A Use Case: the Operational Ground-Based Retrieval Evaluation for Clouds (OGRE-CLOUDS) Framework

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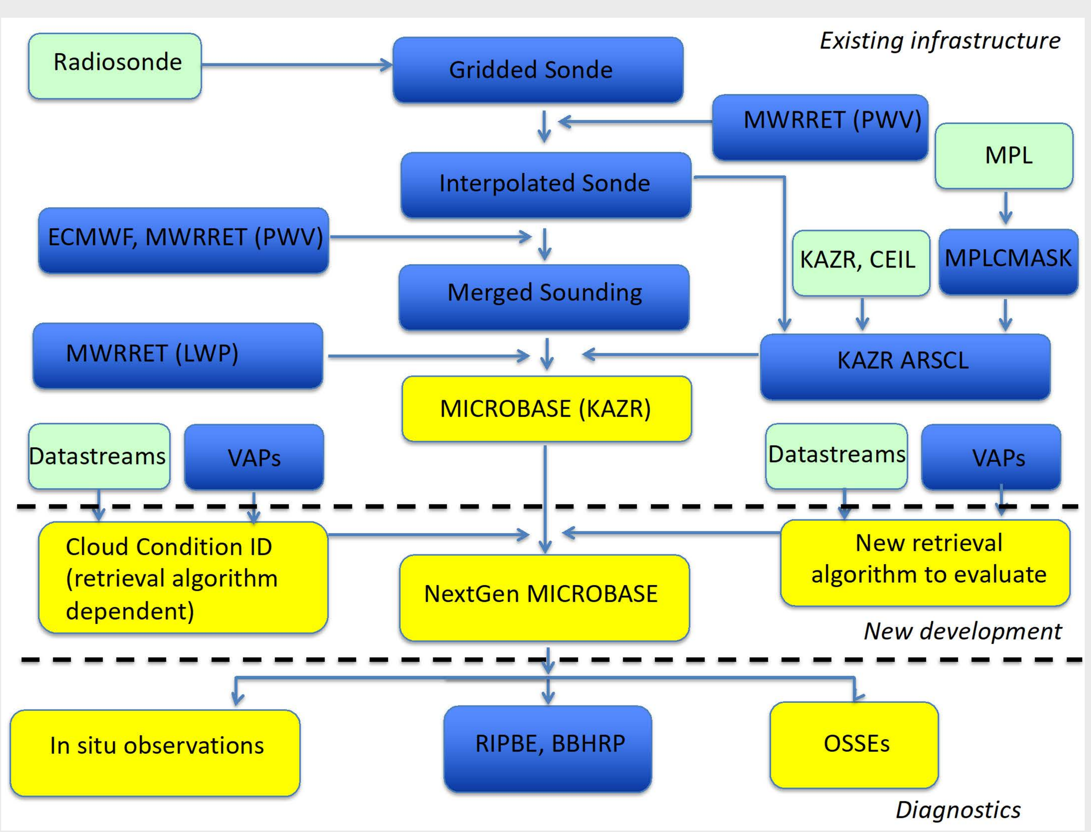
ABSTRACT

The OGRE-CLOUDS framework effort aims to: 1) produce vertically resolved cloud and precipitation properties (with accompanying uncertainties) in the column above an ARM site under all cloud conditions with 2) the ability to implement new, conditional (i.e., applicable under specified cloud conditions) retrieval techniques and 3) a diagnostic package for comparison and evaluation of the new retrieval. The first phase integrated the MICROBASE algorithm into the ARM Data Integrator (ADI), and added quantification of uncertainties for the cloud microphysical quantities. This poster presents a use case from the second phase of development of the OGRE-CLOUDS framework, implementing a radar-lidar retrieval technique for ice microphysics, and evaluation using broad-band radiative closure. Steps including the production of a transient radiatively important parameters best estimate (RIPBE) product using the new MICROBASEPLUS product, calculation of radiative flux profiles using the Broadband Radiative Hating Rate Project (BBHRP) codes and evaluation of the retrieval products through radiative closure.

