

5 May1994

Update on V4.60 TNT products

Introduction

V4.51 of **TNTmips** has held up well for its many users. One intensive user reported only one General Protection Fault (**GPF**) error in 2 weeks of extensive and varied use. This error occurred while filtering an image and the spatial filtering process was drastically revised, extended, and improved in **V4.60**. **V4.60** will prove to be even better than **V4.51**. The delay in shipping **V4.60** from March to mid-April was to test it as much as possible and to eliminate known problems.

Those users of **V4.60** experiencing abnormally slow general operation, **GPFs**, and Application Errors from Microsoft Windows 3.1 (**MSW3.1**) should now suspect their setups. Microlimages daily receives FAXes containing the contents of **AUTOEXEC.BAT**, **CONFIG.SYS**, **SYSTEM.INI**, and **TNTMIPS.INI** files. Frequently, upon review of these files, our technical support staff is able to make recommendations for their alteration which speed up or eliminate inconsistencies in the setup of **MSW3.1** and the operation of **TNTmips**. Please do not hesitate to ask for a review and recommendations for modifications of these files from technical support. Remember, because low demand software is operating properly in **MSW3.1** does not mean that it can not be made to operate better along with **TNTmips**.

Microlimages now has released the entire new **TNT** product line and processes for the first time on almost every available platform. Effort for **V4.70**, and perhaps longer, will concentrate on improving the efficiency and features of these existing processes. Some of these efforts are outlined below as plans for **V4.70**. However, during this period new features will not be totally ignored as it is the nature of Microlimages to keep exploring new concepts and their uses.

A useful article for those who plan to purchase or upgrade an existing PC is: [How Much Memory Do You Need?](#) in PC Magazine, Rick Ayre, 17 May 1994, pp. 115-133.

Further Comments on TNTmipsTM 4.6

ARC/INFO **E00** format.

Work on importing the **E00** (e.g. EXPORT) format used by ESRI continued after the release of **V4.60** and is now complete. **E00** is the file format which ESRI uses to move their complete data sets (coverage files) between different types of computers. It has now been possible to decipher the compression method used by ESRI. Thus, subsequent to shipping **V4.60**, this import process was modified so that it can now import from either the compressed or uncompressed versions of these **E00** files.

Extending this import to accommodate the compressed format was important because often you receive such datasets from someone else and are not in control of the **E00** format selected, which defaults in ARC/INFO to compressed. Please also note that this compressed format is not particularly efficient. It reduces the files by 40% at most. Also the accompanying database records are now correctly transferred from **E00**. This revised process can be obtained via Technical Support.

Faster operation and other improvements are being researched for the import and export process of **TNTmips 4.7** so please continue to identify formats which appear to be slow or produce incorrect results.

Removing Excess Nodes from Digital Chart of the World (VPF format).

After importing a **VPF** theme(s) into a vector object please run the vector editing process on it and specify that you wish to remove excess nodes and produce a new vector object. The presence of excess nodes in vector objects imported from the **VPF** iformat, or any other vector object, are transparent to the operation of **TNTmips 4.6** and earlier processes.

Excess nodes are also created as artifacts of assembling and validating the topology of a vector object. For example, ARC/INFO line segments are limited to no more than 500 vertices and are terminated by a node. A vector object in a TNT Project File does not have any practical limit on the number of vertices in a line. However, the import of the ARC/INFO data will create a vector object with these nodes which are excess and ignored by TNT processes. In general, excess nodes merely expand the storage space required for the vector object and correspondingly slow down its subsequent use in greater or lesser amount depending upon the number present.

In MicrolImages and ESRI parlance, a line is not necessarily straight and can be made up of vertices which define its shape and a line must be terminated at each end by nodes. The entire line has identically the same attributes and can not have any intermediate nodes. Thus, excess nodes such as those in long ARC/INFO lines are those which do not have attributes attached to them and at which 2, and only 2 lines meet, and which have identical attributes.

It is important to note that it is possible that nodes (not excess nodes) will occur between 2, and only 2 lines which meet and have identical attributes when such a node has attributes attached to it. These nodes may represent valves in a continuous pipe, tunnels in a road, and related point control features in what may appear to be a single continuous line.

