Improvements in modelling the diurnal temperature amplitude in ACCESS

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Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

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Diurnal Temperature Range

$$DTR = \sum_{d=1}^{Nd} \left(\max T_d - \min T_d \right) / N_d$$

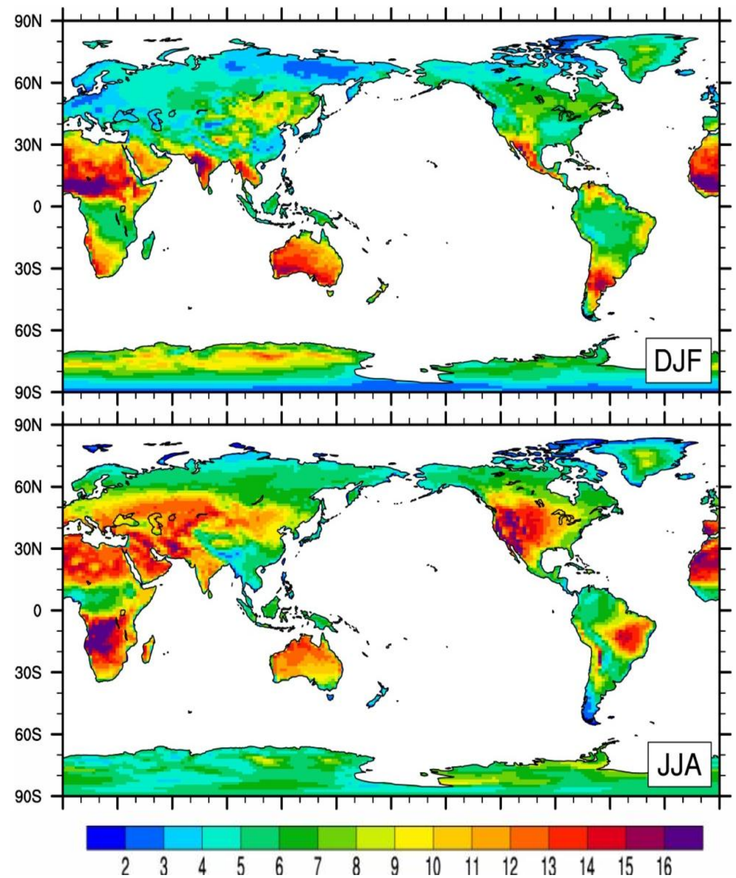
$\max T_d$ and $\min T_d$ are the daily max, min and N_d is of days

$\max T_d$ is largely determined by:

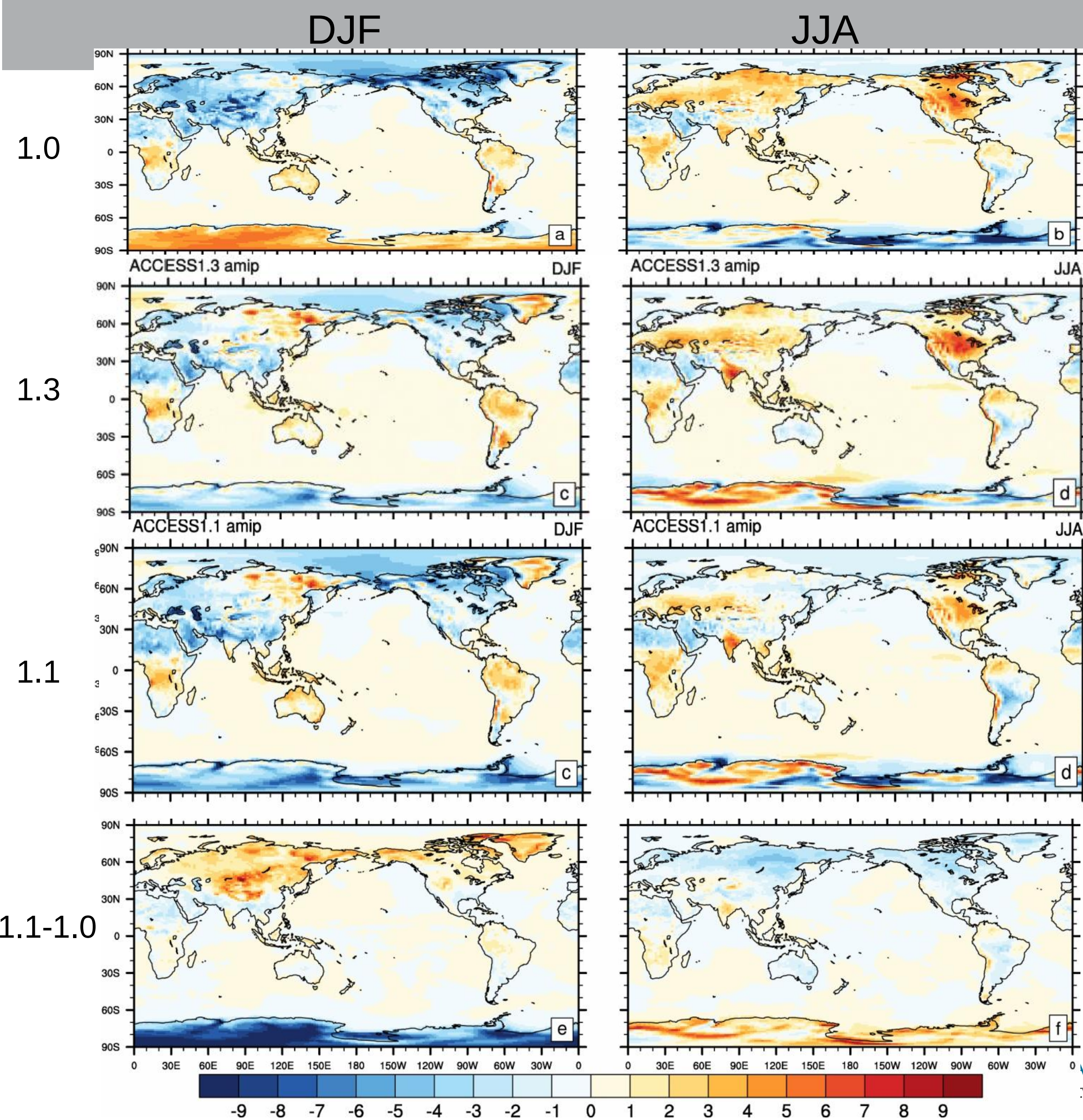
- shortwave forcing, cloud cover & precipitation, stability of the atmosphere
- evapotranspiration, soil moisture availability, surface parameters affecting surface exchange processes (albedo & rougness)

