6. False codling moth (*Thaumatotibia leucotreta*)

Last modified: November 12, 2026

6A. Introduction

Native to sub-Saharan Africa, the false codling moth (FCM), *Thaumatotibia leucotreta* Meyrick (Lepidoptera: Tortricidae), is a highly polyphagous pest distributed throughout much of Africa and parts of the Middle East, including Israel (Carstens and Moore 2020). Its economically important hosts include avocado, *Citrus* spp., corn, cotton, eggplant, grapes, stone fruits, peppers, and cut roses (EPPO 2025). FCM undergoes five larval instars, during which larvae bore into and feed within plant tissues, particularly fruit, causing direct damage before exiting the host to form cocoons in the soil (NAPPFAST 2003, Gilligan et al. 2011). Although not established in the United States, FCM has been repeatedly intercepted at U.S. ports of entry in cargo and passenger baggage (Venette et al. 2003, Stibick 2006). The only confirmed domestic detection occurred in 2008, when a single adult male was found in Ventura County, California. Subsequent extensive trapping detected no additional individuals, and the introduction was successfully eradicated (Gilligan et al. 2011). The establishment of FCM in the United States could result in substantial economic losses, potentially reaching billions of dollars (Venette et al. 2003, Stibick 2006).

A model for FCM developed for the Degree-Day, establishment Risk, and Phenological event mapping system (DDRP) is operationalized to produce near real-time forecasts for the contiguous United States (CONUS) at https://uspest.org/DDRP. The full set of model parameters for FCM, including developmental temperature thresholds, degree-day requirements for individual life stages, and climate stress thresholds and limits, are available at USPest.org (Barker and Coop 2019).

6B. Results

i. Phenology

Entire period: 1981–2025

Trends in predicted first adult emergence and egg hatch for FCM over the 44-year period (1981–2025) were predominantly negative, indicating that both phenological events shifted earlier over time (Figure 1, Figure 2). Earlier phenology was predicted across much of the eastern, south-central, and western United States. Statistically significant trends were more spatially restricted, occurring primarily in portions of the East and Southwest and scattered areas of the Intermountain West. Within these regions, predicted adult emergence and egg hatch shifted earlier by approximately 0.01–0.6 days per year, with some of the largest shifts occurring in southern latitudes. Trends toward later phenology occurred in a some isolated areas of the Great Plains and Intermountain West but most were not statistically significant.

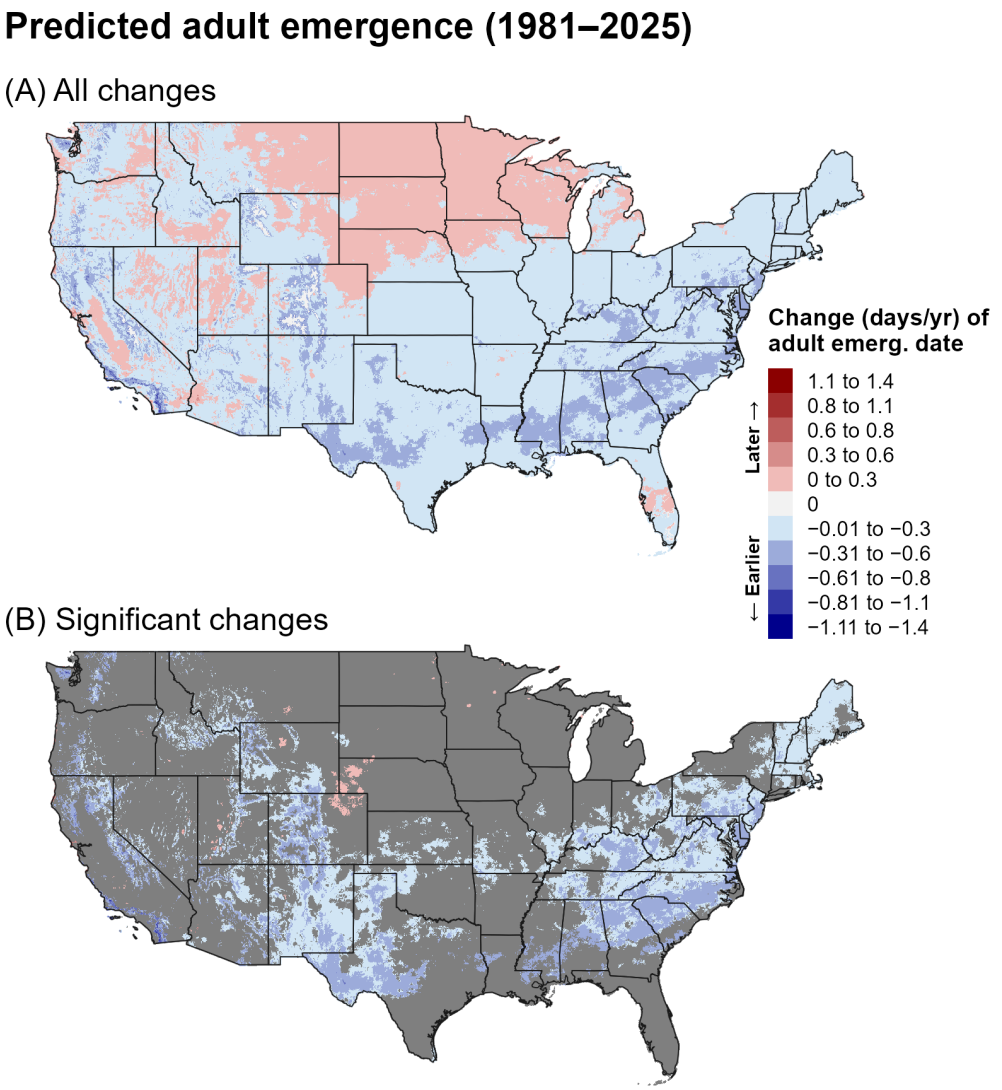


Figure 1. Changes (days/year) in predicted dates of first adult emergence for FCM across the CONUS over the entire 44-year period (1981–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant.

