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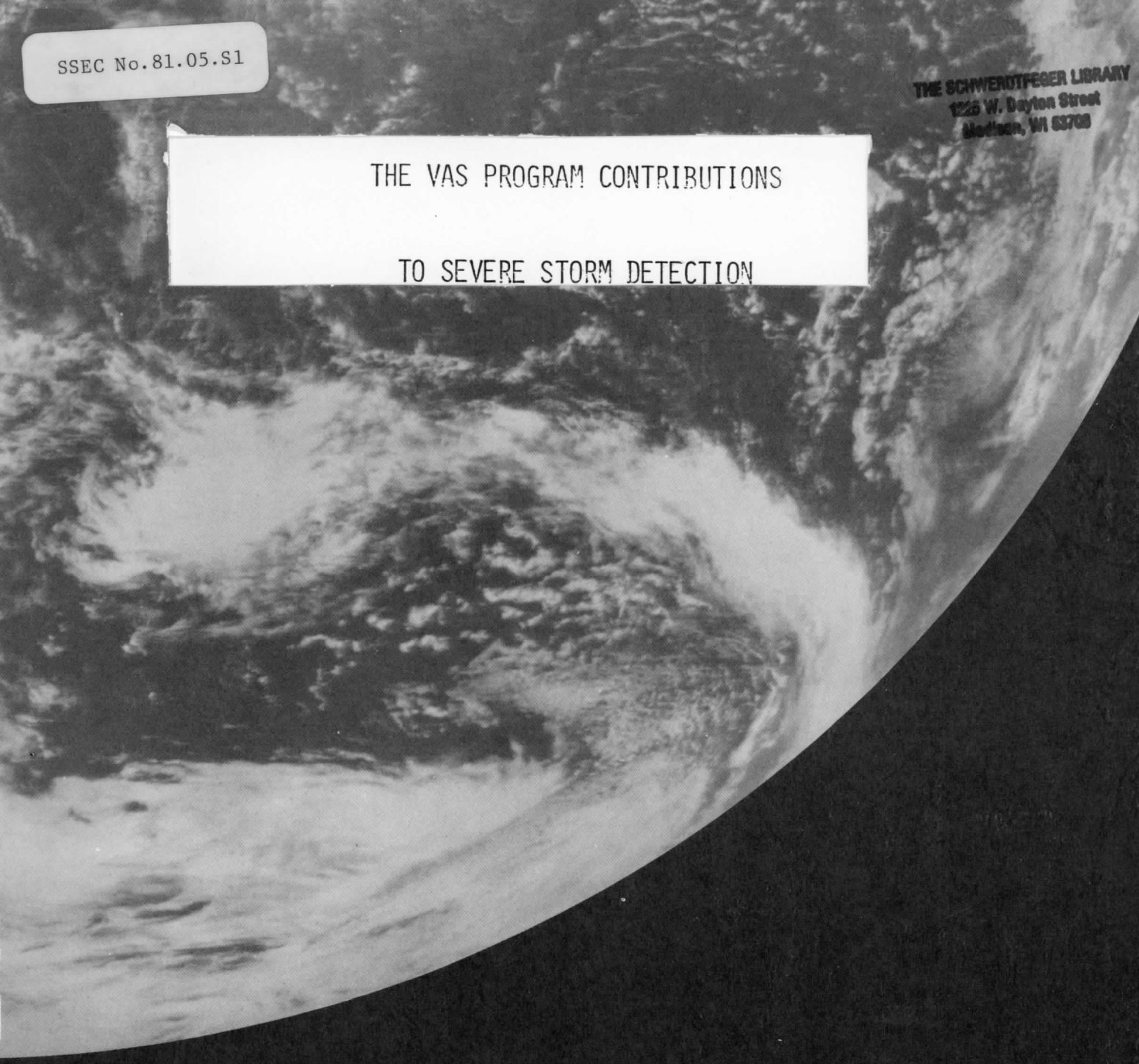
THE VAS PROGRAM CONTRIBUTIONS TO SEVERE STORM DETECTION



A REPORT

from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

SSEC BRIEFING

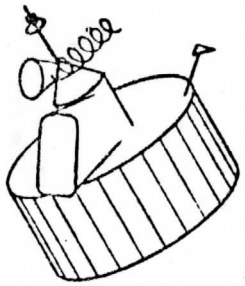
THE VAS PROGRAM CONTRIBUTIONS

TO SEVERE STORM DETECTION

MAY 4, 1981

THE VAS PROGRAM

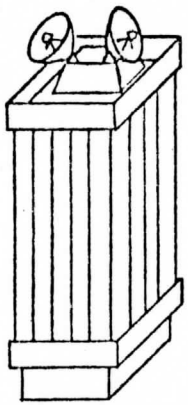
GEOSYNCHRONOUS VAS INSTRUMENT



MORE FREQUENT
METEOROLOGICAL OBSERVATIONS
MORE DENSELY PACKED

→ OPPORTUNITY FOR NEW SCIENCE

UW GROUND
DATA PROCESSING SYSTEM



TWO PHASES OF VAS PROGRAM

1. EXPERIMENTAL PHASE DURING WHICH NASA HAS THE RESPONSIBILITY TO ASSESS THE INFLIGHT OPERATIONAL CAPABILITIES OF THE VAS SYSTEM

