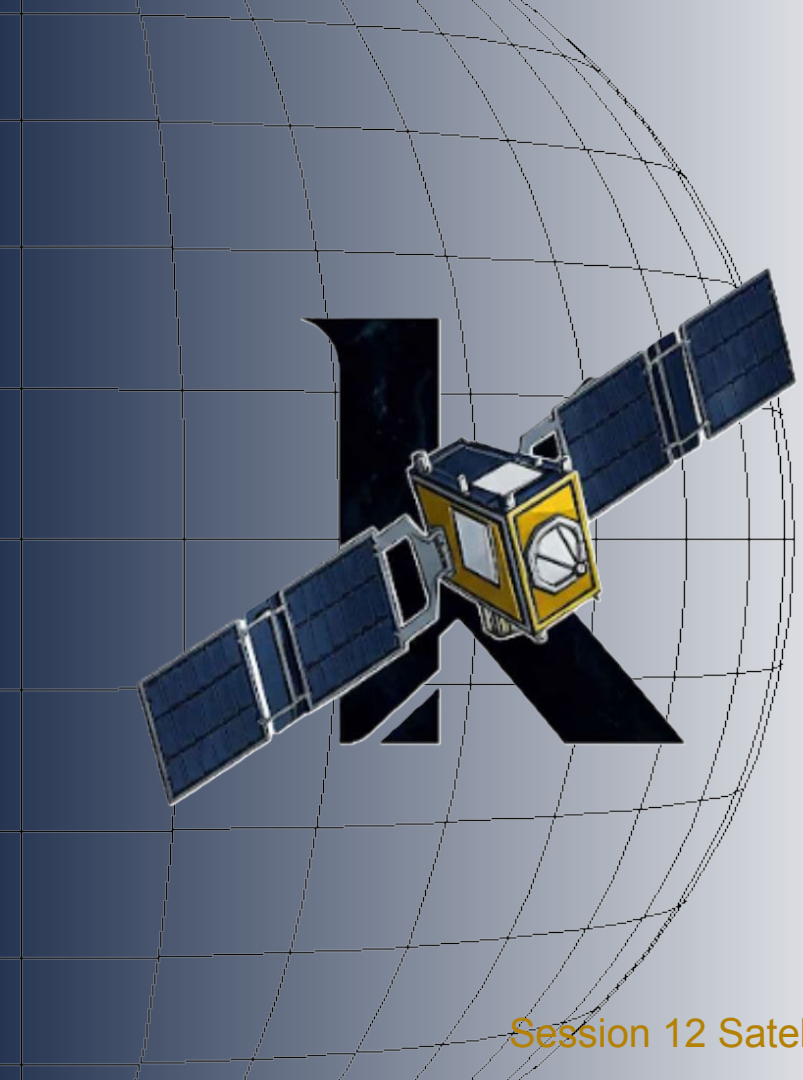


Implementing VGAC

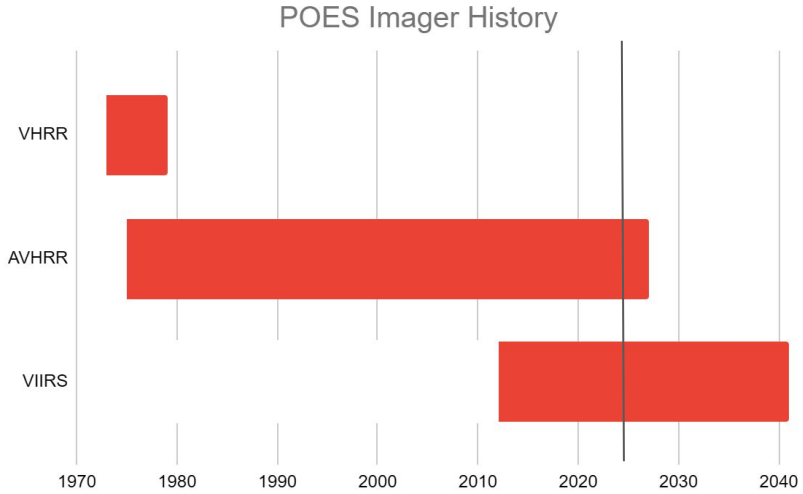
Bridging Climate Data Records with Modern Satellite Capabilities

Ken Knapp, *Knapp WeatherSat Services LLC*
Philip Casey, Douglas Rao, *CISESS*
Changyong Cao, *NOAA/STAR*
Xi Shao, *Univ. Maryland*

AMS SatMet:
Session 12 Satellite-Based Long-Term and Climatological Earth Observations I

Climate data: Continuity crisis

- VHRR
  - 2 channels
  - NOAA 2-5 (1975-1979) … 5 years
- **A**VHRR (1/2/3)
  - 5/6 channels
  - NOAA 6-19 (1979-2027) … 47 years
- VIIRS
  - 22 channels
  - NPP, JPSS 1-2 (2012 - 2041) … 30 years



When we see differences:

Is the change due to new capabilities? **or** climate?

