# Hydrographic variability (1994-2020) in the Ría de Vigo and adjacent shelf (NW Iberia)

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https://ocevi.github.io/

## SUMMARY

*A 27-year time serie (1994 - 2020) of temperature and salinity vertical profiles (CTD) in the Ría de Vigo and adjacent shelf are analyzed in four stations: two inside the ría (~30 and ~40 m depth), one in the mid-shelf (~90 m) and one near the edge shelf (~150 m). This study analyzes the hydrographic variability in the period and its relationship with the main atmospheric teleconnection patterns.*

## THE RADIALES PROGRAM

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | | 10 | | 21 | 26 | 23 | 21 | | 1 | 5 | 3 | 13 |
| 1995 | 3 | 23 | 23 | 5 | 25 | 22 | 20 | 24 | 21 | 19 | 1 | 15 |
| 1996 | 25 | 29 | 1 | 17 | 16 | 13 | 18 | 21 | 19 | 16 | 27 | 18 |
| 1997 | 22 | 27 | 21 | 16 | 21 | 18 | 16 | 27 | 24 | 29 | 27 | 17 |
| 1998 | 15 | 12 | 12 | 23 | 14 | 18 | 15 | 5 | 17 | 21 | 12 | 18 |
| 1999 | 14 | 18 | 25 | 15 | 20 | 10 | 14 | 4 | 15 | | 18 | |
| 2000 | 27 | 18 | 16 | 24 | 22 | 23 | 26 | 24 | 21 | 25 | 23 | 21 |
| 2001 | 31 | 21 | 29 | 26 | 24 | 14 | 11 | 8 | 13 | 24 | 28 | 12 |
| 2002 | 30 | 22 | | 19 | 16 | 13 | 10 | 21 | 12 | 3 | 20 | 18 |
| 2003 | 24 | 19 | 12 | 9 | 16 | 18 | 9 | 21 | 17 | 22 | 20 | 11 |
| 2004 | 21 | 18 | 24 | 28 | 12 | 17 | 8 | 25 | 15 | 27 | 18 | 13 |
| 2005 | | | 9 | 13 | 4 | 15 | 21 | 29 | 15 | 19 | 23 | 14 |
| 2006 | 19 | 8 | 8 | 26 | 25 | 21 | 19 | 30 | 20 | 18 | 22 | 13 |
| 2007 | 24 | 14 | 21 | 25 | 16 | 13 | 4 | 2 | 19 | 17 | 28 | 12 |
| 2008 | 23 | 13 | 25 | 16 | 21 | 18 | 17 | 20 | 17 | 22 | 19 | 17 |
| 2009 | 29 | 26 | 18 | 22 | 20 | | 15 | 26 | 23 | 21 | 18 | 17 |
| 2010 | 20 | 10 | 10 | 14 | 12 | 16 | 14 | 19 | 22 | 20 | 17 | 15 |
| 2011 | 19 | 23 | 17 | 13 | 11 | 22 | 18 | 22 | 21 | 19 | 16 | 21 |
| 2012 | 18 | 15 | 22 | 27 | 16 | 13 | 11 | 22 | 27 | 24 | 15 | 21 |
| 2013 | 25 | 14 | 27 | 17 | 15 | 12 | 17 | 21 | 11 | 17 | 13 | 13 |
| 2014 | 24 | 20 | 12 | 10 | 15 | 18 | | | 24 | 22 | 19 | 17 |
| 2015 | 23 | 6 | 5 | 8 | 13 | 3 | 2 | 5 | 24 | 15 | 18 | 18 |
| 2016 | 15 | 19 | 17 | 7 | 11 | | 6 | 10 | 14 | | 11 | 29 |
| 2017 | 18 | 15 | 15 | | | 6 | 19 | 4 | 1 | 8 | 9 | 1 |
| 2018 | 15 | 4 | | 2 | | 14 | 17 | | 5 | | 20 | 10 |
| 2019 | 14 | 18 | 4 | 28 | | 6 | | 20 | | | | |
| 2020 | 27 | 14 | 6 | 28 | | 4 | 5 | 12 | 7 | | | |

