Idealized weak temperature gradient simulations: focusing on the horizontal advection of environmental moisture

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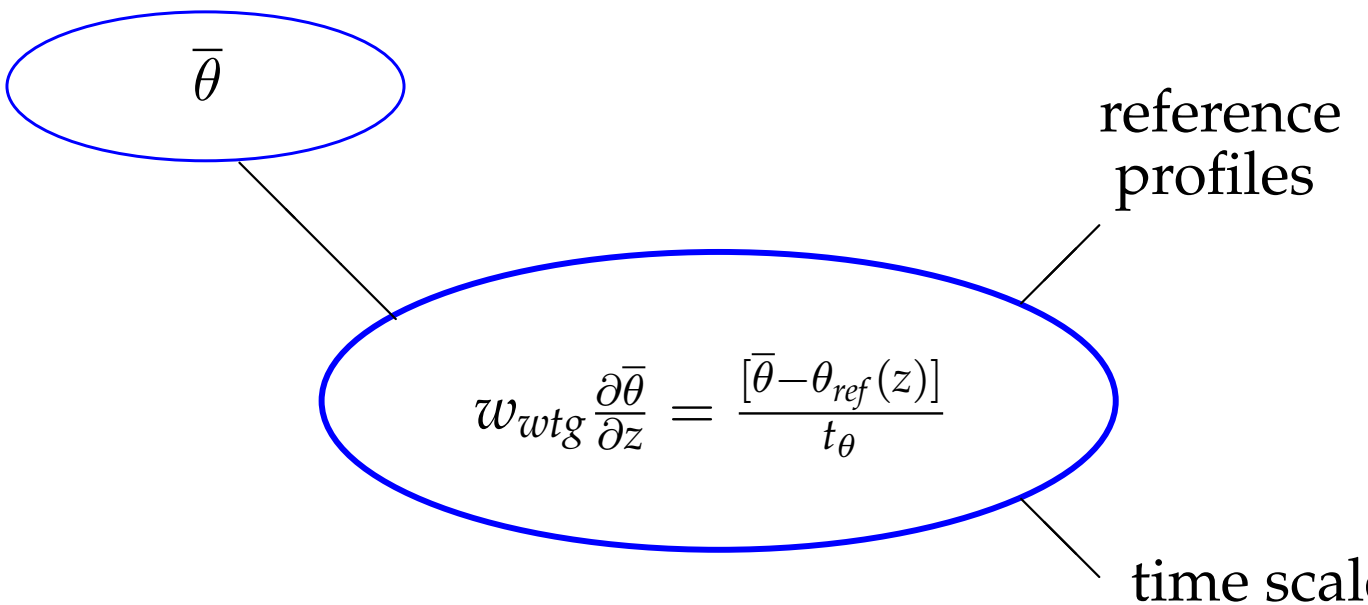
WEAK TEMPERATURE GRADIENT VERTICAL VELOCITY, w_{wtg}

$$w_{wtg}\frac{\partial\bar{\theta}}{\partial z} = \frac{[\bar{\theta}-\theta_{ref}(z)]}{t_\theta}$$

WEAK TEMPERATURE GRADIENT VERTICAL VELOCITY, w_{wtg}



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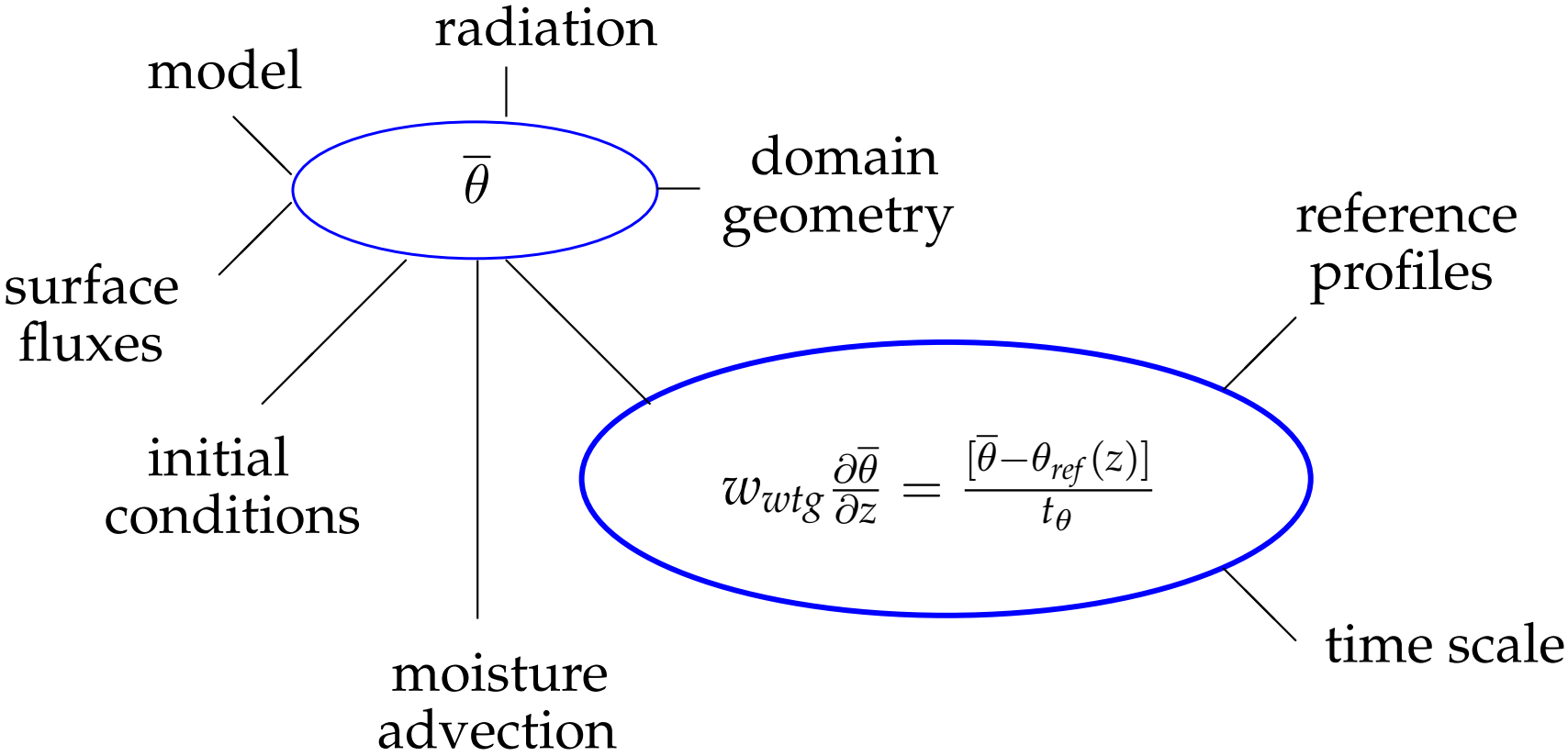

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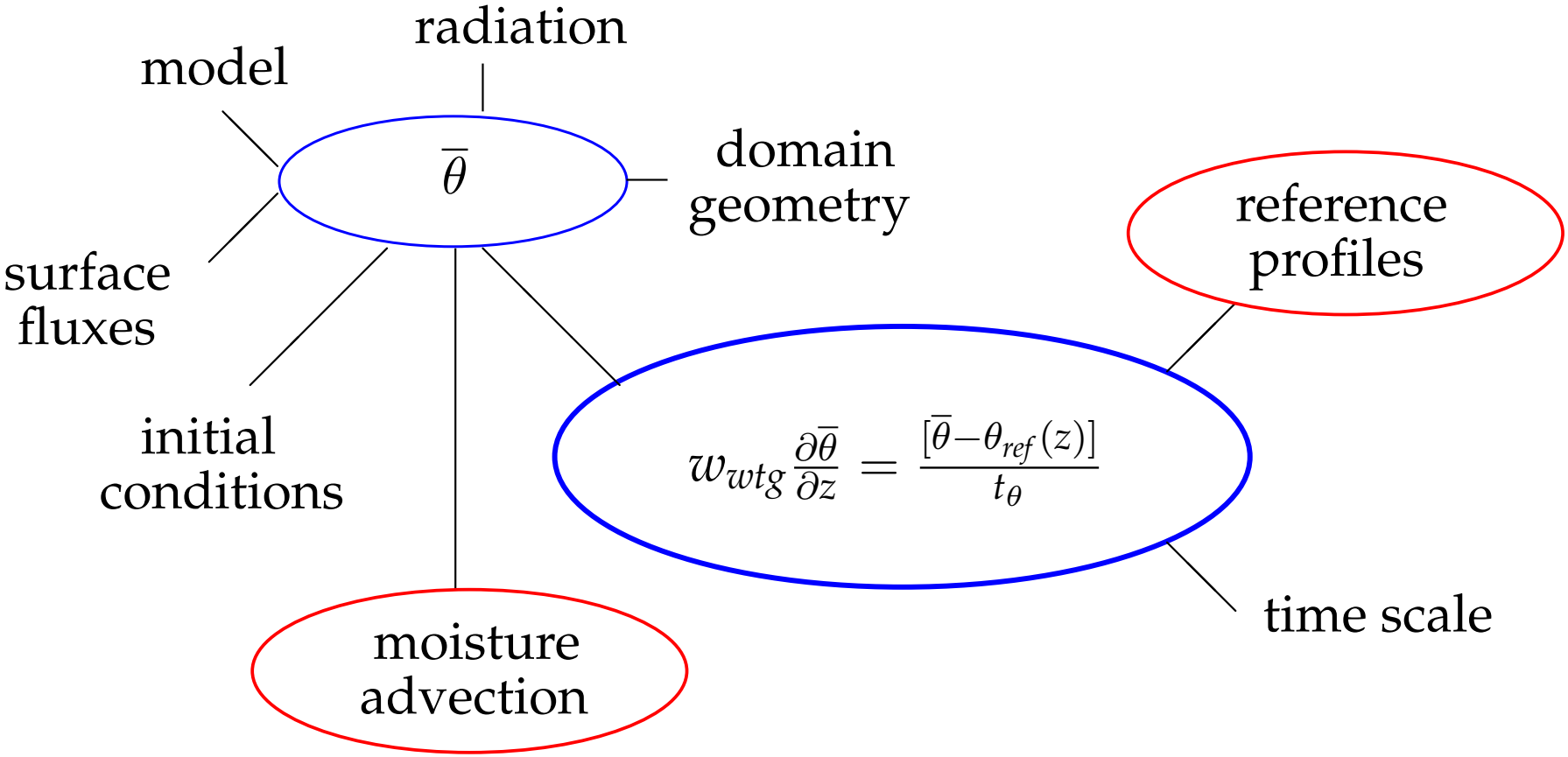
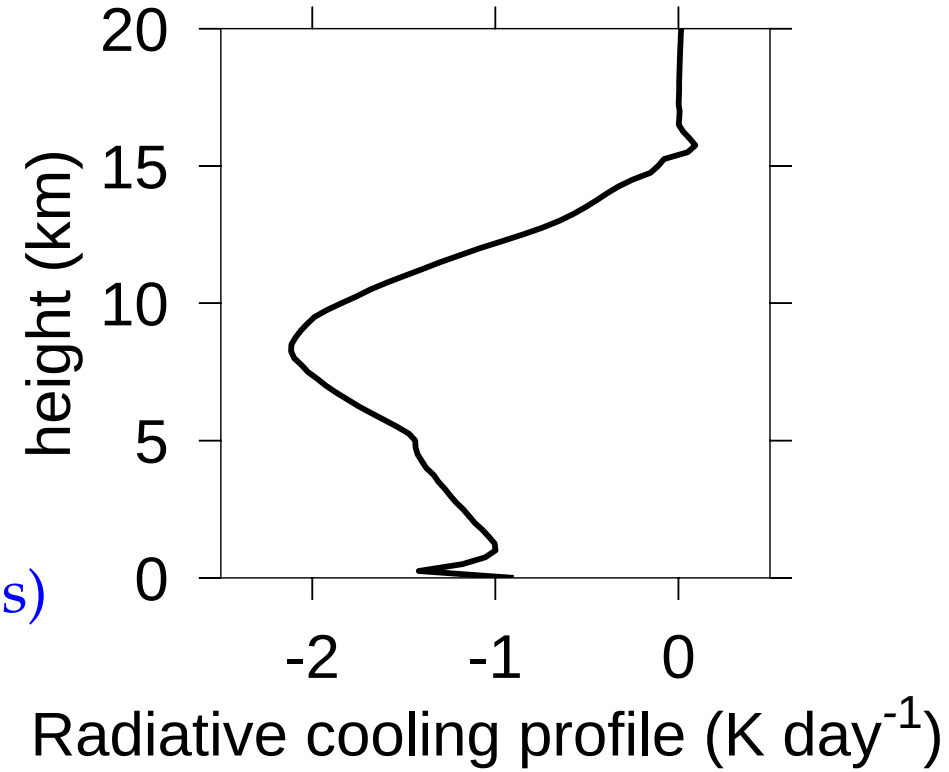


