Cloud-Resolving Modeling of TWP-ICE Deep Convection: Preliminary Results and Future Plans

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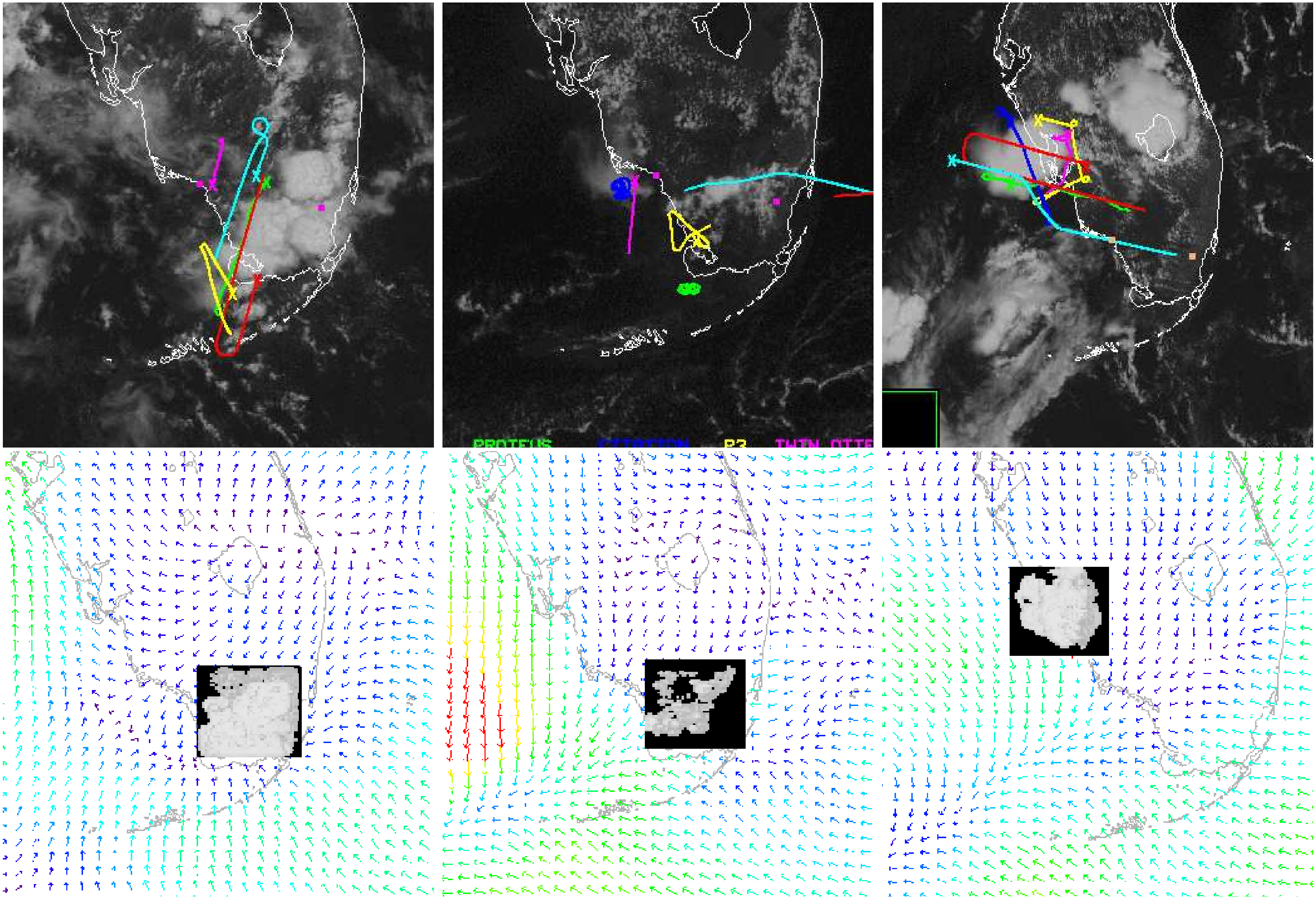
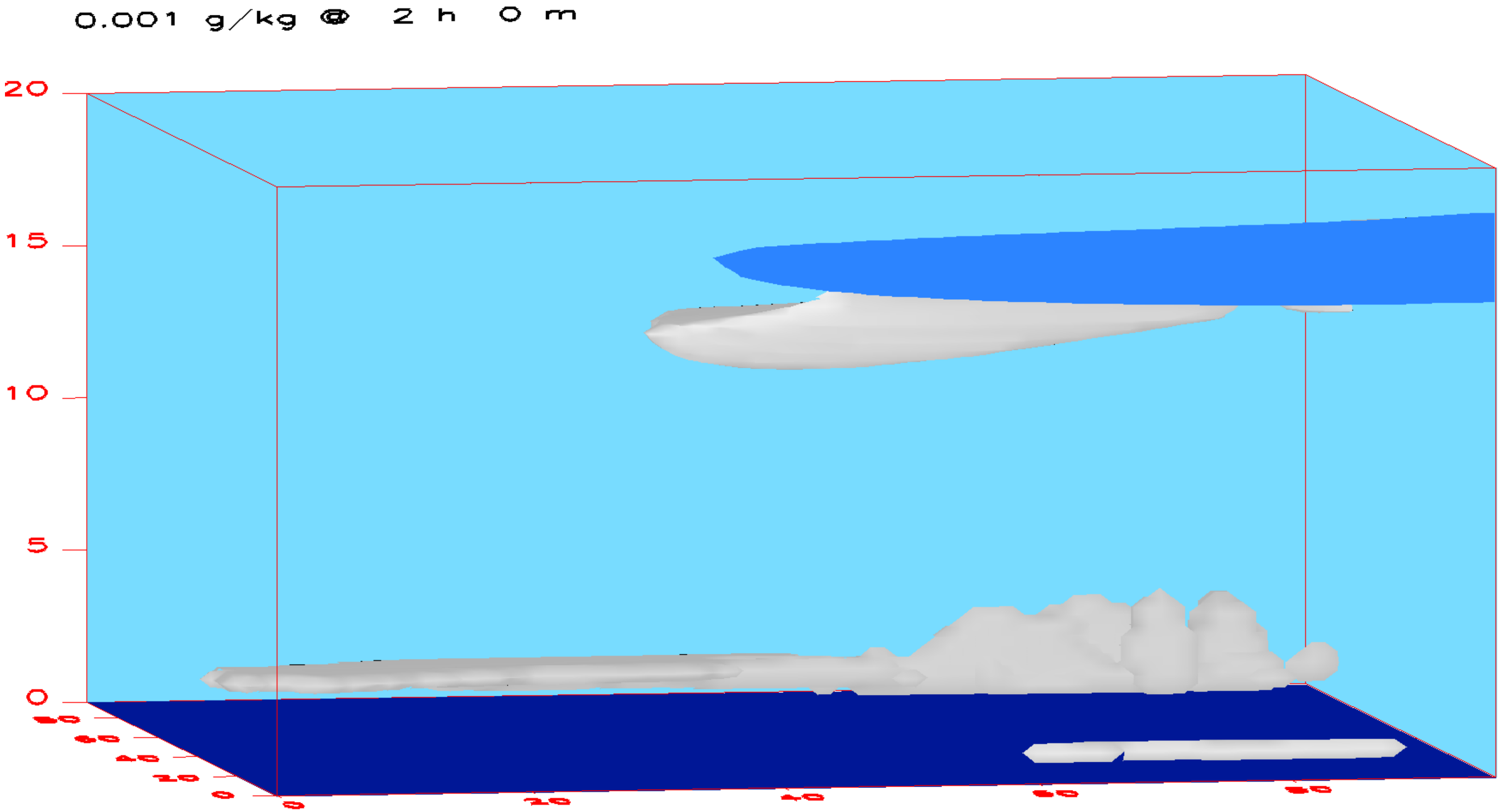
Model Description

