Dynamical Impacts of Surface and Atmospheric Radiative Heating on Cloud Systems
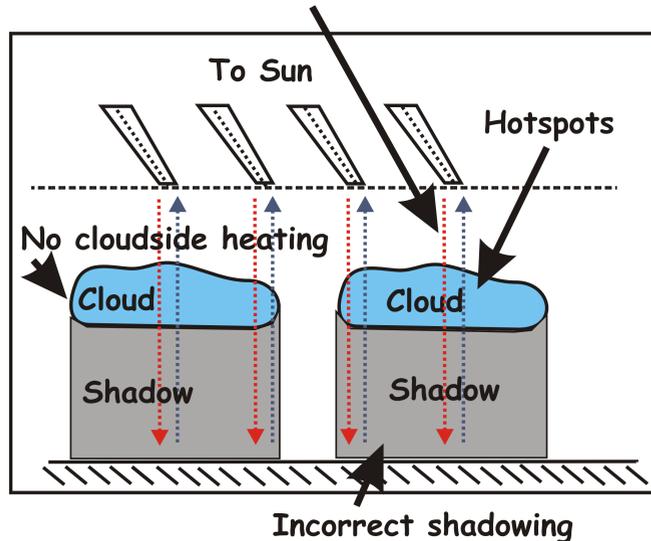
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1 - The Pennsylvania State University 2 - The Meteorological Service of Canada 3 - University of Maryland, Baltimore County
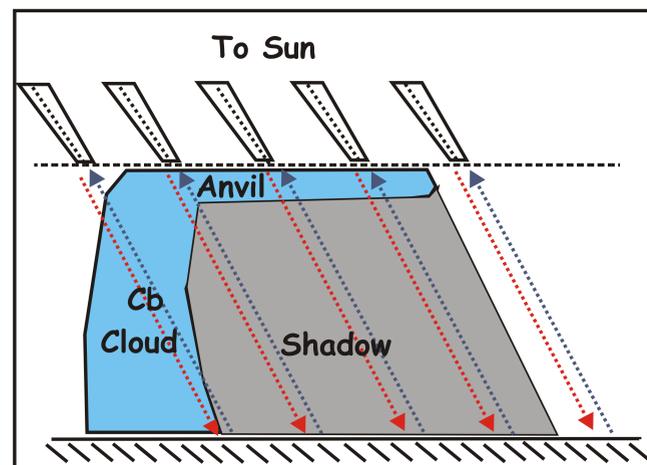
Independent Column Approximation (ICA) leads to radiative heating errors in the atmosphere and surface (focus on solar)

ICA Modeled Solar Atmospheric Radiative Transfer

Radiation only allowed to propagate in vertical directions; this leads to the errors

Do these errors matter?
Errors in the Surface

Important for supercells?! Markowski et al. [1998] observed temperature deficits of ~3K under anvil shadow; how do they affect storm evolution?

To look at impact of anvil shadows on supercell dynamics, need to get the shadowing modeled correctly! How?

Apply tilted ICA (TICA) to cumulonimbus environment (Frame et al. 2009)

