



**DUE GLOBTEMPERATURE PROJECT**

**International Land Surface Temperature and Emissivity  
Working Group (ILSTE-WG) Terms of Reference**

**WP2.1 – DEL-14**

Ref.: GlobTemp-WP2.1-DEL-14

Date: 2-Feb-15

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## ILSTE-WG Terms of Reference

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### Signatures

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## 0. Executive Summary

The International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) Terms of Reference describe the purpose and expectations of the ILSTE-WG. Necessarily these are rather general since the working group is an independent, voluntary and flexible network rather than one set-up under the direction of an international organisation. Accompanying information sets out conceptual information for the ILSTE-WG.

In the future, the Terms of Reference for the ILSTE-WG could be developed to provide a more detailed framework for the group including strategic direction and reporting to key organisations. This is deliberately not the case at the current time; rather the Terms of Reference should be viewed as an expression of the overall philosophy and aims of the ILSTE-WG.

This document also includes draft Terms of Reference for the Steering Committee. These need to be agreed in principle by partners in the ILSTE-WG and by the general membership. The formal agreement would have to take place at an annual meeting of the ILSTE-WG, probably in summer 2015. Important aspects in the draft Terms of Reference include the remit of the Steering Committee; provision for co-Chairs and a secretary; suggestions for ex officio and ad hominem, elected members; guidance as to operations and communications enabled by the Steering Committee.

The initial iterations of Terms of Reference will take place with ESA, Eumetsat, NOAA, NASA and the interim Steering Committee, before being shared with a wider group in the first six months of this year.

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## 1. Introduction

The remit of the International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) is to provide advice and recommendations to the wider scientific and user communities on the best practices for retrieval, validation and exploitation of Land Surface Temperature (LST), Ice Surface Temperature (IST), Lake Surface Water Temperature (LSWT), and Land Surface Emissivity (LSE). This will require establishment of a common understanding of LST/LSE; standard protocols for data, validation and other activities; and communication between data providers, LST experts and users; interaction with international bodies.

There is a very clear rationale for the existence of an ILSTE-WG:

- ❖ LST and LSE datasets from the primary producers are of increasing high quality and increasing impact
- ❖ Exploitation of LST and LSE data is, however, limited by problems which are common to the international community working in this area:
  - users requiring better understanding of the nature of the data
  - users wishing to see signposts to high quality LST products from individual sensors
  - users wishing for data in consistent formats with better understanding of uncertainty budgets
  - users wishing to use combined data or to derive their own combined datasets
  - users wishing to be confident of a formal communication route to LST experts

The group will provide a forum for advice for both individual data providers and users, but also a source of review for ILSTE-WG documents and for those of related projects such as GlobTemperature.

The overall aim of the Group is to be a truly international collective providing a unifying, collaborative element in the LST / LSE community bringing together users with producers and providers of data.

The purpose and scope of this document is primarily to articulate the rationale and philosophy behind Terms of Reference for the ILSTE-WG. For clarity, some key definitions are presented (Section 2). Section 3 provides overall Terms of Reference for the ILSTE-WG and more detailed draft Terms of Reference for the Steering Committee. Further information related to key aspects of the ILSTE-WG are also given (Section 4).

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## 1.1. Applicable documents

**Table 1: List of applicable documents**

Reference Number	Document	Reference
[AD-1]	ILSTE-WG Progress Report	GlobTemp-WP2-DEL-16
[AD-2]	LST White Paper	GlobTemp-WP2-DEL-28
[AD-3]	LST Handbook	GlobTemp-WP3-DEL-25
[AD-4]	Common Nomenclature	GlobTemp-WP2-DEL-8

## 1.2. Reference documents

**Table 2: List of reference documents**

Reference Number	Reference
[RD-1]	Li, Z.-L., et al., Satellite-derived land surface temperature: Current status and perspectives. <i>Remote Sensing of Environment</i> , 2013. 131: p. 14-37.
[RD-2]	Becker, F. and Z.L. Li, Surface temperature and emissivity at various scales: Definition, measurement and related problems. <i>Remote Sensing Reviews</i> , 1995. 12(3-4): p. 225-253.
[RD-3]	Joint Committee for Guides in Metrology, Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement. 2008.
[RD-4]	Norman, J.M. and F. Becker, Terminology in thermal infrared remote sensing of natural surfaces. <i>Agricultural and Forest Meteorology</i> , 1995. 77: p. 153-166.
[RD-5]	Schneider, P., et al., Land Surface Temperature Validation Protocol (Report to European Space Agency). 2012(UL-NILU-ESA-LST-LVP).
[RD-6]	GES DISC, Goddard Earth Sciences Data and Information Services Center ( <a href="http://disc.sci.gsfc.nasa.gov/">http://disc.sci.gsfc.nasa.gov/</a> ).
[RD-7]	Merchant, C.J., et al., The surface temperatures of Earth: steps towards integrated understanding of variability and change. <i>Geosci. Instrum. Method. Data Syst.</i> , 2013. 2(2): p. 305-321.



