文部省の学術審議会の組換えＤＮＡ実験指針やその後の運用との間にそごを生じないよう十分御配慮ください。

（別添写は 11−4 参照）

11−6　　総学庶第１４８６号　昭和５３年１１月１８日

内閣総理大臣　福 田 赳 夫　殿

日本学術会議会長　伏 見 康 治

（写送付先：科学技術庁長官，環境庁長官，大蔵大臣，文部大臣，運輸大臣，気象庁長官，郵政大臣，建設大臣）

中層大気国際協同観測計画（ＭＡＰ）の実施について（勧告）

標記について，日本学術会議第７６回総会の議決に基づき，下記のとおり勧告します。

記

国際学術連合会議（ＩＣＳＵ）が，国際的な太陽・地球系空間観測事業の一環として，国際協力によって推進することに決定した中層大気国際協同観測計画（Middle Atmosphere Program，略称ＭＡＰ）に我が国が参加し，その計画の諸結果を学術研究の推進，応用分野の開発等に有効に利用することは，その意義が極めて大きいと考えられる。したがって，その国際協力事業を成功させるために政府はＭＡＰ計画の我が国での実施について必要な予算措置等を講じられたい。

（別紙）

説　明

地球大気に関する研究は，国際地球観測年（ＩＧＹ，１９５７−１９５８）を境にして大きく進歩した。これは，このとき，史上初めて世界の関連研究者が協力し全地球規模の観測を行った成果によるものであった。人工衛星の出現も時を同じくしており，国際協力の意義を一層深めることになった。

以来，地球大気を研究する上で，ＩＧＹのような国際協力の重要性が認められ，太陽極小期国際観測年（ＩＱＳＹ，１９６４−１９６５），太陽活動期国際観測年（ＩＡＳＹ，１９６９−１９７１）が実施され多くの成果を挙げてきている。我が国もこの国際協力に参加し国際的に高い評価を受けてきた。

現在，国際協同観測と研究のために二つの事業が進行中である。一つは，国際磁気圏観測計画（ＩＭＳ，１９７６−１９７９）であり，他の一つは，地球大気開発計画（ＧＡＲＰ，１９６８−　）である。ＩＭＳでは，地球大気が直接太陽風と接するはるか遠方（地球半径の数十倍）磁気圏境界から電離層（１００キロメートル）までの大気の観測を行い，太陽風エネルギーの地球大気への流入を明かにしようとしている。他方，ＧＡＲＰでは，天気予報の改良と気候のメカニズムの解明を主目的として，対流圏と下部成層圏の観測を行うものであり，全地球規模の観測の外に，

地域的実験計画も行われている。

以上の状況からも分るように，成層圏から電離層に至る広大な大気を解明するための国際協同観測・研究は未だ行われていない。しかし，これはこの大気の適当な観測方法がほとんどなかったためであった。

ＩＭＳ，ＧＡＲＰの研究成果は，中層大気に対流圏界面，中間圏界面を通じて種々の形のエネルギーの入力があることが分ってきており，これを通じて超高層，中層，下層大気が相互作用している実態を科学的に解明する段階にきている。また，環境科学上，人間活動が中層大気にどんな影響を与えるかを科学的に明らかにする必要もでてきている。この外，中層大気が気候変動に及ぼす影響に対しても中層大気の科学的観測・研究が重要である。したがって，ＭＡＰはＩＭＳ，ＧＡＲＰでやり残した問題への挑戦と言える。そして最近の衛星・スペースラブ及び地上からのリモートセンシング技術のめざましい発展及び運動，組成放射が相互作用する複雑な系の解析に必要な大型計算機の出現がＭＡＰ実施の柱となっている。

