DUE GLOBTEMPERATURE PROJECT

International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) Implementation Plan

WP2.1 – DEL-15

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0. Executive Summary

The ESA DUE GlobTemperature International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) Implementation Plan details the creation and current structure of the ILSTE-WG, and looks ahead to its evolution over the foreseeable future. The foundation of the ILSTE-WG has come about through the framework of the GlobTemperature Project. A key motivation is international buy-in to the GlobTemperature support for the LST community and to the principles behind the project through establishment of a working science group involving key experts from inside and outside the project.

Exploitation of LST and emissivity data, while being addressed through GlobTemperature, faces challenges which are common to the international community working in this area. The ILSTE-WG is expected to be a truly international initiative providing a unifying, collaborative element in the LST community bringing together users with producers and providers of data. The Implementation Action Plan for the successful establishment and future growth of the Group is given in the table below.

Action Plan ID	Implementation Plan	Target Phase
IG-IAP-1	Draft Terms of Reference for the Steering Committee	Phase-1
IG-IAP-2	Lay the foundations for regular Steering Committee meetings (at least quarterly) and General Meetings (biannually)	Phase-1
IG-IAP-3	Create a framework for a multi-agency harmonised data format for LST and LSE	Phase-1
IG-IAP-4	Agree Terms of Reference for the Steering Committee	Phase-2
IG-IAP-5	Develop on online home for the ILSTE-WG for sharing, information, documentation and links to data.	Phase-2
IG-IAP-6	Improve visibility of the ILSTE-WG both within the scientific community and the wider public domain	Phase-2
IG-IAP-7	Build an effective base of communication between the ILSTE-WG and the user community	Phase-2
IG-IAP-8	Build a strong case for LST, and LSE classification within the concept of Essential Climate Variables (ECVs)	Phase-2
IG-IAP-9	Build the foundation for the adoption of the standardised LST Validation Protocol as community “Best Practices” guidelines	Phase-2
IG-IAP-10	Maintain a “living” list of priorities for the Group to address	Phase-2
IG-IAP-11	Build partnerships with international agencies, external groups, and LST/LSE-related scientific programmes and projects	Phase-3
IG-IAP-12	Lay the foundations for a sustainability through engagement with space agencies and operational service operators	Phase-3

1. Introduction

The foundation of an International Land Surface Temperature and Emissivity Working Group (ILSTE-WG) has come about through the framework of the GlobTemperature Project. A key motivation is international buy-in to the GlobTemperature support for the LST community through establishment of a working science group involving the strong expertise of the consortium and key experts from outside the project. The Group for High Resolution Sea Surface Temperature (GHRSST) experience for Sea Surface Temperature (SST) has demonstrated how a working science group can provide very significant gearing of additional effort and provide major impact in the exploitation of satellite data sets. The reasoning then is, that an equivalent entity, for Land / Ice and Lake Water Surface Temperature (LST / IST / LSWT) plus Land Surface Emissivity (LSE) could successfully coordinate activities between operational and research entities in a similar manner. Key arguments in the concept and subsequent foundation of such a Group can be summarised as follows:

- Consideration of the missing elements in the international LST community, and mindful of the continuing success of efforts in related Earth Observation areas, the concept of a globally international and multidisciplinary Land Surface Temperature Working Group of measurement experts and users was formulated

- Recent advances in LST and LSE retrieval, validation and exploitation means it has been a timely opportunity for greater coordination within the global community of satellite LST producers and users in this emerging field of Earth Observation

- Financial support has been provided to support ILSTE-WG activities for the first three years, through the GlobTemperature Project

- Promotion of the wider uptake of global-scale satellite LST by the research and operational user communities is a common objective of LST providers.

- Strengthening communication between producers will help to identify best practices in LST and LSE production and thereby accelerate product improvement

- Strengthening communication between users and producers will help raise users' awareness of the range of satellite LST products available and of their relative merits, build on the experience of their peers to make the best and most efficient use of the available LST products, and provide essential feedback to LST producers to help them prioritise product enhancements

The purpose and scope of this document is to: describe the foundation of the ILSTE-WG and the formation of the Steering Committee and the overall structure (Section 2); to define the objectives of the Group (Section 3); to assess the potential for project guidance with regards to GlobTemperature (Section 4); and to propose a strategy for future growth and success (Sections 5 and 0).

1.1. Applicable documents

Table 1: List of applicable documents

Reference Number	Document	Reference
[AD-1]	ILSTE-WG Terms of Reference	GlobTemp-WP2-DEL-14
[AD-2]	ILSTE-WG Progress Report	GlobTemp-WP2-DEL-16
[AD-3]	GlobTemperature Product User Guide (PUG)	GlobTemp-WP3-DEL-11
[AD-4]	GlobTemperature Requirements Baseline Document	GlobTemp-WP1-DEL-05
[AD-5]	GlobTemperature Technical Specification	GlobTemp-WP1-DEL-06
[AD-6]	LST Common Nomenclature Technical Note	GlobTemp-WP2-DEL-10
[AD-7]	GlobTemperature Validation Report	GlobTemp-WP4-DEL-12
[AD-8]	GlobTemperature Intercomparison Report	GlobTemp-WP4-DEL-13
[AD-9]	LST White Paper	GlobTemp-WP2-DEL-28

1.2. Reference documents

Table 2: List of reference documents

Reference Number	Reference
[RD-1]	LSA SAF, EUMETSAT Land Surface Analysis Satellite Applications Facility http://landsaf.meteo.pt/.
[RD-2]	MyOcean, Ocean Monitoring and Forecasting http://www.myocean.eu/.
[RD-3]	GCOS, Global Climate Observing System http://www.wmo.int/pages/prog/gcos/index.php?name=news.
[RD-4]	GloboLakes, Global Observatory of Lake Responses to Environmental Change http://www.globolakes.ac.uk/.
[RD-5]	ISCCP, International Satellite Cloud Climatology Project http://isccp.giss.nasa.gov/.

