



PACIFIC REGION TECHNICAL NOTES

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STORM DEVELOPMENT ASSOCIATED
WITH UPPER LOWS.

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DURING THE FIRST WEEK OF JUNE, SUMMER ARRIVED OVER BC WITH THE FIRST HOT DRY SPELL OF THE SEASON. A CLOSED LOW PERSISTED OVER THE EASTERN PACIFIC WITH AN OMEGA TYPE BLOCKING SITUATION OVER THE NORTH AMERICAN COAST. THE 500 MB ANALYSIS DURING THE AFTERNOON (00Z, JUNE 5TH) OF JUNE 4TH (SEE FIGURE 1) SHOWED A SPLIT IN THE FLOW BEGINNING ABOUT 170W WITH ONE STREAM NORTH INTO ALASKA AND ANOTHER STREAM SOUTHEASTWARD SOUTH OF THE CLOSED VORTEX AND THEN INTO THE OMEGA BLOCK. A SERIES OF SMALL SCALE SYSTEMS (WIND MAXS, VORTICITY CENTERS OR HOWEVER ONE LIKES TO REFER TO THEM) MOVED IN THE SOUTHERN STREAM, UNDERWENT MAXIMUM DEVELOPMENT ON THE SOUTHEAST SIDE OF THE LOW. EACH SURGE OF COLD AIR BEHIND THESE SYSTEMS SUCCEEDED IN "MOVING" THE CLOSED UPPER CIRCULATION EASTWARD SLOWLY. THIS BROUGHT THE BC COAST IN A SOUTHERLY FLOW BY THE AFTERNOON OF JUNE 6TH (SEE FIGURE 4A). WEAK WAVES WERE ALLOWED TO MOVE AS FAR NORTH AS THE BC COAST BEFORE THE ASSOCIATED CLOUD SYSTEM WERE TOTALLY DISSIPATED. SIGNIFICANTLY, THIS RESULTED IN ONLY A SMALL DETERIORATION IN THE WEATHER OVER THE PROVINCE BY THE MORNING OF WEDNESDAY 7TH.

DURING THE MORNING OF WEDNESDAY 7TH (BASED ON 12Z DATA), THE 48HR COMPUTER PROGNOSSES RECEIVED AT THE PACIFIC WEATHER CENTER INDICATED A MARKED CHANGE IN THE GENERAL CIRCULATION OFF THE BC COAST AND OVER THE PROVINCE ITSELF. THE CLOSED LOW WAS FORECAST TO QUICKLY OPEN UP AND BE "KICKED" DOWNSTREAM IN 48 HOURS. THE FORECAST VORTICITY PATTERN INDICATED SOME KIND OF DEVELOPMENT OVER SOUTHERN B.C. WITHIN THIS TIME FRAME. THIS PROGNOSIS WAS QUESTIONED BY THE FORECASTERS ON DUTY AT THAT TIME BECAUSE

- (A) MOTION AND CHANGE OF THE CLOSED LOW WAS VERY SLOW THE PREVIOUS WEEK AS OPPOSED TO THE RADICAL CHANGE WHICH WAS BEING FORECAST.
- (B) THE CMC SPECTRAL COMPUTER MODEL ALWAYS SEEMS TO TAKE THESE CLOSED LOWS AND MOVE THEM INLAND. IT SEEMS THAT THE MODEL "STRESSES" THE ADVECTIVE TERMS.

HOWEVER, WITHIN 24 HOURS IT BECAME INCREASINGLY OBVIOUS THAT THE COMPUTER HAD MADE A VERY GOOD FORECAST.

THE ABOVE OUTLINES A MAJOR FORECAST PROBLEM OVER B.C. DURING THE SUMMER MONTHS. MANY OF THESE VORTICES (COLD LOWS) "ANCHOR" THEMSELVES NEAR THE BC COAST RESULTING IN BAD SUMMER WEATHER. THE COMPUTER PROGNoses (ESPECIALLY THE CMC) WANT TO MOVE THESE CLOSED LOWS EASTWARD QUICKLY WHEREAS THEY TEND TO LINGER SUBBORNLY. THEN UNDER CERTAIN CONDITIONS THEY WILL OPEN UP AND MOVE OFF QUICKLY. AT THE SAME TIME A RAPID CHANGE IN THE WEATHER OCCURS OVER THE PROVINCE. THIS PHENOMENON WILL BE THE TOPIC OF DISCUSSION OF THIS NOTE.

GARDNER (AFTER GEORGE(1960)) CLASSIFIES STORMS INTO TYPE A AND TYPE B. IN TYPE A STORM, THE CLOSED CIRCULATION FIRST APPEARS AT THE SURFACE AND THE CIRCULATION BUILDS UPWARDS UNTIL EVENTUALLY IT EXTENDS WELL INTO THE TROPOSPHERE. THE TYPE B STORM, HOWEVER, BUILDS DOWNWARDS; THE CLOSED CIRCULATION APPEARS FIRST IN THE UPPER TROPOSPHERE AND ONLY LATER DOES IT BECOME MANIFEST AT THE SURFACE. THE TYPE A SYSTEM PROCEEDS FROM A WAVE FORMATION TO AN OCCLUDED STRUCTURE WITH OVERALL FRONTALYSIS; THE TYPE B SYSTEM NEVER EXHIBITS AN OPEN WAVE STRUCTURE BUT ALWAYS HAS THE APPEARANCE OF AN OCCLUDED SYSTEM, THE FRONTAL STRUCTURE DEVELOPS DURING THE CYCLOGENESIS AND IS THUS MORE INTENSE AT THE BEGINNING. THESE TWO TYPES OF STORMS SHOULD BE REGARDED AS EXTREMES ON A SPECTRUM. ACTUAL STORMS FALL FALL SOMEWHERE BETWEEN THESE EXTREMES.