*The Instituto Español de Oceanografía (IEO-CSIC) carries out monthly oceanographic samplings at across-shelf sections off the Spanish coast under the* ***monitoring program RADIALES****. This is a multidisciplinary marine research effort addressing long-term variability issues at the ecosystem level. The monitoring program includes 5 perpendicular coastal transects off northern Spain: Santander, Gijón, Cudillero, A Coruña and Vigo.*

learn more:

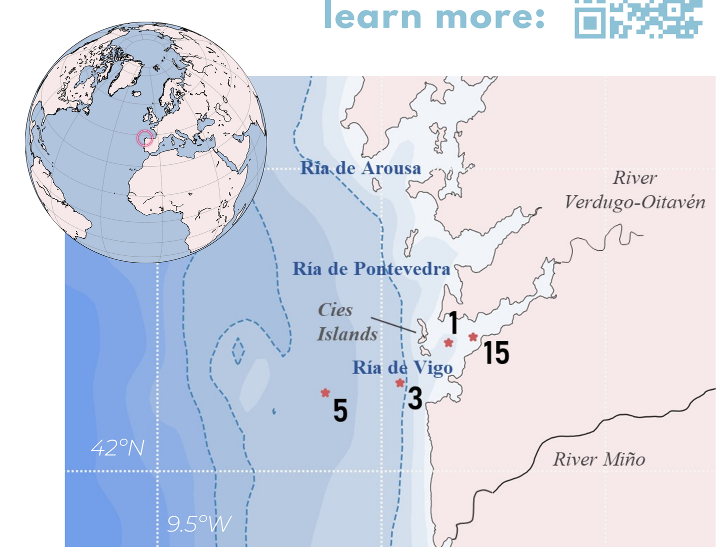



Figure 1. (Left) Sampling months in the Ría de Vigo and adjacent shelf from 1994 to 2020. Samplings were done once (light blue) or twice (dark blue) per month. The number in the box corresponds to the first day of the survey. (Right) Location of the CTD sampling stations (red stars) in the study region.

## THE TIMESERIES

Figure 2. From top to bottom: temperature series at the 15, 1, 3 and 5 stations (from inner to outer locations), upwelling index (UI), North Atlantic Oscillation Index (NAO), Atlantic Multi-decadal Oscillation index (AMO), river discharge of the Miño river and the tandem Verdugo-Oitavén rivers, and finally, salinity series at the previously mentioned stations. Red and blue zig-zag arrows point out positive and negative regime shifts, respectively.

