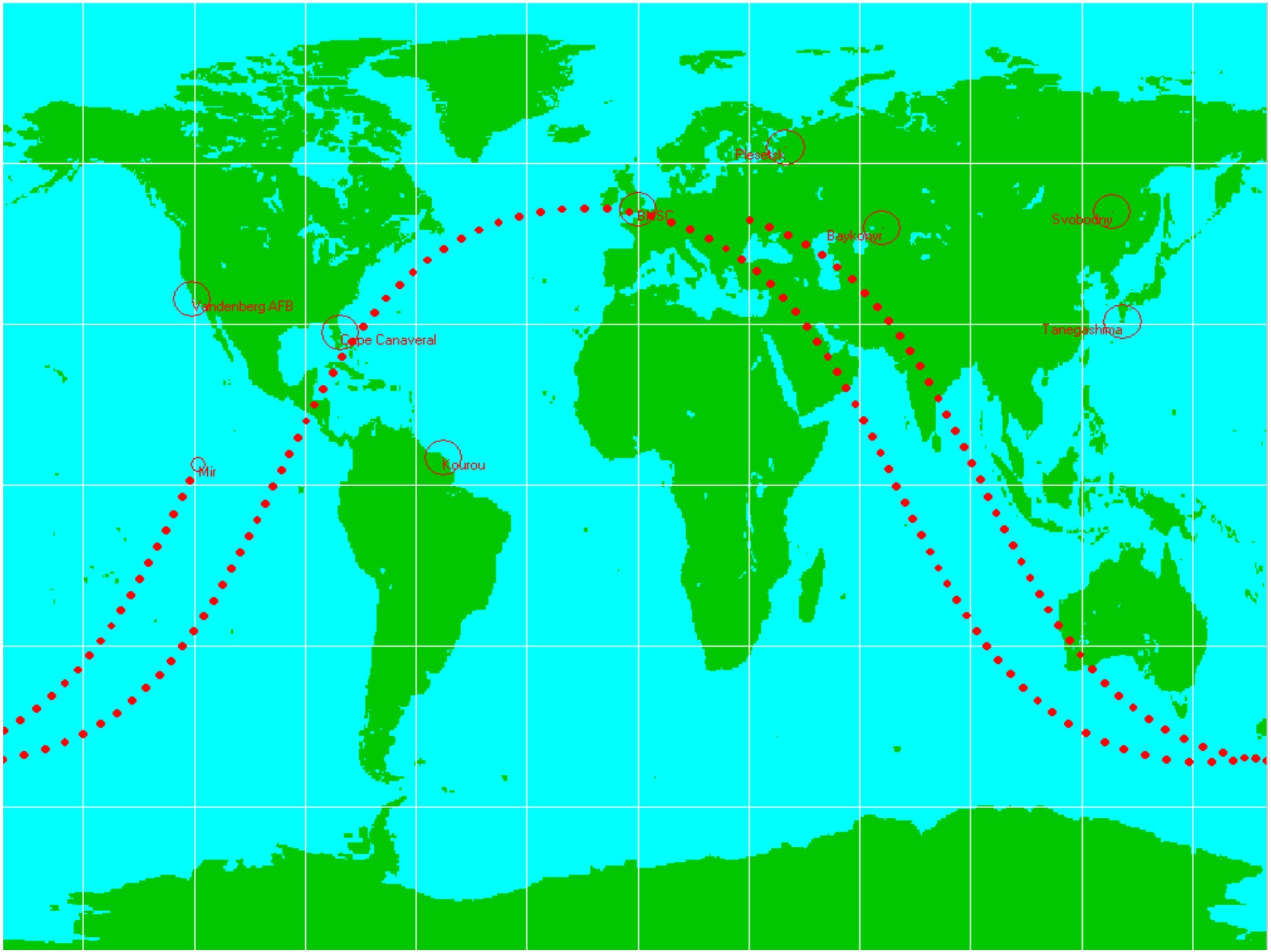
What goes up must come down again!

