Memory of land temperature anomalies over Tibetan Plateau in different land models

Key Laboratory of Regional Climate-Environment for Temperate East Asia (RCE-TEA), Institute of Atmospheric Physics, Chinese Academy of Sciences
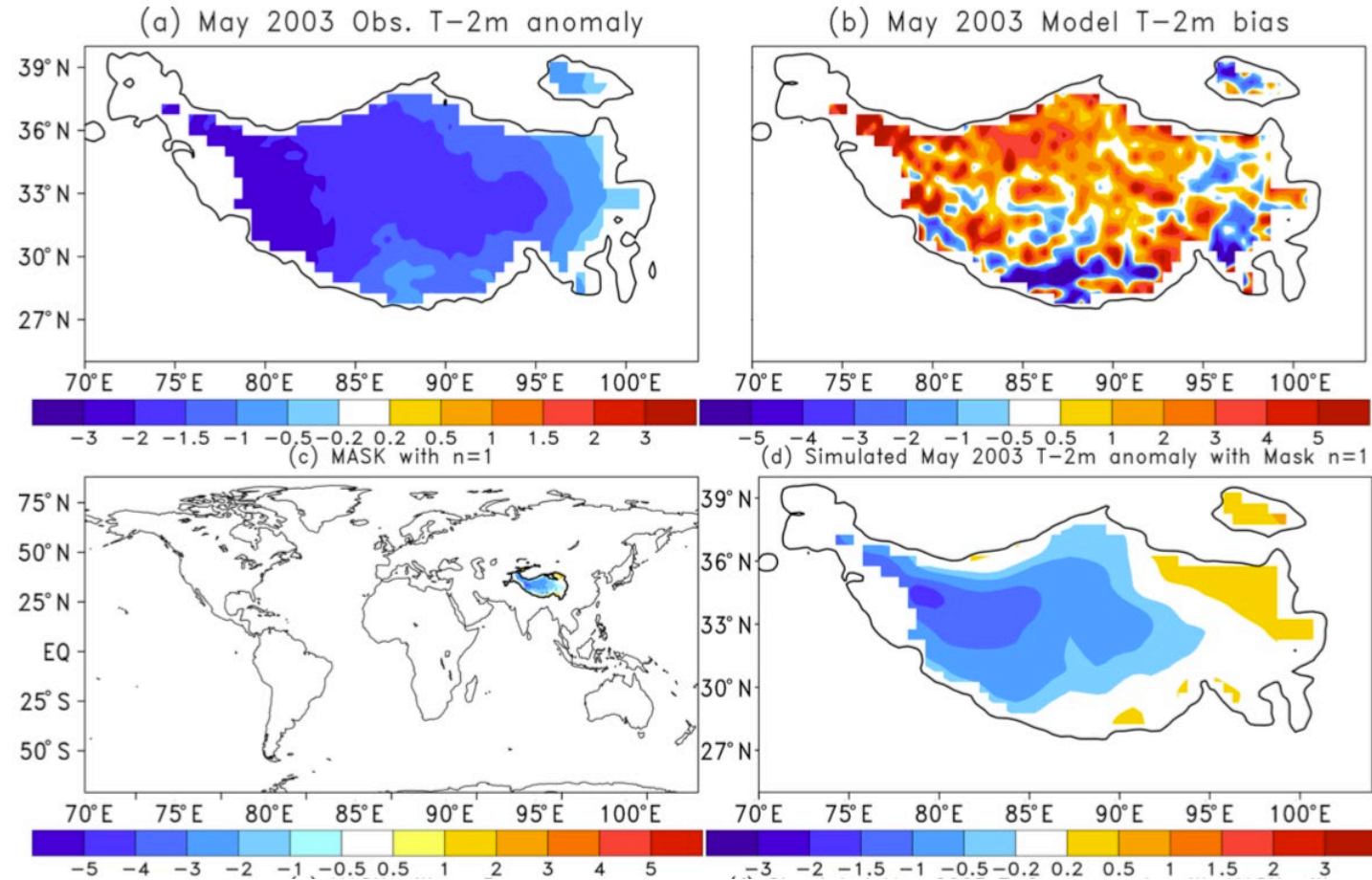
Yuan Qiu and Jinming Feng

