Thermal Roughness Length and Bare Soil Evaporation in LMDZOR

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z_0 in LMDZOR

- Surface roughness length for momentum and heat are the same (z_{0m} = z_{0h}) in LMDZOR.

condveg.f90

z_0(bare soil)=0.01 m;
z_0(veget)=1/16×height;
z_0(ice)=0.001 m

→ Effective z_0 by averaging neutral drag coef. over different surfaces.

$\downarrow z_0$

sechiba.f90, intersurf.f90, surf_land_orchidee.mod.F90

$\xrightarrow{z_0}$

surf_land_mod.F90:
$z_{0h} = z_0$; $z_{0m} = z_0$

$\uparrow z_{0m}, z_{0h}$

pbl_surface_mod.F90
(z_{0m}=z_{0h} used)
$C_{d,h}$ and $C_{d,m}$ calculated;
$C_{d,h}$ used by ORCHIDEE

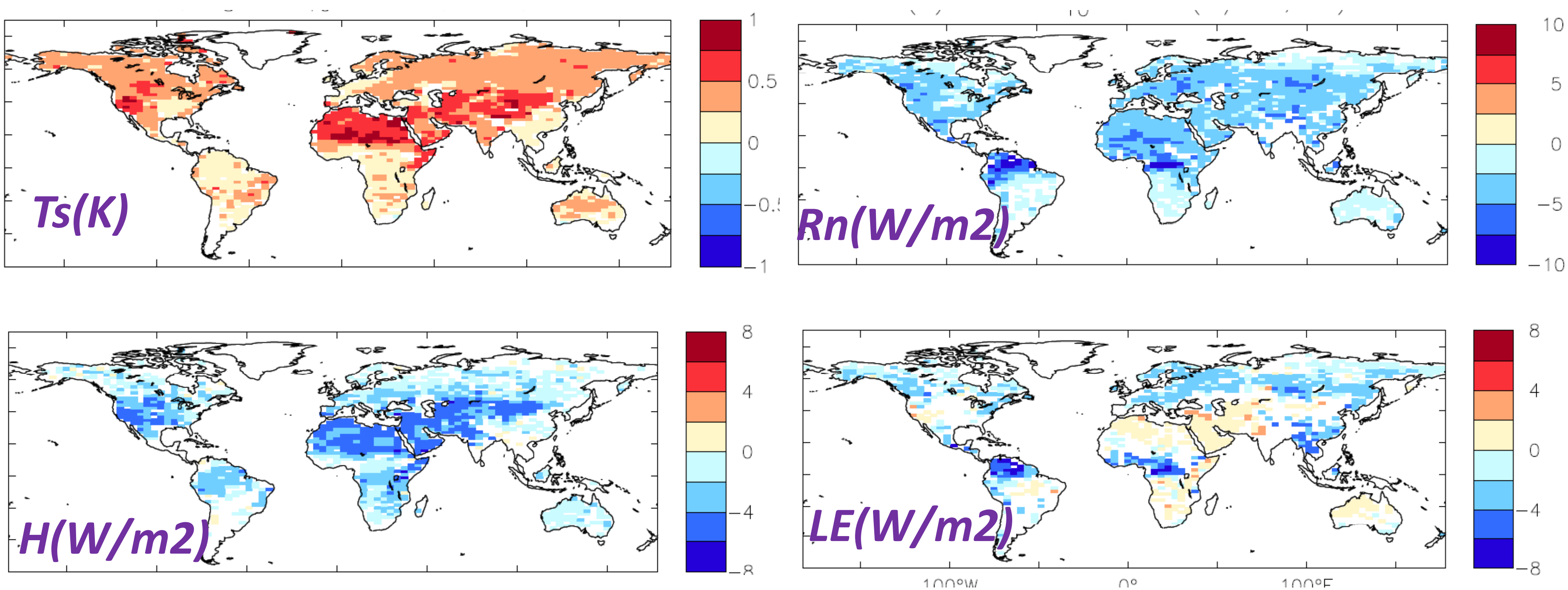
Experiment Design: **CTL**: $z_{0m} = z_{0h}$; **EXP$_{10}$**: $z_{0h} = z_{0m}/10$; **EXP$_{100}$**: $z_{0h} = z_{0m}/100$;

Model: LMDZ-ORCHIDEE (NPv3.2 + CWRR); Resolution: 96×95×39.

