Modelling and Measuring Atmospheric Radiative Heating Profiles

Howard W. Barker
Environment Canada

Warren (Oct 15/2006):

“We need perhaps 100 to 1000 times as much radiative heating profile data ... before we can comfortably say "case closed" on our radiation model parameterizations for climate models.”

- still very much in the validation and verification (V & V) phase

1. intrinsic V & V: models only (ICRCCM, I3RC, RAMI)

2. extrinsic V & V: models compared to observations (BBHRP)

Validation and Verification of RT Codes

The existing paradigm: Intrinsic V & V

Stage 2

- verify 3D codes (non-LBL) against LBL for simple cases

  - parametrization of gaseous transmittance & single-scattering properties
  - verify 3D codes among themselves

Stage 3

- verify GCM-style codes against 3D codes for simple cases

  - radiative transfer & parametrizations

Stage 4

- verify GCM-style codes against conditional benchmarks

Stage 5

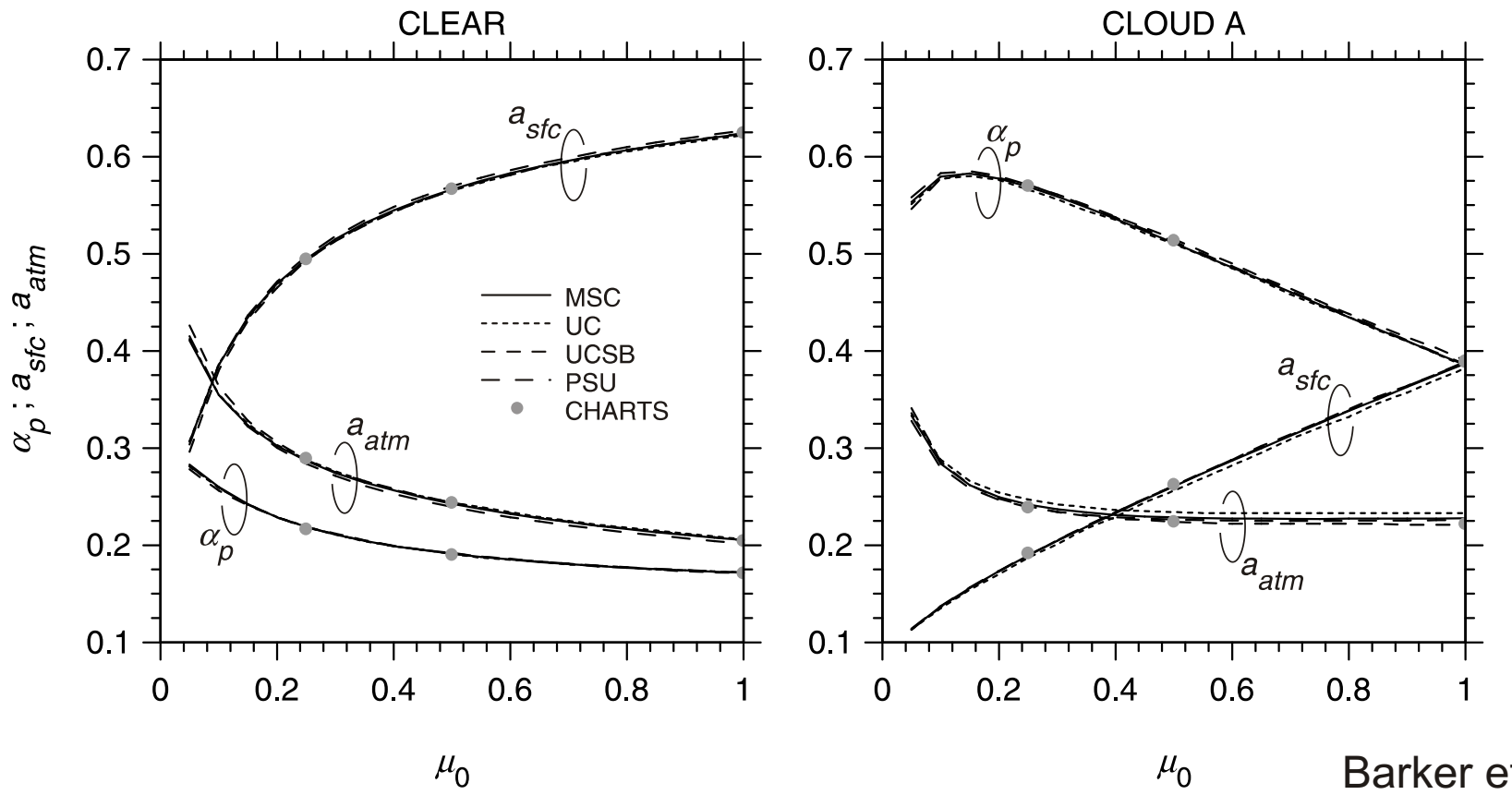
- verify conditional benchmarks against full 3D benchmarks

