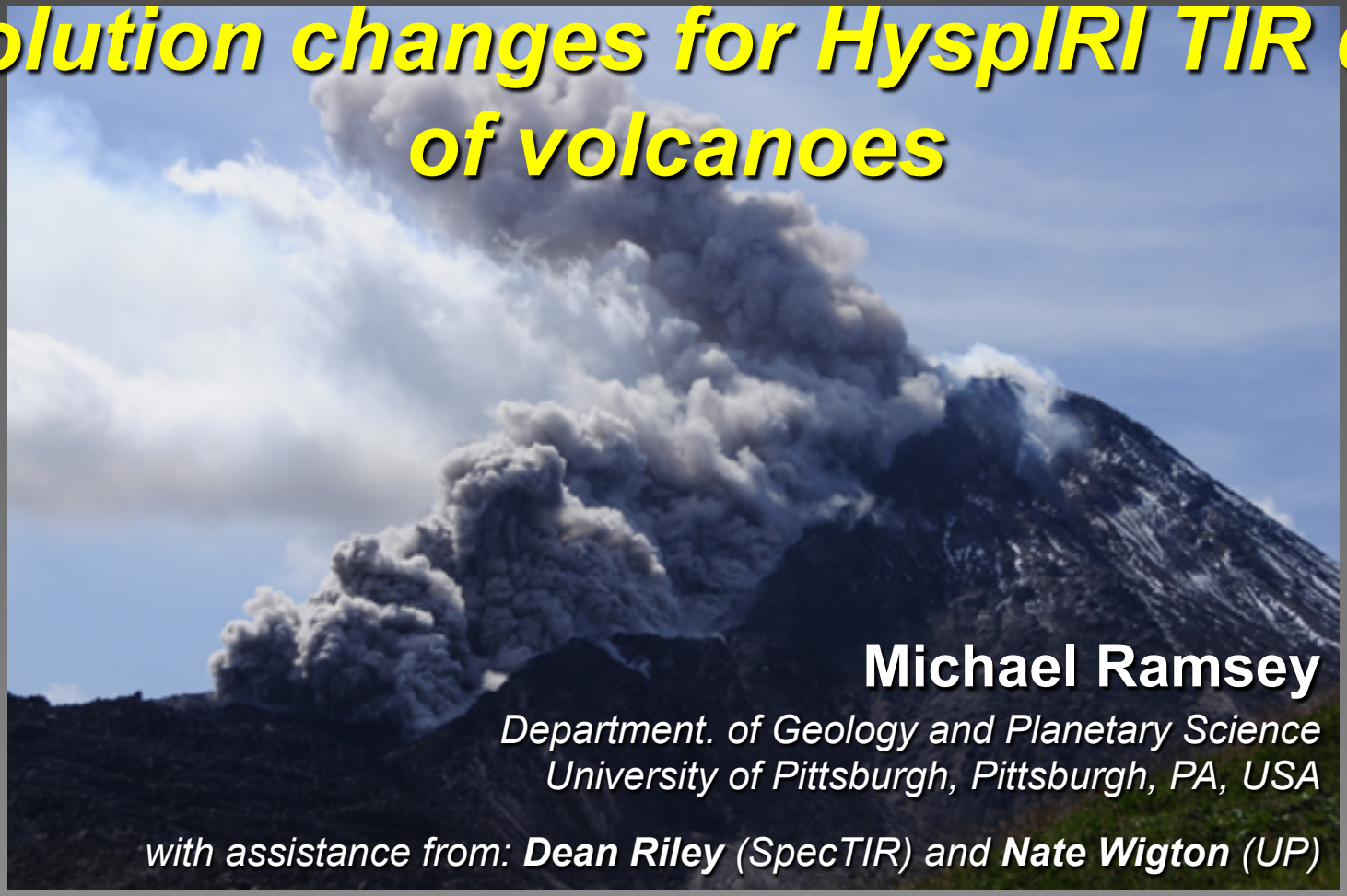
Implications of temporal and spectral resolution changes for HysplRI TIR data of volcanoes



Kizimen volcano (Kamchatka): 01 August 12

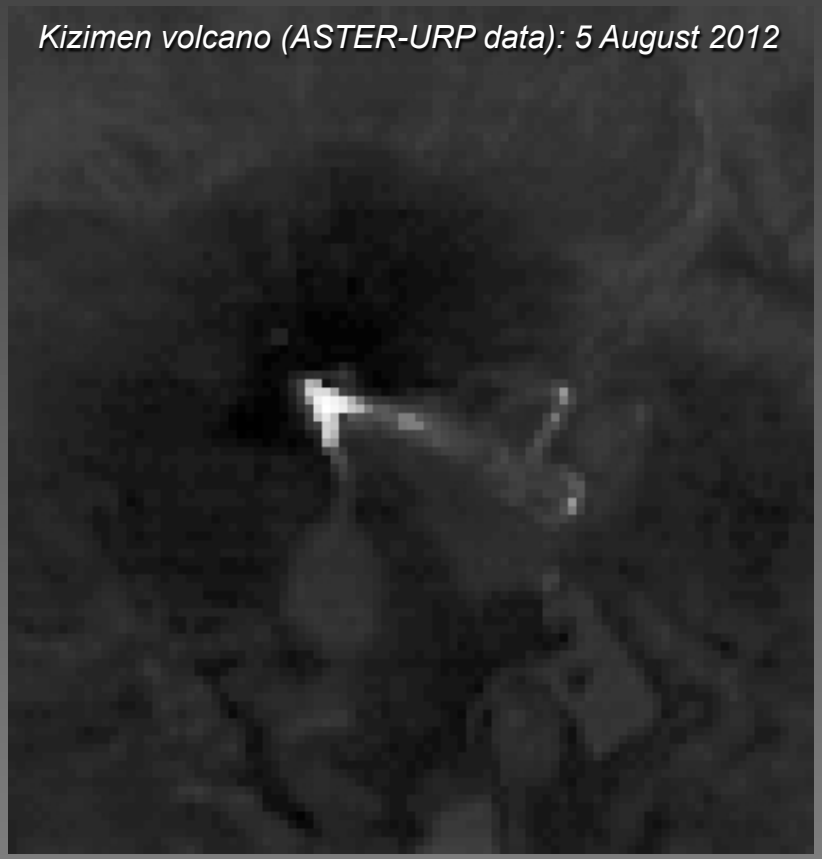
Michael Ramsey

Department. of Geology and Planetary Science
University of Pittsburgh, Pittsburgh, PA, USA

with assistance from: ***Dean Riley*** *(SpecTIR) and* ***Nate Wigton*** *(UP)*

Overview

- **Temporal Resolution**
  - well-established for HyspIRI
  - *what can we glean from the volcano science returned from multispectral TIR data?*
    - the ASTER URP Program
      - proxy for HyspIRI TIR
      - 8 year archive (N. Pacific)
      - statistics *(e.g. cloud vs. anomaly detection)*

