CIRC: Update and status

Lazaros Oreopoulos[1], Eli Mlawer[2], Jennifer Delamere[2], Timothy Shippert[3]

[1]JCET-UMBC and NASA-GSFC, Greenbelt, MD, USA

[2]AER, Lexington, MA, USA

[3]PNNL, Richland, WA, USA

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Refresher: What is the Continual Intercomparison of Radiation Codes (CIRC)?

- RT model intercomparison aspiring to become the standard for documenting the performance of RT codes used in Large-Scale Models
- Supported by ARM and endorsed by GRP and IRC
- Goal is to have RT codes of GCMs (incl. IPCC) report performance against CIRC
- Phase I was launched on June 4, 2008

How CIRC differs from previous intercomparisons:

- *Observation-tested* (LW) LBL calculations are used as radiative benchmarks
- Benchmark results are publicly available
- Observationally-based input (from BBHRP, mostly)
- Flexible structure and longer lifespan than previous intercomparisons

CIRC website

http://www.circ-project.org

Climate and Radiation Branch

NASA | Goddard | Lab for Atmospheres

CIRC: Continual Intercomparison of Radiation Codes

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What is CIRC?

CIRC is in many respects the successor to the seminal ICRCCM (Intercomparison of Radiation Codes in Climate Models) effort that spanned the late 80's - early 00's. CIRC distinguishes itself from ICRCCM by its emphasis on using observations to build its catalog of cases. It is intended as an evolving and regularly updated reference source for GCM-type radiative transfer (RT) code evaluation, and similar to ICRCCM, its goal is to contribute to the improvement of solar and thermal RT parameterizations. CIRC is supported by DOE's Atmospheric Radiation Measurement (ARM) program and endorsed by the GEWEX Radiation Panel (GRP) and IAMAS's International Radiation Commission (IRC). More information on the rationale behind CIRC can be found here. The invitation letter that launched Phase I on June 4, 2008 is available in this page.

Register as a CIRC participant

While anybody can download the input files needed for the radiative transfer runs and the reference output results, we urge users of this website to register as "CIRC participants". Registered CIRC participants will enjoy benefits such as:

- Updates via e-mail about improvements, additions, and corrections to the reference dataset and the accompanying documentation.
- An opportunity to have their results compared to those of other participants.
- Invitation to workshops on CIRC.
- Invitation to coauthor scientific papers on CIRC.

Please register as a CIRC participant by sending your name, affiliation and e-mail address to Lazaros Oreopoulos.

http://circ.gsfc.nasa.gov

Challenges we have faced

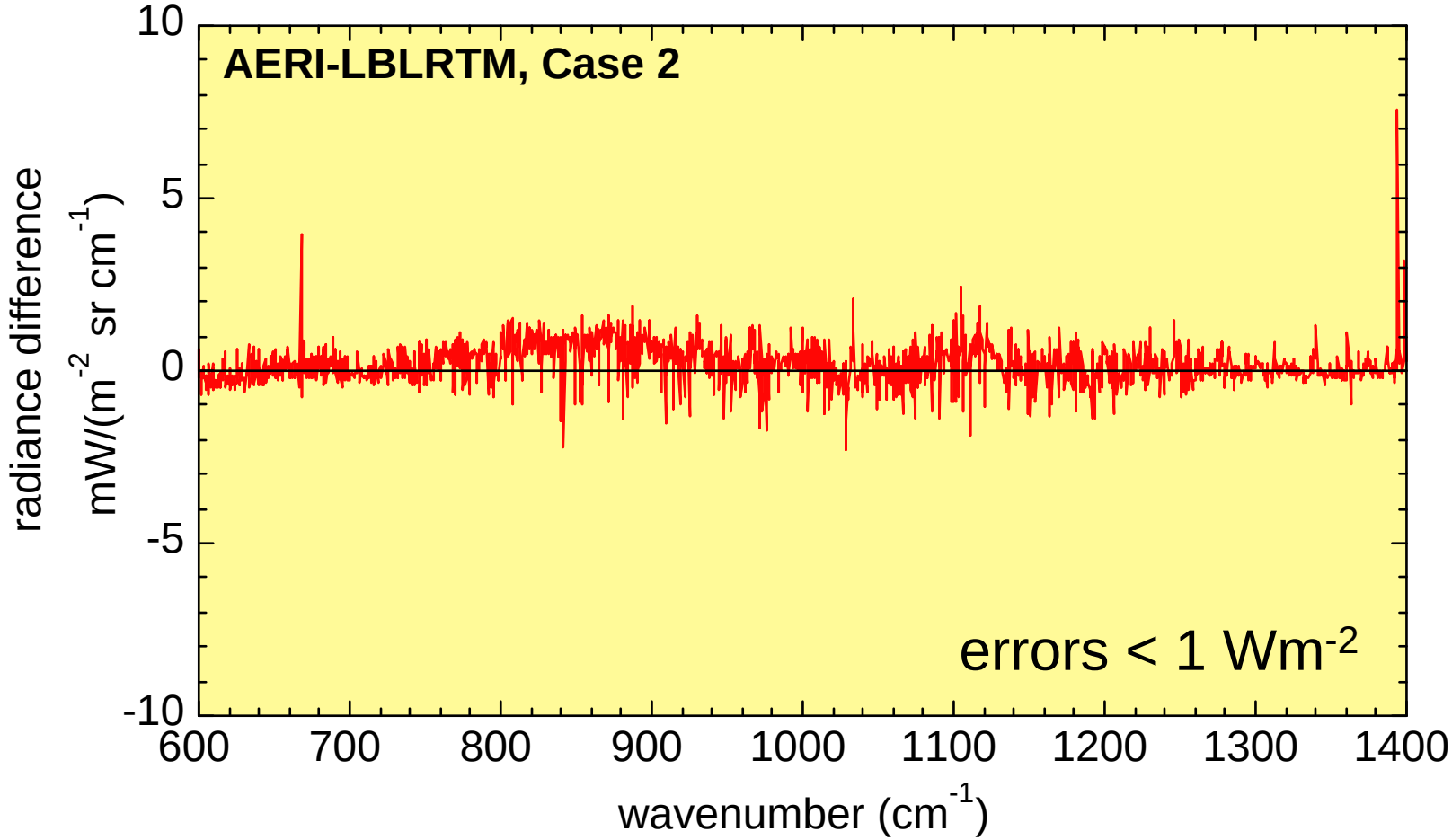
- For input and reference calculations to be credible, a reasonable level of agreement with observations is desirable
- Our designated data source (ARM BBHRP v.1.4.1) is small; very few BBHRP cases satisfy our criteria:
  - ✓ homogeneous* (1D)
  - ✓ closure at both SFC and TOA for both SW and LW
- LBL calculations are not standard in BBHRP
- Input for LBL calculations is not necessarily available from BBHRP (e.g., spectral surface albedo)
- Validation of LBL calculations
- We nevertheless came up with a bunch of (semi-validated) cases

** See also SPECTRE paper by Ellingson and Wiscombe (BAMS 1996)*

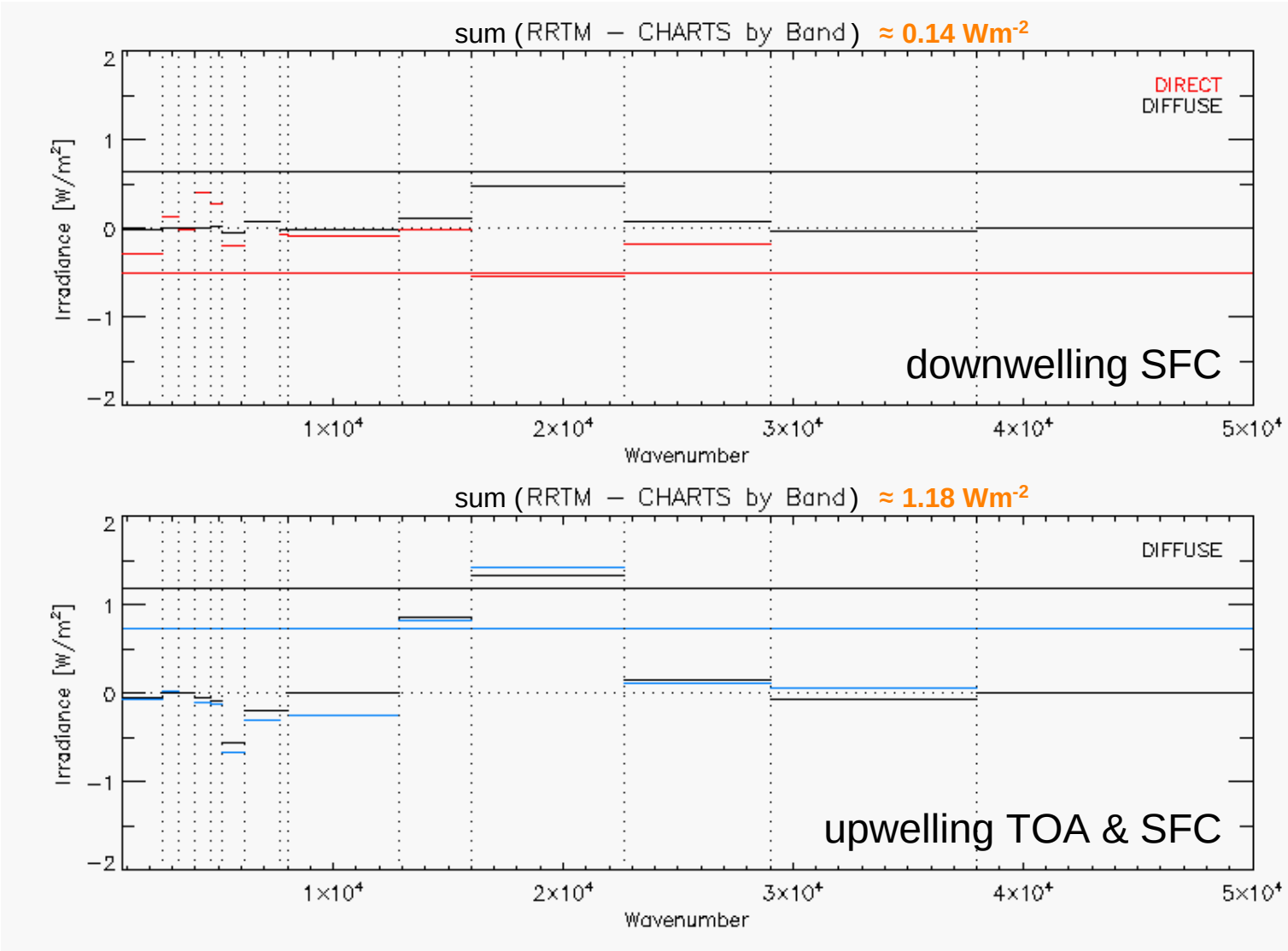
CIRC Phase I cases

Case	SZA	PWV (cm)	τ_{aer}	LWP (gm^{-2})	obs - LBL LW_{SFC}	LW_{TOA}	SW_{SFC}	SW_{TOA}
(1) SGP 9/25/00	47.9°	1.23	0.04		0.4%	-0.5%	0.5%	-3.1%
(2) SGP 7/19/00	64.6°	4.85	0.18		0.6%	-1.4%	-1.1%	8.4%
(3) SGP 5/4/00	40.6°	2.31	0.09		1.0%	-1.2%	-0.1%	-8.7%
(4, 5) NSA 5/3/04 2xCO_2)	55.1°	0.29	0.13		1.2%	-0.6%	-0.8%	0.7%
(6) SGP 3/17/00	45.5°	1.90	0.24	263.4	1.1%	-3.0%	4.9%	-0.9%
(7) PYE 7/6/05	41.2°	2.42		39.1	0.2%	0.6%	-0.4%	-0.1%

