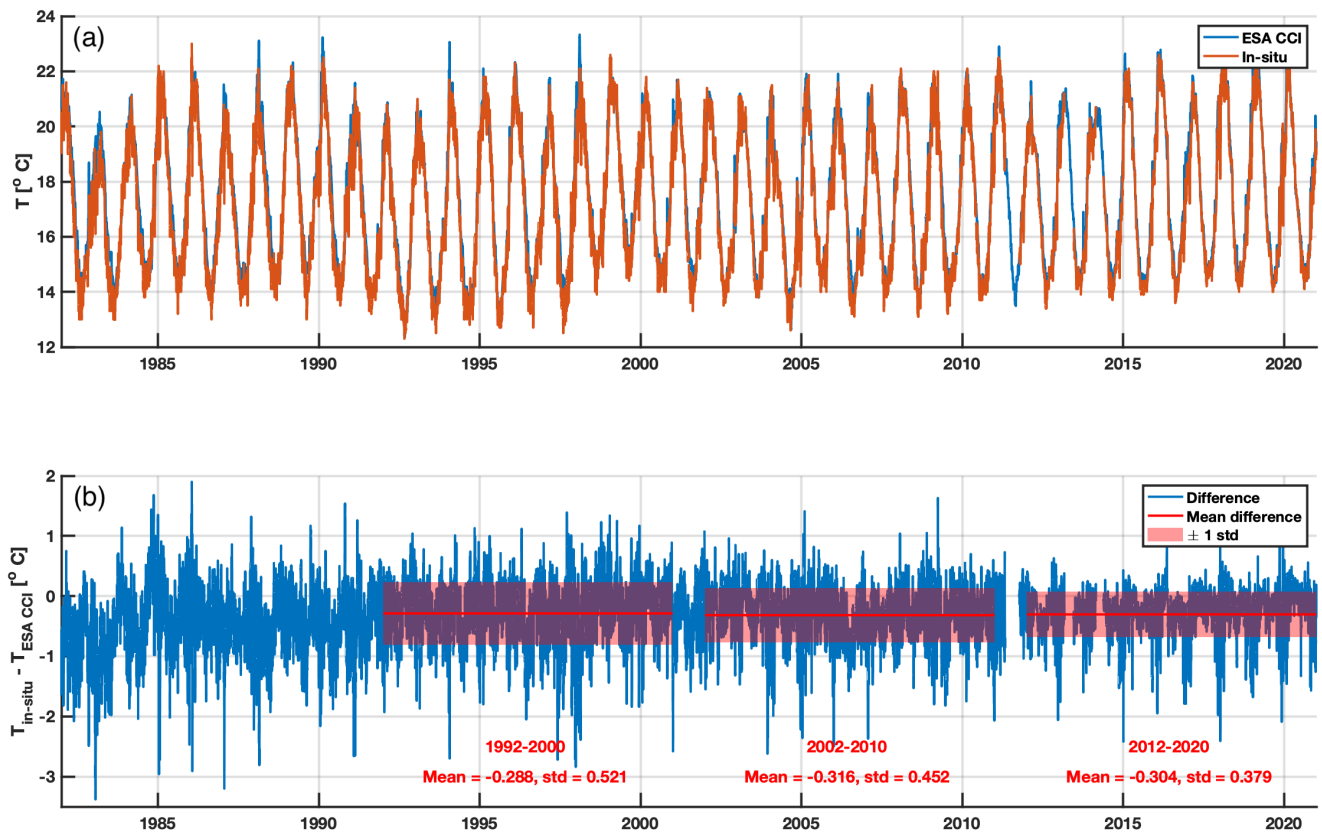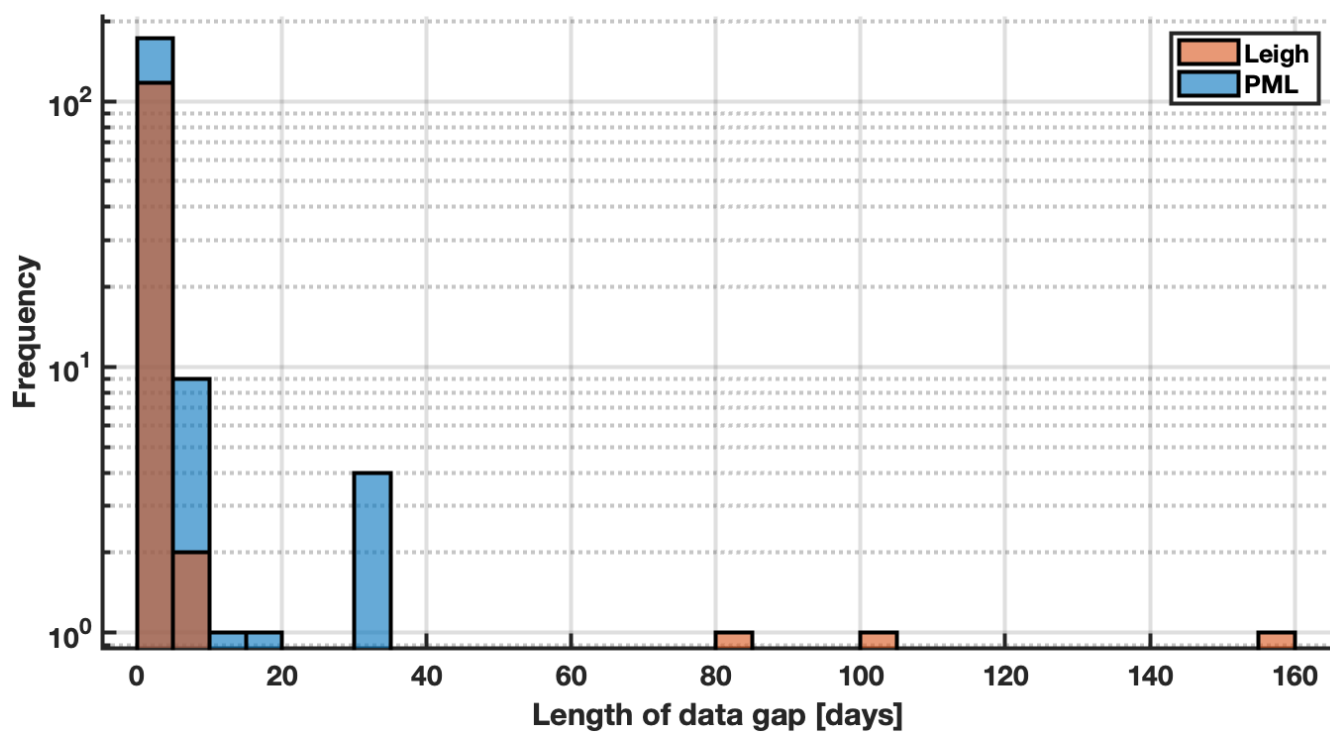# *Supplementary Material*
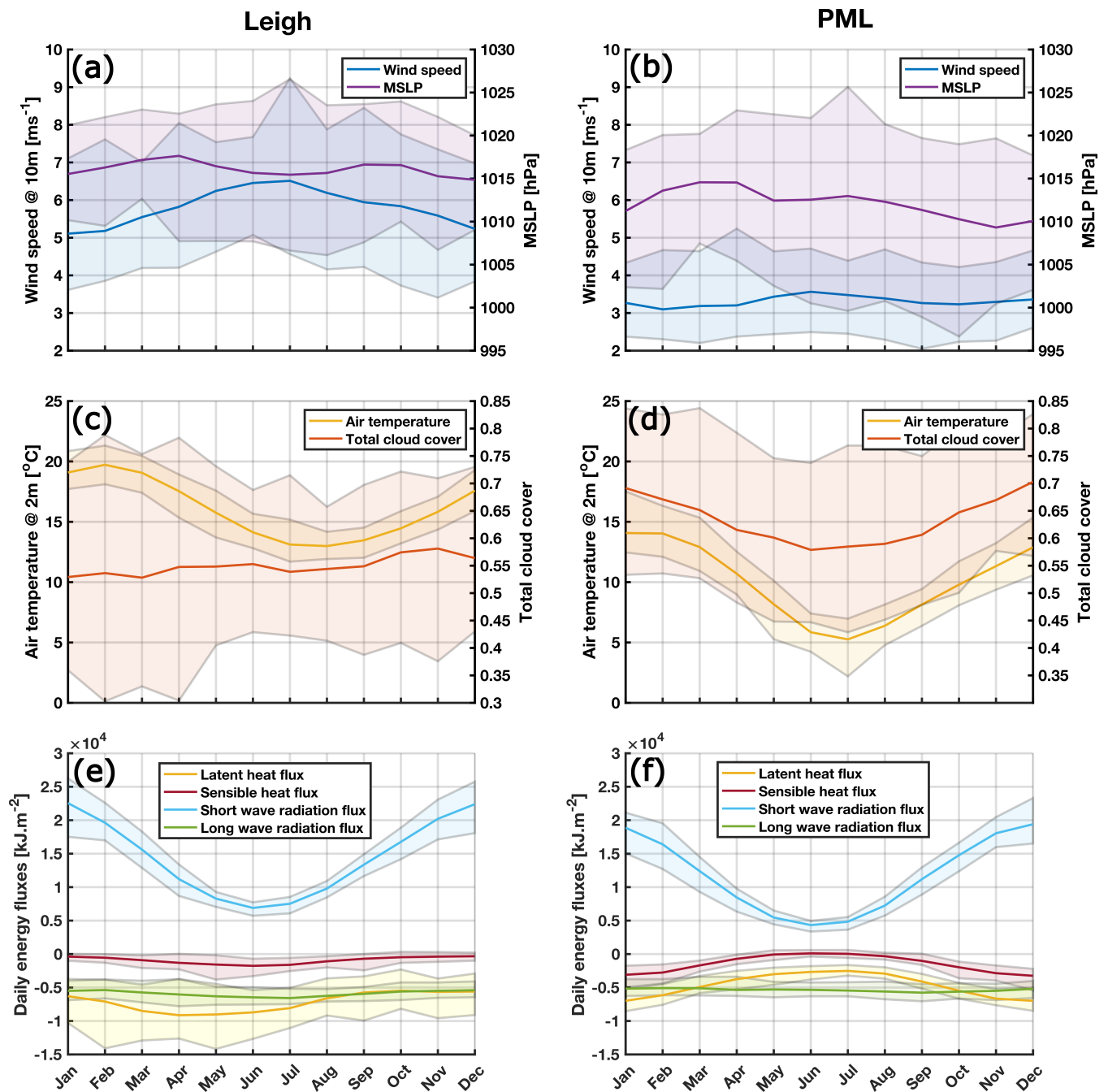