

A Comparison of the Clouds from AVHRR Extended (CLAVR-x) Cloud Phase Algorithm with CloudSat and CALIPSO Cloud Phase

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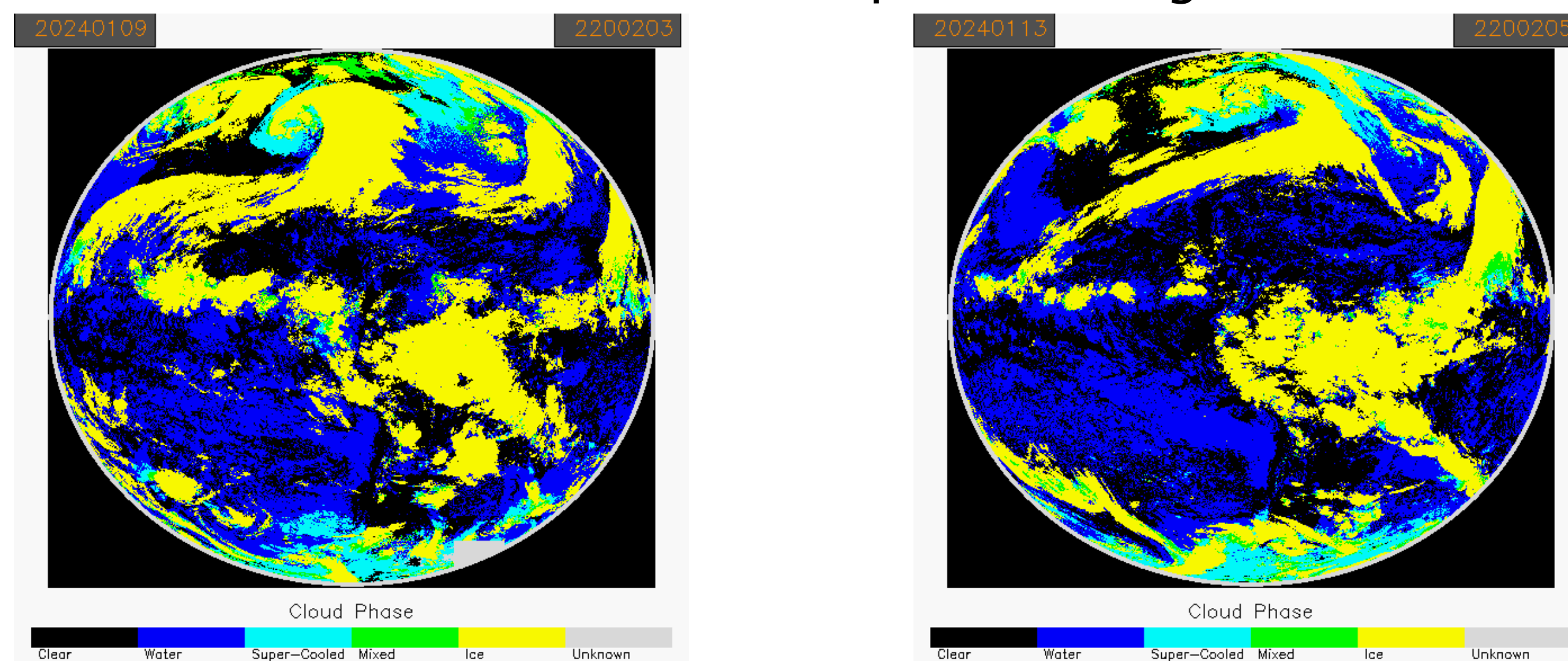
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Introduction

Cloud mask and cloud property retrievals are a critical part of the operational suite of products from operational geostationary- and polar-orbiting satellite imagers. Cloud property retrievals from active sensors, such as CloudSat and CALIPSO, provide a useful validation dataset for retrievals from passive imagers.



Cloud phase images from two recent winter storms to affect the Continental United States, 9 January (left) and 13 January (right).

