

Appendix B

Thermal Concept Design Tool Flux calculation results and the new tool presentation

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Abstract

During its lifetime the TCDT has evolved both through improvements suggested or required by users all over the ESA member states and enhancements as part of the development and maintenance contract with ESA.

The current release 1.6.0 of the TCDT is already available to the European Thermal Community and contains an internal flux calculator for TCDT models. This flux calculator has been validated through comparison of results with ESATAN-TMS r5.

The evolution of the tool that is now under development will be a portable stand-alone application, independent of Excel, that can be more easily integrated in existing workflows. Skilled engineers will be able to easily extend the tool with their own script, re-using the existing functionality, in order to perform their analysis in an easier way. To maximise the functionality available in the basic tool, participants are invited to discuss their ideas and suggestions with us directly during the breaks or contact us after the workshop.

Thermal Concept Design Tool

Future developments



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Overview

- **Background**
- **TCDT 1.6.0 Flux Calculator: Results Evaluation vs Radiative module of ESATAN-TMS**
- **Version 2.0: concepts of the new tool**

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Background

NEW DISTRIBUTION & MAINTENANCE CONTRACT STARTED NOVEMBER 2013

- TCDT is distributed FREE of CHARGE to the European Thermal Community
- TCDT web pages available for download, PR, FR
- TCDT is regularly maintained by BLUE
- Small developments are regularly implemented to improve operability
- TCDT version 1.6.0 is available since July 2013

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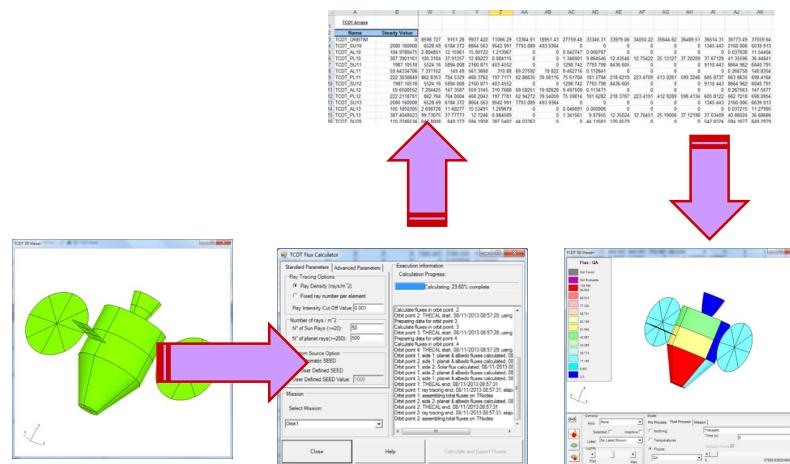
TCDT 1.6.0 Flux Calculator

TCDT 1.6.0 contains a simplified flux calculator algorithm able to evaluate direct absorbed solar, albedo and planet infrared fluxes on the geometrical model surfaces.

The main characteristics of the TCDT calculator are:

- Direct Incident Fluxes are evaluated with analytical functions
- Shadows are Evaluated with MCRT

User point of view workflow



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TCDT 2.0

TCDT 1.6.0 Flux Calculator

The User can access both to the standard parameters and the advanced parameters

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TCDT 2.0

TCDT 1.6.0 Flux Calculator: Results Evaluation vs ESARAD

Test Case 1.

Optical properties:
Alpha = 1
Epsilon = 1

Point 2

Point 1

Coarse Meshed Bar

Fine Meshed Bar

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TCDT 1.6.0 Flux Calculator: Results Evaluation

Sun Flux Results on Test Point 1

The figure consists of two vertically stacked line graphs. Both graphs have 'Node Number' on the x-axis and 'Sun Flux [W]' on the y-axis.

- Top Graph:** The x-axis ranges from 201 to 210. The y-axis ranges from 0 to 60. Five data series are plotted: ESARAD (blue diamonds), 1000-25-1 (red squares), 1000-25-2 (green triangles), 1000-25-4 (purple crosses), and 350-50-4 (cyan asterisks). All series start at approximately 55 W at node 201, drop sharply to near zero by node 204, and then rise sharply to approximately 55 W at node 210.
- Bottom Graph:** The x-axis ranges from 1 to 97. The y-axis ranges from 0 to 6. The same five data series are plotted. The flux values are much lower than in the top graph, starting around 5.5 W at node 1, dropping to near zero between nodes 13 and 17, and then jumping back up to about 5.5 W at node 89.