Validation and Verification of RT Codes

Stage 2: Verify 3D codes (non-LBL) against LBL (simple cases)

- idealized or realistic atmospheres

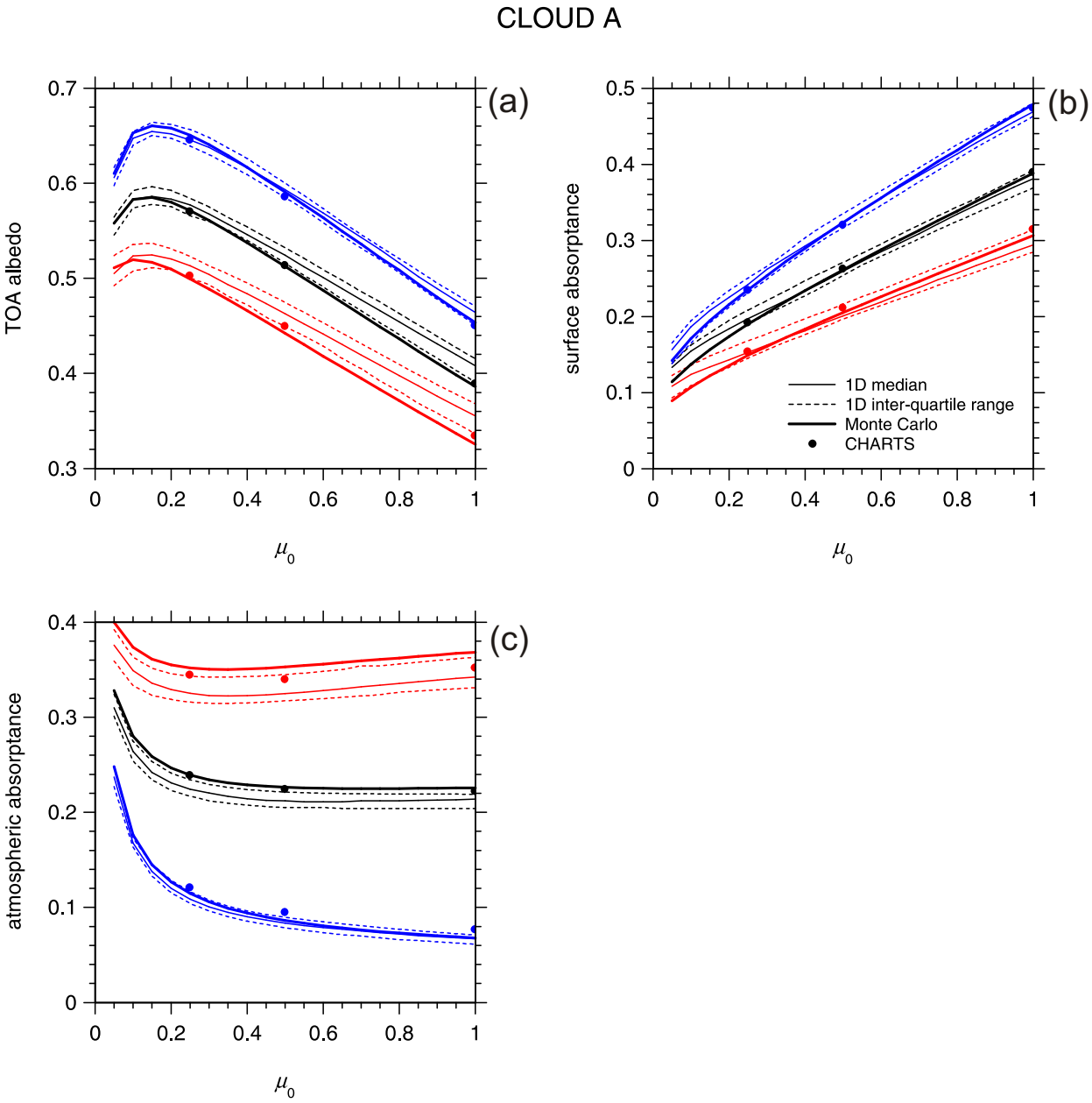
  - 3D codes to be used for verification for realistic cases



Barker et al. 2003

Stage 3: Verify GCM-style codes against 3D codes (simple cases)

- verifies more extensive parametrizations and simple RT



Barker et al. 2003

Stage 4: Verify GCM-style codes against conditional benchmarks

- verifies whether 1D codes are doing as expected

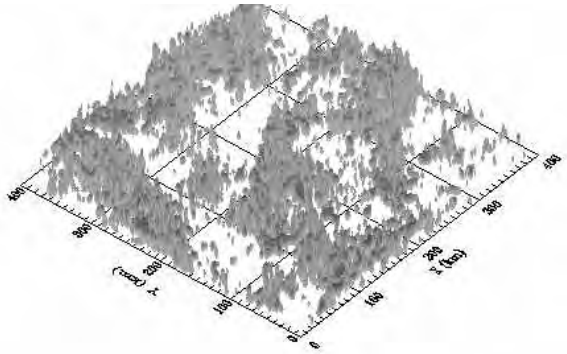
  - how well do they address unresolved cloud-radiation interactions?

