Title: DC-8 Lidar Atmospheric Sensing Experiment (LASE) Data [NASA]

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1.0 DATA SET OVERVIEW

The Lidar Atmospheric Sensing Experiment (LASE) system was deployed on the NASA DC-8 aircraft during the Plains Elevated Convection At Night (PECAN) field experiment, which was conducted during June-July 2015 over the central and southern plains. LASE is an active remote sensor that employs the differential absorption lidar (DIAL) technique to measure range resolved profiles of water vapor and aerosols above and below the aircraft. The DC-8 conducted nine local science flights from June 30- July 15 where LASE sampled water vapor and aerosol fields in support of the PECAN primary science objectives relating to better understanding nocturnal Mesoscale Convective Systems (MCSs), Convective Initiation (CI), the Low Level Jet (LLJ), bores, and to compare different airborne and ground based measurements. LASE observed large spatial and temporal variability in water vapor and aerosol distributions in advance of nocturnal MCSs, across bores resulting from MCS outflow boundaries, and across the LLJ associated with the development of MCSs and CI.

2.0 INSTRUMENT DESCRIPTION

2.1 Instrumentation

LASE is an airborne DIAL system used to measure water vapor, aerosols, and clouds throughout the troposphere. This system uses a double-pulsed Ti:sapphire laser, which is pumped by a frequency-doubled flashlamp-pumped Nd:YAG laser, to transmit light in the 815-nm absorption band of water vapor. The Ti:sapphire laser wavelength is controlled by injection seeding with a diode laser that is frequency locked to a water vapor line using an absorption cell. LASE operates by locking to a strong water vapor line and electronically tuning to any spectral position on the absorption line to choose the suitable absorption cross-section for optimum measurements over a range of water vapor concentrations in the atmosphere. During PECAN, LASE operated from the NASA DC-8 using moderate and weak water vapor lines for optimal measurements from the midtroposphere through the boundary layer. Therefore no zenith water vapor measurements were made for this campaign. The strongly absorbing, temperature insensitive water vapor line at 817.2231 nm (12236.5603 cm-1) with a line strength of 4.060E-23 cm, linewidth of 0.0839 cm-1, and lower energy state of 224.838 cm-1 was used during PECAN. Line strength accuracy is estimated to be 2% and linewidths have agreed with other measurement to within 2% giving an overall accuracy of absorption cross-section of less than 3% (Ponsardin and Browell, 1997). Effective absorption cross-section profiles were calculated at the on-line and off-line wavelengths and the side-line positions, and corrections for Doppler broadening, pressure shift, water vapor line width, spectral purity, molecular density, and aerosol scattering ratio were used in water vapor mixing ratio retrievals (Ismail et al., 1989).

Absolute water vapor distributions are derived from the LASE measurements across the troposphere from 0-9 km over a mixing ratio range of about 20 g/kg to 0.01 g/kg. The water vapor mixing ratio profiles are calculated using a curtain of air density profiles derived from the Global Modeling and Assimilation Office (GMAO), Goddard Earth Observing System Model, Version 5 (GEOS-5) gridded profiles of temperature, pressure, and water vapor. LASE water vapor profiles have a vertical resolution of 330 m and a temporal averaging period of 3 minutes, which corresponds to a horizontal distance of about 42 km. Other temporal and vertical averaging periods can be produced upon request. Previous water vapor comparisons have shown the LASE water vapor mixing ratio measurements have an accuracy of better than 6% or 0.01 g/kg, whichever is larger, across the troposphere (Browell et al., 1997).

In addition to measuring water vapor mixing ratio profiles, LASE simultaneously measures aerosol backscattering profiles at the off-line wavelength near 817 nm. Profiles of the aerosol scattering ratio, defined as the ratio of aerosol scattering to molecular scattering, are determined by normalizing the scattering in the region containing enhanced aerosol scattering to the expected scattering by the "clean" (molecular only atmosphere) in that same region. The aerosol scattering ratio was determined using a curtain of molecular density profiles derived from GMAO (GEOS-5) as described above. Nadir and zenith aerosol profiles are combined to cover from 0 to 14 km with a data gap near the aircraft altitude The aerosol profiles have a vertical resolution of 60 m and a temporal resolution of 9 seconds or about 2.1 km. Corrections for molecular and water vapor attenuation have been performed but not for aerosol attenuation.