$\min T_d$ is largely determined by:

- incoming longwave affected by cloud cover, stability of the atmosphere, roughness length



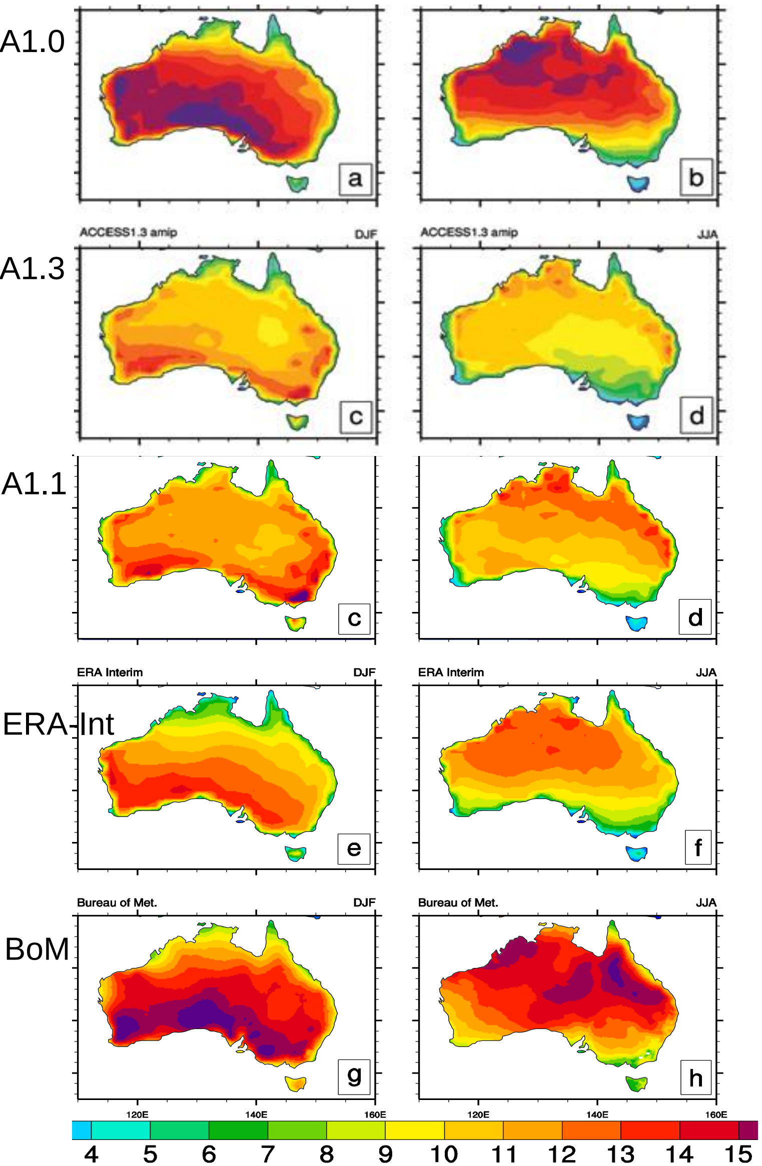
Seasonal Mean Screen Temperature Bias (K)



