Enceladus Eruptions

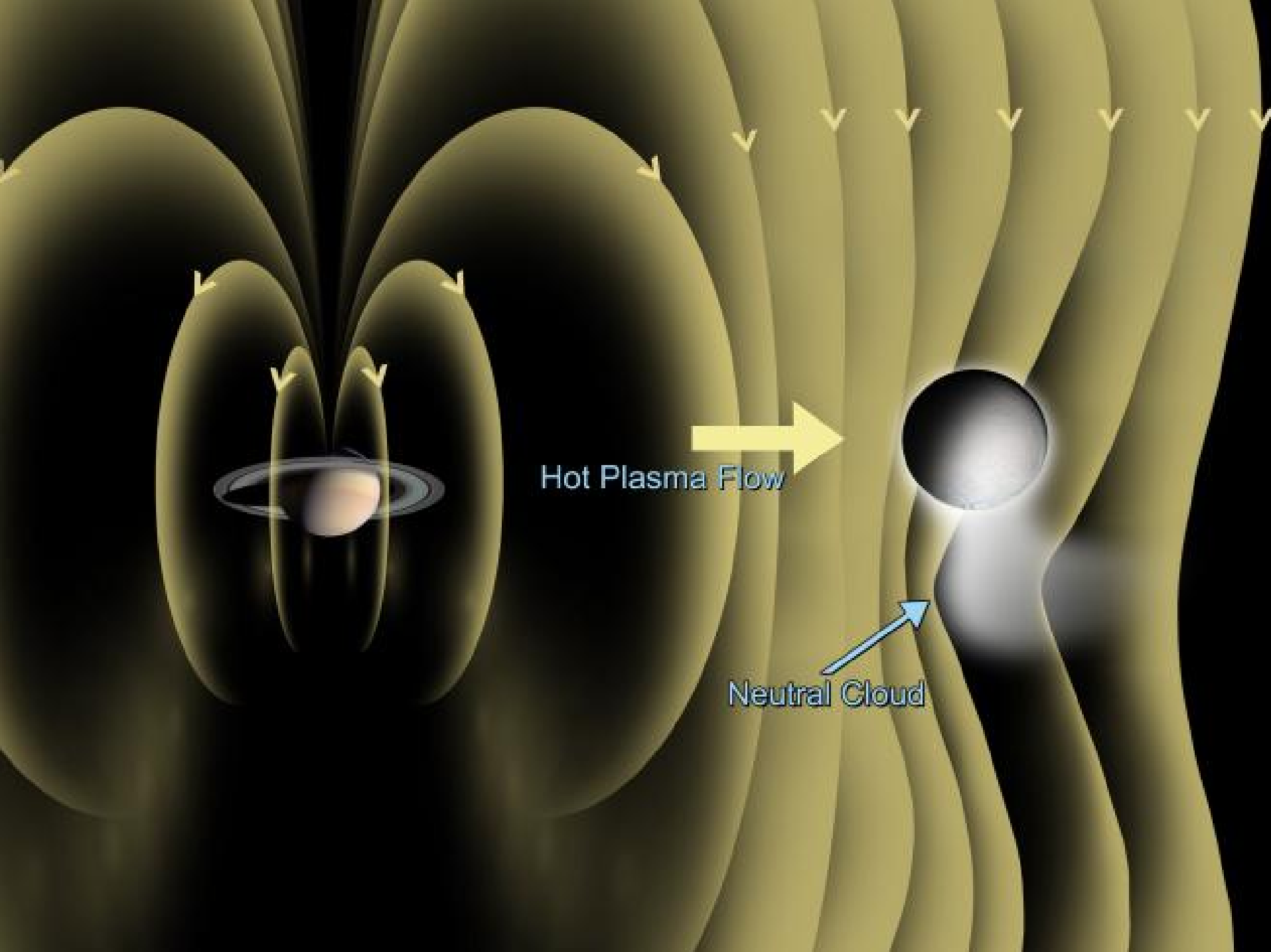
Larry W. Esposito
Principal Investigator
UV imaging Spectrograph

Enceladus Mysteries

- It is the shiniest object in the Solar System
- Broad plains have no craters: they are very young
- It is at the center of Saturn's E-ring
- Cassini UVIS discovered a cloud of oxygen atoms around Saturn, it peaks near Enceladus orbit

First Clues

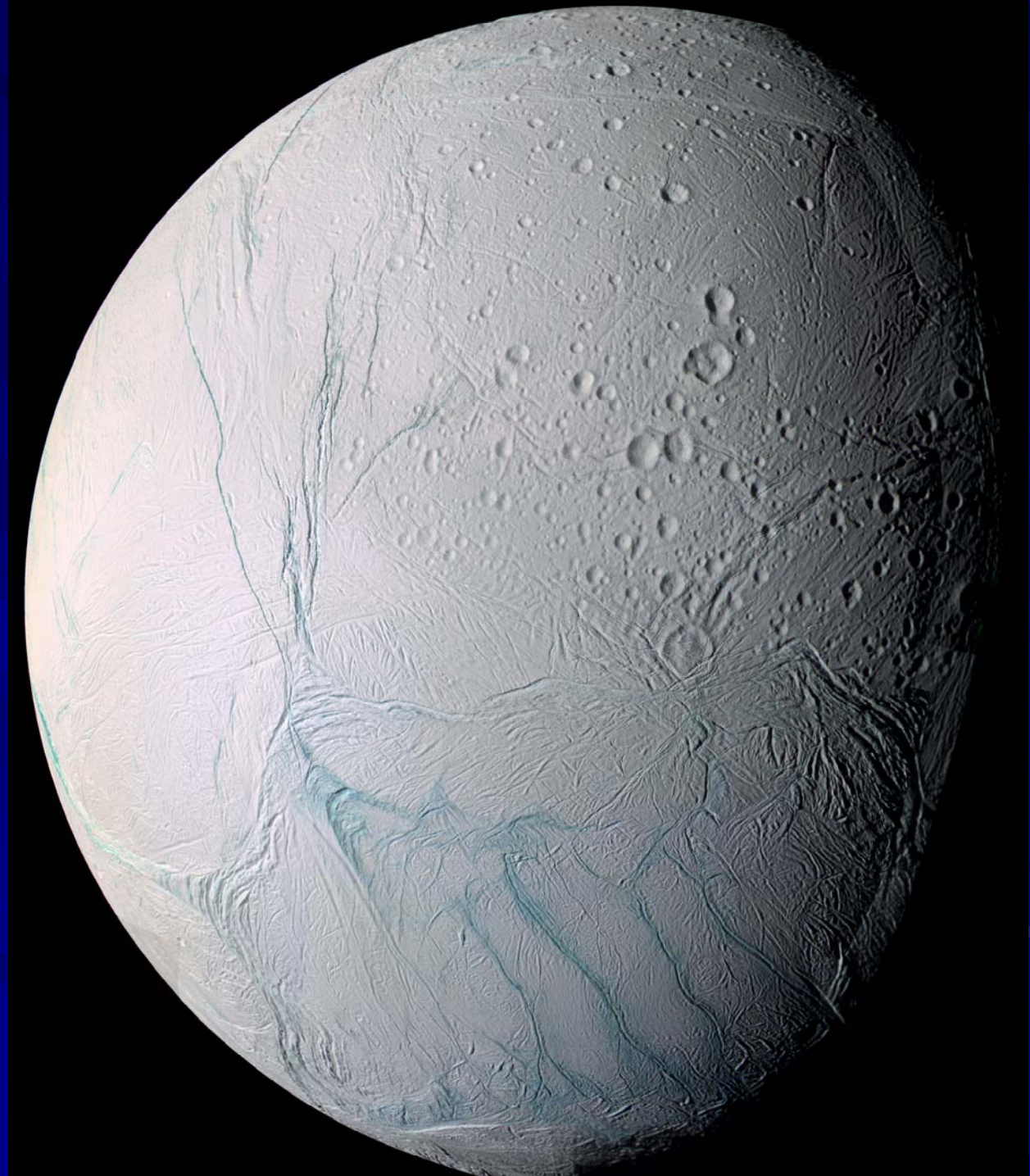
On 17 February 2005, Cassini's Magnetometer detected a bending of the magnetic field around Enceladus

