A Short Talk on the Need to Develop Accident Investigation Guidelines for Sub-Orbital Flights…

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WINDOW JETTISON HANDLE PIN
REMOVE BEFORE JETTISON


2
3

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Aviation Law

- Chicago Convention (1944):
  - State sovereignty over airspace (but no upper limit?);
  - “any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth’s surface”.
- Montreal/Warsaw Conventions:
  - companies liable for injury/delays to passengers;
  - Only applies to international flights not spaceports;

Aviation Law:

- Rome Convention (1952):
  - damage Caused by Foreign Aircraft on Surface;
  - operator absolutely liability for damage from flight;
  - amount of liability determined by mass of aircraft;
  - Unlimited if result of deliberate act or omission;
  - 3rd party claims against both operators in collision.
- UN space law only considers crew rights/liabilities…
  - Liability only expressed between states.

Annex 13 of the Chicago Convention

- Increase consistency between states.
  - Types of events to be investigated;
  - Rights to participate in an investigation.

- “the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability”.

Recession and Crisis in Safety Regulation

- UK Outer Space Act (1986)
  - unlimited liability (cf £140 million for nuclear);
  - Space 3rd party liability insurance of £100 million;
  - US, Russia, China etc. require no insurance
- Minister for Universities and Science:
  - reduced compulsory insurance to €60 million;
  - cap unlimited liabilities to €60 million for most;
  - As risks will be closely monitored;
- Concerns, no independent space regulator:
  - UK Space Agency promotes industry…

New Risks (1)

- *Risks during launch.*
  - companies need to control their launch schedules;
  - space tourism delays can lead to legal liability;
  - US Range Commanders Council 321-10 ‘Common Risk Criteria Standards for National Test Ranges’ ignores passengers and crew on board any vehicle.

- *Risks to other forms of aviation.*
  - disintegrating of Columbia (STS-107);
  - 300g likely to cause the loss of a commercial aircraft;
  - FAA’s Shuttle Hazard Area to Aircraft Calculator;
  - Temporary Flight Restrictions (TFRs) govt focus.

New Risks (2)

- *Risks to other space vehicles.*
  - collision of Iridium 33 and Kosmos-2251;
  - 26,200 miles per hour, 2,000 items of debris;
  - paint flakes, aluminium particles from solid rocket motors;
  - US Strategic Command SPACETRACK
  - monitor 20,000+ objects larger than 10cm in diameter;
  - ‘space situation awareness’

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New Risks (3)

- *Risks to passengers and crew.*
  - Crew training requirements on sub-orbital missions?
  - airworthiness issues and maintenance regimes?
  - Regulatory organizations lack technical expertise.
- *Risks during re-entry.*
  - NASA 5,900kg Upper Atmosphere Research Satellite
  - Russia's Phobos–Grunt Mars Craft debris;
  - Both end up in the Pacific;
  - proliferation of commercial space operations.

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Space Law

- ICAO aircraft support “from the reactions of the air”:
  - Kárman line 84-100 km above sea level;
  - Depends on design, pressure, temperature, density, viscosity;
  - What if aircraft crosses into orbital trajectory?

- UN Committee on Peaceful Uses of Outer Space treaty:
  - Exploration/Use of Space, including Moon & Celestial Bodies;
  - Rescue, Return of Astronauts and Return of Objects Launched;
  - International Liability for Damage Caused by Space Objects;
  - Registration of Objects Launched into Outer Space;
  - Activities of States on the Moon and Other Celestial Bodies.

Registration of Objects

- States must provide UN ephemeris data
  - maintenance of a launch register
  - Information about purpose of object
  - In the future, also document when object will be moved into a disposal orbit.
  - Tensions between existing space law and the rise of commercial space operations.
  - Space law focusses on state responsibilities;
  - Governments ensure companies act responsibly?
  - But to encourage domestic space industries may choose not to ratify COPOUS agreements.

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US Space Law

- Space launch Act (1984).
- Commercial Space Launch Amendment Act (2011).
- FAA Office of Commercial Space Transport (AST):
  - licensed approximately 200 launches
  - operator licenses for 8 commercial spaceports.

