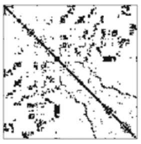
CERFACS

CENTRE EUROPÉEN DE RECHERCHE ET DE FORMATION AVANCÉE EN CALCUL SCIENTIFIQUE

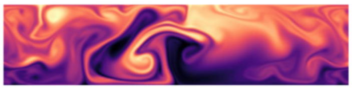
Ph.D. Students' Day

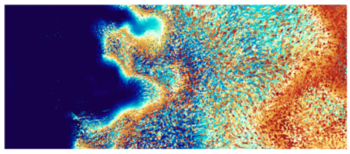
(JDD 2023)

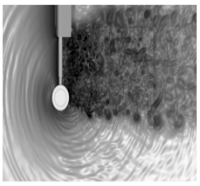
Tuesday May 23rd 2023

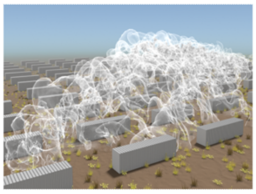


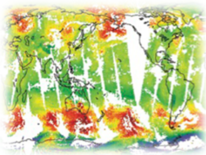
Algo-Coop











Climate Modeling

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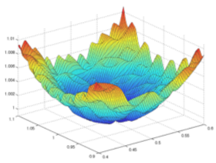
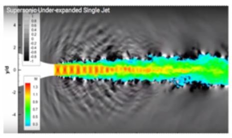
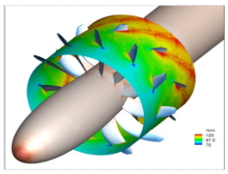
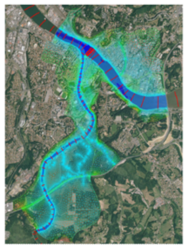
Global Change

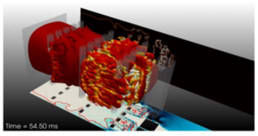


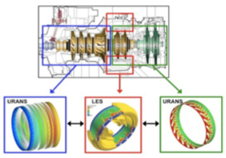


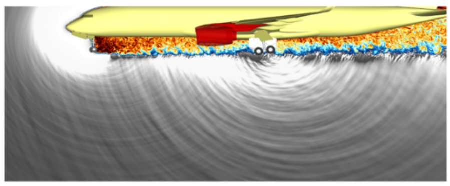




Computational Fluid Dynamics







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EUROPEAN CENTRE FOR RESEARCH AND ADVANCED TRAINING IN SCIENTIFIC COMPUTING

09:15	**Welcome coffee**		
09:25	**Opening speech : Catherine Lambert**		
Session 1		**Chair : Laurent Gicquel**	
09:30	Mehdi Cizeron	Wall modeling for large eddy simulations of turbomachinery flows	CFD
09:35	Antolin William	Fire-atmosphere coupled modeling: Improvement of the representation of the living fuel	GlobC
09:40	Alexis Boudin	Méthodes Numériques pour la Simulation aux Grandes Échelles en Turbomachine	CFD
09:45	Victor Coulon	Deep learning for hydrogen turbulent combustion modeling	Algo-Coop
09:50	Raphaël Costes	Wall modeling for the prediction of heat transfer in anaeronautical chamber	CFD
09:55	Emilio Concha	Meridional Modes of the Southern Hemisphere: Triggering Mechanisms and Sensitivity to Mean State Changes	GlobC
10:00	Jêrome Dabas	Development of LES-based engineering models for the design and control of floating offshore wind farms	CFD
10:05	Baur Susanne	Modeling Uncertainties in Geoengineering	GlobC
10:10	Nicola Detomaso	Large Eddy Simulation of Constant Volume Combustion	CFD
10:15	**Coffee break and posters from session 1:** Mehdi Cizeron, Antolin William, Alexis Boudin, Victor Coulon, Raphaël Costes, Emilio Concha, Jêrome Dabas, Baur Susanne, Nicola Detomaso		
Session 2		**Chair : Olivier Thual**	
11:15	Félicia Garnier	Large Eddy Simulation of non-premixed turbulent hydrogen jet flames	CFD
11:20	Olivier Goux	Accounting for correlated observation error in variational ocean data assimilation: application to wide-swath altimeter data	Algo-Coop
11:25	Riwan Hammachi	Numerical investigation of the laminar-turbulent transition control of boundary layers with porous coating	CFD
11:30	Juliette Deman	Changes of the continental hydrological cycle over Europe at the end of the 21 st century and associated uncertainties	GlobC
11:35	Benoit Péden	Large-Eddy Simulation of atomization in evaporating and reactive conditions	CFD
11:40	Gabriel Vigot	Development and Optimization of Numerical Tools for the Design of Hall Effect Thrusters	CFD
11:45	Markus Holzer	Code generation in a lattice Boltzmann framework for exascale computing	Algo-Coop
11:50	Thomas Lesaffre	Simulation of sustainable aviation fuels (SAFs)	CFD
11:55	Héctor José Vargas Ruiz	High Performance Simulations of Industrial Gas Turbines Decarbonization Through H2/NH3 Mixtures	CFD

12:00	**Lunch break and posters of session 2:** Félicia Garnier, Olivier Goux, Riwan Hammachi, Benoit Péden, Gabriel Vigot, Markus Holzer, Thomas Lesaffre, Héctor José Vargas Ruiz		
Session 3		**Chair : Paul Mycek**	
13:30	Mathieu Cances	Low order model for the study and control of thermo-acoustic instabilities in gaz turbines	CFD
13:35	Rachid El Montassir	Hybrid Physics-AI approach for cloud cover nowcasting	Algo-Coop
13:40	Loïc De Nardi	Deflagration of H2/Air mixtures and flame-wall interaction	CFD
13:45	Jeremy Briant	Multi-fidelity ensembles for high performance ensemble-variational data assimilation applied to earth model systems	Algo-Coop
13:50	Francis Adrian Meziat Ramirez	Large Eddy Simulations of hydrogen/air gas explosions in big-scale, complex geometries	CFD
13:55	Suzanne Salles	Modeling the impact of atmospheric variables on the performance of an aircraft during take-off: Towards the adaptation of air traffic operations to global warming	GlobC
14:00	Benjamin Vanbersel	Automatic Adaptive Mesh Refinement methods for LES of explosions.	CFD
14:05	Shriram Sankurantripati	Study of propagation of airborne viruses in closed environment using high fidelity simulations	CFD
14:10	Patrick Strempfl	LES of flow and combustion in a rotating detonation engine coupled to a turbine	CFD
14:15	**Posters of session 3 and "my PhD in 3 minutes":** Mathieu Cances, Rachid El Montassir, Francis Adrian Meziat Ramirez, Suzanne Salles, Benjamin Vanbersel, Shriram Sankurantripati, Patrick Strempfl, Alexandre Coudray, Rémi Alas, Nathanaël Rouland		
My Phd in 3 minutes		**Chair : Matthieu Pouget**	
15:15	Alexandre Coudray	Modelisation and simulation of SAF combustion including soot production in aeronautical engines	CFD
15:20	Rémi Alas	Deep Learning approaches to urban boundary layer modeling	CFD
15:25	Nathanaël Rouland	Modelisation and Simulation of H2 enriched flames	CFD
15:30	Lukas Gaipl	LES of Jets in crossflow with flame wall interaction	CFD
15:35	Raul Vazquez Cazique	Aeroacoustic simulation of an installed propeller via an LBM approach	CFD
15:40	**Vote for best poster and best "my PhD in 3 minutes" talk**		
15:50	**Closing speech: Catherine Lambert**		

Ma thèse en 3 minutes

Some students have chosen to do their presentation under the “Ma thèse en 3 minutes” format, which is a theatrical science communication exercise. They entered a specific training course given by Dr. Matthieu Pouget, who holds a PhD in Performing Arts from the Université de Toulouse and is a professor at the Conservatoire d’art dramatique de Toulouse. He guided them throughout the process of writing the script, creating their performance, and learning how to communicate their research subject to a wide audience in the format of the national competition “Ma thèse en 180 secondes”.

