Loki Modeling Update

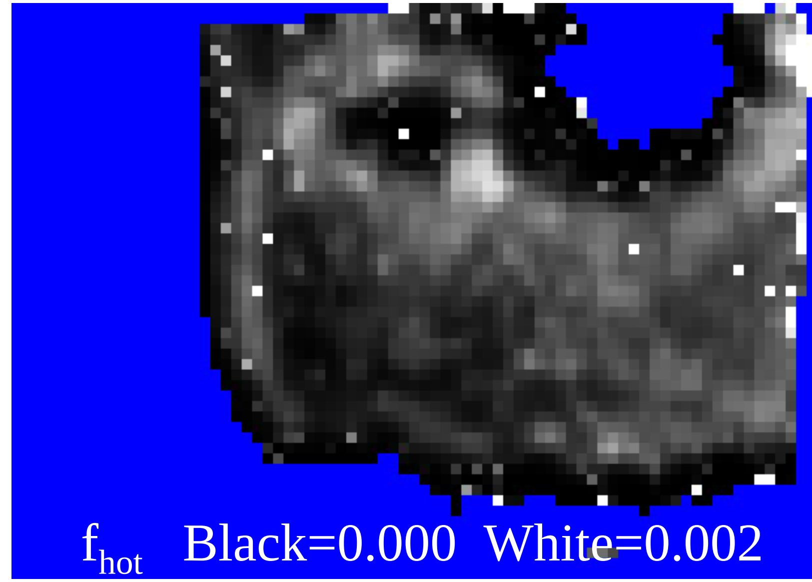
Robert R. Howell

University of Wyoming

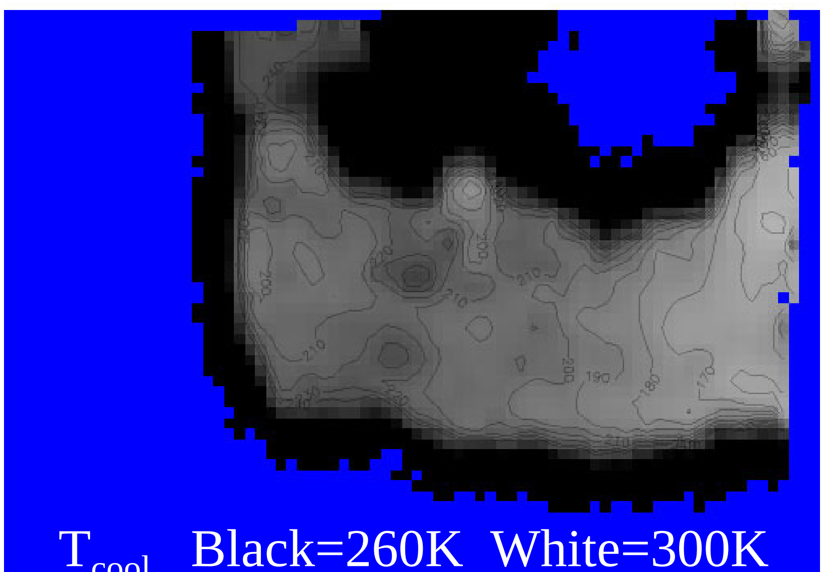
Two Component Models

- T_{cool} (1-f) of surface
- T_{hot} f of surface
- 3 variables, 3 data points
  2.44, 3.28, 4.70μm
  but fits other wavelengths well too
- Using "image cube" (not tube)
  so some spatial mixing. Be suspicious of "edge" effects