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Reference Number	Reference
[RD-8]	Schaepman-Strub, G., et al., Reflectance quantities in optical remote sensing—definitions and case studies. Remote Sensing of Environment, 2006. 103(1): p. 27-42.
[RD-9]	Wan, Z. and J. Dozier, A generalized split-window algorithm for retrieving land surface temperature from space. IEEE Transactions on Geoscience and Remote Sensing, 1996. 34: p. 892–905.
[RD-10]	CEOS, Committee on Earth Observation Satellites ( <a href="http://www.ceos.org/">http://www.ceos.org/</a> ).
[RD-11]	LSA SAF, EUMETSAT Land Surface Analysis Satellite Applications Facility <a href="http://landsaf.meteo.pt/">http://landsaf.meteo.pt/</a> .
[RD-12]	MyOcean, Ocean Monitoring and Forecasting <a href="http://www.myocean.eu/">http://www.myocean.eu/</a> .
[RD-13]	GCOS, Global Climate Observing System <a href="http://www.wmo.int/pages/prog/gcos/index.php?name=news">http://www.wmo.int/pages/prog/gcos/index.php?name=news</a> .
[RD-14]	GloboLakes, Global Observatory of Lake Responses to Environmental Change <a href="http://www.globolakes.ac.uk/">http://www.globolakes.ac.uk/</a> .
[RD-15]	ISCCP, International Satellite Cloud Climatology Project <a href="http://isccp.giss.nasa.gov/">http://isccp.giss.nasa.gov/</a> .
[RD-16]	CEOS-LPV, Land Product Validation (LPV) sub-group of the CEOS Working Group on Calibration and Validation (WGCV) <a href="http://lpvs.gsfc.nasa.gov/">http://lpvs.gsfc.nasa.gov/</a> .
[RD-17]	EarthTemp Network, <a href="http://www.earthtemp.net/">http://www.earthtemp.net/</a> .
[RD-18]	GHRSSST, Group for High Resolution Sea Surface Temperature <a href="https://www.ghrsst.org/">https://www.ghrsst.org/</a> .
[RD-19]	ESA DUE, ESA Data User Elements Programme <a href="http://due.esrin.esa.int/">http://due.esrin.esa.int/</a> .
[RD-20]	ESA CCI, ESA Climate Change Initiative Programme <a href="http://www.esa-cci.org/">http://www.esa-cci.org/</a> .
[RD-21]	MODIS Snow/Ice Project, The MODIS Snow and Sea Ice Global Mapping Project <a href="http://modis-snow-ice.gsfc.nasa.gov/">http://modis-snow-ice.gsfc.nasa.gov/</a> .
[RD-22]	S3-MPC, Sentinel-3 Mission Performance Centre.
[RD-23]	S3VT, ESA Sentinel-3 Validation Team <a href="http://congrexprojects.com/2013-events/13m56/introduction">http://congrexprojects.com/2013-events/13m56/introduction</a> .
[RD-24]	IPCC, Intergovernmental Panel on Climate Change <a href="http://www.ipcc.ch/">http://www.ipcc.ch/</a> .

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Reference Number	Reference
[RD-25]	WMO, World Meteorological Organization <a href="http://www.wmo.int/pages/index_en.html">http://www.wmo.int/pages/index_en.html</a> .
[RD-26]	GEWEX, Global Energy and Water Exchanges Project <a href="http://www.gewex.org/">http://www.gewex.org/</a> .
[RD-27]	GEOSS, Global Earth Observation System of Systems <a href="http://www.earthobservations.org/geoss.shtml">http://www.earthobservations.org/geoss.shtml</a> .
[RD-28]	OSI-SAF, EUMETSAT Ocean & Sea Ice Satellite Application Facility <a href="http://www.osi-saf.org/">http://www.osi-saf.org/</a> .
[RD-29]	NOAA-NCDC, National Oceanic and Atmospheric Administration - National Climatic Data Center <a href="http://www.ncdc.noaa.gov/">http://www.ncdc.noaa.gov/</a> .

