THE EXPLORATION OF THE JET-STREAM BY SAILPLANES

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The jet-stream, discovered during World War II, is a meteorological phenomenon of increasing importance to flight operations. Not only is the mere fact of its very high wind velocities of economical and navigational interest to commercial and military flying, but it becomes more and more apparent that certain hazards of the high atmosphere are connected with it. At least one type of the so-called clear air turbulence occurs in the neighborhood of the jet-stream core. Its origin is still obscure. Some English experts believe that it was responsible for some of the "Comet" accidents.

There is also evidence that the jet-stream contains pulsations in wind speed and vertical motions of periodic nature. Mountain waves are at their best (that is, at their worst for powered aircraft) when the jet-stream is overhead. Even small hills may then create vertical air currents at the cirrus level.

Cloud formations in the jet-stream are peculiar and typical, consisting mostly of long cirrus bands and lenticular clouds. Although the origin and underlying mechanism of these clouds is still unknown, they are being used by some transatlantic airline pilots as navigational help in tracing the jet-stream.

Of course, meterology as such is interested in the jet-stream phenomenon too. From laboratory experiments imitating the rotating heated earth, there is reason to believe that the meandering jet-stream is a means by which the atmosphere exchanges heat between higher and lower latitudes. However, the concentration of high winds in such a relatively narrow and long band is not explained, so far, in a satisfactory theoretical way.

In short, the jet-stream is one of the most interesting but unexplored meteorological phenomena.

At this point it may be appropriate to summarize some of the facts known so far about the jet-stream. Not even its definition is established and some people tend to call any wind speed maximum on the upper air weather map a jet-stream. There is really no sharp distinction between a zone of maximal wind speed and a jet-stream. But it appears wise to restrict the definition of the jet-stream somewhat, for example, to winds of

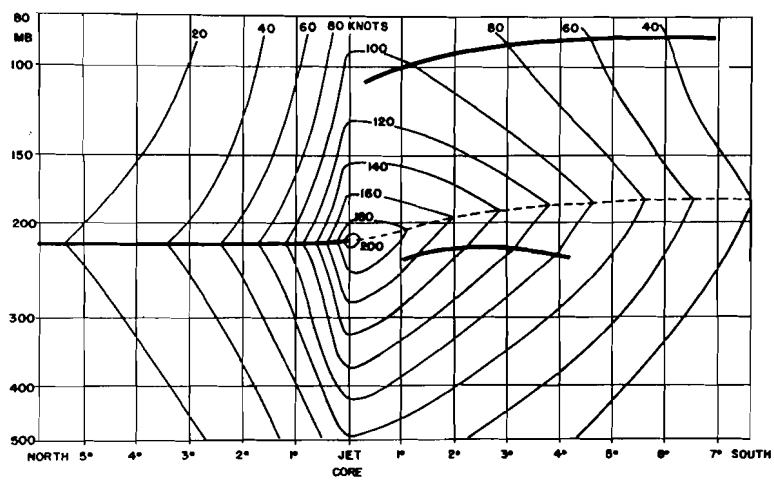

Fig. 1 — Vertical North cross section through average Westerly Jet Stream. (According to Endlich and Solot). Thin lines with numbers are "Isotachs" giving wind velocities in knots. Heavy lines mark the tropopause South of the Jet Stream. Broken line denotes level of maximum wind. Vertical scale = atmospheric pressure in millibars. Horizontal scale = degrees of latitude.

100 knots and more within a belt of 300 miles width or less and a length of 1,000 miles or more. No such definition is so far agreed upon but thoughts along this line underlie most treatments of the subject and should be kept in mind in the following discussion.

The core of the jet-stream lies usually close to and a little below the tropopause (the bottom of the stratosphere) roughly at 37,000 feet at our latitude, somewhat lower in higher latitudes. There is always a strong north-south temperature difference running under the jet-stream, most pronounced near the 500 millibar pressure level (about 18,000 ft.) at about −25°C. This is the frontal zone of the so-called polar front and there are other jet-streams at higher and lower latitudes over the Arctic and Equatorial front. These frontal zones are the breeding grounds of our cyclonic disturbances and the jet-stream, therefore, is a "weather generator" of the first order. In the U.S.A. the main jet-stream lies around 35° latitude in winter when it is most pronounced, and somewhat more northerly in summer, when it is weak.

A most interesting fact is that the tropopause is broken by the jet-stream. On its southern side, the tropopause is frequently more than 10,000 feet higher than on the northern side and this "tropopause break" may occur within a horizontal distance of the order of only 100 miles. (Fig. 1). Doubtless this peculiar phenomenon is part of the jet-stream mechanism.

The jet-stream not only meanders north and south, but also up and down, its core ascending and descending several thousand feet during its long trip. There are also definite wind maxima of several hundred miles length, riding along the jet-stream and traveling at a propagation speed slower than that of the wind in the jet-stream level — but faster than the propagation of upper pressure troughs and ridges through which the jet-stream belt winds its