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Supporting Information for

Observed diurnal cycles of near-surface shear and stratification in the equatorial Atlantic and their wind dependence

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Contents of this file

Text S1
Figure S1
Tables S1 to S2

Introduction

The data sets of the TRATLEQ drifter experiments are described in more detail, focussing on the characteristics of the three types of drifters, on the processing of the raw data, and on the performed collocation of drifter pairs. Furthermore, the IDs of the SVP drifters are listed so that they can be detected in the SVP database.

Text S1.

During the RV Meteor TRATLEQ cruises (M158 and M181), three types of surface drifters (CARTHE, SVP and Hereon drifters) were deployed to intensely monitor velocity differences between about 0.5 m and 15 m depth. CARTHE drifters include a donut-shaped top component, carrying the GPS and batteries, which is attached to a 38 cm long rigid cross-shaped drogue (Novelli et al., 2017). They have minimal wave rectification issues and their wind-induced slip velocity is less than 0.5% of the neutral wind speed at 10 m height. However, in the presence of large waves, the error of the CARTHE velocities can increase to a few cm s^{-1} (Poulain et al., 2022). The absolute slip velocity during laboratory testing was found to decrease with increasing wind speed, likely caused by wind separation from the sea surface due to the presence of surface gravity waves (Novelli et al., 2017). SVP drifters consist of a spherical surface buoy tethered to a weighted holey-sock drogue of 720 cm length that is centred at 15 m depth. Note that SVP drifters do not follow the currents perfectly but have a slip bias of less than 1 cm s^{-1} for 10 m s^{-1} winds according to observations. This bias results from the

direct action of the wind on the surface floating buoy as well as from the vertical shear of the horizontal velocities across the vertical extent of the drogue (Niiler et al., 1995). When comparing the slip for CARTHE and SVP drifters, it should be noted that SVPs have more direct wind drag above the sea surface compared to CARTHE drifters (Poulain et al., 2022). The so-called Hereon drifters were designed and built at Hereon Helmholtz Centre in Geesthacht, Germany. They consist of a tube-shaped top component, containing GPS and batteries, that is attached to a 35 cm long cross-shaped drogue via a flexible cord. When deployed, about 5 cm of the top element remain above the sea surface, resulting in a ratio of drag area inside to drag area outside the water of 21 (Horstmann et al., 2023).

The spatial resolution is $0.00001^\circ = 0.001$ km for Hereon, $0.0001^\circ = 0.01$ km for CARTHE and Copernicus BRST SVP, $0.0003^\circ = 0.03$ km for SIO DWS-D SVP, and $0.001^\circ = 0.1$ km for the remaining SVP drifters. The temporal resolution is irregular for CARTHE and Hereon and mostly hourly for SVP drifters. Therefore, the original data were linearly interpolated to an hourly grid for values less than 4 h apart. Further, the quality of data was validated to account for GPS errors and other failures. The following criteria were considered:

1. The status of the drogue had to be on (only known for SVP). Note that for CARTHE and Hereon drifters a drogue loss cannot be excluded which would result in higher velocities (Lodise et al., 2019). Yet, a drogue loss is unlikely as there have not been large storm and wave events during the deployment period (Haza et al., 2018).
2. A maximum velocity criterion of $3 \text{ m s}^{-1} \approx 10.8 \text{ km h}^{-1}$ was applied (compare Lumpkin & Pazos, 2007).
3. A maximum acceleration criterion of 1 km h^{-2} was used.
4. Drifters with constant velocities for more than 5 h were removed as they are considered grounded.
5. Drifters fetched by ships were manually removed.

The validated and gridded trajectories for SVP and CARTHE as well as SVP and Hereon drifters were then collocated using a maximum distance criterion of 100 km (slightly less than 1° in longitude/latitude) and a temporal criterion of 1 h. The position of the collocated values is depicted in Figure S1. The sensitivity of both criteria was tested. Increasing the temporal criterion to 3 h did not significantly increase the number of pairs. The maximum distance of 100 km was chosen to allow enough pairs for statistics but to avoid an impact of other processes. Furthermore, no criterion is used to eliminate possible outliers as a criterion of three standard deviations off the median removes unproportionally more values in the afternoon where the vertical shear of horizontal velocities is strongest. Hence, this criterion removes ‘true’ velocity peaks and yields a bias. For a better comparison with shipboard observations and to focus on the equatorial region, only values between 1°S and 1°N are considered in the following.

