CONTROL CENTER TECHNOLOGY CONFERENCE

MacSPOC: Orbital Trajectory Calculations On A Laptop Computer

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TOPICS

LAPTOP COMPUTING IN THE SPACE SHUTTLE PROGRAM

CURRENT LAPTOP PROTOTYPING WITH MacSPOC

FUTURE LAPTOP APPLICATIONS

SUMMARY

SPACE SHUTTLE LAPTOP USE BEGAN ONBOARD

BEFORE STS-9 (November 1983 Launch):

- Laptop computer technology was commercially unavailable
- Crew had no orbital position display

ENTER THE SHUTTLE PORTABLE COMPUTER (SPoC)

- Host = GRiD Compass laptop 8086/7
- Proprietary GRiDOS operating system
  - Data entry via menus and forms
  - Primitive windowing capabilities
- World Map application
  - Current Shuttle location and ground track
  - Event timers (sun rise/set, AOS/LOS, etc.)
  - Fixed-format displays
- Crew queries to Mission Control substantially reduced

A PROTOTYPING EFFORT IS IN WORK TO ADVANCE SPoC CONCEPTS

UTILIZE COTS MACINTOSH PORTABLE COMPUTER

- Mature and intuitive graphic user interface
- Applications can address up to several MB RAM
- Reasonably fast 16 Mhz 68000 (no co-processor)
- Cooperative multi-tasking possible
- Minimal safety-of-flight hardware modifications required

DEVELOP MacSPOC APPLICATION

- SPOC = Spacecraft Personal Orbit Computations
- Demonstrate efficient data entry
- Demonstrate reconfigurable display format
- Demonstrate background display updates
- Demonstrate advanced earth observation (EOBS) capabilities
- Demonstrate accurate maneuver and aero drag modeling

MacSPOC RESULTS ARE ENCOURAGING

DETAILED TEST OBJECTIVE (DTO) 1206 COMPLETED

- Inaugural in-flight test during STS-41 (October 1990 launch)
- No anomalies encountered
- Crew requested enhanced attitude-dependent EOBS displays
  - Maintain attitude time line (ATL) onboard
  - Increase world map resolution 10-fold from current 33 nm

DTO 1208 ENHANCEMENTS NEARING READINESS

- In-flight test during STS-43 (July 1991 launch)
- MacSPOC ZoomMap ground testing complete
  - Resolution = 3 nm with ±60° latitude coverage
  - Total MacSPOC RAM = 2.6 MB
- Periodic trajectory, maneuver, and ATL uplinks via modem

ONBOARD PORTABLE COMPUTING IS COMING OF AGE

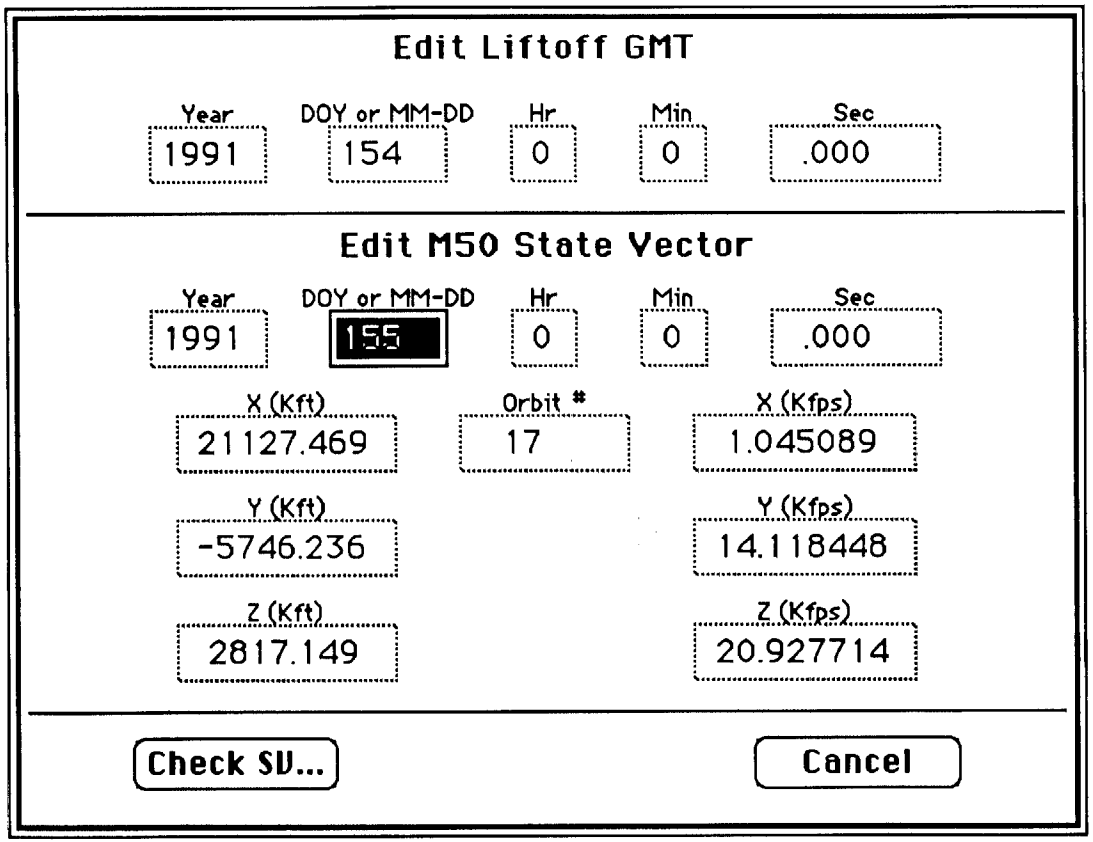
MacSPOC SUCCESS HELPS VALIDATE OTHER EFFORTS