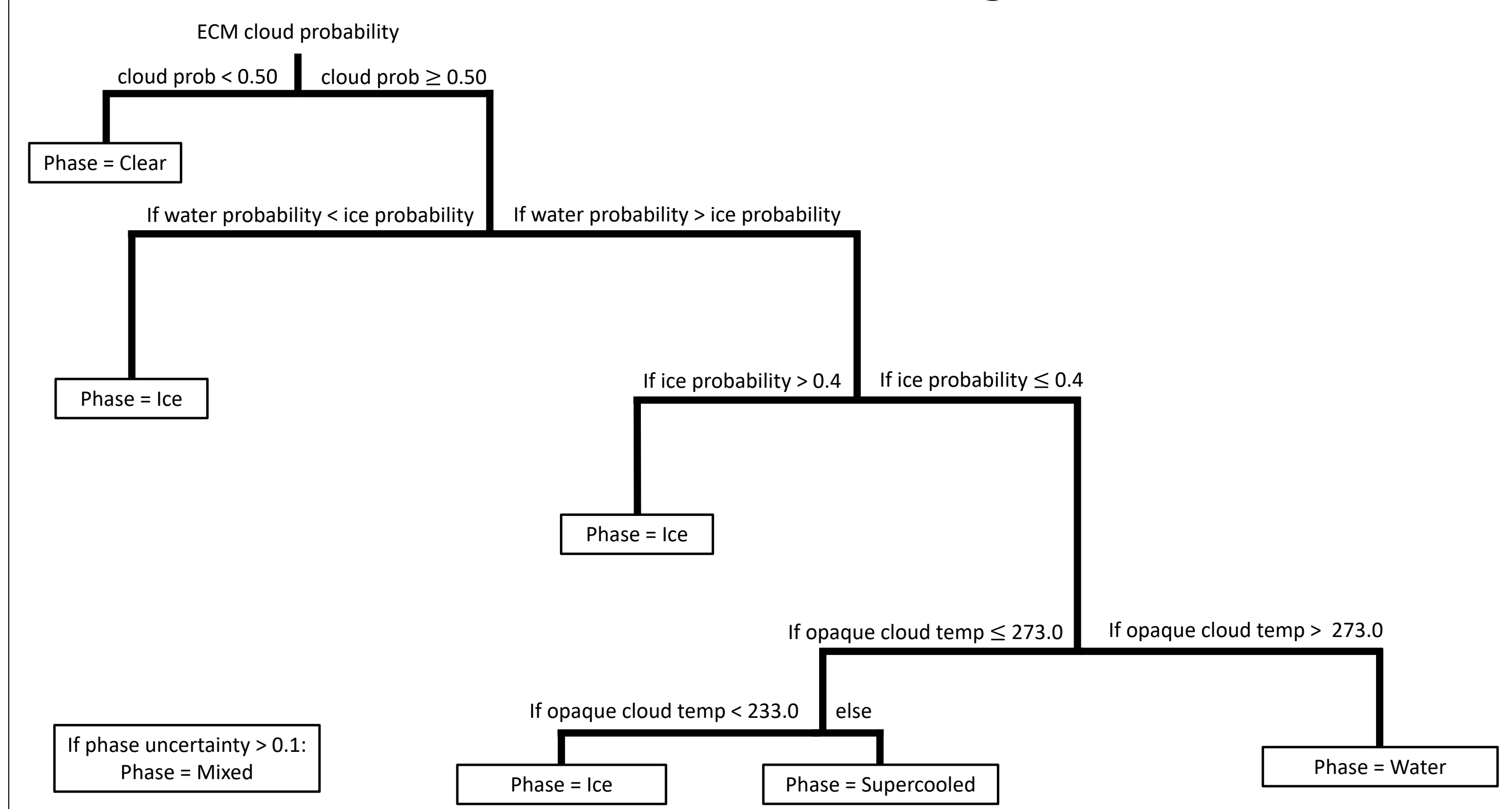
Methods

Dataset	Source	Instrument
CLAVR-x	UW-CIMSS	ABI GOES-16
2B-CLD-CLASS-lidar	CSU-CIRA	CloudSat, CALIPSO
(Sassen et al. 2008)		

We use the 2B-CLD-CLASS-lidar dataset as validation for the CLAVR-x cloud phase retrieval with GOES-16 ABI. Matchup requirements:

- Observations must be within 4 km and 10 minutes.
- Cloud top height retrievals from each dataset must be within 5000 m (identified using a comparison of cloud top heights for phase matched data). This ensures the two sensors are looking at the same cloud layer for the validation

