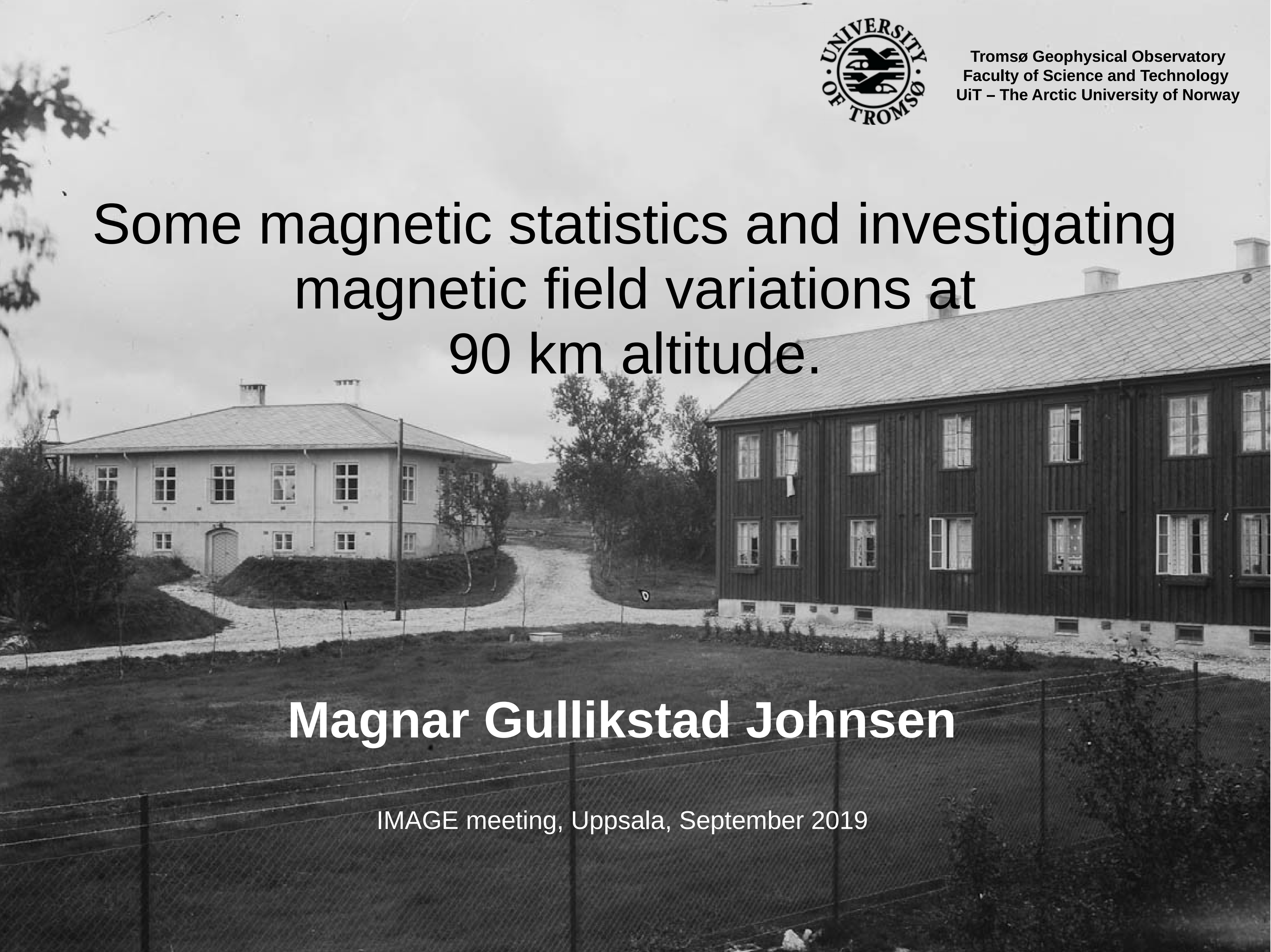


Tromsø Geophysical Observatory
Faculty of Science and Technology
UiT – The Arctic University of Norway

Some magnetic statistics and investigating magnetic field variations at 90 km altitude.

Magnar Gullikstad Johnsen

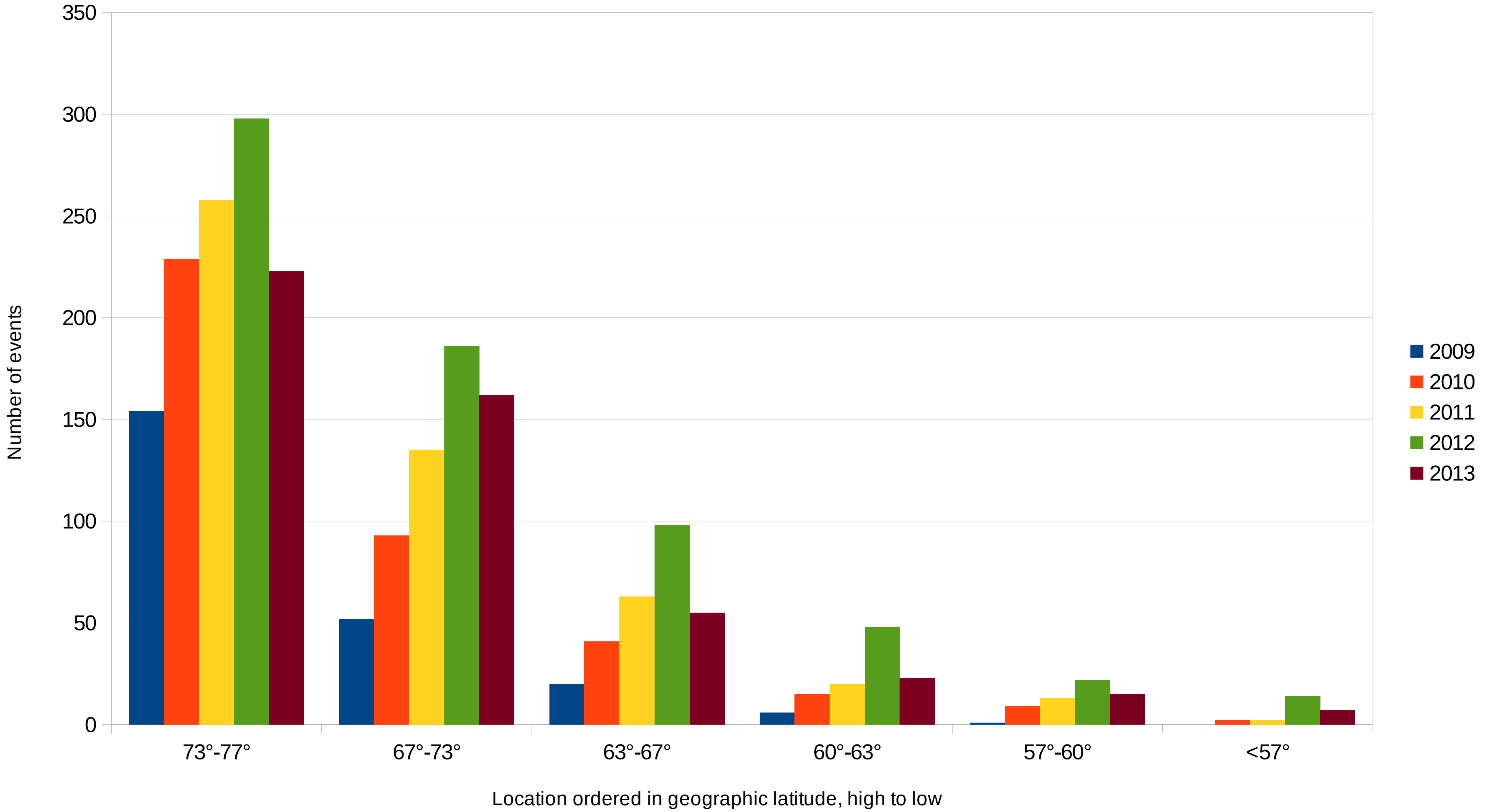
IMAGE meeting, Uppsala, September 2019

Overview

- Some statistics of magnetic field variations in Norway
- Investigating magnetic field variations in the mesosphere (~90 km above ground).