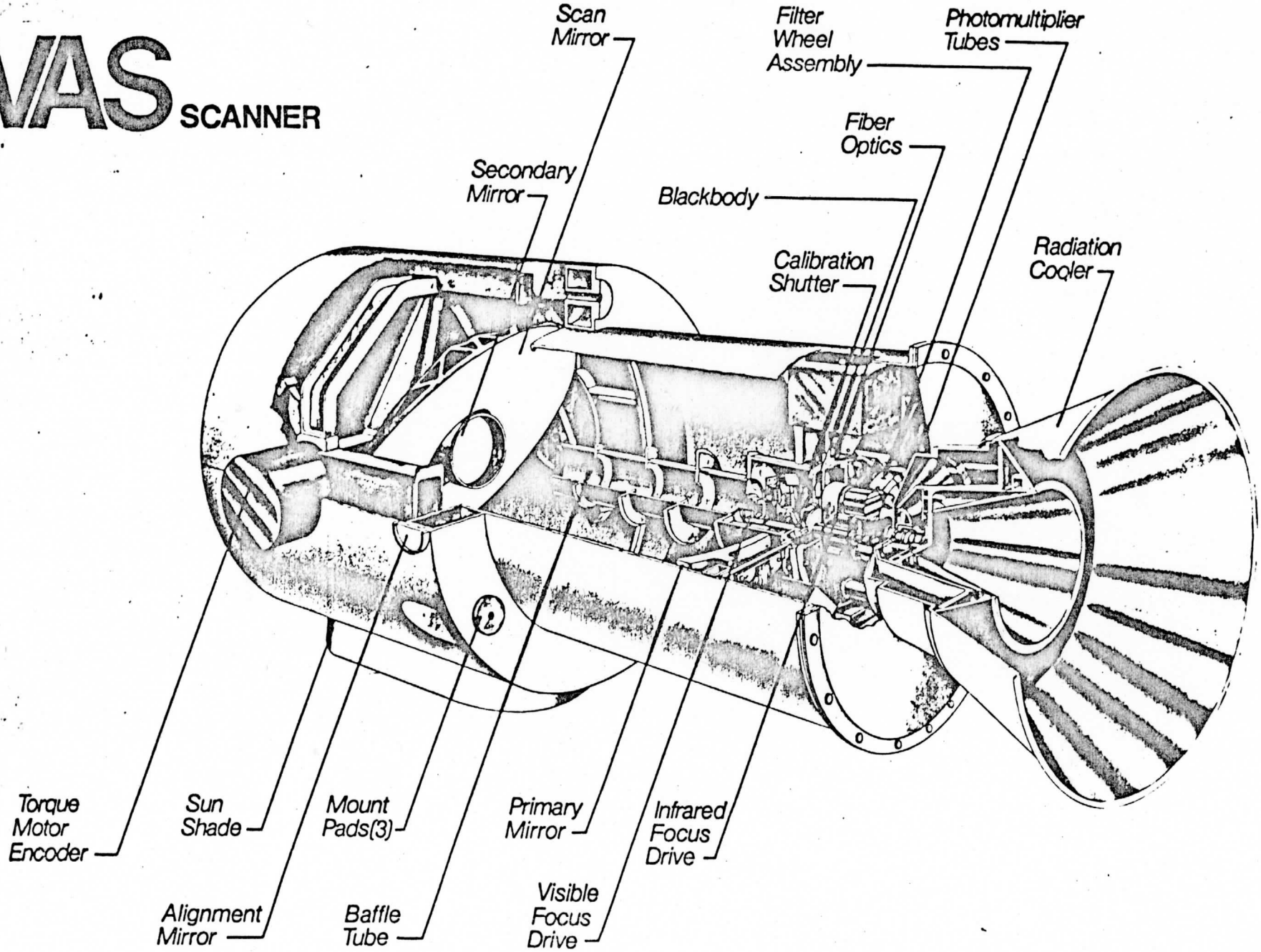
2. OPERATIONAL PHASE DURING WHICH NOAA WILL INTEGRATE THE VAS SYSTEM INTO AN OPERATIONAL NETWORK OF WEATHER FORECAST CENTERS

V A S

INSTRUMENT

VISSR ATMOSPHERIC SOUNDER

VAS SCANNER


Scan Mirror
Filter Wheel Assembly
Photomultiplier Tubes
Fiber Optics
Secondary Mirror
Blackbody
Calibration Shutter
Radiation Cooler
Torque Motor Encoder
Sun Shade
Mount Pads(3)
Primary Mirror
Infrared Focus Drive
Alignment Mirror
Baffle Tube
Visible Focus Drive