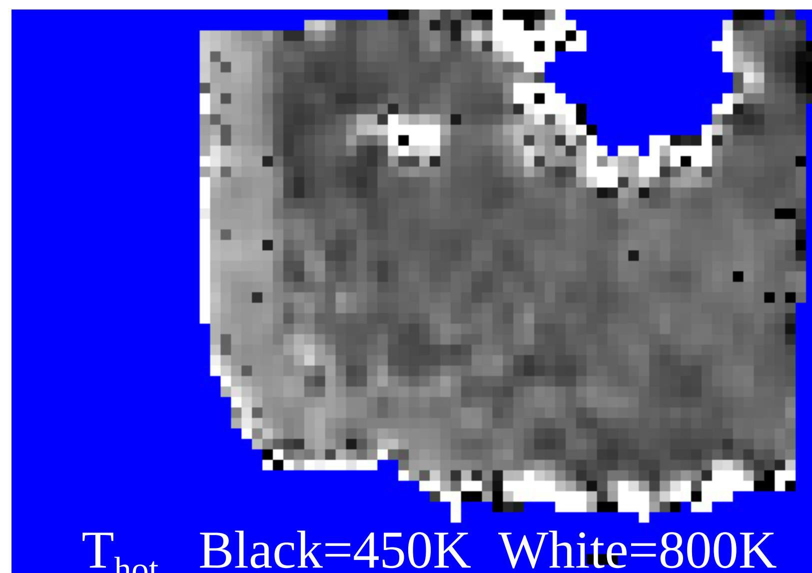
- Similar to work in Davies 2003



f_{hot} Black=0.000 White=0.002

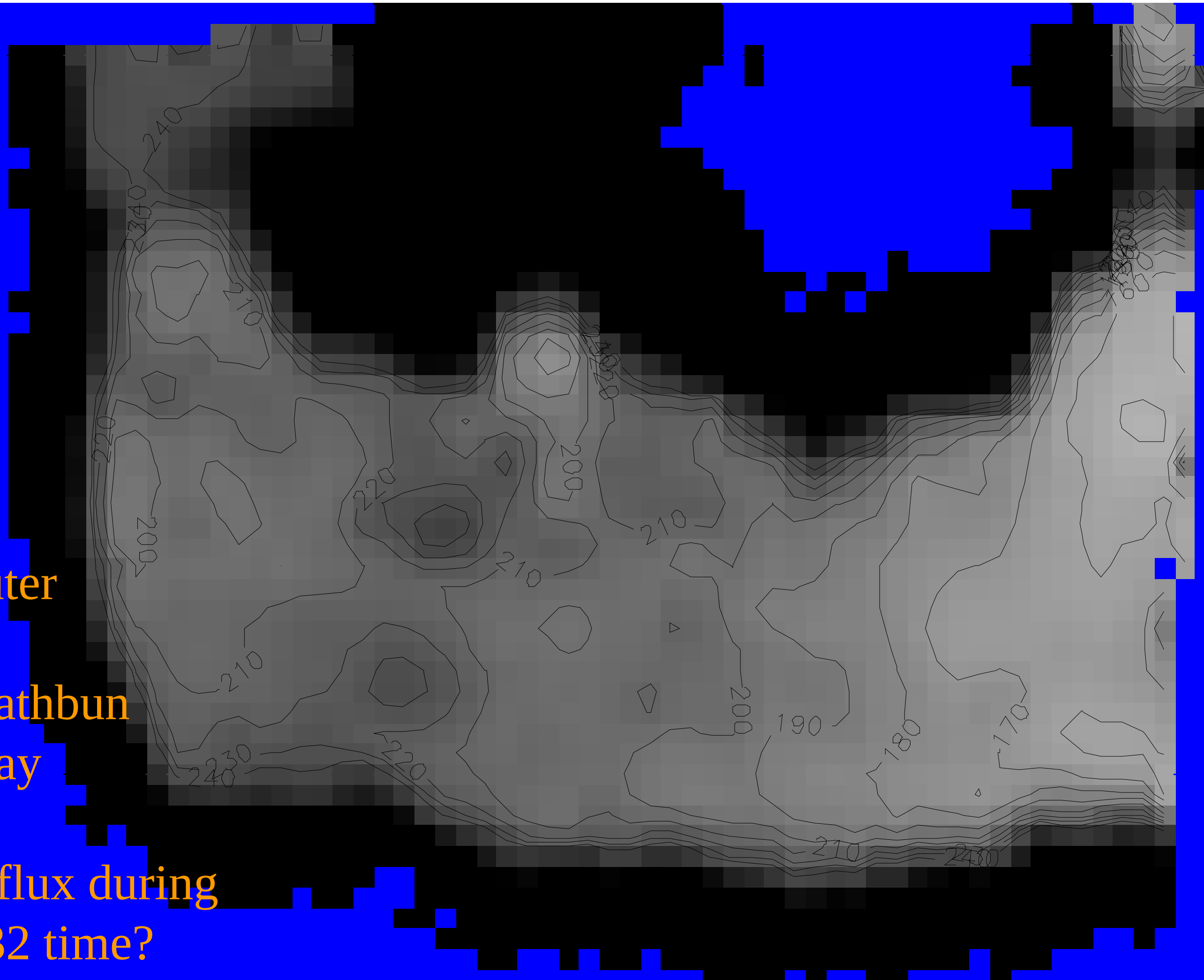


T_{cool} Black=260K White=300K



T_{hot} Black=450K White=800K

Age Based on T_{cool}



Wave velocity
~0.94 km inner
~1.38 km/day outer

Roughly ½ the Rathbun value of ~2 km/day

Related to lower flux during "non-periodic" I32 time?

