



SOLID

Space-based Optical Lightning Detection

The SOLID Team :

CEA, LA, LACy, LATMOS, LERMA, LPC2E,
Météorage, ONERA & IAP Prague

Acknowledgments: CNES-TOSCA



Space-based Optical Lightning Detection (SOLID)

- Project supported in 2015 by CNES-TOSCA Atmosphere
- 2016 SOLID proposal submitted mid-April 2015 (yearly submission)

Institute	Participants
CEA	T. Farges ^[2]
LA	C. Bovalo, S. Coquillat, D. Lambert, J.-P. Pinty
LACy	C. Barthe
<i>LATMOS</i>	<i>M. Godefroy, E. Seran ^[2]</i>
LERMA	E. Defer ^[3]
LPC2E	N. Huret, J.-L. Pinçon ^[1]
Météorage	S. Pédeboy
ONERA	P. Blanchet, M. Buguet, P. Lalande
<i>IAP Prague</i>	<i>I. Kolmasova, O. Santolik ^[2]</i>

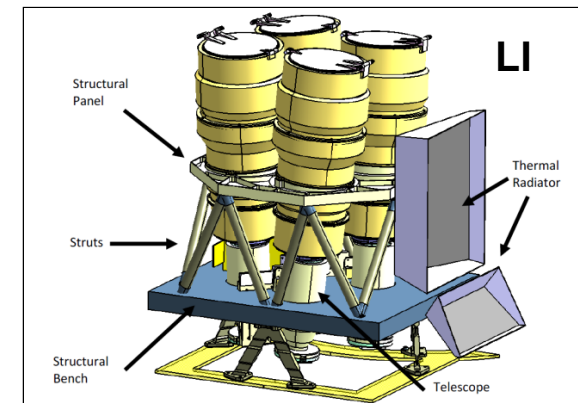
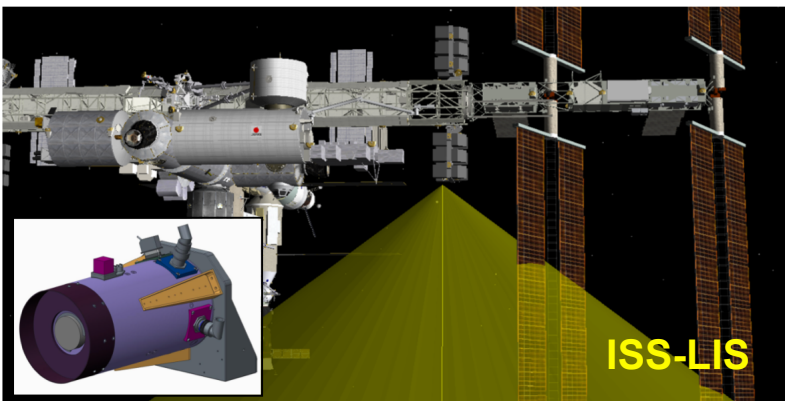
^[1] TARANIS mission PI / ^[2] TARANIS instrument PIs and Lead Co-Is / ^[3] SOLID PI





SOLID Objectives

- **SOLID-PREVALS: PREparation, VALidation and Support**
 - Preparing the French community to the use of the upcoming **ISS-LIS**, **TARANIS** and **MTG-LI** records not only for research activities but also for validation and operational support
- **SOLID-VALEX: VALorization and EXploitation**
 - Activities related to the scientific exploitation of any space-based lightning detection mission, as soon as launched





SOLID-PREVALS Objectives (1/3)

- **Developing, deploying and operating** new or existing lightning sensitive **instruments** in France and in its different territories
 - Support for **verification** and **validation** of any upcoming space-based lightning detection mission on a long-term basis
 - **Operational support**
 - Support for **scientific studies**
 - Design of **new instrumentation**



SOLID-PREVALS Objectives (2/3)

- **Learning** from **existing** space-based optical lightning measurements
 - **Refine** the **validation and verification strategy** proposed by Defer (2010, EUMETSAT study) applicable to any space-based lightning detection
 - **Gain expertise** on the actual optical signal emerging from the clouds by analyzing simultaneously space-based **lightning** and **cloud** passive/active Visible/IR/MW observations
 - Explore the **synergetic use** of space-based lightning and cloud passive/active Visible/IR/MW observations
 - **Calibrate** the LI-like **simulator** coupled to MésoNH CRM



SOLID-PREVALS Objectives (3/3)

- Defining a **Science Plan** to address scientific questions
 - Understanding the **physical processes of natural lightning discharges**
 - Constraining existing **lightning parameterization** used in numerical cloud resolving models
 - Characterizing the contribution of the lightning flashes on **Earth chemistry budget**
 - Exploring **operational applications** through the development of new, or the adaptation of existing, cell tracking and Very Short Range Forecasting algorithms, and Data Assimilation techniques
 - Investigating **new cloud/rain retrieval schemes** using the synergy between space-based lightning detection and infrared, sub-mm and microwave imagery
 - ...