- Dynamics framework
  - large-eddy simulation [Stevens and Bretherton, 1997]
  - open lateral boundary conditions, sponge layer at top
  - 2 km x 300 m uniform grid
  - assimilated surface fluxes and boundary conditions (AUSLAPS)
  - 2-stream radiative transfer, 44 wavelength bands [Toon et al., 1989]
- Bulk microphysics [Grabowski et al., 1999]
  - liquid (cloud water, rain water)
  - ice (fluffy ice, dense ice)
- Size-resolved microphysics [Jensen et al., 1994; Ackerman et al., 1995]
  - 16 mass bins per hydrometeor group
  - liquid (2 μm – 6 mm)
  - fluffy ice (2 μm – $>$ 1 mm)
  - dense ice (2 μm – $>$ 0.5 cm)
  - aerosols (10 nm – 1 μm)
  - diagnostic ice nuclei (10 ‘bins’)

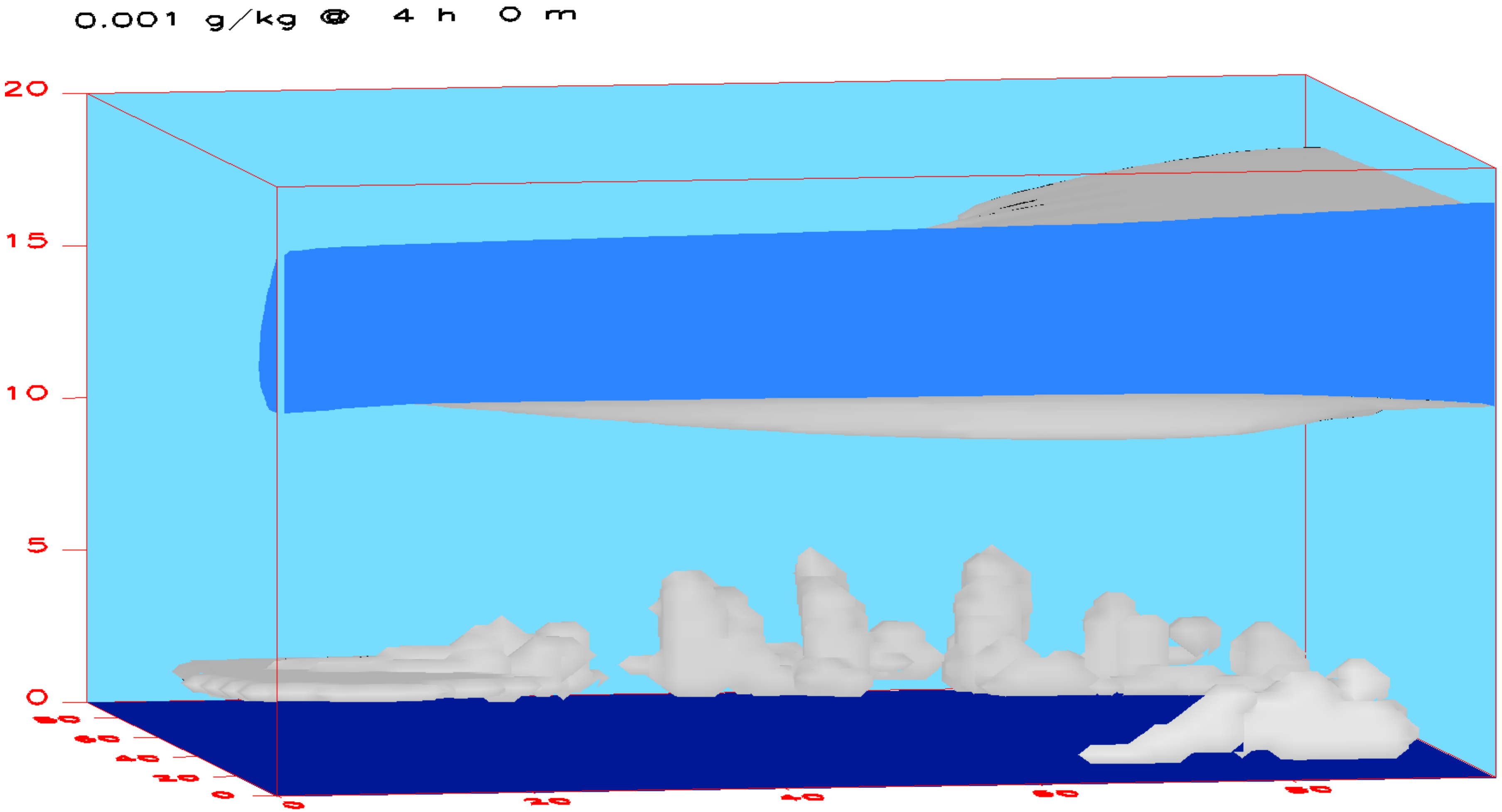
CRYSTAL-FACE: Bin Microphysics (11, 16, 21 July 2002)



Darwin: Bulk Microphysics (7 February 2005, 17-23Z)



Darwin: Bulk Microphysics (7 February 2005, 17-23Z)