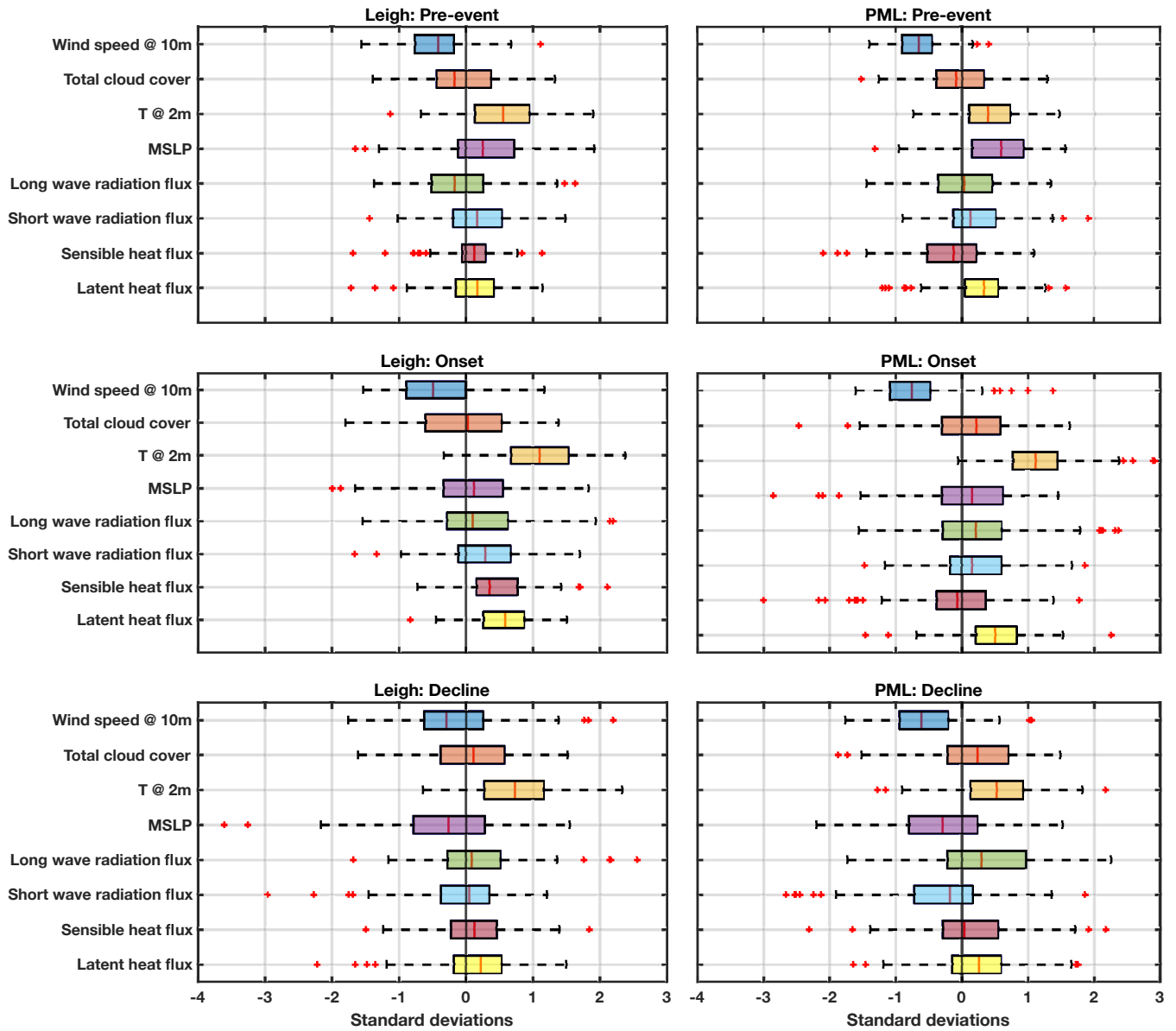
1 FIGURES

Figure S1. (a) Timeseries of *in situ* ocean temperature and remotely sensed ESA CCI sea surface temperature at Leigh. (b) Difference between the *in situ* and remotely sensed data displayed in (a). The mean difference for three 9-year periods are shown as horizontal red lines with $\pm 1\sigma$ of the mean shaded in red.
