EFLIGHT X - Eclipse Flight Planning & Navigation S/W: Making Every Second Count!

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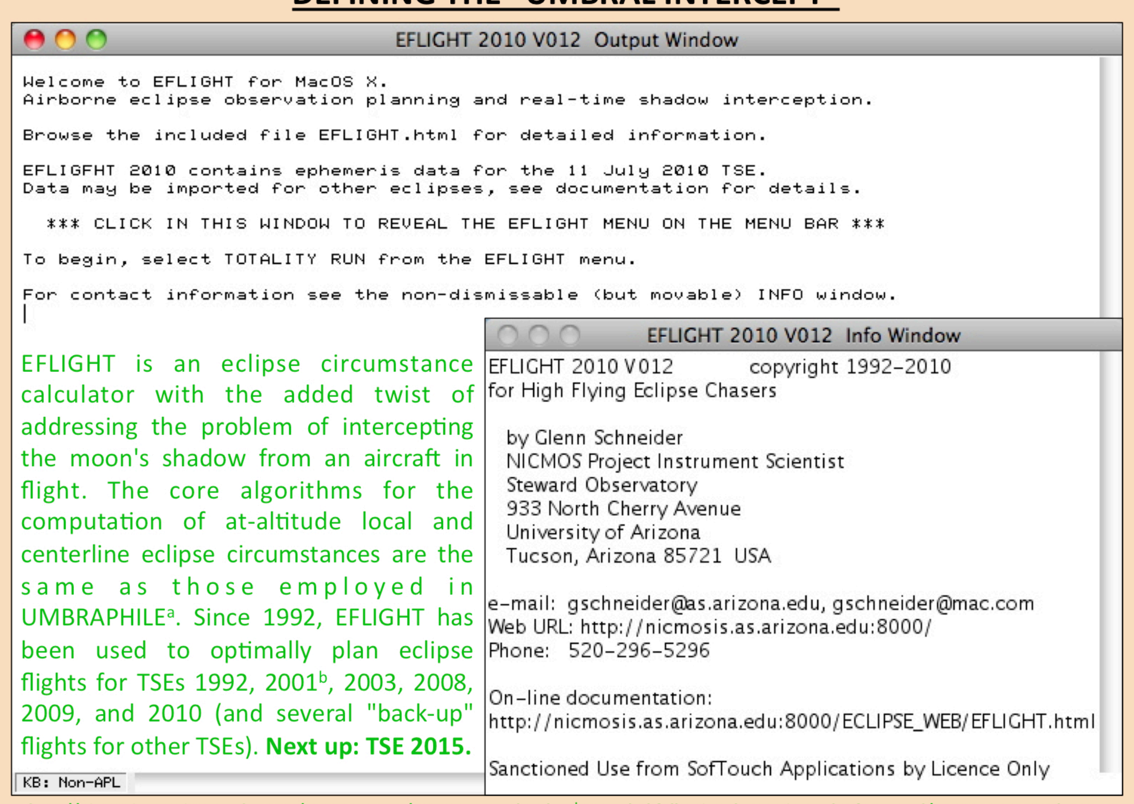
TOP 10 REASONS TO OBSERVE TSEs FROM JET AIRCRAFT

DEPLOYMENT/RELOCATION FLEXIBILITY To Find the BEST Spot in the Area of Operations for Observing	**CLOUD OBSCURATION AVOIDANCE** Clear Skies Virtually Assured
TOTALITY PROLONGATION Aircraft Speed Extends the Duration of Totality	**SKY TRANSPARENCY** Significantly Improved — Lower Particulate Scattering
SKY DARKNESS Much Higher Coronal Contrast, Visibility to Larger Distance	**IMPROVED ASTRONOMICAL "SEEING"** "r_naught" Decreases with Increasing Altitude
REDUCED ATMOSPHERIC TURBIDITY Vorticity & Sheer Decline in Power Above Tropopause	**MORE PANCHROMATIC TRANSMISSIVITY** IR and UV "Windows" Open Up or are Extended
UNPARALLELED HORIZON REACH & OBSERVATION VISTA Apparent Horizon ~ 400 km distant, depressed 3.5° @ 40,000 ft.	**ESTHETIC, ETHERIAL, EXPERIENCE** There is nothing quite like it...

WHY EFLIGHT?