THE TYPICAL UPPER AIR CONFIGURATION PRIOR TO THE ONSET OF A TYPE B STORM MIGHT BE DEPICTED AS FOLLOWS. AN OLD "CUT-OFF" LOW, WHICH MAY HAVE FORMED DURING A PRECEDING CYCLOGENESIS IS FIRST PRESENT. UPSTREAM FROM IT, A SIGNIFICANT SHORTWAVE TROUGH (WIND MAX) IN THE SAME AIRSTREAM IS APPROACHING. (SEE FIGURE 2) AS THE WAVELENGTH DECREASES BELOW A CRITICAL VALUE (ABOUT 1200 N MI), THE FLOW BECOMES DYNAMICALLY UNSTABLE. THE CLOSED LOW THEN IS "KICKED OUT" (OR "OPENED UP") AND THEN A CYCLOGENESIS MAY OCCUR.

THE DEVELOPMENT OF "TYPE B" STORMS ARE QUITE INTERESTING FROM A SATELLITE POINT OF VIEW. PRIOR TO THE ONSET OF DEVELOPMENT, THE CLOUD PATTERN TYPICAL OF AN OLD OCCLUDED CYCLONE WILL BE EVIDENT. THE CLOUD WILL SHOW EVIDENCE OF CYCLONIC BANDING. THERE IS NOT NORMALLY A SUBSTANTIAL AREA OF OVERCAST CONDITIONS, AND IF THERE IS A PREFERRED MAXIMUM IT IS NORMALLY TO BE FOUND ON THE REAR SIDE OF THE SYSTEM AND TO INVOLVE LOW CLOUDS PRIMARILY. AS FILM LOOPS HAVE SHOWN, ONCE DEVELOPMENT STARTS, THERE IS DRAMATIC AND RELATIVELY SUDDEN CHANGE IN THE CLOUD PATTERN. RAPID DEVELOPMENT OF HIGH AND MIDDLE LEVEL CLOUDINESS OCCURS EAST OF THE OLD UPPER LOW CENTER WHILE LOW CLOUDINESS ORIGINALLY WEST OF THE CENTER TENDS TO DISSIPATE. (NOTE--MUCH OF THE PREVIOUS THREE PARAGRAPHS IS TAKEN VERBATIM FROM GARDNER(1978) WITH NO ATTEMPT TO PARAPHRASE.)

WELDON(1975) EVOLVED A CLASSIFICATION SYSTEM BASED ON CLOUD EVOLUTION. THE TYPE OF UPPER AIR (FIGURE 2) CONFIGURATION AND CLOUD SYSTEM DEVELOPMENT DESCRIBED ABOVE WOULD FIT HIS "SPLIT FLOW CYCLOGENESIS" CLASSIFICATION. THE STAGES OF DEVELOPMENT OF THIS TYPE OF CYCLOGENESIS ARE REPRODUCED IN FIGURE 3.

I WILL ATTEMPT TO DEMONSTRATE IN THE REMAINDER OF THIS NOTE

- (A) THE EVENTS OF JUNE 7 TO JUNE 9 FOLLOWED THE TYPE B STORM DEVELOPMENT MODEL AS OUTLINED BY GARDNER.
- (B) THE CLOUD SYSTEM CYCLOGENESIS MODEL OF WELDON'S WOULD SEEM TO BE COMPATIBLE AND A RESULT OF THE TYPE B STORM DEVELOPMENT MODEL AS OUTLINED BY GARDNER. IN PARTICULAR, THE "OPENING UP" AND MOTION OF RESULTANT TROUGH AND CLOUD SYSTEM CYCLOGENESIS OCCURS SIMULTANEOUSLY. THE TRIGGERING MECHANISM SEEMS TO BE THE APPROACH OF A STRONG WIND MAXIMUM IN THE SAME AIRSTREAM RESULTING IN THE BAROCLINIC INSTABILITY OF THE JET.
- (C) WITH THESE MODELS IN MIND, A PROGNOSTICIAN AT PWC COULD OF RECOGNIZED ABOUT 48 HOURS IN ADVANCE THAT A CHANGE IN THE UPPER AIR PATTERN WAS IMMINENT AND WOULD RESULT IN STORM DEVELOPMENT OVER THE PROVINCE.

FIGURES 4 IS THE 500 MB ANALYSES AT 12 HOUR INTERVALS FROM 00Z JUNE 7, 1978 TO 12Z JUNE 9. THE CORRESPONDING SATELLITE PICTURES ARE SHOWN IN FIGURES 5. THESE SATELLITE PICTURES ARE USED TO INFER THE HORIZONTAL EXTENT AND SHAPE OF THE CLOUD SYSTEMS AS SKETCHED ON FIGURES 4.

THE TRIGGERING WIND MAXIMUM (DENOTED BY AN ARROW) COMES WITHIN 1200 NM OF THE CLOSED CIRCULATION BY 00Z JUNE 8 (FRAME C). AFTERWARDS, THE LOW WEAKENS RAPIDLY AND CLOUD DEVELOPMENT OCCURS IN THE SOUTHEAST SIDE. THE LOW "OPENS UP" INTO A TROUGH AND MOVES QUICKLY OVER SOUTHERN BC. MEANWHILE CLOUD CYCLOGENESIS OCCURS RESULTING IN AN EXTENSIVE AREA OF PRECIPITATION AND AN END TO THE WARM DRY SPELL OVER THE PROVINCE.

