P5.3 RECOMMENDATIONS FROM THE GOES USERS' CONFERENCE

James J. Gurka* and Gerald J. Dittberner
National Environmental Satellite, Data and Information Service (NESDIS)
Office of Systems Development, Suitland, MD

1. INTRODUCTION

The GOES Users's conference was held from May 22 through 24, 2001 in Boulder Colorado, with close to 200 participants from government, the private sector, academia and the international community. It was organized by the National Oceanic and Atmospheric Administration (NOAA) with cooperation of the National Aeronautics and Space Administration (NASA), the American Meteorological Society (AMS), the National Weather Association, the World Meteorological Organization, and the National Institute of Standards and Technology.

The goals of the conference were: (1) to inform GOES users of plans for the next generation (GOES R Series) capabilities; (2) to provide information on the potential applications; (3) to determine user needs for new products, data distribution, and data archiving; (4) to assess potential user and societal benefits of GOES capabilities; and (5) to develop methods to improve communication between the National Environmental Satellite, Data, and Information Service (NESDIS) and the GOES user community. Sessions included: Planned and Potential Sensors for U.S. Geostationary Satellites; User Requirements, Applications, and Potential Benefits from Future GOES; Future International Geostationary Satellites; and Communications, Ancillary Services and Training Issues. The third day of the conference consisted of facilitated breakout sessions in which the user community was asked to provide input to ten questions on their future needs for products, services, data distribution, archiving, training and potential benefits of the next generation GOES to their operations and to society.

This paper will provide a summary of the recommendations provided by the GOES user community. It will also provide an outline of plans for a formal process of communication between NESDIS and GOES users, ensuring that the needs of the entire user community are considered in the design of future systems, products and services.

2. POTENTIAL BENEFITS

During the breakout sessions on the third day, the first question the participants were asked dealt with potential benefits to them and society as a whole. Specifically: "Considering the information presented during this conference regarding the potential benefits and service improvements of GOES, can you foresee additional savings in terms of life, injury avoidance or protection of property? Please indicate the three most important benefits to your program or to society."

Respondents indicated that planned improvements for the next generation GOES would lead to significant improvements in detection of atmospheric moisture and improved quality of satellite derived winds, leading to improved numerical model performance. This together with subjective use of the improved satellite data and products by forecasters, will result in more timely and accurate weather forecasts, including: improvements in tornado warnings; forecasts of hurricane landfall; forecasts of flooding; and forecast detail.

The improved forecasts in general will lead to preservation of life and property; improved quality of life due to better recreational planning; improved safety and economic benefits to commercial, military and general aviation; improved management of energy resources; improved planning and management of ground and marine based transportation; improved fisheries management; improved guidance for State Emergency Managers; cost savings for agricultural applications from better planning of watering, and application of pesticides, herbicides and fertilizers; improved management of water resources and flood control; and improved military operations due to improved forecasts for trafficability, weapons trajectories, ship and plane sorties for storm avoidance, and aircraft carrier operations.

3. DATA AND NEW PRODUCT NEEDS

The second and third questions in the breakout session, asked for the users' needs for real time data and for new products. The primary recurring themes in the user responses follow:

1) Twelve spectral channels should be a threshold requirement for the Advanced Baseline Imager (ABI). These channels should include the following: a) 0.64µ for daytime detection of clouds; b) 0.86µ for daytime detection of clouds, aerosols, vegetation and ocean properties; c) 1.375µ for daytime detection of thin cirrus; d) 1.6µ for distinguishing clouds from snow and water cloud from ice cloud (daytime only) e) 3.9µ for detection of fires, and nighttime detection of low clouds and fog; f) 6.15µ for detecting upper tropospheric moisture and determining upper level flow; g) 7.0µ for detecting mid tropospheric moisture and determining mid level flow; h) 8.5µ determining cloud phase, detecting sulfuric acid aerosols and determining surface properties; i) 10.35µ for determination of cloud particle size and surface properties; j) 10.7µ for detection of clouds, generating cloud drift winds, quantitative precipitation estimates and determination of low level

* Corresponding author address: James J. Gurka, NOAA/NESDIS, FB-4, room 3010B , 5200 Auth RD., Suitland, MD 20746-4304;
email: james.gurka@noaa.gov

water vapor; k) 11.2µ for detection of clouds, generating cloud drift winds, and determination of low level water vapor. l) 12.3µ for detection of volcanic ash, low level water vapor, and sea surface temperatures; and m) 13.3µ for determining cloud-top parameters and determining cloud heights for improved quality cloud drift winds.