### 1.3. Glossary

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- AGU ----- American Geophysical Union
- BT----- Brightness Temperature
- CEOS-LPV ----- Committee on Earth Observation Satellites – Land Product Validation
- DAAC----- Distributed Active Archive Center
- DUE----- Data user Element
- ECS----- Earth Climate System
- ECV ----- Essential Climate Variable
- EGU----- European Geosciences Union
- EO----- Earth Observation
- EOEP----- Earth Observation Envelope Programme
- ESA ----- European Space Agency
- EUMETSAT----- European Organisation for the Exploitation of Meteorological Satellites
- FV/FVC----- Fractional Vegetation Cover
- GCOS----- Global Climate Observing System
- GEO----- Group on Earth Observations
- GEOSS----- Global Earth Observation System of Systems
- GEWEX----- Global Energy and Water Cycle Experiment
- GHRSSST----- Group for High Resolution Sea Surface Temperatures
- ILSTE-WG----- International Land Surface Temperature & Emissivity Working Group
- IPCC----- Intergovernmental Panel on Climate Change
- ISCCP----- International Satellite Cloud Climatology Project
- IST ----- Ice Surface Temperature



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LSA-SAF----- Land Surface Analysis Satellite Application Facility  
LSAT----- Land Surface Air Temperature  
LSE----- Land Surface Emissivity  
LST----- Land Surface Temperature  
LSWT----- Lake Surface Water Temperature  
MEaSURES----- Making Earth System Data Records for Use in Research Environments  
NASA----- National Aeronautics and Space Administration  
NCEO----- National Centre for Earth Observation  
NOAA ----- National Oceanic and Atmospheric Administration  
OSI-SAF ----- Ocean and Sea-Ice Satellite Application Facility  
PUG----- Product User Guide  
PW----- Precipitable Water  
SLA----- Service Level Agreement  
SST----- Sea Surface Temperature  
SW----- Split Window  
TAG----- Technical Advisory Group  
TCWV----- Total Column Water Vapour  
TIR ----- Thermal Infrared  
UCM----- User Consultation Meeting  
VAA----- Viewing Azimuth Angle  
VZA----- Viewing Zenith Angle  
WMO----- World Meteorological Organisation

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## 2. Definitions

A series of definitions are given in this section to clarify terms that are needed for the work of the ILSTE-WG, and to ensure consistency of usage in the workings of the ILSTE-WG. Only key definitions relevant to this document are given here.

### 2.1. Physical Principles

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Measurements of LST play a key role in describing the physics of land-surface processes on regional and global scales as they combine information on both the surface-atmosphere interactions and energy fluxes within the Earth Climate System (ECS). An increased recognition of the importance of LST for hydrological, ecological, agricultural and climatic studies has driven the development of LST data products and measurements from space.

There are still significant challenges to retrieving LST and LSE due to the ill-posed nature of the problem [RD-1]. The derivation of LST and LSE data sets requires significant channels with sensitivity to surface emissions, well understood absolute and relative calibration errors (between the channels for LST, LSE retrievals), very good atmospheric corrections and very good cloud clearing. LST and LSE can be derived from thermal infra-red and microwave observations by satellites. The provenance of LST and is well understood but needs expression in common terms and error budgets. The quality of LSE data is rapidly increasing but its Inter-dependence on LSE needs quantifying. For this reason the ILSTE-WG is fundamentally concerned with both variables.

Satellite derived LST can be regarded as the surface skin temperature in the instrument field of view. However due the varying topographic and highly heterogeneous nature of the earth's surface, estimation from space is non-trivial [RD-2] and interpretation requires careful consideration. Scaling of LST to satellite spatial resolution brings further complications due to mixing of several different types of land cover. Nonetheless, progress is being made in defining and describing LST as the effective radiative temperature of an area which can be related, for example, to a canopy temperature, a bare soil temperature, or a water temperature as appropriate.

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## 2.2. Summary of Key Nomenclature

**Table 3: Key common nomenclature for LST and LSE related terms. A full set of definitions can be found in [AD-4]. Starred entries indicate terms that are defined only in the context in which they are used, i.e. in terms of a particular sensor wavelength and a given approximation to the radiative transfer equation.**

Terminology	Definition
Accuracy	Accuracy is defined as the degree of conformity of the measurement of a quantity and an accepted value or the “true” value [RD-3]
Biome	The term biome in LST science is used to define the land cover classification. For some LST retrieval schemes coefficients may be categorised by biome.
Brightness temperature (BT)	Brightness temperature is a directional temperature obtained by equating the measured radiance with the integral over wavelength of the Planck’s Black Body function times the sensor response. It is the temperature of a black body that would have the same radiance as the radiance actually observed with the radiometer [RD-4]
Calibration	Calibration is the process of quantitatively defining the system response to known, controlled system inputs [RD-5]
Error	Result of a measurement minus a true value of the measurand. Note that in practice a true value cannot be determined and therefore a conventional true value is used instead [RD-3]
Ice surface temperature (IST)*	The surface temperature of ice bodies including land ice, and sea-ice, measured in situ and estimated from satellites
Intercomparison	The process of comparing two or more LST data sets to allow evaluation of their relative consistency [RD-5]
Land surface air temperature (LSAT)	A measurement of the average kinetic energy of the air near the surface of the Earth. This is usually measured at 2m height at meteorological stations [RD-6, RD-7]
Land Surface emissivity (LSE)	Emissivity describes a material’s ability to emit the thermal energy which it has absorbed [RD-5]
Land surface temperature (LST)*	Land Surface Temperature (LST) is the aggregated radiative skin temperature derived from thermal radiation of all objects comprising the surface, measured in situ and estimated from satellite. It is a basic determinant of the terrestrial thermal behaviour, as it controls the effective radiating temperature of the Earth’s surface [RD-4, RD-5]