SOLID Tasks (as of 2015)

- Task 1: Development, deployment and operation of new and existing lightning detection sensors for future validation exercises (LA, ONERA, Météorage, LERMA)
- Task 2: Characterization of the properties of the optical signal radiated by lightning flashes as sensed by LIS (LERMA, CEA, LACy)
- Task 3: Inter-comparison between VHF and optical lightning signal for a series of LIS passes over LMAs (LERMA, CEA, LA; NMT)
- Task 4: Coordination of the community (all partners)



SOLID Tasks (as of 2016)

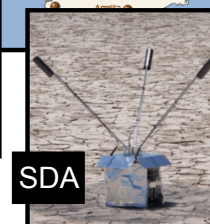
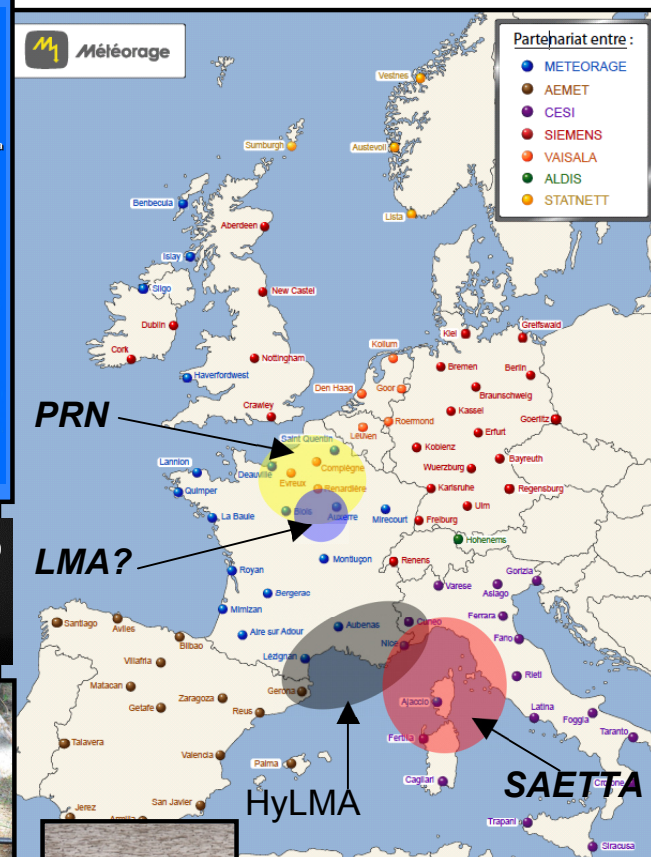
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- Task 4: Coordination of the community (all partners)
- **Task 5: Tropical storms (LACy, LA)**
- **Task 6: LI simulator (LA, LERMA, LACy)**
- **Task 7: Chemistry modeling and electrical discharges in the atmosphere (LPC2E)**



SOLID Task 1

Ground- and Air-based Instrumentation (1/2)

- Lightning Locating Systems:
 - Lab. Aéro. SAETTA LMA
 - Météorage VHF/LF networks
 - ONERA VLF network
- ONERA airborne electric field mills AMPERA
- Lightning Detection Systems:
 - Fast video cameras (portable)
 - Electric field sensors (portable, fixed)
 - LATMOS SDA (portable; DC-60 kHz)
 - IAP Prague BLESKA [5 kHz - 37 MHz]
- CEA MBA/MPA acoustics arrays
- Super sites: Corsica,
Nancay (LICORNE project)

