

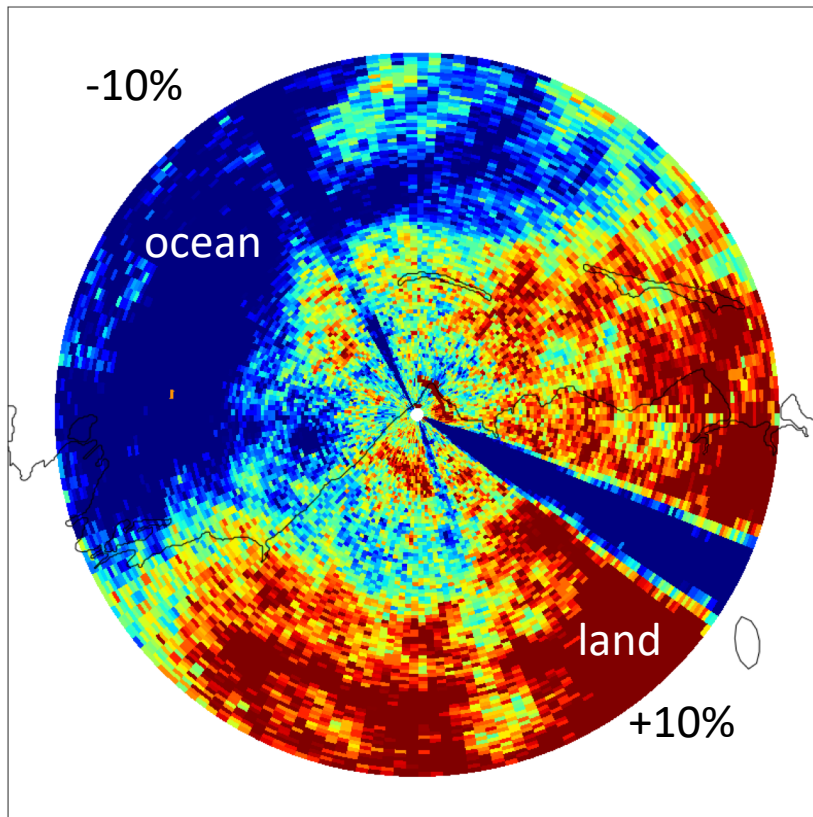
# **1) Spatial Dependence of Cloud Properties at Oliktok Point in Northern Alaska**

## **2) Anthropogenic pollution and cloud properties at the North Slope of Alaska**

Maximilian Maahn

Thanks to C. Acquistapace, C. Cox, J. Creamean, G. de Boer, G. Feingold, T. Marke, S. Matrosov, O. Perrson, M. Shupe C. Wiedinmyer, C. Williams

# Spatial Dependence



- KaSACR at OLI March 2016 to September 2017
- Look at relative differences in number of occurrence (reflectivity > 6 dBz)
- Limited to
  - No sea ice and snow
  - Polar day
- Some sectors are blocked
- More clouds over land
- Scale of change quite small
- -> See poster #19

# Anthropogenic pollution: comparing two Arctic sites

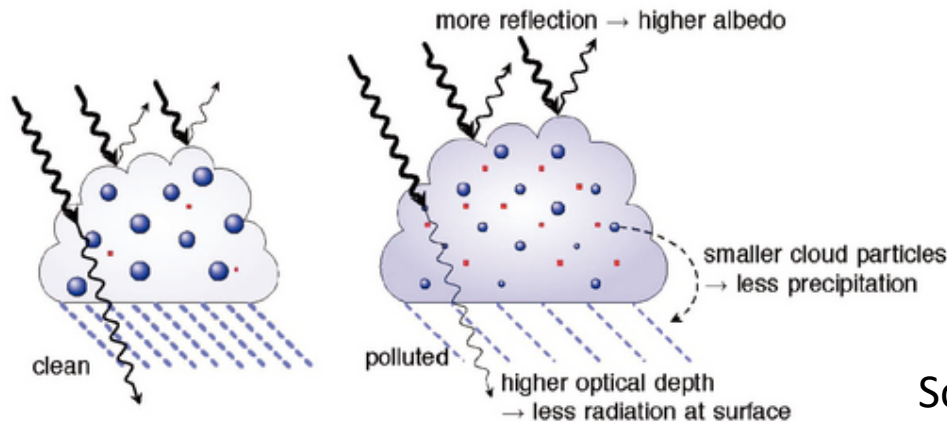
- **Oliktok Point** and Utqiagvik / **Barrow**
- Very **different aerosol** properties
- High **correlation** of surface **pressure**
- Due to the mostly **pristine environment**, Arctic clouds are particularly **susceptible**
- Data set:
  - **Remote sensing** observations
  - April to September 2016
  - Only **warm, shallow clouds**
  - Radar, ceilometer, microwave radiometer, ...



