Cloud Thermodynamic Phase for AIRS Version 6 Support Product

Hongchun Jin[1], Shaima L. Nasiri[1], Brian H. Kahn[2]

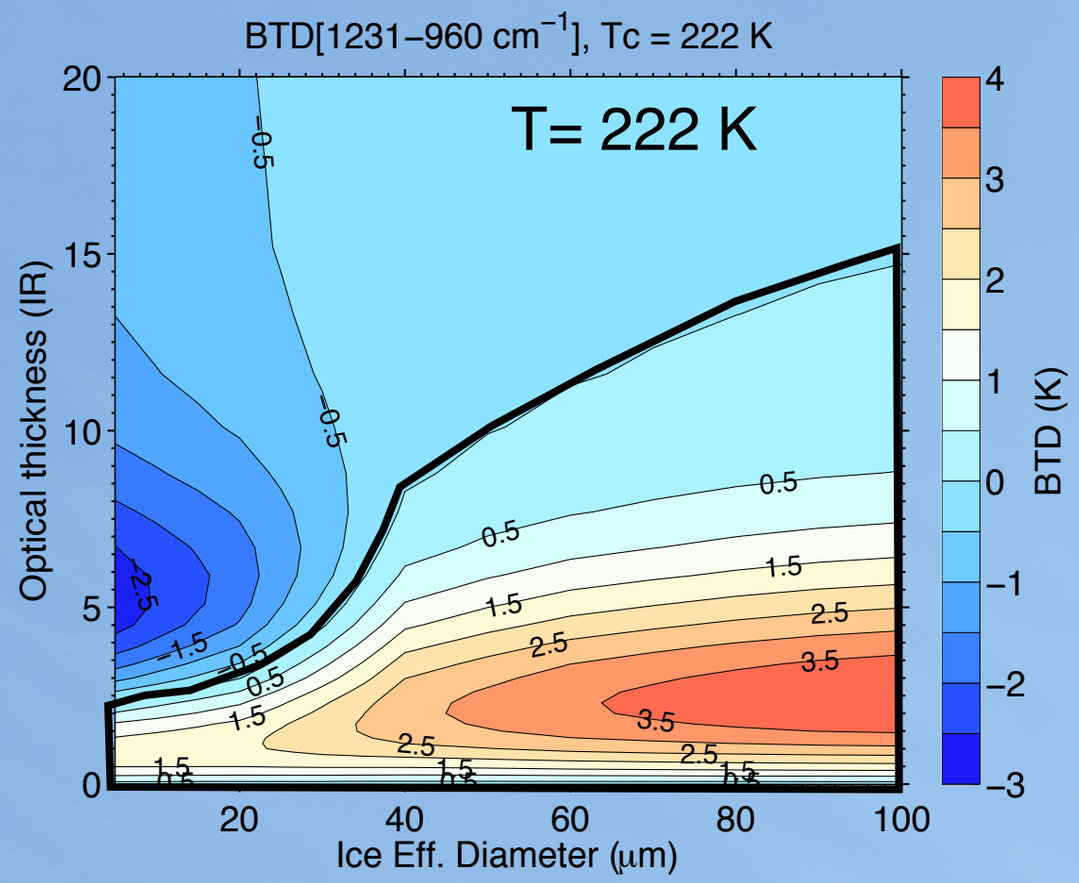
[1]Texas A&M University; [2]Jet Propulsion Laboratory

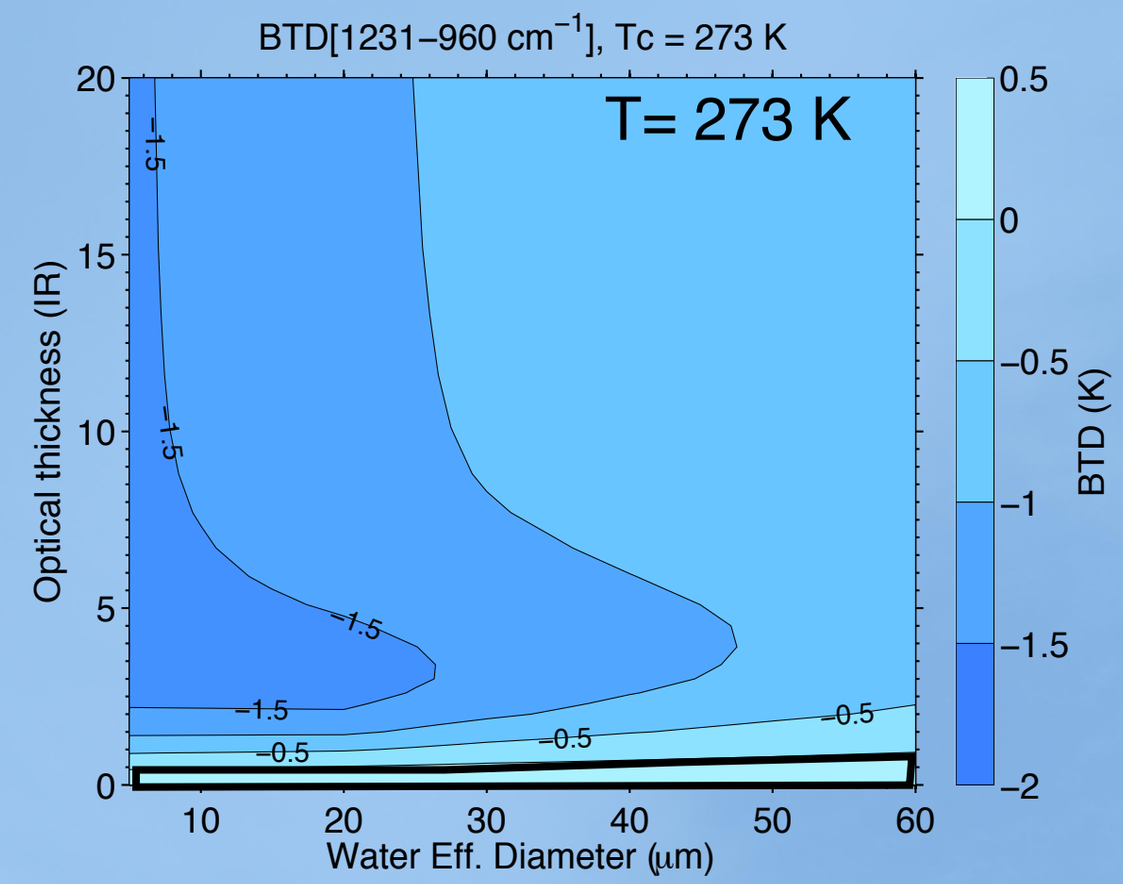
NASA Sounder Science Team Meeting
Greenbelt, MD
Nov 8-11, 2011

Take Home Messages

- **Focus on ice cloud detection**
  - High spectral resolution IR is very sensitive to thin ice clouds
  - High spectral resolution allows us to avoid water vapor absorption lines
- **Algorithm is based on RT simulations**
  - CALIPSO enables us to make sure the model and observations agree
- **Fast algorithm**
  - Easy to implement and computationally efficient for the Support Product
  - Provide measures of confidence for final output
- **Results and comparisons**
  - Co-located AIRS and CALIPSO for 2008

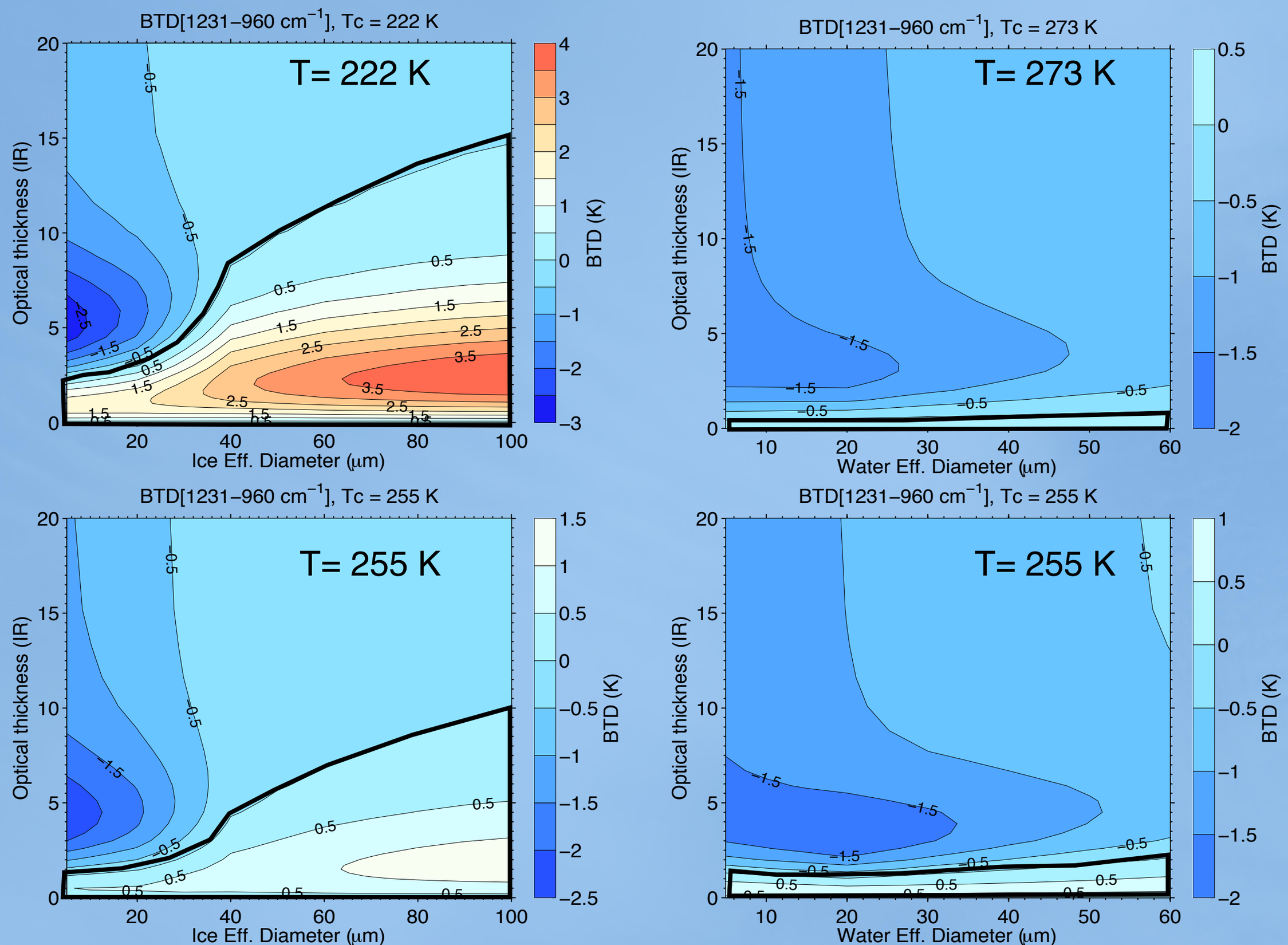
BTD 1231-960 cm^{-1} (8.12-10.42 μm): cloud phase





