Toward the Operational Ground-Based Retrieval Evaluation for Clouds (OGRE-CLOUDS) Framework

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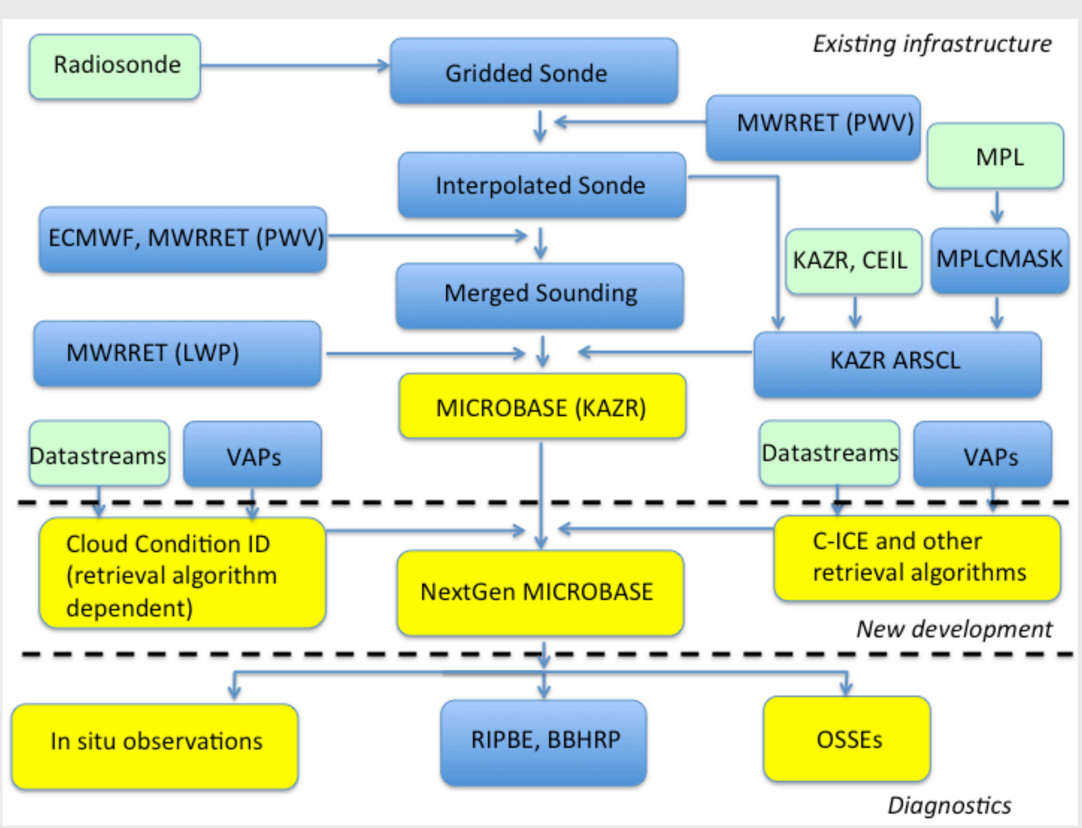
Abstract

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. This poster summarizes the results from the first phase of the development efforts of the OGRE-CLOUDS framework, an improved version of the MICROBASE algorithm, MICROBASEPLUS, including: 1) full integration of the MICROBASEPLUS algorithm into the ARM Data Integrator (ADI) 2) and quantification of uncertainties of the cloud microphysical quantities using a perturbation method first applied through the ARM Quantifying Uncertainties in Cloud Retrievals (QUICR) focus group.

