BOTANICAL SCIENCES TEAM

PRESENTED BY: C.J. TUCKER

BOTANICAL SCIENCES TEAM

MULTISPECTRAL IMAGING SCIENCE WORKING GROUP

APRIL 14-15, 1982 AT ORI

COCHAIRMEN: C. J. TUCKER (NASA) AND C. L. WIEGAND (USDA)

MEMBERS: G. BADWHAR (JSC), B. CIBULA (NSTL), E. CRIST (ERIM), C. DAURGHTY (LARS), R. FRASER (GSFC), D. KIMES (GSFC), D. PITTS (JSC), B. ROCK (JPL), C. SCHNETZLER (GSFC), S. UNGAR (GISS/GSFC)

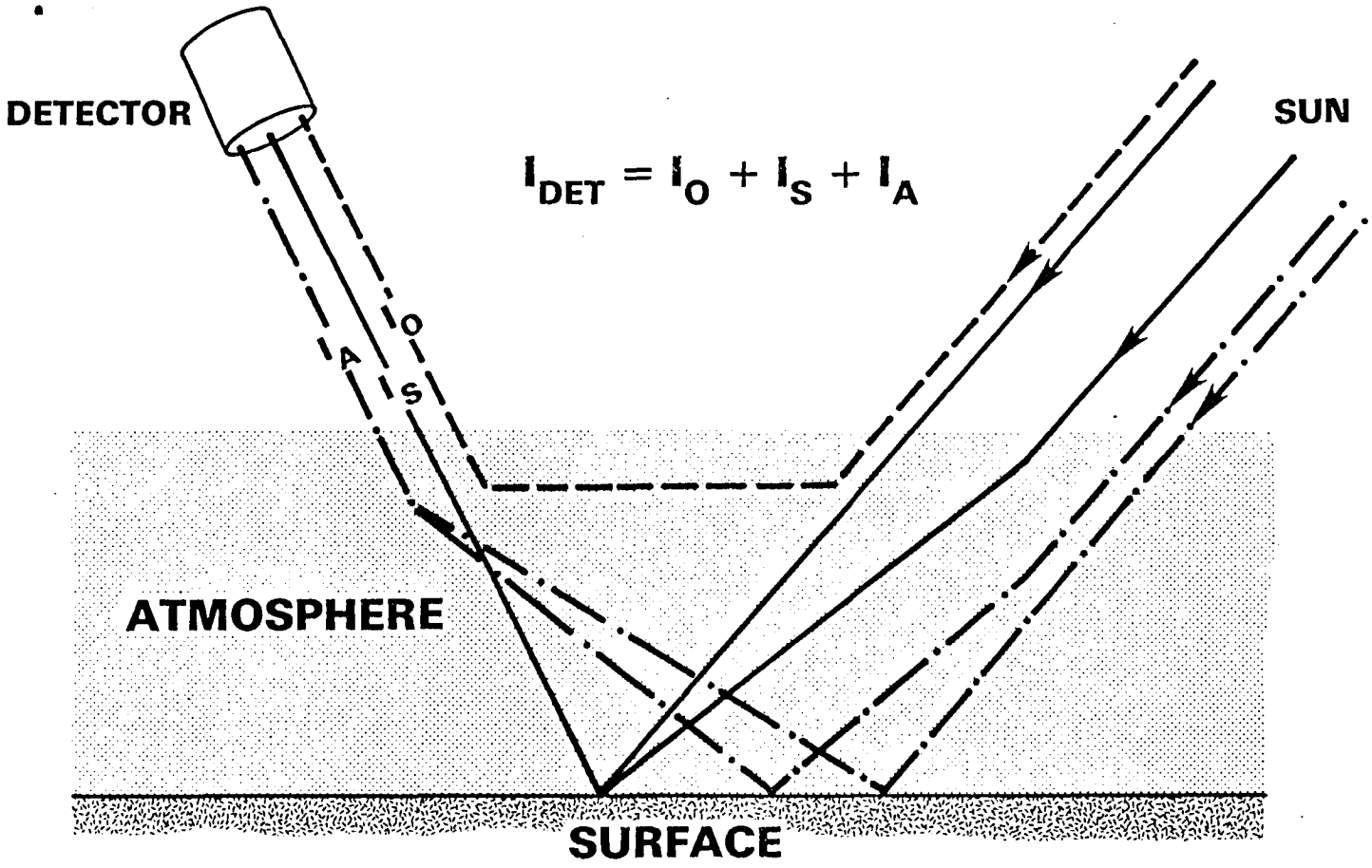
SIGNIFICANT IMPROVEMENTS IN THE ORBITAL ABILITY TO REMOTELY SENSE VEGETATED TARGETS WILL RESULT FROM

