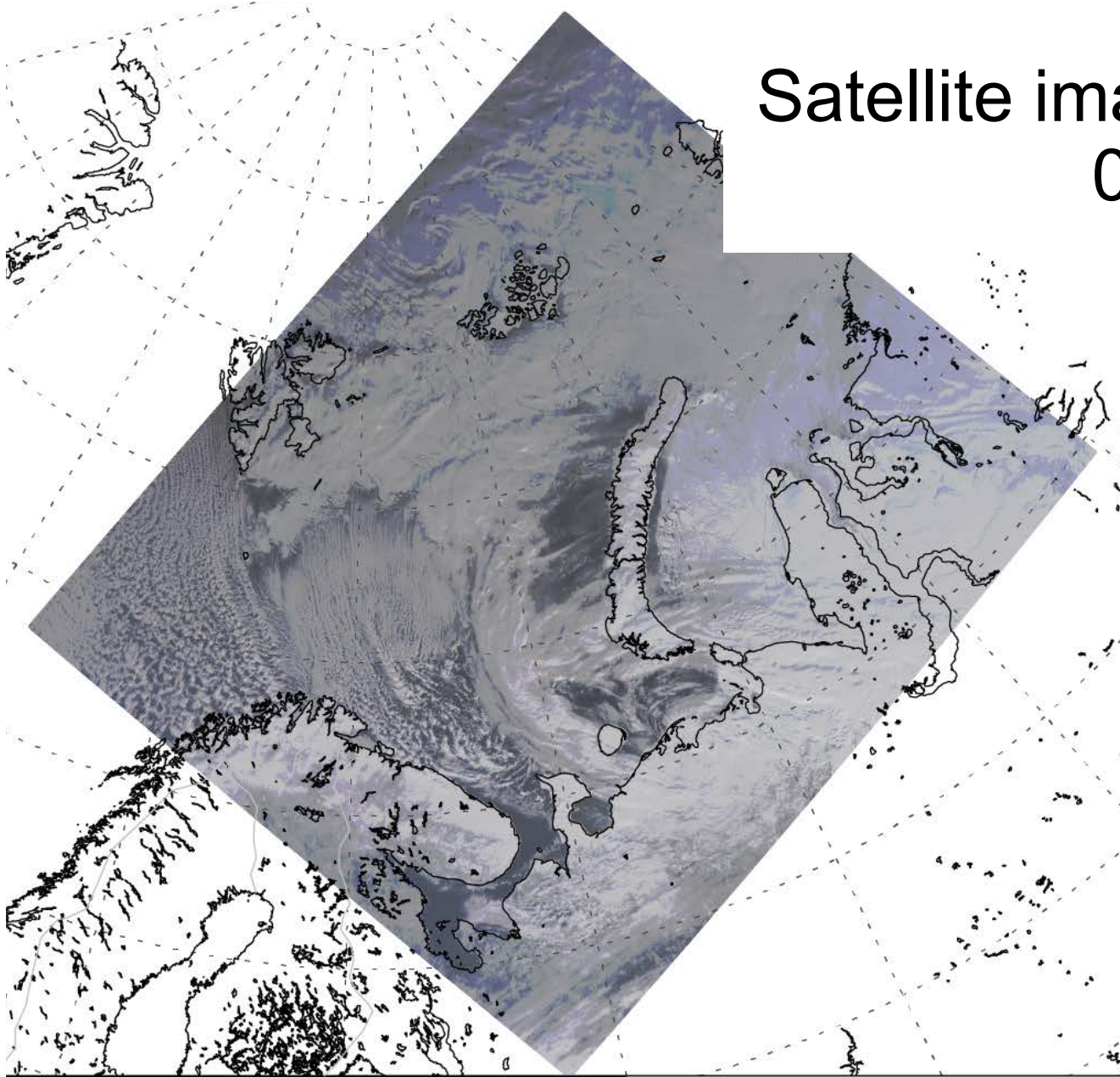


# Case study of a CAO in COMBLE

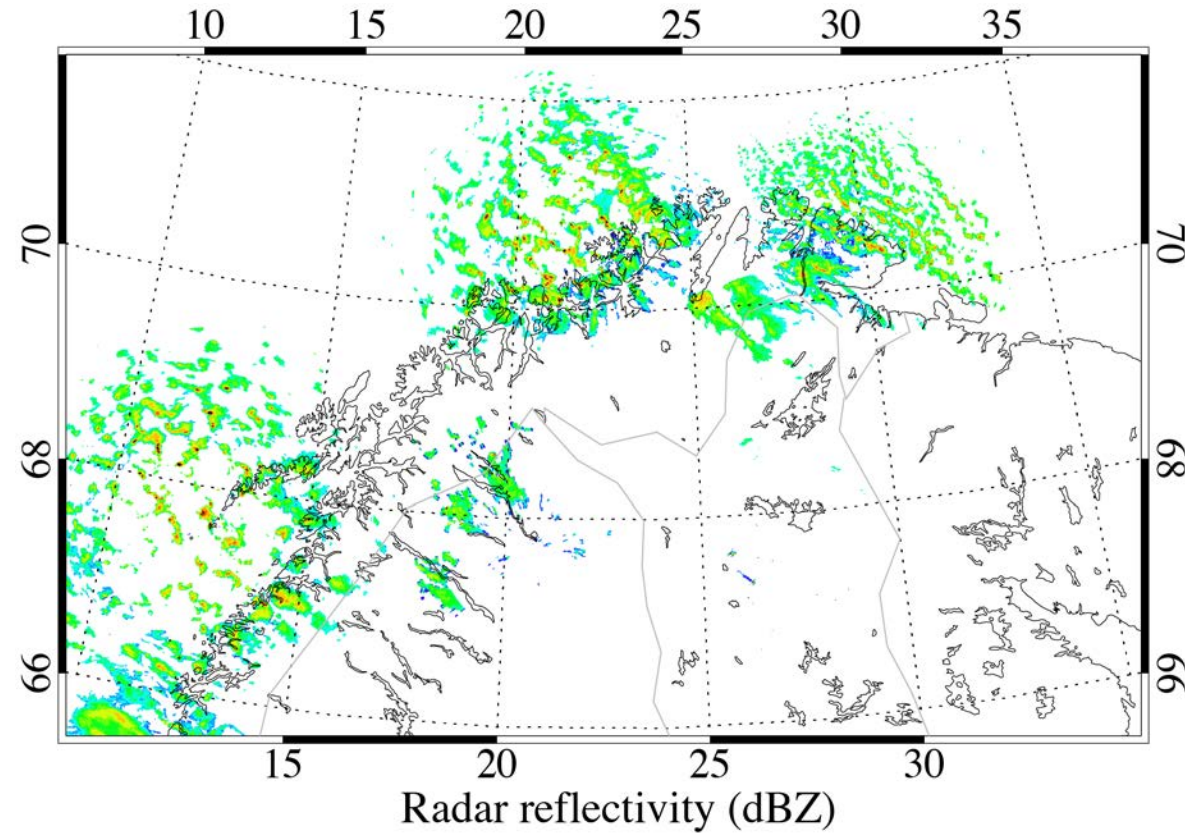
Yonggang Wang<sup>1</sup>([yonggangA.wang@gmail.com](mailto:yonggangA.wang@gmail.com)),  
Bart Geerts<sup>2</sup>, Yazhe Hu<sup>2</sup>, Zachary J. Lebo<sup>2</sup>, Yishi Hu<sup>2</sup>

