Impacts of the changing summer thermal land-sea contrast on the northern hemisphere planetary circulation

SCREEN CAPTURE WELCOME

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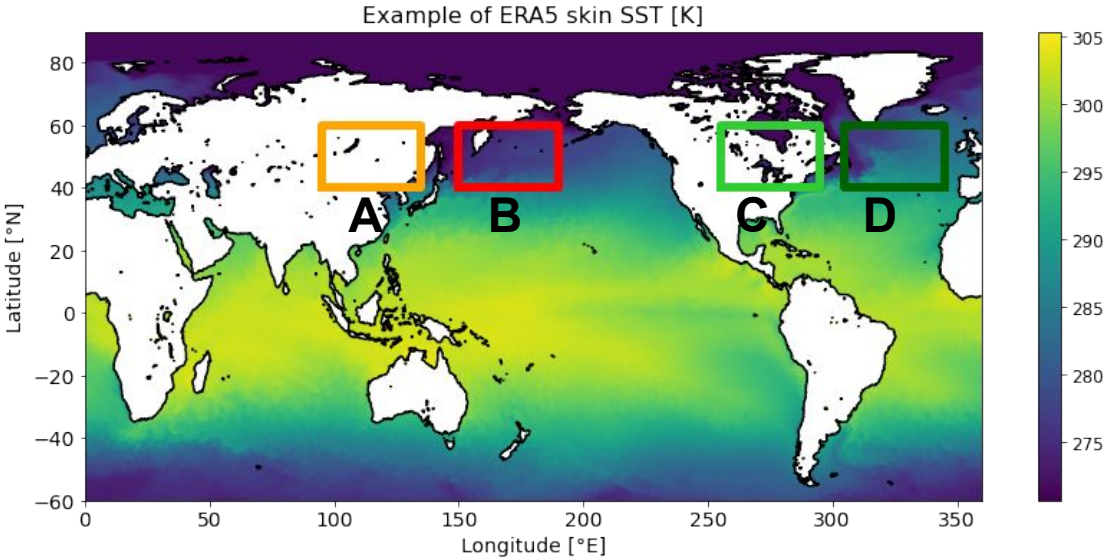
LSC (Land-Sea Contrast) controls the planetary circulation

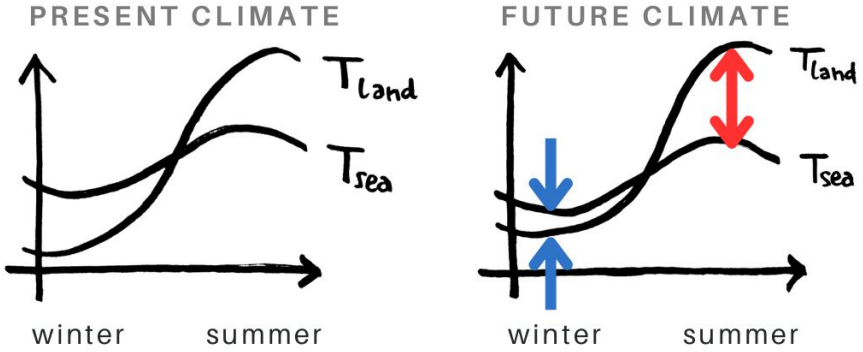
LSC is important because of the differential **surface heat fluxes**, that depend both on **surface temperature** and on **soil moisture**.

Following Portal et al. (2022) we look at LSC defined in terms of surface temperature in the boxes shown in the figure: $LSC_{Pac} = T_B - T_A$; $LSC_{Atl} = T_D - T_C$.