US Space Investigation Framework

- Commercial Space Launch Act 1984/2004:
  - Sec of Transportation oversees regulation and promotion of ‘competitive US commercial space transportation industry’.
  - Potential conflicts here…
- 1989 Memorandum of Agreement:
  - US DoT Office of Commercial Space Transportation
  - National Transportation Safety Board

US Space Investigation Framework

- Office of Commercial Space Transportation
  - retains right to investigate;
  - If accident result of violation of licenses.
  - Aim to “determine the probable cause of an incident or other occurrence as accurately as possible and/or determine if there was a *violation* and make recommendations…, which, if implemented, will limit or significantly reduce the reoccurrence of such event”
- Compare with Annex 13 ‘no blame’…

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European Space Law

- European Aviation Safety Agency, EC 216/2008:
  - Certification & means of compliance, not legally binding;
  - Extensions to type certificates for sub-orbital aeroplanes;
  - If they derive support from the atmosphere.
- Contrasts with FAA license based approach;
  - Criticise EASA certification as ‘premature’ and costly.
  - But maaaaaaaaaaaaan it’s a mess
  - Virgin Galactic, FAA in New Mexico, EASA in Kiruna, Sweden;
  - XCOR Aerospace launch from Curacao.
  - ‘Constituent country’ of the Netherlands but outside EASA.

European Space Investigation Framework

- EC Regulation (EU) No 996/2010
  - implements Annex 13 across member states;
  - consistent framework for investigations in Europe;
  - Unlike OCST focus on aviation safety;
  - Like NTSB no blame or doesn't determine liability.
- EASA ensures implementation of findings:
  - to sustain public confidence and maintain safety.
- Directive 94/56/EC investigator Independence

EUROPEAN AVIATION SAFETY AGENCY

European Space Investigation Framework

- 2003/42/EC on Safety Occurrence Reporting.
  - Article 6 requires “Member States shall participate in an exchange of information by making all relevant safety-related information stored in the databases mentioned in Article 5(2) available to the competent authorities of the other Member States and the Commission…
  - Requirements for disclosure in 2003/42/EC hard to sustain outside member states, when strategic space commercial or security interests might be threatened.

European Space Investigation Framework

- European Space Agency paper on space tourism:
  - activities take place within national air space;
  - national agencies & European organisations EASA, should lead development of regulatory framework.
  - “ESA sees sub-orbital flights as aviation activity to which air law must be applied and would at a later stage look at possible application of space law for regulation of orbital space tourism”.
- ESA technical and advisory organisation;
  - lacks power to enact regulations or enforce harmonised approaches to accident investigation.

