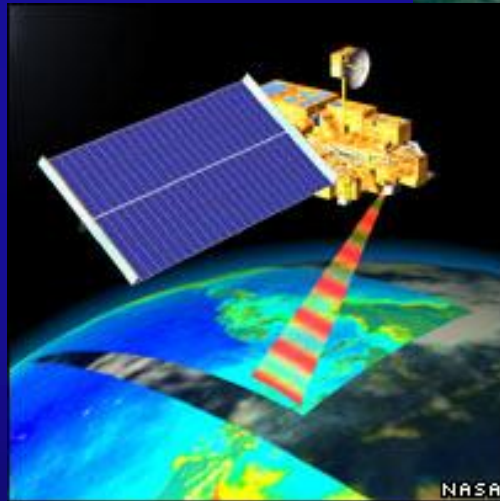# Remote Sensing for the Circumboreal Vegetation Map

Dave Selkowitz, US Geological Survey, Alaska Science Center

Presentation Overview

- **Role of remote sensing in large area vegetation mapping projects**

- **MODIS Overview**

- **Canadian Center for Remote Sensing (CCRS) MODIS Products**

- **Additional MODIS products**

- **Additional remote sensing resources**

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Role of Remote Sensing

- **Remote sensing is crucial for large area vegetation mapping projects such as the Circumpolar Arctic Vegetation Map and the Circumboreal Vegetation Map**

- **Mappers have two tasks:**
  - **Identify distinct units (polygons)**
  - **Provide descriptive labels for these units**

- **Remote sensing provides images that allow both of these tasks to be performed**

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Role of Remote Sensing for the Circumpolar Arctic Vegetation Map

- **AVHRR imagery was used for the CAVM base map**
  - **3 spectral bands**
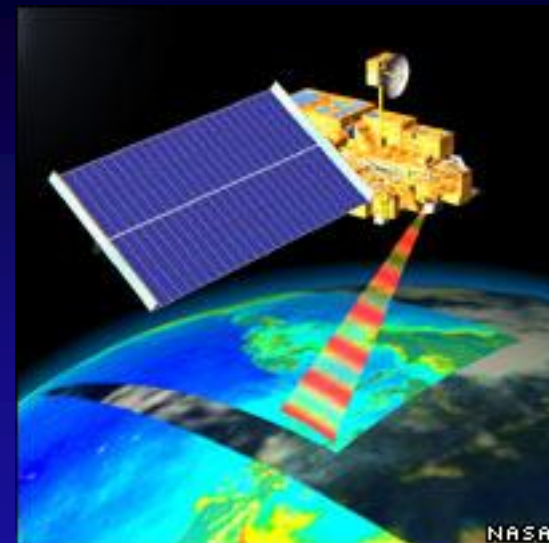 - **1000 meter spatial resolution**

