Seasat Low-Rate Data System

Abstract. *The Seasat low-rate data system is a distributed, nonreal-time, magnetic-tape system for information processing. Its function is to apply the necessary calibrations, corrections, and conversions to yield geophysically meaningful products from raw spacecraft telemetry data. It also provides a remotely accessible catalog of satellite data.*

The Seasat low-rate data system (Fig. 1) is an end-to-end, data-processing and data-distribution system for the four low-rate sensors [radar altimeter, Seasat-A scatterometer system (SASS), scanning multichannel microwave radiometer (SMMR), and visible and infrared radiometer (VIRR)]. The low-rate telemetry frames were continuously recorded on two satellite tape recorders which alternated between record and playback. The data were transmitted by the satellite by means of the S band in a packet format which included an accurate (200-μsec) time tag. The data were frame-synchronized at the receiving stations and, with the Doppler tracking data, sent over communication lines to the telemetry online processing system (TELOPS). The TELOPS and the telemetry-processing system (TPS) performed initial quality checks of the data and created time-ordered files which were merged into a daily project master data file (PMDF). The daily telemetry file was provided to the attitude determination system, where the satellite attitude history was generated from the raw telemetry by means of an attitude control system model. The orbit determination system utilized the Doppler tracking data to create a "definitive" orbit (accurate to 50 m along track, 30 m cross track, and 30 m radial) on a daily basis. These attitude, orbit, and telemetry data were written on magnetic tape and shipped to the instrument data-processing system (IDPS). The IDPS processed all data to create the Earth-located, time-ordered master sensor data record (MSDR) and the accompanying data catalog. The algorithm development facility (ADF) (a remote terminal-oriented, interactive development facility) then processed a subset of these data into the interim geophysical data record (IGDR) sensor files and geophysical files. The IGDR's were then made available to the project science teams for geophysical evaluation. After the algorithms and programs are approved by the science teams, the algorithm development facility will be used to produce a final set of geophysical data records.

The generation of the MSDR's by the IDPS begins with the extraction of telemetry data frames from the project master data file. Data channels or measurements were packed (commutated) within a telemetry frame as efficiently as possible to reduce the volume of data transmitted by the satellite. A process called decommutation and engineering unit conversion was used to extract sensor measurements from the satellite telemetry frame and convert them from telemetered numbers to engineering units (volts, degrees, or other units). These converted channels are positioned in a new data record called the sensor data record (SDR), a record formatted for the convenience of further computer processing. Required auxiliary engineering data channels are similarly processed and added to the SDR. The latitude and longitude of each sensor field-of-view footprint (boresight) and the spacecraft altitude are computed using the telemetered time tag and the satellite attitude and orbit files. Special sensor-dependent Earth-location parameters needed in the geophysical data reduction are also computed; these location parameters are then appended to the SDR. The magnetic-tape file containing data records from all sensors is the MSDR, which is the Seasat archival data base. The SDR tape files, containing data from only one sensor, can be extracted from the archival data base as needed.

The IGDR "sensor" file contains data processed by "sensor algorithms." These algorithms perform instrument-specific calibrations and corrections, producing as outputs physical observables that are essentially independent of the specific hardware implementation of the instrument. In addition to the measurements of interest, the sensor file generally contains the timing and Earth-location of the measurements, assorted warning flags indicating potential instrument or data-processing problems, the values of all corrections made to the measurements, and instrument mode indicators. Each sensor file (and geophysical file) also contains text information describing how it was produced, identifying algorithm versions, and giving values of all constants and tables used by the algorithms. Each sensor has algorithms for detecting and flagging "blunder points" in the data. These may be caused by bit errors arising from various sources between the spacecraft and the ground-processing systems. Users of the data should be aware that the error rate may be quite high in some parts of the data.

The primary measurements available in the sensor files are height (the range from the center of mass of the spacecraft to the mean ocean surface), significant wave heights, and radar backscatter coefficients for the altimeter; radar backscatter coefficients, noise estimates, and cell geometry for the SASS; antenna temperatures (radiometric measurements) and brightness temperatures (corrected for antenna sidelobes, ionospheric Faraday rotation, and other effects) for the SMMR; and visible radiance and infrared temperature for the VIRR.

The IGDR "geophysical file" contains data processed by "geophysical algorithms." These algorithms transform the

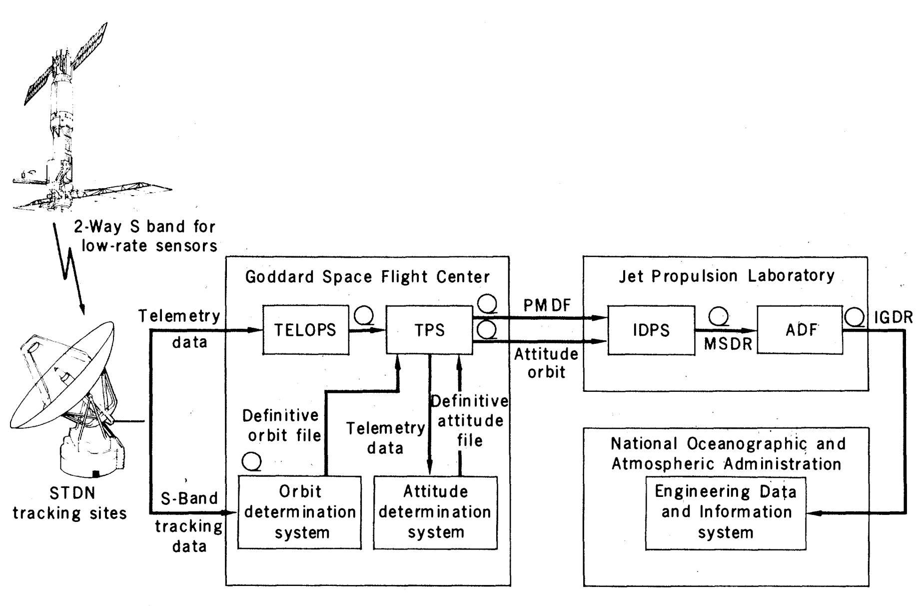

Fig. 1. Seasat low-rate data system; *STDN*, Spaceflight Tracking and Data Network.

