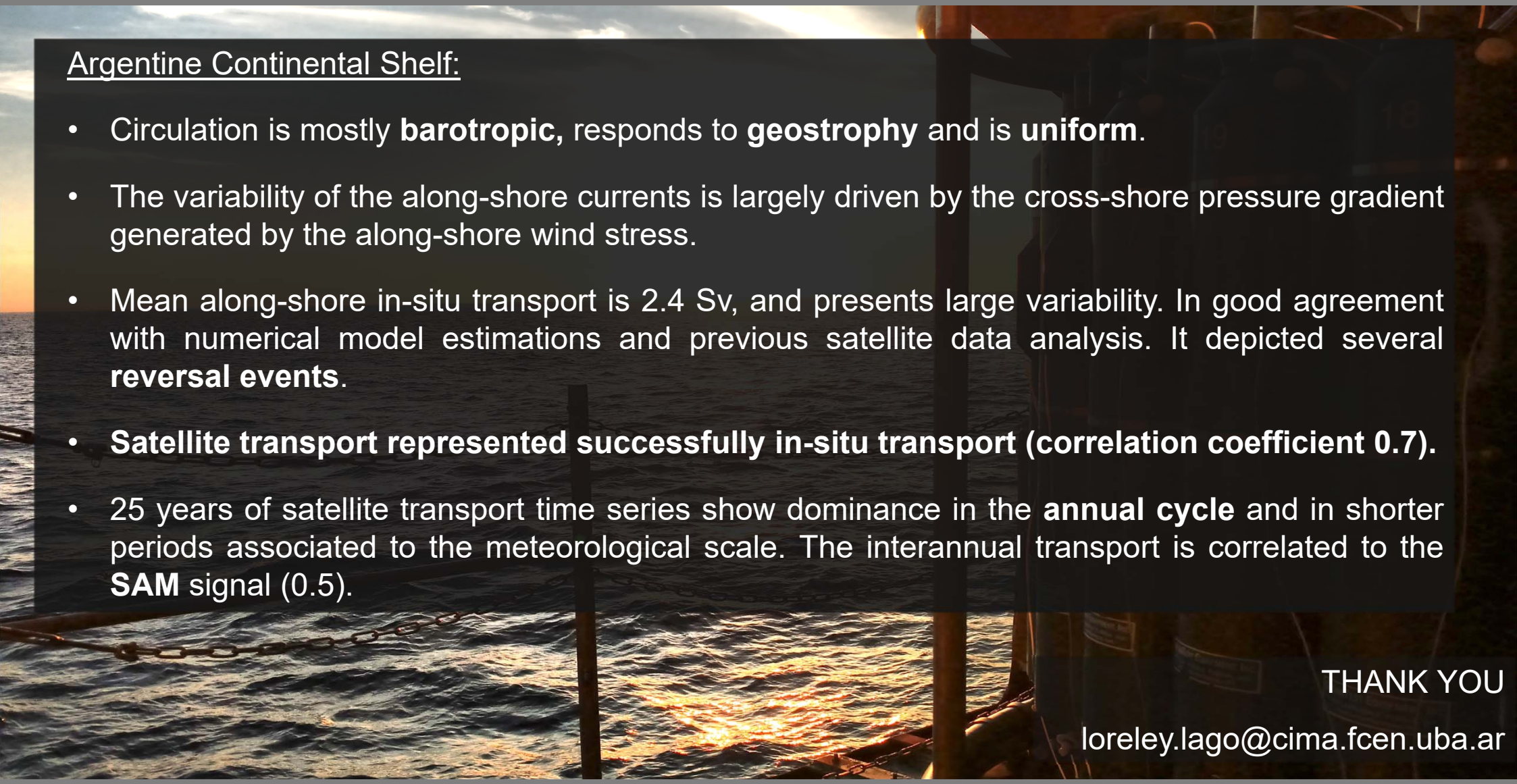
Interannual along-shore satellite transport (black) and interannual component of the inverted SAM index (magenta).

A positive SAM implies less intense westerly winds in the region of study.

→ Less intense transport towards the NE

Ongoing work: 1st EOF mode (62 %)

- Steric effect?
- Remote perturbations?



Argentine Continental Shelf:

- Circulation is mostly **barotropic,** responds to **geostrophy** and is **uniform**.
- The variability of the along-shore currents is largely driven by the cross-shore pressure gradient generated by the along-shore wind stress.
- Mean along-shore in-situ transport is 2.4 Sv, and presents large variability. In good agreement with numerical model estimations and previous satellite data analysis. It depicted several **reversal events**.
- **Satellite transport represented successfully in-situ transport (correlation coefficient 0.7).**
- 25 years of satellite transport time series show dominance in the **annual cycle** and in shorter periods associated to the meteorological scale. The interannual transport is correlated to the **SAM** signal (0.5).

