Geophysical Research Abstracts
Vol. 15, EGU2013-7861, 2013
EGU General Assembly 2013

Moisture transport and Atmospheric circulation in the Arctic

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Cyclones are an important feature of the Mid-Latitudes and Arctic Climates. They are a main transporter of warm moist energy from the sub tropics to the poles.

The Arctic Winter is dominated by highly stable conditions for most of the season due to a low level temperature inversion caused by a radiation deficit at the surface. This temperature inversion is a ubiquitous feature of the Arctic Winter Climate and can persist for up to weeks at a time. The inversion can be destroyed during the passage of a cyclone advecting moisture and warming the surface. In the absence of an inversion, and in the presence of this warm moist air mass, clouds can form quite readily and as such influence the radiative processes and energy budget of the Arctic. Wind stress caused by a passing cyclones also has the tendency to cause break-up of the ice sheet by induced rotation, deformation and divergence at the surface. For these reasons, we wish to understand the mechanisms of warm moisture advection into the Arctic from lower latitudes and how these mechanisms are controlled.

The body of work in this area has been growing and gaining momentum in recent years (Stramler et al. 2011; Morrison et al. 2012; Screen et al. 2011). However, there has been no in depth analysis of the underlying dynamics to date. Improving our understanding of Arctic dynamics becomes increasingly important in the context of climate change. Many models agree that a northward shift of the storm track is likely in the future, which could have large impacts in the Arctic, particularly the sea ice.

A climatology of six-day forward and backward trajectories starting from multiple heights around 70 N is constructed using the 22 year ECMWF reanalysis dataset (ERA-INT). The data is 6 hourly with a horizontal resolution of 1 degree on 16 pressure levels. Our methodology here is inspired by previous studies examining flow patterns through cyclones in the mid-latitudes. We apply these earlier mid-latitude methods in the Arctic. We investigate an Arctic trajectory dataset and provide a phenomenological/descriptive analysis of these trajectories, including key meteorological variables carried along trajectories.

The trajectory climatology is linked to a previously established cyclone climatology dataset from Hanley and Caballero (2011). We associate trajectories and the meteorological variables they are carrying to cyclones in this dataset. A climatology of 'Arctic-influencing' cyclones is constructed from the cyclone dataset.

The resilience of the polar vortex and its effect on circulation, via blocking and breaking, is examined in relation to our trajectory climatology.