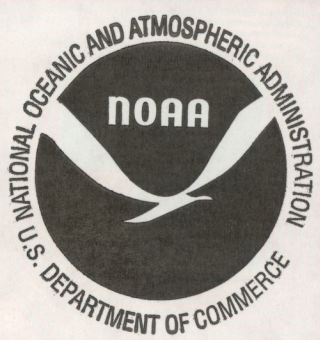# NOAA Technical Memorandum ERL SEL-29

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Environmental Research Laboratories

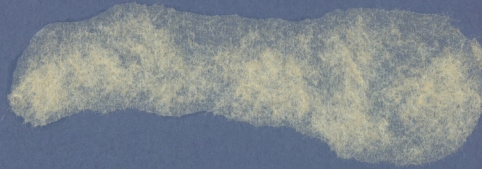## Program Submittal Requirements for Ionospheric Models

R. GREGG MERRILL

Space
Environment
Laboratory
BOULDER,
COLORADO
November 1973

IRONMENTAL RESEARCH LABORATORIES

SPACE ENVIRONMENT LABORATORY

DEPARTMENT OF COMMERCE
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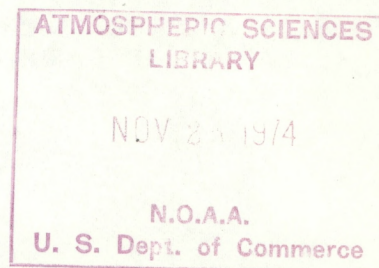
U.S. DEPARTMENT OF COMMERCE
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PROGRAM SUBMITTAL REQUIREMENTS FOR IONOSPHERIC MODELS

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DISCLAIMER

TABLE OF CONTENTS

PROGRAM SUBMITTAL REQUIREMENTS FOR IONOSPHERIC MODELS

R. Gregg Merrill

1. INTRODUCTION

Pursuant to suggestions made at the Advanced Research Projects Agency (ARPA) Ionospheric Modeling Conference, (October 31 through November 2, 1972, at Boulder, Colorado), this report contains information for those who plan to contribute programs and subroutines to the NOAA Modeling Library.

The report describes the CDC 3800's; the FORTRAN requirements and recommendations; units of measurement; and the requirements for decks, tapes, and documentation.

For the present, our requirements are very general and should be easy to satisfy in most cases. When certain subroutines become standard, for example, those for reaction rates, we will require their use.

We attempt to make each program we receive into a subroutine that computes a profile or some characteristic of the ionosphere for *one location at one time*, which simplifies comparisons and incorporation into larger programs. Because a program must check diurnal, seasonal, and latitudinal variations, it usually fills arrays with several outputs; we urge you to keep the computation of such arrays out of the subroutines that do the physics and chemistry of your model. Indeed, if you find it convenient to make your model into the kind of subroutine we require, so much the better.

2. THE CDC 3800's

The 3800's are designated as 3800A and 3800B. The following information comes from the *General User's Guide* (Stevenson, 1972).

Storage organization

The 3800 has 64K words of 48-bit memory with a cycle
time of 900 ns; there are two banks of 32K-word memory, inter-
leaved four ways, of these 48K words are available to the user.

Peripheral equipment

Magnetic tapes. Six seven-track, IBM-compatible tapes per
machine operate at 200, 556, and 800 characters per inch; two
tapes may be operated simultaneously. The availability of all
six cannot be guaranteed at any one time.

Two nine-track, IBM-compatible magnetic tapes on 3800B
operate at 800 and 1600 characters per inch; only one may
operate at a time, though one or two seven-track tapes may
operate simultaneously with one nine-track tape.

Storage units. Two magnetic drums attached to 3800A have
capacities of 1024K 48-bit words. Average access time is
17 ms and transfer rates are 250,000 48-bit words per second.

Two magnetic disk packs attached to 3800B have capacities
of 2048K 48-bit words and average access times of 30 to 165 ms.
Transfer rates are 26,000 48-bit words per second.

Printers. Three high-speed line printers operate at 1200
lines per minute, six or eight lines per inch, 136 characters
per line, 10 characters per inch, two printers are connected
to 3800A and the other to 3800B. The print font has 64
characters.

Card punch. One punch at 250 cards per minute is
connected to 3800A.

Card readers. One reader at 1200 cards per minute is
connected to each 3800.

Microfilm recorder. The recorder is attached to 3800A;
it can operate either as a high-speed printer at 250,000

characters per second, or as a high-speed plotter at 5Ø,ØØØ
vectors per second. Information is recorded on 35-mm film
at a maximum rate of 16 frames per second.

