Geostationary Weather Satellites

Encircling and Observing the Earth

a guest article by Dr Donald Hillger

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Currently five countries or groups of countries have operational geostationary weather satellites in orbit. Geostationary satellites have an orbit altitude of approximately 36,000 km above the earth, about 5.6 earth radii away from the earth's surface. This is much higher than either the orbit of the Space Shuttle or the orbits of most of earth's artificial satellites. At this particular altitude satellites orbit with a period of 24 hours, the same period as that of the rotating earth, allowing instruments on geostationary satellites to view the earth below with little or no perceptible motion.

Two types of geostationary weather satellites are in use: spin-stabilized and three-axis stabilized satellites. Spin-stabilized satellites rotate on one axis to maintain stability, and they view the earth below as instruments on the spinning satellite scan past the earth. Three-axis stabilized satellites are held in relation to the earth using star sensors and sensors which detect the edges of the earth. Spin-stabilized satellites have the advantage of simplified design, but suffer from the fact that instruments on the satellite spend much of their time looking away from earth and only a small part of their time looking at the earth. Three-axis stabilized satellites can view the earth continuously, but are somewhat harder to build and maintain in perfect relationship to the earth.

In the United States, the series of geostationary weather satellites is called GOES (Geostationary Operational Environmental Satellite) operated by the National Oceanographic and Atmospheric Administration (NOAA). The two most recent satellites are *GOES-8* and *GOES-9*, launched in 1994 and 1995 respectively. These two GOES are three-axis stabilized satellites, unlike earlier spin-stabilized GOES. Images of the earth displayed during most TV weather reports in the U.S. come from current GOES. Measurements are normally taken every 15 minutes in five spectral bands (one visible band at 1 km resolution and four infrared bands at 4 km resolution) over most of the U.S. *GOES-8/9*, also called *GOES-east* and *GOES-west*, are positioned over the equator at 75°W and 135°W respectively. These orbital positions allow the two satellites to cover the oceans off of both coasts as well as most of the continental U.S.

Spin-Stabilized GOES Satellite
St. Lucia (*Scott* 611)

Three-Axis Stabilized Satellite
Caymen Islands (*Scott* 628)

One satellite can watch the western Atlantic Ocean for hurricanes, and the other satellite can watch the eastern Pacific Ocean for hurricanes and for cold fronts approaching the west coast. Current GOES also carry lower (10 km) resolution 'sounding' instruments which use 19 spectral bands to probe the vertical temperature and moisture structure of the atmosphere.

Only two postage stamps are known to show any of the GOES series of satellites. Cayman Islands issued the only stamp (*Scott* 628) to picture a current three-axis stabilized GOES. This stamp was issued in 1991, three years before the first GOES of this type was launched owing to long delays in satellite construction. In 1983 St. Lucia issued the only stamp (*Scott* 611) known to show an earlier spin-stabilized GOES. In this case the stamp is in a souvenir sheet issued for World Communications Year.

For Europe, the geostationary weather satellites are called *Meteosat*. The current primary satellite is *Meteosat-5* positioned over the equator at 0° longitude. A more recent launch of *Meteosat-6* is operating in backup mode due to an anomaly in the thermal infrared and water vapor images. Meteosats are spin-stabilized satellites operated by Eumetsat, an organization which operates meteorological satellites for European Union countries. Images of the earth from Meteosat are possible every 30 minutes in one visible band at 2.5 km resolution, and in one thermal infrared band and one water vapor band, each at 5 km resolution. Meteosats were the first satellites to provide a geostationary view of atmospheric water vapor associated with upper air currents. Such images are quite valuable to forecasters and as input to computer models of the global atmospheric circulation.

In 1991 Bulgaria issued one of the best representations of the *Meteosat* series on a stamp (*Scott* 3612). A total of eight known *Meteosat* stamps are listed in a table at the end of this article.

Across the Pacific Ocean, the Japanese have a series of geostationary weather satellites. Their satellites are called GMC (Geostationary Meteorological Satellite) or *Himawari* (sunflower). The current operational satellite is *GMS-5* launched in 1995 and positioned over the equator at 140°E. GMS are spin-stabilized satellites like early GOES and current Meteosats. Images of the earth from GMS are possible every 30 minutes in one visible band at 1.25 km resolution, as well as two thermal infrared bands and one water vapor band, each at 5 km resolution.

