

Cloud Resolving Model Radar SIMulator (CR-SIM): Latest Updates and Applications

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Simulation Overview

CRM data (e.g., WRF, DHARMA) with various microphysics scheme

- 2-moment (Morrison et al., 2005, 2009, Milbrandt and Yau, 2005a,b, and Thompson et al. 2007)
- The spectral bin microphysics (Fan et al., 2012)



CR-SIM

Update!

Radar (scanning/profiling) simulator

- 1) T-matrix scattering calculation
 - For cloud water, cloud ice, rain, snow, graupel and hail for each size.
 - A fixed orientation for every elevation angles (0° - 90°)
 - 3, 5.5, 9.5, 35, and 94 GHz
- 2) Calculate particle size distributions according to a selected microphysics scheme for each model hydrometeor type
- 3) Resample data to radar coordinate

Update!

Zhh, DV, SW, Zvv, Zdr, Kdp, Ah, Av, LDRh for each model hydrometeor type

Ceilometer simulator

- 1) Calculate droplet size distribution
- 2) Compute single particle extinction and backscattering cross sections for spherical droplets at a wavelength of 905 nm.
- 3) Estimate first cloud base height at each column

Backscatter (including attenuation), extinction, lidar ratio, first cloud base

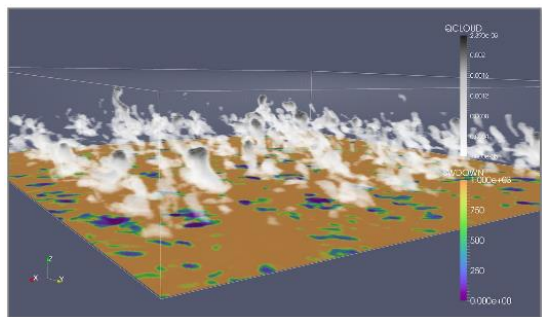
Micro Pulse Lidar (MPL) simulator

- 1) Calculate droplet and cloud ice size distributions
- 2) Compute particle extinction and backscattering cross sections for spherical droplets and ice at a wavelength of 353 or 532 nm.
- 3) Calibrate by aerosol and molecule backscattering

Backscatter (including attenuation), extinction, lidar ratio

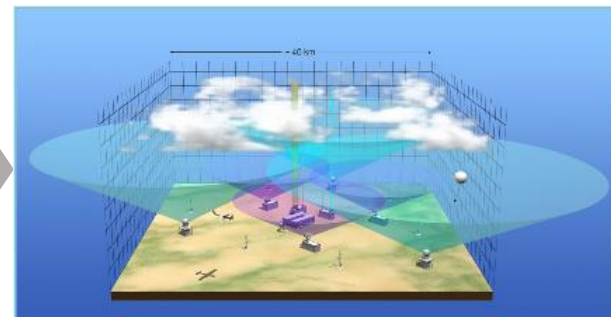
CR-SIM Applications

Cloud Model Simulations



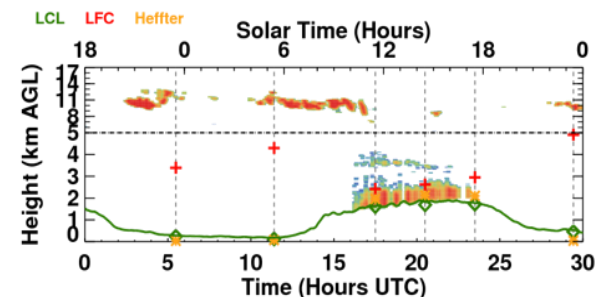
**Cloud Resolving
Model Radar
SIMulator (CR-SIM)**

Virtual Observational Products



1. Compare with the original model output to address potential uncertainties in observational data.
2. Compare with real observational data for LES evaluation.

