ICAO Workshop
Aviation and Carbon Markets
Session 2 - Assessing Aviation Emissions:

Models

Dr. Urs Ziegler, 7 June 2008

Outline

1. ICAO Environmental Goals
2. Role of Modeling in ICAO‘s Environmental System
3. Modeling Methodology used by CAEP
4. ICAO CAEP Environmental Goals
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   - Observations
   - Sample Trends
5. Summary

ICAO Environmental Goals: Assembly Remit

Assembly Resolution A36-22

ICAO and ist Contracting States will strive to

a) Limit or reduce the number of people affected by significant aircraft noise;

b) limit or reduce the impact of aviation emissions on local air quality; and

c) limit or reduce the impact of aviation greenhouse gas emissions on the global climate;

Role of Modeling in ICAO‘s Environmental System (1)

Assembly Resolution A36-22

The Assembly

- *Requests* the Council to assess regularly the present and future impact of aircraft noise and aircraft engine emissions and to continue to develop tools for this purpose

- *Requests* the Council to maintain and update knowledge of the interdependencies and tradeoffs related to measures to mitigate the impact of aviation on the environment so as to optimise decision making

Role of Modeling in ICAO‘s Environmental System (2)

- *Requests* the Council to disseminate information on the present and future impact of aircraft noise and aircraft engine emissions …

- *Invites* States and international organizations to provide the necessary scientific information to enable ICAO to substantiate its work in this field

- *Requests* the Council to continue the work on developing and employing scenarios for assessing the future environmental impact of aviation emissions …

Tasks could not be accomplished without sophisticated sets of modelling tools

Modeling Methodology used by CAEP (1)

4 Modeling Families used within ICAO CAEP to accomplish Assembly remits:

- Local Air Quality Assessment Tools
- Noise Evaluation Tools
- Economics Tools
- **Greenhouse Gas Tools**

GHG tools most important for assessment of aviation carbon emissions and GHG effects

Modeling Methodology used by CAEP (2)

Work Programme of CAEP's Modeling and Databases Task Force (MODTF) for the CAEP/8 cycle (until 2010):

- Model Evaluation: Continue the candidate model evaluation (Report recommending specific models to support policy making decision in the CAEP/8 Work Programme)

- To support CAEP environmental goals … conduct an updated trends assessment, for the baseline case (and forecasts), and various cases which consider technology and operational improvements.

Modeling Methodology used by CAEP (3)

GHG models used within ICAO CAEP and contributing organisations:

AEDT/SAGE (US/FAA)

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/sage/

AEM (EUROCONTROL)

http://www.eurocontrol.int/eec/public/standard_page/SEE_2004_report_15.html

AERO2k (UK/QinetiQ)