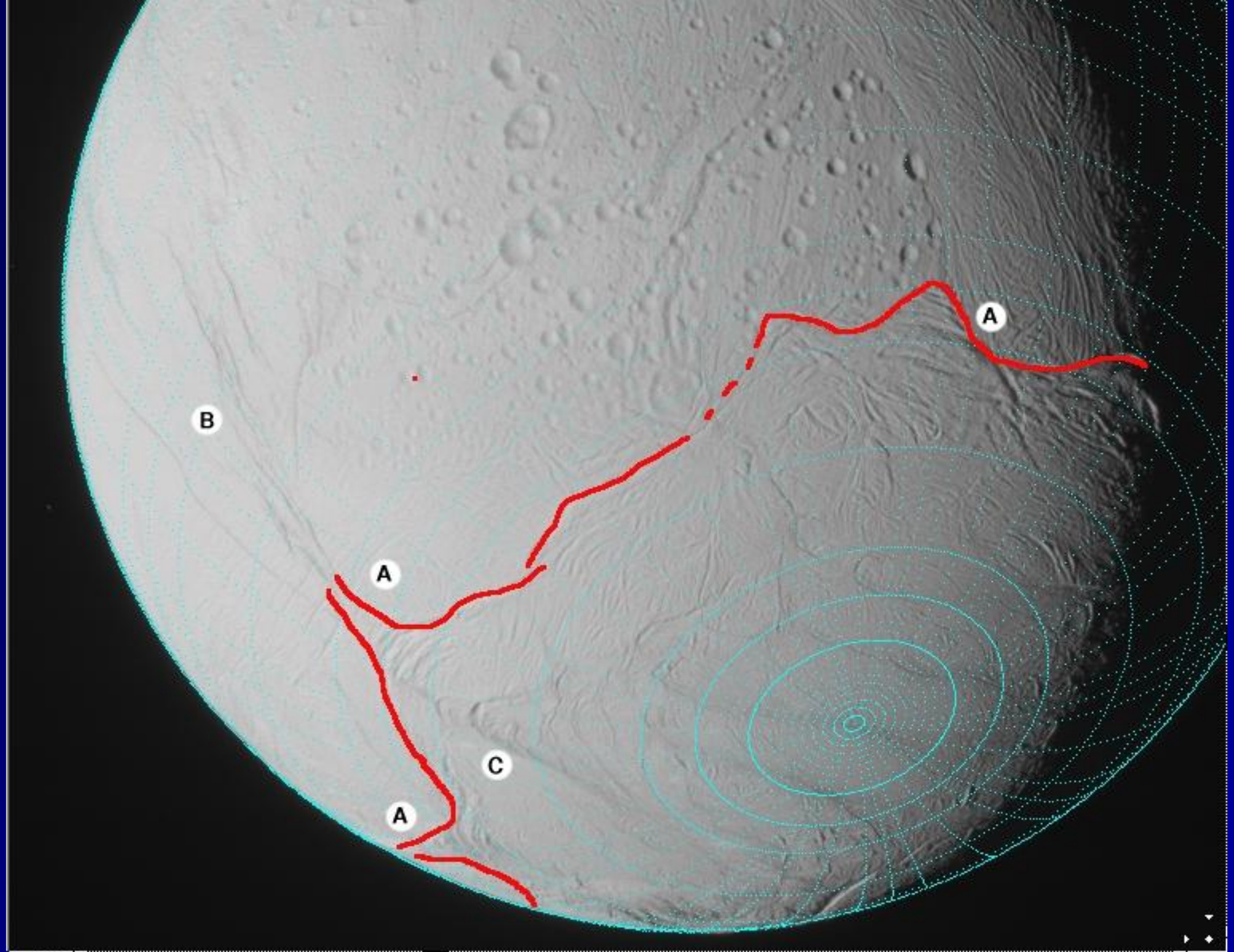

Hot Plasma Flow
Neutral Cloud

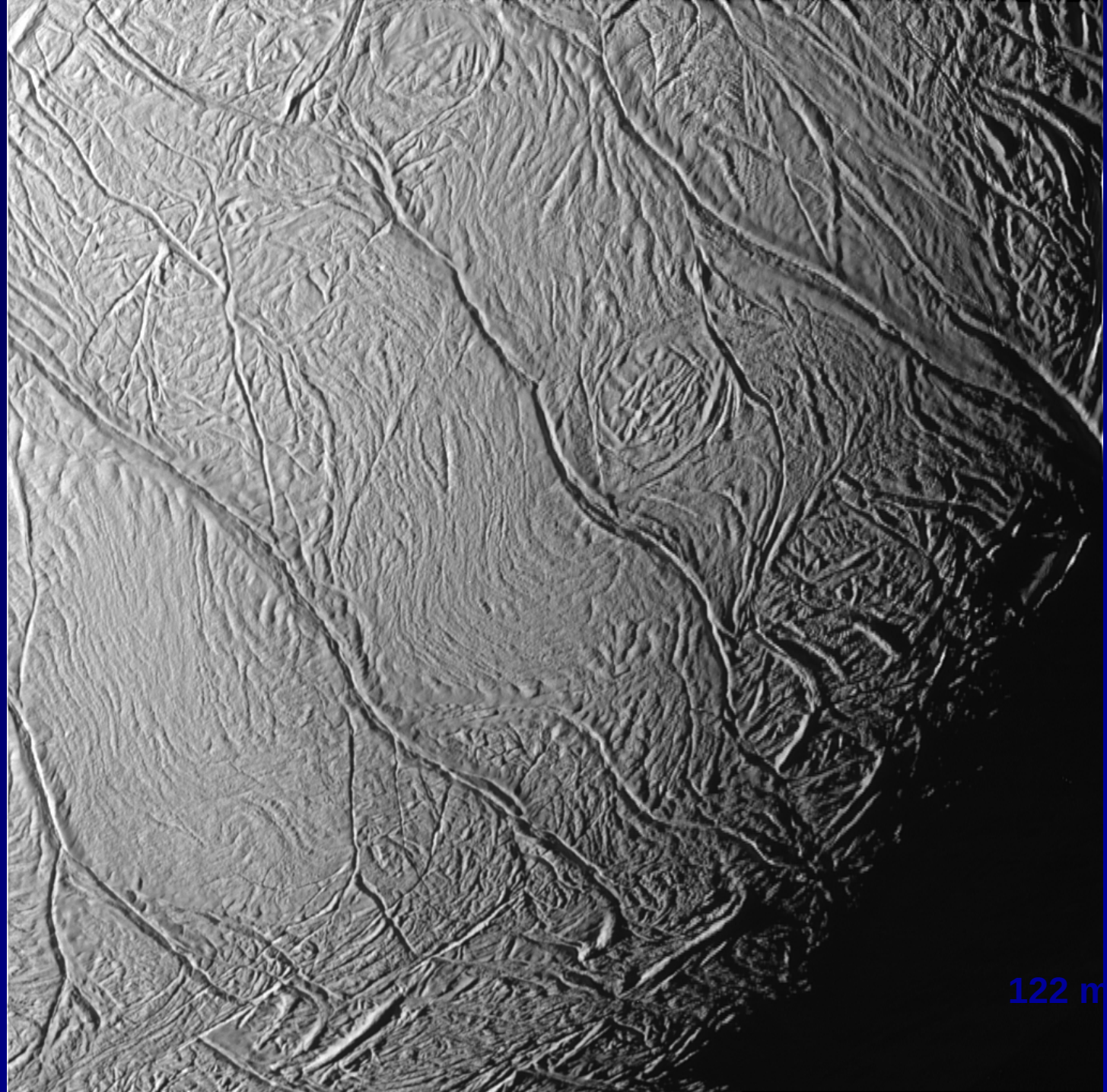
Cassini was re-directed

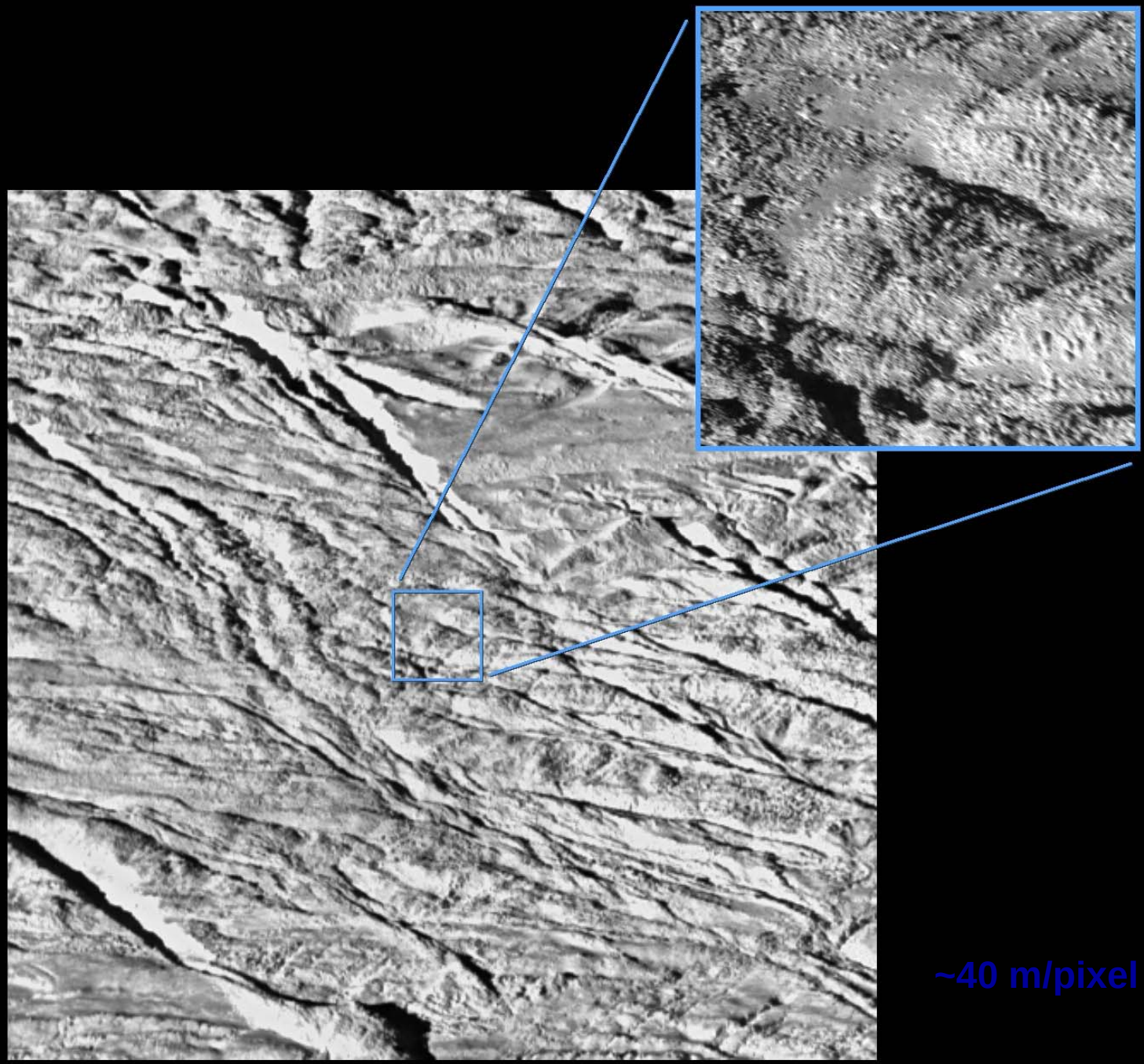
- To fly within 179 km of Enceladus on 14 July 2005