国際学術連合会議（ＩＣＳＵ）の太陽地球間物理学特別委員会（ＳＣＯＳＴＥＰ）は，かねてから大気物理研究計画（Atmospheric Physics Program, 略称ＡＰＰ）をすすめてきたが，その一つとして，中層大気国際協同観測計画（Middle Atmosphere Program, 略称ＭＡＰ）の実施を検討することになり，このために運営委員会（Steering Committee）を結成した。これの委員には，ＭＡＰを支持するＩＣＳＵに所属する国際測地学・地球物理学連合（ＩＵＧＧ）のうち国際地球電磁気学・超高層物理学協会（ＩＡＧＡ）及び国際気象学・大気物理学協会（ＩＡＭＡＰ），並びに国際電波科学連合（ＵＲＳＩ），国際純粋・応用物理学連合（ＩＵＰＡＰ），宇宙空間研究科学委員会（ＣＯＳＰＡＲ）と，政府間団体である世界気象機関（ＷＭＯ）から代表が選ばれ，１９７８年５月下旬，オーストリア国インスブルク市で第一回会合が開かれた。これに先立って，１９７６年６月に米国イリノイ州アバーナ市で研究会が開かれ，ＭＡＰの学術的意義が検討され，その成果がＭＡＰ Planning Document として刊行されている（添付資料２）。

上記ＳＣＯＳＴＥＰはＭＡＰの実施を１９８２−１９８５年と決定しているが，ＭＡＰ実施の準備とＭＡＰに関連したプログラムの早期開始の意義を認め，１９７９−１９８１年をpre−MAPとして支持することにした。

ＩＣＳＵは１９７８年９月の第１７回総会でＭＡＰの支持を認め，各加入国にその旨を勧告した。

我が国では，かなりはやい時期（昭４１. １９６６ ）に，中層大気の力学に対する総合研究班が結成され研究を続けてきており，この方面で活躍する基礎は十分できている。

ＭＡＰの目的は中層大気（１０キロメートル−１３０キロメートル）の力学，構造・組成，放射の状況を明らかにすることであるが，これらの相互作用が重要である点を特に考慮する必要がある。国際間で取り上げている課題は，次の四つである。

1. 中層大気の力学

(a) 平均帯状風

(b) プラネタリー波

(c) 赤 道 波

(d) 潮 汐 波

(e) 重力音波・乱流

2. 中層大気の構造と組成

(a) オ ゾ ン 層

(b) 電離層D層

3. 中層大気のエネルギー収支

(a) 太陽紫外線及び粒子放射

(b) エアロゾルの光学的性質

(c) 赤外線の伝達と収支

4. 太陽活動と気候変動

なお，ＭＡＰでは，実験室内の，主として光化学反応係数の測定も重要であることが認めらている。

添付資料

1. ＩＣＳＵの決議（抜すい）及びＳＣＯＳＴＥＰのＩＣＳＵあて勧告（写）

2. Planning Document の抜すい

3. ＭＡＰパンフレット（日本学術会議国際協力事業特別委員会　ＳＴＰ分科会　ＭＡＰ作業部会作成）の抜すい

4. ＭＡＰ研究課題，担当機関・担当者，必要経費

資料　1

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

17 GENERAL ASSEMBLY

24 - 29 September 1978, Athens, Greece

Resolutions

12. SCOSTEP and Solar-Terrestrial Physics Programmes

In view of the long-term nature of several of the currently planned research programmes in solar-terrestrial physics such as the International Magnetospheric Study (IMS), and the Middle Atmosphere Programme,

Resolves to convert the Special Committee on Solar-Terrestrial Physics into a Scientific Committee,

Endorses the presently planned programmes of the Committee, and

Commends these for support to the members of the ICSU family.

International Council of Scientific Unions

ANNEX A
(Supplementary Report to ICSU July 1978)

SPECIAL COMMITTEE ON SOLAR-TERRESTRIAL PHYSICS

President: Prof. K. D. Cole   Vice-President: Dr. J. W. King   Secretary: Dr. E. R. Dyer
c/o National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. U.S.A. 20418
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Recommendations Concerning the Middle Atmosphere Program 1982-1985

I. ACTIONS REQUESTED

The planners of the Middle Atmosphere Program (MAP), currently represented by the interim Steering Committee for MAP, and the national scientific constituencies for solar-terrestrial physics, as represented by the SCOSTEP Council of National Representatives, have requested that SCOSTEP submit the following resolution to ICSU. SCOSTEP supports this requested action.

1. The SCOSTEP Council of National Representatives,

   Considering the enormous international and inter-Union effort required to solve the scientific problems of the middle atmosphere,

   requests ICSU to officially recognize the Middle Atmosphere Program (MAP) as a major international cooperative program to take place in the interval 1982-1985,

   further requests ICSU to ask for full participation from its member countries, and

   draws attention to the interesting historical fact that the start of this world-wide cooperative project in atmospheric science will appropriately coincide with the centenary of the First International Polar Year of 1882.