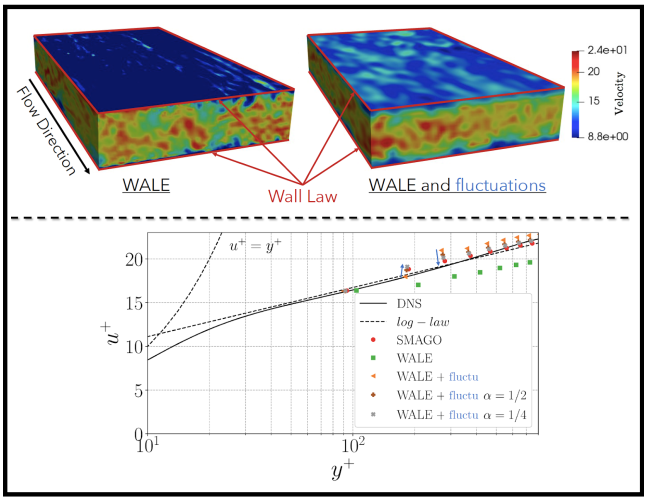
The presentations will be in French. The participants who have prepared a poster will move on to a regular poster session in English.

Mehdi Cizeron

9:30 (poster 10:15)

Wall modeling for large eddy simulations of turbomachinery flows

Boundary layers developing along walls at high Reynolds numbers are too expensive to be numerically resolved in industrial applications, thus analytical laws are used to model them relying on Reynolds-Averaged Navier-Stokes (RANS) assumptions. However, these wall laws present limitations and assumptions that reduce their accuracy (stationary, fully turbulent, no pressure gradient flow), particularly in the complex and unsteady context of Large Eddy Simulations (LES).

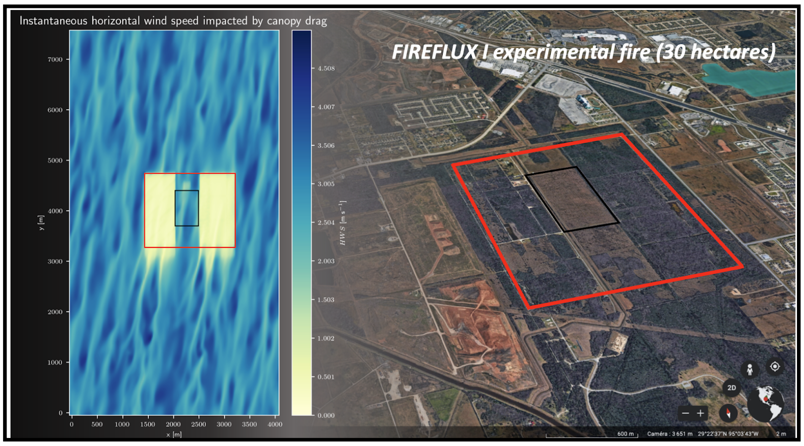


This work aims to improve the accuracy of wall models for LES by incorporating physical effects like the pressure gradient and improving the coupling between wall models and LES. LES dedicated to turbomachinery will be performed to test the improved wall models and quantify their accuracy.

Antolin William

9:35 (poster 10:15)

Fire-atmosphere coupled modeling: Improvement of the representation of the living fuel



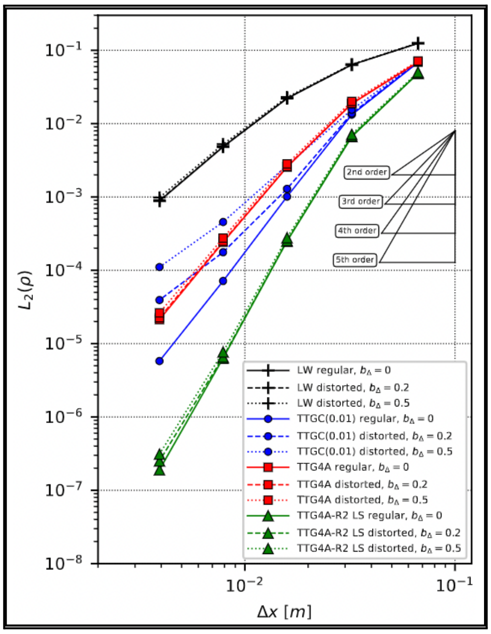
Extreme wildfires are no longer isolated events in the context of a changing climate. Being able to simulate and understand these events is key to discriminate between situations at risk, in order to help decision makers and land managers when facing new wildfires.

Coupled fire / atmosphere modeling is particularly promising to simulate wildfire behavior by representing the fire-induced flow and its retroactive feedback on the fire propagation as well as the smoke plume dynamics. In this PhD project (Cerfacs/CNRM), we aim at including a more realistic representation of the vegetation in the Meso-NH/Blaze coupled model. This is essential to account for the dynamical effects of the living fuel due to canopy drag and to better characterize living/dead fuel properties.

Alexis Boudin

09:40 (poster 10:15)

Méthodes Numériques pour la Simulation aux Grandes Échelles en Turbomachine



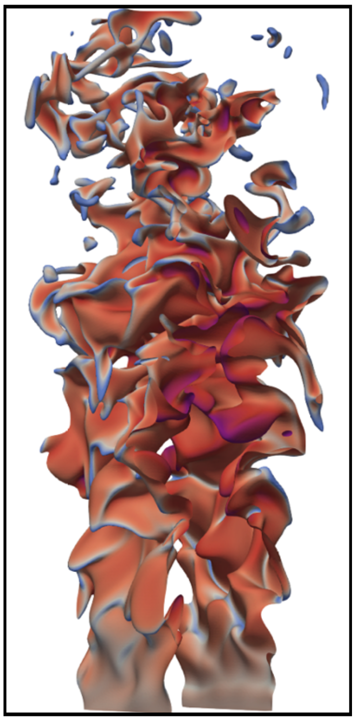
All CFD solvers use numerical schemes in their core to solve physical equations. In AVBP, the Navier-Stokes equations are solved using Galerkin methods based on hybrid finite elements / finite volumes formulations. These methods have a given accuracy and robustness which are trivially linked to their computation cost. The goal of this thesis is to improve these two aspects of the methods while keeping the cost as low as possible. These new methods should allow either to get better results on the meshes currently in use either being able to reduce the quality of the latter while keeping a good precision in the results. Optimizing the number of operations inside these numerical schemes is also a crucial part of the work!

Victor Coulon

09:45 (poster 10:15)

Deep learning for hydrogen turbulent combustion modeling

Hydrogen is a promising alternative fuel for future combustion technologies, with high specific energy content and low emissions. However, its combus1on under lean conditions poses numerical challenges because of properties such as sub-unity Lewis number. In premixed regime, flame-turbulence interaction significantly affects hydrogen flame propagation because of stretch effects at spatial scales still out of reach with current industrial mesh resolutions. To address this issue, this study first focused on assessing the impact of turbulent flow on the propagation of a lean hydrogen premixed flame using Direct Numerical Simulation. Data-driven sub-grid scale modeling is also investigated using Convolutional Neural Network. Preliminary a-priori calculations indicate their promising capabilities in retrieving sub-grid scale flame surface and fuel reaction rate quantities.