Statistics

- Alerts issued to oil industry as function of year and latitude
- Magnetic disturbance events that affect their operations



Thresholds for previous figure

D: 0.48 deg (Barents Sea), 0.45 deg (Norwegian Sea), 0.40 (North Sea)

I: 0.180 deg (Barents Sea and Norwegian Sea and North Sea)

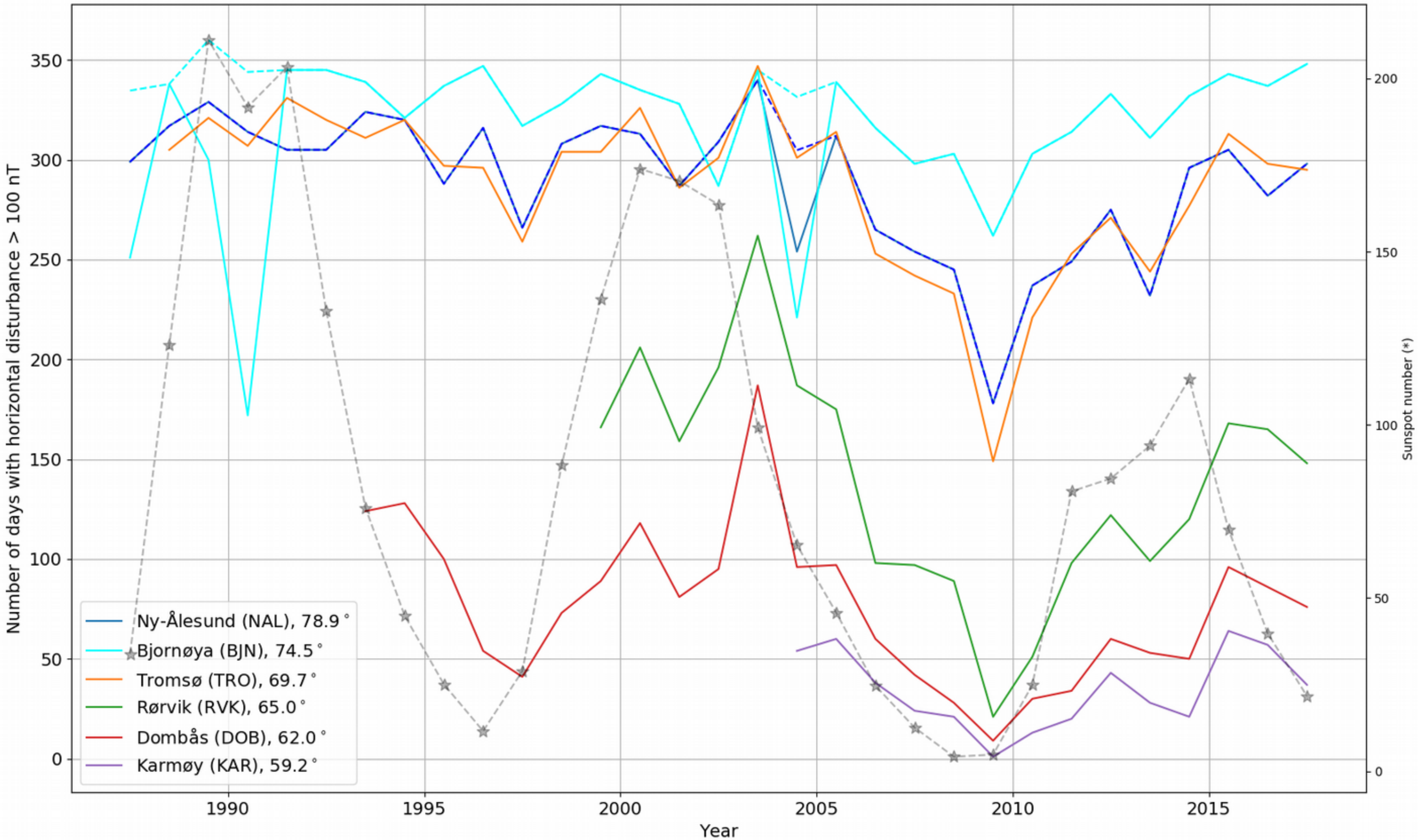
F: 158 nT (Barents Sea), 147 nT (Norwegian Sea), 135 nT (North Sea)

Reasons: Technical aspects related to drilling companies' error models where both external field, magnetic mud and, internal field and drill string interference has been taken into account.

Different threshold to find a more “clean” statistics

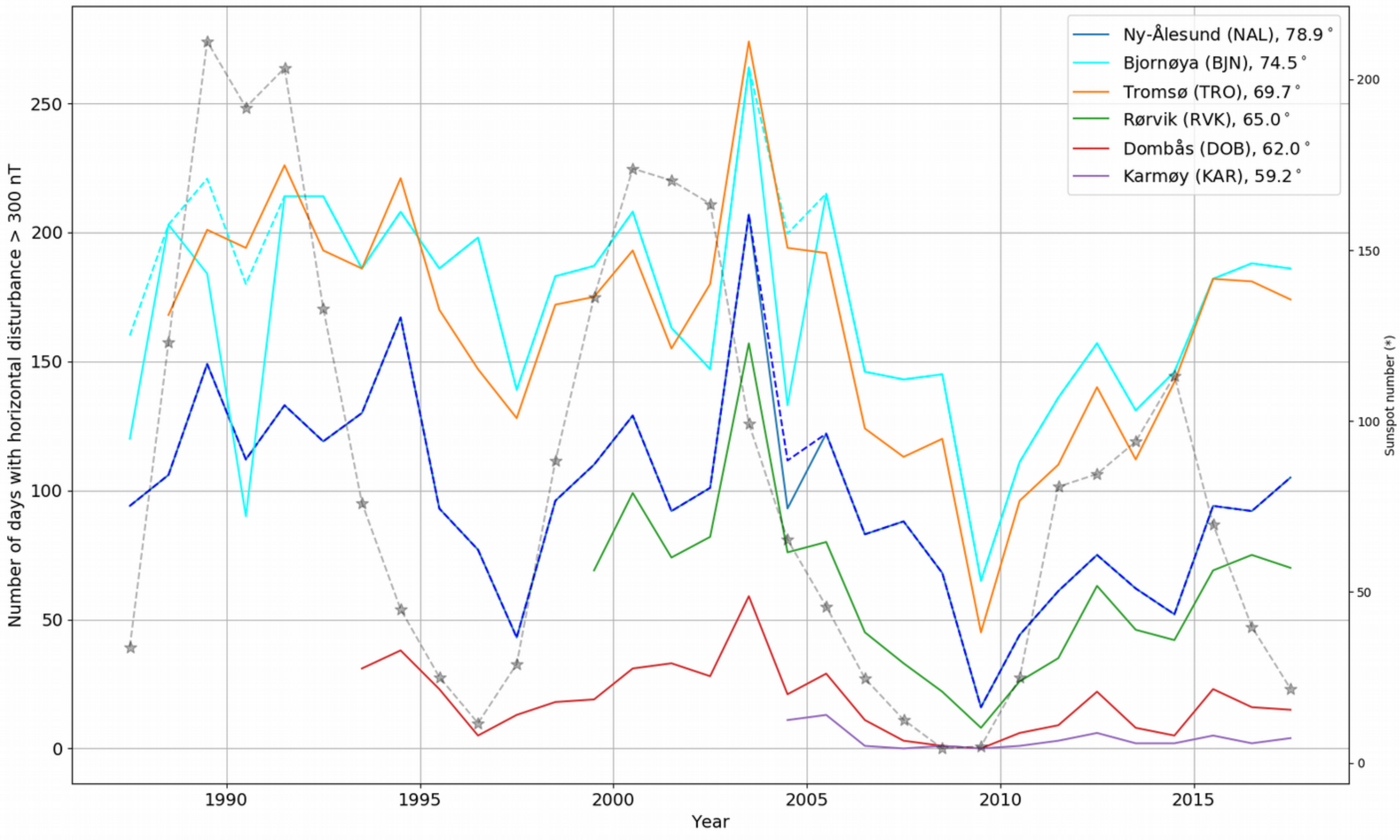
- A nice aid in discussion about the nature of geomagnetic disturbances
- Let’s remove the internal field, use horizontal field disturbance and use different thresholds. I’ve chosen 100, 300 and 500 nT.
- (Horizontal field disturbance includes Sq variation, but it is an external disturbance and I therefore think it should be included here)
- Count number of days where Horizontal field disturbance reaches above the above thresholds.

