3D Scene Construction, Radiative Transfer, and Radiative Closure Assessment
- ACM-COM, ACM-3D, ACM-RT, ACMB-DF -

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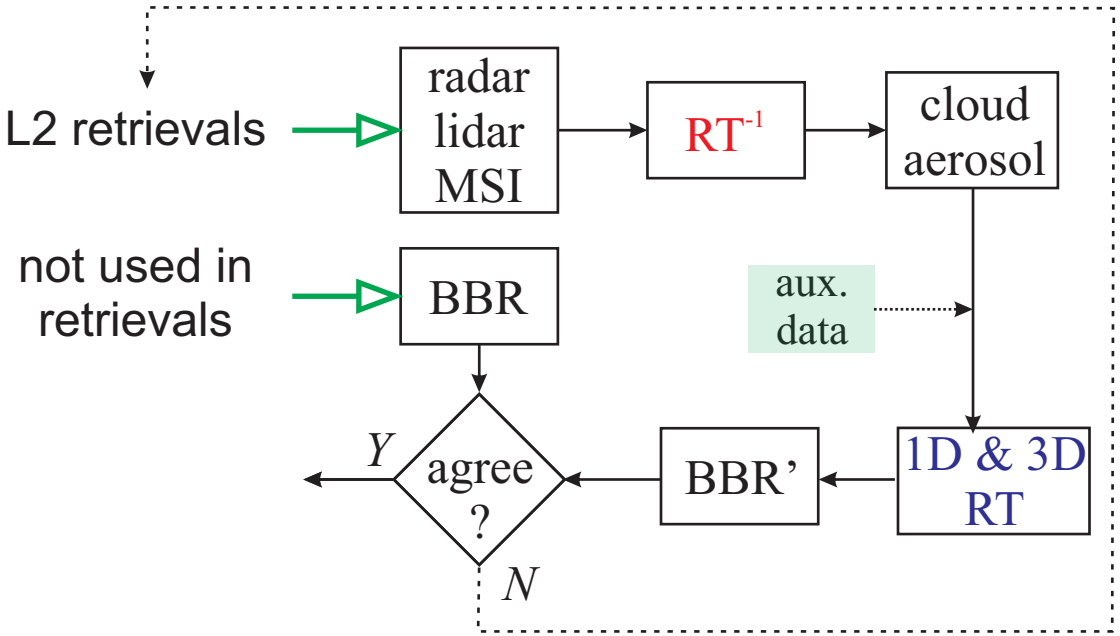
primary scientific goal

retrieve cloud/aerosol properties such that TOA radiative fluxes can be modelled to within ~10 W m^{-2} for ~100 km^2 regions

mission verification

continuous radiative closure assessment...



- compare simulated TOA BB fluxes and radiances to BBR "data"
- purpose: feedback to algorithm developers *and* guidance to users

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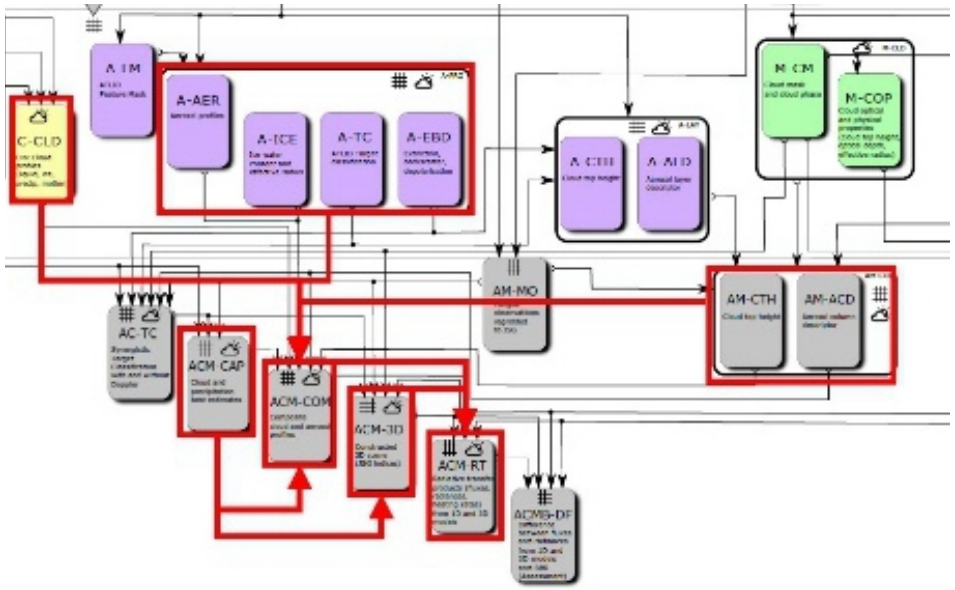
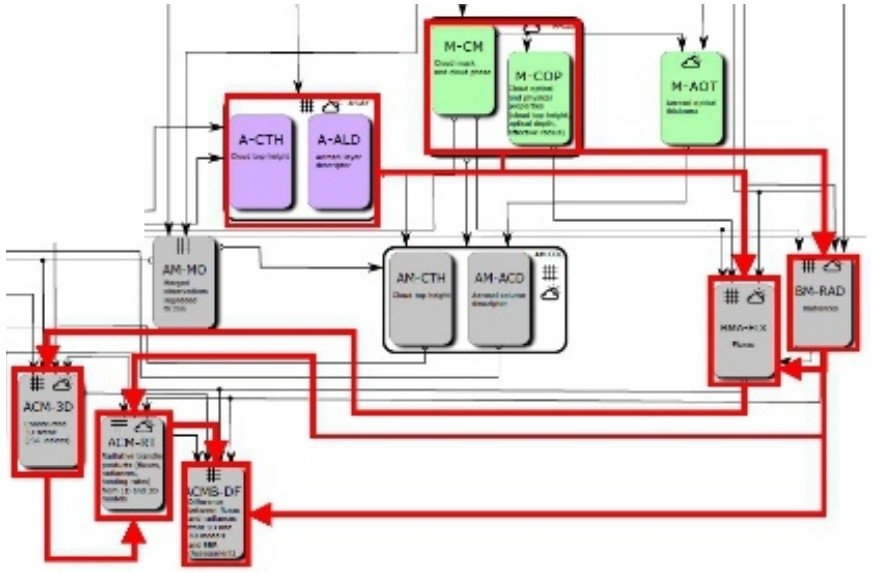
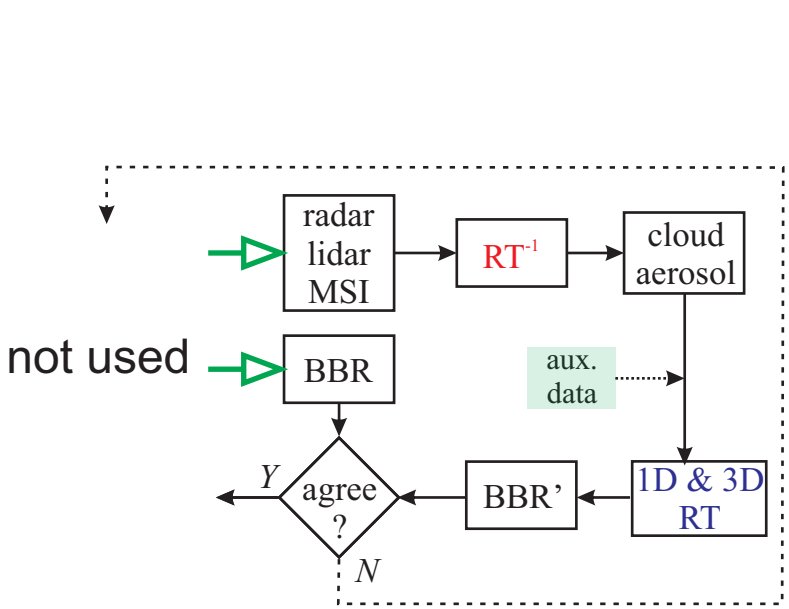
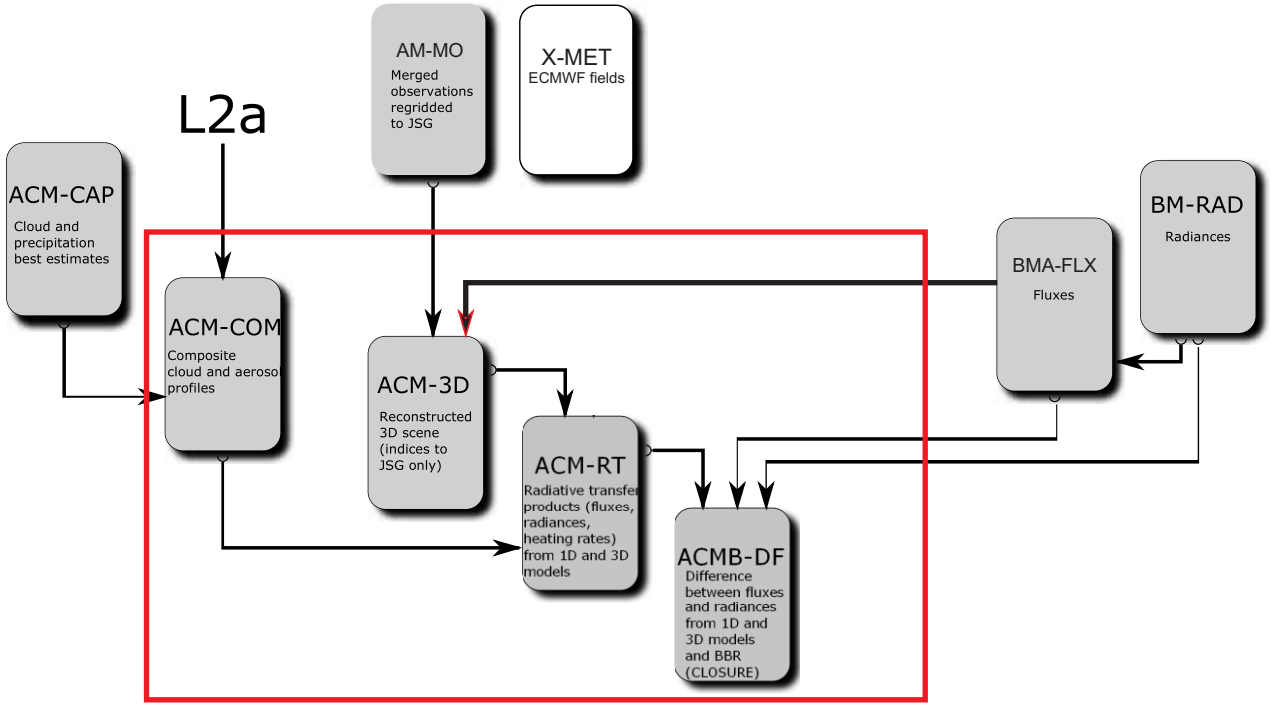
chain 3



