10/9K
MODIS Meeting

DETECTION AND CORRECTION OF THIN CIRRUS EFFECTS USING THE 1.375-μm MODIS CHANNEL

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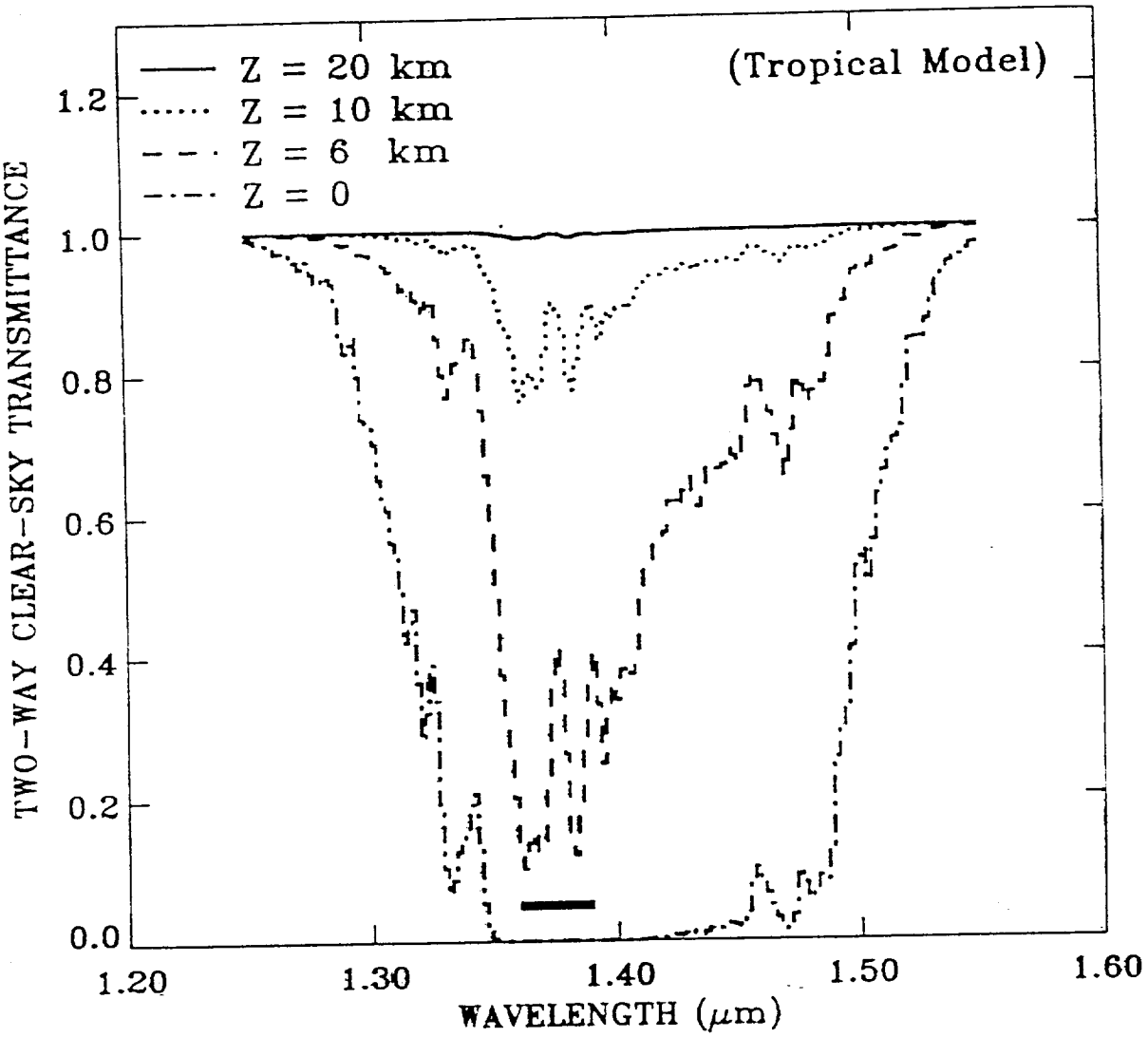
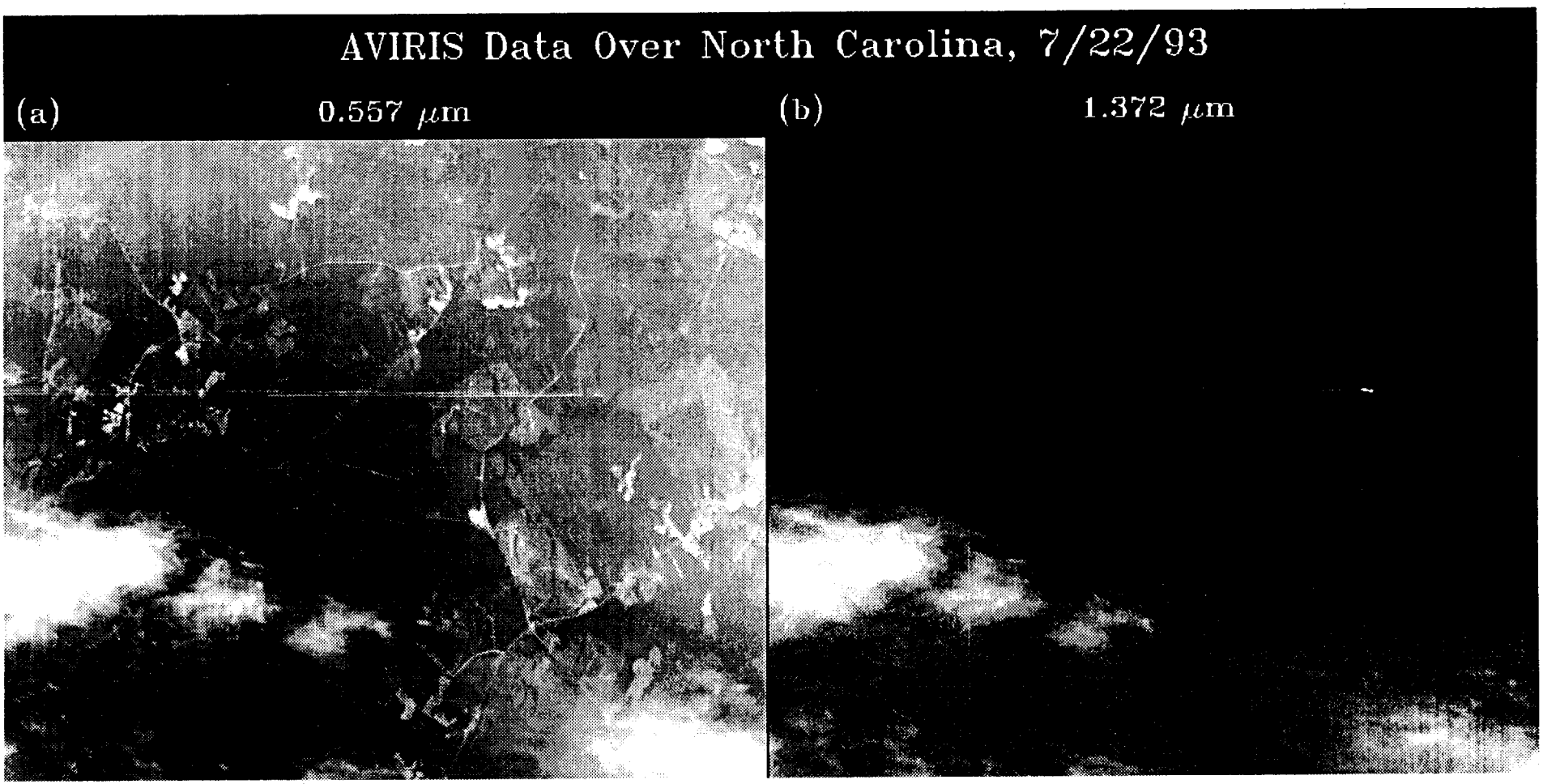
INTRODUCTION