IT IS RECOMMENDED, THAT DURING SITUATIONS OF UPPER AIR CONFIGURATIONS AS SHOWN IN FIGURE 2, AND, THE COMPUTER PROGNOSIS IS FOR "OPENING UP" AND "MOVING OFF" OF THE TROUGH AS IN THE ABOVE EXAMPLE, THAT THE DUTY PROGNOSTICIAN LOOK UPSTREAM TO SEE IF A SIGNIFICANT WIND MAXIMUM IS APPROACHING THE CRITICAL WAVELENGTH IN THE SAME AIRSTREAM. THIS IS BEST DONE BY STUDYING THE SATELLITE PICTURES AND LOOKING AT THE ASSOCIATED CLOUD PATTERNS AS SHOWN IN FIGURES 5.

NOTE THAT THE MOTION OF THE TRIGGERING WIND WIND MAXIMUM SHOULD BE DUE EAST IN ORDER FOR THE THE CLOSED LOW TO BE QUICKLY "KICKED" DOWNSTREAM. IF THE MOTION OF THE WIND MAXIMUM IS MORE TO THE NORTHEAST, SAY, THE CLOSED LOW WILL OPEN UP SLOWER AND THE TROUGH WILL TEND TO "DIG" TO THE SOUTHEAST. THIS SEQUENCE OF EVENTS OCCURED WITH THE NEXT CLOSED LOW WHICH ANCHORED ITSELF OFF THE BC COAST.

REFERENCES

- GARDNER K.D. 1978, CYCLOGENESIS AND CLOUD SYSTEM DEVELOPMENT.
WELDON R.B. 1975, COURSE NOTES, NWS SATELLITE TRAINING.

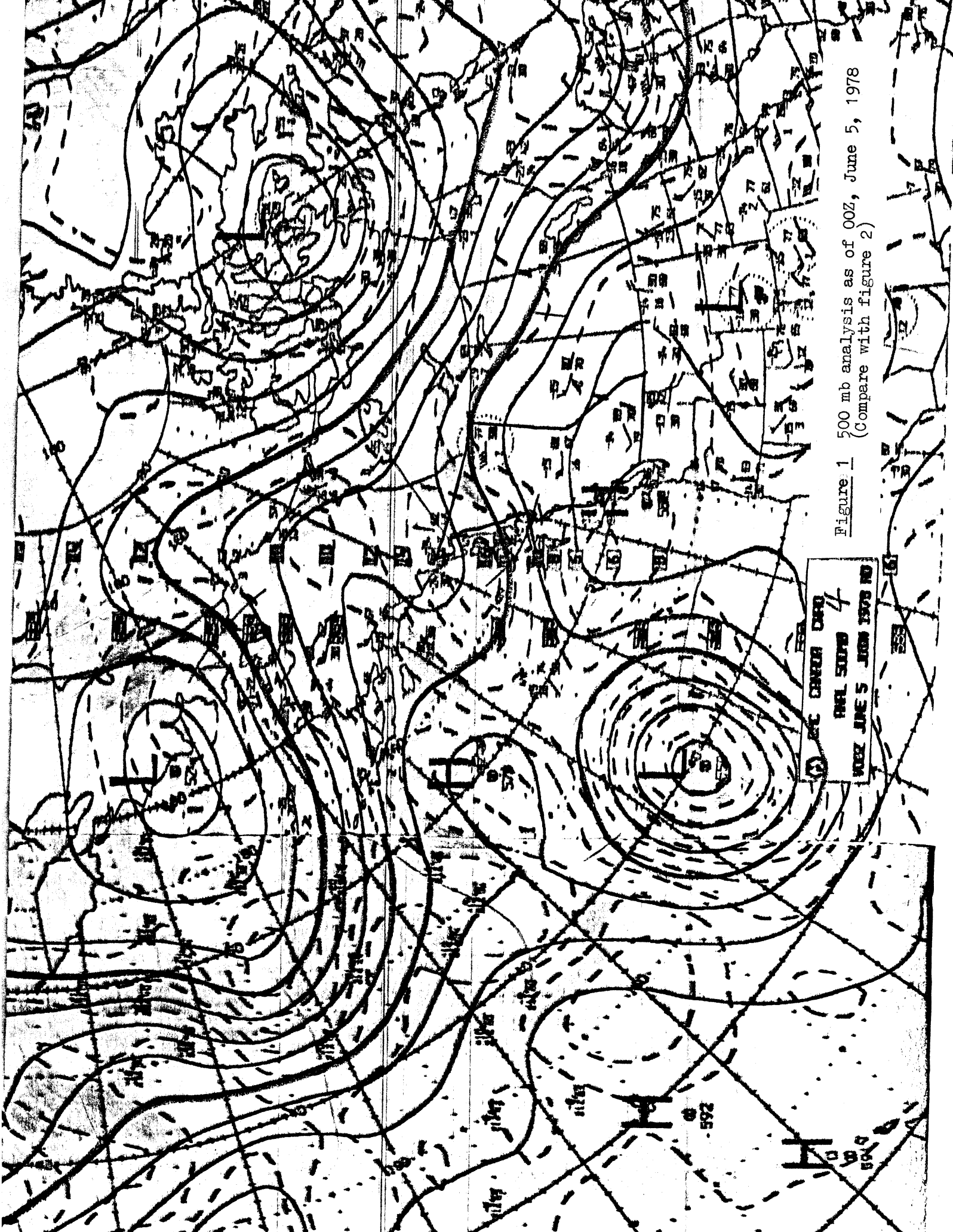


Figure 1 500 mb analysis as of 00Z, June 5, 1978
(Compare with figure 2)