WTG EXPERIMENT PARAMETERS

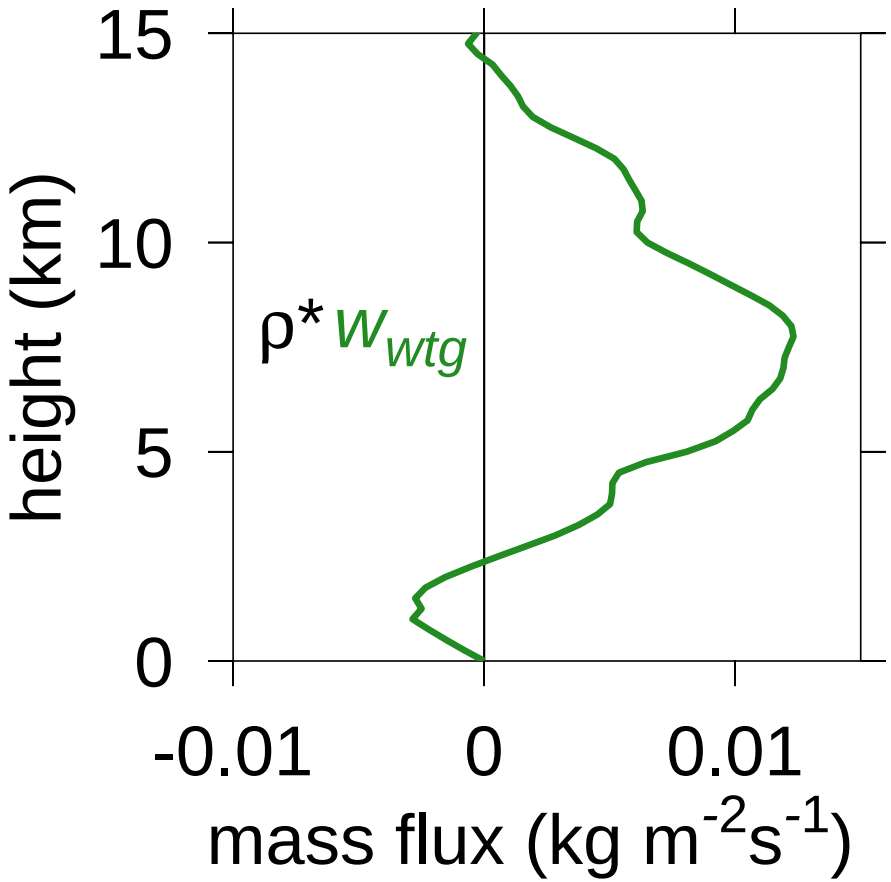
- 2D CRM
- 200 km
- 1 km res.

- SST 303 K
- wind 7 m/s (RCE @ 5 m/s)

- static radiative cooling
- $t_\theta = 11$ min.



ALL RUNS ADVECT MOISTURE VERTICALLY



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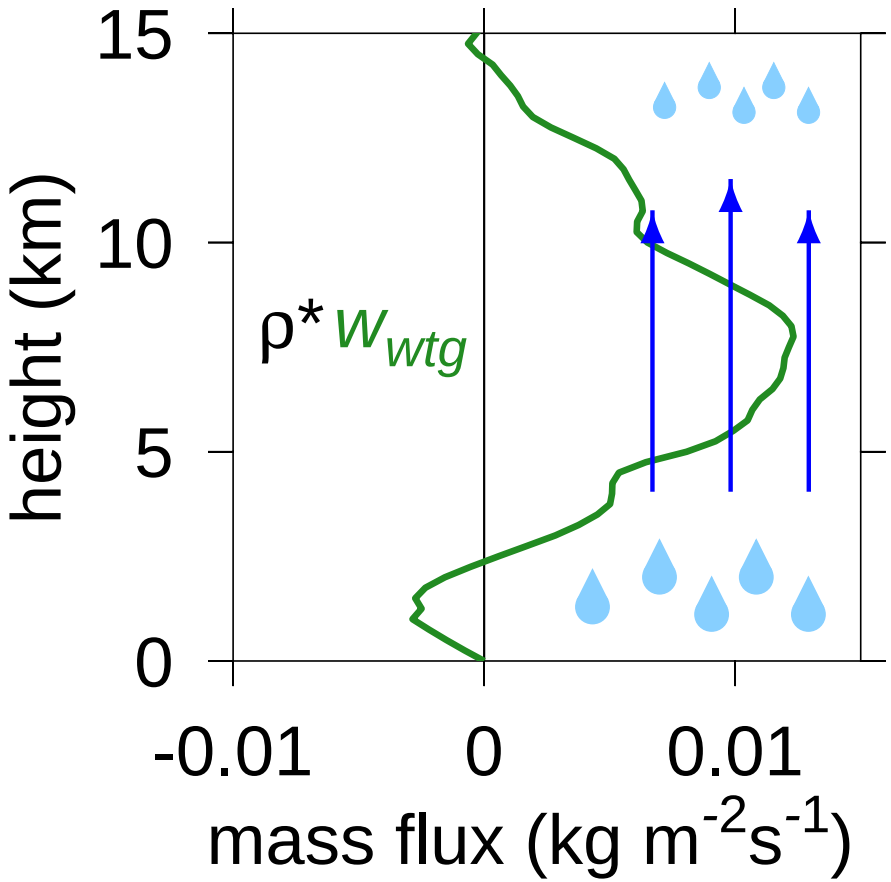

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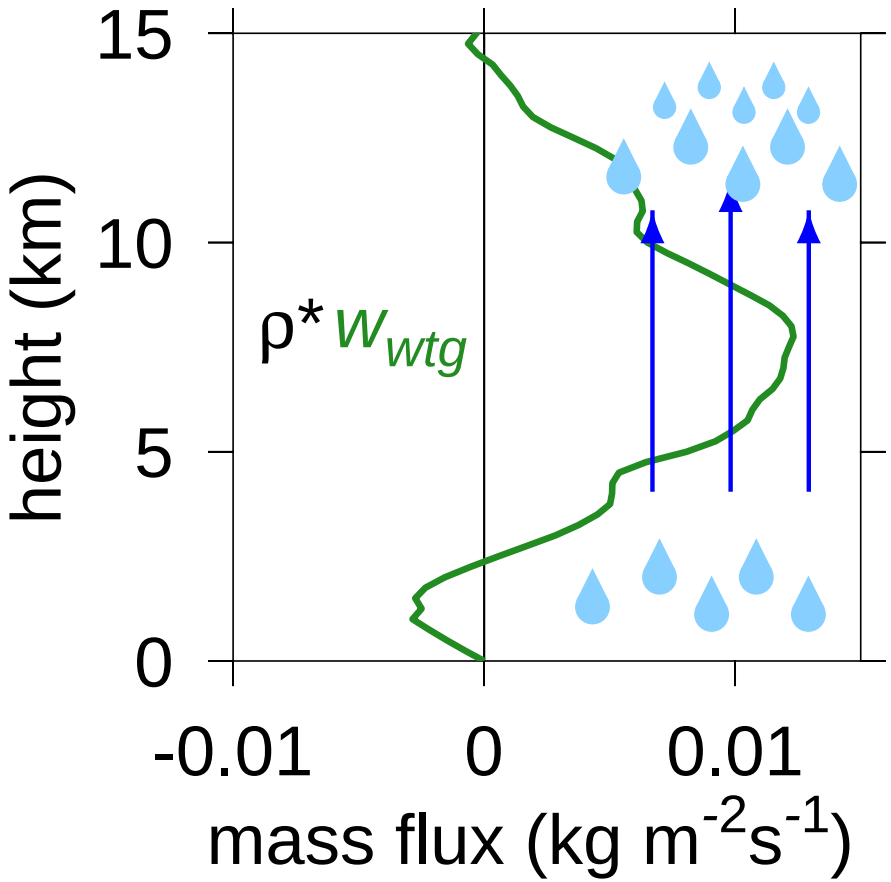
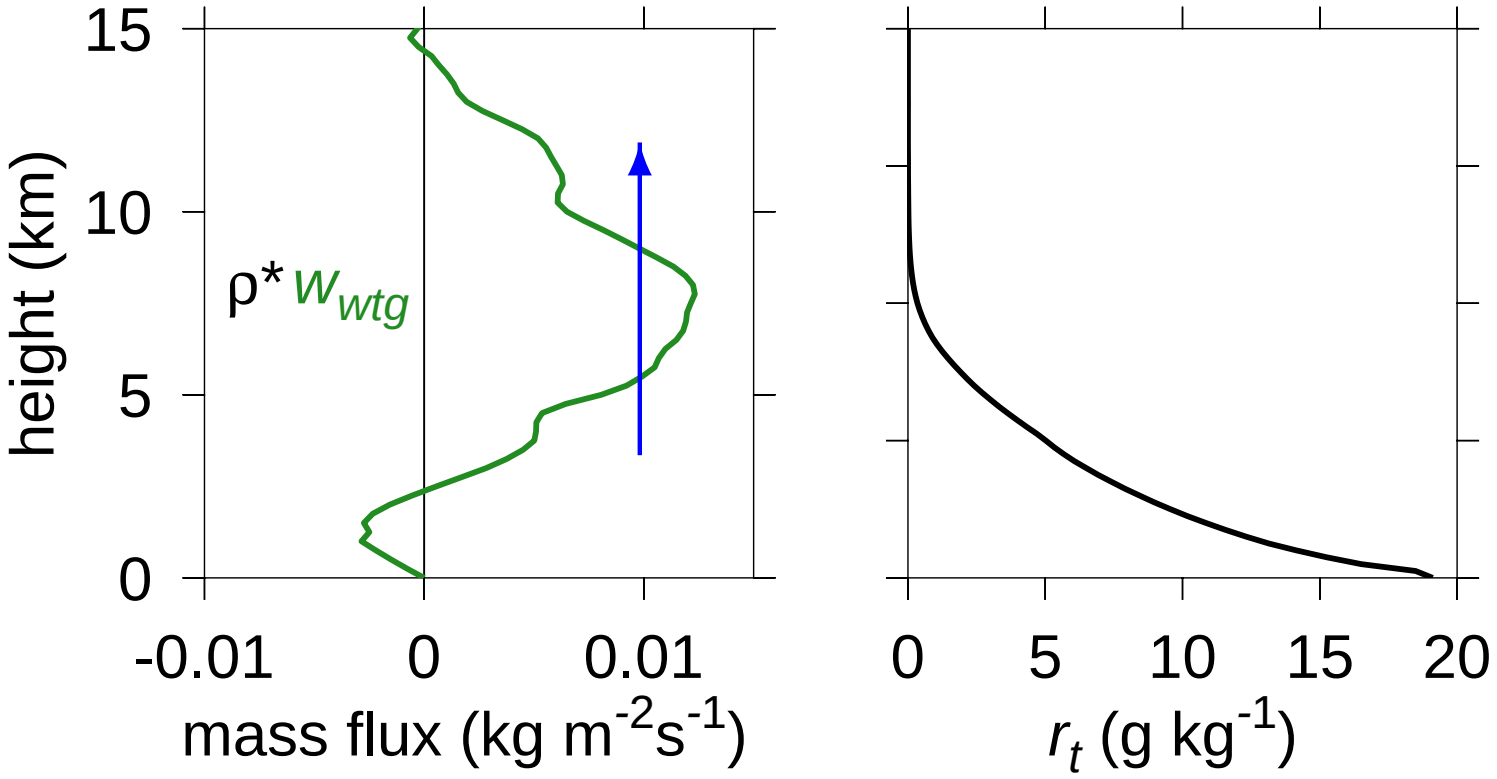


HOW DOES DOMAIN FEEL r_{ref}?