180°
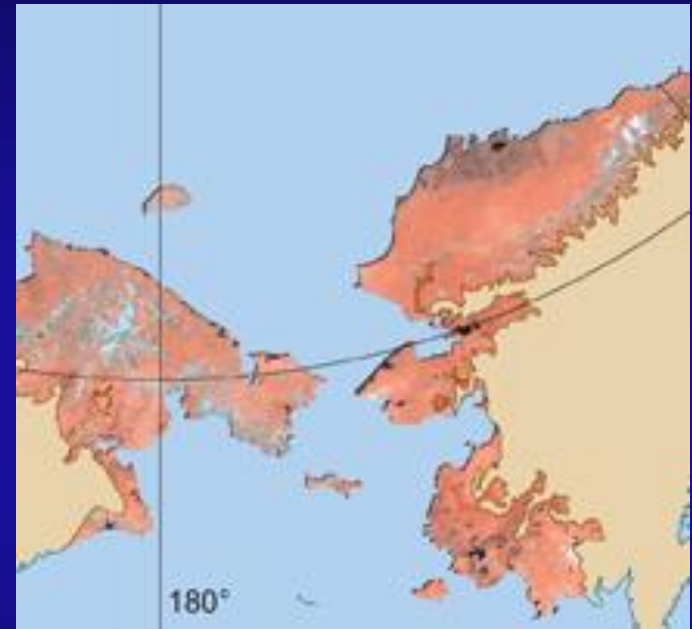
MODIS for the CBVM

- **MODIS is similar to but superior to AVHRR**
- **MODIS provides the best combination of coverage (daily), spatial resolution (250-500 m), spectral bands (7 bands useful for land mapping), and access (free and available to everyone)**
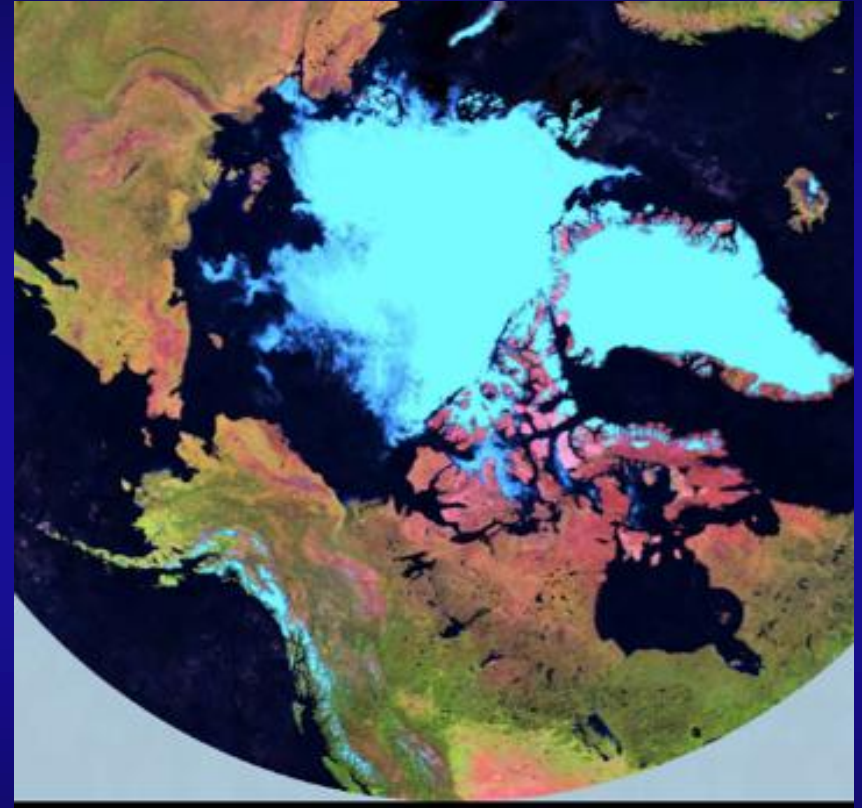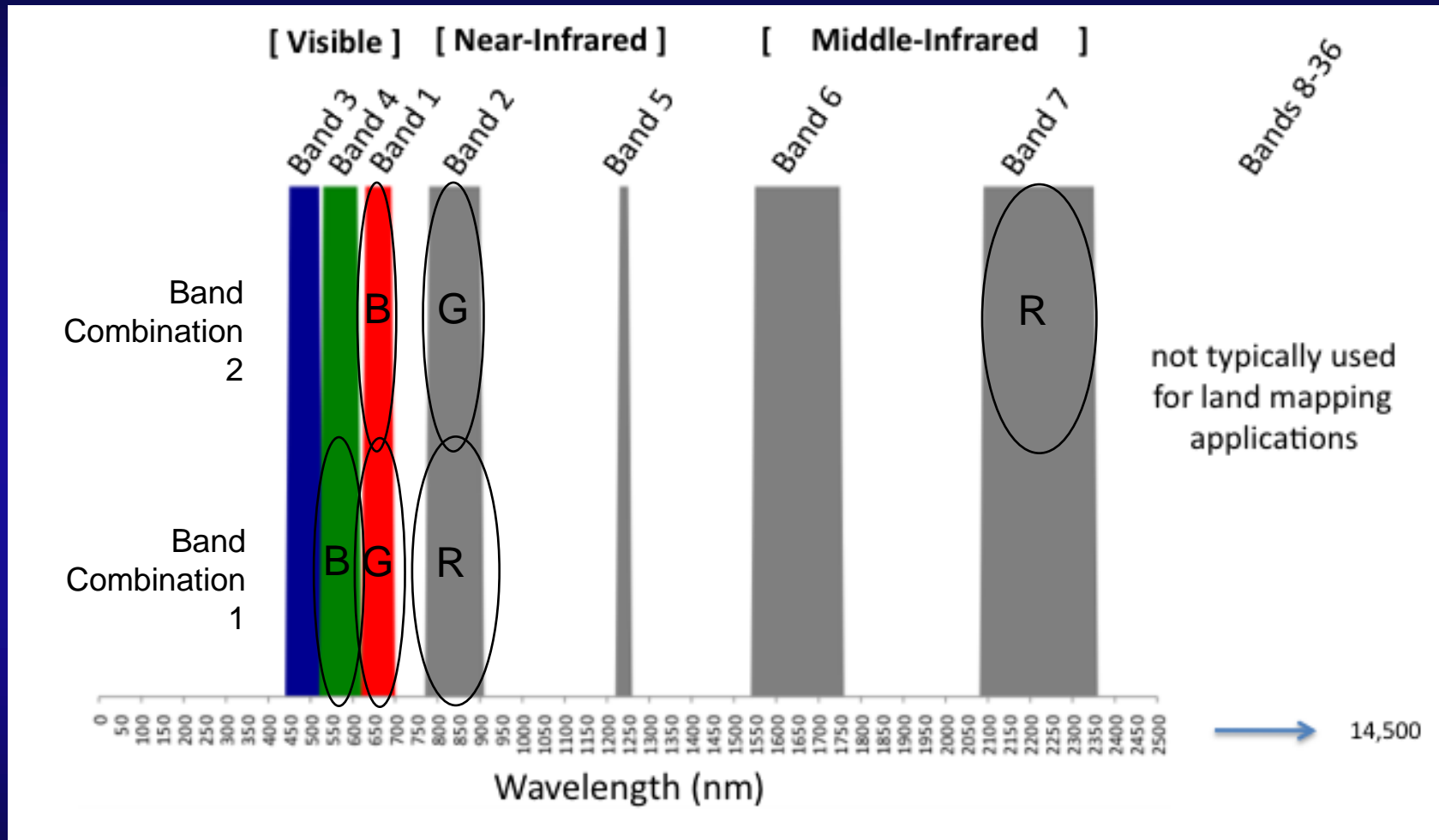
MODIS Overview

