A new algorithm for correcting cloud brokenness effects

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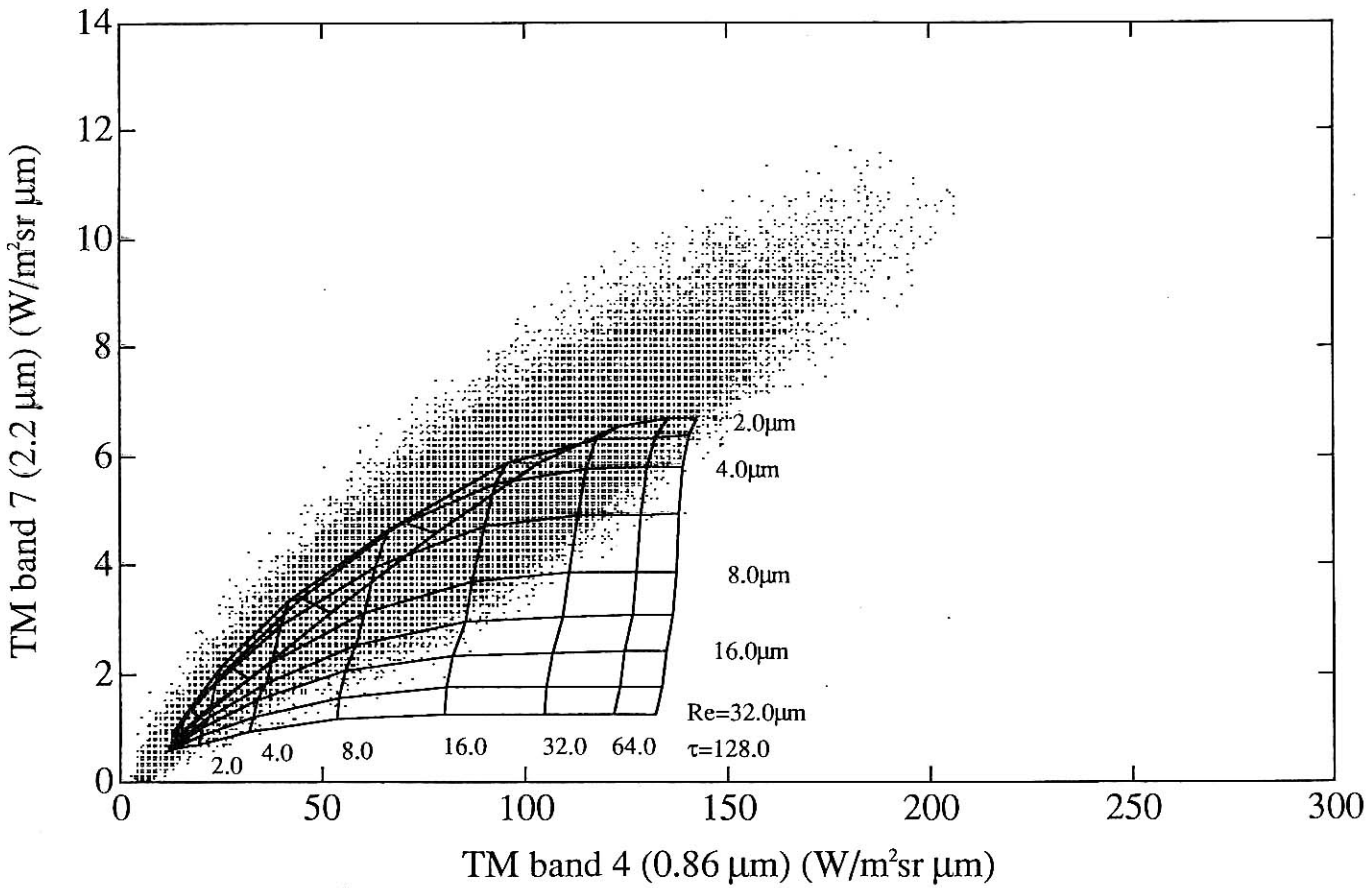
Correction methods for inhomogeneous cloud