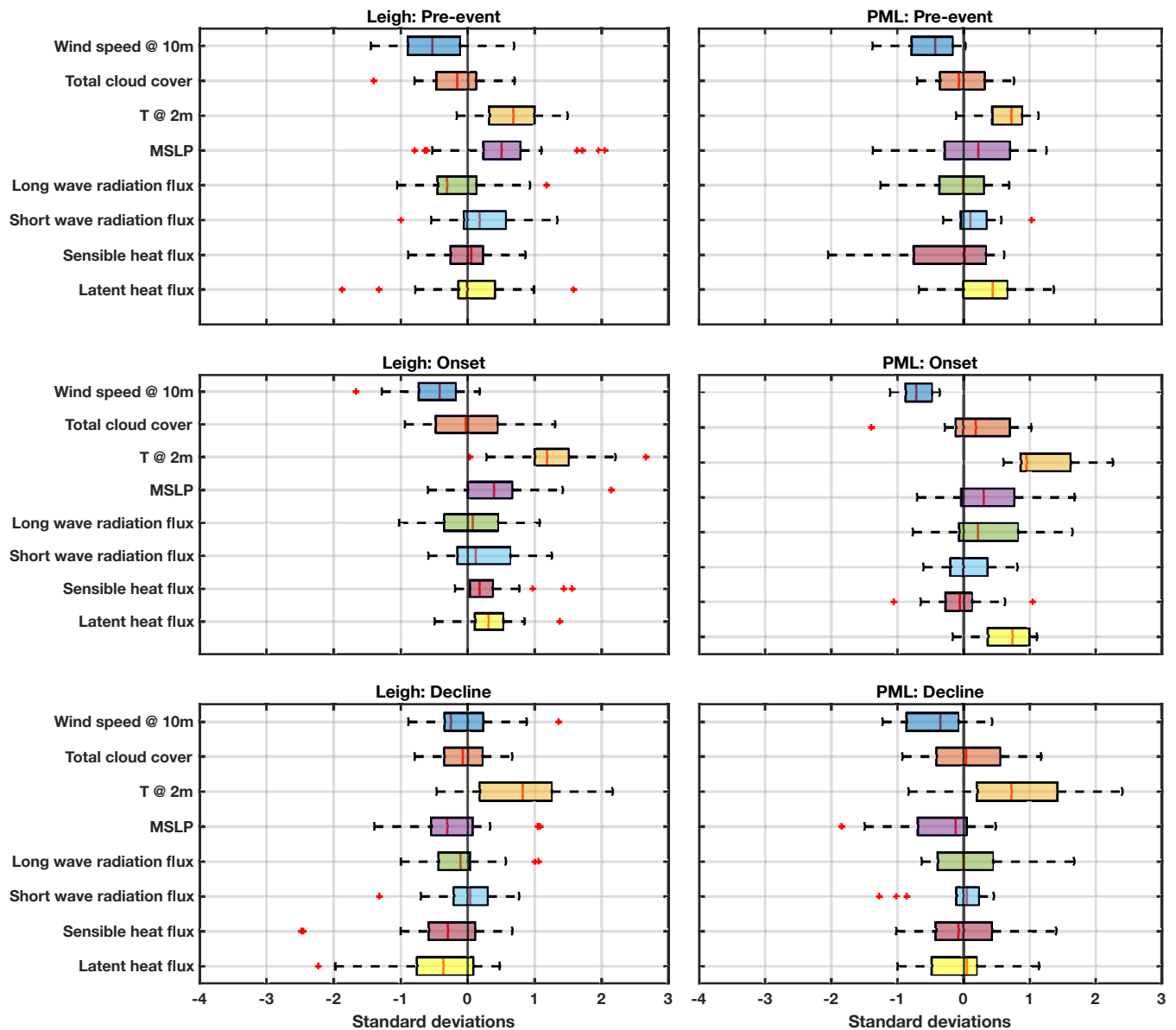
Figure S2. Frequency of data gap lengths present in *in situ* ocean temperature records from Leigh (Orange) and Portobello Marine Laboratory (PML, Blue).