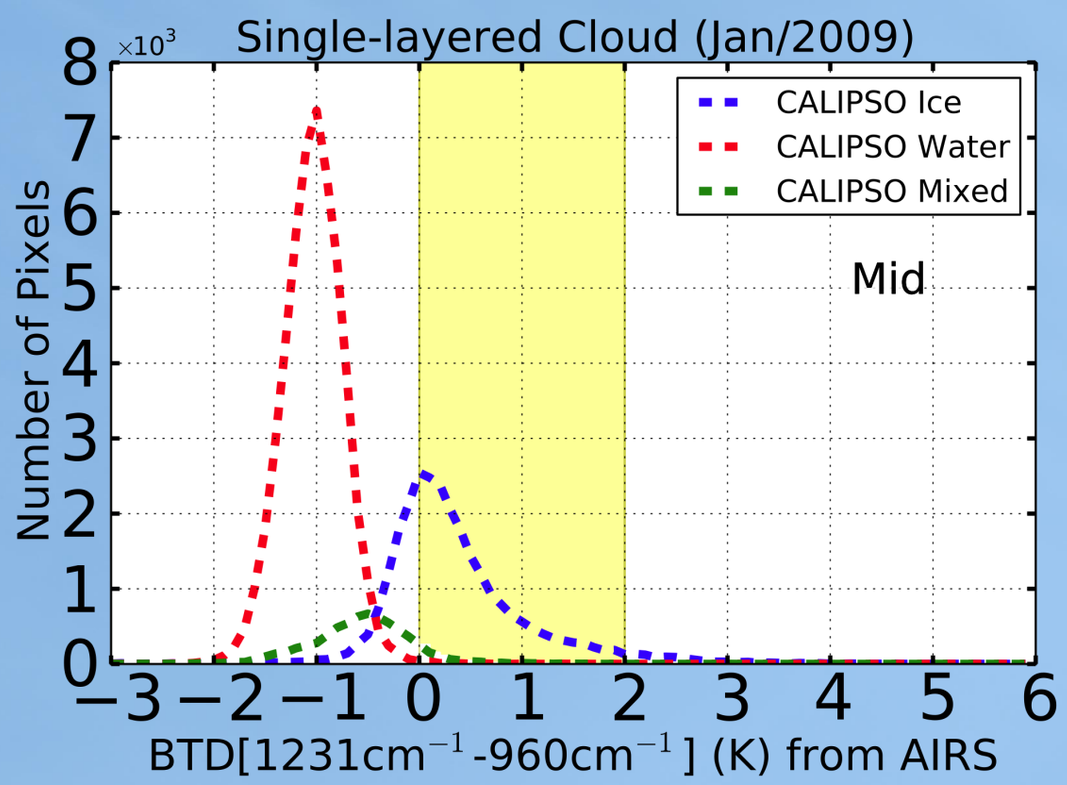
- RT basis for AIRS cloud thermodynamic phase determination
- RT calculations by Chenxi Wang using Ping Yang's fast RT model and ice single scattering properties from Baum et al. 2007
  - Simulates TOA BT for clear sky and single-layer clouds from 700–1300 cm^{-1}
- Sensitivity to cloud phase, temperature, particle size, and optical thickness (τ)

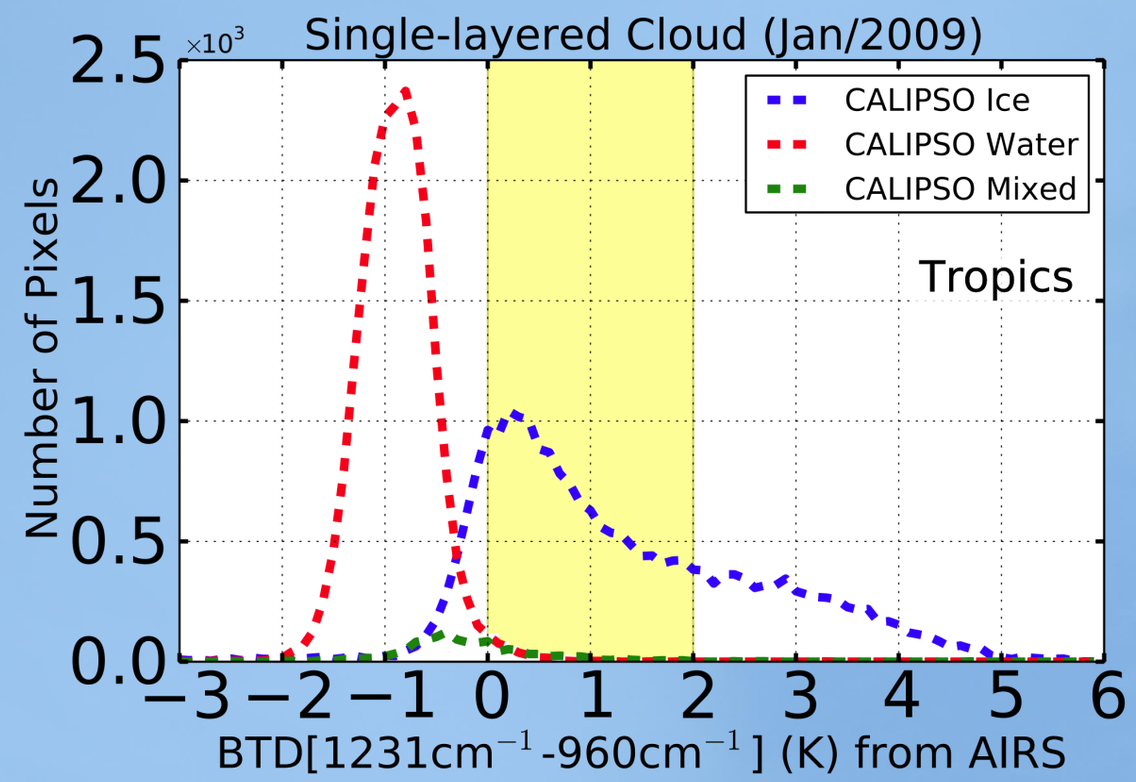
BTD 1231-960 cm^{-1} (8.12-10.42 μm): cloud phase

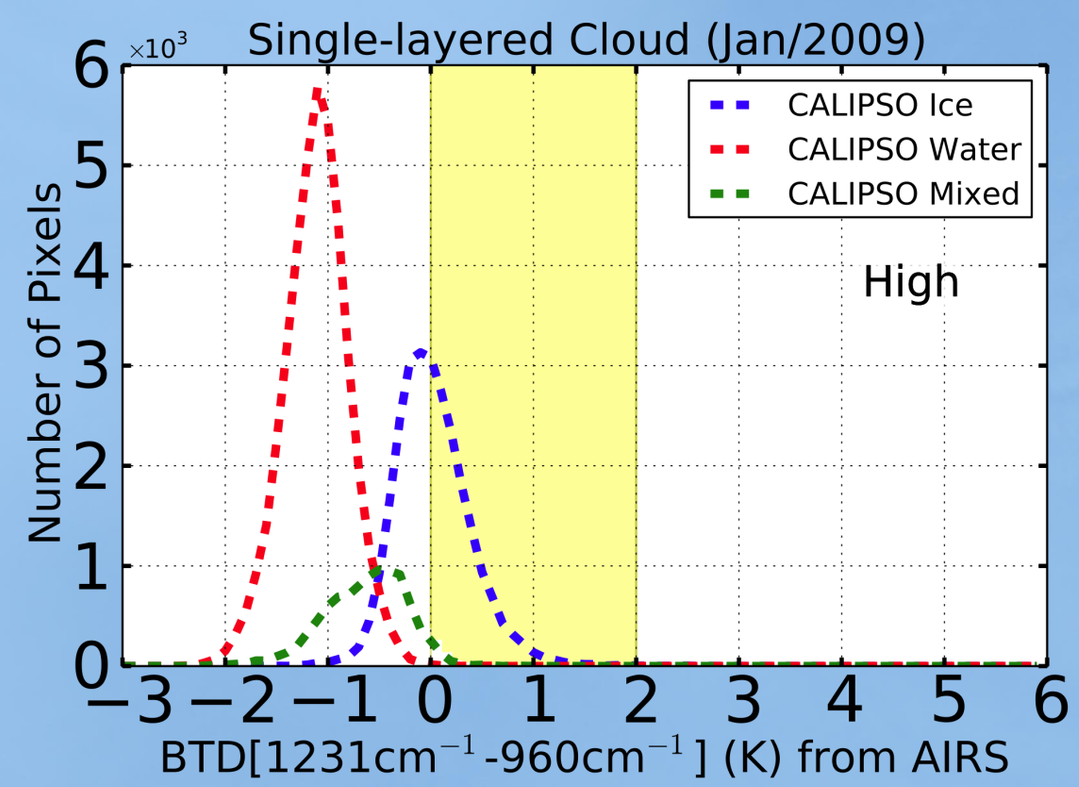


Co-located AIRS/CALIPSO observations match modeled BTDs

Jan 2009
Tropics: 25°S~25°N
Mid-latitudes: 25°N(S)~55°N(S)
High Latitudes: 55°N(S)~90°N(S)