2) In addition to the above listed channels, which should be considered absolutely essential, there was a strong recommendation for at least two additional channels: the 0.47µ and the 9.6µ. The 0.47µ channel would be valuable for detecting aerosols and haze in determining slant range visibility for aircraft operations. The 9.6µ channel would be important for detecting ozone and for the detection and forecasting of clear air turbulence. Beyond these channels, providing they would not result in major additional sensor complexity or expense, a 4.57µ channel would be useful for improved determination of precipitable water and a 14.2µ channel would be valuable for more accurate cloud top heights. However, these products will also be generated by the hyperspectral sounder on the GOES-R series.

3) Full disk imagery should be provided from the ABI every 5 minutes.

4) Calibration information and algorithms to generate products should be made available to the user community.

5) The sounder should be able to operate in a rapid scan mode.

6) Soundings are needed in cloudy areas. Conventional GOES clear air soundings should be supplemented either by a microwave sounder in geostationary orbit, or with GOES IR soundings above the clouds and polar microwave soundings.

7) Funding for research and development of new satellite products should be part of the satellite acquisition budget.

8) For developing new satellite products there should be improved collaboration between research and operations.

9) In operations there is a need for a blend of data and products from operational and research satellites.

10) Suggestions for new products include; a) atmospheric aerosols; b) cloud phase; c) cloud particle size; d) surface properties; e) improved satellite derived winds; f) moisture flux; g) improved quantitative precipitation estimates; h) improved volcanic ash product; i) improved products showing threat areas for atmospheric turbulence; j) cloud emissivity; j) improved low cloud and fog product; k) cloud layers; l) probability of rainfall for each pixel; m) improved sea surface temperature product; n) true color product; o) cloud optical depth; p) sulfur dioxide concentration (precursor to volcanic eruption); q) aircraft icing threat; r) ocean color; s) under (ocean) surface features (i.e. coral reefs); t) improved sea ice products; u) improved vegetation index; v) ozone layers; and w) surface emissivity.

4. SPACE WEATHER

The GOES program has included space environment measurements since its inception about a quarter-century ago, beginning with the launch of the Synchronous Meteorological Satellite (SMS-1 in 1974). These measurements have continued to grow in importance as the Nation's reliance on space and ground-based technology affected by the space environment accelerates, and as we embark upon an era of permanent human presence in space with the occupancy of the International Space Station. For GOES-R, the established requirements for observations of disk-integrated solar x-ray flux, disk integrated extreme ultraviolet flux, solar x-ray imaging, energetic charged particles, and the local magnetic field are basically similar to those set for the GOES N series. Proposed improvements include: Increasing the dynamic range of the Solar X-ray Imager (SXI) to better cover the full dynamic range of solar features and instrument modifications that may extend the measurements to other wavelengths; additional channels and increased cadence on the Solar Extreme Ultraviolet Sensor (EUVS) to obtain improved height resolution for thermospheric heating rates and ionization rates , and to monitor solar EUV flares; improved dynamic range and a lower threshold of the Solar X-Ray Sensor (XRS) so that the instrument will be able to monitor the solar x-ray flux even at low activity levels and to help in establishing secular (>10 year) trends in the solar x-ray flux and to extend the Energetic Particle Sensor (EPS) proton measurements down to 30 KeV to better monitor the bulk of Earth's ring current that contributes to spacecraft charging, and to meet specifications that were requested, but not met with the GOES N series. All of these improvements are important for data products that support systems and human activity affected by conditions in the space environment.

5. INSTRUMENT OF OPPORTUNITY

Each of NOAA's three-axis stabilized series of GOES satellites has a place reserved on the Earth-facing side for an Instrument of Opportunity (IOO). The IOO slot is a location for new technologies that provide space, time, and/or spectral resolution of the environment not possible with the preconceived Imager and Sounder. IOO's have been suggested to detect lightning, volcanic eruptions, ozone, sulfur dioxide, ocean color, vegetation and special weather events. To qualify as an IOO on GOES, the proposed instrument must: 1) have potential benefit to NOAA; 2) fit within the allocation constraints; 3) be independently funded, including pre-launch test equipment and the spacecraft accommodation costs; 4) be delivered two years before launch for integration and testing, and 5) not interfere with the existing launch schedule or the operational instruments.

Four of the breakout groups recommended a lightning mapper for an instrument of opportunity; four recommended a special event imager; and three recommended a microwave sounder. There was also a recommendation to provide baseline funding for spacecraft accommodation costs for an IOO.

