Estimation of target density and age of air transported from the Asian Monsoon Anticyclone to the Arctic

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Introduction

- The Arctic region is undergoing a rapid warming process, outpacing other areas across the globe. This accelerated warming is known as Arctic amplification. Notably, the Barents–Kara Seas (BKS) are experiencing this trend most intensely.

- Asian warming has a remote impact on the Arctic by influencing the poleward transport of atmospheric heat and moisture.

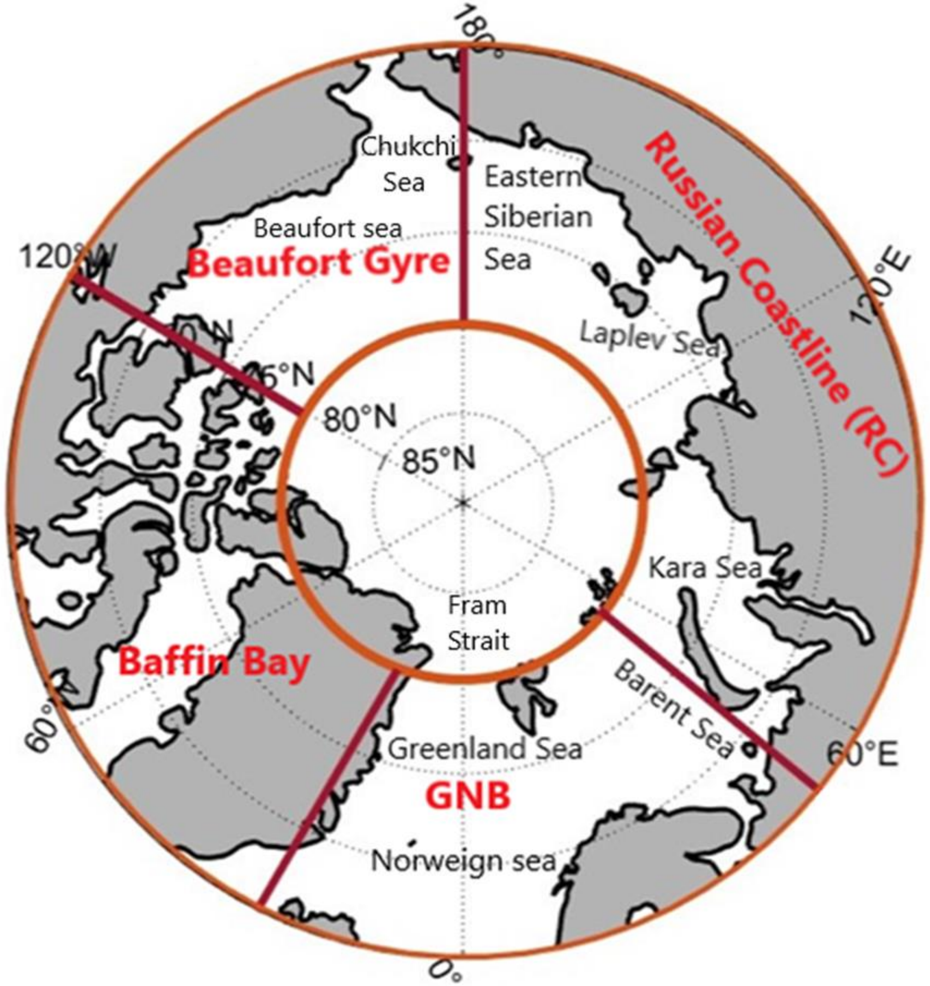
- The connection between Arctic amplification and terrestrial effects in lower latitudes remains elusive.

- The Asian Monsoon Anticyclone (ASMA) in the Upper Troposphere and Lower Stratosphere (UTLS) regions facilitates the upward movement of air masses from the troposphere into the stratosphere.

- A few studies have reported transport of aerosols from Asia to the Arctic through the UTLS.

- Understanding this long-range transport into the Arctic is essential for comprehending the current and future states of Arctic climate.

