Transnational Access project
VESSAER

1. General information

Project acronym VESSAER

Project title VErtical Structure and Sources of AERosols in the Mediterranean Region: a pre-campaign for ChArMEx and HyMeX

Type Scientific project

Scientific theme Vertical profiles in conjunction with ground-based and lidar measurements to study long-range transport and the evolution of aerosols in the Mediterranean region.

Main scientific field and Specific discipline Earth Sciences & Environment / Global change & Climate observation

Participants undertaking research

Name + link to id card	Research status	Email	Institution	Institution country	CV	Letter of reference	Publication
ROBERTS Gregory (lead scientist)	Experienced researcher	roberts.gregc@gmail.com	Meteo France / CNRM-GAME	France	CV		Publication (2)
DULAC Francois	Experienced researcher	francois.dulac@cea.fr	CEA/LSCE	France			Publication (1)
IOANNOU Stelios	Post-doctoral researcher	s.ioannou@cyi.ac.cy	The Cyprus Institute	Cyprus	CV		
KELESHIS Christos	Post-doctoral researcher	c.keleshis@cyi.ac.cy	The Cyprus Institute	Cyprus	CV		
LANGE Manfred	Experienced researcher		The Cyprus Institute	Cyprus	CV		
LEON Jean-francois	Experienced researcher	jean-francois.leon@aero.obs-mip.fr	CNRS	France	CV		
MALLET Marc	Experienced researcher	malm@aero.obs-mip.fr	Lab. Aerologie	France	CV		

Lead scientist's background
*(scientific and aircraft measurements background and experience, English level)*Aerosol chemistry and physics
Cloud condensation nuclei
Aerosol-clouds-radiometric interactions and
climate research
Autonomous unmanned aerial vehicles in atmospheric
sciences

Recent relevant publications by application group in last 5 years (up to 5)

- Project VESSAER
- Project VESSAER
- Project VESSAER
- Project VESSAER
- Project VESSAER

Scientific problems being addressed by the experiments to be performed. Brief summary of the experiments The proposed project to EUFAR's Trans-National Access (TNA) program will explore aerosol sources and atmospheric processes in the northwestern Mediterranean region. The main scientific goals are:

- Investigate local vs long-range sources of aerosols and their vertical stratification in the lower troposphere,

- Use hygroscopicity to study evolution and ageing of aerosols,

- Couple in-situ airborne measurements with ground-based lidar to determine aerosol radiative impacts over a larger spatial scale.

The proposed experiment will complement existing ChArMEx and HyMeX activities supported by the MISTRALS program. MISTRALS (Mediterranean Integrated Studies at Regional And Local Scales; http://mistrals.insu.cnrs.fr) is a French multidisciplinary decadal research program initiated by INSU and supported by ALLENVI, the French multi-agency alliance for environmental research. MISTRALS is one of the few research programmes selected by the Union for the Mediterranean. ChArMEx and HyMeX are the target of many European research institutes in 2012 and 2013. Expected activities on Corsica include ground station observations operated on Cape Corsica and aerosol lidar

measurements (south of Bastia). We propose to conduct research flights with the ENDURO-KIT (W. Junkermann) for a campaign of 2-3 weeks in mid June to early July 2012. This campaign will serve as a pre-campaign for the summer 2013 ChArMEx/ADRIMED campaign to be performed with the French ATR-42 (PI M. Mallet). In addition, our EUFAR proposal aims at integrating a miniaturized cloud condensation nuclei instrument on the ENDURO-KIT opening its possible future use within the EUFAR community.

Aircraft ENDURO - KIT

Why this aircraft best suits the experiments? Proposed alternative aircraft The EUDURO-KIT has been chosen for the following reasons: Standard ENDURO-KIT instrumentation plus already available additional sensors already provide most of the required instrumentation (aerosols, aerosol optical properties and radiation, meteorological parameters), The aircraft can carry additionally a miniaturized CCN spectrometer.

The aircraft can fly the vertical profiles up to FL 120 as demonstrated in several campaigns. This ceiling is sufficient for the intended measurements.

Low-cost; available for desired time frame (mid-June to mid-July 2012)

The main concern with using an Ultralight Motorized (ULM) aircraft in Corsica is limited flight zone (see flight maps below). The ULM flights will be constrained to airspace south of Bastia (ca. 75 km from ground site at Ersa). Higher elevation flights and vertical profiles might be done north of Bastia in coordination with air traffic control (for closer coordination with the fixed lidar).

Other aircraft have not been identified – the SAFIRE ATR-42 has already committed to other projects in the spring and fall 2012.

2. Description of the experiments

Scientific objectives / Proposed work / Anticipated output The Mediterranean region has been identified as one of the most prominent global “Hot-Spots” in future climate change projections [Giorgi and Lionello, 2008; Giorgi, 2006] and is particularly characterized by its vulnerability to changes in the water cycle. General Circulation Model (GCM) and Regional Climate Model (RCM) climate simulations show a substantial precipitation decrease and a warming of the Med. region, especially in the warm season. At this time, most of the global and regional climate simulations have only investigated the impact of global warming on the water resources over the Mediterranean region without correctly considering the likely influence of the different “Mediterranean aerosols” (anthropogenic, biomass burning and mineral dust particle) on the Mediterranean radiative budget.