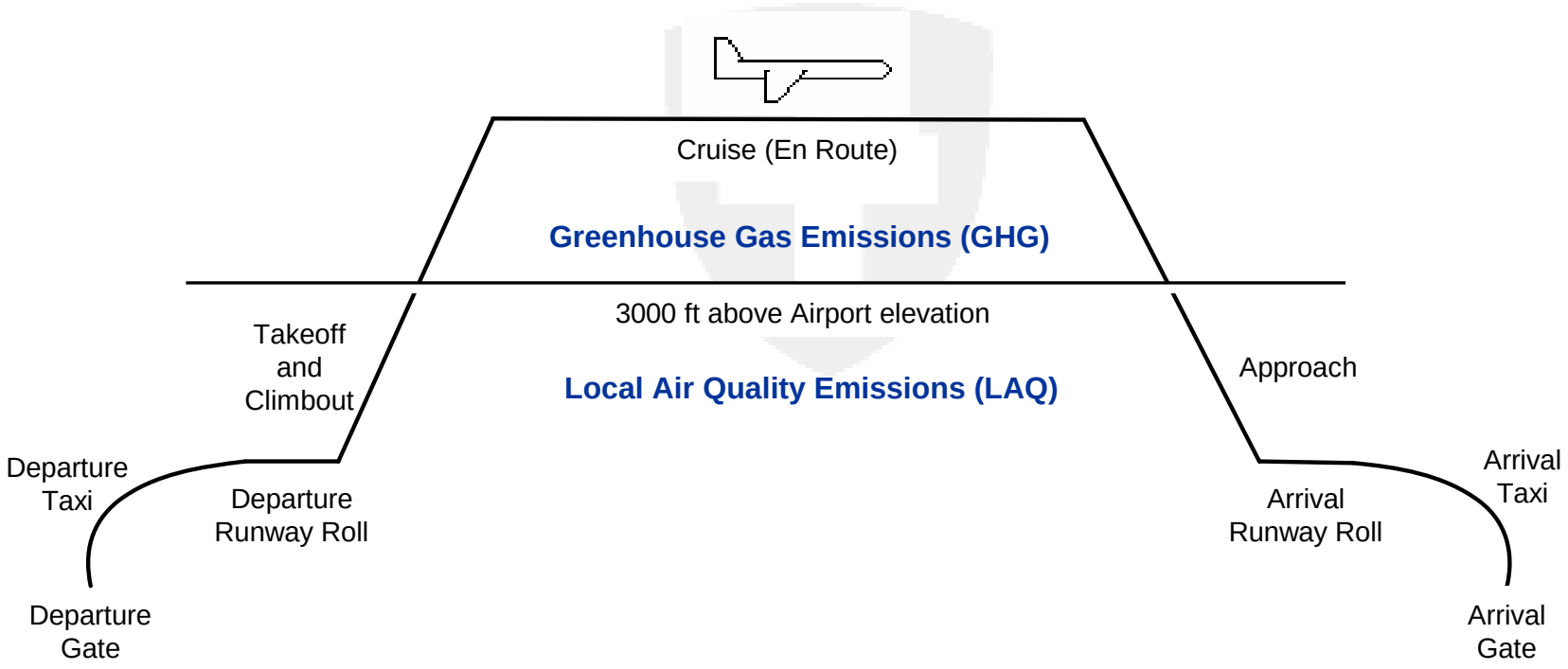
http://www.cate.mmu.ac.uk/aero2k.asp

FAST (UK/MMU)

