

Will Outer Tropical Cyclone Size Change due to Anthropogenic Warming?

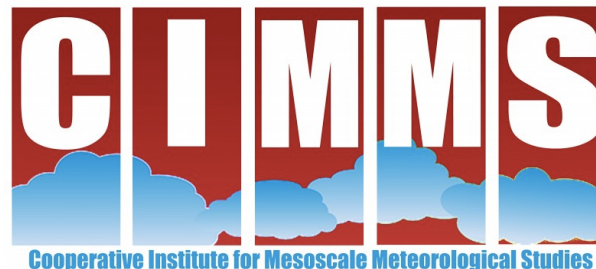
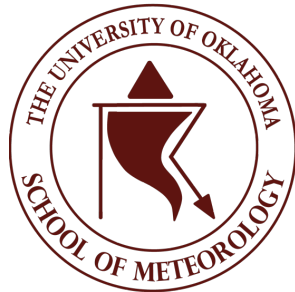
Ben Schenkel¹ (benschenkel@gmail.com),

Ning Lin², Dan Chavas³, Gabe Vecchi², Tom Knutson⁴, and Michael Oppenheimer²

1: OU/NOAA CIMMS, 2: Princeton University, 3: Purdue University, 4: NOAA GFDL

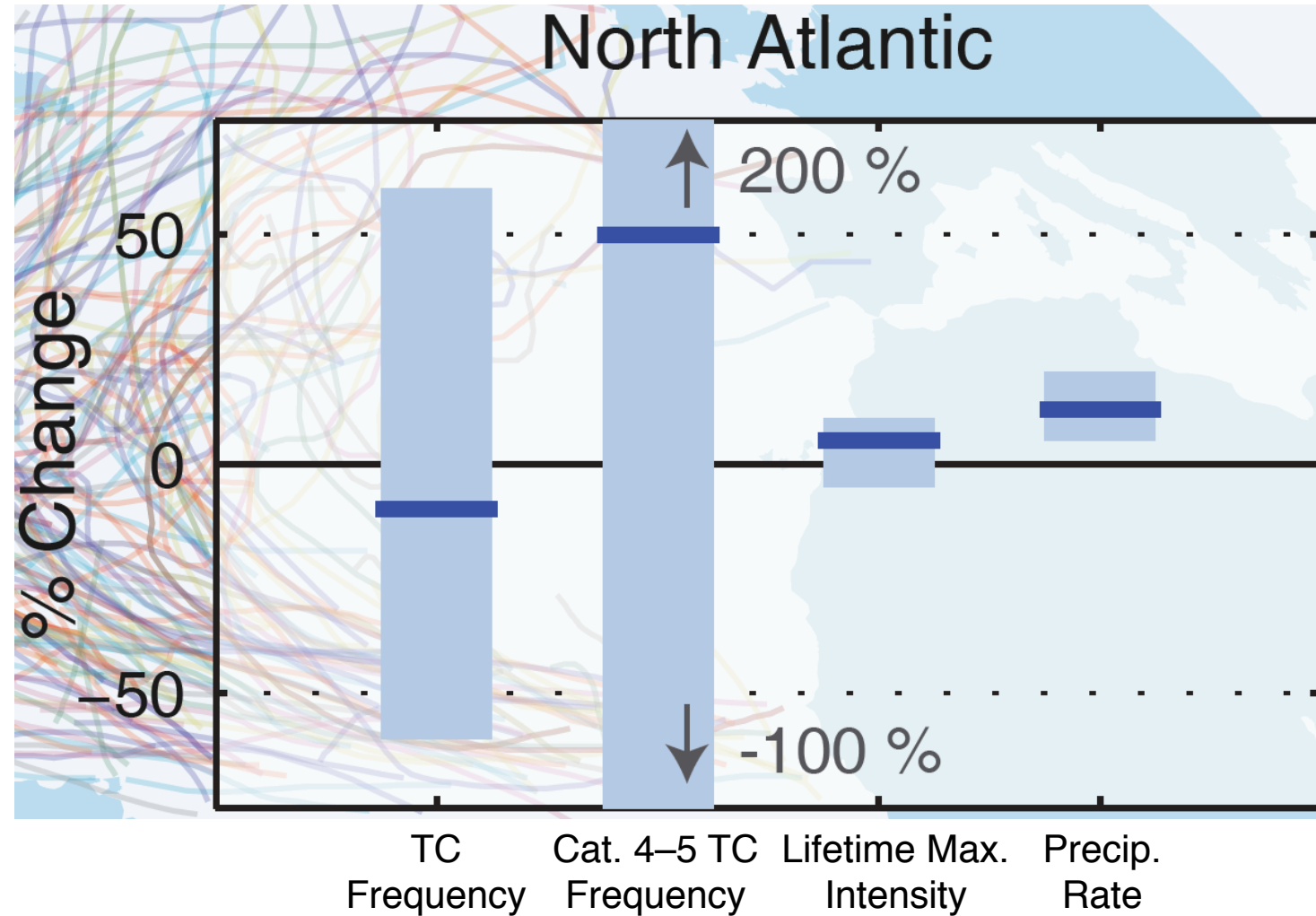
2017 AGU Fall Meeting

12/15/2017



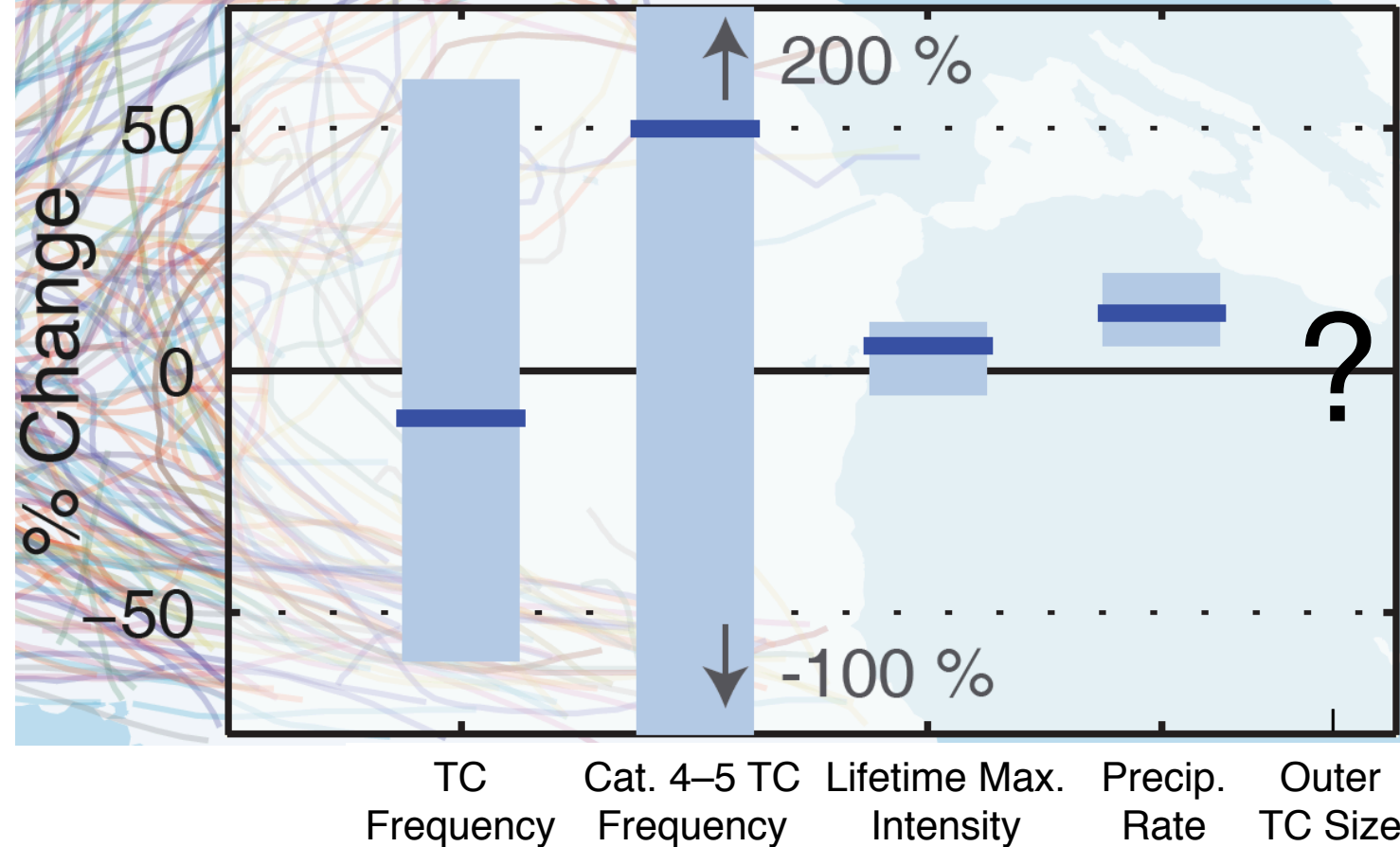
Research Sponsored by NSF EAR-1520683

How will TC Activity Change in Future Climates?



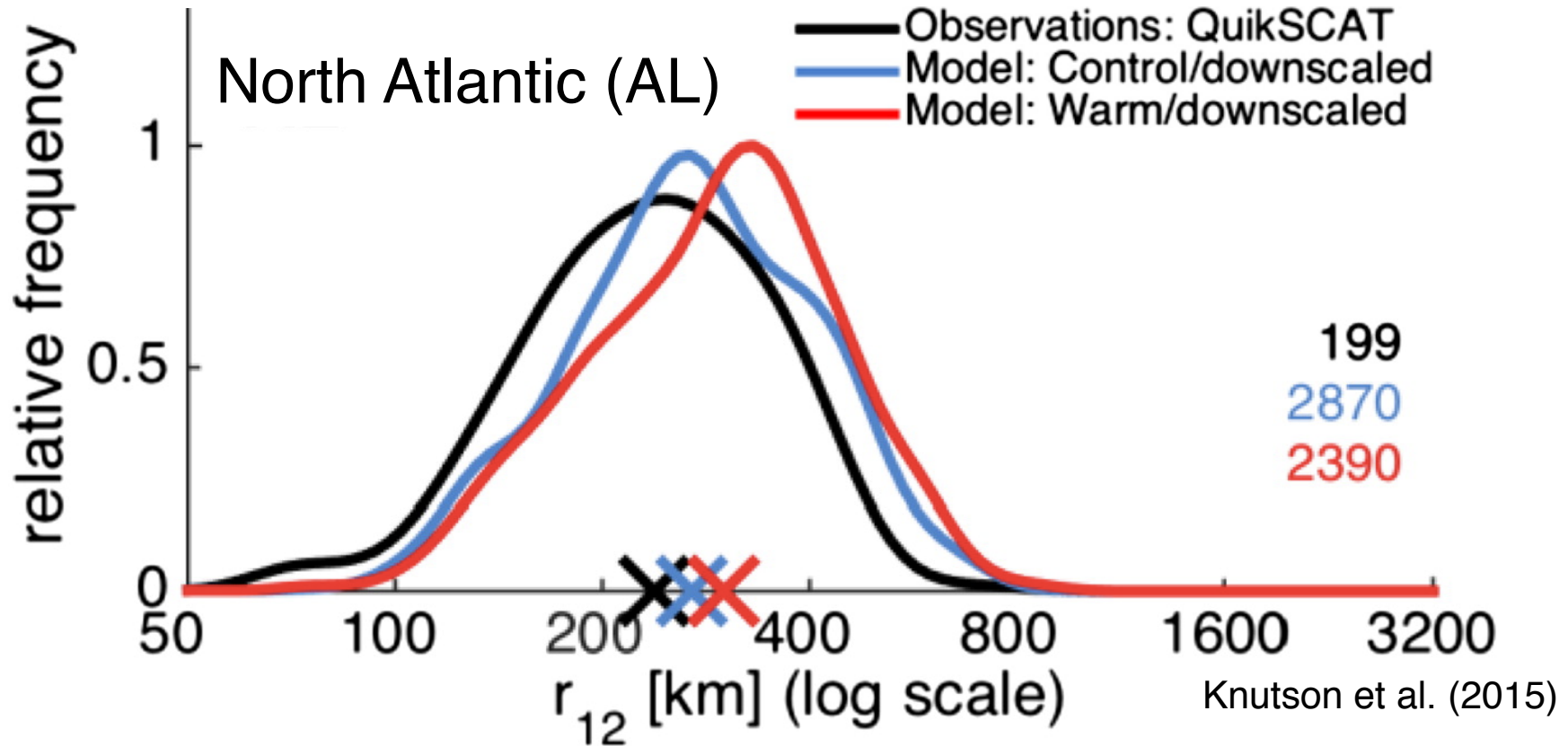
How will TC Activity Change in Future Climates?

North Atlantic

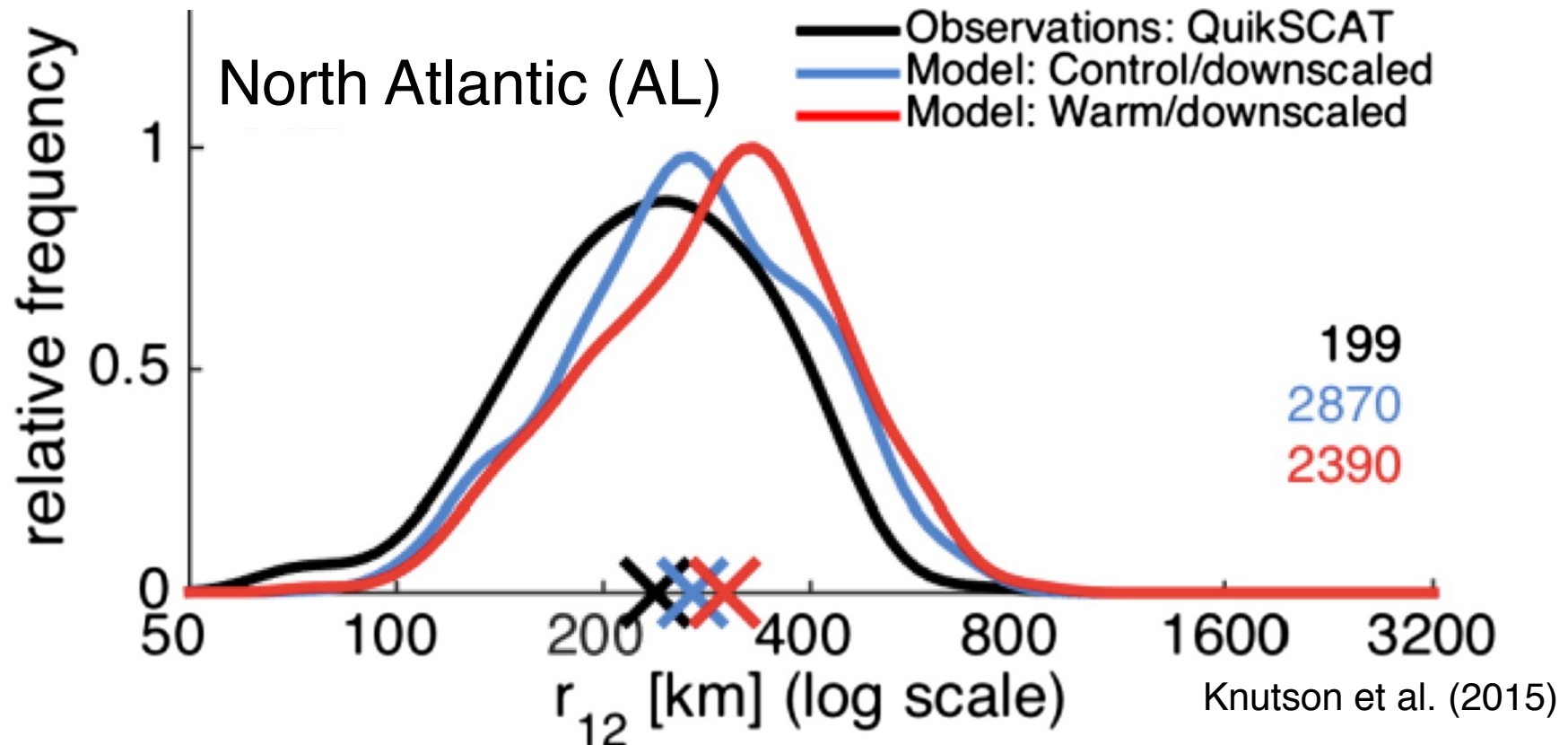


Can we add a fifth category to this figure for outer TC size given its importance to accurately estimating TC hazards and risk?