LW QC: LBLRTM spectral comparisons with AERI



SW QC: Spectral comparison with RRTM



7/19/2000, SGP: Warm and moist

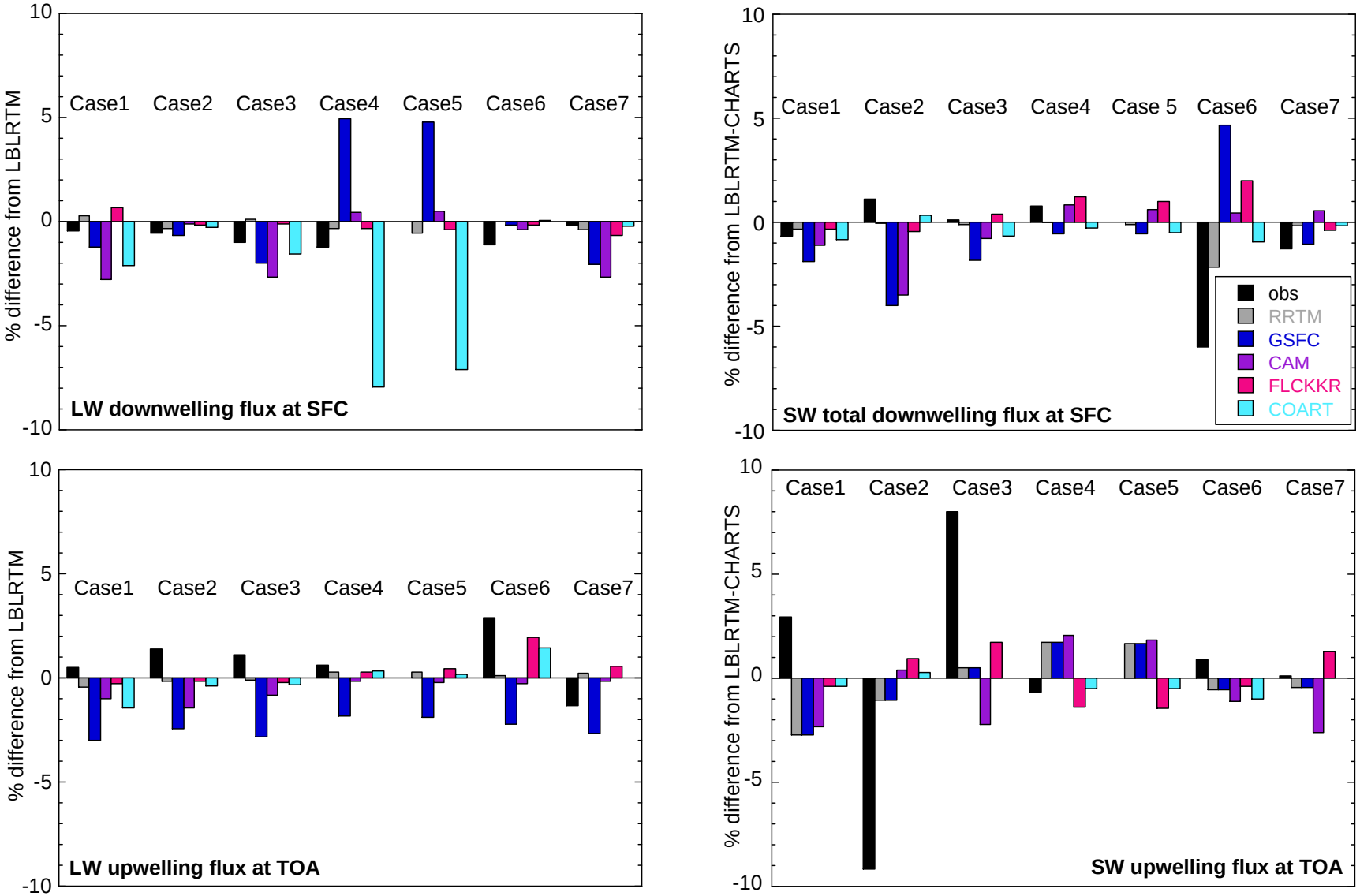
CIRC modus operandi (Phase I)

- Input & output (TOA and SFC fluxes at 1 cm^{-1}) and instructions on how to run the cases are openly available at the CIRC website
- Only registered users (considered as formal participants) have privileges such as:
  - ✓ e-mail notifications about changes, updates, and corrections to the CIRC dataset.
  - ✓ priority to participate in workshops and publications
- Registered users may have to submit results within predetermined deadlines.
- Submitted results and intercomparison analysis will be posted on website
- Implementation details and performances of participating codes will be documented and evaluated

Phase I launch

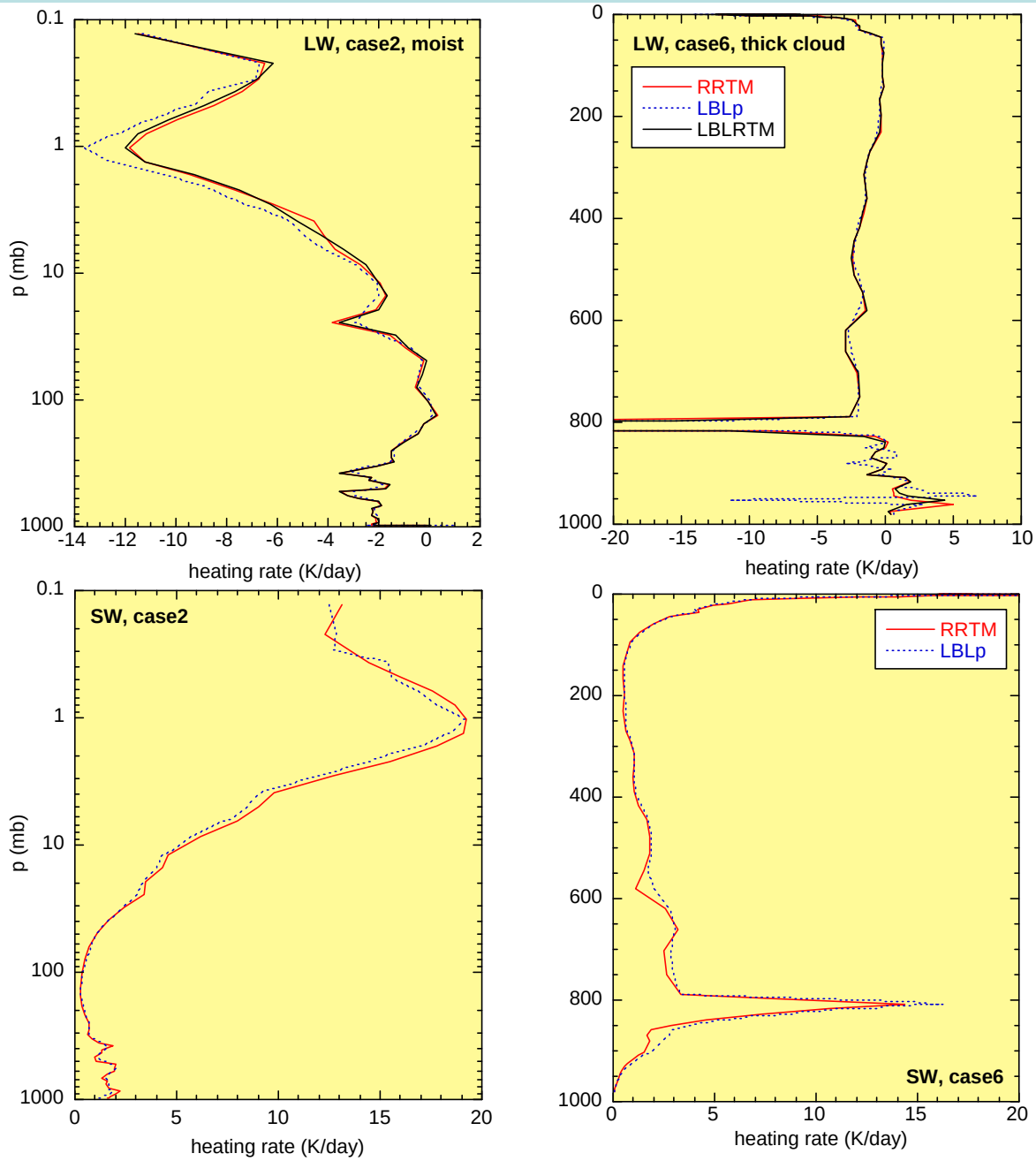
- Mass e-mail on June 4, 2008 (text available at CIRC website)
- 15 requests to register as participants (6 USA, 2 Brazil, 2 France, 1 Russia, 1 Australia, 1 Canada, 1 UK, 1 Finland)
- 5 submissions so far (a few more in the pipeline)
- Feedback at IRS'08 and via e-mail:
  - At IRC business meeting: absorb ICRCCM
  - Should not have publicized the reference results
  - More synthetic cases, please
  - SW heating rates, please
  - Remove aerosols
  - Separate species
- Still fine-tuning and clarifying things
- Please advertise, and if you have a code, participate!

