Implementation of the New Probabilistic CuP Cumulus Parameterization

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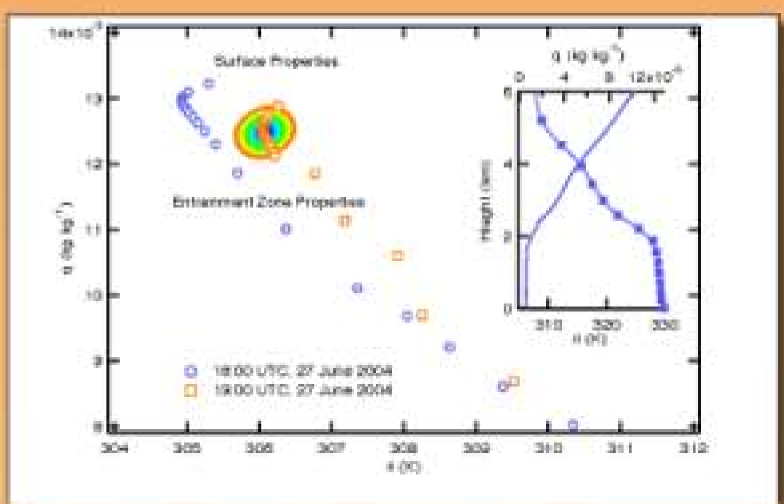
1. Motivation

Shallow clouds are poorly predicted by current global and regional scale models. A new parameterization has been developed that links the boundary-layer turbulence and the shallow clouds.

2. The CuP Parameterization

- The Cumulus Potential (CuP) parameterization uses Probability Density Functions (PDFs) of temperature and moisture to represent the subgrid scale processes (Berg and Stull 2005).
- PDFs represent the range of parcel properties within the grid box.
- PDFs are mixtures of air from the surface, the mixed layer, and the entrainment zone at the boundary-layer top.



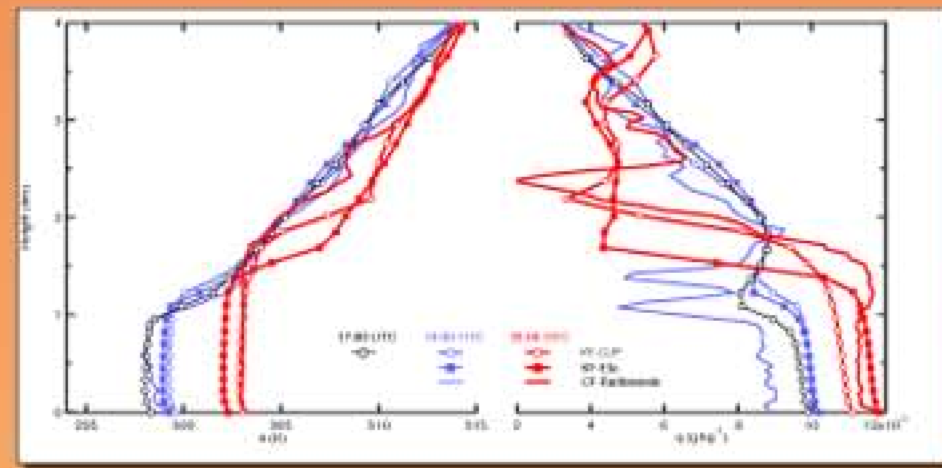
Mixing diagram of water vapor mixing ratio (q) and potential temperature (θ) computed from WRF output at 18:00 and 19:00 UTC on 27 June, 2004. Colored contours show the PDF computed from the surface, mixed layer and entrainment zone properties (Berg and Stull 2004).

3. Implementation in WRF

- The CuP scheme was implemented in the standard Kain-Fritsch KF-Eta scheme (Kain and Fritsch 1990; Kain 2004).
- The trigger function has been replaced by PDFs.

