



### **Wind and Temperature Spectrometry of the Upper Atmosphere in Low-Earth Orbit**

**Multi-point measurements can enhance the capabilities of the GPS network, as well as other communication applications.**

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Wind and Temperature Spectrometry (WATS) is a new approach to measure the full wind vector, temperature, and relative densities of major neutral species in the Earth's thermosphere. The method uses an energy-angle spectrometer moving through the tenuous upper atmosphere to measure directly the angular and energy distributions of the air stream that enters the spectrometer. The angular distribution gives the direction of the total velocity of the air entering the spectrometer, and the energy distribution gives the magnitude of the total velocity. The wind velocity vector is uniquely determined since the measured total velocity depends on the wind vector and the orbiting velocity vector.

The orbiting spectrometer moves supersonically, Mach 8 or greater, through the air and must point within a few de-

grees of its orbital velocity vector (the ram direction). Pointing knowledge is critical; for example, pointing errors 0.1° lead to errors of about 10 m/s in the wind. The WATS method may also be applied without modification to measure the ion-drift vector, ion temperature, and relative ion densities of major ionic species in the ionosphere. In such an application it may be called IDTS: Ion-Drift Temperature Spectrometry.

A spectrometer-based coordinate system with one axis instantaneously pointing along the ram direction makes it possible to transform the Maxwellian velocity distribution of the air molecules to a Maxwellian energy-angle distribution for the molecular flux entering the spectrometer. This implementation of WATS is called the gas kinetic method (GKM) because it is applied to the case of the Maxwellian distribution.

The WATS method follows from the recognition that in a supersonic platform moving at 8,000 m/s, the measurement of small wind velocities in the air on the order of a few 100 m/s and less requires precise knowledge of the angle of incidence of the neutral atoms and molecules. The same is true for the case of ion-drift measurements. WATS also provides a general approach that can obtain non-equilibrium distributions as may exist in the upper regions of the thermosphere, above 500 km and into the exosphere. Finally, WATS serves as a mass spectrometer, with very low mass resolution of roughly 1 part in 3, but easily separating atomic oxygen from molecular nitrogen.

*This work was done by Federico Herrero of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15753-1*

### **Health Monitor for Multitasking, Safety-Critical, Real-Time Software**

**A single software module addresses many health management problems.**

*John F. Kennedy Space Center, Florida*

Health Manager can detect "Bad Health" prior to a failure occurring by periodically monitoring the application software by looking for code corruption errors, and sanity-checking each critical data value prior to use. A processor's memory can fail and corrupt the software, or the software can accidentally write to the wrong address and overwrite the executing software. This innovation will continuously calculate a checksum of the software load to detect corrupted code. This will allow a system to detect a failure before it happens.

This innovation monitors each software task (thread) so that if any task reports "bad health," or does not report to

the Health Manager, the system is declared bad. The Health Manager reports overall system health to the outside world by outputting a square wave signal. If the square wave stops, this indicates that system health is bad or hung and cannot report. Either way, "bad health" can be detected, whether caused by an error, corrupted data, or a hung processor.

A separate Health Monitor Task is started and run periodically in a loop that starts and stops pending on a semaphore. Each monitored task registers with the Health Manager, which maintains a count for the task. The registering task must indicate if it will run more

or less often than the Health Manager. If the task runs more often than the Health Manager, the monitored task calls a health function that increments the count and verifies it did not go over max-count. When the periodic Health Manager runs, it verifies that the count did not go over the max-count and zeroes it. If the task runs less often than the Health Manager, the periodic Health Manager will increment the count. The monitored task zeroes the count, and both the Health Manager and monitored task verify that the count did not go over the max-count.

The Health Manager reports its system health status to the outside world by tog-