Area of study



SL NO	Region	Latitude	Longitude
1	GNB	$65^0 – 80^0$E	25^0W-50^0E
2	RC	65^0-80^0E	50^0E-180^OE
3	Baffin Bay	65^0-80^0E	25^0W-120^0W
4	Beaufort Gyre	65^0-80^0E	120^0W-180^0W

Fig 1 : Map defining the geographical division of high latitude and Arctic (***Courtesy***: *Carret et al 2017).*

TRACZILLA Lagrangian model

- TRACZILLA is a modified version of FLEXPART that performs backward or forward trajectory analysis using reverse integration (Pisso and Legras 2008).

- The **age of an air parcel** refers to the **time elapsed** since the parcel was released or originated from a specific location until it reaches its destination.

- In trajectory analysis, the **target density** refers to the **concentration** or **distribution** of trajectories that reach a specific location or region.

- The **impact level** corresponds to the vertical isentropic level of the air parcel when it reaches the target.

This trajectory analysis helps us to track their movement, study transport processes, and assess their impact on various regions.

TRACZILLA Lagrangian model

Data Specification of model

- **Air Parcel Launching**
  - Initial Potential Temperature: 370K
  - Grid Size: 0.5° x 0.5°
  - Geographical Domain: 20 - 120E, 20 - 40N
  - Frequency: Every 3 hours
  - Duration: 1st June to 30th September
  - Timeframe: Forward in time for 120 days
  - Data Source: ERA5
  - Wind Data:
    - Frequency: 3-hourly
  - Radiative Heating Rates:
    - Frequency: Hourly