- The 1.375-μm MODIS channel
  - Detection of thin cirrus clouds
- Empirical correction of thin cirrus effects using the 1.375-μm channel
- Applications of the 1.375-μm channel for the studies of aerosol, land surface, and ocean color
- Summary


Z = 20 km
Z = 10 km
Z = 6 km
Z = 0
(Tropical Model)
TWO-WAY CLEAR-SKY TRANSMITTANCE
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1.20
1.30
1.40
1.50
1.60
WAVELENGTH (μm)

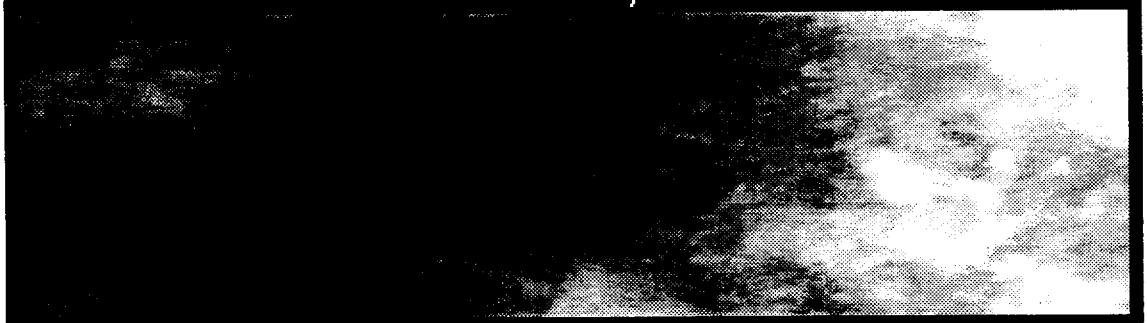

AVIRIS Data Over North Carolina, 7/22/93
(a)
0.557 μm
(b)
1.372 μm

AVIRIS IMAGES OVER MONTEREY, CA

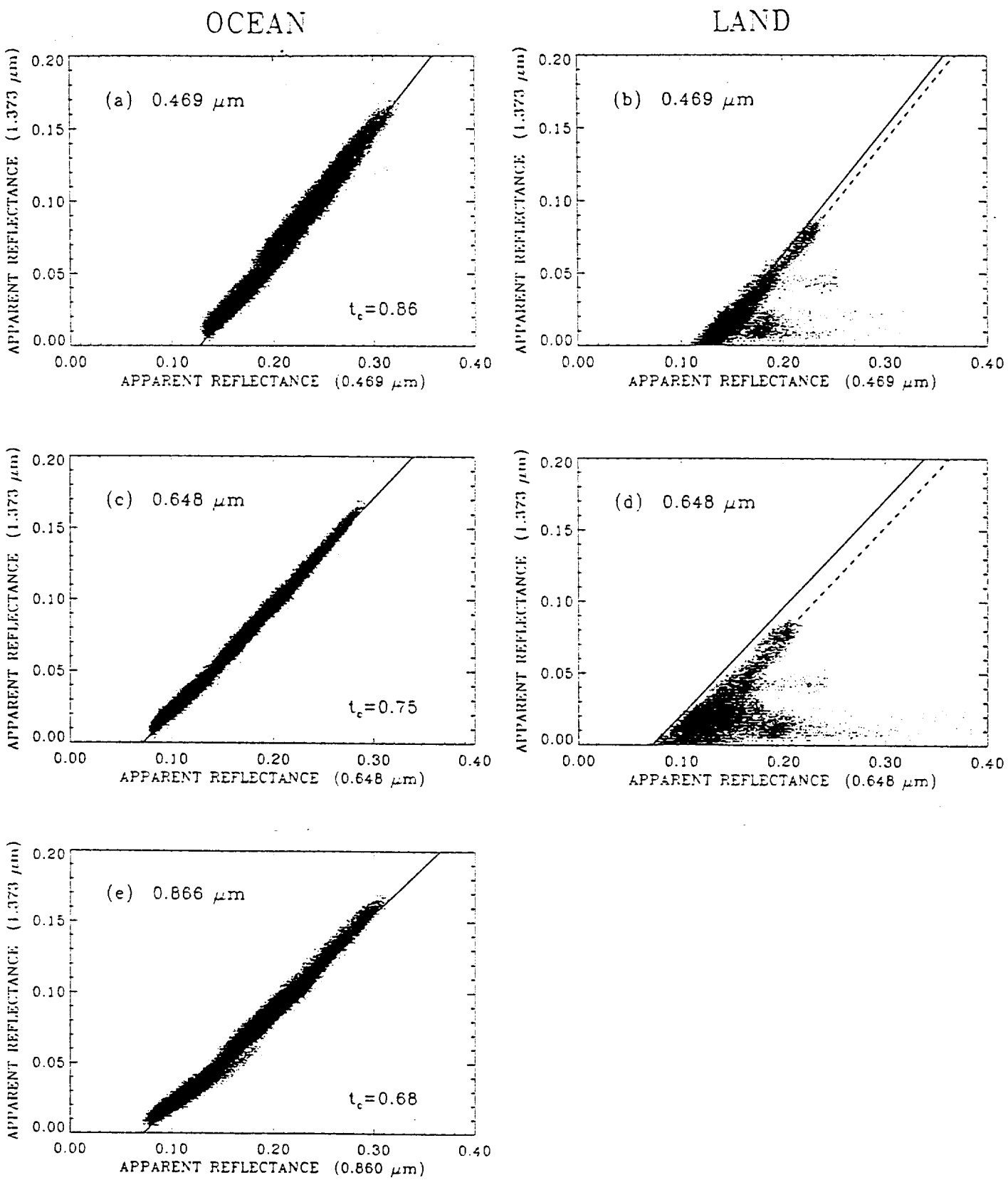
(09/04/92)

0.648 μm

1.373 μm



0.648 μm, Corrected


OCEAN
LAND
(a) 0.469 μm
t_c=0.86
(b) 0.469 μm
(c) 0.648 μm
t_c=0.75
(d) 0.648 μm
(e) 0.866 μm
t_c=0.68
APPARENT REFLECTANCE (1.373 μm)
APPARENT REFLECTANCE (0.469 μm)
APPARENT REFLECTANCE (0.648 μm)
APPARENT REFLECTANCE (0.860 μm)
0.00
0.05
0.10
0.15
0.20
0.30
0.40

EQUATIONS

$$\rho_\lambda^* = \rho_{c\lambda} + T_{c\lambda}\,\rho_\lambda / (1 + S_{c\lambda}\,\rho_\lambda) \quad (1)$$

