The Broadband Radiative Heating Rate Profile (BBHRP) Project: Status and Developments

The ARM BBHRP Focus Group

General BBHRP Outline

Atmospheric State
Surface Albedo

Aerosol Best-Estimate Profiles

Cloud Property Profiles

Radiative Transfer Model (RRTM)

Vertical Profile
Fluxes/Heating Rates

Two resolutions:
"soda straw"
grid-cell

TOA Validation
Satellite LW/SW Fluxes

Surface Validation
ARM LW/SW Fluxes

Recent Developments on BBHRP

- Focus on improving BBHRP 'infrastructure'
  - goal: make BBHRP results more useful to ARM community

    - release of latest versions as PI product

    - tool to compute average heating rate for cases satisfying various criteria

    - direct input to BBHRP of cloud property retrievals by ARM PIs
- Plan in place to improve NSA results, especially clouds properties
  - improved thermodynamic profiles from Mergedsounding VAP
- Generation of many new versions of BBHRP at SGP

BBHRP Web Pages

PI product on ARM IOP archive:
//iop.archive.arm.gov/arm-iop/0pi-data/mlawer/

PNNL Development Web site:
//engineering.arm.gov/~shippert/BBHRP/index.html

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The ARM Broadband Heating Rate Profile Project
7/6/06

The objective of the ARM Broadband Heating Rate Profile (BBHRP) Project is
to provide a structure for the comprehensive assessment of our ability to
model atmospheric radiative transfer for all conditions. This assessment is
performed on two spatial/temporal scales:

    * 'instantaneous' http://engineering.arm.gov/~shippert/BBHRP/instantaneous_frames.html
    * 'average'  http://engineering.arm.gov/~shippert/BBHRP/average_frames.html

The BBHRP Project has been implemented for the year 2000 (3/00-2/01) at the
Southern Great Plains site of the ARM Program. It is planned that the scope
of the project be extended to all ARM sites and all time periods (after
2000) for which appropriate data is available.

A more complete description of the BBHRP project can be found at:

        http://www.arm.gov/publications/proceedings/conf12/extended_abs/mlawer-ej.pdf

The BBHRP presentation from the ARM 2006 Science Team Meeting is at:

        http://engineering.arm.gov/~shippert/BBHRP/bbhrp_summary.ppt

Further information can be found in the site specific READMEs and at the
BBHRP development web site http://engineering.arm.gov/~shippert/BBHRP.

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BBHRP is run in a series of trials; the baseline run will be versioned like
"pi_ver1.4", whereas the various trials will be versioned like "pi_ver1.4tA,
pi_ver1.4tB" etc.  A new trial generally indicates a change to an input (such
as a new set of cloud description files) or some modification to the
models.  Certain trials can become new baseline runs, at which point we
will give them a new minor version number (e.g. pi_ver1.7tC would become
pi_ver1.8 when it became a new baseline).

