

Arizona Department of Water Resources Land Subsidence Monitoring Program Using Interferometric Synthetic Aperture Radar (InSAR) in Cochise County, Southeastern Arizona

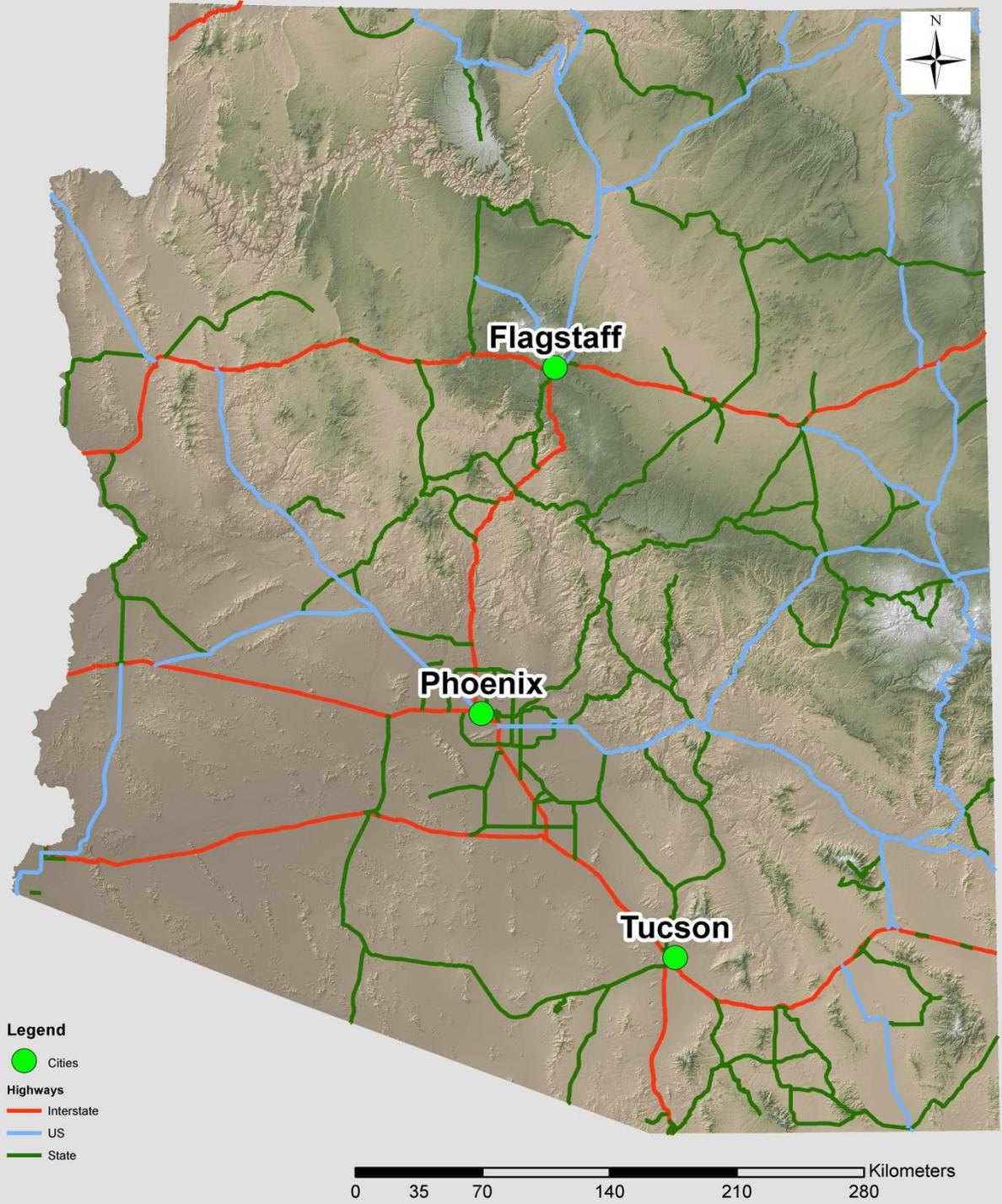


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