Appendix D

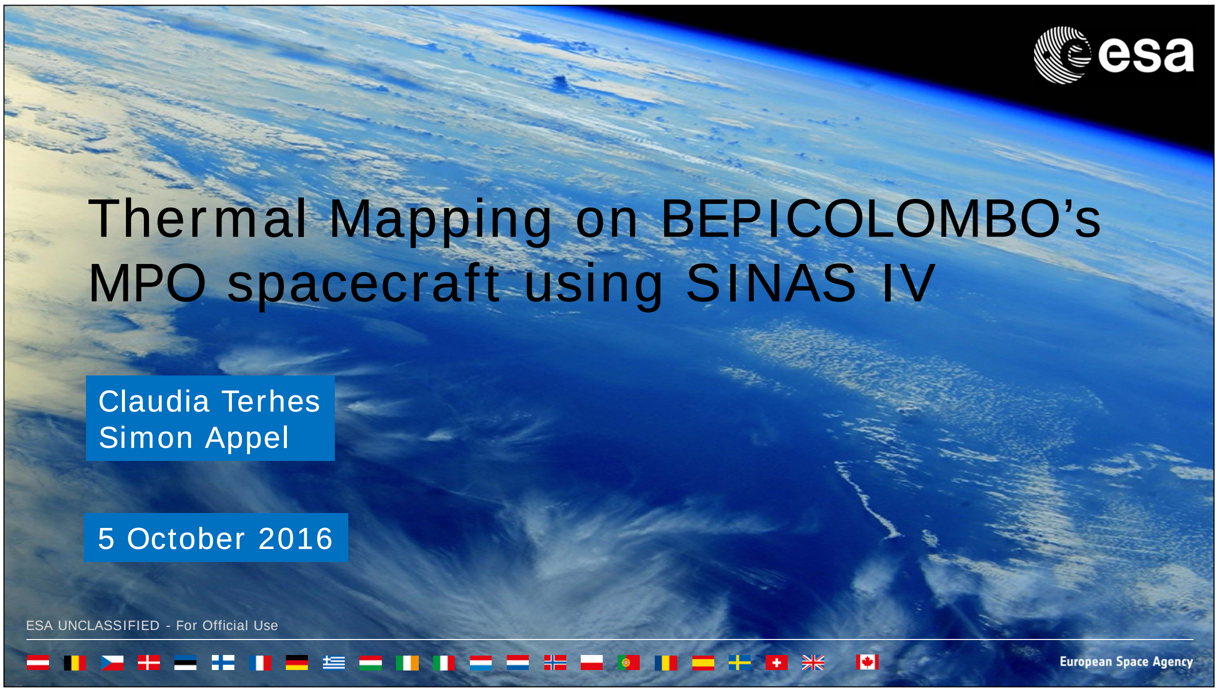
Thermal mapping on Bepicolombo's Mercury Planetary Orbiter (MPO) using SINASIV

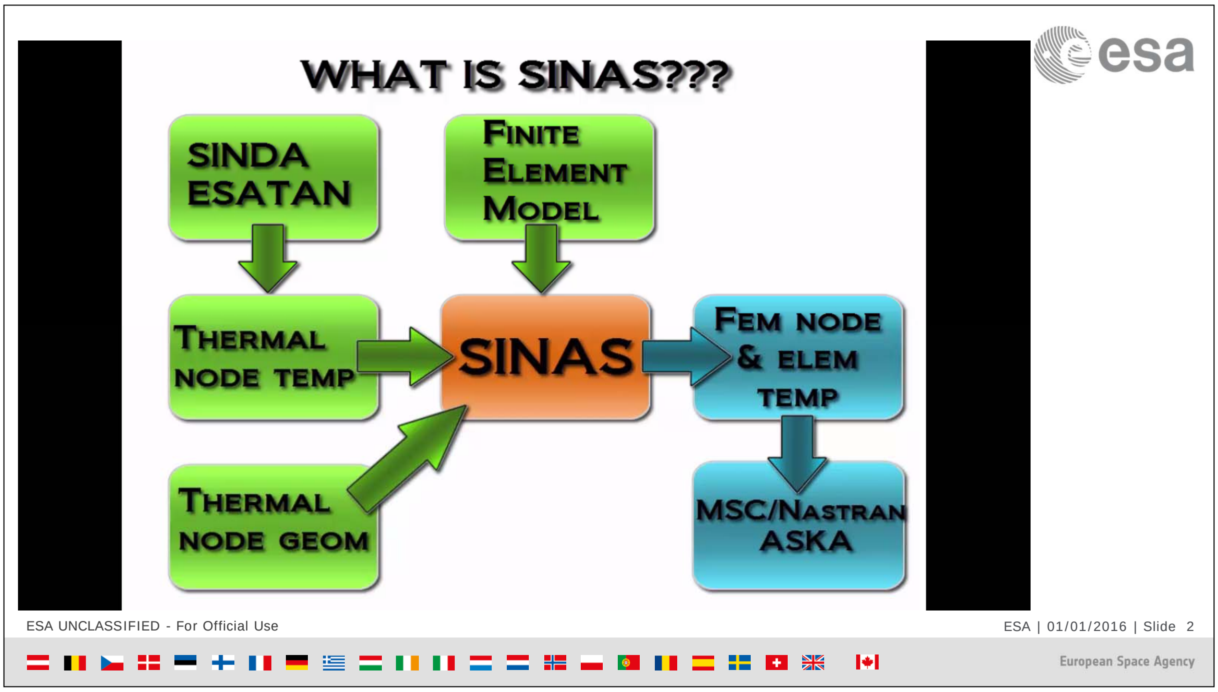
Claudia Terhes Simon Appel
(ESA/ESTEC, The Netherlands)