- conditional benchmarks:

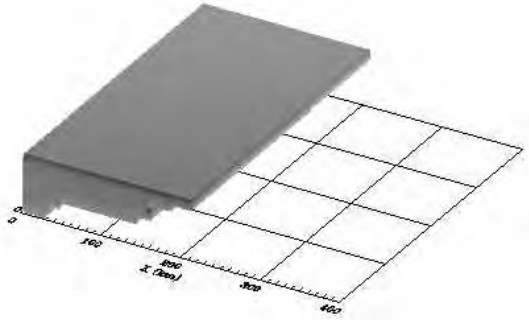
  - 3D domains (from CSRMs) degenerated to 1D input

  - stochastic generation of 1D field ; apply 3D code in ICA mode

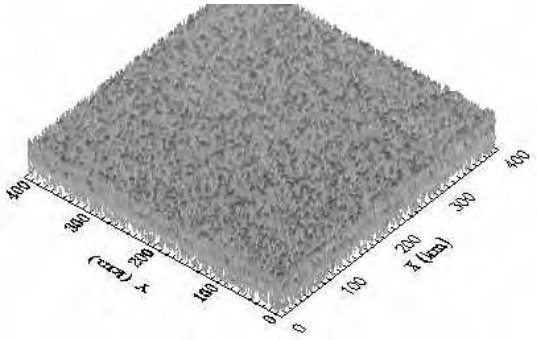
