National Aeronautics and Space Administration

Satellite Support for Climate Change Studies

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International Telecommunications Union (ITU)

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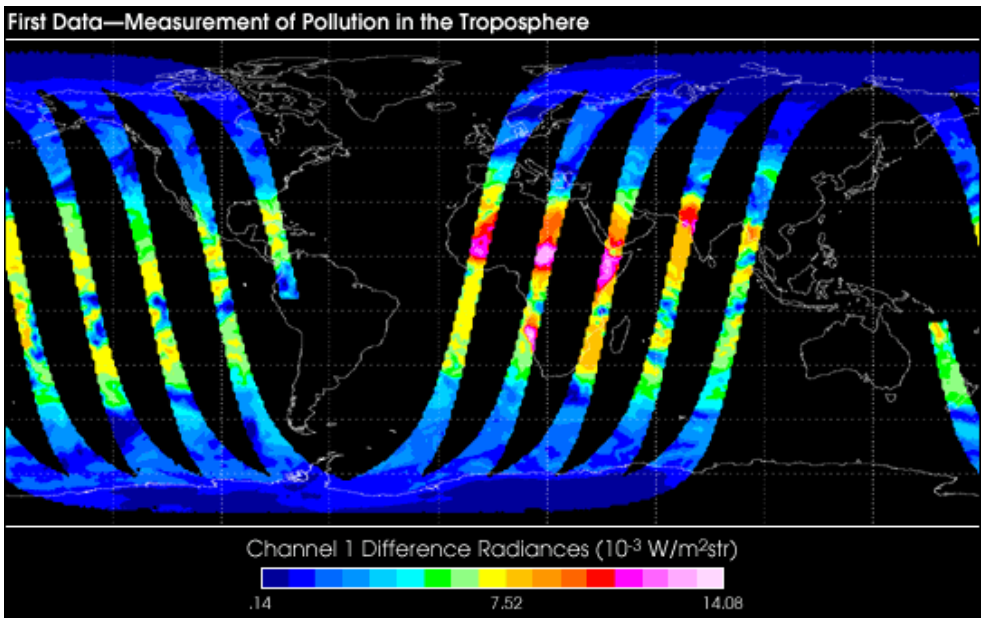
Overview

Satellites provide the only platforms capable of

covering the entire earth (note swaths do not overlap)

with the same instrument

and providing temporal well as spatial coverage.



Further, using the same instrument, rather than copies,

insures consistent data.

Overview

Considering alternative methods –

multiple ground stations,

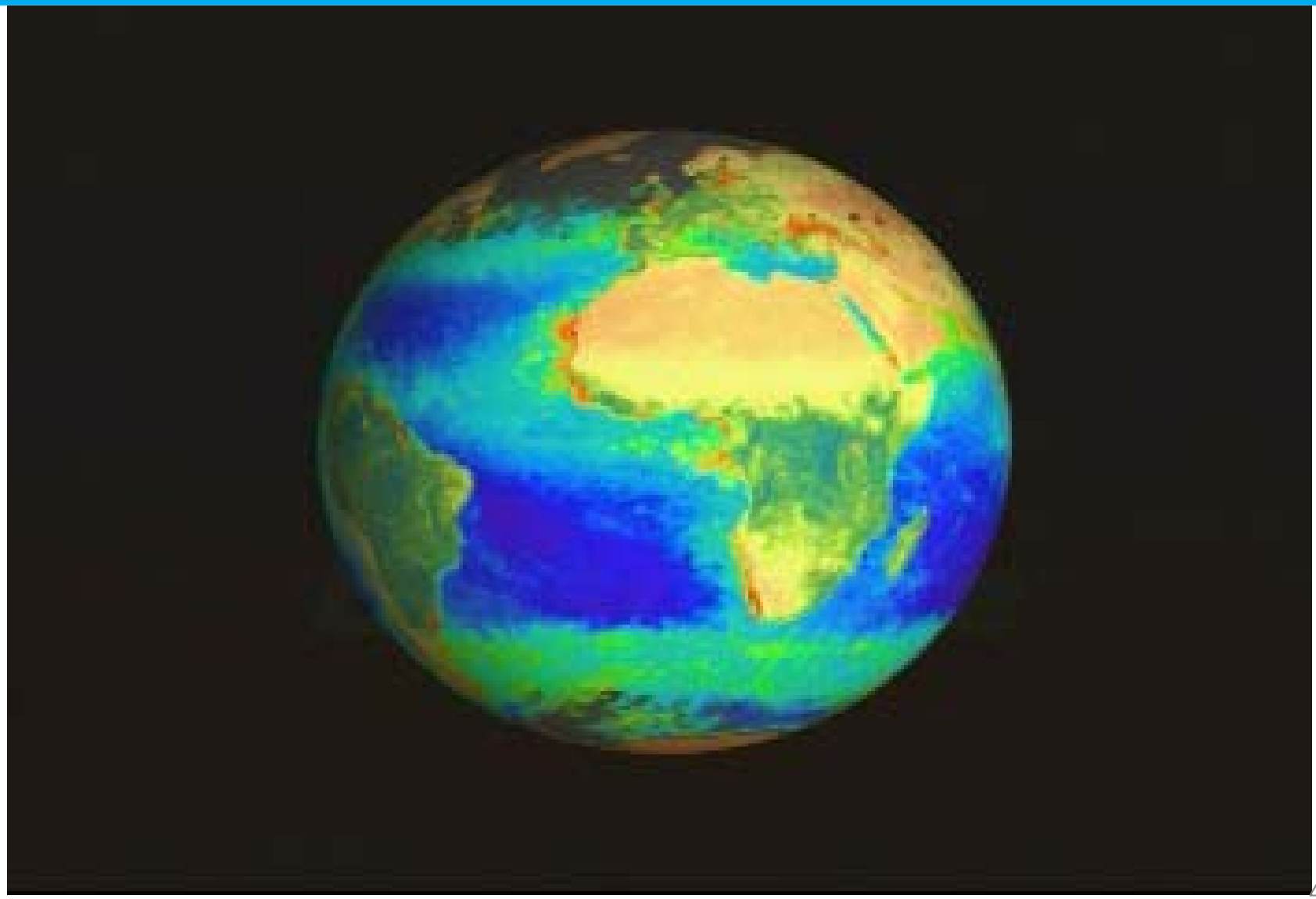
multiple rocket launches,

multiple ships and aircraft on station, etc.-

Satellites are the most cost-effective way of monitoring the state and health of our planet

– without having to constantly cross-calibrate a vast collection of similar, or different, instruments..

Overview



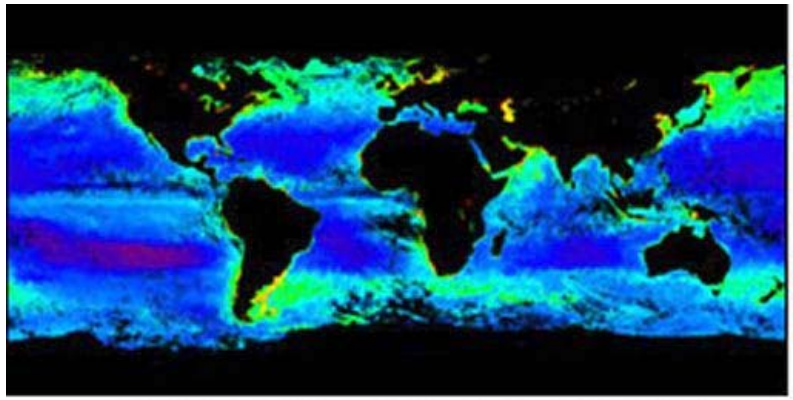
Overview

Examples shown previously include:

- Biosphere production
- Aerosols
- Radiant Energy
- Air Pollution
- Temperature
- Water Vapour

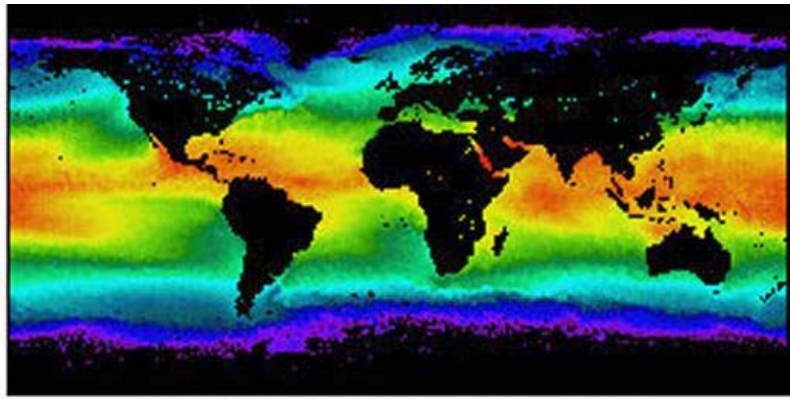
There are others; all pertinent to monitoring the state, and the health, of our planet.

