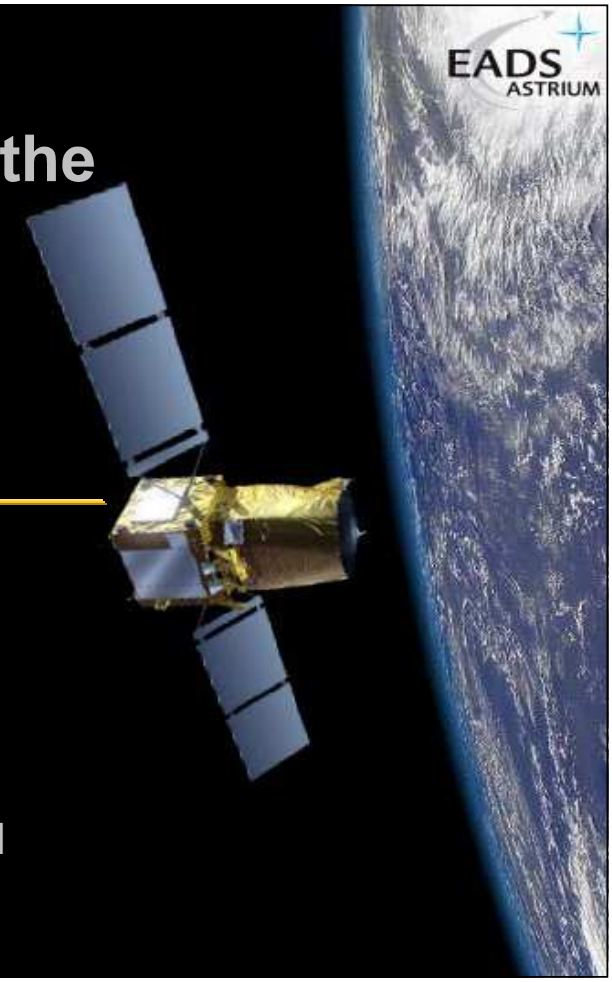
An Excel Database for the Generation of ESATAN and Systema Thermal Models



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17th European Workshop on Thermal and ECLS Software

Summary

1. Introduction
2. The Thermal Model Database
3. Pre-processing
4. Post-processing
5. Summary and Future Development

Introduction

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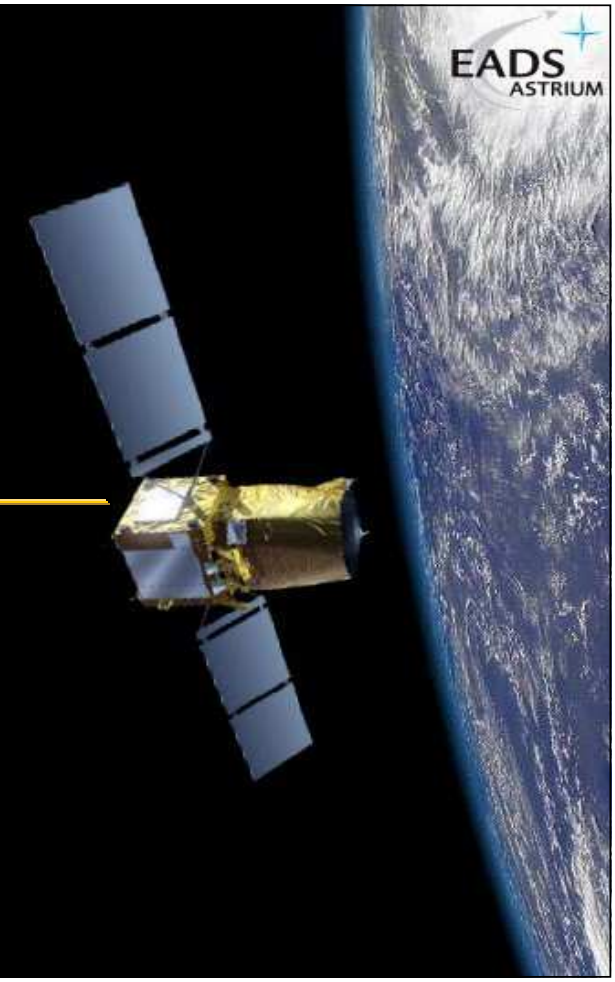
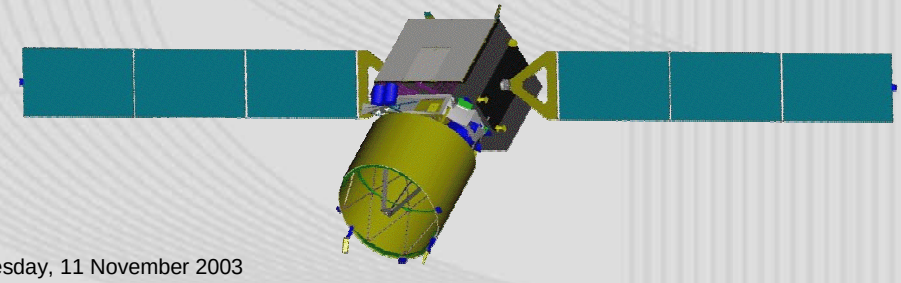


Introduction

AEOLUS sense the wind

- Atmospheric Dynamics Mission ADM-Aeolus Program.
- Global observations of wind profiles in clear air in:
  - the troposphere.
  - the lower stratosphere.