In addition, SCOSTEP reports the two following corollary resolutions, which it has endorsed:

2. The SCOSTEP Council of National Representatives,

   recognizing that SCOSTEP is proposing to ICSU that a major international cooperative program on the middle atmosphere should be organized in 1982-1985,

   recommends that preparatory studies should start in 1979 with available or expected resources. The Council

   notes that four MAP preparatory studies have been identified by the Steering Committee.

3. The interim Steering Committee for the Middle Atmosphere Program,

considering that the efforts of scientists from a wide range of Unions interested in solar-terrestrial physics will be needed to solve the problems of the middle atmosphere, and

recognizing that the management of MAP will require a significant level of organizational support if it is to be successful,

urges the Unions interested in MAP to request ICSU to assign responsibility for the MAP Steering Committee to SCOSTEP (if continued in some appropriate form).

(The explanatory material presented orally with the foregoing resolution pointed out that the MAP Steering Committee is itself an inter-Union body with representation from the "Unions interested in solar-terrestrial physics" referred to in the first clause, namely IAU, IUGG (for both IAGA and IAMAP), IUPAP and URSI; and also from other ICSU bodies (COSPAR and SCAR) and from WMO. All of these are also represented on SCOSTEP. The second clause refers to the need for a secretariat and access to facilities for coordination (communications, information and data services, etc.). The point of the third clause is that SCOSTEP already possesses these assets.)

II. BACKGROUND INFORMATION IN SUPPORT OF THE RECOMMENDATIONS

(Although much of the background material below is contained in reports to ICSU over the past several years, it is summarized here for ease of reference.)

1. Notes on Resolution No. 1.

The justification for launching a major international cooperative program in 1982-1985 to study the middle atmosphere (roughly speaking, the region in the range of altitudes from 10-15 km to about 100 km) includes the following points:

(1) Our understanding of this region is very poor.

(2) Our ignorance is due in part to the enormous physical and chemical complexity of the middle atmosphere, involving as it does the interaction of hundreds of variables describing its structure, composition, chemistry, energetics, and dynamics, all as functions of geographic coordinates, altitude, and time. Further progress requires that many variables, heretofore measured by themselves or only sporadically, be measured simultaneously, with wide geographic distribution, and some temporal continuity. This in turn requires a high degree of worldwide coordination.

(3) Our ignorance is also due in part to the difficulty of observing this region, as compared with the troposphere below (accessible to meteorological techniques) and the thermosphere above (accessible to spacecraft). But just now, techniques are being refined for both remote sensing from the ground below and from spacecraft higher up, and for in situ measurements from aircraft, balloons, and rockets. These will reach full development in the next several years. The variety of platforms just noted and their different modes of operation also require coordination.

(4) The choice of the years 1982-1985 was influenced by the prospective availability of sophisticated ground-based and spaceborne sensors, for instance, those associated with the U.S. "Space Shuttle" program. The interval from now until 1982 will also allow interested countries time to develop other additional observational facilities to supplement already planned programs if they wish and are able to do so.

(5) It goes without saying that understanding the physics and chemistry of the middle atmosphere is of high scientific interest. But only in recent years has the practical importance of understanding the middle atmosphere been realized. One needs to recall only the following examples of practical problems: The fragility of the ozone layer that protects life from killing ultraviolet radiation; the potentially harmful effects of a rise in the level of carbon dioxide or of certain nitrogen compounds; the effects of aerosols on worldwide radiation balance and temperatures; the effects of variation in solar ultraviolet radiation on the middle atmosphere and potential consequences for weather and climate. In fact, the suspected connection between variations in solar, interplanetary, and magnetospheric phenomena on the one hand, and meteorological and climatological phenomena on the other, must be transmitted somehow through the middle atmosphere, regardless of the actual chain of cause-and-effect, whatever it turns out to be.

(6) Some twenty national constituencies of SCOSTEP have shown a positive interest in coordinating middle atmosphere research in their respective countries with a world-wide cooperative program. The World Meteorological Organization has offered its cooperation.

For these reasons, SCOSTEP urges that ICSU adopt a resolution based on Resolution No. 1, above.