Prior Work on Outer TC Size Changes due to Anthropogenic Warming

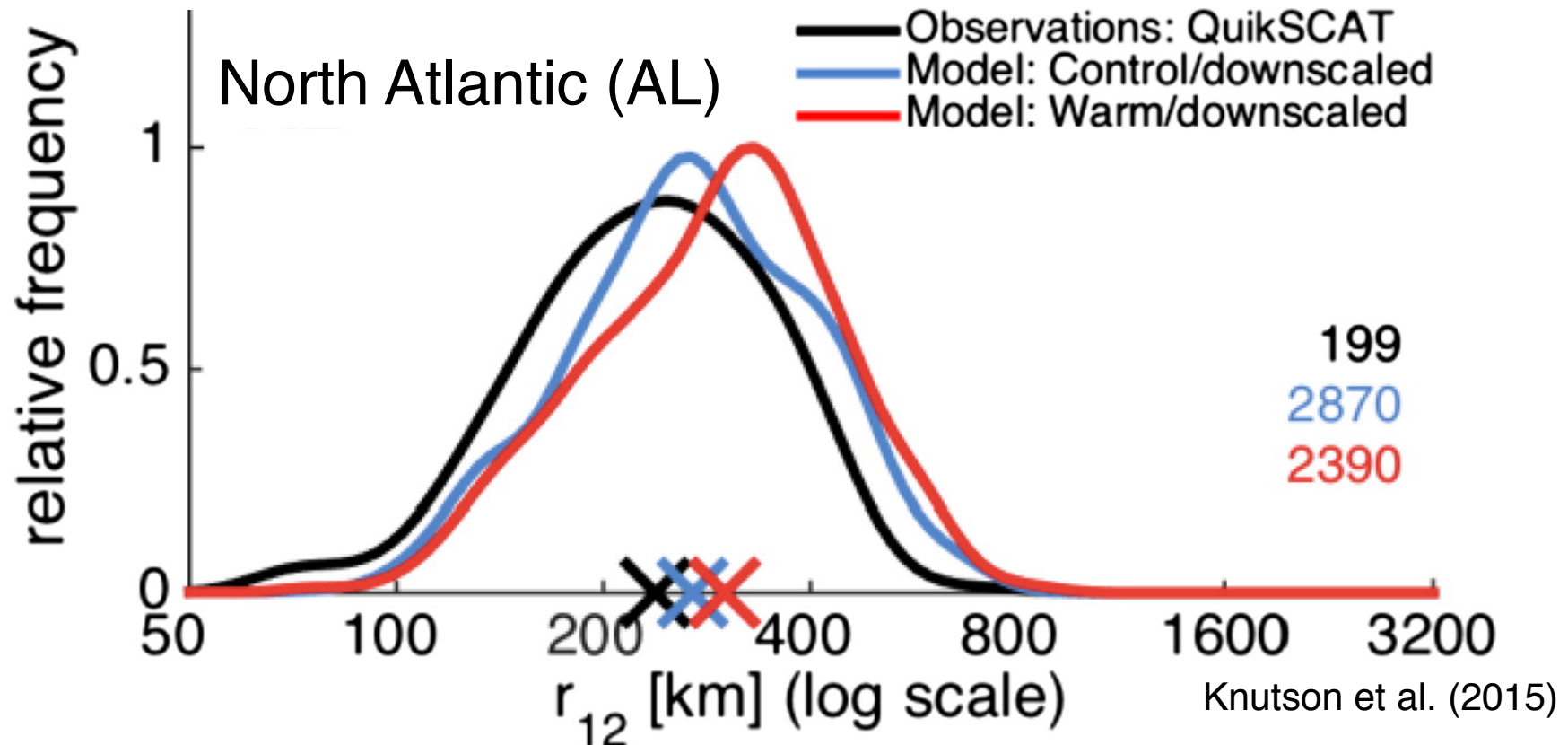


Prior Work on Outer TC Size Changes due to Anthropogenic Warming



- Used high-resolution GFDL hurricane model for simulations of current climate (blue) and late 21st century conditions (CMIP5 RCP4.5; red)

Prior Work on Outer TC Size Changes due to Anthropogenic Warming



- Used high-resolution GFDL hurricane model for simulations of current climate (blue) and late 21st century conditions (CMIP5 RCP4.5; red)
- North Atlantic outer TC size shifts towards larger values in late 21st century conditions

Motivating Questions

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2. Are the differences in outer size between current climate and late 21st century conditions statistically significant?
3. Are changes in outer TC size uniform across the entire TC lifecycle (e.g., genesis versus end of lifetime)?

Data and Methods

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- Each model simulation has two experiments: 1) **current climate** and 2) **late 21st century conditions** (CMIP5 RCP4.5 ensemble mean)

Data and Methods

- Outer TC size metric: radius in which azimuthal-mean 10-m azimuthal winds equals 8 m/s (r_8)

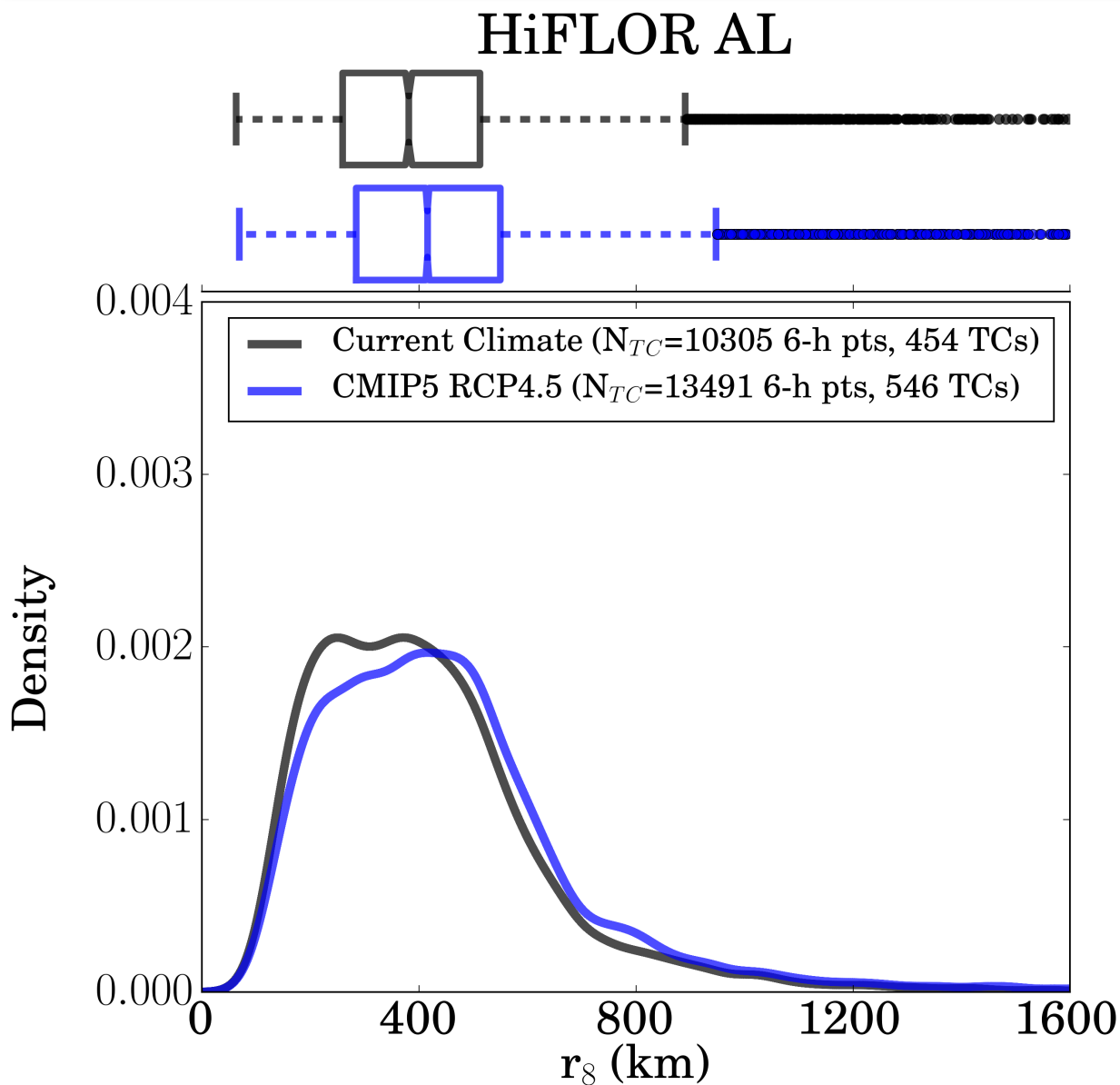
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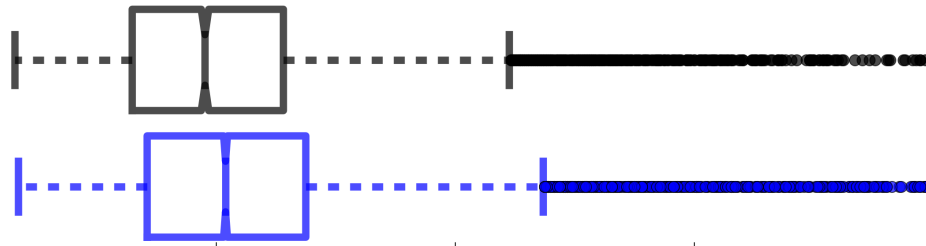
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- Study will statistically analyze r_8 distributions using: **1) 1,000-sample bootstrap approach** to compare median values and **2) two-sample Kolmogorov-Smirnov testing** to compare entire distributions