Simulation: 5-Year (nudged) after 20 years spin-up; global

Impacts of z_{0h} on *Ts, Rn, H, LE* (JJA)

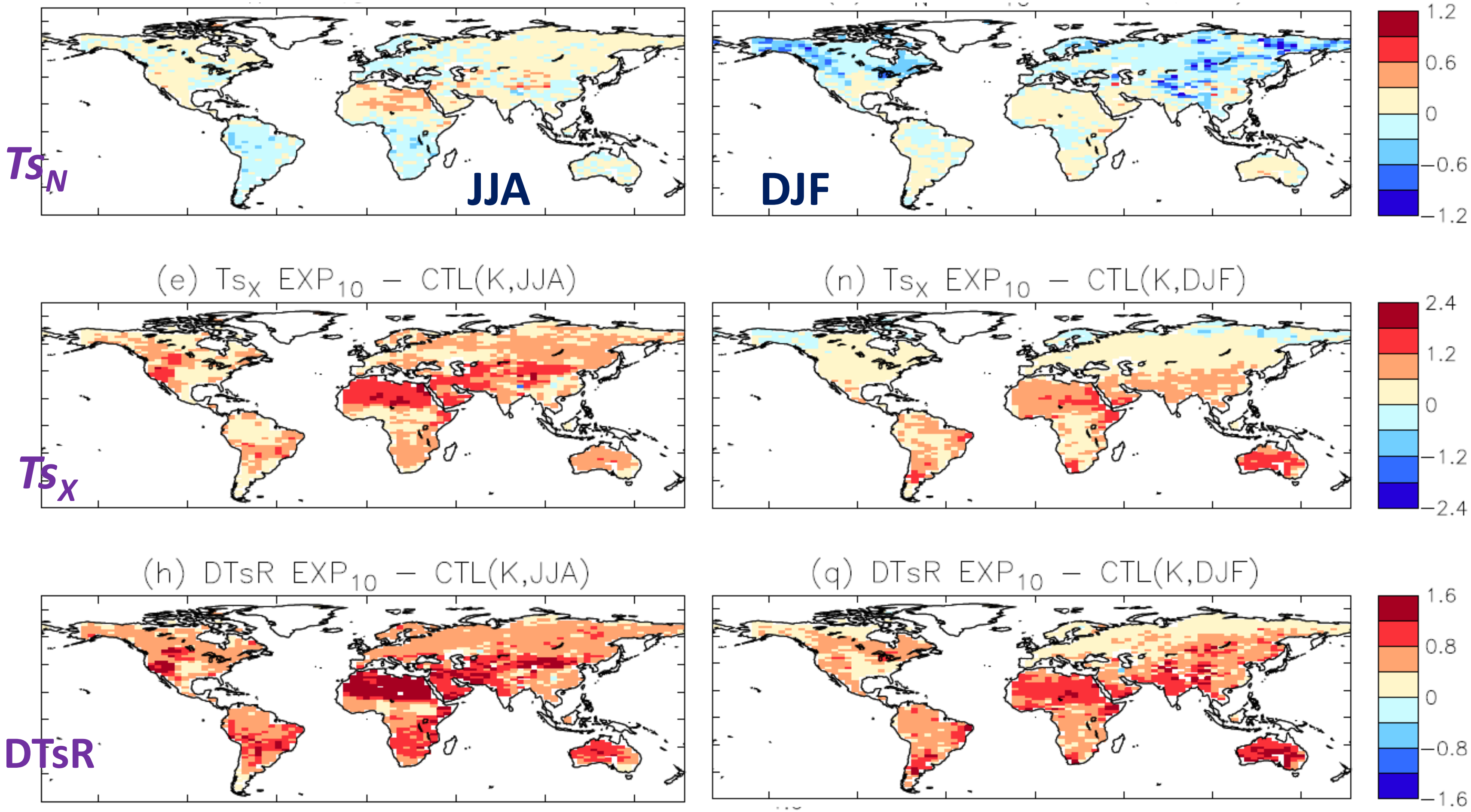
EXP$_{10}$ ($z_{0h} = z_{0m}$ / 10) **- CTL** ($z_{0m} = z_{0h}$)



