ANALYSIS ON THE SPECTRAL REFLECTANCE RESPONSE TO SNOW CONTAMINANTS IN NORTHEAST CHINA

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1. INTRODUCTION

Reflectivity of snow is much higher than the rock, soil, vegetation and most of the other land surface. Snow cover significantly affects the surface radiation balance, the weather and climate changes. Snow reflectance is affected by many factors, including, snow grain size changes, the underlying surface conditions, impurities in the snow, snow humidity and so on. Therefore, the study of snow reflectance change is the basis for snow parameters monitoring and inversion. The investigation of snow spectral properties is usually carried out taking into account the reflectance, defined as the ratio of the radiant energy reflected by a target to that incident upon it.

In this study, an experiment was designed and snow spectral reflectance was measured using a portable spectroradiometer to simulate the atmospheric dust affect on snow reflectivity and albedo. We also clarified the impact of snow particle size on reflectance mechanism. The analyses mainly focused on the following aspects: the impact of different pollutants on snow reflection ratio; the joint action of snow particles and dust on snow albedo changes over time. This will be a good experiment for the next experiments to further analyze impacts of the black carbon, dust and other materials on snow albedo, and to explain the relationship between the snowmelt rate and the albedo of snow.

2. MATERIALS AND METHODOLOGY

We ground the typical soil that collected from northeast region into a certain particle size (diameter le 0.15mm), and evenly scattered the soil on the snow surface. Simulate the atmospheric dust density by controlling the scattering amount of facilities. 10-13 controlled experiments were designed for contaminated snow spectral reflectance measurements, including a natural state of the snow as reference. The Measurement was taken at GMT10:00 ~ 14:00 (solar elevation angle is greater than 45 °) from Nov 17, 2009 to Nov 23, 2009. The weather was basically in good condition without snowing and cloud. We had continuous measurement six days until the snow melt off. Air temperature had been the upswing during the six days.

Snow reflectance was acquired by a field spectroradiometer Fieldspec FR (Analytical Spectral Devices, ASD company), in the wavelength range 350–2500nm, and calculated as the ratio of incident solar radiation reflected from the snow target and the incident radiation reflected from a white reference Spectral on, being regarded as a Lambertian reflector. Snow samples were collected with a specific diameter instrument over the above surface 1.5cm snow that mainly affected by contaminants. All the snow samples are weighted with scale with accuracy of 0.001g in a beaker, then samples would be dry out in the oven setting to 80℃. The contaminants could be derived from minusing the weight of beaker with snow contaminants with that of clean beaker.

3. RESULT AND DISCUSIONS

In this study, 12 samples of snow mixed with contaminants and a natural state snow sample were analyzed. As the amount of contaminants increases in the snow samples, the snow reflectance decreases, this trend is more notable in the visible band spectrum. In natural state, snow has a high reflective in visible spectrum, especially in the spectrum range of 300-800nm wavelength. At 300nm, the reflective can almost reach to 1, and then decreases with the increase of wavelength. But snow mixed contaminants present different patterns, in the whole, its reflectance decreases, but from 450nm to 950nm the reflectance increases as the wavelength moving to long wavelength. These trends generally reach its peak at 950nm for the snow mixed with contaminants, and it is higher than that of natural state snow (Fig.1a). The coefficient of correlation between the reflectance and the level of contaminants in snow is from -0.82 to 0.83 (Fig.1b).In the visible band, snow reflectance inversely related to levels of pollutants. The pollutants in snow seriously affect the reflectivity of snow. From 1400nm-1700nm; the levels of pollutants show positive correlation, the correlation coefficient can reach to 0.83. So we can select the sensitive band to pollutants in snow by this correlation analysis.

