# EGM703 – Advanced Active and Passive Remote Sensing

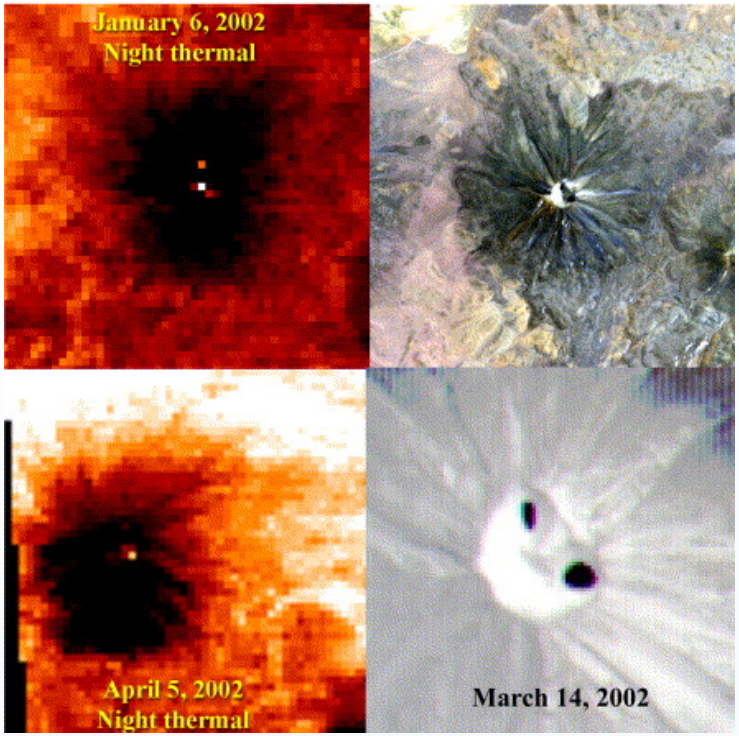
## Week 1, Part 6: Applications of Thermal Remote Sensing

# (Some) Applications of TRS

- Volcanology
- Urban Heat Islands
- Wildfire monitoring
- Sea surface temperature
- … and many more!

# Volcanology: Hot spot detection

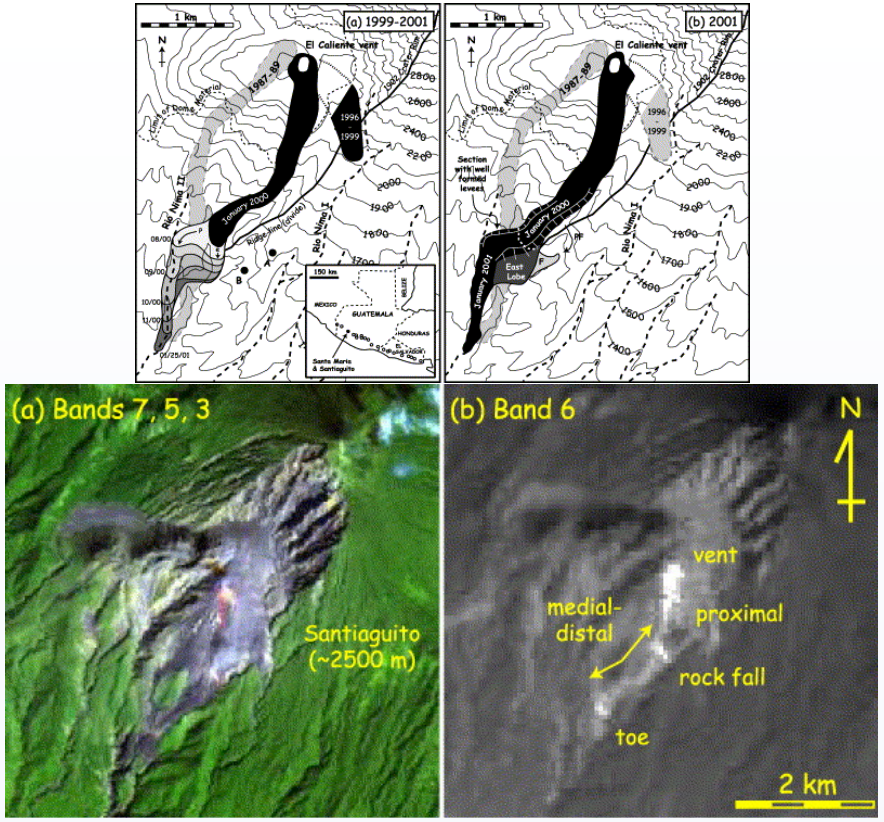
- Thermal  bands can be used to detect hot spots (i.e., very bright pixels)
  - Especially useful with night-time imagery
- On volcanoes, can be indicative of increased activity
  - Fumaroles
  - Crater Lakes
  - Lava flows
- Example: Chiliques Volcano, Chile