Satellites Monitor Parameters Globally



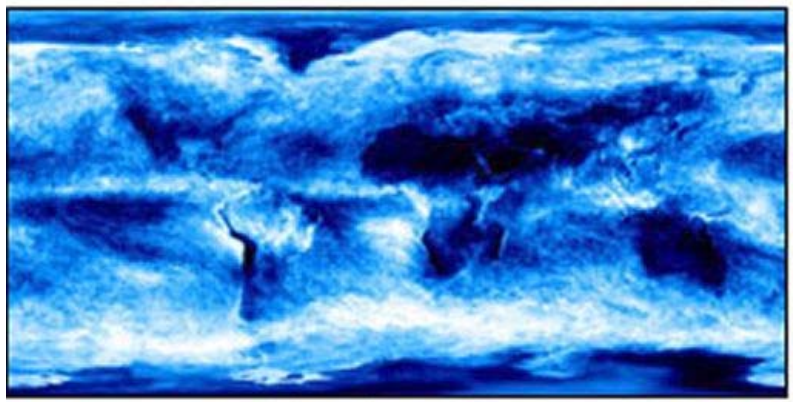
Chlorophyll Concentration (mg/m³)

.01 .03 .1 .3 1 3 10 30 60



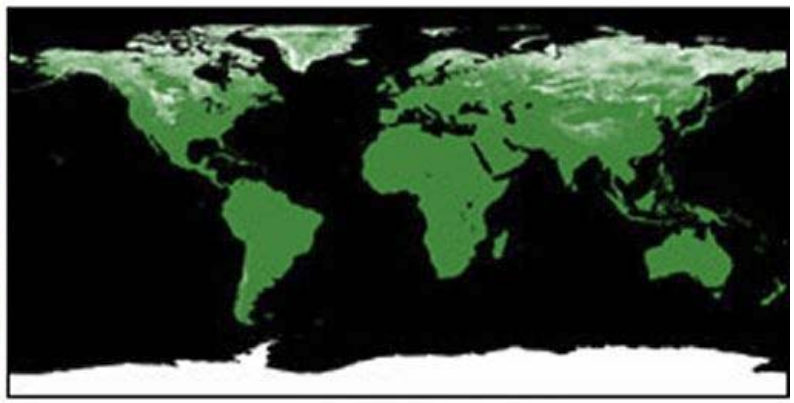
Sea Surface Temperature (°C)

-2 45



Cloud Fraction

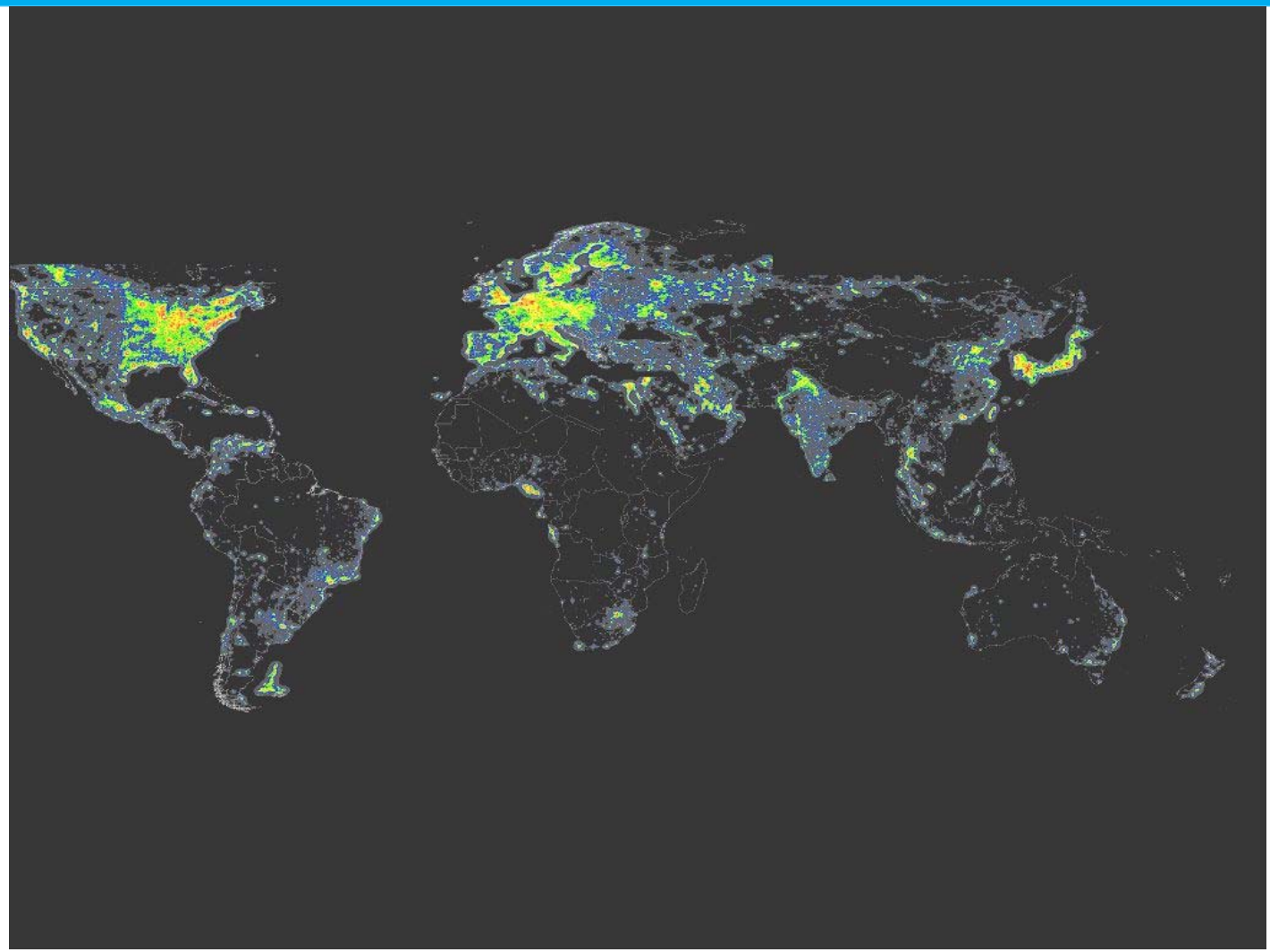
0.0 0.2 0.4 0.6 0.8 1.0



Snow Cover (%)