REC CENTER CDR
PWL 5000 4
WGT JUNE 5 JON 1978 NO

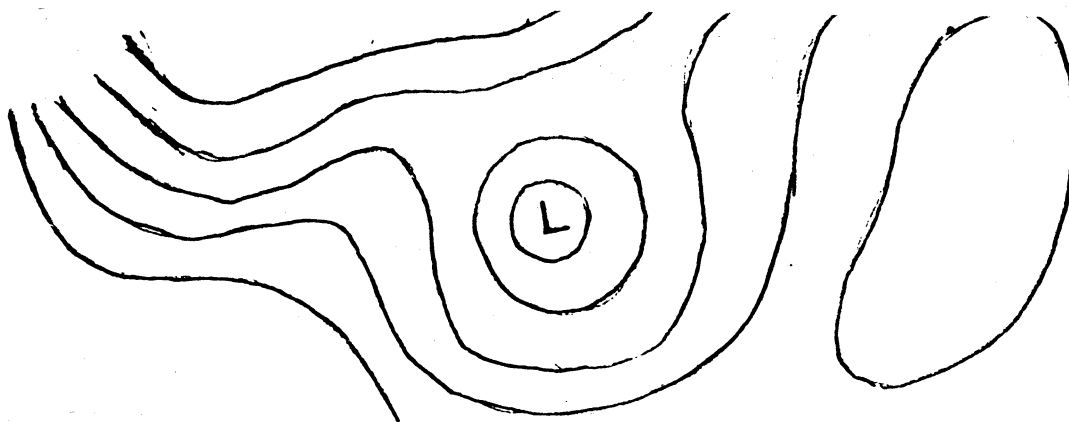


Figure 2 Upper air configuration necessary for type B storm development-after Gardner, 1978.
(compare with figure 1)

TYPE 2 - SPLIT FLOW CYCLOGENESIS

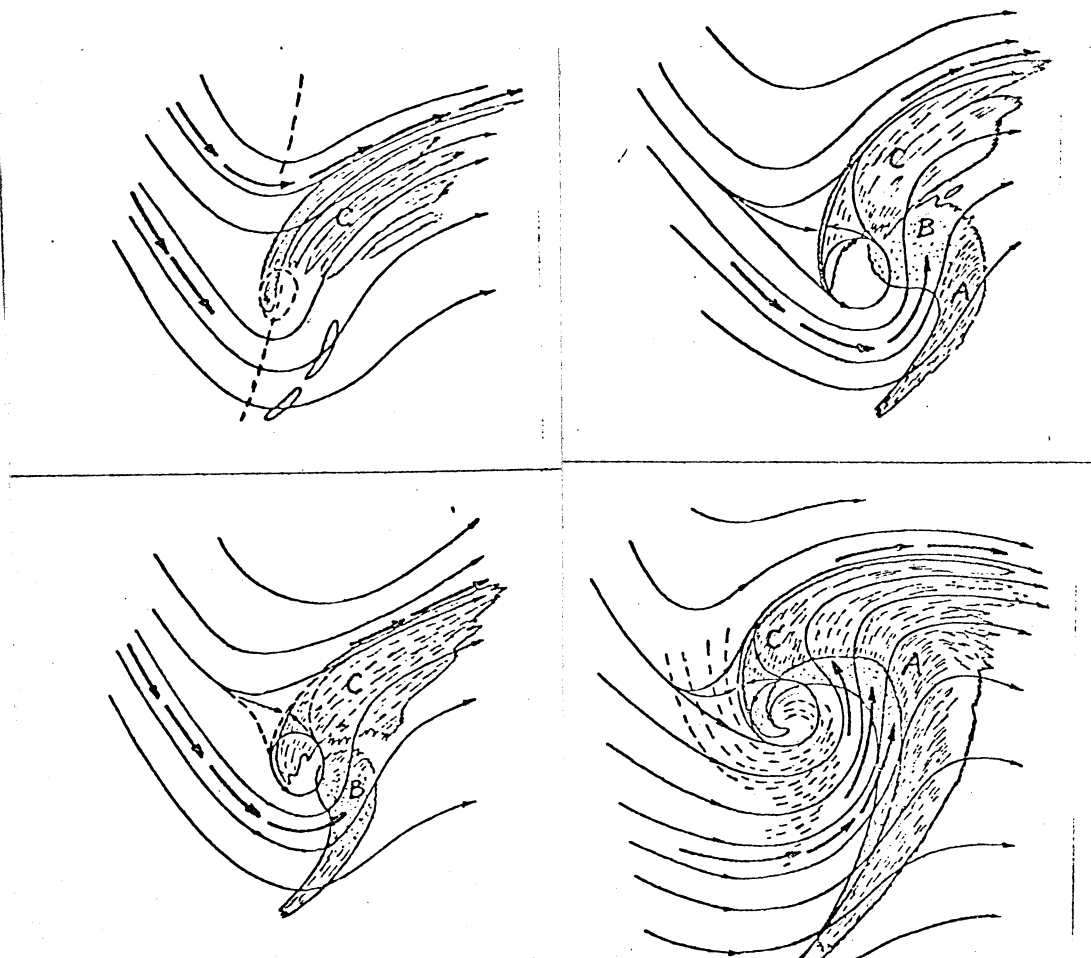


Figure 3 Split flow cyclogenesis- after Weldon, 1975.
(compare with example shown in figure 4)

