# ESTABLISHING ACTIVE FIRE DATA CONTINUITY BETWEEN AQUA MODIS AND SUOMI NPP VIIRS

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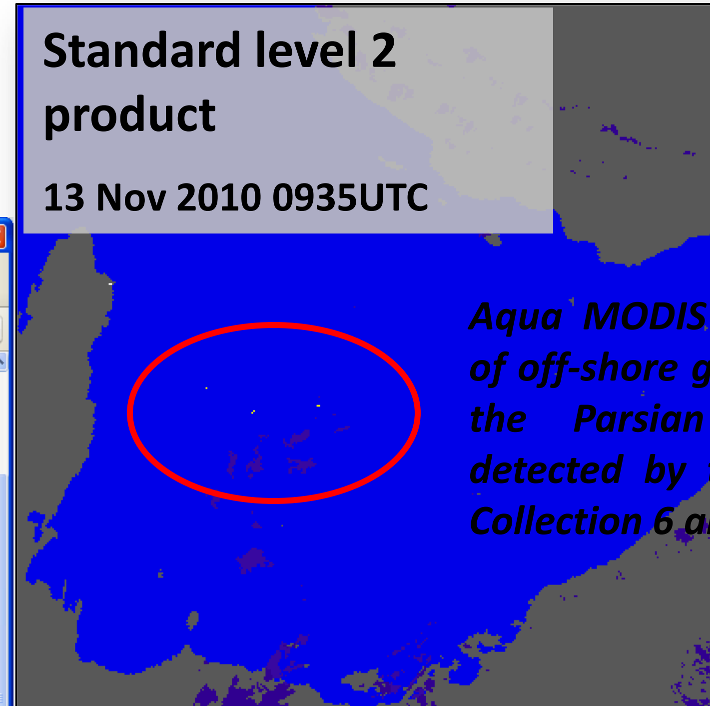
# Why do we need MODIS-VIIRS continuity?

- MODIS is the first sensor designed to **detect and characterize hot targets** (predominantly actively burning fires) on a **global and systematic basis**
- MODIS fire data have been **extensively used** for disaster and resource management, air quality applications, ecosystem monitoring, climate studies etc.
- The community expects and **society needs** the continuation of these high quality observations from VIIRS on NPP (launched on October 28, 2011) and future JPSS satellites

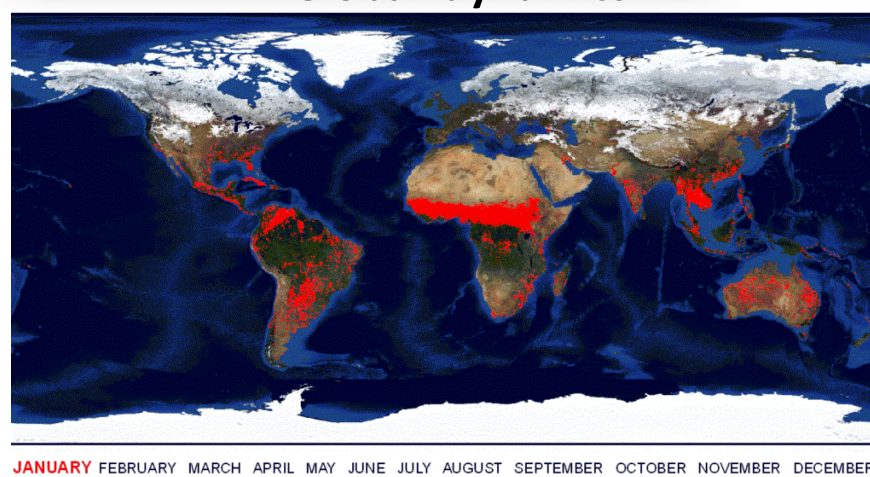
# Examples of MODIS fires/thermal anomalies data

**Real-time data**


*Aqua MODIS detections of off-shore gas flares in the Parsian Gulf as detected by the MODIS Collection 6 algorithm*

**Global dynamics**



# MODIS – VIIRS fire continuity: fundamental possible scenarios

1. **Orbital/daily** MODIS and VIIRS fire maps are **compatible**.

2. Spatially and temporally **aggregated fire statistics** from MODIS and VIIRS **are compatible**.

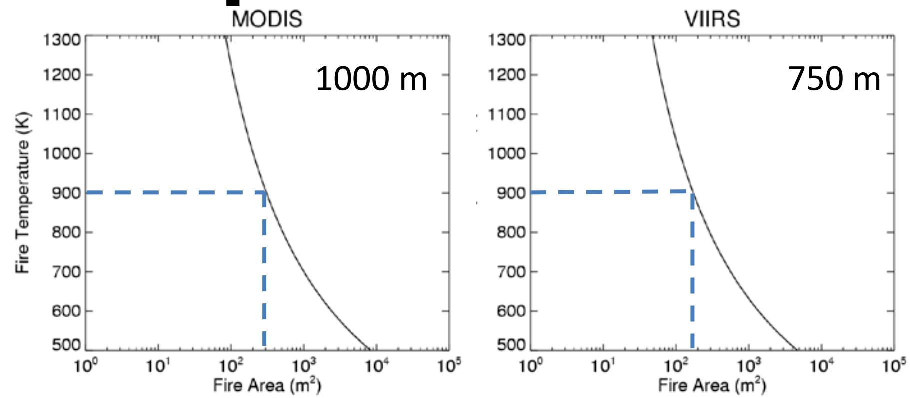
3. Not even spatially and temporally aggregated fire statistics from MODIS and VIIRS are compatible, but MODIS and VIIRS provide **compatible general patterns and trends of fire dynamics**.

# Aqua MODIS vs. NPP VIIRS: fundamental features

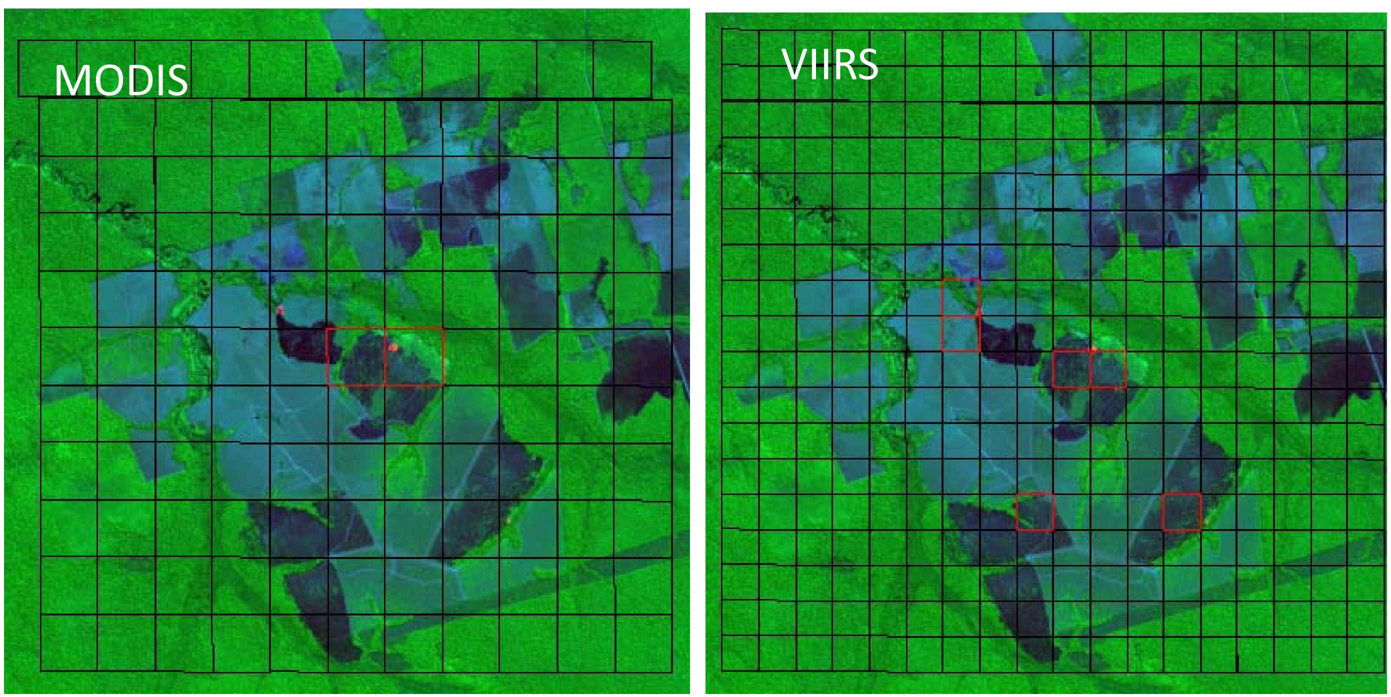
- Aqua and NPP have **similar overpass times (1:30pm)**
  - sampling of the diurnal fire cycle is similar
- Saturation levels of the primary bands allow **unsaturated radiance measurements** for most fires
  - Band 21/22 for MODIS and M13 for VIIRS
- Some differences in **spectral placement**
- Processing **algorithms are compatible**
  - Current VIIRS algorithm is based on MODIS, albeit an earlier version
  - Differences can be resolved and the impact can be minimized
- **Primary driver** of differences is **spatial sampling**
  - Pixel size
  - Variations along scanline (aggregation schemes)
  - Variations within pixels (line-spread function, aggregation)
  - Differences in swath width (VIIRS has no gaps at low latitudes)

# Will orbital/daily MODIS and VIIRS fire maps be compatible?

*VIIRS spatial resolution is higher that of MODIS; in general, VIIRS is expected to detect smaller fires at nadir*




90% probability of detection; boreal forest; nadir view



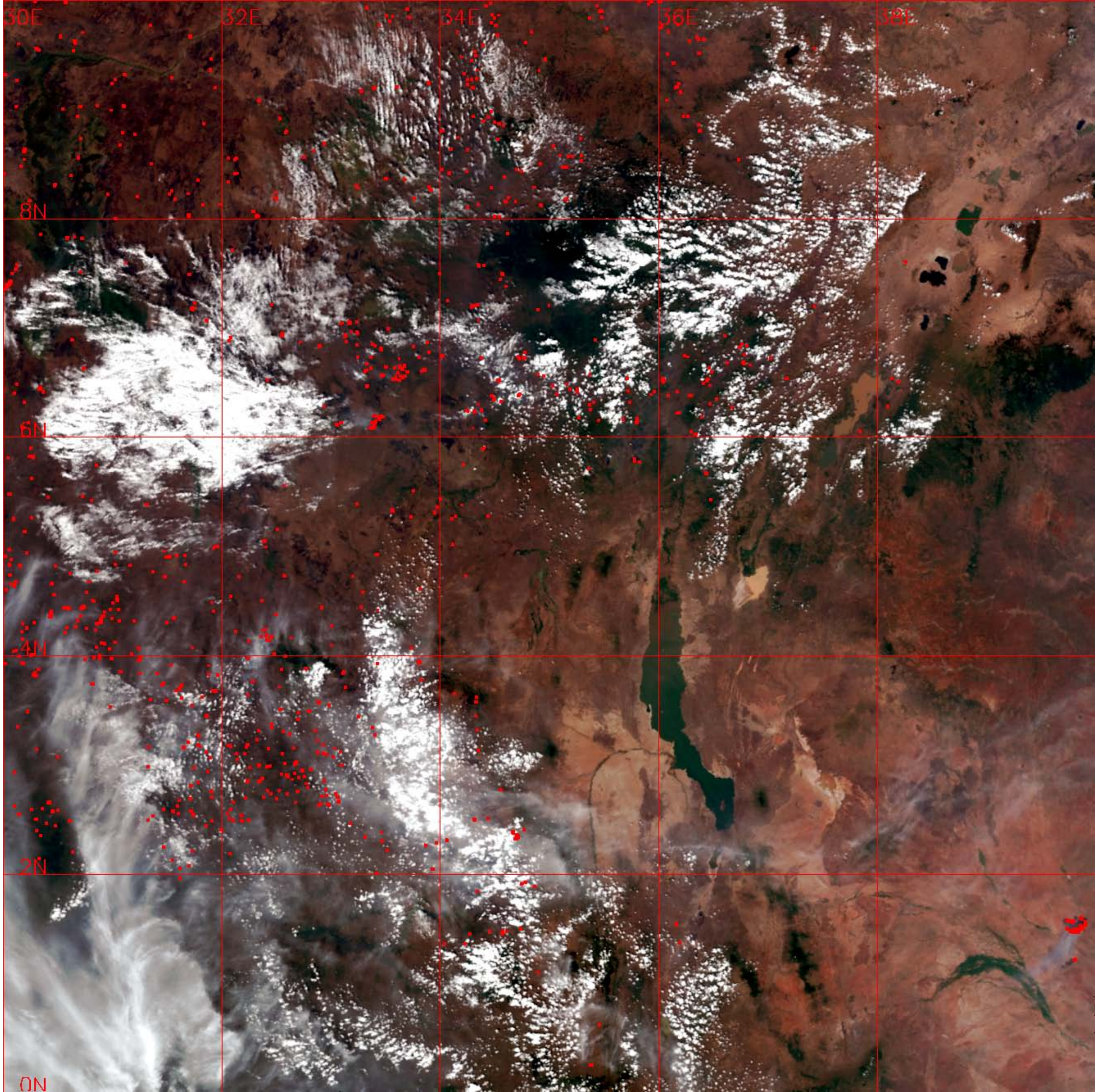

(based on modeling using ASTER fire masks)

