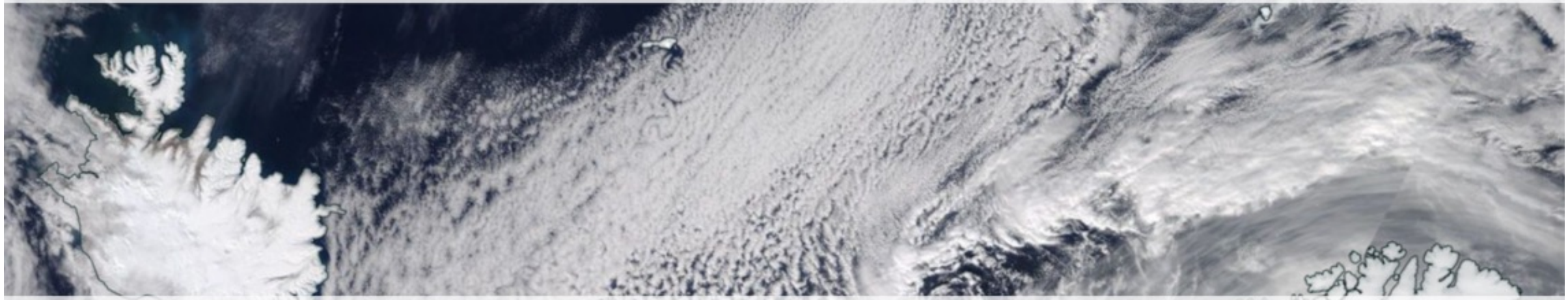
Observational Constraints for Marine Cold—Air Outbreaks during COMBLE



Florian Tornow (Columbia University and NASA GISS) and others

Presented during Breakout: “The COMBLE LES/SCM Model-Observation Intercomparison Project: First Results and Integration with the ARM Data Workbench”, ARM/ASR PI Meeting 2023, Rockville, MD