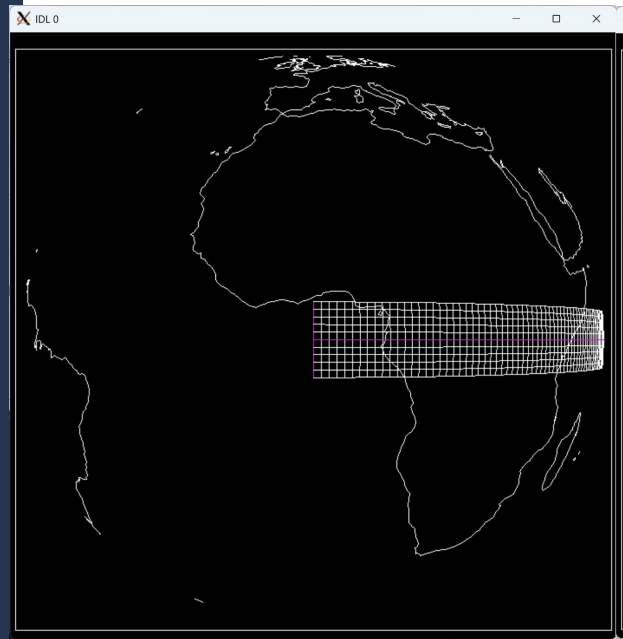
AVHRR & VIIRS: compatibilities and challenges

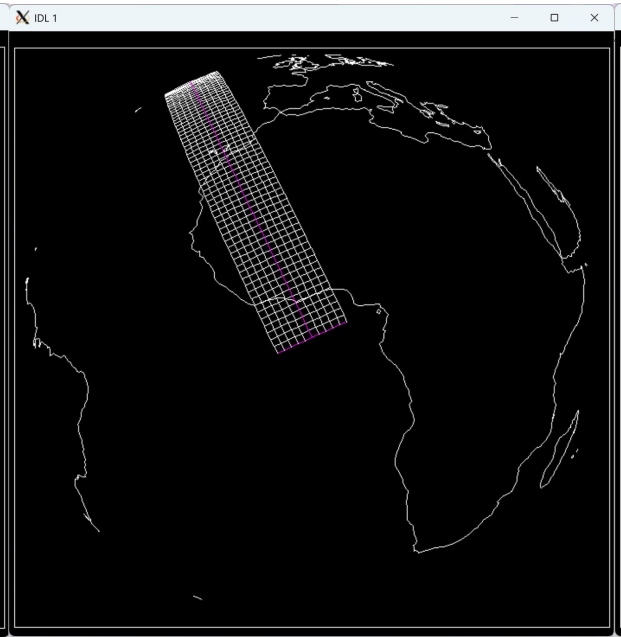
	AVHRR	**VIIRS**
# of channels	5/6	22
Scan rate	6 scans/sec	1.78 scans/sec
Calibration	IR: blackbody & space VIS: vicarious	IR: blackbody & space VIS: solar diffuser & space
Spatial footprint	LAC/HRPT/FRAC: 1km GAC: ~4km	MOD: 750m IMG/DNB: 375m
Footprint growth	Grows with VZA	Pixel aggregation limits growth
Data rate	FRAC orbit: ~590MB GAC orbit: 55 MB	SDRs: 23 GB
# of files per orbit	1	~1800 (varies based on source)
Navigation	Anchor points	All points with lat/lon

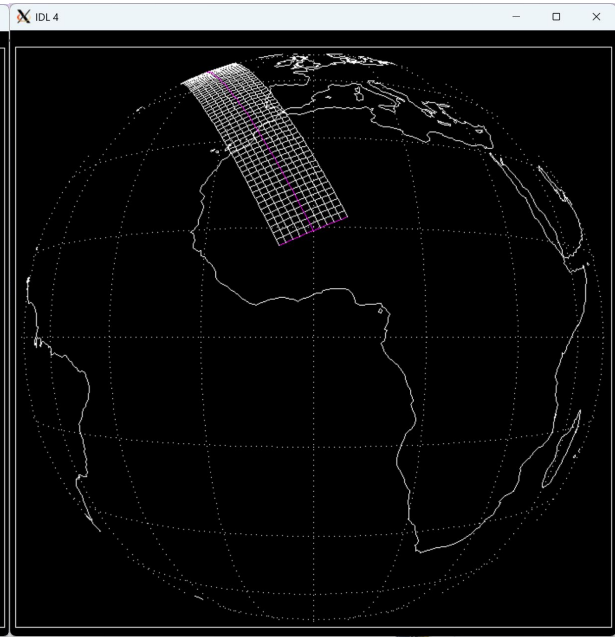
Defining a swath projection

Define a grid
Rotate it to match orbit path
Transform starting point to match orbit.