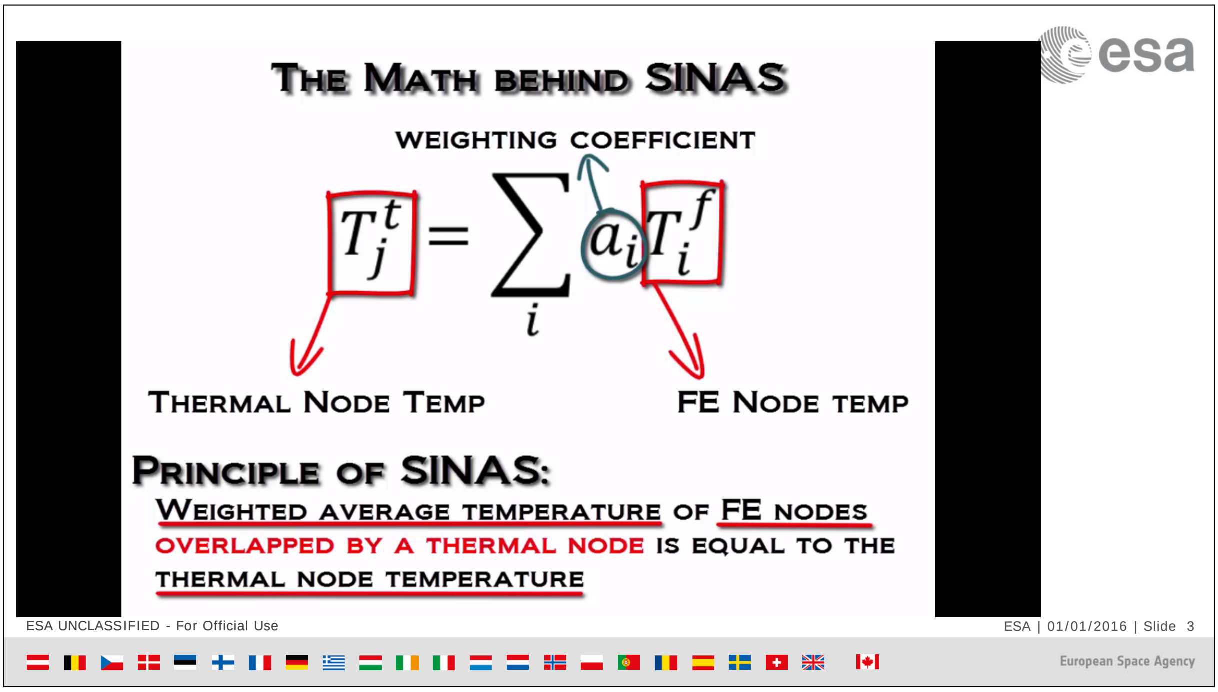
Abstract

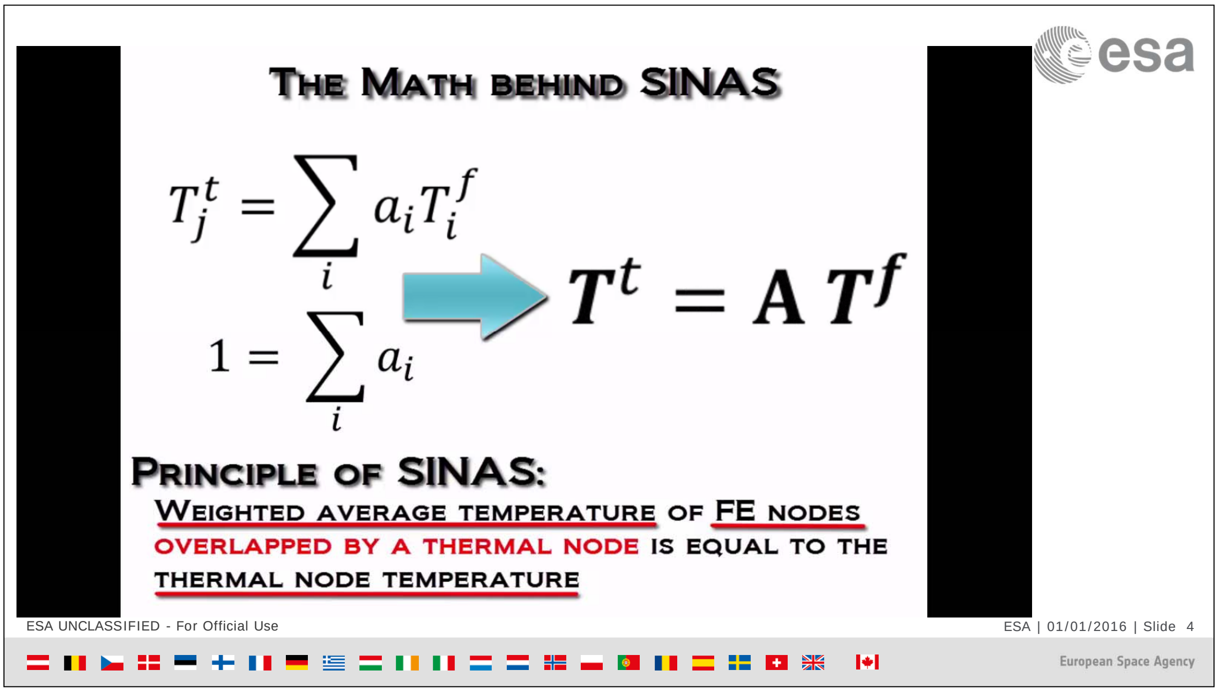
Bepicolombo mission to Mercury poses complex problems in terms of environment aspects, and its effect on the structural behaviour of the spacecraft.
In order to analyse the spacecraft thermal elastic distortions cause by Mercury's harsh environment, the thermal node temperatures were mapped and