

CHANGE OF GEOGRAPHICAL REFERENCE SYSTEM IN THE HRIT/LRIT GLOBAL SPECIFICATION

WMO-WP-25 proposes an amendment to the CGMS HRIT/LRIT Global Specification (CGMS 03) with effect to align the geographical reference system of the normalized geostationary projection with the internationally agreed standards World Geodetic System 1984 (WGS84) and Earth Geodetic Model (EGM-96) as recommended by the WMO Commission for Basic Systems.

It is emphasized that the current discrepancy between the HRIT/LRIT Global Specification and these international standards is a potential source of confusion and generates a risk of positioning errors when merging data with e.g. GPS-based sources, or Geographic Information System (GIS) applications, or when exchanging data with these communities.

The space agency representatives participating in the sixth meeting of the Expert Team on Satellite Systems (ET-SAT-6) thus unanimously agreed that CGMS should be requested to update its HRIT/LRIT Global Specification. The amendment would affect three parameters in Section 4.4.3.1 (Geographical coordinates) and Section 4.4.3.2 (Normalized geostationary projection): the reference meridian, the equator radius and the polar radius, as well as four numerical coefficients derived from these parameters.

Action/Recommendation proposed:

1. CGMS Secretariat to prepare an amendment of the CGMS HRIT/LRIT Global Specification (CGMS 03) with effect to adopt the geographical reference system of the World Geodetic System (WGS84) and Earth Geodetic Model (EGM-96) as described in CGMS-39 WMO-WP-25.
2. CGMS satellite operators to adopt the World Geodetic System (WGS84) and Earth Geodetic Model (EGM-96) geographical reference systems for the normalized geostationary projections in all future geostationary systems and related products, and inform the users accordingly.

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1. BACKGROUND

The Commission for Basic Systems adopted in 2006 the Recommendation 6.1/1 on *Adoption of a World Geodetic System and a Global Geoid Model as References for Positioning the Observing Station* (See Appendix). It recommended:

- (1) The World Geodetic System 1984 (WGS84) be used as the primary reference for horizontal positioning;
- (2) The Earth Geodetic Model (EGM-96) be used as the fixed reference level for Mean Sea Level determination;

The WGS84 is maintained by the United States National Imagery and Mapping Agency (NIMA) and is described in NIMA Technical Report TR8350.2. The WGS84 uses as prime meridian the IERS Reference Meridian (IRM) established by the International Earth Rotation and Reference Service (IERS). The EGM-96 documentation is included in the latest version of WGS84.

It may be noted that the refinement of this system was due to a large extent to satellite observations, in particular altimetry data from the GEOSAT, ERS-1 and TOPEX/POSEIDON satellites and additional satellite tracking data from geodetic satellites at various inclinations. It is the coordinate system used by the Global Positioning System (GPS).

2. WGS84 CHARACTERISTICS

The WGS84 reference ellipsoid is characterized by four parameters, of which several geometric constants are derived, some of them are indicated below:

WGS84 Four Defining Parameters

Parameter	Notation	Value
Semi-major Axis	a	6378137.0 meters
Reciprocal of Flattening	1/f	298.257223563
Angular Velocity of the Earth		7292115.0 x 10 ⁻¹¹ rad/s
Earth's Gravitational Constant (Mass of Earth's Atmosphere Included)	GM	3986004.418 x 10 ⁸ m ³ /s ²

Some WGS84 Ellipsoid Derived Geometric Constants

Constant	Notation	Value
Semi-minor Axis	b	6356752.3142 m
Mean Radius of Semi-axes	R1	6371008.7714 m
Radius of Sphere of Equal Volume	R3	6371000.7900 m

3. DIFFERENCES BETWEEN THE LRIT/HRIT GLOBAL SPECIFICATION AND WGS84

The definition of the normalized geostationary projection in the LRIT/HRIT Global Specification CGMS 03 (http://www.eumetsat.int/groups/cps/documents/document/pdf_cgms_03.pdf) uses a geographical reference system which departs from WGS84 on three elements:

- The reference meridian is the Greenwich meridian instead of the IERS Reference Meridian.
- The IRM is 5.31 arcseconds East of the Greenwich meridian, which corresponds near the Equator to a shift of about 164 m;
- The equator radius is 6378169.0 m instead of 6378137.0 m, i.e. a difference of 32 m;
- The polar radius is 6356583.8 m instead of 6356752.3142, i.e. a difference of 168.5 m.