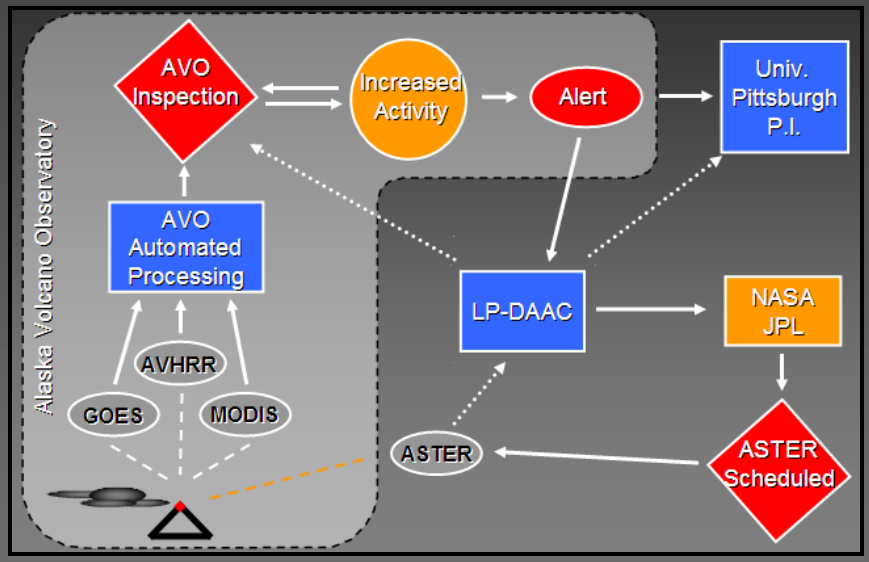


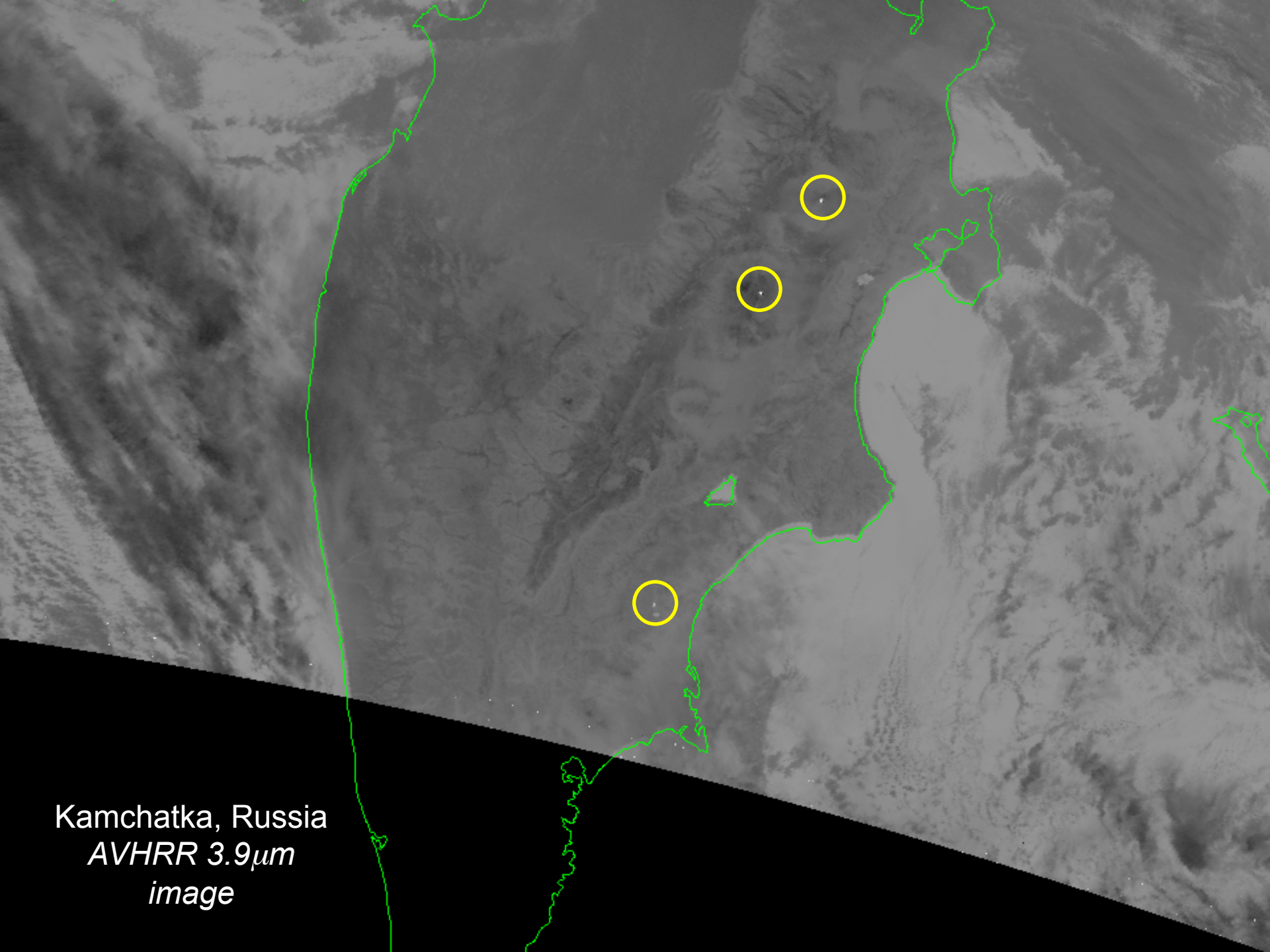
Kizimen volcano (ASTER-URP data): 5 August 2012

- **Spectral Resolution**
  - not established for HyspIRI
  - trade studies of spectral resolution and band positions
    - SEBASS and MAGI airborne data

URP Summary

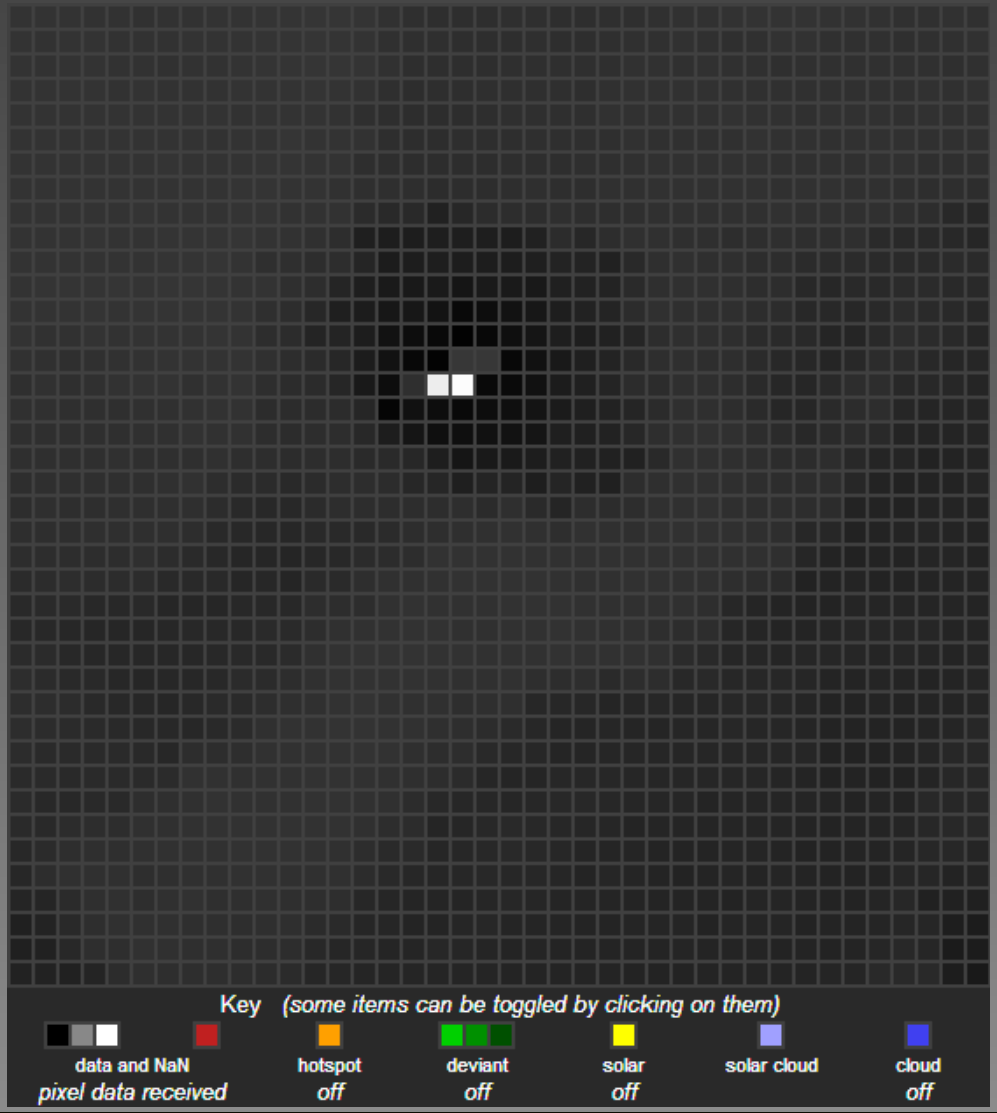
- **ASTER Urgent Request Protocol (URP) Program**
  - integrates Alaska Volcano Observatory monitoring into the ASTER Urgent Request stream
    - initially focused on the northern Pacific region
      - trigger automated ASTER requests via a complex pathway
      - achieve 1 – 5 day repeat times on average
      - archive now contains several thousand high spatial, high temporal TIR scenes
        - can be mined for statistics on cloud/anomaly vs. temporal resolution
    - integrated with MODVOLC since 2010 (global capability)

