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ESA Climate Change Initiative: Evaluation of the FAME-C cloud properties for the years 2007-2009

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Outline

- Introduction to FAME-C

- Comparison to MODIS coll5 cloud optical and micro-physical properties

- Two independent cloud top height retrievals and relation to cloud geometrical extend

FAME-C

FUB **A**ATSR **ME**RIS **C**loud retrieval

- FAME-C is a daytime **synergistic** cloud retrieval algorithm for measurements of MERIS & AATSR (and accordingly OLCI & SLSTR).

- Uses **optimal estimation** to provide for uncertainty estimates (pixel quality flags)

FAME-C

FUB **A**ATSR **ME**RIS **C**loud retrieval

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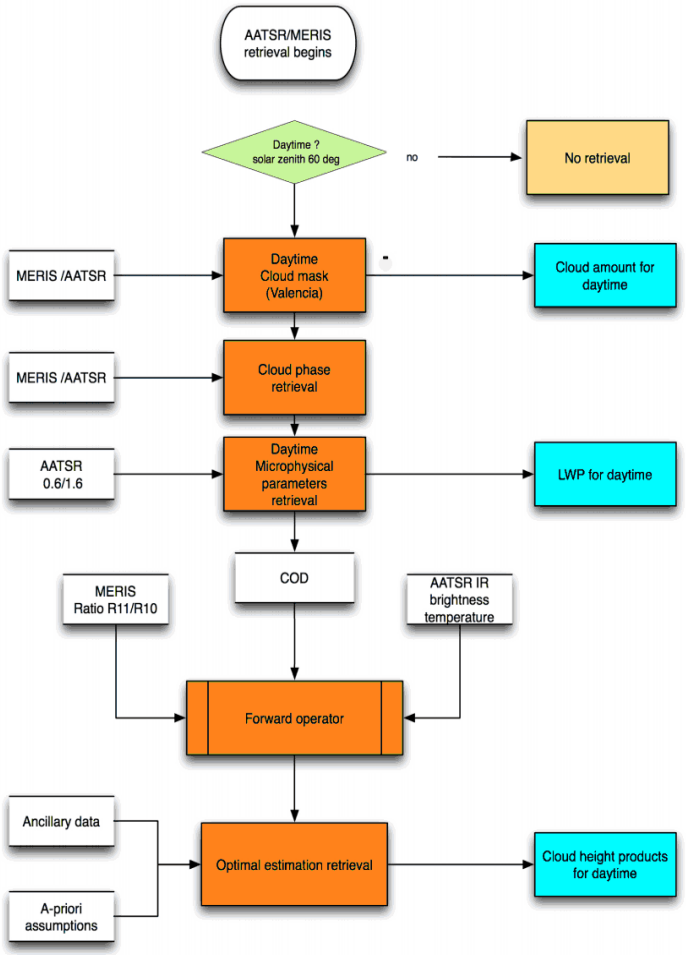
- Uses **optimal estimation** to provide for uncertainty estimates (pixel quality flags)

- In sequential form

1. Synergy products of AATSR and MERIS bands: collocation & cloud mask (Gomez-Chova et al. 2010)
2. Cloud micro-physical retrieval (based on DCOMP; Walther et al. 2011): COT & REFF → LWP/IWP
3. Cloud Height retrieval: CTP and CTT



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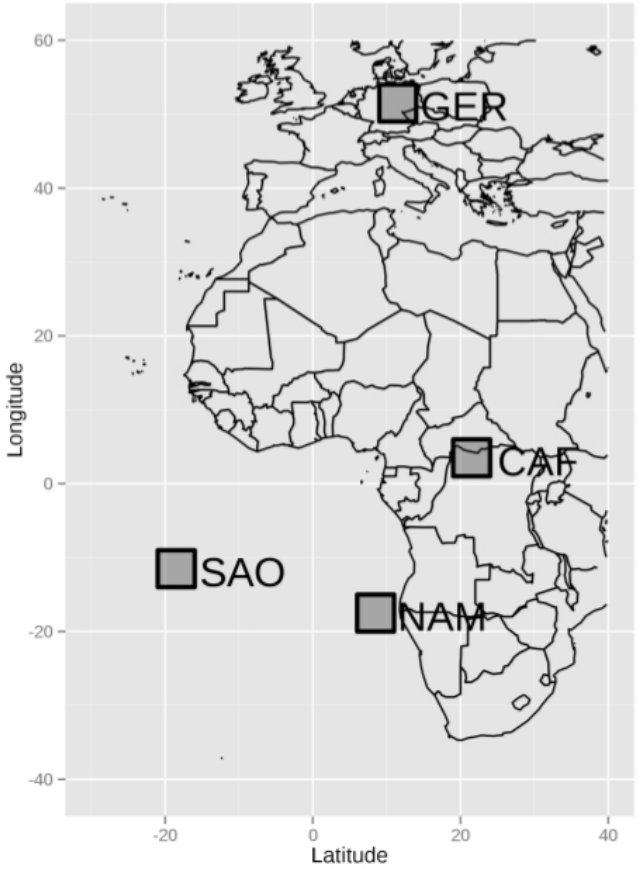
2. Comparison of Cloud Micro-physical properties to MODIS coll5 cloud products