- **MODIS: the Mod**erate Resolution **I**maging **S**pectroradiometer
- **Part of NASA's Earth Observing System**
- **Onboard both the Terra and Aqua spacecraft**
  - **Terra launched December 18, 1999**
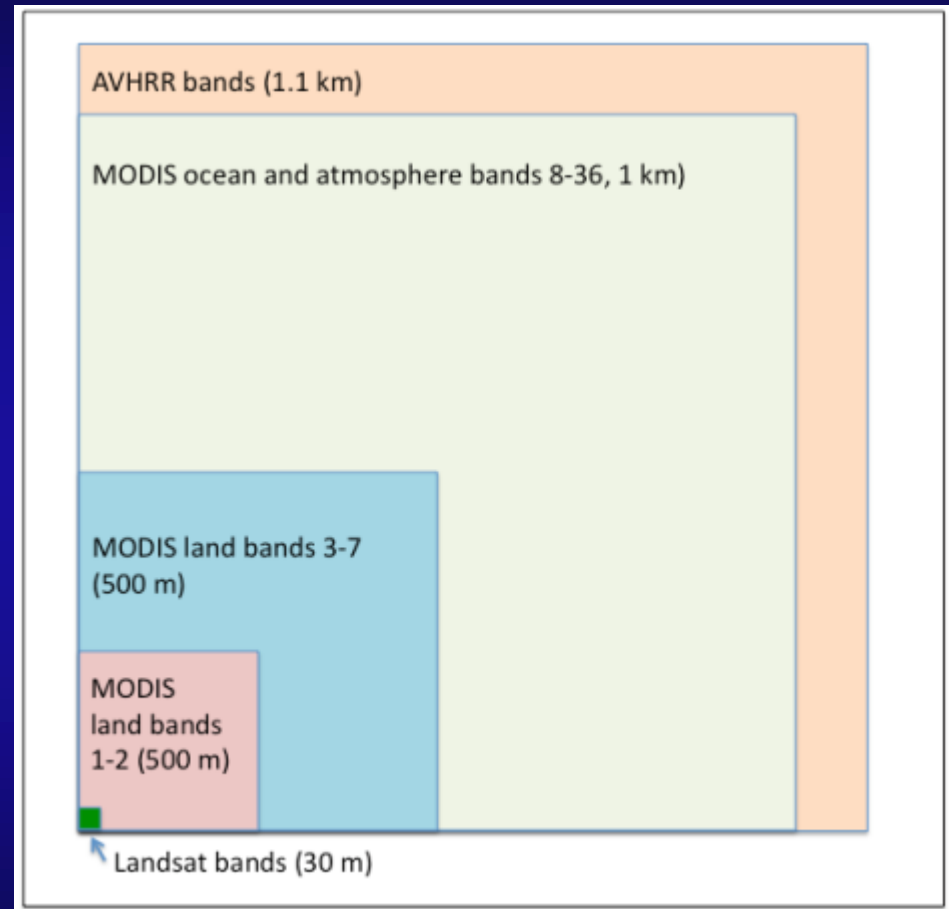 - **Aqua launched May 4, 2002**
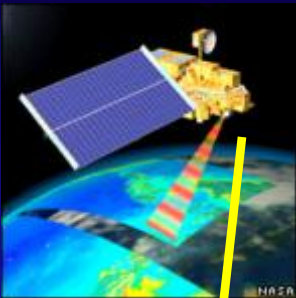
MODIS Overview: Spectral Bands
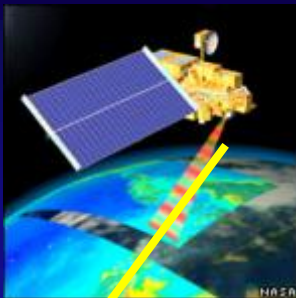
MODIS Overview: Spatial Resolution

