Impact of light-absorbing particles on snow albedo darkening and associated radiative forcing over High Mountain Asia: High resolution WRF-Chem modeling and new satellite observations

Chandan Sarangi[1], Yun Qian[1*], Karl Rittger[2], Kat J. Bormann[3], Ying Liu[1], Hailong Wang[1], Hui Wan[1], Guangxing Lin[1], and Thomas H Painter[3]

[1]Pacific Northwest National Laboratory, Richland, WA

[2]Institute of Arctic and Alpine Research, Boulder, CO

[3]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

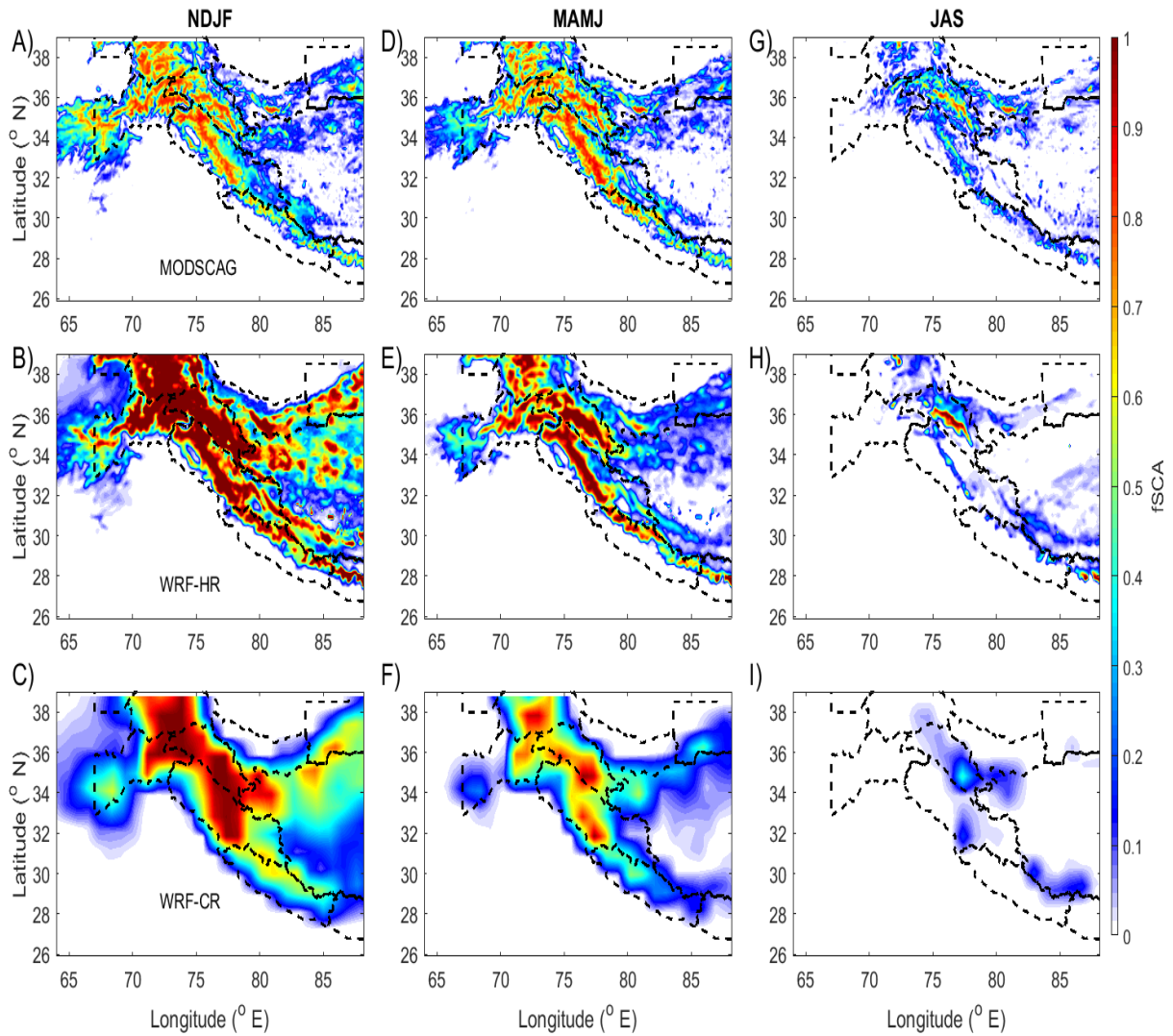Corresponding Author: yun.qian@pnnl.gov

Figure S1: Panels A-C illustrate spatial distribution of seasonal mean snow fraction from A) MODSCAG retrievals, B) WRF-HR simulations and C) WRF-CR simulations during winter. Panels D-F are same as Panels A-C, but, for summer months. Similarly, Panels G-I are same as Panels A-C, but, for monsoon months.
