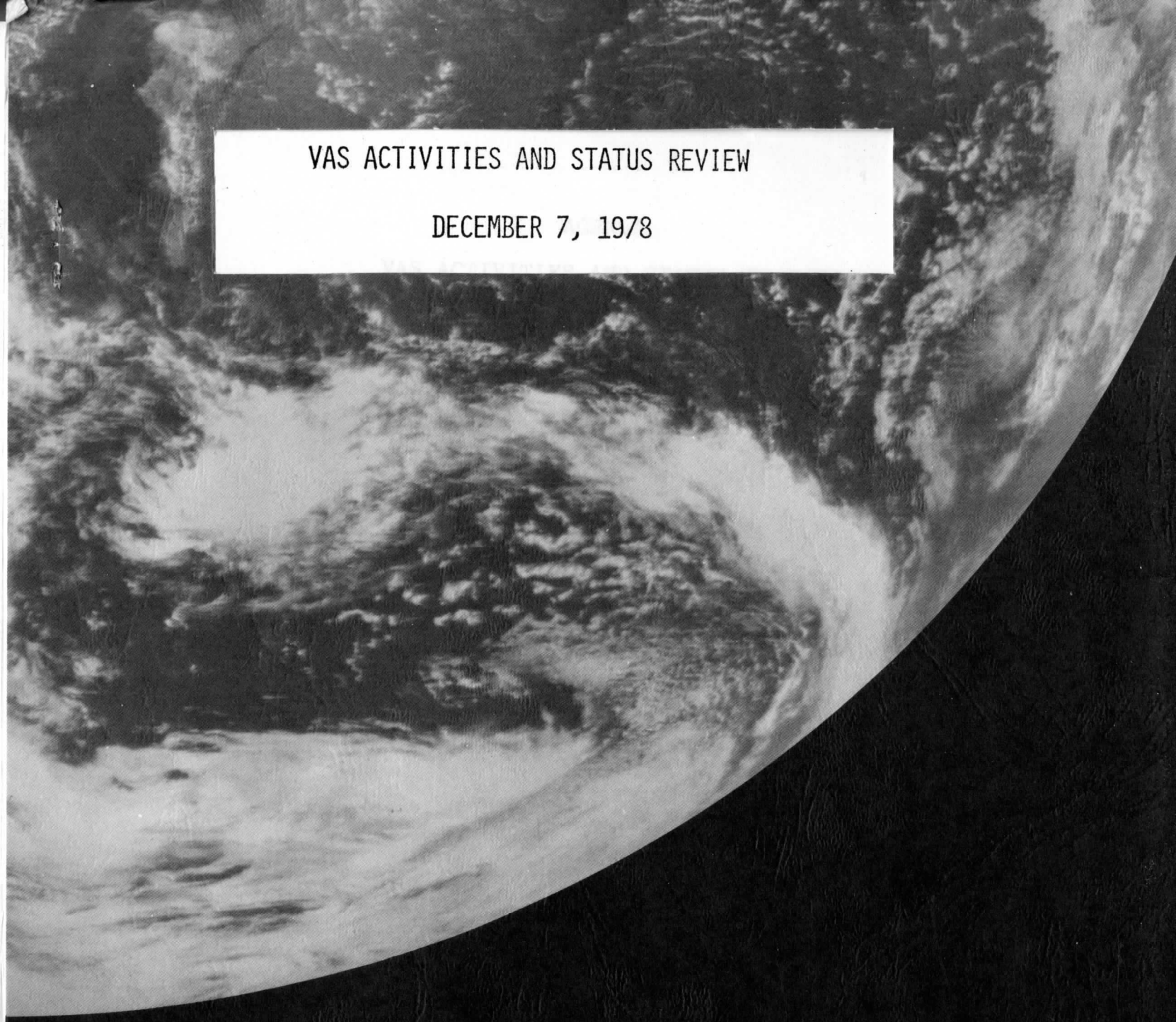


VAS ACTIVITIES AND STATUS REVIEW

DECEMBER 7, 1978

A REPORT

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

VAS ACTIVITIES AND STATUS REVIEW

DECEMBER 7, 1978

AGENDA

VAS ACTIVITIES AND STATUS REVIEW

Date: December 7 & 8, 1978

Place: University of Wisconsin
Room 415
1225 W. Dayton Street
Madison, Wisconsin

Date	Time	
12/7	1300 to 1500	Rationale and Approach for VAS Demonstration
		NASA--Tepper, Plotkin, Hasler, Montgomery
		NOAA/UW--Suomi, Smith, Small, Menzel
	1500 to 1630	Tiros-N Activity Report
		NOAA/UW Team
12/8	0900 to 1100	MCIDAS Demonstration and VAS Hardware Demonstration
	1100 to 1200	Splinter Groups

- OVERVIEW -

V. SUOMI

OVERVIEW

THE YEAR OF THE PLANETS

- PIONEER VENUS

  --IN TWO DAYS WE HAVE PROBE ENTRY

  --THE ORBITER IS ALREADY THERE

  IS THERE A HOLE IN THE POLE?

- JUPITER FLYBY VOYAGER

- GLOBAL WEATHER EXPERIMENT

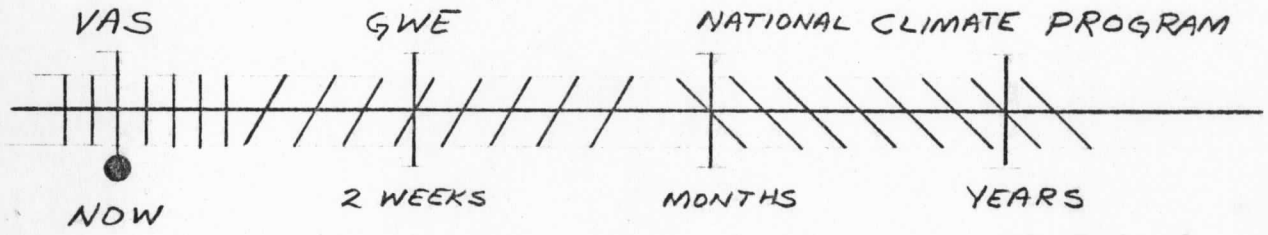
  --GLOBALLY INVESTIGATING THE TROPICS

  --THE TROPICS ARE MAINLY MESOSCALE

  VAS IS GETTING AN EARLY TEST!

- VAS

  --LOOKS AT DETAILS OF CONVECTION AT HOME


VAS
GWE
NATIONAL CLIMATE PROGRAM
NOW
2 WEEKS
MONTHS
YEARS

VAS IS

NOT JUST AN INSTRUMENT

VISSR ATMOSPHERIC SOUNDER

BUT ALSO A PROGRAM

METEOROLOGICAL VARIABLE ASSIMILATION SCHEME

FOR

- BETTER DETECTION AND TRACKING OF CONVECTIVE ACTIVITY
  (KINEMATICS)
- DEVELOPMENT OF BETTER STATISTICAL RELATIONSHIPS BETWEEN MESOSCALE DISTURBANCES AND SYNOPTIC SCALE PROCESSES
  (PROCESS)
- IMPROVEMENT IN DYNAMICAL PREDICTION OF MESOSCALE DISTURBANCES
  (DYNAMIC)

VAS IS A TEST OF

- TECHNOLOGY
- SCIENCE
- INSTITUTIONAL ARRANGEMENTS

WE HAVE

- A NASA EXPERIMENT
- ON A NOAA SPACECRAFT
- WITH UW-NESS-GSFC SCIENTIFIC PARTICIPATION

THE GOAL OF INSTITUTIONAL ARRANGEMENTS

- ELIMINATE REDUNDANCY
- ELIMINATE GAPS
- SHARE TOUGH PROBLEMS

WHO IS DOING WHAT?

GSFC

- NAVIGATION
- TRANSMISSION FUNCTION CALCULATION
- MESOSCALE CASE STUDIES

UW/NESS

- CALIBRATION
- DEVELOPMENT OF CONCEPTS FOR AN OPERATIONAL PARAMETER RETRIEVAL SYSTEM
- QUANTITATIVE DATA ANALYSIS AND SUB-SYNOPTIC MODELING

NOAA

- EVALUATION OF VAS
- IMPLEMENTATION OF OPERATIONAL VAS SYSTEM
- APPLICATION OTHER THAN MESOSCALE

PRESENT CALENDAR OF TASKS

PHASE A (PRESENT → 1981)

- INSTRUMENT ASSESSMENT
- GROUND SYSTEM DESIGN AND IMPLEMENTATION
- SOUNDING RETRIEVAL VERIFICATION
- MESOSCALE DATA SET ASSIMILATION

PHASE B (1981 → ?)

- MESOSCALE FORECAST IMPACT EVALUATION
- NASA APPLICATIONS STUDY
- NOAA EVALUATION

PHASE C (?)

