WindSat — Ground Data Processing and Wind Retrieval Algorithm

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Abstract: The WindSat payload on the Coriolis satellite produces approximately 200MBytes of data per orbit, or 3.0 GB per day. The WindSat team has developed a Ground Data Processing Software (GDPS) to process 100% of available downlink data, providing accurate and precise data products as dictated by the WindSat mission requirements. The GDPS consists of four main processors: the Raw Data Record Processor (RDRP), the Temperature Data Record Processor (TDRP), the Sensor Data Record (SDRP), and the Environmental Data Record Processor (RDRP).

The RDRP receives the WindSat data stream, including receiver, calibration, housekeeping and spacecraft attitude data. The RDRP decodes, unpacks, reformats and merges these data in preparation for further the remaining processing.

The TDRP receives the formatted data and provides the first four critical functions. First the TDRP calibrates the raw counts into radiances using the calibration target measurements and the sensor calibration constants file. Then, each channel is geolocated using the scan angle, spacecraft attitude and ephemeris, and the antenna pointing offsets. Using the spacecraft ephemeris and an ionosphere model, the Faraday rotation is calculated. The Faraday rotation angle and the spacecraft attitude and ephemeris are then used to calculate various antenna parameters, such as the earth incidence angle, the polarization rotation angle and the surface compass azimuth angle, which describes the sensor look direction on the surface. These data are forwarded on to the SDRP.

The next level of processing occurs in the SDRP, which forms the third and fourth elements Stokes parameters by taking the difference of the appropriate polarizations. The antenna pattern correction (APC) follows, using stored cross-coupling correction matrices and feed spillover efficiencies. Because each frequency set has a different beamwidth and relative pointing, the final stage of the SDRP resamples and averages the beams to yield collocated pixels at a common resolution. This is the highest level of phase 1 (brightness temperature) processing before the EDRP.

The EDRP provides the WindSat Level 2 processing. The inputs to the EDRP are the calibrated, geolocated, co-registered WindSat Stokes parameters at 10.7, 18.7, and 37 GHz, and the vertical and horizontally polarized brightness temperatures at 6.8 and 23.8 GHz. These sets of 16 quantities form the basic measurement vector for the retrieval. The primary retrieval algorithm is an optimal estimation technique that simultaneously solves for ocean surface wind speed and direction, as well as sea surface temperature (SST) and atmospheric parameters such a precipitable water vapor, rain rate and cloud liquid water.