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**PLAN FOR
U.S. PARTICIPATION
IN THE
GLOBAL ATMOSPHERIC
RESEARCH PROGRAM**

NATIONAL ACADEMY OF SCIENCES

Plan for U.S. Participation in the Global Atmospheric Research Program

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stations and a computer capable of integrating forecast models. In that experiment the mobile facility would be integrated with the special experimental headquarters, but some of its equipment could be used as emergency back-up, in case of computer failures, etc.

The aircraft sensors in Table IV-2 are currently being tested or evaluated for inclusion in the NCAR-DRI turbulence system, which we consider to be a prototype for the GARP aircraft facility. The replacement or supplementing of existing sensors by a sonic anemometer-thermometer is considered important, if not quite essential, mainly in order to improve temperature sensing in wet clouds. The addition of a hot-wire anemometer is intended to allow direct measurement of the energy dissipation, for comparison with the directly measured turbulent energy generation and the energy spectrum linking them. The most crucial unavailable component of the system is a fast-response stable humidity sensor suitable for measuring moisture flux and insensitive to, or with immediate recovery from, the effects of wet clouds. Several approaches to the problem are available, but none has yet been shown to be fully satisfactory.

An important need for the tropical cloud cluster experiment is the development and procurement of a wind-finding dropsonde suitable for release and tracking from high-altitude jet aircraft. The wind, temperature, pressure, and humidity accuracy should be at least equal to that of existing conventional rawinsondes, and the cost of the disposable instrument package, in quantity, should be under about \$100. In addition, there is need for improvement in both the sensor accuracy (pressure and temperature) and signal resolution in balloon-borne rawinsondes to be used in the GARP experiments. In the tropical experiments, in particular, temperature soundings are of marginal utility unless they are accurate to substantially better than one degree C. Since the expense of the disposable instrument packages will probably be a relatively small part of the overall experiment, a higher unit cost than that of present operational instruments can be accepted.

The Tropical Cloud Cluster Experiment

This experiment is designed to study the convective and large scale interactions occurring in the wet season cloud cluster disturbance of the central and western equatorial North Pacific and is recommended to be carried out in the summer of 1973 in conjunction with the Global Systems Test.

It is the most important, and certainly the most demanding, of the observation programs proposed in this document. In the cloud cluster disturbances important interactions are believed to occur between radiative processes and boundary layer, cloud-scale, meso-scale, and large scale dynamics, and impor-

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tant elements of the disturbances extend nearly to the tropopause. Theoretical models of these disturbances are rudimentary, being based mainly on Manabe and Strickler's (1964) convective adjustment hypothesis or on the mechanism developed by Charney and Eliassen (1964), Kuo (1965), and Ooyama (1967) for tropical cyclone and intertropical convergence zone analysis, generally referred to as "conditional instability of the second kind" (CISK). Manabe's simple hypothesis has been shown to predict disturbances qualitatively similar to the cold-core systems described by Riehl (1965), while the CISK models invariably lead to warm-core systems.

Recognizing the uncertainties of both scientific and technological capabilities between now and mid-1973, we outline what we believe to be the minimum requirements for a viable cloud cluster experiment. The general structure is similar to that proposed by the Stockholm Study Conference, the Study Group on Tropical Disturbances of the Joint GARP Organizing Committee, the NCAR TROMEX conference, and other national and international groups, but with the recognition that the larger scale aspects of these proposed experiments cannot be executed until the existence of a more complete global observation system in the middle or late 1970's.

The Marshall Island chain is believed to be meteorologically most suitable for the experiment. It is also logistically feasible. In this region cloud cluster disturbances, of types common to most equatorial regions, occur at intervals of 4-5 days during the northern hemisphere summer and early fall and undergo a wide range of development. A large number of small flat islands exist which are suitable as instrument platforms, with surface and upper air sounding stations already in existence on some of these and on others of the Micronesian Archipelago. A major airfield and port facility exists on Kwajalein and an adequate airfield on Eniwetok, with a useable emergency strip on Majuro. Figure IV-1 is a map showing the existing meteorological sounding stations in the west central Pacific, those proposed for activation as part of the World Weather Watch by 1971, and the additional stations required for the cloud cluster experiment.

