Titan Wind Analysis using Lagrangian Coherent Structures

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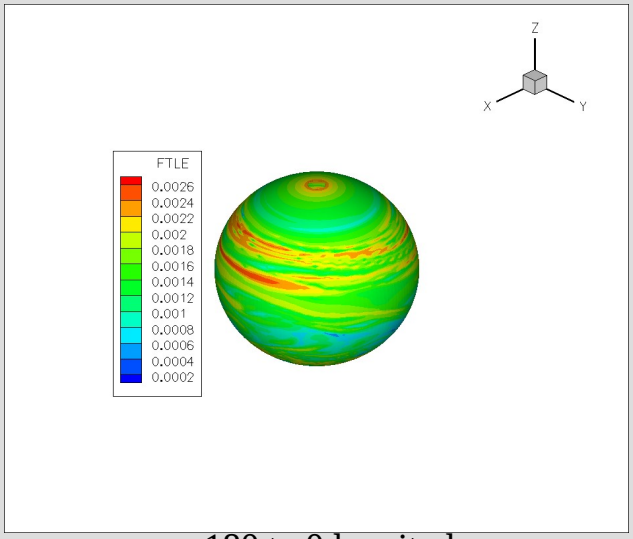
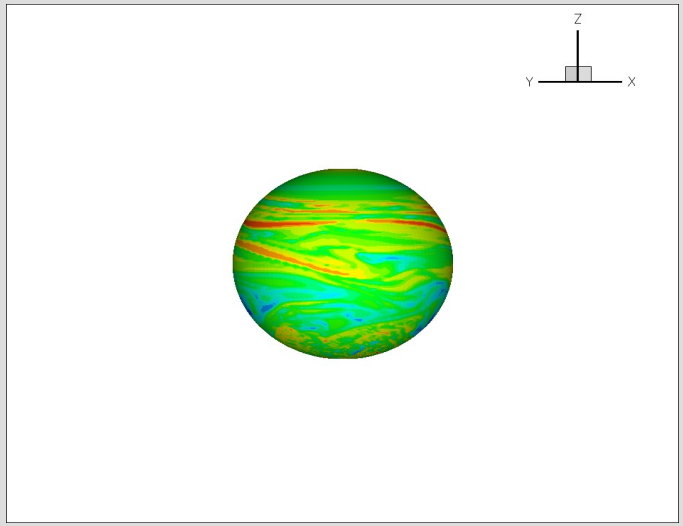
Lagrangian Coherent Structues

- Local maxima of the FTLE field, where FTLE measures the amount of stretching about the trajectory of a point in the domain/how fast neighboring particles diverge from that point as time evolves
- LCS are separatrices between regions with very different dynamical behavior

