Evaluating Microphysical Parameterization Schemes for Use in Hurricane Environments

Robert Black
NOAA/AOML Hurricane Research Division

Robert Rogers
Cooperative Institute for Marine and Atmospheric Studies/U. Miami

Paul Willis
NOAA/AOML Hurricane Research Division

Da-Lin Zhang
University of Maryland
Motivation

- Tropical cyclone intensity governed by magnitude and distribution of latent heat release
- Latent heat release influenced by hydrometeor production, conversion, fallout -- all processes that must be parameterized
- An evaluation of current parameterization schemes is proposed using in situ and remotely-sensed data from NOAA’s P-3’s and NASA’s DC-8 and ER-2 in hurricane environments
- Such evaluations can lead to suggested improvements to current schemes
Methodology

**Observational**
- collect *in situ* and remotely-sensed microphysical and vertical velocity data using HVPS and airborne radar
- coordinate passes using low-level (e.g. melting level or below melting level) aircraft and upper-level (e.g. well above melting level) aircraft

**Modeling**
- perform high-resolution simulations of existing cases to document sensitivities and locate potential biases
- perform simulations of CAMEX-4 cases
- implement improvements based on comparisons with observations, test simulations
- incorporate more complex schemes
Comparison of observed and simulated reflectivities

WSR 88-D

NOAA P-3

MM5

Andrew

MM5

Bonnie
Probability distribution function of vertical motion (m/s) at 650 hPa (P-3) and 650 hPa (model)
Probability distribution function of rainwater mixing ratio (g/kg) at 650 hPa (P-3) and 650 hPa (model)

P-3 data

model
Probability distribution function of vertical motion (m/s) at 225-375 hPa (DC-8) and 300 hPa (model)

DC-8 data

model
Probability distribution function of ice mixing ratio (g/kg) at 225-375 hPa (DC-8) and 300 hPa (model)

DC-8 data

model
Time series of vertical motion (m/s) and mixing ratio (g/kg) from P-3 and model within “convective” region at 650 hPa
Time series of vertical motion (m/s) and mixing ratio (g/kg) from P-3 and model within “stratiform” region at 650 hPa

P-3 data

model
Rainwater mixing ratio (g/kg) averaged within vertical velocity bins for “convective” region at 650 hPa

P-3 data

model
Rainwater mixing ratio (g/kg) averaged within vertical velocity bins for “stratiform” region at 650 hPa

P-3 data

model
Ice mixing ratio (g/kg) averaged within vertical velocity bins for “stratiform” region at 300 hPa

DC-8 data

model
Future work

**Observational**
- continue processing of data
- calculate hydrometeor mass distributions, PDFs of different species
- still looking for a coordinated upper- and lower-level pass

**Modeling**
- incorporate airborne-derived reflectivity, vertical velocity
- evaluate diagnostic terms of GSFC conversion processes in Lagrangian sense
- perform simulations of additional cases
- implement and test improvement to existing schemes
- consider implementing more complex schemes
Data availability for CAMEX-4
(contact: Robert.A.Black@noaa.gov)

• PMS and HVPS droplet spectra
  – poor quality due to a short in canister, so no PMS 2D-C or 2D-P spectra
  – best HVPS data during KAMP 010903H and KAMP 010907H
  – 15-s averaging times

• FSSP aerosol spectra
  – can be analyzed with 24-hr turnaround time

• can be made available via anonymous FTP
Examples of HVPS data from CAMEX-4

Good

Bad