Real Observational Data



Multi sensor product

- Virtual ARSCL

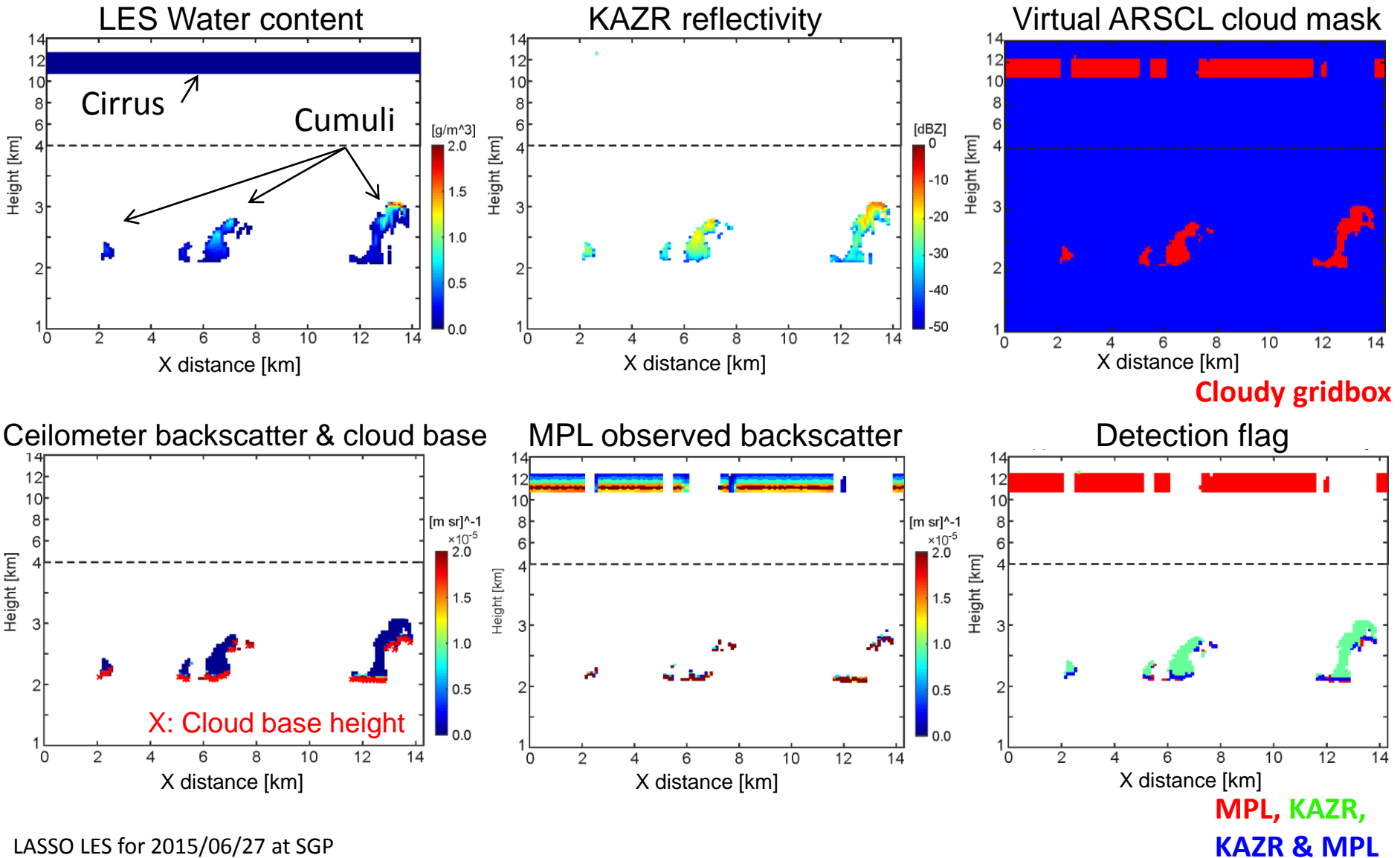
Single radar product

- Best estimates of cloud properties (cloud fraction)
- Polarimetric observables

Multi radar product

- 3DVAR Wind retrieval

Virtual ARSCL from Multi Sensor Simulations



Future Work

- Implement interfaces to other CRMs & different microphysics schemes
 - Predicted particle properties (P3) microphysics scheme (Morrison and Milbrandt, 2015)
 - RAMS with double moment (Walko et al., 1995; Meyers et al., 1997; Saleeby and Cotton, 2004; Saleeby and van den Heever, 2013)
 - SAM with double moment
- Code optimization to incorporate into real-time LES.
- Latest software packages are available at:
 - CR-SIM:
ftp://ftp.radar.bnl.gov/outgoing/moue/crsim/src/crsim2.2.1_beta.tar.gz
 - Radar resampling:
ftp://ftp.radar.bnl.gov/outgoing/moue/crsim/src/radar_filter_v1.2.tar.gz