Improved Algorithms for Combining Satellite Imagery and Geographic Basemaps

Rick Kohrs
Space Science & Engineering Center
University of Wisconsin - Madison

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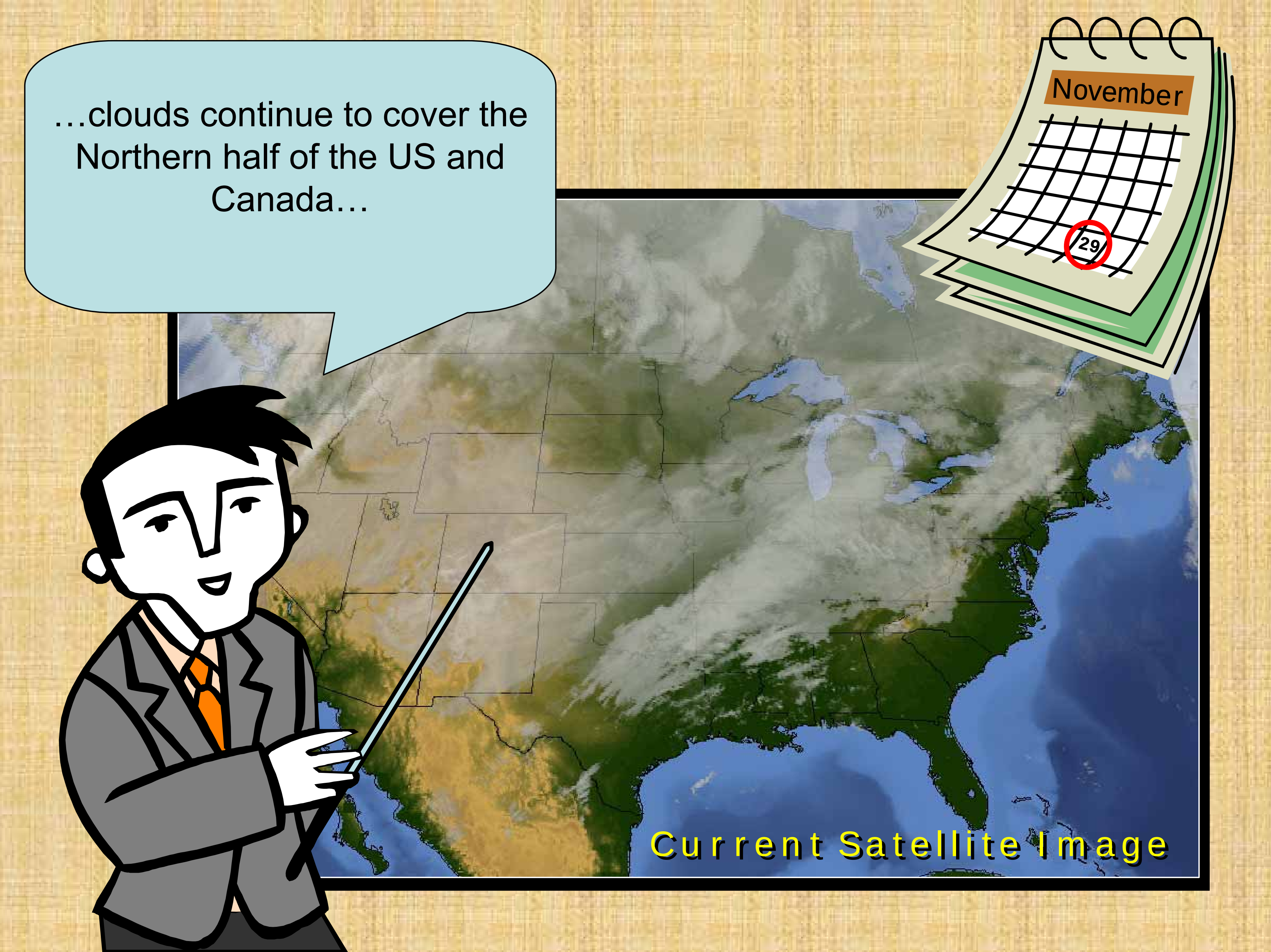
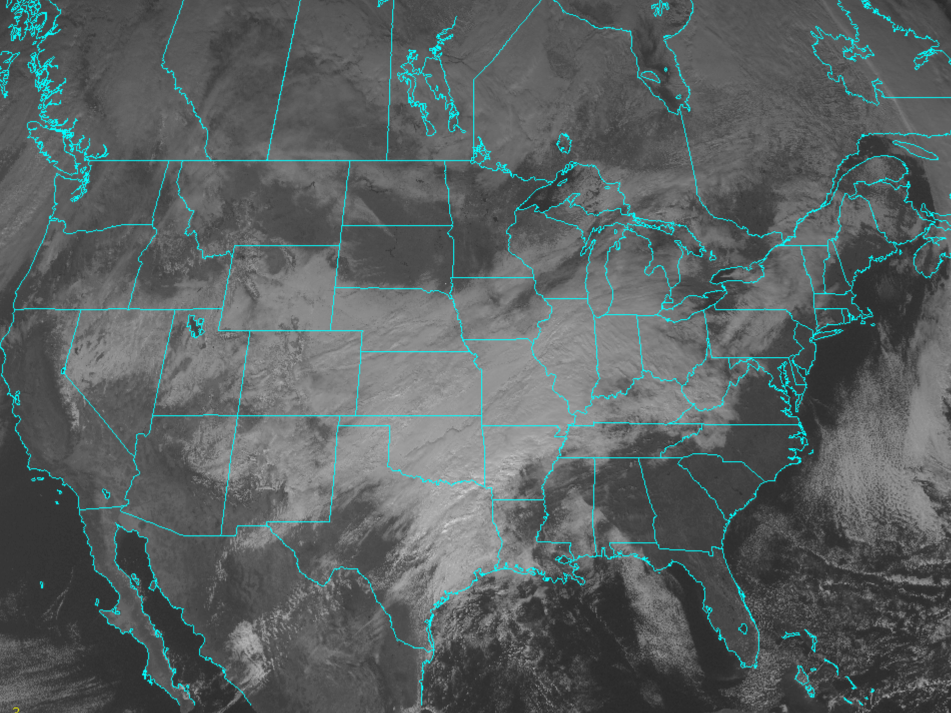
Madison, WI


…clouds continue to cover the Northern half of the US and Canada…
November
29
Current Satellite Image