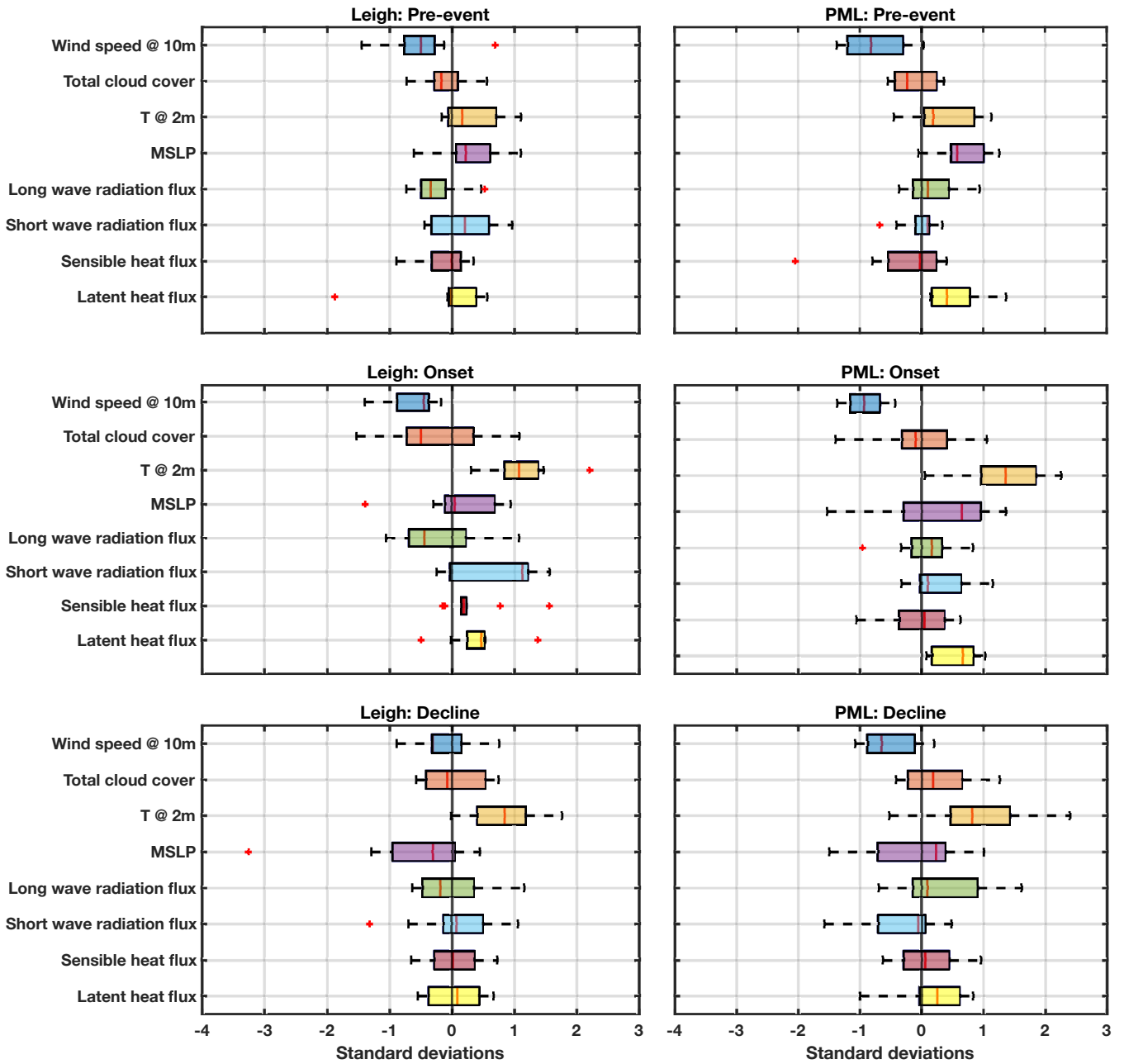**Leigh**   **PML**

Figure S3. The mean monthly values for atmospheric variables obtained from the ERA5 reanalysis for the two study sites: Leigh and PML. Variables include wind speed and mean sea level pressure (a-b), air temperature and total cloud cover (c-d) and atmospheric fluxes (e-f). Grey shading indicates the minimum and maximum monthly mean value for each variable.