Sun fluxes on the coarse meshed strip.

Sun fluxes on the fine meshed strip.

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TCDT 1.6.0 Flux Calculator: Results Evaluation

IR Planet Absorbed Flux on Point 1

The graph shows 'IR Planet Flux [W]' on the y-axis (0 to 0.8) versus 'Node Number' on the x-axis (1 to 101). Five data series are plotted: ESARAD (blue line), 1000-25-1 (red line), 1000-25-2 (green line), 1000-25-4 (purple line), and 350-50-4 (cyan line). The flux starts at ~0.65 W at node 1, drops to a minimum of ~0.05 W at node 49, and then rises to ~0.7 W at node 101.

IR Planet fluxes Test Point 1:

Earth flux on the fine meshed strip of the bar using different mesh discretizations.

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TCDT 1.6.0 Flux Calculator: Results Evaluation



Albedo Absorbed Flux at Point 2

Albedo flux Test Point 2:
Albedo heat flux on the Z- strip of the bar at different mesh discretizations

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TCDT 1.6.0 Flux Calculator: Results Evaluation vs ESARAD



Test Case 2.

Optical properties:
Alpha = 1
Epsilon = 1

Orbital Arc	End Time (s)
Orbit1	5673
Transfer	9151
Orbit2	37560

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TCDT 1.6.0 Flux Calculator: Results Evaluation

Test Case 2. Results

Node 74

Node 150

Node 11

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TCDT 1.6.0 Flux Calculator: Results Evaluation

Node 11 Albedo flux

Node 11 – Capsule Cone

Node 74 Earth flux

Node 74 – Engine Nozzle Paraboloid.

Node 150 Solar flux

Node 150 – Radiator.

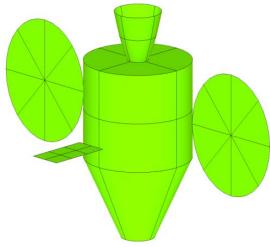
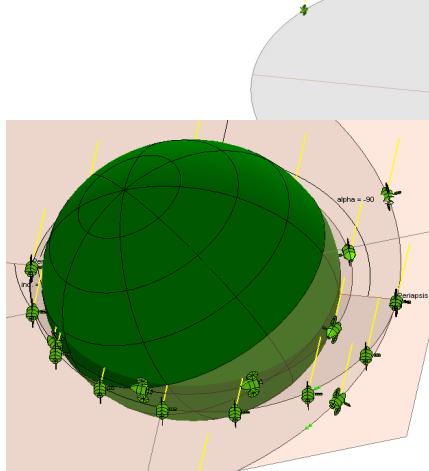
Orbital Arc	End Time (s)
Orbit1	5673
Transfer	9151
Orbit2	37560

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TCDT 1.6.0 Flux Calculator: Results Evaluation vs ESARAD