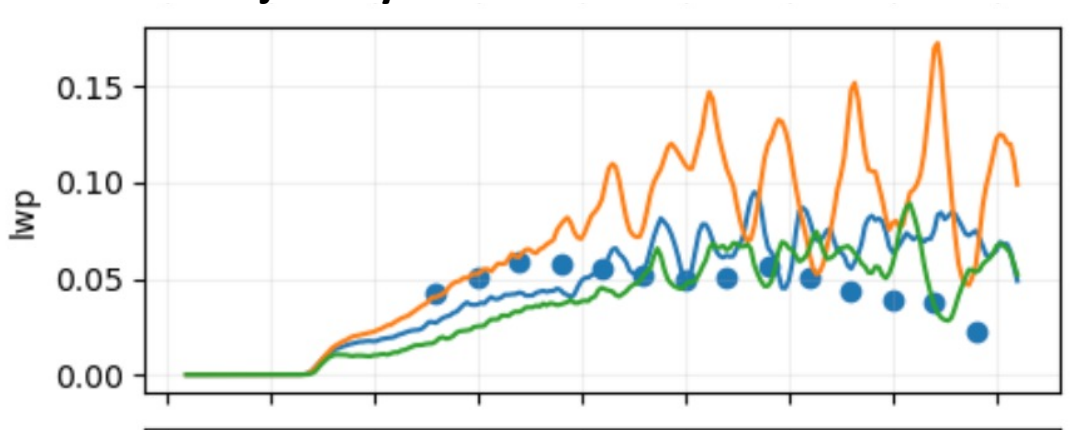
ASR
Atmospheric System Research

c/o NASA Worldview

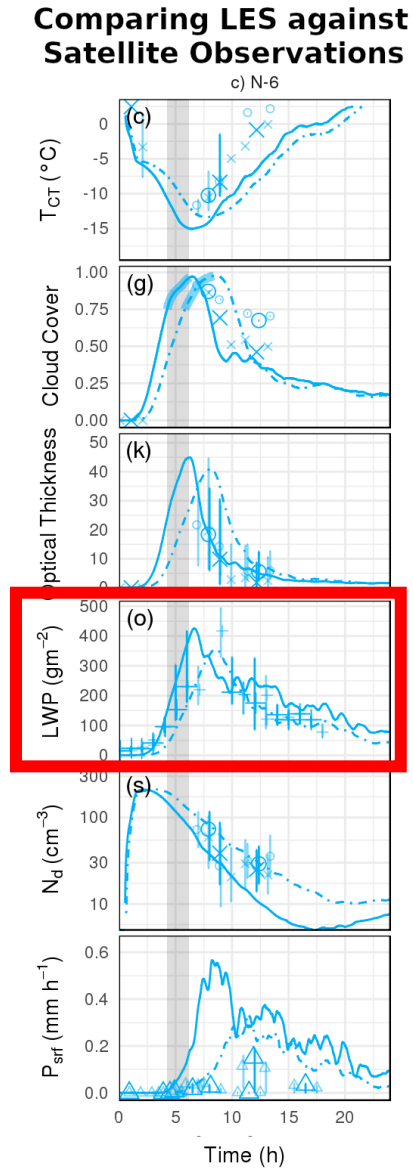
Observational Constraints - Satellite-based LWP

- based on low-frequency microwave radiometers that are blind to ice
  - about a dozen sensors on earth-orbiting platforms
  - MAC-LWP (Elsaesser et al., 2017) retrieval of total liquid water path (LWP), that is cloud plus rainwater paths largely independent of solar and viewing geometry
  - footprints of roughly (25 km)^2 collected over (100 km)^2 domains

MAC-LWP along a Lagrangian trajectory on 13 March 2020



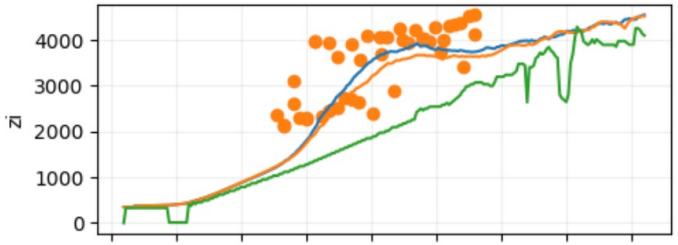
Example of MAC-LWP along a Lagrangian trajectory in Northwest Atlantic

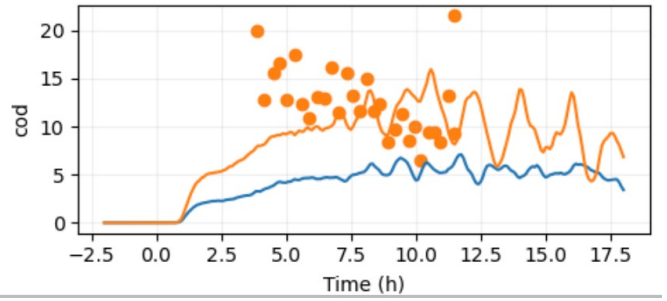


Observational Constraints - Imager-based Retrievals (1/2)

- based on multi-spectral imagers
  - several platforms carrying MODIS, VIIRS, and AVHRR, ~1 km pixel size
  - retrieval of cloud optical depth (COD), cloud-top effective radius (CER), cloud-top temperature (translated into altitude with auxiliary info)
  - derivation of additional products collected over (100 km)^2 domains
    - cloud cover as the number of pixels with COD above threshold
    - cloud droplet number concentration assuming certain sub-adiabaticity of liquid condensate
  - <u>for discussion:</u>
    - which other retrievals are reliable in mixed-phase conditions?
    - is the use of satellite forward simulator useful?

VIIRS-based retrievals along a Lagrangian trajectory on 13 March 2020, including ±1 hours window