T_{cool} Black=260K White=300K

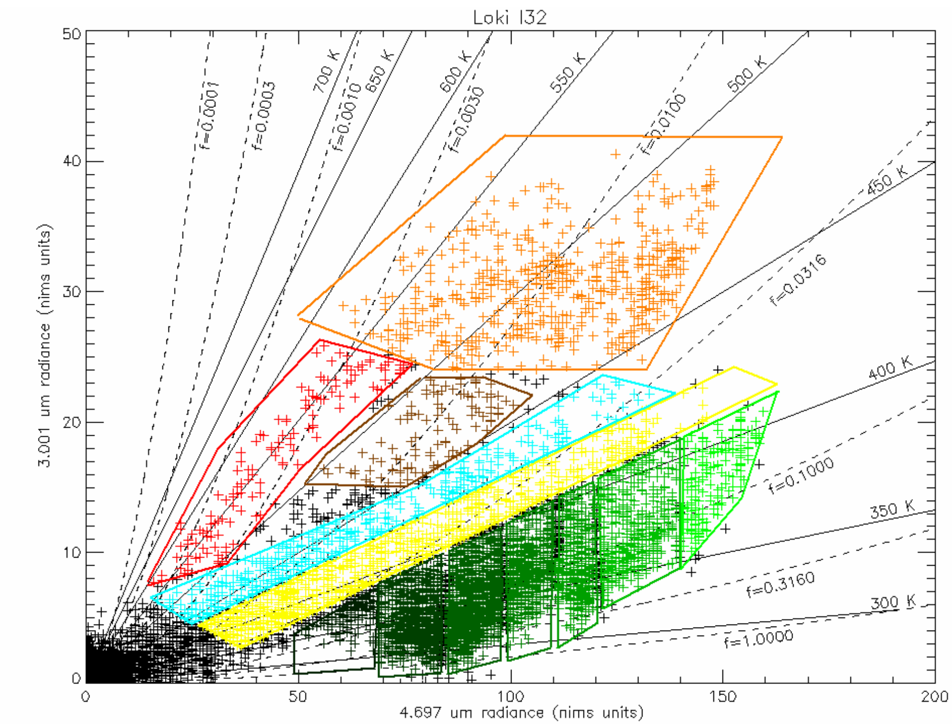
$T = 538\text{K} \ (t \,/\, \text{days})^{-1/8}$

Temperature controls

- Why is temperature distribution this smooth?
  - Differences of a degree or two over 10’s of km

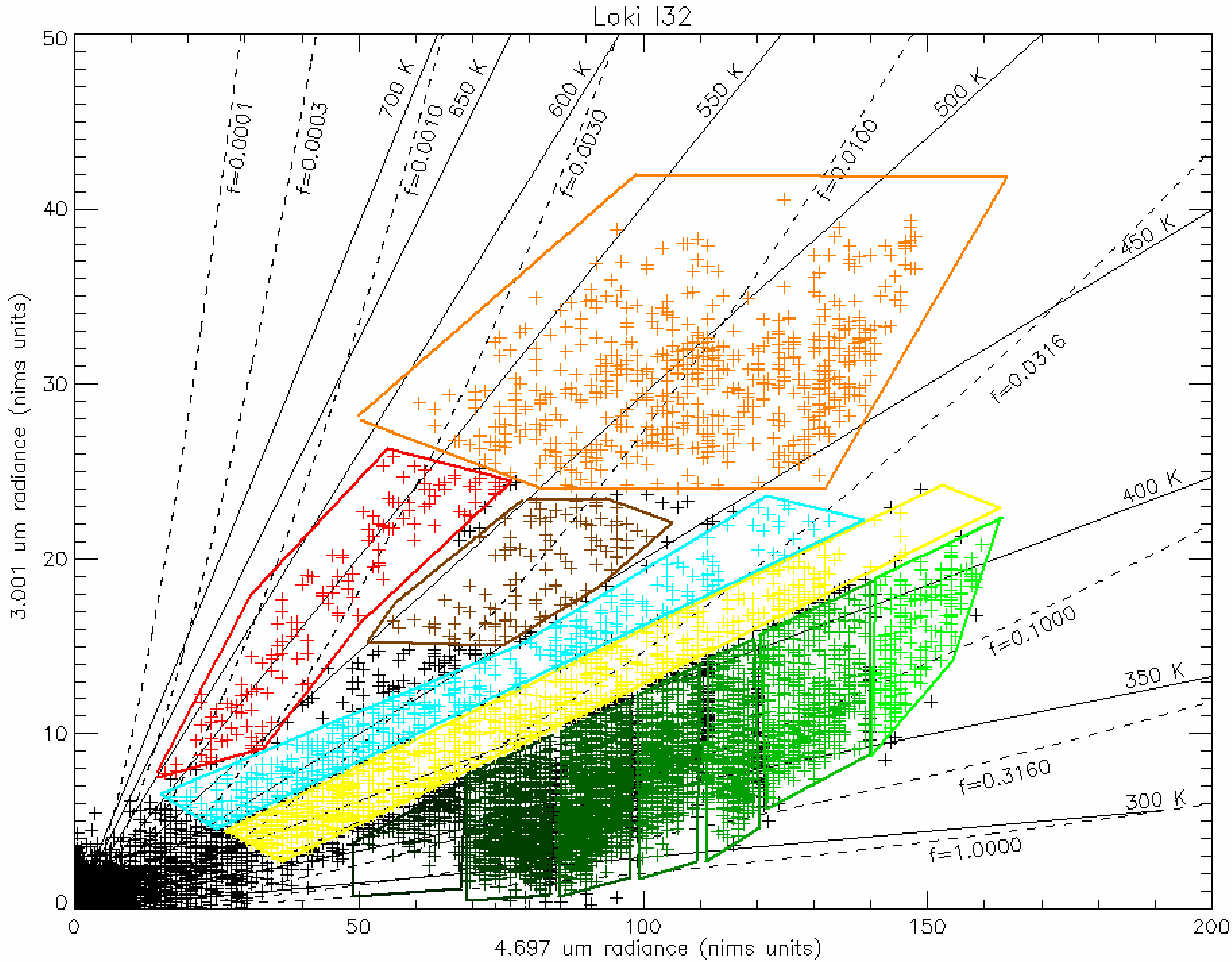
- Why are discrete temperatures present in different regions of the “two intensity” plots?

