Raytheon

Customer Success Is Our Mission

Observing Earth From Space: Engineering to Change the World

Kerry Grant
JPSS CGS Chief Scientist
Bret Lowell
JPSS CGS Program Engineer
April 12, 2014

Agenda

- Introduction
- Societal Benefits
  - Interactive exercise: environmental effects on daily life
  - How weather affects us
  - How improvements in technology improves life
- Phenomena
  - What's relevant and how do we detect it?
  - Interactive demonstration. Interaction between environment & photons
- Engineering
  - Sensors to Products to Actionable Information
- Conclusion
- Resources

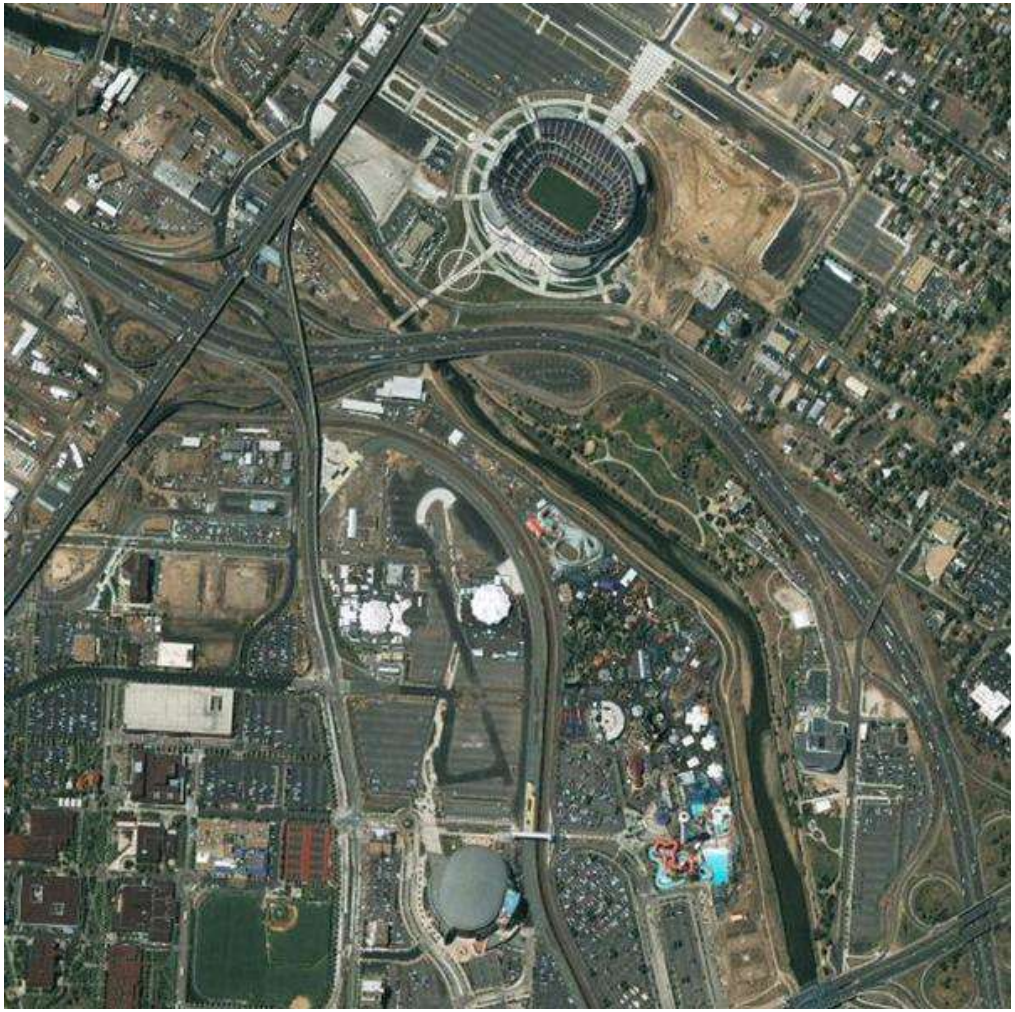
Earth Observation – what's that?

- **Earth observation** is the gathering of information about planet Earth's physical, chemical and biological systems via remote sensing technologies
- **Remote sensing** is the acquisition of information about an object or phenomenon without making physical contact with the object

Image courtesy of NASA

Classes of Earth Observation Missions

- Weather
  - Geostationary
  - Polar Orbiting
- Climate
- Land Use
  - Vegetation
  - Urbanization
- Ocean
  - Biology
  - Winds and currents
  - Ice
- Intelligence, Surveillance, & Reconnaissance (ISR)
  - Imagery
  - Signals



Digitalglobe image

Focus: Weather and Climate

- Who wants environmental information?
- How does environmental information get to these people?
- Why is technology so important?
- How do people benefit?

Activity: Choosing Environmental Parameters to Describe a Given Location

Raytheon

- **Preparation for the activity**
  - Form a team
  - Each team will elect a spokesperson
  - Total time to complete activity: 15 minutes
- **Description of activity**
  - Each team will be assigned a city (or location)
  - Each team will brainstorm and provide 5 environmental parameters for their assigned city
  - Each team will discuss their parameters with the class
  - The class gets to guess the team's location

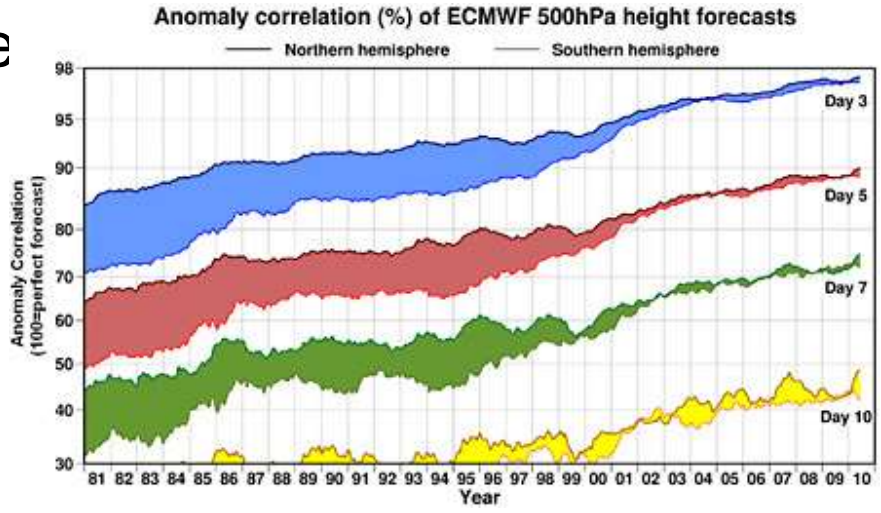
Interesting facts about weather impacts

- Weather disasters with impacts exceeding $1 billion have hit the US 151 times since 1980.
- Federal disaster declarations have risen from 65 in 2004 to 98 in 2012
- Average value of all US daily weather forecast information is around $109 per household; $11.4 billion in total

Photos courtesy of CBS 4 (Colorado Springs)

How is life better today?