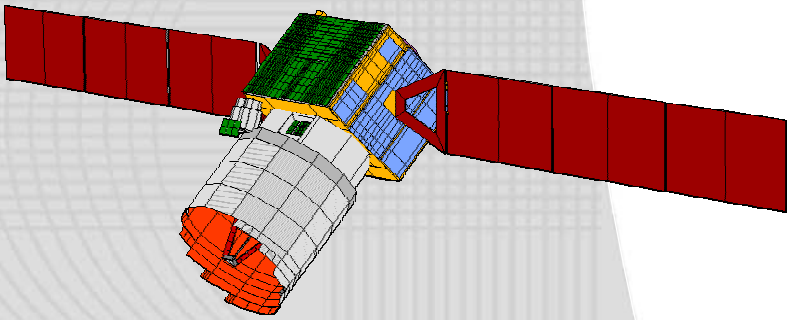
  significant improvement of weather forecasting skills.
- Atmospheric Laser Doppler Instrument (ALADIN), a Direct Detection Doppler Lidar (D3L) operating in the ultra-violet spectral region.
- Polar-orbiting Aeolus will provide ALADIN a near global coverage.



Thermal Modeling

Spacecraft thermal model consist the following elements:

- Spacecraft structure
- Units
- Propulsion equipment
- Power equipment
- Thermal Equipment

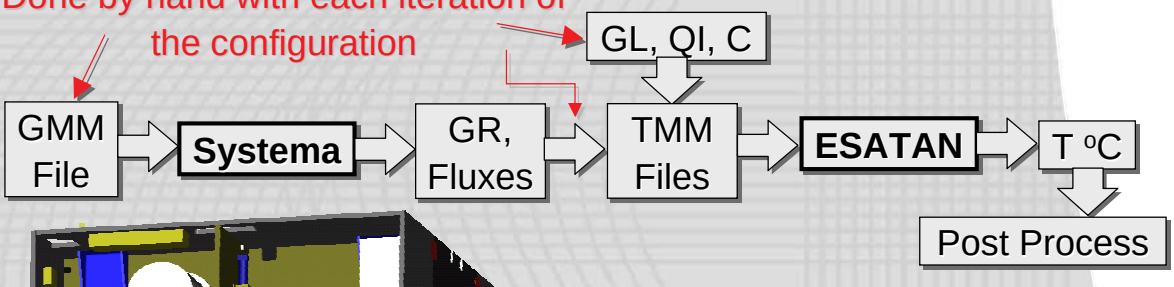


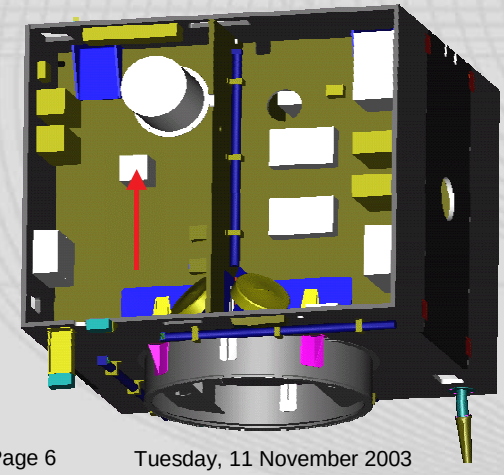
Thermal Models:

- Geometric Mathematical Models (GMM)
  - ↳Geometry of the spacecraft
  - ↳Radiative Exchange factors and environmental fluxes
- Thermal Mathematical Models (TMM)
  - ↳ Thermal Conduction, Capacity and Dissipation
  - ↳Temperature Prediction

The Thermal Model

Done by hand with each iteration of the configuration





Modification to the Configuration:

- Re-build and run GMMs
- Re-build and run TMMs
  - Internal Panel Conductances
  - Unit interface conductances
  - Unit properties (capacity)
  - Cleat couplings
  - Dissipations

Process Improvement

Many Configurations during Phase B

Method of thermal modelling can be improved:

– A central database of modelling information
– Reducing the number of data input errors
– Automatic generation of repetitive calculations