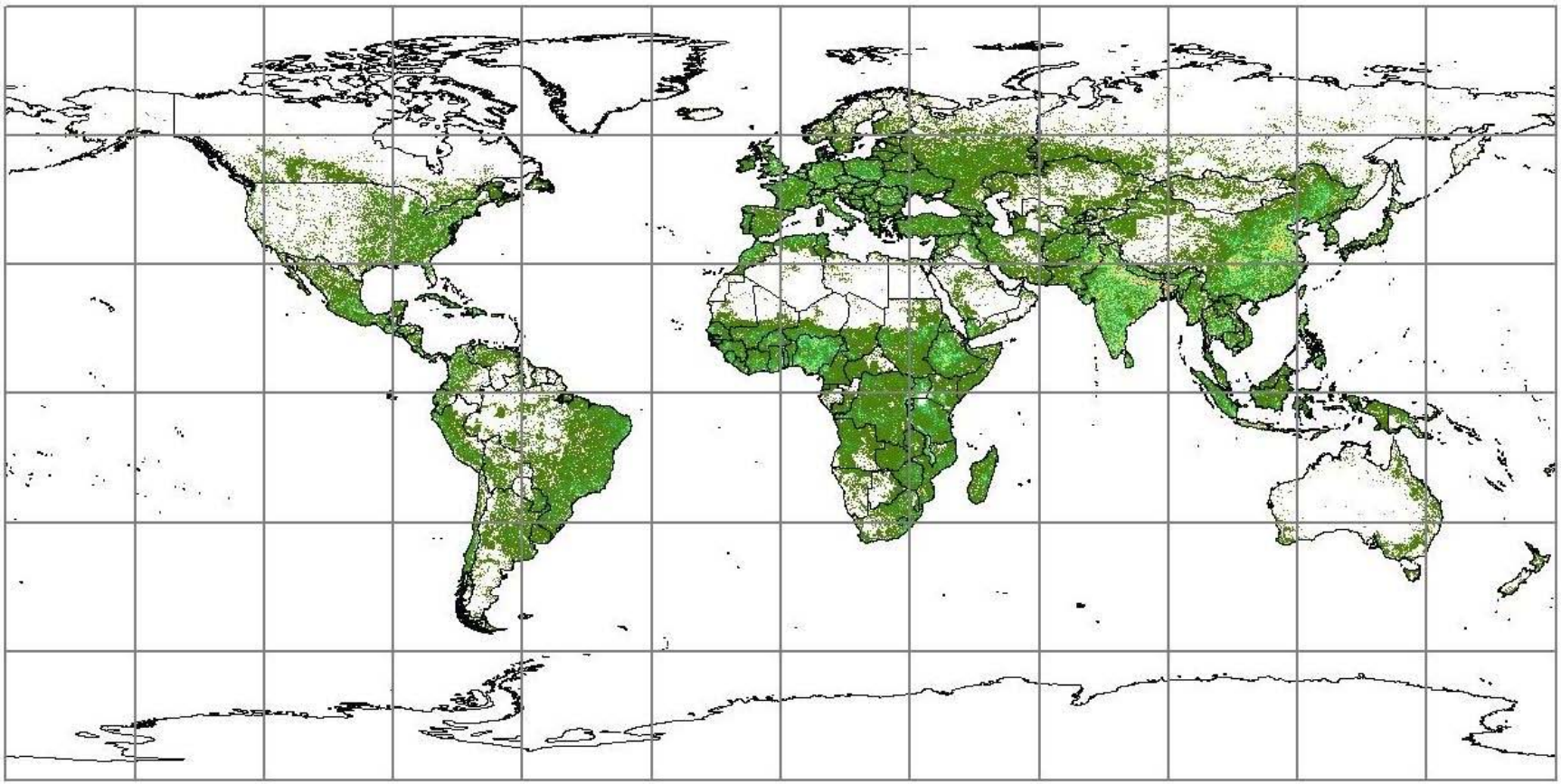
0 20 40 60 80 100

Population Monitoring



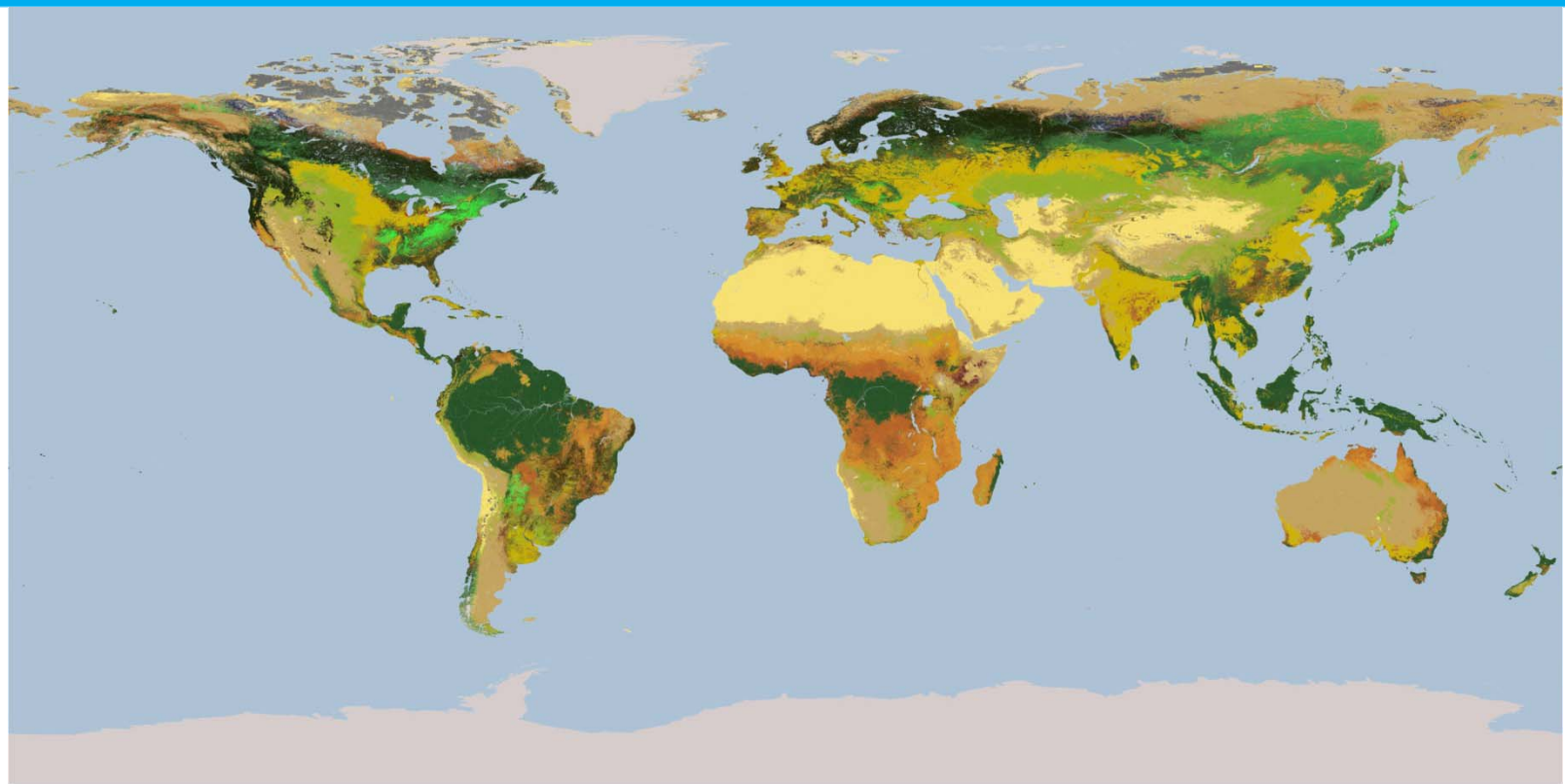
Night lights visible from space indicate populated areas

Population Monitoring



Population model based on proximity to roads, slope*, land cover*, nighttime lights*, and other information. (*from satellite data)

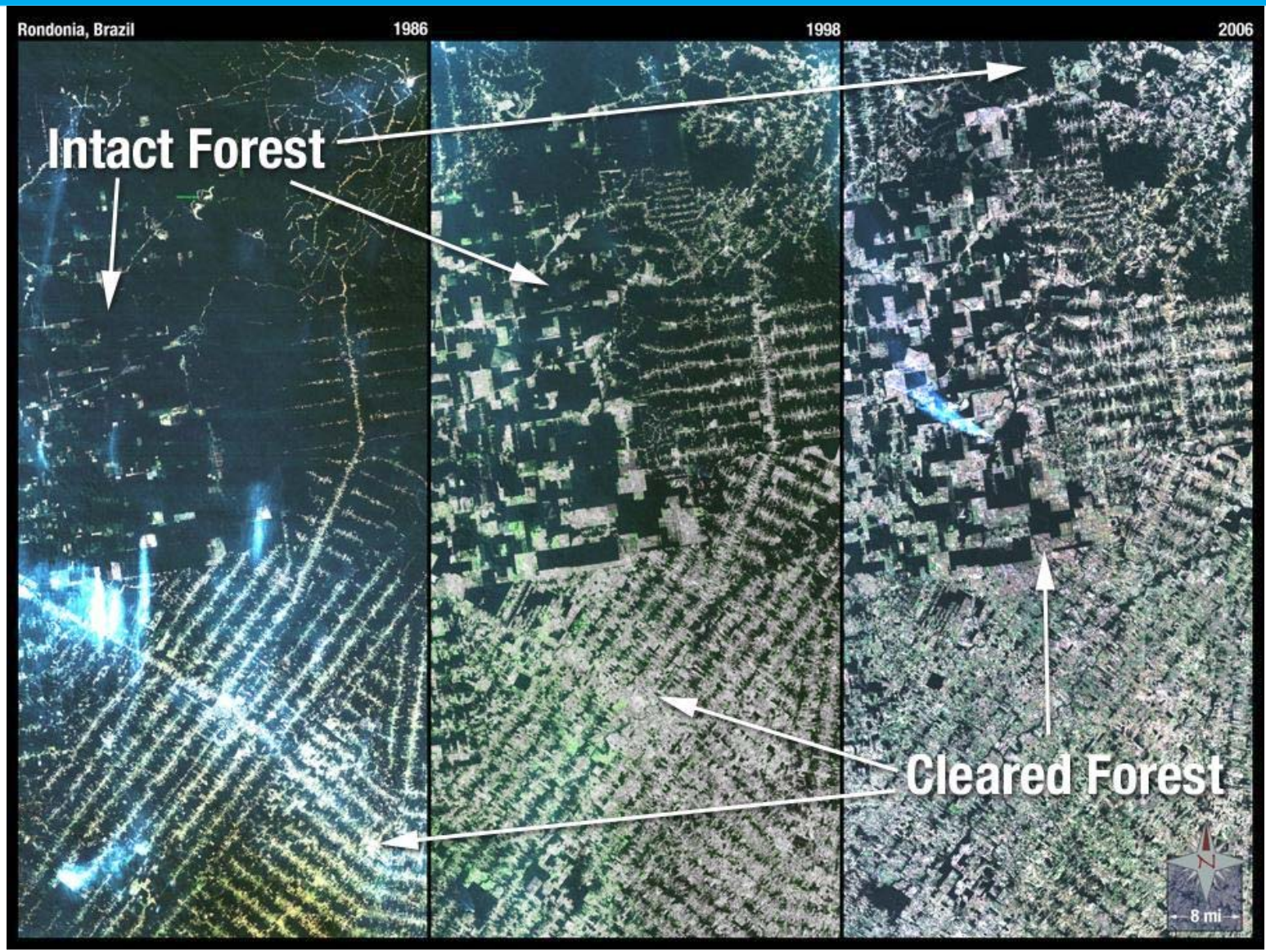
Satellite-Derived Land Usage



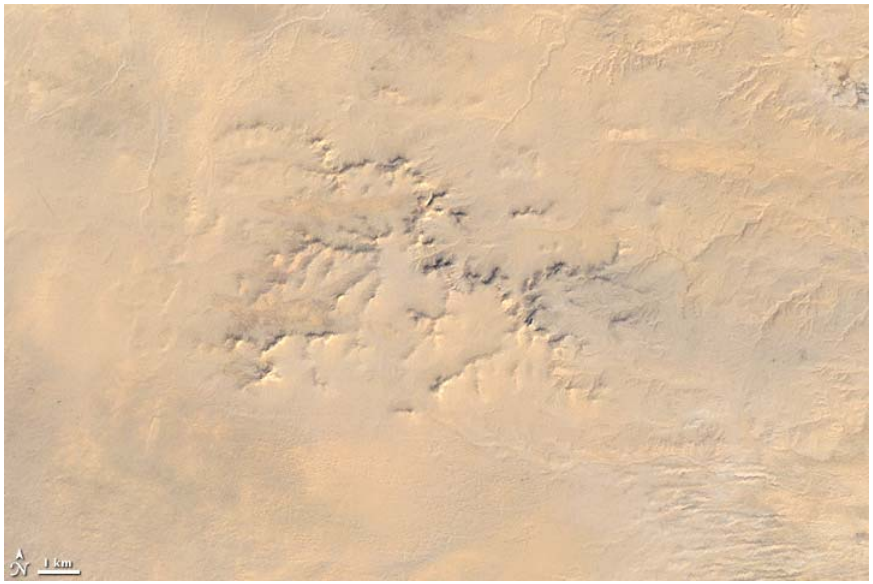
- 0 Water
- 1 Evergreen Needleleaf Forest
- 2 Evergreen Broadleaf Forest
- 3 Deciduous Needleleaf Forest
- 4 Deciduous Broadleaf Forest
- 5 Mixed Forests
- 6 Closed Shrublands
- 7 Open Shrublands
- 8 Woody Savannas
- 9 Savannas
- 10 Grasslands
- 11 Permanent Wetlands
- 12 Croplands
- 13 Urban and Built-Up
- 14 Cropland/Natural Veg. Mosaic
- 15 Snow and Ice
- 16 Barren or Sparsely Vegetated
- 17 Tundra