Phase I initial results, flux errors



FLCKKR (= Fu, Liou Charlock, Kato, Kratz, Rose), submitted by Rose and Charlock
COART (= Coupled Ocean-Atmosphere Radiative Transfer), submitted by Jin and Charlock

Phase I preliminary results, heating rates

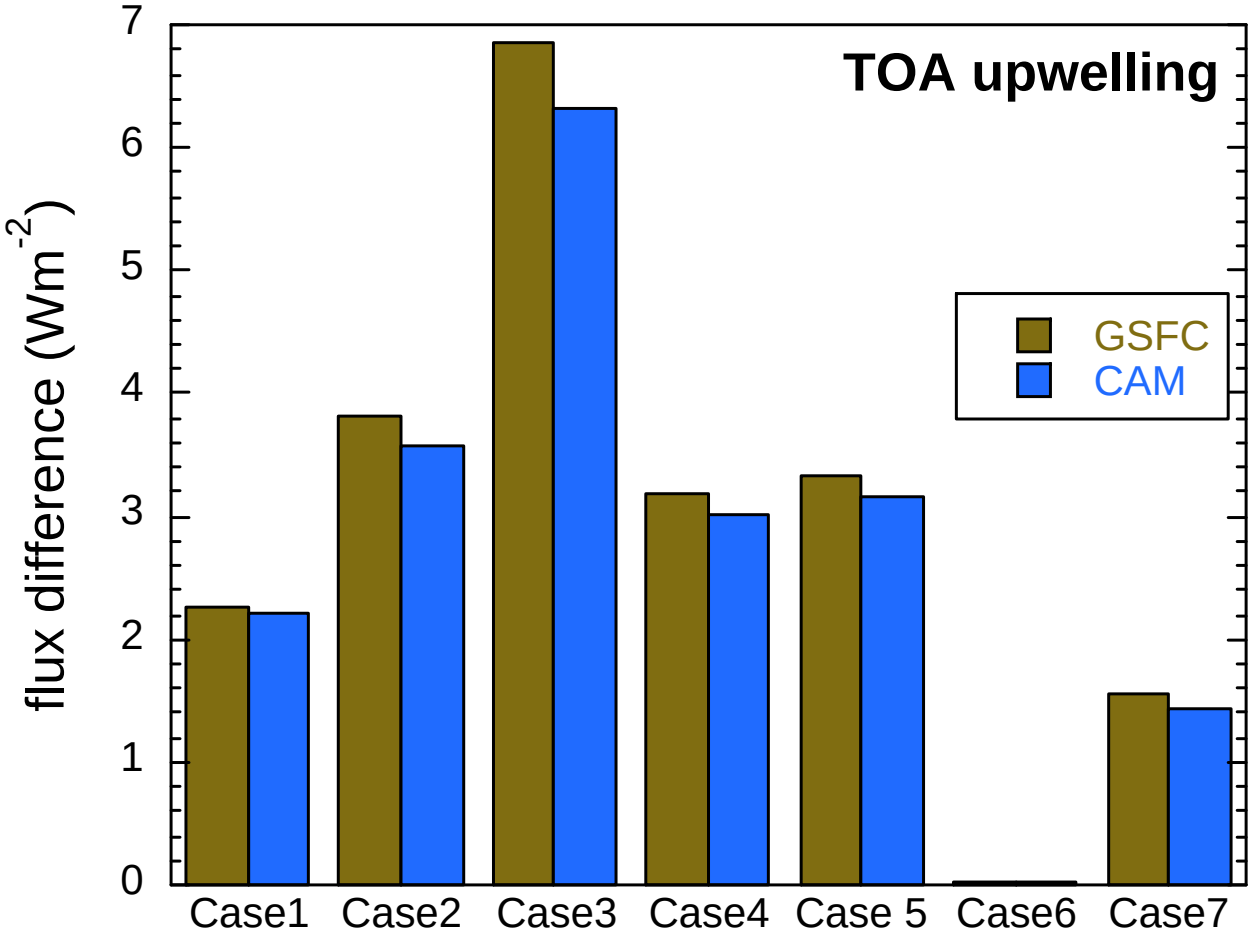


Note: No reference SW HR available from CHARTS

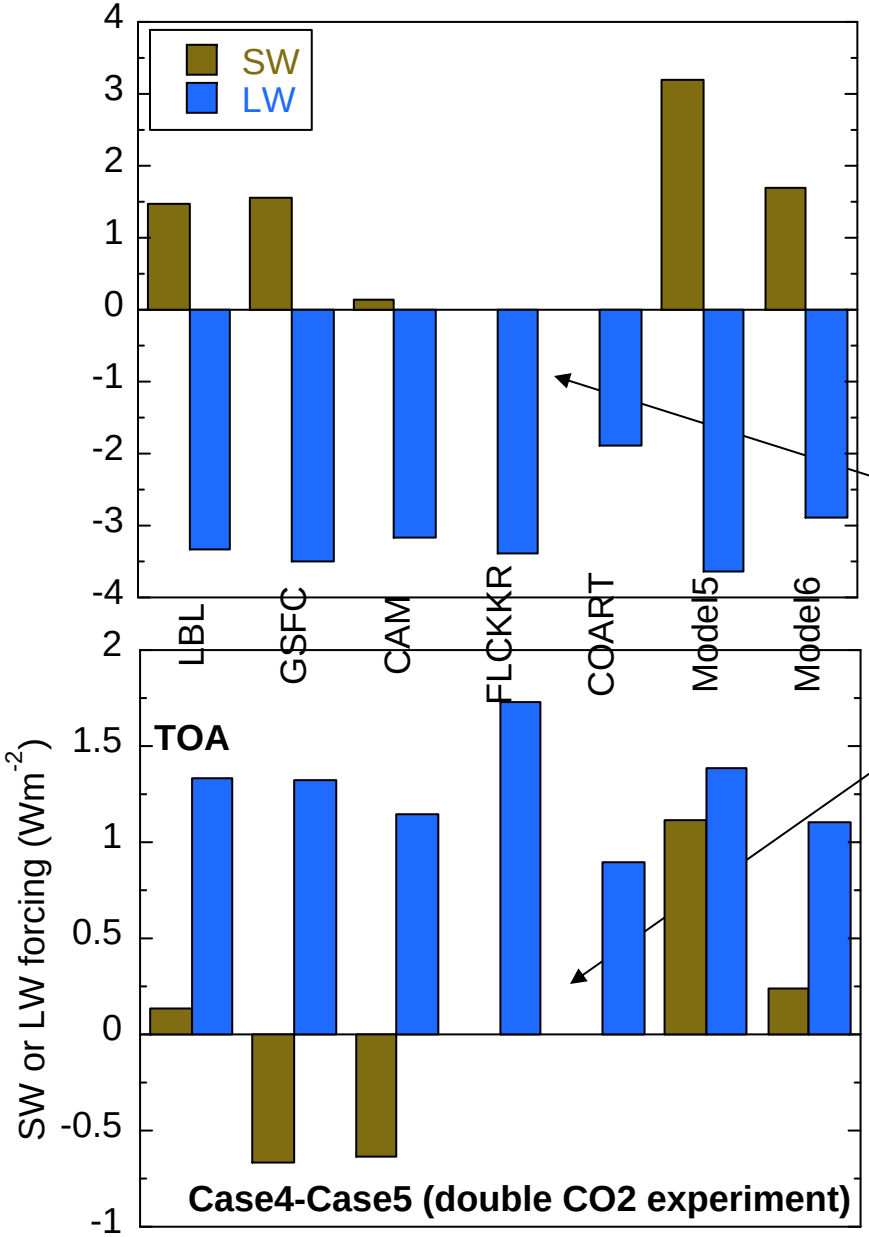
Importance of spectral surface albedo

CHARTS weighted-SSF weighted sfc. albedo

CHARTS-$R_{sfc}^{NIR}(3)$=0.311 SSF-$R_{sfc}^{NIR}(3)$=0.281



Phase I initial results, CO_2 forcing of dry atmospheres

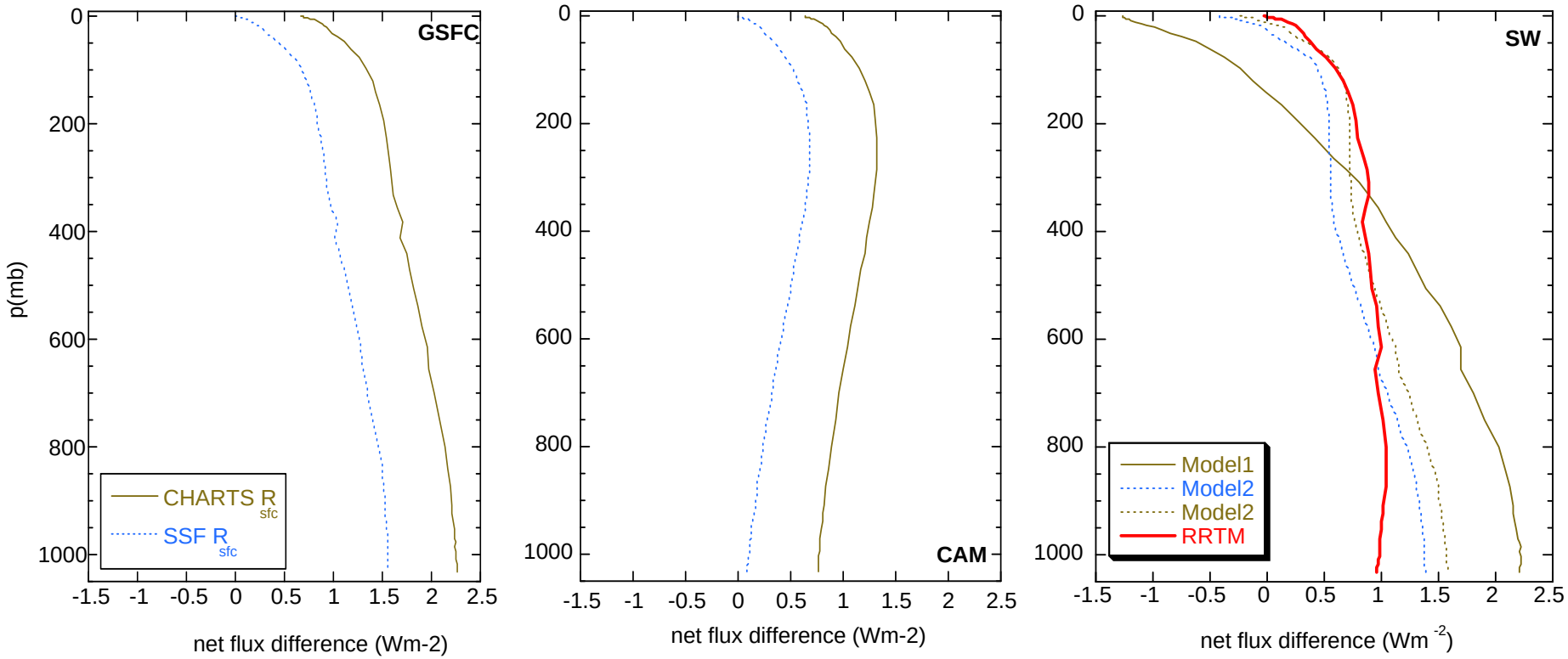


CHARTS-$R_{sfc}^{NIR}(4)$=0.487

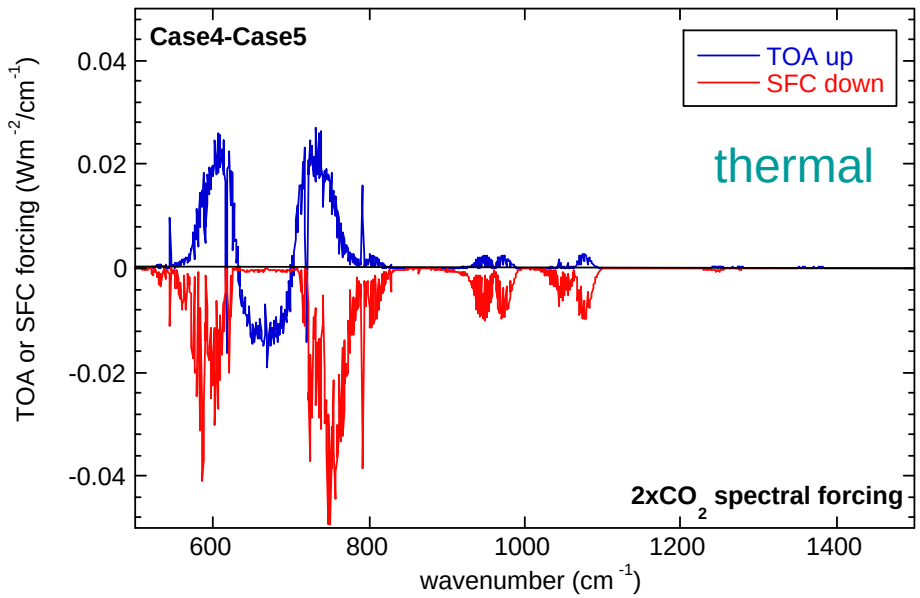
CHARTS-$R_{sfc}^{NIR}(5)$=0.490

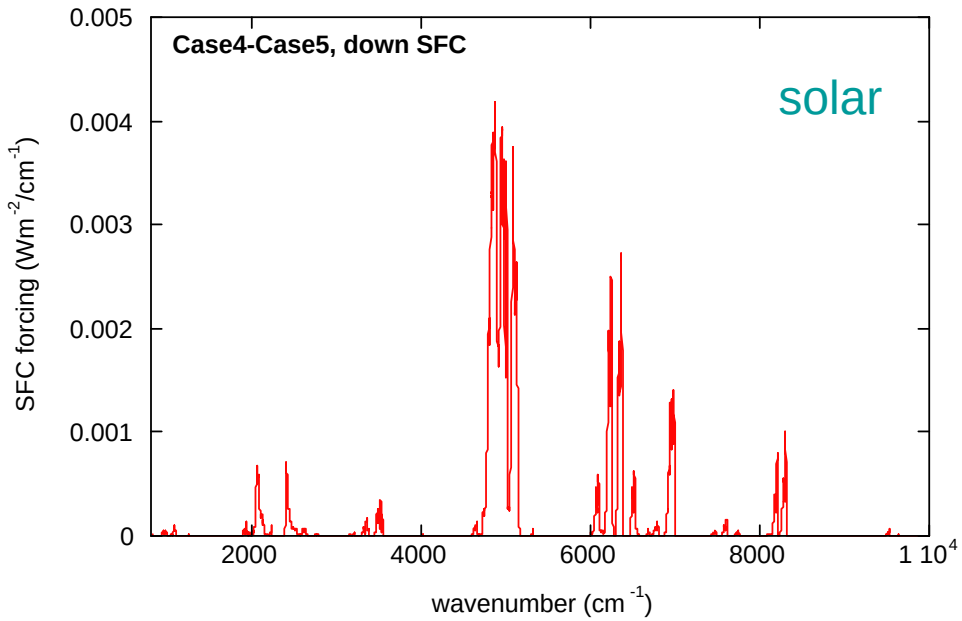
FLCKKR and COART have fixed CO_2 in SW