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Terminology	Definition
Lake surface water temperature (LSWT)*	The temperature of lake bodies including inland seas, reservoirs, both skin and depth, measured in situ and estimated from satellites [RD-7]
Radiance	The measure of the quantity of radiation emitted from the surface. The spectral radiance is the radiant flux in a beam per unit wavelength and per unit area and solid angle of that beam [RD-8]
Reference standard	Measurement standard designated for the calibration of other measurements standards for quantities of a given kind in a given organization or at a given location [RD-5]
Relative bias	A systematic error between measurements obtained from different data sources [RD-5]
Relative error	The relative error is the error of measurement divided by a true value of the measurand [RD-5]
Skin temperature	The temperature of a layer of a medium of depth equal to the penetration depth of the electromagnetic radiation at the given wavelengths [RD-4]. Surface brightness and radiometric temperatures are the effective temperature that a radiometer would measure near the surface, including emissivity effects and reflected downwelling radiance.
Split-Window (SW)	Refers to the use of adjacent infrared bands to correct for atmospheric effects based on differential absorption [RD-9]
Uncertainty	A parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand, that is the value of the particular quantity to be measured [RD-3]
Validation	The process of assessing, by independent means, the quality of the data products derived from the system outputs. Primarily this is an assessment of the accuracy using equivalent in situ observations [RD-10]

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## 3. Terms of References

### 3.1. Terms of Reference for the ILSTE-WG

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The purpose of the International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) is to provide a forum for co-ordination of activities to improve the quality of Land and related Surface Temperatures and Emissivity, to encourage data access and availability, to engage with users, and to provide advice and recommendations on best practice for retrieval, validation and exploitation.

Related surface temperatures to Land Surface Temperature (LST) and Land Surface Emissivity (LSE) include Ice Surface Temperature (IST), Lake Surface Water Temperature (LSWT), and their emissivities.

#### **Rationale for the ILSTE-WG**

There is a very clear rationale for the existence of an ILSTE-WG

- ❖ LST and LSE datasets from the primary producers are of increasing high quality and increasing impact
- ❖ Exploitation of LST and LSE data is, however, limited by problems which are common to the international community working in this area:
  - users requiring better understanding of the nature of the data
  - users wishing to see signposts to high quality LST products from individual sensors
  - users wishing for data in consistent formats with better understanding of uncertainty budgets
  - users wishing to use combined data or to derive their own combined datasets
  - users wishing to be confident of a formal communication route to LST experts
- ❖ An international co-ordination group can unify the LST&E community bringing together users with producers and providers of data.

The ILST&E-WG can enable breakthroughs in LST and LSE data and exploitation:

- ❖ The ILST&E-WG can represent the best available expertise in LST&E data techniques and LST-related science. It will allow data providers and data experts to share best practice in LST&E.
- ❖ The ILST&E-WG can be a natural conduit for interactions with operational and research agencies, drawing on the resources and projects of individual partners to build networking and support for activities.
- ❖ The ILST&E-WG can provide an additional international dimension for interactions with users. Its aims include support of easy access to information on LST&E, enabling of users to

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build on the experience of their peers to make the best and most efficient use of the available LST&E products and re-direction of users to specific sensor experts, strengthening feed backs between users and data providers.

- ❖ The ILST&E-WG can work, on behalf of the community, with major international bodies such as GCOS and WMO, providing a much-needed consensus on LST, LSE and their attributes.

### **Aims of the ILSTE-WG**

To offer maximum support to the community, the ILSTE-WG shall have a wide and open, international membership, related to LST and LSE, with oversight from a Steering Committee, part-elected and part *ex officio*.