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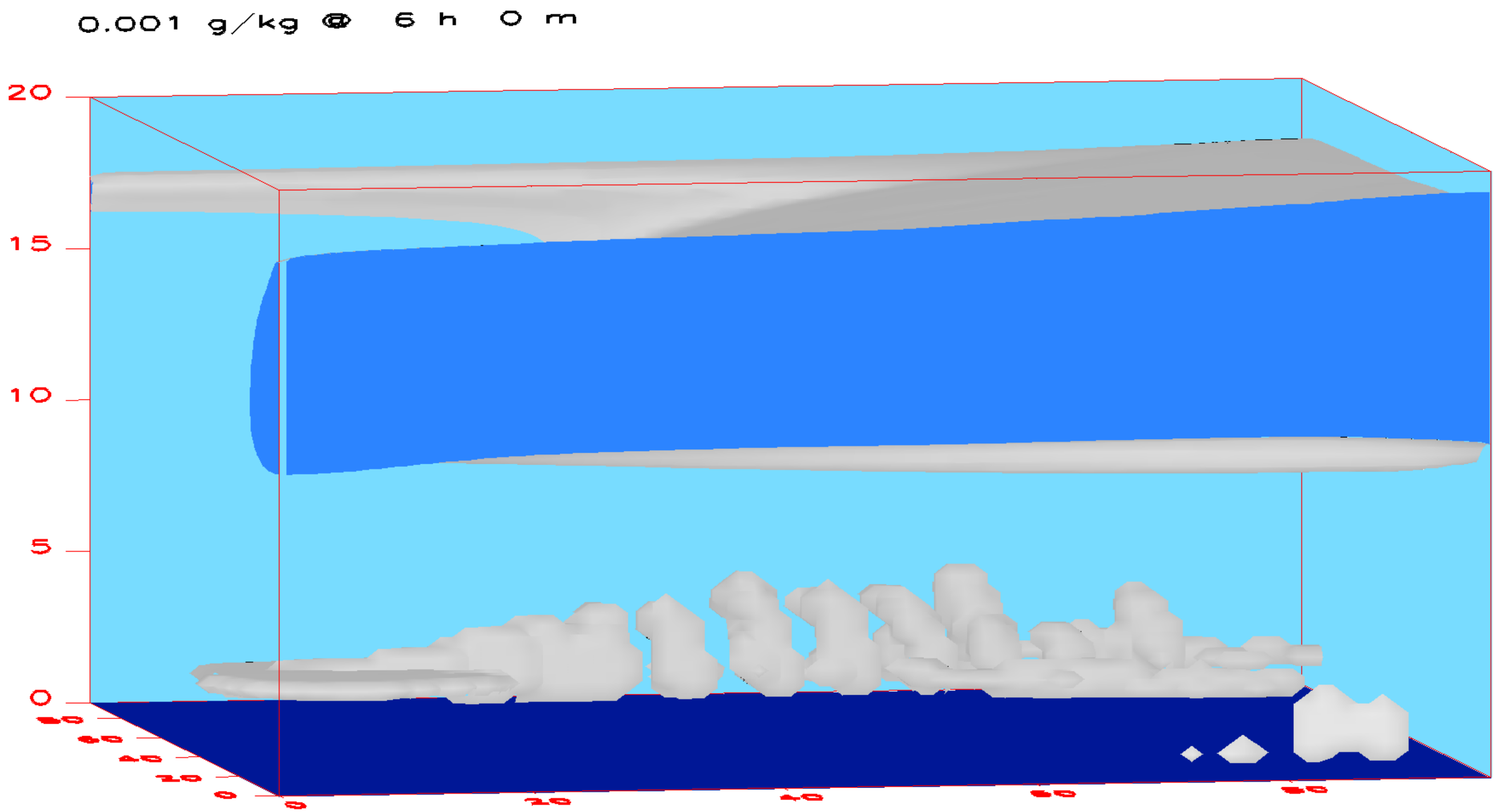
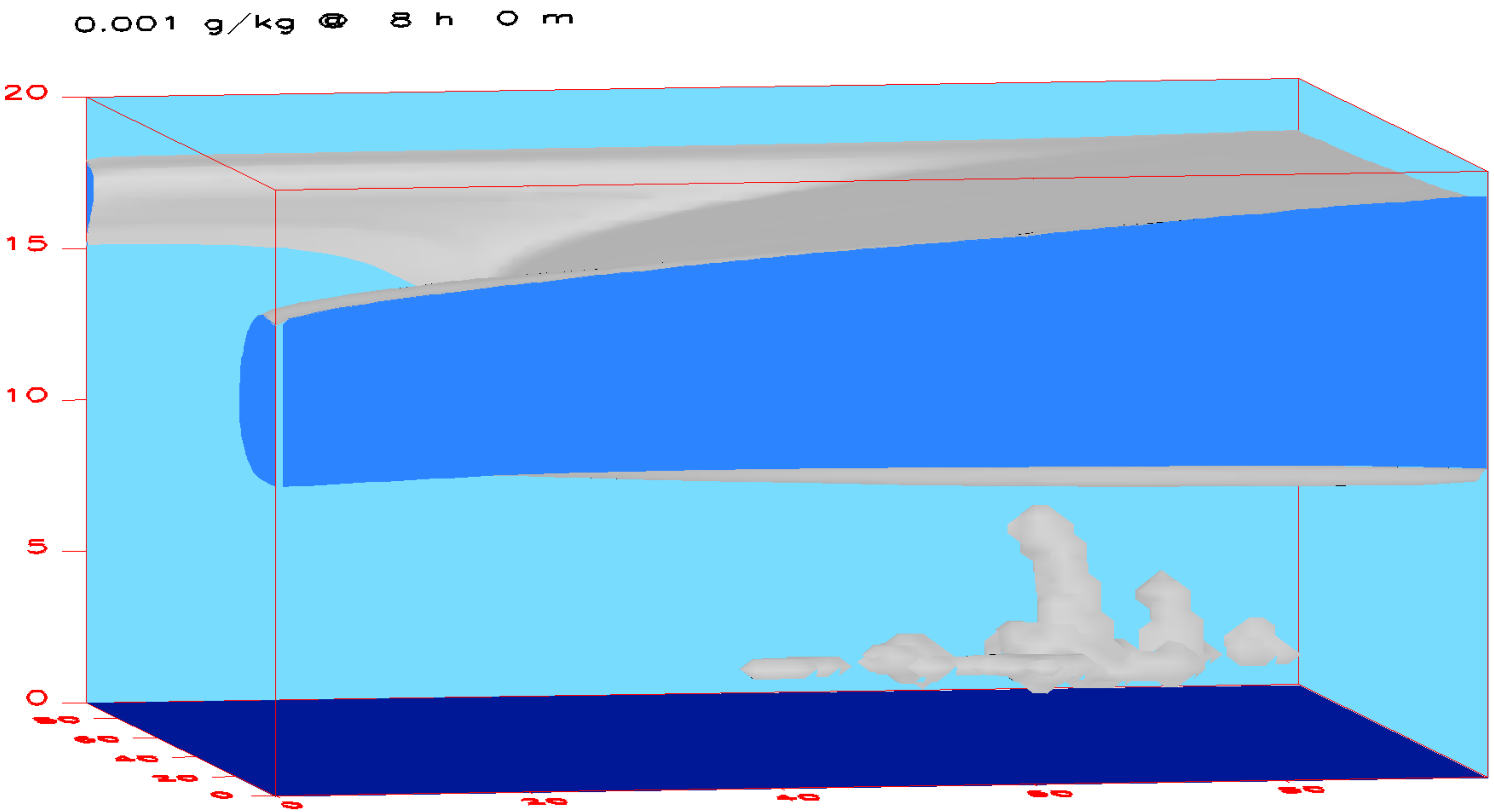
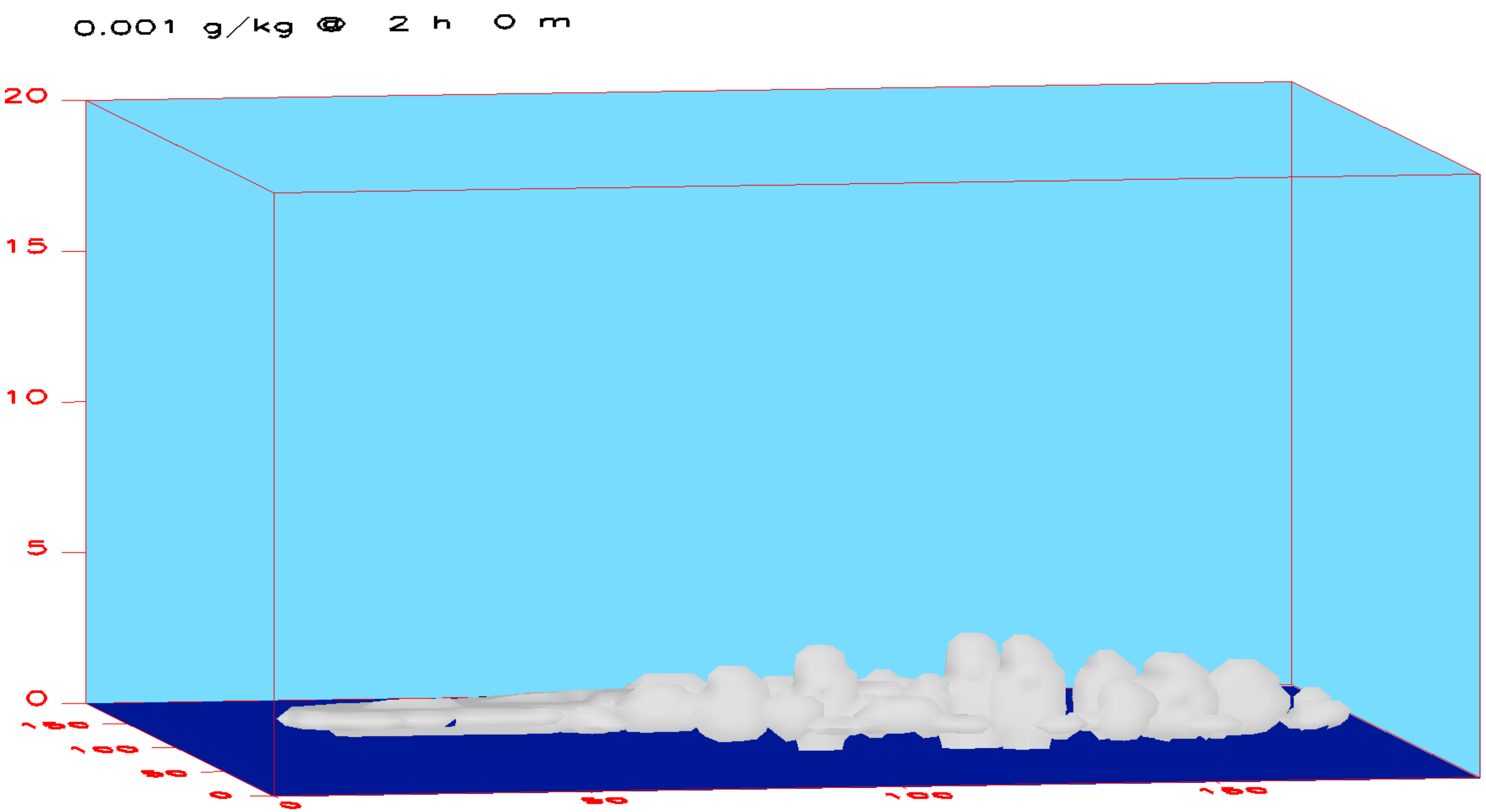


