



# AERO2K

## Aviation Emissions Inventory for 2002 and 2025

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# AERO2k Overview - Objectives

- Create a database of global aviation emissions for the year 2002 based on:
  - an aircraft movements database
  - aircraft fuel usage predictions,
  - engine emissions data.
- Produce a forecast of global emissions for 2025 based on predicted aircraft movements
- ... .. but the AERO2K tool has wider applications (more on this later)

# AERO2k Overview

## Project Partners:

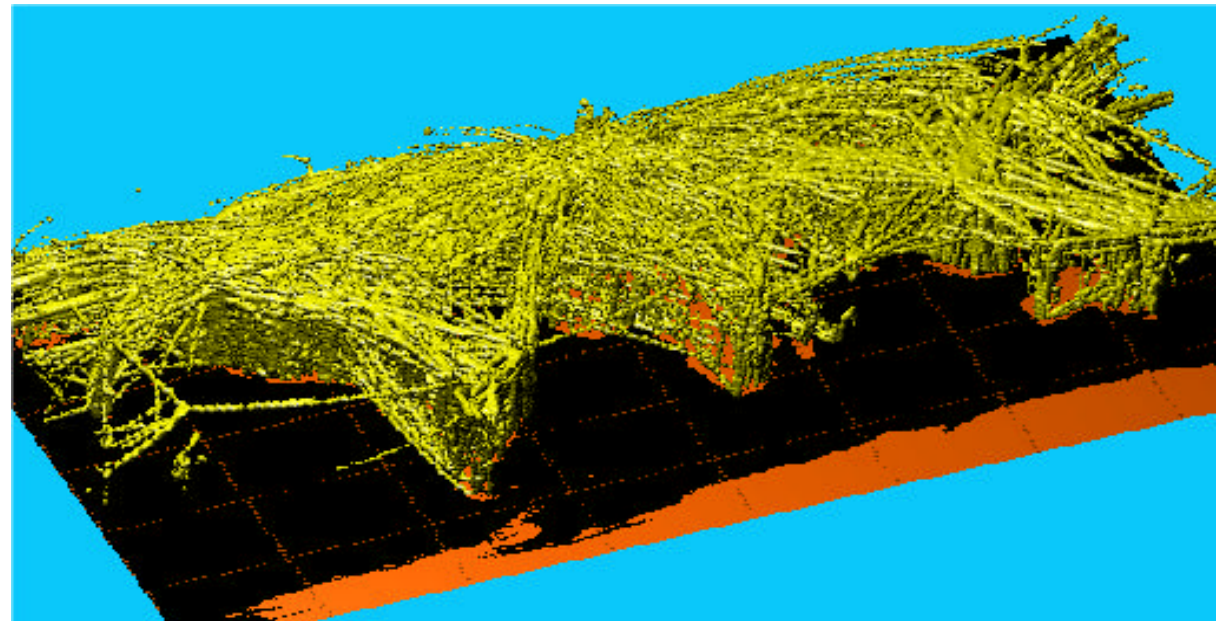
- QinetiQ (UK, Co-ordinator),
- DLR (Germany),
- Manchester Metropolitan University (UK),
- NLR (The Netherlands),
- Department of Trade and Industry (UK)
- Airbus France (France)
- Eurocontrol (European Agency)

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Work for this presentation was funded by UK Department for Transport

