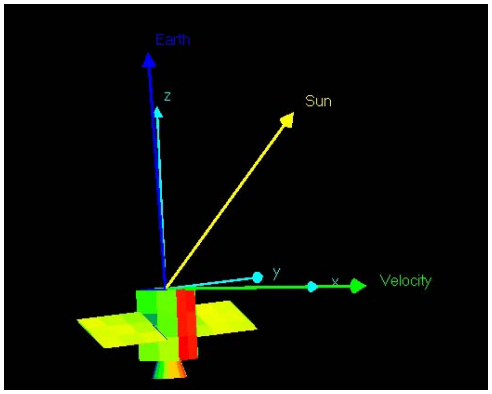
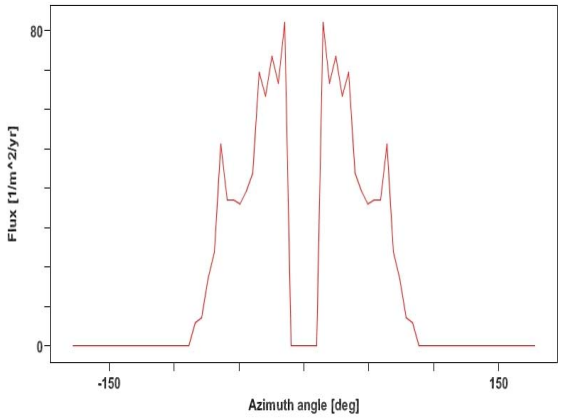
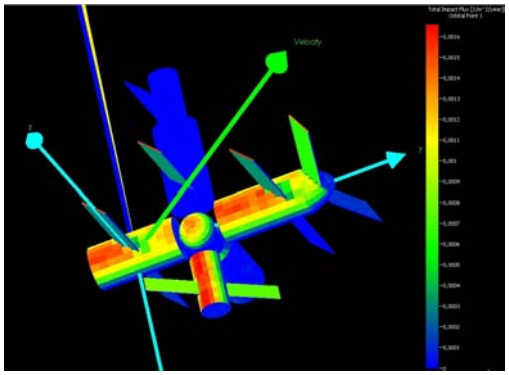
ESABASE2/Debris Impact Analysis Tool







ESA/ESTEC Contract 16852/02/NL/JA
Final Presentation
15 March 2006

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Overview

- Study Organisation
  - Study facts
  - Scope of the study
- ESABASE2 Overview
  - Concept
  - Components
  - Handling
  - Available debris models
- Summary & Conclusions, Outlook & Future Perspectives

Study Organisation

Study Facts

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- Title: PC Version of Debris Impact Analysis Tool
- Duration: 2003-01-03 – 2006-03-31
  - Initial Study + CCN to include new debris models
- ESA Technical Officer: Gerhard Drolshagen
- Study Team:
  - Prime Contractor: *eta_max space*

H. Sdunnus,
K.D. Bunte,
A. Langwost,
D. Gunia,
K. Ruhl
(S. Hauptmann)

Scope of the Study

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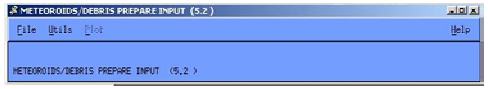
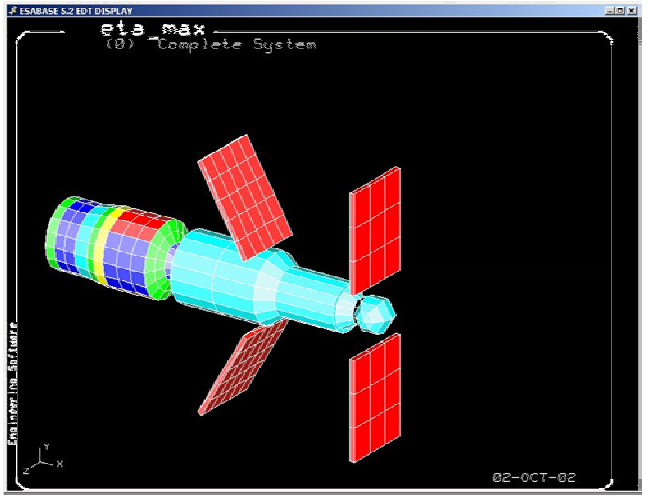
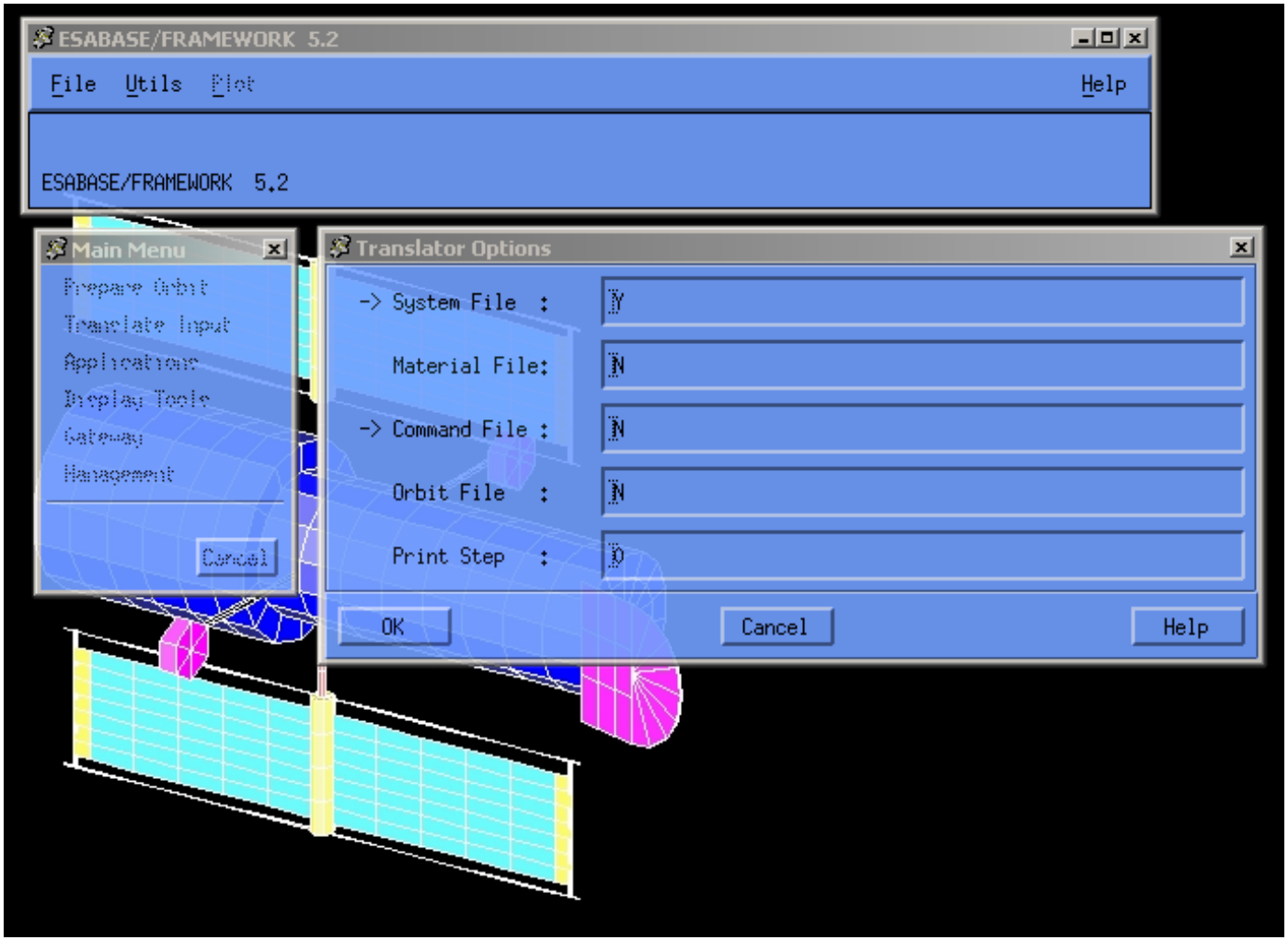