The "pi_" prefix indicates that this is an instantaneous run; a "pa_"
prefix indicates an average run.  See the links above for these two terms
for more information.
```

/arm-iop/0pi-data/mlawer/

Parent Directory
README.html
File last modified: Tue Aug 15 17:25:09 2006 UTC
File size: 3122 bytes
File description: HyperText Markup Language document
nsa/
sgp/

ARM Intensive Operational Period (IOP) Data Browser, Version 0.12

My IOP Download Page | ARM IOP Data Browser | ARM Archive User Interface | ARM Homepage

Package Type
- bzip2 tar file
- gzip tar file
- zip file

Directories/Files to Include
Remove from list

Directories/Files to Exclude
Remove from list

Submit request
Cancel request

The ARM Broadband Heating Rate Profile Project

The objective of the ARM Broadband Heating Rate Profile (BBHRP) Project is to provide a structure for the comprehensive assessment of our ability to model atmospheric radiative transfer for all conditions. This assessment is performed on two spatial/temporal scales:

- 'instantaneous'
- 'average'

The BBHRP Project has been implemented for the year 2000 (3/00 - 2/01) at the Southern Great Plains ACRF and for the year 2004 (2/04 - 10/04) at the North Slope of Alaska ACRF. The methodology differs somewhat from site to site. Documentation for the latest versions can be found here:

- SGP description
- NSA description

It is planned that the scope of the project be extended to all ARM sites and all time periods (2000 and later) for which appropriate data is available.

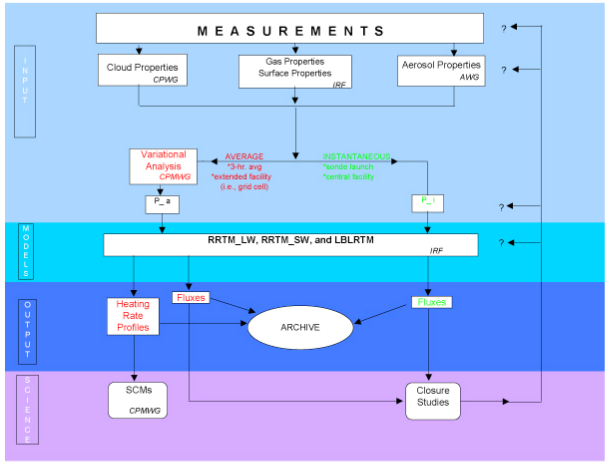
A more complete description of the BBHRP project (pdf)

BBHRP presentation from 2006 ARM Science Team Meeting (ppt)

The BBHRP project is a collaborative effort of all the Working Groups in the ARM program.

A schematic overview of the project:

The Broadband Heating Rate Profile (BBHRP) VAP



Mlawer, et al
2002 ARM IRF Meeting

Results

- Current Results of 'Instantaneous' Measurement-Model Comparisons - P_i version 1.4.1 (SGP)
- Results of All 'Instantaneous' (P_i) Measurement-Model Comparisons (SGP)
- Current Results of 'Instantaneous' Measurement-Model Comparisons - P_i version 2.3 trial F (NSA)
- Results of All 'Instantaneous' (P_i) Measurement-Model Comparisons (NSA)
- Current Results of 'Average' Measurement-Model Comparisons - P_a version 1.1.1
