Profiling radars and precipitation imagers: What GV can do for YOU

Claire Pettersen

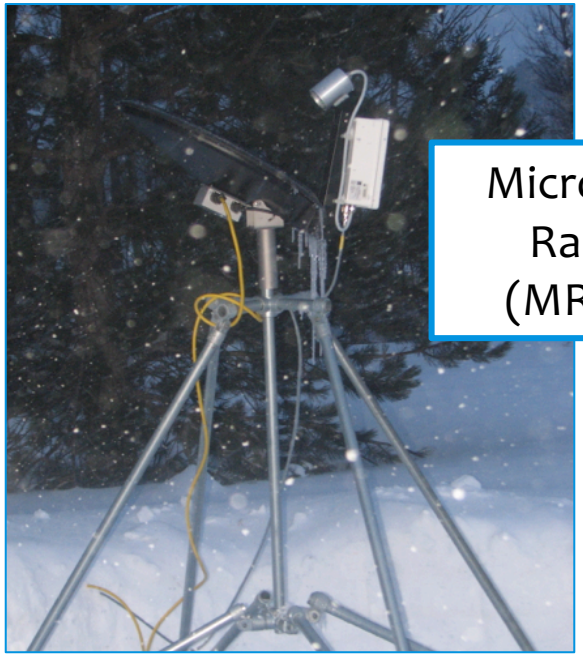
Contributors: Dave Hudak, Christopher Kidd, Stefan Kneifel, Mark Kulie, Jim Mather, Dmitri Moisseev, Annakaisa Von Lerber, Dave Wolff, Norm Wood

Nov 6, 2019

NASA PMM Science Team Meeting

Instrumentation: MRR and PIP

* 24 GHz Frequency Modulated Continuous Wave Radar
* Height range 3000 m/100 m bin
* Optimize for snow using Maahn *et al.*, (AMT 2012)



MicroRain Radar (MRR-2)

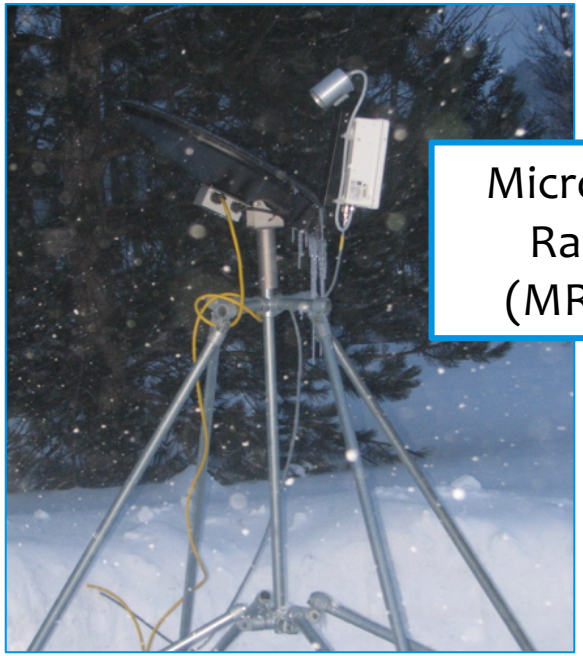
Particle Imaging Package (PIP)

* Camera and light coupled for imaging falling precipitation
* Captures ~400 images/second
* Saves one-minute videos during events
* Size distributions and fall speeds are processed in real-time on local machine

Instrumentation: MRR and PIP

* Useful tools for surface, near-surface, and profile information

Particle Imaging Package (PIP)



MicroRain Radar (MRR-2)