Excess nodes also occur in the vector objects created by importing and assembling other vector data types. For example, the **VPF** data has excess nodes at the boundaries of the **VPF** tiles where two identical lines, one from each vector tile, were joined. At present they are not removed by the topological or validate process which runs as the last step in the import process or by other processes which create vector objects. However, they can be removed in the vector edit process by selecting this option and creating a new vector object. This will remove the excess nodes by splicing the many divided lines.

More effective methods are now being investigated for **V4.70** for managing the use and creation of vector objects to prevent the formation of excess nodes and automatically remove them during import processes. The buffer zone process is currently being rewritten for **V4.70** to increase its speed and eliminate the large number of excess nodes it creates in **V4.60**.

An example of the effect of removing excess nodes from a vector object which has been imported from **VPF** makes their effect clear. On page 17 of the Release MEMO (31 March 1994) for **V4.60**, times and sizes were reported for the import of the railroad theme for all of North America. Subsequent removal of the excess nodes from this

vector object significantly improves the display performance previously reported. Before removing excess nodes and splicing lines the vector object has 29595 nodes, 32696 lines, 3498 polygons, 0 points, and 42 labels. After using vector edit process to clean up this same vector object it has 11107 nodes, 14208 lines, 3498 polygons, 0 points, and 42 labels.

As reported earlier, the display of this **DCW** railroad theme from CD-ROM by the software provided with the Digital Chart of the World took 6 minutes. Without removing the excess nodes to compress the same vector object, its display in **TNTmips** 4.60 required 21 seconds. After creating the new, compressed vector object without these artifacts the same display took 11 seconds. Clearly, reducing the vector object size gives a directly proportional reduction in the time for its display and other uses.

Importing a Subarea from VPF.

Some of the themes (e.g. drainage) in this VPF dataset for the large continental areas provided by each CD-ROM are huge relative to PC use, well over 100 megabytes for a single vector object. It takes a lot of computing and hard drive resources to import and manage such large vector objects. Efforts have continued on the **VPF** import process and it now allows for the import of geographic windows from each theme where you require only the area covering a country, state, or satellite image.

Remember that the **VPF** is organized into tens of thousands of theme, attribute, and descriptive files representing 5 by 5 degree tiles. Modifications of the **VPF** import process in **TNTmips** subsequent to the release of **V4.60** now permit the selection and import of any latitude and longitude box by entering its geographic extent. The process will then import into a vector object all **VPF** tiles which contain any portion of the extents requested (e.g., if you need only 1 by 1 degree area from within a 5 by 5 degree source tile, you will get it all). As a result, your imported vector object will usually be larger than the geographic area you specified. Thus, after import it will be necessary to trim down to the precise area you need using the copy vector process. There are no plans to refine this import process to have it trim to the exact area required. Assembling each theme from its many tiles and reconstructing and validating its topology is messy, and MicroImages has not located anyone who plans to provide additional data in this complex and cumbersome format.

A geographic extent specified during import which spans any area off the edge of the coverage of a **DCW** CD-ROM will be truncated at the edge if some of the required data is contained in tiles on another CD-ROM. However, the 4 CD-ROMs contain considerable overlap at the edges over the land areas, so this should not be a problem.

This revised **VPF** process to import a specified extent, but which does not yet automatically remove excess nodes, can be obtained now from Technical Support, or via **V4.70**.

Test use of Subarea from VPF.

As a test a subarea of **VPF** data was imported for a 15 by 15 degree vector object covering California and surrounding area. The import of all 17 themes for this area into separate vector objects on a DEC AXP Alpha (150 mHZ) running NT required 5 hours. The total of the Project File containing these 17 vector objects for this test area was 20.2 megabytes after removing the excess nodes. Using this same computer, each vector object was then selected as a layer in 2D display and the lines designated to

display in the same colors as they display via the **DCW** software. The display of all 17 themes in this fashion required 26 seconds. A similar display of the same 17 layers for a 5 by 5 degree subarea selected by 2D display from the same Project File and 17 vector objects required 17 seconds. For comparison, the table below contains the results of the same display tests with TNTmips on other platforms. It should be noted that the times to display these objects in this test fashion do not reflect differences in display boards, use of MI/X, and other display issues. These test times are primarily controlled by the processor available as extensive floating point coordinate conversion is involved in computing the transformation of every vertice in every line into the View Window's coordinate framework.