7 Aug 2004 1405 UTC ~11.7° S 56.6° W (Brazil)

# First light NPP VIIRS fire data

***M5-M4-M3 RGB***
***+***
***IDPS Active Fire ARP***

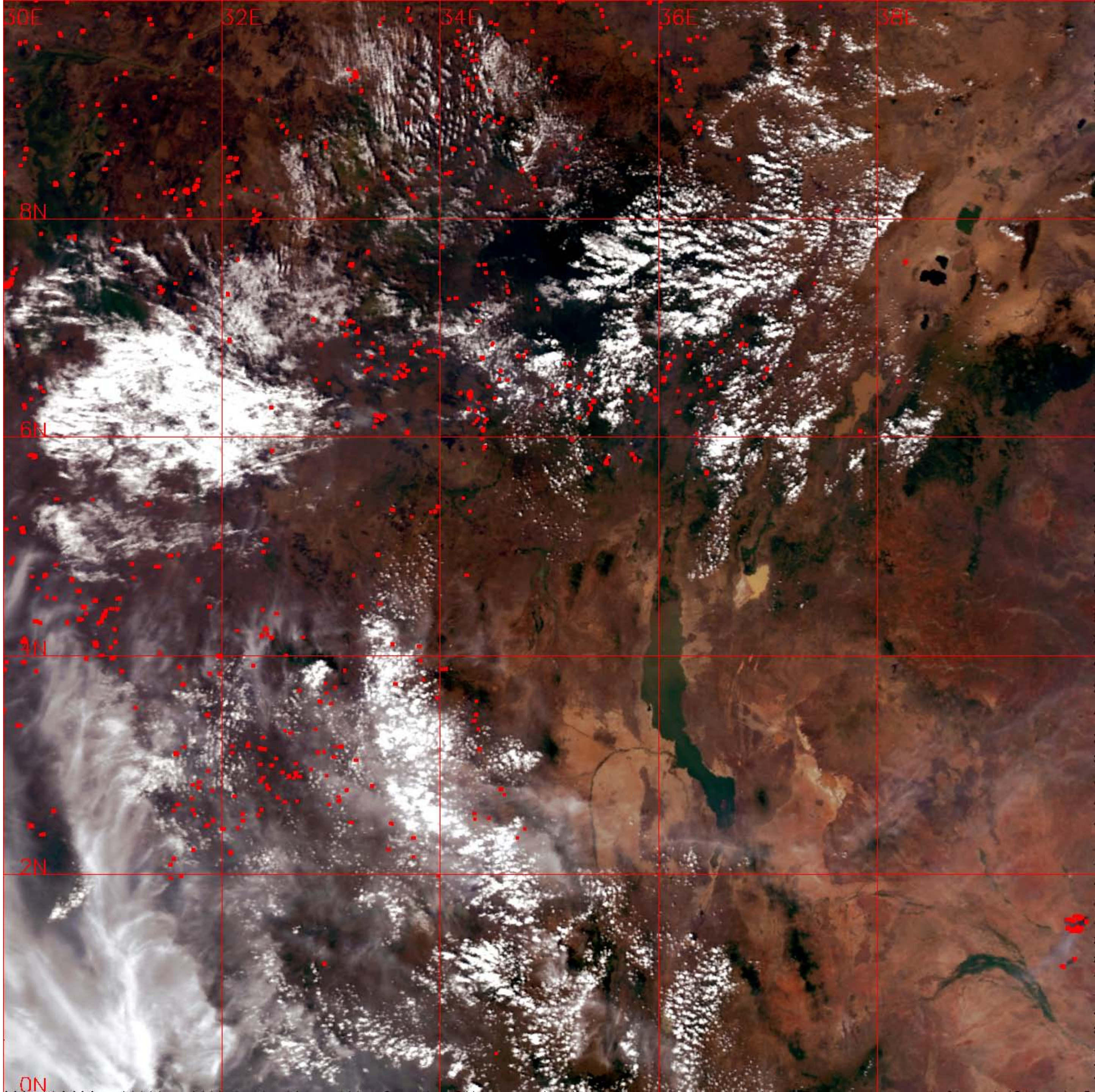
January 19, 2012
~11:05 UTC



...followed by Aqua MODIS five minutes later

***Band 1-4-3 RGB***
***+***
***MYD14***

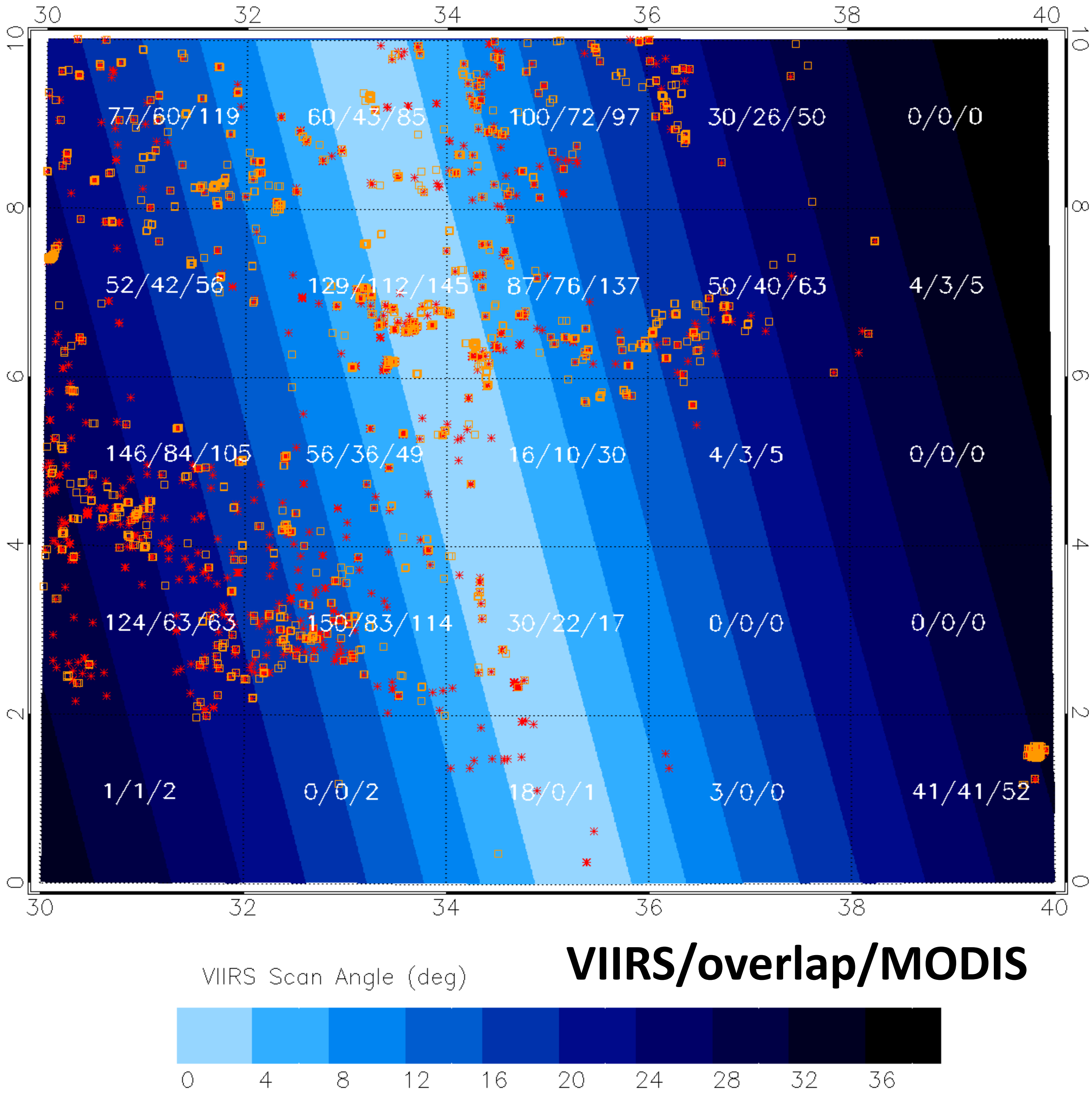
January 19, 2012
~11:05 UTC



# MODIS vs. VIIRS detections

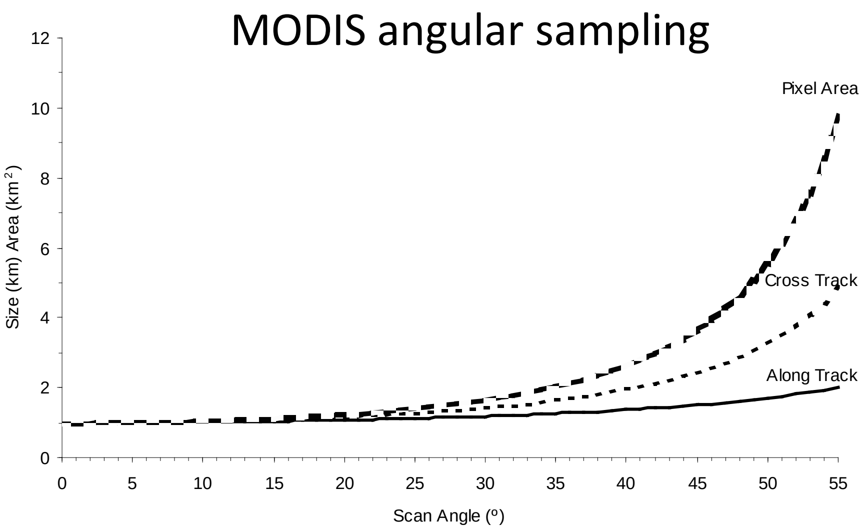
**both near-nadir**

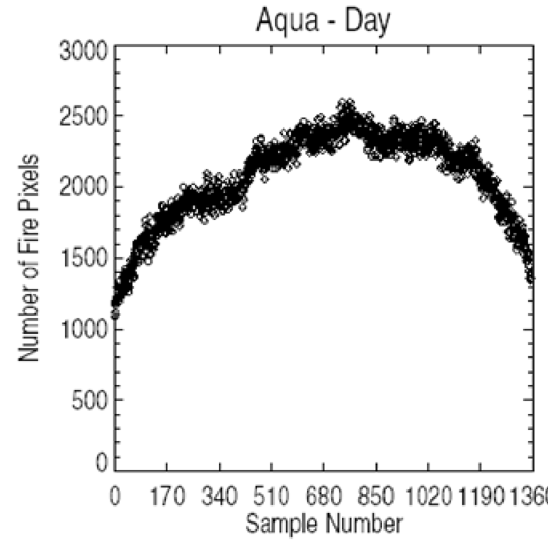
January 19, 2012
~11:05 UTC

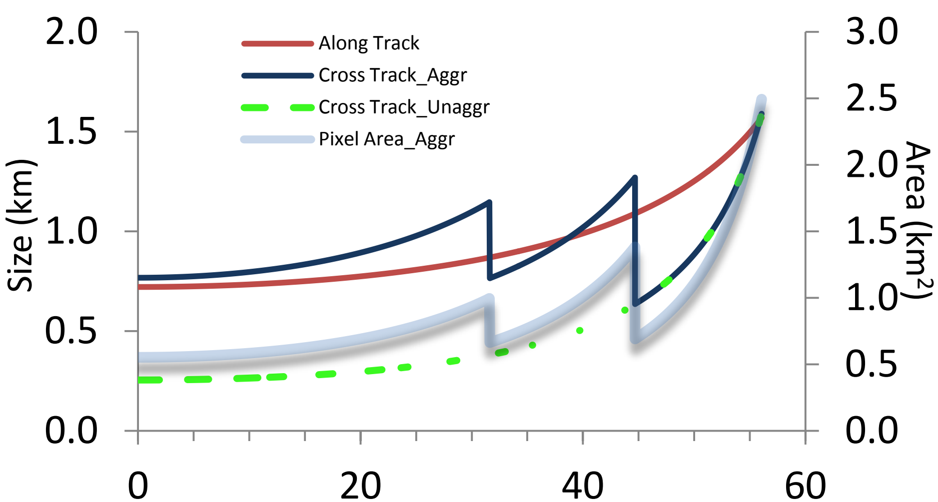



**VIIRS/overlap/MODIS**

# Angular sampling



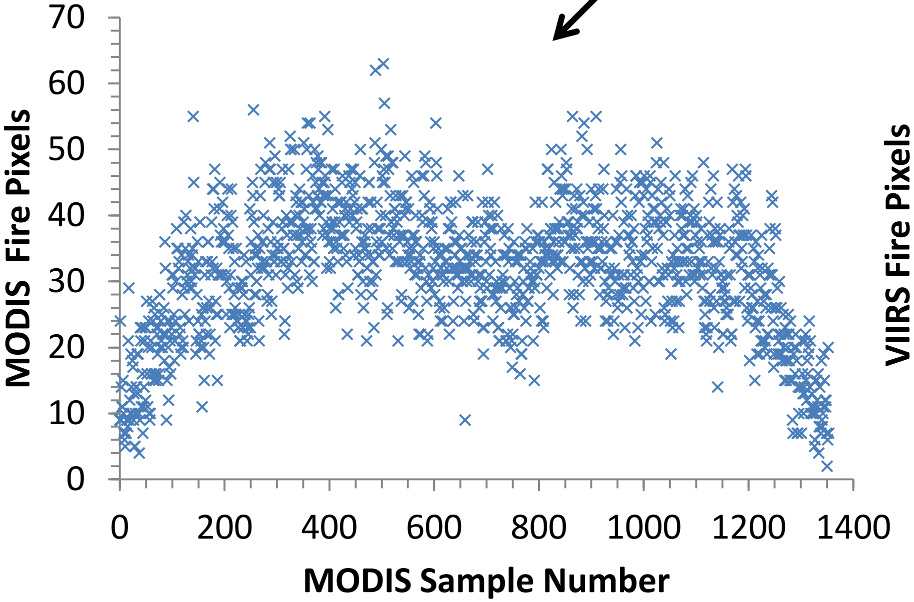



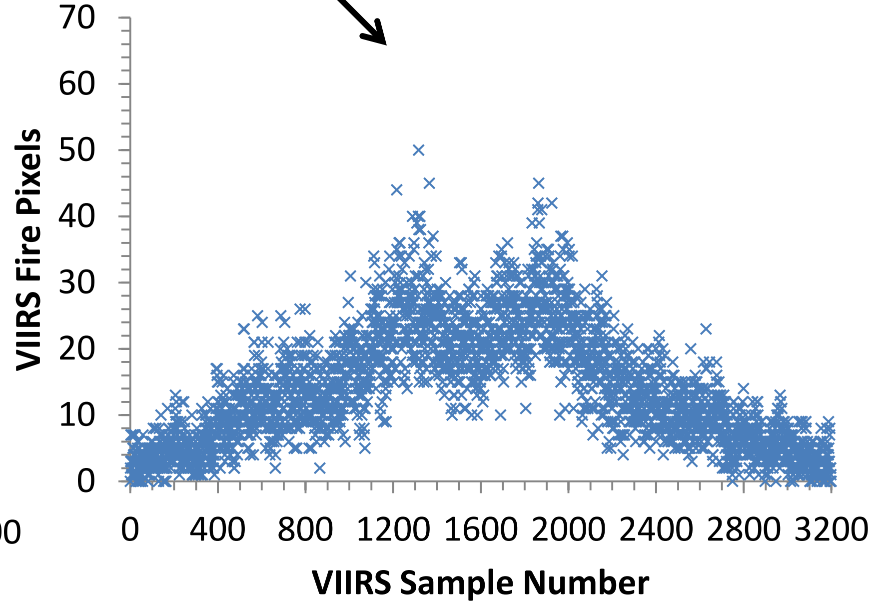

?