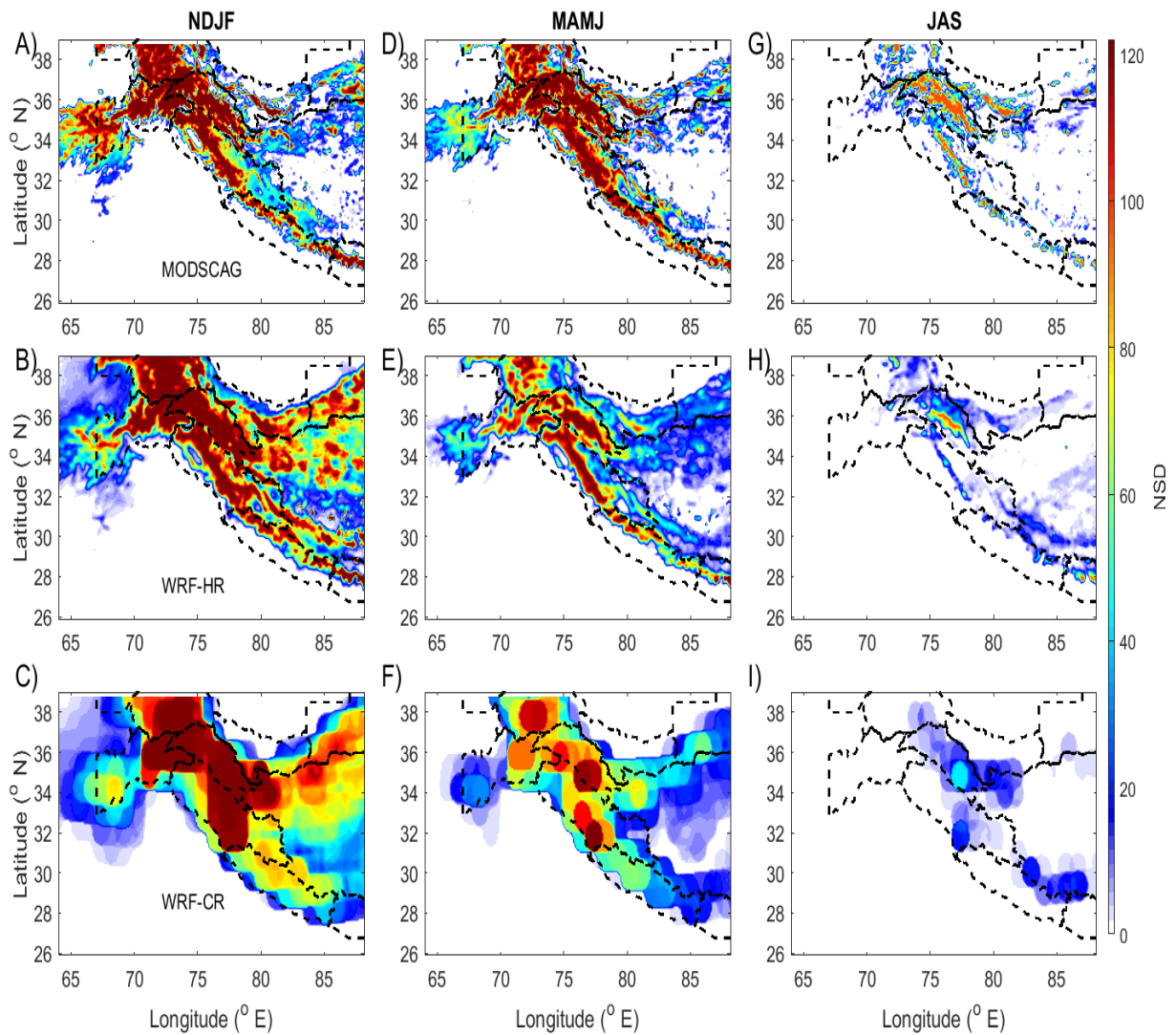
Figure S2: Panels A-C illustrate spatial distribution of number of snow days in winter season from A) MODSCAG retrievals, B) WRF-HR simulations and C) WRF-CR simulations. Panels D-F are same as Panels A-C, but, for summer months. Similarly, Panels G-I are same as Panels A-C, but, for monsoon months.
