

Using eMODIS Vegetation Indices for Operational Drought Monitoring

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NIDIS Knowledge Assessment Workshop

“Contributions of Satellite Remote Sensing to Drought Monitoring”

Boulder, Colorado – February 6-7, 2008

Topics

- Context for drought monitoring of vegetation targets using remote sensing (Vegetation Indices)
- eMODIS processing system (at USGS/EROS)
- eMODIS products for drought monitoring
- Data continuity (AVHRR and MODIS)
- Irrigated lands mapping from MODIS
- Future plans

Requirements of remote sensing for operational drought monitoring

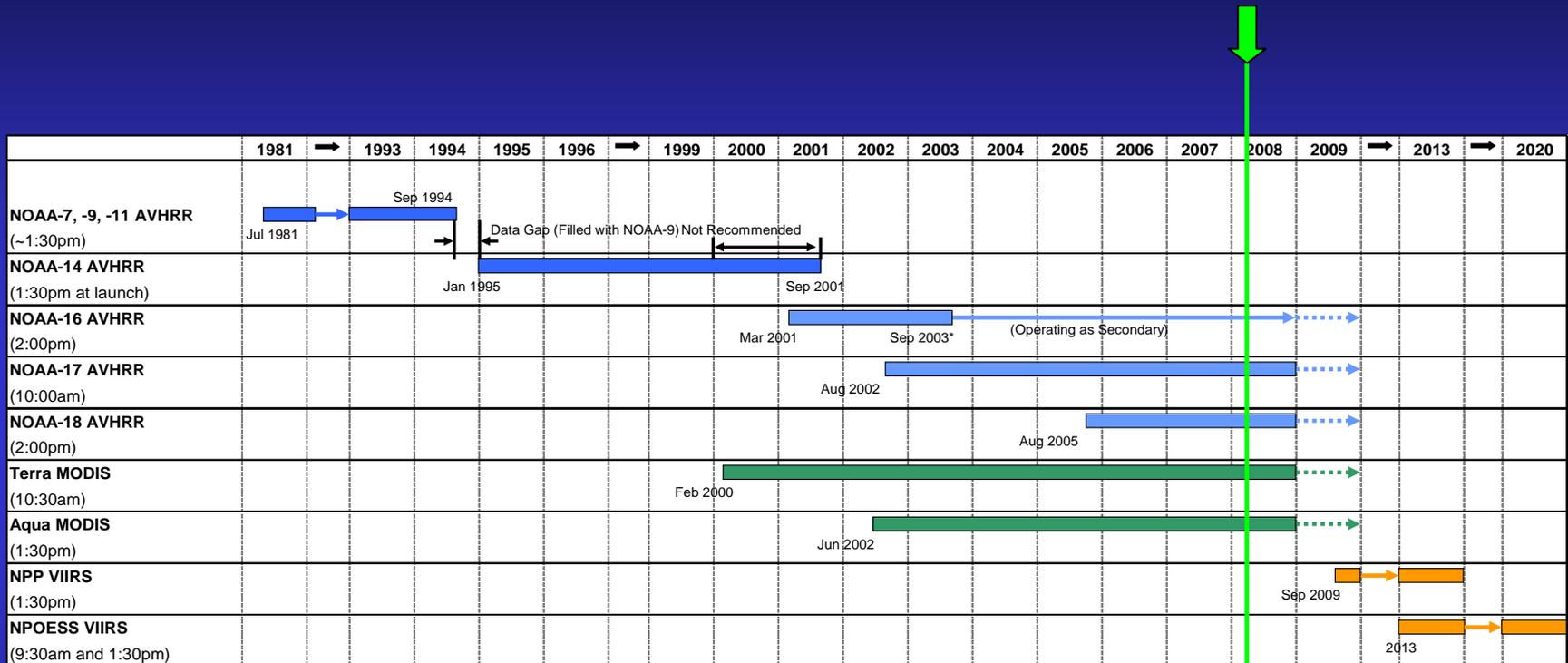
- Repetitive measurements (day after day, month after month, year after year)
- Reliable sources of time-series data
- Effective spatial and temporal scales
- Synoptic coverage of the land surface
- Objective, automated data streams
- Coverage where ground data is sparse

Daily satellite VI data in operational monitoring since the 1980s

- **AVHRR** – Other presentations will cover the history and status of using AVHRR
 - Eidenshink
 - Kogan
 - VanLeeuwen
- **MODIS (since 2000)** provides improved radiometric, geometric, and spatial characteristics
- **VIIRS (aboard NPP and NPOESS)** – next generation operational instrument for monitoring