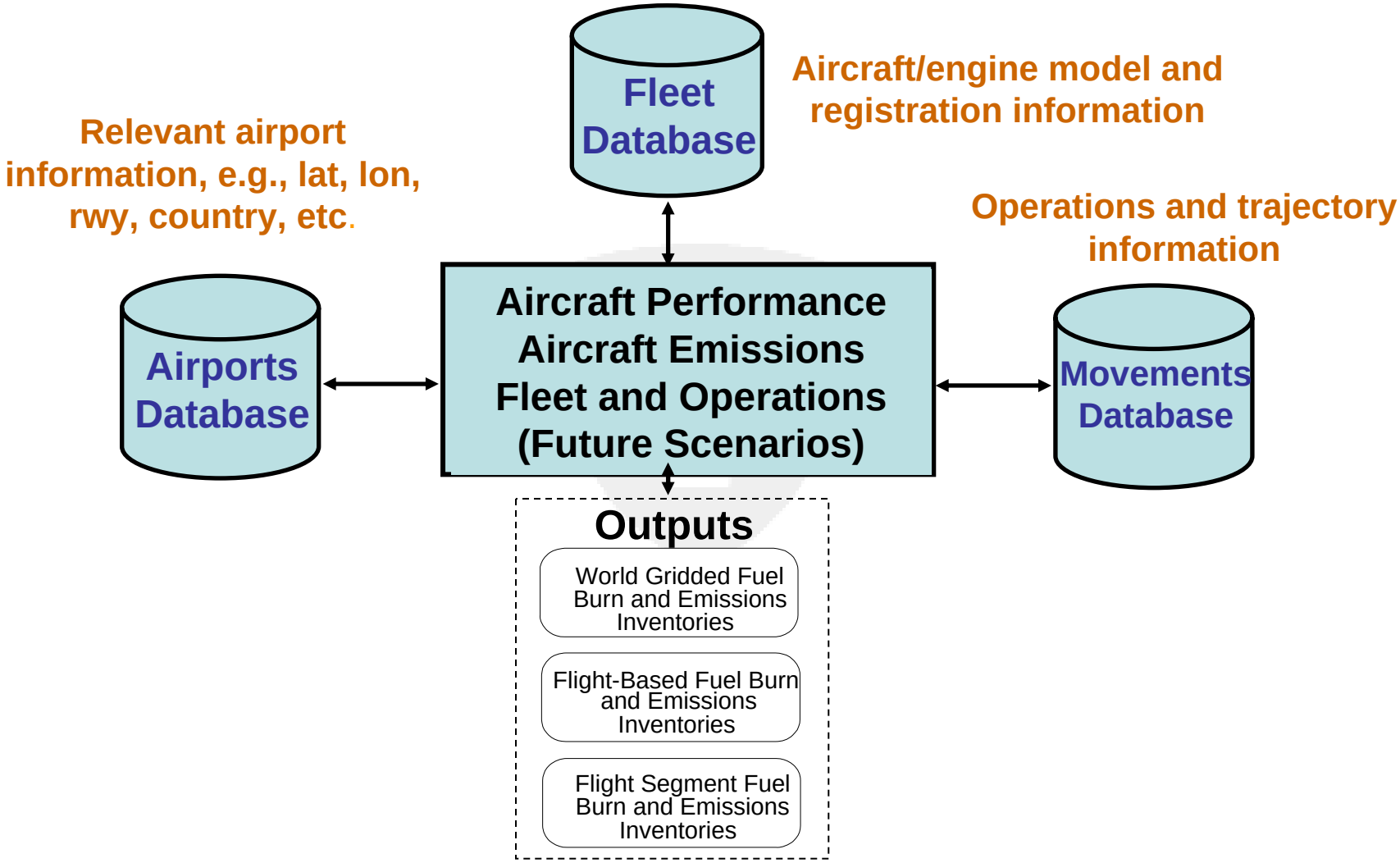
http://www.cate.mmu.ac.uk/documents/projects/mmuallocationsreport2currentdayv15.pdf