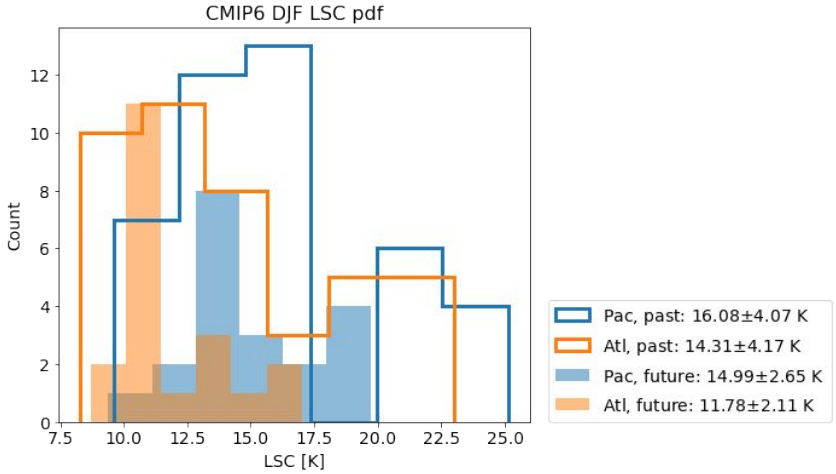


LSC is expected to change in a warmer climate

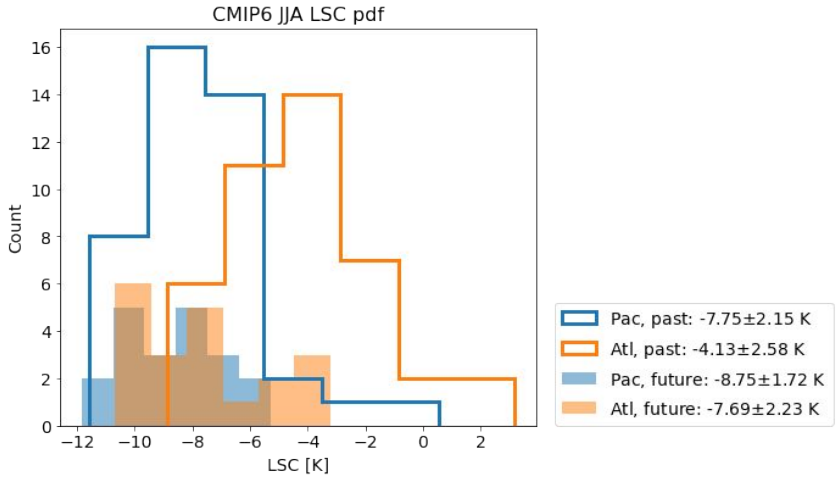
LSC = T_{sea} - T_{land} from various CMIP6 models in a past (1979-2008) and a future (2071-2100, SSP5-8.5) climates.



winter: reduced LSC



summer: enhanced LSC



A reduced LSC in winter produces

- a weakening and poleward shift of the midlatitude jet
- a strong interference with zonal wavenumbers 1 and 2
- a reduction of the amplitude of waves 1 and 2,
  - that is responsible for a strengthening of the stratospheric vortex,
  - which then affects the midlatitude winter NH climate even remotely from the forcing

For more details look at Portal et al. (2022) [https://doi.org/10.1175/JCLI-D-21-0941.1].

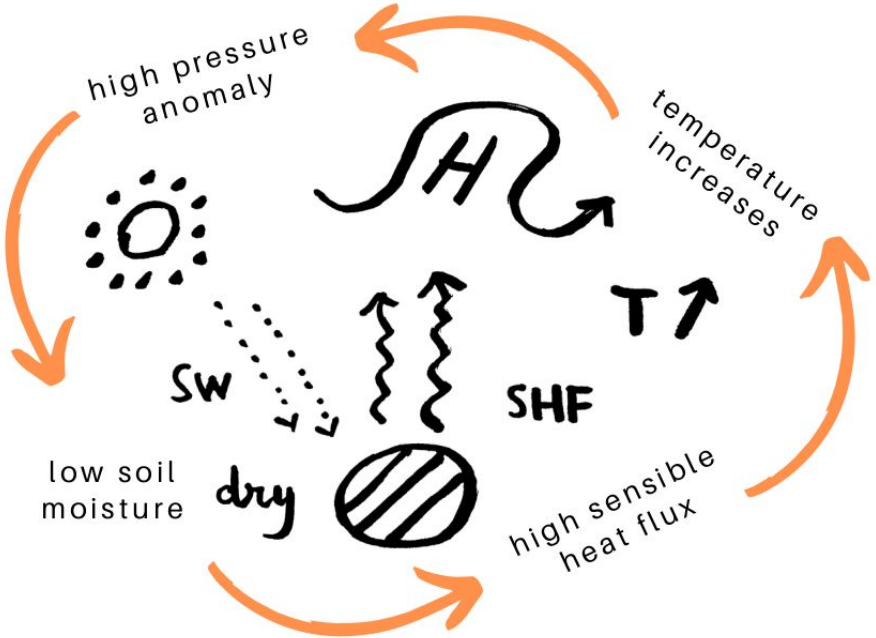
What is the planetary circulation response to an enhanced summer thermal LSC?

