A Possible 1.38-μm Channel For Remote Sensing of Cirrus Clouds From EOS/MODIS

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Proposal - to introduce 1.38 μm channel (D) ~ 30 km

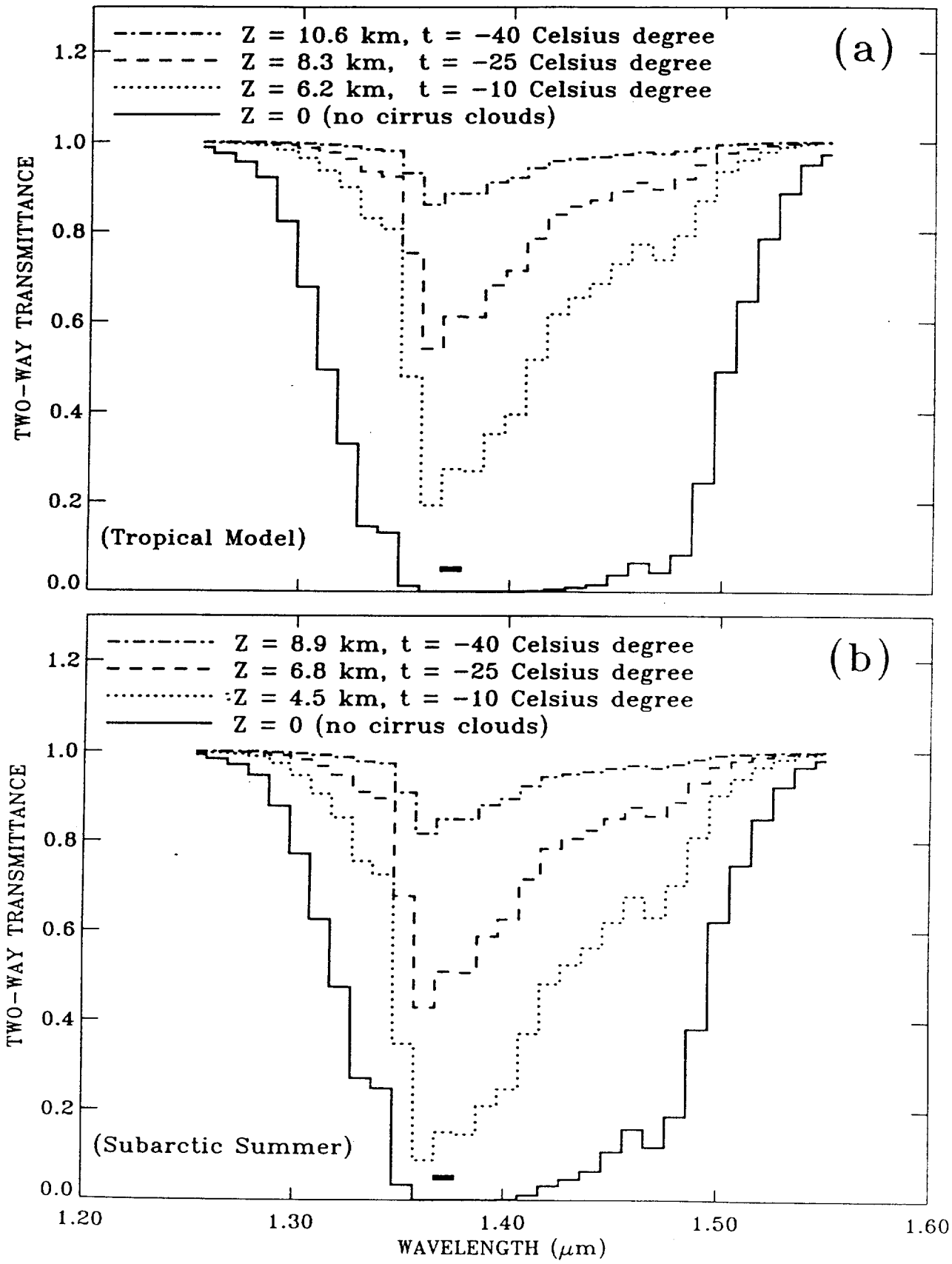
* Can sense thin cirrus above black background
* Undected cirrus can affect apparent temperature of up to 3°K
* Important for ~~ocean~~ and land temp. ~~measurements~~
* Undected cirrus can affect reflectance measurements of up to several hundreths ?
* Important for land/Ocean measurements and aerosol detection