- Motivation
  - Ageing Space Environment Analysis Tools
    - Platform dependence
    - Cumbersome user interfaces
    - Restricted data models
    - Undefined or non-existent interfaces to external tools
    - Unsatisfactory pre- and post-processing capabilities
    - Serious constraints of their acceptance and availability (ESABASE;..)
  - ESA Study
    - “Porting of the existing ESABASE/Debris Application to PC platform“
    - Usage of off-the-shelf (OTS) tools and Open Source software
    - Provision of Open Interfaces (STEP)
- Result
  - ESABASE2 = Open Frontier framework + ESABASE/Debris solver

ESABASE2 Overview

Introduction



ESABASE2 Concept

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User Input Acquisition

- Satellite Model
  - Geometry
  - Kinematics
  - Pointing

→ Geometry file

- Mission
  - Orbit
  - Duration
  - Manoeuvres

→ Mission file

- Solver Parameters
  - Debris
  - Other

→ Physics file

Application of Models

- "General Services"
  - Orbit Propagation
  - Meshing
  - Ray Tracing
- Physical Model(s)
  - Debris & Meteoroids
  - Radiation
  - …
  - ..

→ Results file

Analysis of Results

- Results Visualisation
  - 2D Charts
  - 3D Chart
  - Mapping to geometry
  - File viewing
- Post-Processing
- Report Generation
  - Export to office tools

ESABASE2 Components

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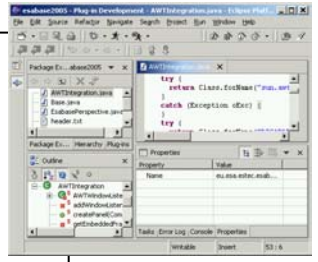
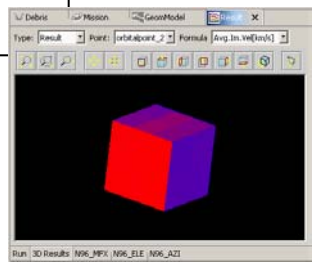
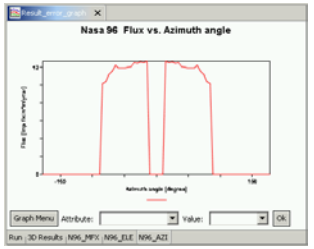
- GUI → Eclipse (CPL)
  - full availability to the features of the Java Standard Widget Toolkit (SWT)
    - Window management
    - File handling
  - Offers a “Plugin Model“



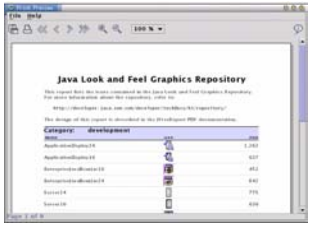
- Model Builder/Viewer → Open Cascade (GPL like license)
  - Open Source CAD library
  - available on PC and other platforms (Windows, Linux, Solaris)
  - Interfaces: STEP (AP 203 and 214;[209]), IGES and others



- Visualisation → VisAD (LGPL)
  - Java component library for interactive and collaborative visualisation and analysis of numerical data



- Reporting → JFreeReport (LGPL)
  - JFreeReport is used to display formatted data tables and analysis reports



Handling

Editor Area

- Dedicated editors for specific purposes
- Geometry editing
- Input acquisition
- Results visualisation
- ...