* Couple with ancillary ground-based observations, reanalysis, and models

GPM Ground Validation Campaigns

LPVEx - 2010

MC3E- 2011

GCPEx- 2012

IFloodS- 2013

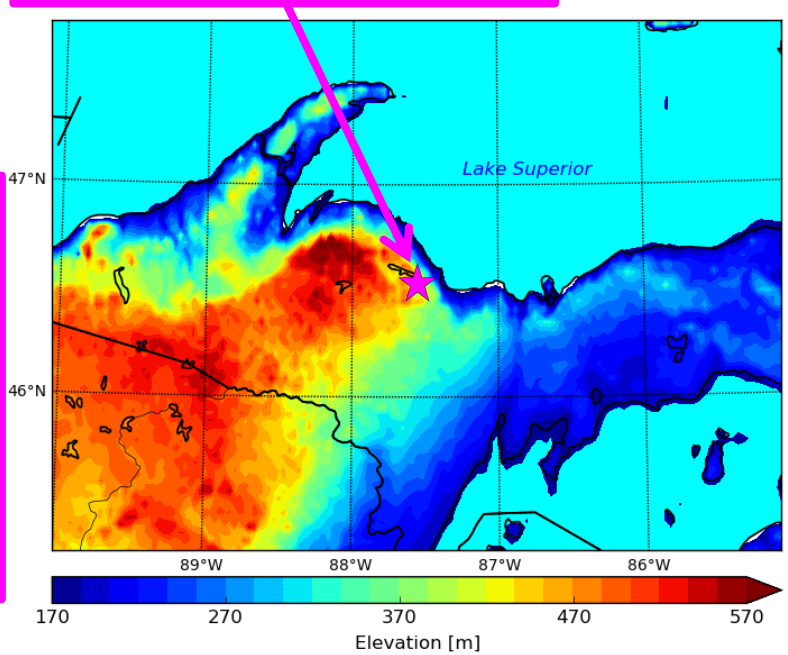
IPHEx- 2014

OLYMPEX- 2015

ICE-POP 2018

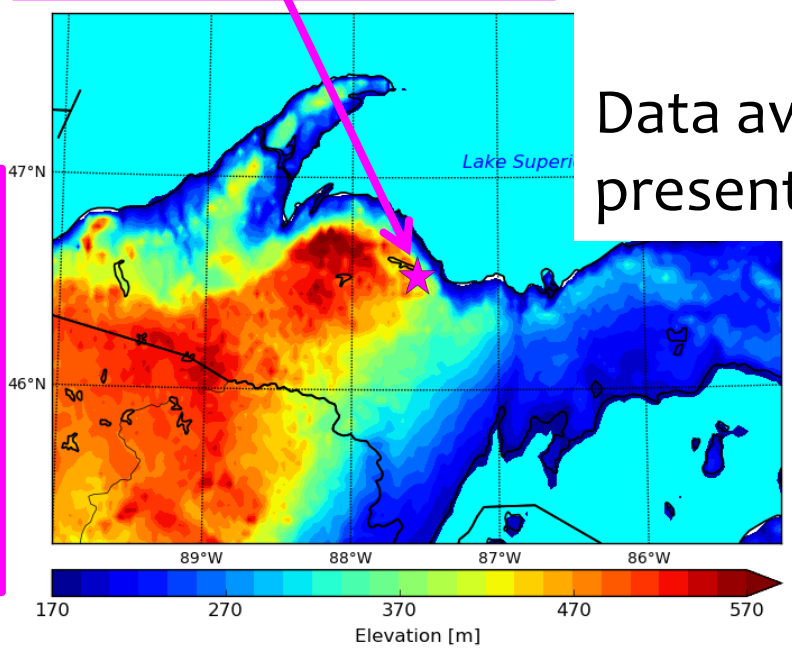
https://gpm-gv.gsfc.nasa.gov

Marquette, Michigan Site



Contact:
Mark Kulie
Claire Pettersen

Marquette, Michigan Site



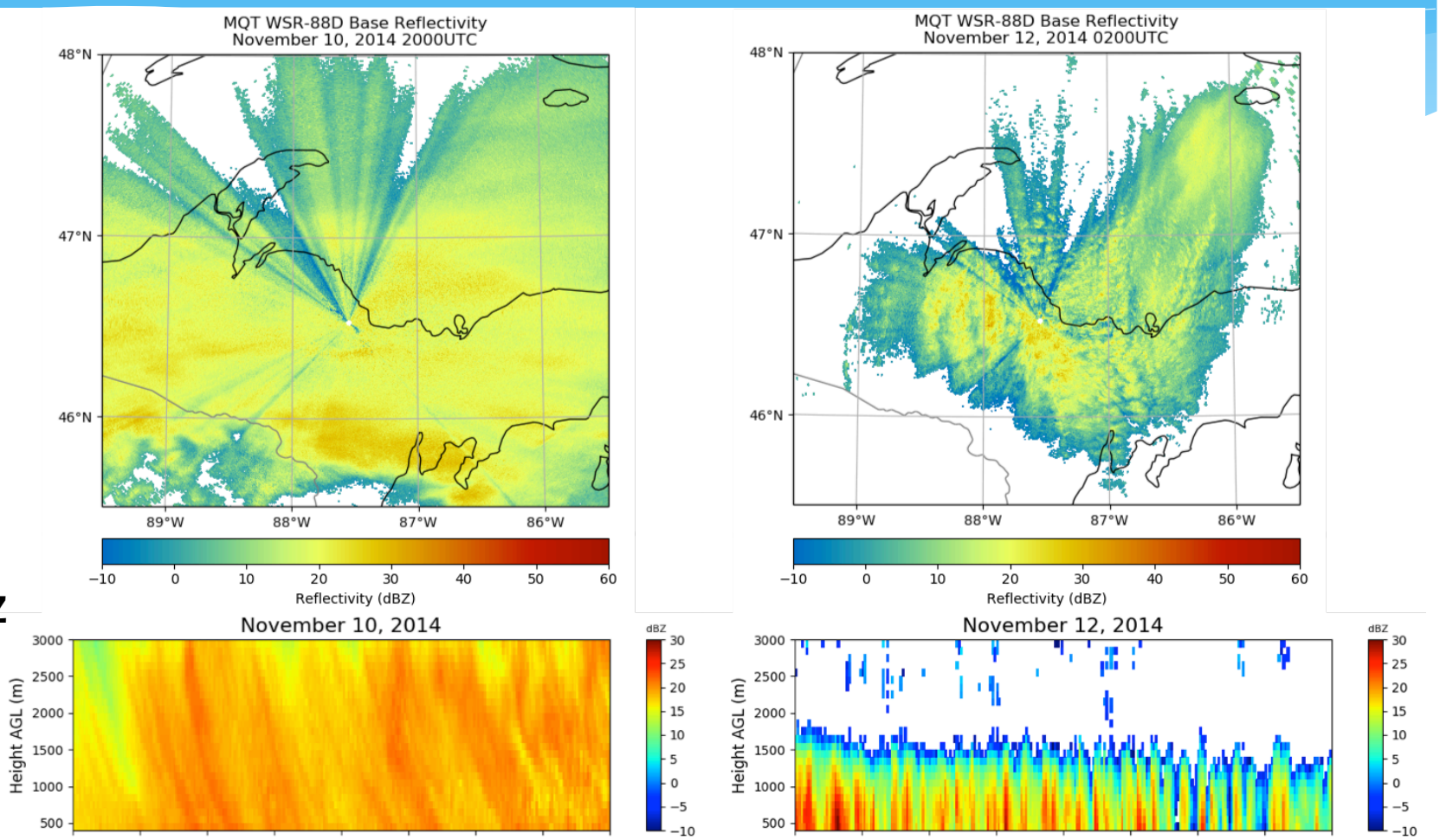
- WSR-88D
- Meteorological Observations
- Snow Field Measurements
- Parsivel and Pluvio

Data available 2014 – present

MRR-defined Snowfall "Modes" Deep vs. Shallow

NEXRAD L2 spatial context

MRR dBZ vertical context



Pettersen et al., JAMC, 2019; Kulie et al., PMM STM 2019

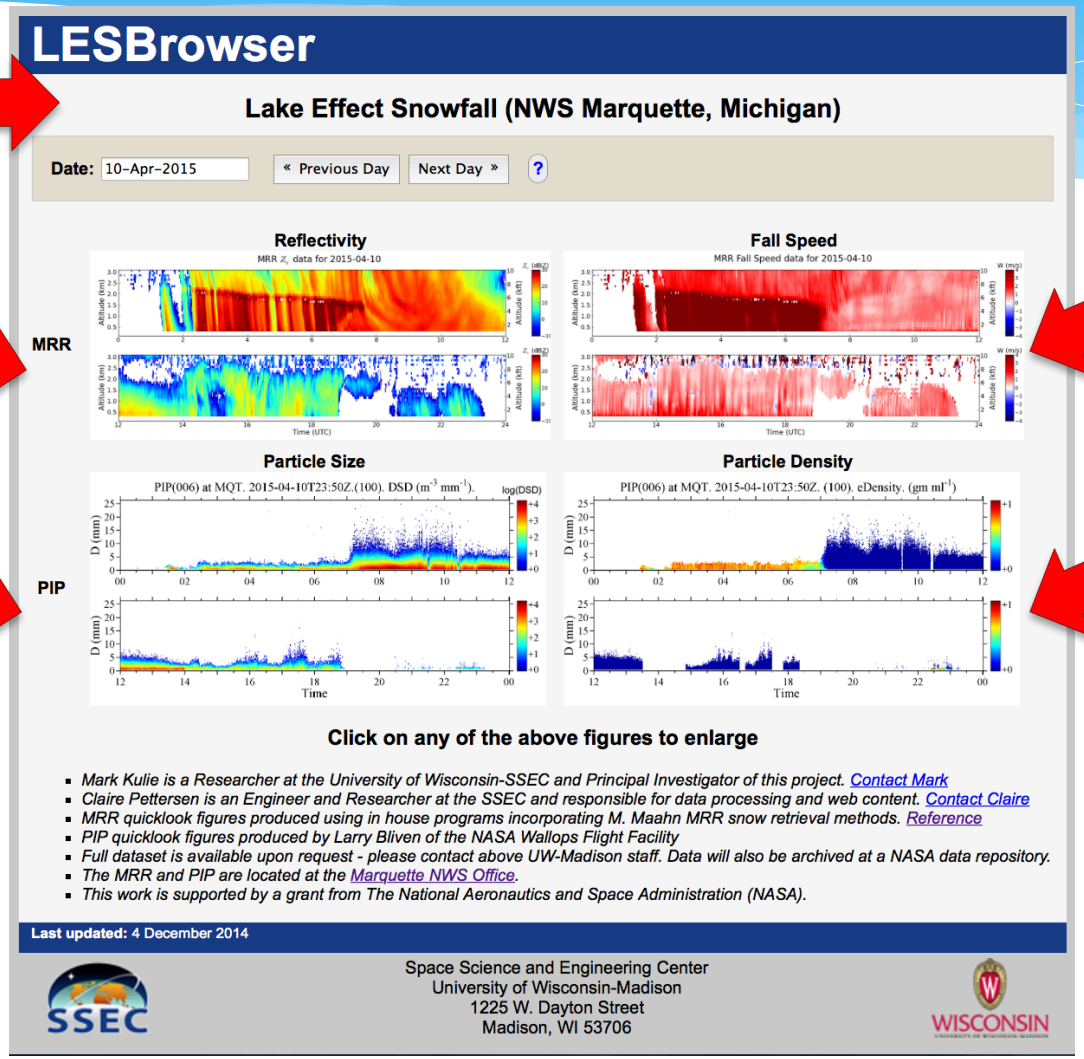
Data Processing: MQT Browser

http://www.ssec.wisc.edu/lake_effect/mqt/

5+ years of data from the site to easily access

Time/Height plot of MRR reflectivity

Time/Diameter plot of PIP particle concentration



Time/Height plot of MRR measured fall speeds

Time/Diameter plot of PIP particle densities

All data is pulled from site daily (0200UTC+1), processed, and uploaded to website