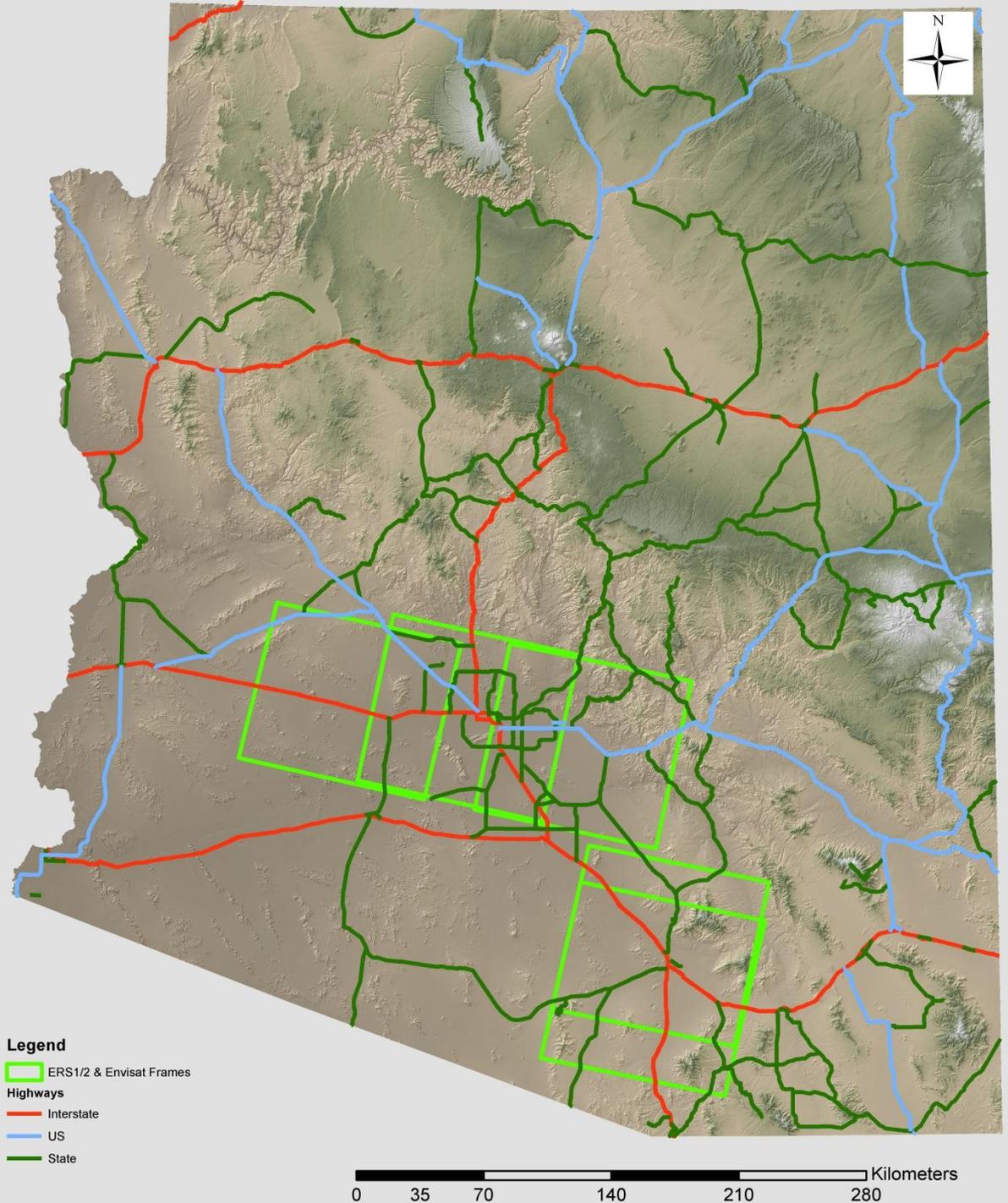
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Program started in 1998, collecting static GPS measurements over a small regional network in the eastern part of the Phoenix Metropolitan Area.