Project Explorer

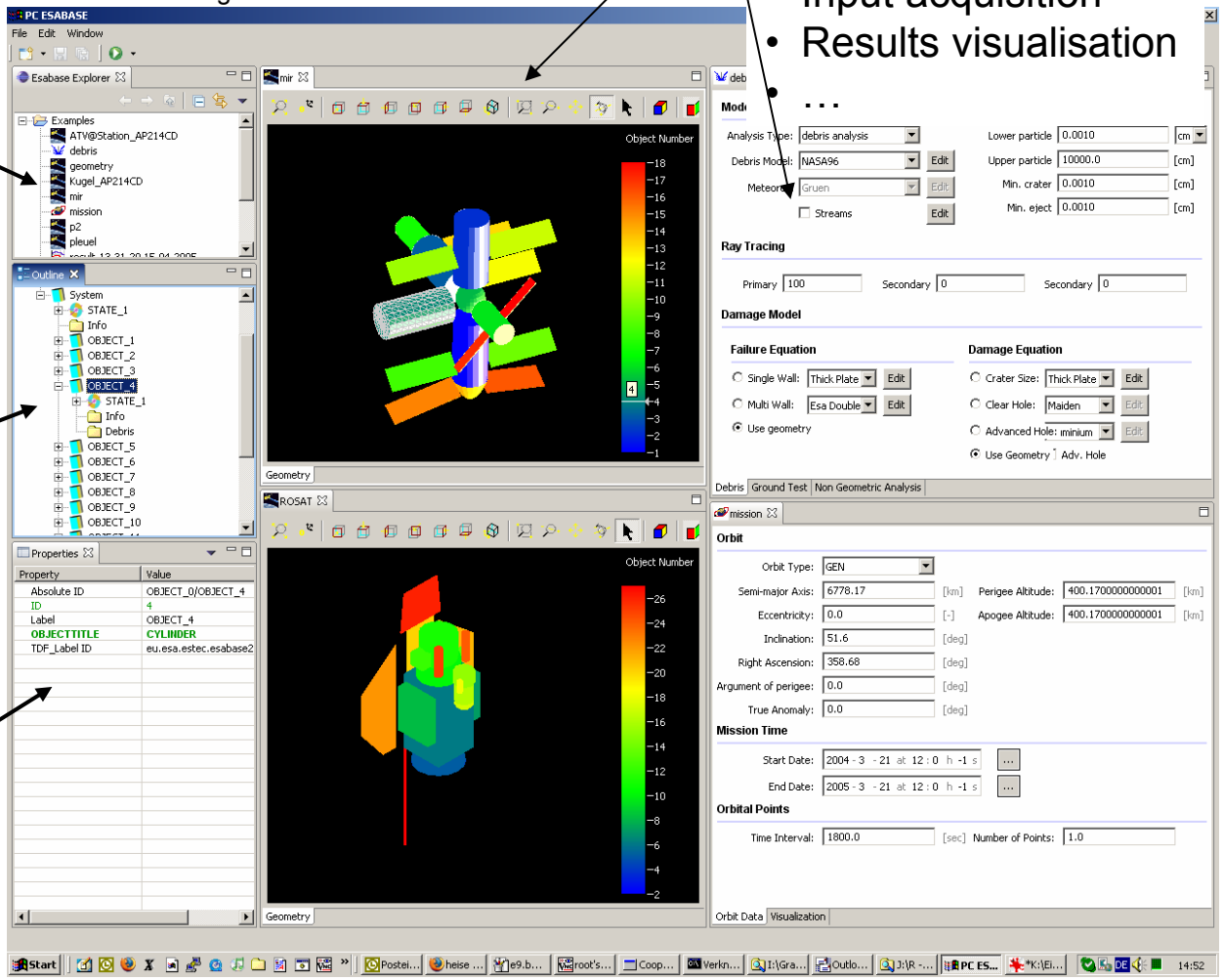
- List of currently open projects
- List of available project files, organised in project directories

Outline

- Structured, generic visualisation of selected data file

Property Editor

- Generic editing of data model content



Available Models

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Debris Models	
	NASA 90 NASA 96 MASTER 2001 **ORDEM 2000**
Meteoroid Models	
Sporadics	Grün Cour-Palais Divine-Staubach
Streams	Jenniskens
Advanced (directional effects of the sporadic component)	Apex Enhancement α, β separation Interstellar Sources
Velocity Distribution	HRMP (also altitude dependant) Kessler

Secondary Ejecta	yes
Design Equations	
Single Wall **Multiple Wall**	▪ Commonly used equations are selectable ▪ Generic equations with user-editable parameters are available.
Damage Equations	
Craterisation **Clear Hole** **Advanced Hole**	▪ Commonly used equations are selectable ▪ Generic equations with user-editable parameters are available.