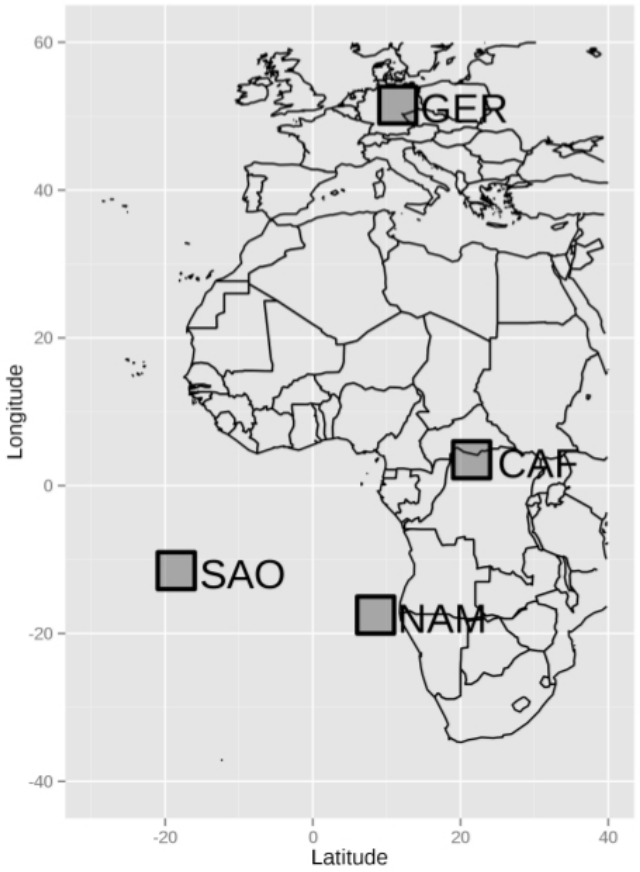
Comparison to MODIS coll5

- FAME-C 10.00 am descending node
- MOD08 (TERRA) 10.30 am descending node
- For micro-physical retrievals, both on horizontal resolution 1 km



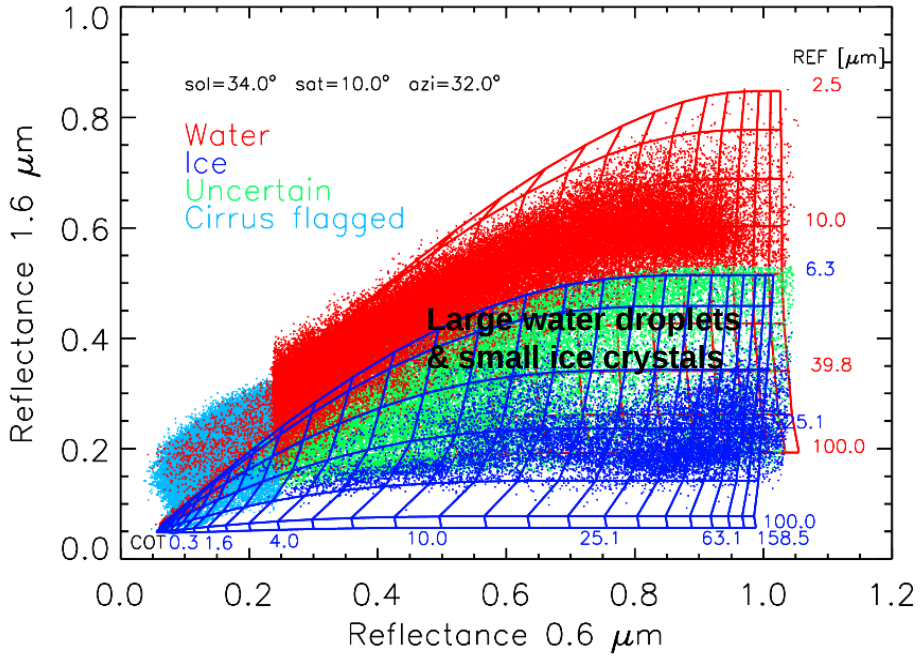
Comparison to MODIS coll5

- Cut out MODIS swath to width of AATSR swath → similar viewing angles
- Take MODIS cloudy pixels with QA = general assessment good
- Overflying orbits about every 3 days

