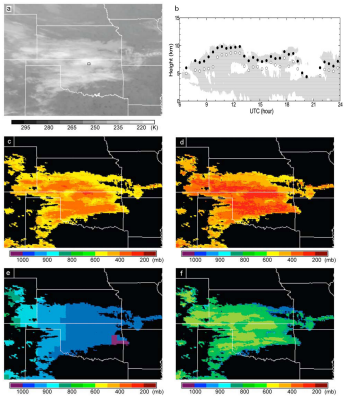
New Method for Retrieving Cloud Heights from Satellite Data

Research Highlight

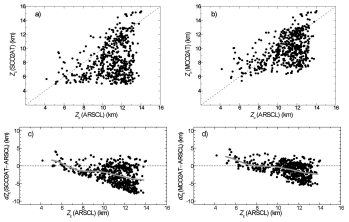
Determining 3D cloud structure from passive satellite imager data is a challenge because unique solutions are difficult when viewing multi-layered cloud scenes. Yet, such data sets are important for understanding cloud and radiation interactions on large scales. Interpreting radiances for pixels containing multi-layered (ML) clouds requires determining if the pixel likely contains ML clouds and then retrieving the properties of the clouds in the lower and upper layers. In the past, this required knowledge of low clouds in the vicinity of a high-over-low cloud, which may not be sufficient to define the low cloud properties in the ML system. This paper presents the first step in the process, which involves simultaneously retrieving the brightness temperature of the high cloud and the background brightness temperature (BT), which can correspond to either the surface or an underlying cloud, using only two channels available on several operational meteorological satellites.

An iterative technique, the Modified CO2 Absorption Technique (MCO2AT) was developed to use the 10.7- and 13.3-µm channel BTs to retrieve the cloud BT and background BT in both single-layer and ML cloud conditions. All other methods require that the background temperature be specified to accomplish the retrieval. The new algorithm was applied to GOES-12 data over the central US (Chang et al. 2010a) and over Central America during TC4 (Chang et al. 2010b). Image 1 shows an example of the retrievals from the MCO2AT and the Standard CO2 Absorption Technique (SCO2AT) using GOES-12 data at 1045 UTC, 1 May 2005. The results were compared with ARM SGP ARSCL (Image 2b) and CALIPSO data over the US and with ER-2 CPL data over Central America. The results clearly demonstrate that, compared to older techniques (e.g., SCO2AT) the new method yields better cloud top heights Zc for both SL and ML pixels (Image 2).

A relatively simple method for retrieving cloud-top height temperatures from two spectral radiances in both multi-layer and single-layer cloud conditions has been developed and verified using ARM and other data. The method is the first step in operationally retrieving multi-layered cloud properties over certain ARM sites. It is currently being used in conjunction with the VISST to detect multi-layer clouds and retrieve their properties over the SGP domain.



Clouds over SGP domain, 1 May 2005. (a) GOES-12 10.7-µm brightness temperatures, SCO2AT (c) cloud and (e) background pressures, and MCO2AT (d) cloud and (f) background pressures for 32°N–42°N and 105°W–91°W at 1045 UTC. The square in (a) indicates the ARM SGP CART site. (b) Comparison of cloud-top heights from SCO2AT (open) and MCO2AT (solid) with ARSCL data over SGP CART site.



Comparison of GOES-12 cloud-top heights over SGP, May 2005. (a) Mean Zc (SCO2AT) versus mean Zc (ARSCL). (b) Mean Zc (MCO2AT) versus mean Zc (ARSCL). (c) Mean difference dZc (SCO2AT # ARSCL) versus Zc (ARSCL). (d) Mean difference dZc (MCO2AT # ARSCL) versus Zc (ARSCL).

Reference(s)

Chang F, P Minnis, B Lin, MM Khaiyer, R Palikonda, and DA Spangenberg. 2010. "A modified method for inferring cloud top height using GOES-12 imager 10.7- and 13.3-µm data." Journal of Geophysical Research – Atmospheres, 115, D06208, doi:10.1029/2009JD012304.

Chang F, P Minnis, JK Ayers, MJ McGill, R Palikonda, DA Spangenberg, WL Smith, Jr., and CR Yost. 2010. "Evaluation of satellite-based upper-troposphere cloud-top height retrievals in multilayer cloud conditions during TC4." Journal of Geophysical Research – Atmospheres, , . ACCEPTED.

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Working Group(s)

Cloud Properties