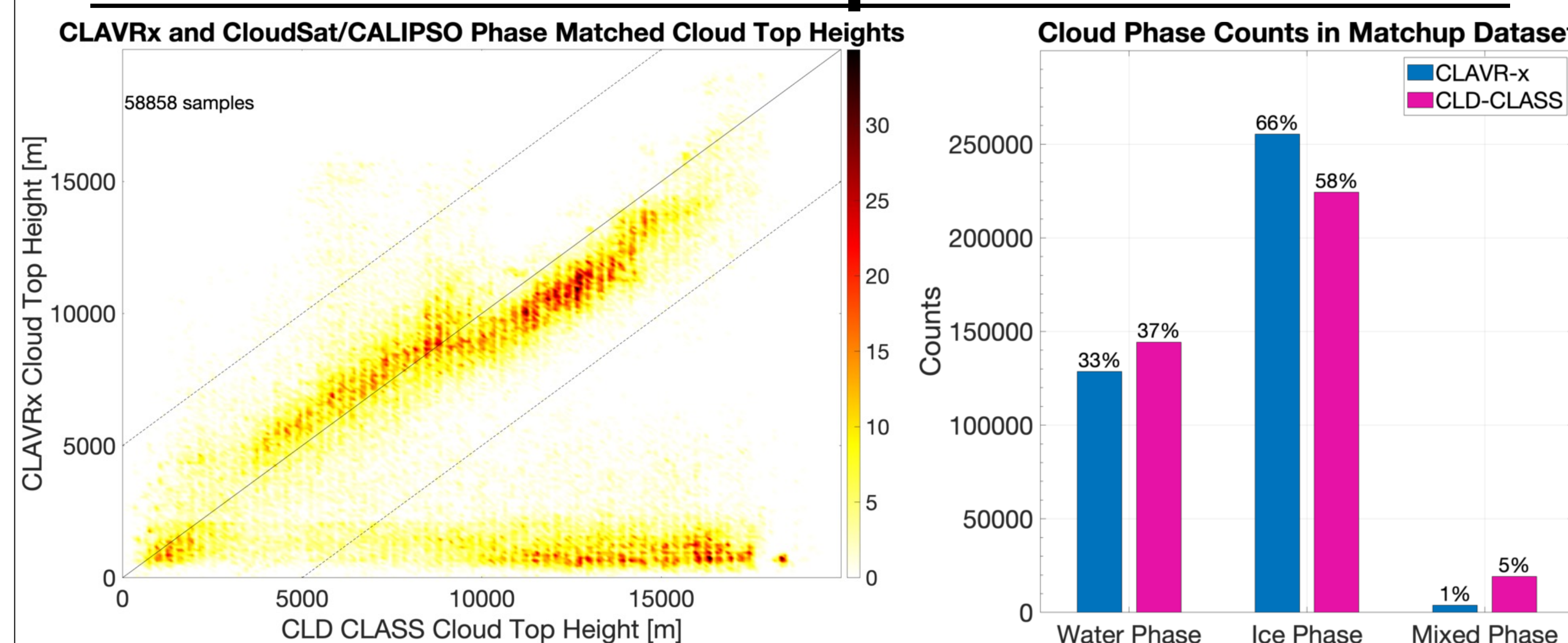
CLAVR-x Cloud Phase Algorithm



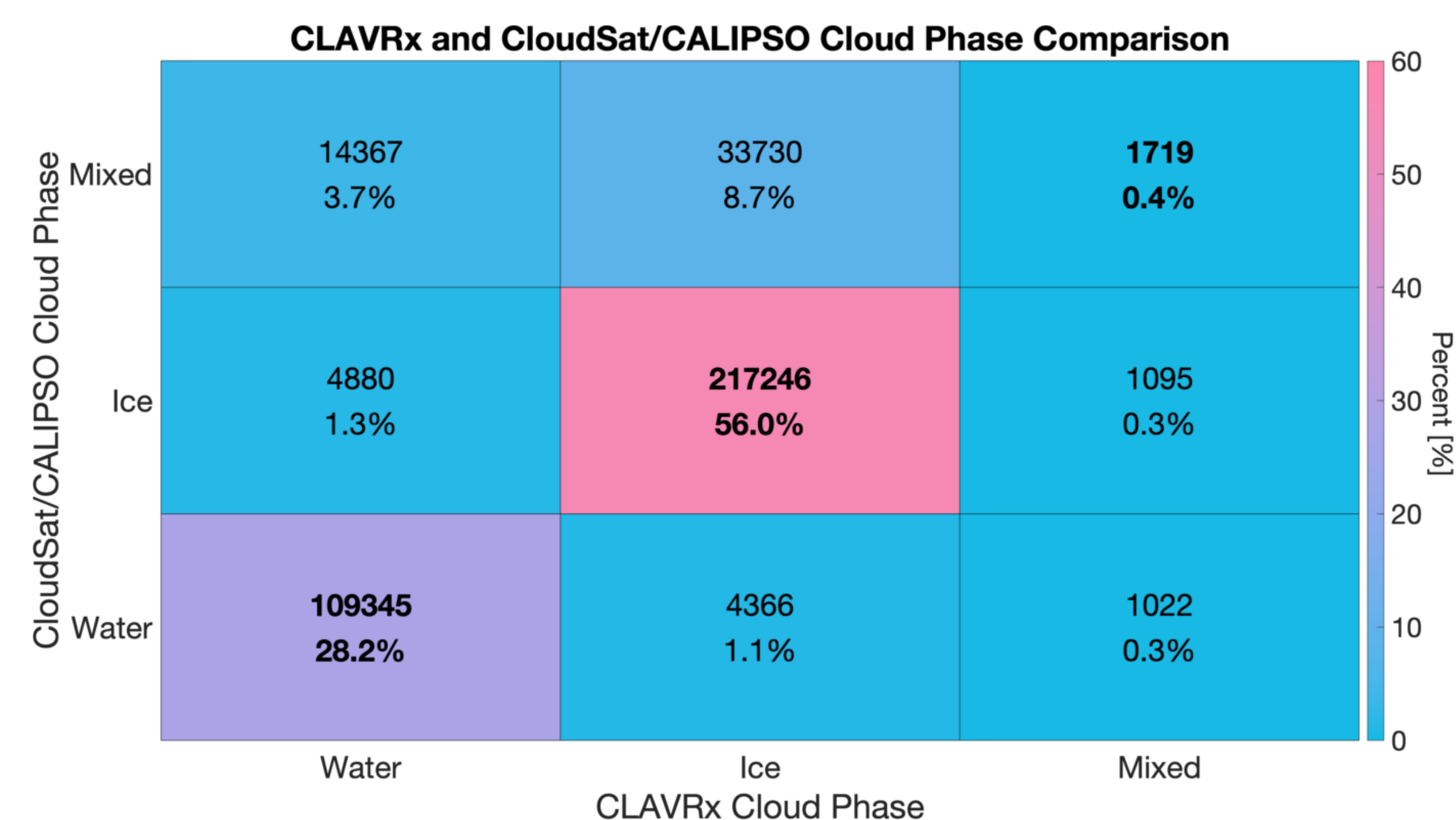
Key Points:

1. Both CLAVR-x and the NOAA operational cloud phase algorithm meet the 80% accuracy requirements when compared to the CloudSat/CALIPSO derived cloud phase.
2. CLAVR-x has an agreement in 84.6% of pixels, the NOAA operational algorithm has agreement in 81.8% of pixels.
3. Primary area of misclassification is mixed phase clouds being identified as ice clouds, and cloud phase detection in coastal regions.

