Wednesday (17 September 2025)
Imperial College South Kensington Campus

Start	End	Research Presentations
8:30	9:00	**Arrival + Breakfast**
9:00	9:15	**Welcome**
9:15	10:15	**Presentations: Observations I** Presenters: Ed Gryspeerdt (Imperial), Denis Vida (University of Western Ontario), Philippe Very (Eurocontrol), Tim Wagner (UW-Madison)
10:15	10:45	**Break + Poster Viewing**
10:45	11:45	**Presentations: Observations II** Presenters: Irene Ortiz (UC3M), Aarón Sonabend and Kevin McCloskey (Google Research), Marlene Euchenhofer (MIT), Zeb Engberg (Contrails.org) and Thymen Woldhuis (TU Delft)
11:45	13:00	**Lunch**
13:00	14:10	**Presentations: Forecasts** Presenters: Vincent Meijer (TU Delft), Oliver Driver (Imperial), Sara Arriolabengoa Zazo (Meteo-France), Remi Chevallier (Airbus), Alan Pechman (American Airlines)
14:10	14:30	**Break + Poster Viewing**
14:30	16:00	**Presentations: Process Modeling** Presenters: Seb Eastham (Imperial) and Caleb Akhtar-Martinez (Cambridge), Ulrich Schumann (DLR), Manuel Soler (UC3M), Ian Poll (Cranfield), Catherine Mackay (Airbus), Roger Teoh and Joel Ponsby (Imperial)
16:00	16:20	**Break + Poster Viewing**
16:20	16:30	**Intro to Day 2**
16:30	17:00	**Day 1 Review**
17:00		End of Day 1
From 18:00		Social at a nearby venue

Thursday (18 September 2025)
Imperial College South Kensington Campus

Start	End	Action Planning Breakout Sessions
8:30	9:00	**Arrival + Breakfast**
9:00	10:15	**Session 1: critical barriers**
10:15	10:45	**Break**
10:45	12:00	**Session 2: action plans**
12:00	13:30	**Lunch**
13:30	14:45	**Session 3: execution**
14:45	17:00	**Unstructured co-working**
17:00		End of Workshop

Titles and Abstracts

Observations I

Ed Gryspeerdt (Imperial): *Isolating and constraining the human impact on clouds*

Denis Vida (University of Western Ontario): *First Results of Automated Ground-based Contrail Observations at a Global Scale with the Global Meteor Network*

The Global Meteor Network (GMN), originally designed for meteoroid tracking, has been repurposed for global, ground-based aircraft contrail monitoring. A December 2024 software update enabled 24/7 time-lapse acquisition (one frame every five seconds) without hardware changes. Over 5000 images were manually labeled to train machine learning models, achieving 70–90% detection accuracy depending on scene complexity. An automated flight attribution algorithm links contrails to specific aircraft via advected flight paths. Validation against GEOS satellite contrail products shows promising agreement. A low-cost all-sky contrail camera prototype and an integrated visualization and analysis suite further demonstrate the feasibility of systematic contrail monitoring.

Philippe Very (Eurocontrol): *A Dataset for Contrail Identification and Tracking on All-Sky Cameras*

This talk will introduce GVCCS, a dataset providing ground-truth observations from an all-sky camera. These data support the systematic testing of computer vision models, flight attribution, as well as comparisons with model predictions. The talk will also provide an update on ContrailNet, a collaborative initiative that aims to pool datasets such as GVCCS.

Tim Wagner (UW-Madison): *Long-term Observations of Contrail Microphysics from Ground-Based Instrumentation*

For over two decades, the Atmospheric Radiation Measurement facility has been recording observations of atmospheric and cloud characteristics from multiple sites around the world. Routine measurements include atmospheric profiles, downwelling radiation, and cloud microphysics, all at high temporal resolution. Numerous instruments are particularly well-suited for contrail studies given their sensitivity to ice particles and their ability to discriminate between ice and liquid clouds. In this presentation, the utility of these observation sites will be demonstrated through a long-term study of contrail microphysical characteristics, including their evolution as a function of lifespan.