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physical observables of the sensor file into geophysical measurements of interest to end users. Geophysical algorithms also make corrections for atmospheric and surface effects which influence the desired geophysical measurements.

The altimeter geophysical algorithms provide corrections for refraction caused by the ionosphere and by air and water in the atmosphere and for modeled ocean surface effects such as tides (ocean and solid earth), atmospheric pressure loading, water density (salinity), and the geoid. In addition, one algorithm converts radar backscatter to wind speed and another replaces the medium-accuracy (50 m) location information obtained from the SDR (by way of the sensor file) with more precise orbit information (2 to 3 m) calculated from the best available tracking data.

The SASS geophysical algorithms convert radar backscatter measurements to wind vectors by combining measurements made in orthogonal directions and applying one of several models to the measurements. Because of the form of the functional relationship between wind vectors and backscatter measurements, the wind vector algorithms yield multiple solutions called "aliases." Work on an algorithm to select the correct solution from the aliases, typically four in number, is still in a preliminary stage. Currently available data products contain up to four wind solutions at each measurement point. A planetary boundary layer model is also planned for inclusion in the SASS geophysical algorithms so that winds will be reported both as friction velocity (u^*) and as winds at a height of 19.5 m. Also planned for future inclusion is a set of algorithms that will use microwave brightness measurements from SMMR to correct the SASS backscatter measurements for the effect of atmospheric attenuation. This is currently thought to be a negligible effect, except in heavy rain cells.

The SMMR geophysical algorithms are derived from models of ocean surface emissivity and atmospheric emission and absorption. These models are effectively inverted to derive estimates of ocean surface temperature, wind speed, and atmospheric water content (liquid and vapor). In addition, an estimate of the integrated water column is converted to a refractive path length correction for the altimeter.

Two catalogs of the Seasat data, the MSDR catalog and the general catalog, are available to provide convenient access to data of specific interest among the thousands of reels of tape. The Seasat data base consists of a number of large, time-ordered data sets on magnetic tape, specifically: the MSDR, SDR, IGDR sensor files, and IGDR geophysical files. Only the MSDR contains all the available data; the others contain subsets.

The MSDR catalog is a detailed summary of all the MSDR tapes and can be searched for data satisfying any desired combination of geography, instrument mode, and time span. Search results include tape reel numbers and other access information and specific time intervals within each tape reel which contain data satisfying all user-specified criteria. The general catalog is essentially a cross-reference between time and tape reel number, for all types of data tapes.

Both catalogs are on-line and can be searched interactively by users with remote terminals. One would begin a typical search by specifying a geographical region, time span, and sensor or sensors of interest and executing a search in the MSDR catalog. The resulting times can then be checked in the general catalog to determine the availability of data processed to any of the other forms.

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Surface Observations for the Evaluation of Geophysical Measurements from Seasat

Abstract. *The surface observations used in the initial assessment of Seasat are discussed with emphasis on their ability to describe the synoptic-scale winds over the ocean.*

We made the initial assessment of the capabilities of Seasat by comparing subsets of the satellite data against conventional measurements, both in situ and remote. These data are sometimes referred to as surface truth data but can be more accurately described as surface observations. These observations were used for direct comparison with Seasat-derived values at fixed locations as well as for input to analyzed fields of pressure, wind, air and sea temperatures, and surface dew point.

The principal source of conventional measurements was a series of special observations taken in August and September 1978 during an intensive data-gathering effort in the northwest Pacific termed the Gulf of Alaska Seasat Experiment (GOASEX). Measurement platforms consisted of National Oceanic and Atmospheric Administration (NOAA) data buoys, the NOAA research vessel *Oceanographer*, and two Canadian weather ships, *Quadra* and *Vancouver*, which were stationed alternately at ocean station PAPA (50°N, 145°W). In addition to the standard surface and upper-air weather observations, the investigators on the ships took special surface wind and wave measurements that began 10 minutes before and ended 10 minutes after the arrival of the satellite. Buoys reported standard observations hourly. Four aircraft (two National Aeronautics and Space Administration, one U.S. Navy, and one Canadian) flew over either ships or buoys for selected orbits, taking remotely sensed data on surface and flight-level winds, air and sea temperatures, and ocean waves. A less reliable source of measurement, but one that was essential to the construction of fields, was the network of weather observations from ships reporting through the World Weather Watch and the Fleet Numerical Weather Central at 0000, 0600, 1200, and 1800 G.M.T.

Visible and infrared satellite imagery from the Geostationary Operational Environmental Satellite (GOES) and NOAA-5 weather satellites, and from the Defense Meteorological Satellite Program, provided additional sources of detailed analyses of cloud cover and precipitation.

In general, the reliability of observations ranged from excellent to fair. The most reliable observations were those from *Oceanographer* and the weather ships which reported at satellite overpass times. The least reliable were observations from merchant ships reporting visual observations at other than overpass times. For surface winds, the accuracy of measurement has been shown to be a function of the type of ship making the report (*1*). Weather ships gave the