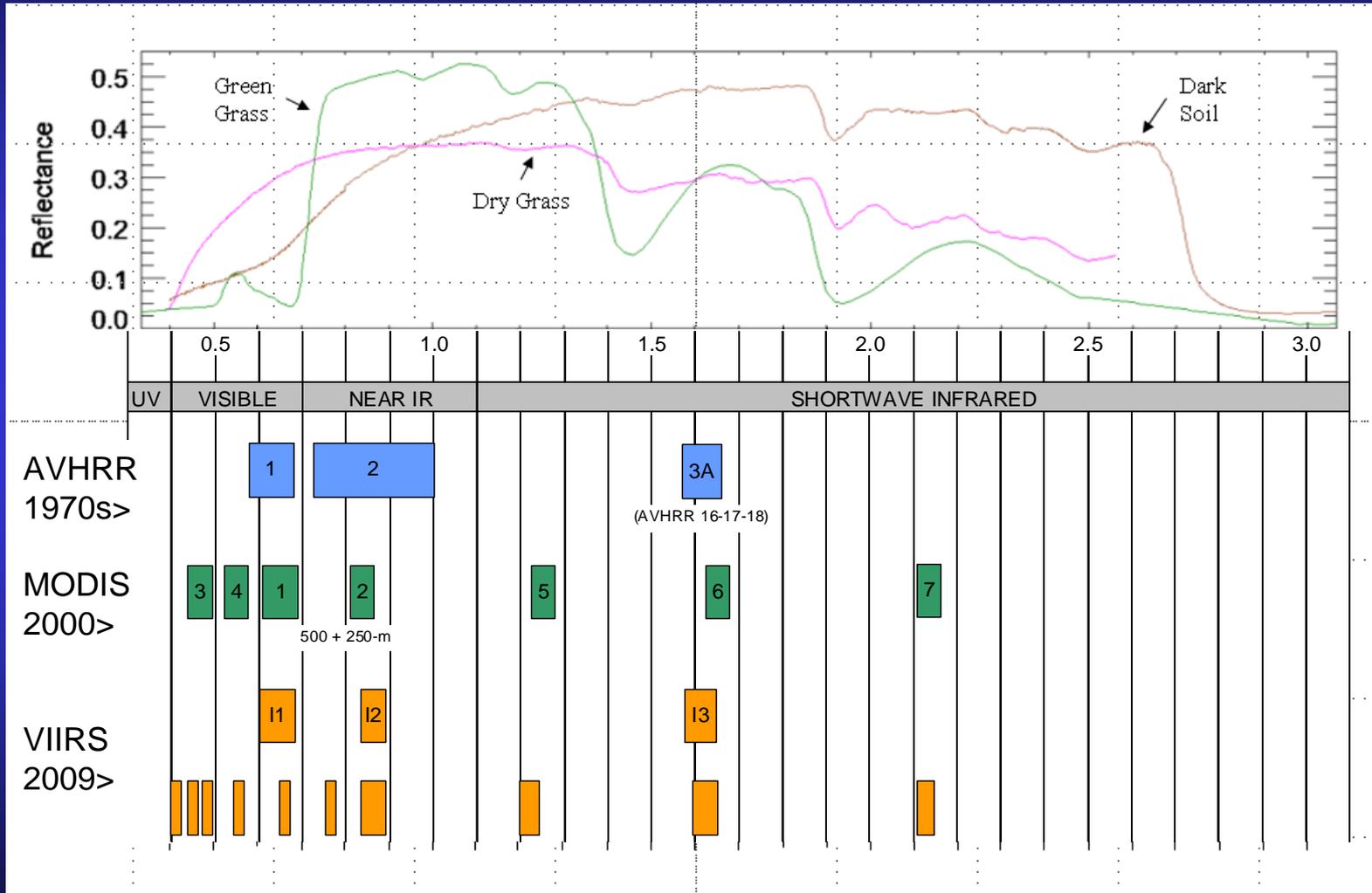
The AVHRR-MODIS-VIIRS continuum



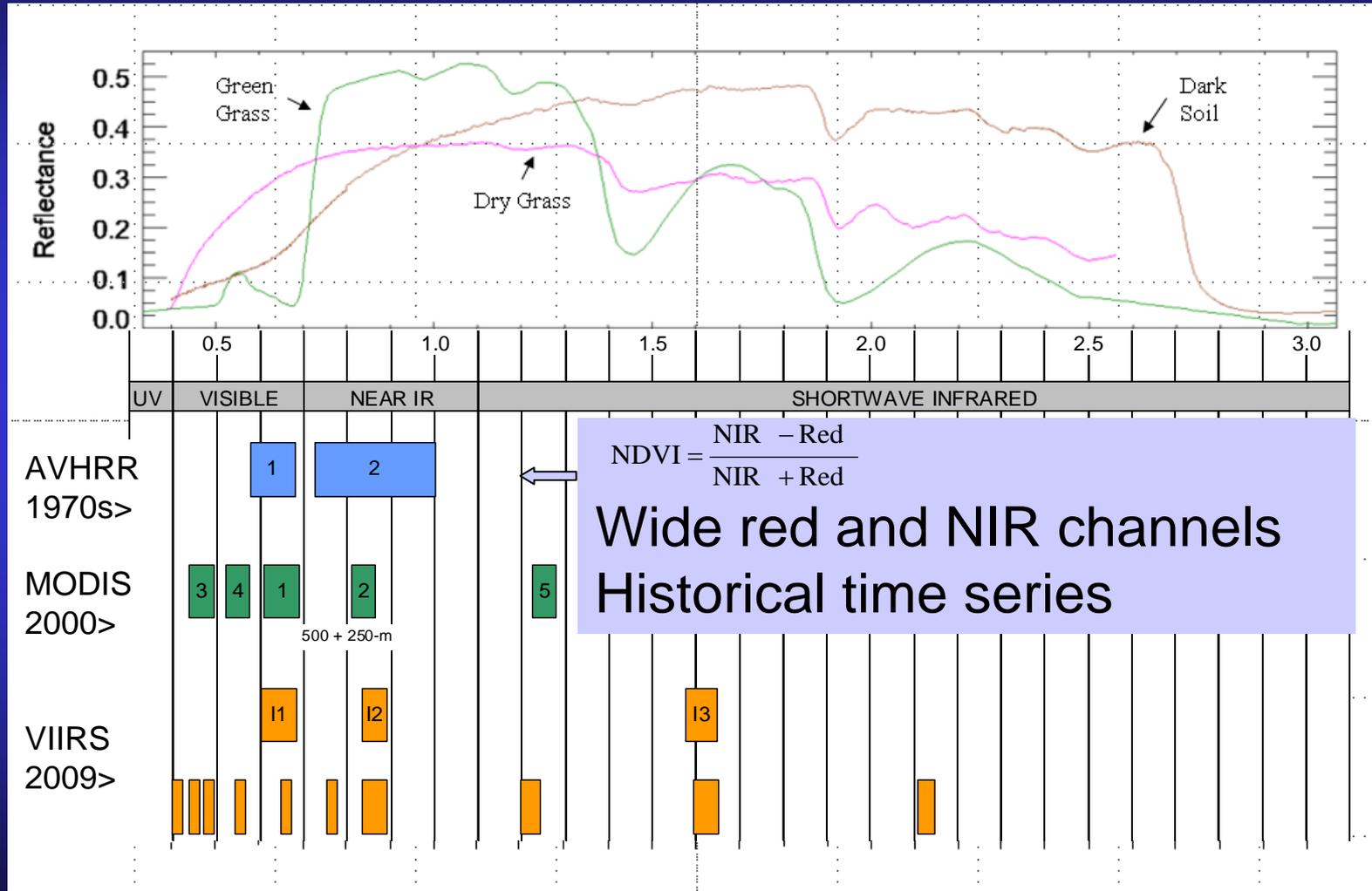
VIIRS optical band widths will be similar to MODIS



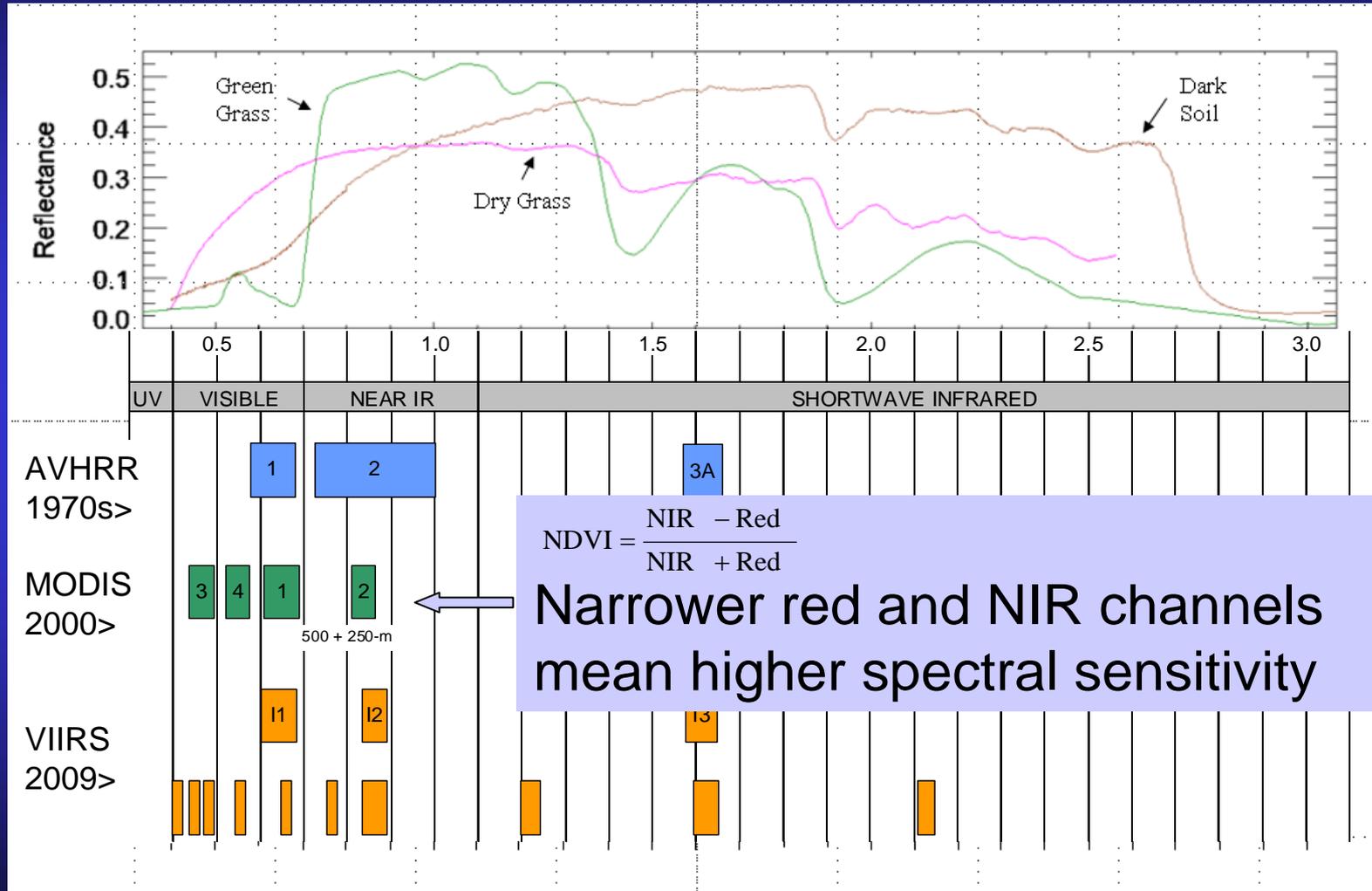
Optical (land) channel band widths for AVHRR, MODIS, and VIIRS instruments