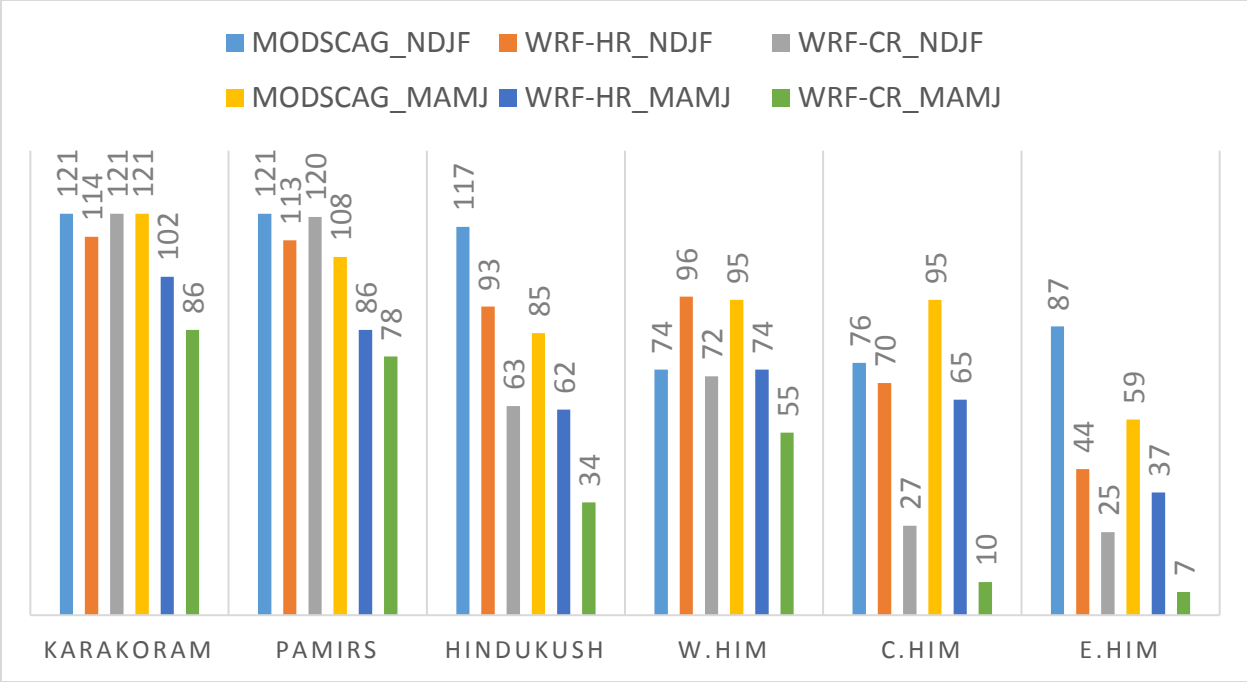
Figure S3: Region-wise estimate of snow duration in terms of NSD (number of snow days) during NDJF and MAMJ months.
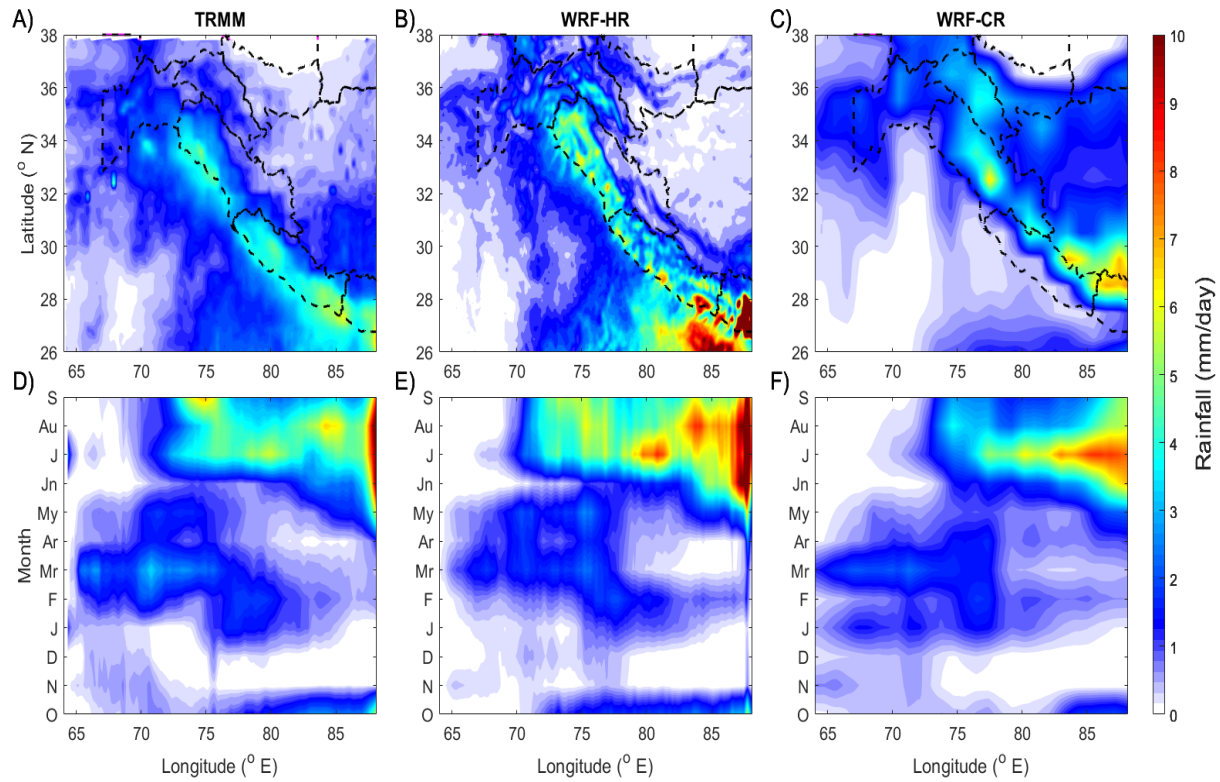
Figure S4: Spatial distribution of annual mean surface rainfall (in mm/day) for water year 2013-14 A) as observed in TRMM