all times shown in seconds for:	15 by 15	5 by 5 degrees
DEC AXP Alpha (150 MHz - 32 mb memory) with MSNT	26 sec.	17 sec.
Gateway 586 (66 MHz - 24 mb memory) with MSNT	32	20
Gateway 586 (66 MHz - 16 mb memory) with MSNT	32	20
Gateway 586 (66 MHz - 24 mb memory) with MSW3.1	38	26
Sun SPARCstation LX (16 mb memory) with Solaris 1.x	51	22
Sun SPARCstation LX (16 mb memory) with Solaris 1.x [1]	57	25
CAF 486 (33 MHz - 16 mb memory) with MSW31	104	56
CAF 486 (33 MHz - 16 mb memory) with MSNT	116	57

All objects used had the correct byte order for their processor unless noted. Also all machines including Sun were isolated from the network and other multitasking demands. MSNT = Microsoft Windows NT. MSW3.1 = Microsoft Windows 3.1.

[1] Project File and all vector objects were created on under MSW3.1 and thus had reverse byte order for the Sun.

Interesting interpretations can be made of the results in the table above. MicroImages will be conducting further testing of various tasks (e.g., buffer zones) and reporting the results by platform and operating system.

Exporting TYDAC SPANS.

A very minor alteration was made to the process for exporting TYDAC data which can be obtained from Technical Support now or later via **V4.70**. With this change you can now specify that each vector element will have 1, and only 1, record in the TYDAC database file (*.TBA). Previously, more than one vector element could be attached to an entry in a *.TBA file.

Increasing Precision in Georeferencing.

It is doubtful that any of you know, nor did we, that there are two accepted definitions of the "foot" unit of measurement: the international foot = .3048 meters and the commonly used U.S. Surveyors foot = .304800609601219 meters. Obviously, the choice of which standard conversion is selected begins to affect how things from different sources, areas, and map projections fit together. The **TNT** products handle all computations in meters, and thus are affected by the choice of these units when you are using the foot or meter as the unit of measurement and combining data from metric sources with data from U.S. unit sources.

All other factors being correct, such as the geode and others, the difference between these units can cause a difference of 2.5 feet in the length of 4 million meters measured north from the equator. Thus, this is a factor to be reckoned with in the use of **TNT**

products for certain applications and with the increasing accuracy of **GPS** measurements which are independent of their length. All **TNT** processes are being modified to allow you to use either definition of the length of the foot, depending upon the source of your material. These precision adjustments in **TNTmips** affect many processes and will thus first become available with **V4.70**. Additional measurements of length will also become available including the chain = 66', nautical miles, additional U.S. definitions, and so on.

Further Comments on TNTsdk™ 4.6

TNTsdk information.

A small piece of information was omitted from the previous Release MEMO (31 March 1994) for **V4.60**. It failed to note that descriptions were provided for 550 additional functions leaving about 50 obscure functions without descriptions from among the 1950 distributed with **TNTsdk 4.6**.

Exclusive International Representatives

Japan. MicrolImages is pleased to announce that it will now be exclusively represented in Japan by OpenGIS Corporation; Kinokuniya Building 6F, 1-19-14 Azuma-bashi; Sumida-ku, Tokyo 130; voice (8133)622-9315; FAX (8133)623-3025; ask for Dr. Toshihiko Waza. This is a new company just being formed by Dr. Waza and partners to provide GIS and image processing software, systems, support, and related services in Japan. Dr. Waza has a Ph.D. in Geophysics from Tokyo University in 1984. Since then, and until leaving to form this new company, he has been in a management position with PASCO, the long-time exclusive distributor of ARC/INFO and ERDAS products in Japan.

Italy. MicrolImages will no longer be Represented in Italy by GALILEO SISCAM S.p.A. All clients and potential clients in Italy have been informed of this and requested to seek assistance directly from MicrolImages. Direct support of the sale and use of the **TNT** products in Italy will continue by MicrolImages until a new Representative is appointed.

India. MicrolImages will no longer be Represented in India by Kirloskar Computer Company. All clients and potential clients in India have been informed of this and requested to seek assistance directly from MicrolImages. Direct support of the sale and use of the **TNT** products in India will continue by MicrolImages until a new Representative is appointed.

Enhancements for V4.70.

The following are some enhancements underway for existing processes for **TNTmips 4.7**. These activities illustrate the improvements which can be expected now that MicrolImages has the opportunity to shift more emphasis toward improving the features, efficiency, and speed of existing processes.

RVC Buffering.