Mixed: Ice & Water in AIRS FOV

Developing an AIRS phase algorithm

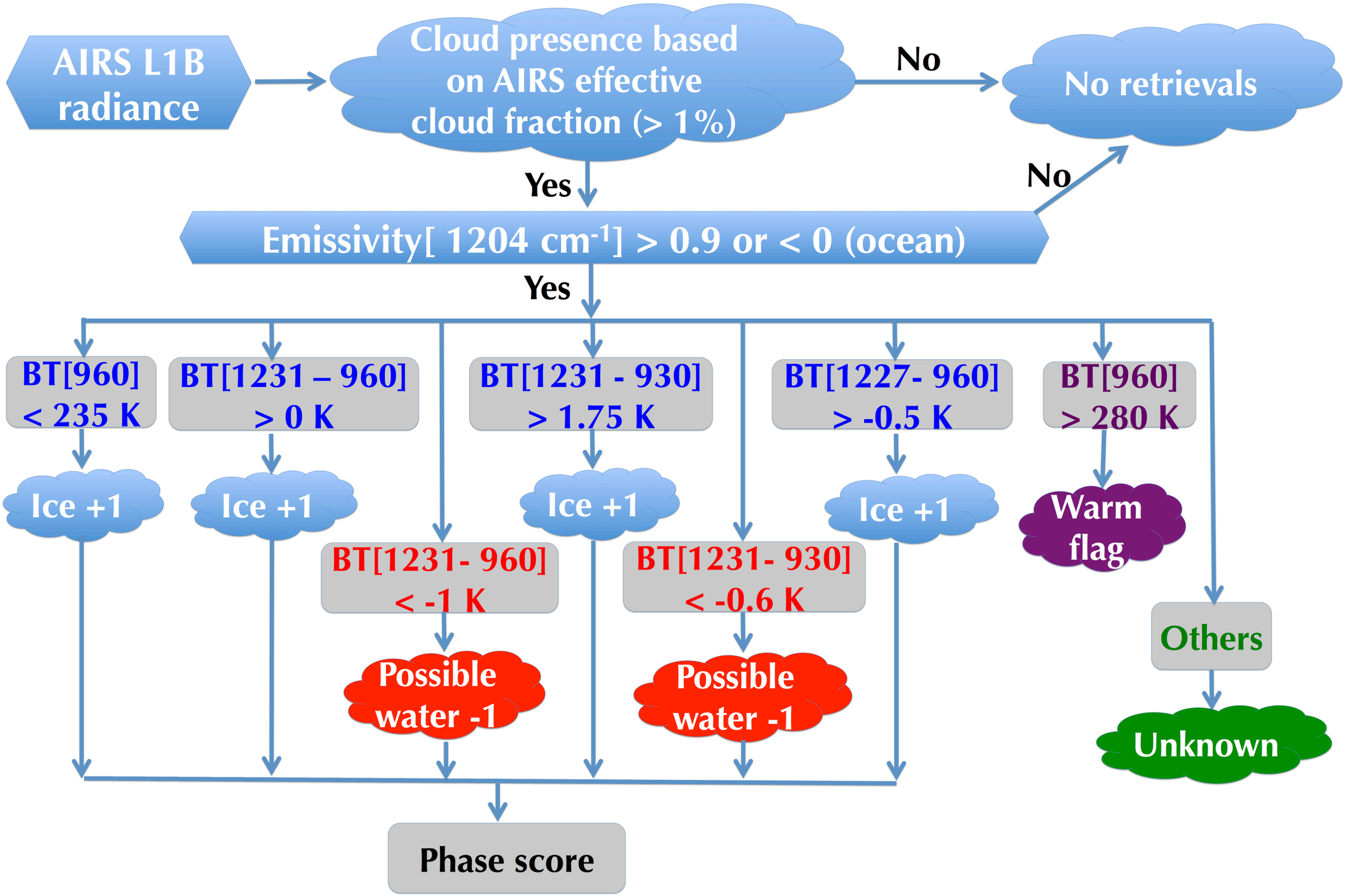
Algorithm input

- AIRS L1b radiances/L2 standard products
- AIRS 930 cm^{-1}, 960 cm^{-1}, 1227 cm^{-1} and 1231cm^{-1} “channels”
- Surface emissivity in 8 μm region (Seemann et al. 2008)

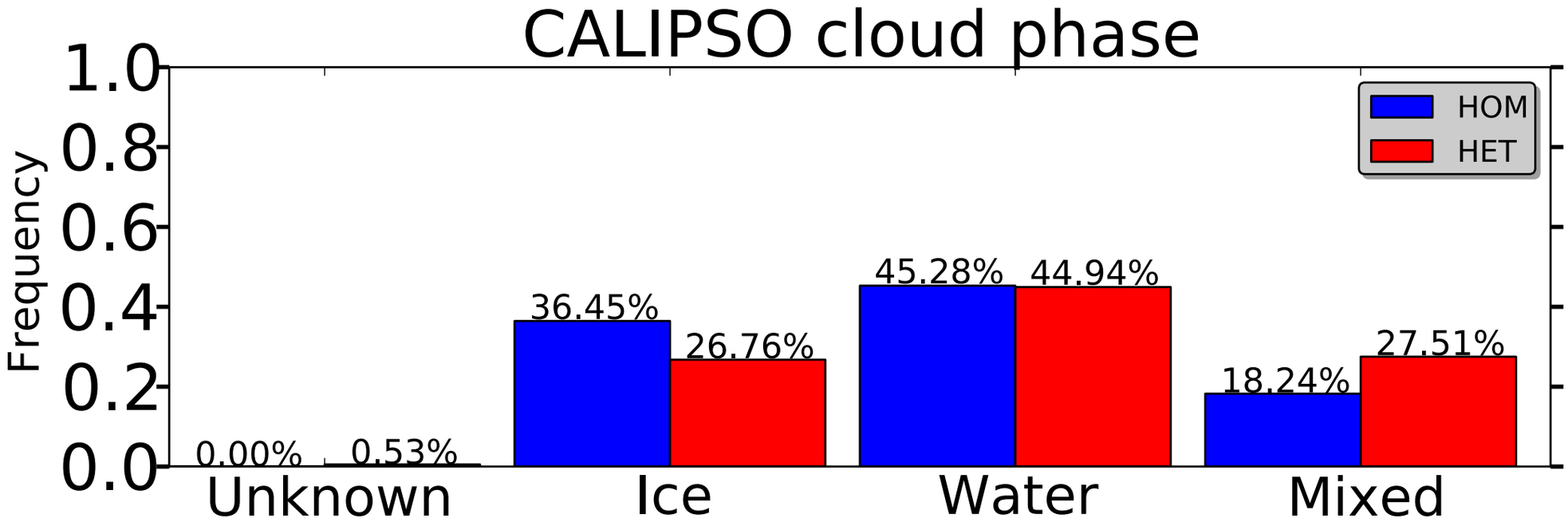
Algorithm Evaluation

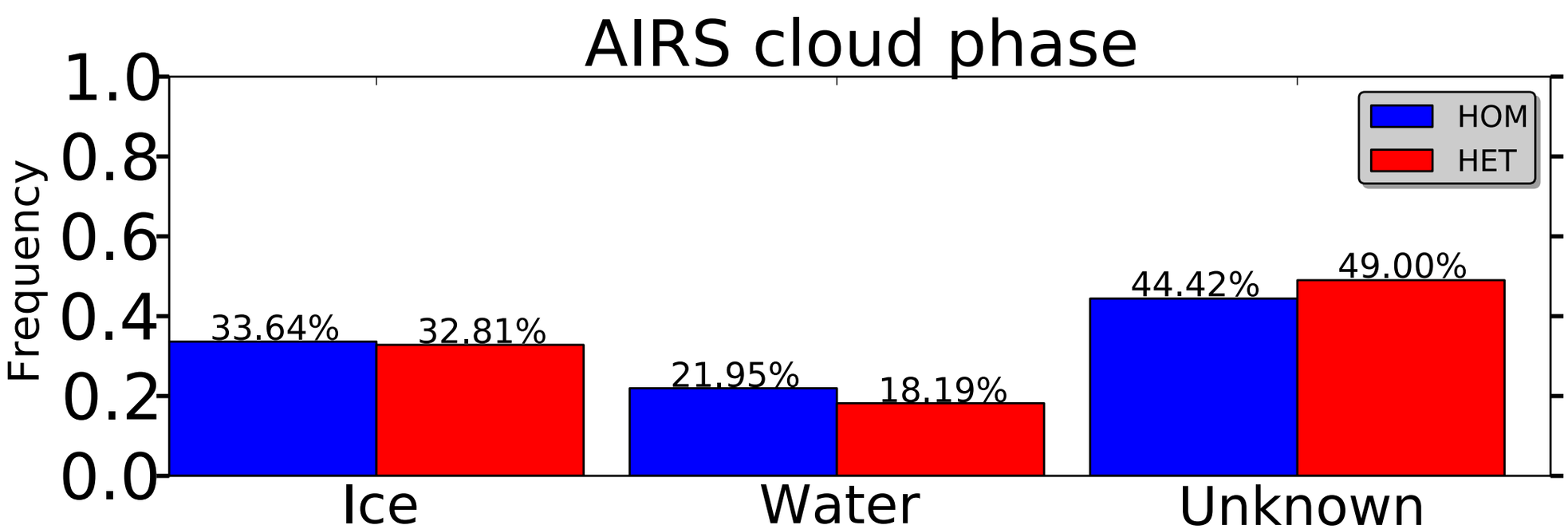
- Co-locate AIRS L1B radiance with CALIPSO L2 1-km cloud layer products
- Determine single-layered and heterogeneous scenes
- Use CALIPSO phase classification
  - Within AIRS FOV:
    CALIPSO Ice, water, mixed