Seasonal Land Cover Change

Deforestation



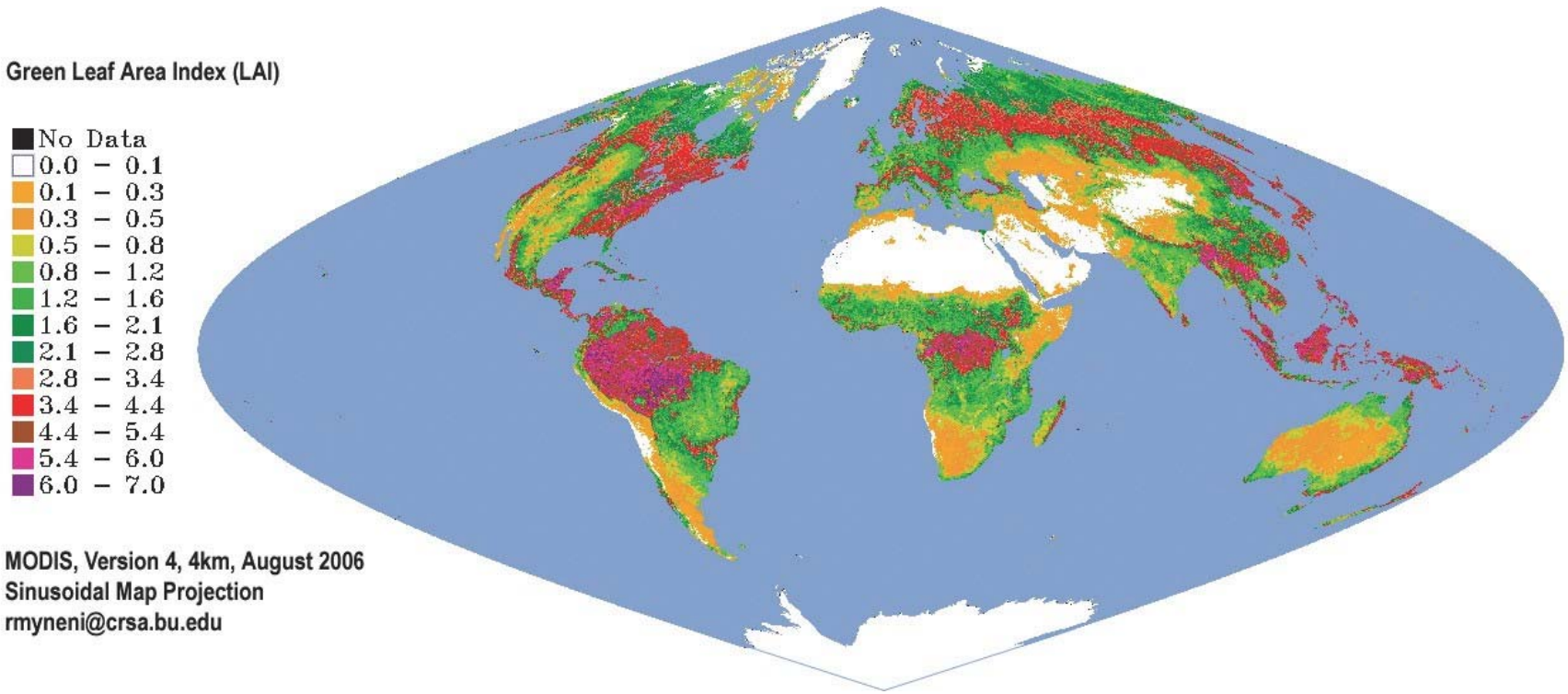
Desertification Reversed



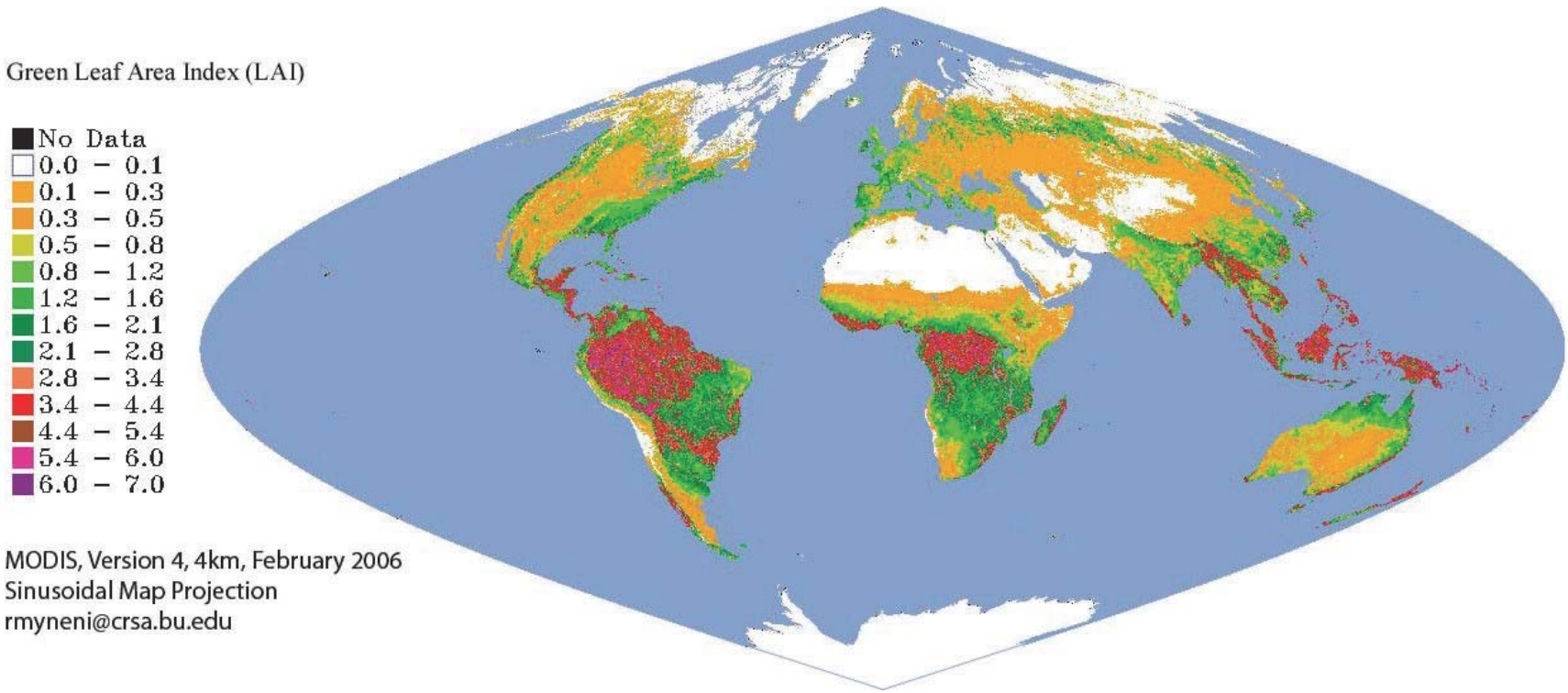
1987 – Drought, agriculture and overgrazing pushed an area towards desertification.

1999 – Sidi Toui National Park (Tunisia) established in 1993 and fenced, native Grassland revived (winter image).