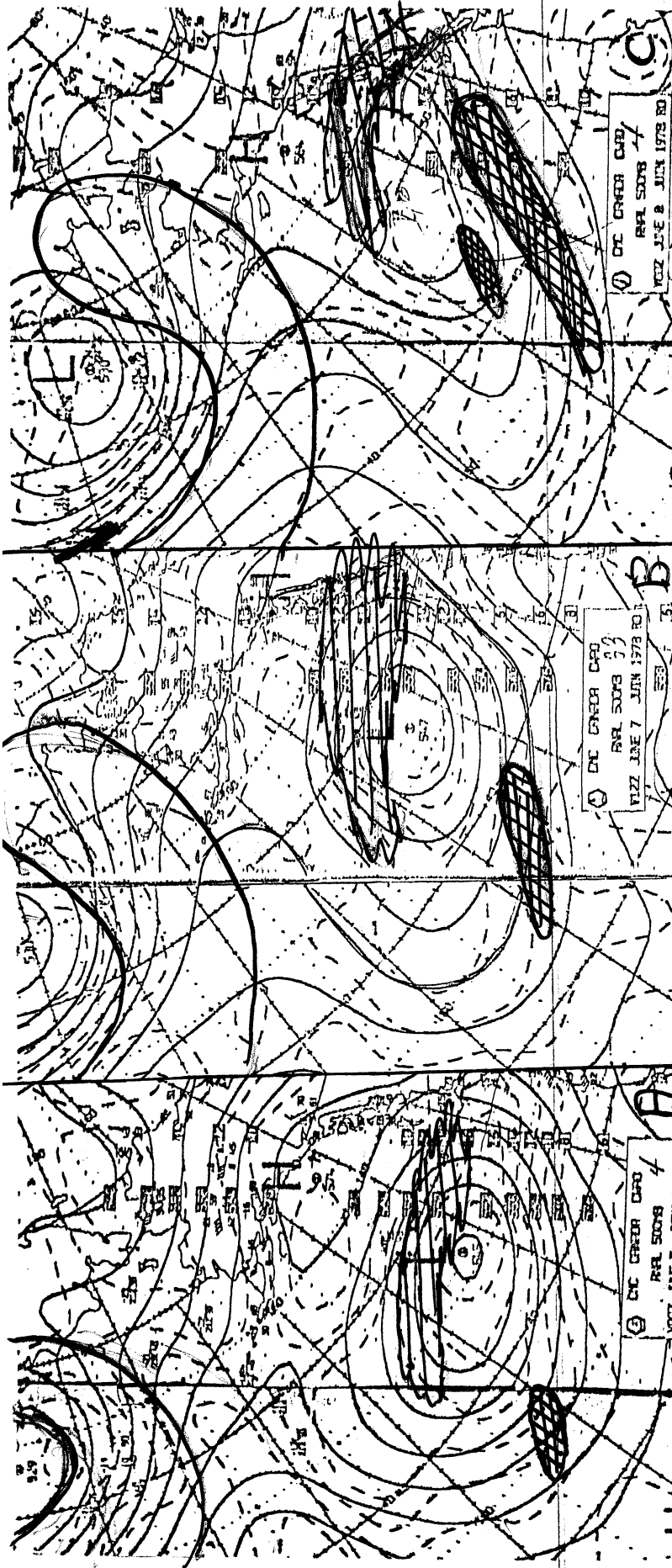
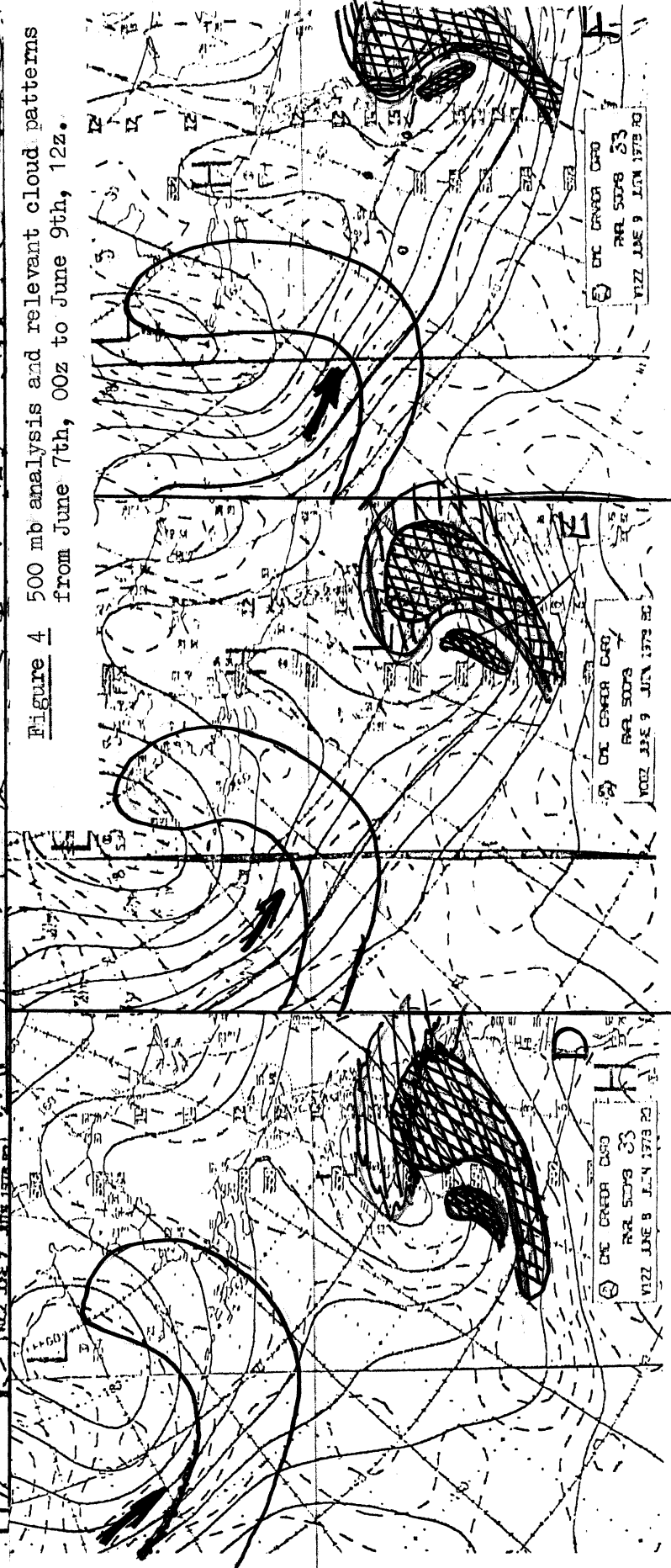