# How does pollution change cloud properties?

- **Aerosol indirect effect**

Cloud albedo and lifetime effect (negative radiative effect for warm clouds at TOA; less precipitation and less solar radiation at the surface)



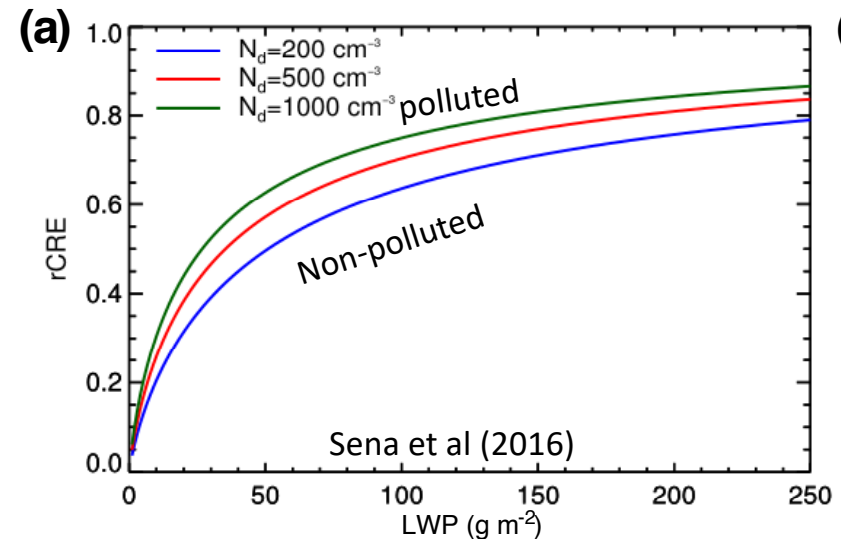
Source: IPCC

- **Polluted** clouds are **brighter**, have higher emissivity
- Less effective collision/coalescence



# Solar radiation perspective: shortwave relative cloud radiative effect

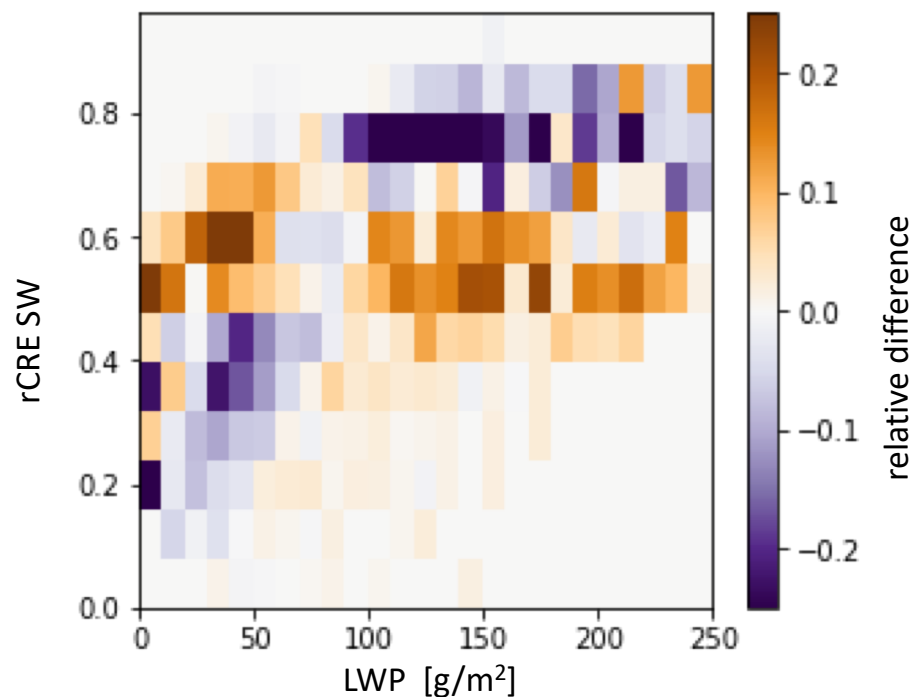
- $rCRE = \frac{F_{\text{clear}}^{\text{down}} - F_{\text{all}}^{\text{down}}}{F_{\text{clear}}^{\text{down}}}$
- down welling instead of net fluxes removes dependency on surface albedo
- normalized by  $F_{\text{clear}}^{\text{down}}$  to reduce dependency on solar zenith angle
- depends on droplet concentration



