## ALAQS (Airport Local Air Quality Studies)

# ALAQS-AV
# A GIS based airport emissions and dispersion toolset



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H11-180
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# ALAQS-AV an overview

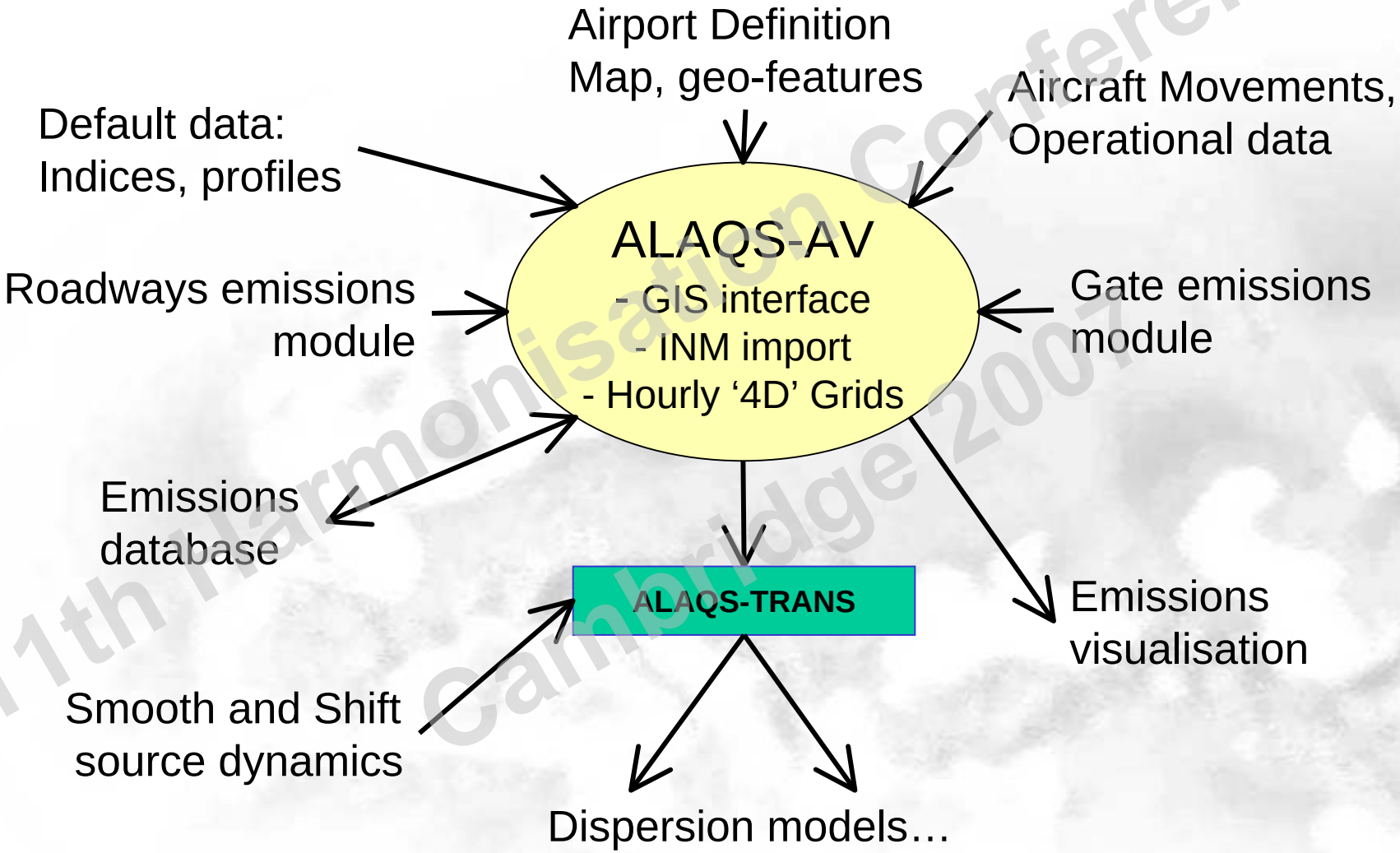
- ALAQS project summary
  - Objectives
- ALAQS-AV
  - General Overview of ALAQS-AV
  - ALAQS methods: 4D Emissions Inventory GSE, Vehicles, Shift and Smooth, TransALAQS
  - Methods/Operational Factors
  - Dispersion overview - components

# ALAQS-Objectives

ALAQS project, started in 2003 and financed by EUROCONTROL, has the following objectives:

- Source Apportionment: to understand the spatio-temporal impact of airport operations on emissions and air quality, including new operating procedures and future scenarios
- to develop European methodology to evaluate airport emissions and concentrations using best practices.
- Provide a test bed GIS based toolset, ALAQS-AV:
  - Case studies - evaluate an airport's impact on local air quality.
  - sensitivity analysis
  - A verified source of input data for use by modelling community
  - Interdependency studies between emissions, noise and Air Traffic flow management (a safe and orderly air traffic system with minimised impact on the environment)

# The ALAQS-AV toolset



# ALAQS-AV Summary

- ALAQS-AV ArcMap Application
  - Capture emission sources
  - Test bed for airport Emissions inventories
  - Test bed for dispersion models
- Initially based on FAA's EDMS4, new methods and data introduced to adapt to European needs.
- Linked to a generic geo-database
  - Aircraft data
  - Default approach and climb-out profiles
  - Default Emission Indices:
    - Aircraft engines, APU
    - Road vehicles
    - Other sources
  - ALAQS-AV application settings

# ALAQS-AV principle features - 1

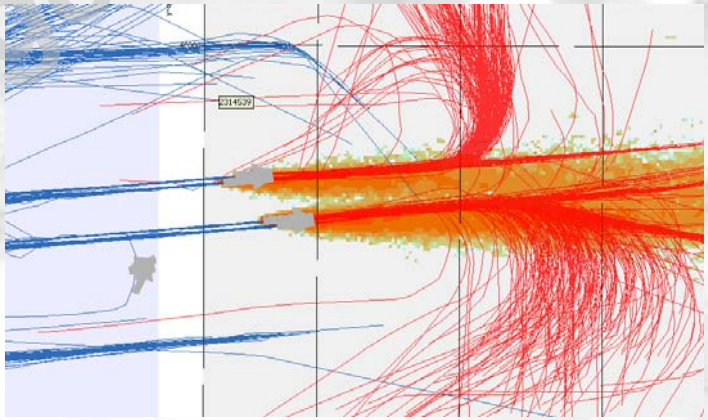
- Detailed spatial modelling of airport emissions
- Emissions stored for each source and on an hourly basis during the study period - choice of 3D grid per source or merged grid.
- GSE calculations – 'bottom up' –based on GSE fleet and aircraft movements and stand characteristics
- ALAQS road vehicle emissions method – a modified COPERT-III and adapted for airport scenario
- User can choose between various methodologies and emissions indices for nearly all sources of pollution, e.g. Road vehicles: EDMS4, LASPORT, CITEPA and ALAQS methods.