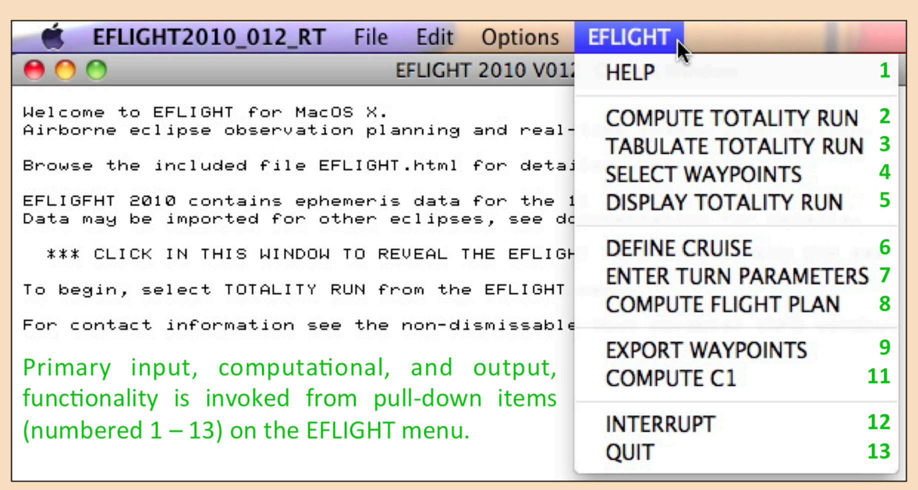
Hitting a moving target (the moon's shadow) from a moving platform (a high speed aircraft) is intrinsically not too complex a problem, though it certainly is non-trivial. To do so, successfully, while optimizing an aircraft flight intercept to strike a desired balance between duration, observability (e.g., line-of-site restrictions due to aircraft windows), cost, and other constraints, must be approached with both care and rigor. By 1992, the availability and capabilities of portable (aka "laptop") computers had so rapidly evolved, that eclipse flight optimization and *re*-planning in reaction to *in situ* conditions became possible. As a result, the first version of EFLIGHT, an integrated eclipse flight planning and navigation S/W package, was engineered for the then fledgling Macintosh PowerBook 100 series laptop computers, and then successfully used to navigate a DC-10 precisely through the path of the 30 June 1992 eclipse. Since then, EFLIGHT has evolved into a fully integrated airborne eclipse observation planning and navigation tool. Many of its current capabilities are illustrated here. Got an airplane?

DEFINING THE "UMBRAL INTERCEPT"



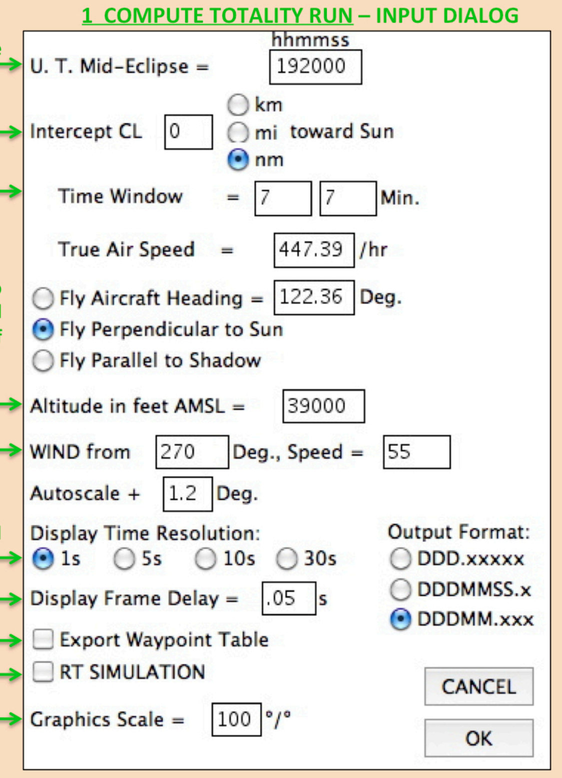
EFLIGHT is an eclipse circumstance calculator with the added twist of addressing the problem of intercepting the moon's shadow from an aircraft in flight. The core algorithms for the computation of at-altitude local and centerline eclipse circumstances are the same as those employed in UMBRAPHILE[a]. Since 1992, EFLIGHT has been used to optimally plan eclipse flights for TSEs 1992, 2001[b], 2003, 2008, 2009, and 2010 (and several "back-up" flights for other TSEs). **Next up: TSE 2015.**

[a] http://nicmosis.as.arizona.edu:8000/ECLIPSE_WEB/UMBRAPHILE.html [b] Canceled following the tragic crash of Concord/AF 4590 on 25 July 2000.



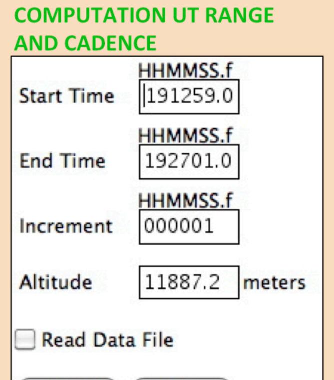
Primary input, computational, and output, functionality is invoked from pull-down items (numbered 1 – 13) on the EFLIGHT menu.