full variability



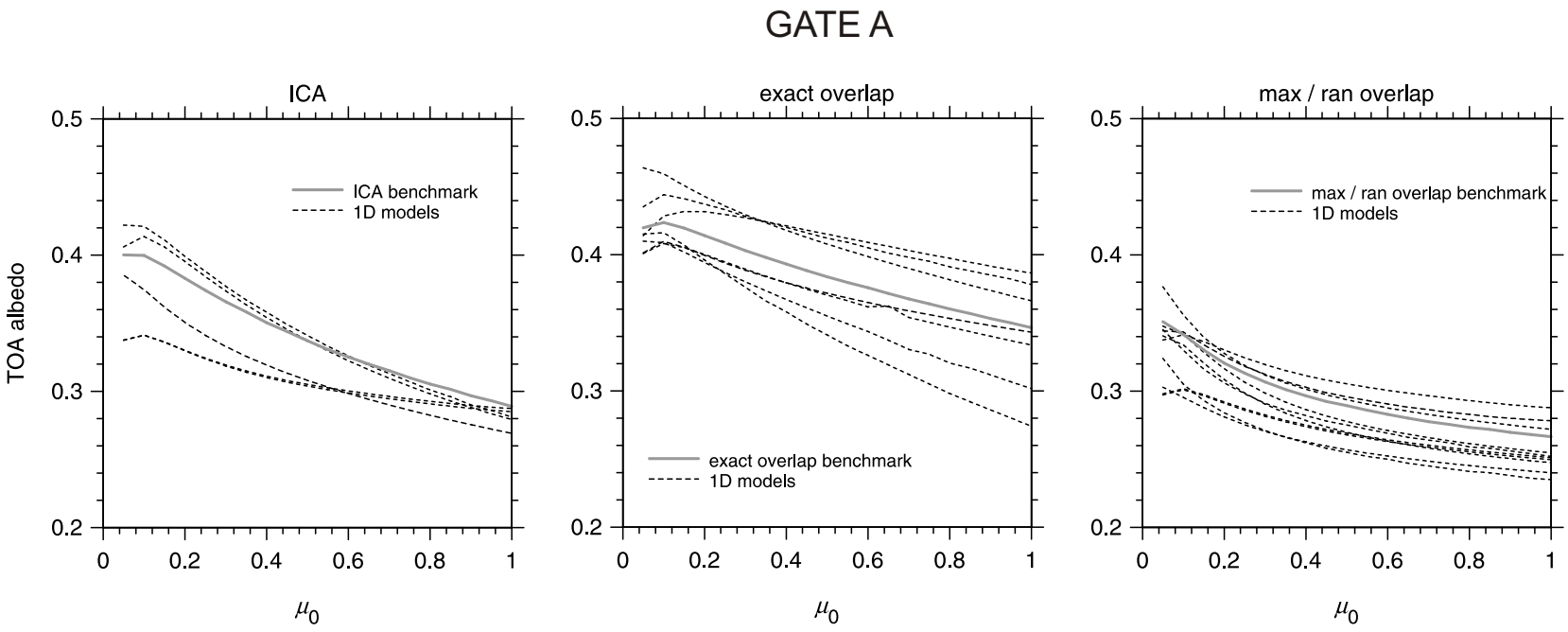
maximum overlap

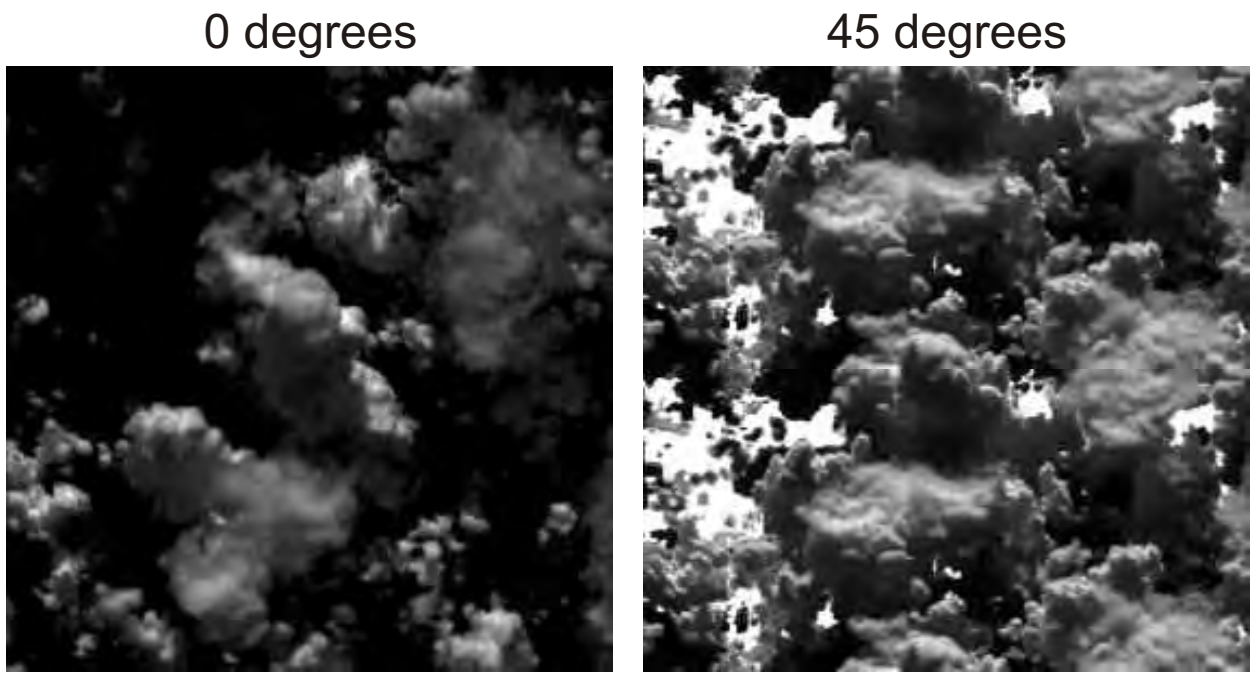


random overlap



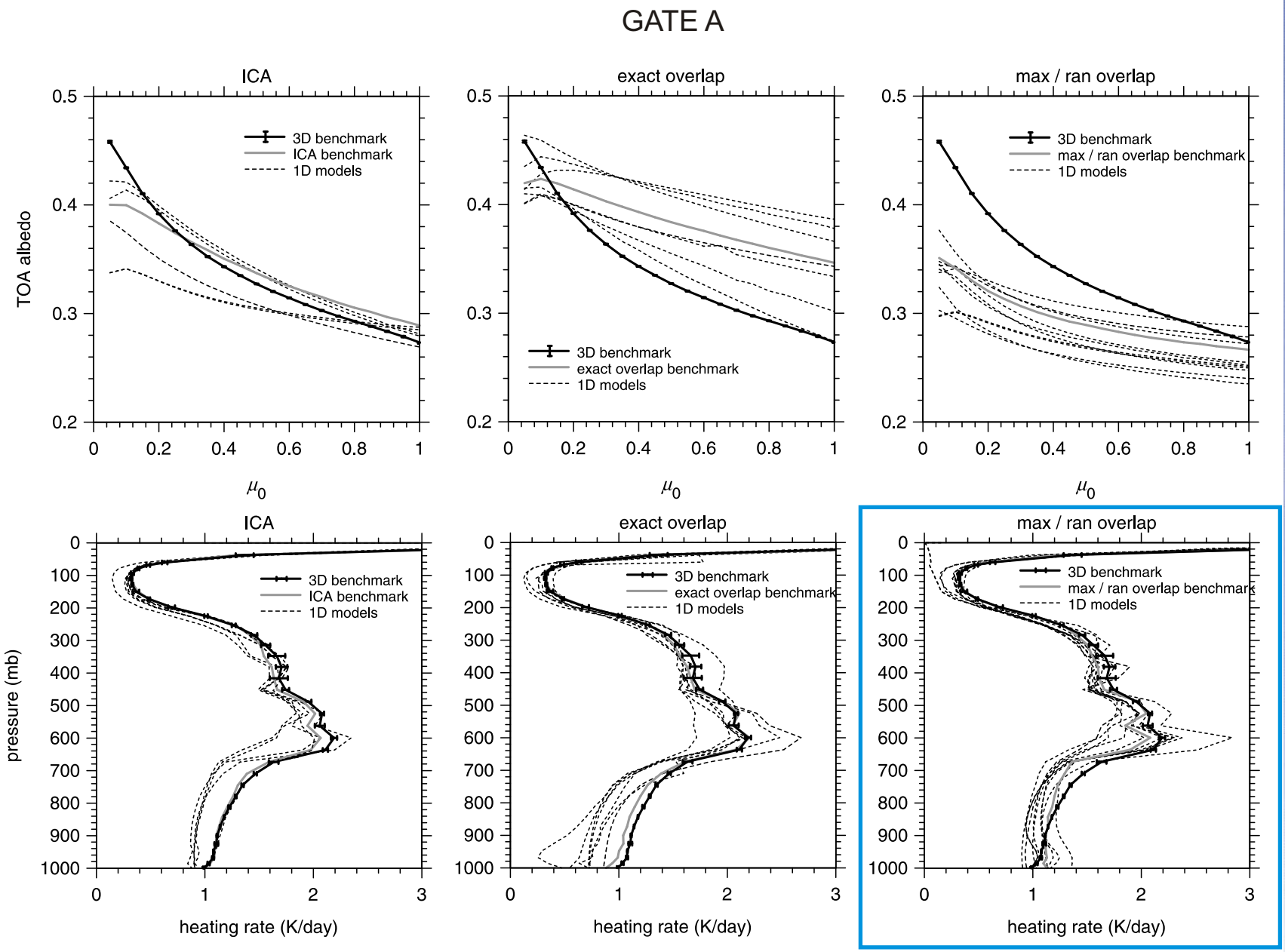
Stage 4: Verify GCM-style codes against conditional benchmarks