Reference Number	Reference
[RD-6]	CEOS-LPV, Land Product Validation (LPV) sub-group of the CEOS Working Group on Calibration and Validation (WGCV) http://lpvs.gsfc.nasa.gov/.
[RD-7]	EarthTemp Network, http://www.earthtemp.net/.
[RD-8]	GHRSST, Group for High Resolution Sea Surface Temperature https://www.ghrsst.org/.
[RD-9]	ESA DUE, ESA Data User Elements Programme http://due.esrin.esa.int/.
[RD-10]	ESA CCI, ESA Climate Change Initiative Programme http://www.esa-cci.org/.
[RD-11]	MODIS Snow/Ice Project, The MODIS Snow and Sea Ice Global Mapping Project http://modis-snow-ice.gsfc.nasa.gov/.
[RD-12]	S3-MPC, Sentinel-3 Mission Perfomance Centre.
[RD-13]	S3VT, ESA Sentinel-3 Validation Team http://congrexprojects.com/2013-events/13m56/introduction.
[RD-14]	IPCC, Intergovernmental Panel on Climate Change http://www.ipcc.ch/.
[RD-15]	WMO, World Meteorological Organization http://www.wmo.int/pages/index_en.html.
[RD-16]	GEWEX, Global Energy and Water Exchanges Project http://www.gewex.org/.
[RD-17]	GEOSS, Global Earth Observation System of Systems http://www.earthobservations.org/geoss.shtml.
[RD-18]	OSI-SAF, EUMETSAT Ocean & Sea Ice Satellite Application Facility http://www.osi-saf.org/.
[RD-19]	NOAA-NCDC, National Oceanic and Atmospheric Administration - National Climatic Data Center http://www.ncdc.noaa.gov/.
[RD-20]	Schneider, P., et al., Land Surface Temperature Validation Protocol (Report to European Space Agency). 2012(UL-NILU-ESA-LST-LVP).

1.3. Glossary

AFG---------- Algorithm Focus Group
AGU ---------- American Geophysical Union
(A)ATSR---------- (Advanced) Along Track Scanning Radiometer
ASTER ---------- Advanced Spaceborne Thermal Emission and Reflection Radiometer
ASTER-GED------ ASTER Global Emissivity Database
AUX---------- Auxiliary
CCI-2---------- Climate Change Initiative 2
CEOS-LPV ------- Committee on Earth Observation Satellites – Land Product Validation
CF ---------- Climate and Forecast Conventions
DAAC---------- Distributed Active Archive Center
DUE---------- Data user Element
ECOSTRESS------ ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station
ECV ---------- Essential Climate Variable
EO---------- Earth Observation
ESA ---------- European Space Agency
EUMETSAT------ European Organisation for the Exploitation of Meteorological Satellites
GCOS---------- Global Climate Observing System
GEO---------- Geostationary Earth Orbit
GEOSS---------- Global Earth Observation System of Systems
GEWEX---------- Global Energy and Water Cycle Experiment
GHRSST---------- Group for High Resolution Sea Surface Temperatures
ILSTE-WG------- International Land Surface Temperature & Emissivity Working Group
IPCC---------- Intergovernmental Panel on Climate Change
IPMA---------- Instituto Português do Mar e da Atmosfera
ISCCP---------- International Satellite Cloud Climatology Project
IST ---------- Ice Surface Temperature
JPL---------- Jet Propulsion Laboratory
LEO ---------- Low Earth Orbit
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
MODIS---------- Moderate Resolution Imaging Spectrometer

NASA---------- National Aeronautics and Space Administration
NASA-GCMD--- NASA Global Change Master Directory
NetCDF ---------- Network Common Data Format
NOAA ---------- National Oceanic and Atmospheric Administration
PUG---------- Product User Guide
SLSTR---------- Sea and Land Surface Temperature Radiometer
SST---------- Sea Surface Temperature
TAG---------- Technical Advisory Group
TOPC---------- GCOS Terrestrial Observation Panel for Climate
UCG---------- User Challenge Group
UCM---------- User Consultation Meeting
ULeic---------- University of Leicester
WMO---------- World Meteorological Organisation

2. Foundation and Structure

2.1. Steering Committee

2.1.1. Initial concept and implementation

The concept of where an ILSTE-WG would fit within the LST / LSE community was driven by the overarching aim to enable the LST / LSE community to achieve breakthroughs in the provision and exploitation of LST data in key areas. In order to do this the following concepts were envisaged:

- The ILSTE-WG would represent the best available expertise in LST and LSE data techniques and LST-related science, sharing best practice amongst data providers and data experts.
- The ILSTE-WG would provide a forum for linking LST data provision from different sources, raising the profile of LST and E data with user communities.
- The ILSTE-WG would be a natural conduit for interactions with operational agencies.
- The ILSTE-WG would provide a platform for co-ordinated validation programme, based on individual project plans.
- The ILSTE-WG would be provide an additional international dimension for interactions with users, delivering easy access to LST and LSE information, enabling users to build expertise and strengthening feed backs between users and data providers.
- The ILSTE-WG would work collectively with major international bodies such as the Global Climate Observing System (GCOS) and the World Meteorological Organisation (WMO) to increase the profiles of LST and LSE.

A benchmark for a successful international working group is the GHRSST community, who have achieved an equivalent breakthrough in Sea Surface Temperature (SST) usage through co-ordination.

The Terms of Reference of the Steering Committee are defined in [AD-1] (not reproduced here).

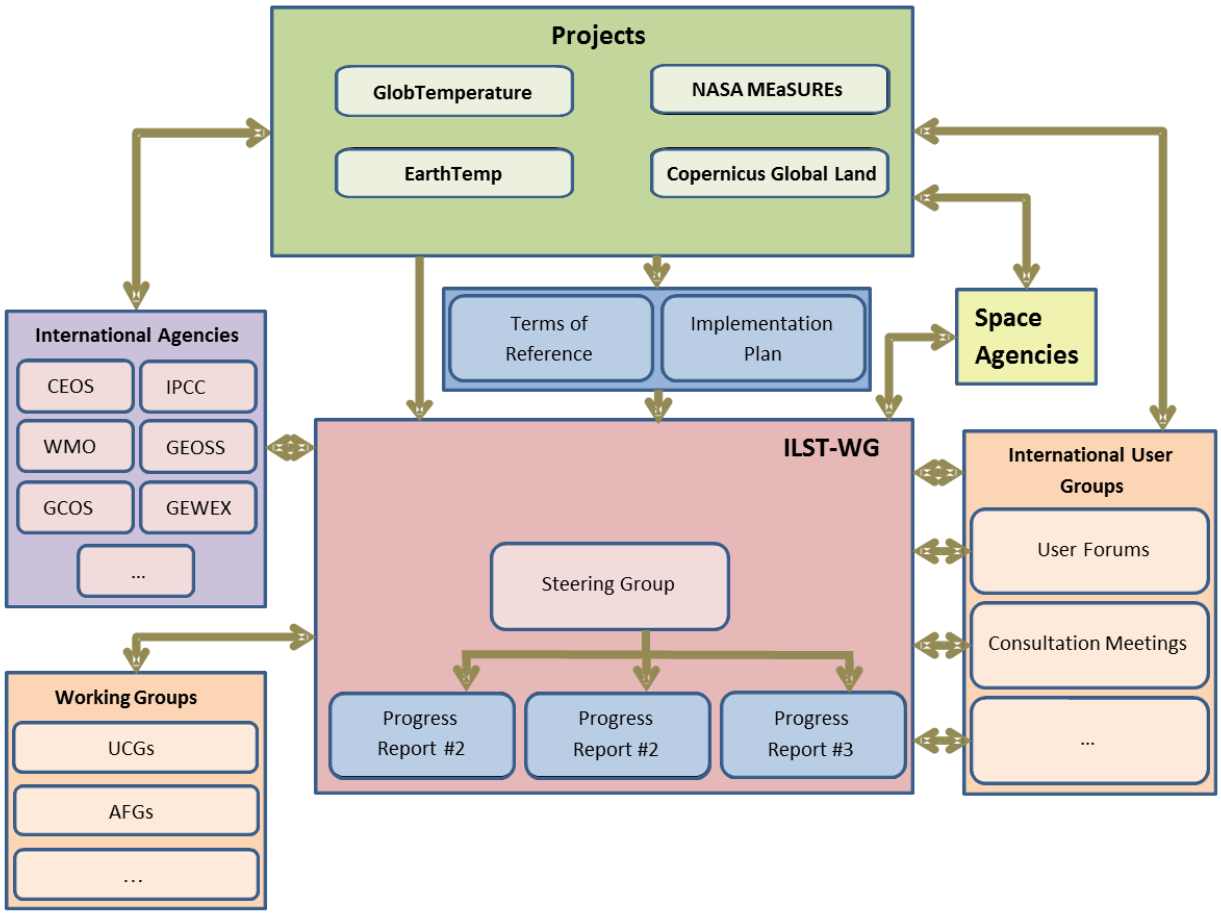

Figure 1: Schematic detailing the expected structure of the International LST & E Working Group (ILSTE-WG); UCGs are User Challenge Groups, and AFGs are Algorithm Focus Groups.