$$\tilde{T}_0(i,j) = T_0(i,j) + \Delta T_{mask}(i,j) = T_0(i,j)$$
$$+ \left[-n \times T_{obs\ anomaly}(i,j) - T_{bias}(i,j)\right],$$
when $\bar{T}_{obs\ anomaly} \times \bar{T}_{bias} \geq 0,$

$$\tilde{T}_0(i,j) = T_0(i,j) + \Delta T_{mask}(i,j) = T_0(i,j)$$
$$+ \left[n \times T_{obs\ anomaly}(i,j) - T_{bias}(i,j)\right],$$
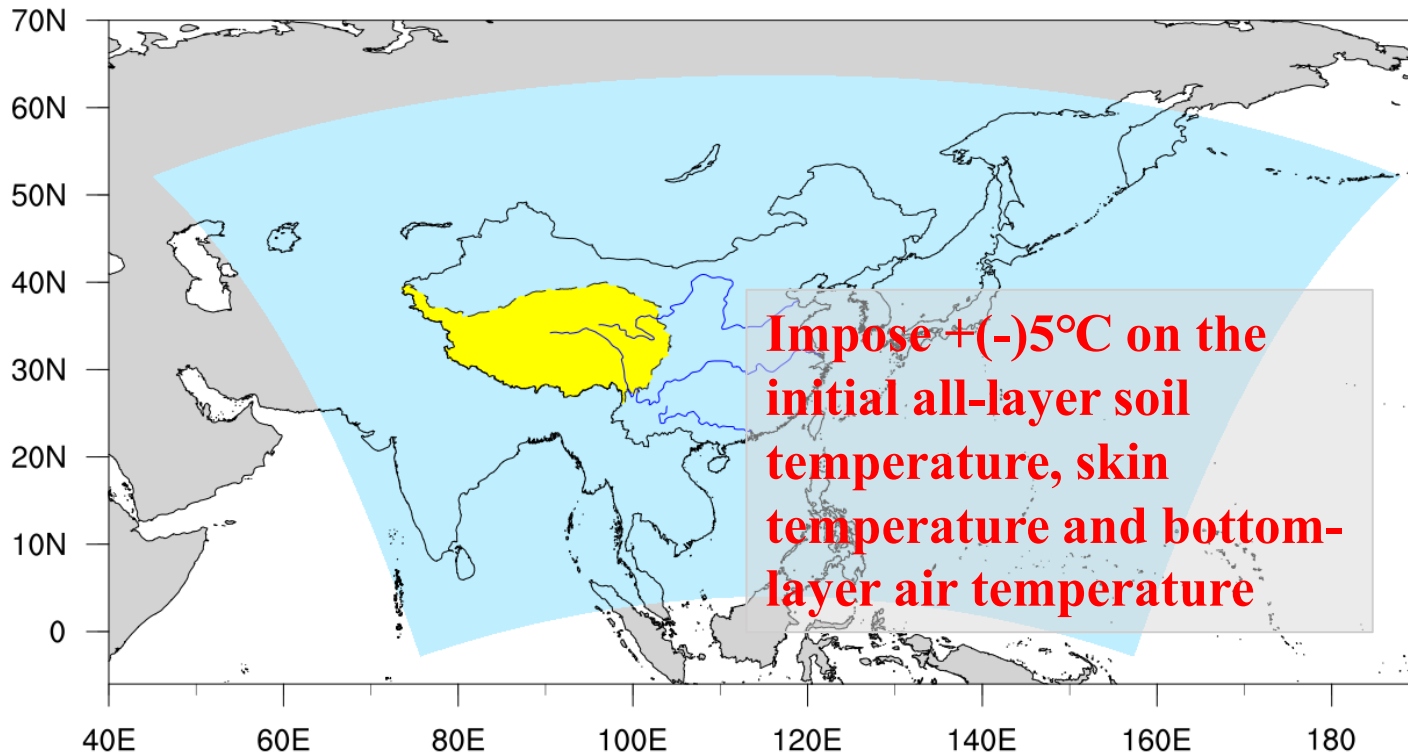when $\bar{T}_{obs\ anomaly} \times \bar{T}_{bias} < 0,$