Modeling Methodology: Basic Modeling Principle

Models used for computing local (LAQ) and global (GHG) inventories of aviation emissions and fuel usage.

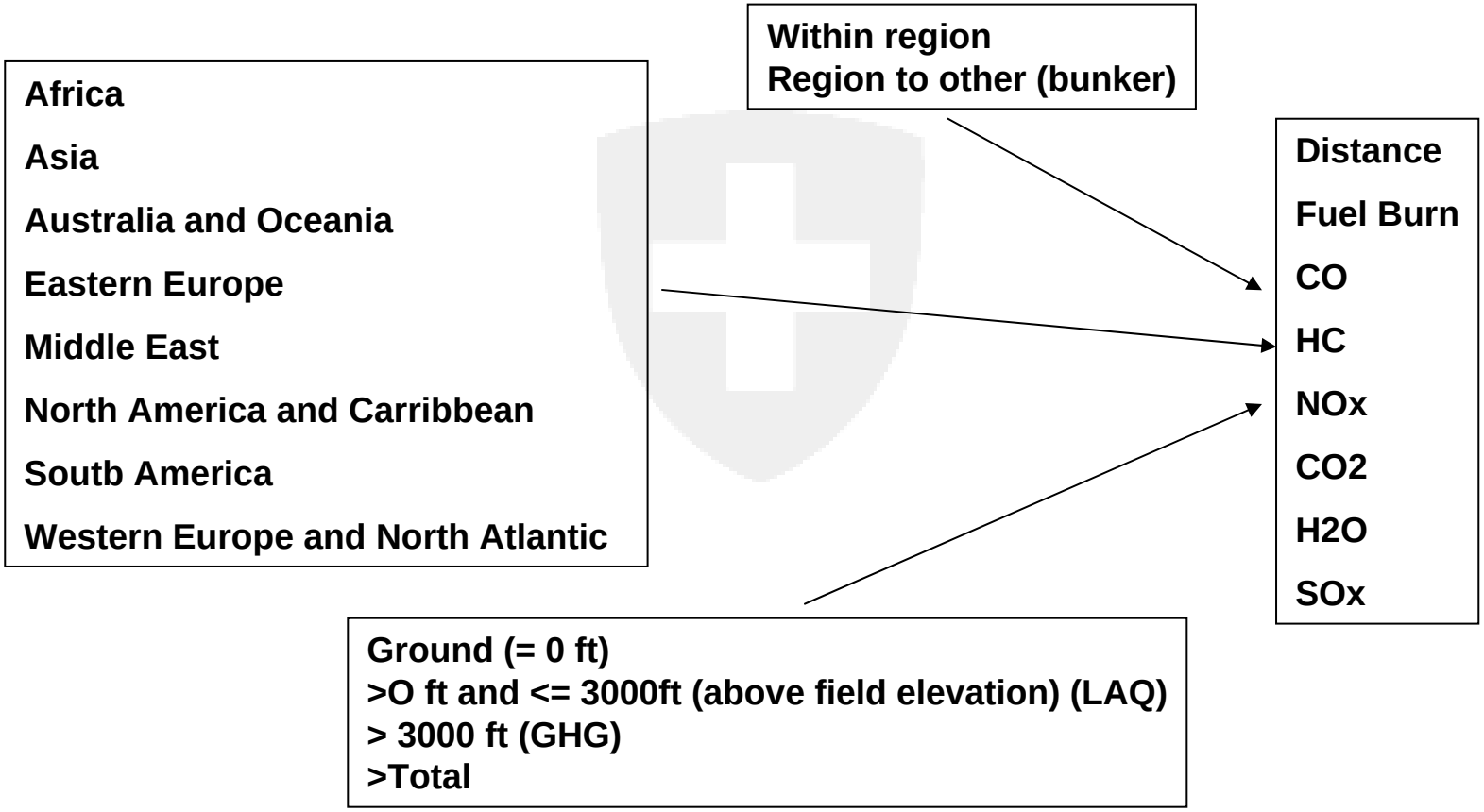


Modeling Methodology: Basic Modeling Principle



Modeling Methodology: Output Data/Results

Aggregate/Queried Results: Results by region, country and/or mode; Regions/countries are defined by the airports within an area



