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Decadal Trends in the Width of the Tropical Belt

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Several lines of research indicate that the tropical Hadley cell and the associated subtropical dry zones expanded poleward over the past few decades and that this expansion is likely to continue in the future. This trend is associated with important changes in tropical and extratropical circulation, and to shifts in wind, precipitation, and other climate patterns. The expansion of the Hadley cell may also be connected to a poleward movement of the storm tracks and to positive trends in the Annular Modes. The widening of the Hadley cell and the Tropics therefore represents an important new aspect of climate change. However, our overall understanding of this phenomenon is still very limited.

In the first part, we will review some of the recent key-findings related to this phenomenon. For example, various studies using independent observations indicate that the width of the Hadley cell and other measures for the width of the Tropics have been increasing by several degrees latitude since 1979. Model-based studies also find robust positive widening trends in response to increasing levels of greenhouse gases and warming sea surface temperatures, suggesting that the widening is related to anthropogenic climate change. We will discuss the scientific and societal implications of the expansion trend, explain the currently existing theories, and outline future research directions to improve our understanding of this phenomenon.

In the second part, we will present results from specifically designed attribution experiments with a comprehensive stratosphere resolving climate model. The experiments were conducted with the goal in mind to understand the role of different forcing agents

for the latitudinal extent of the Tropics, such as sea surface temperatures, stratospheric ozone, and greenhouse gases. The analysis of these simulations will also shed light on the underlying mechanisms and on the role of the stratosphere for the widening. We will clarify the significance of these results for the future evolution of the tropical belt, for the expected changes in extratropical climate, and for the realistic prediction of this phenomenon with climate models.