interpolated on the structural finite element model using SINAS software.
This presentation will describe the work that has been done so far:

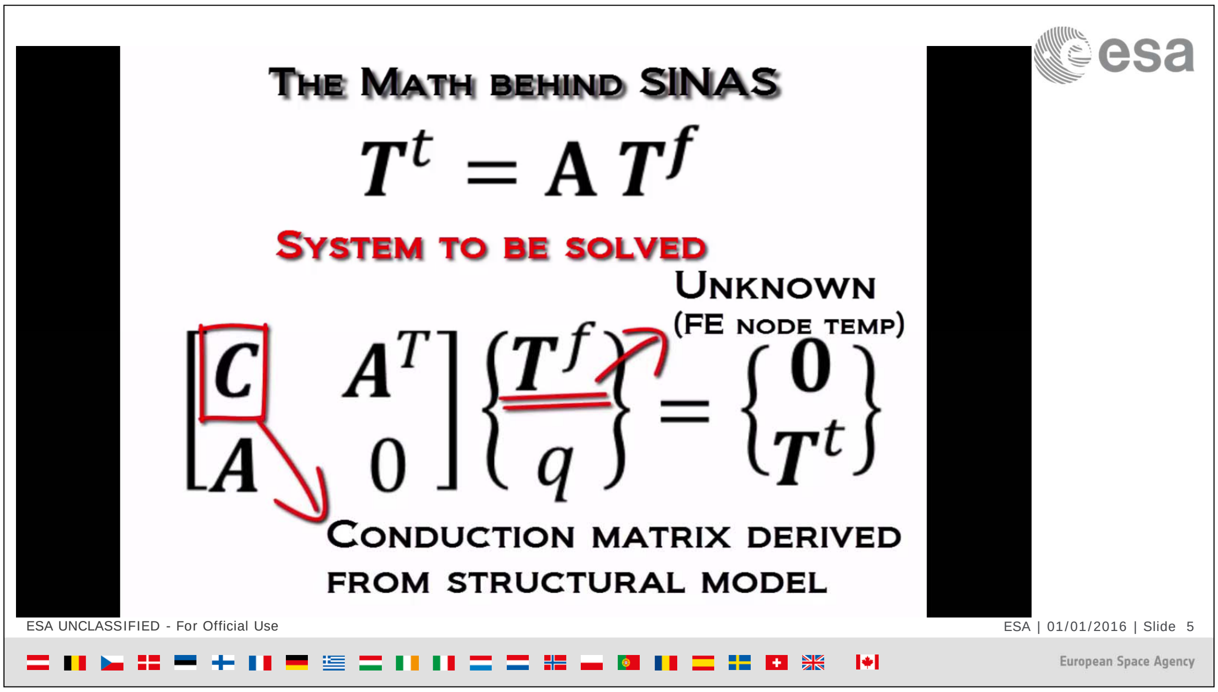
- Temperatures mapping onto the MPO finite element model;
- Challenges regarding the gradients areas and embedded heat pipes;
- Discrepancies between thermal and structural model and how they can be reduced.