# Radiation perspective: shortwave rCRE

Maritime winds (cloud base)

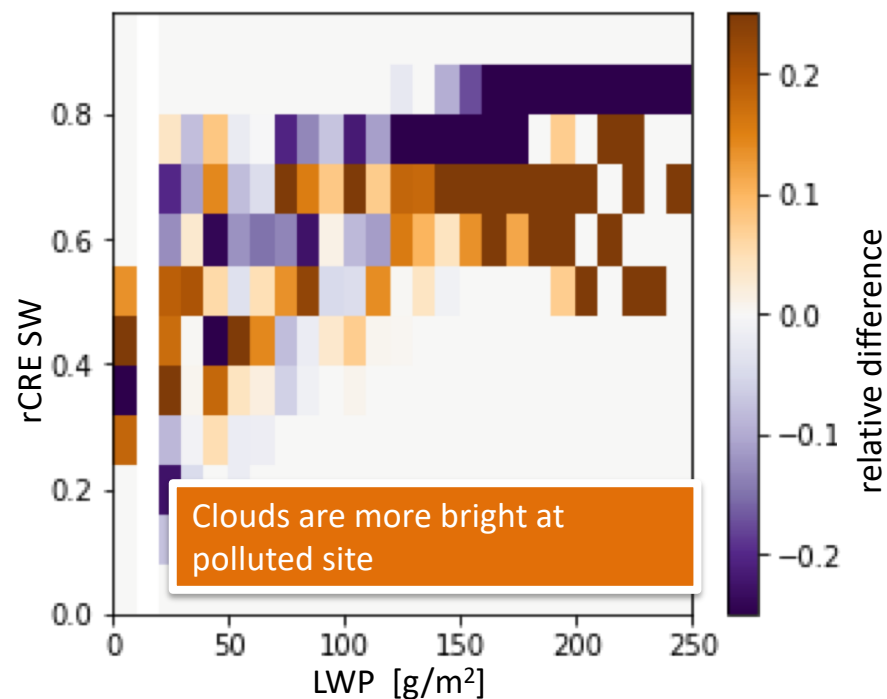
Non-polluted - Polluted



~9000 cases

Continental winds (cloud base)