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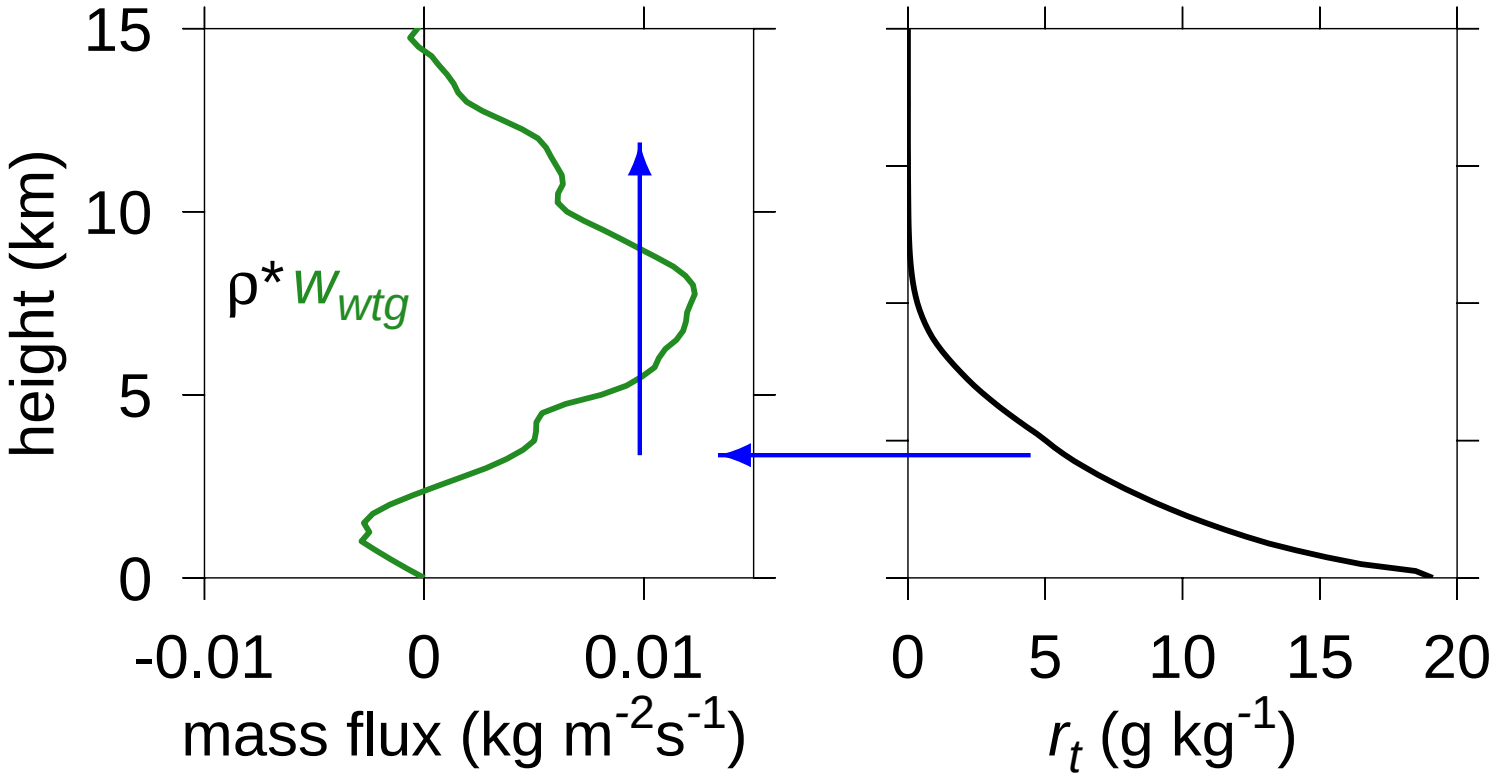

- lateral entrainment

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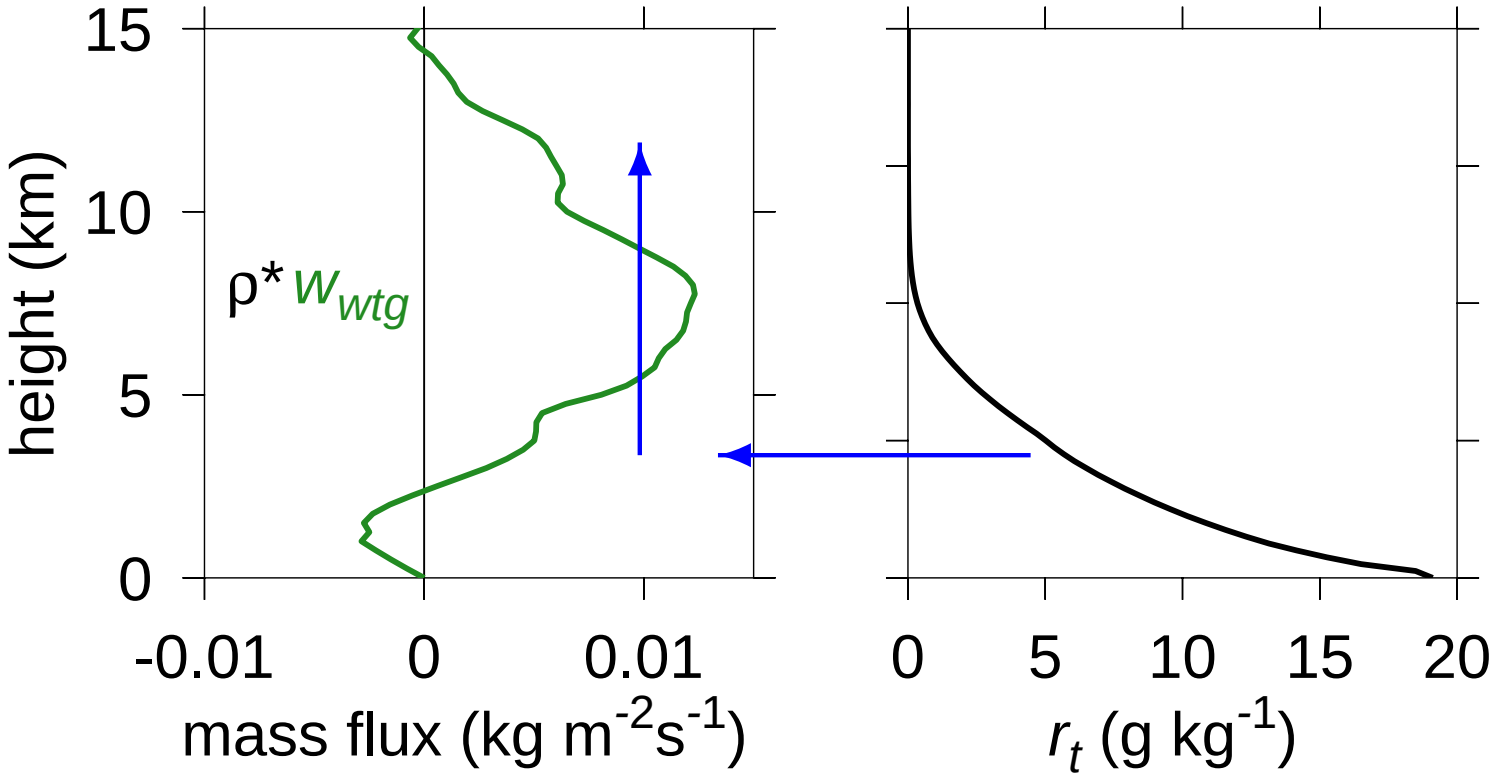
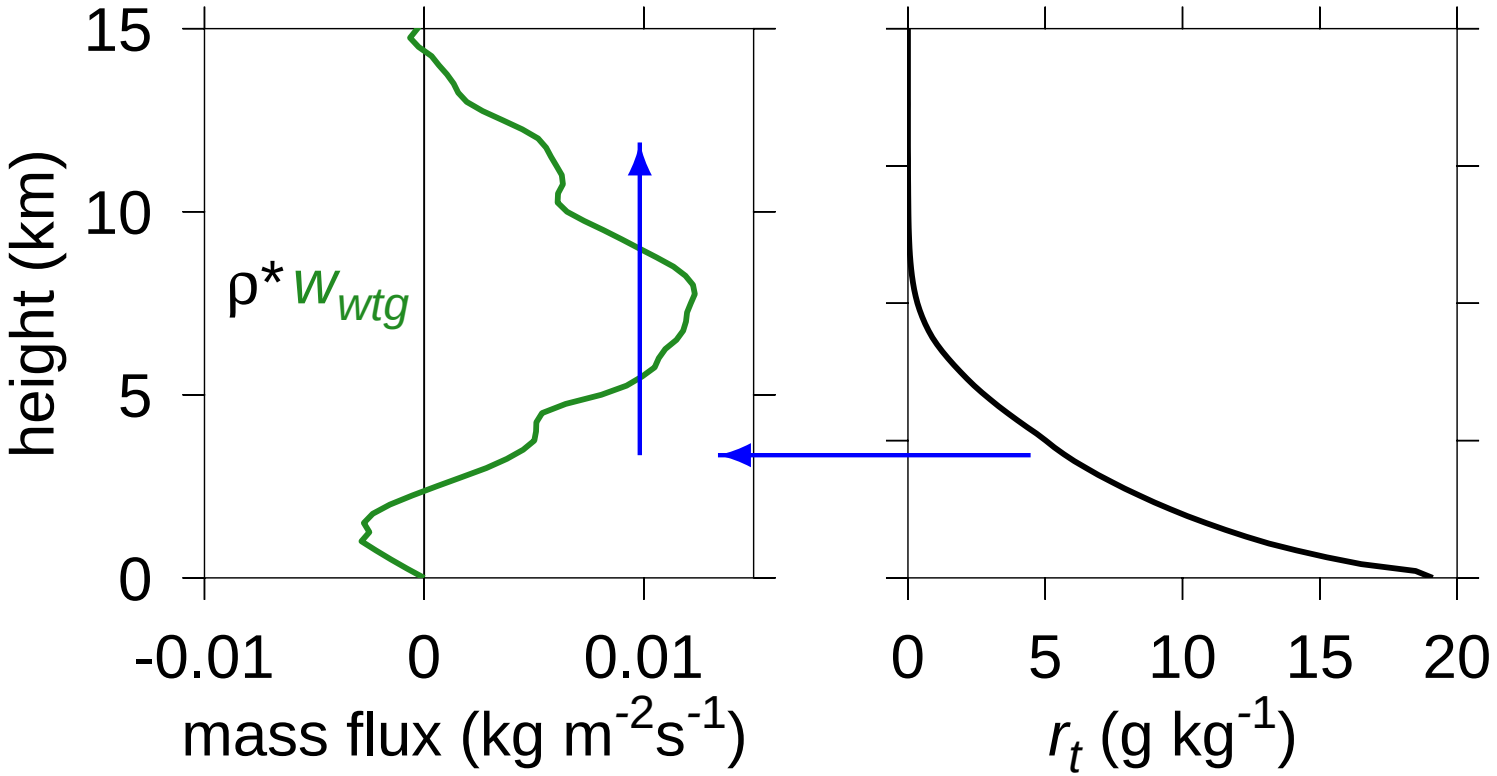