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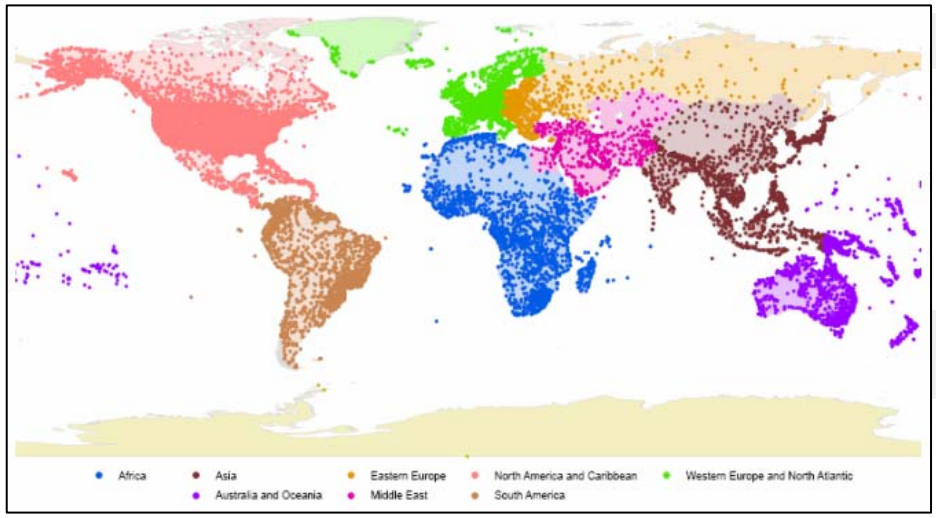
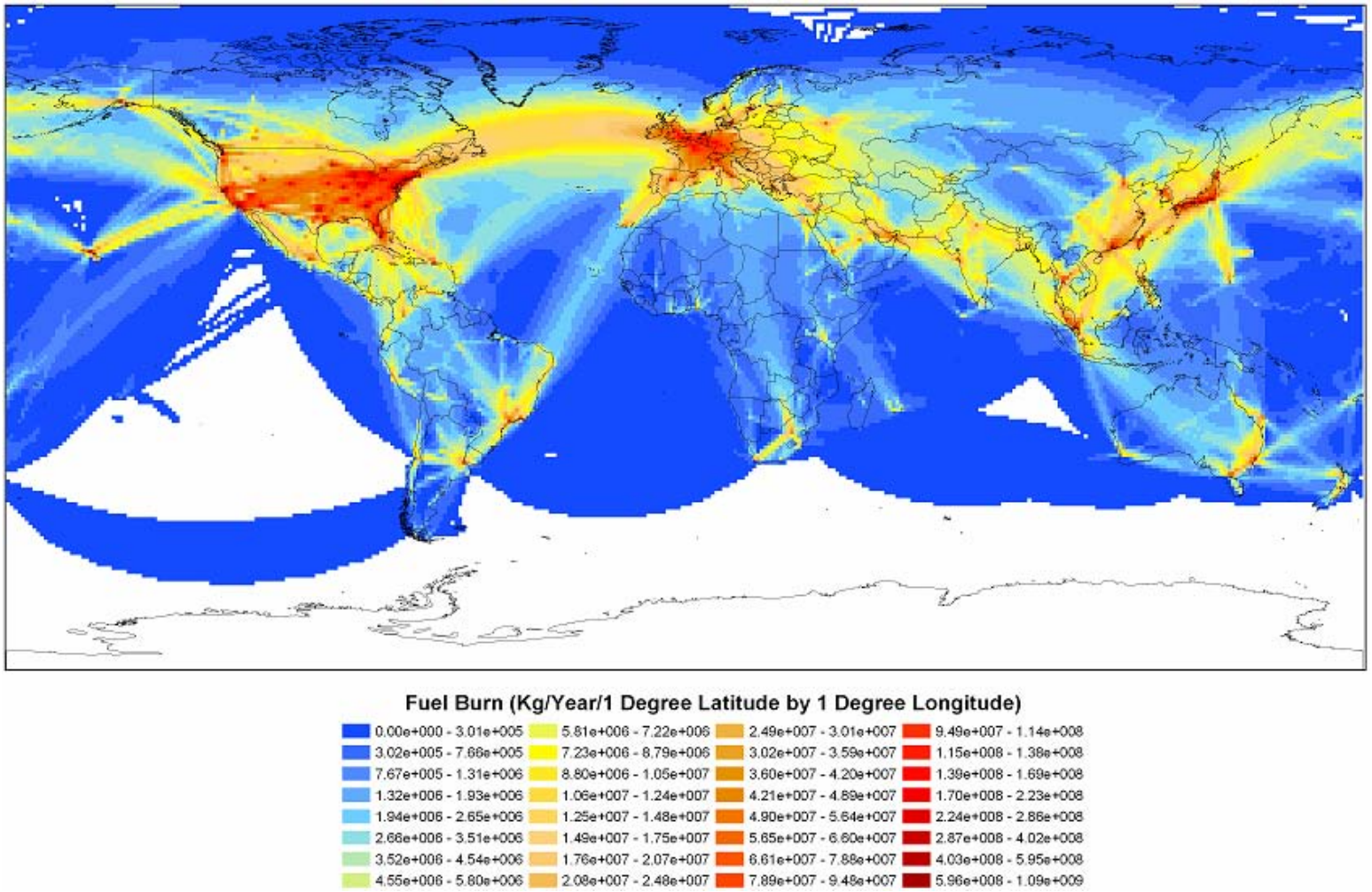


Within region
Region to other (bunker)

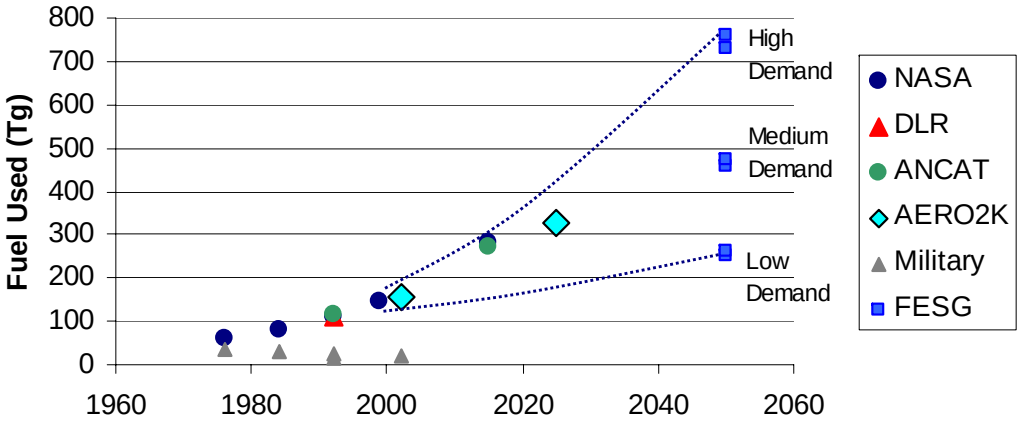
Distance
Fuel Burn
CO
HC
NOx
CO2
H2O
SOx

