Improved cloud screening technique in AVHRR data processing for climate change applications

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Earth Sciences Sector

Reducing Canada's vulnerability to climate change

Introduction

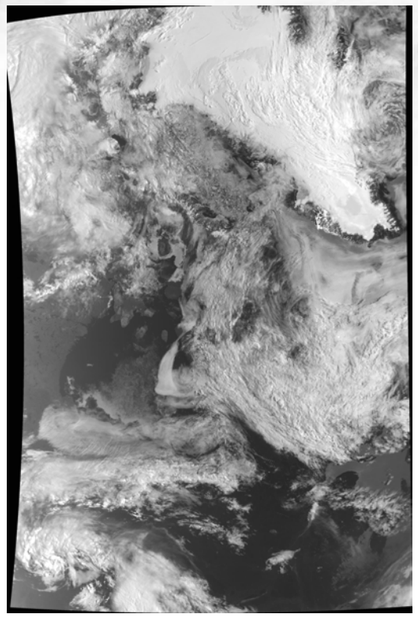
Clouds have a powerful influence on the radiation budget because they provide the greatest contribution to the scattering of solar radiation, enhancing the albedo of the earth-atmosphere system, which remains one of the main factors controlling the current climate. One useful way for quantifying this effect is by determining the "cloud radiative forcing", which is often defined as the difference in the TOA flux between the cloudy and clear-sky atmosphere. Reliable clear-sky identification is also required for generating clear-sky composites for land surface applications, such as retrievals of surface albedo, NDVI, leaf area index, snow, land and water temperatures.

Method

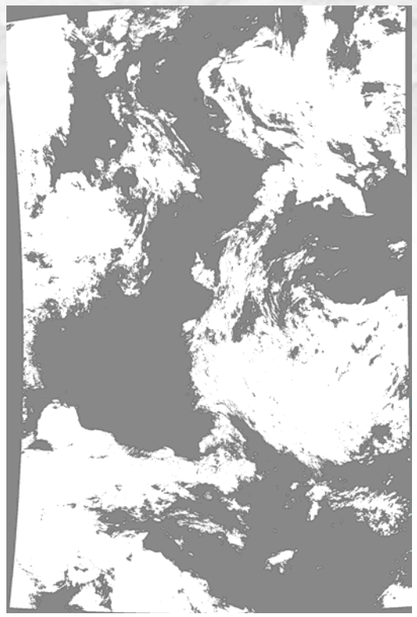
The algorithm uses a sequence of spectral and spatial signature threshold tests. Unique feature of the developed algorithm is the use of brightness temperature threshold which is dynamically set based on the 6-hour NCAR/NCEP Reanalysis-2 data on surface skin temperature. We also attempt to use temporal sequence of images to better identify clear-sky thresholds for particular pixel.

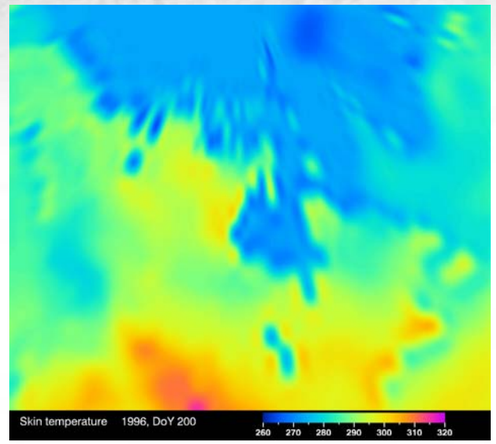
RGCT – Reflectance Gross Cloud Test;
TGCT – Thermal Gross Cloud Test;
C3AT – Channel 3 Albedo Test;
RRCT – Reflectance Ratio Cloud Test;
FMFT – Brightness temperature difference (Four-Minus-Five Test);
RUT – Reflectance Uniformity Test;
TUT – Thermal Uniformity Test;
T_{RA} – temperature retrieved from Reanalysis data.
Cloud tests are met if any of the 4 pixels returns YES;
Restoral tests are met if all 4 pixels return YES;
R1, R2, R3 are Channel 1, 2, 3, reflectance;
R1min is Minimum Channel 1 reflectance of 4 pixels;
R1max is Maximum Channel 1 reflectance of 4 pixels;
T4, T5 are Channel 4, 5 brightness temperatures.
Gamma is the half-angle of the cone of specular reflection.

Sample image of AVHRR Channel 1 reflectance



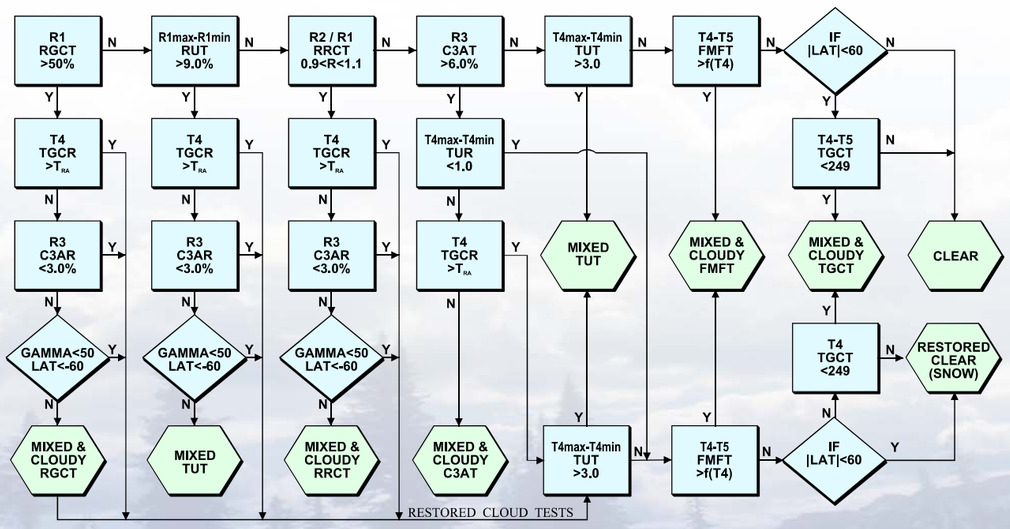
Generated cloud mask





Skin temperature map of Canada built from Reanalysis-2 data.

FLOWCHART FOR DAYTIME CLOUD DETECTION OVER LAND



Conclusions

To improve a clear-sky retrieval technique currently employed in GEOCOMP system, we developed an algorithm that generates the pixel level cloud mask separately over the ground and water pixels during both day and night conditions. The procedure is applied to full resolution AVHRR images.

The preliminary results have demonstrated the consistent operation of the algorithm for both day and night time conditions, including an improved separation of snow and cloudy pixels. Further potential improvements such as utilizing MODIS BRDF/Albedo spectral products and previously accumulated AVHRR 10-day data series for better cloud screening and cloud optical depth retrievals are currently being implemented.

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