- **Bands 1 (red) and 2 (NIR) at 250 m**

- **Bands 3-7 at 500 m**

- **CCRS MODIS product resamples all bands to 250 m spatial resolution**

AVHRR bands (1.1 km)

MODIS ocean and atmosphere bands 8-36, 1 km)

MODIS land bands 3-7 (500 m)

MODIS land bands 1-2 (500 m)

Landsat bands (30 m)

MODIS Imaging and Processing Chain

MODIS
(Terra)

MODIS
(Aqua)

- **Terra and Aqua continuously imaging**
- **Data transmission to White Sands Ground Terminal**
- **Transmission to Goddard Space Flight Center, home of MODAPs**


White Sands Ground
Terminal, New Mexico

Goddard Space Flight Center
Maryland

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Overview of MODIS Swath Data

- **Calibrated radiance data available in swath format (level 1B)**

- **No atmospheric correction, cloud masking, compositing, or additional processing**

- **Original image geometry preserved**

- **best representation of "what the sensor sees" for a given overpass**

- **Forms the input for almost all other MODIS products (NASA or other)**
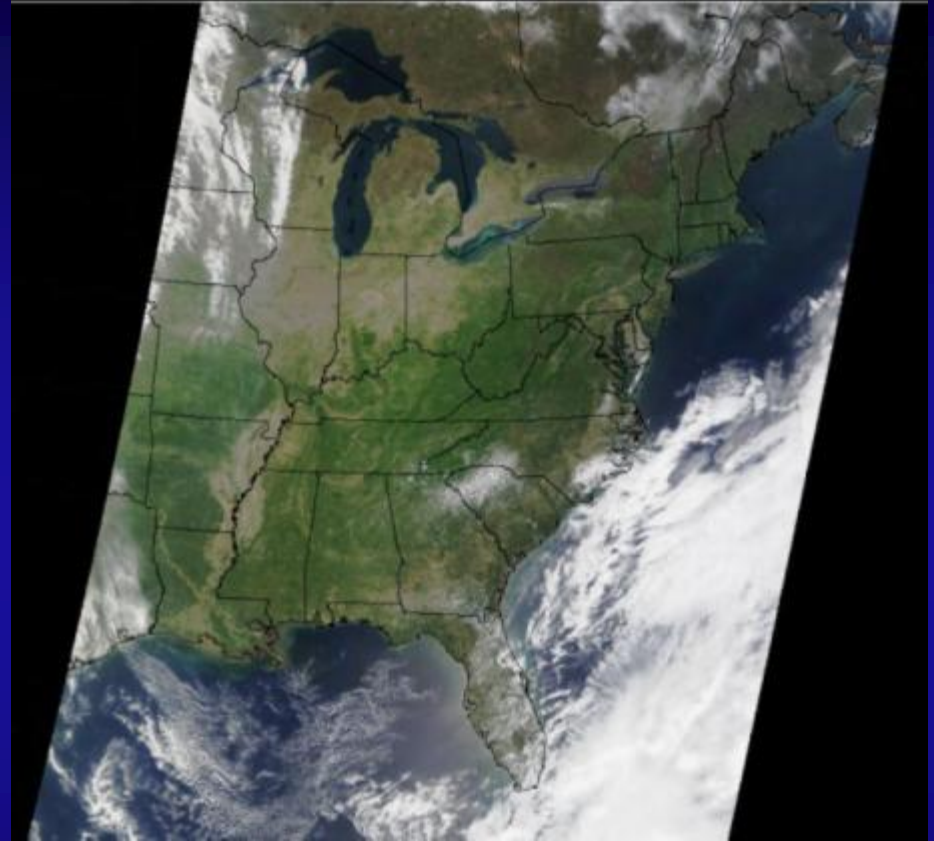
MODIS Overview: Gridding Process

- **Comprehensive, cloud-free MODIS coverage requires additional processing steps**

- **Swath data are the input to these processes**

- **NASA's standard higher level MODIS products, including daily surface reflectance, are mapped to the Sinusoidal grid**

- **NASA MODIS gridding process introduces image geometric distortion**

- **Geometric distortion appears to be more significant at higher latitudes and further away from the Prime Meridian**

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CCRS MODIS Product

- **Developed by Alex Trishchenko, Canadian Centre for Remote Sensing**

- **Available for (almost) the entire circumboreal region**
- **10 day composite period for entire MODIS period of record**
- **Cloud free mosaics available for late summer 2000-2008**
- **Uses adaptive regression and normalization image fusion technique to make all bands available at 250 m resolution**