- Weather forecasts have become more accurate
- Weather forecasts can be made further out in time
- Climate forecasts are more accurate



- These technology driven changes allow people to plan better
  - Prepare for bad weather events (blizzards, hurricanes, tornados)
  - Plan for changes in climate (longer periods of drought, more violent weather, rising sea levels)
  - Schedule outdoor activities (want to go swimming? climb a mountain? fly a kite?)

Building A More Capable System
The Historical Context

Raytheon

First Image from TIROS-1 (April 1, 1960)

New Brunswick and Nova Scotia

S-NPP VIIRS Image-375 m

VIIRS First Light – US East Coast

Images courtesy of NASA

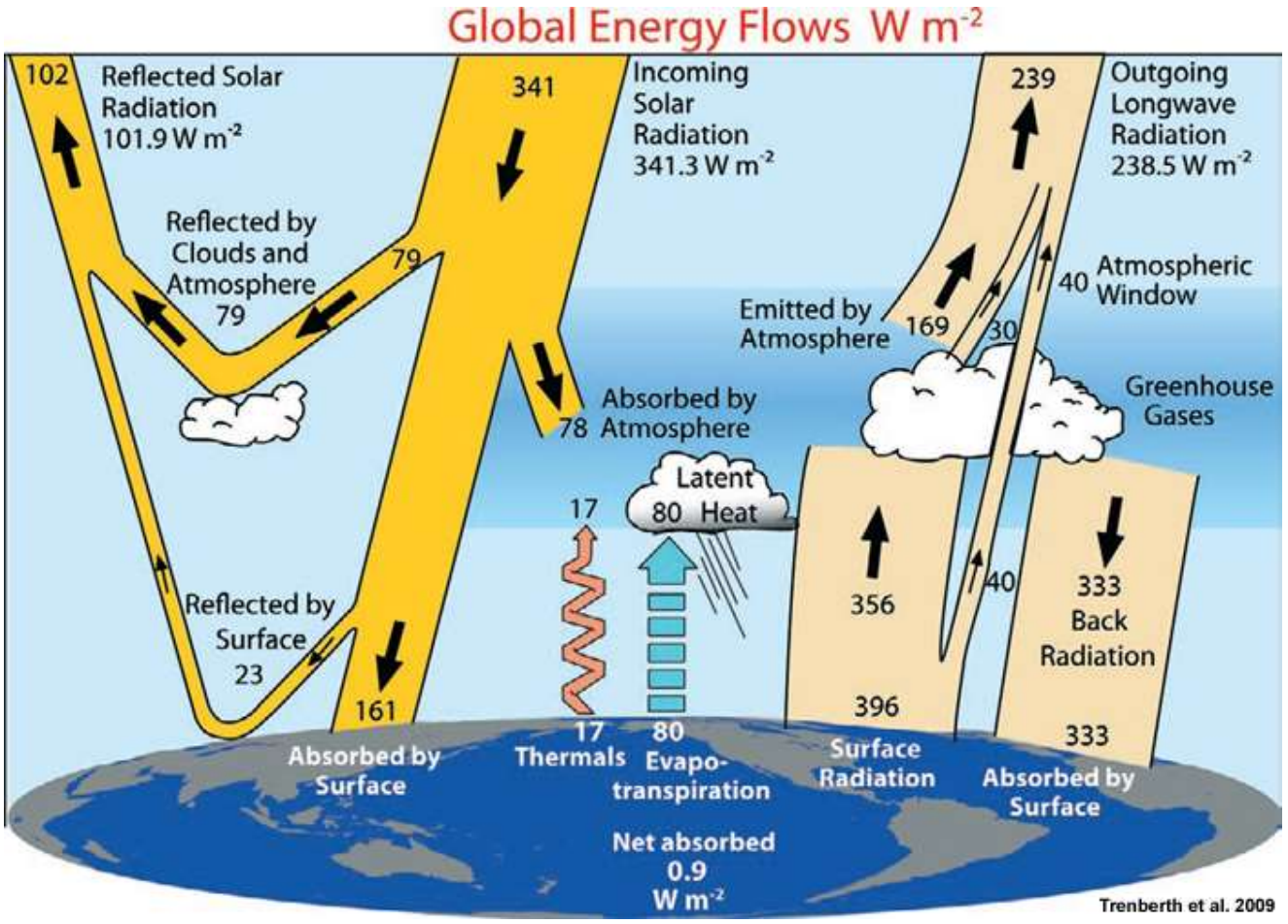
The problem of remote sensing

- What do we need to measure?
  - Temperature
  - Pressure
  - Humidity
  - Cloud properties
  - Wind speed and direction
  - Precipitation
- What can we actually measure from space?
- Does what we can measure have anything to do with what we need to measure?

What we can measure

- Some things we can see – so take a picture
  - Clouds (where they are, type)
  - Taking a number of pictures shows movement, so we can measure winds
  - *But a picture is an incomplete measurement*
- The solution
  - Electromagnetic energy can be measured directly
  - The energy we measure is affected by the things we care about in very predictable ways: temperature, humidity, winds, clouds, precipitation
  - By measuring electromagnetic energy very precisely, and understanding how this energy is changed by the environment, we can derive the actual physical conditions of the earth

Electromagnetic Energy Flow

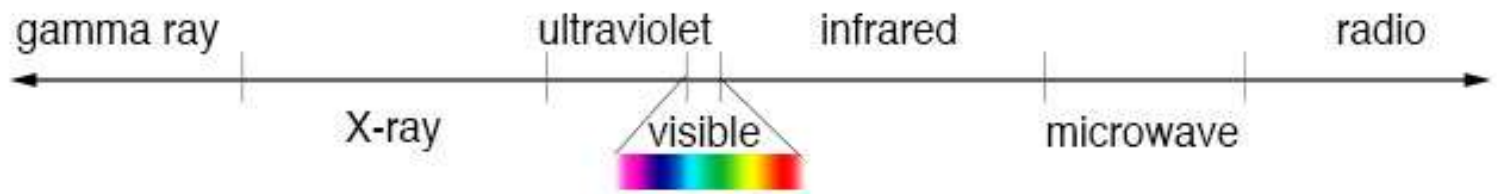


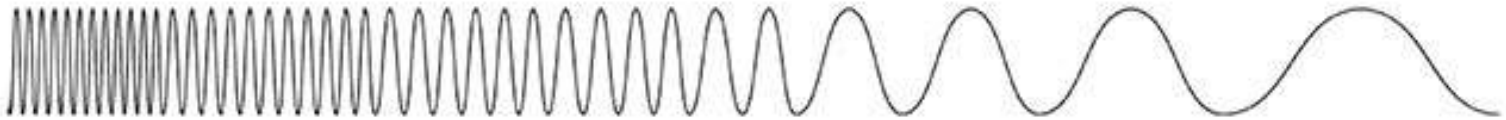
Source: Tropical Meteorology, 2nd Edition, © 2011 COMET

