

How well do models capture sub 3nm particles?

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Representation of Nucleation events in models

With end of April: Nucleation is happening almost every other day

⇒ main source for particles < 3 nm

⇒ NPF is a major source of particles in Arctic atmosphere

- Do models capture particle nucleation?
- Do models represent the main drivers for NPF events?
- How does it vary with location and altitude?

Data

Observational aerosol data from different stations in the Arctic

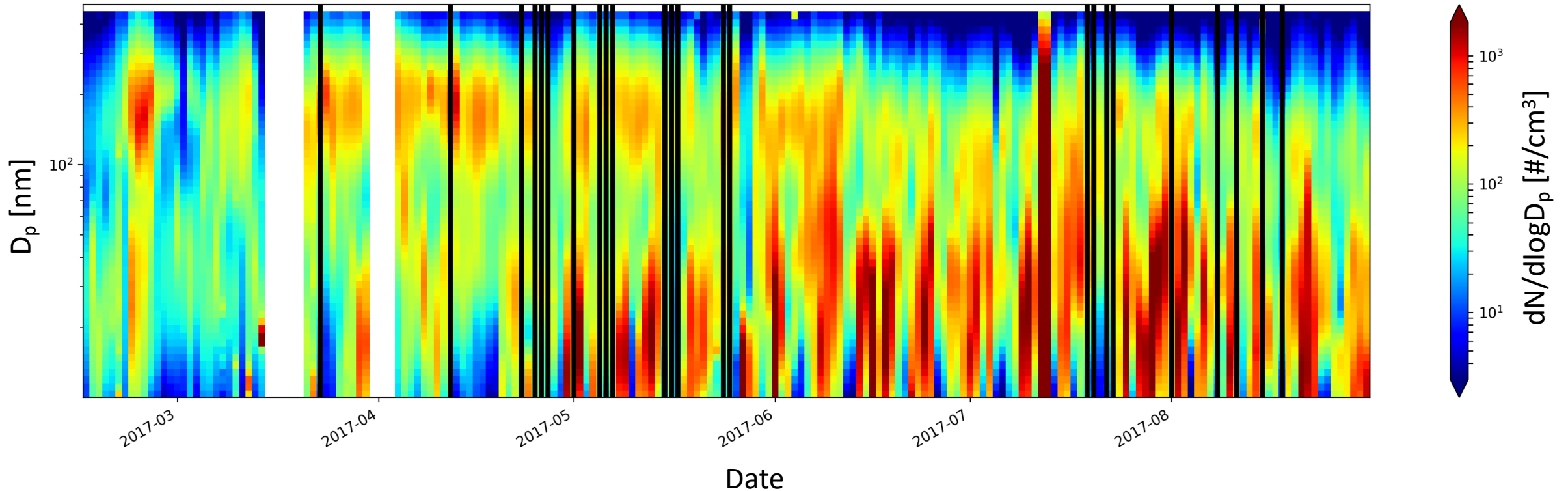
- Gruvebadet (Svalbard) – 2017
(note: only particles > 20nm available):
- Zeppelin (Svalbard) – 2010 - 2015
- Villum (Greenland) – 2010 - 2013
- Alert (Canada) – 2011 - 2013

Model data:

- Model: UKESM
 - Historical run
 - using GLOMAP for Atm. chemistry and aerosols (Walters et al., 2019)
- Number concentration of nucleation mode particles (< 3 nm)
 - Precursor gases for NPF are in general poorly simulated in the models