CO_2 forcing profile differences



CO_2 spectral forcing





CIRC activities and future

- Talks at GRP’08 meeting and IRS’08
- Extended abstract accepted to IRS’08 proceedings
- Short (“Nowcast”) BAMS article to be submitted soon
- Submitted ARM proposal seeking funding for Phase II (ice clouds, SW spectral closure)
- “Pristine” and “cloudless” (Cases 6 & 7) versions under consideration
- Would like to see submission from RT codes used for global flux datasets
- Advertise via ARM web pages
- Workshop within 2009
- Standards, certification, funding?

Additional slides

2xCO2 forcing from Collins et al. (2006)

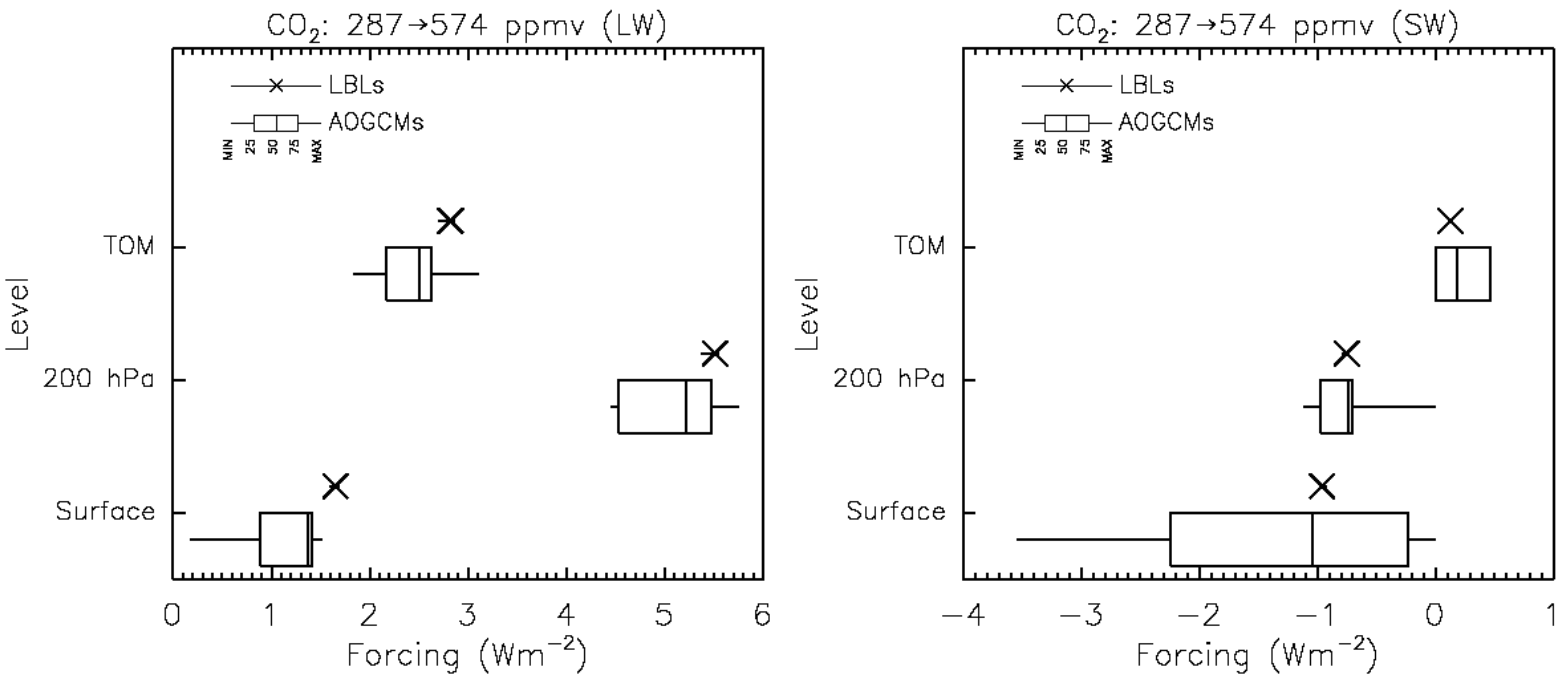
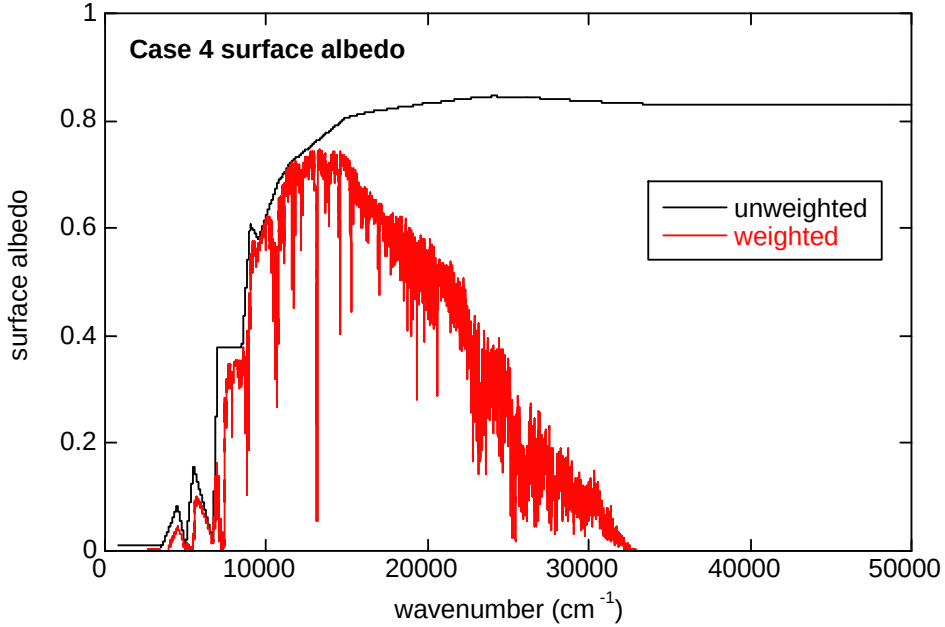
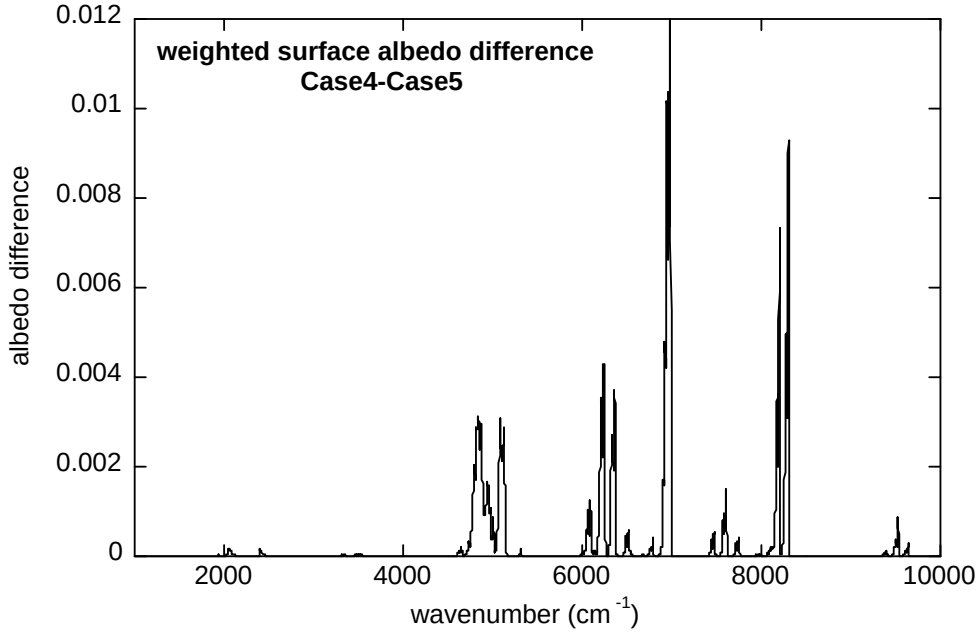
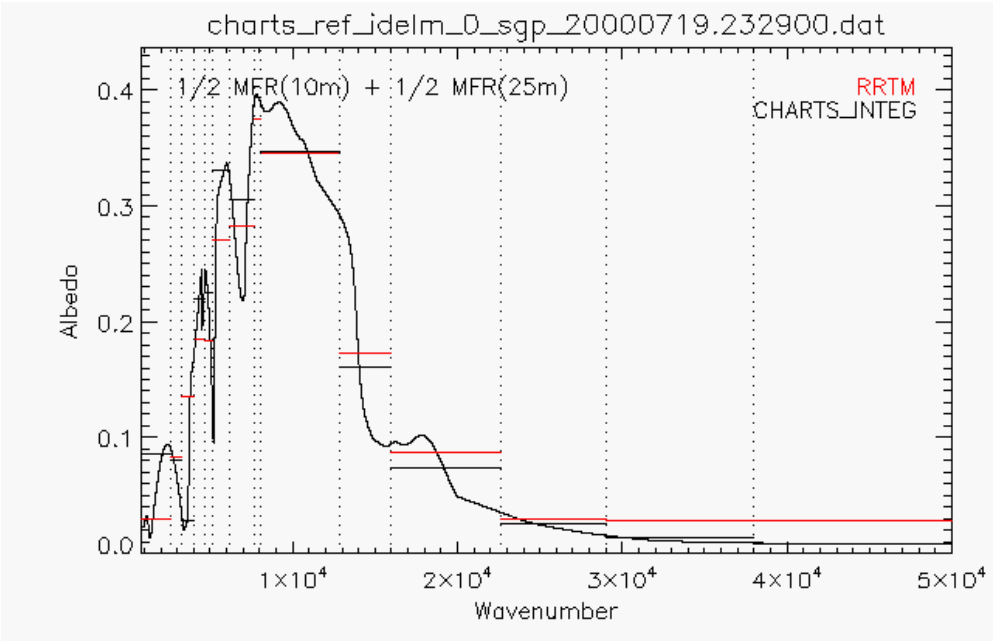