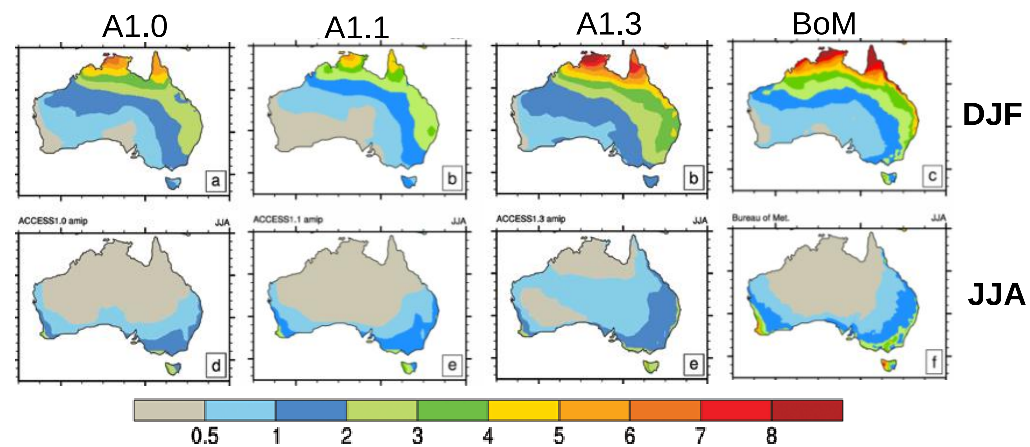
Model	Mean land temp	Mean precip
1.0	8.73	2.13
1.1	8.58	2.20
1.3	9.15	2.57

Impact of precipitation on diurnal amplitude in ACCESS

Diurnal amplitude for DJF left column and JJA right column



DFJ and JJA Precipitation



In A1.3 HadGEM3' settings include PC2 cloud scheme

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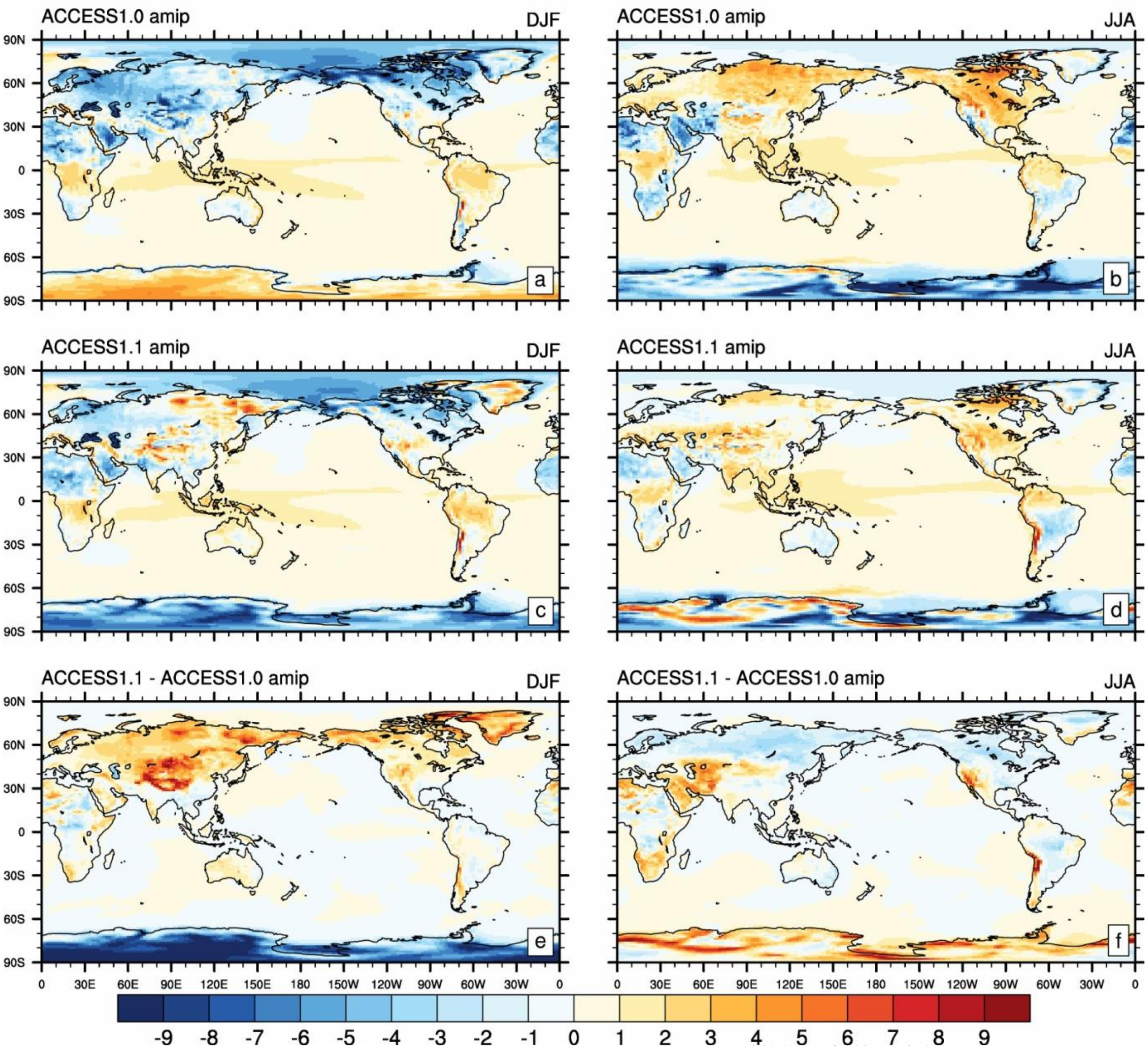
Seasonal minimum screen temperature biases for A1.0 and A1.1 AMIP simulations