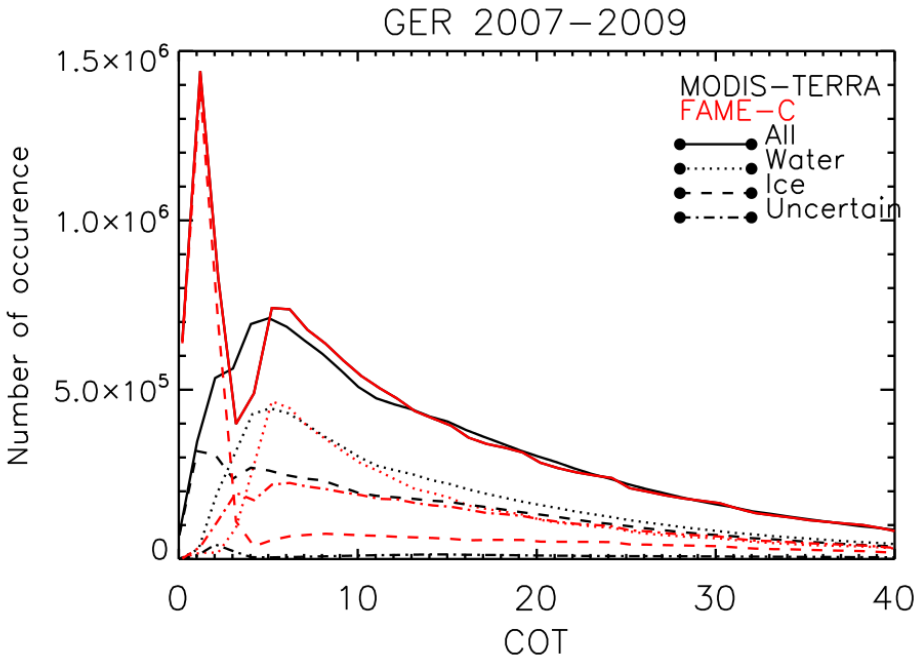


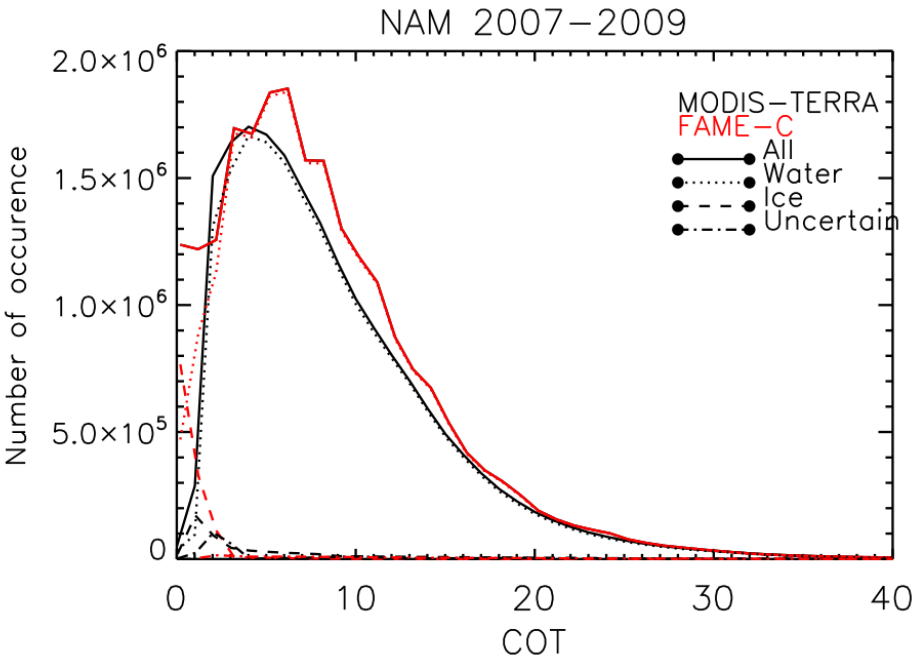
Cloud Phase

- Brightness Temperature threshold 261 K (Pruppacher and Klett, 1997)
- Additional Cirrus test: split-window technique BT11-BT12 with dynamic threshold (MOMO simulations with different atmospheric and surface situations)