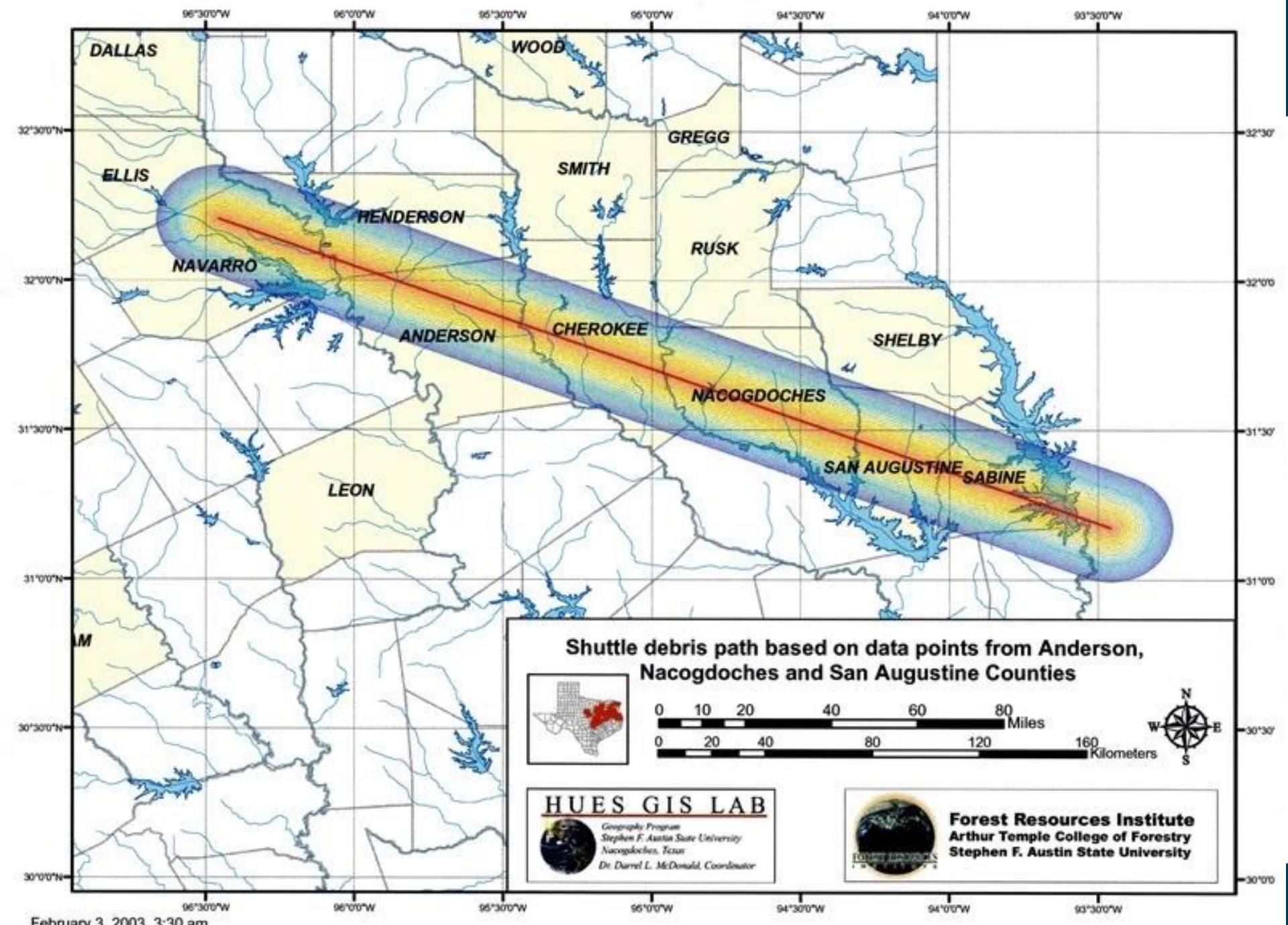
Recommendations and Requirements

- *Confidence in the recommendations.*
  - other nations must trust findings;
  - appropriate tools & techniques used transparently.
- *Defences against bias.*
  - Use experts from national space programmes?
  - rivalry between public and private organisations;
  - How to ensure independence of investigator?
- *Separation of responsibilities.*
  - preservation of safety vs economic promotion;
  - causes of an accident from regulatory failure?

Recommendations and Requirements

- *Ensuring sufficient technical expertise.*
  - Need independent bodies with sufficient expertise
  - Specialist investigators coordinate teams…
- *Balancing disclosure, commercial sensitivity.*
  - investigator prosecuted for disclosure of IP?
  - protection to ensure public safety/confidence.
- *Recognition of national security.*
  - recommendations to bar market access?
  - overseas companies cannot view findings;
  - place lives at risk and discourage cooperation

East Texas



February 3, 2003, 3:30 am

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Part Two: Sub-Orbital Debris

- With Marco Sarconi and Yvon Le Saint.
- 2003 Columbia loss during re-entry:
  - 250 mile long debris footprint over Texas;
  - 300+ grams causes the loss of an aircraft.
- Increasing risk from sub-orbital flights.
- But how to assess prob X consequence?

Debris Model

- A debris model is a theoretical model that calculates the motion, impact locations and areas, and the probabilities and risks associated with debris falling within a finite area (Van Suetendael, 2003).

- Predict debris field by modelling forces:
  - Gravity, wind, lift, drag and acceleration;
  - Vehicle data (weight and Ballistic co-efficient).

