

Task Team GCOS Surface Reference Network

28th AOPC Session

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We have got a logo for GSRN!

- Many thanks to the LC for creating several styles for the logo to choose from.
- The Lead Centre will provide different types of version of this logo (high-resolution, reverse, ...)



A GCOS Surface Reference Network (GSRN)

Improved long-term accuracy, stability and comparability of observations.

- To achieve simultaneous high-quality observations of many Essential Climate Variables (ECVs)
- GSRN is the recognized reference network for surface observations within the WMO tiered system (like GRUAN for upper air)
- GSRN will provide reference data with full traceability and defined and quantified uncertainties
- All measurements need to be documented in accessible literature including a complete metadata description
- GSRN could/should be a subset of stations in existing networks (e.g. GSN, GBON), but is open to include new stations (e.g. scientific stations)
- The PILOT Phase will focus on **surface air temperature** and **precipitation**





Establishment of the GSRN Task Team

2019

Report **GCOS-226** provides a proposal for the establishment of a GCOS Surface Reference Network (written by a previous Task-Team starting in 2017, based on Thorne et al. (2018) “Towards a global land surface climate fiducial reference measurements network”; Intl Journal of Climatology)

2020

INFCOM -1: **GCOS Surface Reference Network Task Team** (TT-GSRN) is established under the leadership of the GCOS SC and SC-ON to be responsible for the initial implementation of the GSRN (two co-chairs (SC-ON and SC-MINT), several ordinary members, representatives from relevant stakeholders, namely SC-MINT, SC-IMT, AOPC, JET EOSDE, BIPM, GRUAN, GSN, GCW, satellite community and HMEI, supported by the GCOS Secretariat)

2021

24th March: 1st Meeting of TT-GSRN, several meetings followed in 2021/22
March: letter to members to express their interest in hosting the GSRN Lead Centre (GSRN LC)
November: **China Meteorological Administration (CMA)** is selected to become GSRN LC

- Generate first GSRN products (e.g. daily mean air temperature near surface) considering all uncertainty components (using measurements of AQI)
- Gather experience dealing with different instrumentation at stations in member states and climate regions
- Implement procedures on how to manage, process and archive data
- Implement data quality assessment methods (QA / QC)
- Generate certification process for stations

- Proof of concept of GSRN
- Pilot GSRN phase can be used to bring a station towards reference quality in collaboration with the GSRN LC and TT-GSRN!!



Requirements for Air Temperature measurements

General:

- GIMO, Volume I, Chapter 2 (Measurement of temperature) must be regarded (WMO-No. 8)

Shielding:

- artificially or natural ventilated screens (depending on climate region and experience)

Number of parallel instruments:

- Threshold: 2
- Recommended: 3 (for added confidence and robustness)

Target system uncertainty:

- corresponds to **Class A** of the Measurement Quality Classification (MQC) ([INFCOM 1, Decision 6](#))
- Class A is aligned with OSCAR/Requirements Goal.



Image is of the USCRN site at CA Bodega, taken from:
https://www1.ncdc.noaa.gov/pub/data/uscrn/documentation/site/photos/stationsbystate_hires.pdf

Target system uncertainty (k=2)	0.2 K
Product resolution	Minimum: 0.01 K Recommended: 0.001 K
Maximum calibration uncertainty (k=1)	0.05 K
Maximum drift (k=1)	0.02 K/year
Sampling frequency	10 s
Maximum time constant / response time	20 s
Averaging and recording time	1 minute
Calibration regime	Yearly
Verification regime	6-monthly
Maintenance regime	6-monthly

Requirements for Precipitation measurements

General:

- GIMO, Volume I, Chapter 6 (Measurement of precipitation) must be regarded (WMO-No. 8)

Shielding:

- Natural or artificially protected against wind

Number of parallel instruments:

- Recommended: 2 (not necessarily of the same type)

Target system uncertainty:

- corresponds to **Class A** of the Measurement Quality Classification (MQC) (INFCOM 1, Decision 6)
- Class A is aligned with OSCAR/Requirements Goal.