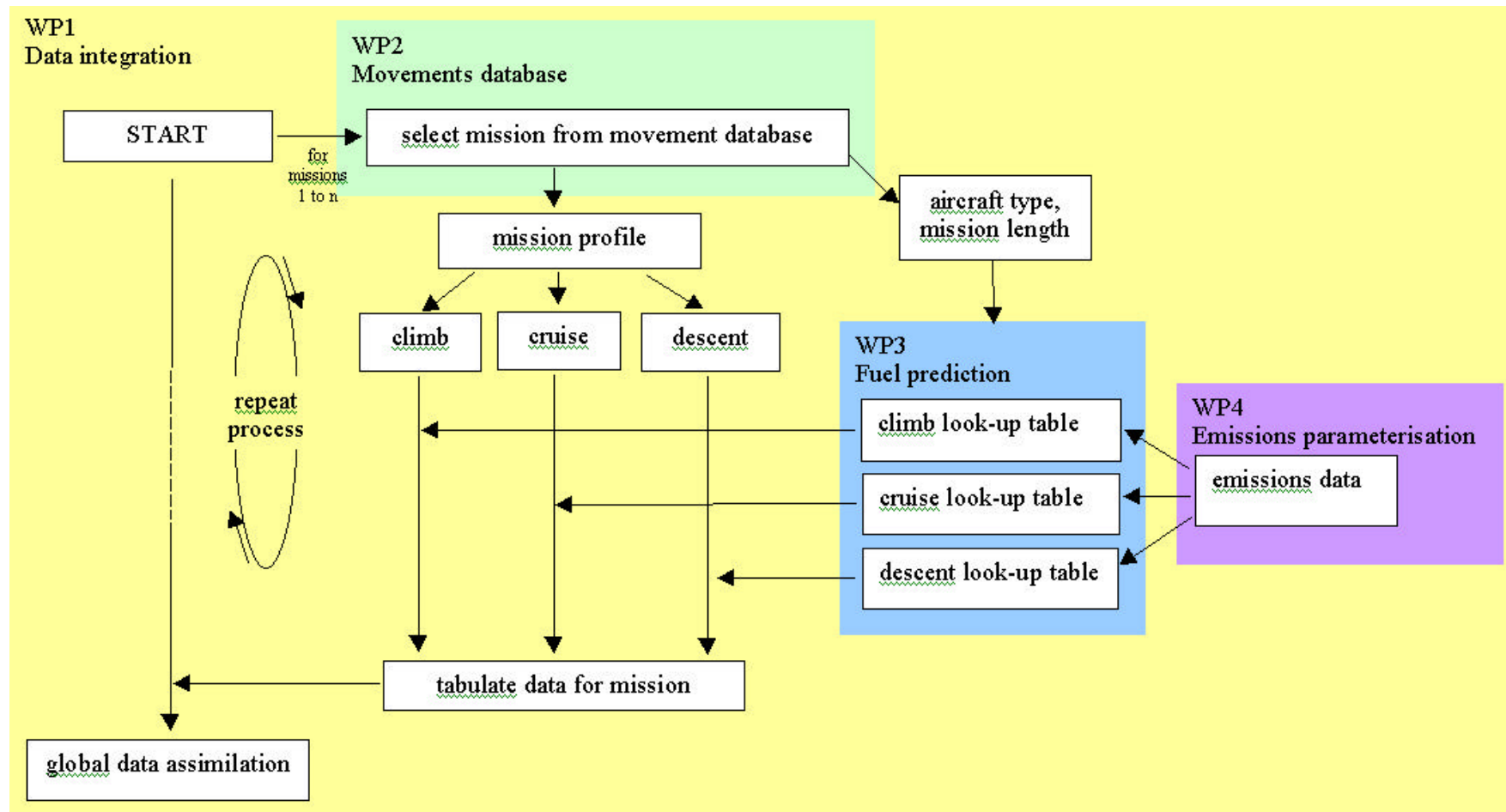
# AERO2k Overview

- Gridded 4D emissions results
  - 2002 inventory
  - 2025 forecast
- available Summer 2004



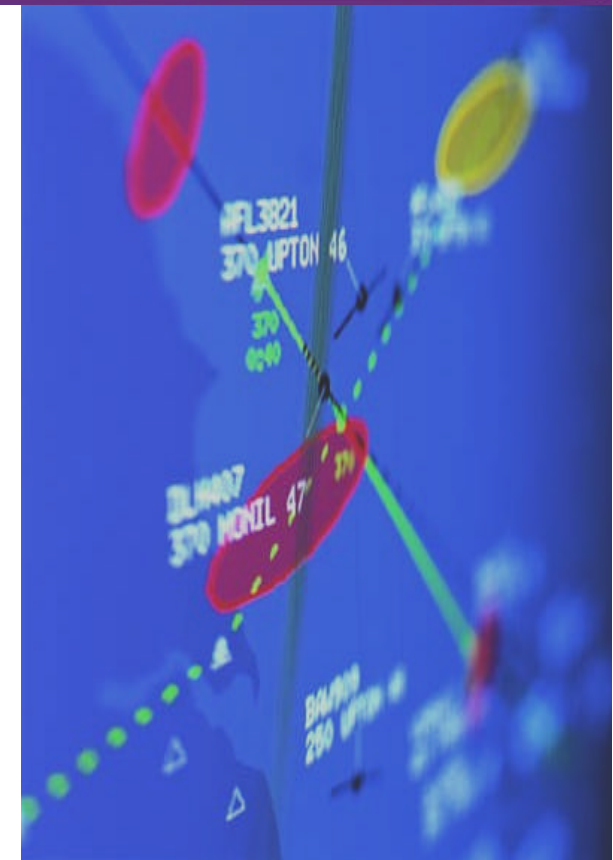
Gridded fuel data (total mass) for one full day

