Huygens Dataset Gazeteer v1.0 Ralph Lorenz 5/27/2018

This tabulation is provided to the Cassini project as a guide to the Huygens datasets and the literature in which they are discussed. The reference list is not intended to be exhaustive, but rather indicates in particular papers where the use of the data are emphasized ; pure modeling papers are not discussed.

This tabulation is hoped eventually to be augmented with narrative description and published as a journal paper. Please check with ralph.lorenz@jhuapl.edu for fuller citation details, or for updates to the present document.

A useful overview of the Huygens datasets as delivered to the ESA PSA and NASA PDS is by (Witasse et al., 2008)

In the following tables, for brevity, the full path in the PDS directory tree is not given. In the 'Observation/Instrument' column, the relevant dataset provider is identified e.g. 'Housekeeping' and thus data volume HP-SSA-HK-2/3-V1.0 for the entry deceleration profile from engineering accelerometer, and in the dataset column, the measurement channel or subsystem (CDMS/CASU) and dataset ID (HK_CDMS_CASU_D7006A) is noted. Thus the dataset and label can be found by navigating the PDS directory structure to find https://atmos.nmsu.edu/PDS/data/hphk_0001/DATA/CDMS/CASU/HK_CDMS_CASU_D7006A.LBL and .TAB. In the table below (2nd entry) there is also reference to a 'postflight engineering analysis report' : this is not unnaturally found from the Housekeeping directory by following the 'DOCUMENT' link from the volume root. Some modest judgement or exploration is needed to select the 'INDUSTRY DOCUMENTS' link and thence to find https://atmos.nmsu.edu/PDS/data/hphk_0001/DOCUMENT/INDUSTRY_DOCUMENTS/POST_FLIGHT_ANALYSIS_2006.PDF

Entry Data

Observation / Instrument	Fundamental Dataset	Relevant Papers	Comments
Entry Deceleration Profile (HASI)	Original data is the high-quality X-axis servo accelerometer HASI_L3_ACCE_SERVO.TAB and 3-axes of piezoelectric accelerometers. Derived atmosphere profile is in DATA/PROFILES directory, HASI_L4_ATMO_PROFILE_ENTRY.TAB	(Fulchignoni et al., 2005)	Initial report.
		(Aboudan et al., 2008; Colombatti et al., 2008a; Colombatti et al., 2008b)	These (and the other analyses) require the aerodynamic database of drag and other coefficients. These are found in the Housekeeping volume under /DOCUMENT/AEDB. Aboudan uses a Kalman filter dynamics model; Colombatti et al papers emphasize the original data more. The 'prettiest' entry temperature profile is in Aboudan et al. (2008)
Entry Deceleration Profile (Housekeeping)	CDMS Central accelerometer units (CASU) e.g. CASU 3B HK_CDMS_CASU_D7006A	(Lingard and Underwood, 2007; Lorenz, 2007)	See also flight performance report in the Housekeeping/Industry Documents directory, POST_FLIGHT_ANALYSIS_2006
Reconstructed trajectory (DTWG)		(Kazeminejad et al., 2011; Kazeminejad et al., 2007)	2011 paper discusses impact on landing site coordinates due to revised Titan rotation state determination from (Stiles et al., 2008)