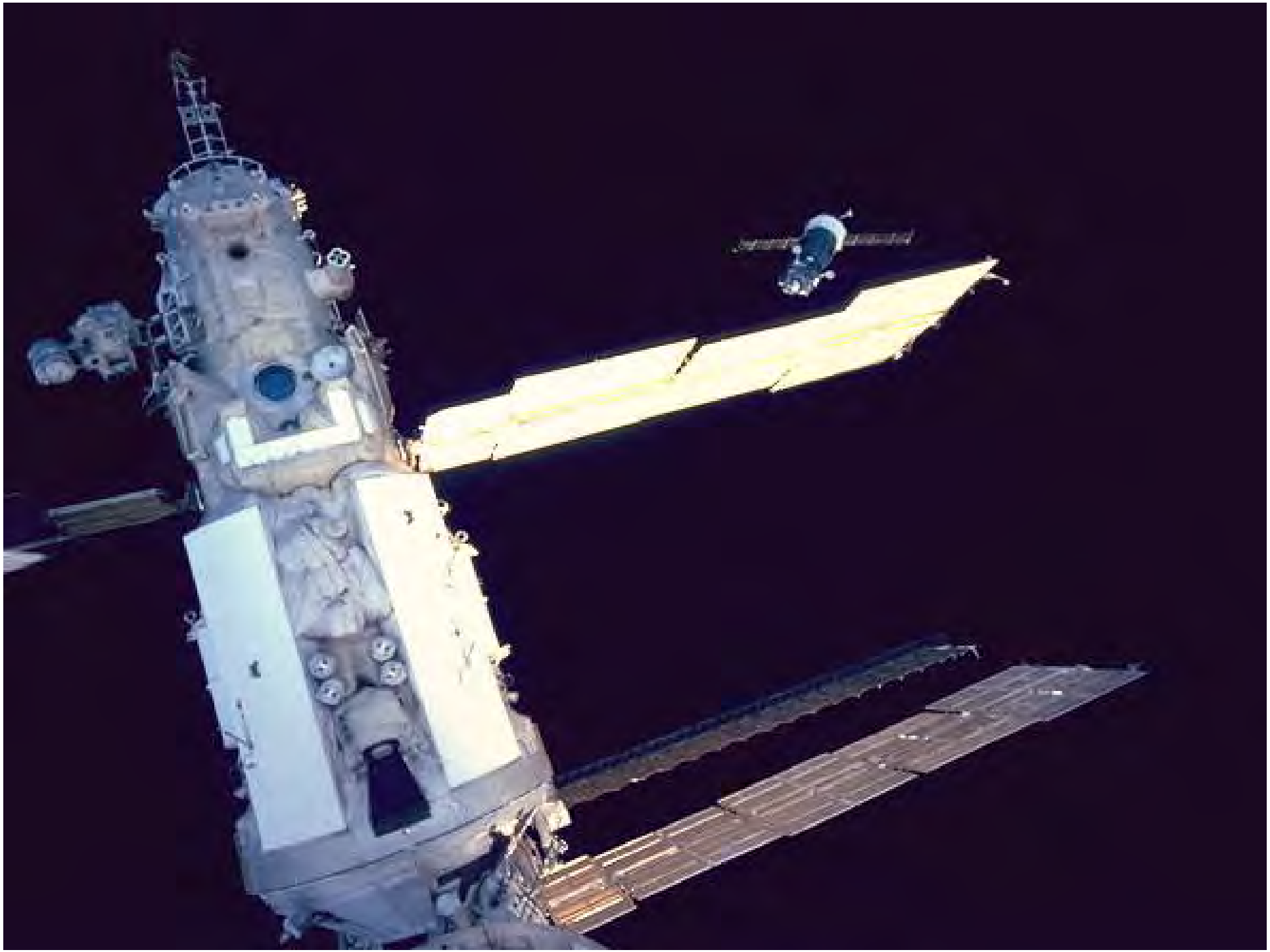
Controlled and un-controlled re-entries of objects from orbit