The Thermal Model Database

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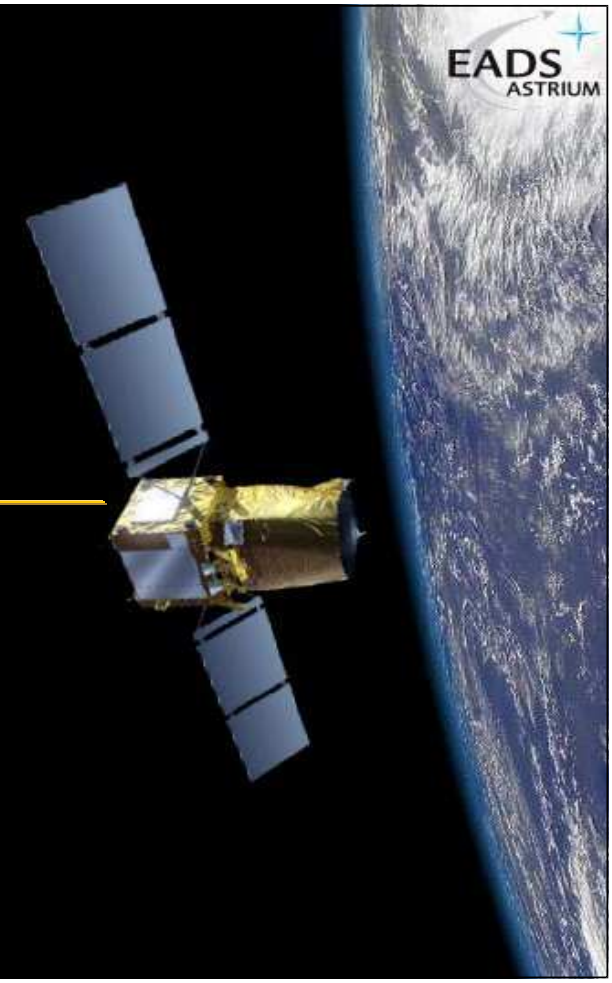
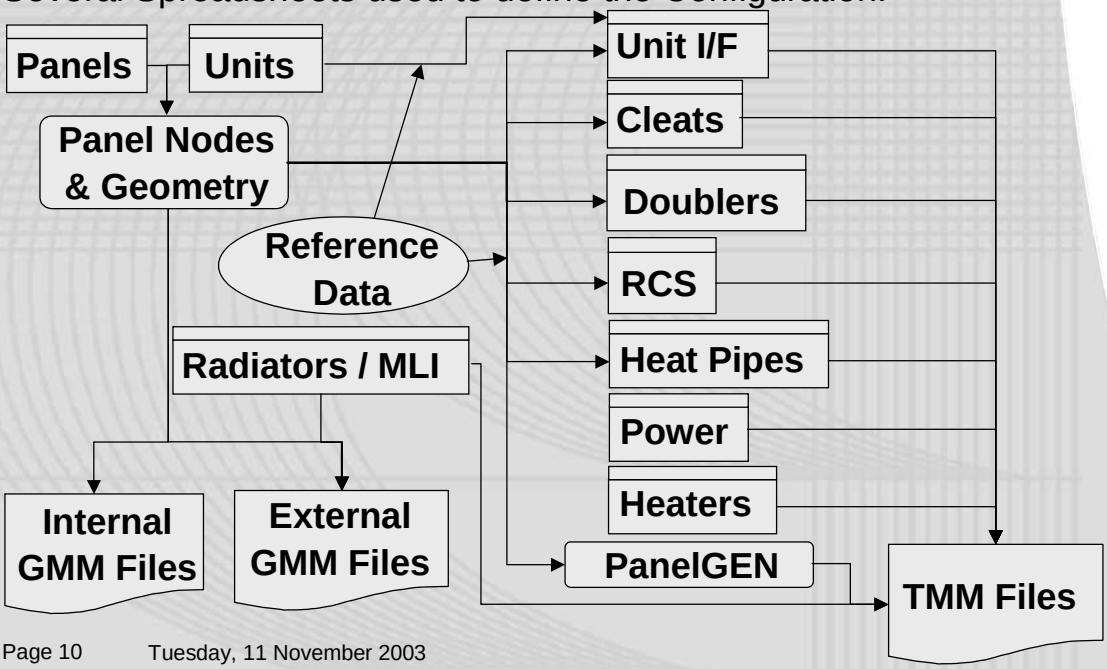


Excel Thermal Database

- Developed during the Phase B of the Aeolus platform
- Written using Excel 2000
- Extensive use of Visual Basic Macros and functions
- Information categorised on separate sheets broken down into the components of the spacecraft
- Spreadsheet processes the relevant information and generates text files
- Text files collated in Unix to create the TMM and GMM input files (no additional input)

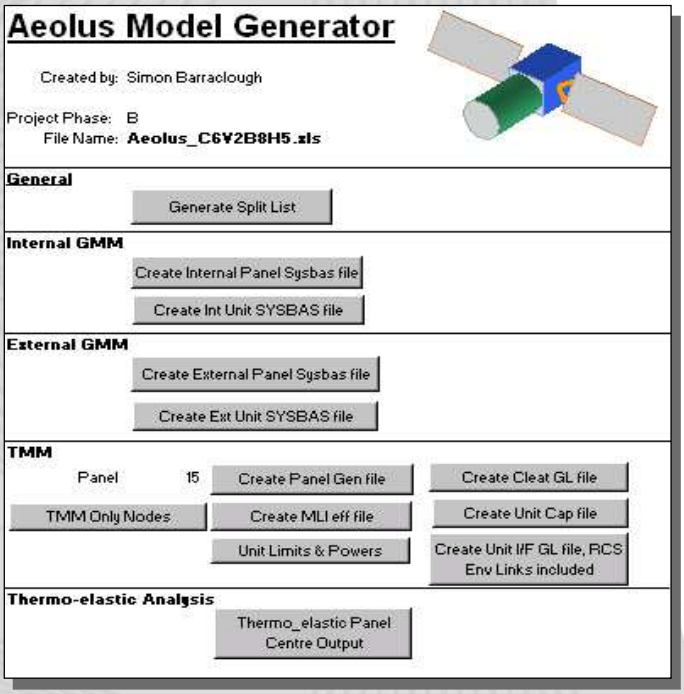
Structure

Several Spreadsheets used to define the Configuration:



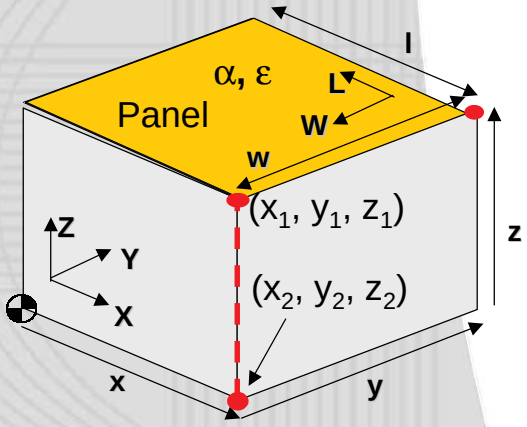
Generator Interface

- All outputs controlled from the main page
- Buttons activate the relevant macros to output the thermal data to Unix



Panels & Cleats

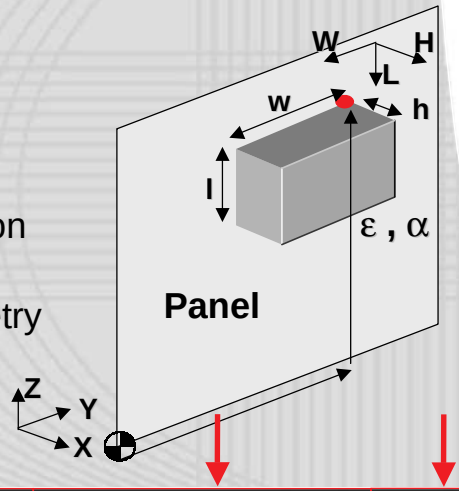
- Define in spreadsheet by:
  - Number and Label
  - Material
  - Node Number Series
  - Dimensions
  - Location & Orientation
  - Optical Properties
- Cleats in spreadsheet by:
  - Start & Finish points



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1			Panel	Node Numbers			Dimensions (mm)		Location wrt origin			Orientation			Optical Properties		
2		Panel	Material	Inner	Outer	MLI	x	y	X	Y	Z	Unit X	Unit Y	Unit Z	Int Surface	MLI	Radiator
3		+Z Floor	Main_panel	71100	71200	71300	1600	1600	-800	-800	1621.6	+X	+Y	-Z	Black Paint	MLI	OSR
4		+X Wall	Main_panel	52100	52200	52300	680	1400	800	340	221.6	-Y	+Z	-X	Black Paint	MLI	OSR
5		+Y Wall	Main_panel	61100	61200	61300	1600	1400	-800	-800	221.6	+X	+Z	-Y	Black Paint	MLI	OSR
6		Mid Shear Wall	Shear_panel	57100	57200	N/A	1600	1400	0	-800	221.6	+Y	+Z	+X	Black Paint	MLI	OSR

Units

- Define in spreadsheet by:
  - Number and Label
  - Capacity
  - Geometric type and dimension
  - Panel and location
  - Orientation of the unit geometry
  - Optical Property



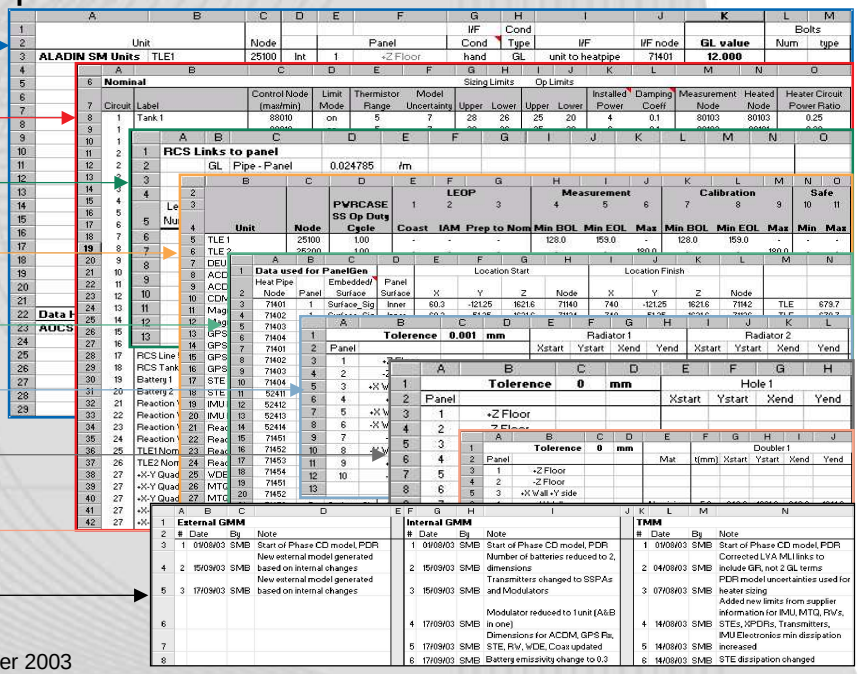
TMM Only Node

	A	B	C	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Unit				Geo	Dimensions (mm)						Location wrt origin			Orientation			
2			Node	Capacity	Type	x	y	z	Dia		Panel	X	Y	Z	Unit X	Unit Y	Unit Z	Opt Prop
3	ALADIN SM Units	TLE1	25100	25309.2	BOX5	500	275	205			+Z Floor	110.3	137.5	1621.6	+X	-Y	-Z	Black Paint
4	Data Handling	CDMU	40100	23200.1	BOX5	500	260	280			+Y-X Shear Wall	-110.3	340.0	600.6	+Z	-X	+Y	Black Paint
5	AOCS	IMU Head	41410	4951.8		0	0	278	282		-Y-X Shear Wall	-362.4	-340.0	1400.6				Black Paint
6		IMU Head MLI	41415	0	CYL2	0	0	278	282		-Y-X Shear Wall	-362.4	-340.0	1400.6	-Z	-X	-Y	VDA MLI
7		RW Baseplate	41541	6510.7	DISCO	0	0	125	351		-Z Floor	-150.0	500.0	351.4	+X	+Y	+Z	Black Paint
8		RW Cover	41542	0	CYL2	0	0	125	351		-Z Floor	-150.0	500.0	351.4	+X	+Y	+Z	Black Paint