Hands-on Presentation

Overview GUI

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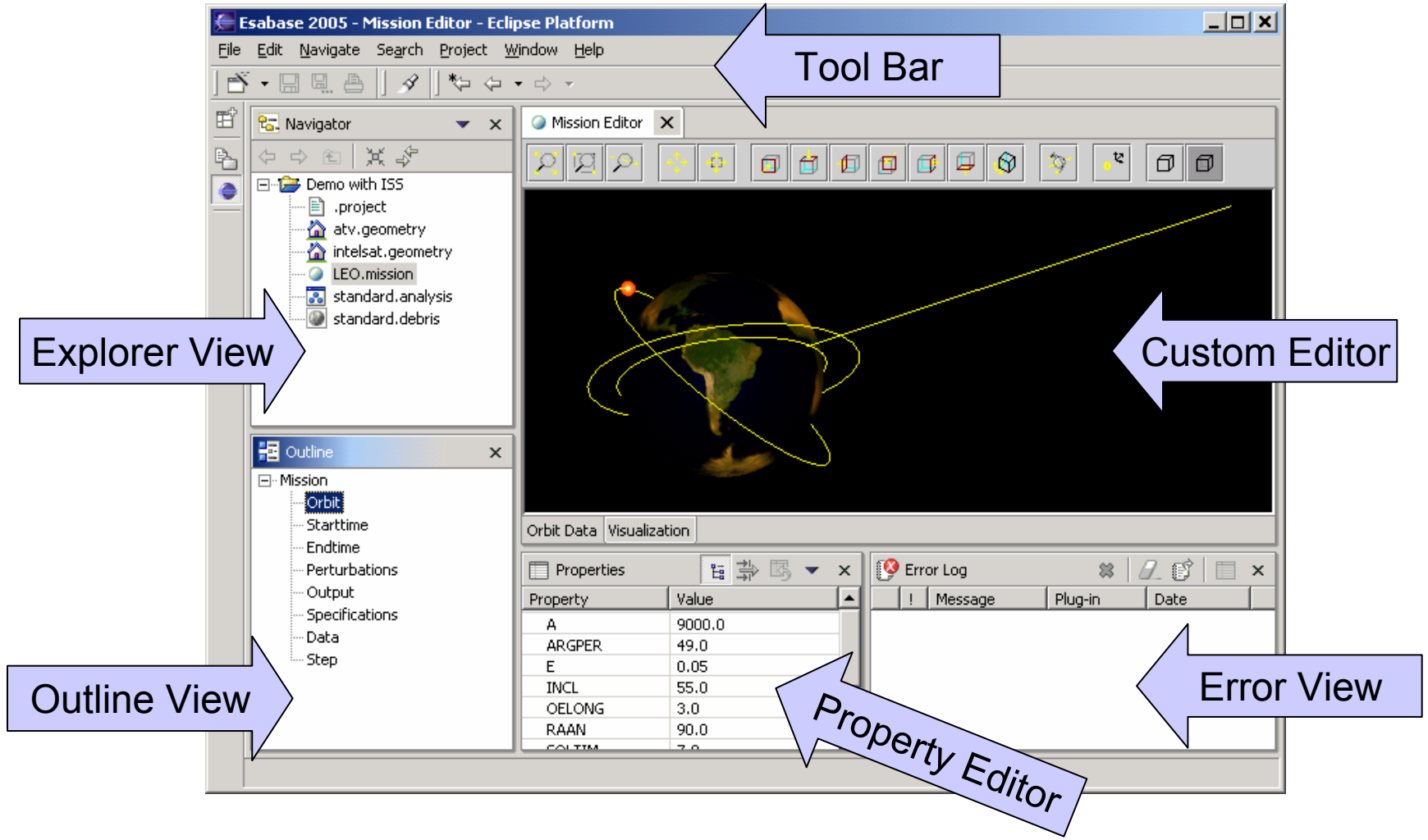
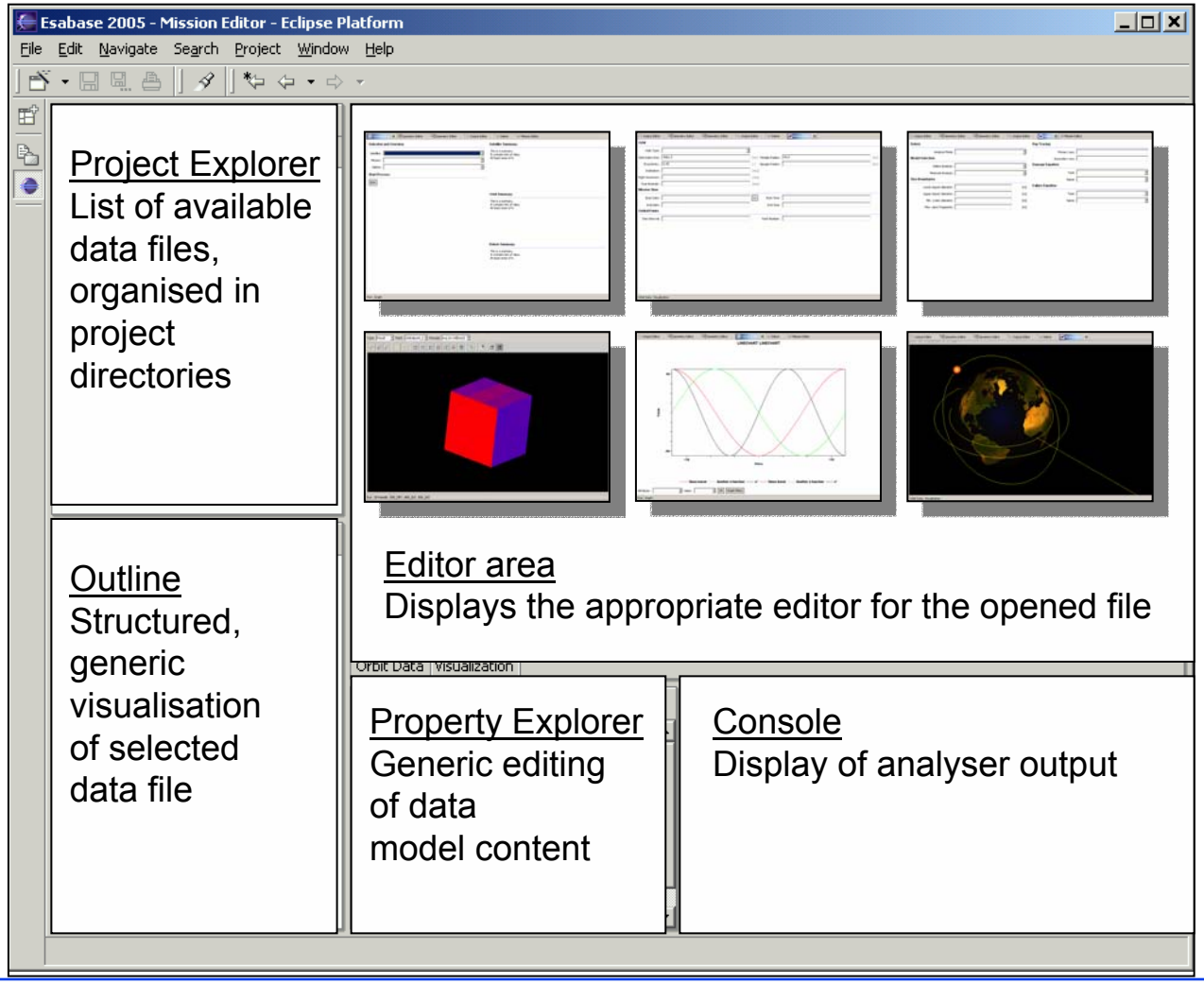