GENERAL CHARACTERISTICS OF VAS INSTRUMENT

1) GEOSYNCHRONOUS

2) SOUNDER

3) IMAGER

4) PROGRAMMABLE

5) EXPERIMENTAL

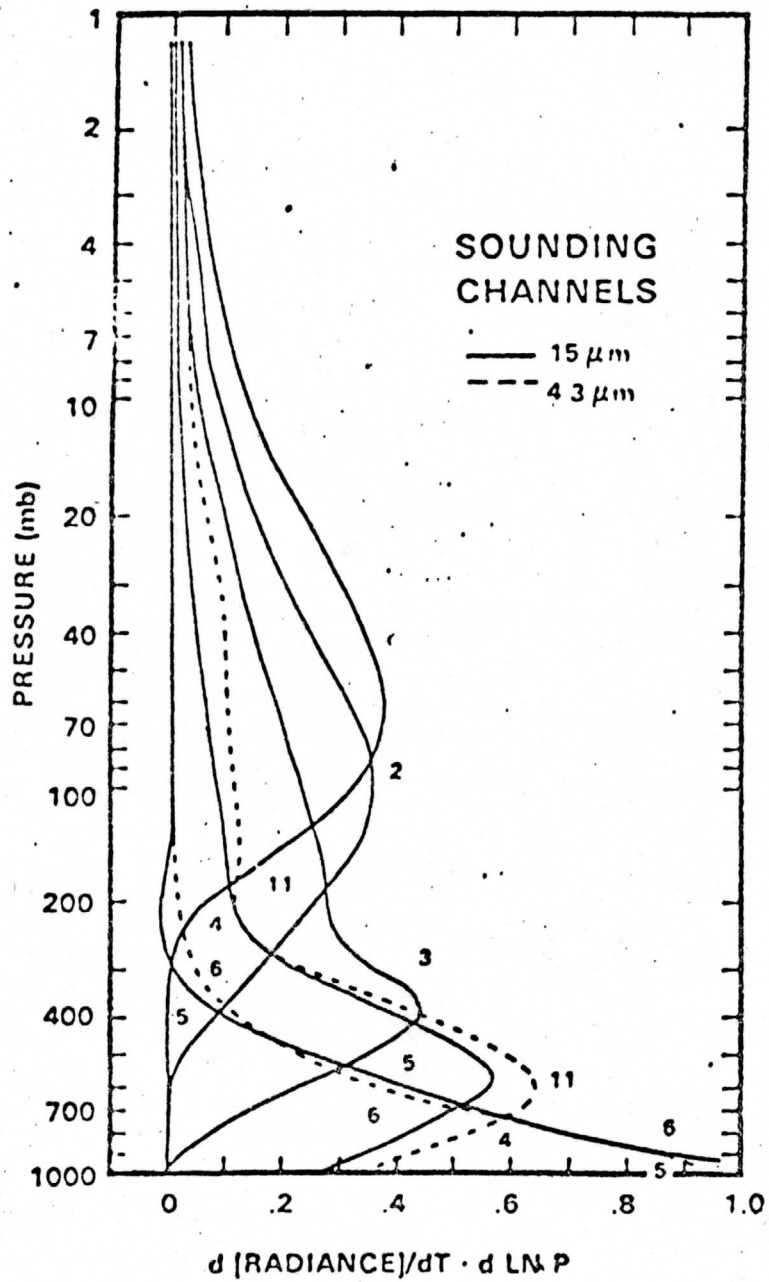
UNIQUE CAPABILITIES OF VAS

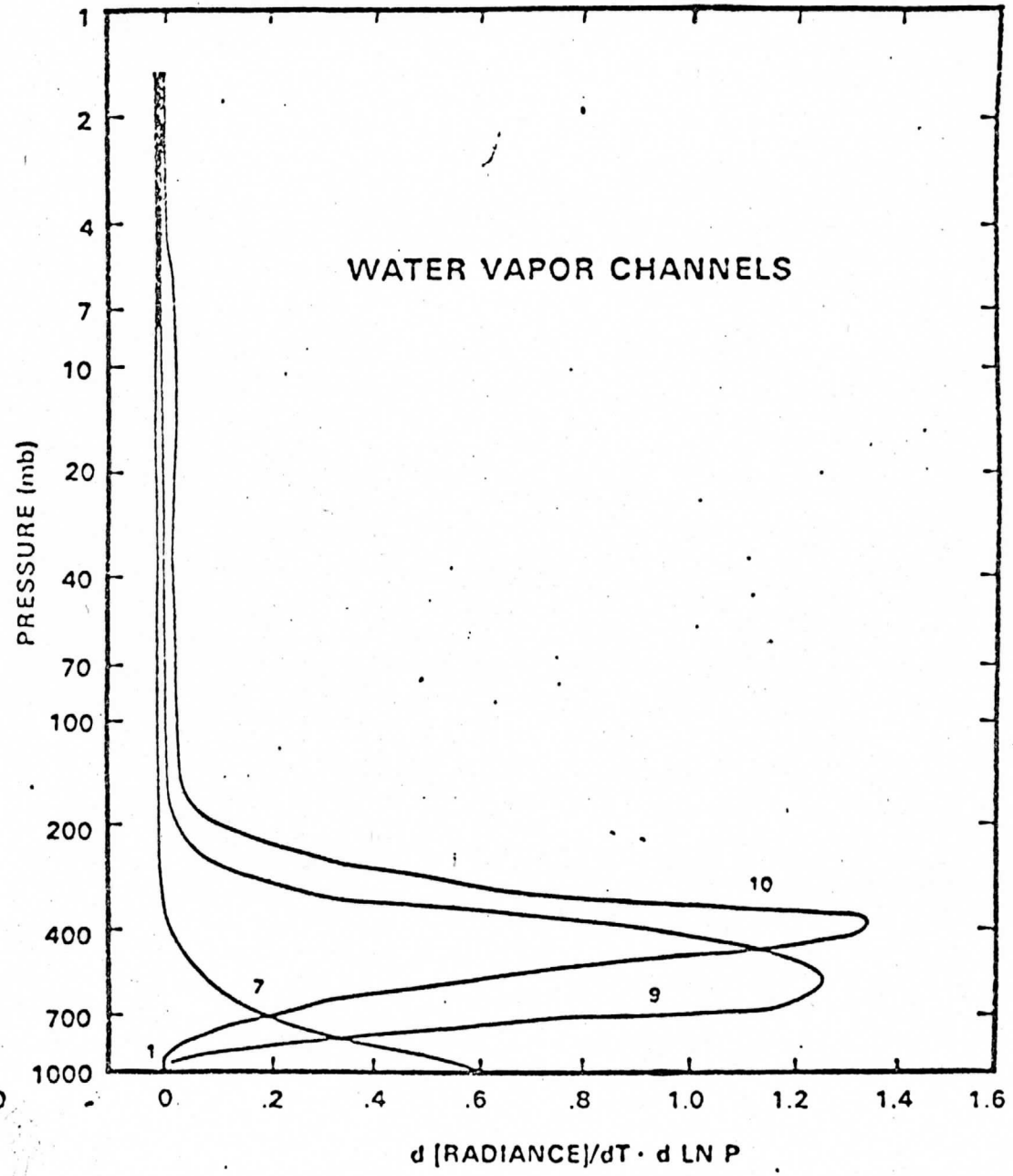
1. TIME DOMAIN SOUNDING
2. OBSERVATION OF TARGETS OF OPPORTUNITY

VAS Infrared Spectral Bands

Spectral Band	Atmos Press. (mb)	ν (cm^{-1})	λ (μm)	$\Delta\nu$ (cm^{-1})	Single Sample S/N for 320 K Scene Temperature		Remarks	
					0.192 mr IGFOV	0.384 mr IFGOV	Band	Detector Type
1	65	678.7	14.73	10	N/A	37.4	CO_2	HGCDTE
2	100	690.6	14.48	16	N/A	92.3	CO_2	HGCDTE
3	325	701.6	14.25	16	50.4	100.8	CO_2	HGCDTE
4	450	713.6	14.01	20	65.3	130.6	CO_2	HGCDTE
5	Surf.	750	13.33	20	64.1	128.3	CO_2	HGCDTE
6	700	2210	4.525	45	N/A	108.9	CO_2	IN SB
7	Surf.	790	12.66	20	60.7	121.4	H_2O	HGCDTE
8	Surf.	895	11.17	140	607.1*	953.5	Window	HGCDTE
9	375	1377.2	7.261	40	24.2	48.5	H_2O	HGCDTE
10	330	1487	6.725	150	73.7	147.4	H_2O	HGCDTE
11	280	2250	4.444	40	N/A	83.7	CO_2	IN SB
12	Surf.	2535	3.945	140	N/A	111.1	Window	IN SB