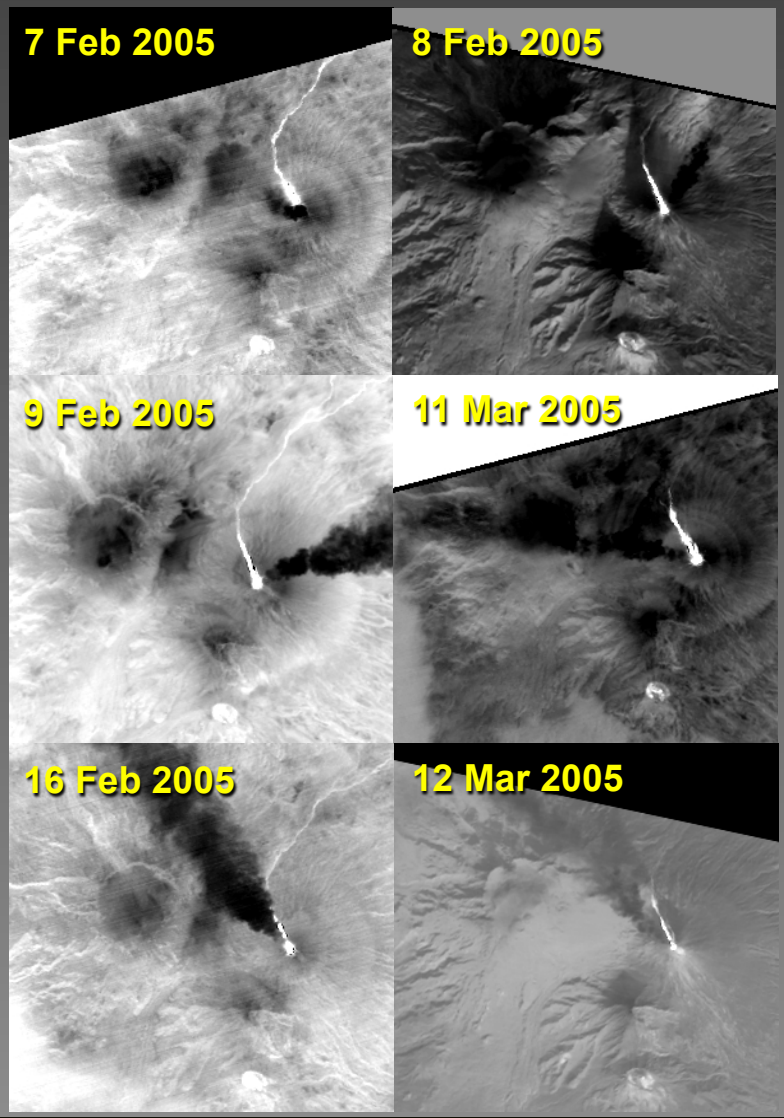



Kamchatka, Russia
AVHRR 3.9μm
image

URP Products

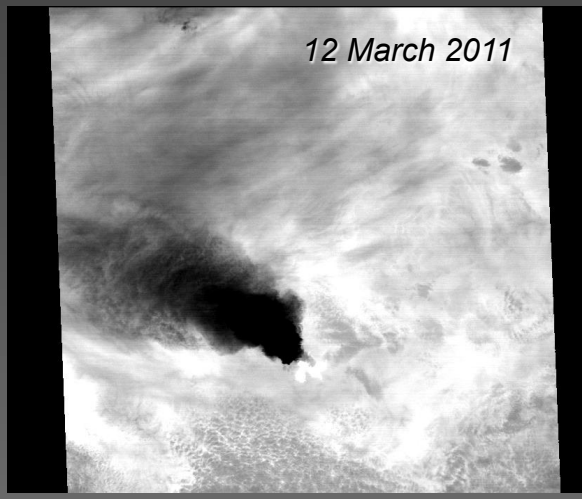
Kluichevskoi time series

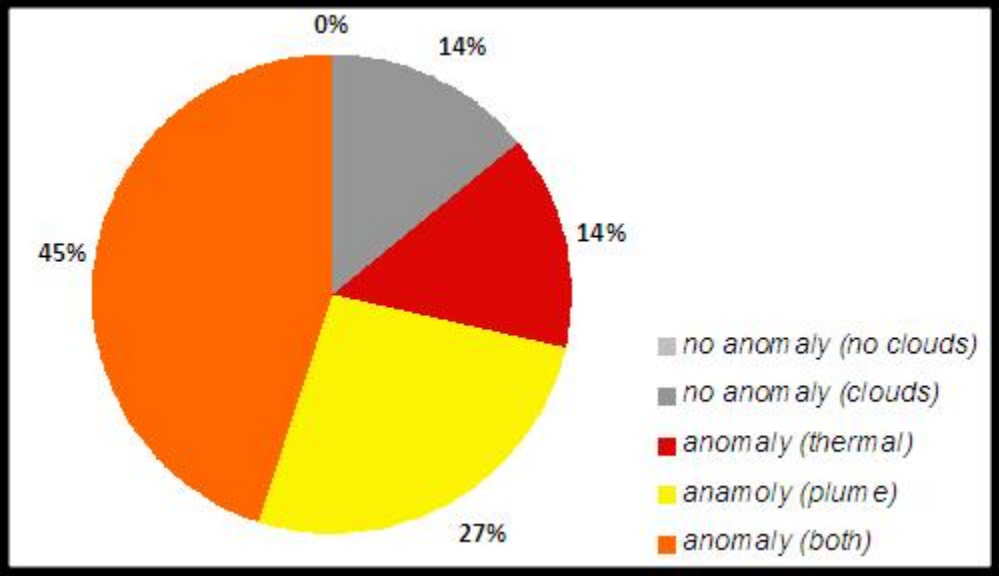


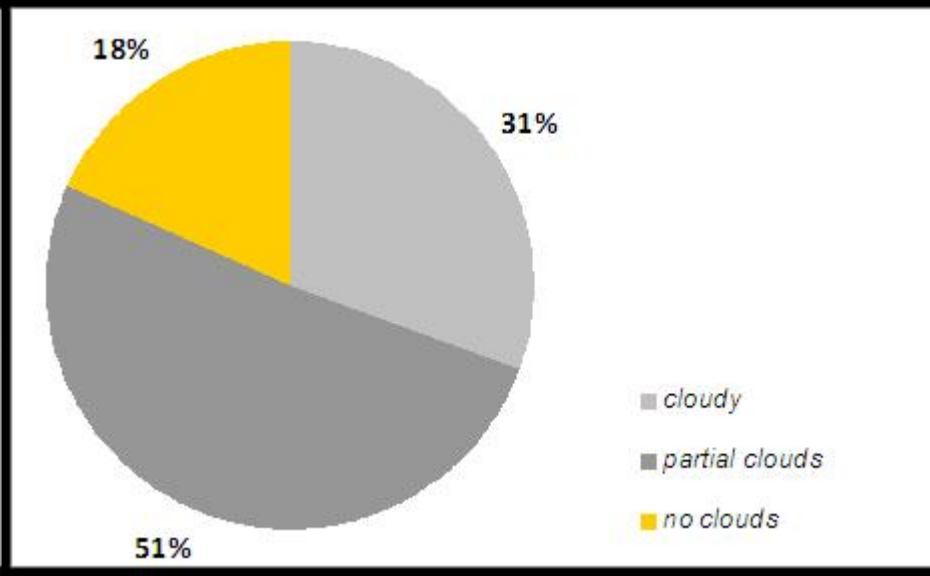


ASTER URP Statistics

- **Kizimen Volcano *(newer eruption)***
  - 1 Jan 2011 to 15 Oct 2012
  - 109 ASTER observations
    - average: 1 scene / 6 days
    - 40 contained clouds (7 had no anomaly)
      - *7 (thermal), 13 (plume), 22 (both)*

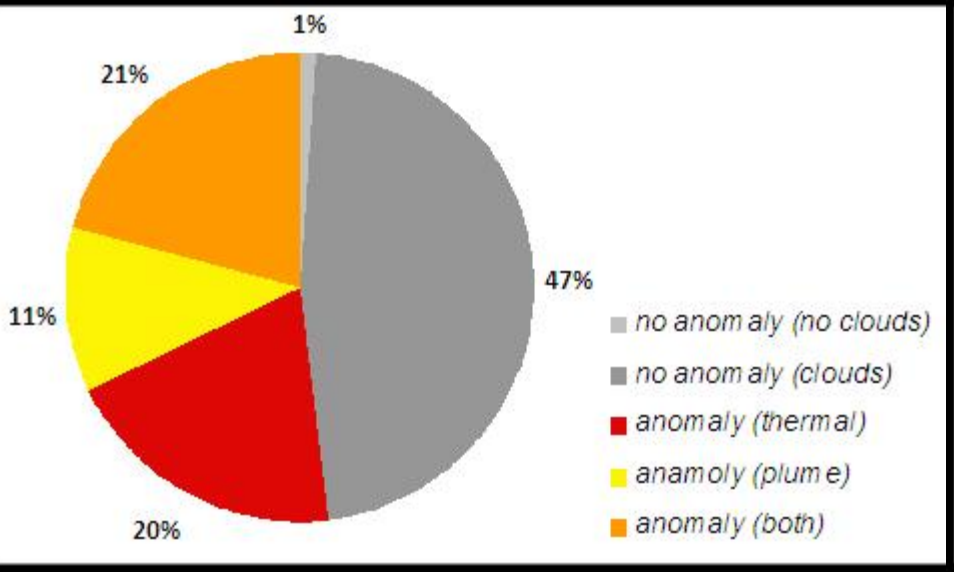


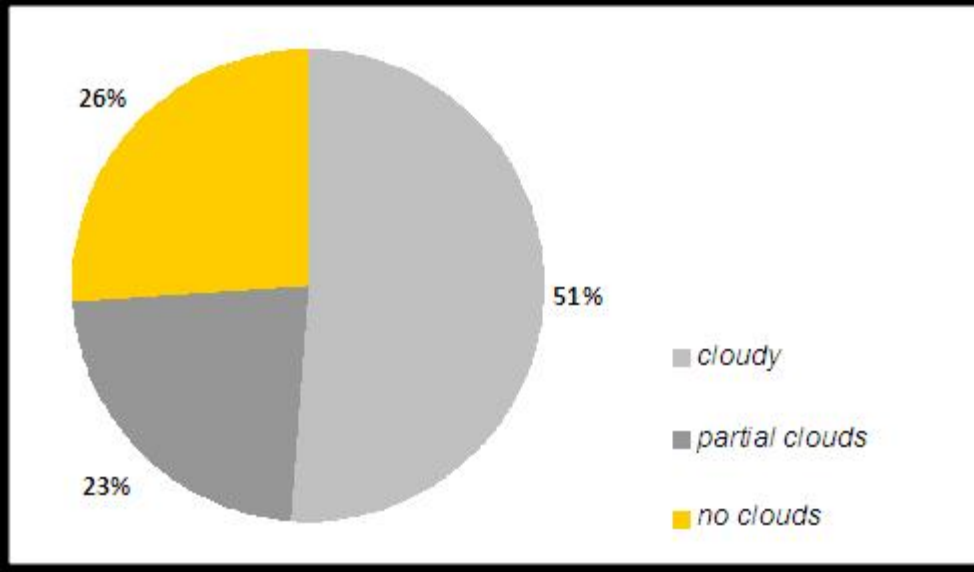




ASTER URP Statistics

- **Karymsky Volcano *(longer eruption)***
  - 1 Jul 2007 to 15 Oct 2012
  - 108 ASTER observations *(not continuous)*
    - average: 1 scene / 18 days *(1 / 5 days)*
    - 71 contained clouds (45 had no anomaly)
      - 19 *(thermal)*, 11 *(plume)*, 20 *(both)*