Overview GUI II



Geometry Editor

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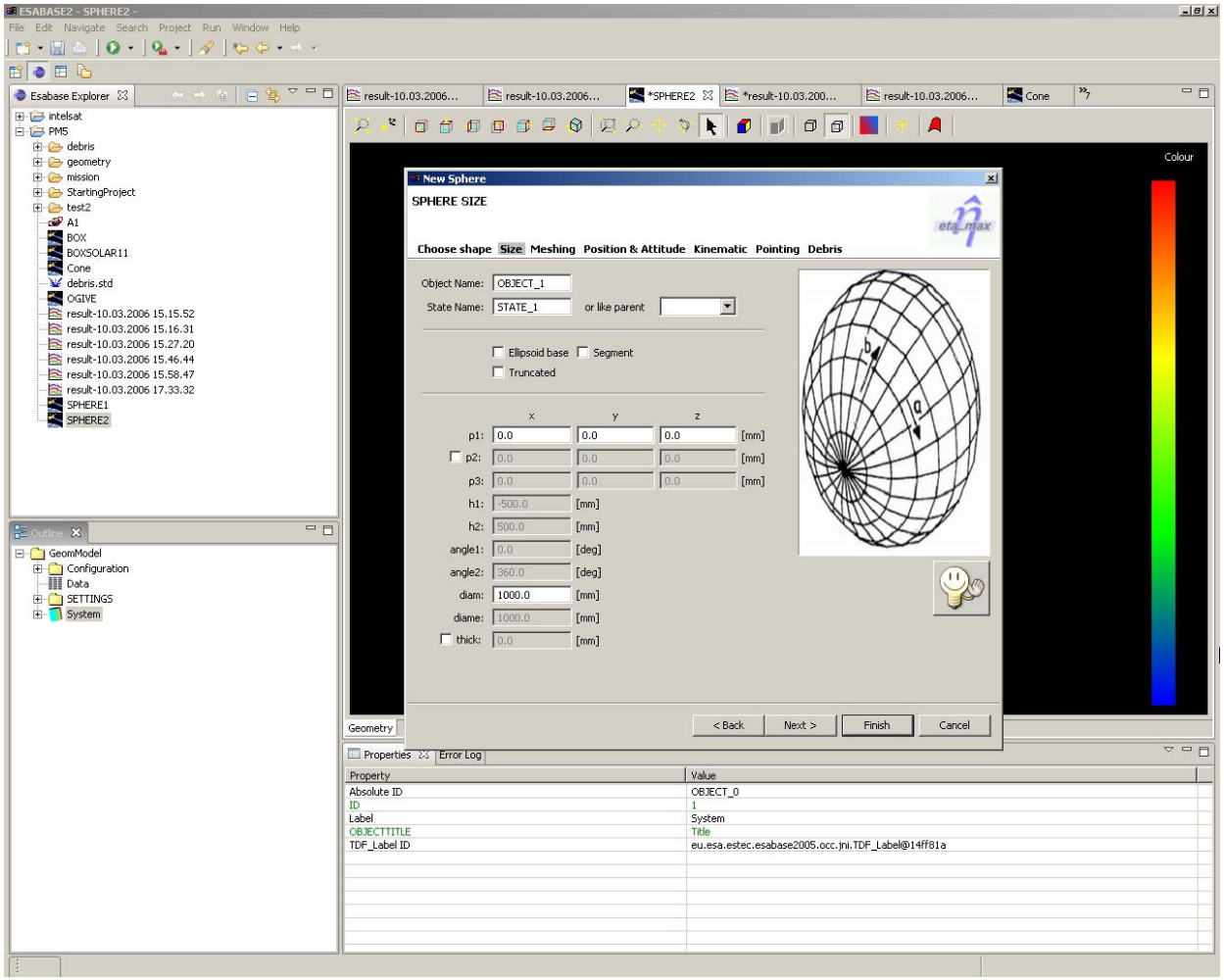
- Graphical geometry-builder
- Possible import-formats:
  - STEP
    - AP203
    - AP214
  - BAS
- Predefined sample shapes (e.g. box, sphere, cone,...)
- Hierarchical relationship between the objects



Mission Editor

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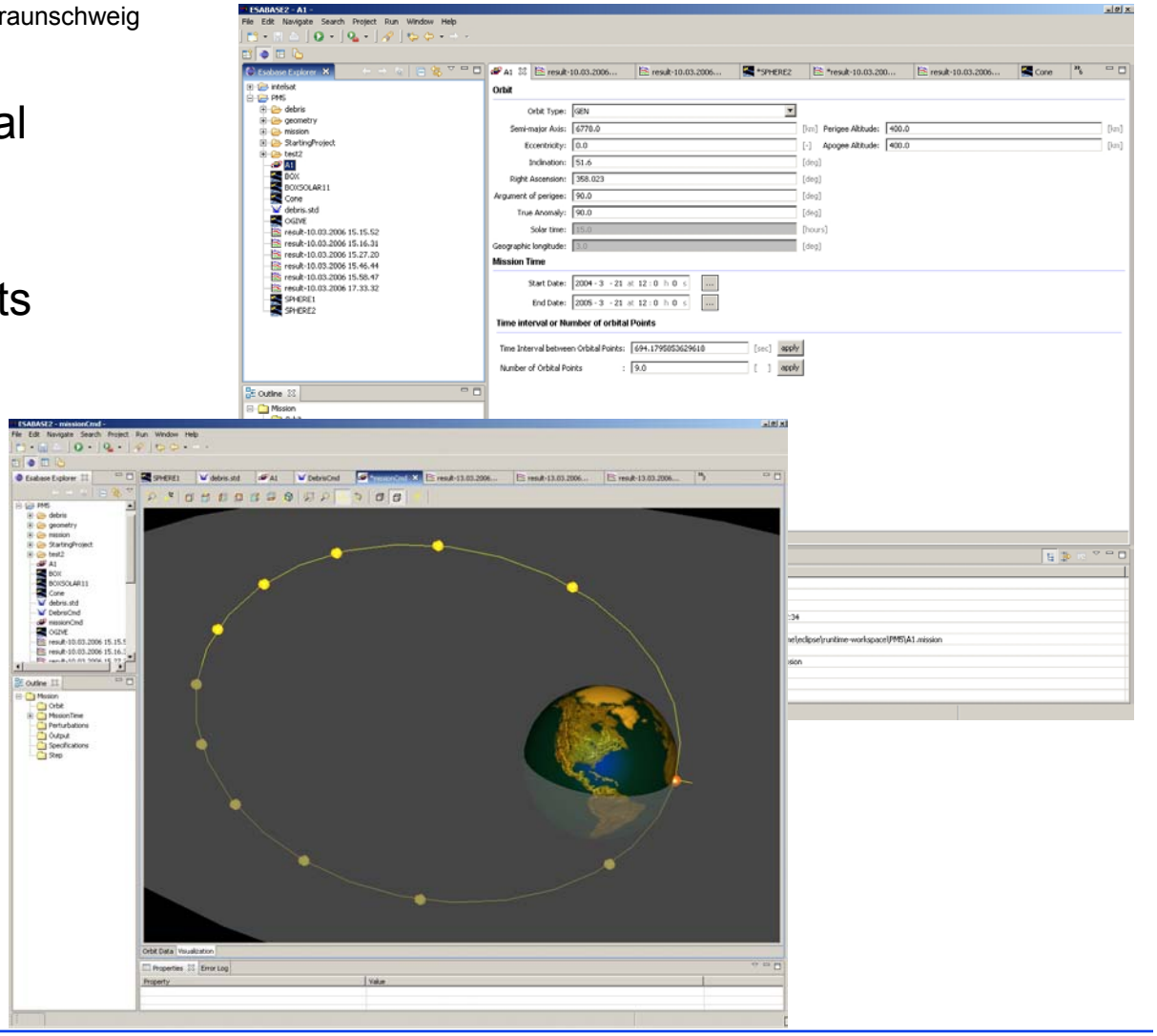
- Input via classical orbital elements or apogee / perigee
- Input of no. orbital points or time between the orbital points
- Orbit visualisation including orbital point visualisation
- Pre-defined Sun-synchronous and geostationary orbits



