COST
Technical Committee "Physics"

COST Action P18

The Physics of Lightning Flash and its Effects

MONITORING PROGRESS REPORT

Period: from: 2005/06/24
to: 2005/12/31

This report is prepared by the Management Committee of the Action and presented to the Technical Committee of Physics.

1. OVERVIEW: ACTION IDENTIFICATION DATA

COST Action P18 Title : **The Physics of Lightning Flash and its Effects**

TC Recommendation: 26/11/2004	First MC meeting: 24/06/2005
CSO approval: 15/03/2005	Last MC meeting: 14/11/2005
Start date: 24/06/2005	Final Report:
Duration: 48 months	Evaluation Report:
Extension:	TC Evaluation:
End date: 23/06/2009	
Number of signatories: 19	

Signatories and date of signature:

Austria	31/05/2005	Confirmed
Belgium	24/05/2005	Confirmed
Bulgaria	19/08/2005	Confirmed
Denmark	16/06/2005	Confirmed
Finland	21/04/2005	Confirmed
France	19/07/2005	Confirmed
Germany	21/04/2005	Confirmed
Hungary	21/04/2005	Confirmed
Israel	16/08/2005	Confirmed
Netherlands	13/05/2005	Confirmed
Poland	21/04/2005	Confirmed
Serbia and Montenegro	11/07/2005	Confirmed
Slovenia	30/08/2005	Confirmed
Spain	02/06/2005	Confirmed
Sweden	16/06/2005	Confirmed
Switzerland	29/06/2005	Confirmed
United Kingdom	27/04/2005	Confirmed
Cyprus	19/07/2005	Intention
Italy	20/05/2005	Intention

Institutes of non-COST countries:

Ryerson University (Toronto – Canada)
University of Toronto (Canada)
Doshisha University (Kyoto – Japan)
Usikov Institute for Radio-Physics and Electronics (Kharkov - Ukraine)
National Technical University of Ukraine (Kiev -Ukraine)
University of Alaska (Fraibanks - USA)
University of Florida (Gainesville - USA)

Area: PHYSICS

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TC Rapporteur: Z. Kajcos
External Evaluator: to be nominated later
External Evaluator: **to be nominated later**

2. OBJECTIVES

The main objective of the Action is to increase the knowledge of the physics of the lightning discharge and of its effects on natural and man-made systems. This will include

(a) To understand and model the different physical processes in the lightning channel.
(b) To understand and model the lightning attachment to objects.
(c) Measurement of characteristics of lightning flashes in Europe and an establishment of a data bank on the lightning parameters, including a databank on the characteristics of the electromagnetic radiation of lightning from ELF to gamma rays.
(d) Develop models for the inverse source problem in lightning that is, inferring the characteristics of the processes in the lightning channel from remote measurements of the electromagnetic waves associated with lightning.
(e) To understand the mechanism of the production of the trace gas species in the atmosphere by the hot plasma channel and corona in lightning discharge.
(f) To understand the connection between the particular characteristics of lightning flashes and the associated observation of luminous events in the mesosphere and the lower ionosphere.

3. TECHNICAL DESCRIPTION AND IMPLEMENTATION

3.1 Organization of the work

The Management Committee (MC) is responsible for coordinating all the activity within the Action and will take advice from the Technical Committee Physics to liaison with other COST projects. To reduce cost, these meetings will be conducted in connection with the workshops and international conferences.

Research and Development Activities

The research and development activities of the Action will be concentrated into five areas as described below. Each will eventually be the focus of a working group.
WG1: Measurement of properties of various types of lightning discharge
WG2: Phenomenology and modeling of the processes in the lightning flash
WG3: Physics and models for the lightning attachment to objects
WG4: Inverse source problems in lightning
WG5: Mesospheric transient luminous events associated with lightning

WG1. Measurement of properties of various types of lightning discharges

Knowledge of the properties of the various physical processes in lightning is fundamental for the development of appropriate numerical models to calculate effects of a lightning strike to technical infrastructure or the human body. It is the goal of this WG to organize, compare and analyze following measurements from lightning: 1) Electric and magnetic fields from lightning for the whole duration of the lightning flash 2) Measurements of lightning current in lightning strike to towers and in triggered lightning, correlated with fields at different distances from lightning. 3) Time resolved optical measurements of the lightning channel correlated with the current and fields measurements 4) Measurements of X-rays and gamma rays from triggered lightning and lightning strike to towers, correlated with current, fields, and optical radiation. 5) Measurements of ELF (Schumann resonance) from the same lightning at different stations around the globe, correlated with wide-band measurements of fields near to the lightning.

In Europe, the tower on Mount Gaisberg in Austria is struck by lightning on average 65 times in a year and at present the tower is instrumented to measure lightning currents and plans are there for measuring time correlated electric fields at different distances also. The random nature of lightning requires that the correlated multi-station measurements of the various aspects on the same event are carried out to gather more insight in the physical processes of this natural phenomenon.