The size and other aspects of the memory buffering used in reading and writing **RVC** Project Files are being revised to possibly speed up data access operations. For example, where memory is available, a whole row of raster tiles will be read into memory to increase the processing speed where tiled raster access is not feasible, such as in certain printing operations.

Buffer Zones.

The computational approach for computing buffer zones around elements in vector objects has been rewritten to speed it up significantly over V4.60 and eliminate its tendency to generate many excess nodes. It has already been verified by clients that the buffering process in **TNTmips 4.60** is significantly improved in performance relative to **MIPS V3.33**. Results to date for **V4.70** indicate that further speed improvements over **V4.60** should be from 3 to 10 times faster depending upon the nature of the elements being buffered. For example, complex drainage lines made up of many vertices will produce yield lower improvement when compared to a city road network made up of many long straight lines with few vertices.

Validating Vector Objects.

The validation (Fix) process for vector objects is being redesigned to speed it up and also eliminate its tendency to generate excess nodes. These same enhancements can then be included in every other process which validates topology.

Raster Import/Export.

The process for importing selected raster formats are being improved to speed them up. If you believe a particular raster import is slow please communicate that information to us as soon as possible for review for possible improvement in **V4.70**.

MicroImages X Server.

The MicroImages X Server (**MI/X**) for **MSW3.1** is being adjusted to speed up its use of the "backing store" process used in the X Window System. This would provide **TNT** products with faster save and restoration of the background areas under pull down menus and option menus. Effort is also being expended to try to support sockets in **MI/X** for **MSW3.1** so that full **X** terminal support would be available via **MI/X**.

Printing.

The time required to create a print-raster in Map and Poster Layout was reduced significantly in **V4.60**. Considerable effort continues to reduce this time even further for **V4.70**. The following review of the time required to create a large sample print file shows the considerable improvement to date.

The layout used to create the test print-raster consisted of a non-georeferenced 8 bit color composite raster of 12271 lines by 2432 columns. The group orientation specified that the projection was oriented to the top. The resampling method was set to use the affine approximation. The printer selected was a Versatec CE3444/8944. The media size was 44 inches by 70 inches. The resolution was 400 dpi. The dither pattern used was dot diffusion 2. The raster was read from an **IDE** hard drive and the print raster was written (as strongly recommended) to a separate physical hard drive using a Trantor T130 **SCSI** interface. This sample layout was computed on a 486 based PC of 25 megahertz with 8 mb of RAM memory.

<u>TNTmips</u>	<u>Time to print the print-raster</u>
V4.51	17 hours and 43 minutes
V4.60	5 hours and 44 minutes
V4.70	4 hours and 45 minutes

Symbol Design.

The interactive process used to design symbols for display of points is being expanded and enhanced to allow you to create more complex shapes. The release of the pin

mapping process in **V4.60**, as well as other recent enhancements, has indicated the need for more complex shapes for point symbols. Another feature added to this same process will be the ability to design accurately defined symbol shapes by numeric entry of parameters. Accurate symbol shapes are required where these symbols will be used at a variety of scales. A qualitative interactive approach can produce symbols which appear fine in small size but which look distorted when zoomed.

Supervised Back Propagation Classification. This process was first released in prototype form in **V4.60** and has now been improved to expand the number spectral bands and training set points used to much larger numbers. These parameters were limited in **V4.60** to 7 bands and 2500 cells.

You may find interesting the paper Neural Network Approaches Versus Statistical Methods in Classification of Multisource Remote Sensing; Jon A. Benediktsson, Philip H. Swain, and Okan K. Ersoy; 1990; Vol. 28, No. 4 of the IEEE Transactions on Geoscience and Remote Sensing; pages 540 to 552. Supervised Back Propagation represents a neural network approach while Maximum Likelihood represents a statistical approach to classification. Multisource, in the context of this paper, means not only using multispectral bands as variables, but also elevation, slope, aspect, and other rasters which are not statistically well behaved (i.e., not approximating a normal distribution). In general the neural network methods are slower, however, if computer time is discounted as a variable (e.g., you own the machine outright) then both concepts produce similar results if all the multisource images (i.e., rasters) used have data distributions which approximate a normal distribution. However, neural network approaches give improved results when some of the multisource raster do not meet this condition.

DEM/Orthophoto.

Some of the flaws in this process which require work arounds in the **V4.60** (and earlier) **DEM/Orthophoto** process are being fixed.

Spatial Filters.