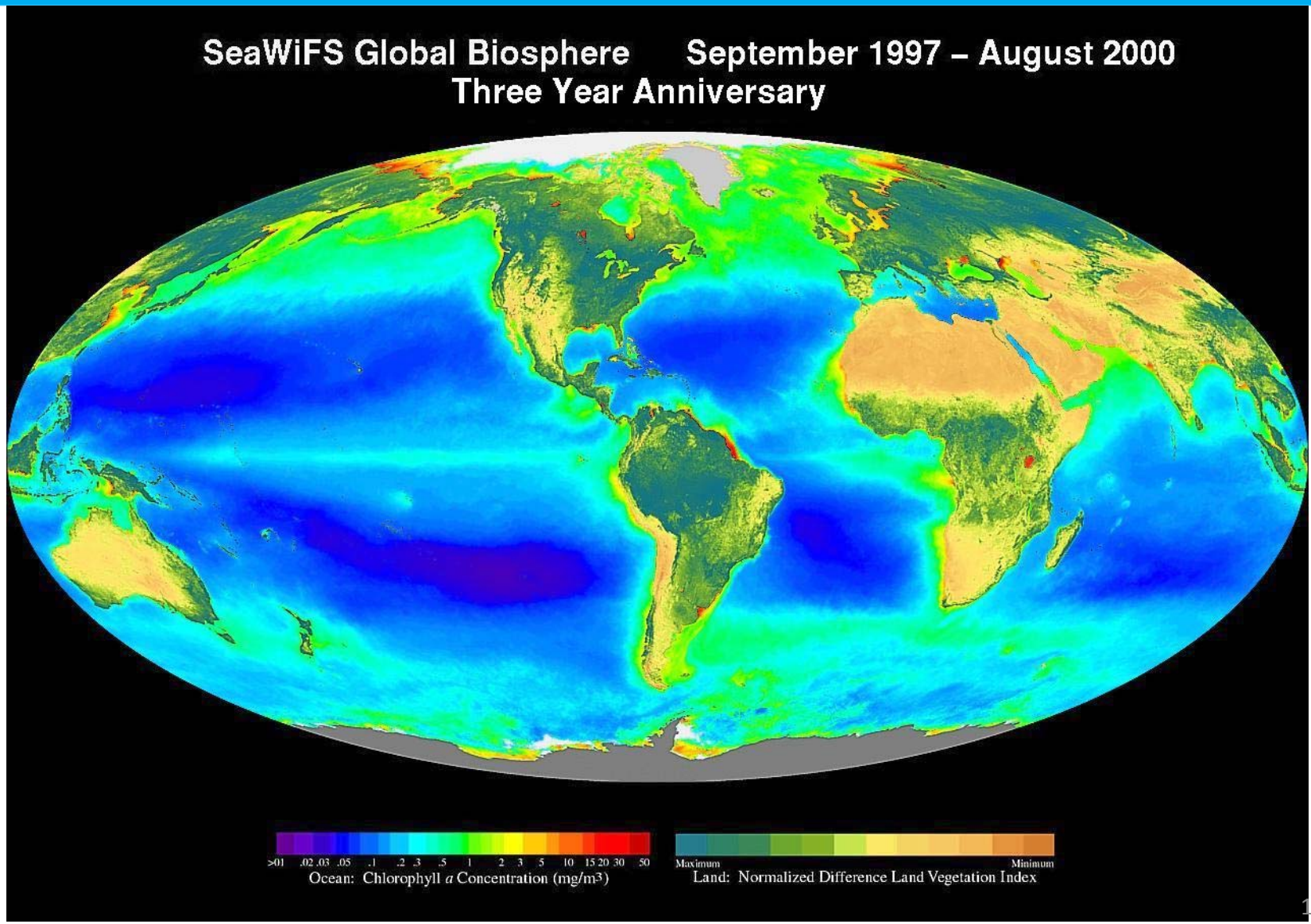
Plant Health - August



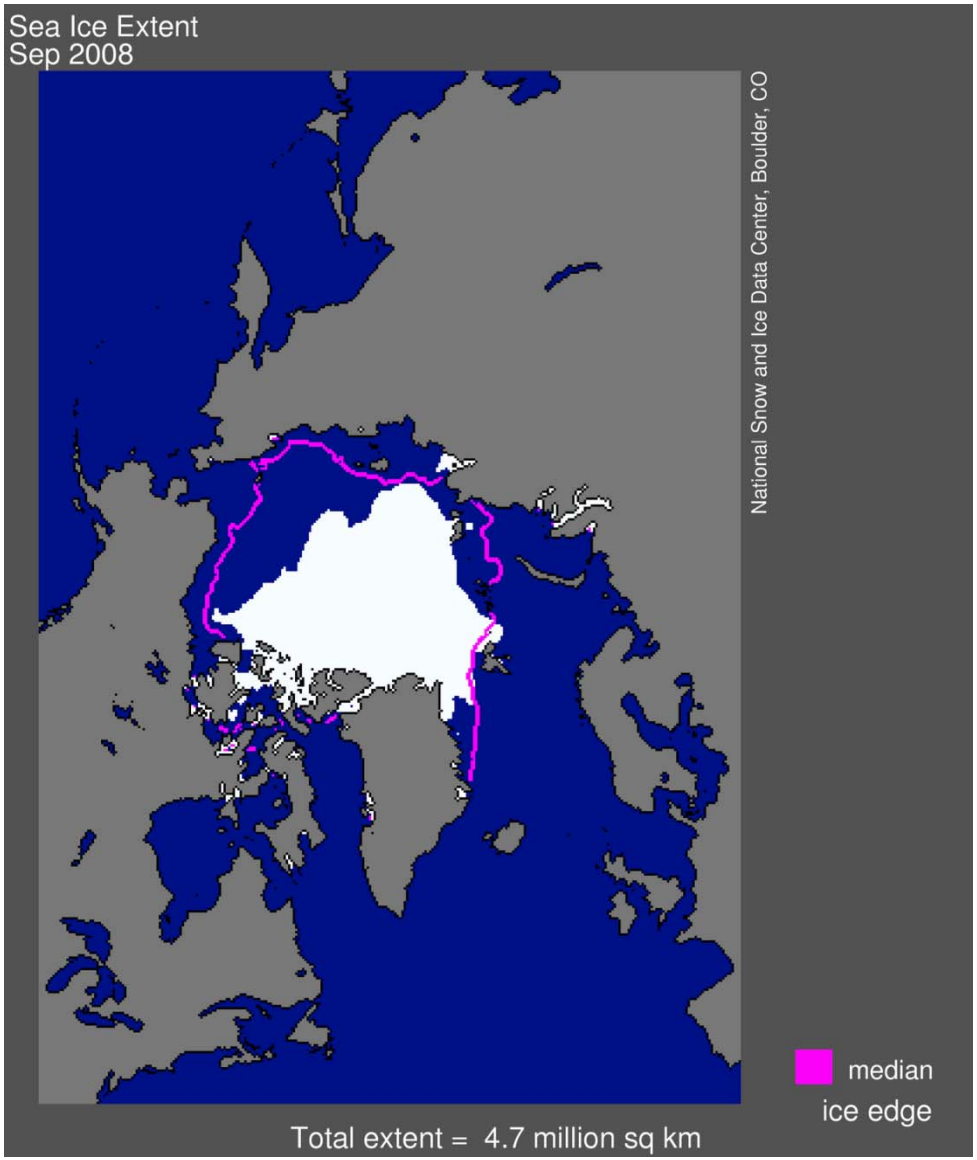
Plant Health - February



Biosphere Productivity

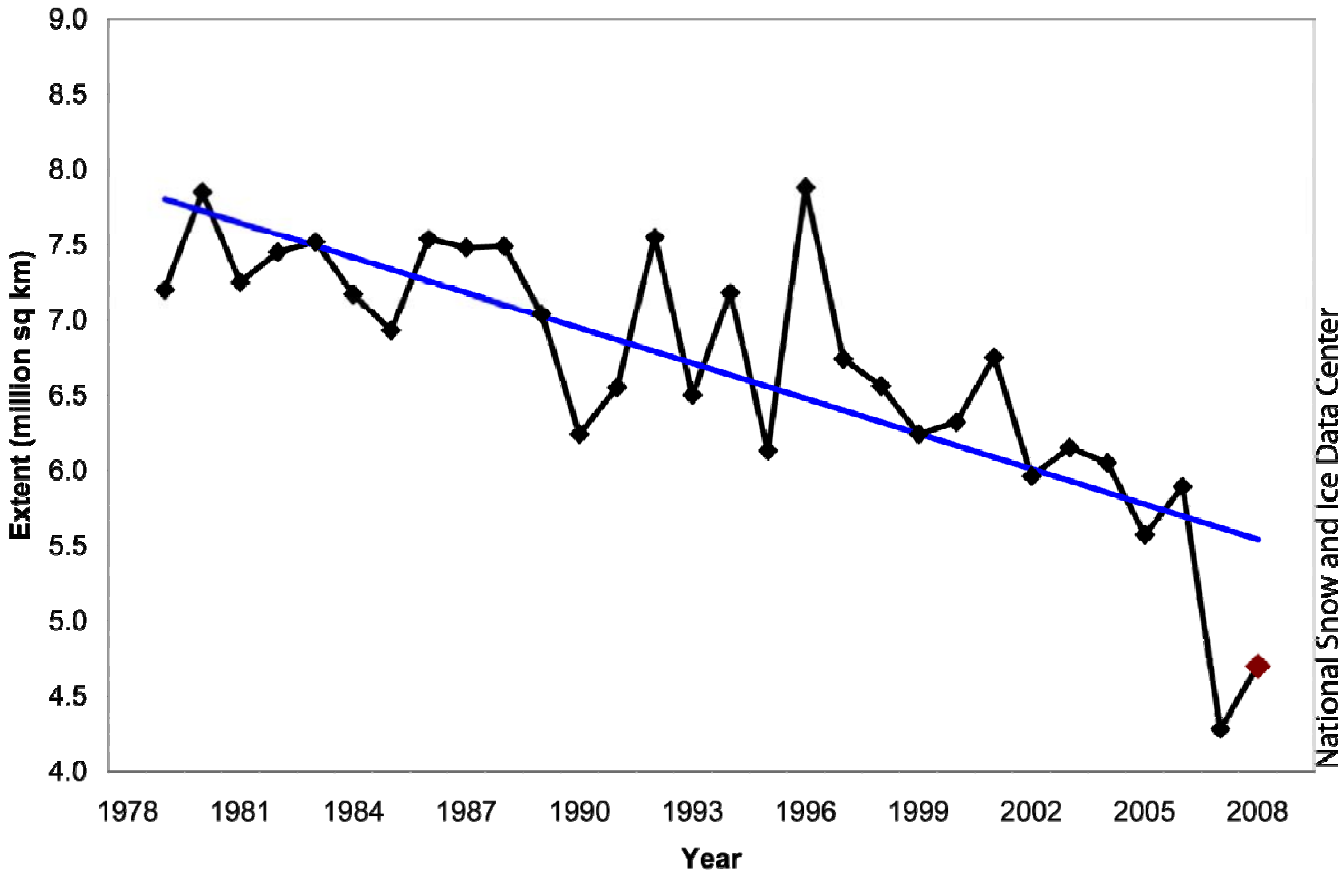


Arctic Sea Ice Mapping



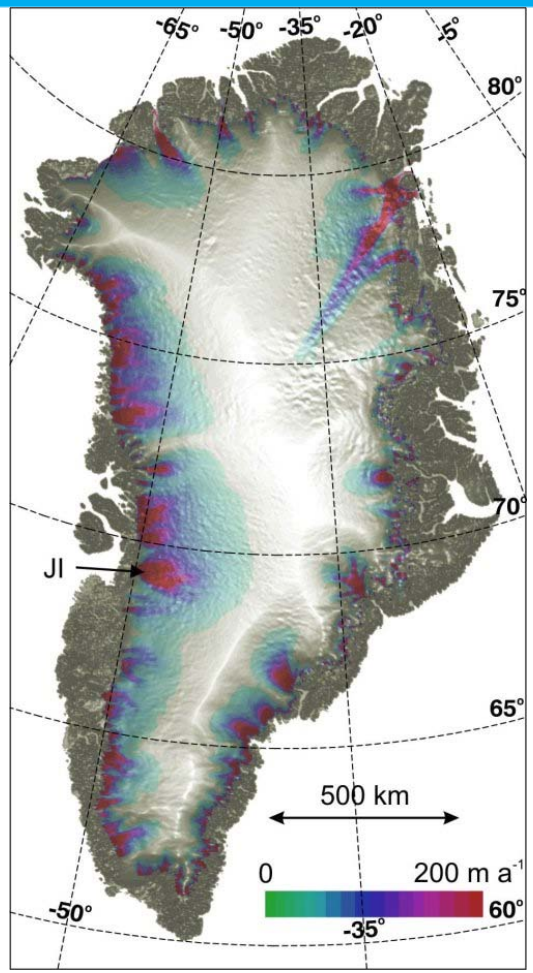
Daily Arctic Sea Ice – Summer 2009

Arctic Sea Ice Trends



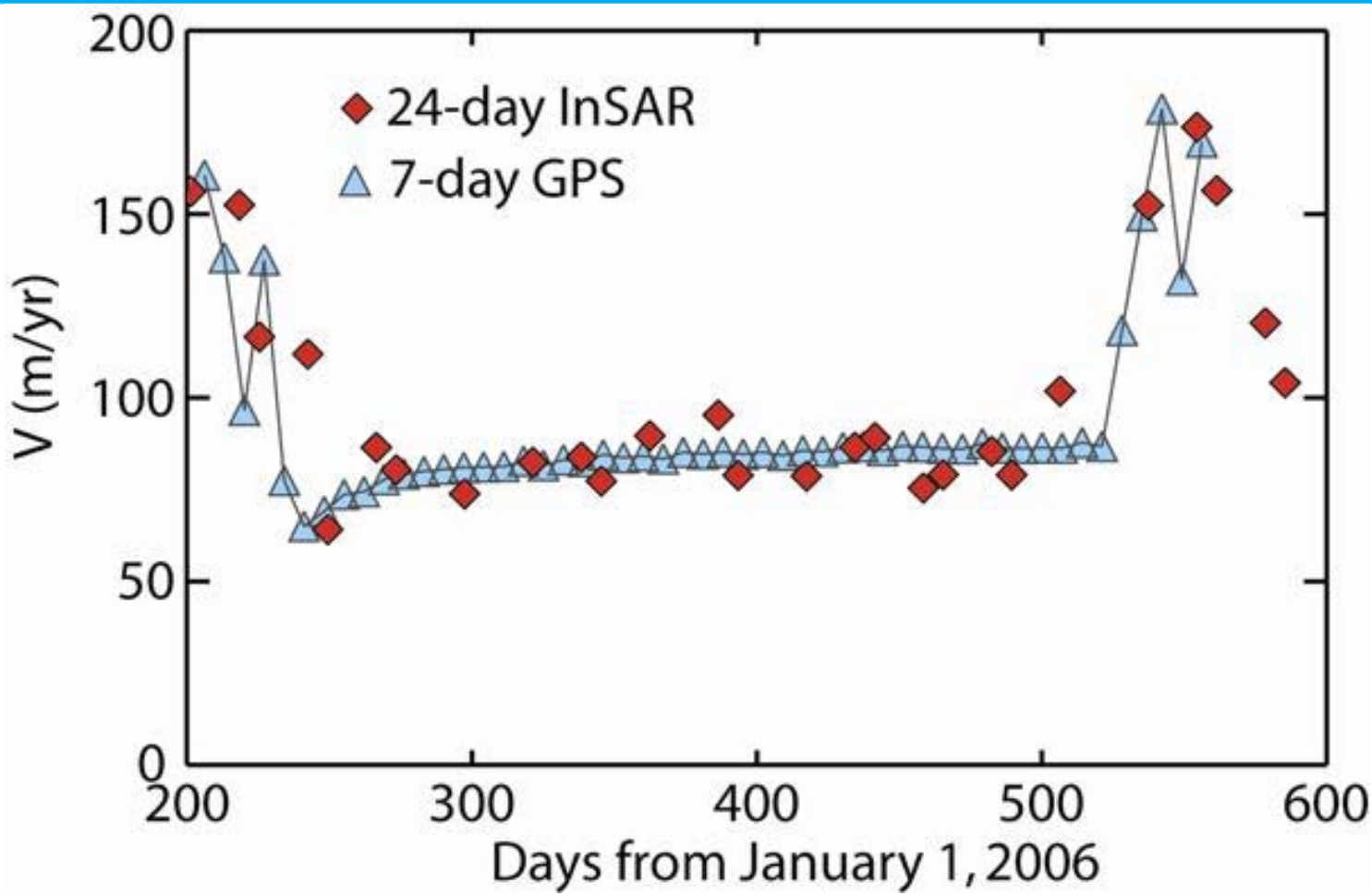
