Data Article

Hydro-thermodynamic dataset of the Amazon River Plume and North Brazil Current retroflection

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A B S T R A C T

This dataset was generated by the ROMS model, the output files constitute a monthly and weekly mean hydro-thermodynamics climatology of the region of Amazon and Para river mouths and the North Brazil Current retroflection (60.5°-24°W and 5°S-16°N, with 0.25° of horizontal resolution). This dataset includes the tri-dimensional grids of temperature, salinity and ocean currents at 32 depth levels, as well as the sea surface height. Sea surface temperature and sea surface salinity were validated using the SODA dataset, surface currents were validated with SCUD dataset and the vertical structure of temperature and salinity were compared with values recorded at 38°W,8°N and 38°W,12°N PIRATA buoys. The dataset is hosted on the website https://www.seanoe.org/data/00718/82958/. This dataset will help oceanographers and other researchers have information about the hydro-thermodynamics of this region.

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Specifications Table

Subject	Earth and Planetary Sciences
Specific subject area	Oceanography
Type of data	2D, 3D and 4D grids.
How the data were acquired	The data were obtained by simulation of hydro-thermodynamics using the ROMS model.
Data format	Files in NetCDF format generated by the ROMS model (Raw).
Description of data collection	The parameters were obtained through hydro-thermodynamic simulation with the ROMS model with output of monthly and weekly means and geospatially distributed in 2D, 3D and 4D grids.
Data source location	• Country: Brazil • Latitude and longitude (and GPS coordinates, if possible) for collected samples/data: Limited region by (60.5°W – 24°E)/ (5°S – 16°N).
Data accessibility	Repository name: SEANOE Data identification number: https://doi.org/10.17882/82958 Direct URL to data: https://www.seanoe.org/data/00718/82958/ ROMS AGRIF model source code (version developed by Institute of Research for Development, France), available at: https://www.croco-ocean.org/download/roms_agrif-project/ ROMSTOOLS V3.1.1 (Matlab toolboxes), available at: https://www.croco-ocean.org/download/utilities/
Related research article	H.L. Varona, D. Veleda, M. Silva, M. Cintra, M. Araujo, Amazon River plume influence on Western Tropical Atlantic dynamic variability, Dynamics of Atmospheres and Oceans, Volume 85, Pages 1-15, 2019, doi:10.1016/j.dynatmoce.2018.10.002, [1].

Value of the Data

- This dataset collection can be useful for any researcher studying the hydro-thermodynamics of oceanographic parameters at the mouths of the Amazon and Pará rivers, as well as in the NBC retroflexion region.
- This database is made up by 2 files in NetCDF format. There are many tools for viewing and processing NetCDF files so the data is extremely easy to use and does not require any prior processing.

1. Data Description

The Amazon River Plume Hydro-thermodynamic Dataset (ArpHD) is composed of 2 files (both with the same structure and variable names), one is a monthly mean climatology and the other is a weekly mean climatology. Both files are in NetCDF format, this is a standard, self-describing data format and was designed to store scientific data represented by n-dimensional mathematical structures. There are many free and proprietary software tools to handle this format, which facilitates the handling of this dataset. Both NetCDF files are products of an output from the ROMS AGRIF model [2] and they were the dataset used for the articles published [1] and [3].

All 2D grids have a horizontal dimension of 185 × 161 nodes (Table 1) with a horizontal resolution of 0.25°, these define two horizontal coordinate systems, one for the field of marine currents defined by lon_u, lat_u, lon_v and lat_v, (Table 2) and another for the rest of variables defined by lon_rho and lat_rho (Table 2), in addition, between the 2D grids these are also the bathymetry grid (h) and the mask grid (mask_rho), the latter is used to differentiate what is the land (represented by a 0) and what is the ocean (represented by a 1), from this way the coastal limits are defined.

Table 1

List of dimensions.