GCOS ECV Product OSCAR Variable	Accumulated precipitation Precipitation intensity at surface
Target system uncertainty (k=2)	The greater of 1 mm or 2% (liquid) The greater of 0.2 mm/h or 5% (liquid)
Product resolution Variable resolution	0.1 mm 0.1 mm/h
Maximum calibration uncertainty (k=1)	1% 0.1 mm/h
Maximum drift (k=1)	1% / year
Sampling frequency	1 s
Starting threshold	0.1 mm/h for liquid precipitation intensity only
Maximum time constant / response time	1 s at event start (for liquid)
Averaging and recording time	Integrating data at 1 minute Total daily precipitation recorded
Calibration / Verification regime	Yearly / 6-monthly
Maintenance regime	Monthly

Associated quantities of influence (AQI)

To produce a reference measurement of a mandatory variable, parallel measurements of additional quantities at the same site are needed, because they affect the result of the reference measurement:

AQI for Air Temperature measurement		AQI for Precipitation measurement	
Precipitation (liquid and solid)	<ul style="list-style-type: none"> • Cooling of thermometer solar shields • Aspirated shields can also generate droplets or spray on the temperature sensors • Solid precipitation can accumulate over solar shields 	Air temperature	<ul style="list-style-type: none"> • Indicator in determining the likely state (liquid/solid) of precipitation
Relative humidity	<ul style="list-style-type: none"> • Condensation or evaporation forcing heat transfers 	Relative humidity	<ul style="list-style-type: none"> • Low humidity can cause evaporation in the gauge prior to measurement
Global solar radiation	<ul style="list-style-type: none"> • Incoming solar radiation causes extra heat 	Global solar radiation	<ul style="list-style-type: none"> • Determining any biases in timing of precipitation events due to frost melt or melting of solid precipitation
Reflected solar radiation	<ul style="list-style-type: none"> • Reflected radiation can cause extra heating 	Wind (speed and direction)	<ul style="list-style-type: none"> • Wind speed and its direction can introduce positive and negative biases in precipitation records due to turbulences associated with the presence of the instrument structures. • Anemometer should be mounted at the same height as orifice of gauge
Wind (speed and direction)	<ul style="list-style-type: none"> • Wind reduces biases in temperature records due to solar radiation • Wind can cause cooling, if the radiation shield is wet 		

Presentations at Conferences to encourage members to nominate stations for the Pilot network:

“Specifying, designing and implementing a global surface reference network - first steps for the GSRN”

13.10.2022: WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2022) - Paris

17.10.2022: 2nd GCOS Climate Observation Conference - Darmstadt



INFCOM decides:

- (1) to endorse the implementation plan for a Pilot GCOS Surface Reference Network Pilot, as provided in the Annex to the present decision;
- (2) to request the Secretary-General to issue a call to WMO Members to nominate stations for the pilot GSRN;
- (3) to urge Members to consider nominating stations with reference measurements to be part of the pilot GSRN;
- (4) to request the GSRN Lead Centre and the GCOS Secretariat in consultation with the TT-GSRN to manage the process of establishing a pilot GSRN Pilot as specified in the document in the Annex to the present decision.



Process for the implementation of Pilot GSRN

1. Letter to all WMO Members inviting them to nominate Pilot GSRN stations was sent on 22nd November 2022
 - Stations should meet the requirements described in Annex A (of Annex to INFCOM decision 6)
 - Submit the completed proforma (Annex B)
 - If requirements can (yet) not be met, give reasons
 - Stations in different climatological zones and their global distribution and uniqueness should be considered
2. WMO Members were encouraged to consider all potential sources for candidate GSRN Pilot stations within their jurisdiction.
3. GCOS Secretariat manages the replies from WMO Members and addresses any questions/issues raised, in consultation (as required) with GSRN LC and TT-GSRN.
4. GCOS Secretariat and GSRN LC will review the responses, and additional technical information, and generate a draft list of stations for the Pilot GSRN.
5. Approval of the list by TT-GSRN (planned for September 2023) and followed by SC-ON and GCOS-SC.