- Results of All 'Average' (P_a) Measurement-Model Comparisons

Researchers Involved in this Project

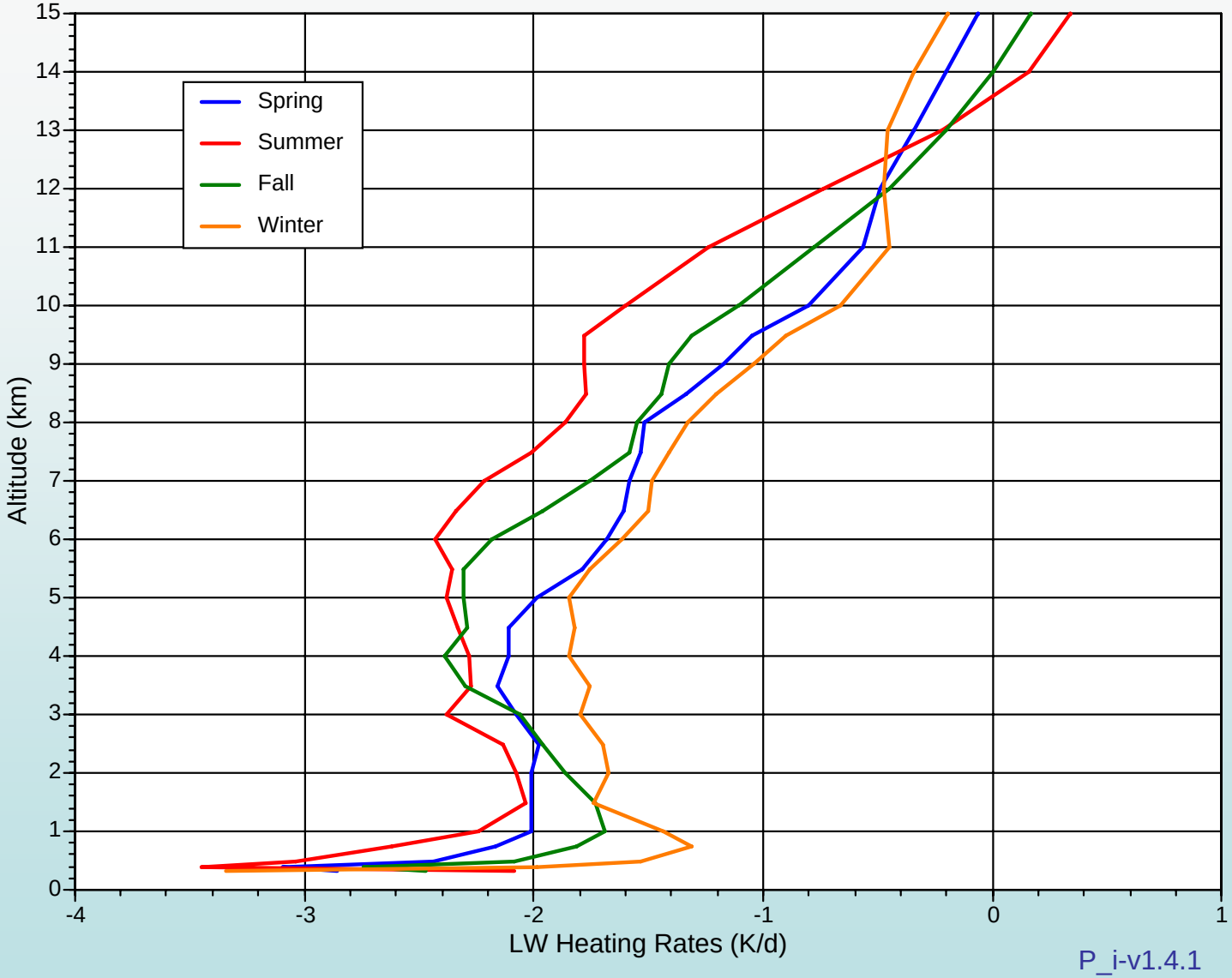
Making BBHRP Heating Rates More Accessible

- Tool to produce average longwave, shortwave, and total heating rates for cases *in any BBHRP version* satisfying chosen criteria:
  - dates, time of day, cloud classification, cloud cover, cloud top, cloud bottom, PWV, AOD, solar zenith angle, …
  - e.g. spring 2000 heating rates for clear sky cases at SGP

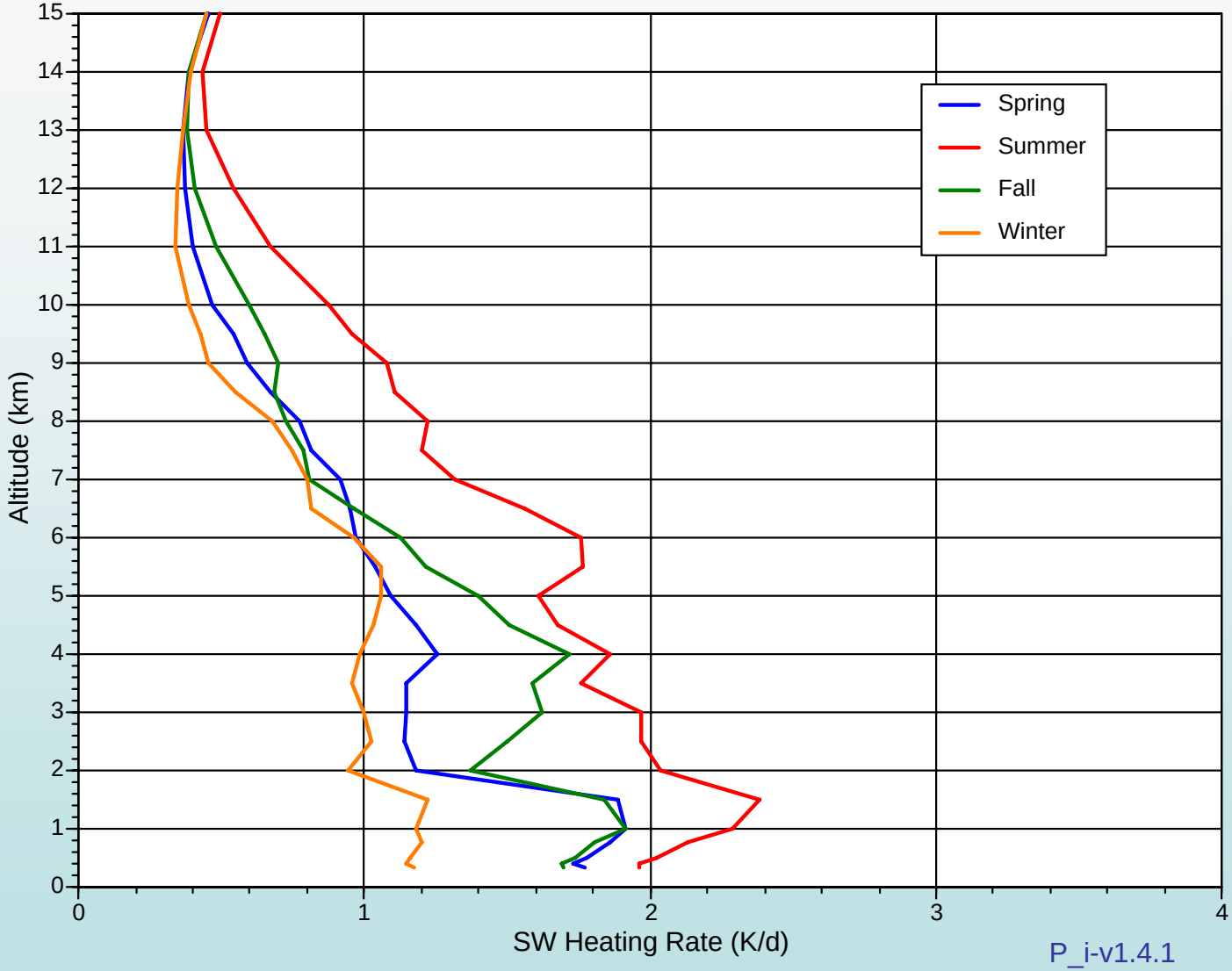
height	lw	sdev	sw	sdev	sum	sdev
0.320	-2.855	6.646	1.774	0.777	-2.210	7.398
0.374	-3.094	2.173	1.728	0.751	-2.465	2.913
0.500	-2.441	1.095	1.777	0.786	-1.794	1.829
0.750	-2.167	0.984	1.857	0.785	-1.491	1.652
1.000	-2.011	0.849	1.912	0.746	-1.316	1.430
1.500	-2.012	0.697	1.888	0.708	-1.325	1.248
2.000	-2.014	0.790	1.182	0.514	-1.584	0.985
2.500	-1.978	0.837	1.140	0.582	-1.563	1.004
3.000	-2.072	0.830	1.147	0.576	-1.655	1.038
3.500	-2.157	0.971	1.148	0.699	-1.739	1.140

FYI: Since the beginning of the BBHRP project, heating rates from each version of BBHRP have been publicly available

Clear-sky LW Heating Rates at SGP for 2000 by Season