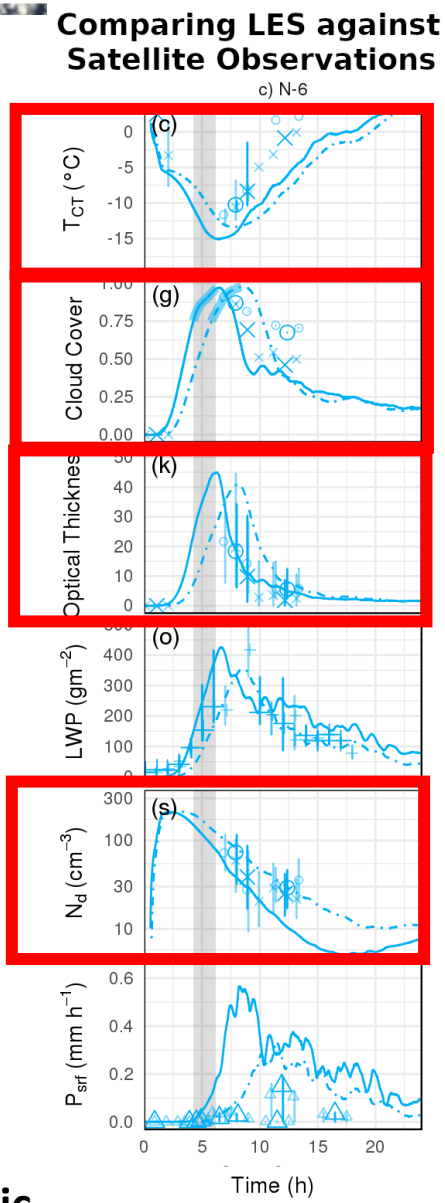




MIZ near Svalbard

Andenes, Norway

Comparing LES against Satellite Observations

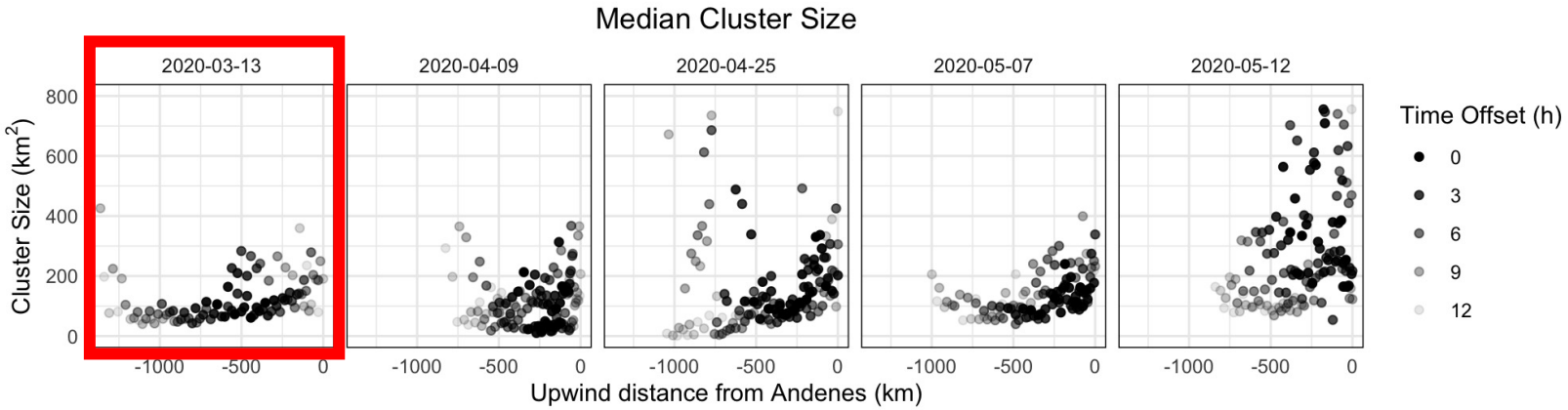


Example from Northwest Atlantic

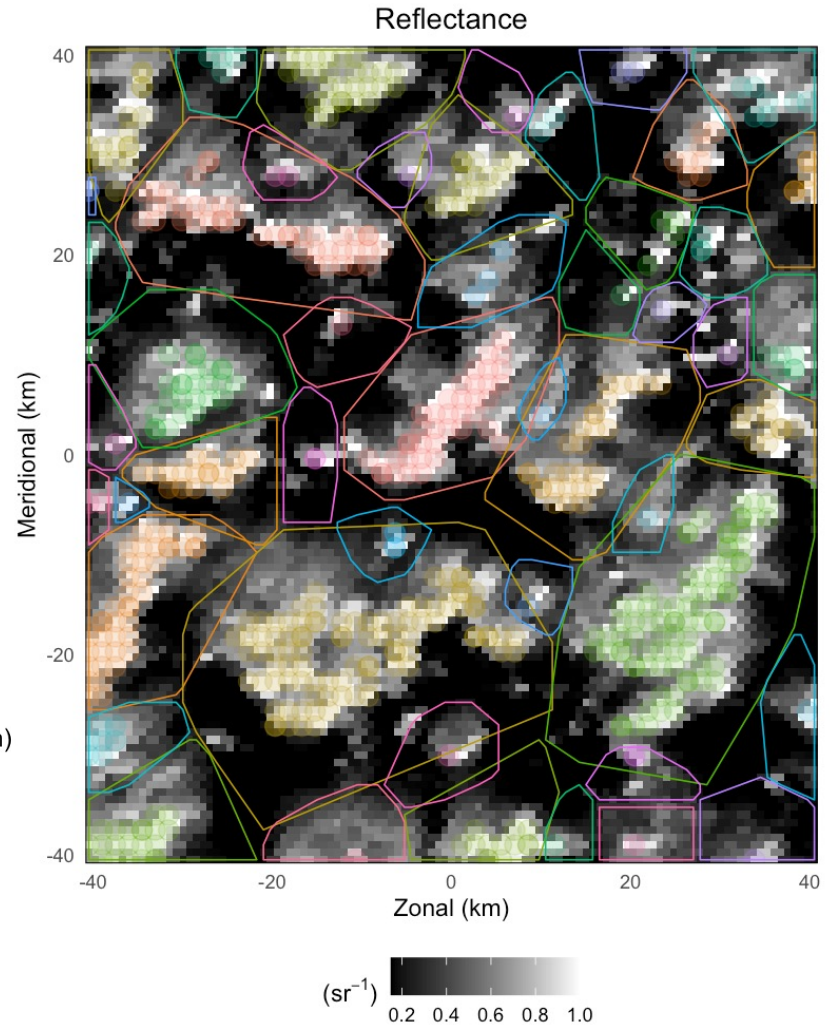
Instrument ◎ AVHRR + MAC-LWP △ IMERG × MODIS

Observational Constraints - Imager-based Retrievals (2/2)

- extracting cloud morphological information over (~100 km)^2 domain
  - application of simple watershed algorithm (Tornow et al, in prep.)
    - on brightest subset of cloud, iterate from brightest to dimmest pixel
    - using radiance or COD threshold to merge clusters
  - cell size, number, orientation (where elongated)
  - <u>for discussion:</u>
    - other metrics that should be extracted?



Median cluster size with downwind distance, extracted from a suite of COMBLE cases