Review process of nominated stations for Pilot GSRN

Review process (Nominated stations)

- (1) A review document proforma was agreed by SG-4 of TT-GSRN
- (2) GSRN-LC undertakes the review of all stations using the proforma.
- (3) Any necessary communication with the nominated station contact (i.e. clarification on information provided or requests for additional information), will be done through the GCOS Secretariat.
- (4) Once GSRN-LC have completed their review, additional experts from SG-4 will provide a second/third review.
- (5) Outcome of these reviews will be presented back to SG-4.
- (6) List of recommended GSRN(Pilot) stations will be provided to plenary GSRN for final discussion and approval. (Target Deadline –Sept 2023)

GSRN (PILOT) – Nominated Stations Review

Station details (Name/Identifier):

Country/Region/Organisation:

Date Received:

Received from:

Reviewed By:

Review Date:

Mandatory Criteria Information (Insert n/a in box if Air Temperature or Precipitation is not being provided)

		Yes	No
1.	Have all the requested general and station information been provided, with a sufficient level of detail?		
2.	Will the station provide data of Air Temperature and/or Precipitation?		
3.	Is the instrument siting for the variable (Air Temperature) Class 1 or 2?		
4.	Will all associated quantities of influence for Air Temperature be provided?		
5.	If 'No' for (4) has a comment been provided as to why this is not available/applicable?		
6.	Is the instrument siting for the variable (Precipitation) Class 1 or 2?		
7.	Will all associated quantities of influence for Precipitation be provided?		
8.	If 'No' for (7) has a comment been provided as to why this is not available/applicable?		
9.	Does the station fulfil the GSRN requirements (Annex A), for the reference variable(s) being offered?		
10.	If 'No' for (9) has a commitment to fulfil these in the future been provided?		

Additional Information

		Yes	No
1.	Has information on the historical observing record been provided?		
2.	Has information on the long-term assurance of the measurements/station been provided?		
3.	Has information on the maintenance of the site/equipment been provided?		
4.	Has information on calibration, traceability and uncertainty evaluation been provided?		
5.	Have requested pictures and geo-location of the site been provided?		
6.	Does the nominated station have a special status/location (i.e. polar, desert, mountain)?		

Climate Zone –

Station (Date established) -

Supporting Information on review (Mandatory if outcome is 'Reject') –

Nominated stations for GSRN (Pilot)

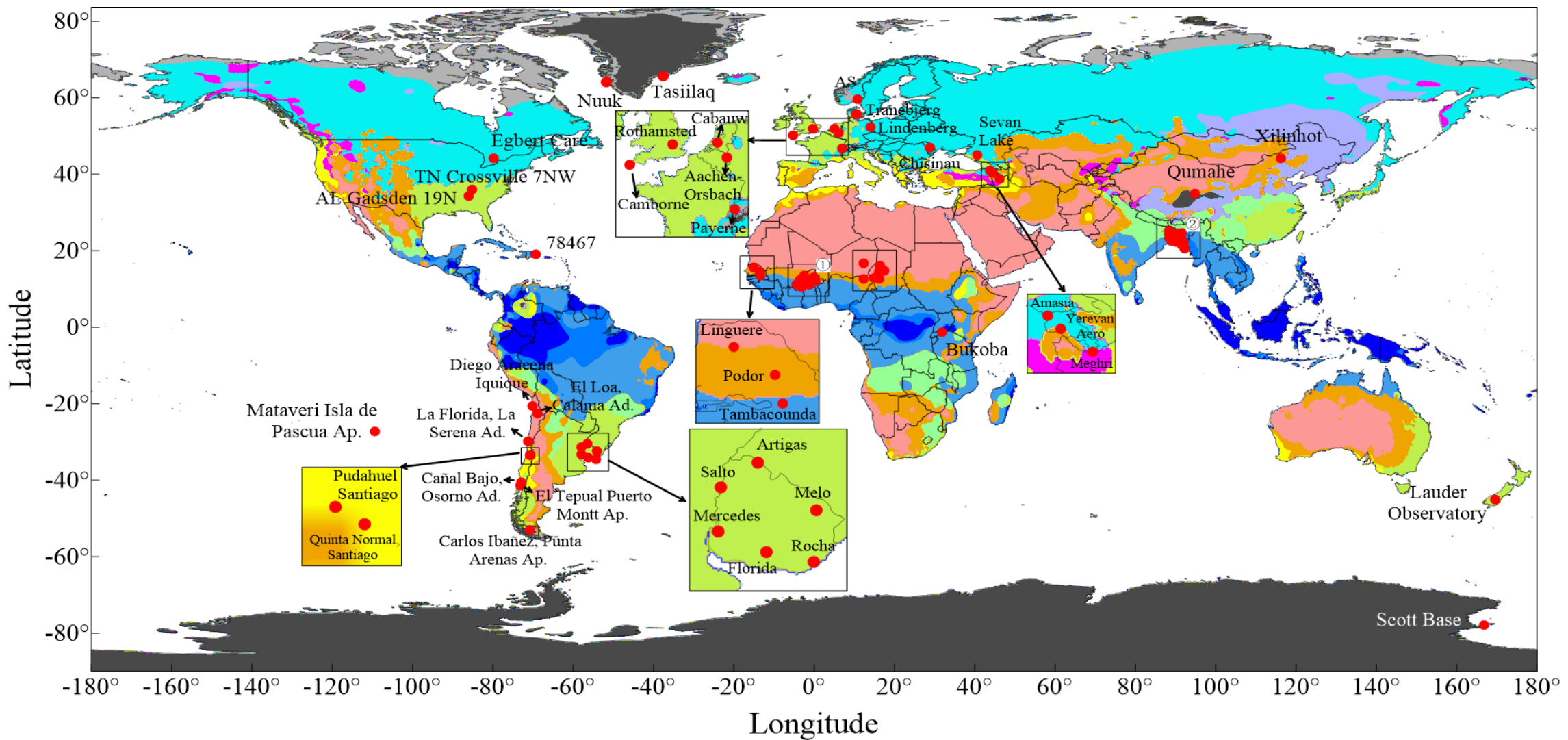
Country	n. of stations
The Netherlands	1
US	2
Uruguay	6
Republic of Moldova	1
Norway	1
Germany	2
Chile	9
New Zealand	2
Denmark	3
Burkina Faso	9
Bangladesh	14
Republica Domenicana	1
Armenia	5
Tanzania	1
Canada	1
Senegal	13
UK	2
China	2
Switzerland	1