Cloud Phase Comparison Results



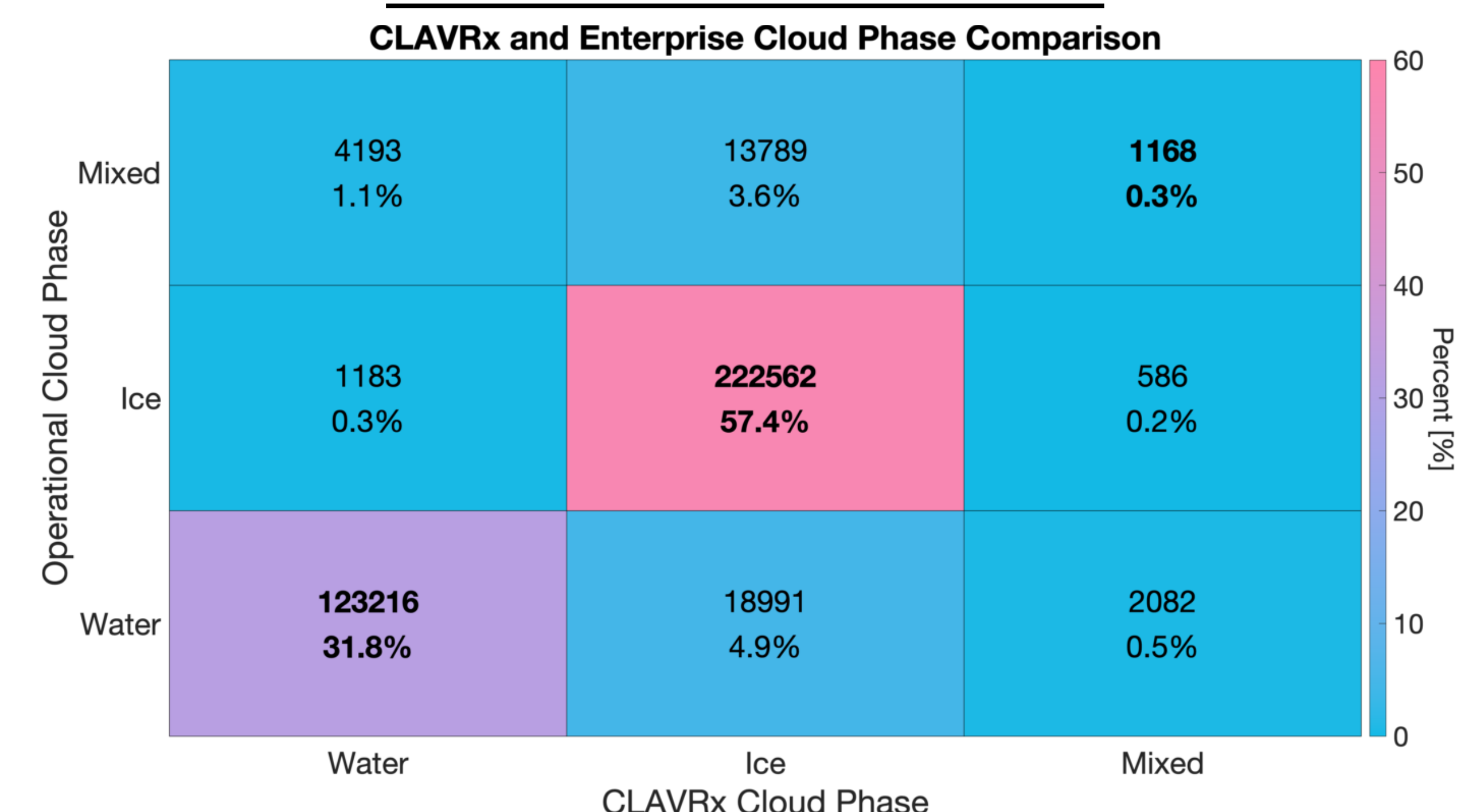
- Cloud top heights for phase matched pixels determines the cloud top height difference threshold for validation.
- CLAVR-x generally over-estimates the number of ice clouds in this collection of matchups compared to CloudSat/CALIPSO.