Observations II

Irene Ortiz (UC3M): *AI-Based Insights into Aviation's Climate Impact using Satellite Imagery in E-CONTRAIL Project: Contrail detection and Radiative Forcing estimation over the full year 2023 in Europe*

Aviation's non-CO_2 effects are dominated by contrails, yet continent-scale, year-long assessments remain limited. Within E-CONTRAIL, we processed an entire year (2023) of Meteosat Second Generation/SEVIRI data over Europe with an enhanced AI pipeline. Contrail detection builds on an ensemble of state-of-the-art semantic and instance segmentation networks trained on OpenContrails, augmented by the Boundary Soft framework to accommodate labeling uncertainties, achieving Bounday-Soft Global Dice Scores >80%, ~93% true detections, and <3% false positives. To better capture aged, diffused, and non-linear contrails, an Optical Flow Correction (OFC) layer propagates information from previously detected features, markedly improving coverage of aviation-induced cloudiness relevant for climate studies.

Radiative forcing (RF) was quantified through a Rapid Contrail-RF Estimation Approach: cloud properties from the MSG/SEVIRI Optimal Cloud Analysis product were combined with libRadtran-based look-up tables to derive shortwave, longwave, and net top-of-atmosphere RF maps. Validation against CERES fluxes shows accuracies above 80% (overall methodological uncertainty ~15%).

Preliminary findings reveal: (i) successful first-year application of both detection and RF algorithms over Europe; (ii) April–May concentrate the highest number of contrail detections, with daily peaks at 07:30 and 15:30 UTC; (iii) a net cooling during central daytime hours, but an overall net warming from August through April, intensifying between November and February. These results underscore the need to account for timing and persistence when evaluating mitigation options and demonstrate how AI-enabled satellite analytics can inform contrail-aware operational strategies and policy.

Aarón Sonabend and Kevin McCloskey (Google Research): *Observing long-lived longwave contrail forcing*

Marlene Euchenhofer (MIT): *Contrail observation limitations using geostationary satellites*

Many observational contrail studies rely on data from a single sensor, in recent years increasingly from a geostationary imager, accepting lower spatial resolution in exchange for higher temporal and spatial coverage. However, the ability of geostationary imagery to resolve contrails has not been systematically characterized. By comparing higher spatial resolution low Earth orbit satellite imagery from VIIRS to geostationary satellite imagery from GOES ABI, we show that the latter does not resolve 80% of the contrails nor half of the total length compared to contrails identified with VIIRS. Our findings underscore the need for multi-sensor approaches to collect observational contrail data to better calibrate climate models and enable more rigorous and verifiable contrail avoidance strategies.

Zeb Engberg (Contrails.org) and Thymen Woldhuis (TU Delft): *Enabling New Applications of High-Resolution LEO Satellites through Improved Co-locations*

High-resolution low earth orbit (LEO) satellites provide unique opportunities to create high-fidelity datasets. Such datasets can for instance be used for advancing flight attribution problems, validating contrail models, and comparing in-situ and remote sensing data. We have developed and implemented a set of satellite correction and co-location tools within pycontrails. In this presentation, we highlight several applications: a curated, labeled dataset (to be made public as well) of IAGOS aircraft co-locations in Landsat and Sentinel imagery, examples of contrail model validation using these data, and a fleet-level advection case study.

Forecasting

Vincent Meijer (TU Delft): *ECATS workshop update*

Oliver Driver (Imperial): *Understanding meteorological limitations using the structure from weather systems*

Input meteorological data limits modelled contrail populations. Upper-tropospheric humidity is often not accurate enough to determine if contrail ice crystals will persist or sublimate. This hinders the validation of contrail models against observations. We show that critical ice-supersaturated regions (ISSRs) and their modelling performance are strongly structured around North Atlantic low pressure systems. Scaling humidity is an effective strategy for altering ISSR morphology to increase recall within these limitations without sacrificing information where the model is rightly confident. This link to meteorological processes articulates how model development is ultimately needed to support the needs of contrail management.