Seasonal Minimum Arctic Sea Ice Extent

Greenland's Ice Fields



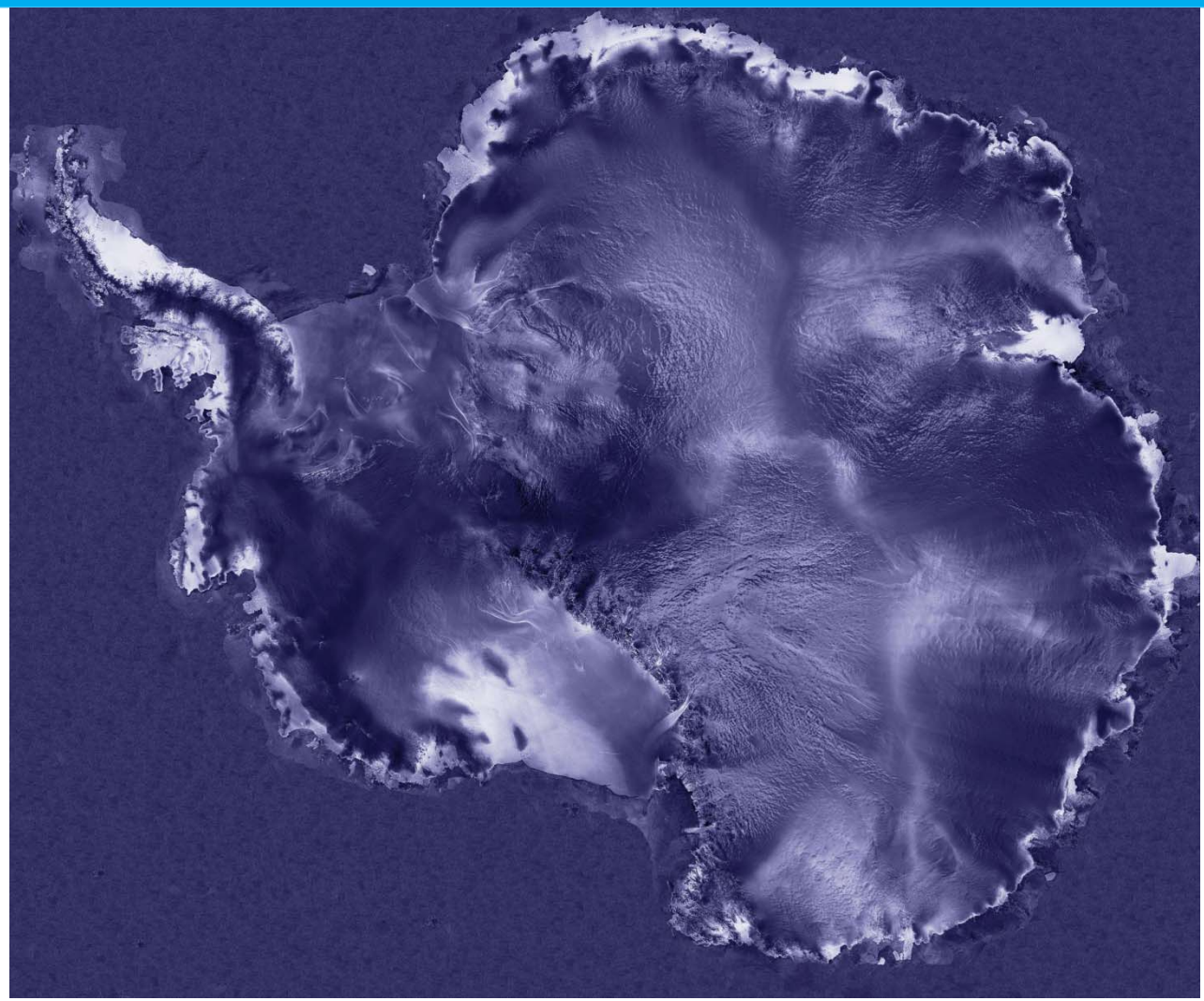
Greenland's ice fields have also been mapped and its ice flows identified – with satellite-borne Radar

Monitoring Greenland's Ice Flow



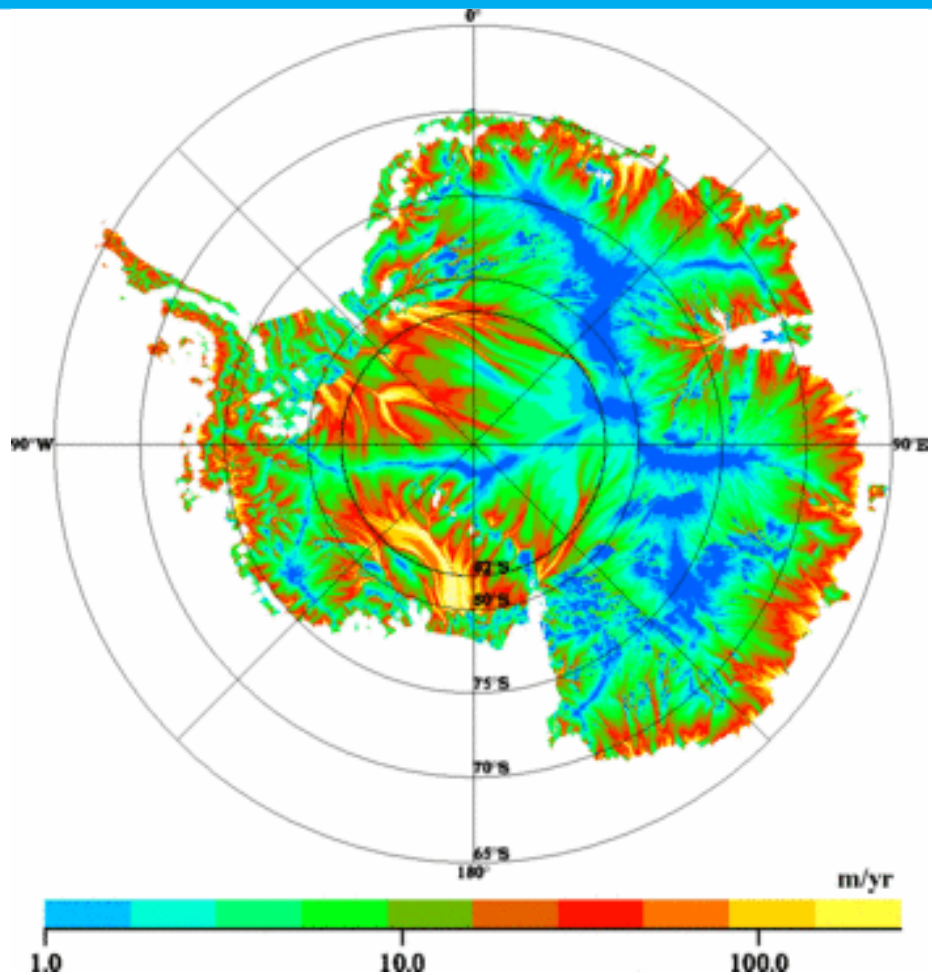
Satellite Radar Techniques are Confirmed by GPS on-ice Measurements