WG2. Phenomenology and modeling of the processes in the lightning flash

The goal of this work group is to contribute to the understanding of the physical phenomena in the different lightning flash processes. This WG will participate in the analysis of experimental data from WG 1 to improve our understanding of lightning phenomena and it will interact with WG 3 to help in the modeling and in the theoretical analyses of existing and proposed models. The specific objectives of this WG are:

Detailed analysis of the measurements carried out in WG1
Modeling of the various phases of the lightning discharge (the lightning initiation, stepped leader, lightning attachment, return stroke, continuing current, the M component, K changes, and dart leader).

WG3. Physics and models for the lightning attachment to objects

It is generally thought that the beginning of attachment process decides the strike point of lightning and therefore this process has great significance in the practical task of lightning protection. However, in the current lightning protection standard the point of strike of a lightning flash on a structure is evaluated by utilizing a concept called the

rolling sphere method which neglects almost all the physical processes that play important roles in determining the point of strike of a lightning flash.

The physical parameters that determine the lightning attachment, the differences in the attachment process when upward leaders are initiated from insulated objects (e.g., trees, rotor of windmills) as opposed to from grounded conducting objects (e.g., air terminals on top of buildings, towers), the conditions necessary for a tall object (e.g., tall tower, mountain top) to initiate long upward leader all the way to the cloud, the physics of triggering of lightning by flying objects (e.g., air planes, rocket carrying trailing wire in triggered lightning experiments) etc. are some of the questions, but not limited to, that this WG will try to find answer for.

WG4. Inverse source problems in lightning

The electromagnetic radiation from processes in lightning is not confined to the radio frequency spectrum, but also extend to microwave, infrared, visible light, ultraviolet, X-ray and gamma ray regions of spectrum. When compensated for the propagation effects, the radio waves from lightning can give information on the magnitudes of the currents and charges, its position and its time variation at the source region of lightning. The commonly used radio-frequency locating technique of the lightning processes are the magnetic direction finding, the time of arrival of the pulse technique, and the interferometric technique at higher frequencies. The lightning location networks, that continuously monitor time and position of lightning strikes works based on one of the above three principles. The other methods of detecting global lightning are Schumann resonance and satellite-based optical observations of lightning. This WG will conduct research required for deriving the properties of the sources in lightning from the remotely measured signals.

WG5. Mesospheric transient luminous events associated with lightning

The aim of WG5 is to promote European coordinated research on transient luminous events in the mesosphere. These transient luminous events are named sprites, elves, blue jets, and gigantic jets and they occur in association with particular tropospheric lightning discharges and thunderstorms. Many transient luminous events emanate from the top of thunderclouds and reach up to the ionosphere, briefly illuminating the mesosphere. Transient luminous events are a manifestation of the vertical coupling between the troposphere and the ionosphere and they release a substantial amount of electrodynamic and thermodynamic energy into the mesosphere.

Two European space-based sprite observation programs have been funded and are now in preparation, i.e., the TARANIS satellite (Elisabeth Blanc, CEA, and Francois Lefeuvre, CNRS) and the ASIM experiment on the International Space Station (Torsten Neubert, Danish Space Research Center). Both missions are scheduled to be launched in 2008/2009 at the end of this COST action. The aim of WG5 is to stimulate interest within the scientific community to support the planned space-based observations with ground-based observations and modeling.

Mode of Operation

Workshops

The Management Committee together with respective WG leaders will organise a series of workshops on the subject area of each Working Groups for better information flow and also to link this Action with the national research projects. Following this, at least one yearly workshop in the subject area of each Work Group (total 5) will be organised. In addition, there will be several cross-group workshops, the details of them will be decided later as the Action progresses. Once in two years, a symposium covering all the work groups will be held. At the end of each workshop and symposium, the proceedings will be published.

The Workshops will be timed to coincide with Management Committee meetings and may be associated with EMC Conferences in Europe.

Technical Visits

Technical visits to facilities of interest to the Workshop attendees and Management Committee delegates will be arranged around the workshops where appropriate.

Joint Technical Actions

In addition to the workshops, the MC will encourage development of Joint Technical Actions (JTAs) to enhance the existing national research programmes contributing to the Action.

4. PARTICIPATION AND COORDINATION

4.1 Management Committee

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Secretary: **Piotr Swiatek**

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Country	**MC Member**	**Affiliation**
Austria	Dr. Gerhard DIENDORFER	OVE-ALDIS (Austrian Electricity Association)
Belgium	Prof. Christian BOUQUEGNEAU	Faculté Polytechnique de Mons – Service Physique
Bulgaria	Prof. Alexander BLAGOEV	Faculty of Physics, St Kliment Ohridski University of Sofia
Cyprus	Dr. George GEORGHIOU	University of Cyprus
Denmark	Dr. Troels SORENSEN	Energi E2
Denmark	Dr. Torsten NEUBERT	Danish National Space Center
Finland	Dr. Tapio TUOMI	Finnish Meteorological Institute
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France	Dr. Gerard BERGER	University of Paris-Sud
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Italy	Prof. Carlo Alberto NUCCI	Universita di Bologna
Netherlands	Dr. Ute EBERT	CWI
Netherlands	Prof. Jan KUIJPERS	Radboud University
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Serbia and Montenegro	Prof. Miomir KOSTIC	Faculty of Electrical Engineering, University of Belgrade
Serbia and Montenegro	Prof. Jovan CVETIC	Faculty of Electrical Engineering, Belgrade University
Serbia and Montenegro (deputy member)	Prof. Snjezana MILIVOJEVIC	Faculty of Political Sciences of the Belgrade University
Slovenia	Dr. Janko KOSMAC	Elektroinstitute Milan Vidmar

