



Recent Progress in Cloud Thermodynamic Phase and Ice Cloud-Top/Optical Property Retrieval Algorithms for MOD06 C7 and CLDPROP v2



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A Random Forest (RF) Based Cloud Phase Algorithm

► Features:

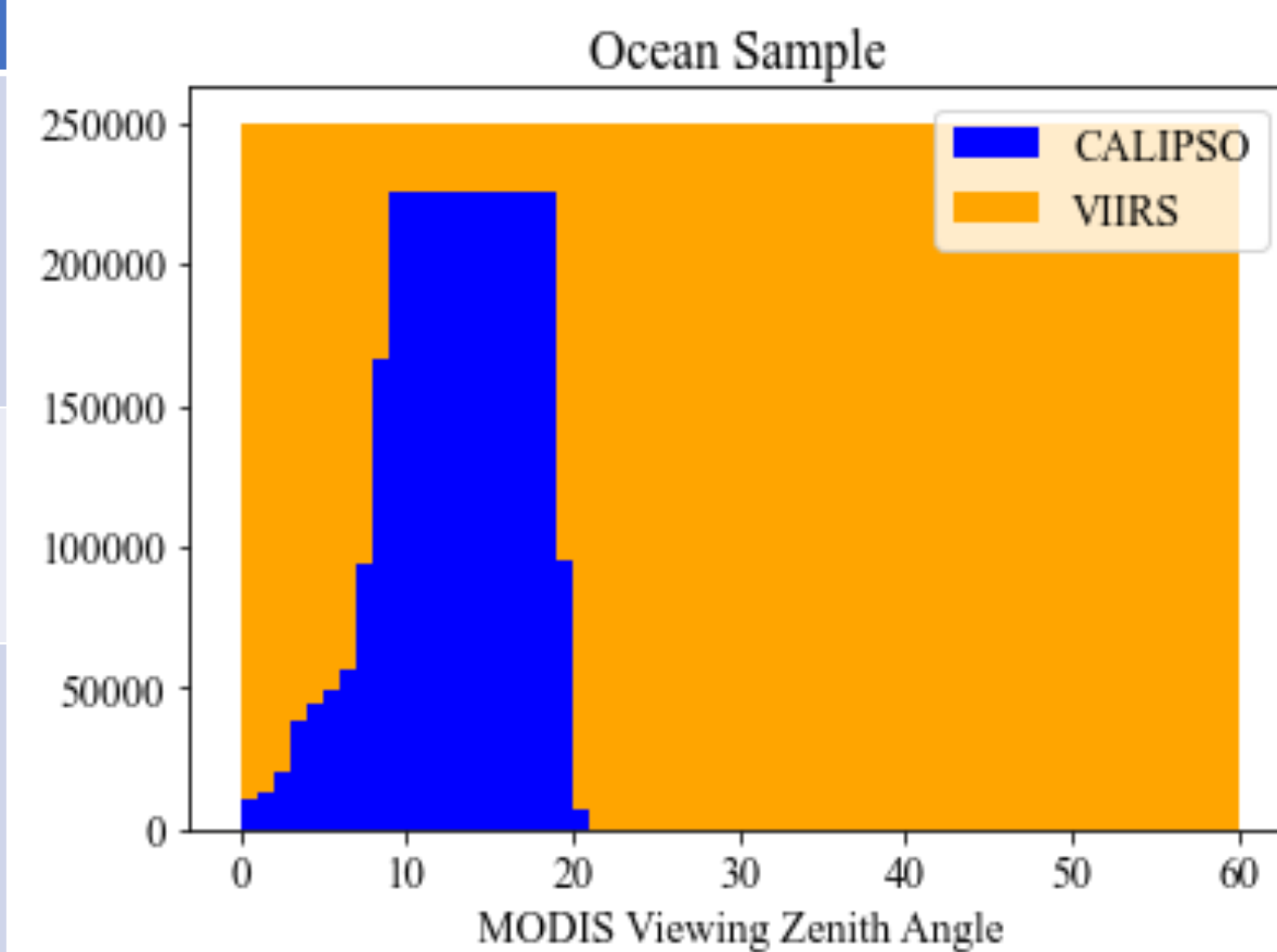
- Efficient training and application to different instruments. Manual adjustment and tuning process are no longer needed.
- Improved performance over existing MOD06 and CLDPROP algorithms.
- Currently in science testing for MOD06 C7 and CLDPROP v2 (to replace existing cloud optical property phase algorithm)

► Status:

- The RF Cloud Thermodynamic Phase Classification Algorithm are developed and tested for **MODIS** (Aqua), **VIIRS** (SNPP), and **ABI** (GOES-R).
- **A daytime model** uses shortwave (SW) and infrared (IR) observations; an **all-day model** that uses IR-only observations. Individual instruments are trained separately.
- **7 surface types are considered**, namely, ocean/water, forest, cropland, grassland, snow/ice, barren/desert, and shrubland.

