# Trends in solid, mixed and liquid precipitation in the changing climate of the Atlantic Sector of the Arctic

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# CONTENT

#### Goals

- Data, study area, methods
- Trends in solid, liquid and mixed precipitation
- Probability of solid, liquid and mixed precipitation for daily air temperature intervals
- Conclusions

# MOTIVATION & GOALS



- Determine trends in solid, liquid and mixed precipitation
- Estimate the relationships between precipitation phases and air temperature

## DATA & STUDY AREA

- Daily precipitation totals [mm]
- Daily **air temperature** [°C]: average (Avg), maxiumum (Tmx), minimum (Tmn)
- Notation of **meteorological phenomenon**:
  - current weather [ww]
  - past weather [W1, W2]

Bjornoya	1956 - 2015
Hopen	1956 - 2015
Jan Mayen	1956 - 2015
Ny-Alesund	1969 - 2015
Svalbard Lufthavn	1975 - 2015
Hornsund	1978 - 2015

Sources of data:

- eKlima (www.eklima.met.no)
- OGIMET (www.ogimet.com)



Source: www.mapsland.com/europe/svalbard Fig.1. Location of meteorological stations

## METHODS

#### **Statistical methods:**

- Trend analysis
  - Trend significance Mann-Kendall test
  - Trend magnitude linear regression of least square method
- Spearmen correlation coefficient
- Conditional probability

#### Annual and seasonal perspective:

- Jan-Dec, Aug-Jul
- DJF winter, MAM spring, JJA summer, SON autumn

## METHODS

#### The method of precipitation types recognition methods:

- Meteorological phenomenon notation
  - current weather [ww]
  - past weather [W1,W2]
- Air temperature:
  - average (Avg)
  - maximum (Tmx)
  - minimum (Tmn)



Precipitation day from 06 UTC to 06 UTC of prevoius day Solid precipitation – snow during precipitation day Liquid precipitation – rain or/and drizzle during precipitation day Mixed precipitation – snow and rain or sleet during precipitation day

### TRENDS IN SOLID, LIQUID AND MIXED PRECIPITATION Number of days, annual trends 7/15

#### Dec-Jan, all avaiable data

Dec-Jan, 1979 - 2015

Number of days with precipitation types [change in days/10 years]			Number of days with precipitation types [change in days/10 years]				
Station	Liquid	Mixed	Solid	Station	Liquid	Mixed	Solid
Bjornoya (1956)	+2.5	+0.9	+0.6	Bjornoya	+ 9.2	+0.4	-6.4
Hopen (1956)	+1.3	+0.9	-1.2	Hopen	+2.3	+0.7	-8.4
Hornsund (1978)	-	-	-	Hornsund	+2.4	+0.7	-8.4
Jan Mayen (1956)	+2.7	+1.3	-2.1	Jan Mayen	+9.5	-2.8	-8.6
Ny Alesund (1969)	+4.6	+0.5	+0.4	Ny Alesund	+5.6	-0.7	+1.2
Svalbard L. (1975)	+4.9	+0.8	-1.5	Svalbard L.	+4.9	+0.9	-3.5

### TRENDS IN SOLID, LIQUID AND MIXED PRECIPITATION Number of days, seasonal trends 8/15













Trends in days per 10 years



## TRENDS IN SOLID, LIQUID AND MIXED PRECIPITATION Precipitation totals, annual trends 9/15

Dec-Jan, all avaiable data			Dec-Jan, 1979 – 2015				
Totals of precipitation types [change in mm /10 years]			Totals of precipitation types [change in mm /10 years]				
Station	Liquid	Mixed	Solid	Station	Liquid	Mixed	Solid
Bjornoya (1956)	-1.2	+6.8	+13.3	Bjornoya	+16.6	+8.8	+4.1
Hopen (1956)	-4.6	-2.4	-10.4	Hopen	-0.6	-5.3	-73.5
Hornsund (1978)	-	-	-	Hornsund	+17.4	+14.0	-18.3
Jan Mayen (1956)	-0.1	-7.4	-5.1	Jan Mayen	+28.6	-23.4	-34.2
Ny Alesund (1969)	+11.2	+15.9	+6.4	Ny Alesund	+18.4	+14.9	+4.7
Svalbard L. (1975)	+6.8	+2.5	+2.2	Svalbard Luft.	+7.5	+2.2	+2.3

### TRENDS IN SOLID, LIQUID AND MIXED PRECIPITATION Precipitation totals, seasonal trends 10/15







+19.9 +3.2 +8.9







-2.5 -1.1

Trends in mm per 10 years



## RELATIONS BETWEEN PRECIPITATION TYPES AND AIR TEMPERATURE 11/15



Conditional probability [%] of liquid precipitation for daily air temperature intervals [°C]

Temperature ranges with liquid precipitation probability bigger than 0.5% (hole range) Temperature with conditional probability >80%, \*conditional probability lower than 80%

## RELATIONS BETWEEN PRECIPITATION TYPES AND AIR TEMPERATURE 12/15



Conditional probability [%] of mixed precipitation for daily air temperature intervals [°C]

Temperature ranges with mixed precipitation probability bigger than 0.5% (hole range) Temperature with conditional probability >20%

#### PRECIP **TYPES** P) E **FAN** Ξ E Ξ $\mathbb{N}$ ĥ

ER D

13/15

Hornsund

3 <T≤ 4

3 <T≤ 4 6 <T≤ 7 9 <T≤ 10 12 <T≤ 13

0 <T≤ 1

0 <T≤ 1

6 <T≤ 7

12 <T≤ 13

9 <T≤ 10

Hopen

-3 <T≤ -2

-12 <T≤ -11 ℃ -9 <T≤ -8

-18 <T≤ -17

-35° °C

-18 <T≤ -17

[ວີ12 <T≤ -11 -9 <T≤ -8 -6 <T≤ -5 -3 <T≤ -2

-15 <T≤ -14

-15 <T≤ -14

-9 <T≤ -8

-6 <T≤ -5



Conditional probability [%] of solid precipitation for daily air temperature intervals [°C]

Temperature ranges with solid precipitation probability bigger than 0.5% (hole range) Temperature with conditional probability >80%, \*conditional probability lower than 80%

#### RECIP B E TAT 5 E P ΓYΡ R h ERA P P 14/15



Conditional probability [%] of solid, liquid and mixed precipitation for daily air temperature intervals [°C]

Temperature ranges with close probability\* of liquid, solid and mixed precipitation occurence \*The difference of conditional proability at least two precipitation types is not bigger than 10%

#### CONCLUSIONS

- Increase in the frequency of liquid precipitation and decrease in the frequency of solid precipitation particurarly since 1979
- Direction of significant trends in mixed precipitation varied depending on season.
- Regional and seasonal diversity in precipitation types trends. Frequency of significant trends increases in line with longitude – most relevant changes in Ny-Alesund, lest relevant in Jan Mayen
- Probability of solid precipitation occurence is more than 80% while daily air temperature is between -6°C and -13°C
- Liquid precipitation occures with probability of 80% with daily air temperatures between +5°C to +11°C
- Frequency of particular precipitation types can be considered as revelant indicators of current climate change



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