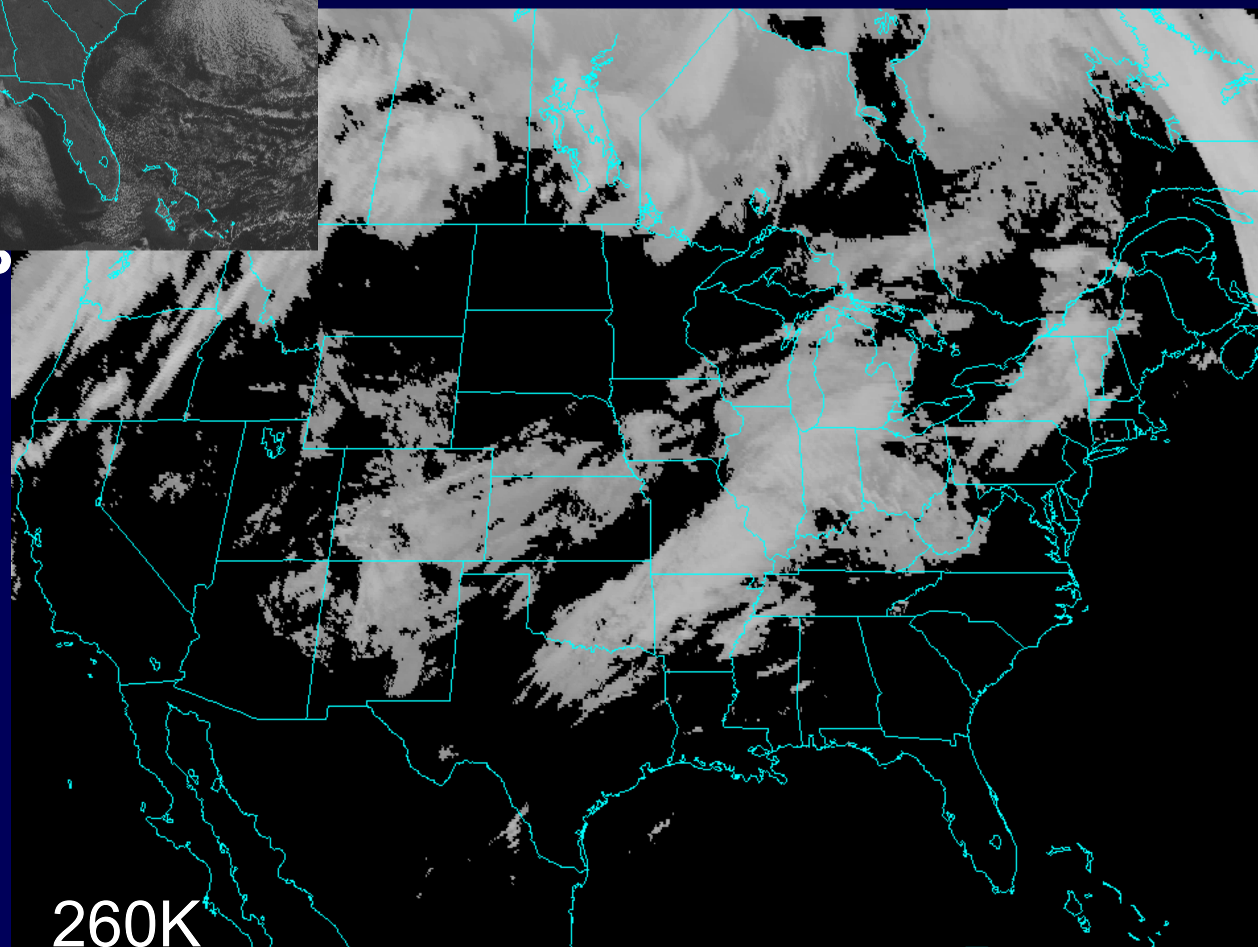

10^{o}F

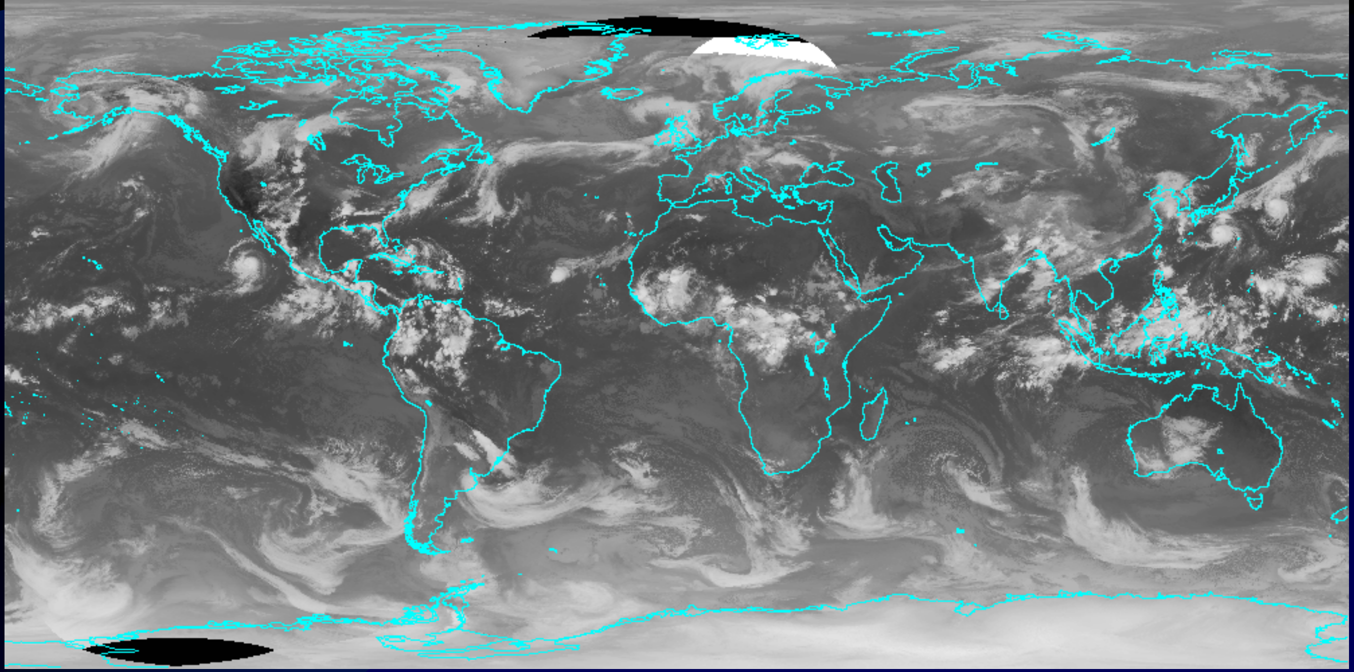
Current Algorithm

- Infrared Brightness Temperature (T_{ir}) based cloud/no-cloud threshold
- Basemap is shown when pixels are warmer than T_{ir} threshold
- Temperature based transparency is applied to “cloudy” pixels, where warm clouds are semi-transparent and cold clouds are opaque