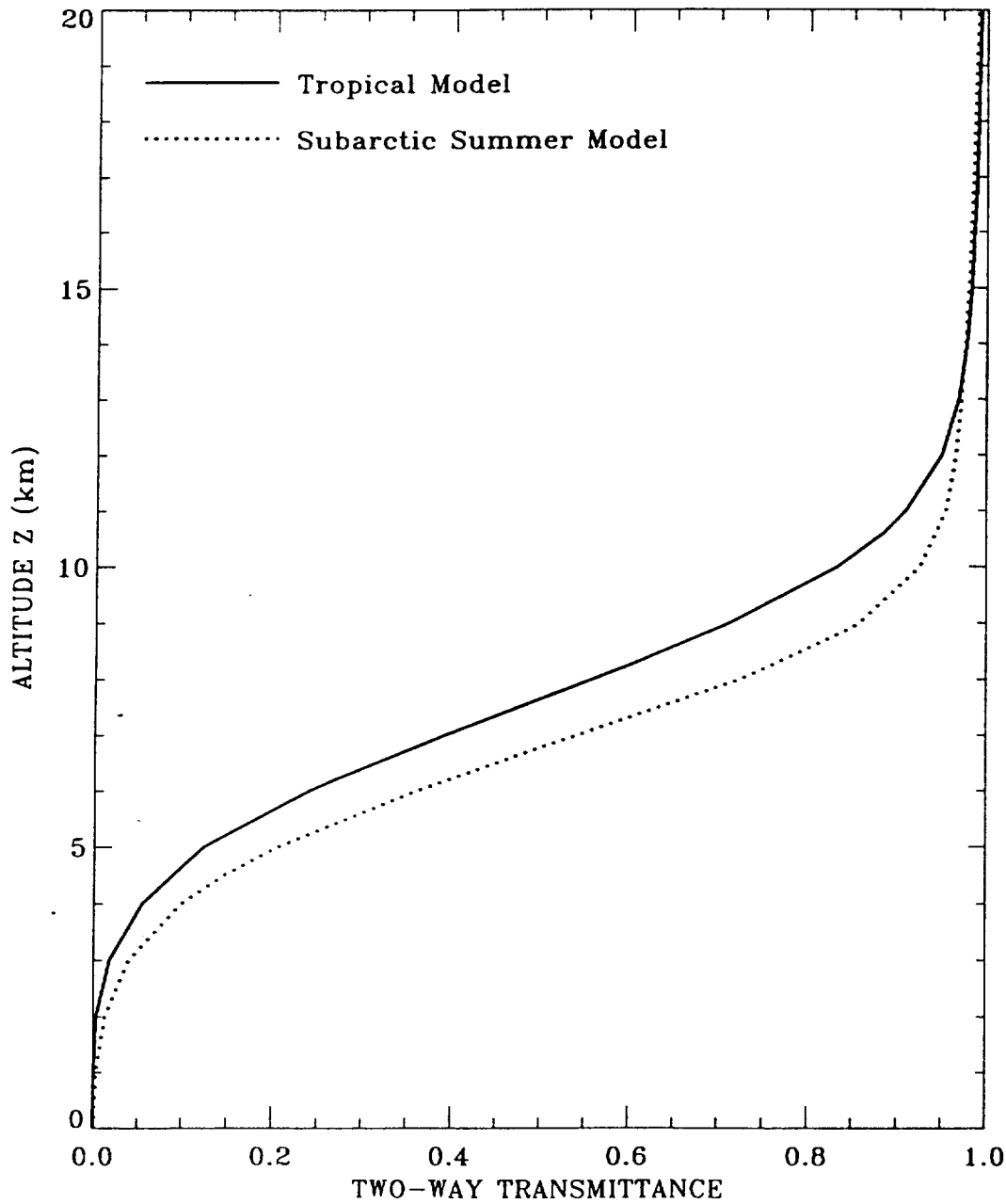
Propose to merge the fire channel with channel 20 or 21 or 22 700°K → 500-400°K