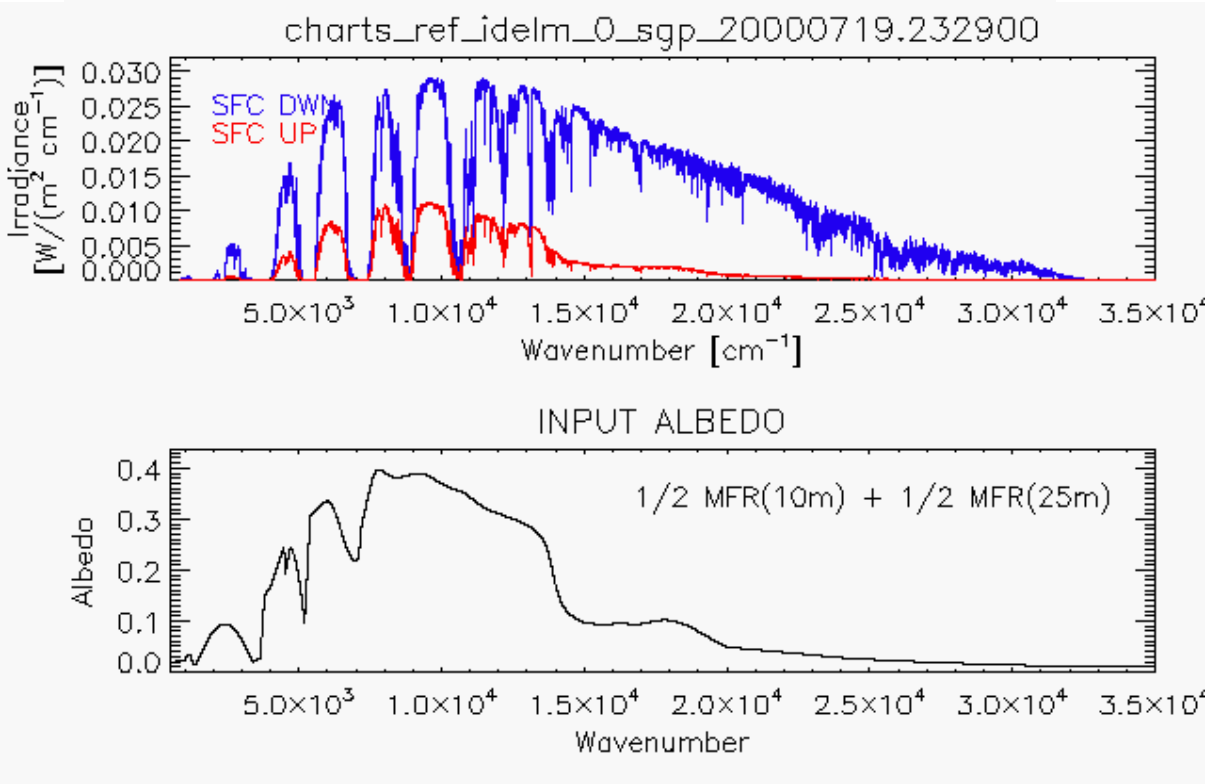
Figure 4. (left) Longwave forcings at TOM, 200 hPa, and the surface for increasing CO_2 from 287 to 574 ppmv (case 2b-1a, Table 2; same symbols as Figure 3). (right) Corresponding shortwave forcings.

Solar

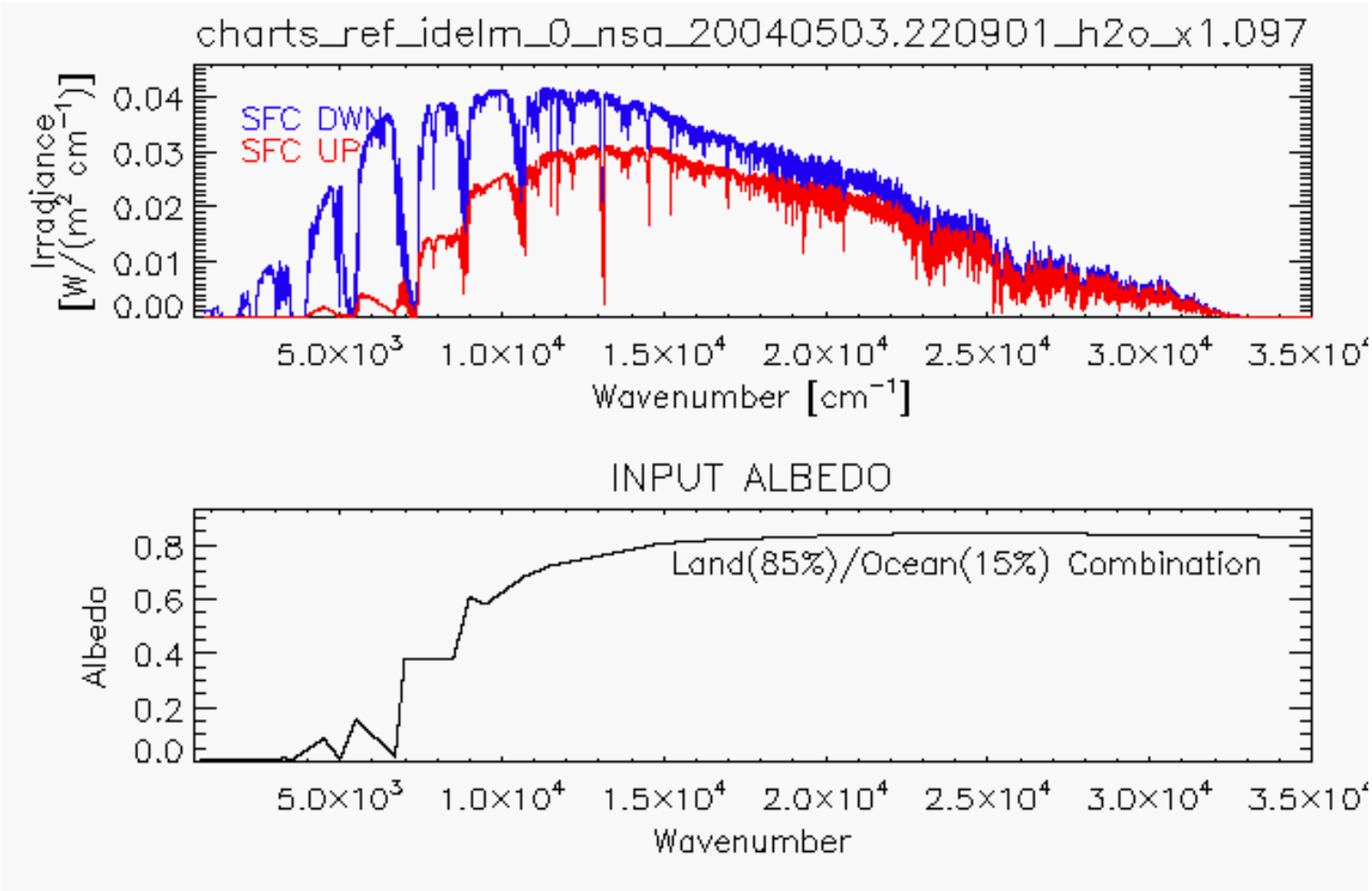

Case 4 surface albedo
unweighted
weighted
surface albedo
wavenumber (cm -1)
0
0.2
0.4
0.6
0.8
1
0
10000
20000
30000
40000
50000


weighted surface albedo difference
Case4-Case5
albedo difference
wavenumber (cm -1)
0
0.002
0.004
0.006
0.008
0.01
0.012
2000
4000
6000
8000
10000