To understand climate effects of aerosols in the Mediterranean region, we need to better understand the sources and evolution of aerosols. Ground-based observations do not provide the full picture as in-situ measurements in the vertical dimensions are lacking [Corrigan et al., 2008]. In addition, active and passive remote sensing instrumentation, such as lidars and AERONET/PHOTON sun photometers, need in-situ measurements of aerosol properties to expand their measurements to larger domains.

The proposed experiment will complement existing ChArMEx (PI: F. Dulac) and HyMeX (PI: V. Ducroc and P. Drobinski) activities supported by the MISTRALS program, which are the target of many European research institutes in 2012 and 2013 (ChArMEx: http://charmex.lsce.ipsl.fr/ and HyMeX: http://www.hymex.org/). We have attached a scientific description of the goals of ChArMEx and HyMeX in the appendix.

Expected activities on Corsica include ground station observations operated at Ersa (on Cape Corsica) and aerosol lidar measurements (south of Bastia). The proposed project will explore two different aspects (aerosol-CCN & aerosol-radiation) that represent important scientific questions of the HyMeX and the ChArMEx programs. Nonetheless, the airborne measurements proposed in this proposal go beyond ChArMEx and HyMeX activities and will allow us to specifically focus in the following scientific goals:

- Investigate local vs long-range sources of aerosols and CCN (marine, anthropogenic and African dust) and their vertical stratification in the lower troposphere,

- Use aerosol hygroscopicity as a function of altitude to study evolution and ageing due to atmospheric processing in the boundary layer,

- Couple in-situ airborne measurements with ground-based lidar to determine aerosol direct radiative impacts over a larger spatial scale.

- Use ozone as tracer of long-range transport of polluted air masses form the continent.

We propose to conduct research flights on Corsica with the ENDURO-KIT ultra-light aircraft (W. Junkermann) for a campaign of 2-3 weeks in late June-early July 2012. This campaign will serve as a pre-campaign for the summer 2013 ChArMEx/ADRIMED campaign supported by the French ANR-Blanc program, to be performed at a larger scale with the French ATR-42 (PI M. Mallet). Research groups at CNRM, LSCE, LA, LAMP and Ecole des Mines de Douai will instrument the ground site at Ersa beginning early 2012. The table in the next section shows the instruments that will be deployed before summer 2012. The ground base observations will run continuously for at least two years within the MISTRALS / ChArMEx program.

In addition, CCN instruments have never been flown on the ENDURO-KIT. Our EUFAR proposal aims at integrating a miniaturized cloud condensation nuclei instrument on the ENDURO-KIT opening its possible future use within the EUFAR community. We are also exploring options to integrate instrumentation from the Cyprus UAS program for testing and validation.

[local vs. long-range transport of aerosols]

The main sources of aerosols in Corsica’s immediate vicinity include marine, anthropogenic, and biogenic emissions. The location of the field site at Ersa (northern tip of Cape Corsica) minimizes the influence of biogenic and local anthropogenic emissions, except for southerly winds. During the June/July period of the proposed EUFAR experiment, we expect a transition of south-easterly winds than transport dust from Africa to north-westerly winds that bring in industrial and biomass burning aerosol from Southern France. It is also possible to observe the intrusion of pollution from the Po Valley when winds originate from the northeast. Aerosol physical and chemical properties, in conjunction with

backward wind trajectories will likely point to marine sources during low aerosol loading and to continental sources (African dust, secondary organic particles from vegetation emissions, forest fires, and anthropogenic pollution sources) during periods of high aerosol concentrations.

Continuous ground-based measurements of aerosol physical and chemical properties further confirm aerosol sources in the boundary layer. However, vertical profiles are needed to obtain in-situ measurements of the aerosol layers – particularly from long-range transport. Often these layers are not measured by ground-based observations; hence remote sensing techniques are the sole indicators that such layers are present. However, the cloud-microphysical and radiative properties of aerosols aloft cannot be determined by lidar measurements alone. Understanding the vertical structure of the different aerosol sources is important for understanding the evolution of the boundary layer and the impact of long-range transport on direct and indirect radiative forcing.

[vertical profiles of aerosol hygroscopicity]

The airborne measurements will study the effect of atmospheric processes (e.g., cloud processing and transport) on aerosols using CCN and aerosol size distributions to infer aerosol hygroscopicity as a function of aerosol size, supersaturation and altitude. Recent studies have explored the relationship between hygroscopicity and aerosol chemistry to assess chemical transformations related to atmospheric processes [George and Abbatt, 2010; Roberts et al., 2010; Sullivan et al., 2009]. In addition, measurements of hyscopicity as a function of supersaturation and size provide insight to atmospheric aging processes [Gunthe et al., 2009; Roberts et al., 2008]. Nonetheless, existing observational data does not provide a clear picture of the global distribution and characteristic regional differences of aerosol hygroscopicity [Pringle et al., 2010].