# AERO2K – Data Integration



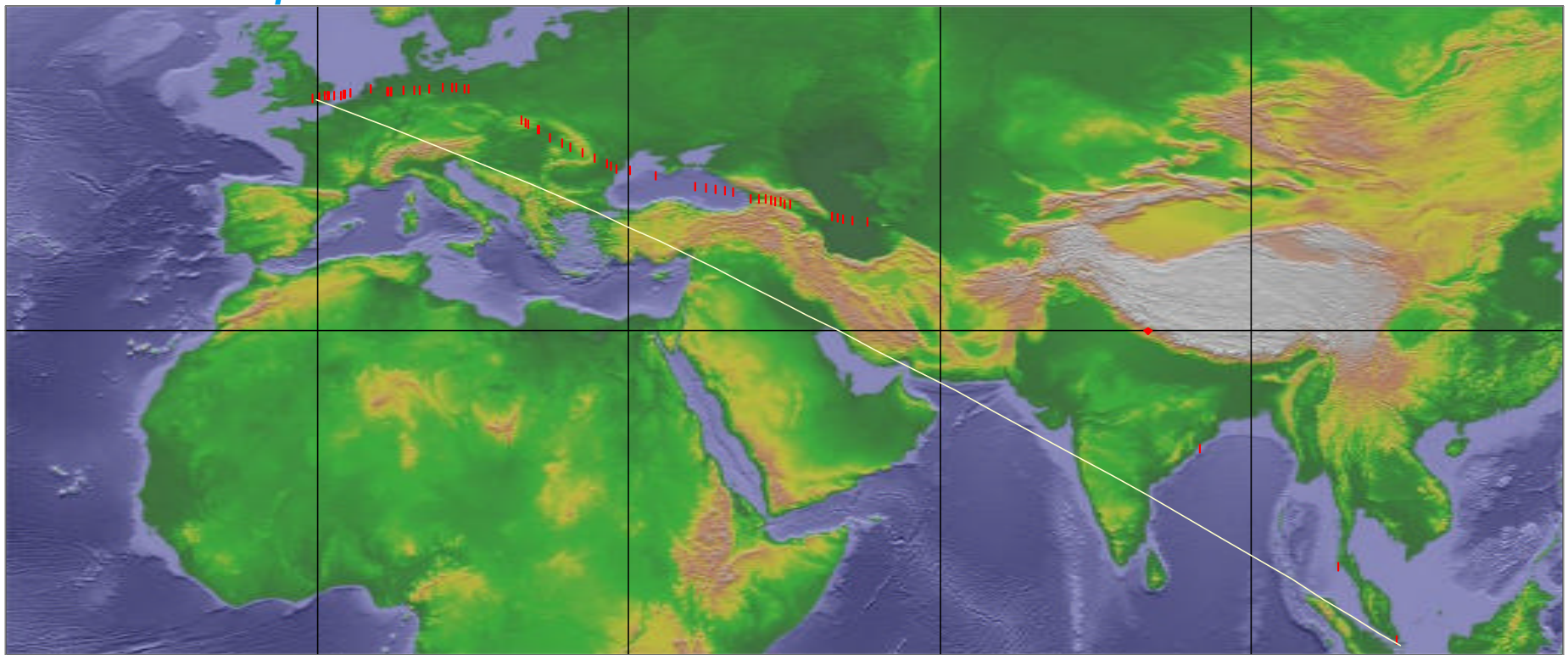
## Flight movement data

- EUROCONTROL providing flight data for all IFR flights around the world for six separate weeks from 2002.
- Data includes:
  - aircraft type,
  - departure airport, departure time, arrival airport,
  - latitude, longitude, altitude throughout flight (at approx 20-50 points throughout each flight, depending on flight length)
- These data are from radar tracks or from flight trajectory predictions