- Funded a pilot InSAR program through the Center for Space Research to test the InSAR technology in Arizona.
- Awarded a \$1.3 million NASA grant in 2002 to develop ADWR's InSAR program for three years.



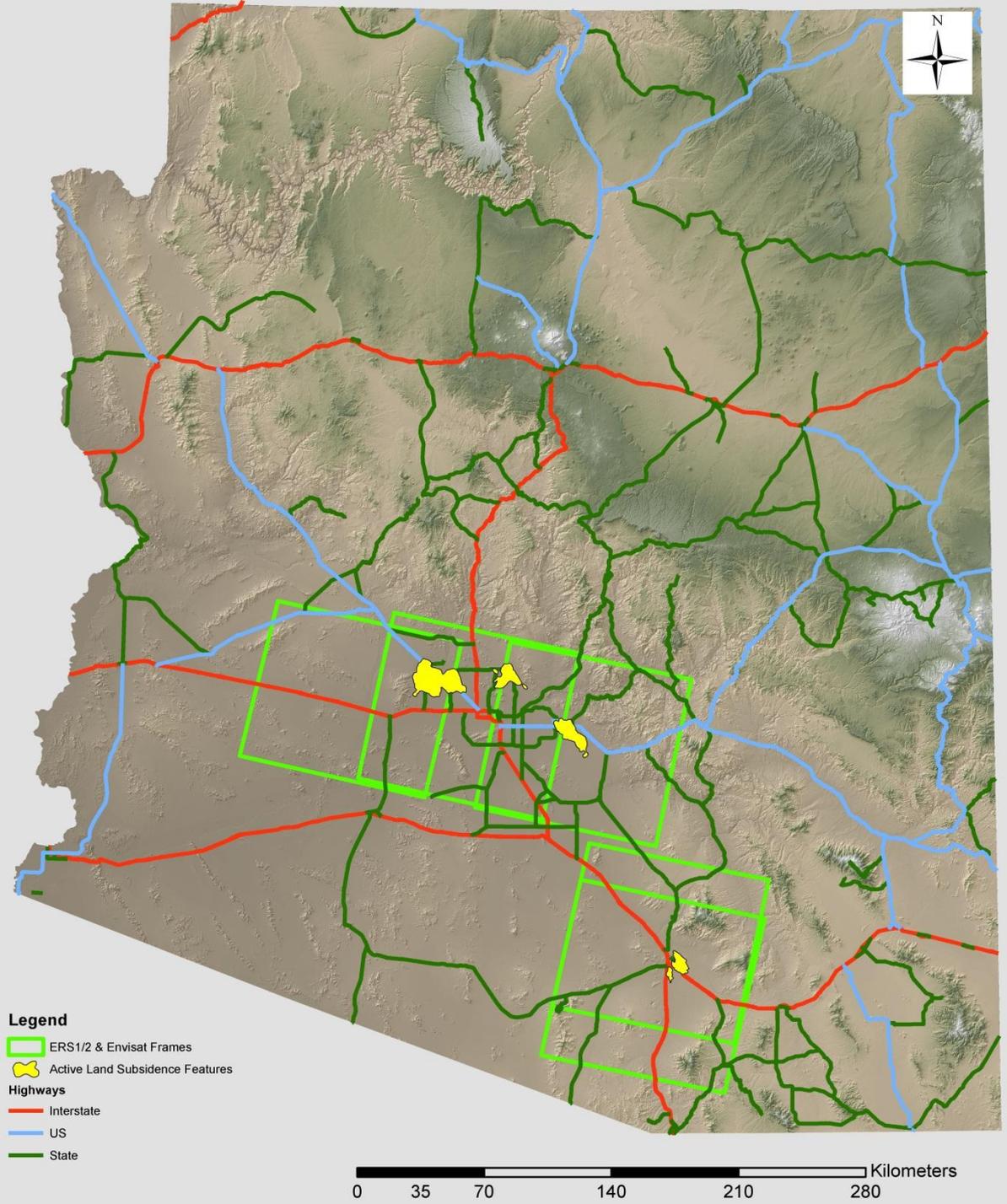
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Started collecting 4 satellite frames, covering the Phoenix and Tucson Metropolitan Areas.



