Commercial microwave link (CML) signal level data from the cellular backhaul network:

A private data source for rainfall information, still to be fully unlocked

Strong attenuation of microwave radiation by rain

Countries in which CML data was used for rainfall estimation

Country-wide availability of large opportunistic rainfall sensors network

Robust relation between measured attenuation and rain rate
Examples of CML rainfall observations in different countries

Germany (christian.chwala@kit.edu, harald.kunstmann@kit.edu)
- 4000 CMLs with 1-min instantaneous data with real-time data acquisition
  https://doi.org/10.5194/amt-9-991-2016
- Country-wide rainfall maps compare well to gauge adjusted radar product
  https://doi.org/10.5194/hess-24-2931-2020

Czech Republic (baresvoj@cvut.cz, fenclmar@cvut.cz)
- ≈2000 CMLs with Δt = 10-5 - 1-min instantaneous data with real-time data acquisition
- Focus on urban hydrology, collaboration with water utilities

Netherlands (overeem@knmi.nl, r.ujlenhoet@tudelft.nl)
- Years of CML data from T-Mobile NL
- via ftp (1 h – 1 d delay)
- Up to thousands of CMLs
- Min/max RSL 15 min or inst. RSL 15 min

Switzerland (joan.guccioni@uniswiss.eth.ch)
- 10 sec data from thousands CMLs in Switzerland, France, Spain, and Italy
- Operational prototype of 1-min rainfall over Zurich
  https://www.smhi.se/memo
- Optimal grid resolution from commercial microwave link networks
  https://doi.org/10.5194/asr-17-79-2020

Sweden (remco.vandebeek@smhi.se, jafet.andersson@smhi.se)
- 10 sec data from thousands CMLs in Sweden, Denmark, Germany and Rwanda
- Operational prototype of 1-min rainfall over Gothenburg and Stockholm
  https://www.smhi.se/memo
- Optimal grid resolution from commercial microwave link networks
  https://doi.org/10.5194/asr-17-79-2020

Burkina Faso (zougmore@univ-ouaga.bf, doumouniaali@yahoo.fr)
- Number of CMLs: 586 for Telecel
- Resolution: 1 min real time data
- Partners: ANAM, Telecel, Telmob, WASCAL, UO1, IDS

Israel (messer@eng.tau.ac.il, pinhas@post.tau.ac.il, jonatano@tauex.tau.ac.il)
- Street-level measurements from all cellular providers (since 2005)
- Typical NMS measurements (daily or 15-min)
- Various algorithms for rain mapping
- CML-derived air moisture and mapping

Open source code for CML rainfall retrieval: https://github.com/overeem11/RAINLINK
2.5 years of country-wide rainfall maps https://doi.org/10.1002/2016WR019412
Overview of CML rainfall estimation https://doi.org/10.1002/wat2.1289

Observed and simulated sewer runoff from 19 CMLs:
Open source code for CML processing: Runoff modelling with CML data: E-band CMLs for observation:
https://github.com/fenclmar/Rcmlrain
https://doi.org/10.2166/wst.2018.149
https://doi.org/10.5194/amt-2020-28
WMO could help to fully unlock CML data for rainfall estimation

• Potential of CMLs:
  • Proven to provide rainfall estimation with quality similar to weather radar and significantly better than satellite rainfall products, albeit with limited spatial coverage
  • Large networks also in developing countries (millions of CMLs world-wide)
  • Ideally used as complementary source of rainfall information, next to and ultimately combined with rainfall products from dedicated sensor networks (rain gauges, weather radars, satellites)

• Challenges of CML rainfall estimation:
  • Robust data processing methods are required for continuous rainfall estimation (which is in large parts resolved with already published methods)
  • Data is owned by mobile network operators and data sharing beyond research projects is still an unresolved issue

• Suggestions for supporting pathway towards operational usage of CML data
  • WMO could help to highlight the importance of CML data as relevant rainfall information, in particular in developing countries
  • WMO could support and facilitate CML data acquisition with general guidelines for cooperation between NMHS and data providers from the private sector