Southern elephant seal (*Mirounga Leonina*) diving and foraging behavior in the Patagonian slope

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The Patagonian slope is a very complex region, where subantartic waters and bathymetry give raise to a unique area of ecological processes and one of the greatest fisheries in the world. As part of a French-Argentine collaboration realized in 2018, nine adult female southern elephant seals (*Mirounga leonina*) were tracked along the Argentinian Patagonian shelf and outer ocean. The Southern elephant seals (SES) are known to dive during their foraging trip from the surface down to 1000 m depth, going up and down every 20 minutes approximately, thus being an excellent vehicle for ocean data acquisition by tagging the animals with positional GPS and different water properties sensors. For this work, almost 5,000 profiles of temperature, conductivity, pressure, light and prey encounters collected by one female SES in the Patagonian slope during November and December 2018, along with satellite altimetry, color data and Mercator system outputs, were used to investigate the ocean dynamics and its linkage to the seal diving and foraging behavior (Fig. 1).

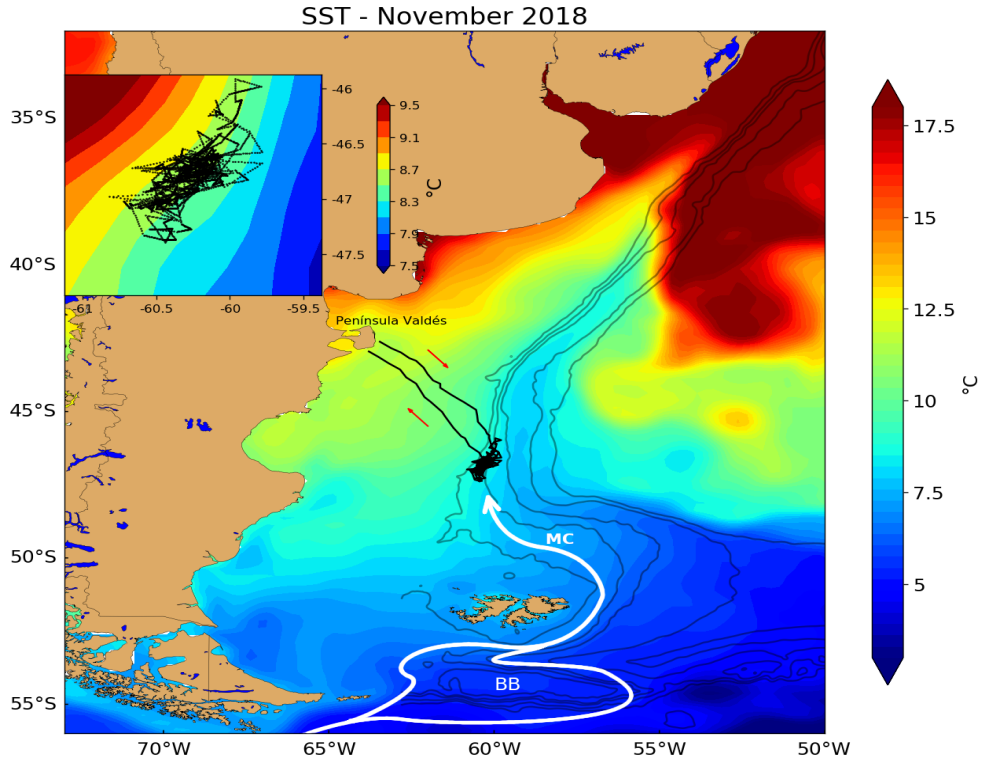

Figure 1. November 2018 monthly mean sea surface temperature (°C) and elephant seal trajectory during the 73 days (of which 63 correspond to the Patagonian slope) post breeding trip (black line). Red arrows indicate direction of trajectory. The 200, 600, 1000, 2000 and 3000 m isobaths are indicated in shading gray. The top left sub-panel shows a zoom of the seal trajectory in the slope area where the seal spent most of the days. Note that the scale of the contours is different. White arrow indicate the Malvinas Current (MC) and the subantartic water around the Burdwood Bank (BB).

Measurements obtained by the seal show a decrease in temperature of 0.2°C (Fig. 2) and a salinity increase (0.04 psu) below the mixed layer during December.