1. PROJECT WORKFLOW



2. CLOUD CONDITION ID (CCI)

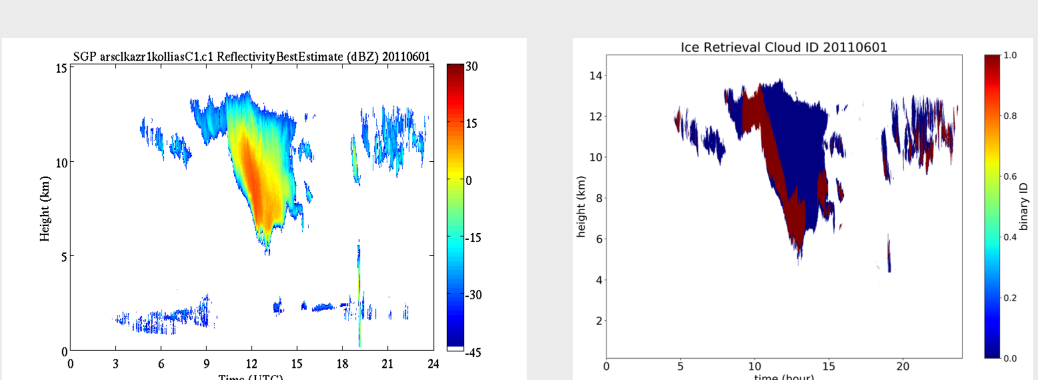
The CCI outputs a binary mask in time-height space identifying when and where the new algorithm can be properly applied. Each new conditional retrieval to be evaluated in the OGRE-CLOUDS framework will require the CCI to facilitate the substitution into the continuous background microphysical product.

Demonstration CCI

Development of the OGRE CLOUDS framework includes the implementation and testing of CCI on the new retrieval algorithms for evaluation:

Ice Retrieval Algorithm – retrieval is performed over ice/snow layers, if:

1) temperature lower than -20 degrees C
2) no lower liquid cloud
3) both radar measurements and lidar attenuated backscatter measurements exist



Demonstration of cloud ID binary mask: new ice retrieval results will be substituted into the background microphysical product (i.e., microbasekaplus) where the CCI mask has a value of by 1. Where CCI has a calue of 0, the microbasekapluse results remain.

3. IMPROVEMENTS TO MICROBASE: MICROBASEPLUS

- A perturbation method (Zhao et al. 2013) has been used to estimate *uncertainties* in the microbase output.
- **Unit testing** has been added to the product code focusing on the determination of cloud phase, and cloud L/IWC and liquid/ice effective radius.
- The microbase code has been **modularized** to separate the cloud phase determination, and liquid, ice and mixed phase cloud microphysics retrievals.

With these improvements to the MICROBASE code, the resulting product MICROBASEPLUS, will serve as a background cloud microphysics field (available under all cloud conditions) onto which new retrievals may be implemented, inserted and tested for the cloud conditions under which they are applicable. ***In this manner, a continuous cloud microphysical product will always be retained, but with opportunities for improvements under given cloud conditions following a set of diagnostic tests.***

4. MICROPHYSICS AND UNCERTAINTIES FROM MICROBASEPLUS

Initial implementation has focused on the MC3E time period (22 April through 06 June 2011) at the SGP fixed site. This period was chosen because of optimal operations of the ARM instrumentation, availability of previous BBHRP output, and the availability of in situ aircraft observations.

