High Resolution Models Fail to Reproduce Rising Heat Hazard in South Florida

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I. Introduction

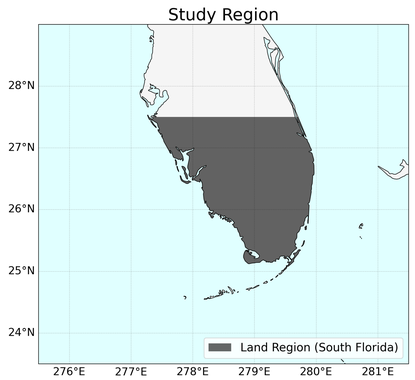

Figure 1: Study region of South Florida used for analysis.

- Wet Bulb Globe Temperature (WBGT) is a physiologically based metric of heat hazard that incorporates temperature, humidity, wind speed, and sun angle. The number of hours at hazardous WBGT thresholds in the South Florida region has increased over time, particularly in April and November, due to the seasonal variation in temperature trends (Figure 2).

- Previous work has established the key role of precipitation in suppressing increases in temperature during the wet/heat season.

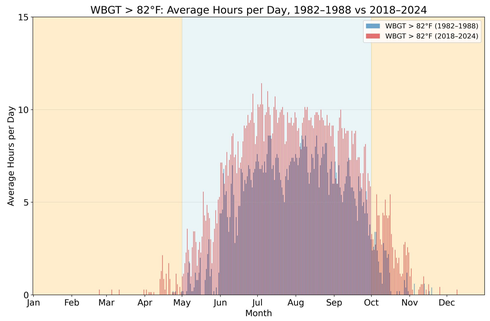

Figure 2: The monthly exceedance hour climatology for WBGT greater than 82°F from the base period 1982-1988 (blue) and the recent period 2018-2024 (red).

- **We evaluate CESM-LR (40-member ensemble) and CESM-HR (10- member ensemble) and compare with the ERA5-Reanalysis to assess how well these models simulate the observed climatology and trends in precipitation and temperature.**

II. Results- Land Surface Temperature Climatology

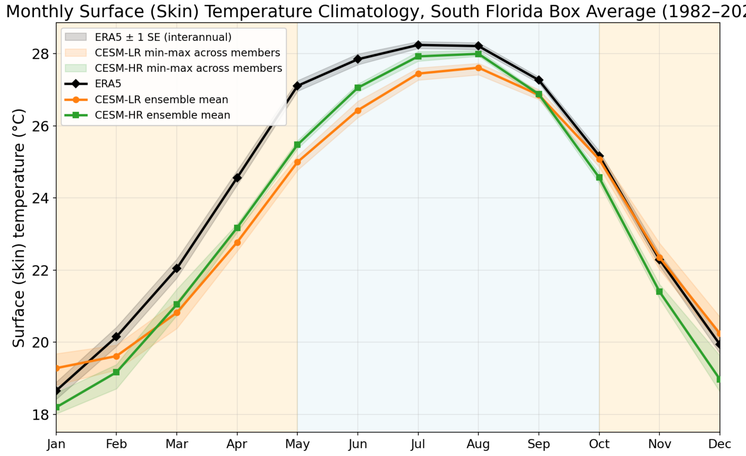

Figure 3: The monthly climatology of surface temperature in South Florida for ERA5 Reanalysis (black), CESM-LR ensemble mean (orange), and CESM-HR ensemble mean (green). The black cloud denotes +/- 1 SE for ERA5, while the orange and green clouds denote the minimum and maximum ensemble member for each model.

Both CESM-LR and CESM-HR simulate the seasonal cycle of surface temperature in South Florida, though they have a consistent cool bias compared to ERA5-Reanalysis during the late dry season and wet season.

III. Results- Precipitation Climatology

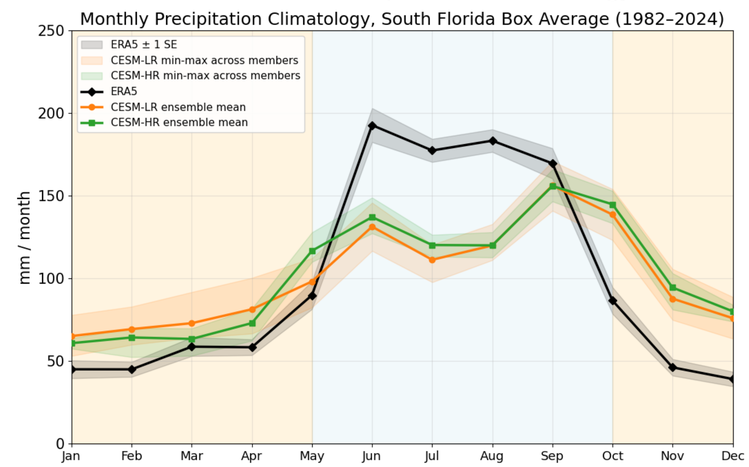

Figure 4: The monthly climatology of precipitation in South Florida for ERA5 Reanalysis (black), CESM-LR ensemble mean (orange), and CESM-HR ensemble mean (green). The black cloud denotes +/- 1 SE for ERA5, while the orange and green clouds denote the minimum and maximum ensemble member for each model.