(1) The average and standard deviation of radiance

(2) Neighbor pixel's radiance

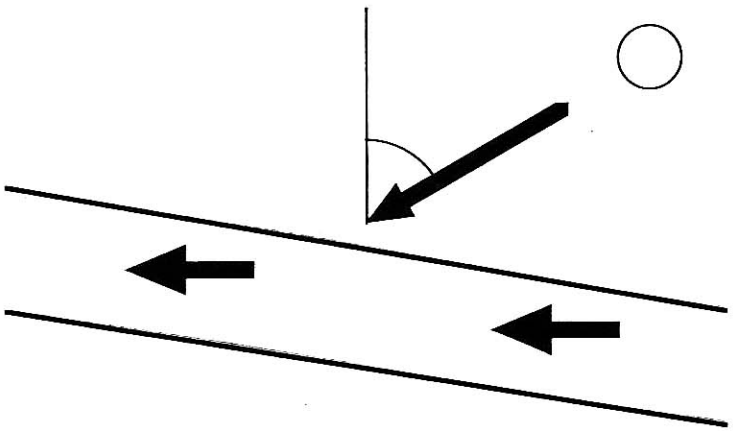
(3) A multi channel sensor

Comparison of plane parallel model and Landsat TM data

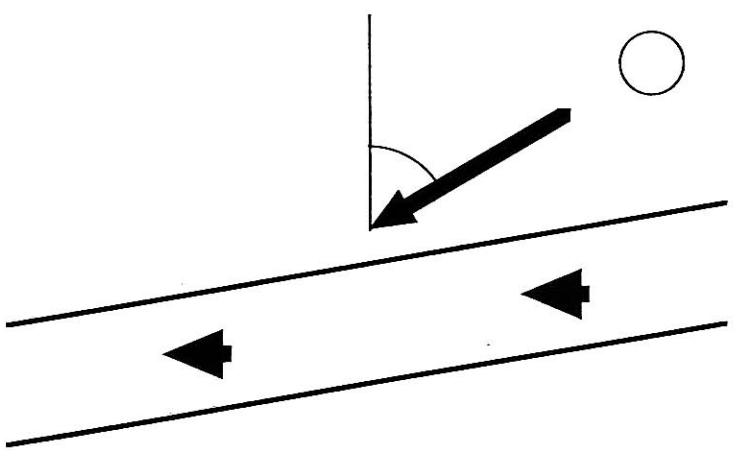


Theoretical relationships between the reflection function at 0.86 μm and 2.2 μm for various values of the cloud optical thickness and effective radius.Data from Landsat TM sensor are superimposed on the figure (18 June 1991).

Oblique plane parallel cloud model

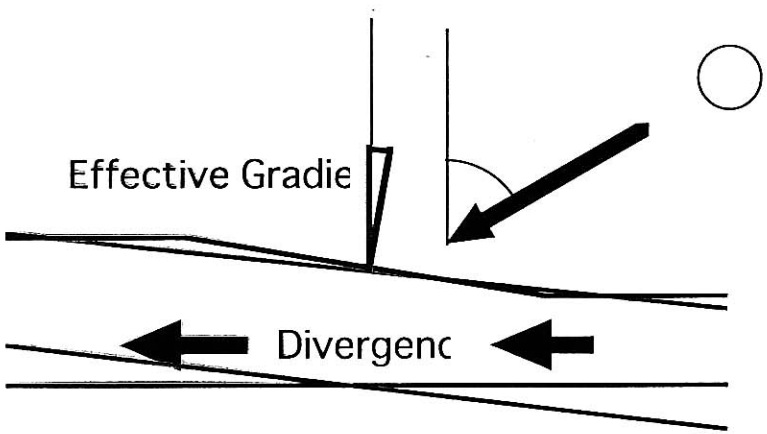


- Positive gradient
  - Solar incident: increase
  - Reflectance: increase
  - Horizontal transport: increase

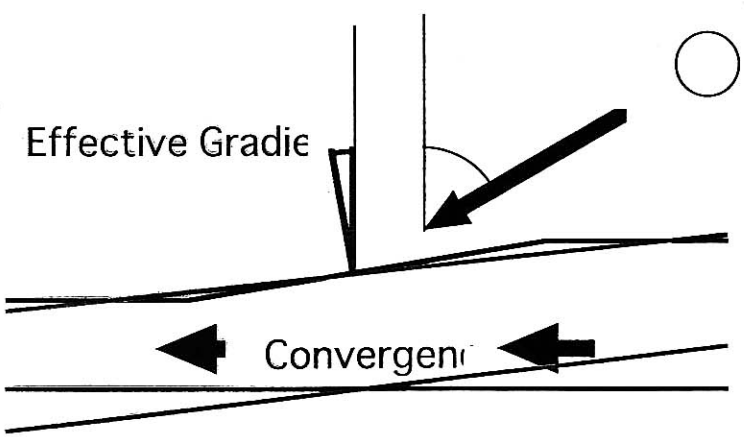


- Negative gradient
  - Solar incident: decrease
  - Reflectance: decrease
  - Horizontal transport: decrease

