# The Malvinas Current at the Confluence with the Brazil Current: inferences from 25 years of Mercator Ocean reanalysis

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#### The Brazil-Malvinas system



- Malvinas Current, MC: offshoot of the Antarctic Circumpolar Current – delimited by the Subantarctric Front SAF
- Brazil Current, BC: western boundary of the subtropical gyredelimited by the Subtropical front STF
- Large EKE in Brazil-Malvinas Confluence BMC (> 1000 cm<sup>2</sup>/s<sup>2</sup>)
- Lower EKE in the MC (< 100 cm<sup>2</sup>/s<sup>2</sup>)
- 25 years (1993-2017) of high-resolution global Mercator Océan reanalysis (GLORYS12) used to revisit the BMC region.

#### GLORYS12:

- NEMO OGCM at 1/12° spatial resolution
- Assimilation: along track DUACS SLA + MDT based on the CNES/CLS 2013, SST and in situ T, S data (Argo, XBT, etc)

### MC and BC vertical structure: mean





- MC at 41°S : velocity core of 40 cm/s
- BC at 36°S : shallower and weaker than MC
- Mean positive along-slope velocities at 37°S at 1000 m: MC Subsurface northward branch
- MC waters subduct below the BC

#### MC and BC vertical structure: std





• Contrasts in std:

highly variable/baroclinic BC - rather stable barotropic MC

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- Frontal region: largest stds
- Seasonal cycle accounts for 40% of the std

#### Synoptic situation : example





- Rich mesoscale field
- Fresh Rio de la Plata waters exported offshore
- MC branching at 40°S:
- outer branch: retroflects south
- inner branch: flows north and subducts below BC (W $\simeq$ -100 m/d)

#### MC subsurface northward branch







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- MC subsurface branch : V> 50 cm/s , T< 3°C and S< 34.1 psu</li>
  - Energy peaks at 50-100 days -> coastal trapped waves
- Low frequency modulation in T and S time series

### MC volume transport at 41°S



- Surface V (CNES-CLS18 MDT):
  - Larger than surface V(CNES-CLS13 MDT)
  - Consistent with surface V deduced from altimetry + in situ (Artana et al., 2018)
- Model transport time series in agreement with obs:
- Difference in mean: 1 Sv
- Difference in std: 0.7 Sv
- R = 0.75
- No significant trend
- Model reproduces observed interannual variations
- Similar salient peaks
- Model more energetic at 60 & 100d: trapped waves?

#### BC transport at 36°S





- BC transport mean = 23 Sv std = 11 Sv
- Model transport consistent with previous estimates (Garzoli et al. 2013, Schimd 2014, etc)

#### Seasonal variations in fronts location



- Fronts move N (S) in winter (summer)
- Small displacements

   SubTropical Front :150 km
   SubAntarctic Front : 50 km
- Marked seasonality in BC transport (7 Sv/ 23 Sv)
- Small seasonality in MC transport (3 Sv/ 37Sv)
- Wind  $\tau_x=0$  : large seasonal migrations (1500 km)
- STF and BC transport covaries with  $\tau_x=0$  (2 m lag)

## Interannual variations in fronts location



- Large interannual front displacements (300 km):
  - -1990s: fronts to the north -2000-10: fronts to the south -2010-17: large interannual variations (e.g. 16,17)

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•  $\tau_x = 0$ : large interannual migrations 2000-2017

#### 25-Year trends at the BMC





- BC trends over 25 years:
  - more intense (12.5 cm/s)
  - warmer (2.5°C)
  - saltier (0.375 psu)
  - denser in first 200 m and lighter below
- MC trends are small
- Southwards displacement of the fronts:
  - SAF: 50 km
  - STF: 150 km

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# Altimetry data assimilation contribution



SSH forecast RMS error reduction (in red) in cm<sup>2</sup>: From 1 to 2 altimeter assimilated (1-year run)



SSH forecast RMS error reduction (in red) in cm with a more recent CNES/CLS based MDT versions • A 4-altimeter constellation allows reducing the SSH forecast error of about 30% globally and more than 80% in WBC areas in the global 1/4° Mercator Ocean system.

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 SSH forecast error and 0-2000m T and S bias compared with in situ observations are reduced with more recent CNES/CLS MDT version.

See poster APOP006: "Impact of altimetry observations on the Mercator Ocean real time monitoring and forecasting systems"

M. Hamon, work supported by CNES

#### Conclusions

• MC branches at the Confluence: - outer part veers offshore and back to the south,

- inner part subducts and flows north along the slope.

- MC model transport (mean: 37 Sv and std: 6 Sv) in agreement with transport derived from satellite and in situ data
- BC model transport (mean: 23 Sv and std: 11 Sv) consistent with previous estimates
- The migrations of the SAF and STF are large at the interannual time scales (300 km) and at the seasonal time scale (150 km)
- Over 25 years southward migration of 50 km for the SAF and 150 km for the STF

The global 1/12° reanalysis outputs (1993-2018) can be downloaded from the Copernicus Marine Service webportal: <u>http://marine.copernicus.eu/services-portfolio/access-to-</u> <u>products/?option=com\_csw&view=details&product\_id=GLOBAL\_REANALYSIS\_PHY\_001\_030</u>