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MEMORANDUM FOR : Acting Chief, DPD

SUBJECT : Air Weather Service Item of Interest

1. Attached are extracts from a briefing which was presented recently to Brigadier General H. L. Peterson, Commander, Air Weather Service by ████████████████ of the AWS Scientific Service Directorate. A similar briefing will be presented to Dr. Charyk, sometime within the next few weeks. It deals with the development of an electronic computer program for forecasting cloud cover by means of numerical models. The program was initiated and given top priority by AWS because of our CORONA weather support requirements. However, most of the people working on the program thought they were working solely in support of SAMOS.

2. While somewhat technical in nature, the text may give some insight into one of the many AWS activities which directly benefit DPD, but which are not part of our routine operational mission support. The terms used are generally self explanatory in context, with these few exceptions:

Numerical Model — A particular set of mathematical formulas and the electronic computer procedures used for their solution.

JNWPU — The Joint Numerical Weather Prediction Unit located at Suitland, Md.

AWSS — Air Weather Service Scientific Service Directorate.

SIGNED

Major ████████
Chief, Weather Staff

Attachment - 1
As noted above

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The dynamic model brings known theoretical principles of dynamic meteorology to bear on cloud forecasting. These principles are similar to those pertinent to JNWU operations, except ours also include certain moisture laws. Since this model is based on strong dynamic principles, any advancements which may be made in numerical forecasting or cloud physics will be of direct benefit to our method. Hence, we are in a position to profit from fields where the best brains in fundamental research are currently being employed.

It is fairly obvious that any theoretical scheme to predict largescale cloudiness must necessarily be an indirect one. This is true since clouds are not continuous but have a very discreet distribution in the atmosphere. It appears logical from experience that the humidity conditions (i.e., relative humidity, temperature-dewpoint spread, etc.) which are closely associated with cloudiness would afford parameters which could be more conducive to theoretical treatment than clouds themselves. Suppose we were given the normal multilayer cloud distribution over a large area.

To predict the future of such a conglomerate pattern directly would present problems. However, if we could associate the overcast portion with high humidities and the broken with lower ones, the scattered and clear with still lower humidities, then we would have a humidity pattern representing a cloud pattern; then our problem becomes that of forecasting the humidity distributions. To predict the humidity distribution we would need to consider the displacement by the horizontal wind, humidity changes due to rising and falling motion associated with dynamic or topographic influences, and changes brought about by precipitation and evaporation. If we relegate our problem to shorter periods, perhaps we can neglect evaporation since its affect is usually felt more slowly.

After considerable deliberation we elected to use the condensation pressure spread as our basic humidity variable. Perhaps you recognize this term from the isentropic analysis era. It is the difference between the actual atmospheric pressure of an air particle and the pressure to which that parcel must be reduced to provide sufficient cooling to cause saturation. After further deliberation we also concluded that the most effective means of computing the displacement of condensation pressure spread, along with the changes affected en route by the above mentioned processes, would be a 3-dimensional trajectory computation scheme that would utilize the hour-by-hour forecast of the numerical prognosis and at the same time would keep account of the minimum pressure attained along the path of each moving particle. Such a technique would predict the subsequent distribution of condensation pressure spread for characteristic levels in the atmosphere which could then be reassociated with clouds to give forecast cloud distribution.

To show this pictorially suppose we start with a parcel at a certain height. From the radiosonde data we compute its degree of saturation and the condensation pressure. Now we advect this particle along with the forecast winds and after 8 or 9 hours find that the parcel has risen, as well as moving horizontally, causing the pressure to lower to that of the original condensation pressure. Hence, it begins to precipitate some of the moisture out, thereby causing the condensation pressure to rise. After 12 hours the parcel starts to descend and in this illustration reaches its 24-hour displacement value at the same level as at time T_0, but with a lower humidity due to the rain. Hence, if we were making 0-6 hour forecasts, our forecasts would range from clear to cloudy with rain at 12 hours with clouds dissipating after 12 hours with clear skies for the 24-hour forecast. This illustration shows that even in short-period forecasts a cloud could be followed through a complete life cycle by our scheme. In other words, we are taking developmental processes into account and not merely advecting the current cloud pattern.

The net result of previous planning to accomplish the desired result consisted of 5 separate computer programs selectively united to produce the required forecasts. The following input is employed by this series of programs.

a. The forecast hour-by-hour 3-dimensional distribution of height, temperature, and vertical velocities produced by the numerical weather prediction baroclinic forecast model.

b. The edited and sorted radiosonde data as produced by the Global Weather Central automatic data processing program.

c. The objective analysis of temperature and height fields from the Global Weather Central's objective analysis program.

All three of these magnetic tapes are available at the completion of the Global Weather Central's operational run.

In the first step two programs are united to compute the locations of the air particles at the required forecast time. In addition, these programs compute the minimum pressure attained by the air particle in arriving at the final point. This value is necessary to compute the new condensation pressures. These programs were prepared by ████████ of the Electronic Computer Branch.

The second step on the program is the computation of a dewpoint analysis field from the observed radiosonde data for the required levels. Because of his familiarity with the data format at the Global Weather Central, this job was accomplished by ████████ of GWC.

The next step is the computation of the condensation pressure fields from the output of the dewpoint analysis program and the Offutt objective analysis of the temperature fields. Using this analysis of the condensation pressure field and the 3-dimensional trajectory data previously computed, the program then proceeds to compute forecast condensation pressure spreads for the required levels and forecast periods. This was accomplished by ███████████ of the ███████████████████ (now of ███████████ using various JNWPU programs as parts to a master program. The final output consists of charts at three levels—850, 700, and 500—portraying significant moisture distribution; these charts are then delivered to the special projects section of GWC to be integrated into the conventional forecasting routine.

There are two points which I wish to stress in the philosophy of this program. First, the task is not a one-unit affair. Several persons and units were involved. Secondly, we in AWSS did not do all the programming. Our job was to:

1. Formulate the plan.

2. Coordinate the AWS efforts at our disposal.

   a. Seeing that the proper approach was followed.

   b. Assuring program compatibility.

   c. Enforcing target deadlines.

   d. Keeping ever cognizant of all phases of the problem, bringing assistance to bear on any phase that may be lagging and acting as a consultant to iron out any difficulties—technical, theoretical, or engineering—which may impede the progress of this program. Perhaps the best tribute that can be paid to any method is for a conventional forecaster to place it along side his favorite, personally developed, pet methods. As I understand it, this model, in so short a time, has acquired this stature with ███████████████████ whom we all recognize as being one of the best practical forecasters in Air Weather Service. This was the basic objective of this program—to provide a forecasting tool and not an end product by itself. Really we're not trying to replace the forecaster, but quite the opposite, we are trying to provide him the tools so that the full state of the art can be realized — and subjective forecasting still comprises very much of the state of the art.