100 nT



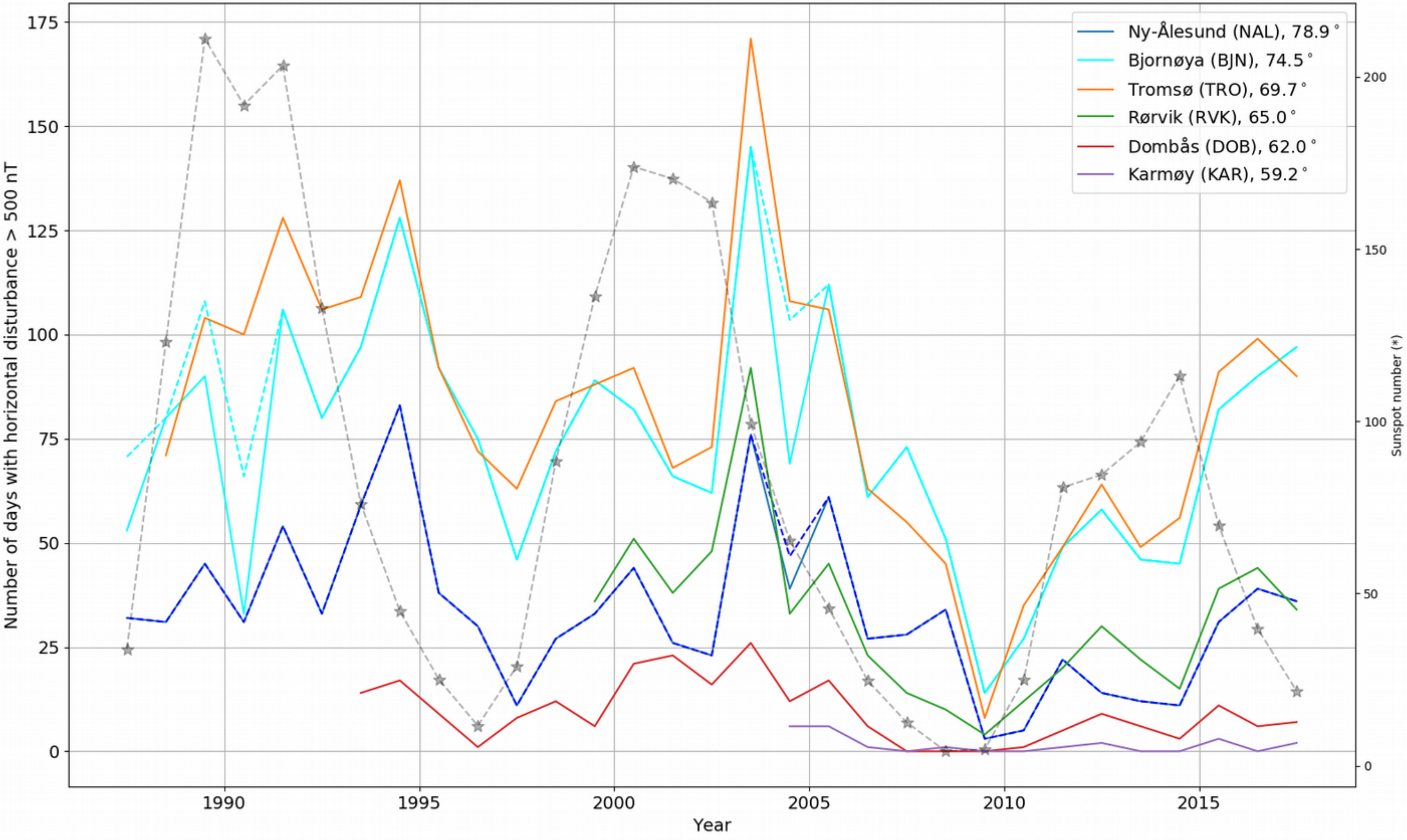
Number of days with horizontal disturbance > 100 nT
Sunspot number (*)
Year
0
50
100
150
200
250
300
350
1990
1995
2000
2005
2010
2015
Ny-Ålesund (NAL), 78.9°
Bjornøya (BJN), 74.5°
Tromsø (TRO), 69.7°
Rørvik (RVK), 65.0°
Dombås (DOB), 62.0°
Karmøy (KAR), 59.2°

300 nT



Ny-Ålesund (NAL), 78.9°
Bjornøya (BJN), 74.5°
Tromsø (TRO), 69.7°
Rørvik (RVK), 65.0°
Dombås (DOB), 62.0°
Karmøy (KAR), 59.2°
Number of days with horizontal disturbance > 300 nT
Sunspot number (*)
Year
0
50
100
150
200
250
1990
1995
2000
2005
2010
2015