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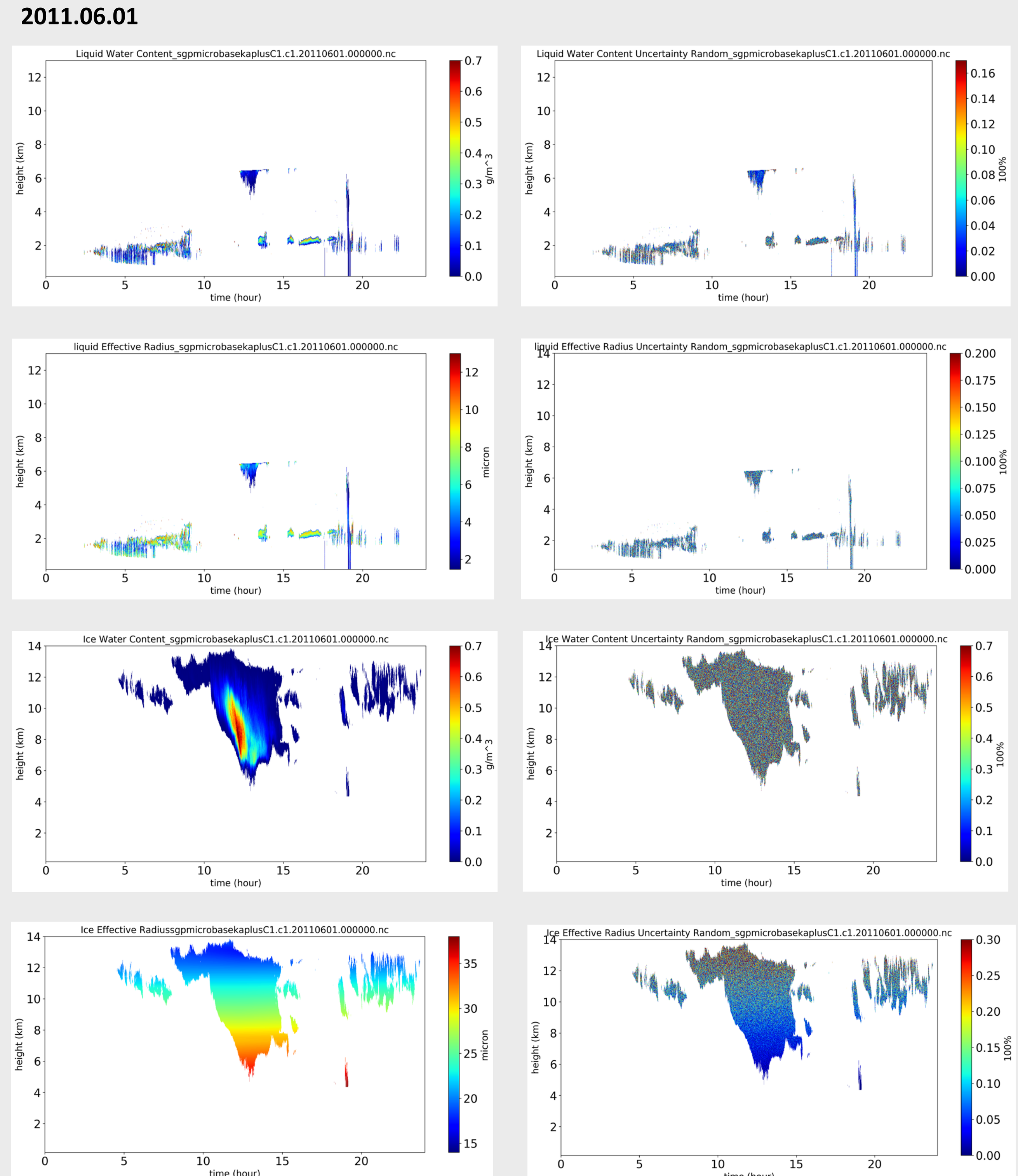