MRR "real time" capabilities are in development for operational use (processed MRR every 15 min)

Finland Sites

Contact:
Dmitri Moisseev

UH Hyytiälä Station
(61.84 N , 24.29 E)

FMI Ikaalinen weather radar
(61.77 N, 23.08 E)

- Radars: C/W bands, Ka-band (on campaign basis)
- Microwave radiometers 89 GHz and HATPRO
- Doppler lidar
- Precip. Sensors: PIP, 2DVD, 2x OTT Pluvio, 2x Parsivel, Snow depth sensor
- AWS and 3D anemometers

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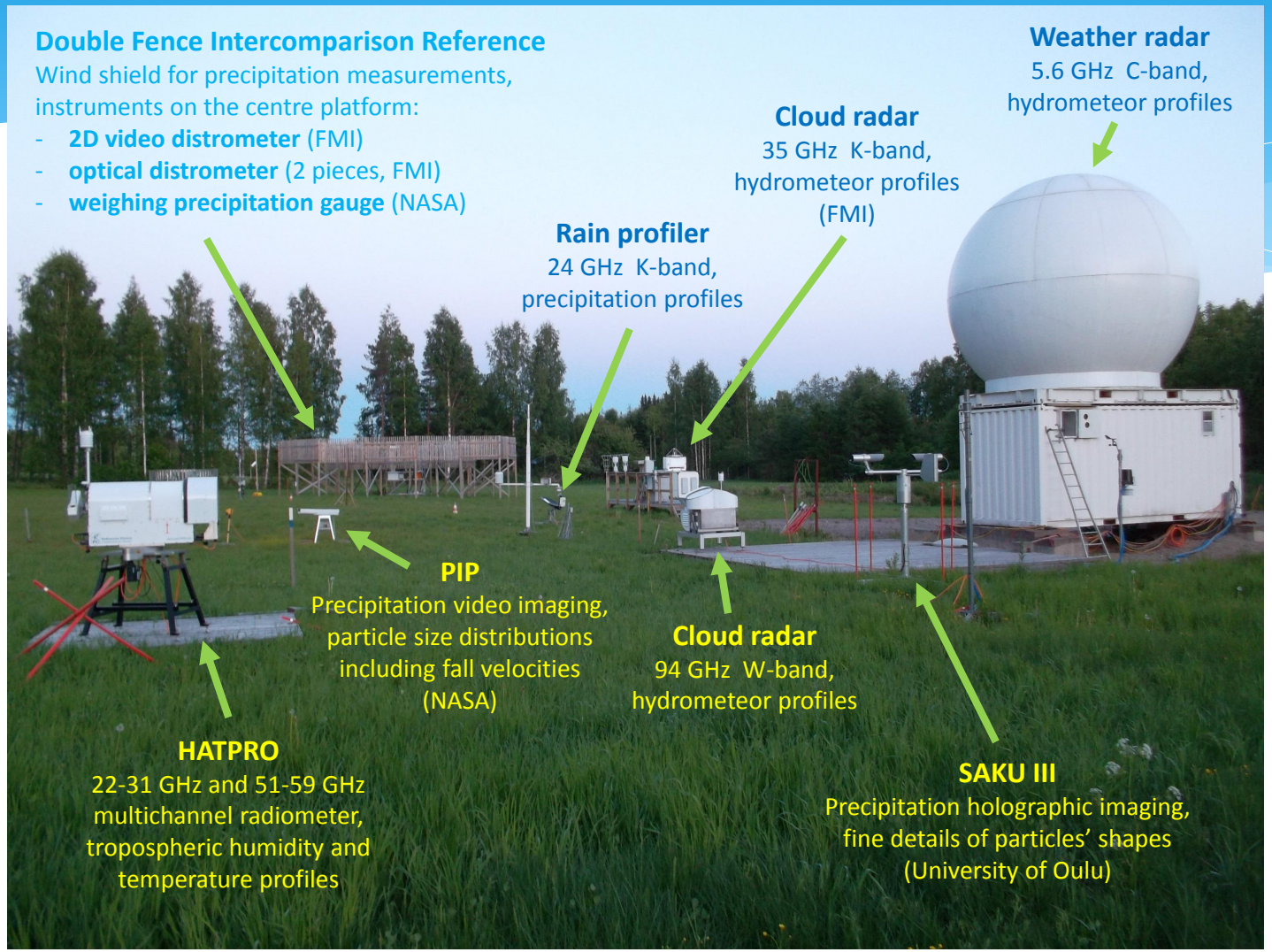
Finland Sites



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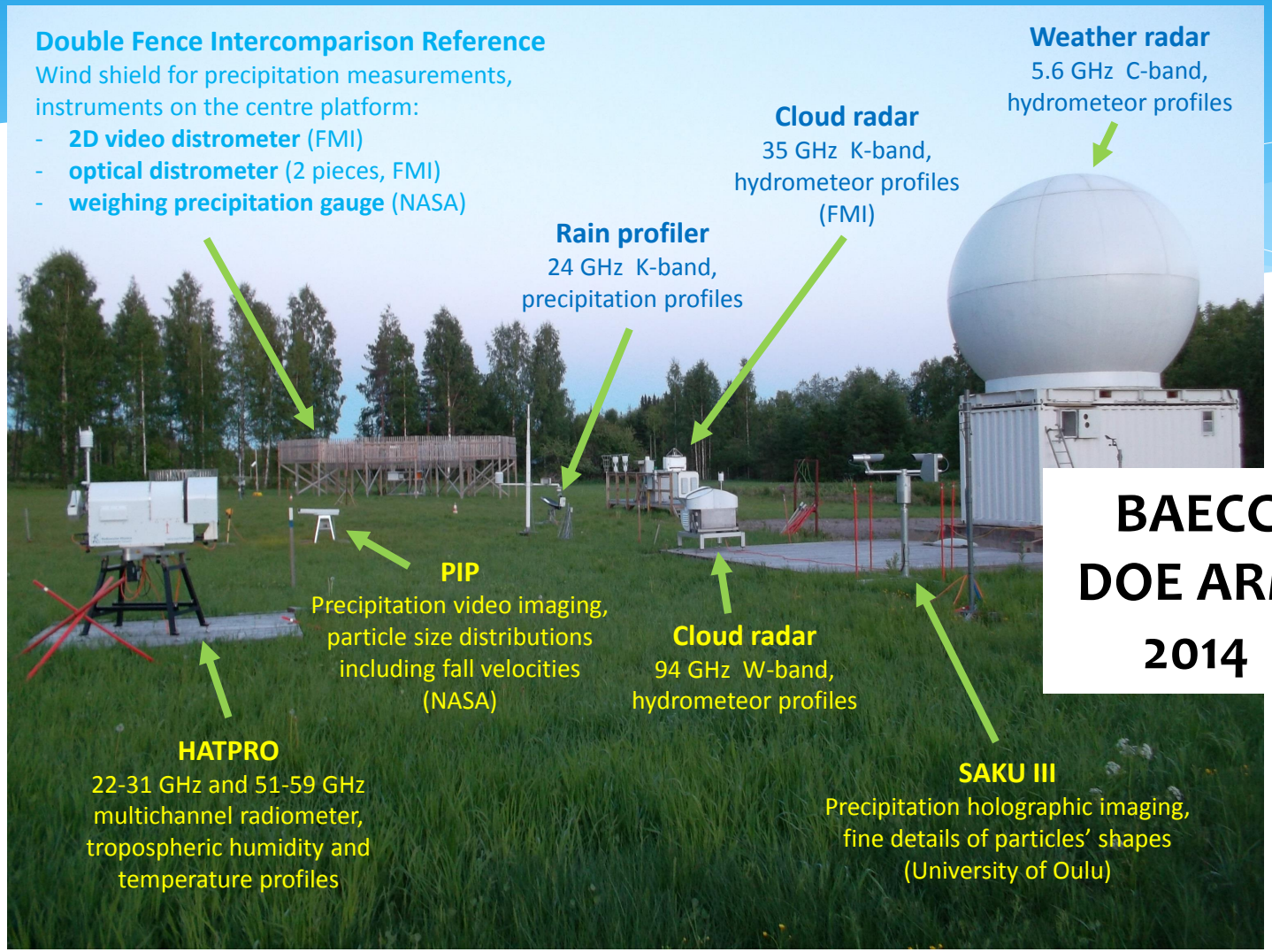