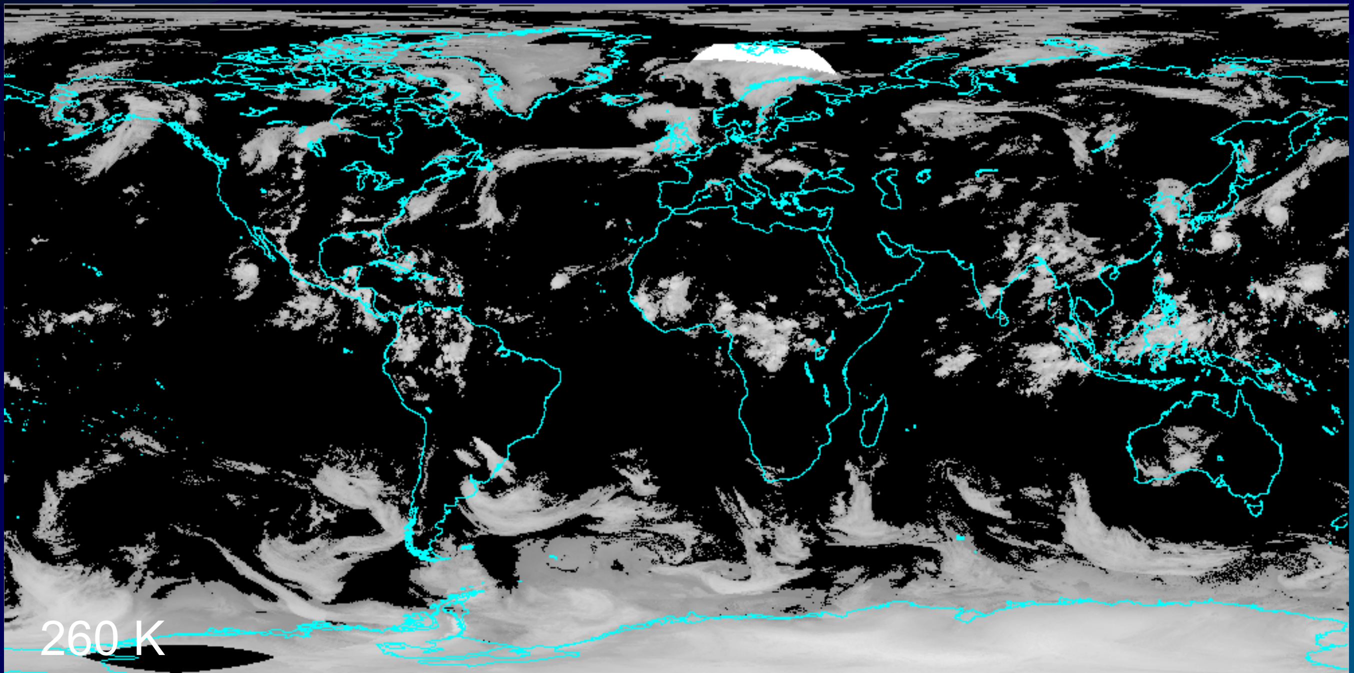


Choosing a B





Global Scale

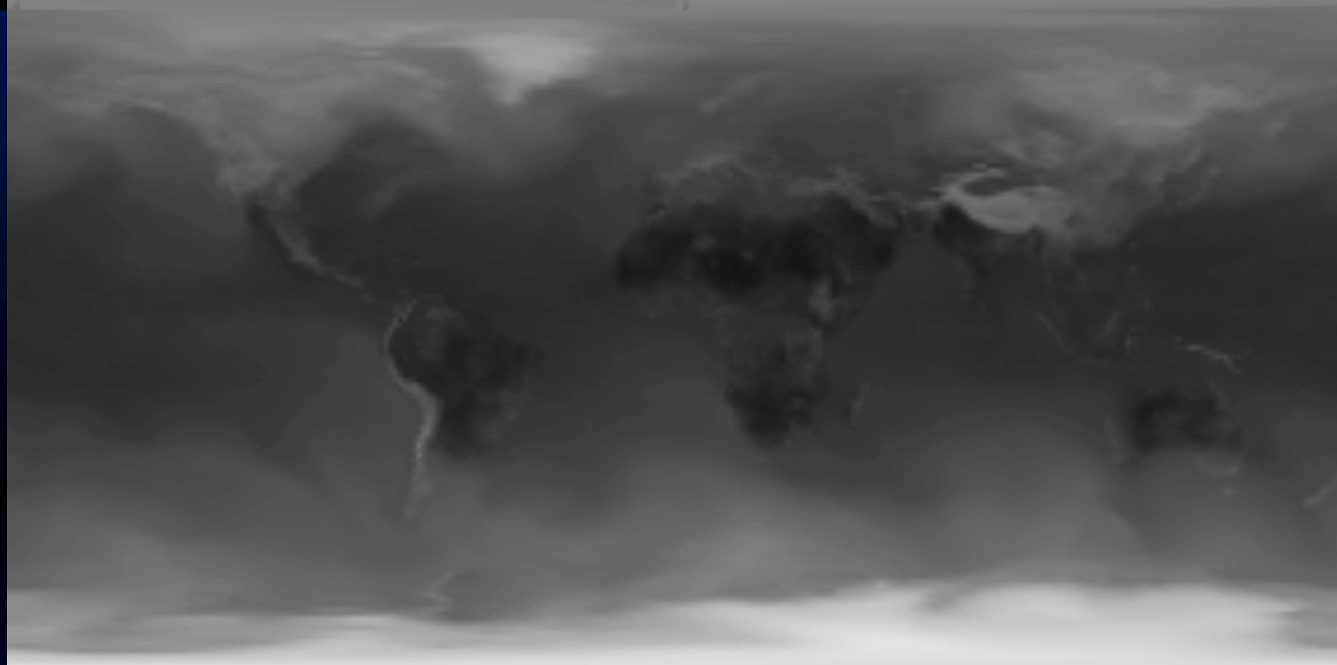


Current Algorithm - Problems

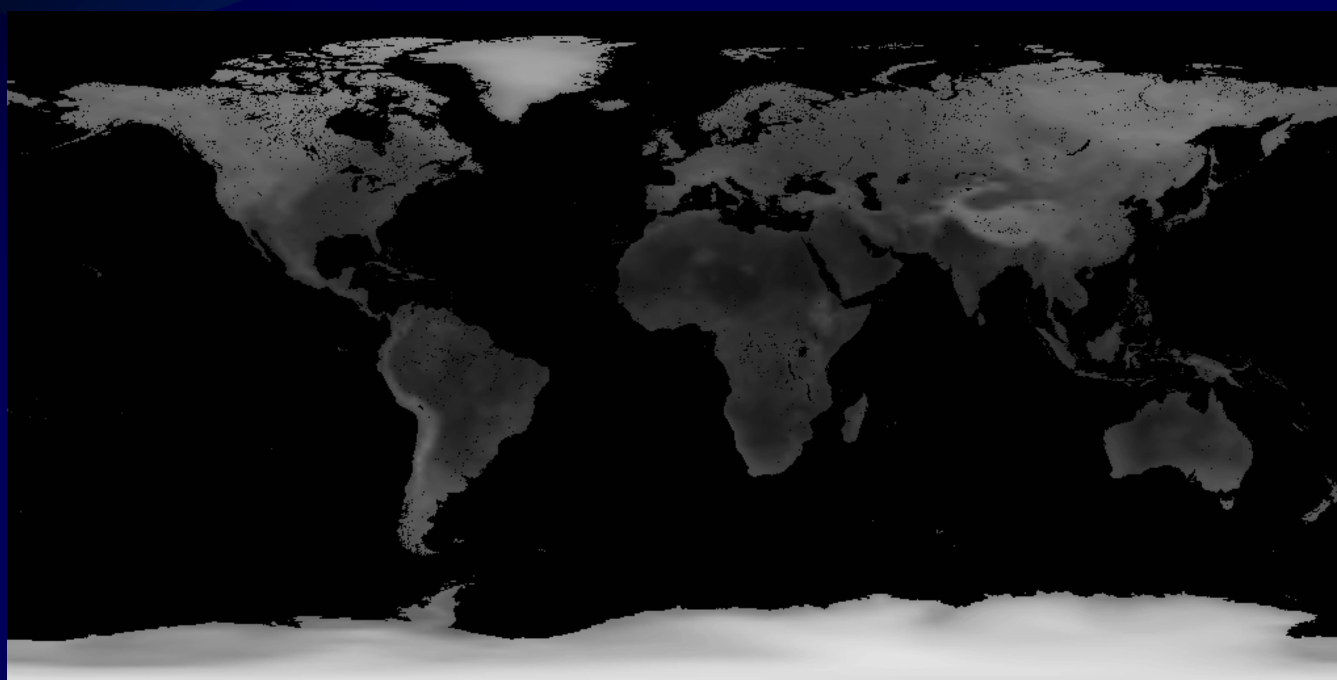
- Exaggerates cloud coverage in higher latitudes
- Underestimates low-level cloud coverage in lower latitudes
- Seasonal variability
- Global Scale

New Algorithm

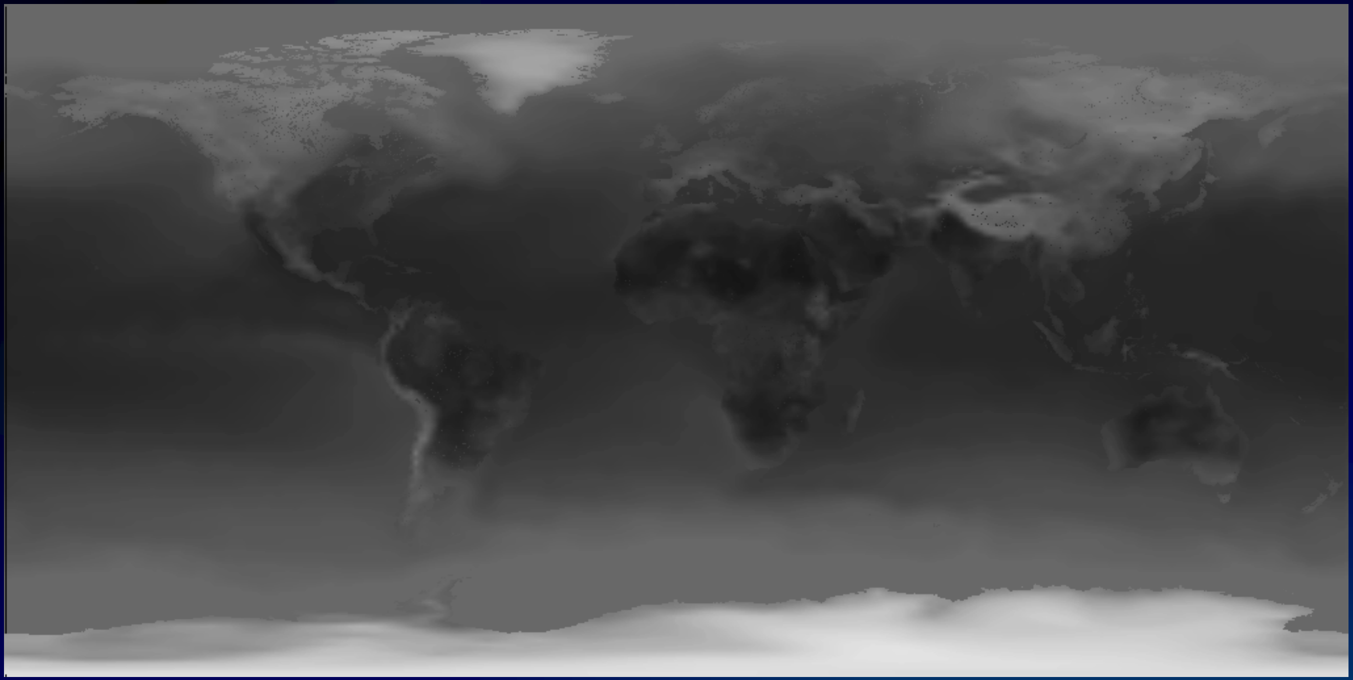
- Incorporates Surface Temperatures (T_{sfc})
  - 6-hourly global products use surface observations over land and NCEP sea surface temperatures over oceans
  - 3-hourly global products use GFS surface temperatures over land and NCEP sea surface temperatures over oceans



GFS T_{sfc} Land Temperatures (320-200K Black-White)



NCEP T_{sst} Ocean Temperatures (320-200K Black-White)

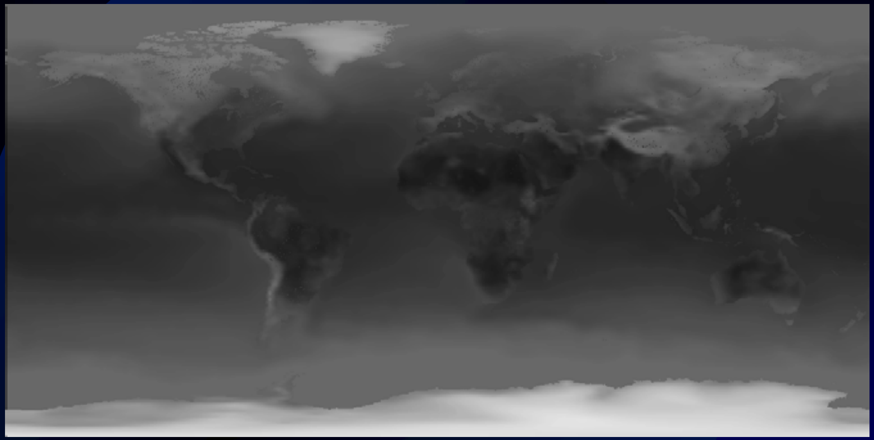


Combined T_{sfc} Image (320-200K Black-White)