"To date, all the LS4P ESMs with their land models … are also unable to maintain the imposed LST/SUBT anomaly from the mask during the model integration."   *Xue et al. 2021, GMD*

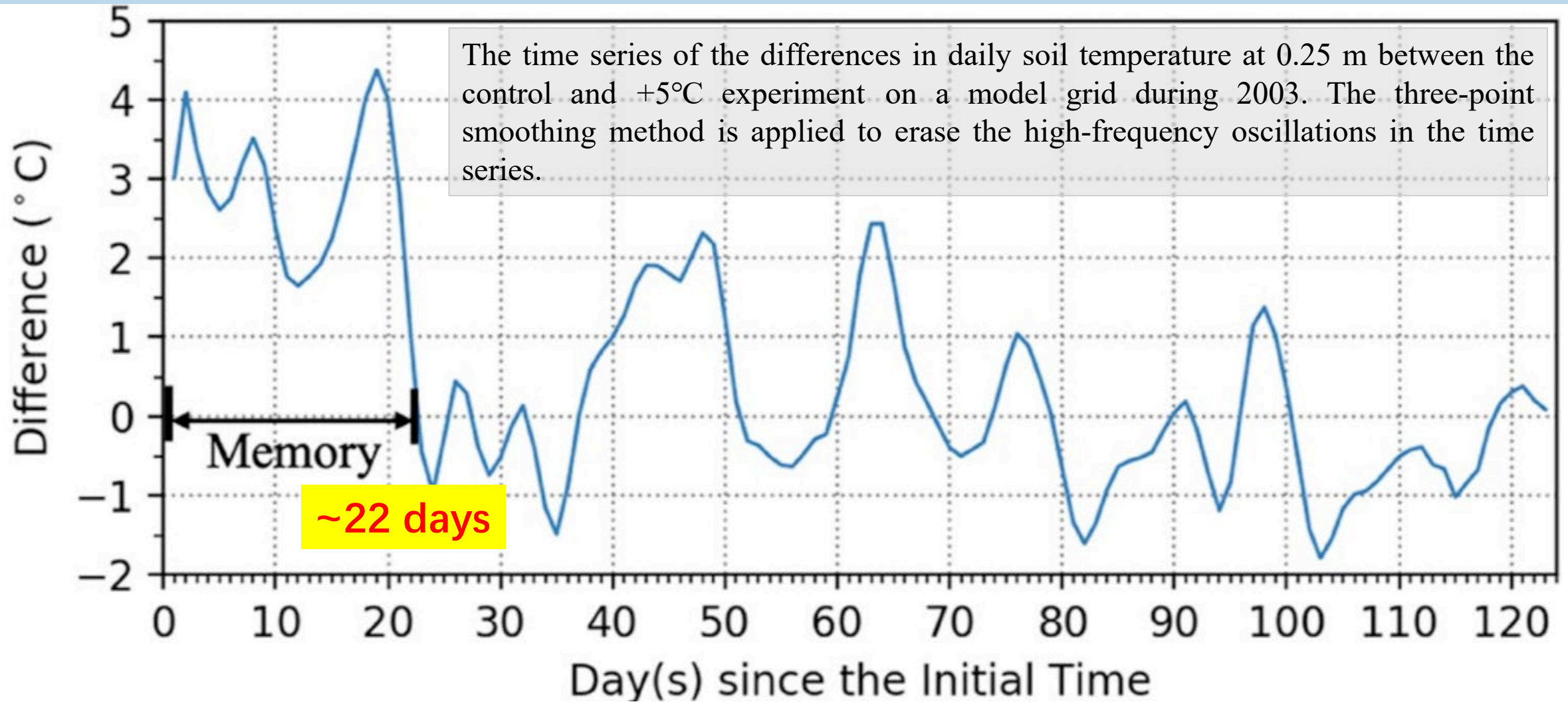Impose +(-)5°C on the initial all-layer soil temperature, skin temperature and bottom-layer air temperature