Effective gradient



- Positive gradient
  - Horizontal transport: divergence
  - Reflection: decrease
  - Gradient: decrease

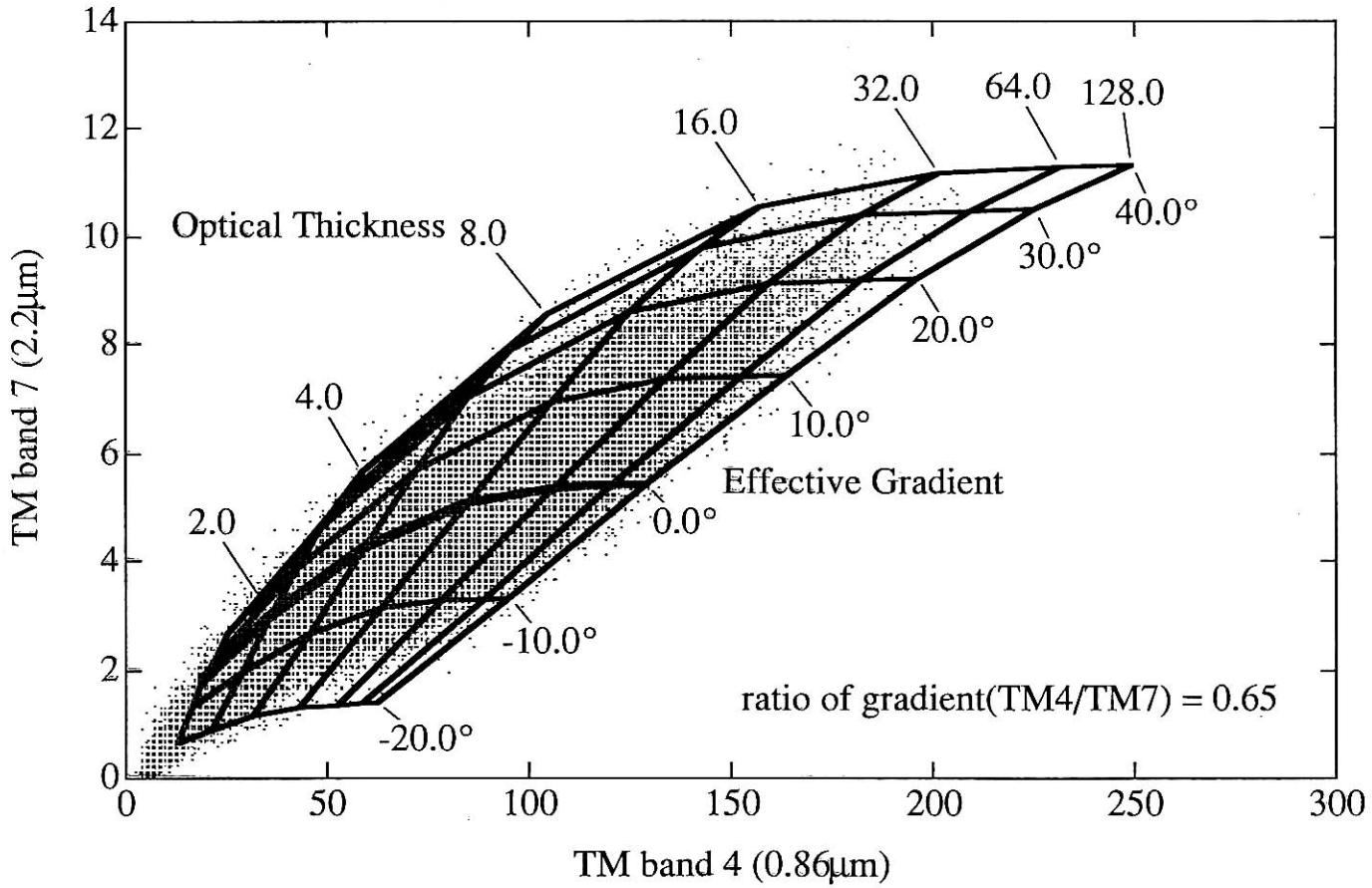


- Negative gradient
  - Horizontal transport: convergence
  - Reflection: increase
  - Gradient: increase