We propose to extend this global picture of aerosol hygroscopicity by ultilizing CCN spectra and aerosol size distributions to infer the chemical transformation of cloud-active aerosol in the Mediterranean region. The miniature CCN generates continuous supersaturation spectra between 0.1 and 1% supersauration in a few minutes. Hence, by coupling the CCN spectra to aerosol number size distributions, changes in CCN behavior will be used to elucidate changes in aerosol chemical composition as a function of supersaturation and size. Given the different sources of aerosols in this region, we expect the hygroscropicity to vary as a function of altitude and even with layers of long range transport; such data will provide insight on the aging and evolution of aerosols.

For example, recent laboratory experiments have shown that the critical supersaturation of calcium carbonate dust decreases with exposure to gas-phase nitrates as the insoluble calcium carbonate converted to soluble calcium nitrates [Sullivan et al., 2009]. These results suggest that Saharan dust may undergo similar processes during its transport across the Mediterranean to the European Continent. Models results indicate that Saharan Dust aerosol have been through multiple cloud processes by the time they arrive over Europe (Begue et al., in prep); thereby, increasing its hygroscopicity in each cloud passage.

[ground-based lidar / radiative impacts]

The combination of ground-based, lidar, AERONET and ULM observations over the Western Mediterranean region during summer 2012 will be used to document the surface, columnar aerosol optical (scattering-absorption) properties as well as their vertical distributions for the main “Mediterranean aerosols” (i.e., marine, anthropogenic and African dust). Such observations, obtained over this region, will be used to calculate the direct radiative effect of particles on the regional scale. Such results should also be used for significantly improving the parameterizations used in the Regional Climate Model (RCM) over this region for studying the possible feedbacks of aerosols on the Mediterranean climate The in-situ observations will be also used to estimate the local and regional direct radiative forcing (shortwave and longwave) of aerosols at the sea surface (associated with changes in surface evaporation), top of the atmosphere, and within the atmospheric layer (associated with changes in the heating rate vertical profiles).

The aerosol physical properties (total number size distribution) will be measured by SMPS (ultrafine) and OPC GRIMM (fine/coarse) analysers. In addition, the nephelometer, aethalometer (onboard the ULM) and AERONET observations will serve to document the optical properties (scattering & absorption, Aerosol Optical Depth, Single Scattering Albedo and Asymetry parameter). Finally, Lidar observations will be used to compare in situ measured vertical distribution of the aerosol extinction coefficient with the remote sensing technique. Note that vertical profiles on the ULM can be conducted in the vicinity of eye-safe lidars. These in-situ observations will be used to conduct 1-D radiative transfer simulations at local scale for different aerosol types. The results obtained from the Radiative Transfer Model GAME [Mallet et al., 2008; Roger et al., 2006; Dubuisson et al., 2004] will be evaluated using pyranometers (shortware) and pyrgeometers (longwave) measurements.

The fixed lidar (Hervé Delbarre) will be reinstalled in January 2012 in northern Corsica; and the availability of a lidar in Northern Corsica strengthens the justification of ULM flights -- particularly since the flights will be 75 km south of Ersa. A mobile lidar in car (Patrick Chazette) may also be deployed during this time.

Main scientific topics (by participating groups)
- Cloud condensation nuclei (CCN) / aerosol hygroscopicity – Roberts, Gomes / CNRM-GAME
- Aerosol Radiative properties – Mallet / LA
- Aerosol transport (satellite-balloon tests) – Dulac / CEA
- Aerosol extinction profile – Léon / LA
- Testing and validation of UAS instrumentation – Lange, Keleshis (CI)

References

George, I.J., and J.P.D. Abbatt, Chemical evolution of secondary organic aerosol from OH-initiated heterogeneous oxidation, Atmos Chem Phys, 10 (12), 5551-5563, 2010.

Pringle, K.J., H. Tost, A. Pozzer, U. Poschl, and J. Lelieveld, Global distribution of the effective aerosol hygroscopicity parameter for CCN activation, Atmos Chem Phys, 10 (12), 5241-5255, 2010.

Roberts, G., D. Day, L. Russell, E. Dunlea, J. Jimenez, J. Tomlinson, D. Collins, Y. Shinozuka, and A. Clarke, Characterization of particle

cloud droplet activity and composition in the free troposphere and the boundary layer during INTEX-B, Atmos. Chem. Phys., doi:10.5194/acp-10-6627-2010 (10), 6627–6644, 2010.

Gunthe, S.S., S.M. King, D. Rose, Q. Chen, P. Roldin, D.K. Farmer, J.L. Jimenez, P. Artaxo, M.O. Andreae, S.T. Martin, and U. Poschl, Cloud condensation nuclei in pristine tropical rainforest air of Amazonia: size-resolved measurements and modeling of atmospheric aerosol composition and CCN activity, Atmos Chem Phys, 9 (19), 7551-7575, 2009.

Sullivan, R.C., M.J.K. Moore, M.D. Petters, S.M. Kreidenweis, G.C. Roberts, and K.A. Prather, Timescale for hygroscopic conversion of calcite mineral particles through heterogeneous reaction with nitric acid, Phys Chem Chem Phys, 11 (36), 7826-7837, 2009.