# ALAQS-AV principle features - 2

- Aircraft default engine, profile and horizontal tracks assigned on for each aircraft type
- ECAC Doc29 (SAE1845) aircraft vertical profiles by default Optional vertical limit

- Direction of motion on taxiways implemented
- User defined emissions indices
- Compatible with INM6 noise studies (Import runways, ground tracks)

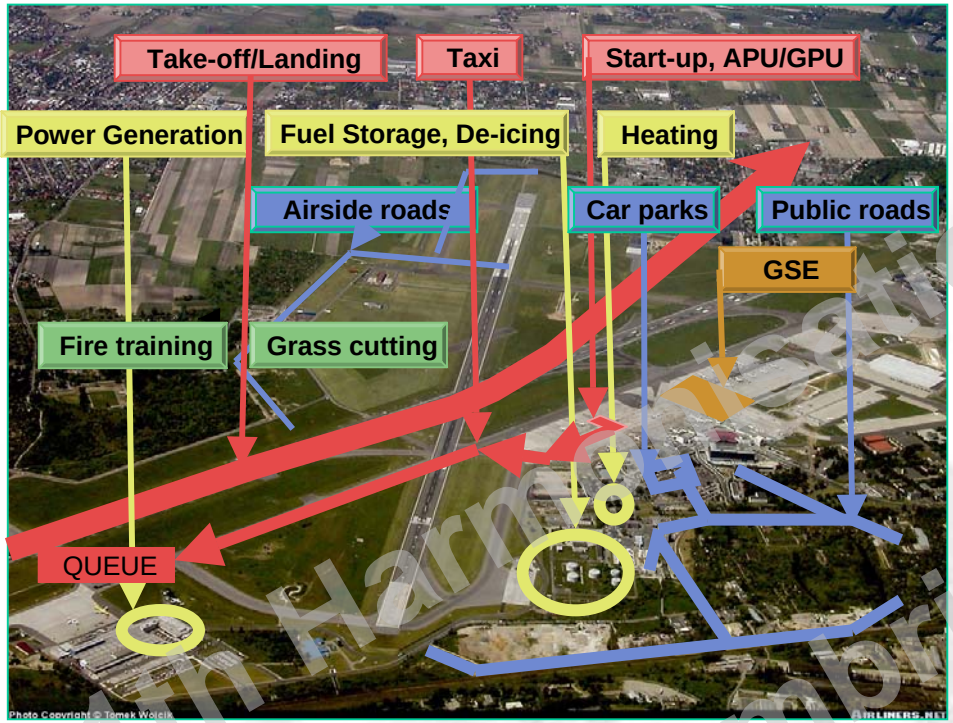
| ICAO | ENG COUNT | ENGINE | DEP_PROF | ARR_PROF |
|---|---|---|---|---|
| A306 | 2 | PW4158 | **A300-D-2** | A300-A-1 |
| A30B | 2 | CF6-50C1, -C2 | **A300-D-3** | A300-A-1 |
| A320 | 2 | V2527-A5 | **A320-D-2** | A320-A-1 |
| A332 | 2 | TRENT 772 | **A310-D-1** | A310-A-1 |
| A340 | 4 | CFM56-5C4 | **DC870-D-2** | DC870-A-1 |
| B734 | 2 | CFM56-3C-1 | **737400-D-3** | 737400-A-1 |
| B744 | 4 | CF6-80C2B1F | **747400-D-4** | 747400-A-1 |
| B757 | 2 | RB211-535E4 | **757RR-D-3** | 757RR-A-1 |
| B762 | 2 | CF6-80A1 | **767CF6-D-4** | 767CF6-A-1 |
| B773 | 2 | PW4090 | **777200-D-2** | 777200-A-1 |
| B777 | 2 | GE90-92B | **777200-D-4** | 777200-A-1 |



# ALAQS-AV implementation

- A VBA geo-database application running under ArcView 9.0
- GIS User interface
- Default database in Ms Access format, easily accessible and updatable
- Using a GIS allows for the precise scaling of the airport map (either printed or electronic, using XML airport definition) between others AIP published data (e.g. apron or runway coordinates)

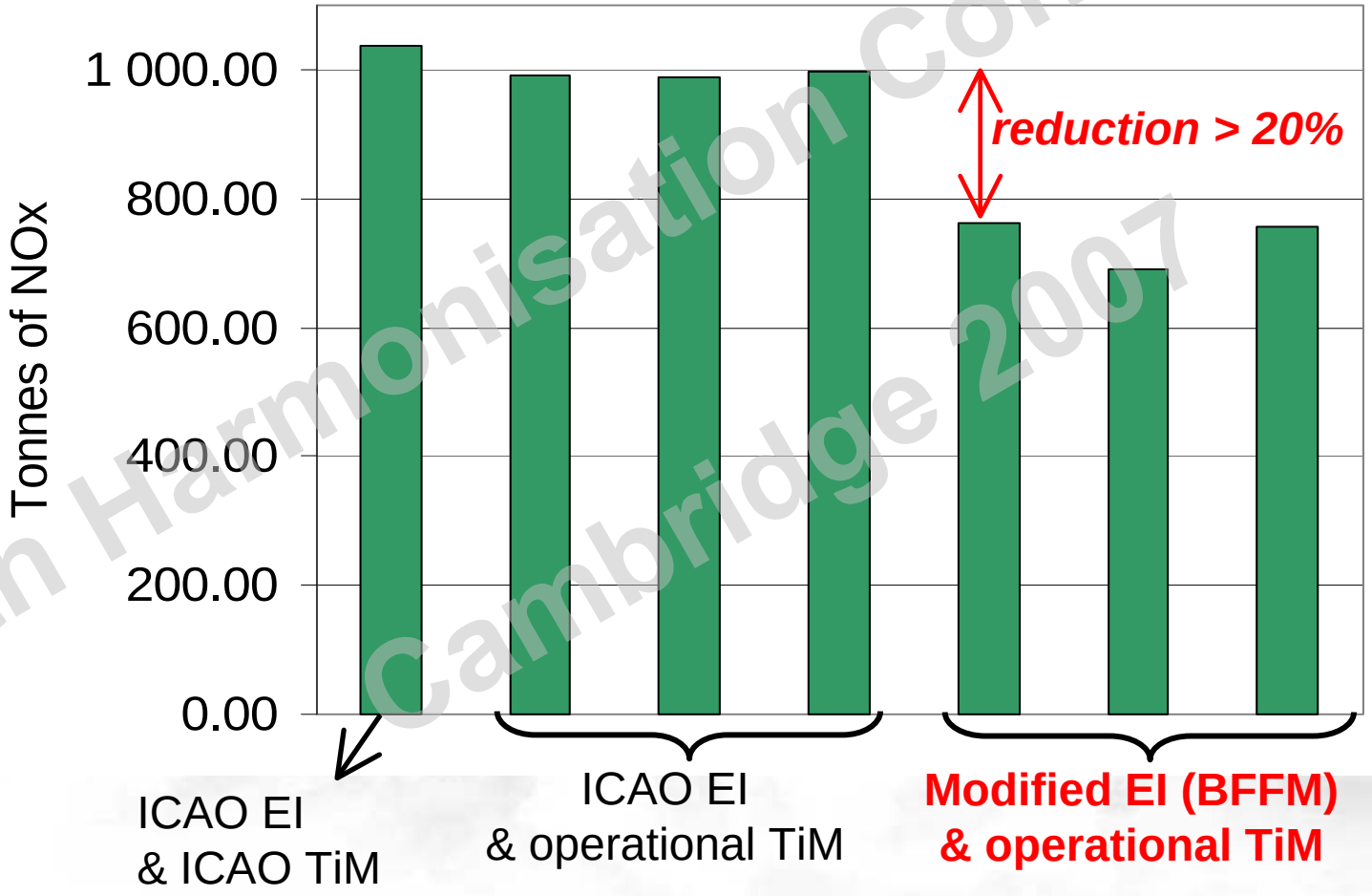
# ALAQS – 4D Airport Emissions Inventory