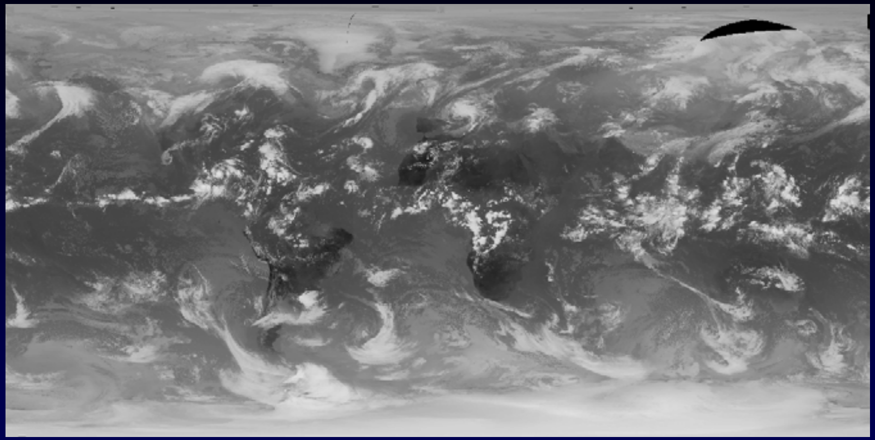
New Algorithm

- Incorporates Surface Temperatures (T_{sfc})
- Temperature difference (T_{sfc}-T_{ir}) based cloud/no-cloud threshold

T_{sfc}



T_{ir}



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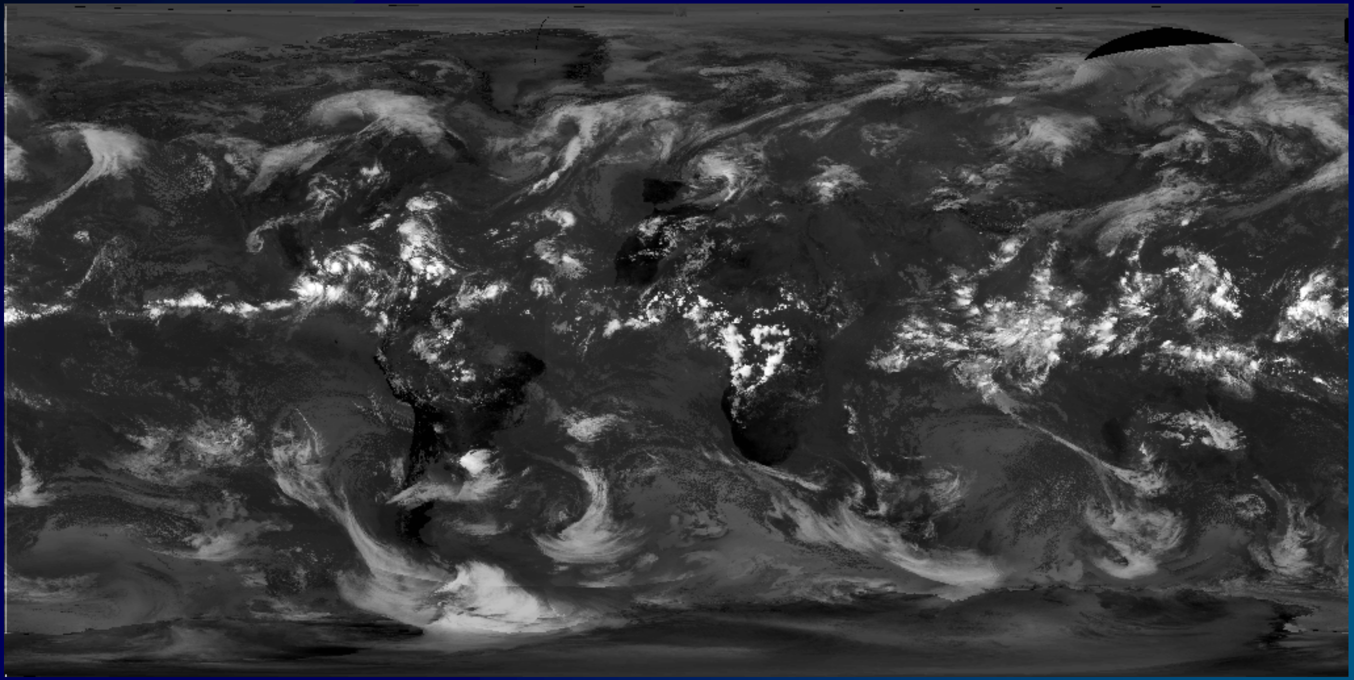
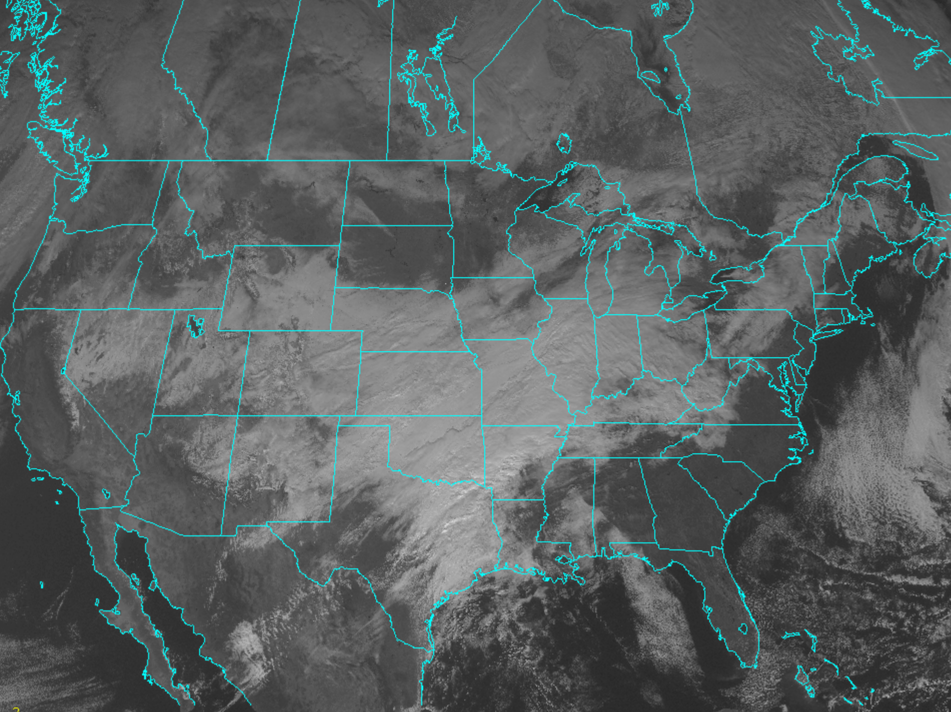
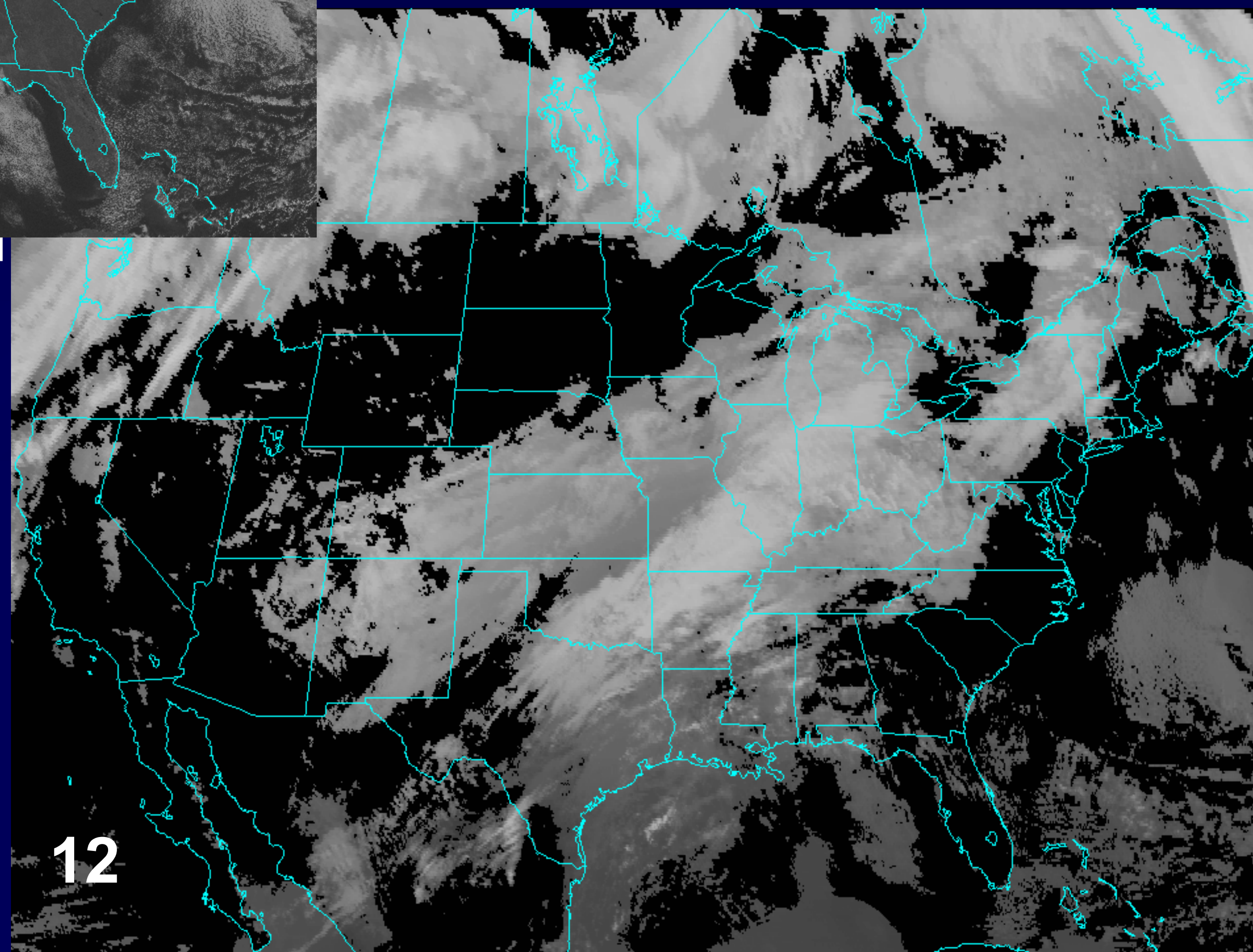