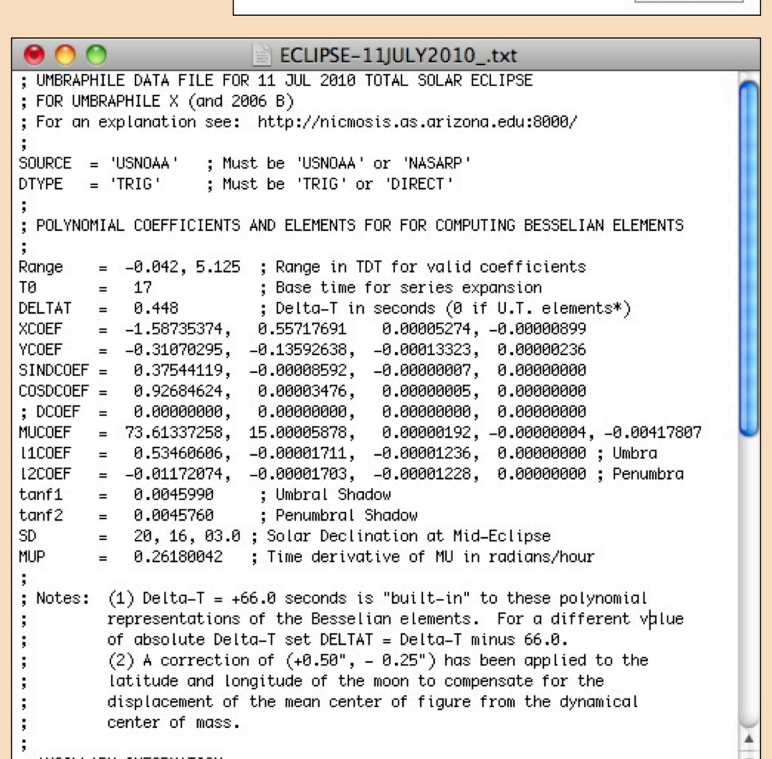
1 COMPUTE TOTALITY RUN – INPUT DIALOG



- Specifies the Universal Time (with one second granularity) at which the aircraft is to be concentrically located in the moon's shadow.
- Non-central mid-eclipse intercept: displacement from centerline (CL).
- Computation time window ± UT of mid-eclipse for Totality Run.
- Aircraft true AIRSPEED in units of distance/hr (unit per CL displacement).
- At mid-eclipse fly: (a) specified heading, (b) perpendicular Sun LOS to optimize passenger window viewing (best near the points of local noon/midnight), (c) parallel to shadow motion to maximize duration of totality (at path extrema requires flying "across the shadow").
- Aircraft altitude above mean sea level (in feet) at mid-eclipse.
- Expected Winds Aloft at UT/Location of mid-eclipse.
- Border pad in latitude/longitude for graphical display output window.
- Time granularity for CL computation and graphical display (right: CL and aircraft latitude/longitude tabulation/display output format).
- Graphical output inter-frame cadence. / Coordinate display format.
- Export time-correlated waypoints to ASCII (text) file.
- Real-Time simulation: synchronize UT with offset to system clock.
- Size of graphical display window w.r.t. default.

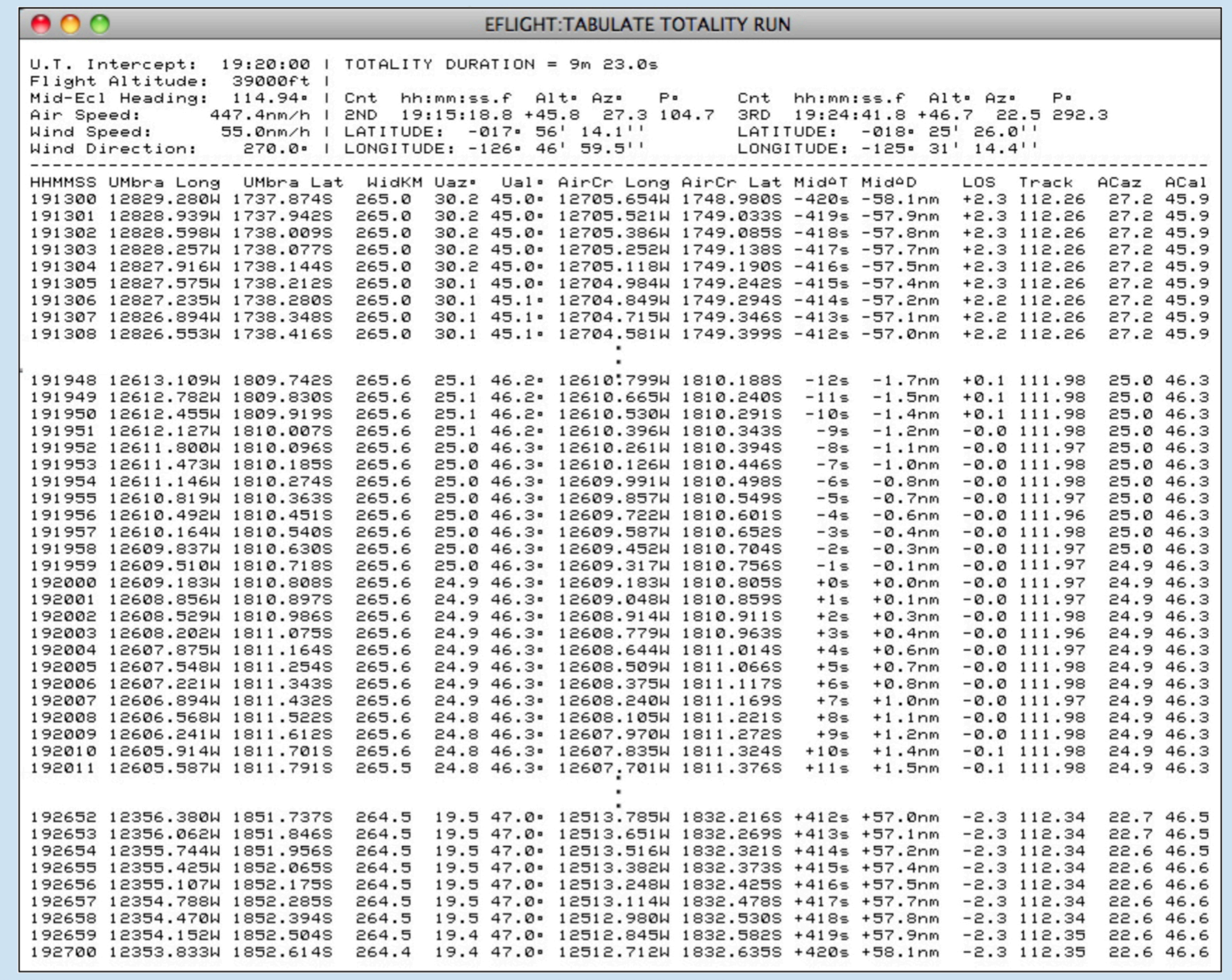
1 COMPUTE TOTALITY RUN
OPTIONAL BESSELIAN ELEMENT FILE IMPORT & COMPUTATION UT RANGE AND CADENCE