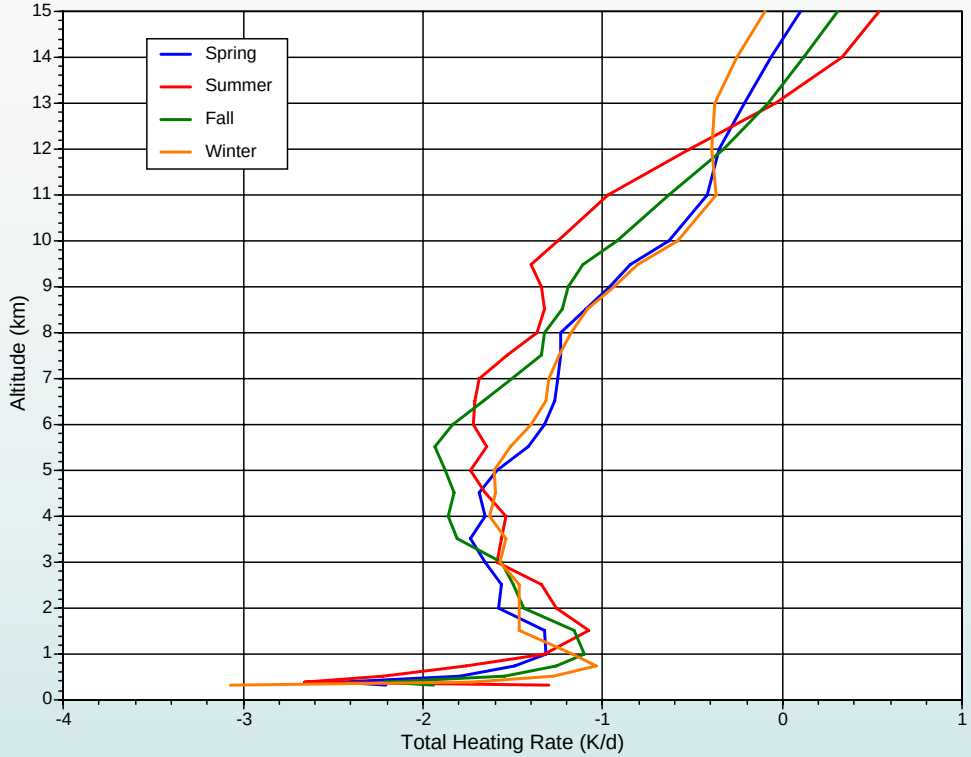


Clear-sky SW Heating Rates at SGP for 2000 by Season

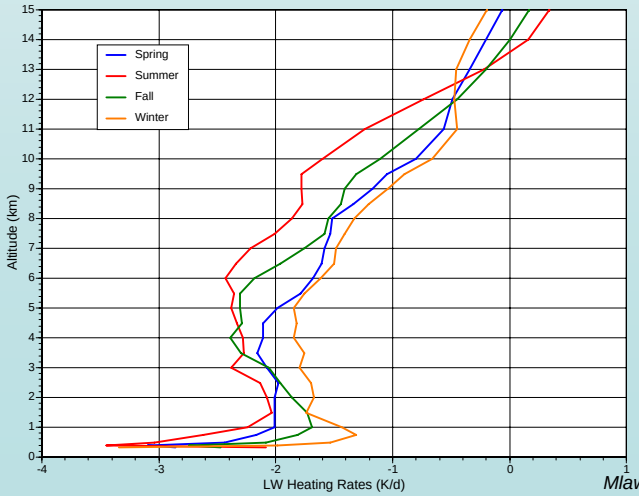


P_i-v1.4.1

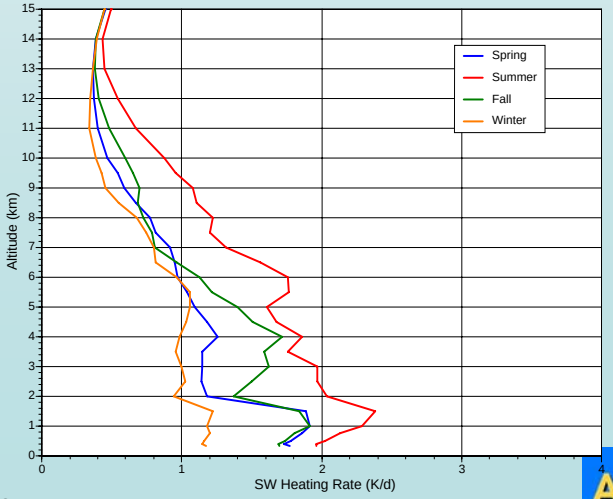
Clear-sky Total Heating Rates at SGP for 2000 by Season



Clear-sky LW Heating Rates at SGP for 2000 by Season



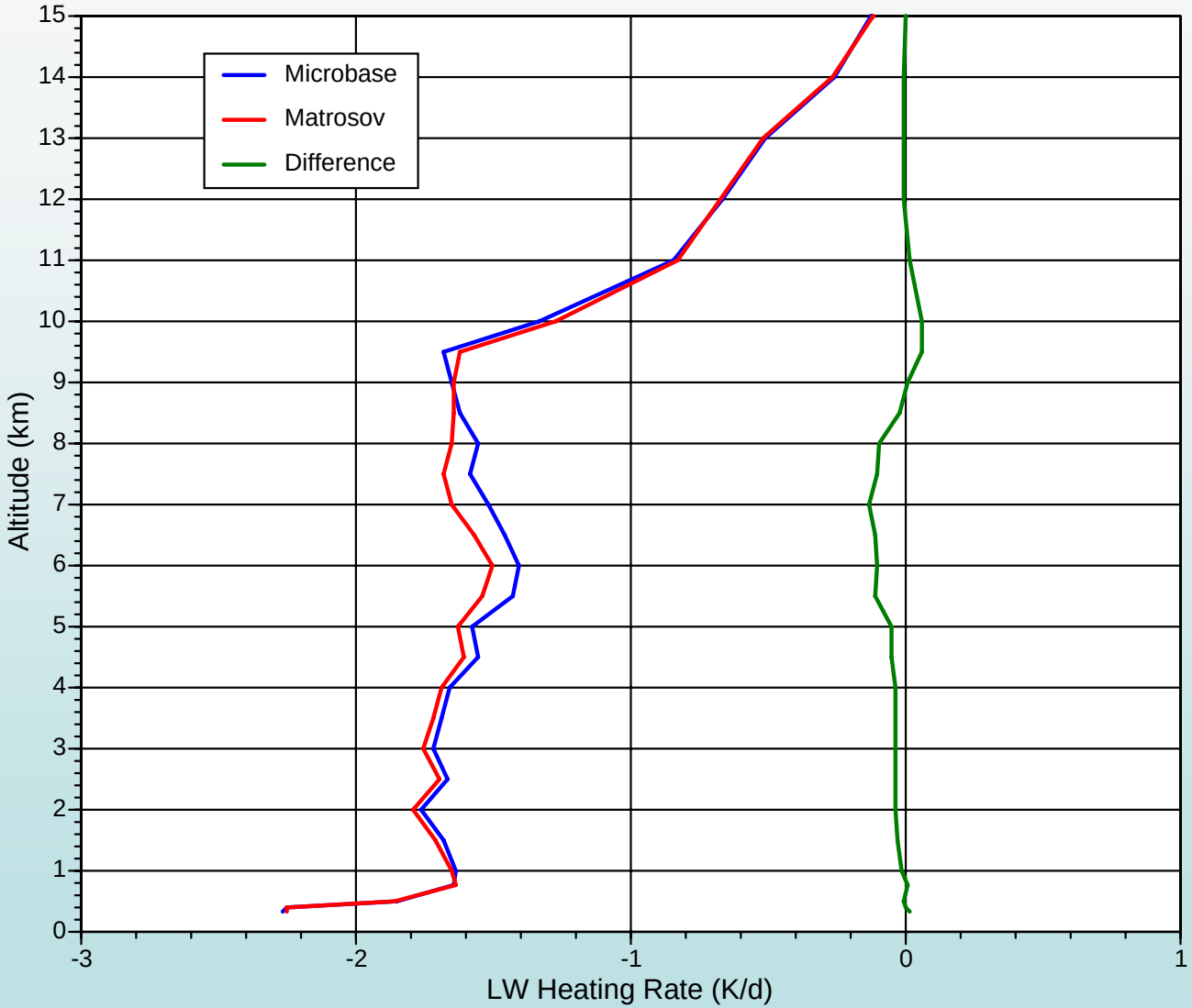
Clear-sky SW Heating Rates at SGP for 2000 by Season



Mlawer et al., October 2006
ARM IRF Workshop, Washington, DC

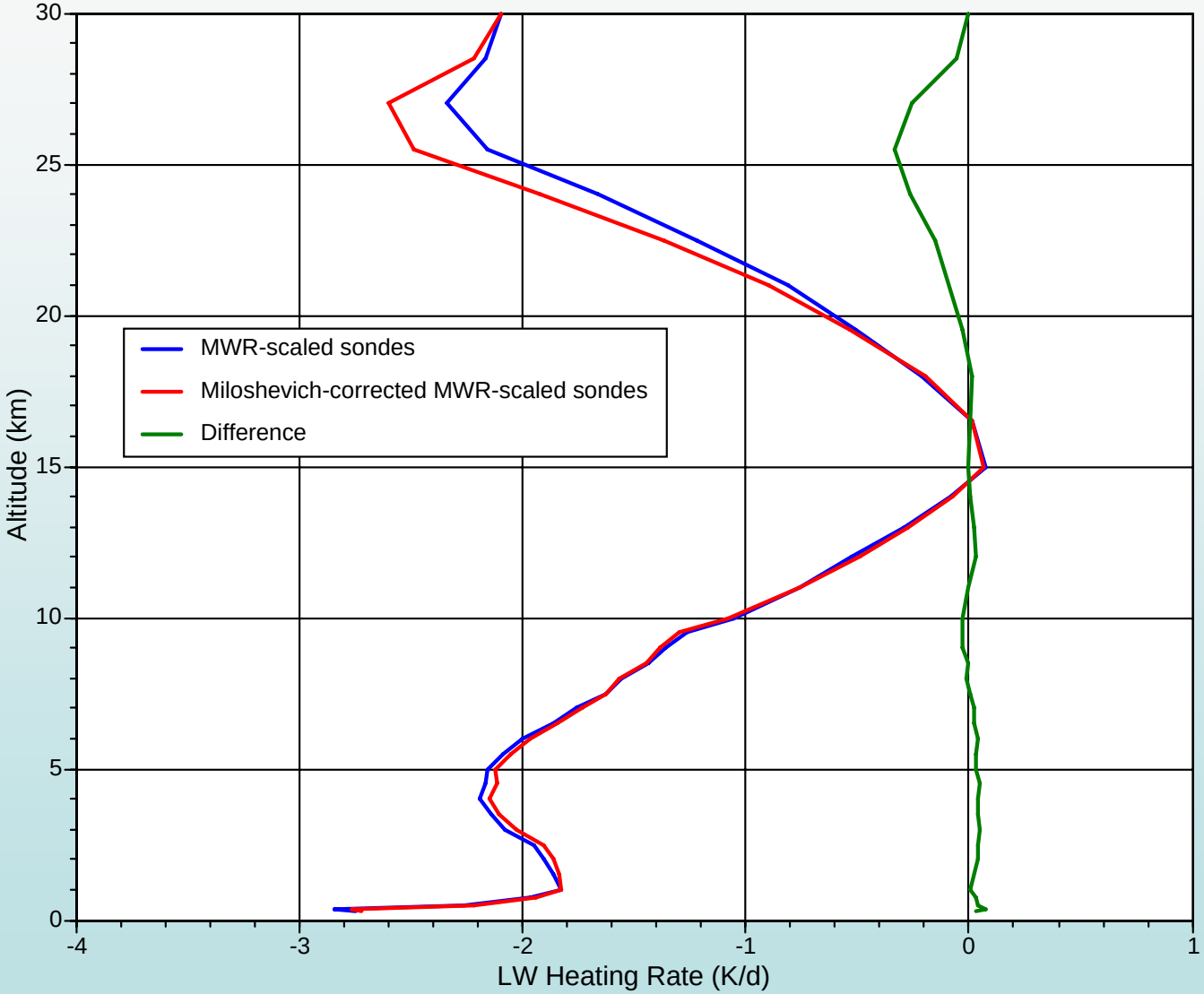
LW Heating Rates at SGP for 2000 for Ice Cloud Cases

Comparing Heating Rates: Two Ice Cloud Property Retrievals



Clear-sky LW Heating Rates at SGP for 2000

Comparing Heating Rates: Effect of Miloshevich-Corrected Sonde Profiles



Direct Input of Cloud Property Retrievals into BBHRP

- All BBHRP trials of alternate cloud property retrievals have been coded by BNL
  - Microbase w/o MWR, Dong-Mace, Frisch, Matrosov
- More such trials desired ⇒ direct path into BBHRP has been designed:

float Heights(nheights) ;	Heights:long_name = "Height of Computed Value (in the center of the layer)" ; Heights:units = "m ASL" ;
