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A Modelling Approach to the Impact Assesment of Climate Change on Glacial Covers

[1]Isha Negi, [2]Lavish Tyagi, [3]Mahak Singh

[1,2,3] Department of Civil Engineering, Noida Institute of Engineerimg & Technology (Gr Noida), India

ABSTRACT

Black carbon (BC) plays an important role over the climate change due to its absorption capabilities. As such BC reduces the snow albedo and increases the snow melting process accelerating the rapid melting of glacial mass content on the planet. In this paper, a general view of the BC indiced radiative forcing along with the sources of BC and the measurement techniques are described in brief. The paper also explores the potential of SNICAR (The snow, ice and aerosol radiative) model in simulating the effect of BC on the snow albedo by taking into account the microphysical properties of snow.

Keywords *Black carbon(BC),albedo,simulation,SNICAR,visible wave length.*

I.INTRODUCTION

Carbonaceous particles constitute a major part of the atmospheric aerosol community . They exist in two forms, organic carbon (OC) and elemental carbon (EC), more commonly known as black carbon (BC). Combustion processes such as vehicular exhaust, biomass burning and coal combustion form the major sources of such aerosol particles. Black carbon alters the radiative balance of the Earth primarily in three ways – by heating up the atmosphere in the vicinity of the aerosols, by decreasing the snow albedo and accelerating glacier melting, and by acting as cloud condensation nuclei, altering the precipitation patterns. Snow, being the most reflective surface is significantly affected by the presence of BC on its surface. The glaciers in the Himalayas and Tibetan Plateau are receding at a faster rate than the polar regions due to its proximity from the BC emission sources. Investigations carried out in the Himalayan region indicated the loss in glacier area from almost 6000 glaciers covering an aerial extent of 20,000 km2, which is almost half of the glacier-covered area in the region and these investigations suggest that the glaciers are losing at average 0.4% area per year . Investigations conducted on glaciers and snow covers across different parts of the Himalayas and Tibetan Plateau have shown significant accumulation of BC in the glaciers and seasonal snow.

This paper presents a review of the possible effects of such carbonaceous aerosols along with the different experimental as well as modelling techniques to help assess and measure its impacts

BC Albedo Forcing & Albedo Reduction

It is well known that snow is the most reflective natural surface on earth at the ultraviolet and visiblewavelengths. BC is considered as the most effective Insoluble light abosrbing partice that areproduced by the burning of biofuel, fossil fuel, and biomass. Snow albedo is a key issue for climate change studies in radiative transfer (RT) calculations and satellite applications.The albedo of a surface results from the target's capability to wavelength-dependently reflect the direct and diffuse irradiance. For snow, the albedo is typically very high compared to other natural objects or surfaces .The decrease in albedo due to the presence of BC in snow was studied using spectroradiometer. The results were then compared to that of a climate model called SNICAR. The results showed that black carbon, dust, and grain growth in the winter snowpack here can reduce the broadband albedo by 11%, 28%, and 61%, respectively. The contents of black carbon and dust were measured forsurface snow samples collected from the Nam Co region in Central Tibet in the winter of 2011. Their average concentrations were 72 ppbm (close to that in the glaciernearby) and 120 ppm, respectively (Jing Ming, 2009).

BC Measurement Techniques

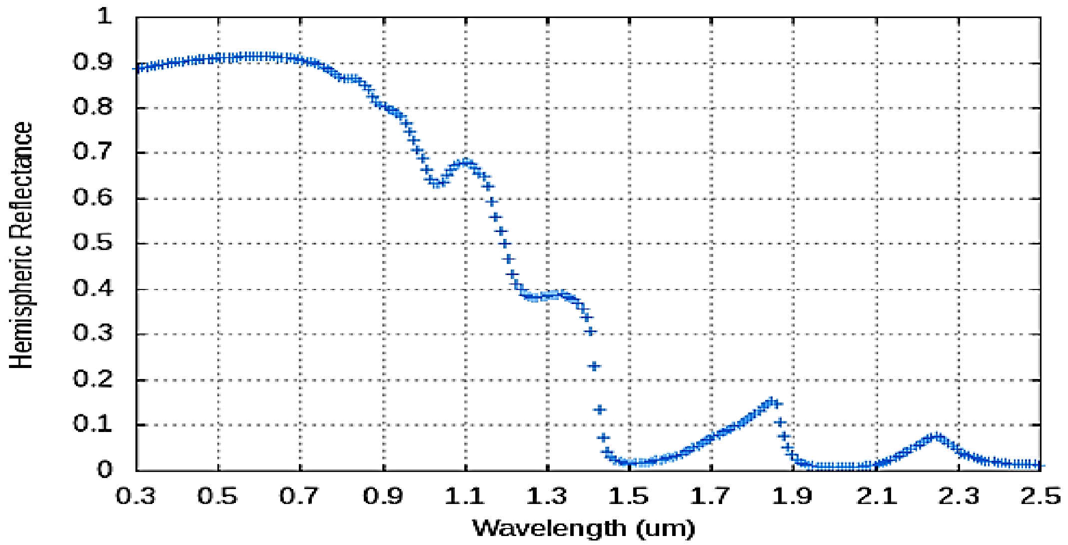
Since the late 90's seasonal snow has been collected and analyzed from most high latitude regions across the Northern Hemisphere such as the polar region Greenland, Canada and Russia. Sampling and analysis of snow/ice to study the BC and dust concentrations in northern China have been taken up since 2004 following which several investigations were taken up. Usually sampling locations are selected away from cities or villages and freeways or roads so that the snow samples are not contaminated by local sources of pollution and results obtained can represent large areas.