and release channel 21 for cirrus

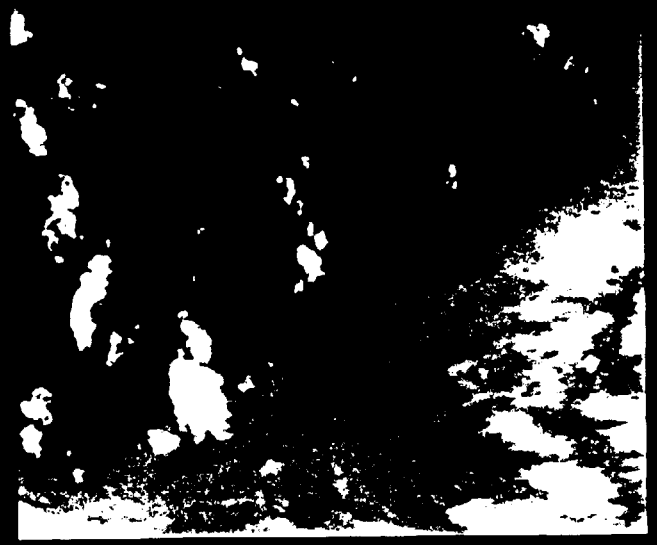
Discussion with SBRC.

The channel will loose small fraction of dynamic range (250 from 4000)


Z = 10.6 km, t = −40 Celsius degree
Z = 8.3 km, t = −25 Celsius degree
Z = 6.2 km, t = −10 Celsius degree
Z = 0 (no cirrus clouds)
(a)
(Tropical Model)
Z = 8.9 km, t = −40 Celsius degree
Z = 6.8 km, t = −25 Celsius degree
Z = 4.5 km, t = −10 Celsius degree
Z = 0 (no cirrus clouds)
(b)
(Subarctic Summer)
TWO-WAY TRANSMITTANCE
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.20
1.30
1.40
1.50
1.60
WAVELENGTH (μm)

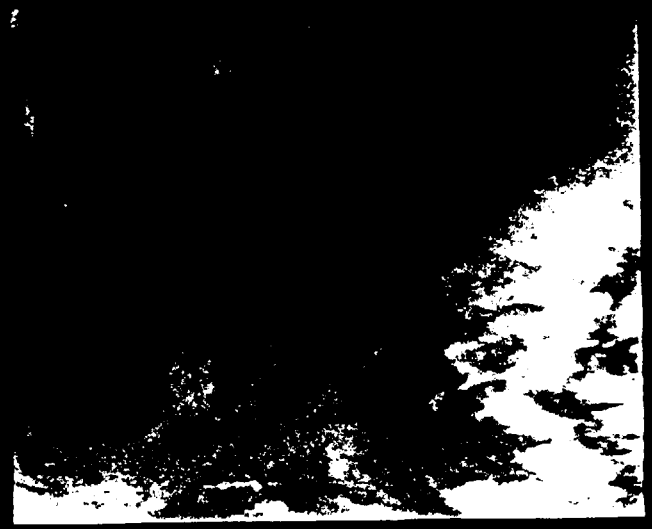

Tropical Model
Subarctic Summer Model
ALTITUDE Z (km)
TWO-WAY TRANSMITTANCE
0
5
10
15
20
0.0
0.2
0.4
0.6
0.8
1.0

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(0.56 um, B17, RUN: 03, SEG: 04)