chain 4







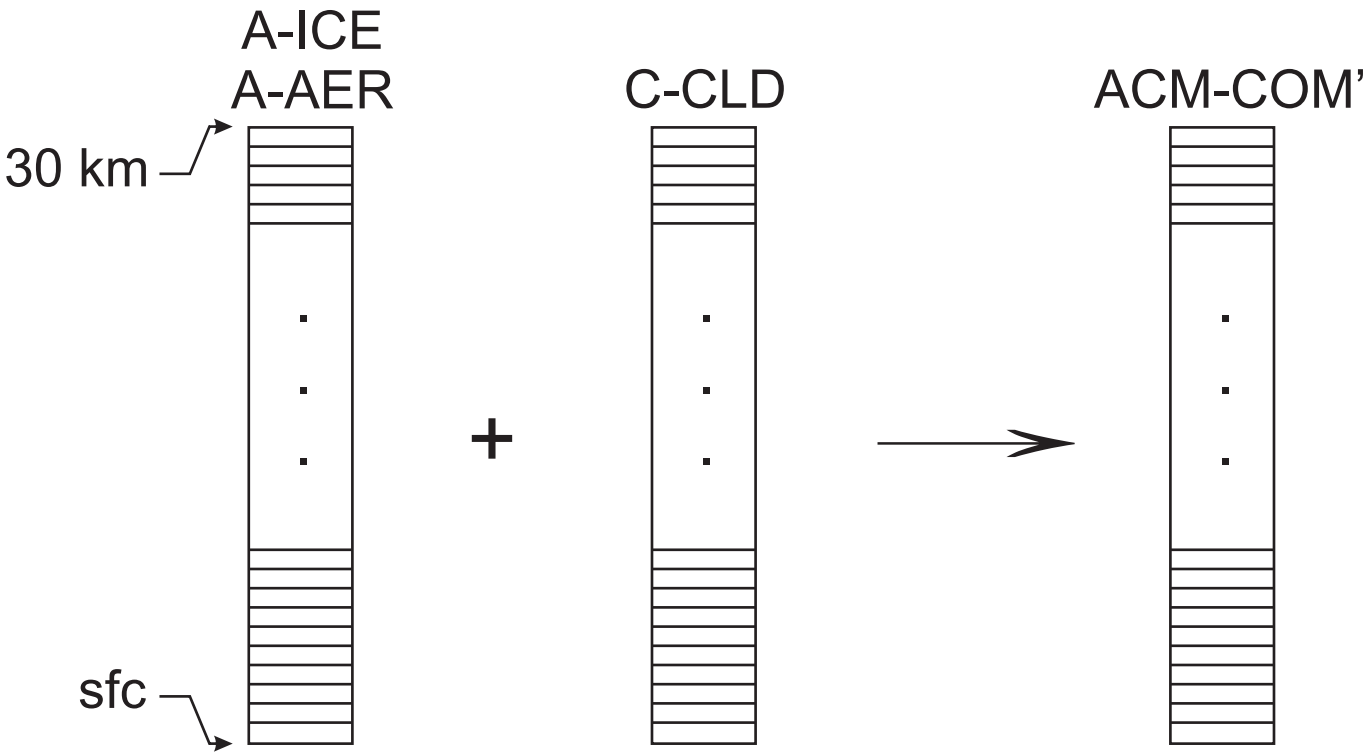
ACM-COM

- Prepare surface-atmosphere system for use in ACM-RT -

1. Create an L2a composite atmosphere (in addition to ACM-CAP)

- expected to be a step above NASA's C3M merged product (Kato et al. 2010)

- a ***simple*** fall-back 'best-estimate' if ACM-COM is not ready or fails



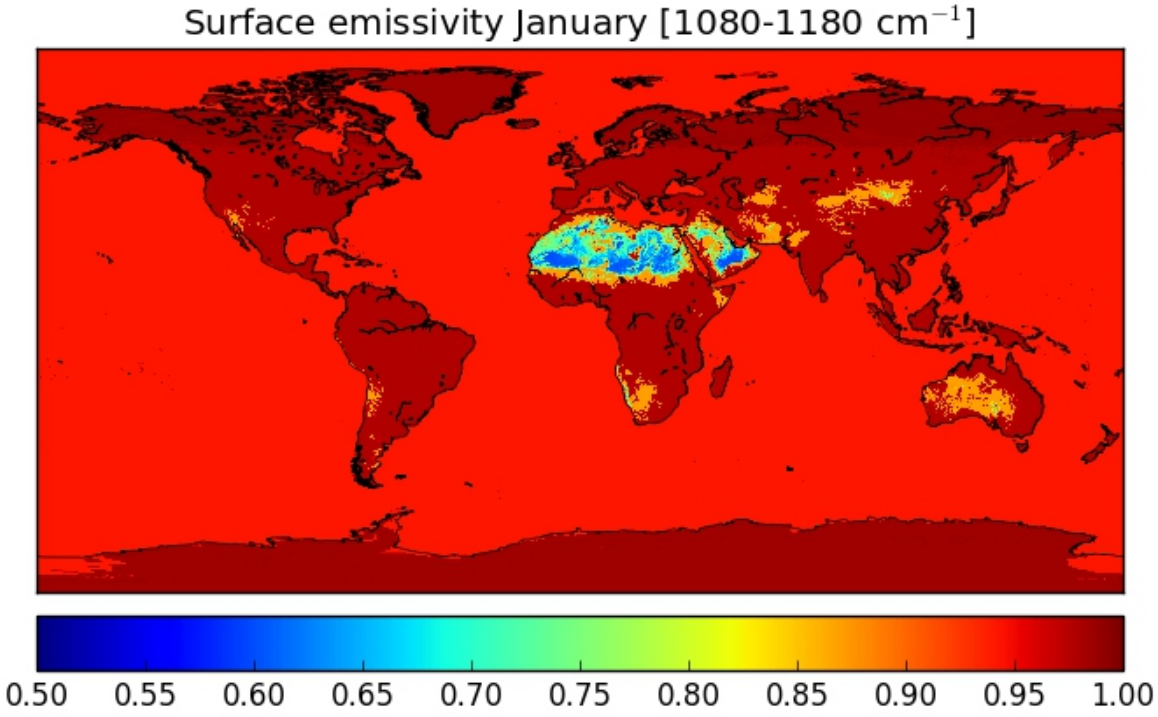
Kato, S., S. Sun-Mack, W. F. Miller, F. G. Rose, Y. Chen, P. Minnis, and B. A. Wielicki (2010), Relationships among cloud occurrence frequency, overlap, and effective thickness derived from CALIPSO and CloudSat merged cloud vertical profiles, *J. Geophys. Res.*, **115**, doi:10.1029/2009JD012277.