The structure and function of the ILSTE-WG (Figure 1) has been being jointly defined by representatives of three core institutions with an established heritage of LST data production and validation, and which represent some of the leading expertise in LST and LSE: i) NASA-JPL in the US; ii) University of Leicester (ULeic) in the UK; and iii) Instituto Português do Mar e da Atmosfera (IPMA) in Portugal. The aim being to create a truly international group dedicated to the development of products and exploitation by users of LST and LSE data with multi-agency support. This is particularly important in the post-GlobTemperature era where continuing development of this Group may be sustained by various inter-agency funding streams. The latter two institutions are members of the GlobTemperature Team, and the first is a member of the NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) Team. It was clear that there would be distinct advantages for the ILSTE-WG to exploit the synergies between LST components of NASA MEaSUREs and GlobTemperature.

A steering committee was subsequently setup including representatives from the three initiator institutions plus representatives from the space agencies (Table 3) involved in the satellite-retrieval of LST and LSE to facilitate inter-agency support: ESA, NASA, NOAA and EUMETSAT. The Steering

Committee is responsible for agreeing the Terms of Reference of the Group, planning for the General Meetings, and providing the leadership.

Table 3: Steering Committee Members

Name	Institute	Country	Role
Darren Ghent	University of Leicester	UK	GlobTemperature Project Scientist
Glynn Hulley	NASA-JPL	USA	NASA MEaSUREs representative
Isabel Trigo	IPMA	Portugal	LSA-SAF representative
John Remedios	University of Leicester	UK	GlobTemperature Project Director
Lothar Schuller	EUMETSAT	Germany	EUMETSAT representative
Pierre Guillevic	NASA-JPL	USA	NASA Validation Scientist
Simon Hook	NASA-JPL	USA	NASA representative
Simon Pinnock	European Space Agency	UK	ESA representative
Yunyue Yu	NOAA/NESDIS	USA	NOAA representative

A first key step in the implementation was to gain agency support, and NASA HQ was presented with the concept, with support received. Important in the acquisition of NASA support was an early rebranding from the original LST-WG to the ILSTE-WG this incorporating LSE in the concept and the recognition of it being a truly international collection of scientists. An invitation package was then sent to key potential members, who were identified as being able to bring important knowledge and contacts to the Group – all invitees accepted. The General Membership thus includes key experts and data providers (termed the “LST and LSE Measurement Team”) and key application users across all land, ice, and lake surfaces of the Earth. A full list of members, including subsequent additions, is presented in [AD-2].

In order to manage the ILSTE-WG, the current arrangement is for the Steering Committee to be initially co-chaired by Simon Hook from JPL and John Remedios (the GlobTemperature Project Director) supported by the GlobTemperature Project Scientist. The Project Scientist provides co-ordination support for the group and records minutes of the meetings. A dedicated Actions Database has been set up to manage activities agreed during meetings.

2.1.2. Evolution

Although initial funding of the ILSTE-WG has been through the GlobTemperature Project, management is to be light touch. This will involve selected members for review of GlobTemperature deliverables (see Section 4), sections for ILSTE-WG news in the GlobTemperature Newsletters, and collaborative work between the Steering Committee and ESA.

General Meetings have been proposed to take place bi-annually alternating between Europe - initially during the GlobTemperature User Consultation Meetings and North America during a large conference such as the American Geophysical Union (AGU) - with Steering Committee teleconferences taking place at least quarterly.

In addition to the invited members the General Membership has grown considerably following the 1st General Meeting in Karlsruhe, Germany, on June 26th 2014 (see [AD-2] for full meeting synopsis). The intention is for the group to continue to grow and new members are anticipated to join particularly following future General Meetings. Membership of the Steering Committee is also expected to evolve in terms of new members being invited onto the committee. This is important to maintain momentum and enthusiasm.

Currently, the ILSTE-WG does not have a formal online presence – all communication has to date been via email. It is the intention of the Steering Committee to develop on online home for the Group. In the immediate future it is proposed that an area of the GlobTemperature Web Portal be set aside for use by the ILSTE-WG with member specific access. All documentation and activities can then be managed through this restricted area. In addition, an ILSTE-WG specific email distribution list has already been created. The long-term aim is a dedicated website, but still maintaining a string link to GlobTemperature. A further key point on the visibility of the ILSTE-WG is the need for a discussion within the Steering Committee on a more memorable name for the Group (cf GHRSST for SST).

2.2. Technical Advisory Groups

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. Similar to the TAGs within GHRSST, the ILSTE-WG TAGs are to be formed and will operate as specialist forums for increasing scientific understanding and disseminating advice. The TAGs will support the development and use of satellite LST datasets and 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 identified international bodies.

Members of both the ILSTE-WG and other GlobTemperature consortium partners will contribute to these TAGs. A chair will be nominated for each TAG. It will be the responsibility of the Chair to organise meetings and teleconferences of the TAGs, to ensure meeting outcomes are documented, and activities are progressed. The Chair of each TAG will be supported by the GlobTemperature Management Team in all these aspects.

Initially, two types of groups have been identified as potentially useful: algorithm focus groups (AFGs) and user challenge groups (UCGs). The former would be more concerned with specific technical areas for research and development: emissivity and cloud clearing are two relevant areas. The user challenge groups would be more focussed at the interface where a combination of users and data experts might wish to make progress in a particular area (for example data assimilation, forest canopy temperatures, land surface air temperatures in relation to LST). Within these broad themes specific TAGs are anticipated. Although no TAG has currently been formed, since much of the first year of existence has

concentrated on building a strong foundation for sustainability, the expectation is that as the Group becomes established the TAGs will then become more prevalent.