- UNDERSTANDING OF ATMOSPHERIC EFFECTS
- APPROPRIATE SPATIAL RESOLUTION
- NARROW SPECTRAL BANDWIDTHS
- ADDITIONAL SPECTRAL BANDS
- TEMPORAL FREQUENCY OF 2-3 DAYS

EFFECTS OF THE ATMOSPHERE UPON RADIATIVE TRANSFER

- RESTRICT MOST BANDS TO ATMOSPHERIC WINDOWS
- VERTICAL AND HORIZONTAL DISTRIBUTION OF AEROSOLS, DUST, CONDENSATION NUCLEI, ICE CRYSTALS, WATER VAPOR, CLOUD DROPLETS, TRACE GASES, ETC. NEEDED
- RELATIONSHIP BETWEEN AVAILABLE METEOROLOGICAL DATA AND ATMOSPHERIC OPTICAL PARAMETERS NEEDS TO BE ESTABLISHED
- ADJACENCY EFFECTS UNDERSTANDING NEEDED
- CONCURRENT DETAILED SURFACE MEASUREMENTS, ATMOSPHERIC MEASUREMENTS, AIRCRAFT MEASUREMENTS, AND SATELLITE MEASUREMENTS NEEDED.
- POSSIBILITIES OF ATMOSPHERIC "SOUNDER" BANDS SHOULD BE INVESTIGATED

REMOTE SENSING
OVER A NON-UNIFORM SURFACE



$I_{DET} = I_O + I_S + I_A$ **FOR AVERAGE CONDITIONS**

$100\% = 48\% + 38\% + 14\%$ $\lambda = 0.55\,\mu m$, $A = 0.1$

I_O—ATMOSPHERIC RADIANCE SCATTERED FROM THE SOLAR BEAM INTO THE DETECTOR

I_S—THE "SIGNAL"—RADIANCE FROM THE TARGET ATTENUATED BY THE ATMOSPHERE

I_A—THE DIFFUSE LIGHT SCATTERED FROM BRIGHT AREAS TO THE DARK AREAS (ADJACENCY EFFECT)

$$A(x, y) \xrightarrow{\text{RADIATIVE TRANSFER}} I(x, y)$$
$$A(x, y) \xleftarrow{?} I(x, y)$$

APPROPRIATE SPATIAL RESOLUTION FOR TASK AT HAND

- 10-30 M FOR HIGH SPATIAL FREQUENCY COVER TYPES FOR SMALL AGRICULTURAL PLOTS
- 500-5000 M FOR LARGE-SCALE EARTH FEATURES CONSISTANT WITH CLIMATE PHENOMENA
- TARGET SIZE DISTRIBUTIONS NEEDED
- ADJACENCY EFFECTS, "TEXTURAL" INFORMATION, ETC. WITH FINER SPATIAL RESOLUTIONS

