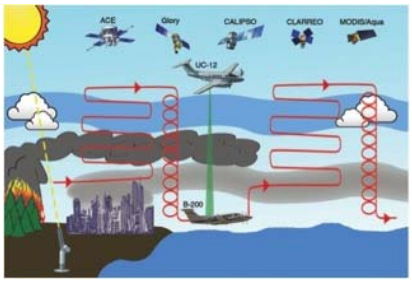

DEV-04-SCI-002

VER 1.0

National Aeronautics and
Space Administration

DATE: MARCH 16, 2011

DEVELOPMENT AND EVALUATION OF SATELLITE VALIDATION TOOLS BY EXPERIMENTERS (DEVOTE)

DATA MANAGEMENT PLAN

SIGNATURE PAGE (AS REQUIRED)

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REVISION AND HISTORY PAGE

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1 INTRODUCTION

1.1 SCOPE

The DEVOTE data management plan is built upon the experience gained from recent NASA airborne field campaigns (e.g., INTEX-A, INTEX-B, ARCTAS, and DISCOVER-AQ) and the consideration of the unique circumstances of the DEVOTE campaign. The PM, PI, and Mission Operations Manager are primarily responsible for drafting the data management plan and accommodating the needs of flight planning as well as those of the instrument scientists. The final version of the plan has been discussed and approved by the DEVOTE science team in terms of data submission deadlines and data exchange protocols.

1.2 DATA SUBMISSION AND FORMAT REQUIREMENTS

The data archival goal for DEVOTE is to have data from each instrument submitted to the data archive within two weeks after the completion of each flight. Data sets for each instrument for all flights are required to be submitted to the data archive by the completion of the project. Instrument scientists are allowed to revise data sets according to the applicable data formats. The latest revision of each archived data set will be released to the general public within six months of project completion. Note that only archived data will be used in scientific publications.

The DEVOTE science team has opted to use the ICARTT data file protocol, i.e., ESDS-RFC-019, for all data sets with the exception of the HSRL instrument. The ICARTT protocol was initially developed by NASA and NOAA airborne scientists and has been widely used by recent NASA, NOAA, NSF, and international airborne science teams. A detailed description of the data format protocol can be found at http://www-air.larc.nasa.gov/missions/etc/IcarttDataFormat.htm. The HSRL data sets will be available in HDF 5, which is defined at: http://www.esdswg.org/spg/rfc/ese-rfc-007. Metadata for HSRL will be provided in ASCII format in addition to HDF 5. The DEVOTE data management team is committed to supporting the instrument scientists in strictly conforming to the ICARTT and HDF 5 protocols. However, many DEVOTE instrument scientists are already quite familiar with these file formats.

1.3 ARCHIVE LOCATION

The DEVOTE data archive will reside at the Tropospheric Chemistry Integrated Data Center located at NASA Langley Research Center (www-air.larc.nasa.gov). This center has archived the NASA Tropospheric Chemistry Program's field campaign measurement products for over two decades. After DEVOTE data are released to the public, the data will be transferred to the NASA Langley Atmospheric Science Data Center which is responsible for long-term archival of tropospheric chemistry data sets.

1.4 MERGE FILES

For DEVOTE, merge files will be generated for the archived B-200 in situ data after completion of the program. Merge files are data files that contain all primary in situ platform measurement variables on a common time base. Merge files have proven to be extremely useful in data interpretive analysis and comparison with models. The merge files will be available as part of the public data release.

1.5 DEVOTE DATA PRODUCTS

The following tables outline the primary data products that will be archived in the DEVOTE data archive, as well as the secondary data products that can be archived as a goal for the project.

LARGE Primary Data Products:

Table 1: LARGE primary data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution[1]
Total Number Concentration	Condensation Particle Counter (CPC)	cm^{-3}	TSI	D_p > 0.008 µm	1 sec.
Total-Aerosol Scattering Coefficient	Integrating Nephelometer (TSI-neph)	Mm^{-1}	TSI	Red – 700nm Green – 550 nm Blue – 450 nm	10 sec.
Submicron-Aerosol Scattering Coefficient	Radiance Research Nephelometer with a one-micron size cut (RR-sub)	Mm^{-1}	Radiance Research	Green – 532 nm	10 sec.
Total-Aerosol Absorption Coefficient	Particle Soot Absorption Photometer (PSAP-tot)	Mm^{-1}	Radiance Research	Red – 660 nm Green – 532nm Blue – 470 nm	10 sec.
Submicron-Aerosol Absorption Coefficient	PSAP with a one-micron size cut (PSAP-sub)	Mm^{-1}	Radiance Research	Red – 660 nm Green - 532nm Blue – 470 nm	10 sec.