Figure 4 500 mb analysis and relevant cloud patterns from June 7th, 00z to June 9th, 12z.



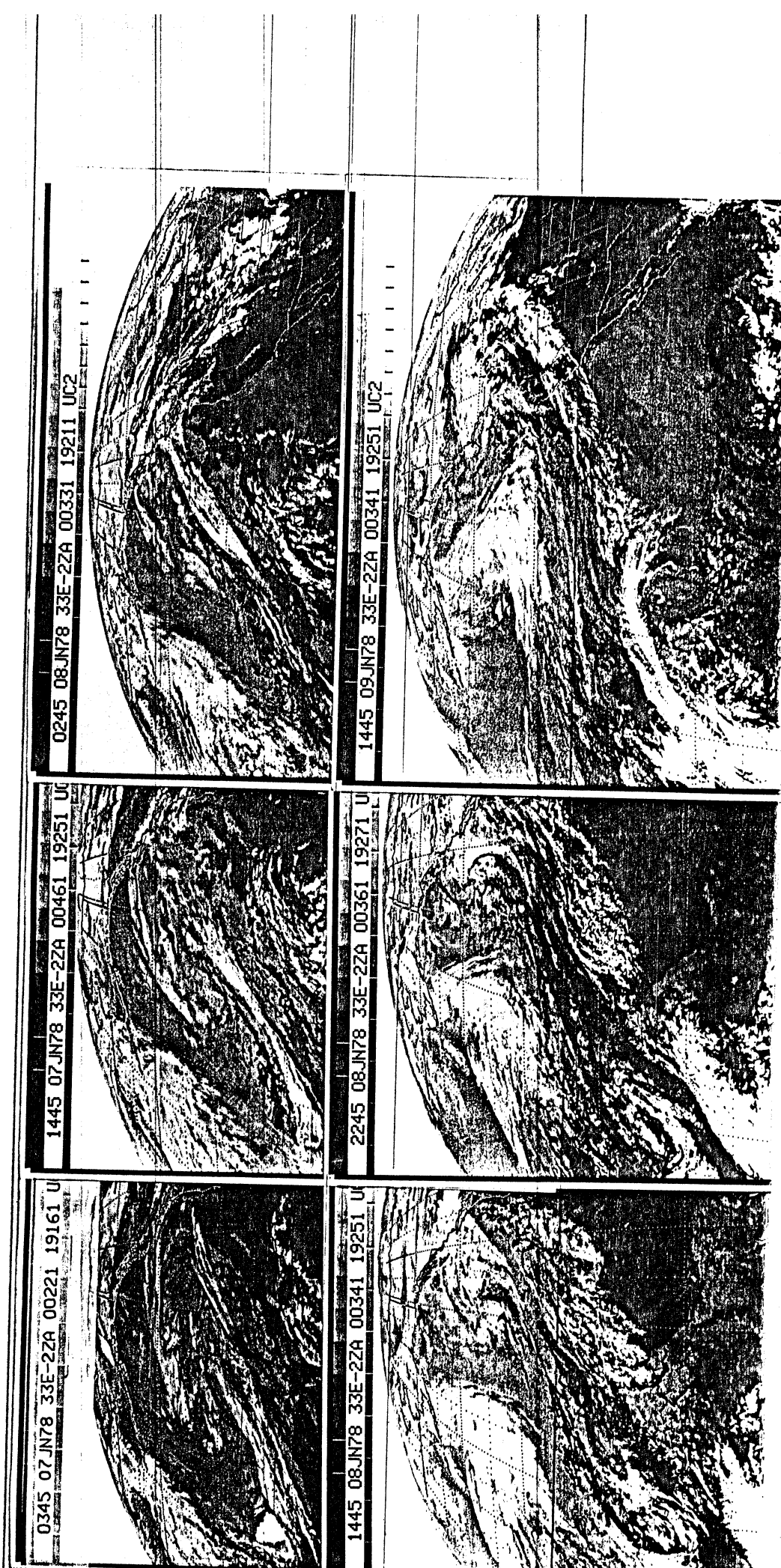
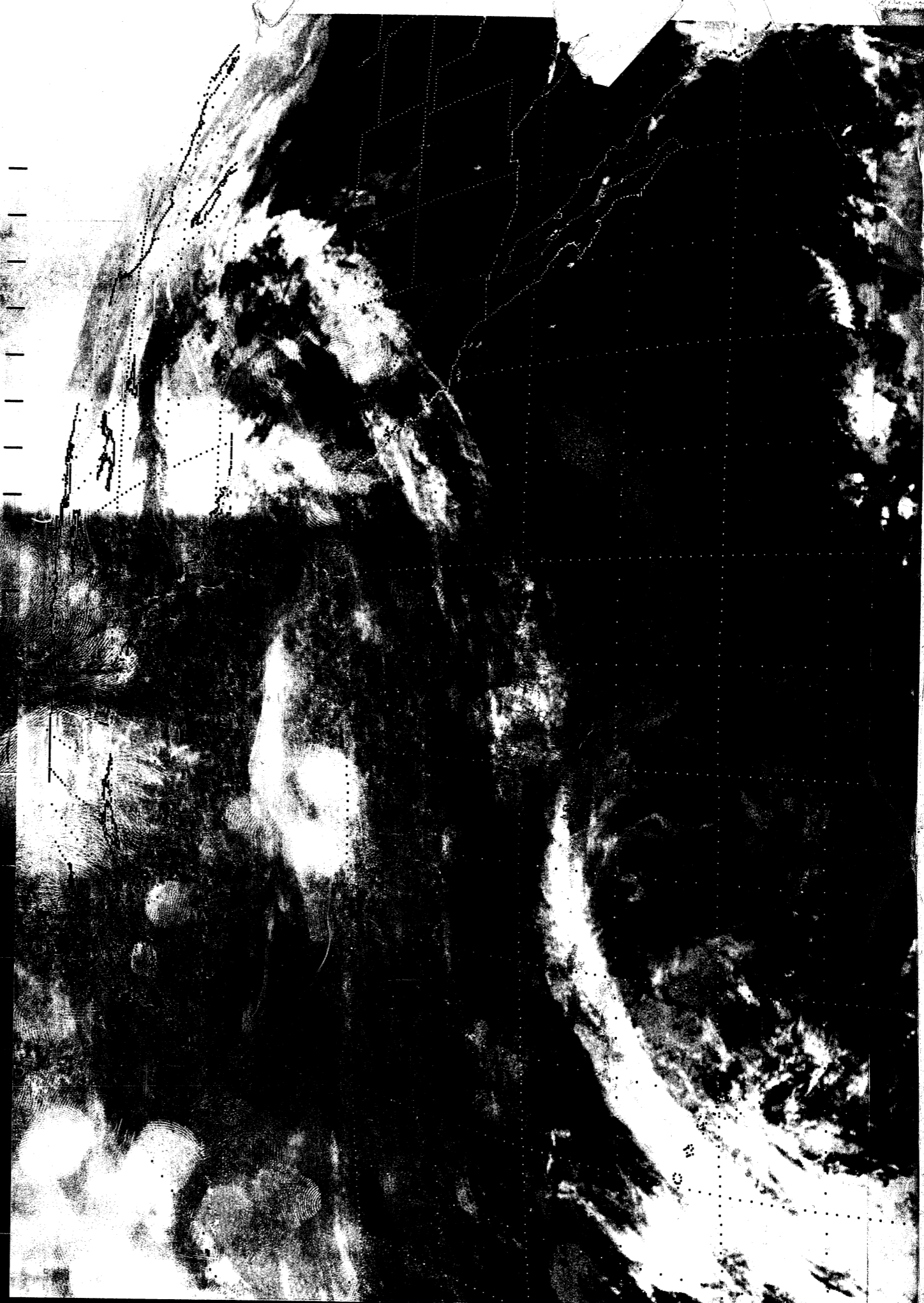


