Data Use Considerations for Application of Decadal Missions in Operational Weather Support

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The definition of "research satellite" and "operational satellite" has blurred. Historically, the main distinction has been in terms of operational system availability and data latency requirements. For the NOAA polar and geostationary backbone satellite systems, that distinction is still true. The GOES-R and JPSS satellite systems both have data availability requirements that exceed 99%. Data latencies for these two systems are also driven by operational needs of the weather community and generally range from 10's of seconds to 10's of minutes. In general, all observational data applications for weather operations are perishable, and the value of the observation can diminish rapidly with increased latency.

Nevertheless, a number of non-operational NASA research satellite systems supplemented by an increasing number of arrangements with foreign satellite data providers are now, or soon will be, used operationally. Some examples include data from AQUA, GPM, SMAP, SENTINEL, RADARSAT, METEOSAT, GCOM, ADM-AEOLUS and HIMAWARI. This growing set of operationally relevant satellite data sources along with improved numerical model data assimilation schemes are making the entire observational system more robust and less likely to be impacted by a single system drop out. Weather operations would far prefer to have advanced satellite capabilities provided most of the time, than to not have access to the data at all because of availability concerns. In terms of latency, the practical data utility ranges from seconds/minutes for lightning data to multiple hours/1-2 days for some hydrology and fire weather applications. Many of the next NASA decadal missions could be operationally relevant, especially with the advent of advanced communications designs and data processing improvements.

Assuming latency and availability considerations make the data useful to operations; consideration also needs to be given as to exactly how the data will be used. Satellite data use in the NWS falls into two general categories: 1) input to numerical weather models used in forecasting and 2) observational situational awareness needed for accurate diagnostics and nowcasting and, in some circumstances, as a supplement to warning decisions. In terms of typical satellite systems definitions, Level-1 processed data are generally applicable to numerical weather models and Level-2 and Level-3 processed data are generally applied in situational awareness applications. For situational awareness and forecast and warning operations, the NWS uses the Advanced Weather Interactive Processing System (AWIPS), which ingests, integrates, and displays model and observational data and contains the production software to provide forecast and warning products to the public.

Advances in numerical modeling will drive many of the improvements to weather, water, and climate forecasting over the next decade. Higher spatial and temporal resolution, more cohesive atmospheric-oceanic coupling, enhancements to fundamental physics packages, explicit modeling of convective processes, and more sophisticated use of ensembles will form the basis for more accurate prediction and development of calibrated probability information. Critical to the value of any modeling system is the accuracy and reliability of its analysis. Assimilation and integration of content from multiple disparate observations, satellite data included, will be crucial inputs to the goal of creating a best state-

of-the-atmosphere, which is continuously updated through time to initialize these numerical guidance products.

As to the human forecaster, the sheer volume of satellite-derived information available operationally is multiplying rapidly, owing to the diversity of spectral channels providing data, the flexibility of scanning strategies, and the low data latency alluded to earlier. Considerable concern exists in the operational community about optimizing the capability to utilize this diverse array of information to enhance decision making while minimizing the potential for data overload or additional pressure on work processes.

At the NWS Operations Proving Ground (OPG), Operational Readiness Evaluations (OREs) are conducted to address these concerns. Forecasters are placed in a realistic operational setting and assigned a variety tasks in which they attempt integrate new or experimental data/tools into their normal operating practices. Typically, these evaluations are comprised of both historical cases and live weather scenarios. In addition, there is intentional effort to test decision-making across a broad spectrum of situations (e.g., flooding, severe thunderstorms, winter weather, fire weather, fog, etc.), service sectors (e.g., emergency management, aviation, marine, tropical, etc.), as well as multiple geographic locations.

Incorporating satellite imagery into weather analysis and forecasting tasks has historically been accomplished by view (or animating) single-channel imagery, sometimes with surface observations superimposed. Evidence is mounting that the best way to integrate satellite imagery for future operations may be through data fusion, merging multi-spectral combinations along with other data sets such as high-resolution gridded model output. Continuing to add data does not necessarily lead to better forecasts. There are definite limits to how much information a forecaster can assimilate for high-pressure decision making. Therefore, as considerations are made for deploying new tools or products, attention must be paid to effective use of data, over and above the amount of data available. Identifying the most valuable combinations, color schemes, and display strategies becomes a priority, along with what training will be required to prepare forecasters to use the data properly, reliably, and intelligently.