Algorithm Flow Chart

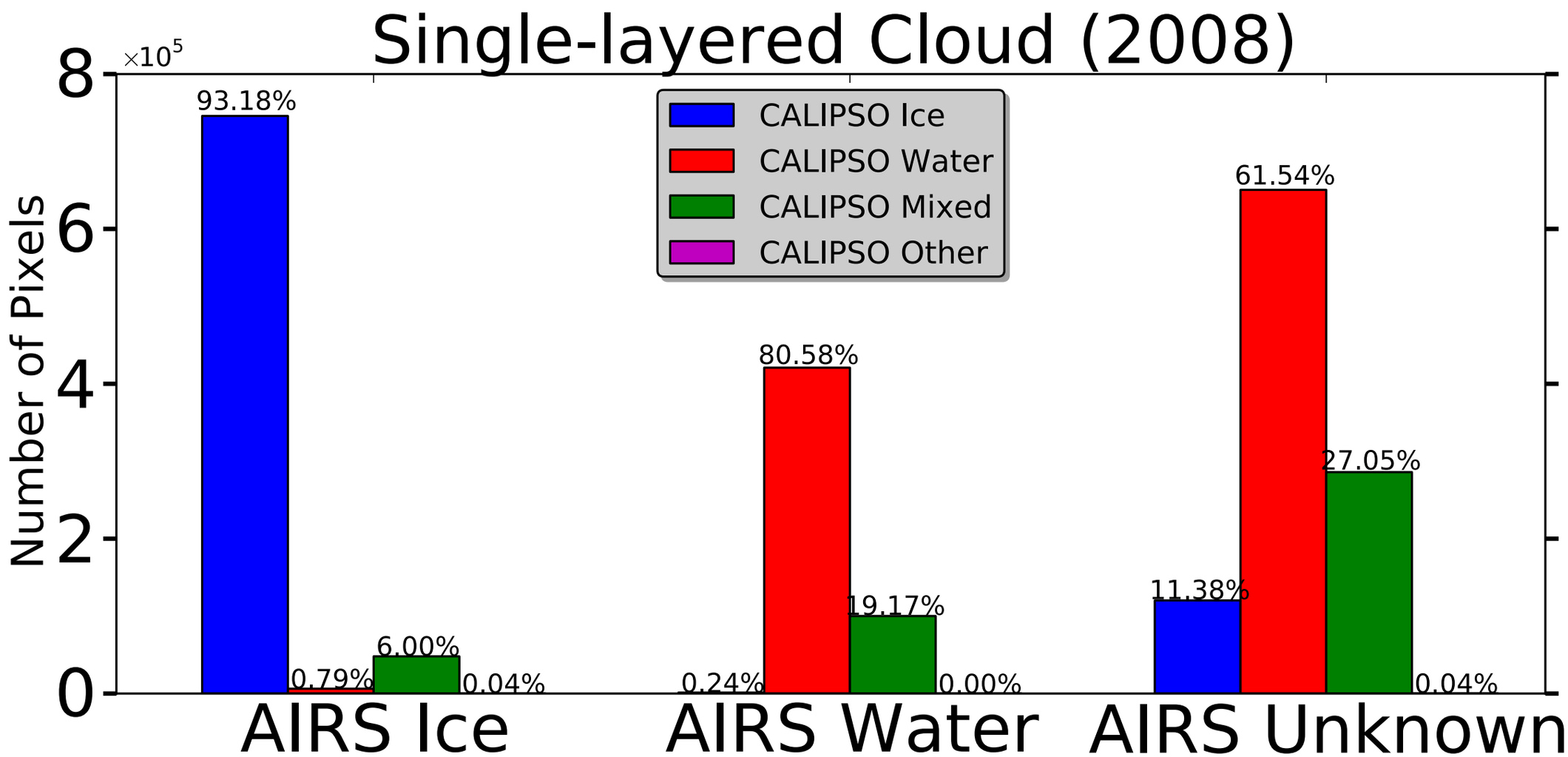


CALIPSO and AIRS cloud phases





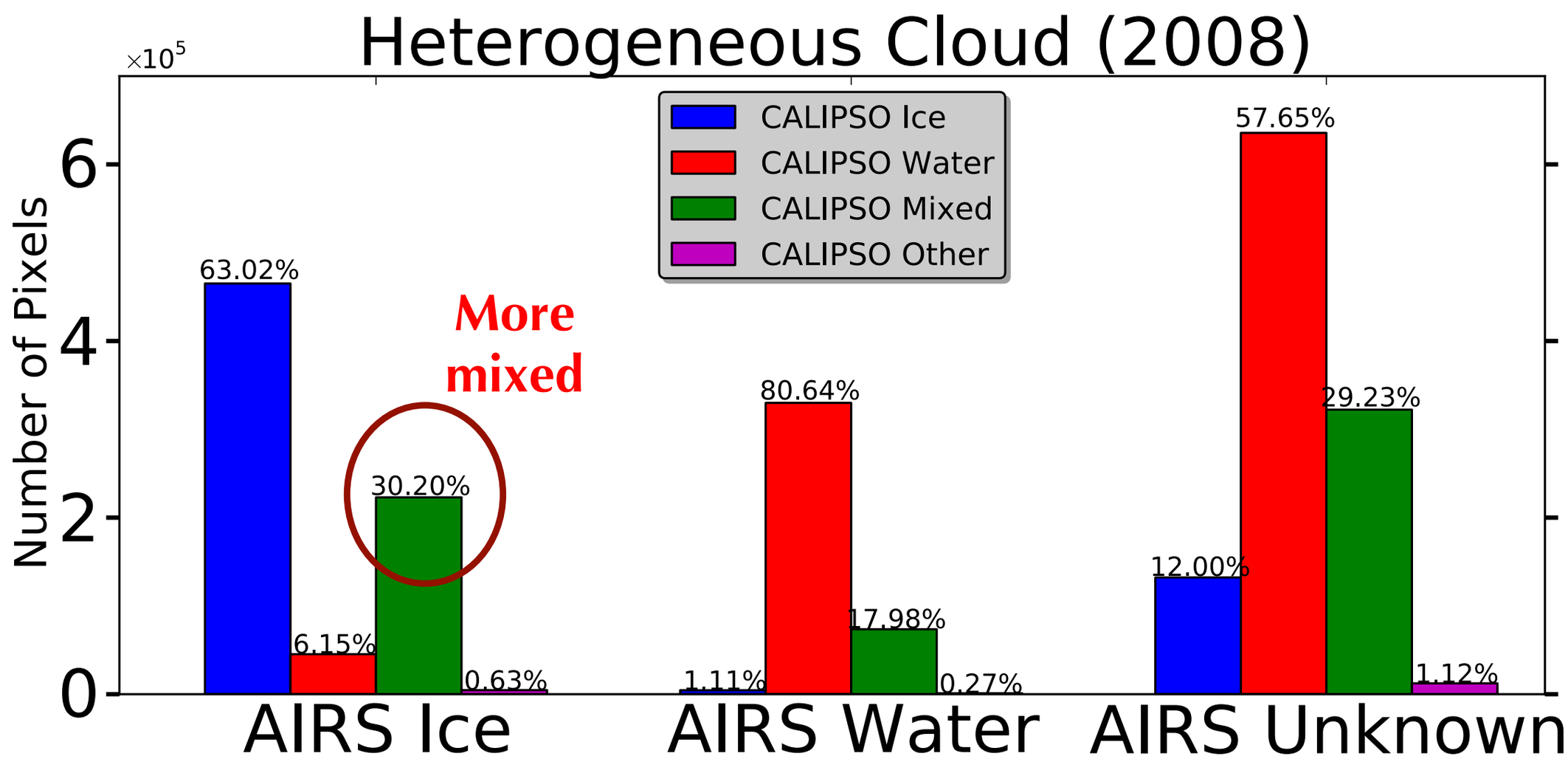
AIRS phase compared with CALIPSO phase: Single-layered cloud scenes



CALIPSO Water: < 1%

CALIPSO Ice: < 1%

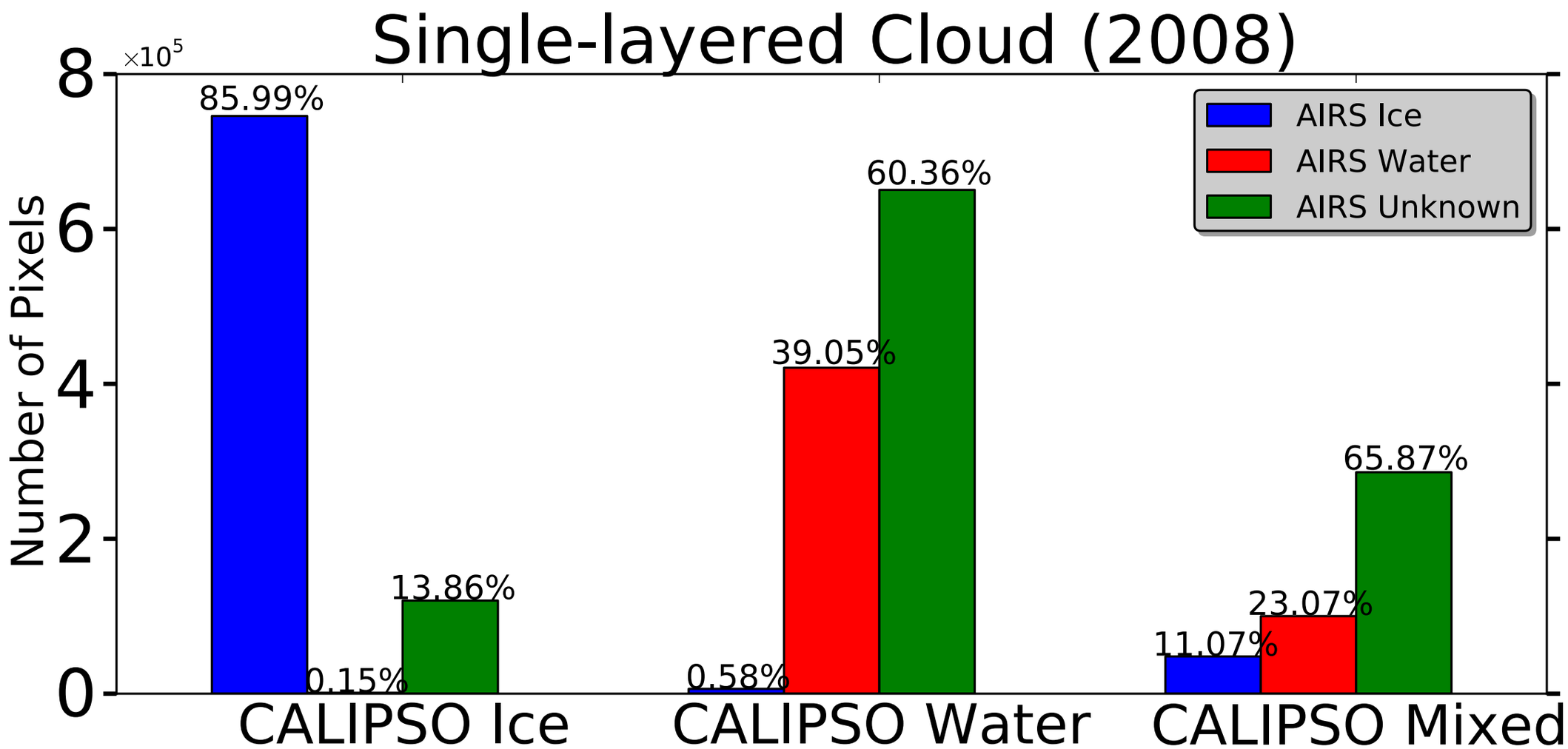
AIRS phase compared with CALIPSO phase: Heterogeneous scenes



