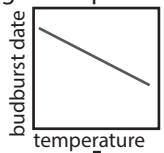
# Forecasting future biological responses to climate change: why photoperiod matters

**Common approach** (without photoperiod)- e.g., species distribution models

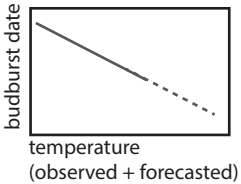
Observational climate & biological data (e.g., phenology, presence)

| year | temperature | day of year |
|---|---|---|
| 1901 | 12 | 90 |
| 1902 | 13.5 | 95 |
| 1903 | 11.8 | 88 |
| 1904 | 14 | 100 |
| ... | ... | ... |

Use temperature data to predict biological response.




Forecast future using temperature projections.



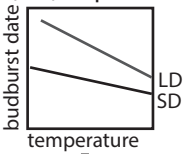

Erroneous predictions?

**Alternative approach** (with short-day/long-day)- e.g., process-based models

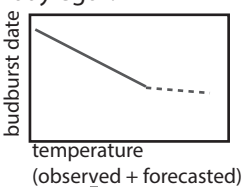
Experimental data with temperature & daylength

| daylength | temperature | day of year |
|---|---|---|
| SD | 10 | 90 |
| SD | 12 | 80 |
| LD | 10 | 85 |
| LD | 12 | 78 |
| ... | ... | ... |

Use temperature & daylength categorical data (L/S) to predict biological response




Forecast future using temperature projections & daylegth.



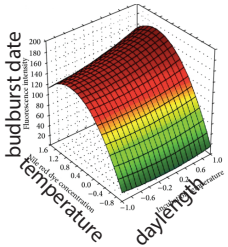

More accurate predictions?

**An even better(?) approach** (with continuous photoperiod)-

Observational or experimental data with temperature & daylength

| daylength | temperature | day of year |
|---|---|---|
| 8 | 11 | 90 |
| 8.2 | 12.5 | 80 |
| 10.1 | 10.8 | 85 |
| 9.5 | 12.1 | 78 |
| ... | ... | ... |

Use temperature & daylength data to predict biological response




Even more accurate predictions?