Test Case 2.1

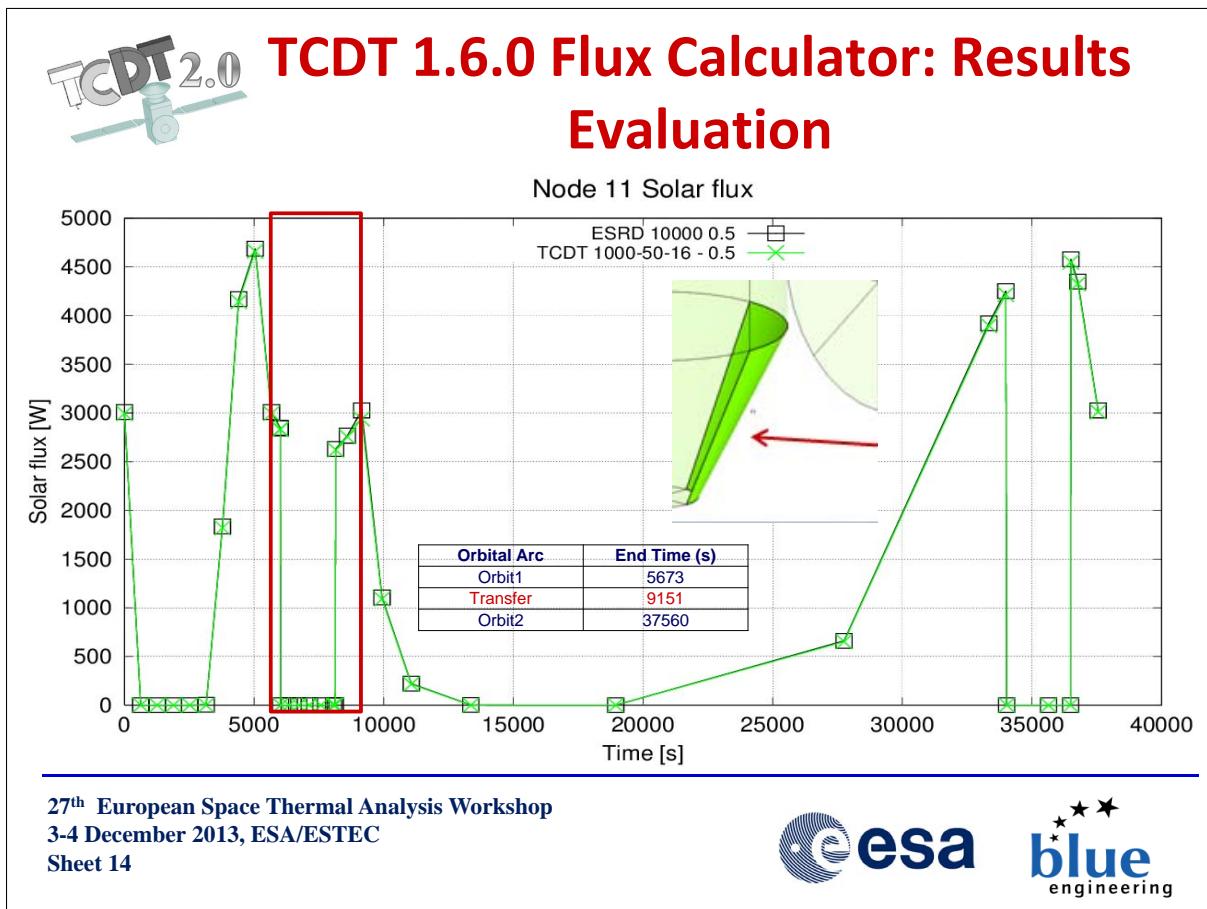



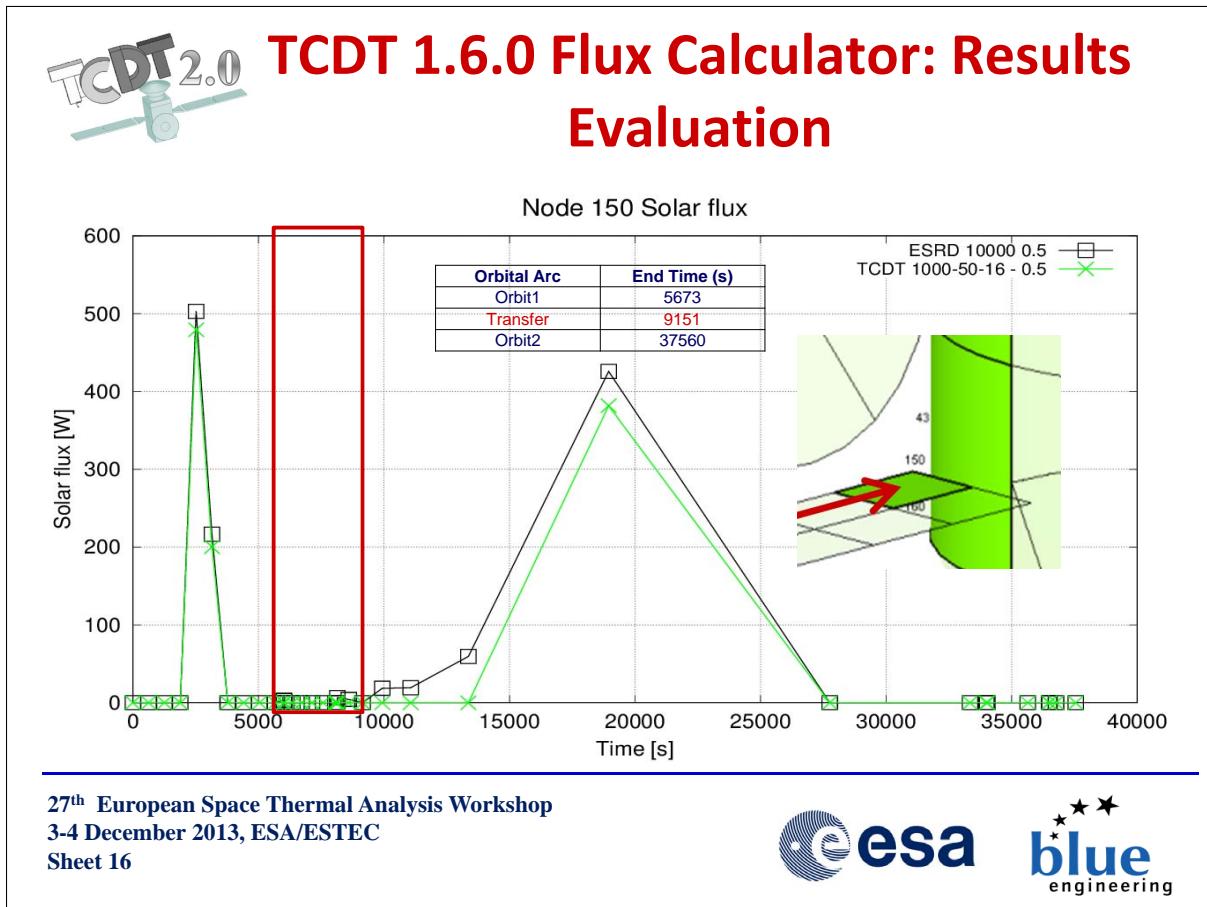