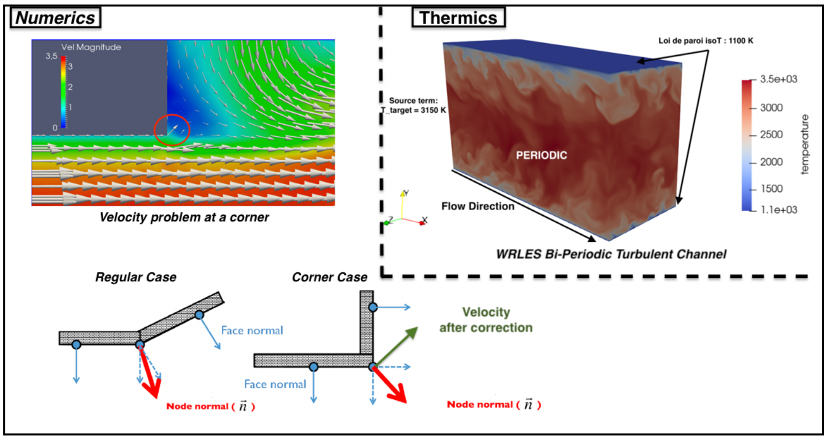


09:50 (poster 10:15)

Raphaël Costes

Numerical methods and wall-modeling for heat transfer effects in combustion chamber

Accurate prediction of wall heat transfer is required in Large Eddy Simulation (LES) of aeronautical combustion chambers in order to compute the wall heat flux and wall shear stress. In the industrial context, wall-modeled approaches are considered to allow an affordable computational cost by assuming several assumptions of a Reynolds Averaged Navier-Stokes (RANS) context. Wall models however involve significant couplings between numerical methods at the boundary and physical modeling. For this reason, this PhD intends to propose an accurate numerical framework for boundary conditions in the cell-vertex, finite element context of AVBP, as well as to propose a physical model for heat transfer prediction in aeronautical combustion chambers where strong temperature gradients take place.

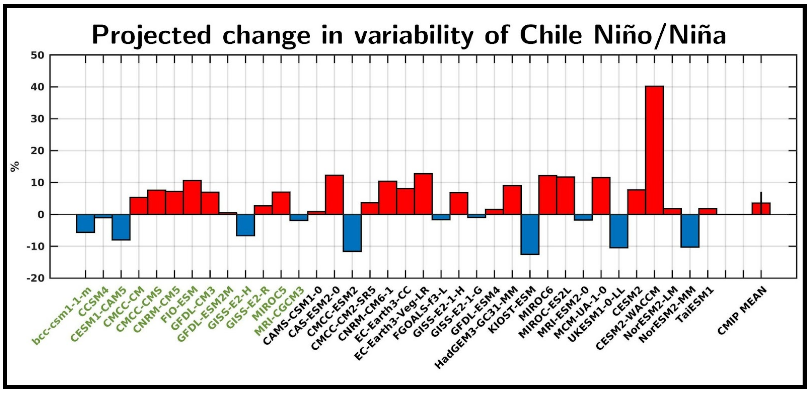


09:55 (poster 10:15)

Emilio Concha

Chile Niño in the Coupled Model Intercomparison Project

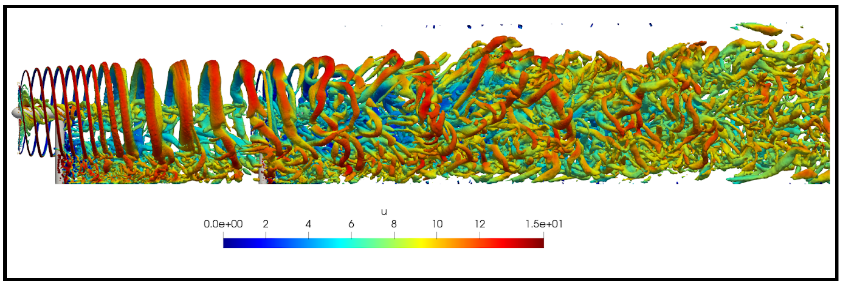
A new interannual climate mode of variability in the south-eastern Pacific, off Central Chile, has been recently described. It has been called Chile Niño and it results from air-sea interactions. It explains nearly 40% of sea surface temperature anomalies in the region, having important impacts on climate and local marine ecosystems. We evaluate how this mode of variability is simulated in the historical runs of the CMIP models, phases 5 and 6. Also, the change in properties under climate change scenarios (RCP8.5/SSP5-8.5) is evaluated. Despite limitations of the global models in accounting for coastal upwelling dynamics, CMIP models simulate reasonably well its main characteristics. Additionally, we find that 75% of the models exhibit an increase in variability under climate change.



10:00 (poster 10:15)

Jérome Dabas

Development of LES-based engineering models for the design and control of off-shore floating wind farms

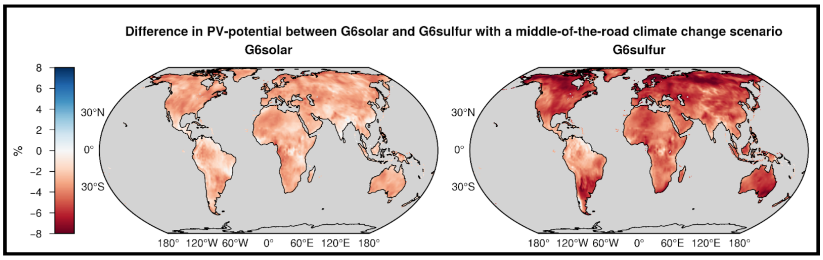


Floating Off-shore Wind Turbines (FOWT) are a promising solution for the energy transition. Yet, they raise new challenges due to the sea-induced motion of their platforms. Because of this induced motion, standard engineering tools are not suited to accurately predict the wake of such wind turbines and thereby the actual performance of floating wind farms. To improve existing engineering tools and develop new models for FOWT, deeper understanding of their physics is required. This can be obtained using the so-called high-fidelity CFD approach relying on wall-modelled LES. The purpose of this thesis is thus to develop such methods in the context of FOWT and gather the necessary knowledge to develop wake models which include the effect of the platform motion.

10:05 (poster 10:15)

Baur Susanne

The decarbonization potential with Renewable Energies under Solar Radiation Modification

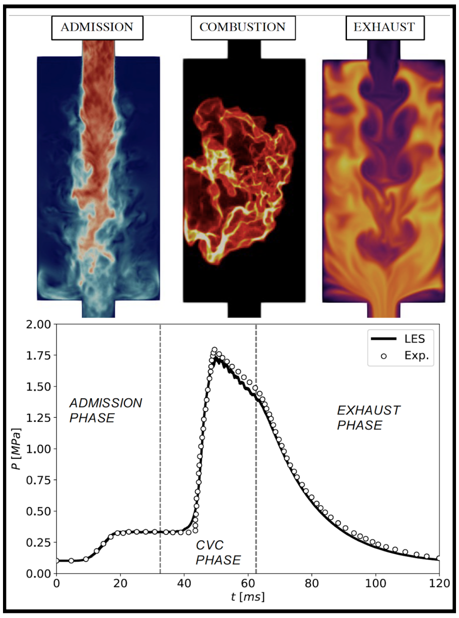


Solar Radiation Modification (SRM) is a form of geoengineering that intends to artificially lower global climate change impacts by modifying the radiative energy budget of the Earth system. Proposed techniques include stratospheric aerosol injection (sulfur-SRM) or the placement of reflective objects in space (solar-SRM) that reduce the amount of incoming solar radiation reaching the surface. Because SRM does not reduce the cause of climate change, the increase in anthropogenic greenhouse gas emissions, it needs to be combined with decarbonization until net-zero.
Here we analyze the change in Renewable Energy capacity (photo-voltaic, concentrated solar power, wind and biofuel energy production potential) under solar and sulfur-forced SRM, giving a first indication as to how decarbonization rates may be affected by SRM deployment.