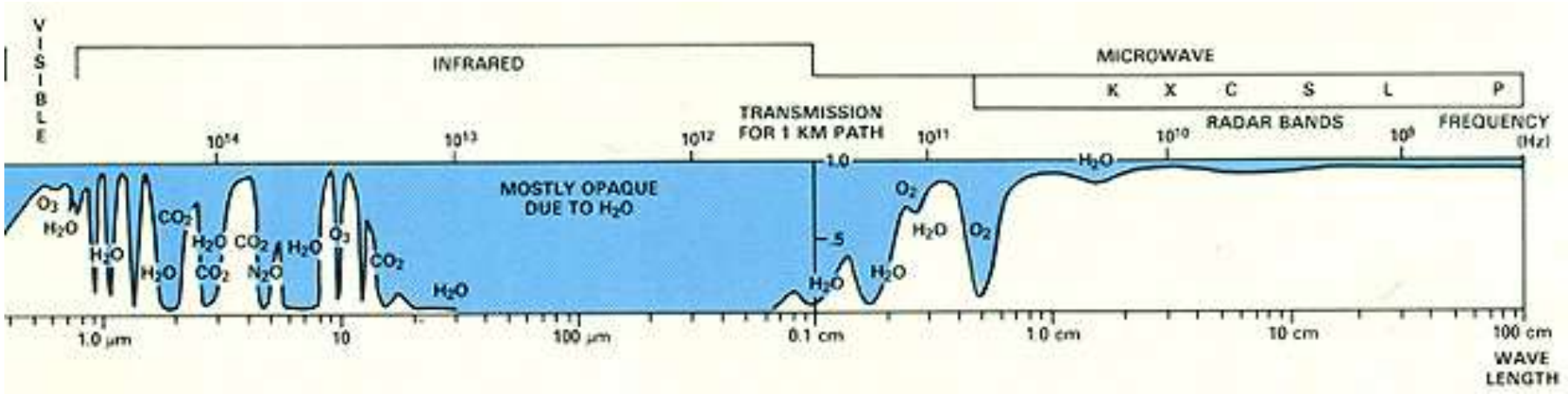
Demonstration

- How does a cloud affect electromagnetic energy at two different wavelengths?

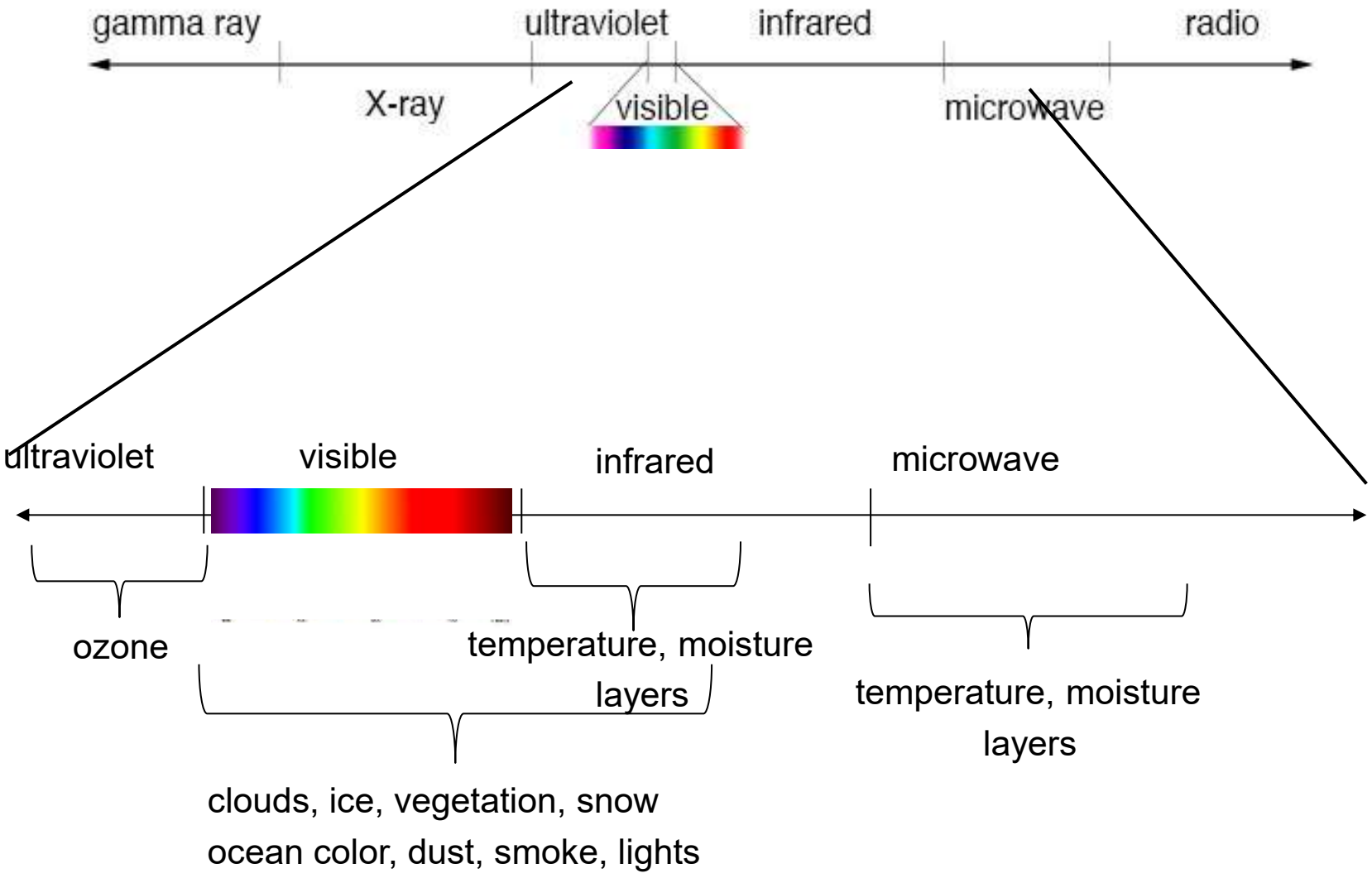
The Electromagnetic Spectrum and the Atmosphere



