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A first attempt to model an Artificial Ice Reservoir (Ice Stupa) using a simple energy balance approach

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Artificial Ice Reservoirs (AIRs, also called icestupas) have been successful in storing water during winter and releasing the water during spring and summer. Therefore, they can be seen as a vital fresh water resource for irrigation in dry environments. Many different forms of AIRs do exist and not many studies have tried to model these ice structures.

We will present simulations of the most important physical processes that causes the formation and melt of AIRs using one dimensional equations governing the heat transfer, vapour diffusion and water transport of a phase changing water mass. For validation, an AIR was constructed in Schwarzsee region in the Canton of Fribourg, Switzerland. Meteorological data in conjunction with fountain discharge data was measured. According to the model, the Schwarzsee AIR was able to store and discharge 850 litres or 3.7 percent of all the water sprayed over a duration of 41 days. Alternate model scenarios will also be presented to show how this freezing efficiency can be increased.