BBHRP: A Testbed for Cloud Retrieval Evaluation?

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Introduction to BBHRP

- BroadBand Heating Rate Profile Project
  - Concept developed by Eli Mlawer (2002)
  - Extension of LW Quality Measurement Experiments (QMEs)
  - Designed to provide:
    - broadband closure analysis
    - vertical profiles of LW and SW heating rates for all sky conditions
- Procedure:
  - Takes input profiles of:
    - Atmospheric state
    - Cloud properties
    - Aerosol properties
  - Using RRTM model, calculates:
    - Broadband surface and TOA fluxes
    - Radiative heating rate profiles
- Outputs:
  - 1-min files containing vertical profiles of cloud, aerosol properties and calculated fluxes/heating rates
  - 30-min files containing average fluxes/heating rates and residuals compared to observed surface and TOA fluxes

Brief BBHRP History

- Early days:
  - Input datasets were not available or not standardized or mature; development time went into identifying issues and developing work-arounds
  - Development of Microbase product used BBHRP flux residuals to evaluate algorithm decisions
  - Focus on analysis of BBHRP residuals in research mode identified major issues and led to improvements in various input datasets and methodology
- "Mature" stage:
  - Ver1.5 (SGP)
    - Have run 6 years
  - Ver2.5 (NSA)
    - Have run 2 years
  - Input datasets and methodology standardized and (mostly) frozen
  - Part of original BBHRP plan was to create 'test suite' for improved retrievals through analysis of closure results (Mlawer et al. 2002)
  - Develop testbed idea as an ARM community tool for evaluation of PI retrievals

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Testbed Concept

- Flux closure is a metric for evaluating cloud retrievals
  - Agreement in observed/calculated fluxes implies good retrieved cloud properties
- Use of BBHRP framework as a community testbed for evaluation of PI retrievals provides:
  - Consistent set of radiative transfer calculations, input fields, and observed fluxes for evaluation of PI retrievals
  - Benchmark set of calculations based on standard BBHRP runs
  - Auxiliary inputs; PI only has to provide retrieval dataset to be evaluated, rather than developing full set of model inputs
  - Use of Infrastructure resources to run radiative transfer computations
- Initial application to cloud retrievals; but could test any aspect of input (aerosol, atmospheric state, etc.)

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Issues w/ Current Implementation

- BBHRP was originally developed more in research mode than as a VAP
- Code Improvements are needed to run operationally:
  - Options are set within scripts rather than parameter file
  - Code/scripts do not have good error checking; reasons for missing output files have to be tracked by hand
  - Code produces thousands of output files per run – clogs DMF computers; leads to memory and processing errors
  - Code currently outputs 400 Gb/year of auxiliary files
- Additional development is needed for testbed approach:
  - Complete documentation of BBHRP process and input datasets (update website and write technical report)
  - Development of simple set of checks for input datasets
  - Development of standard set of analysis plots

Possible Testbed Paths

- PI Testbed
- Working Group Testbed

Possible Testbed Paths

- PI Testbed
  - Evaluate PI retrieval against standard microbase for any site/period for which standard BBHRP has already been run
  - PI provides cloud retrieval in standard format
  - PI analyzes results
- Example - Shupe-Turner comparison at NSA
  - Turner et al. poster
  - Input files provided in standard format
  - BBHRP run for one year
  - Matt/Dave analyzed results; found error in aerosol methodology (now corrected)
  - BBHRP re-run with new version of Shupe-Turner and new aerosol methodology for 2 years
  - Shupe-Turner and original Microbase results will be archived as Evaluation Product
- Outcome
  - Shupe-Turner produces smaller residuals than microbase at NSA

PI Testbed (cont.)

- Advantages:
  - Requires less infrastructure work
  - More flexibility for PIs
- Possible Issues:
  - Likely fewer retrievals involved – only currently funded PIs
  - Who decides that a retrieval is 'better' for a certain cloud type? And what does that mean? What is the path forward?
  - Resource prioritization and limitations
    - How do we prioritize PI requests?
    - Can we run multiple years (4 days comp time/year) and multiple iterations of BBHRP for PIs?
    - Can we develop BBHRP 'package' so PIs can run it themselves?
  - Should all BBHRP heating rates/fluxes produced with infrastructure support be archived?