Schematic Representation

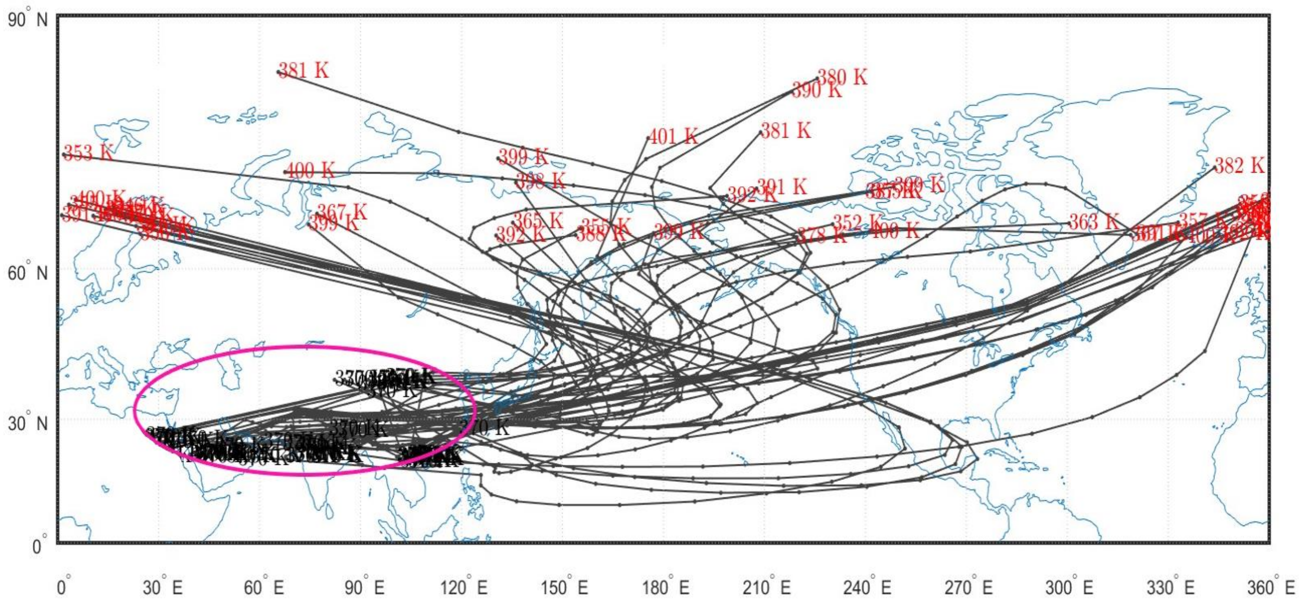
