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NIOZ high-resolution moored temperature observations: benefits and new challenges.

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The Royal Netherlands Institute for Sea Research has been developing for several years a family of temperature sensors (NIOZ1 to NIOZ5). In the latest iterations of this project, these instruments are precise (10^{-3} K or better), have a very low noise level (below 10^{-3} K), are relatively fast (sampling rate of 1 Hz) and can measure for extended periods of time (several months). Being also compact and lightweight, several thermistors can be attached on a single line at a fine vertical spacing (20 cm or more). When mounted on a cable, the instruments are all synchronised to a single clock, thus providing simultaneous measurements throughout the depth range of the mooring (usually in the order of 100 m). Recently, the instruments have also been deployed in a group of 5 lines approximately 5 m apart from each other, providing a unique view on the three-dimensional temperature field. After almost 10 years of successful deployments at sea, we try to draw some conclusions from this effort, from the scientific and technical point of view.

This observational system provides temperature measurements with vertical spatial resolution comparable to that of microstructure profilers, but in comparison to ship-borne systems it offers some distinctive features:

- providing instantaneous measurements throughout the mooring, observations of waves and overturning structures are not influenced by the time delay between measurements at different depths;
- the very low noise level and high precision enables the study of the deep, weakly stratified ocean;
- by using a heavy ballast at the bottom and a high net buoyancy at the top of the mooring, Eulerian measurements are effectively obtained;
- continuous, high sampling rate Eulerian measurements enable to assess the intermittent, sporadic nature of turbulence and wave activity in the ocean;
- the large range of time scales included in the observations ($10^0 - 10^6$ s) allows to study a large portion of the turbulence inertial range, the full internal wave spectrum, modulation by submesoscale and mesoscale activity and seasonal variations.

These features have been exploited for characterising the internal wave spectrum in the open ocean, for evaluating turbulence parameters above seamounts, and to characterise the statistics of temperature fluctuations. Main results include the observational demonstration of extreme inhomogeneity in space and intermittency in time of turbulence, and evidence of the importance of convective activity within strong geophysical turbulence.

The data collected challenges the classical methods of turbulence parameters estimation in the ocean. Classical "Thorpe scale" methods have been adapted to the particular characteristics of the data, and efforts have been made to adapt other methods, providing higher detail on the vertical and temporal modulation of turbulence. The large datasets have also enabled the application on observational data of analysis methods previously used on laboratory data alone.