



Review of WG1 (AI 25.1) Data of Interest to WG2 (WG2 Internal Task 3)

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WG1 Data of Interest to WG2 (WG2 Internal Task 3)

The stated purpose of WG2 IT3 is to review the latest draft of the WG1/WG2 data exchange format document (presented by WG1 at 26th IADC, 2008 in Moscow) and make comments, requests, and include suggested format for light curve observations. The editing of the document will be discussed later in this presentation.

Here we discuss the current and future WG2 usage of WG1 campaign data and WG2 requirements.

- To this end WG2 reviewed WG1 campaign reports and data available on IADC website – 3 radar 24-hour campaigns, 3 optical campaigns

IADC AI	Obs.	Detail	Campaign year	IADC Report year	Participants	IADC Report tabulated data	IADC Report plotted data
AI 17.1	radar, optical	LEO 24hr BPE	2000	2006	ESA, NASA	binned distribs	histograms, 2-D plots
AI 19.3	radar	LEO 24hr BPE, ~1500km	2003	2004	ESA, NASA	binned distribs	histograms, 2-D plots
AI 21.1	radar	LEO 24hr BPE, <600km	2004	2006	ESA, NASA	binned distribs	histograms, 2-D plots
AI 18.1	optical	GEO Jan-Mar	2002	2003	ESA, NASA	observation lists, #objects seen	histograms, 2-D plots
AI 20.2	optical	GEO Sep-Nov 2002, Mar-Apr 2003	2002-2003	2005	ASI, BNSC, ESA, JAXA, NASA	observation lists, # objects seen, JAXA detection list	histograms, 2-D plots
AI 21.2	optical	HEO Jan-Mar-Apr-Sep (1wk each)	2004	2008	BNSC, CNES, ESA, JAXA, NASA	observation lists, #objects seen	histograms, 2-D plots



WG1 Data of Interest to WG2 (WG2 Internal Task 3)

- WG2 member (agency) poll results (11 WG2 members)
 - Viewed WG1 campaign reports – 2
 - Using reports - 2
 - Plan to use reports in near future – 4 to 6
 - Find histogram format useful – 3
 - Request detection list format – 4

Agency	Viewed reports?	Using reports?	Plan to use?	Histograms useful? (see comments)	Detection lists desired? (see comments)	comments
ASI	no	no	maybe	no	yes	can get histogram info from publications
CNES	no	no	yes	no	yes	beginning new modeling effort
CNSA	no	no	maybe	yes	no comment	no comment
ESA	yes	yes	yes	yes	yes	get insight into pops beyond current data sources, also use for planning
NASA	yes	yes	yes	yes	yes	histograms useful for pop comparisons only, campaign periods are short, also need more recent data
UKSA	no	no	yes	no comment	no comment	beginning new modeling effort



WG2 Remote Measurements Usage

- WG2 members with current or planned orbital debris environment modeling programs
 - ASI, CNES, ESA, NASA, UKSA
- WG2 members that explicitly use remote measurement data currently to develop and/or validate orbital debris environment models
 - ESA, NASA
- WG2 members that use WG1 campaign data in some form for models
 - ESA, NASA
 - Both groups primarily use data that is in-house, in the form of detection lists



WG2 Remote Measurements Usage

- ESA MASTER-2009 debris environment model stores quarterly populations for the years 1957-2055. Populations are derived from debris source models
 - Radar (TIRA) WG1 24-hour campaign data (in detection list format) compared to modeled MASTER-2009 via PROOF code (using populations). The source models may be edited so the resulting MASTER-2009 populations better match the TIRA data
 - Optical (ESA SDT) WG1 campaign data (in detection list format) with same process as radar data
 - The ESA method can also use data in histogram format directly, though significant population information would be lost
- NASA ORDEM 3.0 debris environment model stores yearly populations for the years 2010-2035. Populations are derived from debris source models with supporting radar, optical, and in-situ data
 - Populations are derived from hundreds of hours per year of radar (Goldstone, Haystack, HAX, SSN) data (in detection list format). WG1 campaign data are included in those hours. Model predictions are reweighted to match the data populations.
 - Optical (MODEST) GEO 2-year survey (2004-2006) data (in detection list format) are extended to 10 cm via the NASA BU model
 - The NASA method uses data in detection list format directly, histogram format cannot be used
- ESA and NASA are in the process of testing usage of WG1 AI 19.3 Haystack and TIRA histogram data (assistance provided by Eugene Stansbery and Ludger Leushacke) respectively for possible use in model validation