CALIPSO Ice + Mixed: ~ 93%

CALIPSO Ice: ~ 1%

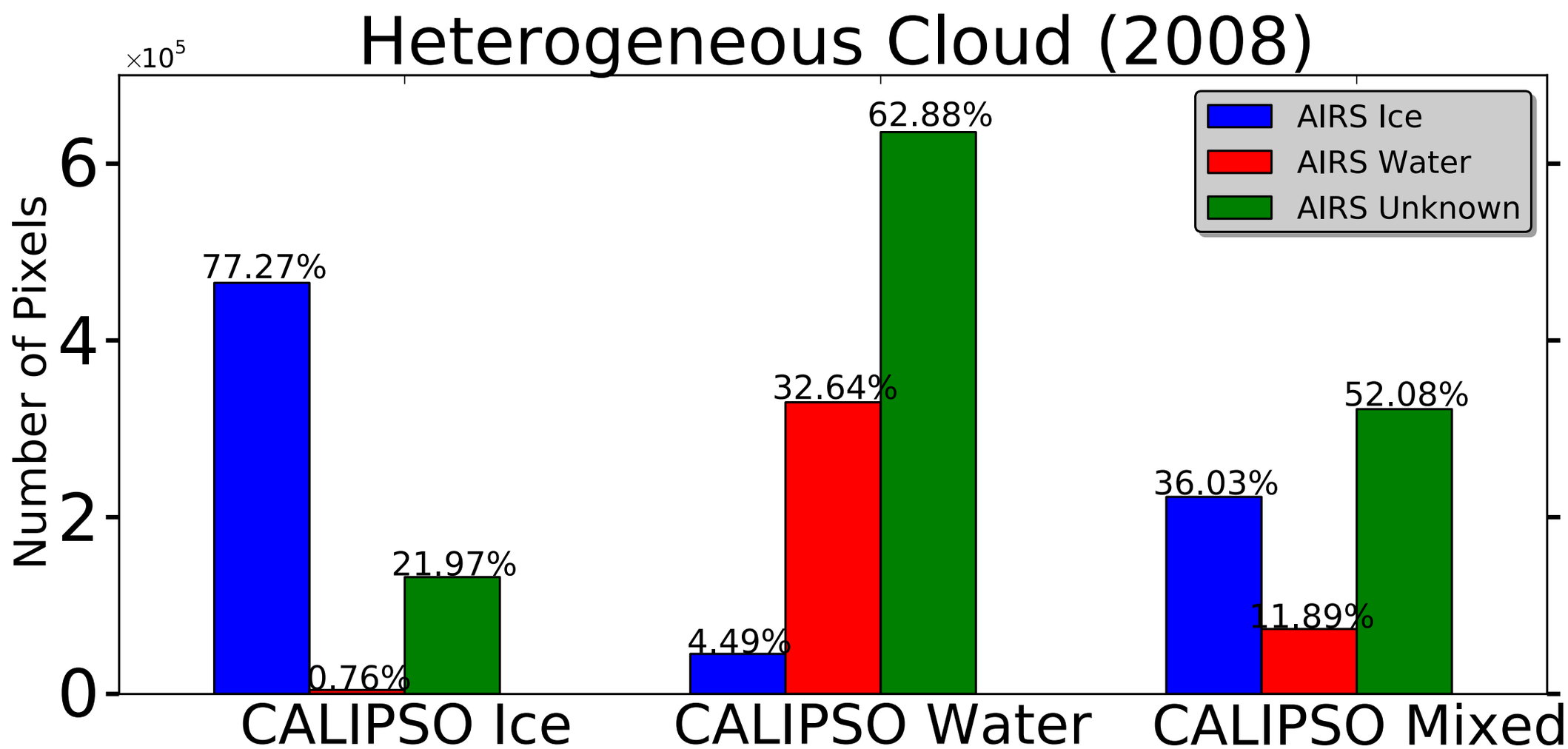
CALIPSO phase compared with AIRS phase: Single-layered cloud scenes