Antarctic Ice Cap Map



RADARSAT produced the first image of all of Antarctica

Antarctic Ice Cap Flows

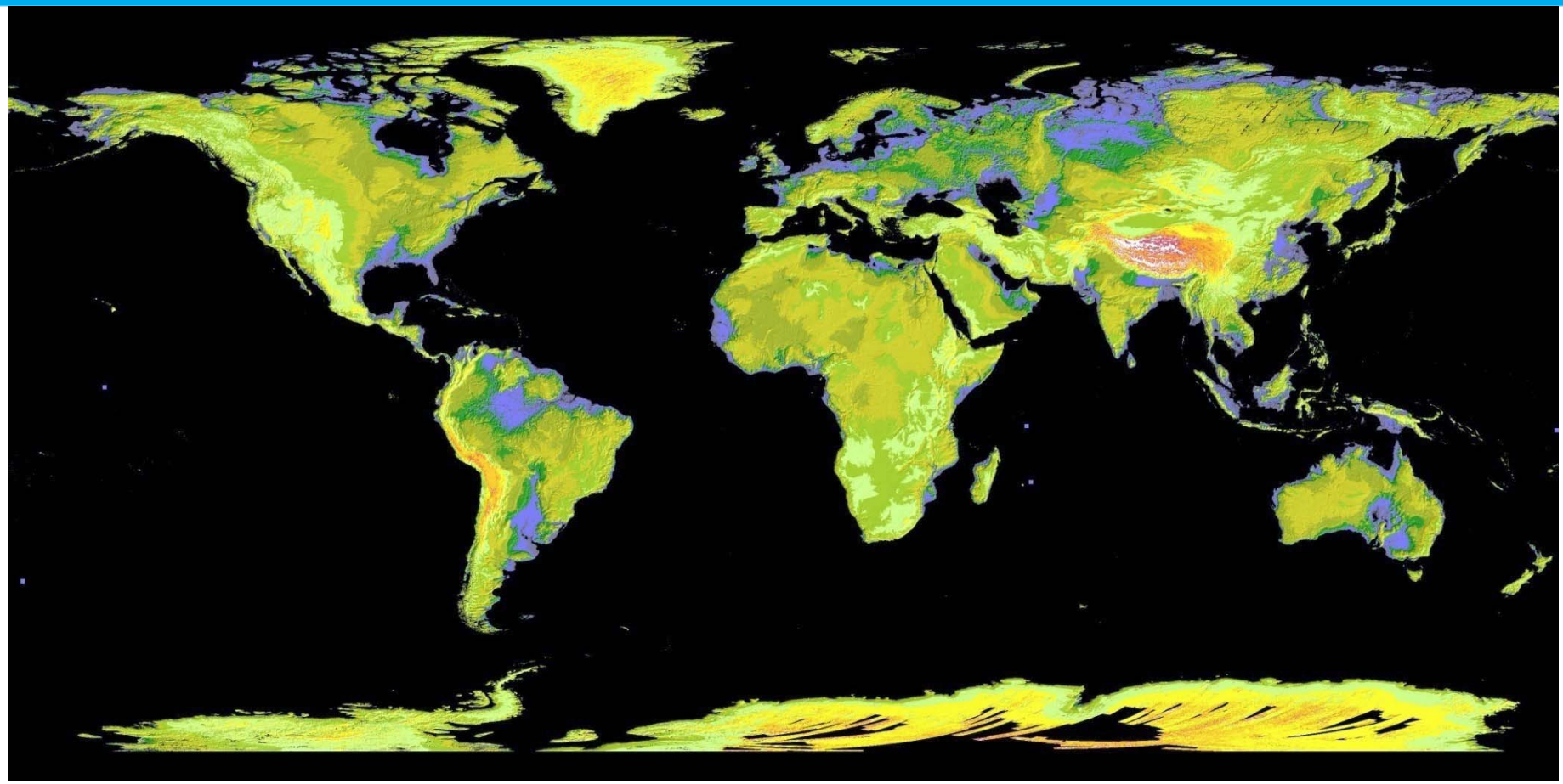


Additional Observations produced Ice flow Maps

Global Topology – Areas at Risk

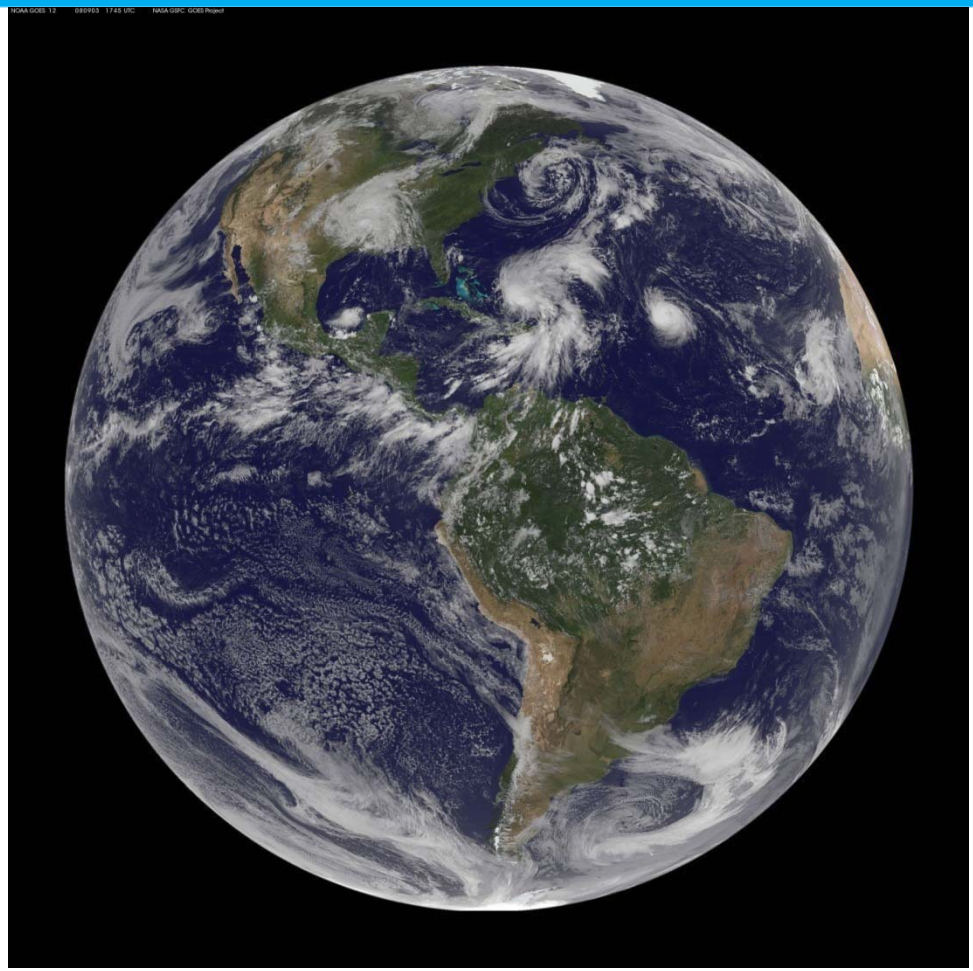
Shuttle Radar Topology Mission covered between +/- 60° latitude and penetrated most of the vegetation and all of the clouds.

Global Topology – Areas at Risk



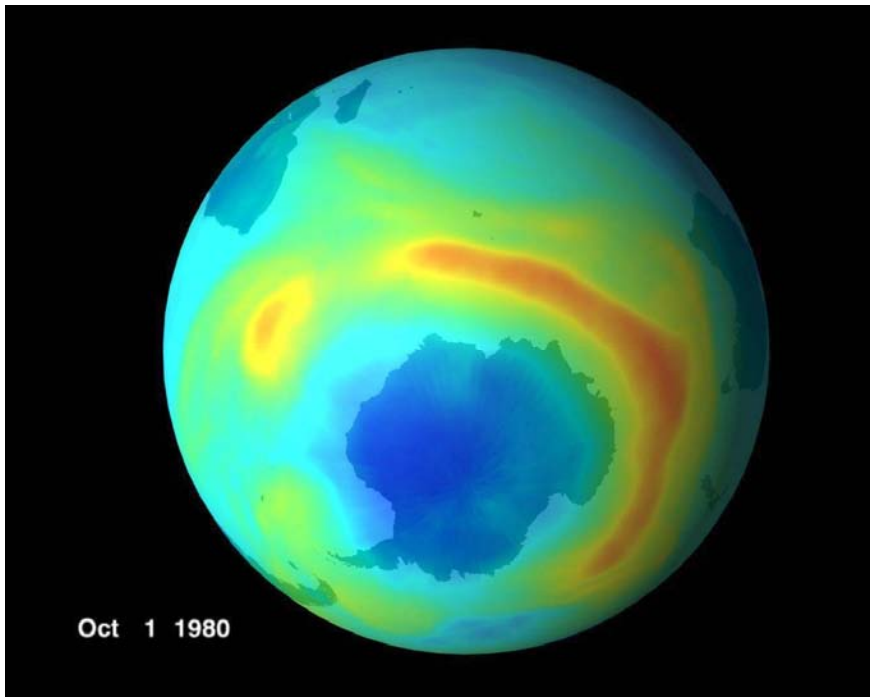
ASTER on TERRA covered between +/- 83° latitude
but did not penetrate vegetation or clouds.