<sup>1</sup>Texas Tech University    <sup>2</sup>University of Wyoming

# Satellite imagery & radar mosaic reflectivity 03/29/2020 0810 UTC

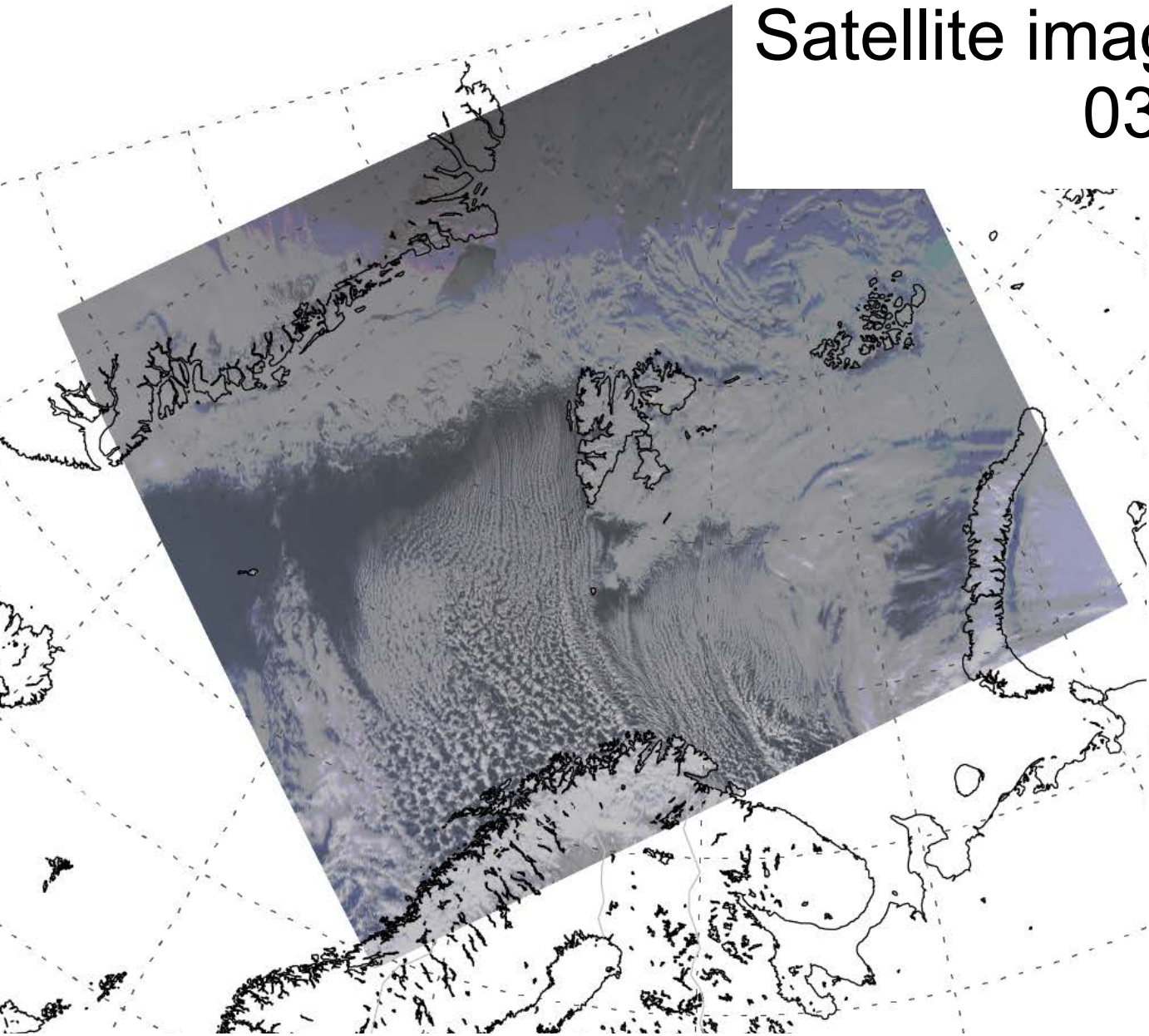


45  
MODIS image  
(data source: <https://earthobservatory.nasa.gov/>)

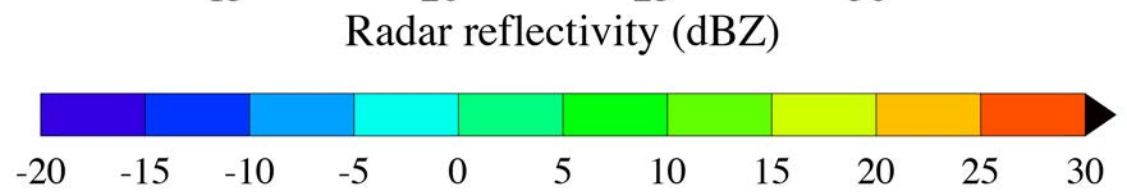
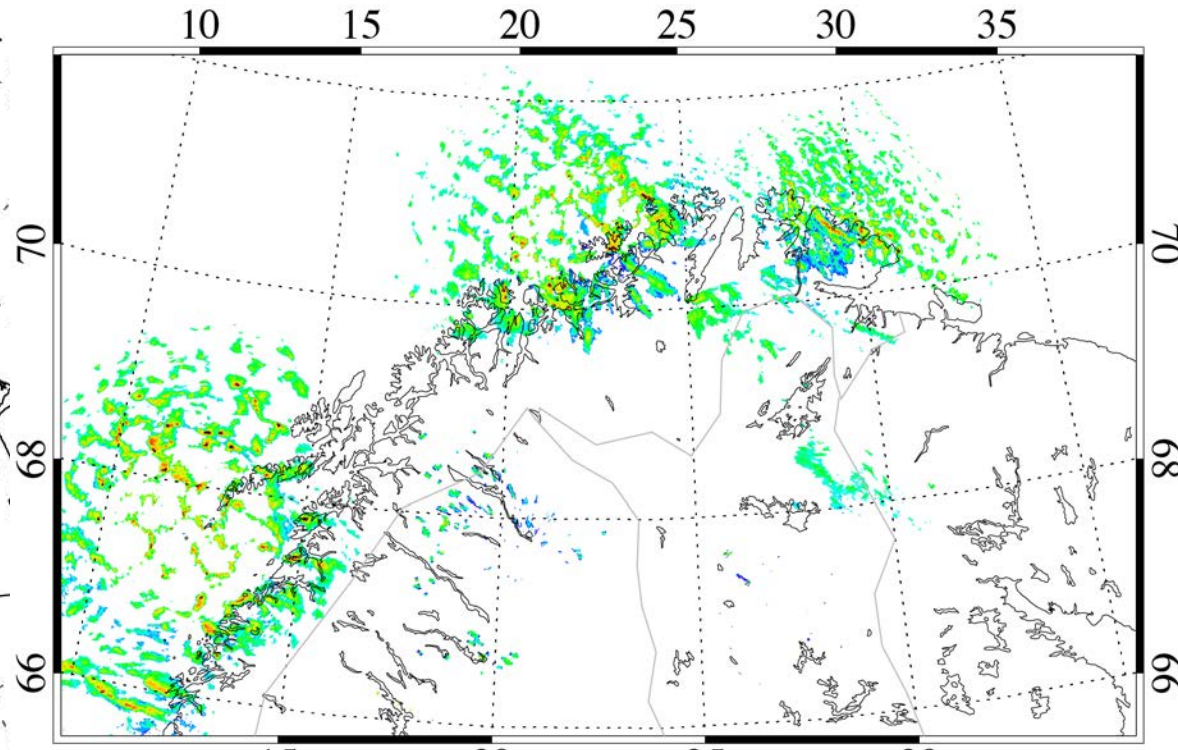


MET Norway radar mosaic  
(data source: <https://thredds.met.no>)