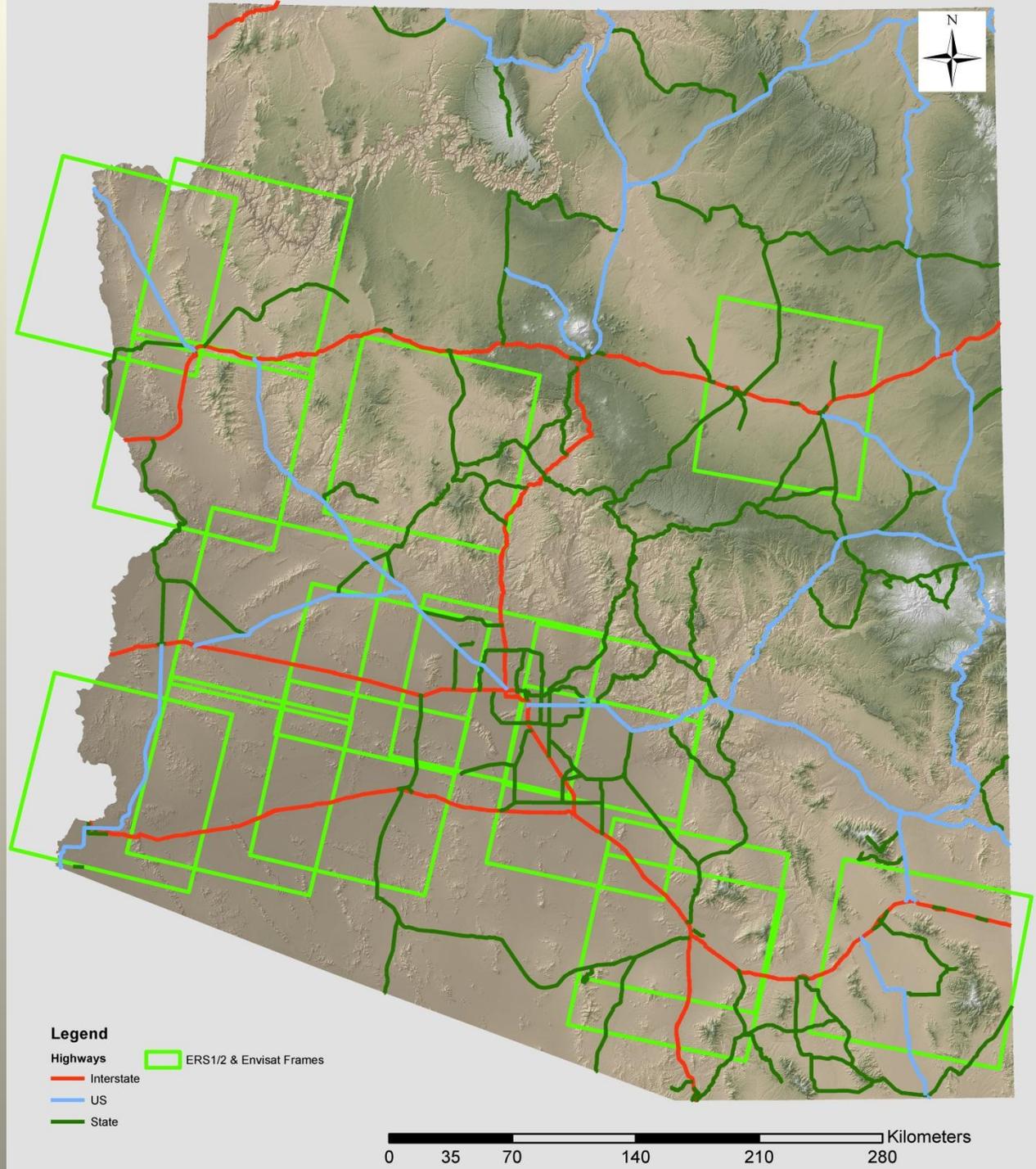
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Identified 5 land subsidence features, 2 in the Tucson Area and 3 in the Phoenix Area.