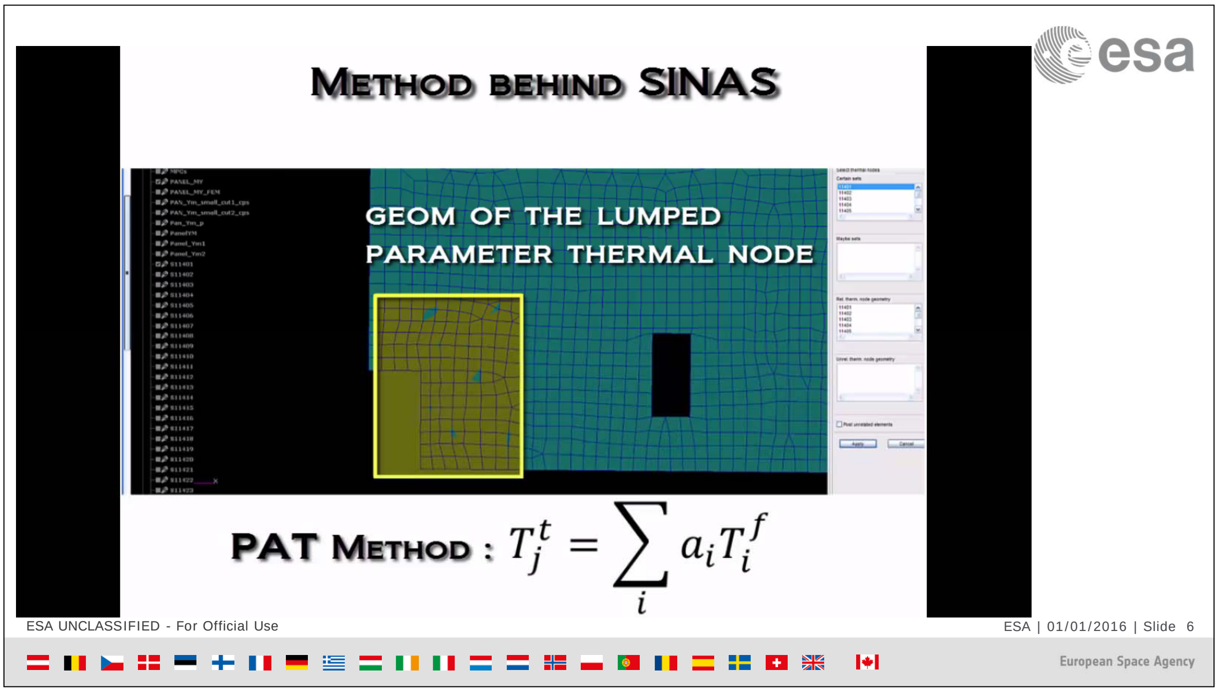

Thermal Mapping on BEPICOLOMBO's MPO spacecraft using SINAS IV
Claudia Terhes
Simon Appel
5 October 2016
ESA UNCLASSIFIED - For Official Use
European Space Agency