Besselian Element ASCII File Format (common format for UMBRAPHILE S/W)

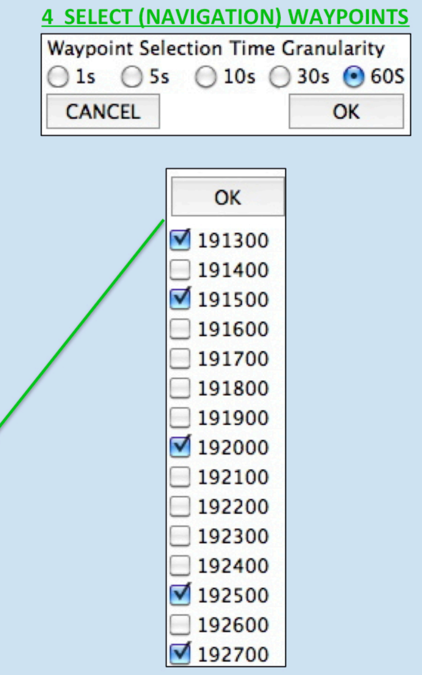
THE "TOTALITY RUN"

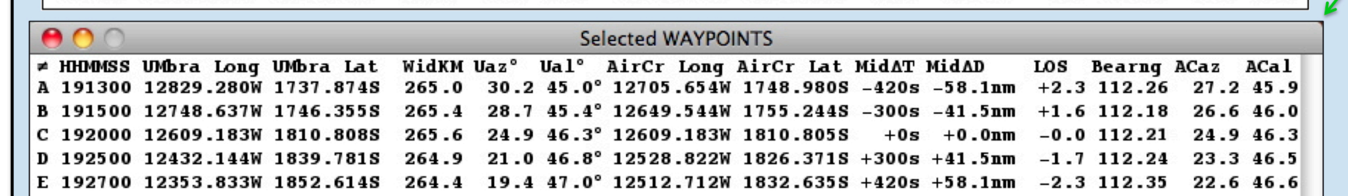


"Local" circumstances for contacts II and III are computed for specified mid-eclipse UT intercept, air speed, direction, winds aloft and altitude.

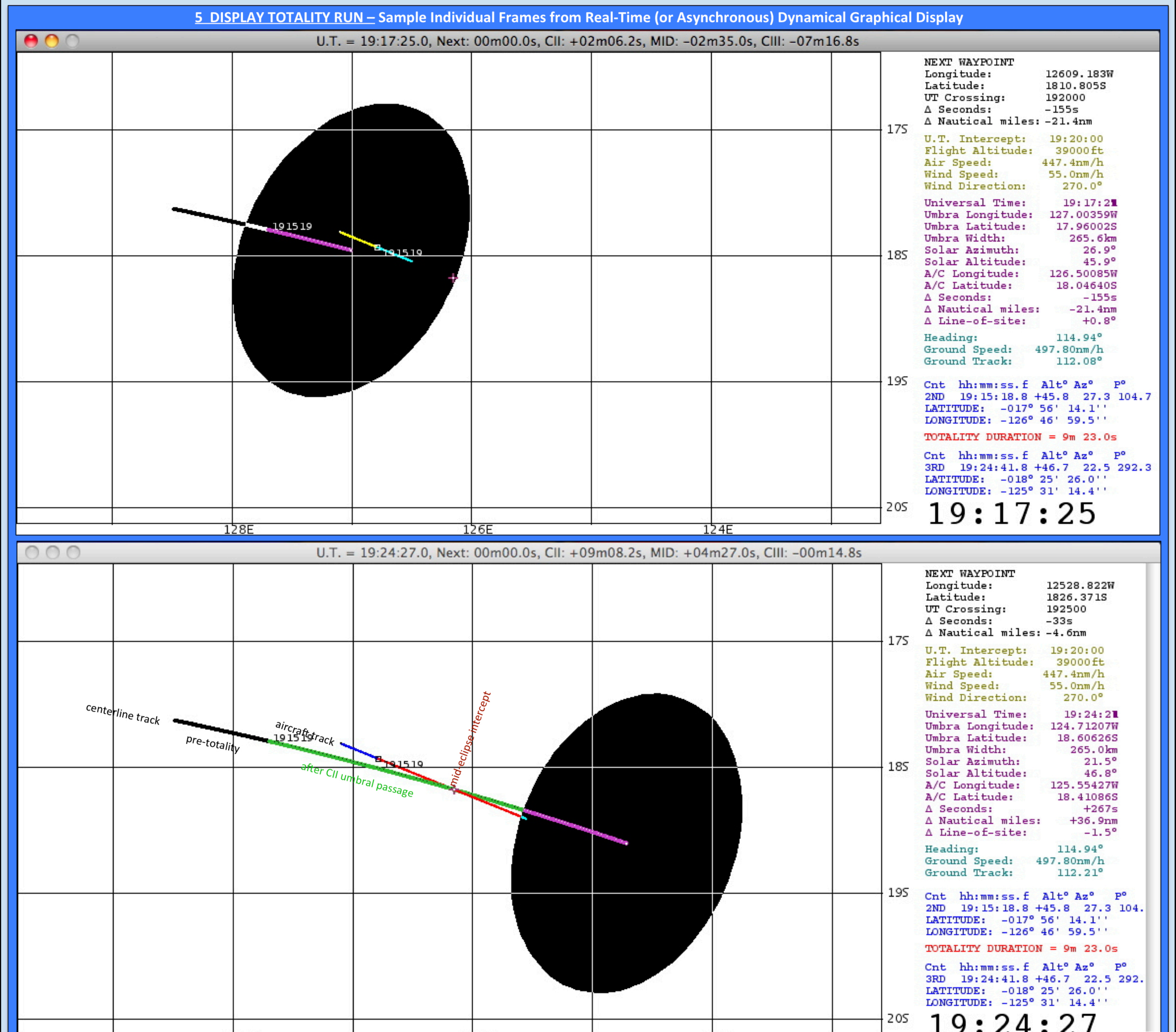
UT correlated position (long./lat.) of umbra shadow axis at height AMSL, shadow width (km), solar azimuth & altitude angle from umbra center with aircraft long./lat.,time and distance (in seconds and km) to mid-eclipse intercept, solar Line-of-Site deviation from window normal angle, aircraft track (w.r.t. true north), solar azimuth and altitude angle from aircraft.