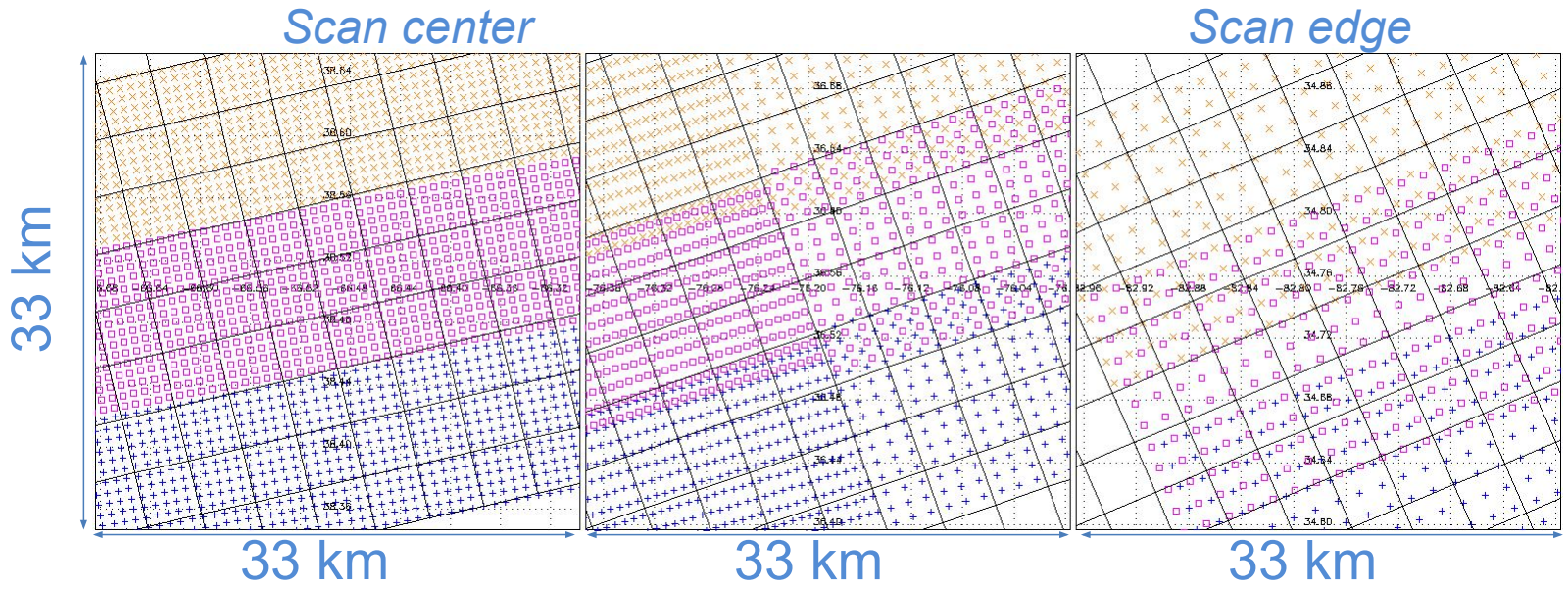
Allows direct conversion:
(lat,lon) → (i,j) → (lat,lon)





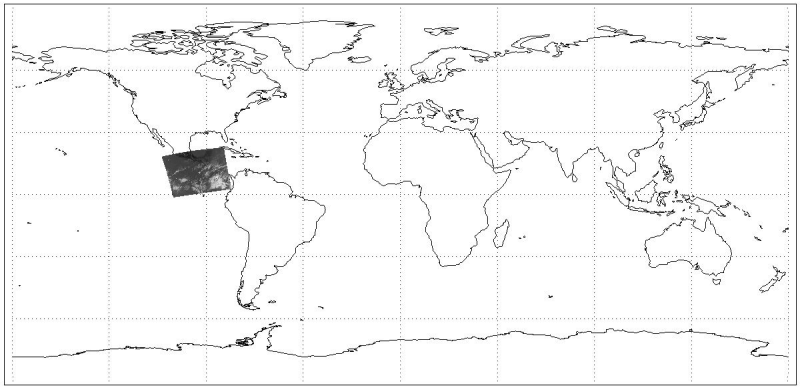


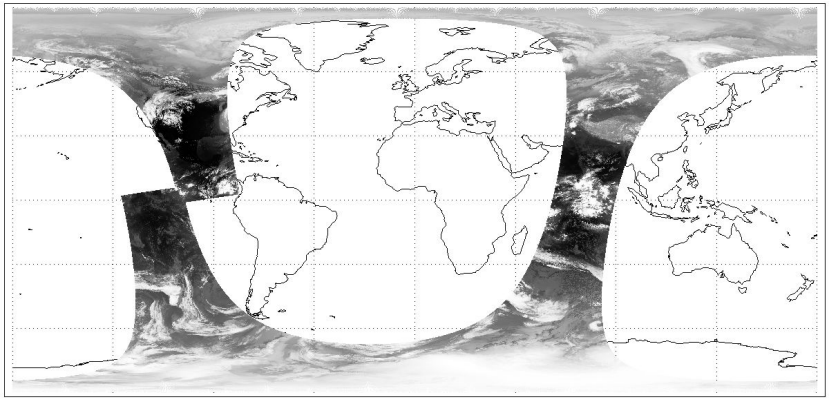
VGAC gridding

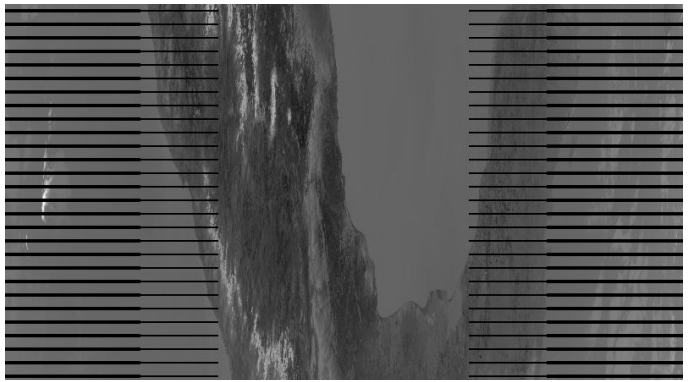


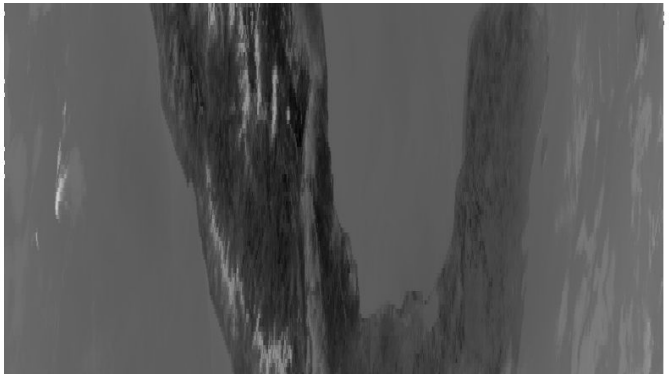
- Same grid size across entire swath – 801 ‘pixels’
- Data averaged – provide mean and variance for each ‘pixel’
- ‘swaths’ are perpendicular to satellite track