- NOAA OPERATIONS

- VAS SCIENTIFIC APPROACH -

P. MENZEL

THE VAS GOAL

TO BETTER UNDERSTAND AND FORECAST SHORT-LIVED WEATHER PHENOMENA

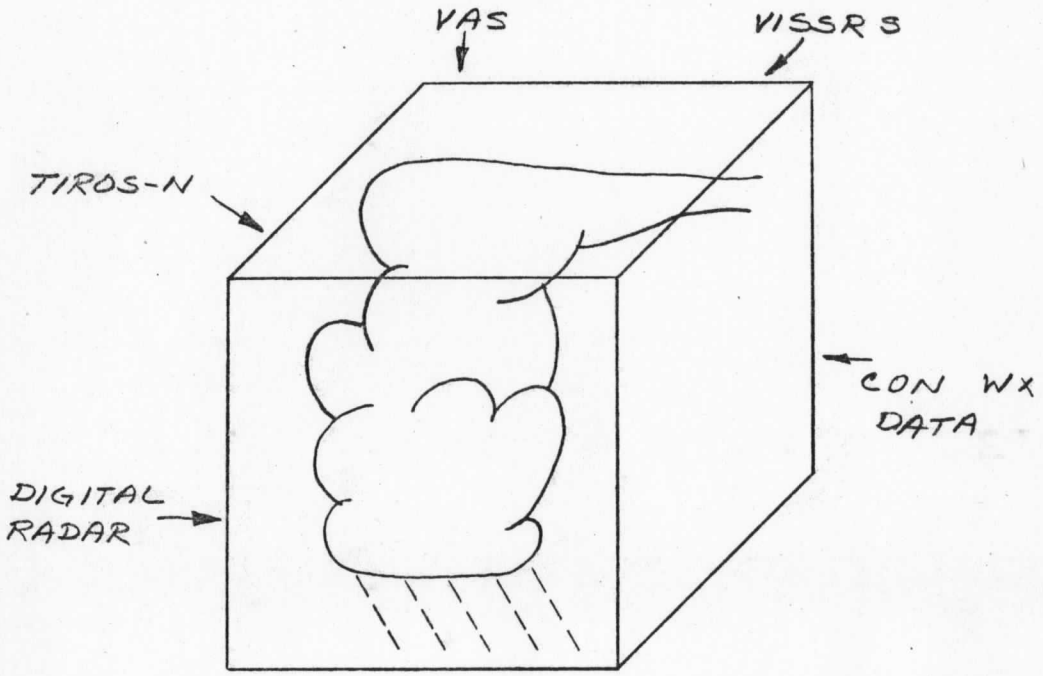
DIFFICULTIES IN FORECASTING SHORT-LIVED WEATHER PHENOMENA

- DATA SET INADEQUACY
- MODEL SIMPLIFICATION OF ATMOSPHERIC PROCESSES

VAS IS PRIMARILY ADDRESSING THE FIRST, BUT MUST BE VERY FAMILIAR WITH THE SECOND.

THE PRIMARY NEED FOR INVESTIGATION AND PREDICTION OF SHORT LIVED WEATHER PHENOMENA

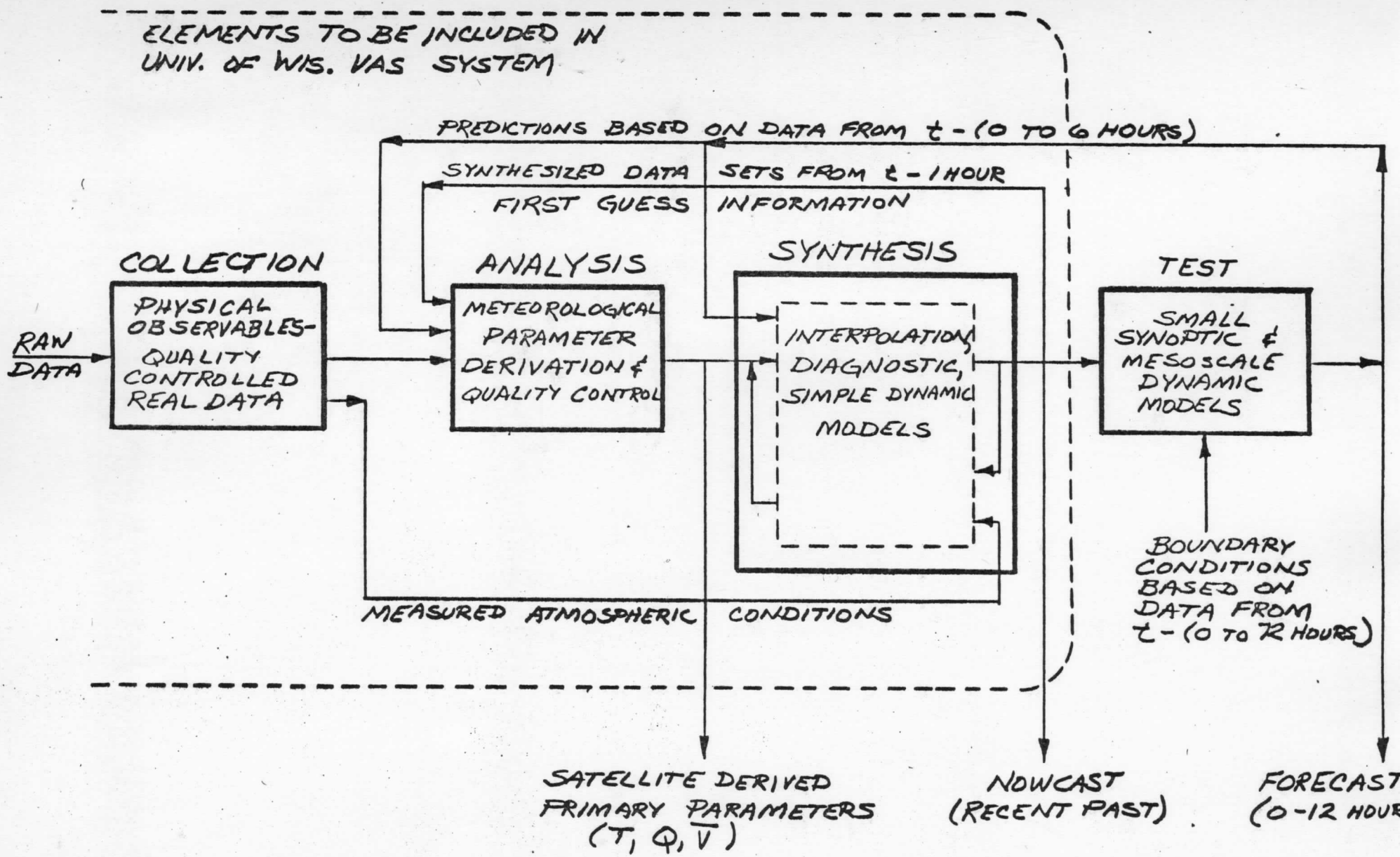
A COORDINATED HORIZONTAL, VERTICAL, AND TEMPORAL DESCRIPTION OF THE ATMOSPHERIC STATE



COMPLETE AND CONSISTENT 4-D DATA

VAS SYSTEM WILL HAVE THE FOLLOWING FOUR FUNCTIONAL ELEMENTS:

- COLLECTION
- ANALYSIS
- SYNTHESIS
- TEST



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

DATA SETS MUST CONTAIN

PRIMARY PARAMETERS

- Z(P)
- T(P)
- Q(P)
- U(P)
- V(P)

SECONDARY PARAMETERS

- BOUNDARY CONDITIONS

  --SYNOPTIC WEATHER
  --GROUND COVER
  --SEA STATE

- REFERENCE DATA (DETERMINABLE FROM PRIMARY PARAMETERS)

  --LIQUID WATER
  --VERTICAL MOTION
  --CLOUD CHARACTERISTICS
  --PRECIPITATION

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)