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ACCESS1.0 evaluated against ERA-Interim for DJF (left column) and JJA (right column).

ACCESS1.1 simulation

Tmin difference, ACCESS1.1 minus ACCESS1.0

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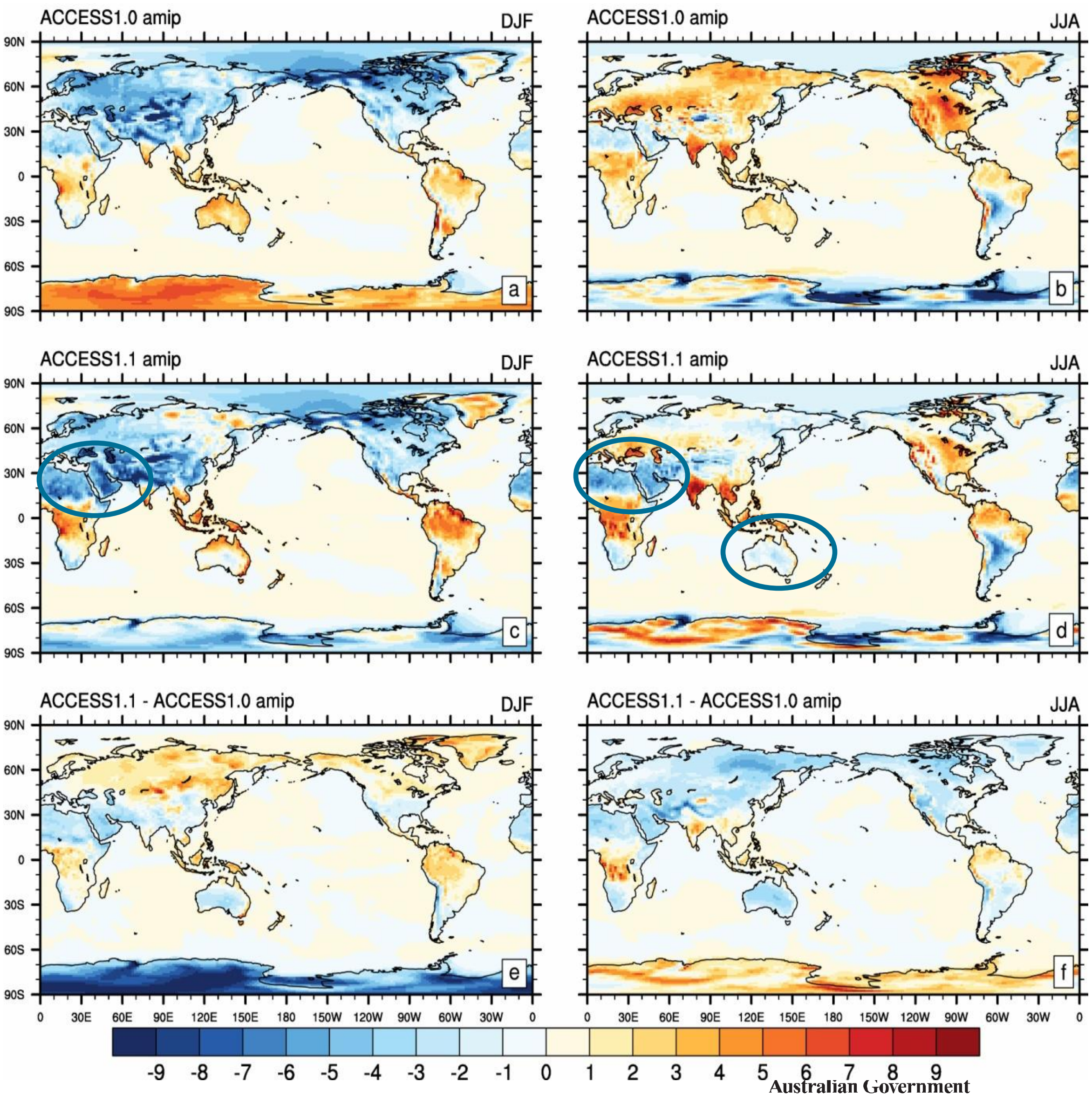
Seasonal maximum screen temperature biases for A1.0 and A1.1 AMIP simulations



ACCESS1.0 evaluated against ERA-Interim for
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ACCESS1.1 simulation