LSMs: SSiB, CLM4, and Noah-MP (coupled in the WRF model)

Simulation duration: May-August of 6 typical years (1987, 1991, 1996, 1998, 2003, and 2007)

Experiments: control, +5°C, -5°C

- How long do the LST/SUBT initial anomalies last in different land models?

- How does T2m response to the LST/SUBT initial anomalies in each model?

The time series of the differences in daily soil temperature at 0.25 m between the control and +5°C experiment on a model grid during 2003. The three-point smoothing method is applied to erase the high-frequency oscillations in the time series.
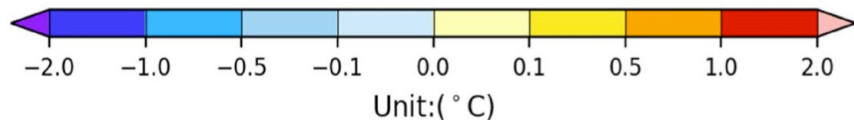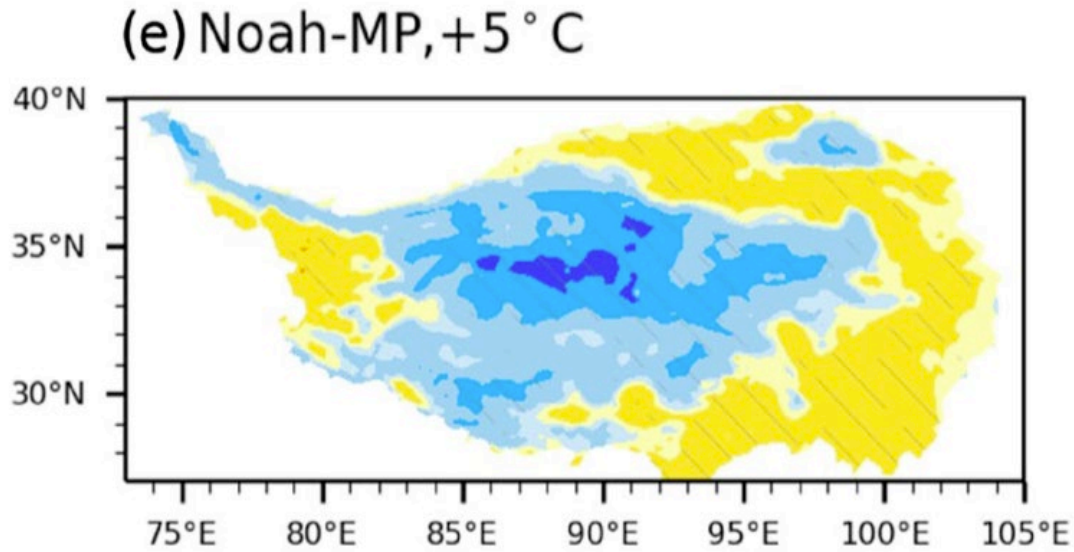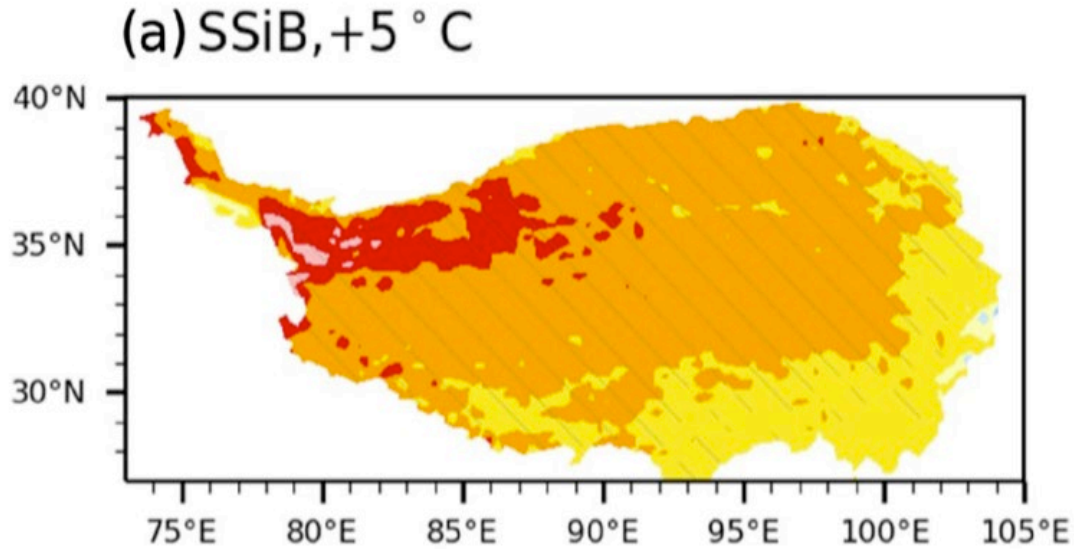
The memory of the initial LST/SUBT anomalies (surface/soil memory) is defined as how long the imposed anormal signals can last in the model integration, with the unit of days.
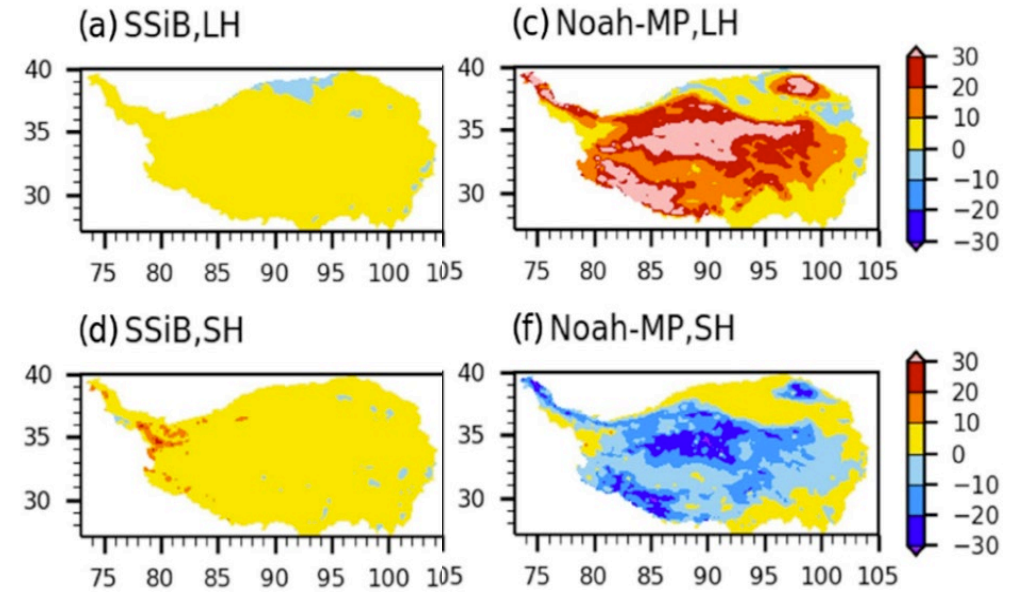