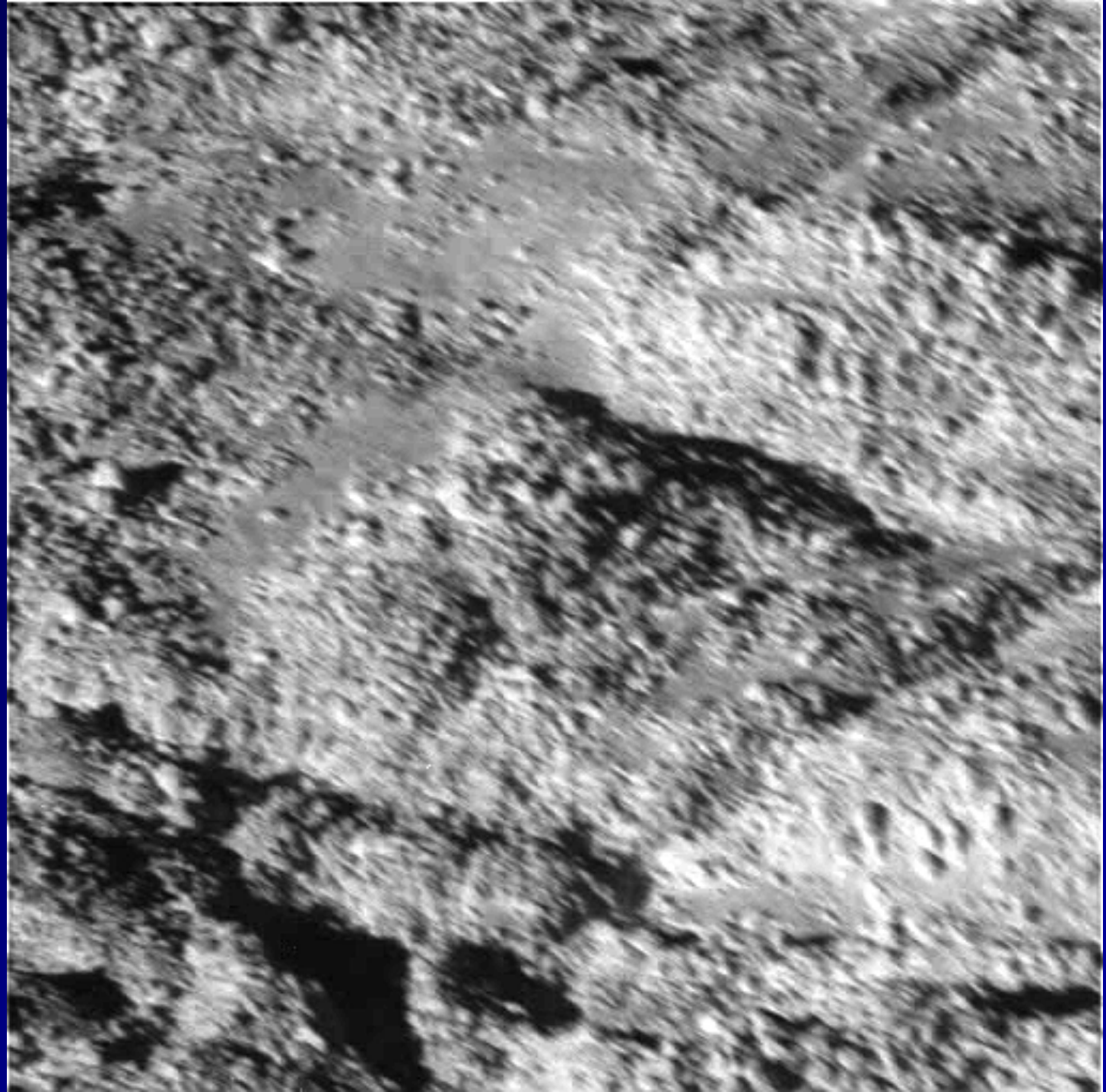
ISS Color Mosaic Rev 11



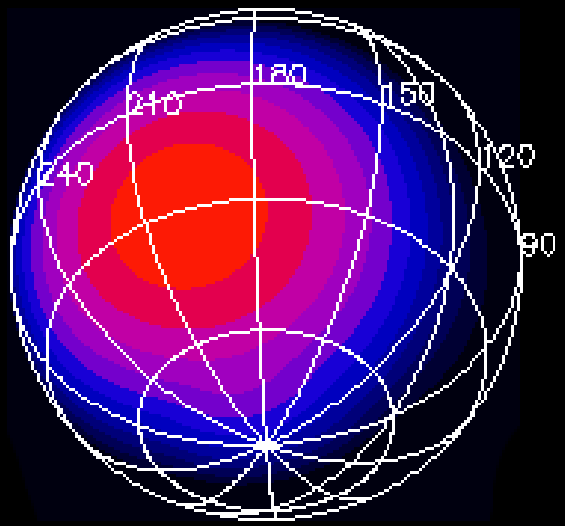

A
B
A
C
A


122 m

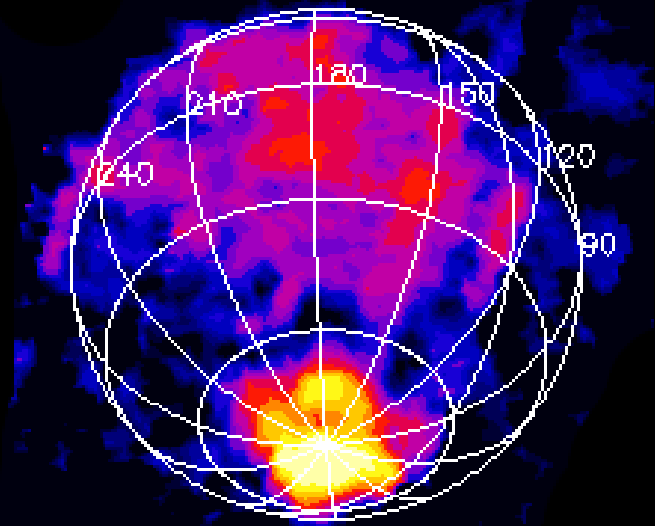

~40 m/pixel



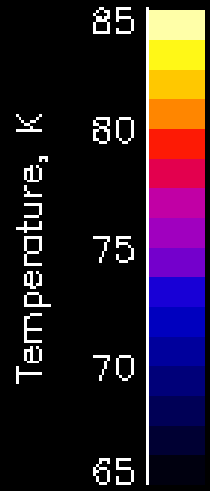
Cassini CIRS 11 - 17 micron Observation of Thermal Emission from Enceladus, July 14 2005