6. DATA DISTRIBUTION

The current GOES transmits data with a rate of 2.1 Mbits per second. The GOES-R series, with thousands of bands on the sounder, as well as more channels on the imager with higher spatial and temporal resolution, the data rates will increase to 20 to 80 Mbits per second, depending on the amount of data compression used. Options include land line distribution, commercial satellite distribution, or rebroadcast from the GOES. The current L band broadcast may have to be changed to an X band transmission (which has problems with rain fade and low angle reception). This would require completely new reception equipment. The current L band is also the only approved method of transmission while the satellite is moving into position from a storage location. The conference participants were asked to convey their needs for data distribution and provide suggestions for optimum methods of distribution.

Some recurring themes among the user responses include: 1) there is a wide spectrum of user needs with different tiers of data access. There should be a full range of methods of reception to accompany the broad range of data requirements. 2) data distribution should be timely and have low cost and low data rate options available. 3) Data distribution options that should be considered include: a) commercial satellite broadcast; b) direct broadcast from GOES; c) Internet; d) dedicated land lines. e) data acquisition by users from a central location; and f) some combination of "a" through "e". 4) Re-use existing ground station assets and broadcast a subset of the ABI/ABS data streams from decommissioned GOES satellites.

7. DATA AND PRODUCT ARCHIVE NEEDS

The breakout groups recommended that a full spectrum of GOES products, ranging from raw data to highly processed products be available in an archive for applications ranging from the nowcasting scale to the climate scale. The products should be stored in a user friendly format, allowing for easy remote access at minimal cost to the user. The user must also have access to metadata, including information on data and product quality trends due to variations in instrument or satellite performance. Users should be able to browse, select and submit requests for products via the internet. Potential options for product distribution to the users include: File Transfer Protocol (FTP) for electronic transfer, CD-ROMs, and DVDs. Turnaround for most data requests should be less than 1 day, while one week should be allowed for extremely large requests (i.e. years worth of data).

8. NEW DATA INTEGRATION

Participants of the workshop provided several recommendations on ways to minimize the time required for integrations of the GOES-R data stream into operations: 1) leverage data from relevant instruments on other satellites to better understand GOES-R capabilities (i.e. use AIRS and GIFTS data to prepare for ABS; use MODIS to simulate ABI data); 2) provide correctly formatted sample data sets to the user community at least one year prior to the GOES-R launch; 3) requirements for operational algorithms should be identified by the spring of 2002; 4) operational algorithms should be developed 3 to 5 years prior to launch; 5) establish a working group to develop plans to provide sample data sets and for development of new operational algorithms; 6) NOAA should invest in education, training, research, and product development to ensure optimal use of GOES-R products shortly after launch; 7) provide an extended scientific checkout period following the GOES-R launch to allow use of current data and to ease the transition to new data sets. 8) NOAA should have in place a fully operational infrastructure for reception, distribution, processing, and archiving, ready for use with test data sets prior to the GOES-R launch.

8. EDUCATION OF USER COMMUNITY

To ensure maximum return on the investment in the next generation GOES, the breakout groups recommended a comprehensive education program for all levels of GOES users, including: forecasters, emergency managers, recreational users, academia, the media, industrial users, and commercial users. Education programs should be funded as part of the end-to-end GOES program budget.

Methods of education should include: 1) conferences and workshops; 2) web-based training; 3) teletraining; 4) CD-ROM or DVD based training; 5) brief segments on the Weather Channel; 6) educational packages appropriate for Congress, upper level management, and business leaders.

9. SUMMARY AND CONCLUSIONS

The GOES User's Conference was a good initial step for improving communication between NESDIS and the GOES User Community. Participants strongly supported a continuation of the process promoting a two way dialogue between GOES users and those planning the development of the next generation GOES. Recommendations for communication venues included: 1) regular conferences similar to the GOES Users' Conference; 2) formation of working groups to deal with specific issues; 3) provide a bulletin board for information exchange; 4) hold informational sessions at end-user conferences (e.g. NWA, CWSA, AMS, Space Weather Week); 5) provide an updated, focused, supported web site; 6) provide information via e-mail; 7) make an expert team available to all users and instrument developers.

In response to the user recommendations, a permanent working group has been established to deal with action items originating from the conference. Also, a bulletin board has been set up at: http://www.osd.noaa.gov/GOES/feedback/sign.asp for two way communication between NESDIS and the user community. Finally, plans for the next GOES User Conference are being prepared.

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