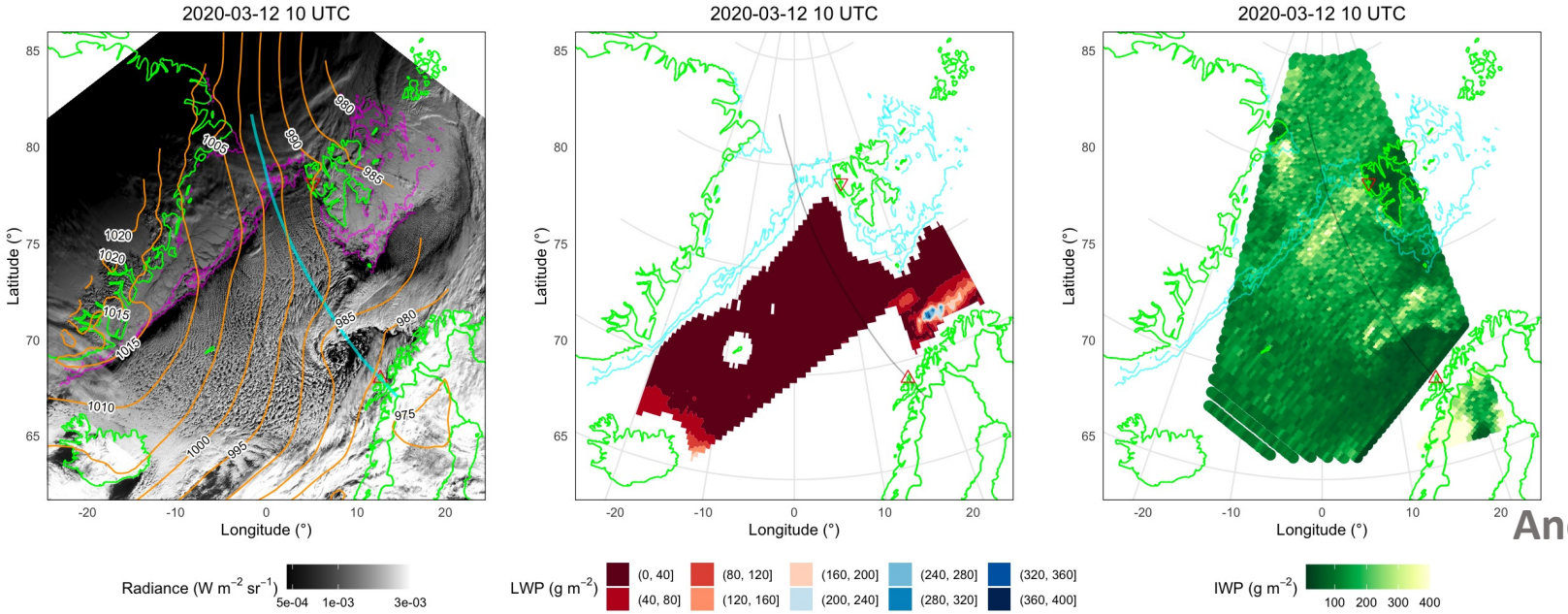


Clustering applied to snippet of VIIRS visible imagery

Observational Constraints - Satellite-based IWP

- based on microwave radiometers of greater frequency sensitive to frozen hydrometeors
  - several platforms on low-Earth-orbiting platforms
  - retrieval of ice water path (courtesy Jie Gong, NASA Goddard)
  - <u>for discussion</u>:
    - other products that should be considered?
    - use of satellite forward simulator useful?