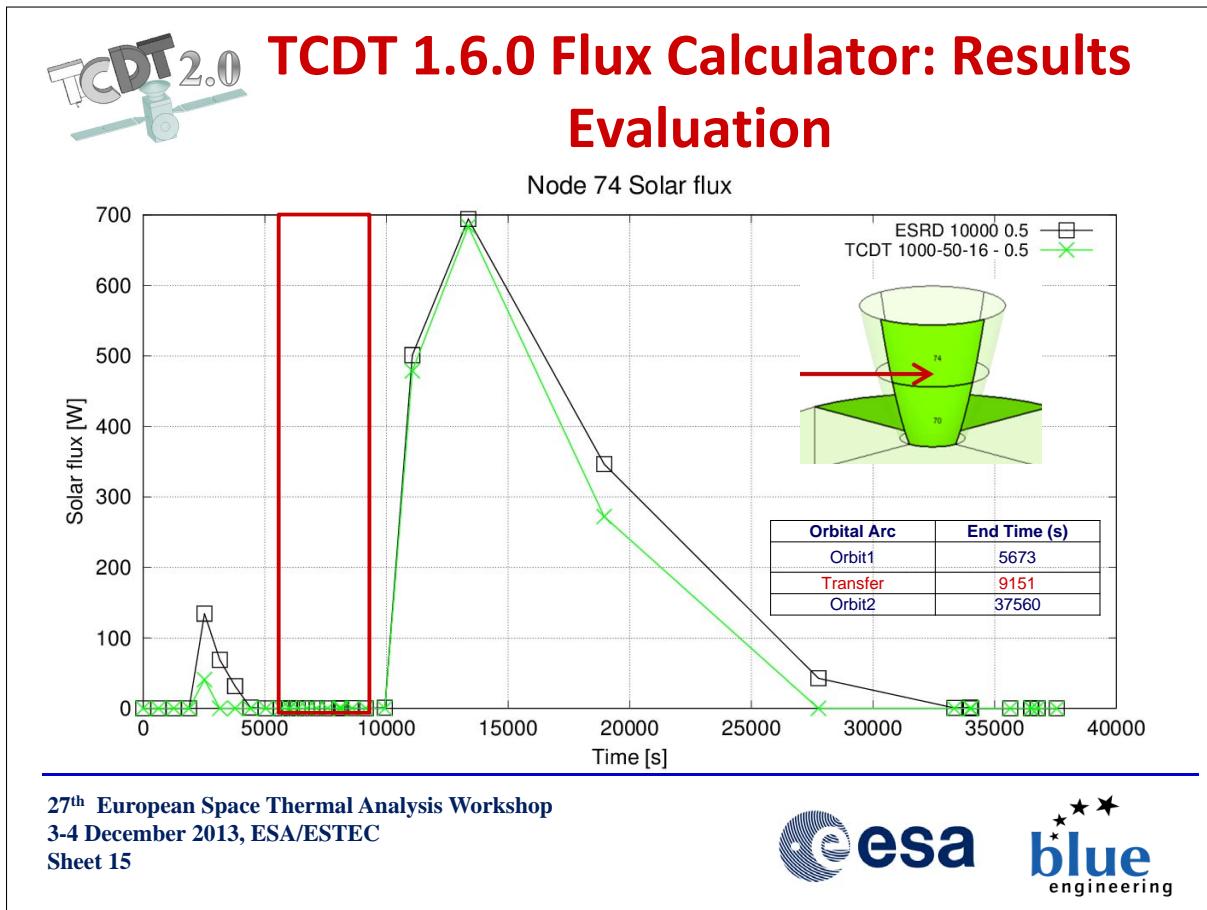
Orbital Arc	End Time (s)
Orbit1	5673
Transfer	9151
Orbit2	37560