# MODIS vs. VIIRS fire counts

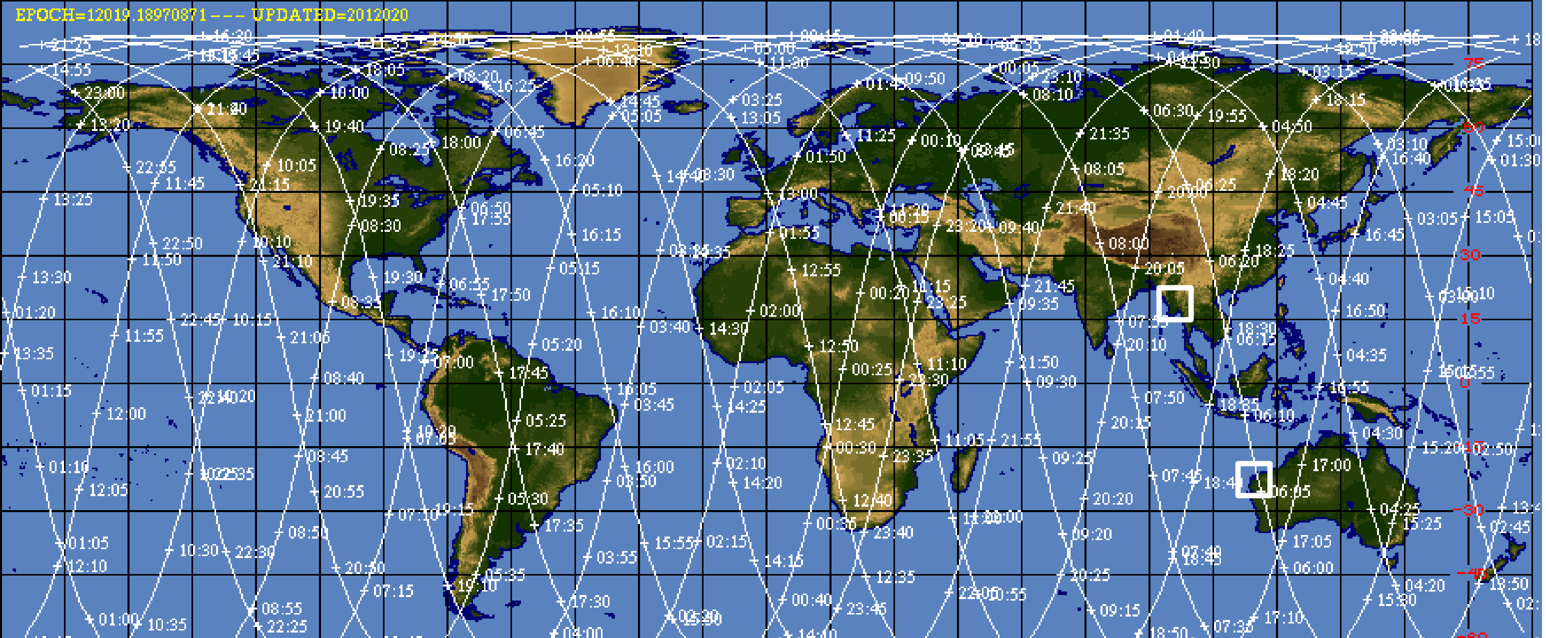
Jan 19-24

***VIIRS has a wider swath than MODIS***



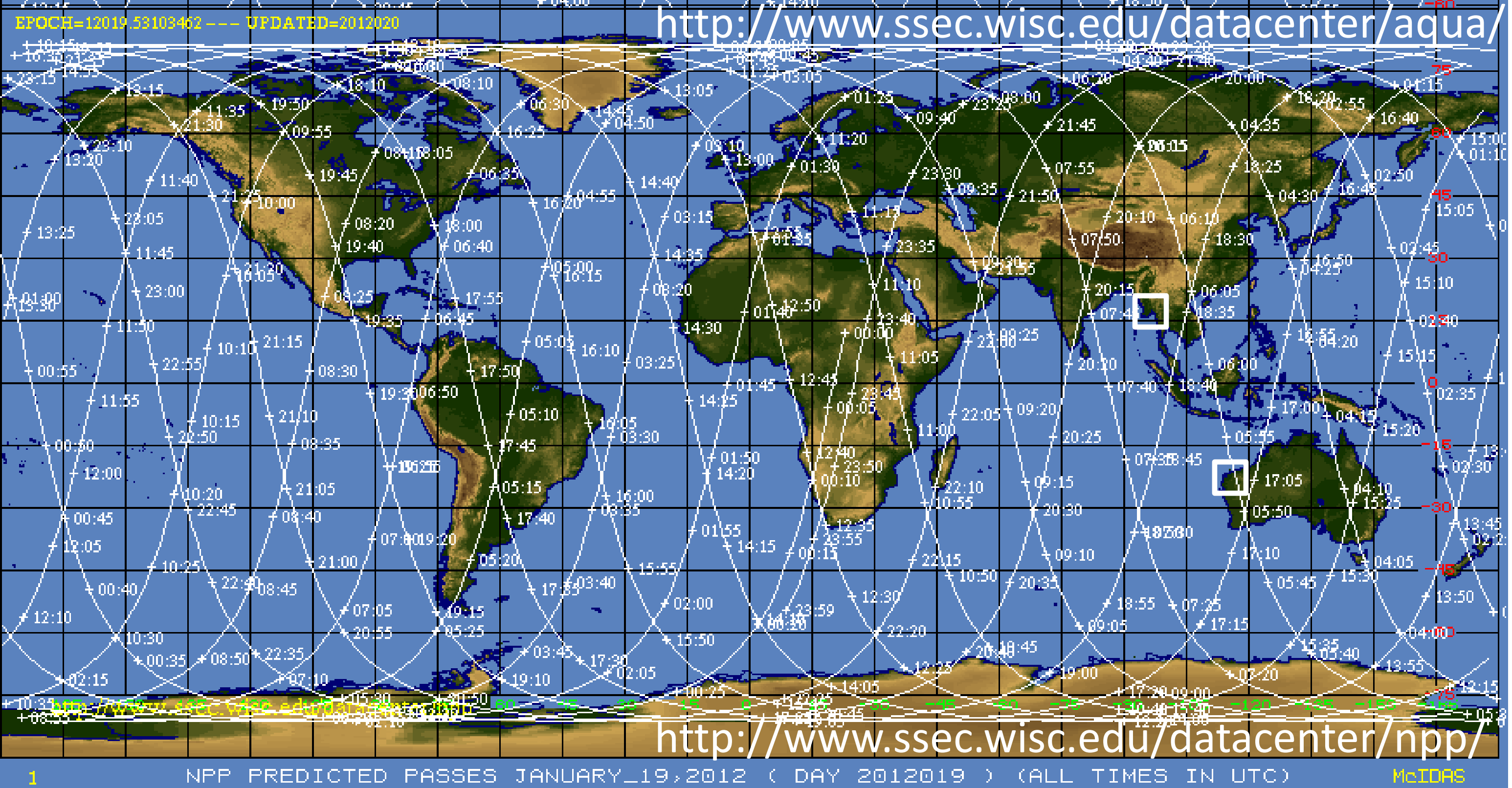




***Preliminary, for illustration purposes only!***



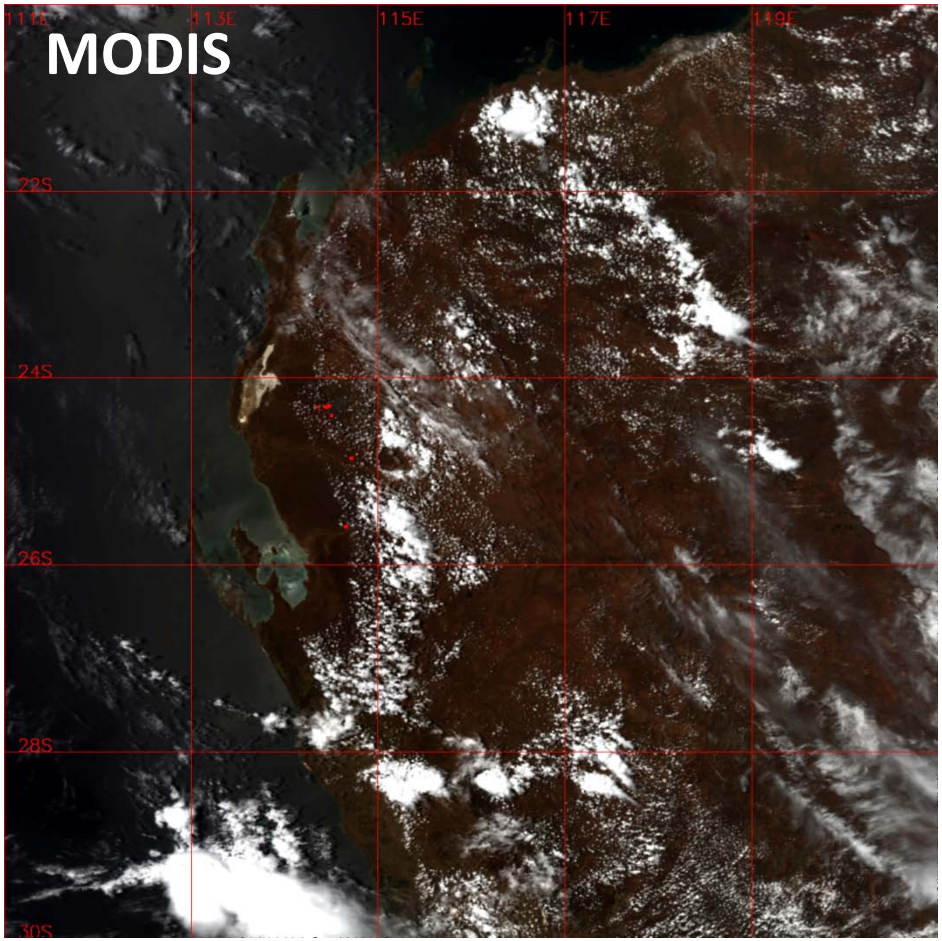

Aqua

Jan 19
2012

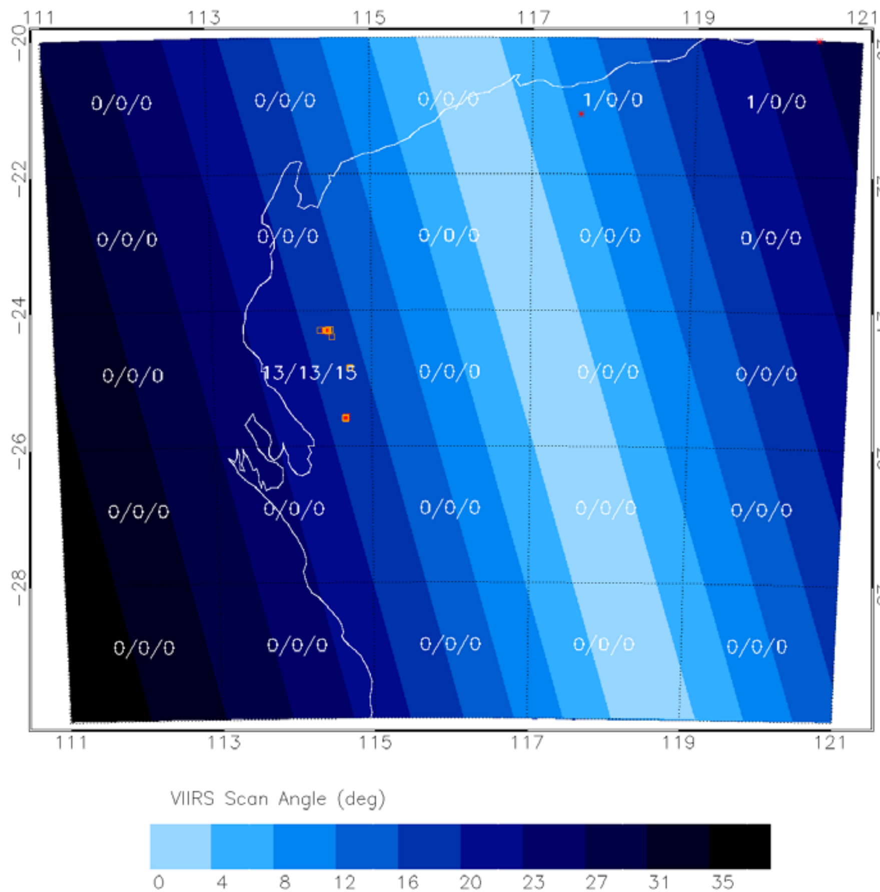



NPP

# Western Australia



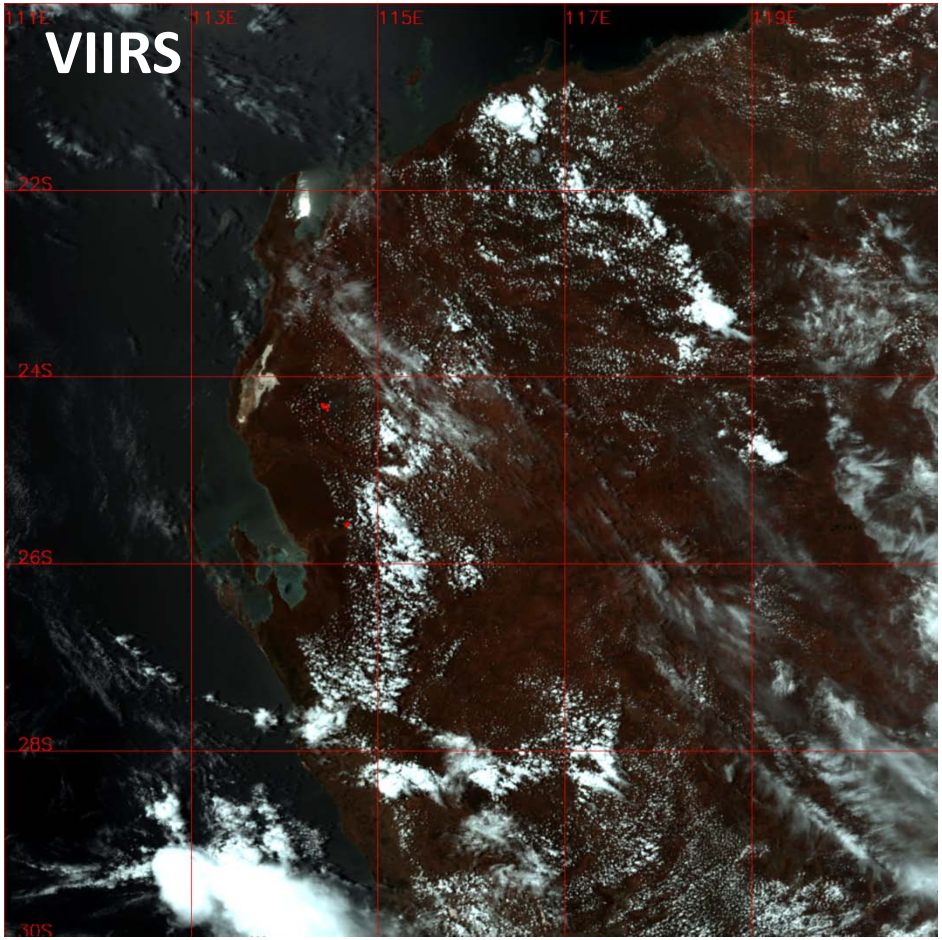

both near-nadir



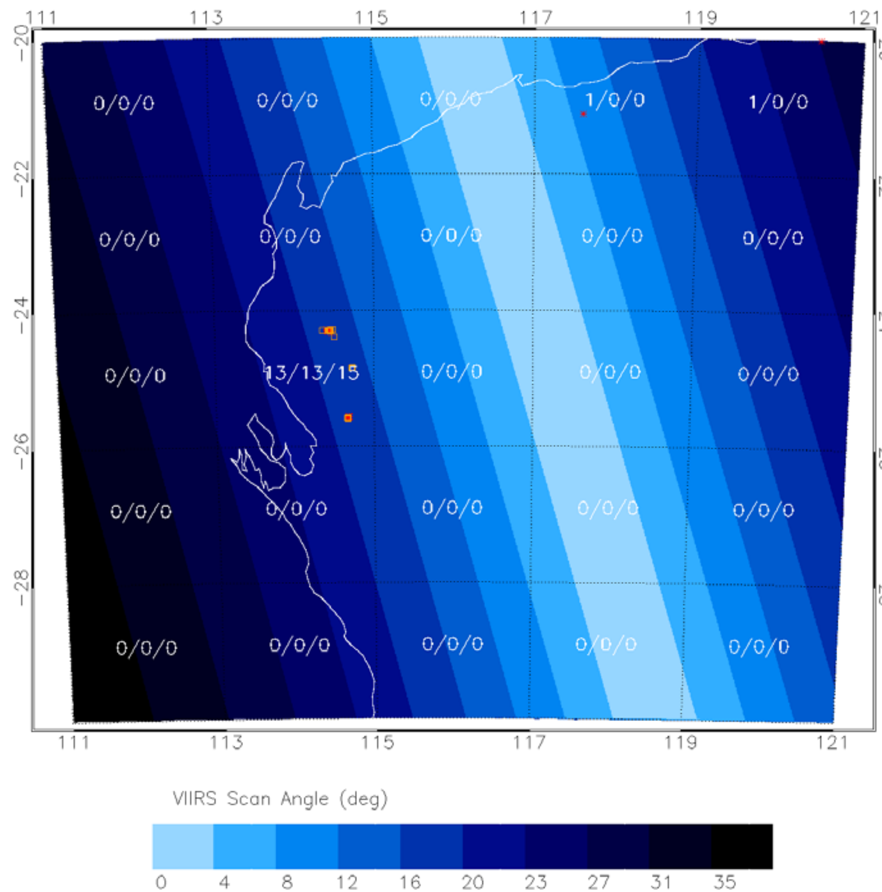

Jan 19 2012 06:00 UTC

VIIRS/overlap/MODIS

# Western Australia



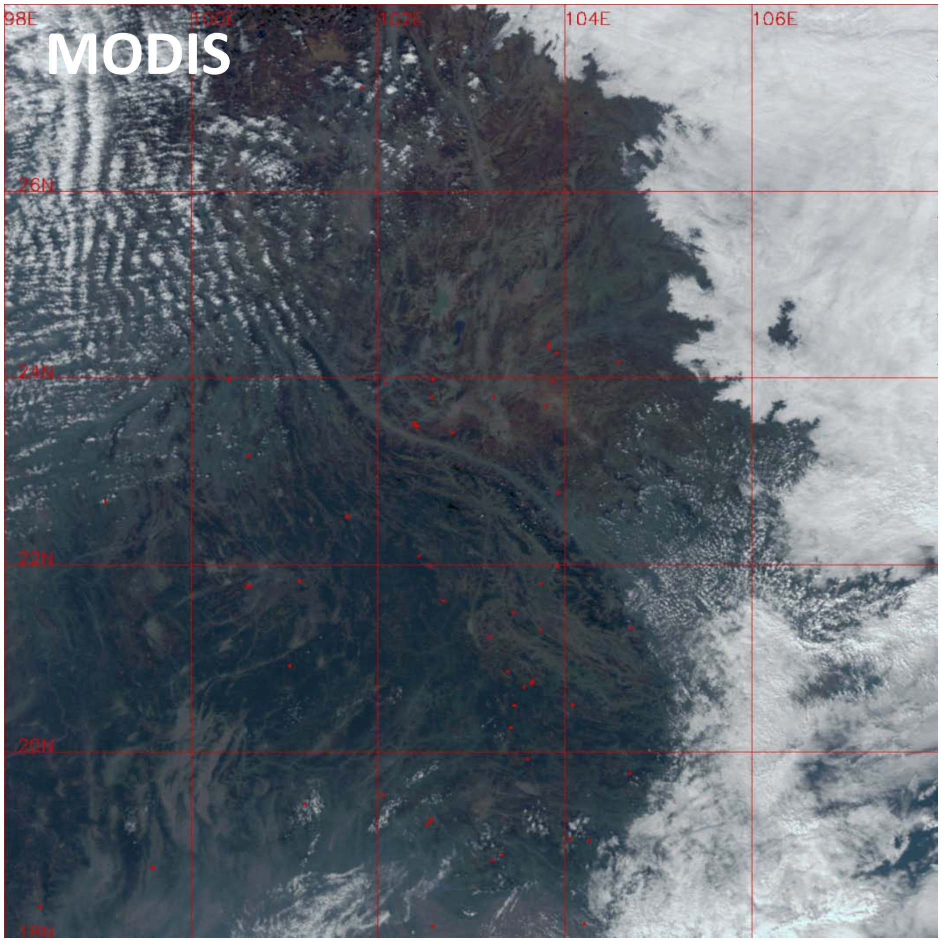

both near-nadir



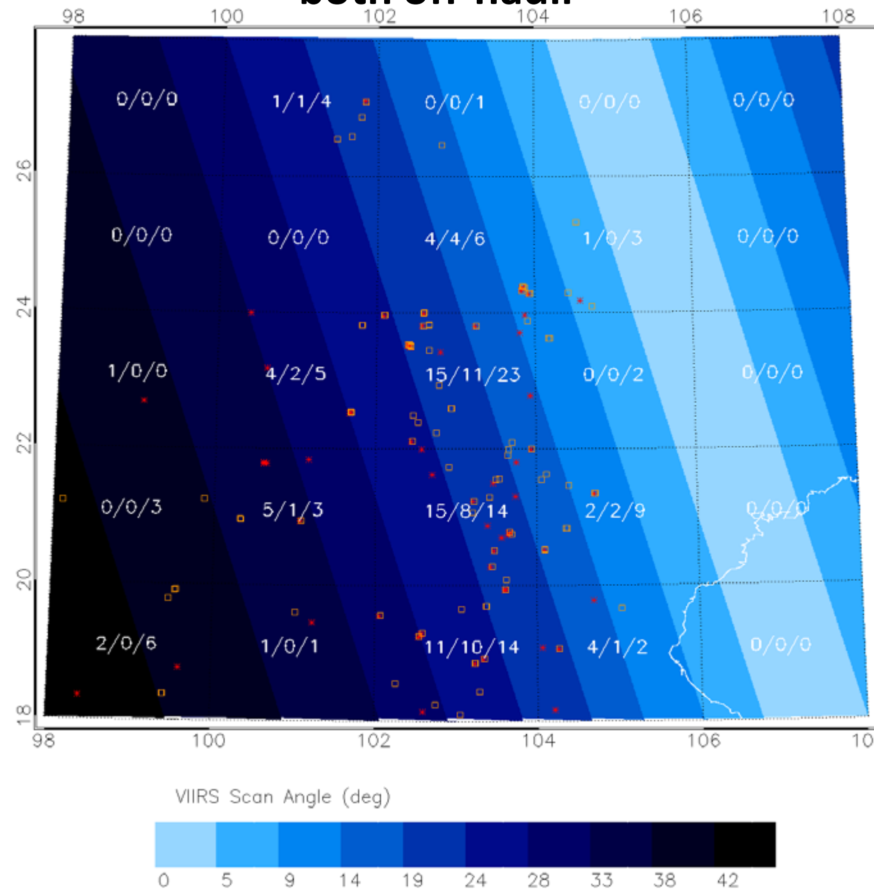

**Jan 19 2012 05:45 UTC**

**VIIRS/overlap/MODIS**

# South-East Asia



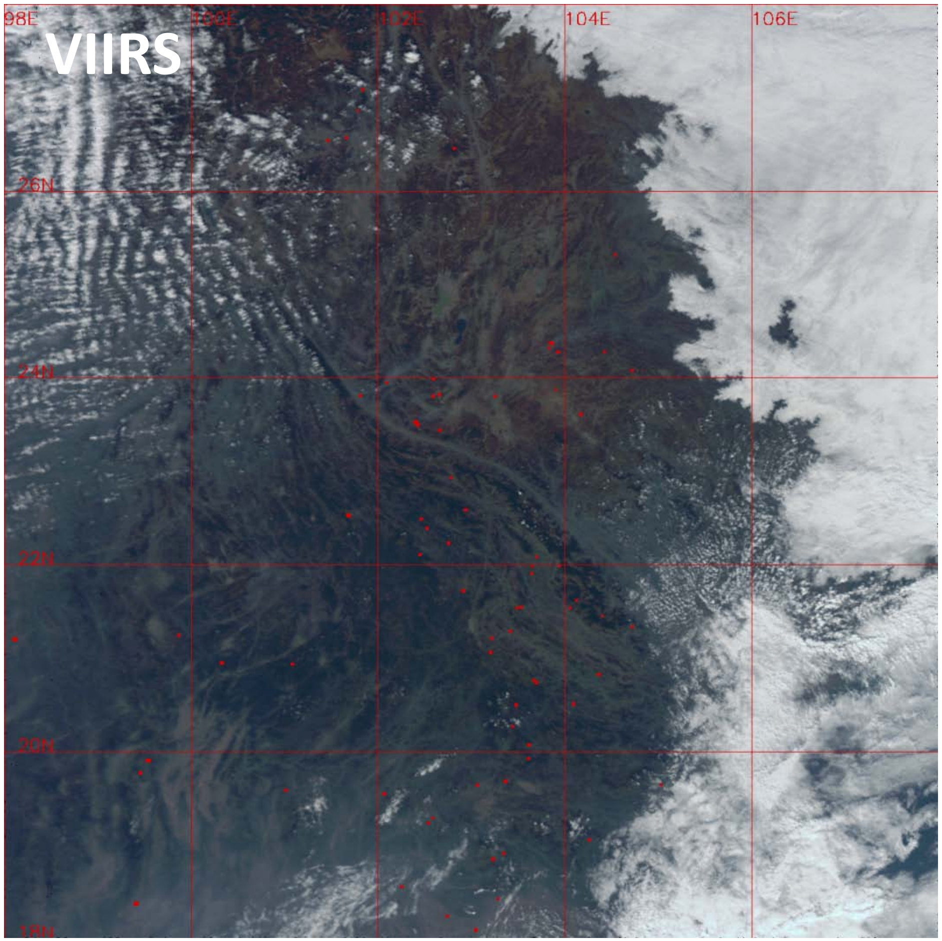

both off-nadir