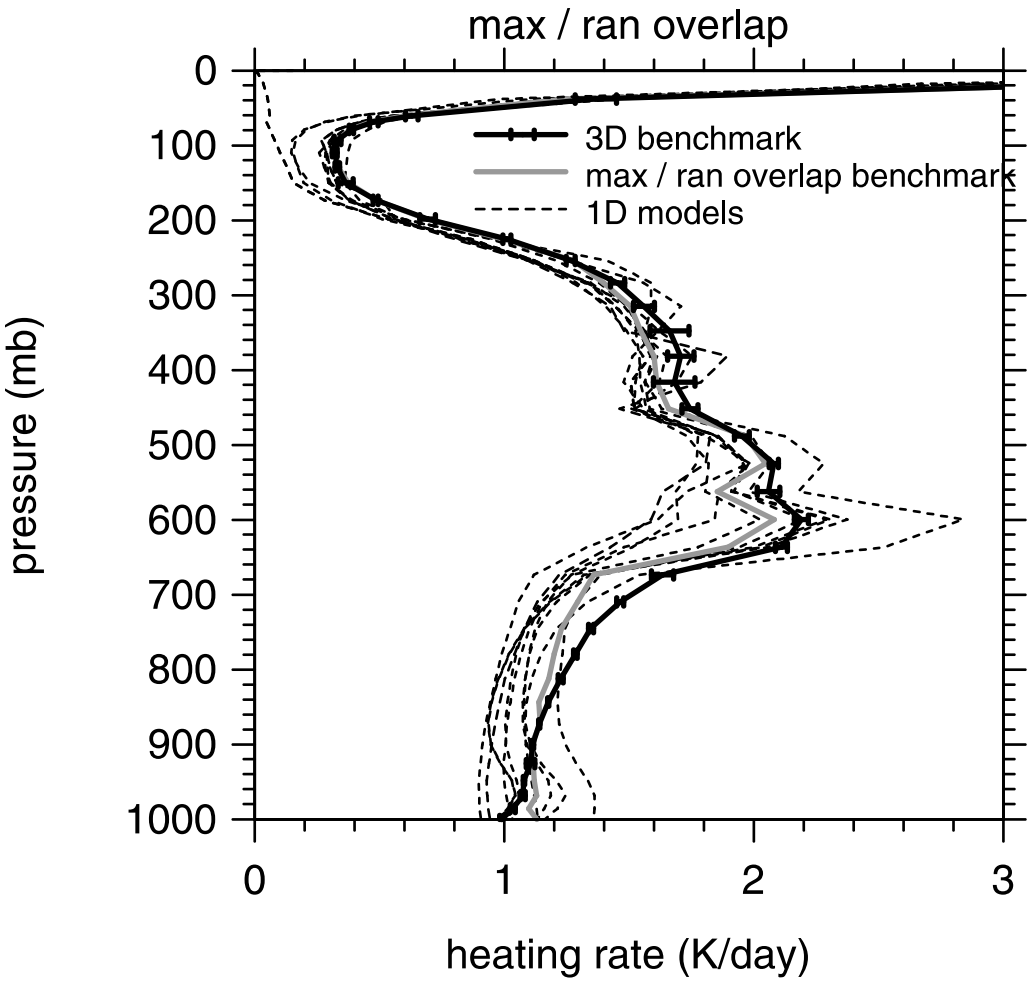
Barker et al. 2003

Stage 5: Verify conditional benchmarks against full 3D benchmarks