76 Nominated Stations (19 Countries)

- GSRN-LC (CMA experts) have completed a first assessment.
 - 19 stations (12 countries) - Accepted/partially accepted
 - 57 stations (7 countries) – Request further information
- GSRN SG-4 Experts will provide an additional assessment of the 19 stations
- Further classification of other 57 stations (climate zone/location) to be undertaken before communication back to country contact.
- Some members nominated only 1-3 stations, others nominated many stations (5 - 14).
- Members with many stations nominated will be asked to reduce their nomination to 1 station to be assessed.
- Depending on the assessment and the relevance for representing different climate zones additional stations of these members will be taken into account.



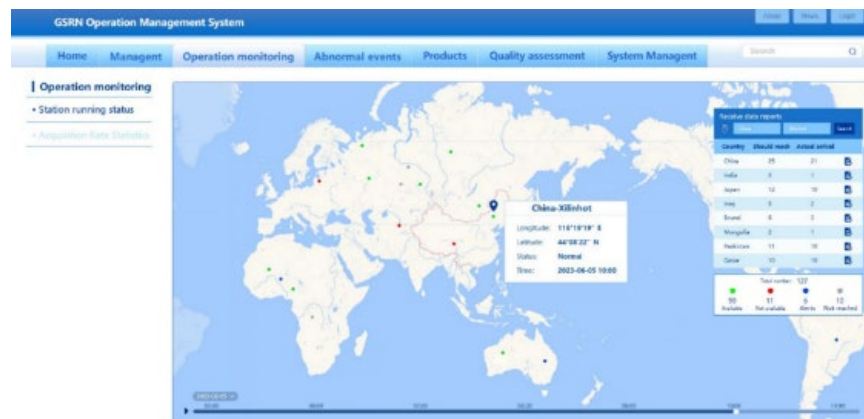
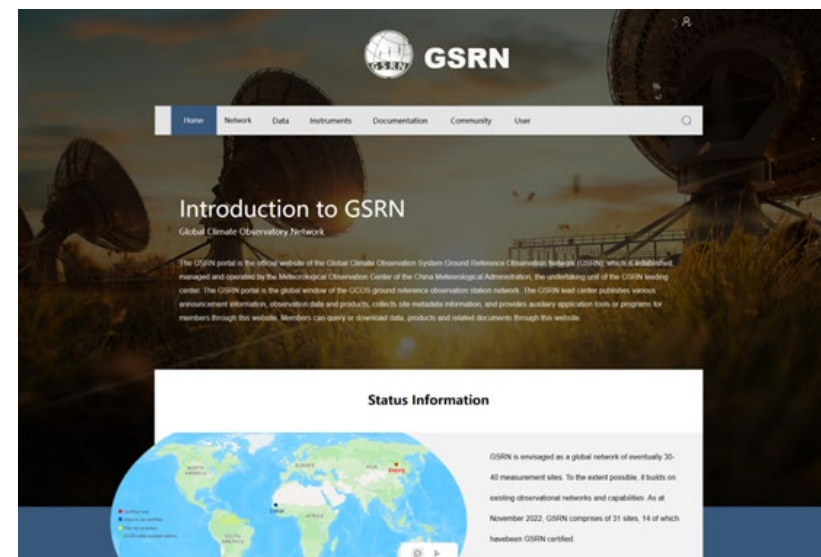
Climate Zones of nominated stations



