Supplementary Text 3. Parameter estimation.

This study's parameter estimation is based on published experimental data from tomato [6, 20], specifically the relative expression profiles of core genes under combined light and temperature signals (Figure 3A). The fitting process is defined as follows: under a low-temperature stress condition (4°C) and a 12-hour light/12-hour dark photoperiod (12L:12D), we used the relative expression data of the *SlHY5* gene in wild-type plants as the primary fitting target. Simultaneously, the expression data of *SlMYB15* in wild-type, *hy5* mutant, and HY5-overexpression plants under identical conditions were integrated to establish correlations between gene expression and model parameters.

Model parameters were iteratively optimized using a least-squares error method to minimize the deviation between simulated and experimentally measured expression values for *SlHY5* and *SlMYB15*, yielding an optimal parameter set.

To validate the optimized parameters and the model's predictive capability, we simulated the relative expression of downstream genes *SlCBF1* and *SlCOR413* under altered light conditions (24L and 16L:8D). Comparing these simulations with potential experimental patterns verified the model's stability and applicability, providing a reliable foundation for analyzing the molecular mechanisms of light-temperature signal integration in tomato cold acclimation.

References

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[20] Han, N., Fan, S., Zhang, T., Sun, H., et al., SlHY5 is a necessary regulator of the cold acclimation response in tomato. *Plant Growth Regul* 2020, *91*, 1–12.