Descent Data

Observation / Instrument	Fundamental Dataset	Relevant Papers	Comments
Images from Surface (DISR)	Original released images under /IMAGER but subsequent higher quality processing is in DISRSOFT_G_IMAGES (as well as MOSAICS) in EXTRAS/PROCESSED_IMAGES	(Karkoschka and Tomasko, 2009; Tomasko et al., 2005)	Many papers touch on these data (e.g. interpretation of rock sizes and surface spectra)
Images of Surface during descent (DISR)		(Soderblom et al., 2007)	Soderblom et al. (2007) perform stereophotogrammetry to deduce terrain heights
Huygens Radar altimeter (Housekeeping/HASI)	Altitude fixes (corrected for temperature drift) are e.g. HK_CDMS_RADAR_A_CORRECTED.TAB AGC data indicating echo strength are HK_CDMS_PROXSENSORB_D40010.TAB	{Lorenz, 2016 #391}	
Optical Illumination vs Wavelength & altitude (DISR) and resultant haze properties	Most useful compilation is ULVS_DDP.TAB in DERIVED_DATA_PRODUCTS/ULVS	(Doose et al., 2016; Tomasko et al., 2008a; Tomasko et al., 2008b)	(Many other papers exist. Note that haze profile interpretation was revised appreciably in Doose et al. 2016)
Methane Abundance (GCMS)	Raw counts in DESCENT_GCMS_1US_L2_STG3 but extremely difficult to work with	(Niemann et al., 2005; Niemann et al., 2010)	Initial results (X[CH4]=4.92%) Final calibrated data (e.g. X[CH4]=5.7% at surface; 1.48% above 75km) tabulated in Niemann et al. (2010) but not on PDS.
Methane Abundance (DISR/spectral absorption) at Surface	relevant spectra are in DLIS_I_DDP.TAB in DERIVED_DATA_PRODUCTS/DLIS	(Jacquemart et al., 2008; Tomasko et al., 2005)	(Jacquemart et al., 2008) indicate 5.1% in lowest 20m of atmosphere and limited (<20%) change after landing
Methane Abundance from DISR in Stratosphere	ULIS_AZ_DDP.TAB in DERIVED_DATA_PRODUCTS/ULIS	(Bézard, 2014; Rey et al., 2018)	Rey et al. use new linelist : suggest ~1% above 110km, increasing to ~1.5% around 50km
Methane Abundance (SSP/sound speed)	SSP_APIV_123456_0_R_ATMOS.TAB	(Hagermann et al., 2007)	Data quality rather poor, not a strong constraint.
Probe Trajectory and Winds (DWE ; DISR ; HASI; Housekeeping)	DWE data derived product is ZONALWIND.TAB Note that additional Doppler data is in	(Bird et al., 2005)	Doppler Wind Experiment initial report of wind profile
		(Folkner et al., 2006)	Further analysis of Doppler winds,

	Huygens Summary data product		particularly near surface
		(Lorenz, 2017)	Examination of wind gradient (shear) and turbulence
	DISR data in HUYGENS_DESCENT_PARAMETERS.TXT in EXTRAS/PROBE_ATTITUDE	(Tomasko et al., 2005)	Initial report of image correlations – identifies reversal near surface and meridional motion
		(Karkoschka et al., 2007)	Tip and tilt history from image data ; spin history from AGC as well as DISR data
		(Karkoschka, 2016)	Full inversion of probe trajectory from image data, recovery of meridional winds
Probe Dynamics (tilt, oscillations)	Radio signal strength from AGC (added as a separate product outside the Housekeeping tree - HUYGENS_AGC.TAB)	(Dzierma et al., 2007)	Places bounds on probe attitude during descent; notes tilt in wind shear region at 70km. Also examines surface attitude.
	Tilt sensors on SSP	(Lorenz et al., 2007) see also (Lorenz, 2010) and (Lorenz, 2017)	(Lorenz et al., 2007) examine statistical and spectral properties of 1/s tilt data, suggesting atmospheric turbulence component in upper troposphere.
	Engineering sensors (RASU)	(Lingard and Underwood, 2007)	A charitable perspective on the parachute. See also flight performance report in the Housekeeping/Industry Documents directory, POST_FLIGHT_ANALYSIS_2006
Probe Spin History	RASU data in Housekeeping ; AGC data. Also SSP Tilt sensors	(Karkoschka et al., 2007) (Lorenz, 2006)	This topic is still the subject of investigation, e.g. {Lorenz, 2017 #2664}. See also IPPW papers by Perez-Ayucar and Sarlette in /DOCUMENTS/PUBLICATIONS directory of housekeeping volume
(Potential) temperature profile in boundary layer (HASI)	Derived from Pressure and Temperature records. See HASI_L4_ATMO_PROFILE_DESCEN.LBL in DATA/PROFILES directory in archive	(Tokano et al., 2006)	Identifies 300m planetary boundary layer
		(Lorenz et al., 2010)	Notes that signature of ~3km boundary layer exists as well as 300m. Relates profile to dune spacing.
Gravity Waves in atmosphere (HASI)	Entry deceleration profile ; original data are HASI_L3_ACCE_SERVO.TAB, but the derived profile is in	(Fulchignoni et al., 2005)	Initial report. See also DTWG papers.
		(Aboudan et al., 2008)	Analyzes entry data with Kalman filter,

	DATA/PROFILES directory, HASI_L4_ATMO_PROFILE_ENTRY.TAB		presents assumed aerodynamic coefficients and entry state; Fig.10 shows retrieved temperature profile
	Descent temperature profile (but requires highest-temporal resolution and separate fine/coarse sensors, so Level 3 data, not L4 profile) ID HASI_L3_TEMD_FINE1.TAB	(Lorenz et al., 2014b)	NB detection of gravity waves required 'unsharp masking' of Level 3 data ; signatures less obvious in Level 4 profile due to averaging.