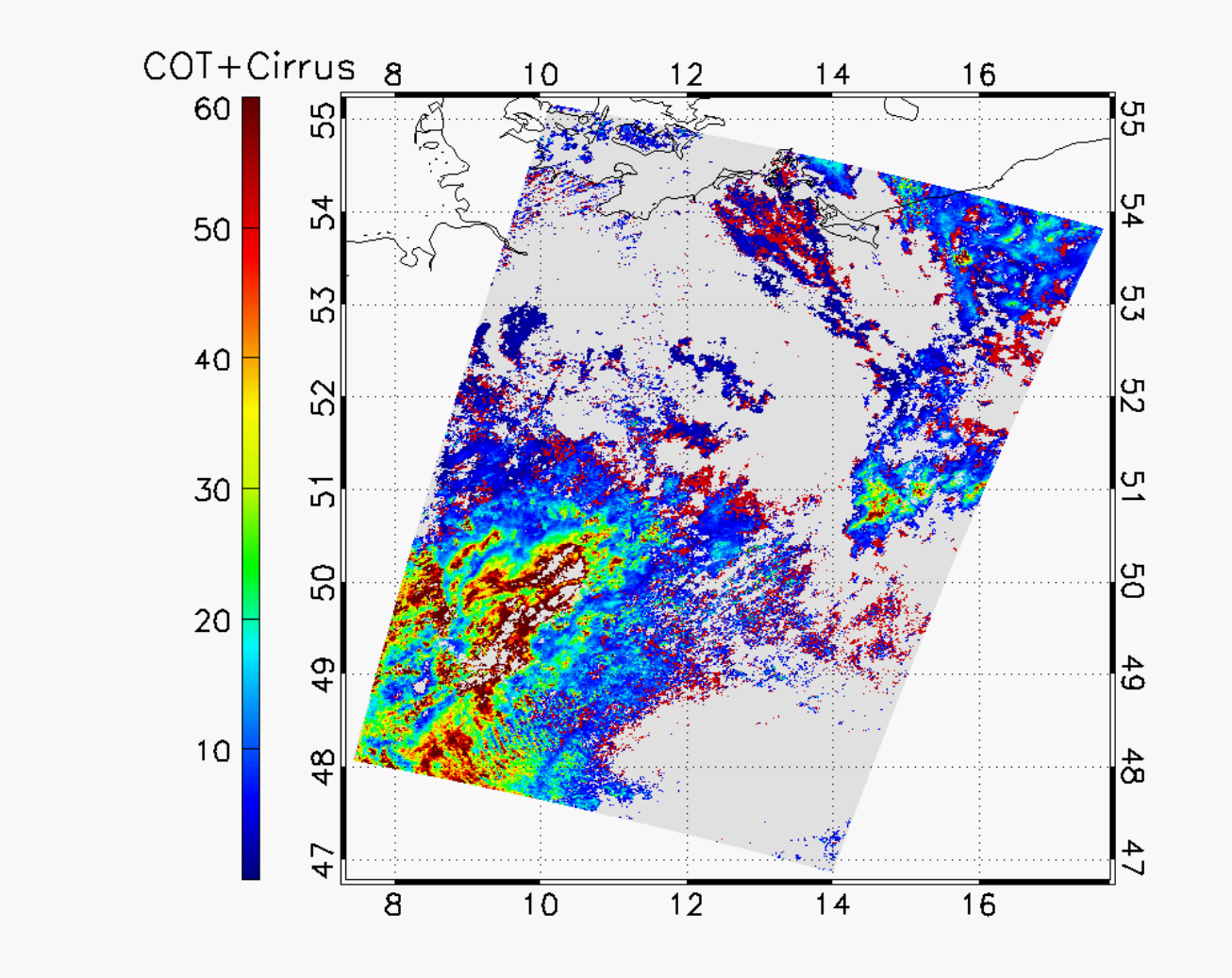


Level-2 Histograms

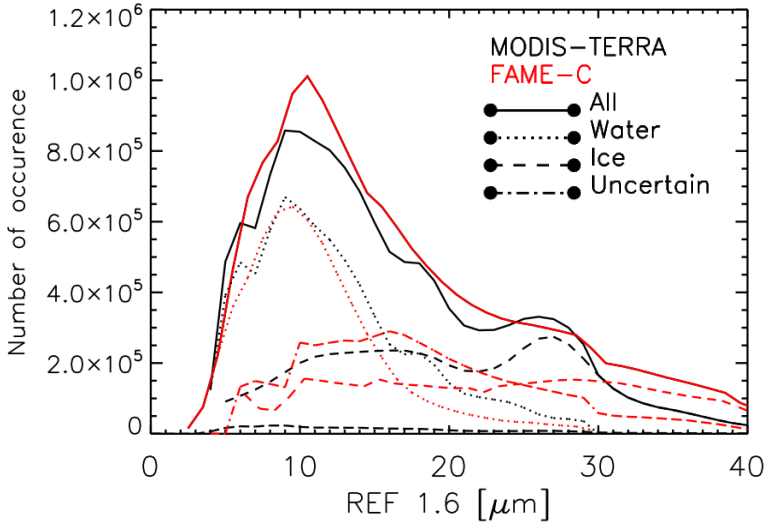


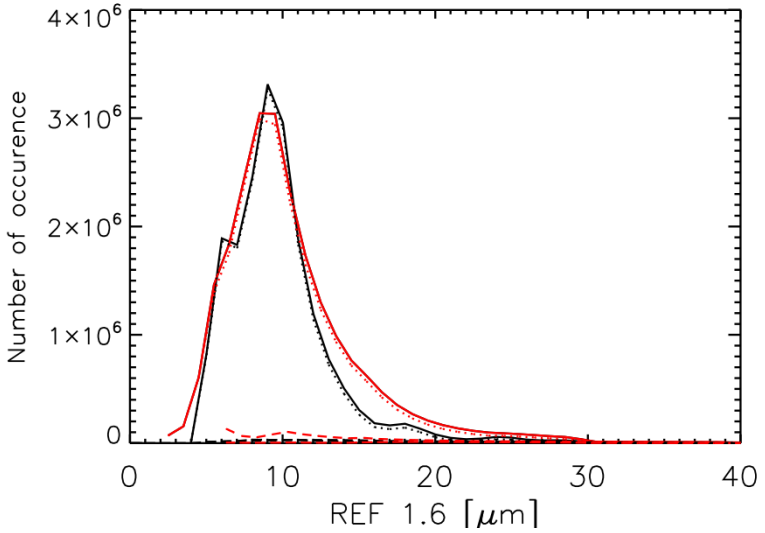


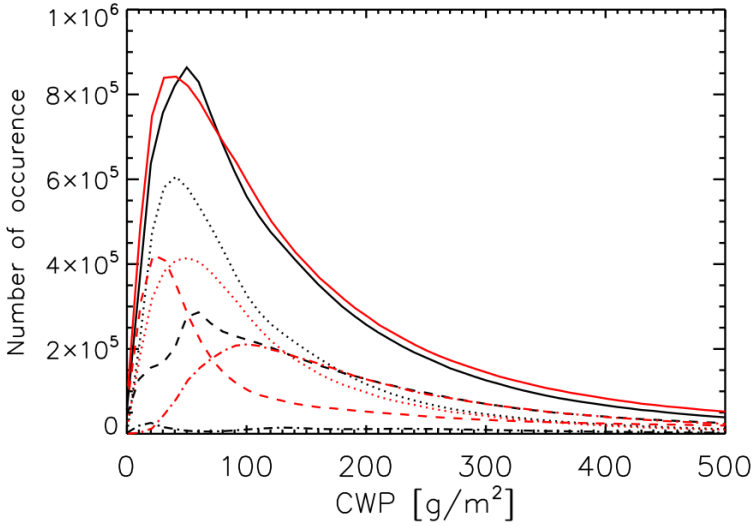
Cirrus/cloud boarders

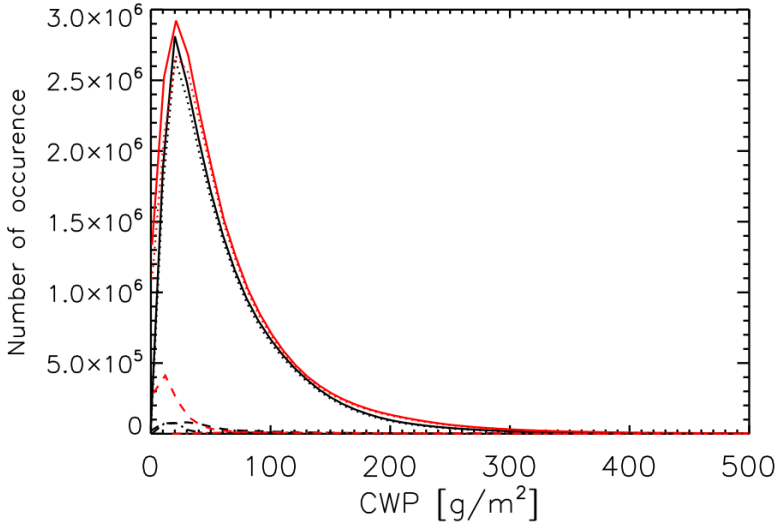


Level-2 Histograms



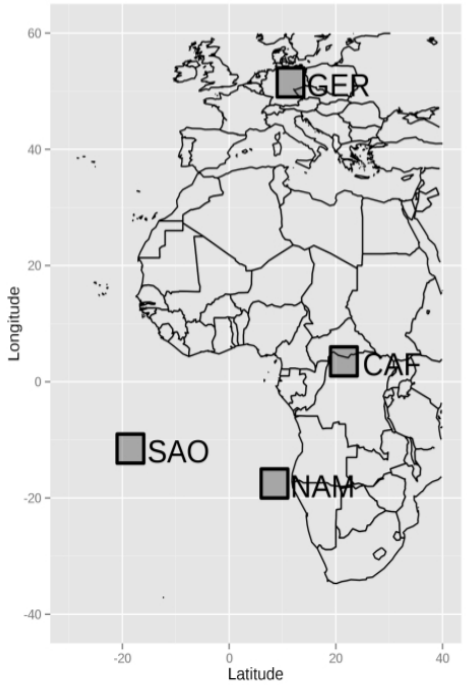






Monthly means

		Bias				RMSE			
		All	Wat	Ice	Unc	All	Wat	Ice	Unc
CAF	CF [%]	-1.87	-10.13	-1.95	21.83	12.45	16.24	6.73	22.87
	COT [1]	-1.54	0.58	-3.73	-2.70	4.84	2.08	7.40	7.52
	REF [μm]	0.07	-1.49	0.92	0.28	3.48	1.95	4.10	2.45
	REF16 [μm]	-1.06	-3.11	0.42	0.21	3.56	3.33	4.13	2.03
	CWP [g/m^2]	21.62	4.61	29.05	2.48	83.70	19.11	111.78	75.29
GER	CF [%]	4.70	-11.97	-2.39	29.81	15.59	17.26	9.66	33.82