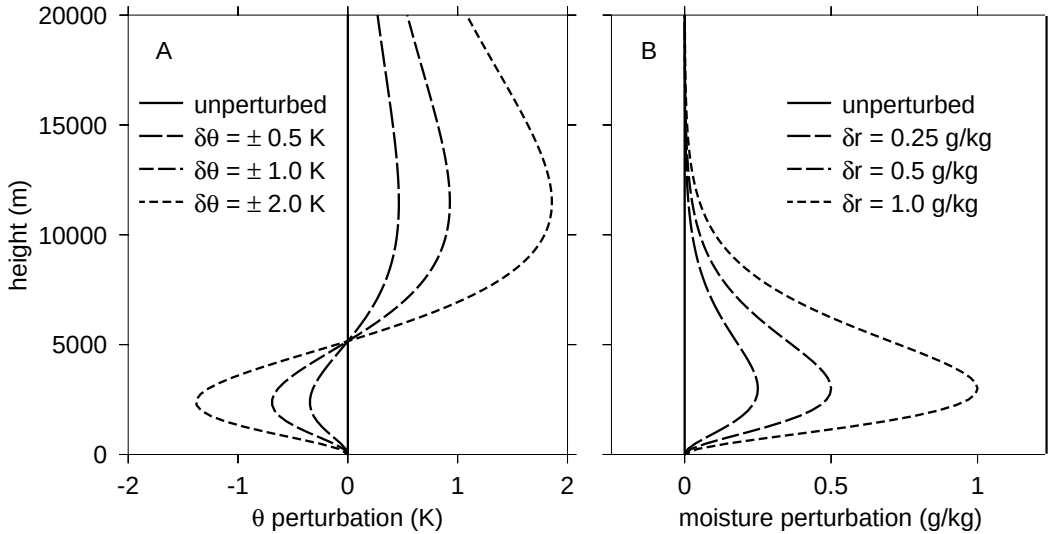
- lateral entrainment
- relax to r_{ref}: $(\overline{r_t} - r_{ref})/t_{moist}$

HOW DOES DOMAIN FEEL r_{ref}?



- lateral entrainment
- relax to r_{ref}: $(\overline{r_t} - r_{ref})/t_{moist}$
- both
- none

EFFECT OF θ_{ref}, r_{ref} ON MASS FLUX



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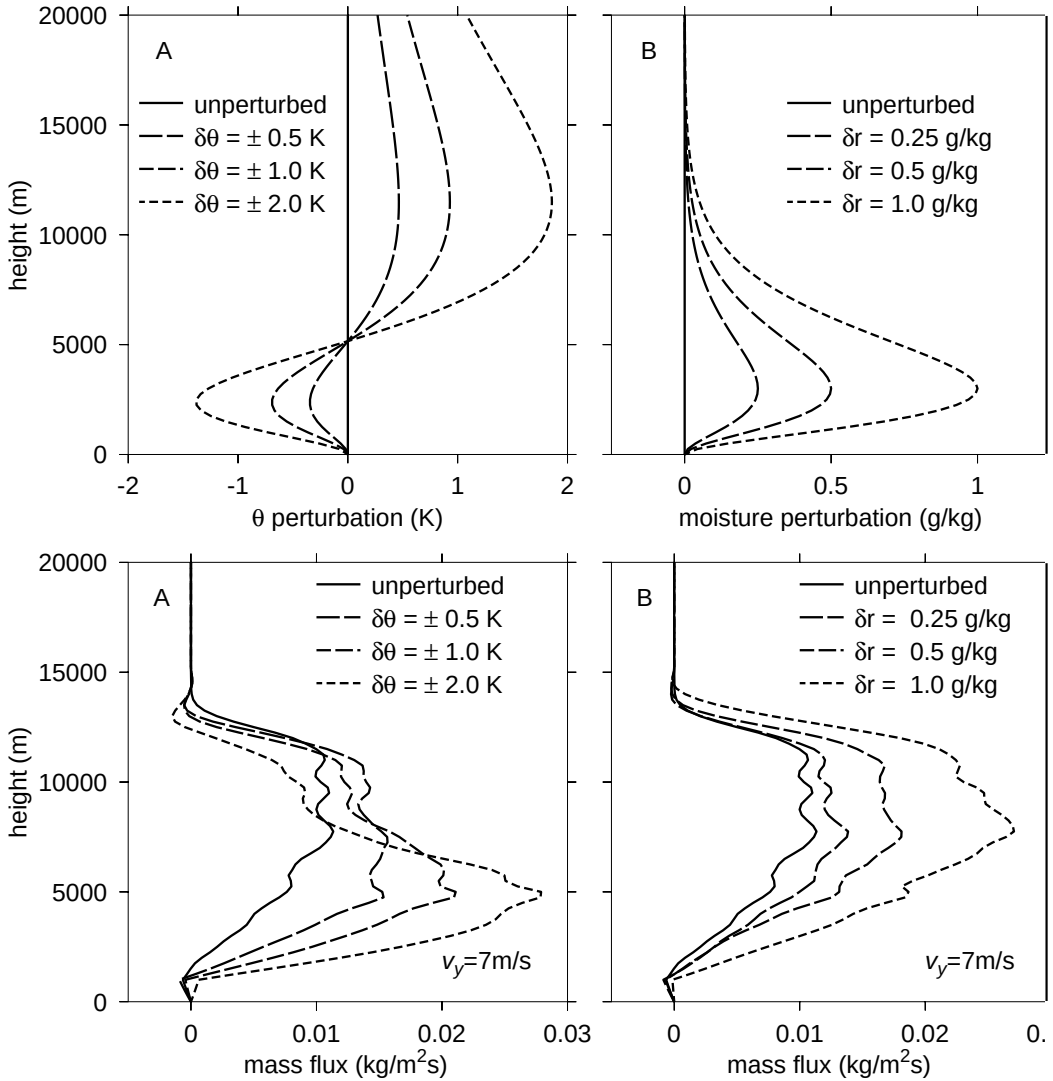
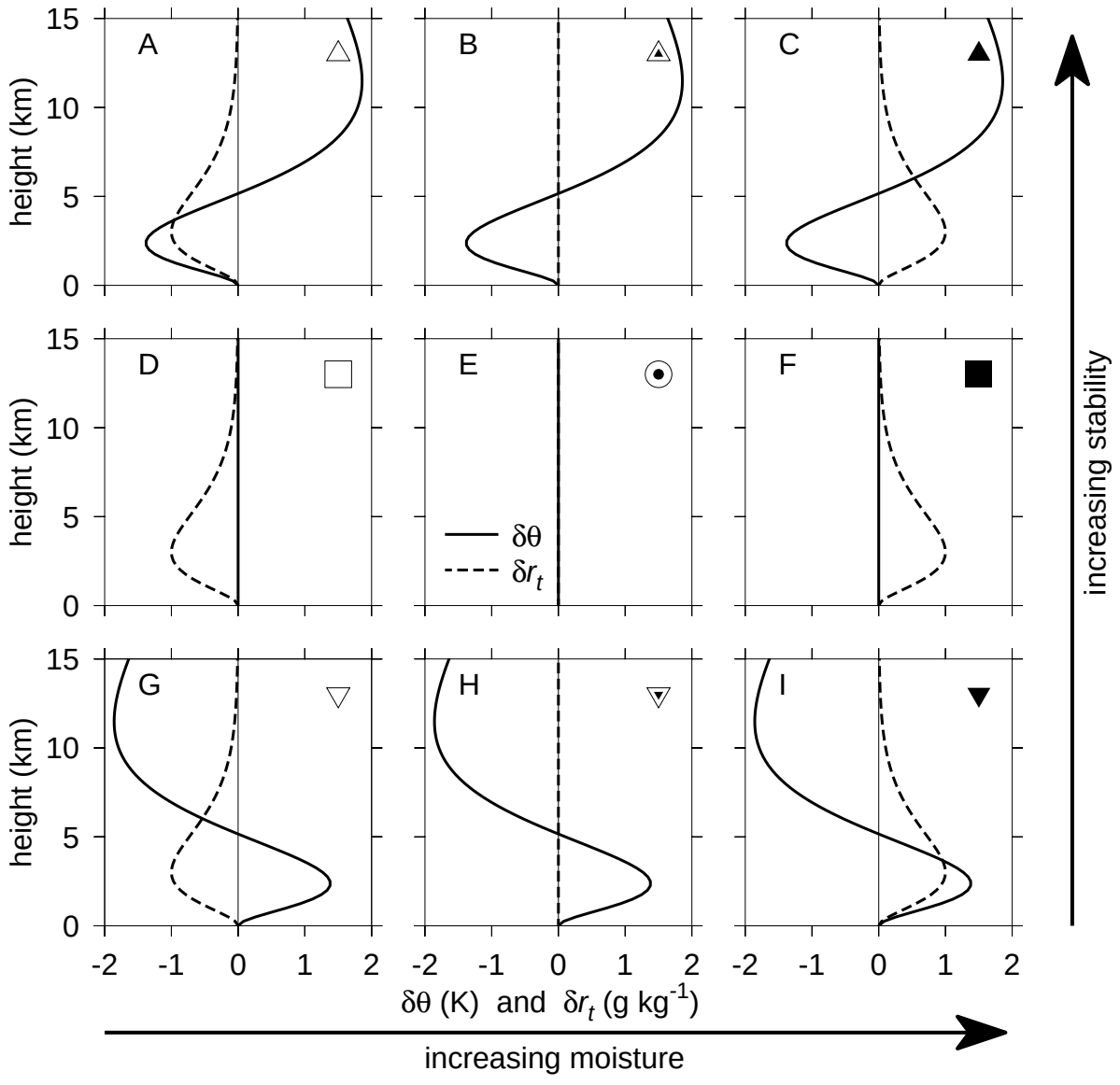