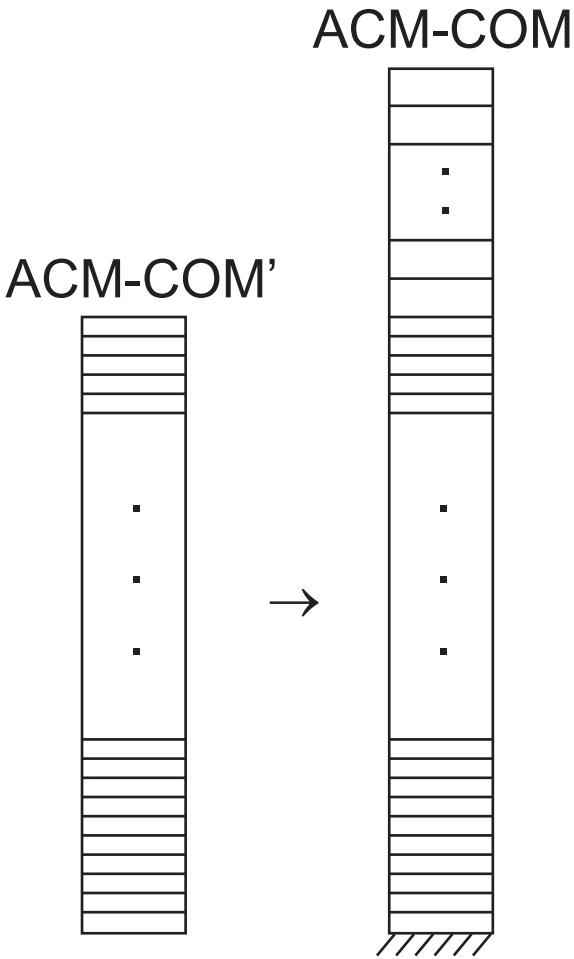
ACM-COM

- Prepare surface-atmosphere system for use in ACM-RT -

2. Prepare retrieved profiles for radiative transfer calculations (ACM-RT)

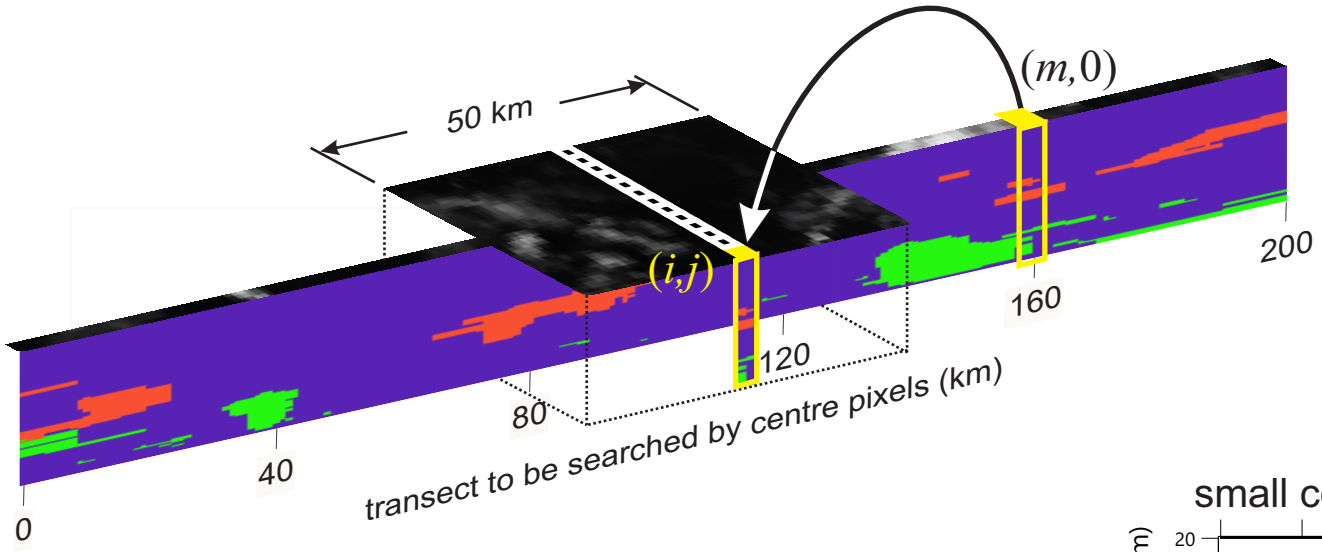
- extends profiles from 30 km up to ~80 km using ECMWF data (X-MET)
- 'climatological' profiles for various trace gases (static files)
- set-up surface optical properties (X-MET)
  - e.g., X. Huang (U of Michigan):

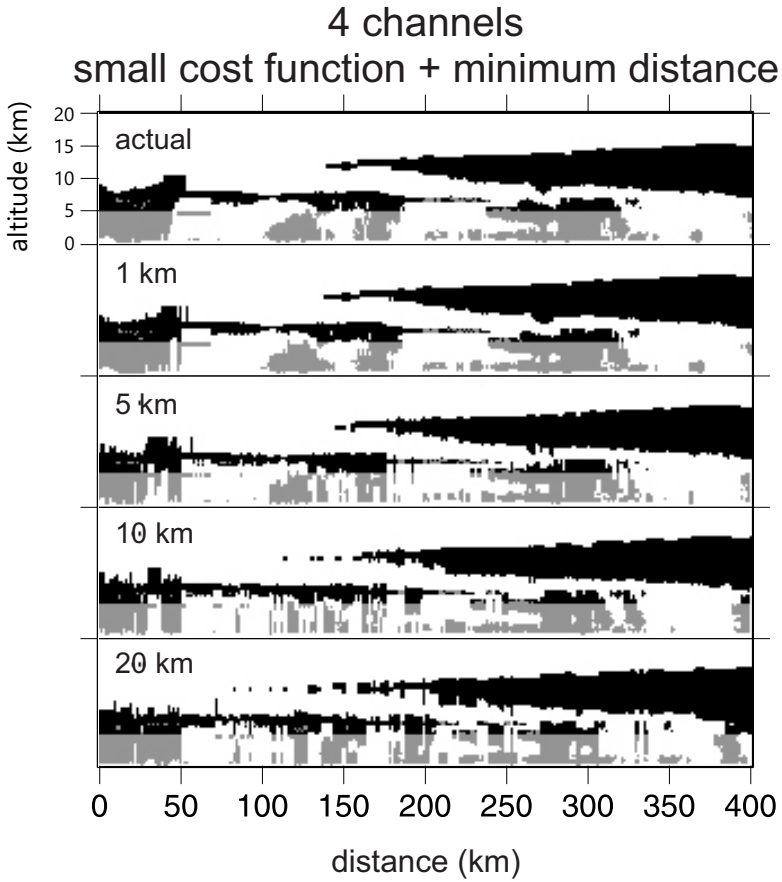




ACM-3D

- Scene Construction Algorithm -





1. produce 3D scenes for closure assessment
   - assessment domain selection algorithm
   - define “buffer-zones” for assessment domains

2. produce ordered list of assessment domains
   - 5 x 21 km
   - ACM-RT does as many as possible (3D RT)

3. approximate radiometric errors associated with the SCA

ACM-RT

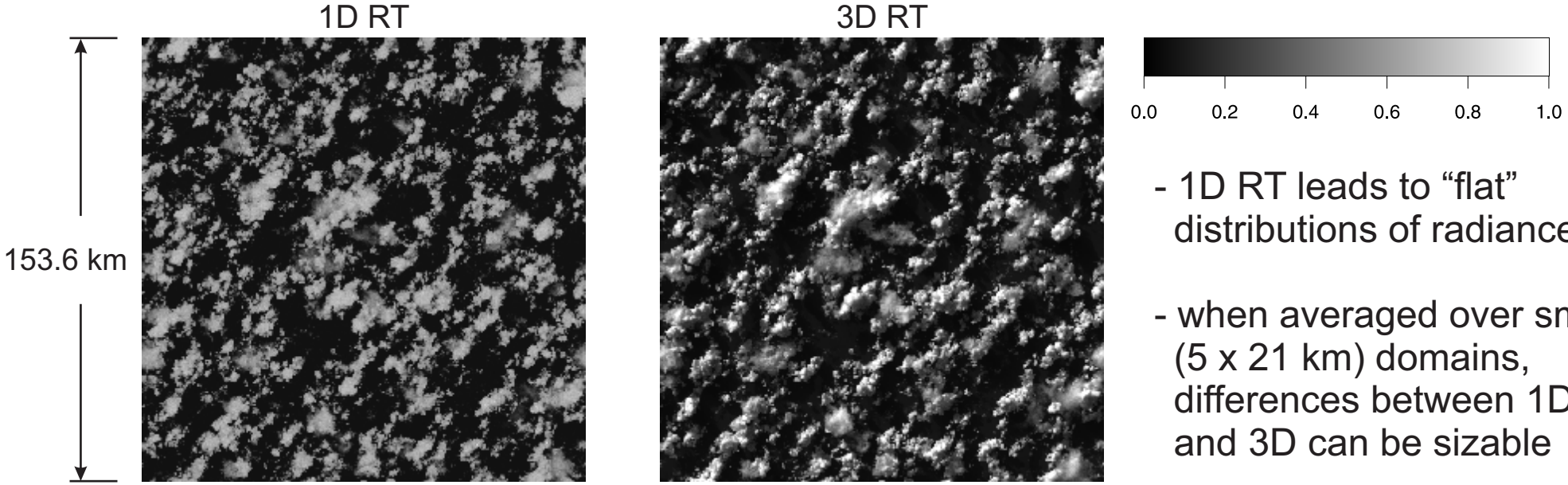
- 1D and 3D broadband fluxes and radiances -