Different Geometry Types

Input Data

- Similar type of Input is done for the:
  - –Unit Interfaces
  - –Heaters
  - –RCS
  - –Power
  - –Heat Pipes
  - –Radiators
  - –Holes
  - –Doublers
  - Changes



Pre-processing

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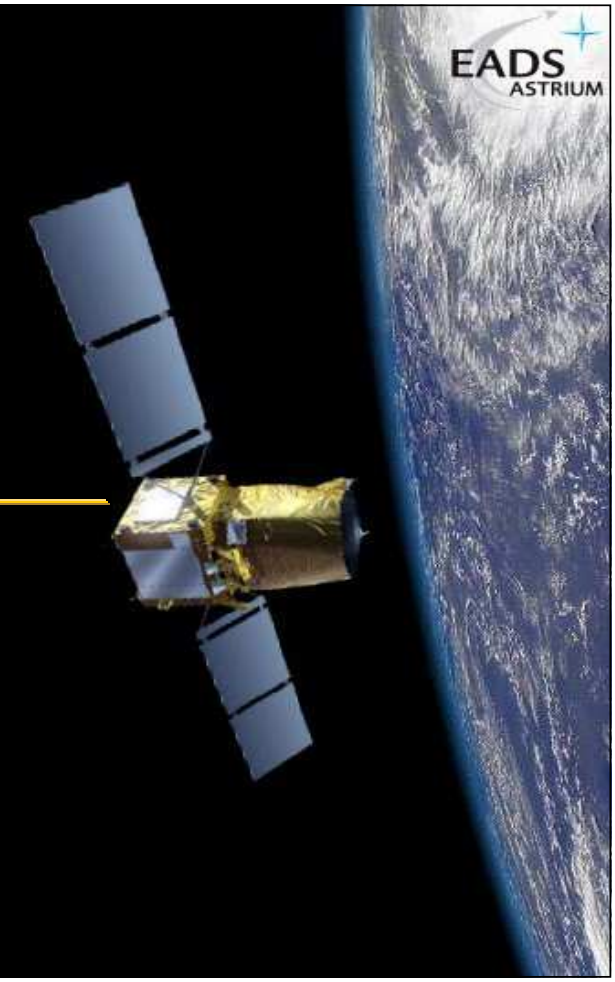


Panel Node Breakdown

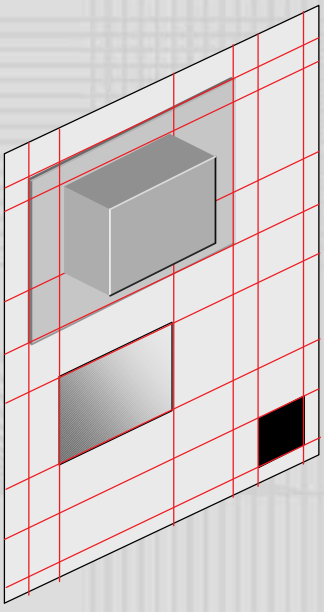
Panel Components:

- Doublers
- Radiators
- Holes
- Units

» Panel splits

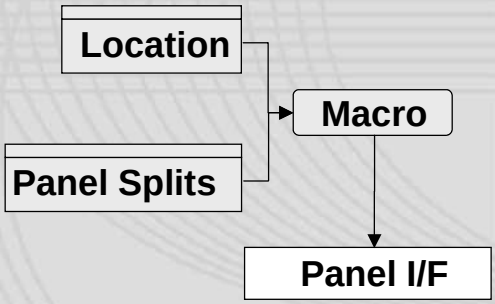
↓

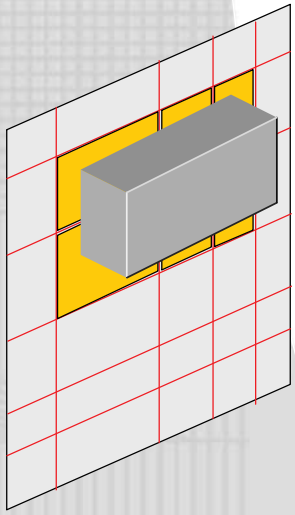
PanelGen (panel conduction)



