large-scale cross-country studies. Indeed, one of the striking things about Bechtel et al.'s findings is how similar they are across countries. This both increases confidence in the results and implies that the psychological foundations of individuals' preference for constant cost schedules are not rooted in the political debates of any one country. Second, this study shows the benefits of careful research designs. It is notable, for instance, that the descriptive differences in public support for different cost paths are much larger than the causal effects of the cost schedules in the study's conjoint experiment. Finally, this study uses multiple interdisciplinary research designs to try and learn why individuals prefer constant cost schedules, including text analysis and survey questions rooted in behavioural economics. This shows the value of interdisciplinary research teams with training in multiple disciplines and methodologies.

An important open question from this study is how the public would trade-off differences in the average cost of climate policies and the future cost schedule. Another important question is how the public interprets the cost paths of complex policies without explicit cost schedules. For example, many climate policies such as Renewable Portfolio Standards (RPS), cap-and-trade or technology standards do not include an explicit cost schedule. Finally, it's important for future work to consider the interaction between public views about climate policy design and views about global warming. For instance, are voters who are more concerned about a warming planet more likely to support increasing cost paths?

Overall, the study by Bechtel and colleagues[4] shows that the public prefers a constant cost schedule for climate mitigation policies rather than an increasing cost schedule. These findings are important for policymakers designing the next generation of climate mitigation policies. ❐

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HIGH-MOUNTAIN ASIA

A darker cryosphere in a warming world

Dust and black carbon deposition in high-mountain Asia darkens snow and ice, increases sunlight absorption and causes melt — a reinforcing feedback. Now research shows the increasing importance of dust over black carbon at higher altitude, and the sensitivity of aerosol transport and delivery to Arctic sea-ice melt.

Biagio Di Mauro

The glaciers and snowpack of high-mountain Asia serve as an important water resource throughout the region, and understanding how climate warming and anthropogenic activity will impact seasonal melt and perennial glacier longevity is important. Aerosol deposition on pristine snow and ice is a key component of this[1], as they act as light-absorbing particles (LAPs) that darken and warm the surface, causing a reinforcing feedback that melts the snow and ice, exposes darker ground underneath and leads to further warming. Writing in *Nature Climate Change*, two author teams investigate LAP deposition in high-mountain Asia. Chandan Sarangi and colleagues[2] find that dust dominates black carbon deposition at higher altitudes, implying a shift in aerosol type as snow lines shift higher with warming. Fei Li and co-authors[3] identify a mechanism by which reduced Arctic sea ice increases aerosol transport to the Tibetan Plateau. Together, these studies improve understanding of the deposition of aerosols at high altitude as well as the large-scale mechanisms controlling their delivery.

During the spring and summer, elevated aerosol layers (EALs) — portions of the atmosphere with higher aerosol concentrations between altitudes of about 1.5 and 6 km — are an important source of LAP deposition in high-mountain Asia. Black carbon and dust are the dominant aerosol types in the region and are transported from the west and southwest by prevailing winds, peaking in abundance around 5 km. Sarangi and colleagues[2] combine satellite observations and an atmosphere–chemistry–snow model to study the relative importance of dust and black carbon in these layers, showing that dust dominates black carbon deposition as altitude increases. Similar aerosol transport layers have been identified in Europe, where seasonal input of mineral dust from the Saharan desert are known to alter the optical properties of snow[4] and promote melt[5]. As climate warming causes the snowline in high-mountain Asia to move to higher altitudes, these results suggest an increasing importance of dust, relative to black carbon, in darkening the future cryosphere.

In addition to the importance of aerosol type, the large-scale mechanisms controlling aerosol transport are also expected to change in a warming climate. Aerosol deposition in high-mountain Asia is largely from transport of anthropogenic emissions and dust from South Asia via mid-latitude circulation patterns, and Arctic warming is suspected to impact these dynamics[6]. Li and co-authors[3] combine in situ observations of aerosol optical depth, wind speed and precipitation over the Tibetan Plateau with satellite and reanalysis data to show that seasons with lower Arctic sea ice increase aerosol transport to the Tibetan Plateau. This mechanism begins in February, when low Arctic sea ice inhibits snowfall in Eurasia. This decreased snowpack reinforces

Fig. 1 | Mineral dust and snow algae darken high-mountain snow. The image here shows dust (brown) and algae (light-red) on snowpack near the Presena Glacier, Italy. While this image was taken in the European Alps, these impacts have been reported in high-mountain Asia as well, and show that both organic and inorganic LAPs can reduce snow albedo[15]. Sarangi and co-authors[1] find that dust deposition similar to that shown here dominates black carbon deposition as altitude increases in high-mountain Asia, with implications as the snowline moves higher with warming. Li and colleagues[2] find that seasons with low Arctic sea ice modify large-scale aerosol transport mechanisms and increase aerosol delivery from South Asia to the Tibetan Plateau. Together, these studies imply a darker and dustier cryosphere in a warmer world. Photograph courtesy of Francesca Ferrari (https://francesca-ferrari.com/).

regional circulation patterns through April and strengthens a subtropical jet along the southern edge of the plateau. This enhanced jet carries emissions up and over the Himalayas, increasing aerosol delivery to the Tibetan Plateau. These findings suggest increased seasonal aerosol delivery to high-mountain Asia as Arctic sea ice decreases.

Beyond high-mountain Asia, the cryosphere's vulnerability to aerosol deposition is global and varied. For example, glacier algae at high latitudes are known to thrive on the surface of melting ice during the summer season. Recent work shows that the darkening of a large area in southwest Greenland[7] (also known as the 'dark zone') is biological in nature[8], leading to a bio-albedo feedback that has also recently been identified on mountain glaciers[9]. Similar biological darkening can also occur on snow; recent work on snow in the Antarctic Peninsula[10] and Alaska[11] studied this process using satellite data, representing a new field of application for the remote sensing of the cryosphere.

LAPs can be either carbonaceous (black carbon, brown carbon, algae or microorganisms) or inorganic (mineral dust or volcanic ash), and their abundance is influenced by climate variability. For example, drier conditions are expected to lead to more frequent dust transport, and this could cause more dust deposition on snow and ice. Warmer temperatures during spring and summer are expected to increase the surface melting of snow and ice, creating the perfect environment for algae to grow. Possible interactions between dust and algae (Fig. 1) are still poorly studied. In particular, it is possible that dust induces a rapid increase in liquid water content of snow, and this promotes the growth of snow algae that would foster the bio-albedo feedback. If climate change causes these conditions to occur more frequently in the future, these feedbacks will operate more strongly during spring and summer.

Another source of cryospheric impurities is wildfires. Large forest fires, such as those over Siberia and Australia during 2019 and 2020, can produce LAPs deposited on glaciers and sea ice. In fact, an intensification of summer wildfire activity in subarctic and subtropical regions may lead to more LAP emissions and deposition over the different components of the cryosphere. This process has been studied using ice cores[12], but the possible impact on surface melt deserves more attention in future research.

These studies add important understanding to this and highlight underappreciated feedbacks in the region. Sarangi and co-authors[2] report an altitudinal dependence of aerosols delivered to mountain regions, with implications for which aerosols will dominate melt as snowlines move higher with warming. Li and colleagues[3] show that Arctic sea-ice melt enhances aerosol delivery mechanisms over the Tibetan Plateau. Characterizing the regional dynamics that cause uplift, transport and deposition of aerosols as well as more accurately estimating LAP impacts via in situ observations, models and global remote sensing data[13,14] are important for understanding future impacts of aerosol deposition in high-mountain Asia. ❐

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Competing interests

The author declares no competing interests.