The surface/soil memory in the +5°C experiment
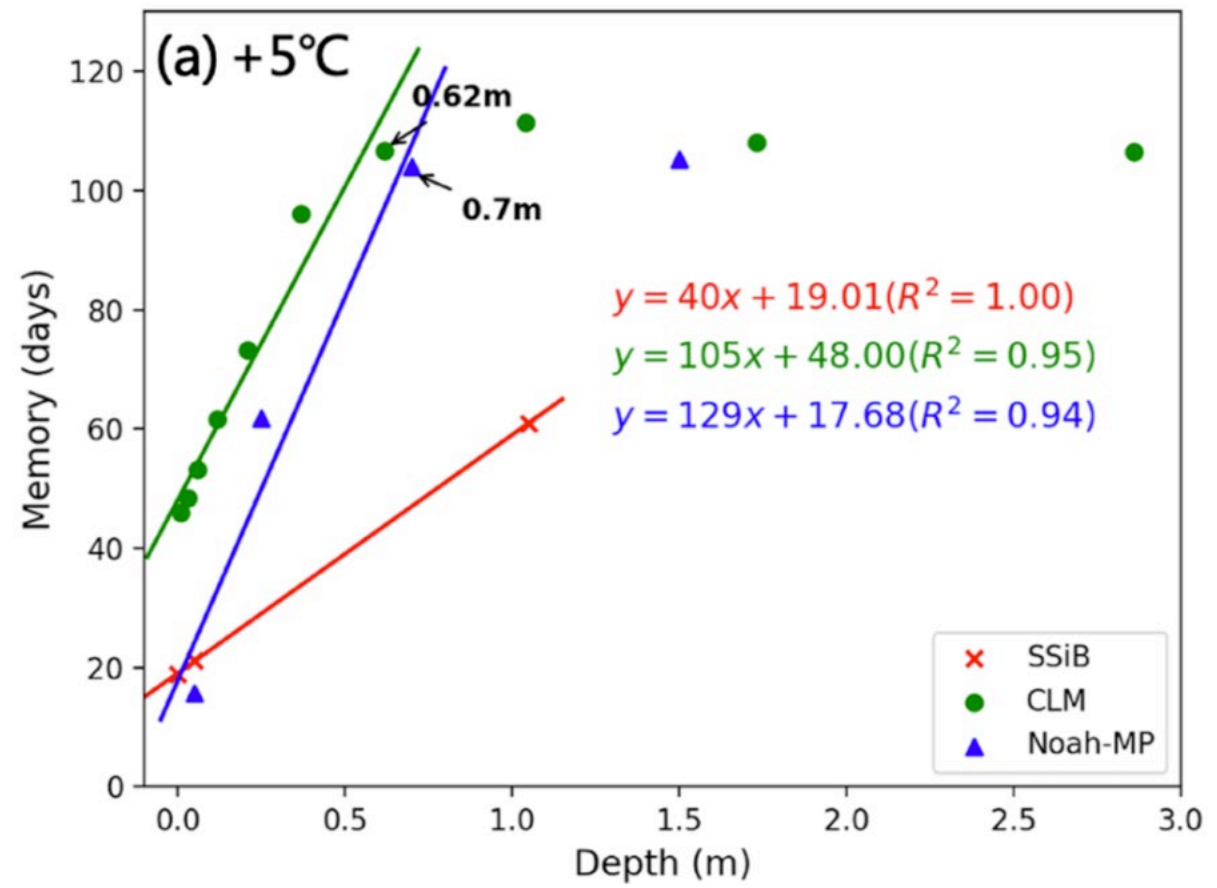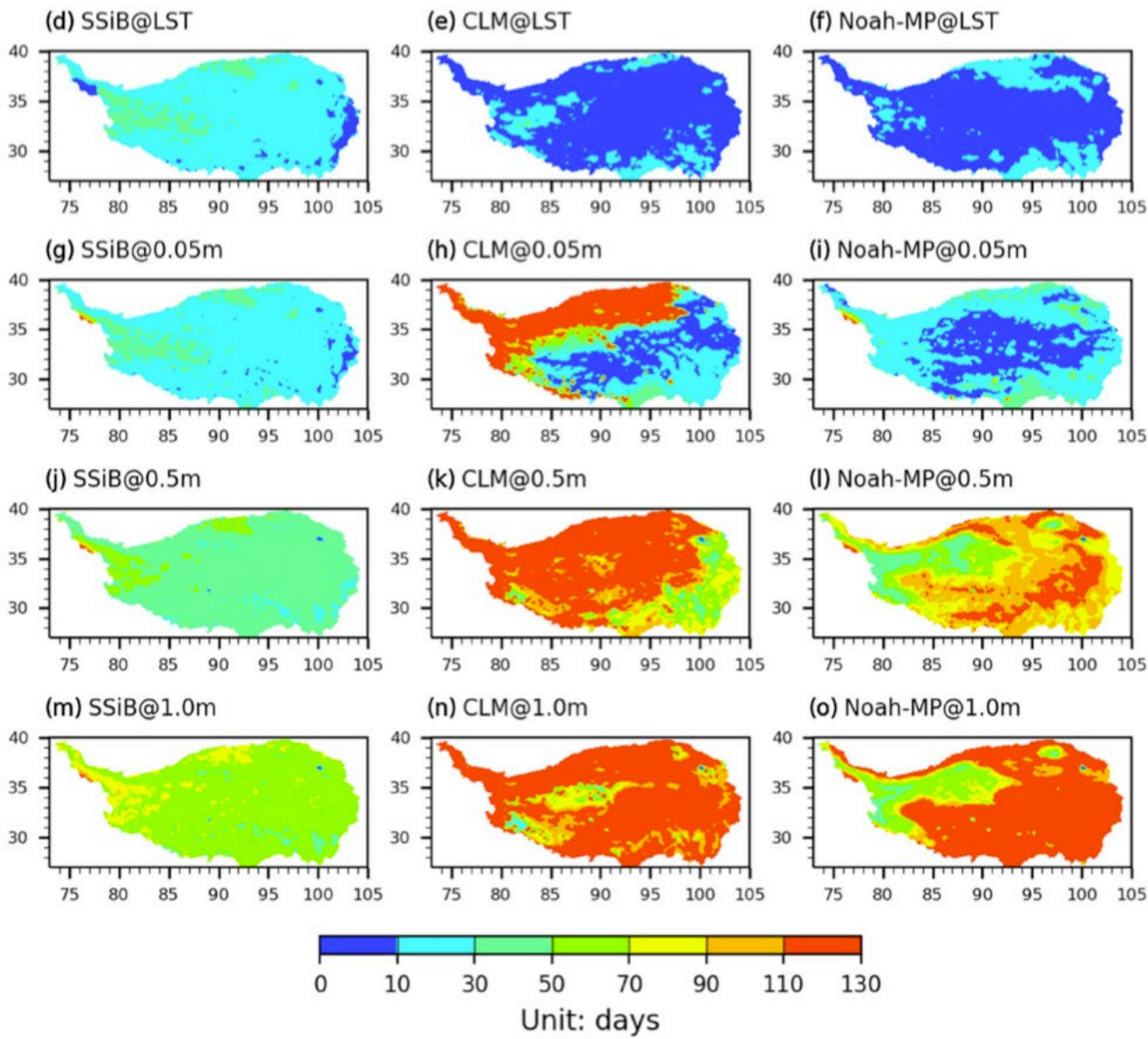
Long deep-layer soil memory (> ~60 days) and short surface-layer soil memory and surface memory (< 10 days)

Differences in May T2m (+5℃ vs. control)

(a) SSiB, +5 °C

(e) Noah-MP, +5 °C

Unit:(°C)

Differences in May LH and SH (+5 ℃ vs. control)

(a) SSiB,LH

(c) Noah-MP,LH

(d) SSiB,SH

(f) Noah-MP,SH

SSiB

Noah-MP

+ 5℃

+ 5 ℃

LH and SH slightly ↑

LH largely ↑

May T2m ↑

SH largely ↓

May T2m ↓

Summary

- A method to evaluate the ability of the land models in preserving the imposed LST/SUBT initial anomalies.

- Long (short) soil memory at the deep (surface) layer.

- The responses of T2m to the LST/SUBT initial anomalies differ among the land models, which is related with the changes in the surface heat fluxes.

Thanks for your attention!