2 channel method

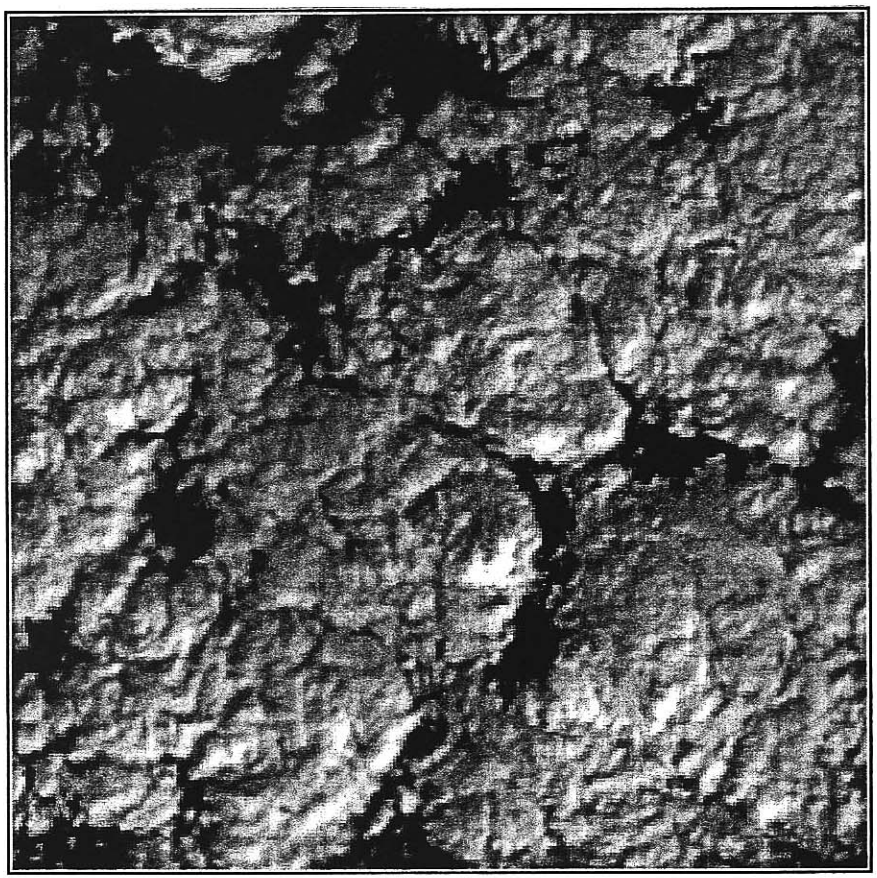
- Horizontal transport of radiation in absorbing wavelength (2.2 μm) is smaller then conservative wavelength (0.86 μm).
- Assumption
  (1) The ratio of effective gradient between 2.2 μm and 0.86 μm is constant.
  (2) The effective particle radius is constant in the cloud layer.

Comparison of oblique plane parallel model and Landsat TM data



Theoretical relationships between the reflection function at 0.86 μm and 2.2 μm for various values of the cloud optical thickness and effective gradient. Data from Landsat TM sensor are superimposed on the figure (18 June 1991).