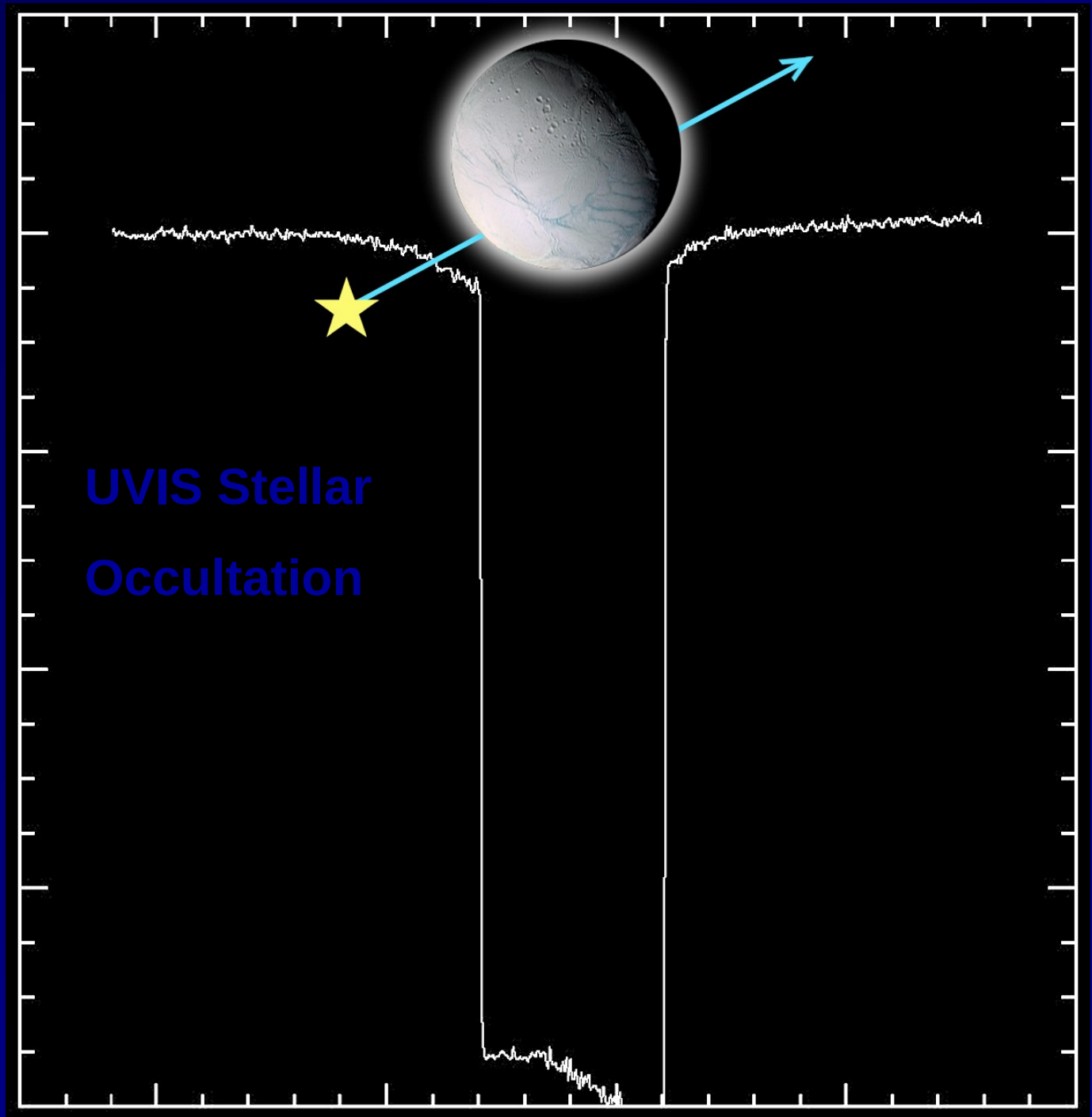
Predicted Temperatures



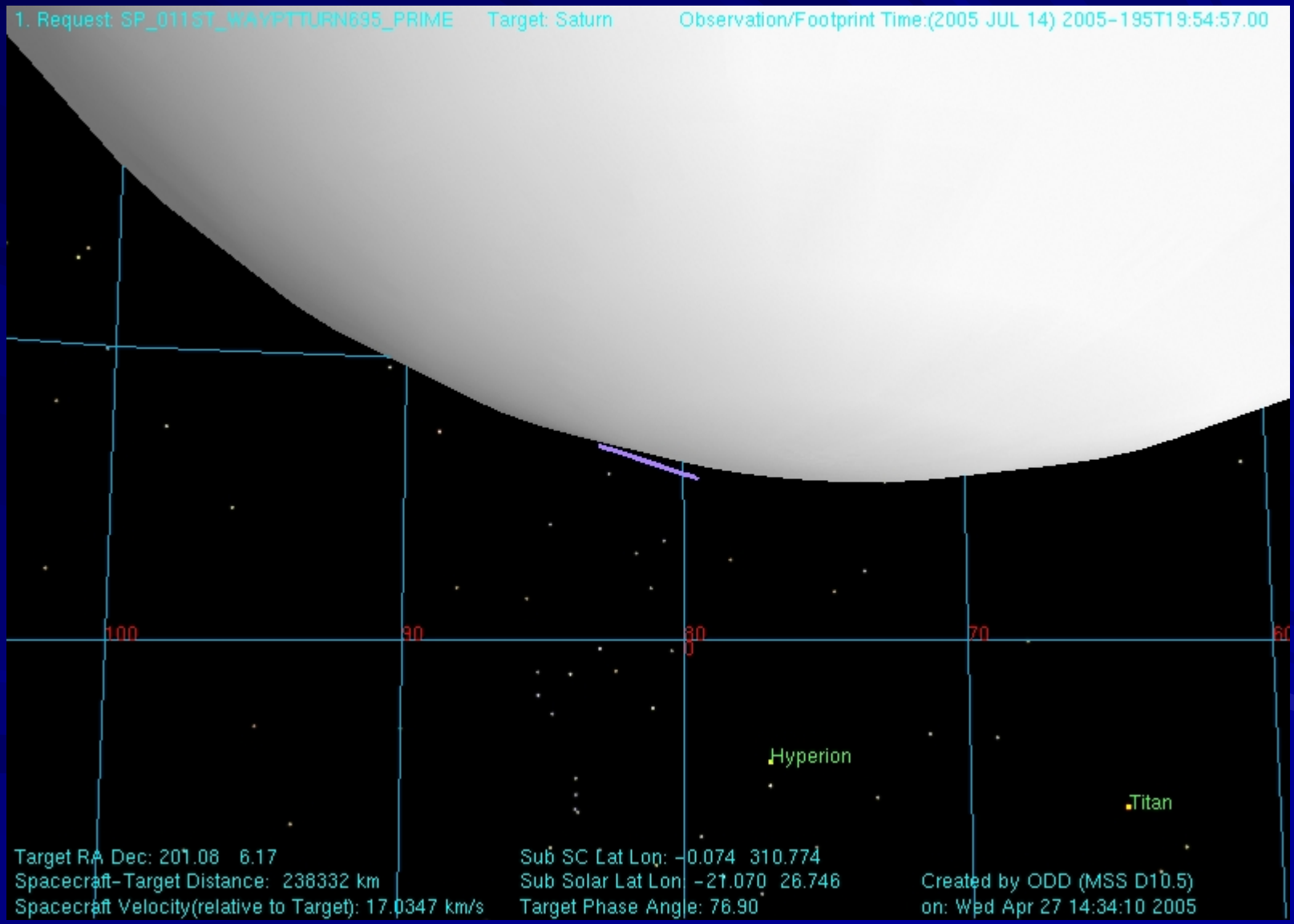
Observed Temperatures



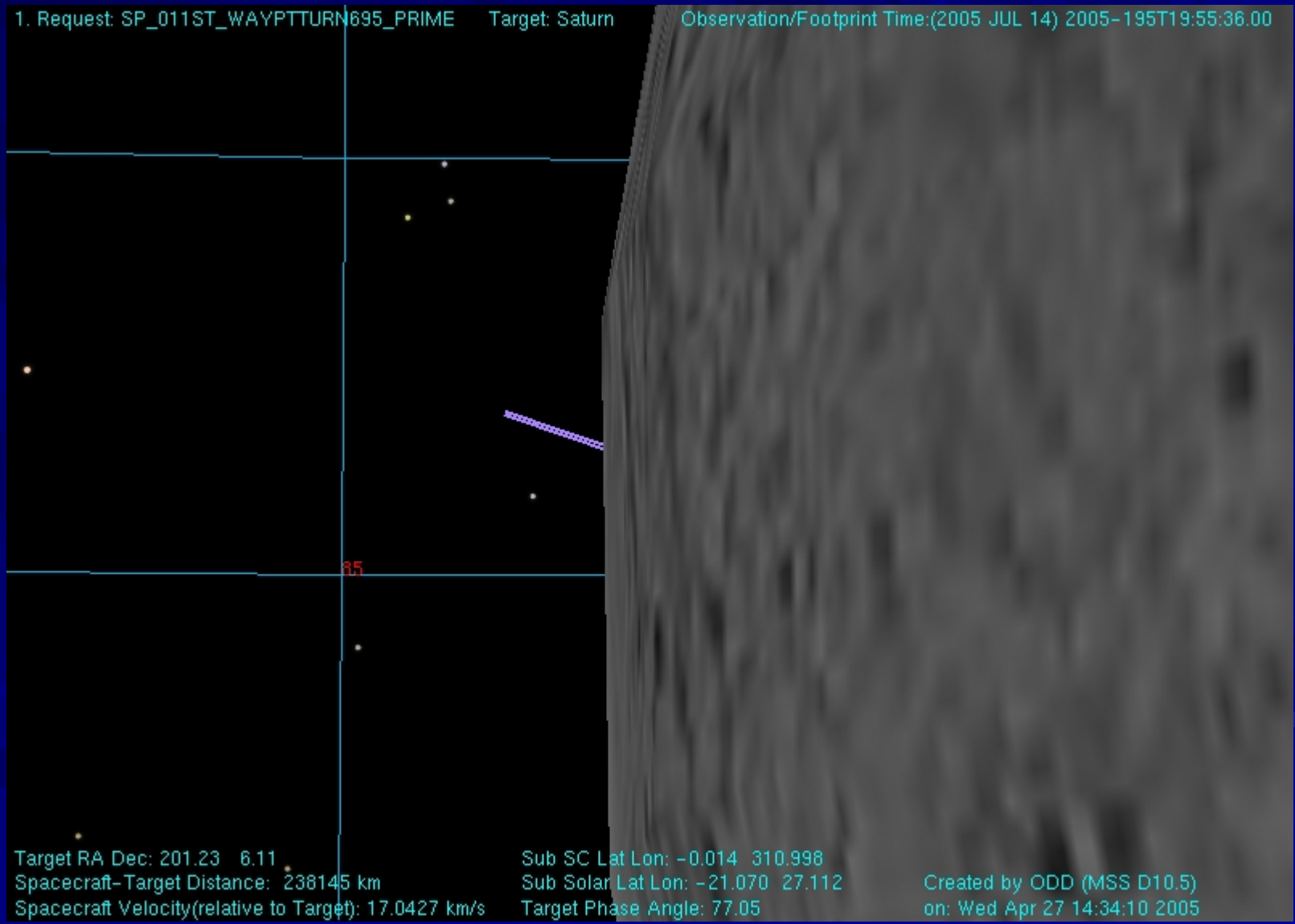

80 79 80 81 91 87 78 74 78 74

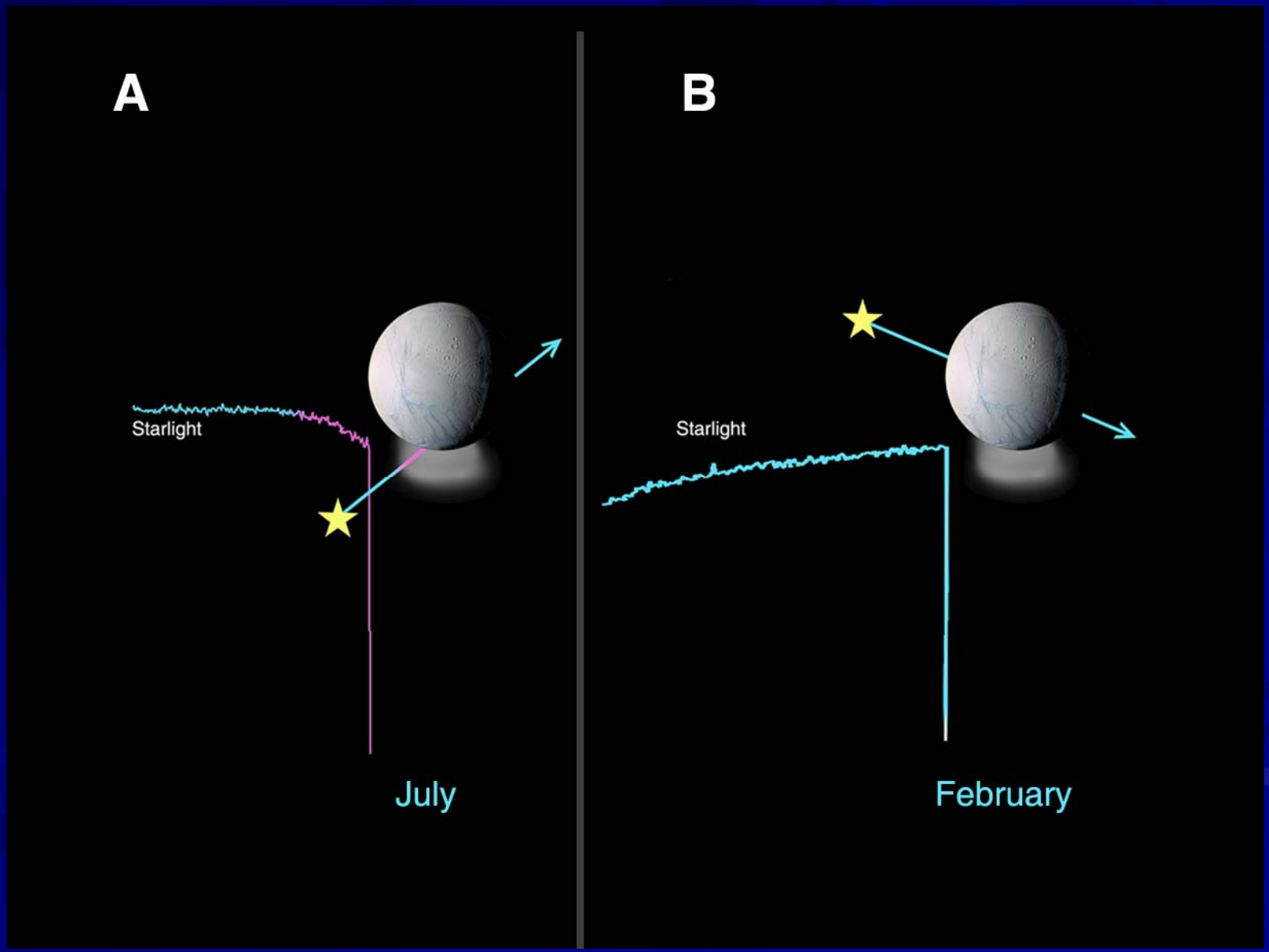

UVIS Stellar
Occultation

Gamma Orionis Ingress

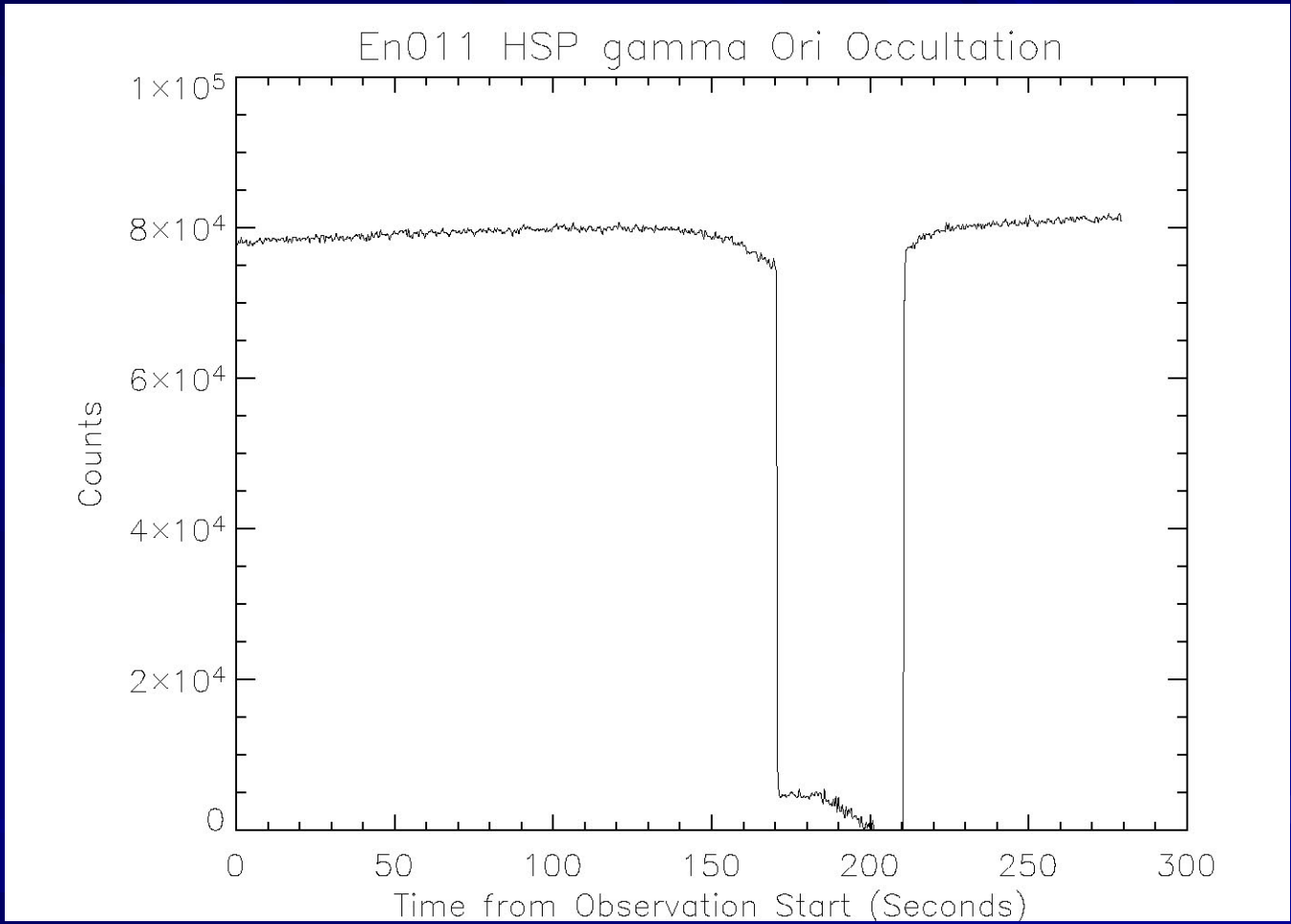