BAECC
DOE ARM
2014

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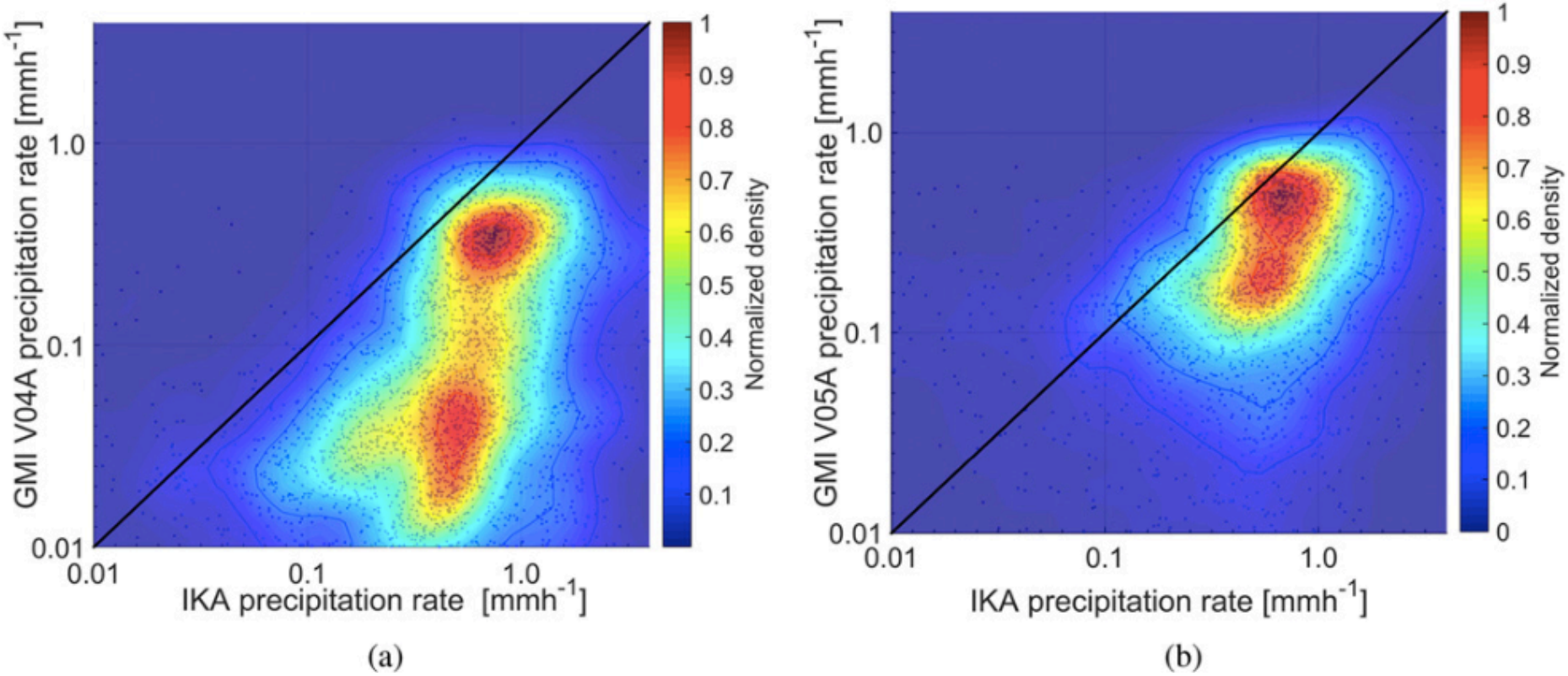
Finland Sites



Von Lerber et al., JAMC, 2018

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Environment Canada Sites

Contact: Dave Hudak

CARE

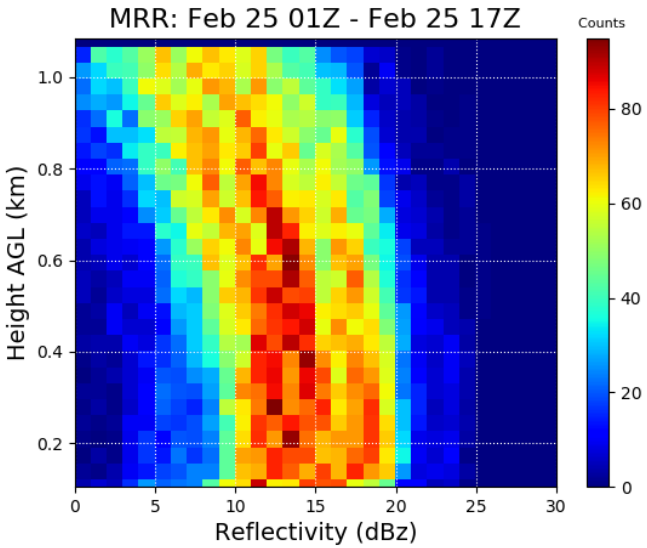
- ❖ MRR-2
- ❖ PIP
- ❖ Parsivel
- ❖ King City Radar

- ❖ Double fence intercomparison reference
- ❖ WMO-SPICE

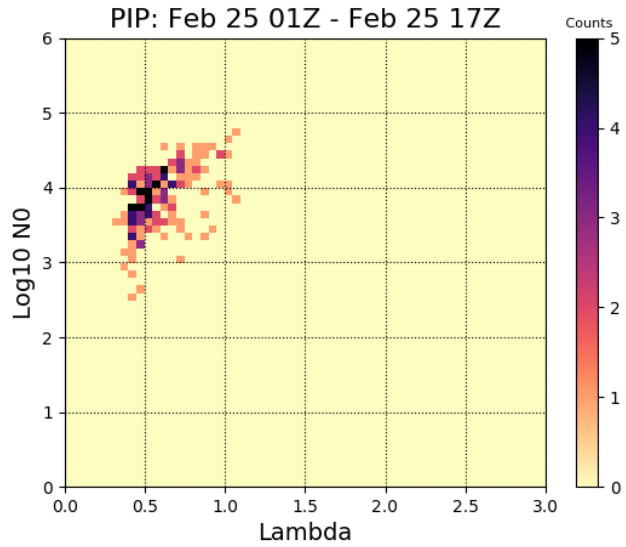
Data available 2006 – present

Environment Canada Sites

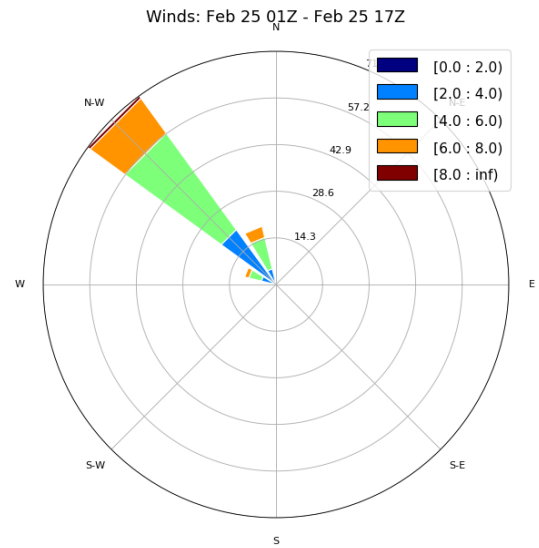
MRR



SVI (PIP)