2.3. Functions

Exploitation of LST and emissivity data, while being addressed through GlobTemperature, faces challenges which are common to the international community working in this area. The ILSTE-WG is expected to be a truly international initiative providing a unifying, collaborative element in the LST community bringing together users with producers and providers of data. The ILSTE-WG has thus been structured to provide some key functions:

- 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 deliver a range of user-provider meetings and workshops, increasing links across the community.
- To support the alignment of LST best practice with the planned activities and data provision of operational agencies
- To agree standardised protocols for data formats and access to data, appropriate to key sectors of the LST user community.
- To support a dedicated validation group, supporting a consistent approach to data validation, in line with CEOS-LPV Best Practices, and linking individual validation projects.
- To provide an independent source of advice and appraisal, as requested, for related projects such as the NASA MEaSUREs (Making Earth System Data Records for Use in Research Environments) Projects and the ESA DUE GlobTemperature Project.
- To develop white papers on LST, setting out the state-of-the-art at regular intervals

Some Projects have already been identified by the Steering Committee as either closely linked, or that would benefit from the oversight of the ILSTE-WG: GlobTemperature, NASA MEaSUREs, EarthTemp, the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), and Copernicus Land Services. The Steering Group is responsible to producing Progress Reports (the first one being [AD-2]), and the group as a whole is governed according to the Terms of Reference [AD-1] and this Implementation Plan. Strong links are envisaged both with Space Agencies (see Steering Committee links in Section 2.1.1), other International Agencies and International User Groups (Section 3). The TAGs (Section 2.2) are also an integral part of the structure.

3. ILSTE-WG Objectives

Common threads have already been identified for which the ILSTE-WG would be the forum to recommend best practice:

- Improved engagement with the international community of LST and Emissivity users
- The process towards acceptance and compliance of a harmonised data format
- Sharing of information, documentation and data – such as ground validation datasets
- Agreeing the derivation and endorsement of standard protocols in the field of LST and Emissivity
- Requirements for future instruments

3.1. International Partnerships

Partnerships with international bodies, scientific programs and user agencies are a key focus for the ILSTE-WG, with inter-agency support important for underpinning such cooperation. Here we expand the overall objectives for building international partnerships (as presented in [AD-1]) with further details on implementation:

- To build partnerships with international bodies, scientific programmes, and user agencies to harmonise international efforts and advance LST and LSE science and applications:

Table 4: Identified partnership agencies and programmes with proposed ILSET-WG contacts

Title	Reference	Proposed ILSTE-WG Contact(s)	Membership (SC = Steering Committee; GM = General Membership)
EUMETSAT's LSA SAF	[RD-1]	Isabel Trigo	SC
MyOcean project	[RD-2]	Jacob Hoyer	GM
GCOS	[RD-3]	John Remedios	SC
GloboLakes	[RD-4]	Chris Merchant	GM
ISCCP	[RD-5]	Catherine Prigent	GM
CEOS-LPV	[RD-6]	Simon Hook / Jose Sobrino	SH / GM

Title	Reference	Proposed ILSTE-WG Contact(s)	Membership (SC = Steering Committee; GM = General Membership)
EarthTemp Network	[RD-7]	Chris Merchant / John Remedios	GM / SC
GHRSST	[RD-8]	Chris Merchant	GM
ESA Data User Element Projects	[RD-9]	Simon Pinnock	SC
ESA Climate Change Initiative Projects	[RD-10]	Simon Pinnock	SC
MODIS Snow/Ice Project	[RD-11]	Dorothy Hall	GM
Sentinel-3 Mission Performance Centre	[RD-12]	Darren Ghent	SC
Sentinel-3 Validation Team	[RD-13]	Darren Ghent	SC
IPCC	[RD-14]	Lizzie Good	GM
WMO	[RD-15]	Lizzie Good	GM
GEWEX	[RD-16]	Catherine Prigent	GM
GEOSS	[RD-17]	John Remedios	SC
Eumetsat Ocean and Sea Ice SAF	[RD-18]	Jacob Hoyer	GM
NOAA-NCDC	[RD-19]	Yunyue Yu	SC

- To work with international partners to discuss the reclassification with LST and LSE as (part of) a primary Essential Climate Variable (ECV):
  - Initial contacts have been made with GCOS to discuss the status of LST
  - To work with GCOS to promote the case for LST and LSE to be classified as an ECV, with CEOS to promote virtual constellations for LST and standardised data protocols, and with GEO to build new user communities
  - First progress on this has been made with a set of slides derived for GCOS Terrestrial Observation Panel for Climate (TOPC) meeting in March 2014
  - The ILSTE-WG intend to engage with ESA in the preparation of Climate Change Initiative 2 (CCI-2) and to promote the case for inclusion of LST