4 SELECT (NAVIGATION) WAYPOINTS



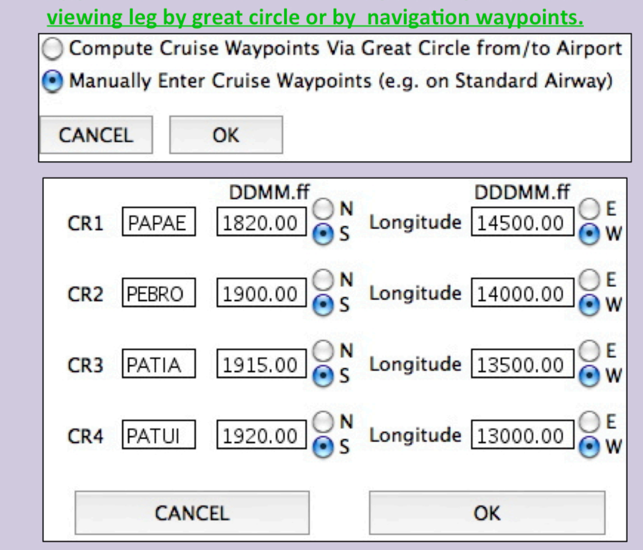


5 DISPLAY TOTALITY RUN – Sample Individual Frames from Real-Time (or Asynchronous) Dynamical Graphical Display

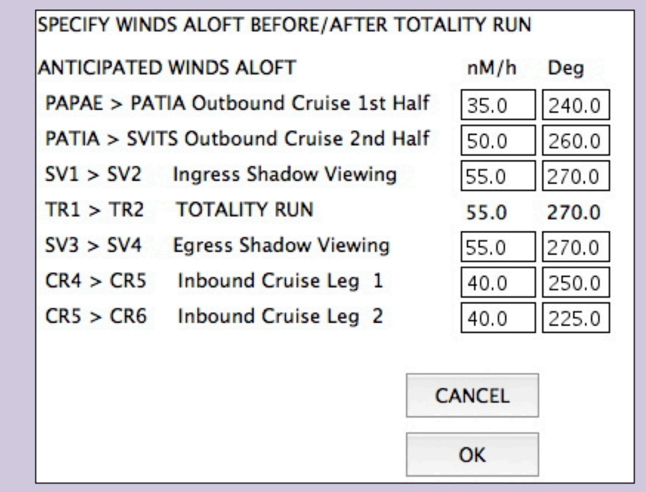


END-TO-END EFLIGHT PLANNING

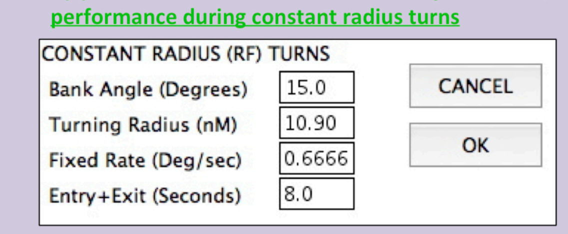
6(a) DEFINE CRUISE – from airport to pre-CII shadow viewing leg by great circle or by navigation waypoints.



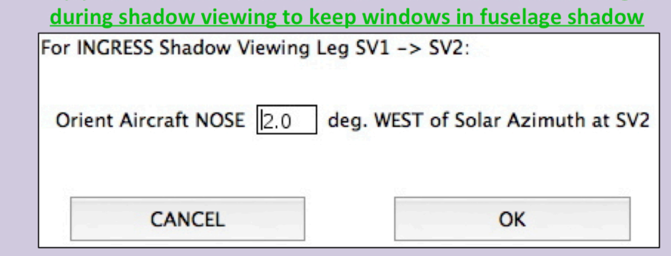
6(b) DEFINE CRUISE – anticipated winds aloft for all primary at-altitude flight legs