10:10 (poster 10:15)

Nicola Detomaso

Large Eddy Simulation of Constant Volume Combustion



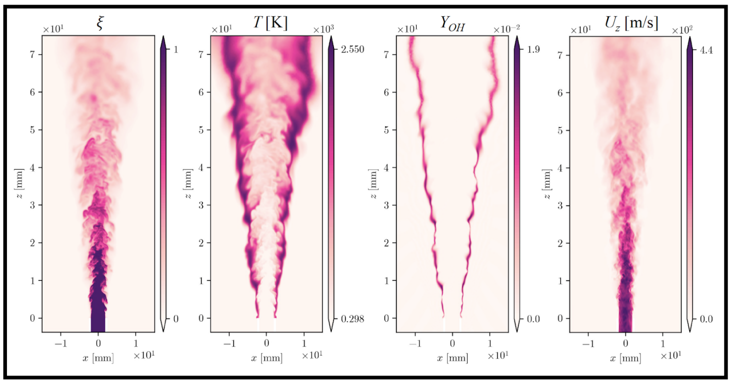
Classical gas turbine thermodynamic cycle has undergone no change over the last decades. Pressure Gain Combustion represents an interesting solution to break out current technological limits. Cycle models show that a pressure raise across the combustion process would reduce the fuel consumption, increasing the efficiency. Constant Volume Combustion represents a viable solution still particularly challenging form a modeling point of view. In the current project, the CV2 (Constant-Volume Combustion Vessel) installed at the Pprime laboratory is numerically investigated using the high-fidelity compressible solver AVBP. The successive phases of the cycle are considered in the LES. Spark ignition, dilution with residual burnt gases, high pressure effects, stretched flame behavior and autoignition will be tackled and modelled for an LES approach.

11:15 (poster 12:00)

Felicia Garnier

Large Eddy Simulation of non-premixed turbulent hydrogen jet flames

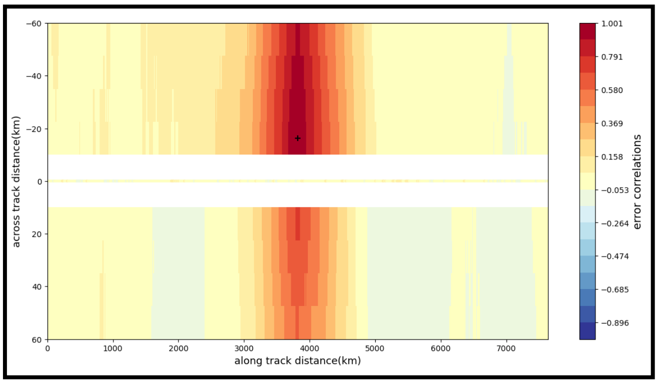
The introduction of hydrogen in aircraft raises significant issues in terms of safety: risk of hydrogen leakage and subsequent ignition is high, possibly causing major damage to its surroundings. The present PhD focuses on conditions of leaking hydrogen into open space, possibly igniting into a turbulent jet fire. Using the compressible LES (Large Eddy Simulation) solver AVBP, simulation tools have been adapted to hydrogen combustion properties for safety applications. The latter include non-premixed turbulent hydrogen flames in co- or cross-flow, from subsonic and supersonic under-expanded jets. Further numerical developments, validation and physical investigation of representative LES computations are still required on the specific research topic of under-expanded hydrogen-air jet flames.



Olivier Goux

11:20 (poster 12:00)

Accounting for correlated observation error in variational ocean data assimilation: application to wide-swath altimeter data



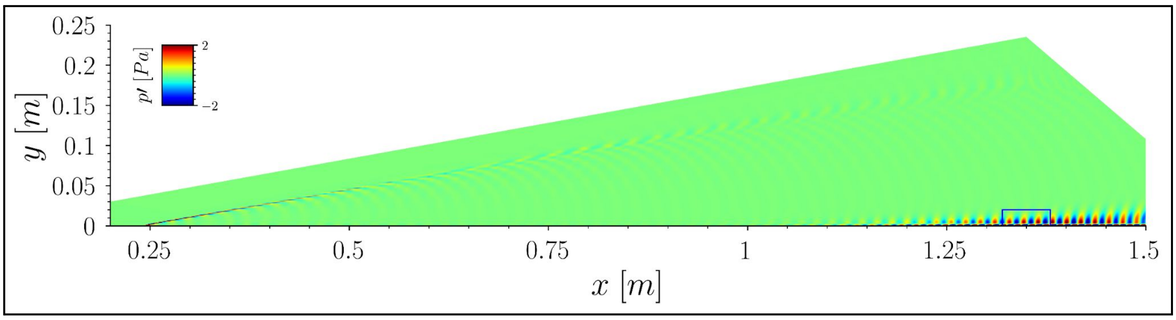
In variational data assimilation, the analysis is obtained by minimizing iteratively a cost function measuring the least-square fit of an estimate of the state of the system to the background state and to the observations, weighted by the respective error covariance matrices of the background and observations, **B** and **R**. While **B** has been thoroughly studied and is well represented in current data assimilation system, **R** is generally assumed to be diagonal to simplify the access to its inverse. This assumption is especially suspicious for high resolution satellite data. In order to use high resolution observations at their full potential, new methods need to be developed for data assimilation algorithms to be able to account for observation error correlations.

Riwan Hammachi

11:25 (poster 12:00)

Numerical investigation of the laminar-turbulent transition control of boundary layers with porous coating

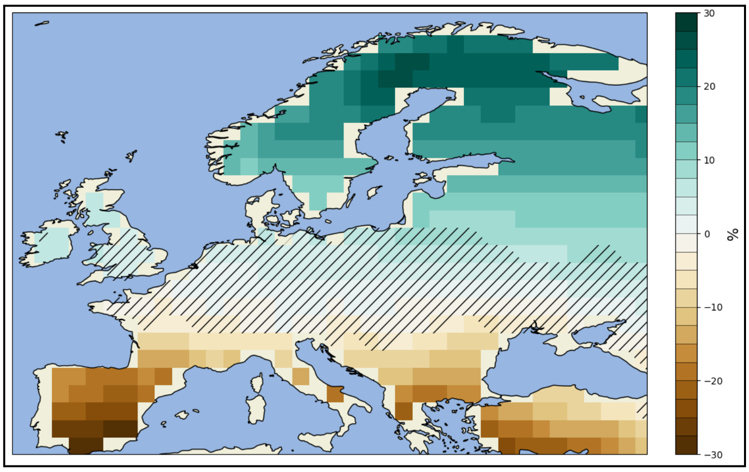
This study investigates natural transition to turbulence in subsonic and hypersonic boundary layers using modal linear stability analysis and direct numerical simulation. The study aims to provide insights into the stability characteristics and means of transition control that are specific to these types of flows. The primary instabilities leading to turbulence, namely the Tollmien-Schlichting wave and Mack second mode for subsonic and hypersonic regimes, respectively, are firstly identified using linear stability theory. Direct numerical simulations are then conducted to evaluate the effects of porous coatings modeled by time-domain boundary conditions on transition mechanisms.



11:30

Juliette Deman

Changes of the continental hydrological cycle over Europe at the end of the 21st century and associated uncertainties



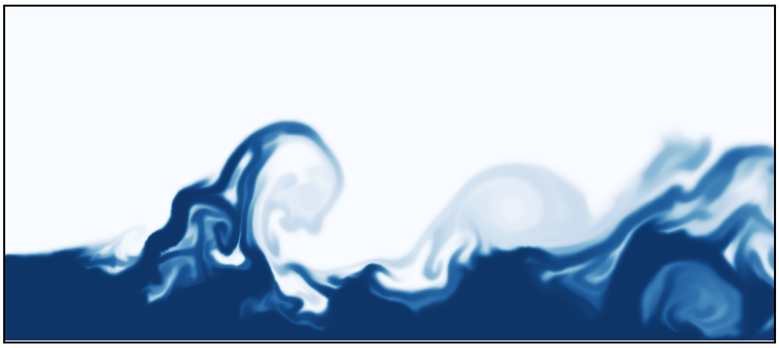
Human activities are dependent on the water availability in river flows and soil water stocks. These water fluxes and stores are expected to change with the increase in greenhouse gases concentration. However, there are still many uncertainties regarding the future evolution of the continental hydrological cycle in Europe. Even considering the projections of the latest generation of global climate models, the signals are often not clear considering a particular region or time period. Here, we question the mechanisms responsible for this diversity of responses, such as the relative importance of soil-atmosphere coupling compared to large-scale circulation.