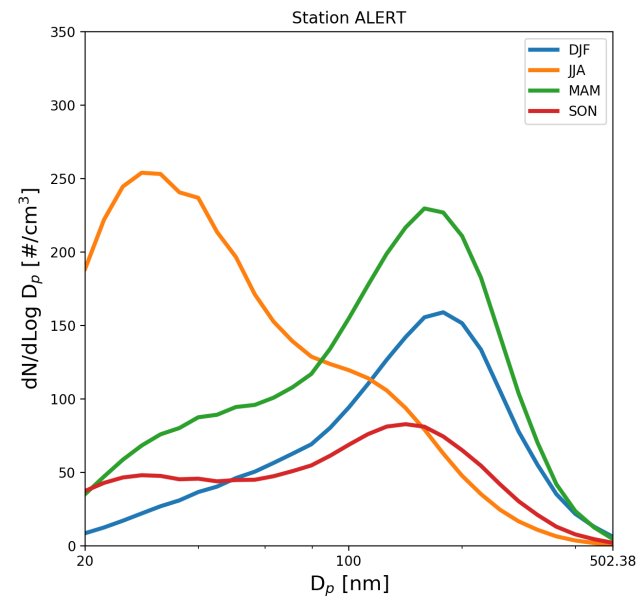
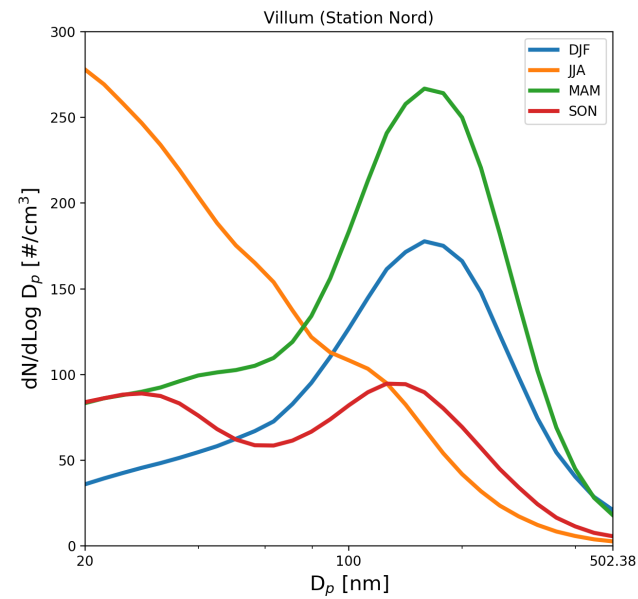
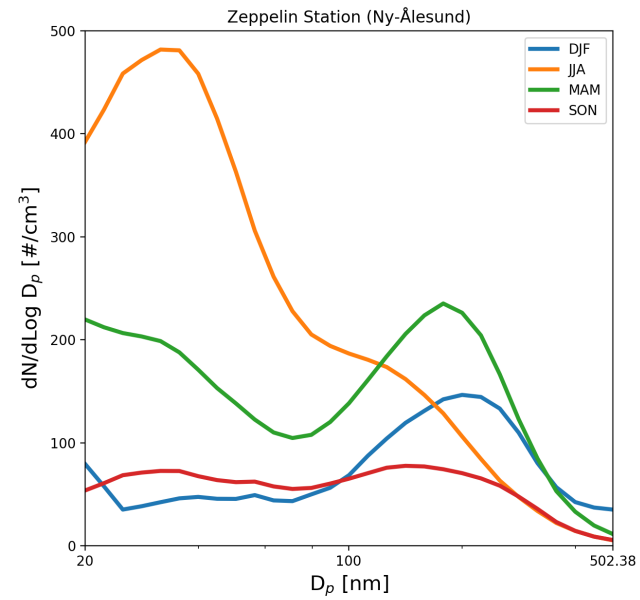
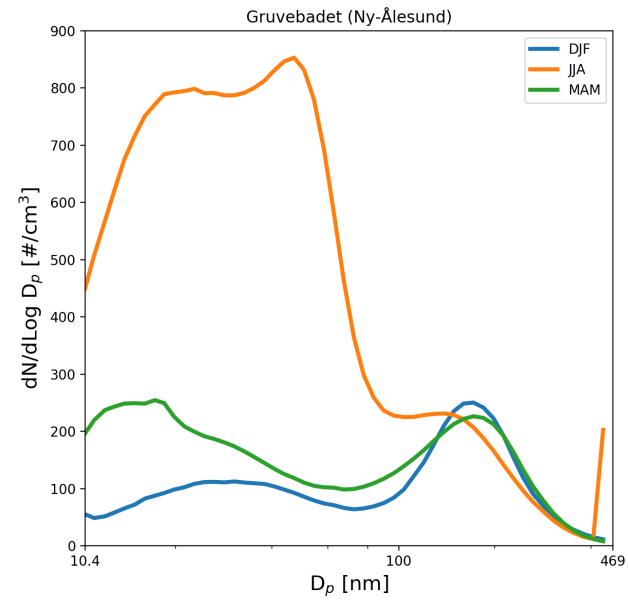
Observational data from Gruvebadet Station in 2017