	COT [1]	-4.57	-3.02	-9.70	-3.03	6.20	5.80	11.91	11.18
	REF [μm]	2.26	0.09	4.50	0.43	3.14	1.38	5.61	3.61
	REF16 [μm]	1.64	-1.01	4.18	1.10	2.78	1.90	5.83	3.04
	CWP [g/m^2]	0.45	-8.39	-40.89	11.31	40.39	35.27	107.55	86.28
NAM	CF [%]	7.57	-2.41	0.08	0.28	12.98	6.08	0.48	2.22
	COT [1]	-0.60	-0.28	-4.94	7.95	1.38	1.27	7.06	10.52
	REF [μm]	-0.31	-0.47	1.59	3.68	1.33	1.34	5.48	5.29
	REF16 [μm]	0.65	0.41	3.60	4.71	1.35	1.18	6.45	6.21
	CWP [g/m^2]	-1.95	-0.18	-27.91	115.42	13.62	14.46	47.44	141.66
SAO	CF [%]	14.23	-1.77	0.26	1.25	16.17	8.30	1.17	2.51
	COT [1]	-1.10	-0.56	-3.57	1.96	1.75	1.43	4.38	5.31
	REF [μm]	1.11	1.11	-1.44	4.38	2.41	2.18	7.04	6.58
	REF16 [μm]	2.00	1.80	2.05	5.38	2.70	2.39	6.92	7.18
	CWP [g/m^2]	-0.28	5.20	-28.78	66.98	17.25	17.16	44.56	88.68