Optical properties:
 $\text{Alpha} = 0.5$
 $\text{Epsilon} = 0.5$

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TCDT 1.6.0 Flux Calculator: Results Evaluation

CONCLUSIONS:

The results show a good fit with the ESATAN-TMS results. Care should be taken with low absorption thermo-optical properties

It is possible to note that, due to the complex shapes of the model, an increase of the number of sub-elements used by the TCDT tool generates a better solution

The performances of the TCDT in terms of speed vs ESATAN-TMS vary according the complexity of the model, TCDT is 1 to 4 time slower

The default parameters provide results that differ slightly from ESATAN-TMS with acceptable performance (averagely 2 times slower)

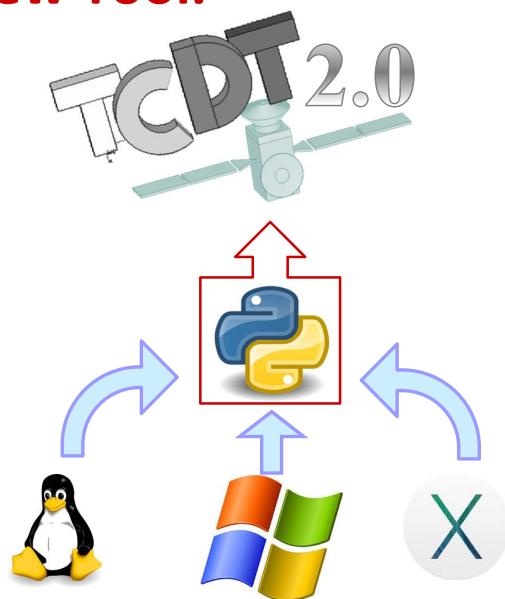
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Highlights

- Stand Alone
- Multiplatform
- Parametric
- Scriptable
- Extensible

Version 2.0: A New Tool.



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Version 2.0: A New Tool.

TCDT 2.0, what is new:

- GUI, workflow.
- TCDT classes, objects and functions will be used in python scripts within the GUI or externally.
- User skilled in python can make their own scripts to automate processes.

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Version 2.0: A New Tool.

TCDT 2.0, inherited features:

- TCDT will be full parametric.
- Basic users can manage the TCDT with a short learning curve.
- Skilled users can customize the TCDT and make their own scripts to automatize processes.

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**Version 2.0:
A New Tool.**

The screenshot shows the TCDT 2.0 software interface. At the top left is the TCDT 2.0 logo. The main window has several panes: a 'Project Tree / Operative Tree' on the left containing a tree view of a project named 'Project01'; a central 'Model Views Area' showing a 3D model of a satellite in space; a 'Functions & Tools Area' on the right listing various projects and templates; a 'General Purpose Area' at the bottom; and a 'Console & Message Log Area' at the very bottom. Red text annotations are overlaid on the interface: 'Model Views Area' points to the central 3D model, 'Functions & Tools Area' points to the right pane, 'General Purpose Area' points to the bottom section, and 'Console & Message Log Area' points to the bottom-most pane.

Model Views Area

Functions & Tools Area

General Purpose Area

Console & Message Log Area

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**Version 2.0:
A New Tool.**

Functionalities that will be transferred to the new version:

- Thermal community suggestions: SURVEY
- Base classes development
- THECAL Model Based and non Model based functions
- GUI for THECAL functions
- GTMM data structure and GUI
- External Tools Managements

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TCDT Team

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Version 2.0: A New Tool.

Workshop Survey:

<http://www.blue-group.it/TCDT/survey.php>



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Version 2.0: A New Tool.

Workshop Survey:

Alternative url:

https://docs.google.com/spreadsheets/viewform?usp=drive_web&formkey=dHZLO3dwREQ1bEFOVFltaDNWeGVuX0E6MA#gid=0



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