Radiance

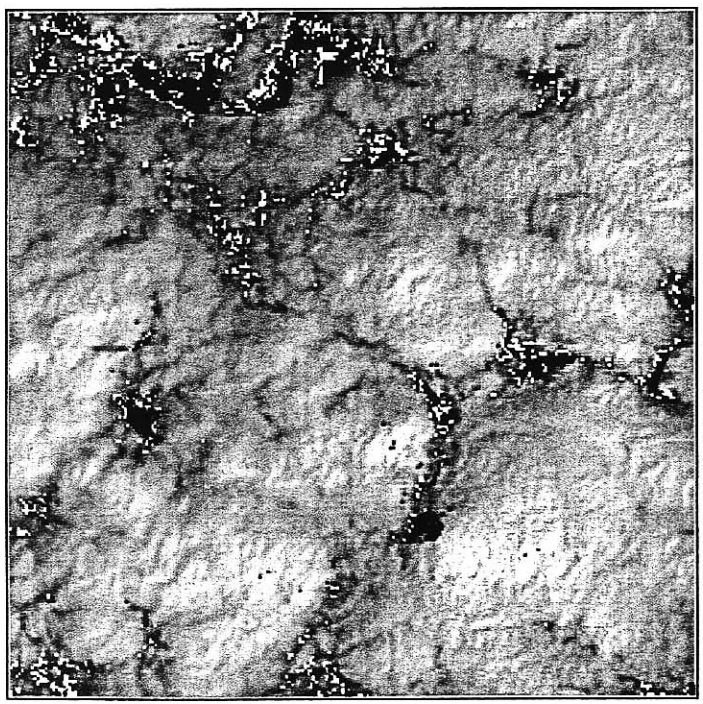


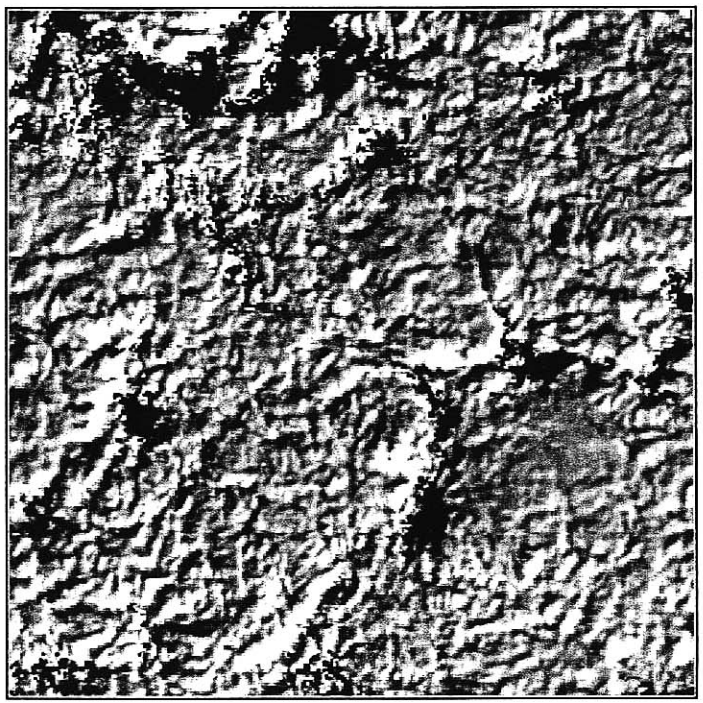
Band 4 (0.86 μm)

Band 7 (2.2 μm)

Images of Landsat TM band 4 and band 7 measurements

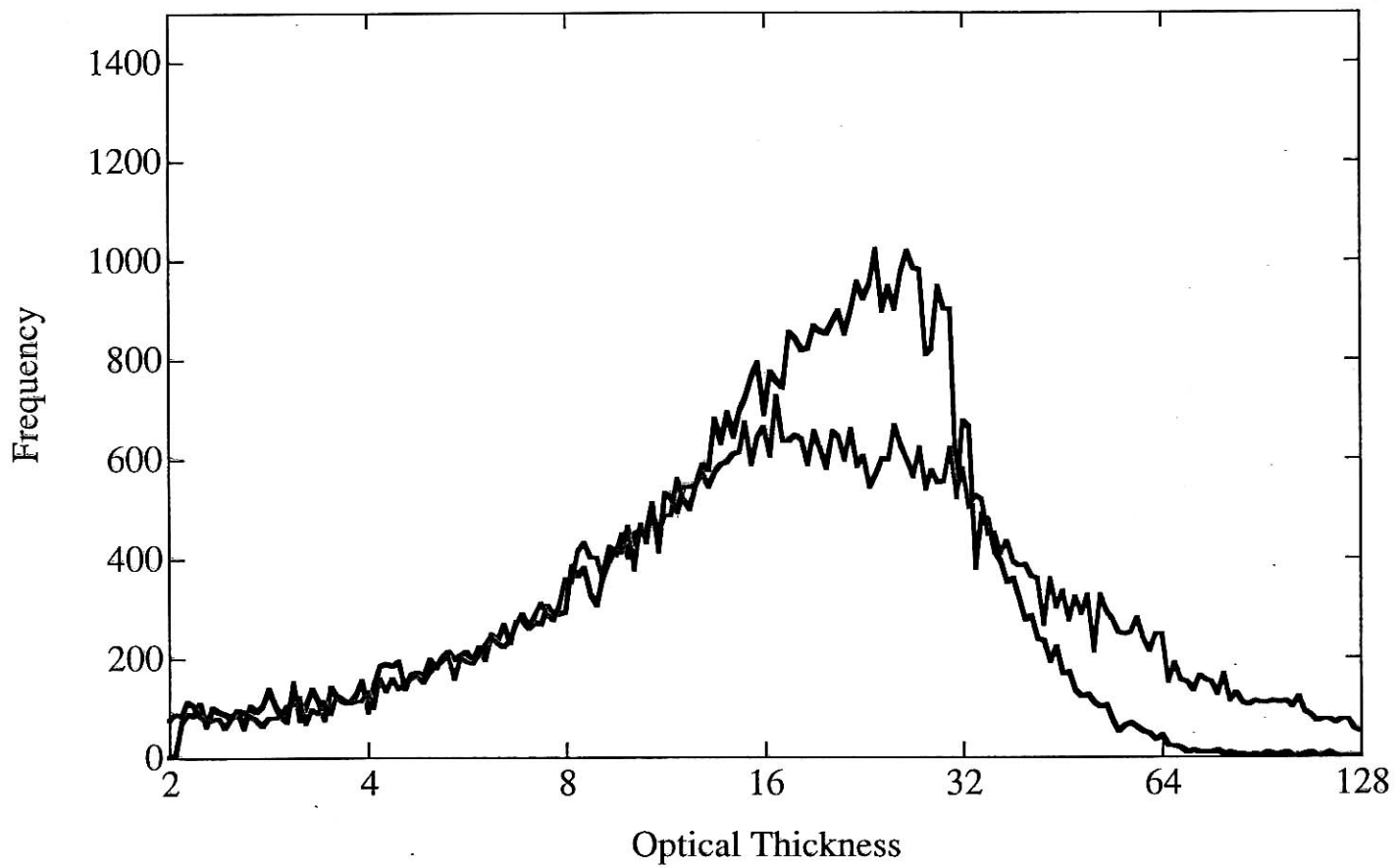
Optical thickness and effective gradient