Central Processing Unit

The CPU includes six 15-bit index registers, one 48-bit
display register, and two general purpose 48-bit registers.
Execution times for instructions vary from 5ØØ ns to several
ms; floating-point multiply takes 5.88 μs and floating-point
divide takes from 8.Ø to 12.75 μs.

3. FORTRAN

Standard

The NOAA-ERL Modeling Group requires the use of ANSI
Standard FORTRAN X3.9-1966.   Because local variations are
sometimes irresistible, we require complete documentation of
any exceptions to X3.9, preferably in the form of the manual
for the particular FORTRAN used.

We have the manual that describes IBM System/36Ø/37Ø
FORTRAN IV (IBM, 1971).

Common exceptions

ENTRY statement. Because X3.9 fails to provide multiple
entry points to a subroutine, there are incompatibilities in
the format of this statement. For example, IBM FORTRAN IV
allows an argument list that may differ from that of the SUB-
ROUTINE statement or from those of other entry points to the
same subroutine. CDC FORTRAN prohibits an argument list in
the ENTRY statement and requires calls to entry points to
have the same number and type of arguments as calls to the
subroutine name. Therefore, if entry points are useful, we
recommend that all arguments be transmitted by labeled
commons so that neither the SUBROUTINE statement nor any
ENTRY statements have argument lists.

IMPLICIT declaration. IBM FORTRAN defines the IMPLICIT declaration by which the X3.9 naming conventions for real and integer variables may be arbitrarily altered. If you use this feature, we recommend that you insert a set of comment cards containing the REAL and INTEGER declarations that would be required by your program in the absence of the IMPLICIT declaration.

Multibyte declarations. IBM FORTRAN IV allows REAL declarations to specify twice the standard length to provide double precision, and INTEGER declarations to specify half the standard length. Complex variables may be twice the standard length, and logical variables may be one bit rather than four. CDC FORTRAN provides for non-standard types (TYPE-other declaration) allowing any number of bits that divides 48 and multiple word types of up to seven words, each 48 bits. So far, no need for double precision on the 38$\emptyset\emptyset$ has been required for REAL*8; we have no experience thus far with IBM complex variables.

Do-loops. Some FORTRAN dialects execute one loop when the initial index is out of bounds (which is implicitly allowed by X3.9), while others treat this condition as a CONTINUE. *Never* count on either process to control program flow; if necessary, detect the initial value before entering the loop, and then branch accordingly.

Machine dependent ranges

Integers. The maximum absolute value of an integer is $2**47-1$ or $140\ 737\ 488\ 355\ 327$.

Reals. The maximum absolute value of the exponent is $3\emptyset 8$; the limit for significant digits is $2**36-1$, or slightly less than $6.8*10**10$.

Double precision. The exponent limit is $3\emptyset 8$ and the limit for significant digits is $2**84-1$, or slightly more than $1.7*10**25$.

4

Initialization of variables

Do not count on machine initialization of storage to zero or some other value to provide the first value of a variable: use the data statement or an arithmetic replacement.

4. UNITS OF MEASUREMENT

Units should be SI (<u>S</u>ystème <u>I</u>nternational d´unités)(Page and Vigoureaux, 1972). The NOAA policy on units is the same as that of NBS (1971), which allows you to use non-SI units that are well established in "particular technical areas" provided they are stated in terms of SI. We recommend that you use SI units in the output from programs even though this may not be reasonable for the output from a specific subroutine. In any case, you must state the units of all variables containing final results, preferably on comment cards.

5. SUBMITTALS

Physical program

The physical form of the FORTRAN program or subroutine may be either a deck of cards or a compatible magnetic tape of card images. You need not be concerned with the differences between codes such as BCD and EBCDIC.

Documentation

Integral. The program deck should contain extensive documentation with comment cards; we will doubtless appreciate your putting in more comments than you think necessary. Comments are easier to find and to read if they begin somewhere other than in column SEVEN; we prefer column THREE or indentations to column NINE and beyond. You may include a listing of your deck or tape at your option.

Independent. We require a list of published scientific papers on the physics and chemistry of your model, or copies of reports intended for publication. Any reports on the operation of the program itself are most welcome.

6.   REFERENCES

IBM (1971) Publication IBM System/360 and System/370 FORTRAN IV Language, GC-28-6515-8 with amendment GN28-0595.

NBS (1971), Policy for NBS usage of SI units, Reprint from Technical News Bulletin 55, No. 1, 18-20 (Jan.).

Page, C.H., and P. Vigoureaux (1972), The international system of units, Internat. Commission on Weights and Measures, NBS Spec. Pub. 330 (translated by Page and Vigoureaux).

Stevenson, W.S. (1972), Computer Services General User's Guide, Computer Services, ERL, National Oceanic and Atmospheric Admin., Boulder, Colo. (Apr).