2. Notes on Resolution No. 2.

This requires no ICSU action, but is included to complete the picture. It arose from the following circumstances. During the exploratory stages of developing MAP (leading up to the publication of the MAP Planning Document in 1977), it was proposed to divide MAP into two stages: (A) running from about 1979 to 1981, with emphasis on coordinating programs already in existence during this interval; and (B) 1982-1985 or longer, when spacecraft missions and other long lead-time facilities (some not yet approved) with highly refined capacities to provide synoptic and/or continuous data on physical and chemical variables of the middle atmosphere would be available.

After considerable discussion at the MAP Steering Committee and SCOSTEP meetings in Innsbruck, it was agreed that the seven-year interval 1979-1985 would be too long to sustain a maximum world-wide effort; on the other hand, participants in many countries were prepared to begin immediately with the facilities they already have. To disregard this possibility would be a waste of good science and of the opportunity of learning how to coordinate individual middle atmosphere research programs by actually trying it.

3. Notes on Resolution No. 3.

Various alternatives for the management of MAP have been mentioned in previous reports, usually in the context of the future of SCOSTEP as an ICSU committee:

Middle Atmosphere Program

PLANNING DOCUMENT

Prepared at the
MAP Planning Conference

June 21-24, 1976

Urbana, Illinois, USA

Contents

(ページ略)

1
Introduction

Dr. J. B. Gregory, Chairman of the MAP Preparatory Group has prepared the following answer to commonly asked questions concerning the Middle Atmosphere Program, and these are reproduced below as an introduction to the MAP Planning Document.

What is MAP?

The Middle Atmosphere Program is an attempt to obtain the scientific knowledge which is required to answer these important questions:

1. What are the possibilities for damage to the earth's middle atmosphere as a result of mankind's activities: e.g., the permanent reduction of the ozone concentration in the stratosphere?
2. What role does the middle atmosphere play in determining climate and climatic changes?
3. What are the processes by which the sun, acting through the middle atmosphere, may be able to affect weather?

Why MAP now?

For a convergence of reasons. First, because each of the above questions is gaining in importance very rapidly. Second, because available scientific knowledge is inadequate to give the needed answers; and in particular, to make quantitative estimates of the probable consequences of particular courses of action by humanity. Third, because there exists a consensus of opinion among scientists internationally that the time has come to replace our previously uncoordinated and fragmentary activity with coordinated and comprehensive studies of this region of the atmosphere. Fourth, because new techniques of observation and measurement are now available, and are in operation, or are firmly planned. These techniques involve ground-based, balloon and rocket, and satellite-borne experiments. Fifth, because "modeling" the atmosphere, using large computers, is advancing rapidly, but requires data not currently available before calculations can be considered satisfactory.

What are the main specifics of MAP?

Under the aegis of MAP, scientists will collaborate internationally

1. To determine the structure and composition of the atmosphere in the regions of the stratosphere and mesosphere, i.e., in the approximate altitude range 15 to 85 km; especially in regard to important minor species.

2. To determine the interaction of radiation from the sun, the earth and the atmosphere with the middle atmosphere.

3. To investigate the motions of the middle atmosphere on all scales, including the interactions with troposphere and magnetosphere, and to monitor these motions on a continuing basis.

While substantial research has been conducted previously into the above matters, augmentation and collaboration of efforts is necessary to meet current demands for knowledge.

The global scale of the program will involve large quantities of data, for the handling of which there . lready exist organizations (World Data Centers) with expertise.

What form will MAP take?

MAP will be essentially in the pattern of other programs of scientific study of the planet Earth, such as commenced with the International Geophysical Year, and are current as the Global Atmospheric Research Project (GARP) and the International Magnetospheric Survey (IMS). The program is expected to be supervised by a committee of scientists, composed of nominees of international scientific unions. Within the program, specific projects will be proposed by scientists to their own countries for support, and for conduct either nationally, or in cooperation, internationally. The findings and conclusions of the projects will be made available to all without restriction.

What is the current (mid-1976) status of MAP?

MAP, as an interdisciplinary program, is currently an approved planning activity of the Special Committee on Solar-Terrestrial Physics, within the division of Atmospheric Physics Programs.