$\rho_{c\lambda}$: path radiance due to cirrus
$S_{c\lambda}$: cloud scattering of upward radiation back to surface
ρ_λ : Surface reflectance

If $S_{c\lambda} << 1$, then Eq. (1) becomes

$$\rho_\lambda^* = \rho_{c\lambda} + T_{c\lambda}\,\rho_\lambda \quad (2)$$

We found an empirical relation:

$$\rho_{c\lambda} = \rho_{c1.375} / t_{co} \quad (3)$$

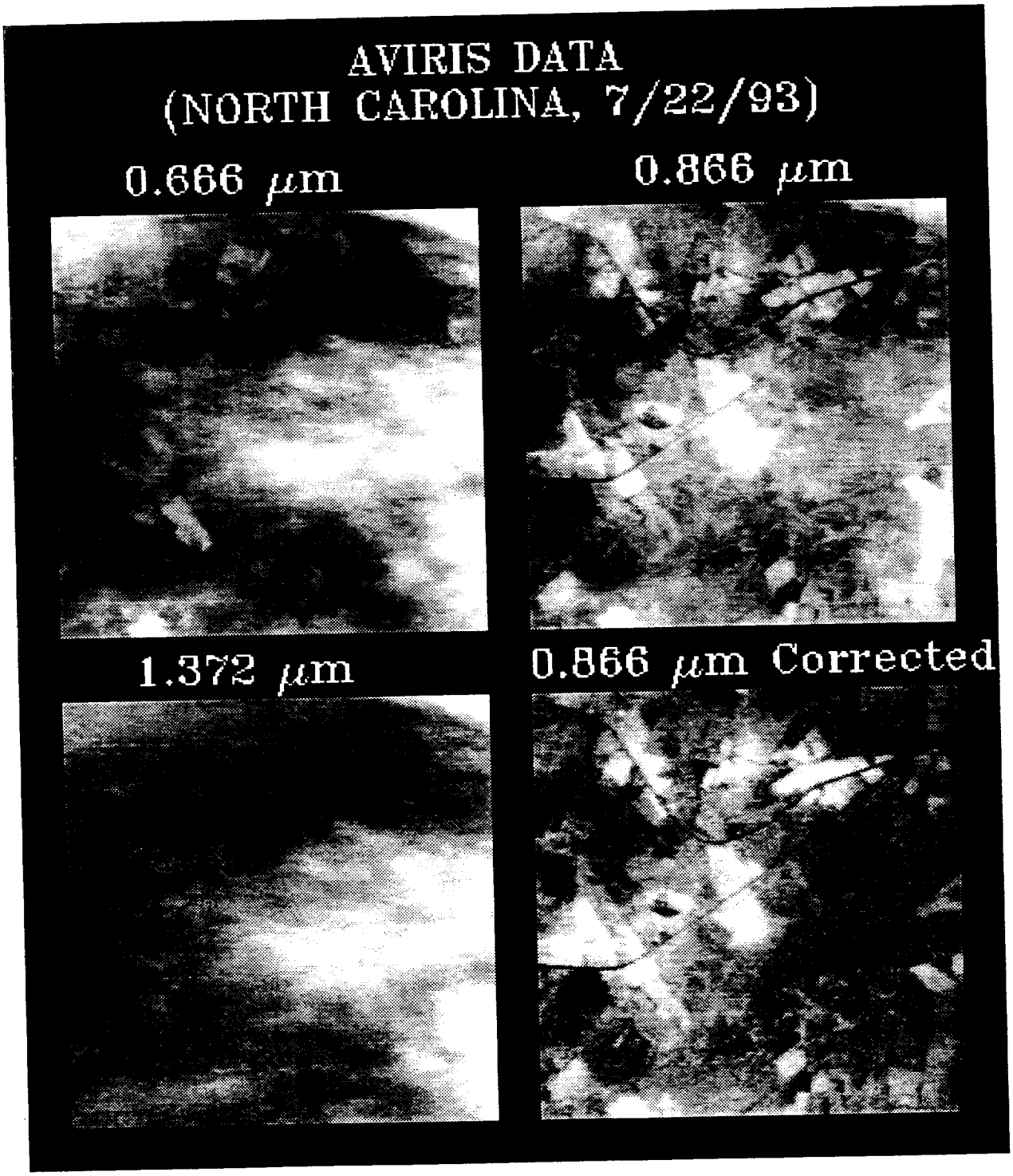
t_{co} is a function of water vapor above & within cirrus clouds