Pieri and Abrams, 2004

# Volcanology: lava flows

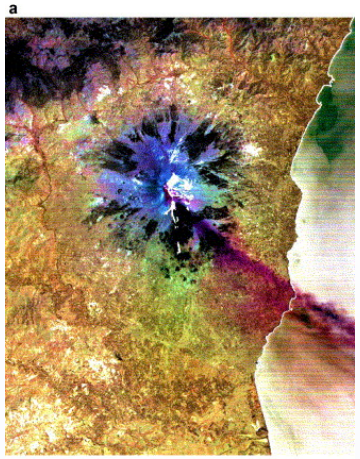
- Active lava flows are hot (>400 K)
  - Significant emission in SWIR, TIR
  - Helps with atmospheric correction
- Repeat images:
  - Map flows, changes
  - Estimate cooling rates



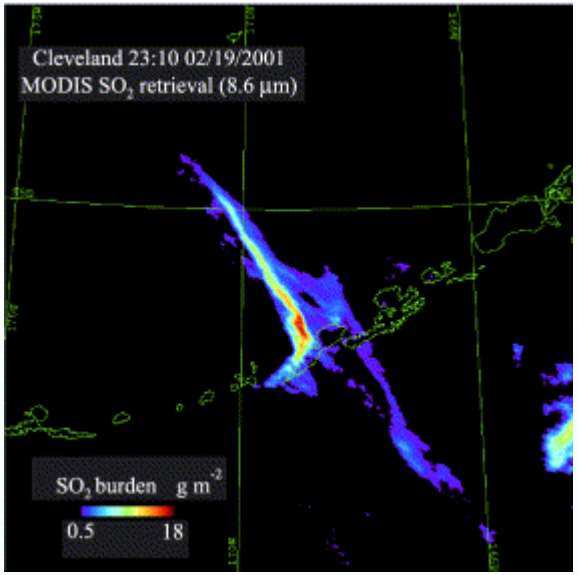

Harris et al., 2004

# Volcanology: $SO_2$ concentration

- Volcanoes also emit gases
  - e.g., $SO_2$ (sulfur dioxide)
  - Can be hazardous
  - Can also be indicative of eruptions
- $SO_2$ concentration is tied to absorption (emissivity)
  - Using multiple TIR bands, can detect, estimate concentrations