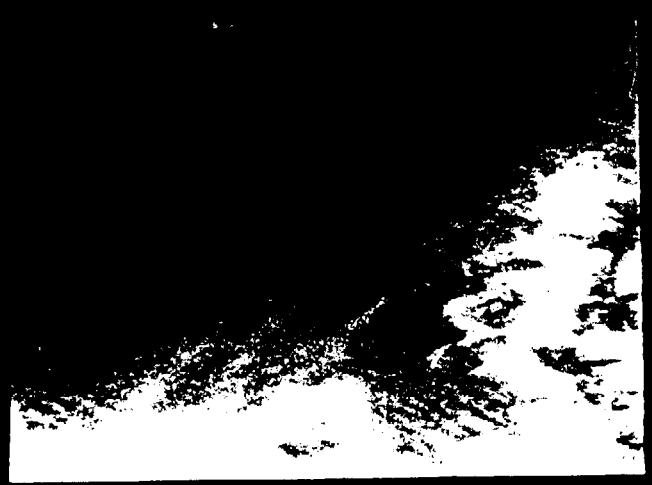
(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.35 um, B108, RUN: 03, SEG: 04)



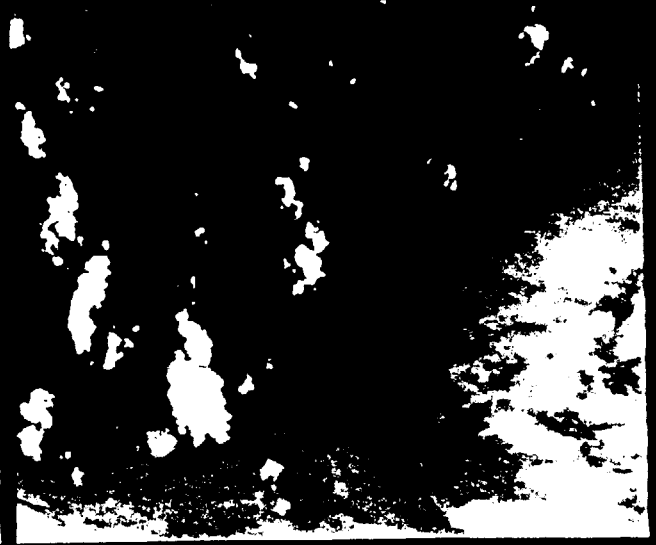
(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.38 um, B111, RUN: 03, SEG: 04)



(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.50 um, B123, RUN: 03, SEG: 04)



(CSES/U. OF COLORADO)

TABLE 1. Characteristics of HIRS/2 Sounding Channels

Channel Number	Central Wavelength, μm	Principal Absorbing Constituent	Level of Peak Energy Contribution, mbar
1	15.0	CO_2	30
2	14.7	CO_2	60
3	14.5	CO_2	100
4	14.2	CO_2	250
5	14.0	CO_2	500
6	13.7	$CO_2;H_2O$	750
7	13.4	$CO_2;H_2O$	900
8	11.1	Window	Surface
9	9.6	O_3	25
10	8.3	H_2O	900
11	7.3	H_2O	600
12	6.7	H_2O	400
13	4.57	N_2O	950
14	4.52	N_2O	850
15	4.46	$N_2O;CO_2$	700
16	4.40	$N_2O;CO_2$	600
17	4.24	CO_2	5
18	4.0	Window	Surface
19	3.7	Window	Surface
20	0.7	Window	Surface; Cloud