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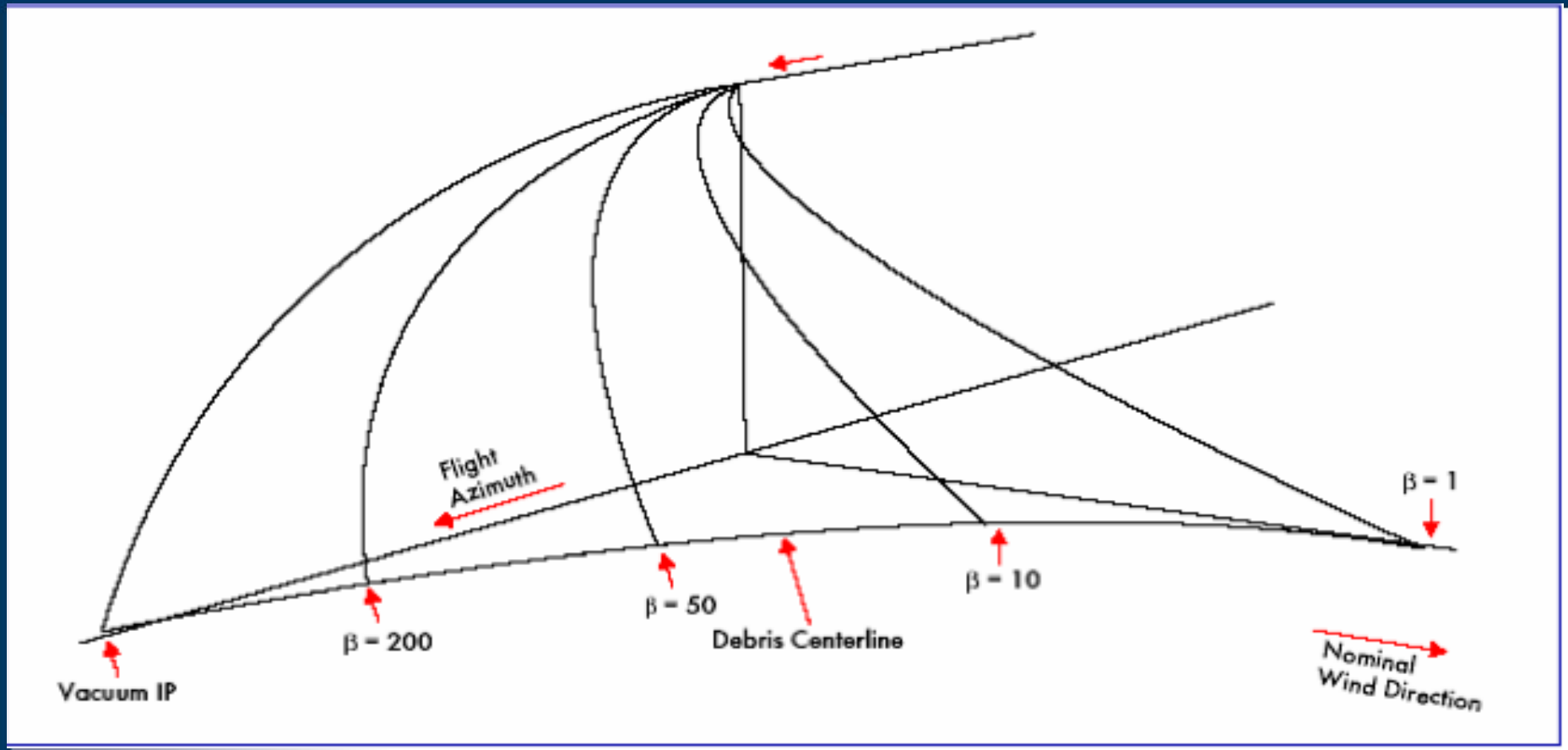
Debris Model



- The influence of the ballistic coefficient, β , and wind upon debris impact points (CAIB Report, 2003).