Optical (land) channel band widths for AVHRR, MODIS, and VIIRS instruments



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MODIS use for research applications

- **Enhancements over AVHRR**
 - Higher spatial resolution
 - 250-m, 500-m, 1-km
 - Improved spectral sensitivity
 - Improved geometric precision
 - Improved atmospheric correction



Use of standard MODIS VI products in operational applications

- **Barriers**

- 16-day composite intervals
 - Compositing good for noise reduction
 - Reduces temporal sensitivity
 - Schedule not ideal for more frequent monitoring
- Tiling scheme
- Projection
- HDF-EOS format
- Changes in processing algorithms (C4 vs C5)
- Latency of delivery

eMODIS product specifications

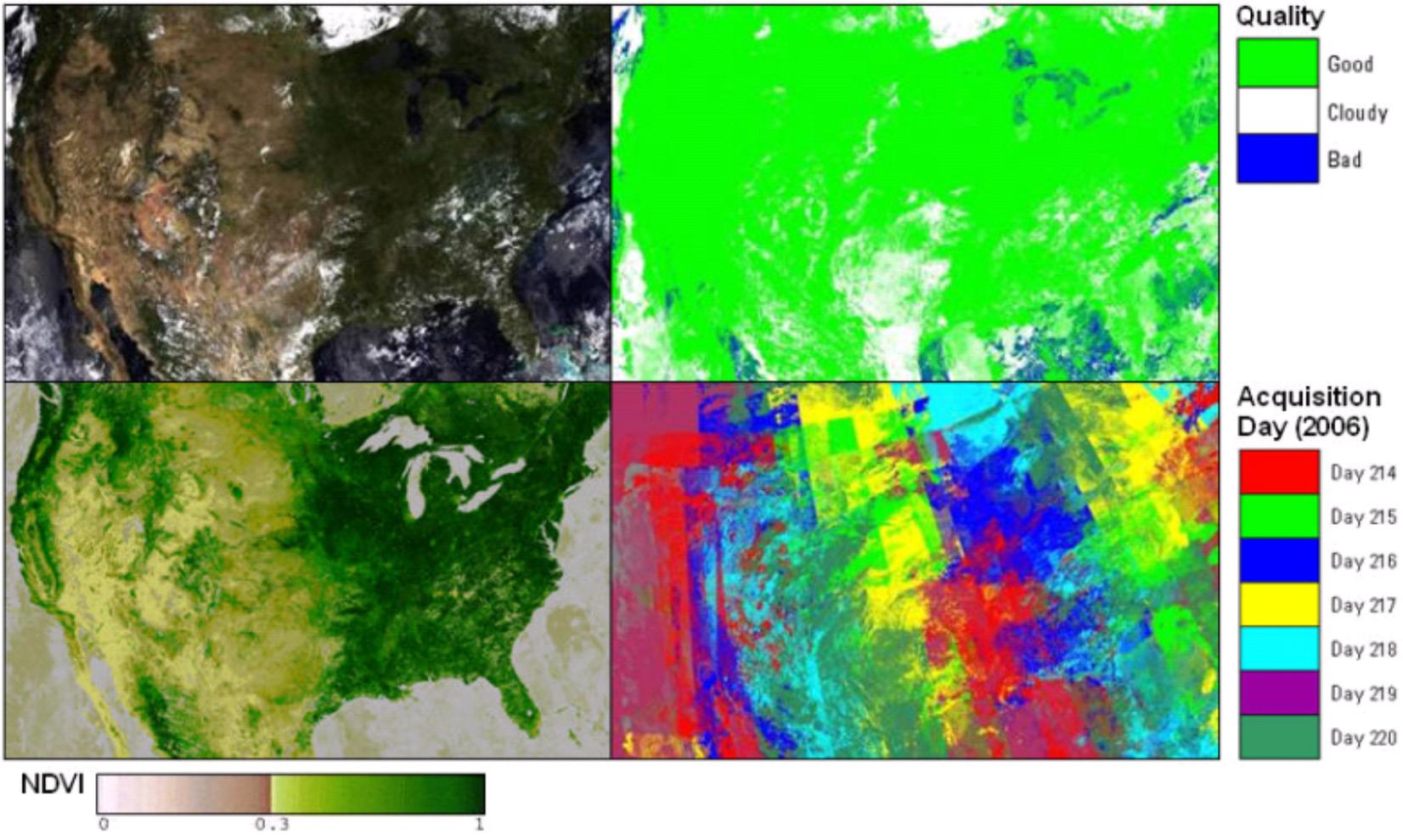
Monitoring target	Vegetation, land surface phenology, drought
Source instrument, mission, processing chain	MODIS instrument Aqua and Terra missions (Terra launched in 1999, overpass time 1030) (Aqua launched in 2002, overpass time 1330)
Product description	<ul style="list-style-type: none">• NDVI (Band 2 – Band 1 / Band 2 + Band 1)• Atmospherically corrected surface reflectance (Bands 1-7)• Quality (reflectance and NDVI)• Day of Acquisition• Metadata
Spatial resolutions	250-m, 500-m, and 1,000-m
Geographic map projection	Lambert Azimuthal Equal Area
File format	Geotiff (zipped)
Geographic extent	Conterminous United States (48 states) (daily expedited data products starting in 2008, Alaska historical prototyping in 2008)

eMODIS product specifications (continued)

Product frequency	Daily
Product delay (or Latency)	Expedited: < 24 hours from last observation Historical: < 30 days from last observation
Period of record	Expedited Prototype: Sep 2007 forward Expedited: Jan 2008 forward Historical: 2005-2007, 2008 forward planned
Gaps (or time-series heterogeneity)	Only as applicable from spacecraft anomalies
Product access (anonymous FTP)	ftp://elpdl02.cr.usgs.gov/eMODIS
Compatibility with commonly used software	Yes
Relevant citations	Maiersperger and others, 2007

eMODIS product example

Surface Reflectance (Natural Color)



Drought monitoring with eMODIS NDVI

- Daily product frequency (rolling 7-day composites) and <24 hour latency is ideal for monitoring land surface vegetation dynamics and can be used to characterize anomalies

