Western Region Technical Attachment
No. 89-22
August 8, 1989

GOES I-M CAPABILITIES

Beginning in 1990, NOAA plans to launch a new generation of geosynchronous environmental (GOES) satellites; by the year 2000, five satellites will have been launched, with many improved capabilities over the current operational GOES satellite. The project, known as "GOES I-M", begins with the launch of GOES-I, GOES-J, and GOES-K in late 1990, 1992, and 1995, respectively, and will continue in 1997 and 2000 with GOES-L and GOES-M. The satellites will be launched by an Atlas Centaur rocket, rather than by the Space Shuttle as was the original plan. The GOES I-M satellites will supplement the other improving technologies and data-collecting instruments in the National Weather Service, such as AWIPS-90 and NEXRAD.

The operational improvements which will be realized from the GOES I-M satellites include an increased total number of images and soundings, increased resolution of infrared images and soundings, more accurate soundings, more frequent data transmission, more viewing channels, and a designed longer operational lifetime. The GOES I-M satellites are projected to last 5-7 years, whereas the current satellites have an expected lifetime of five years. Many of the improvements are directly related to the physical differences between the GOES I-M satellites and the current satellites. The GOES I-M satellites will be "three-axis stabilized" rather than "spin stabilized" (see Figure 1), which means that the sensors will literally be able to stare at the Earth, rather than scan 100 times per minute for a fraction of a second each scan. As a result, the sounder will be able to cover a given area more quickly than before. Because the sounder will be able to "dwell" on a particular location for a period of time (usually less than a second) temperature measurements will be more accurate than before.

The imager and the sounder on board the satellite will be two separate instruments, instead of one instrument with shared responsibility as is now the case (Figure 1). Both instruments will be able to scan at the same time, as well as transmit data at the same time. This will have tremendous advantages over the current instrument which operates on a time-share basis between imager and sounder modes. Furthermore, both instruments are being designed for better accuracy and sensitivity.

Imager

The imager will view in basically the same five channels as the current imager; one in the visible, two in the infrared (IR), one thermal window, and one IR water vapor channel. The exact spectral ranges of the two IR channels will be slightly different than before. The important difference from the current satellite is that the GOES I-M imager will be able to view in all five channels at the same time, and all five channels will be available to the Satellite Field Service Stations (SFSS). However, since GOES-tap can only send one image at a time to the field offices, the same three channels which are currently sent from the SFSSs will be the only images sent, at least initially, from the GOES satellites. The visible/IR combined images will still be available.

The resolution of the IR channels and thermal window will improve from 8 km to 4 km (at the sub-satellite point), and the resolution of the water vapor channel will improve from 14 km to 8 km. The resolution in the visible channel will remain the same, 1 km (sub-satellite point), as it is now.

Derived products from the imager (produced by NESDIS, NMC, NHC, and NSSFC) are expected to include cloud-top heights (temperatures), low-level winds and deep layer mean winds from water vapor and IR images, moisture analyses, sea-surface temperature composites, precipitation estimates, snow cover, and volcanic activity.
The capability to increase the frequency of certain images when severe weather is likely or is occurring will also be improved. Currently, when there is a threat of severe weather, the satellite can go into a rapid-interval-scan mode of operation (RISOP), which provides U.S. images and mesoscale sectors every 15 minutes (or every five minutes for a short period of time). Although much of the coordination of GOES I-M scheduling has yet to be decided, the general plan as of this writing is as follows. There will be three modes of operation: normal, watch, and warning. These modes will be determined by whether the National Weather Service has issued any severe weather watches or warnings. The watch mode will be similar to the current RISOP mode; a contiguous U.S. image and mesoscale sector will become available every 15 minutes, while the full disk image drops from every 30 minutes to every three hours. In the warning mode, the contiguous U.S. and mesoscale images will be available every five minutes for as long as necessary. The availability of different mesoscale sectors, in the case of multiple watches and warnings, is yet to be determined. Many of the expected changes will evolve gradually as the needs of the field are determined. The important point is that the new GOES imager will have the capability of producing more images more frequently than the current imager, and without having to interrupt the operations of the sounder. This will have a significant impact on the ability to monitor severe storms and pre-severe storm conditions.

Sounder

The sounder on the GOES I-M satellites will be able to scan at the same time the imager is scanning, since it is a completely separate instrument. Furthermore, it will have greater sensitivity and accuracy than the current sounder, and will scan in more channels more quickly than before. The new sounder will be capable of viewing in at least 14 channels, and as many as 19 channels, all at the same time; the current sounder views in 12 channels on a time-share basis. This means the new soundings will have greater vertical resolution since each channel measures temperature and moisture at a different level of the atmosphere. Each of the channels will also be narrower than before, resulting in better accuracy. The horizontal resolution of each sounding will increase from 14 km to 8 km (at the sub-satellite point). The sounder will scan an area in 10 km steps, east to west, before dropping 40 km to the south to begin the next east-west scan. A 3000 x 3000 km region can be scanned in 40 minutes (it takes two and a half hours with the current sounder), and a rectangle surrounding the contiguous U.S. can be completed in 35 minutes.

Derived products from the sounder will include temperature and moisture profiles, precipitable water, lifted and total-totals indices, temperature at 20 levels, relative humidity at low, middle, and high levels, dew points, thickness field analyses, and thermal gradient winds.

Increased accuracy and sensitivity, along with the fact that the imager and sounder will be two separate instruments, means there will be improvements in other areas as well. Both instruments will have better pointing accuracy; the sounder sensor location currently has a maximum error of 20 km, but that is expected to improve to 2 km with the new sounder. The imager and sounder are capable of scanning space, as well as full Earth; both use star sensing to determine satellite location, which is especially important after a maneuver.

The GOES I-M satellites are being designed with the flexibility to accommodate future expansions. They will have the versatility to allow for large power and weight variations. Also, a dedicated transponder will detect and relay distress signals from aircraft or ships, continuing the Search and Rescue (SAR) program in operation today. The Weather Facsimile Service (WEFAX) will also have a dedicated transponder to allow WEFAX to transmit without interference from image data.

The start of the GOES I-M era is eagerly anticipated, not only for the improvements in instrumentation and satellite design, but also since current coverage is limited due to only one operational satellite. Along with the installation of NEXRAD radars and the switch from AFOS to the more advanced data-processing system of AWIPS-90 (as well as other new data-collection technologies such as profilers and automated surface observations), the GOES I-M satellites represent a new generation of data collection and processing in the National Weather Service. The GOES I-M satellites are an important part of the modernization plan of the National Weather Service, as we continue to enhance our capabilities through the 1990s and into the 21st century.

Acknowledgements:

Gary Ellrod, Gene Legg, and Carl Staton, NESDIS

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Additional information came from documents produced by the Ford Aerospace and Communications Corporation.