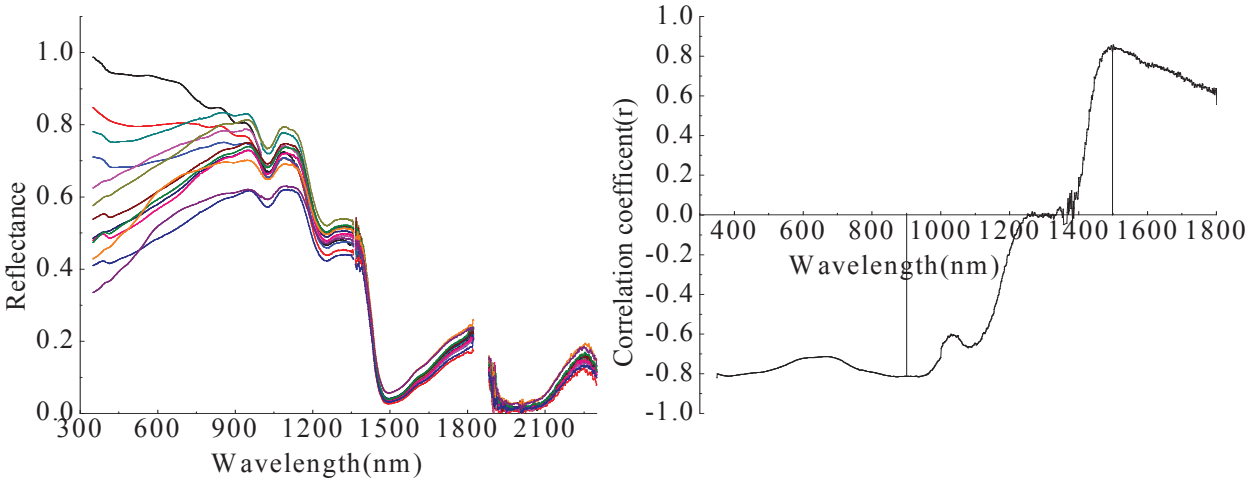

Fig.1 the spectral curves of different contaminants in snow on Nov 17, 2009

The follow days' analysis had the similar results (Fig.2a, Fig.2b).In addition, because snow on Nov.19 had begun to melt off, increasing the ratio of pollutants, to a certain extent; the spectral reflectance represents the characteristics of the contaminated snow. We found that the reflectance also was affected by the snow particle size by analysis the curve of natural state snow daily changes which can be illustrated by fig.4b.

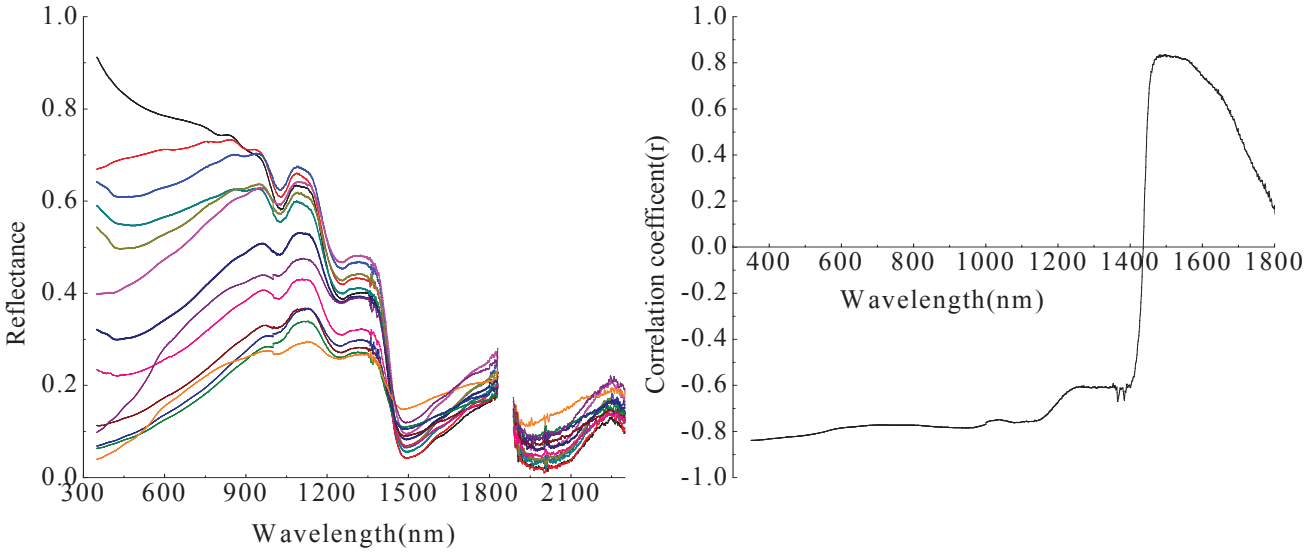

Fig.2 the spectral curves of different contaminants in snow and the correlation between snow reflectance and contaminants on Nov 19, 2009