In 1984 Japan issued the best representa-

Himawari (Sunflower) Satellite
Japan (*Scott* 1564)

Indian National Satellite
India (*Scott* 1020)

tion of GMS on a stamp (*Scott* 1564). A total of four known GMS stamps are listed in the table at the end of this article.

There are other geostationary meteorological satellites in the far east. India commissioned the first three-axis stabilized weather satellite called INSAT (Indian National Satellite), built in the U.S. and launched by the Space Shuttle. Currently there are two operational satellites: one is a first-generation *INSAT-1D* located over the equator at 83°E; and the other is a second-generation *INSAT-2B* located over the equator at 93.5°E, both above the Indian Ocean. Unfortunately for the world meteorological community, India does not share INSAT imagery with the rest of the world. Images of the earth from INSAT are possible every 30 minutes in one visible band at 2 km resolution and one thermal infrared band at 8 km resolution.

In 1983 India issued the only known stamp (*Scott* 1020) showing INSAT. The stamp was issued for World Communications Year since INSAT is a communications satellite as well as a weather satellite.

The only other geostationary weather satellite was launched by the Commonwealth of Independent States (CIS or the Russian Federation). The first GOMS (Geostationary Operational Meteorological Satellite), also officially known as *Elektro*, is positioned over the equator at 76°E above the Indian Ocean. *GOMS-1* was to have been launched many years earlier, but was finally launched in late 1994 after long (cold-war) delays. GOMS is a three-axis stabilized satellite, but the instrumentation is more basic, similar to early GOES, with images of the earth possible every 30 minutes in one visible band at 1.25 km resolution and one thermal infrared band at 6.25 km resolution.

No stamps are known to show GOMS, although Russia has a long history of featuring its meteorological satellites on stamps.

It is worth mentioning that the People's Republic of China should also have a geostationary meteorological satellite, but their first such satellite was seriously damaged in a rocket-fueling accident at the test site. Had it not been damaged, *FY-2* (*Feng-Yun* or wind-cloud) was to have been launched in 1994 and would have been located over the equator at 105°E. The next *FY-2* satellite is expected to be available for launch sometime in 1997.

In conclusion, a list is provided of all known postage stamps showing current geostationary weather satellites. The author would appreciate knowing of any additional stamps that may have been missed.

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Operational Geostationary Meteorological Satellite Positions

Satellite	Country (Agency)	Longitude
GOES-8 (east)	USA (NOAA)	75°W
GOES-9 (west)	USA (NOAA)	135°W
Meteosat-5	Europe (Eumetstat)	0° longitude
GMS-5 / Himawari	Japan	140°E
INSAT-1D	India	83°E
INSAT-2B	India	93.5°E
GOMS-1 / Elektro	Russian Federation	76°E

Table 2: Postage stamps showing current geostationary meteorological satellites

Country	*Scott* Number	Year	Satellite
Bulgaria	3612	1991	Meteosat
Cayman Islands	628	1991	GOES
Central Africa Rep.	C234 (Fig. 1)	1980	Meteosat
Chad	?	1996 ?	INSAT ?
China (Taiwan)	2222	1981	GMS
Ciskei	193 (Fig. 2)	1992	Meteosat
Comoro Islands	392 ss	1978	Meteosat ?
Congo PR	961	1992	Meteosat launch
France	1903	1983	Meteosat
Gr. Britain (Jersey)	561	1991	Meteosat
India	1020	1983	INSAT
Japan	1564	1984	GMS
Korea (South)	1572 (Fig. 3)	1990	GMS
Liechtenstein	956	1991	Meteosat
Maldive Islands	1575	1991	GMS
Morocco	464	1983	Meteosat
St. Lucia	611 ss	1983	GOES
Thailand	1472	1992	GMS
Turkey	2331	1985	Meteosat
Vanuatu	566	1992	GMS
Venezuela	1426e	1992	GOES?

ss = souvenir sheet

The chart is reprinted from a further article *Weather Satellites* by Dr Hillger published in the *Astrophile* or November 1997, which updates the chart in his *Topical Time* article.

The cover below celebrating Arthur C Clarke who conceived the idea of the Geostationary satellite is from Bert van Eijck.