Late Summer 2008

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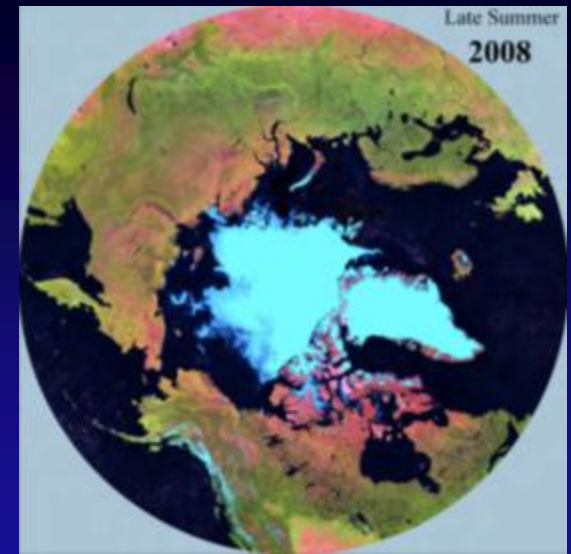
Advantage of CCRS MODIS Product
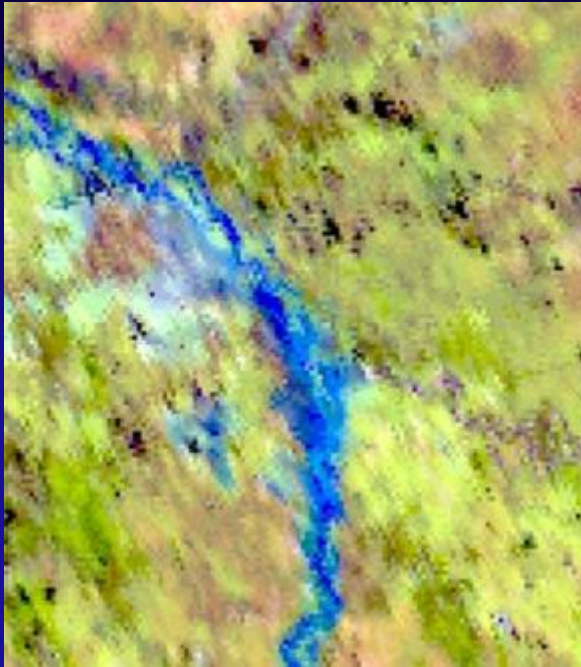
Standard MODIS (NASA)
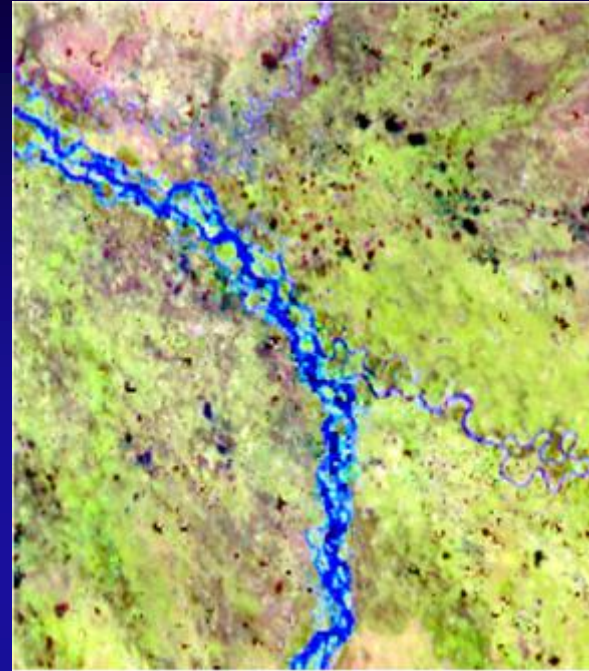
CCRS MODIS

- **Minimal geometric distortion**
- **Improved handling of clouds**
- **Higher spatial resolution (for bands 3-7)**