# Satellite imagery & radar mosaic reflectivity 03/29/2020 0950 UTC

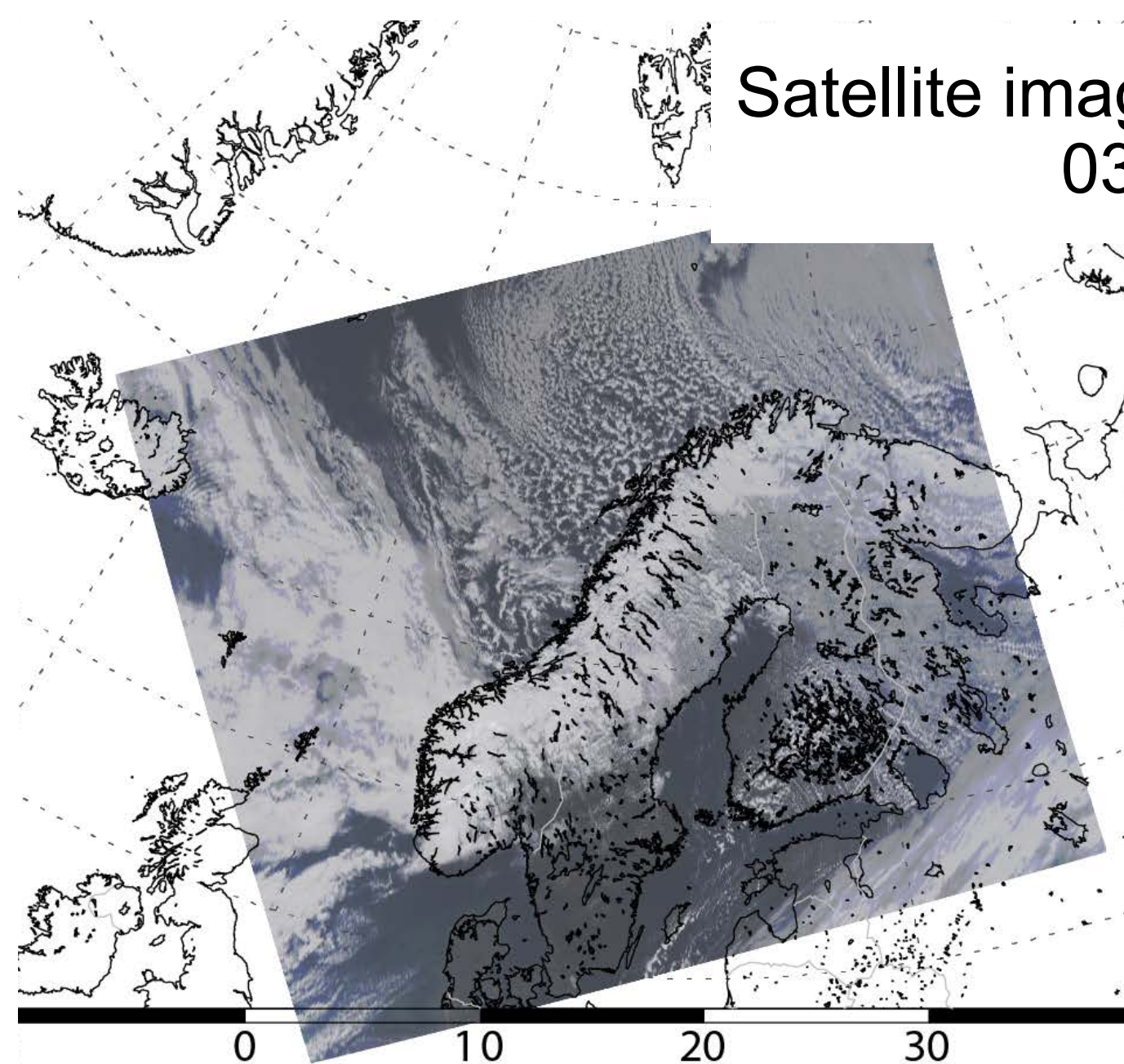


MODIS image  
(data source: <https://earthobservatory.nasa.gov/>)



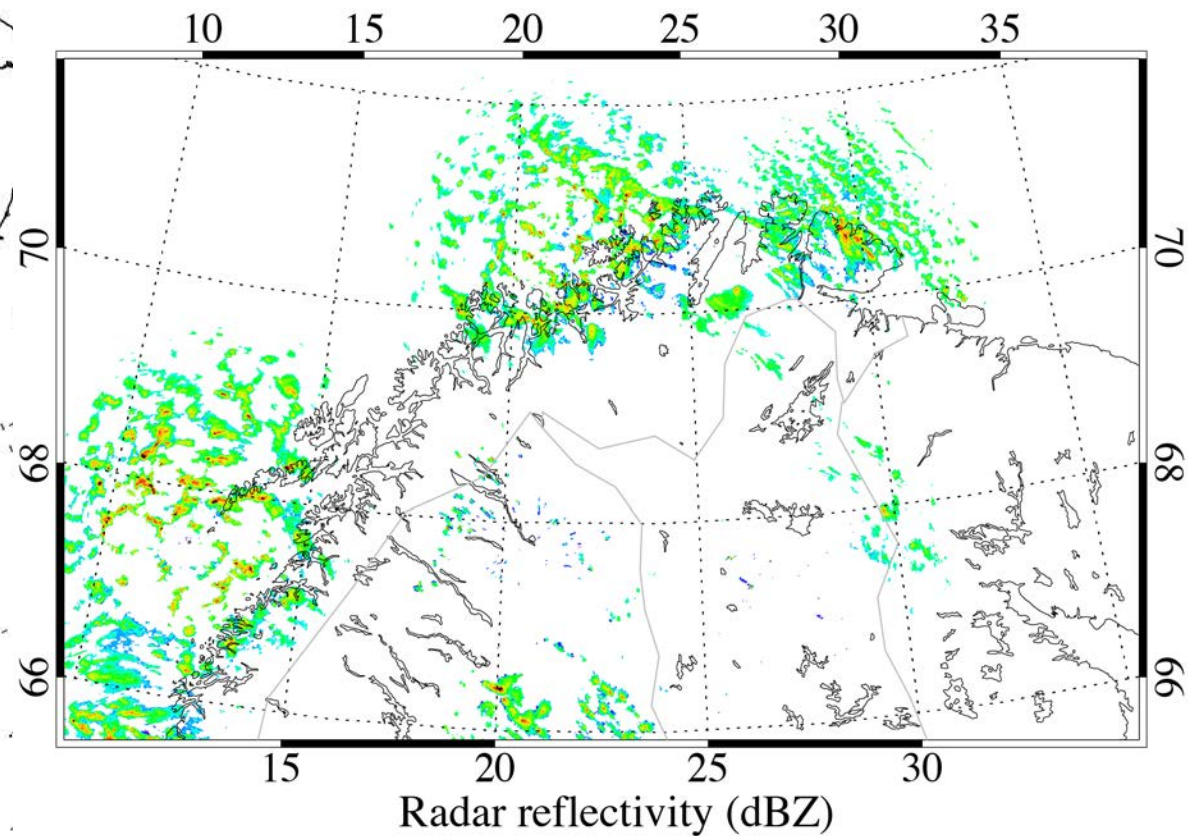
MET Norway radar mosaic  
(data source: <https://thredds.met.no>)

# Satellite imagery & radar mosaic reflectivity 03/29/2020 1125 UTC



MODIS image

(data source: <https://earthobservatory.nasa.gov/>)