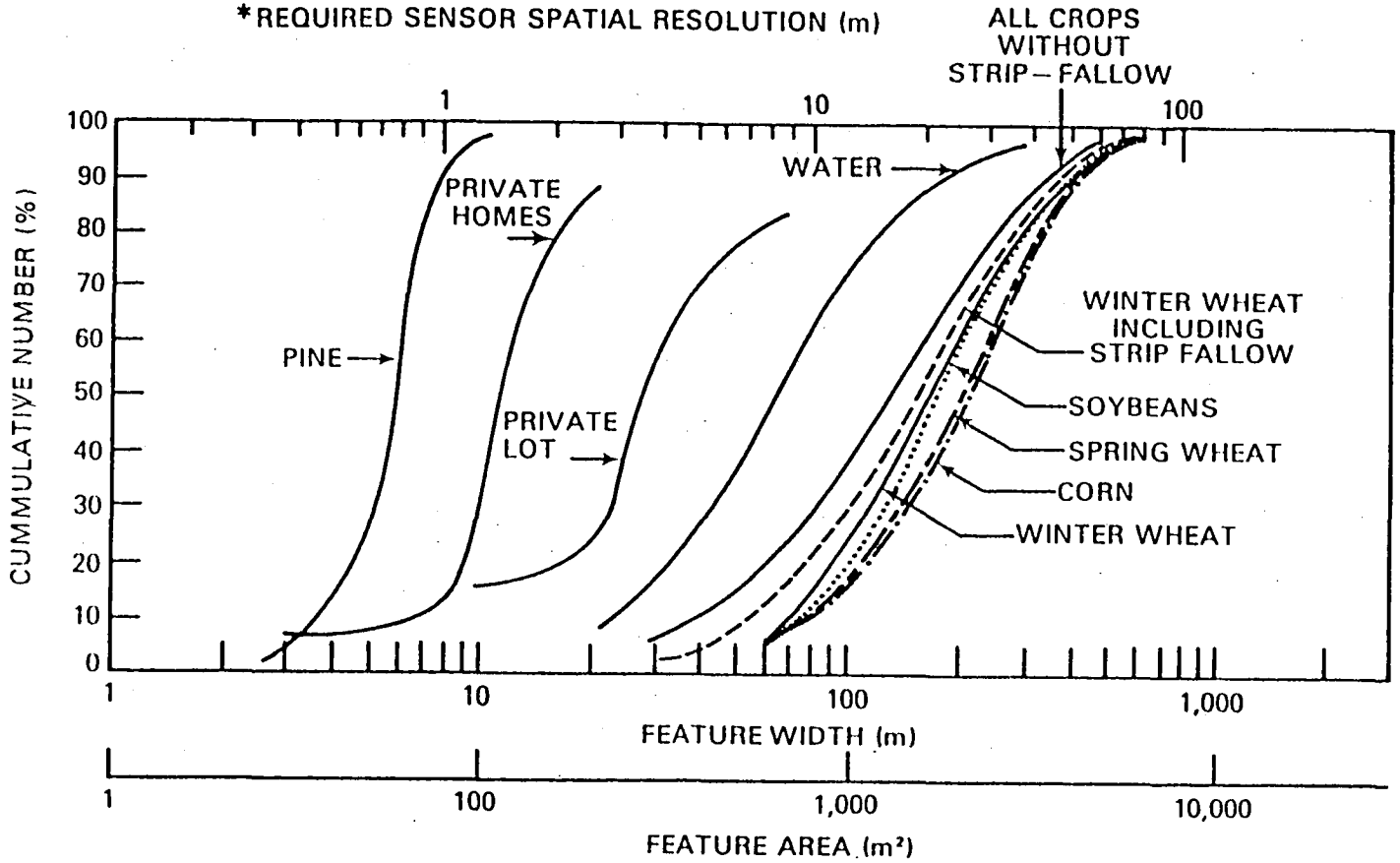
MAJOR PLANT COMMUNITIES: AREA, NPP, AND C STORAGE*