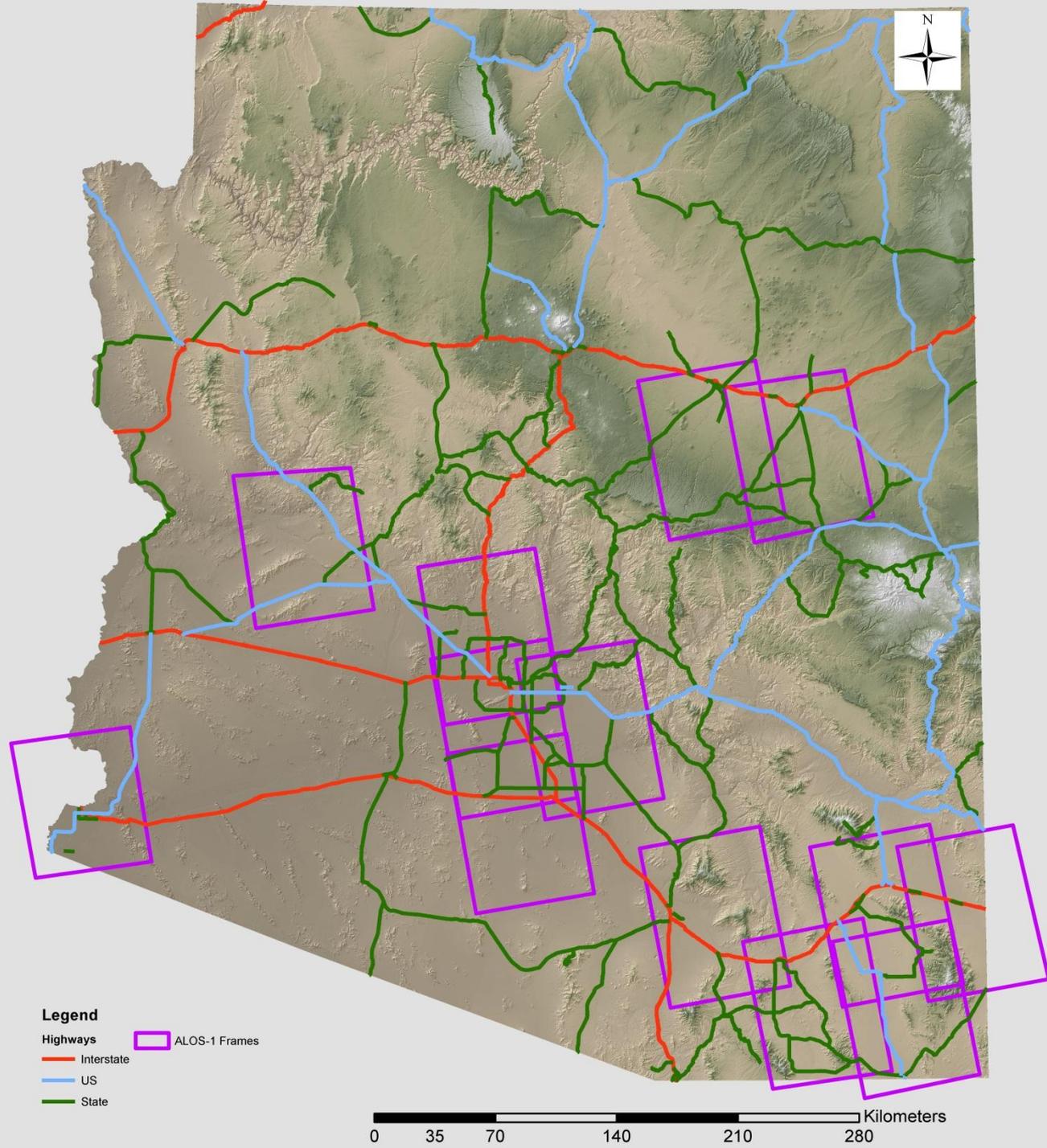
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- By 2009, InSAR program was greatly expanded to cover other areas of the State in order to investigate other potential land subsidence areas where there have been historical groundwater declines.