Project Workflow



OGRE-CLOUDS *framework split generally into "existing infrastructure", "new development", and "diagnostics. Ongoing development activity includes:*

- The use of an improved version of the MICROBASE (Dunn et al. 2011) algorithm, MICROBASEPLUS, as the underlying product. MICROBASEPLUS is fully integrated into the ARM Data Integrator (ADI), include regular unit testing, quantification of uncertainties (incorporating the work of Zhao et al. 2013) and improved modularity to facilitate testing of new algorithms.
- Each new algorithm to be implemented needs an accompanying quantitative CLOUD CONDITION ID (CCI) algorithm that defines the conditions for which the retrieval algorithm can be applied.
- Multiple diagnostics of the new retrieval algorithm compared to MICROBASEPLUS
- Implementation and testing of state-of-the art retrieval algorithms for ice clouds and drizzling clouds

Improvements to MICROBASE: MICROBASEPLUS

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

With these improvements 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.***

References

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Szyrmer, W., A. Tatarevic, and P. Kollias, 2012: J. Geophys. Res., 117, D14203, doi:10.1029/2011JD016675.
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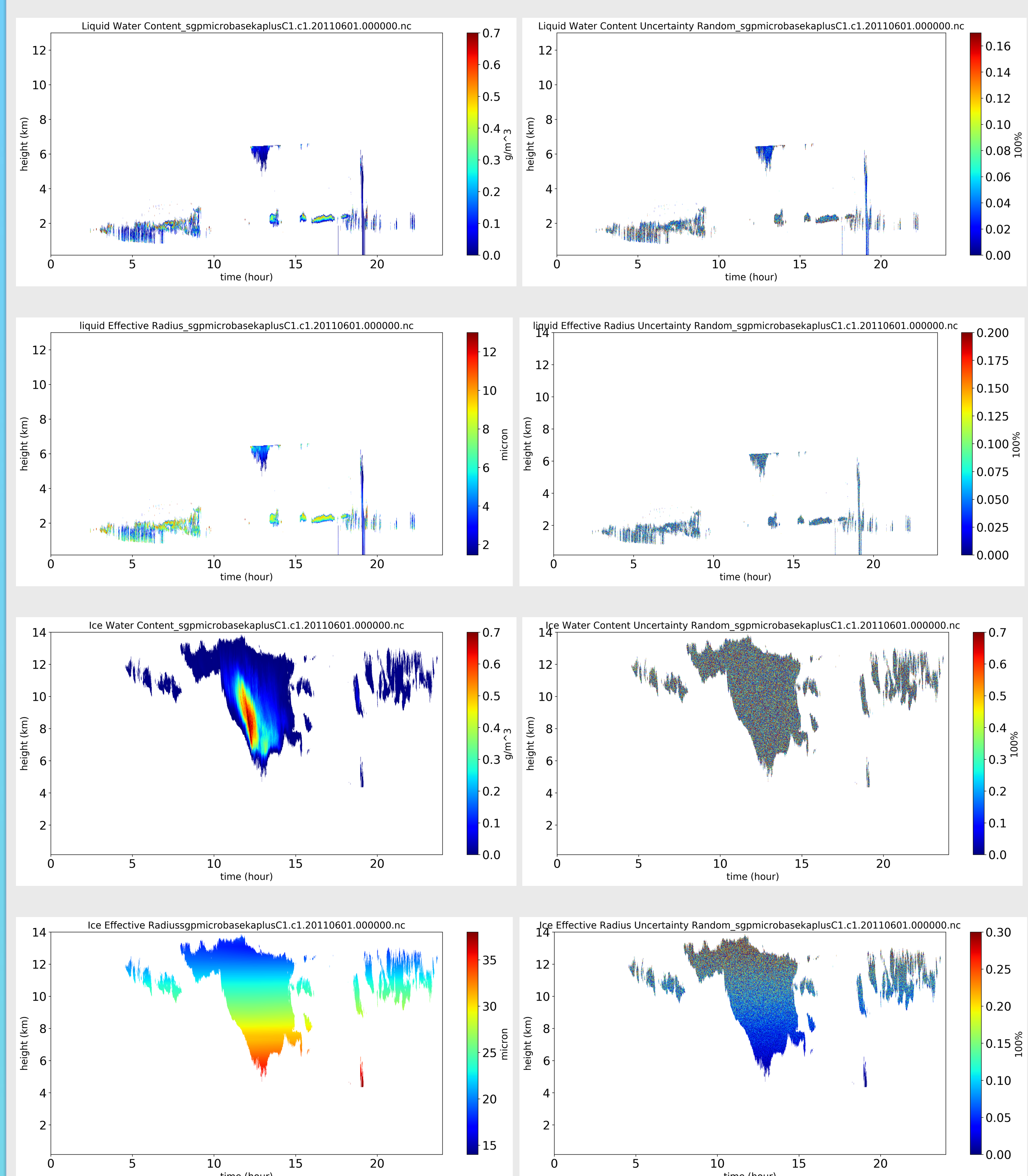
Microphysics and Uncertainties from MICROBASEPLUS