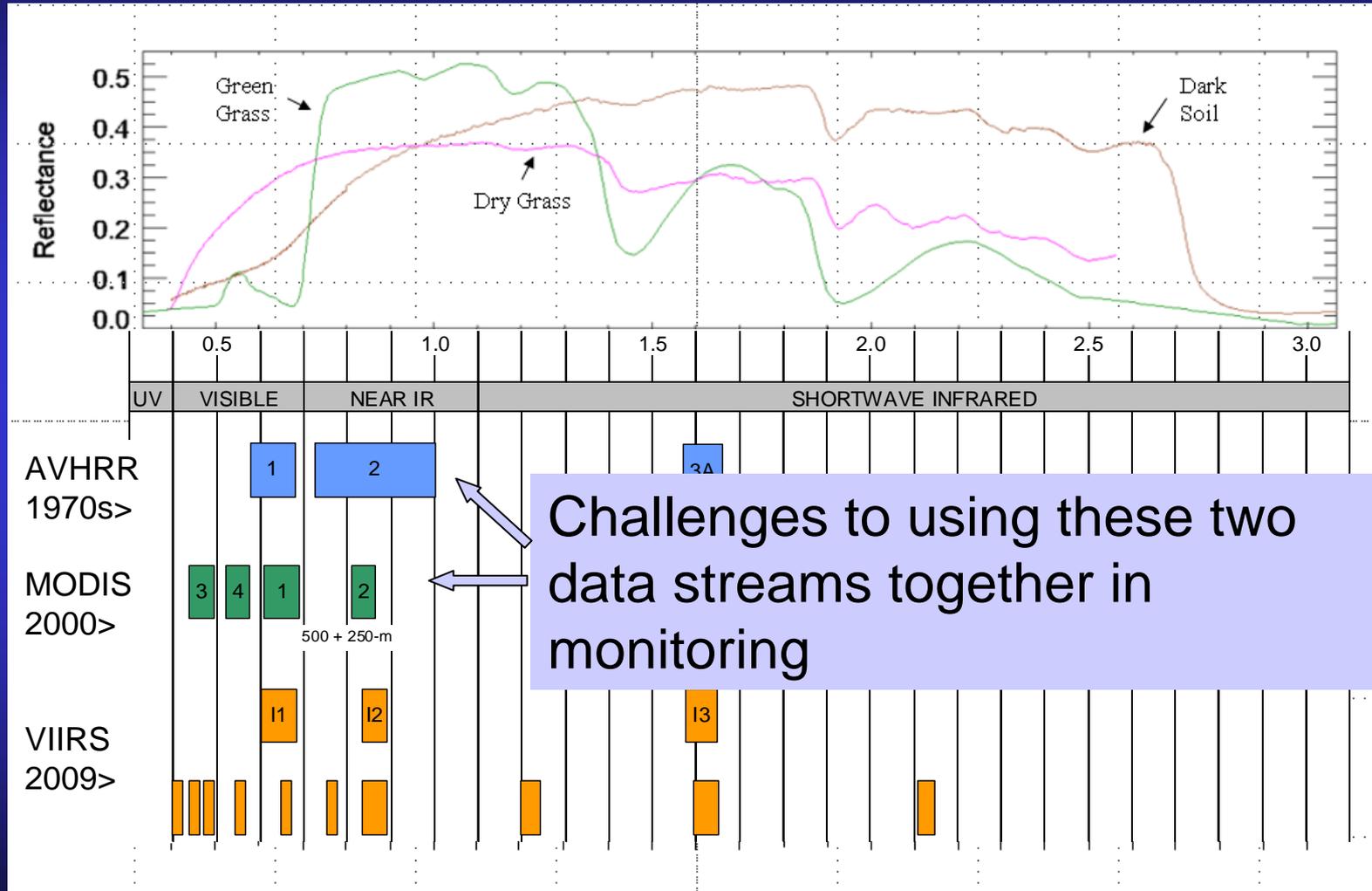


Drought monitoring with eMODIS NDVI

- **Continuity with the AVHRR historical time series is required in order to create anomaly products**
 - Smoothed NDVI
 - Percent of Average Seasonal Greenness
 - Start of Season and Start of Season Anomaly
 - Vegetation Drought Response Index (VegDRI)
 - Relative Greenness



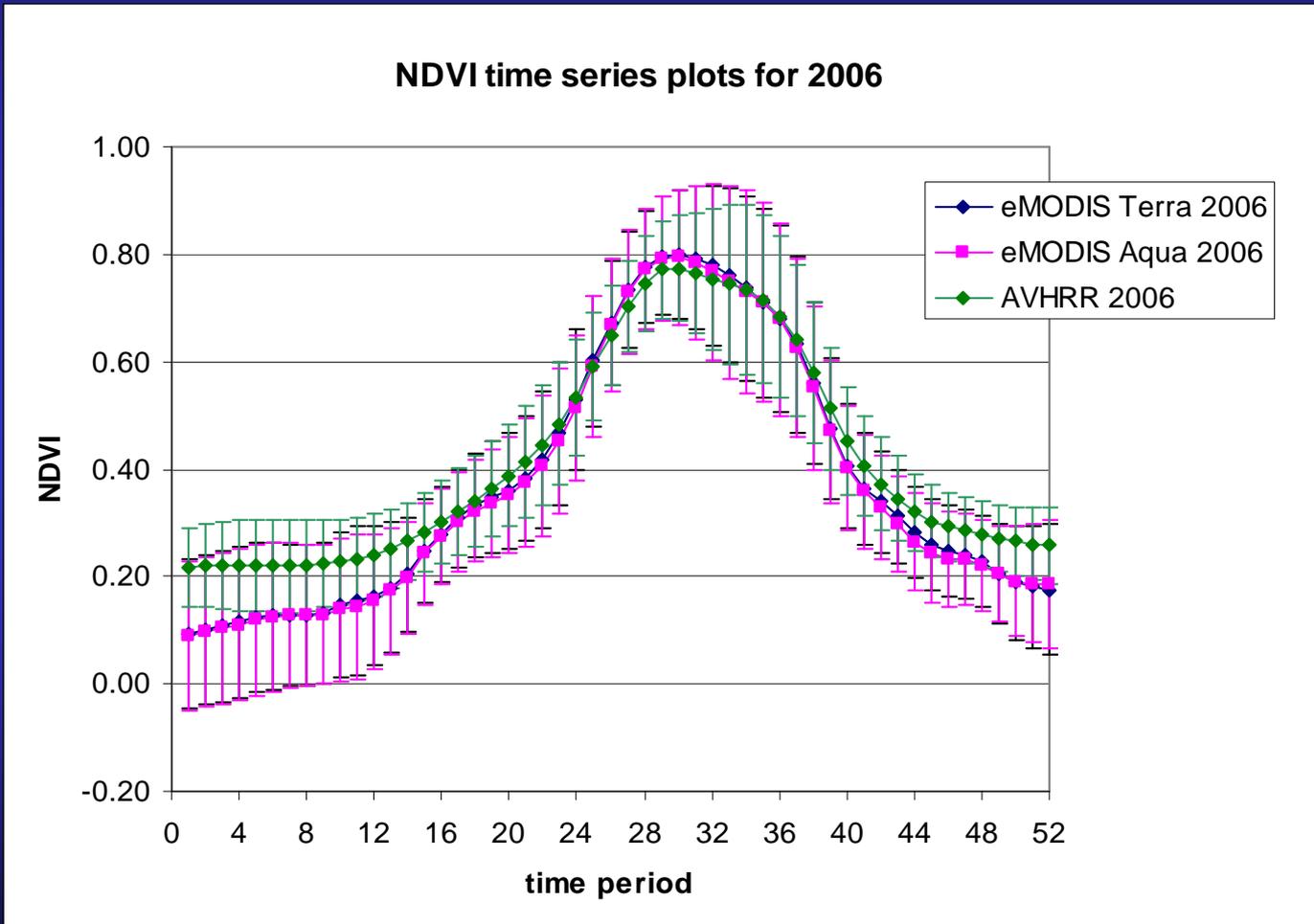
Optical (land) channel band widths for AVHRR, MODIS, and VIIRS instruments