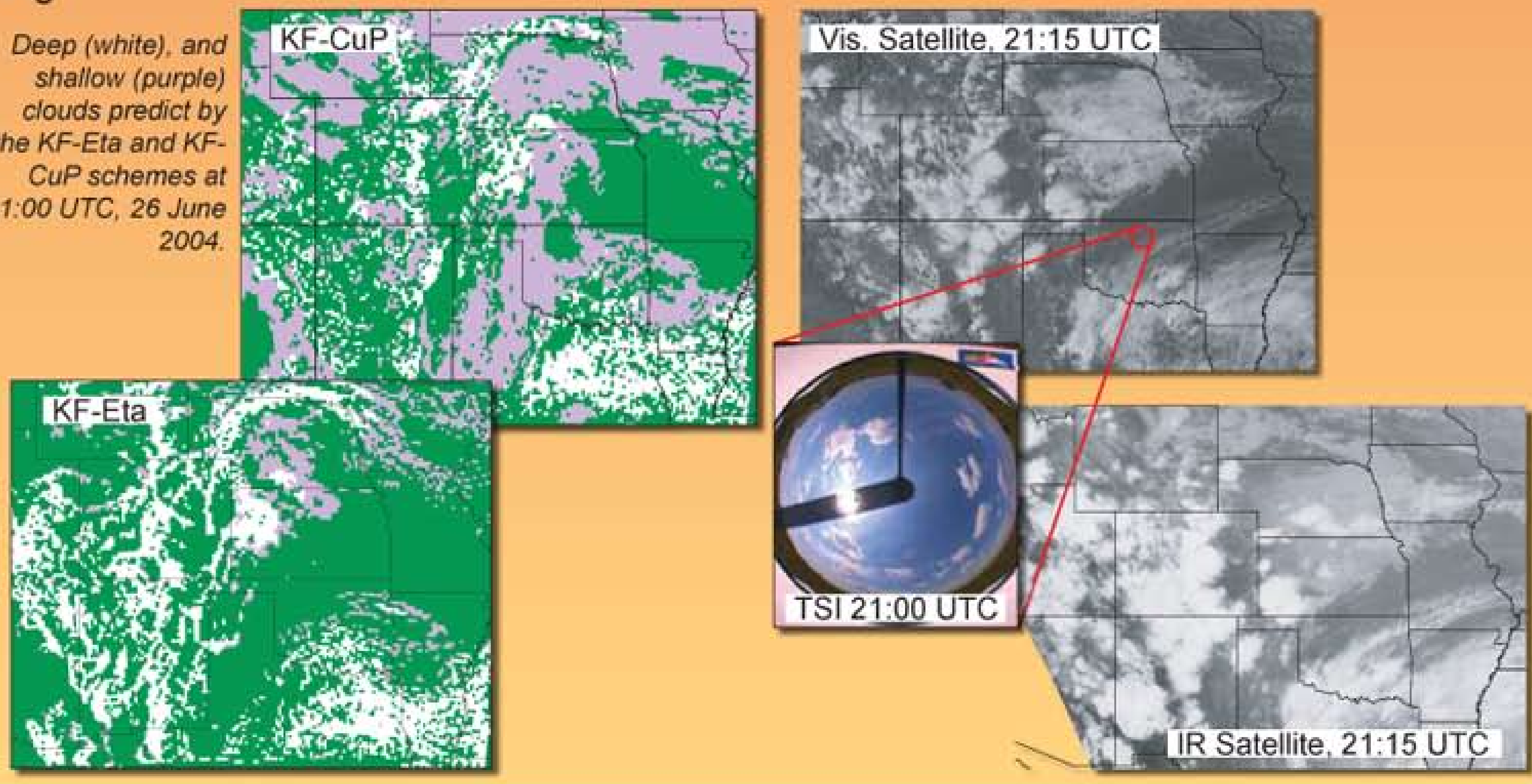
4. Case Studies Results

- Time periods selected from the TSI (Total Sky Imager).
- Both the KF-CuP and KF-Eta predicted some shallow clouds on 26 June 2004.
- Generally good agreement with observed profiles (Right).
- More clouds were predicted by the KF-CuP scheme, leading to enhanced vertical mixing



Observed (lines) and modeled profiles of θ and q for 26 June 2004 using the KF-CuP (circles) and KF-Eta (squares) schemes.

Deep (white), and shallow (purple) clouds predict by the KF-Eta and KF-CuP schemes at 21:00 UTC, 26 June 2004.

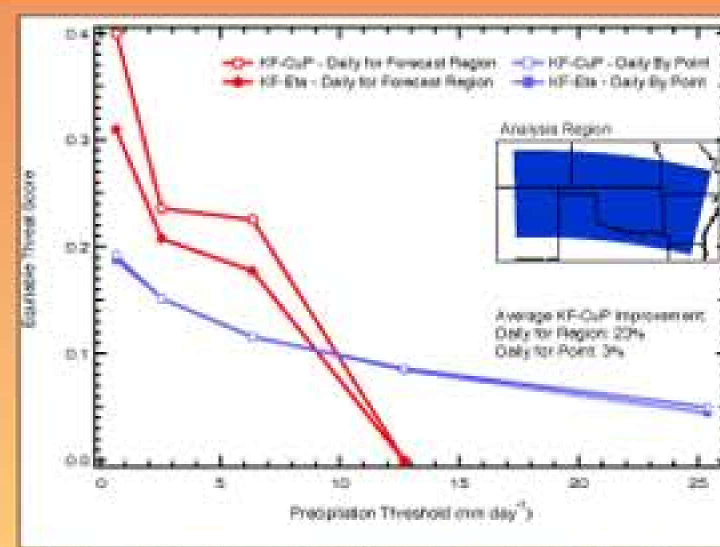


5. Seasonal Simulation Results

- April was simulated to spin up soil moisture and is not used in our analysis.
- May, June, July, and August 2004 selected for analysis.
- Preliminary analysis has been started.
- Reduction in ETS compared to KF-Eta.

Equitable Threat Score (ETS)

- *Commonly used measure of model skill (Rogers et al. 1996)*
- *Compares prediction of a threshold amount with random chance*
- *Perfect forecast = 1, random = 0.*



ETS at various precipitation thresholds for the region around the Arkansas-Red Basin and by model grid point for 24-hour accumulated rain.

6. Future Efforts

- Link cumulus cloud fraction with 3-D radiation and improve estimates of cloud fraction.
- Perform seasonal simulations for the TWP.
- Compare regional-scale water budgets predicted by KF-Eta and KF-CuP.

References:

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