- z_{0h} ↓ →drag coeff. ↓ → Turbulent heat flux ↓(weaker turbulent exchange);
- T_s ↑ (0.9-1.8 K); larger change over bare soil (lower soil heat capacity);
- R_n decreases ↓ (outgoing R_{lw} ↑);
- The change for EXP$_{100}$ ($z_{0h} = z_{0m}$ / 100) is even larger.

Max, Min, DTR of Ts (JJA and DJF)

EXP$_{10}$ ($z_{0h} = z_{0m}$ / 10) **- CTL** ($z_{0m} = z_{0h}$)



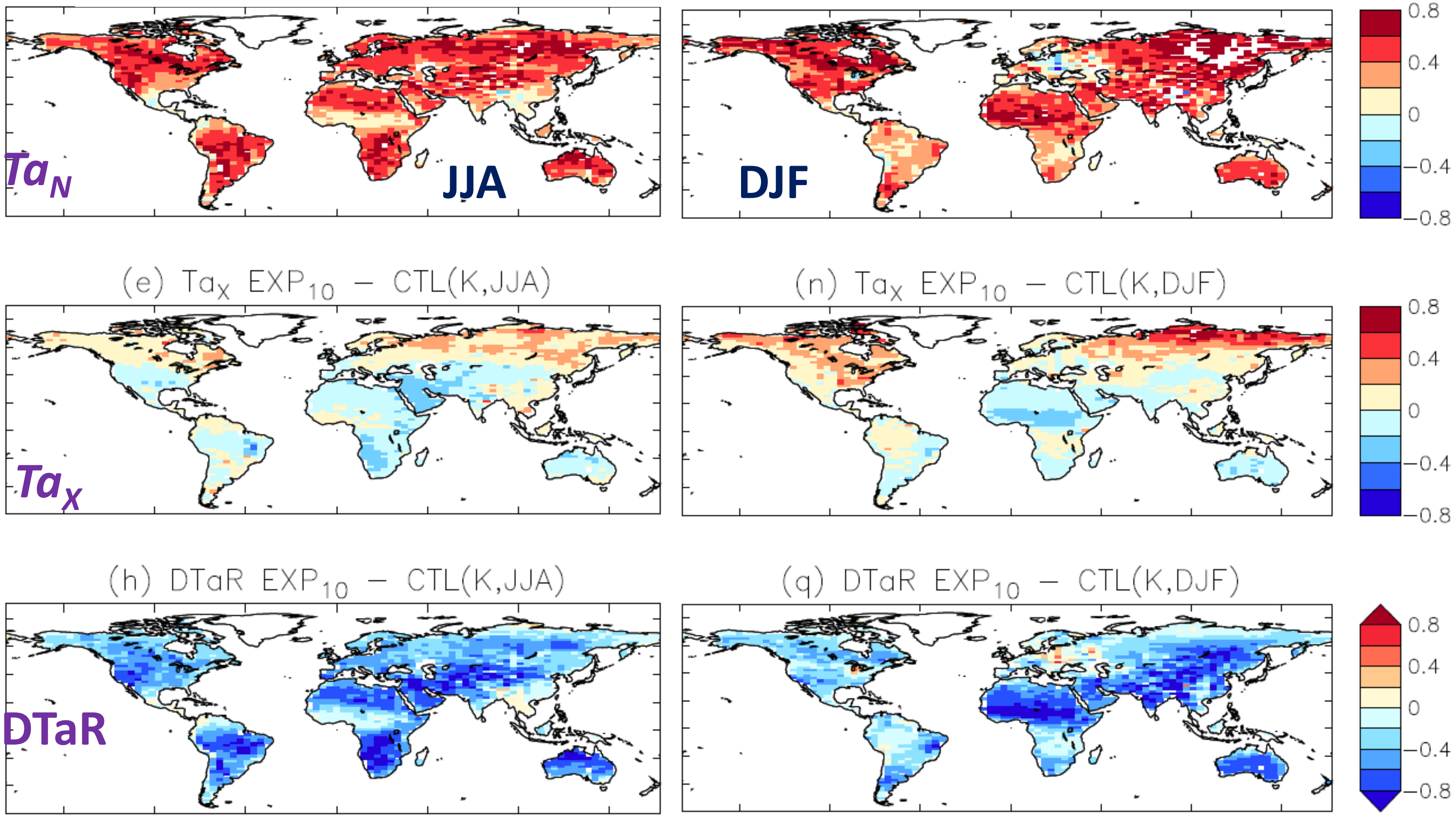
Ts_X ↑ (during the day, turbulent heat flux ↓, less cooling).