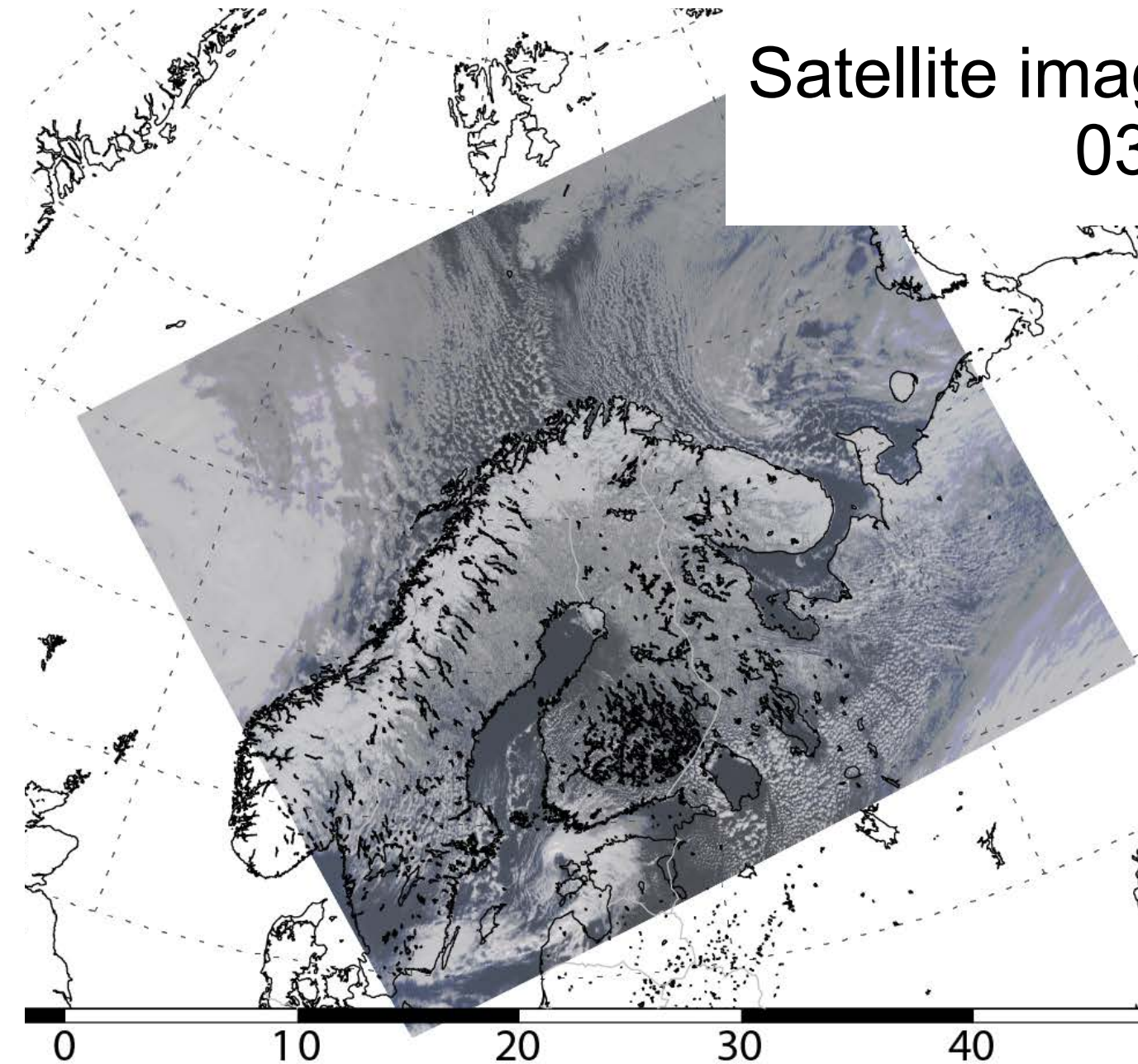


Radar reflectivity (dBZ)



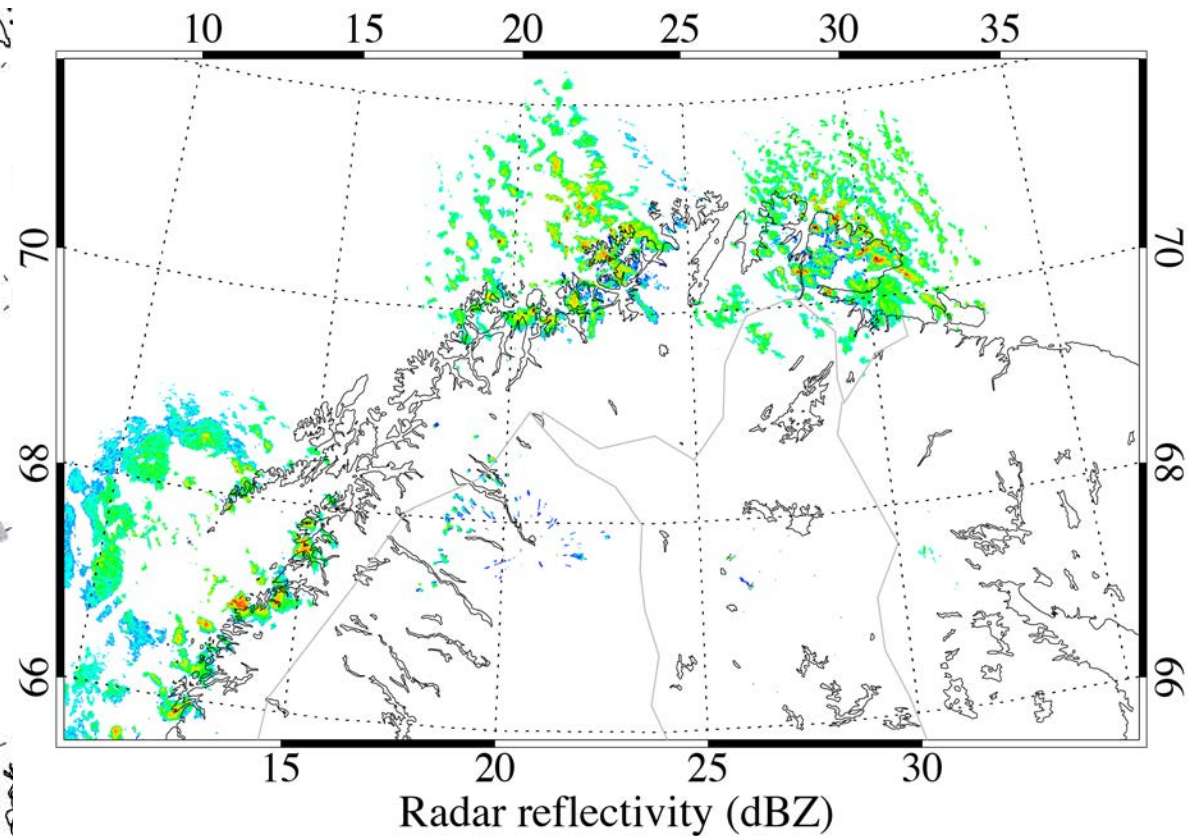
MET Norway radar mosaic  
(data source: <https://thredds.met.no>)

# Satellite imagery & radar mosaic reflectivity 03/30/2020 1030 UTC



MODIS image

(data source: <https://earthobservatory.nasa.gov/>)



MET Norway radar mosaic

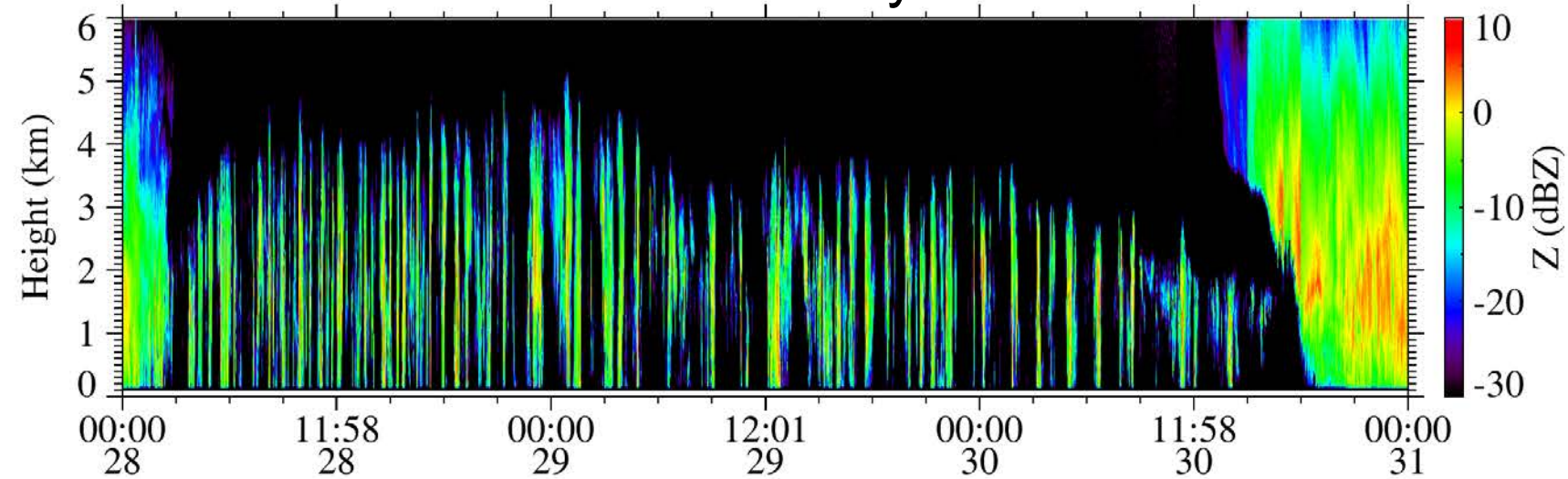
(data source: <https://thredds.met.no>)