Major Updates: Improving MODIS Cloud Phase Algorithm's large viewing zenith angle (VZA) performance with Atmosphere SIPs MODIS-VIIRS collocations

	Collocated (MODIS+CALIPSO) + (MODIS+VIIRS) Data
Daytime Models	5 Solar Bands (0.64, 0.86, 1.24, 1.38, 2.13 μm) + 3 IR (8.5, 11, and 12 μm), 4 IR (add 7.3 μm), 8 IR (add 6.7, 13.3, 13.6, 13.9 μm) Bands
All-day Models	IR-only 3 IR Bands, 4 IR Bands, 8 IR Bands
Notes	Training with data in 2013 Evaluation with data in 2014 MODIS-VIIRS observations are within 2 minutes



An Improved InfraRed Optimal Estimation (IROE) based Ice Cloud Retrieval Algorithm

► History:

- IROE was developed in 2016 [Wang et al., JGR-Atmosphere 2016a, b: doi:10.1002/2015JD024526; doi:10.1002/2015JD024528].
- Recent updates include improved code efficiency and stability, various bug fixes, and addition of RTTOV (alongside existing CRTM) as option for clear-sky transmittance calculation.
- IROE is currently in science testing for inclusion in MOD06 C7 (to replace existing 1km CT retrievals) and CLDPROP v2 (in parallel to existing NOAA CLAVR-x retrievals). Note: CLDPROP science testing includes exploring the inclusion of IR sounder absorbing channels.

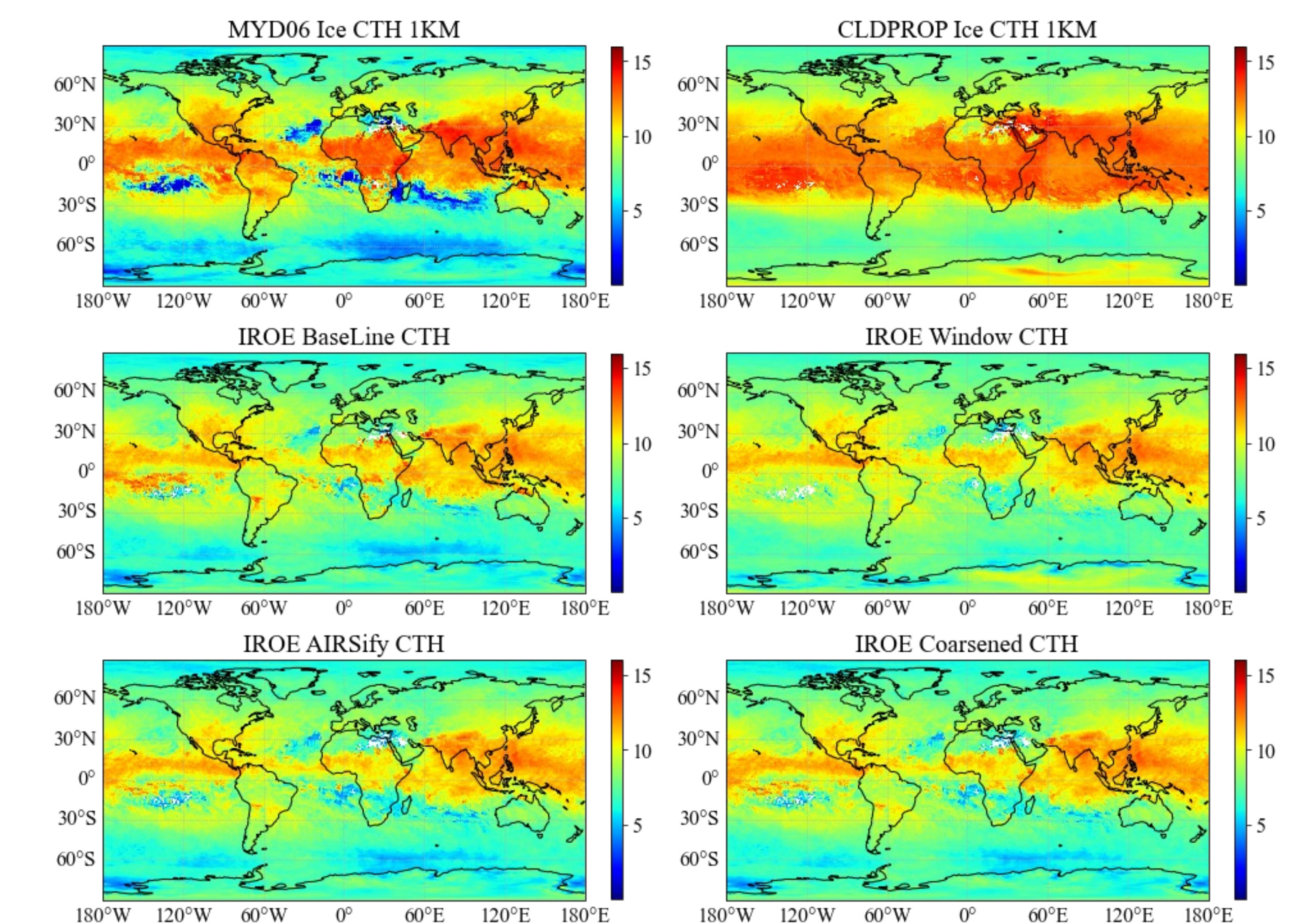
► Features:

- Instantaneous 1-km ice cloud optical thickness (COT), effective radius (CER), and cloud-top height (CTH) retrieval with uncertainty estimation.
- Consistent day/night cloud retrieval algorithm.
- Computationally efficient: ~ 4 mins/granule with a single core, comparable to current MOD06 COP algorithm.
- **User defined IR band combinations.**

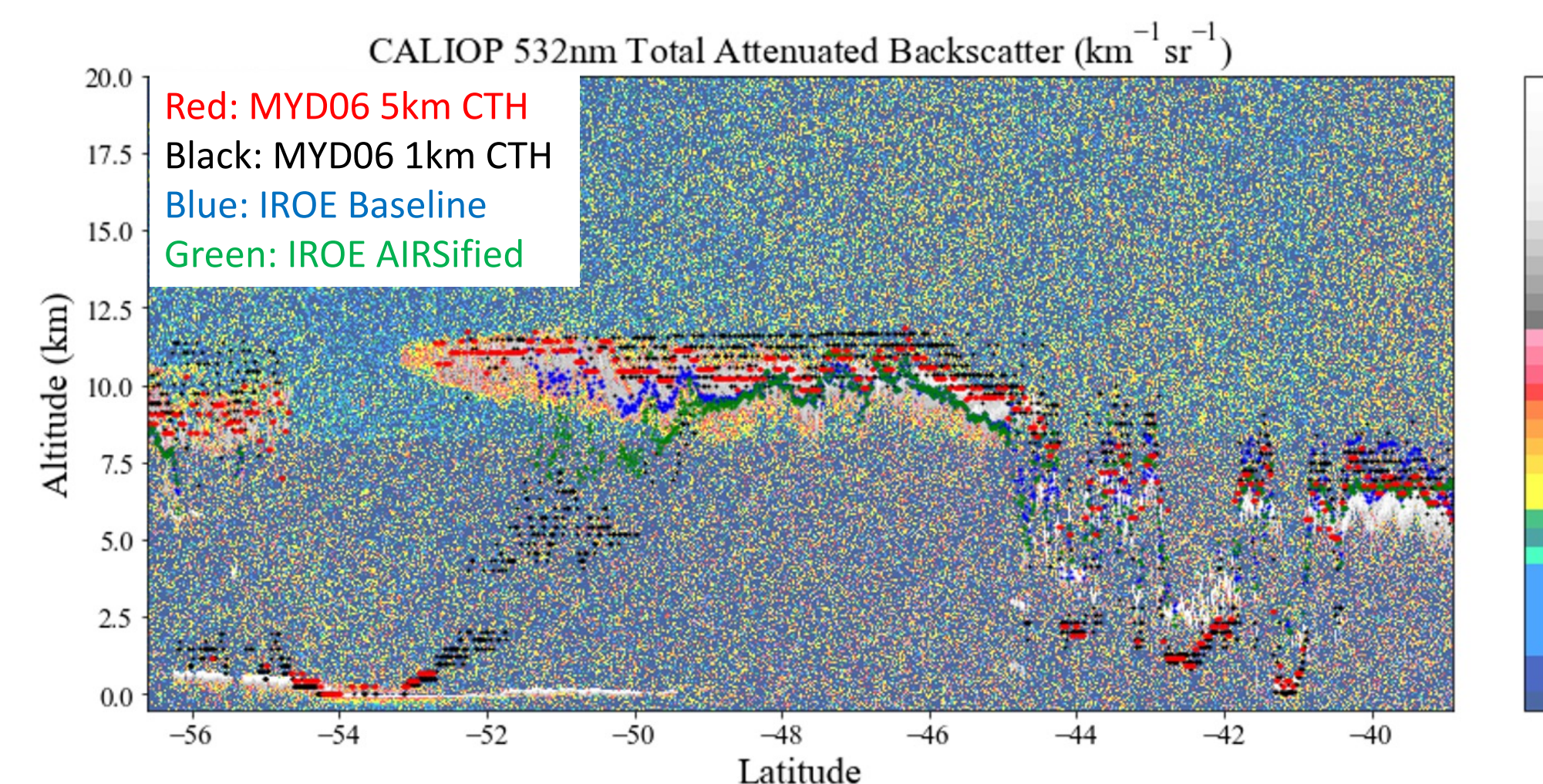
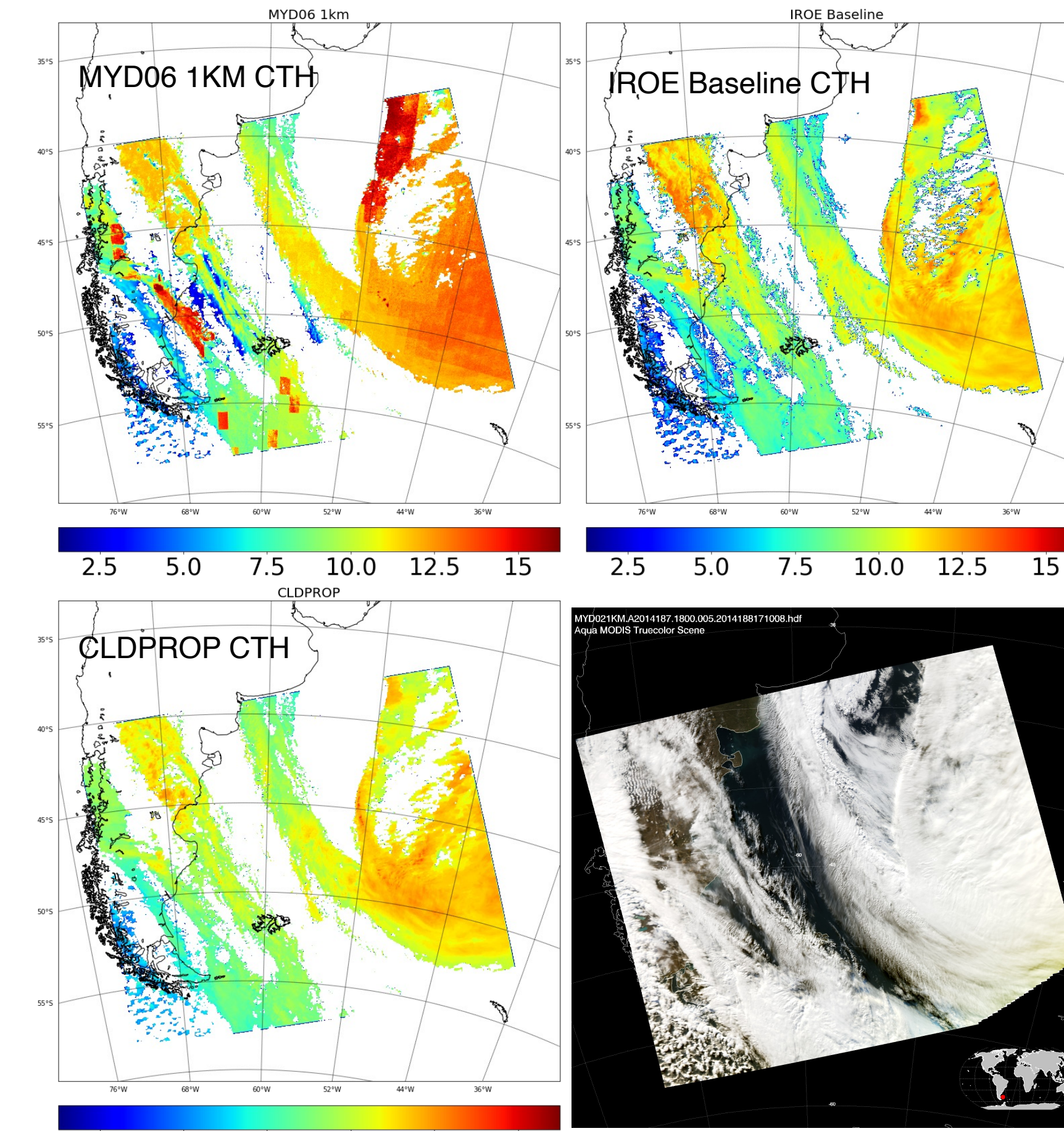
Cloud-top Height Comparison using Different IR Bands