Granule vs. Orbit









VGAC Channels

IMG channels (original resolution: 375m)

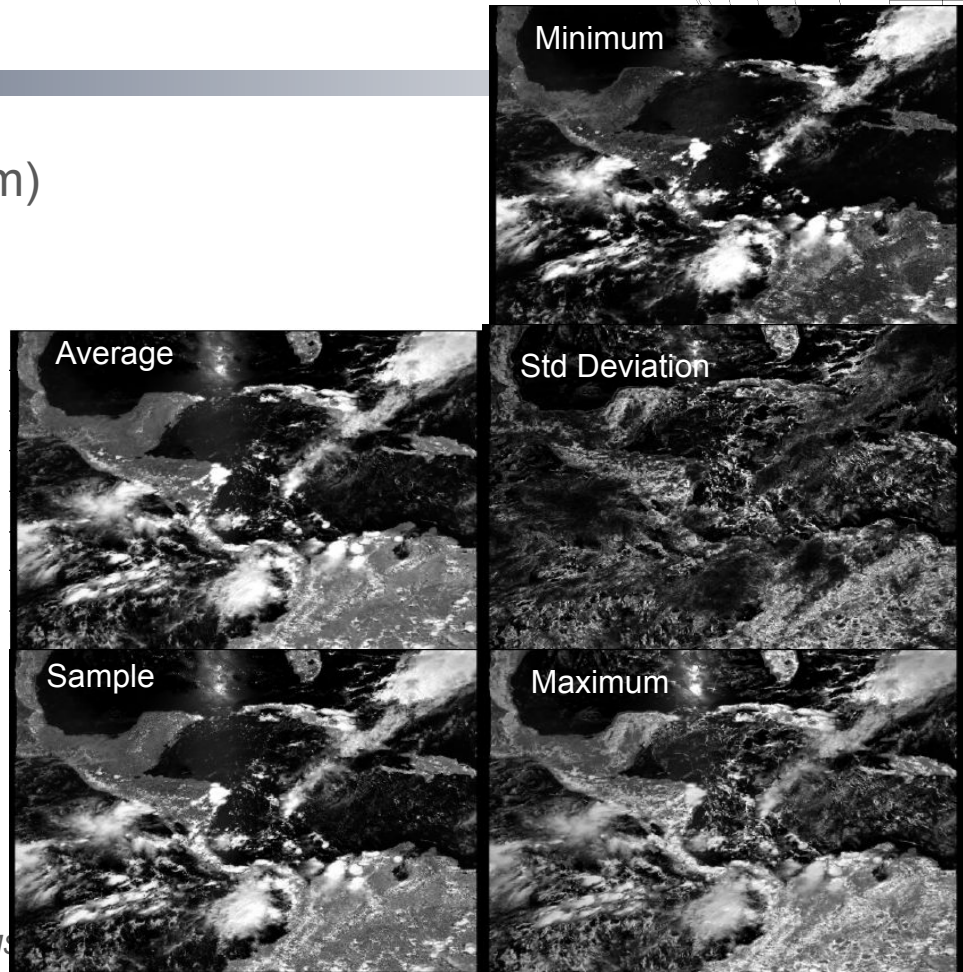
- Mean and Standard deviation
- Minimum & maximum
- Sample (nearest VGAC center)

MOD Channels (750m)

- Mean and Standard deviation

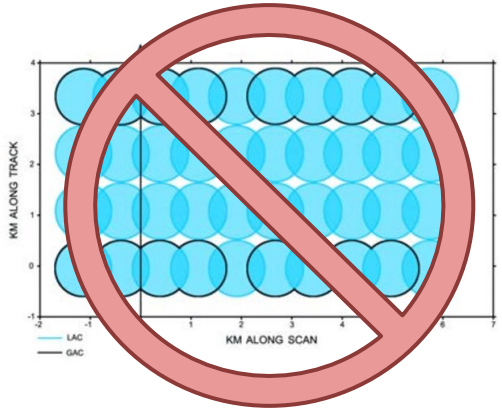
Other information

- Solar angles
- View angles



What VGAC is not …

- No spectral band adjustment factors (SBAF) applied
  - But GAC can be simulated with SBAF
- Not a complete simulation of the GAC averaging/sampling strategy
  - Likely not initially possible to emulate
- Not a simulation of GAC pixel growth
  - But GAC can be simulated



Sample processing: Calibration monitoring

- Deep Convective Cloud monitoring
- Simplified global monitoring
- High resolution not necessary