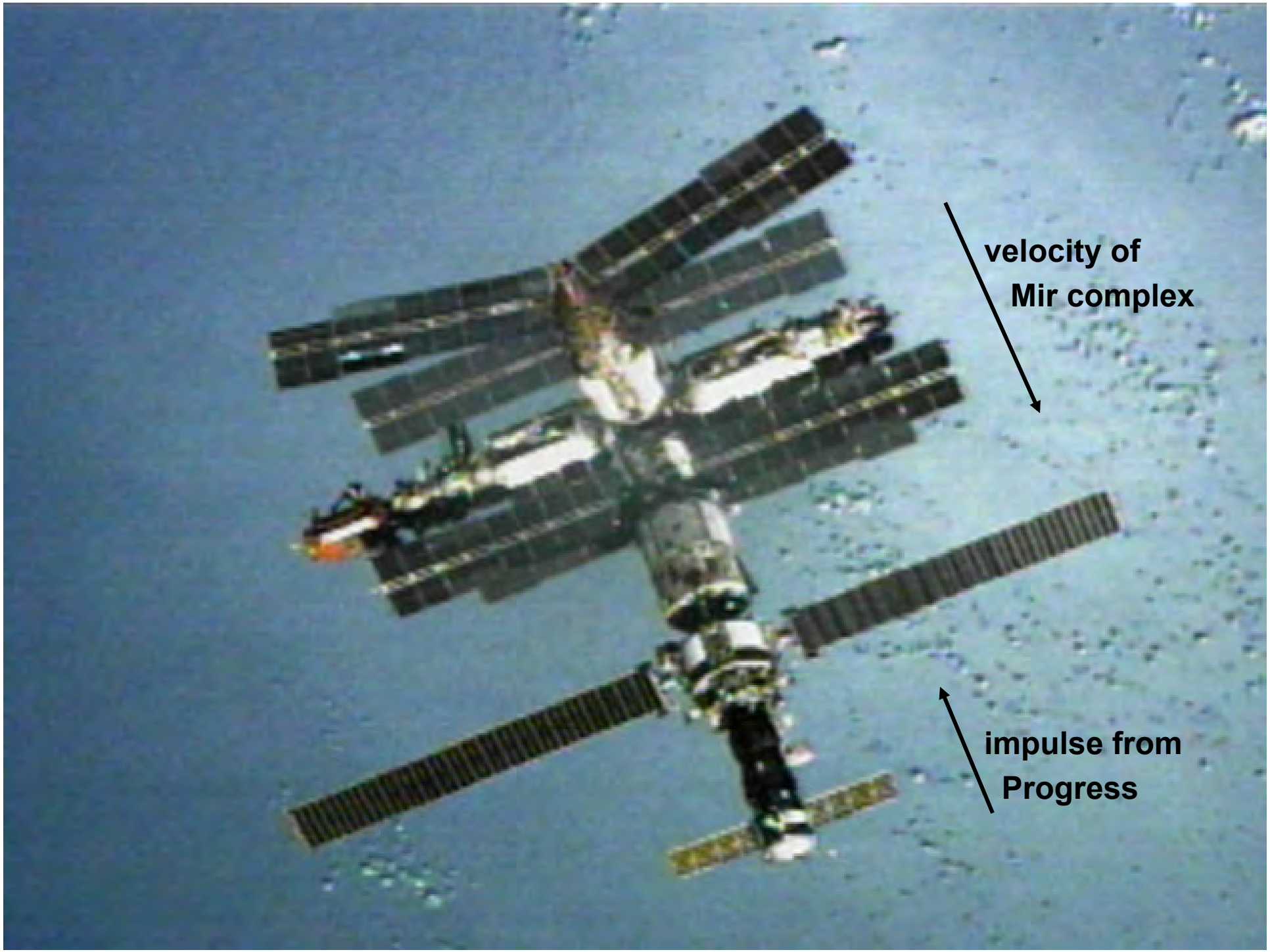
Controlled re-entry

Case Study: Mir Space Station