satellite observations and simulated values from B) WRF-HR and C) WRF-CR runs is shown. Corresponding time-Longitude distribution is shown in Panels D-F, respectively.
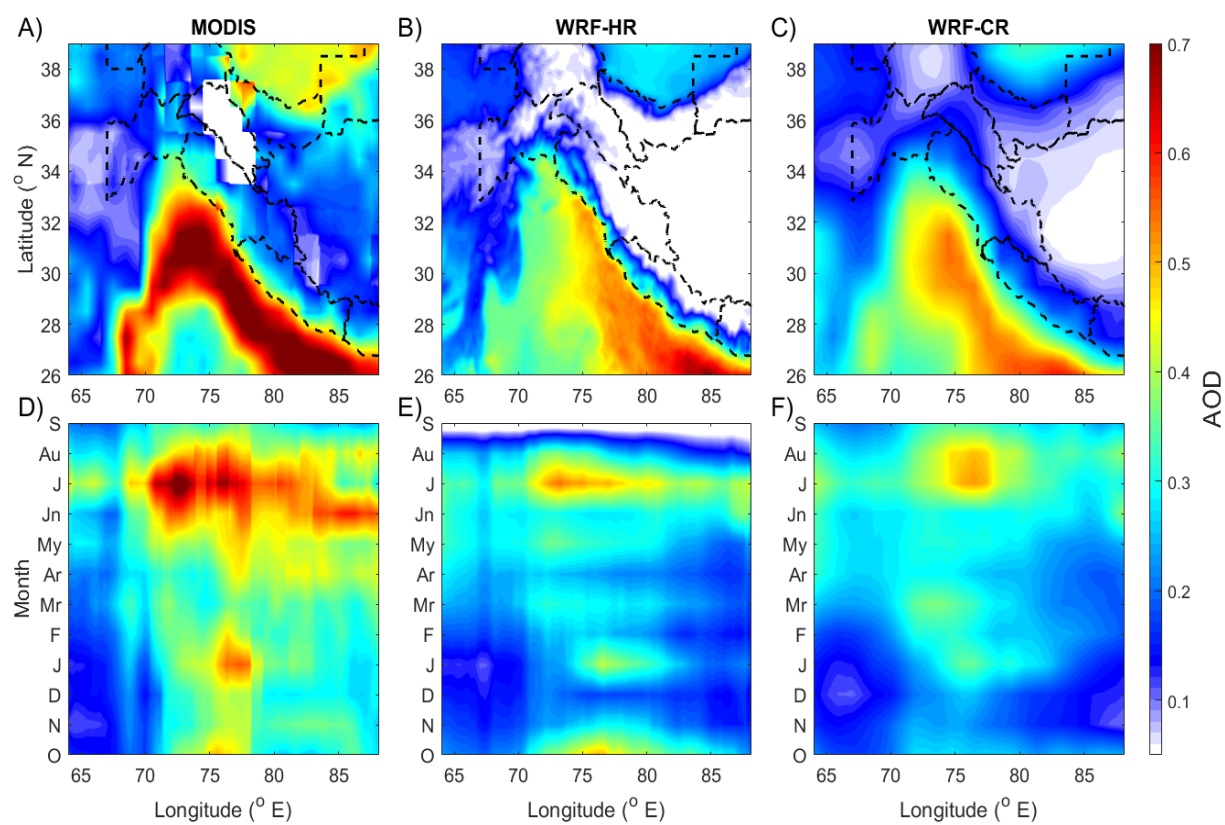
Figure S5: Same as Figure S4, but, for aerosol optical depth (AOD) values. Panels A and D are MODIS-observed AOD.