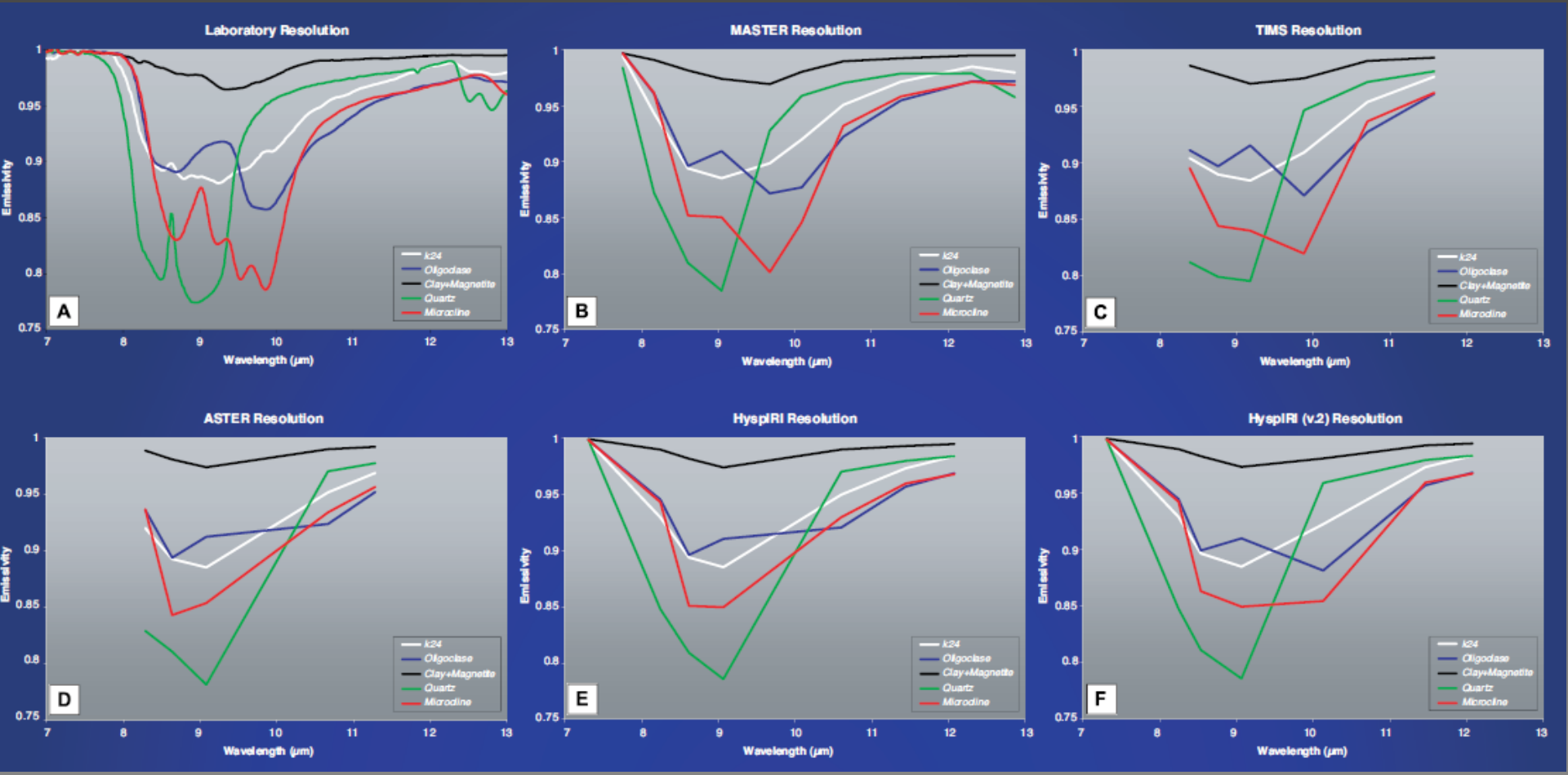




ASTER URP Statistics

- **URP Expansion**
  - MODVOLC-based targets:
    - Cordon Caulle *(Chile)*
    - Erta Ale *(Ethiopia)*
    - Etna *(Italy)*
    - Nyamuragira *(DR Congo)*
    - Nyiragongo *(DR Congo)*
    - Pu'u O'o / Kilauea *(Hawaii, USA)*
    - Reventador *(Ecuador)*
    - Santa Maria *(Guatemala)*
    - Semeru *(Indonesia)*
    - Stromboli *(Italy)*
  - criteria
    - volcanoes with high activity / danger potential
    - globally distributed
    - 10 targets initially chosen to test the scheduling demand
      - will grow based upon capacity of the system

Spectral Analysis



Ramsey and Rose (2009)

Spectral Analysis

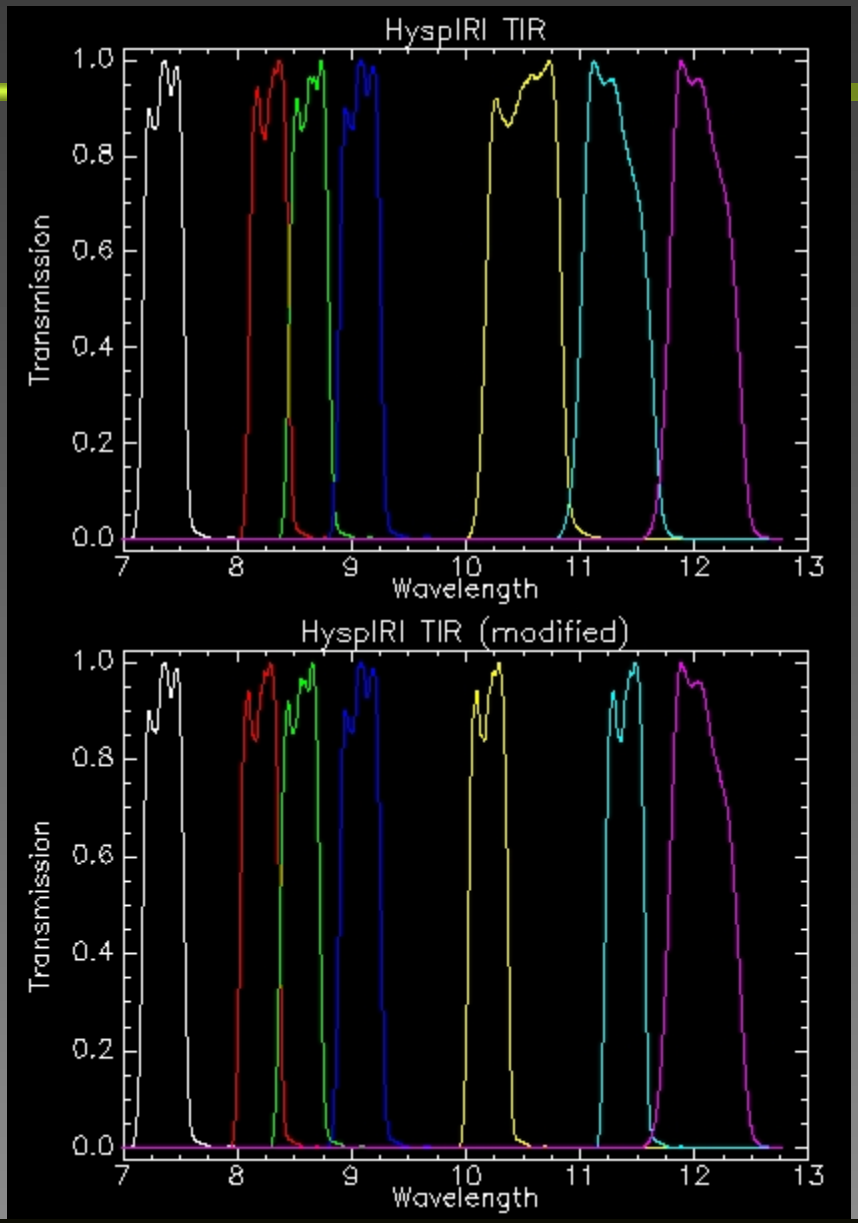
- **Salton Sea Geothermal Field (SSGF)**
  - diversity of thermal/compositional targets
  - geology validation target for new airborne MAGI instrument
    - funded by the NASA IIP
    - built by Aerospace Corp.
    - 32 TIR channels
  - SEBASS TIR data *(6 Apr 2010)*
  - MAGI TIR data *(9 Nov 2011)*
  - this study
    - TIR band positions of HyspIRI
    - compositional results

"sandbar" geothermal site
Salton Sea, CA *(6 Apr 2010)*

Spectral Analysis

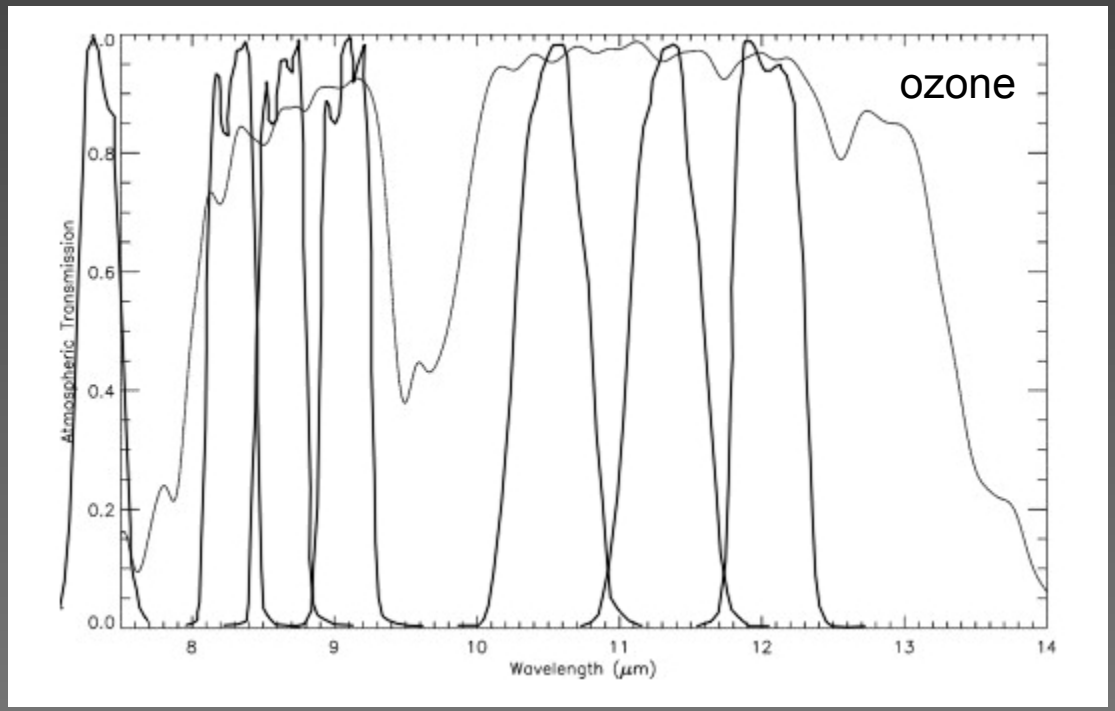
- **Proposed HyspIRI TIR Bands *(μm)***
  - 3.98, 7.35, 8.28, 8.63, 9.07, 10.53, 11.33, 12.05
- **Suggested Variant *(μm)***

  [Ramsey & Rose, 2009]
  - 3.98, 7.35, 8.28, 8.55, 9.07, 10.05, 11.35, 12.05
    - better discrimination of:
      - SO_2, feldspars (10.05), carbonates (11.35)
    - effects of 10μm placement *[Ramsey, 2012]*



Spectral Analysis

- **10 μm channel**
  - currently planned
    - longward of the ozone absorption region
    - marginal spectral diversity for most silicate minerals
      - e.g. feldspars and quartz
      - *especially where mixed which is common*



  - we proposed a shift to shift to a short wavelength position
    - also proposed changes to 8.55μm (SO_2) and 11.35μm (carbonates)