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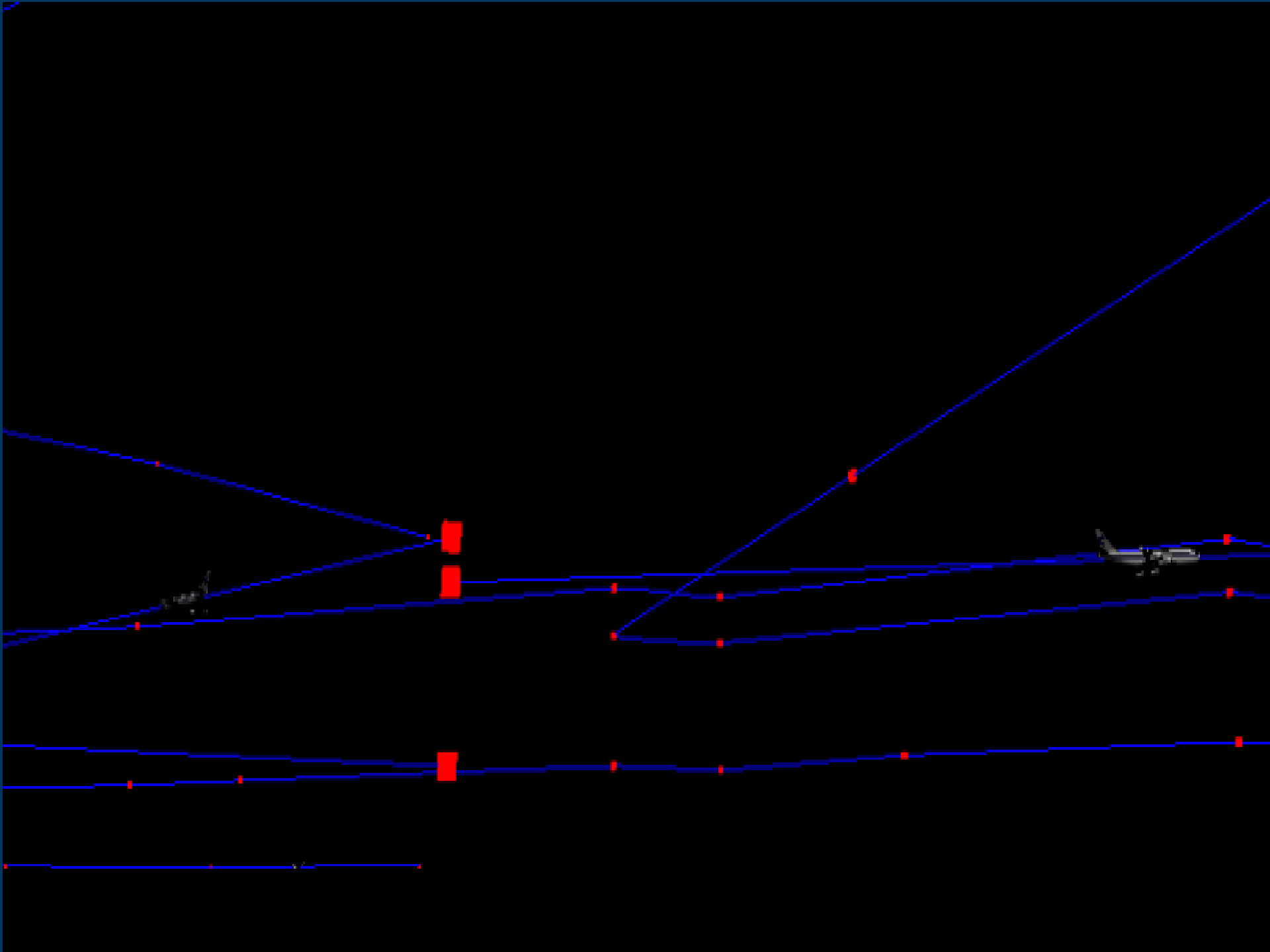
The Airspace Model

- ADS-B:
  - Automatic dependent surveillance-broadcast.
  - SBAS positioning plus broadcast;
  - Aircraft to continuously transmit position;
  - Possible replacement to radar.

- Retrieve aircraft in specified area:
  - current position, altitude and flight-path.

- Ground stations pass data to servers.