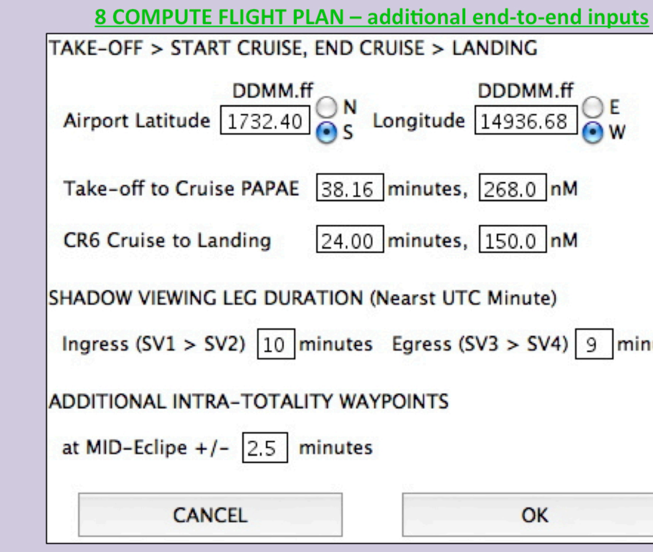
7(a) ENTER TURN PARAMETERS – entry of aircraft performance during constant radius turns



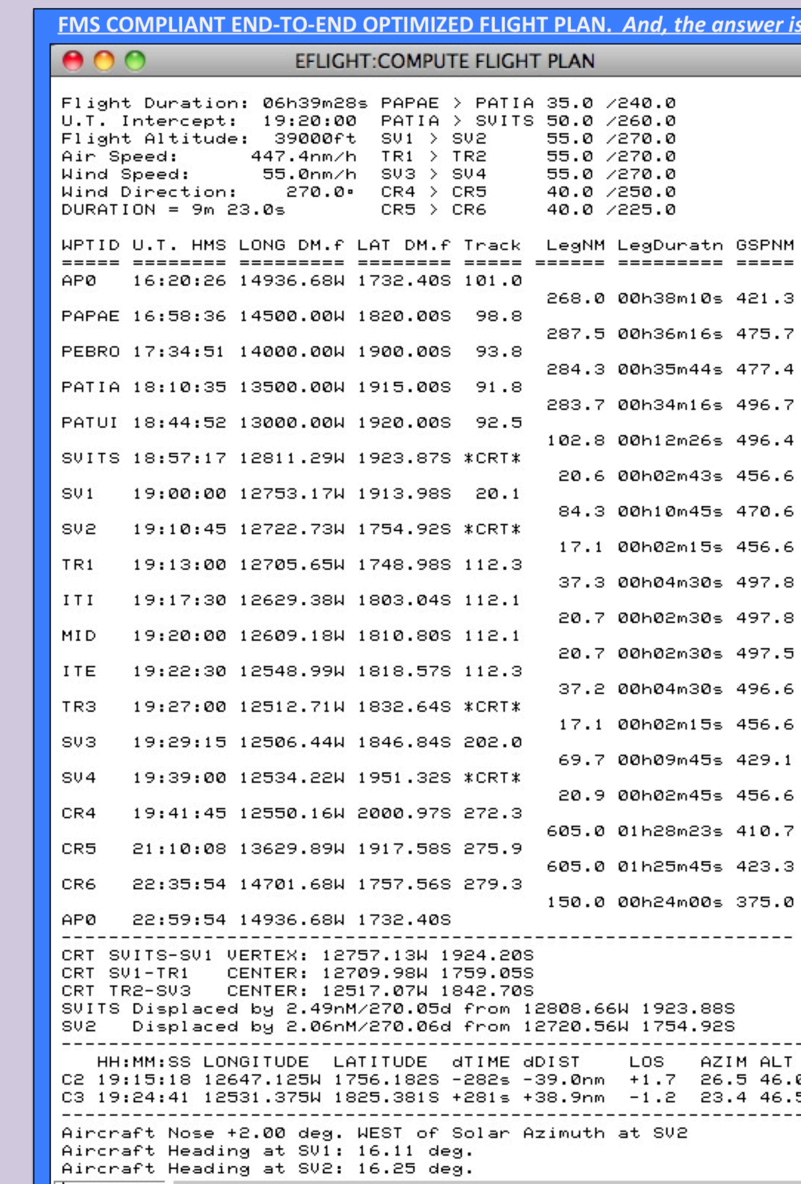
7(b) ENTER TURN PARAMETERS – A/C nose deviation angle during shadow viewing to keep windows in fuselage shadow