Tmax difference,
ACCESS1.1 minus ACCESS1.0

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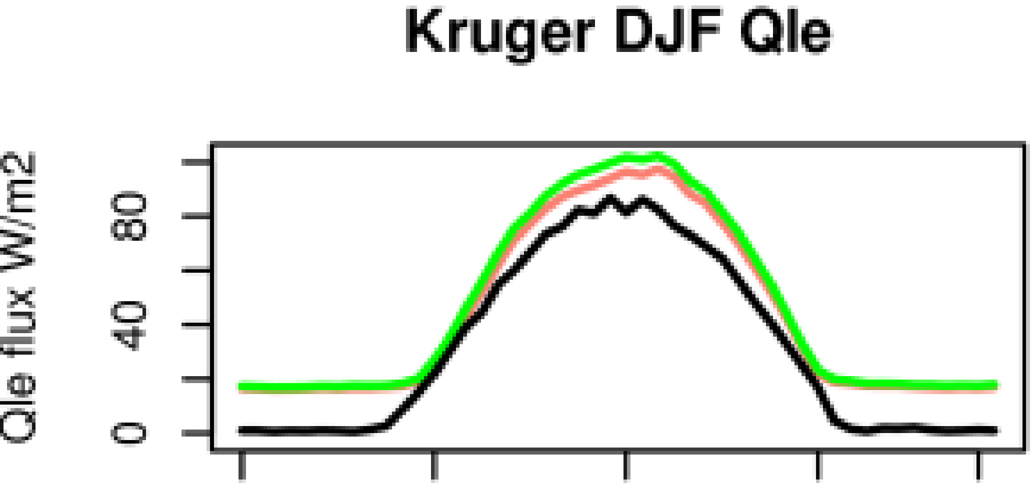
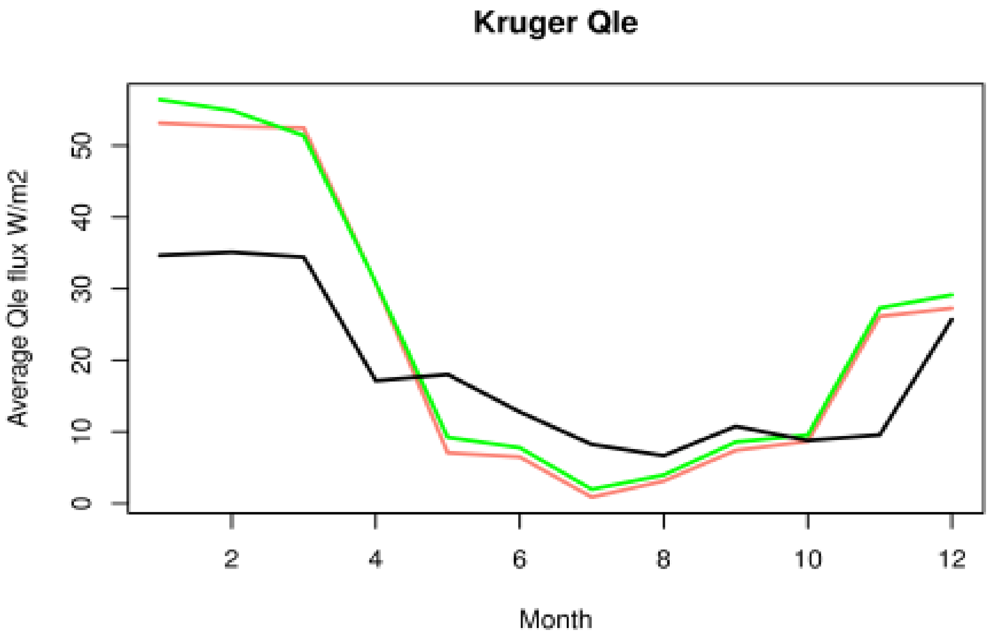
Model improvements

- Evapotranspiration and soil moisture availability
  - Changes to restrict transpiration/photosynthesis in dry conditions (Vanessa Haverd)
  - Setting more stringent criteria to maintain water balance
  - Soil evaporation cut off below the soil wilting value
  - Increased surface runoff in areas of high topography
  - Increased speed of drainage for coarse texture soil

- Surface roughness length for bare ground
  - New formula for bare ground roughness length as a function of friction velocity and leaf area index (Ian Harman)

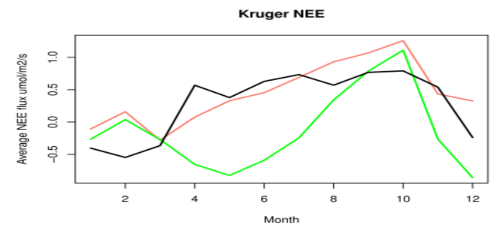
Rescaling the minimum stomatal resistance with soil availability modifier (Venessa Harverd)

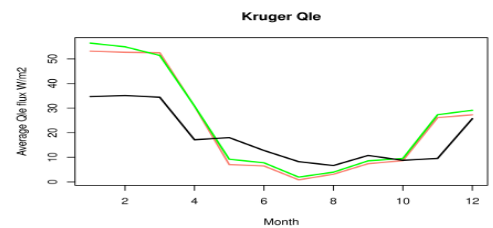




Hour of day

Hour of day





Roughness length (z0) of sand / bare ground

Constant value of z0soil in UM/CABLE produced cool bias in Tmean over arid and semi arid areas:

- low value of z0 = 1.e-6

  gives reasonable Tmin but Tmax and Tmean are underestimated

- high value of z0 =1.e-2

  gives reasonable Tmax but Tmin and Tmean is severely underestimated.