3. Comparison of retrieved Cloud Top Heights to ARM site measurements

Cloud Height Retrievals

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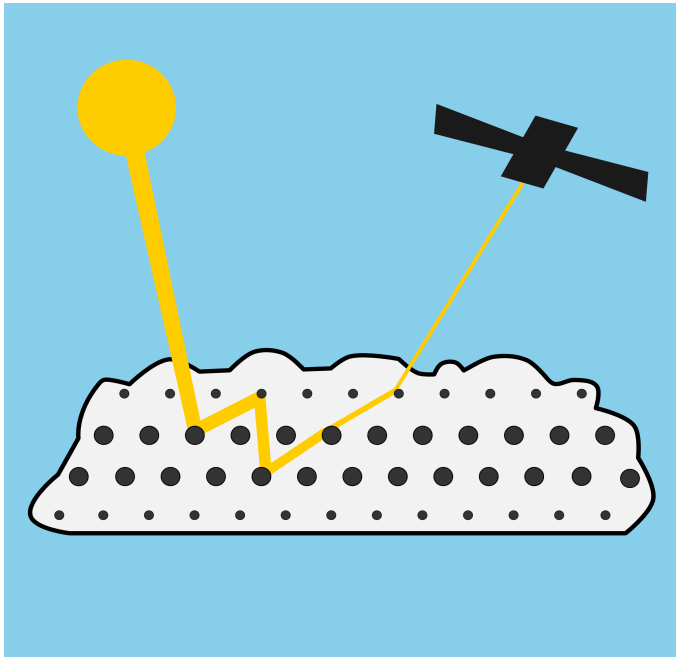
AATSR-CTT

- Brightness Temperatures
- More sensitive to higher clouds

MERIS-CTP

- Oxygen-A absorption band
- More sensitive to lower clouds



CloudSat mean vertical cloud profiles

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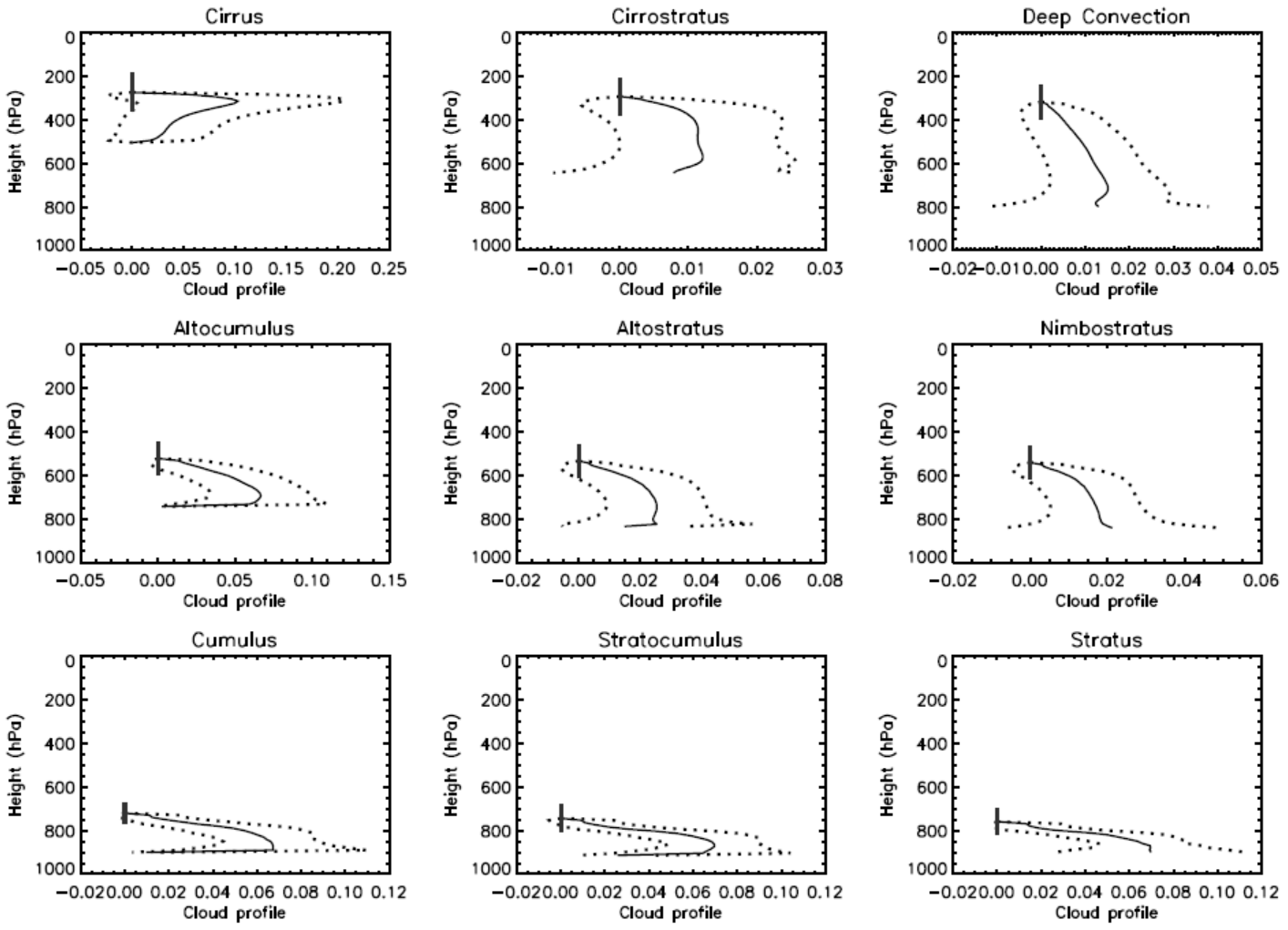