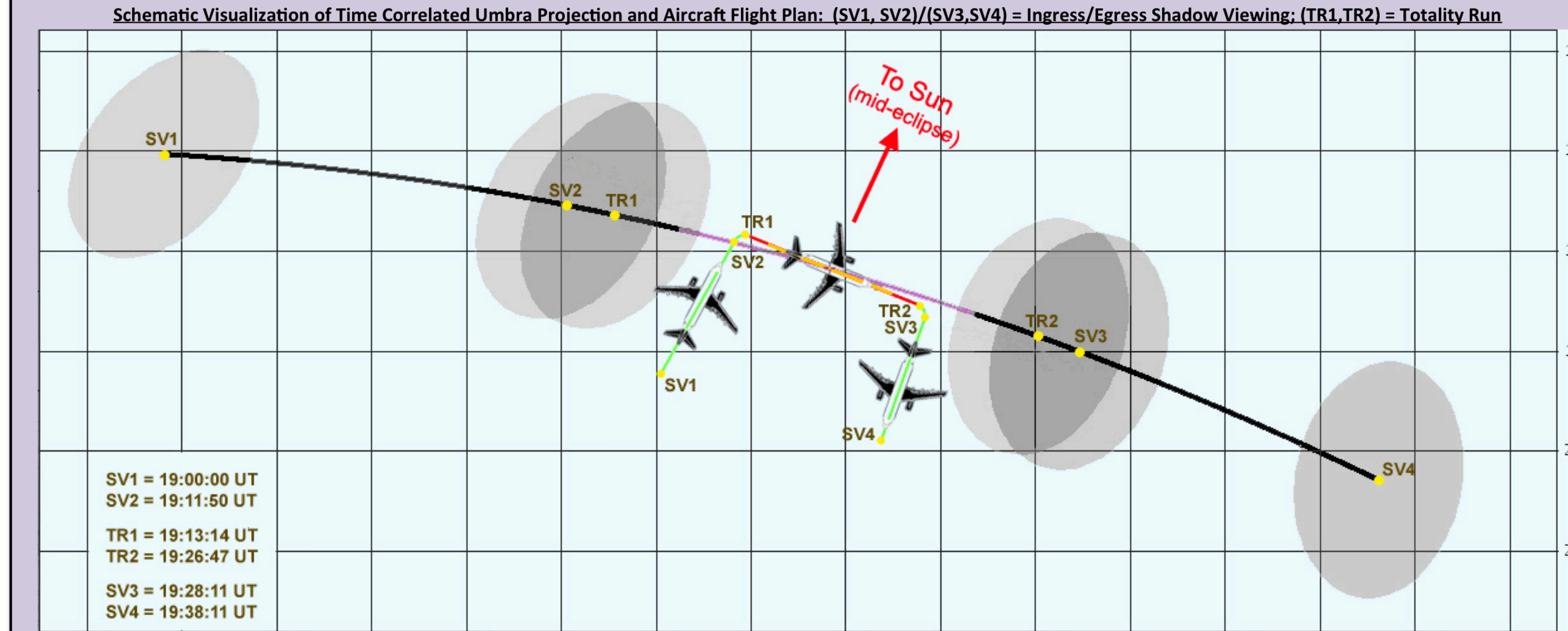
8 COMPUTE FLIGHT PLAN – additional end-to-end inputs



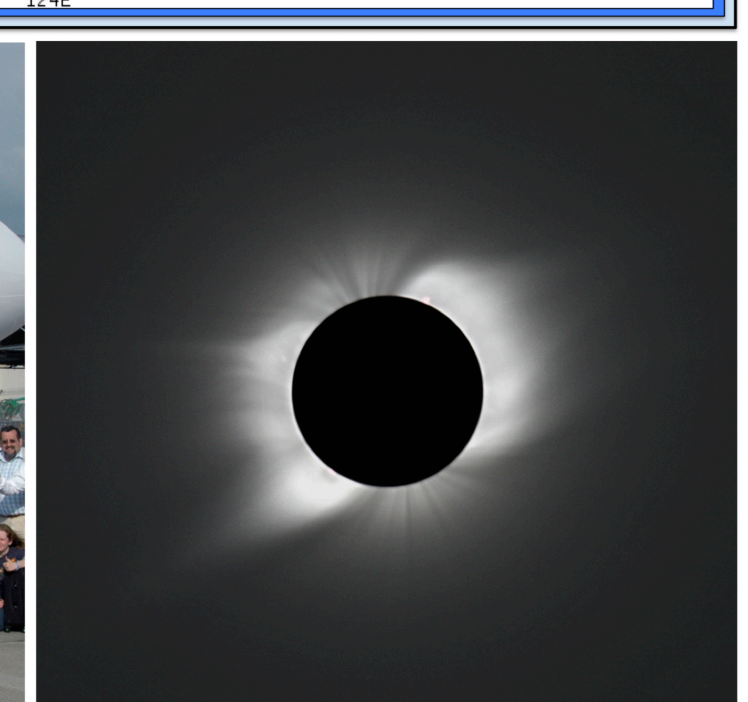
FMS COMPLIANT END-TO-END OPTIMIZED FLIGHT PLAN. *And, the answer is...*



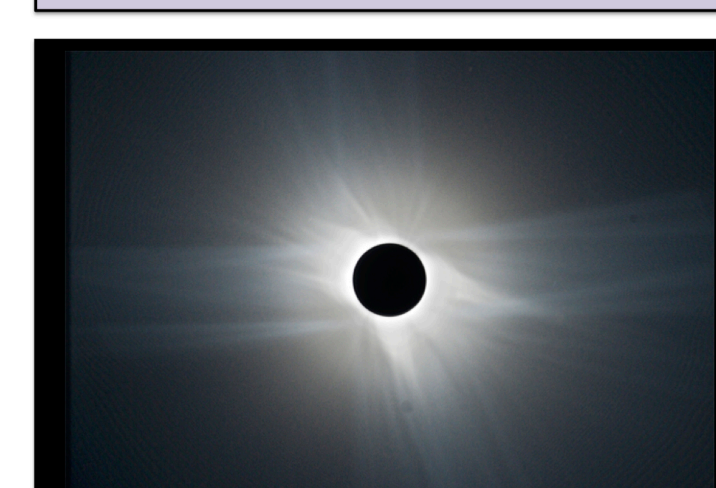
Schematic Visualization of Time Correlated Umbra Projection and Aircraft Flight Plan: (SV1, SV2)/(SV3,SV4) = Ingress/Egress Shadow Viewing; (TR1,TR2) = Totality Run