float Avg_Retrieved_LWC(time, nheights) ;	Avg_Retrieved_LWC:long_name = "Retrieved, MWR-Scaled, Liquid Water Concentration in-cloud Averaged over 120 seconds" ; Avg_Retrieved_LWC:units = "g m-3" ;
float Avg_Retrieved_IWC(time, nheights) ;	Avg_Retrieved_IWC:long_name = "Retrieved Ice Water Concentration in-cloud Averaged over 1200 seconds" ; Avg_Retrieved_IWC:units = "mg m-3" ;
float Avg_LiqEffectiveRadius(time, nheights) ;	……

- First ARM PIs to use this: 1) J. Comstock
  2) B. d'Entremont/D. Mitchell

Improving BBHRP Results at NSA

- Committee formed to design plan:

  Delamere, Dunn, Jensen, Johnson, Miller, Mlawer, Shupe, Troyan, Turner

- Approach
  - Improve Mergedsounding
  - Remove ‘clutter’ from ARSCL (done - P_i-v2.3tG)
  - Redo Microbase with new Mergedsounding and clutter removed (done - BBHRP trial imminent)
  - new Shupe-Turner cloud property retrieval

BBHRP Trials Based on Current Version (1.4.1)

Trial	Description
A	Removal of unscaled sondes
B	Miloshevich (partial correction)
C	Miloshevich (full correction)
D	Matrosov ice properties
E	Frisch liquid properties
F	Dong-Mace properties
H	Time-averaging analysis (ICA using 10s data)
J	CERES overpasses using Mergedsounding