Data Continuity

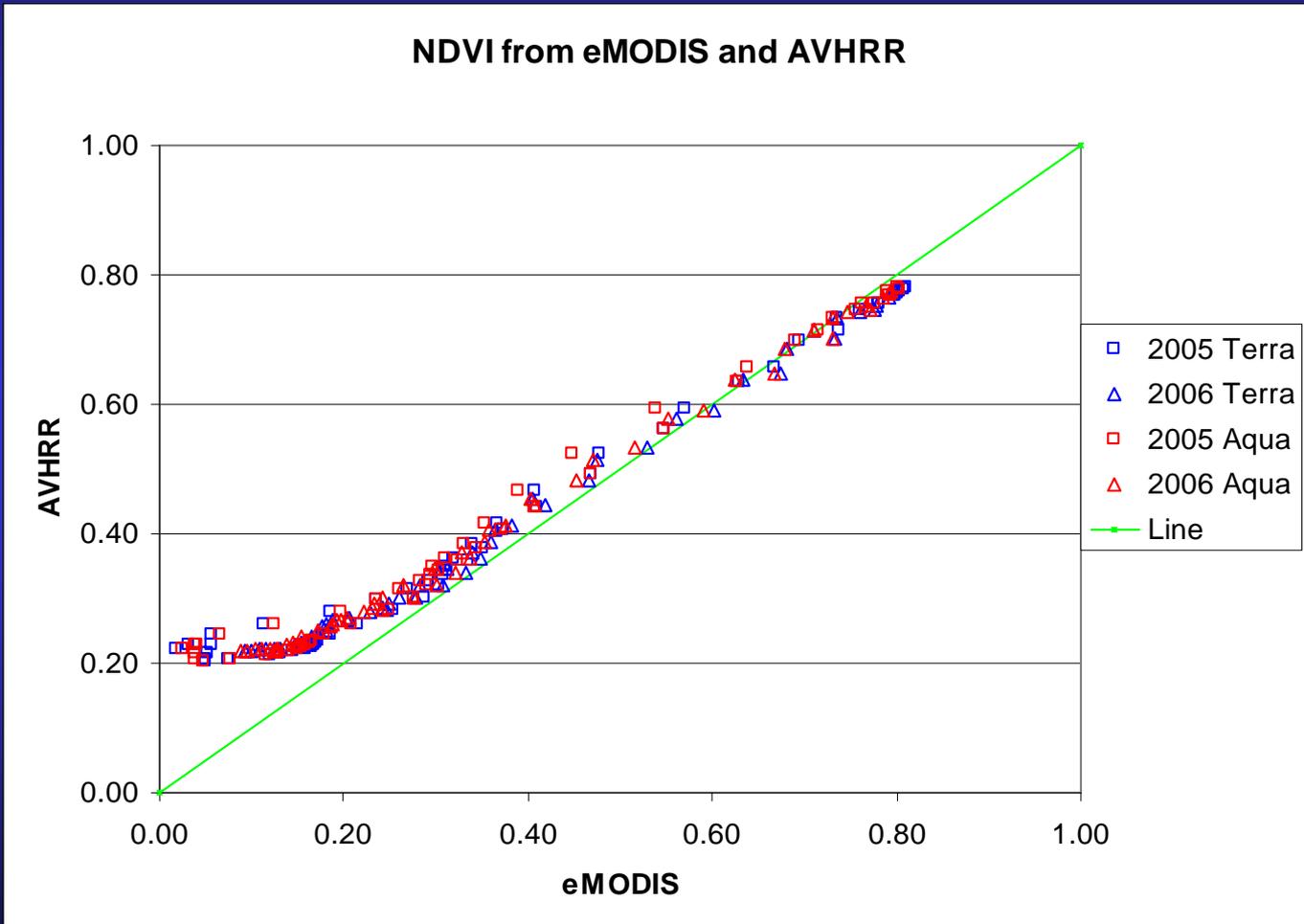
NDVI from AVHRR, Terra eMODIS, Aqua eMODIS

For Iowa
Corn Belt



Data Continuity

NDVI for AVHRR, Terra eMODIS, Aqua eMODIS



R^2 (with AVHRR):