500 nT

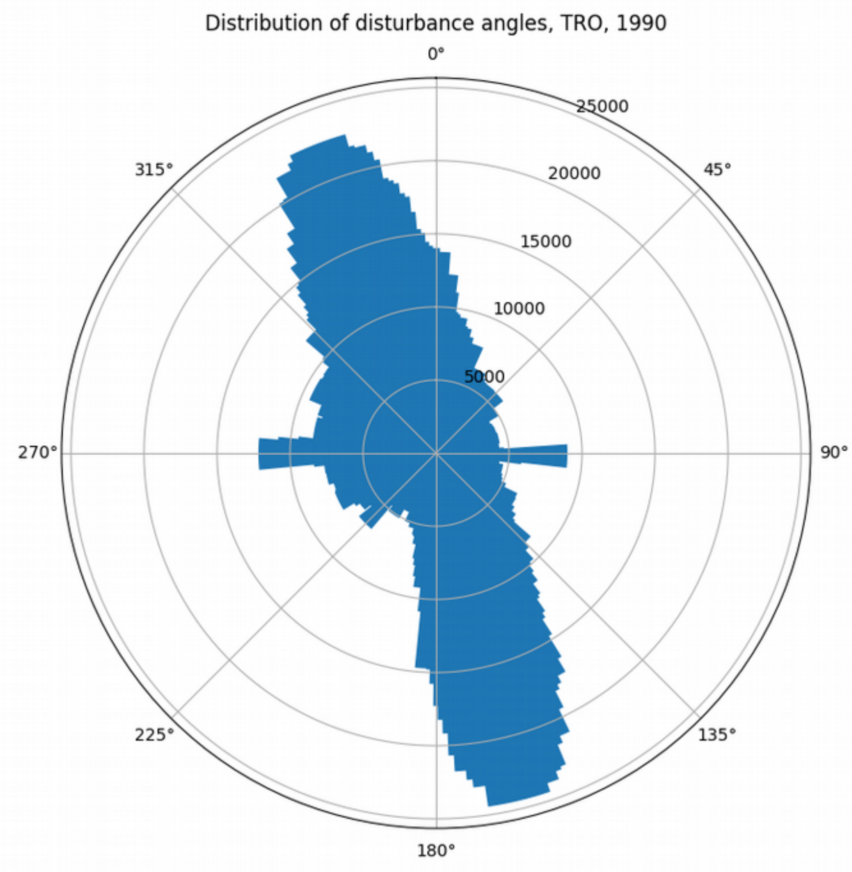

Ny-Ålesund (NAL), 78.9°
Bjornøya (BJN), 74.5°
Tromsø (TRO), 69.7°
Rørvik (RVK), 65.0°
Dombås (DOB), 62.0°
Karmøy (KAR), 59.2°
Number of days with horizontal disturbance > 500 nT
Sunspot number (*)
Year
0
25
50
75
100
125
150
175
1990
1995
2000
2005
2010
2015
0
50
100
150
200

Observations

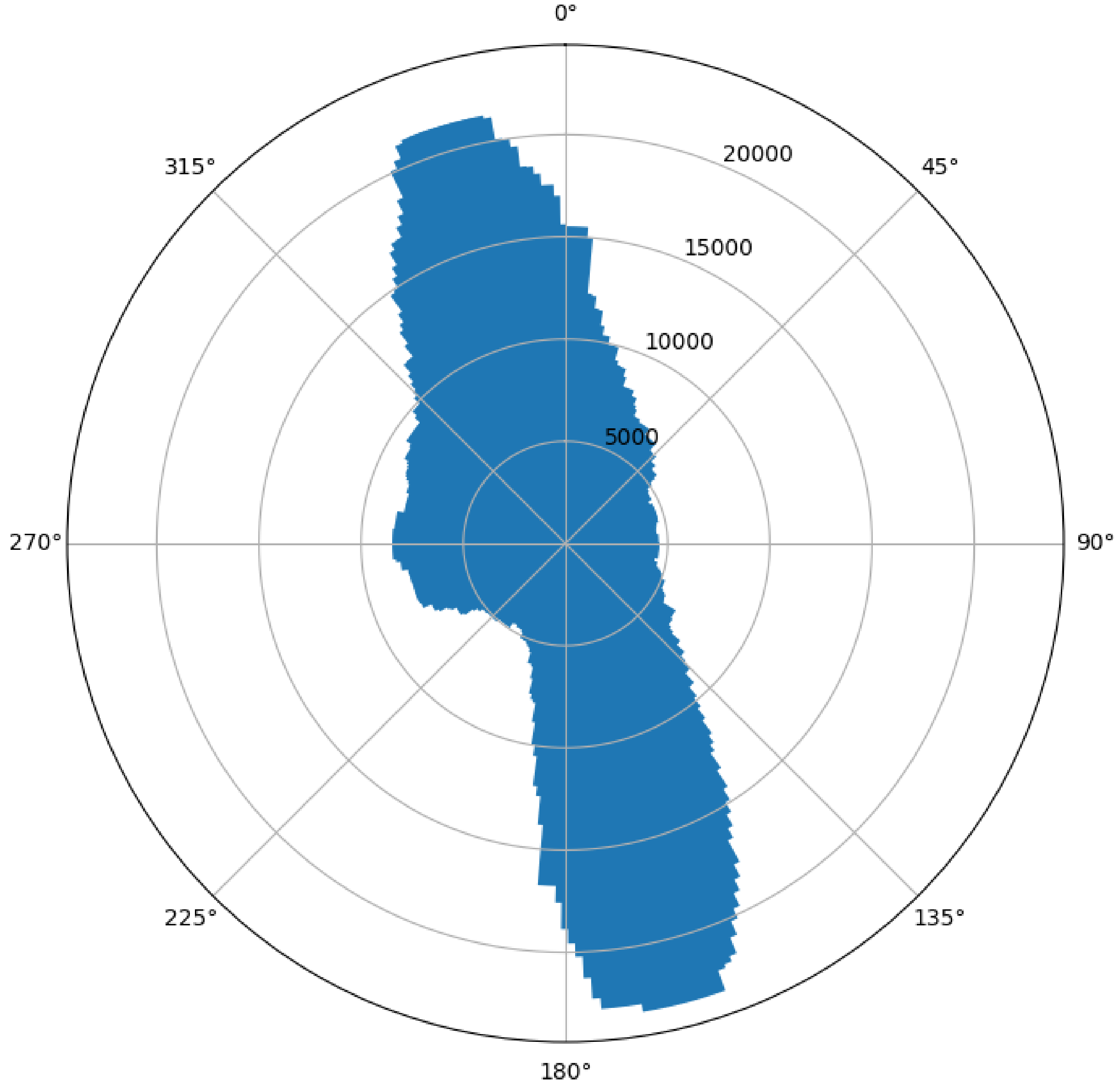
- Southern stations see solar cycle variation always for all thresholds
- Northern stations don’t see much solar cycle variation for disturbances 100nT and 300 nT but clear signature at 500 nT
- Solar minimum of cycle 23-24 (2009) is special
  - The one in 1996 did not have the same effect
- Well known ~two year lag og geomagnetic activity behind sunspot shows up nicely

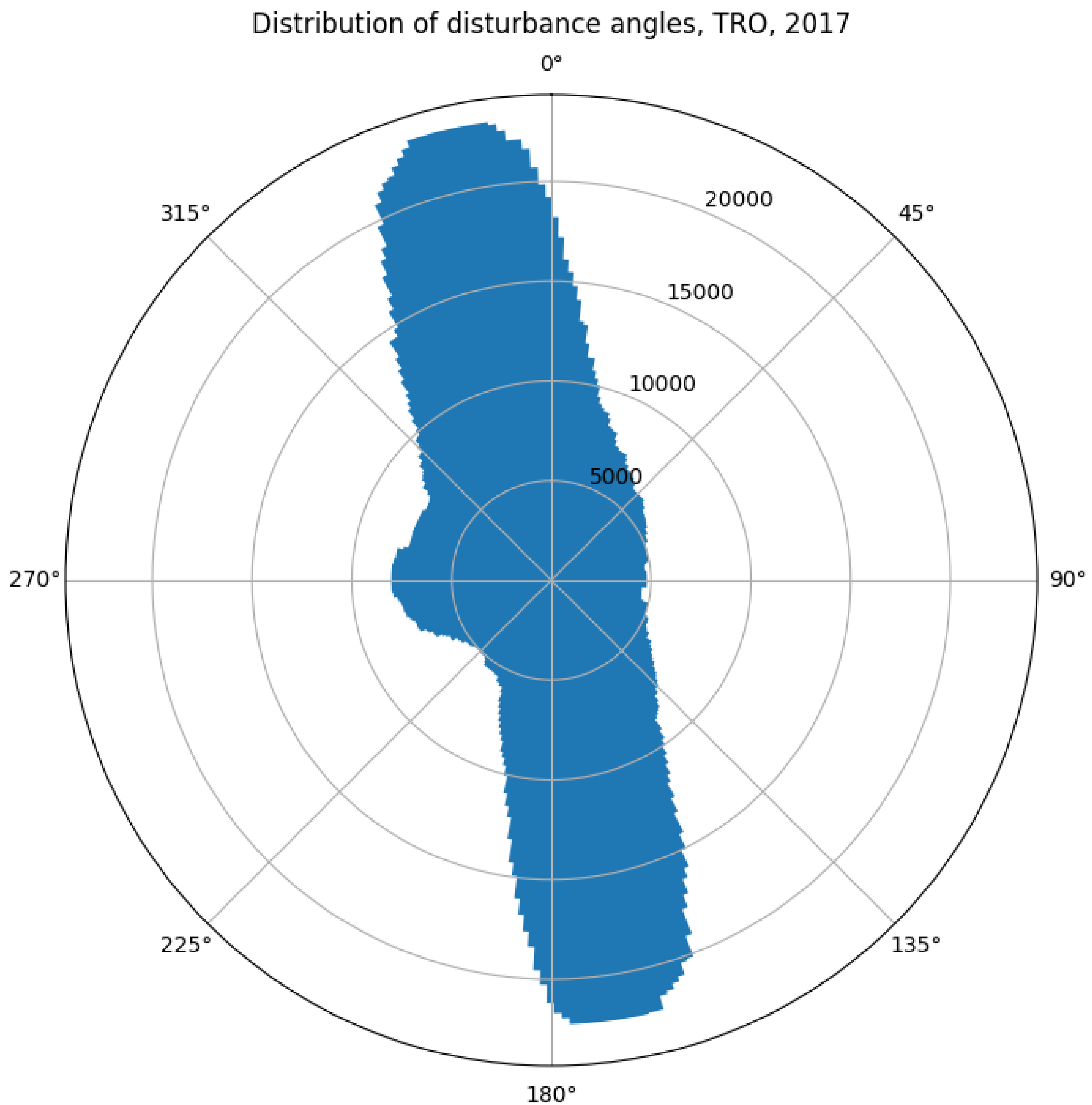
How does the horizontal disturbance angle vary?