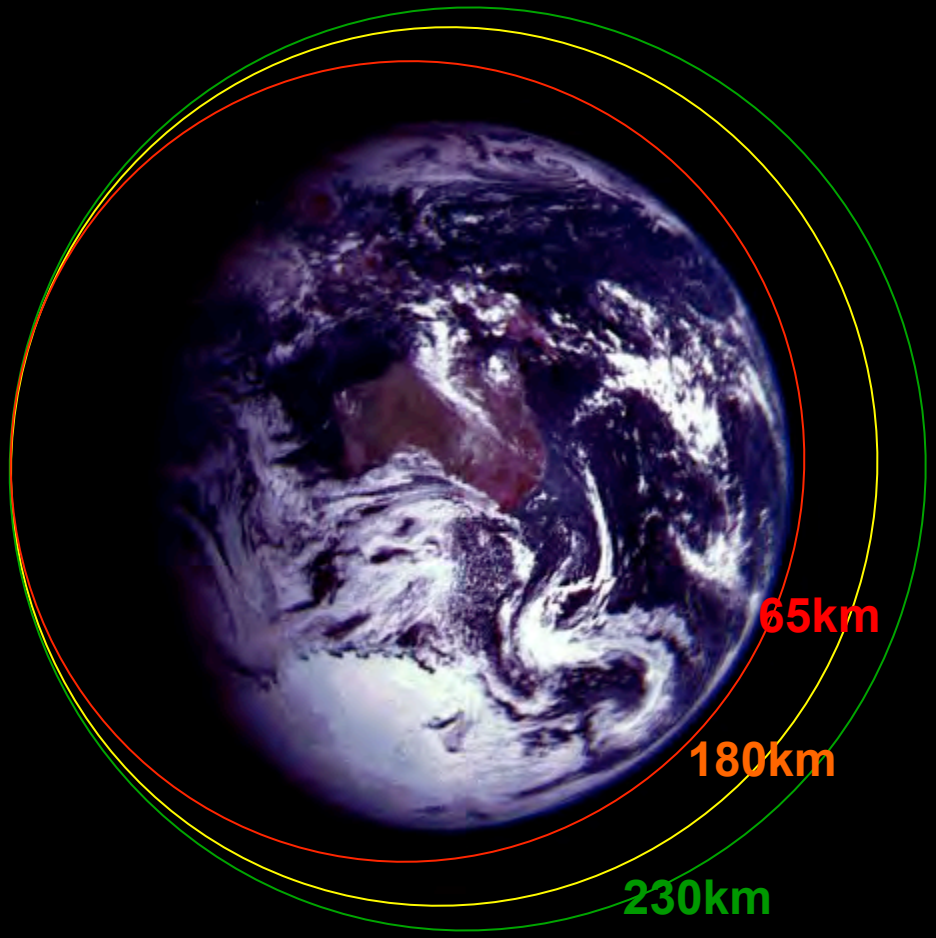

Plesetsk
ESOC
Baikonur
Svobodny
Vandenberg AFB
Cape Canaveral
Tanegashima
Kourou
Mir