- RRTMG; droplets = Mie functions; crystals = Yang et al.; multiple aerosol classes
- results for two atmospheres (ACM-COM's L2 composite and ACM-CAP) + 'diagnostic' pristine and clear-sky (i.e., including aerosols)
- 1D-TSA: for all L2 columns
- 3D RT
  - SW: flux profiles + BBR radiances via local estimation method (forward MC)
  - LW: flux at a defined level (see ACM-FLX) + BBR radiances (backward MC)
  - for as many assessment domains as time allows (see ACM-3D)
- Why 3D RT?...
  - radiances (and fluxes) for narrow assessment domains *D* are influenced by surface-atmosphere conditions outside *D...*

ACM-RT

- 1D and 3D broadband fluxes and radiances -

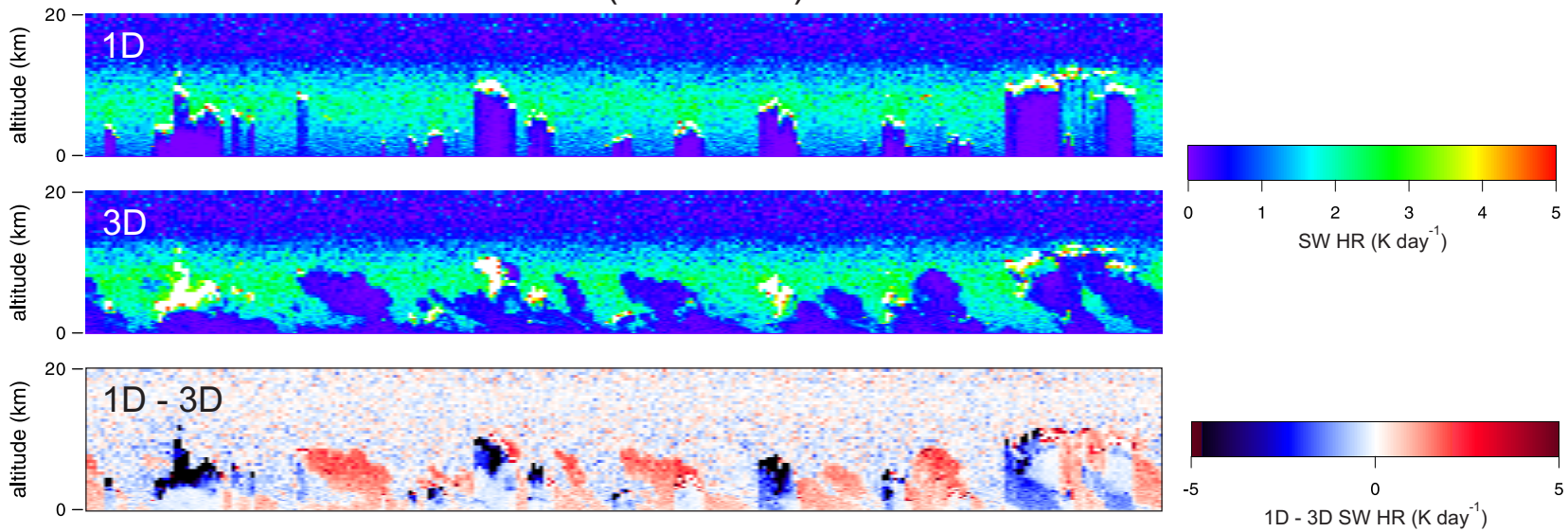
nadir SW reflectance



- 1D RT leads to “flat” distributions of radiances

- when averaged over small (5 x 21 km) domains, differences between 1D and 3D can be sizable

1D v. 3D (SZA = 60°)

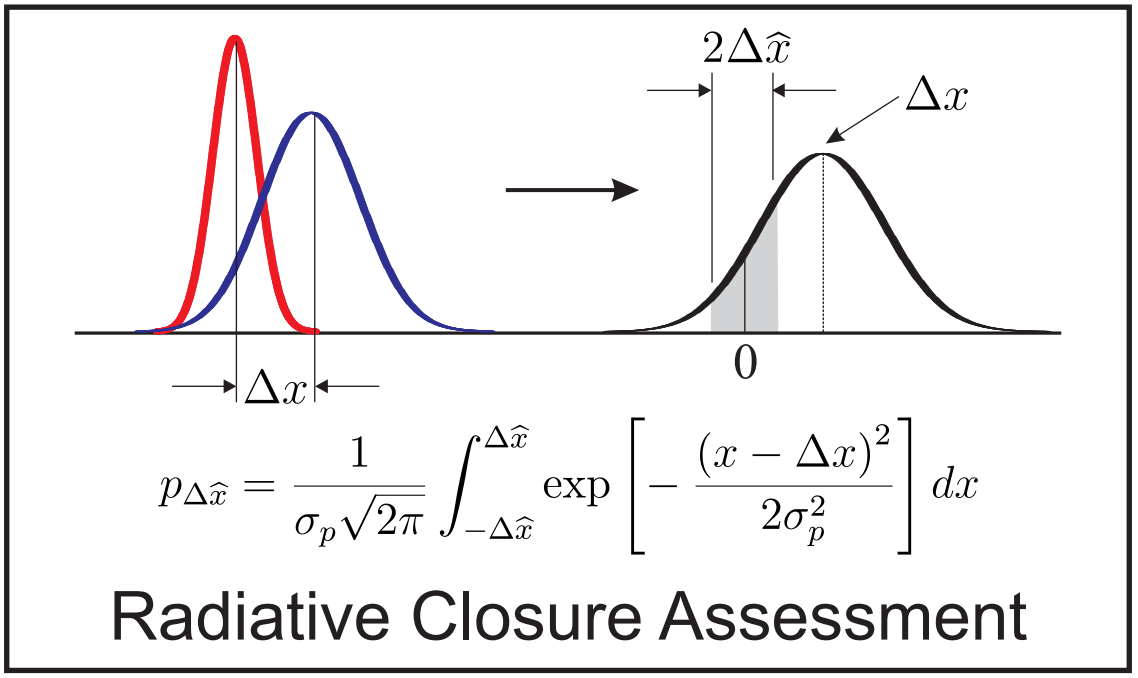


ACMB-DF

- Continuous radiative closure assessment -

- primarily an aid for algorithm developers (perhaps users will find it useful, too)