These differences are a potential source of confusion and generates a risk of positioning errors when merging data with e.g. GPS-based sources, NWP, Geographic Information System (GIS) and various land surface applications, or when exchanging data with these communities.

4. PROPOSED CHANGES TO THE LRIT/HRIT GLOBAL SPECIFICATION

With respect to the LRIT/HRIT Global Specification CGMS 03 Issue 2.6, the proposed changes are located in Section 4.4.3.1 and 4.4.3.2 as indicated in the table below:

Element	Old value	New value	Location
Reference meridian	Greenwich meridian	IERS Reference Meridian (IRM)	4.4.3.1, 2 nd paragraph p.21 and Figure 4.6, p.22
Equator radius (r_{eq})	6378.1690 km	6378.1370 km	4.4.3.2, 2 nd paragraph, p.22 and formula on top of p.23
Polar radius (r_{pol})	6356.5838 km	6356.7523 km	4.4.3.2, 2 nd paragraph, p.22 and formula on top of p.23 and formula r_l p.24
$(r_{eq}^2 - r_{pol}^2) / r_{eq}^2$	0.00675701	0.00669438	Formula r_l p.24
r_{pol}^2 / r_{eq}^2	0.993243	0.993306	Formula c_{lat} p.24
r_{eq}^2 / r_{pol}^2	1.006803	1.006739	Formula (lon, lat) and formula S_n and formula S_d , all on p.25
Coefficient for S_d	1737121856	TBD	Formula S_d , p.25

Incidentally, on p.23, first line, “ l_e ” should be corrected by “ e ”.

5. CONCLUSION

CGMS is invited to update the LRIT/HRIT Global Specification (CGMS 03) in order to align the geographic reference system of the normalized geostationary projection with the WGS84 geodetic references.

CGMS satellite operators are furthermore invited to subsequently adopt this geographical reference system in their mission specific implementation of the global HRIT/LRIT specification, and more generally speaking in the implementation of their programmes.

Appendix:

Rec. 6.1/1(CBS-Ext.(06)) – ADOPTION OF A WORLD GEODETIC SYSTEM AND A GLOBAL GEOID MODEL AS REFERENCES FOR POSITIONING THE OBSERVING STATION

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

- (1) The position of a weather station is given by longitude, latitude and altitude,
- (2) No standard reference system has been endorsed by the WMO to be used as the reference for both horizontal and vertical position of a station,
- (3) Both longitude and latitude require one universal standard positioning system as reference,
- (4) The *International Meteorological Vocabulary* (WMO-No. 182) defines the Mean Sea Level (MSL) as the average sea surface level for all stages of the tide over a 19-year period, usually determined from hourly heights observed above a fixed reference level, while the fixed reference level for MSL is yet to be identified,

Considering that:

- (1) The standard reference system the World Geodetic System 1984 (WGS84) is applicable for the worldwide use by all applications used in meteorology,
- (2) Most regional and national systems refer to WGS 84,
- (3) The WGS 84 is endorsed by other international bodies, such as ICAO,
- (4) The Earth Geodetic Model - EGM-96 is applicable for all applications in meteorology,

Recommends that:

- (1) The World Geodetic System 1984 (WGS84) be used as the primary reference for horizontal positioning;
- (2) The Earth Geodetic Model - EGM-96 be used as the fixed reference level for MSL determination;
- (3) The *WMO Technical Regulations* (WMO-No. 49) and the appropriate WMO Manuals and Guides are updated accordingly.