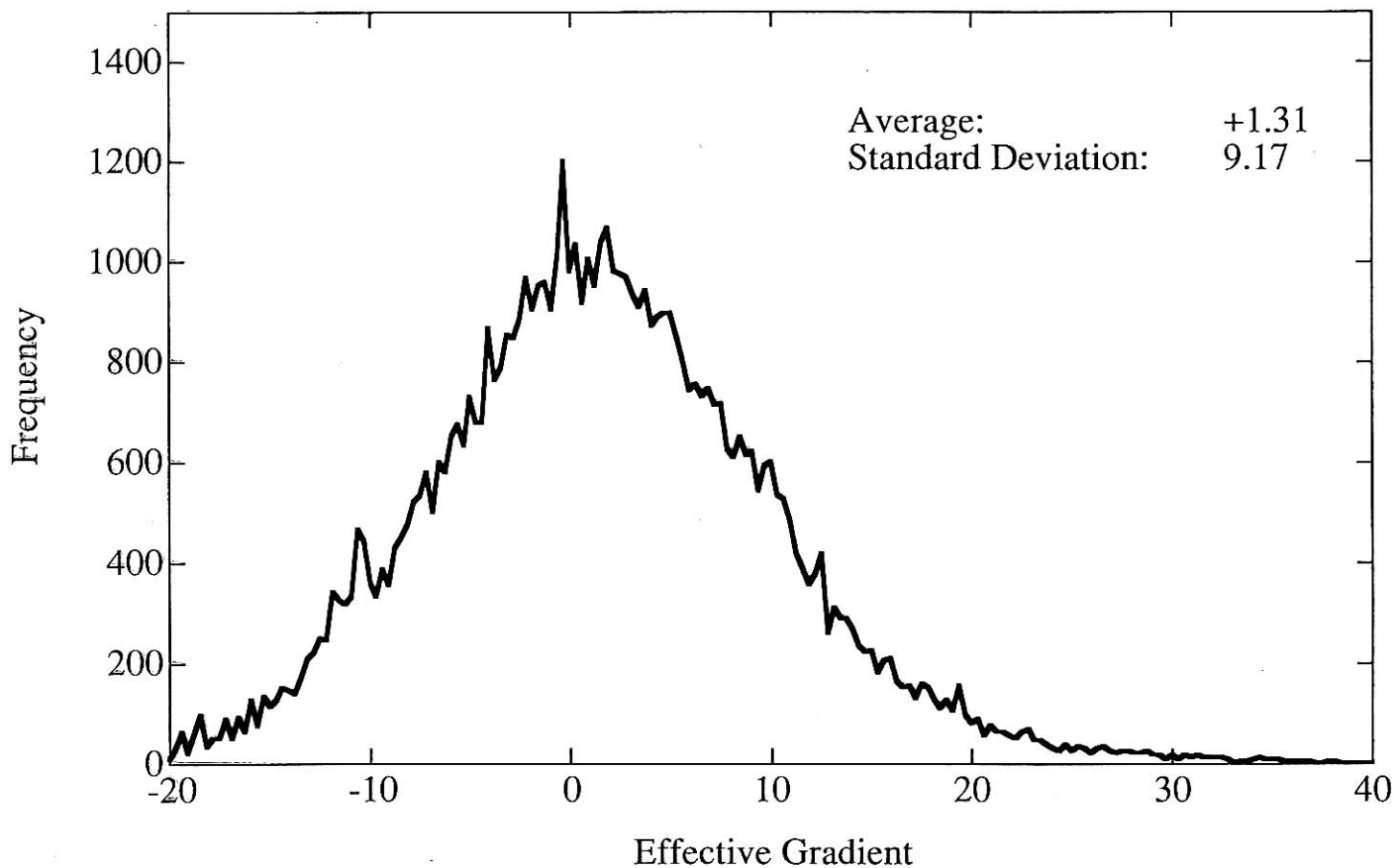
Images of optical thickness and effective gradient retrieved from a scene of Landsat TM sensor using the oblique plane parallel method.