- Collected both regularly scheduled and archived SAR data for this task of identifying land subsidence areas.



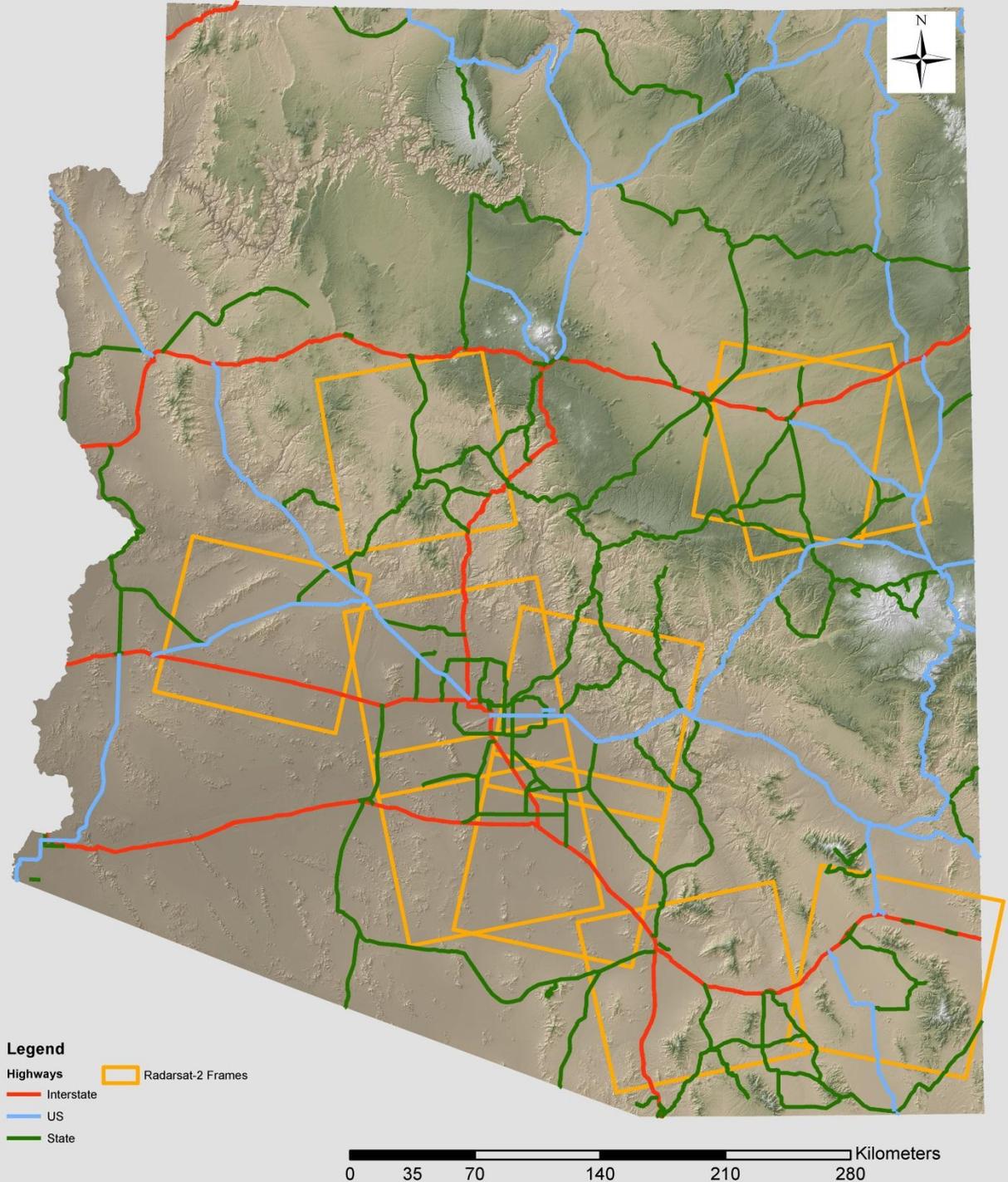
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- ALOS-1 data collected through the Alaska Satellite Facility.



