THE GENESIS SOLAR WIND COLLECTION MISSION: CURRENT STATUS B.L. Barraclough[1], R.C. Wiens[1], J.T. Steinberg[1], E.E. Dors[1], M. Neugebauer[2], D.S. Burnett[3], J. Gosling[1], R.R. Bremmer[1], [1]Space & Atmospheric Sciences, Los Alamos National Laboratory (MS D466, Los Alamos, NM 87545, bbarraclough@lanl.gov), [2]Jet Propulsion Laboratory (MS 169-506, 4800 Oak Grove Drive, Pasadena, CA 91109), [3]Geology & Planetary Sciences, Caltech (MS 100-23, Pasadena, CA 91125)

Introduction: The NASA Genesis spacecraft was launched August 8, 2001 on a mission to collect samples of solar wind for ≥2 years and then return them to Earth in 2004. Detailed analyses of the solar wind ions implanted into high-purity collection substrates will subsequently be carried out in earth-based laboratories using various mass spectrometry techniques. These analyses are expected to determine key isotopic ratios and elemental abundances in the solar wind and, by extension, in the solar photosphere. Further, the photospheric composition is thought to be representative of the solar nebula with a few exceptions so that the Genesis mission will provide a baseline for the average solar nebula composition with which to compare present-day compositions of planets, meteorites, and asteroids. The implications of the solar oxygen isotopic composition have been discussed in [1]. A list of other isotopic and elemental measurement objectives, and some of the rationale behind them, is given in [2].

It is critical to understand the solar-wind conditions during the collection phase of the mission. For this reason, plasma ion and electron spectrometers are continuously monitoring the solar wind proton density, velocity, temperature, alpha/proton ratio, and the angular distribution of suprathermal electrons. Based on these observations, various collector materials are autonomously exposed to the solar wind, depending on the type of plasma found to be flowing past the spacecraft. Here we report on the solar-wind conditions as observed by these *in-situ* instruments during the first half of the collection phase of the mission, from December, 2001 to present.

Solar-Wind Regimes: There are three distinct types of solar wind plasma [e.g., 3]. All three types, or regimes, are elementally fractionated relative to the photosphere, but by different amounts and in different ways based on the characteristics of their acceleration out of the solar atmosphere [e.g., 4]. Because of these differing elemental compositions, a key feature of the Genesis mission is the collection of separate samples of the three solar-wind regimes.

The <u>interstream</u> (IS), or slow (< 500 km/s), solar wind is the dominant regime encountered in the ecliptic. It is consistently fractionated based on first ionization potential (FIP), with elements having FIPs below 10 eV enhanced by a factor of about four relative to high-FIP elements. <u>Coronal hole</u> (CH) material is characterized by high velocity (500-800 km/s) and a relatively low FIP fractionation of around 2, with a consistent alpha/proton ratio of ~0.043. The Ulysses mission has shown that CH is the dominant regime over the solar poles, particularly during the low-activity portion of the solar cycle [5]. <u>Coronal mass ejection</u>s (CMEs) are characterized by strong and often uneven enrichments of heavy elements, including alpha/proton ratios often > 0.10. A colder-than-expected plasma temperature is nearly always an indicator of CME material. This solar wind type can many times also be identified via observation of suprathermal electrons streaming in both directions along closed magnetic field lines.

Solar-Wind Collection To Date: Genesis solar-wind collection began when the sample arrays were deployed December 3, 2001, and should continue until April, 2004 with only occasional interruptions for spacecraft maneuvers. Through the end of 2002, collection has been continuous on the bulk sample collectors, which collect all solar wind regimes. The regime-specific collectors have been in operation 98% of the time, while the solar-wind concentrator, which electrostatically concentrates oxygen and similar-mass ions onto a small, ultrapure target, has been in operation 96% of the time. The concentrator's hydrogen rejection grid, which is designed to reject >90% of solar-wind protons (thereby reducing radiation damage to the target) while allowing the heavier ions through, has had to have its maximum voltage limited to ~2000 V. This allows somewhat more hydrogen than planned to reach the target during high-speed streams but, nevertheless, proton rejection averaged over the entire mission will still be about 85%. This will result in up to ~1.2×10^{17} protons/cm^2 being implanted at the center of the target: this dose is low enough to prevent significant damage to the collector materials.