MIZ near Svalbard

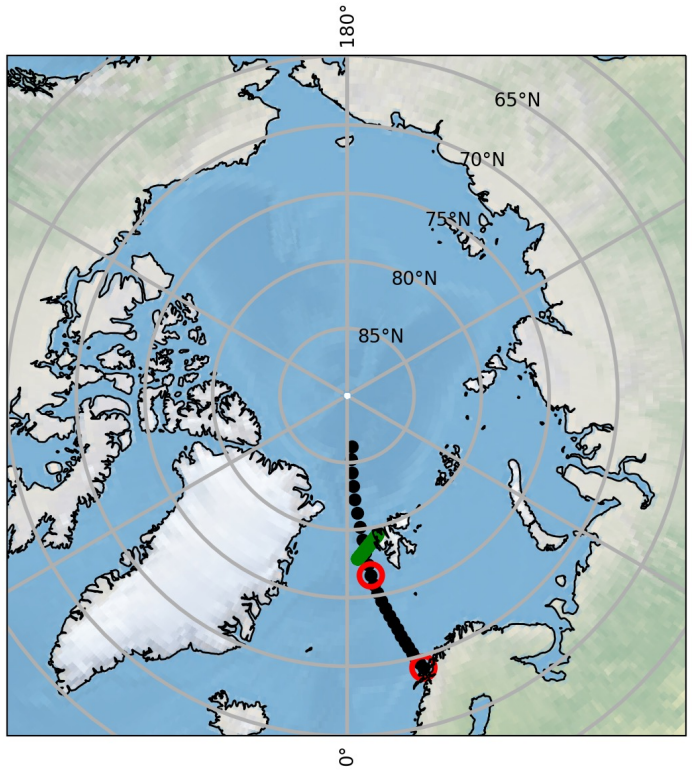


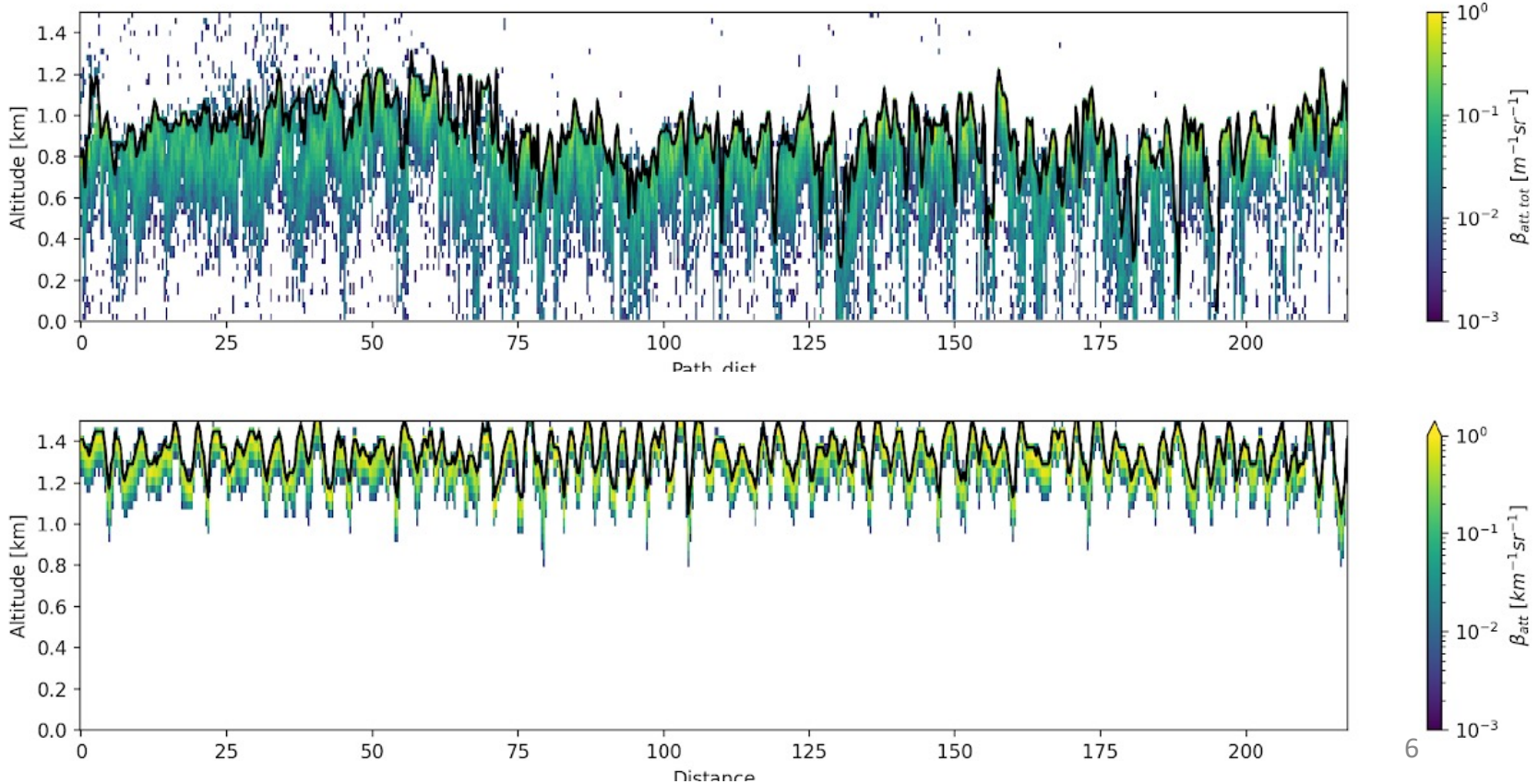
Example of IWP (right) along a Lagrangian trajectory on 13 March 2020

Andenes, Norway

Observational Constraints - CALIPSO vs. LES (Israel Silber, in prep.)

- use EMC^2 (Silber et al. GMD 2022) to evaluate LES vs CALIPSO satellite
- LES clouds too deep + dense





Observational Constraints - CALIPSO vs. LES (Israel Silber, in prep.)

- use EMC² (Silber et al. GMD 2022) to evaluate LES vs ground-based radar + lidar