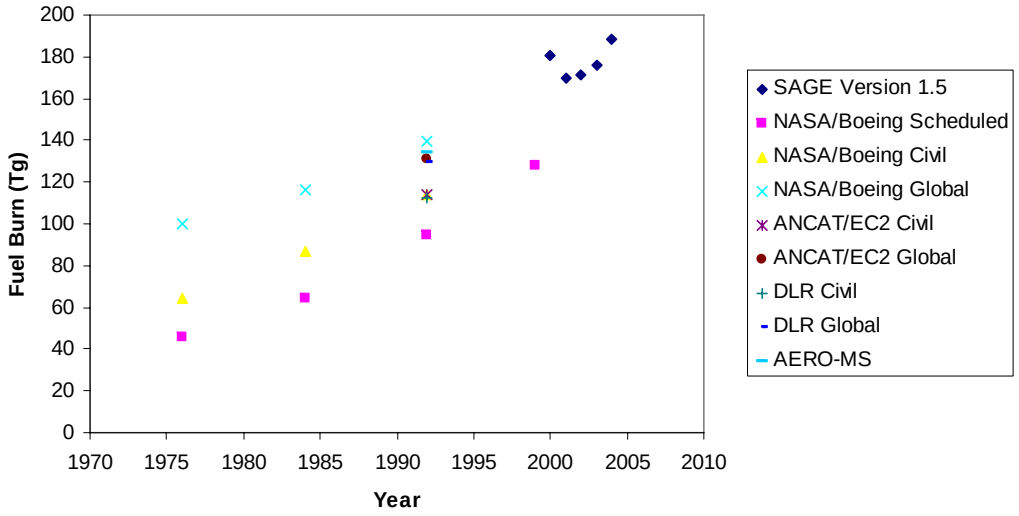
Ground (= 0 ft)
>O ft and <= 3000ft (above field elevation) (LAQ)
> 3000 ft (GHG)
>Total

Modeling Methodology: Output Data/Results



Modeling Methodology: Historical Emissions Inventories: Fuel Burn





ICAO CAEP Environmental Goals (1)

- There is no accepted metric or modeling system for reporting impact of LAQ and GHG emissions
- Model evaluations are currently being finalised (see above)
- Existing GHG models offered under the model evaluation process by CAEP Member States used to provide initial emissions trends for GHG and LAQ emissions
  - AEDT/SAGE (US/FAA)
  - AEM (EUROCONTROL)
  - AERO2k (UK/QinetiQ)
  - FAST (UK/MMU)

ICAO CAEP Environmental Goals (2)

Assumptions for initial emissions trends (CAEP/7, 2007):

- 2002 CAEP forecast
- No projections of future aircraft technologies
- No projections of communications navigation surveillance, air traffic management technologies
- No operational improvements, e.g. continuous descent arrivals (CDA), single engine taxi, etc.

As such the 2007 assessment overestimates future emissions trends as it does not take into account improvements in either aircraft technology or air traffic operations which can be expected