January 24 2001: *Progress* launched from Baikonur



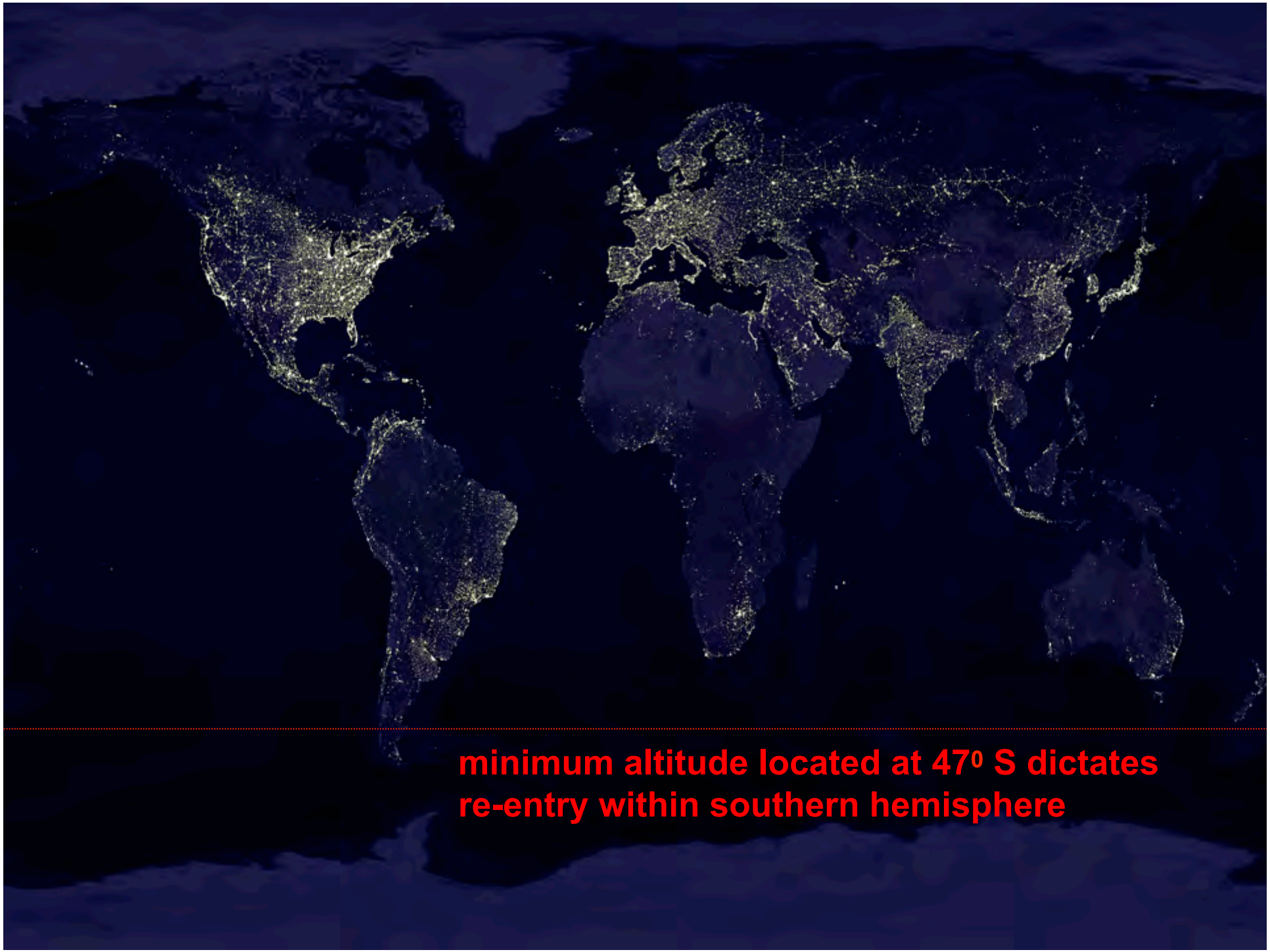

velocity of
Mir complex
impulse from
Progress

Series of manoeuvres to reduce altitude

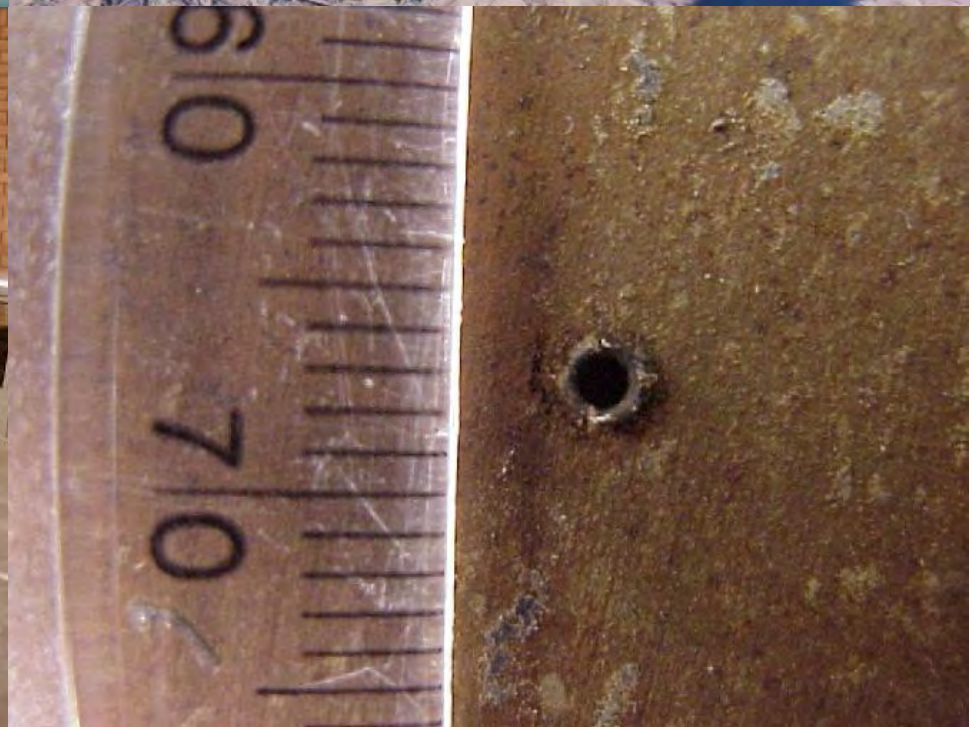


phasing of manoeuvre around orbit to determine latitude

not to scale


minimum altitude located at 47⁰ S dictates
re-entry within southern hemisphere


AP



Uncontrolled re-entry

Case Study: USA 193

Operation Burnt Frost

In January 2008, US State Department reported that:

- US satellite in a low altitude orbit had malfunctioned and was expected to re-enter Earth's atmosphere in 4-7 weeks