VEGETATION TYPE	AREA 10^6 km^2	PERCENT OF LAND AREA	NPP 10^{15} g C yr^{-1}	PERCENT OF NPP	PLANT MASS 10^{15} g C	PERCENT OF MASS	
TROPICAL RAIN FOREST	17.0	11.4	16.8	31.8	344.0	41.6	
TROPICAL SEASONAL FOREST	7.5	5.0	5.4	10.2	117.0	14.2	
TEMPERATE EVERGREEN FOREST	5.0	3.4	2.9	5.5	79.0	9.6	77%
TEMPERATE DICIDUOUS FOREST	7.0	4.7	3.8	7.2	95.0	11.5	
BOREAL FOREST	12.0	8.1	4.3	8.1	108.0	13.1	
WOODLAND AND SHRUBLAND	8.5	5.7	2.7	5.1	22.0	2.7	
SAVANNA	15.0	10.1	6.1	11.6	27.0	3.3	
TEMPERATE GRASSLAND	9.0	6.0	2.4	4.5	6.3	0.8	
TUNDRA AND ALPINE MEADOW	8.0	5.4	0.5	0.9	2.3	0.3	
DESERT SCRUB	18.0	12.1	0.7	1.3	5.9	0.7	
ROCK, ICE, AND SAND	24.0	16.1	0.03	0.1	0.2	0.02	
CULTIVATED LAND	14.0	9.4	4.1	7.8	6.3	0.8	
SWAMP AND MARSH	2.0	1.3	2.7	5.1	13.5	1.6	
LAKE AND STREAM	2.0	1.3	0.4	0.8	0.02	0.002	
TOTAL CONTINENTAL	149.0	100.0	52.8	100.0	826.5	100.0	

*FROM: WHITTAKER AND LIKENS 1973.

SPATIAL INFORMATION CONTENT FOR RENEWABLE RESOURCES

SIZE DISTRIBUTION OF TYPICAL GROUND COVERS



(REFERENCE: AgRISTARS, L.MILLER, J. BARKER AND R.WHITMAN , 1980)