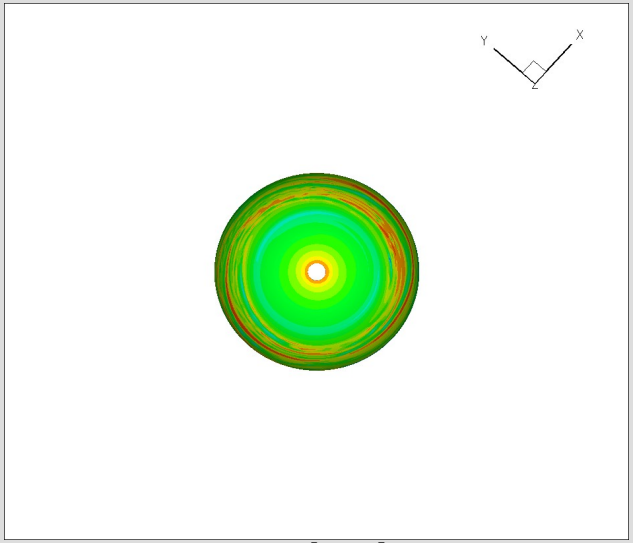
Ls 270 (northern winter) at 10km



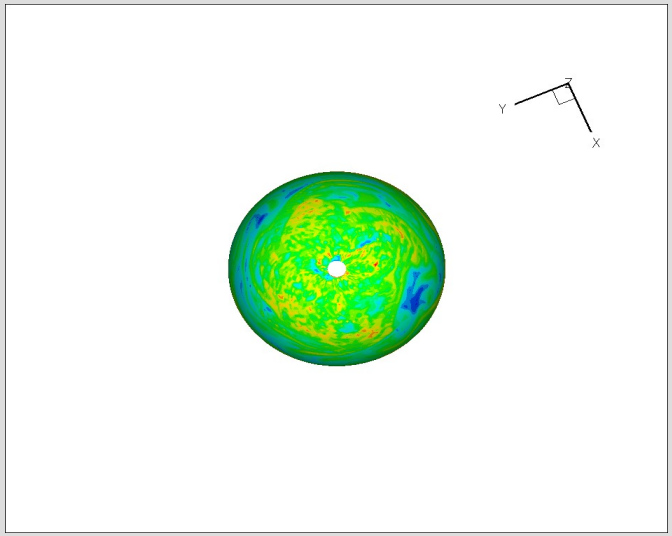
-180 to 0 longitude



0 to 180 longitude

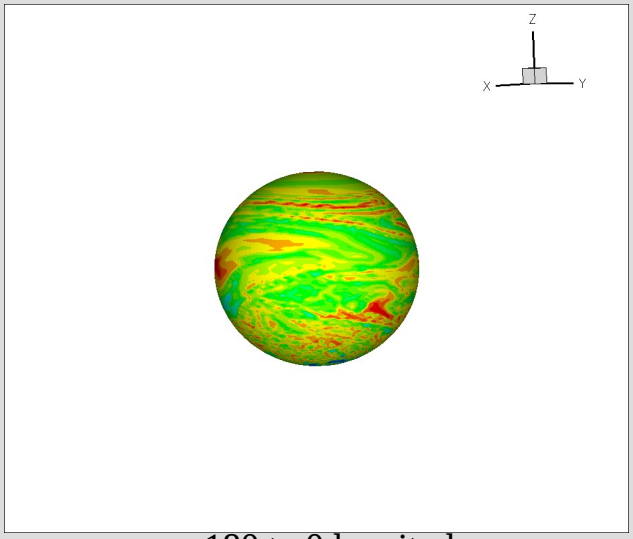


North Pole

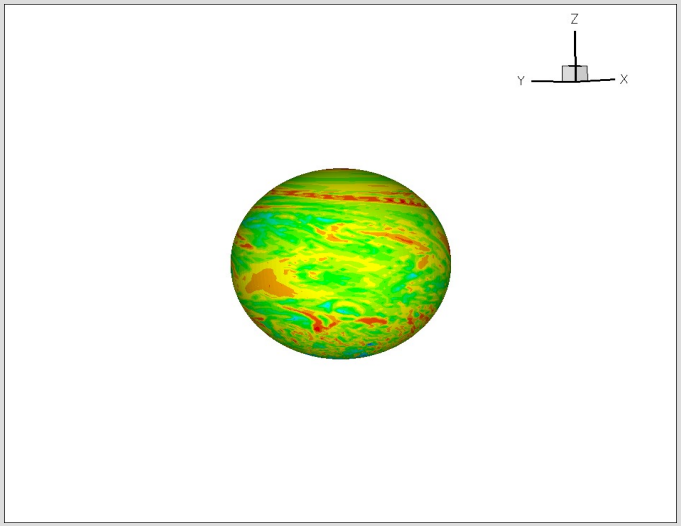


South Pole

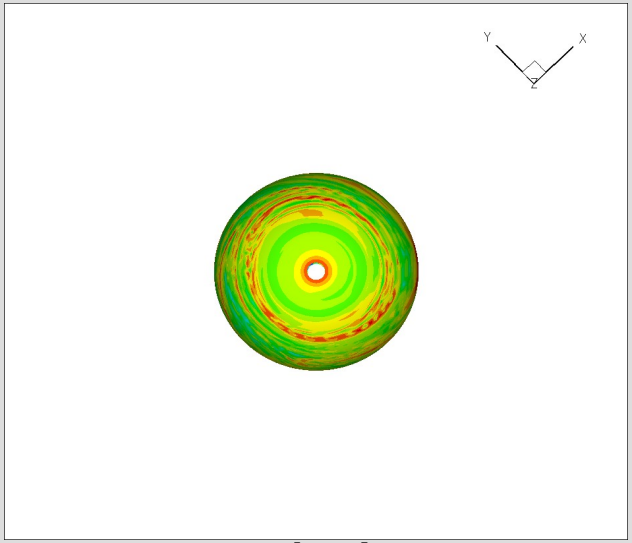
Ls 270 (northern winter) - 5km