3.0 DATA COLLECTION AND PROCESSING

LASE was operated from the NASA DC-8 aircraft collecting 51 hours of science data during nine PECAN science flights during July 1 through July 16, 2015. In addition, there were two transit flights from/to the NASA Dryden Flight Research Center (DFRC) facility in Palmdale, CA where LASE was operational while transiting into and out of the PECAN region on 28 June and 16 July 2015, respectively.

Data Intervals

Water vapor and aerosol horizontal data interval is 9 seconds or ~2.1 km.
Water vapor and aerosol vertical data interval is 30m.

Data Resolution (Averaging Interval)
Water vapor horizontal resolution is 3 minutes or 42 km
Water vapor vertical resolution is 330 m
Aerosol scattering ratio vertical resolution is 60 m

4.0 DATA FORMAT AND FILE NAMING

4.1 Data Format

Data file archive format

Format specification for Data Exchange by Steve E. Gaines and R. Stephen Hipskind found at cloud1.arc.nasa.gov/solve/archiv/archive.tutorial.html http://cloud1.arc.nasa.gov/solve/archiv/archive.tutorial.html. LASE uses format number 2310.

IDL 2310 format read code

The following IDL program (attached), "rd_arc_pcn_2310.pro" will read the 2310 formatted LASE aerosol and water vapor profile data.

4.2 File Naming conventions

Data Files

The PECAN file naming convention for LASE data products is:
aircraft.YYYYMMDDHHmm.product_name.ext where

- aircraft = NASA_DC8
- YYYYMMDDHHmm = UT date and start time
- product_name = LASE_H2O_R1 or LASE_AER_R1
- ext = extension denoting file type = TXT

For example, revision 1 of water vapor data from July 15, 2015 is NASA_DC-8_201507152130_LASE_H2O_R1.TXT

NASA DC-8 flights during PECAN:

- Transit - Palmdale, CA to Salina, KS - June 28, 2015
- IOP17 - MCS - July 1, 2015
- IOP19 - Bore - July 5, 2015
- IOP20 - MCS - July 6, 2015
- UFO10 - MCS - July 7, 2015
- IOP21 - MCS - July 9, 2015
- IOP25 - Bore - July 11, 2015
- IOP26 - CI-LLJ - July 12, 2015
- IOP29 - CI - July 14, 2015
- IOP30 - CI - July 15, 2015
- Transit - Salina, KS to Palmdale, CA - July 16, 2015

5.0 DATA REMARKS

LASE PECAN URLS:

The LASE PECAN campaign images are located at:
http://science.larc.nasa.gov/lidar/PECAN/
The LASE aerosol, water vapor profile data, and images are archived at http://data.eol.ucar.edu/master_list/?project=PECAN under Aircraft: NASA DC-8 LASE Data.

LASE PECAN data set release history

a. "Quick-look", preliminary data

These data were produced and distributed during the PECAN field mission during June - July 2015. These initial (R0) data sets are for "quick-look" purposes only and are replaced by the final processed data (R1).

b. Processed data

These data completed post-processing in the fall of 2015 and were submitted to the archive in January 2016.

Algorithm for data reduction

Water vapor analysis employs the DIAL technique, which is explained at http://science.larc.nasa.gov/lidar/instruments-dial.html. Aerosol scattering ratio computations are described in this document instrument description (item 2.1 above).

6.0 REFERENCES

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Ismail, S., E. V. Browell, 1989: Airborne and spaceborne lidar measurements of water vapor profiles: A sensitivity analysis, Appl. Opt., 28, 3603-3615.

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