STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY: CAPABILITIES FOR PLANETARY SCIENCE. W. T. Reach[1], [1]Universities Space Research Association (MS 211-3, Moffett Field, CA 94035, wreach@sofia.usra.edu)

Introduction: The Stratospheric Observatory for Infrared Astronomy (SOFIA [1]) is a 2.5 meter telescope on a modified 747SP aircraft. The program is managed by the National Aeronautics and Space Administration (NASA) and the Deutsches Zentrum für Luft- und Raumfahrt (DLR). Operations are supported by NASA and DLR in a partnership, with an 80/20 split per international Memorandum of Understanding.

Status and recent News: SOFIA's first light flight occurred in May 2010, with all systems performing acceptably. Two subsequent Observatory Characterization Flights occurred in November, followed by a series of three science flights in December 2010. These flights are part of the Early Science program, which comprised those 3 flights using the first scientific instrument (FORCAST) plus flights in March using the second scientific instrument (GREAT; see Table), plus an upcoming set of Basic Science flights.

For the 12 US Basic Science flights, a call for proposals was issued and the proposals were evaluated by a Time Allocation Committee in October 2010. All institutions and nationalities (except Germany, which is covered by a separate process) were invited to participate in the proposal call. Twenty-seven (27) proposals were accepted, spanning a range of extragalactic, galactic, and planetary science. The observations use the first two scientific instruments, FORCAST and GREAT.

Three (3) German Basic Science flights will utilize the GREAT instrument under the leadership of the Principal Investigator R. Guesten. An additional 3 German flights will include observations by the German scientific community to be selected by an allocation committee after a 2011 Feb/Mar workshop.

Observatory Capabilities:

Telescope. The 17-ton SOFIA telescope was provided by Germany. The telescope has an agile secondary mirror that can chop at 1-5 Hz for atmospheric suppression. The telescope is mechanically isolated from the aircraft on a hydrostatic beating, and active stabilization is using gyros. The telescope performed admirably on its commissioning flights, exceeding its requirement of providing stabilized images smaller than 4″.

Instruments. There are 7 scientific instruments developed or being developed for SOFIA (Table). NASA is issuing a call for proposals in early 2011 (the draft is already posted) for Second-Generation instruments, including the possibility of upgrading existing instruments: http://soma.larc.nasa.gov/SOFIA/

Early Science Results: The Faint Object infrared Camera for the SOFIA Telescope (FORCAST [2]) was used during the Telescope Assembly Characterization and First Light flight in May 2010 to obtain images of Jupiter and of the galaxy M 82. The Jupiter image (Figure) shows, at 5.4 microns, extremely bright emission in relatively cloud-free regions that provide windows into the deeper atmosphere; these regions are relatively dark in optical images. Further images of Jupiter were obtained during the Short Science flights in December 2010 and are presently under analysis.

Figure. False-color image of Jupiter and 3 Jovian satellites obtained by SOFIA in May 2010. In blue is the 5.4 μm image, in green, the 24.2 μm image, and in red the 37.1 μm image. This image was taken using FORCAST by Principal Investigator T. Herter (Cornell) and the color image was created by J. DeBuizer (USRA).

Planetary Science Capabilities: The instruments on SOFIA present a wide range of capabilities that are designed to enable guest investigators to explore diverse topics in planetary science. Some examples include the following. More details can be found in a booklet issued by the project, entitled *The Science Vision for the Stratospheric Observatory for Infrared Astronomy*.

Thermal emission. All Solar System bodies emit thermal radiation within SOFIA's wide 1-200 μm wavelength range. The sensitivity estimate for FORCAST indicates that SOFIA readily detects main belt asteroids larger than 10 km. The brightness and spectral energy distribution of comets can be assessed using the photometric and grism-spectroscopy capabilities of SOFIA. During the Short Science flights, comet Hartley 2 was observed as part of the Earth-based support of the *Deep Impact* mission, detecting the comet at 11.1, 24.2, 31.4, and 37.1 μm.

Planetary Atmospheres. The opacity sources of giant planet atmospheres in the mid- to far-infrared include molecular species, such as the H_2 features that dominate the opacity of at 20-40 μm as seen with *Spitzer*. In the inner Solar System, Venus is a special case because it has been inaccessible to infrared spectroscopy (with cryogenic infrared space telescopes necessarily avoiding the sunward viewing hemisphere). SOFIA can target Venus and using mid-infrared spectroscopy it is sensitive to the vertical and wind profiles, atmospheric structure, Cl abundance, and SO and SO_2. For Mars, we expect to detect methane using high-resolution mid-infrared spectroscopy by EXES and the Doppler shift to move the Martian feature relative to the terrestrial one. In Titan, hydrocarbon chemistry can be addressed.

Kuiper Belt. The HIPO instrument (Principal Investigator T. Dunham) was specifically designed for planetary science, including stellar occultations by Kuiper Belt objects as well as extrasolar planet transits. SOFIA/HIPO will achieve few-km resolution at 30 AU distance to measure sizes and shapes of Kuiper Belt Objects. HIPO can be dual-mounted with FLITECAM to allow simultaneous near-infrared and visible observations of occultations and measure properties of KBO atmospheres.

Future Proposal Calls: In the fall of 2011, the first full open proposal call for SOFIA will be issued, covering an entire year and multiple scientific instruments. The announcement will be on the main SOFIA Science Mission Operations Center website, http://www.sofia.usra.edu.

References: [1] Becklin, E.E., Gehrz, R.D. 2009, SPIE 7453, p. 745302 [2] Adams, J. et al. 2010, Proc. SPIE 7735, p. 77351

Table. Instrumentation for SOFIA

Instrument	Wavelength	Capability	Availability
GREAT	60-200 μm	High-resolution spectra	**2011**
FIFI LS	42-210 μm	Integral field spectra	2012
HAWC	50-240 μm	Filter images	2012
EXES	5-28 μm	High-resolution spectra	2013
FORCAST	5-40 μm	Filter images, grism spectra	**2010**
FLITECAM	1-5 μm	Filter images, grism spectra	2011
HIPO	0.3-1.1 μm	High-time-resolution photometry	2011