- To link the ILSTE-WG to other international groups in technical practice, such as CEOS and its Land Product Validation (LPV) working group:
  - Simon Hook (ILSTE-WG Steering Committee member) and Jose Sobrino (ILSTE-WG General Member) are leading the LST/Emissivity focus area within the LPV.
  - A consistent approach to data validation, in line with CEOS-LPV Best Practices has been proposed within the LST Validation Protocol of [RD-20] which is publically available on the GlobTemperature Website.
- To consolidate strong links to existing networks / programmes / conferences to maximise the opportunities for attendance:
  - Alignment of meetings between the EarthTemp Network / GlobTemperature and the ILSTE-WG:
    - 1st ILSTE-WG General Meeting was held in conjunction with the 3rd EarthTemp Network Meeting and the 2nd GlobTemperature User Consultation Meeting (UCM #2) in Karlsruhe, Germany in June 2014
    - 3rd ILSTE-WG General Meeting is planned to collocate with the 4th EarthTemp Network Meeting and the 3rd GlobTemperature User Consultation Meeting (UCM #3) in Reading, UK in June 2015
  - Alignment of meetings with large international conferences and non-European programmes:
    - 2nd ILSTE-WG General Meeting is scheduled to collocate with a NASA MEaSUREs Project Meeting during the AGU 2014 Fall Meeting in San Francisco, US in December 2014
- To enable the ILSTE-WG is to provide an independent source of advice and appraisal, as requested, for related projects run by supporting agencies:
  - The ILSTE-WG is invited to provide advice on the quality of LST datasets, and of documentation produced within the framework of the GlobTemperature Project.
  - Key ILSTE-WG Steering Committee members are involved in the NASA MEaSUREs Project:
    - An objective of this project, in terms of LST and LSE, is to merge Low Earth Orbit (LEO) data - specifically from the Moderate Resolution Imaging Spectrometer (MODIS) - and Geostationary Earth Orbit (GEO) data. Considerable prospects of cross-collaboration between GlobTemperature and MEaSUREs are envisaged through the focal point of the ILSTE-WG.
  - Concepts initiated within Projects (such as the harmonised format and common nomenclature from GlobTemperature) have the potential to be adopted by the ILSTE-WG

and therefore incorporated into other affiliated projects, such as data processing within the LSA-SAF.

3.2. User Support

Evidence from the first year of the ILSTE-WG indicates that improvement in user-access to satellite LST data is a primary user requirement. A first activity has been to examine the process towards a common ("harmonised") format for LST products across all data providers, including metadata, quality control, and a common naming convention similar to that agreed by GHRSST. A start has already been made with the GlobTemperature-inspired format.

The Proposed harmonised format, which is defined and reported in [AD-5], has been circulated amongst the ILSTE-WG membership and has already been used for the implementation of ATSR and SEVIRI data on the GlobTemperature Data Portal.

There are already some initial signs that the concept of the harmonised format is being given due consideration. For example, the next EUMETSAT processing chain will be moving to netCDF-4 and the proposed ILSTE-WG harmonised format is being promoted as the one to adopt for LST. Additionally, there is a similar promotion within the NASA MEaSUREs Project for LST and LSE products to adopt the ILSTE-WG harmonised format.

However, it remains unlikely that operational MODIS products disseminated by the Distributed Active Archive Centers (DAACs) would change to a common format. Potential medium-term solutions here are: i) common format for European datasets with a link to existing MODIS data; ii) to make available the MODIS data and include the MODIS re-formatting tool; iii) the re-formatting of MODIS data within a current project such as GlobTemperature. Furthermore, while there is progress on the route towards harmonisation an agreed file naming convention has yet to be identified outside of GlobTemperature as a possible starting point. Assuming the ILSTE-WG is successful in implementing harmonised data and metadata across data providers then a common naming convention would then be priority.

3.3. Data Sharing

A core strategy of the ILSTE-WG is to both encourage the open exchange of satellite, model and in-situ LST data streams, and to propose guidelines for such a strategy. This includes support to both the sharing of data internally within the ILSTE-WG and also the provision of data to the wider community.

In the first case, online repositories for the exchange of data are required. Initially this can be on the GlobTemperature Website. A future aim may well be a separate entity. In the second case, the GlobTemperature Data Portal can accommodate the sharing of data within the wider community. Since this already adheres to the principle of the harmonised data format it is an ideal solution – at least in the immediate future. Moreover, since the GlobTemperature Project Partners are committed to maintained the Web Portal post-Project this provides the option of a longer term solution for an ILSTE-WG home.

Use of the GlobTemperature We b Portal means the ILSTE-WG should be internationalised, where logos of all supporting agencies could be added in acknowledgement of their support to the ILSTE-WG.

An example of the early sharing of data includes NASA-JPL agreement, through the ILSTE-WG, for the GlobTemperature Data Portal to externally link with their most recent datasets – MOD21 and the Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Emissivity Database (ASTER GED).

Strong links have been developed with the Sentinel-3 Validation Teams in the Land domain. This brings the benefit of community agreement to share both LST data and associated validation data. For example, data collected by our international partners at NASA JPL are to be made available to both the Sentinel-3 LST Validation Team and GlobTemperature from the well calibrated and established validation sites at Lake Tahoe and Salton Sea.

Software tools will be provided on the GlobTemperature portal in order to allow users to:

- Convert the LST data sets in user-required formats
- Project the data sets in specified map projections

These tools will be based on free libraries and will be described in the GlobTemperature Product User Guide (PUG) [AD-3] in PDF format. These tools can be made available for data sharing within the remit of the ILSTE-WG.