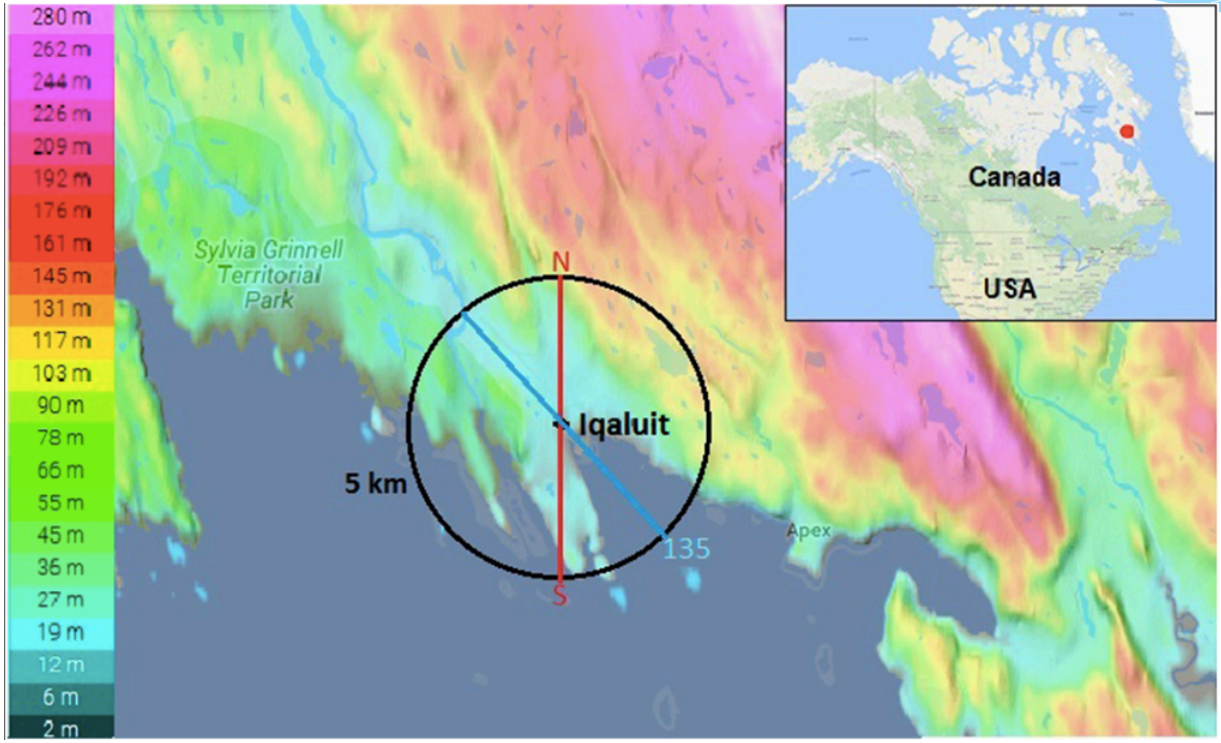


Winds



Wood and Pettersen, PMM STM, 2018

Environment Canada Sites

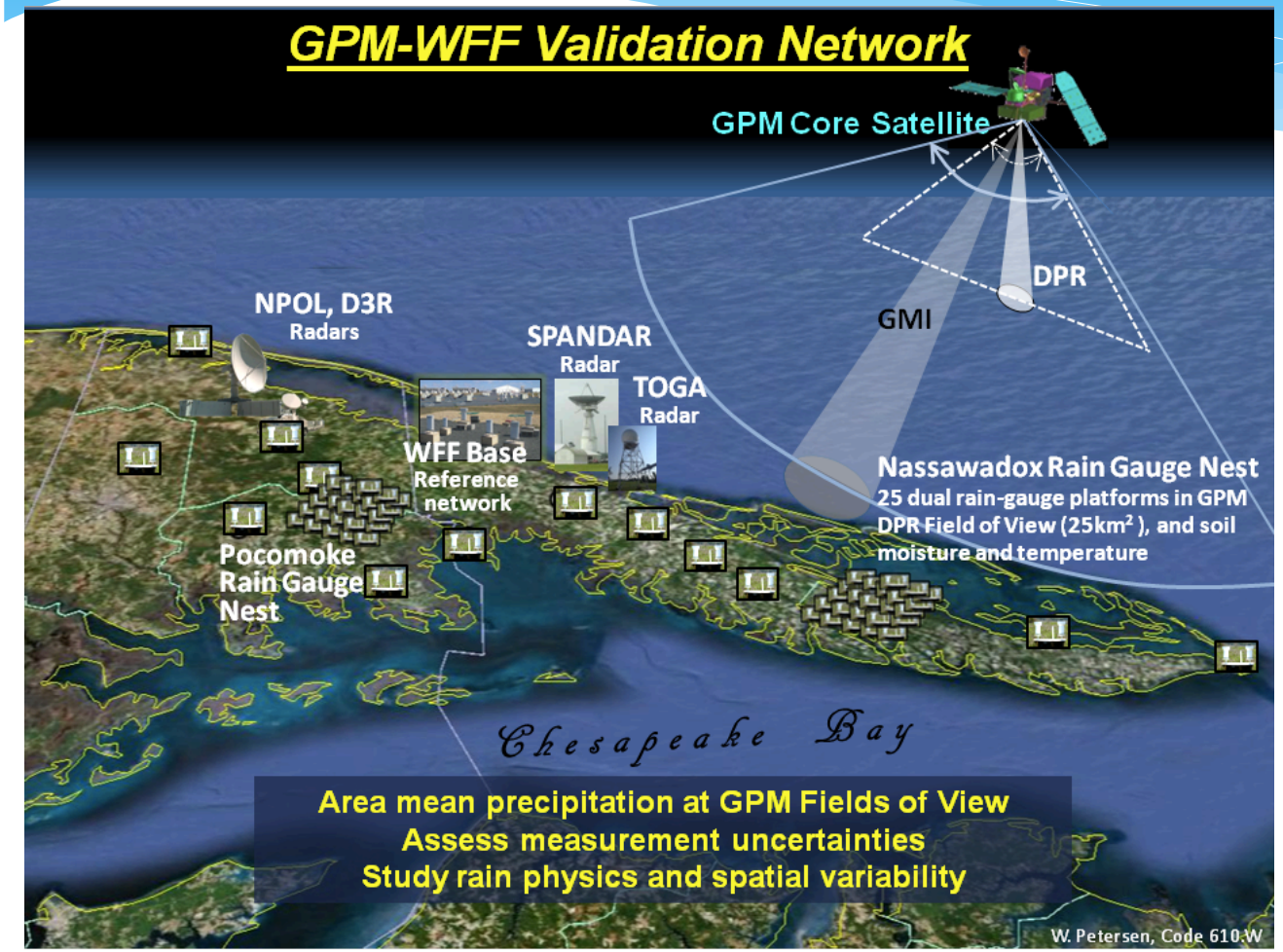


Iqaluit

- ❖ Ka-band scanning radar
- ❖ Parsivel
- ❖ Double fence intercomparison reference
- ❖ WMO-SPICE