Gamma Orionis Egress



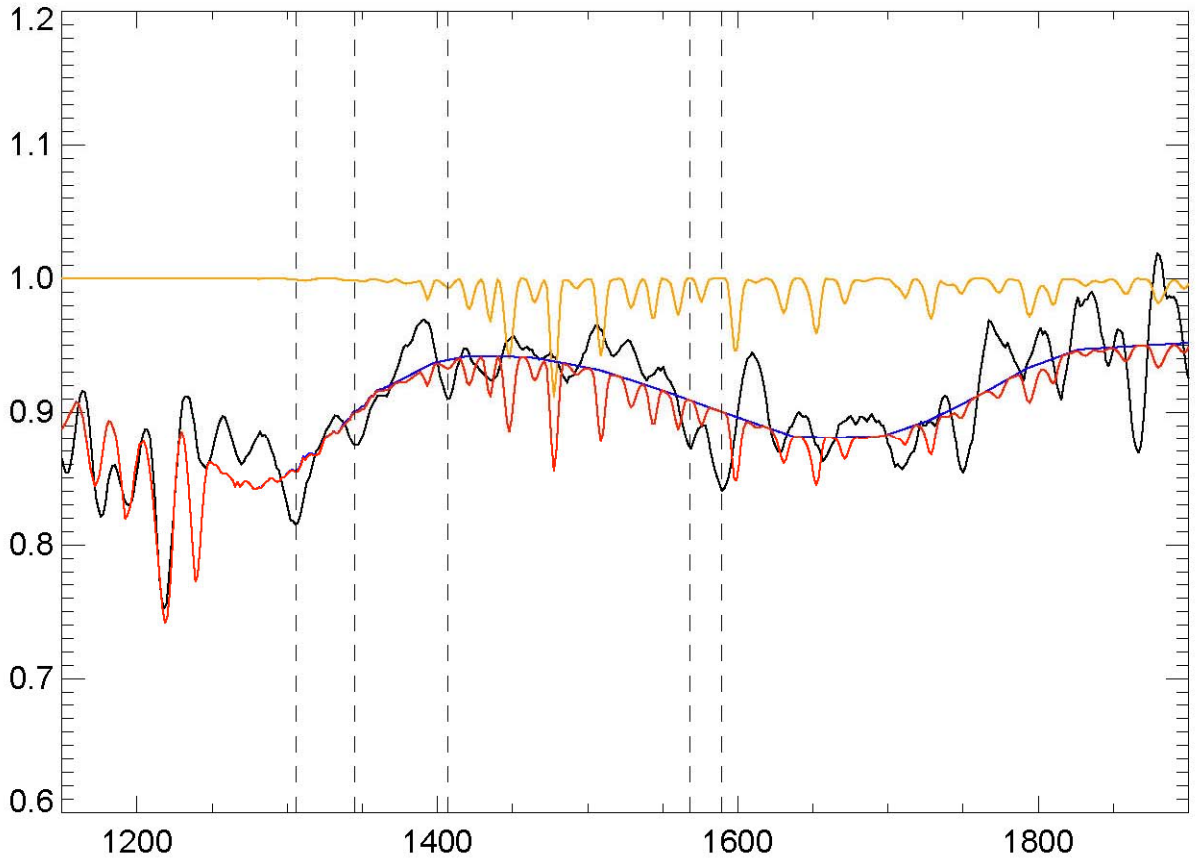

A
Starlight
July
B
Starlight
February

High Speed Photometer (HSP) vs. Time



- Clear indication of attenuation of signal during occultation ingress; egress is signature of HSP warmup
- Start to sense atmosphere ~24 sec prior to hard limb occultation
- Ray height at –24 sec is ~ 155 km