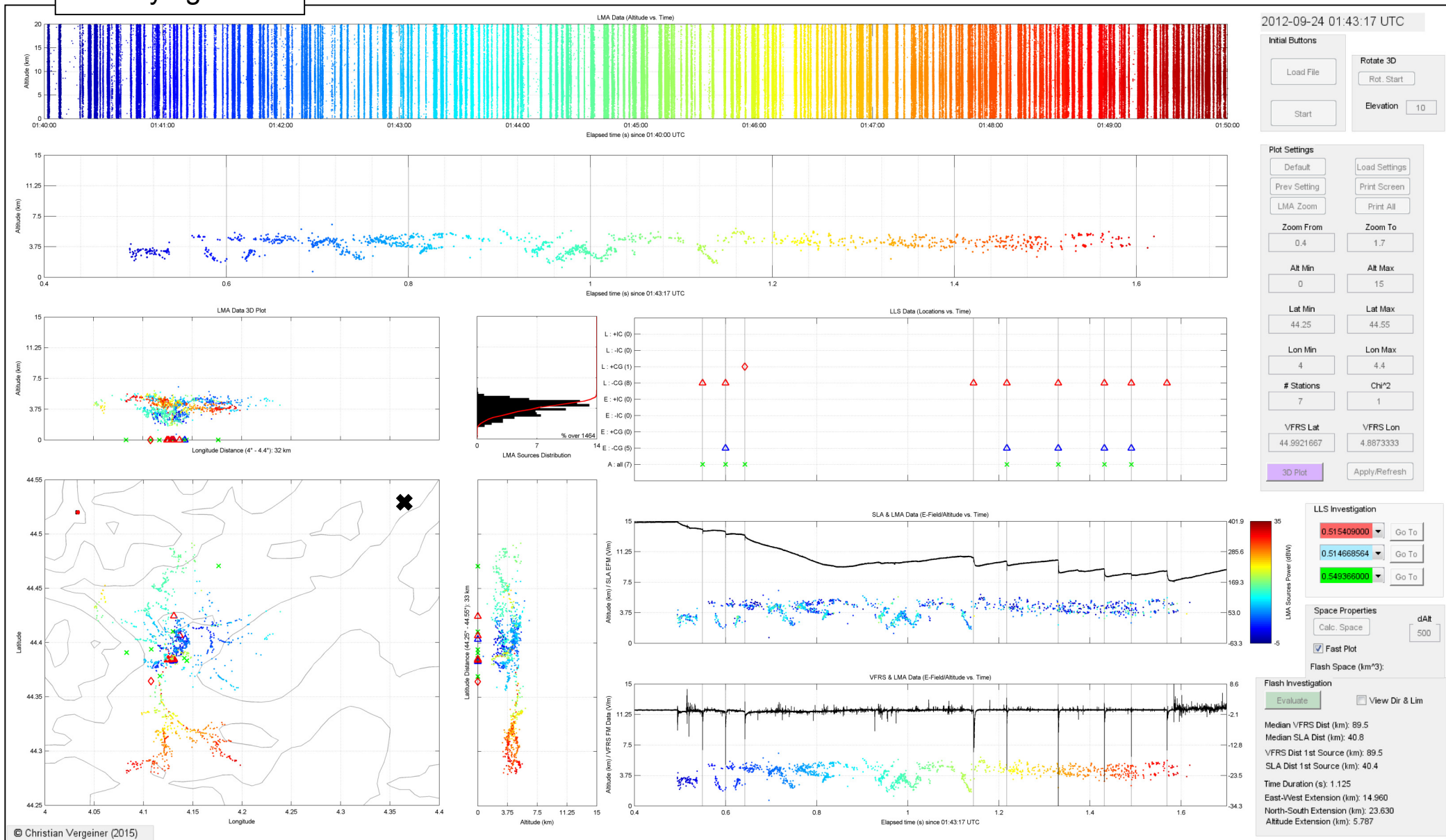




SOLID Task 1

Ground- and Air-based Instrumentation (2/2)