Barker et al. 2003

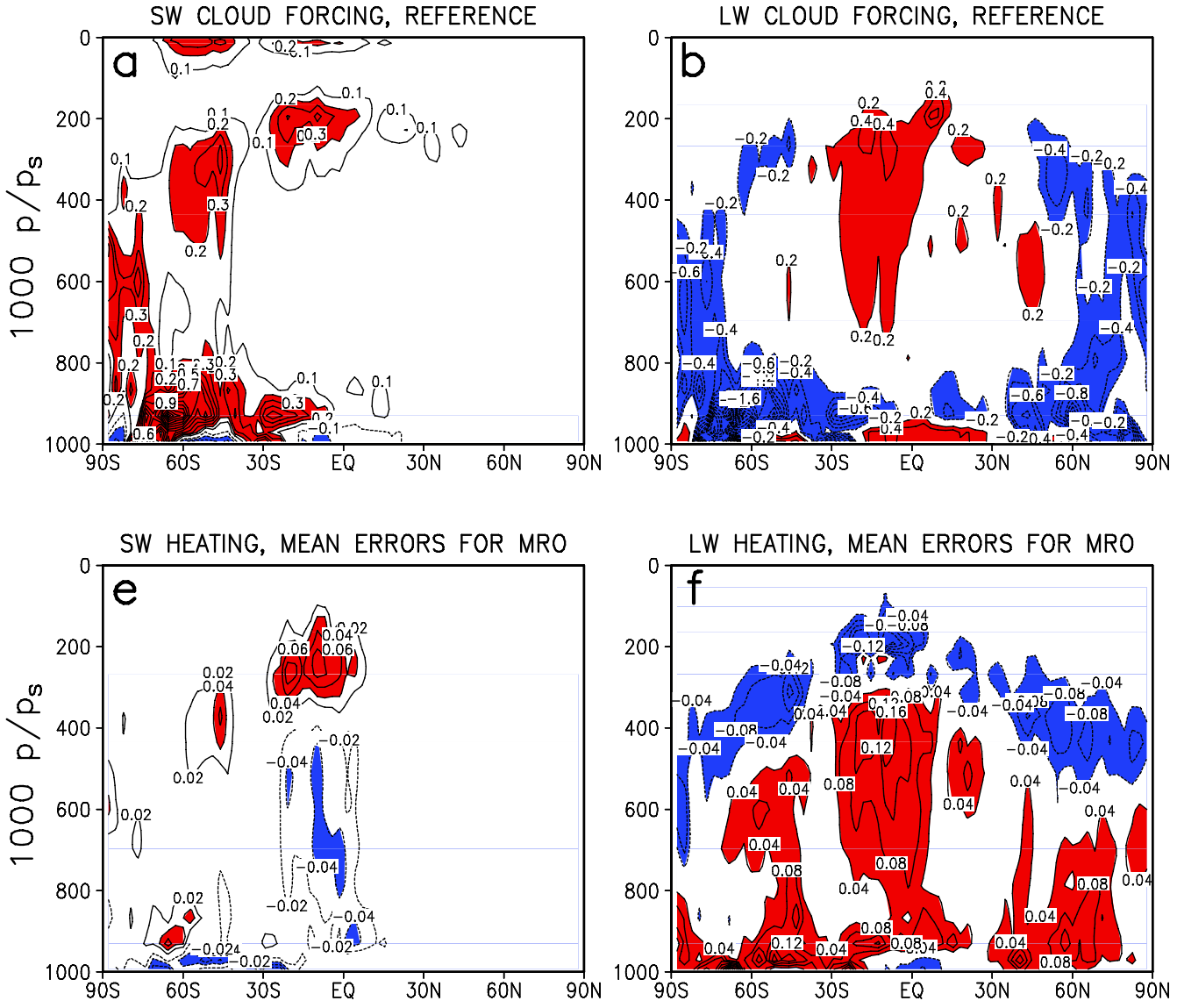
Stage 5: Verify conditional benchmarks against full 3D benchmarks