Histogram of optical thickness



Histogram of the optical thickness derived from Landsat TM band 4 and 7 measurements using the oblique plane parallel method and plane parallel model.

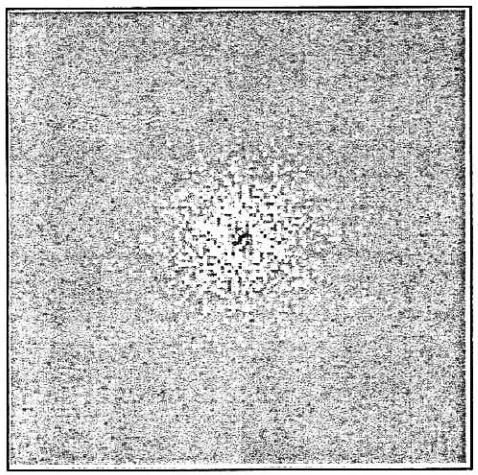
Histogram of the effective gradient



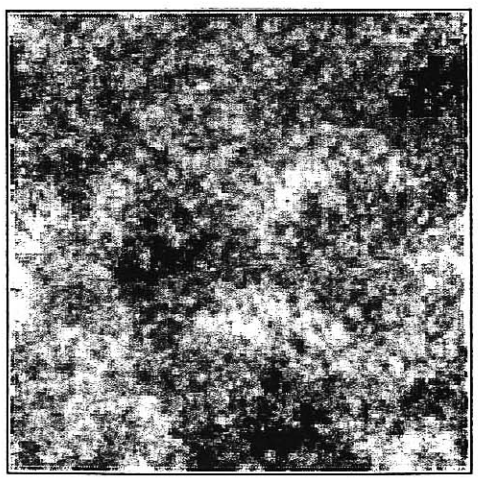
Histogram of the effective gradient derived from Landsat TM band 4 and 7 using the oblique plane parallel method.

Monte Carlo radiative transfer calculation of fractal cloud

Exp + White noise



↓ Inverse FFT



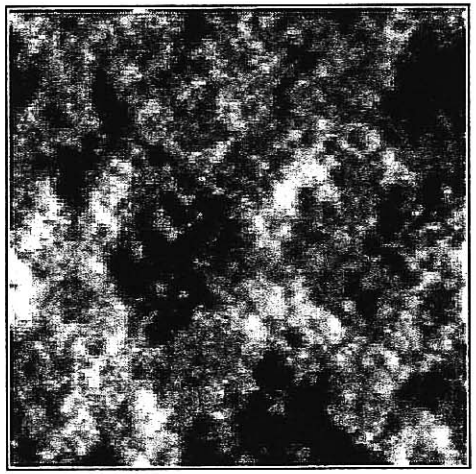
Optical thickness of fractal cloud model

