I. CIPS Measurement Technique & Sampling

- CIPS employs four nadir-pointing cameras to image clouds.
- The nadir-viewing setup allows for a simple way of obtaining the ozone scale height to the atmospheric scale height ratio.
- This understanding provides a quantitative foundation for comparing CIPS detection sensitivity in interpreting cloud occurrence frequencies observed by CIPS, particularly the latitude dependence.

II. Separation of Background & Cloud Signal

- The albedo measured by CIPS at a given location is a sum of contributions due to the Rayleigh background plus cloud scattering:

\[ \phi = \phi_{\text{Rayleigh}} + \phi_{\text{cloud}} \]

- The essential task of the retrieval algorithm is to determine the Rayleigh background, and retrieve effective cloud parameters from the residual PMC signal. We therefore need a parameterization of these two terms which allows for a direct retrieval of both background and cloud parameters.

- The Rayleigh term can be written in a simple analytical form. The primary assumptions required are that the Rayleigh scattering extinction is negligible compared to ozone absorption, and that the ratio of the ozone scale height to the atmospheric scale height is constant.

\[ \phi_{\text{Rayleigh}} = A_{\phi} \exp \left( \frac{-\sigma_{\text{Rayleigh}}}{\rho} \right) \]

- Taking the log and rearranging, this model can be rewritten in a simple linear form that is useful for cloud detection:

\[ Y = aX + b \]

For a pure Rayleigh atmosphere, \( Y \) should be a simple linear function of \( X \) with a slope of \( -\sigma \). This leads to a simple way of estimating \( C/V \) from the observations. If a cloud is present, the slope is changed, the effect is different for forward scattering angles versus backward scattering angles.

- The cloud albedo is written in the following form, where \( \sigma_{\text{cloud}} \) is the assumed theoretical ice scattering phase function, \( R \) is the mean particle radius and \( A_{\text{cloud}} \) is the nadir albedo if the cloud is observed at 90° scattering angle:

\[ \phi_{\text{cloud}} = A_{\phi} \int_{0}^{\infty} \left( \frac{\sigma_{\text{cloud}}(\theta)}{\sigma_{\text{Rayleigh}}} \right) \cos(\theta) d\theta \]

III. Version 4.0 Algorithm

- In the Version 4.0 algorithm, we consider the background ozone field, as parameterized by \( \phi_{\text{Rayleigh}} \), to be uniform over an area much larger than individual cloud pixels. The analysis divides the orbit into 0.25° solar zenith angle bins. These bins are essentially cross-track slices and span an area of \( \pm 25 \times 800 \) km. A single \( C/V \) is retrieved in each bin and used to characterize the Rayleigh background for all points in that bin. The flow of the V4.0 algorithm is summarized in the diagram below.

IV. Results

- We are in the process of running detailed simulations of the Version 4.0 retrieval algorithm.

- These studies will be used to test new ideas in the algorithm development, as well as characterizing the retrievals in terms of cloud detection sensitivity and random and systematic errors.

- This plot shows the frequency of detection and minimum retrieved cloud albedo as a function of solar zenith angle for an orbit of simulated data. At low solar zenith angles it is more difficult to detect dim clouds because the background Rayleigh signal is very bright and CIPS loses its forward scattering sampling (see the figure in I).

- Comparison between CIPS and the SSI is to the solar occultation instrument on AIM. CIPS Cloud detection and retrieval algorithms with the SSI to be used in the future.

- Clouds are in the process of being extended to the SSI CIPS to use as an alternative to the SSI specific CIPS retrieval algorithm.

- The CV portion of the CIPS Level 2 image.

- Retrieval Simulations

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