	IROE-Baseline	Bands 28 29 31 32 33 34	MODIS Original Bands
MOD06 C7	IROE-Window	Bands 29 31 32	MODIS original window bands only (8.5, 11, and 12 μm)
CLDPROP v2	IROE-AIRSified	Bands 28*, 29, 31 32 33* 34*	MODIS original window bands MODIS water vapor (7.3 μm) and CO ₂ (13.3 and 13.6 μm) bands are replaced by AIRS spectra integrated with MODIS response functions
	IROE-Coarsened	Bands 28' 29 31 32 33' 34'	MODIS original window bands MODIS water vapor (7.3 μm) and CO ₂ (13.3 and 13.6 μm) bands are replaced by averaged MODIS observations over AIRS FOVs.

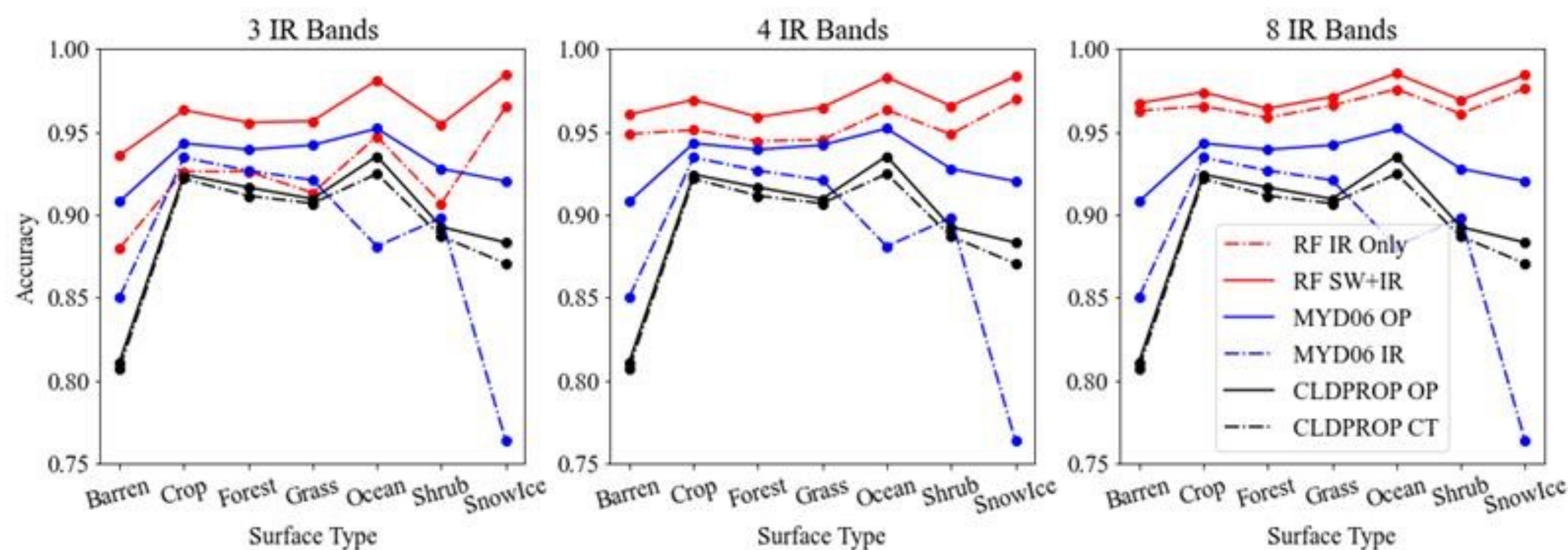
Monthly Mean CTH comparison Jul 2014



Case Study: MODIS Granule 2014187.1800