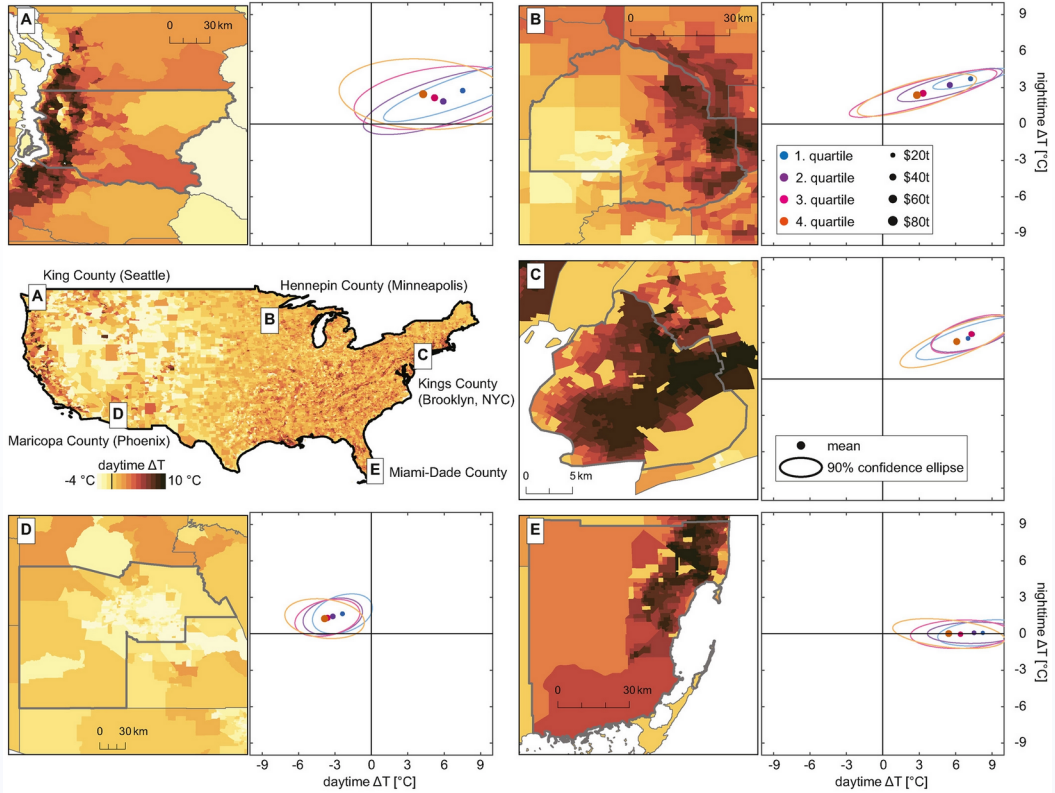

Pieri and Abrams, 2004




Watson et al., 2004

# Urban Heat Islands

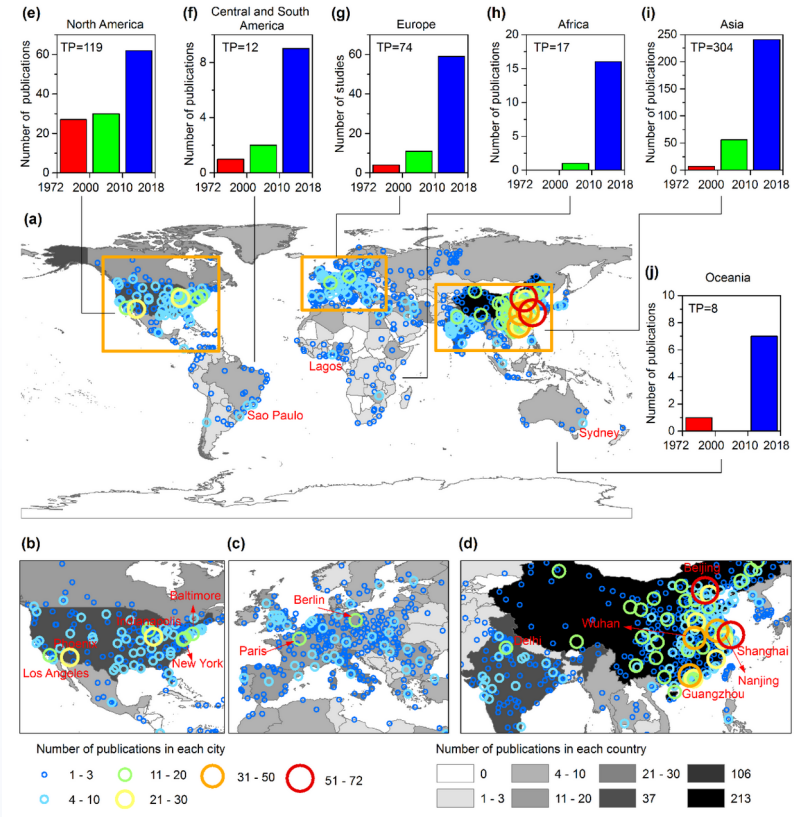
- Urban (built-up) areas tend to be hotter than rural (not built-up) areas
- Even within urban areas, significant variation
- In the US, significant correlation with race, economic class