Changes in Outer TC Size Throughout TC Lifetime

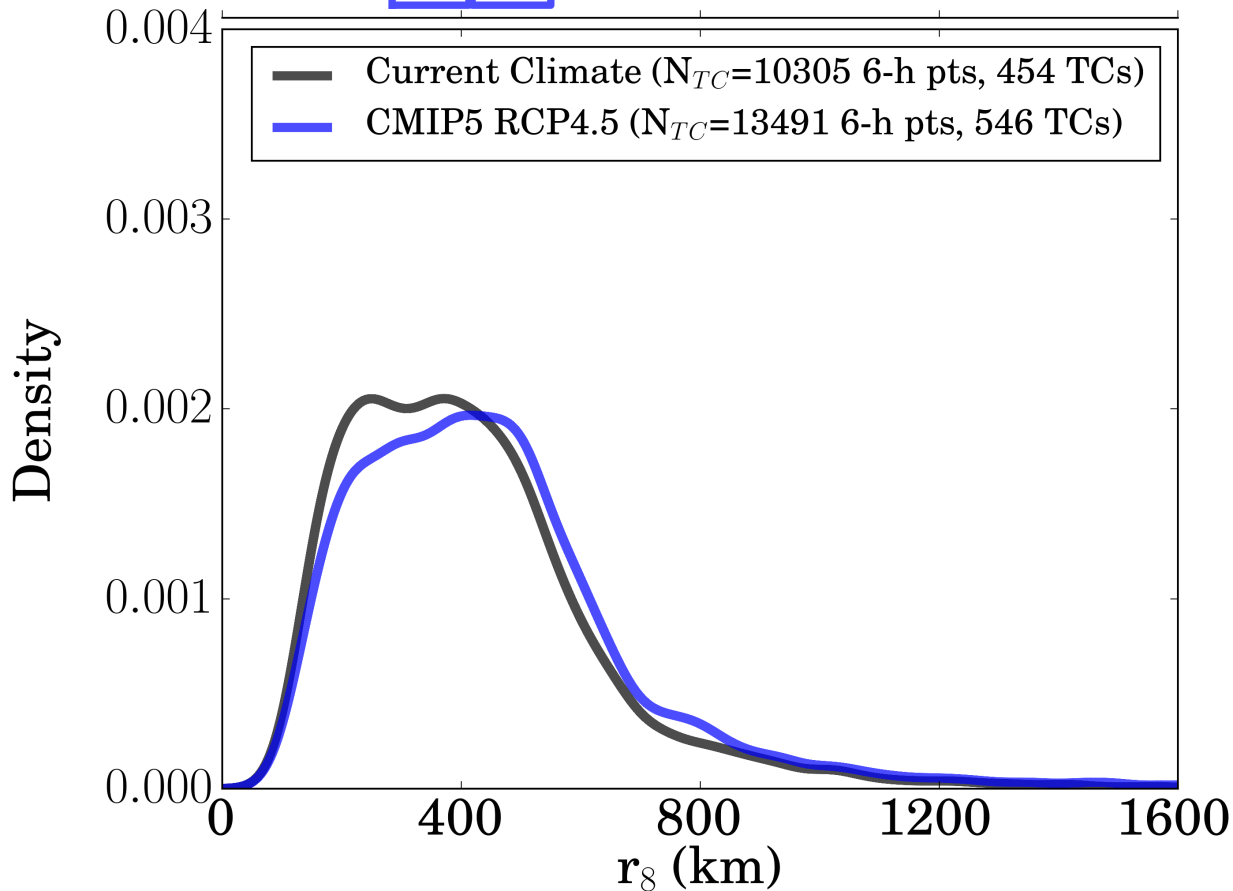


Changes in Outer TC Size Throughout TC Lifetime

HiFLOR AL

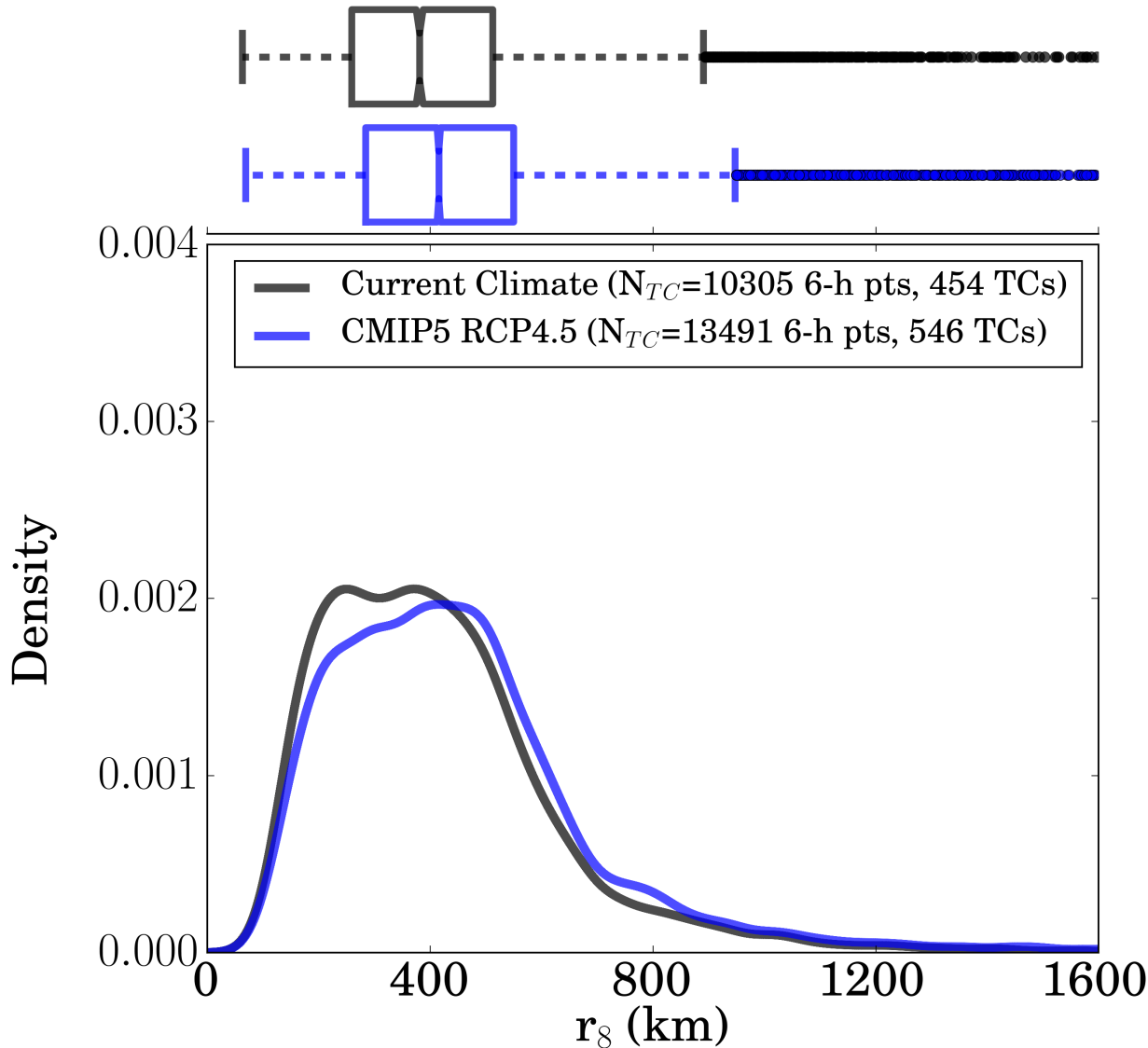


- Median r_8 is significantly larger by ~ 34 km in late 21st century conditions ($p < 0.05$)



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HiFLOR AL

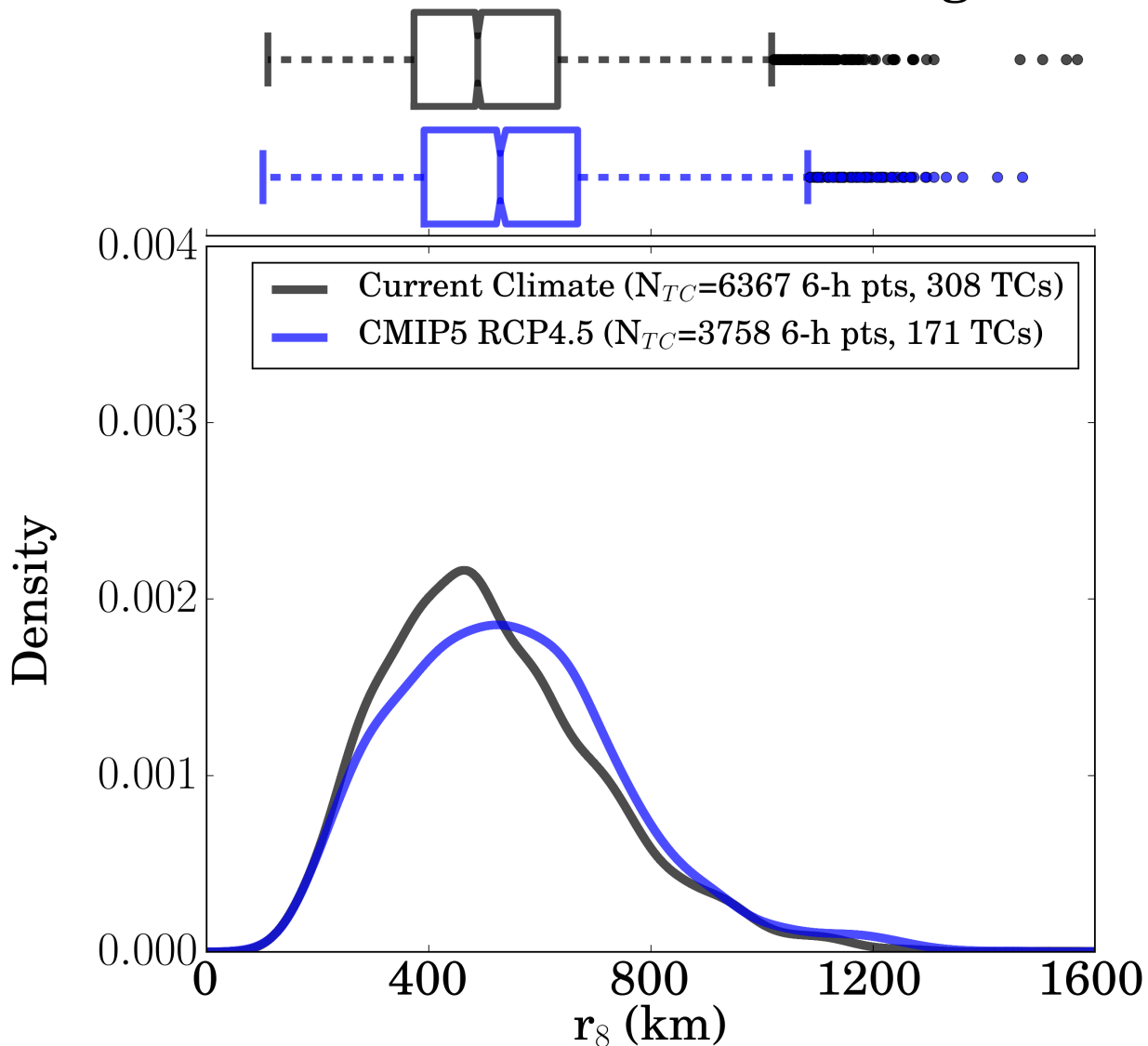


- Median r_8 is significantly larger by ~ 34 km in late 21st century conditions ($p < 0.05$)

- r_8 distribution significantly shifted towards larger values in late 21st century conditions ($p \ll 0.01$)

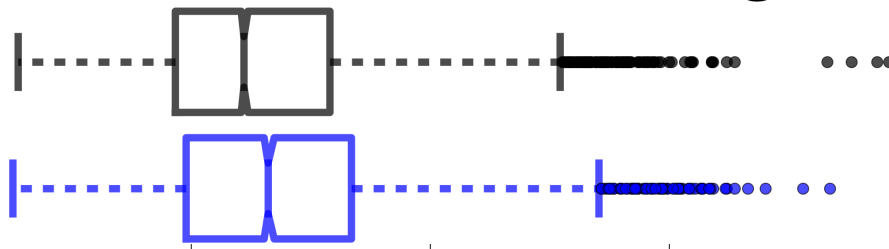
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GFDL HiRAM-Downscaling AL

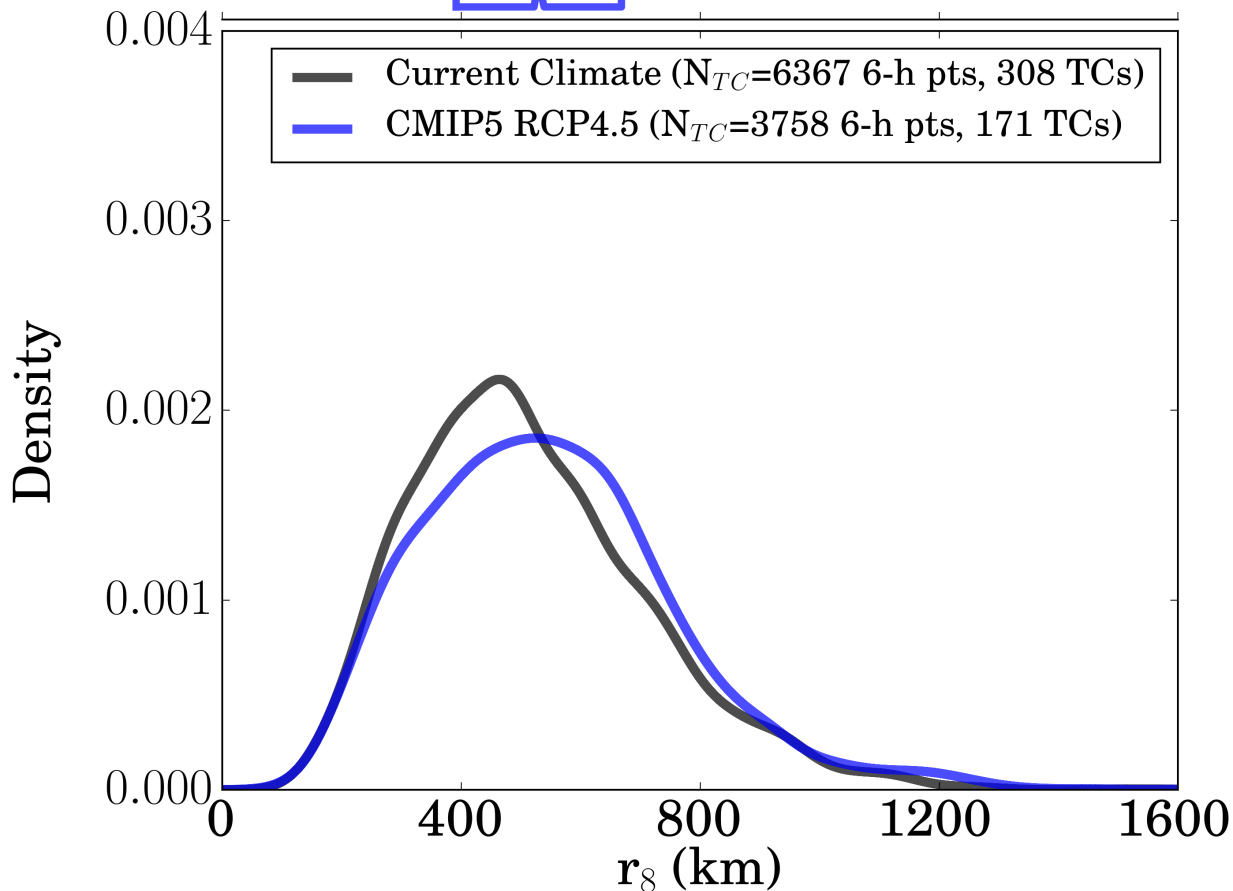


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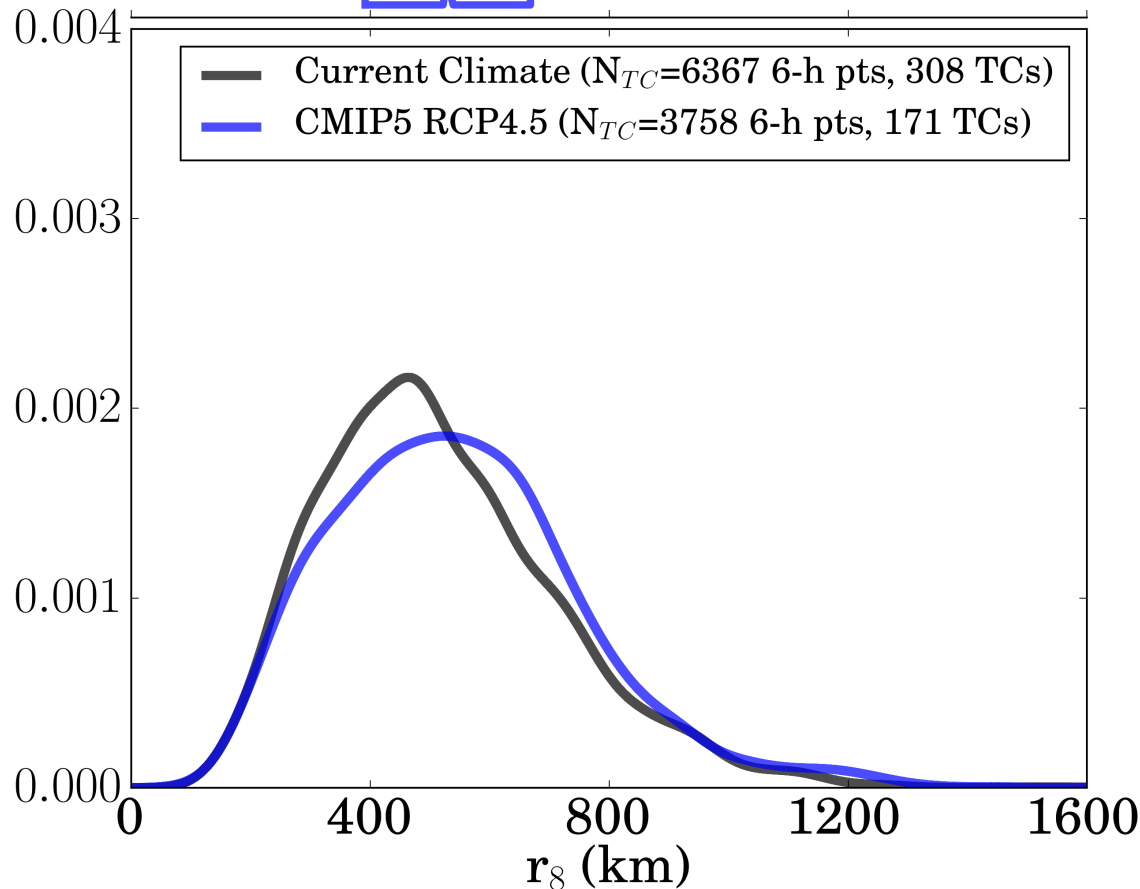
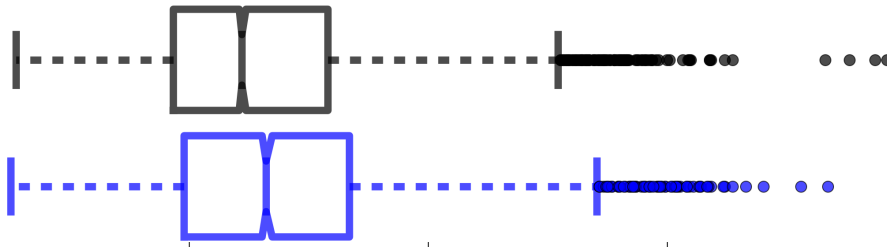


- Median r_8 is significantly larger by ~ 40 km in late 21st century conditions ($p < 0.05$)