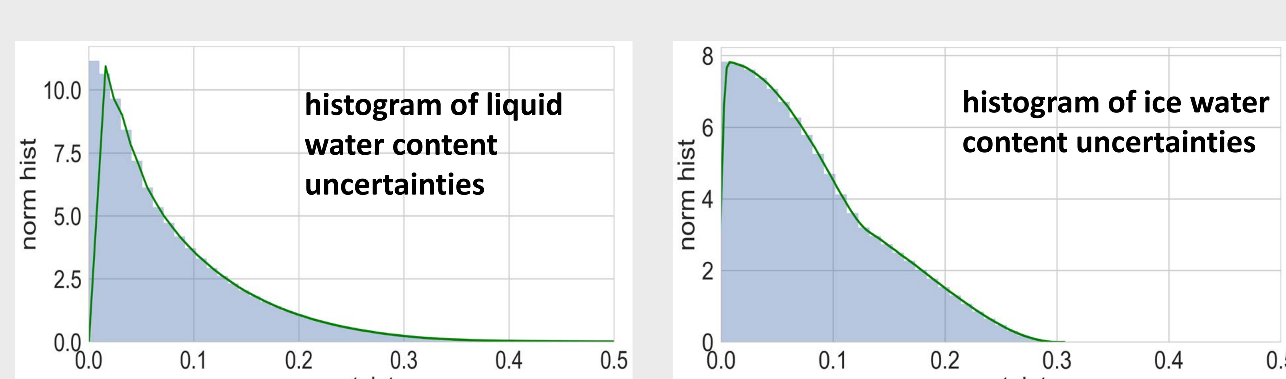
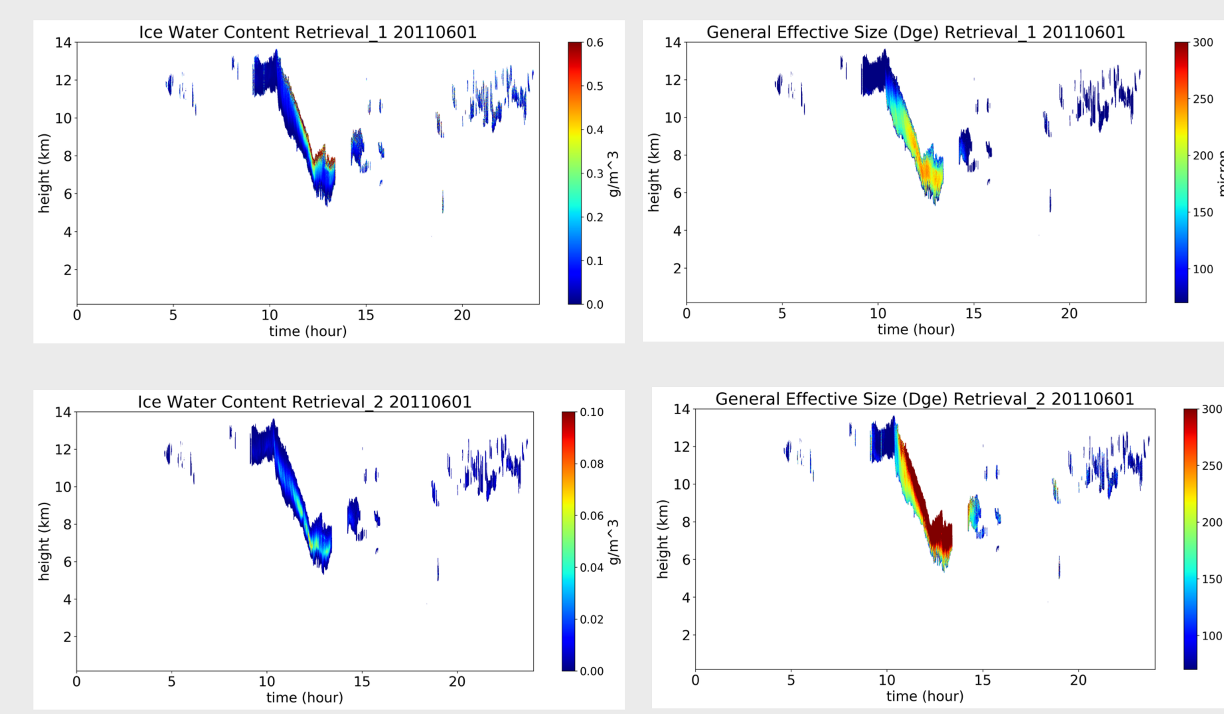