The spatial filters process is being extended to allow you to test or preview the results of a filter design. These interactive filter test features were present in **MIPS V3.33** and are now being converted into **TNTmips**. The process has also been modified to allow you to specify the data type (integer, real, 2-byte integer, etc.) for the new raster objects created.

Route Tracing.

The simple vector route tracing process available in **MIPS V3.33** is being transferred into **TNTmips**.

DEC via OSF/1

MicroImages has finally received a **DEC** Alpha 3000 model 600 with **OSF/1 (UNIX)** so that **TNTmips 4.7** will be available on this platform. This computer is rated at 175 SPECmarkf and approximately the same of SPECmarki. For comparison, the Sun SPARCstation 10 and related venue workstations provide 40 to 60 SPECmarks of performance while the IBM RS/6000 model 220 provides about 20 SPECmarks. It will be interesting to observe the use of **TNTmips** processes on this powerful desktop unit which will immediate pin-point those which are input/output bound for further critical examination.

Native Macintosh.

MicroImages is investigating the possibility of applying the **MIX** approach to using the **TNT** products on all Apple Macintosh computers. Creating a **MIX** interface for this platform would then make the operation of **TNTmips** the same on the Macintosh platform as on computers using **MSW3.1**, **MSNT-I**, and **MSNT-A**. Apple has declared that **AUX** will not be ported to the new PowerPC platforms and their other plans in this direction are vague and indeterminate. Should the **MIX** strategy prove viable, **TNTmips** would operate on any current or new Macintosh including their color portables with sufficient computing power and memory. All **TNT** products would then operate on the Macintosh computers without special drive formatting or the use of any Unix such as **AUX**, **AIX**, PowerOpen, etc.

2D Display.

A new visualization feature is being added which will geographically lock 2 or more View Windows together when opened within a single **2D** display process. A simple illustration of the use of this new feature would be to display a portion of a georeferenced scan of a color map in a View Window. A second adjacent View Window of any size could then be opened and a georeferenced image selected and automatically displayed for the same area, scale, and projection as the reference map in the first window. These two locked windows would display matched tandem views in any supported map projection regardless of the projection in which they were created and stored. Scrolling and zooming the contents of any window will automatically scroll or zoom the contents of the others to which it is locked. In summary, two or more View Windows containing complex layers of raster, vector, and **CAD** objects, text layers, and so on will thus be locked together and their contents automatically manipulated in tandem.

This modification to geographically lock dual View Windows will support the future stereo image display processes planned for **TNTmips** and **TNTview** using the \$200 Cyberscope stereo viewing hood Simalabim Systems for 14 to 17 inch monitors (brochure included). Simalabim has indicated that a unit to fit 19 to 21 inch monitors is planned. Test use of this simple stereo hood viewer has produced better stereo image viewing than any of expensive, complex active and passive stereo viewing devices previously tested or supported by MicroImages. The device also works better and more conveniently at much lower cost than the mirror stereoscopes tested. With this viewer, any **MSW3.1** monitor, and **TNTmips** you will be able to view good quality color stereo images. The stereo locking of the dual View Windows will enable the common area of the stereo images to be rapidly displayed, viewed, scrolled, and zoomed while retaining the stereo lock and image fusion. With high resolution display boards of 1200 by 1600 pixels, the stereo view of scanned air photos can provide very good quality results similar to viewing photographs.

Of course, stereo viewing alone is often only a curiosity. However, plans for future releases of **TNTmips** and **TNTview** will build upon this "locked" viewing option to allow **3D** digitizing via edit vector or edit **CAD** while viewing in stereo. These **RVC** line object formats already support X, Y, and Z coordinates but are currently restricted to manually entered z values (e.g. contour elevation values). Other new **3D** features could include measurements of heights of objects, volumes inside polygons drawn with a mouse, display and measurement of cross sections, and other interesting new opportunities as

additional **3D** visualization, **GIS**, and analysis procedures make their way into the **TNT** products.

Surface Fitting.

The various improvements in the surface fitting processes in **V4.60** included significant reductions in their execution times. Additional effort is being expended to further reduce the time to execute the inverse distance and profiles surface fitting methods. This is important as clients are now applying these surface fitting processes to vector objects containing up to 2 million points.

Map Projections.