MC3E at SGP

2011.06.01



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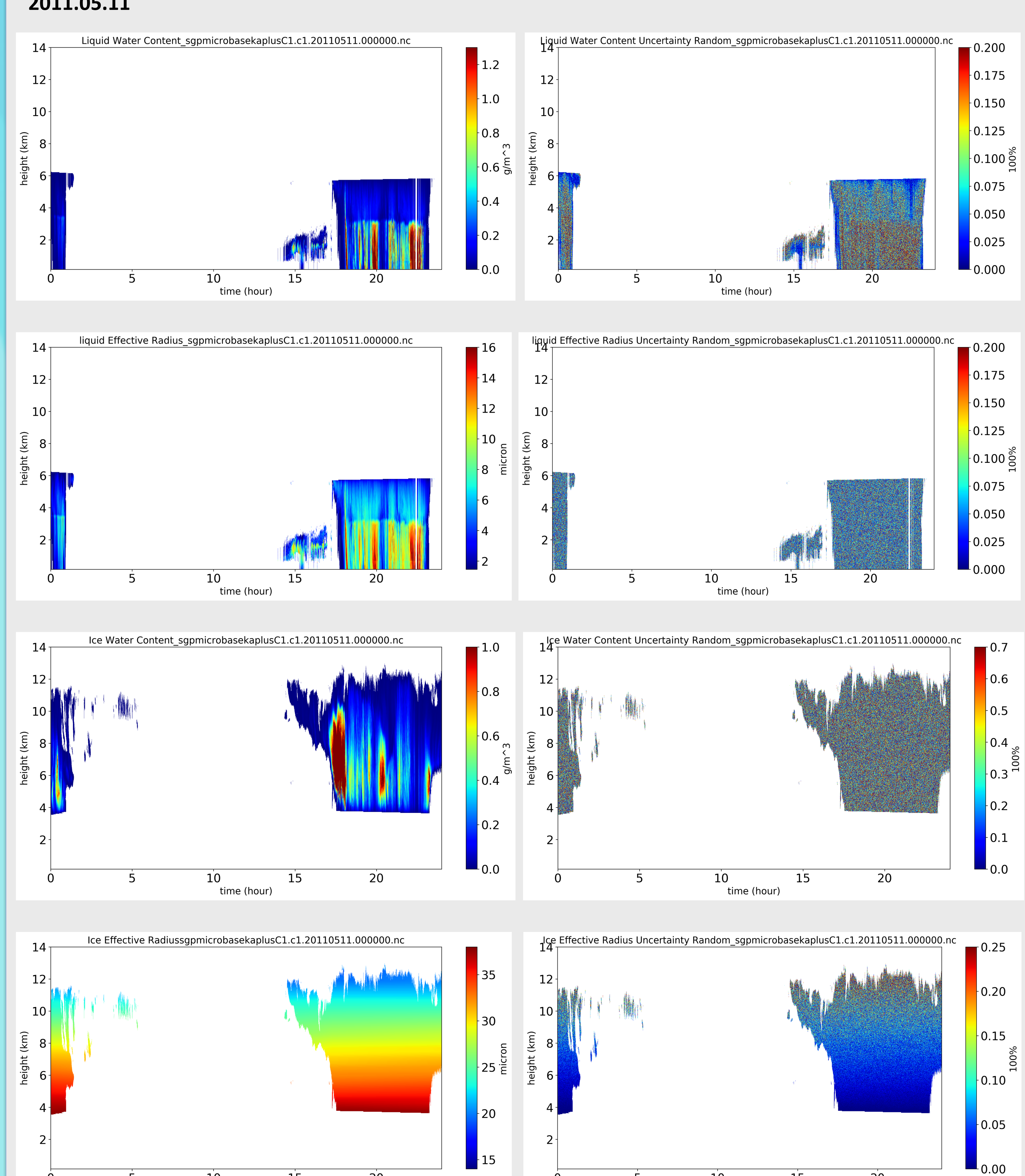