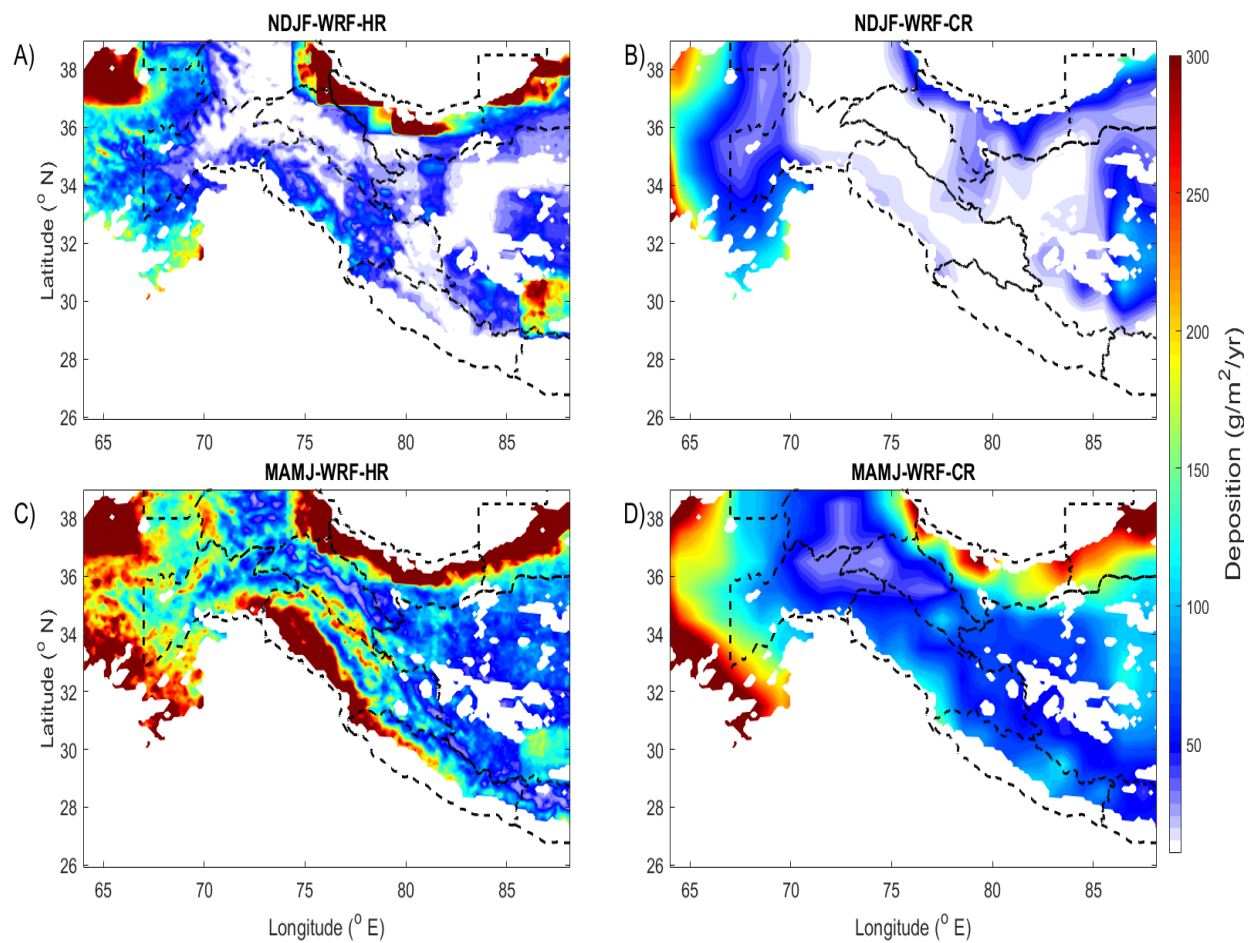
Figure S6: Spatial distribution of mean deposition rate for A) WRF-HR runs and B) WRF-CR during winter months. Panel C) and D) are same as Panels A) and B), but, for summer months.