$T_{sfc} - T_{ir}$ (-10 – 100 Black-White)

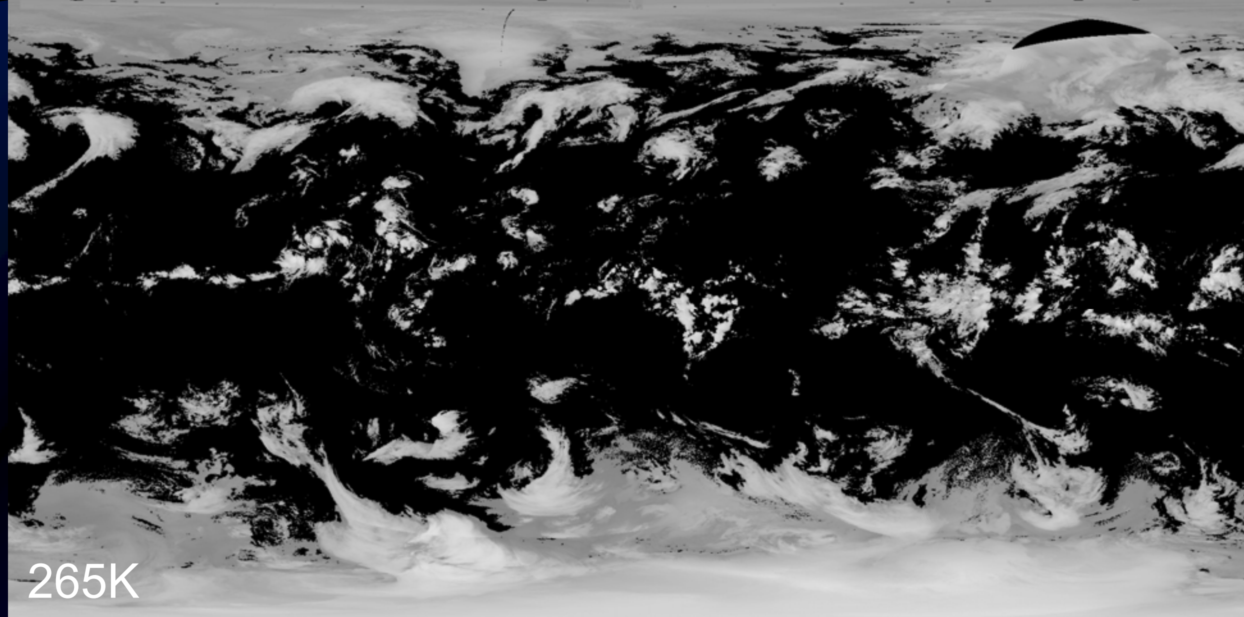
Choosing a T





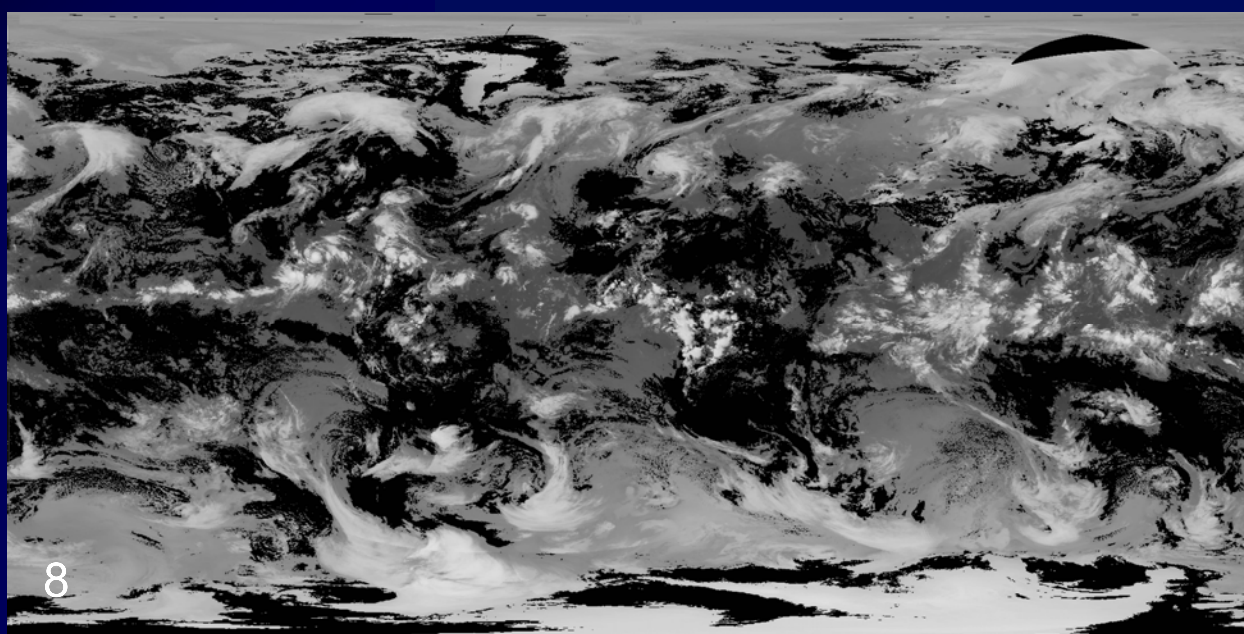
$T_{sfc} - T_{ir} =$ 12

$T_{ir} =$



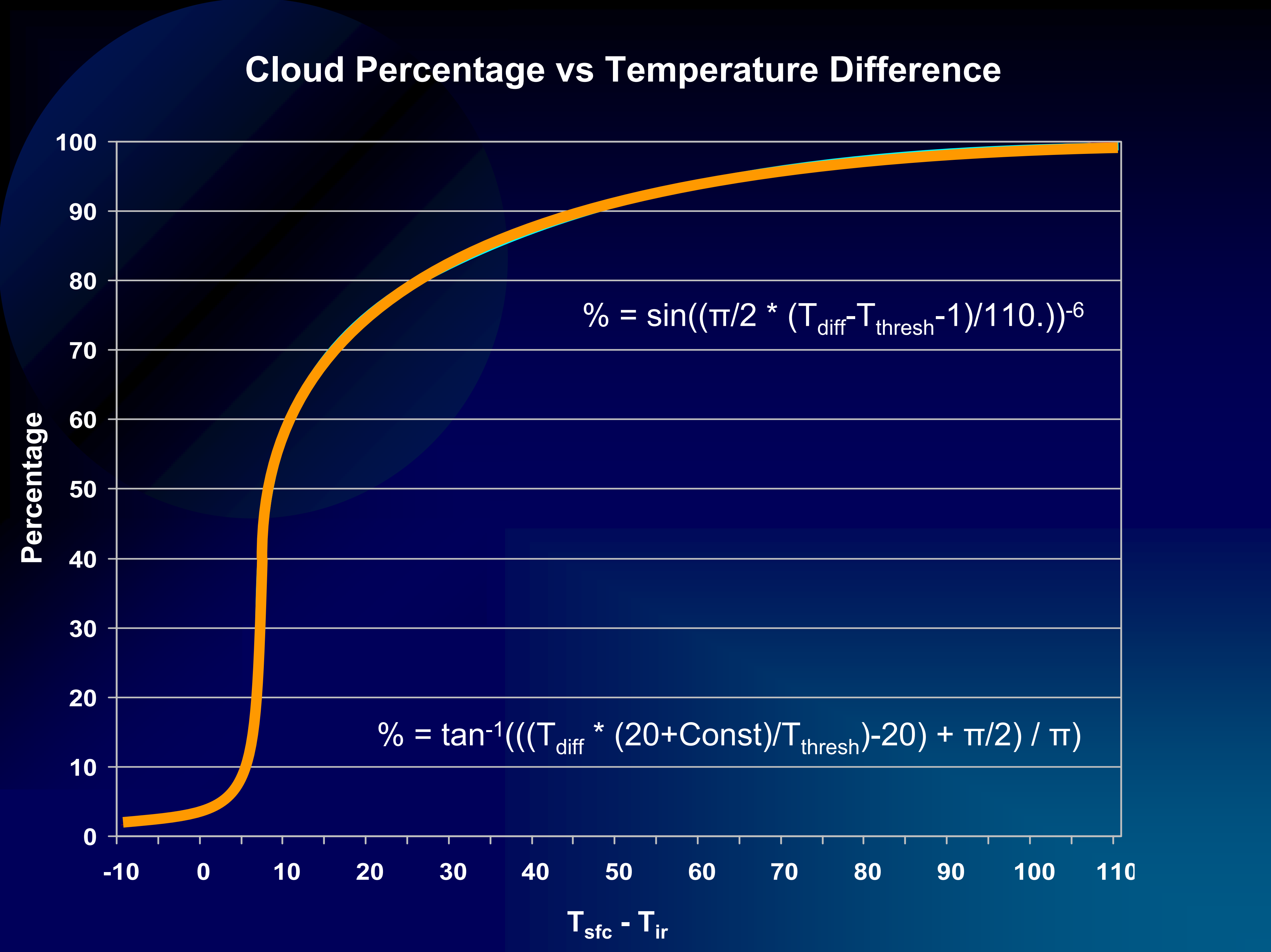
Globally

$T_{sfc} - T_{ir} =$

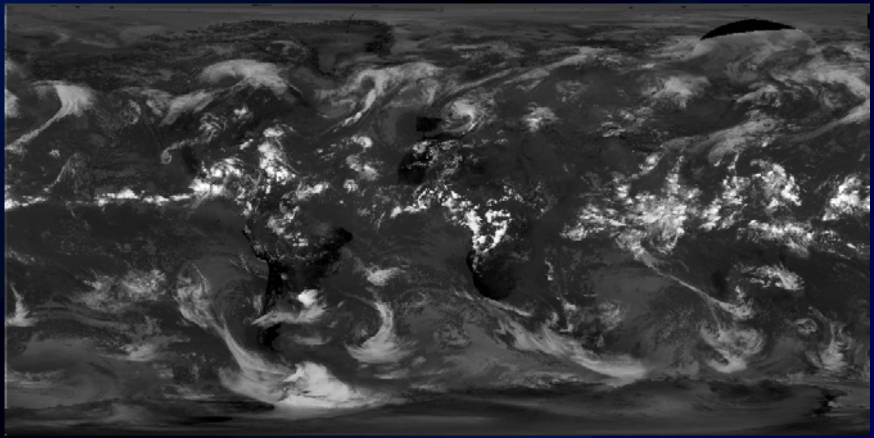


New Algorithm

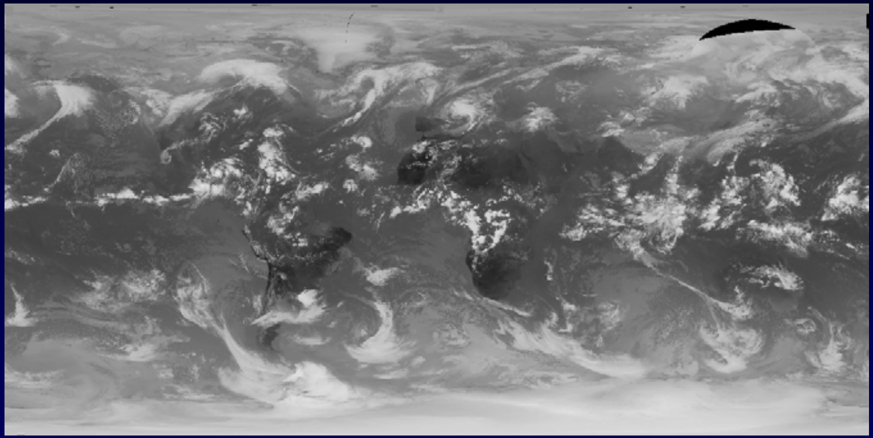
- Incorporates Surface Temperatures (T_{sfc})
- Temperature difference (T_{sfc}-T_{ir}) based cloud/no-cloud threshold
- Transparency based on T_{sfc}-T_{ir}


Cloud Percentage vs Temperature Difference
100
90
80
70
60
50
40
30
20
10
0
Percentage
$\% = \sin((\pi/2 * (T_{diff}-T_{thresh}-1)/110.))^{-6}$