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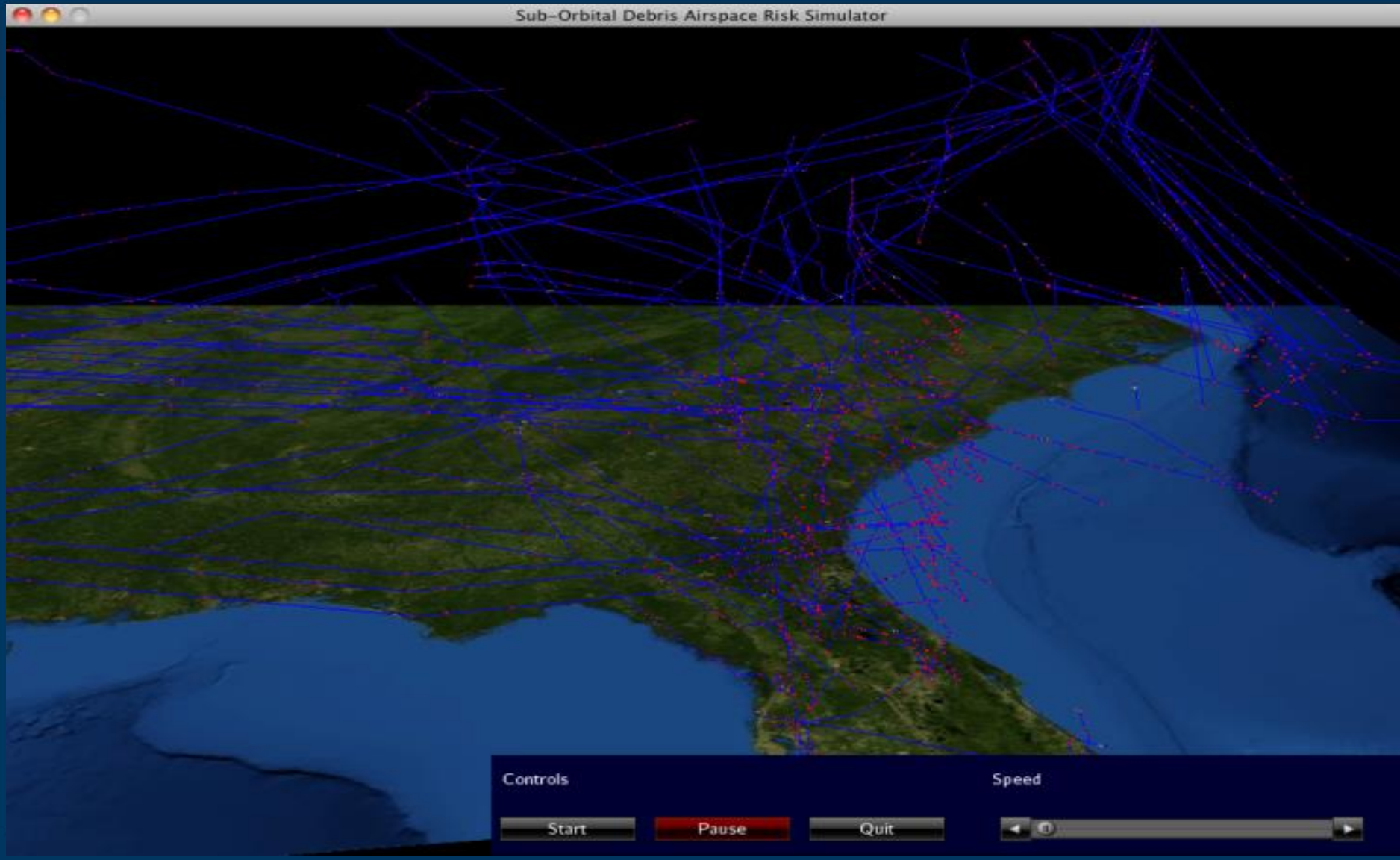
Visualization 2