# AMF1 instruments used for this study

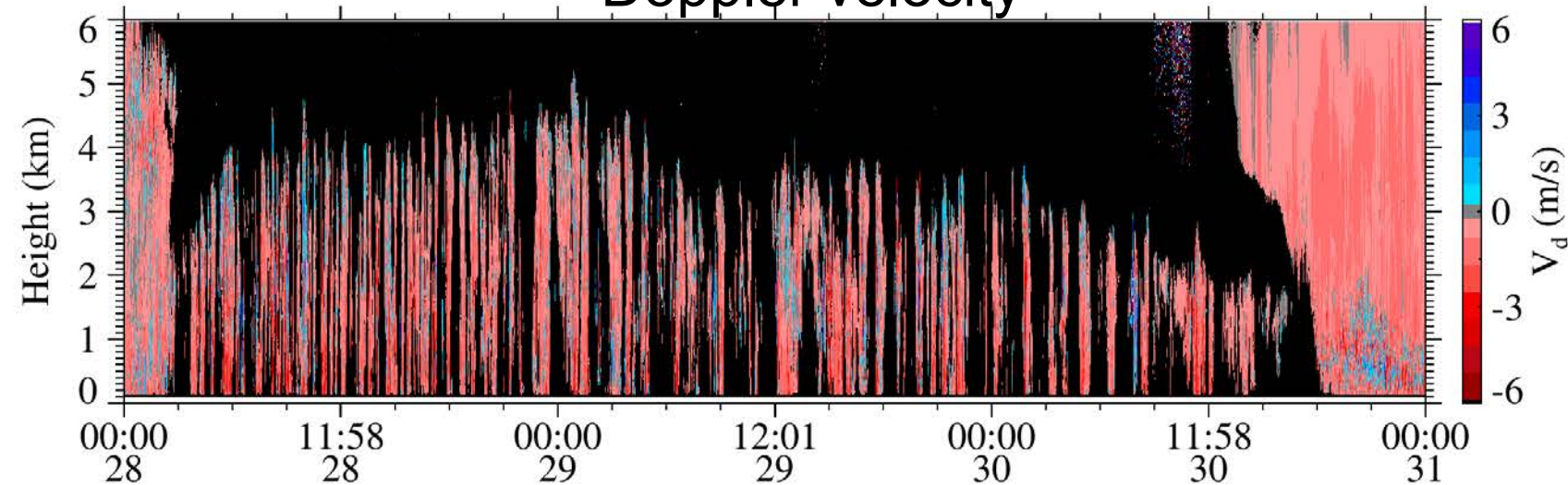
Acronym	Instrument	Observed and/or retrieved variables
KAZR	profiling cloud radar	Doppler velocity, reflectivity, echo top
MWR	passive microwave radiometer	liquid water path
CEIL	ceilometer	cloud base height
MET	1-minute surface station	surface horizontal wind speed and direction
INTERPSONDE	combination of SONDE, MWR and MET	temperature

# KAZR measurements: 03/28/20 - 03/30/20

reflectivity



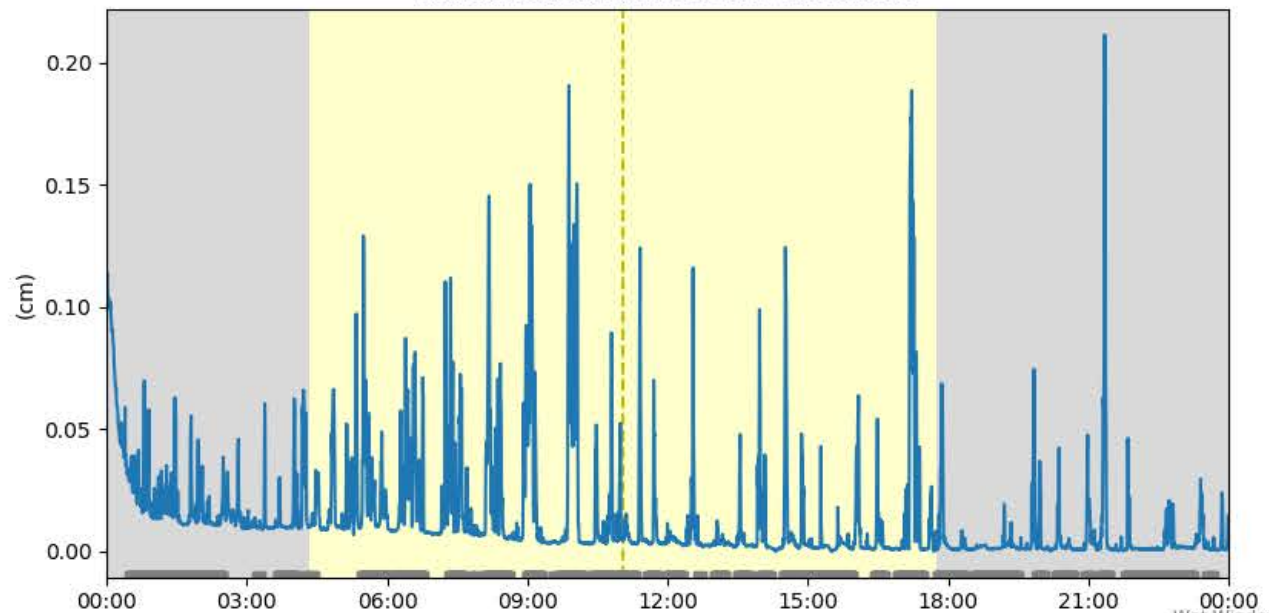
Doppler velocity



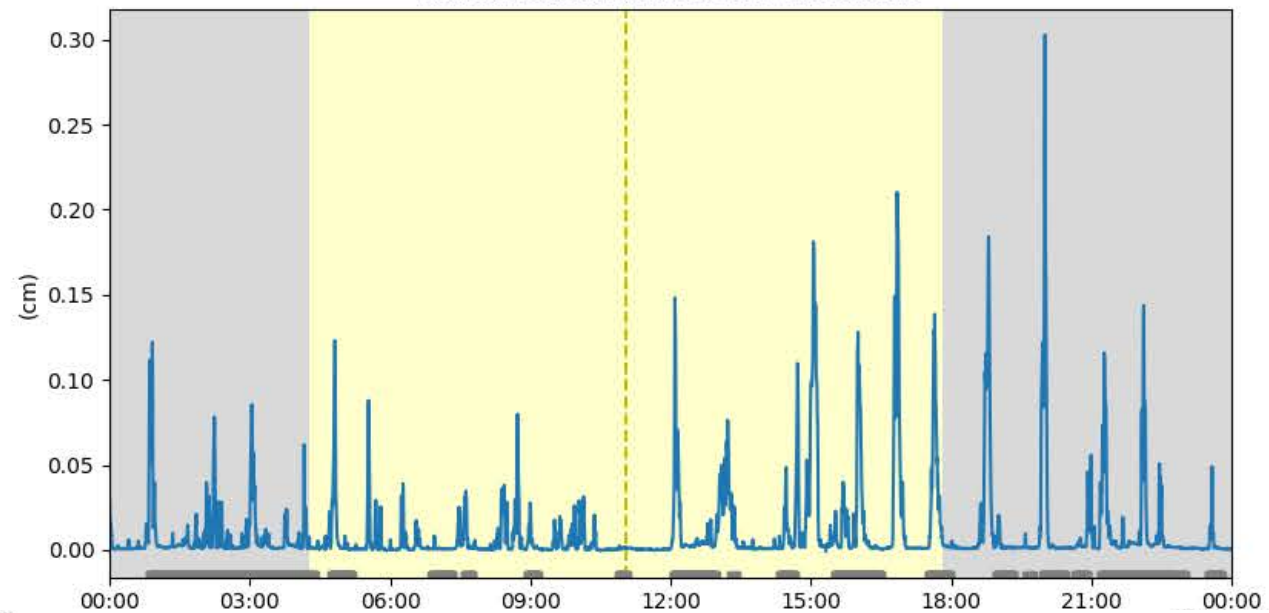
- long duration: ~ 58 hrs
- strong thermal instability
- relatively shallow convective clouds producing precipitation

