

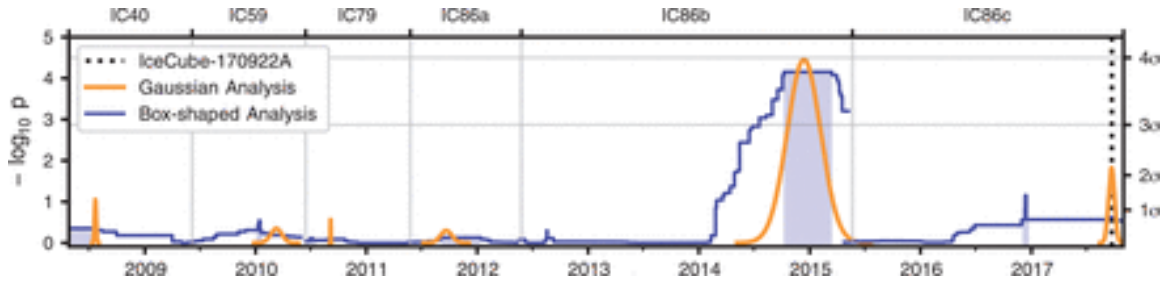
time window and a box-shaped time window. Each analysis varies the central time of the window,  $T_0$ , and the duration  $T_W$  (from seconds to years) of the potential signal to find the four parameters ( $\Phi_{100}$ ,  $\gamma$ ,  $T_0$ ,  $T_W$ ) that maximize the likelihood ratio, which is defined as the test statistic  $TS$ . (For the Gaussian time window,  $T_W$  represents twice the standard deviation.) The test statistic includes a factor that corrects for the look-elsewhere effect arising from all of the possible time windows that could be chosen (30).

For each analysis method (time-integrated and time-dependent), a robust significance estimate is obtained by performing the identical analysis on trials with randomized datasets. These are produced by randomizing the event times and recalculating the RA coordinates within each data-taking period. The resultant  $P$  value is defined as the fraction of randomized trials yielding a value of  $TS$  greater than or equal to the one obtained for the actual data.

Because the detector configuration and event selections changed as shown in Table 1, the time-dependent analysis is performed by operating on each data-taking period separately. (A flare that spans a boundary between two periods could be partially detected in either period, but with reduced significance.) An additional look-elsewhere correction then needs to be applied for a result in an individual data segment, given by the ratio of the total 9.5-year observation time to the observation time of that data segment (30).

## Neutrinos from the direction of TXS 0506+056

The results of the time-dependent analysis performed at the coordinates of TXS 0506+056 are shown in Fig. 1 for each of the six data periods. One of the data periods, IC86b from 2012 to 2015, contains a significant excess, which is identified by both time-window shapes. The excess consists of  $13 \pm 5$  events above the expectation from the atmospheric background. The significance depends on the energies of the events, their proximity to the coordinates of TXS 0506+056, and their clustering in time. This is illustrated in Fig. 2, which shows the time-independent weight of individual events in the likelihood analysis during the IC86b data period.



**Fig. 1** Time-dependent analysis results.

The orange curve corresponds to the analysis using the Gaussian-shaped time profile. The central time  $T_0$  and width  $T_W$  are plotted for the most significant excess found in each period, with the  $P$  value of that result indicated by the height of the peak. The blue curve corresponds to the analysis using the box-shaped time profile. The curve traces the outer edge of the superposition of the best-fitting time windows (durations  $T_W$ ) over all times  $T_0$ , with the height indicating the significance of that window. In each period, the most significant time window forms a plateau, shaded in blue. The large blue band centered near 2015 represents the best-fitting 158-day time window found using the box-shaped time profile. The vertical dotted line in IC86c indicates the time of the IceCube-170922A event.