Location Macro

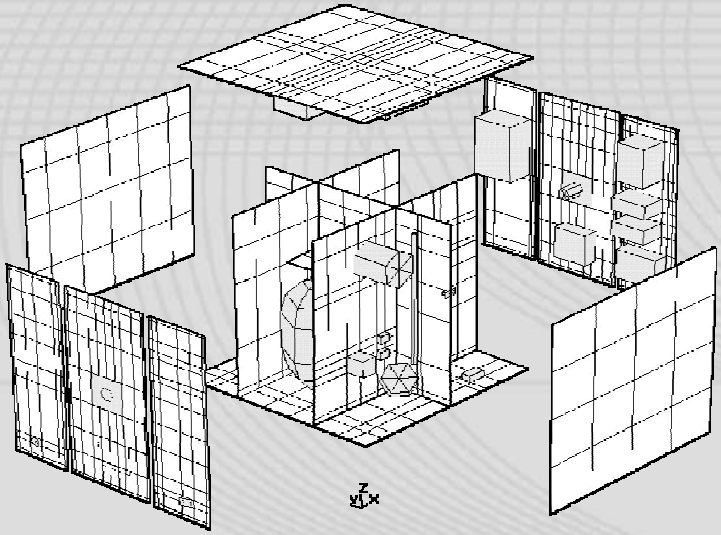
- With panel node breakdown info Excel works out the links to the relevant panel node for:
  - –Cleats
  - –Units
  - –RCS
  - –Heat pipes
  - –Holes
  - –Radiators
  - –Doublers

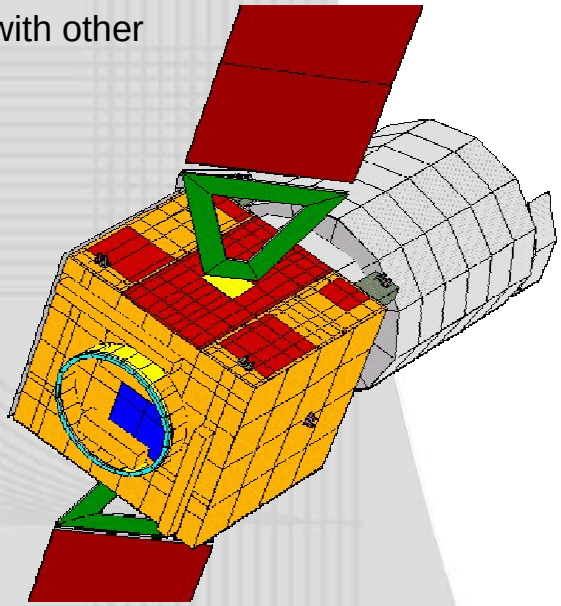




Output Files - GMM

- Geometric data from database combined with other model files in Unix
- Internal Geometry Model





- External Geometry Model

Output Files - TMM

Thermal model built using data from various different files:

TMM

- Excel Database Output
- PanelGen Results
- Supplied Model
- GMM Results
- TMM Control Inputs

One main TMM file used for all cases

```
$MODEL AEOLUS
$INCLUDE "/phase_b/Excel_out/Comments.dat"
$NODES
$INCLUDE "/phase_b/Excel_out/TMMnodes.dat"
$INCLUDE "/phase_b/PanelGen/Panelgen_nodes.dat"
$INCLUDE "/phase_b/Aladin_Model/Aladin_nodes.dat"
$INCLUDE "Systema/nodes.dat"
$CONDUCTORS
$INCLUDE "/phase_b/Excel_out/Unit_IF.dat"
$INCLUDE "/phase_b/Excel_out/Cleat_GL.dat"
$INCLUDE "/phase_b/PanelGen/Panelgen_GLs.dat"
$INCLUDE "/phase_b/Aladin_Model/Aladin_conds.dat"
$INCLUDE "Systema/GRs.dat"
$CONSTANTS
$INCLUDE "/phase_b/Constants.dat"
$CONTROL
$INCLUDE "/phase_b/Control_var.dat"
$ARRAYS
$INCLUDE "/phase_b/Excel_out/Unit_Power.dat"
$INCLUDE "/phase_b/Aladin_Model/Aladin_arrays.dat"
$INCLUDE "Systema/Ext_flux_array.dat"
$SUBROUTINES
$INCLUDE "/phase_b/Excel_out/Unit_cap.dat"
$INCLUDE "/phase_b/Excel_out/Unit_power.dat"
$INCLUDE "/phase_b/Aladin_Model/Aladin_subs.dat"
$INCLUDE "Systema/HCYCLC.dat"
```


Post Processing

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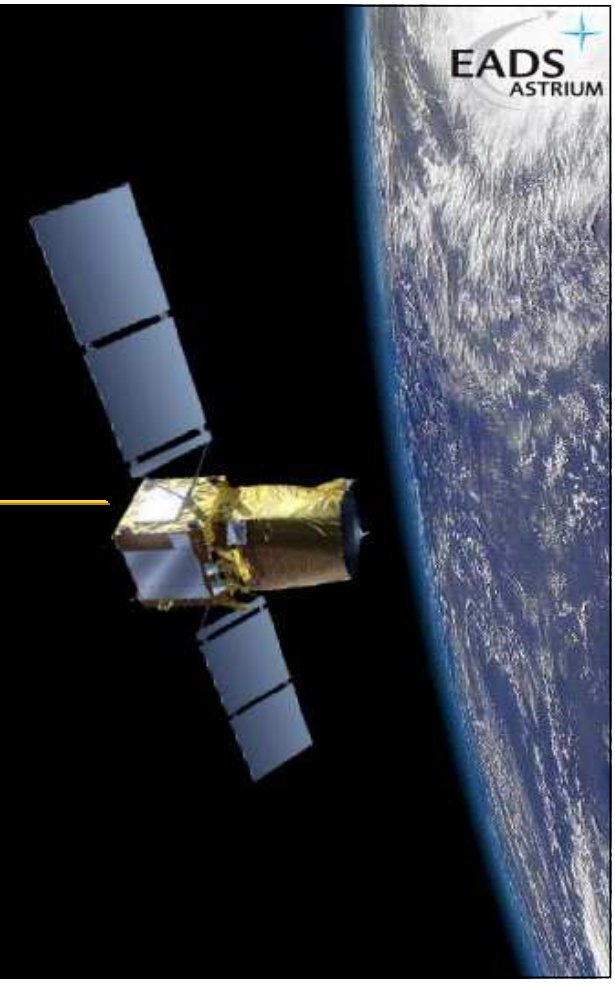