The HyLight Tool

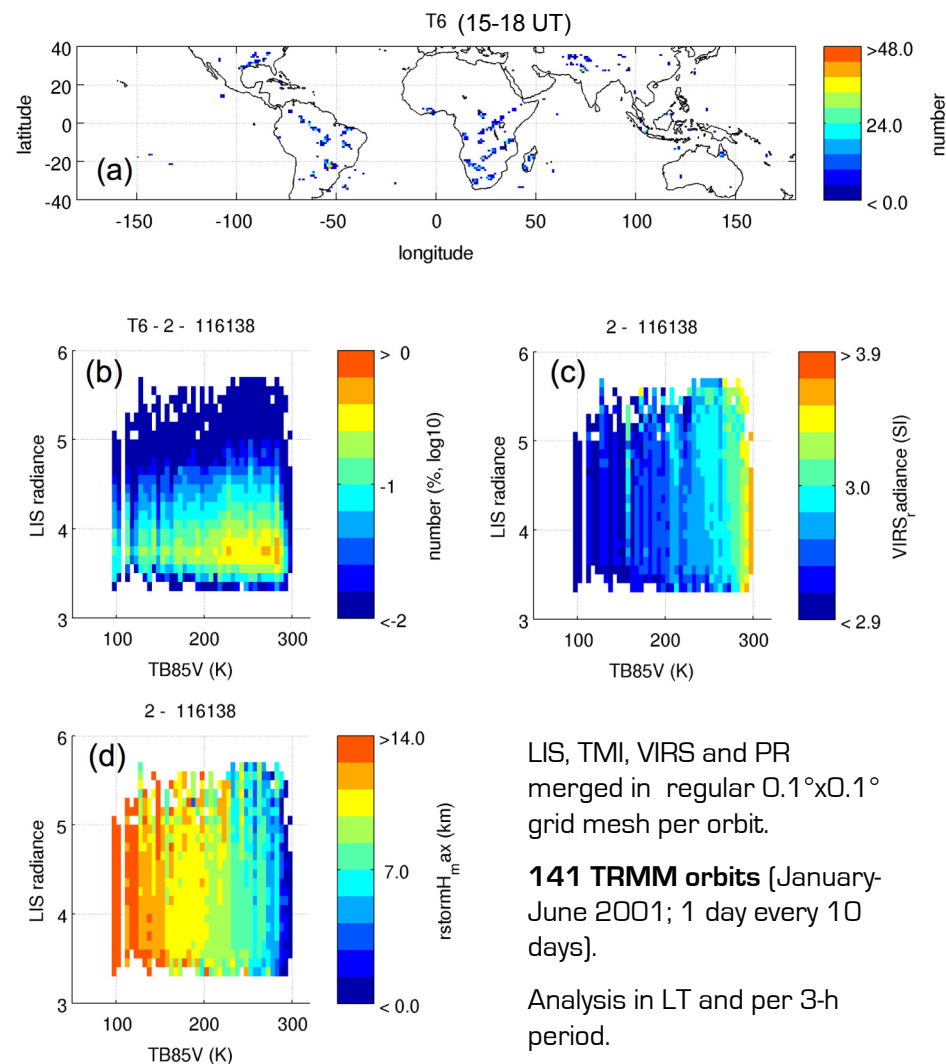




SOLID Task 2

Properties of LIS Optical Signal Relative to Cloud Properties

- Learning from existing datasets
- Understanding the optical signal relative to the parent cloud hydrometeor properties and stage at flash, storm, regional and global scales in the Tropics
- Providing references to other SOLID Tasks and on-going projects
- *Identifying the cloud properties to characterize for optimal use and application of optical space-based records*