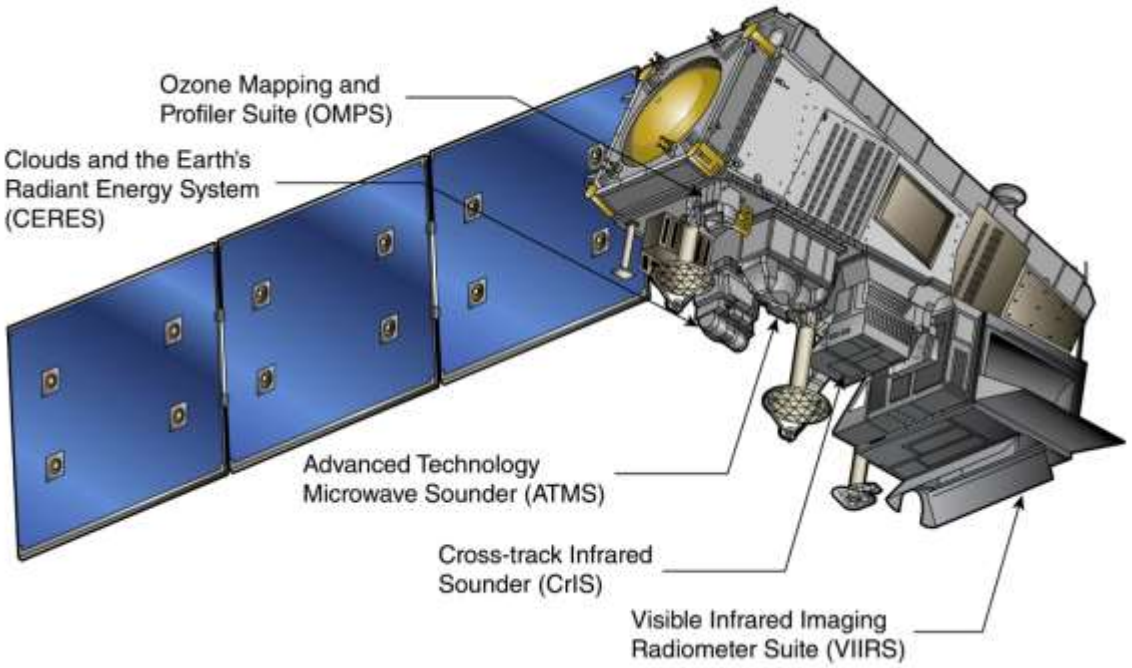




Observing the Electromagnetic Spectrum – the Suomi NPP spacecraft



The Suomi NPP Satellite



VIIRS

ATMS

CERES

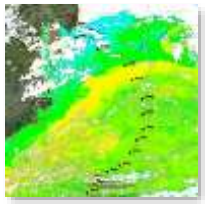
OMPS

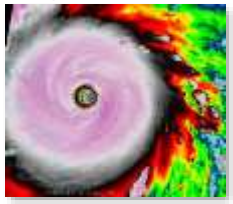
CrIS

Sensors to Products to Actionable Info

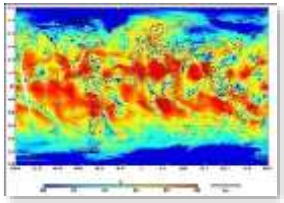
S-NPP Data Products