Dimensions	Description	Quantity
xi_rho	Longitude dimension for scalar variables	185
eta_rho	Latitude dimension for scalar variables	161
s_rho	Vertical levels for all variables	32
time	Time values, monthly climatology (1 year plus 1 month)	13
xi_u	Longitude dimension for vector variable	184
eta_v	Latitude dimension for vector variable	160

Table 2

Coordinate system variables of the ROMS AGRIF model [2]. * Grid nodes: mask, bathymetry, temperature, salinity and sea surface height. ** Grid nodes of ocean currents.

Variables	Description	Dependency	Unit
lon_rho	Horizontal nodes longitude*	eta_rho, xi_rho	Degree east
lat_rho	Horizontal nodes latitude*	eta_rho, xi_rho	Degree north
lon_u	Horizontal nodes longitude**	eta_rho, xi_u	Degree east
lat_u	Horizontal nodes latitude**	eta_rho, xi_u	Degree north
lon_v	Horizontal nodes longitude**	eta_v, xi_rho	Degree east
lat_v	Horizontal nodes latitude**	eta_v, xi_rho	Degree north
h	Bathymetry	eta_rho, xi_rho	m
mask_rho	Land mask (0 to land, 1 to ocean)	eta_rho, xi_rho	-

Table 3

Hydro-thermodynamic parameters simulated in the ROMS AGRIF model [2].

Variables	Description	Dependency	Unit
temp	Potential temperature	time, s_rho, eta_rho, xi_rho	°C
salt	Salinity	time, s_rho, eta_rho, xi_rho	psu
u	u-momentum component	time, s_rho, eta_rho, xi_u	m s-1
v	v-momentum component	time, s_rho, eta_v, xi_rho	m s-1
w	vertical momentum component	time, s_rho, eta_rho, xi_rho	m s-1
zeta	Sea Surface Height	time, eta_rho, xi_rho	m

Table 4

Additional parameters contained in NetCDF files.

Variables	Description	Dependency	Unit
ubar	Vertically integrated u-momentum component	time, eta_rho, xi_u	m s-1
vbar	Vertically integrated v-momentum component	time, eta_v, xi_rho	m s-1
f	Coriolis parameter	eta_rho, xi_rho	s-1
bostr	Kinematic bottom stress	time, eta_rho, xi_rho	N m-2
wstr	Kinematic wind stress	time, eta_rho, xi_rho	N m-2
sustr	Kinematic u wind stress component	time, eta_rho, xi_u	N m-2
svstr	Kinematic v wind stress component	time, eta_v, xi_rho	N m-2
diff3d	Horizontal diffusivity coefficient	time, s_rho, eta_rho, xi_rho	-
hbl	Depth of planetary boundary layer	time, eta_rho, xi_rho	m
hbbl	Depth of bottom boundary layer	time, eta_rho, xi_rho	m
shflux	Surface net heat flux	time, eta_rho, xi_rho	W m-2
swflux	Surface freshwater flux (E-P)	time, eta_rho, xi_rho	cm day-1
swrad	Short-wave surface radiation	time, eta_rho, xi_rho	W m-2

In both coordinate systems, the ROMS AGRIF model [2] evaluates the primitive equations using curvilinear orthogonal coordinates fitted to the limits in an Arakawa type C cell. The 3D and 4D grids (Tables 3 and 4), in addition to the horizontal coordinates, depending on the number of vertical levels and/or the time. In the vertical dimension, the primitive equations are discretized
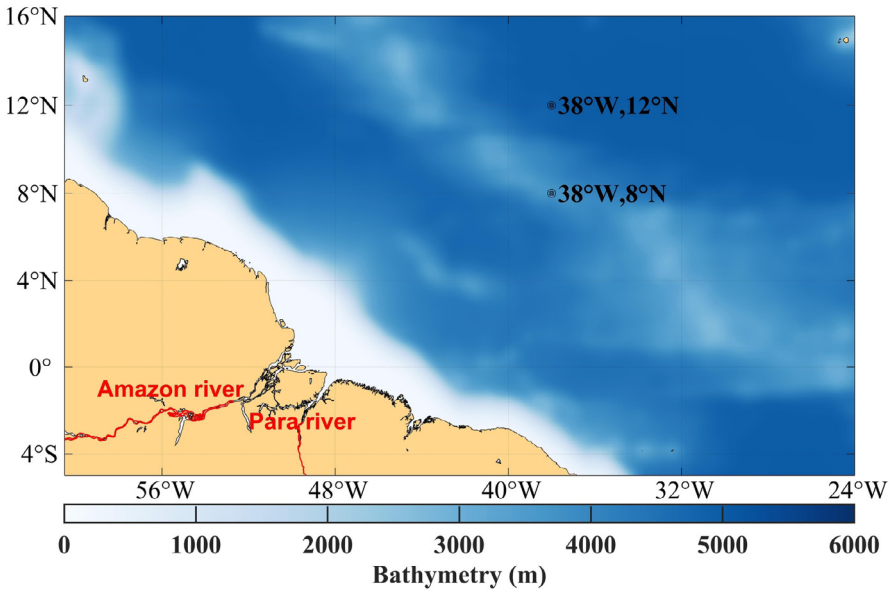
Fig. 1. Geographic boundaries of the study region. PIRATA buoys located at 38°W,8°N and 38°W,12°N, used for the validation of potential temperature and salinity. Adapted from [1].