11:35 (poster 12:00)

Benoit Péden

Large-Eddy Simulation of atomization in evaporating and reactive conditions

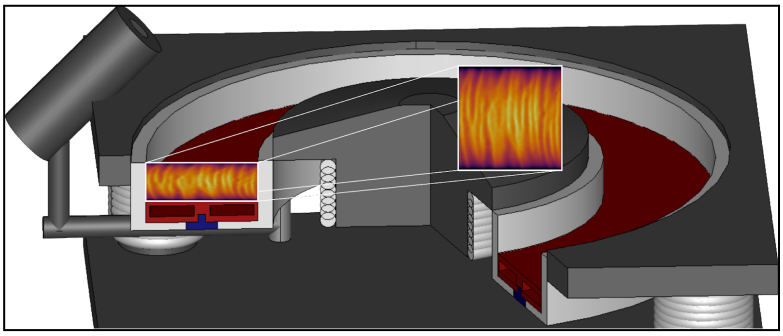
In aeronautical engine combustion, liquid fuel is atomized into a spray to enable efficient evaporation and mixing with air. However, accurately predicting this process numerically remains a challenge due to the high computational costs associated with using a fine mesh resolution to capture the liquid-gas interface. As a result, most Large Eddy Simulations do not consider primary atomization and instead rely on liquid models. The purpose of this PhD is to predict primary atomization using a diffuse interface method. Numerical simulations of the Airblast atomization configuration were performed and the results were compared with experimental correlations obtained from the LEGI lab. A phase transition algorithm was implemented to enable the simulation of reactive and evaporating conditions, paving the way for advanced numerical simulations.



11:40 (poster 12:00)

Gabriel Vigot

Development and Optimization of Numerical Tools for the Design of Hall Effect Thrusters

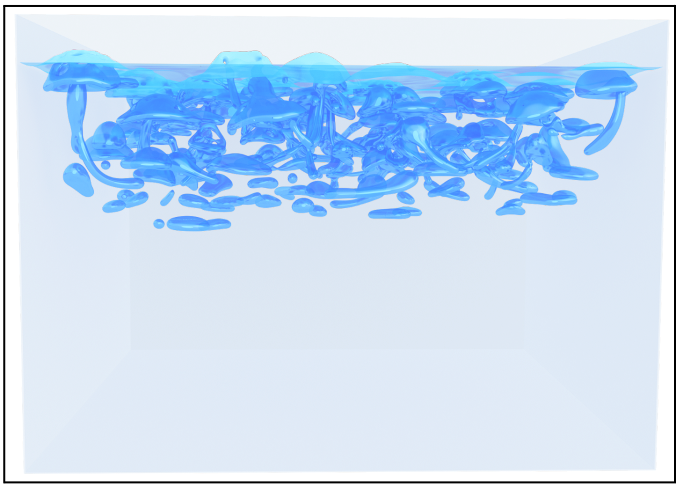


Hall-effect thrusters rely on a powerful electromagnetic mechanism that induces a tremendous amount of thrust in deep space travel. With the force of an electromagnetic field, a gas can be transformed into a plasma which is the key to the Hall-effect principle. Yet, its functioning is not entirely understood. For this question, powerful but costly numerical simulations must be used to model the plasma on an atomic scale if necessary. This thesis proposes a new approach based on artificial intelligence to reduce the cost of plasma simulations and obtain the configuration of the electromagnetic field by solving the Poisson equation and, by extension, linear systems, where the mathematical definition of an electromagnetic field depends on.

11:45 (poster 12:00)

Markus Holzer

Code generation in a lattice Boltzmann framework for exascale computing

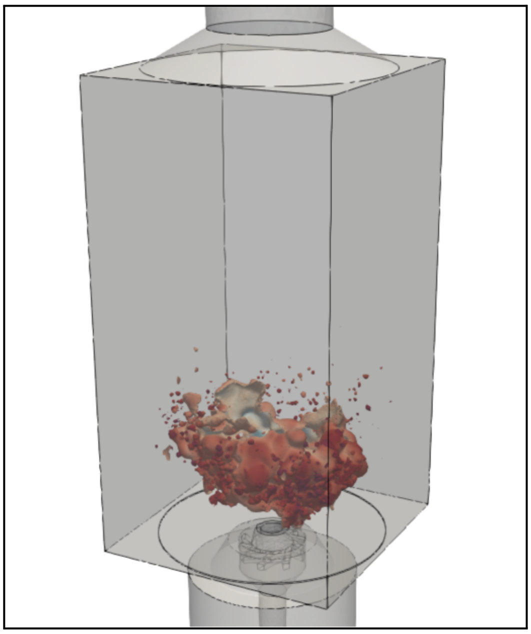


Adapting codes to new heterogeneous systems is challenging and time-consuming. Therefore, higher-level methods such as code generation must be researched to reduce the burden on developers and legacy codes. Code generation entails taking a step back from the code, tackling the problem from the equation level, and automatically generating compute kernels adapted to the physics of the problem and the target architecture to be used for the computation. The PhD project will study and develop this new approach to scientific software in the context of lattice Boltzmann simulations for fluid flow and apply it on accelerator hardware and complex flow configurations.

Thomas Lesaffre

11:50 (poster 12:00)

Simulation of sustainable aviation fuels (SAFs)



The certification of Sustainable Aviation Fuels (SAFs) through the ASTM D4054 standard requires a long and expensive experimental test campaign to study the fuel impact on the engine operability. Different indicators are investigated: lean blow-out (LBO), cold start, and high-altitude relight. Complementary to test campaigns, the capability to predict those operability indicators is crucial to reduce the cost and duration of the certification process of an aviation engine. The thesis aims to study numerically the SAFs effect on engine operability using Large Eddy Simulation (LES). Surrogates and kinetic mechanisms are derived to capture accurately the fuel specificities. Those models are used to simulate the LBO and ignition behavior of SAFs in academic configurations.

Hector-José Vargas Ruiz

11:55 (poster 12:00)

High Performance Large Eddy Simulations of Ammonia Hydrogen Industrial Gas Turbines

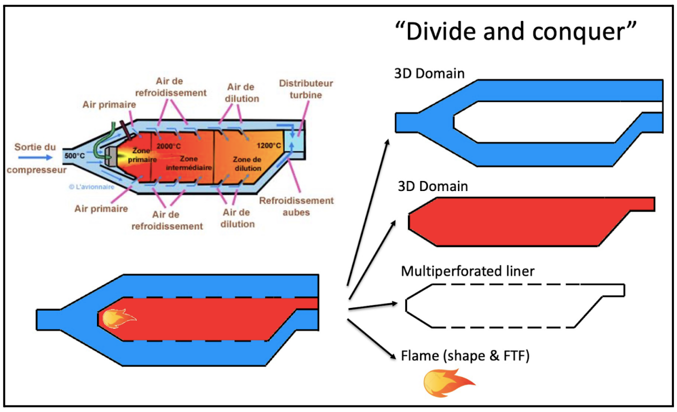
Decarbonization on off-grid off-shore oil platforms can be foreseen by adopting power generation fueled by NH3/H2 blends resulting from on-site ammonia cracking, thus benefiting from ammonia's logistical advantages (transportation and storage) and hydrogen's high reactivity. However, ammonia-based combustion is prone to high NOx production. High pollutant emissions are currently a showstopper for decarbonized fuels. Fortunately, recent studies have shown that novel staged-combustion burner technologies effectively mitigate pollutant emissions. The objective of the present work is thus to understand and accurately model flame dynamics and pollutant emissions of ammonia-hydrogen-fired gas turbines.