Corrigan, C., G. Roberts, M. Ramana, D. Kim, and V. Ramanathan, Capturing Vertical Profiles of Aerosols and Black Carbon over the Indian Ocean using Autonomous Unmanned Aerial Vehicles, Atmos Chem Phys, 8, 737-747, 2008.

Giorgi, F., and P. Lionello, Climate change projections for the Mediterranean region, Global Planet Change, 63 (2-3), 90-104, 2008.

Mallet, M., V. Pont, C. Liousse, L. Gomes, J. Pelon, S. Osborne, J. Haywood, J.C. Roger, P. Dubuisson, A. Mariscal, V. Thouret, and P. Goloub, Aerosol direct radiative forcing over Djougou (northern Benin) during the African Monsoon Multidisciplinary Analysis dry season experiment (Special Observation Period-0), J Geophys Res, 113, doi: 10.1029/2007JD009419, 2008.

Roberts, G., M. Ramana, C. Corrigan, D. Kim, and V. Ramanathan, Simultaneous observations of aerosol-cloud-albedo interactions with unmanned aircraft, PNAS, 105, 7370-7375, 2008.
Giorgi, F., Climate change hot-spots, Geophys Res Lett, 33 (8), doi: 10.1029/2006GL025734, 2006.

Roger, J.C., M. Mallet, P. Dubuisson, H. Cachier, E. Vermote, O. Dubovik, and S. Despiau, A synergetic approach for estimating the local direct aerosol forcing: Application to an urban zone during the Experience sur Site pour Contraindre les Modeles de Pollution et de Transport d'Emission (ESCOMPTE) experiment, J Geophys Res, 111 (D13), doi: 10.1029/2005JD006361, 2006.

Dubuisson, P., D. Dessailly, M. Vesperini, and R. Frouin, Water vapor retrieval over ocean
using near-infrared radiometry, J Geophys Res, 109 (D19), doi: 10.1029/2004JD004516, 2004.

Weather conditions *(e.g. clouds, atmospheric stability, wind speed and direction, weather…)* The main operational issues with an ULM (i.e., ENDURO-KIT) are orographic turbulences generated by strong westerly winds. During Junkermann's site visit to Corsica in Aug. 2011, westerly winds (beaufort 3-4 with gusts up to 60 km/h) caused visible turbulence clouds downwind of the mountains in elevations between 800 and 1500 m. Corsica is well known for these turbulences; consequently, a significant effort has already been dedicated to ensuring a safe base for operations. Ghisonaccia (no hangar) and Solenzara are the two airports that are less affected by these turbulences. Junkermann commented that thermal turbulence is heavy near both of these airports but would be manageable (and not more intense than in the Alps where the ENDURO-KIT has already been deployed).

Flights will be conducted in low wind situations since strong westerly winds that create orographic turbulence may prevent flights. For this reason, we are stretching the flights hours over a period of three weeks to accommodate for potential no-flight days.

Time constraints *(time of the day, pass(es) of satellites, weekends, season…)* To coordinate with other planned ChArMEx activities, we propose to conduct the experiment between 16 June and 7 July 2012. The proposed period is also supported by W. Junkermann. These dates can be shifted by a week on either side; however, we cannot start before June 2012 because of commitments to other projects by team members and after 15 July is the heavy tourist season (which adds air space constraints to flight plans). It may also be possible to coordinate the timing of VESSAER with the TRAQA (TRAnsport à longue distance et Qualité de l'Air) experiment near Marseille-Fos-Berre, France. The interactions between VESSAER and TRAQA will depend on regional meteorological conditions and back trajectories that may pass in the vicinity of Corsica during the proposed period. A PTR-MS, an AMS, and an aerosol lidar are planned for deployment on the ATR-42 during TRAQA, which would add science value to transport and evolution of aerosols if flown in coordination with the proposed EUFAR flights (ENDURO-KIT).

In addition, CNRM and LAMP will contribute ground-based measurements at Ersa and airborne measurements on the SAFIRE ATR-42 during the HyMeX SOP 1.1 in September and October 2012.

Visual Flight Rules (VFR) on the ULM require daytime flights. In any case, daytime flights are preferable to relate in-situ measurements with aerosol lidar and sun photometers. We plan to conduct vertical profiles in the morning and afternoon of flight days to gain insight on boundary layer development.

Location(s) and reason for that choice Map of general area: Project VESSAER - Map of general area

Solenzara was chosen for the operating base because it was the only airport that allows ULM flights and has a hangar (see figures below). The Science Team recognizes that securing access to Solenzara is the most critical part of this proposal. The airport is on a military base – Junkerman and Lambert have contacted the base, verbally agreed on flight operations, and are in the process of obtaining the permits to conduct flights there (the requests must be made through the Ministry of Defense). As the Solenzara airport will also be used during the HyMeX (SOP 2.1; Feb. 2013) experiment, a joint request will be made within the framework of the Corsica Observatory. . Junkermann has visited other airports on Corsica, but the lack of a hangar or nearby emergency landing areas prohibited further consideration.

Vertical profiles will be up to 75 km south of ground-based instrumentation at Ersa (yellow marker at the northern tip of Corsica in right figure below). Fixed lidar will be reinstalled in Bastia. Driving times from Solenzara to Ersa are about 2.5 hours (140 km) to maintain operations at the ground site in Ersa (Cape Corsica) during the flight mission.