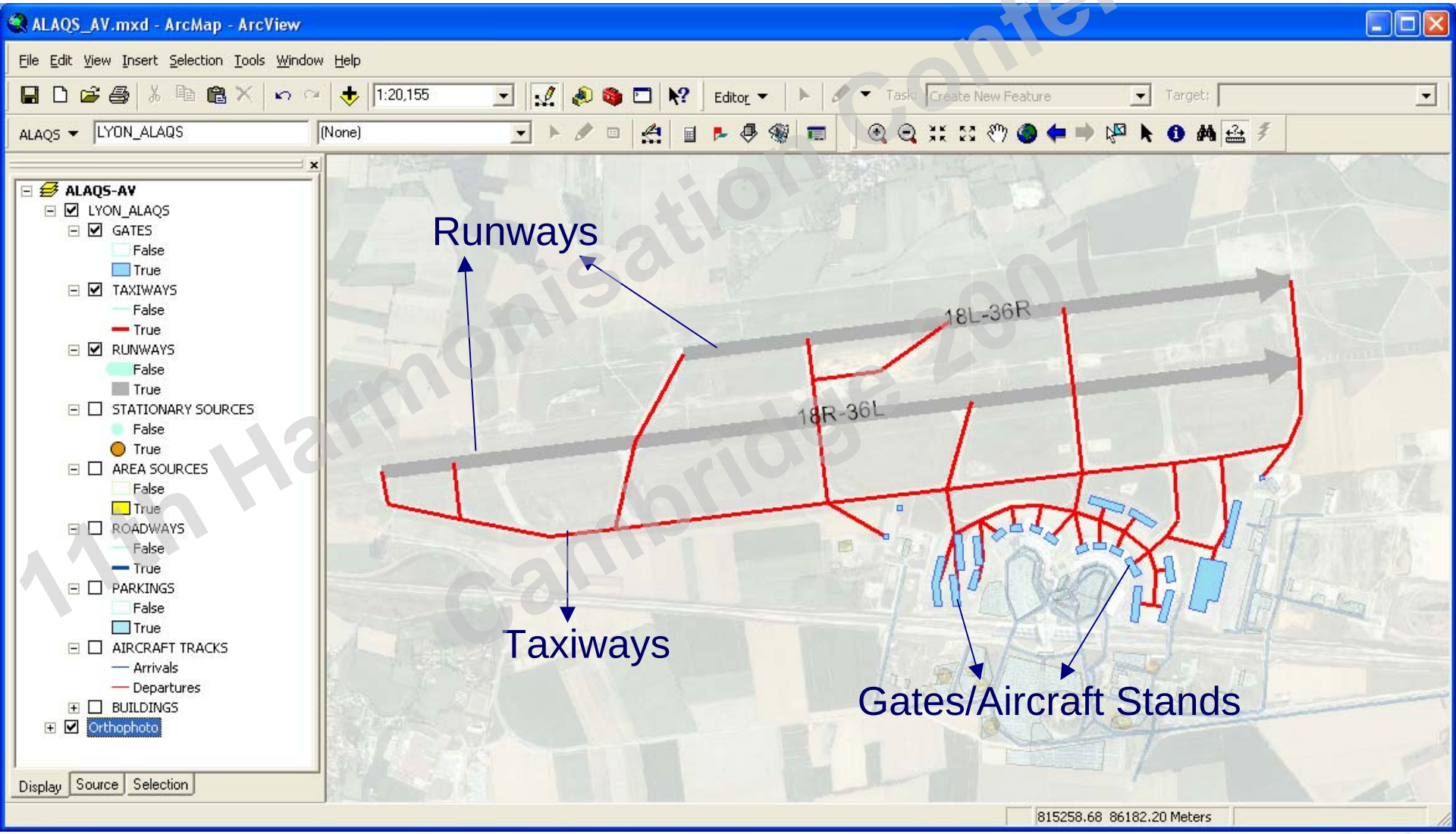

- Emission Inventory Database
  - Standard structure/format for all sources
  - Minimise storage requirements
  - Retain maximum input information
  - Complex table schema
- Each emission source is associated to
  - A set of emission indices
  - Emission dynamics parameters
  - Hourly activity profile
  - XYZ Geometry

# Importance of operational factors

ALAQS-AV has can use operational factors. The example below from the Zurich sensitivty study shows that aircraft operational data can have a major impact on the emissions.

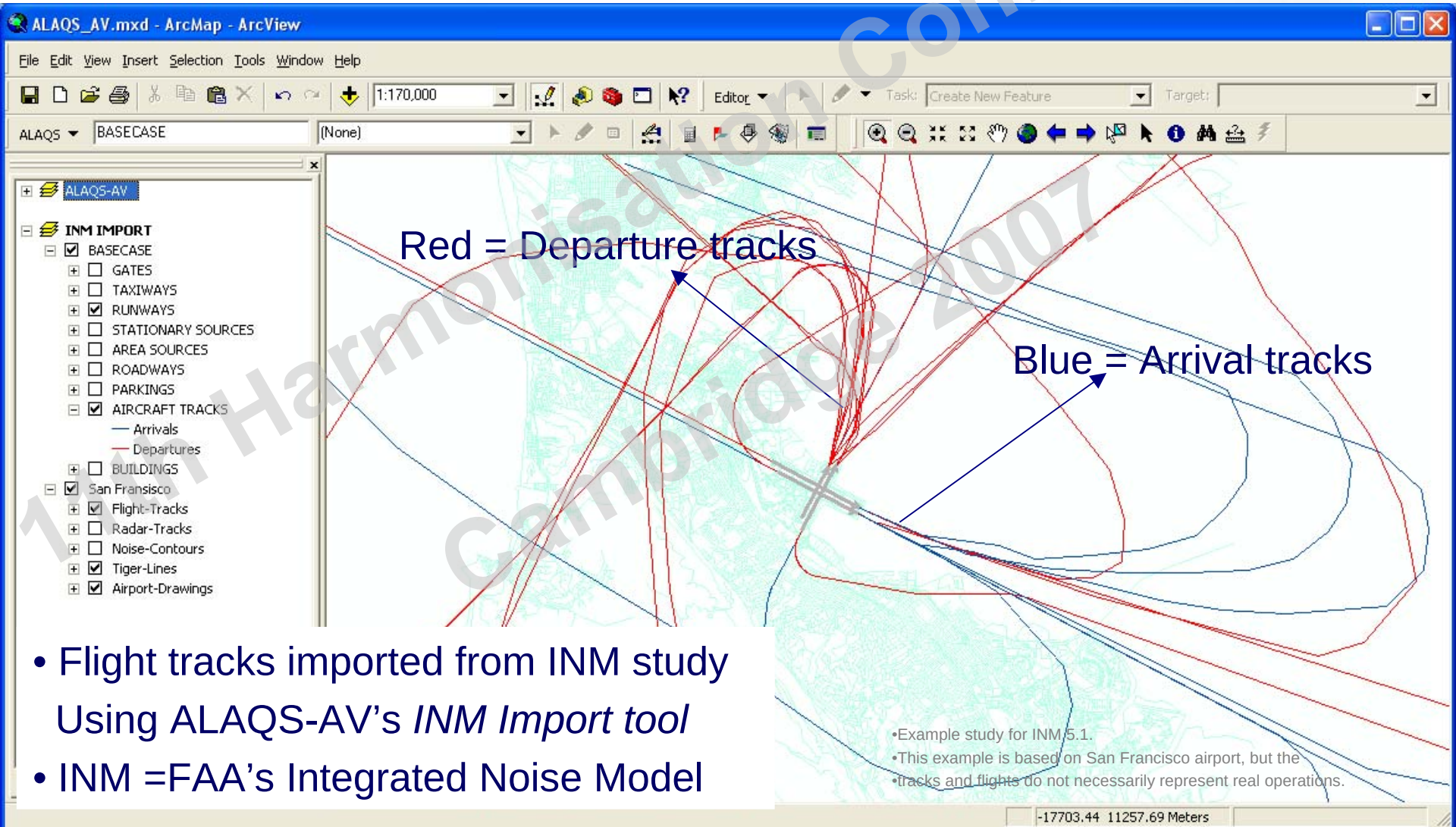


# Aircraft Sources



# Aircraft Sources

- Aircraft Tracks are optional




- Flight tracks imported from INM study
  Using ALAQS-AV's *INM Import tool*
- INM =FAA's Integrated Noise Model