VAS SENSITIVITY FUNCTIONS

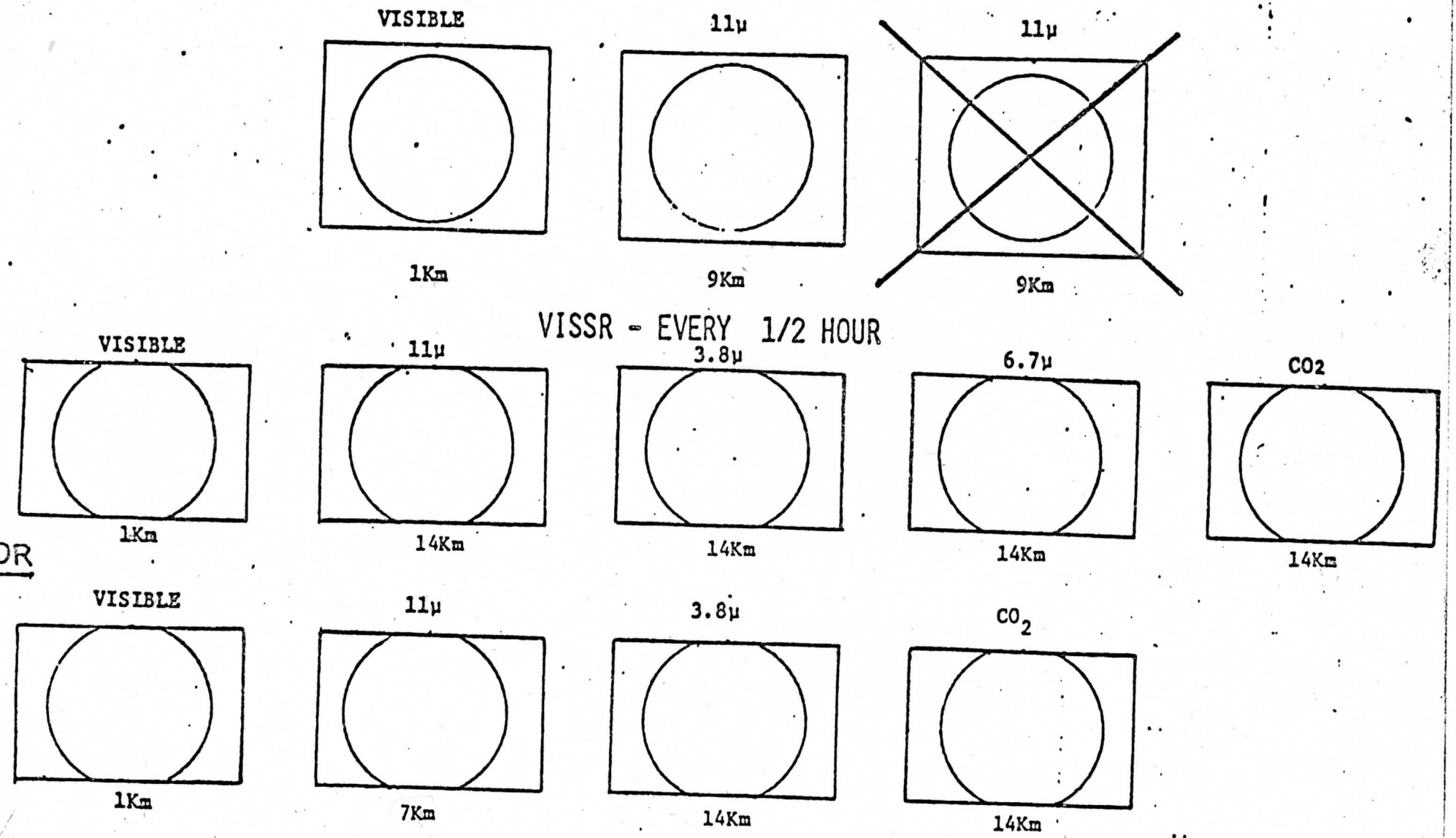




VAS MODES OF OPERATION

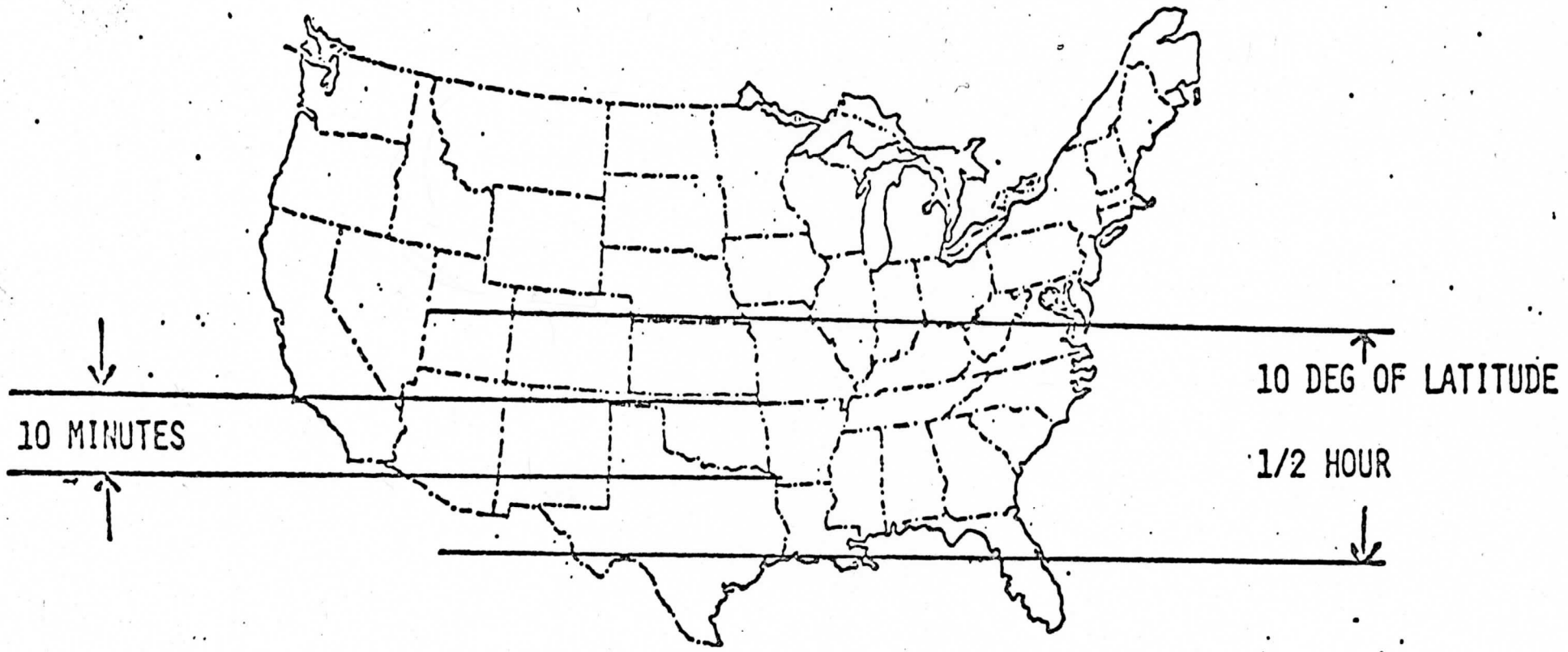
- VISSR
- MULTI-SPECTRAL IMAGING
- DWELL SOUNDING

MULTISPECTRAL IMAGING



TYPICAL - SPECTRAL BAND AND RESOLUTION ARE SELECTABLE

SOUNDING MODE



RESOLUTION = 40KM x 40KM (AT 45° LAT)

SCAN RATE = 40KM/MINUTE

VAS IMPROVEMENTS OVER VISSR

- MULTISPECTRAL IMAGING
- TEMPERATURE AND MOISTURE SOUNDINGS FROM GEOSYNCHRONOUS ORBIT
- MONITORING TIME RATE OF CHANGE OF TEMPERATURE AND MOISTURE FIELDS
- IMPROVED MEASUREMENT OF
  - -CLOUD AMOUNT, TYPE, AND HEIGHT
  - -WINDS
  - -SURFACE TEMPERATURE

VAS IMPROVEMENTS IN SOUNDING VERSUS A LOW ORBITING SATELLITE

- CONSTANT SURVEILLANCE
- CONSISTENT VIEWING GEOMETRY TO A PARTICULAR LOCATION
- BETTER OPPORTUNITY FOR DETERMINING TEMPORAL AND SPATIAL GRADIENTS
- EASIER SYNCHRONIZATION WITH DATA FROM RADIOSONDES AND OTHER SATELLITES
- NEARLY SYNOPTIC COVERAGE OVER A LARGE AREA

VAS PERFORMANCE DEPENDS ON

- NOISE REDUCTION BY MULTIPLE SCANNING
- REGISTRATION OF FIELDS OF VIEW OF DIFFERENT SPECTRAL BANDS