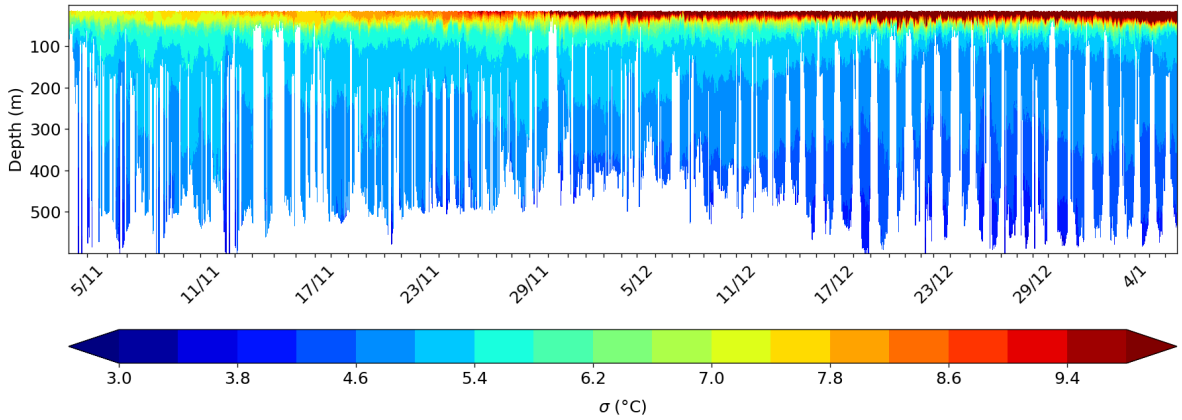

Figure 2. Potential temperature (°C) measured by the seal in the Patagonian slope during November and December 2018.

Light data revealed a significant increase of luminosity in December, almost reaching the ocean bottom, associated with a decrease of chlorophyll-a (chl-a) in the upper levels (Fig. 3). Analysis of ocean currents using altimeter mean dynamic topography data and velocity outputs from Mercator revealed that the decrease in temperature below the mixed layer in December was due to the arrival of deep and colder water from the eastward boundary of the Malvinas Current.

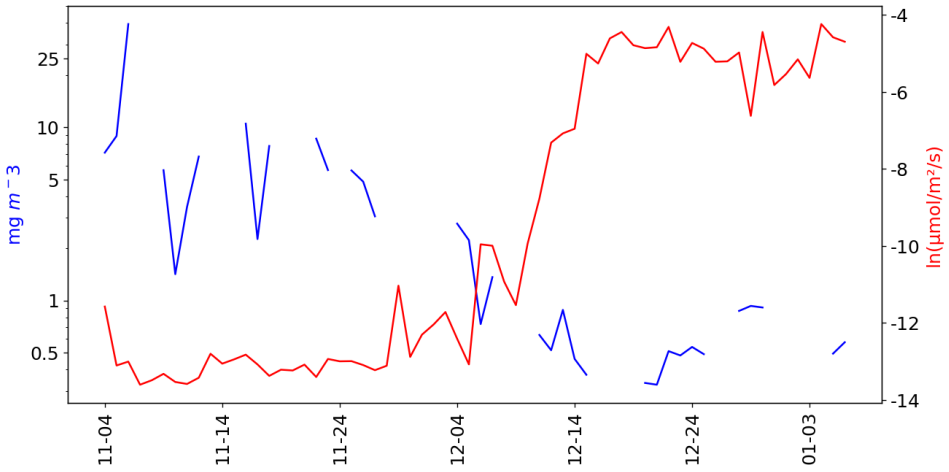

Figure 3. Daily mean chl-a (mg m^{-3}) in SES area (blue line) and light (ln(µmol/m^2/s)) at 200 m recorded by the SES (red line). Chl-a data correspond to MODIS-Aqua ocean color satellite. Missing satellite data was due to cloud cover.

Moreover, a 3-D Lagrangian particle tracking model (ARIANE) run backwards in time shows that the water from the SES area came either from the western and eastern passage of the Burdwood Bank, as first reported by Piola & Gordon, 1988. A daily analysis of particles trajectory suggest that the arrival of colder water can be associated with an increase of subantartic water transport from the eastern passage of the Burdwood Bank during December compared to November, in agreement with a recent work by Matano & Combes, 2019.

Measurements of dive maximum depth and prey capture attempts show that the change in water temperature and luminosity had a great impact on SES foraging and diving behavior (Fig. 4).

