Solid Precipitation Intercomparison Experiment
WMO SPICE

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Report Objective

1. Provide a status report of the WMO SPICE intercomparison, including challenges and risks.
2. Provide high level work planning, to 2016.

Overview

The IOC of the WMO SPICE commenced its work in May 2011, and the formal experiments started in December 2012.

The intercomparison has been organized on 20 different sites in 16 countries, and with contributions of teams from 15 countries.

The field experiments are scheduled to end by April 2015 in the Northern Hemisphere, and by Oct 2015, in the Southern Hemisphere.

Over 30 different instrument models in multiple configurations have been tested, covering all major measurement principles for the point measurement of solid precipitation and snow on the ground (current and emerging). These have been provided by the host organizations, reflecting their national interest, and by eighteen manufacturers. The instruments provided by manufacturers are being tested on ten of the participating sites.

The project has been managed through five face to face meetings (Oct 5-7, 2011, in Geneva; June 11-15, 2012, in Boulder, CO, USA; Oct 15, 2012, in Brussels, June 17-21, in Davos, Switzerland; May 19-23, 2014 in Sodankylä, Finland), and weekly frequent teleconferences facilitated by WMO. The use of WebEx contributed significantly to increasing the effectiveness of the teleconferences.

The 6th meeting is scheduled for May 18th-22nd, in Zaragoza, Spain. This meeting will formally close the field experiments, and will advance the development of the analysis methodology.

High level work plan:

- 2015, June- September:
  - priority 1: development of instrument data sheets, for the instruments provided by Instrument Providers.
    - June: advance the production of graphs for data sheets, as per Zaragoza meeting decisions;
    - July/August: prepare datasheets; look for gaps, inconsistencies and address; write text, where needed.
  - priority 2: advanced science topics to address project objectives.
- 15th Sept 2015: Share Instrument Data Sheets with Providers, for their review and feedback.
- 15th-17th Oct 2015: meet the Instrument Providers to review Instrument Datasheets, in the context of the Meteorological Technology World Expo
- Sept –Oct, 2015:
  - refining the derivation of the reference dataset;
  - identify key new/innovative advanced science results
- Nov-Dec, 2015: integrate the Expo feedback, generate second generation Instrument Data Sheets, and include all instruments tested, regardless he provider.
- Jan-Sept, 2016: advance data analysis, write report.
- Advanced Draft of Report planned for TECO 2016.

Status of Experiments

For the seasons 2013/14 and 2014/15 most of the participating sites have run complete experiments, which have led to the availability of a comprehensive dataset, to enable the derivation of planned results.

- The sites running experiments, as planned are
  - Northern Hemisphere:
    - Bratt's Lake (Canada);
    - CARE(Canada);
    - Caribou Creek (Canada);
    - Sodankylä (Finland);
    - Haukeliseter (Norway);
    - Weissfluhjoch (Switzerland);
    - Marshall (USA);
    - Col de Porte (France)
    - ARAMON – Formigal (AEMET – Spain)
    - Gochang Observatory (Republic of Korea)
    - *Forni Glacier/Upper Valtellina/Italy,* EVK2CNR – UNIMI, University of Milan
    - *Pyramid International Laboratory Observatory/ Lobuche /Solu Khumbu/Nepal,* EVK2CNR – UNIMI, University of Milan

- Southern Hemisphere:
  - Guthega Dam (Australia);
  - Mueller Hut (New Zealand);
  - Tapado (Chile).

Reduced engagements have taken place with the experiments organized on the following sites:

- Valdai (Russian Federation);
- Voljskaya (Russian Federation)
- Joetsu and Rikubetsu (Japan)

Since late 2014, the communication with two of the participating sites, Hala Gasienicowa (Poland), and Tapado (Chile), as not been possible, in spite of the efforts made by the Project Lead and WMO Secretariat to connect with the project teams.

Data archive

The SPICE Data Archive is being hosted by the National Centre for Atmospheric Research (NCAR), USA; this is a significant contribution, which facilitates the archival and quality control of SPICE data in a consistent manner, making it available for analysis.

- The SPICE Archive from NCAR is being mirrored by Environment Canada.
- At NCAR the SPICE data is QC'd, and made available to participants on the NCAR ftp.
- Event Selection Datasets are generated off line by the participating scientists.

Data Analysis

In addition to the data analysis conducted by the members of the individual site teams, dedicated resources for data analysis and data management have been made available through WMO funding, starting Nov 2014 (Audrey Reverdin). The current agreement with MeteoSwiss runs until Nov 2015.

Significant advancements on methodologies and data analysis have been made as a result of the availability of these resources. Significantly more effort is required to carry out to completion the planned analysis.

About 400 instruments are included in the experiment, resulting on an estimated 50,000 daily data files for each year of the experiment. The participating teams have different levels of expertize. Many participating teams are dedicating resources to the data analysis, but these are not sufficient to analyze all the data and prepare reports by 2016. While the project team includes a number of well-known international experts, their availability is limited.

It is recommended that efforts are made to secure the continuation of dedicated resources through WMO funding, to enable the completion of the data analysis and the preparation of the final report.

It is estimated that the equivalent of one person year is needed to finalize the data analysis, and report writing

If the funding for the additional required resources is not available, it would impact the ability to deliver on the SPICE results on time and within the defined scope, resulting in a final report that would take additional years for completion and including results on fewer objectives, than defined.

Given the broad interest from the scientific community in timely and comprehensive SPICE results, as identified above, neither the delay in issuing the Final Report, nor reducing scope of the report are satisfactory, nor desirable.