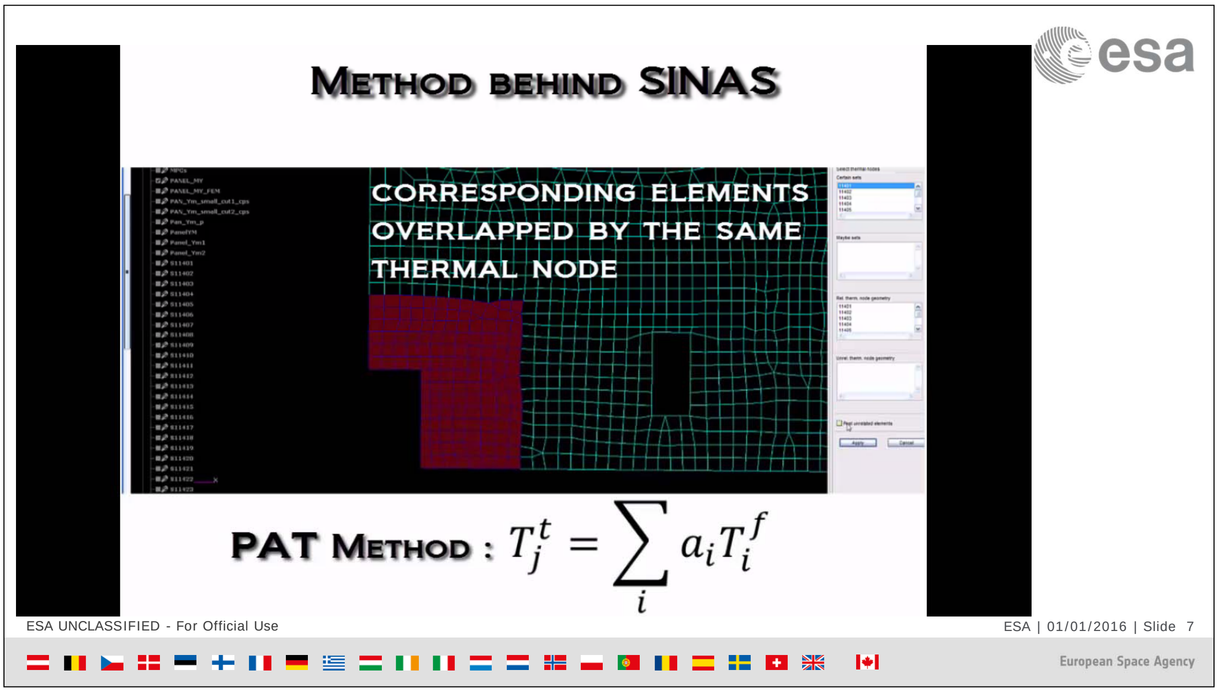

WHAT IS SINAS???
SINDA ESATAN
FINITE ELEMENT MODEL
THERMAL NODE TEMP
SINAS
FEM NODE & ELEM TEMP
THERMAL NODE GEOM
MSC/NASTRAN ASKA
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 2
European Space Agency

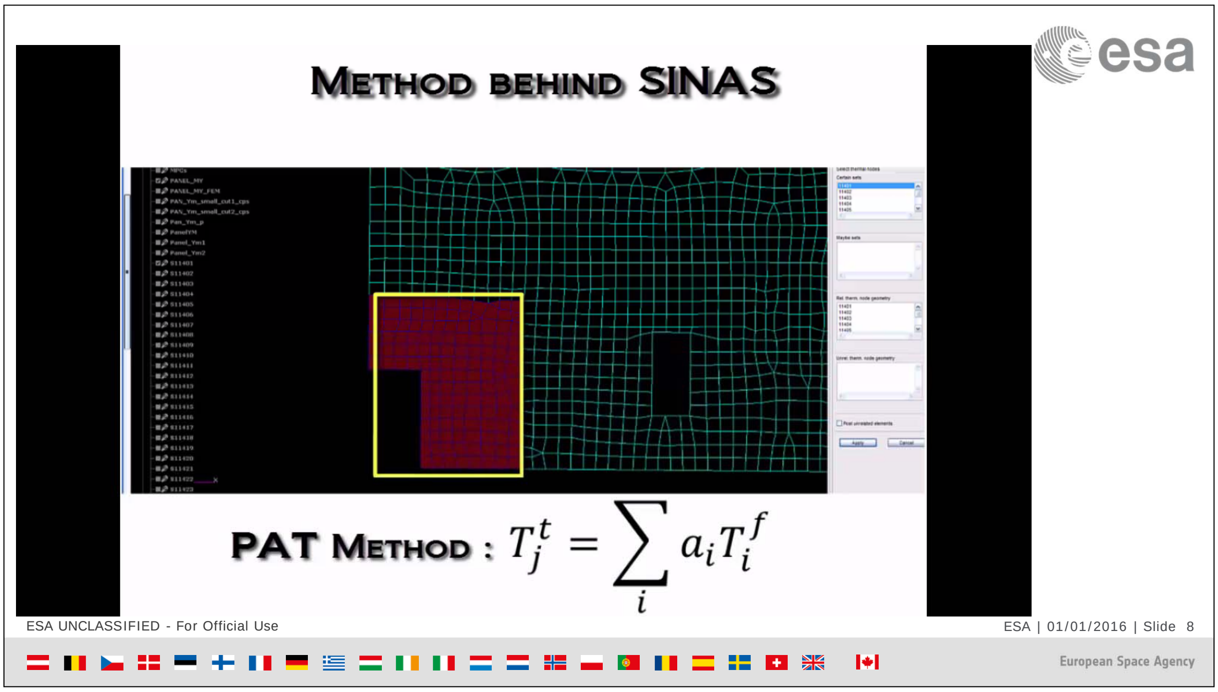

The Math behind SINAS
Weighting coefficient
$T_j^t = \sum_i a_i T_i^f$
Thermal Node Temp
FE Node temp
Principle of SINAS:
Weighted average temperature of FE nodes overlapped by a thermal node is equal to the thermal node temperature
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 3
European Space Agency