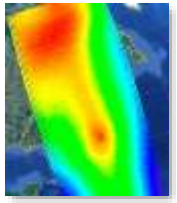
VIIRS



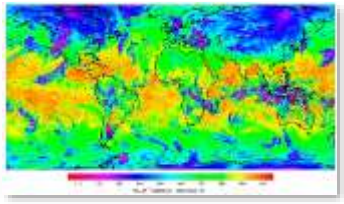


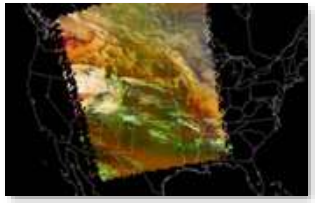
ATMS



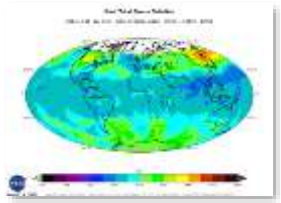


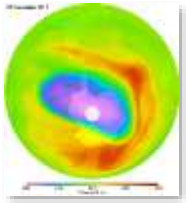
CrIS



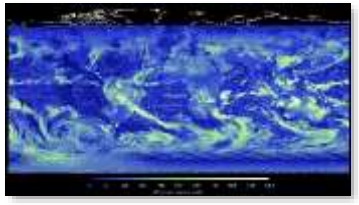


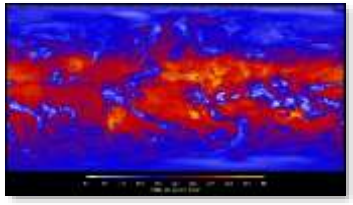
OMPS





CERES