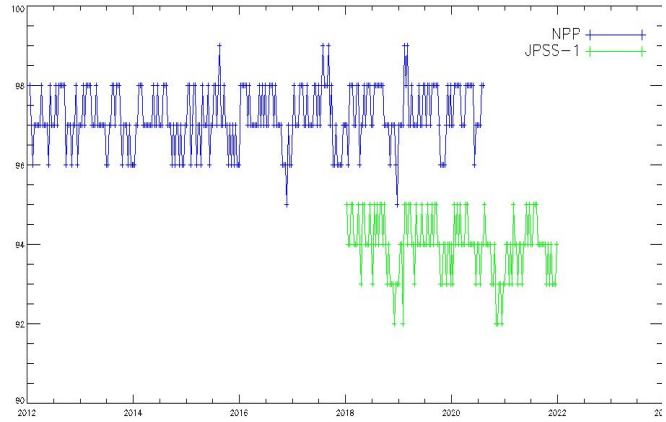
11 years VIIRS SDRs

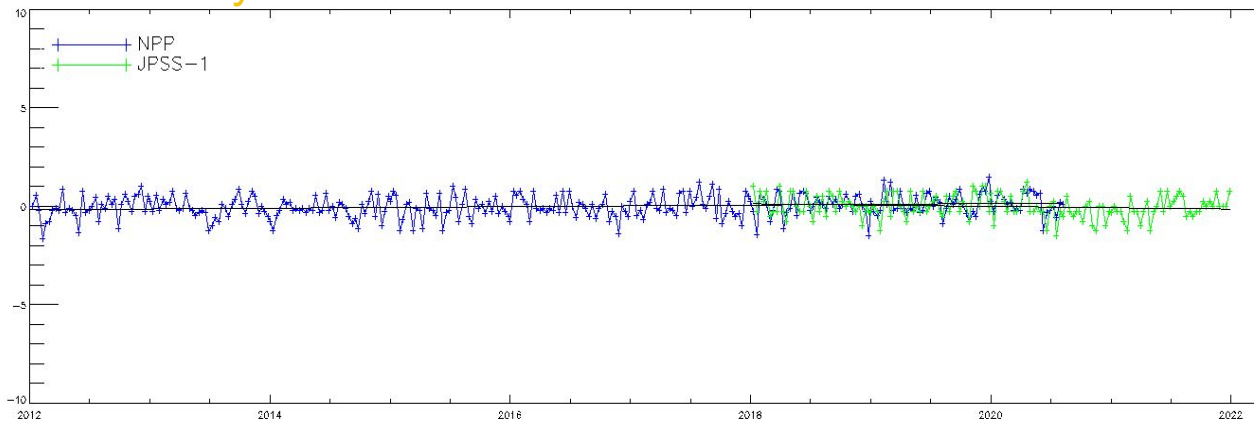
- 104,500,000 granule files
- 1.3 PB
- ~$50,000

11 years VGAC

- 57,000 orbit files
- 24 TB
- ~$50

Annual cycle removed

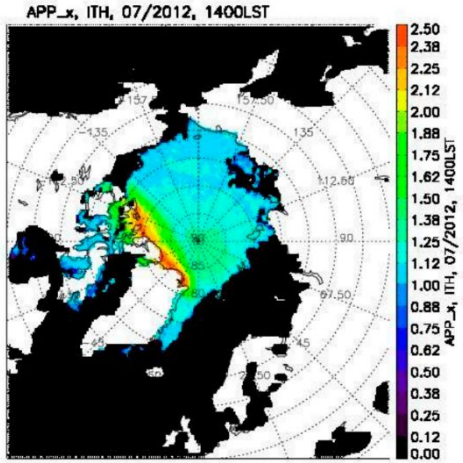


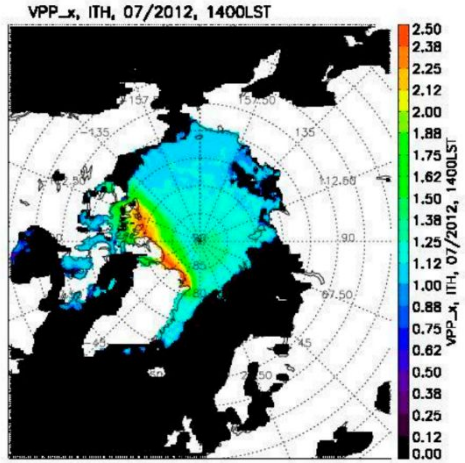


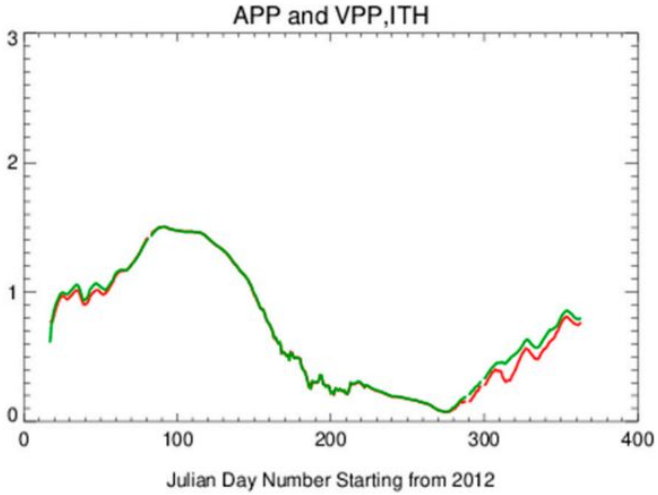
Polar Pathfinder products

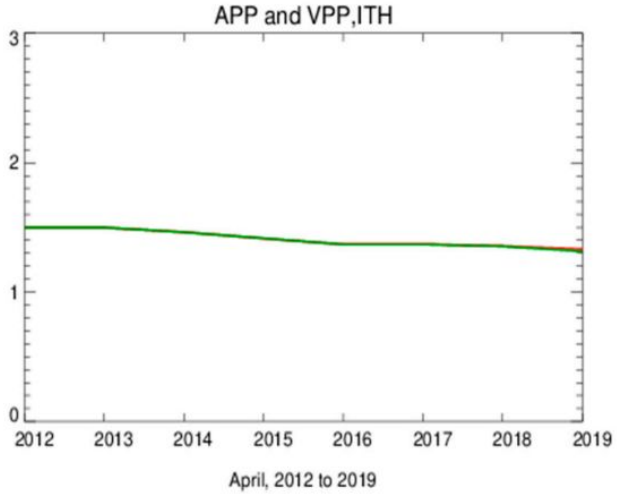
Wang et al (2025)