The ILSTE-WG has a portfolio of aims:

- ❖ To act as an international forum for regular interactions between LST Measurement Teams, enabling improvements in data algorithms and data quality, and increased understandings of user requirements.
- ❖ To provide advice and scientific guidance to, and receive feedback from, the user community; to respond to feedback and issues raised by the user community including the exchange and serving of data.
- ❖ To agree standardised protocols for data formats and access to data, appropriate to key sectors of the LST and Emissivity user community; and to promote these protocols among dataset managers with the objective of adoption of these protocols in processing chains.
- ❖ To support a dedicated validation Technical Advisory Group, supporting a consistent approach to data validation, in line with the Committee on Earth Observation Satellites (CEOS) Land Product Validation (LPV) Best Practices, and linking individual validation projects.
- ❖ To support the alignment of LST best practice with the planned activities and data provision of operational agencies.
- ❖ To provide an independent source of advice and appraisal, as requested, for affiliated projects.
- ❖ To develop through the Measurement Teams both a White Paper and Handbook on LST and Emissivity to provide the user community with guidance on the physical principles, validation, and recommended approaches to application.
- ❖ To encourage full participation of members in all aspects of the ILSTE-WG for the benefit of all, including General Meetings and planned actions.
- ❖ To liaise as appropriate with other groups associated with measuring surface temperature and emissivity over land, lakes and ice.

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### **General Membership of the ILSTE-WG**

The general membership of the ILSTE-WG requires only light definition and should be defined in consultation with the partners in the working group.

- ❖ The criteria for general membership of the ILSTE-WG shall be proposed by the Interim Steering Committee and agreed at an open meeting of the ILSTE-WG
- ❖ Thereafter, changes to the general membership shall be agreed by the Steering Committee and ratified at an annual meeting of the ILSTE-WG
- ❖ The principle underlying these criteria shall be to ensure that the ILSTE-WG is open to a range of members interested in LST&E, is flexible, includes both data providers and users, is able to carry out its activities in an open and transparent manner, shall be able to operate publically and publish documents in an appropriate manner, e.g. on a publically accessible web-site.
- ❖ The general membership of the ILSTE-WG will expect to be pro-active in LST&E activities, ideally be pro-active in the community and able to contribute to the work of the ILSTE-WG or to benefit from its support.

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## 3.2. Terms of Reference for the ILSTE-WG Steering Committee

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### Purpose of the ILSTE-WG Steering Committee

The Steering Committee exists as the guiding body for the work of the ILSTE-WG through each year, promoting LST and LSE activities, supporting data accessibility and availability, advising on LST and LSE science, and encouraging users.

It is endorsed annually by the ILSTE-WG, with a refresh of the membership of the committee as defined below.

### Remit of the Steering Committee

The Steering Committee shall:

- ❖ Be the guiding force behind the ILSTE-WG, enabling it to act as a unifying element in the LST&E community, bringing together data providers and data users and enhancing communications between them at international level.
- ❖ Promote work on LST and LSE through the ILSTE-WG, publicising activities of the group, its international partners, associated projects and relevant community meetings.
- ❖ Enable the ILSTE-WG to be an international forum for regular interactions between LST&E measurement Teams, enabling improvements in data algorithms and data quality, and increased understanding of user requirements
- ❖ Support users to develop applications of LST&E, using appropriate data with uncertainty information, and encourage feedback from users on required accuracies for products and future sensors.
- ❖ Endorse and promote plans for Thematic Action Groups (TAGs) to support the development and use of satellite LST&E information , act as a forum for co-ordinating the groups, receive TAG reports and recommendations, and recommend routes for implementation of
- ❖ Support publication of advice on LST and LSE matters, signposting experts with relevant knowledge and enabling the sharing of best practice.
- ❖ Encourage easy access to LST and LSE data for users, working with its key partners who are data providers and providing a path to agreed standards of data format and quality characterisation.
- ❖ Facilitate joint activities on validation of LST&E data sets, working with agencies to encourage use of consistent validation protocols and best practice, and drawing on the resources of individual partners to develop co-ordinated validation programmes enabling traceable, multi-sensor evaluations.

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- ❖ Encourage interactions between the ILSTE-WG and international bodies such as the IPCC, CEOS and WMO.
- ❖ Plan and convene open meetings of the ILSTE-WG, preparing items for discussion and resolution at the ILSTE-WG meetings
- ❖ Monitor the success of the ILSTE-WG

### **Membership of the Steering Committee**

- ❖ The Steering Committee will have two co-Chairs, each of which will have a term of three years, renewable for one year to aid in handovers
- ❖ Relevant LST&E public agencies will have the right to nominate one representative, *ex officio*, onto the steering committee.
- ❖ 50% of the Committee shall be elected, ad hominem, from the general membership of the ILSTE-WG. The term of membership for each member shall be two years, extendable for a third year.