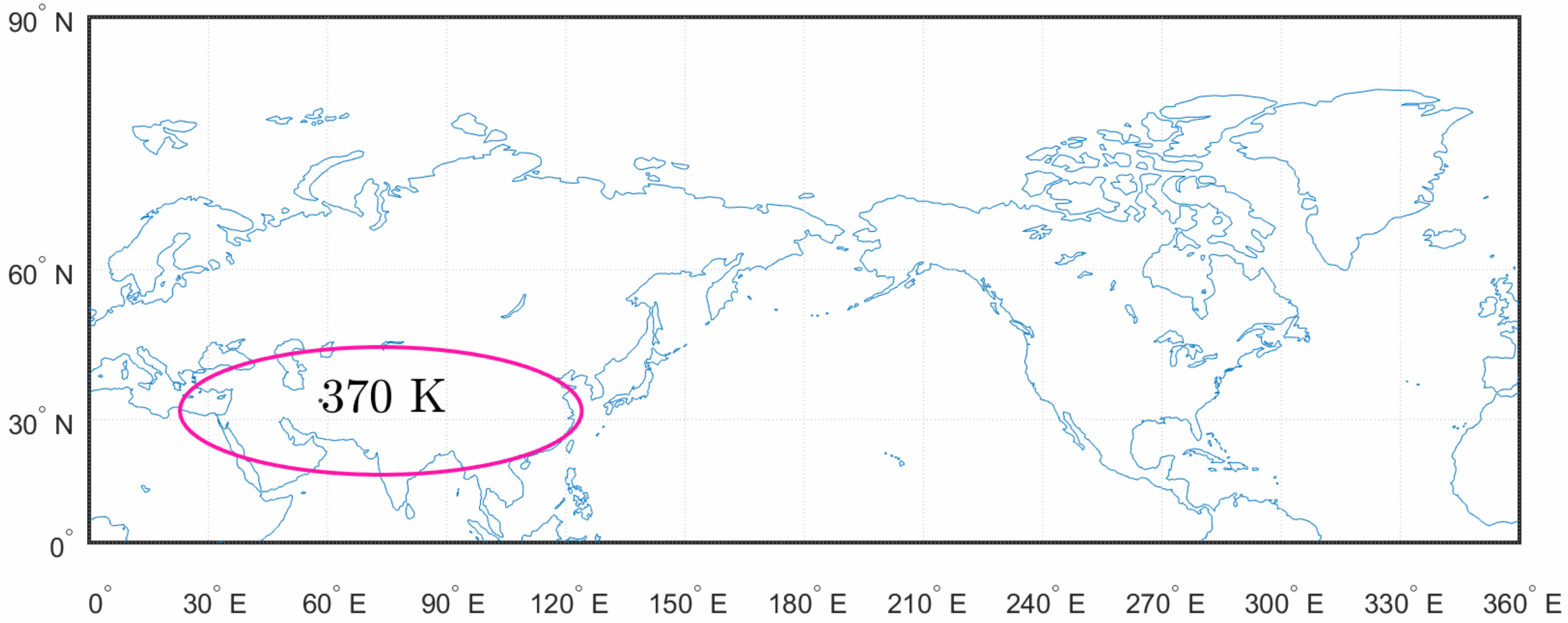
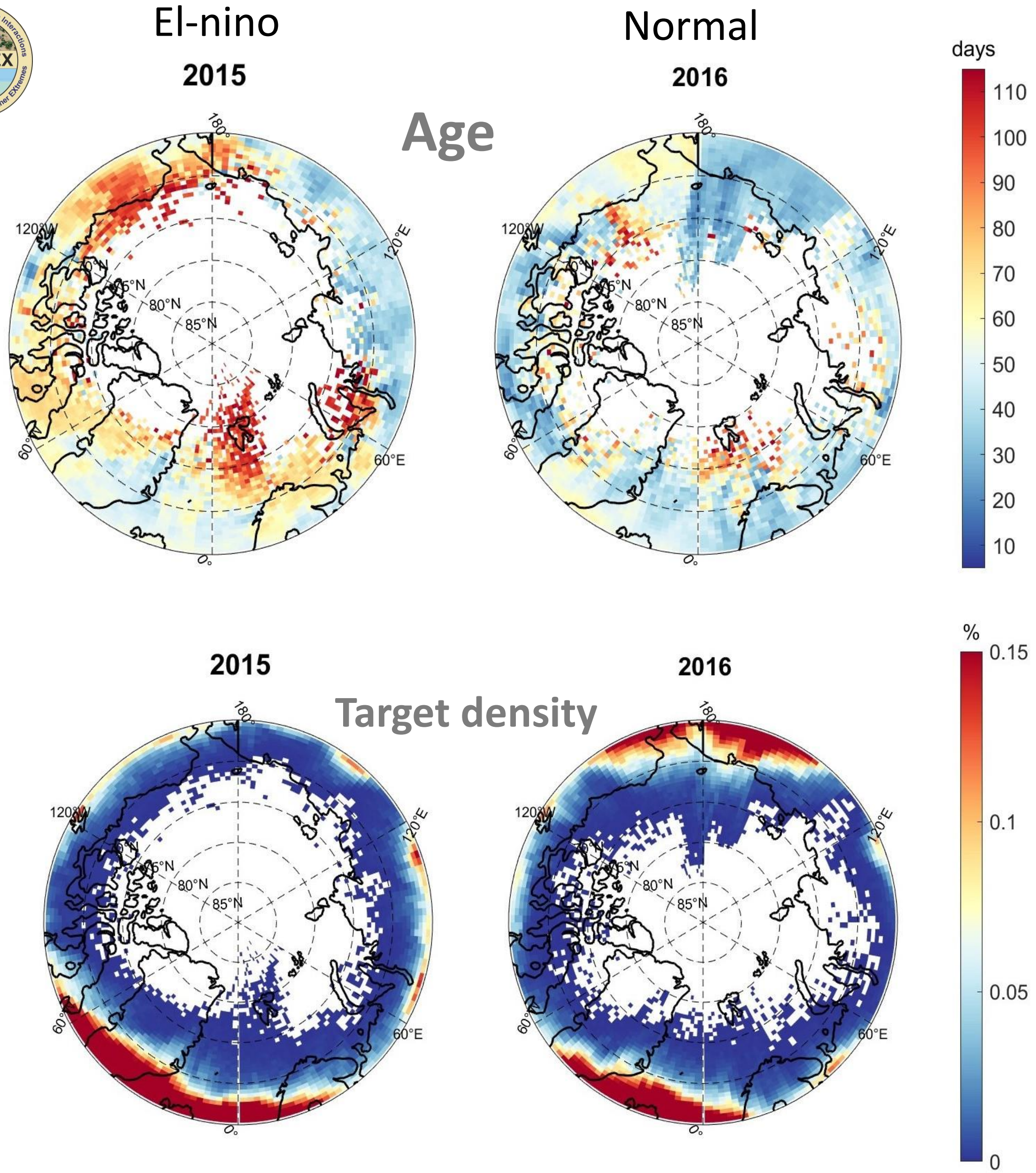