2005 Terra **0.97**

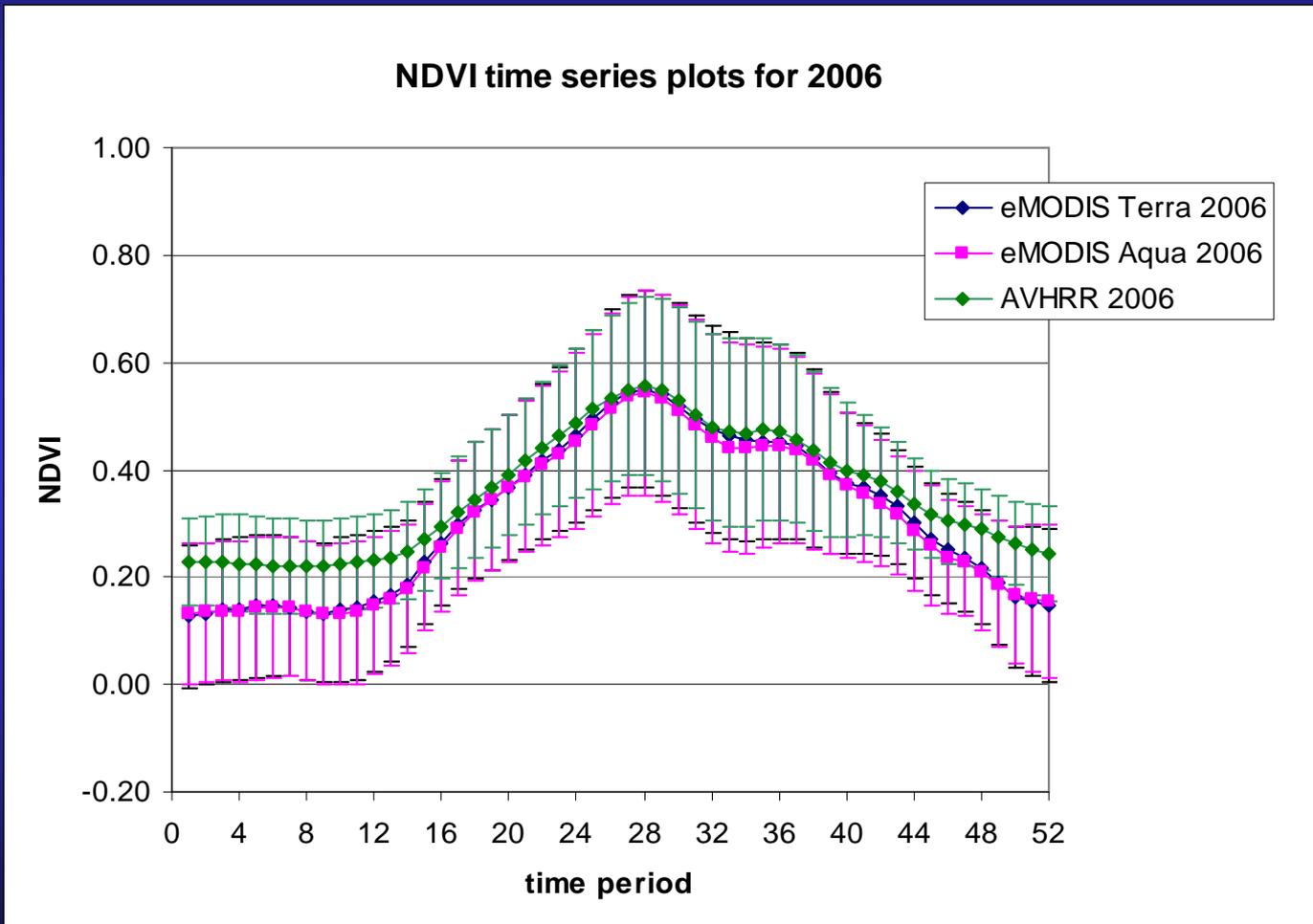
2006 Terra **0.99**

2005 Aqua **0.97**

2006 Aqua **0.99**

Data Continuity

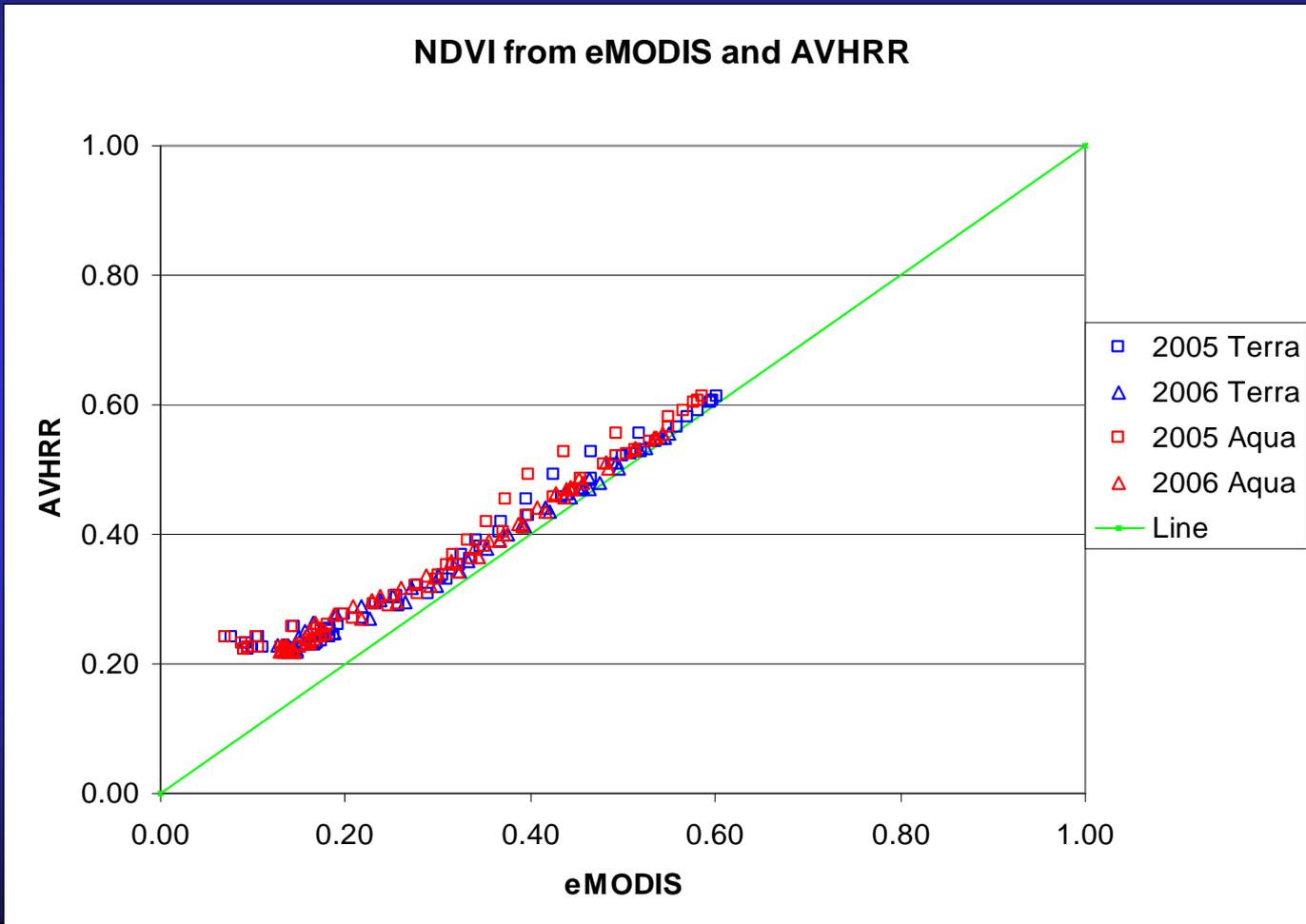
NDVI from AVHRR, Terra eMODIS, Aqua eMODIS



For Cool
Season
Grasses, SD
and ND

Data Continuity

NDVI for AVHRR, Terra eMODIS, Aqua eMODIS



R^2 (with AVHRR):

