Atmospheric Sensing Opportunities

S&T Campaign: Information Sciences
Sensing and Effecting

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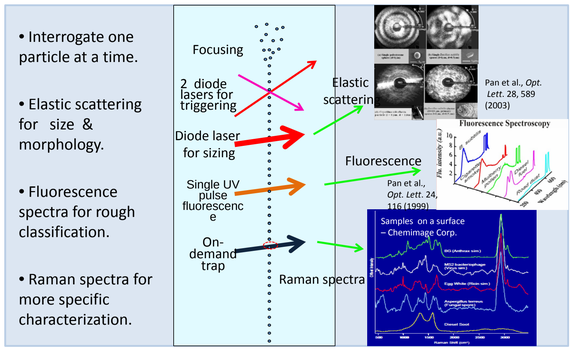
Atmospheric Aerosols Research and Characterization

Research Objective

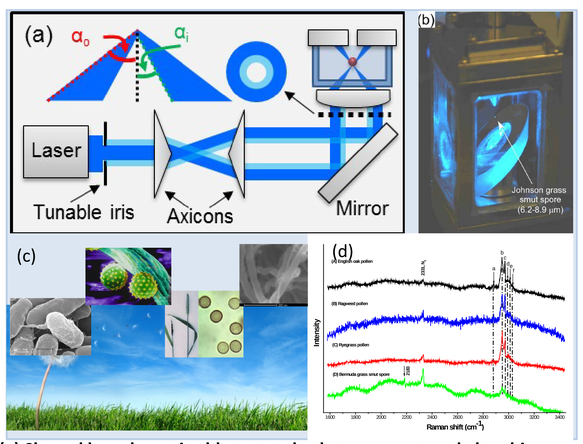
- Develop a technology that traps and measures Raman spectra of aerosol particles from continuously sampled stream
- Use the technology for the detection and characterization chem/bio agents and atmospheric aerosol particles



Real-time & *in-situ* detection and characterization of single aerosol particles exploiting scattering, fluorescence, & Raman spectral signatures

Challenges

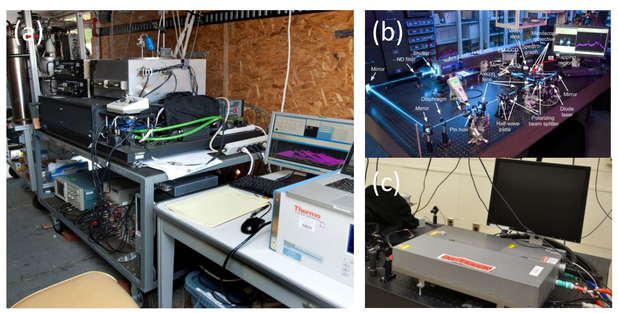
- Raman spectra are extremely weak.
- Drag forces from air tend to make particles move.
- Trapping particles in air is very difficult, especially from continuous sampling.
- Complex atmospheric aerosols background can confound the detection of chem/bio threat agents.



(a) Shaped laser beam is able to trap both transparent and absorbing particles in air using low N.A. optics; (b) Single Johnson grass smut spore is trapped in air; (c) SEM images from *B. Subtilis*, Ragweed, Johnson grass smut spores, and Carbon nanotubes; (d) Raman spectra from pollens.

ARL Facilities and Capabilities Available to Support Collaborative Research

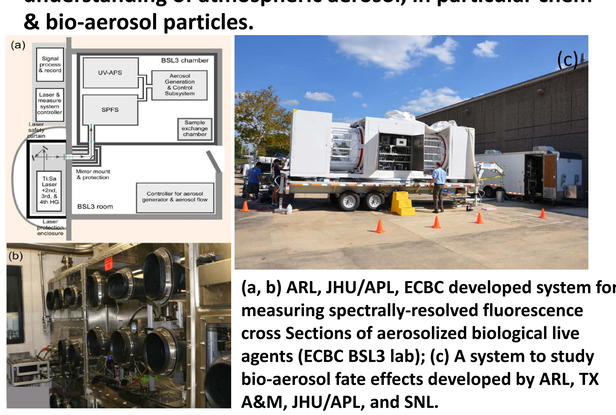
- 4 labs over 1200 square feet of research space.
- Continuous-wave and pulsed laser sources from deep UV to visible and near IR.
- Spectrographs; image and spectral detectors; microscopes; aerosol trapping devices; and aerosol generators.
- Dual-wavelength single particle fluorescence spectrometer.
- Detection of single particle elastic scattering patterns.
- Single particle Raman spectroscope for trapped aerosol particles in air.



(a) Double-wavelength single particle fluorescence spectrometer in bio-aerosol fate study; (b) Single particle Raman Spectroscope from trapped airborne aerosol particles; (c) Pulsed, tunable Ti:Sapphire laser system 220 nm-450 nm.