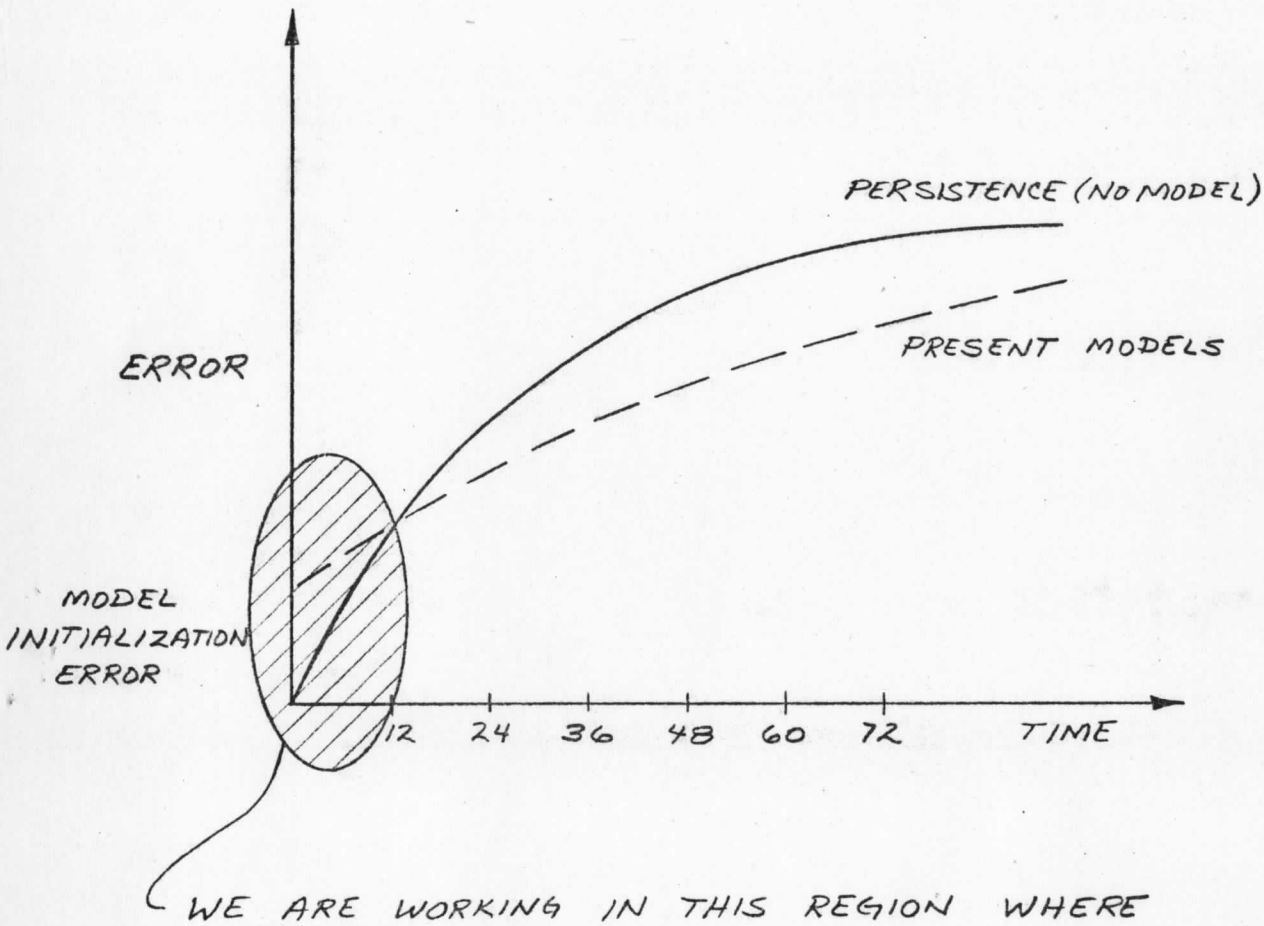
  --USED TO CHECK CONSISTENCY OF DERIVED AND OBSERVED SECONDARY PARAMETERS

  --USED TO FIND KEY INDICATORS OF SEVERE WEATHER

- DYNAMIC

  --PREDICT FUTURE VALUES OF PRIMARY PARAMETERS FROM INITIAL CONDITIONS

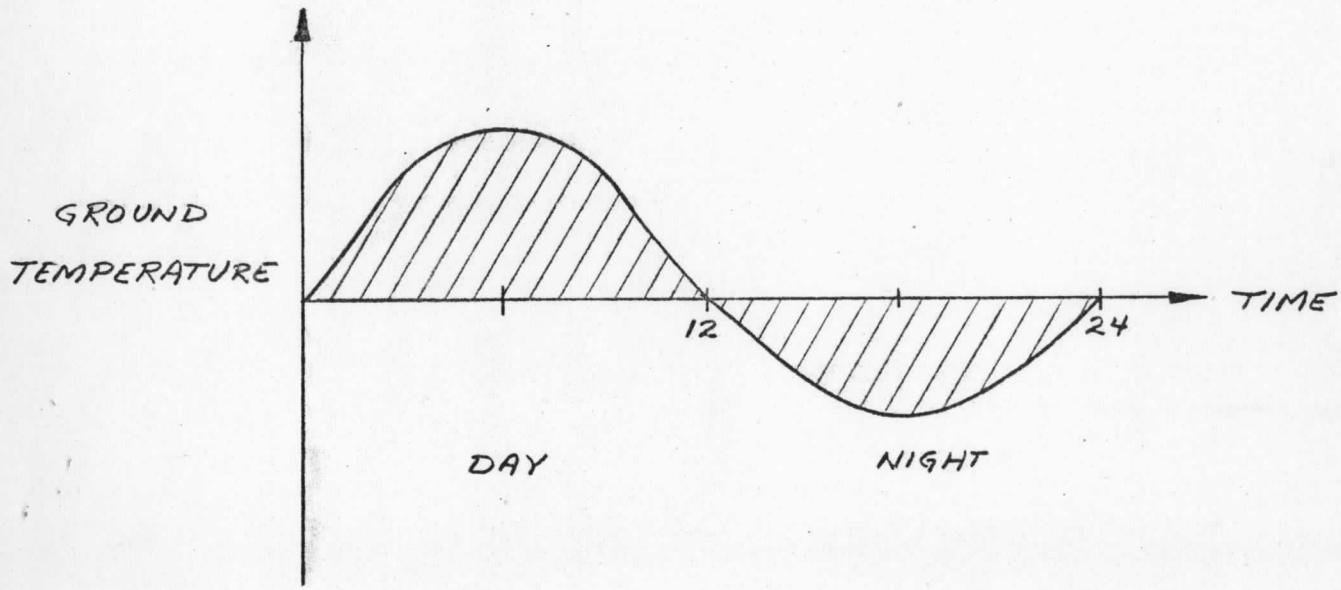
NUMERICAL FORECASTING SKILL



WE ARE WORKING IN THIS REGION WHERE

- ATMOSPHERIC STATE IS UNBALANCED
- NUMERICAL FORECAST SKILL HASN'T SHOWN UP YET

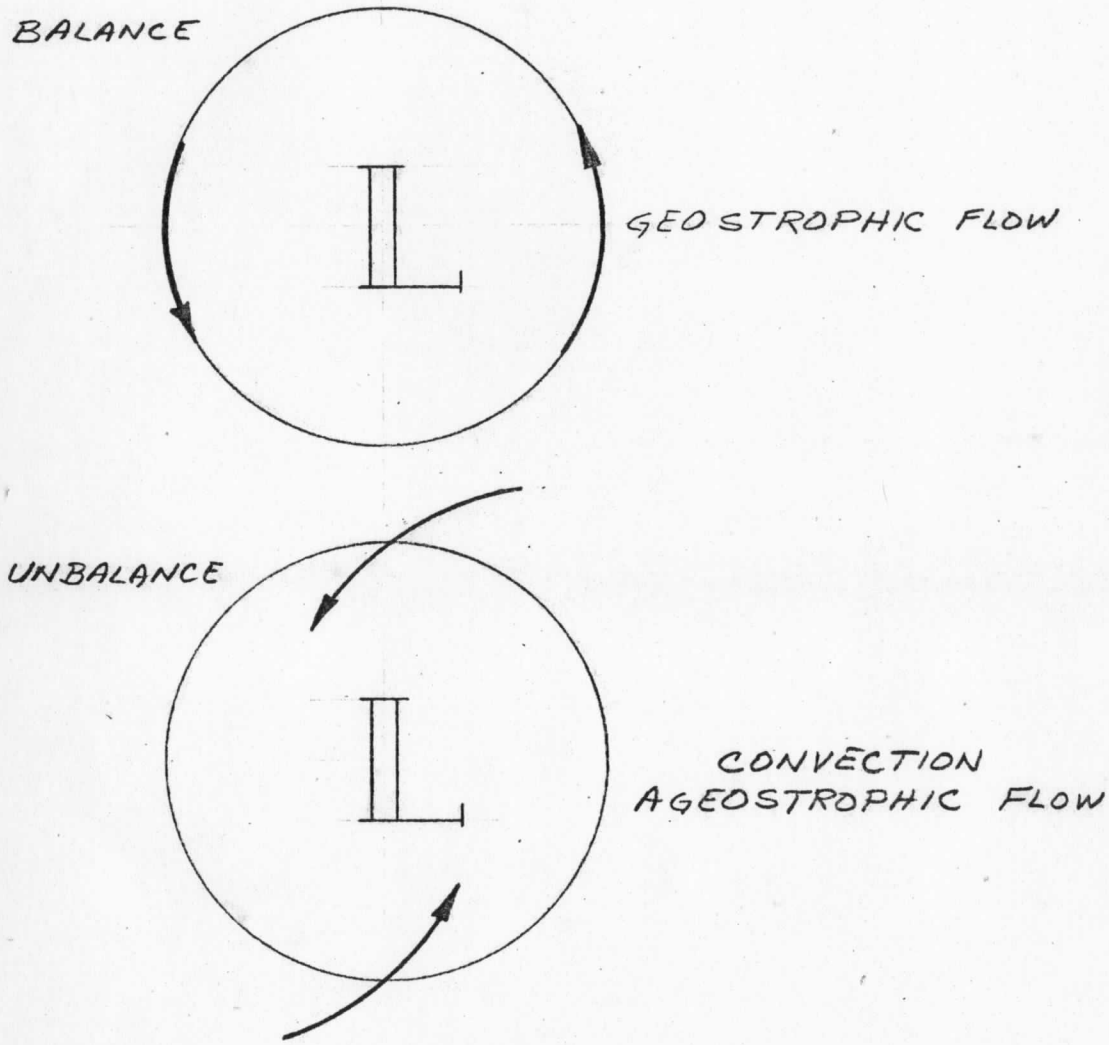
BALANCE vs UNBALANCE



GROUND HEAT BUDGET

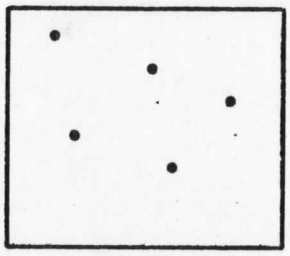
- IS APPROXIMATELY THE SAME AFTER 24 HRS (BALANCED)
- SHOWS NET GAINS OR LOSES FOR SMALLER TIME INTRAVALS (UNBALANCED)