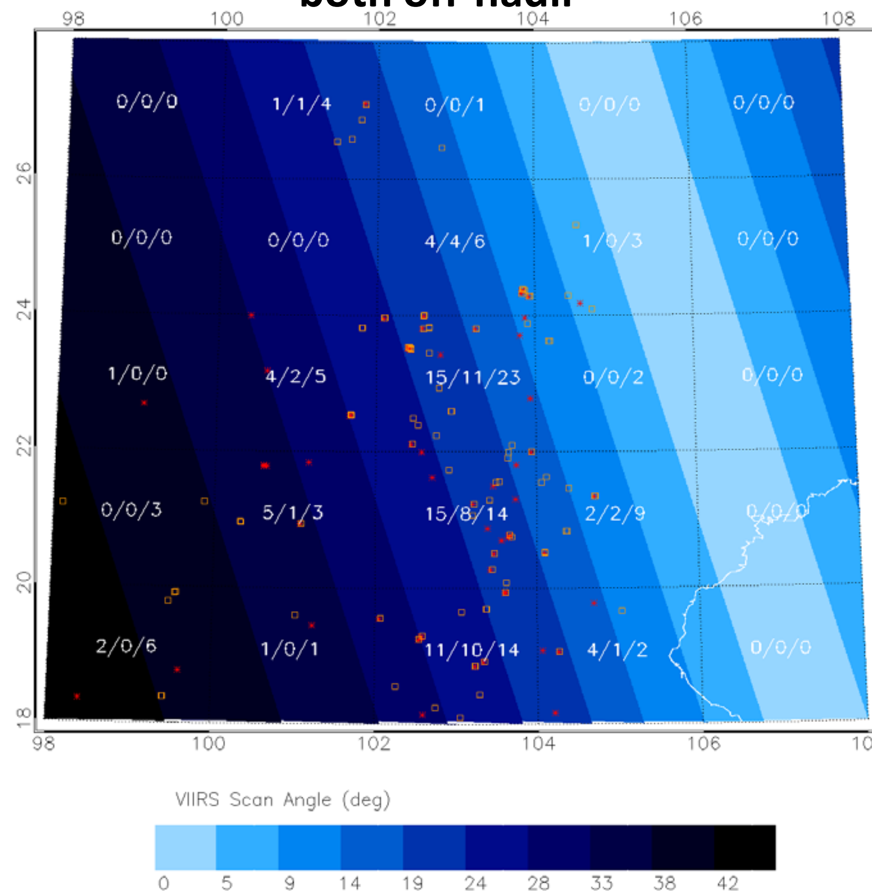

**Jan 19 2012 06:15 UTC**

**VIIRS/overlap/MODIS**

# South-East Asia

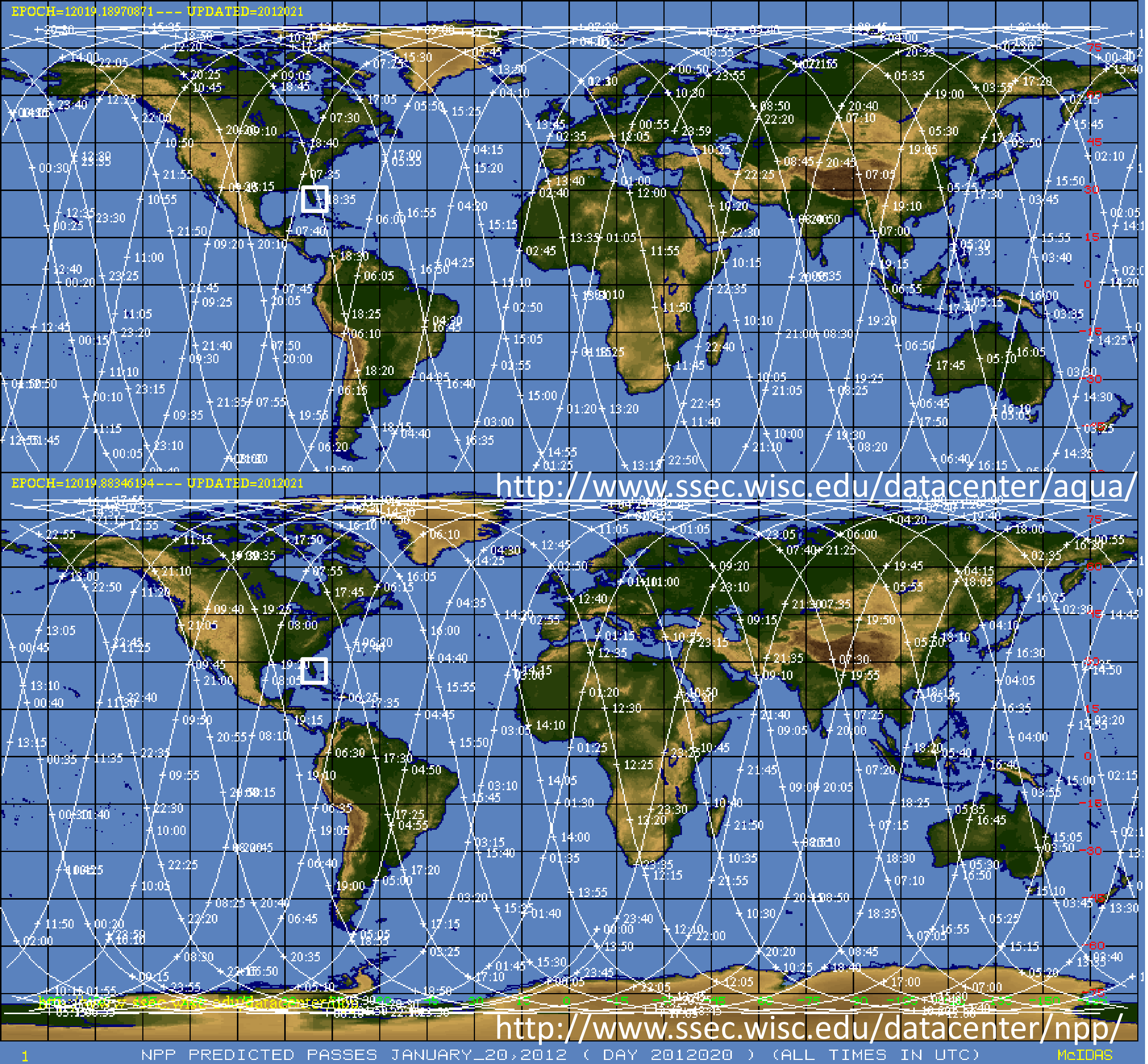



**both off-nadir**




**Jan 19 2012 05:57 UTC**

**VIIRS/overlap/MODIS**

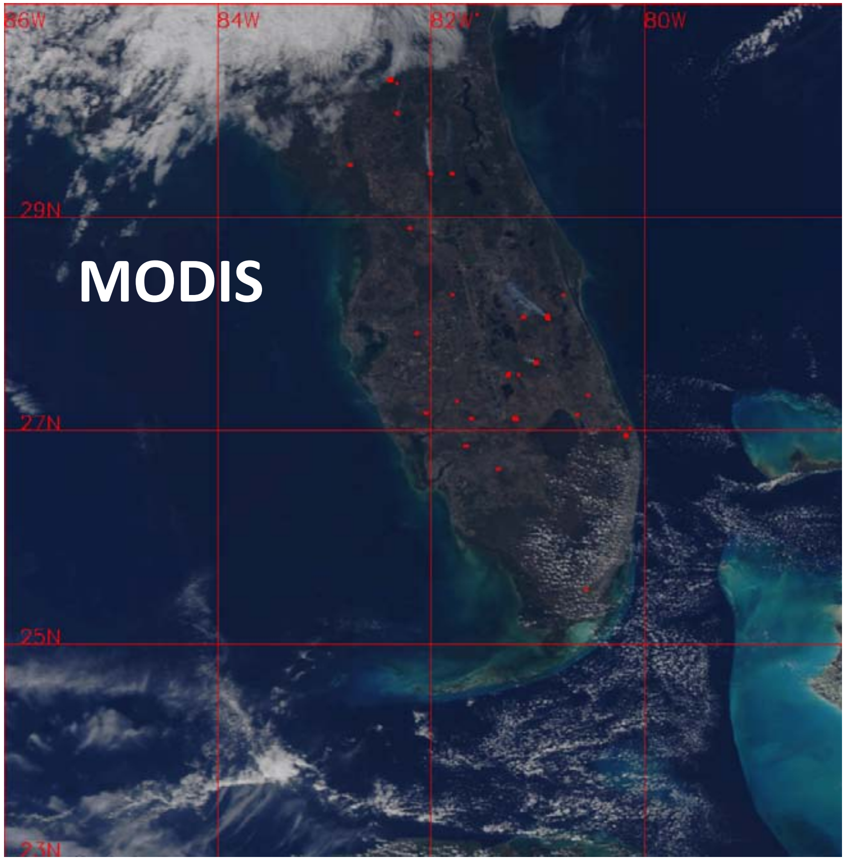



Aqua

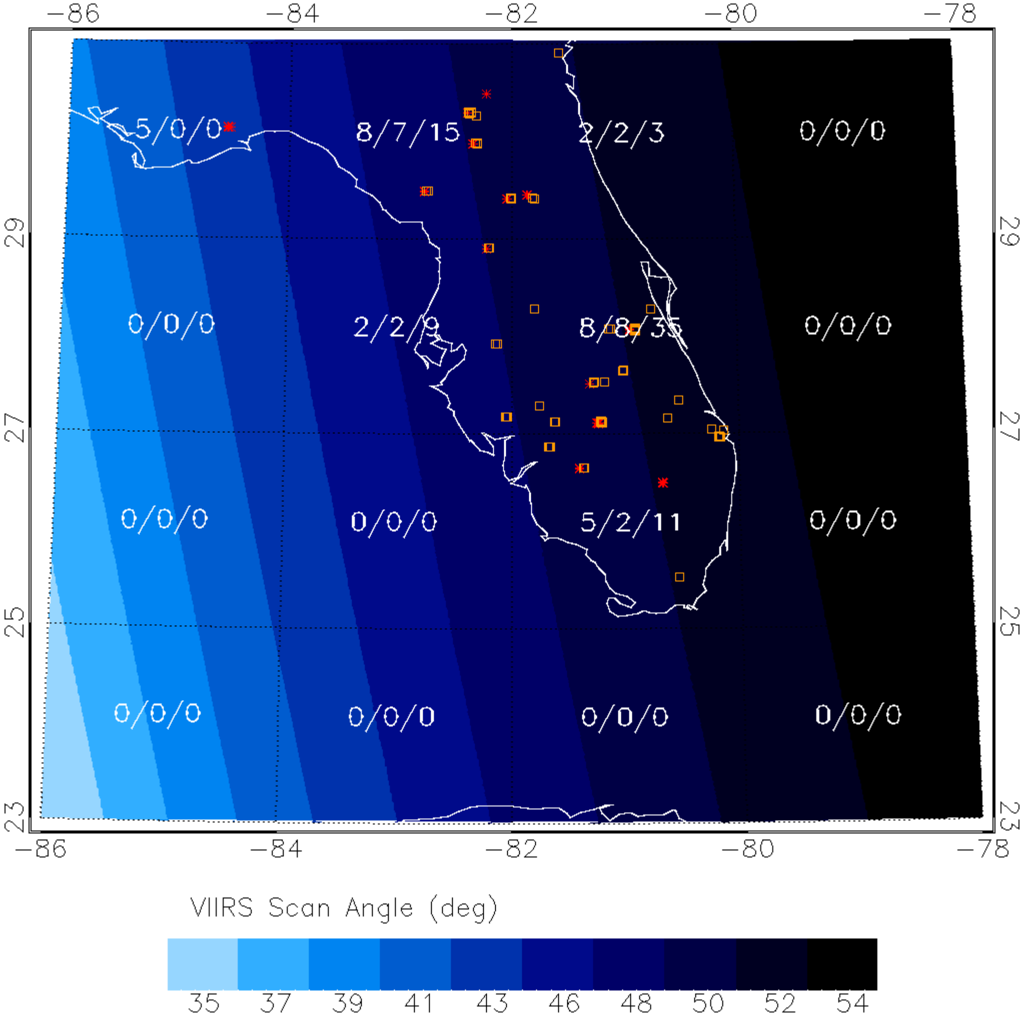
Jan 20
2012

NPP

# Florida



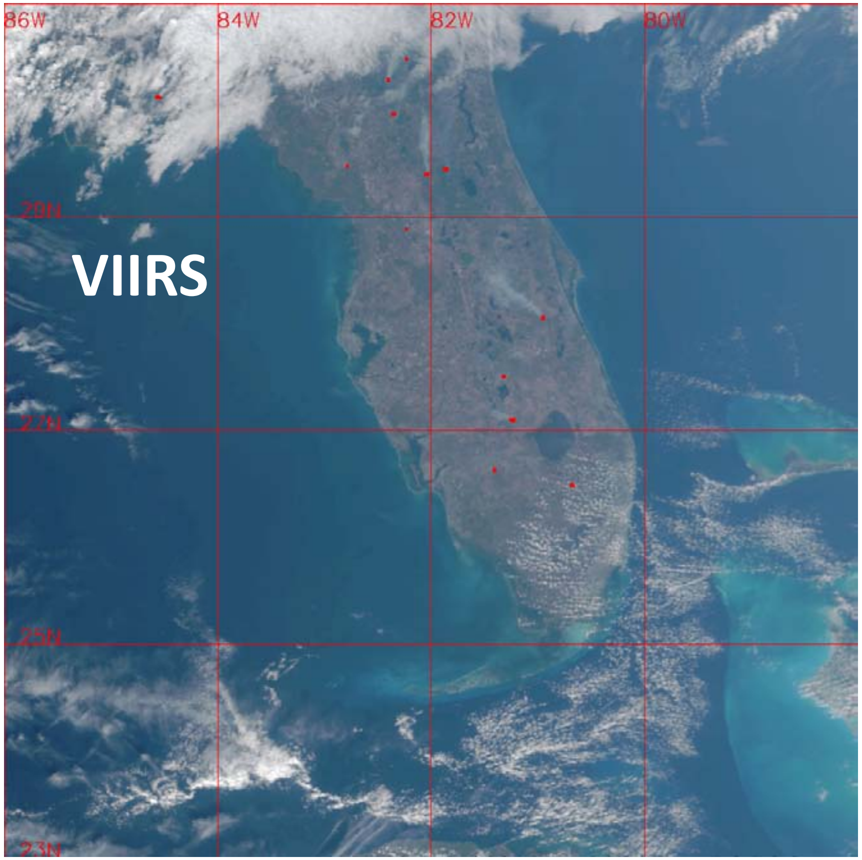

**MODIS: near-nadir; VIIRS: off-nadir**



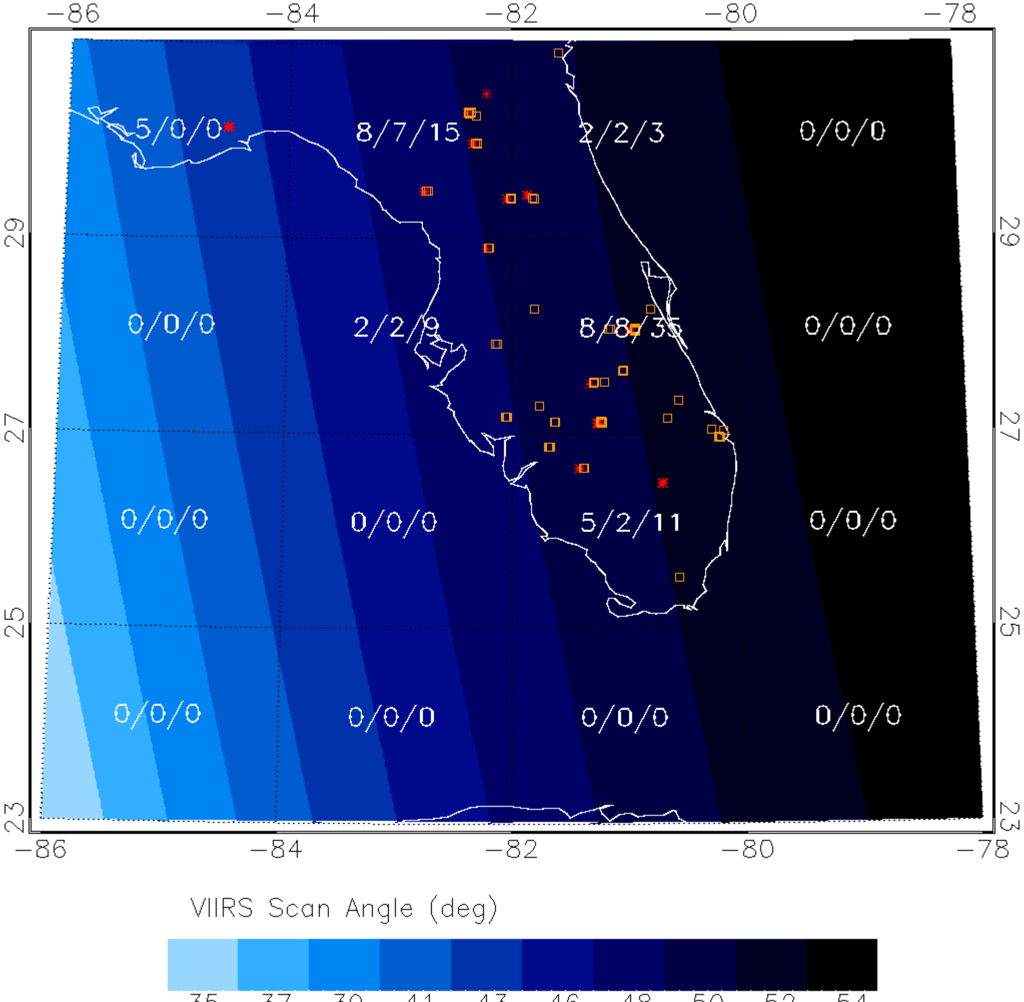

**Jan 20 2012 18:33 UTC**

**VIIRS/overlap/MODIS**

# Florida




**MODIS: near-nadir; VIIRS: off-nadir**



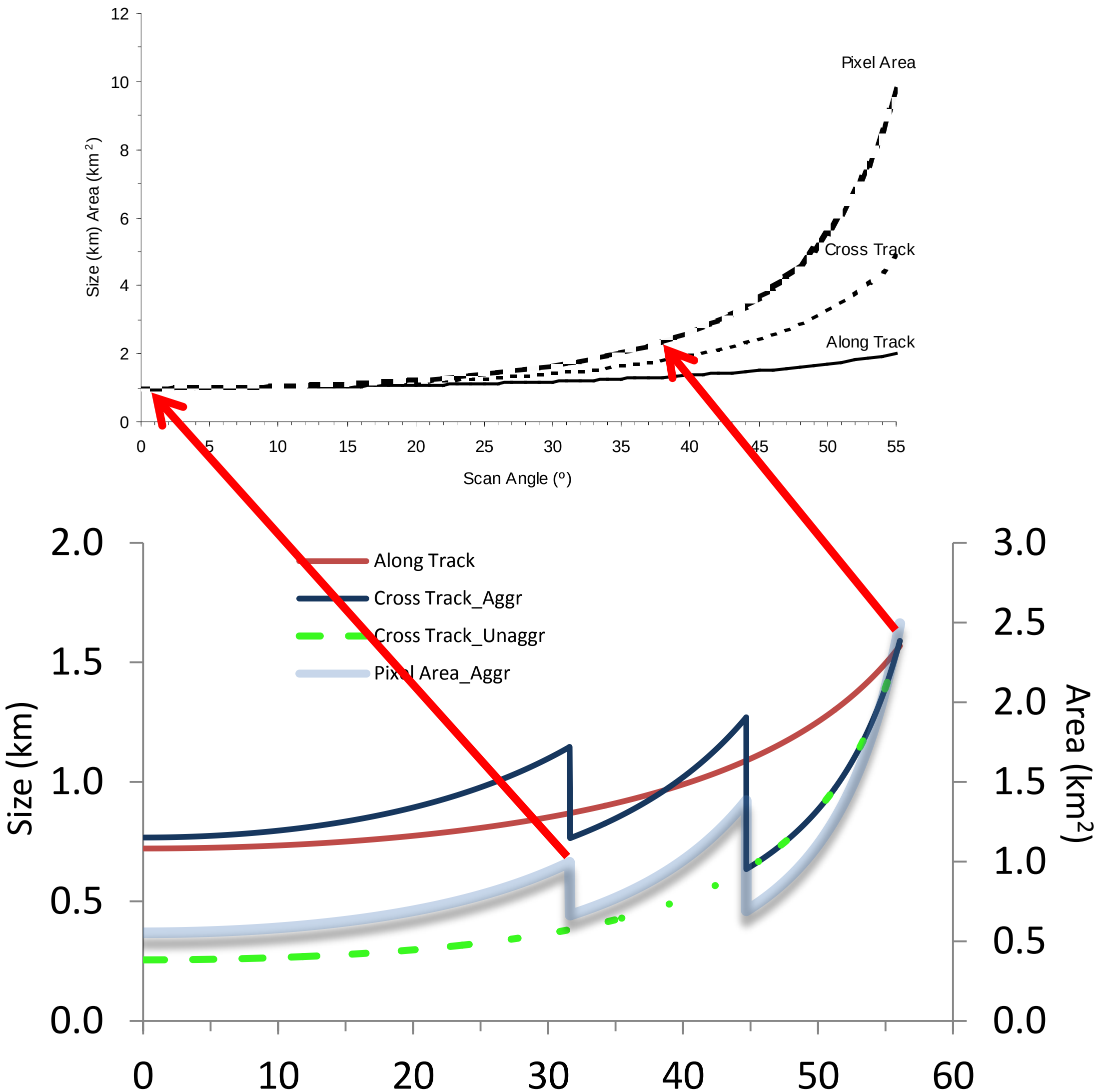

**Jan 20 2012 19:15 UTC**

**VIIRS/overlap/MODIS**

# Truly compatible spatial sampling for MODIS-VIIRS comparison

- Simultaneous, compatible spatial sampling