Sara Arriolabengoa Zazo (Meteo-France): *Verification of ISSR forecasts for contrail avoidance applications*

Reliable weather forecasts are essential for effective operational planning aimed at avoiding contrails and thus reducing aviation's climate impact. ISSR forecasts from the modified ARPEGE and the IFS models are compared with in situ IAGOS flight data and RS41 radiosonde observations. In addition to conventional comparisons between observed and forecast distributions, spatial measures are defined using a method based on a neighbourhood tolerance approach in the horizontal direction (with IAGOS) and in the vertical direction (with radiosondes). This allows for a spatial interpretation of the scores, which could be used in contrail management strategies.

Remi Chevallier (Airbus): *Beyond Deterministic Models: On the Importance of Modeling Variability for Designing Fair and Effective Contrail Impact Mitigation Strategies*

Contrails are a significant contributor to aviation's climate impact, but mitigation strategies are hampered by major uncertainties in weather and climate models. In our experiment, relying on deterministic reanalysis (thus neglecting the weather related uncertainties) for flight planning results in a significant loss of potential climate mitigation. This presentation illustrates that explicitly modeling these uncertainties is important for effective and fair implementation of a climate incentive. We propose a simple method to account for weather variability in the flight planning process. This approach significantly outperforms the deterministic approach, illustrating that simple methods of accounting for uncertainty exist, and lead to more reliable climate-optimized trajectories.

Alan Pechman (American Airlines): *The role of flight dispatchers in operations and contrail trials*

Flight dispatchers are the unseen counterparts to pilots, sharing legal authority for every flight's safety and operational control. My presentation first examines their mission-critical role in flight planning, in-flight monitoring, and decision-making that ensures compliance and passenger safety. It then presents American Airlines' January–May 2025 Contrail Trial, conducted with Breakthrough Energy, Google, and Flightkeys—the first large-scale U.S. effort to integrate contrail avoidance into routine transatlantic operations. By testing dispatcher- and pilot-driven adoption of contrail routes, the trial demonstrated measurable contrail reduction with minimal fuel impact, offering key insights for operational feasibility and shaping future climate-focused aviation regulation.

Process Modeling

Seb Eastham (Imperial) and Caleb Akhtar-Martinez (Cambridge): *Understanding and addressing scientific compromises in simplified contrail modelling*

Ulrich Schumann (DLR): *Contrail-weather interactions, based on a coupled ICON-CoCiP study*

Contrail forecasts typically neglect feedbacks with the atmosphere. We investigate these using a two-way coupling of the CoCiP contrail model with the global NWP model ICON, which includes two-moment cloud ice microphysics for improved humidity representation. The coupled system yields results broadly consistent with standard offline CoCiP simulations but captures additional feedbacks. Contrails slightly reduce cloud cover and alter humidity. Particularly under convective conditions, they affect regional circulation, temperature, and precipitation. These interactions introduce a butterfly effect, suggesting contrails can influence atmospheric dynamics and reduce weather predictability.

Manuel Soler (UC3M): *Insights into contrail modelling: A Multi-Physics Eulerian Framework for Long-Term Contrail Evolution*