Ts_N small change (weak turbulent heat transfer during night).

DTsR (Diurnal range of Ts = Ts_X - Ts_N) ↑ (most significant over desert).

Max, Min, DTR of Ta (JJA and DJF)

EXP$_{10}$ ($z_{0h} = z_{0m}$ / 10) **- CTL** ($z_{0m} = z_{0h}$) paper in prep.

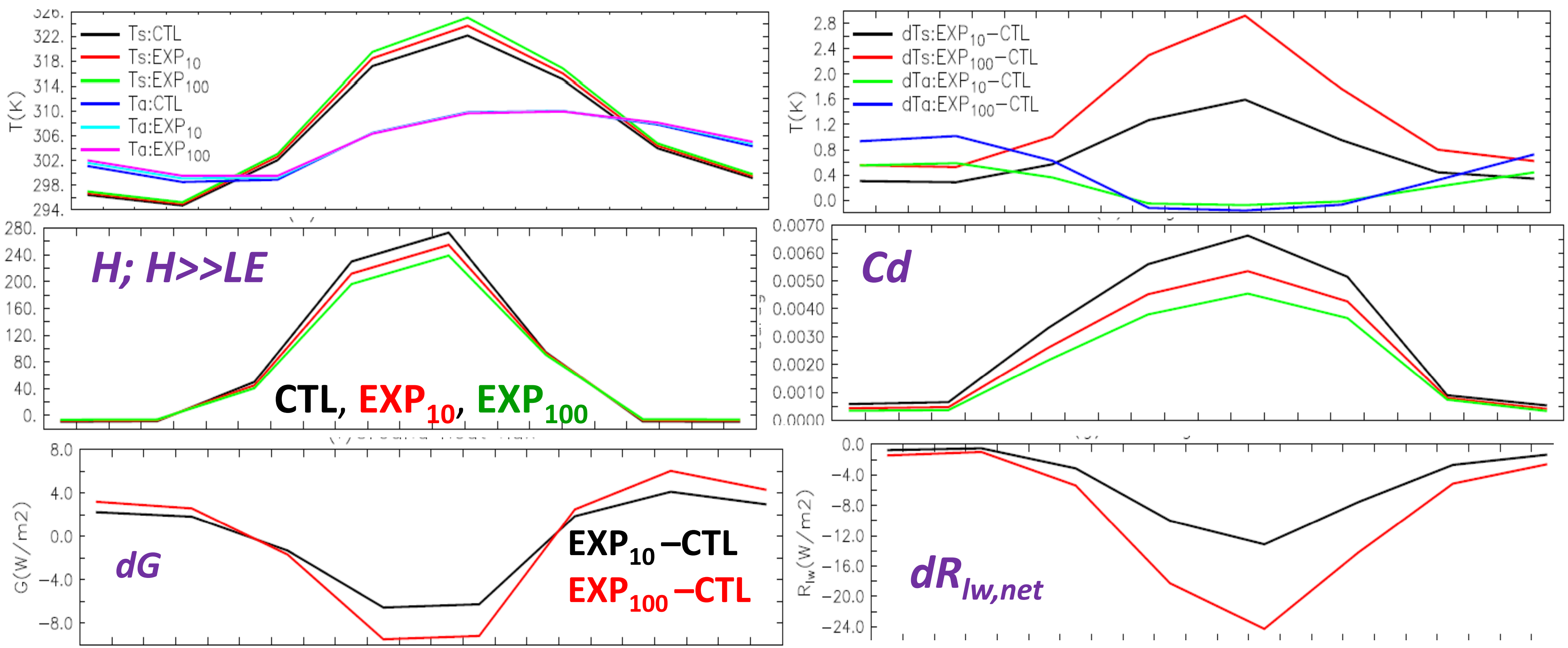


Daytime: ***Cd*** ↓ → ***H+LE*** ↓ **(weaker turbulent)** → ***Ts*** ↑ → **heat absorbed by soil** ↑; ***H+LE*** ↓ **compensated by** $R_{lw,up}$ ↑ **(little difference of diabatic heating of the lowest layer ,*Ta* less affected).**
Nighttime: ***H*** **~0,** ***Cd*** **changes small; heat released by soil** ↑, $R_{lw,up}$ ↑ → ***Ts, Ta*** ↑

Diurnal Cycles (Arid Environment)

Sahara desert [10W-10E, 20N-25N], July

DTsR ↑; DTR ↓