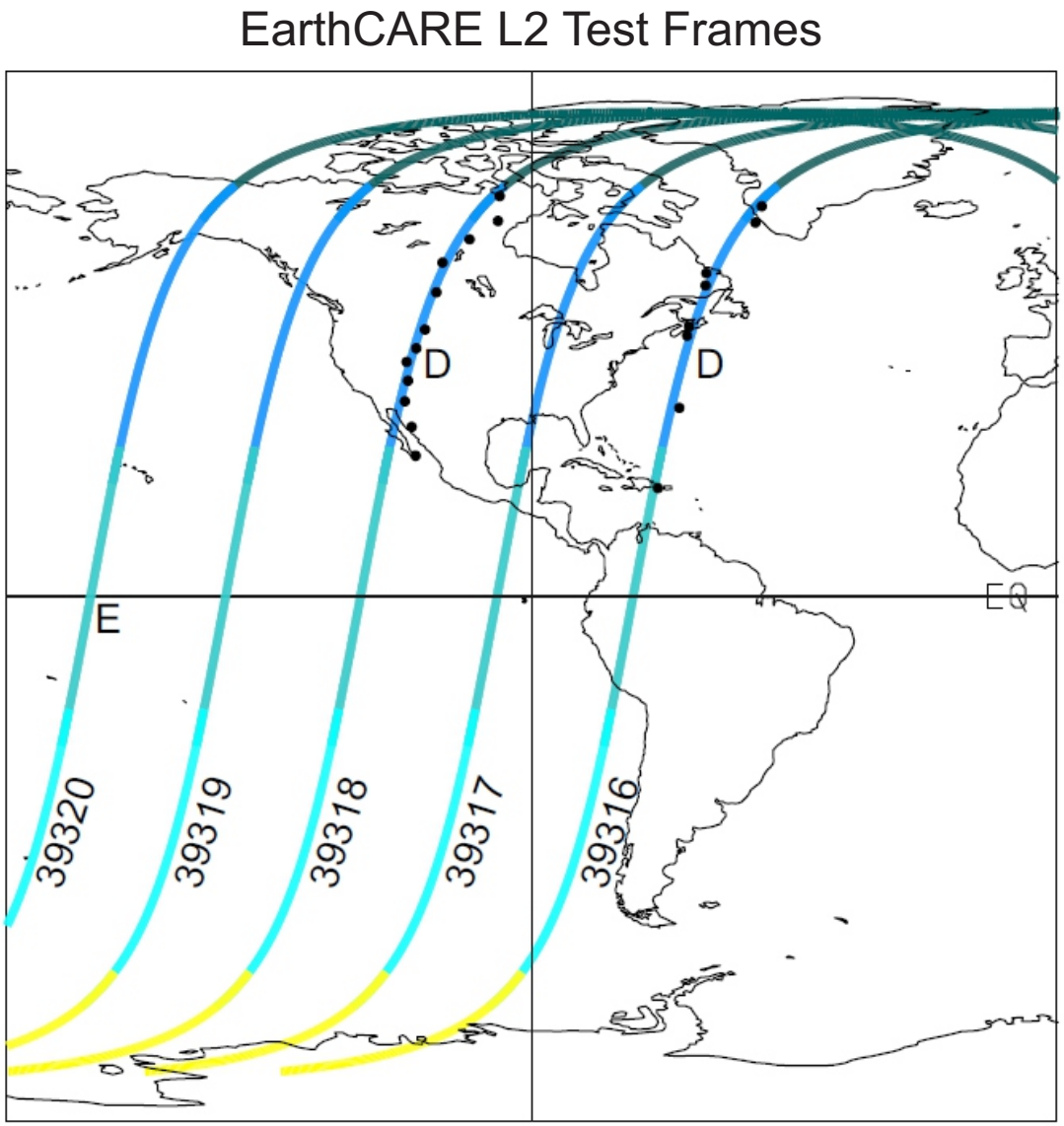
ACMB-DF



- while Δx might be < 10 W m^{-2}, how much does that say about goodness of retrievals?

- obvious need for as many sources of uncertainty as possible (radiances, ADMs, sfc-atmos conditions, SCA, RT models, retrievals...)

ACM-COM & ACM-3D - Halifax Scene



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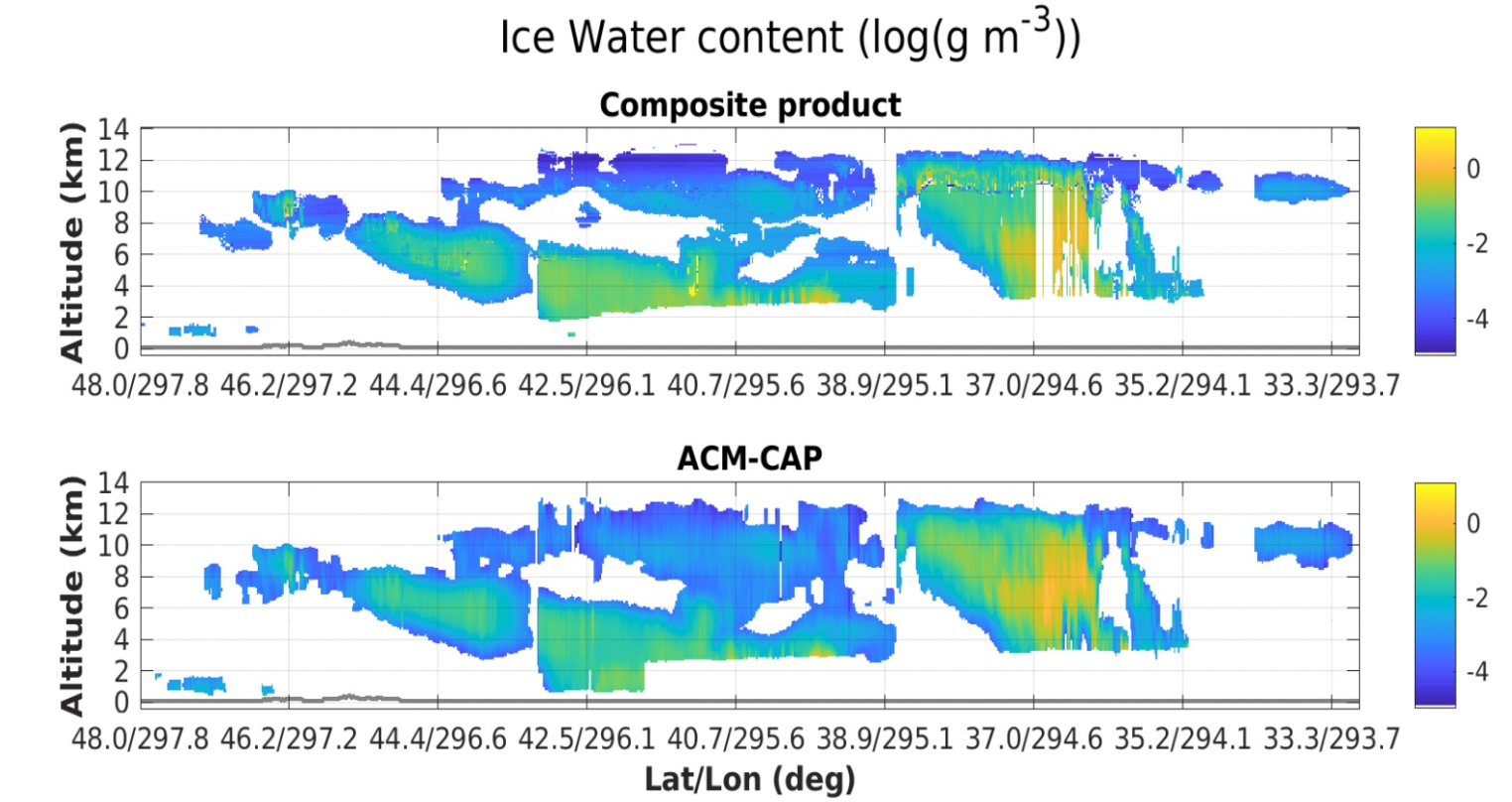

