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Analysis of aerosol deposition on snowpack over global high mountain ranges

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Snow and ice over high mountain ranges are often not pure, but contains absorbing aerosols such as black carbon or dust. These impurities can alter the surface albedo and influence cryosphere melt dynamics and feed back on broader circulation. These effects will depend on the intensity of snowfall accumulation and aerosol deposition, as well as their spatial and temporal distributions.
Here, we present an analysis of a 36-year simulation (1980-2015) with the new Geophysical Fluid Dynamics Laboratory (GFDL) atmospheric and land model (AM4-LM4) using the latest CMIP6 inventory of emission of aerosols, GHGs and other forcing agents, with a 50 km resolution, and nudging of wind components by NCEP re-analysis. After briefly presenting the evaluation of AM4 performances by comparing precipitation, snow and aerosol properties with observations, we will discuss the key features of the variability and trends of snow and aerosol deposition over major mountain ranges in North America (Alaska and Rockies), South America (Andes), Europe (Alps), and Central (Caucasus) and East (Hindu Kush, Karakoram, Tian Shan, Hengduan, and Himalayas) Asia.
While most mountain ranges have nearby sources of dust or pollutants, they are rarely collocated. This will translate into distinct spatial distributions and temporal variations. One important factor is the vertical distribution of aerosol deposition, which generally does not coincide with maximum snow depth. Regional sources have their maximum deposition rates on the flank of the mountain with large contribution from dry deposition. Remote sources will contribute dominantly by wet deposition at higher elevation. We can then classify mountain ranges where one or both aerosol depositions are in phase or out of phase with the snow accumulation season. Our results indicate considerable variability of aerosol deposition between mountain ranges, and the importance of taking into account their spatial and seasonal variability. We are also able to classify high mountain snowpack with significant trends of aerosol deposition since the 1980s. The sign of these trends varies not only between mountain ranges, but also by aerosol classification within a single range, highlighting the importance of regional aerosol-snowpack assessments.