CIRCULATION AROUND LOW PRESSURE SYSTEM

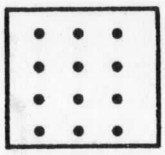


UW/NESS APPROACH TO SHORT-LIVED WEATHER MODELING

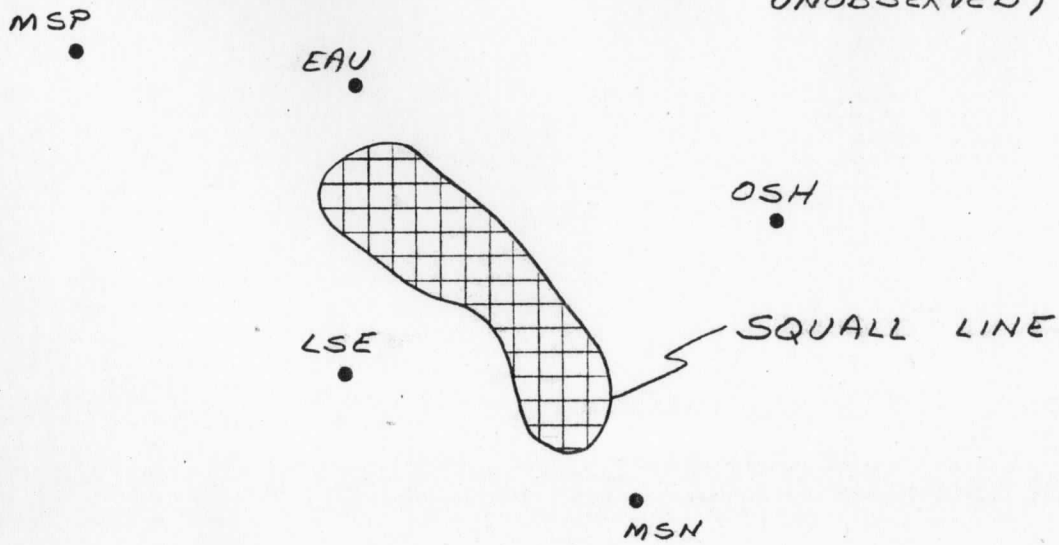
START FROM LARGER SCALE



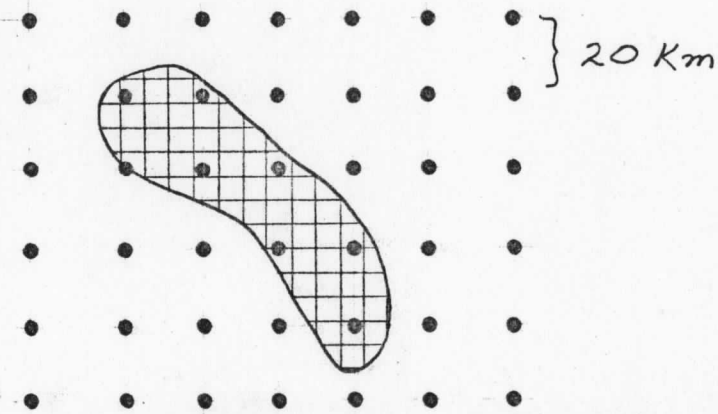
INSERT MORE PHYSICS TO WORK DOWN



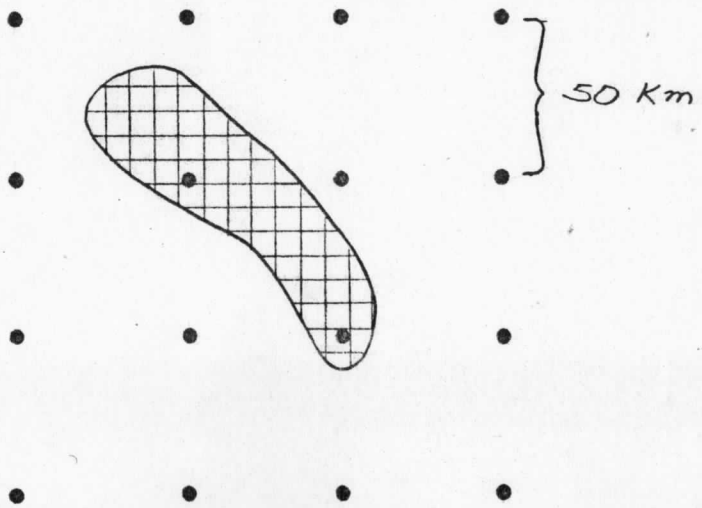
SYNOPTIC SCALE (SHORT LIVED WEATHER OFTEN GOES UNOBSERVED)



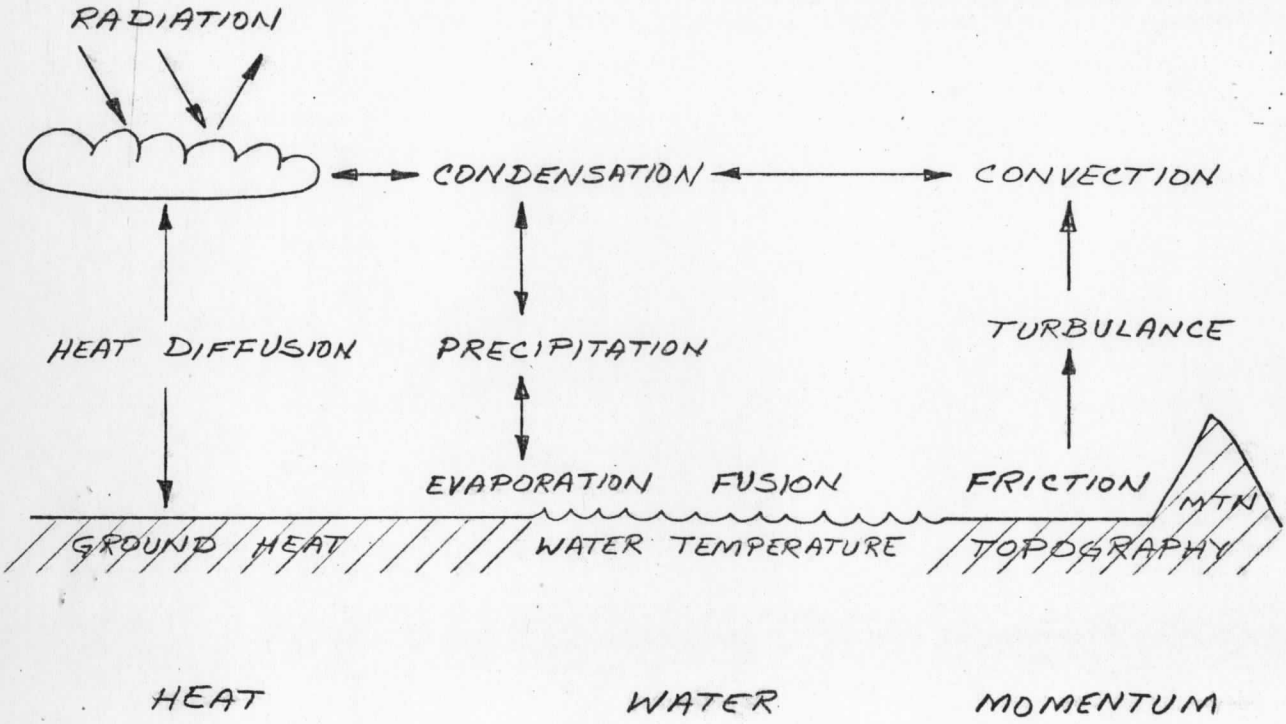
MESOSCALE (DON'T HAVE COMPUTER POWER TO HANDLE THIS)



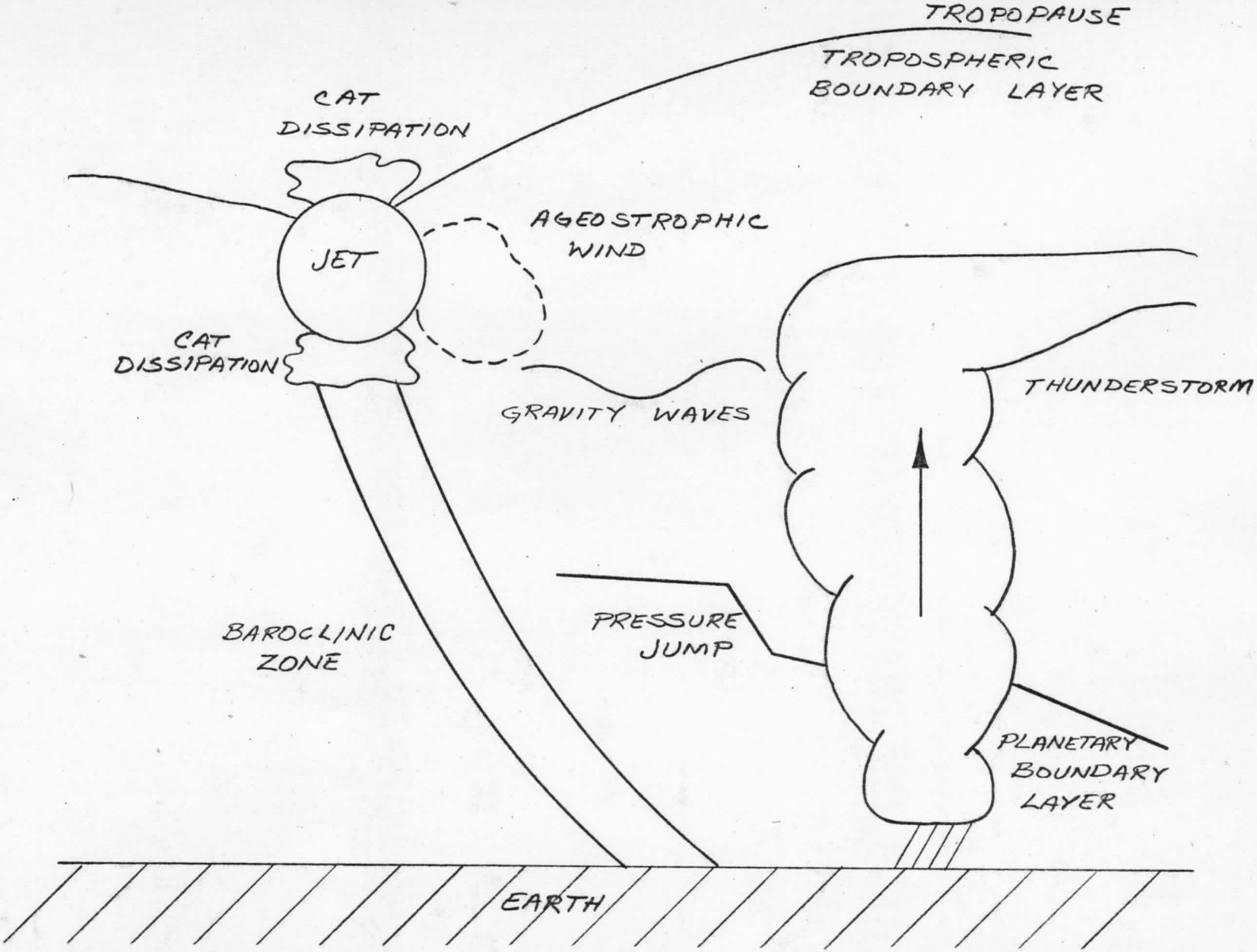
SUB-SYNOPTIC SCALE (HOW COARSE CAN IT BE AND STILL DESCRIBE SQUALL LINE?)