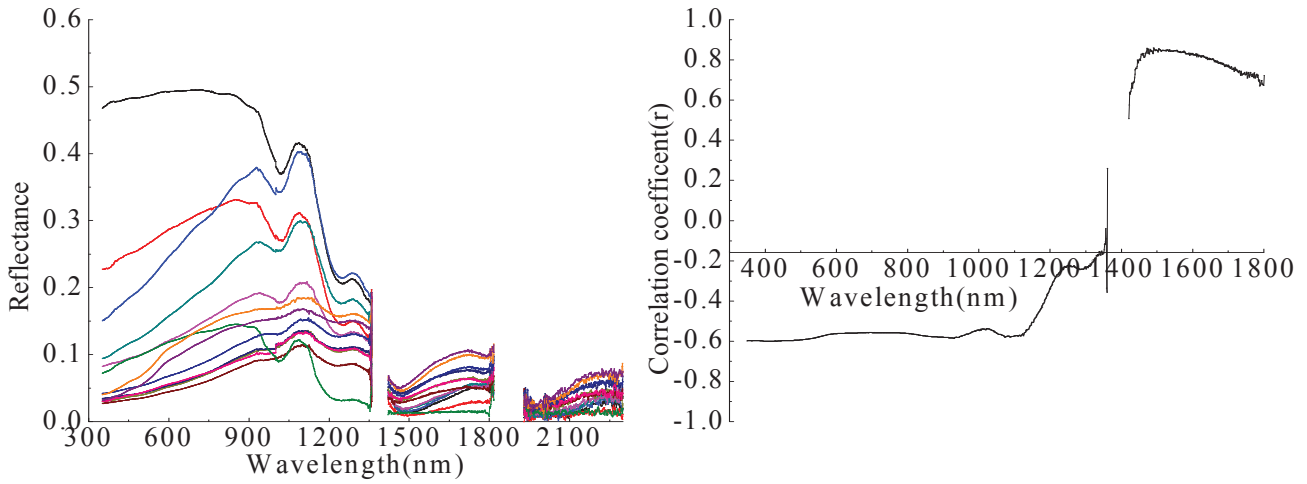

Fig.3 the spectral curves of different contaminants in snow and the correlation between snow reflectance and contaminants on Nov 23, 2009

The follow days' analysis had the similar results (Fig.3a, Fig.3b).In addition, because snow on Nov.23 had been basically melting off, increasing the ratio of pollutants, to a certain extent, the spectral curve reflected the characteristics of the contaminants. Again, the reflectance of all snow samples continuing to decrease by the coupling effects of contaminants and snow particle size increasing, which result in significant reduction of snow reflectance (fig.4a and fig.4b). However, the reason why the snow reflectance of natural status obtained on

Nov.21 is a little bit lower than that of Nov.22 can not be explicitly explained. The possible reason could be attribute to illumination conditions changed or the snow particle or water vapor in the snow changed. We found that the reflectance also was affected by the snow particle size by analysis the curve of natural state snow daily changes. In the further study, we can invert the contaminants in snow from its spectral curve and study the relationship between reflectance and snow particle size.

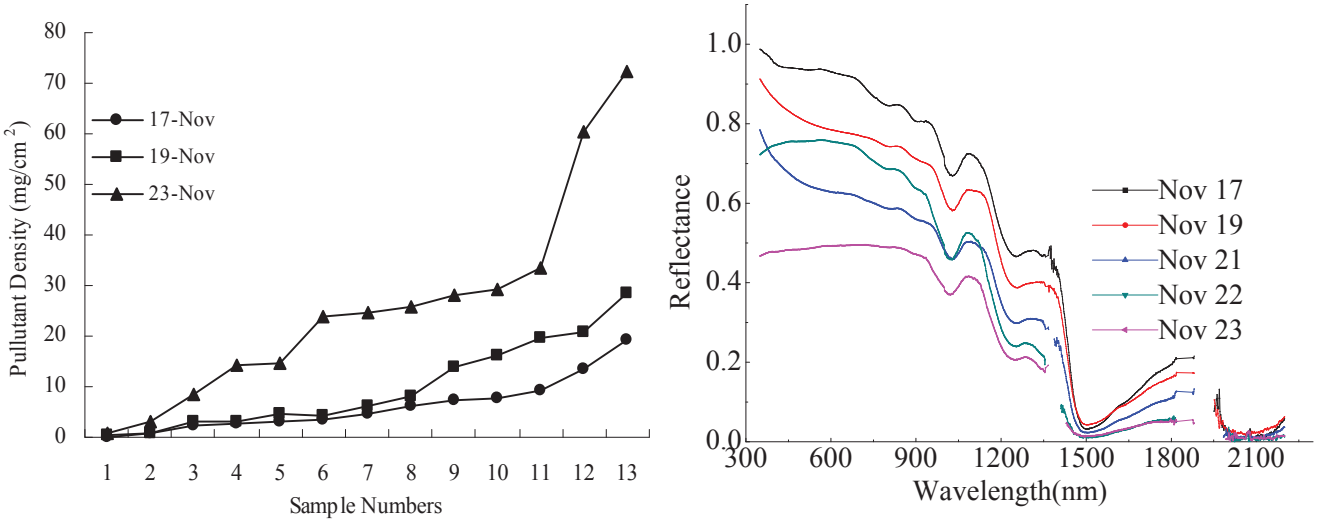

Fig.4 the reflectance daily changes of natural state snow

4. REFERENCES

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