Surface data

questions and/or themes and/or hypotheses that are the most important to address in this section of the assessment:

How well can precipitation & characteristics be measured at the surface?

- Gauges – extremely good where they exist – relative to other sources – with the longest historical record, but inconsistent gauge network density, physical rain-gauge interactions and data access can be problematic. **Gauges are the *de facto* standard**;
- Radar data – very good resolution spatially and temporally, but absolute calibration not straightforward (gauge correction), limited regional extent (<gauges) and limited climatological record;
- Additional sources: Microwave links – promising new source of information (albeit with limited history!);
- 3rd party data, e.g. streamflow, surface moisture – useful indicators of precipitation but not necessarily sufficiently quantitative for precipitation assessment.

Surface data

studies and analyses and comparisons that have been done so far by the community

Gauge data sets	Input data	Space/time grid	Coverage/dates	Producer (Developer) URL
APHRODITE	~12,000 gauges	0.25°, 0.5°/daily	Eurasia/1951-2007	APHRODITE Project (Yatagai)
CPC Unified Gauge-based Analysis of Global Daily Precip.	30,000 gauges	0.5°/daily	Global/1979-2005	NOAA/NWS CPC (Chen & Xie
	> 17,000 gauges real-time	0.5°/daily	Global/2006	NOAA/NWS CPC (Chen & Xie)
CRU Gauge	~10,000 gauges	2.5°x3.75°, 5°/monthly	Global/1900-1998	CRU at U. East Anglia (Hulme)
CRU TS 3.10.01 Gauge	~10,000 gauges	0.5°/monthly	Global/1901-2009	CRU and BADC (Harris)
Dai Gauge Dataset 2	~4,000 gauges	2.5°/monthly	Global regions with data/1850-1996	NCAR (Dai)
GHCN+CAMS Gauge	~3,800 gauges	2.5°/monthly	Global/1979	NOAA/NWS CPC (Xie)
GPCC Monitoring	~8,000 gauges	1°,2.5°/monthly	Global/1986-2007	DWD GPCC (Becker)
GPCC Reanalysis V6	~67,200++ gauges	0.5°,1°,2.5°/ monthly	Global/1901-2010	DWD GPCC (Becker)
GPCC VASClimo V1.1	~9,000 gauges	0.5°,1°,2.5°/ monthly	Global/1950-2000	DWD GPCC (Becker)

Radar data sets: limited global coverage, with limited historical record.

MRMS (USA), Nimrod/OPERA (Europe)

Other data: distrometer, MRR, etc

Oceanic data extremely limited to shipboard observations, Comprehensive Ocean-Atmosphere Data Set (COADS), Pacific Atoll rainfall data (PACRAIN).

Surface data

the gaps, i.e. the analyses and comparisons that still need to be done

- Very limited credible, comprehensive ocean surface precipitation data sets exist (71% of Earth's surface);
- Quality of land-based precipitation products spatially highly variable in quality due to density of observations; large regions with few or no gauge observations;
- High latitude and snowfall measurements extremely limited, compounded by effects of relief and remoteness;
- Very limited observations of the characteristics of precipitation (beyond occurrence and accumulation), e.g. drop size distribution;
- Characterisation of errors and uncertainties not well developed across all data sets (including integration of errors/uncertainties in multi-source data sources)

Ground based data

Key criteria for ground validation data:

i) availability – easily obtainable, together with metadata;

ii) Accuracy - including knowledge of, or constraint of known errors and uncertainties, consistency;

iii) Extent and resolution – good spatial coverage with resolution commensurate with validation requirements;

iv) Information characteristics – rain/snow classification, error assessment, quality flags

v) Source – relevance to precipitation products being validated (e.g. gauge, radar, '3rd party'…)

Surface data classification

	Availability	Accuracy	Extent	Information	Source
Class I	Freely available	Very high, constraint of errors, consistent in space/time	Very good, broad, long time record at good resolution	Full explanation of data set with ancillary data	Multisource, direct measurements
Class II	Easily available (after registration)	High accuracy, knowledge of/constraint of errors, consistent	Good time/space extent with good resolution	Good with quality control information	Single source, direct
Class III	Special request	Good, some constraint of errors, some inconsistency	Regional, with usable resolution	Some quality control, but not fully explained	Single source, indirect
Class IV	Official request (e.g. licenced)	Reasonable, but inconsistent	Local or poor resolution	Limited, often implied quality control	3rd party direct
Class V	Not publically available	Poor, intermittent in time/space	Very limited, with poor coverage/ resolution	Very limited, unknown quality control	3rd party indirect

GPCC

	Availability	Accuracy	Extent	Information	Source
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Class IV	Official request (e.g. licenced)	Reasonable, but inconsistent	Local or poor resolution	Limited, often implied quality control	3rd party direct
Class V	Not publically available	Poor, intermittent in time/space	Very limited, with poor coverage/ resolution	Very limited, unknown quality control	3rd party indirect

MRMS

	Availability	Accuracy	Extent	Information	Source
Class I	Freely available	Very high, constraint of errors, consistent in space/time	Very good, broad, long time record at good resolution	Full explanation of data set with ancillary data	Multisource, direct measurements
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UKMO Nimrod

	Availability	Accuracy	Extent	Information	Source
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