Dynamical Impact of TICA use in modeled supercell evolution:
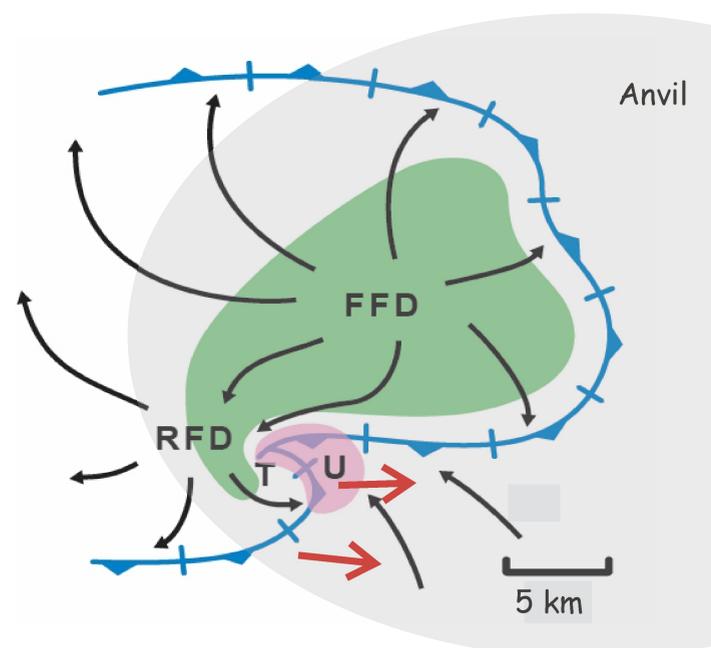
With anvil shadowing, rear-flank gust front accelerates and can undercut mesocyclone faster, leading to weakening of the storm
Frame PhD Dissertation (2008)
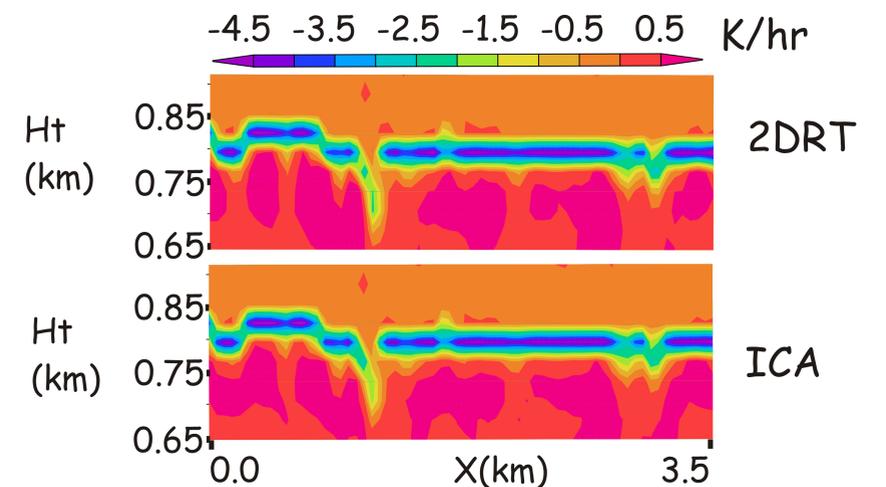

Errors in the Atmosphere

Investigate stratocumulus, which is radiatively driven

Horizontally homogeneous ICA may be applicable
Photo - Alexei Koralev

Inhomogeneous Sc field ICA likely not applicable
Photo - Amy Dobryzn
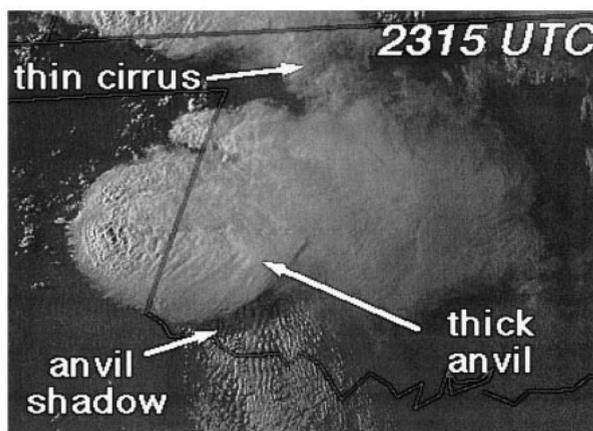
Framework prepared for study...

Radiative heating rates as computed within RAMS for 2-D Sc cloud field - shortwave Monte Carlo (45° zenith, azimuth E), longwave two-stream. Cloud field is fairly horizontally homogeneous.   Horizontal transport of shortwave radiation not significant here!

...but need a candidate Sc cloud field

Have a good candidate to observe 3D radiative impact on modeled Sc dynamics if 3D radiative effects on integrated solar heating are comparable to those that influence Sc evolution.