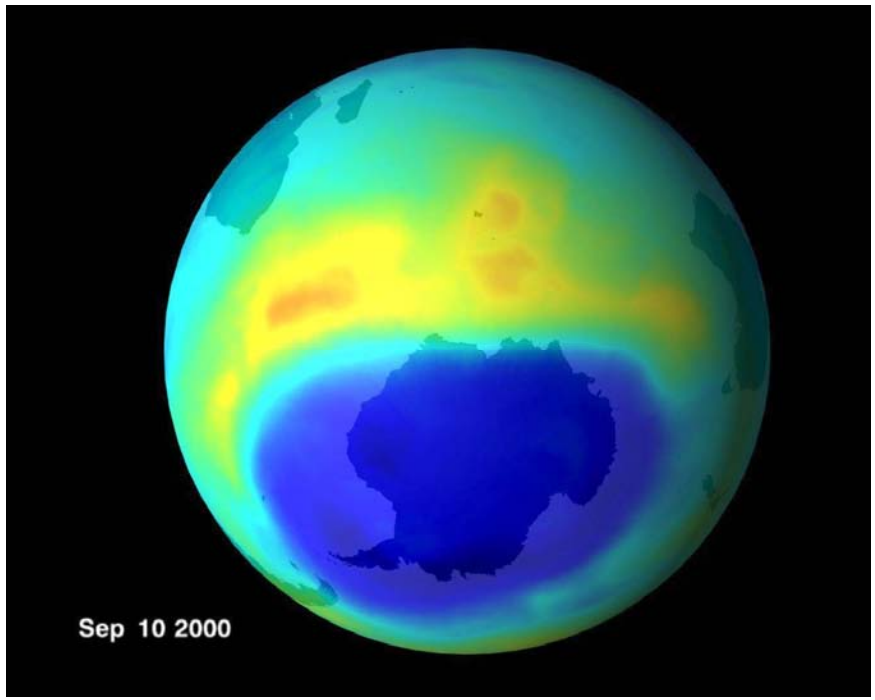
Weather Prediction and Climate Variables



Geosynchronous Weather Satellites
Track Weather Systems worldwide

Ozone – Action Needed

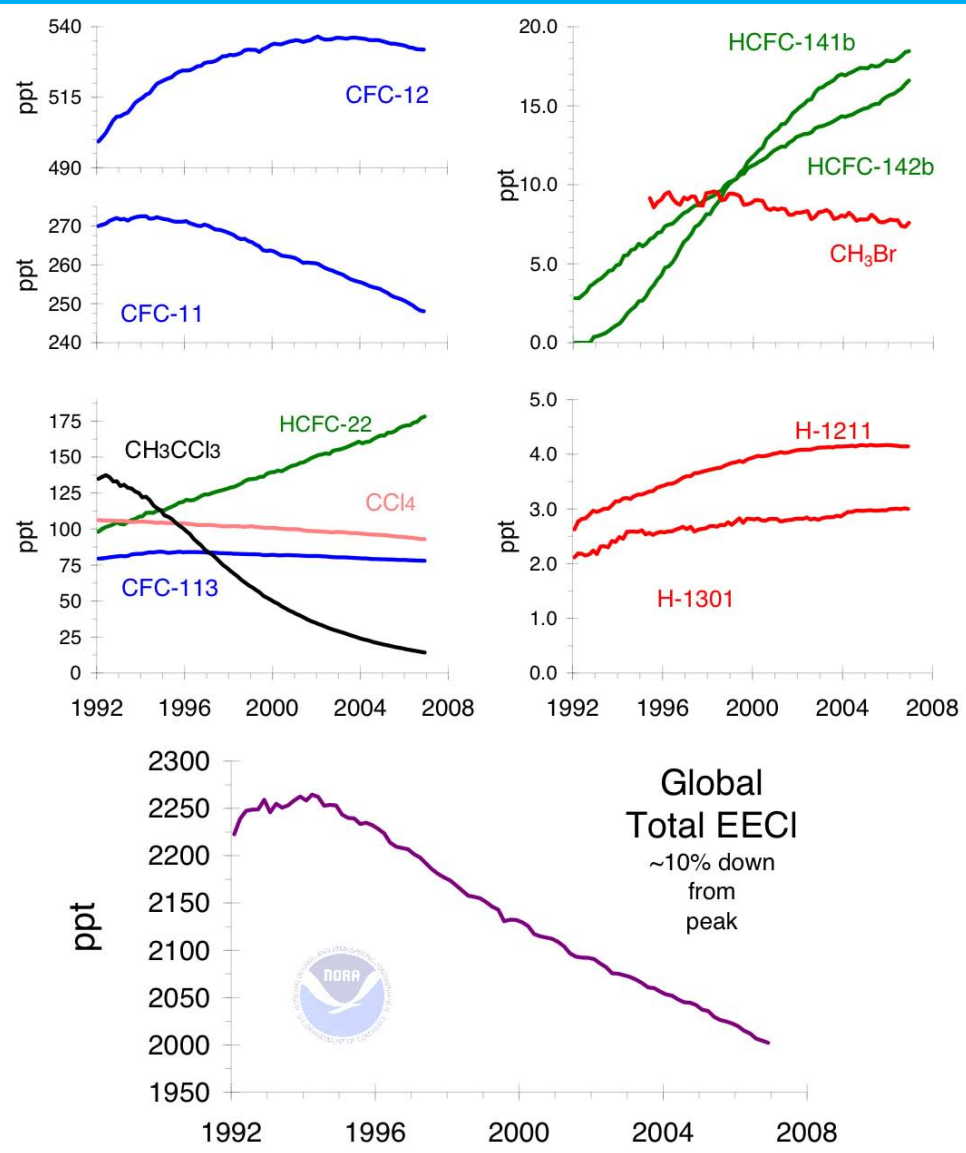




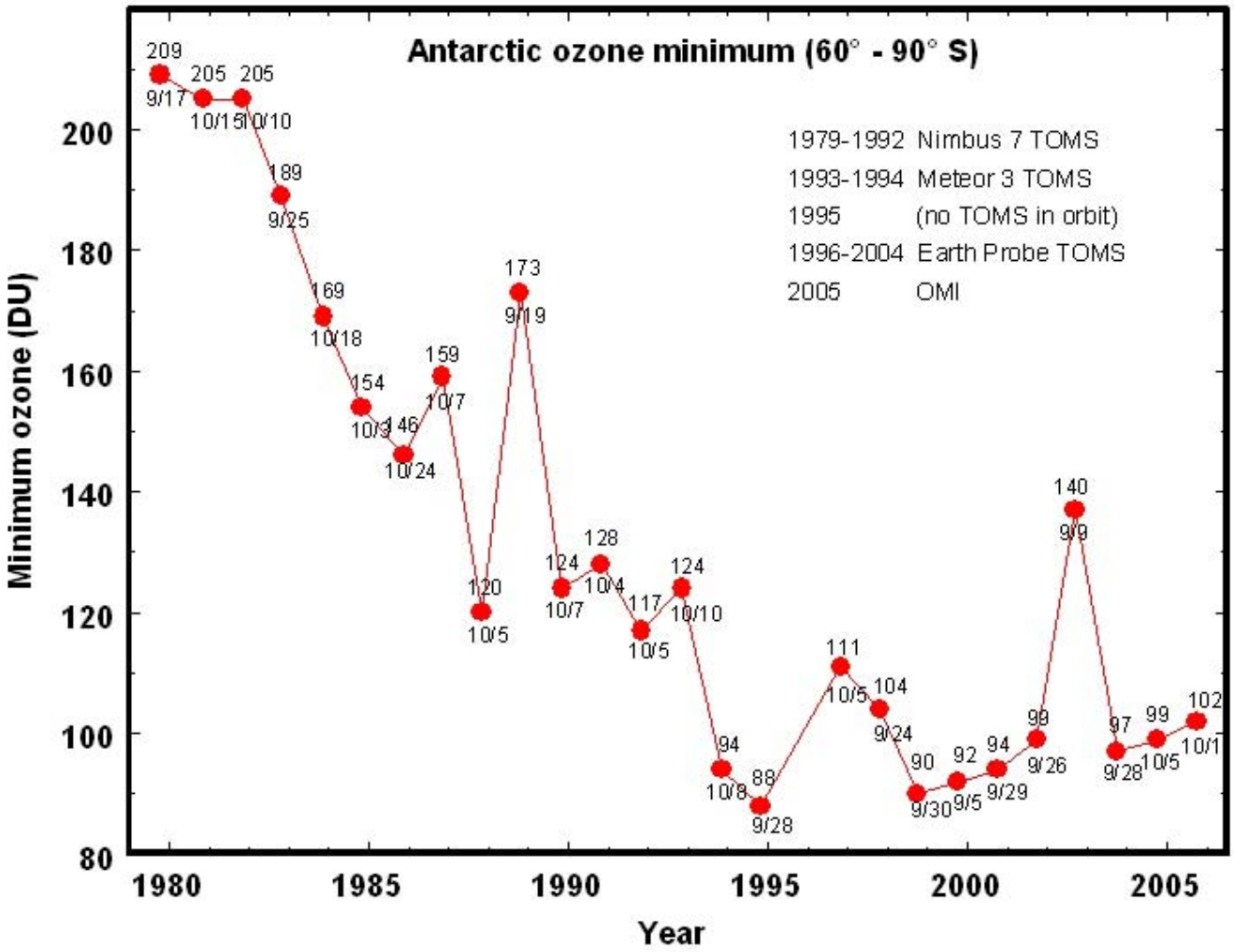
A Growing Antarctic Ozone “hole” admitted more UV to the Southern Hemisphere

Ozone – Action Taken

The Montreal Protocol, effective Jan. 1, 1989, reduced global CFC production



Ozone – Results



Summary

Satellites provide data necessary
to monitor environmental change
over the entire globe,
including climate change.

Radio Spectrum is required
to return data from
ALL environment-monitoring satellites,
regardless of their instrumentation.

Radio Spectrum
is necessary to provide **unique** observations
of some environmental parameters and
is **critical** to monitoring polar regions.