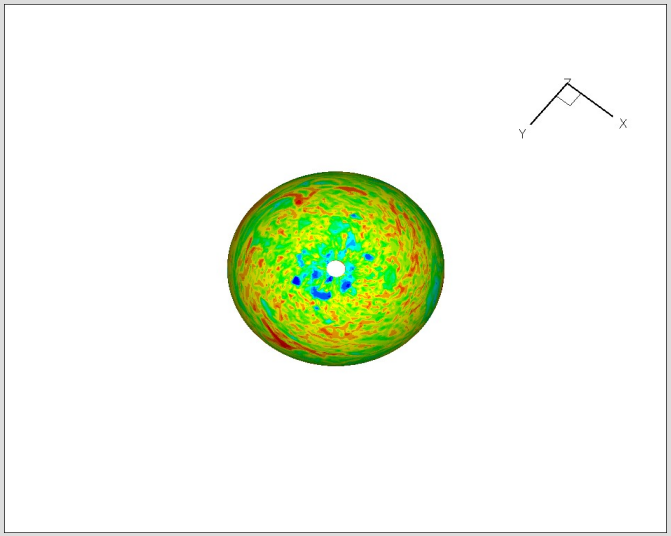
-180 to 0 longitude



0 to 180 longitude

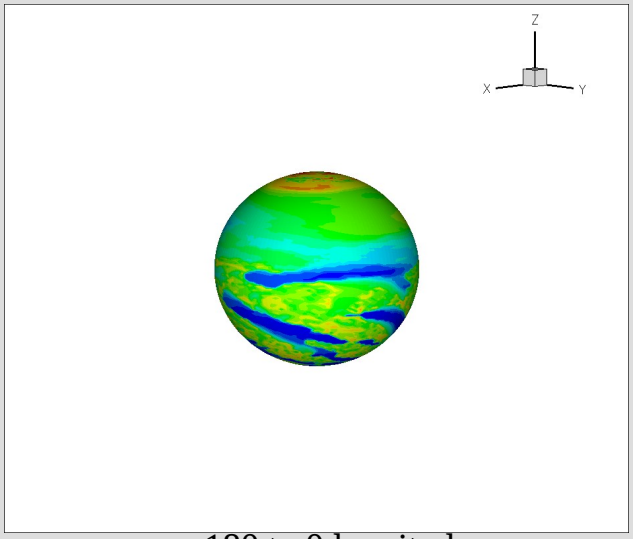


North Pole

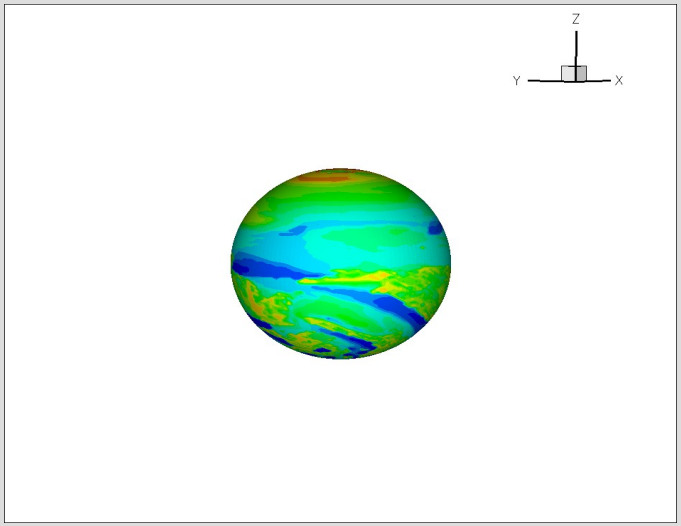


South Pole

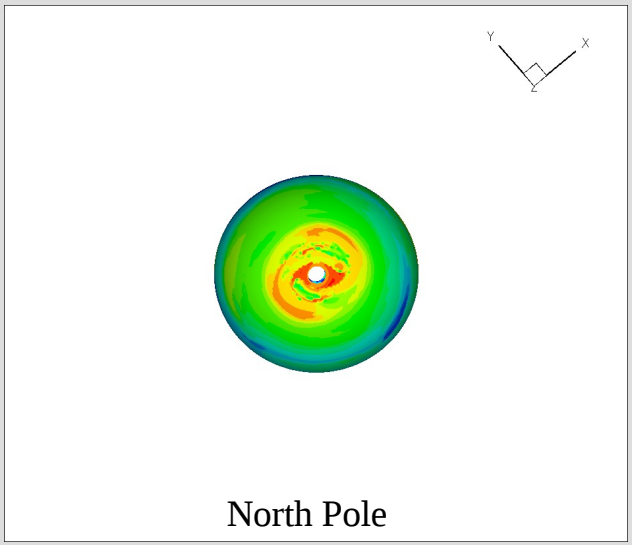
Ls 270 (northern winter) - 1km



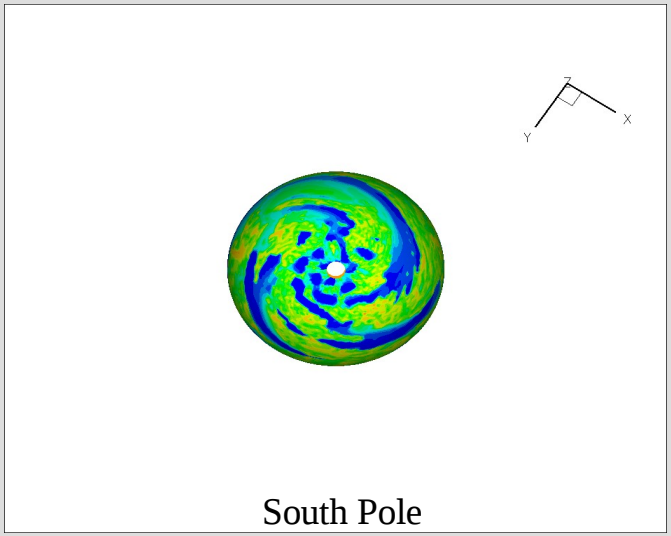
-180 to 0 longitude



0 to 180 longitude



North Pole