In recent years, several methods have been developed for measuring the concentration of light absorbing particles in snow. However only three such techniques have been found to be effective till date. These are the filter based method (Doherty et al.,2010), the thermo – optical technique, and the single soot photometer method (Schwarz et al., 2012). The filter based techniques are largely based on measuring the changes in the light transmission through the filter. In the filter based method the snow samples collected are kept frozen in a glass container before they are analyzed in the laboratory. In order to minimize possible loss of BC to the container's walls, all snow samples are thawed in a microwave oven and immediately filtered through Nucleopore Quartz filters (with a pore size of 0.4 μm). The filters are then dried and light transmission through the filters is measured. The equivalent BC loading cannot be estimated accurately by visual inspection if the filter is heavily loaded with soil dust, because of the color difference between the sample filter and the calibration filters, in case of heavy soil dust deposition the filters turn yellow.

Simulation Techniques

The snow, ice and aerosol radiative(SNICAR) model is a freely available simulation model deveoped by Flanner et al. in 2007. This model effectively simulates the albedo of snow affected by BC deposition for different types of atmospheric and topographic conditions. It also considers the microphysical properties of snow in order to take into account the age of snow.

The model requires the input for direct incident radiation which means the solar radiation - Sky conditions, condition of sky when the test was done - Solar zenith angle, Spectral conditions, snowpack thickness, the thickness of the snow at the sampling site. The albedo of the underlying ground in the visible and near infrared band were fixed at the default values ,albedo is the diffused radiation from the total radiation falling on the snow .The Mass absorption cross section (MAC) of BC was also set to the default value of 1.The BC concentration used for the simulation was also considered whether be coated or uncoated,-Grain radius was also considered grain radius is the radius of the grain of snow, which were stimulated for various value, so as to study the combined effect of BC and snow grain growth. It is to be noted here that the albedo feedback only due to BC and snow grain size has been considered in this study. The influence of dust and other such particles has been ruled out.



II.CONCLUSION

Black Carbon accounts for a very small proportion of the atmospheric aerosol family but it plays a significant role in perturbing the global as well as local climate through the reduction in snow albedo and acceleration in glacial melting. BC also has the potential to change the cloud properties and cause an uneven precipitation pattern. BC deposition on snow is considered to be a factor of uncertainty while as certaining the radiative impacts of aerosols on the climate system. Keeping all these issues in mind, this paper aims to review some of the prominent studies carried out across the globe in order to assess the climatic impact of BC loadings on snow. The use of single particle soot photometer(SP2) can produce satisfactorily results as long as the size distribution of particles in the snow sample is within the detection range of the SP2. Although several climate models have also indicated that the altered radiative forcing estimates of BC by their absorption capabilities in snow or ice cores can significantly affect regional and global climate, the larger impact of BC deposition flux in terms of glacial melting is still highly uncertain.

REFERENCES

1) Flanner M.G., and Zender C.S., "SNICAR Online", 2007. [Online]. Available: http://snow.engin.umich.edu/info.html.

2) Hadley O.L., and Kirchstetter T.W., "Black-carbon reduction of snow albedo," *Nature Climate Change*, vol. 2, no. 6, pp. 437–440, 2012

3) Li Y., Chen J., Kang S., Li C., Qu B., Tripathee L., Yan F., Zhang Y., Guo J., Gul C., and Qin X., "Impacts of black carbon and mineral dust on radiative forcing and glacier melting during summer in the Qilian Mountains, northeastern Tibetan Plateau," *Cryosphere. Discussions*, doi:10.5194/tc-2016-32, 2016.

4) Ming J., Xiao C., Cachier H., Qin D., Qin X., Li Z., and Pu J., "Black Carbon (BC) in the snow of glaciers in west China and its potential effects on albedos," *Atmospheric Research*, vol. 92, pp. 114–123, 2009.

5) S. Gardner, G. Moholdt, J. G. Cogley, B. Wouters, A. A. Arendt, J. Wahr, E. Berthier, R. Hock, W. T. Pfeffer, G. Kaser, S. R. M. Ligtenberg, T. Bolch, M. J. Sharp, J. O. Hagen, M. R. van den Broeke, and F. Paul, "A reconciled estimate of glacier contributions to sea level rise: 2003 to 2009.," *Science.*, vol. 340, pp. 852–857, 2013.

6) S. John . ,Hassan R.,"A Modelling Approach to Assess the Impact of Black Carbon Deposition on Snow Surface Albedo",2016*IJIRSET(International journal of innovative*

7) Thind P.S., John S., Hassan R,"Black Carbon deposition in glacial snow: Its effects on climate change", 2016. , Proceedings of the 32nd Annual convention of environmental engineers for mitigation of climate change. The Institution of Engineers, Punjab Chapter, Chandigarh.

8) Wang X., Baiqing X., and Ming J., "An Overview of the Studies on Black Carbon and Mineral Dust Deposition in Snow and Ice Cores in East Asia," *Journal of Meteorological Research*, vol. 28, pp. 354–370, 2014.

9) Xu J., Ramanathan V., and Washington W.M., "Observed high-altitude warming and snow cover retreat over Tibet and the Himalayas enhanced by black carbon aerosols," *Atmospheric Chemistry and Physics Discussions*, vol. 15, pp. 19079–19109, 2015.

10) Ye H., Zhang R., Shi J., Huang J., Warren S.G., and Fu Q., "Black carbon in seasonal snow across northern Xinjiang in northwestern China," *Environmental Research Letters*, vol. 7, 044002, 2012.