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Impact of gravity waves on the motion and distribution of atmospheric ice particles

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Gravity waves are an ubiquitous feature of the atmosphere and influence clouds in multiple ways. Regarding cirrus clouds, many studies have emphasized the impact of wave-induced temperature fluctuations on the nucleation of ice crystals. In contrast to this, I will consider the effect of the waves on the subsequent evolution of ice crystals, to investigate how gravity waves affect the motion and distribution of ice particles. This will be explored in the idealized 2-D framework of a monochromatic wave, and requires special attention to the combined wind and temperature fluctuations induced by the waves.

In particular, I will show the existence of a wave-driven localization of ice crystals, where some ice particles remain confined in a specific phase of the wave. The precise location where the confinement occurs depends on the background relative humidity, but it is always characterized by a relative humidity near saturation and a positive vertical wind anomaly. Hence, the wave has an impact on the mean motion of the crystals and may reduce dehydration in cirrus by slowing down the sedimentation of the ice particles.

The wave-driven localization is consistent with temperature-cirrus relationships recently observed in the tropical tropopause layer (TTL) over the Pacific during the Airborne Tropical Tropopause EXperiment (ATTREX). I will argue that this effect may explain such observations. Finally, the impact of the described interaction on TTL cirrus dehydration efficiency will be quantified using ATTREX observations of clouds and temperature lapse rate.