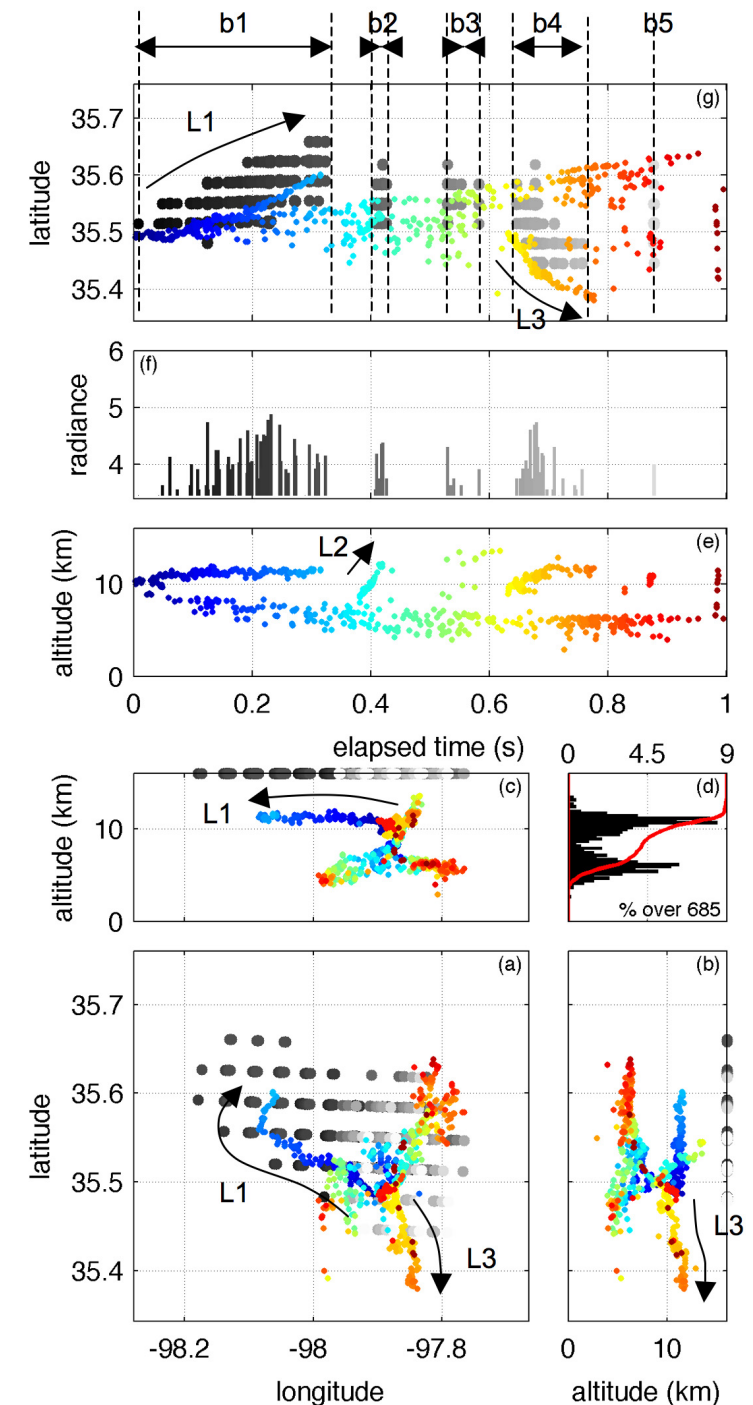


SOLID Task 3

Inter-comparison Optical/VHF Signal

- Learning from existing datasets (OTD included)
- Understanding the optical signal relative to the flash history and properties (and cloud properties too) through study cases and statistical analysis
- Providing references to other SOLID Tasks and on-going projects
- *Consolidating the validation and verification strategy proposed in Defer (2010, EUMETSAT study)*
- *Preparing the use of optical space-based lightning records for operational use (DA, VSRF)*

NMT-LMA & NASA-LIS (deep convection; nighttime)