Fig 2: Schematic representation of trajectory releasing from ASMA reaching the Arctic region. The potential temperature level is indicated in red color.


90° N
60° N
30° N
0°
0°
30° E
60° E
90° E
120° E
150° E
180° E
210° E
240° E
270° E
300° E
330° E
360° E
370 K

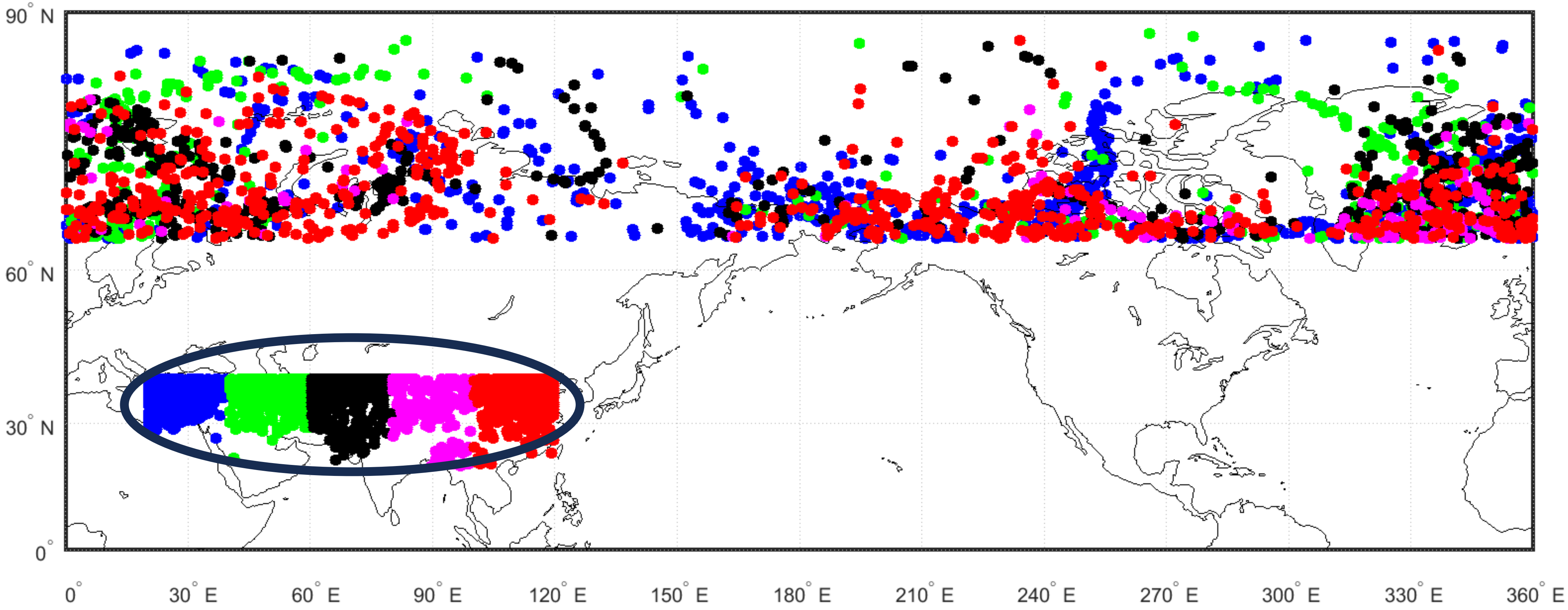
Result



	2015		2016	
REGION	AVERAGE AGE (DAYS)	TARGET DENSITY (%)	AVERAGE AGE (DAYS)	TARGET DENSITY (%)
GNB	66	39	50	36.5
RC	54	10.7	44	25.4
BAFFIN	62	43.6	48	20
BEAUFORT	77	6.6	54	18.07

Table: 1

Fig 3: Age (top) and target density (%) (bottom) of air parcel reaching the Arctic region



