Autonomous ozone, aerosol and water vapour lidar measurements: a synergistic approach to air quality

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Overview

• Motivation – Why build it??
• Instrument Design
  – Fully autonomous operation – near real-time upload to website
  – Mobile Platform
  – Aerosol Backscatter LIDAR
  – Tropospheric Ozone DIAL
  – Night time water vapour
• Testing and Early Results
• TOLNet collaboration
• Summary and Future Work
Ozone and Aerosols

• Tropospheric ozone and aerosols (PM10 and PM2.5) are important atmospheric constituents in low altitude pollution affecting human health and vegetation

• Ozone is photo-chemically active with nitrogen oxides – diurnal variations of photochemical smog

• Aerosols contribute to the radiative budget, tracer for pollution transport, complex mixing, visibility and cloud formation

• Improve AQ forecast and diagnostic models
ECCC Autonomous Lidars

www.coralnet.ca
Username: TOLNet
Password: Alabama_rules
Website: Monthly calendar plots

It should be noted that all images are first look images and are not for use in publications. For all enquiries concerning CORAL Net data please contact Dr. Kevin Strawbridge at Kevin.Strawbridge@ec.gc.ca

Wavelength: [Ozone Concentration]  Date: [2016 June Eastern Time(EST)]
Autonomous LIDAR challenges

- Active radar
- Interlock system
- pan/tilt surveillance camera
- Heat strips – snow!
- Automated wiper System – dirt!
- Remote alignment
System Parameters – Aerosol Lidar

• range/resolution
  - near ground to 15 km
  - 3 – 7.5 m vertical resolution
  - 10 s – 1 min temporal resolution

• three wavelength transmitter / 6 channel receiver
  - 355 nm/532 nm/1064 nm (355 nm is 65mJ @ 20Hz) – Continuum Inlite III-20
  - cross polarization channel at 355 nm
  - 35 cm Schmidt Cassegrain telescope
  - two Raman channels
  - 355/387/532/607 nm - LICEL electronics/PMT’s
  - 1064 nm – APD with log amp
System Parameters – Ozone DiAL

- range/resolution
  - near ground to 10 km
  - 3.75 m vertical resolution minimum
  - 1-10 min temporal resolution

- transmitter / receiver
  - Continuum Inlite III-20 laser
  - output energy/power @ 266 nm
    - 45mJ @ 20Hz = .9 W
  - 35 cm Schmidt Cassegrain telescope
  - 276/287/299 nm - LICEL electronics/PMT’s
Dual Laser Design
Lidar Optics Bench Layout
Transmitter Layout
Small Telescope/Optical Fibre
Water Vapor Mixing Ratio (g/kg) from 2016/06/17 00:00:00 to 2016/06/22 00:00:00

Ozone Mixing Ratio (ppbv) from 2016/06/17 00:00:00 to 2016/06/22 00:00:00

Backscatter Ratio at 532 nm from 2016/06/17 00:00:00 to 2016/06/22 00:00:00
Ozone Mixing Ratio (ppbv) from 2016/06/23 21:00:00 to 2016/06/24 12:00:00

Water Vapor Mixing Ratio (g/kg) from 2016/06/23 21:00:00 to 2016/06/24 12:00:00

Backscatter Ratio at 532 nm from 2016/06/23 21:00:00 to 2016/06/24 12:00:00
TOLNet P.I. :
Mike Takes the Bull by the Horns LITERALLY!!
TOLNET WITHOUT ECCC

TOLNet - Tropospheric Ozone Lidar Network
Ground-Based Profiling of Tropospheric Ozone
Deployment to the Oil Sands Region

- Coincident and long-term record for aircraft measurements
  - In-situ chemistry package
  - Winter campaign planned

- Coincident and long-term record for ground measurements
  - Ground-level ozone, NO\textsubscript{x} etc
  - CIMEL sunphotometer
  - WIND RAS

- Satellite comparison/validation (e.g. TEMPO, TOLNet)

Environment Canada GEM-MACH Model
Summary and Future Work

• the newly developed autonomous tropospheric ozone/3+2 aerosol lidar will add a unique capability for Environment and Climate Change Canada to explore the presence, vertical distribution and seasonal variability in the lower atmosphere

• the synergistic approach to simultaneous measure tropospheric ozone, aerosol and water vapour (night time) will provide an improved understanding of boundary layer and free tropospheric processes which impact visibility and air quality

• Interested in getting our algorithm tested against the TOLNet standard!!