4. GlobTemperature and the ILSTE-WG

As mentioned in Section 0 financial support has been provided to support ILSTE-WG activities for the first three years, through the GlobTemperature Project. This means there is in intimate relationship between the ILSTE-WG and the GlobTemperature Project and its individual team members. For instance, core partners from GlobTemperature were involved in the initiation stage of the ILSTE-WG and the GlobTemperature Management Team retain responsibility – at least during the first three years – of ensuring meetings are organised and documented, actions are recorded and executed, and the lines of communication to the General Membership and beyond are maintained.

An important part of the implementation plan is that all data providers will be represented in the ILSTE-WG, and will interact regularly with consortium partners during the development of the harmonised data format to be hosted on the Web Portal. Input to the Web Portal documentation will also be sought from the Group for appropriate datasets. The ILSTE-WG will also be invited to collaborate with the respective consortium partners in several other GlobTemperature developments:

- Provision of data and tools on the Web Portal
- Validation and intercomparison utilising additional in situ measurements
- Data merging
- Climate Data Record
- Submitting algorithms to the cloud clearing round robin
- Preparatory work for SLSTR

With regards to the independent source of advice and appraisal for the GlobTemperature Project several deliverables have been identified whereby the ILSTE-WG is seen as a forum for review (ILSTE-WG members have already contributed to the review of documents marked with *):

- DEL-04: GlobTemperature Web Portal
  - v2 [M24], v3 [M36]
- DEL-05: Requirements Baseline Document [AD-4]
  - v1 [M12]*, v2 [M24], v3 [M36]
- DEL-06: Technical Specification Document [AD-5]
  - v2 [M24]
- DEL-10: Technical Note – Definition of a common nomenclature for LST [AD-6]
  - [M12]*
- DEL-12: Satellite LST Validation Report [AD-7]

- v2 [M24], v3 [M36]

- DEL-13: Satellite LST Intercomparison Report [AD-8]
  - v2 [M24], v3 [M36]
- DEL-28: White Paper on Satellite LST [AD-9]
  - [M24]

With regard to DEL-05, ILSTE-WG members contributed at the 2nd GlobTemperature user consultation. DEL-10 was reviewed by members of the ILSTE-WG. With respect to future documents, individuals from the ILSTE-WG General Membership will be identified and approached to review selected deliverables appropriate to their skills and interests; these individuals will be external to the GlobTemperature Project Team. Documents will be reviewed once they have attained a level of maturity. For most, Version 2 will be the appropriate level for review.

Important to note that the objective from GlobTemperature has been to set up and grow this Working Group. As such, while encouragement is given for members to contribute to the review of GlobTemperature products and deliverables this should not be a barrier to the success of the Group, and if resistance is met then the success of the Group is to take priority. Indeed, an option here is to task ILSTE-WG members who are also UCS partners to carry out reviews. Moreover, in the interest of international buy-in and cooperation other projects affiliated with the ILSTE-WG should also be provided with the same level of support in terms of document and product review.

5. Responsibilities

Members of the ILSTE-WG have several duties to perform as part of this evolving initiative. These can be summarised as:

- Monitoring and advising on the scientific quality and user exploitation of LST and LSE from affiliated projects
- Proactive participation in ILSTE-WG meetings
- Building partnerships with international bodies and user agencies
- Facilitating negotiations on data access in common formats
- Promoting the long-term continuity of satellite LST and LSE data sets; the development of operational LST and LSE data services and new generations of LST and LSE satellite missions; and the integration of data from complementary satellites
- Documenting the activities of the ILSTE-WG:
  - ILSTE-WG Terms of Reference
  - ILSTE-WG Implementation Plan
  - ILSTE-WG Progress Reports
  - LST White Paper

These responsibilities are formalised within the Terms of Reference [AD-1] but are not designed to be overly burdensome. Indeed, it is the intention that individual members of the ILSTE-WG gain considerable benefits through membership, such as:

- Sharing of knowledge and data
- Positive influence on the strategic direction of LST and LSE data production and exploitation
- Forging of good working relationships with LST scientists internationally leading to future collaboration