90° N
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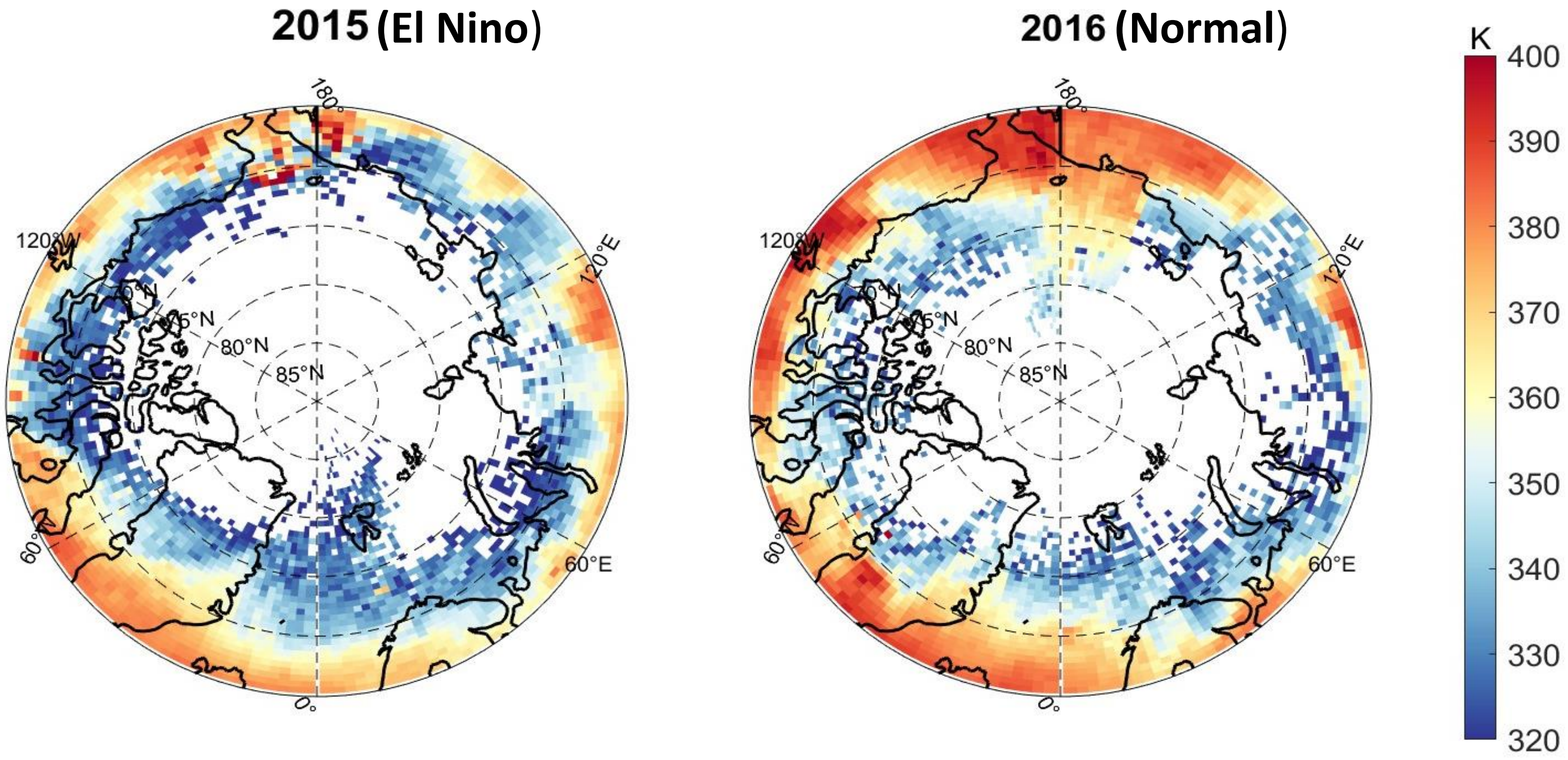

Fig 4: Isentropic level at which the parcel hit the Arctic region (impact level) during 2015 and 2016.

- The parcel reaching the Arctic at higher isentropic level during the normal years as compare to El nino years.
- Most of the parcel reaching above 72^0N are at lower isentropic level below 340 K