Debris Editor

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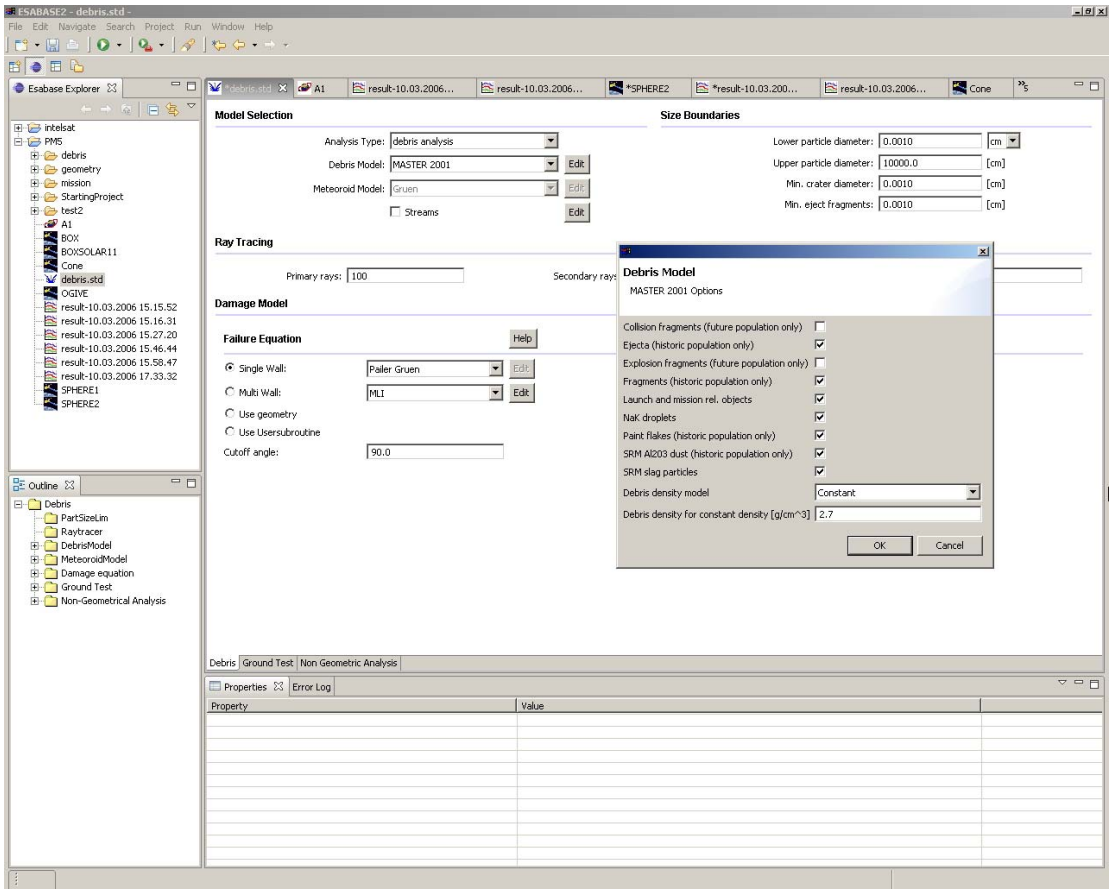
- Possibility to select between different debris/meteoroid models and different damage/failure equations
- Ground-test option to verify damage/failure equations
- Non-geometrical analysis for all debris/meteoroid models available
- Possibility to implement a user defined damage-equation