Changes in Outer TC Size Throughout TC Lifetime

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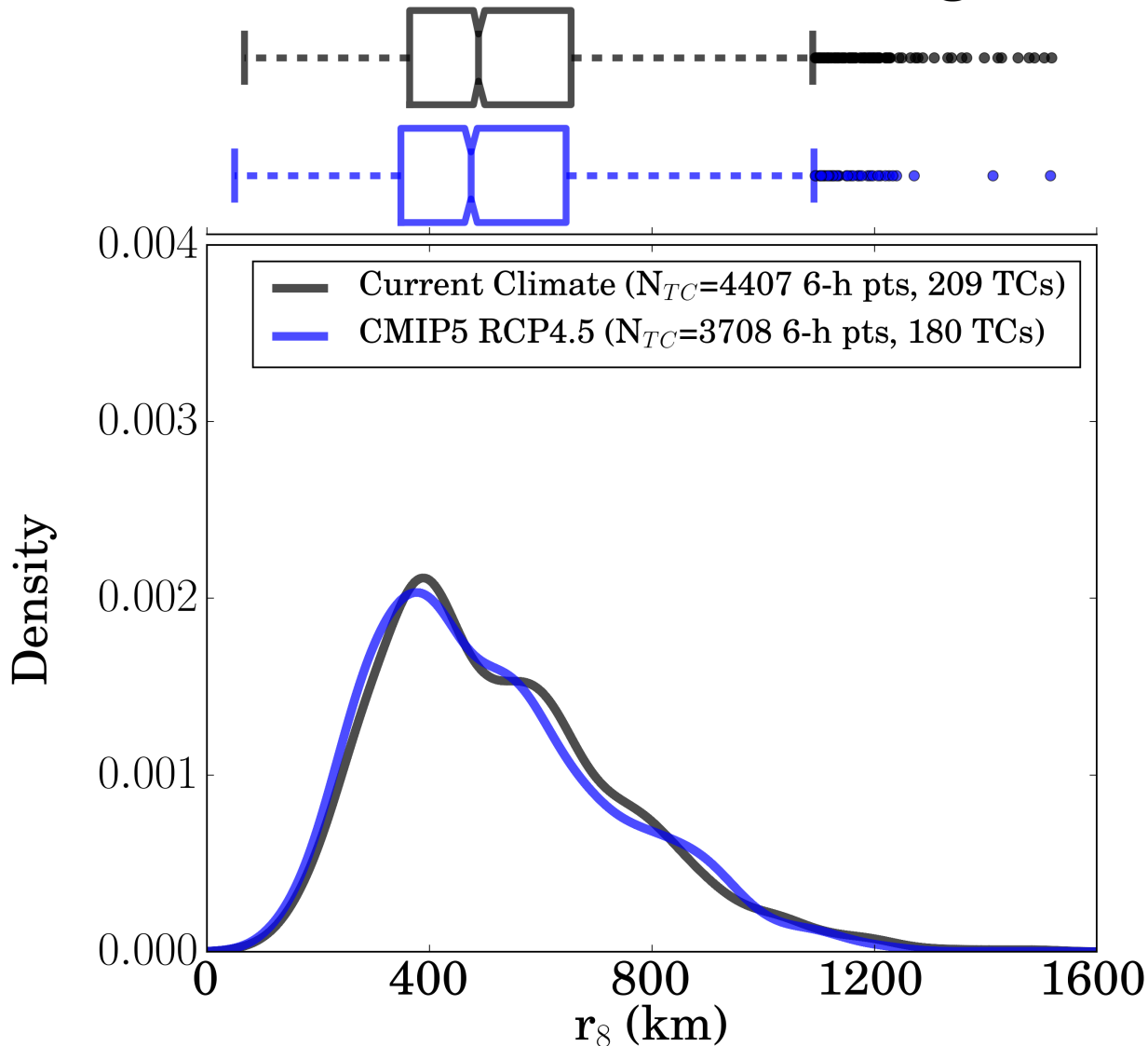


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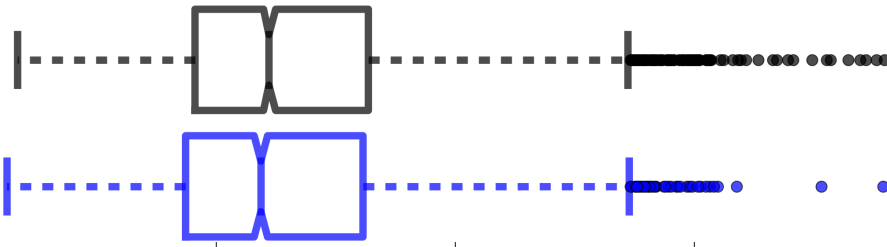
Changes in Outer TC Size Throughout TC Lifetime

GFDL ZETAC-Downscaling AL

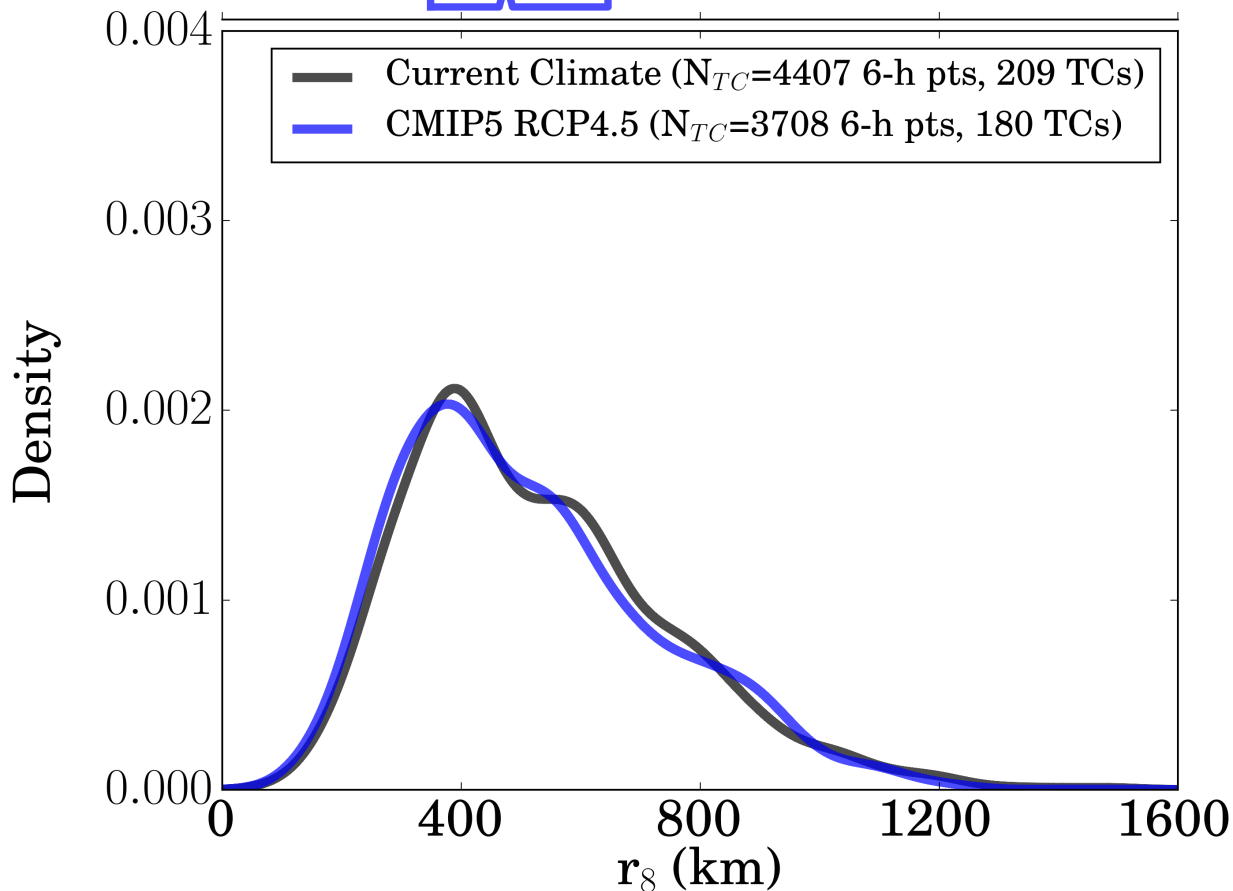


Changes in Outer TC Size Throughout TC Lifetime

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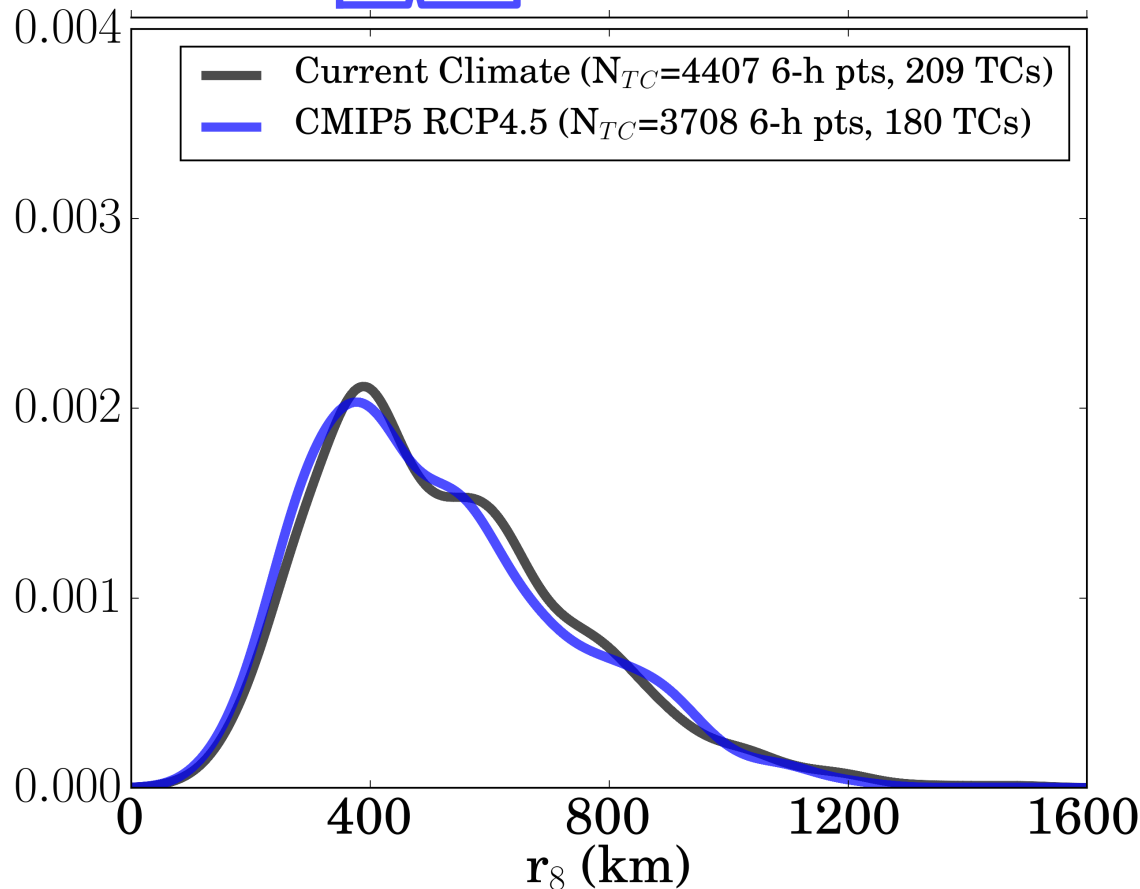
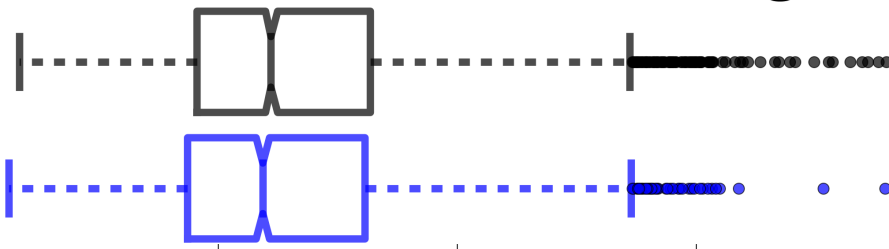


- Median r_8 is not significantly different in late 21st century conditions ($p > 0.05$)



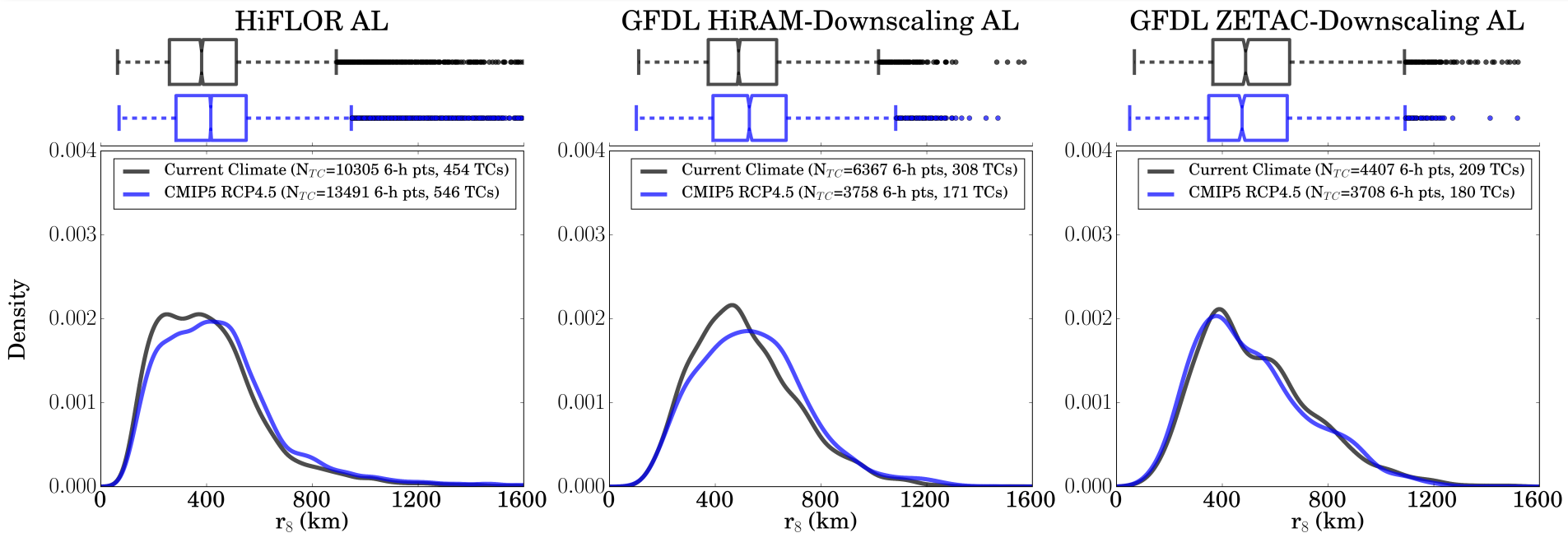
Changes in Outer TC Size Throughout TC Lifetime

