Validation of Surface Reference Data Sets using Satellite and Model Information

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Background

Surface reference data sets (SRDs; radar, gauges, etc) are an integral part of any precipitation retrieval scheme.

Despite extensive work to reduce/mitigate inherent errors within SRDs, errors still exist, particularly at local scales.

There is a need to identify regions of good (and conversely, poor) data within SRDs to ensure that i) where used, good quality data is used for calibration, verification/ validation and; ii) so that the quality of the SRDs can improve.
SE England analysis (vs radar)

Timeline

Reference Data: Surface Radar

evaluation of individual 0.25° x 0.25° boxes

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SRDs vs other measures

- Satellite & model vs surface errors should be random – particularly over small regions with similar features;
- The relative performance of products at particular locations remain generally constant;
- Local differences in surface reference data lead to differences in statistical performance

Local factors include:
- Radar range (*beam height above ground*)
- Blockage (*terrain/buildings*)
- Anaprop errors (*terrain/buildings, shipping/aircraft*)
Cross-comparison of satellite/surface

Kidd 1997: Comparison of satellite retrieval and surface radar

- Analysis of AIP-3 (TOGA-COARE) radar data vs satellite estimates: Significant range effects (>120 km poor)
- Spatial mapping of radar errors identifying range effects and surface clutter

Through the generation of a contingency table of rain/no-rain and subsequent spatial mapping, errors can be identified.
Data sets:

- US NMQ radar data (0.01 degree, 5 minute)
- European Nimrod data (5 km, 15 minute)
- TRMM Precipitation Radar data (4.3 km, occasional)
- Global IR data (4 km, 30 minute)
- ECMWF operational forecast output (15 km, 3 hour)

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TRMM PR vs NMQ surface radar

PR rain vs NMQ no-rain

PR no-rain vs NMQ rain

Co-incident (time/space) matchups at 5 km resolution (2009-2011)

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Heidke Skill Score (0.5 mmh\(^{-1}\) threshold)
- Radar range is a significant artefact
- Identification of regions of ‘good’ surface data

*Co-incident (time/space) matchups at 5 km resolution (2009-2011)*
Extension to extra-TRMM regions

How do you verify surface data sets outside the TRMM PR region?

- Surface radar data are inconsistently correct
- Infrared retrievals are consistently incorrect

- Use of Global IR data as proxy for rainfall (simple Tb thresholding)

Also, use of modelled precipitation
IR vs NMQ

Darker = radar overestimates

Global IR data as proxy for rain: radar over/under-estimation

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Darker = IR ‘overestimates’

Global IR data as proxy for rain: IR errors/characteristics

NOTE: NMQ is NOT on an equal-area projection!
ECMWF vs NMQ

Darker = radar overestimates

0.2 degrees
ECMWF vs NMQ

Darker = ECMWF ‘overestimates’

0.2 degrees
IR & ECMWF vs NMQ

IR comparison

ECMWF comparison

Darker = radar overestimates

Darker = product overestimates

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HSS scores: ECMWF & PR vs NMQ

Magnitudes differ, but patterns are similar
Europe: UKMO-Nimrod radar vs IR

Radar underestimation w.r.t. infrared

Large-scale differences due to IR

Clutter

terrain blockage

Radar overestimation w.r.t. infrared

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Europe: UKMO-Nimrod radar vs ECMWF

Heidke Skill Score (0.5 mmh-1 threshold)

- Radar range is a significant artefact
- Eastern region – different surface radar thresholding?

Extension of technique to European OPERA & Australian Rainfields

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Conclusions

Emphases that the cross-validation of data sets is useful.

IR data, using a simple threshold, can help identify small-scale artefacts within the surface radar data sets;
Models, although coarser resolution reinforce the findings of the simple IR thresholding;
PR data (the best) – similar observing systems (GPM-DPR…)

Through use of IR/model/PR maps of ‘confidence’ can be produced to help identify regions of high-quality surface reference data:
- helps to improve validation/verification satellite products
- identifies regions requiring improved surface data