Approval of, or interest in, MAP as a proposal has been expressed by IAGA and IAMAP (within IUGG), by COSPAR, URSI, and WMO. Its development is known to the Committees responsible for GARP, and for IMS and other SCOSTEP activities.

Why is MAP conceived as a new and separate program?

Because no existing program has its central thrust directed towards the middle atmosphere, which would, in the absence of MAP, continue to be a relatively neglected region. GARP is essentially directed to the behavior of the troposphere, as a necessary prelude to more effective observation and prediction of its behavior. IMS deals with a region of plasma and energetic particles, in which the interaction of the solar wind with the earth's atmosphere and magnetic field occurs. By contrast, MAP deals with a "mixed" region, influenced by processes originating in the troposphere, e.g., planetary and gravity waves, and also in the magnetosphere, e.g., energetic electron precipitation mainly in the auroral zone. The need for cooperative disciplinary efforts, and the requirements for special organization, follow from this "mixed" character.

Does MAP have a distinctive justification?

MAP shares the common justifications of all attempts to understand man's atmospheric environment: satisfaction of human curiosity and possible practical utilization are familiar. However, a new urgency exists for completion of our knowledge of stratosphere and mesosphere; as evidenced by several national programs, e.g., U.S. Climatic Impact Assessment Program, mounted for the evolution of advice on specific problems such as are potential in supersonic flight, or in the release of chemical compounds into the atmosphere at the surface.

Perhaps the most appropriate justification is a new sense of the value of our atmosphere to the human beings who will populate this planet to capacity. This atmosphere may no longer be conceived as unalterable, and thus unaffected by us. It is increasingly seen, despite the prodigious energies which are inherent in it, as fragile, limited and above all, beyond price to us. It is our least responsibility to future generations to leave them the same atmosphere in which we and they evolved as human organisms, and to do our part towards future control of this complex aspect of our environment.

Individual projects will evolve from a series of recommendations of a Planning Conference, which are to be found in Section II of this document.

What is the likely scale of requests for resources for MAP?

Only a comparative and qualitative answer is possible at present. MAP may be expected to require more support than earlier geophysical programs such as IGY and IQSY because more expensive techniques are involved. On the other hand, it will almost certainly be less expensive than GARP, which requires the collection of data on a much larger scale. Further, MAP will take advantage of projects for which funding has been in principle committed in some countries, e.g., for space vehicles.

When will MAP take place?

The project activity of MAP is intended to reach a maximum in the mid-1980's. In part, this development is proposed as a means of utilizing the planned availability of space vehicles such as the Space Shuttle, and in part it is an estimate of the time when new satellite-borne remote sounding techniques will be in operation. Further, it is held desirable that MAP should not compete for funding with the existing GARP and IMS; and finally, it is recognized that MAP will require the availability of scientific data to be produced from GARP and IMS.

No restrictions will be placed on the start of MAP projects, though formal approval of the program by international scientific bodies is not expected to be available till late 1977.

The determination of the desirable duration of MAP will be a responsibility of the supervising committee, with cognizance and approval of the scientific unions. It is too early to anticipate a closure date; but the program will not continue indefinitely.

What status will MAP have?

MAP will require the approval of all constituted scientific bodies whose disciplines are related to the science of this portion of the atmosphere. These bodies include:

The International Union of Geodesy and Geophysics
The International Union of Pure and Applied Physics
The International Astronomical Union
L'Union Radio Scientifique Internationale
The Committee on Space Research
The World Meteorological Organization

Approval by these bodies will be sought after the presentation to them of this document for their comment and amendment. Formal approval is to be sought in autumn, 1977 and will be marked by the establishment of a Steering Committee.

2 Relationship to Applications

2.1 INTRODUCTION

MAP is primarily a scientific program designed to enhance our understanding (currently very limited) of the atmosphere between 15 and 100 km. Such understanding will give, as an important byproduct, an improved ability to assess matters of practical concern, such as the state of the ozone layer and climatic change. These applications, along with a few others of lesser current weight, are discussed in this section. If attention is directed to the possible applications from the beginning of a program, relatively small and inexpensive modifications can make the data much more useful.

A narrow definition of the term "practical application" is adopted here. Scientific results that can be applied to other scientific fields are not included. An "application" must be of benefit to the average person, either directly or through agricultural or commercial productivity.