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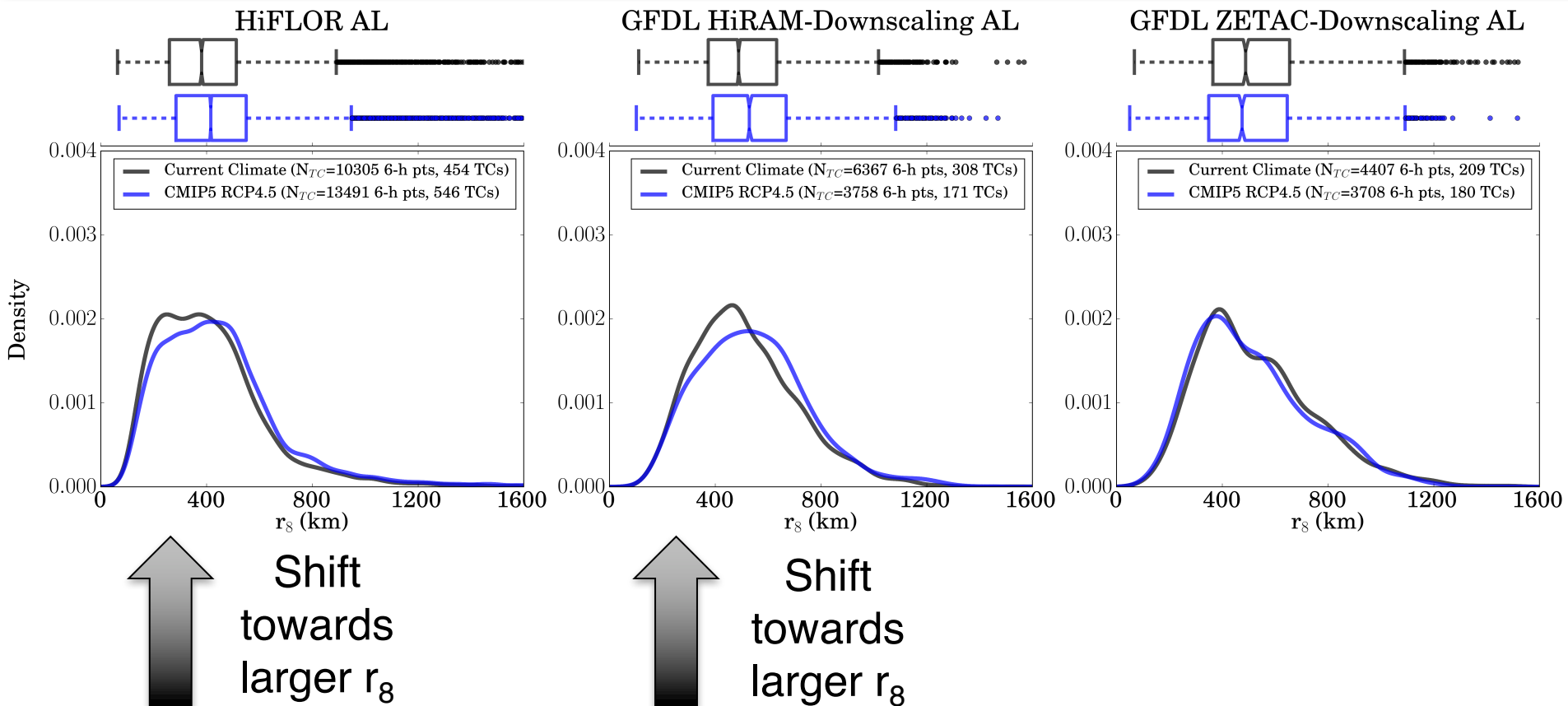


- Median r_8 is not significantly different in late 21st century conditions ($p>0.05$)
- r_8 distribution significantly shifted towards smaller values in late 21st century conditions ($p=0.01$)

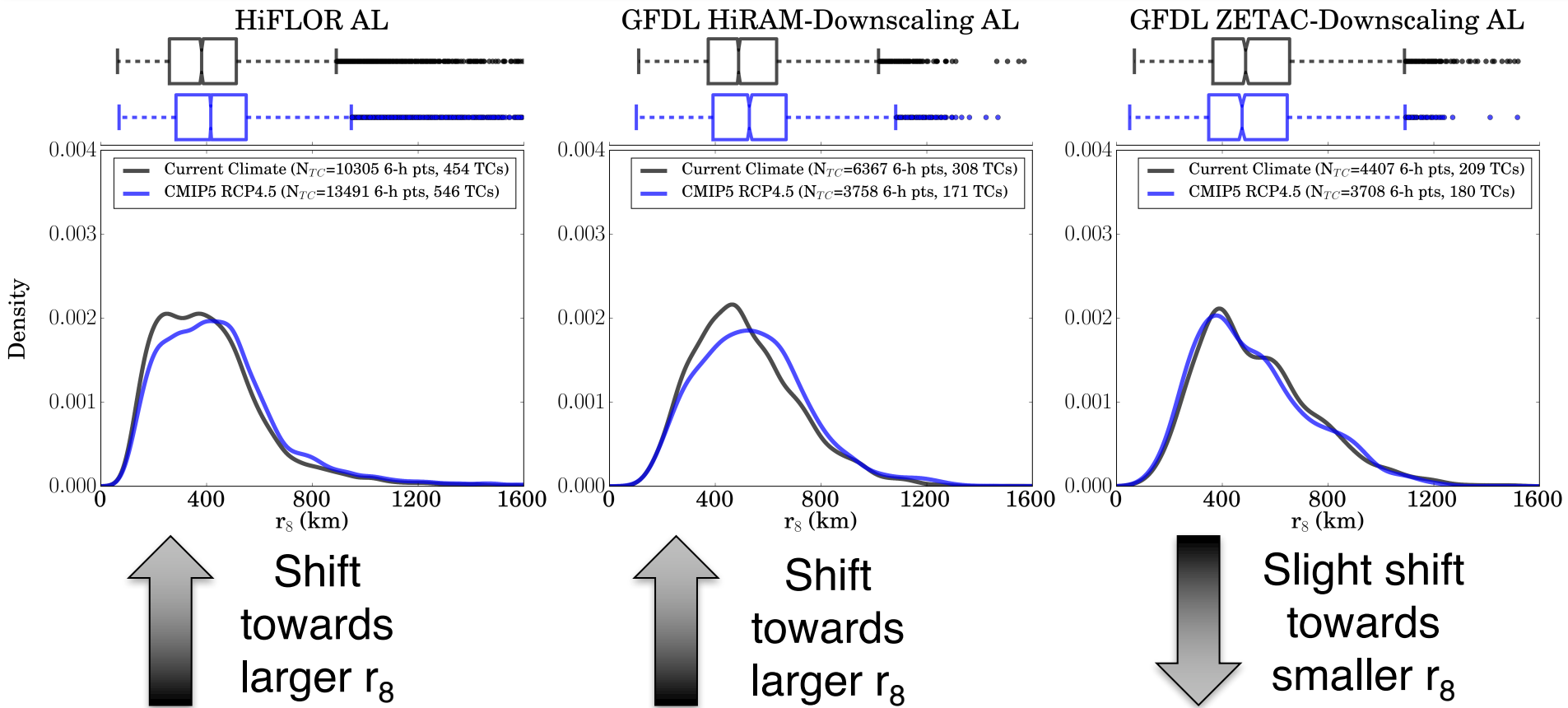
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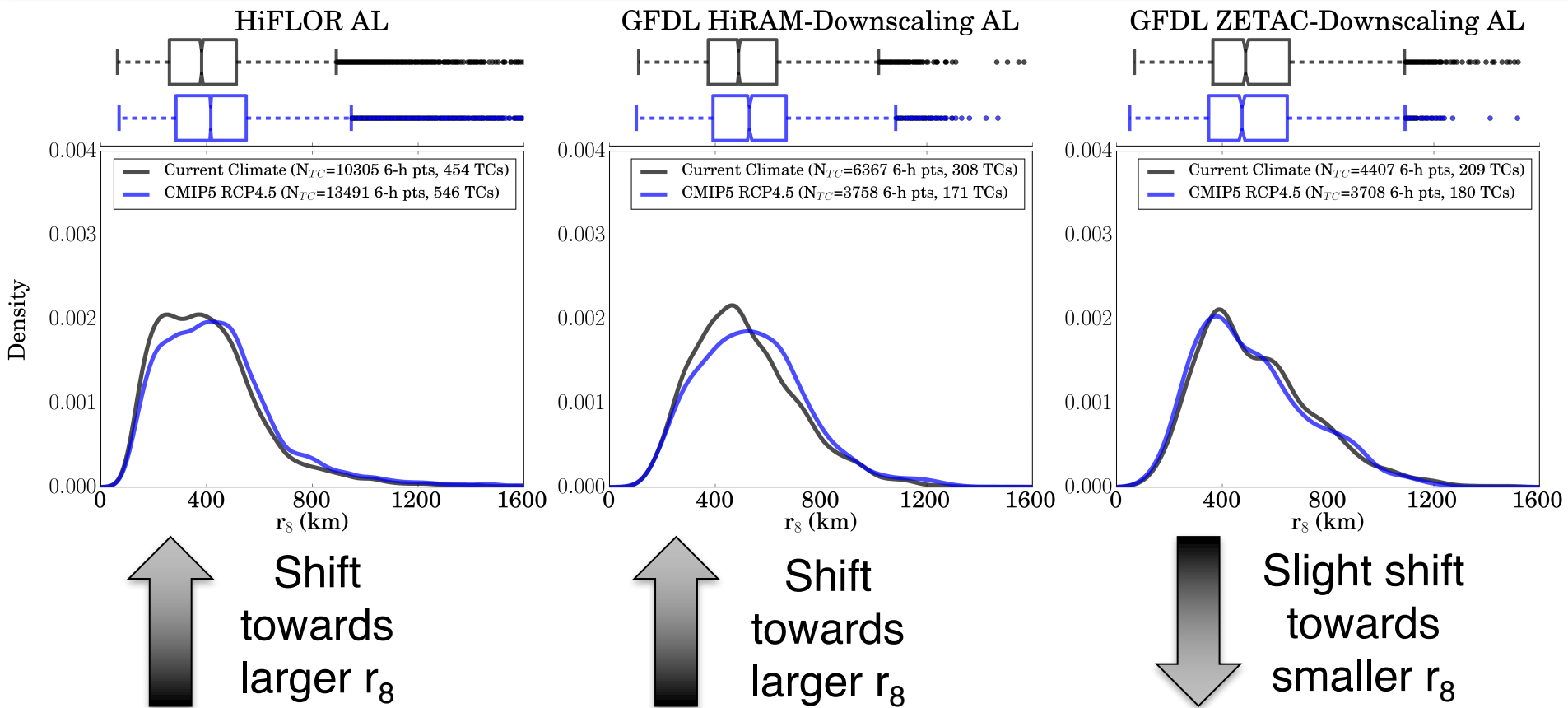
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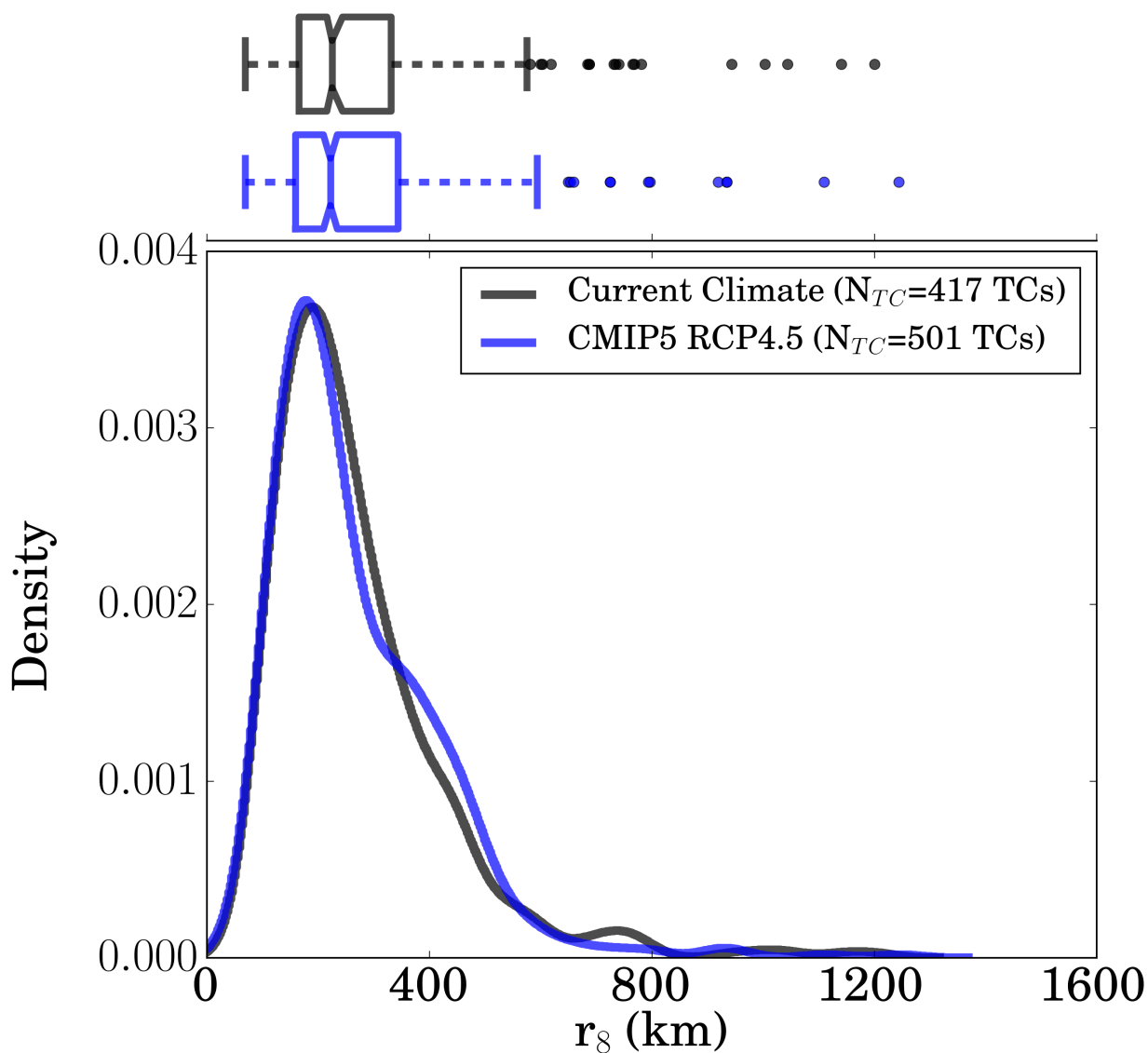
Changes in Outer TC Size Throughout TC Lifetime



Does this change in outer TC size begin at TC genesis?