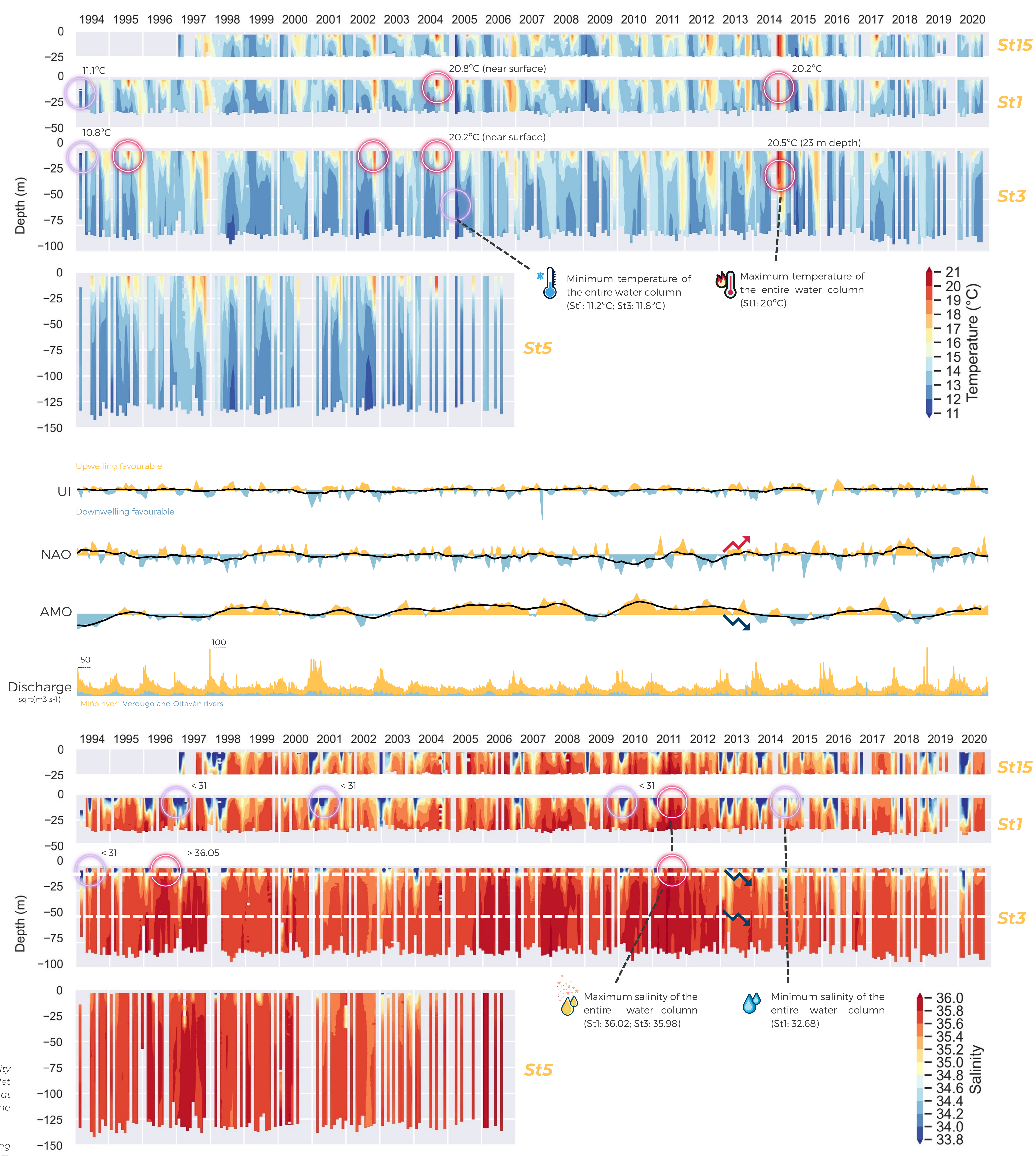
UI index data were obtained on a monthly basis from www.indicedeafloramiento.ieo.es in a location off Ría de Vigo.

NAO index data were obtained from the NOAA Climate Prediction Center (https://www.cpc.ncep.noaa.gov/).

Monthly data of the AMO index data were provided by the Climate Analysis Section, NCAR, Boulder, USA (https://climatedataguide.ucar.edu/climate-data/atlantic-multi-decadal-oscillation-amo).

Daily discharge data for the Verdugo-Oitavén rivers were obtained through the Spanish regional organization Augas de Galicia (https://augasdegalicia.xunta.gal/). The River Miño data were obtained from the Spanish national organization Confederación Hidrográfica del Miño-Sil (https://www.chminosil.es/)

Regime shifts are detected with a sequential t-test analysis on the time series, following Rodionov, S. N. (2004).




*886 CTDs obtained during a 27-year period have been reprocessed with the same methodology to ensure the highest performance during the quality control process. Semi-automatic quality control was applied with the use of the CTDCheck software (Otero et al., 2021).*

*October and November usually have warmer near-surface waters. However, below 50 m depth, November and December are the warmest months. Cooling is favoured by upwelling events, but also by surface cooling during winter months.*

*Salinity is strongly influenced by river discharge. Salty events are also associated with the presence of ENACWst waters.*

*The analysis shows a descend in salinity from 2013 onwards, at both 10 m and 50 m. This fact coincides with a positive change in the NAO. This positive phase is usually associated with below-average precipitation over southern Europe. However, winter river discharge is high, which requires further analyses. A change to negative sign in the AMO series is also detected during 2013. In contrast, no temperature shift has been observed.*

References:

*Otero, P., González-Nuevo, G., Tel, E., 2021. Simplifying quality control and standardization of CTD data under SeaDataNet requirements, in: Instrumentation Viewpoint. Presented at the MARTECH 21: 9th International Workshop on Marine Technology, Vigo, p. 50.*