Daytime: *H* **large,** *Cd* **↓ → *H*↓ (weaker turbulent transfer) → *Ts* ↑ → heat absorbed by soil ↑; *H* ↓ compensated by $R_{lw,up}$ ↑ (little difference of diabatic heating of the lowest layer ,*Ta* less affected).**

Nighttime: *H* **~0,** *Cd* **changes small; heat released by soil ↑,** $R_{lw,up}$ **↑ →** *Ts, Ta* **↑**

Bare Soil Evap. in LMDZOR

BSE overestimated in LMDZOR.

- **In trunk:**

```
IF ((evapot.GT.min_sechiba).AND.(tmc_litter(jst).GT.(tmc_litter_wilt(jst)))) THEN
    evap_bare_lim_ns(jst) = evap_bare_lim_ns(jst) / evapot
ELSEIF((evapot.GT.min_sechiba).AND. (tmc_litter(jst).GT.(tmc_litter_res(jst)))) THEN
    evap_bare_lim_ns(jst) = (un/deux) * evap_bare_lim_ns(jst) / evapot
ELSE
    evap_bare_lim_ns(jst) = zero
END IF
evap_bare_lim_ns(jst)=MAX(MIN(evap_bare_lim_ns(jst),1.),0.);  ! it is used to calculate the BSE at next step.
```