WG2 Remote Measurements Usage Summary

- WG1 radar 24-hr campaign data usage
 - ESA
 - uses TIRA WG1 campaign data (in detection list format)
 - experimenting with Haystack/HSX WG1 campaign data (in histogram format)
 - NASA
 - uses Haystack/HAX WG1 campaign data (in detection list format), but within the larger Haystack/HAX data set
 - experimenting with TIRA WG1 campaign data (in histogram format)
- WG1 optical campaign data usage
 - ESA
 - Uses ESA SDT WG1 campaign data (in detection list format)
 - NASA
 - uses MODEST GEO 2-year survey (2004-2006) data (in detection list format)

**DRAFT****Information exchange between WG1 & WG2:content & format (1/4)**

- WG1 has streamlined the original document (data exchange format.pdf) of the 20th IADC titled, “Measurement parameters and data of interest for WG2” to the current draft document (IADCwg1and2V2.pdf on the IADC website under tab *WG Exchange-WG1*) of the 26th IADC titled “Information exchange between WG1 and WG2:content and format”
 - WG1 deleted figures, changed font and formatting
- WG1 contextual edits and requests
 - No ‘secondary’ products be delivered generally, (i.e. no derived orbital elements or derived object size), **exception: histogram data**
 - detection rate instead of flux
 - Radar cross section/apparent magnitude instead of size
 - Range/range rate or RA/DEC instead of RAAN, inclination, mean motion
 - Slight changes in measurement regions of interest
 - At 29th IADC WG1 requested that WG2 include a format for light curve observations (new type of observations) of rotation states and rates of bodies in LEO (R/B) and GEO (HAMR objects)



DRAFT

Information exchange between WG1 & WG2:content & format (2/4)

- WG2 discussion points, recommendations, and request summary
 - **Discuss** WG1 request to deliver only primary metrics generally in detection lists, i.e. detection rates instead of flux
 - Selected secondary metrics will still be included in histogram files and figures
 - Size, semi major axis, right ascension of ascending node
 - Required sensor specifics must be noted by WG1, i.e., RCS definition (OP & PP vs PP only)
 - WG2 requests more timely campaign report turnaround (1 year)
 - WG2 requests measurements data (detection lists or histogram tables) be delivered in ASCII files (SEPARATE from report documents)
 - **WG2 requests data detection lists instead of histogram data**

**DRAFT****Information exchange between WG1 & WG2:content & format (3/4)**

- WG2 discussion points, recommendations, and request summary (cont')
 - WG2 requests expansion of measurement regions of interest (Section 3)
 - Separate bullet for 1mm sized object data investigations, as this size region is proving to be critical to crewed-spacecraft safety and existing data is very sparse
 - Expand model deficient region of 1400-1500km and 50°-55° to 1000-1800km and 50°-90° to include studies of recently noted anomalous debris events from possible sources Snapshot, Transit, 56° objects
 - Plan NaK region measurements investigating Haystack NaK peak at ~65° and ~850-900km in disagreement with NASA and ESA NaK models
 - Plan opportunistic 24-hr campaigns to view fresh explosive or collisional breakups, newly formed breakup cloud may give higher fidelity data on small fragmentation debris (< 5cm)
 - WG2 requests expansion of histogram data to finer binning (Section 4), for example,
 - 100km → 50km altitude bins
 - 20°-40° → 5° inclination bins
 - 20°-220° → 10° RAAN bins
 - 0.1 → 0.01 eccentricity bins

**DRAFT****Information exchange between WG1 & WG2:content & format (4/4)**

- WG2 draft format to accommodate analysis of light curve measurements of rotation states and rates of bodies in LEO (R/B) and GEO (HAMR objects)
 - Optical data format common to any observation
 - time tag [YYDDD.DDDDDDD] The time tag corresponds to the beginning of each frame over the entire observation period
 - right ascension and declination [$^{\circ}$], RA(t),DEC(t), or azimuth and elevation [$^{\circ}$], Az(t),El(t) of the field center for each frame
 - apparent magnitude, m(t)
 - filter identification
 - exposure time for each frame
 - SATNO of correlated objects
 - Required for light curve studies
 - Time tag of at least tens to hundreds of seconds (enough to see variations)
 - Desired for light curve studies (if available)
 - range corrected absolute magnitude (1000 km) over observation
 - 1- σ errors in absolute magnitude over observation
 - solar phase angle (SPA) [$^{\circ}$], over observation
 - extinction correction