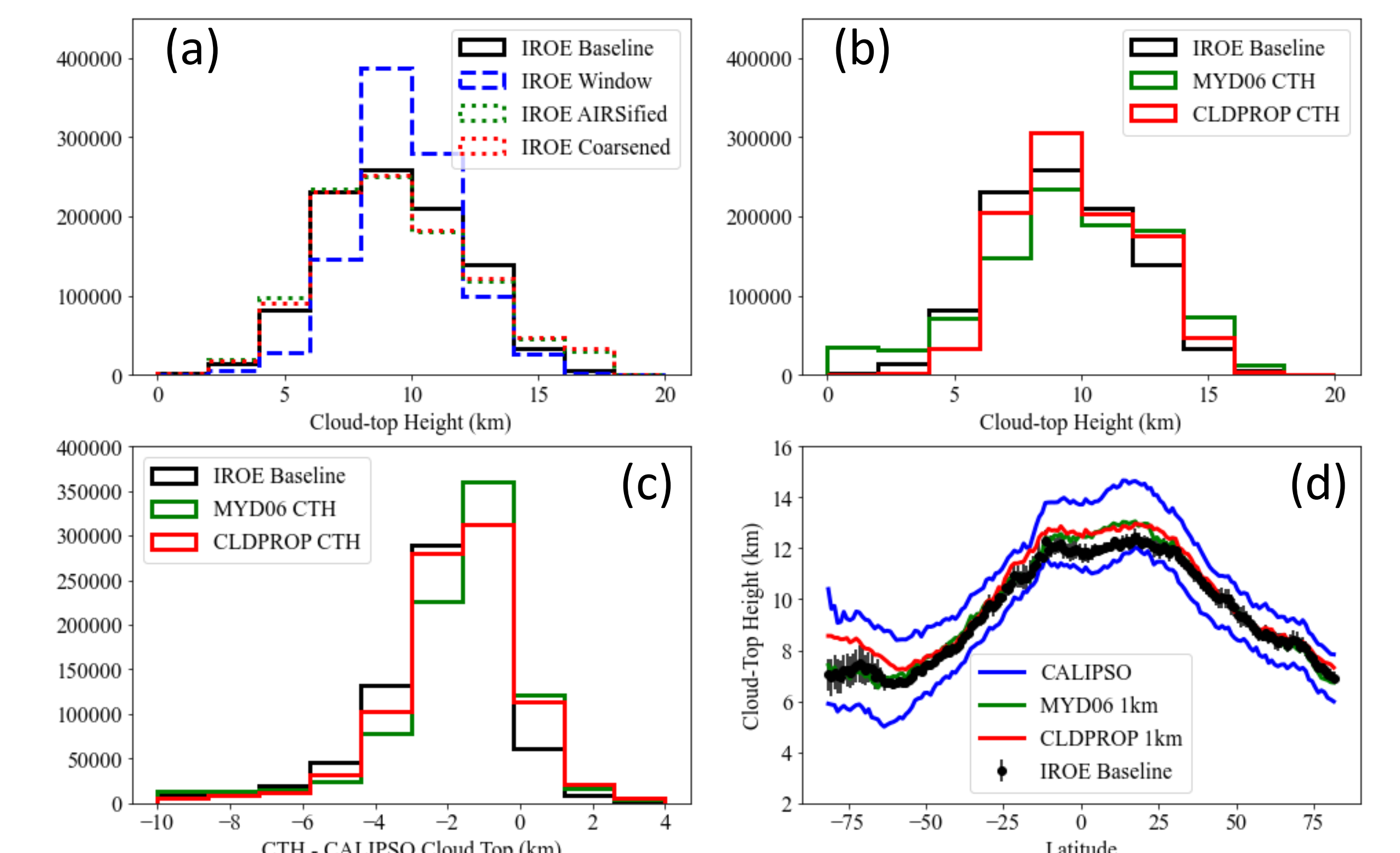


Model Evaluation vs. CALIPSO (MODIS-CALIPSO collocation in 2014)



Cloud phase classification accuracies for RF models, MYD06 C6.1 Cloud Phase Infrared (IR) and Optical Property (OP), MODIS CLDPROP Cloud Phase Cloud Top Property (CT) and Optical Property (OP). Clear sky pixels and uncertain phase pixels in MYD06 and CLDPROP are removed.

Cloud-top Height Comparisons along CALIPSO Track



Panel a: CTH histograms for the 4 IROE Tests.
Panel b: CTH histograms for IROE, MODIS MYD06 1km and CLDPROP
Panel c: CTH bias (compare with CALIPSO top-layer CTH) histograms
Panel d: Monthly Zonal Mean CTH plots.