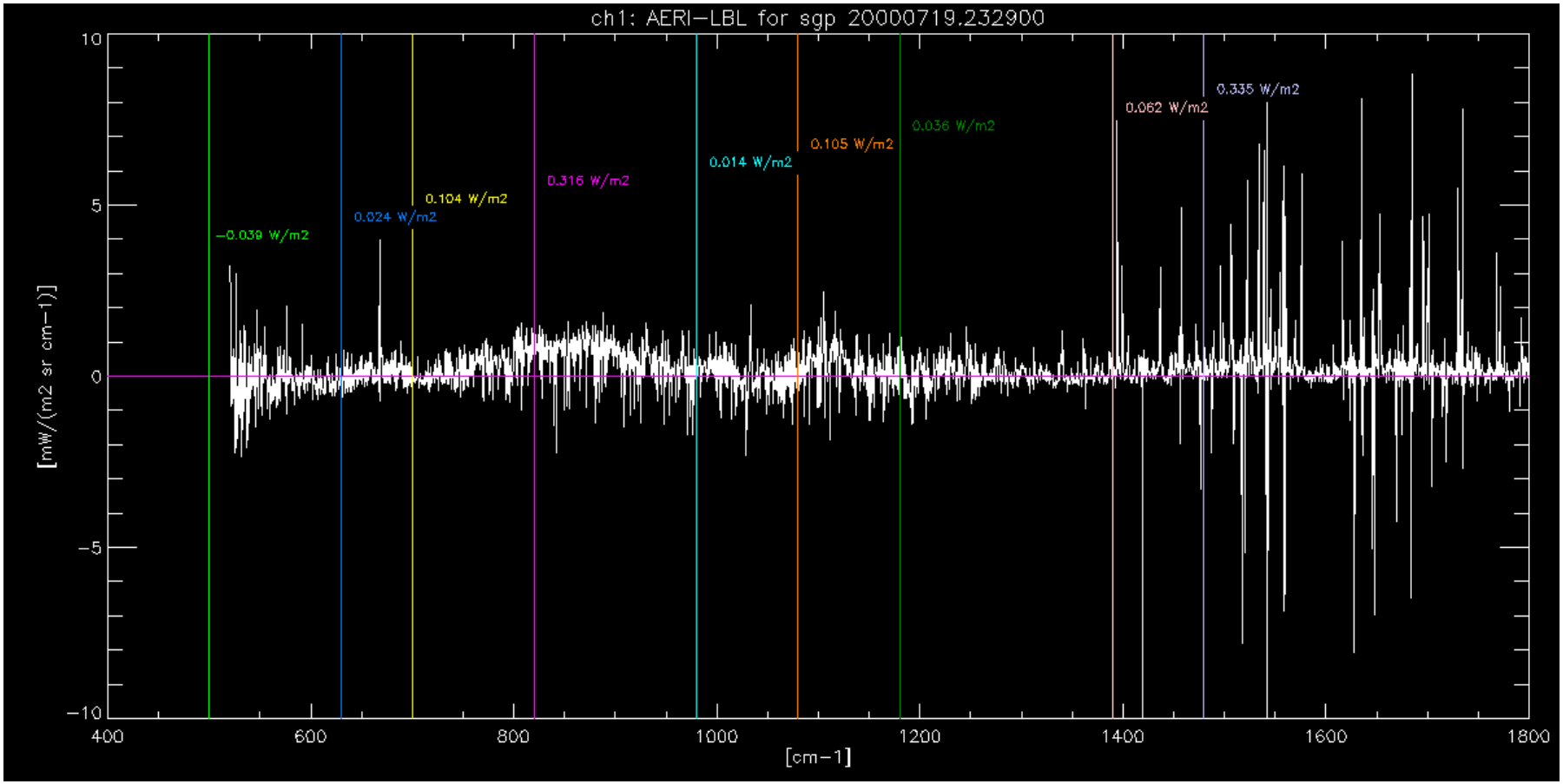

charts_ref_idelm_0_sgp_20000719.232900.dat
1/2 MFR(10m) + 1/2 MFR(25m)
RRTM
CHARTS_INTEG
Albedo
0.0
0.1
0.2
0.3
0.4
1×10⁴
2×10⁴
3×10⁴
4×10⁴
5×10⁴
Wavenumber


charts_ref_idelm_0_sgp_20000719.232900
SFC DWN
SFC UP
Irradiance [W/(m² cm⁻¹)]
0.000
0.005
0.010
0.015
0.020
0.025
0.030
5.0×10³
1.0×10⁴
1.5×10⁴
2.0×10⁴
2.5×10⁴
3.0×10⁴
3.5×10⁴
Wavenumber [cm⁻¹]
INPUT ALBEDO
1/2 MFR(10m) + 1/2 MFR(25m)
Albedo
0.0
0.1
0.2
0.3
0.4
5.0×10³
1.0×10⁴
1.5×10⁴
2.0×10⁴
2.5×10⁴
3.0×10⁴
3.5×10⁴
Wavenumber

Case 4 (NSA)


charts_ref_idelm_0_nsa_20040503.220901_h2o_x1.097
SFC DWN
SFC UP
Irradiance [W/(m² cm⁻¹)]
0.04
0.03
0.02
0.01
0.00
5.0×10³
1.0×10⁴
1.5×10⁴
2.0×10⁴
2.5×10⁴
3.0×10⁴
3.5×10⁴
Wavenumber [cm⁻¹]
INPUT ALBEDO
Land(85%)/Ocean(15%) Combination
Albedo
0.8
0.6
0.4
0.2
0.0
5.0×10³
1.0×10⁴
1.5×10⁴
2.0×10⁴
2.5×10⁴
3.0×10⁴
3.5×10⁴
Wavenumber