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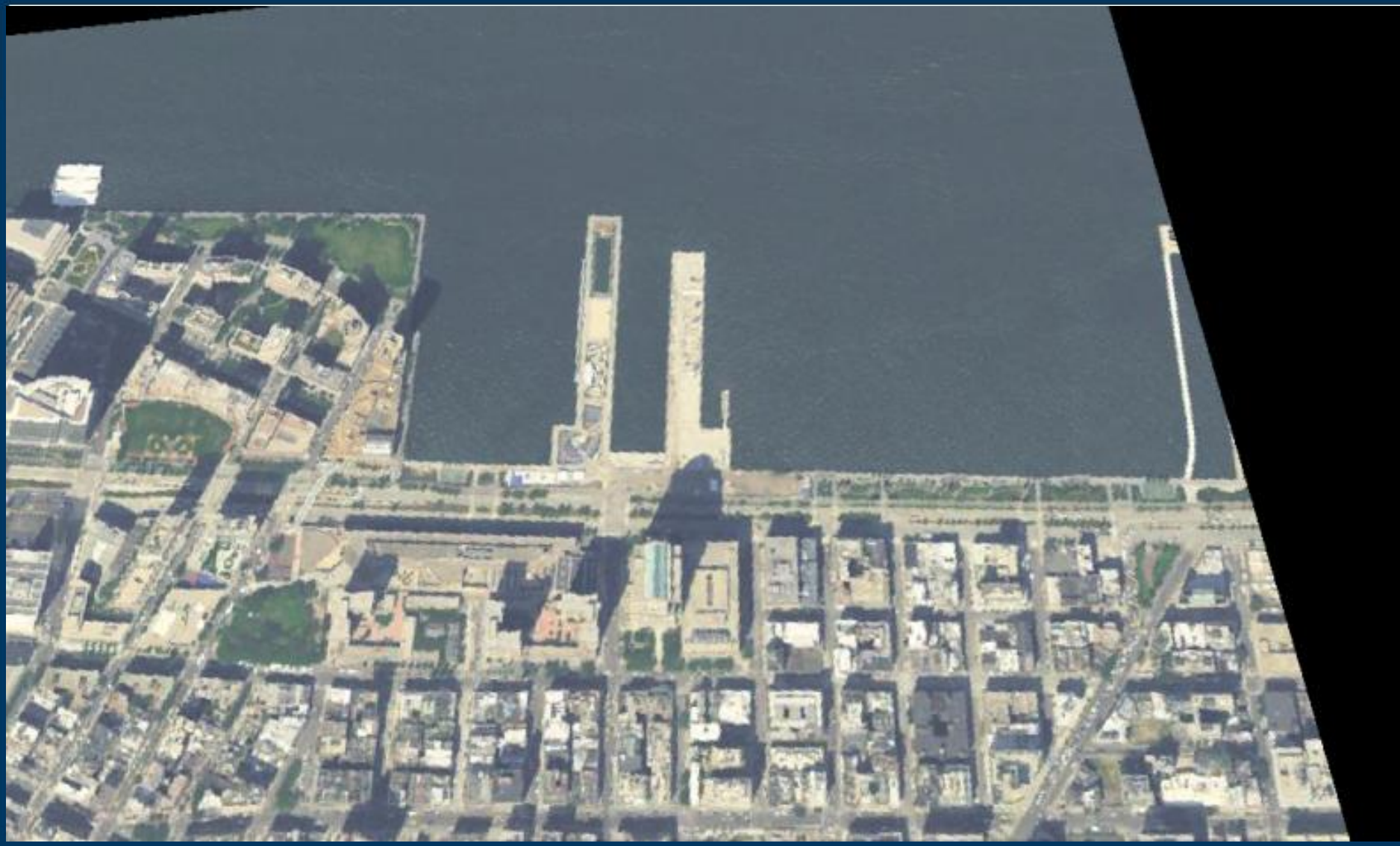
Present Work



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Present Work

- 4 October 1992, El Al Flight 1862.
  - Boeing 747 El Al cargo plane;
  - Hits Groeneveen and Klein-Kruitberg flats.
- 43 killed:
  - 3 crew, non-revenue passenger in a jump seat,
  - 39 people on the ground
- Worst aviaition accident in Netherlands:
  - plane exploded, starts large fire after the crash.

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Present Work

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Present work

- Lockerbie, 21 December 1988.
  - Bomb killed 243 passengers, 16 crew.
  - Killing 11 people on the ground.
- Extend simulator to assess mid-air collision.
- Michael Bell and Martin Craig…
  - Extend integration with GIS.
- Safety of additional runway at Heahrow?

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Any Questions?