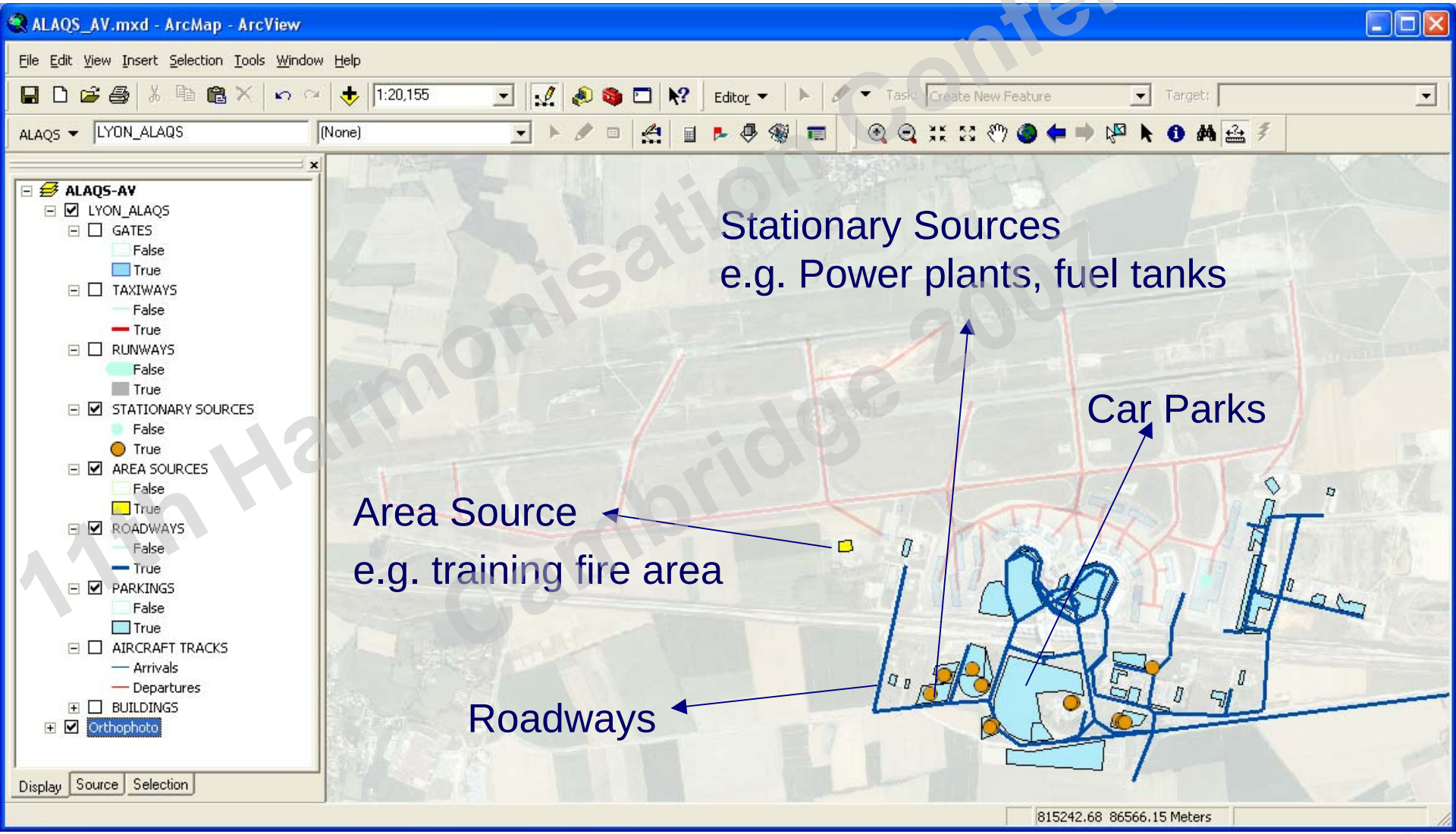
# Aircraft Sources

- Movements Table
  - No Activity Profiles for Aircraft Sources
  - Level of activity based on Aircraft Movements
  - Data Sources
    - Recorded traffic data - Actual flights
    - Flight schedules
    - Air Traffic modelling systems
- Information required

| date_time | Block Time | ac_reg | aircraft | Dep Arr | gate | RWY | profile |
|---|---|---|---|---|---|---|---|
| 06/03/2002 11:39:08 | 06/03/2002 11:34:00 | A-BCD1 | AT45 | D | APR1W | 27 | DHC8-D-1 |
| 06/03/2002 14:16:34 | 06/03/2002 14:19:55 | A-BCD2 | E145 | A | APR2E1 | 24 | CL601-D-1 |
| 06/03/2002 19:16:11 | 06/03/2002 19:11:01 | A-BCD4 | B735 | D | APRON4 | 27 | 737500-D-3 |

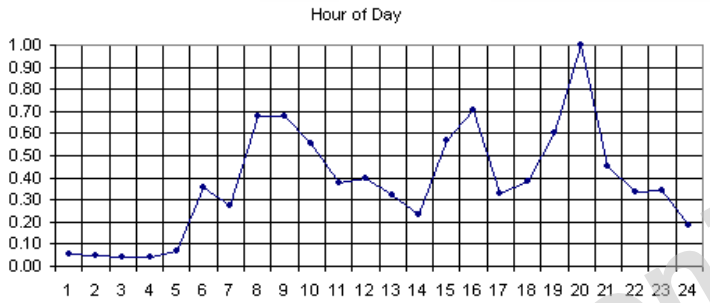
Block Time, Aircraft registration and vertical profile are optional fields