Impact with the Surface, Landing Orientation/Position

Measurement / Subsystem	Dataset	Reference	Comments
Surface impact acceleration (SSP/ACCI)	raw volts as SSP_ACCI_057_1_R_IMPACT.TAB see SSP_CAL.ASC in /CALIB for force conversion	(Zarnecki et al., 2005)	Initial report
		(Lorenz et al., 2009)	Reviews deceleration profile from SSP impact accelerometer in context with lab measurements and pre-launch predictions
Surface impact acceleration (HASI/ACC Piezo)	HASI_L3_ACCS_PIEZOIMP.LBL in DATA/ACC/	Fulchignoni et al. (2005) ; Zarnecki et al. (2005)	Initial reports of HASI accelerometer data
		Bettanini et al. (2008) Schroeder et al. (2015)	(Bettanini et al., 2004) Performs finite element analysis of probe deformation : negative spike in HASI record attributed to 'trampoline' structural mode of experiment platform. Schroeder et al. (2015) examine integrated view of impact and bounce dynamics from a variety of sensors
Impact Penetrometer (SSP/ACCE)	raw volts as SSP_ACCE_057_1_R_IMPACT.TAB see SSP_CAL.ASC in /CALIB for force conversion	Zarnecki et al. (2005)	Initial report
		Atkinson et al. (2010)	Presents new laboratory experiments of penetrometer impact into targets with damp sediments and various particle sizes
Optical Data (DISR)	Various	(Karkoschka et al., 2007)	Notes landing orientation. Also reports detection of shadow of parachute, inferring windspeed constraint
		Schroeder et al. (2015)	Forward-models probe motion as bouncing/skidding out of initial impact cavity. Examines other datasets (housekeeping RASU, SSP etc.)
Radio signal strength (Housekeeping – from PSA chain B receiver Automatic Gain Control, AGC)	Original data (coded DN) in R6001S, R6002S, R6003S and R6004S telemetry status word e.g. HK_PDRS_PSAB_R6001S.TAB In reduced, convenient form	Dzierma et al. (2008)	Evaluates probe resting azimuth from signal strength (AGC) record
		(Pérez-Ayúcar et al., 2006)	Assesses post-landing AGC evolution as multipath reflection from surface; accurate estimate of probe position relative to ground

	(dBm) on PDS page as HUYGENS_AGC.TAB (in 'extras')		

Post-Landing Changes, Effects on Surface

Thermal evolution of Probe (Housekeeping)	Housekeeping temps e.g. HK_CDMS_TEMP_D5017.TAB	Lorenz (2006a)	Infers average winds on surface as <0.3 m/s.
Dielectric Constant of Surface Material (HASI/PWA)	In principle, relevant data is HASI_L2_PWAS_MIP.TAB	Early results in Grard et al. (2007). Hamelin et al. (2016), see also Lethuillier et al. (2018)	Only Level 2 data are archived : surface dielectric constant is a derived quantity, strongly model-dependent, especially on the assumed geometry of the electrodes with respect to surrace
Detection of Possible Dewdrop (DISR)	Image data. Dewdrop appears in	(Karkoschka and Tomasko, 2009)	Possible dewdrop detected in image #897 Constraints on drizzle from nondetection of rainbow. See also (Karkoschka et al., 2007)
GCMS Inlet Temperature Evolution (GCMS Housekeeping)	DESCENT_GCMS_HK_TYPE2_STG2	Lorenz et al. (2006b)	T_INLT is temperature sensor on inlet pipework several cm away from actual exposed inlet pipe : history of the exposed inlet was deduced from a thermal model in the paper
Change in Probe tilt (DISR, SSP, HASI)	Image data; SERVO ; TIlt	(Karkoschka et al., 2007)	see also (Zarnecki et al., 2005) for tilt sensor and (Hathi et al., 2009) for Servo accelerometer.
Change in Acoustic properties (SSP/API-V)	SSP_APIV_123456_0_R_ATMOS. TAB	(Lorenz et al., 2014a)	Notes increase in acoustic attenuation after landing, possible evolution of surface volatiles
Air temperature history (HASI)	HASI_L3_TEMS_FINE1.TAB	(Lorenz, 2015)	

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