Two Wavelength NIMS Plots

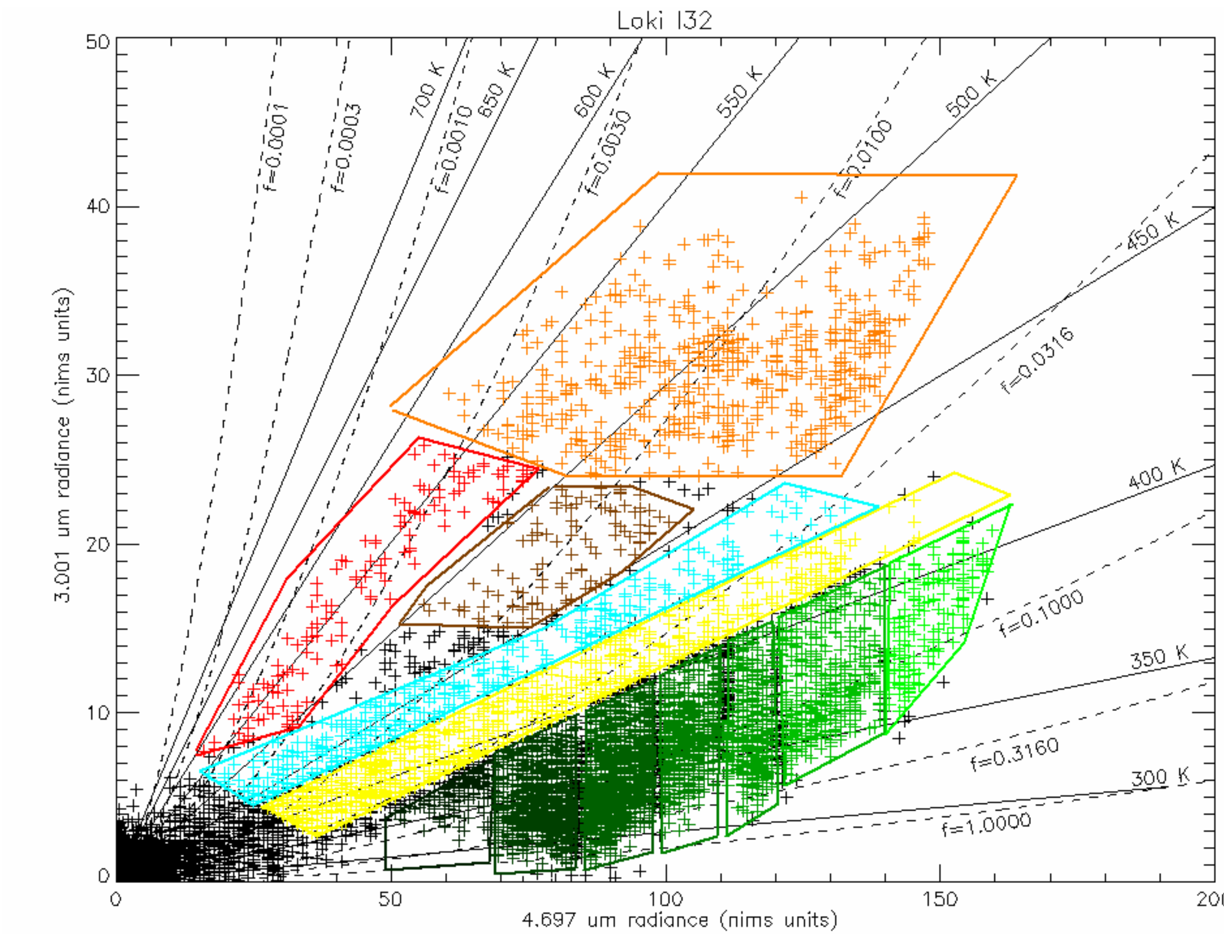


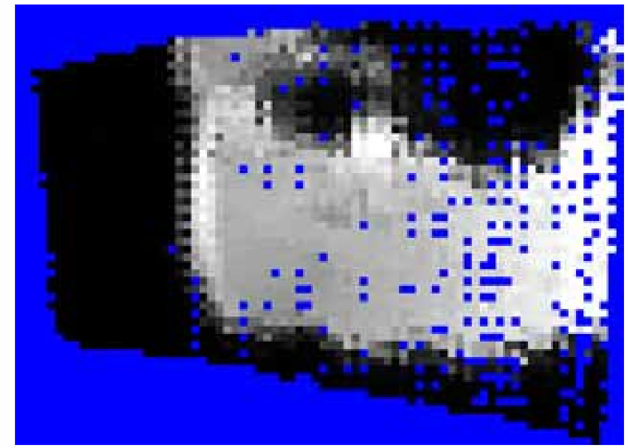
- Use simultaneously measured fluxes from I32 NIMS "Tube"
  - avoids spatial registration and averaging problems
- Plot 3.0007 µm flux vs. 4.6967 µm flux
- Model as single hot temperature (T) filling fraction of pixel (f)
  - Because wavelengths are relatively close, T and f are not "orthogonal"
  - Solid straight lines = constant T (from 300K to 700K) $(F_y/F_x \Leftrightarrow T)$
  - Dashed curve lines = constant f (from 1.0 to 0.0001)
- Colors "arbitrary", used to identify points from different regions of plots for later use
  - However, even without colors, points clearly fall into distinct regions of 2I plot