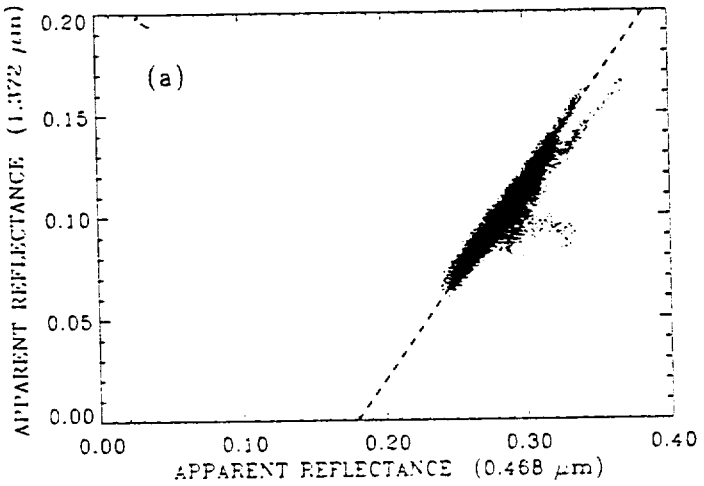
We found another empirical relation:

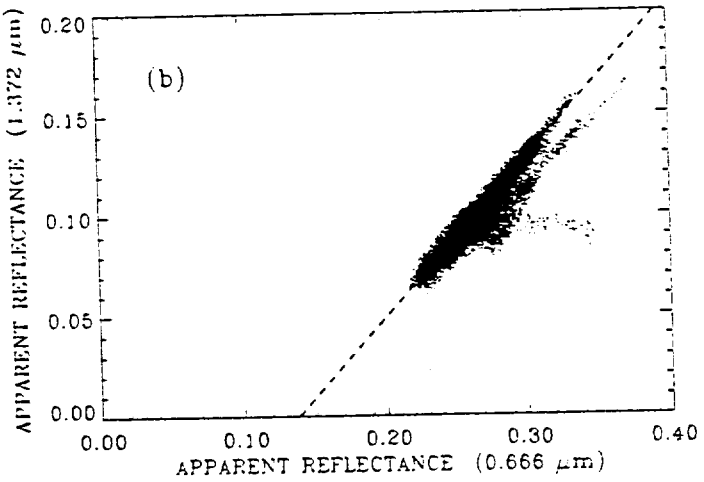
$$T_{c\lambda} \sim (1 - 0.84\,\rho_{c1.375}) \quad (4)$$