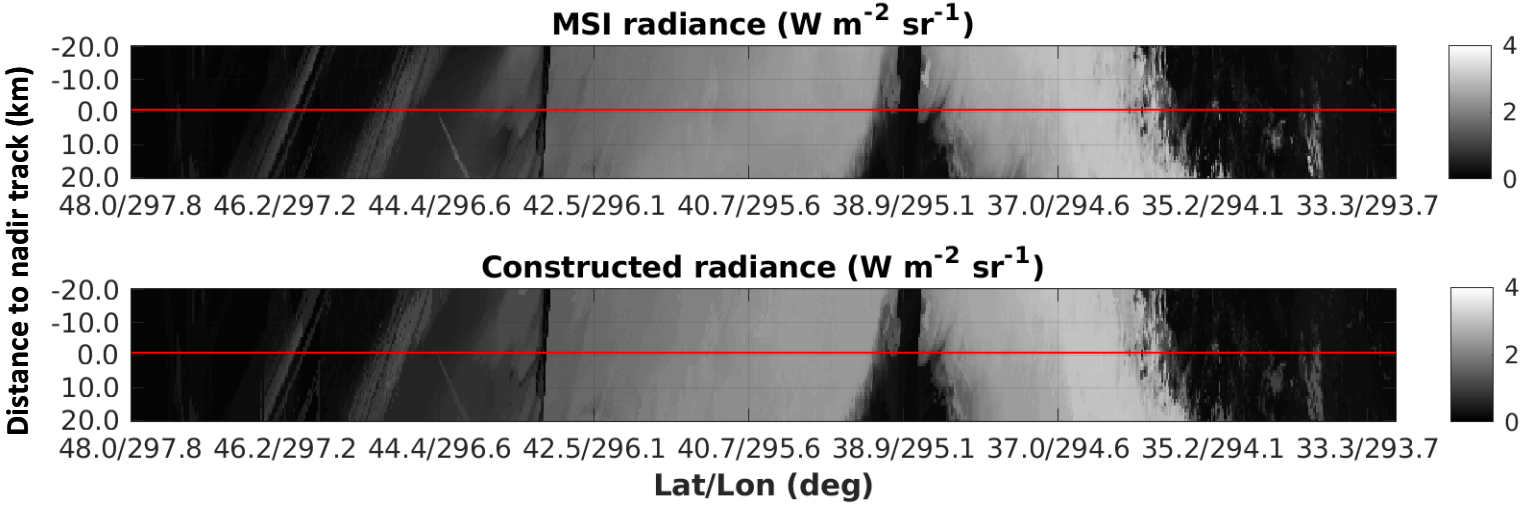

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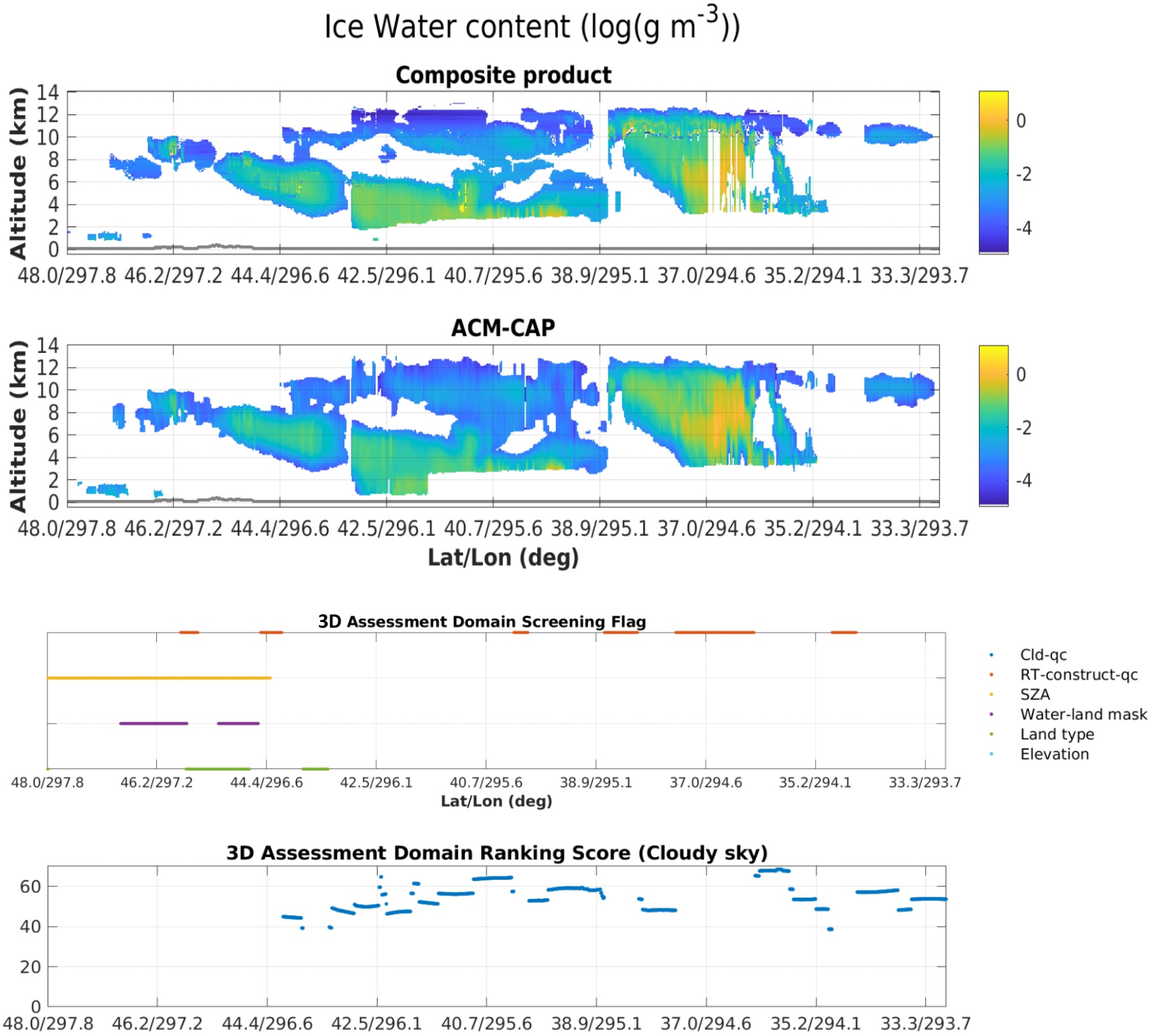
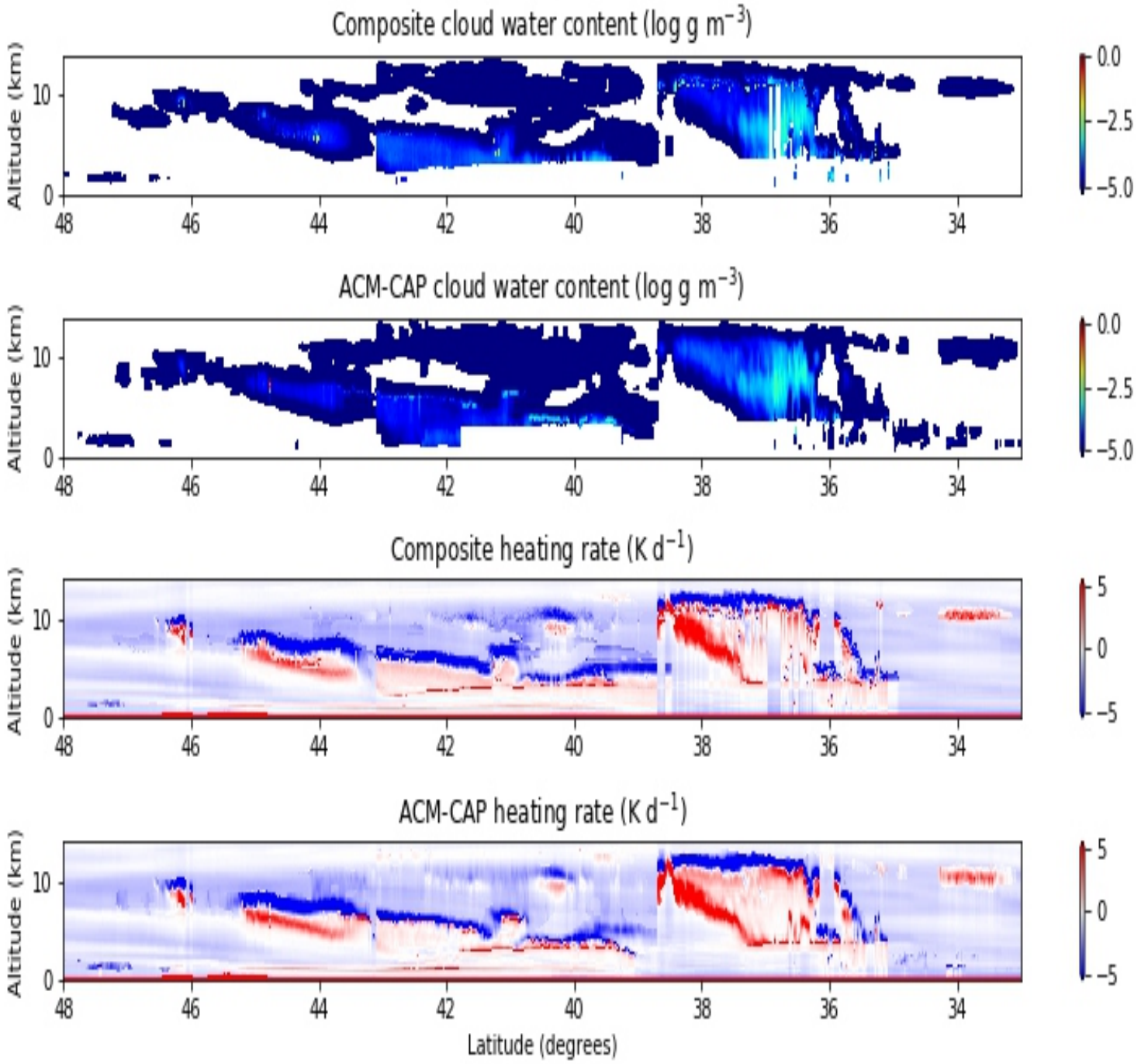
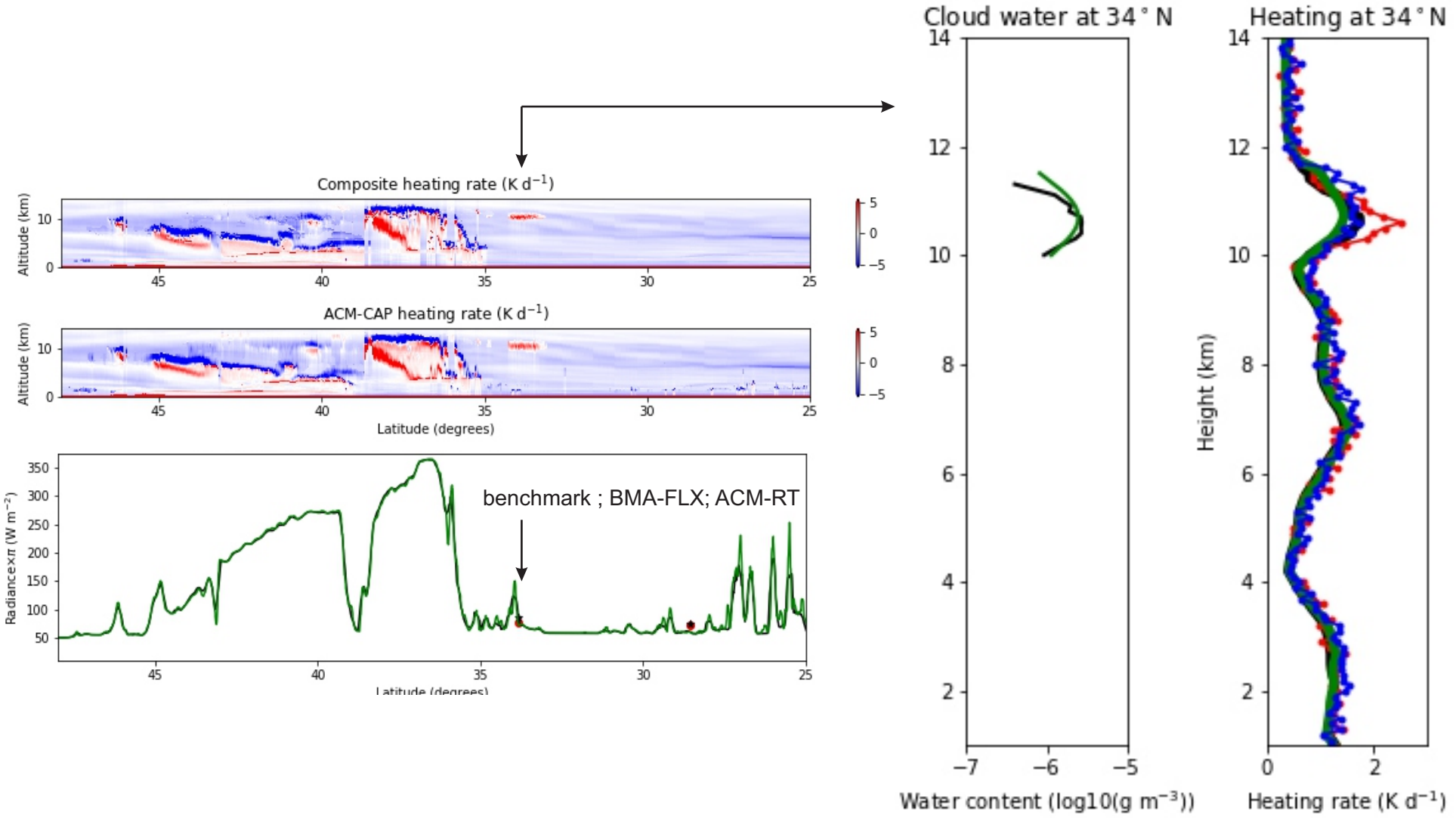