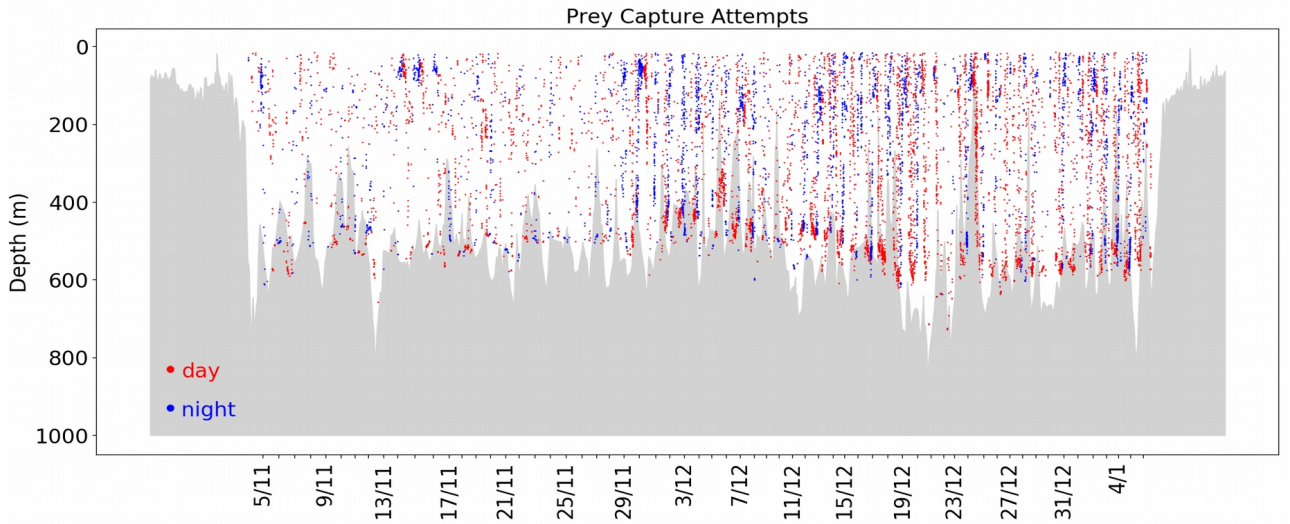

Figure 4. Depth location of prey capture attempts with different colors for day (red) and night (blue). The shading gray is the bottom topography along the elephant seal diving trip.

In December, the prey capture attempts increased more than double with respect to November with the SES diving preferentially at surface during the night and in the bottom layers during the day. This diving behavior in December is reflected in the prey capture attempts percentages in response to light, with 57% of them during daylight hours occurring in the bottom layers and 60% at night near the surface.

We suggest here that the combination of the arrival of a colder and saltier water mass and the decrease in surface chlorophyll-a concentration are the dominant key factors that controlled the foraging and diving behavior of one SES in the Patagonian slope during austral late spring 2018.

In order to sustain seal observations in the Southwestern Atlantic an OSTST project for the period 2021-2024 has been submitted. The main objective of this project, named *Studying physical processes in the Southwestern Atlantic to understand BIOlogical productivity* & regional ecosystems (SABIO), is to improve our understanding of the physical processes in the Southwestern Atlantic that impact the biological productivity and the regional ecosystems through the use of satellite altimetry, in-situ and model output data. In the last 25 years, more than 80 SES were tracked in the Patagonian shelf an outer ocean as part of this program (Figure 5).

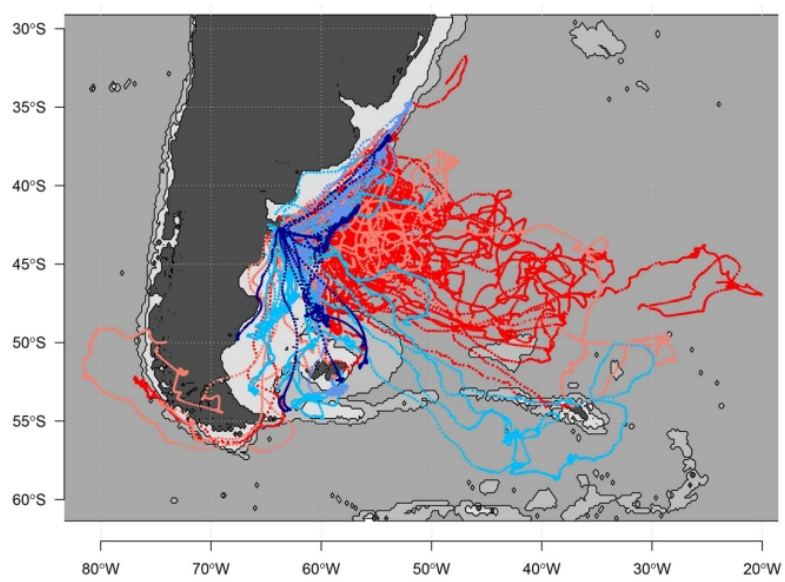

Figure 5 . Map of tracks for 85 elephant seals from Valdes Peninsula tracked between 1994 and 2019 and color-coded by age/sex groups. Red: adult females (both PM and PB); Pink: juvenile females. From dark to light blue: adult, subadult and juvenile males respectively (from Campagna et al. 2020).

References

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