# Evidence of liquid from MWR

ANXMWRLOSM1.B1 LWP for 20200328



ANXMWRLOSM1.B1 LWP for 20200329



ANXMWRLOSM1.B1 LWP for 20200330

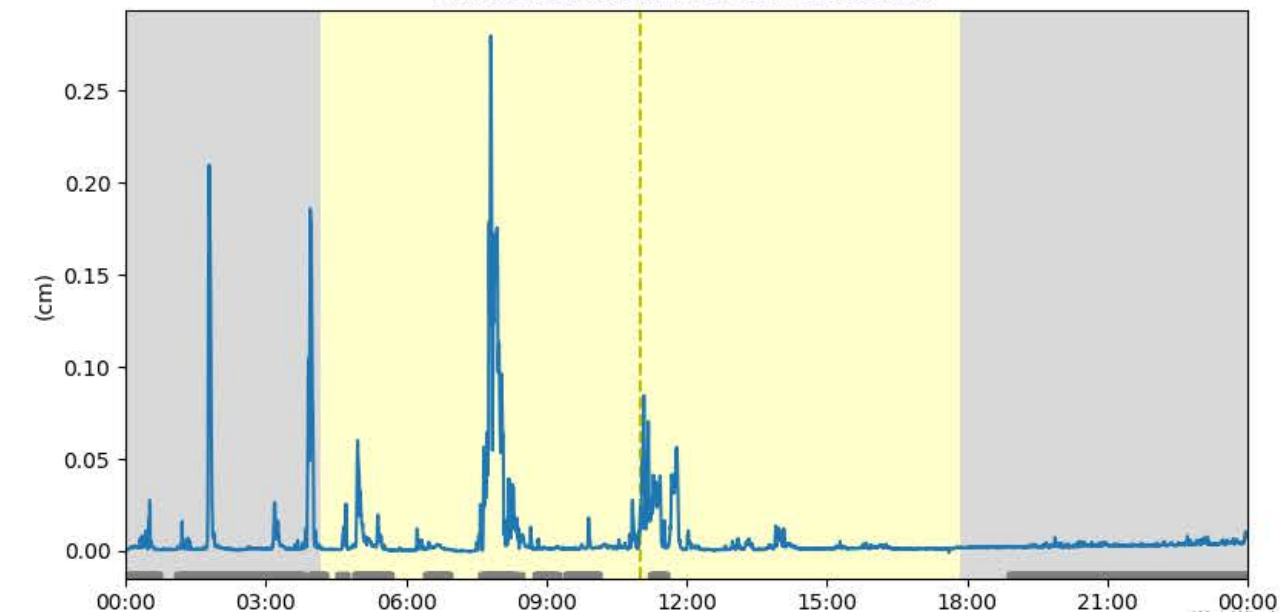


image source: <https://dq.arm.gov>

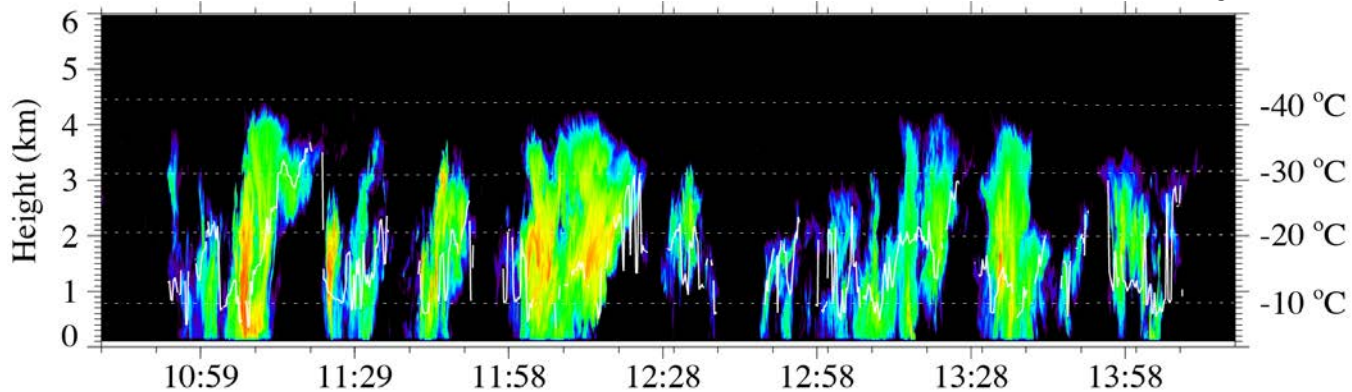
- measurable liquid water
- mixed-phase clouds



