A13F-2514: Characteristics of In Situ Fine Fraction Aerosol Spectra from 300-700 nm
Observed Around the Korean Peninsula During KORUS-OC

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In situ aerosol extinction and absorption spectra covering the 300-700 nm range at ≤ 1 nm spectral resolution were measured aboard the R/V Onnuri during the Korea U.S. – Ocean Color (KORUS-OC) cruise around the Korean Peninsula from May 21 through June 3, 2016. Total absorption spectra were obtained from aerosols collected on glass fiber filters and subsequently placed in the center of an integrating sphere (Labsphere DRA-CA-30) attached to a dual beam spectrophotometer (Cary 100 Bio UV-Visible Spectrophotometer, 0.2 nm spectral resolution). Absorption spectra from methanol and deionized water extracts of aerosols collected on Teflon filters were measured in a liquid waveguide capillary cell (World Precision Instruments LWCC-3100, ~0.4 nm spectral resolution). Extinction spectra were measured with a custom built instrument (SpEx, ~0.8 nm spectral resolution). The measurements were obtained at a height of ~10 m above the sea surface with an inlet that limited the measured aerosols to diameters ≤ 1.3 µm. All four sets of spectra exhibit curvature in log-log space with 2nd order polynomials providing a better fit to the measured spectra than power law fits. The deionized water extracts were also analyzed with an ion chromatograph (Dionex ICS-3000 Ion Chromatography System) and with an aerosol mass spectrometer (Aerodyne Research, Inc. HR-ToF High Resolution Aerosol Mass Spectrometer) to examine chemical composition. These data indicate the optical spectra are sensitive to differing chemical properties of the measured ambient aerosols and suggest differing sources and/or atmospheric processes influence the observed optical signatures. The measured suite of spectra are combined to examine the spectral characteristics of single scattering albedo, as well as to examine the contribution of soluble absorbing chromophores to the total absorption spectra. Additional measurements made during the affiliated Korea U.S. - Air Quality (KORUS-AQ) campaign will be used to provide further insight on the observed spectral characteristics.
In situ fine fraction aerosol spectra from 300-700 nm observed around the Korean Peninsula during KORUS-OC

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Abstract

In situ aerosol extinction and absorption spectra covering the 300-700 nm range at 5.1 nm spectral resolution were measured aboard the R/V OOI during the Korea U.S. – Ocean Ceter (KORUS-OC) cruise around the Korean Peninsula from May 21 through June 3, 2016. Total absorption spectra were obtained from aerosols collected on glass fiber filters and subsequently placed in the center of an integrating sphere (Labsphere DRA-CA-30) attached to a dual beam spectrophotometer (Cary 100 Bio UV-Visible Spectrophotometer, 0.2 nm spectral resolution). Absorption spectra of methanol (MeOH) and deionized water (DIW) extracts of aerosols collected on Teflon filters were measured in a liquid waveguide capillary cell (World Precision Instruments LWCC-3100, ~0.4 nm spectral resolution). These measured DIW-soluble extinction spectra were measured with a custom built instrument (Spex, ~0.8 nm spectral resolution). The measurements were made at a height of ~10 m above the sea surface, which is in a region that limited the measured aerosols to diameters ≤1.3 μm. All four sets of spectra exhibit curvature in log space with second order polynomials providing a better fit to the measured spectra than power law fits. The DIW extracts were also analyzed with an ion chromatograph (Dionex ICS-3000 Ion Chromatography System) to examine chemical composition. These data indicate the optical spectra are sensitive to differing chemical properties of the measured ambient aerosol and suggest different sources and/or atmospheric processes influence the observed optical signatures. The measured suite of spectra are combined to examine the spectral characteristics of single scattering albedo, as well as to examine the contribution of soluble absorbing chromophores to the total absorption spectra. Additional measurement methods utilizing the affiliated Korea U.S. - Air Quality (KORUS-AQ) campaign will be used to provide further insight on the observed spectral characteristics.