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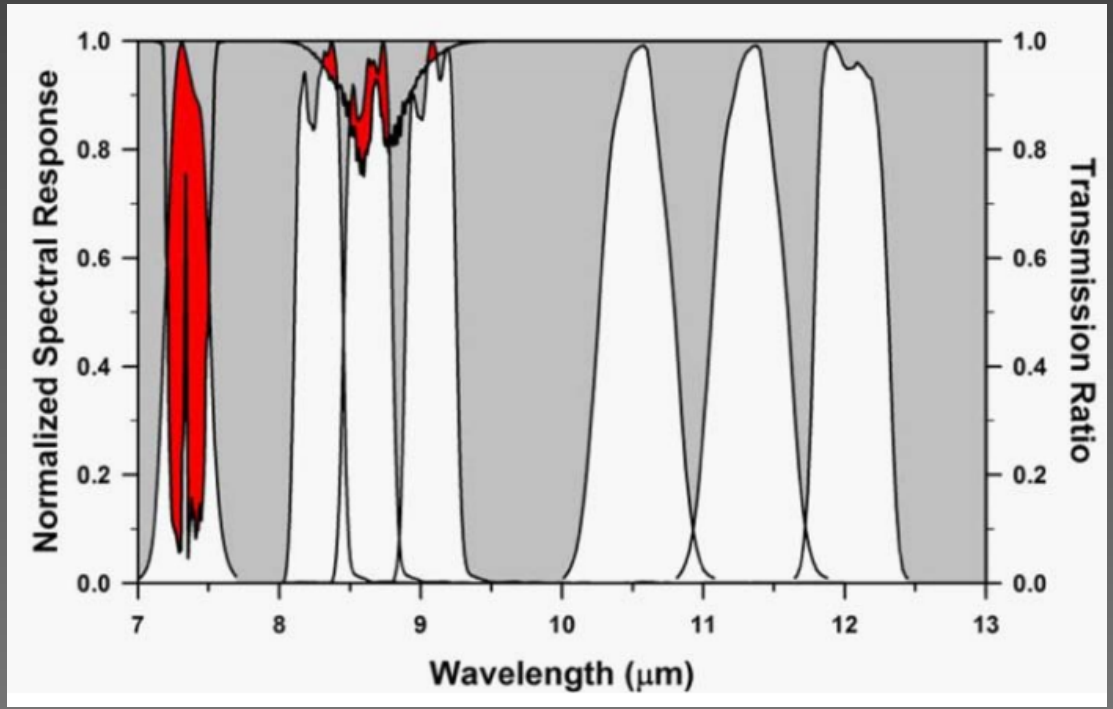

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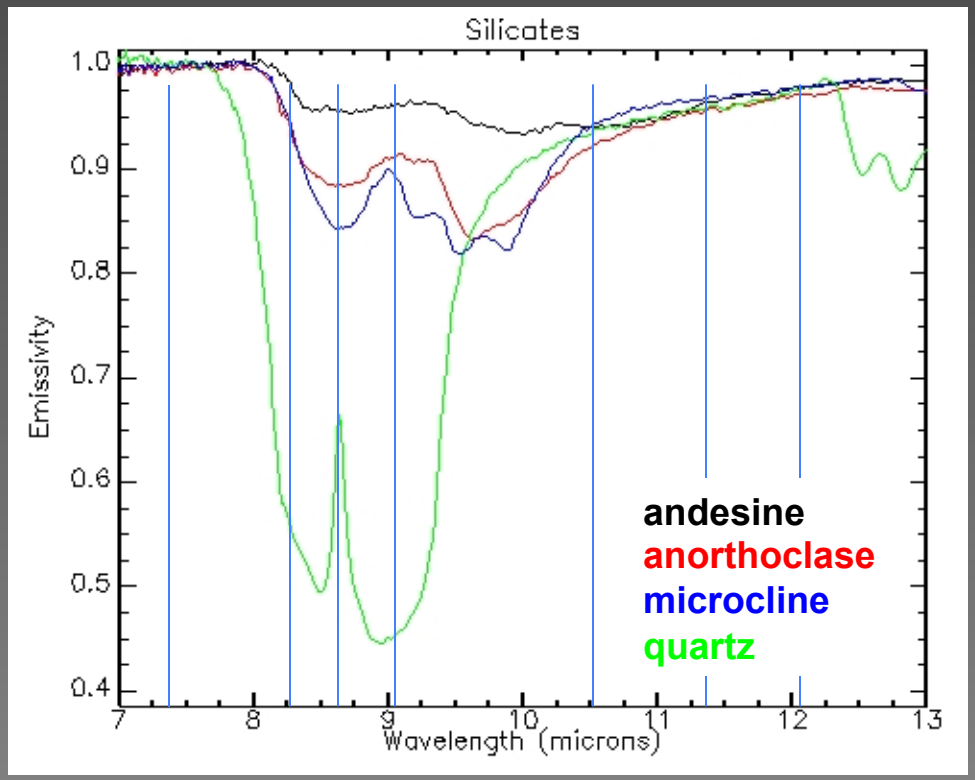
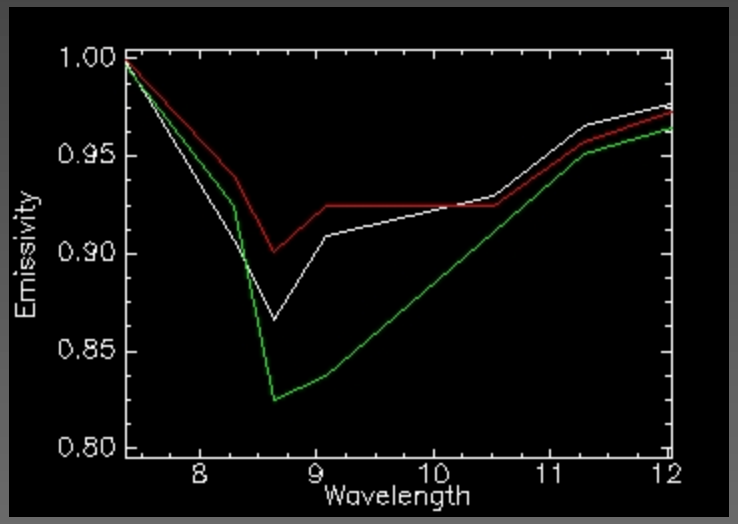
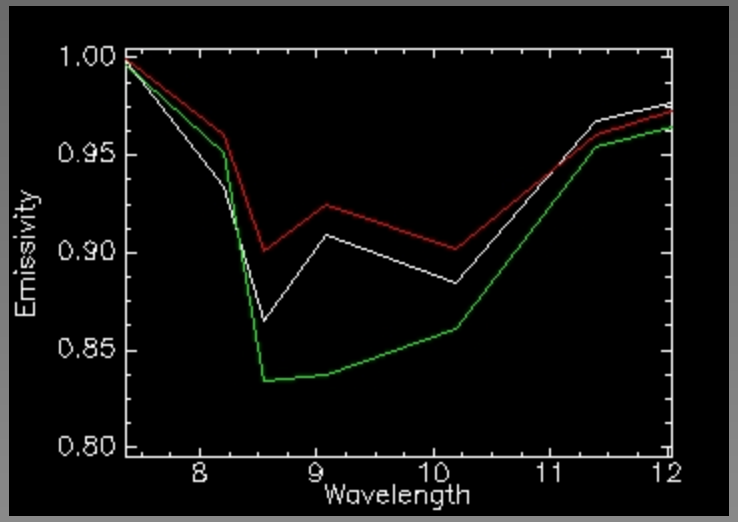
Spectral Analysis







Spectral Analysis

Kelso Dunes, CA (red indicating improved feldspar detection in [B]). Ramsey and Rose [2009]

Spectral Analysis

Salton Sea Geothermal Field (SSGF)

SEBASS 10 μm radiance

"feldspar" (R), "gypsum" (G), "quartz" (B)

