F: Coupling implications of the sensitivity to turbulent mountain stress, gustiness and vertical resolution:

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Objective

The plans for the ACME model are to ultimately develop a credible, fully coupled system. We present a set of experiments that illustrate the potential impact we might see in the fully coupled system in response to a number of near surface change sensitivities in the atmosphere model.

We examine the potential impact of turbulent mountain stress, convective gustiness and increased vertical resolution on the surface fluxes to assess the possible coupling implications. We only show a subset of results. The full set of simulations and diagnostics is available at:
https://acme-climate.atlassian.net/wiki/pages/viewpage.action?pageId=38043978

We initially proposed to assess the impact in the standalone framework and then, to further investigate the sensitivity in the fully coupled framework. With the slow turnaround on edison we were not able to complete the fully coupled simulations.

Turbulent Mountain Stress

The introduction of turbulent mountain stress (tms), a missing stress process keying off sub-grid orographic scales between small and resolved scales, demonstrated many improvements in north-Atlantic and southern ocean surface stress biases in CAM5.
The tms parameterization include free parameters (see: Table 1) that have significant potential to influence the coupled system by regulating surface stresses over the ocean.
As illustration, we show the impact of horomin = 10 on the 10-meter wind (see: Figure 1)

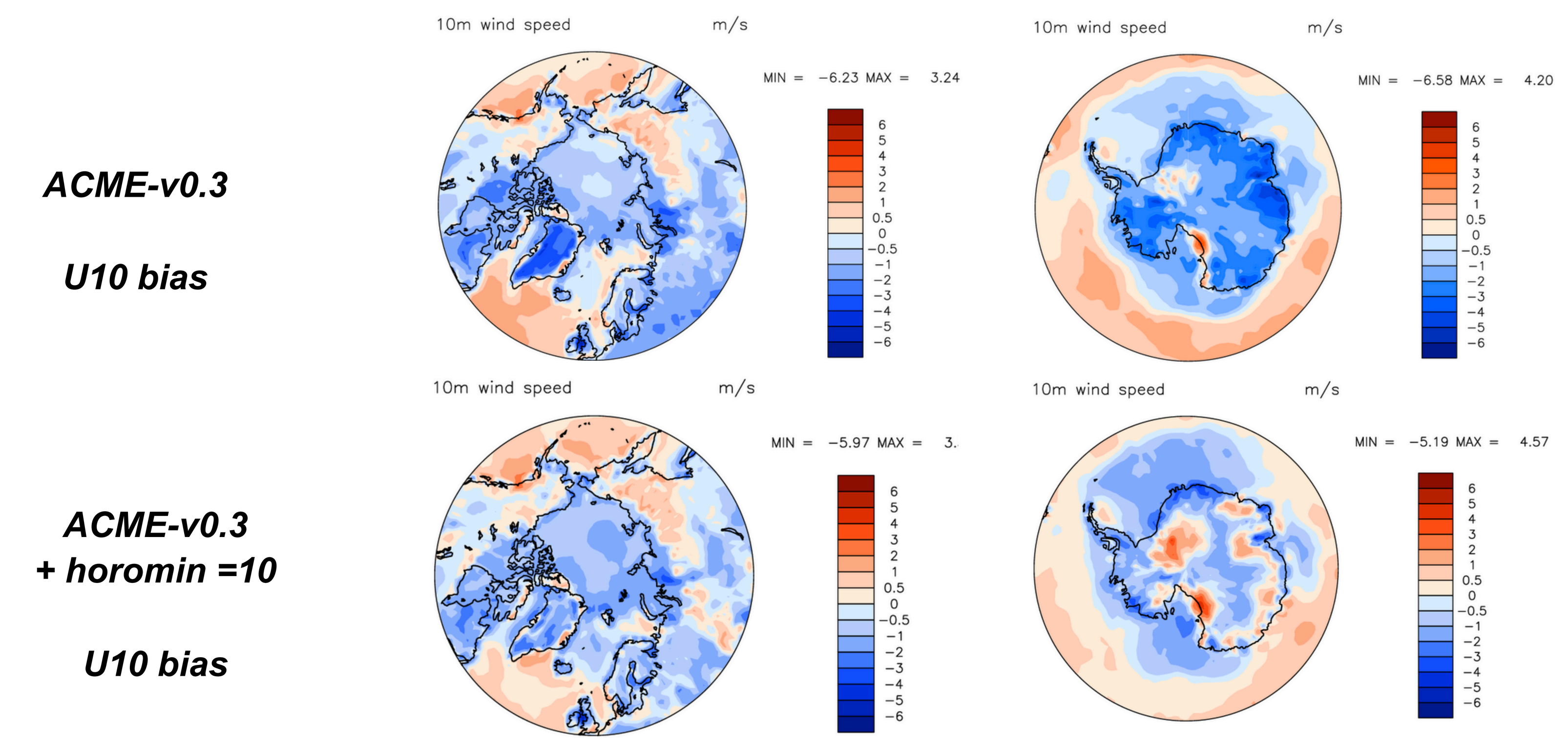

Figure 1: 10-meter wind biases compared to ERA-Interim
Top row: ACME v0.3. Bottom row: ACME V03 + horomin =10 m

	Default	Range	
horomin	1	[0.5,10]	Minimum value of subgrid orographic height for mountain stress
orocnst	1	[0.5, 2]	Converts from standard deviation to height
z0fac	0.075	[0.004, 0.2]	Factor determining z_0 from orographic standard deviation
zomax	100	[10, 100]	Maximum of Zo for orography

Table 1: Parameters in the sensitivity studies: default value and explored range

Convective Gustiness

Convective gustiness was previously shown to have a beneficial impact on surface latent heat fluxes in equatorial regions, with improvements in the Asian monsoon precipitation 'hole' currently seen (Neale et al, 2015). Because of the dependence of the scheme on surface convective precipitation, and the different patterns seen in coupled experiments compared to AMIP, coupling could prove to moderate the simulation.

