Differences in penetration depth for MODIS and RSP/VIIRS spectral ice cloud effective particle size retrievals

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- Columbia University-

-NASA GISS-
SWIR bands and absorption
RSP data from the SEAC$^4$RS campaign

- Convective clouds only
- COT > 5 only

Using 2.25 $\mu$m channel
Using 1.59 $\mu$m channel
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~Level of neutral buoyancy
Vertical weighting functions

- Defined as in Platnick (2000)
- Homogeneous layers
Vertical weighting functions: Larger particle size

- Defined as in Platnick (2000)
- Homogeneous layers
Vertical weighting functions: Larger asymmetry parameter

- Defined as in Platnick (2000)
- Homogeneous layers
Vertical weighting functions: Higher sun

- Defined as in Platnick (2000)
- Homogeneous layers
RSP data from the SEAC4RS campaign

- Convective clouds only
- COT>5 only
- 2.25 micron channel sees (optically) deeper into cloud

Using 2.25 μm channel
Using 1.59 μm channel
Optical depth $\rightarrow$ physical depth

Dense cloud top

Diffuse cloud top
Probing cloud top ‘diffuseness’ with lidar

Lidar Penetration depth:
\[ H(\tau = 0.1) - H(\tau = 3) \]
Difference between SWIR band retrievals depends on ‘diffuseness’ of top

Lidar Penetration depth:
\[ H(\tau = 0.1) - H(\tau = 3) \]
Difference between SWIR band retrievals depends on ‘diffuseness’ of top
MODIS+POLDER retrievals at TWP

- Vertical variation of effective radius and asymmetry parameter varies

From van Diedenhoven et al., JGR, 2014
Conclusions

- MODIS vs VIIRS will depend on cloud top structure.
- MODIS vs VIIRS will depend on g (higher in warm clouds)
- MODIS vs VIIRS will depend on geometry
- Smallest differences expected for dense, cold convective cloud tops clouds near LNB
Suggestion

- Use two (or more) SWIR bands to retrieve
  - Effective radius at specific level (e.g., OD=1)
  - Linear slope of effective radius w.r.t. optical depth

- Benefits:
  - Comparison between sensors more straightforward
  - Easier to use for model evaluation
  - Paring with lidar allows estimate of slope w.r.t. to physical height/temperature
  - Can also be applied to liquid clouds?
SWIR bands and absorption