ACM-RT - Halifax Scene

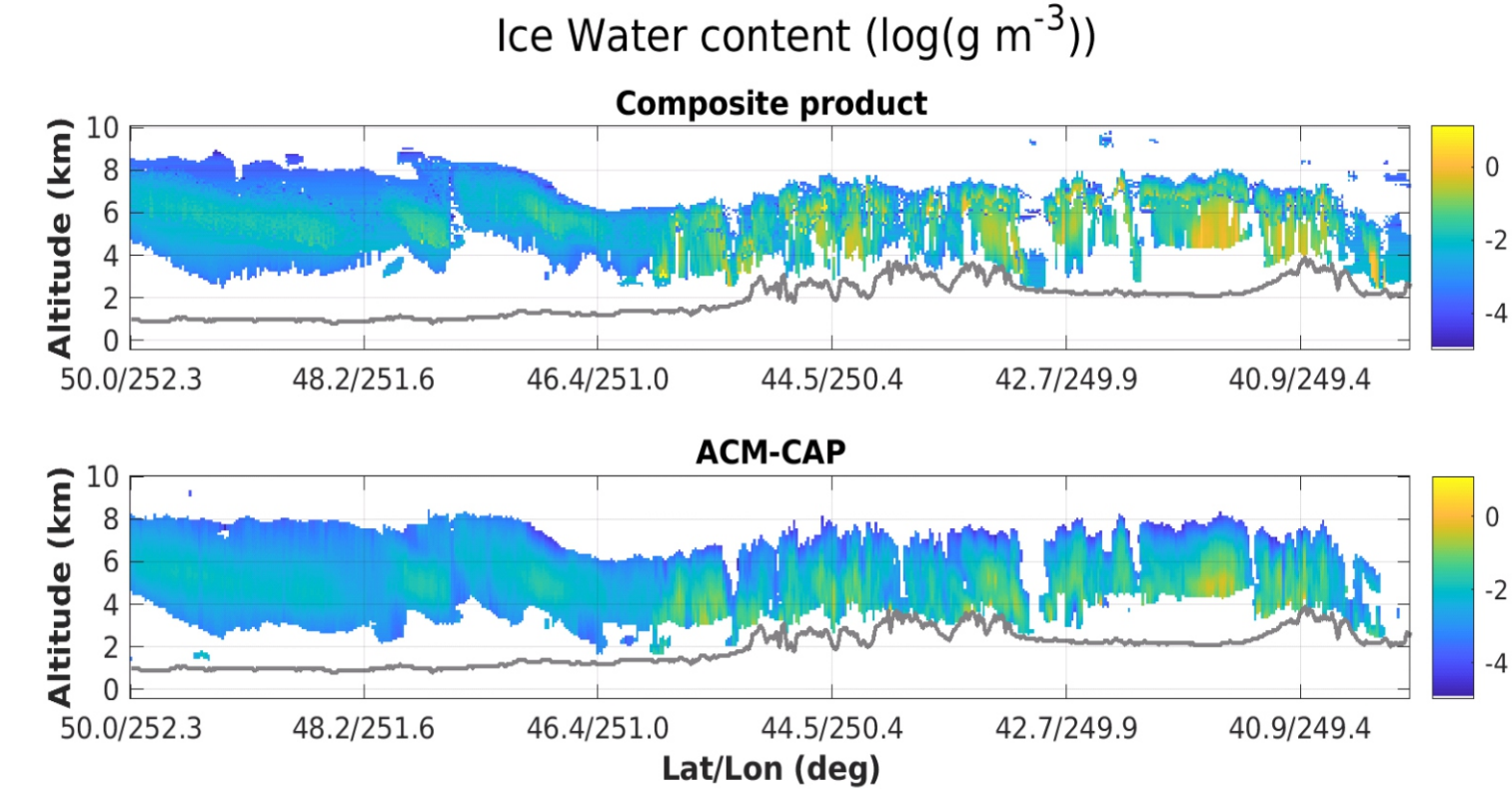


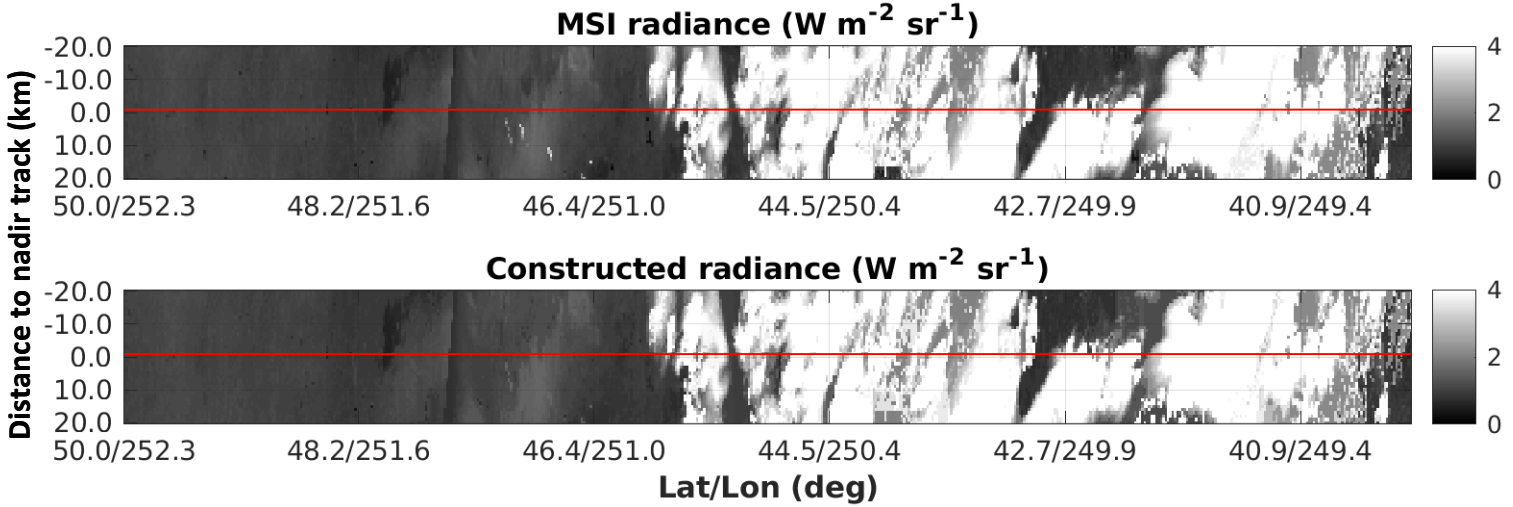
ACM-RT - Halifax Scene



3D RT: 1,000,000 photons / domain

ACM-COM & ACM-3D - Baja Scene





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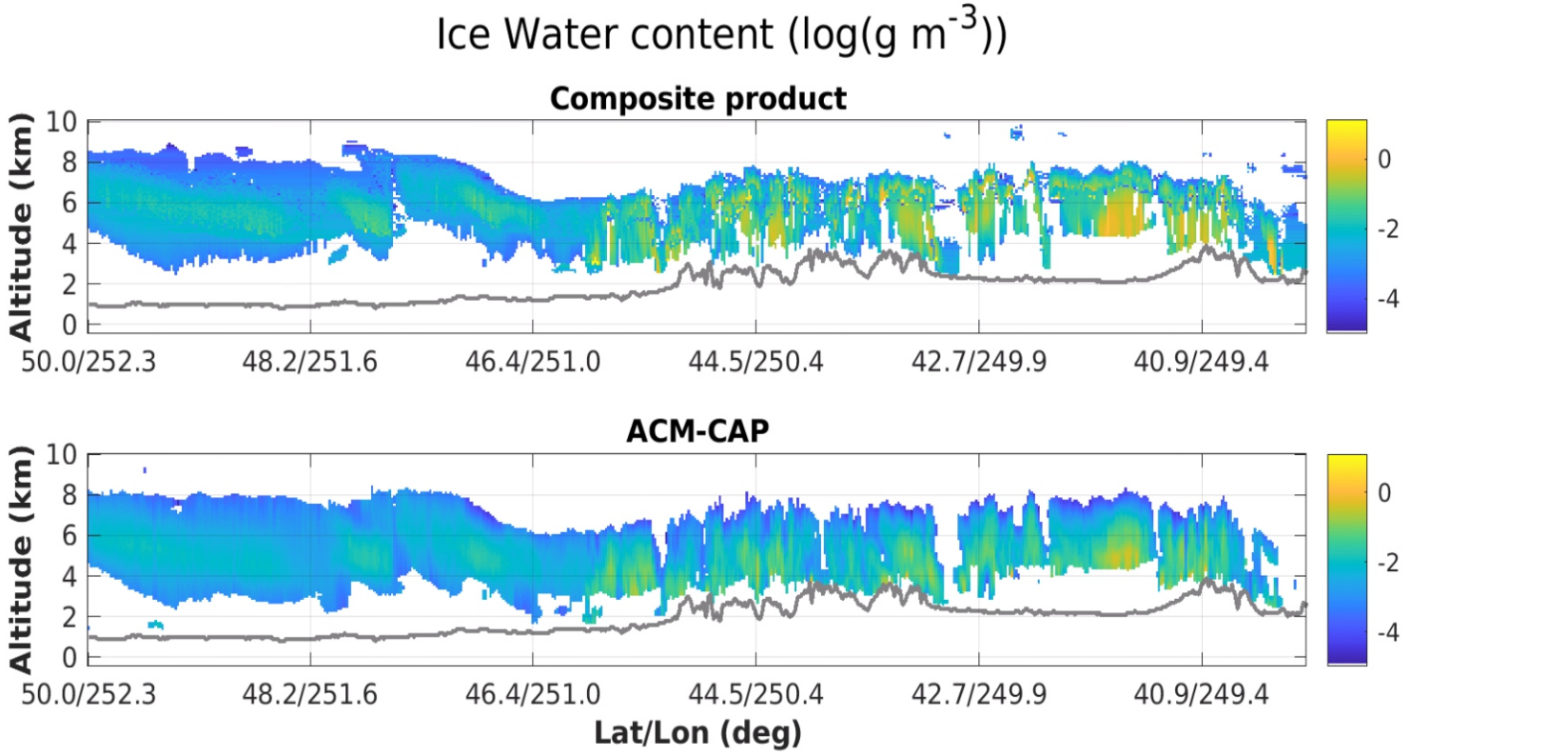

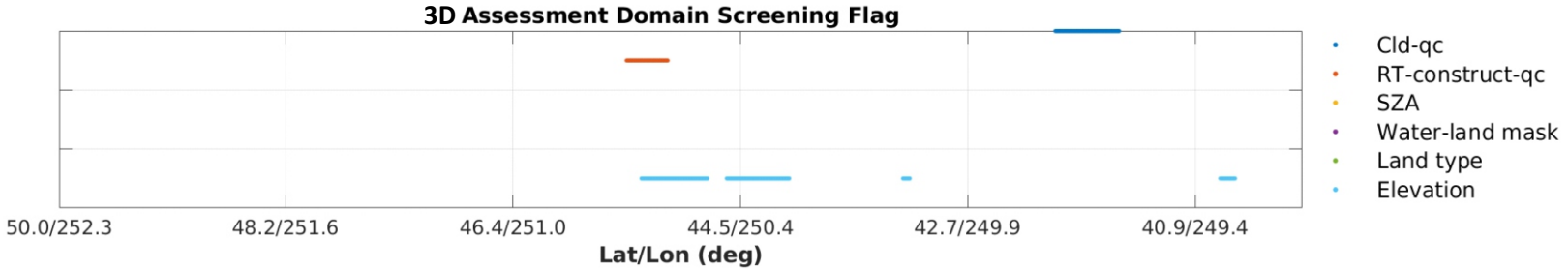

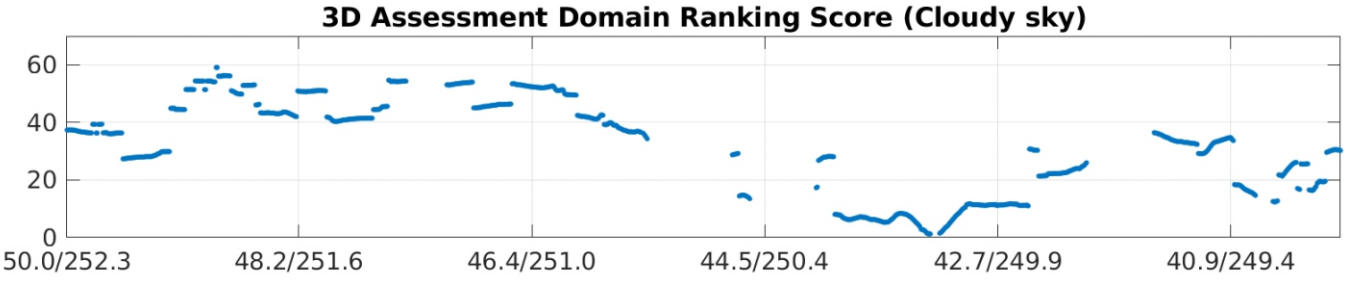

Summary

- **ACM-COM & ACM-3D**: Are working but requiring "stamps-of-approval" from others

    - rationale behind "alternate" to ACM-CAP
    - ranking assessment domains... commissioning phase v. regular operations
    - full application to all test scenes (3D RT for MSI and BBR "observations")

- **ACM-RT**: 1D and 3D RT models working (first "operational" use of 3D RT)

    - confirm usages of aerosol and surface optical properties
    - full application to all test scenes

- **ACMB-DF**:

    - include uncertainties (where possible)
    - full application to all test scenes
    - pre-launch assessment of achievement of EarthCARE's "goal" (< 10 W m^{-2} at TOA)

    - resource-limited number of assessment domains due to SW Monte Carlo...
        - had been assuming $O(10^6)$ photons / domain...
        - $N_p < \alpha(1-\alpha)(S_0\mu_0 / \Delta F)^2$
        - α = 0.3, μ_0 = 0.7, ΔF = 2 W m^{-2}... N_p = 50,000... 20x more throughput!
            - noisy HR profiles, but good (and many) TOA assessments