Changes in Outer TC Size at Genesis

HiFLOR AL

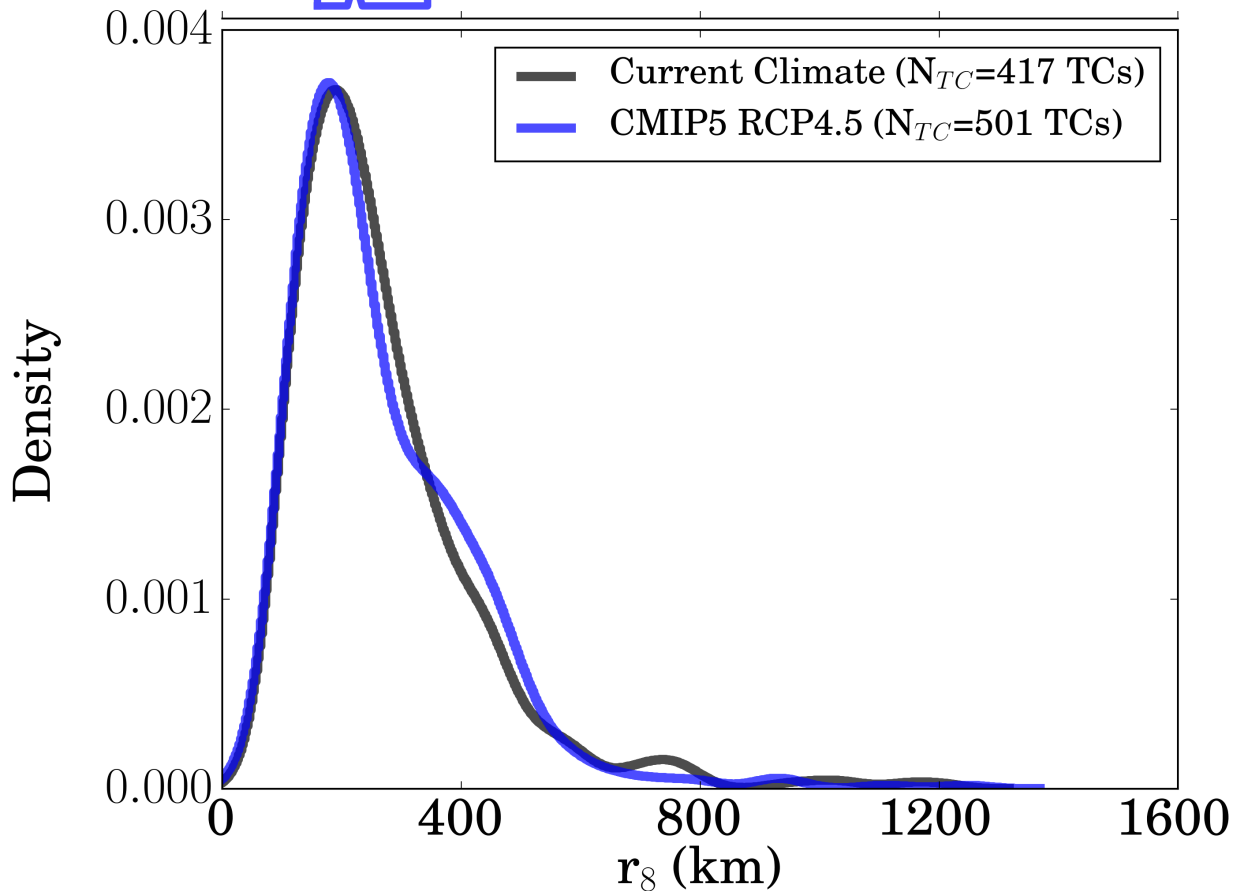


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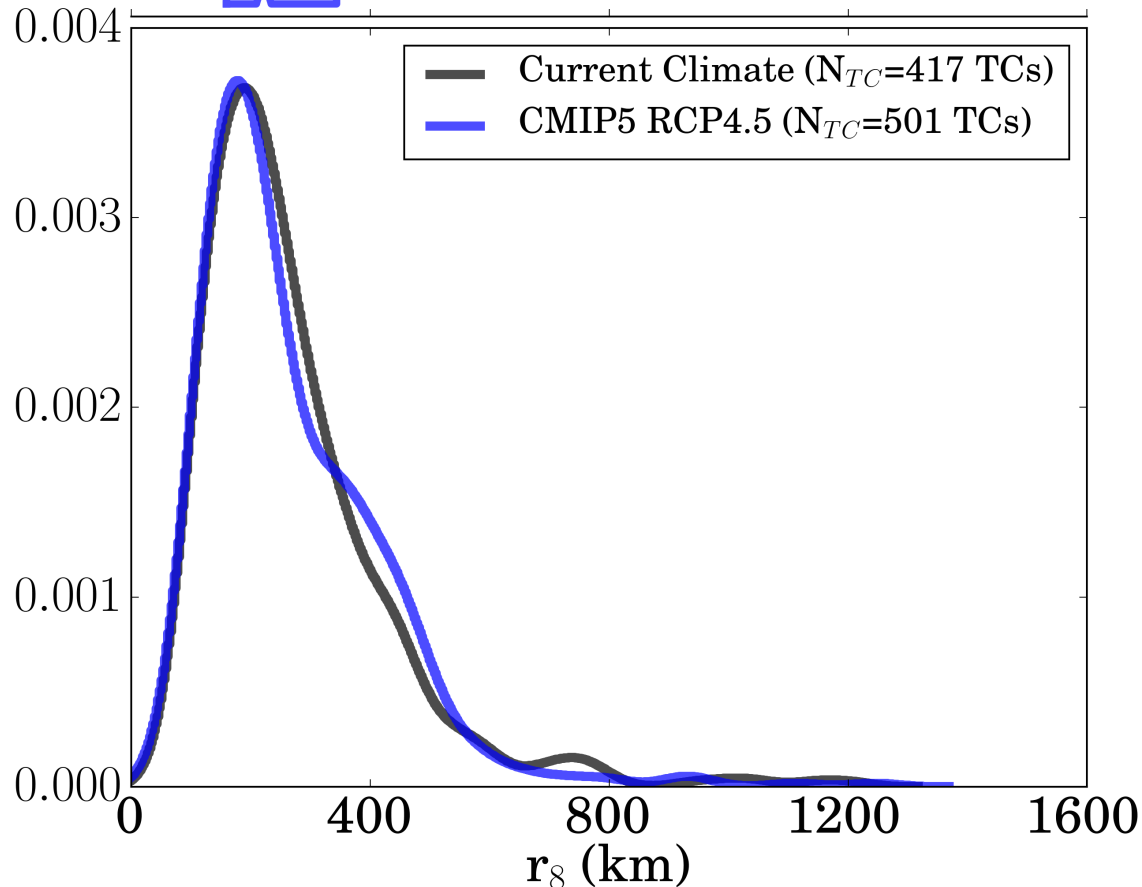


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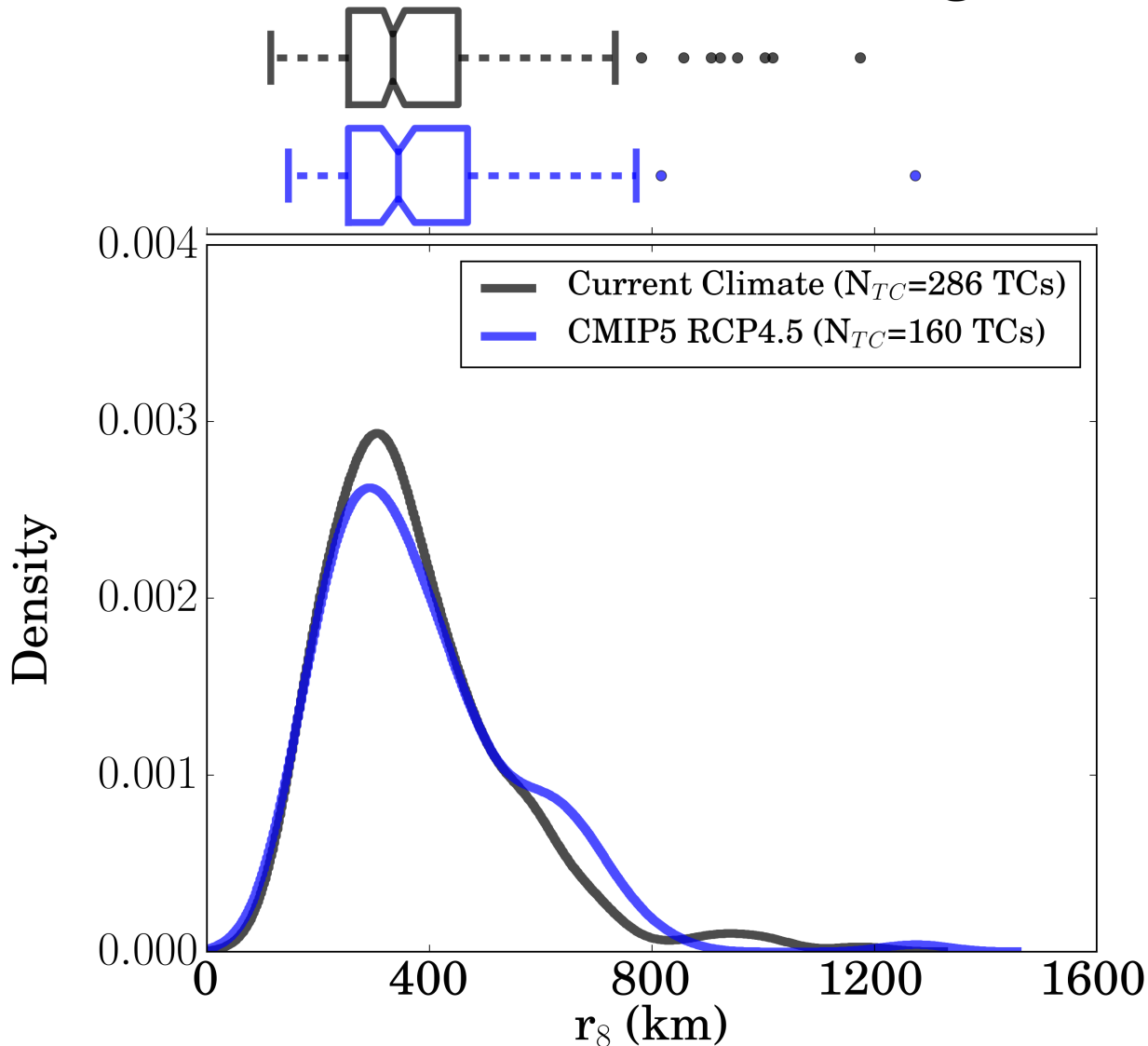
HiFLOR AL



- Median r_8 is not significantly different in late 21st century conditions ($p>0.05$)
- r_8 distribution unchanged in late 21st century conditions ($p>>0.05$)