# *Flight Trajectory Projection Data - Improvement over Great Circle Assumption*



*B 747-400 Singapore to London*

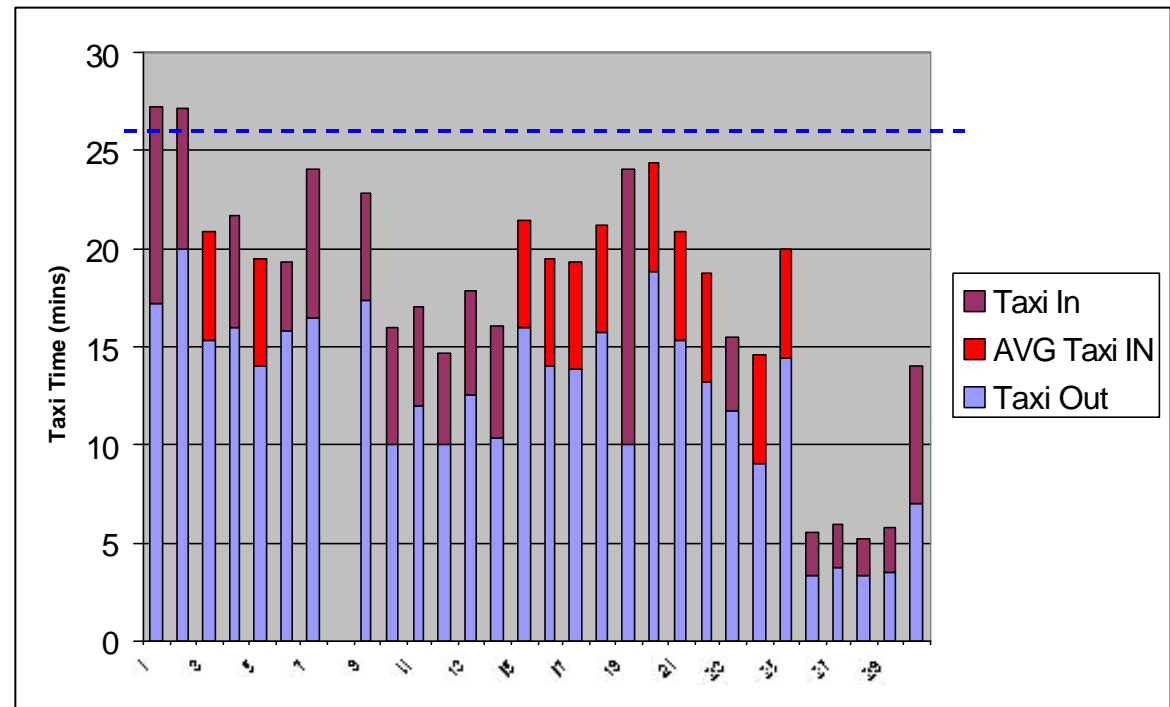
## LTO data

- LTO times-in-mode for individual airports are compiled by MMU. Based on survey of 400 worldwide airports representing 75% of traffic
- These times applied to ICAO databank LTO fuel and emissions to give LTO emissions