We aim to run similar simulations with an Earth Model of Intermediate Complexity (EMIC) to simulate the effects of the enhanced summer LSC in a future climate.

What is the role of soil moisture in affecting the LSC? How do SM changes impact circulation?

Not only the land-sea thermal contrast is important for the circulation, but also soil moisture can impact the differential land-sea surface heating.

In fact**, soil moisture (SM)** is important in controlling the partitioning of the surface turbulent fluxes and is known to affect the large scale dynamics, in transitional climate areas (see, e.g. Seneviratne et al., 2010). This happens through a feedback loop as sketched here:

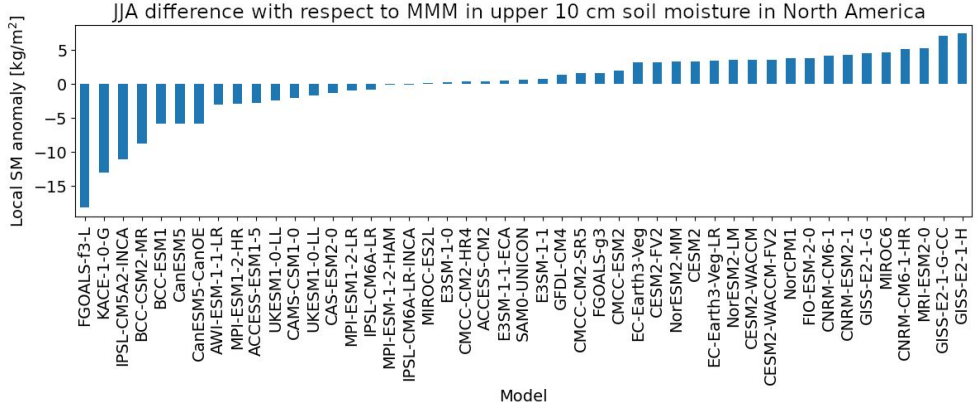


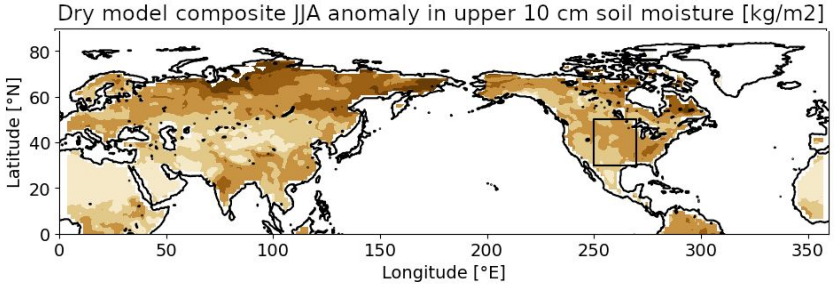
SM dry anomalies can drive a circumglobal response in planetary stationary waves

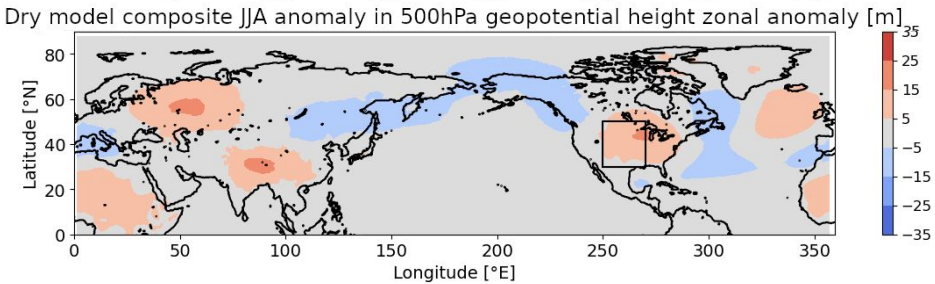
An imposed dryness in North America produces a **circumglobal** anomaly in the large-scale **summer circulation** (Teng et al., 2019) [https://doi.org/10.1175/JCLI-D-18-0823.1]. It is robust for various strength, location, duration (1-4 months) and soil depth considered.

We try to isolate a similar response in the CMIP6 ensemble.

We consider the 6 CMIP6 models that have the strongest negative SM anomaly (with respect to the multi-model-mean) and average their 500hPa geopotential height anomalies. The signal is in line with the results of Teng et al. (2019) so that we can explore the dynamical process in a multi-physics ensemble, linking SM and surface temperature anomalies.







TBC

This is an ongoing project. For any comments or clarification please feel free to drop me a line at agostino.meroni@unimib.it