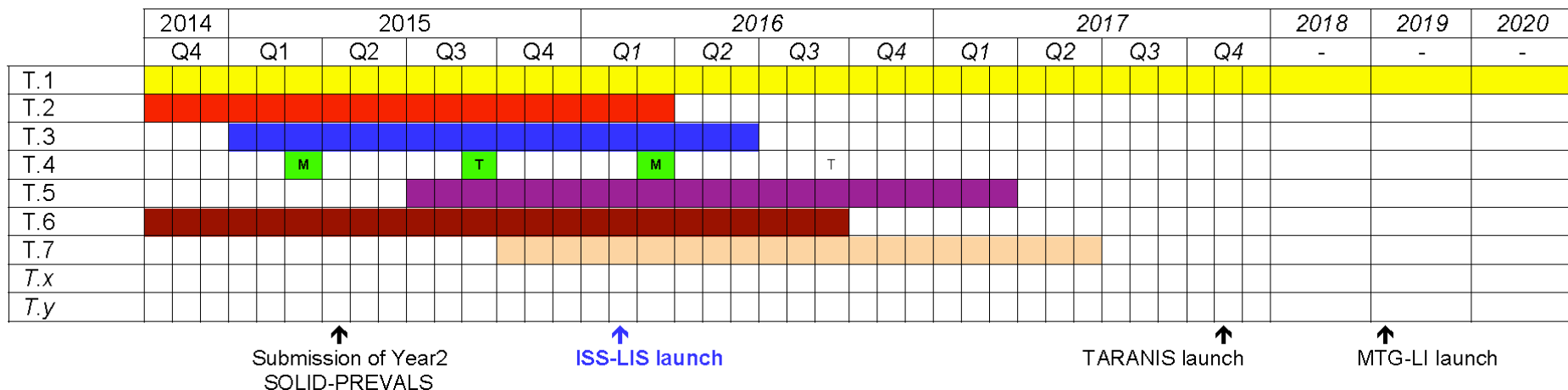




SOLID Task 4

Organizing the French Community

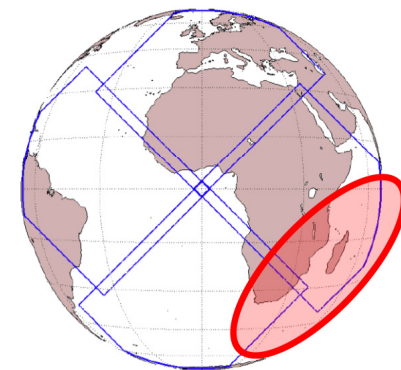
- Coordination, monitoring and valorization of SOLID activities
- Coordination with other projects and proposals
 - HyMeX (HYdrological cycle in the Mediterranean EXperiment)
 - LICORNE (LIghtning and COsmic Rays in Natural Environment; B. Revenu)
 - *EXAEDRE (EXploiting new Atmospheric Electricity Data for Research and the Environment; E. Defer) submitted to ANR*
 - *French contribution to the RELAMPAGO project*
- Collaboration with other European and International groups





New SOLID Tasks in 2016 Proposal

- **Task 5: Tropical Storms (LACy, LA)**
 - Study the benefit of lightning flash observations in understanding and forecasting intensity change of storms
- **Task 6: Optical Lightning Signal Simulator (LA, LERMA, LACy)**
 - C. Bovalo's CNES post-doctorate research project (LA)
 - Develop an L-like simulator coupled with MésoNH CELLS module
- **Task 7: Chemistry modeling and electrical discharges in the atmosphere (LPC2E)**
 - Implement a detailed plasma-chemistry code in the MIPLASMO model to investigate tropospheric lightning NO_x production versus stratospheric Blue Jet NO_x production

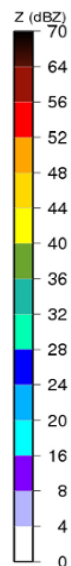
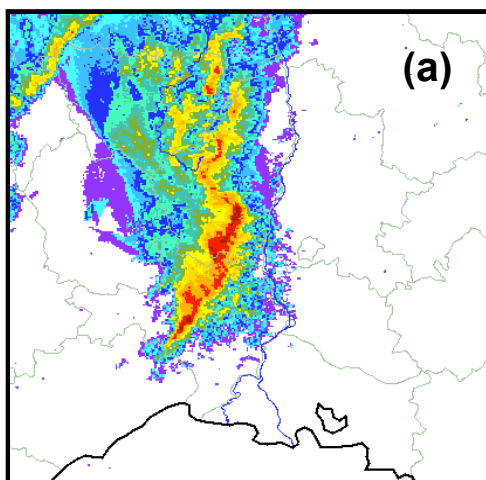




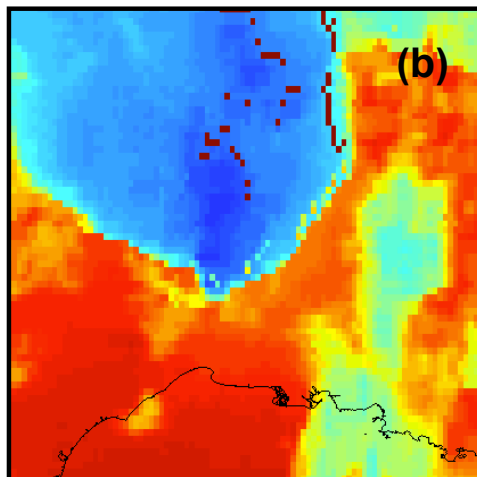
Optical Lightning Signal Simulator

Preliminary Results (Courtesy C. Bovalo & J.-P. Pinty)