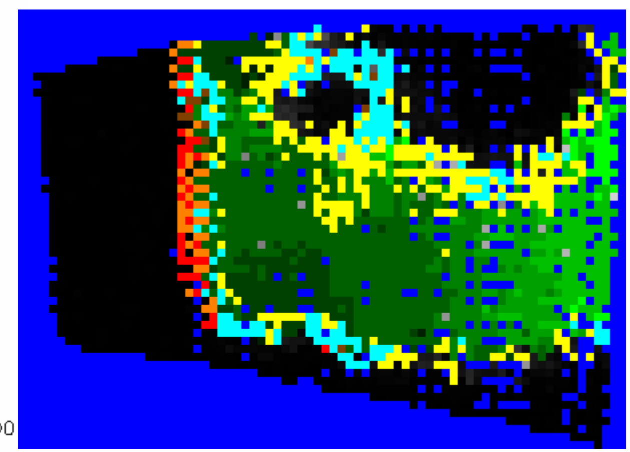
Large version of 2I plot



Spatial Pattern of Clusters

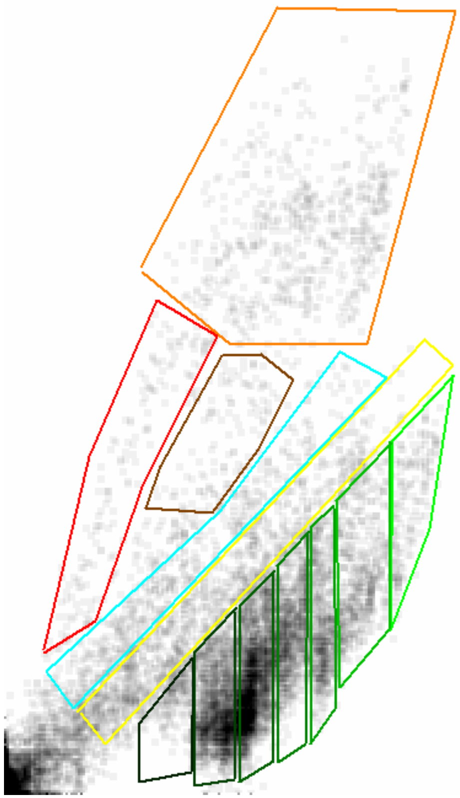


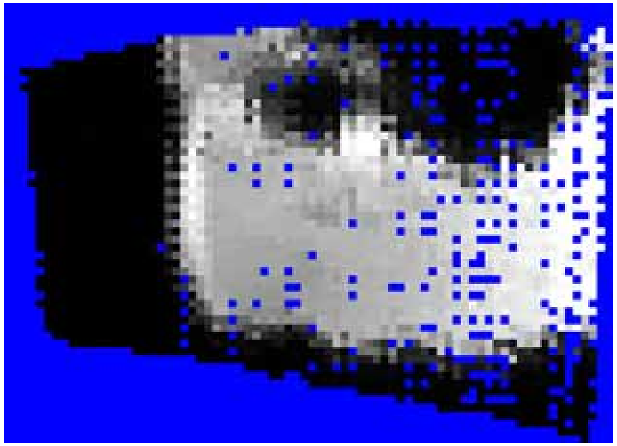


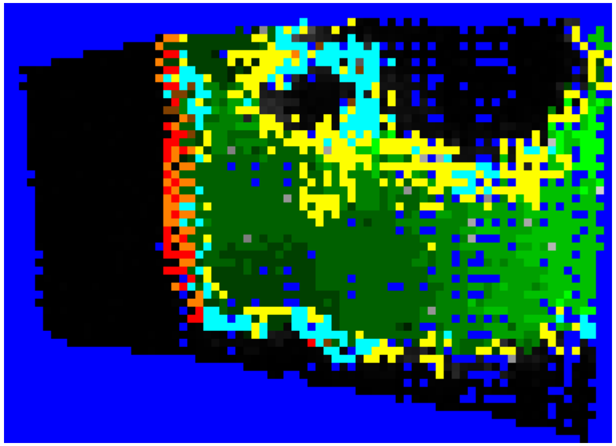


- Red: Hot western edge (with hottest at very edge)
- Aqua and yellow: Inner and outer margins
- Orange: Location near “island”
- Green: Bulk of patera – with smooth spatial gradient from “resurfacing wave”

Additional structure within the "Green Band"







- Red: Hot western edge (with hottest at very edge)
- Aqua and yellow: Inner and outer margins