Nucleation (< 3 nm) represented by black bars



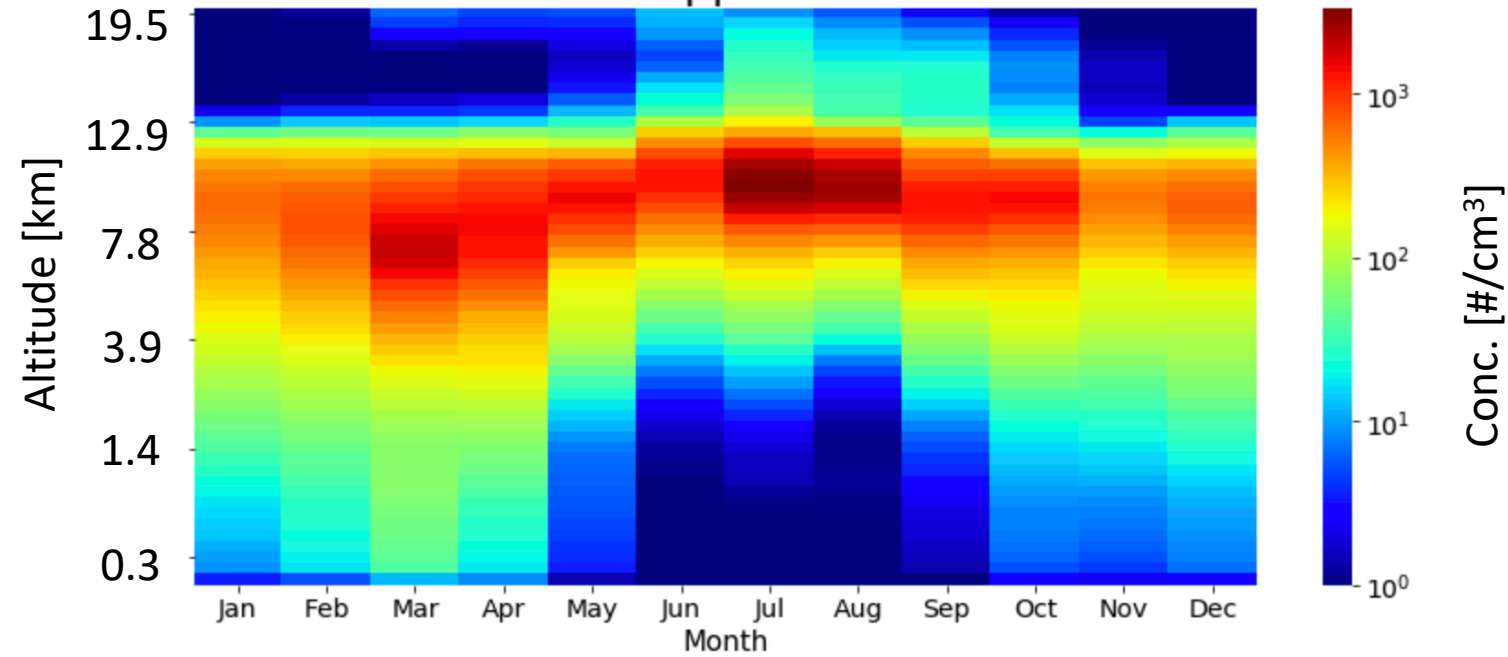
- Instrument for $D_p < 3$ nm was not working during 02.06.2017 – 29.06.2017
- Data indicates increase in nucleation events between end of April and August

Seasonal particle size distribution in the Arctic

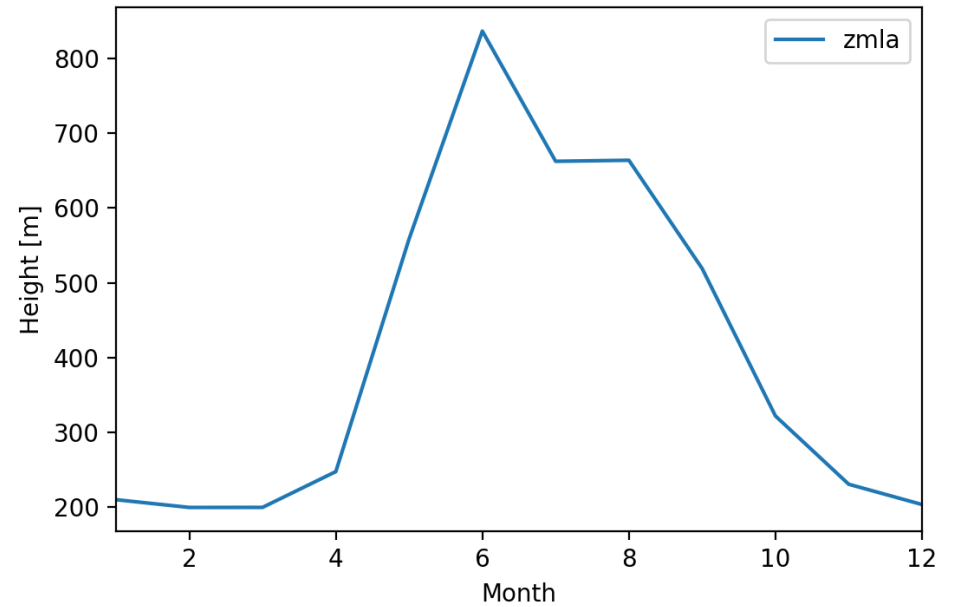


Vertical Distribution of sub 3 nm particles from the model

Zeppelin



Weighted Area Average of Arctic Boundary Layer Height (15 Years)



Conclusions

Observations:

- Expecting higher concentrations of $<3\text{nm}$ in summertime due to NPF
 - No $< 3\text{nm}$ measurements during wintertime available

Model:

- In summertime concentrations are lower in lower level
 - More dilution \rightarrow increased boundary layer height
 - Higher condensation sink \rightarrow small particles condense on bigger particles
 - Concentrations in lower level unrealistically low ($10\text{-}20\text{ cm}^{-3}$)
 - Model underrepresenting nucleation mode as expected
 - \rightarrow missing chemistry in models NPF

Outlook

Literature

Walters et al., The Met Office Unified Model Global Atmosphere 7.0/7.1 and JULES Global Land 7.0 configurations, *Geosci. Model Dev.*, 2019

Mann et al., Description and evaluation of GLOMAP-mode: a modal global aerosol microphysics model for the UKCA composition-climate model, *Geosci. Model Dev.*, 2010

Williamson et al., A large source of cloud condensation nuclei from new particle formation in the tropics, *Nature*, 2019