气候区分	Aw热带疏林气候	Cf常湿温暖气候	Df常湿冷温气候	EF苔原气候
Af热带雨林气候	Bs草原气候	Cs夏干温暖气候	Ds亚寒带大陆性气候	ET冰原气候
Am热带季风气候	Bw沙漠气候	Cw冬干温暖气候	Dw亚寒带季风性气候	

Topics from the workplan of the LC:

1. Design a first GSRN data product for air temperature (LC with SG 7)
2. Draft the Quality management system document (LC with SG 3)
3. Design of the GSRN LOGO
4. Establish a website for lead center (LC)
5. Site Selection (LC, SG4)
6. Operational management system Development (LC, SG4)
7. Operational phase of the pilot GSRN (LC)



Subgroups and focus of work

No		Status and focus of work
1	Lead Center decision and TOR	<ul style="list-style-type: none"> Develop initial ToR for the GSRN LC Propose a supporting structure for the LC with the other countries who expressed interest Refine ToR of LC and finalize them (approved in June 2022)
2	Concept for Network governance and structure of GSRN	<ul style="list-style-type: none"> Draft concept for Network governance and organizational structure (approved in December 2022, regular review)
3	Requirements for GSRN sites and uncertainty determination	<ul style="list-style-type: none"> Define the requirements for the mandatory parameters and the relevant (specific) areas of expertise (e.g. measurement protocols, data transfer, metadata retention and the criteria for site and instrumentation) Document updated with all requirements for the pilot GSRN Contribute to uncertainty calculation
4	Pilot stations and initial composition and implementation of the pilot phase.	<ul style="list-style-type: none"> Generate Document with the guidelines and implementation for the pilot project Develop a proposal for the initial composition of the GSRN
5	Climatological Reference stations document (on hold)	<ul style="list-style-type: none"> Finalize existing document on Climate reference stations Publish technical documentation
6	Certification and nomination process (Q3 2023)	<ul style="list-style-type: none"> Generate a final document with the process for nomination, review and site certification that can be used for the certification process
7	GSRN Data Products	<ul style="list-style-type: none"> Define and describe GSRN Data Products for Surface Air Temperature Define and describe GSRN Data Products for Precipitation Data Products visualization Optimize and update products' scheme and Data Product visualization
8	GSRN Documentation (not yet started)	<ul style="list-style-type: none"> Develop the GSRN Documentation in collaboration with the GSRN LC



Relevant deliverables from the workplan

Focus on deliverables from workplan for in person meeting in September 2023 in Turino

	Action	Deliverable	Expected milestone
SG 2	2.c Draft concept for Network governance and organizational structure	Review of the GSRN governance document	Sept. 23
SG 3	3.b define the requirements for the mandatory parameters and the relevant (specific) areas of expertise (e.g. measurement protocols, data transfer, metadata retention and the criteria for site and instrumentation)	Document updated with all requirements for the pilot GSRN (Doc. 7) GSRN Quality Management Document (Doc. 7a)	December 2023 Full document e.g. measurement protocols, data transfer, metadata retention)
	3.c expand 3.b for all surface atmospheric parameters referenced in GCOS 226	3.c Document including all requirements <ul style="list-style-type: none"> • Focus on the AQI as primary variables: Radiation, Humidity, Wind, Pressure 	December 2023
SG 4	4.c GSRN pilot phase: stations nomination by Members and review	4.c(i) Circular letter to Members 4.c(ii) Consultation period 4.c(iii) GSRN agreed list of pilot stations	Dec 22 Mar-Jun 23 Sept 23
	4.d Generate guidance documents/Functions for the pilot phase implementation <ul style="list-style-type: none"> • Requirements • Included stations/metadata • GSRN Functions • Timeline 	4.d(i) GSRN metadata (OSCAR capability) 4.d(ii) GSRN metadata database (off-line) 4.d(iii) Implementation Plan for Pilot GSRN (Initial draft) (Doc. 10i) 4.d(iv) Prototype functions for GSRN data transfer/archive/display in test-environment.	June 23 Sept 23 Sept 23 Dec 23
	4.e status report of the pilot phase	4.e status report of the pilot phase for INFCOM-3 as a basis for next phase	Dec 23
SG 7	7.a Define and describe GSRN Data Products for Surface Air Temperature	7.a Documentation of the GSRN Data Product for Surface Air Temperature	June 2023
	7.b Define and describe GSRN Data Products for Precipitation	7.b Documentation of the GSRN Data Product for precipitation	June 2023