Non-polluted - Polluted

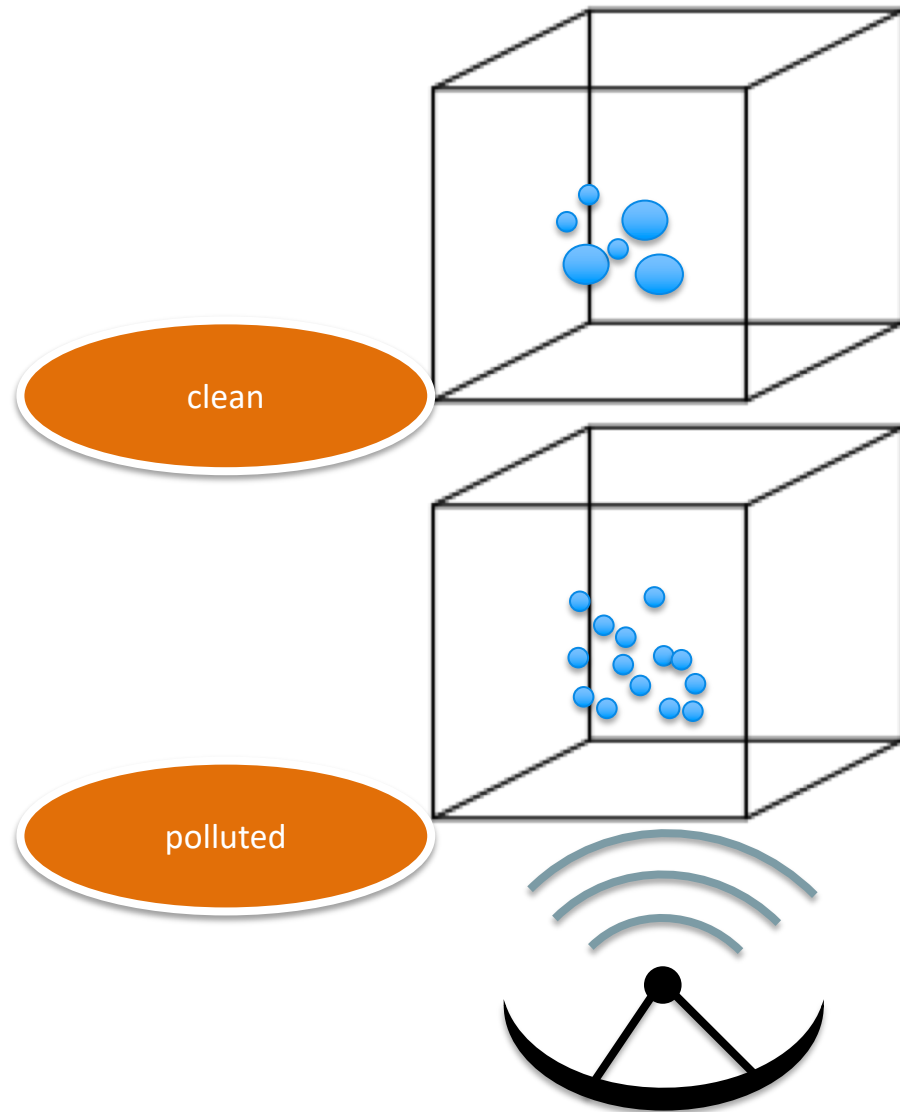


~1500 cases

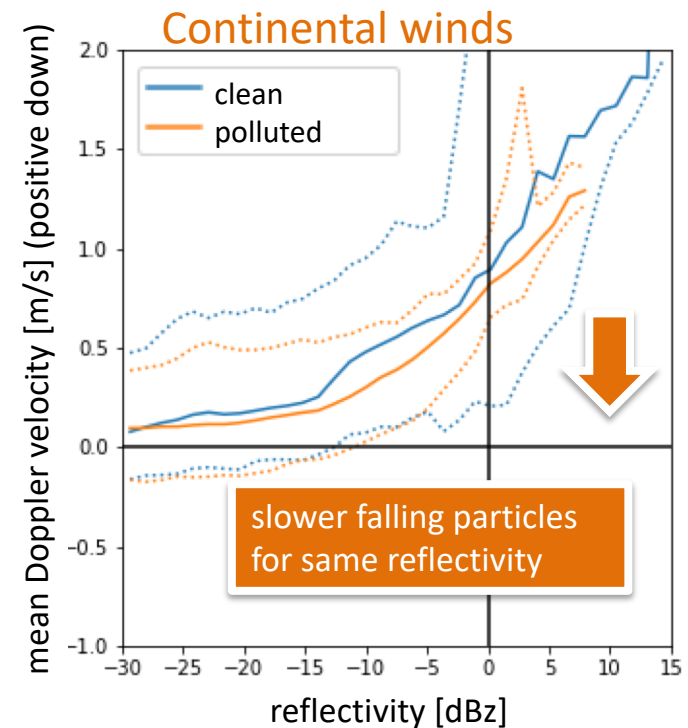
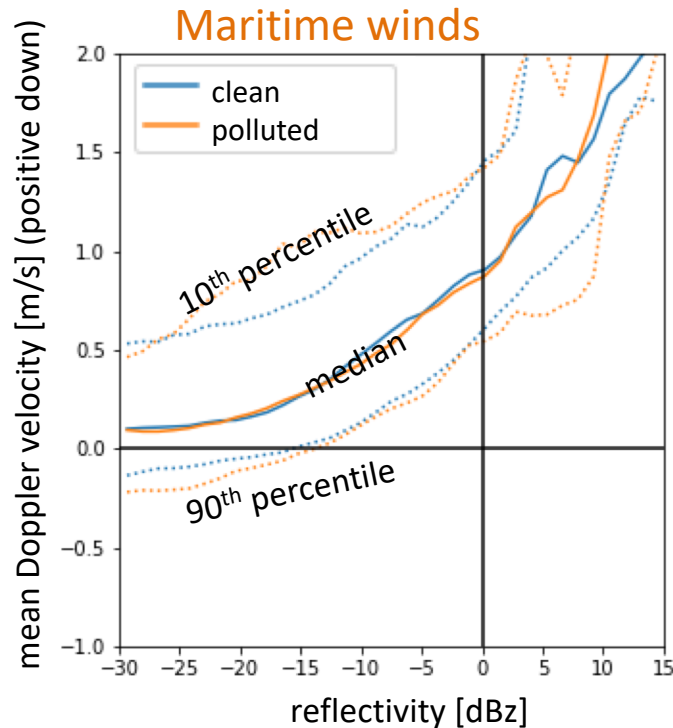
# Radar perspective: What to expect?