Comparison of MERIS and AATSR CTH to radar-CTH

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Collect MMCR from ARM sites (SGP, TWP)

- For years 2007-2009
- For ENVISAT overflight times
- Filter out cases with temperature inversion

Compare to radar-CTH

- Use -30 dBZ to find upper cloud layers
- Apply parallax correction to satellite data
- Compute temporal (radar) and spatial (satellite) mean
- For not too variable cloudy cases in time and space

Comparison to radar-CTH

		Bias [km]		RMSE [km]	
		Single	Multi	Single	Multi
AATSR-CTH	CPR	-1.48	-1.38	3.06	2.19
	HOM	-1.30	-1.20	2.96	2.07
MERIS-CTH	CPR	0.62	0.10	2.91	2.72
	HOM	-4.10	-5.11	4.90	5.54
AATSR-CTH, COT > 5	CPR	-0.40	-1.36	1.58	2.33
	HOM	-0.25	-1.21	1.52	2.23
MERIS-CTH, COT > 5	CPR	0.92	-0.31	2.27	2.69
	HOM	-3.39	-5.43	4.03	5.84

Comparison of CTH-DIFF to lidar-CBH and radar-CTH

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Compare to radar-CTH

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Collect LIDAR data for CBH

Comparison to lidar-CBH and radar-CTH

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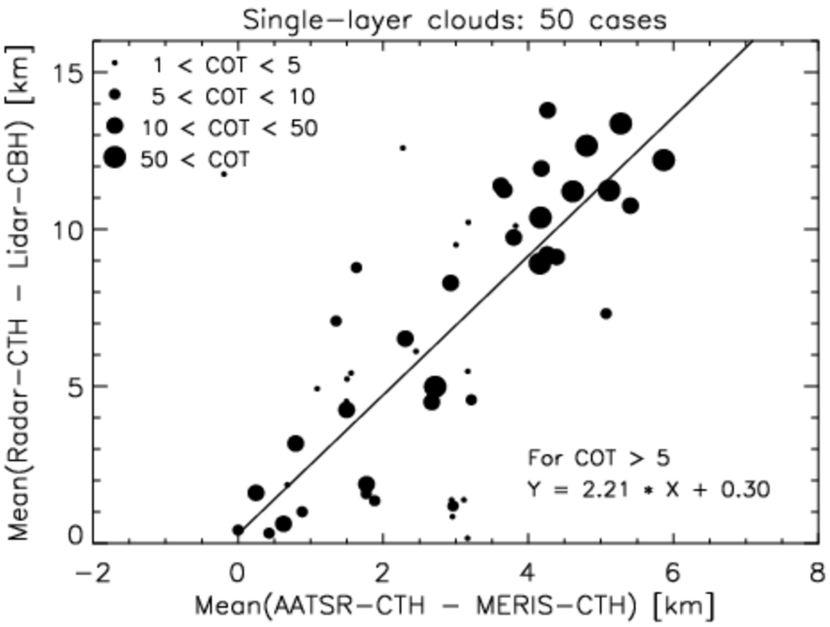