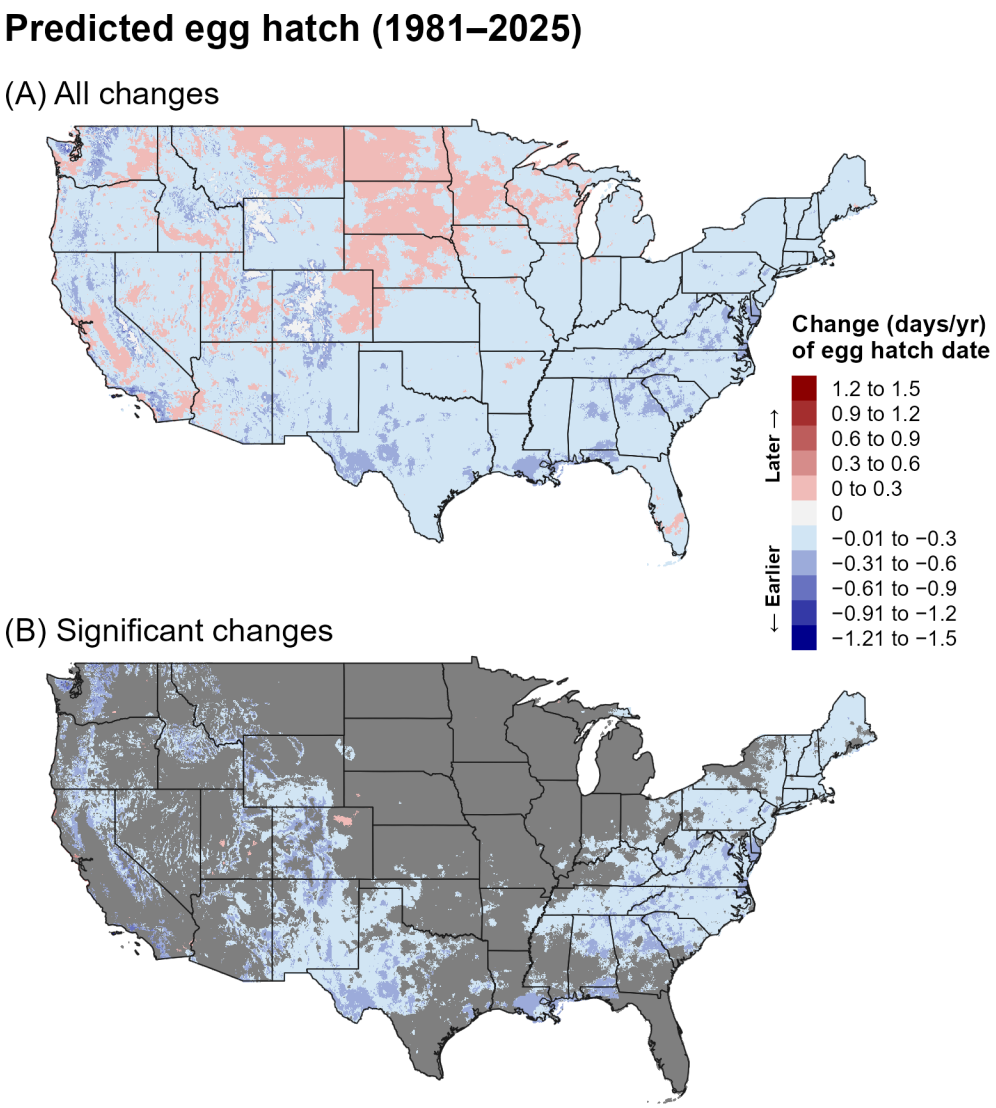


Figure 2. Changes (days/year) in predicted dates of first egg hatch for FCM across the CONUS over the entire 44-year period (1981–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant.

Recent period: 2001–2025

Trends in predictions of first adult emergence and egg hatch for FCM over the recent 24-year period (2001–2025) were partially consistent with those observed over the 1981–2025 period. Trends were more spatially heterogeneous, with significantly later predicted events across portions of the central and northern United States and earlier events in parts of the Southeast and West (Figure 3, Figure 4). Significant changes were relatively localized, particularly in the central and eastern United States.