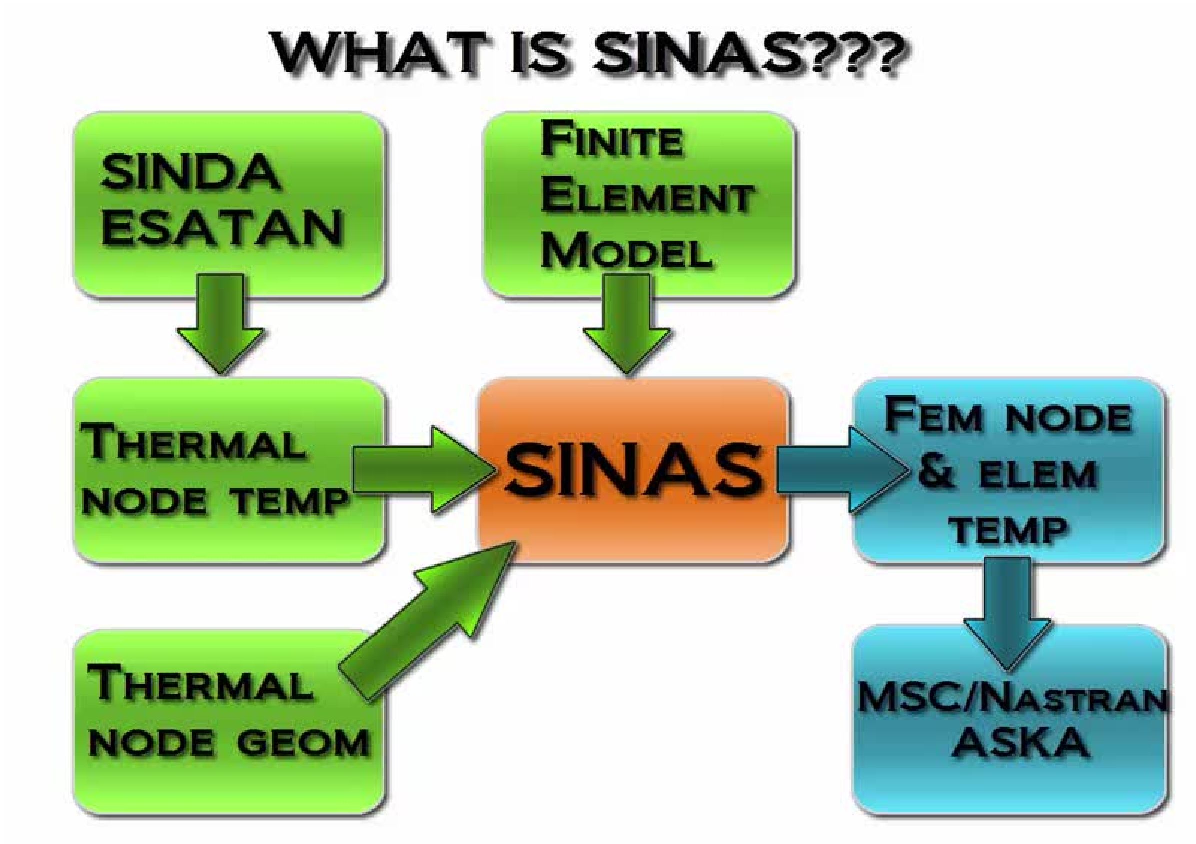

The Math behind SINAS
$T_j^t = \sum_i a_i T_i^f$
$1 = \sum_i a_i$
$\boldsymbol{T^t = A\,T^f}$
Principle of SINAS:
Weighted average temperature of FE nodes overlapped by a thermal node is equal to the thermal node temperature
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 4
European Space Agency


The Math behind SINAS
$T^t = A\,T^f$
System to be solved
Unknown
(FE node temp)
$\begin{bmatrix} C & A^T \\ A & 0 \end{bmatrix} \begin{Bmatrix} T^f \\ q \end{Bmatrix} = \begin{Bmatrix} 0 \\ T^t \end{Bmatrix}$
Conduction matrix derived
from structural model
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 5
European Space Agency