- Orange: Location near "island"
- Green: Bulk of patera – with smooth spatial gradient from "resurfacing wave"

Possible buffering by volatiles

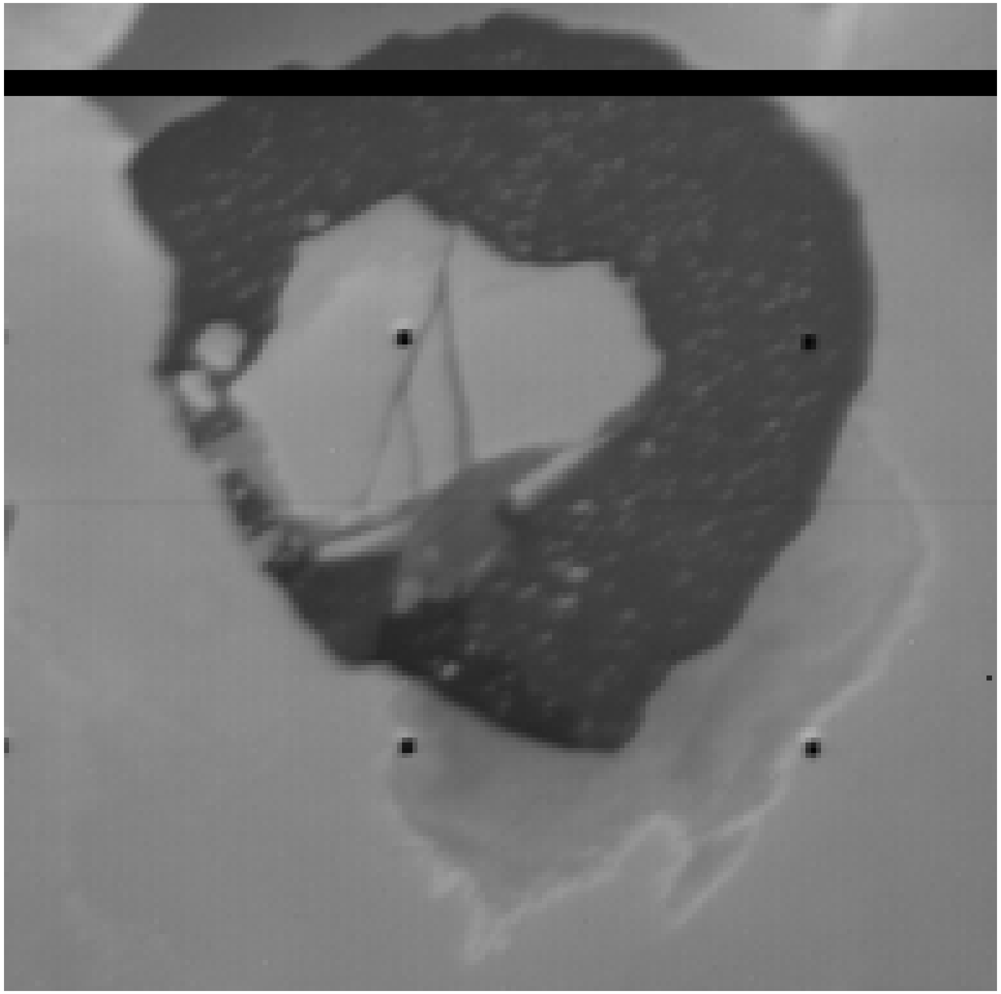
- 200 days old $\Rightarrow$277K $\Rightarrow$366 W/m^2 radiative flux from surface
  - presumably balanced by conductive flux from below
- To produce this from S vapor deposition (latent heat) $\Rightarrow$ 0.036 m/day
  - Some reasonable fraction of this needed to buffer temperatures
- Depth consistent with geometric contraints
- Is it consistent with constraints from
  - Spectra
  - Required pressure
  - Sources of S