- SPoC rehost to Unix and X-Windows
- Laptop software proliferation at Mission Control
- Emergency Mission Control applications
- Education and public relations

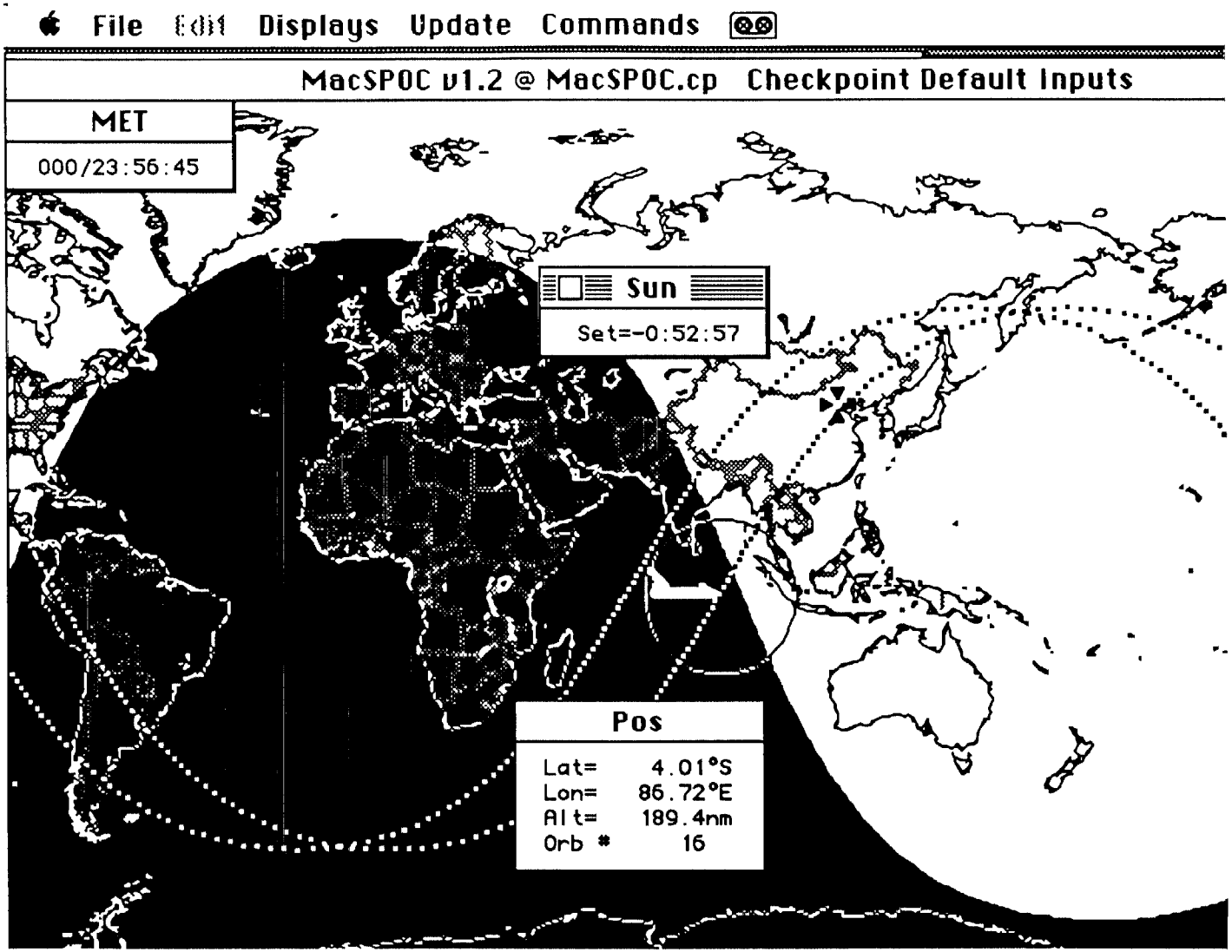
POSSIBLE FUTURE ADVANCEMENTS

- Macintosh laptop w/ 6888x co-processor: 100x more speed
- Expanded ZoomMap landmark database with annotation
- Rendezvous relative motion graphics display
- Space Shuttle TAEM and Landing proficiency trainer
  - Demonstrate real time man-in-the-loop capability
  - Provide piloting practice during extended duration flights

