ATTACHMENT 1. REPORT OF MSG-6 ON THE SCIENTIFIC ASPECTS OF AN INTERNATIONAL EQUATORIAL OBSERVATORY (IEO)

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1. FOREWORD

MSG-6 has been set up to study this on the basis that there is need to have observatories very close to the equator so that we may understand equatorial dynamics much more precisely than we do now. Such observatories, which are equipped with MST radars, lidar and other facilities, should be constructed snd operated through international cooperation. Specific requirements for the observation of equatorial middle atmosphere dynamics were discussed at the Workshop held 10-12 May 1982 at Estes Park, CO, USA, as will be shown in Section 2. MSG-6 has further worked on the problem, obtaining the opinions of each member as to the following questions: (1) locations of IEOs; (2) specification of the facilities at IEOs; and (3) finanical support on the construction and the maintenance of IEOs.

The proposed locations for IEOs are, in alphabetical order, Christmas Island, Galapagos Island, Kourous, Nauru and Tumbes (or Iquitos).

2. SCIENTIFIC SPECIFICATIONS FOR MIDDLE-ATMOSPHERE DYNAMICS OBSERVATIONS (see Handbook for MAP Vol. 7, pp. 103-150)

3. LOCATION OF IEOs

As to location, IEOs must be close to the geographic equator, say, within 5° from it. However, IEOs should be far enough away from the equatorial electrojet which produces unfavorable echoes; 5° may be a minimum distance from the equatorial electrojet.

Another consideration is that we wish to obtain the maximum possible contribution by IEOs to increase our understanding of middle-atmosphere dynamics. Thus, we favor, at first, those IEOs which take advantage of the existing radar observatory chains. For tidal studies such IEOs are essential. At present, there are three chains along different meridians. One is a chain which consists of Christchurch (44°S, 173°E; partial reflection drift (PRD) radar), Adelaide (35°S, 138°E; PRD radar and ST radar), Kyoto (35°N, 136°E; meteor radar and MST radar) and Khabarovsk (48°N, 135°E; meteor radar). Scott Base (78°S, 165°E; PRD radar), in the Antarctic has just commenced operation. We call this chain the Western Pacific Chain (WPC). Note that Adelaide and Kyoto are geographically conjugate, a characteristic which is very important for tidal mode studies. Nauru (0.5°S, 167°E) is on this chain. Thus, it is a good candidate for an IEO site.

There could be another, though less complete, chain than the WPC. This consists of Poker Flat (65°N, 145°W; MST radar) and two other stations which could be in existence in the future, i.e., Hawaii (20°N, 156°W) and Raratonga (21°S, 160°W). If Christmas Island (2°N, 157°W) is chosen, an important chain will be set up. This chain is called the Central Pacific Chain (CPC).

We may pick up another chain in the American/Atlantic sector. In this sector we have Saskatoon (54°N, 110°W; PRD radar), Durgam (43°N, 71°W; meteor radar), Millstone Hill (42.6°N, 71.5°W; ST radar), Urbana (40°N, 88°W; meteor radar, PRD radar, and MST radar), Atlanta (35°N, 84°W; meteor radar), Arecibo

(18°N, 68°W; IS and ST radar) and Jicamarca (12°S, 77°W; IS radar). Platteville and Sunset (40°N, 110°W) have also ST radars in good operation. Of these stations, Saskatoon, Platteville and Sunset may be too far deviated towards the west. We call this chain the American-Atlantic Chain (AAC). There are two candidates for IEOs along this chain. They are Tumbes and Iquitos, both being at 3°S and about 65°W in Peru. Though a little deviated toward the west, Galapagos Island (0.3°S, 91°W) can be an additional candidate.

Of the above-mentioned candidates, we should consider some special features that relate to specific scientific interests. Nauru is situated at a very good point for studying the stratospheric fountain where air enters the stratosphere from the troposphere, bringing water vapor upward with the air (NEWELL and GOULD-STEWART, JAS, 38, 2789, 1981). Tumbes, Iquitos and Galapagos would be useful for investigating the impact of the Andes on middle-atmosphere dynamics.

As to transportation, all candidates are acceptable, although there are certain advantages with Nauru, Tumbes and Iquitos. It would be reasonable to expect technical service from all candidates, though there would be degrees of service among them.

The distance from the equatorial electrojet is more than 5° for all candidates (see Table 1).

Kourou in French Guyana (5°N, 53°W) is on the northern boundary for being an IEO site, but would still be suitable for some equatorial dynamics studies except for tidal dynamics which require a location closer to the equator.