Mathieu Cances

13:30 (poster 14:15)

Low order model for the study and control of thermo-acoustic instabilities in gaz turbines

Thermoacoustic instabilities are a major concern in the design of aeronautical engines, they could have destructive effects on gas turbine and combustion chamber. The constructive coupling between flames and acoustic waves leading to these instabilities is expressed through the Helmholtz equation. Several numerical methods have been developed for solving this equation, but the Low Order Model (LOM) named "frame modal expansion" shows promising results in terms of modularity and calculation time. Recasting the system into an interconnected network of sub-elements allows to tune the parameters of each individual subdomains for parametric studies, helpful in the dimensioning step of an aeronautical engine.

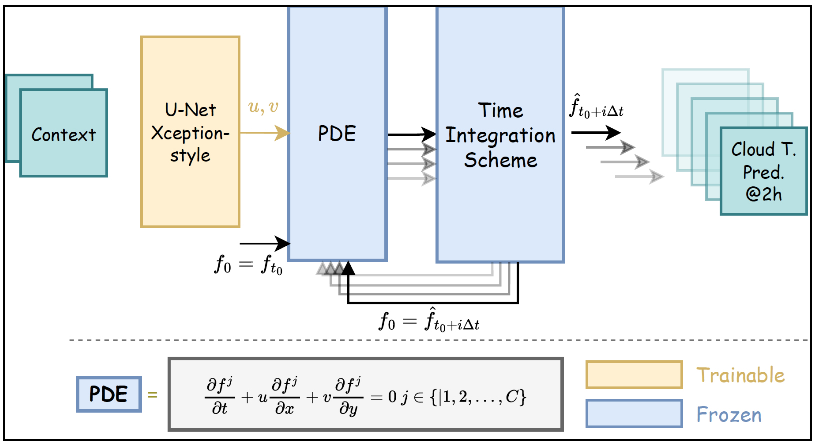


Rachid El Montassir

13:35 (poster 14:15)

Hybrid Physics-AI approach for cloud cover nowcasting

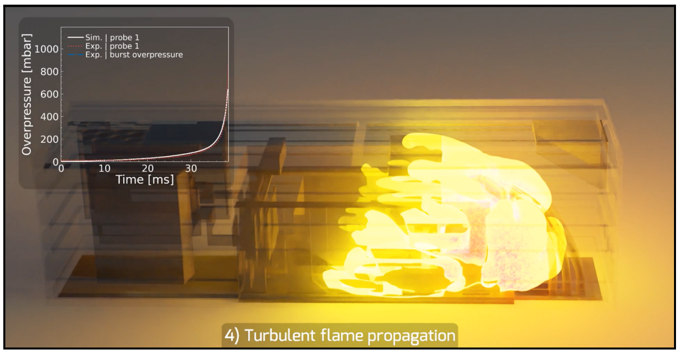
We propose a hybrid physics AI approach for cloud cover nowcasting, which addresses the limitations of traditional deep learning methods in producing realistic and consistent results that can generalize to unseen data. The proposed approach enforces multi-level advection dynamics as a hard constraint for a trained U-Net architecture. Our experiments show that the hybrid model outperforms traditional deep learning methods and the EUMETSAT Extrapolated Imagery model (EXIM) in both qualitative and quantitative results. Specifically, the hybrid model generates less blurry forecasts than U-Net and achieves higher similarity scores compared to both U-Net and EXIM. The proposed architecture provides a promising solution to overcome the limitations of classical AI methods and opens up new possibilities for combining physical knowledge with deep learning models in other domains.



Loïc De Nardi

13:40

Deflagration of H2/Air mixtures and flame-wall interaction



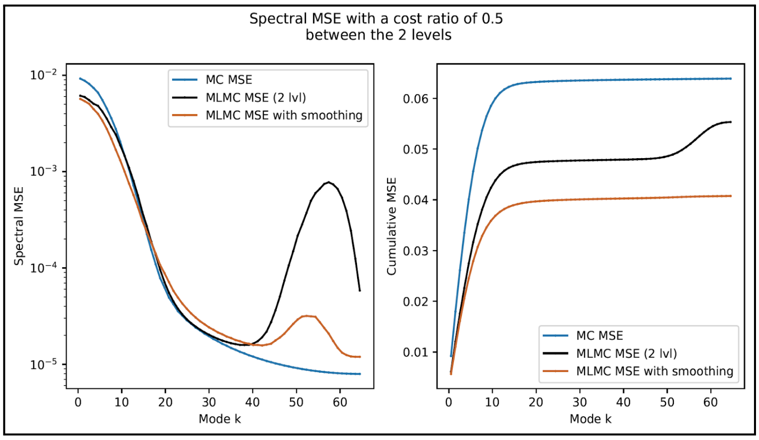
Hydrogen has become one of the most promising energy carriers to face global warming and make aviation carbon-free. However, its enhanced reactivity raises safety issues that are critical for zero-emission aircrafts design. The present thesis is part of a cooperation between CERFACS and AIRBUS, in order to study hydrogen deflagrations within realistic conditions. Currently, explosions are studied experimentally and numerically in quiet chambers. Using AVBP, a combustion code developed at CERFACS, the goal of my thesis is to address hydrogen deflagrations in turbulent flows and to develop numerical models that are able to capture the physics that drive flame propagation. The methods developed during this thesis will help AIRBUS to address hydrogen safety scenarios within flight condition.

Jeremy Briant

13:45

Multi-fidelity ensembles for high performance ensemble-variational data assimilation applied to earth model systems

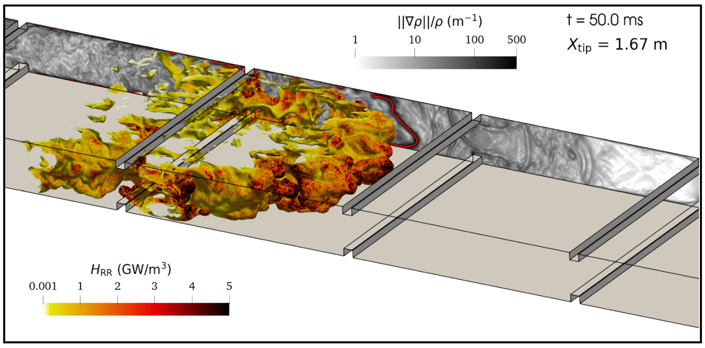
In geoscience it is common to represent unknown parameters as random variables. Uncertainty quantification methods like Monte Carlo estimators are then used to estimate the propagation of those random variables through the model. However a costly model can greatly limit the number of available samples and thus the accuracy of the estimation. Multilevel Monte Carlo estimators combine low fidelity models that are cheap but inaccurate with the accurate high fidelity model to reduce the total error of the estimation compared to simple MC estimators. We performed a spectral analysis of MLMC estimators to decompose their total error in error contributions from different scales, which then led us to propose an improvement of MLMC estimators by adding filters.



