# Validation of MÉRA total precipitation at Stornoway (Scotland) with a 24 GHz micro rain radar: A Preliminary Investigation

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University of the Highlands and Islands Oilthigh na Gàidhealtachd agus nan Eilean



# Where is University of the Highlands and Islands (UHI)?



# The Highlands and Islands of Scotland



# Stornoway



### **Quick overview of precipitation dynamics in Scotland**



Source: UK Met Office

# Quick overview of precipitation dynamics in Scotland

 Sweeney and O'Hare (1992): Geographical Variation in Precipitation Related to Lamb Circulation Types. Mayes (2000): Strong anti-correlation NW/SE UK.



# The North Atlantic Oscillation (NAO)



NCEP-NCAR Reanalysis (Kalnay et al. 1996)

Stornoway Monthly Precipitation v NAO <u>Pearson (r) correlation</u> <u>coefficients (1967-2017)</u>

November	0.57
December	0.72
January	0.74
February	0.75
March	0.69

# **Quick overview of precipitation dynamics in Scotland**



Source: NASA Terra

# **Quick overview of precipitation dynamics in Scotland**

• SNIFFER (2006), Changes in precipitation 1961 to 2005





Jan: 22% Feb: 27% Mar: 11% Apr: 14%

Annual: 7%

Graham, 2012)

 Overall UK precip increase of 5-6% from 1961-90 to 1981-2010 (same as in Ireland; Dwyer 2012, Gleeson *et al.* 2013)

# The Stornoway 24Ghz micro rain radar (LE-Radar)

- Motivation: NASA Global Precipitation Mission
- Operates continuously in FM mode at 24GHz with saw tooth signal
- Vertical pulse of radiation, back-scattered (reflected) by hydrometeors (snow, hail, sleet, rain) and possibly aerosols
- Vertical resolution of 30m x 100 steps, maximum height penetration 3100m. Data averaged over time bins of 1min
- As λ (1.3cm) > drop size, then amount of back scatter ∝ to 6<sup>th</sup> power of the drop radius
- Bright band / fall velocity / Doppler shift determined from reflection & est. drop spectrum. Very high spatial/temp resolution
- Can detect low-tropospheric light drizzle which conventional PPI radar can't





# The Stornoway 24Ghz micro rain radar (LE-Radar)



3 x other rain gauges within ~1.5km (SEPA, my own x 2)

# **Example 4-panel graphical output**



# **Example Event 1: Low-Level Drizzle**



### Example Event 2: #StormFrank 29-30 Dec 2015



METEK

# Example Event 2: #StormFrank 29-30 Dec 2015



Left: 00z 29 Dec 2015 / Right: 00z 30 Dec 2015

# **Example Event 3: Convective Boundary Layer**



### A Case Study: MRR, MÉRA and Met Office PPI radar: 30 June 2015



MRR total precip: 20.0mm, 20.9mm at 200m, 300m above MRR

#### Met Office Radar (PPI zoom): 30 June 2015



Total Met Office PPI precip (Stornoway): ~15-20mm

3 x rain gauges (within ~1.5km): 18.6mm, 18.4mm, 19.0mm

### Case Study: MÉRA, 30 June 2015, 00-06z



## Case Study: MÉRA, 30 June 2015, 06-12z

Tuesday 30 June 2015 06 UTC eidb t+0 VT: Tuesday 30 June 2015 09 UTC 0 m Total precipitat Tuesday 30 June 2015 09 UTC eidb t+0 VT: Tuesday 30 June 2015 12 UTC 0 m Total precipitation



### Case Study: MÉRA, 30 June 2015, 12-18z



MÉRA Stornoway Point total: 6.9mm (but Isle max: 20.5mm)

#### Tuesday 30 June 2015 12 UTC eidb t+0 VT:Tuesday 30 June 2015 15 UTC 0 m Total p

#### Tuesday 30 June 2015 15 UTC eidb t+0 VT:Tuesday 30 June 2015 18 UTC 0 m Total precipitation

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#### Simple 1-day quantitative summary

DATA SOURCE	PRECIP AMOUNT (24hr)
MÉRA Stornoway (single point only):	6.9mm
MÉRA (island max):	20.5mm
Micro rain radar (MRR):	20.0 to 20.9mm
Rain gauge #1:	18.4mm
Rain gauge #2:	18.6mm
Rain gauge #3:	19.0mm

Lower rain gauge totals easily accounted for by wind loss / spashing / higher altitude of MRR estimate

Possible edge effects? (as on northern boundary of MÉRA)

#### **Summary / Conclusions**



- Significant precipitation changes are afoot in NW Scotland. The Stornoway MRR with MÉRA offer new research opportunities
- Precipitation is largely stochastic mesoscale phenomenon -> longer time series needed for a comprehensive <u>climatological</u> analysis and <u>validation</u>
- Inadvertent complex choice of 30/6/2015, as front had localised embedded convective precip...-> need full MÉRA precipitation 2015-2018 please!
- Direct assimilation of very high resolution radar into models might continue to pose complications (*e.g.* PWV by GNSS, Guerova *et al.* 2004)
- Possibility of separate MÉRA geopotential paper in Weather re: Extreme thin thicknesses during recent #BeastfromtheEast

# Thank you!









#### Twitter: @eddy\_weather

# Appendix



# Stratus drizzle (smirs) missed by conventional Met Office PPI radar in $M_{T}$ airflows

# **Quick overview of precipitation dynamics in Scotland**



Precip Radar 30 Jan 2018: Source: UK Met Office

# The North Atlantic Oscillation (NAO)



Hurrell (2003), NCAR; Osborn (2011)



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#### 30-06-2015 06 UTC

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#### 30-06-2015 12 UTC Analysis chart valid 12 UTC TUE 30 JUN 2015 ENE? Geostrophic wind scale the in kt for 4.0 hPa intervals 1020 JO20 40 15 П 70N 60N 1025 50N 1 40N 0 X 80 25 10



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#### 30-06-2015 18 UTC

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