Composition of the Atmosphere is Water Vapor



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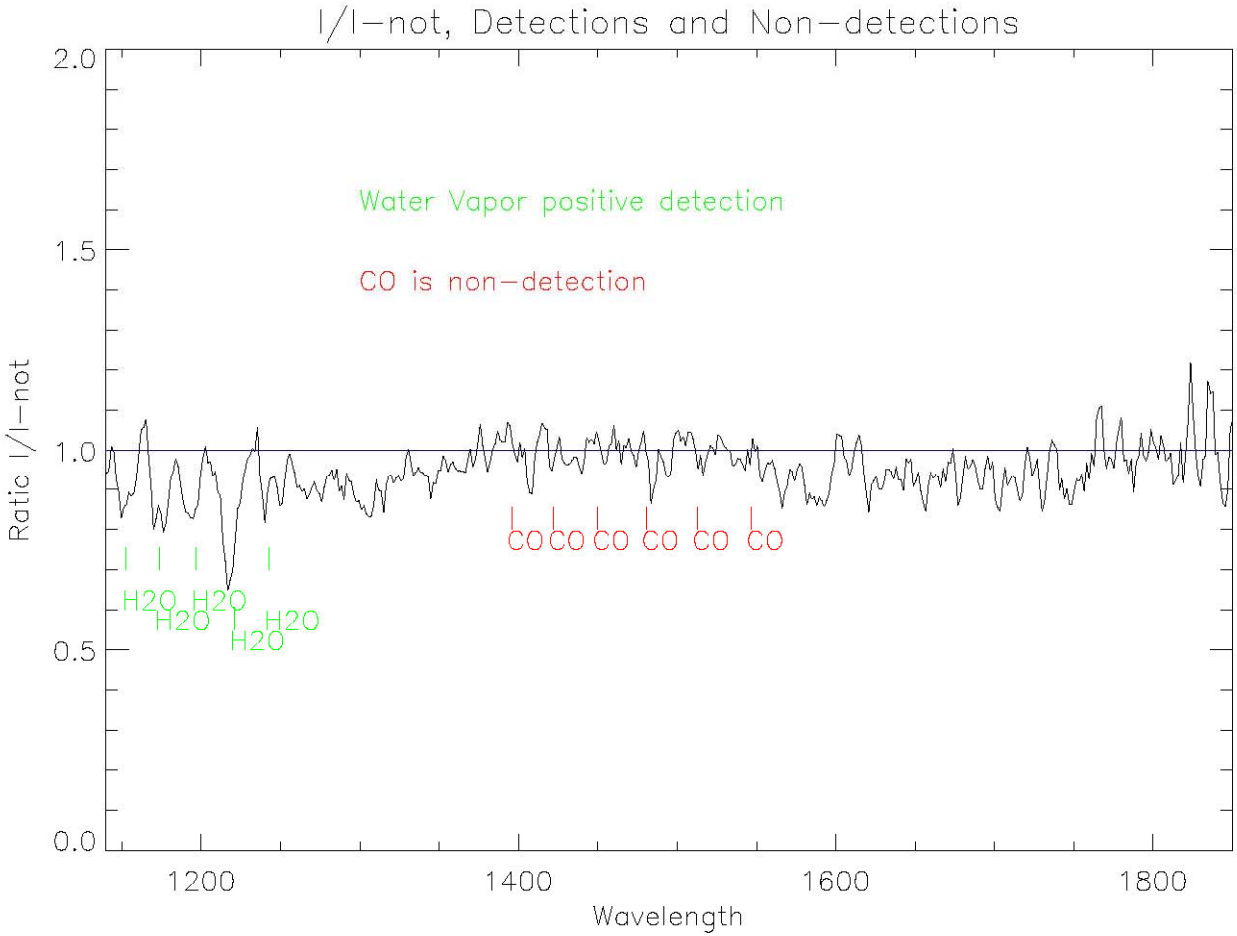
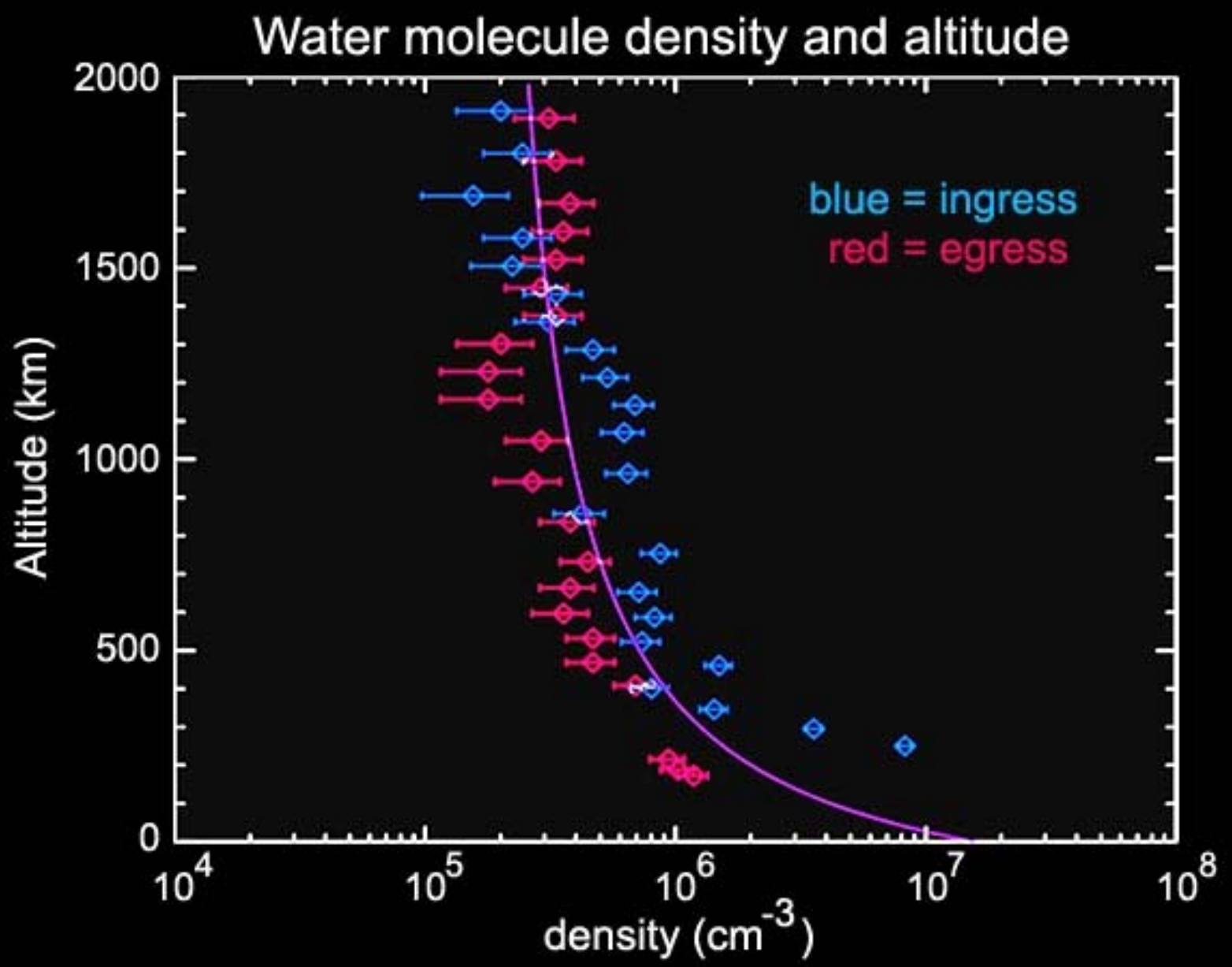
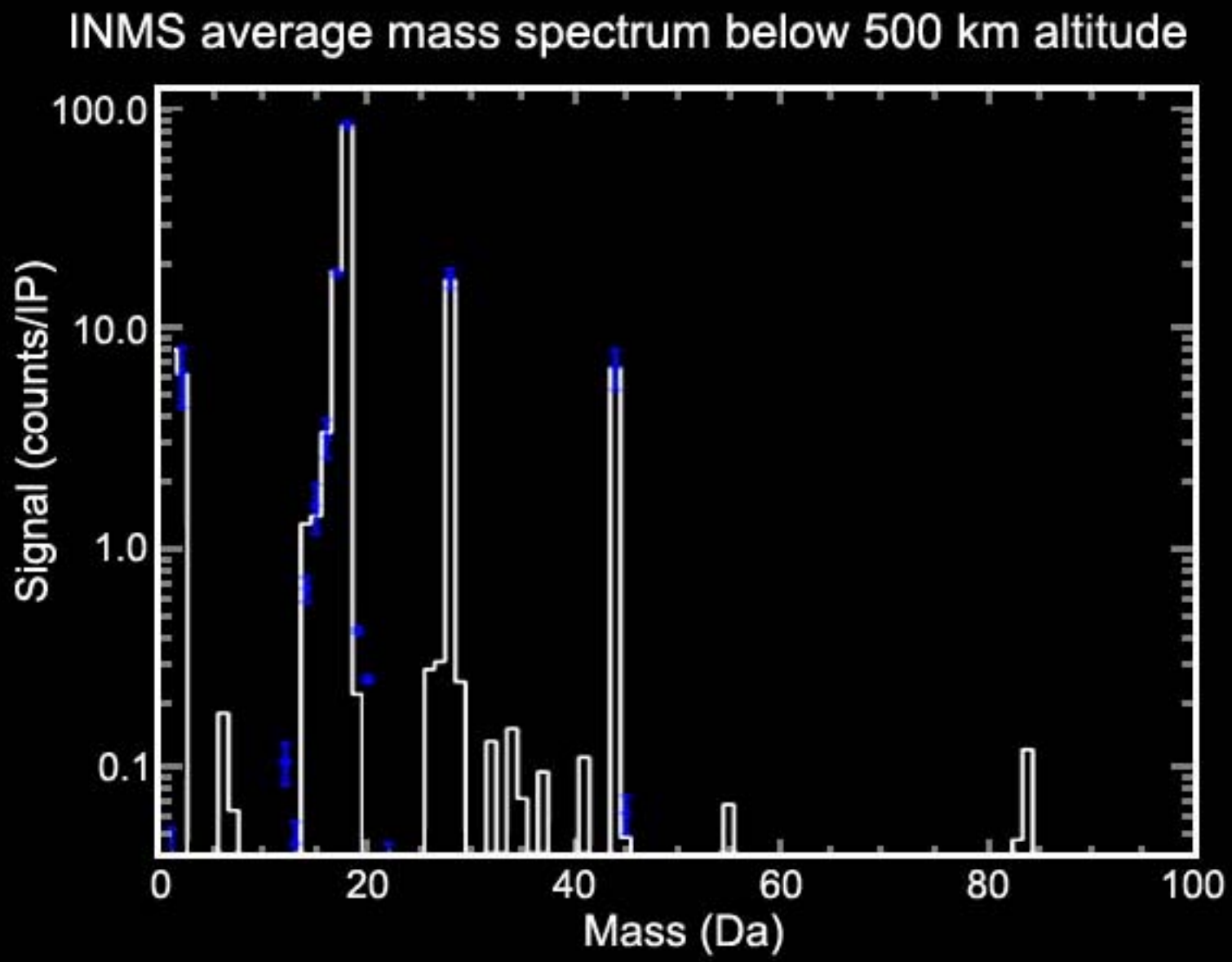
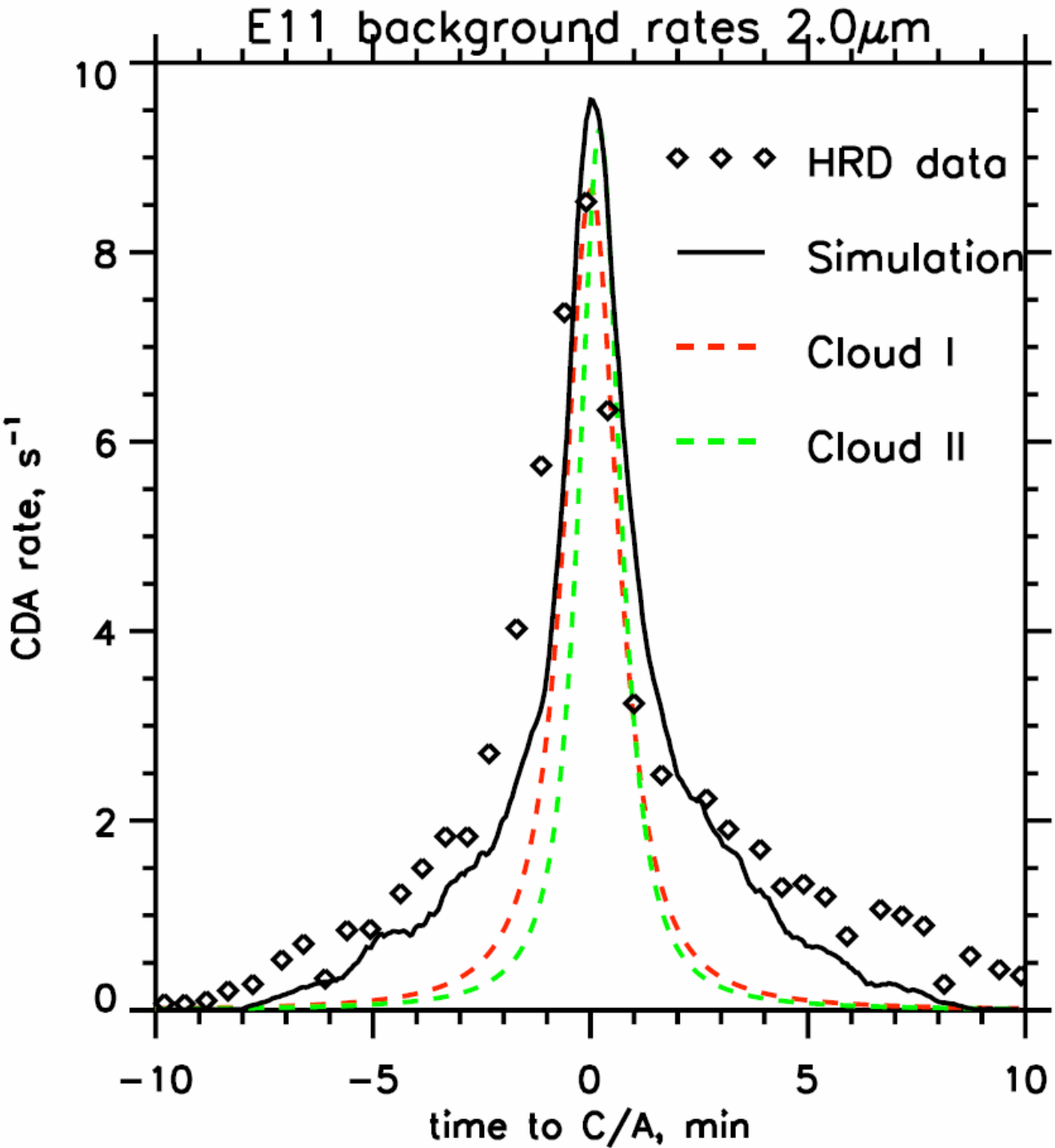
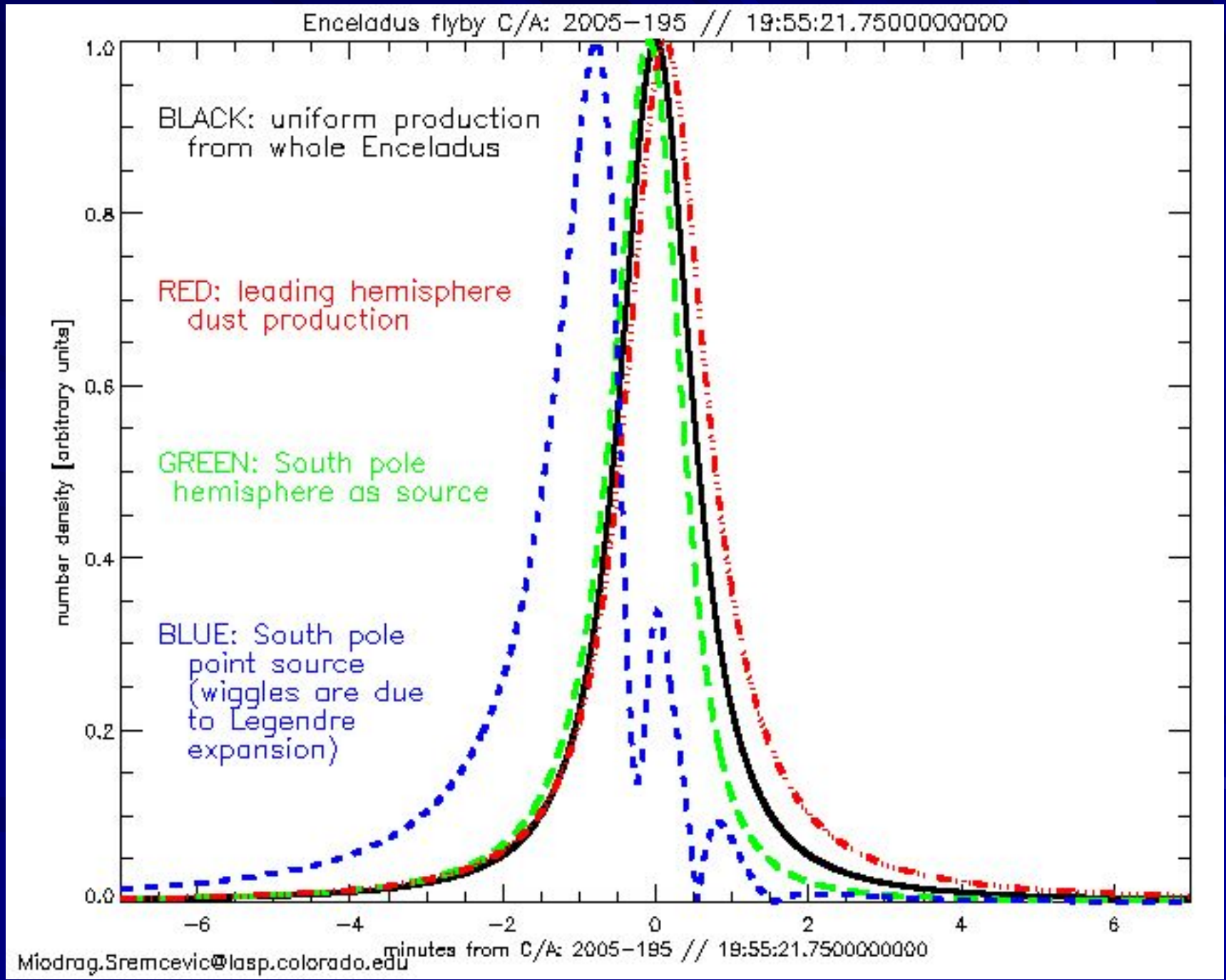