Benz and Burney, 2021

# Urban Heat Islands

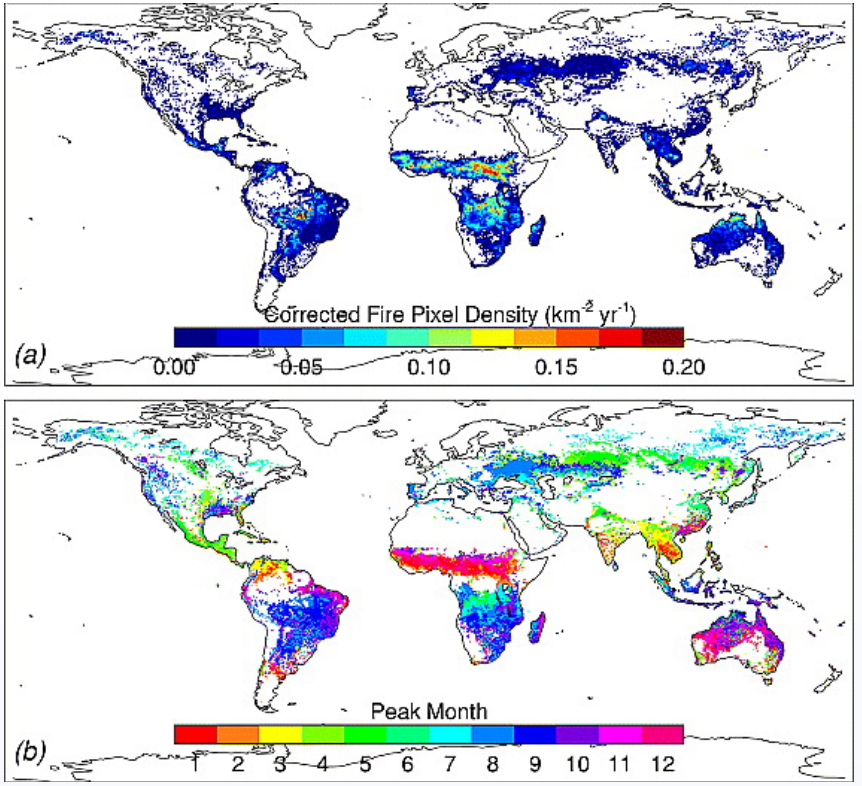
- Number of studies on (surface) urban heat islands has exploded since 2005
- Majority (78%) of these studies use:
  - Landsat (TM/ETM+/TIRS)
  - MODIS
- Studies broadly agree on what controls distribution
- Some limitations:
  - Not directly comparable to air temperature
  - Cloud-free images can be hard to find
  - Resolution trade-offs




Zhou et al., 2019

# Wildfire monitoring

- For actively-burning fires:
  - *L*(~4 µm) >> *L*(~ 11 µm)
  - *L*(~4 µm) >> 300K*
- MODIS:
  - 1-2 day repeat global coverage
  - Multiple bands in mid, thermal IR
- Can use this to study global wildfire dynamics:
  - Season duration, timing
  - Intensity