- CALIBRATION OF DETECTOR RESPONSE

STATUS OF VAS INSTRUMENTS

1) VAS-D ON GOES-4 WAS SUCCESSFULLY LAUNCHED ON 9 SEP 1980

   A) NOISE REDUCTION BY MULTIPLE SCANNING VERIFIED; SPIN BUDGET OF 85 BEING USED.

   B) CALIBRATION OF 12 SPECTRAL BANDS VERIFIED BY INTERCOMPARISIONS WITH HIRS AND RADIO-SONDE DATA; CHANNELS 2 THRU 4 UP TO 3°C TOO COLD.

   C) REGISTRATION OF FIELDS OF VIEW OF DIFFERENT SPECTRAL BANDS NO PROBLEM.

2) VAS-E IS SCHEDULED FOR LAUNCH ON GOES-E ON 14 MAY 1981.

EARLY SCIENTIFIC RESULTS FROM VAS

1) VAS CAN SOUND FROM GEOSTATIONARY PLATFORM

2) VAS CAN DEPICT TIME VARIATIONS IN ATMOSPHERIC STATE. WITH 3-HOUR INTERVAL SOUNDINGS, DIURNAL WARMING BELOW 500 MB IS READILY OBSERVABLE.

3) MOISTURE PROFILES FROM VAS YIELD USEFUL INFORMATION FROM 850 MB TO 300 MB. T_D WITHIN 5°C OF RADIOSONDE OBSERVATIONS.

4) CONTOUR ANALYSIS OF VAS TEMPERATURE FIELDS EASILY REVEAL COOLINGS AND WARMINGS AT 1000 MB, 850 MB, 500 MB AND 300 MB.

5) DETERMINATION OF SEA SURFACE TEMPERATURE WITHIN 1°C OF SHIP OBSERVATIONS POSSIBLE WITH VAS.