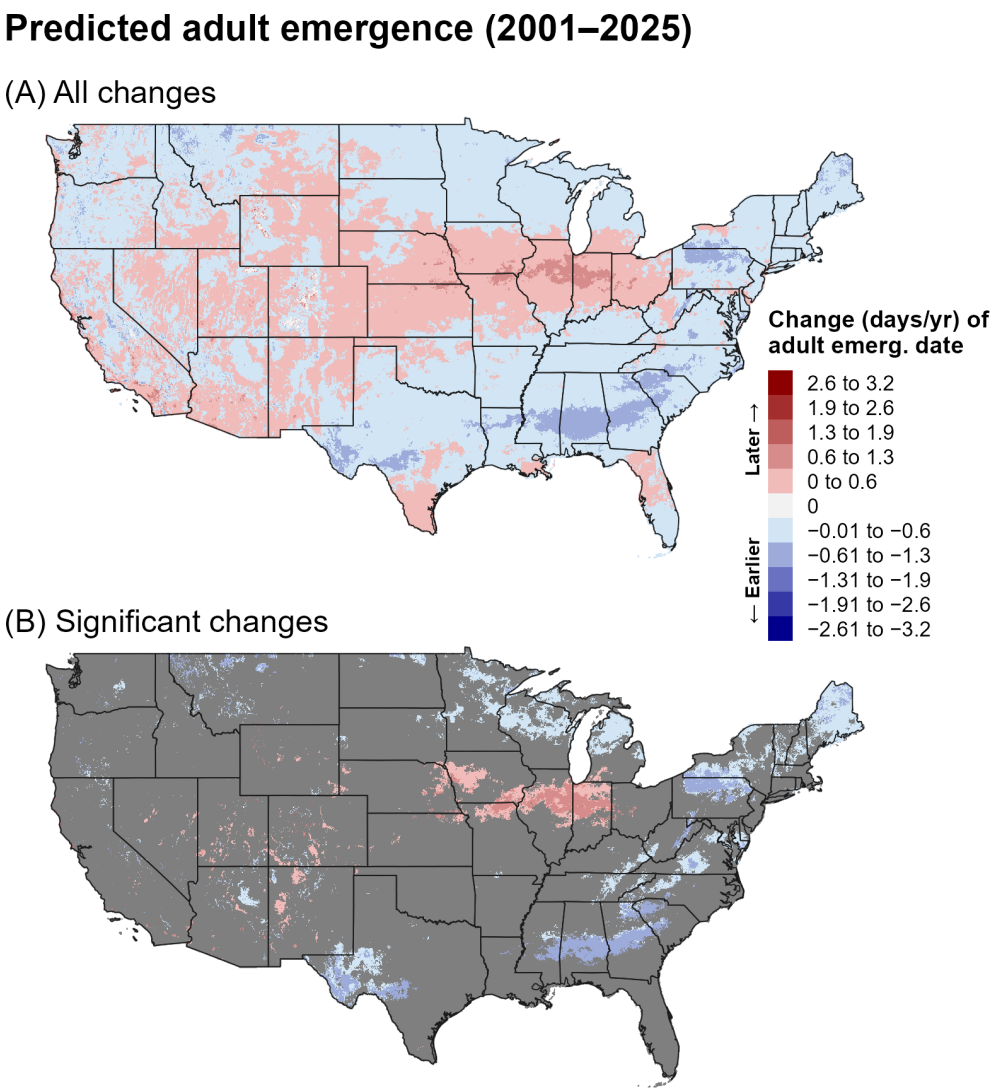


Figure 3. Changes (days/year) in predicted dates of first adult emergence for FCM across the CONUS over the recent 24-year period (2001–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant.

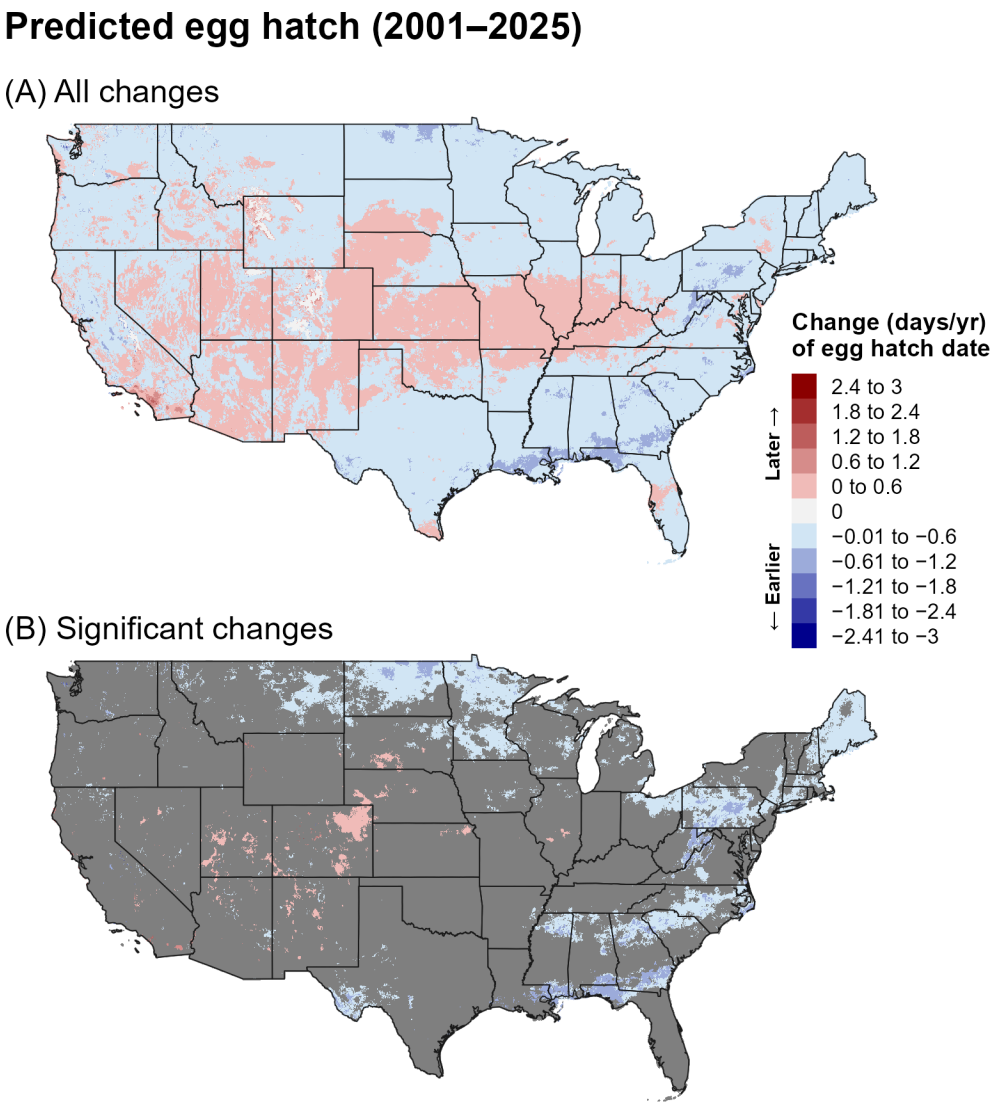


Figure 4. Changes (days/year) in predicted dates of first egg hatch for FCM across the CONUS over the recent 24-year period (2001–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant.