Dry Extinction Coefficient	TSI-neph & PSAP-tot	Mm^{-1}	TSI & Radiance Research	Green	10 sec.
Mobility Particle Size Distribution	Scanning Mobility Particle Sizer (SMPS)	$dN/dlogD_p$ (cm^{-3})	TSI	D_p: 0.010-0.273 µm	120 sec.
Optical Particle Size Distribution	Ultra-High Sensitivity Aerosol Spectrometer (UHSAS)	$dN/dlogD_p$ (cm^{-3})	DMT	D_p: 0.1-1.0 µm	10 sec.
Aerodynamic Particle Size Distribution	Aerodynamic Particle Sizer (APS)	$dN/dlogD_p$ (cm^{-3})	TSI	D_p: 0.5-20 µm	10 sec.
Cloud Number Concentration	Cloud Aerosol and Precipitation Spectrometer (CAPS)	cm^{-3}	DMT	D_p: 5-1500 µm	1 sec.

*all products excluding cloud number concentration are reported at dry (<40%) relative humidity (RH)

[1]optical and size distribution data (excluding those from the SMPS) will be available at 1-sec time resolution upon request

LARGE Secondary Data Products:

Table 2: LARGE secondary (goal) data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution[1]
Scattering Angstrom Exponent	TSI-neph	Unitless	TSI	450 – 700 nm	10 sec.
Absorption Angstrom Exponent	PSAP-tot	Unitless	Radiance Research	470 – 660 nm	10 sec.
Single Scattering Albedo	TSI-neph & PSAP-tot	Unitless	TSI & Radiance Research	Red, green, blue	10 sec.

Wet Aerosol Scattering Coefficient	Radiance Research Nephelometer with humidified air flow (RR-wet)	Mm^{-1}	Radiance Research	RH: 70-80% Green – 532 nm	10 sec.
Ambient Aerosol Scattering Coefficient	Radiance Research Nephelometer corrected using f(RH) relationship (RR-amb)	Mm^{-1}	Radiance Research	Green – 532 nm	10 sec.
Ambient Extinction Coefficient	RR-amb & PSAP-tot	Mm^{-1}	Radiance Research	Green – 532 nm	10 sec.
Optical Particle Size Distribution	Optical Particle Counter	$dN/dlogD_p$ (cm^{-3})	MetOne	D_p: 0.3-5.0 µm	10 sec.
Cloud Liquid Water Content (LWC)	CAPS	g m^{-3}	DMT	N/A	10 sec.
Cloud Particle Size Distribution	CAPS	$dN/dlogD_p$ (cm^{-3})	DMT	D_p: 5-1500 µm	10 sec.

*all products excluding those from the CAPS instrument, and where specifically noted, are reported at dry (<40%) relative humidity

[1] data will be available at 1-sec time resolution upon request

DLH Primary Data Products:

Table 3: DLH primary data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution
Water Vapor Mixing Ratio	Diode Laser Hygrometer (DLH)	ppmv	NASA	IR – 1.4 µm	1 sec.
Water Vapor Pressure	Diode Laser Hygrometer (DLH)	mbar	NASA	IR – 1.4 µm	1 sec.

DLH Secondary Data Products:

Table 4: DLH secondary (goal) data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution
Cloud Extinction Coefficient	Diode Laser Hygrometer (DLH)	km^{-1}	NASA	IR – 1.4 µm	1 sec.
RH_w and RH_i	Diode Laser Hygrometer (DLH)	%	NASA	IR – 1.4 µm	1 sec.

HSRL Primary Data Products:

Table 5: HSRL primary data archive products

Product	Unit	Vertical Resolution	Temporal Resolution	Notes
Aerosol Scattering Ratio (ASR at 532 nm)	none	30 m	10 sec. (~ 1 km)	Ratio of aerosol backscatter to molecular backscatter at 532 nm.
Aerosol Backscatter Coefficient (532 nm)	km^{-1} sr^{-1}	30 m	10 sec. (~ 1 km)	Aerosol backscatter coefficient is computed from the 532 nm ASR by multiplying the ASR by molecular backscatter profile determined from model (GMAO) density profile.
Aerosol Extinction Coefficient (532 nm)	km^{-1}	300 m	60 sec. (~ 6 km)	These have been derived using the derivative with respect to altitude of the molecular channel. A model (GMAO) density profile was used to estimate and remove molecular extinction. A cloud mask has been applied to the data before the retrieval
Aerosol Backscatter Wavelength Dependence (1064nm/532nm)	none	30 m	10 sec. (~ 1 km)	The wavelength dependence for aerosol backscattering is a parameter sensitive to the size of the aerosols and, to a lesser extent, composition and shape. The values range from about 0

