

TOWARDS A GLOBAL CLIMATOLOGY OF OPTICALLY THIN CLOUDS DERIVED FROM NETWORKS OF GROUND-BASED LIDARS

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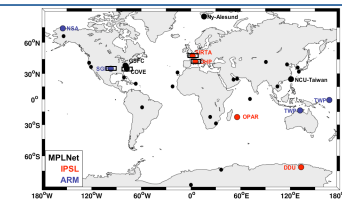
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Introduction

Over 100 Lidar stations can be found around the globe. Only few are equipped with fully automated systems, but several networks have gathered 5-10 years records from routine observations. Long time series can be used to derive statistics of cloud vertical distributions clouds and their corresponding optical properties. Regional statistics are compared to Level-2 product retrievals from CALIOP observations above several ground Lidar stations. Comparisons focus on cirrus clouds (cloud base > 7km, non opaque clouds).

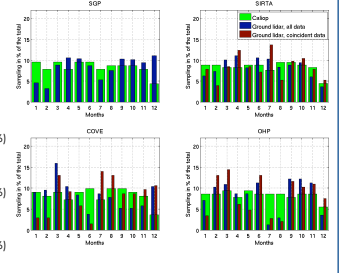
Lidar Networks

- ARM/DoE (since 1998): 4 sites (e.g. Turner et al. 1999)
- IPSL/CNRS (since 2002): 4 sites (e.g. Haeffelin et al., 2005; Keckhut et al., 2006)
- MPLNET/NASA (since 2000): 20 sites including 4 long-term sites (Wellton et al. 2001)
- CALIOP/NASA (since 2006): on-board CALIOP (Winker et al., 2007)



Lidar Datasets and Sampling

- CALIOP:**
- 532 nm elastic Lidar
 - CALIPSO level-2 data
 - 5 km feature mask (CBH, CTH)
 - COD from transmittance only
- SGP (ARM/DoE): 36.8°N/97.5°W**
- 355 nm Raman Lidar
 - Cloud mask from depol ratio
 - COD from N2 Raman and elastic
- COVE (MPLNET/NASA): 36°N/75°W**
- 532 nm elastic MPLidar
 - Cloud mask from STRAT
 - COD from STRAT/MI
- OHP (NDAAC/IPSL): 44°N/5°E**
- 532 nm elastic tropo/strato Lidar
 - Cloud mask from STRAT
 - COD from STRAT/MI
- SIRTA (INSU/IPSL): 49°N/2°E**
- 532 nm elastic tropo Lidar
 - Cloud mask from STRAT
 - COD from STRAT/MI



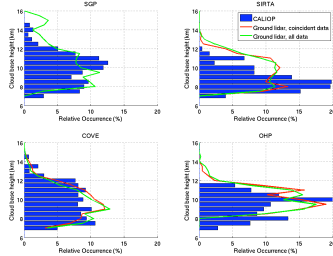
- Focus on non opaque ($T > 0$), high-altitude (CBH > 7km) clouds
- All COD retrievals are based on layer attenuation or transmittance
- Account for primary multiple scattering effect in cirrus clouds: small-angle forward scattering (Chen et al., 2002)

Cloud Base Height Statistics

Cloud Base Height (CBH).

The base height of high-altitude clouds range 7-14 km over the European sites and 7-16 km over the US sites.

The CBH distribution from CALIOP range about 2km less than that from the ground sites.



Cloud Top Height Statistics

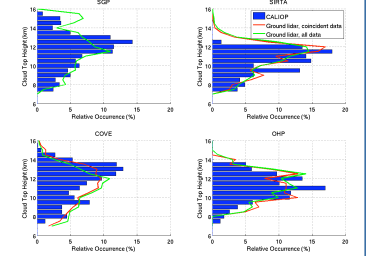
Cloud Top Height (CTH).

The top height of high-altitude clouds range 7-14 km over the European sites and 7-16 km over the US sites.

Over SGP both the ground Raman Lidar and CALIOP show a mode around 15 km. This mode is not observed over COVE.

CTH distributions over OHP and SIRTA agree remarkably well.

The CTH capacity of the COVE MPL can be discussed.

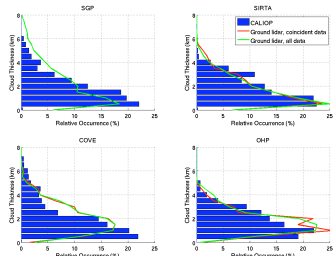


Cloud Thickness Statistics

Cloud Thickness (CTK).

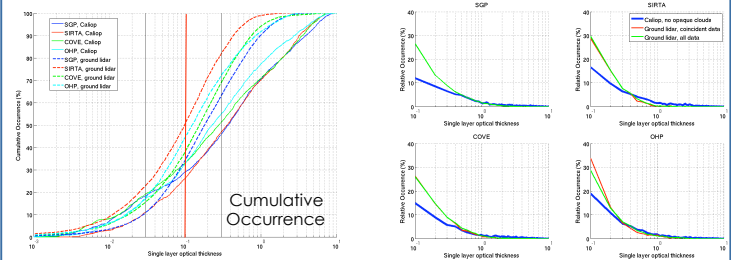
The thickness of high-altitude clouds range 0-4 km over the European sites and 0-6 km over the US sites.

At SGP and COVE, CTK distributions from CALIOP overestimate in the 0-2 km range and underestimate in the 2-4 km when compared to ground-based lidar CTK distributions.

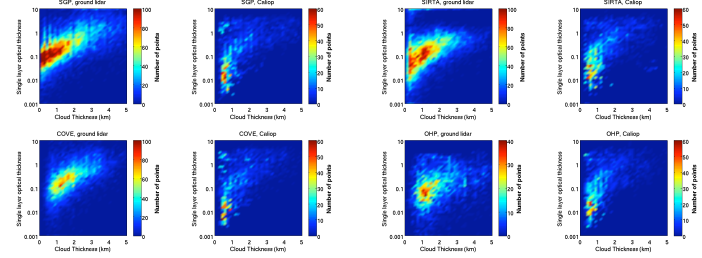


Cloud Optical Depth Statistics

Cloud Optical Depth (COD) for non-opaque clouds based on transmission data.



Cloud Thickness vs Optical Depth



Conclusion

- Overall good consistency in CBH, CTH and CTK statistics derived from ground-based Lidar and CALIOP

- For non-opaque clouds, using consistent transmission-based retrieval methods, discrepancies are found in COD retrievals from ground Lidar and CALIOP. Ground-Lidar retrievals contain less thick cirrus than CALIOP. A careful assessment of must be carried out to compare the cirrus population in the two datasets.

- Overall, the results show that cirrus clouds with COD < 0.1 (not included in historical cloud climatologies) represent 30-50% of the non-opaque cirrus class (COD < 3, Pressure < 440mb from ISCCP/Rossov et al., 2006). The high abundance of cirrus clouds at the global scale (> 13%; e.g. Chen et al., 2000; Stubenrauch et al., 2006) is thus likely to be greatly underestimated.

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