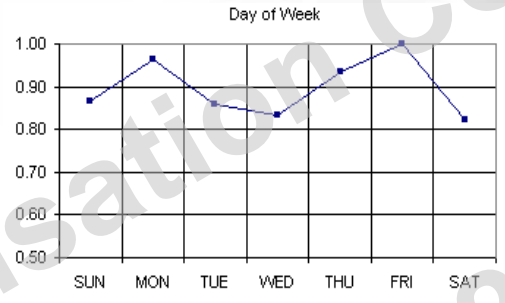
# Non-Aircraft Sources

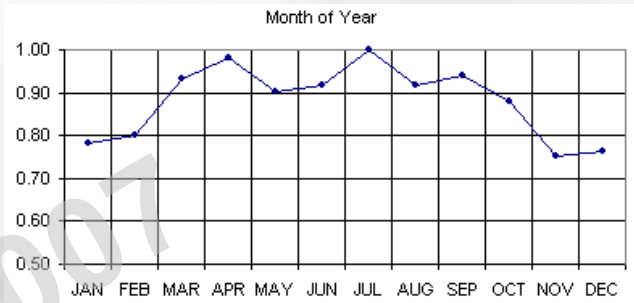


# Non-Aircraft Sources – Activity Profiles

- Activity Profiles for non-Aircraft sources - Graphs

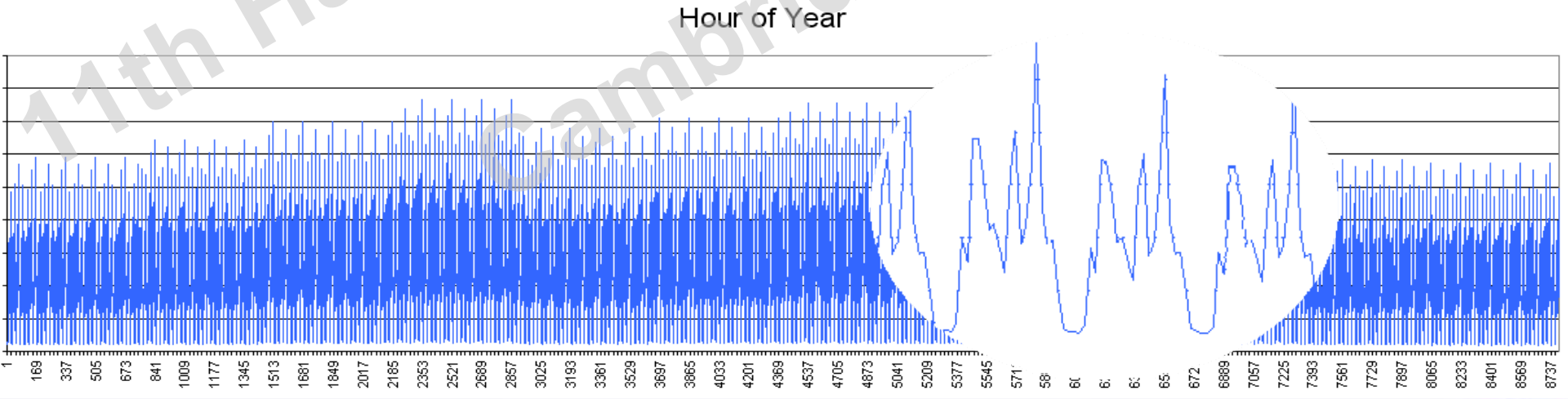



Hour of Day + Day of Week + Month of Year

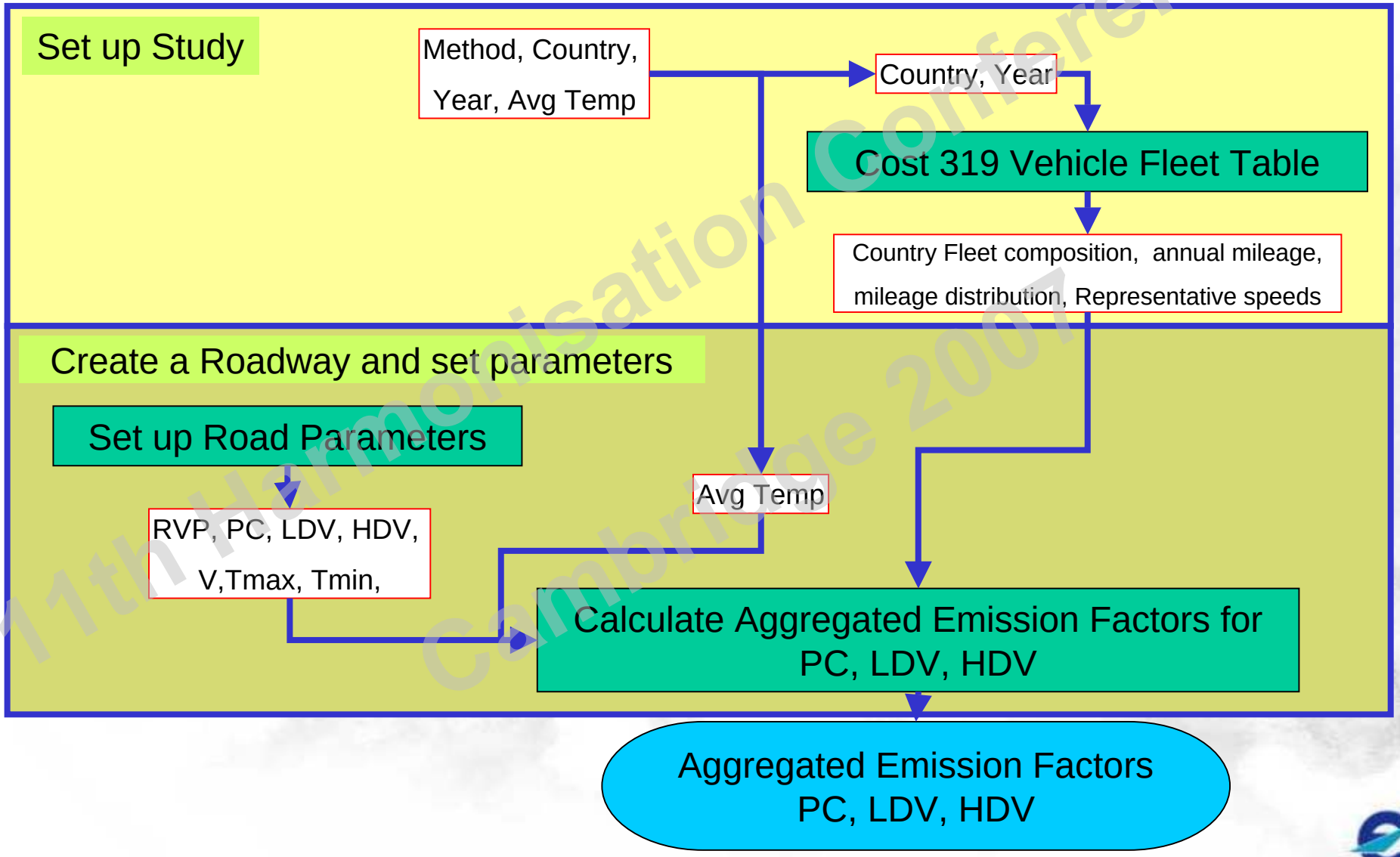
= Activity for each Hour of the Year



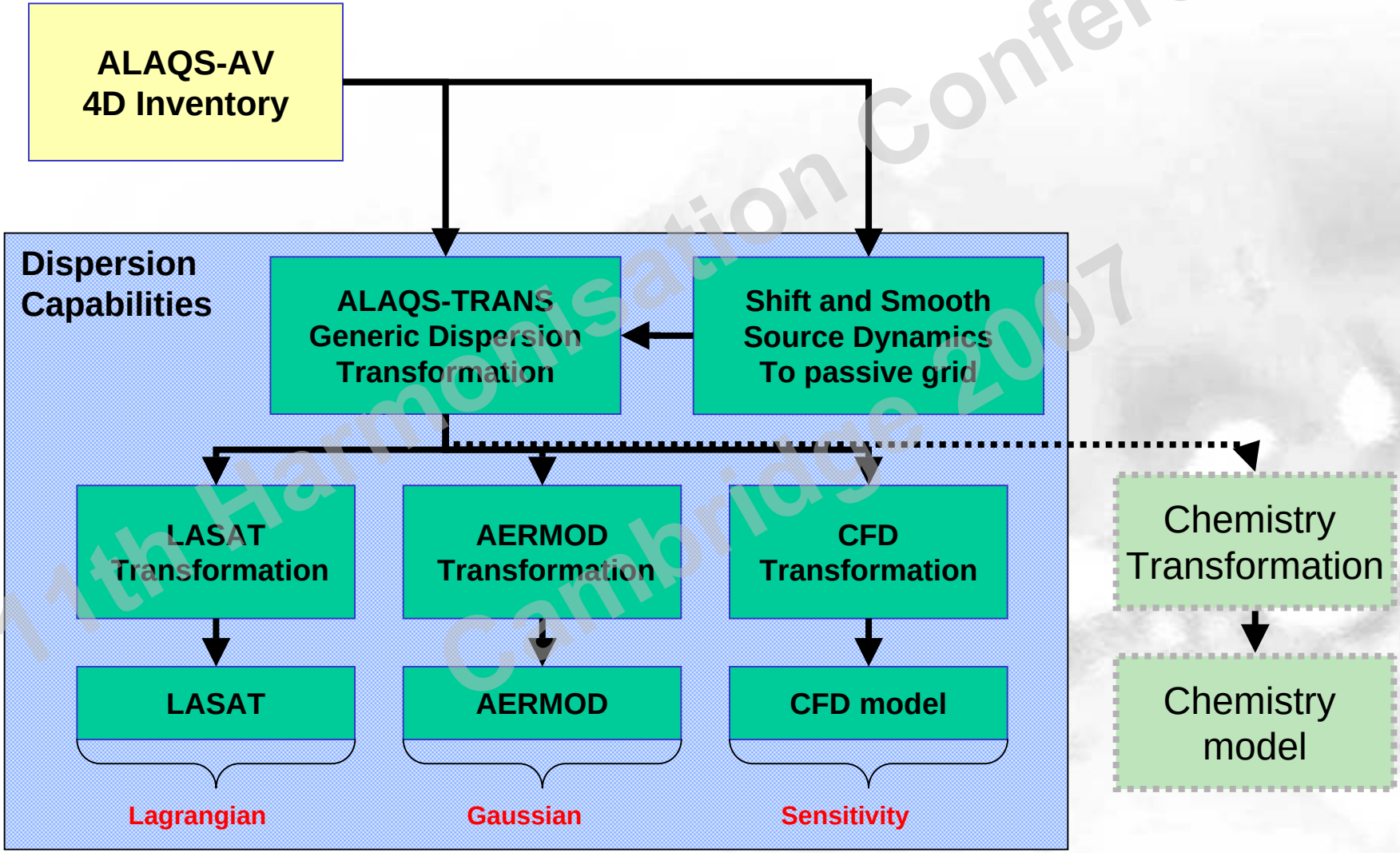
# Road Vehicle Emissions - 1

| Method | Parameters required | |
|---|---|---|
| | **Study Setup** | **Roadway Attributes** |
| ALAQS | Fleet year (1990-2020,multiple of 5)<br>Fleet country<br>Average year temperature | Vehicle fleet mix<br>Average vehicle speed |
| EDMS | Fleet year (1988-2020)<br>Average year temperature<br>Altitude | Average vehicle speed |