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Additional Considerations

- **Band compositing**
  - **Paper base maps produced to date use a standard NIR-red-green (2-1-4 for MODIS) band composite**
  - **Digital files provided to mappers allow for viewing of additional band composites, (e.g. IR-NIR-red 7-2-1), depending on the preferences of the group or individual**
- **Missing areas**
  - **A small area within southeast Russia's boreal zone is not included in CCRS arctic mosaic**
  - **Plan is to extend the mosaic to include this area using MODIS swath data**
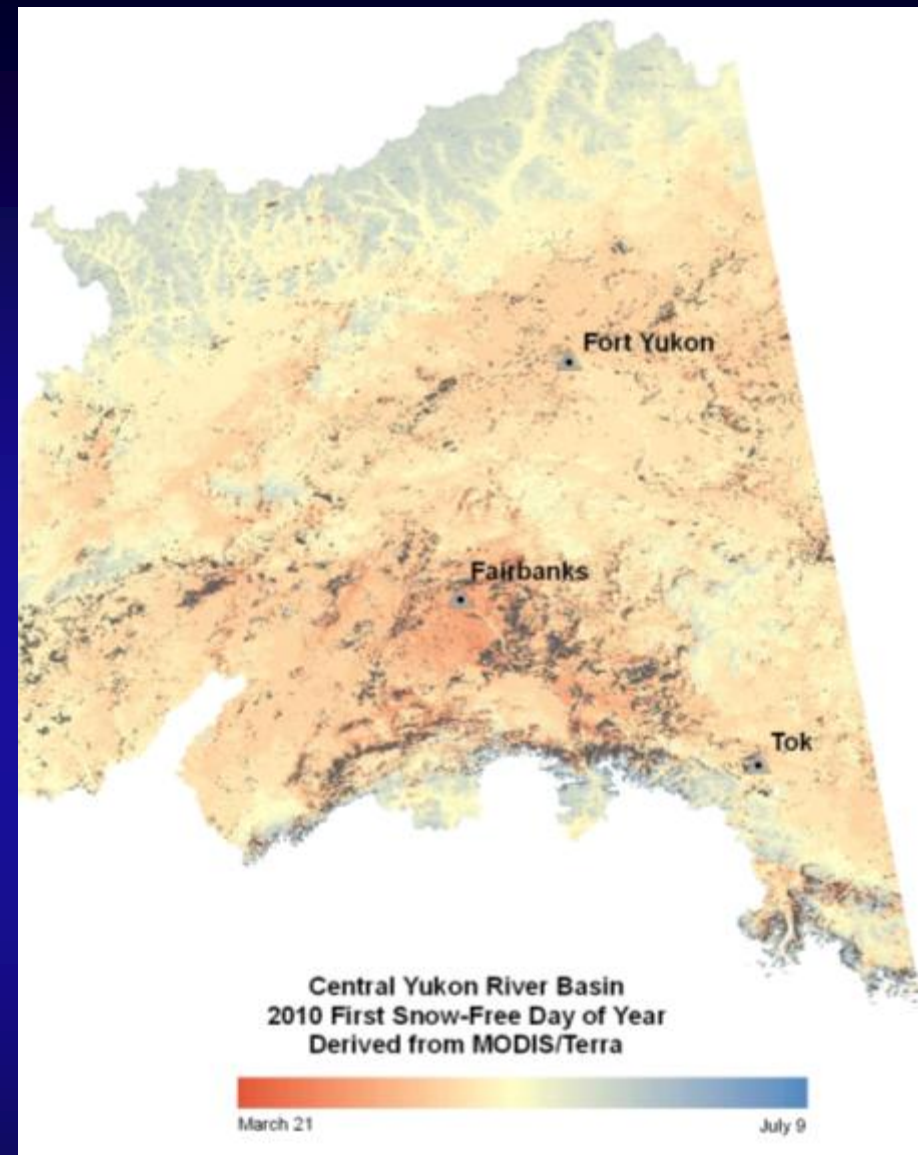
Additional Uses for MODIS Data

- **Bioclimatic zones are a key element of the map classification hierarchy**

- **Delineation of these zones will require multiple input layers**

- **Most bioclimatology input layers derived from interpolated weather station data**

- **MODIS has the potential to provide additional input layers that could shed light on certain key aspects of boreal zone bioclimatology**

- **All MODIS-derived bioclimatology maps would be based on the period 2000-2010**


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MODIS Derived Bioclimatology: Mean Snow Cover Duration

- **Existing MODIS products would allow for derivation of days with snow cover, first snow cover day and first snow free day**

- **Fairly straightforward to derive, but would require extensive image processing (~ 180,000 MODIS tile input images)**


Fort Yukon

Fairbanks

Tok

Central Yukon River Basin
2010 First Snow-Free Day of Year
Derived from MODIS/Terra

March 21   July 9

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MODIS Derived Bioclimatology: Mean Land Surface Temperature

- **Existing MODIS products provide 8 day composites of land surface temperature**

- **Land surface temperature could be useful for inferring permafrost status and land cover characterisics**