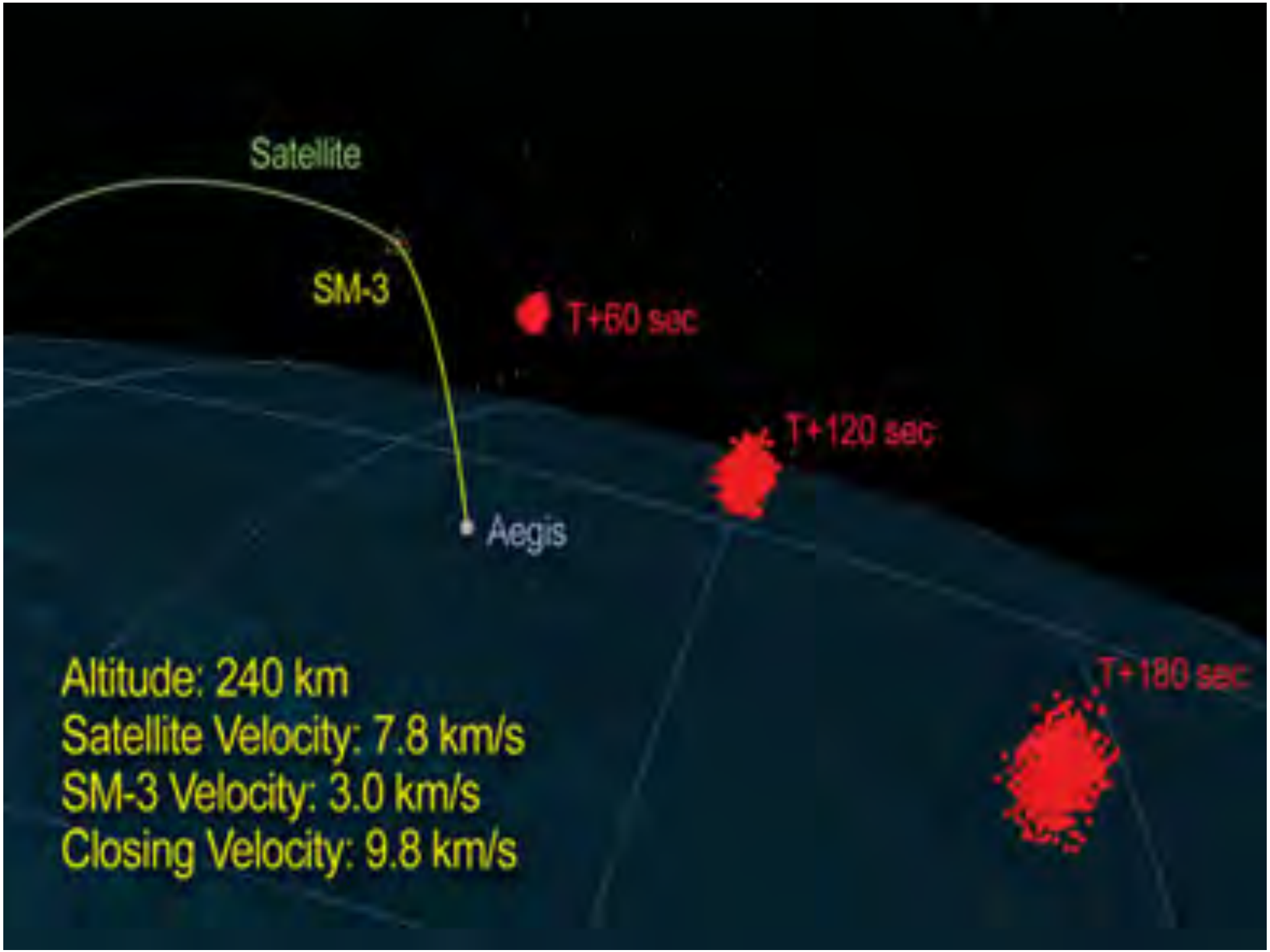
- Satellite in an orbit which extends from latitude 58 deg N to 58 deg S, and debris is expected to survive re-entry and strike the Earth within this region

- Satellite is not responding to commands, re-entry will be uncontrolled, impact location cannot be selected

What were the hazards?

- Impact
  - ~30% of 2 tonnes in-orbit mass will survive re-entry
  - large objects such as fuel tanks likely to survive intact

- Contamination
  - Fuel tanks contain ~0.5 tonnes of hydrazine
  - Highly toxic chemical used as propellant


Satellite
SM-3
T+60 sec
T+120 sec
Aegis
T+180 sec
Altitude: 240 km
Satellite Velocity: 7.8 km/s
SM-3 Velocity: 3.0 km/s
Closing Velocity: 9.8 km/s

USA 193 SM-3 Impact and Destruction

1.

3.

New approach to spacecraft design:
“Design for demise”

Reduce mass surviving re-entry heating to limit casualty expectation on the ground


FRIBEL