Formalising the reference / baseline / comprehensive networks concept - the what, the why and the how?

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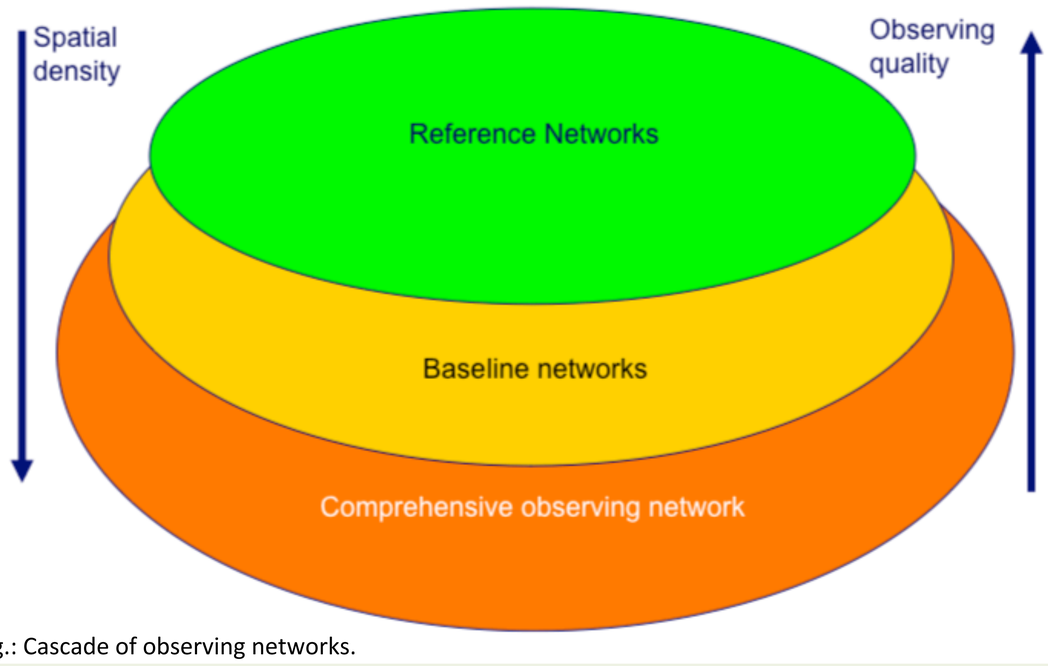

Fig.: Cascade of observing networks.

Reference Networks

These networks provide metrologically traceable observations, with quantified uncertainty, at a limited number of locations, or for a limited number of observing platforms, for which traceability has been attained.

- The measurements are traceable through an unbroken processing chain to SI units or community recognised standards
- Uncertainties arising from each step in the processing chain are fully quantified and included in the resulting data.
- Full metadata concerning the measurements is captured and retained, along with the original raw data, to allow subsequent reprocessing.
- The measurement and its uncertainty are verified through complementary, redundant, observations of the same measurand on a routine basis.
- The observations program is actively managed and has a commitment to long-term operation, to the extent possible.
- Change management is robust.
- Measurement technology innovation is pursued.

Baseline Networks

These networks provide long-term records that are capable of characterising regional, hemispheric and global-scale features.

- The measurements are periodically assessed, either against other instruments measuring the same geophysical parameters at the same site or, alternatively / in addition, through intercomparison campaigns held under international or national auspices.
- Representative uncertainties, that are based upon understanding of instrument performance or peer reviewed lines of evidence, are available.
- Metadata about changes in observing practices and instrumentation are retained.
- The observations have a long-term commitment.
- Changes to the measurement program are minimized and managed
- The measurements aim to meet stakeholder stated requirements.

Comprehensive Observing Networks

These networks provide high spatio-temporal density data information necessary for characterising local and regional features.

- The comprehensive networks provide observations at the detailed space and time scales required to fully describe the nature, variability and change of a specific climate variable.
- Representative uncertainties based upon e.g. instrument manufacturer specification and knowledge of operations should be provided. In their absence gross uncertainties based upon e.g. expert or operator judgement should be provided.
- Metadata should be retained.
- Although encouraged, long-term operation is not required.

1. Background

There are many documents and networks that make reference to a system of systems observing architecture but there is precious little agreement, let alone adoption, to date. Different domain areas and networks have adopted distinct conventions leading to a mosaic of conventions that serve to obfuscate and confuse more than illuminate or help.

2. Why?

A perfect measurement is not a metrological possibility, because any measurement will always to some extent differ from the true value of the measurand. In an ideal world, all measurements undertaken to monitor the climate system would be sustained, metrologically traceable and comparable, and have a robustly determined and comprehensive total uncertainty budget. These uncertainties would be commensurate with the best practices in the Guide to Uncertainty in Measurements [JGCM, 2008]. In the real-world, the heterogeneity of different instruments and the complexity of requirements for observations (including process studies, long-term monitoring, real-time applications etc.) require, instead, a tiered system of systems architecture. Such an approach combines the advantages of high-quality achieved by a few selected reference-quality sites, with the ability of baseline networks to both provide a representative sampling and benefit from reference-network innovations, and then with denser coverage achieved by comprehensive observing networks.

3. How?

We have taken as a starting point the CDR maturity assessment criteria arising from the FP7 CORE-CLIMAX project. There are aspects of measurements that are distinct from CDRs ,which requires somewhat distinct guidance to be developed. A GAIA-CLIM deliverable (http://tinyurl.com/GAIA-CLIM-maturity) detailing this guidance is available.

The assessment is performed against quantifiable aspects of the measurement series under seven primary strands:

1. Metadata
2. Documentation
3. Uncertainty characterisation
4. Public access, feedback, and update
5. Usage
6. Sustainability
7. Software (optional)

Each strand has two or more sub-strands. The final assessed maturity shall depend upon what is important to the user, but the exercise provides an objective framework to assess where different observations sit.

Metadata	Documentation	Uncertainty charaterisation	Public access, feedback and update	Usage	Sustainability	Software (optional)
Standards	Formal Description of Measurement Methodology	Traceability	Access	Research	Siting environment	Coding standards
Collection level	Formal Validation Report	Comparability	User feedback mechanism	Public and commercial exploitation	Scientific and expert support	Software documentation
File level	Formal Measurement Series User Guidance	Uncertainty Quantification	Updates to record		Programmatic support	Portability and numerical reproducibility
		Routine Quality Management	Version control			Security
			Long-term data preservation			
Legend						
1	2	3	4	5	6	Not applicable

Example potential maturity assessment is shown above. Scores 1-2 would indicate comprehensive observing network capabilities. Scores 3-4 would indicate baseline network capabilities. Scores 5-6 would indicate reference network capabilities. For each sub-category guidance is provided to enable an objective assessment of capabilities.

4. Next steps

- Write up the concept as a peer-reviewed paper submission
- Assess (at least) 56 candidate networks using the approach
- Assess robustness through redundant assessment
- Workshop to assess fitness-for-purpose

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