6) WATER VAPOR TRACKING PRODUCES WINDS IN REGIONS WHERE CONVENTIONAL WINDS ARE SPARSE (ESPECIALLY AROUND JET).

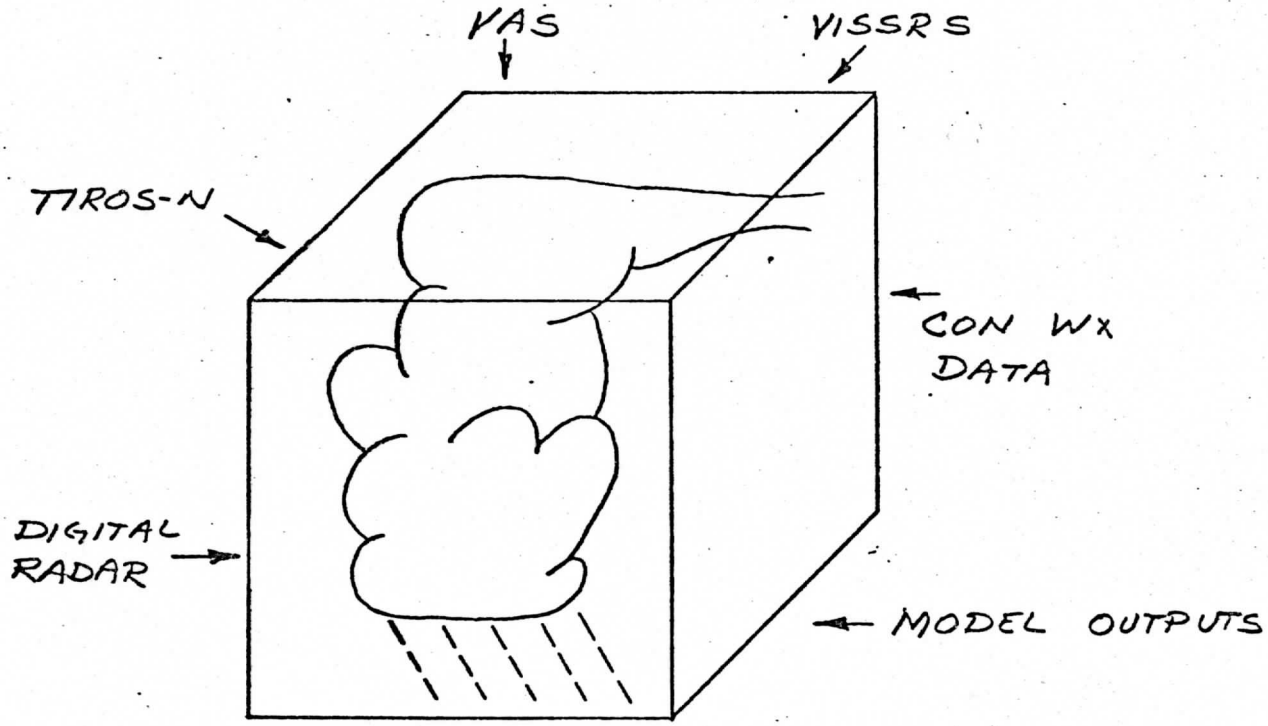
7) CLOUD TOP PRESSURE DETERMINATIONS USING 4 BAND MSI ENABLE SIMULTANEOUS WIND AND HEIGHT ASSIGNMENT.

VAS

VARIABLE ASSIMILATION SYSTEM

THE VAS PROGRAM REPRESENTS AN OPPORTUNITY FOR FULFILLING THE PRIMARY NEED FOR INVESTIGATION AND PREDICTION OF SHORT LIVED WEATHER PHENOMENA:

A COORDINATED HORIZONTAL, VERTICAL, AND TEMPORAL DESCRIPTION OF THE ATMOSPHERIC STATE



COMPLETE AND CONSISTENT 4-D DATA

UW SCIENTIFIC OBJECTIVES FOR VAS

ASSIMILATION OF FOUR DIMENSIONAL MESOSCALE DATA SETS

1. COLLECT RAW DATA BASES FROM ALL USEFUL SOURCES

2. ANALYZE SATELLITE OBSERVATIONS TO OBTAIN METEOROLOGICAL PARAMETERS

3. SYNTHESIZE METEOROLOGICAL PARAMETERS INTO DATA SETS

4. DEVELOP FORECAST TECHNIQUES

COLLECTION OF METEOROLOGICAL OBSERVABLES FROM MANY SOURCES IS NECESSARY.