Vapor transport models

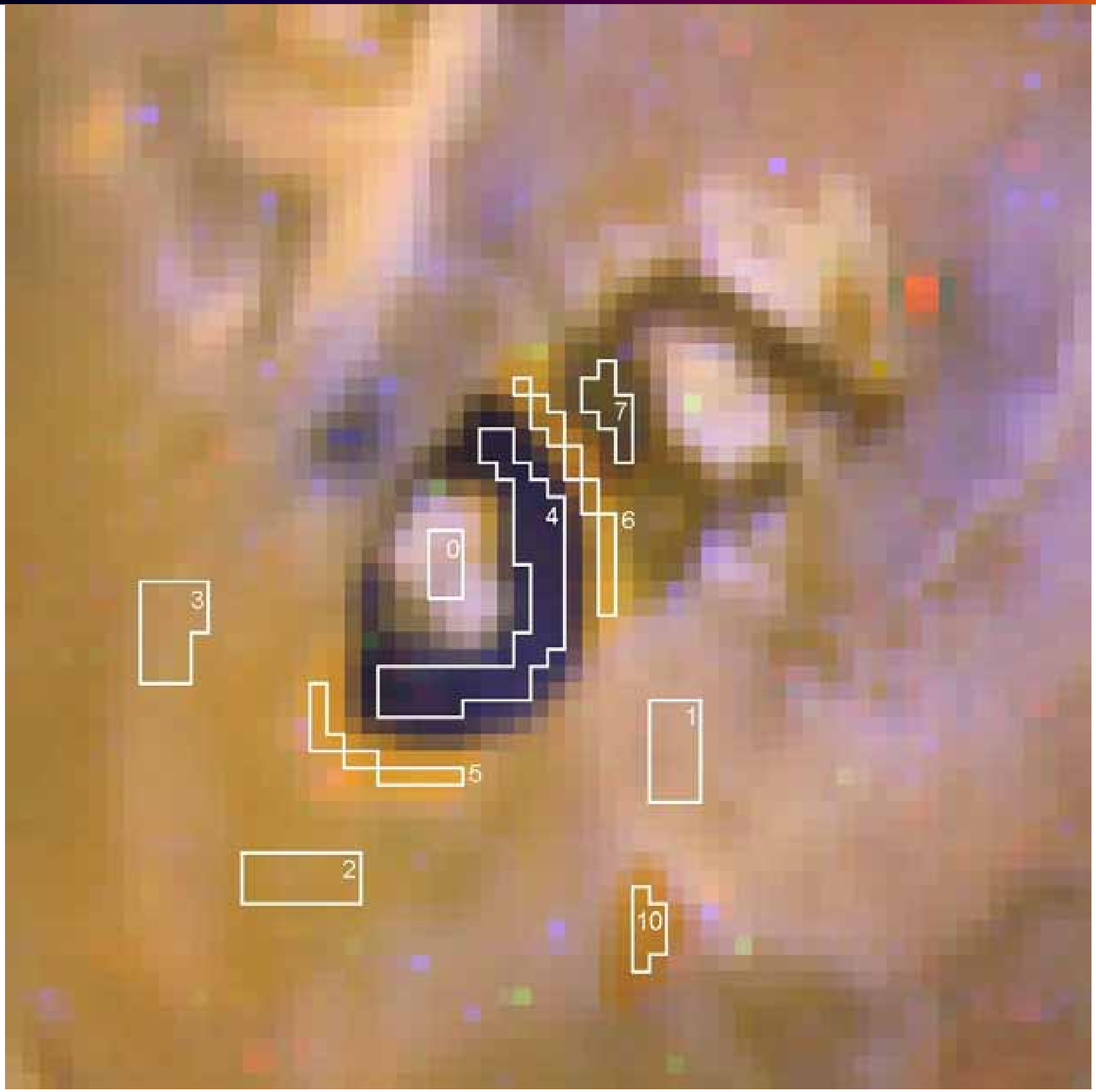
- Adapted from Ingersoll (and others) SO_2 models
- Expect transport on horizontal scale of $L = (2\ \pi)^{1/2}\ (k\ T)/(mg)] = 15$ km
- Consider 300 K vs. 260 K surface separated by 15 km
  - S vapor pressure at 300K is few nanobars
  - Produces transport and deposition too low by factor of ~100
- At 350K S vapor pressure is high enough to produce sufficient transport
  - Because of exponential dependence of P on T
  - No 350K present in "low T" component of surface
  - 350K is present only 0.3 m below the surface
  - Even higher temperatures present in the high T "crack" fraction
- Just getting started on transport models involving small hot component / vertical transport