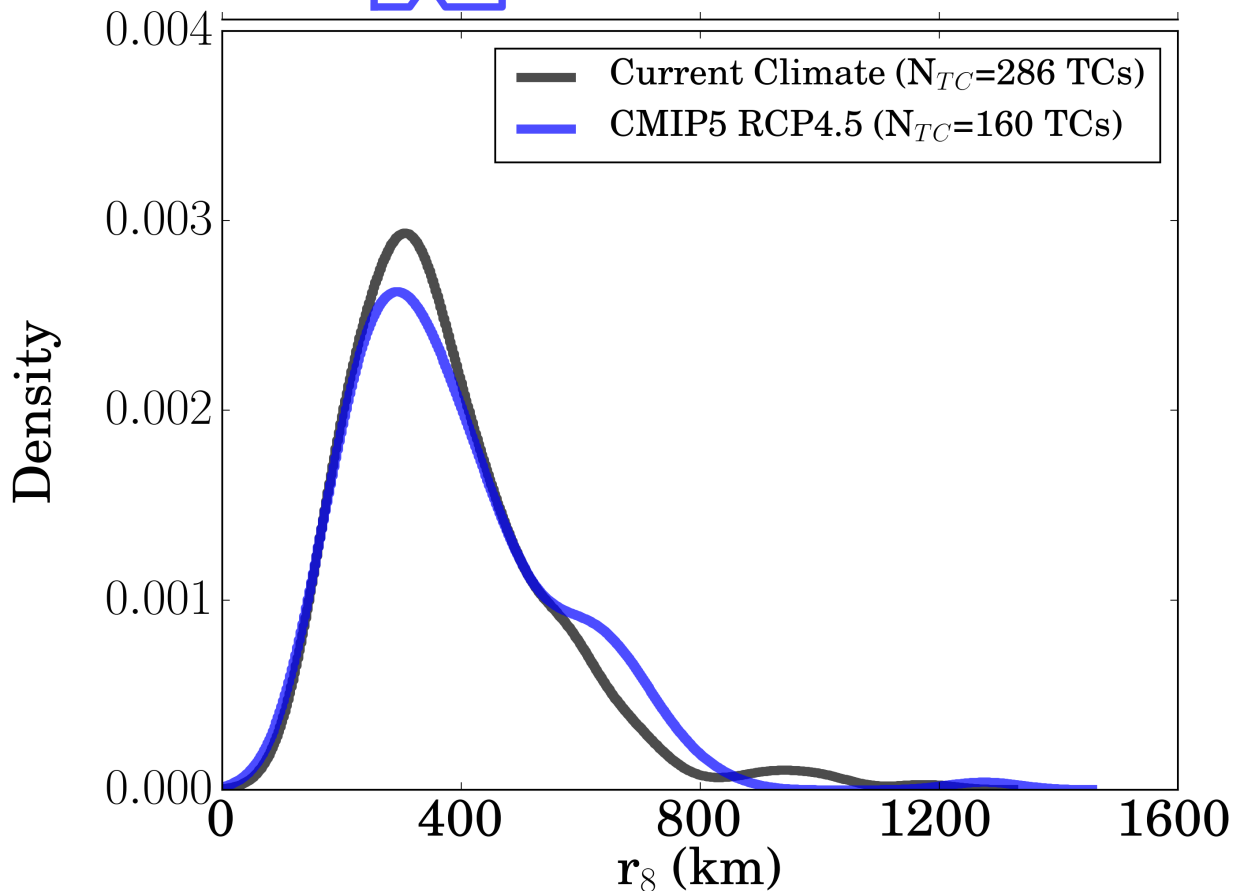
Changes in Outer TC Size at Genesis

GFDL HiRAM-Downscaling AL



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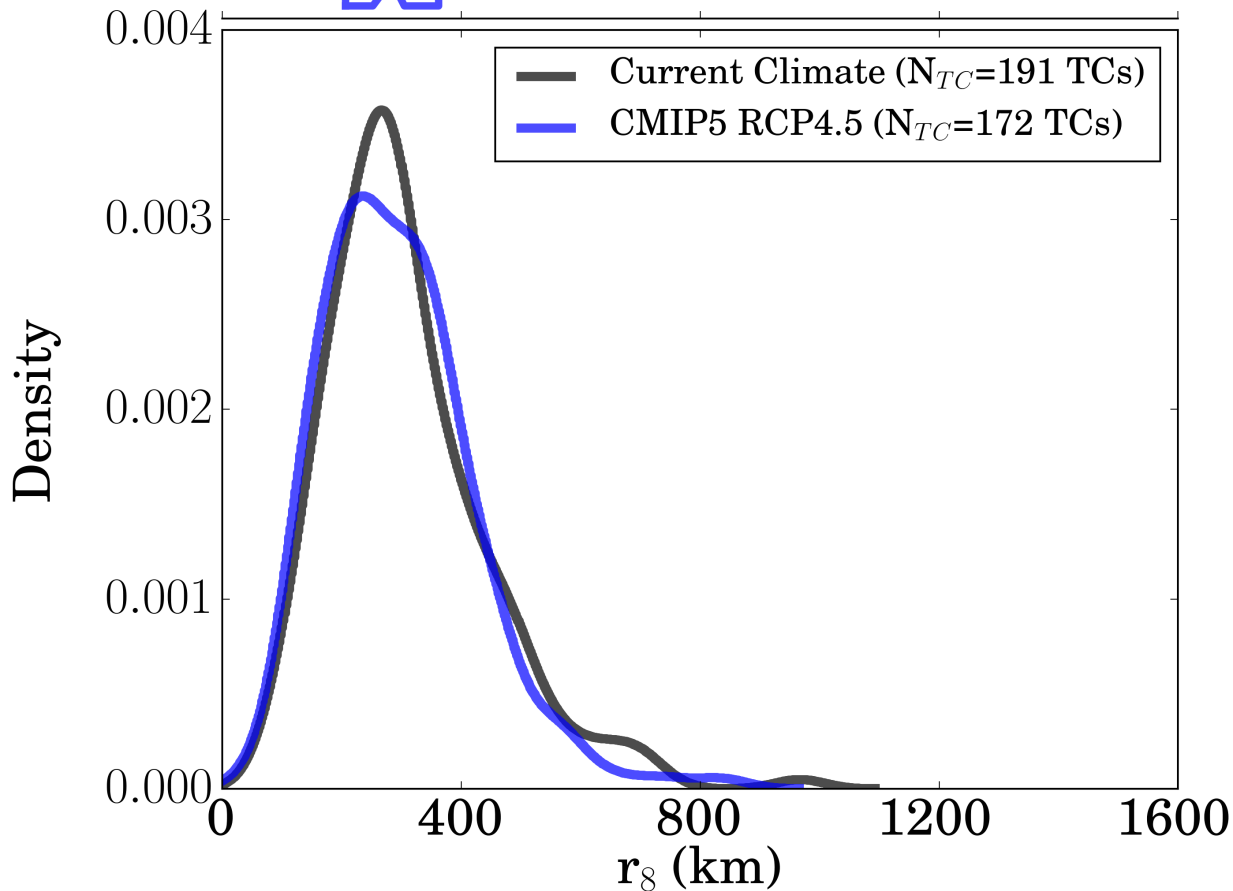
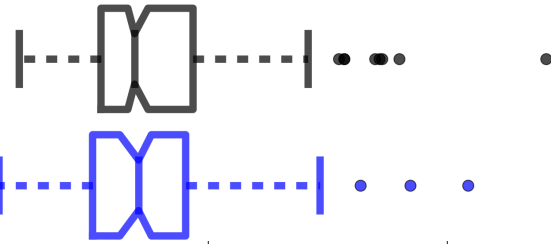
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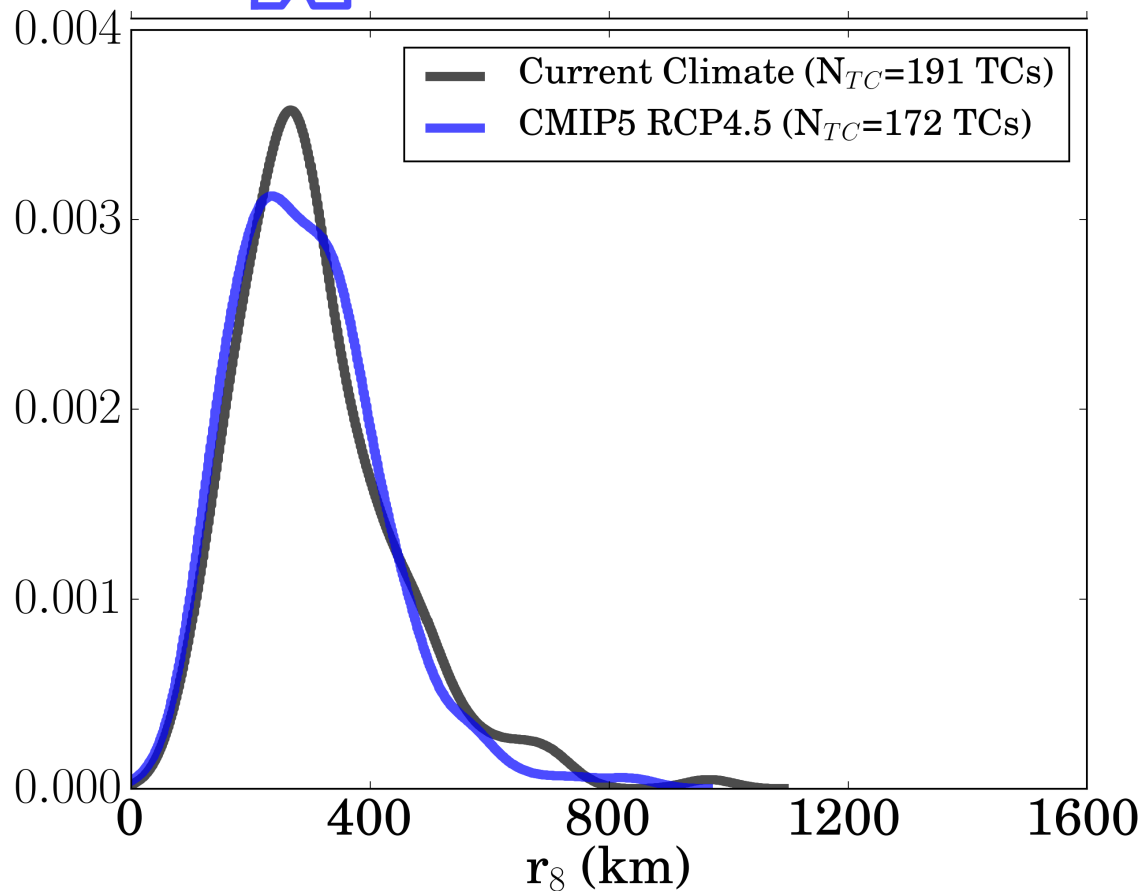
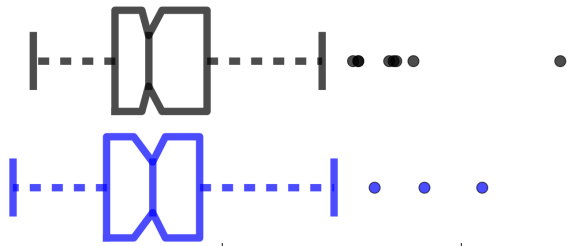
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GFDL ZETAC-Downscaling AL



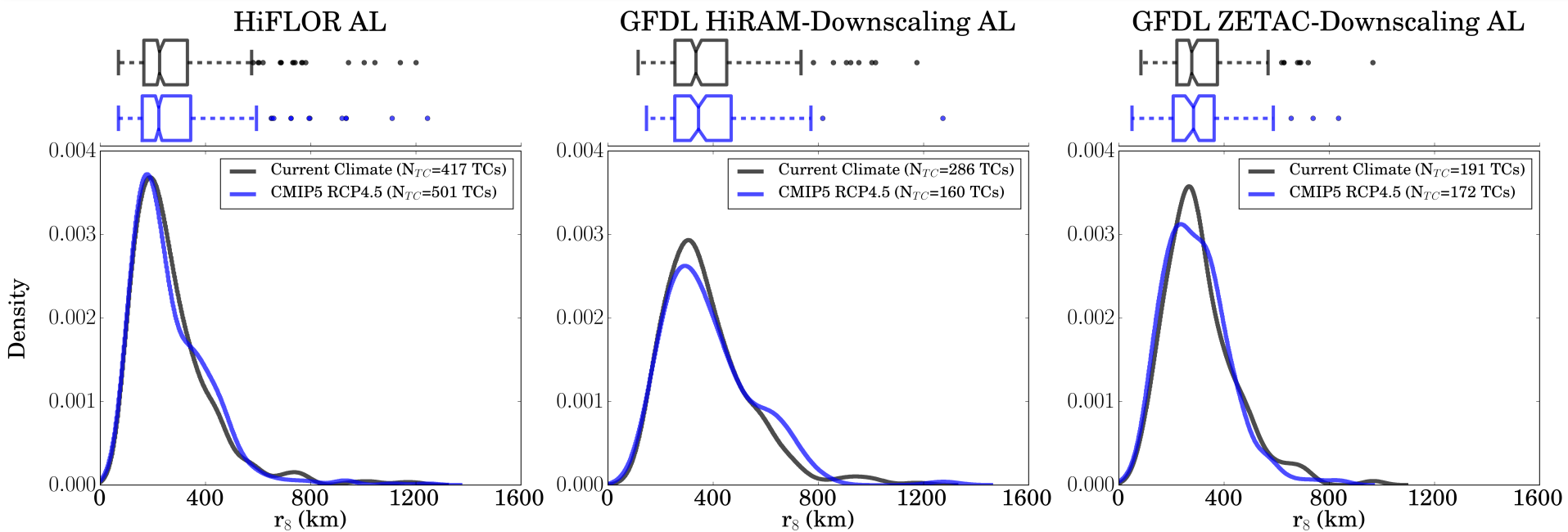
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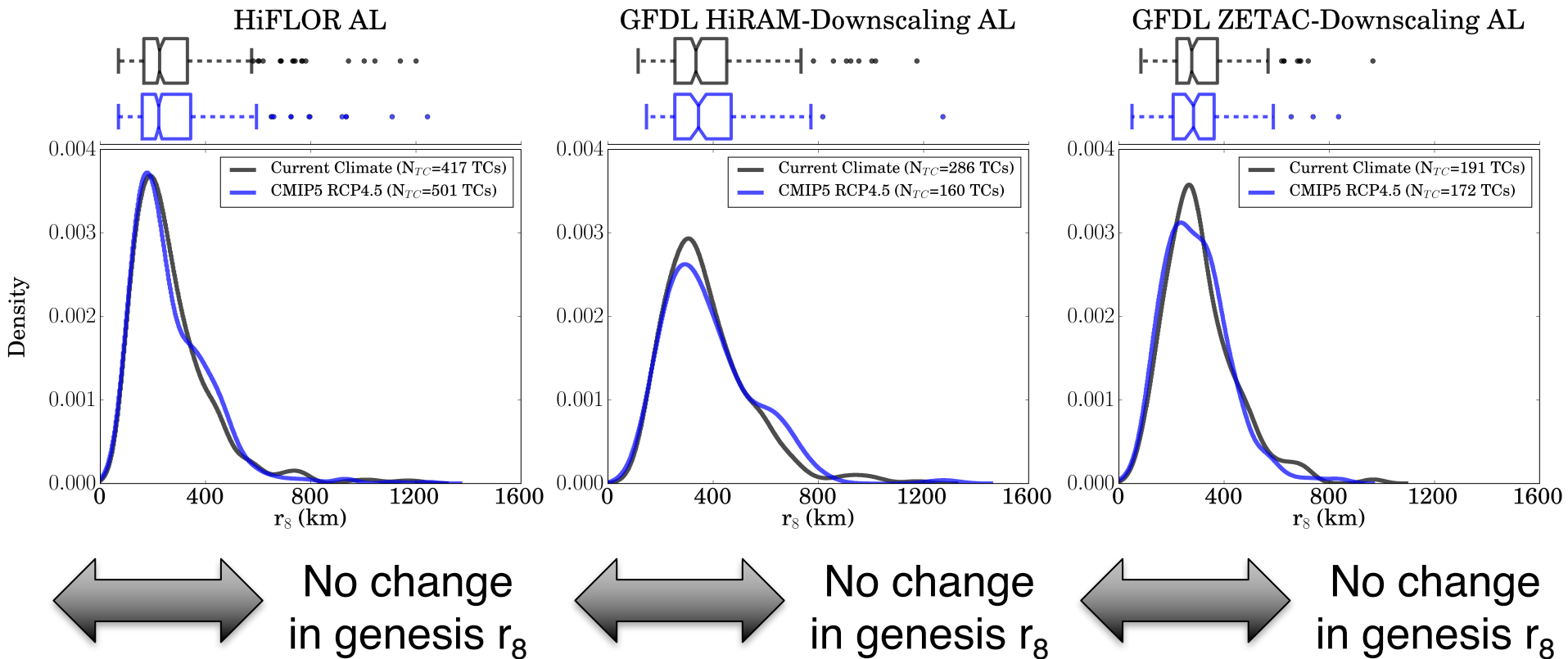


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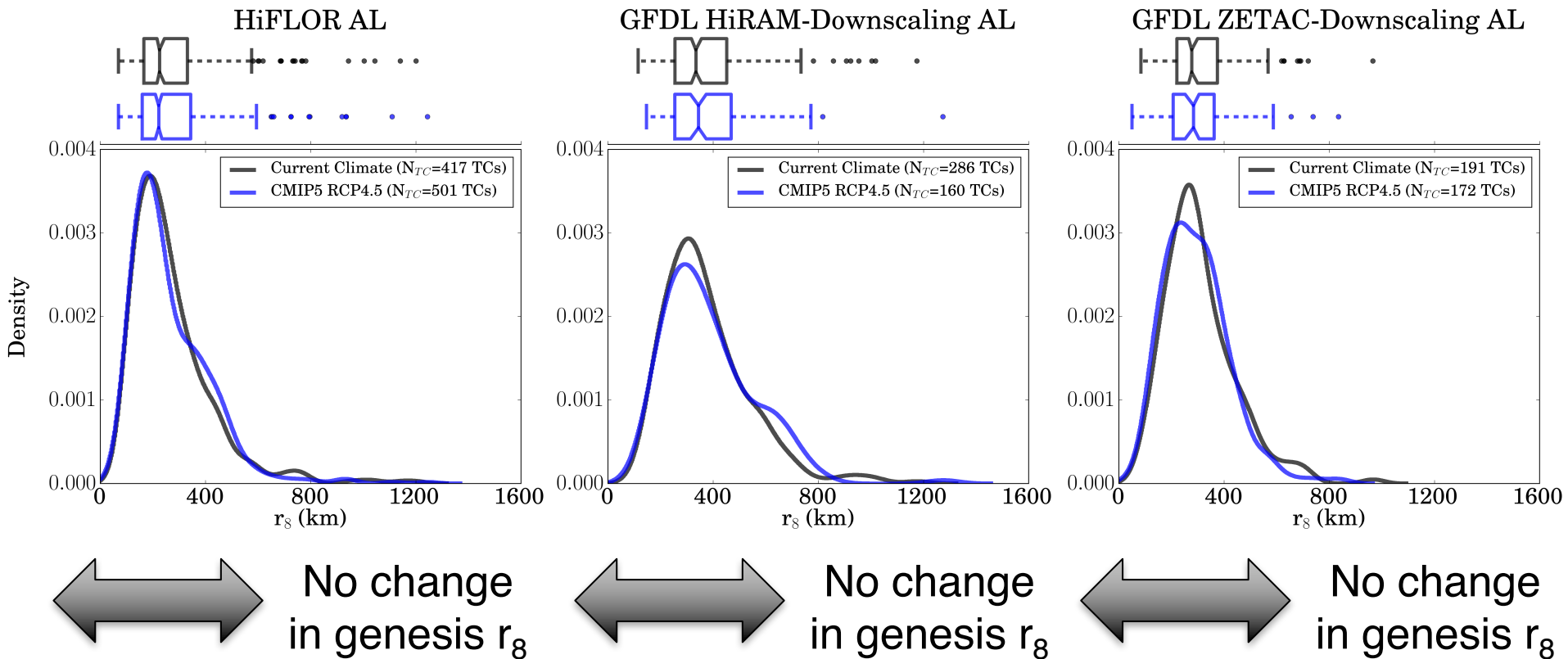
Changes in Outer TC Size at Genesis