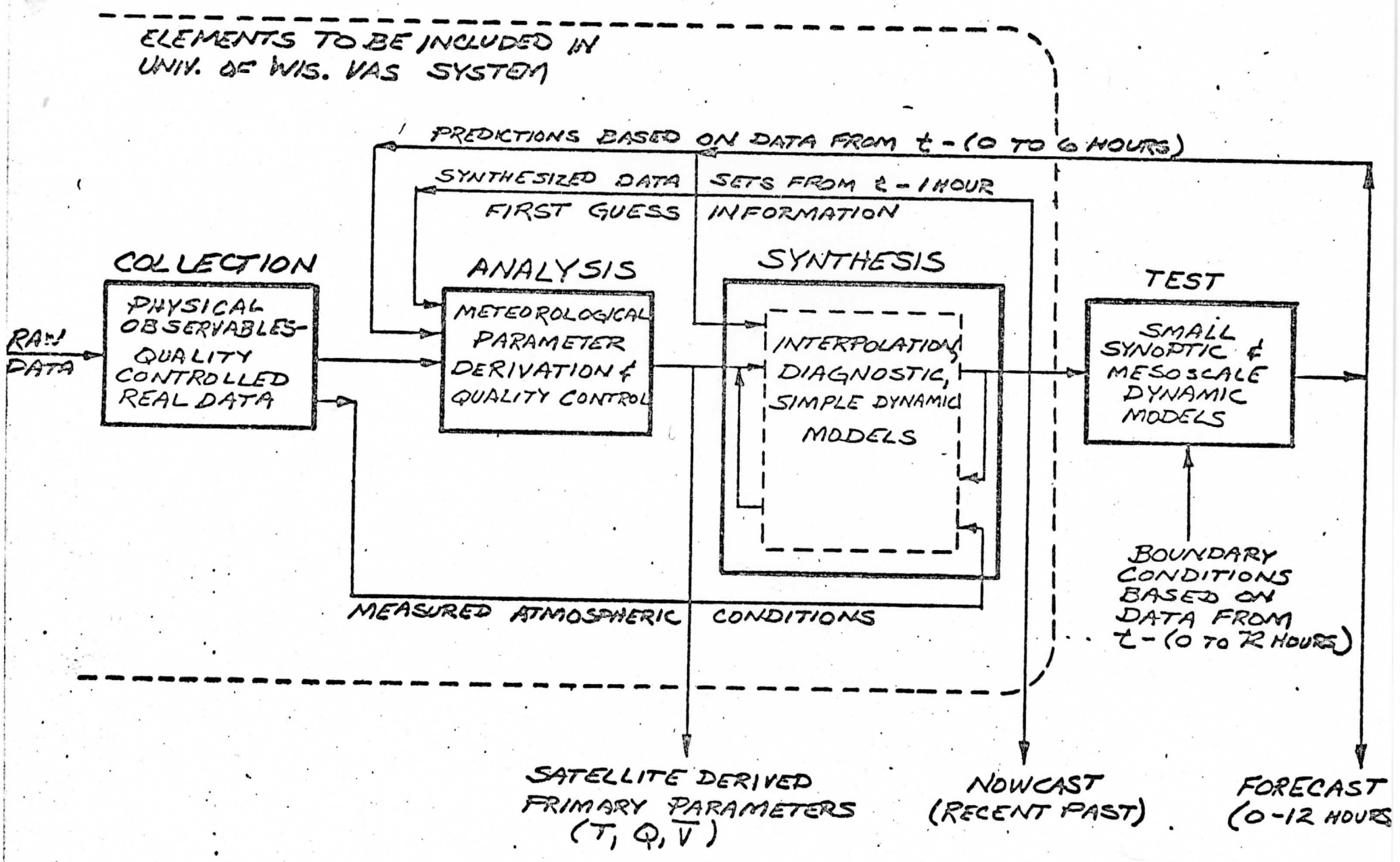
A DESCRIPTION OF MESOSCALE PHENOMENA REQUIRES SPATIAL RESOLUTIONS OF 20-50 KM AND TEMPORAL RESOLUTIONS OF 5-15 MIN DURING SEVERE ATMOSPHERIC CONDITIONS. ONLY WITH COORDINATION OF VAS AND ANCILLARY DATA WILL THIS BE POSSIBLE.

ANCILLARY DATA WILL PROVIDE

- OBSERVATIONS OF SYNOPTIC SCALE PHENOMENA
- DESCRIPTION OF THE BOUNDARY LAYER
- GROUND TRUTH INFORMATION
- SOUNDINGS WHERE THERE ARE CLOUDS

VAS WILL

- PROVIDE TIME DOMAIN SOUNDINGS
- FILL OBSERVATION TIME AND SPACE GAPS



THE VAS SYSTEM FUNCTIONAL ELEMENTS

GENERATION OF 4-D DATA SETS WILL REQUIRE

- INTERPOLATION

  TO ACCOMPLISH COMPLETE SPATIAL COVERAGE

- SMOOTHING

  TO ACHIEVE FIXED SPATIAL RESOLUTIONS

- INTERPOLATION AND EXTRAPOLATION

  TO MAKE MEASUREMENTS FROM IRREGULAR TIMES CONTEMPORANEOUS

- WEIGHTING

  FOR UNIQUE DETERMINATIONS AT EACH GRID POINT

- QUALITY CONTROL

  TO ACHIEVE COMPATIBLE DATA SETS

TYPES OF MODELS IN THE VAS PROCESSING SYSTEM

- KINEMATIC

  --USED FOR VERY SHORT TERM EXTRAPOLATION

  --BASED ON FLUID FLOW RATHER THAN PHYSICAL FORCES (E.G., CLOUD MOVEMENT, MOISTURE MOVEMENT, ETC.)

- DIAGNOSTIC OR PROCESS

  --USED FOR DERIVATION OF SECONDARY PARAMETERS (E.G., RAIN AREAS) FROM PRIMARY PARAMETERS (T,Q,U,V)