2.2 THREATS TO THE OZONE LAYER

The ozone layer is important to man because it screens out biologically harmful ultraviolet radiation in the wavelength range 200 to 300 nm. Of particular importance is the range called UV-B, from 280 nm which is completely absorbed to 320 nm which is completely transmitted. The ozone layer is also an integral part of the stratospheric climate through its absorption and emission of radiation.

Since ozone is the major absorber of UV-B radiation, perturbations in the ozone layer will yield changes in the ground-level dosage. Several effects of such changes have been suggested. The most widely quoted of these is the increase in skin cancer incidence. Other possible effects include changes in agricultural yields, increased damage to natural ecosystems, increased UV germicidal action, enhancement of photochemical smog, and photodegradation of xenobiotic materials.

A variety of possible threats to the ozone layer is listed below along with a brief statement of the status of understanding of each one:

2.2.1 *Aviation*

(a) Supersonic Transports - subject of 3 year CIAP program and related efforts in Britain, France, and other European countries. Significant ozone depletions predicted for large fleets with existing engine technology.

(b) Subsonic Aircraft - small ozone depletion effects predicted. Highly uncertain because flight is near tropopause where transport is uncertain.

(c) Military Aircraft - same as SST's but small ozone depletions because of smaller fleets.

2.2.2 *Nitrogen Fertilizer*

Still highly speculative with crucial processes not known. Could be the most important long-term threat because of intimate link to food chain.

2.2.3 *Nuclear Explosions*

Predicted ozone depletions due to NO_x formed could provide test of theory, but results inconclusive and controversial.

2.2.4 *Chlorofluoromethanes (CFM's)*

Significant predicted ozone depletions for continued usage. Absolute numbers changing fairly rapidly as new laboratory and atmospheric data become available. Major current focus of applied research effort.

2.2.5 *Solid-Fueled Rockets*

Small predicted ozone depletions from ammonium perchlorate boosters.

2.2.6 *Assorted other Halogenated Compounds*

Brominated fumigants, chlorination of water, etc. Small effects but not yet studied fully.

2.3 CURRENT UNDERSTANDING OF THE OZONE LAYER

Ozone is produced from the attachment of oxygen atoms to O_2 molecules. The ultimate source of the oxygen atoms is the dissociation of O_2 by solar UV radiation in the wavelength range 2000 Å to 2420 Å.

The major destruction mechanisms for ozone are cycles of reactions equivalent to $O + O_3 \rightarrow 2O_2$. The major controller of ozone destruction is the catalytic cycles of the nitrogen oxides (NO_x). They are responsible for perhaps 60 to 70% of the ozone destroyed. Catalytic cycles of the hydrogen oxides and the direct Chapman mechanism reaction of O and O_3 are responsible for perhaps 15% apiece of the ozone destruction. Catalytic cycles of the chlorine oxides and transport to the troposphere for destruction at the surface are responsible for probably not more than a few percent each of the total ozone destruction.

Ozone is produced mainly at tropical and midlatitudes and its destruction is also maximum there. It is transported downward and toward the poles resulting in maximum column content in the chemically inactive polar region.

The major source of stratospheric NO_x is the reaction of $O(^1D)$ atoms with N_2O to form two NO molecules. N_2O is produced at the ground as a part of the biological nitrogen cycle. N_2O is essentially inert in the troposphere and provides a means for transport of nitrogen oxides from the ground to the stratosphere where attack by solar UV or reactive radicals converts N_2O to N_2 or catalytically reactive NO_x.

The stability of stratospheric ozone is governed by a complex system of feedbacks in which reactive species of the O_x, NO_x, HO_x, ClO_x, and other chemical systems react with one another and are affected by the available solar UV which, in turn, depends on the column of ozone above a given point.

While it is possible, and frequently profitable, to calculate natural concentrations of stratospheric species from partial models in which some parameters are held fixed at measured values, predictions of the effect of perturbations require consideration of the complete detail of the complex stratospheric feedback system. Frequently a small change in the concentration will result in near cancellation of a perturbation. For this reason it is necessary when considering ozone perturbations to develop models of stratospheric processes which self-consistently calculate as many of the relevant feedbacks as possible.

No model yet exists which can include all of the known chemical, radiative, and dynamical feedbacks in the stratospheric system. For this reason several distinct types of models have