* ASSUMES 8x8 PIXEL AREA CONTAINED WITHIN SMALLEST FEATURE DESIRED FOR ADEQUATE AREA MEASUREMENT

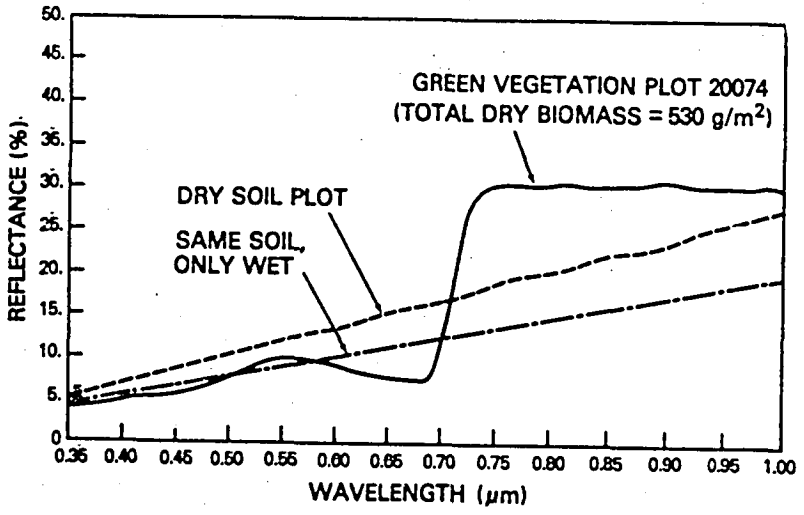
JLB/SCC

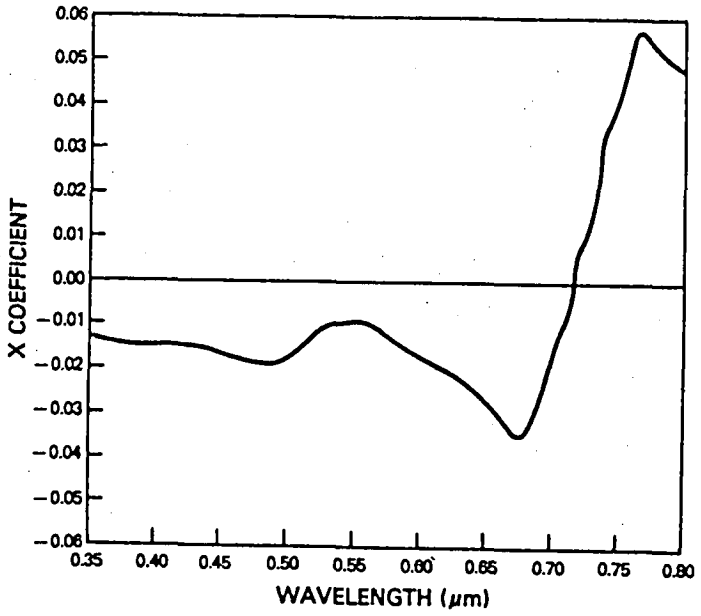
GSFC

SPECTRAL RESOLUTION IMPROVEMENTS

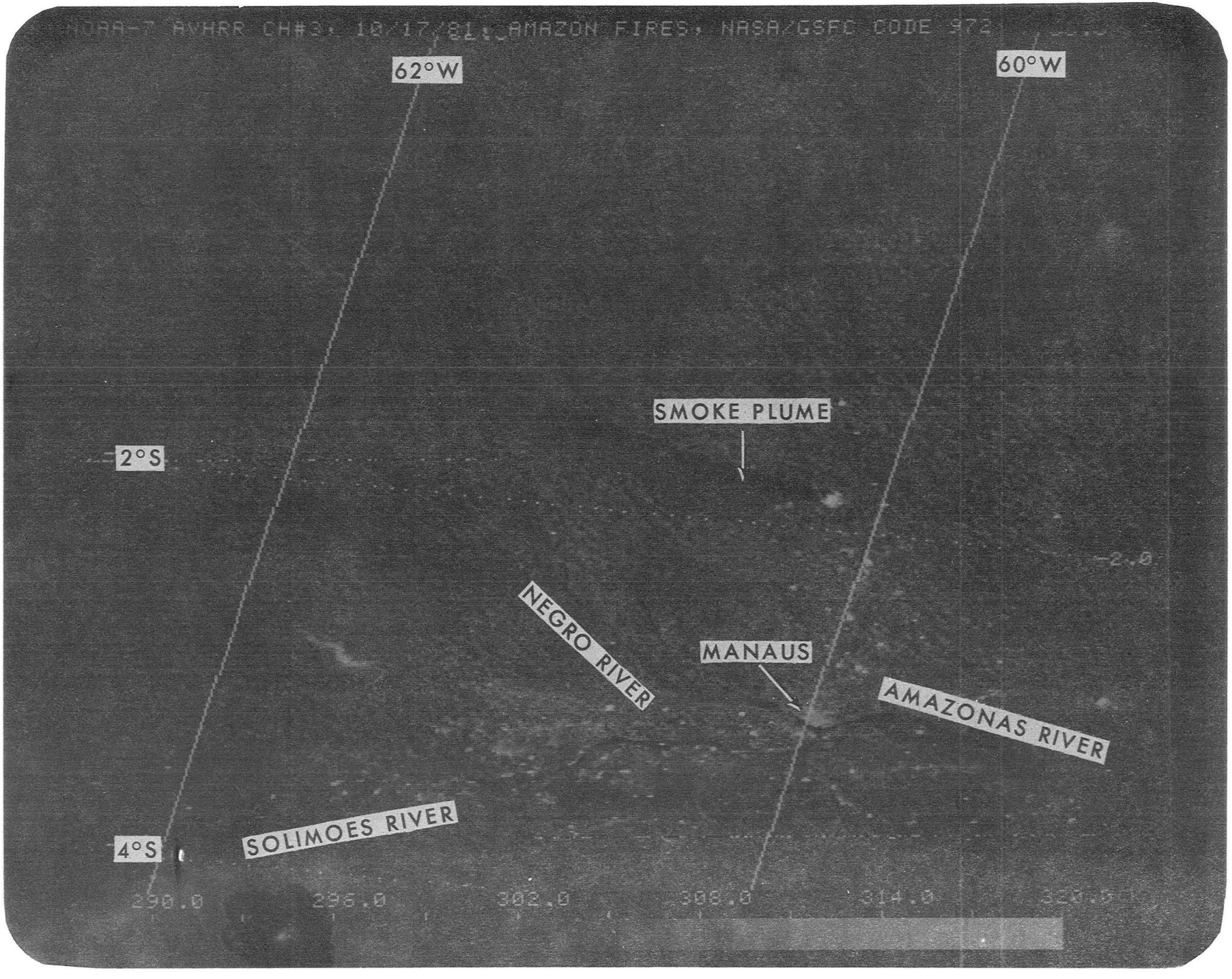
- NARROW BANDWIDTHS TO MAXIMIZE SPECTRAL CONTRASTS AND MINIMIZE ATMOSPHERIC EFFECTS
- BANDS CENTERED AT ~0.44, 0.55, 0.66, 0.85, 1.65, AND 2.2 μM FOR MONITORING GREEN LEAF VEGETATION
- 3.5-3.9 μM BAND FOR FIRE DETECTION AND 10.5-12.5 μM THERMAL BAND FOR CLOUD DETECTION
- ADDITIONAL RESEARCH NEEDED
  - o HIGH RESOLUTION SPECTRAL DATA
  - o DIRECTIONAL REFLECTANCE DISTRIBUTION
  - o POLARIZATION
  - o 0.75-0.78 μM, 1.0-1.3 μM, AND OTHER SPECTRAL REGIONS OF CONTROVERSY (I.E., NO CONSENSUS)
  - o ATMOSPHERIC "SOUNDER" BANDS

