

Sea Surface Salinity in the Pacific sector of the Southern Ocean during the last two decades

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INTRODUCTION: We present here a sea surface salinity (SSS) and temperature (SST) dataset collected during 10 campaigns realized between 2001 and 2021 on board the Italian polar vessels R/V Italice and R/V Laura Bassi, in the framework of several scientific projects funded by the Italian National Program of Research in Antarctica (PNRA). This dataset, soon available through an unrestricted repository, contributes to improving the knowledge of surface water features in one of the most important regions for global climate. The dataset will be highly valuable for studies focusing on climate variability in the Pacific sector of the Southern Ocean, especially across the Antarctic Circumpolar Current and its fronts. Furthermore, we expect that the collected SSS data will represent a valuable tool for the calibration and validation of present and future SSS enhanced products derived from available satellite observations, such as SMOS, Aquarius and SMAP missions.

DATA AND METHODS: SSS and SST data were collected during 10 cruises (Table 1) in the Pacific sector of the Southern Ocean (Figure 1) through the use of onboard TSG systems which were regularly calibrated and continuously monitored in-between cruises (no appreciable sensor drift emerged). For each cruise, the full-resolution TSG data was processed and undersampled with a median filter over a 1 min interval.

Cruise Name	Ship	Start Date	End Date	Latitude	Longitude
PNRA XVIII	R/V Italice	05/01/2003	27/02/2003	44.16 - 49.32 °S	173.28 - 170.10 °E
PNRA XXI	R/V Italice	31/12/2005	21/02/2006	44.97 - 63.70 °S	173.65 - 173.12 °E
PNRA XXV	R/V Italice	26/01/2010	16/02/2010	51.19 - 43.87 °S	174.48 - 173.19 °E
PNRA XXVII	R/V Italice	12/01/2012	19/02/2012	43.60 - 45.90 °S	172.72 - 173.98 °E
PNRA XXVIII	R/V Italice	05/01/2013	27/02/2013	44.16 - 49.32 °S	173.28 - 170.10 °E
PNRA XXIX	R/V Italice	30/12/2013	27/02/2014	51.62 - 44.16 °S	176.07 - 173.35 °E
PNRA XXXI	R/V Italice	16/01/2016	16/02/2016	43.84 - 44.65 °S	173.20 - 173.90 °E
PNRA XXXII	R/V Italice	30/12/2016	10/02/2017	43.59 - 66.15 °S	173.00 - 172.99 °E
PNRA XXXV	R/V Laura Bassi	06/01/2020	18/02/2020	44.16 - 47.64 °S	172.93 - 171.62 °E
PNRA XXXVI	R/V Laura Bassi	25/12/2020	08/02/2021	47.18 - 45.57 °S	173.10 - 172.46 °E

Table 1. List of scientific cruises between 2001 and 2021 included in the dataset

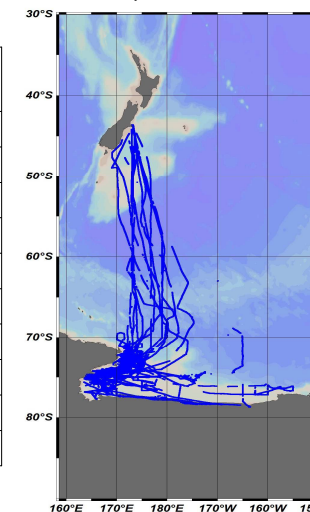


Figure 1. R/V Italice and R/V Laura Bassi cruise tracks (blue dots) in the southern Pacific Ocean and in the Southern Ocean along the New Zealand – Ross Sea chokepoint. Data refer to field cruises realized between 2001 and 2021. Bathymetry is expressed through GEMCO 2021 gridded product available in ODV.