				representing large aerosols with diameters greater than several microns and 4 representing nearly molecular size aerosols in the nanometer range. This parameter can be thought of as the Angstrom exponent for aerosol backscatter.
Aerosol Depolarization (532 nm)	none	30 m	10 sec. (~ 1 km)	Aerosol depolarization is the ratio of perpendicular to parallel aerosol backscatter at 532 nm expressed as a fraction. This parameter is independent of aerosol loading and depends only on particle shape (non-spherical particles depolarize the backscatter, while spherical particles result in zero depolarization).
Aerosol Depolarization (1064 nm)	None	30 m	10 sec. (~ 1 km)	(see above for 532 nm)
Aerosol Extinction-to-Backscatter Ratio (532 nm)	sr	300 m	60 sec. (~ 6 km)	Extinction-to-Backscatter ratio is computed from the ratio of the 532 nm aerosol extinction and aerosol backscatter profiles. This parameter is independent of aerosol loading and depends only on microphysical parameters (size distribution, composition, and shape). A cloud mask has been applied to the data before the retrieval.

*All measurements are time-height curtain profiles and are at the atmospheric ambient relative humidity.

RSP Primary Data Products:

Table 6: RSP primary data archive products

Product	Unit	Notes	Time Resolution*
First three components of Stokes vector (I, Q, U)	W m^2 nm^{-1} sr^{-1} (normalized radiance)	Convertible to: Total Reflectance (W m^2 nm^{-1}) Polarized Reflectance (W m^2 nm^{-1}) Aircraft attitude and GPS data are also merged in the archived CDF files.	0.8 s
RSP files geolocation	NA	Flight trajectory map showing segmentation and data quality of RSP files (post-flight analysis)	NA
Pseudo-true color images of RSP files	NA	TIF images useful for selecting scenes for further analysis (post-flight analysis)	NA

RSP Secondary Data Products:

Table 7: RSP secondary (goal) data archive products (post-flight analysis)

Product	Unit	Notes	Time Resolution*
Column spectral** aerosol optical thickness (fine and coarse modes)	unitless	Range: 0-5 Uncertainty: 0.02 over ocean and 0.04 over land	Scene-dependent
Aerosol effective radius (fine and coarse modes)	m	Range: 0.05–5 μm Uncertainty: 10%	Scene-dependent
Effective variance of aerosol size distribution (fine and coarse modes)	unitless	Range: 0-3 Uncertainty: 40%	Scene-dependent
Aerosol spectral** real refractive index (fine and coarse modes)	unitless	Range: 1.3-1.7 Uncertainty: 0.02	Scene-dependent
Aerosol spectral** single-scattering albedo (fine and coarse modes)	unitless	Range: 0-1 Uncertainty: 0.03	Scene-dependent

Aerosol morphology (fine and coarse modes)	NA	Spherical aerosols, irregular dust particles, soot clusters	Scene-dependent
Cloud thermodynamic phase	NA	Liquid, mixed, ice	Scene-dependent
Cloud top pressure	mbar	Range: 300-1000 mbar Uncertainty: 50 mbar	Scene-dependent
Cloud column optical thickness	unitless	Range: 0-300 Uncertainty: 8%	Scene-dependent
Cloud effective radius	m	Range: 1–50 μm Uncertainty: 10%	Scene-dependent
Cloud effective variance (liquid only)	unitless	Range: 0–2 Uncertainty: 50%	Scene-dependent
Column water vapor	cm	Range: 0-10 cm Uncertainty: 0.2 cm	Scene-dependent

* Defined by aircraft speed and target distance (see http://data.giss.nasa.gov/rsp_air/specs.html). Angular resolution (instrument IFOV) is 14 mrad.

**At least in three spectral channels.

PI-Neph Primary Data Products:

Table 8: PI-Nephelometer primary data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution
Linear volume scattering coefficient	PI-Neph	m^{-1}	UMBC	Integrated volume scattering coefficient provides direct comparison with TSI-Neph and with corrections for humidity comparisons to HSRL profiles measurements.	10 s (TBR)

Polarized Phase function	PI-Neph	unitless	UMBC	Calibrated polarized phase function. Filtered clear air polarized phase functions will also be obtained and archived.	10 s (TBR)
Raw Beam Images	PI-Neph	unitless	UMBC	Images useful for quality control and instrument diagnostics	10 s (TBR)

PI-Neph Secondary Data Products:

Table 9: PI-Nephelometer secondary (goal) data archive products

Product	Instrument	Unit	Manufacturer	Notes	Time Resolution
Spectral Aerosol Phase matrix elements*	PI-Neph	unitless	UMBC	F11, F12, F22, F33 at 473nm, 532nm, and 671 nm in scattering angle range 2-178 degrees (includes polarized phase function).	10 s (TBR)
Real part of refractive index*	PI-Neph	unitless	UMBC	473nm, 532nm, 671 nm	60 s (TBR) – specific flight segments
Particle size distribution*	PI-Neph	$dN/dlogD_p$ (cm^{-3})	UMBC	10 to 20 size range bins	60 s (TBR) – specific flight segments
Particle Shape Parameters*	PI-Neph	unitless	UMBC	Aspect ratio(s) of ellipsoid model	60 s (TBR) – specific flight segments

*Key parameters derived from PI-Neph but will require future funding for full dataset from flights. As a goal for the instrument, particular case study dataset segments will be investigated.