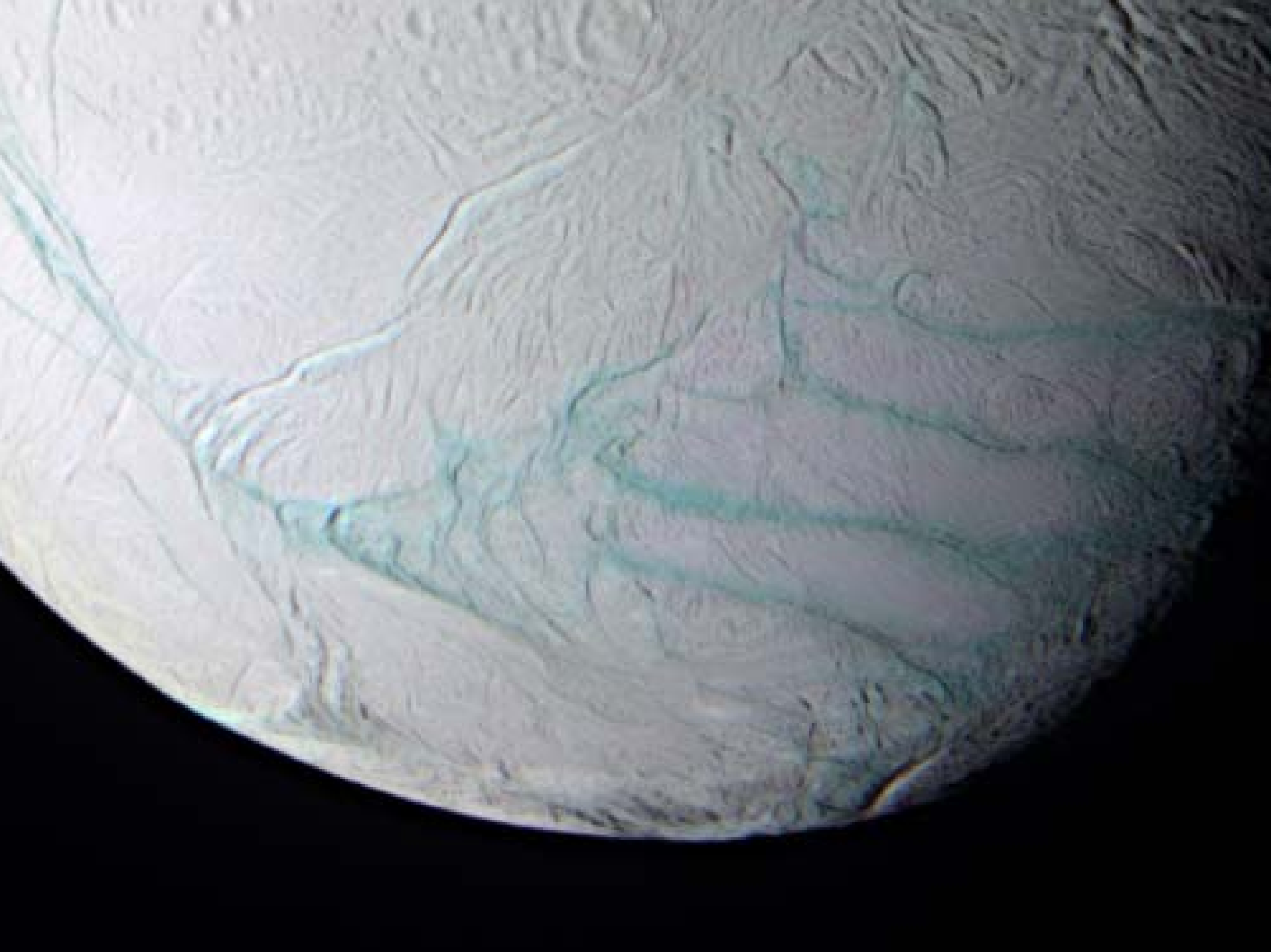
The non-detection of CO is important because the Cassini Ion Neutral Mass Spectrometer detected a species with mass 28. That constituent could be CO or N_2, but the UVIS data place an upper limit on CO of 3 x 10^{14} cm^{-2}.