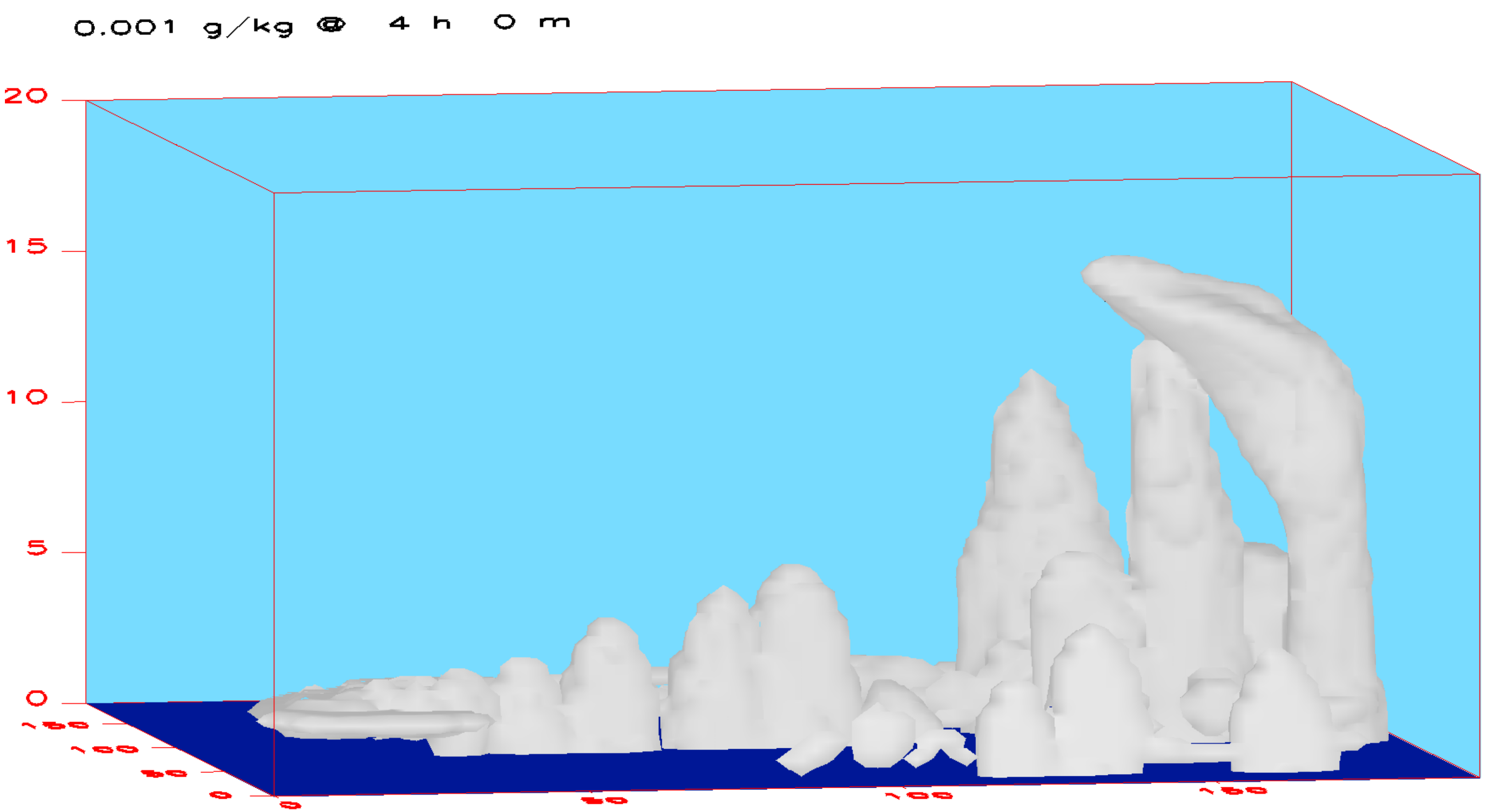
Darwin: Bulk Microphysics (7 February 2005, 17-23Z)