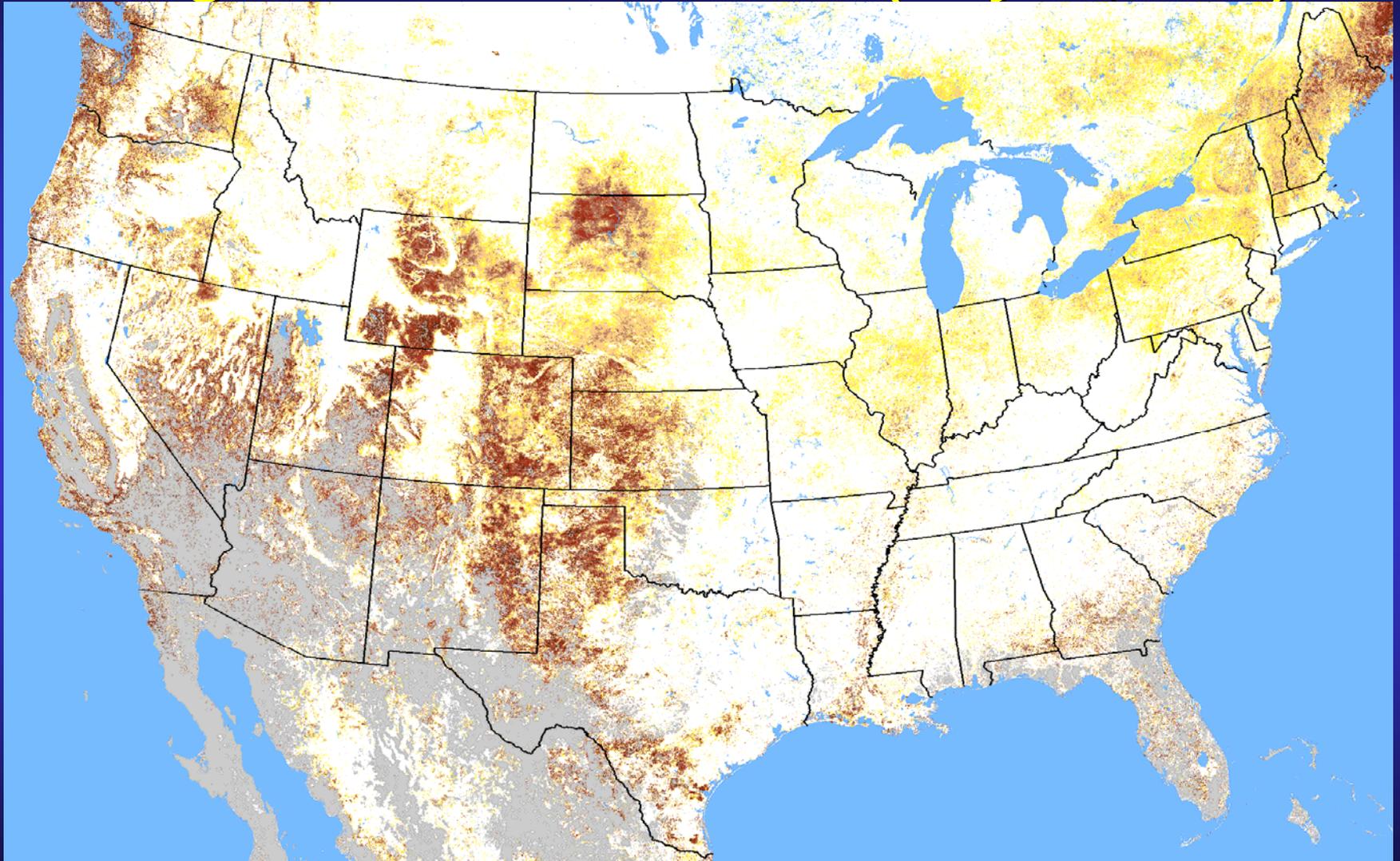
2005 Terra **0.97**

2006 Terra **0.99**

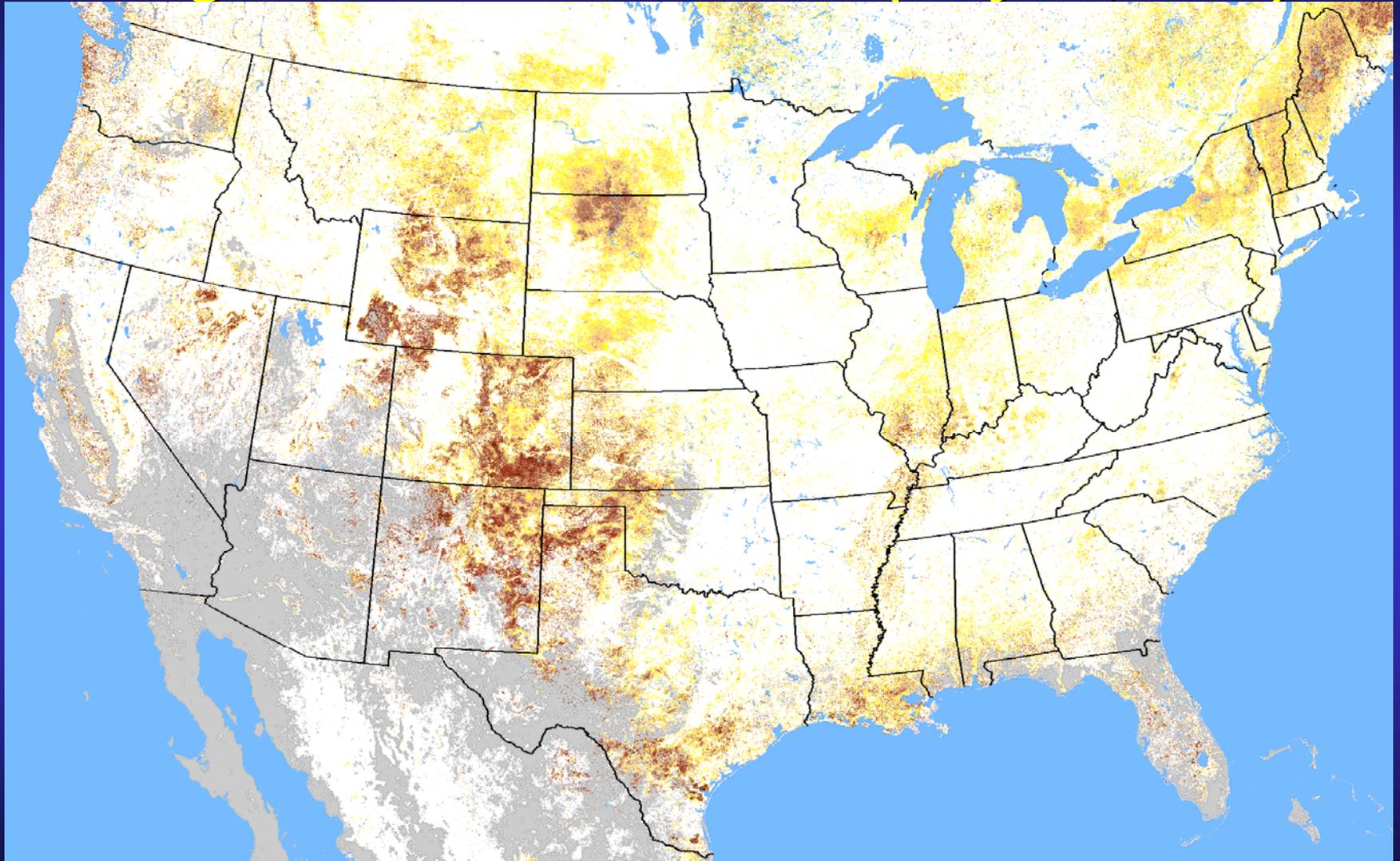
2005 Aqua **0.97**

2006 Aqua **0.99**

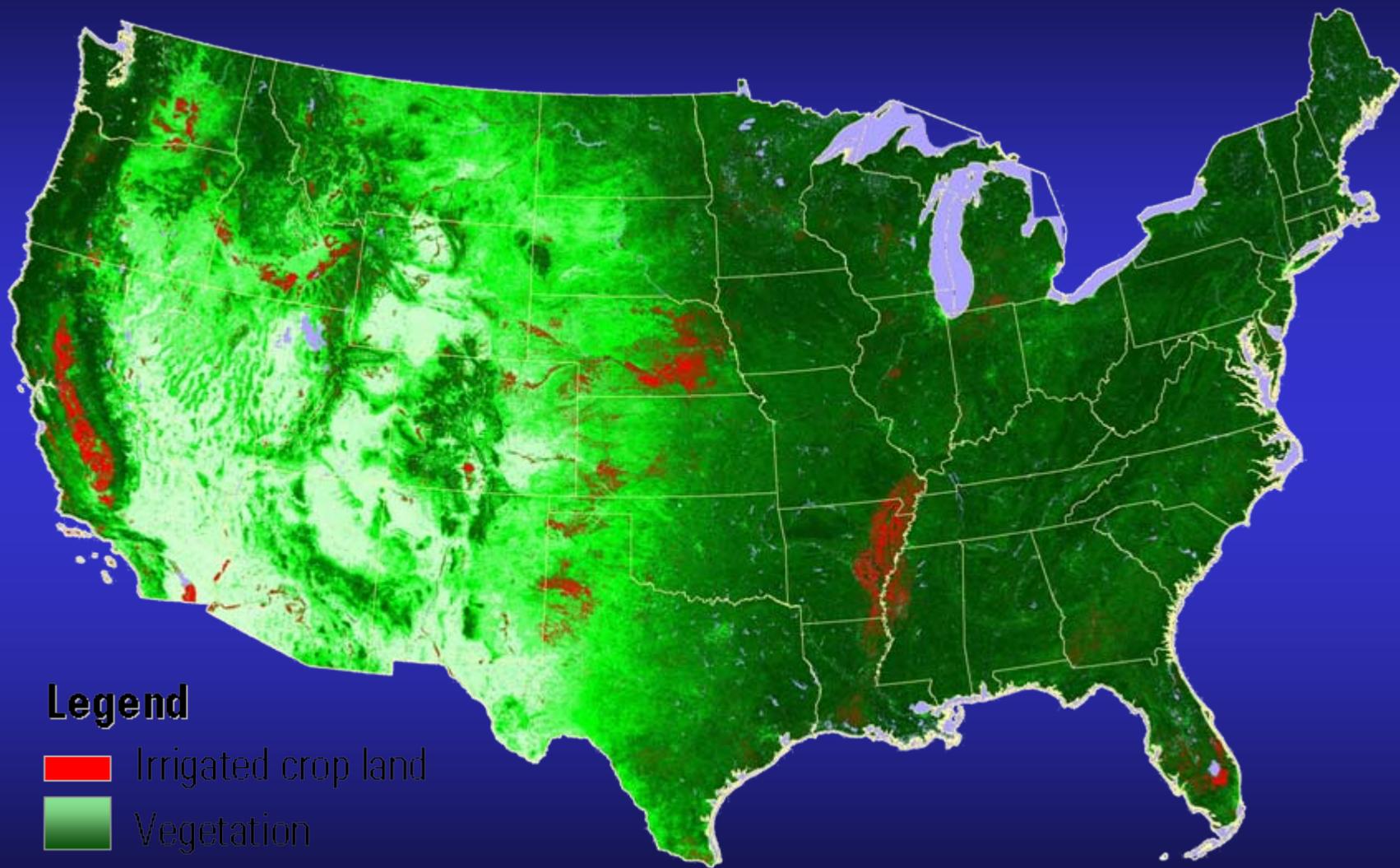
Anomaly Product Example: AVHRR Percent of Average Seasonal Greenness (July 25, 2006)