WHY USE THE RED AND PHOTOGRAPHIC IR PORTIONS OF THE SPECTRUM?



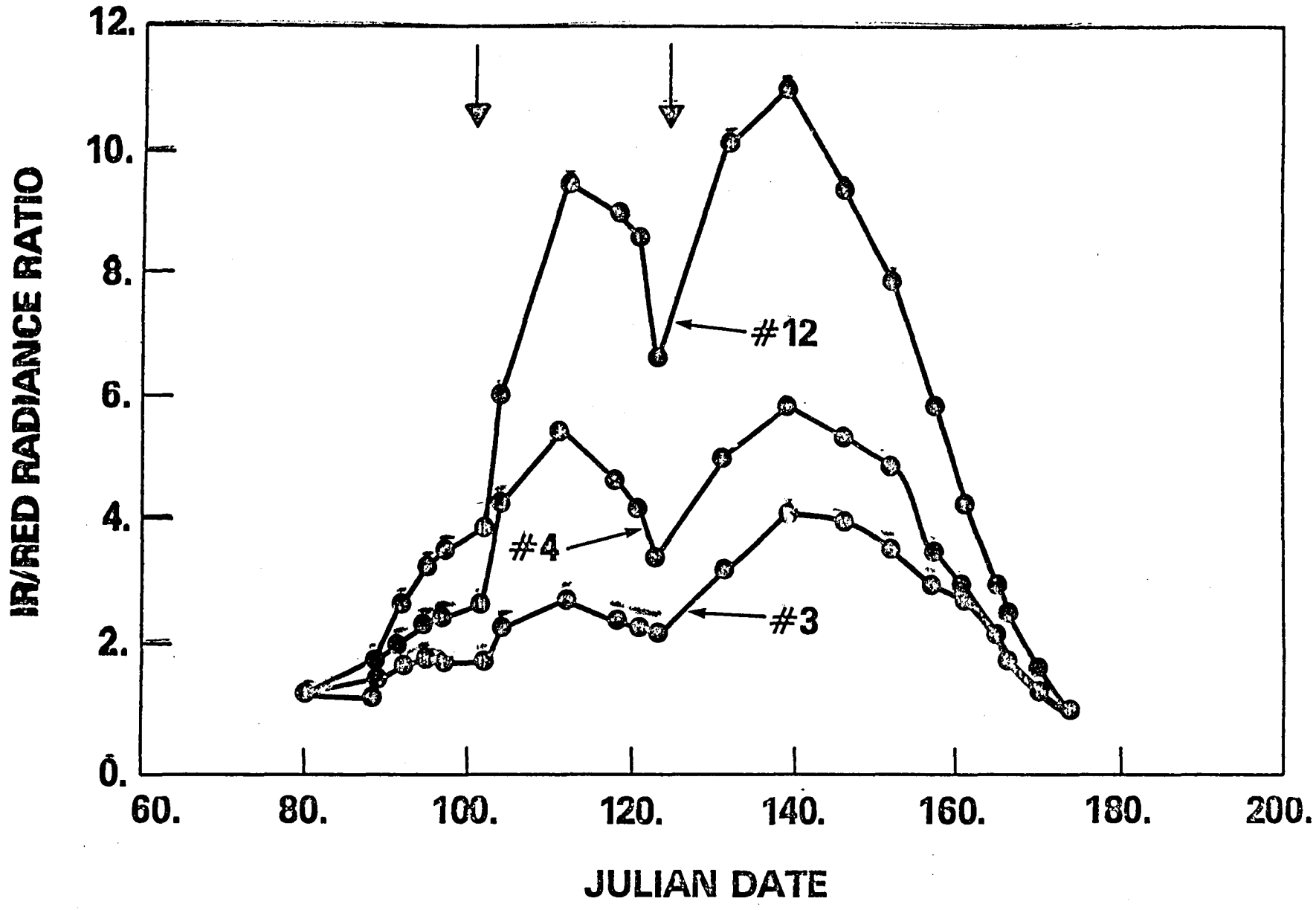


BECAUSE THE SOIL-VEGETATION CONTRAST IS AT A MAXIMUM FOR THESE REGIONS.


NOAA-7 AVHRR CH#3, 10/17/81, AMAZON FIRES, NASA/GSFC CODE 972
62°W
60°W
SMOKE PLUME
2°S
NEGRO RIVER
MANAUS
AMAZONAS RIVER
SOLIMOES RIVER
4°S
290.0
296.0
302.0
308.0
314.0
320.0

RADIOMETRIC AND TEMPORAL RESOLUTION REQUIREMENTS

- GOAL IS TO MAINTAIN RADIANCE/REFLECTANCE DIFFERENCES THROUGH RADIATIVE TRANSFER FOR RANGE OF VIEWING CONDITIONS
- DETERMINED BY ATMOSPHERIC EFFECT(S) UPON ORBITAL MEASUREMENT ACCURACY
- TEMPORAL FREQUENCY OF 4-6 DAYS NEEDED AT SELECTED TIMES
  - SENESCENCE
  - FLOWERING, HARVEST, ETC.
  - STRESS ONSET/RECOVERY
  - "ACTS OF GOD"
- ASSUMING CLOUD COVER PROBABILITY OF 50% LOWERS TEMPORAL FREQUENCY TO 2-3 DAYS AT SELECTED TIMES


12.
10.
8.
6.
4.
2.
0.
IR/RED RADIANCE RATIO
#12
#4
#3
60.
80.
100.
120.
140.
160.
180.
200.
JULIAN DATE