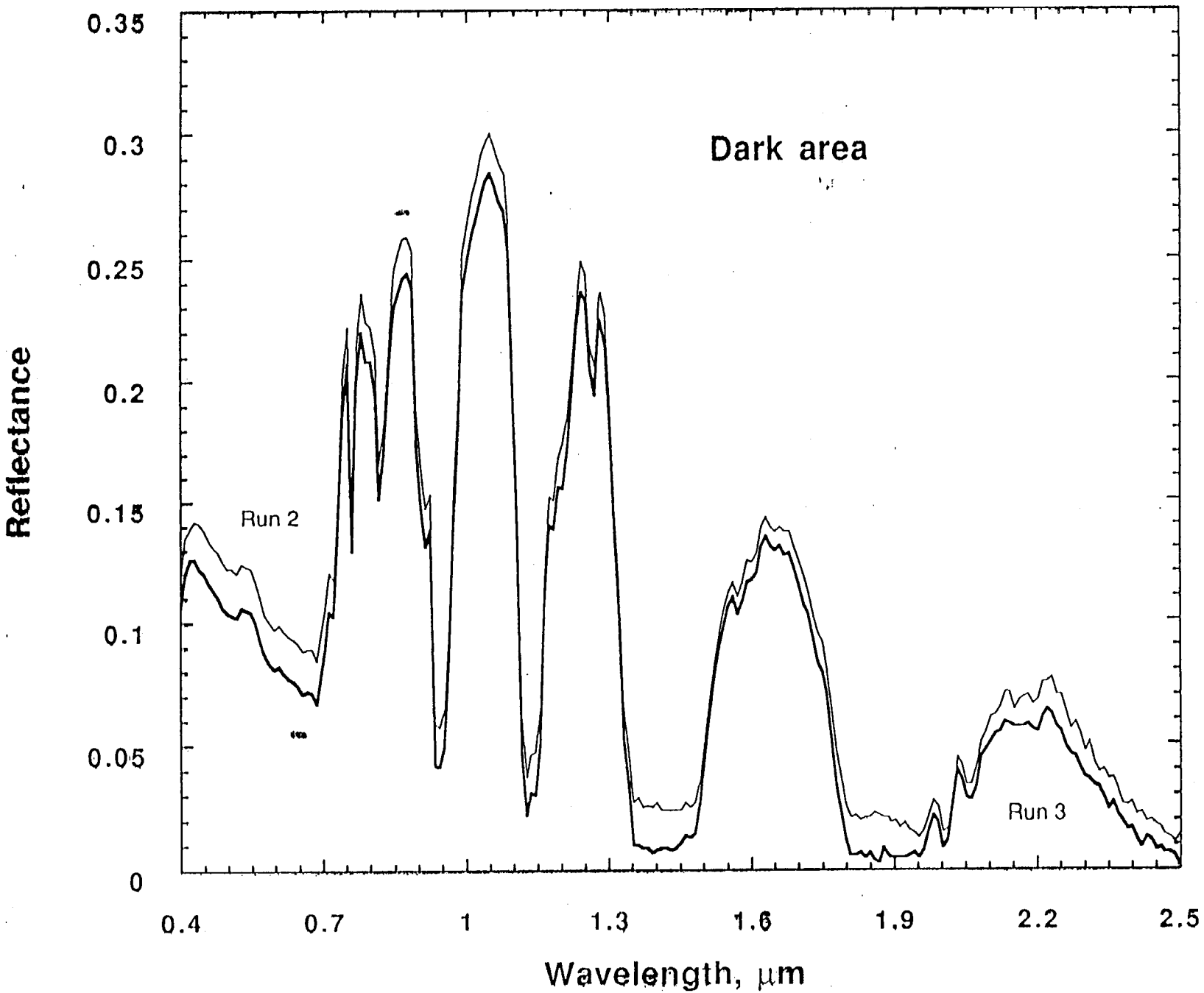
Substitute (4) and (3) into (2), we get

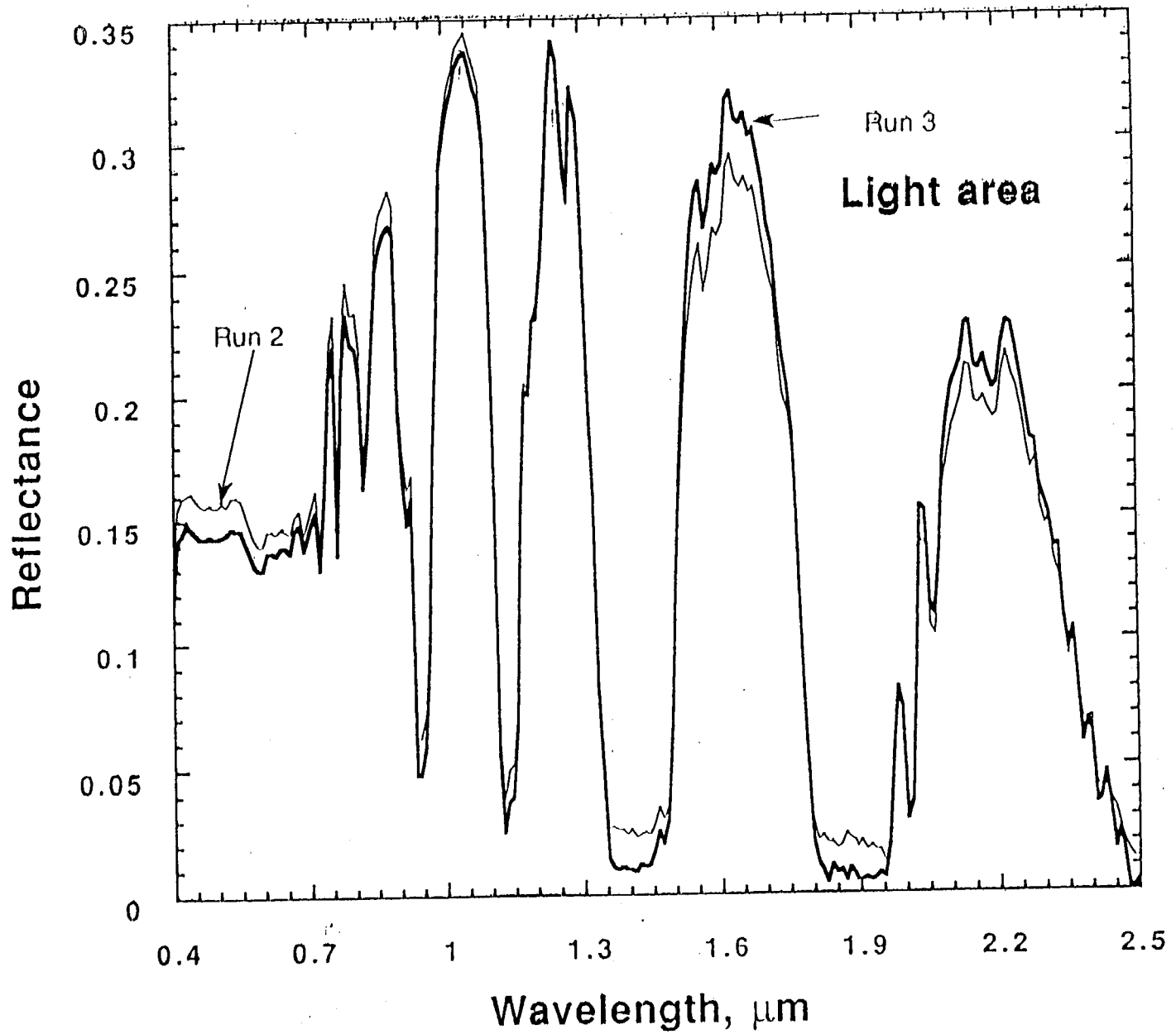
$$\rho_\lambda \sim \{\rho_\lambda^* - \rho_{c1.375} / t_{co}\} / \{1 - 0.84\,\rho_{c1.375}\} \quad (5)$$