The shaded box in both figures is a bit wider than the restricted area, that would allow some operation outside the restricted airspace at least in higher elevations. The prefered flight zone avoids all the approaches to Bastia. Access to Bastia airspace can be requested at altitudes above approaches (ca. 3000 m asl) and coordinated with air traffic authorities. We will focus on vertical profiles from 30 m to 3600 m asl (FL 10 – FL 120) within the red shaded zone. Flights will largely take place in the low plain to compare with lidar profiles. Missed approaches may be conducted in Ghisonaccia and Solenzara to obtain complete vertical profiles down to a few meters.

We are requesting 20 hours of flights to be spread over a three week period. Given the expected instrument configuration, the ENDURO-KIT will have a flight ceiling of FL120 (3600 m asl). Climb rates are 500 ft/min up to 10000 ft; above 10000 ft, these rates cannot be guaranteed. Hence, we expect that each vertical profile will take about 1 hour; we propose to conduct two vertical profiles per flight to compare with lidar backscatter – so we can count 2.5 hours / flight. With 20 flight hours, we can count on six days of flights (two days of a.m. / p.m. flights and four days of single flights). Such a strategy will permit us to study the development of the boundary layer on two different days and obtain a sufficient number of vertical profiles to compare with the ground based lidar. The ULM operator has agreed to these flight plans.

Number of flights / flight hours and flight patterns Vertical profiles will be the priority of the airborne experiments because of the limited area of flat terrain and orographic turbulence in the mountains. A typical flight will include climbing to FL100 after takeoff, reaching the maximum altitude (FL120) at the lidar site and descend in spirals to the site. Climb again in spirals for the return flight and return to the airfield/airport. Flight duration will not be more than 3 hours. Flights above open water will be avoided as the ENDURO-KIT has only a single engine.

Other constraints or requirements The project will be coordinated with planned ChArMEx and HyMeX activities for summer and fall 2012.

3. Key measurements required to achieve science aims

Parameter / measurement required Key airborne parameters for this study include:

• Boundary layer state (mixing and evolution)
o Temperature, relative humidity, pressure
o Equipotential temperature (stability)
o Lifting condensation level (cloud base)

• Aerosol sources and evolution
o Aethelometer (absorption; anthropogenic contribution)
o Aerosol size distribution (insight to atmospheric processes)
o Aerosol hygroscopicity (proxy for aerosol chemistry)
o Ozone and CO gas phase (anthropogenic contribution; dilution)

• Aerosol – cloud interactions
o Cloud condensation nuclei (cloud forming potential)
o Aerosol size distribution (cloud processing, new particle formation, scavenging)
o Aerosol number concentrations (scavenging)

• Direct radiative effects
o Radiometers (broadband solar fluxes)
o Aerosol size distributions (light scatter properties)
o Aethalometer and nephelometer (absorption, scatter, single scatter albedo)
o AERONET/PHOTON (Aerosol Optical Depth, Single Scattering Albedo, Asymetry parameter)
o Lidar (aerosol vertical profiles)

If applicable, specify TA instrument required None

Instruments to be provided by hosting aircraft operator *(basic instrumentation owned by the aircraft operator described on EUFAR website only)* Standard parameters measured on the ENDURO-KIT

Instrument type, Instrument, Measured parameter, Range

Laser Altimeter, ULS, distance aircraft-surface, 600 m
Aethalometer, AE-42, BC equivalent mass (370 and 880 nm), 0.1 - 10 µg m-3
Ozone by UV absorption photometry, PSI-O3, Ozone mixing ratio, 2-150 ppb
CPC (Condensation Particle Counter), TSI 3010, Total number concentration, Dp > 10 nm
OPC (Optical Particle Counter), GRIMM 1.108, Aerosol size distribution, 0.3 < Dp < 20 um
Scanning Mobility Particle Sizer, SMPS, Aerosol size distribution, 5 < Dp < 350 nm
Nephelometer, AVMIII, Aerosol light-scattering coefficient (total) , lambda = 870 nm
Dew/Frost-point hygrometer, Dewpoint Mirror, Dew Point, ± 0.2°C
Filter-radiometer Irradiance, SKYE 4WL, Irrandiance, NDVI up- and downwelling, 400; 550; 660, 996 nm (W m-2)
BBR (LICOR pyranometer), RAD_UP/DN, broadband SW irradiance up- and downwelling, 400 < labmda < 1100 nm (W m-2)
Pyrgeometer (IR), CGR4, broadband IR irradiance up- and downwelling, 4.5 < lambda < 42 µm (W m-2)
Actinic filter-radiometer, , Photolysis frequency JO1D up- and downwelling, 295-310 nm (UVB, sec-1)
Actinic filter-radiometer, , Photolysis frequency JNO2 up- and downwelling, 360-400 nm (UVA, sec-1)
Incident flow vector 5/9-hole probe, Turbulence-Probe, Airspeed/ Wind speed and direction, ±0.4 m s-1; ± 15°