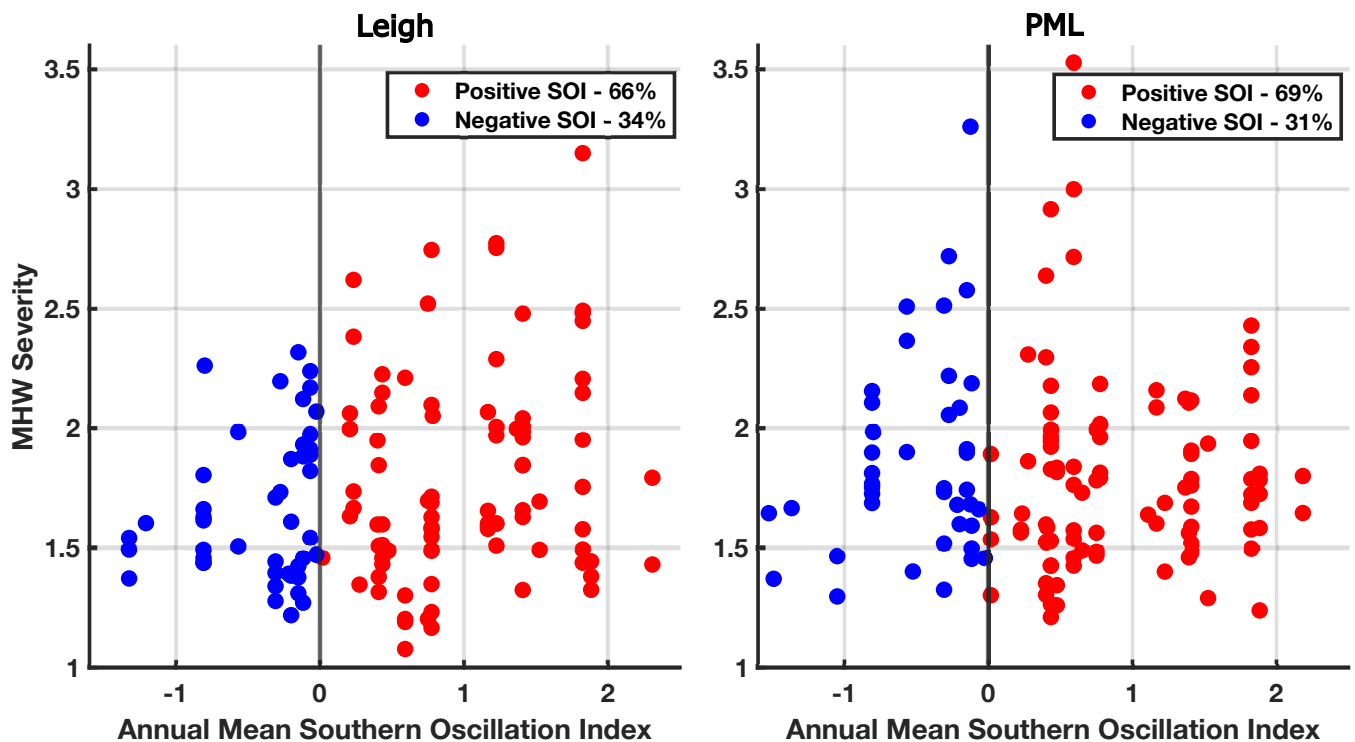
Figure S4. Box and whisker plots of normalised atmospheric anomalies averaged over the specified phase for each MHW detected at Leigh and PML with a duration of 14 days or less. The pre-conditioning phase (a,d) is 7 days before the start of a MHW, onset (b,e) is from the start of the event to the peak intensity date, and decline (c,f) is from the peak intensity date to end of event. Outliers are shown as red crosses.

Figure S5. Box and whisker plots of normalised atmospheric anomalies averaged over the specified phase for each MHW detected at Leigh and PML with a duration greater than 14 days. The pre-conditioning phase (a,d) is 7 days before the start of a MHW, onset (b,e) is from the start of the event to the peak intensity date, and decline (c,f) is from the peak intensity date to end of event. Outliers are shown as red crosses.

Figure S6. Box and whisker plots of normalised atmospheric anomalies averaged over the specified phase for the 10 most severe MHWs detected at Leigh and PML. The pre-conditioning phase (a,d) is 7 days before the start of a MHW, onset (b,e) is from the start of the event to the peak intensity date, and decline (c,f) is from the peak intensity date to end of event. Outliers are shown as red crosses.

Figure S7. Scatter plot of MHW event severity and the annual mean Southern Oscillation Index value for the year in which the event occurred at (a) Leigh Marine Laboratory and (b) Portobello Marine Labaortory. Negative (positive) SOI values are in blue (red). The percentage of events associated with positive and negative SOI sign are shown in the legend.