Daytime averaged LST (K) in MOD11A2.A2000121.h11v05.005 (2000/04/30–05/07)
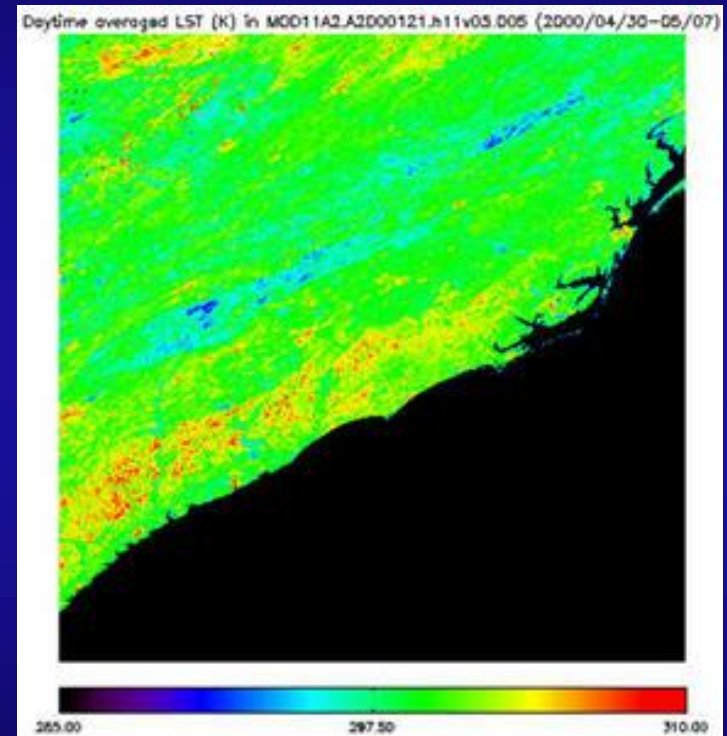
MODIS Derived Bioclimatology: Phenology Metrics

- **Phenological metrics can be derived from NDVI or similar indices**

- **Metrics include: length of growing season, start of growing season, end of growing season, etc.**

Length of growing season for 2005

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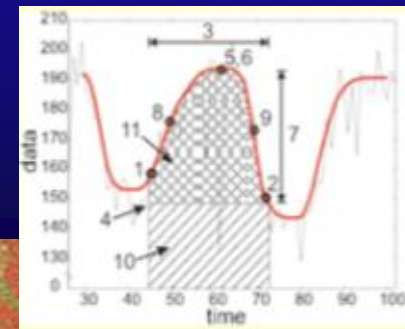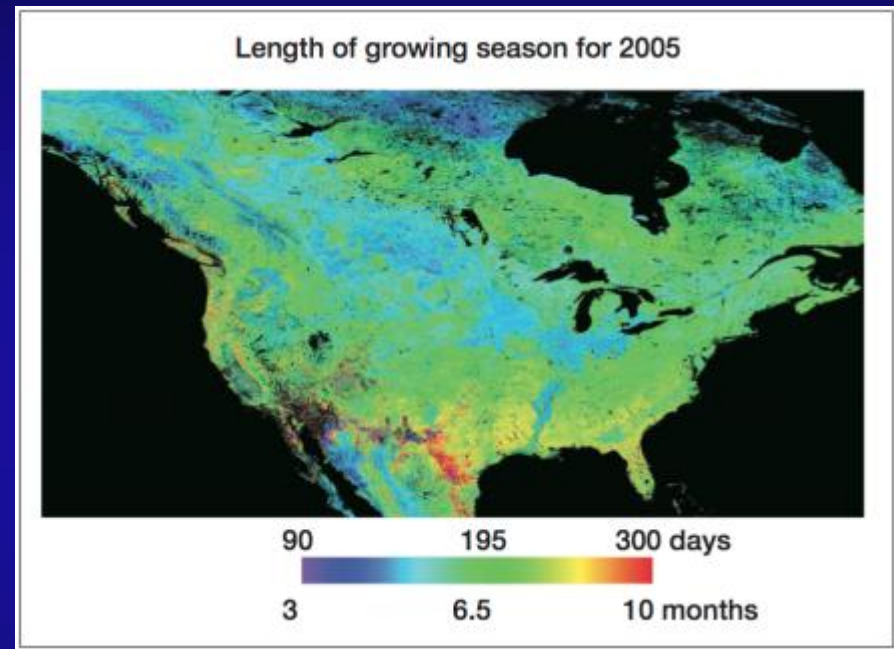
Beyond MODIS: Additional Remote Sensing Resources for CBVM Mapping

- **Mappers will invariably be required to label polygons they are not familiar with**

- **For these cases, it may be beneficial to consult additional remote sensing imagery**
    - **Landsat: available from USGS GLOVIS, or from NASA's GeoCover global Landsat mosaic**
    - **QuickBird/IKONOS/GeoEye: some images available via Google Earth**
    - **Other sensors**