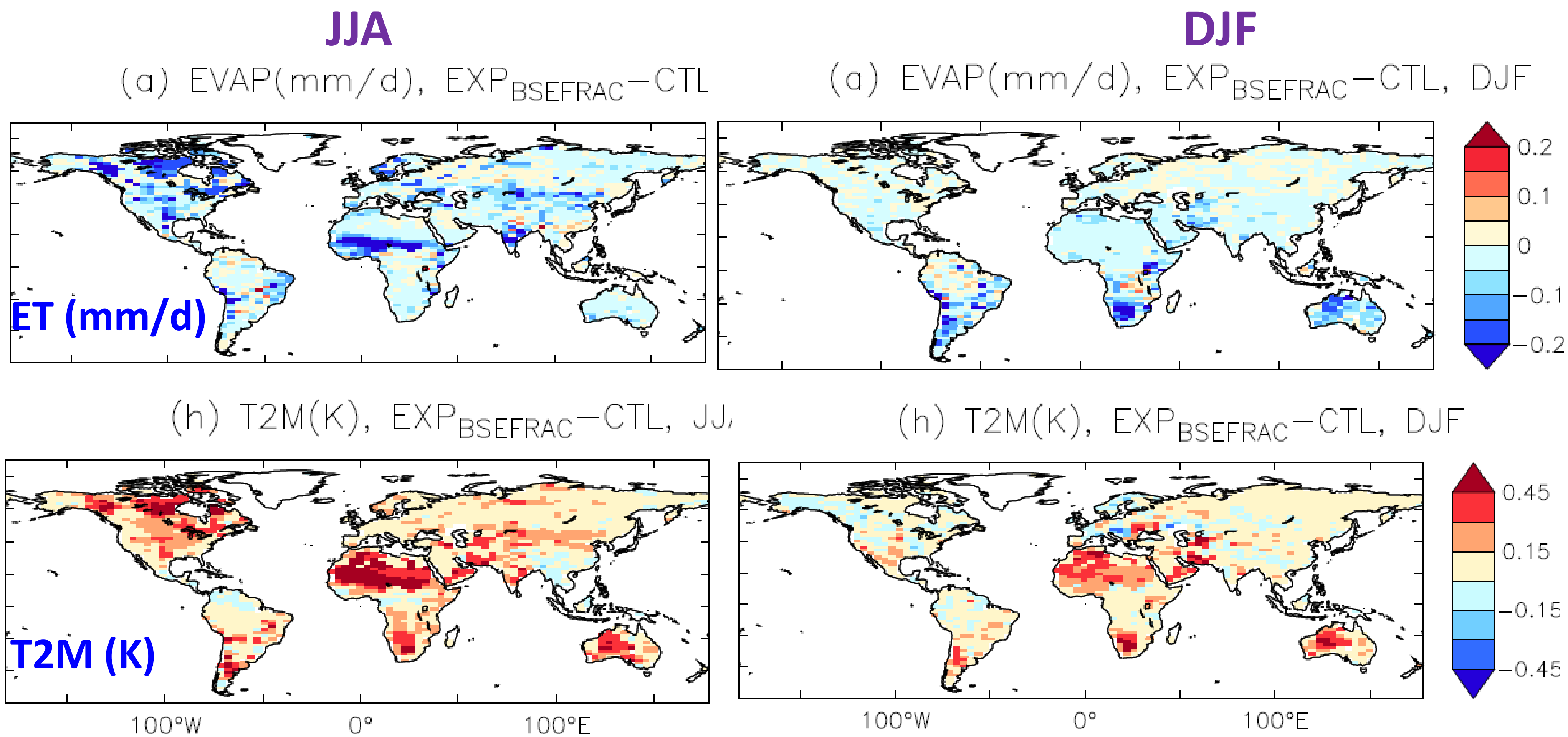
- **Revised: In a GCM grid, when the average moisture is low, probably part of the grid is already dry.**

```
IF (soil_wet_litter.LT. threshold) THEN
    evap_bare_lim_ns(jst) = evap_bare_lim_ns(jst) / evapot * MIN(soil_wet_litter(jst)/threshold, 1)
ELSE
    evap_bare_lim_ns(jst) = evap_bare_lim_ns(jst) / evapot
END
```

soil_wet_litter(jst) = (tmc_litter(jst)-tmc_litter_wilt(jst))/(tmc_litter_field(jst)-tmc_litter_wilt(jst))
soil_wet_litter is between 0 and 1.

Experiments: CTL: same as trunk; EXP_{BSE}: threshold = 0.5.
Simulations: CWRR+NPv3.2; 96×95×39; 1Y (nudged)