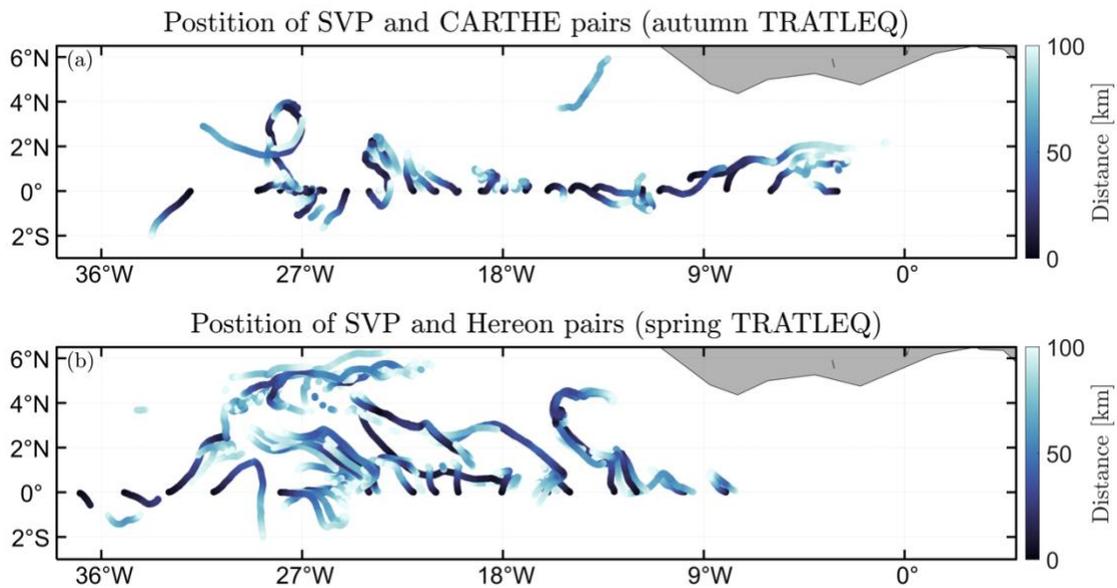


Figure S1. Position of the collocated drifter pairs. The collocation is performed for (a) SVP and CARTHE drifters deployed during autumn TRATLEQ and for (b) SVP and Hereon drifters deployed during spring TRATLEQ drifter experiments with the mean distance of the paired drifters shown in colour.

IMEI number	WMO number
300234066438030	4401868
300234066312490	4101684
300234066025240	1501669
300234067112260	1501663
300234066312380	4101680
300234066513790	4402502
300234067112280	1501664
300234066438020	4401867
300234067112240	1501661
300234066025220	1501667
300234066518820	4402500
300234067112180	1501660
300234065514820	4101677
300234067112250	1501662
300234066438040	4401869
300234066519790	4402503
300234067111290	1501659
300234066025230	1501668
300234067111280	1501658
300234066838680	4401859
300234066514830	4402501
300234066312570	4101685
300234067110240	1501655
300234066025210	1501666
300234064909760	1501654
300234066514800	4101773
300234067110300	1501657
300234066312250	4101679
300234066837700	4401858
300234067110280	1501656
300234066025100	1501665

Table S1. IMEI and corresponding WMO numbers of the SVP drifters deployed during autumn TRATLEQ drifter experiment.

IMEI number	WMO number
300534062125180	1501765
300534062123870	1501761
300534062124880	1501764
300534062123380	1501760
300534062122880	1501758
300534062123370	1501759
300534062023990	1501768
300534062023750	1501766
300534062123880	1501762
300534062024550	1501769
300534062024720	1501770
300534062023970	1501767
300534062124870	1501763
300534062024940	1501774
300534062024800	1501773
300534062024960	1501775
300534062024730	1501771
300534062024770	1501772

Table S2. IMEI and corresponding WMO numbers of the SVP drifters deployed during spring TRATLEQ drifter experiment.