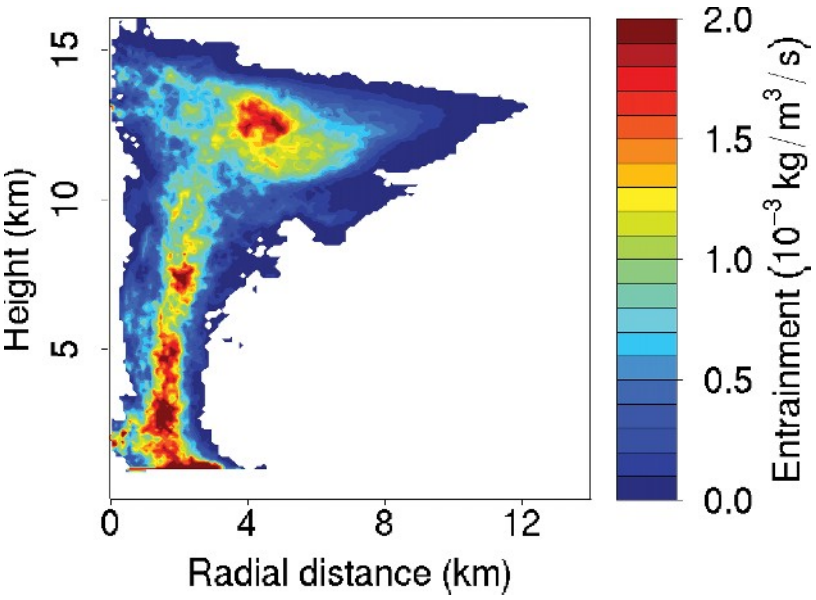
A Direct Measure of Entrainment

As convecting clouds rise, they mix some of the surrounding clear air into themselves, a process referred to as convective entrainment. Since the clear air has lower humidity than the cloud itself, entrainment dries the cloud and saps it of its energy, profoundly altering its evolution. A new numerical method for use in cloud-resolving simulations allows for the quantification and visualization of this important process.

Cloud-resolving models have been used to quantify entrainment rates in several studies, but most of those studies have diagnosed entrainment rates by assuming that entraining air has the mean properties of clear air and that detraining air, or the air mixed out of the convective cloud, has the mean properties of the cloud. This is the so-called bulk-plume approximation. Unfortunately, there are reasons to suspect that this bulk-plume approximation is violated. For example, clouds tend to detrain their least buoyant parcels, which also tend to be much drier than the cloudy mean. As can be shown analytically, this causes the bulk-plume estimates of entrainment to be biased low.

An alternative approach to measuring entrainment is to think of "cloudy air" as a distinct fluid. Like any other fluid, cloudy air obeys a continuity equation. In this case, the source of this fluid is entrainment and the sink is detrainment. By keeping track of the local tendency and divergence of this fluid, the sources and sinks (entrainment and detrainment) can be diagnosed for each grid cell as a function of time. Unlike the bulk-plume method, which only produces horizontally averaged profiles, this direct measurement provides spatially and temporally resolved pictures of entrainment.



Azimuthally averaged entrainment rate during a 20-minute interval of a single cumulonimbus.

Using this direct-measurement technique in a cloud-resolving simulation, it is found that the bulk-plume method underestimates convective entrainment by a factor of two or more. This highlights the importance of cloud heterogeneity and suggests that efforts to understand convection must take this variability into account. With this research, the ability to quantify and visualize entrainment will provide a deeper understanding of cloud lifecycles.—David M. Romps (Harvard University). *"A Direct Measure of Entrainment," in a forthcoming* Journal of the Atmospheric Sciences.

DOES RAIN BRING ON BOY BUFFALOS

There's a theory that in times of war more male babies are born than females. Could weather possibly have a similar gender effect? A new study from BMC Evolutionary Biology indicates this could be the case regarding African buffalo. The researchers, led by Pim van Hooft of Wageningen University in the Netherlands, found that there are more male buffalo babies born during the rainy season. The scientists studied the animals of the Kruger National Park, collecting data from 1978 to 1998 to correlate an association between rainfall, birth rates/ratios, and genetic information. They discovered the increase of male births linked to a so-called sex ratio gene, which causes a difference in the number, quality, and function of X- and Y-bearing sperm. According to van Hooft, there is a decline in overall sperm quality during dry seasons, which could account for the skew toward the baby boys in the rainy season. (Source: ScienceDaily.com)