Angle between horizontal disturbance and true north

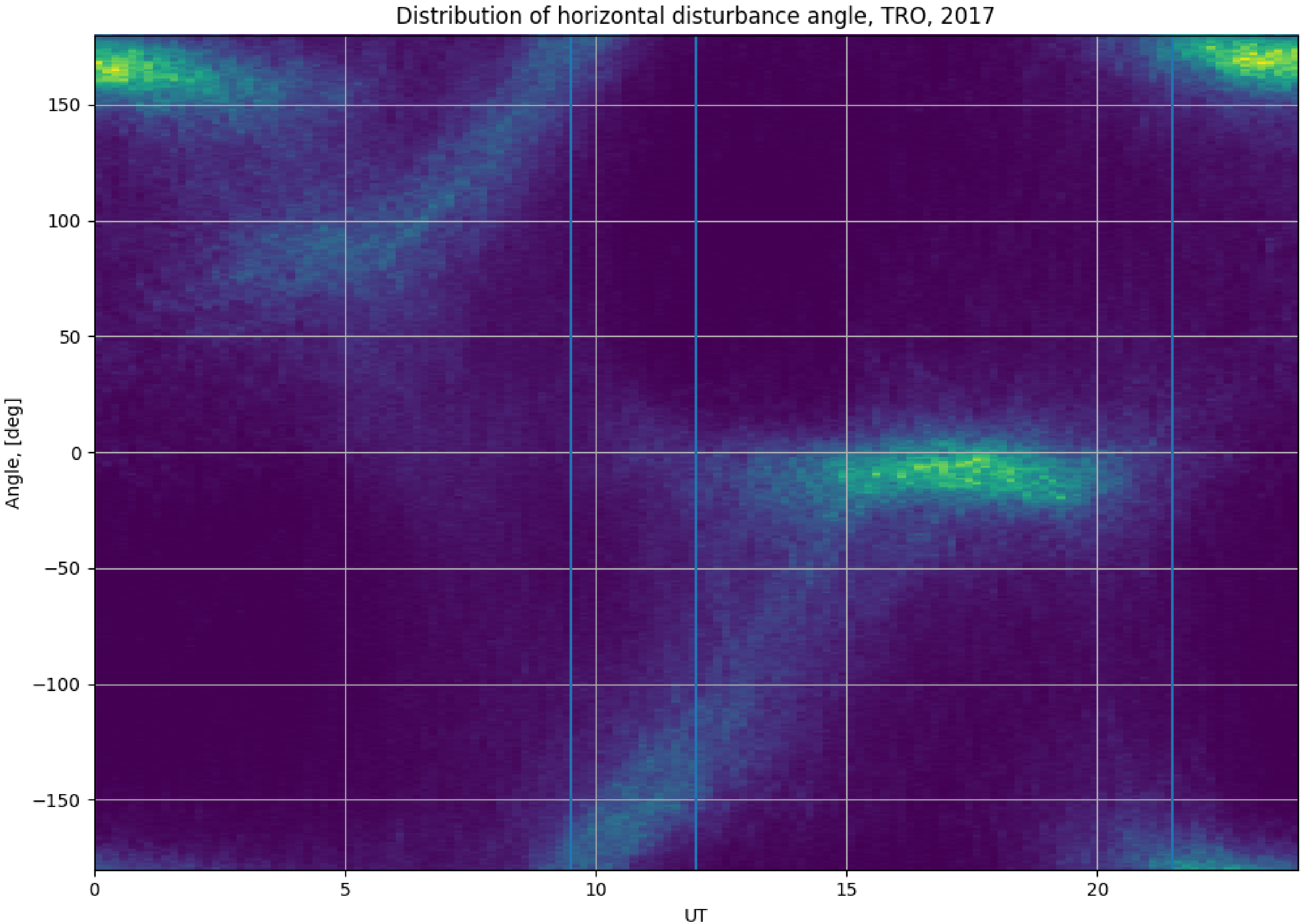


Distribution of disturbance angles, TRO, 2001



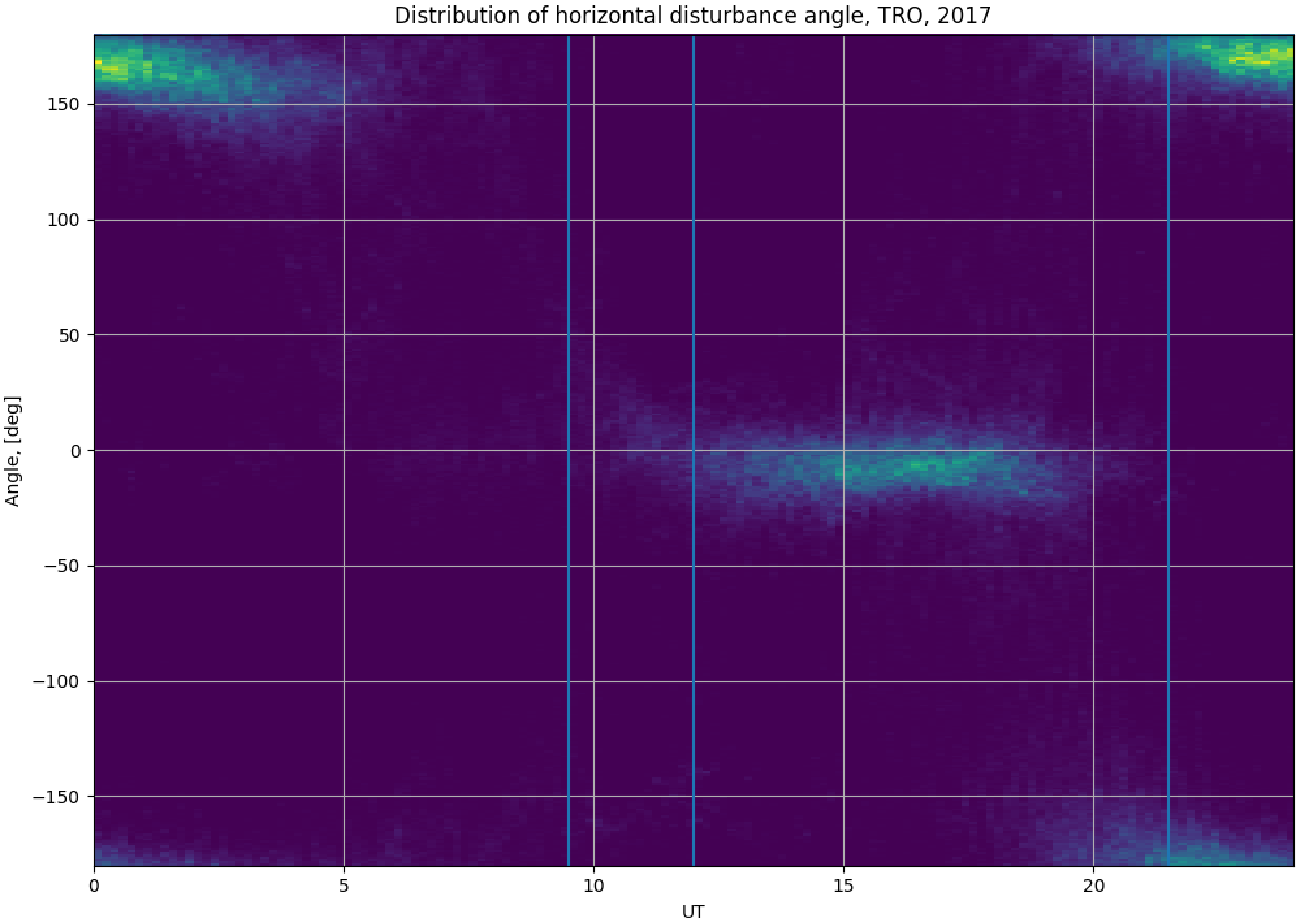


Distribution of disturbance angles, TRO, 2017
