Geophysical Research Abstracts
Vol. 21, EGU2019-4757, 2019
EGU General Assembly 2019

On Atmospheric Energy Transport by Waves

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The Arctic region shows some of the world's most significant signs of climate changes; for instance a negative trend in summer sea-ice cover of around 15% per decade to a surface-air warming three times as large as the global average. The atmospheric energy transport plays an important role for the Arctic climate; the atmospheric energy transport contributes to an amount of energy into the Arctic that is comparable with the energy provided directly by the sun.

Recently a new method for studying the atmospheric energy transport contribution by planetary and cyclone scale waves has been proposed. The method is based on a Fourier decomposition in the zonal direction. Recent studies based on this method show that planetary waves contribute more than cyclone-scale waves to the atmospheric energy transport into the Arctic. In addition, the planetary waves contribute to the Arctic amplification through latent heat transport, even when the total atmospheric energy transport is decreasing in model projections.

However, the performance of the energy split method to capture transports by cyclone and planetary scale waves has not yet been evaluated. Here an attempt to evaluate the performance of the energy split method is presented.

The energy split method is applied on synthetic data, where the wave structure and energy transport are known. The synthetic data representing an isolated cyclones is constructed from Gaussian functions. Applications of the energy split method on these data reveals that transport due to an isolated cyclone-scale wave is resolved into transport due to both planetary- and cyclone-scale waves.

From atmospheric reanalysis data cases with only isolated cyclones are found by applying a conditional filter. The filter controls the amplitude of planetary-scale waves and the strength of the cyclone depression in the geopotential height field. When applied on atmospheric reanalysis data where isolated cyclones are clearly dominating, it is found that more than 80% (70%) of the transport of dry static energy (latent heat) is contributed by planetary waves. From inspections of the vertically integrated energy transport field it is evident that in these situations the latent heat transport of cyclones is large compared to the climatology, which implies that the energy split method exaggerate the transport contribution from the planetary waves when the atmospheric state is characterized by an isolated cyclone-scale wave. Further work is pursued on the development of an alternative wave-split method based on wavelets, which could possibly overcome the challenges encountered by the Fourier method.