Diff.(EXP_{BSE} -CTL): ET & T2M



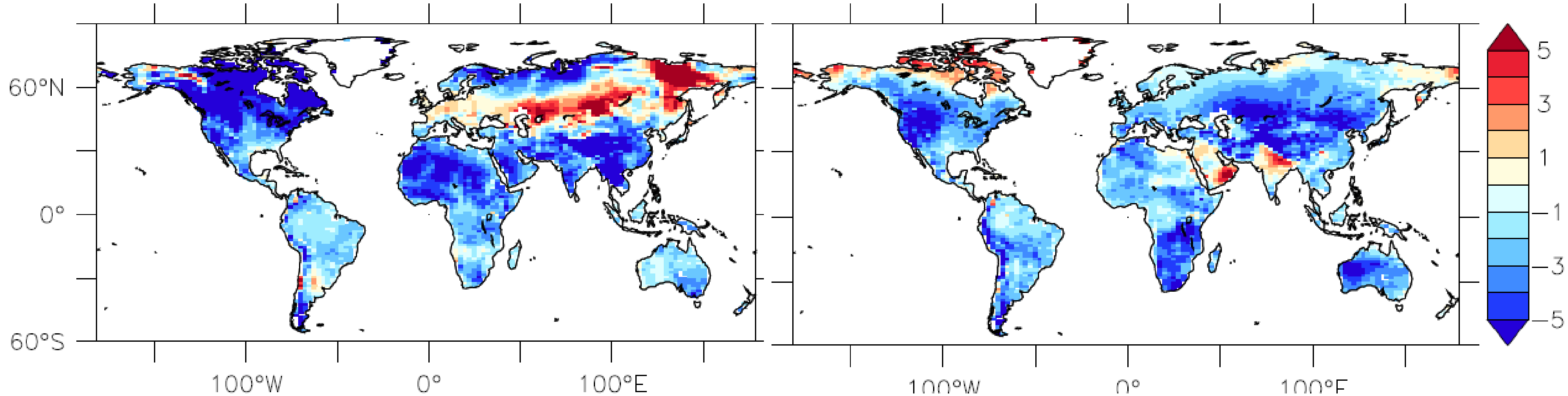
***T2M*↑, ET↓.**

Thank You for Your Attention !

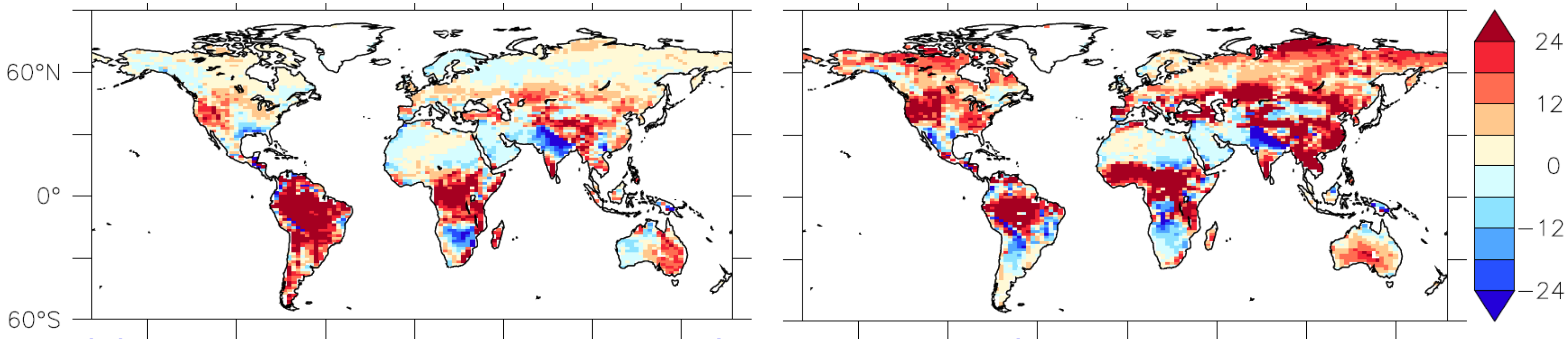
Bias in T2M (underestim.) & LE (overestim.)

ORC (CWRR): r2992; LMDZ (NPv5.17h): r2327; 144×142×79; 5Y climatology.

T2m, LMDZOR – CRU: DJF **T2m, LMDZOR – CRU: JJA**



LE, LMDZOR – landfluxEVAL: DJF **LE, LMDZOR – landfluxEVAL: JJA**



(1) In LMDZOR, T2m underestimated (LE overestimated) over most regions;

(2) Lower z_{0h} could eliminate part of T2m and LE bias.