Introduction: KORUS-OC & In Situ Aerosol Measurements

• Affiliated with airborne KORUS-AQ & KOCOA cruise – joint missions to study the Korean air quality (AQ) & OC
• Under way of S. Korean Geranotomical Ocean Color Imager (GOCI)
• Providing hourly OC & aerosol optical depth (AOD)
• Cruises conducted from May 20 to June 4, 2016
• OC objectives for atmospheric measurements to:– Address atmospheric correction requirements– Explore interdisciplinary science questions

1 minute Data Set: 3 visible wavelengths
– Scattering (Ap/Phot Nephelometer model (Nic101-450, 532, and 632 nm)
– Absorption (Brechtal Transistor Absorption Photometer, TAP model (Nic101-457, 528, and 582 nm)

Key Points
– 1 min scattering and absorption coefficients (UC and AC respectively) used to flag ship plume intercepts (left compare top 2 panels)
– Simple scattering albedo (SSA) decreases when scattering concentration (middle panel at left)
– Absorption Ångström Exponents show little variability with one of the wavelength pair used in calculation (left bottom panel)
– Scattering Ångström Exponents show some variability with wavelength, along with an increase in values later in cruise (left bottom panel)
– The cruise ended (Below: right panel, excluding periods within the S. Korean Territorial Sea) was due to the east of the peninsula for the 1st half of the cruise, then crossed to the west of the peninsula for the 2nd half of the cruise.
– 450 nm SC, AC and SSA mapped to show peak values observed to the east, lowest values to the west (right panel)

Spectra Data Set: 300-700 nm wavelengths
– Extinction (Spectral Aerosol Extinction (SpEx) instrument, 4 nm resolution)
– Total Absorption (Glass fiber filter measured in liquid waveguide capillary cell (World Precision Instruments LWCC-3100))
– DIW- and MeOH-soluble Absorption (extracts from Teflon filters measured in liquid waveguide capillary cell (World Precision Instruments LWCC-3100))
– Filters sampled – 3 hr daytime, 12 hr nighttime
– Chemical Aging Calculations
– Dorney-ICSM 305 (Ion Chromatography System)
– Aerodyne High Resolution – Time Of Flight Aerosol Mass Spectrometer (TOF-AMS)

Characterizing Spectral Shapes

• Aerosol interaction between light is wavelength dependent often characterized by a power law: p(λ) = α λ β

• Previous studies using ambient total column measurements and/or models have investigated sensitivities of the 2nd order polynomial coefficients and considered additional information content they may offer.[Eck et al., 2001; Schuster et al., 2006] Here, we can map various in situ observations into α vs. β coefficient space following Schuster et al. [2006] to examine the relationship between these observations and the spectral shape of extinction, total absorption, and soluble absorption, a few examples are shown in Figure 1.

• DIW-soluble Absorption Wavelength-Dependent Absorption Coefficient-Total Absorption
– Only values 3 σ below the mean black and white
– The strong wavelength-dependence of the total absorption results in many parallel spectra over the 300-700 nm range for the soluble absorption
– Extreme values for α and β for both DIW- and MeOH-Abs arise from partial spectra
– All Ext and Total Abs spectra were complete spectra resulting in a more limited range of values for α and β

SSA & Total Absorption Spectra

• SSA spectra exhibit diverse features throughout the cruise
– These features arise from the Total Abs spectra
– Unlike Ext and soluble-Abs spectra, there was a lot of structure in Total Abs spectra here, smoothed over 10 nm using a binomial algorithm prior to 2 nm averaging for SSA calculations)
– That structure limited the utility of the α vs. β for either Total Abs or SSA

Implications of Results & Future Work

In situ aerosol spectral measurements have been combined with other in situ aerosol measurements showing that both targeting specific wavelengths, as well as evaluating the spectral shape, can provide insight into the linkages between chemical and optical aerosol properties.

Work is ongoing to fully assess these data and investigate the results obtained within the broader KORUS-AQ data set. Efforts are also underway to refine and expand the spectral measurement capabilities as deployed during KORUS-OC.

Future studies combining these spectral measurement techniques with more extensive micropychrometric and chemical information will have the potential to provide a wealth of new information regarding key aerosol characteristics responsible for particular optical signatures.