| LASPORT | Fleet year (2001-2010) | Vehicle fleet mix<br>Roadway scenario |
| CITEPA | France 1997 | Average vehicle speed<br>Vehicle fleet mix |

# Road Vehicle - Processing sequence



# Dispersion Model Test Bed



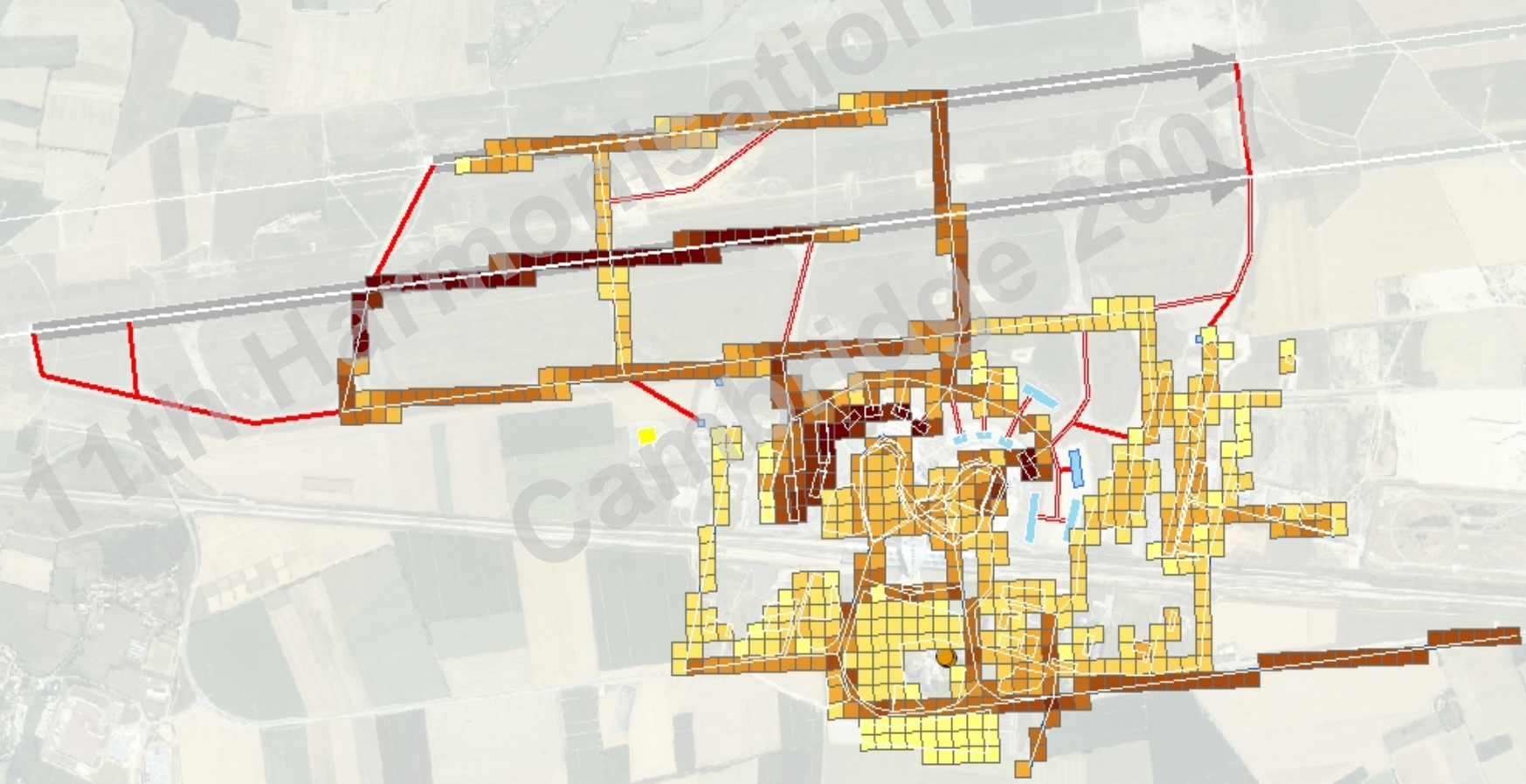
# 3D Grid and Smooth and Shift

- Make data compatible with *most* Dispersion Models
- Source dynamics is an Issue
  - Turbulence and momentum jet engine exhaust
  - Thermal plume
- Incorporate effects of source dynamics
- Smooth and Shift approach
  - Developed by Ulf Janicke, Germany
  - "Smooth and Shift" approach distribute emissions to surrounding passive grid cells
- Converter to format 4D grid as input to dispersion model