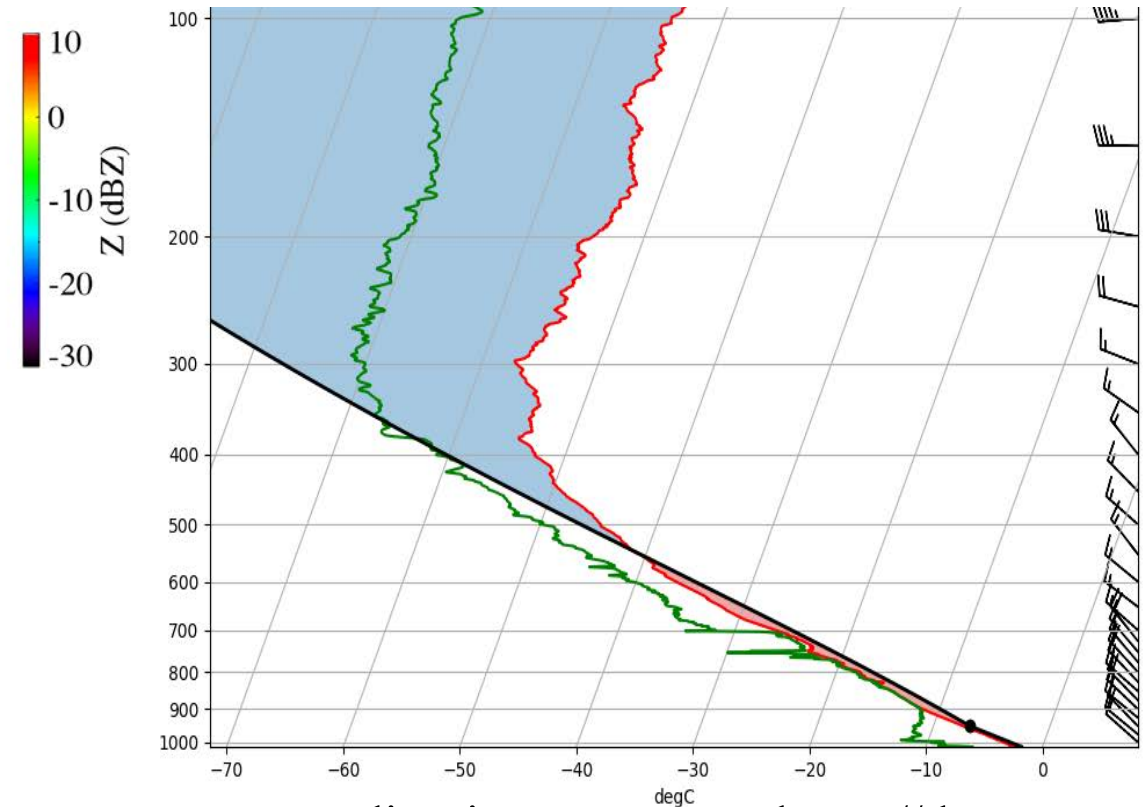
# A closer look: 03/28/20

white solid lines: CEIL cloud base  
white dotted line: INTERPSONDE T

reflectivity



03/28/2020 1123 UTC

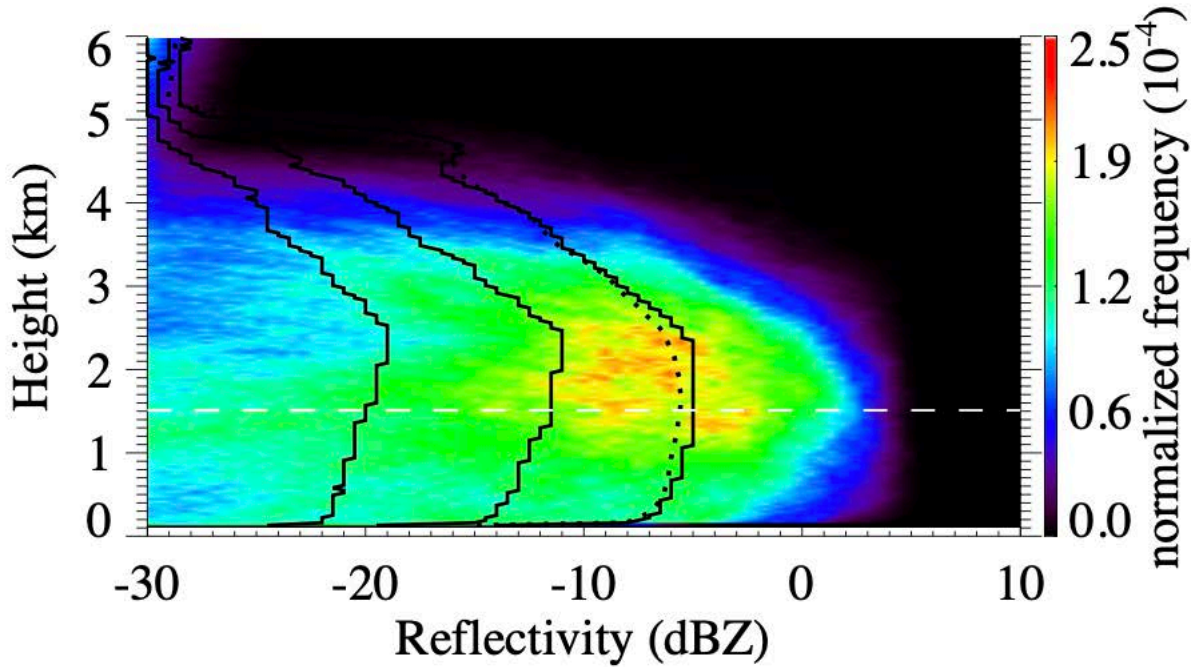


sounding image source: <https://dq.arm.gov>

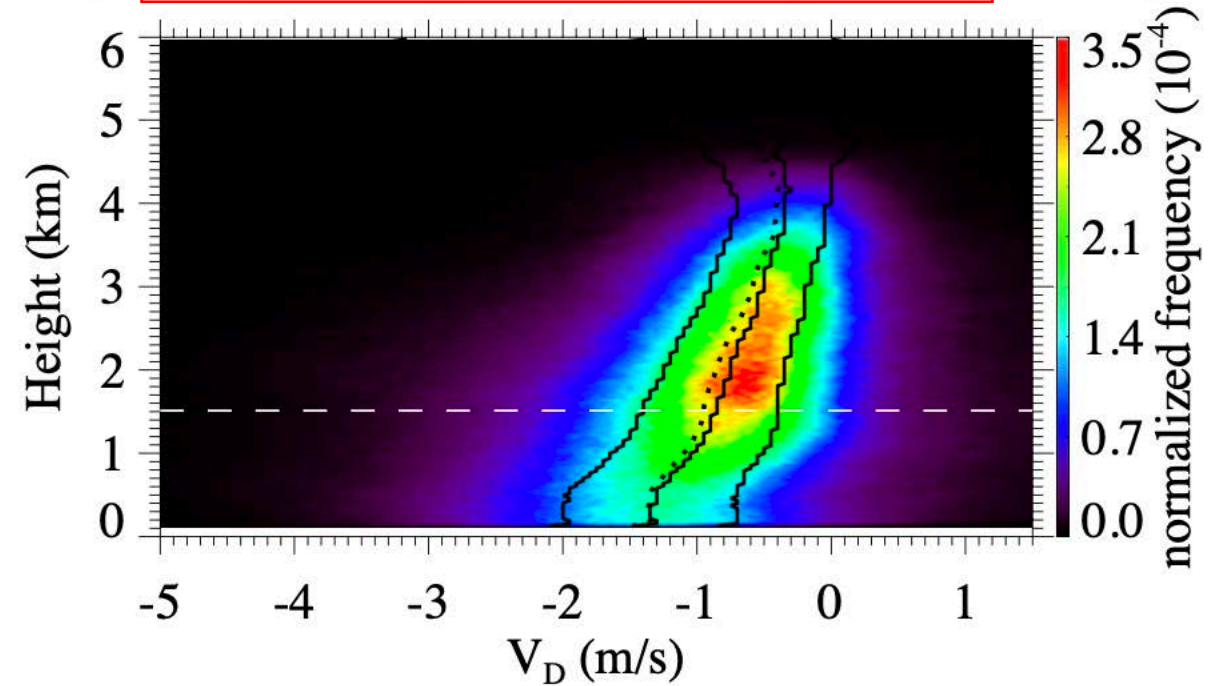
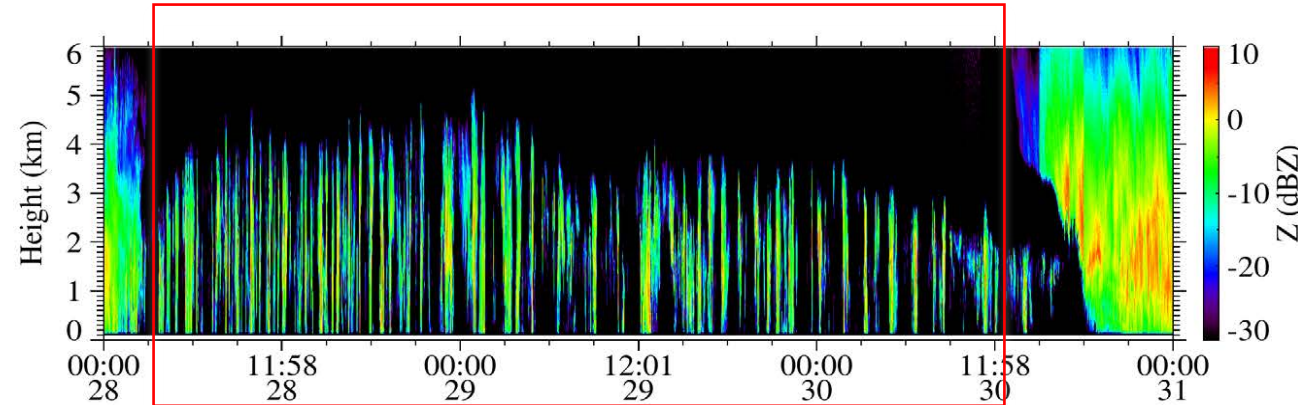
- cloud streets aligned with the low-level wind direction
- cloud top temperature: -30 to -40 °C
- mean cloud base ~ 1.5 km