HyspIRI TIR bands

HyspIRI TIR *(band 10 shift)*

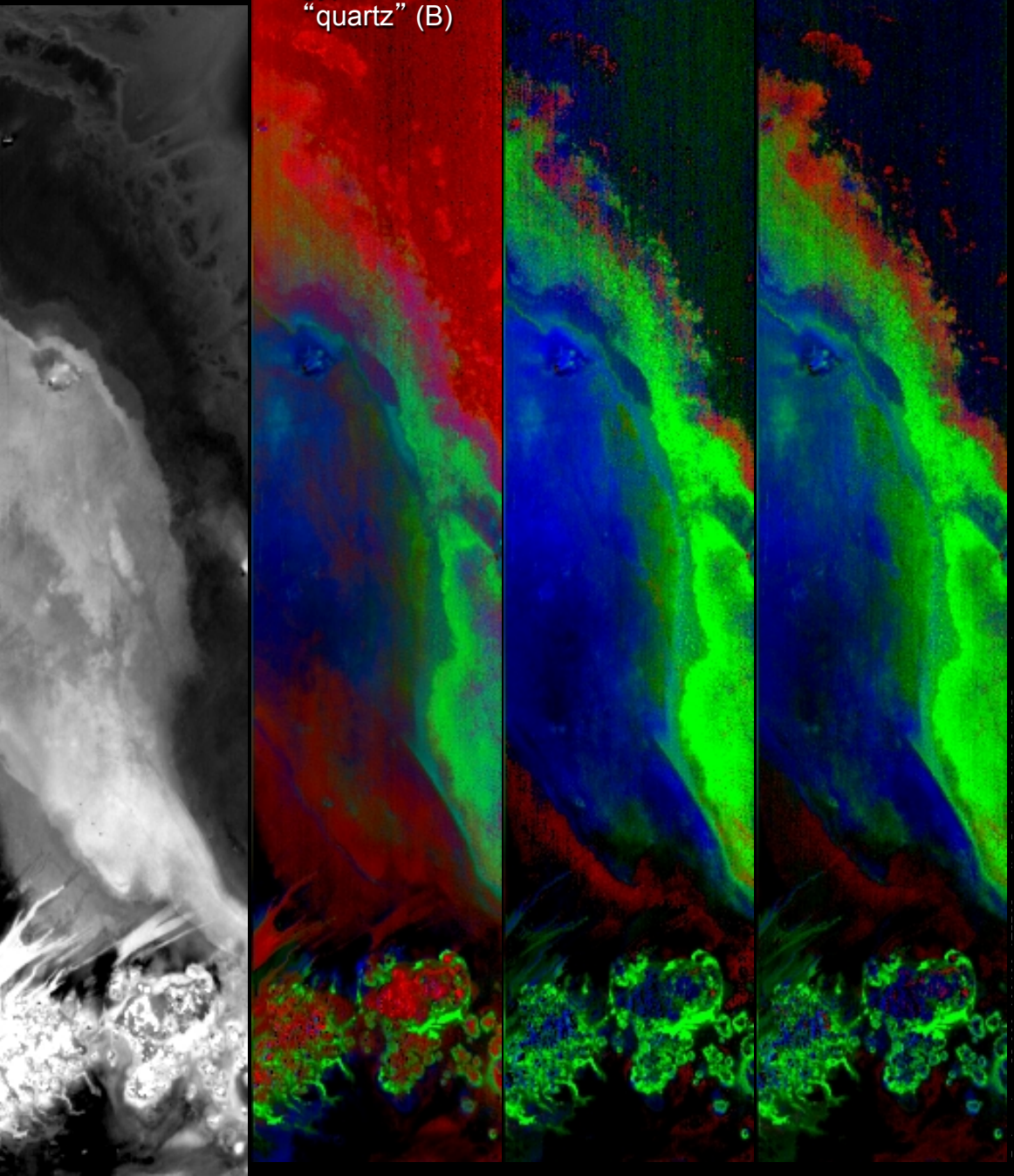
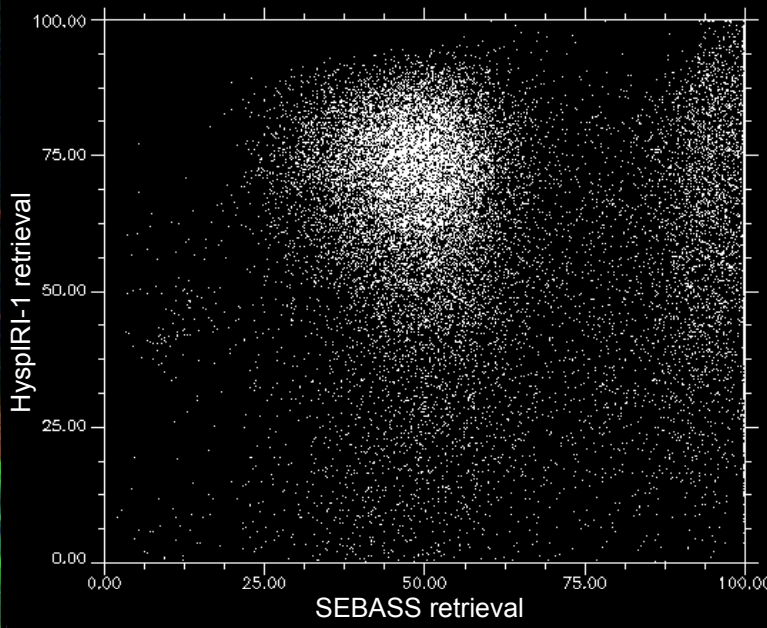
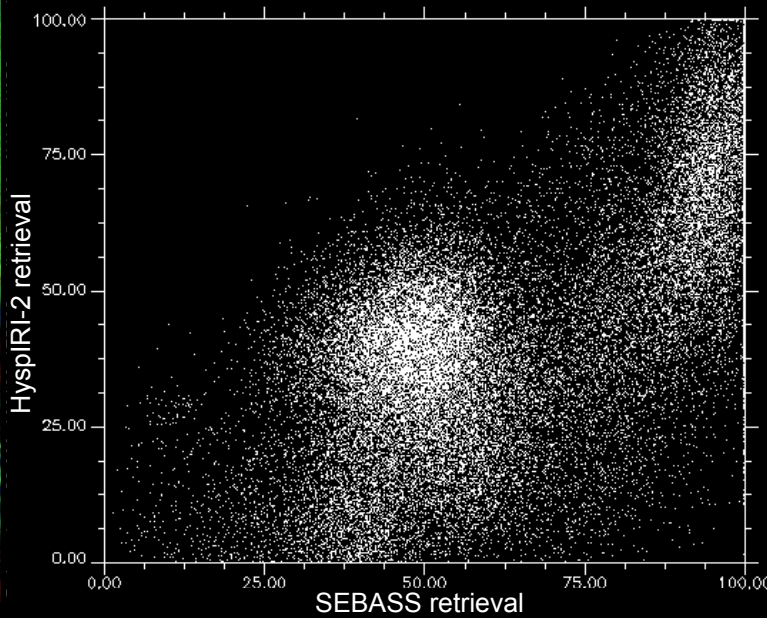


Image end-members: "feldspar"



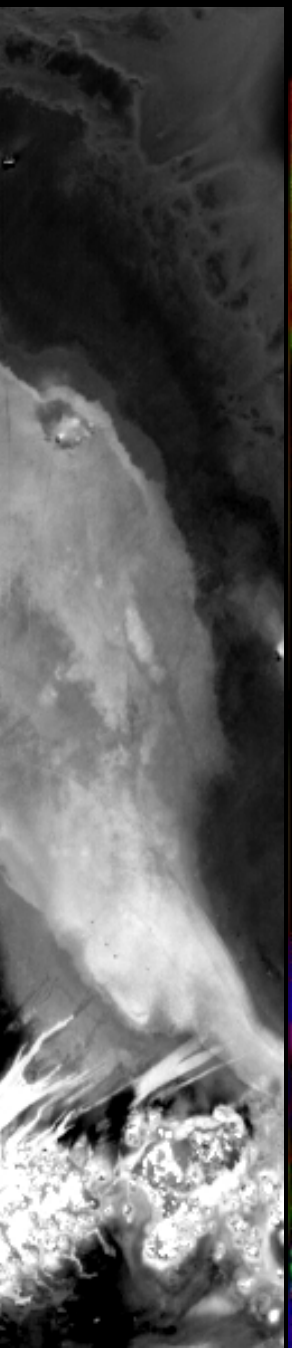


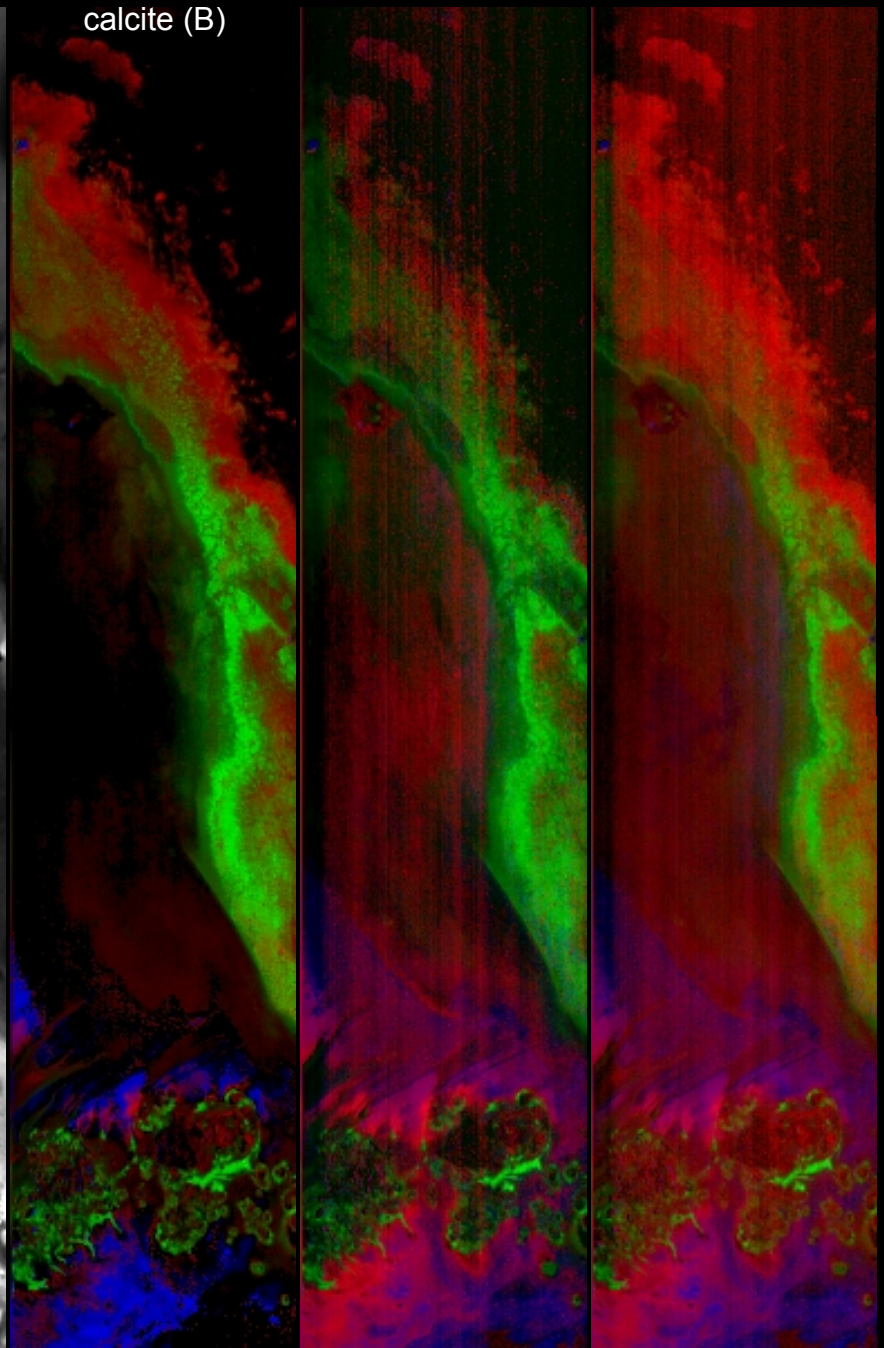
SEBASS 10 μm radiance

oligoclase (R), gypsum (G), calcite (B)