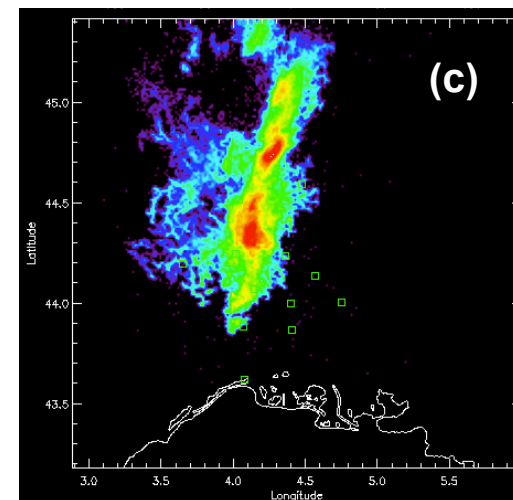
Reflectivity composite



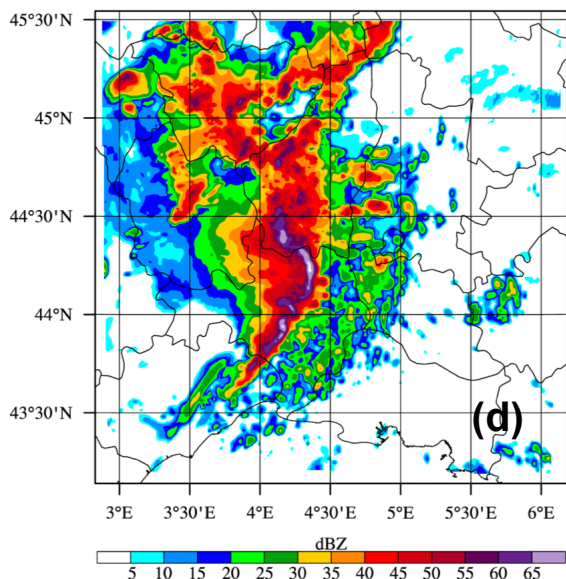
11- μ m IR
[no parallax correction^o]



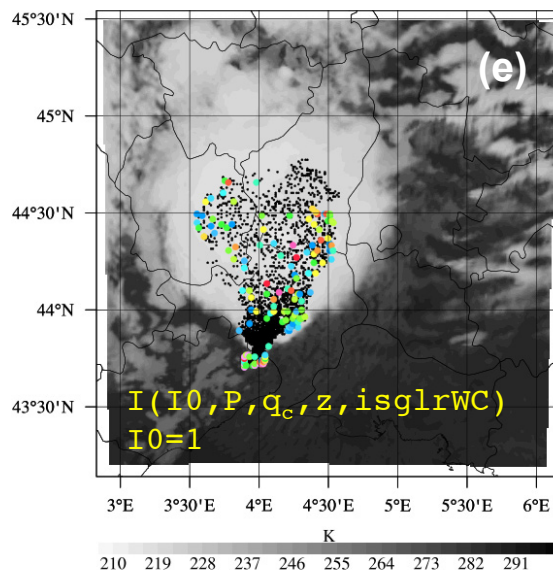
LMA source 6-min density
[21:57-22:03 UTC]



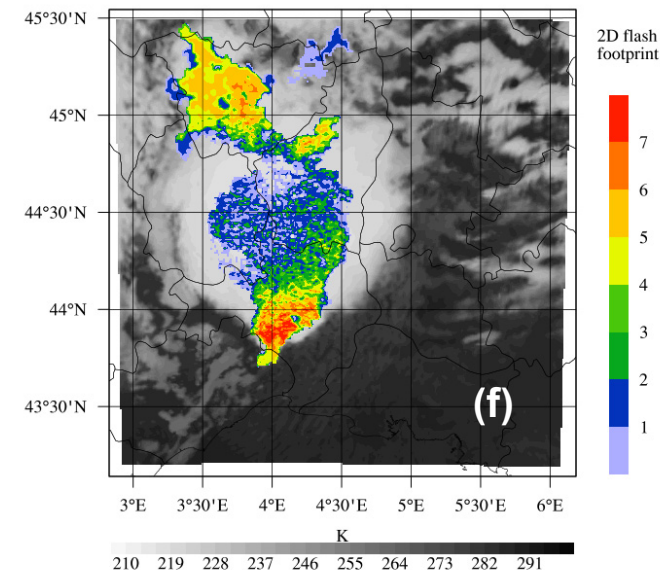
Reflectivity composite
[Meso-NH 1km / AROME 2.5km / MAO 3h]



One simulated flash and
radiance exceeding a threshold



Flash density during 10 sec.
[20,000 flashes simulated for the storm]





Acknowledgements: CNES-TOSCA supports the SOLID project