PHYSICAL PROCESSES AFFECTING
MODEL FORECASTING SKILL



DIFFERENT DOMAINS REQUIRE DIFFERENT PROCESS TREATMENT



ON McIDAS WE ALREADY HAVE DIAGNOSTIC ROUTINES THAT EVALUATE THINGS LIKE:

- POTENTIAL TEMPERATURE
- MIXING RATIO
- DIVERGENCE
- VORTICITY
- SHEAR
- T ADVECTION
- DEW POINT DIVERGENCE

THESE PARAMETERS HELP RESOLVE THE PHYSICAL PROCESSES OF SHORT-LIVED WEATHER.

- DYNAMIC MODELING ACTIVITIES AT UW -

G. KELLY

DYNAMIC MODELS THAT WILL BE PART OF UW SYSTEM

- NMC PE MODEL
  - --RESULTS WILL BE ACCESSED VIA PHONE LINK TO SUITLAND
  - --USED TO PREDICT NORTHERN HEMISPHERE LARGE SYNOPTIC SCALE WEATHER
  - --WILL HELP PROVIDE BOUNDARY CONDITIONS FOR THE NORTH AMERICAN REGION

- NMC LFM PE MODEL
  - --RESULTS WILL BE ACCESSED VIA PHONE LINK TO SUITLAND
  - --USED FOR NORTH AMERICAN SYNOPTIC FORECASTS
  - --HAS APPROXIMATELY 190 KM HORIZONTAL GRID SPACING
  - --WILL HELP PROVIDE MESOSCALE BOUNDARY CONDITIONS

- ANMRC PE MODEL
  - --UW PROGRAMS TO BE RUN ON CRAY-1
  - --USED FOR REGIONAL FORECASTS ON SUBSYNOPTIC SCALE
  - --HAS APPROXIMATELY 60 KM HORIZONTAL GRID SPACING AND 100 MB VERTICAL RESOLUTION

AUSTRALIAN NUMERICAL METEOROLOGY RESEARCH CENTRE MODEL

- IS A HYDROSTATIC PRIMITIVE EQUATIONS MODEL

- USES VARIATION BLENDING TECHNIQUES

  (FOR COMBINING CONVENTIONAL, SATELLITE, AND MODEL OUTPUTS)

- USES EFFICIENT SEMI-IMPLICIT FORMULATION

  (BY PARAMETERIZING SOUND WAVES)

- TAKES INTO ACCOUNT

  --ADVECTION
  --HORIZONTAL PRESSURE GRADIENT FORCE } INCLUDED IN ALL PE MODELS
  --CORIOLIS FORCE
  --DIFFUSION OF MOMENTUM
  --DIFFUSION OF HEAT
  --DIFFUSION OF WATER VAPOR
  --SURFACE HEATING (BASED ON SOIL ENERGY BUDGET APPROACH)
  --PRECIPITATION (PARAMETERIZED LARGE SCALE AND PARAMETERIZED CONVECTIVE)

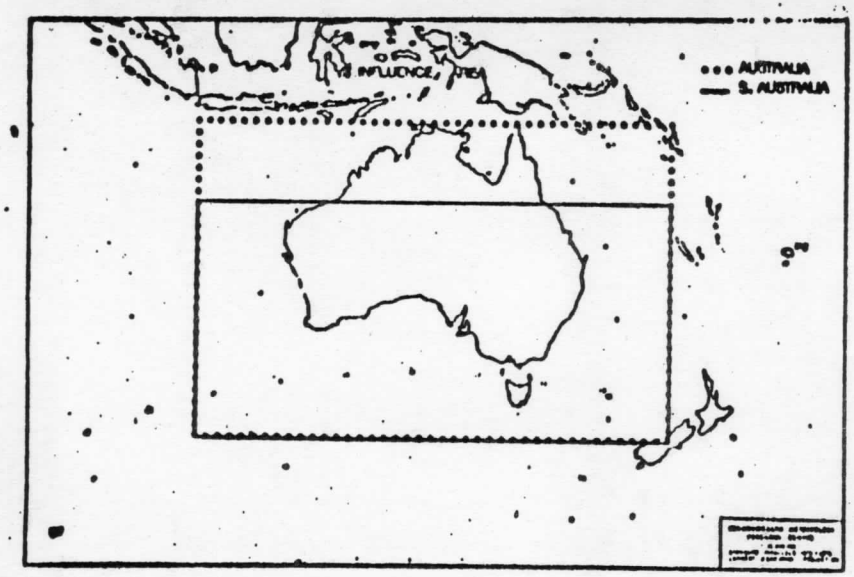
- GENERATES PREDICTIONS OF FOUR PRIMARY VARIABLES

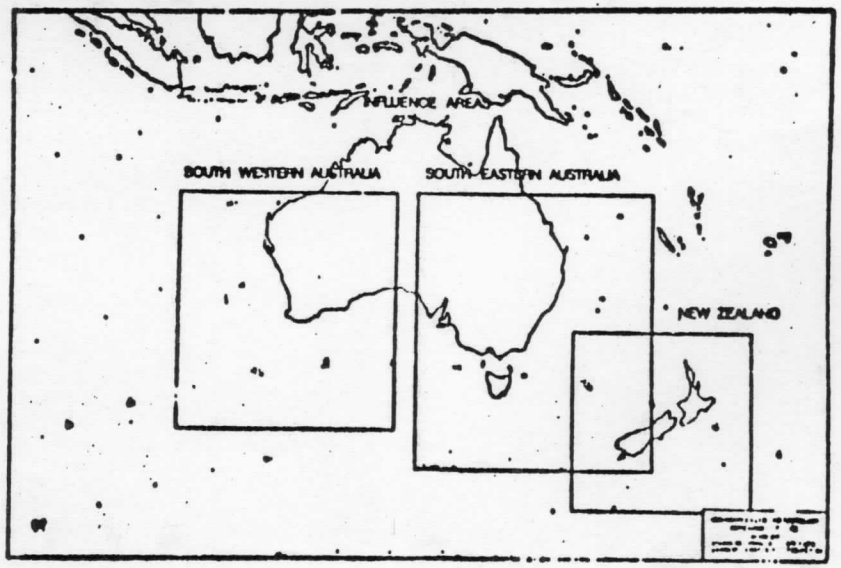
  --U(P)
  --V(P)
  --T(P)
  --Q(P)