0°
45°
90°
135°
180°
225°
270°
315°
5000
10000
15000
20000

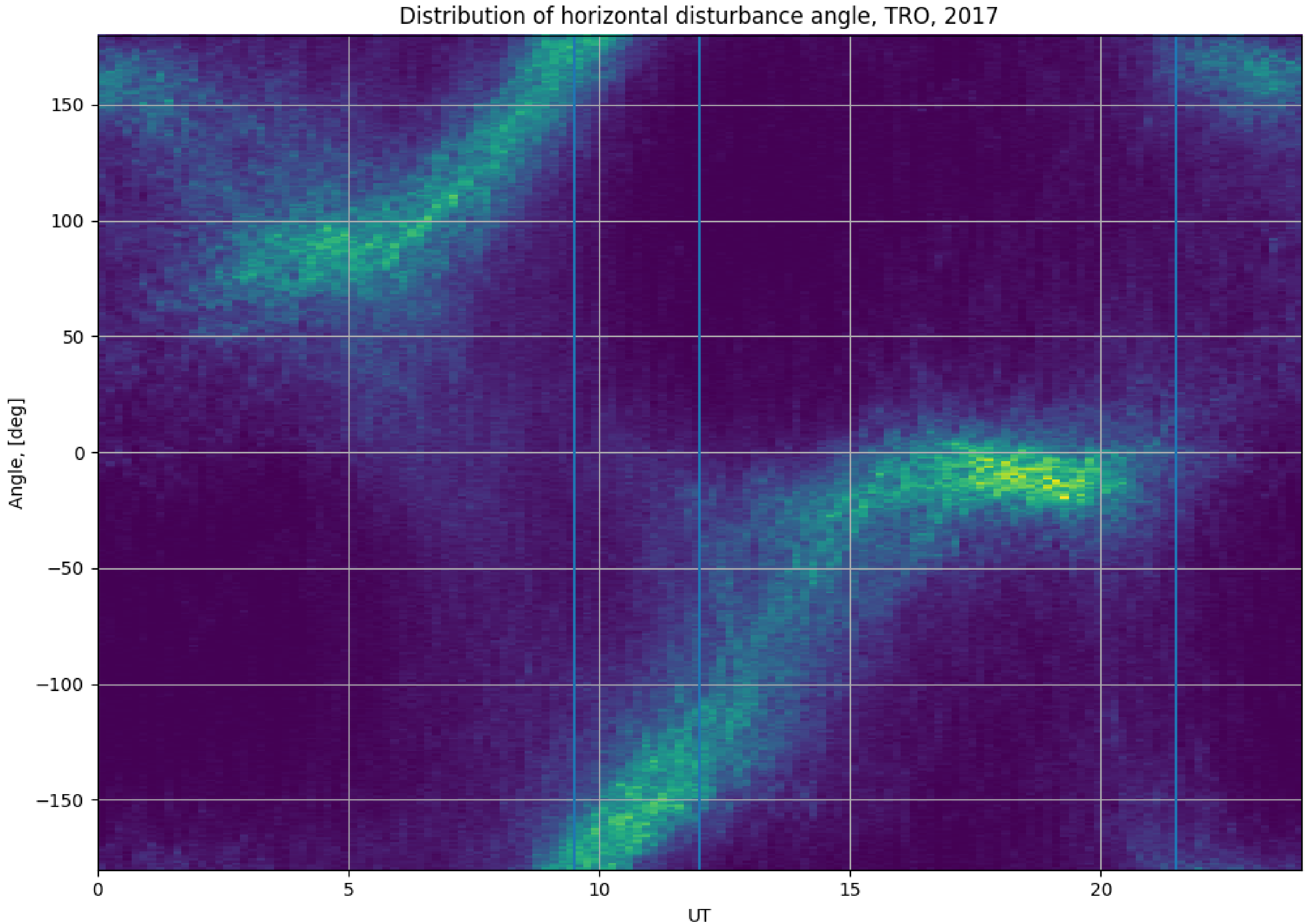


Distribution of horizontal disturbance angle, TRO, 2017
Angle, [deg]
150
100
50
0
−50
−100
−150
0
5
10
15
20
UT