Instruments to be provided by scientific group *(Have already been flown. On which aircraft? Do the instruments have their own data acquisition system?)* miniature Cloud Condensation Nuclei spectrometer (m-CCN).
The m-CCN instrument will be installed in the ENDURO-KIT. A compartment for the ENDURO-KIT has already been constructed (by Junkermann) to accommodate the m-CCN (CCN weight and power: 1.8 kg and 30 W). Roberts (Météo France) will adapt the CCN instrument to fit in the compartment. The instrument will tap off the same inlet as the other aerosol instruments in the payload (CPC, SMPS, OPC). The m-CCN is well-tested and has been flown on other airborne platforms including:

• ACTOS helicopter pod in Barbados (Institute for Tropospheric Research, Leipzig, Germany)
• Tether balloon in Colorado Springs (SPEC Inc., Boulder, USA)
• DOE G1 Aircraft in Sacramento (PNNL, Spokane, USA)

• ATR-42 in Paris (SAFIRE, Toulouse, France)

EUFAR funds are requested for travel to Garmisch-Partenkirchen for installation and testing (see budget below). The flight data will be post-processed to obtain research quality dataset and placed on the ChArMEx database (http://mistrals.sedoo.fr/ChArMEx) with a link to EUFAR.

Instrument operators onboard (in addition to those provided by the aircraft operator). If so, how many?

If applicable, plans for simultaneous field work plans / ground equipment to be used EUFAR flights will coincide with ChArMEx activities planned for summer 2012. There will be a ground station at Ersa (the northern tip of Cape Corsica), an aerosol lidar at the air quality monitoring station of Poretta south of Bastia, and possibly a mobile lidar deployed in vicinity of the airborne measurements.

4. Data processing and analysis

Methodology for handling the data and analysis of output *(airborne data acquisition, ground-truthing / observations, data processing and interpretation)* The data system and instruments onboard the ENDURO-KIT are already in place; with the exception of the CCN. The integration of the CCN will be completed prior to the experiment. The EUFAR operator (Junkermann) performs airborne measurements and provides final dataset for all onboard instruments (except the m-CCN instrument). All flight data on the ENDURO-KIT are in an SQL database with GPS position, altitude, etc. The data is exported via ASCII files that can be processed accordingly. Coincidence correction is done for CPC particle concentrations greater than 104 cm-3 and the dependence of the mean free path is corrected for pressure effects on the aerosol size distributions (SMPS). The CCN data will be stored on its own internal compact flash and will be synchronized to the flight data in post-processing. The data output from this experiment will be relatively small (20 hours of flight with a moderate payload). The final data will be archived on the ChArMEx data base presently under development (http://mistrals.sedoo.fr/ChArMEx) within six months of the experiment.

We will provide two persons to coordinate flight planning and operations (one student and one senior research scientist). The m-CCN instrument will be calibrated before and after the flights at Météo France.

Resources available to support the project beyond the flying/data acquisition period *(funding, cooperation with other projects, manpower for analysis of results and preparation of user report, availability of laboratory facilities…)* CNRM (Roberts) has requested a master's student to analyse airborne CCN data from the Cloud Aerosol Radiation and tuRbulence of Trade wInd cumuli over Barbados (CARIBBA) experiment (in collaboration with IfT Leipzig). The CARIBBA experiment was designed to study the links between aerosol particles and shallow trade cumulus clouds. Aerosol and cloud size distributions / number concentrations, CCN spectra and turbulence were measured using the helicopter-borne ACTOS (Airborne Cloud Turbulence Observations System; Seibert et al., 2006). Hence, the tools that the master's student will learn during the analysis of the CARIBBA dataset will be largely applied to this proposed EUFAR project. Furthermore, this project will provide the basis for continuing as Ph.D. student at CNRM - Météo France; the student will publish the results of this proposed EUFAR project in a peer-reviewed journal.

In addition to a dedicated Ph.D. student for the airborne measurements, the teams at CNRM-GAME and LA are responsible for operations of the Ersa site. The operation of the Ersa Site has been secured through funding within MISTRALS and related funding (see instrument table in Appendix).

The ChArMEx database will be maintained at least for the duration of the MISTRALS programme, presently announced until end of 2018.

5. Planning

Starting date: 22-06-2012
Ending date: 13-07-2012

Preferred and acceptable dates *(season / time windows)* To coordinate with other planned ChArMEx activities, we propose to conduct the experiment from 25 June to 7 July 2012 (plus / minus one week). The proposed period is also supported by W. Junkermann (operator of ENDURO-KIT). See 'Time Constraints' for further details.

Agreement to share aircraft time *(project clustering, cost sharing)* Yes

6. Other useful comments

Training benefit of the project *(e.g. spread potential of airborne research to a wide scientific community; training of research students in experimental planning, methodology, data analysis and applications, etc)* The proposed project provides an opportunity to open doors for students / post-docs in Cyprus to 'traditional' airborne research. There are obvious similarities between Corsica and Cyprus and many of the science goals presented here can also be applied to Cyprus. In addition, the technical knowledge (instrumentation of the ENDURO-KIT) may be applied to the current unmanned aerosol system (UAS) project at the Cyprus Institute.