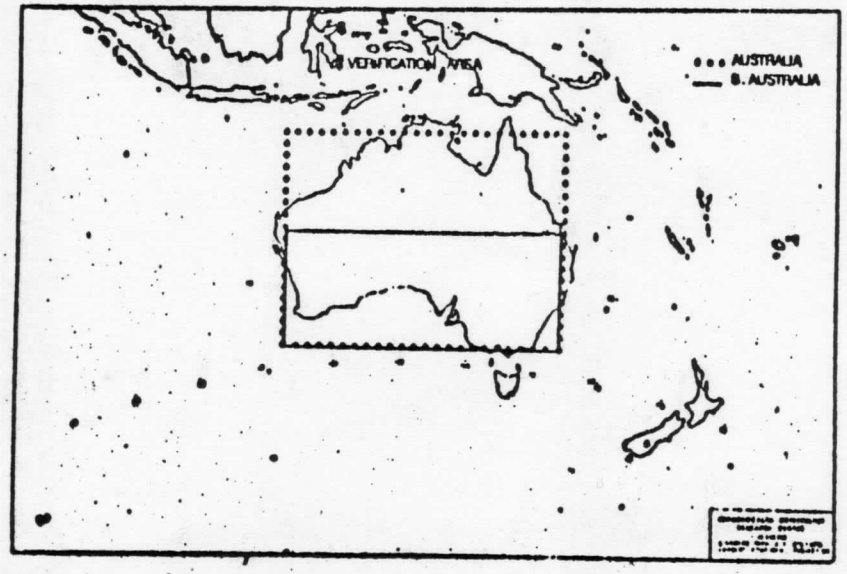
- DERIVES TWO SECONDARY PARAMETERS

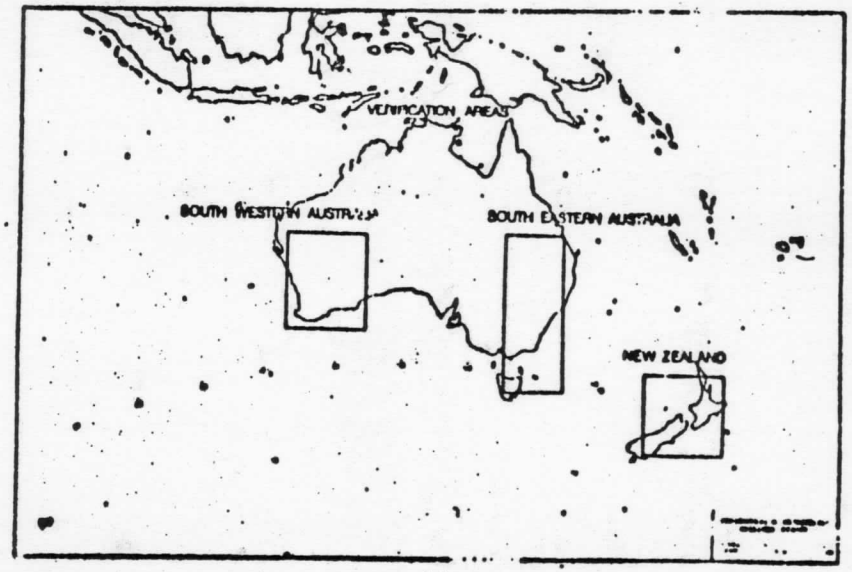
  --VERTICAL VELOCITY
  --GEOPOTENTIAL

CONTROL AREAS FOR ANMRC IMPACT STUDY

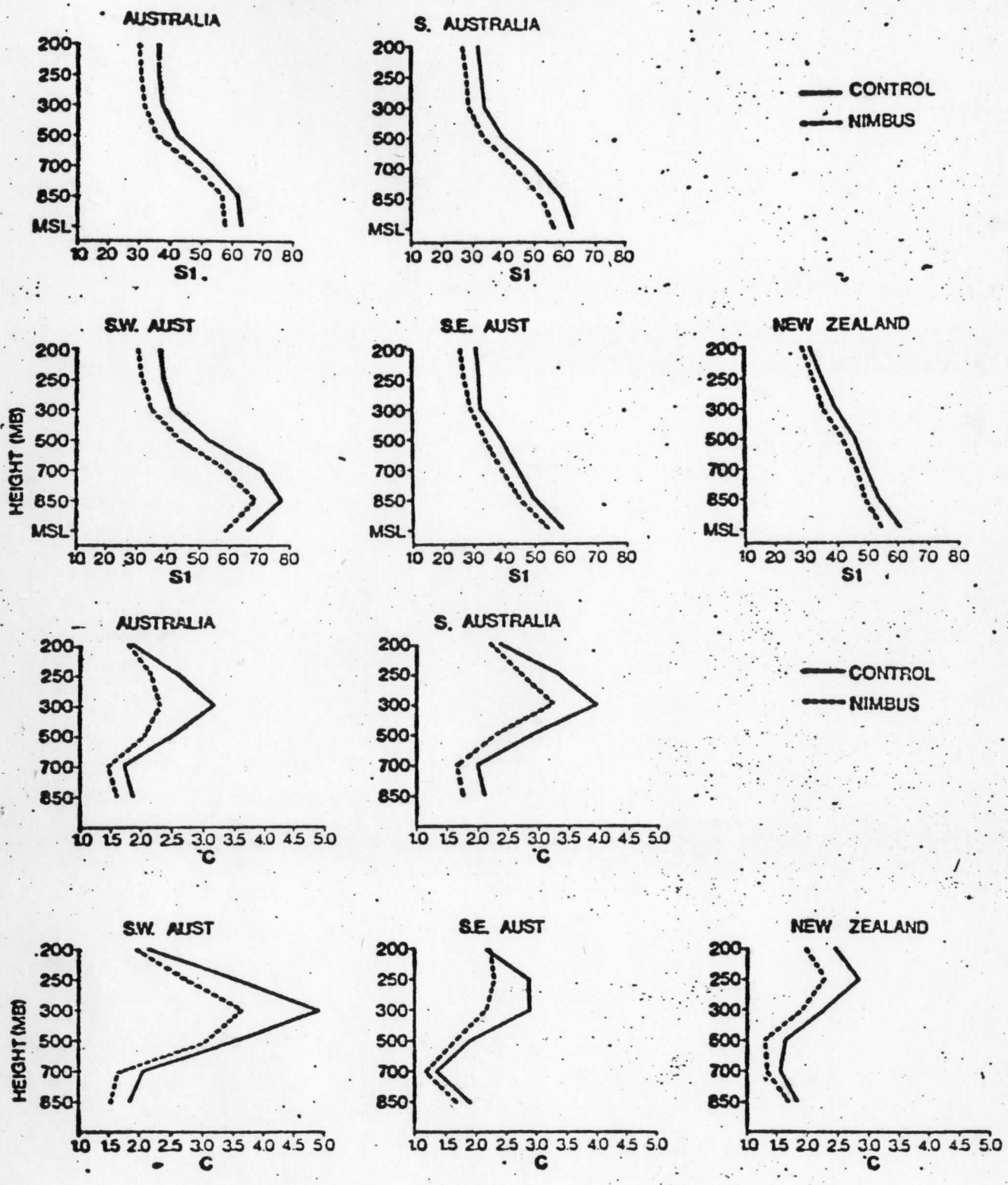








RESULTS OF ANMRC IMPACT STUDY



(Top) Mean S_1 skill scores for 28 pairs of forecasts for each area

(Bottom) Mean rms T errors for same

MAJOR PROBLEMS WITH OPERATIONAL NUMERICAL MODELS

- INITIALIZING PROCEDURES
- GRID RESOLUTION
- PHYSICAL PARAMETERIZATION
  (E.G., BOUNDARY LAYER TREATMENT)

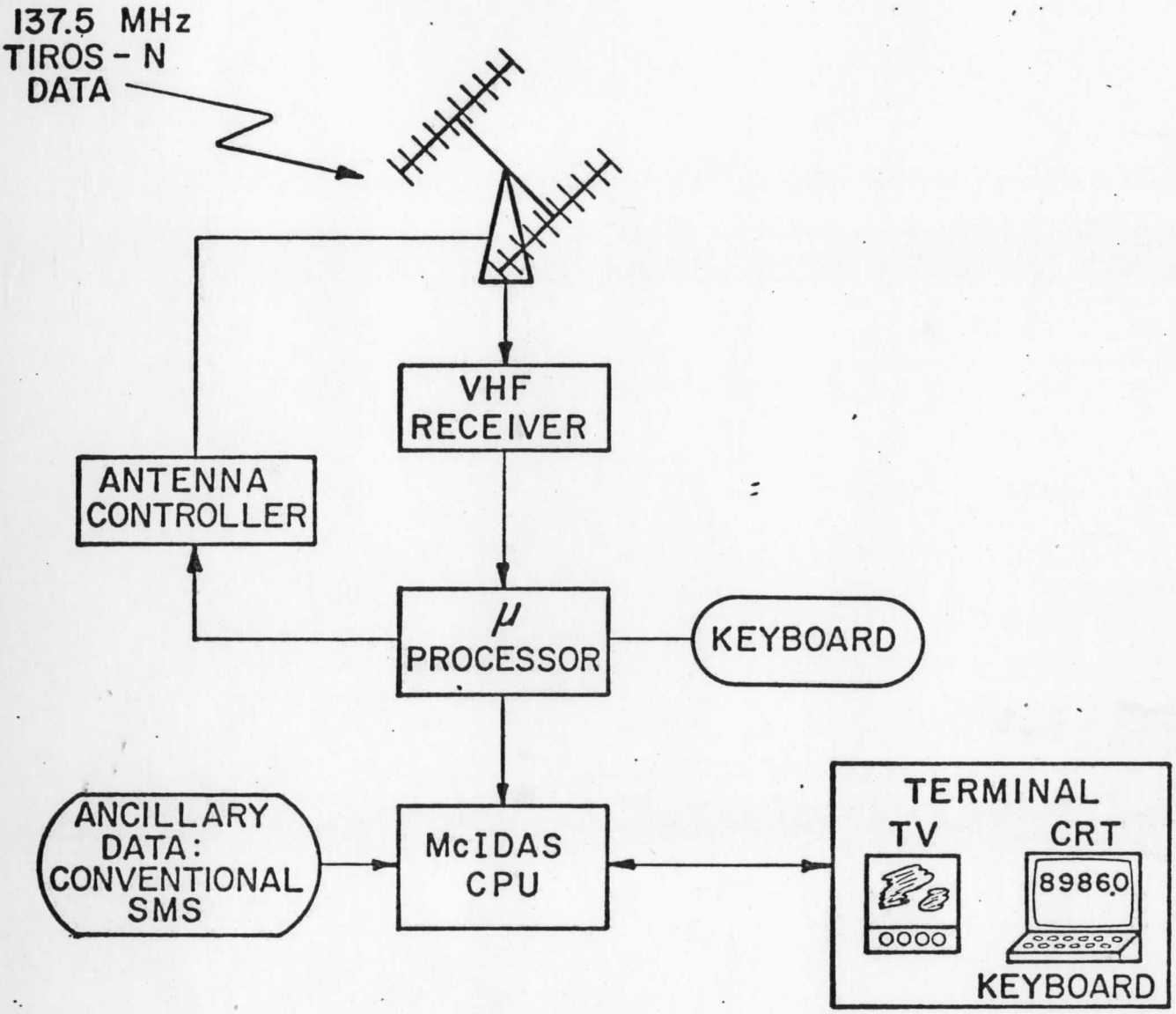
WITH CAREFUL ATTENTION TO ALL THREE PROBLEMS WE HOPE TO ACHIEVE IMPROVED MESOSCALE WEATHER PREDICTION.