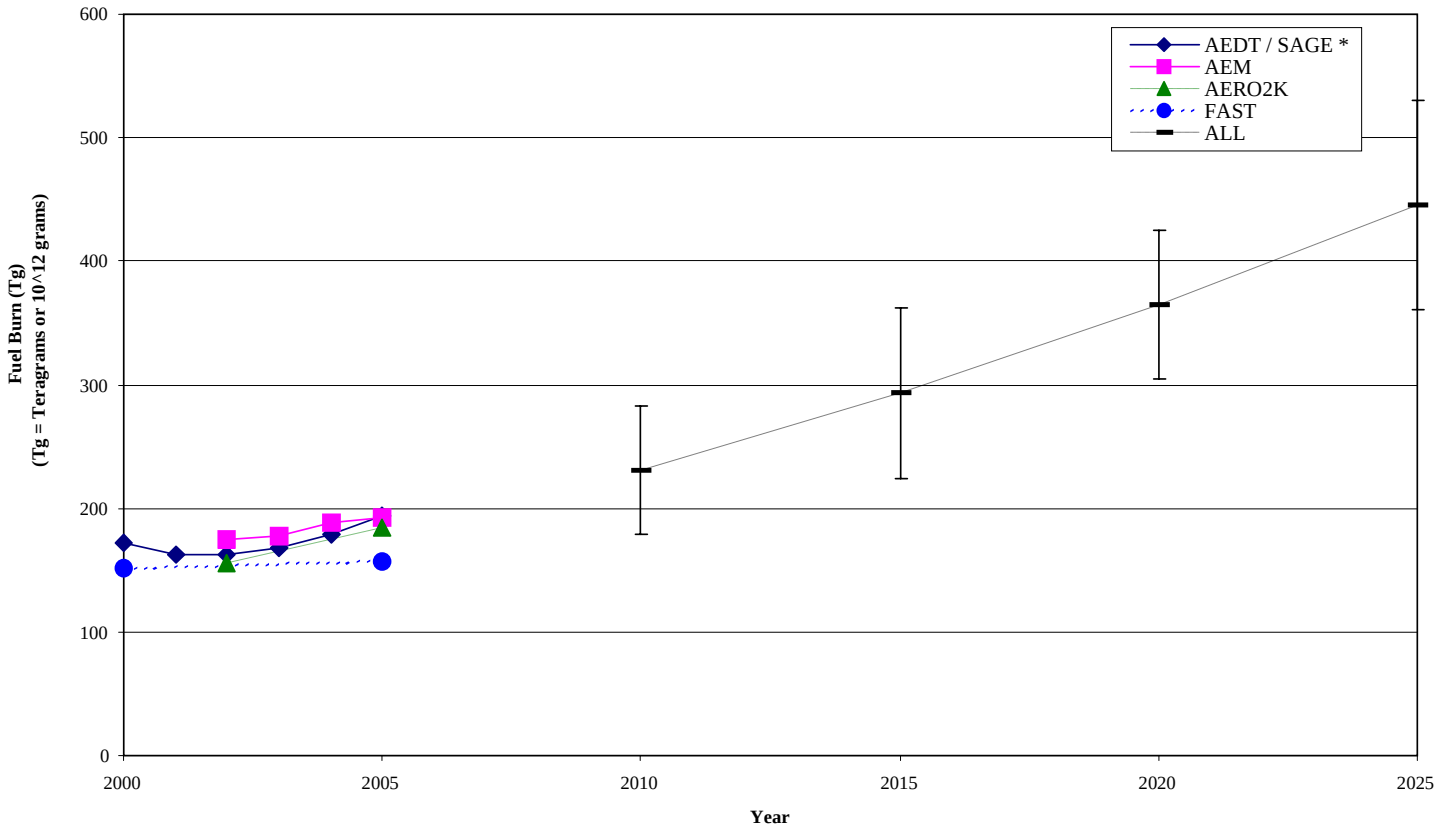
ICAO CAEP Environmental Goals (3)

GHG Observations

- **CO2-Emissions**
  - 500 million tons in 2002
  - substantially lower than in 2000 (9/11, SARS and economy)
  - since 2002, market recovery resulted in an up to 13% increase by 2005 and beyond
  - 2025 levels approximately 2.25 times higher than 2005 levels
- **NOx-Emissions**
  - 2.25 million tons in 2002
  - larger percentage increase in NOx emissions Vs CO2
  - 2025 levels approximately 2.75 times higher than 2005 levels
  - migration of the fleet to higher NOx emissions per unit fuel burn (old Vs new technology)