Spectral-Morphological Constraints

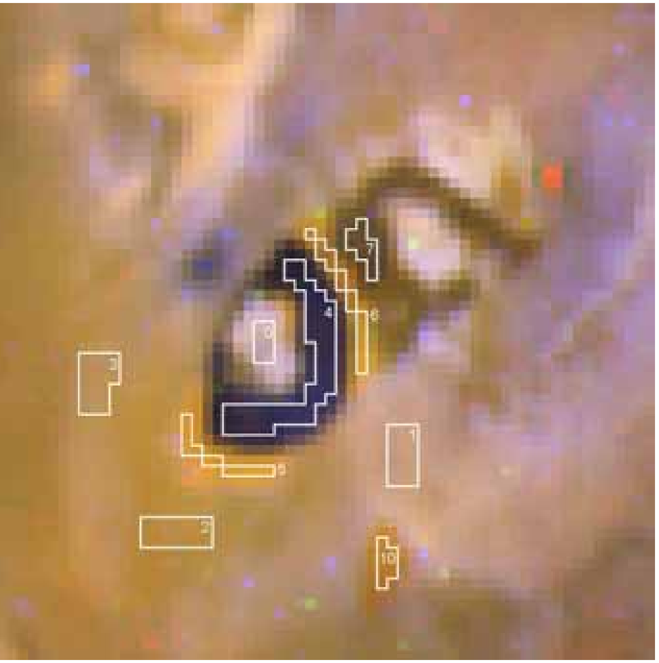
- Only high resolution images are from Voyager

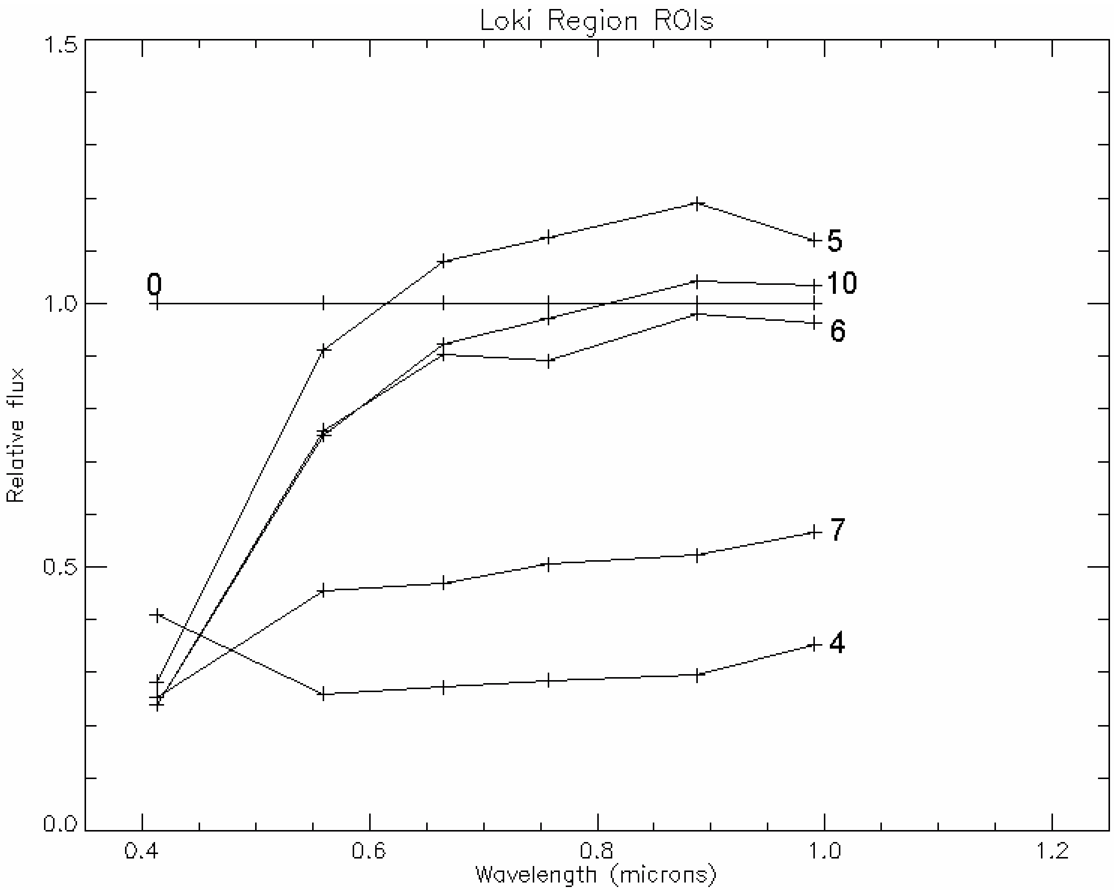


C10 is best Galileo full wavelength set



C10 spectra normalized to "island"





Current work

- Analysis of morphology / temperature structure in NIMS data (2I plots)
- Better modeling of volatile transport
- Spectral analysis
  - Proper normalization (true reflectance) for Galileo spectra
  - Comparison with standards and other Io regions
  - Incorporation of higher resolution Voyager images

End