More information: H11-182

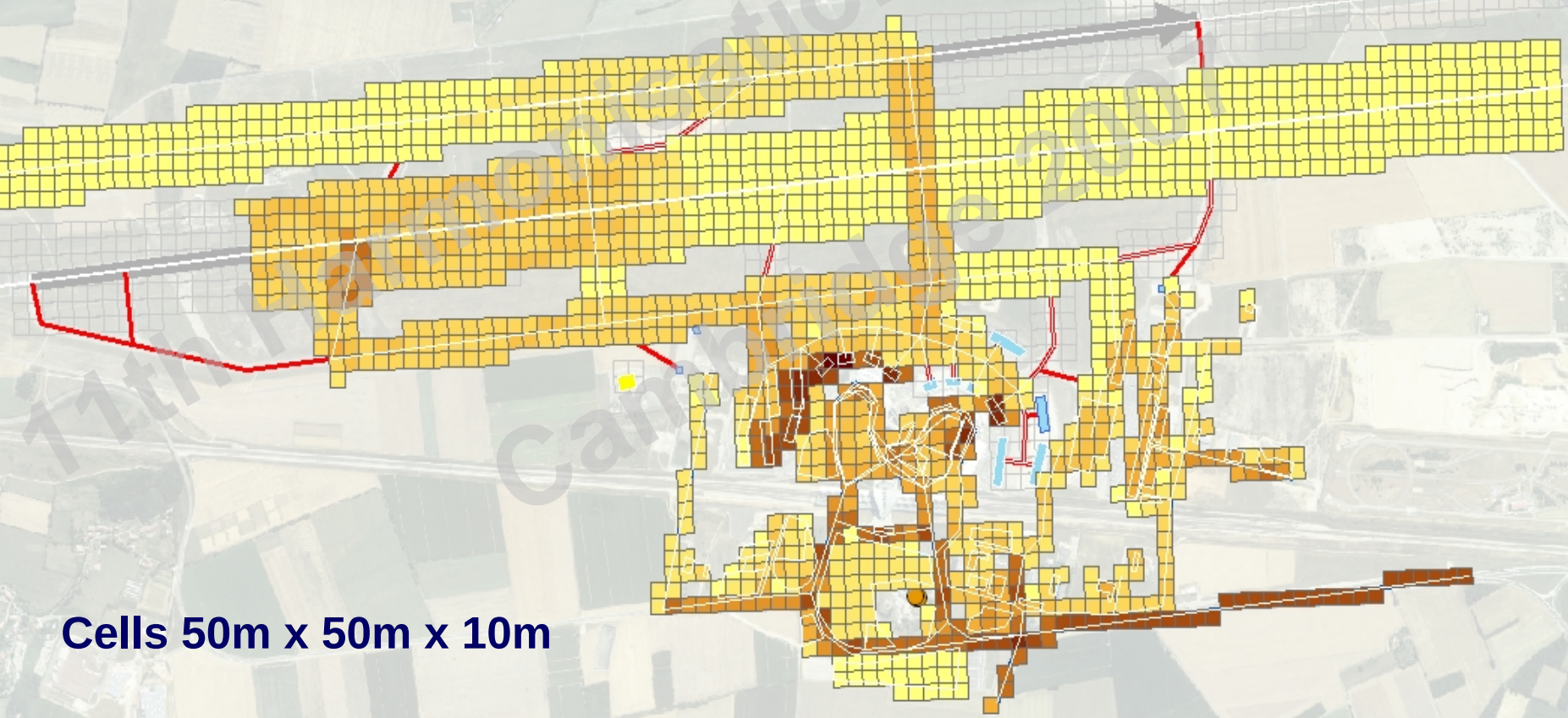
# 3D Grid

## Ground level grid cells without Source Dynamics
## No dilution



# 3D Grid

**Ground level (0 to 10m) grid cells with Source Dynamics**
**High dilution of aircraft emissions**
**Also some emissions shifted downwards**



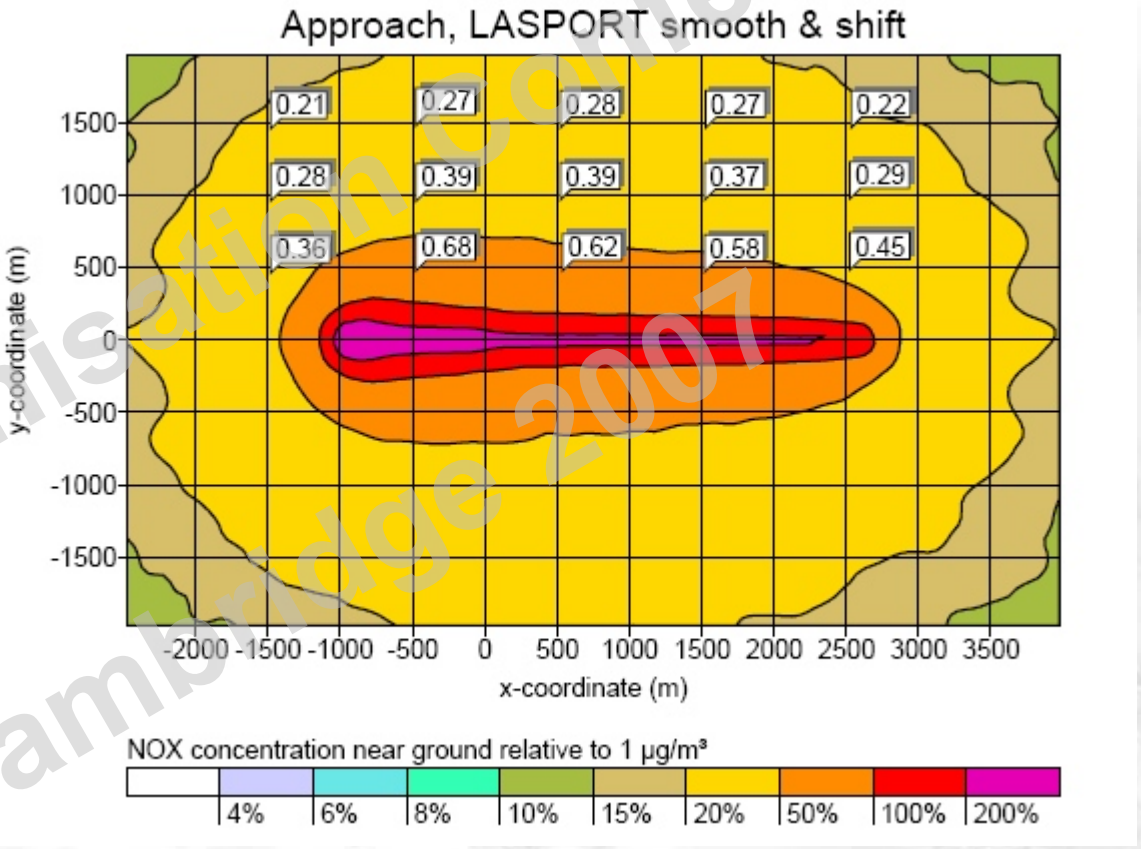
**Cells 50m x 50m x 10m**

# Source Dynamics – shift and smooth

Provide a simplified emissions output that, in principle, can be directly applied by any dispersion model – without the need of a source model or other auxiliary models.