ii. Climatic suitability

Entire period: 1981–2025

Over the entire 44-year period (1981–2025), predicted cold stress for FCM decreased across much of the northern and western United States, with significant decreases especially evident in the Upper Midwest, Northeast, and the Intermountain West (Figure 5). However, decreases across the Southeast, Great Plains, northern interior, and Pacific Coast were generally smaller and significant in only some areas. Predicted heat stress significantly increased in isolated parts of the Southwest and California (Figure 6). Climatic suitability increased significantly in parts of California and the southern United States, particularly along the Gulf Coast, although these trends were spatially limited (Figure 7). Decreases in suitability owing to heat stress were predicted in parts of the Sonoran Desert region of the Southwest.

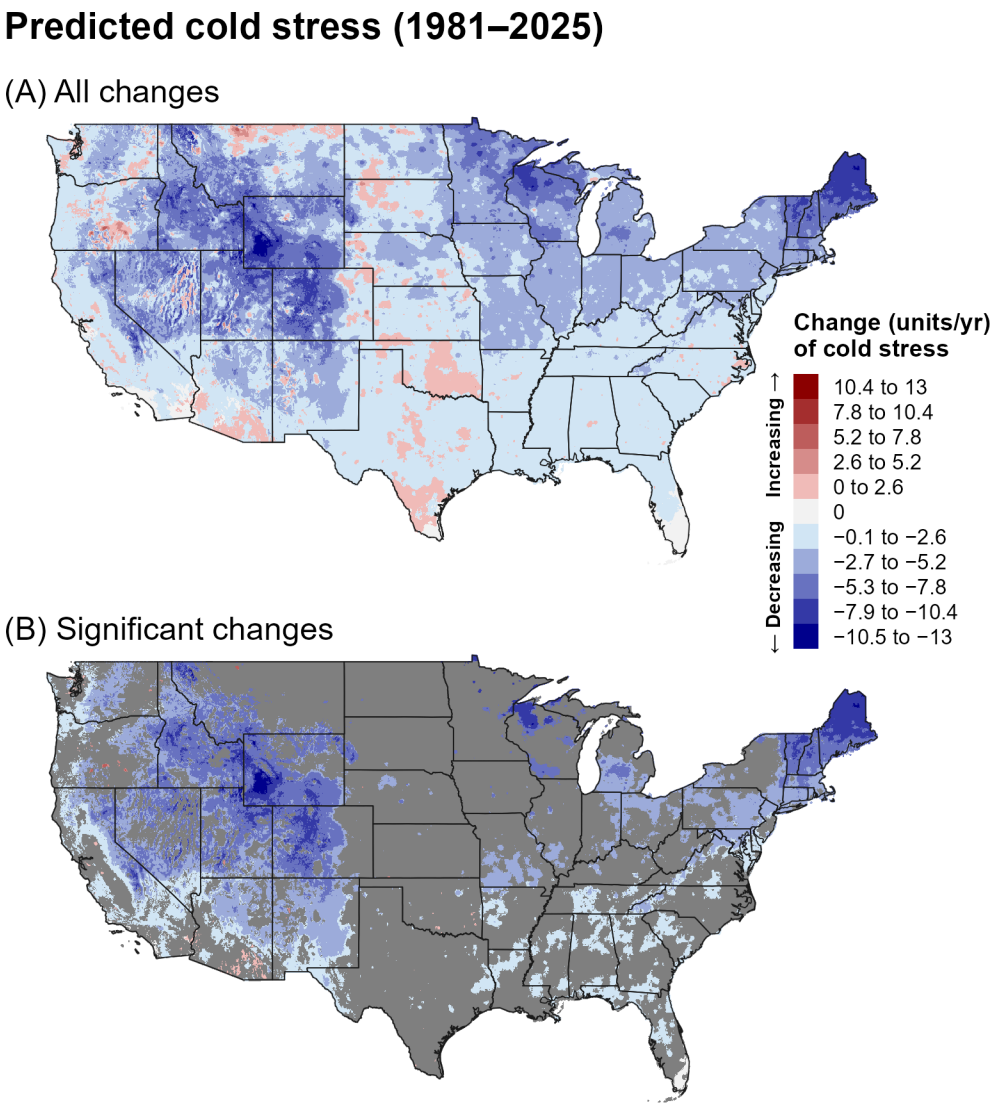


Figure 5. Changes (units/year) in predicted cold stress for FCM across the CONUS over the entire 44-year period (1981–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant. Areas shown as 0 in (B) had significant trends but very small changes.

