Detection of Thin Cirrus in Cirrus/Aerosol Atmospheres

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(SCIENTIFIC OBJECTIVES)

- Develop a new cirrus cloud detection scheme that utilizes the MODIS 1.38-micron band in a series of reflectance thresholds along with 8.6-11 micron brightness temperature difference as the two parameters for identifying cirrus cloud.
- Validate results by comparison with other existing cloud detection schemes, MODIS cloud phase products, and ground based sensors.
- Discover accurate 1.38-micron reflectance thresholds that detect very thin cirrus cloud with low optical thickness and exclude reflectance off lower cloud layers.

**Radiative Transfer Calculations**

1.38-micron reflection:
- Theoretical 1.38-micron reflectance for clear sky (solid curve) and cirrus clouds (dashed curves) with optical depth (x) between 0.3 and 0.6.
- The reflectance varies from 1.1 to 1.3.
- A relative axis on the x-axis is used for cirrus clouds above 1 km thick.

**Reflectance and Other Thresholds**

Threshold Value  | SGP  | TWP  |
--- | --- | --- |
R\(_{1.38}\) | 1.10 | 1.13 |
R\(_{8.6-11}\) | 1.42 | 1.41 |
R\(_{1.38}\) \(_{10}\) | 1.69 | 1.68 |
R\(_{1.38}\) \(_{20}\) | 1.96 | 1.98 |
R\(_{1.38}\) \(_{20}\) | 2.23 | 2.23 |
R\(_{BTD}\) \(_{10}\) | 11.2 | 4.2 |
R\(_{BTD}\) \(_{20}\) | 17.7 | 15.6 |
R\(_{BTD}\) \(_{10}\) | -0.9 | 0.57 |
R\(_{BTD}\) \(_{20}\) | 0.76 | 0.85 |

**SUMMARY**

- The new 1.38-micron/8.6-11 micron BTD based cloud type detection scheme is able to identify a greater amount of thin cirrus clouds than other schemes in cases involving single-layer cirrus only. Best results were found using the lowest (T1) 1.38-micron reflectance threshold.
- Higher 1.38-micron cirrus thresholds (T3-T4) were needed to exclude reflection off low clouds when present. Mid-level clouds above 4 km reflect too much 1.38-micron energy to distinguish them from thin cirrus and are separated from mid-level clouds by using 8.6-11 micron BTD thresholds.
- The Cirrus detection parameter (P), shows potential in separating high cloud, including thin cirrus, from clear sky and low cloud.