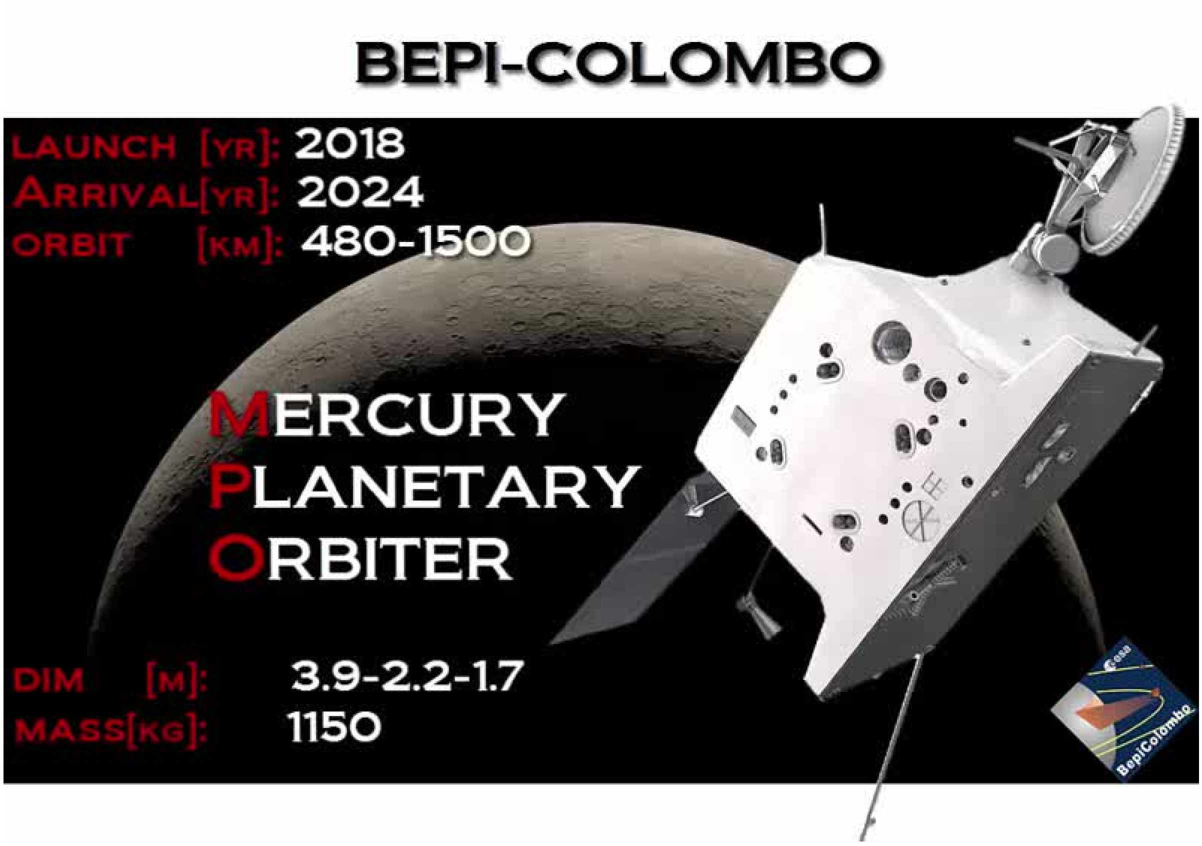

Method behind SINAS
GEOM OF THE LUMPED
PARAMETER THERMAL NODE
PAT Method : $T_j^t = \sum_i a_i T_i^f$
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 6
European Space Agency


Method behind SINAS
Corresponding elements overlapped by the same thermal node
PAT Method : $T_j^t = \sum_i a_i T_i^f$
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 7
European Space Agency