### **Meetings of the Steering Committee**

- ❖ Meetings of the Steering Committee will be held quarterly, by teleconference or face-to-face.
- ❖ One meeting of the Steering Committee will be held at the annual meeting of the ILSTE-WG.
- ❖ The Steering Committee will co-opt a non-voting member to act as the Secretary to the ILSTE-WG. The Secretary and co-Chairs will draft and approve minutes of the meeting which will be available to the ILSTE-WG on approval from the Steering Committee.
- ❖ The Steering Committee will produce an annual report, supported by the Secretary, to be presented to the ILSTE-WG at an annual meeting of the group.

### **Internal Communications**

- ❖ The Steering Committee will communicate with the general membership of the ILSTE-WG through an annual General Meeting, newsletters at regular intervals, minutes of its meetings and by interactions through its TAGs.
- ❖ Through the General Meetings, the Steering Committee will develop a set of Recommendations and subsequent Implementation Plan for the ILSTE-WG which will include: i) a set of objectives and strategy; ii) a set of actions to be undertaken; and iii) a schedule for these actions. The Committee will report on the success of the Implementation Plan to the General Meeting.

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- ❖ The ILSTE-WG will develop a web presence to add to its normal communications with members.

**External Relationships**

- ❖ The Steering Committee will maintain good relationships with agencies providing LST&E data
- ❖ The Steering Committee will establish relationships with major international organisations, formalising these where appropriate and agreed by the general membership of the ILSTE-WG.
- ❖ The Steering Committee will work with the wider ILSTE-WG to develop a Communications Plan identifying a strategy for external relationships.

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## 4. Building Partnerships

### 4.1. Contacts

Building partnerships across the community will be a very important role of the ILSTE-WG, providing a platform to bring users, data providers, international agencies, and other external groups together:

- ❖ A key element of the ILSTE-WG work will be to build partnerships with international bodies, for example the World Meteorological Organisation (WMO), the Committee on Earth Observation Satellites (CEOS), and the Intergovernmental Panel on Climate Change (IPCC); scientific programmes, for example the Global Climate Observing System (GCOS), the Global Energy and Water Cycle Experiment (GEWEX), and the Global Earth Observation System of Systems (GEOSS); and user agencies, for example meteorological offices and environment agencies, to harmonise international efforts and advance LST science and applications.
- ❖ Specific activities are needed to work with GCOS to promote the case for LST and LSE to be classified as an Essential Climate Variable (ECV), and with CEOS to promote virtual constellations for LST and standardised data protocols – including its Land Product Validation (LPV) working group to encourage its adoption of the LST Validation Protocol as a basis for a “Best Practices” set of guidelines.
- ❖ The ILSTE-WG will link to existing networks such as the EarthTemp network; and be affiliated with existing and new Projects such as GlobTemperature, NASA MEaSUREs (Making Earth System Data Records for Use in Research Environments) and ECOSTRESS. This will provide a platform for alignment of meetings.
- ❖ The ILSTE-WG will manage Technical Advisory Groups to support the development and use of satellite LST information, to promote scientific insight and innovation, to identify best-practices, and to facilitate the transfer of new science into user's applications. These groups will seek to develop partnerships with international bodies.

Individual members of the ILSTE-WG will play key roles in fostering formal links with the entities detailed in Table 4.

**Table 4: International external contacts**

Title	Reference	Rationale
EUMETSAT’s Land SAF	[RD-11]	EUMETSAT’s LandSAF includes the operational production of SEVIRI LST
MyOcean project	[RD-12]	The primary collaboration is in sea ice temperatures



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Title	Reference	Rationale
GCOS	[RD-13]	The Global Climate Observing System coordinates global efforts to provide long-term comprehensive observations for monitoring of climate. GCOS Essential Climate Variables (ECVs) are required to support the work of the UNFCCC and the IPCC. Although LST is not identified as an independent ECV, the work on the LST CDR and use of LST as a secondary ECV need to feed into GCOS.
GloboLakes	[RD-14]	The GloboLakes project extends the ARC-Lake LSWT database, including quantifying retrieval uncertainty and applying retrieval methods to other sensors.
ISCCP	[RD-15]	ISCCP provides almost 30 years of global land surface temperature data from a combinations of polar and geostationary satellites.
CEOS-LPV	[RD-16]	The CEOS Land Product Validation sub-group on LST and Emissivity aims to guide the community on validation protocols and working with users to define validation objectives.
EarthTemp Network	[RD-17]	The EarthTemp network aims to encourage and improve quantification and scientific understanding of surface temperature from meteorological stations and Earth Observation through sharing of knowledge and data.
GHRSSST	[RD-18]	The Group for High Resolution Sea Surface Temperatures coordinates the provision of state-of-the-art global high-resolution SST products to the operational oceanographic, meteorological, and climate communities.
ESA Data User Element Projects	[RD-19]	The Data User Element (DUE) is a programmatic component of the Earth Observation Envelope Programme (EOEP), with a mission is to favour the establishment of a long-term relationship between the User communities and Earth Observation
ESA Climate Change Initiative Projects	[RD-20]	Common theme of cloud detection being investigated with Cloud-CCI and Aerosol-CCI groups, with objective of their participation in Cloud Clearing Round Robin. The development of the long time series of SST from AVHRR by the SST-CCI group will provide guidance particularly on the development of the GlobTemperature Climate Data Record
MODIS Snow/Ice Project	[RD-21]	This project provides sea-ice and ice sheet surface temperature from MODIS.