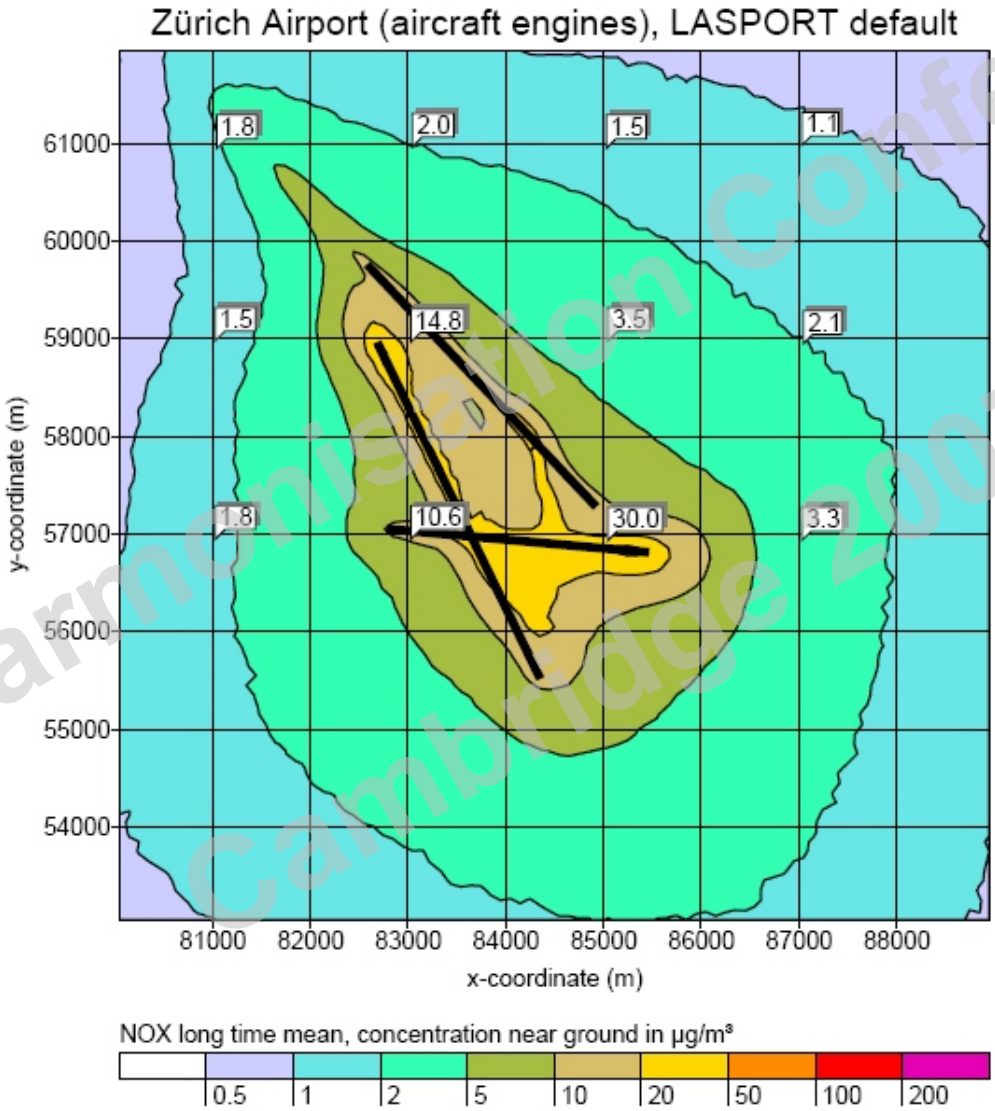
A conceptually simple emission output is a three-dimensional, passive emission grid: For each grid cell, the amount of trace material is specified that is passively emitted in a given time interval.

Thus, in each cell, any source dynamics are already included in the distribution of the emissions over the grid.



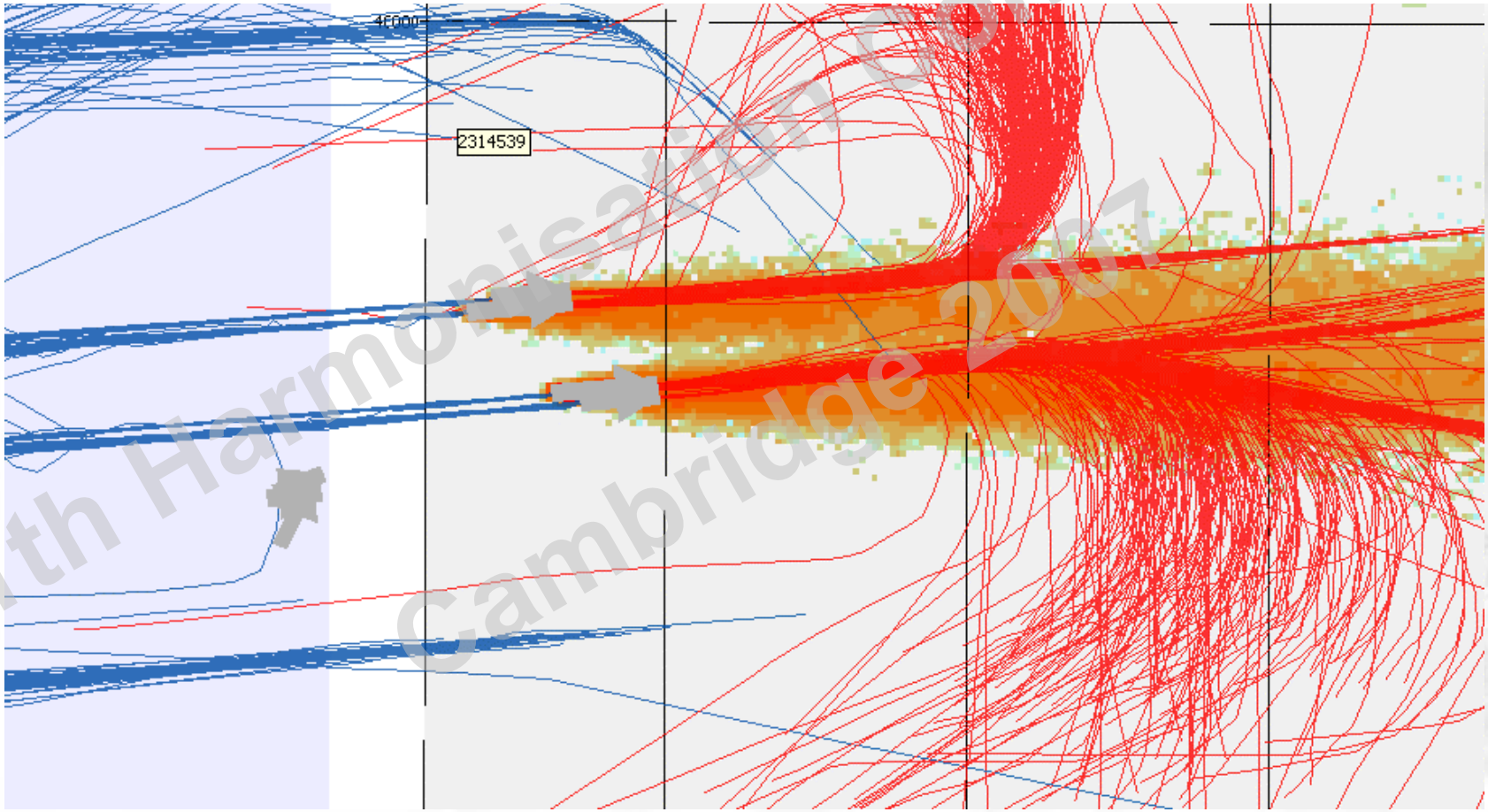

More information: H11-182

# Shift and Smooth - airport case



# Dispersion results from an INM study

Aircraft tracks imported from an INM study and emissions dispersed via shift-and-smooth input to LASAT. $NO_2$ shown departures



# Thank you for your attention

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