Result Editor I

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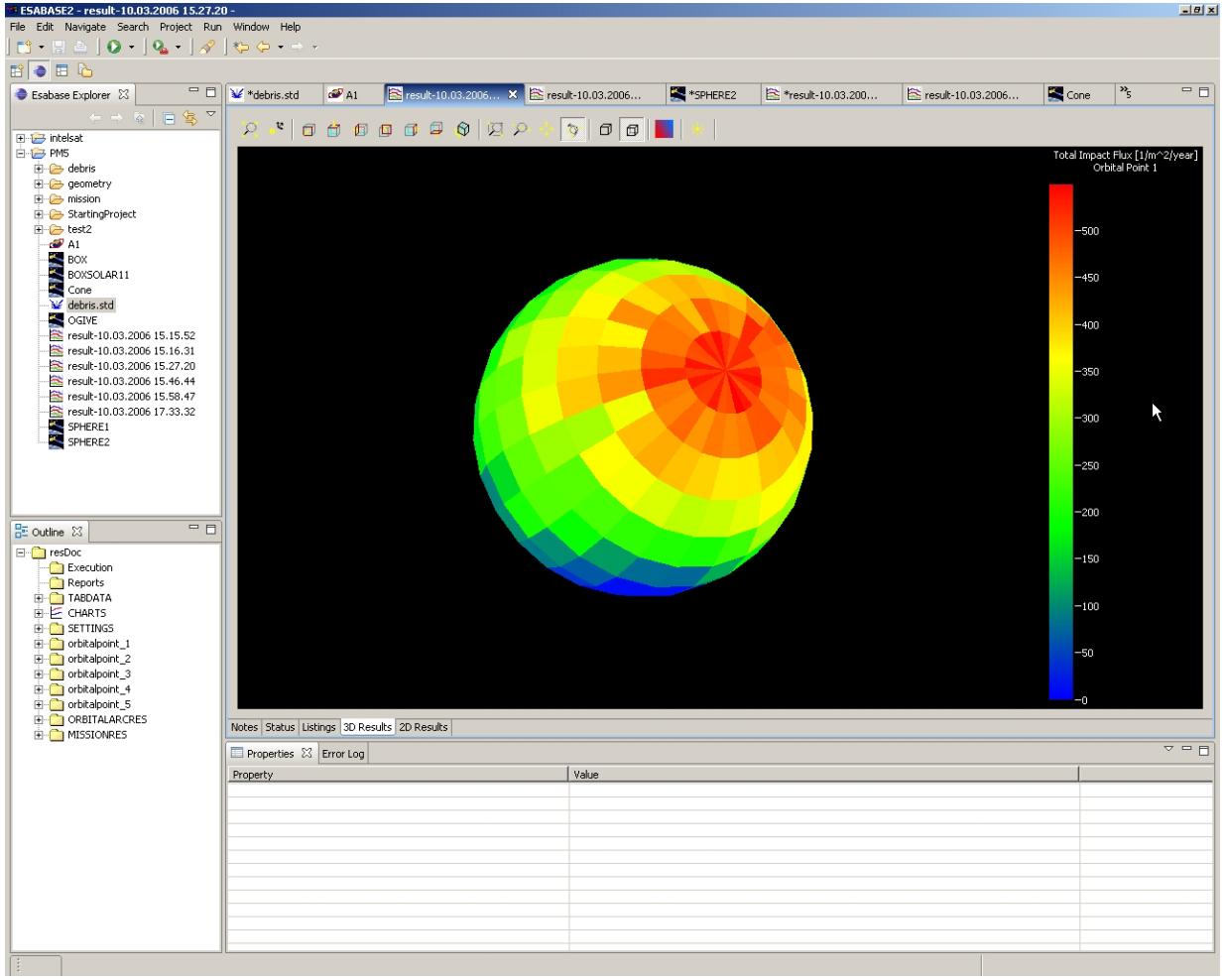
- 3-D colour overlay on the geometry for different types of results (e.g. flux, impact velocity, impact angle,...)
- A legend assigns element colours to result values
- Possibility to display coordinates and pointing information



Result Editor II

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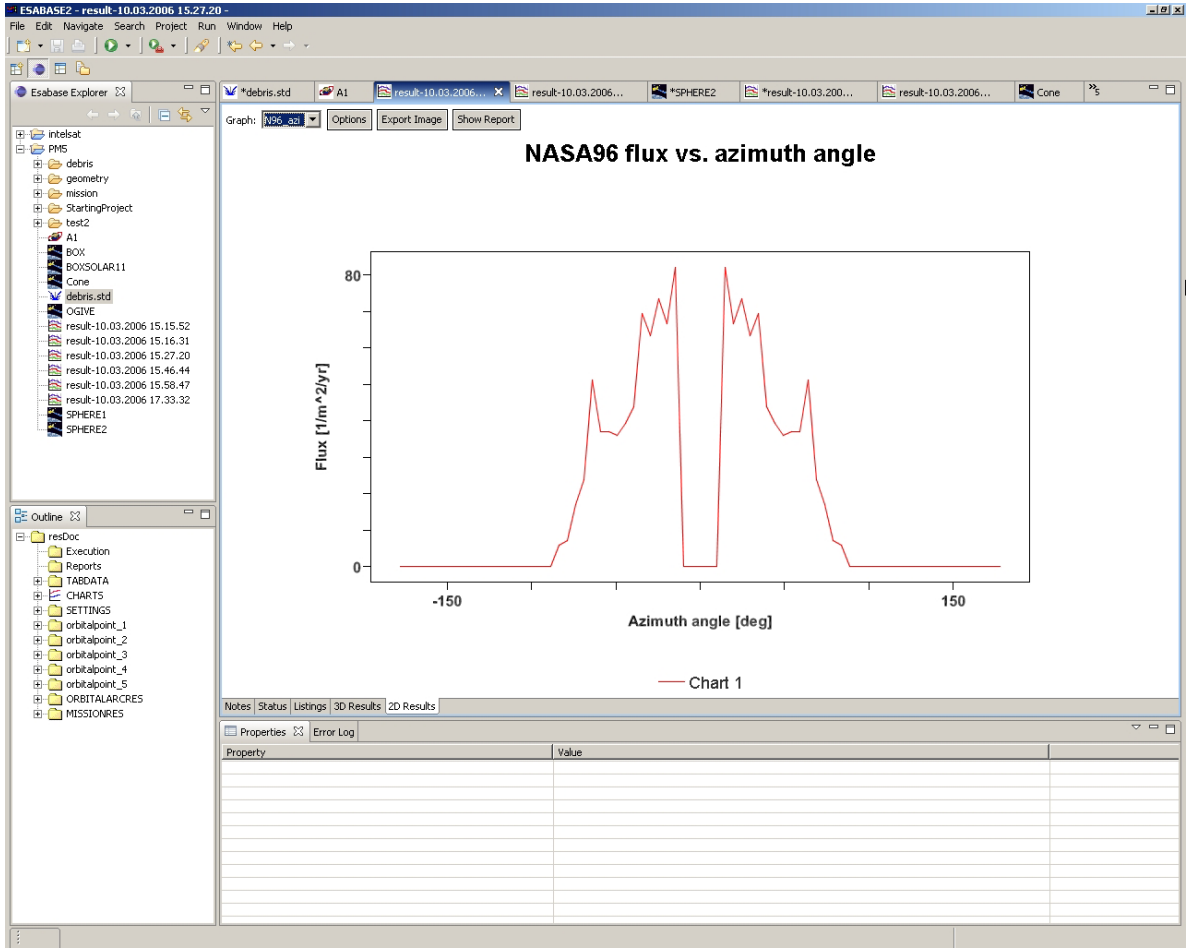
- Different possibilities to visualise results
- 2-D Charts
- Reports
- Export options for graphs and 3-D images