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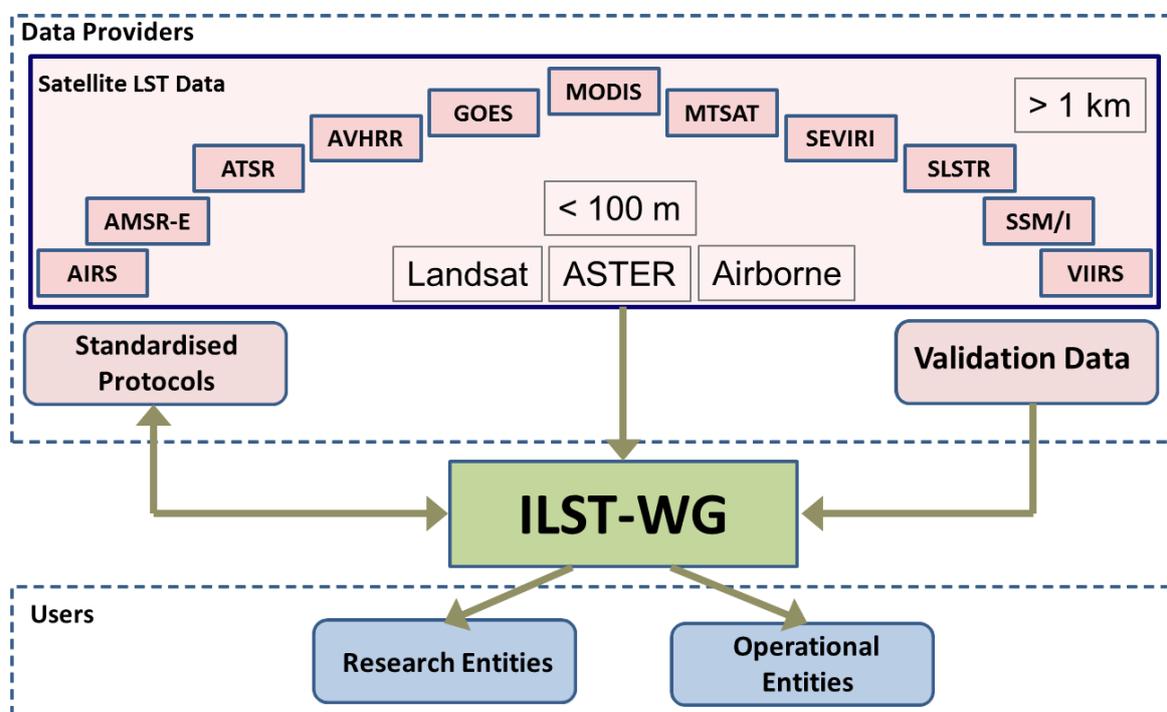
Title	Reference	Rationale
Sentinel-3 Mission Performance Centre	[RD-22]	The Sentinel-3 Mission Performance Centre is concerned with the quality of the operational Sentinel-3 core products, of which LST is one
Sentinel-3 Validation Team	[RD-23]	The Sentinel-3 Validation Team has an LST component in the Land sub-group.
IPCC	[RD-24]	The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. Creation of a LST Climate Data Record designed to satisfy the GCOS climate observation requirements for LST would be relevant.
WMO	[RD-25]	The WMO's Space Programme aims to promote availability and utilization of satellite data and products for weather, climate, water and related applications. The open provision of global multi-sensor LST data via the GlobTemperature Data Portal in harmonised format is in accordance with this aim.
GEWEX	[RD-26]	The Global Energy and Water Cycle Exchanges Project (GEWEX) is an integrated program of research, observations, and science activities that focuses on the atmospheric, terrestrial, radiative, hydrological, coupled processes, and interactions that determine the global and regional hydrological cycle, radiation and energy transitions, and their involvement in climate change
GEOSS	[RD-27]	The Group on Earth Observations (GEO) is coordinating efforts to build a Global Earth Observation System of Systems (GEOSS).
Eumetsat Ocean and Sea Ice SAF	[RD-28]	The Ocean and Sea Ice Satellite Application Facility (OSI SAF) manages the common requirements of meteorology and oceanography for a comprehensive information on the ocean-atmosphere interface
NOAA-NCDC	[RD-29]	NOAA are responsible for data archiving and dissemination of VIIRS Land Surface Temperature standard EDR.