List of members

No.	Representative	Name	Gender	Organisation
1	Co-Chair TT-GSRN, SC-ON, GCOS	Sarah Gallagher	F	Met Éireann, Ireland
2	Co-Chair TT-GSRN, S-MINT	Tilman Holfelder	M	DWD, Germany
3	TT-GSRN Member	Elian Augusto Wolfram	M	Servicio Meteorológico Nacional (SMN), Argentina
4	TT-GSRN Member	Howard Diamond (Tilden Meyers)	M	National Oceanic and Atmospheric Administration (NOAA), USA
5	TT-GSRN Member	Sergey Chicherin	M	Voeikov Main Geophysical Observatory, Russia
6	TT-GSRN Member	Xiaolan Wang	F	Environment and Climate Change Canada (ECCC), Canada
7	GCOS Secretariat	Caterina Tassone	F	WMO, Geneva
8	AOPC Chairman	Peter Thorne	M	National University of Ireland, Maynooth
9	JET EOSDE (Joint Expert Team on Earth Observing System Design and Evolution)	Seiyoung Park	F	Korea Meteorological Administration (KMA)
10	SC-MINT	Jitze van der Meulen	M	KNMI, The Netherlands
11	SC-IMT	Li Xiang	F	CMA (China Meteorological Administration), China
12	AOPC (GCOS - Atmospheric Observation Panel for Climate)	Maria Hakuba	F	NASA JPL, USA

List of members

No.	Representative	Name	Gender	Organisation
13	TOPC (GCOS - Terrestrial Observation Panel for Climate)	Nigel Tapper	M	Monash University, Australia
14	BIPM (Bureau International des Poids et Mesures)	Dolores del Campo Maldonado	F	CEM (Centro Espanol de Metrología), Spain
15	GRUAN (GCOS Reference Upper-Air Network)	Shwei Lin WONG	M	NEA (National Environment Agency), Singapore
16	GCOS Secretariat / GSN (GCOS Surface Network)	Tim Oakley	M	WMO, Geneva
17	GCW representative (Global Cryosphere Watch)	Jiankai Wang	M	CMA (China Meteorological Administration), China
18	CMA representative and official representative of the lead centre	Nan Zhang	F	CMA (China Meteorological Administration), China
19	Satellite community	Albrecht von-Bargen	M	Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany
20	HMEI (Hydro-Meteorological Equipment Industry)	Foeke Kuik	M	Campbell Scientific, Inc, The Netherlands
21	CCI document "Climatological reference stations: definitions and requirements"	Andrea Merlone	M	INRiM (Istituto Nazionale di Ricerca Metrologica), Italy
22	CCI document "Climatological reference stations: definitions and requirements"	Andrew Harper	M	NIWA (National Institute of Water and Atmospheric Research Ltd.), New Zealand
23	Director of the lead centre	GUO Jianxia	F	CMA (China Meteorological Administration), China

- 2nd in Person Meeting in September 2023 in Torino (Italy) will be essential
 - to finalize station assessment for the pilot phase
 - to define first GSRN products (not enough input from the climate users yet, what should be included in the products) for temperature and precipitation
 - The meeting will be held in parallel to the “4th Metrology for Meteorology and Climate Conference – MMC 2023” – chance to exchange with other experts
- Ideas for INFCOM III (April 2024):
 - ask for an extension of the work of the TT-GSRN until INFCOM IV (April 2026)
 - slightly change the composition of the TT

Thank you



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