Comparison of Galileo Probe and Earth-Based Translation Rates of Jupiter's Equatorial Clouds

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The Doppler wind speeds derived from Galileo probe data are comparable with the maximum translation speeds observed in the equatorial zone by Voyager 1 and the Hubble Space Telescope. Slower published values of east-west winds are based on measurements of larger features and should be interpreted as translation rates of large weather systems interacting with the wind. The nature of the hot-spot region that the Galileo probe entered is compatible with a high-speed jet at 6 degrees north. The hot spot is associated with an equatorial weather system that spans 5 degrees of latitude and translates at 103 meters per second.

The wind speeds in the jovian atmosphere derived from the Galileo probe data (*1*), 160 to 220 m/s at altitudes corresponding to pressures ranging from 0.5 to 21 bars, are considerably faster than the 103-m/s translation speed of the probe's entry site that was derived from Infrared Telescope Facility (IRTF) data. The IRTF observations agree with earlier values derived from Voyager data (*2, 3*); even so, the winds measured by the probe are not incompatible with the Voyager results. Analysis of Voyager data has established that cloud features large enough to be tracked from the ground interact with the prevailing wind as they translate from west to east. These large weather systems move more slowly than the jets that constrain them (*2, 4*).

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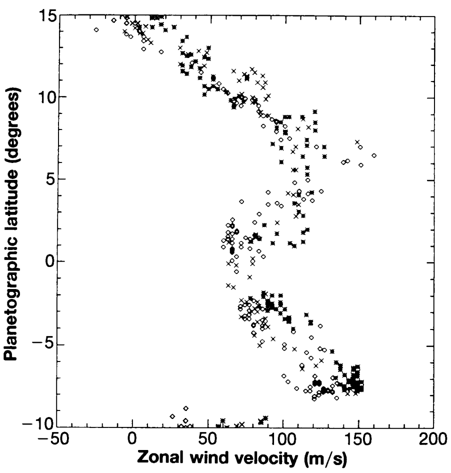

Fig. 1. Zonal wind versus planetographic latitude, measured from individual translation rates of selected cloud features. The data are derived from HST PC images taken on (◇) 29 July 1994 and (×) 4 and 5 October 1995 and from Voyager images of similar resolution taken in (*) February 1979.

The high-resolution 1979 Voyager data revealed (i) strong jets that were surprisingly constrained in latitude (*5*) and (ii) north-south asymmetries in the equatorial winds that correlated with the size of the cloud systems that were measured (*2*). The drift rate of one well-defined cloud, centered at 30°S and spanning 20° of longitude, was 40 m/s less than that of small chevrons embedded in the narrow jet at 6°S (*6*). This feature, which had a morphology similar to that of the large cloud that was south of the probe entry site, rotated counterclockwise with wind speeds of 40 m/s around its perimeter (*4, 6*), and featureless clouds hid the high-speed jet along its southern perimeter.

The drift rates derived from 1995 Hubble Space Telescope (HST) data obtained with the planetary camera (PC) mode of the Wide Field Planetary Camera 2 agree with the 1979 Voyager (*2*) and the 1995 IRTF (*7*) data. However, larger rates were measured in 1994 (Fig. 1) when the clouds in the northern half of the equatorial zone were smaller and centered closer to the jet at 6°N. These data provide evidence that the high-speed jet is always present even though the plume structure in the northern equatorial zone frequently masks it. Only the smallest cloud features centered at 6°N can be considered wind tracers (Fig. 1). These results indicate that the maximum derived translations of 150 ± 25 m/s in Fig. 1 and earlier analyses (*2, 3*) are less than or equal to the true speed of the jet at 6°N. These values agree with the Doppler-derived zonal winds (*1*) of 160 m/s at 0.5 to 0.8 bar of pressure, the range where ammonia clouds should form.

The morphology of the cloud system associated with the hot spot that the probe entered (visible at a wavelength of 5 μm) (Fig. 2) is typical of a hot spot. The zonal winds decrease from 6° to 15°N latitude, and more slowly moving trails of clouds expanding southward (feature 1, Fig. 2) in this cyclonic region are swept into the 6°N jet as the leading edge of the large cloud (feature 2) overtakes them. Northwest of the large cloud, a region of low reflectivity (feature 3) corresponds to the area of high 5-μm emission in the IRTF images. This morphology and the 103-m/s translation rate of the hot spot (*7*) are consistent with the presence of a high-speed jet. Measurements of HST PC images from October 1995 yielded a 103-m/s drift rate for feature 2 and a latitudinal wind gradient across the feature indicating anticyclonic environment. If the cloud system rotates as it translates (*6*), a central upwelling and subsidence around the perimeter is expected, which would lead to the formation of fresh ammonia ice inside the cloud system and evaporation around the perimeter. Along the north edge of the system, the expanding cloud would encounter a steep latitudinal gradient in the zonal winds. The descending clouds would be entrained by the narrow jet and swept eastward, further reducing the number density of cloud particles and thinning the ammonia cloud deck.

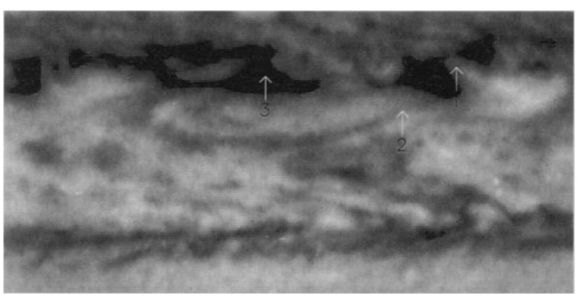

Fig. 2. Clouds associated with the probe entry site. The map is derived from a near-infrared (953-nm) HST image taken on 5 October 1995. Features 1 and 2 are clouds associated with feature 3, the 5-μm hot spot that the Galileo probe entered. This map spans ±15° latitude and −34° to 26°W longitude (System III).

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