The Space Oblique Mercator (**SOM**) projection used for Landsat **TM** imagery has been added. The processes which import the TIPS and Fast Format Files are also being modified to transfer the **SOM** georeference information to the raster objects as created. The Bipolar Oblique Conformal Conic is being added for covering both North and South America in a single vertical map. The New Zealand and some other projections previously requested will also be provided.

The following is a list of projections recently documented in equations by the U.S. Geological Survey. If you find one you need please let us know and it may be added (about 20% do not have an inverse equation defined and can not be used).

- | | | |
|--------------------------------------|--------------------------------|--|
| Airy | Aitoff | Apian Globular I |
| August Epicycloidal | Bacon Globular | Boggs Eumorphic Bonne (Werner lat_1=90) |
| | Cassini | Central Cylindrical Equal Area Cylindrical |
| | Chamberlin Trimetric | |
| Collignon | Craster Parabolic (Putnins P4) | Denoyer Semi-Elliptical |
| Eckert I | Eckert II | Eckert III |
| Eckert V | Eckert VI | Eckert IV |
| Fahey | Foucaut | Equidistant Cylindrical (Plate Caree) |
| Gall (Gall Stereographic) | | Foucaut Sinusoidal |
| General Sinusoidal Series | | Ginsburg VIII (TsNIIGAiK) |
| Mod. Stererographics of 48 U.S. | | Goode Homolosine |
| Hammer & Eckert-Greifendorff | | Mod. Stererographics of 50 U.S. |
| Kavraisky V | Kavraisky VII | Hatano Asymmetrical Equal Area |
| Larrivee | Laskowski | Laborde |
| Lee Oblated Stereographic | | Lagrange |
| McBryde-Thomas Flat-Polar Sine | | Lambert Equal Area Conic |
| McBryde-Thomas Flat-Polar Parabolic | | Loximuthal |
| McBryde-Thomas Flat-Polar Sinusoidal | | McBryde-Thomas Flat-Pole Sine (No. 2) |
| Mod. Stereographics of Alaska | | McBryde-Thomas Flat-Polar Quartic |
| Nell | Nell-Hammer | Miller Oblated Stereographic |
| New Zealand Map Grid | | Mollweide |
| Oblique Cylindrical Equal Area | | Nicolosi Globular |
| Ortelius Oval | Perspective Conic | Near-sided perspective |
| Putnins P3' | Putnins P4' | General Oblique Transformation |
| Putnins P6 | Putnins P6' | Oblated Equal Area |
| Sinusoidal (Sanson-Flamsteed) | | Putnins P1 |
| Transverse Cylindrical Equal Area | | Putnins P2 |
| Tilted perspective | Universal Polar Stereographic | Putnins P3 |
| | | Putnins P5' |
| | | Quartic Authalic |
| | | Rectangular Polyconic |
| | | Transverse Central Cylindrical |
| | | Two Point Equidistant |
| | | Urmaev V |

Urmaev Flat-Polar Sinusoidal	van der Grinten II	van der Grinten III
van der Grinten IV	Wagner I (Kavraisky VI)	Wagner II
Wagner III	Wagner IV	Wagner V
Wagner VII	Werenskiold I	Winkel I
Winkel Tripel		Winkel II

The sources of the detailed information on these projections and geoids noted below are available on Internet (FTP charon.er.usgs.gov) and include Cartographic Projection Procedures for the UNIX Environment - A User's Manual, USGS Open-File Report 90-284, Gerald I. Evenden, 1990 and revised 1991, 64 pages. Also Cartographic Projection Procedures, Release 4, Interim Report, Gerald I. Evenden, 1994, 42 pages. Also Cartographic Projection Procedures, Release 4, Second Interim Report, Gerald I. Evenden, 1994, 42 pages, 21 pages.

Geoids

The following new definitions of the shapes of the earth have been supported. If the geoids already defined in **V4.60** or below do not cover one you need then please supply us with its name, year, semi-major axis, semi-minor axis or inverse flattening (or equivalent).

Geoids added in **V4.70**:

MERIT 1983	SGS 1985	Applied Physics 1965
WGS 1984	Engelis 1985Naval	Weapons Lab 1965
WGS 1960	Kaula 1961	Delambre 1810 (Belgium)
Everest 1965	Lerch 1979	Bessel 1841 (Namibia)
Everest 1969	Fischer Modified 1960	Plessis 1817 (France)
Maupertius 1738	Andrae 1876 (Denmark and Iceland)	
Comm. des Poids et Mesures 1799		