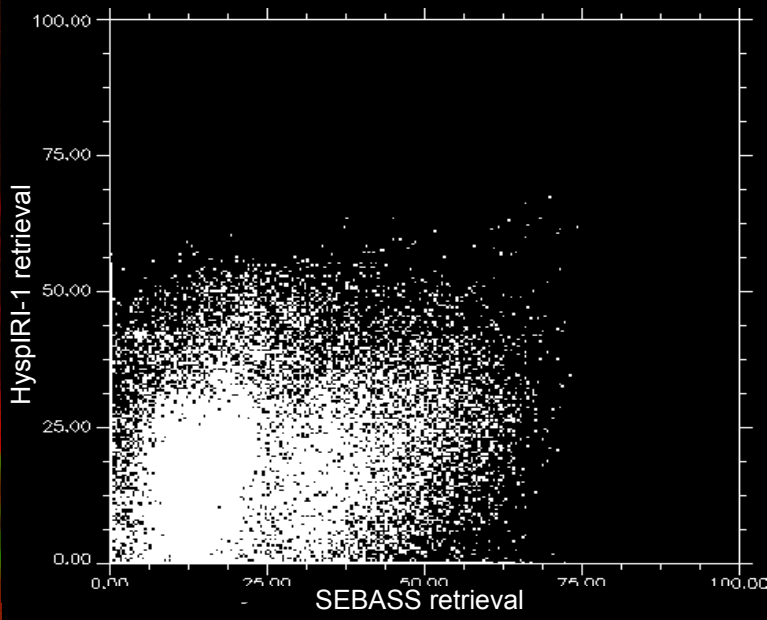
HyspIRI TIR bands

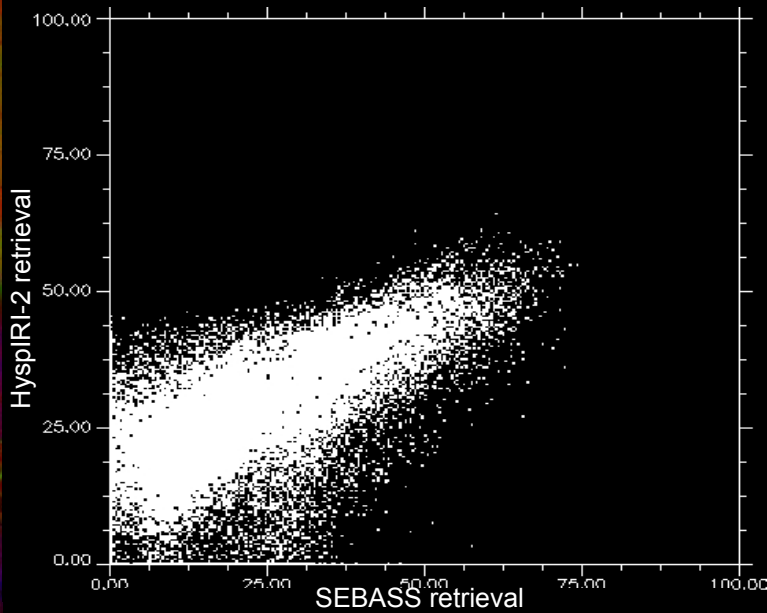
HyspIRI TIR *(band 10 shift)*





Library end-members: oligoclase



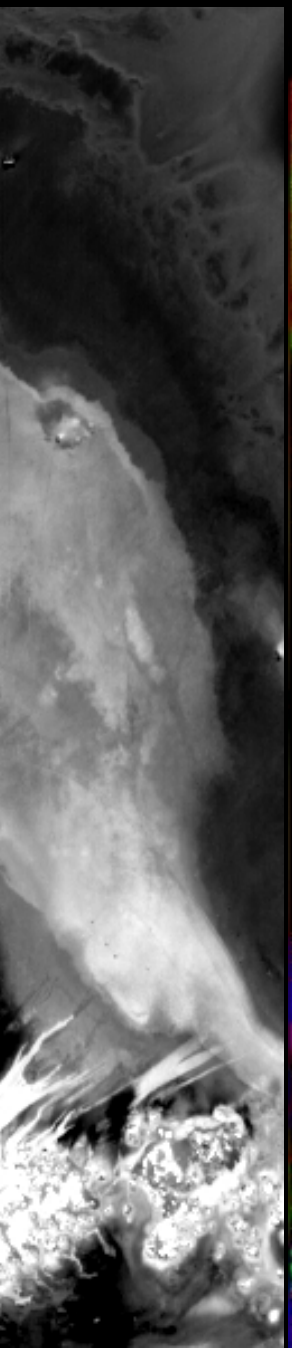


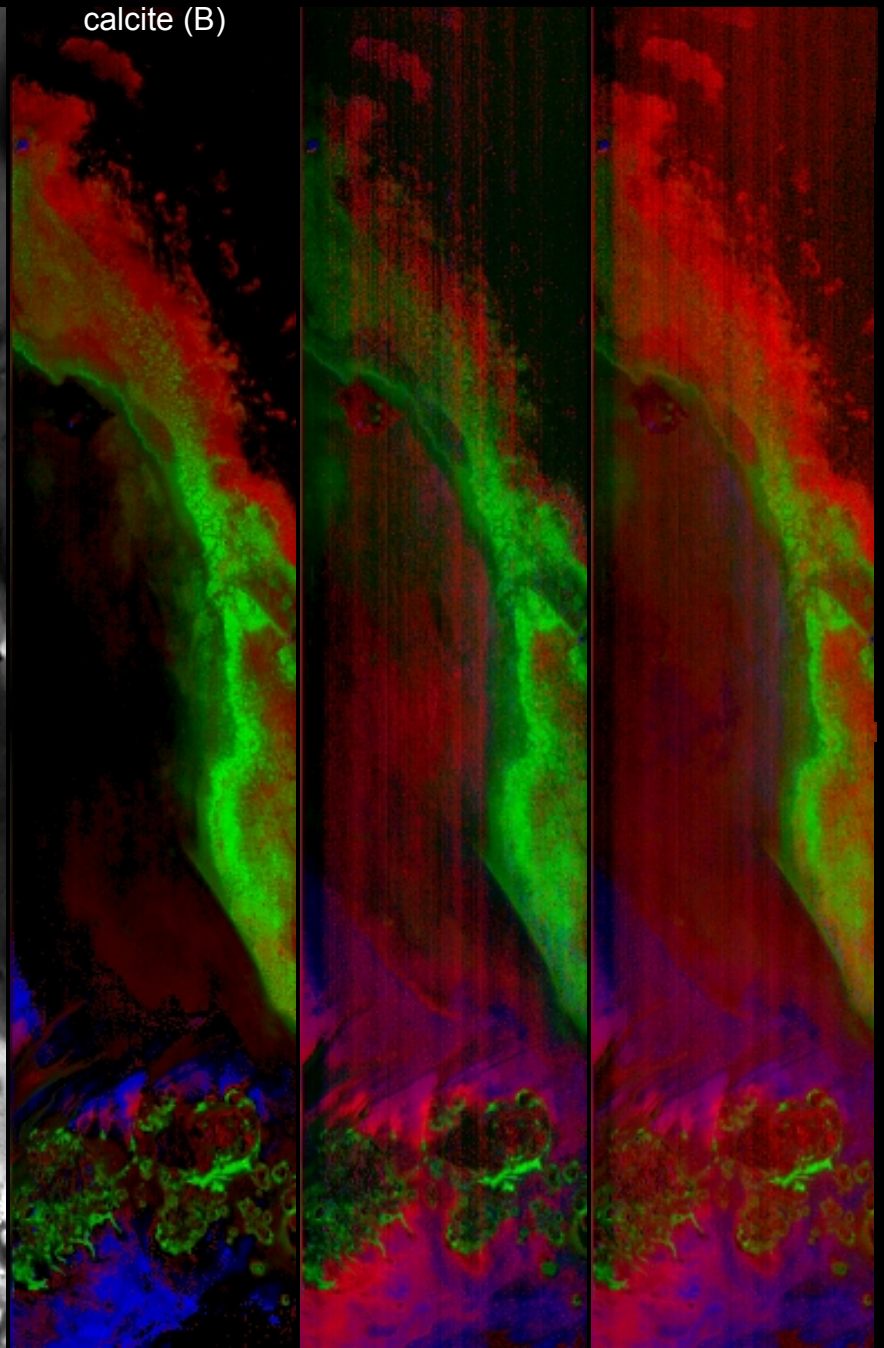
SEBASS 10 μm radiance

oligoclase (R), gypsum (G), calcite (B)