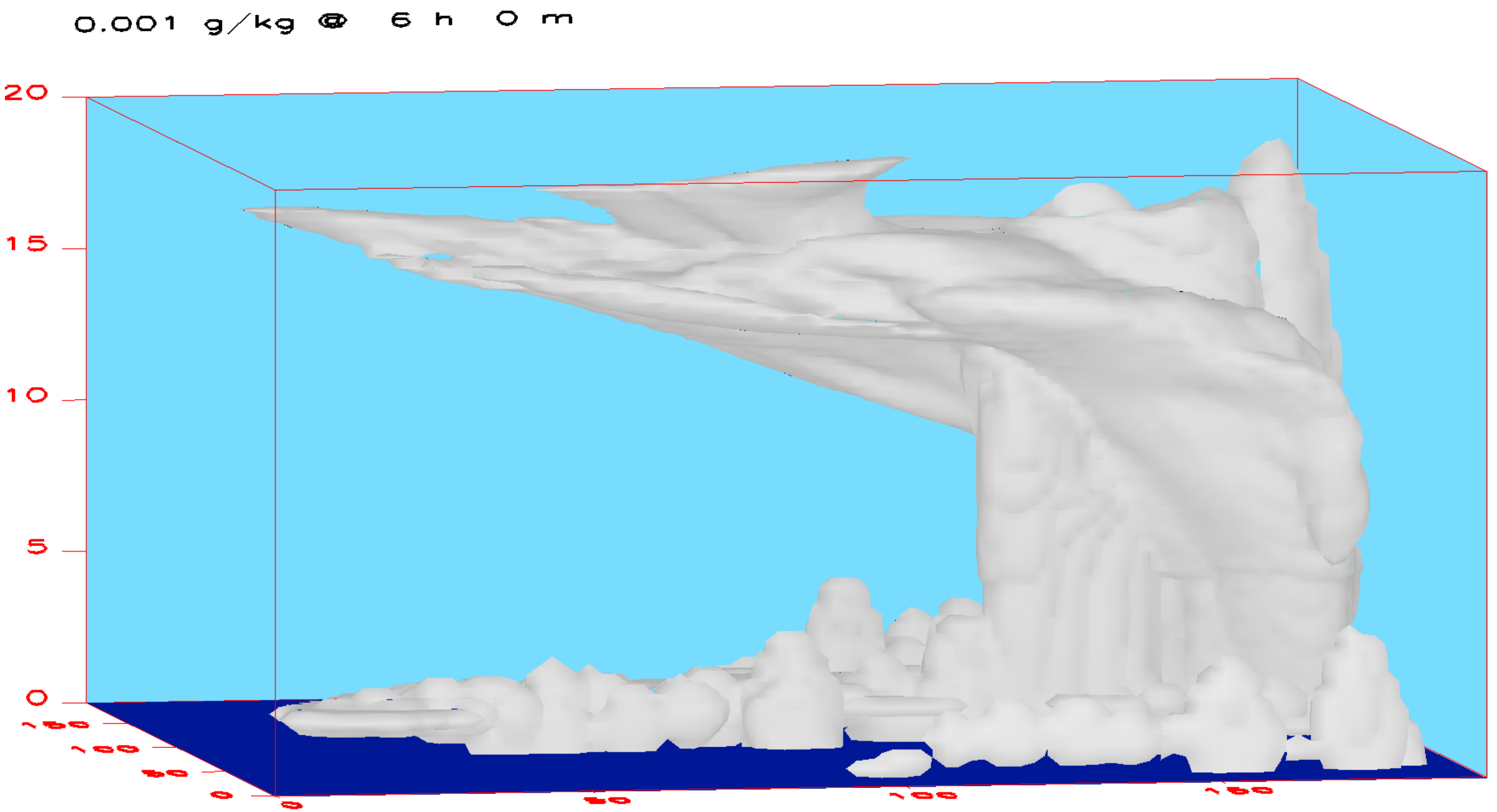
Darwin: Bin Microphysics (7 February 2005, 17-23Z)



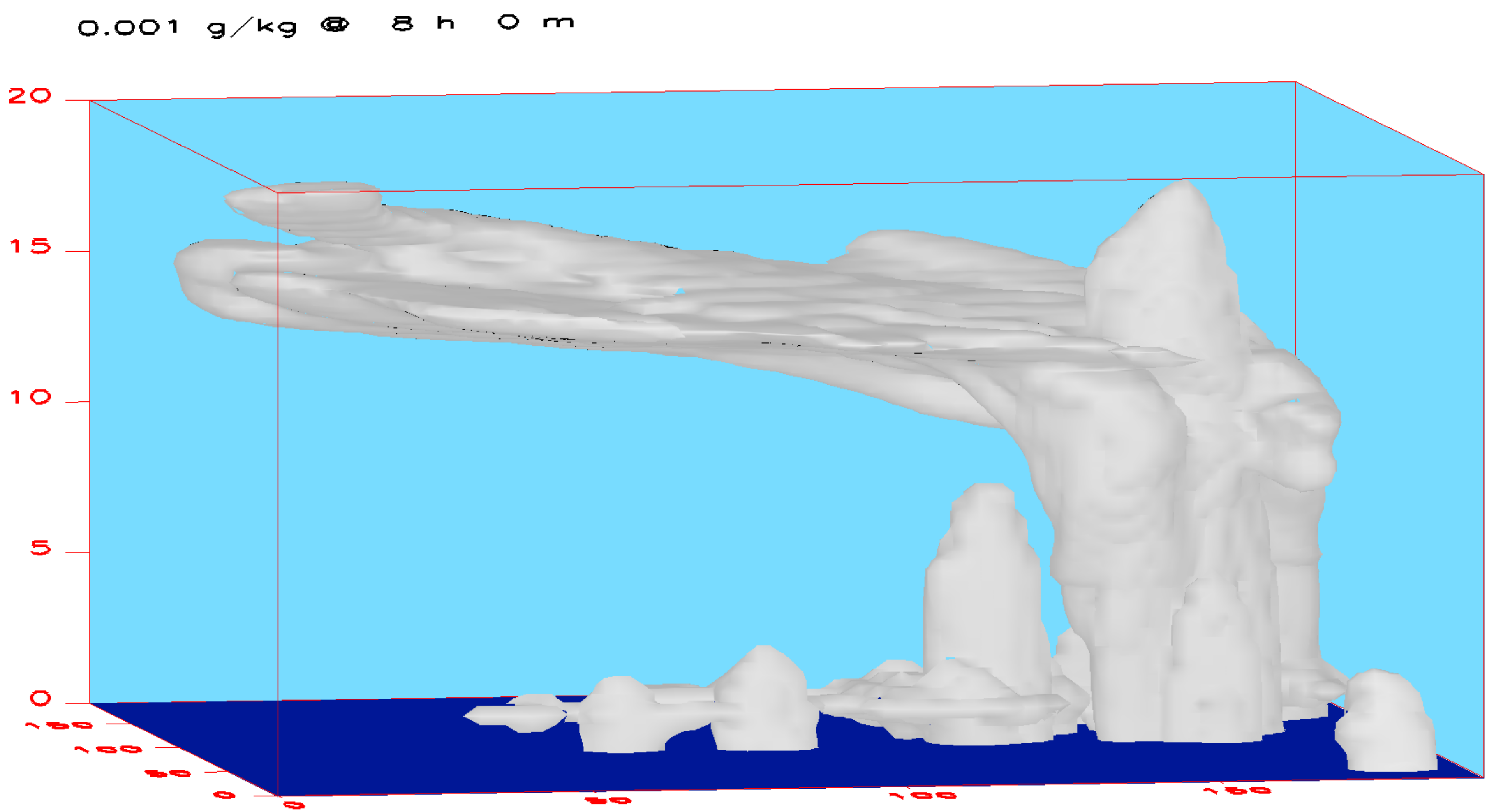
Darwin: Bin Microphysics (7 February 2005, 17-23Z)