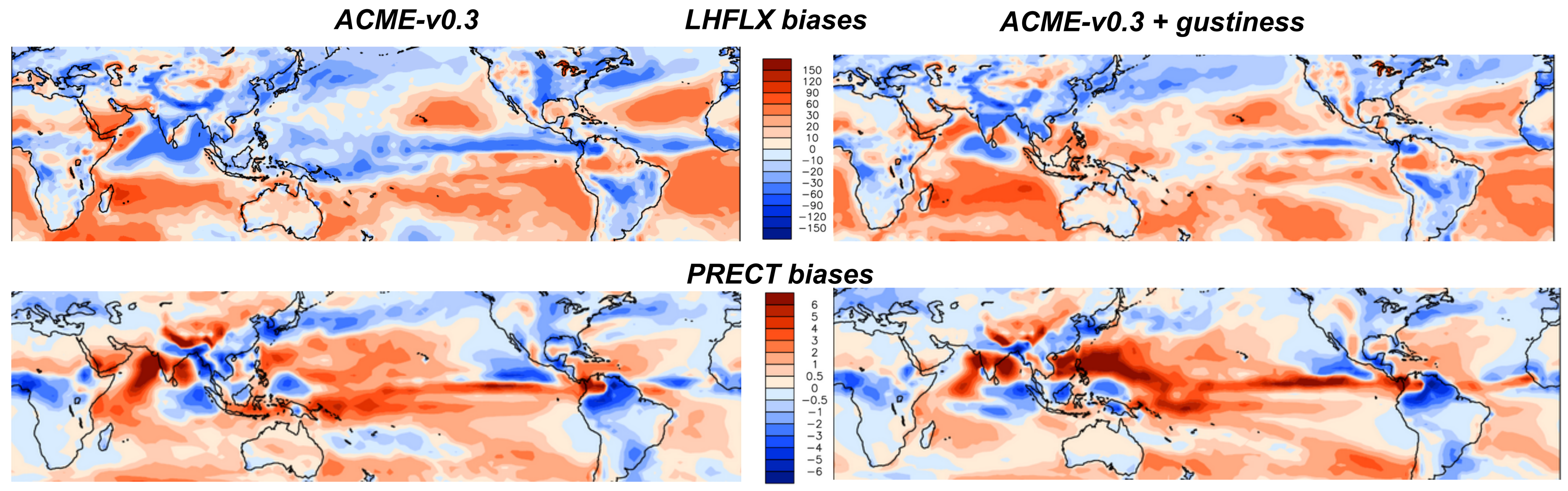

Figure 2: Impact of gustiness on LHFLX and Precipitation biases
Top Row LHFLX biases compared to ERA-Interim
Bottom Row: Precipitation bias compared to GPCP

Vertical resolution

The increase vertical resolution from 30 to a possible 72 layers in the vertical (Ma et al, 2015) could have the signifiicant impacts on the coupled simulations A simple systematic increase in vertical resolution has previously been shown to exacerbate the existing monsoon 'hole': a problem that intensifies even at vertical levels numbers as high as 120. Perhaps more importantly the thinning of the atmosphere level nearest the earth's surface has a greater potential to impact the coupled simulation. This could be both due to the decreased, and more responsive, mass of the layer and the interaction with aspects of the atmosphere parameterizations that are dependent on just the existence of the lowest model layer and not its thickness: this is certainly the case for turbulent mountain stress.

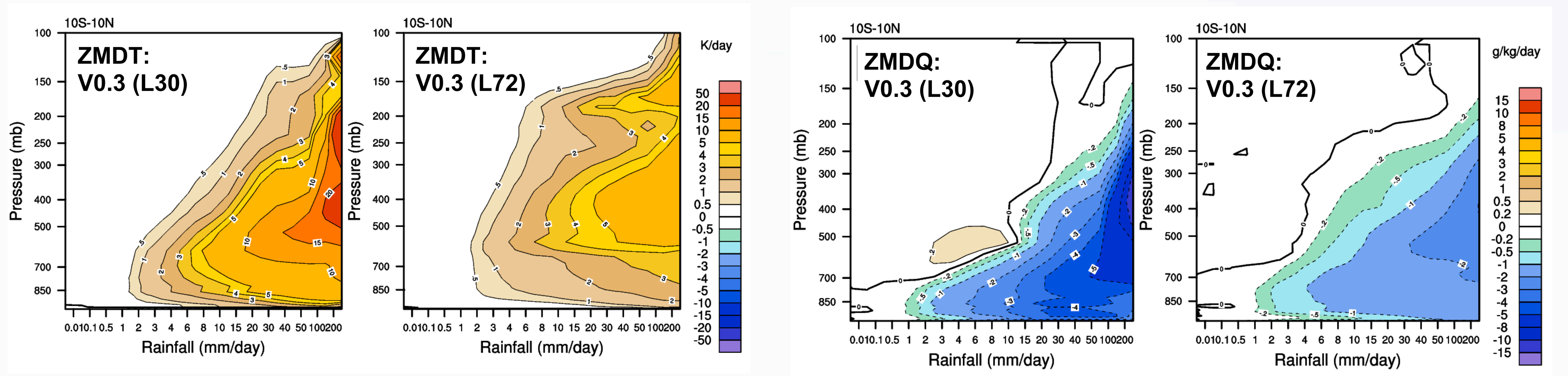

Figure 3: T and Q tendencies from Zhang-McFarlane moist convection sorted by total precipitation.
ZMDT plots show there is more heating at elevated precipitation both at L30 and L72, but the heating occurs higher in the L72 configuration. The ZMDQ plot shows that congestus (around 600mb) are a source of moisture at L30. However, this source of moisture seems to be turned off at L72.

ACME Accelerated Climate Modeling for Energy

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