D09205 PRIGENT ET AL.: GLOBAL ROUGHNESS LENGTHS FROM SATELLITE

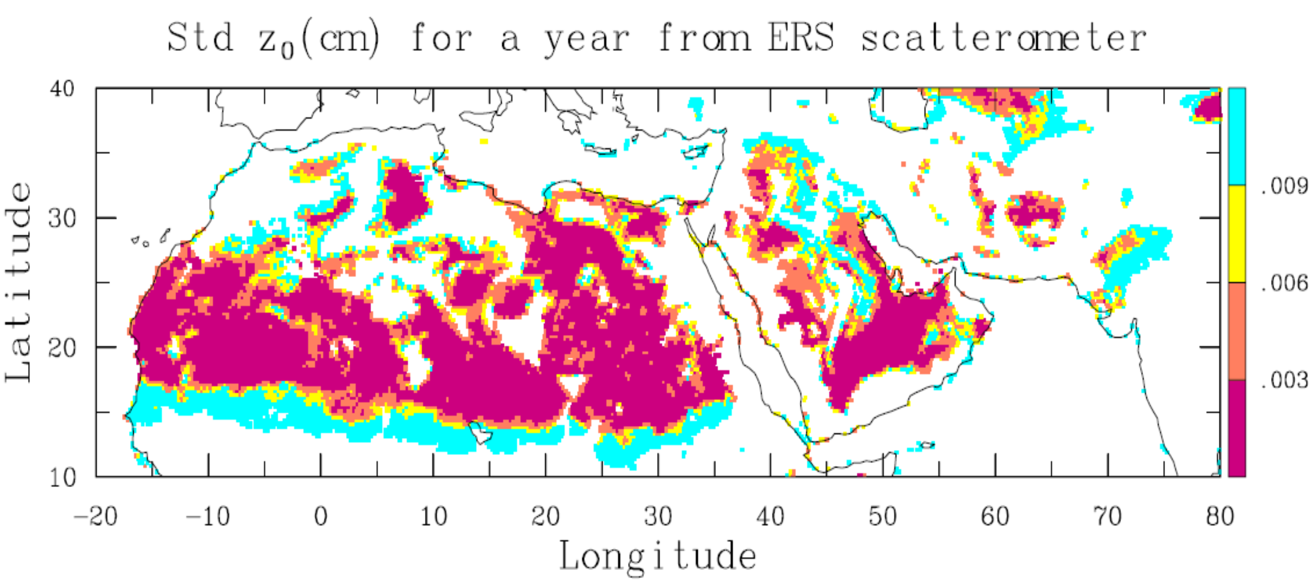


Figure 9. Standard deviation of the ERS z_0 calculated for 1993 over Africa and Middle East.

Estimation of the aerodynamic roughness length in arid and semi-arid regions over the globe with the ERS scatterometer. Prigent et al., 2005, JGR

Roughness length (z0) of sand / bare ground

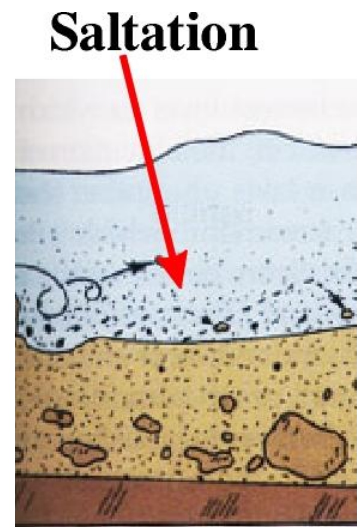
Saltation is downwind movement of particles in a series of jumps or skips.