on topography using stretched terrain-following coordinates and 32 levels were used (Table 1). In both, horizontal and vertical dimensions, second-order centered finite differences are used.

Table 3 shows the main variables (simulated with the ROMS AGRIF model) are temperature (temp), salinity (salt), the 3 components of the speed field of marine currents (u, v, w) and the sea surface height (zeta). Additionally, in both NetCDF files some of the grids used to estimate the temperature, salinity, the speed field of marine currents and the sea surface height are given (Table 4), on the other hand, parameters used in the simulation of the ROMS AGRIF model are also given.

2. Experimental Design, Materials and Methods

In this dataset, we have simulated the hydro-thermodynamics of the Amazon River plume as close to reality as possible. The Regional Ocean Modeling System model (ROMS AGRIF)has been used, which integrates the primitive Reynolds equations in a free-surface rotational system through the Boussinesq approximation, the hydrostatic approximation and the balance of the vertical momentum [3,4]. The official ROMS model website is at http://www.myroms.org/, the AGRIF version is based on this version and has been developed by the ROMS community and by the Institute of Research for Development (IRD), France. All versions of the ROMS model are free and its source code is available for download at https://www.croco-ocean.org/download/roms_agrif-project/.

The geographic boundaries of the region in this dataset are 60.5°-24°W and 5°S-16°N (Fig. 1) with 0.25° of horizontal resolution and 32 vertical levels, 12 of which are in the upper 100 m and 20 in the 500 m. In the simulation of the ROMS model, the freshwater contributions of the Amazon and Pará rivers have been taken into account, the Amazon river has a fairly branched delta, for which it was detailed considering 4 input cells of ROMS model grid, which correspond to the mouth of the 4 main channels: North channel, Santa Rosa Bay, Dangerous channel and Jurupari channel (Fig. 2), the amount of freshwater that each one contributes was determined
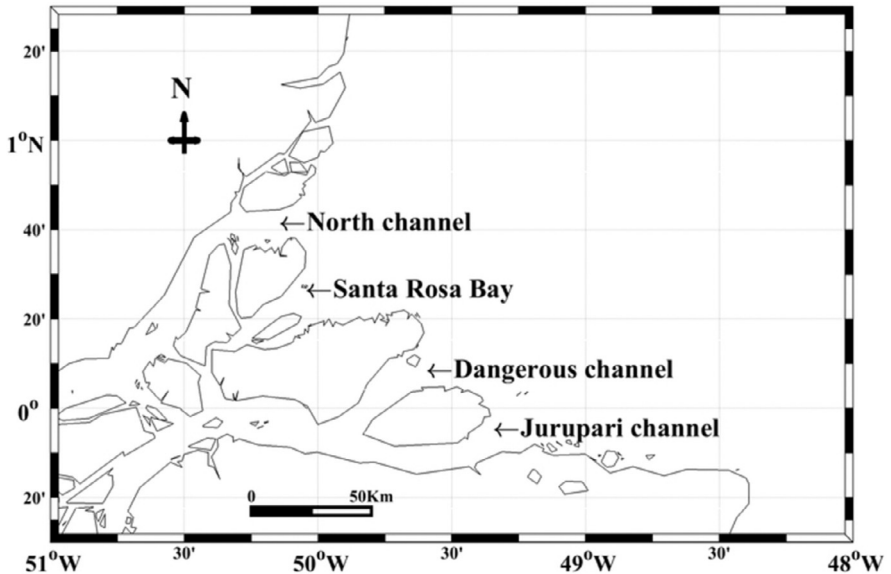
Fig. 2. Delta of the Amazon River detailed with its 4 main channels (North channel, Santa Rosa Bay, Dangerous channel and Jurupari channel). Adapted from [1].