$\delta\theta$, δr_t



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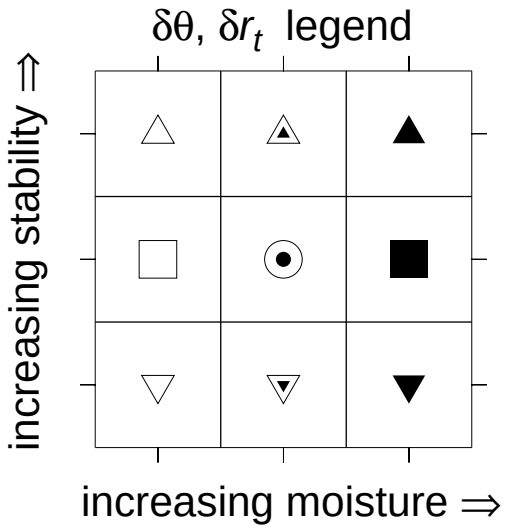
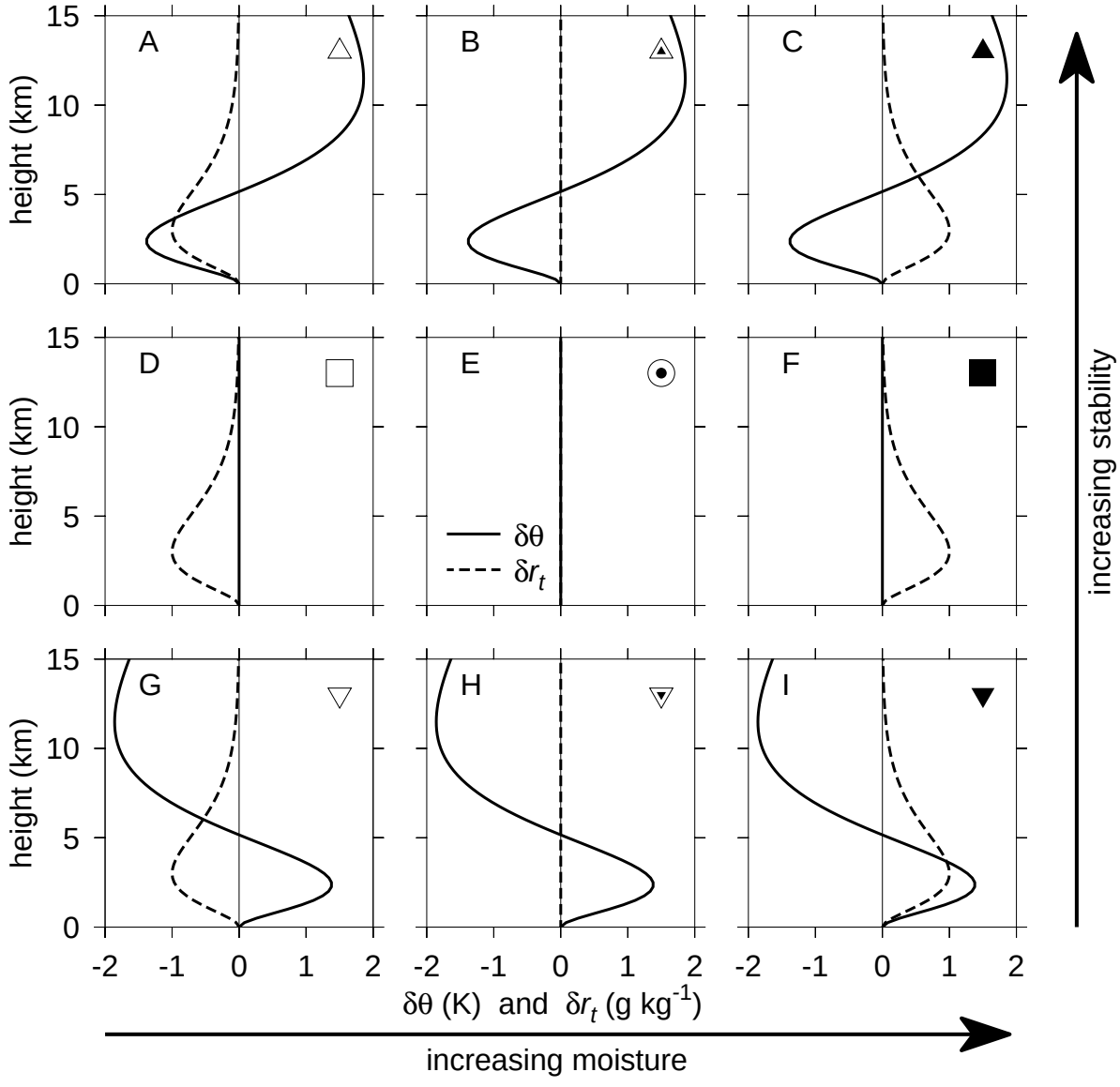
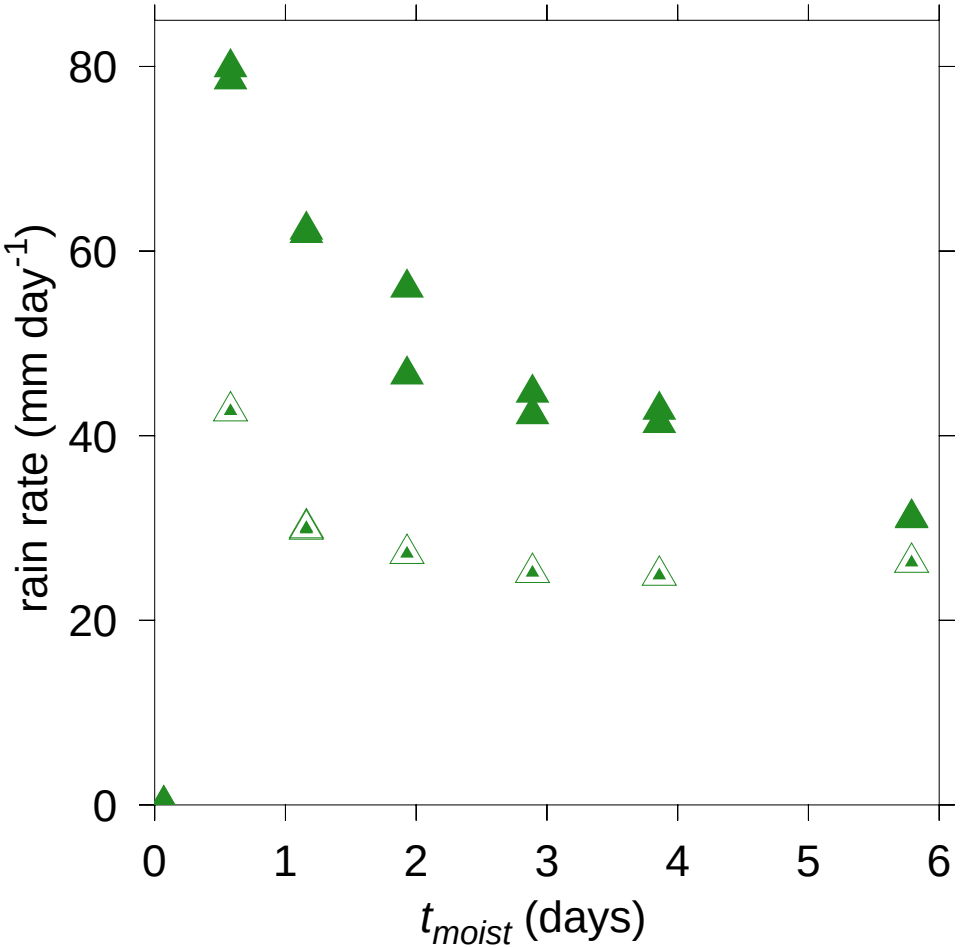
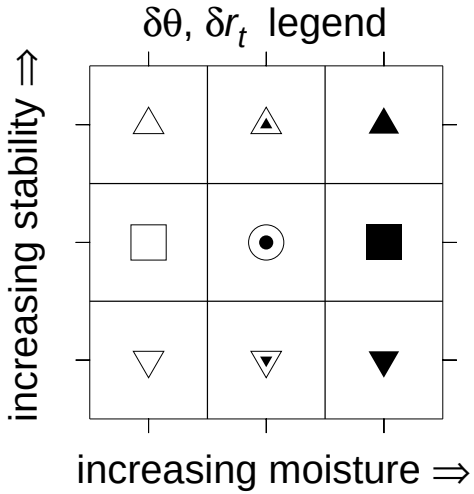




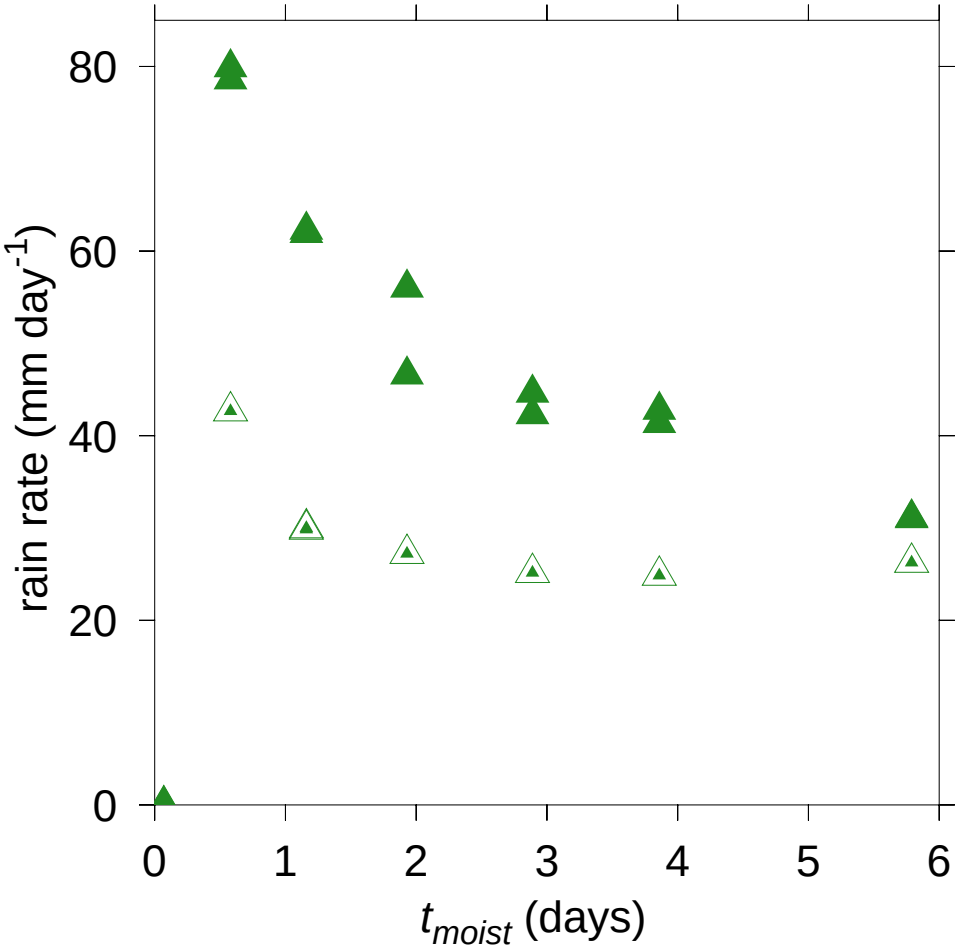
MOISTURE RELAXATION TIME SCALE, t_{moist}