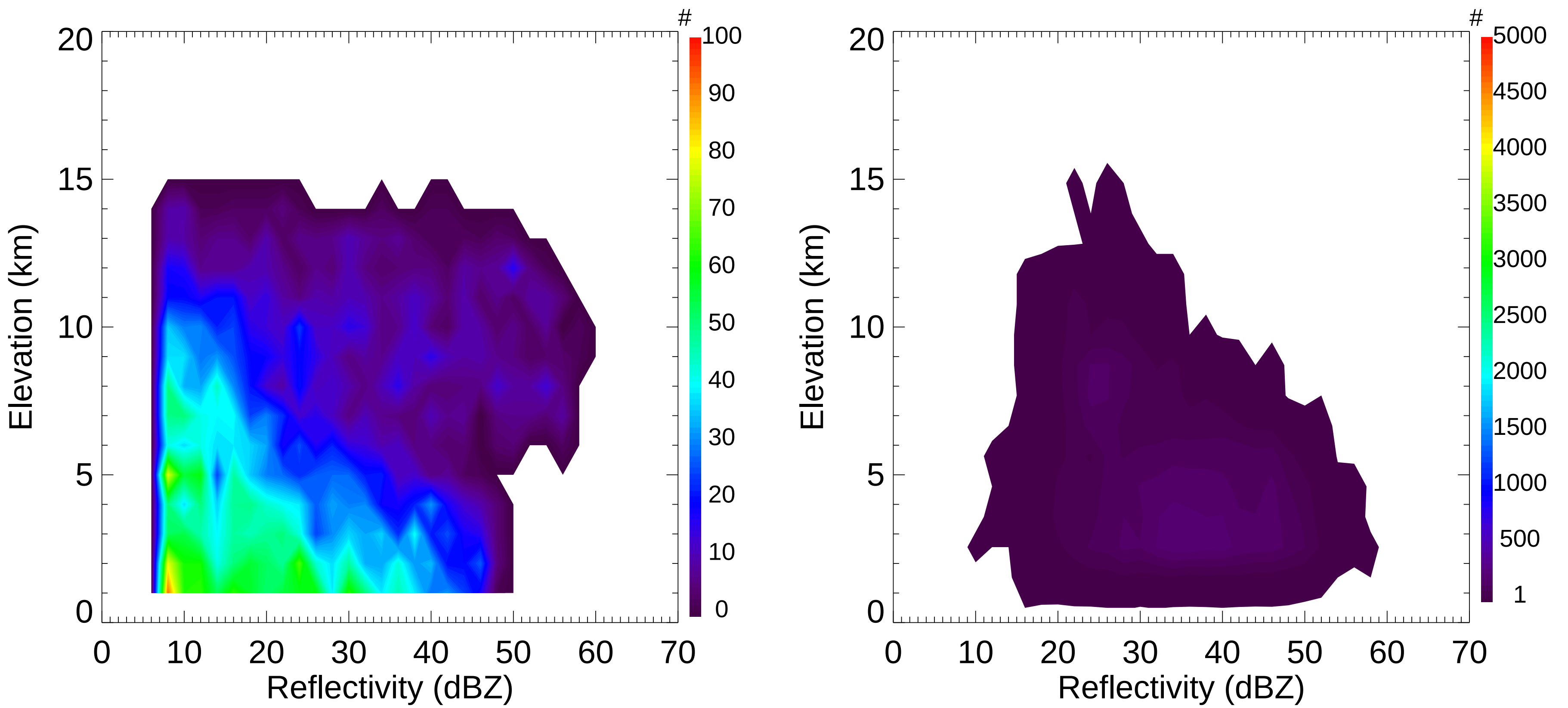
Darwin: Bin Microphysics (7 February 2005, 17-23Z)



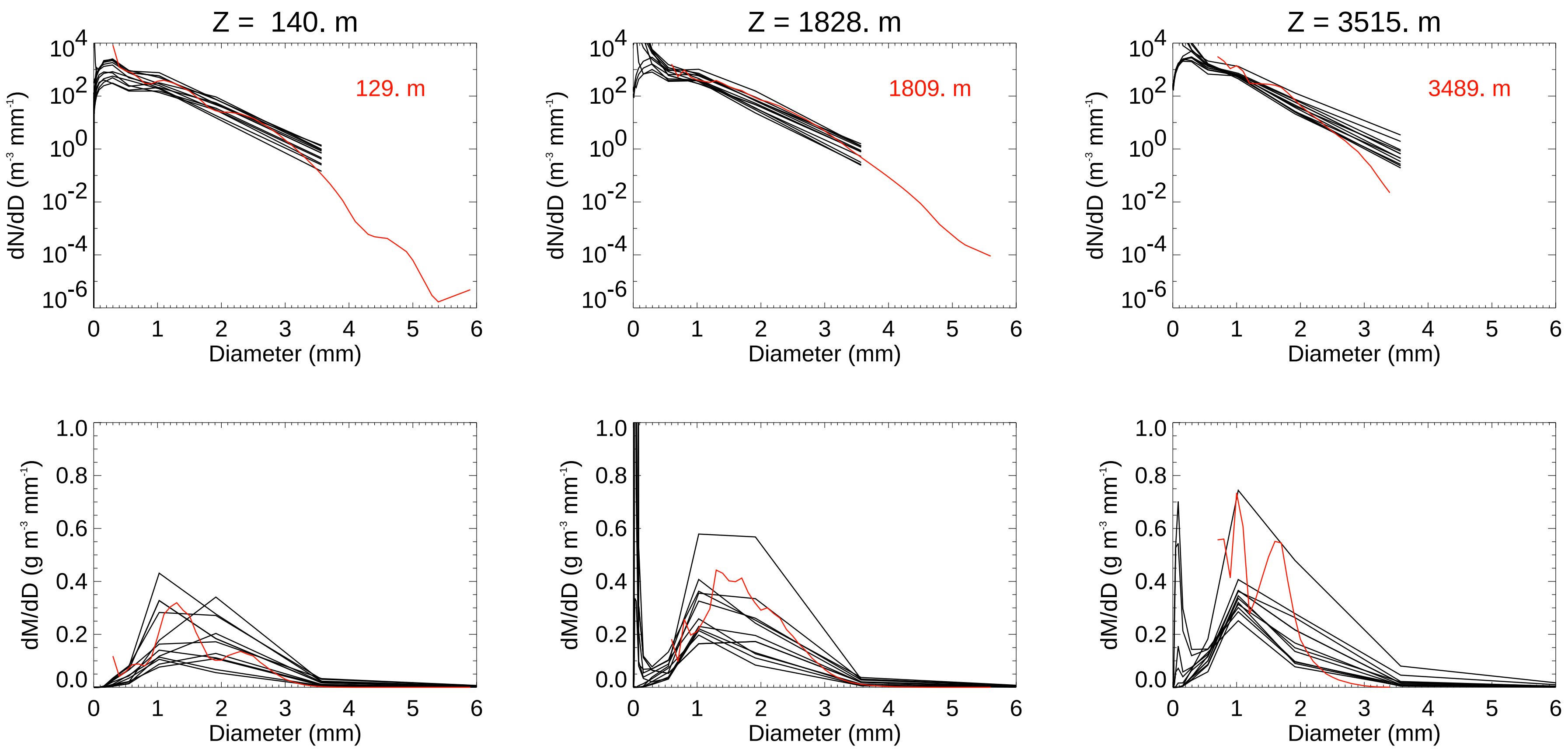
Darwin: Bin Microphysics (7 February 2005, 17-23Z)



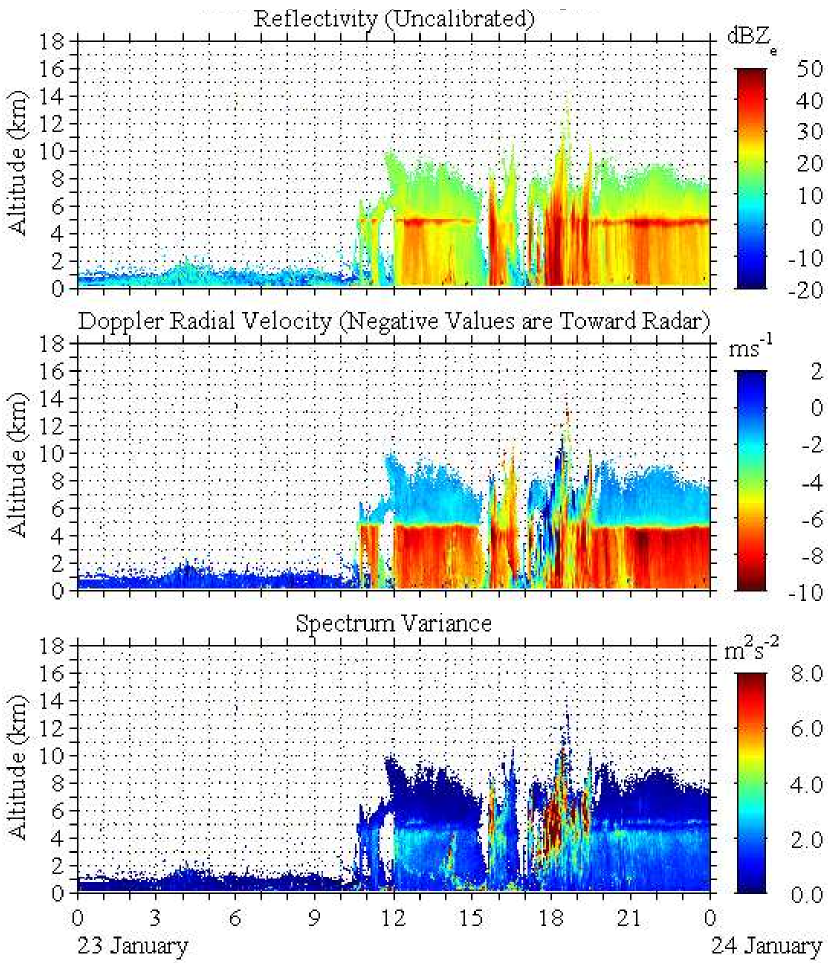
Darwin: Comparison with Scanning Radar Reflectivities (February 2005)

