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Humidity trends imply increased sensitivity to clouds in a warming Arctic

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Infrared radiative processes are implicated in Arctic warming and sea-ice decline. The infrared cloud radiative effect (CRE) at the surface is modulated by cloud properties, but CRE also depends on humidity because clouds emit at wavelengths that are semi-transparent to greenhouse gases, most notably water vapour. Here we show how temperature and humidity control CRE through competing influences between the mid- and far-infrared. At constant relative humidity, CRE does not decrease with increasing temperature/absolute humidity as expected, but rather is found to be approximately constant for temperatures characteristic of the Arctic. This stability is disrupted if relative humidity varies. Our findings explain observed seasonal and regional variability in Arctic CRE of order 10 W m-2. With the physical properties of Arctic clouds held constant, we calculate recent increases in CRE of 1-5 W m-2 in autumn and winter, which are projected to reach 5-15 W m-2 by 2050, implying increased sensitivity of the surface to clouds.