Result Editor III

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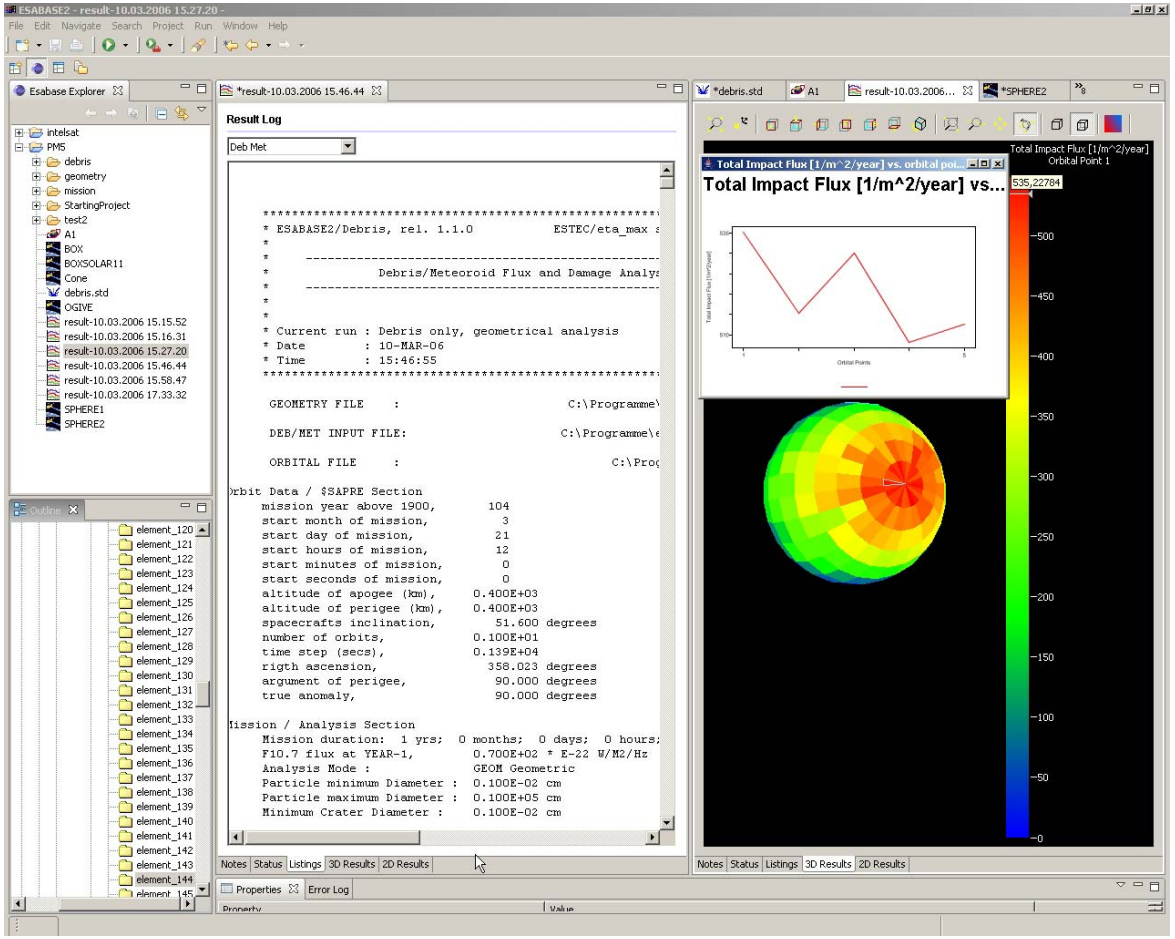
- 2-D Charts available for the result of each single element (vs. orbital points)
- Listing-files for
  - Orbit
  - Kinematic
  - Debris/meteoroid flux analysis
- Results for each orbital point, for an orbital arc and for the mission



Summary & Conclusions
Outlook & Future Perspectives

Maintenance and Distribution

- Distribution
  - Copies of the software are available from 01-04-2006
  - Interest may be expressed via lists circulated at FP or via website http://www.esabase.net/
  - Initial distribution by CD (code plus documents), updates via web http://www.esabase.net/ or CD
  - New releases plus release notes will be regularly (every 3 months) issued on the web

- Licensing
  - Source code of shell (Open Frontier) is distributed under ESA Open Source License
  - Source code of debris module only on request, object code will be distributed
  - Maintenance and support contracts are offered by eta_max space

  - Class A contracts: Main contractors,
    - Automatic updates
    - Priority user support at reasonable best effort level
    - Yearly Fee: 5K/yr

  - Class B contracts: SME's and Space Agencies
    - Automatic updates
    - User support at reasonable best effort level
    - Yearly Fee: 2.5 K/yr

  - Class C contracts: students, universities, research Labs, private persons
    - Basic support, no automatic updates
    - For internal use only, tool not to be used for work for customers which themselves would require a license
    - Publication of results only upon acceptance
    - No fee

  - Specific customer requests will be handled on a case-by-case base.

Summary and Conclusions

- The Debris module of the former ESABASE application has been integrated into Open Frontier, an up-to-date PC-based platform based on Open Source components.

- ESABASE2
  - is available for PC platforms,
  - provides an ergonomic framework for
    - user input acquisition,
    - post processing,
    - result visualisation,
  - offers considerable performance enhancements, mainly due to a revised ray tracing algorithm,
  - offers an interface to external CAD tools via STEP (STEP SPE in preparation),
  - contains new debris modules (e.g. ORDEM 2K),

  - will be distributed and maintained by eta_max space from 01-04-2006 onwards.

Outlook and Future Perspectives

- ESABASE2
  - Implementation of other, ‘classic’ ESABASE components
    - Atomic oxygen
    - Radiation
    - ...
  - Further enhancement of the Debris application
    - Vulnerability of internal components
    - New models (e.g. MASTER 2005)
  - Further enhancement of platform
    - Optimisation module
- Open Frontier Platform
  - May serve as platform also for other solvers, e.g.
    - Radiation
    - Thermal
  - Offers particular advantages due to the fact that different solvers may work on exactly the same geometry