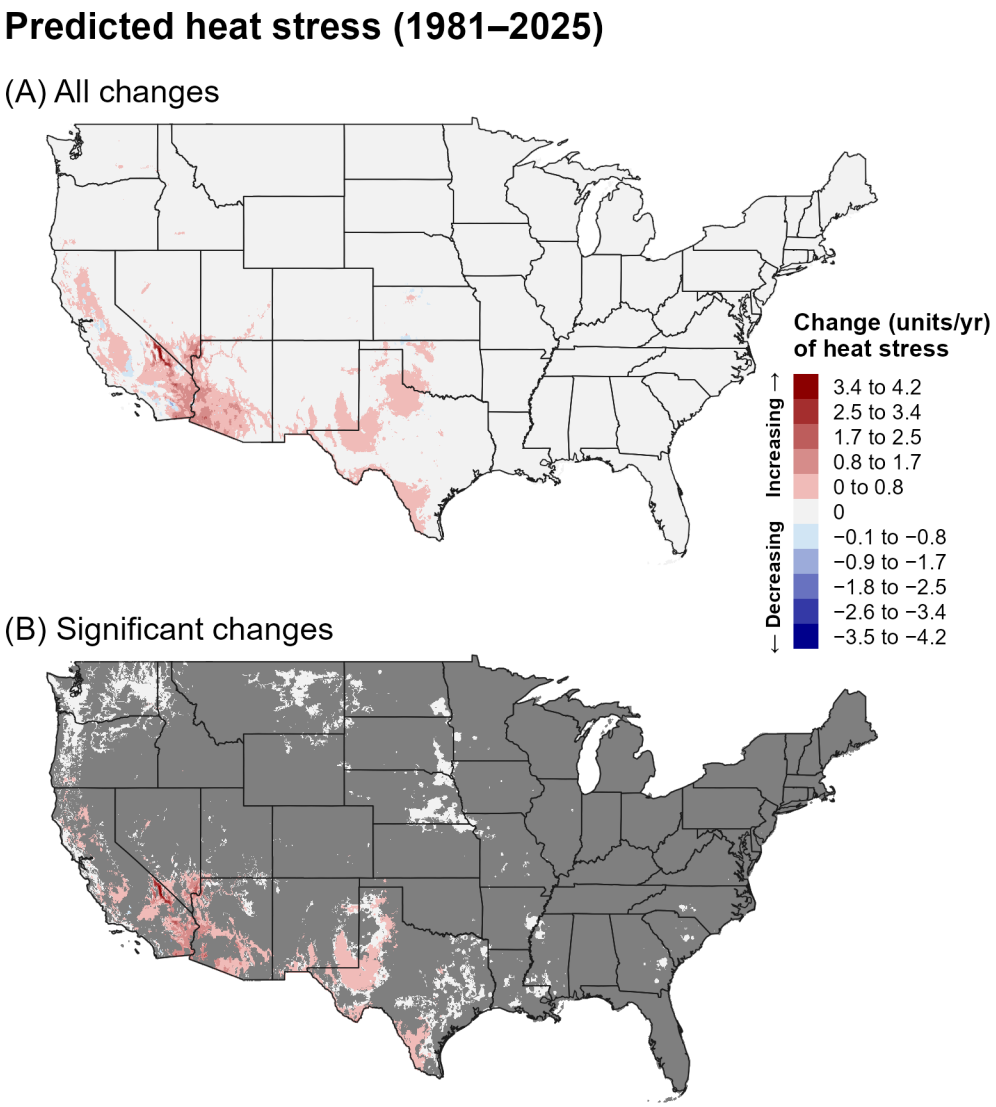


Figure 6. Changes (units/year) in predicted heat stress for FCM across the CONUS over the entire 44-year period (1981–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant. Areas shown as 0 in (B) had significant trends but very small changes.