Benefits for Decision Makers

Weather Consumer

Maritime Operations

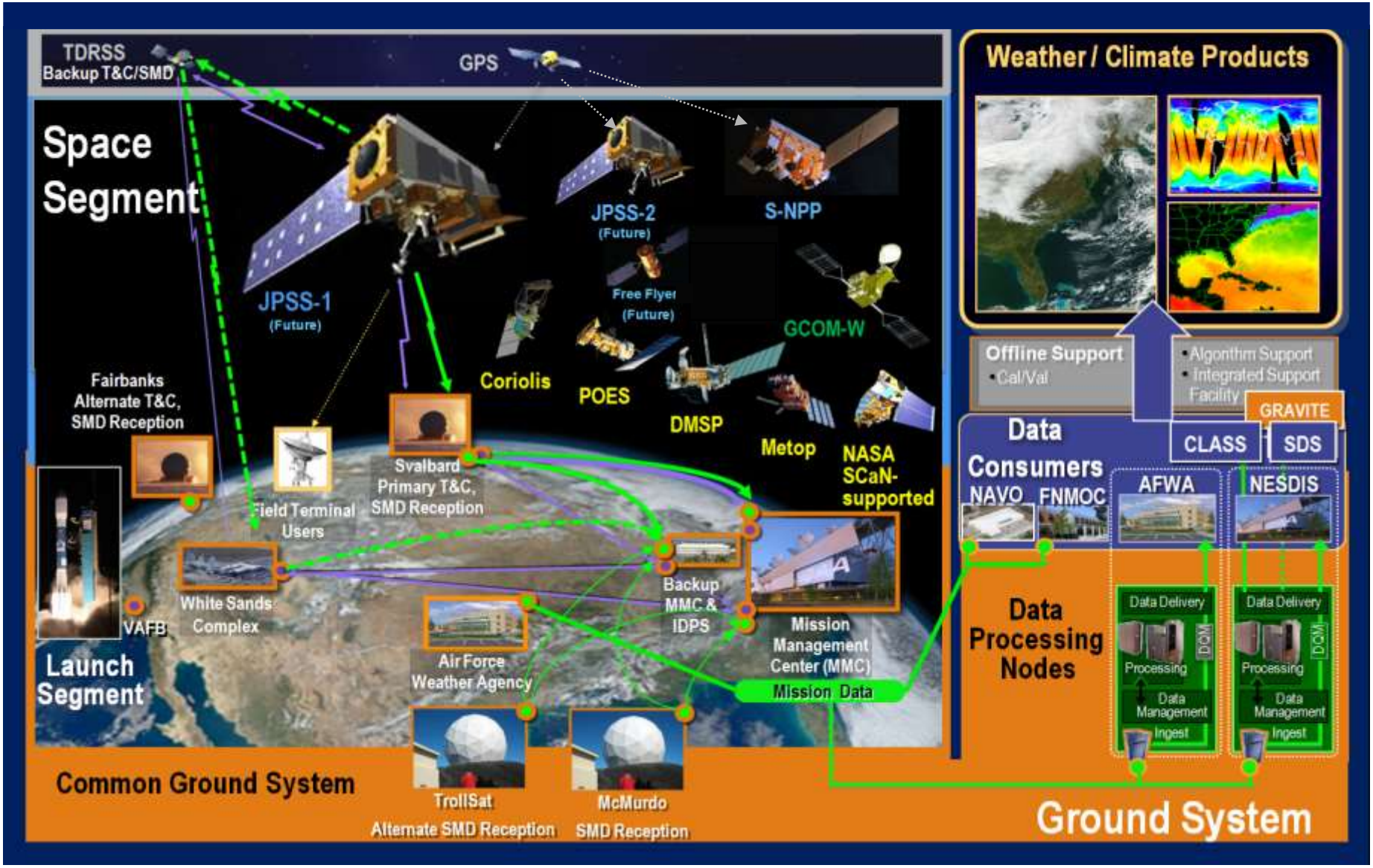
Military Operations

Transportation

Public Utilities

7/16/2025

Daily Operations



Hurricane Isaac in Infrared

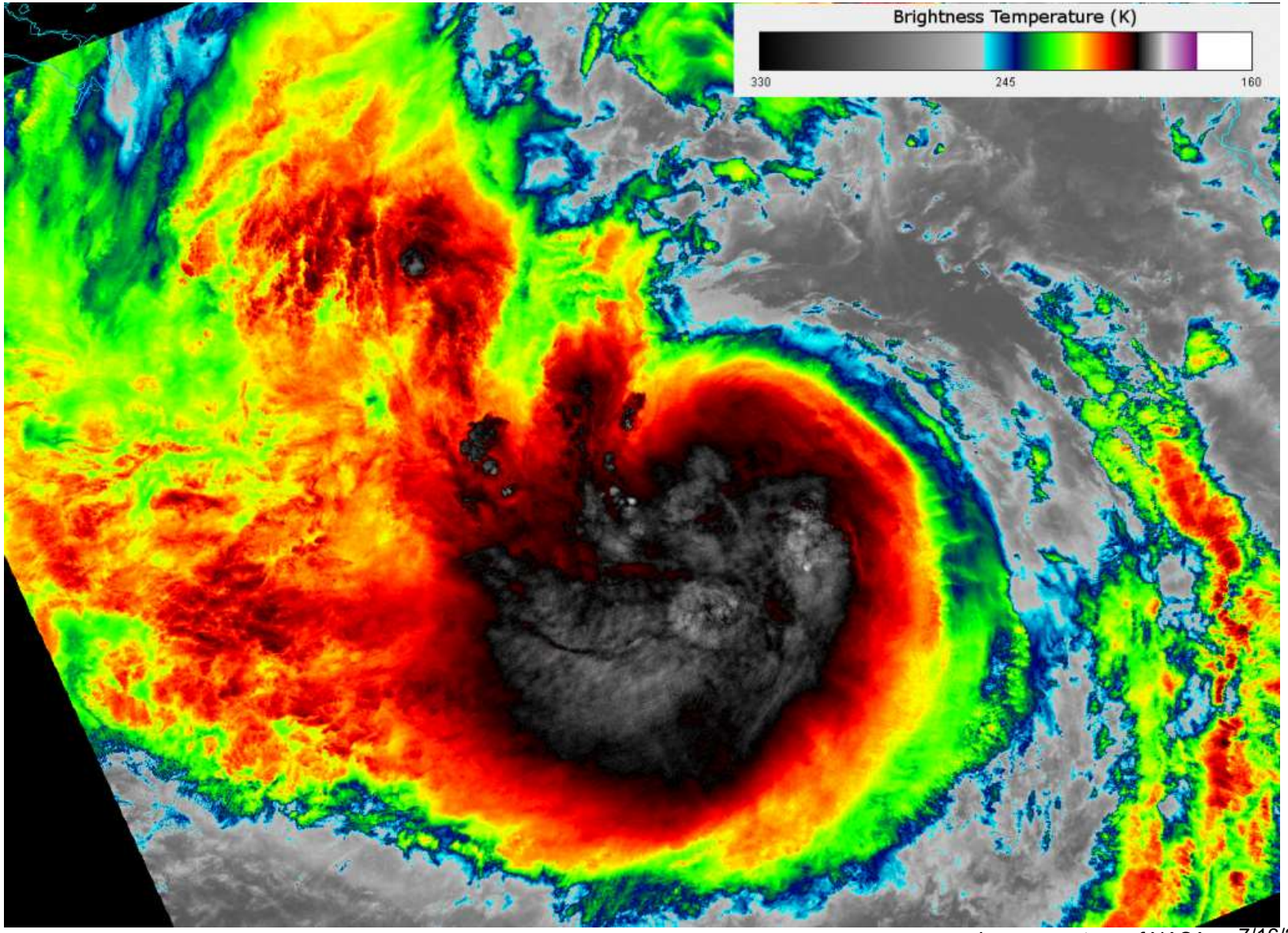


Image courtesy of NASA

VIIRS True Color – Waldo Canyon Fire

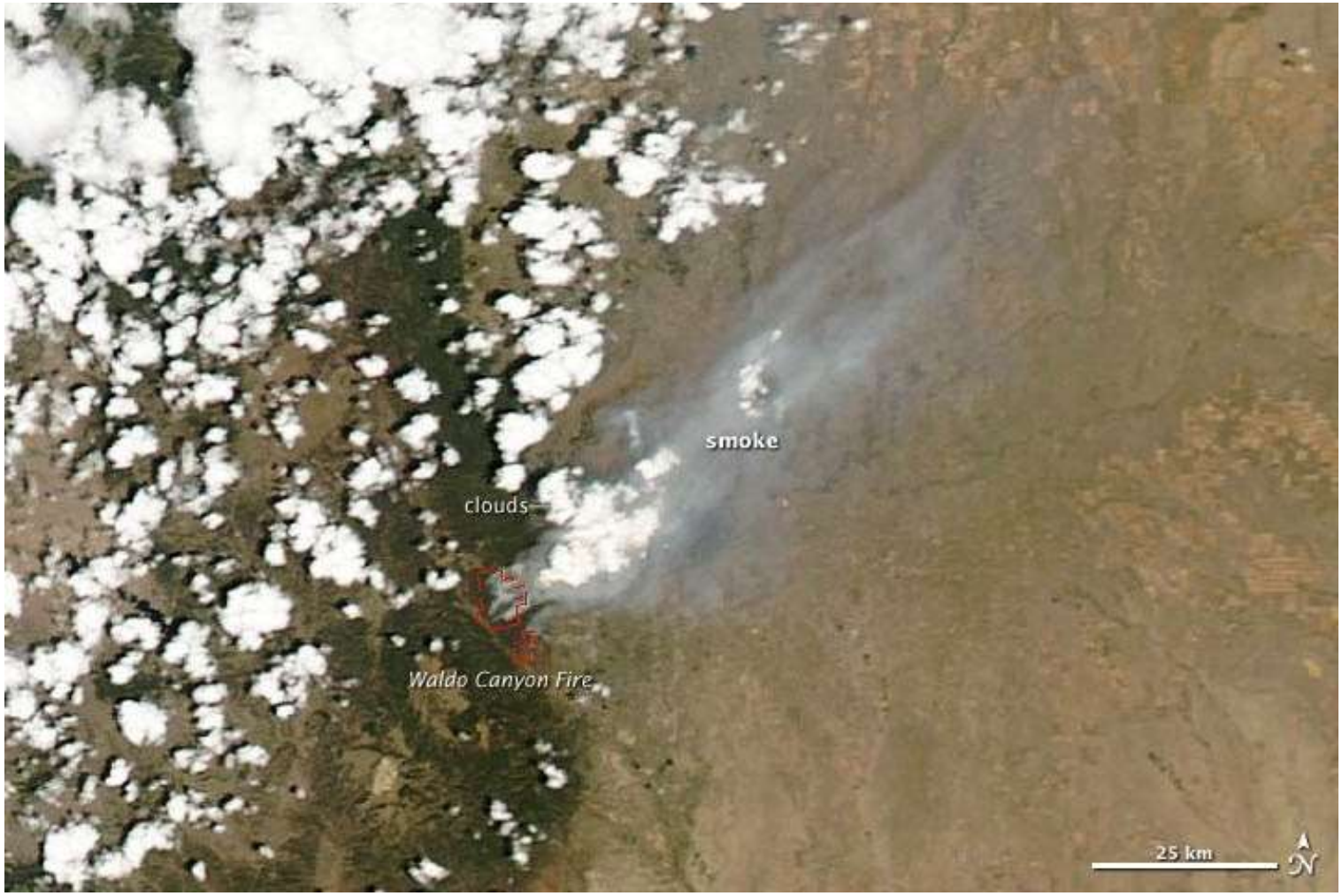