Applications to
Sea Ice Thickness (ITH)









VGAC Summary

50x Smaller than SDR

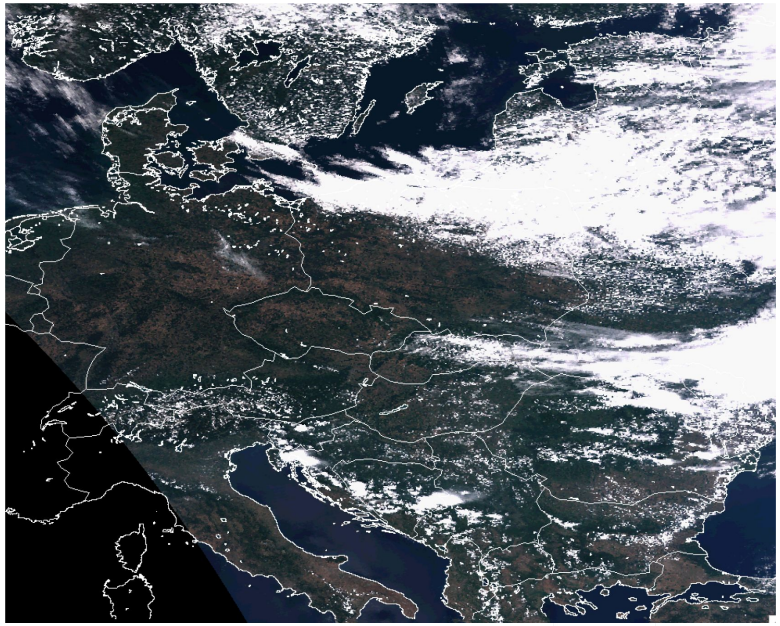
Scalable

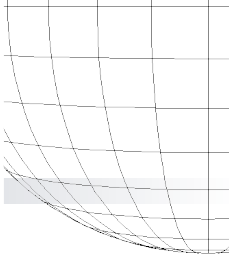
Stable

Versatile

Useful statistics

A projection





VGAC_VN2102MOD_A2026027_2334_n16666_K005.nc	461,215 KB	1/27/2026 11:01 PM
VGAC_VN2102MOD_A2026028_0115_n16667_K005.nc	460,844 KB	1/28/2026 12:31 AM
VGAC_VN2102MOD_A2026028_0257_n16668_K005.nc	465,233 KB	1/28/2026 2:01 AM
VGAC_VN2102MOD_A2026028_0438_n16669_K005.nc	462,718 KB	1/28/2026 4:01 AM
VGAC_VN2102MOD_A2026028_0620_n16670_K005.nc	460,693 KB	1/28/2026 5:31 AM
VGAC_VN2102MOD_A2026028_0801_n16671_K005.nc	454,113 KB	1/28/2026 7:31 AM
VGAC_VN2102MOD_A2026028_0943_n16672_K005.nc	459,894 KB	1/28/2026 9:02 AM

Available - *email me for current access location: ken@knappweathersat.com*

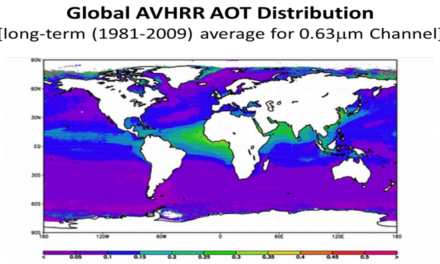
VGAC lowers the barrier from
"needs institutional HPC resources" to "can run on a personal cloud budget."

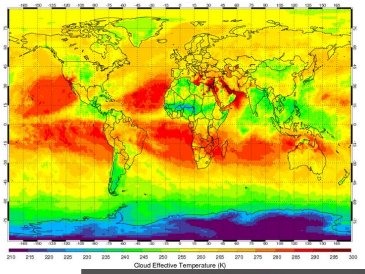
Extra slides

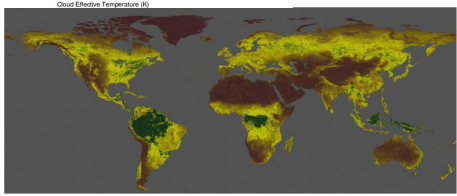
NOAA Climate Data Records depend on AVHRR

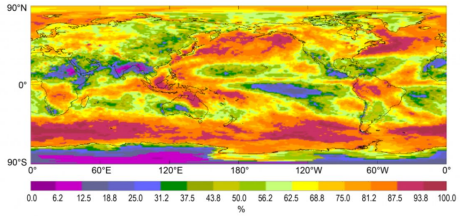
40+ years of information

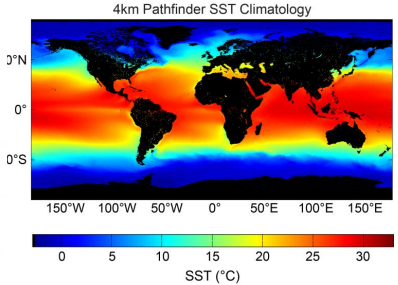
- Aerosol Optical Thickness
- PATMOS-x cloud properties
- NDVI, LAI, FAPAR
- Polar Pathfinder products
- Sea Surface Temperature
- ISCCP - Cloud products

