Earth’s Future

Supporting Information for

Decreasing Dust over the Middle East Partly Caused by Irrigation Expansion

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**Table S1.** List of observations and reanalyses used in this study.

| Sources     | Variables                  | Purposes                                      |
|-------------|----------------------------|-----------------------------------------------|
| HYDE        | Area equipped with irrigation | Trend analysis                                |
| CALIPSO     | DOD                        | Trend analysis and model evaluation           |
| GLEAM       | Top 10 cm soil moisture     | Trend analysis and model evaluation           |
| GLDAS       | Top 10 cm soil moisture     | Trend analysis                                |
| ESA-CCI     | Top 10 cm soil moisture     | Trend analysis                                |
| CPC         | Top 10 cm soil moisture     | Trend analysis                                |
| CPC         | Precipitation               | Trend analysis and model evaluation           |
| TRMM        | Precipitation               | Trend analysis                                |
| GPCP        | Precipitation               | Trend analysis                                |
| JRA-55      | Winds                      | Trend analysis and model evaluation           |
| ERA-5       | Winds                      | Trend analysis                                |
| MERRA-2     | Winds                      | Trend analysis                                |
| MODIS Aqua  | NDVI                       | Trend analysis                                |
| MERRA-2     | Surface pressure            | Model evaluation                              |
| MERRA-2     | Surface air temperature     | Model evaluation                              |
Table S2. Evaluation of variables simulated by CESM against observations/reanalyses over the domain (10°-40° N, 40°-80° E). For observations/reanalyses, CALIPSO is used for DOD, CPC product for precipitation and GLEAM for top 10 cm soil moisture, and JRA-55 for 700 hPa wind speed and MERRA2 for surface pressure and surface air temperature. Values in the columns for CESM and OBS are the regional mean ± standard deviation. The statistical parameters are the coefficient of determination ($R^2$), the weighted root-mean-square error (RMSE), and the mean bias error (MBE).

| Variables (Units)          | CESM      | OBS       | $R^2$ | RMSE | MBE  |
|----------------------------|-----------|-----------|-------|------|------|
| DOD                        | 0.09 ± 0.02 | 0.17 ± 0.03 | 0.80  | 0.10 | -0.08|
| Precipitation (mm day$^{-1}$) | 1.75 ± 0.35 | 1.14 ± 0.13 | 0.73  | 1.10 | 0.61 |
| 700 hPa wind speed (m s$^{-1}$) | 2.31 ± 0.92 | 3.20 ± 0.06 | 0.62  | 1.44 | -0.89|
| Surface soil moisture (kg m$^{-2}$) | 16.86 ± 0.38 | 15.50 ± 0.47 | 0.66  | 5.62 | 1.37 |
| Surface pressure (hPa)     | 1009.93 ± 3.28 | 1010.18 ± 5.57 | 0.67  | 2.02 | -0.25|
| Surface air temperature (K) | 295.81 ± 3.30 | 296.08 ± 5.27 | 0.89  | 2.51 | -0.26|
Figure S1. Spatial distributions of annual DOD, precipitation, and surface soil moisture in CTL and observations/reanalysis.
Figure S2. Same as Fig. S1, but for 700hPa winds, surface pressure, and surface air temperature.
Figure S3. Global distributions of (a) fractional coverage of irrigation (%) and (b) annual irrigation rates (mm/year) in each CLM grid in the IRR simulation.
**Figure S4.** Spatial distributions of seasonal differences in irrigation amounts (mm month\(^{-1}\)) for (a) winter, (b) spring, (c) summer, and (d) autumn between the IRR and CTL simulations (IRR minus CTL).
Figure S5. Same as Fig. S4, but for top 10 cm soil moisture.
Figure S6. Same as Fig. S4, but for total precipitation.
Figure S7. Same as Fig. S4, but for soil evaporation.
Figure S8. Same as Fig. S4, but for latent heat flux.
Figure S9. Same as Fig. S4, but for sensible heat flux.
Figure S10. Spatial distributions of seasonal total precipitation (mm/day) in the CTL simulation for (a) winter, (b) spring, (c) summer, and (d) autumn.
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Figure S13. Same as Fig. S4, but for dust wet deposition.
Figure S14. Frequency distributions of rainfall intensity over the study area (10° N–40° N, 40° E–80° E) from the CTL and IRR simulations.
Figure S15. Same as Fig. S4, but for surface air temperature.
Figure S16. Spatial distribution of annual differences in the planetary boundary layer (PBL) height (m) between the IRR and CTL simulations (IRR minus CTL).
Figure S17. Same as Fig. S4, but for surface pressure.
Figure S18. Same as Fig. S4, but for 10 m surface wind speed.
Figure S19. Same as Fig. S4, but for dust emission.