- TIROS-N ACTIVITIES REPORT -

W. SMITH

UW TIROS-N PROCESSING STATUS

- SUCCESSFUL LAUNCH
- RECEPTION OF SIGNAL AT UW
- MSU AND HIRS DATA BEING PROCESSED
- REAL TIME DATA PROCESSING ACCOMPLISHED

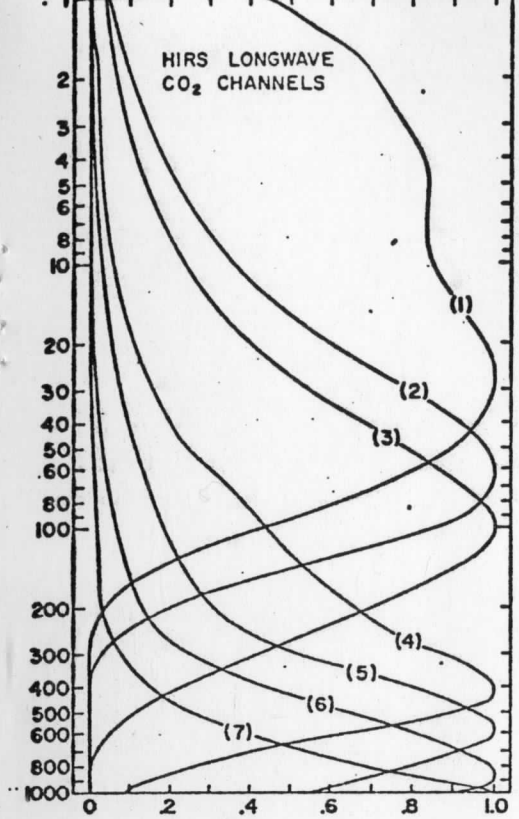


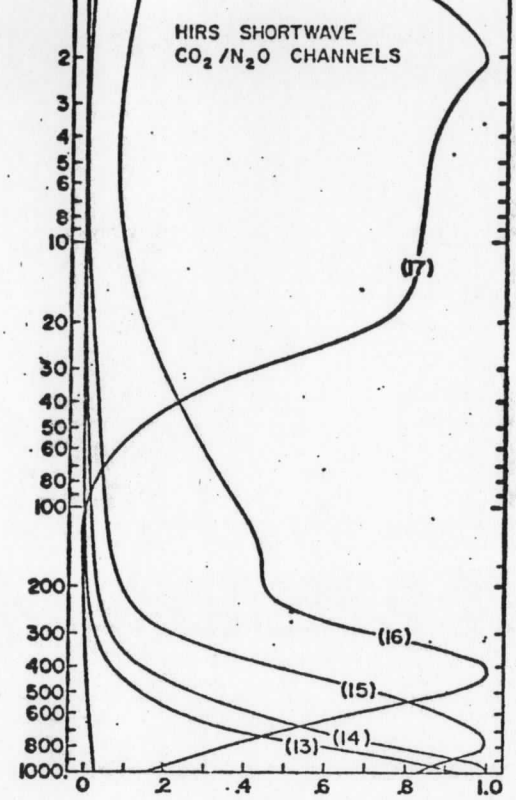
TIROS-N REAL TIME DATA ACCESS AND PROCESSING SYSTEM

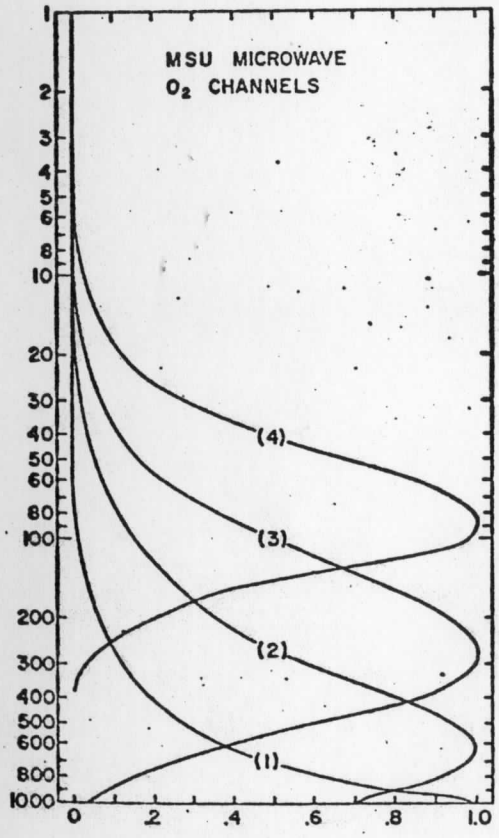
Channel Number	Channel Central Wavenumber	Central Wavelength (μm)	Principal Absorbing Constituents	Level of Peak Energy Contribution	Purpose of the Radiance Observation
1	668	15.0	CO_2	30 mb	Temperature Sounding. The 15 μm band channels provide better sensitivity to the temperature of relatively cold regions of the atmosphere than can be achieved with the 4.3 μm band channels. Radiances in Channels 5, 6, and 7 are also used to calculate the heights and amounts of cloud within the HIRS field of view.
2	679	14.7	CO_2	60 mb	
3	691	14.5	CO_2	100 mb	
4	704	14.2	CO_2	250 mb	
5	716	14.0	CO_2	500 mb	
6	732	13.7	CO_2/H_2O	750 mb	
7	748	13.4	CO_2/H_2O	900 mb	
8	898	11.1	Window	Surface	Surface Temperature and cloud detection.
9	1028	9.7	O_3	25 mb	Total Ozone concentration.
10	1217	8.3	H_2O	900 mb	Water Vapor Sounding. Provide water vapor corrections for CO_2 and window channels. The 6.7 μm channel is also used to detect thin cirrus cloud.
11	1364	7.3	H_2O	600 mb	
12	1484	6.7	H_2O	400 mb	
13	2190	4.57	N_2O	950 mb	Temperature Sounding. The 4.3 μm band channels provide better sensitivity to the temperature of relatively warm regions of the atmosphere than can be achieved with the 15 μm band channels. Also, the short-wavelength radiances are less sensitive to clouds than those for the 15 μm region.
14	2213	4.52	N_2O	850 mb	
15	2240	4.46	CO_2/N_2O	700 mb	
16	2276	4.40	CO_2/N_2O	600 mb	
17	2361	4.24	CO_2	5 mb	
18	2512	4.0	Window	Surface	Surface Temperature. Much less sensitive to clouds and H_2O than 11 μm window. Used with 11 μm channel to detect cloud contamination and derive surface temperature under partly cloudy sky conditions. Simultaneous 3.7 μm and 4.0 μm data enable reflected solar contribution to be eliminated from observations.
19	2671	3.7	Window	Surface	
20	14,367	0.70	Window	Cloud	Cloud Detection. Used during the day with 4.0 μm and 11 μm window channels to define clear fields of view.

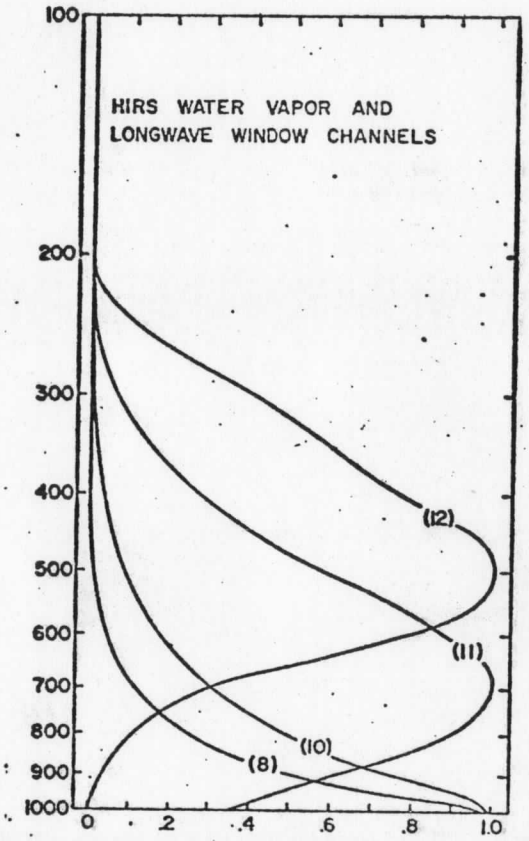
MSU	Frequency (GHz)	Principal Absorbing Constituents	Level of Peak Energy Contribution	Purpose of the Radiance Observation
1	50.31	Window	Surface	Surface Emissivity and Cloud Attenuation determination.
2	53.73	O_2	850 mb	Temperature Sounding. The microwave channels probe through clouds and can be used to alleviate the influence of clouds on the 4.3 μm and 15 μm sounding channels.
3	54.96	O_2	500 mb	
4	57.95	O_2	100 mb	