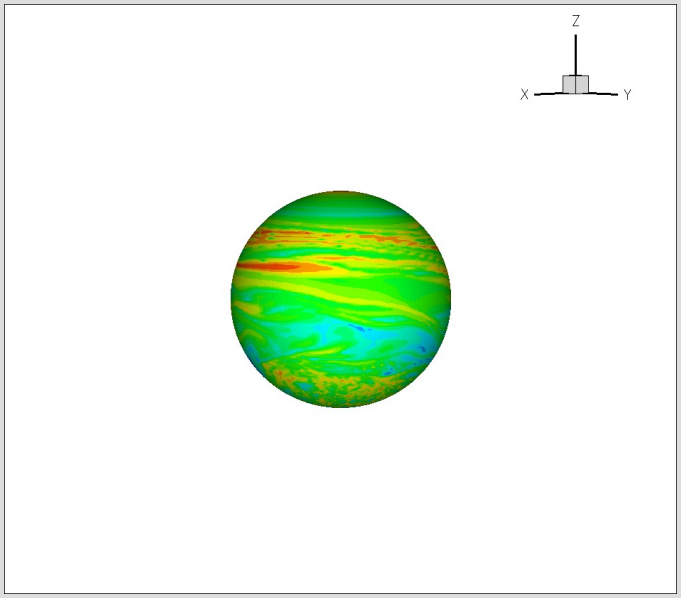


South Pole

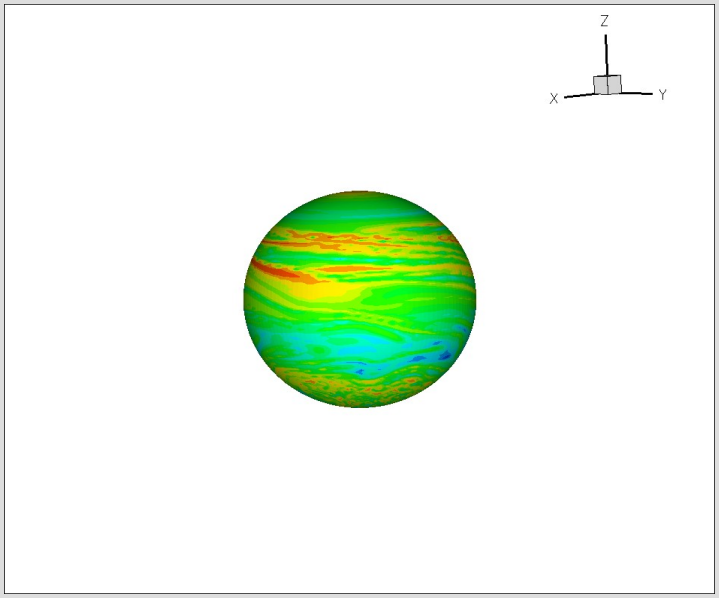
Conclusions

- Thick band of LCS surrounding the North Pole – a Montgolfiere would be trapped if deployed at the North Pole
- Smaller transport barriers at 1km altitude- vertical control can be utilized to minimize need for horizontal actuation

Time-dependence of LCS?