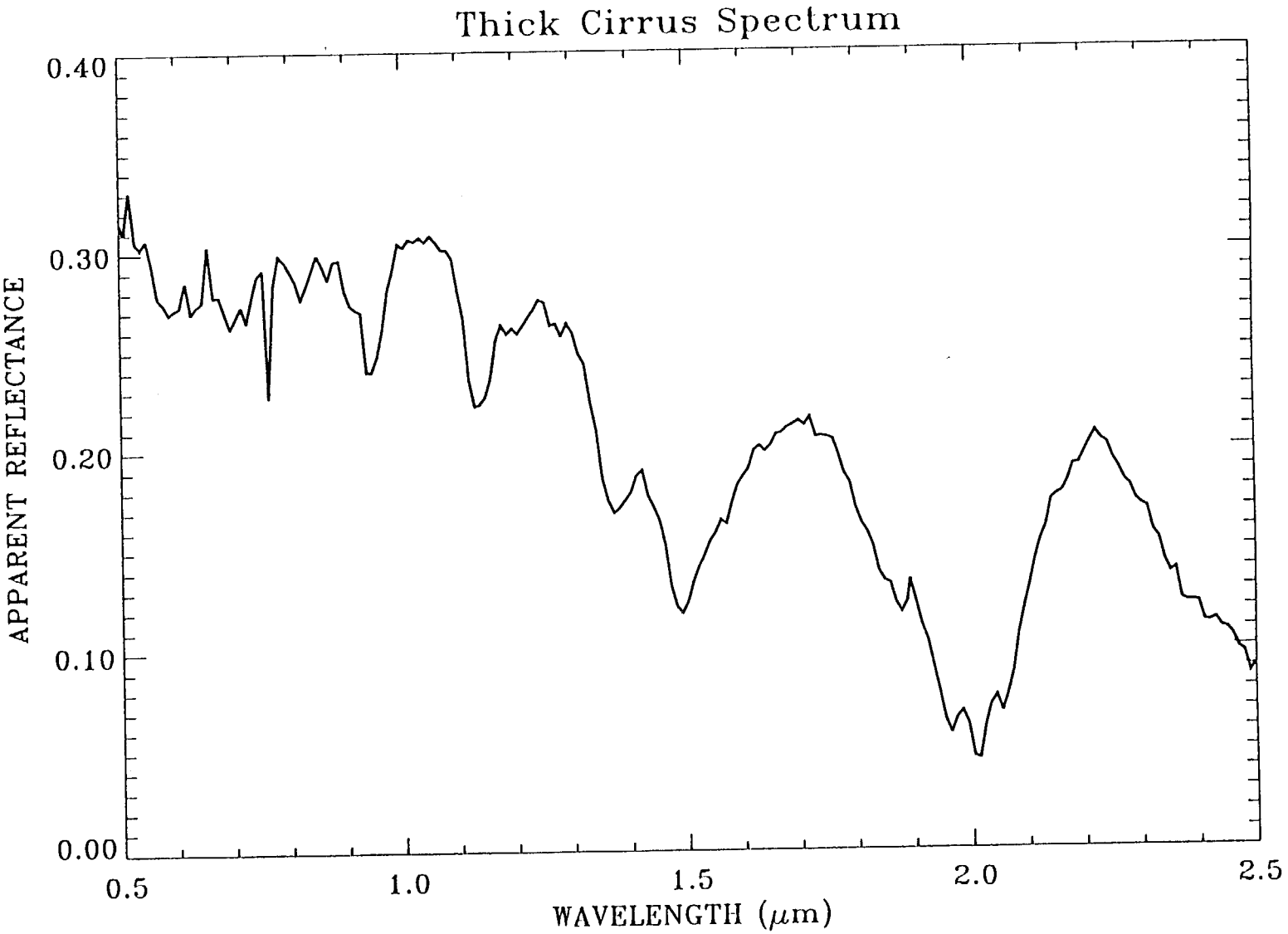

AVIRIS DATA
(NORTH CAROLINA, 7/22/93)
0.666 μm
0.866 μm
1.372 μm
0.866 μm Corrected