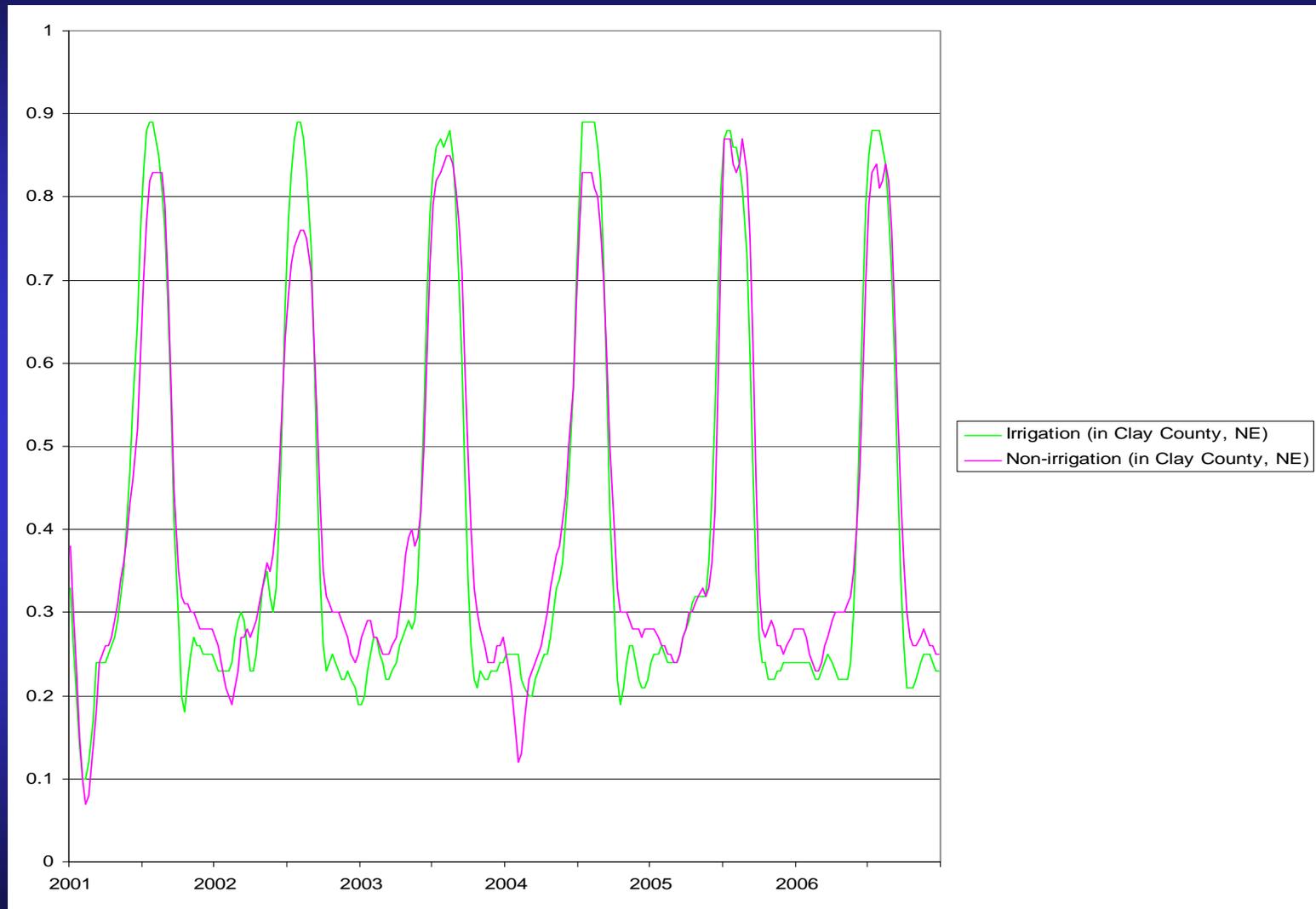
Anomaly Product Example: eMODIS Percent of Average Seasonal Greenness (July 25, 2006)



Prototype 2002 Irrigated Lands Map



MODIS 250-meter NDVI time series



Irrigated Agriculture Methodology

MODIS Annual Peak NDVI

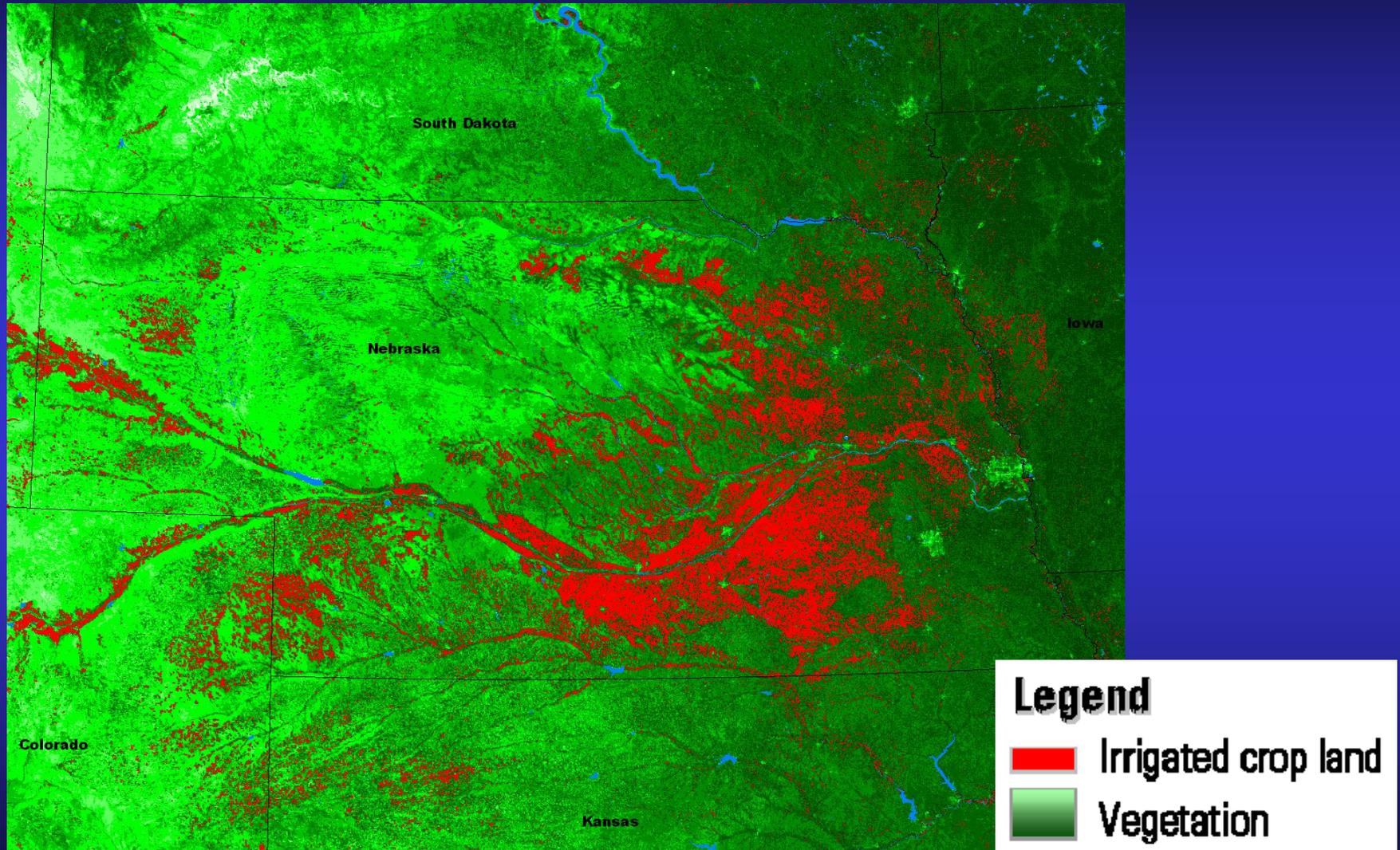
Ag
Census
USA

County irrigated
area statistics

Land cover mask

Irrigation Status Data

Prototype 2002 Irrigated Lands Map



Future Plans

- **Data continuity**
 - Develop and implement fast-track NDVI cross-walk algorithms (T. Miura)
- **Production streams based on eMODIS:**
 - Smoothed NDVI
 - Percent of Average Seasonal Greenness
 - Start of Season and Start of Season Anomaly
 - Vegetation Drought Response Index (VegDRI)
 - Relative Greenness
- **Prototyping data and make quasi-operational in 2008; operational in 2009**

Future Plans (continued)

- **Irrigation mapping**

- Update using 2007 Census of Agriculture county statistics
- Update using 2001 National Land Cover Database
- Update using 2005-2006 MODIS annual peak NDVI
- Continue evaluation
- Merge irrigated area data with Simplified Surface Energy Balance model to estimate irrigation water usage (with G. Senay)