Comparisons of aerosol types and associated lidar ratios between CALIPSO and GOCART model

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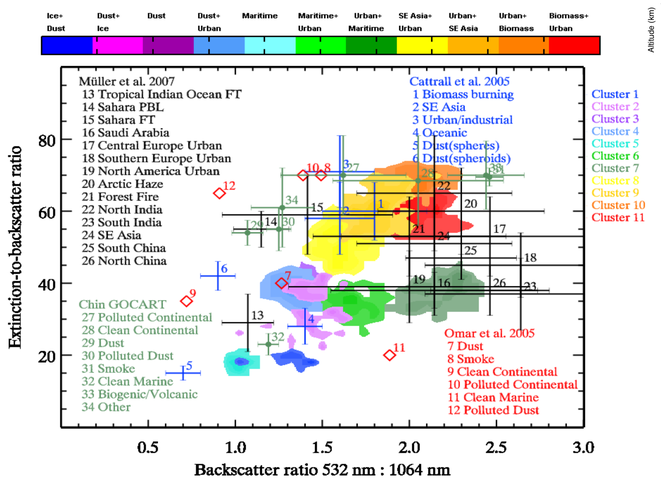
Introduction

- Determining aerosol type and selecting the associated lidar ratio S_a are essential steps in CALIOP aerosol extinction retrieval
- Understanding the differences between the CALIOP and model on the fundamental quantity, aerosol extinction profile, requires the evaluation of aerosol types, because different aerosols have different S_a
- This study compares the aerosol types and their lidar ratios between those selected by CALIOP scheme that is based on measured depolarization ratio, attenuated backscatter, and surface type, and GOCART that is based on the aerosol origin

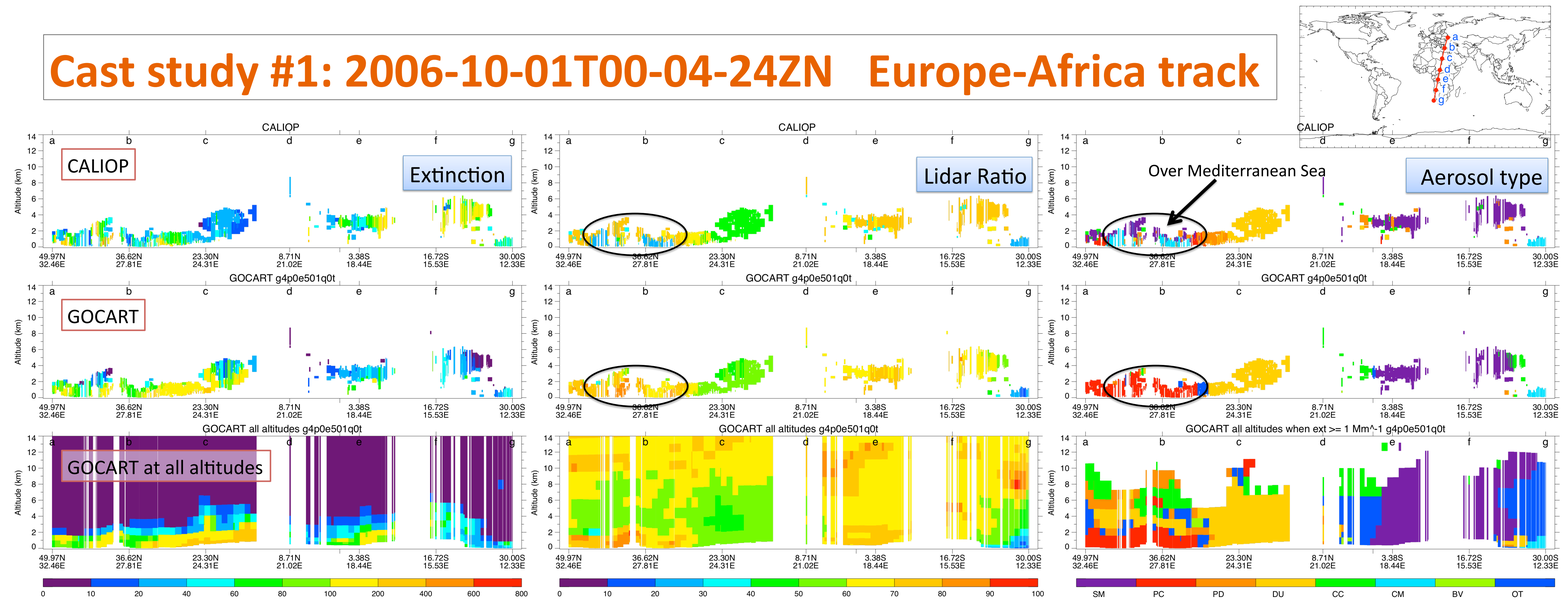
Table 1. Comparisons of CALIOP and GOCART aerosol type selection schemes and type-dependent lidar ratios.