# Frequency-by-altitude diagrams (FADs)

black solid lines: 25%, 50%, and 75% quartiles  
black dotted line: mean  
white dashed line: cloud base



- reflectivity decreases with height within cloud layer

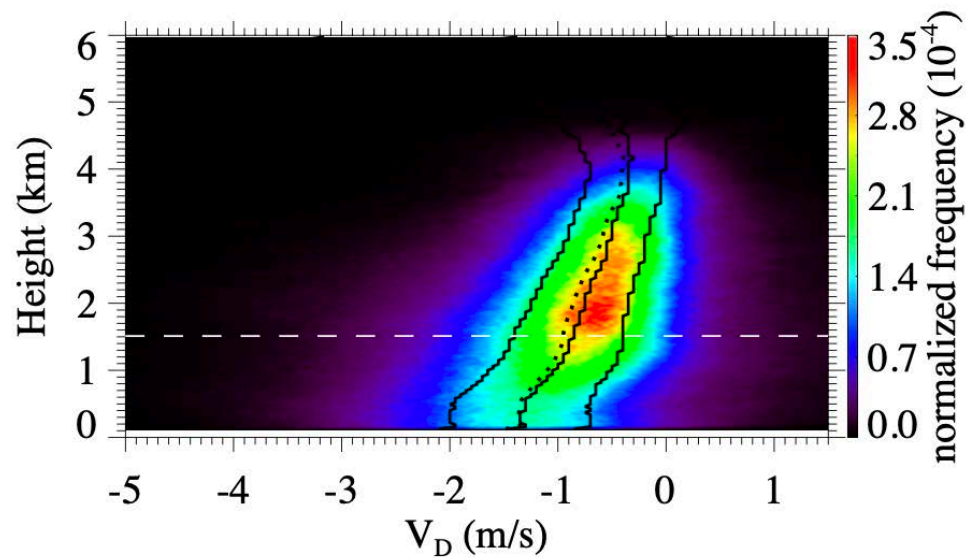
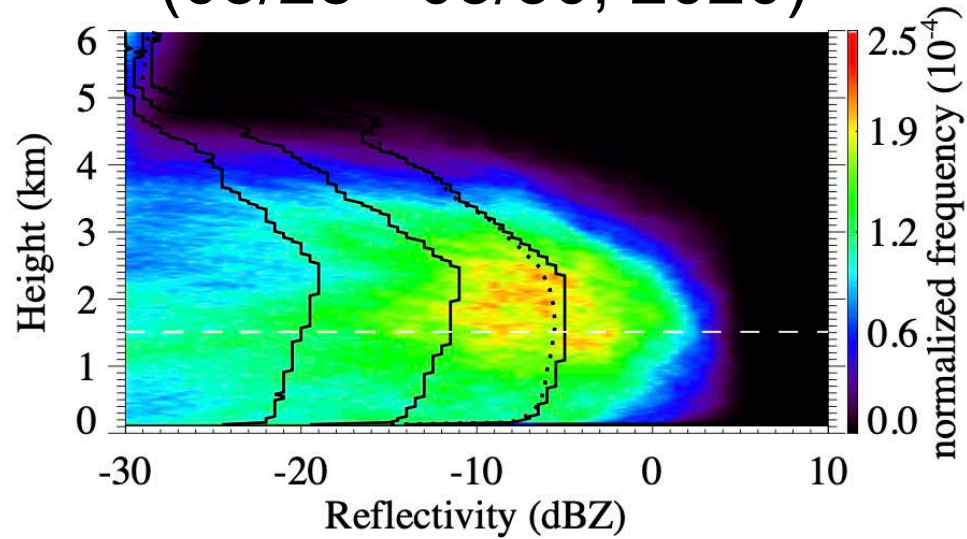


- $V_D$  shows fluctuations over about -3.5 to +0.9 m/s

# Comparison of CAO cases: COMBLE vs. NSA

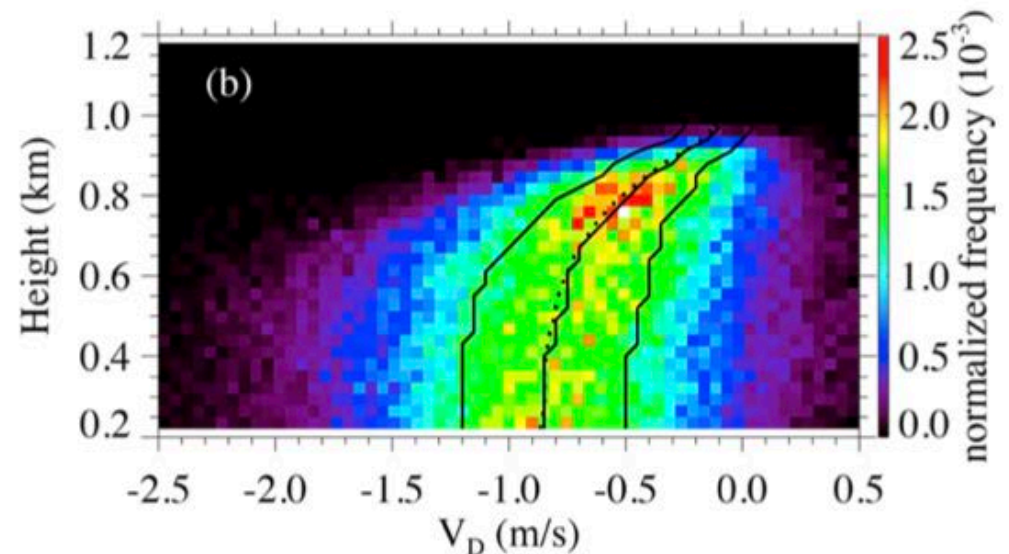
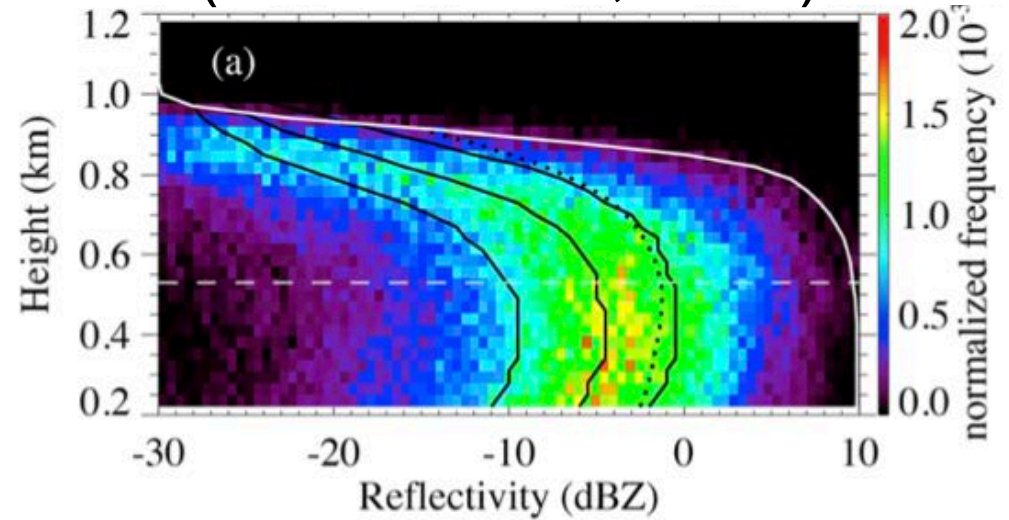
## COMBLE

(03/28 - 03/30, 2020)



## NSA

(10/26 - 10/27, 2011)



Questions?