Image courtesy of NASA

VIIRS Night Visible Fire Detection

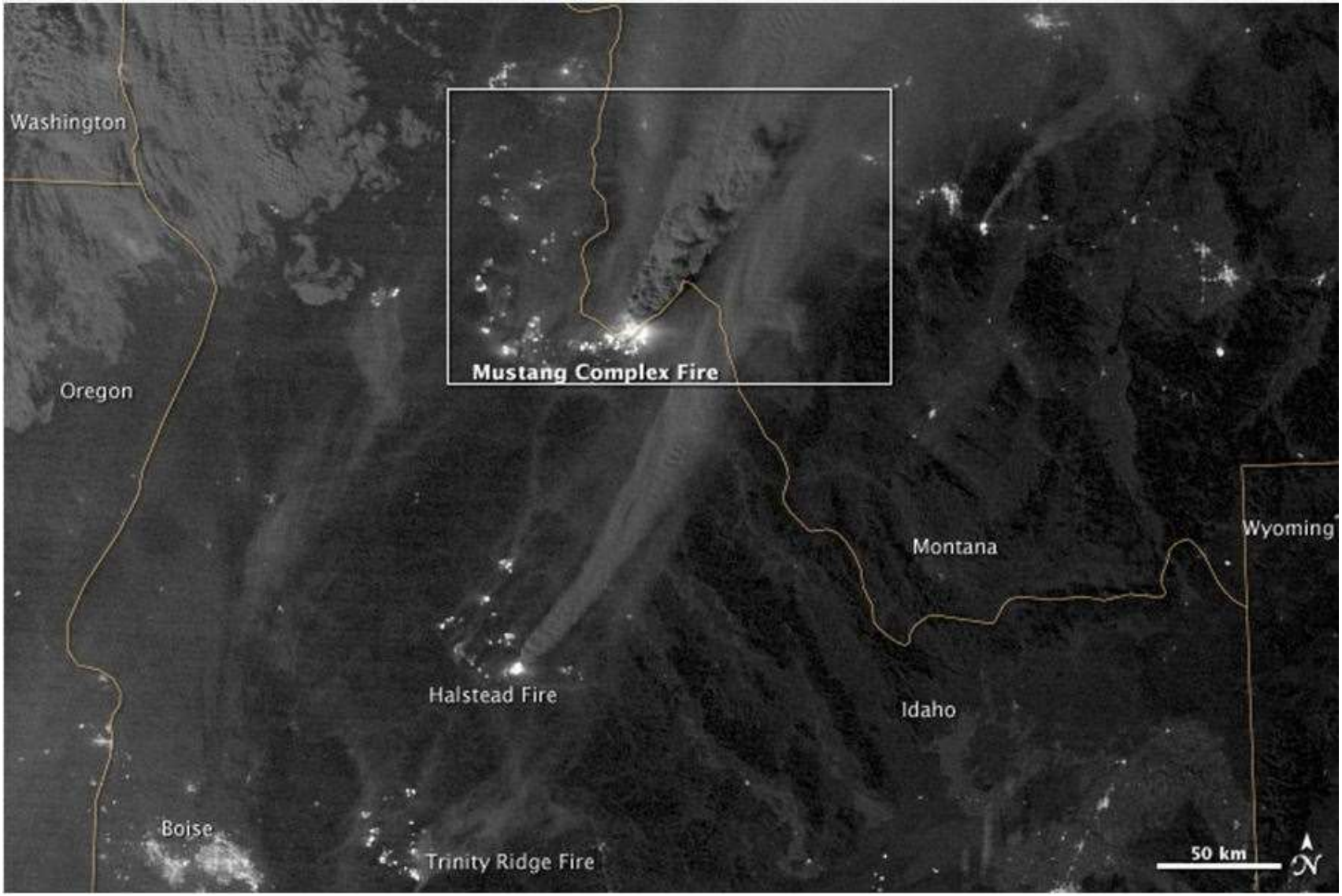


Image courtesy of NASA

OMPS Smoke (Aerosol) Detection

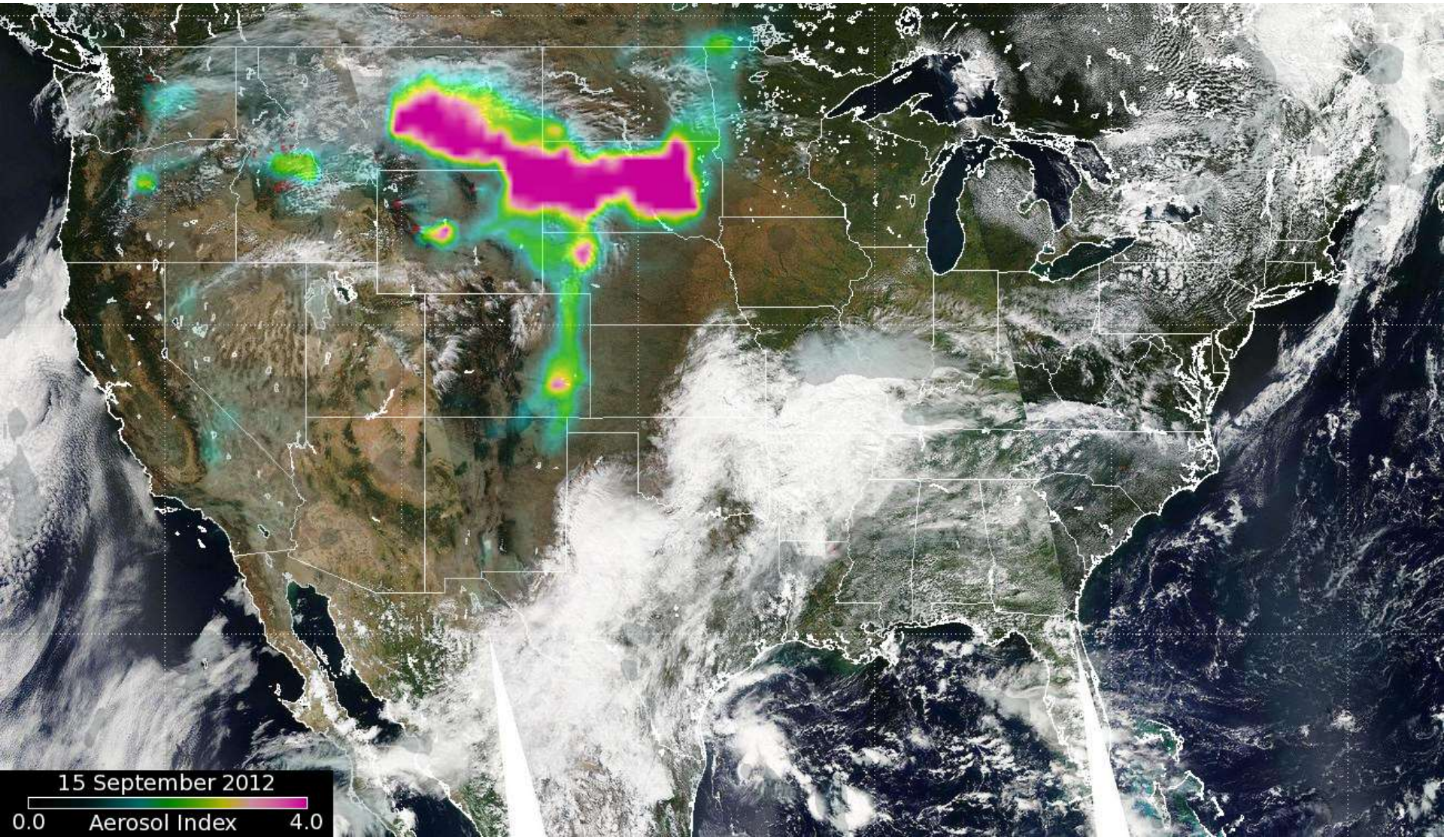


Image courtesy of NASA

OMPS Measurement of Ozone Hole

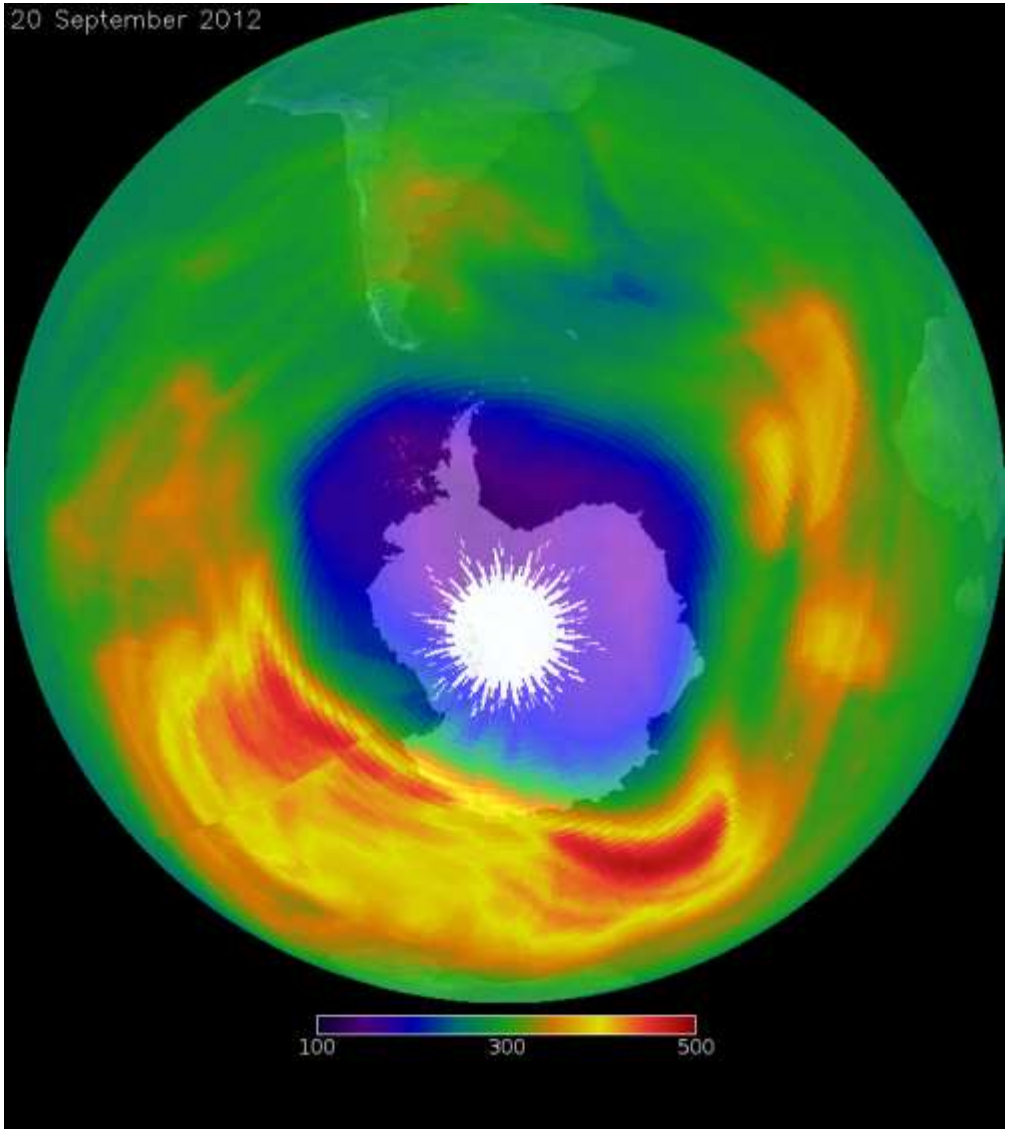
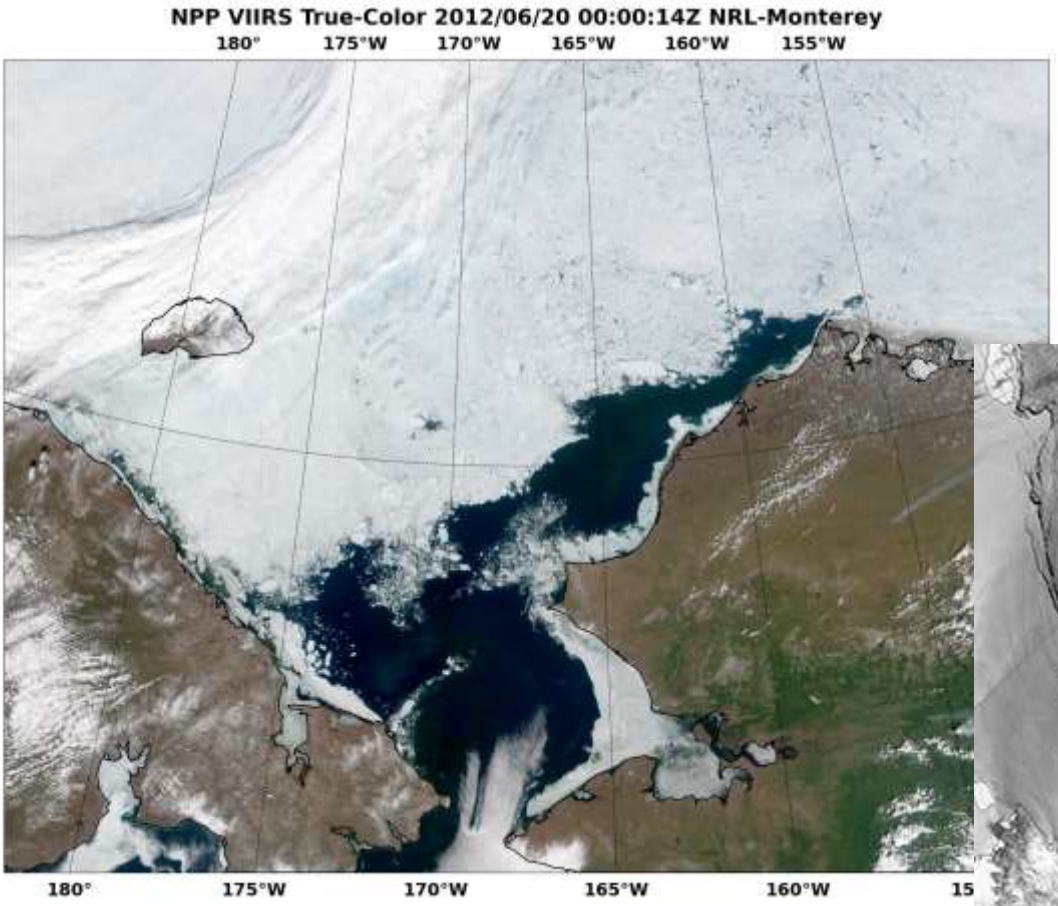