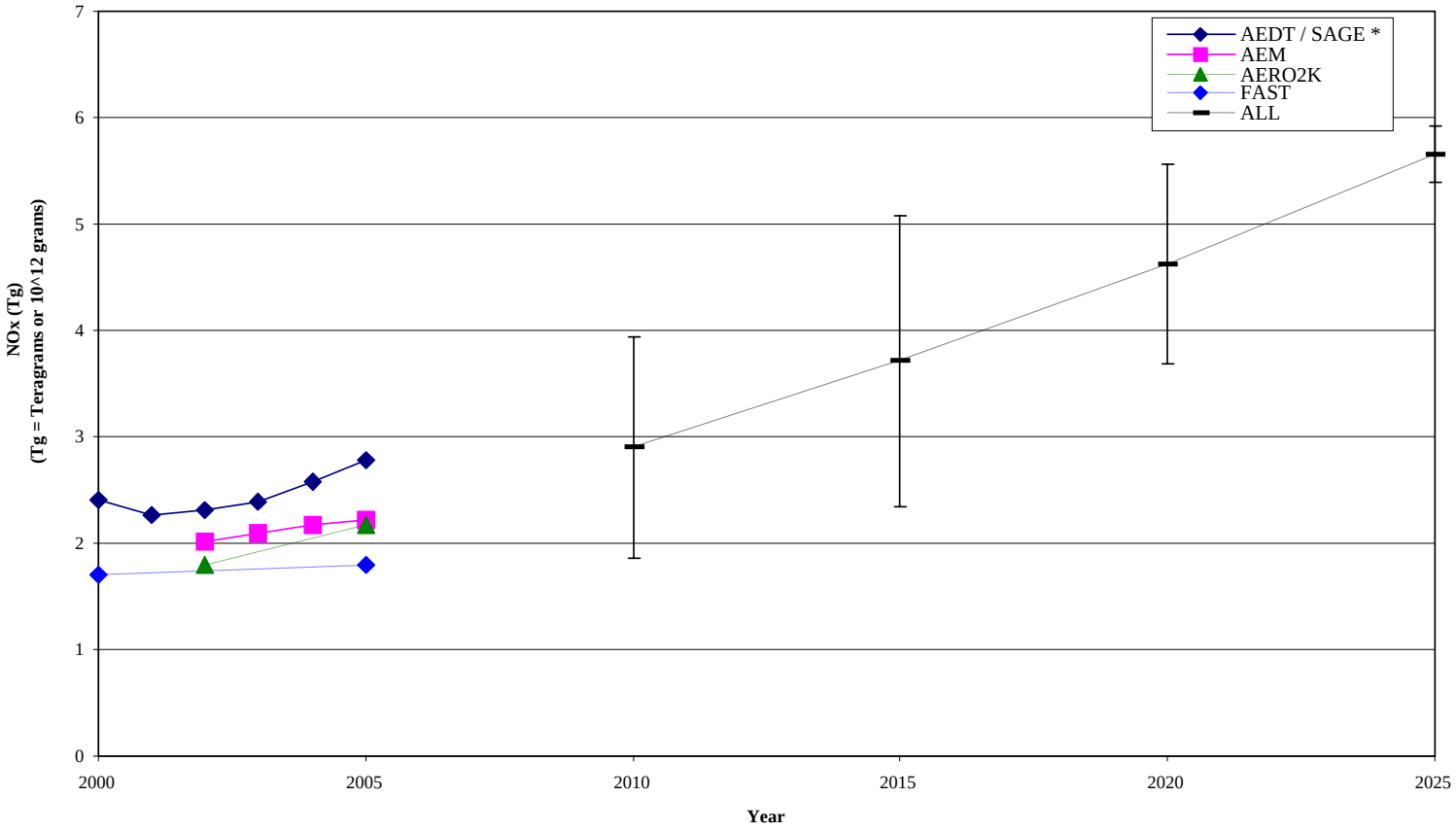
ICAO CAEP Environmental Goals (4)

Trends in Global Fuel Burn



ICAO CAEP Environmental Goals (5)

Trends in Global NOx (GHG)



Summary

- **Modeling important element of the CAEP assessment process**
- **Four GHG models evaluated and used by CAEP**
- **Generally use consistent methodologies**
- **Used to compute LAQ and GHG trends for CAEP/7**
- **Will also be used for CAEP/8 goals/trends assessment and will include:**
  - **Aircraft technology**
  - **CNS/ATM technology**
  - **Operational improvements, e.g., CDA, single-engine taxi, etc.**

Summary

- **CAEP model evaluation process is in its final stage (MODTF)**
- **Modeling for trends & goals assessment starts summer 2008**
- **Results (pre-final) not available before early summer 2009**
- **Next CAEP Goals assessment report scheduled for CAEP/8 (February 2010)**

Summary

Questions ?