AIRS Water: < 1%

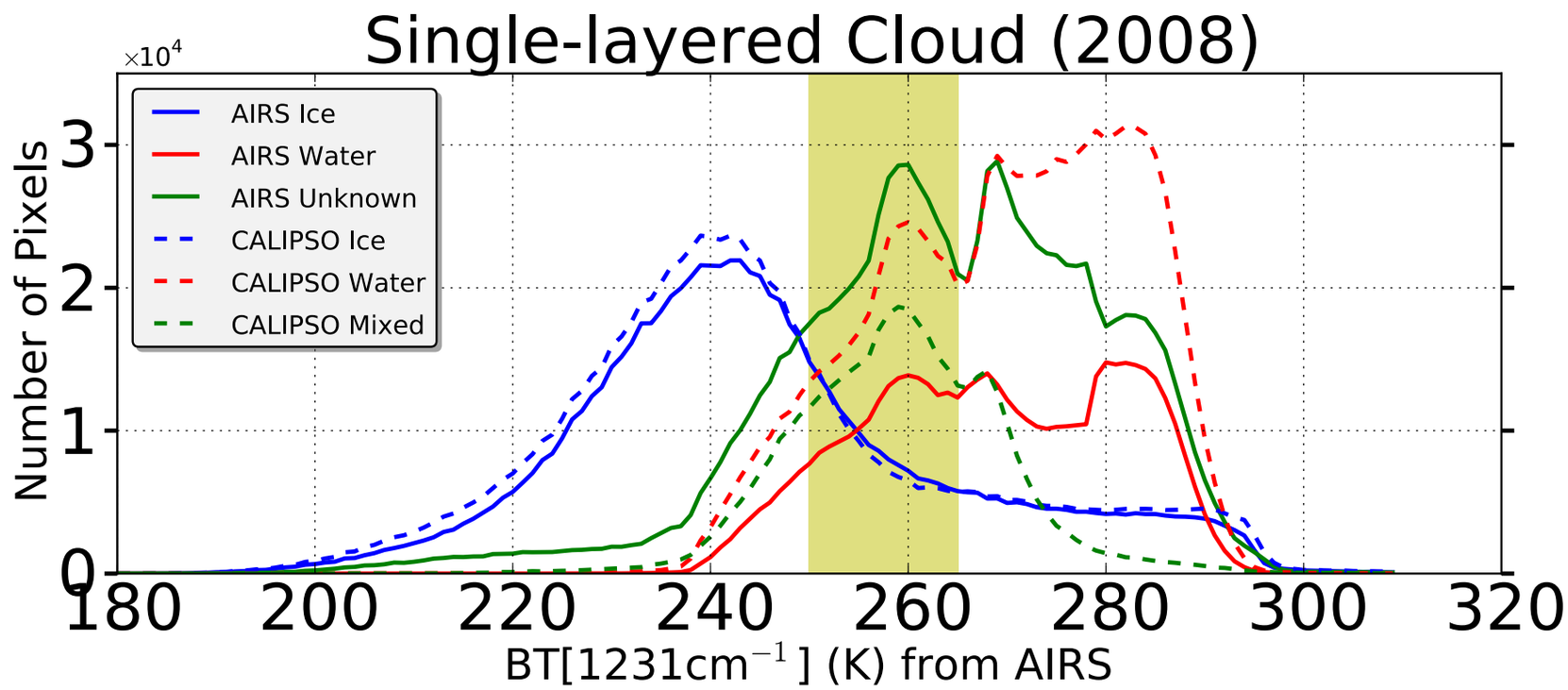
AIRS Ice: < 1%

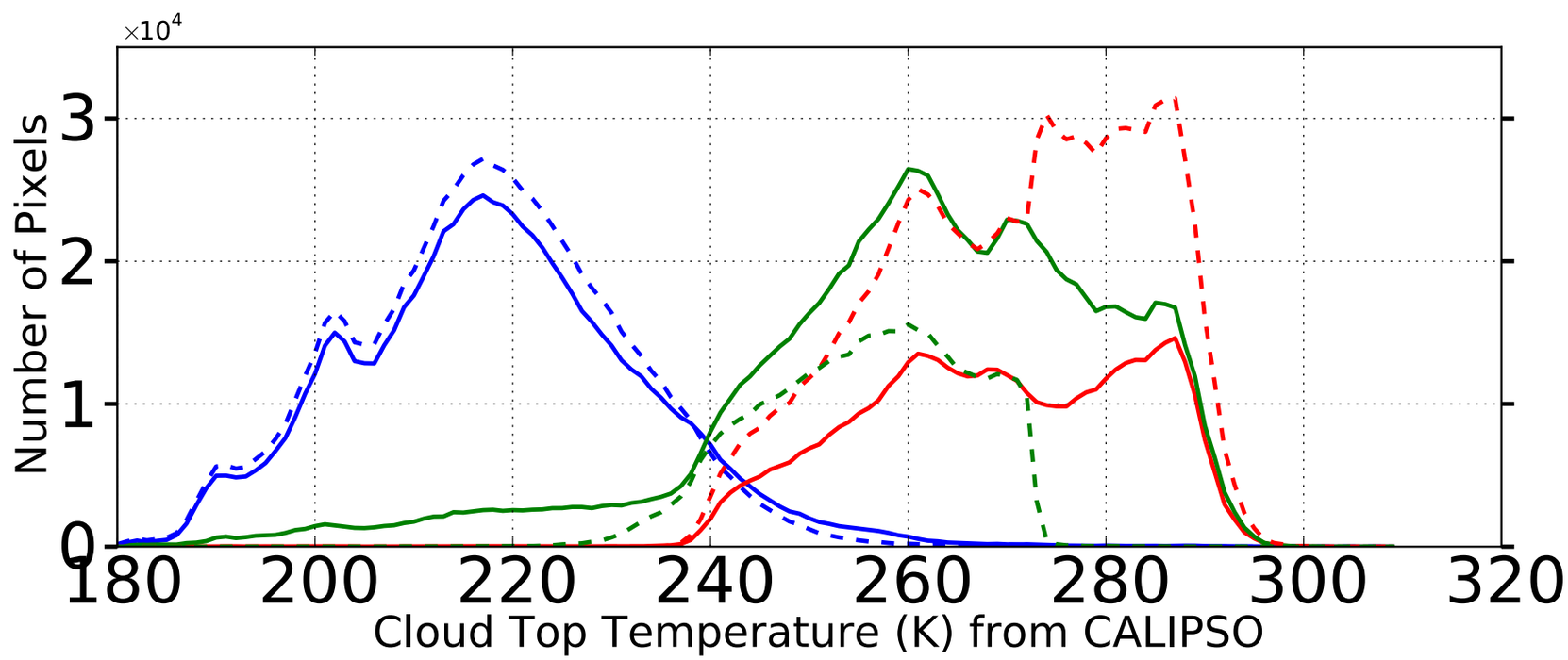
CALIPSO phase compared with AIRS phase: Heterogeneous scenes



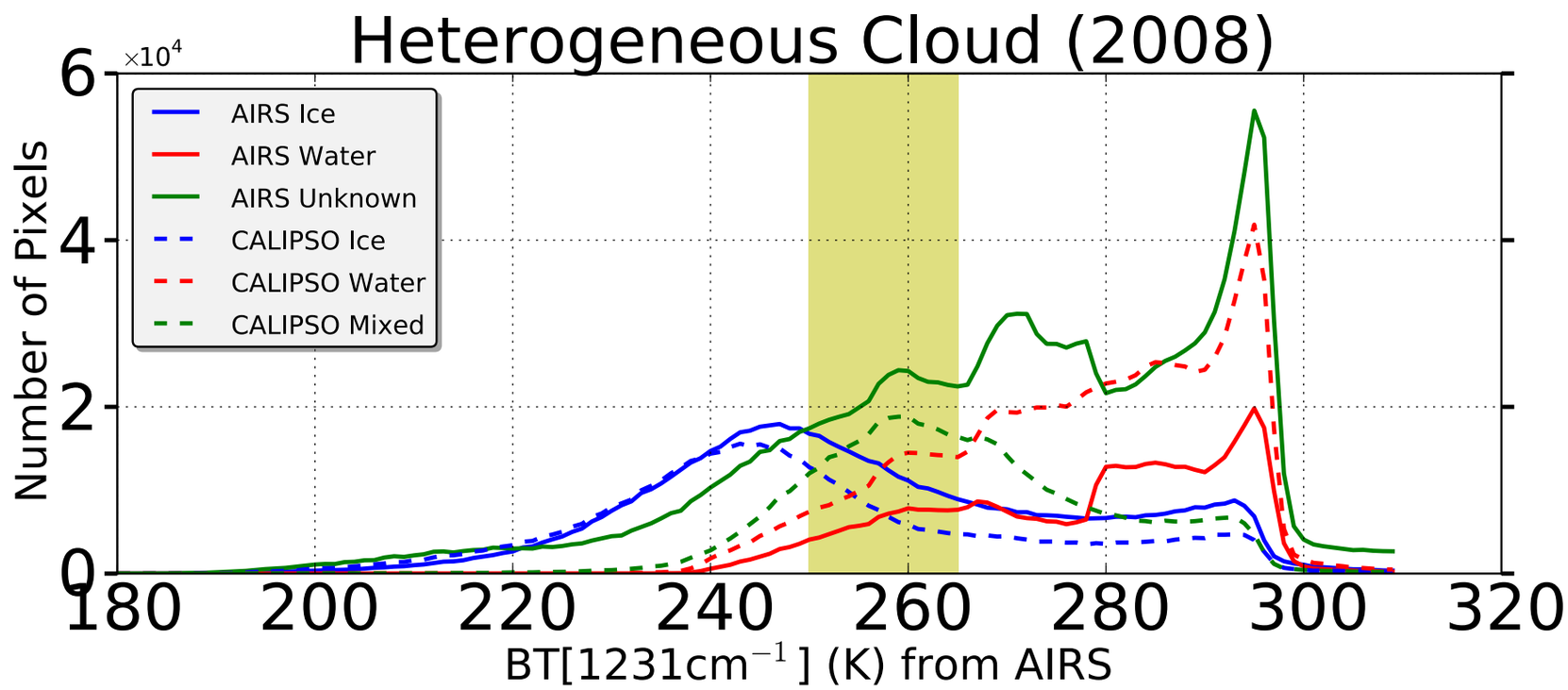
AIRS Water: < 1%

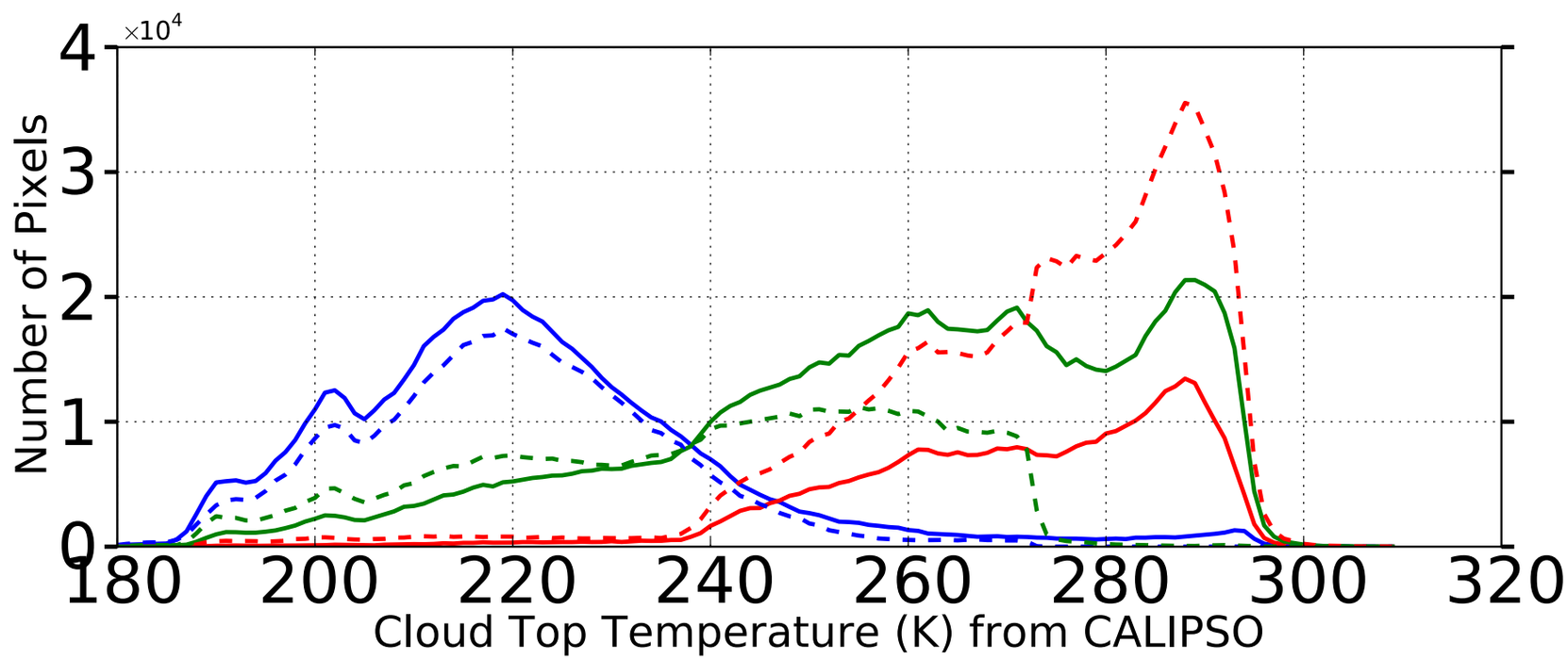
AIRS and CALIPSO phase: Single-layered clouds