even if max / ran is correct, out by ~10%

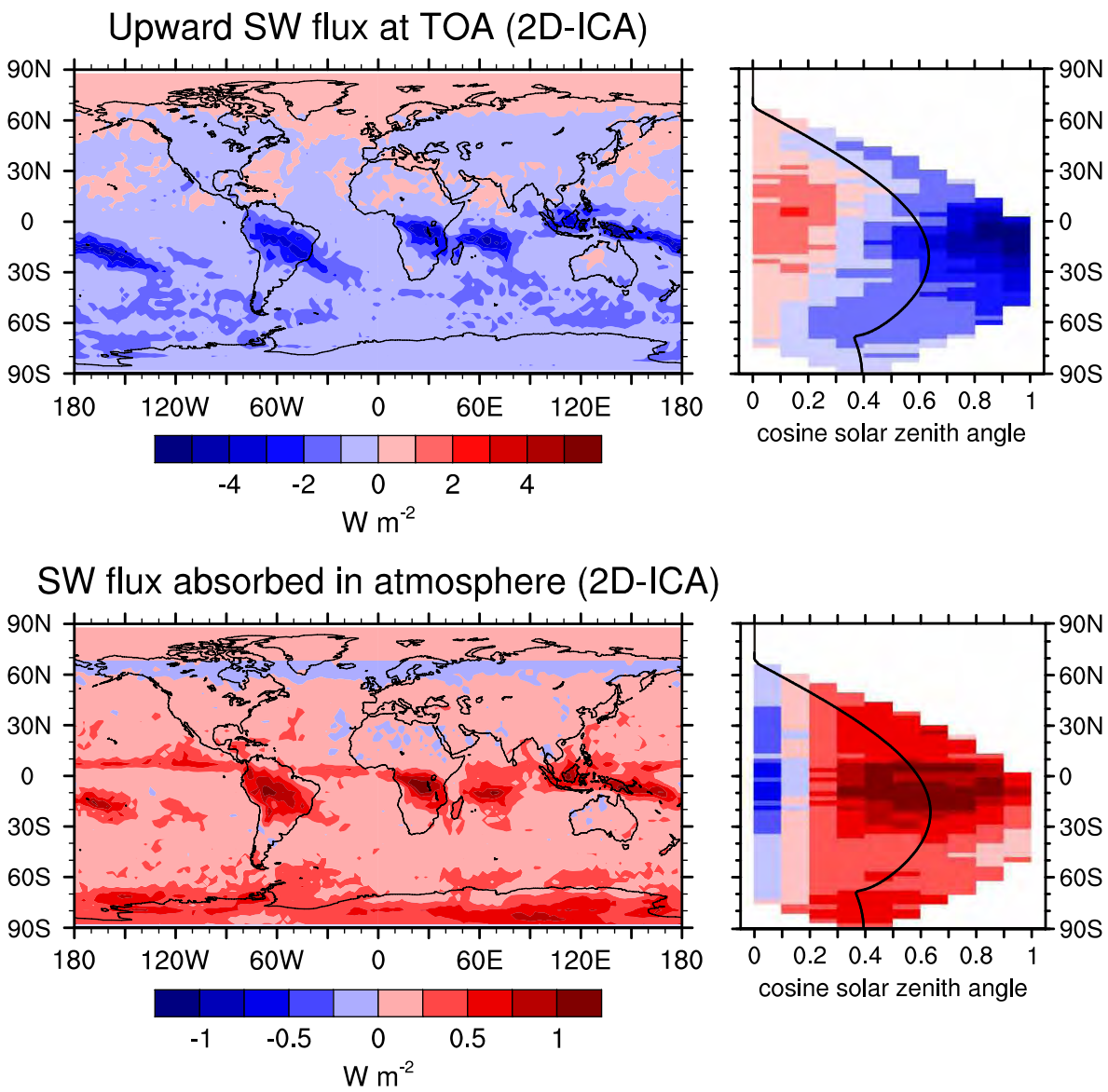
(for this *pathological* case)

