
Cloud based freeware tool for CubeSat thermal analysis

Dr. B. Yendler

YSPM, LLC

C. Jayne; B. Kuznetsov

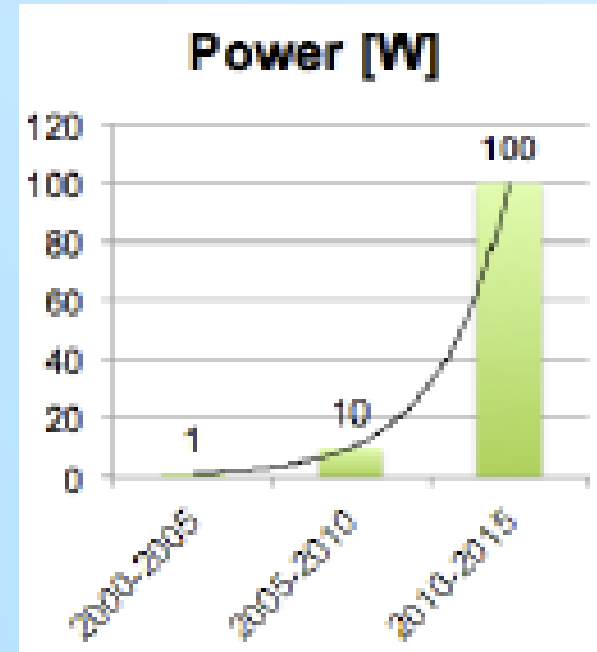
InSatConsulting LLC.

Importance of thermal analysis

- Ensuring mission survival
 - Temperatures far outside of acceptable ranges can kill components in a short period
- Extending operational lifespan
 - Even if temperatures are not extreme enough to quickly disable electronics, high temperature variation and long term exposure to extreme temperatures can reduce the lifespan of internal components.

Demand for thermal management

- Earlier years of cubesats - low power consumption
- Rapidly increasing cubesats functionality
- Satellites become more and more power “hungry”
- Lack of thermal management threatens s/c mission success
- Thermal management reduces s/c failure rate => decrease space junk



Platzer, et al, “Smaller Satellites, Smarter Forecasts: GPS-RO Goes mainstream”, 29th Annual AIAA/USU, SSC15-VII-10

Simple Thermal Analysis Tool

- Offers a modern fully automated solution for cubesat's thermal analysis
- Replaces existing tools requiring expert knowledge of thermal physics
- Designed for small to medium size companies and universities lacking thermal expertise
- Based on technology proven with multiple spacecraft
- Cloud based web application

Tool Features

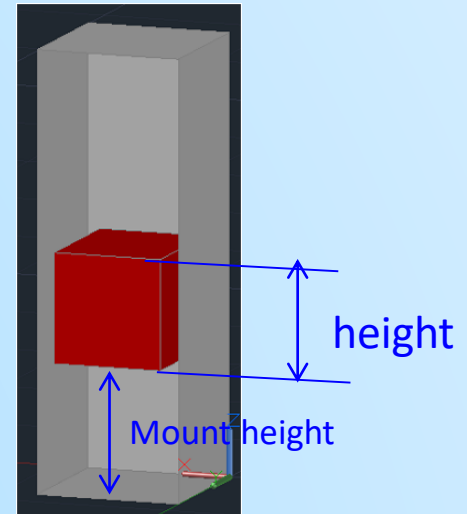
- **Why** thermal expertise is not required:
 - Use of pre-built libraries of common materials with defined thermal and optical properties
 - Pre-built configurations based on industry practices
 - Pre-built library of components(battery, CPU, etc.)
 - Simplified orbits
 - Possible Customization
- S/c Configuration
 - 1U-3U (done) ; 6U-12 U (under construction now)
- Rapid evaluation of s/c thermal performance

Tool Features – Cont'd

- **Sanity** check for input values:
 - Dimensions, power, optical treatments, etc.
 - Preventing mistakes of an inexperienced user
 - Verify input values been in a reasonable range (E.g., you can not have cubesat bus wall 5 cm thick)
- **Option for Customized input is also provided:**
 - If user has a material in mind which is not listed in the library
 - If user wants to study an effect of material properties, optical treatments, etc. on thermal behavior

Input Data

- Bus Construction parameters – mass, etc.
- Surface treatment
- Orbit
- Component(s) parameters – dimensions, position, heat load, etc.