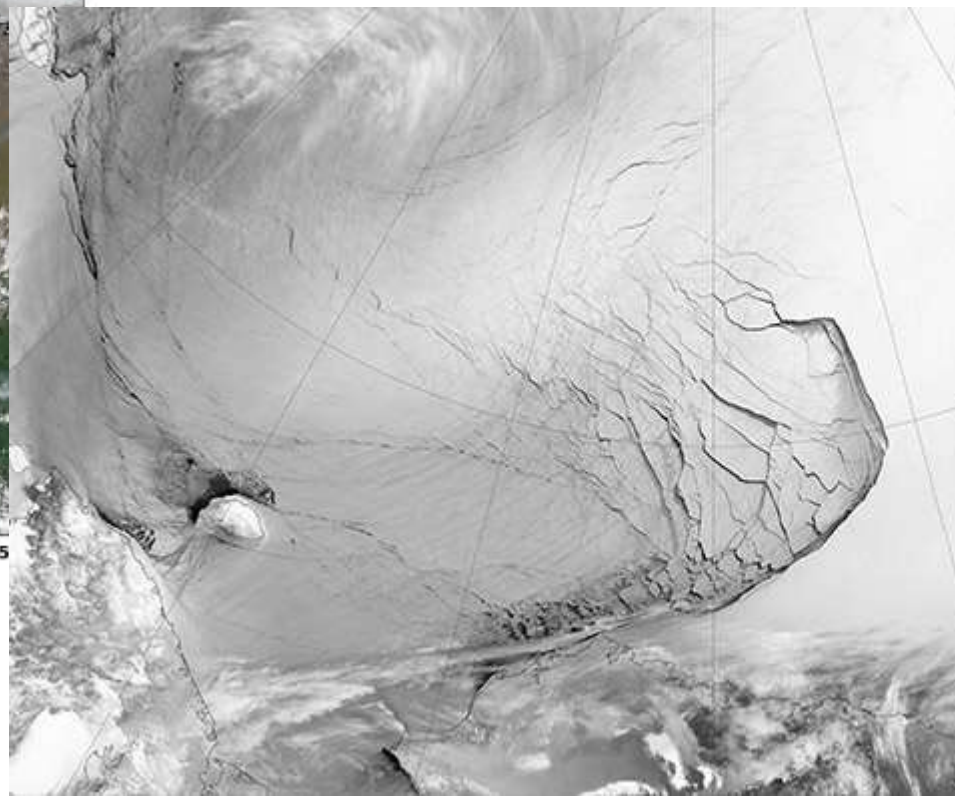
Image courtesy of NASA

VIIRS Ice Detection – Day and Night



Day

Night



Images courtesy of NASA

Conclusion

- Understanding the environment provides direct benefits to people in terms of safety, quality of life, and future needs
- Measuring the environment in great detail allows people to understand its current state and predict its future
- Only way to measure the entire globe in detail is by using remote sensing techniques
- Understanding how electromagnetic energy interacts with the environment makes remote sensing possible
- Engineering brings it all together – building sensors, flying satellites, processing the data, making forecasts, delivering the information

Resources

- Interactive blue marble
  http://www.raytheon.com/newsroom/technology/rtn12_bluemarble/
- S-NPP information
  http://npp.gsfc.nasa.gov/suomi.html
  http://www.nasa.gov/mission_pages/NPP/main/
- Instrument overviews
  http://npp.gsfc.nasa.gov/viirs.html
  http://npp.gsfc.nasa.gov/cris.html
  http://npp.gsfc.nasa.gov/atms.html
  http://npp.gsfc.nasa.gov/omps.html
  http://npp.gsfc.nasa.gov/ceres.html

Raytheon