*Rodionov, S. N. (2004). A sequential algorithm for testing climate regime shifts. Geophysical Research Letters, 31, L0920*

## MEAN TEMPERATURE CONDITIONS

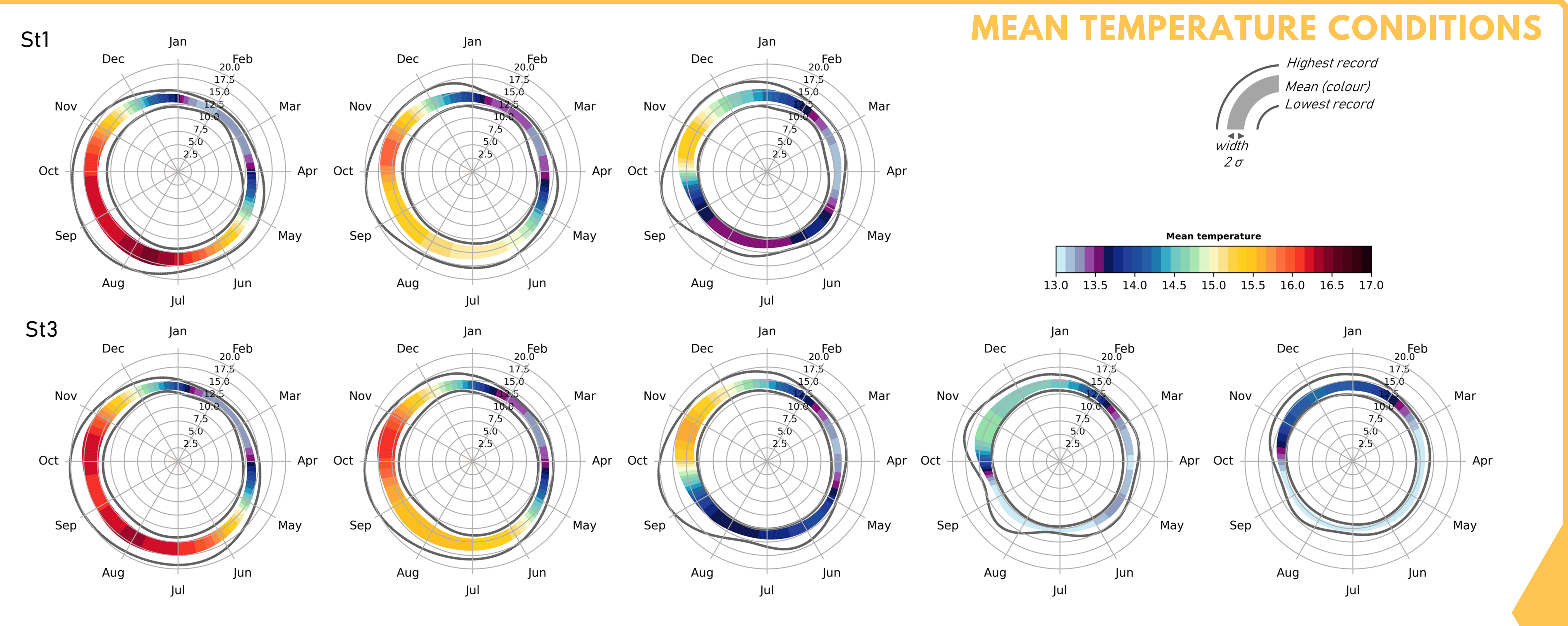



Figure 3. Comparison of the mean temperature distribution between the two stations with the longest time series: the station in the Ría de Vigo (1) and the station in the shelf (3). The middle ring represents the mean temperature (colour) and its variability (width), estimated here as 2 times the standard deviation. The outer and inner rings are the highest and the lowest temperature recorded over the period, respectively.

## IN A NUTSHELL

- Warm (> 20°C), cold (< 12°C), fresh (<31) and salty (>35.9) events have been identified.
- Runoff and upwelling are responsible of the short-term variability.
- Salinity shifts fit with changes in both the NAO and the AMO teleconnection patterns.
- No temperature shifts have been observed; local phenomena can be masking the signal and a deeper analysis is needed.
- Future work requires extending the time series since 1987, when the monitoring program began.