EFFICIENT DATA ENTRY



RECONFIGURABLE DISPLAY FORMAT



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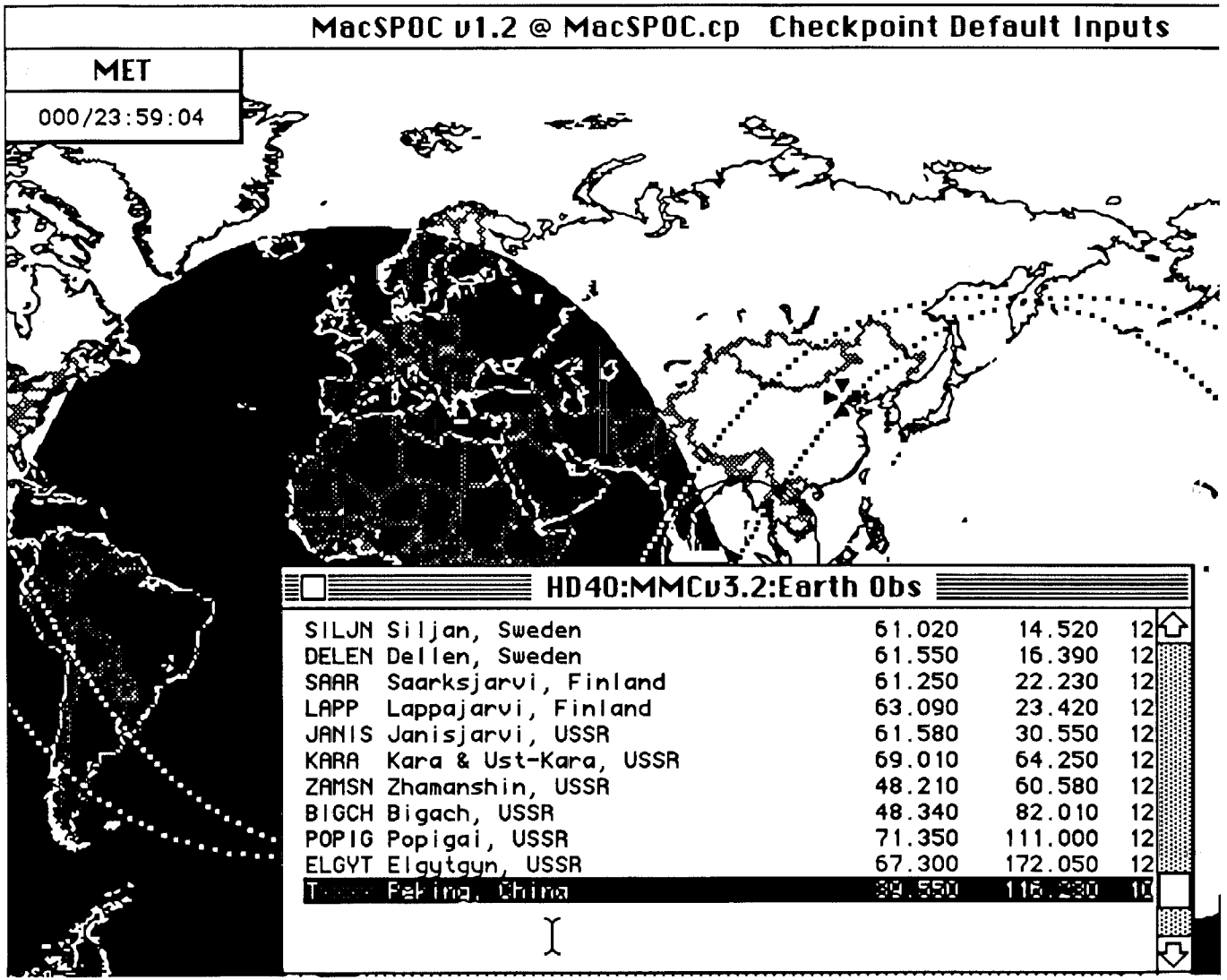