Francis Adrian Meziat Ramirez

13:50 (poster 14:15)

Large Eddy Simulations of hydrogen/air gas explosions in bigscale, complex geometries



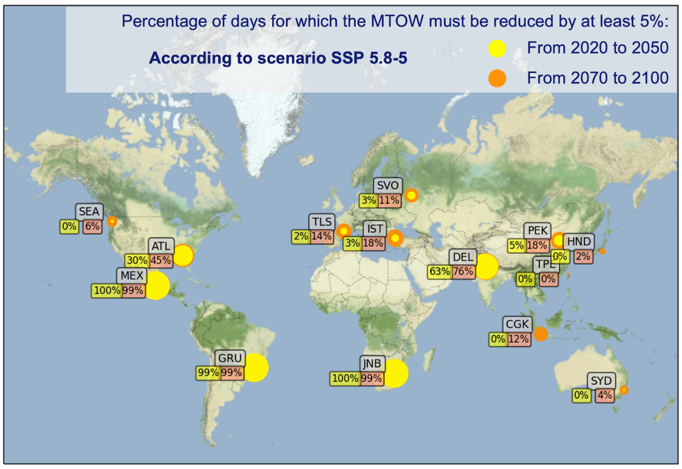
Hydrogen safety is nowadays a priority for many industrial sectors due to the properties and the rising importance of this fuel. Being able to correctly understand and predict explosions is a key step in the safe deployment of hydrogen across the industry. In this context, Large Eddy Simulations (LES) have shown great potential to finely reproduce the flow characteristics of hydrogen explosions. However, many real-world industrial systems are large-scale; resulting in a substantial computational burden when simulated via LES. The objective of this thesis is to develop methods, based on state-of-the-art algorithms, and models to perform affordable and predictive LES calculations of large-scale hydrogen/air explosions, in complex geometries.

Suzanne Salles

13:55 (poster 14:15)

Modeling the impact of atmospheric variables on the performance of an aircraft during take-off: Towards the adaptation of air traffic operations to global warming

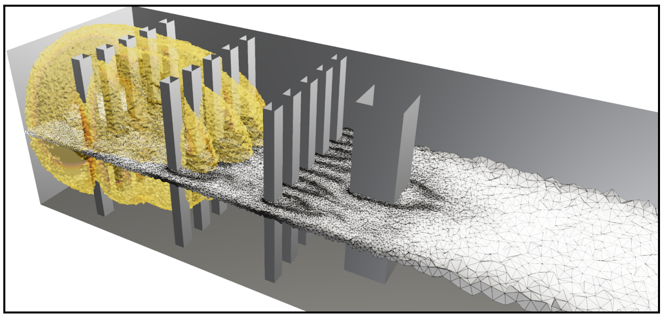
The study aims at investigating the impact of global warming on aviation. More precisely, the multiplication and severity of heat waves could drastically decrease performance during take-off, which would lead to weight restrictions being necessary. The methodology focuses on the transposition of uncertainties on atmospheric variables impacted by climate change into a quantified estimation of the reduction of the take-off weight (TOW) of medium haul aircrafts. Future atmospheric variables according to different emission scenarios are computed with the CNRM-CM6 climate model. The aircraft aerodynamic response to atmospheric modification is simulated with an in-house aircraft performance model. A global sensitivity analysis allows to rank the different sources of uncertainty and quantify their share in the uncertainty related to the computed TOW.



14:00 (poster 14:15)

Benjamin Vanbersel

Automatic Adaptive Mesh Refinement methods for LES of explosions



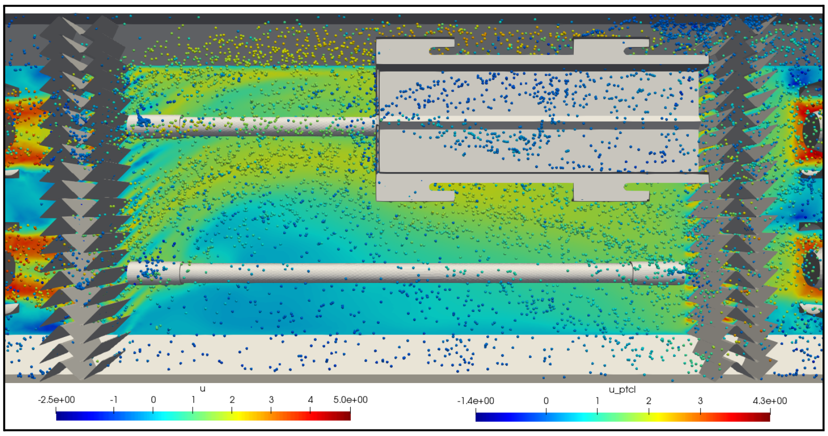
The most limiting parameter in numerical simulation is computational time. To capture all the physics of a turbulent flame, the mesh needs to be refined enough to resolve flame and turbulence. This homogeneous mesh can reach several billion cells in industrial configurations. Such simulations are unaffordable in the context of LES. That is why mesh adaptation is used. It aims to refine the mesh in regions where the quantities of interest are detected and to coarsen it otherwise. In the case of explosions, the mesh adaptation needs to be dynamic because the flame and turbulence evolve in the whole domain. The strategy is to follow these quantities and develop criteria for triggering mesh adaptation to keep an acceptable computational cost.

14:05 (poster 14:15)

Shiram Sankurantripati

Study of propagation of airborne viruses in closed environment using high fidelity simulations

Airborne viruses such as COVID-19 can infect an individual through direct or indirect transmissions. Research suggests that the survivability of these virus-laden droplets is heavily dependent on numerous factors such as humidity, room temperature, turbulence dispersions, wind speed and orientation. To provide a mitigation solution, one has to accurately simulate and understand the flow physics of these droplets inside a closed environment (eg: Bus). In collaboration with VALEO, UV purifier design is proposed to install inside a bus to bring down the infection spread. Large Eddy Simulations coupled with a Lagrangian tracking of droplets and a radiation – disinfection solver will be used to simulate this purifier setup. Then, simulations will be carried inside a bus with an installed purifier.

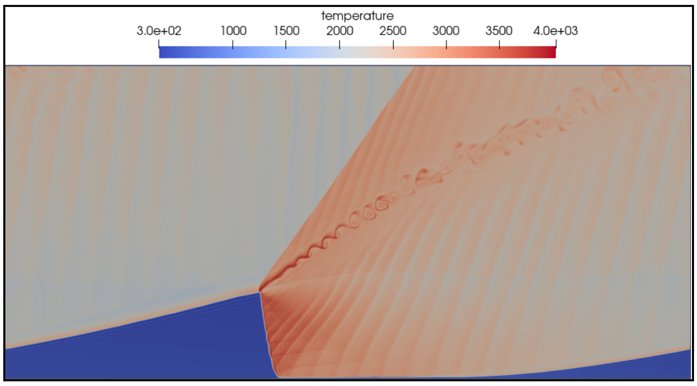


14:10 (poster 14:15)

Patrick Strempfl

LES of flow and combustion in a rotating detonation engine coupled to a turbine

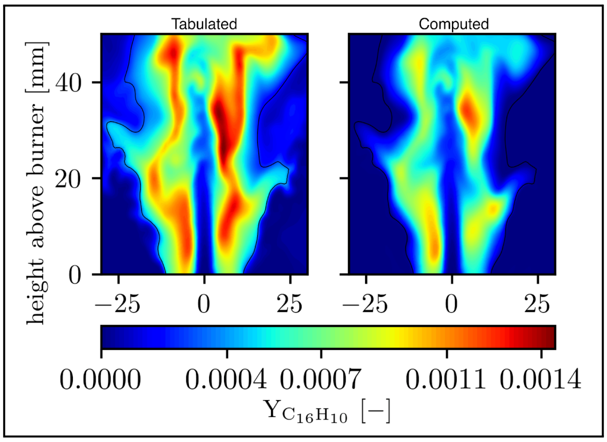
Rotating detonation engines (RDE) are a novel pressure gain combustion (PGS) system for the generation of thermal energy for gas turbines or thrust generating devices such as rocket engines. In theory, RDEs are capable of delivering higher thermal efficiency than conventional combustion systems. In recent years, the interest in these combustors increased significantly, which led to the emergence of various experimental setups worldwide, dedicated to understanding the performance of RDEs. Large Eddy Simulations (LES) can contribute significantly to gain insight into the flow phenomena in RDEs, such as mixing, reaction or losses.



