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Arctic warming induced by atmospheric transport of water vapour

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The atmospheric northward energy transport plays a crucial role for the Arctic climate; the transport brings to the Arctic an amount of energy comparable to that provided directly by the sun. During recent decades warming of the Arctic surface air has been more than twice as large as the warming averaged over the Northern Hemisphere. This is known as Arctic amplification. Climate models predict that Arctic amplification will continue during the 21st century. The models also show that the atmospheric energy transport to the Arctic will remain almost unchanged or will even decrease in the future. This has led to the conclusion that atmospheric energy transport does not contribute but rather opposes Arctic amplification. Here we show that the atmospheric energy transport will indeed contribute to Arctic amplification even while decreasing. A split of the transport into latent and dry-static components reveals that a change of the latent transport compared to a change of the dry-static has a much larger effect on the Arctic climate. This is because the latent transport brings not only energy, but also water vapour into the Arctic. This water vapour enhances the local greenhouse effect, both in itself and through the formation of clouds. An increase of the latent transport at the Arctic boundary therefore causes Arctic warming, both directly due to latent heat release, and indirectly due to an enhancement of the local greenhouse effect. Climate models tend to agree that the latent energy transport will increase on the expense of the dry-static transport in future simulations. Our results imply that the Arctic cooling caused by the reduction of the dry-static transport is more than compensated for by the warming induced by the latent transport.