Description of TIROS-N HIRS and MSU Channels

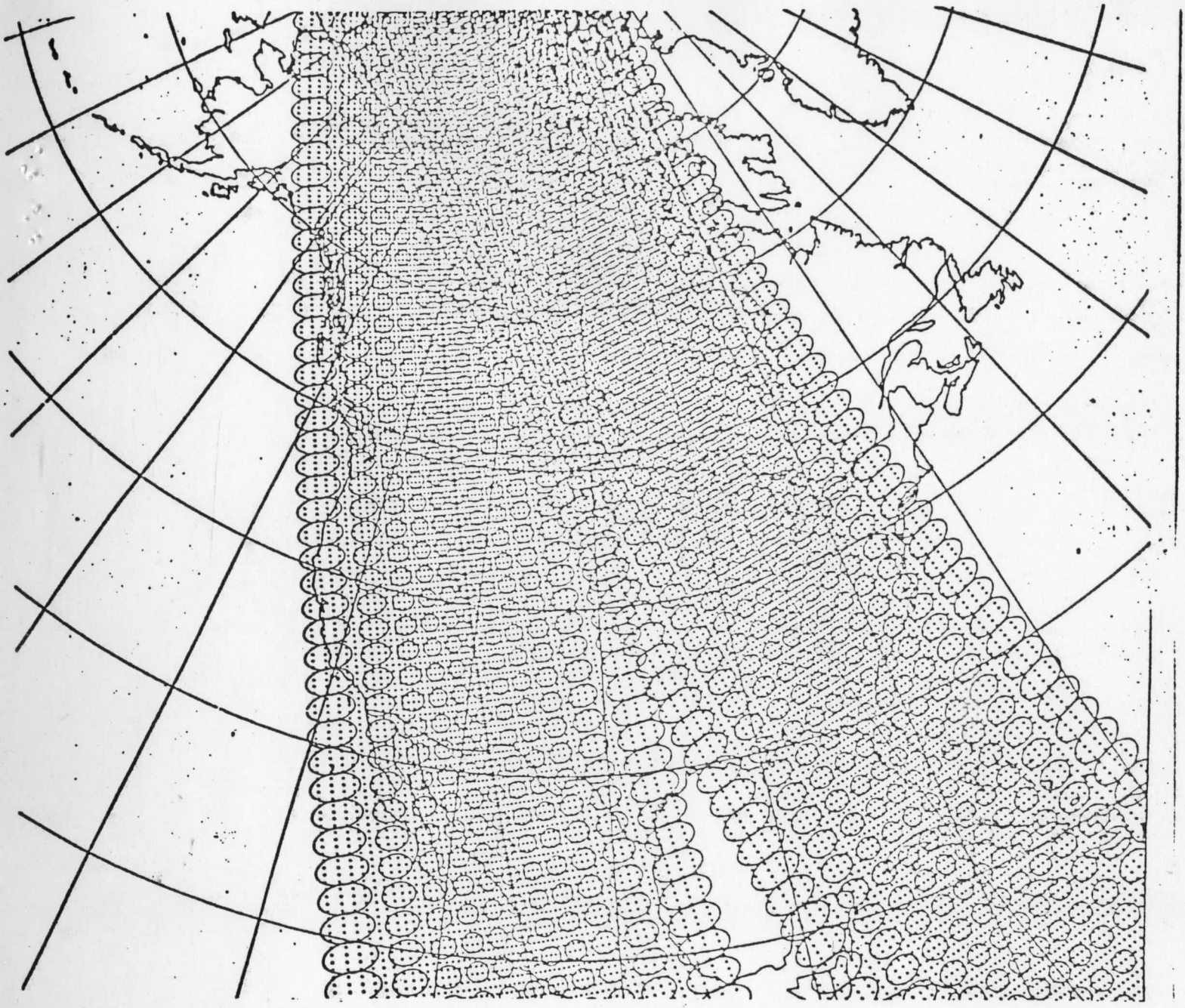




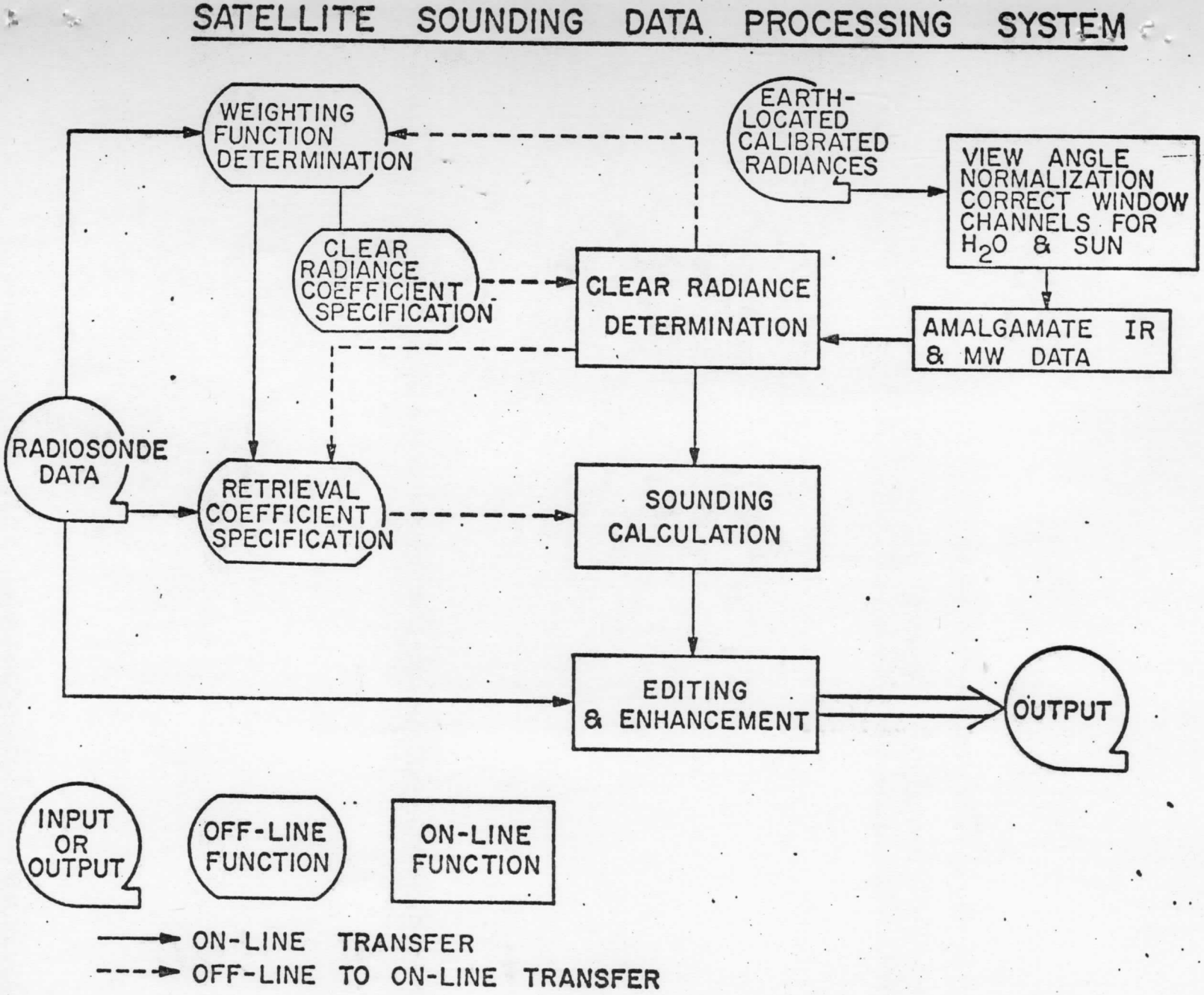




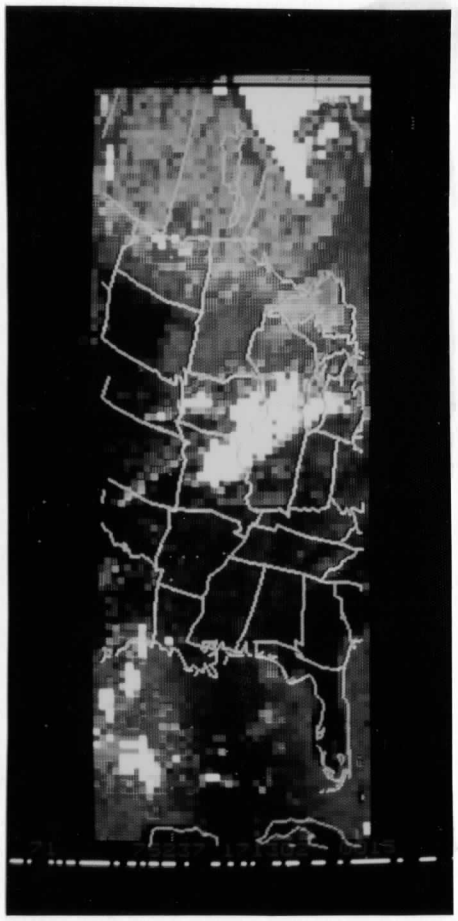
TIROS-N HIRS and MSU temperature and water vapor profile weighting functions (normalized).



Earth scan patterns of TIROS-N HIRS (dots) and MSU (elipses) for two orbits over the United States.



Flow diagram of a satellite sounding data processing system.



HIRS VIEW OF U.S.

- NOAA VAS EVALUATION -

D. SMALL

NOAA VAS EVALUATION

- PLAN APPROVED FOR FY80 → FY82
- FUNDED FOR $1,000,000
- ERL, NWS, NESS PARTICIPATION
- IN COOPERATION WITH GSFC AND UW
- EVALUATES MANY POSSIBLE APPLICATIONS OF VAS
- DECIDES IF THERE SHOULD BE AN OPERATIONAL VAS