- advected mass flow of sand increases with friction velocity U_*^3
- vertical velocity of the grain is proportional to U_*
- the height to which particuce rises is proportional to U_*^2 / grav

So the soil roughness length is also proportional to

$$U_*^2 \ / \ \mathrm{grav}$$

Chamberlain BLM 1983



ROUGHNESS LENGTH OF SEA, SAND, AND SNOW   BLM 1983, A. CHAMBERLAIN

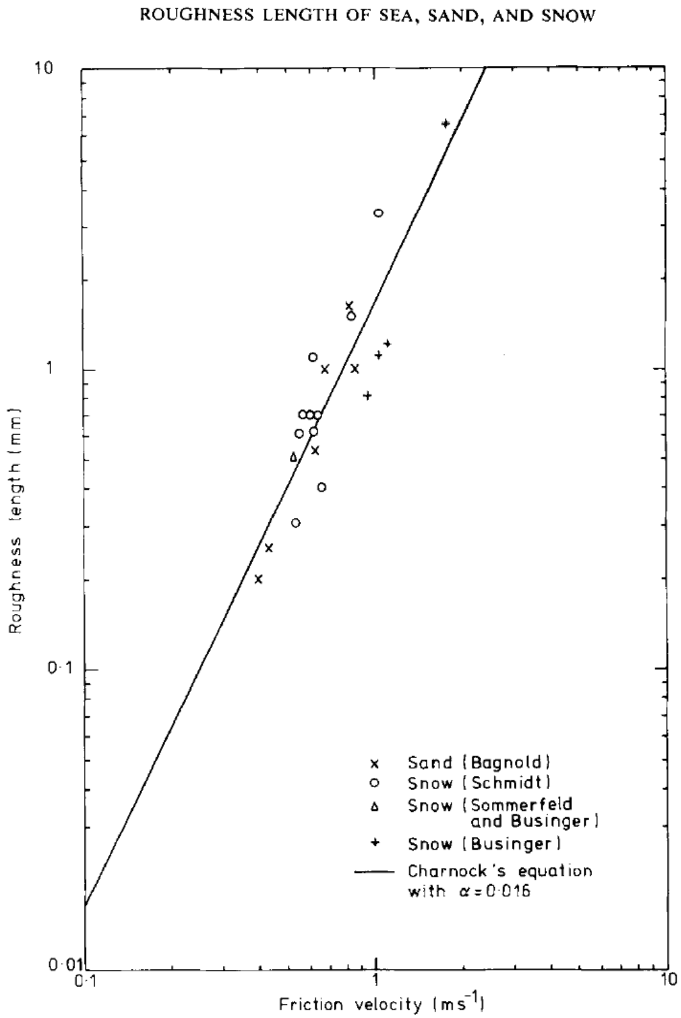
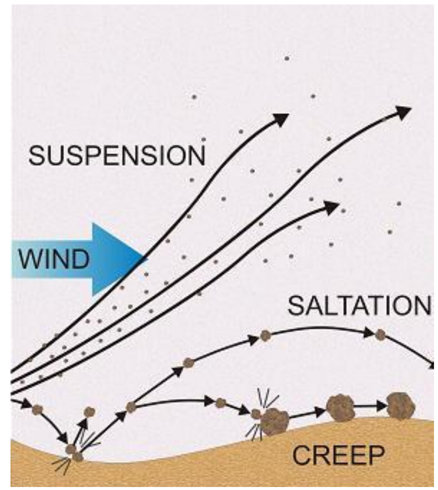


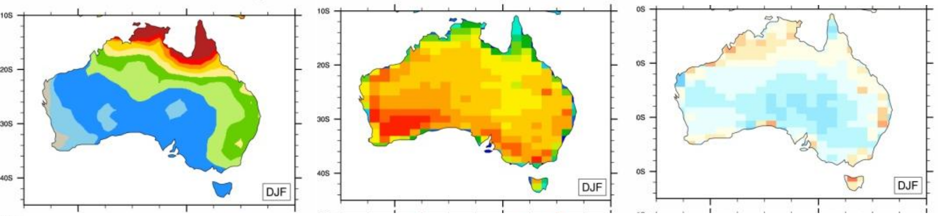
Fig. 2. Roughness length during blowing of sand or snow.



$$z0 = a * (U_* * U_*) / grav + b * \min(1,lai)$$

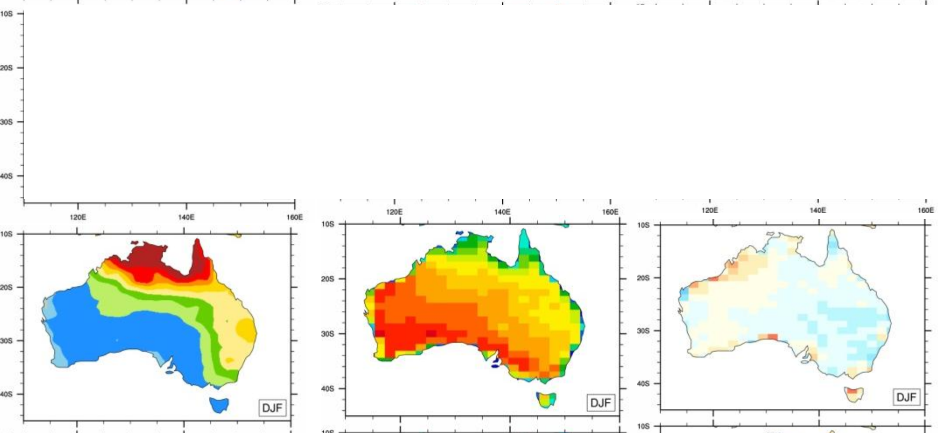
where $a = 0.02$, $b = 0.01$

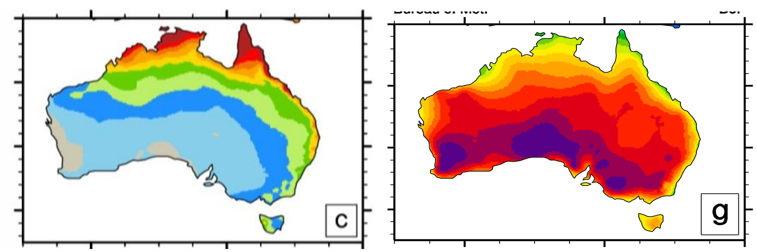
DTR over Australia in UM/CableV2.0 & V2.2 DJF