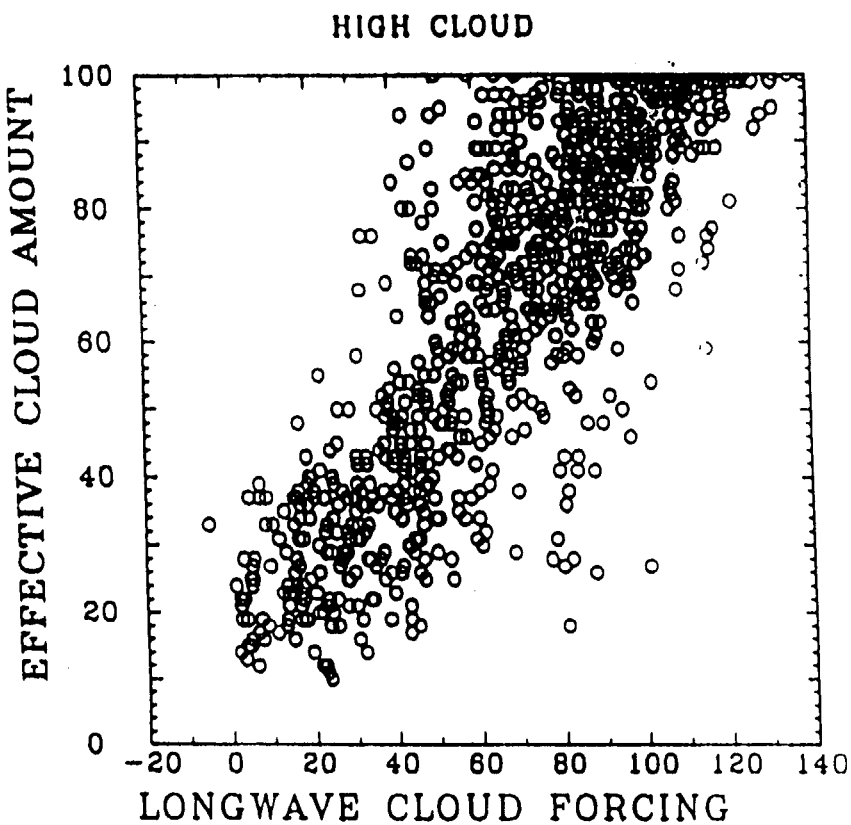


Fig. 15. Longwave cloud forcing (W m^{-2}) as a function of effective cloud amount (percent) for cloud top pressures between 300 and 400 mbar.

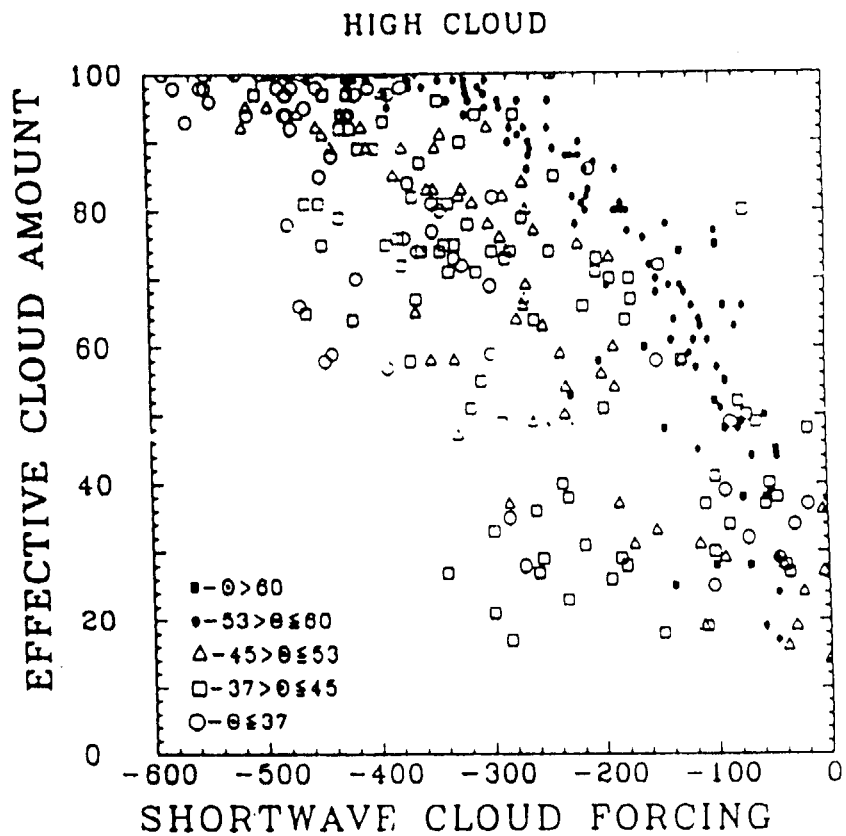


Fig. 20. Shortwave cloud forcing (W m^{-2}) as a function of effective cloud amount (percent) for cloud top pressures between 300 and 400 mbar. The different symbols represent different solar zenith angles as shown in the legend.