Table 1. Locations of each candidate for IEO. The MAGSAT data were used to find dip.

PLACE	LAT°	LONG°	DIP(°)
Nauru	0.53 S	167 E	-11.58
Christmas I	1.57 N	157.27 W	6.03
Galapagos	0.56 S	91.0 W	17.65
Kourou	5.0 N	53.0 W	25.66
Iquitos	3.45 S	73.10 W	18.39
Tumbes	3.59 S	80.43 W	16.41

4. SPECIFICATIONS OF THE FACILITIES OF IEOs

The central facilities of IEOs are middle atmosphere radars which are able to measure the middle atmosphere motion with the required time- and space-resolution, sampling rates, and velocity accuracy. Quick steering of the radar beam would also be preferable. In the case of MST radars, these requirements can be realized by adopting proper pulse widths, pulse repetitions and signal integrations, and quick beam-steering mechanisms. A narrow pulse width for good height resolution implies a wide frequency spreading which may cause interference with other communications. Frequency allocation may be subject to some restrictions in the IEO area. Practically speaking, we must find quiet places with little radio noise to have a good S/N. However, it seems essential to have, as a minimum, a 10^9W m^2 average power-aperture product for operations at about 50 MHz. Easy electric power supply, is a requirement for IEOs. All of the candidate sites mentioned above are satisfactory with respect to this condition.

However, the power would be expensive and comprise an important part of the maintenance cost. The power also would produce various problems for the maintenance, such as requiring large cooling systems. If we use PRD radars

instead, the power can be reduced drastically together with other simplifications of the radar systems. Since observed results by PRD radars at Townsville and Adelaide (VINCENT and BALL, JGR, 86, 9159, 1981) and Saskatoon (MANSON, MEEK and GREGORY, JGR, 86, 9615, 1981) have been very successful, PRD radars should seriously be considered as important facilities at IEOs. A scientific restriction of PRD radars is that, in simple PRD radars, we can measure only horizontal translation velocities. The height resolution of PRD radars is inferior to MST radars. But vertical velocities also might be investigated with phase coherent systems. Note that such improvement has recently been done successfully to detect GW in the mesosphere by VINCENT and REID (1982). If a PRD radar is set up, we need, in addition, an ST radar to observe the stratosphere which cannot be measured by a PRD radar.

In addition to radars, lidars would be increasingly important in middle atmosphere observationa (HAUCHECORNE and CHANIN, JATP, 44, 577, 1982). Though dependent on weather, lidar systems are able to contribute to our purpose and it is recommended that they also be set up. The facilities are unique in that the atmospheric density perturbation is detected and, assuming the hydrostatic equilibrium of the atmosphere, the atmospheric temperature perturbation is obtained. The time resolution now available is a few ten minutes. Note that the (1,1) mode of tides may suffer a convection instability at the equator and the detection of temperature perturbation is crucial.

Balloon and meteorological rockets have remained important for observing the middle atmosphere, and the facilities not far from IEOs for their launching would be useful. Kourou in French Guyana seems especially favorable for these facilities, though the Ascension Island and Antigua rocket launching sites are available for the AAC. Usual radiosonde facilities are available for all candidates, as mentioned above.

5. FINANCIAL SUPPORT ON THE CONSTRUCTION AND THE MAINTENANCE OF IEOs

Technically, the IEO facility maintenance should be as simple as possible. A minimum number of service personnel is essential for operation. In the case of radars, once an observation has started, no attendance of personnel would be desirable. This implies "fully computerized systems", yet with minimum regular checks which are supplied from outside.

In order to keep periods of stay at IEOs at a minimum, or to avoid staying altogether, computer programs used for observation should be prepared beforehand and checked properly. One solution for the checking would make simulators of the IEO radars to be distributed to each member country. One such simulator is being developed for the MU radar system of Kyoto University for outside users to whom the computer program for "normal mode" observation is ready except for specifying some parameters such as start- and stop-time, beam steering and height range for observation.

A remote control system would be another solution; however this may be expensive and require a control headquarters to be located conveniently in some member country.

Financial support for the construction and the maintenance of IEOs is a problem to be solved for realizing our idea for setting up IEOs. The cost may be paid by the member countries as in the case of EISCAT, but for now the question will be left unresolved for future investigation.