according to the dimensions of the mouth of each channel, being 14.47% the North channel, 37.27% the Santa Rosa Bay, 29.13% the Dangerous channel and 19.13% the Jurupari channel. In these 4 input cells, the same Sea Surface Temperature (SST) was set as a boundary condition, oscillating between 27.8°C (January) and 28.5°C (October) [1] and Sea Surface Salinity (SSS), oscillating between 0 and 2 psu, the month of minimum discharge was set to 2 psu (November) and the month with maximum discharge, was set to 0 psu (May). In the case of the Para River, there is no delta, therefore, the only freshwater contribution made through the Marajo Bay, as the grid resolution is 0.25°, it was enough with only 1 input cell in the ROMS grid. The climatologies of the monthly means of the discharges of both rivers were obtained from the Obidos and Tucurui gauge stations [5] and the SST monthly means in the river mouths were obtained from the World Ocean Atlas (WOA2009) dataset [6].

The dataset used to discretize the bathymetry was ETOPO2 [7] which has 2 min of resolution, which is a sufficient approximation to create a bathymetric grid of 0.25°. In the ROMS model simulation, the initial and lateral boundary conditions were constrained by the monthly mean values of SST and SSS from the WOA2009 dataset [6,8], the North, South, East and West lateral boundaries were considered open. Using the climatology of monthly means from the Comprehensive Ocean-Atmosphere Data Set (COADS05) dataset [9], the surface forcing grid was created. In the simulation, the tide is considered because it is a very important physical process in the mixing of freshwater from rivers with the open ocean, whose data were obtained from OSU TPXO7 Tide model [10,11], this model has satellite altimetry data which improve the precision of the results obtained through the hydrodynamic model [12,13]. All the initial and boundary conditions were prepared by the Matlab toolkit called ROMSTOOLS V3.1.1 which is available for download in https://www.croco-ocean.org/download/utilities/. ROMSTOOLS is free software and is distributed under the terms of the GNU General Public License.

In order to validate the ROMS model output, the numerical variability of the SST and the SSS were compared with a monthly climatology calculated from the Simple Ocean Data Assimilation (SODA) version 2.2.4 [14,15,16], in the period from 1991 to 2010 (20 years). Surface currents are compared with a monthly climatology of Surface Current form Diagnostic model (SCUD) [17] covering the period from 2000 to 2008. The ROMS model results were also

compared with results reported [18] for the zonal component of the surface current velocity in the zone bounded by 50-40°W/5–8°N and the zone bounded by 30-25°W/5-8°N. The vertical distributions of temperature and salinity were compared with a monthly climatology from data observed in the Pilot Research Moored Array in the Tropical Atlantic (PIRATA buoys located at 38°W,8°N and 38°W,12°N (Fig. 1) [19,20], the period used was from 2000 to 2015, the output temperature of the ROMS model was linearly interpolated for the levels at which the temperature sensors are located (1 m, 20 m, 40 m, 60 m, 80 m, 100 m, 120 m, 140 m, 180 m, 300 m, 500 m) and salinity also interpolated linearly, but for the levels where the conductivity sensors are located (1 m, 20 m, 40 m, 120 m). No significant differences were found in any of the comparisons between the variables obtained by the ROMS model and the respective datasets.

CRediT Author Statement

H. L. Varona: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - Original draft, Visualization; **M. Araujo:** Conceptualization, Visualization, Writing- Reviewing and Editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The authors also declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Acknowledgments

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