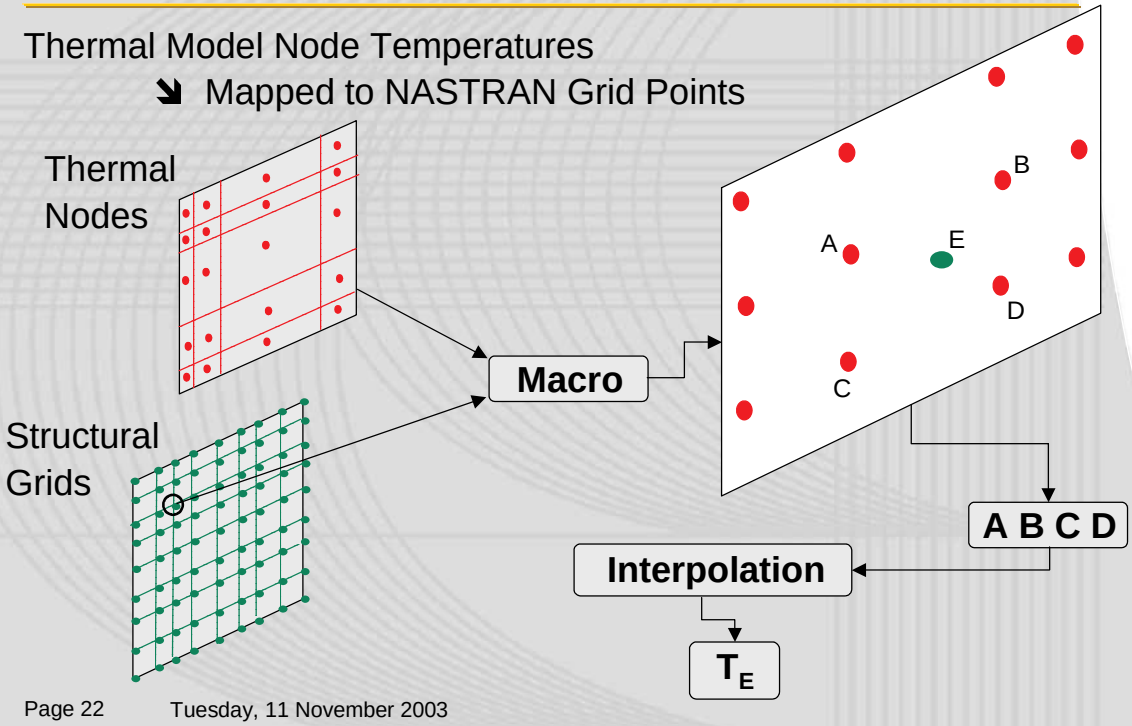
Post-processing Applications

- Information within the database used for:
  - Comparisons of temperature predictions with limits
  - List of nodes for heat flow analysis
  - Locating interface node temperatures
  - Thermo-elastic analysis