Both CESM-LR and CESM-HR models underestimate the wet season precipitation comparted to ERA5-Reanalysis. Additionally, they overestimate precipitation in the early dry season (Oct-Dec), producing a less distinct annual precipitation cycle compared to ERA5-Reanalysis.

IV. Results- Land Surface Temperature Trends

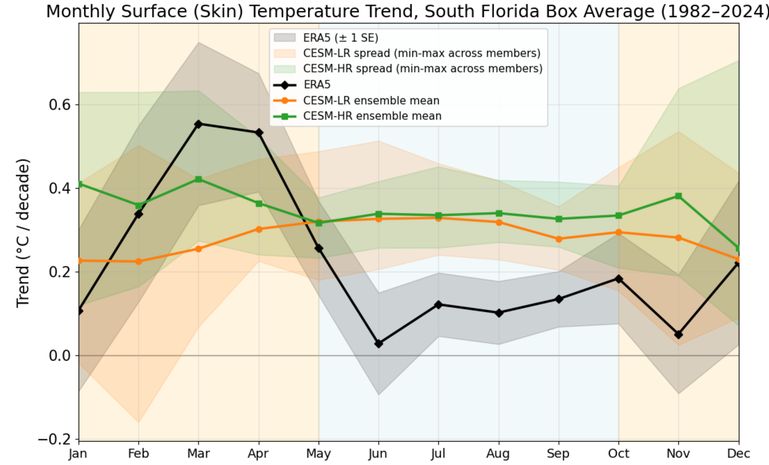

Figure 5: Monthly trends of surface temperature in South Florida for ERA5-Reanlaysis (black), CESM-LR (orange), and CESM-HR (green). The black cloud denotes +/- 1 SE for ERA5, while the orange and green clouds denote the minimum and maximum ensemble member for each model.

ERA5-Reanalysis surface temperature trends show a distinct seasonal cycle, with decreased warming trend in the wet season. Both CESM-HR and CESM-LR fail to produce this seasonal trend. This suggests that models likely underestimate the increases in hazardous WBGT hours during the dry season and overestimate the increase in hazardous hours during the dry season.

V. Results- Precipitation Trends

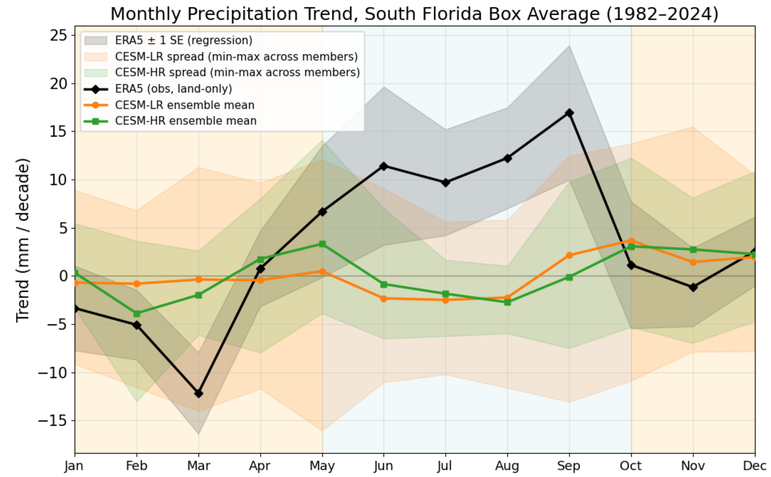

Figure 6: Monthly trends of precipitation in South Florida for ERA5-Reanlaysis (black), CESM-LR (orange), and CESM-HR (green). The black cloud denotes +/- 1 SE for ERA5, while the orange and green clouds denote the minimum and maximum ensemble member for each model.

ERA5-Reanalysis precipitation trends show a seasonal pattern of increasing precipitation during the wet season. This seasonal precipitation trend is absent in CESM-LR and CESM-HR, which both show minimal precipitation trend throughout the year.

VI. Key Points

- While the CESM-LR and CESM-HR models capture land surface temperature climatology relatively well, they fail to simulate precipitation climatology in the region.
- Models fail to capture the seasonal patterns in land surface temperature trends as well as precipitation trends. Increased model resolution does not improve the simulation of these trends.
- Since models fail to capture these key trends, they likely underestimate the increase in heat hazard in the dry season, and their future projections may not capture how wet season precipitation changes will influence future warming.

VII. References

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