- smaller drops
  - less collision/coalescence
  - less drizzle
  - smaller mean Doppler velocity  $W$  for same reflectivity  $Z$

$$Z_{\text{polluted}} = Z_{\text{clean}}$$
$$W_{\text{polluted}} < W_{\text{clean}}$$

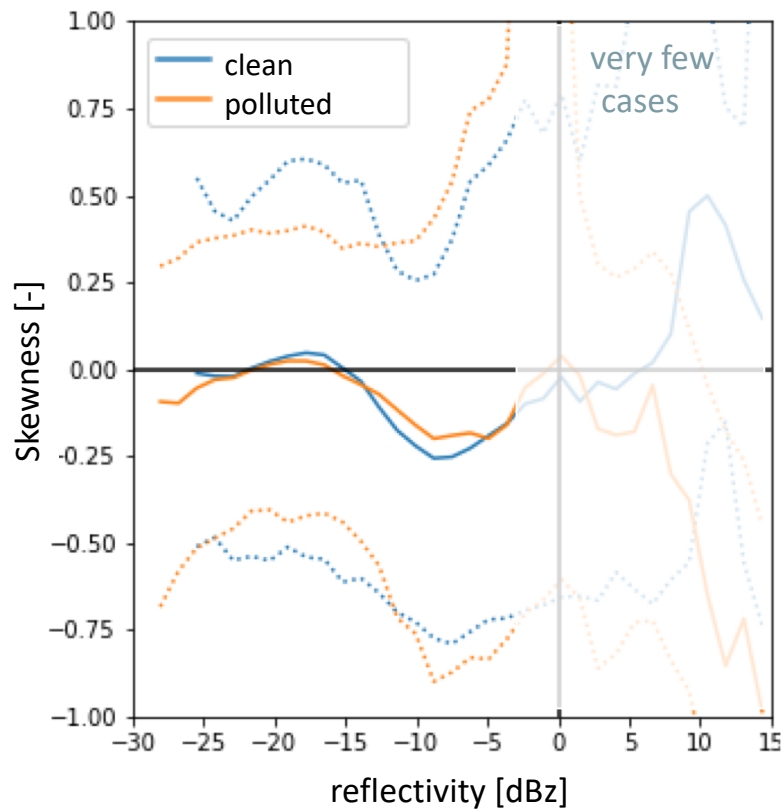


# Radar perspective: fall velocity

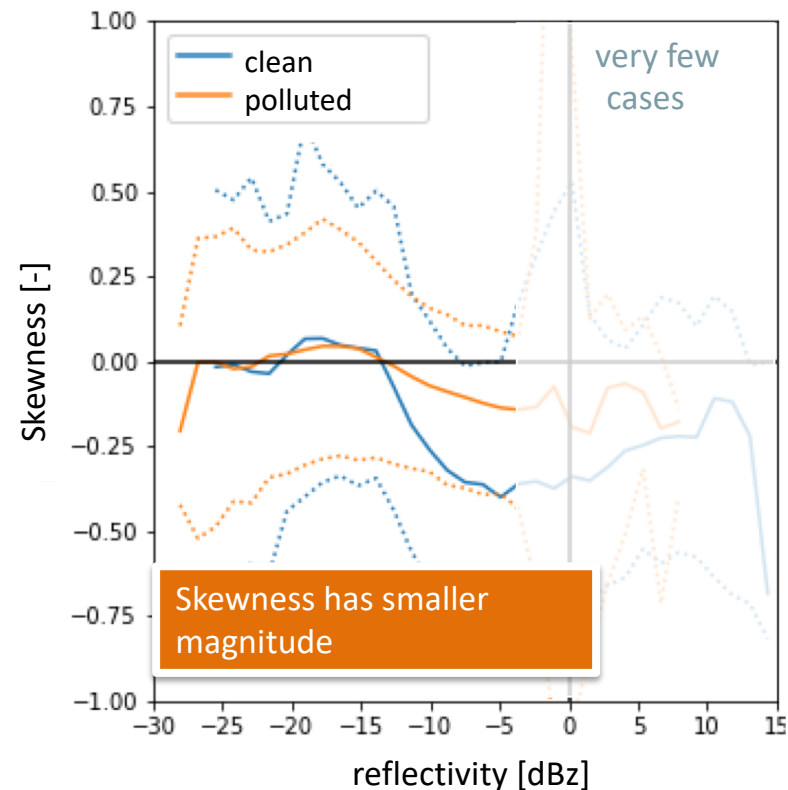


# Radar perspective: Skewness

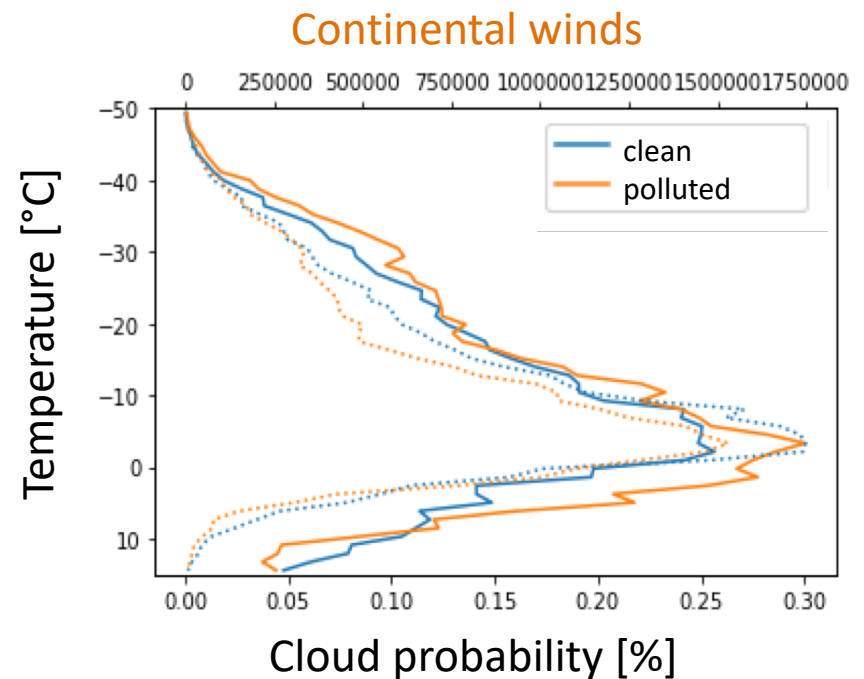
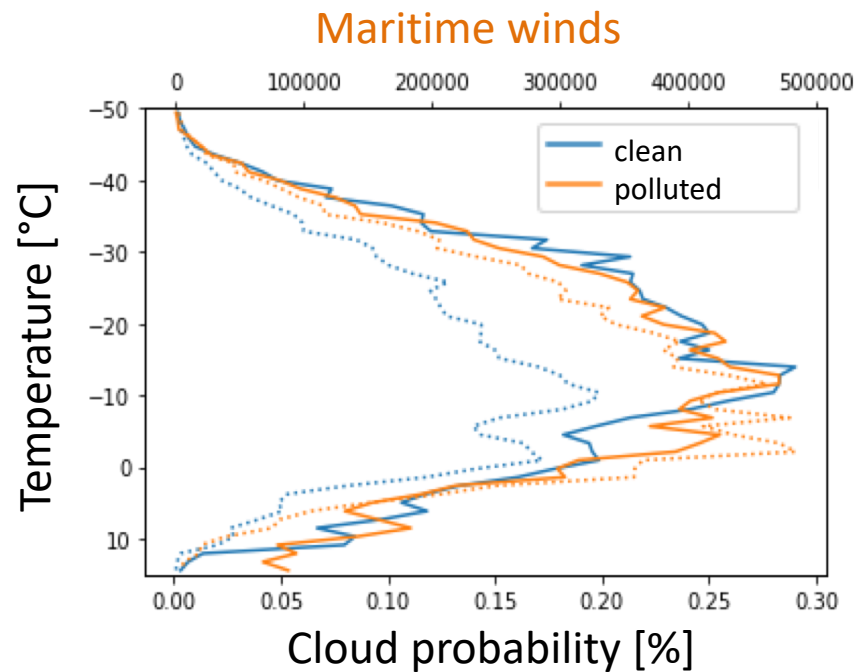
Maritime winds