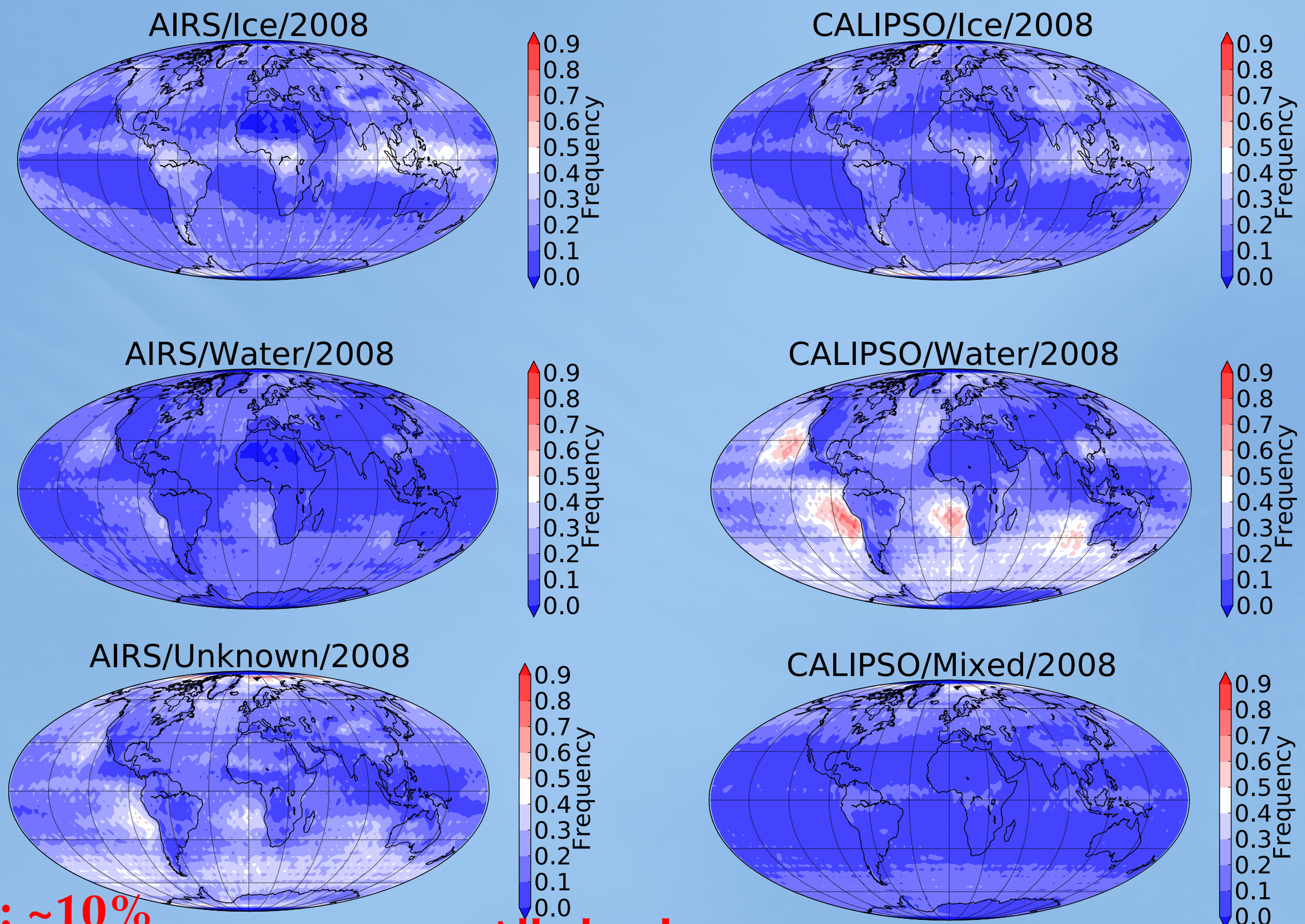


AIRS and CALIPSO phase: heterogeneous scenes





Global distributions of AIRS/CALIPSO phases

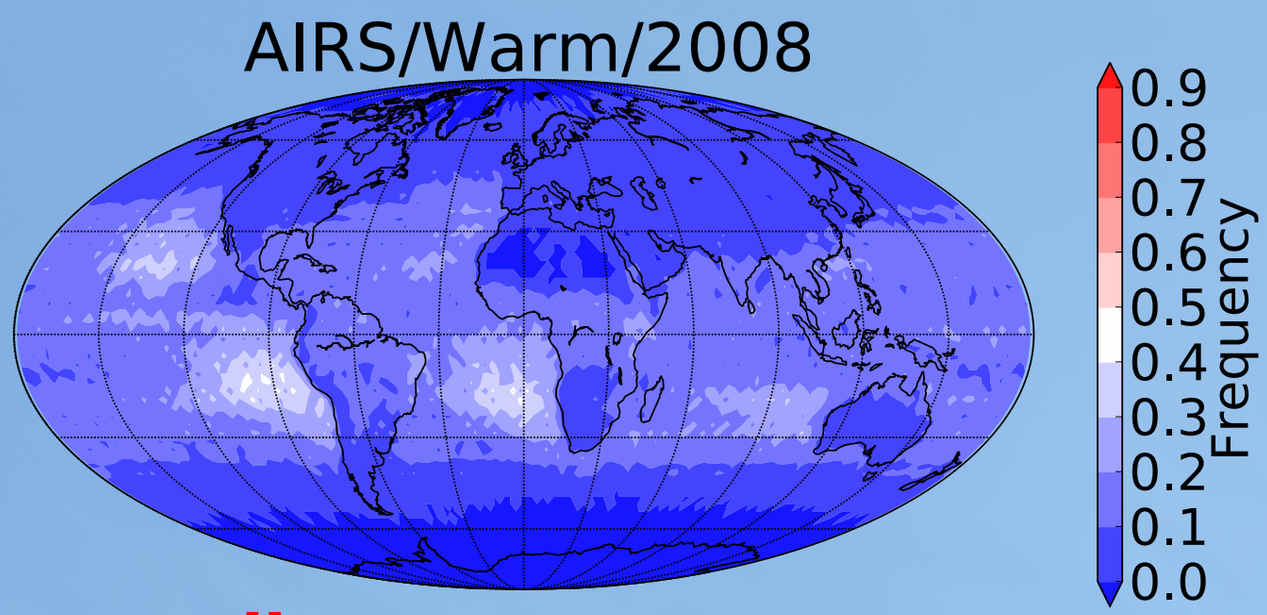


Ice: ~10%

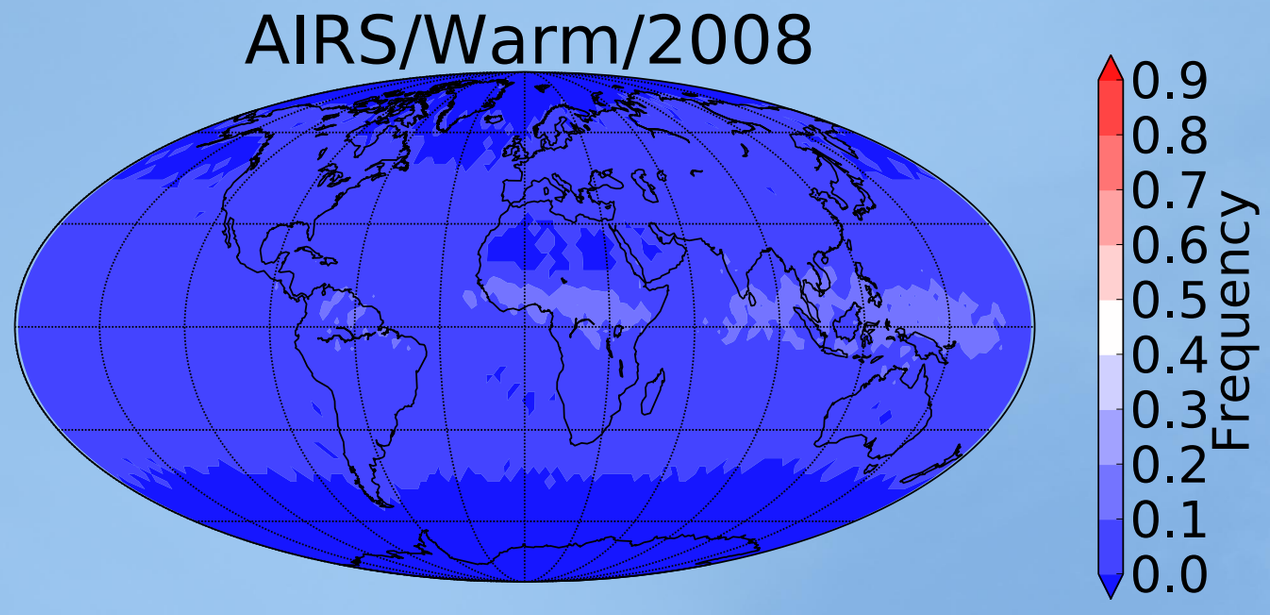
Water: ~60%

All cloudy scenes

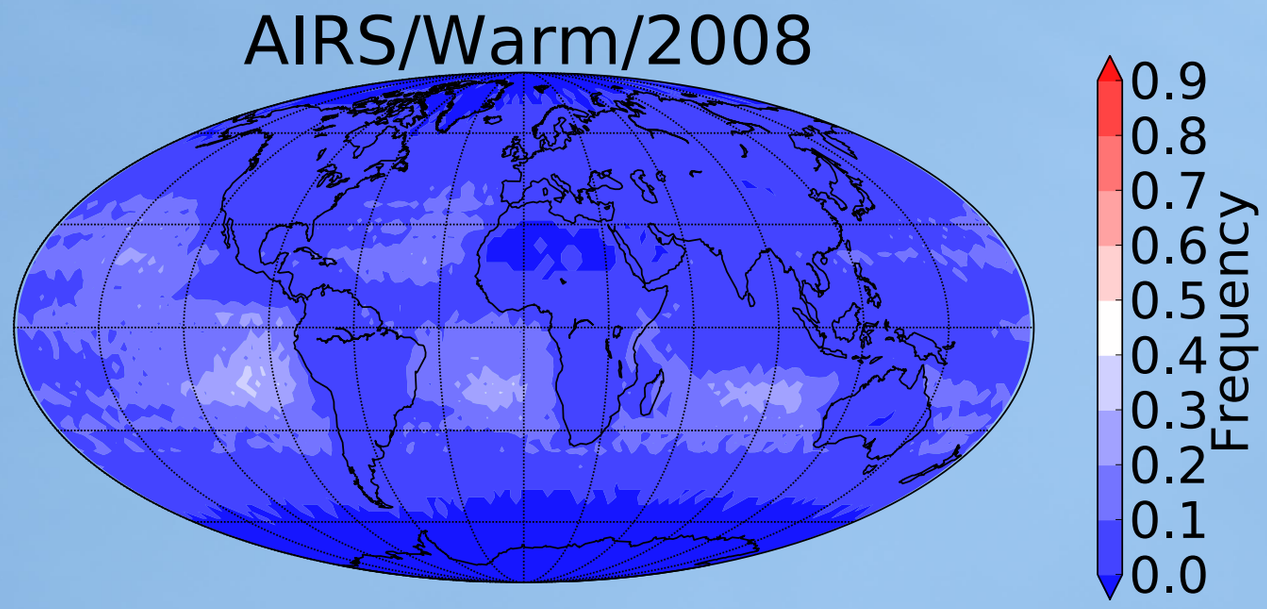
About warm scenes



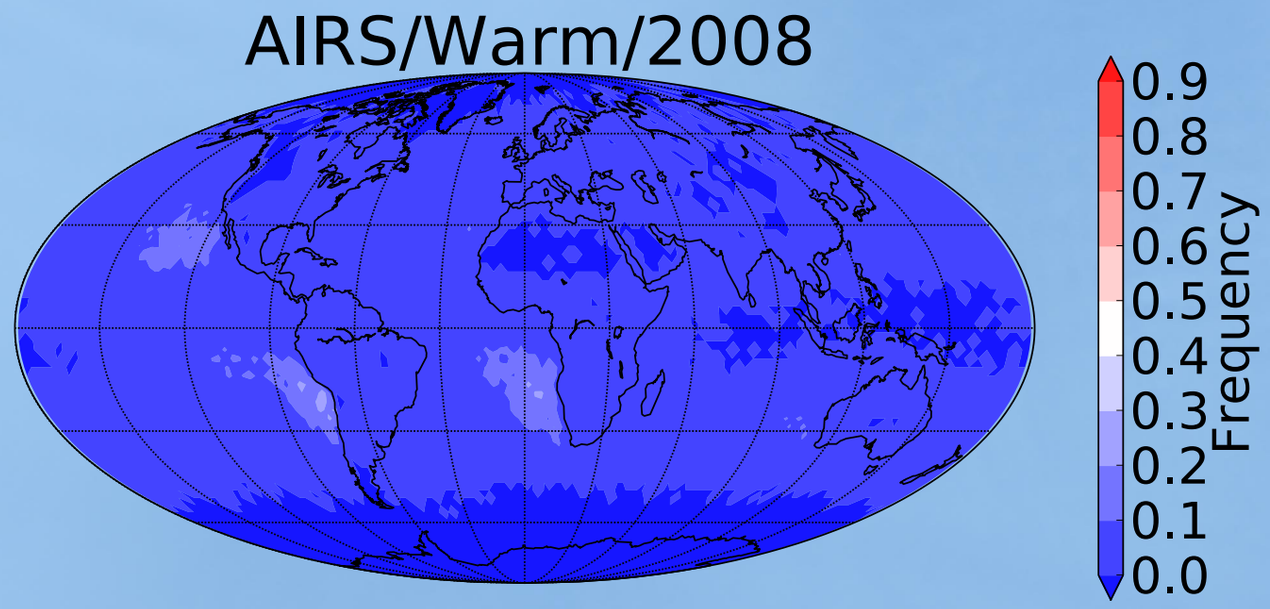
All warm scenes



AIRS Ice

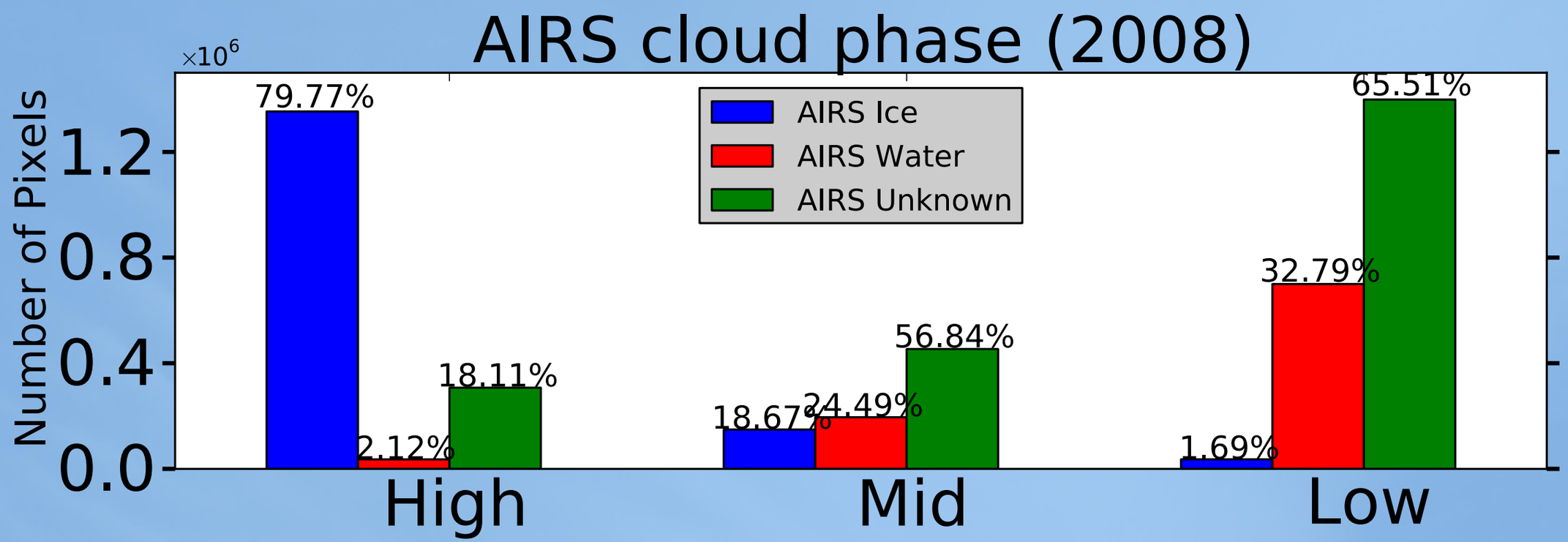


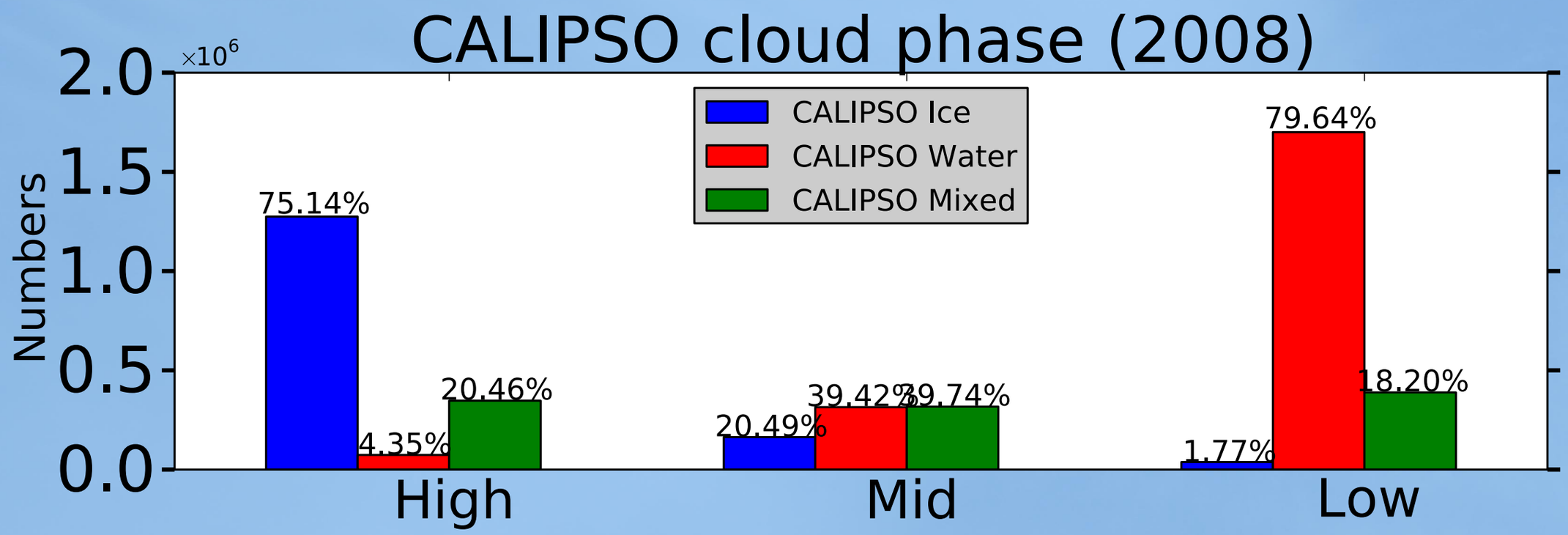
AIRS Unknown



AIRS Water

Potential ideas for improvements





For future, add tests with height sensitivity, or bring in CTP retrievals

Summary and Future work

- Current efforts for AIRS Version 6
  - Phase output: Ice phase, water phase, unknown
  - AIRS ice phase agrees well with CALIPSO ice phase (> 90%)
  - AIRS water finds less water than CALIPSO due to lower sensitivity
  - A warm scene flag may be useful in certain cloud regimes, such as stratocumulus
- Future work
  - Comprehensive evaluation of V6 support product phase
  - Evaluate and improve heterogeneous scene performance
    - Consider tests with height sensitivity
  - Build climatology (~9 yrs)