Figure 5 Satellite pictures taken at approximately the same time as the 500 mb charts of figure 4.

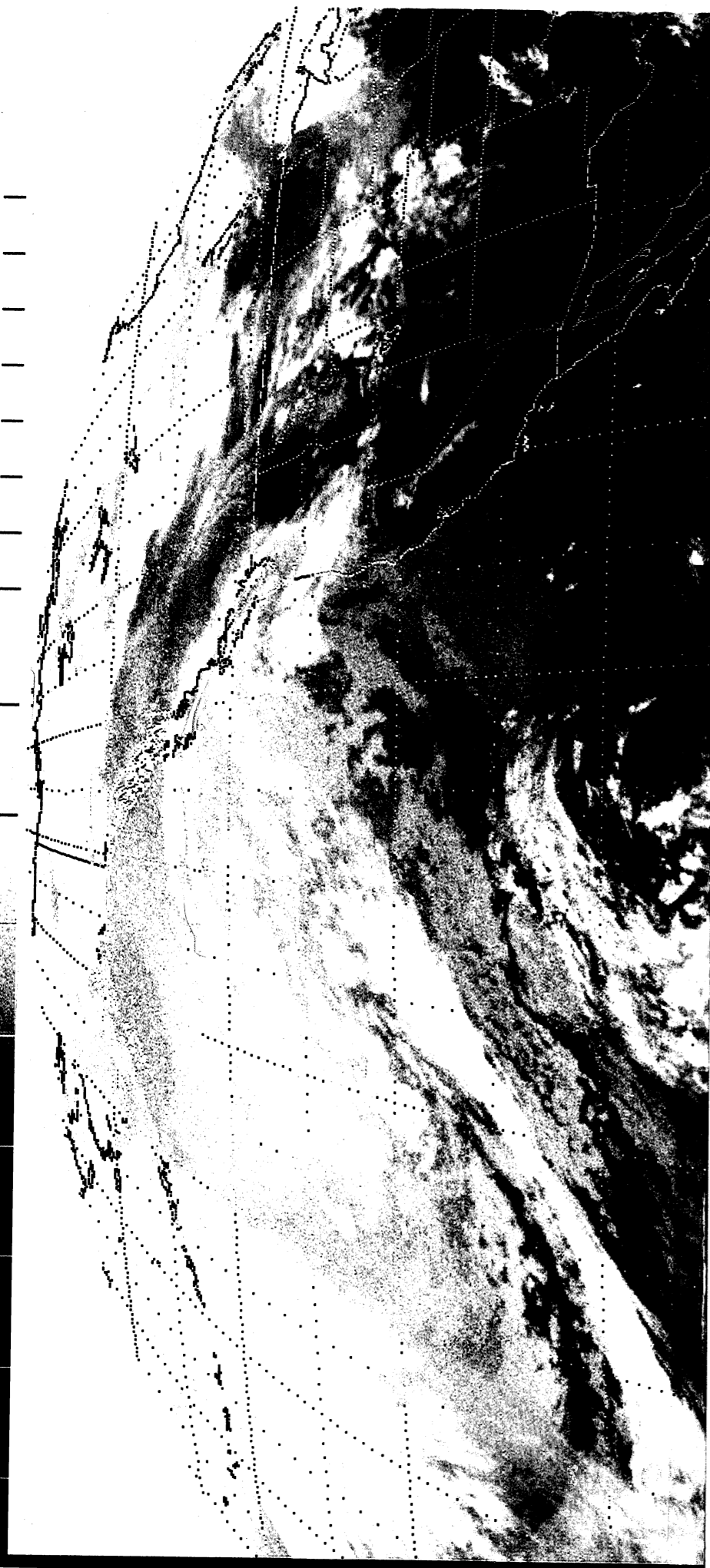
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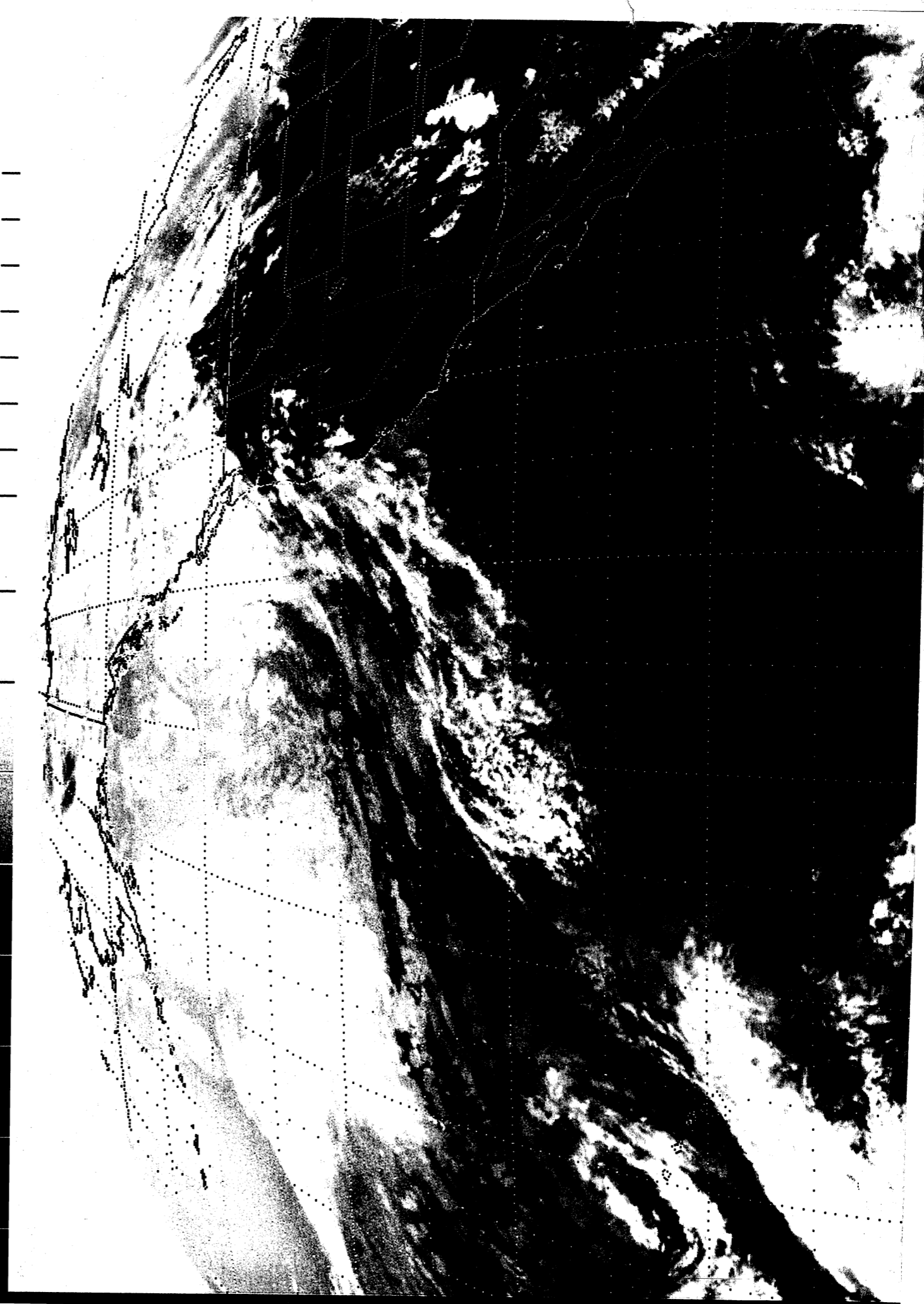
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1445 07JN78 33E-22A 00461 19251 UC2



2245 08JN78 33E-22A 00361 19271 UC2



0345 07 JN78 33E-2ZA 00221 19161 UC2



1445 08 JN78 33E-2ZA 00341 19251 UC2