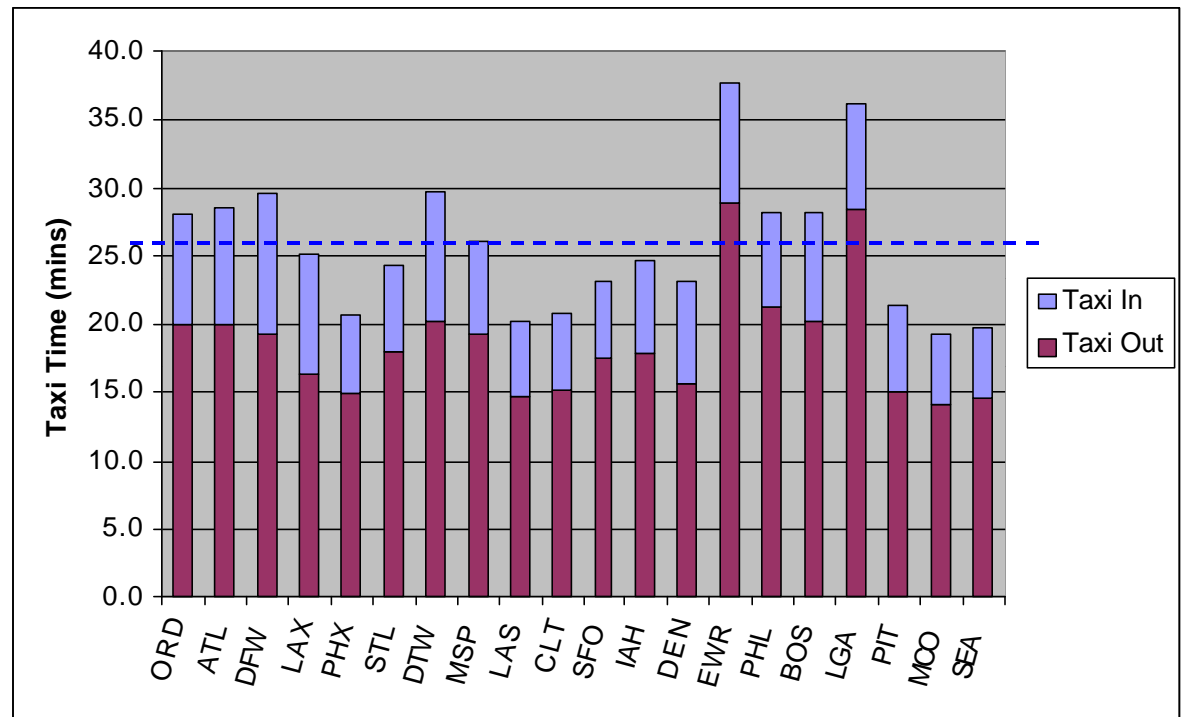
## Taxi Times - Europe

- Majority of European Airports surveyed have total taxi times < ICAO 26 min ref
- Times are very variable and confirm the need for airport specific times
- Similar range to AEROCERT (12 – 33 mins, typically < 21)



## Taxi Times - USA

- Majority of US Airports surveyed have total taxi times < ICAO 26 min ref
- However these large US airports tend to be closer to the reference value than European
- Other US airports have lower times



## Aircraft representation and fuel prediction

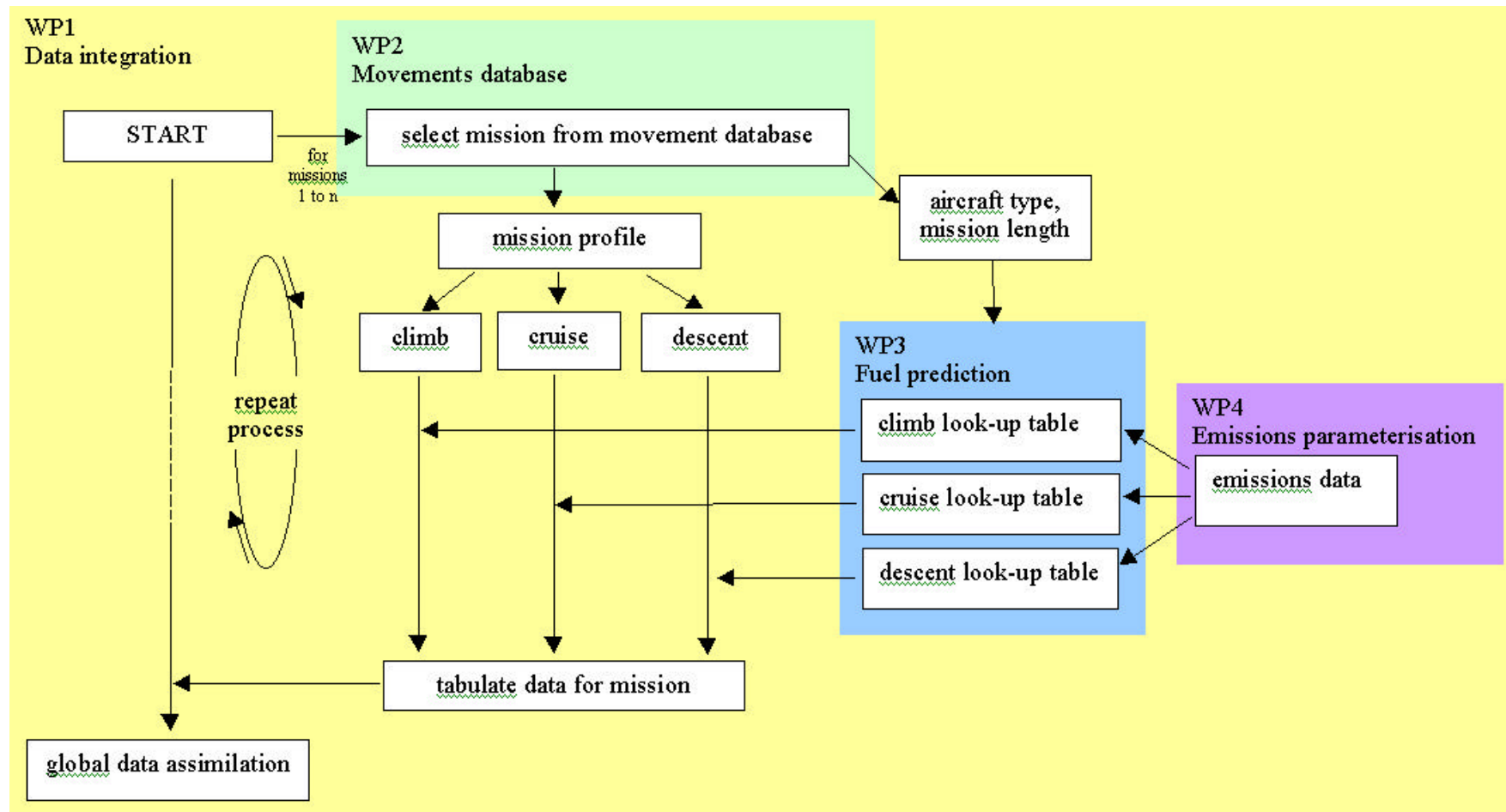
- Select representative aircraft and engine types:
  - not practical to individually model the large number of aircraft types and variants in use throughout the world,
  - necessary to make use of a smaller number of 'representative' types (40) whose combined performance is broadly representative of the performance of the global fleet.
- Generate fuel flow data for representative aircraft types,
  - generated using the PIANO aircraft performance tool.
- Divided into two areas:
  - *civil* aircraft movements (QinetiQ)
  - *military* aircraft movements (NLR) – not included for this analysis