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Multi-Scale Imagery Resources
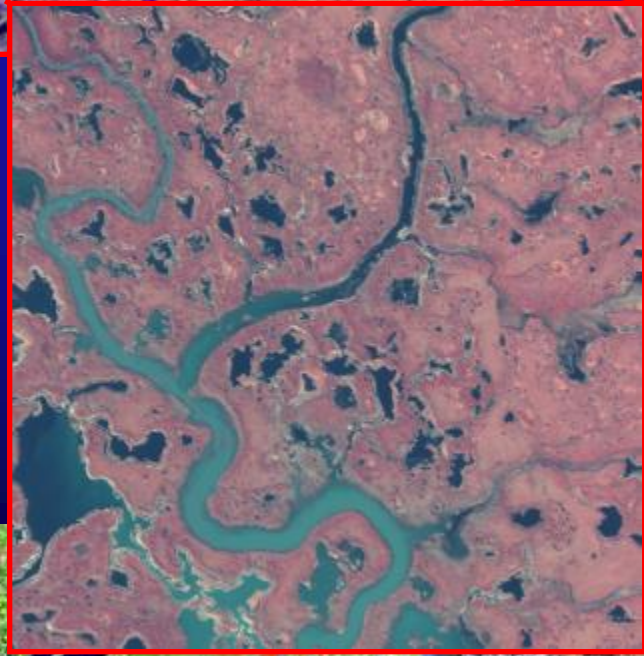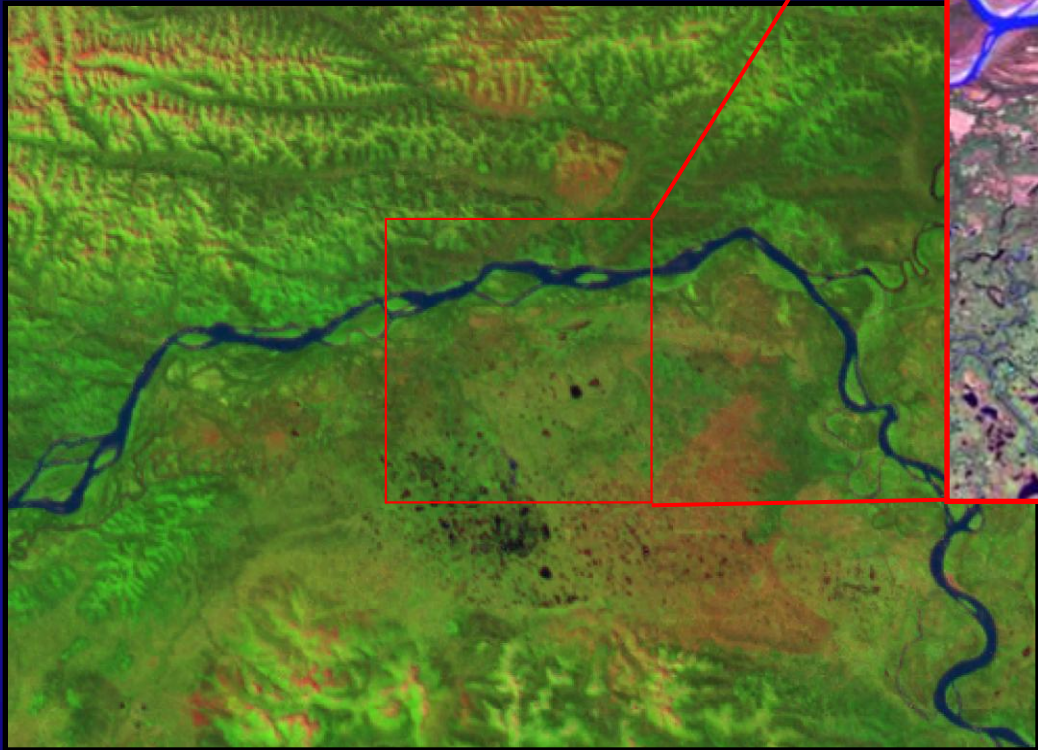
MODIS (250 m) → Landsat (30 m) → Quickbird (2.4 m)

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Acknowledgements

- **Alex Trishchenko, Candian Center for Remote Sensing, for providing the MODIS circumpolar arctic mosaics**

- **James Brandt, Natural Resources Canada, for providing boreal forest extent boundary for North America**

- **Nicolai Ermakov, Russian Academy of Sciences, for providing boreal forest extent boundary for Eurasia**

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Resources for More Information

- **MODIS web site:**
  - **http://modis.gsfc.nasa.gov/**
- **MODIS Land Team:**
  - **http://modis-land.gsfc.nasa.gov/**
- **CCRS MODIS Product:**
  - **http://ccrs.nrcan.gc.ca/geospatial/mosaic_e.php**

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