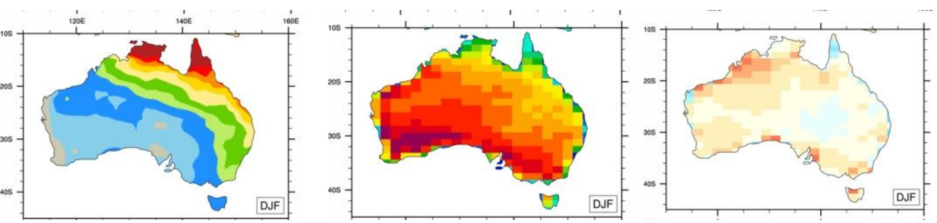
original V2.0

BoM BoM



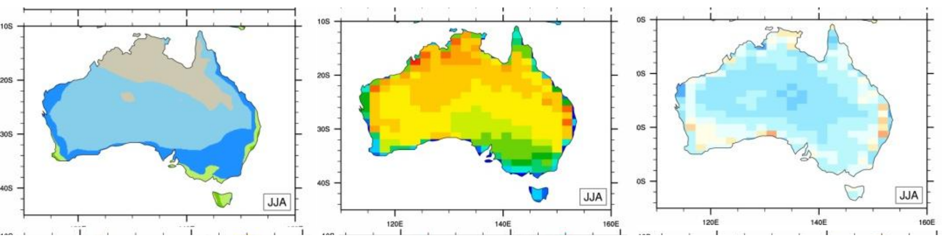


hydrology related updates V2.0

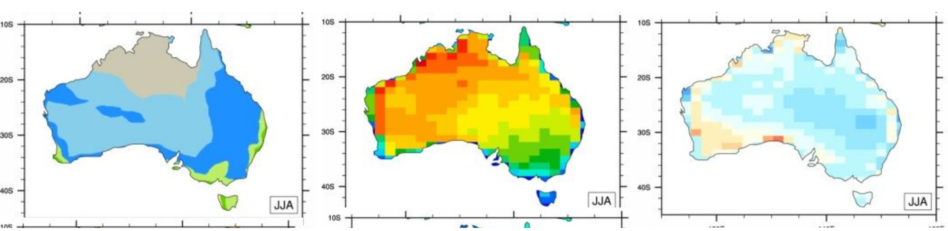


new roughness length V2.2

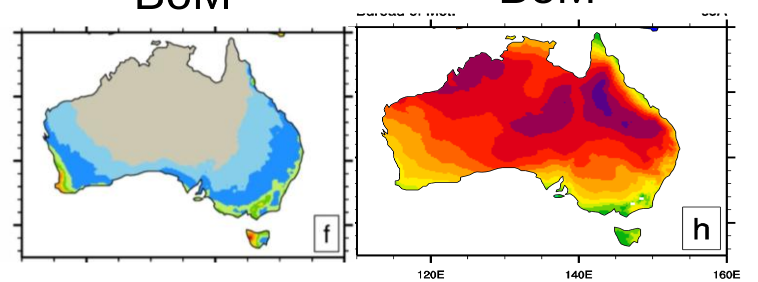
DTR over Australia in UM/CableV2.0 & V2.2 JJA



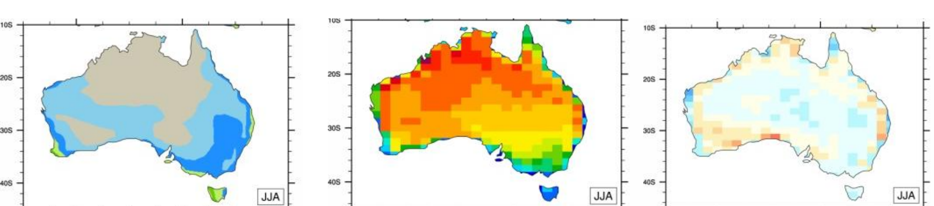
original V2.0



BoM BoM



hydrology related updates V2.0



new roughness length V2.2

Future work related to Tmax and Tmin

Sensitivity analysis with updated water balance parameters

- Further increase in surface runoff in areas of high topography

- Increase speed of drainage for coarse texture soil

- Rescaling of canopy vcmax parameter consistently with the carbon budget

Amplitude bias V2.2