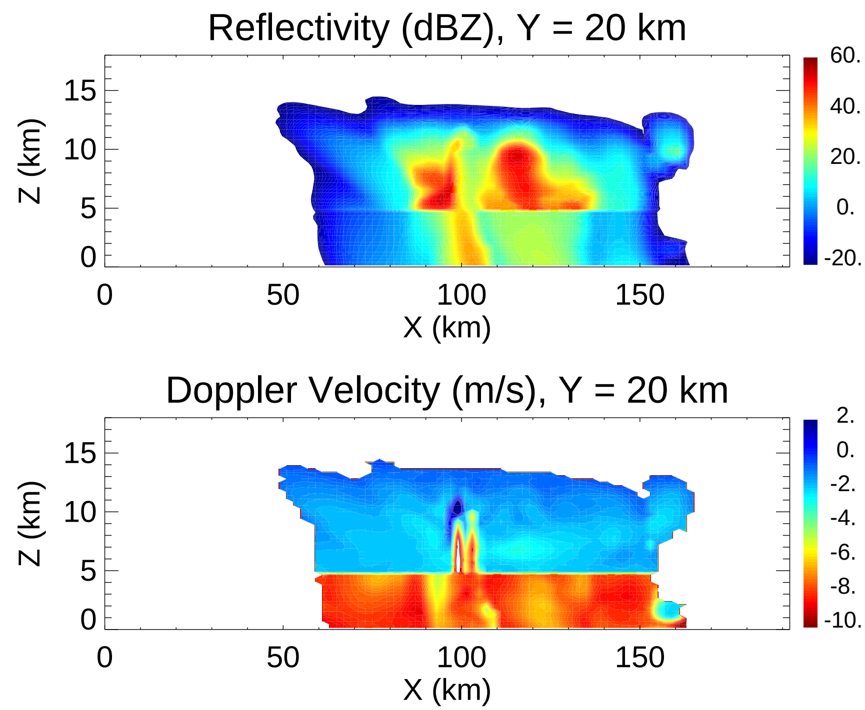


Darwin: Comparison with Vertically-Pointing Radar Retrievals (January 2006)



Darwin: Comparison with Vertically-Pointing Radar Retrievals (January 2006)





