

# Future projections of North Atlantic polar low frequency

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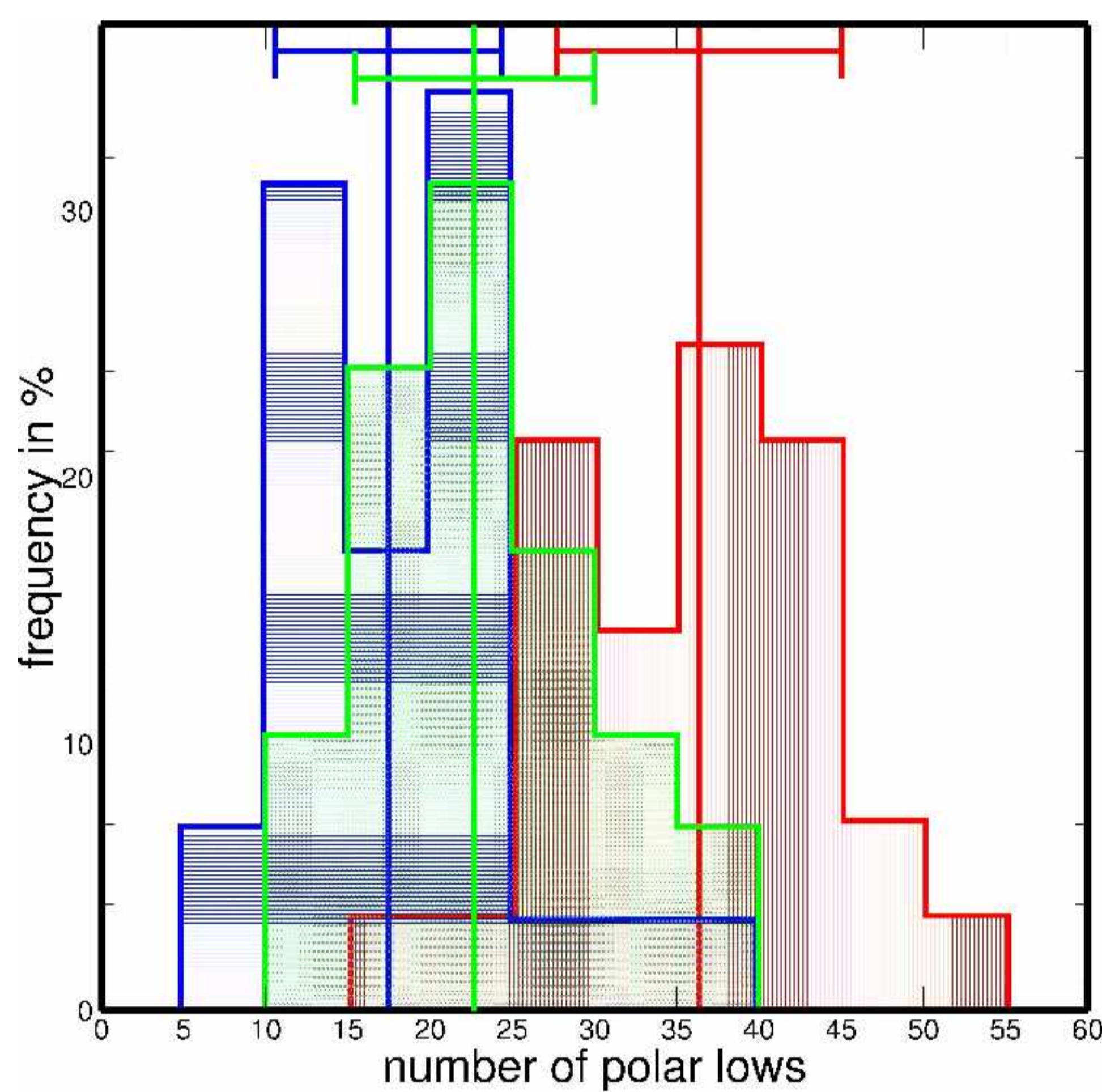
## Abstract

To assess the frequency of polar lows in an anthropogenically warmed climate, IPCC-AR4 global climate change scenarios were downscaled to reproduce and identify polar lows. In a warmed climate we found a considerably reduced seasonal number of polar lows.