Possible Testbed Paths (cont.)

- Working Group Testbed
  - Working group or focus group decides on an intercomparison
  - Infrastructure works with PIs to get retrievals in standard format
  - Infrastructure provides missing inputs (i.e. surface albedo)
  - Shorter time period or case studies run with multiple retrievals
- Example - CLOWD Intercomparison at PYE
  - Lo et al poster; Comstock talk in RACORO session (Tues aft)
  - Ran 5 retrievals for 1-month period through BBHRP
  - Infrastructure efforts to:
    - put retrievals in required format
    - develop methods for retrievals without vertical information
    - develop surface albedo input
    - analyze results
  - Expected outcomes:
    - CLOWD-recommended retrieval for thin water clouds
    - Group publication
    - BBHRP runs (and retrievals?) will be archived

Working Group Testbed (cont.)

- Advantages:
  - Can be a true “inter-comparison” with multiple retrievals
  - Broader participation; more conclusive results
  - Focus or working group support can lead to a recommendation of best retrieval or path forward to improve microbase
- Possible Issues
  - Requires more infrastructure investment
    - To get broad participation, need infrastructure support
    - How to prioritize effort against other VAP efforts?
    - How to get participation from non-ARM funded PIs?
  - “Publicizing” retrieval performance
    - Are names attached to retrieval performance?
    - Can a PI pull out of the intercomparison if their retrieval performs badly?
    - Should all retrieved cloud properties and BBHRP runs be archived?

Issues for Discussion

- Continue both paths forward for testbed or pick one?
- Prioritization of spending effort on code improvement or development vs doing more calculations
- Require archiving of cloud retrievals/results if infrastructure efforts used?
- Develop a version PIs can run themselves?
  - On DMF or stand-alone?

Issues for Discussion (cont.)

- BBHRP should not be the only metric for retrieval evaluation!!
- BBHRP will have difficulty evaluating retrievals for:
  - Broken cloud fields
  - Thin cirrus
  - Precipitating clouds
  - Multi-layer cloud systems
- BBHRP is only an indirect metric of cloud properties
  - (high LWP, small particle size) and (low LWP, large particle size) can give similar flux if optical depth is the same

Current BBHRP Inputs

- Inputs to current version (v1.5) of BBHRP are:
  - atmospheric profile information (MergedSounding + TOMS ozone)
  - cloud properties (MicroBase)
  - surface properties (spectral albedo)
  - aerosol properties (AerosolBestEstimate + MFRSR)
  - measured surface/TOA fluxes (for analysis/evaluation of results; BEFlux/QCRad and GOES/CERES)
- Current methodology:
  - 1-min IPA calculations; 8-streams
  - Fixed 500-m clear sky grid
  - Higher resolution (100m) cloudy sky grid, where cloud exists
  - ABE aerosol when cloudy; MFRSR AOD and SSA for clear skies
  - 30-min averages around satellite overpass time for residuals

BBHRP Runs Currently Processed

- SGP
  - Have processed 6 years of ver1.5 at SGP (Mlawer et al poster)
  - 200003 – 200102 available in archive as Evaluation Product
  - 200103 – 200602 processed and being evaluated
    - Available from Sally on request; will be archived in April/May
  - Microbase development intercomparison at SGP:
    - Have run: Microbase, Frisch, Sengupta, Microbase unscaled
    - Will run: Matrosov, Boudala
- NSA
  - Processed 2 years at NSA (2004-2005) using Shupe-Turner (Turner et al poster)
  - Shupe-Turner and standard Microbase runs will be archived
- CLOWD-BBHRP Intercomparison
  - Using BBHRP to evaluate retrieval algorithms for CLOWD-type clouds at Pt Reyes (Lo et al poster)
  - Have calculated heating rates and fluxes for one month at Pt Reyes for five different retrieval algorithms