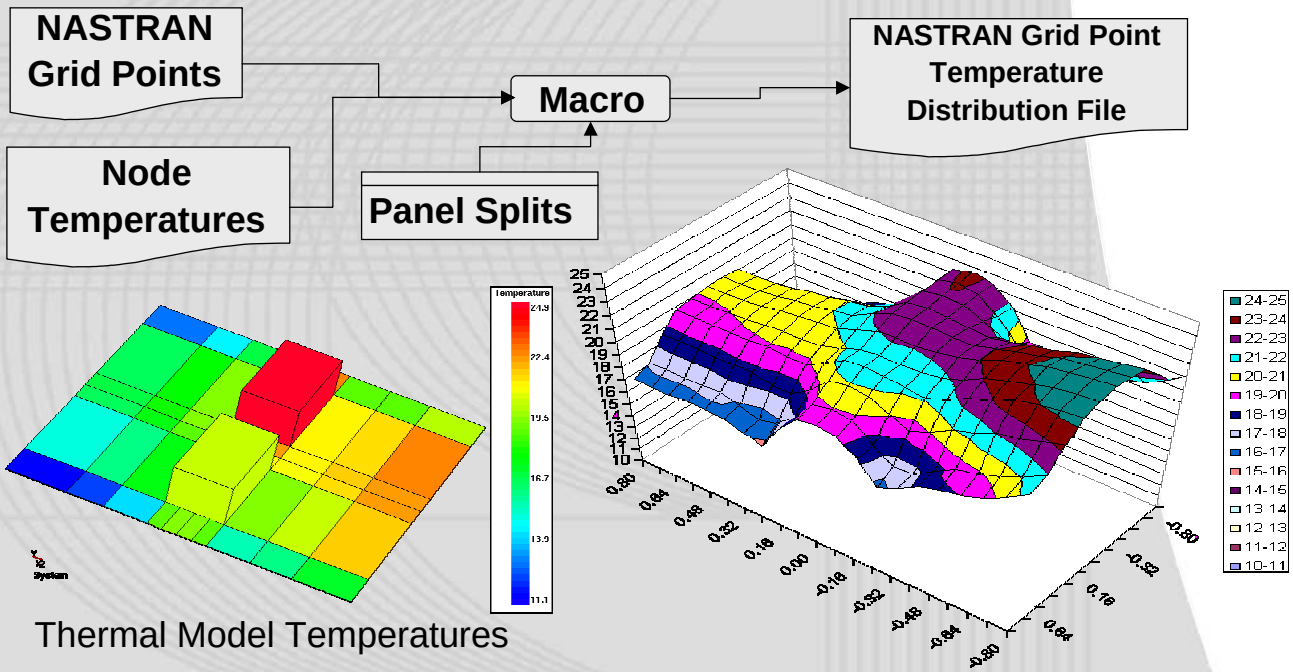
Thermo-elastic Temperatures

Thermal Model Node Temperatures

➘ Mapped to NASTRAN Grid Points



Thermo-elastic Temp Maps



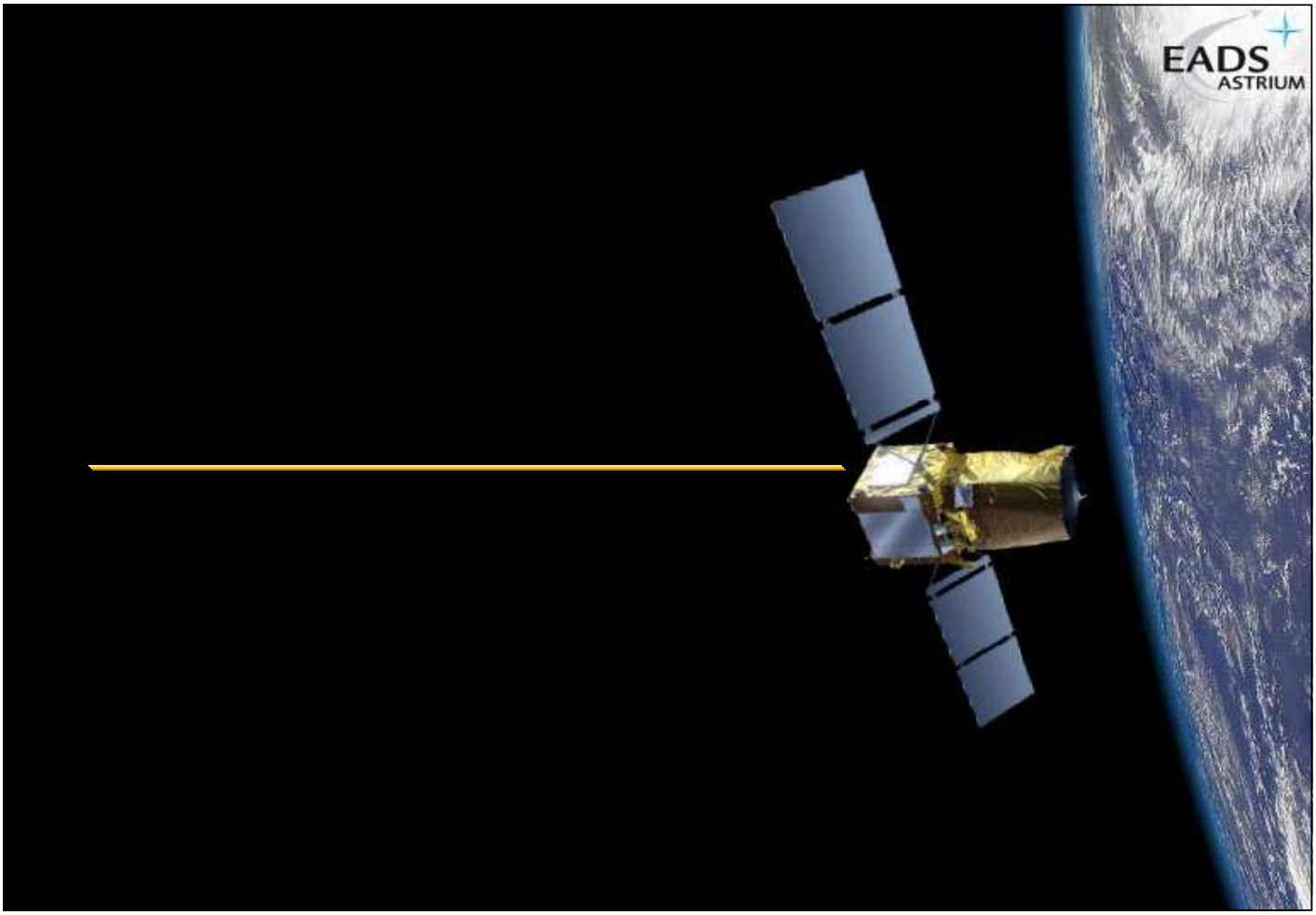
Thermal Model Temperatures

NASTRAN Grid Point Temperatures

Summary – Future Development

- Thermal Model Database for Aeolus
- Successfully applied for Phase B
- Model creation reduced to 1week
- Model modification time reduced from ≈3 days to ½ day
- Systematic updating of models
- Useful tool in post-processing applications

- Improvements
  - More generic
  - More user “friendly” (i.e. drop down menu options)
  - Ability to update from a system database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