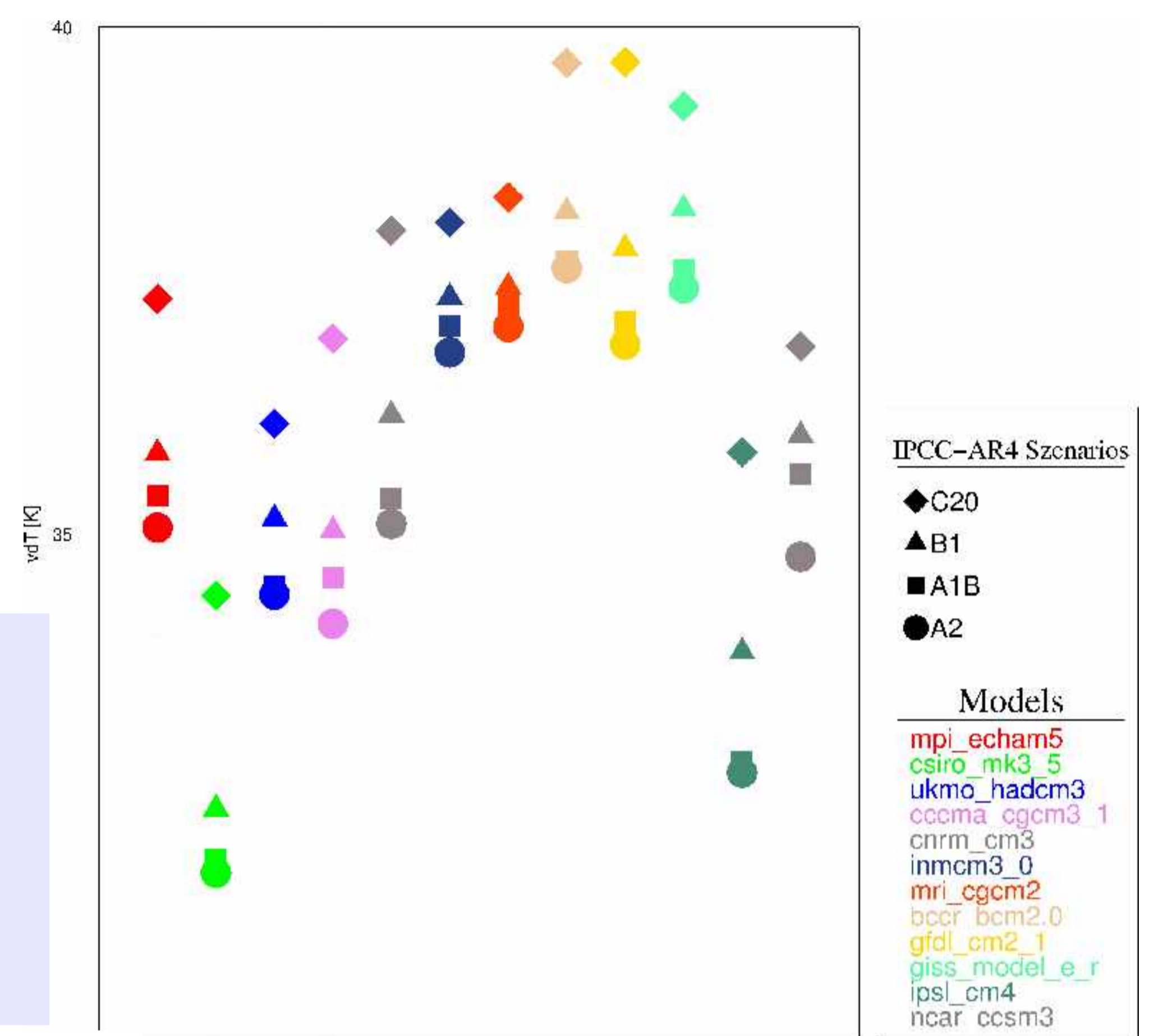
## CONCLUSIONS

- Under climate warming conditions, a **considerably lower number of polar lows** is to be expected
- The more the atmosphere warms up, the more the number of polar lows is decreasing
- We link the decrease of polar lows frequency to an increase of vertical atmospheric stability
- The mean latitude of polar low genesis is shifted northward