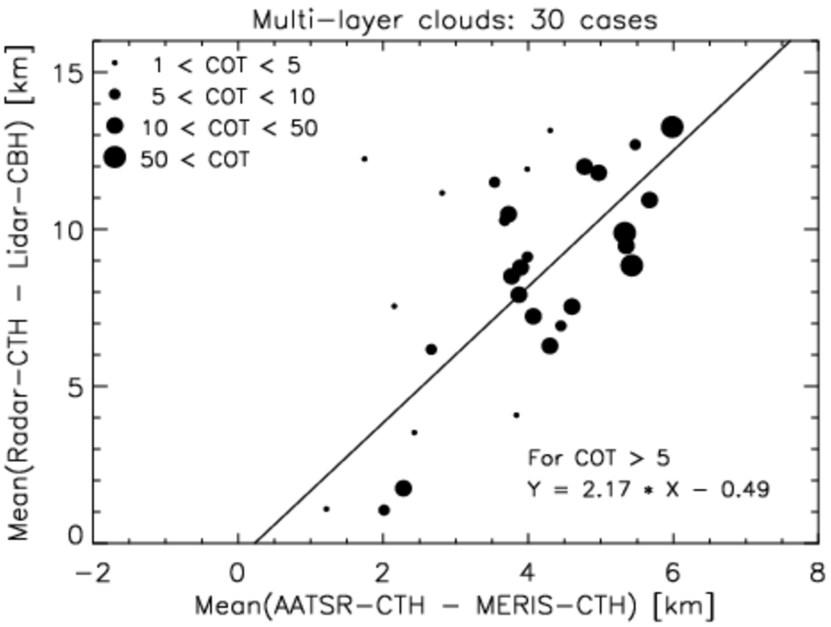

Comparison to lidar-CBH and radar-CTH

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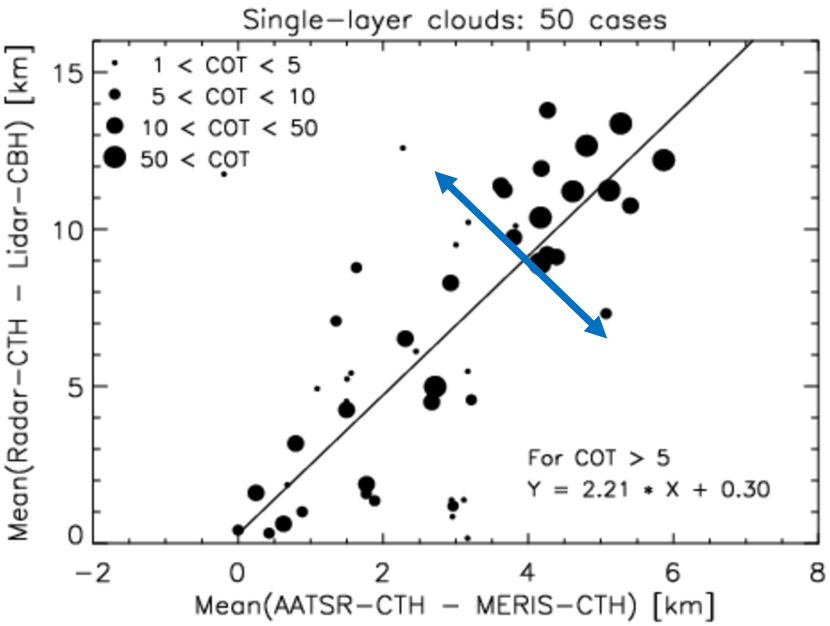

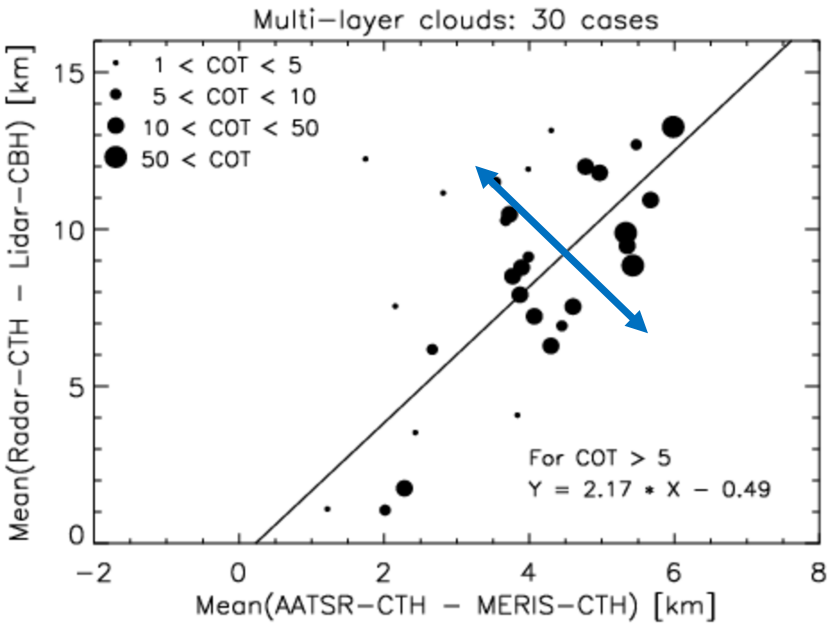

Natural variations in cloud vertical profiles

Summary and Outlook

- Level-2 Histograms useful to identify cloud property retrieval issues
- CTH difference related to cloud vertical extend

- Compare CTH difference to DARDAR dataset
- Cloud Masking/Cloud phase → Cloud typing
- Look into uncertainty estimates
- Perform retrievals for years 2002-2012
- Prepare FAME-C for OLCI and SLSTR on SENTINEL-3
  → more channels in OLCI Oxygen-A band
  → 1.3 and 2.2 micron channel for SLSTR
  → larger swath width

More information: **www.esa-cloud-cci.org**

Thank you!

MERIS Oxygen-A band

- Oxygen: constant and well-mixed in atmosphere
- Can therefore be used to estimate **average photon path length** in atmosphere
- In cloudy situations this average photon path length is mainly determined by cloud top pressure (CTP)
- Transmission O2A band → Ratio L11/L10