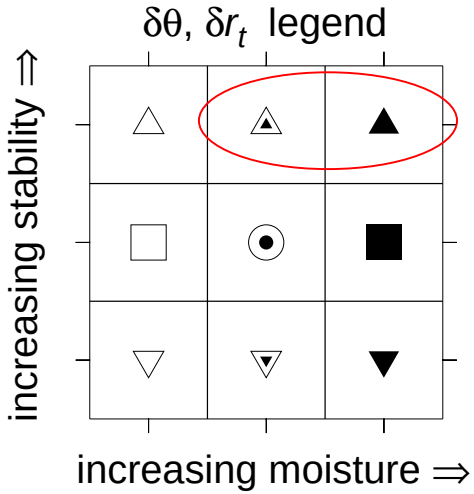




moisture relaxation

MOISTURE RELAXATION TIME SCALE, t_{moist}





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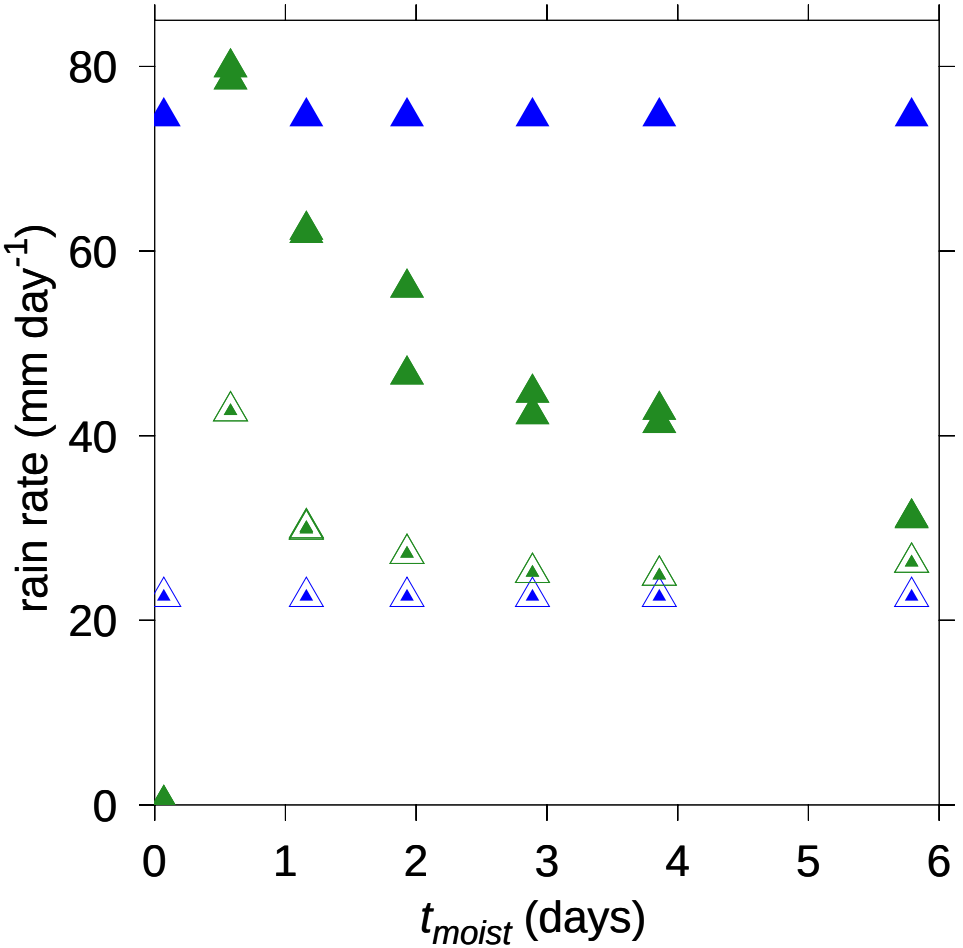
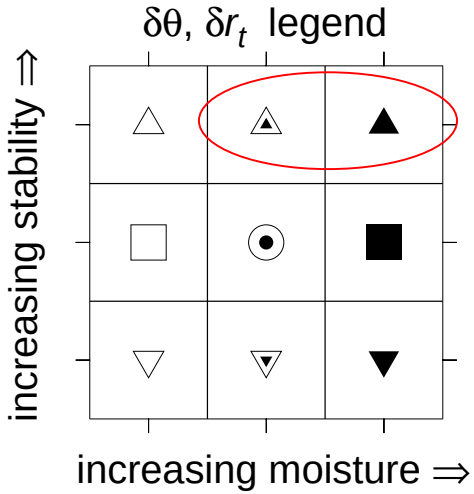
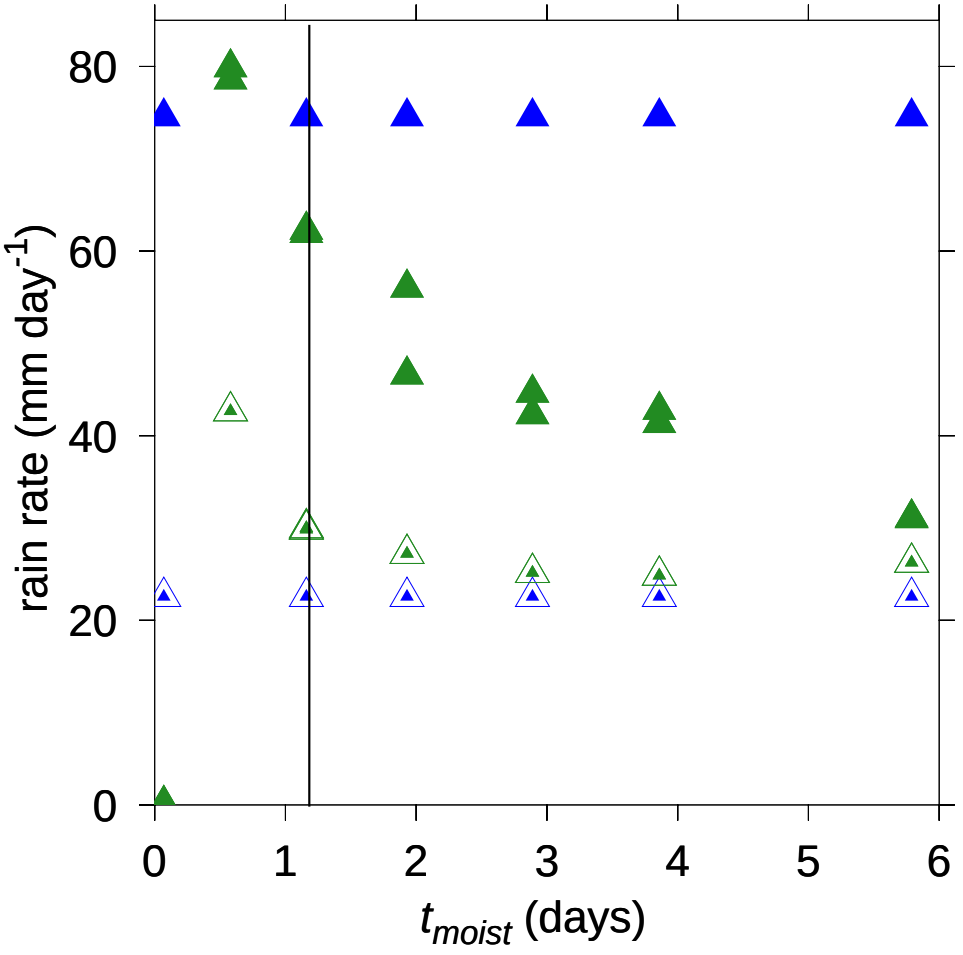