## 4.2. User Support

User support from the ILSTE-WG can fall into two broad categories: i) LST and LSE data provision; and ii) scientific advice from LST and LSE experts.

### Data Provision

The ILSTE-WG will be a key guiding hand facilitating improved communications between the LST data providers and the user community. One aspect is ease of access to data products and standardised, relevant information. In principle, this includes both satellite and in situ data provision (Figure 1), although satellite data will likely be the main focus, and the respective Product User Guides (PUGs), validation reports, validation protocols, and scientific terminology (Section 2).



**Figure 1: Position of the International LST Working Group as the forum for improved communications between the LST data providers and user community**

### Advice and Guidance

A key element of improving data provider interactions with users is for the ILSTE-WG itself to foster close integration of the two communities in its own workings. Therefore the Steering Committee and Technical Advisory Groups (TAGs) should include key users in their working structures. In addition, the annual meetings should include discussion and breakout activities designed for users to drive developments in the LST and LSE community. Surveys of user needs should be continued as pioneered for LST and LSE in GlobTemperature.

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The scheduled two ILSTE-WG General Meetings (see [AD-1] for more details) – one in Europe and one in North America - are dedicated events to foster this interaction between the LST scientific experts and the LST application users, where advice and guidance can be exchanged, and feedback recorded to support an improved service to the user community.

Conferences and workshops are an important forum for dissemination of user information through presentations to a wider audience. Moreover, they represent ideal opportunities for face-to-face interaction between experts and users. In addition to the well-known international conferences such as the annual American Geophysical Union (AGU) Fall Meetings and the European Geosciences Union (EGU) General Assemblies, more focused meetings / workshops such as the annual EarthTemp Networking Meetings and the GlobTemperature User Consultation Meetings (UCMs) offer possibilities for expert / user interaction.

It is also the objective for the ILSTE-WG to be a source of advice and guidance whenever required. In other words, the ILSTE-WG will intend to respond to requests for help from users when required. How such requests can be best expedited needs further discussion in the ILSTE-WG but it should be a priority to experiment with cost-effective mechanisms in the next year with a view to developing long-term solutions. One option is to maintain contact details for dataset coordinators and / or helpdesks - such as the NASA Distributed Active Archive Centers (DAACs) - as provided in the dedicated ILSTE-WG Web presence; a dedicated help email address may provide an important single point-of-contact to underpin this signposting.

### 4.3. Data Sharing

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To improve the access and availability of data streams for the user community the ILSTE-WG will play a key role in encouraging the open exchange of satellite, model and in-situ LST data streams. A harmonised format is a concept being proposed and implemented by the Group including consistent Quality Control information and standardised auxiliary data. In this respect the lead is being taken by GlobTemperature, but much work is going on through individual members of the ILSTE-WG to promote the harmonised format to the dataset managers for new products / and future re-processing of existing archives.

The ILSTE-WG should adopt two key strategy points in their liaison with dataset managers: i) for satellite data providers - the correct acknowledgement of the original providers is important to maintain visibility; ii) for in situ data providers – to maintain dialogue and build close collaboration so such individuals continue to contribute to the utilisation of their data in terms of expertise.

Currently the GlobTemperature Data Portal offers the most appropriate stage for a user to coordinate their data access. This provides a single point of entry for access of many of the major LST datasets. The access itself can be divided into: i) direct access and dissemination to GlobTemperature LST products; ii) links and metadata descriptions for external datasets.

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#### **4.4. Communication and Training**

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The ILSTE-WG will manage and support Technical Advisory Groups (TAGs) which aim to address challenging aspects of LST development, such as data merging, uncertainty analysis and cloud clearing. Members of both the ILSTE-WG and GlobTemperature consortium partners will contribute to these TAGs. Furthermore, although official GlobTemperature deliverables the proposed LST White Paper [AD-2] and LST Handbook [AD-3] falls very much within the remit of the ILSTE-WG and it is intended that such documents would benefit from ILSTE-WG member contributions; and be a basis for user guidance.

At this current stage of its existence the ILSTE-WG has yet to have a formal web presence. In the immediate future the GlobTemperature Web Portal ([www.globtemperature.info](http://www.globtemperature.info)) offers the most feasible option to host: firstly, a public area for ILSTE-WG news, activities and documentation; and secondly, a private area dedicated to the sharing of information and data between ILSTE-WG members. The link to the Data Portal and links to external Data Portals would also be important here. The long term objective is a dedicated site / area that will be maintained well into the post-GlobTemperature era.

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