The fraction of collection time for each solar-wind regime to date is shown in Figure 1. Typical for most solar cycles, the period just after solar maximum (around June, 2000) was characterized by abundant CMEs. This characteristic continued to be observed after the Genesis spectrometers were turned on in late Summer, 2001, and into Spring of 2002. Starting in October, 2002, CH flow encounters became more frequent, a typical characteristic of the declining phase of the solar cycle. It is hoped that this trend will continue through the end of the collection phase, as the CH samples are the most desirable: their elemental composition is likely to be most closely representative of the photosphere. The extent of *isotopic* fractionation among elements > 4 amu is poorly known [e.g., 7]. It is hoped that there is no isotopic fractionation between the photosphere and the solar wind. The best indication of this with Genesis data would come from identical isotopic ratios in material from all three solar-wind regimes. If isotopic fractionation does exist, its direction and magnitude can be estimated from intercomparison of the regime-specific samples.

Solar-wind conditions and the sample collector deployments are being catalogued to allow analyses of the samples to be placed in the proper context with regard to FIP fractionation and other solar-wind properties. These data are available at http://genesis.lanl.gov.

The Genesis samples are due to be returned to Earth in September, 2004. The mission plan originally called for deorbiting the spacecraft bus over the Pacific Ocean after the separation of the return capsule. However, due to the excellent launch injection, a large amount of delta-v will remain at the end of mission. The Genesis space physics co-investigators are currently proposing to NASA's Sun-Earth Connections office to use the spacecraft bus, including the two plasma spectrometers, as a new mission starting in late 2004. The "Exodus" mission would, if accepted, provide plasma observations from a never-before used [8] distant retrograde orbit 6-12 million miles from Earth. From this vantage point it would, along with current L1 spacecraft, enable multi-point measurements of plasma topology and structure.

References: [1] Wiens R.C. et al. (1999) *Meteoritics & Planet. Sci. 34*, 99-107. [2] Burnett D.S. et al. (2002) The Genesis Discovery Mission: Return of solar matter to Earth. *Spa. Sci. Rev. 105/1-2*, in press. [3] Neugebauer M. (1991) *Science 252*, 404-409. [4] Bochsler P. (2000) *Rev. Geophys. 38*, 247-266. [5] McComas D.J. et al. (2001) subm. To *Geophys. Res. Lett.* [6] Neugebauer M. et al. (2002) to be subm. to *Spa. Sci. Rev.* [7] Kallenbach R. (2001) *Solar and Galactic Composition* (R. F. Wimmer-Schweingruber, ed), 113-119, Am. Inst. Of Physics. [8] St. Cyr O.C. et al. (2000) *JASTP 62*, 1251-5.

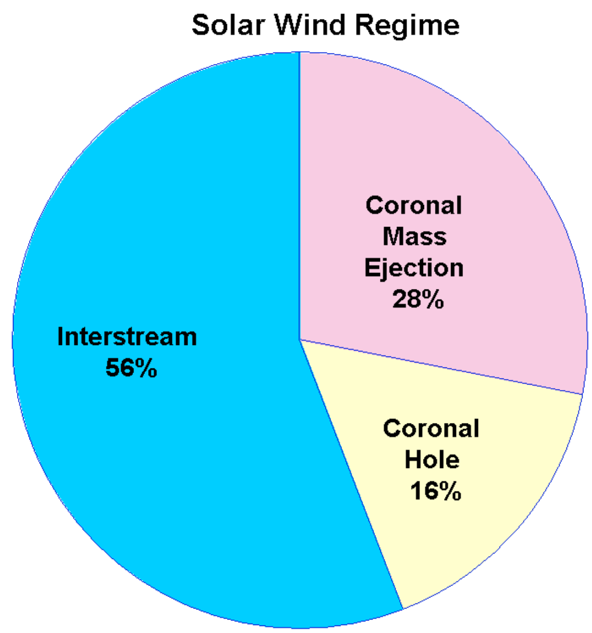

Fig. 1. Fraction of time each type of Genesis regime-specific solar wind sample collector has been exposed during the collection phase to date (12/3/01 to 12/31/02). Bulk sample collection materials are exposed continuously.