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An atmospheric sounding capability, with primary emphasis on winds at 6-hour intervals or less should be established with a spatial resolution of 150-200 km in the lowest 2000 m within the designated inner area, consisting of about $4 \times 10^5 \text{ km}^2$, and with a resolution of 400 km in a surrounding area of about $2 \times 10^6 \text{ km}^2$. The outer ring of this fixed network could be replaced by two high-altitude jet aircraft equipped with a proven wind-finding dropsonde capability, and one or two additional such aircraft are almost essential for finer time and space scale surveillance of the disturbance areas. Conventional surface observation stations, including a system for obtaining continuous mean planetary boundary layer winds, should be established at all the proposed rawin sites plus those noted with a cross. Telemetered automatic recording

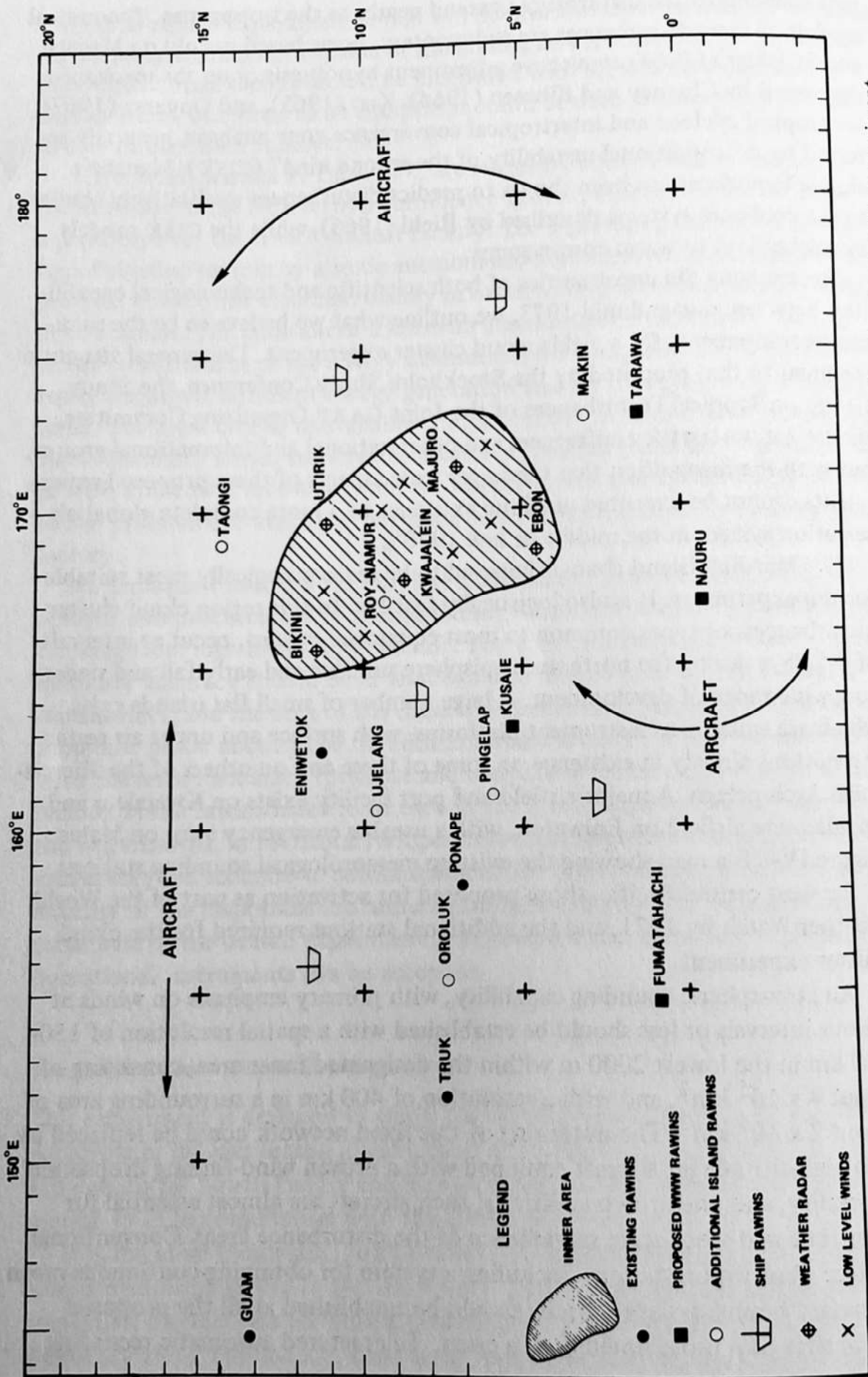


FIGURE IV-1 Existing meteorological stations in west central Pacific and recommended additions for cloud cluster experiment.