Uncertainty distribution for the MC3E period:
Normalized histograms and the estimated PDF present the distributions of liquid/ice water content uncertainties.



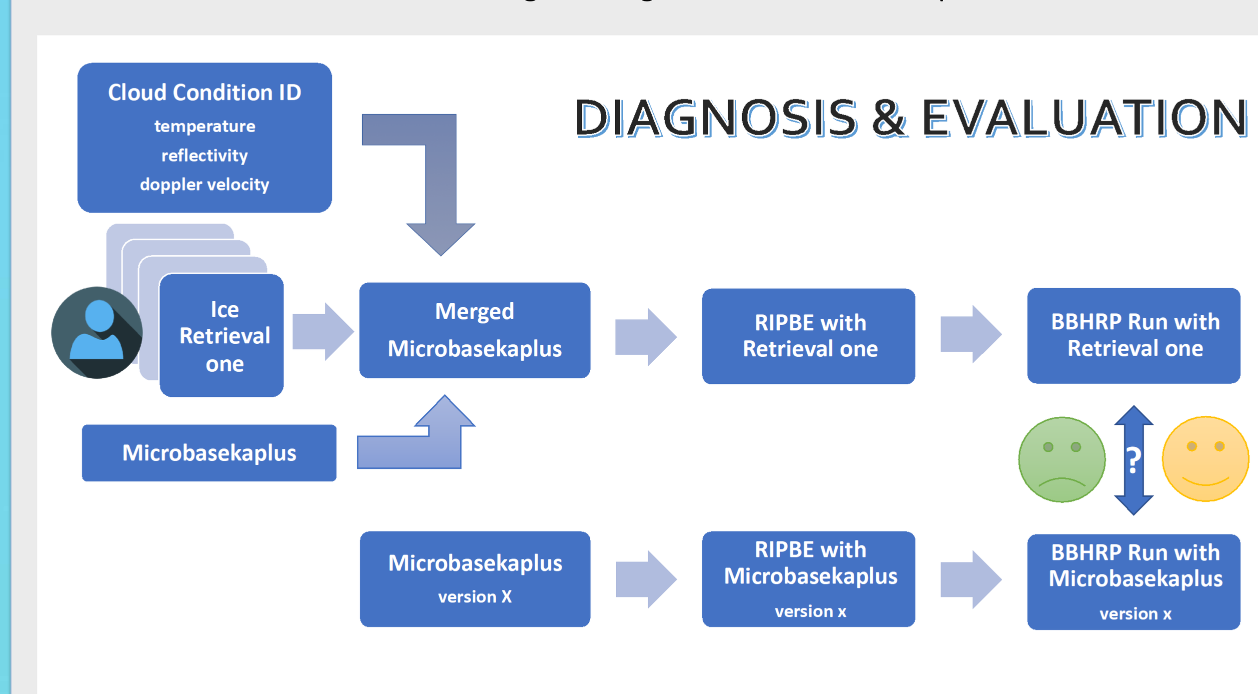
5. A USE CASE OF OGRE FRAMEWORK: IWC AND D_{ge} RETRIEVAL ALGORITHM

Ice water content (IWC) and general effective size (D_{ge}) profiles are retrieved from combined ground-based lidar and radar measurements using algorithms developed by Wang and Sassen (2002). The retrieval algorithms take lidar extinction coefficient (σ) and radar reflectivity factor (Ze) as inputs. Inversion of lidar attenuated backscatter measurements using Fernald's (1984) method with an assumption of the extinction-to-backscatter ratio of 25 for cirrus ice particles is employed to obtain particle σ profiles (Retrieval one). In addition, to test the sensitivity of OGRE-CLOUDS framework, σ profiles are also estimated using calibrated lidar total attenuated backscatter coefficient profiles (Retrieval two)