QUALITY CONTROL: No systematic differences appeared after a rigorous quality control on continuous data. Quality control included several steps (see Aulicino et al., Earth Syst. Sci. Data, 10, 1227–1236, 2018), among which an automatic detection of unreliable values through selected threshold criteria and attribution of quality flags based on multiple criteria (i.e., analysis cruise reports, detection of insufficient flow and/or presence of air bubbles and ice crystals in the seawater pipe, visual inspection of individual campaigns, and ex-post check of seaice maps for confirming ice field location). Data processing led us to discard about 20% of the acquired TSG observations, most of them inside the sea ice infested Ross Sea area.

COMPARISON TO REFERENCE DATASETS: An excellent agreement was found between our TSG SSS and co-located independent reference gridded Copernicus SSS products (i.e., **MULTIOBS**, namely MULTIOBS_GLO_PHY_S_SURFACE_MYNRT_015_013; **ARMOR3D**, namely MULTIOBS_GLO_PHY_TSUV_3D_MYNRT_015_012; **GLORYS**, namely GLOBAL_REANALYSIS_PHY_001_031), with absolute biases well within the level of spread found among the references themselves, except than in the inner Ross Sea area. Figure 3 suggests that the level of agreement changes with latitude, probably due to the sea ice presence and the high variability that characterizes ocean surface in proximity of ACC fronts. As expected, GLORYS daily products (green) reconstruct TSG SSS (black) better than ARMOR3D (red) and MULTIOBS (blue) weekly products that cannot resolve completely the spatial and temporal variability of the in situ observations. Additionally, model outputs seem to slightly overestimate in situ observations, especially during summer 2014.

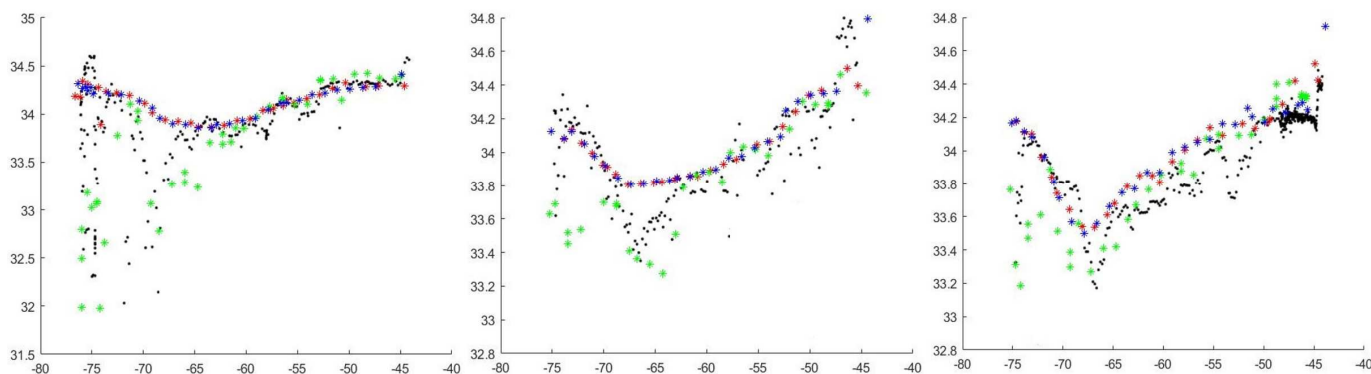


Figure 3. A comparison between TSG-SSS (black dots) and co-located reference Copernicus gridded products from GLORYS (green), ARMOR3D (red) and MULTIOBS (blue), during (a) January 2003, (b) February 2006 and (c) January 2014.

CONCLUSIONS: Even though limited in time (few months/year) and space (Southern Pacific Ocean), this TSG SSS dataset may allow us to identify interesting surface ocean features (e.g., sharp gradients in proximity of the ACC fronts, eddies presence, ACC transport and variability, freshening signature), develop cal/val of SSS satellite observations, and improve the reconstruction of density fields in combination with numerical model outputs and remote sensed data.