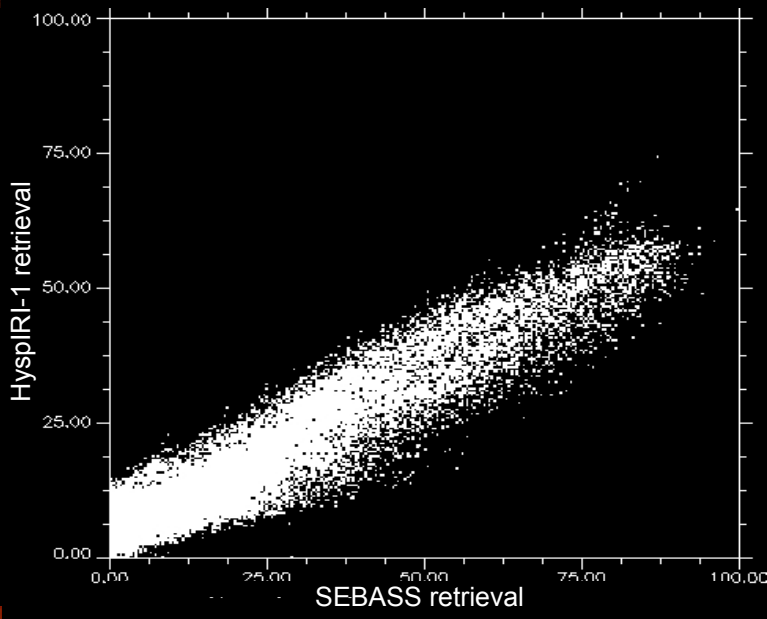
HyspIRI TIR bands

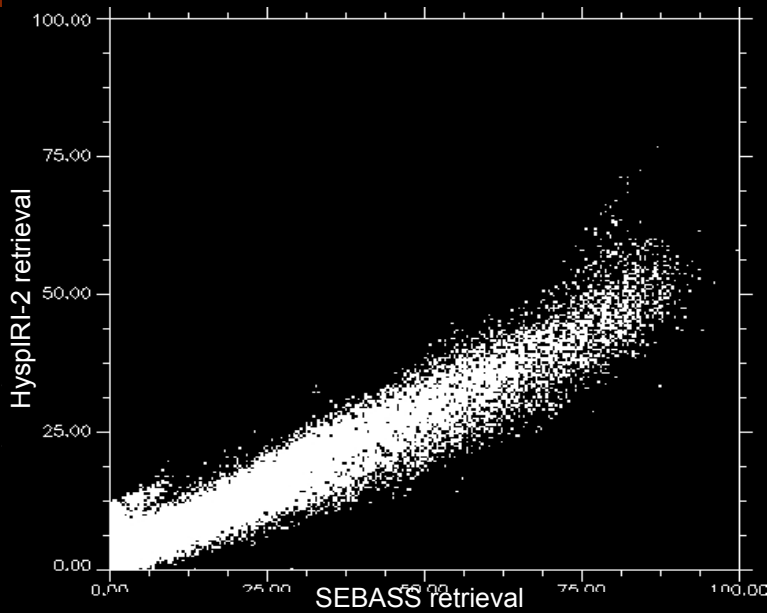
HyspIRI TIR *(band 10 shift)*



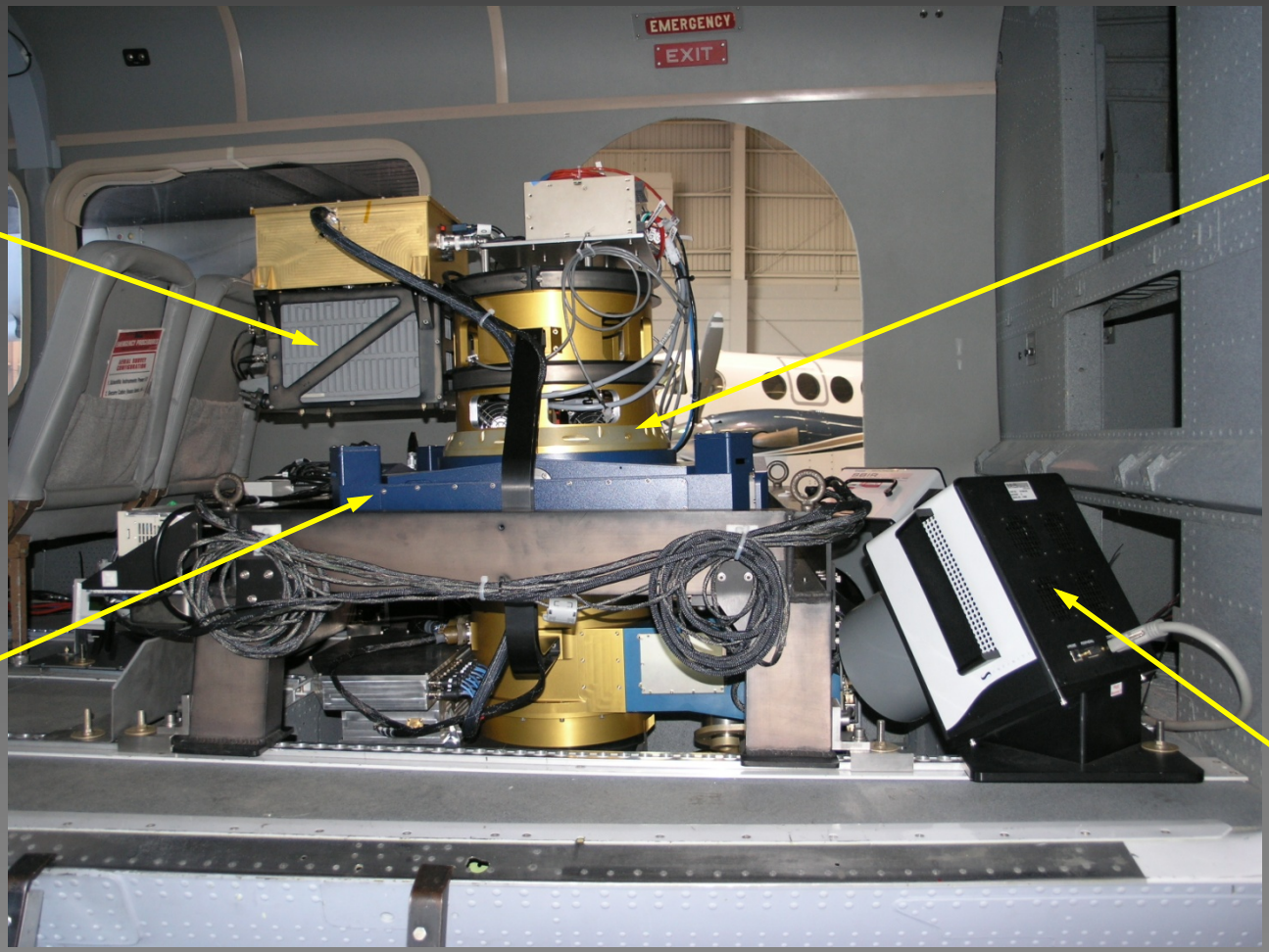


Library end-members: gypsum





MAGI On The Twin Otter



Inertial Navigation System

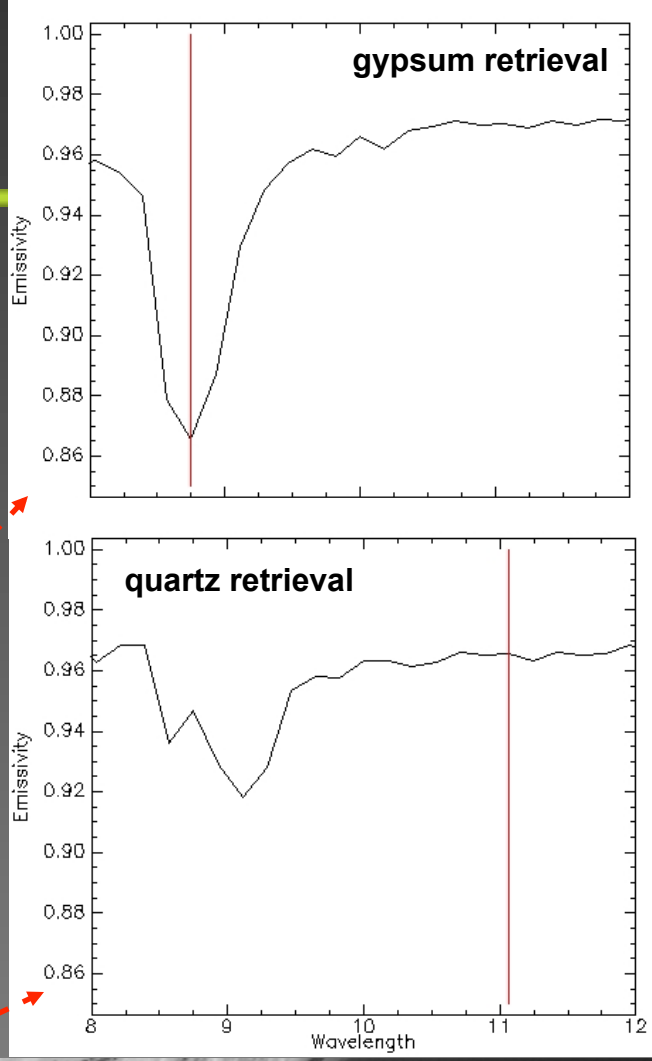
Sensor

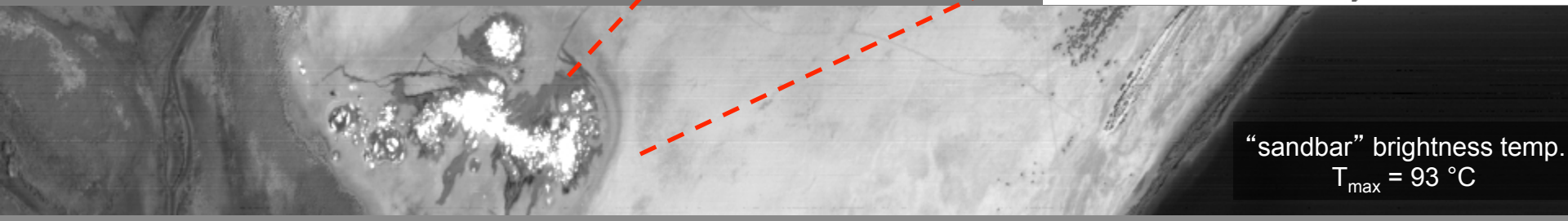
Commercial Stabilization Platform

Calibration Blackbody

MAGI Analysis

- **Analysis**
  - limited amount of data processed from L1
    - each whisk: 1024 x 128
  - minor detector line noise
  - temperature/emissivity data appear very good
    - compositional diversity matches well with SEBASS mineral maps
      - *example: gypsum, quartz*





"sandbar" brightness temp.
T_{max} = 93 °C

Conclusions

- **TIR Observations of Volcanic Targets**
  - temporal
    - 8 year/several 1000 scene ASTER URP volcano archive
    - *nearly identical to HyspIRI TIR spatial/spectral/temporal data*
    - clouds (74 – 82% of URP scenes)
    - anomalies (52 – 86% of URP scenes)
      - *high repeat time is critical*
  - spectral
    - have the new instruments/tools to simulate HyspIRI TIR bands
    - slight tweaking of band positions should be being studied
    - e.g., 7.35, 8.20, 8.55, 9.07, 10.2 (n), 11.4(n), 12.05 μm
      - greatly improves detection of feldspar silicate minerals
      - possibly carbonates and SO_2 as well
        - may be trades between gas and ground detection, however