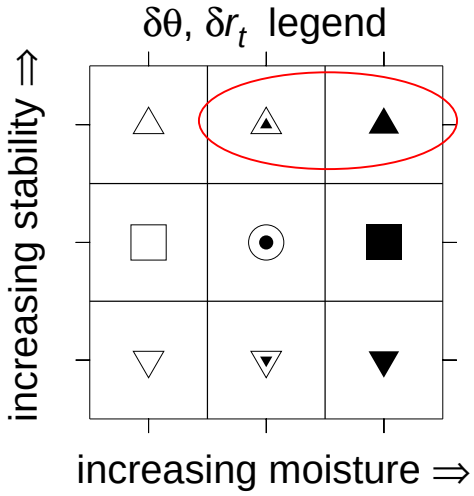


moisture relaxation

lateral entrainment

MOISTURE RELAXATION TIME SCALE, t_{moist}





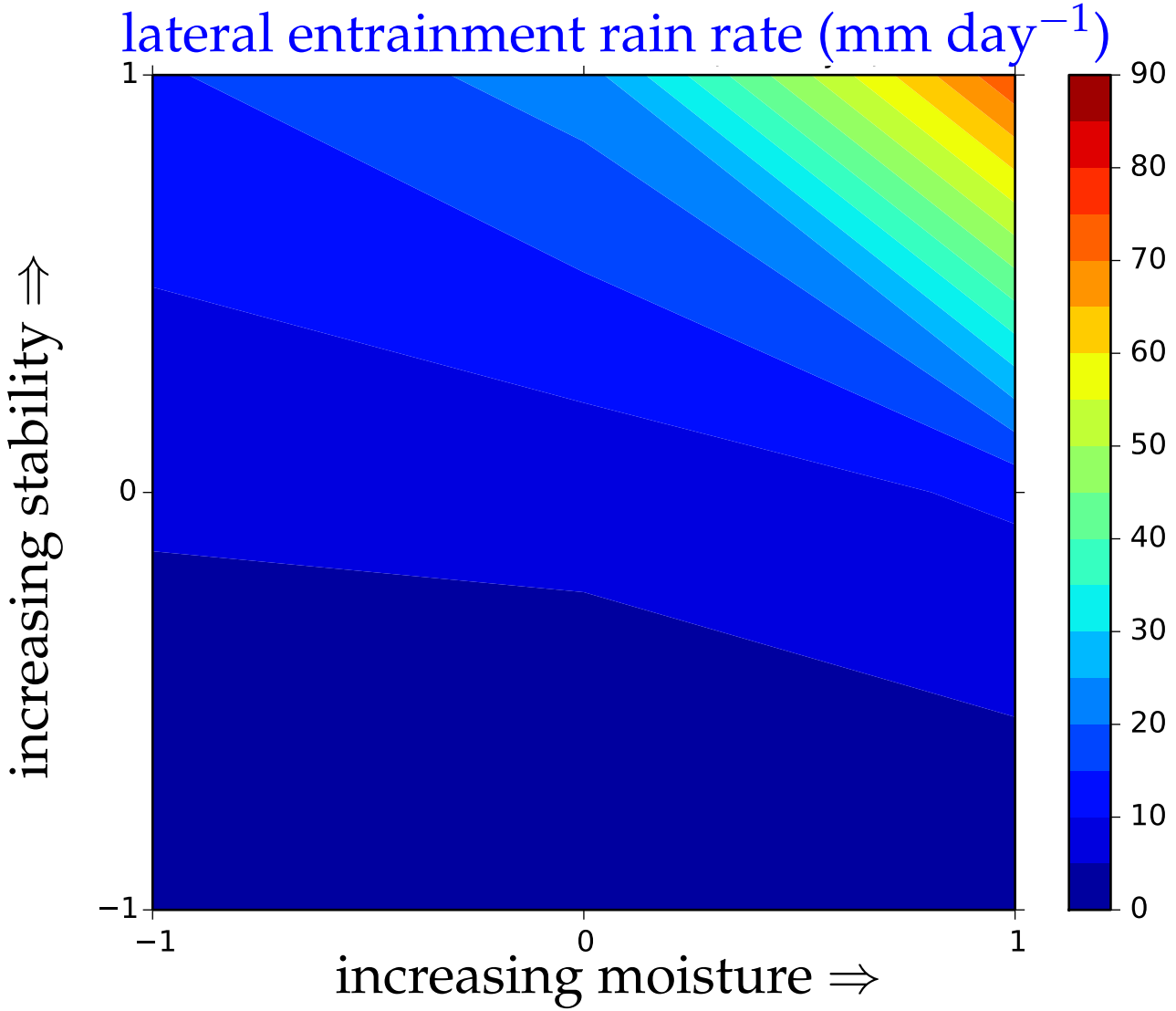
moisture relaxation

lateral entrainment

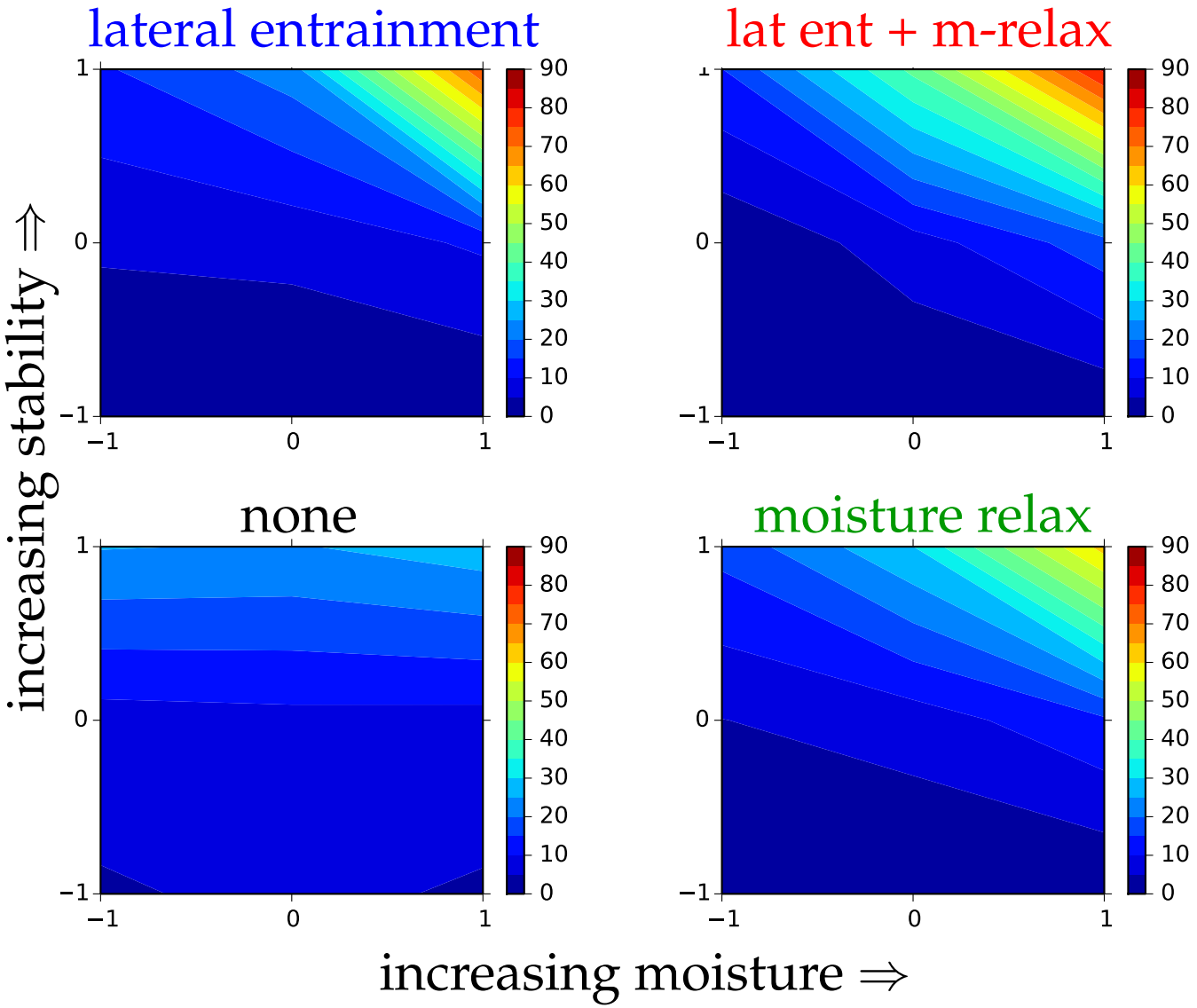
Choose $t_{moist} = 1.2$ days

RAIN RATE AS A FUNCTION OF θ_{ref}, r_{ref}

LATERAL ENTRAINMENT



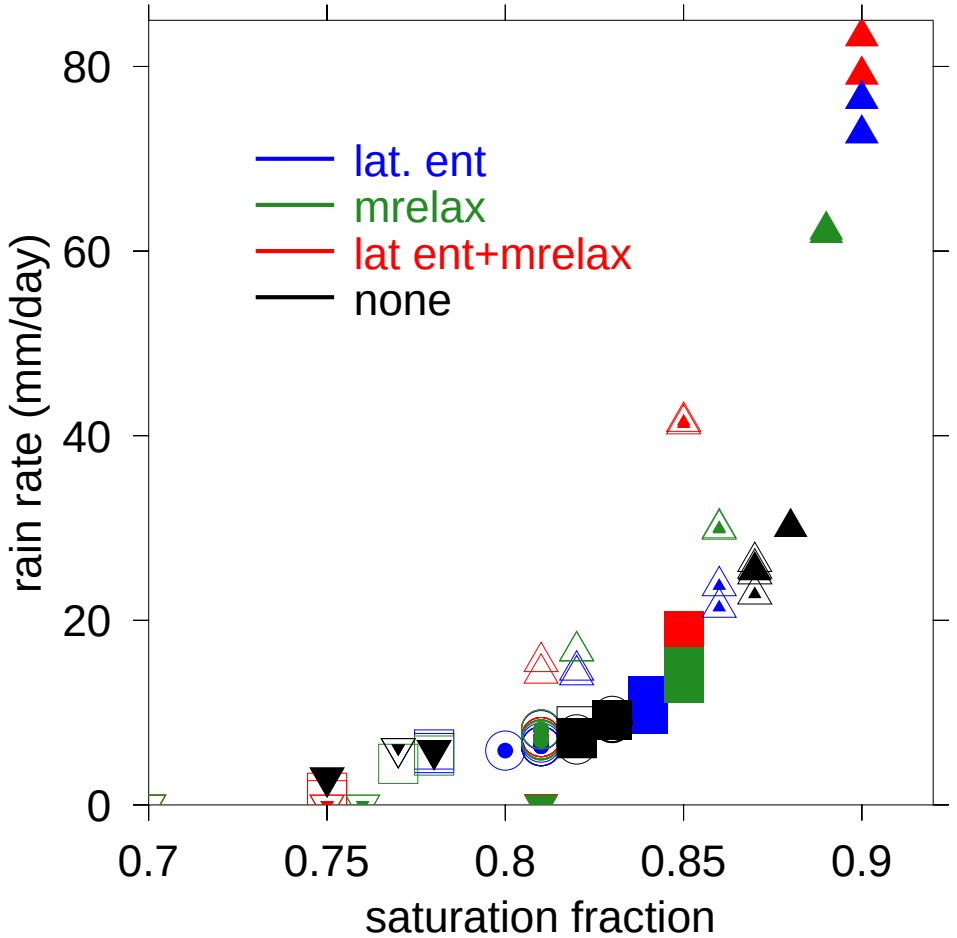
RAIN RATE AS A FUNCTION OF θ_{ref}, r_{ref}

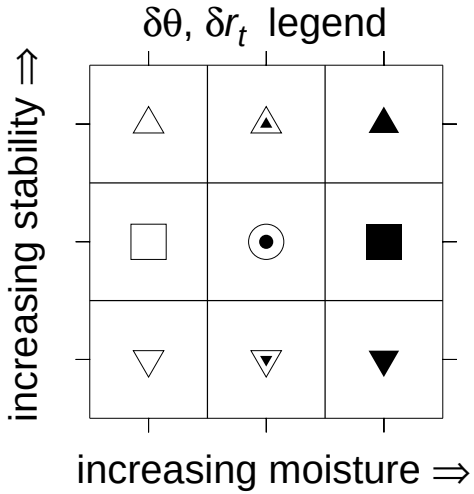


DIAGNOSTIC VARIABLES

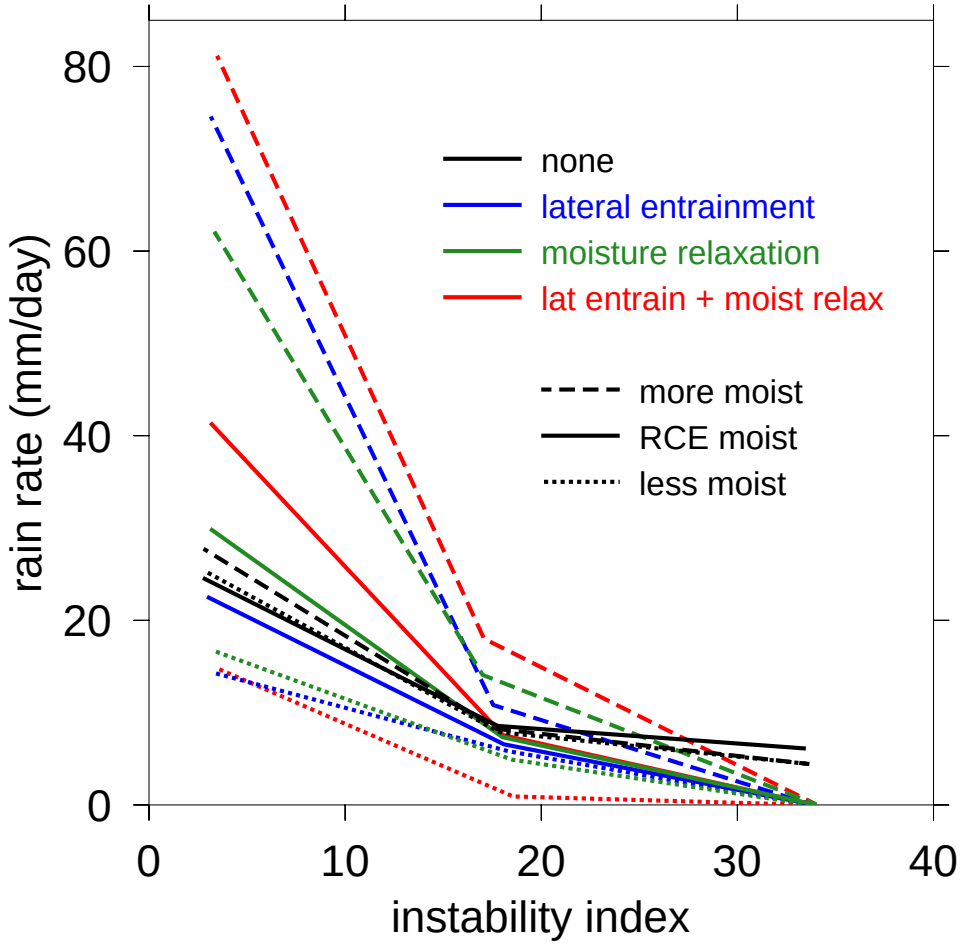
- saturation fraction$= \frac{\text{precipitable water}}{\text{sat'd precipitable water}}$
- instability index, $\Delta s^* = s^*_{1-3km} - s^*_{5-7km}$
- $NGMS = \frac{\text{moist entropy export}}{\text{moisture import}}$