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

Seek wide collaborations with universities, research institutes, and governmental agencies; Explore deep understanding of atmospheric aerosol, in particular chem- & bio-aerosol particles.

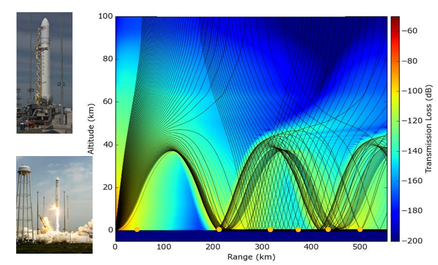


(a, b) ARL, JHU/APL, ECBC developed system for measuring spectrally-resolved fluorescence cross Sections of aerosolized biological live agents (ECBC BSL3 lab); (c) A system to study bio-aerosol fate effects developed by ARL, TX A&M, JHU/APL, and SNL.

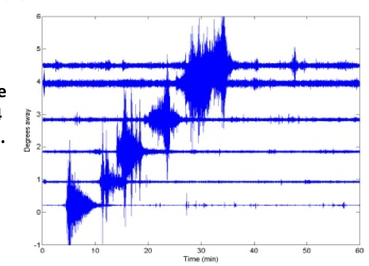
Atmospheric Acoustics Propagation Research

Research Objective

- Development of accurate infrasound propagation models which account for environmental effects.
- Provide realistic atmospheric data cubes for infrasound propagation models from the surface to 180 km AGL.
- Develop models to design and predict performance of novel portable wind screens for infrasound microphones.



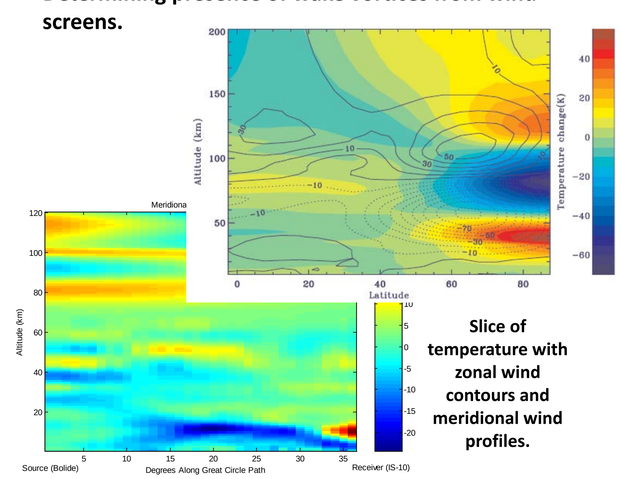
Parabolic equation and ray trace of acoustic propagation modeling results from an Antares rocket launch.



Time-series with range from the 13 July 2014 Antares rocket launch.

Challenges

- Incorporation of terrain and large scale turbulence effects into infrasound propagation models.
- Determining source dynamics for the generation of infrasound signals.
- Determining presence of wake vortices from wind screens.

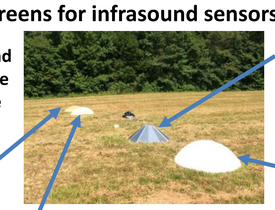


Slice of temperature with zonal wind contours and meridional wind profiles.

ARL Facilities and Capabilities Available to Support Collaborative Research

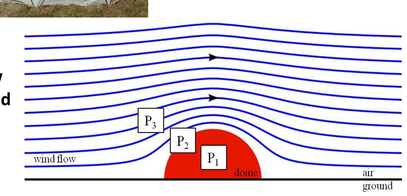
- Quiet experimental range located in southern Maryland.
- Infrasound propagation models.
- Suite of atmospheric models to generate atmospheric data cubes over the earth.
- John M. Noble, W.C.K. Alberts, Stephen M. Tenney, "Infrasonic Propagation Modeling of Orbital Launch Vehicles," J. Acoust. Soc. Am., 137, p. 2408 (2015).
- John M. Noble, W.C. Kirkpatrick Alberts, II, Sandra L. Collier, Richard Raspet, and Mark A. Coleman, "Wind Noise Suppression for Infrasound Sensors," ARL Tech Report, ARL-TR-6873, March 2014.
- K. Alberts, S. Tenney, and J. Noble, "Assessment of Operational Progress of NASA Langley Developed Windshield and Microphone for Infrasound," ARL Tech Report, ARL-TR-6417, April 2013.
- Porous fabric domes have been shown to perform very good as wind screens for infrasound sensors.

Scaling down the wind screens looking at the effects of difference material covers.



Hemispherical wind screens with difference material covers.

The turbulent wind flow over a hemispherical wind screen placed on the ground.



Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Time domain wave propagation modeling over large scale terrain features.
- Large scale wind tunnel with variable turbulence fields.
- Modeling of infrasound sources.
- Temporal variability of atmospheric processes from the surface to 180 km.

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