## Emissions data

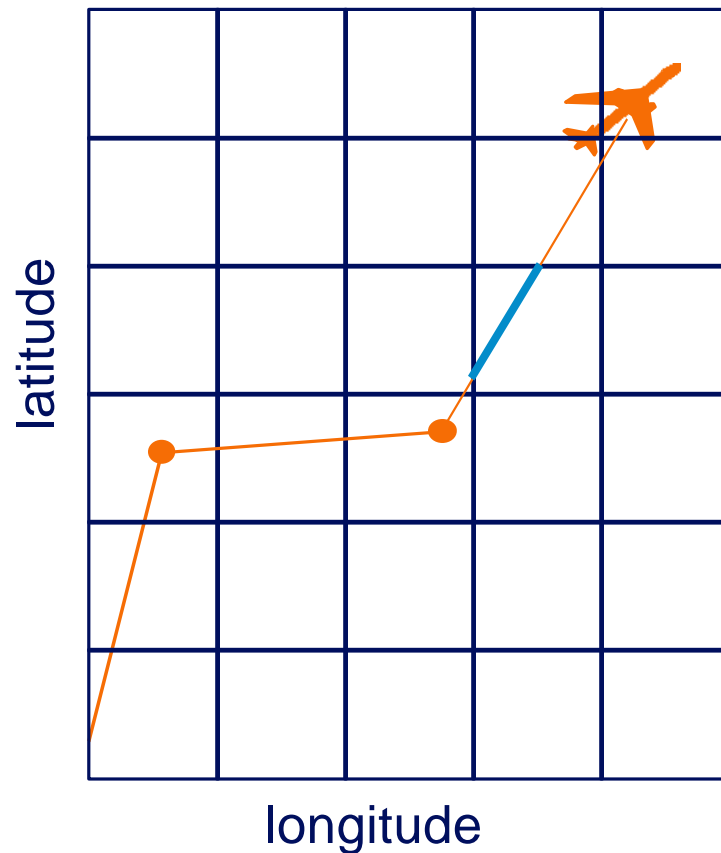


- DLR (Institute of Propulsion Technology) providing engine emissions data.
- DLR's engine models simulate engine performance at range of operating conditions to get combustor inlet conditions (pressure, temperature, air mass flow etc).
- Emissions data for NO<sub>x</sub>, CO, HC, particulates based on latest publicly available information
- Not used in this presentation