RAIN VS. SATURATION FRACTION

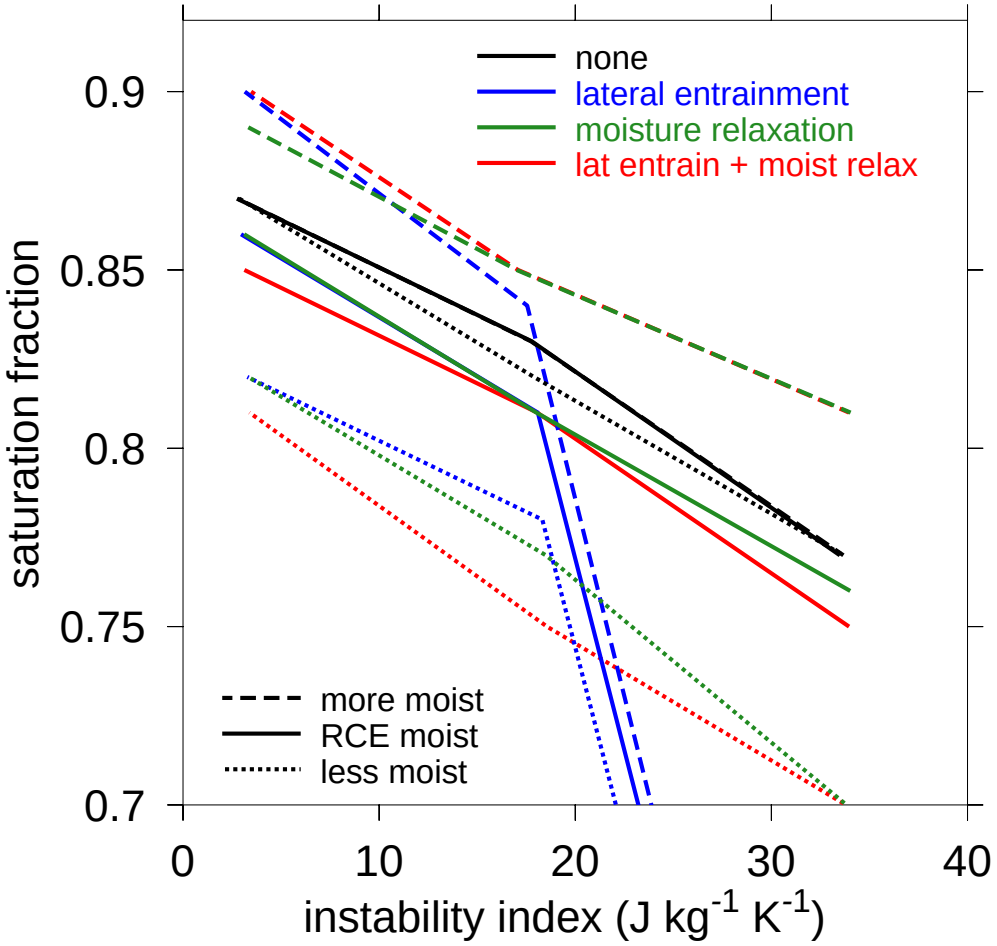




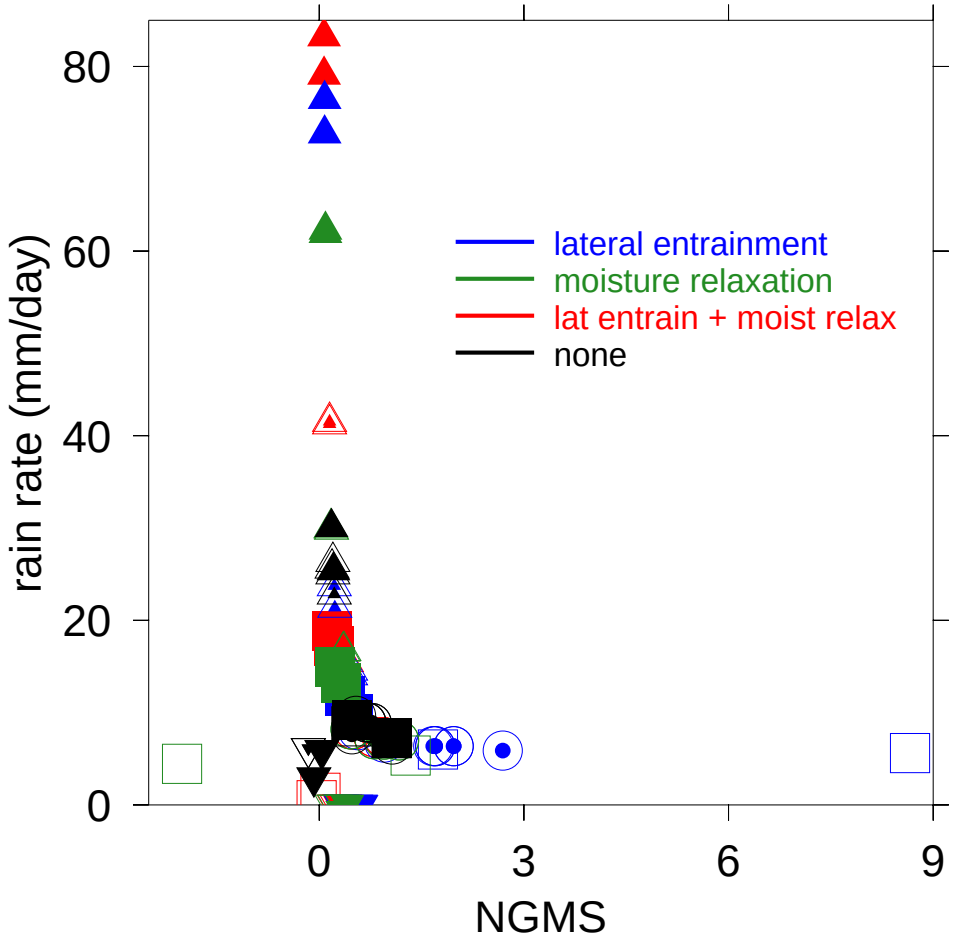
RAIN VS. INSTABILITY INDEX

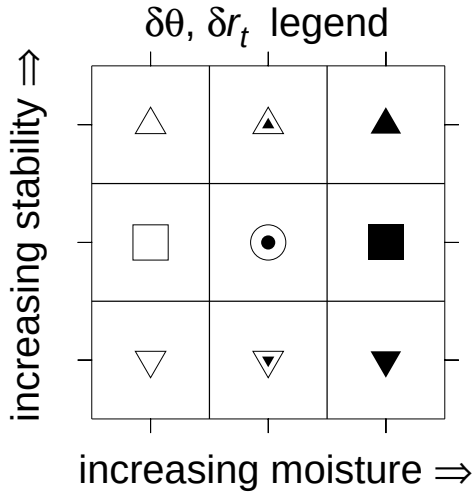


SATURATION FRACTION VS. INSTABILITY INDEX



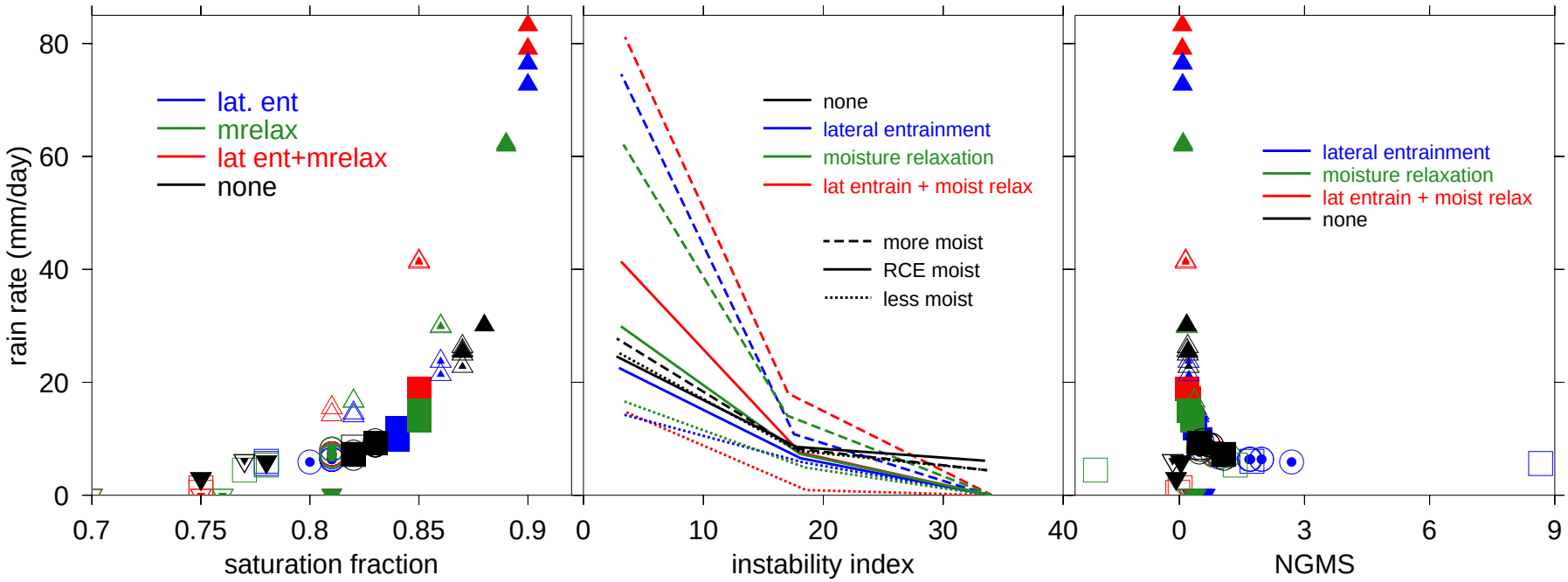
RAIN VS. NGMS



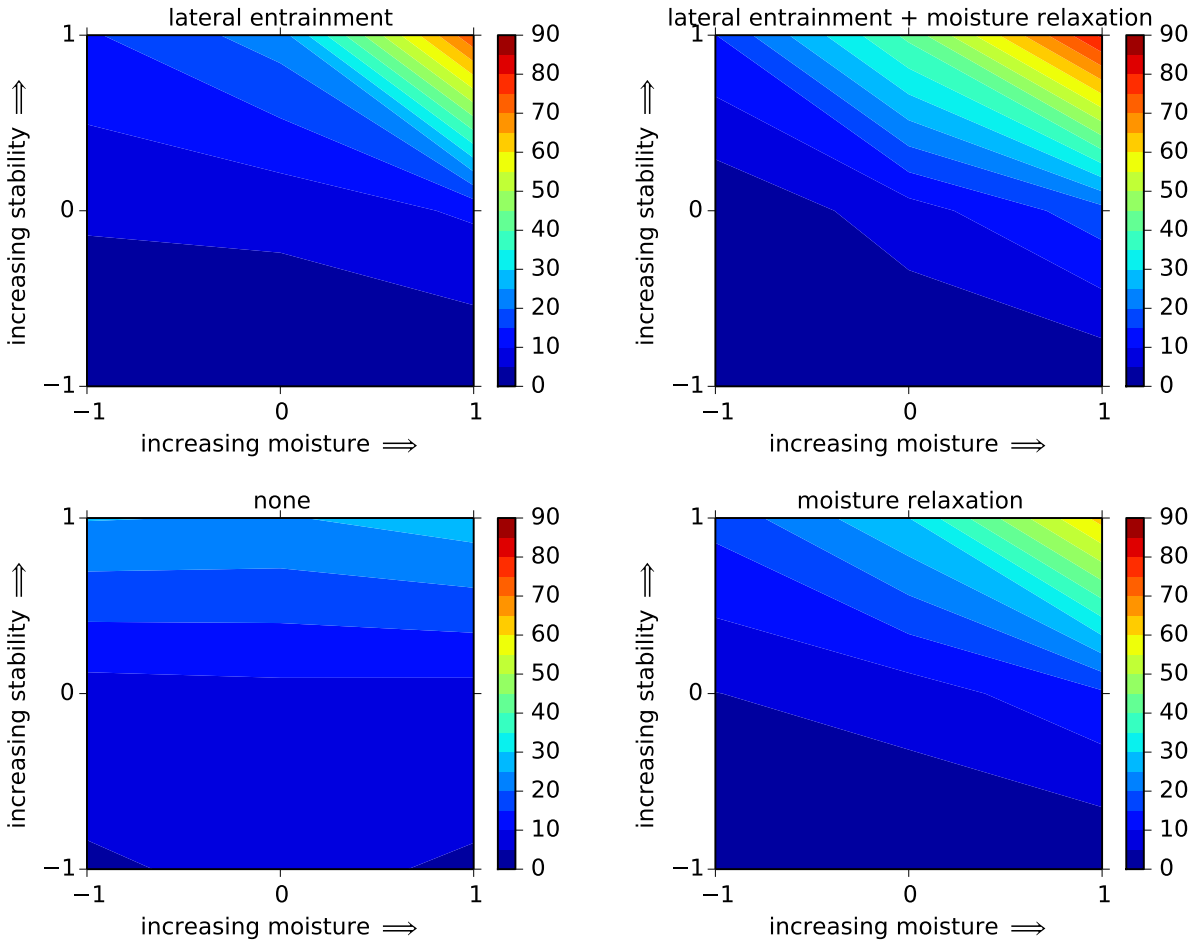


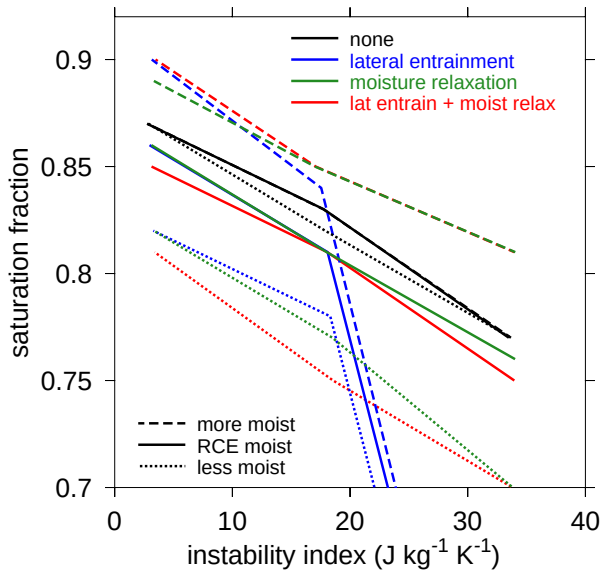
$$NGMS \propto \frac{\text{entropy forcing}}{\text{net precip}}$$

MOISTURE CHOICES ARE SIMILAR IN SOME RESPECTS...



...BUT ALSO HAVE SIGNIFICANT DIFFERENCES





Dependence of rain on θ_{ref}, r_{ref}