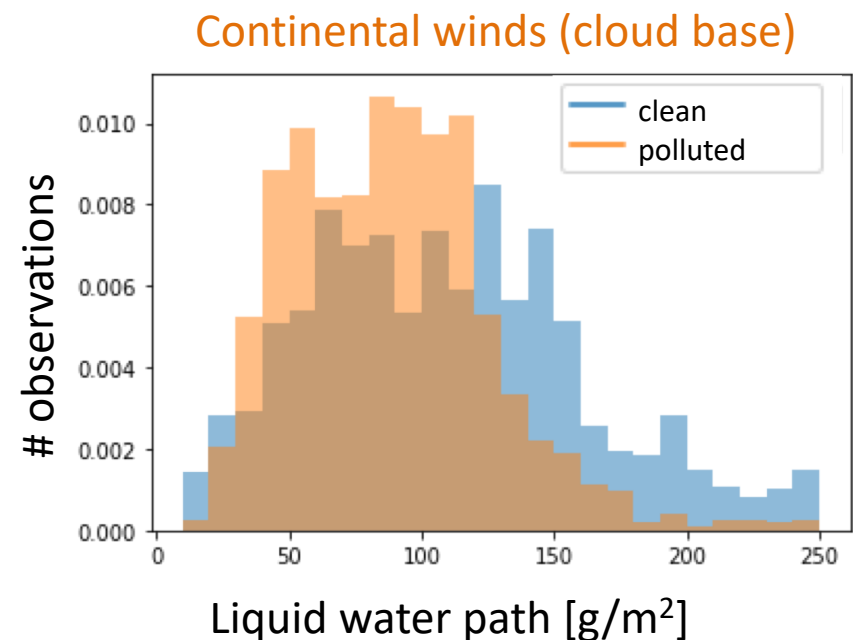
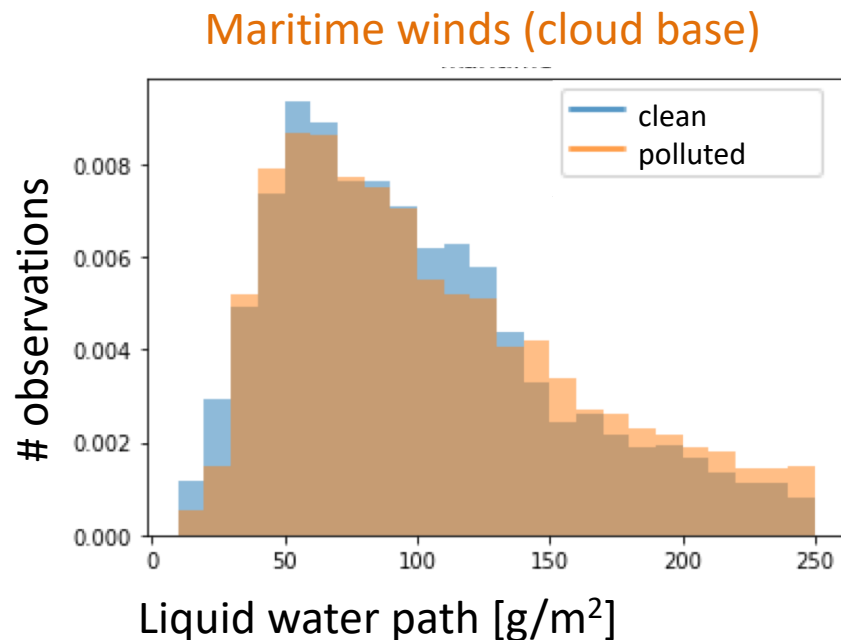
Continental winds



# Radar perspective: cloud occurrence



# MWR perspective: Liquid water path



Only data with radar cloud base & top  $> 0^\circ\text{C}$



# Anthropogenic pollution and cloud properties

- Polluted site has
  - Smaller droplets
  - Brighter clouds
  - Less drizzle
  - More clouds
  - **Less LWP**
  - No collocated aerosol observations
- Radar data helpful without retrievals
- Local pollution changes cloud properties in the Arctic
- More industrial activities & ship traffic in the future
- Effects hard to quantify with respect to radiative forcing
- Poster #18

**Thank you!**