WMO SPICE Project Results: Practical Perspective

The SPICE Final Report should provide guidance to WMO Members for the operation of their networks within the WWW and WIGOS context, i.e. operational networks (continuous operations, stations distributed over a large area).

WMO expects that the SPICE Final Report will include information that will support its Members with:

- Guidance on best practices to follow for obtaining solid precipitation measurements of known quality, at all their stations.
- Relevant information on the participating instruments and tested configurations, to support the configuration of operational networks in all Member jurisdictions, as well as improving the operation and update of their systems
- Information on performance which would help Members procure new instruments/systems

Important note of consideration is that not all Members have staff with expertise in instrumentation or in the measurement of solid precipitation; as a result, the results of the intercomparison should be formulated such that they could be understood and used by people with a broader range of skills.

It is important of engaging manufacturers in the preparation of the final report and evaluation of results. Failing to engage manufacturers early enough could delay the publication of the report

- The SPICE Project is a **partnership with manufacturers**, who have enabled the work in SPICE.
- The results could impact the business lines of the participating manufacturers
- Presentation of results needs to be impartial and fair. Differentiate issues coming from the instruments and possible issues coming from the site management/setup.
- The report must include recommendations on how manufacturers could improve their systems to better meet the requirements of WMO Members based on experience gained during the intercomparison.

Contribution to the update of the CIMO Guide he results reported by SPICE in its Final Report need to prepare the ground for the update of the chapters of the CIMO Guide relevant to the measurement of falling precipitation, especially when the precipitation is solid, as well as for snow on ground, snow water equivalent, etc.

WMO Observations User Requirements on Precipitation and Snow Depth
http://www.wmo-sat.info/oscar/observingrequirements

The Observing Systems Capabilities Analysis and Review tool (OSCAR) is a resource developed by WMO in support of Earth Observation applications, studies and global coordination.
It contains quantitative user-defined requirements for observation of physical variables in application areas of WMO (i.e. related to weather, water and climate), as resulting from the so-called Rolling Requirements Review process.

The surface- and space-based capabilities components of the OSCAR are intended to record observing platform/station metadata according to the WIGOS metadata standard described in the *Manual on WIGOS*.

Definitions
Requirements are expressed for geophysical variables in terms of 6 criteria: **uncertainty**, **horizontal resolution, vertical resolution, observing cycle, timeliness,** and **stability** (where appropriate).
For each of these criteria the table indicates 3 values determined by experts:

- The **"threshold"** is the minimum requirement to be met to ensure that data are useful
- The **"goal"** is an ideal requirement above which further improvements are not necessary
- The **"breakthrough"** is an intermediate level between "threshold" and "goal" which, if achieved, would result in a significant improvement for the targeted application. The breakthrough level may be considered as an optimum, from a cost-benefit point of view, when planning or designing observing systems.

The "uncertainty" characterizes the estimated range of observation errors on the given variable, with a 68% confidence interval (1 σ).

There are several documented variable requirements in OSCAR, on precipitation (near surface) and snow (at surface), as follows:

Accumulated precipitation (over 24 h):

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm)	2.0; 5.0; 10.0	1.0; 1.3; 2.0; 5.0	0.5; 1.0; 2.0	GEWEX; Global NWP, High Resolution NWP; Agriculture

Observing Cycle	6h; 12h; 24h; 3d	2h; 3h; 16h; 36h	30 m; 60m; 12h; 24h	Meteorology; Climate Monitoring – Atmospheric Domain (AOPC)
Timeliness	24 h to 60 d	9h to 45d	6h to 30d	

The Global Energy and Water Cycle Experiment (GEWEX) is a core project in the World Climate Research Programme (WCRP) concerned with the dynamics and thermodynamics of the atmosphere and interactions with the Earth's surface. ***

Precipitation intensity at surface (liquid or solid):

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm/h)	1.0; 2.0	0.2; 0.3; 0.5	0.1	**Used in Application Areas:** Agricultural Meteorology Climate-AOPC Global NWP High Res NWP Nowcasting / VSRF Ocean Applications Aeronautical Meteorology
Observing Cycle	1h; 2h; 3h; 6h; 12h	10m; 12m; 30m; 60m; 3h; 4h;	5m; 8m; 60m; 3h	
Timeliness	30m; 2h; 6h; 12h	9m; 10m; 30m; 6h	5m;5m; 3h6m; 12	

Precipitation type at the surface:

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm/h)	-	-	-	**Used in Application Areas:** High Resolution NWP
Observing Cycle	3h	60m	15m	
Timeliness	2h	30m	15m	

Snow depth:

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm/h)	2 cm	0.5 cm	0.1 cm	**Used in Application Areas::** Nowcasting / VSRF
Observing Cycle	24h	60m	10m	
Timeliness	24h	60m	10m	

Snow water equivalent:

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm/h)	10mm; 20 mm; 500mm	6.5 mm; 8mm;; 10mm; 23.2mm	2mm; 5mm	**Used in Application Areas:** CLIC Agricultural Meteorology Climate-AOPC GEWEX Global NWP High Res NWP Hydrology SIA
Observing Cycle	6h; 5d; 7d; 30d	3h to 11d	60m to 7 d	
Timeliness	24h to 90 d	24 h to 11 d	3h to 30 d	

Snow cover

Criteria	Threshold	Breakthrough	Goal	Applications
Uncertainty(mm/h)	10% to 50%	7% to 20%	2% to 10%	**Used in Application Areas:** CLIC Agricultural Meteorology Climate-AOPC GEWEX Global NWP High Res NWP Hydrology Nowcasting / VSRF Climate-TOPC
Observing Cycle	12h to 30d	3h to 6d	1h to 5d	
Timeliness	12h to 90d	2h to 45d	1h to 7d	