Long-term dataset

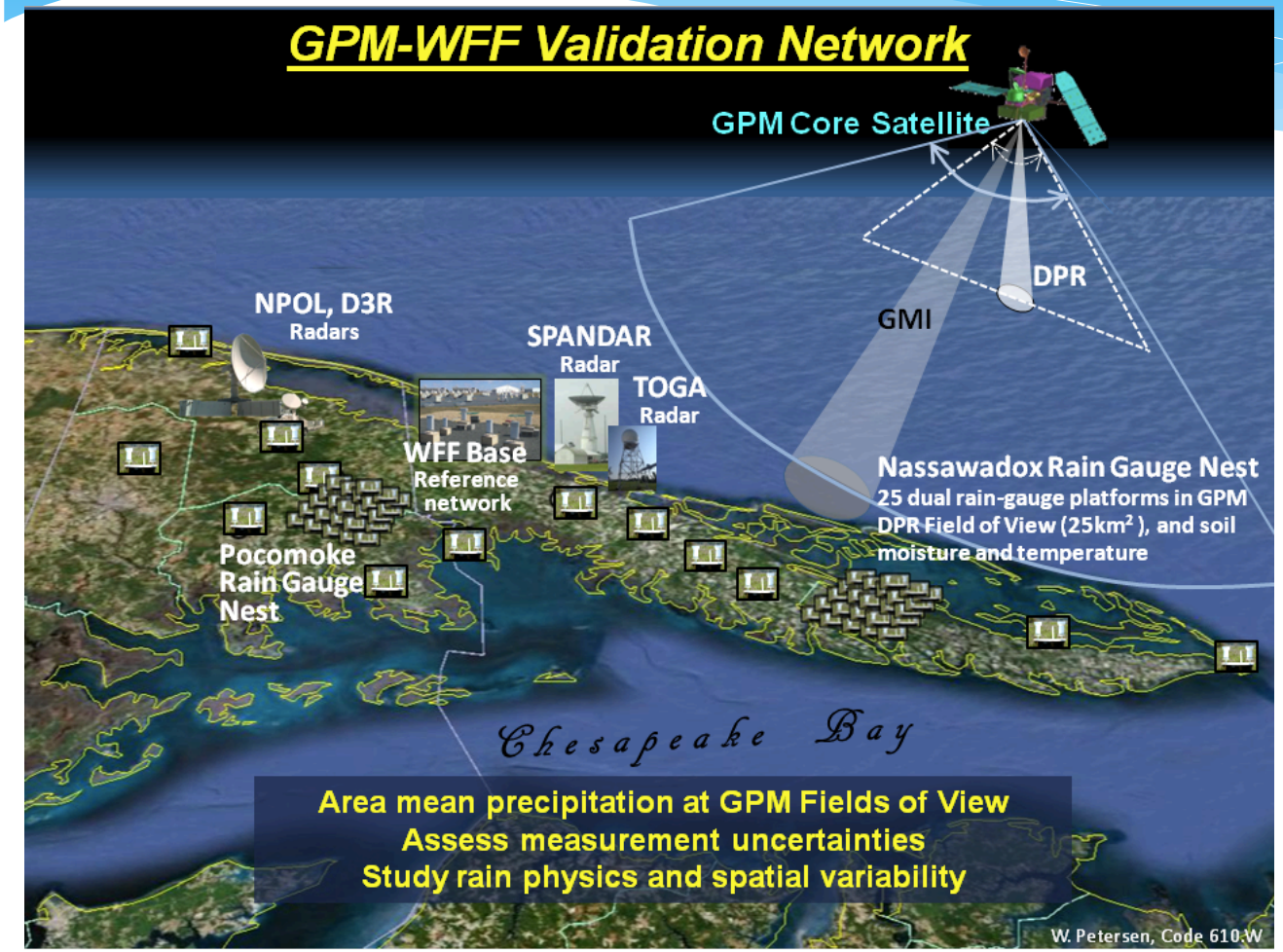
Wallops Facility



Contact:
Dave Wolff

- 2 MRR-2
- 1 MRR Pro
- 1 PIP

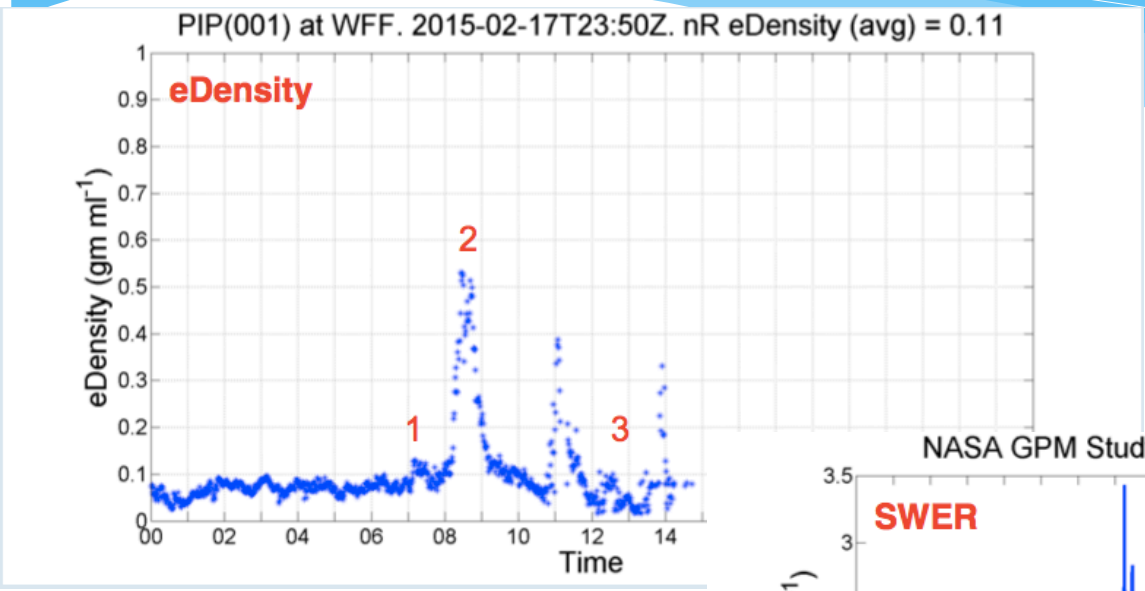
Wallops Facility



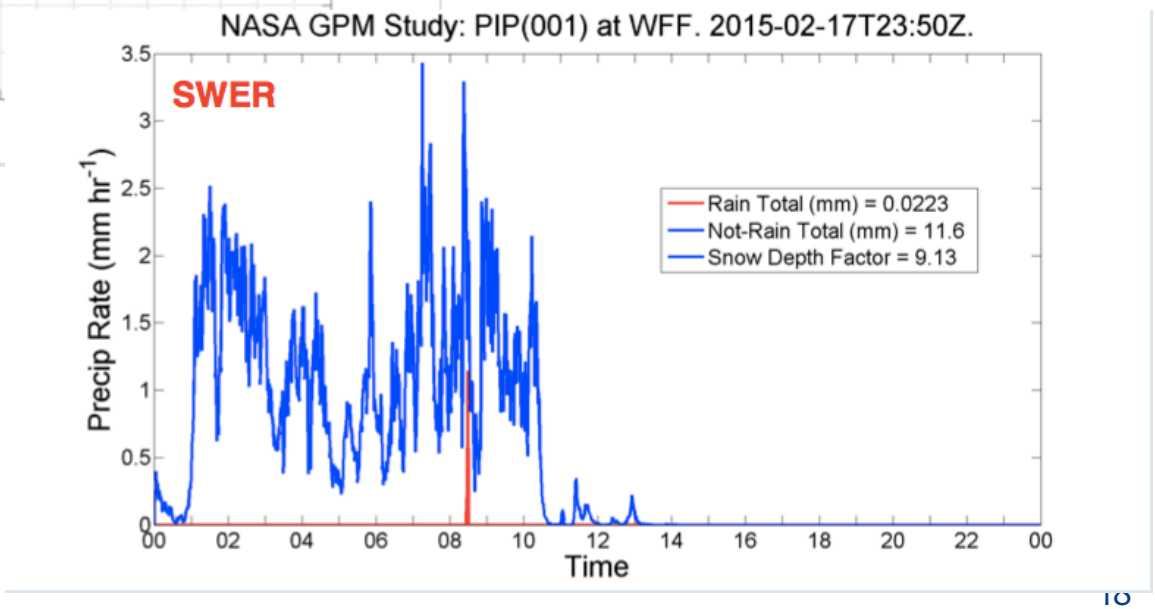
Contact:
Dave Wolff

- Meteorological Observations
- Disdrometers
- Gauges
- Radars
- Rain gauge network/nest