K	Every hour (GOES overpass at HH:48) using Mergedsounding
L	Improved aerosol extinction in RRTM_SW
M	Evaluation of beta-test version of newly-calibrated MFRSR data
N	Evaluation of old PIR calibration
O	Evaluation of new PIR calibration
Q	RRTM_SW with Monte Carlo Independent Column Approximation

More than 60 BBHRP versions have been created since the inception of the project.

P_i-v1.4.1tM - Evaluating New Calibration of MFRSR Data

Clear cases, spring 2000

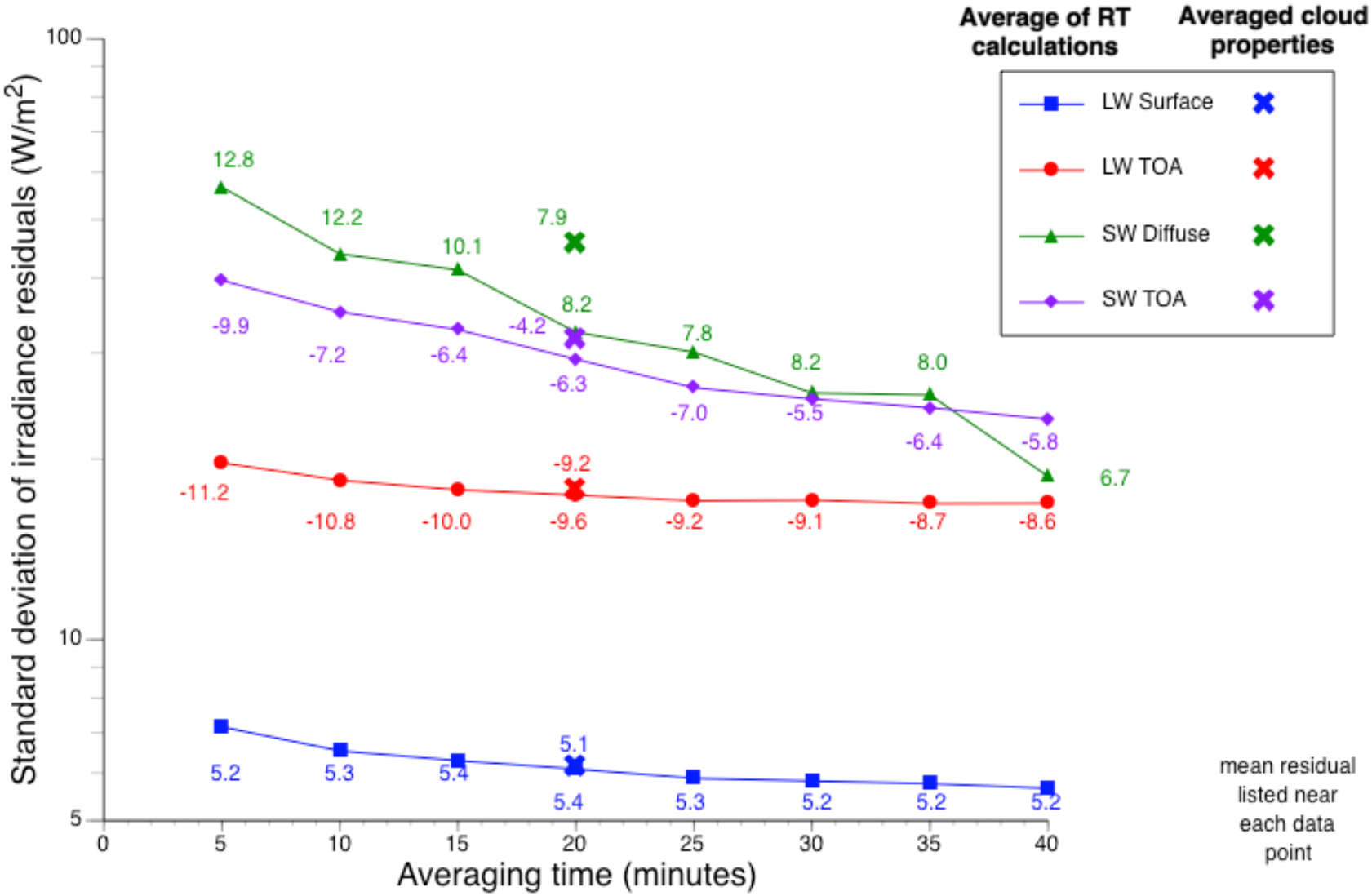
Version	Direct		Diffuse	
	Mean Residual	Stdev	Mean Residual	Stdev
1.4.1	1.9	7.4	-0.4	2.9
1.4.1tM	297.1	143.3	-3.1	29.8

Units are W/m^2

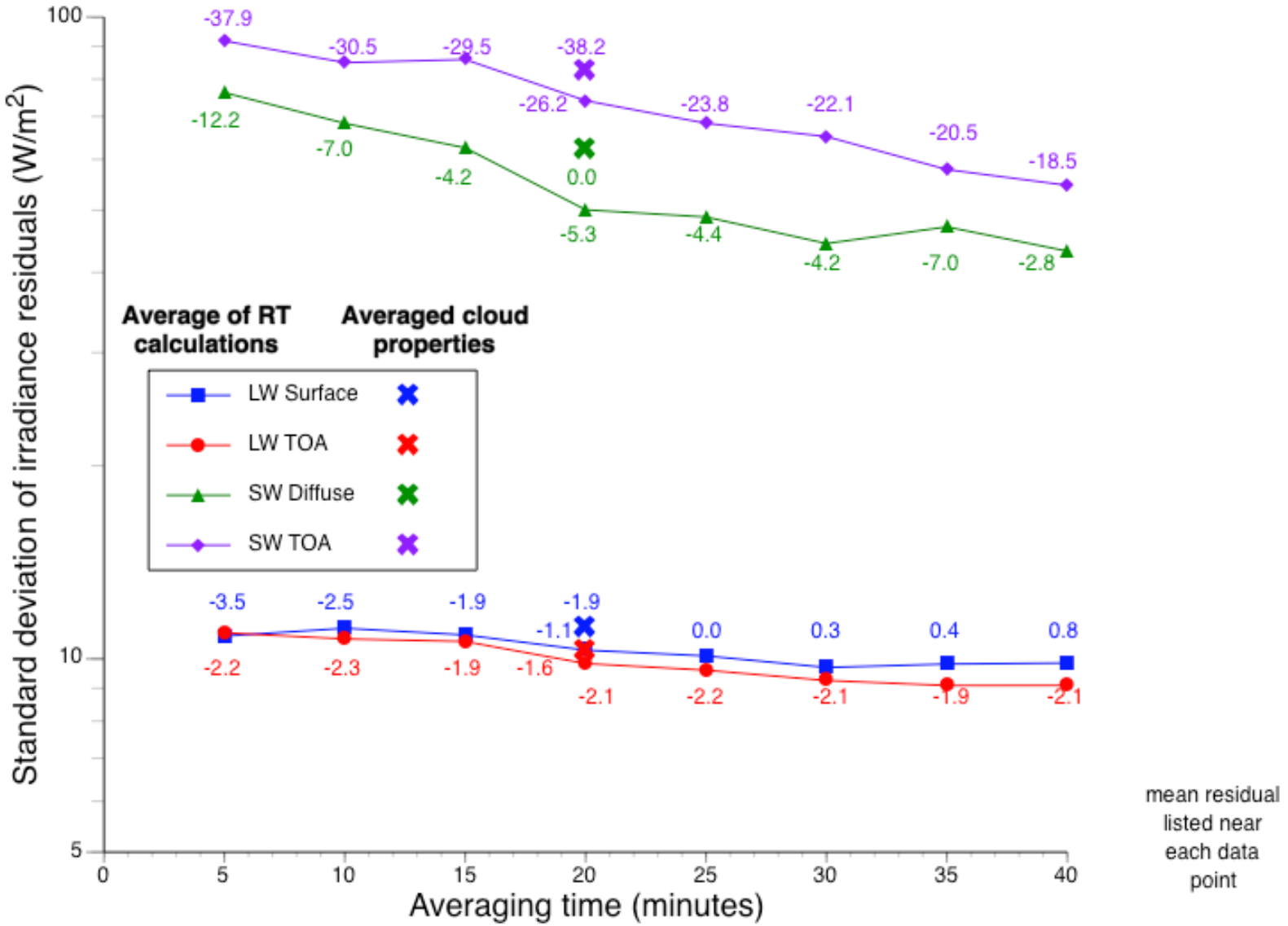
Evaluating Temporal Averaging in BBHRP

- Cloud properties used in BBHRP are 20-minute averages of Microbase cloud properties retrieved every 10 seconds
- Questions:
  - Is 20 minutes the optimum averaging time to obtain agreement with ‘instantaneous’ irradiance measurements?
  - What is the impact of averaging the cloud properties at 10s resolution over the 20 minutes instead of averaging irradiances computed every 10 s?
- Approach:
  - Compute irradiances every 10 seconds (i.e. ICA) for 2000, average results over various time periods, compute residuals every hour (HH:50) and compare to usual BBHRP approach

Effect of time-averaging on residuals: ice clouds



Effect of time-averaging on residuals: water clouds



Background for Evaluating MCICA

SW Diffuse Residuals, Overcast Cases, 3/00 - 2/01

Method	Cloud type	N	Mean residuals ($W\ m^{-2}$)	Stdev of residuals ($W\ m^{-2}$)
Reference (non-GCM)	Mixed	103	24.0	60.4
	Ice	60	-14.1	72.9
	Liquid	9	20.3	37.4
	All	172	10.6	66.3
ECMWF (GCM)	Mixed	103	88.9	104.0
	Ice	60	137.1	121.7
	Liquid	9	78.0	72.0
	All	172	105.2	111.2

For MCICA, mean residual for ice clouds is > 50 W/m^2

Summary

- BBHRP a key tool for ARM community

  Welcome input about:

  - Cloud retrievals (directly from PIs)
  - New trials
  - Interesting ways to look at heating rates
- SGP: Mature, but still improving

  Return to grid cell

  NSA: Improvement plan in place, being implemented

  PYE: Next
- Journal articles in works
- Optimal averaging time for agreement with instantaneous fluxes: 30-40 minutes

Web sites: //engineering.arm.gov/~shippert/BBHRP

//iop.archive.arm.gov/arm-iop/0pi-data/mlawer/