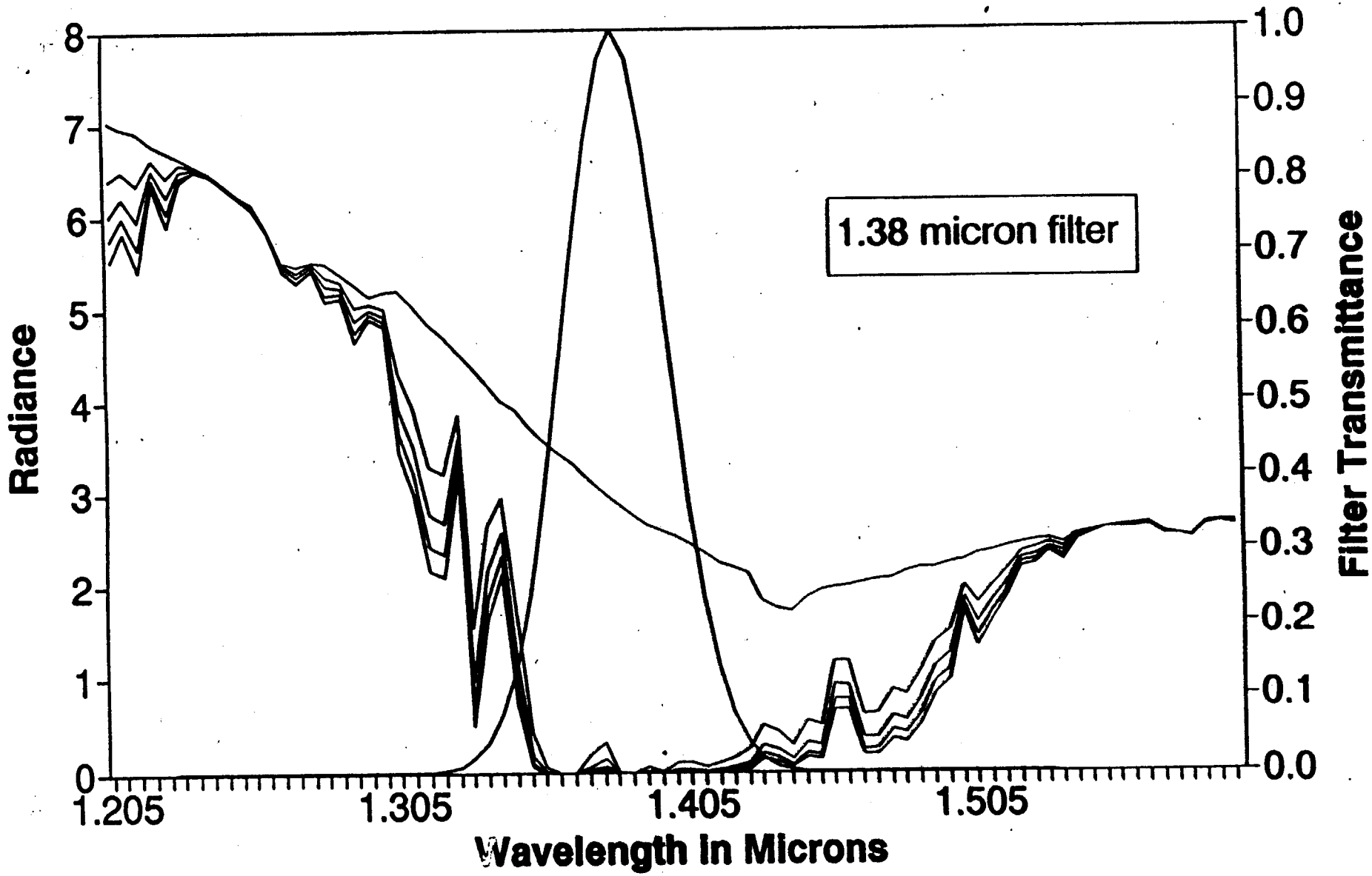
TABLE I

SPECTRAL CHARACTERISTICS, SPATIAL RESOLUTION, SATURATION REFLECTION FUNCTION (AT $\theta_0 = 22.5°$), SATURATION BRIGHTNESS TEMPERATURE AND PRINCIPAL PURPOSES OF ALL ATMOSPHERIC CHANNELS OF MODIS-N

Channel	λ (μm)	$\Delta\lambda$ (μm)	Ground resolution (m)	R_{max}	T_{max}(K)	Atmospheric Purpose
1	0.659	0.050	250	1.49		Aerosol Properties and Cloud Optical Thickness
2	0.865	0.040	250	1.00		Aerosol Properties
3	0.470	0.020	500	1.04		Aerosol Mass Loading and Optical Thickness
4	0.555	0.020	500	0.93		Aerosol Optical Thickness
5	1.240	0.020	500	0.51		Aerosol Optical Thickness
6	1.640	0.020	500	1.02		Snow/Cloud Discrimination; Cloud Phase; Aerosol Optical Thickness
7	2.130	0.050	500	0.81		Cloud Effective Particle Radius; Aerosol Optical Thickness
8	0.415	0.015	1000	0.33		Aerosol Optical Thickness
9	0.443	0.010	1000	0.23		
10	0.490	0.010	1000	0.17		
11	0.531	0.010	1000	0.15		
12	0.565	0.010	1000	0.12		
13	0.653	0.015	1000	0.08		
14	0.681	0.010	1000	0.07		
15	0.750	0.010	1000	0.07		
16	0.865	0.015	1000	0.06		
17	0.905	0.030	1000	0.67		Total Precipitable Water
18	0.936	0.010	1000	1.00		Total Precipitable Water and Cloud Fraction
19	0.940	0.050	1000	0.74		Total Precipitable Water and Cloud Fraction
20	3.750	0.180	1000		335	Cloud Effective Particle Radius; Cloud and Surface Temperature
21	3.750	0.050	1000		700	Fire and Volcano Temperature
22	3.959	0.050	1000		328	Cloud and Surface Temperature