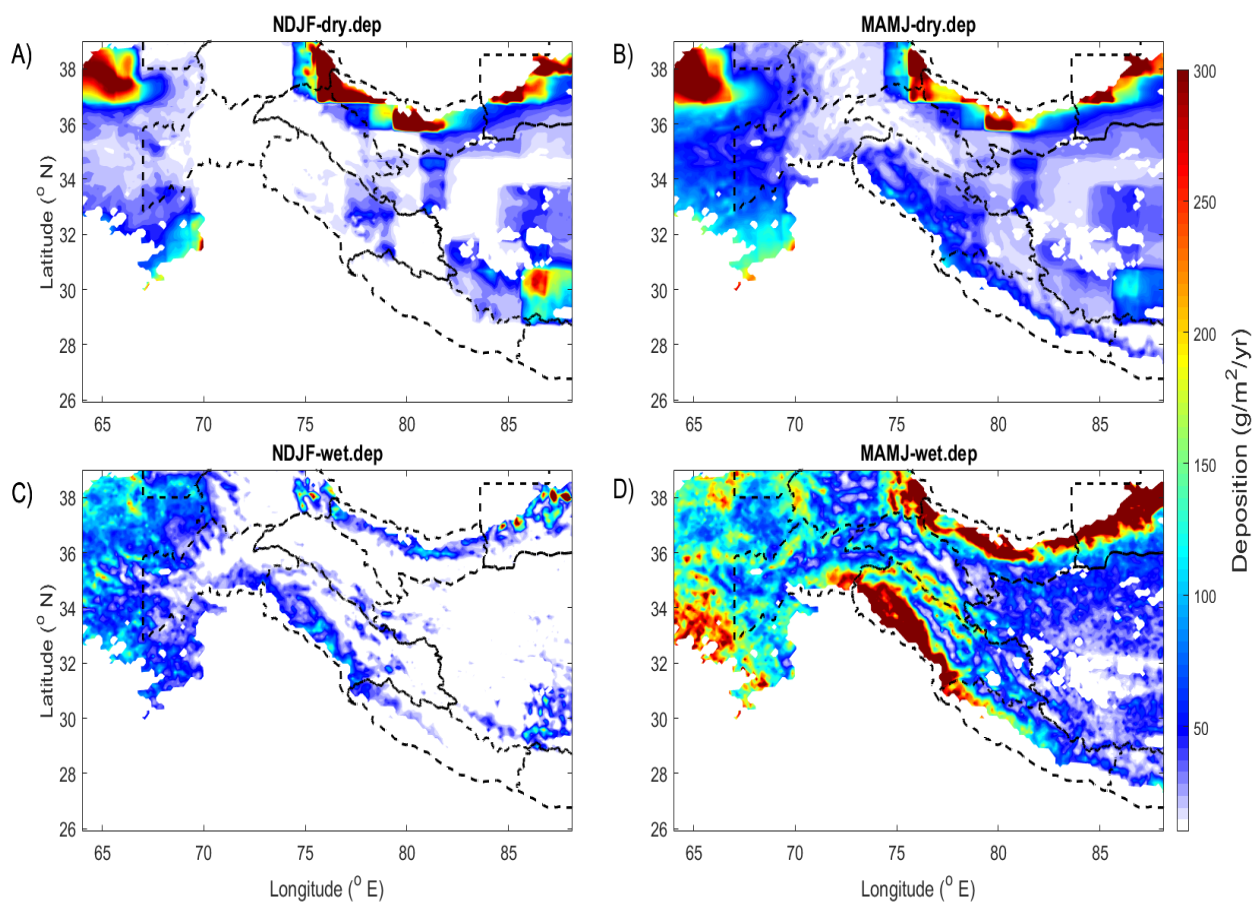
Figure S7: Spatial distribution of mean fluxes of A) dry deposition and C) wet deposition during winter months. Panel B) and D) are same as Panels A) and C), but, for summer months.