Crossbow Inertial Measurement Unit (IMU) Primary Data Products:

Table 10: Crossbow Inertial Measurement Unit primary data archive products

Product	Instrument	Unit	Manufacturer	Time Resolution
GPS Time	IMU	Hours (UTC)	Crossbow Technologies, Inc.	1 s
GPS Altitude	IMU	Km	Crossbow Technologies, Inc.	1 s
GPS Latitude	IMU	Degrees	Crossbow Technologies, Inc.	1 s
GPS Longitude	IMU	Degrees	Crossbow Technologies, Inc.	1 s
Aircraft Pitch	IMU	Degrees	Crossbow Technologies, Inc.	1 s
Aircraft Roll	IMU	Degrees	Crossbow Technologies, Inc.	1 s
Aircraft Heading	IMU	Degrees	Crossbow Technologies, Inc.	1 s

Auxiliary Measurement Suite Primary Data Products:

Table 11: Auxiliary Measurement Suite primary data archive products

Product	Instrument	Unit	Manufacturer	Time Resolution
Temperature	Rosemont 102 TAT Sensor	Degrees Celsius	Rosemont	1 s
Static Pressure	Rosemont 1201 Static Pressure Transducer	PSIa	Rosemont	1 s
Dynamic Pressure	Rosemont 1221 Differential Pressure Transducer	PSId	Rosemont	1 s

Auxiliary Measurement Suite Secondary Data Products:

Table 12: Auxiliary Measurement Suite secondary (goal) data archive products

Product	Instrument	Unit	Manufacturer	Time Resolution
Frost-point/Dew-point	GE 1011 Hygrometer	Degrees Celsius	General Eastern	3 s *

* Time resolution of the GE 1011 depends on altitude, ambient temperature, and atmospheric water vapor content and may be much slower (minutes) in certain situations.

2 APPLICABLE AND REFERENCE DOCUMENTS

This section identifies all documents that are applicable to the DEVOTE activities or referenced in this document. Current version is assumed unless otherwise noted.

2.1 APPLICABLE DOCUMENTS

DEVOTE Project Documents	
DEVOTE Proposal	Development and Evaluation of satellite ValidatiOn Tools by Experimenters (DEVOTE) HOPE TO Proposal (April 5, 2010)
DEV-04-SCI-001	DEVOTE Science Traceability Matrix

2.2 REFERENCE DOCUMENTS

2.3 DOCUMENT CONTROL

This document will follow the configuration control process in the DEVOTE Configuration Management Plan, DEV-01-PCP-002. Any changes after baseline will go through a change control process, system level Configuration Control Board review and an approval process.

3 ACRONYMS AND DEFINITIONS

3.1 ACRONYMS

APS	Aerodynamic Particle Sizer

ARCTAS	Arctic Research of the Composition of the Troposphere from Aircraft and Satellites measurement campaign
ASR	Aerosol Scattering Ratio
CAPS	Cloud, Aerosol and Precipitation Spectrometer
CDF	Common Data Format
CPC	Condensation Particle Counter
DEVOTE	Development and Evaluation of satellite ValidatiOn Tools by Experimenters
DISCOVER-AQ	Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality measurement campaign
DLH	Diode Laser Hygrometer
DMT	Droplet Measurement Technologies
GMAO	Global Modeling and Assimilation Office
GPS	Global Positioning System
HSRL	High Spectral Resolution Lidar
HDF	Hierarchical Data Format
ICARTT	International Consortium for Atmospheric Research on Transport and Transformation
IFOV	Instantaneous Field of View
IMU	Inertial Measurement Unit
INTEX-A/B	Intercontinental Chemical Transport Experiment, phases A and B of measurement campaign
LARGE	Langley Aerosol Research Group Experiment
LWC	Liquid Water Content
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
PI-Neph	Polarized Imaging Nephelometer
PSAP	Particle Soot Absorption Photometer
RH	Relative Humidity
RR	Radiance Research
RSP	Research Scanning Polarimeter
SMPS	Scanning Mobility Particle Sizer
TAT	Total Air Temperature
TBR	To Be Resolved
TIF	Tagged Image File
TSI	TSI, Inc., Shoreview, MN
UHSAS	Ultra-High Sensitivity Aerosol Spectrometer
UMBC	University of Maryland, Baltimore County

3.2 DEFINITIONS

4 ADDITIONAL DOCUMENT SECTIONS AS NECESSARY