Wallops Facility



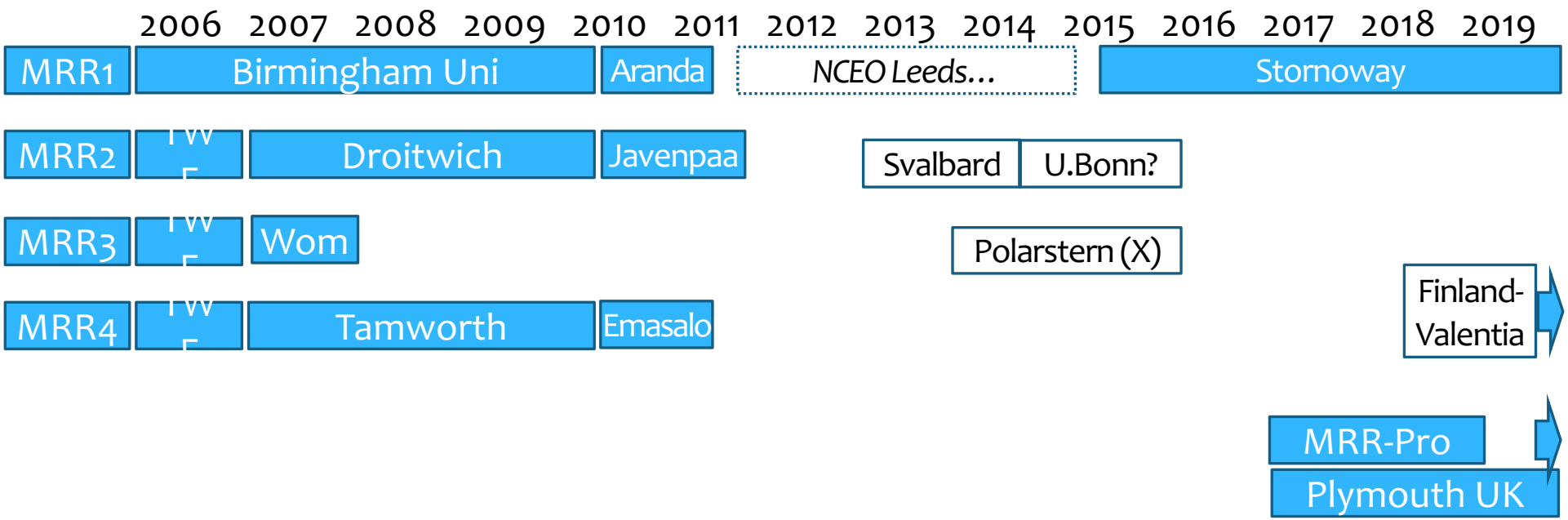
PIP Snow Retrievals



Bliven, PMM STM, 2015

UK Sites

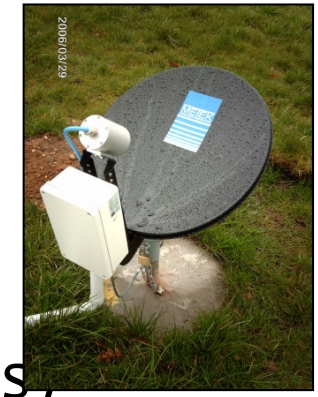
Contact: Christopher Kidd



UK Sites

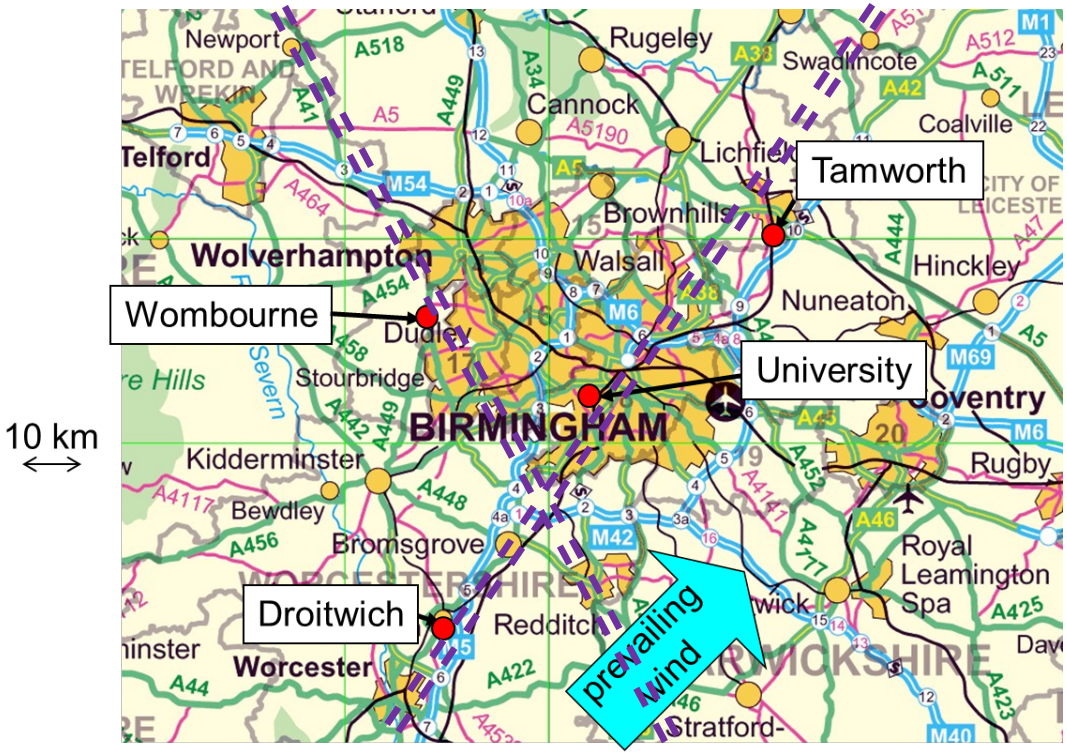
University of Birmingham facility (2006)

- 4 MRR-2 – vertical Doppler, 24.1 GHz
- 8 calibration gauges (2 per radar)
- 16 'outer' gauges
- zeus lightning network
- rain sampler (0.2 mm/tip – DOC & isotopic analysis)



UK Sites

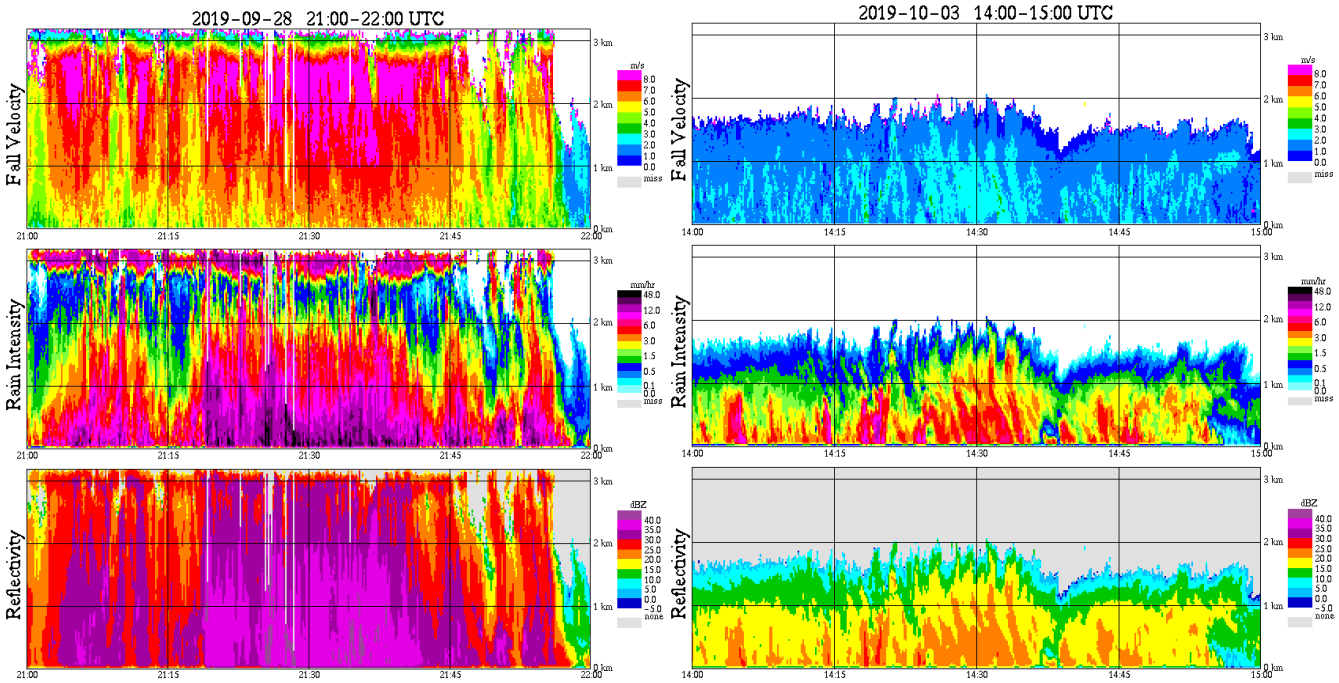
Urban precipitation 2007-2010 (4 MRR-2)