  - SNO/SNOx type method for intercalibration
  - primarily driven by sample size
  - angular effects secondary, but potentially non-negligible, especially for off-nadir looks
- Matching swath segments with similar spatial sampling
- Advantage: allows for direct comparison of fire data
- Disadvantage: angular effects are not accounted for

# Compatible swath segments




*In principle, it is possible to select swath segments with compatible sampling for direct intercomparison*

*Compatible cloud masks are crucial*

*(Need for spatially explicit land/water/cloud/fire mask in the VIIRS product!)*

# Possible scenarios - practicalities

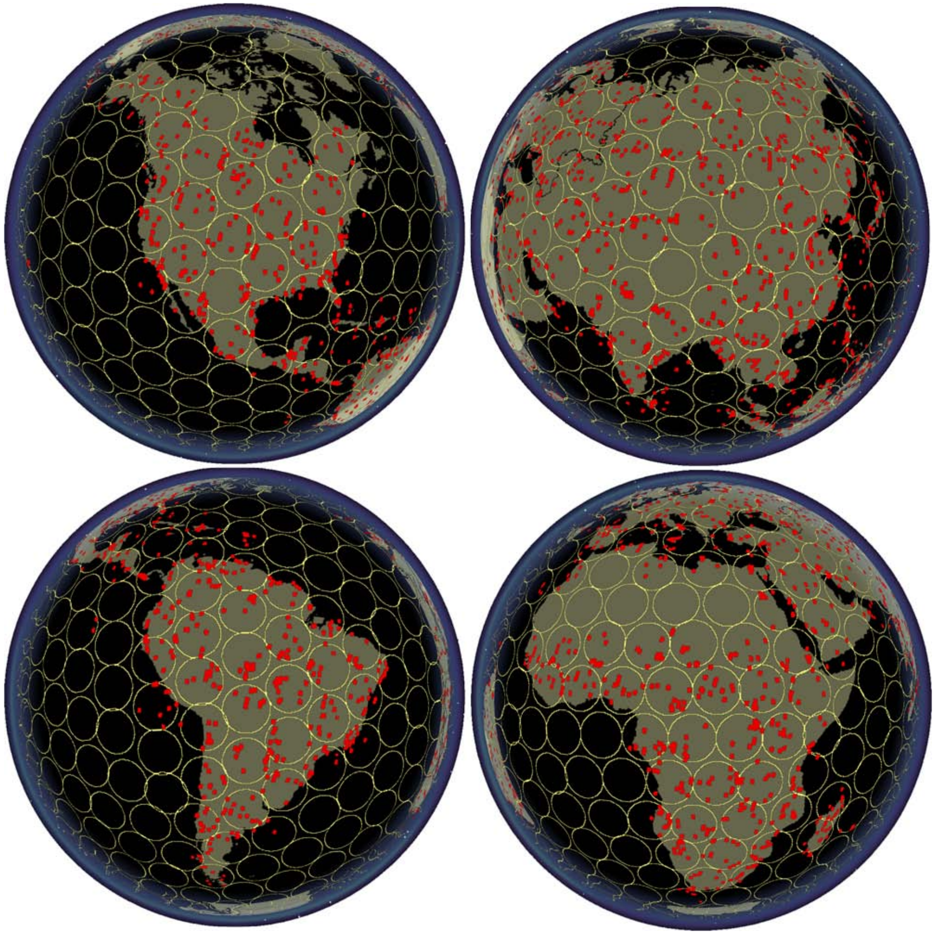
1. **Orbital/daily** MODIS and VIIRS fire maps are **compatible**.