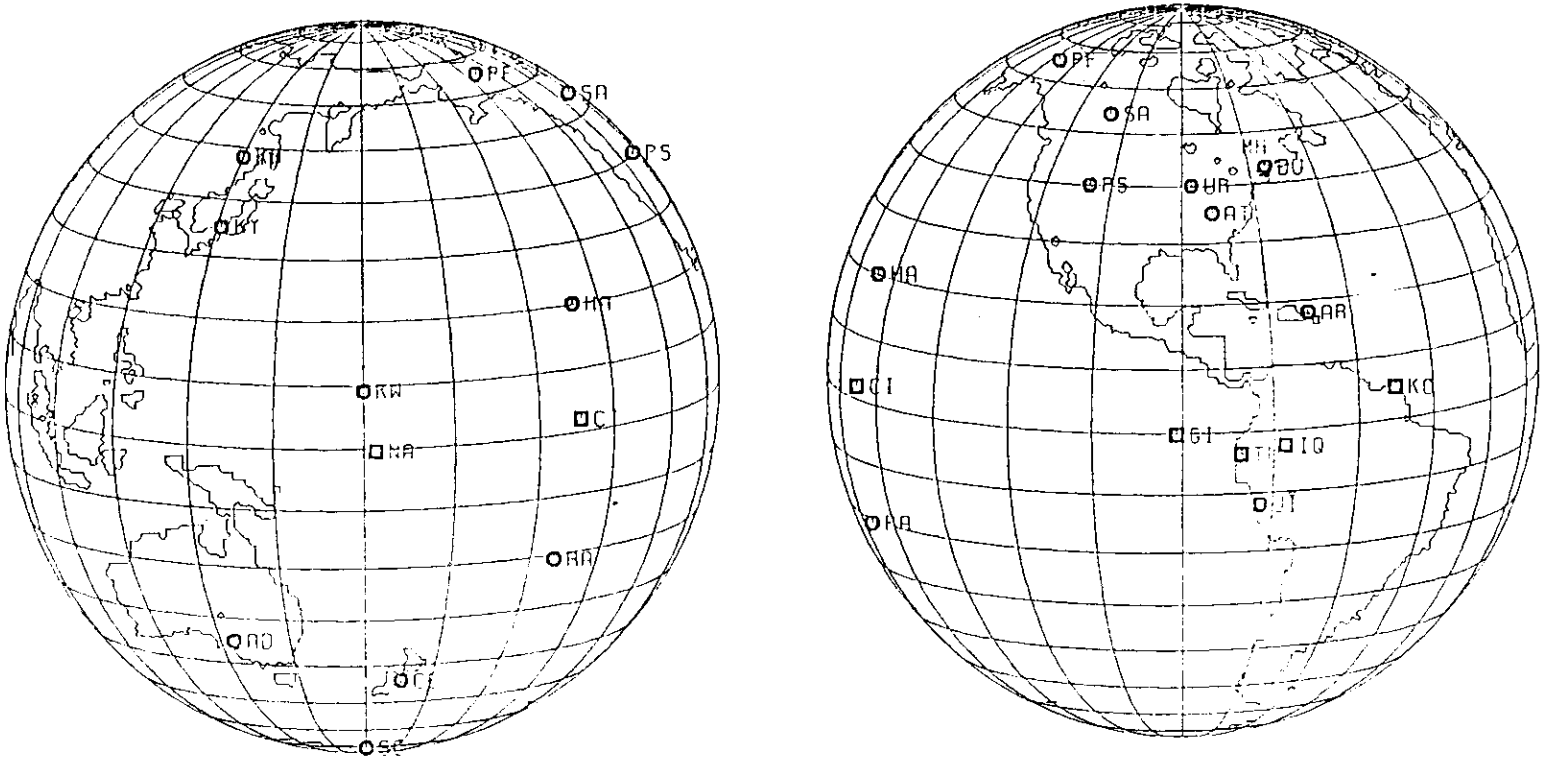
6. RECOMMENDATION FOR IEOs

It is found that all of the proposed places have significant scientific aspects to constructing IEOs. However, it is practical, for funding considera-

tions, to put a priority for each candidate.

The first choice is Nauru Island because the WPC seems best in coverage of latitudes, and in configuration having an almost exact conjugate pair in mid-latitudes between Adelaide and Kyoto. The location would also be suitable for the study of a very interesting scientific problem, "the stratosphere fountain". Other IEOs are desirable to be added in order to study longitudinal dynamic differences together with other interesting scientific problems characteristic to each location. It should be seriously considered to equip each IEO with those facilities which best suit that location.

We have, however, various other choices. As to low- and midlatitude coverages, the AAC would be excellent in the number of the existing stations and in the capabilities of the existing facilities which include Arecibo and Jicamarca which have contributed tremendously to the study of middle-atmosphere dynamics.



Locations of middle atmosphere dynamics observations.