Cloud Condition ID (CCI)

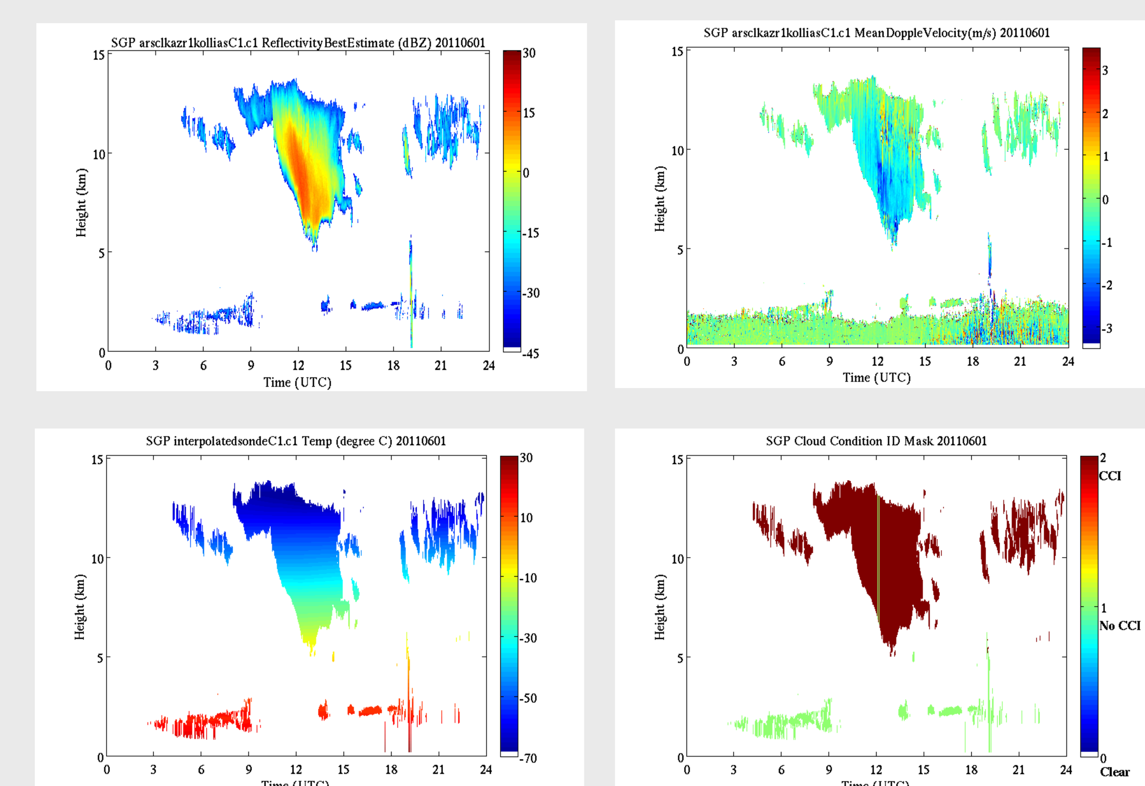
The CCI algorithm may use ARM instrument datastreams, high-order value-added products or other inputs but will likely be different for each new retrieval algorithm. **The CCI should output a binary mask in time-height space identifying when and here the new algorithm can be properly applied.**

Demonstration CCI

Development of the OGRE CLOUDS framework includes the implementation and testing CCI on the new state-of-the-art retrieval algorithms:

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

1) temperature lower than -5 degrees C,
2) maximum reflectivity less than +15 dBZ,
3) Doppler velocity in no riming conditions lower than 1.75 ms^{-1},
4) Doppler velocity in riming conditions lower than 2.5 ms^{-1},
5) cloud depth larger than 100 m.