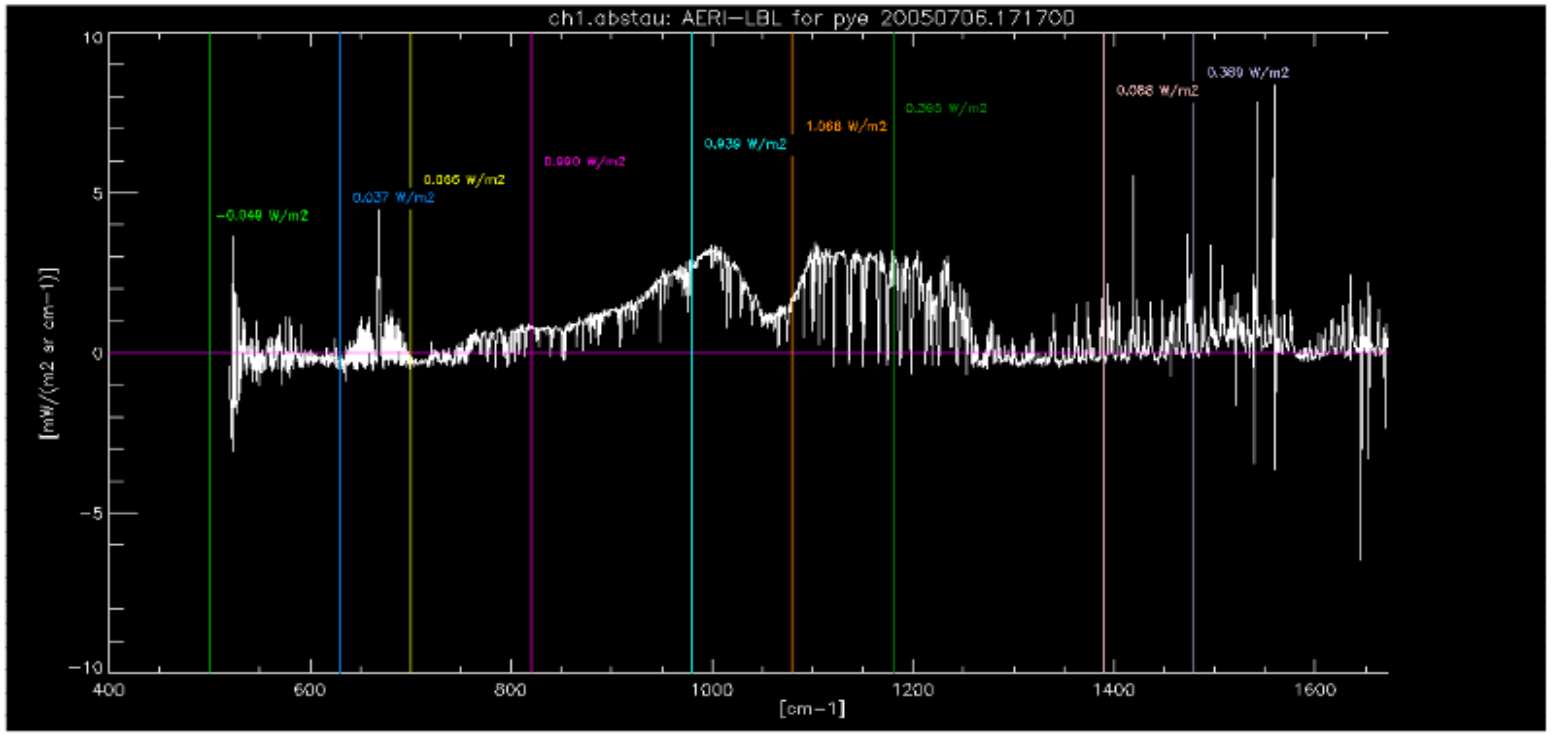
LW QC: Spectral comparison with obs

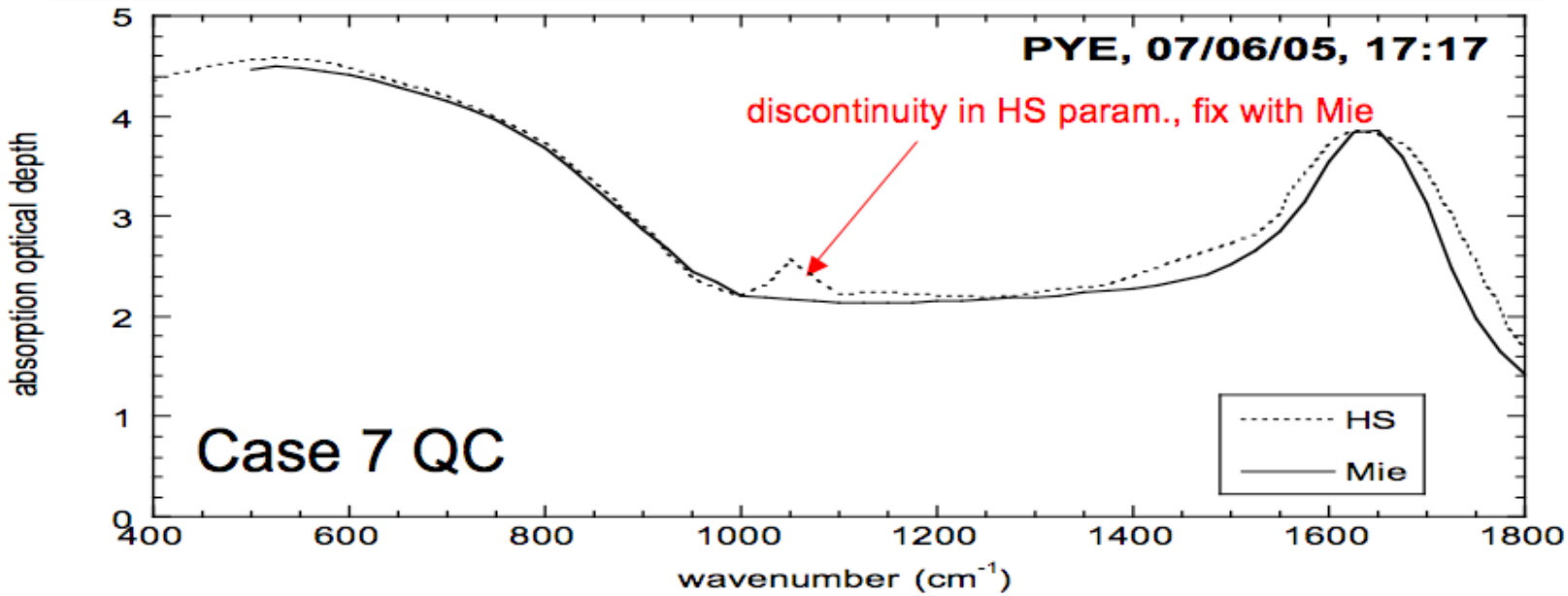


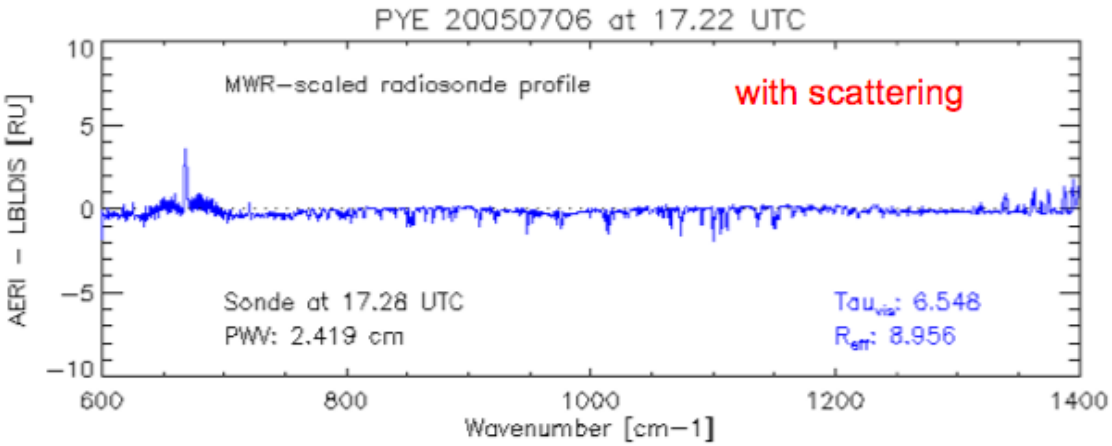
LBLRTM vs AERI

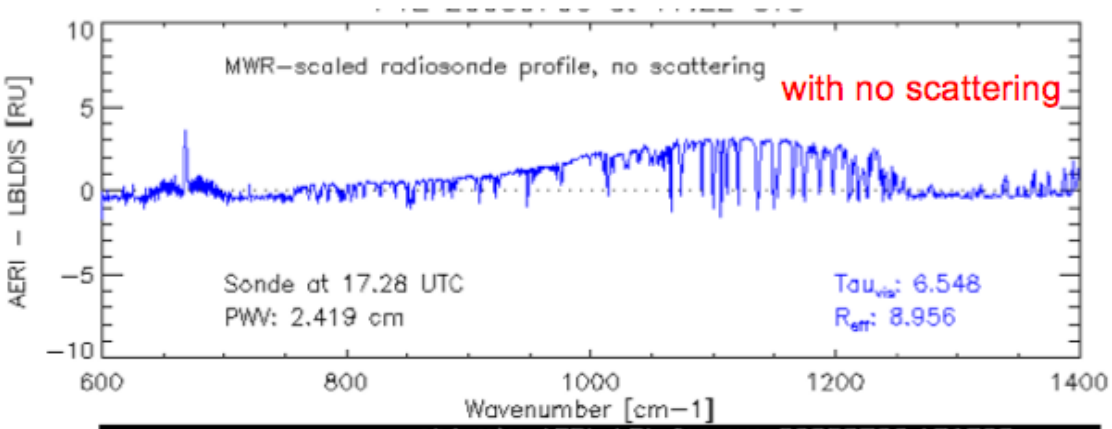
7/19/2000, SGP: Warm and moist

LW_{TOA} = 292.6 (LBLRTM), 288.6 (obs)
LW_{SFC} = 439.3 (LBLRTM), 441.8 (obs)

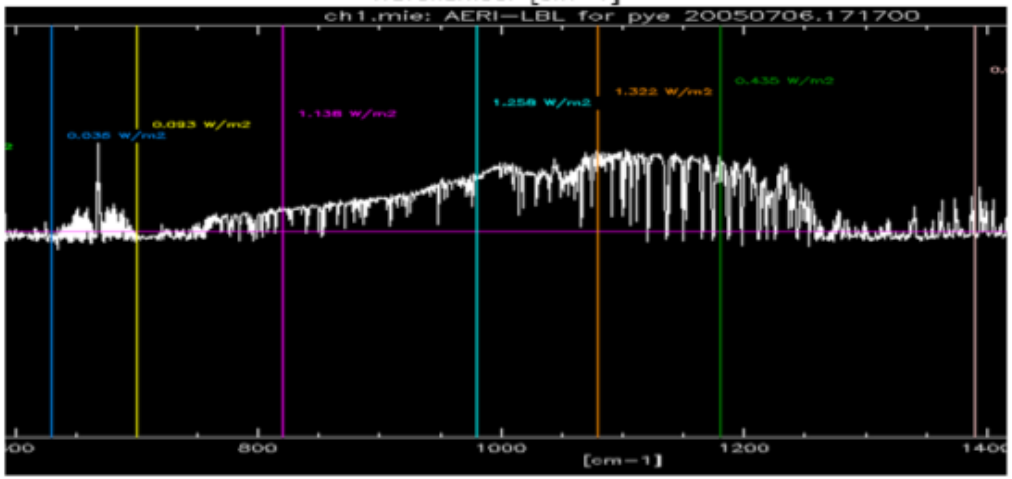

ch1.abstau: AERI-LBL for pye 20050706.171700
-0.049 W/m2
0.037 W/m2
0.066 W/m2
0.990 W/m2
0.939 W/m2
1.068 W/m2
0.365 W/m2
0.088 W/m2
0.389 W/m2
[mW/(m2 sr cm-1)]
[cm-1]


PYE, 07/06/05, 17:17
discontinuity in HS param., fix with Mie
Case 7 QC
HS
Mie
absorption optical depth
wavenumber (cm^{-1})



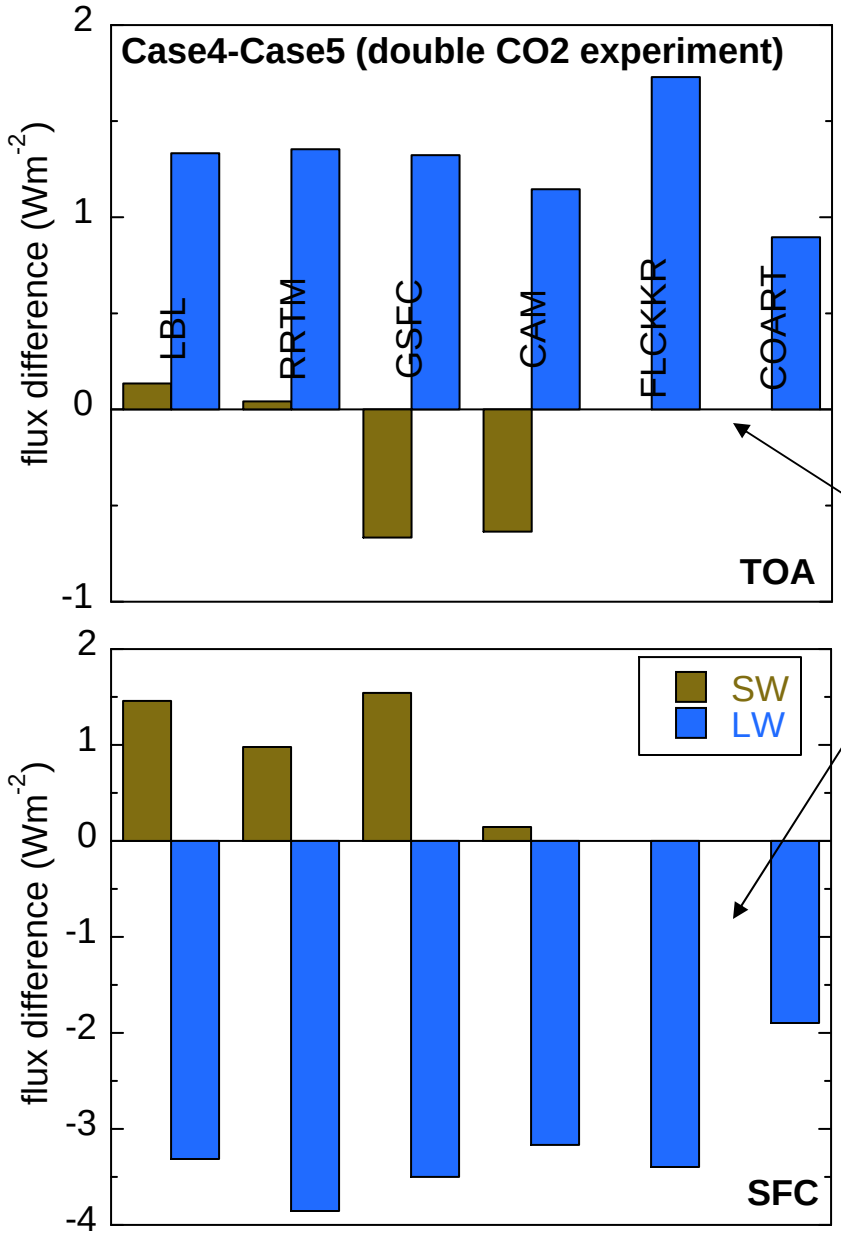


Turner's LBLDIS



LBLRTM (no scattering)