23	4.050	0.050	1000		328	Cloud and Surface Temperature
24	4.465	0.050	1000		264	Temperature Profile
25	4.515	0.050	1000		285	Temperature Profile
26	4.565	0.050	1000		302	Temperature Profile
27	6.715	0.360	1000		271	Mid-Tropospheric Water Vapor
28	7.325	0.300	1000		275	Upper-Tropospheric Water Vapor
29	8.550	0.300	1000		324	Surface Temperature; Cloud Effective Particle Radius; Cirrus Detection
30	9.730	0.300	1000		275	Total Ozone Content
31	11.030	0.300	1000		400	Cloud and Surface Temperature; Fire and Volcano Temperature
32	12.020	0.500	1000		400	Cloud and Surface Temperature; Fire and Volcano Temperature
33	13.335	0.300	1000		285	Cloud Top Pressure and Temperature; Temperature Profile
34	13.635	0.300	1000		268	Cloud Top Pressure and Temperature; Temperature Profile
35	13.935	0.300	1000		261	Cloud Top Pressure and Temperature; Temperature Profile
36	14.235	0.300	1000		238	Cloud Top Pressure and Temperature; Temperature Profile

Satellite Radiances over Vegetation

with 0 to 4 cm. of water vapor



CONCLUSIONS - RECOMMENDATIONS

- The 1.375 μm ($\Delta\lambda$=30-50 nm) channel can sense thin cirrus clouds undetectable otherwise during the day.

- Very good separation between cirrus clouds and clear surface areas due to the strong water vapor absorption in the lower atmosphere, small sensitivity to mid-level clouds between 4 and 6 km.

- We recommend that this channel should be implemented on MODIS.