6. Road Map

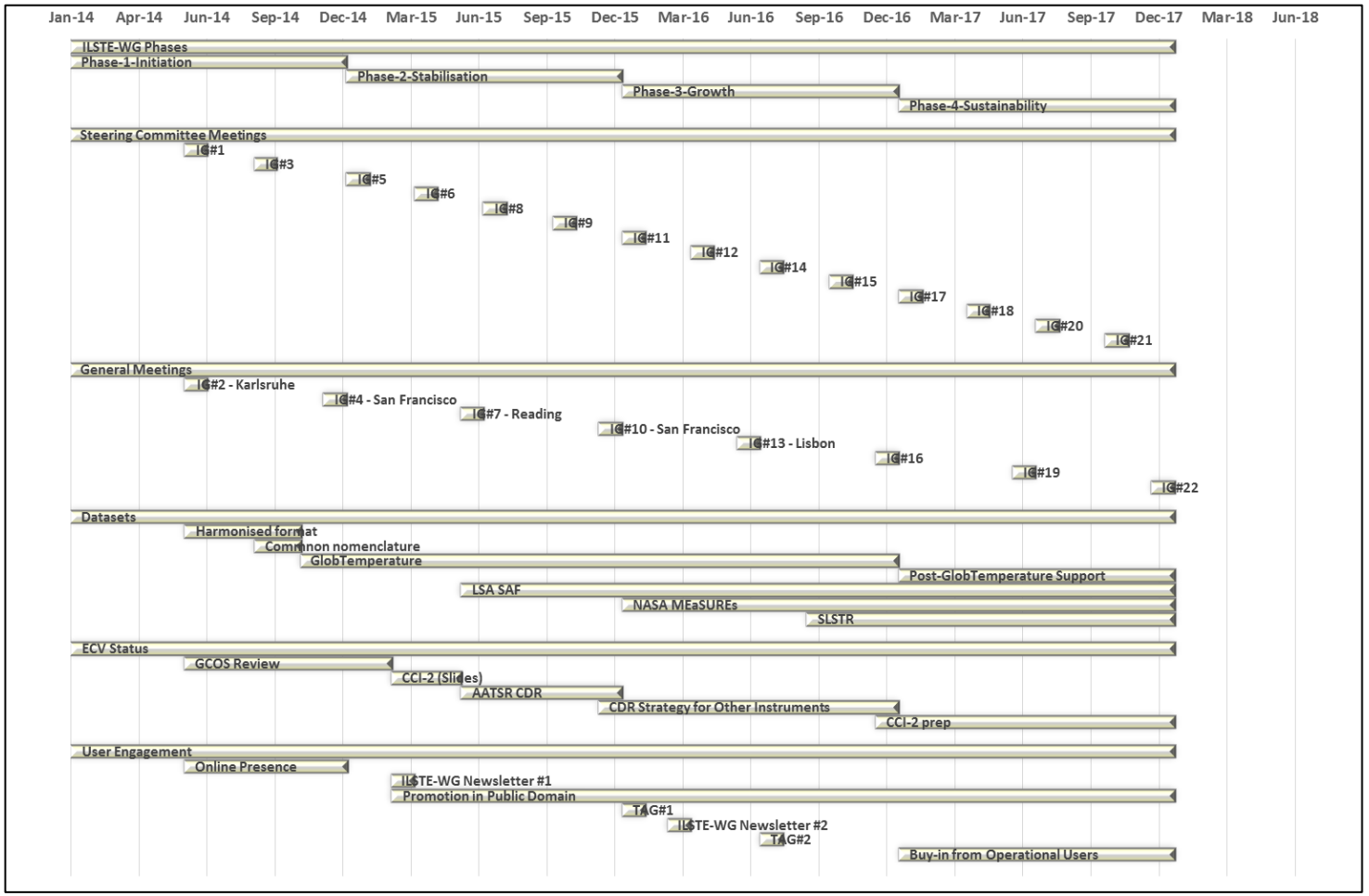

Figure 2: Road map of ILSTE_WG Implementation Activities

7. Conclusions

Exploitation of LST and emissivity data, while being addressed through GlobTemperature, faces challenges which are common to the international community working in this area. The ILSTE-WG is expected to be a truly international initiative providing a unifying, collaborative element in the LST community bringing together users with producers and providers of data. The concept of where an ILSTE-WG would fit within the LST / LSE community has been driven by the overarching aim to enable the LST / LSE community to achieve breakthroughs in the provision and exploitation of LST data in key areas.

Since initial funding of the ILSTE-WG has been through the GlobTemperature Project, there is in intimate relationship between the ILSTE-WG and the GlobTemperature Project and its individual team members. ILSTE-WG General Membership is growing, and members have already contributed to GlobTemperature documents. It will be possible to approach members to review selected deliverables appropriate to their skills and interests, and the ILSTE-WG will also be invited to collaborate with the respective consortium partners in several other GlobTemperature developments.

The aim is to create a truly international group dedicated to the development of products and exploitation by users of LST and LSE data with multi-agency support. This will be particularly important in the post-GlobTemperature era where continuing development of this Group may be sustained by various inter-agency funding streams.

The implementation plan effectively has three streams of priorities. The first is concerned with the prominence, effectiveness and infrastructure of the group: a memorable name for the group; Terms of Reference for the group; definitions of meetings and space agency engagements; updates to implementation plans; relationships to other international programmatic activities; involvement of users. The second stream is concerned with technical developments: an online home for the Group (in the immediate future it is proposed that an area of the GlobTemperature Web Portal be set aside for use by the ILSTE-WG with member specific access); user engagement mechanisms; promotion of harmonised format and accessibility of datasets; identification of first priority technical issues (see comment on TAGs below). The third stream is concerned with support to LST and emissivity projects, particularly GlobTemperature as noted.

Common threads have already been identified for which the ILSTE-WG would be the forum to recommend best practice:

- Improved engagement with the international community of LST and Emissivity users
- The process towards acceptance and compliance of a harmonised data format
- Sharing of information, documentation and data – such as ground validation datasets
- Agreeing the derivation and endorsement of standard protocols in the field of LST and Emissivity

- Requirements for future instruments

The ILSTE-WG will also 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.

End of document