If possible, 3 scientific reviewers that EUFAR may contact Michael Sicard (Universitat Politecnica Barcelona, Spain; msicard@tsc.upc.edu)
Lucas Alados-Arboledas (Univ. Granada, Spain; alados@ugr.es)
Girogio Di Sara (ENEA-Rome; alcide.disarra@enea.it)
Hugh Coe (University of Manchester; hugh.coe@manchester.ac.uk)

Sources of funding of the project and of related projects *(if clustering with existing projects supported either by national or other EC funding, how the project add additional or complementary aims to the already funded experiments)* Funds for the following projects have been secured. Below is also a brief description of related activities.

• MISTRALS – ChArMEx: Deployment of long-term measurements at Ersa (Cape Corsica), including aerosol chemistry, air quality parameters, radiation measurements and aerosol optical properties (see table).

• HyMeX: Aerosol network at two sites in the Mediterranean region. CCN and SMPS instruments will be installed in Montpellier and Corsica (TT05g Working Group). Installation in the Balaeric Islands to be confirmed (pending funding). In addition, CNRM and LAMP contribute to aerosol instruments onboard the SAFIRE ATR-42 (TS5 Working Group).

• ADRIMED – ANR: Funded for 30 hours of ATR-42 flights in the Western Mediterranean (based in Cagliari, Sardinia) in summer of 2013, as part of the ChArMEx work package 4 on aerosol radiative impact on regional climate.

• COST ES0802: We will request funding for one of the young scientists from Cyprus through the Short-Term Scientific Missions program to participate in the airborne measurements.

Scientific training provided by lead scientist to other EUFAR sponsored scientists within the fields of the proposed experiments and analysis Yes

Number of students 1

Number of days recommended 20

Knowledge about EUFAR opportunities from From your colleagues

Related documents
You may need to login to the EUFAR Back Office to see all the documents.

- Newspaper article on VESSAER campaign in Corse-matin
- Project VESSAER

7. Reporting

Campaign dates: From 25-06-2012 to 13-07-2012

Participants

Name	First time flying this aircraft	Participation in the campaign	Number of visits to campaign	Duration of stay	T&S reimbursed	Additional information
ROBERTS Gregory	Yes	On site	1	21	No	
DULAC Francois	Yes	On site	1	2	No	
IOANNOU Stelios	Yes	On site	1	13	Yes	
KELESHIS Christos	Yes	On site	1	13	No	
LANGE Manfred	Yes	Remotely	0	0	No	
LEON Jean-francois	Yes	On site	1	11	No	
MALLET Marc	Yes	Remotely	0	0	No	

Meetings

Start date	End date	Location	Title	Number of persons from the group attending the meeting	Overall number of attendees
29-05-2012	29-05-2012	Laboratoire d'Aérologie	Pre VESSAER	4	4
04-06-2012	06-06-2012	KIT	Pre VESSAER	2	2
04-09-2012	04-09-2012	Laboratoire d'Aérologie	Post VESSAER	3	3

Confirmation of the user access (list of flights, number of flight hours) / Evaluation of the service provided by the operator: mark (1-Unsatisfactory, 2-Insufficient, 3-Satisfactory, 4-Good, 5-Excellent) and comments
Flight Table: Research Flight Date Day of Year Take-off (UTC) Land (UTC) Duration (hours) Profile Location Aerosol RF01 27 June 179 8:45 10:56 2.18 Gh, SG AM RF02 30 June 182 7:31 10:15 2.73 Gh, SG ABL, D RF03* 1 July 183 9:37 12:33 2.93 Gh, SG, C ABL, D RF04 4 July 186 7:37 10:45 3.13 Gh, SG, C ABL, AFT RF05 6 July 188 7:25 10:17 2.87 Gh, SG, C AM RF06* 8 July 190 9:40 12:26 2.77 Gh, SG ABL, AFT, D RF07 9 July 191 16:08 17:36 1.47 Gh, SG ABL, AFT, D RF08 12 July 194 9:17 10:59 1.70 Gh, SG AM 20.0 Hours of ULM research flights during VESSAER. Profiles were conducted over Ghisonaccia Airport (Gh), San Giuliano (SG), and Corte Airport (C). The last column describes the aerosol structure: AM) aerosol mixing in lower troposphere; ABL) aerosol in boundary layer; AFT) aerosol layer(s) in troposphere; D) Saharan Dust. The flights marked with (*) coincide with CALIPSO overpasses. Operator service (4-Good): Junkermann contributed as a science collaborator as well as reasearch pilot. His effort in meteorological forecasting, flight planning and discussions on the data analysis contributed to the overall sucess of the experiment. In addition, The relatively small nature of the experiment provided ample opportunities of exchange of technical ideas between Junkermann and the Cyprus team (Ioannou and Keleshis).