Type		Selection Criteria*	Lidar Ratio at 532 nm
Polluted Continental (PC)	CALIOP	(1) Over land: $\gamma > 0.0005$, $\delta' \leq 0.075$, layer not elevated (2) Over ocean: $\gamma \leq 0.01$, $0.75 \geq \delta' \geq 0.05$ (3) Over snow/ice or tundra: $\gamma > 0.0005$, $\delta' \leq 0.075$	70
	GOCART	σ(pollution) / σ(total) ≥ 0.55	70.0 ± 11.1
Smoke (SM)	CALIOP	(1) Over land: $\delta' \leq 0.075$, $\gamma > 0.0005$, elevated layer (2) Over ocean: $\delta' \leq 0.075$, elevated layer	70
	GOCART	σ(smoke) / σ(total) ≥ 0.55	67.7 ± 6.3
Dust (DU)	CALIOP	$\delta' > 0.075$, $\gamma > 0.2$	40
	GOCART	σ(dust) / σ(total) ≥ 0.55	54.0 ± 3.5
Polluted Dust (PD)	CALIOP	(1) Over all surface: $\delta' > 0.075$, $\gamma \leq 0.2$ (2) If (1) does not meet: over desert $\delta' \leq 0.075$, $\gamma \leq 0.005$	65
	GOCART	σ(dust) / σ(total) = 0.4 – 0.55 and σ(pollution +smoke) / σ(total) = 0.15 – 0.4	55.8 ± 6.2
Clean Marine (CM)	CALIOP	(1) Over ocean, layer not elevated, $\delta' \leq 0.075$, $\gamma > 0.01$ (2) Over ocean, $\gamma \leq 0.01$, $\delta' < 0.05$	20
	GOCART	σ(sea salt) / σ(total) ≥ 0.55	22.8 ± 2.8
Clean Continental (CC)	CALIOP	(1) Over land, non-desert surface: $\delta' \leq 0.075$, $\gamma \leq 0.0005$ (2) Over snow/ice or tundra: $\delta' \leq 0.075$, $\gamma \leq 0.0015$	35
	GOCART	σ(total) < 0.002 km^{-1} and σ(sea salt) / σ(total) < 0.4	64.3 ± 9.7
Biogenic / Volcanic (BV)	CALIOP	N/A	
	GOCART	σ(biogenic +volcanic) / σ(total) ≥ 0.55	69.7 ± 3.9
Other (OT)	CALIOP	N/A	
	GOCART	Mixture with σ fractions not meet the criteria for the above	59.2 ± 17.1

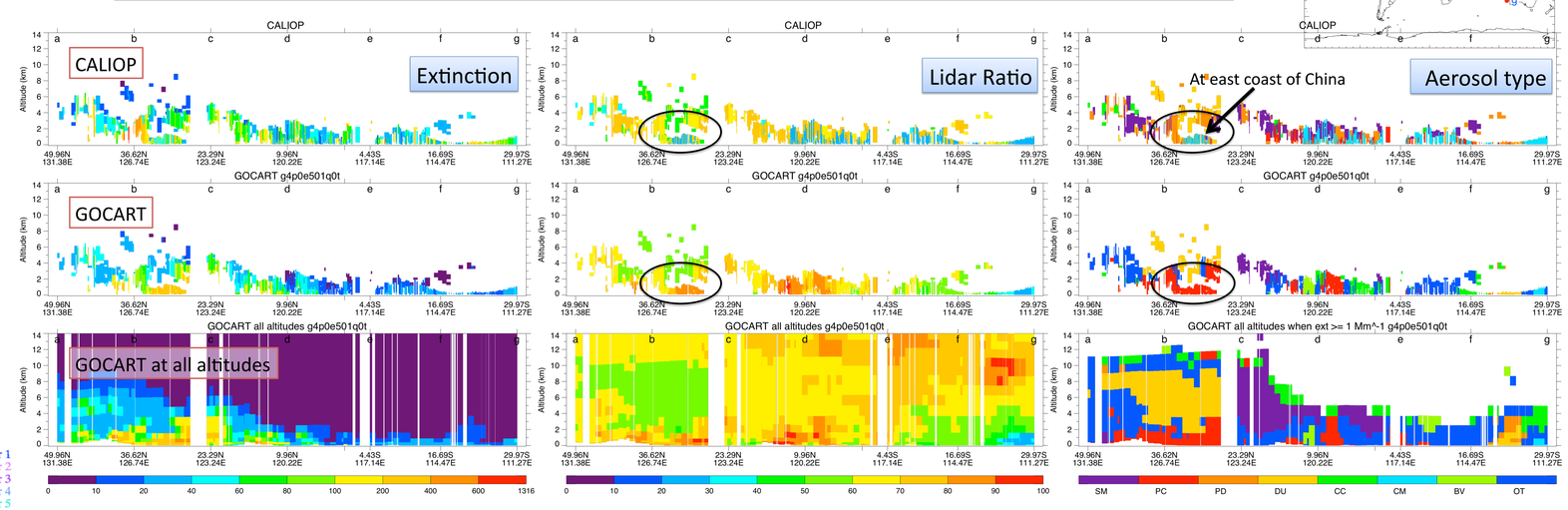
*γ = attenuated backscatter at 532 nm; σ = extinction (km^{-1}) at 532 nm; δ' = corrected depolarization ratio (or estimated particle depolarization ratio, which is corrected from the volume depolarization ratio to account for the molecular contribution. See Omar et al., 2009).



Cast study #1: 2006-10-01T00-04-24ZN Europe-Africa track



Cast study #2: 2007-04-10T17-32-23ZN Asian outflow



Remarks

- From two completely independent classification of aerosol types, CALIOP and GOCART show similar types over source regions and transported aerosols above BL
- Major differences are seen in the boundary layer over water near the continents where CLAIOP often identifies the aerosol as "clean marine" while GOCART as "polluted continental" – CM and PC have ~3x difference in S_a!
- For dust, S_a from CALIOP is 40 while from GOCART is about 54
- It is unclear what "clean continental" is…

Future study: Characterizing aerosol types and transport through an integrated analysis of CALIPSO and A-train data with global models

- Characterizing aerosol type with A-train and other satellite data, trajectory model, and chemistry transport models (GOCART + AeroCom)
- Improving CALIOP aerosol type selection scheme within continental outflow boundary layer over ocean
- Examining the transport, emission, and removal processes of aerosols
- Achieving greater synergies among multi-platform measurements and multiple models