$\% = \tan^{-1}(((T_{diff} * (20+Const)/T_{thresh})-20) + \pi/2) / \pi)$
-10
0
10
20
30
40
50
60
70
80
90
100
110
$T_{sfc} - T_{ir}$

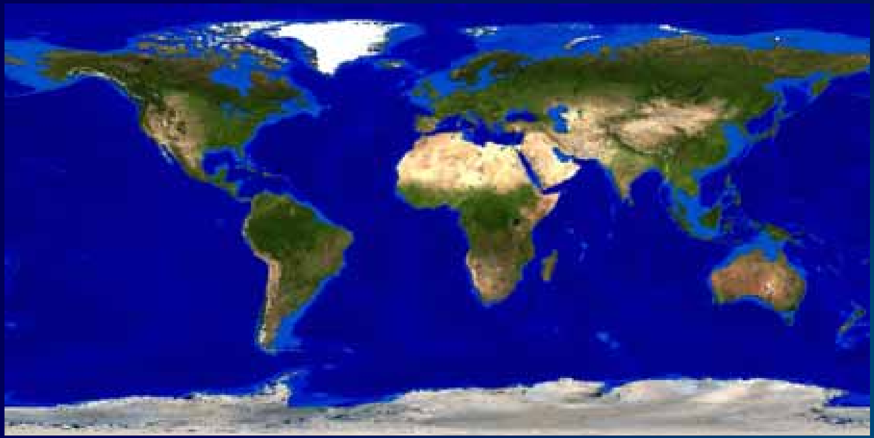
$T_{sfc} - T_{ir}$

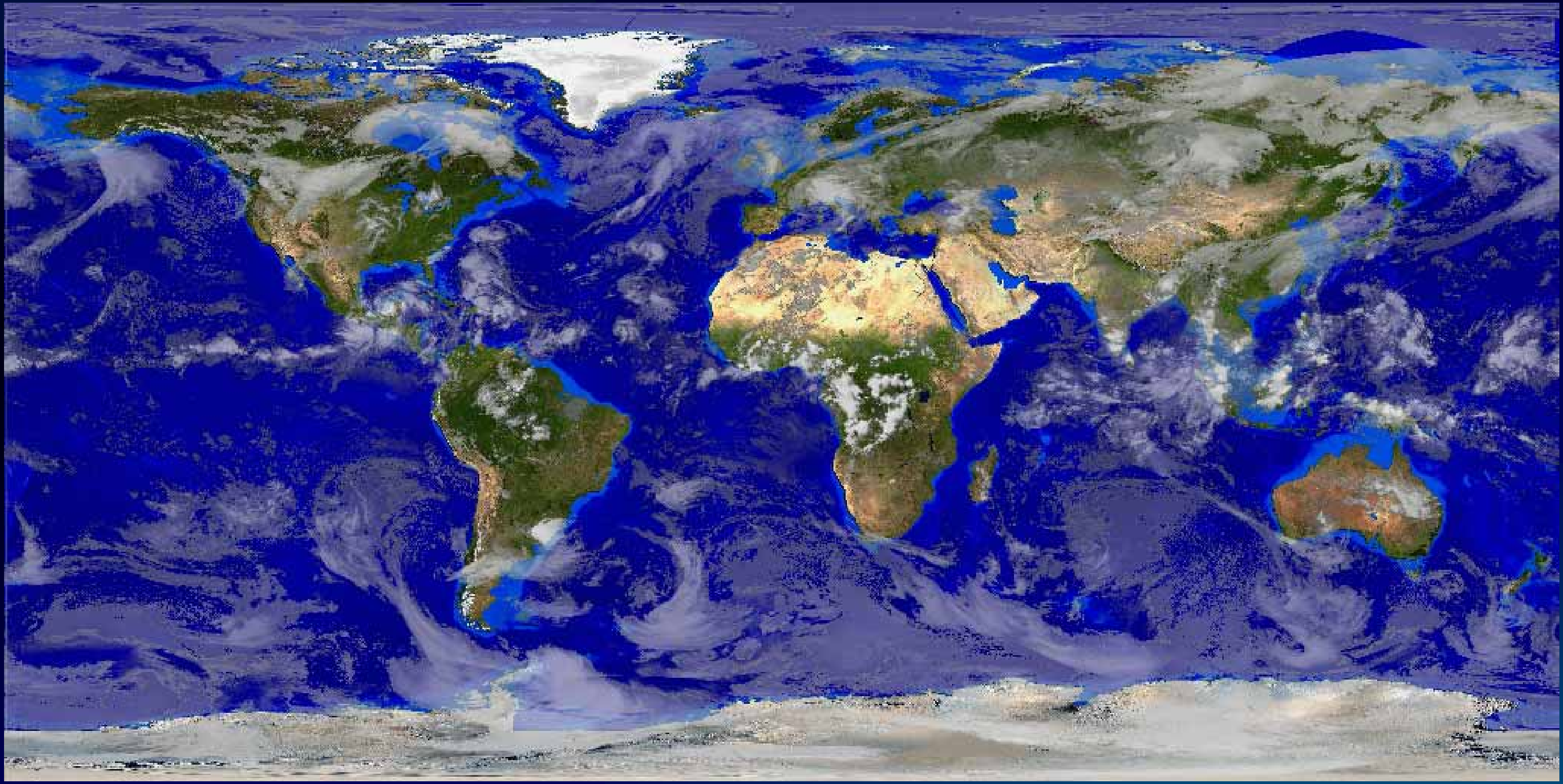


T_{ir}



Basemap





Movie

Current Algorithm - Problems

- Rapid surface cooling after sunset produces erroneous clouds

$T_{sfc} = 70F$

$$T_{sfc} - T_{ir} = 0$$

$T_{ir} = 70F$

Current Algorithm - Problems

- Rapid surface cooling after sunset produces erroneous clouds
  - Possible Solution – Adjust transparency curve based on date & time
- Values of $T_{sfc} – T_{ir}$ can be small for fog
  - Possible Solution – Adjust transparency curve based on relative humidity