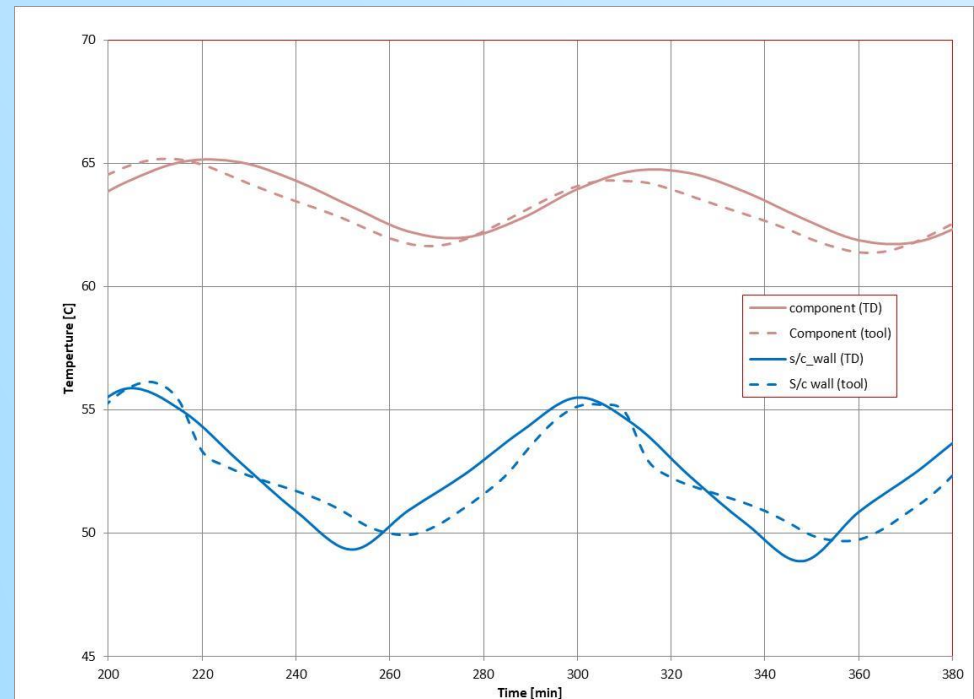
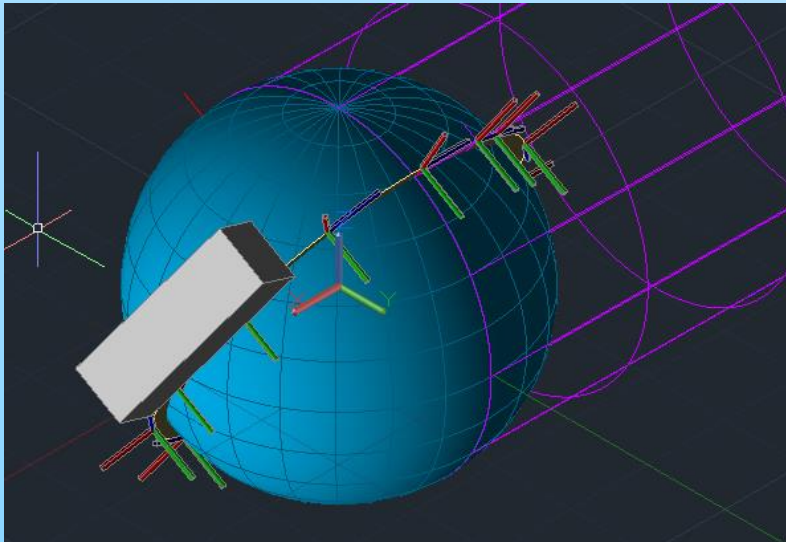
<https://cubes.yspm.net/Data>

Output

- Plots
 - Temperatures of all components over the simulation period
- Spreadsheets
- Minimum and maximum temperatures
 - Quick assessment of safe temperature ranges

Tool Verification

- The tool was verified by using Thermal Desktop
 - Identical thermal models were run on both platforms under identical boundary and initial conditions. Shown orbit -94 min



Future work

- More advanced configurations
 - Side by side components (for 6U and 12U)
 - Deployable solar arrays and radiators
- Support for more specific hardware
 - Pre-built busses
 - Specific components
- TBD

Conclusion

- Simple to work with
- Does not require thermal knowledge, anybody can run it
- Rapid estimations
- Verified using industry widely used thermal s/w
- Can be used for “sanity” check
- Easy Web access
- Does not require local installation