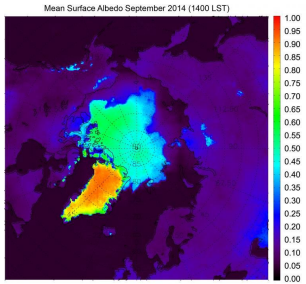






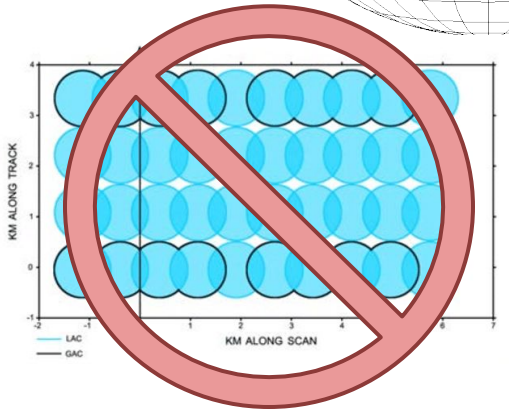






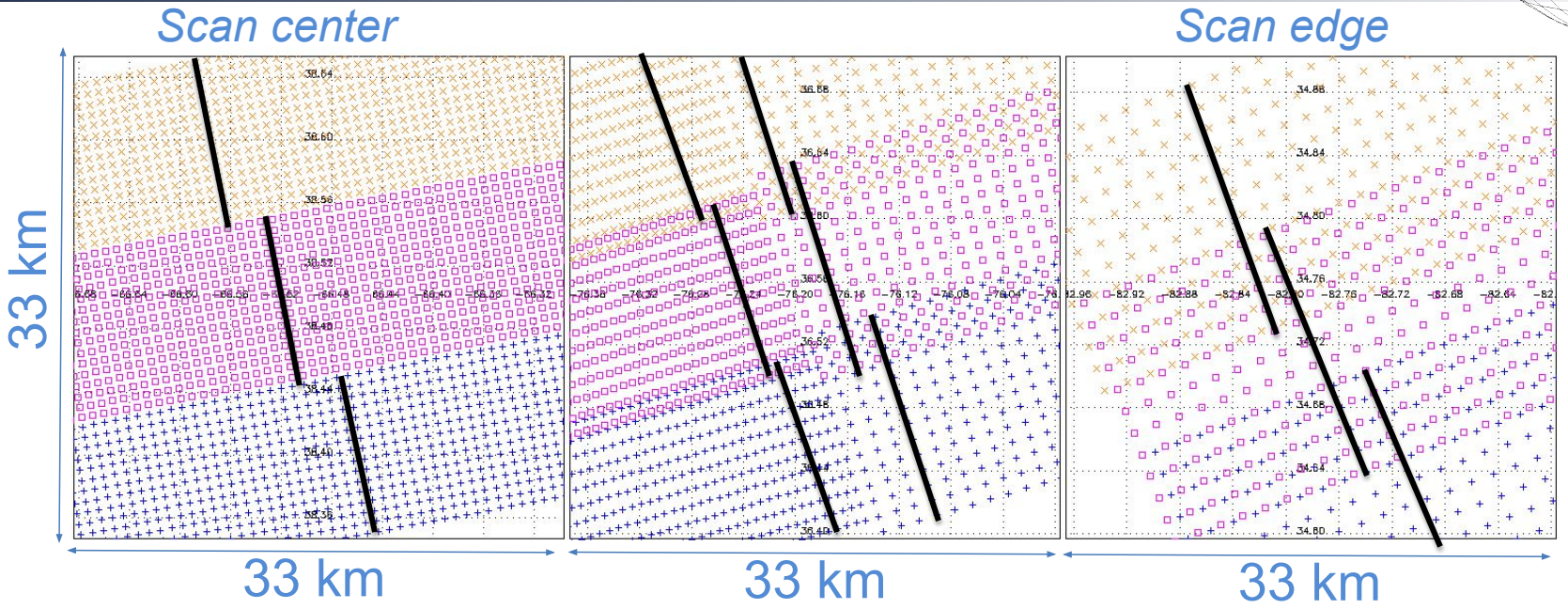
Data harmonization: a scalable framework

- Requirements
  - Be similar to historical GAC, but not identical
  - Ability to perform similar spatial tests
- Definitions
  - “footprint” = 3.9 km = 1/3 the VIIRS swath
  - Constant cross scan footprint size
  - Can be scaled!
- Similar to GAC
  - small differences
  - not groundbreaking changes in processing
- Storage – 1 file per orbit
  - Ability to process many years