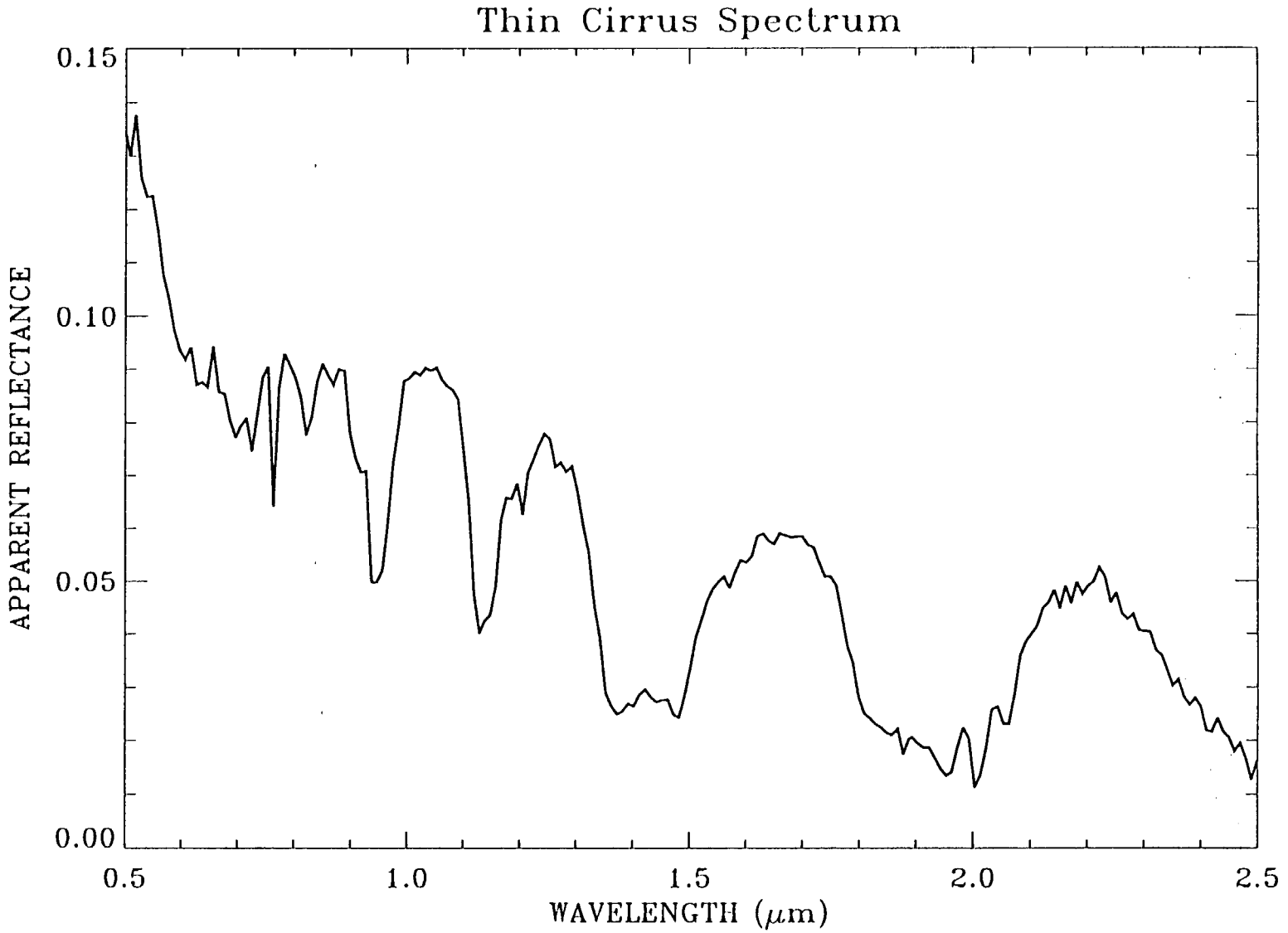

(a)
APPARENT REFLECTANCE (1.372 μm)
0.20
0.15
0.10
0.05
0.00
0.00
0.10
0.20
0.30
0.40
APPARENT REFLECTANCE (0.468 μm)


(b)
APPARENT REFLECTANCE (1.372 μm)
0.20
0.15
0.10
0.05
0.00
0.00
0.10
0.20
0.30
0.40
APPARENT REFLECTANCE (0.666 μm)


Dark area
Reflectance
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Run 2
Run 3
0.4
0.7
1
1.3
1.6
1.9
2.2
2.5
Wavelength, μm


0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Reflectance
Run 2
Run 3
Light area
0.4
0.7
1
1.3
1.6
1.9
2.2
2.5
Wavelength, μm


Thick Cirrus Spectrum
APPARENT REFLECTANCE
0.40
0.30
0.20
0.10
0.00
0.5
1.0
1.5
2.0
2.5
WAVELENGTH (μm)


Thin Cirrus Spectrum
APPARENT REFLECTANCE
0.15
0.10
0.05
0.00
0.5
1.0
1.5
2.0
2.5
WAVELENGTH (μm)

SUMMARY

- Using spectral imaging data collected by the NASA/JPL Airborne Visible Infrared Imaging Spectrometer (AVIRIS), we have demonstrated that it is possible to remove thin cirrus effects from remote sensing data using the 1.375-μm channel.

- We expect that the 1.375-μm MODIS channel can have important applications for the quantitative studies of atmospheric aerosols, land surfaces, and ocean color.