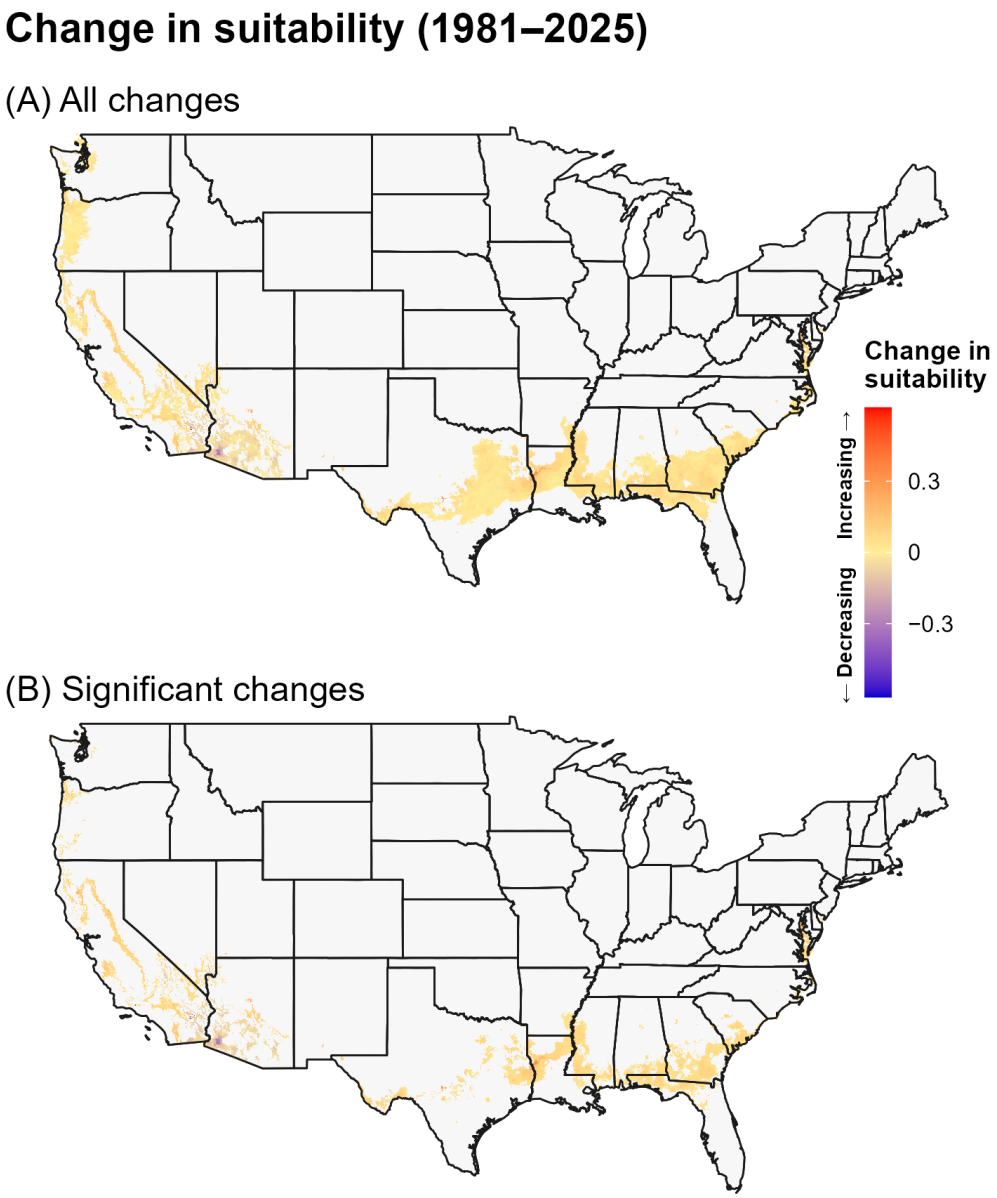


Figure 7. Changes in predicted climatic suitability for FCM across the CONUS over the 44-year period (1981–2025). Suitability is defined as areas not excluded by climate stress. Positive changes (warmer colors) indicate an increased likelihood of establishment, whereas negative changes (cooler colors) indicate a decreased likelihood of establishment.

Recent period: 2001–2025

Many areas that exhibited significant decreases in cold stress for FCM over 1981–2025 no longer showed significant trends during the recent period. These areas were concentrated in scattered patches across the Northeast, Southeast, and California (Figure 8). Significant increases in predicted cold stress occurred in a few small, isolated areas of the Northwest. Areas with increasing heat stress were concentrated in the Southwest, particularly Texas, whereas parts of California showed significant decreases (Figure 9). The climatic-suitability map showed relatively limited significant change, although increases remained evident in small portions of the South (Figure 10).

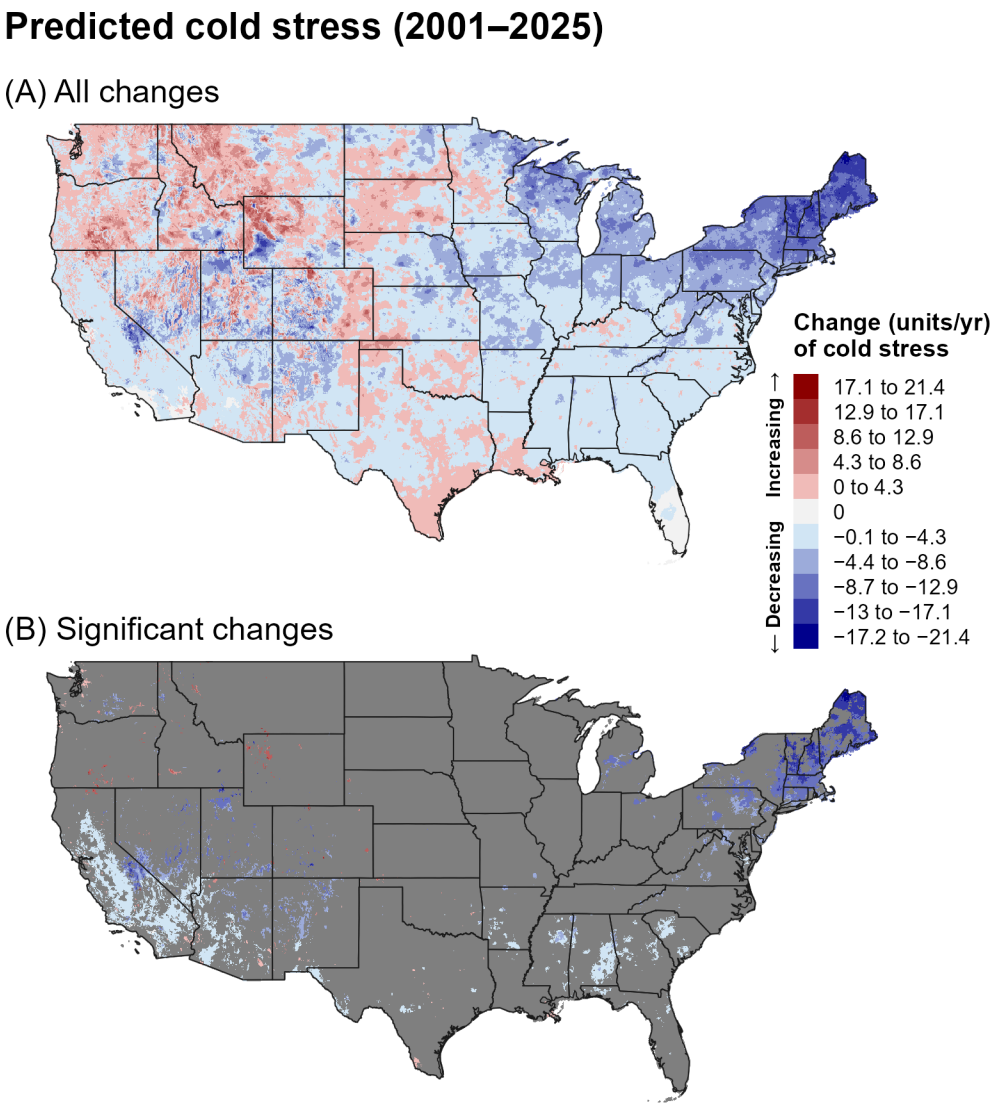


Figure 8. Changes (units/year) in predicted cold stress for FCM across the CONUS over the recent 24-year period (2001–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant. Areas shown as 0 in (B) had significant trends but very small changes.