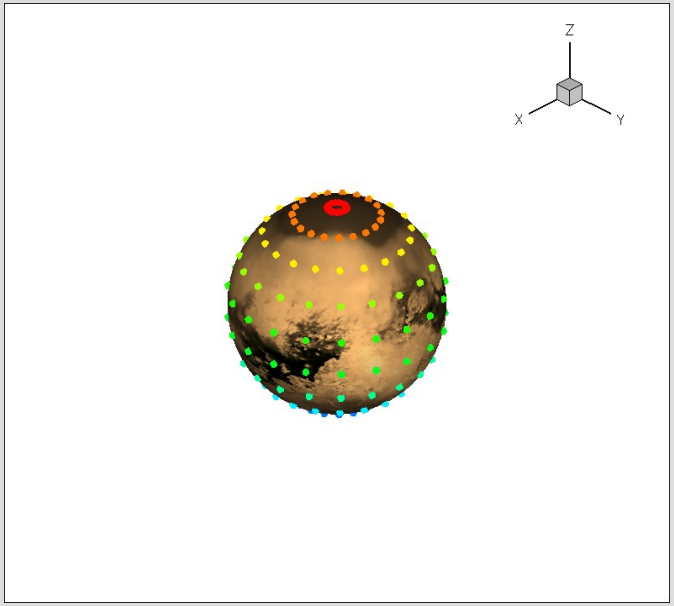


Frame 1, t=0

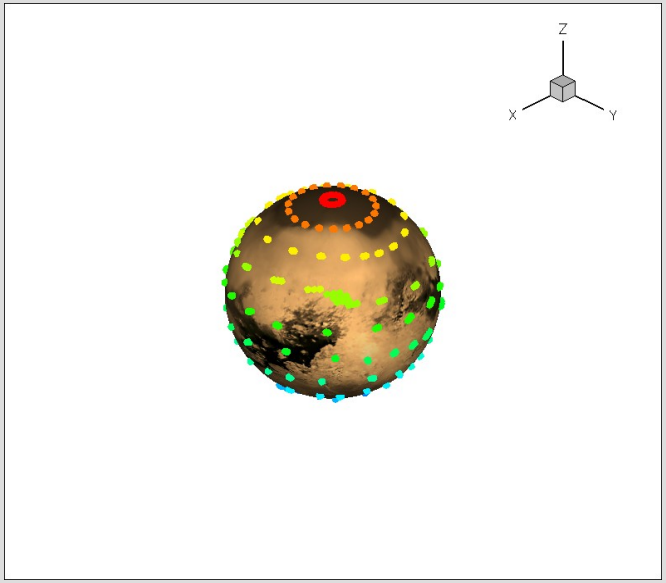


Frame 25, t=2
Titan days or 32
Earth days

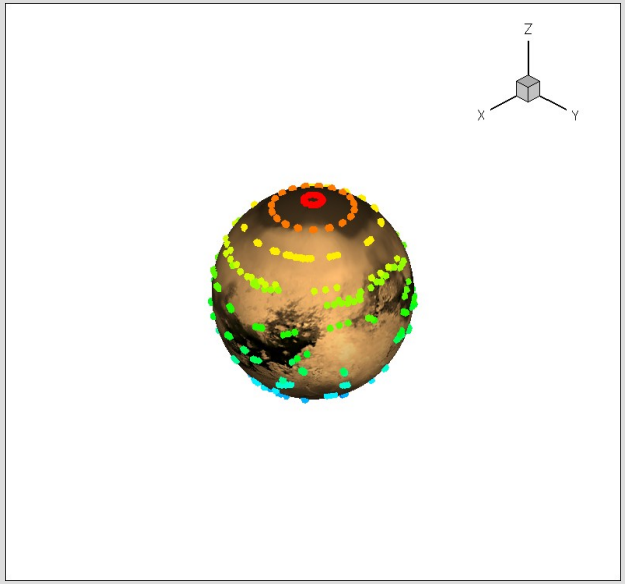
Drifter plots



Frame 1, t=0

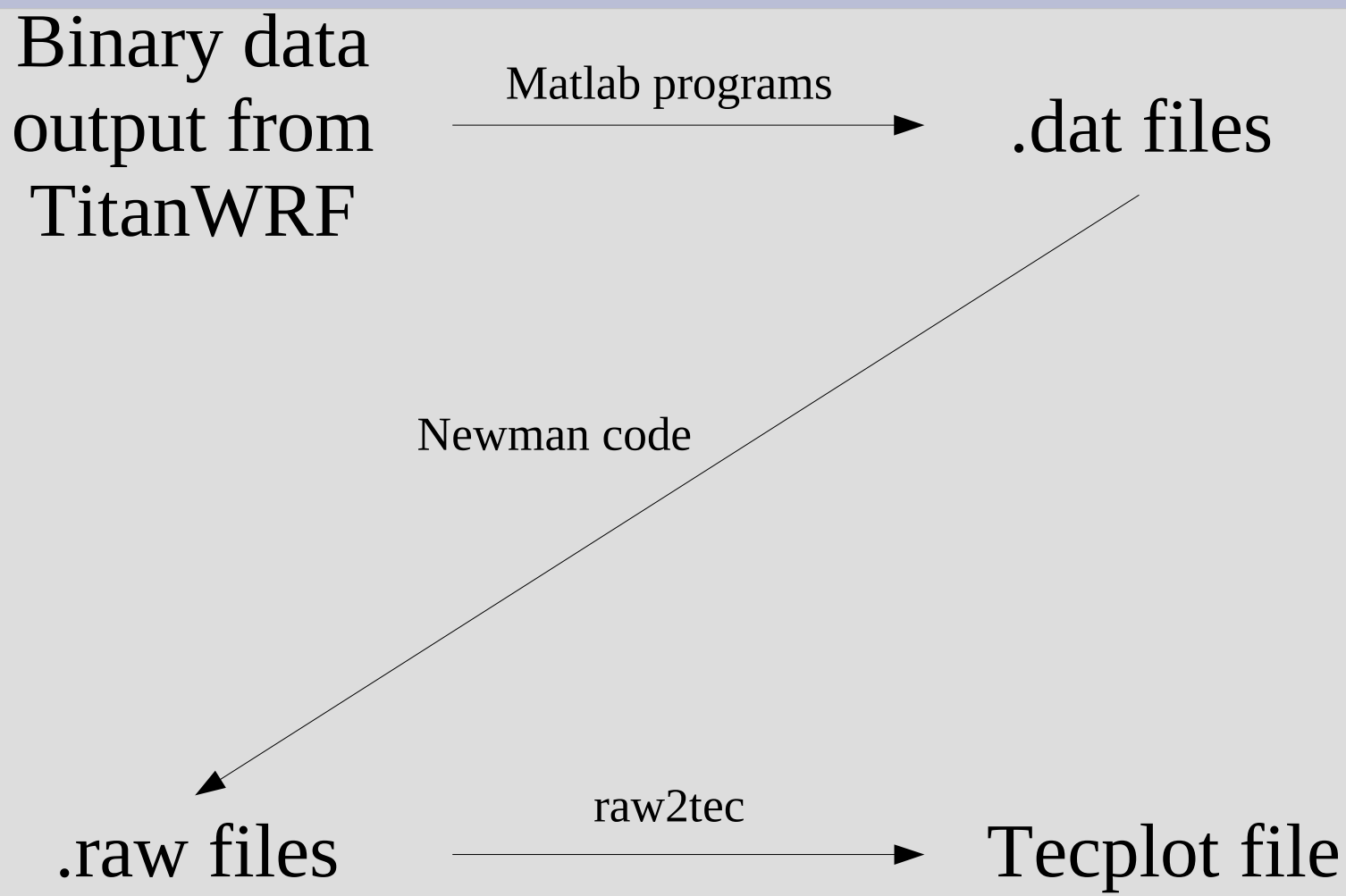


Frame 50, t=4
Titan days or 64
Earth days



Frame 100, t=8
Titan days or
128 Earth days

The process


Binary data output from TitanWRF
Matlab programs
.dat files
Newman code
.raw files
raw2tec
Tecplot file

Goals

Experiment with :
- Integration time
- Backward time integration
- Resolution

How robust are LCS to noise?
(qualitative/quantitative measure)

More drifter plots