## RESULTS (change of frequency)

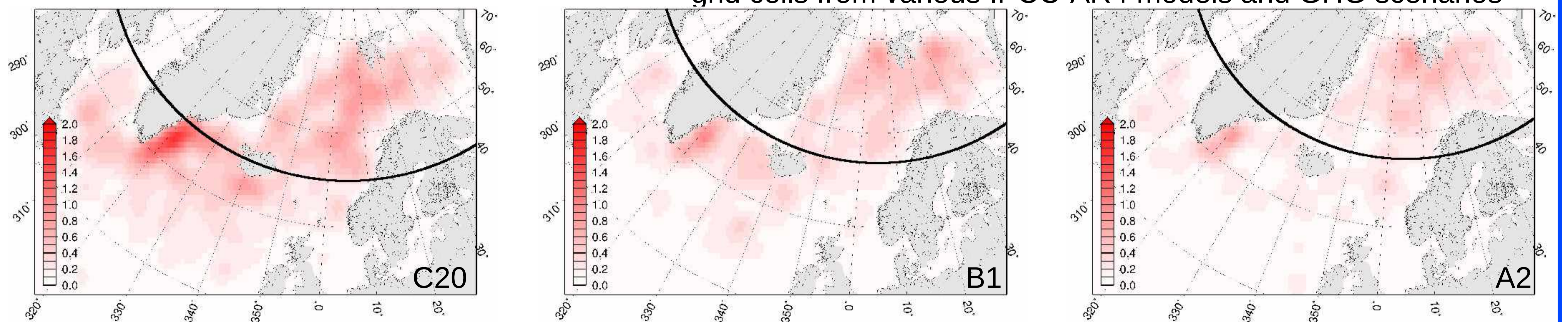


In our opinion, decrease is linked to increasing vertical stability in IPCC future scenarios (atmosphere warms faster than ocean)



Distribution (and mean and std) of the seasonal number of detected polar lows in A2, B1 and C20 in bins of five

As a measure of ONDJFM-vertical stability, spatial and 30yrs mean vdT ( $vdT = SST - T_{500hPa}$ ) is shown over all ice free ocean grid cells from various IPCC-AR4 models and GHG scenarios



Spatial density and mean latitude (black line) of polar low genesis in the downscaled scenarios (from left to right) C20, B1 and A2

- The detection algorithm works in three steps:
- 1<sup>st</sup> all bandpass filtered mslp minima ( $< -1hPa$ ) are located
  - 2<sup>nd</sup> positions are merged to individual tracks
  - 3<sup>rd</sup> further conditions are requested along the individual tracks:
    - strength of the minimum ( $\leq -2hPa$  once along the track)
    - wind speed ( $\geq 13.9$  m/s once along the track)
    - air-sea temperature difference ( $SST - T_{500hPa} \geq 43K$ )
    - north south direction of the track
    - limits to allowable adjacent land grid boxes

## INTRODUCTION

Polar lows are mesoscale sized, gale producing maritime ground level storms in subpolar regions, which can be of hazardous impact to human offshore activities. Due to their scale, polar lows are not properly resolved in global climate model (GCM) data. In this study, we downscaled GCM data as provided by IPCC-AR4 global climate change scenarios. In these higher resolved data we identified polar lows by means of a previously developed detection procedure (Zahn, M. and H. von Storch (2008a)). Counting polar lows in 20<sup>th</sup> century and future climate conditions, we **estimated the possible change of frequency of polar lows in an anthropogenically warmed climate.**