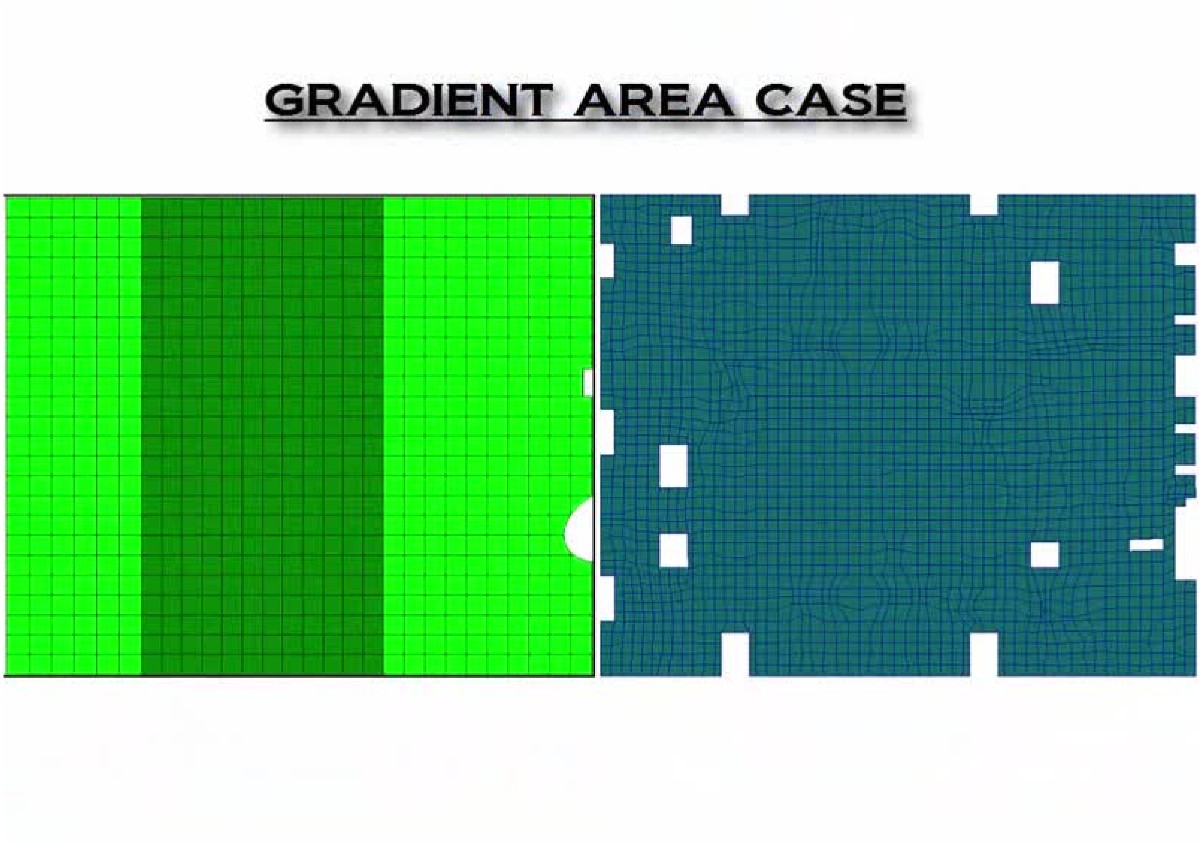

Method behind SINAS
PAT Method : $T_j^t = \sum_i a_i T_i^f$
ESA UNCLASSIFIED - For Official Use
ESA | 01/01/2016 | Slide 8
European Space Agency



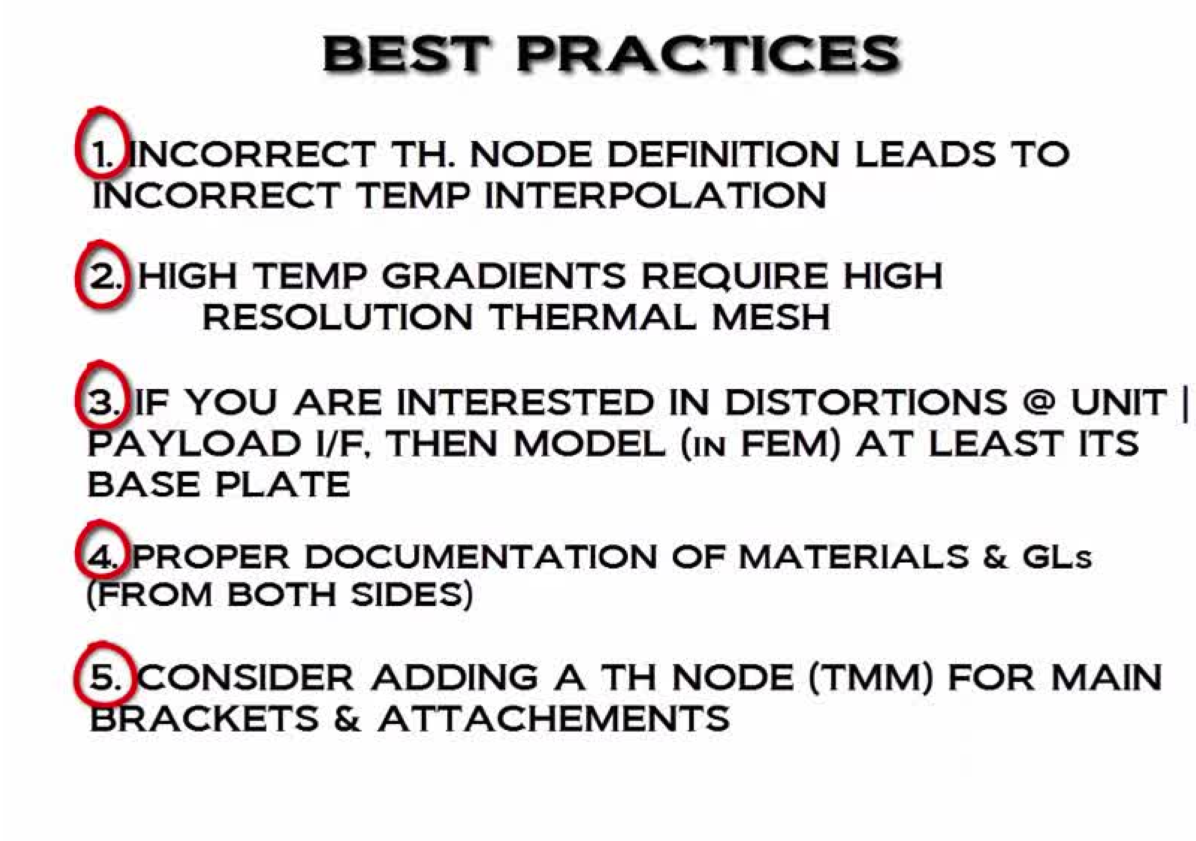
Save the attachment to disk or (double) click on the picture to run the movie.



Save the attachment to disk or (double) click on the picture to run the movie.



Save the attachment to disk or (double) click on the picture to run the movie.



Save the attachment to disk or (double) click on the picture to run the movie.