Spain	Prof. Joan MONTANA PUIG	Universidad Politecnica de Catalunya
Spain	Dr. Manuel ARRAYàS	Universidad Rey juan Carlos
Spain (delegate)	Joan MONTAñA (full details not available)	
Sweden	Prof. Rajeev THOTTAPPILLIL	Angstrom Laboratoriet, Uppsala Universitet
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Switzerland	Dr. Marcos RUBINSTEIN	University of Applied Sciences of Western Switzerland
Switzerland	Dr. Farhad RACHIDI	EPFL Lausanne
United Kingdom	Dr. Martin FüLLEKRUG	University of Bath
United Kingdom	Dr. Clive P.R. SAUNDERS	The University of Manchester
United Kingdom (substitute to Martin Fullekrug)		Dr. Giles HARRISON The University of Reading

4.2 Participating Institutes

Ryerson University (Toronto – Canada)
University of Toronto (Canada)
Doshisha University (Kyoto – Japan)
Usikov Institute for Radio-Physics and Electronics (Kharkov - Ukraine)
National Technical University of Ukraine (Kiev -Ukraine)
University of Alaska (Fraibanks - USA)
University of Florida (Gainesville - USA)

4.3 Meetings of the Management Committee

Kick-off Meeting: June 24, 2005, Bruxelles

Second MCM Meeting: November 14 and 15, 2005, Lausanne, Switzerland

4.4 Meetings of the Working Groups

November 14 and 15, 2005, Lausanne, Switzerland

4.5 Short Term Scientific Missions

2005/12/03 – 2005/12/10, Host: Rajeev Thottappillil – Uppsala University, Sweden, Scientist: Davide Pavnello, Switzerland, Topic: Modeling lightning strikes to tall structures and the associated EM radiation

2005/12/13 – 2005/12/19, Host: Colin Price - Tel Aviv University, Israel, Scientist: Oscar van der Velde, France, Topic: Assisting the Sprite observation campaign in Israel.

5. RESULTS

In the first year (June-December 2005) there are no results of scientific programmes to report, other than the reports of the two STSM's conducted (The STSM reports 'Modeling lightning strikes to tall structures and the associated EM radiation' and 'Assisting the Sprite observation campaign in Israel' are enclosed). There are number of initiatives that will lead to scientific results from the Action and the first year has been spent in setting these up.
Regarding the organization of WGs, the MC appointed Working Group leaders (WGL) responsible for the activities of each group.
The first workshop will be organized in April 2006 in Vienna, in conjunction with the European Geosciences Union (EGU) meeting. The workshop is organized jointly with the International Project on Electromagnetic Radiation from Lightning to Tall Structures (http://emcwww.epfl.ch/iplt).
The MC defined a Joint technical Action on the simultaneous measurements of different lightning parameters at the unique European facility in Gaisberg, Austria. Other JTAs will be initiated as the Action progresses.

6. DISSEMINATION OF RESULTS

6.1 Publications and Reports

A brochure on COST Action P18 is published.

6.2 Conference and Workshops

Planned in year 2006

6.3 Web site

Dedicated Website for the Action is created. This is www.costp18-lightning.org
The website has a public area and a member area. All documents related to the co-operation within this Action will be appearing at the website. The website includes Background information to this COST Action, MC minutes, Publications (Published journal and conference papers, discussion manuscripts), Links to other lightning related websites, Breaking news in lightning research, Activities of the Work Groups etc. Website is being improved and updated on a continuous basis.

6.4 Scientific and Technical Co-operation

Data on lightning strike to the Gaisberg tower in Austria is available to COST participating groups for research purposes. This data is now being used by groups from Israel and Sweden.

6.5 Transfer of results

It is decided to arrive at a consensus on the definition or meaning of the scientific terms associated with lightning. For this purpose the glossary of lightning terms used by scientific/standardization organizations in different disciplines are being compiled and put at the website for discussion among the participants. The newly started International Journal of Lightning Research (http://www.jolr.org/), where the editor and several of the associate editors are MC members of COST P18, will be one of the vehicles for disseminating scientific results.

6.6 Contacts in the ERA

Some members of the MC are engaged in the Atmosphere – Space Interactions Monitor (ASIM) experiment on the International Space Station to be launched in a few years.

7. ECONOMIC DIMENSION

Estimate of total manpower for the first year (June-December 2006) of the Action: 15 man years.

Estimate of funds for first year	€40098
Secretarial and publications	€2000
MCMs	€30553
STSTMs	€2810