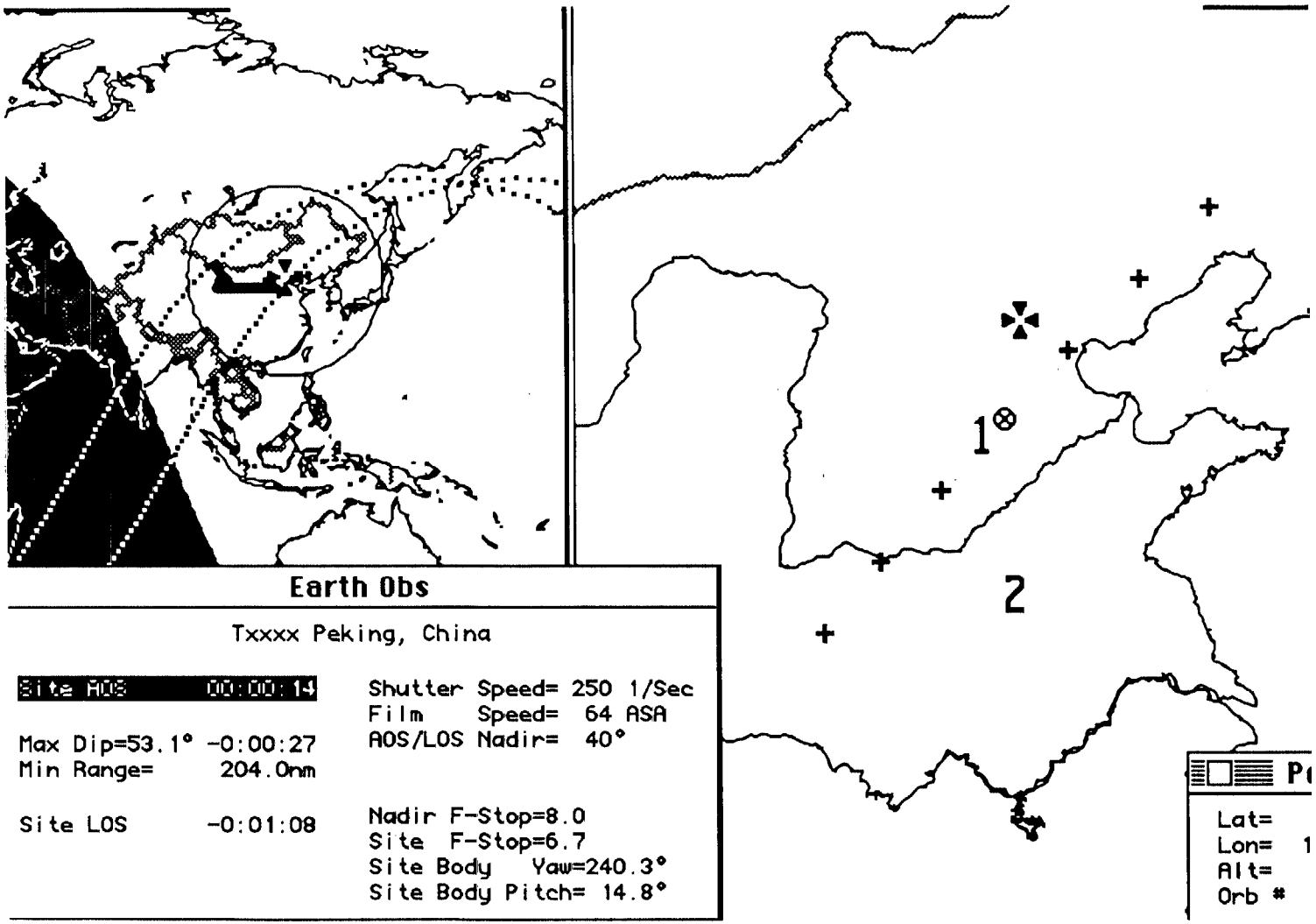
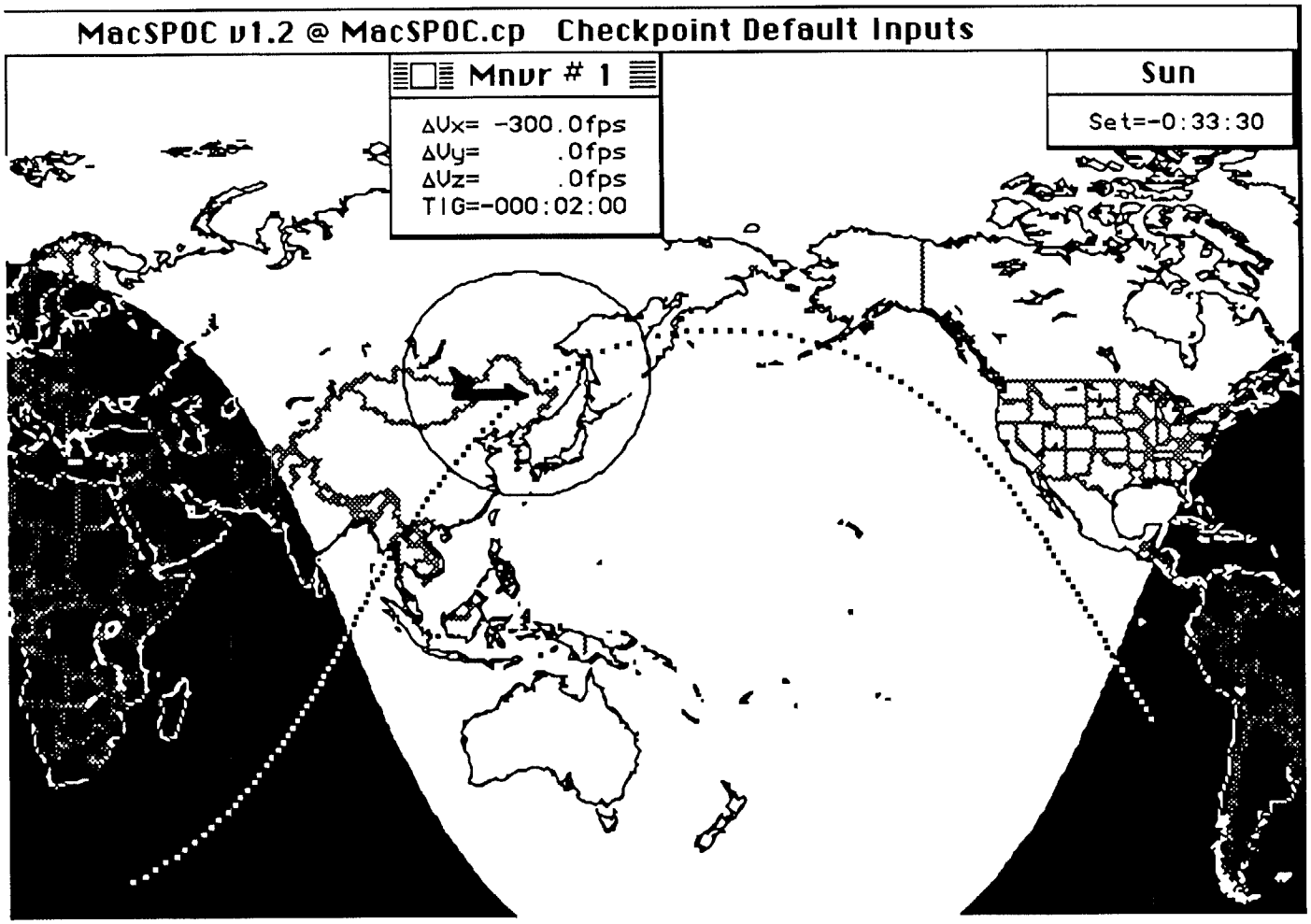
BACKGROUND DISPLAY UPDATES



ADVANCED EARTH OBSERVATION CAPABILITIES



ACCURATE MANEUVER AND AERO DRAG MODELING



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