    - Not crucial for operational users as long as VIIRS is comparable or superior to MODIS
2. Spatially and temporally **aggregated fire statistics** from MODIS and VIIRS **are compatible**.
    - Useful for evaluating algorithm consistency, data continuity
3. MODIS and VIIRS provide **compatible general patterns and trends of fire dynamics**.
    - Contingent upon the statistical population of fires
    - Statistics can be derived from Landsat-class data
    - Fire of interest – what is the desired lower limit?

# Explicit validation

**<u>Near-nadir</u>** pixels
(using ~2,500 coincident ASTER scenes)

*17K MOD14 pixels sampled*

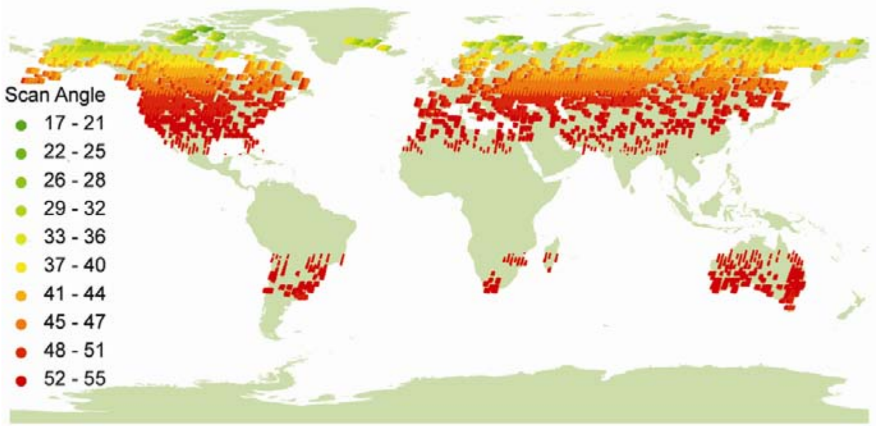
*120K MODIS pixels with 1+ ASTER fire pixel*