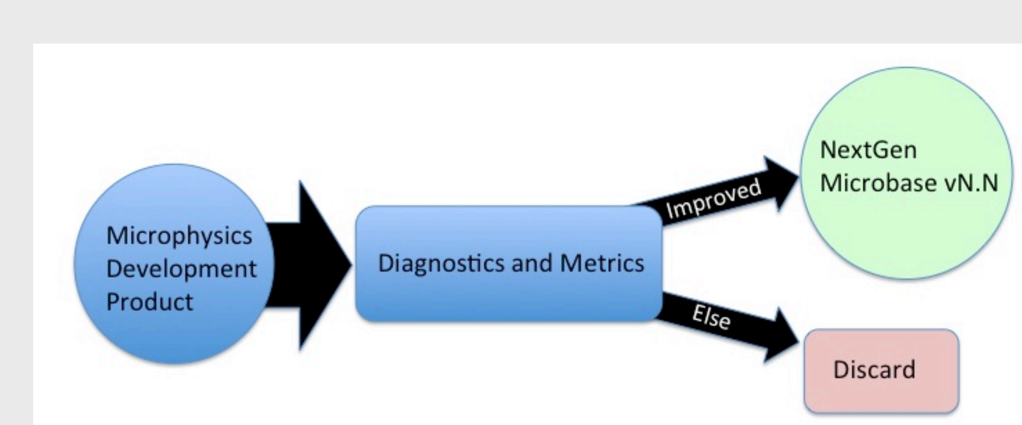
Future Work

OGRE-CLOUD framework will be demonstrated on two algorithms:

Ice and Snow Retrieval Algorithm **–** The Szyrmer et al. (2012) retrieval is performed over ice/snow layers. The algorithm applies an optimal estimation (OE) method as described in Rodgers (2000), which is a variational approach that employs Gauss-Newton method and allows a quantitative evaluation of the uncertainty of the retrieved quantities. The forward model within the OE approach maps the retrieved parameters (mean mass-weighted melted equivalent diameter D_m, and ice mass (water) content) to the measurements (radar reflectivity Z_e, Doppler velocity corrected for air motion [Kalesse and Kollias, 2013], U_D). The ice/snow particles number concentration is also retrieved as a by-product of the retrieval.

Liquid Cloud and Drizzle Retrieval Algorithm **–** Profiling cloud radar observations, combined with LWP and ceilometer backscatter measurements provide a good observational framework for the retrieval of cloud and drizzle properties in warm stratiform clouds.

- Vertical air motion and reflectivity-weighted particle fall velocity, retrieved from decomposed Doppler spectra, enables us to relate the mean Doppler velocity to the drizzle particle size distribution parameters (Luke and Kollias, 2013).
- Recent advancements in the decomposition of the radar Doppler spectrum width to its two primary components: spectra broadening due to turbulence and spectra broadening due to the different fall velocities of the hydrometeors. This enables us to relate the recorded radar Doppler spectrum width to the drizzle particle size distribution parameters (Borque et al., 2016).
- The use of the radar-lidar technique for the retrieval of the drizzle particle size distribution below the cloud base (O'Connor et al., 2005).



Diagnosis and evaluation **–** of the microphysical properties retrieved by each new algorithm with the end goal of producing a "best estimate" cloud microphysical product.

- Radiative closure through RIPBE and BBHRP
- Comparison to available aircraft in situ observations and observations that were not used as input in the retrieval algorithm
- Use of Observing System Simulation Experiments