Algorithm for Combining Visible and Infrared Data

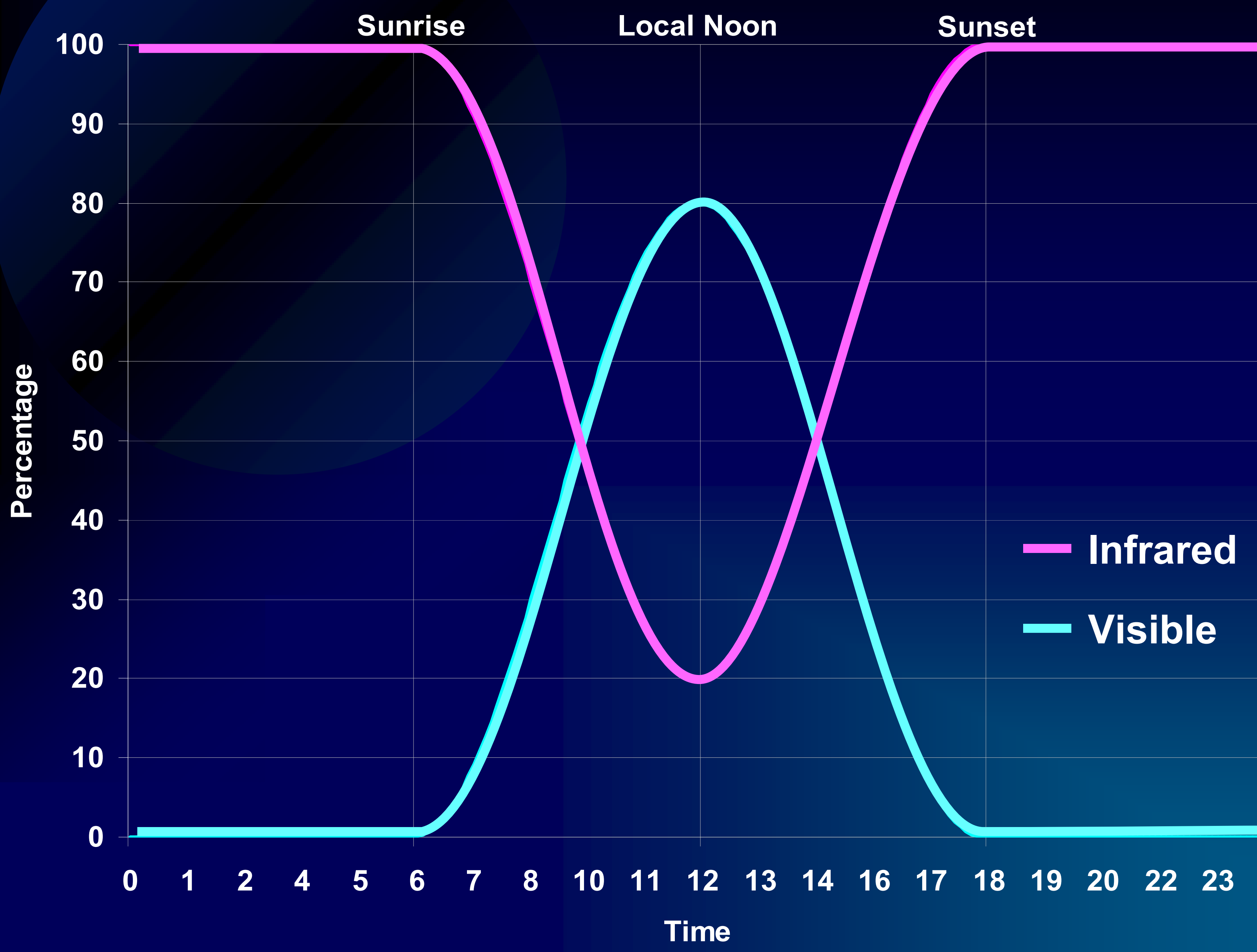
- Visible and Infrared percentages are determined by day and time

$$\text{Visible}(\%) = 80 * (\sin(\text{Day}_{pct} * \pi/2))^2$$

$$\text{Infrared}(\%) = 100 - \text{Visible}(\%)$$

where: $\text{Day}_{pct} = \text{abs}(\text{Time}_{image} - \text{Time}_{noon})/(\text{Length}_{day}/2)$