Phase I initial results, CO_2 forcing of dry atmospheres

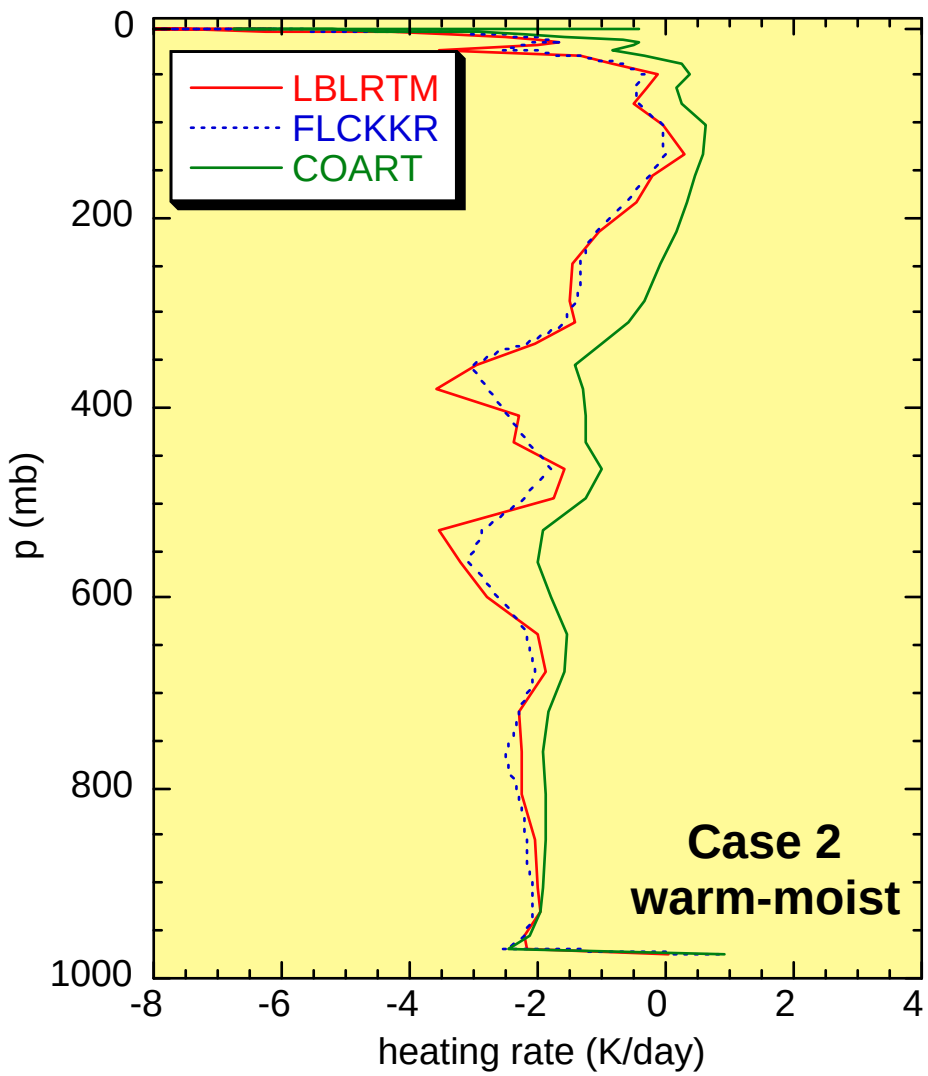


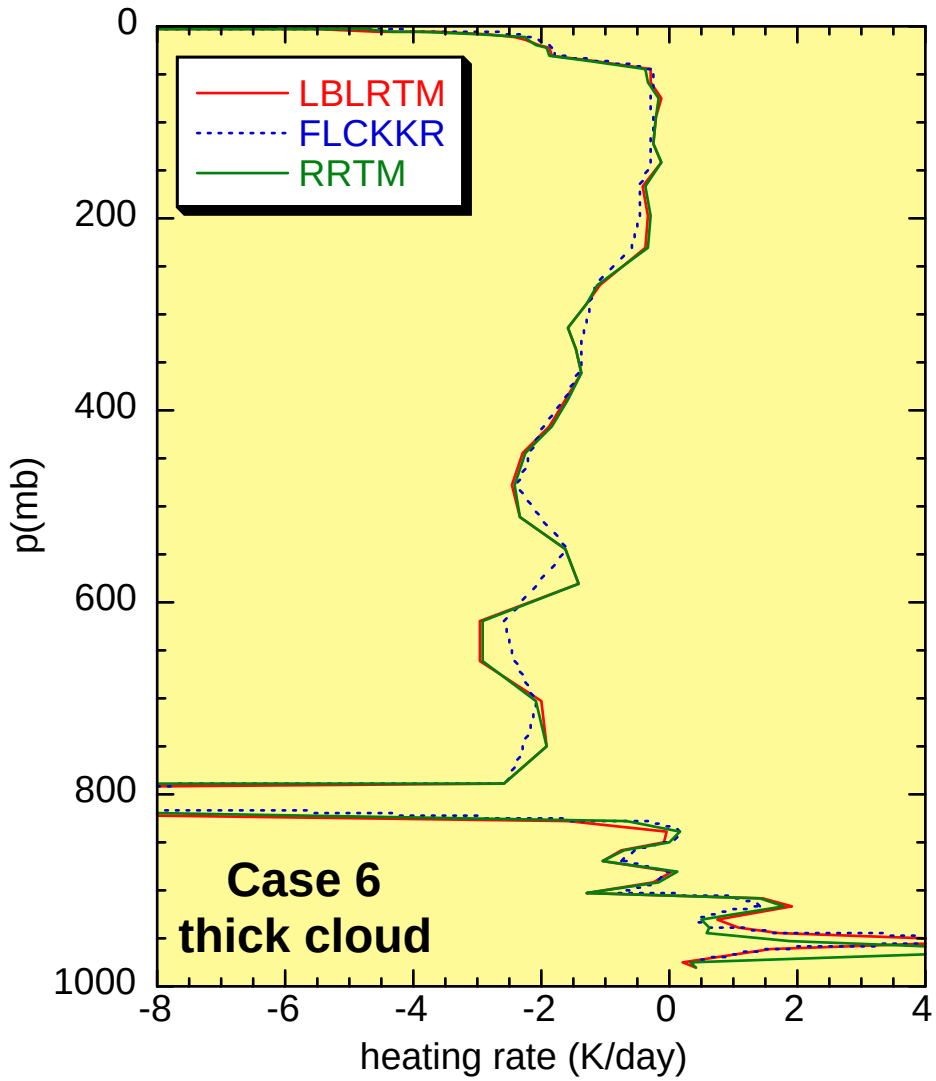
CHARTS-$R_{sfc}^{NIR}(4)$=0.487

CHARTS-$R_{sfc}^{NIR}(5)$=0.490

FLCKKR and COART have fixed CO_2 in SW

Phase I initial results, LW heating rates





Note: No reference SW HR available from CHARTS

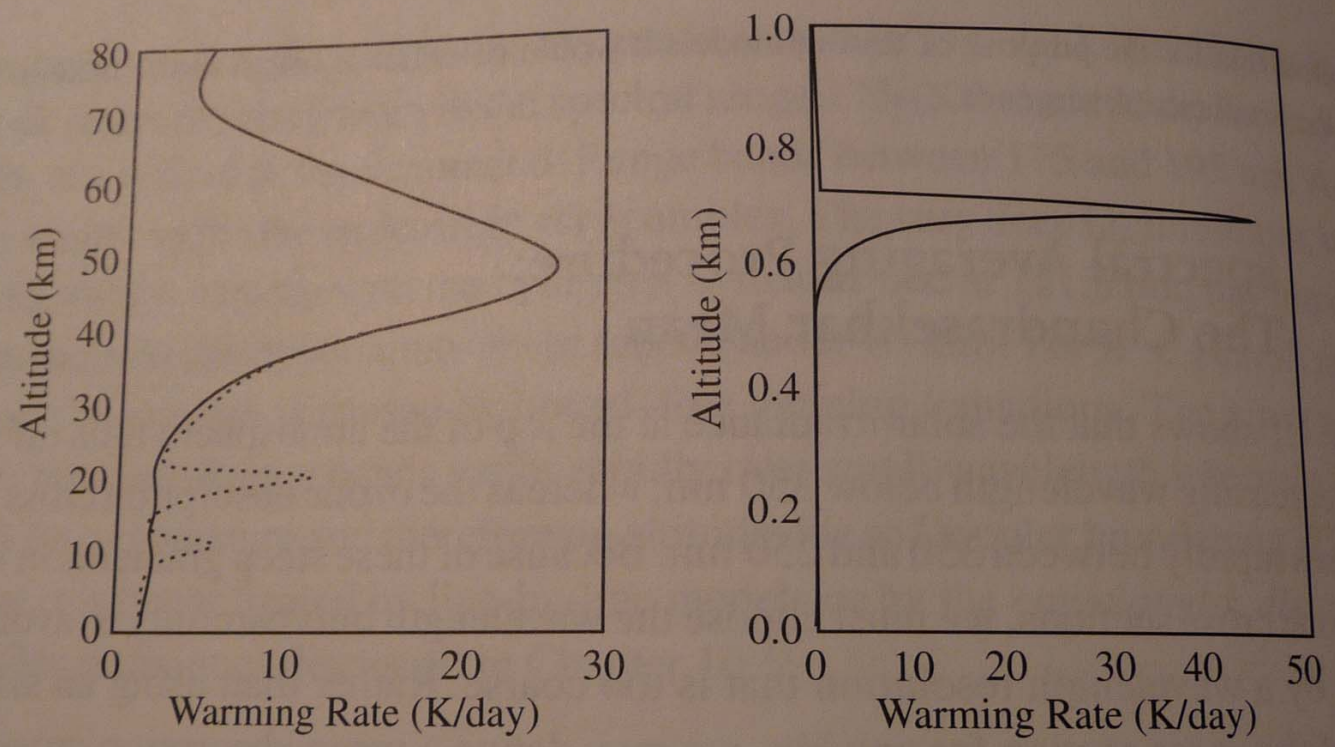


Figure 9.9 Left panel: Instantaneous warming rate due to ozone absorption between 200 and 700 nm for a solar zenith angle of 30°. For this computation optical properties derived from O_3 cross sections and the midlatitude summer atmosphere (see Appendix C) were used as input to the DISORT radiative transfer code (§8.8). Instantaneous warming rates for stratospheric aerosols and a cirrus cloud are also shown. Right panel: Warming rate for a simulated low-level warm cloud (see text) where the solar zenith angle is 60°.

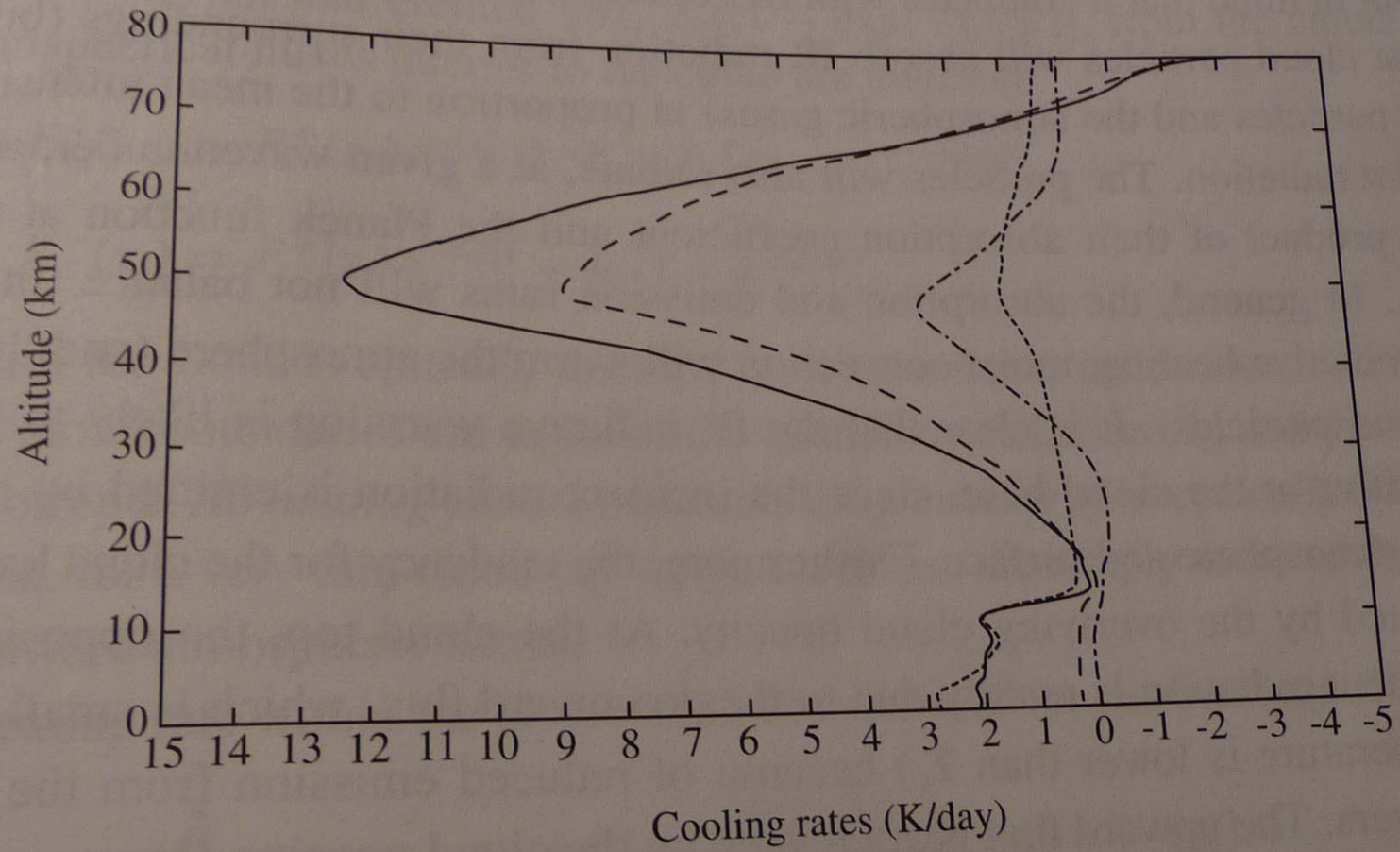


Figure 11.4 Clear-sky cooling rates based on line-by-line computations for H_2O (dotted line), CO_2 (dashed line), and O_3 (dashed-dotted line). The solid line gives the total cooling rate.