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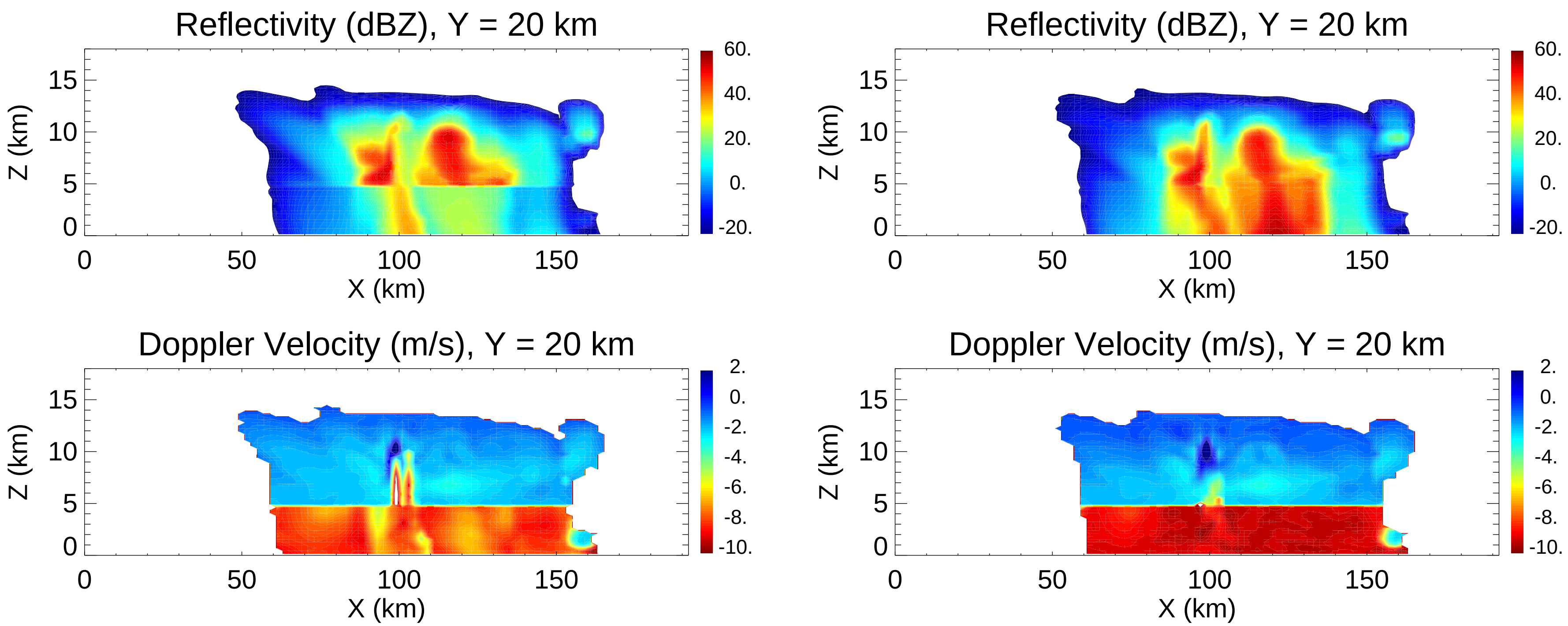
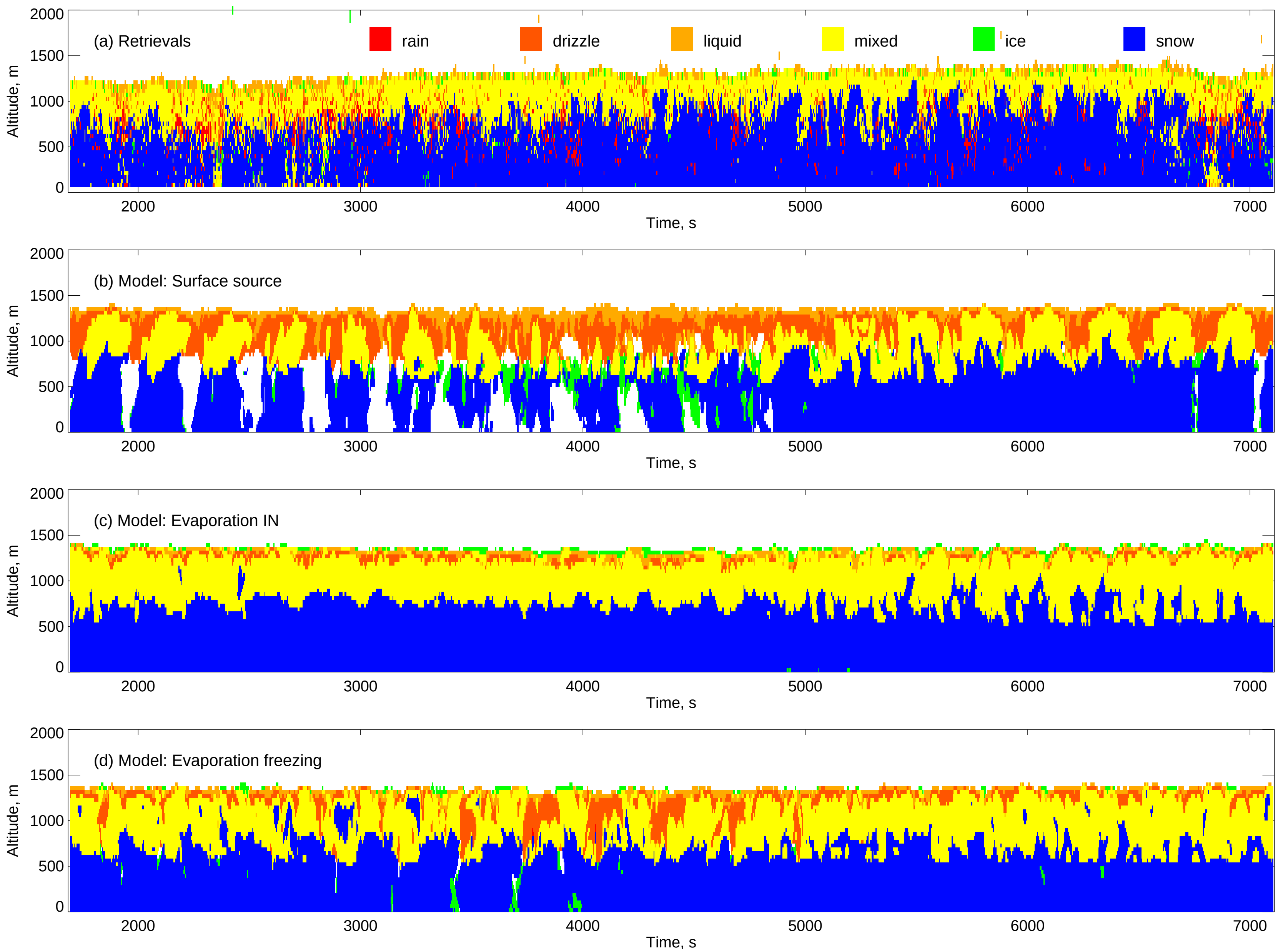
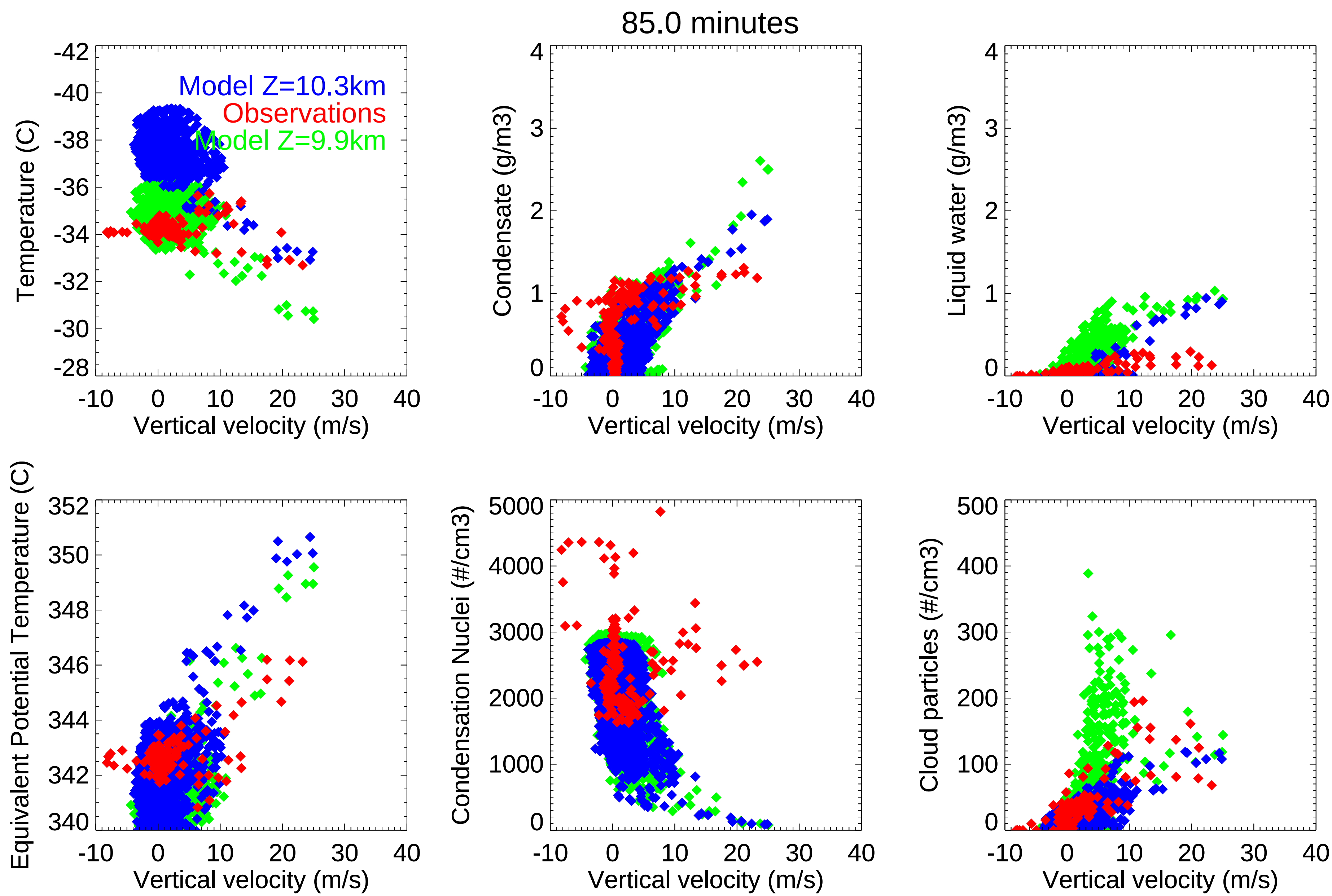


M-PACE: Bin, Comparison with Phase Retrievals (10 October 2004)



CRYSTAL-FACE: Bin, Comparison with In Situ Data (18 July 2002)



Summary

- Constraint of model microphysics
  - pileus layer formation (aerosol homogeneous freezing)
  - maximum radar echo heights (collision-coalescence)
  - precipitation drop size distribution (break-up)
  - Doppler fall velocity (collision-coalescence, vapor growth)
  - retrieved hydrometeor class (freezing processes, everything)
  - in situ particle number size distribution (freezing processes, everything)
- Primary scientific questions
  - what processes determine early anvil properties, subsequent evolution?
  - what are the primary modes of ice formation?
  - what is needed to predict these—CAPE, BL depth, UT RH, aerosol, ice nuclei?
- Strategy
  - choose marine and Hector case studies within radar range
  - drive LES with meso-scale model output or soundings, fluxes, forcings
  - simultaneously constrain results with in situ, profiler, radar data
  - aerosol data may be lacking (CN, size distribution, ice nuclei)