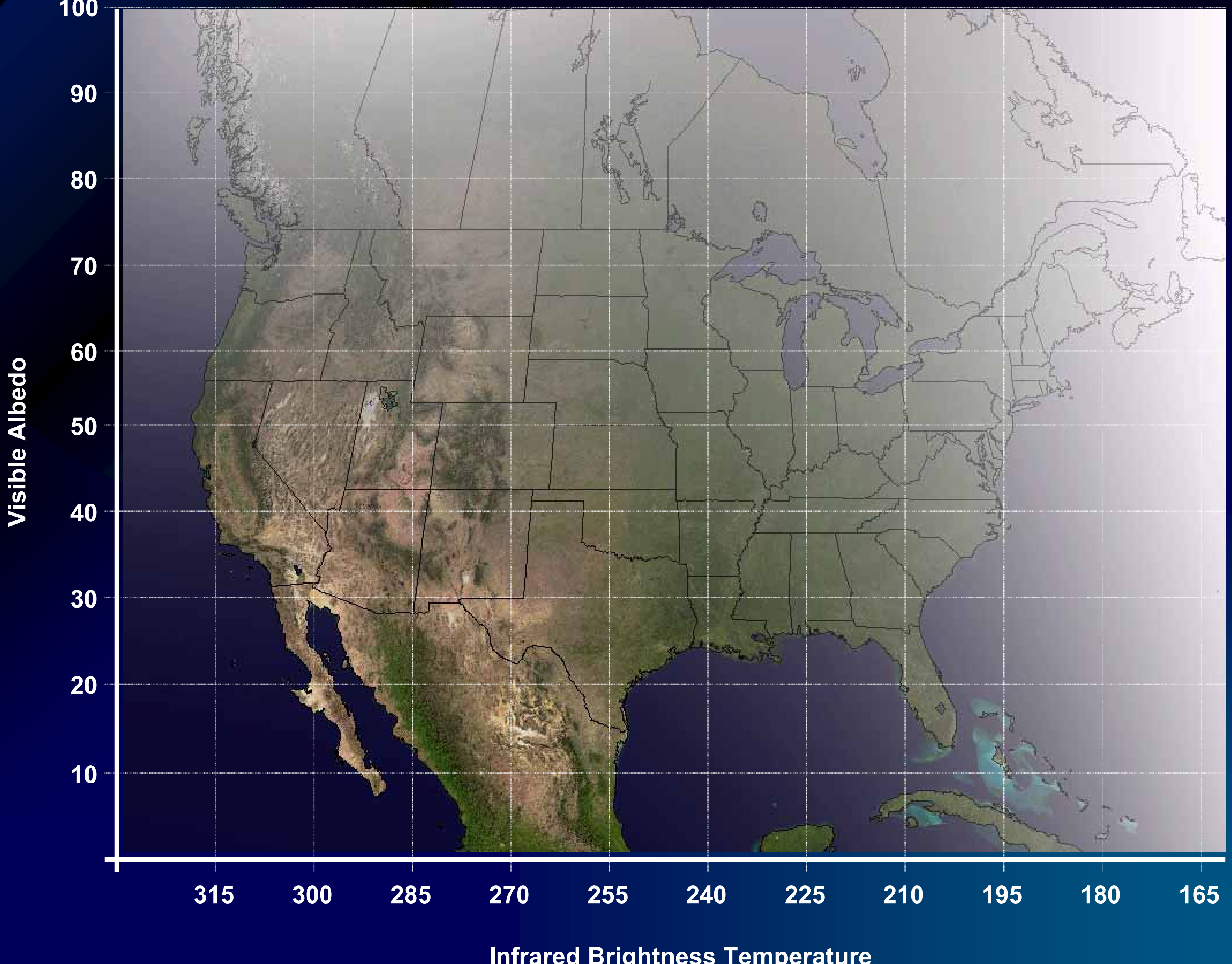
Visible and Infrared Pecentages

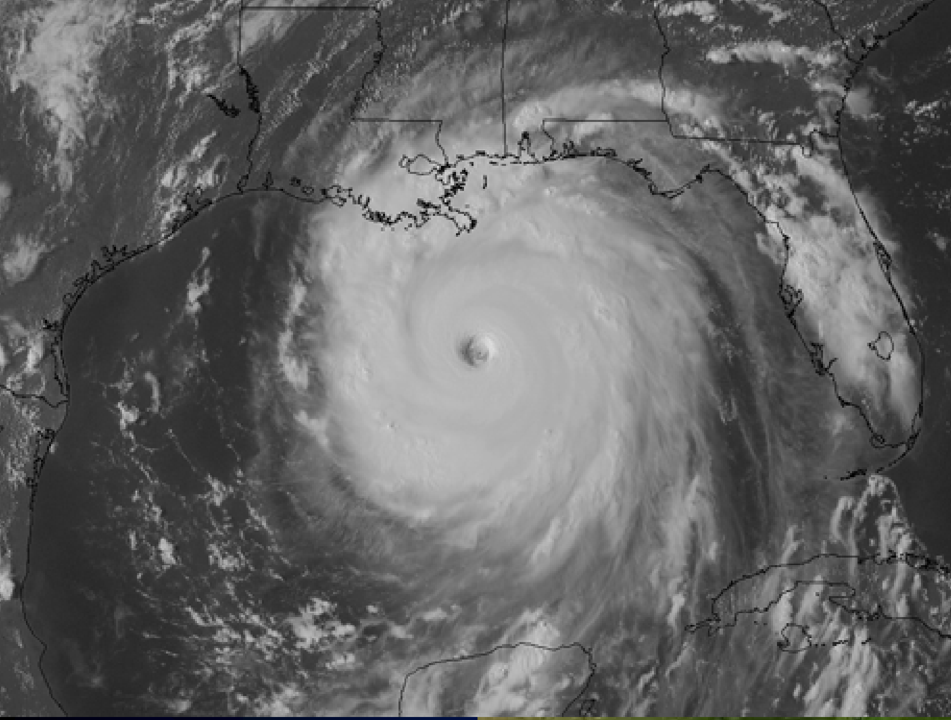


Algorithm for Combining Visible and Infrared Data

- Visible and Infrared percentages are determined by day and time
- Transparency based on Visible Albedo and Infrared Brightness Temperature

Transparency





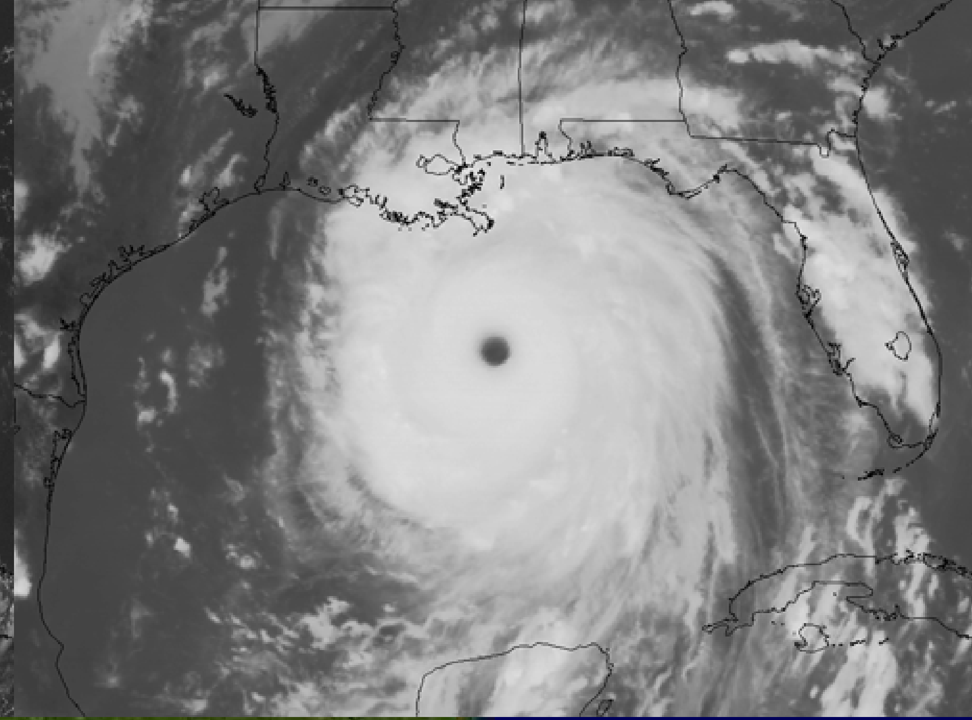
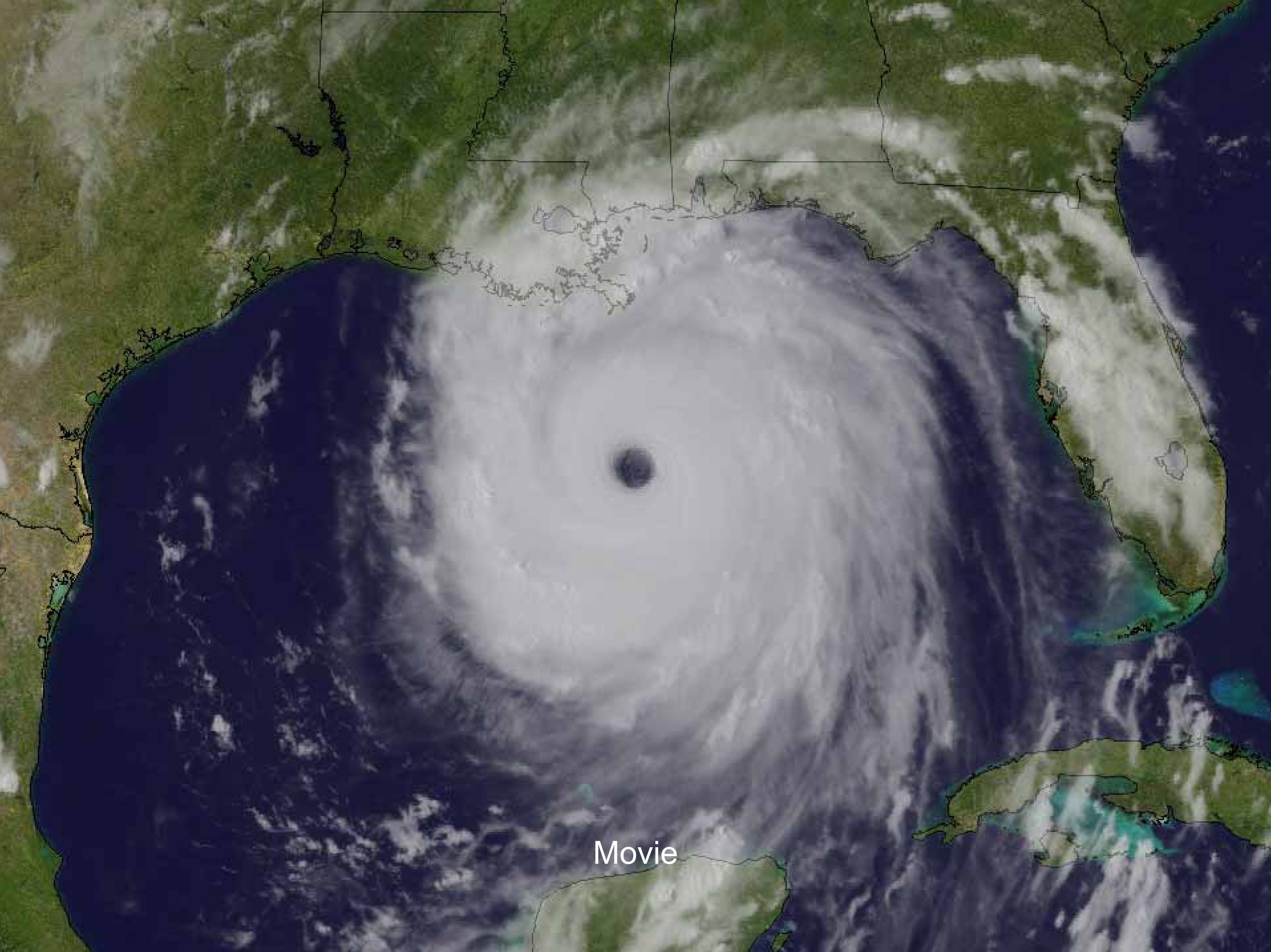


Image Time: 20:45
Sunrise: 11:34
Sunset: 00:20

Visible: 48%
Infrared: 52%


Movie

Availability of Applications and Basemaps

- New core supported application available in 2006
  - Similar to IMGFILT using FILTER=VISIR, VIS, IR, TDIFF …
  - Work with NASA Big Blue Marble or Topography and Enhancement
- Global Basemaps available via ftp and possibly ADDE
  - 1 km NASA Big Blue Marble – RGB areas – 1 GB/area
  - 1 km Topography – 2 byte data – 2 GB/area
  - 1 km Topography with Lakes – 2 byte data – 2 GB/area
  - 1 km Land Sea Mask – 1 GB
  - 10 km Topography and Bathymetry – 9 MB
  - 20 km NASA Big Blue Marble and Bathymetry – RGB areas - 2 MB/area