For story: Future change of soil moisture in CCAM models

The story is written by two parts: the first part would check the reliability of CCAM models by comparing with BARRA-TA; the second part would present the future change of soil moisture in CCAM models. (need to mention here: here we use the newest version of CCAM models and the (perhaps) old version of BARRA-TA to do to the comparison.)

In the first part, there are three steps to prove: CCAM has a reasonable spatial and temporal distribution.

First, through Figure 1, we know that the seasonal cycle between BARRA-TA and six CCAM models are very similar, expect from the last two years by running with different mode at the first two layers.

Second, through Figure 2, across Tasmania, the temporal correlation over the spatially distribution is very high at both layer 1 and layer 2. Although the correlation is slight lower in the east coast, but this is probably due to the anomalous precipitation and evaporation in the east coast.

Lastly, through Figure 3, CCAM and BARRA-TA both behave similarly with regards to the relationship between soil moisture (at both layer 1 and 2) and the three variables: precipitation, temperature and evaporation.

So, soil moisture in CCAM models behaves a similar way with soil moisture in BARRA-TA, and thus the evolution of soil moisture from CCAM models under climate change is the next we would talk about.

The second part is the future change of soil moisture in CCAM models, and here wants to show the future change of soil moisture, but also explore the variables, which have positive or negative relationship with soil moisture, to obtain a batter grasp on the future change of soil moisture.

Three divides part two into three steps: the first step presents the future change of soil moisture; the second step presents the future change of precipitation and evaporation; the last step presents the correlation between surface soil moisture and the two relative variables.

In the first step, through Figure 4, we found soil moisture has slight change (the maximum is below 5 %) from 1969-1989 to 1990-2019, and soil would be drier at most region of Tasmania. When the time span increases, from 1990-2019 to 2070-2099, soil moisture would drop largely and the extreme change of soil moisture would beyond 20% in the future. Although the annual change of soil moisture would decrease, the seasonal change of soil moisture is quite different. There has opposite change between spring and summer. In spring, soil moisture has quite drop at east coast. In summer, the quite drop is located at the west region, and soil moisture located in some east coast would increase in the future. Therefore, we wonder the reason to cause the change of soil moisture between different regions and seasons.

In the second step, through Figure 5, we observed the change of precipitation and evaporation. We found the annual change of evaporation in the future is uneven: evaporation in most season would increase at the west region and decrease at the east region. In winter, evaporation has largest increase at almost all regions, the maximum of evaporation beyond 50 %. The change in autumn has a lot decrease than winter. For spring and summer, west region would have less evaporation by time, and east region would keep the less evaporation. Precipitation would have wide range of decrease in the future, especially in spring. In summer, precipitation would have quite increase at the east region. Combined with the decrease of evaporation in summer at the east region, it could response to the increase of soil moisture in summer (and autumn by the lag).

In the last step, though Figure 6 and Figure 7, we know there are different tendency of the variables between west and east region. In area A, surface soil moisture would have large drop in summer and autumn. In the same period, precipitation also has large drop in advance than soil moisture. Evaporation has not significant relationship. In area B, surface soil moisture has not big change in summer, which is similar with precipitation but in advance for precipitation. Evaporation has a big change in summer, but which has no influence on soil moisture as big as precipitation. Then from the percentage of the four variables’ change from 1960-1989 to 2070-2099, through Figure 8, we know soil moisture would drop in the future in the most month apart from the first three month at area A. But there are large range of change of precipitation and evaporation over all seasons. It shows both precipitation and evaporation have correlation with soil moisture, but precipitation takes more. To confirm this, through Table 1 there is the spatial correlation between surface soil moisture and the relative variables over all seasons. In spring, evaporation has more correlation with soil moisture. In the other three seasons, precipitation has more correlation with soil moisture.

Overall, this research proves the reliability of CCAM models by comparing with BARRA-TA, and explore the future change of soil moisture. Last, this research indicates the relationship between soil moisture and the relative variables.