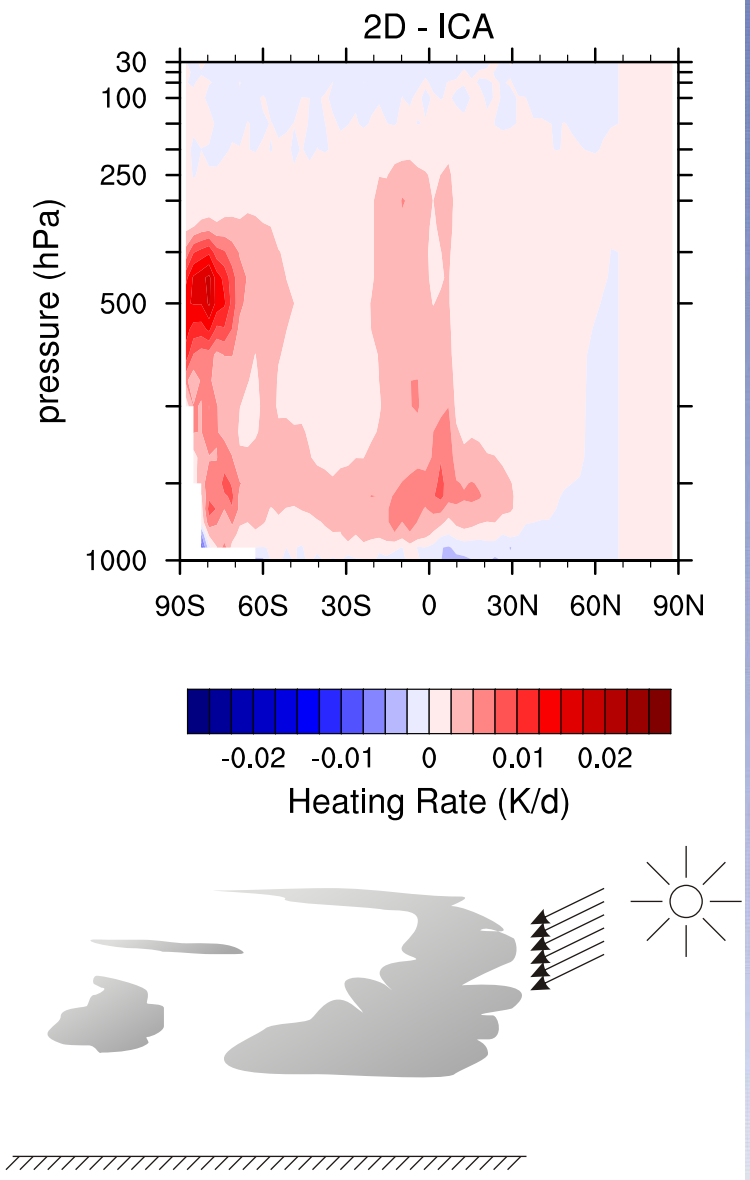
Stage 5: Verify conditional benchmarks against full 3D benchmarks



- data from MMF-GCM (4 km)

Stage 5: Verify conditional benchmarks against full 3D benchmarks





- data from MMF-GCM (4 km)

Cole et al. 2005

Extrinsic Validation and Verification of RT Codes *and* Information

Stage 1

- validate LBL codes using ***observations*** $\Rightarrow$ closure for simple cases

- clear-skies + 'homogeneous' overcast clouds

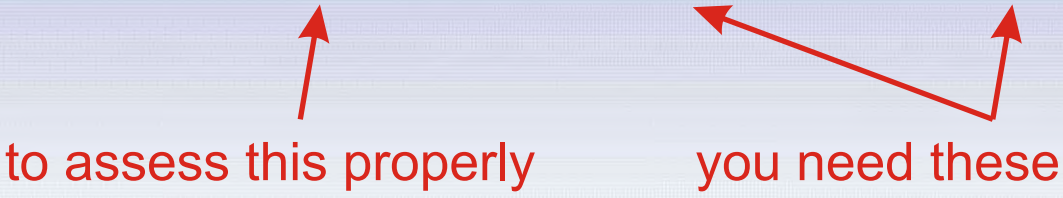
e.g., Mlawer et al., 2000: *Geophys. Res. Lett.*, **27**, 2653-2656.

- Is it sufficient, and reasonable, to stop here?... intrinsic V & V thereafter?...

- *observations* of HR profiles (fluxes) aren't too useful on their own...

- profiles of coincidental observed/inferred atmospheric states are needed too

RT algorithm (information) --> HR (flux) profile



Extrinsic Validation and Verification of RT Codes *and* Information

- under what conditions can we expect to get good obs of HRs and conditions?

1. clear-skies: ‘simple’ ascent/decent of a single plane

2. ‘homogeneous’ clouds: ‘simple’ ascent/decent of a single plane

3. ???

suggestion: **Use ARM simulator before investing too much into observations**

- derived from the EarthCARE simulator

- surface; aircraft; satellite platforms
- spectral and BB fluxes and radiances (3D)
- lidar (3D multiple scattering)
- CPR
- MWR
- ...

Extrinsic Validation and Verification of RT Codes *and* Information

phase I

- intrinsic model verification: ICRCCM, I3RC, RAMI
- have we reached the end... are we happy?

phase II

- extrinsic model validation: CIRC (BBHRP)
- are HR profiles needed... have we exhausted efforts with fluxes?
- assuming HR profiles are needed:
  - can we expect to measure them with sufficient accuracy?
  - under what conditions can they be useful (including res.)?