THE JETS OF ENCELADUS ERUPT FROM THE WARMEST REGIONS ON ITS SOUTH POLAR FRACTURES. J. N. Spitale[1] and C. C. Porco[1], [1] CICLOPS, Space Science Institute, 4750 Walnut St., Boulder, CO 80301

Introduction: Cassini ISS images of Enceladus have revealed about a dozen jets of fine icy particles emerging from the south polar terrain (SPT) of Enceladus and feeding a giant plume that extends thousands of kilometers into space[1]. Cassini CIRS infrared observations have also shown the SPT to be anomalously warm[2], and the comparison of high resolution images of the SPT with the highest resolution thermal measurements has shown a coincidence between the hottest measured temperatures in the SPT and the "tiger stripe" fractures, which straddle the region[1,2].

Preliminary triangulation measurements of the plumes seen in a series of 11 images over 36 minutes and spanning only 7.5° of total separation, suggested that the tiger stripes are the source regions of the jets[1]. Here we use Cassini ISS images taken from a large range of viewing directions and spanning over 2 years time to determine by triangulation the precise source locations for the most obvious jets, and compare these with the CIRS hot spot locations. We also compare our results with the recently proposed localized heating mechanism[3] that predicts a daily cycle of jet activity as a result of tidally induced shearing within the tiger stripes.

Approach: Positional measurements of the jets were taken from Cassini Narrow Angle Camera images[4] obtained from a variety of look directions with respect to the surface of Enceladus and distributed in phase angle from 148° to 178°. The highest resolution image acquired at high phase angle, in which tiny particles become more visible due to the process of diffraction, clearly shows about a dozen prominent jets emanating from the south polar region of the satellite. It was taken looking perpendicular to the south polar fractures[1]. Comparable images at different geometries but somewhat poorer resolution had to be digitally enhanced to distinguish individual jets. The lowest resolution image used in this study has a spatial scale of about 14 km/pixel. Because of the tenuous nature of the jets and the (inferred) predominance of tiny, micron-sized particles, jets have been seen only in images obtained at high phase geometries – i.e., phase angles greater than about 150° – where tiny particles are bright due to diffraction scattering of light. (The ISS does not sense vapor in these images.) For most images, the sub-spacecraft latitude was within a few degrees of Enceladus' equator, putting the south pole close to the satellite's limb. In one image, the sub-spacecraft latitude was ~ 15° N.

A plume's position and direction in the two-dimensional plane of an image were measured by selecting two points: one at the base of the visible plume as seen from the spacecraft, and another at higher altitude. Each of the two points defines a geometric ray extending from the camera, and the two rays in space define a plane coincident with the plume. The sources of all of the jets contributing to the measured plume must lie somewhere on the ground track formed by the intersection of that plane with the surface of the satellite.

Results: The figure shows the locations of our jet source solutions (yellow roman numerals) as well as the locations of the hot spots (green capital letters) identified by the CIRS experiment[2]. The red regions show the CIRS footprints for each hot spot that they identified and the white circles show the scatter in our source solutions, which were observed to be comparable to the uncertainties estimated in a rigorous, but time-consuming Monte Carlo approach in which the measurement was repeated several times and the camera pointing was varied by one pixel in each direction. We see a strong correspondence between our source locations and the hottest CIRS locales: of the six sources that occur in areas covered by the CIRS observations, three overlap CIRS hot spots, and a further two are within less than one CIRS footprint of hot spots. As the latter two CIRS observations were not accompanied by simultaneous ISS imaging, the imperfect correspondence may be explained by errors in `pointing', i.e., locating the CIRS footprint on the surface. The source associated with the largest number of unambiguous sightings, source I, was not observed at high resolution by CIRS; however, their low-resolution brightness temperature map[2] does suggest elevated temperatures along the 30° W meridian in that vicinity.

Our solution accounts for the most obvious jets in our image set and associates each of them with one of the four tiger stripes. The fainter plumes observed during the two closest encounters would probably not have been visible in the other image sets and are thus impossble to triangulate. The strongest sources are on Baghdad and Damascus. For each tiger stripe, although individual jets may emerge at oblique angles, all of the jets appear to lie in nearly the same plane, which in all 4 cases is within 2° of being perpendicular to the surface. The plumes from each of the 4 fractures appear to be well collimated, with most of the visible material from the Baghdad plume confined to about ± 10° of the mean plane.

Our source locations are largely consistent with the CIRS hot spot locations[2], but disagree with the prediction of the shear-heating model[3] in that we observe Baghdad to be the most active fissure while the model predicts it to be the least active. We predict that several additional hot spots will be discovered in future Cassini thermal observations.

References: [1] Porco, C.C. *et al.* (2006) *Science* **311**, 1393. [2] Spencer, J. R. *et al.* (2006) *Science* **311**, 1401. [3] Nimmo F. *et al.* (2007) *Nature* **447**, 289. [4] Porco, C. C. *et al*. (2004) *Space Sci. Rev.* **115**, 363.