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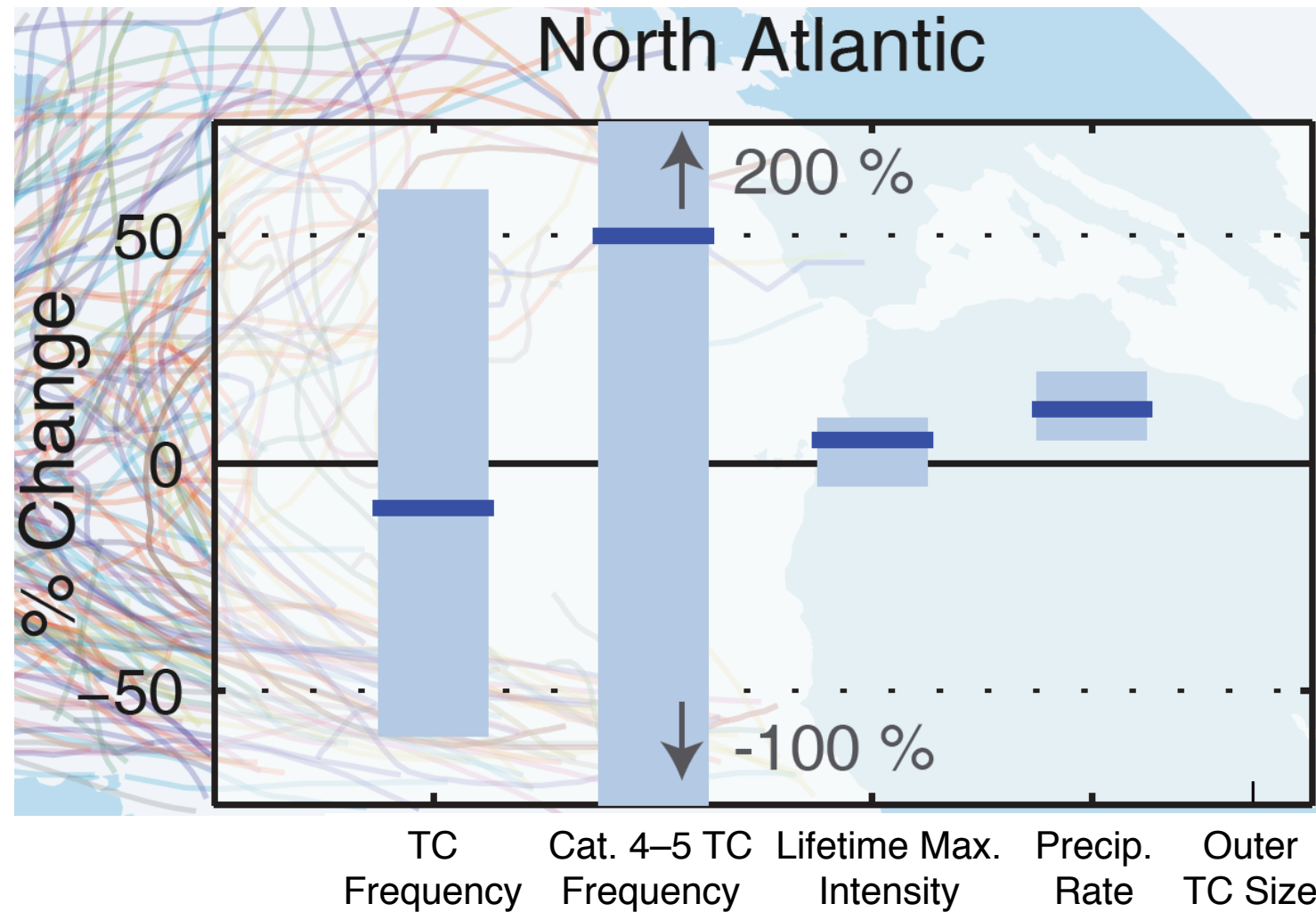


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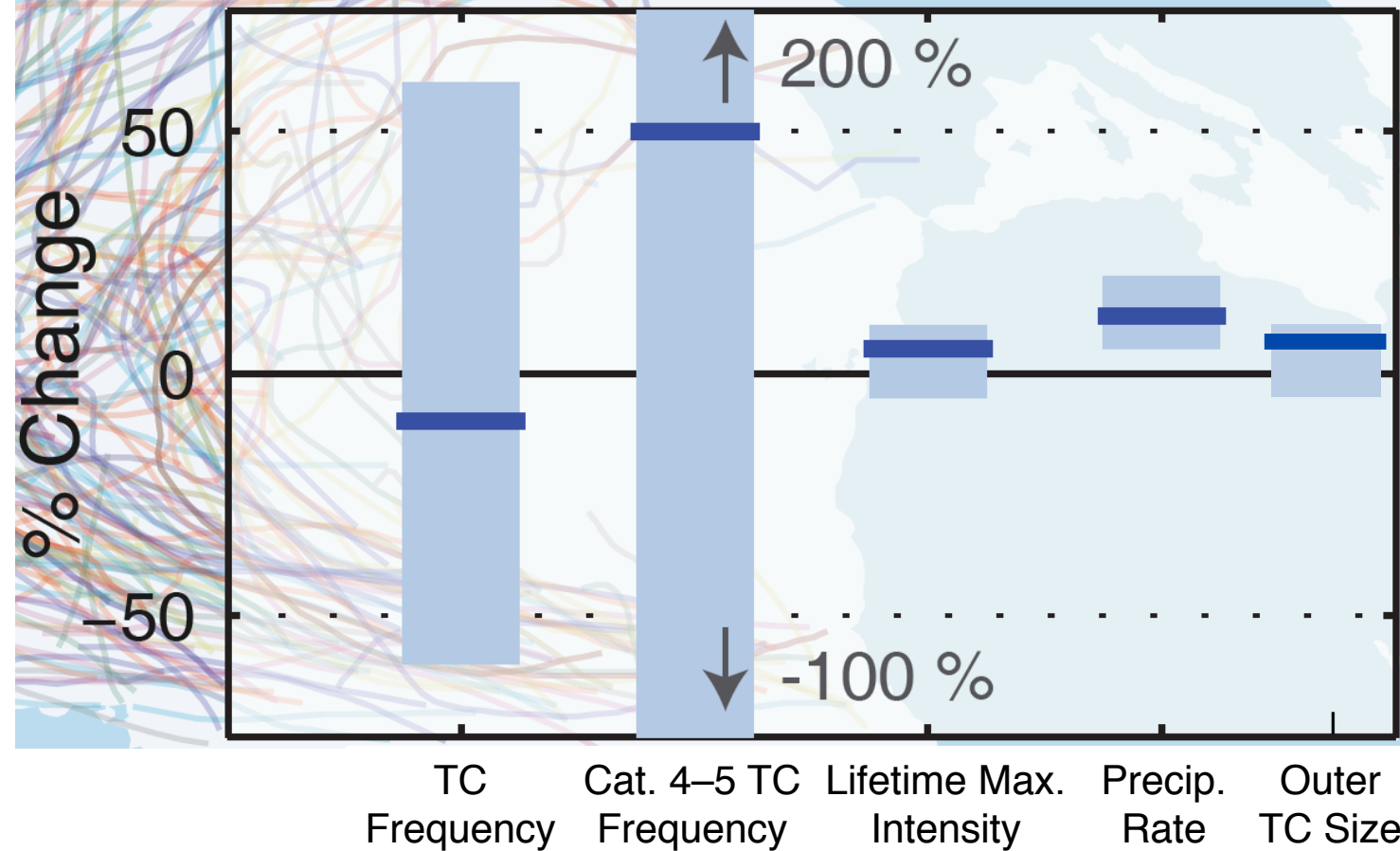
Changes in r_8 in late 21st century conditions are primarily confined to later stages of TC lifecycle

Summary and Discussion



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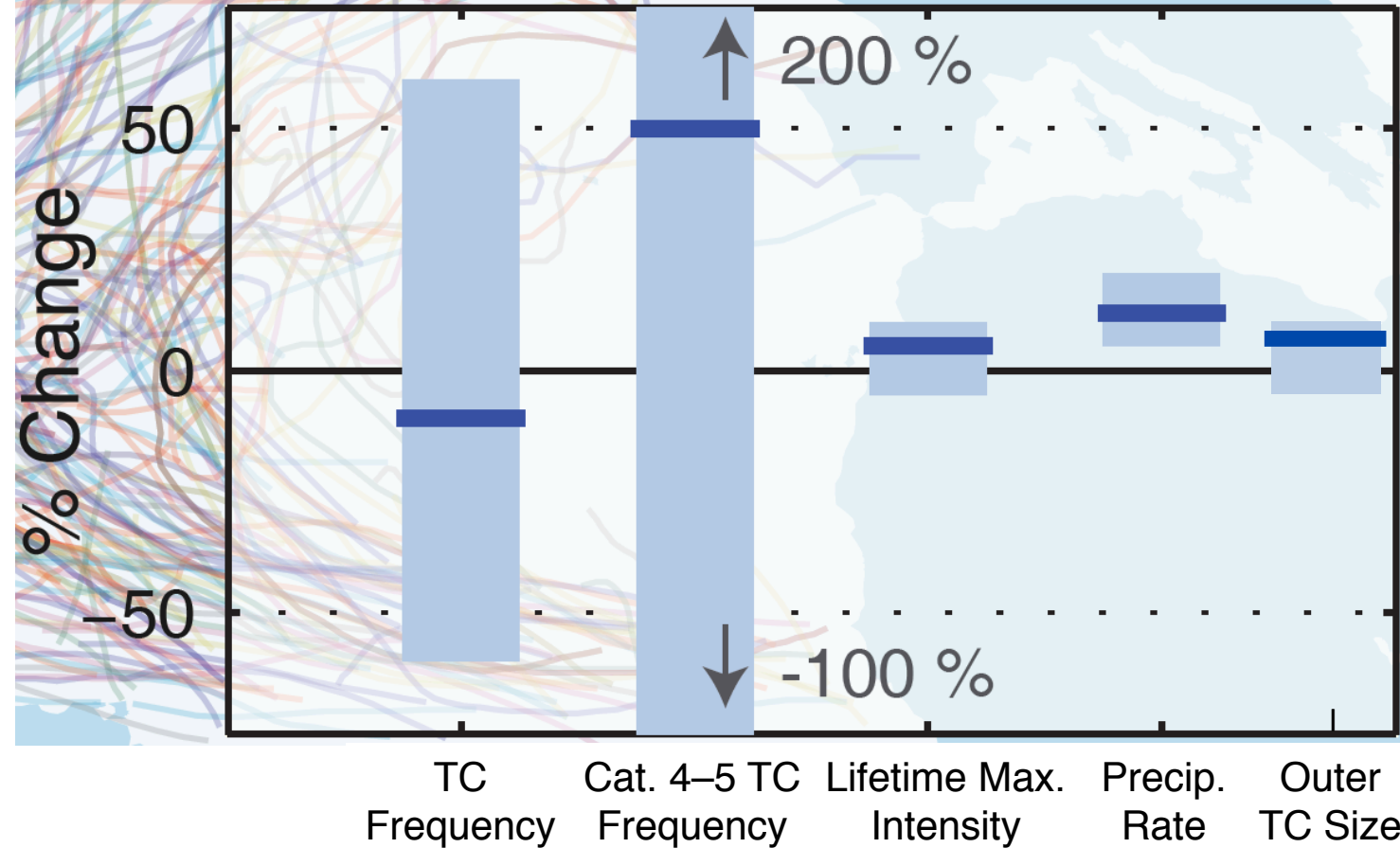
North Atlantic



- Median r_8 may change by -5% to 10% in late 21st century conditions

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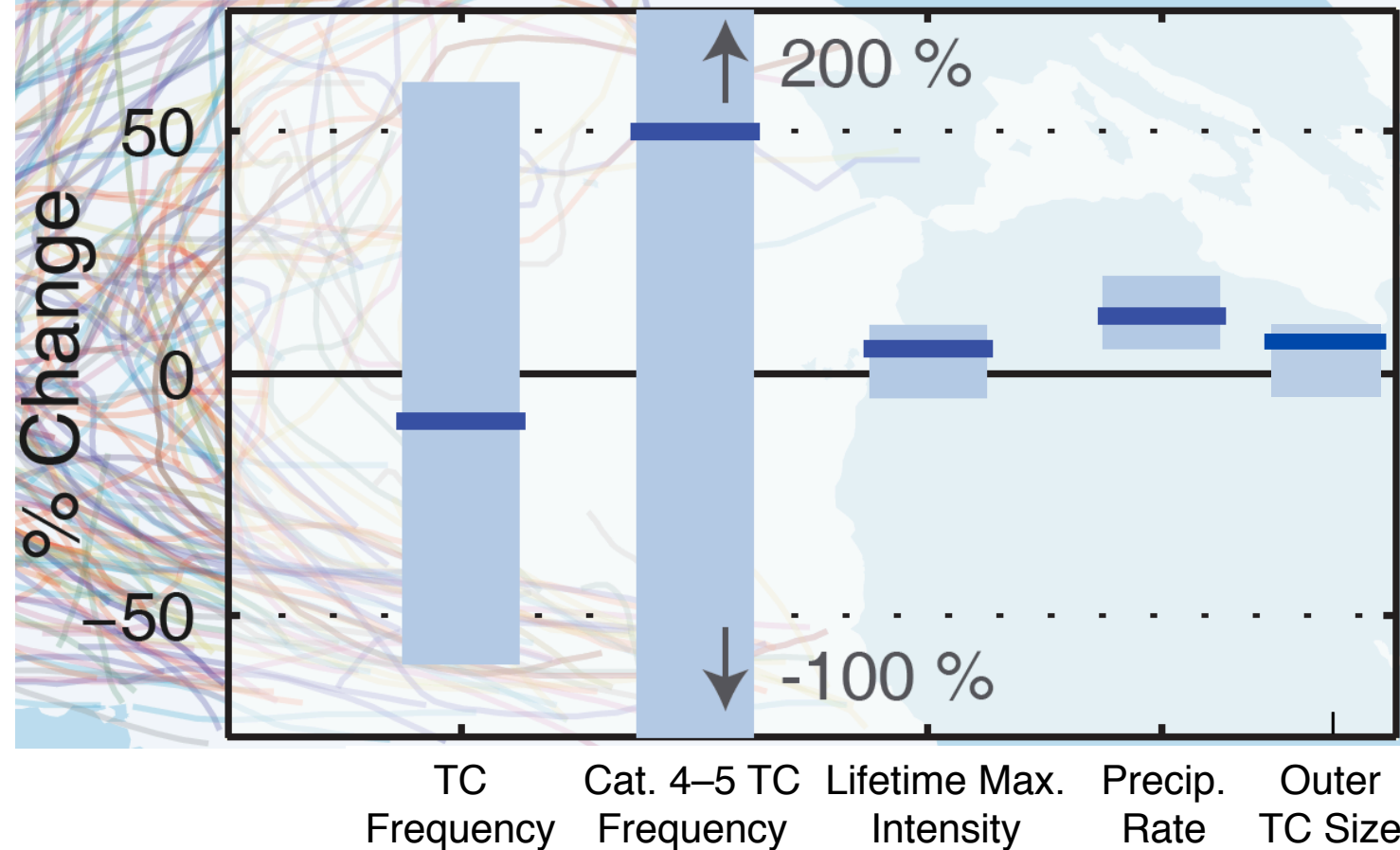
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- r_8 at genesis does not significantly change in late 21st century conditions

Results suggest that changes in full r_8 distribution are primarily due to r_8 changes in later part of TC lifecycle