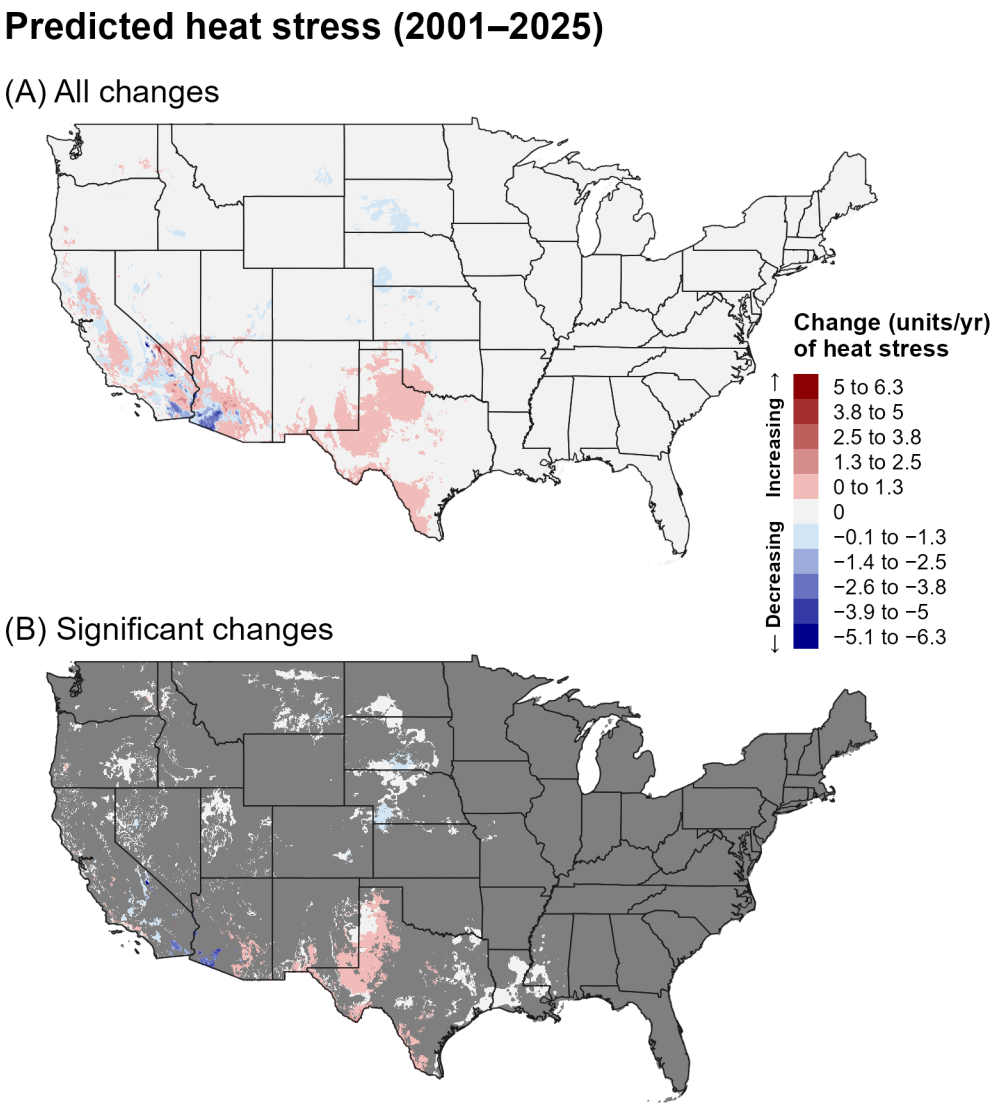


Figure 9. Changes (units/year) in predicted heat stress for FCM across the CONUS over the recent 24-year period (2001–2025). Maps show (A) all changes and (B) statistically significant changes ($P < 0.1$); areas shown in gray are not statistically significant. Areas shown as 0 in (B) had significant trends but very small changes.