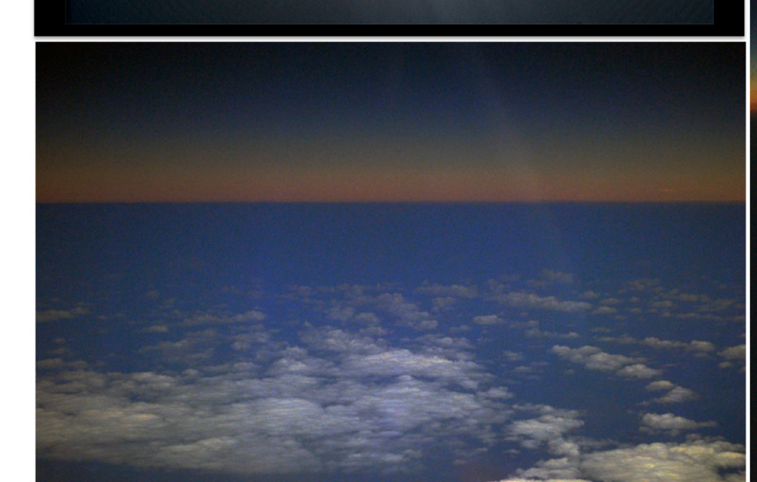


BACK ON THE GROUND AFTER TSE PLANNED & EXECUTED WITH EFLIGHT 2008 (2m 52s TOTALITY, 82.6°N)

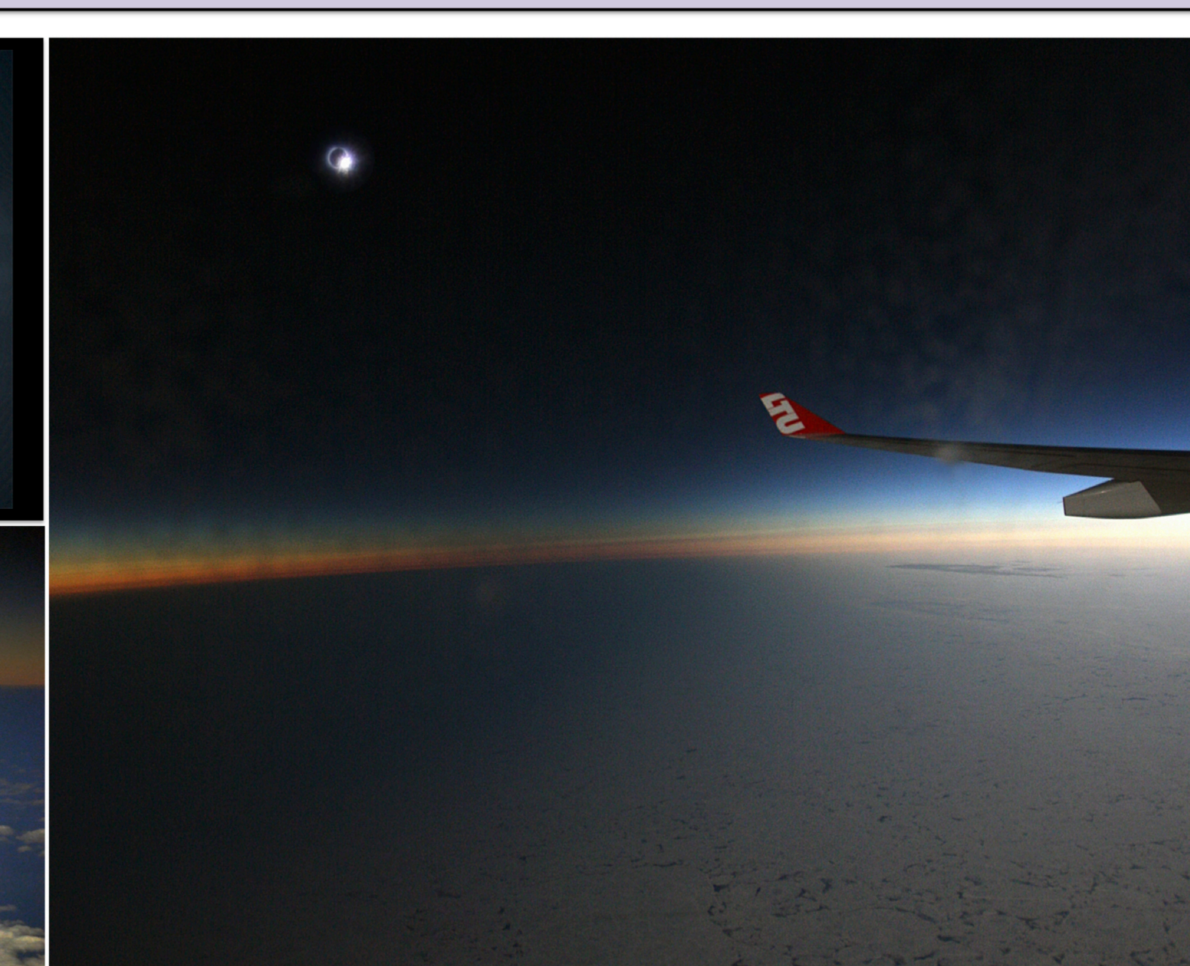


TSE 2008 HIGH CONTRAST/DARK SKY CORONA FROM 36,000 FT. AMSL





EFLIGHT 2010 SHADOW INTERCEPT: MID-TOTALITY & UMBRA APPROACH



TSE 2008 CII: STUNNING VIEW OF THE SKY ABOVE AND SEA-ICE BELOW ENABLED BY EFLIGHT PRECISION NAVIGATION