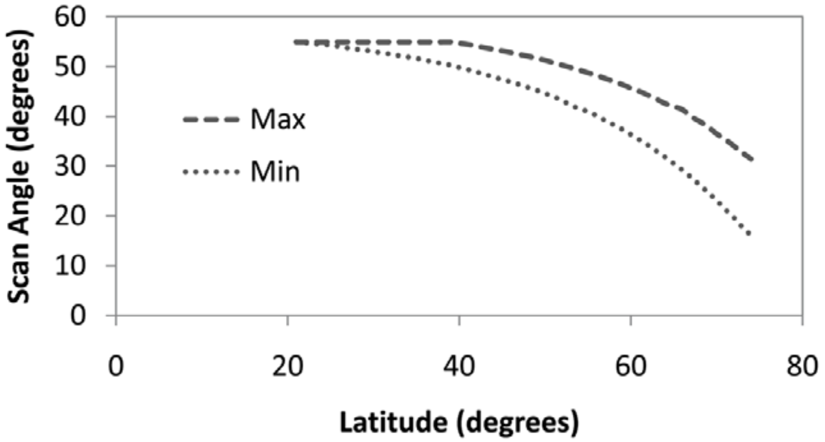


**<u>Off-nadir</u>** pixels
(using ~3,700 near-coincident TM scenes)

*12K MOD14 pixels sampled*

*270K MODIS pixels with 1+ TM fire pixel*



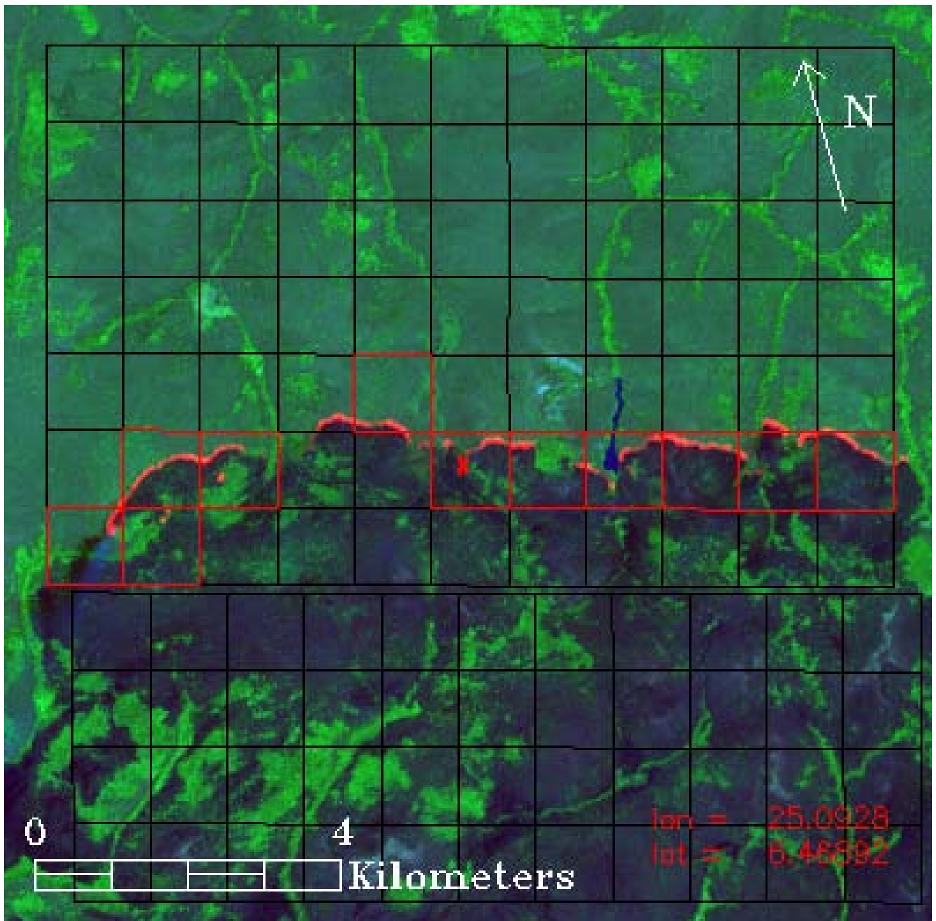



# Explicit validation

**<u>Near-nadir</u>** pixels
(using ~2,500 coincident ASTER scenes)

ASTER 2001-2006

SWIR detector problem > May 2007

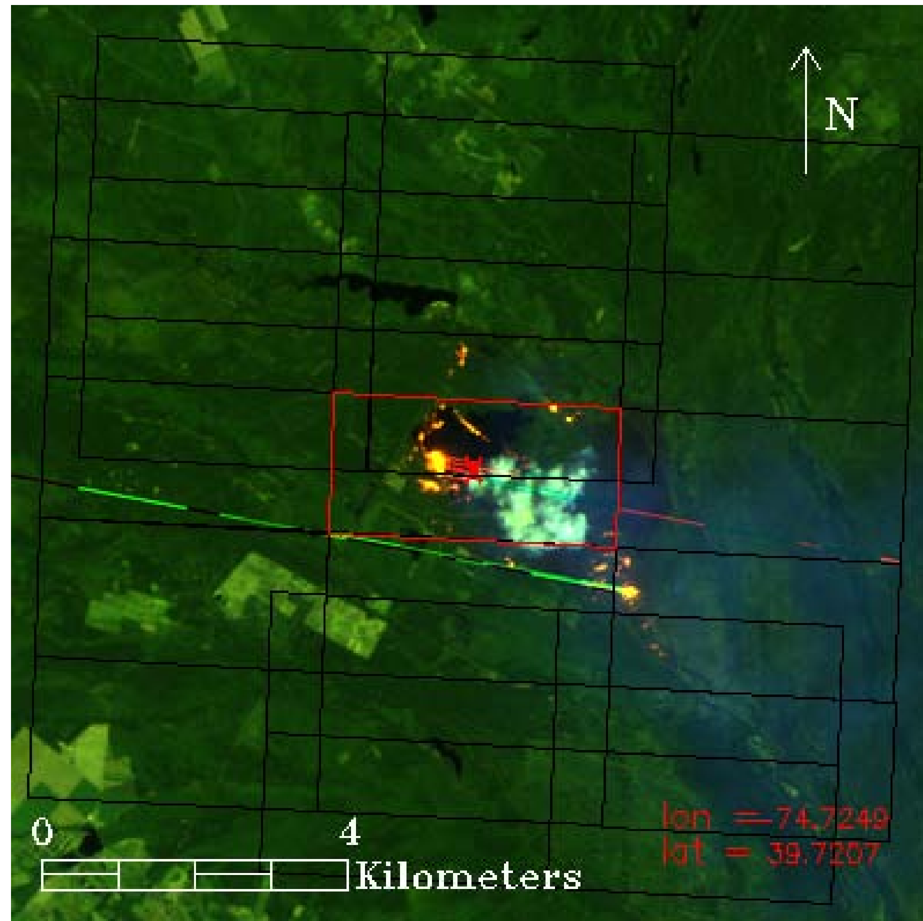



MODIS/ASTER 19 Jan 2006 0852UTC (near nadir)

**<u>Off-nadir</u>** pixels
(using ~3,700 near-coincident TM scenes)

Landsat5 TM 2001-2010

Fire-related artifacts – saturation/bleeding

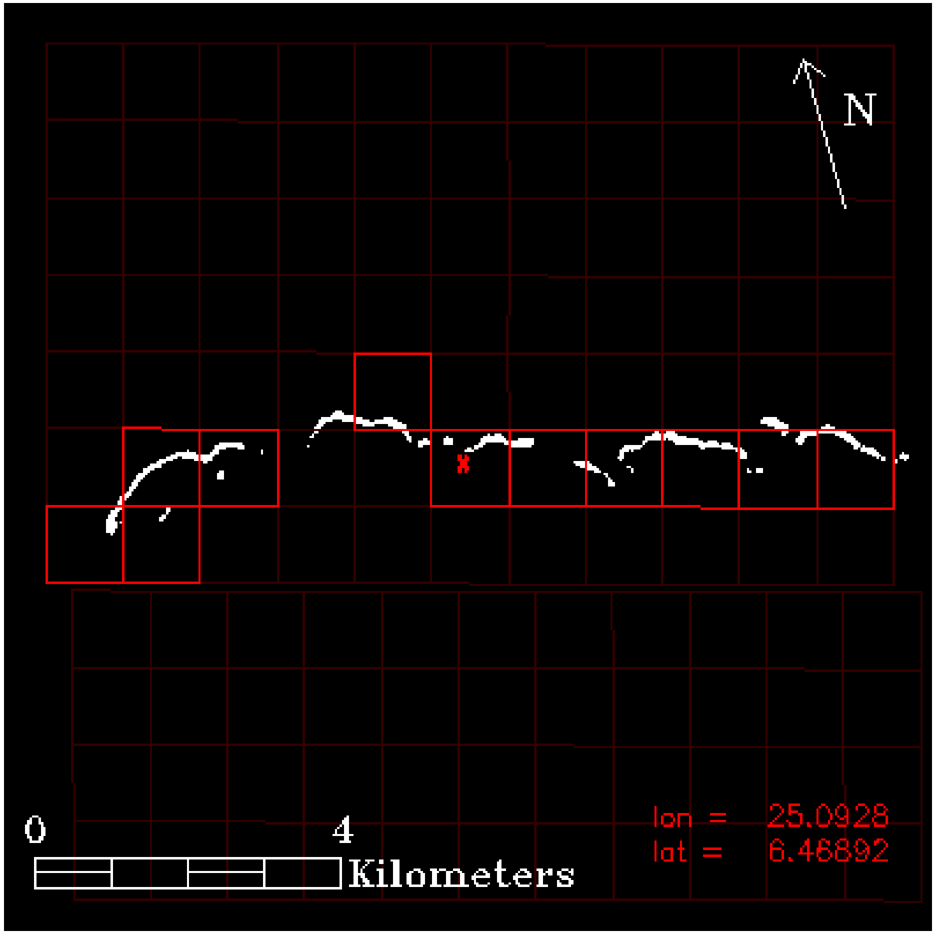



MODIS/TM 04 Aug 2007 1533UTC ($52^{o}$ scan angle)

# Explicit validation

**Near-nadir** pixels
(using ~2,500 coincident ASTER scenes)

ASTER 2001-2006
SWIR detector problem > May 2007

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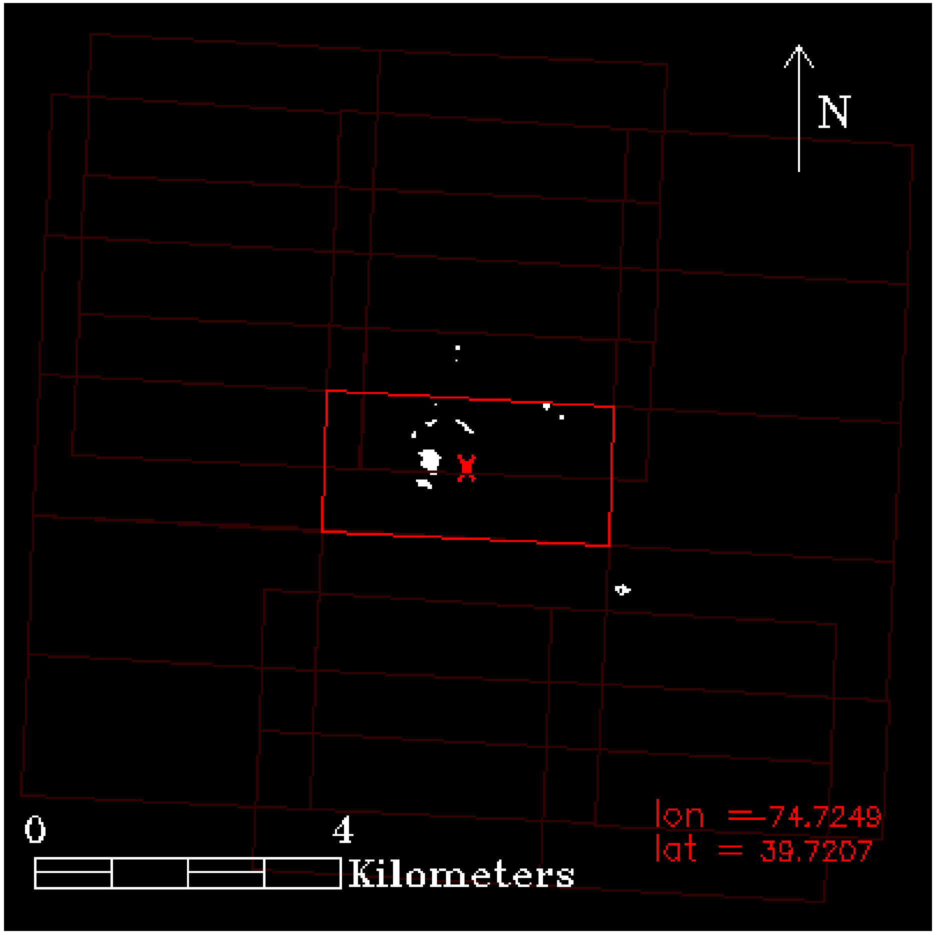


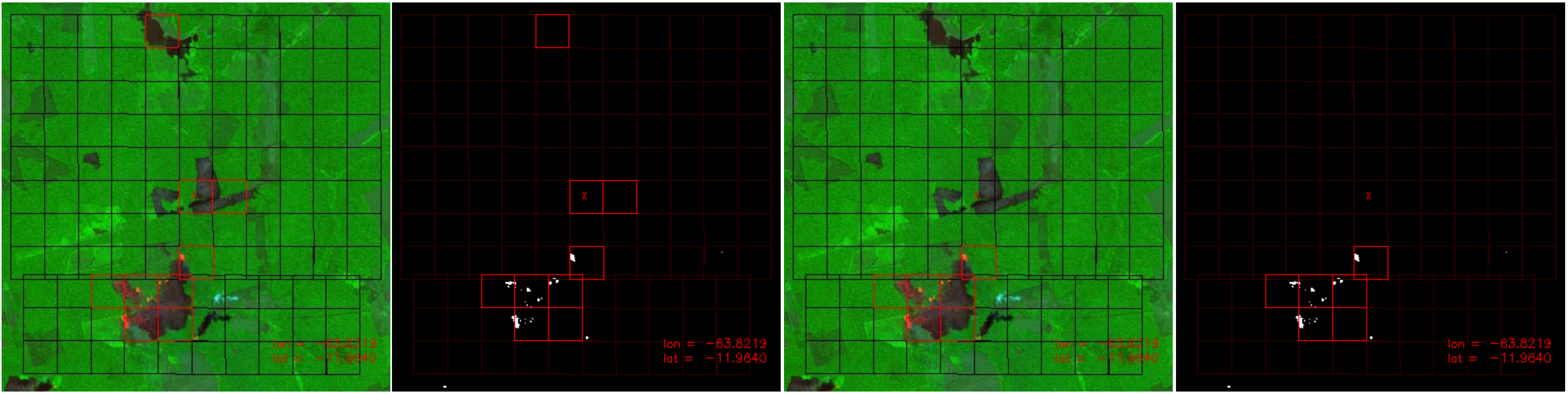

MODIS/TM 04 Aug 2007 1533UTC ($52^{o}$ scan angle)

# Algorithm continuity: MODIS Collection 6 updates

- Adaptive assignment of potential fire thresholds to **better capture small, cool fires** and **reduce false alarms** occurring in hot, arid environments;
- A new rejection test to **eliminate persistent false alarms** caused by **small clearings** within Amazonian rainforest
- Extended processing to **water pixels** to facilitate monitoring of offshore gas flaring
- Improvements to the **internal cloud mask** to eliminate occasional misclassification of snow and desert as cloud.

# Algorithm continuity: MODIS Collection 6 updates

**MODIS Collection 5 (and 4)** **MODIS Collection 6**




***True fire detections and false alarms from Terra MODIS over a small-scale cleared area in the Amazon on August 27, 2001, as detected by the MODIS Collection 5 and 6 algorithms. The MODIS Collection 6 algorithm removed the false alarms.***

# Summary and conclusions

- **Initial assessment** of the NPP VIIRS fire product is **encouraging**
- True statistical **comparison is possible** using proper matching of similar sampling conditions
- Implementation of **new MODIS algorithm components** and sensor-specific tuning are necessary
- Need for spatially explicit **fire mask** and **Fire Radiative Power** in the VIIRS product
- Explicit **validation** is crucial
- Continuity of the MODIS **Climate Modeling Grid** (CMG) product is necessary for **long-term and large-scale monitoring**