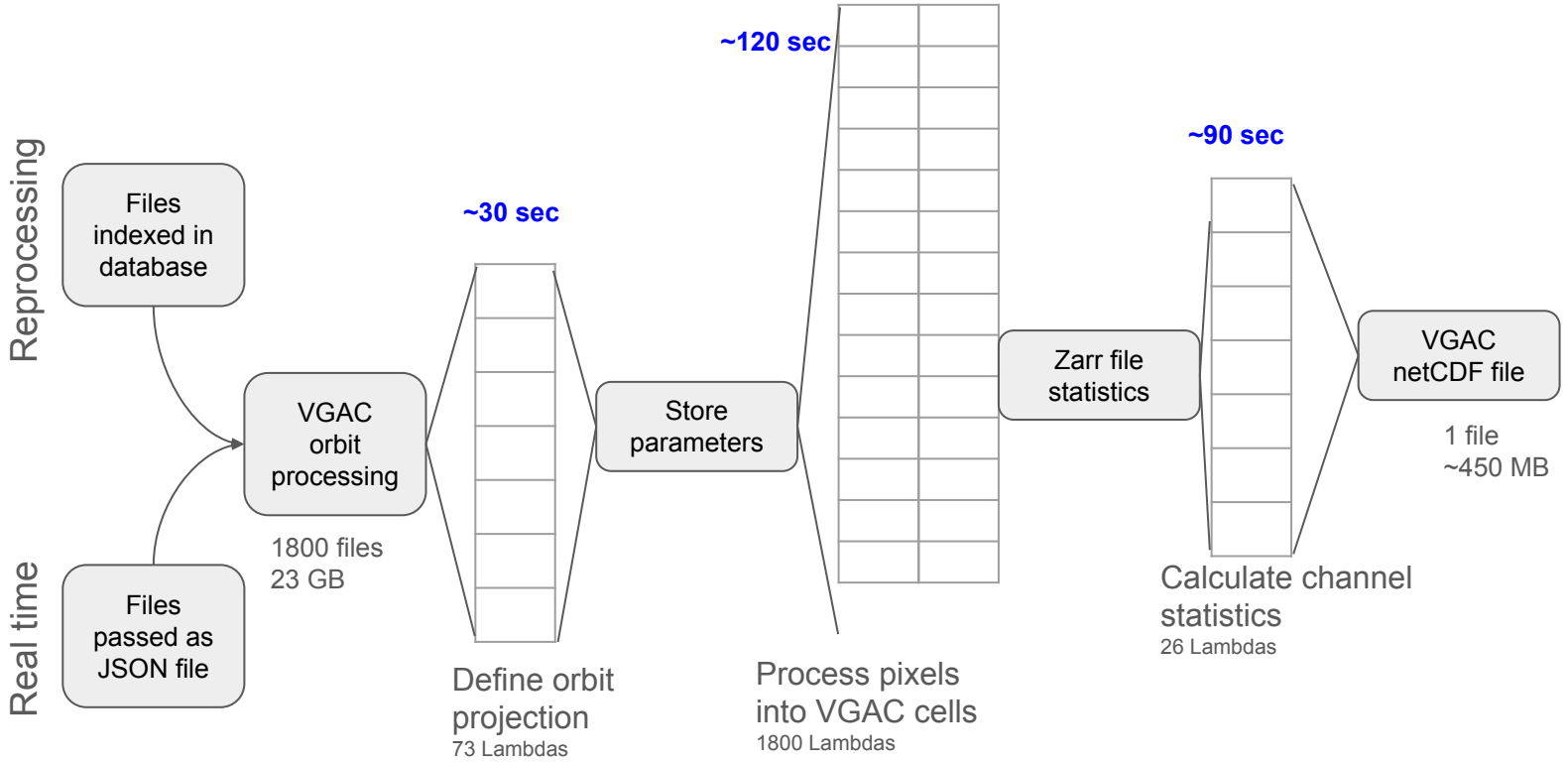
Transformation not simulation

VIIRS scans: Can ISCCP process VIIRS directly?



- Scanning isn't spatially continuous
- Spatial resolution is much higher than historical record

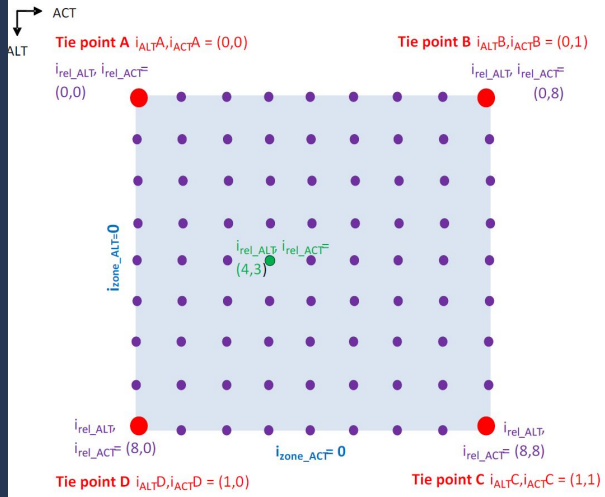
Processing VGAC



METImage Global Area Coverage: MGAC!

- Many similarities to VIIRS
- VGAC is scalable
  - Cell size can be adjusted … can keep at 3.9km … or can adjust for METImage
  - 24 pixels ~ 12km: 4km would allow 3 cells per swath
- MGAC can provide consistency as instruments change
- Unified processing across systems (VIIRS, METImage, *others*)

METImage Global Area Coverage: MGAC?



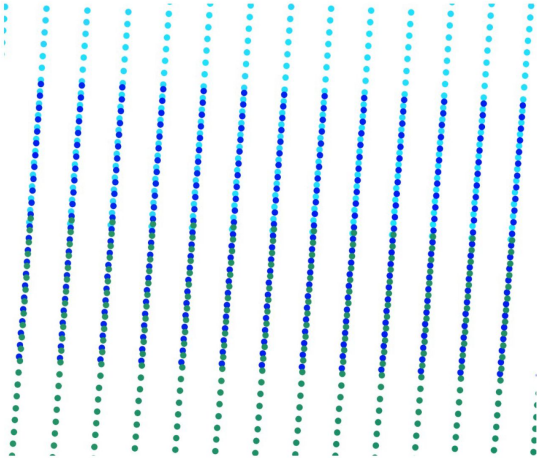


Figure 7: Zoomed image of overlapping samples from 3 neighbouring swaths at the swath