# AERO2K – Data Integration



## Allocation onto global grid

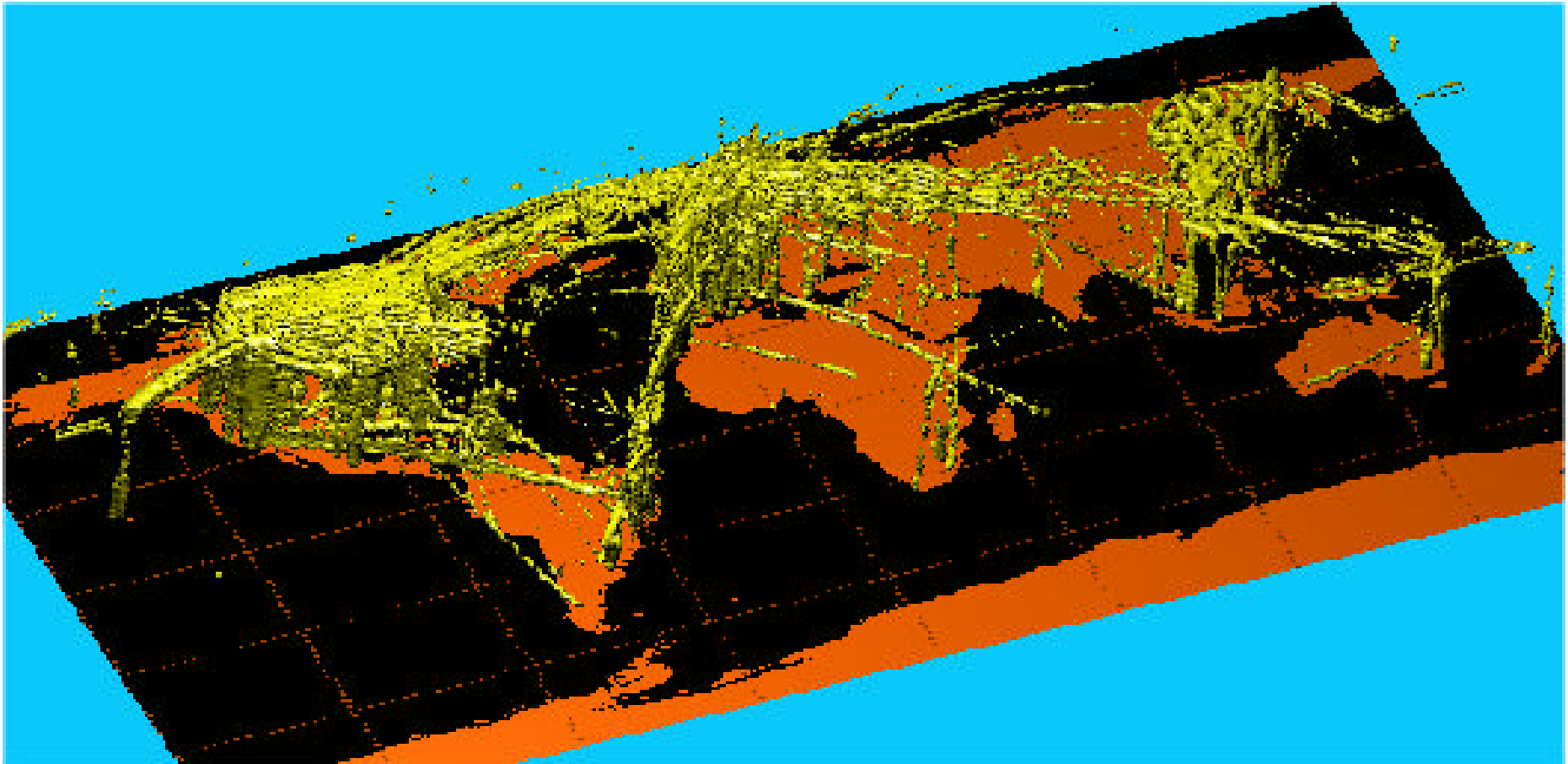


- Fuel and emissions are allocated onto global grids.
- The method determines length of path flown in each cell (e.g. blue line on flight path shown).
- Fuel and emissions allocated accordingly.



## Workings of AERO2k software tool

- Identifies individual flights, assigns representative aircraft and engine
- Identifies departure and arrival airports, separates flight segments (climb, cruise, descent), calculates flight great circle distances between waypoints
- Selects fuel profile data and emissions data for relevant flight segments i.e. for climb, cruise and descent. Tracks aircraft weight throughout flight as fuel is burnt
- **CALCULATES FUEL USED AND EMISSIONS for each flight**
- Translates representative weeks into annual data
- Allocates fuel and emissions data onto a 4d global grid (longitude, latitude, altitude and time).
- Isosurfaces and volume-rendered images of the gridded data can be created in a versatile graphical user interface.