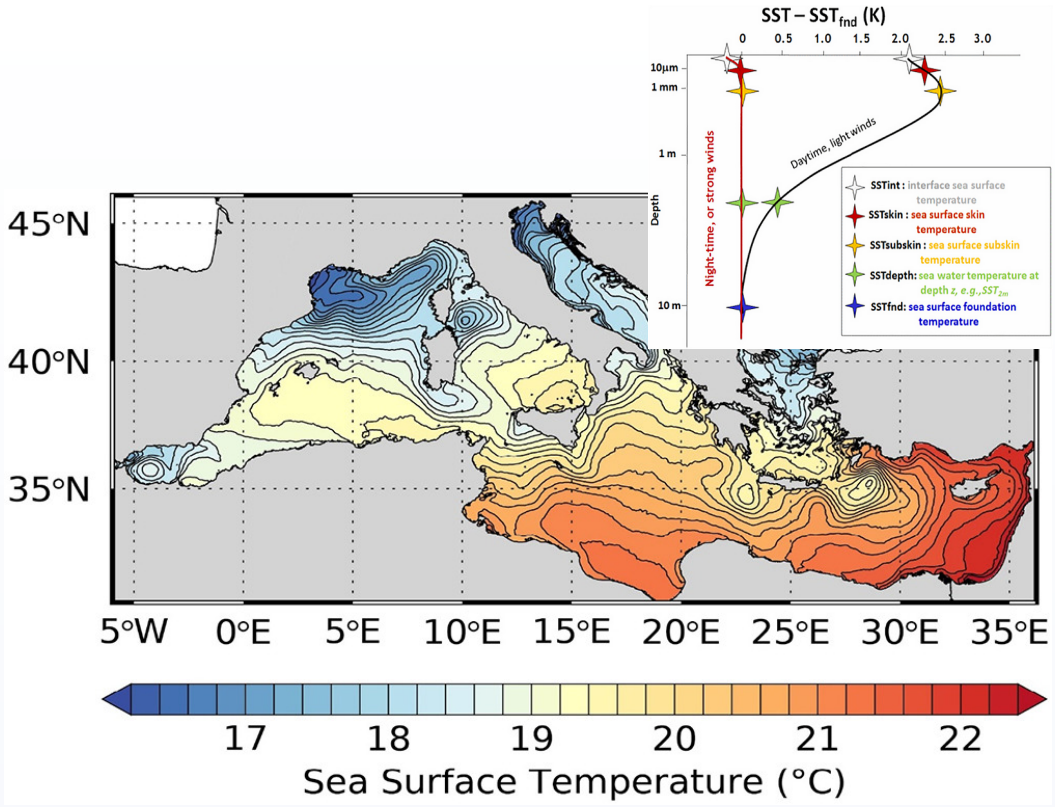



*remember: low-resolution sensors!

Giglio et al., 2006

# Sea Surface Temperature

- First satellite-based estimates: 1967*
  - Global estimates: 1972
  - Two-band atmospheric correction: 1979
- Thermal sensors:
  - AVHRR (1978* – present)
  - (A)ATSR (1991 – present)
  - MODIS (2000 – present)
  - VIIRS (2011 – present)
  - SLSTR (2016 – present)
- Other sensors (e.g., ASTER) are useful for smaller-scale studies




Minnett et al., 2019

# Summary

- Thermal remote sensing has many applications
- Not all of these applications deal directly with land surface temperature!
  - e.g., volcanic plume composition
  - mineral identification
- A lot of them do, though.

# Additional resources

- Pieri and Abrams, 2004 [J. Volcanology Geotherm. Res.]
- Harris et al., 2004 [J. Volcanology Geotherm. Res.]
- Watson et al., 2004 [J. Volcanology Geotherm. Res.]
- Benz and Burney, 2021 [Earth's Future]
- Zhou et al., 2018 [Rem. Sens.]
- Giglio et al, 2006 [J. Geophys. Res. Biogeosci.]
- Hua and Shao, 2017 [J. Forest. Res.]
- Minnett et al., 2019 [Rem. Sens. Env.]
- More: EGM703 Zotero Library