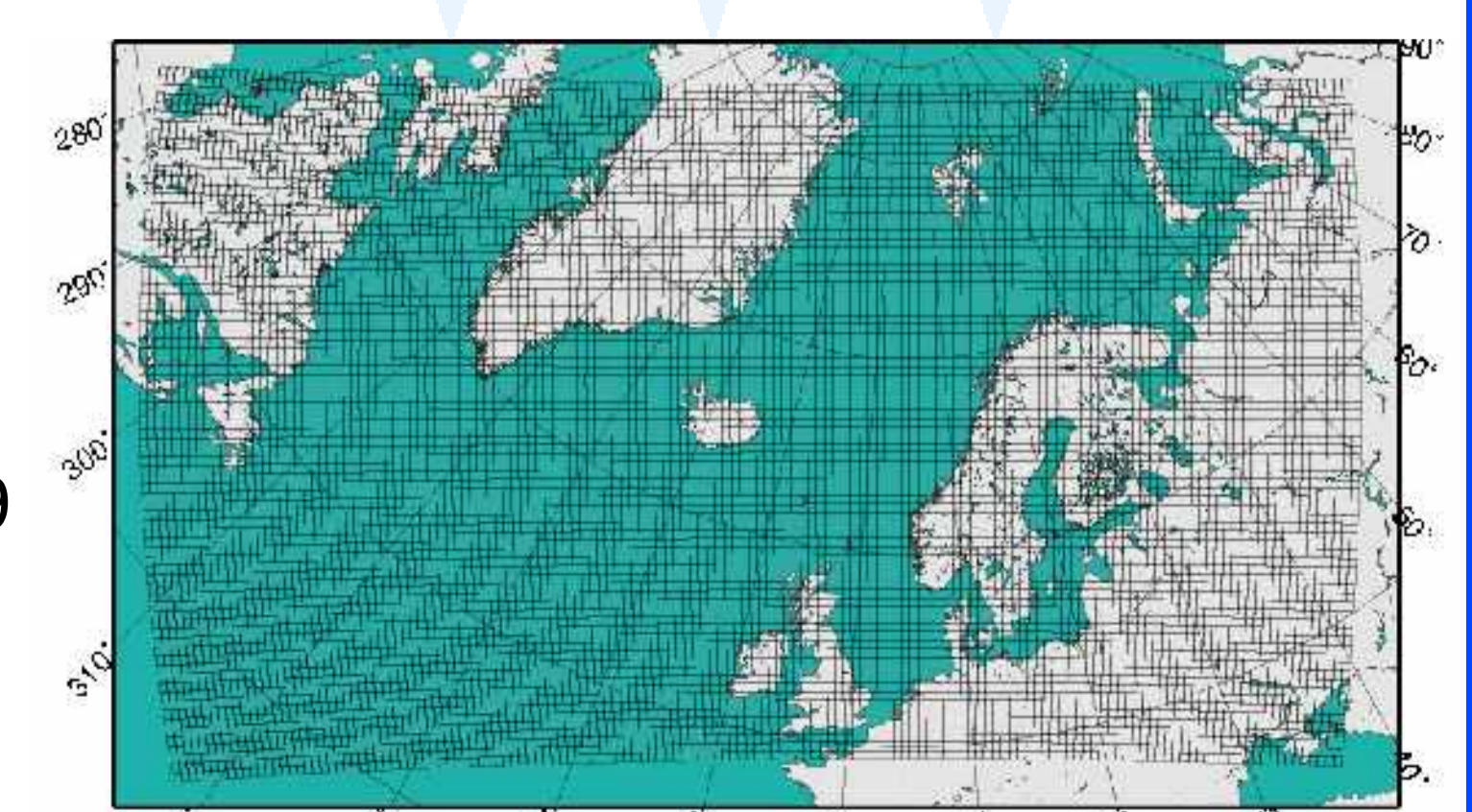
## Model

Used model: CLM 2.4.6.  
driven by GCM data delivered by different IPCC-AR4 scenarios and ECHAM5

## Setup

- 20<sup>th</sup> Century conditions (C20):  
Simulation time: Jan 1960 until Dec 1989
- Future warmed up conditions (A2, B1):  
Simulation time: Jan 2070 until Dec 2099
- Simulations are only constrained at the lateral boundaries and by the SST
- Additionally the large scale ( $> 700km$ ) conditions are enforced (sn, spectral nudging)

MPI\_ECHAM5



Simulation area used in this study

## Further reading:

Zahn, M. et al. (2008), Climate mode simulation of North Atlantic Polar Lows in a limited area model, Tellus A, 60, 620 - 631, doi:10.1111/j.1600-0870.2008.00330.x  
Zahn, M. and H. von Storch (2008a), Tracking Polar Lows in CLM, Meteorologische Zeitschrift, 17(4), 445 - 453, doi:10.1127/0941-2948/2008/0317  
Zahn, M. and H. von Storch (2008b), A long-term climatology of North Atlantic Polar Lows, Geophysical Research Letters, 35, L22702, doi:10.1029/2008GL035769  
see: "http://coast.gkss.de/staff/zahn/" or "http://coast.gkss.de/staff/storch/"