Fuel Used for One day - Isosurfaces for higher concentrations

## Forecast for 2025

- Factors or methods describing:
  - change of fuel burn (sfc),
  - change of emissions characteristics,
  - selection of aircraft types (based on ASK & load factor),
  - uplift on numbers of movements
- Factors specific to regions
- Factors produced by UK DTI (in conjunction with Airbus) will be applied within the AERO2k software tool to produce a forecast of global emissions for 2025

# Validation

- Validation is carried out against:
  - Airline data
  - Previous inventories
  - Other aircraft performance models
  - SAGE

# Improvements over previous inventories

- Other inventories (ANCAT/EC2, NASA, AERO, FAST, AEM, Corinair etc) exist and all have their specific application
- AERO2K aims to provide the "best available" aviation emissions data, via:
  - *Improved* routing assumptions and representation of flight profiles for present day traffic
  - *Updated and improved* methodologies for determining fuel usage
  - *New inventory parameters* e.g. flown distances per grid cell per hour (for contrail impact analysis) and CO/HC and particle number emission indices

## Future Application - General

- AERO2K software tool can be re-run or developed further to produce, for example,
  - selected datasets (eg national emissions, by aircraft type, by airline)
  - other forecasts (eg using FESG forecast)
  - other base years or forecast years
  - additional/improved emissions data (eg particulates)
  - comparison of data with other inventories/methodologies

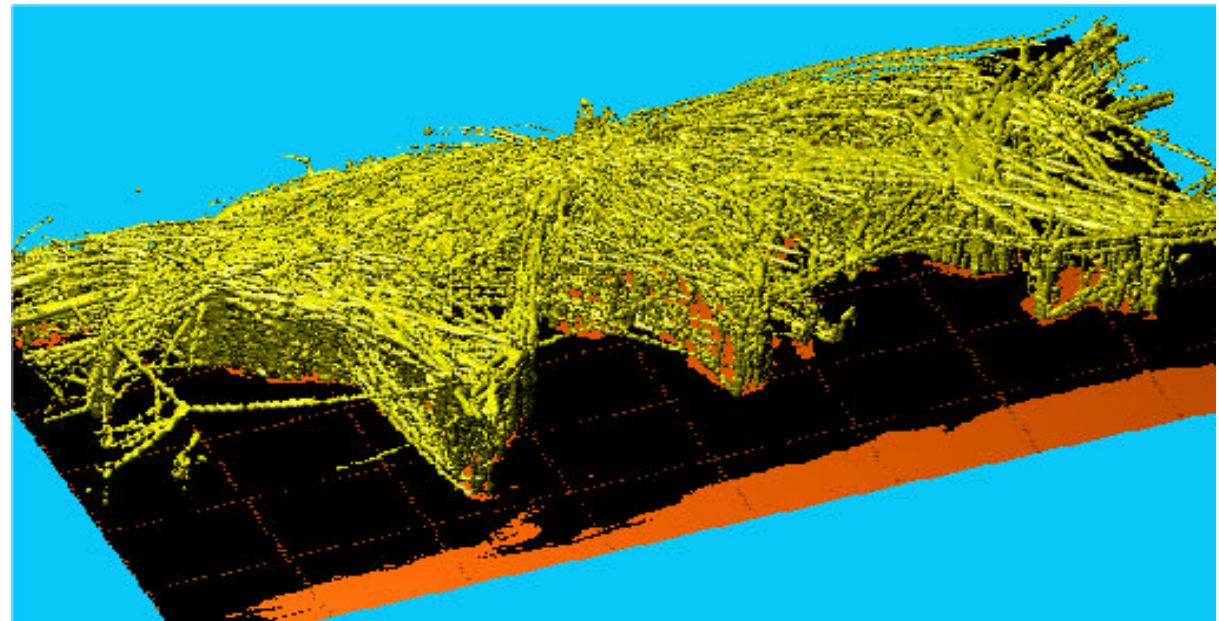


# Application to other Methodologies

- Quality check of data from existing methodologies
- To consider replacement of existing methodologies
- Provision of better assumptions (eg emissions parameterisation) to existing methodologies
- Disaggregation of annual data by aircraft type, registration, airline, departure/arrival airport/country, global location and time of emission, forecasts for future years ... ..
- Any queries can be added if data is available (eg operator nationality, passenger nationality)

# AERO2k

- 2002 and 2025 4-D data will be available Summer 2004
- Initial results available today
- . . . . .



Gridded fuel data (total mass) for one full day



AERO2K

DLR| Manchester Metropolitan University| NLR| DTI| Airbus France| EUROCONTROL| QinetiQ

**QinetiQ**

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