Monte Carlo calculation

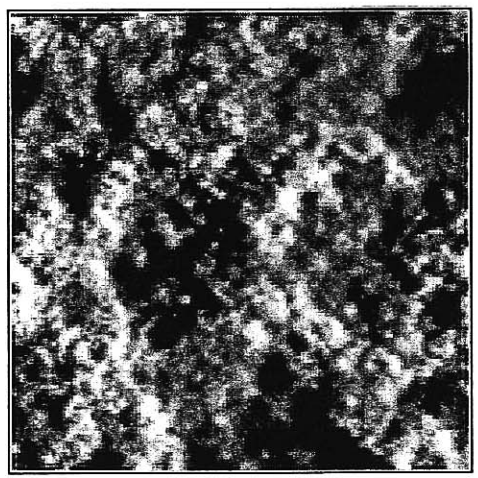
Solar zenith angle: 60°

Number of photons: 1billion

0.86μm

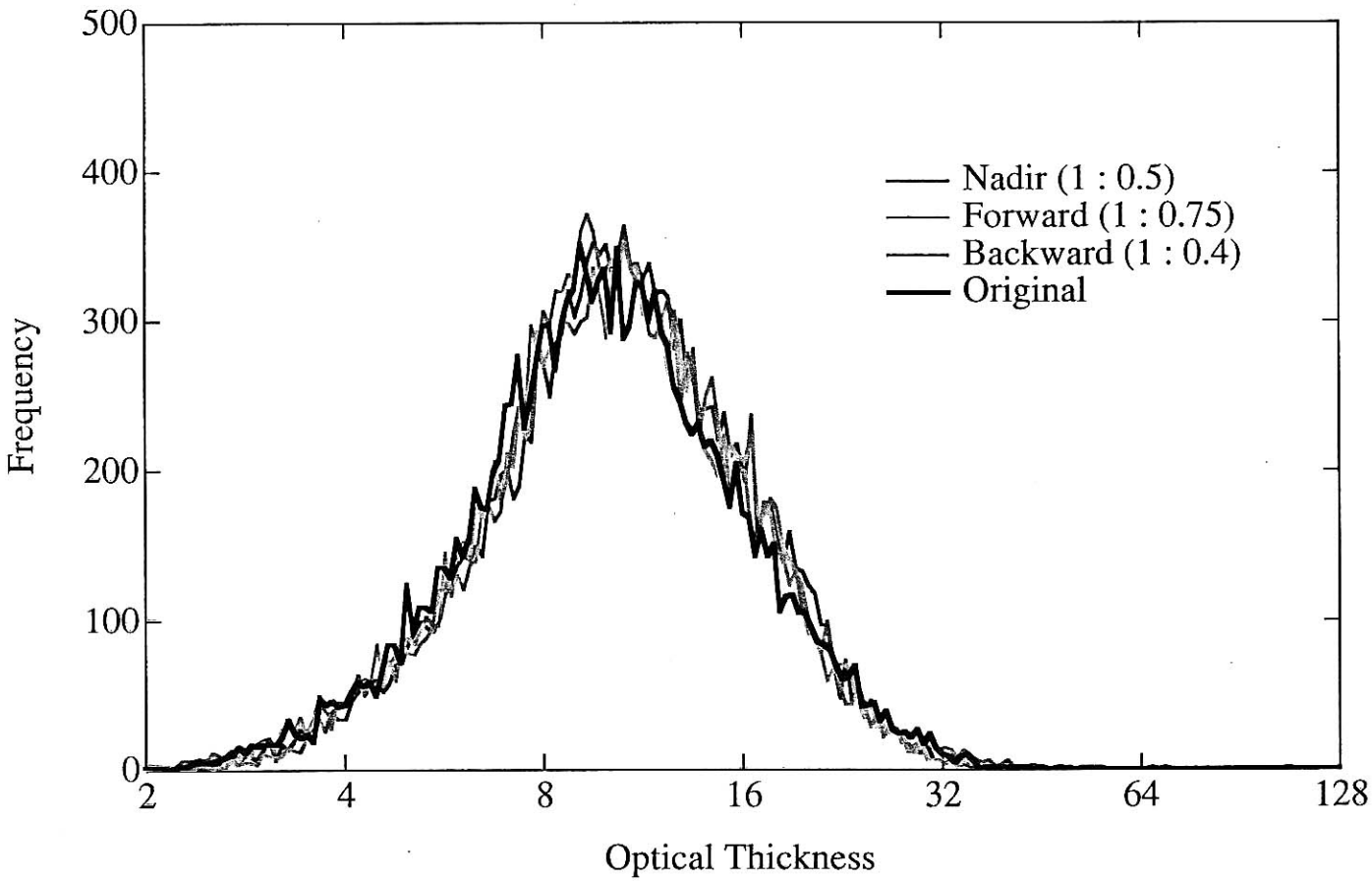


2.2μm



Radiance

Histogram of the optical thickness



Histogram of the optical thickness of fractal cloud determined using the oblique plane parallel method.

Conclusion

For determination of the optical thickness of horizontally inhomogeneous clouds

(1) A oblique plane parallel cloud model

(2) Absorbing and conservative wavelengths

(3) Effective gradient