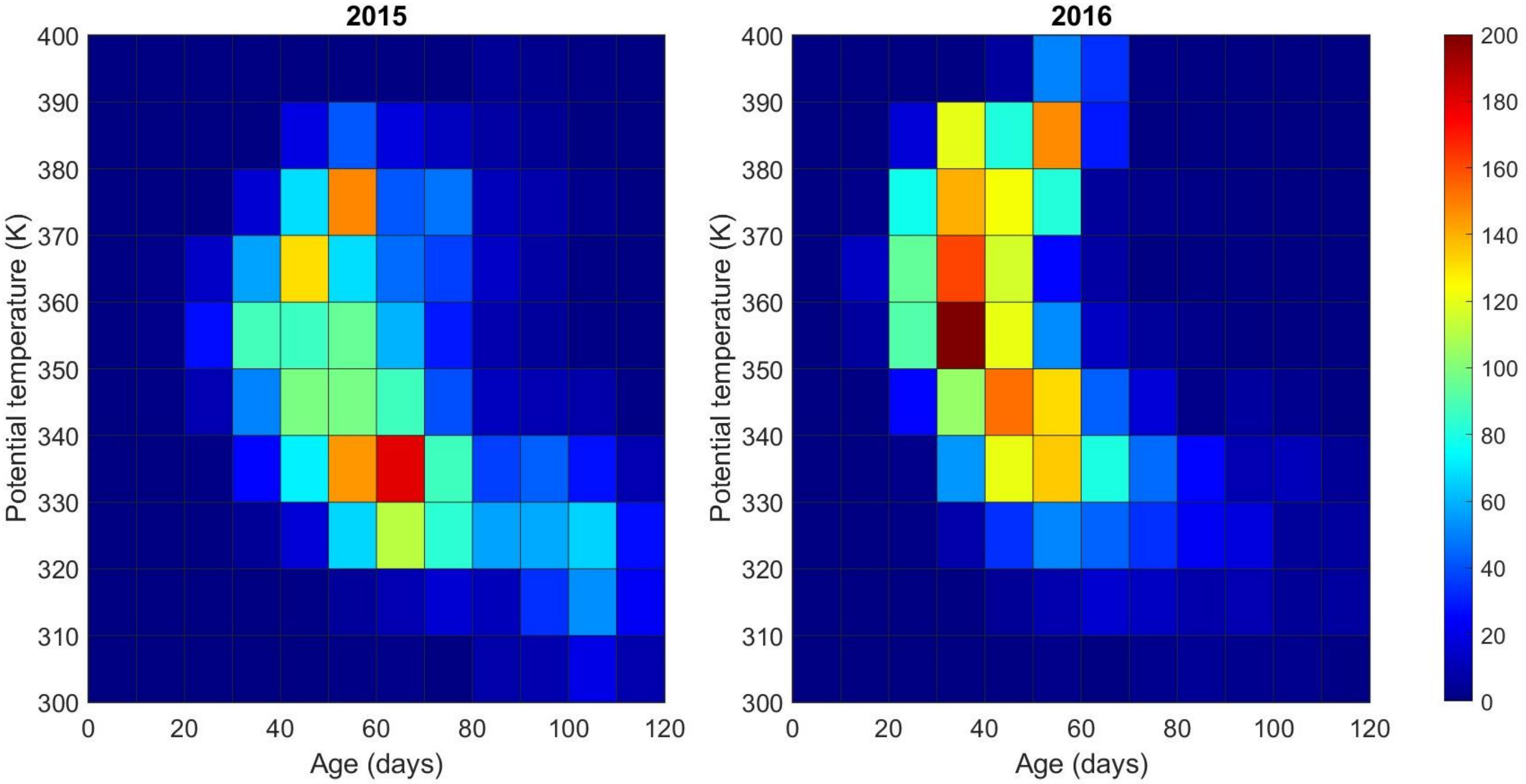

Fig 4: 2D histogram of the isentropic level versus the age of the air parcel reaching the Arctic for the year 2015 and 2016.

- The number of parcels reaching arctic at an isentropic level of 380 to 390 K is very high as comparing to El Nino years.

Conclusion

- El Niño Year (2015): Prolonged transit times for ASMA parcels to the Arctic compared to the normal year
- Target Density: The highest target density occurred in the Baffin **region** in 2015 and GNB region in 2016.
- Parcel reaches to higher isentropic level during Normal years compare to El nino.
- El Niño years consistently result in longer Arctic transit times.

Thank You

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