Without disturbances < 50 nT



Without disturbances > 50 nT



Observations

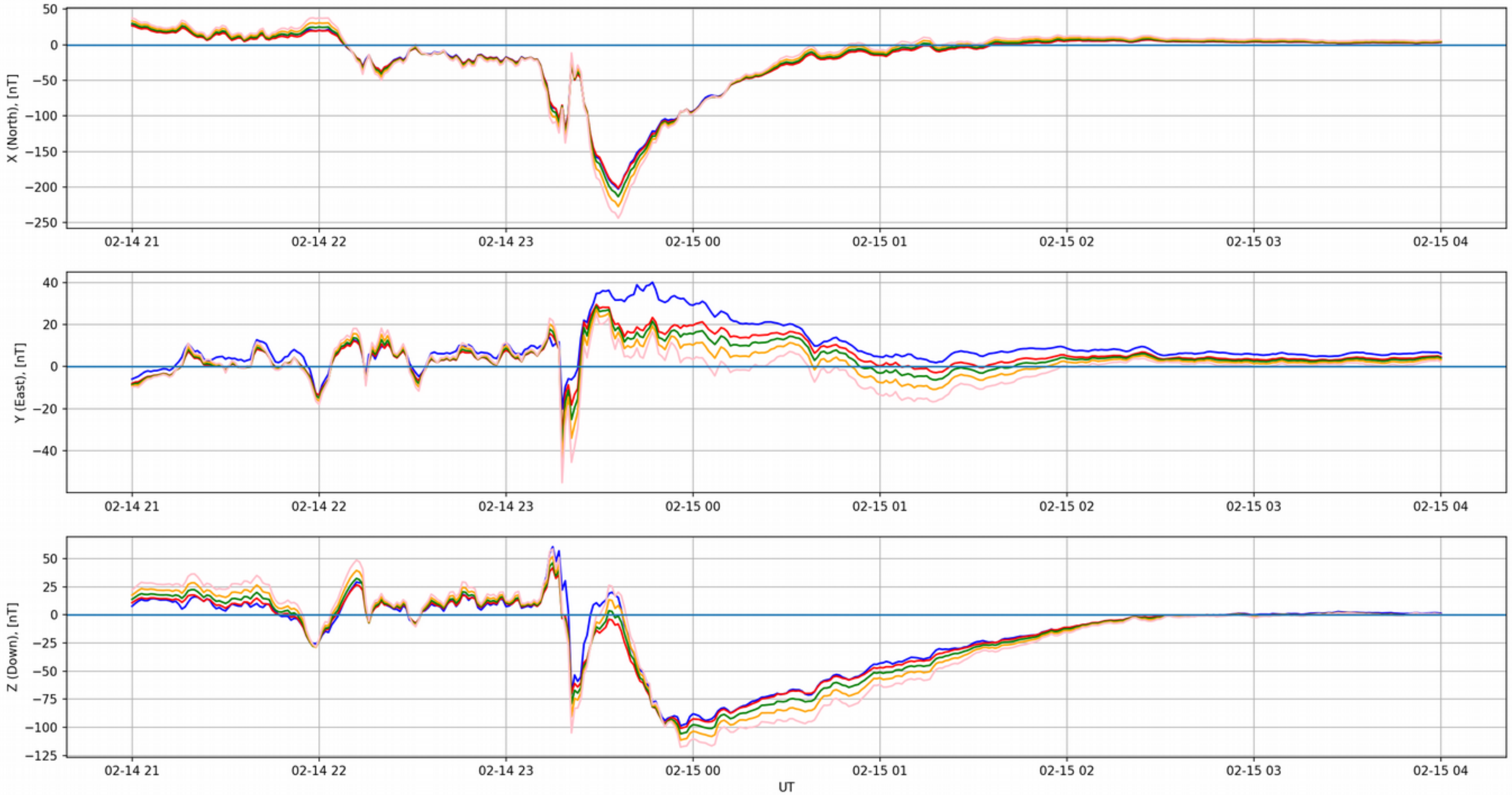
- Direction of EJ disturbances changes over the years (secular variation)
- In this domain Sq and EJ are separate populations
- WEJ and EEJ disturbances are not 180 degrees separated
  - Hall/Pedersen conductivity ratio difference
  - WEJ population includes Substorm EJ which is also westward, but not alligned with the auroral oval in the same fashion

How does variations look at 90 km altitude?

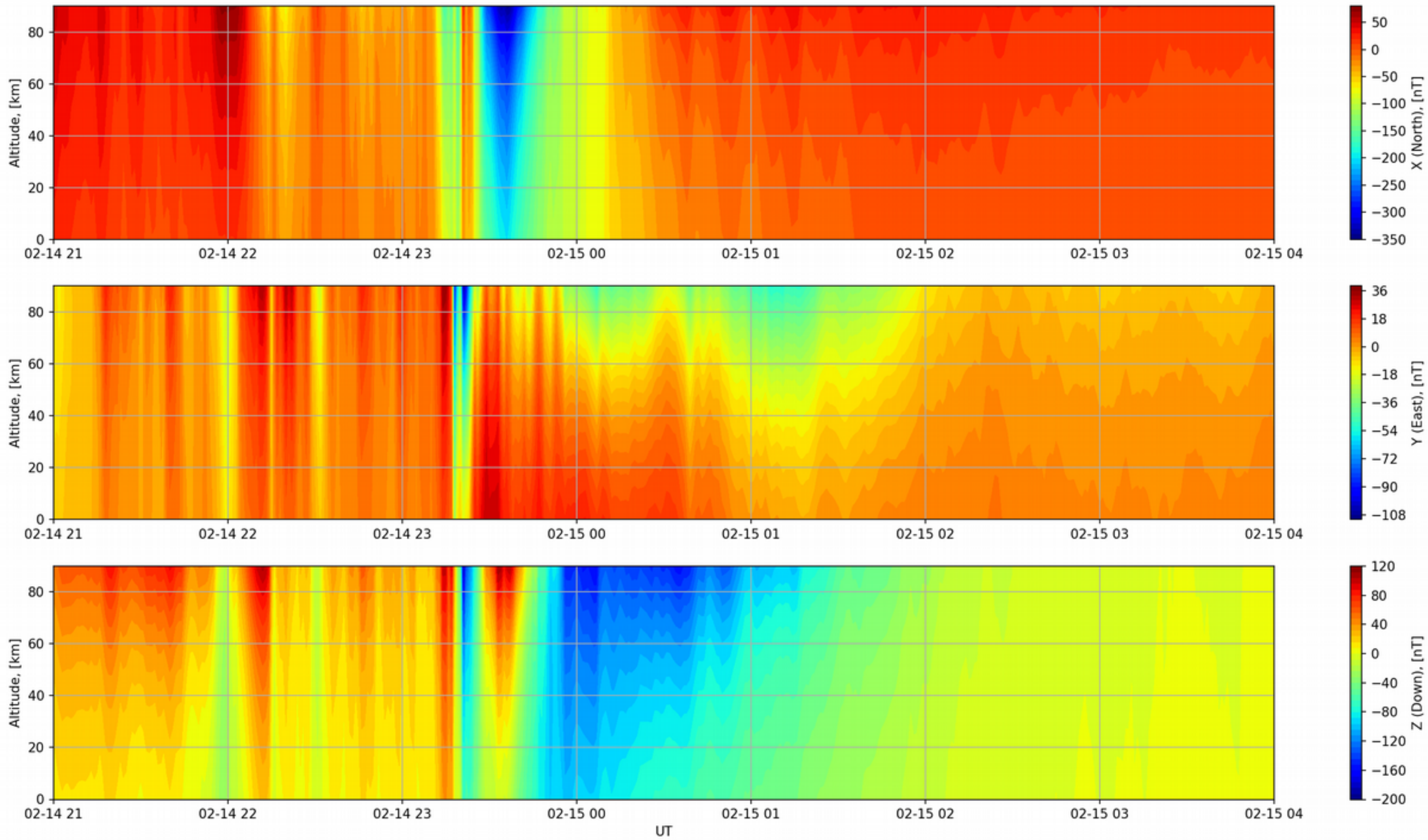
Through the Mesospheric Optical Magnetometry (MOM) project we intend to measure the scalar field in the mesosphere – What can we expect?