  --USED TO CHECK CONSISTENCY OF DERIVED AND OBSERVED SECONDARY PARAMETERS

  --USED TO FIND KEY INDICATORS OF SEVERE WEATHER

- DYNAMIC

  --PREDICT FUTURE VALUES OF PRIMARY PARAMETERS FROM INITIAL CONDITIONS

V A S

DATA PROCESSING SYSTEM

REQUIREMENTS OF DATA PROCESSING SYSTEM

1) TEST FACILITY FOR EVALUATION OF IN ORBIT VAS PERFORMANCE

2) RESEARCH FACILITY FOR MESOSCALE STUDIES

3) ARCHIVE OF ALL DATA DURING VAS DEMONSTRATION

4) CONCEPTUAL PROTOTYPE OF NOAA OPERATIONAL SYSTEM

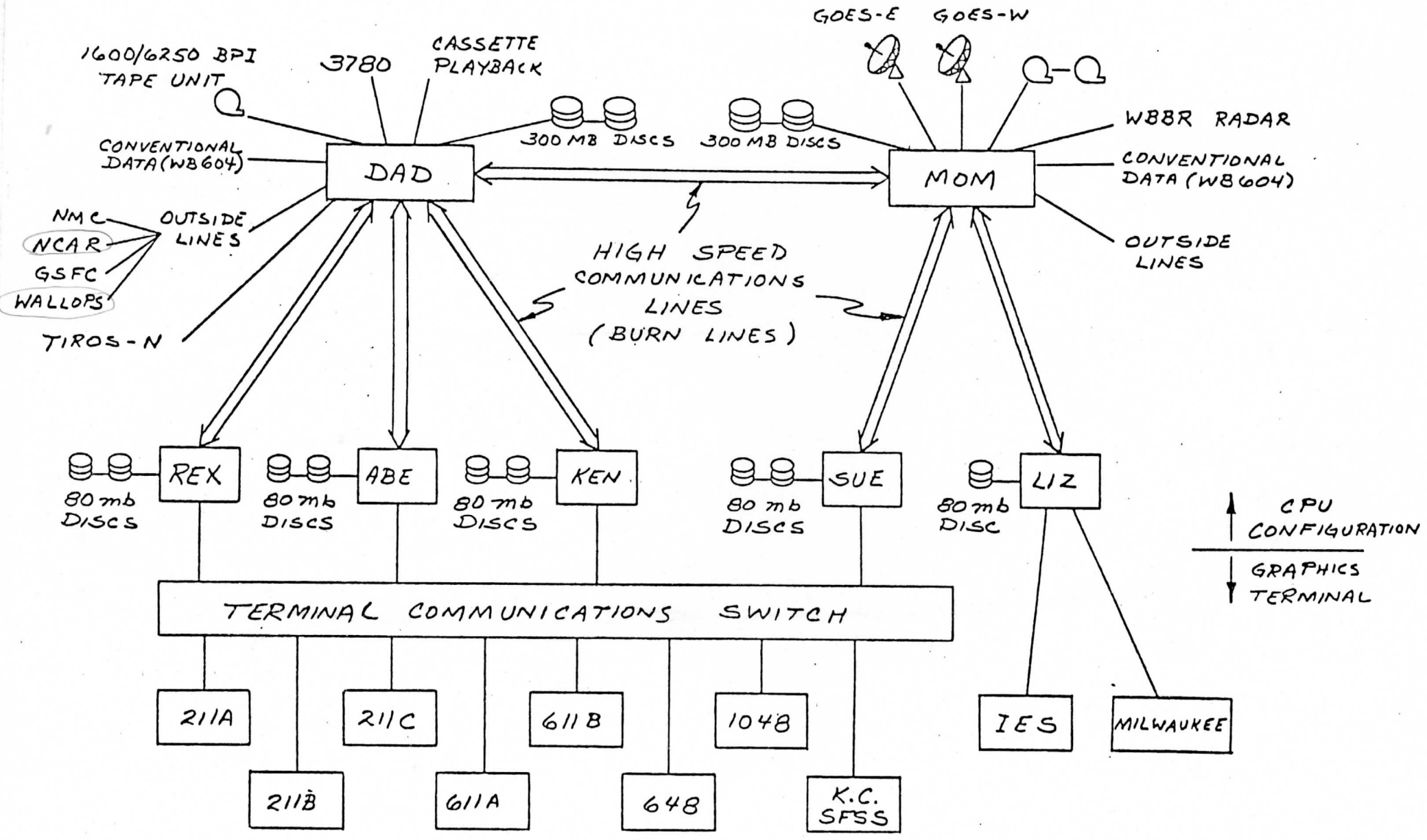
McIDAS SPECIALIZES IN THREE TYPES OF ACTIVITIES

(1) DATA ACQUISITION AND HANDLING,

(2) APPLICATIONS PROCESSING,

(3) USER COMMUNICATIONS.

SEPARATE MIDICOMPUTERS (OR MICROPROCESSORS) ARE DEDICATED TO EACH OF THE ABOVE ACTIVITIES.


1600/6250 BPI TAPE UNIT
3780
CASSETTE PLAYBACK
300 MB DISCS
300 MB DISCS
GOES-E
GOES-W
WBBR RADAR
CONVENTIONAL DATA (WB604)
DAD
MOM
CONVENTIONAL DATA (WB604)
NMC
NCAR
GSFC
WALLOPS
OUTSIDE LINES
TIROS-N
HIGH SPEED COMMUNICATIONS LINES (BURN LINES)
OUTSIDE LINES
REX
ABE
KEN
SUE
LIZ
80 mb DISCS
80 mb DISCS
80 mb DISCS
80 mb DISCS
80 mb DISC
CPU CONFIGURATION
GRAPHICS TERMINAL
TERMINAL COMMUNICATIONS SWITCH
211A
211B
211C
611A
611B
648
1048
K.C. SFSS
IES
MILWAUKEE

SSEC PROCESSING SYSTEM MUST WORK IN

1) OPERATIONAL MODE

(DAILY DATA GATHERING)

2) RESEARCH MODE

(SOFTWARE AND HARDWARE IMPROVEMENT)

THE SYSTEM HAS BEEN SEGMENTED INTO OPERATIONAL AP's AND RESEARCH AP.

SUPPORT OF OPERATIONAL BRANCH OF WEATHER SERVICE

1) KANSAS CITY USER TERMINALS (ATTACHED TO McIDAS) ALLOW:

   A) ACCESS TO VISSR IMAGES IN REAL TIME (THUNDERSTORM MONITORING POSSIBLE)

   B) ABILITY TO MONITOR MORE AREAS OF POTENTIAL SEVERE WEATHER

   C) ACCESS TO TIROS-N SOUNDINGS AND MICRO-WAVE DATA (SOMETIMES SEE WEATHER THAT CONVENTIONAL OBSERVATIONS MISS, IE GRAND ISLAND TORNADO IN SPRING 1980)

   D) ABILITY TO MERGE DATA FROM MANY SOURCES FOR MORE COMPLETE WEATHER ANALYSIS

2) NMC DATA LINE

   A) CAN DELIVER VAS SOUNDING IN PACIFIC WITHIN 3 HOURS OF SYNOPTIC 12Z

   B) ENABLES IMPACT STUDY OF VAS ON LFM ANALYSIS AND FORECAST