THANK YOU

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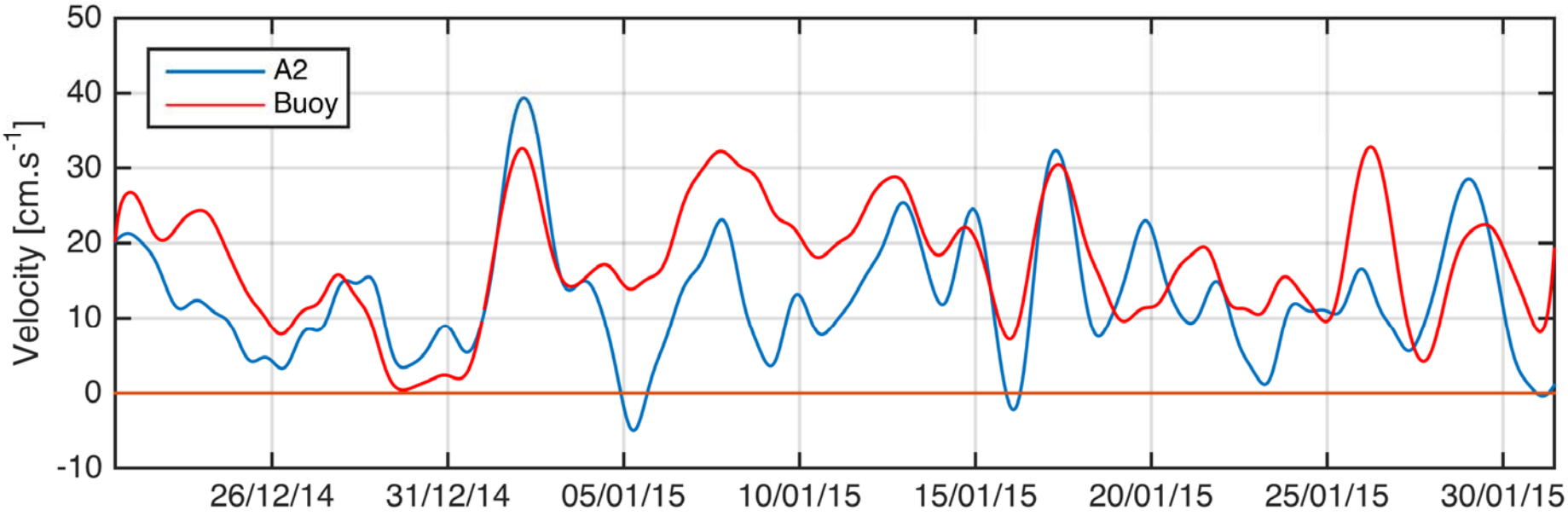
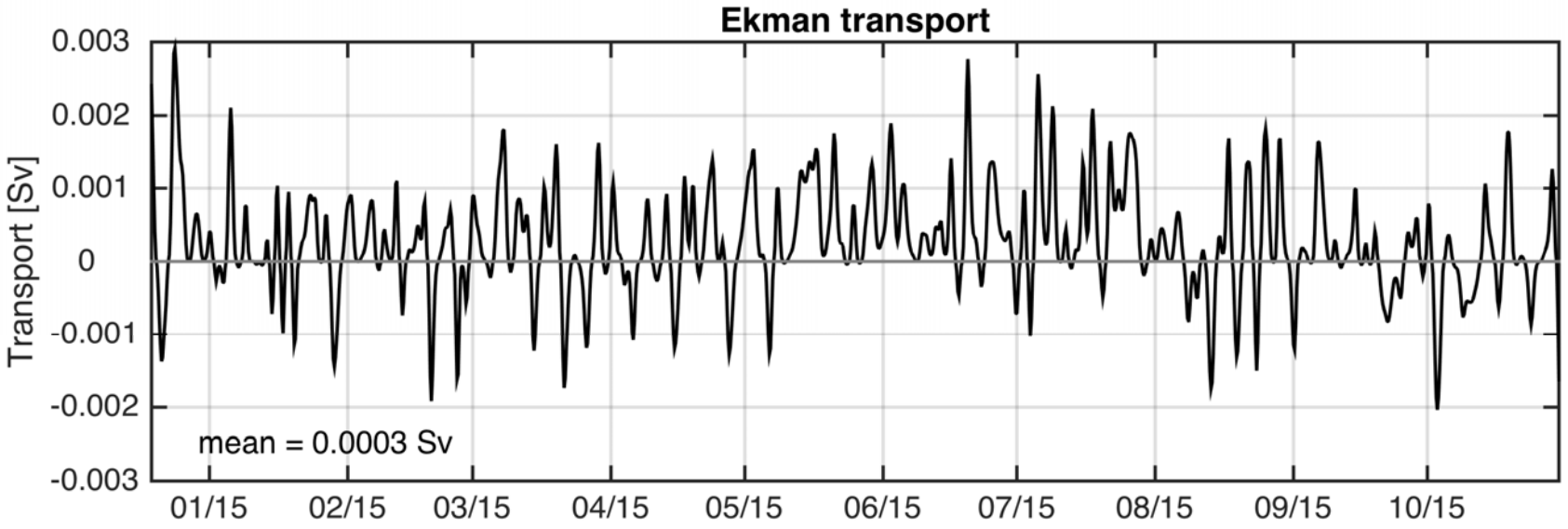
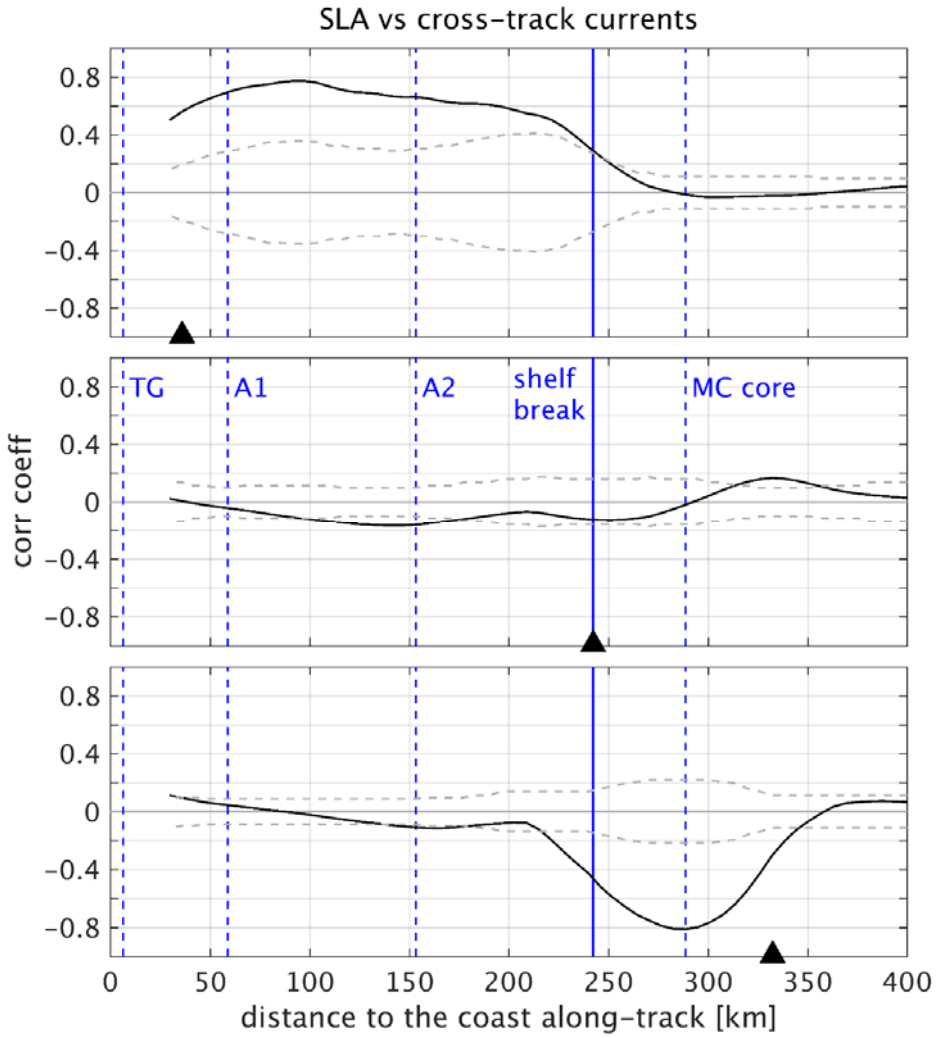

A2
Buoy
Velocity [cm.s-1]
50
40
30
20
10
0
-10
26/12/14
31/12/14
05/01/15
10/01/15
15/01/15
20/01/15
25/01/15
30/01/15


Ekman transport
Transport [Sv]
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
mean = 0.0003 Sv
01/15
02/15
03/15
04/15
05/15
06/15
07/15
08/15
09/15
10/15


SLA vs cross-track currents
corr coeff
0.8
0.4
0
−0.4
−0.8
TG
A1
A2
shelf
break
MC core
0
50
100
150
200
250
300
350
400
distance to the coast along-track [km]