Condensation trails (contrails) are increasingly recognized as a major contributor to aviation-induced atmospheric warming, rivaling the impact of carbon dioxide. Mitigating their climate effects requires accurate and computationally efficient models to inform avoidance strategies. Contrails evolve through distinct stages, from formation and rapid growth to dissipation or transition into cirrus clouds, where the latter phase critically determines their radiative forcing. This long-term evolution is primarily driven by advection-diffusion processes coupled with ice-particle growth dynamics. We propose a new multi-physics Eulerian framework for long-term contrail simulations, integrating underexplored or previously neglected factors, including spatiotemporal wind variability; nonlinear diffusion coefficients accounting for potential diffusion-blocking mechanisms; a novel multiphase theoretical model for the bulk settling velocity of ice particles; and ice-crystal habit dynamics. The proposed model is solved using a directional-ODE discretization approach to enhance both accuracy and computational efficiency. Additionally, the Eulerian model introduces several theoretical, adjustable parameters that can be calibrated using ground-truth data to optimize the built-in non-linear advection–diffusion equations (ADEs). We further demonstrate that the governing nonlinear ADEs admit dimensional separability under suitable assumptions, making the multi-physics Eulerian model particularly promising for large-scale simulations of contrail plumes and, ultimately, their associated radiative forcing.

Ian Poll (Cranfield): *A description of the P-S aircraft performance method and an outline of future developments*

Since the last presentation in 2023, the P-S has been developed and extended considerably. These improvement will be described and the status of the currently available methods and the data base will be given. Further improvements of the engine model are now being made. These and other potential improvments will be discussed.

Catherine Mackay (Airbus): *How engine overall efficiency and fuel type affect the probability of contrail and persistent contrail formation*

Roger Teoh and Joel Ponsonby (Imperial): *Integrating a vPM activation model into global contrail simulations*

Posters

Thanguy Chauvet (SII): *Contrail Tracker: a visualization tool to compare contrail model predictions with observations*

Following the 2024 Contrail Workshop, SII Research worked in partnership with Reuniwatt and SWISS International Airlines to develop a tool comparing contrail model predictions with ground observations. The prototype, using a Reuniwatt all-sky camera in Toulouse, has already tracked contrails from SWISS selected flights. The ultimate goal is a full automation of every processing module, using ground and satellite images. Scaling to diverse data sources would provide valuable statistical insights on contrail models. What's more, such wider tool would offer verified contrail information to contrail community and stakeholders like airlines and authorities.

Nathan Grimmer (ISAE-Supaero/Contrails.org): *Linear contrail verification product*

We develop a gridded dataset of contrails detected from satellite imagery to assess their climate impact and compare it with outputs from the CoCiP model. To ensure consistency, CoCiP contrails are filtered to retain only those potentially observable by satellites. A neighborhood-based verification method is introduced to evaluate spatial agreement between satellite-derived observations and CoCiP simulations. This approach enables a comparison between modeled and observed contrail coverage and their associated radiative effects.

Laurent Sauvage (Reuniwatt): *Contrail characterisation with thermal ground based all-sky imagers*

In order to mitigate the climate impact of contrails it becomes necessary to evaluate their radiative forcing and propose aircraft rerouting strategies. The aviation community is actively testing solutions that need to be intensively validated. Satellites are able to identify contrails at global scale. However they miss the crucial first minutes of the contrails lifetime, necessary for accurate pairing with planes. All-sky thermal imagers are well designed to fill this gap for both identification and radiative characterization of contrails and well suited for validation of contrail modeling at night. Contrail identification features and validation examples will be presented.

Marcus Wiegand (TU Dresden): *Contrail Modeling for Aircraft Engine Design*

Contrails are a major contributor to aviation's climate impact and must be addressed in future engine design. Using pycontrails, global air traffic data, and analytically derived great-circle trajectories, we estimate the global contrail climate impacts of kerosene, SAF, and hydrogen. For hydrogen engines, where soot is absent, we incorporate time- and location-resolved ambient aerosol data (CAMS) and compare results with constant aerosol concentration assumptions. Results align with literature for kerosene and show contrail reductions of >30% with SAF and well over 90% with hydrogen. Additionally, we developed efficient surrogate models to predict global contrail impacts for new engine designs based on key parameters (fuel consumption, nvPM, cruise altitude, aircraft size), enabling the development of climate-optimized engines and operations.