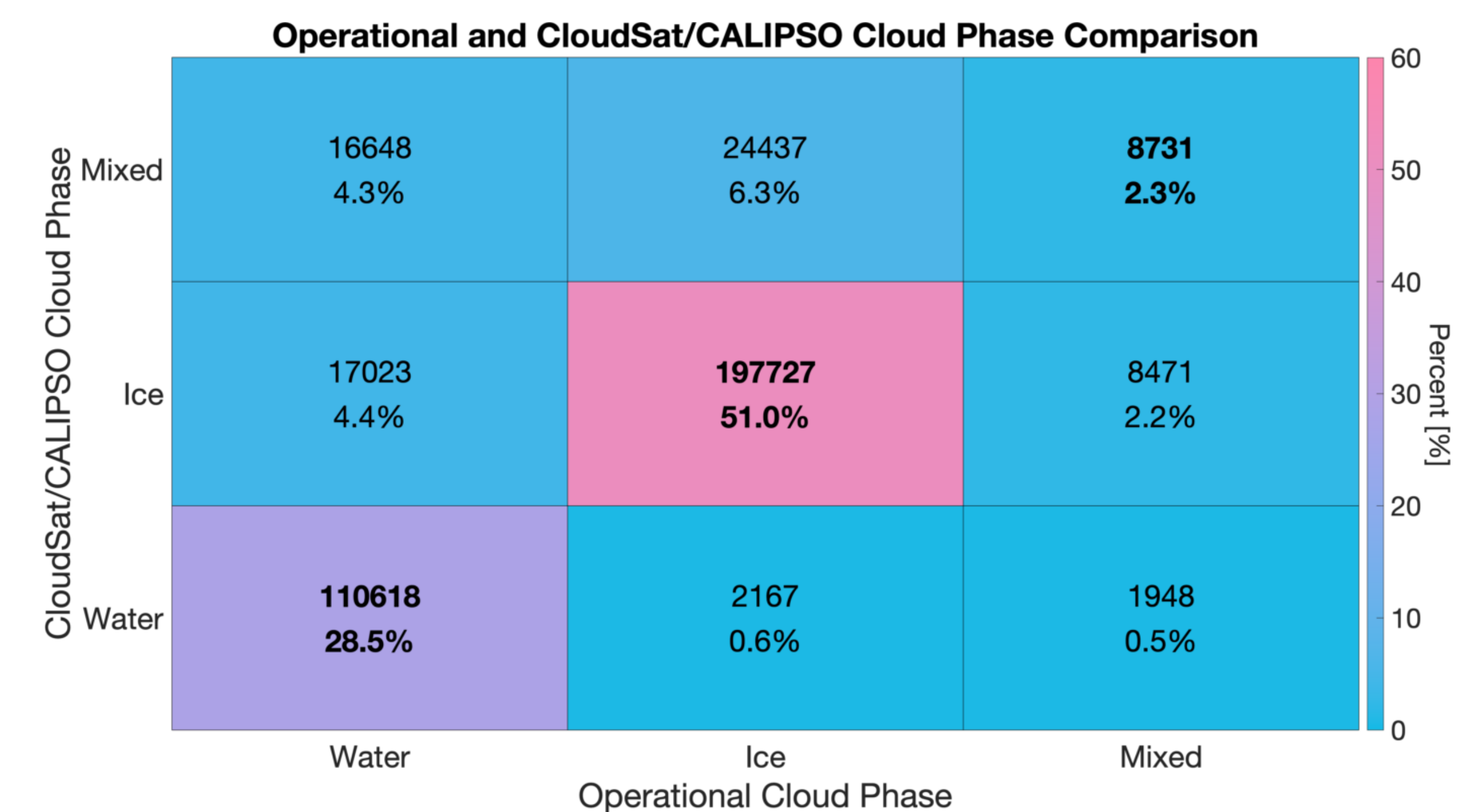
- CLAVR-x agrees with CloudSat/CALIPSO in 84.6% of pixels.
- Greatest difference between the two datasets is CLAVR-x identifying mixed phase clouds as ice clouds.
- Coastal regions are the most difficult surface type for the CLAVR-x cloud phase algorithm.

Surface Type	% of Cloudy Pixels with Matched Phase
Land	80.7%
Water	86.0%
Coastal	77.9%

Comparison to Operational Cloud Phase Retrieval



- CLAVR-x agrees with the operational NOAA algorithm in 89.5% of cloudy sky pixels in this collection of matchups.
- Operational NOAA algorithm agrees with CloudSat/CALIPSO in 81.8% of pixels.



Future Work

1. CLAVR-x fails to identify enough mixed phase clouds when compared to CloudSat/CALIPSO. Future paths to improve the mixed phase designation:
 - Validate cloud phase with other sensors (e.g. VIIRS).
 - Change uncertainty threshold that decides mixed phase.
2. The NOAA operational algorithm is no longer being updated; therefore, the long-term objective is for the CLAVR-x cloud phase algorithm to take over as the operational algorithm in the future.

Acknowledgements:

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Reference:

Sassen, K., Z. Wang, and D. Liu, 2008: Global distribution of cirrus clouds from CloudSat/Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) measurements, *J. Geophys. Res.*, **113**, D00A12.