Our goal
To learn when and why we succeed or fail to achieve radiative flux closure (RFC) under cloudy conditions in BBHRP.

Our tools
The BBHRP dataset itself and radiative fluxes calculated as in BBHRP (aka our “shadow” dataset) with two pairs (SW and LW) of additional RT algorithms: from CAM3 and from GSFC’s fvGCM. BBHRP uses AER’s SW and LW RRTM codes.

How do we learn from such an approach?
If the RT models generally agree, but disagree with the observations for particular types of conditions, there is greater likelihood that there are flaws in the input. If on the other hand, for the same conditions the models give a wide range of answers, with some being close and some being far from the observations, flaws in the failing models are likely.

Specific tests
We examine:
• The correlation of RFC errors between RRTM and the other models
• The RFC rmse’s for all models under different cloud conditions
• The RFC absolute mean deviation under different cloud conditions
• GSFC and CAM errors for small and large RRTM errors

Ice vs. mixed vs. liquid clouds

RFC errors (obs-calc) calculated for clouds containing ice crystals. Clockwise from top: Percent errors in downwelling SFC SW diffuse flux for the CAM and GSFC RT codes vs. those for RRTM for overcast clouds identified to consist exclusively of ice crystals; similar, but for overcast mixed-phase clouds; for overcast mixed-phase clouds that are relatively homogeneous; for overcast mixed-phase clouds with more liquid than ice water. Note the greater scatter (but still correlated errors) for pure ice clouds and the significant tightening of the error dispersion only when significant water amounts coexist with ice. Based on BBHRP version 1.4.11K data (like everything in this poster).

How close are the models?

RFC rmse’s for different radiation budget components as function of cloud type (phase, cloud fraction). TOA rmse’s are worse than SFC, SW rmse’s are worse than LW, and overcast is not necessarily better than average cloud conditions. RRTM is almost always better (LW TOA has almost all exceptions). SW SFC is diffuse.

High and low RRTM errors

RFC % SW SFC errors (obs-calc) vs. TWP for cases with RRTM diff errors greater than mean ± 2sdev. For the thin and moderate TWP’s (~55% of cases) RRTM SW diff errors do not correlate with the errors from the other two models. However, for large TWP’s, the errors collapse (left). Much better correlation is seen for total (diff+dir) flux (right), indicating differences in partitioning total flux into direct and diffuse.

Summary of findings
Our analysis shows that:
• There is broad consistency between the BBHRP (RRTM) closure errors and those of the “shadow” dataset, pointing to problems in the values or interpretations of the input.
• Inter-model inconsistencies are greater for ice and mixed-phase clouds.
• Many large SW SFC closure errors are associated with very thick clouds; for thin clouds the models differ in the partitioning of total flux into direct and diffuse.
• RRTM performs overall better than the other models.
• When all radiation budget components are accounted for (SW & LW, TOA & SFC) the overall flux closure error is ~10%. This is driven largely by the LW, but is still remarkable.