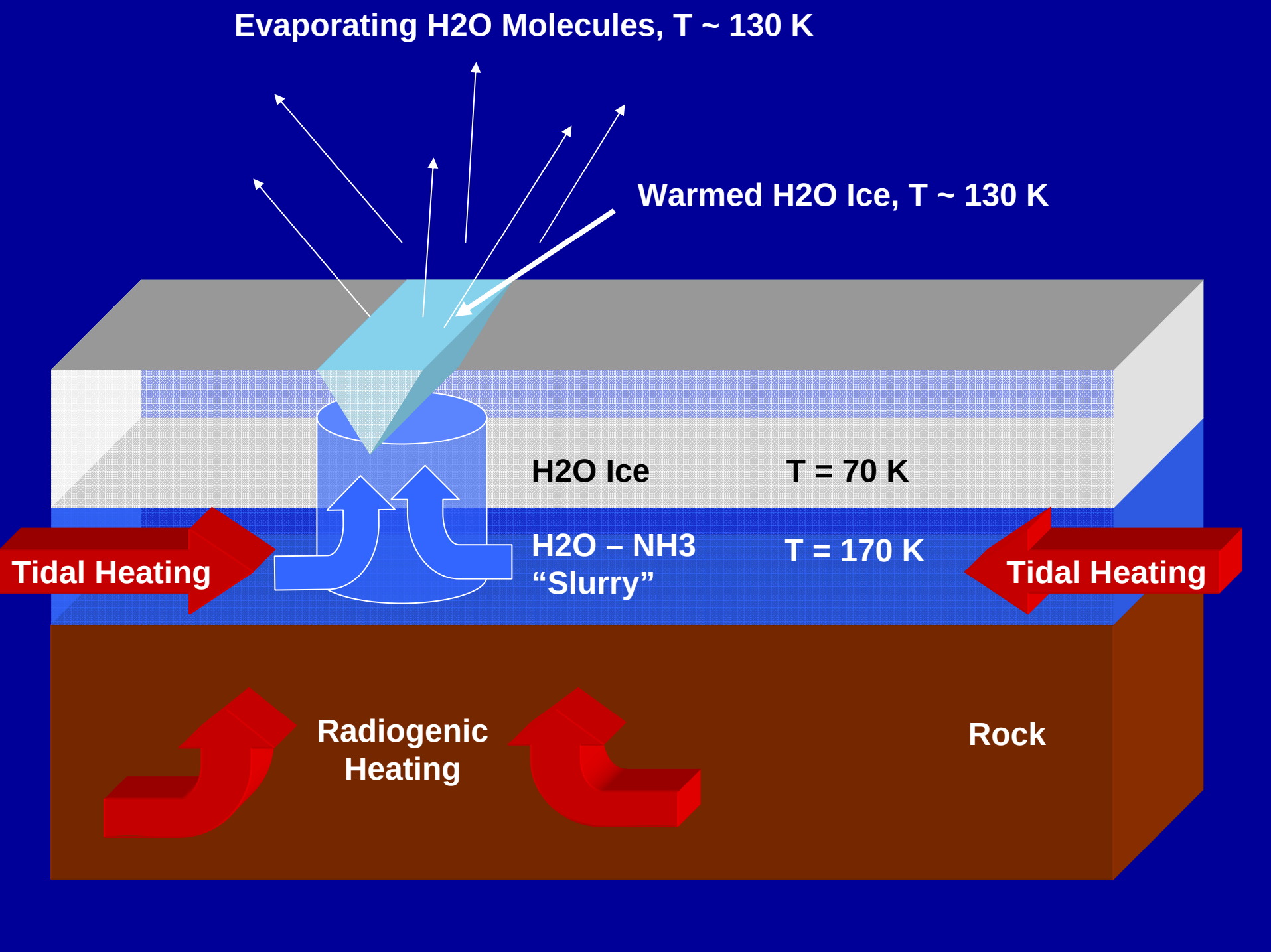

Water molecule density and altitude
2000
1500
1000
500
0
Altitude (km)
blue = ingress
red = egress
10^4
10^5
10^6
10^7
10^8
density (cm^{-3})


INMS average mass spectrum below 500 km altitude
Signal (counts/IP)
100.0
10.0
1.0
0.1
0
20
40
60
80
100
Mass (Da)

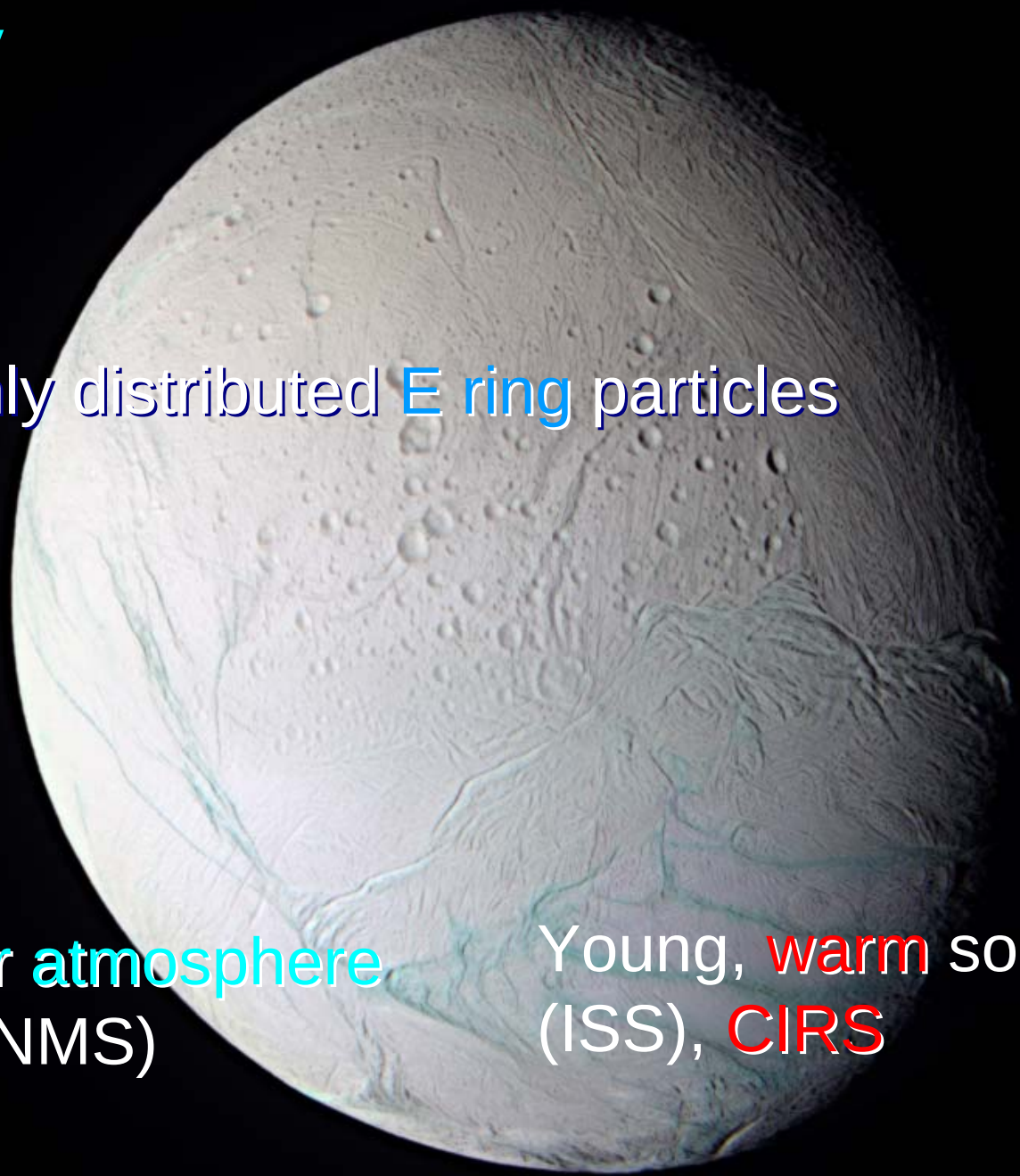

E11 background rates 2.0μm
HRD data
Simulation
Cloud I
Cloud II
CDA rate, s⁻¹
time to C/A, min
10
8
6
4
2
0
−10
−5
0
5
10


Enceladus flyby C/A: 2005-195 // 19:55:21.7500000000
BLACK: uniform production from whole Enceladus
RED: leading hemisphere dust production
GREEN: South pole hemisphere as source
BLUE: South pole point source (wiggles are due to Legendre expansion)
number density [arbitrary units]
1.0
0.8
0.6
0.4
0.2
0.0
-6
-4
-2
0
2
4
6
minutes from C/A: 2005-195 // 19:55:21.7500000000
Miodrag.Sremcevic@lasp.colorado.edu




Evaporating H2O Molecules, T ~ 130 K
Warmed H2O Ice, T ~ 130 K
H2O Ice
T = 70 K
H2O – NH3
“Slurry”
T = 170 K
Tidal Heating
Tidal Heating
Radiogenic
Heating
Rock

Summary



Non-uniformly distributed E ring particles (CDA)

Tenuous, polar atmosphere (UVIS, MAG, INMS)

Young, warm south pole (ISS), CIRS

UVIS Results

The occultation of Gamma Orionis July 11 observed by UVIS during the EN011 flyby has led to the following results:

- Determination of the composition of Enceladus' atmosphere
  - Water vapor fits the absorption spectrum best
    - Near surface abundance = 1.5 x 10^{16} cm^{-2}
  - Upper limit for CO abundance ~ 2% of water column density
- Localization of Enceladus' atmosphere
  - Enceladus' atmosphere is not global, it has only been detected near the south pole
    - The atmosphere was not detected on the ingress or egress of the Lambda Sco occultation in February 2005
    - The atmosphere was detected on the ingress but not the egress of the gamma Orionis occultation
- *The water vapor escaping from Enceladus is adequate to supply the atomic oxygen in the Saturn system detected by UVIS, and to re-supply Saturn's E ring*