Deployment to study effect of the urban environment upon precipitation, particularly DOC and isotopes.

UK Sites

Plymouth (UK) (1x MRR-Pro)

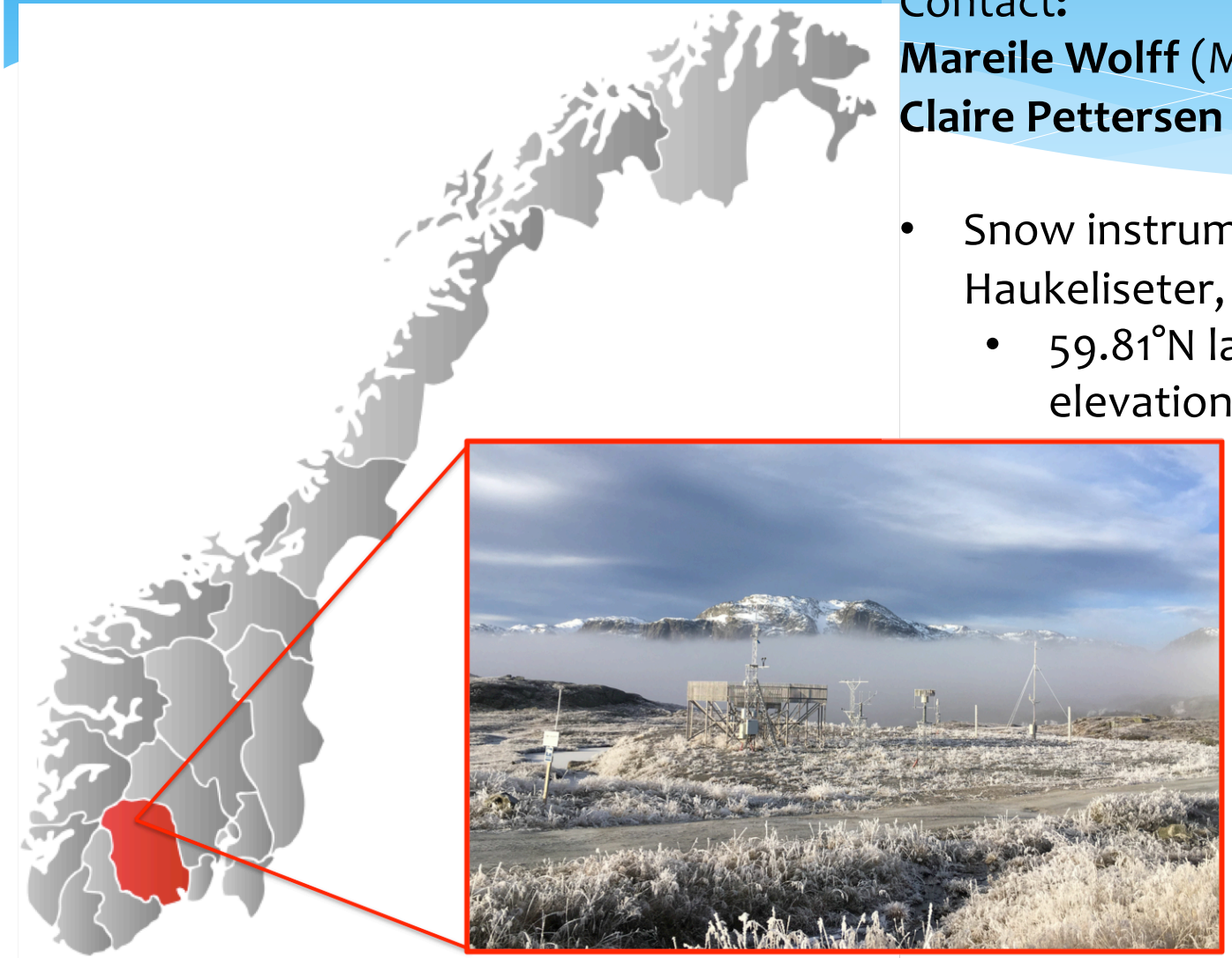


Mid-latitude coastal/ocean regime

Norway Site

Contact:
Mareile Wolff (MetNorway)
Claire Pettersen

- Snow instrument suite in Haukeliseter, Norway
  - 59.81°N latitude, 991 m elevation



Norway Site

- MRR-2
- PIP

Deployment winter 2016 – 2017
Planned deployment winter 2020 – 2021

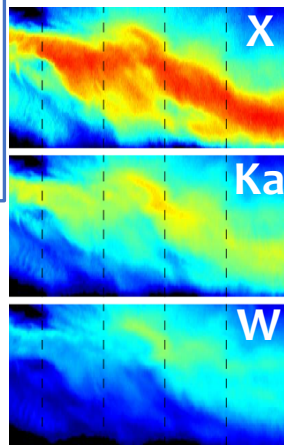
- Meteorological data (temperature, relative humidity, winds)
- Snow accumulation
  - Double Fence Automated Reference
  - WMO-SPICE
- Broadband radiation

Data available from 2014 – present

Pettersen et al., NASA STM 2019

German Site

OPTIMIce project: Synergy of multi-frequency moments, Doppler spectra, and polarimetry for ice process studies



80 km

200 m

50 km

Jülich Column (JuCol) ← 3.8 km → Sophienhöhe

Radar	Band	Polarimetry	Spectra	Beam-width	Scanning	Resolution
Joyrad-10	X	**No**	Yes	1°	No	30m
Joyrad-35	Ka	**LDR**	Yes	0.6°	Yes	30m
RPG-94-SP	W	**No**	Yes	0.6°	No	5..30m
Ju/BoXPOL	X	**Full**	No	1°	Yes	100m
DWD-Essen	C	**Full**	No	1°	Yes	250m/1km

Contact:
Stefan Kneifel
(University of Cologne)

Jülich Observatory of Cloud Evolution (JOYCE)

Löhnert et al., BAMS, 2015

Barrow, Alaska (DOE)

Contact:
Jim Mather

- Vertically pointing Ka-Band Radar
- Scanning radars
- PIP
- MASC
- Rain sensors

Data available 1998 – present

More Data is Better!

* Should not limit studies to the GPM footprint
  * Much can be learned by studying different environmental regimes
* Leverage DOE ARM Field Deployments
  * ACE-ENA, CACTI, MOSAiC, COMBLE, TRACER
* NWS Partners
  * Excellent support for short and long-term deployments (power, people, collocated observations, connectivity)
* Currently consolidating available ground-based data
* Got an idea for a ground-based study?
  * Talk to PMM science team members and collaborators with instrumentation!