Investigation of Januarys Polar Low genesis conditions over the North Atlantic using satellite, reanalysis and model data for the period between 2003 and 2011

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Introduction

Polar lows (PLs) are high latitude maritime cyclones whose characteristics are:
- small diameter (< 600 km)
- strong winds (> 15 m/s)
- short life time (can be only 3h)

These cyclones bring large amounts of precipitation that combined with strong winds cause great damage to coastal communities but are still hard to predict.

Motivation

The AMSU – B (Advanced Microwave Sounding Unit – B) and the MHS (Microwave Humidity Sounder) onboard NOAA KLM and MetOp satellites, respectively offer an excellent coverage of the Arctic (≈ 10 times/day). We use satellite measurements together with atmospheric reanalysis [2] to better understand PLs and to answer the following questions:
1. Can we detect the occurrence of PLs from microwave satellite observations?
2. Is atmospheric reanalysis able to represent the precipitation signature of PLs?
3. What are the conditions necessary for the genesis of PLs?

Summary

AMSU-B observations – able to detect PL with strongly precipitating clouds at 183.31 ± 1, ±3, ± 7 GHz frequencies
AMSU-B simulations – able to represent PL and strongly precipitating clouds
ASR genesis conditions – RH of ≈ 85 % at ≈ 1 km, LR – strong surface inversion, $T_{surf} - T_{500hPa}$ usually > 40 K

Tools & Methods

AMSU-B/MHS

5 channels

2 window: 89 and 150 GHz (157 GHz MHS)

Fig 1: January polar low cases (blue dots) between 2003-2011 using list of polar lows from Noer and Lien, 2010 [1]

ASR v1 – Arctic System Reanalysis version 1 with 30 km spatial resolution and 29 vertical levels that has best estimate of atmospheric state including precipitation

PAMTRA – Passive and Active Microwave Radiative TRAnster that connects ASR to AMSU-B and is able to simulate the 1-800 GHz frequency range

Output

Simulated BT

Convective cores calculated as in Melsheimer et al., 2015 [3] using Hong et al., 2009 algorithm [4]:

$\Delta T_{3}\text{=}T_{89,183.31|-1} - T_{89,183.31|+1}$

$\Delta T_{3}\text{=}T_{89,183.31|-7} - T_{89,183.31|+7}$

$\Delta T_{3}\text{=}T_{183.31|-3} - T_{183.31|+3}$

$\Delta T_{3}> 0, \Delta T_{1}> 0, \Delta T_{2}> 0$

Fig 2: Difference between: 183.31 GHz and 183.31 ± 3 GHz (left), 183.31 ± 7 GHz middle and 183.31 ± 3 and 183.31 ± 7 GHz (right) channels.

Next step

- extend study for the entire PL season (October-May)
- find the amount of precipitation brought by PL when making landfall using the disappearance of the convective cores
- use the HIRHAM5 regional model with 15 km resolution to simulate the PL cases

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References

[2] ASR data, Polar Meteorology Group at Byrd/Polar and Climate Research Center, the Ohio State University, available at https://irase.earthscope.org/doe_dr1