Quality of data and associated service
Flight CCN DMA CPC OPC AETH EXT RAD MET CO2 GPS RF01 *** * ** ** ** ** NA *** *** *** RF02 *** *** *** *** *** *** NA *** *** *** RF03 *** ** *** *** *** *** NA *** *** *** RF04 ** ** *** *** *** *** NA *** *** * RF05 ** ** *** *** ** *** NA ** *** ** RF06 *** *** *** *** *** *** NA *** *** *** *** RF07 *** *** *** *** *** *** NA *** *** *** RF08 *** *** *** *** *** *** NA *** *** *** ---------- *** Fully functional ** Partially functional * Not functional NA not yet analyzed Overall the data quality is good (4-Good), but there were critical holes in the data related to heat issues during the campaign (notably the overheating of the DMA). A concerted effort was done by the entire science team to overcome these issues (for example, venting cool air to the instruments / shading the instrumentation from the sun, adapting flight schedules to avoid the hottest periods of the day). Electromagnetic interference from the UAS payload (CIT) also caused the loss of ENDURO-KIT GPS signal during RF04. This flight was reconstructed in post-processing.

Main achievements / Further plans for analysis
[Note that uploaded report contains much more detail than reported here] The main scientific goals of VESSAER are to investigate local

versus long-range sources of aerosol and cloud condensation nuclei (CCN), assess their vertical stratification in the lower troposphere, use aerosol hygroscopicity to study evolution and ageing due to atmospheric processes, and couple in-situ airborne measurements with ground-based lidar to determine aerosol direct radiative impacts over a larger spatial scale. In VESSAER, we found that atmospheric ageing of European emissions occurred exclusively in the boundary layer (and not in aerosol layers aloft). Aerosol hygroscopicity (at 0.38 % Sc) did not change as a function of transport time (12 hours vs. 48 hours) in elevated aerosol layers, which suggests that photochemical ageing of less hygroscopic material is relatively slow compared to processes in the BL. It's worth noting, though, that VESSAER measurements only provide insight to a relatively short period of four days and do not cover a range of aerosol types. In future experiments, we will determine the characteristic time of ageing as a function of size and assess diurnal variability in and above the BL to identify the important atmospheric processes (i.e., photo-oxidation, cloud-processing). Because of the strong presence of dust during VESSAER, we will also use aerosol hygroscopicity assess the chemical transformation of dust. Since the presence of dust coincided with the increase of 300 nm particles in VESSAER, aerosol hygroscopicity of dust will be determined using CCN-size distributions at supersaturations as low as 0.05% Sc. As noted by Twohy et al. [2009], even submicron dust can be important as CCN due to its slightly hygroscopic nature. Laboratory experiments have shown that the critical supersaturation of calcium carbonate dust decreases with exposure to gas-phase nitrates as the insoluble calcium carbonate converted to soluble calcium nitrates [Sullivan et al., 2009]. These results suggest that Saharan dust may undergo similar processes during its transport across the Mediterranean especially when mixed with continental pollution (which occurred during RF06 and RF07 in VESSAER). Model results indicate that Saharan Dust aerosol has been through multiple cloud processes by the time they arrive over Europe [Begue et al., 2012], increasing its hygroscopicity in each cloud passage. The activation of dust, particularly at low supersaturations, impacts cloud microphysics and latent heat release, which can influence vertical transport, the development of convention and precipitation in complex ways (e.g., [Khain et al., 2008]). In addition, in-situ measurements of the dust events will be compared to ALADIM and RegCM models to valid dust transport in the models. Results from the VESSAER campaign will be presented at upcoming AGU 2012 and EGU 2013 meetings and a Charmex workshop in Nov. 2012. Future observations In the June/July 2013 period (ADRIMED), we expect a transition of south-easterly winds that transport dust from Africa to north-westerly winds that bring in industrial and biomass burning aerosol from Spain, France and Italy. The airborne observations during VESSAER clearly indicate the transport of Saharan Desert and pollution from the European continent in layers above the BL. Airborne observations in summer 2013 will be performed on both the Falcon 20 and the ATR-42 (ADRIMED; PI: Mallet) and include aerosol size distributions, concentrations, CCN, scatter and absorption, and aerosol chemistry, and radiometric fluxes. The supersite at Cape Corsica is already characterizing aerosol physico-chemical properties; and a minimum set of instruments (aerosol concentration and size distributions) will be installed at Venaco (as in VESSAER) in the summer 2013. Lidar and AERONET measurements have also been installed to monitor the aerosol radiative properties – these remote sensing observations will run continuously to December 2013. The combination of ground-based and airborne observations over the Western Mediterranean region in summer 2013 will characterize the aerosol optical (scattering-absorption) properties and be used to conduct 1-D radiative transfer simulations for different aerosol types. These results, from the Radiative Transfer Model GAME [Dubuisson et al., 2004; Mallet et al., 2008; Roger et al., 2006], will improve the parameterizations used in the Regional Climate Model (RCM) for studying the feedbacks of aerosols on the Mediterranean climate.

Difficulties encountered

A few weeks before the campaign, we were required to find another airport to accomodate the ENDURO-KIT as the requested fees to conduct the campaign at the BA126 - Solenzara Airport were beyond the financial resources available. Therefore, we moved operations to the civilian airfield at Ghisonaccia (about 10 km north of the Solenzara Airport). At the Ghisonaccia airfield, the hangar doors were too low to move the ULM in and out of the hangar; consequently, the wing had to be lowered / raised between research flights. This change meant that instrumentation could only be prepared for flight under the sun, which contributed to the overheating issues experience in the first several flights.

Publications linked to the project

Website of the project