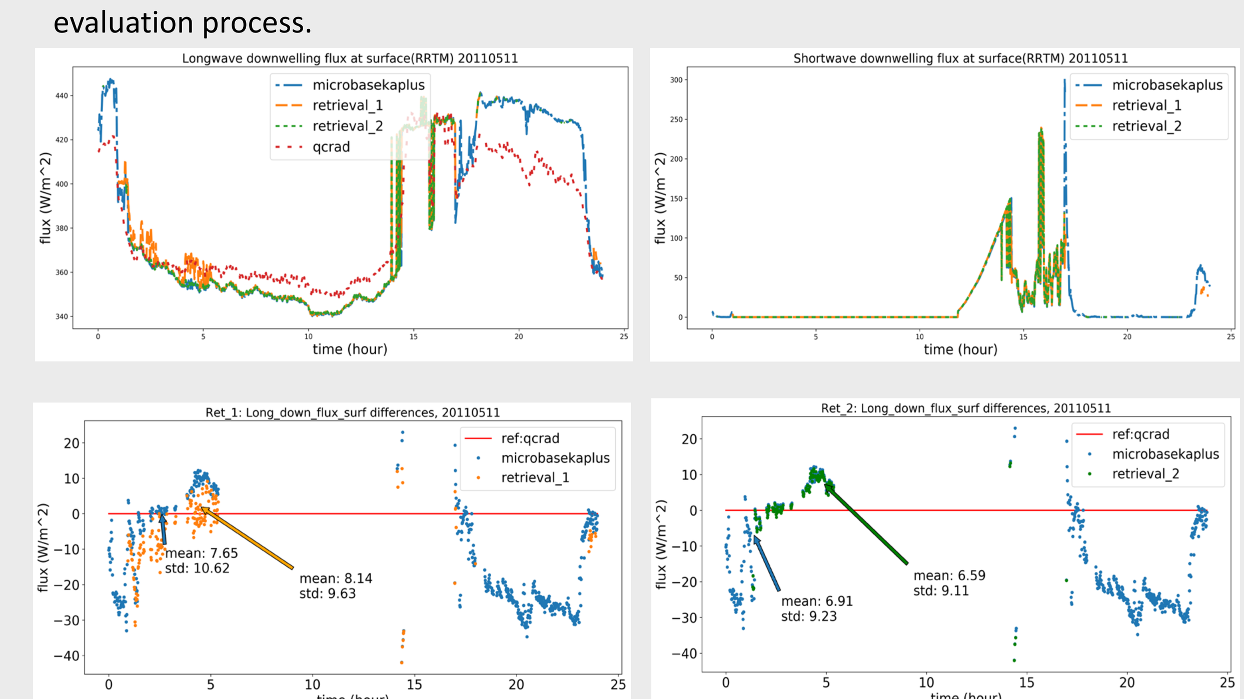


6. DIAGNOSIS AND EVALUATION

A set of diagnostic tests under given cloud conditions have been done for ice retrieval one and ice retrieval two following the diagnosis and evaluation procedure.



Ret_1 and Ret_2 are evaluated by comparing downwelling longwave and shortwave surface flux results from BBHRP run for each retrieval, with the flux data from the initial BBHRP run for microbasekaplus. Downwelling longwave and shortwave surface flux data from observation datastreams (qcrad in this case) are also used in the evaluation process.



7. FUTURE WORK

Focus of next steps will be on:

- **Refinement of the evaluation framework**
  - Definition of radiative flux closure criteria for identifying improved retrieval
  - Framework for comparison to in situ aircraft observations (when available)
- **Incorporation of additional new retrievals**
  - Identify candidate retrieval algorithms and collaborations.
  - Precipitating cloud systems are next target.
- **Consider operational framework**
  - Current framework requires ARM infrastructure collaboration
  - Is there a pathway to user implementation?

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