Here we present some initial attempts to model the variation based on real ground based data, using Spherical Elementary Current Systems (SECS)

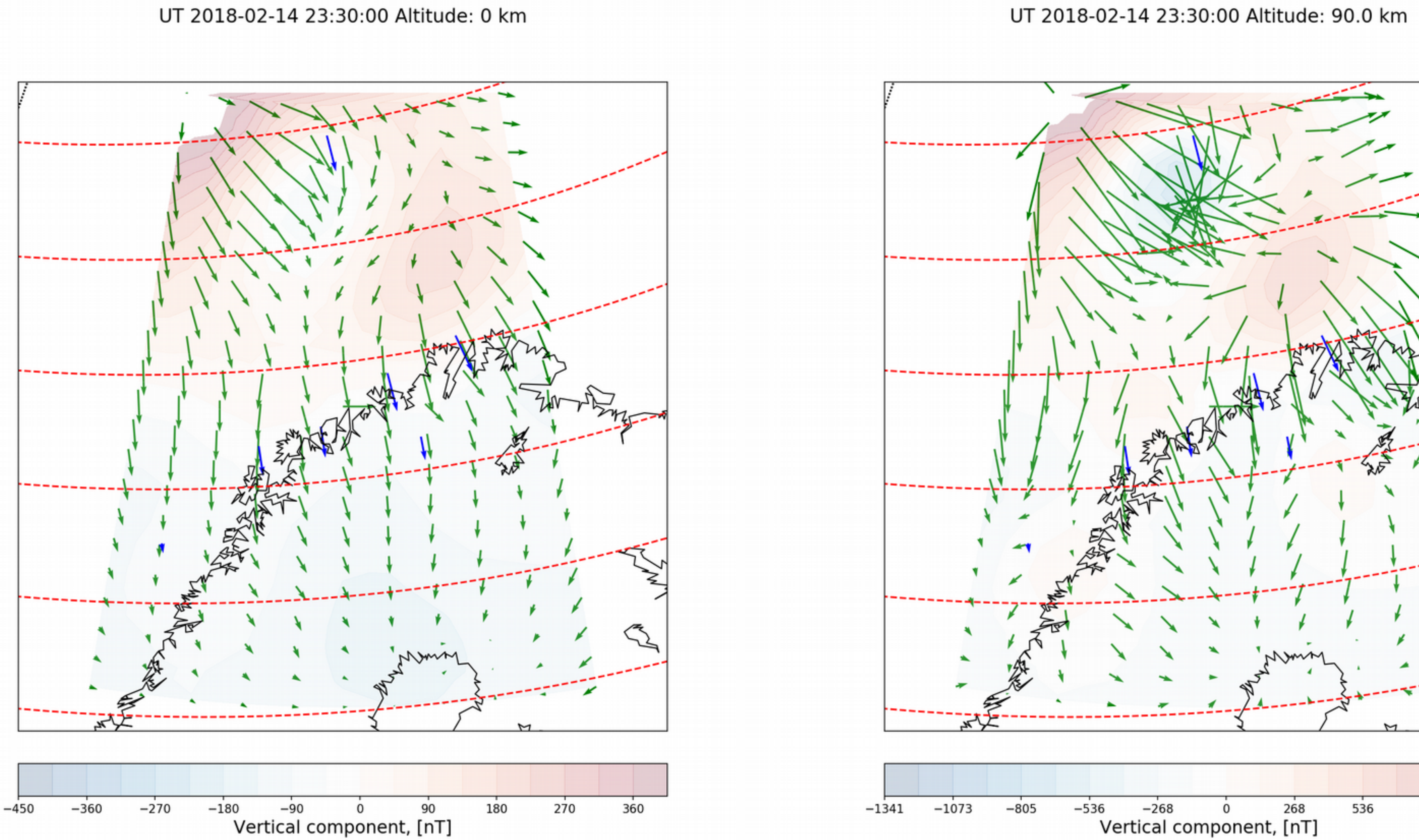
SECS (magnetic field variations over Andøya as function of altitude)



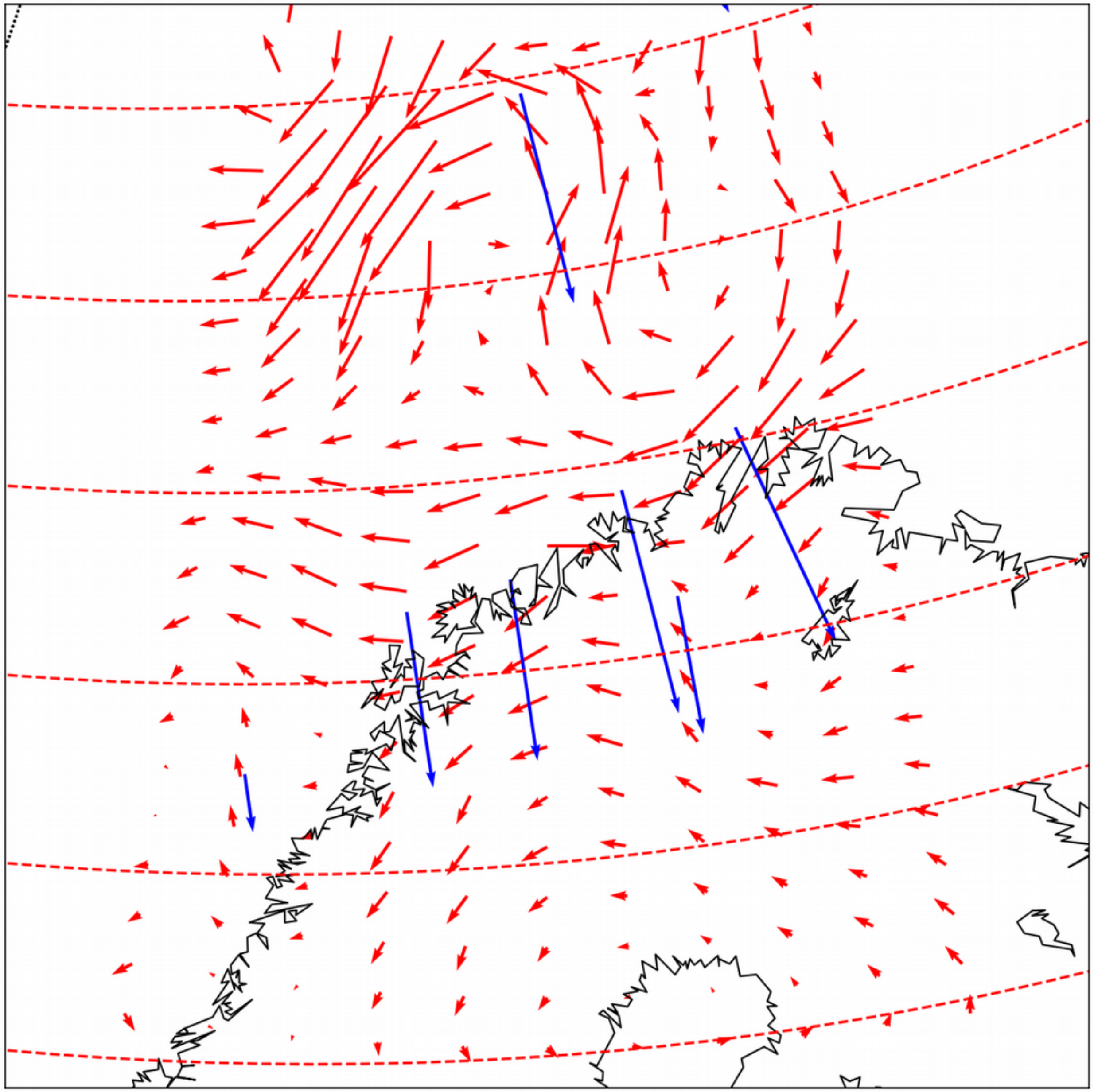
SECS (magnetic field variations over Andøya as function of altitude)



Magnetic disturbances 0 and 90 km



Eq Current UT 2018-02-14 23:30:00



Observations

Vertical component has a tendency to increase upwards → Which is good news for total field measurements

Method does not shed light on ability to measure small scale current structures, of course.

In some cases the sign of z component changes between 0 and 90 km → it remains to be seen if this is real or not.

Questions? (magnar.g.johnsen@uit.no)