15:15 (poster 14:15)

Alexandre Coudray

Modelisation and simulation of SAF combustion including soot production in aeronautical engines



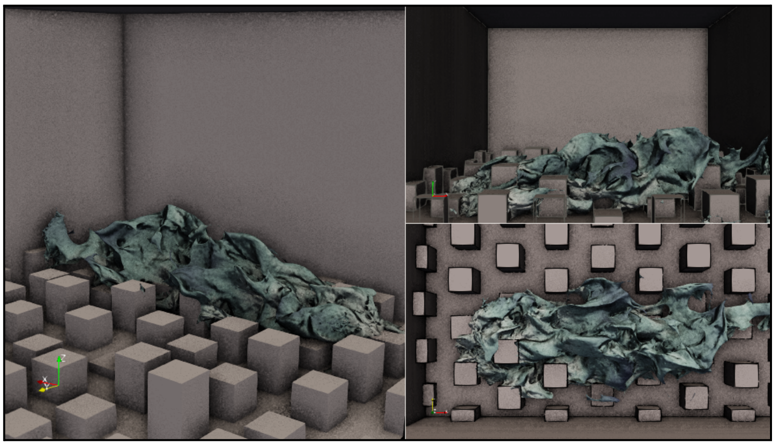
With the objective of moving towards a fossil fuel free kerosene, this thesis focuses on the use of 100% SAFs (Sustainable Aviation Fuels) through the modelling of soot in the case of turbulent combustion. The chemical description of fuel pyrolysis, oxidation of pyrolysis products, soot precursors and gaseous pollutants is delicate because it requires a large number of species.

To reduce the computational cost, several strategies need to be developed aiming two main axes. The first axis is the gaseous phase description where soot precursors need to be correctly described while keeping the number of species low when soot models are used. The second axis focuses on the description of the soot morphology to better predict particle size distribution and soot volume fraction.

Rémi Alas

15:20 (poster 14:15)

Deep Learning approaches to urban boundary layer modeling



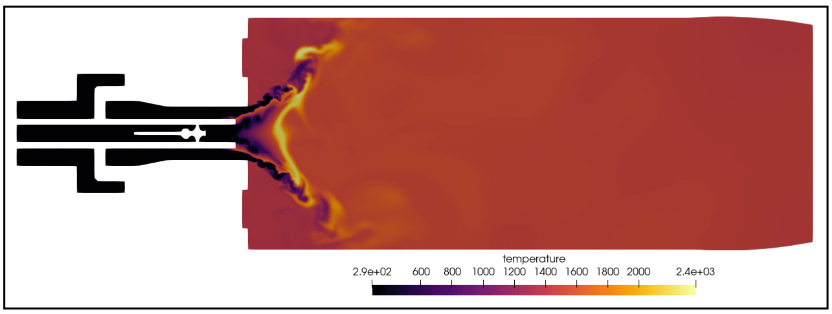
Capturing the relevant scales of motion is crucial to perform accurate simulation. The task gets tricky when the flow is subjected to strong scale disparity resulting in a very high computational cost. The aim of the present study is to accelerate LES of flow with strong scale disparity while guaranteeing an appropriate accuracy. The Urban Boundary Layer (UBL) problem, where the flow encounters elements size varying from few meters (threes, housing...) to hundreds of meters (buildings) over a boundary layer of depth δ = 1km, is the perfect example to illustrate the scale disparity problem. A data-driven approach to model the impact of the smallest elements in the UBL is being implemented to drastically reduce the computational cost.

Nathanaël Rouland

15:25 (poster 14:15)

Simulation and modelling of turbulent flames enriched with H2

The use of hydrogen in combustion, either pure or mixed with other fuels, is promising to achieve an efficient energetic transition. However, modelling and simulating those flames remains a challenging scientific and technological issue. The first objective of this thesis is to handle the particular issue of modelling transport phenomena in multicomponent gas phases, which requires new strategies balancing complexity and accuracy. Then, it has been shown in multiple burners that the diffusion flame regime is dominant in H2 combustion. Consequently, the second main objective is to propose an efficient model to deal with those cases. The LAMIRADAS case and a reactive mixing layer with a blend of H2 and methane in air are mainly studied.



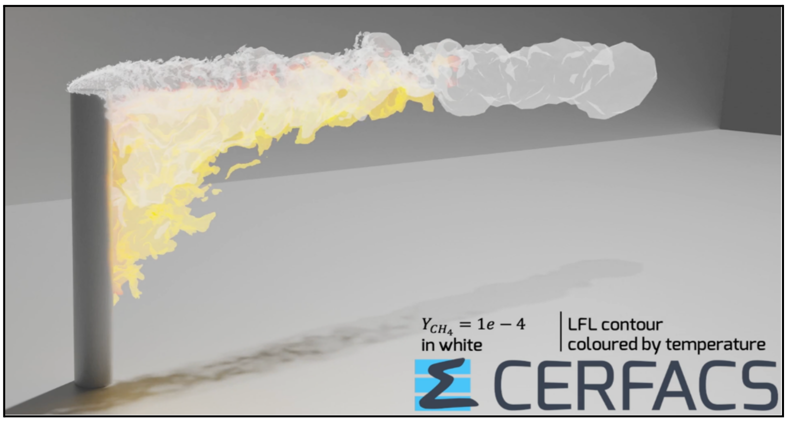
3'

Lukas Gaipl

15:30

LES of Jets in crossflow with flame wall interaction

The objective of the thesis is the numerical simulation using DNS and LES of diffusion flames, which are created by a jet of combustible gas in air. This configuration is used in torches and further in safety scenarios in aviation industry. Moreover, the interaction of flames and walls is studied. The first part of the thesis is dedicated to 'free' flames e.g., without any obstacle. The stabilisation of the flame in the vicinity of jet lips is studied. In the second part, these flames are placed close to walls and the interaction of flames and walls is studied: the kinetics close to the wall are re-examined as well as turbulence models in the vicinity of walls.



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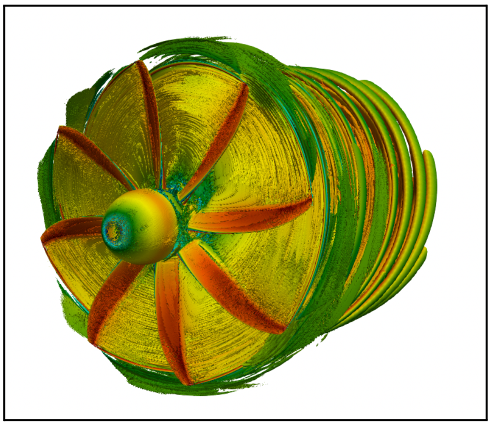
Raul Vazquez Cazique

15:35

Aeroacoustic simulation of an installed propeller via an LBM approach



Noise prediction plays a major role in the conception and certification of future aircraft configurations. Numerical methods (CFD) have established themselves as an important tool for aeroacoustic simulations in the industry. Among the existent methods, the lattice Boltzmann method (LBM) has emerged in recent years as an interesting option due to its low numerical dissipation, its easy implementation, and its ability to handle complex geometries with ease. However, the existence of mesh refinements and fixed and mobile regions in the mesh can generate spurious noise sources, which need treatment for aeroacoustic simulations of turbomachinery. The objective of the thesis is to develop the method to reduce spurious noise sources appearing at interfaces to carry out accurate and inexpensive aeroacoustic simulations of propeller noise.