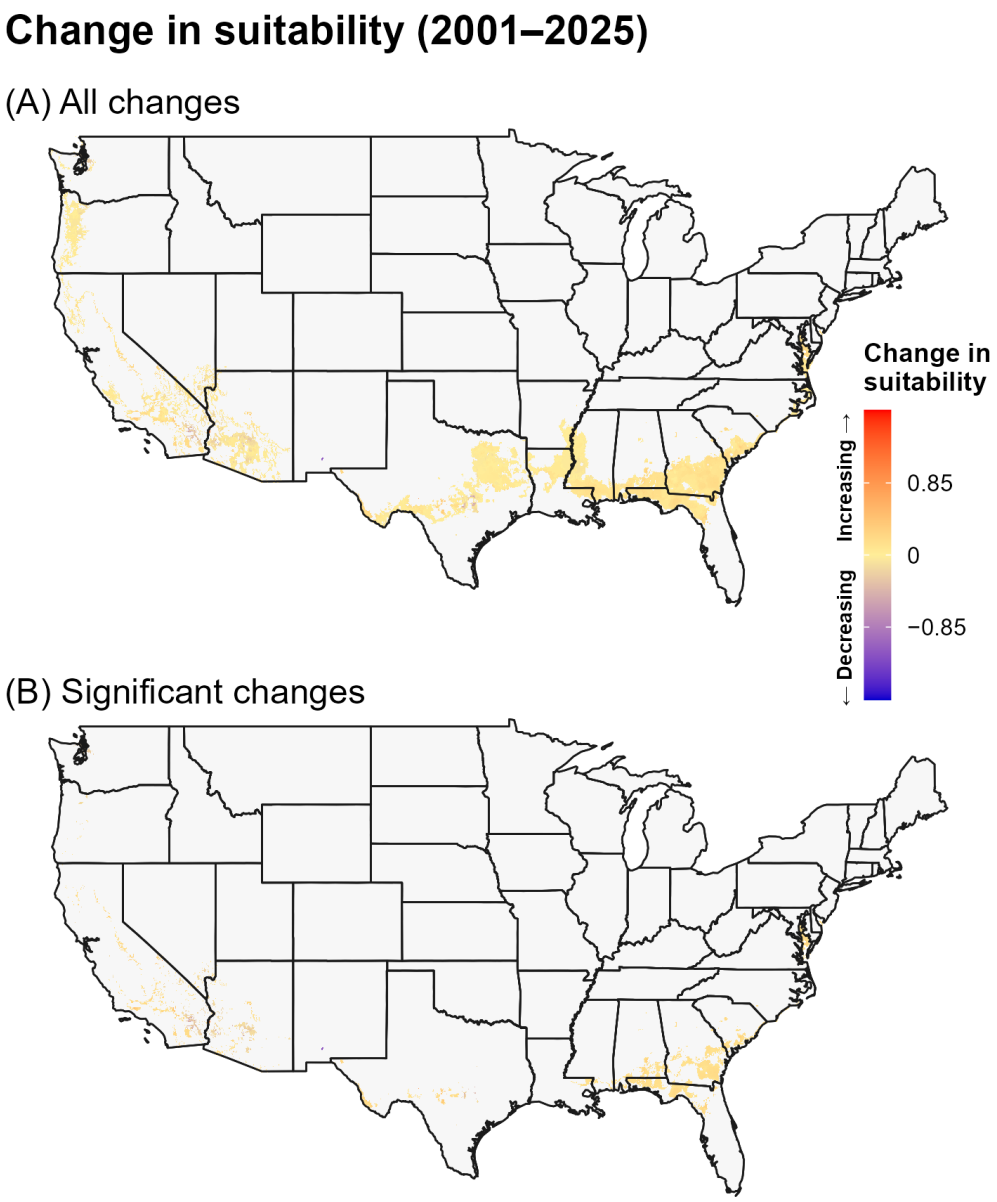


Figure 10. Changes in predicted climatic suitability for FCM across the CONUS over the recent 24-year period (2001–2025). Suitability is defined as areas not excluded by climate stress. Positive changes (warmer colors) indicate an increased likelihood of establishment, whereas negative changes (cooler colors) indicate a decreased likelihood of establishment.

6C. Discussion

Although FCM is not established in the CONUS, understanding potential changes in phenology can inform surveillance planning. In areas exhibiting significant trends toward earlier phenology, predicted dates shifted earlier by approximately 0.01–0.6 days per year, suggesting that surveillance materials may need to be deployed earlier in the season. These trends may be particularly relevant where they overlap with major host-fruit production areas, including regions supporting intensive cultivation of citrus and other susceptible crops, such as avocados, peaches, and cotton. Such areas include parts of Florida, the Gulf Coast, and California (NAPPFAST 2003).

Earlier adult emergence and egg hatch could potentially allow FCM to complete more generations per year, increasing pest pressure and associated crop damage. FCM can complete 2–10 generations annually, with developmental rates and voltinism influenced by temperature, food availability and quality, photoperiod, and humidity (Venette et al. 2003, Gilligan et al. 2011). In areas predicted to be environmentally suitable in the CONUS, FCM may complete 1–9 generations (Barker and Coop 2019). Moisture conditions may further modify development and host use: drought can affect host-plant availability and quality (Gilligan et al. 2011), and experimental studies have demonstrated effects of moisture stress on FCM development and tomato infestation (Patrick et al. 2021).

Decreases in predicted cold stress across parts of the CONUS, particularly in southern regions with substantial host-fruit production, suggest that low temperatures have become less limiting to FCM establishment in these areas. A biome-based risk assessment identified parts of Florida and the western United States, excluding the Pacific Coast, as suitable for FCM establishment (Venette et al. 2003), while subsequent modeling predicted suitable conditions in California and other parts of the Pacific Coast, as well as portions of the South (Barker and Coop 2019). These findings highlight the importance of continued surveillance, particularly in regions where susceptible crop hosts overlap with increasingly favorable climatic conditions.

In contrast, predicted heat stress increased significantly in the hottest parts of the Southwest, particularly the Sonoran Desert region, corresponding to declines in establishment suitability. Thus, despite the availability of suitable crop hosts, increasing thermal stress may make some areas less favorable for FCM establishment. However, these patterns should be interpreted cautiously because DDRP models assume equivalent climatic tolerances across life stages, which may not reflect FCM thermal biology. Larvae tolerate a broader range of temperatures than adults, while adults exhibit a heat-hardening response (Stotter and Terblanche 2009, Terblanche et al. 2017). Consequently, predicted climate-stress trends provide an indication of changing thermal constraints but should not be interpreted as a definitive measure of establishment potential.

The stronger and more spatially extensive trends in predicted phenology and climate stress over the entire 44-year period likely reflect both the greater number of years included, which may reduce interannual variability and improve the detection of directional trends, and differences in the underlying climatic trends between the two study periods. In particular, the recent 24-year period may capture climate variability or regional trends that differ from those observed over the longer 44-year period. Thus, differences between the two periods should be interpreted as reflecting both long-term climate trends and shorter-term regional variability.

6D. References

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