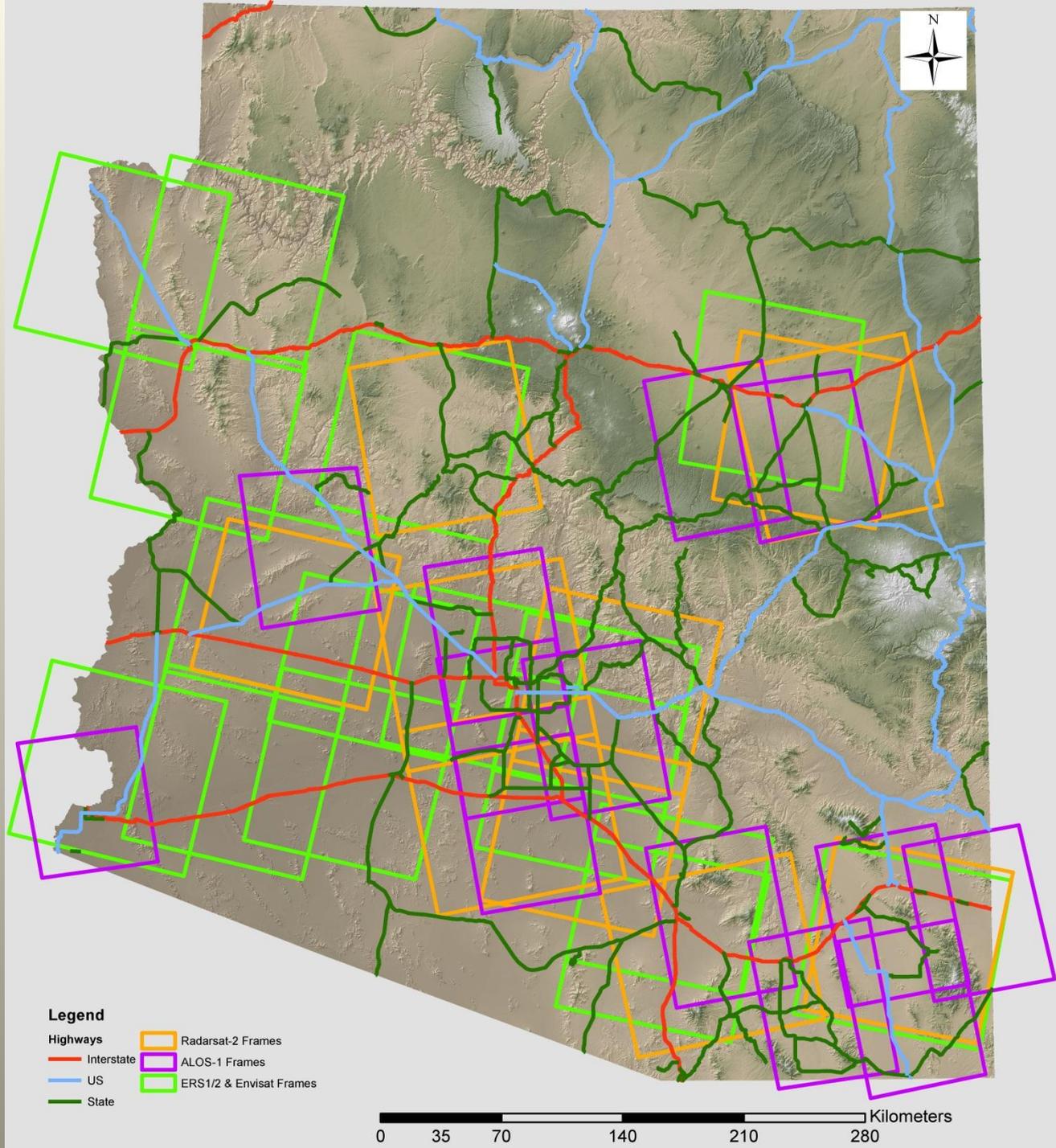
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Radarsat-2 data frames, started collecting in 2010 to replace the aging Envisat satellite.



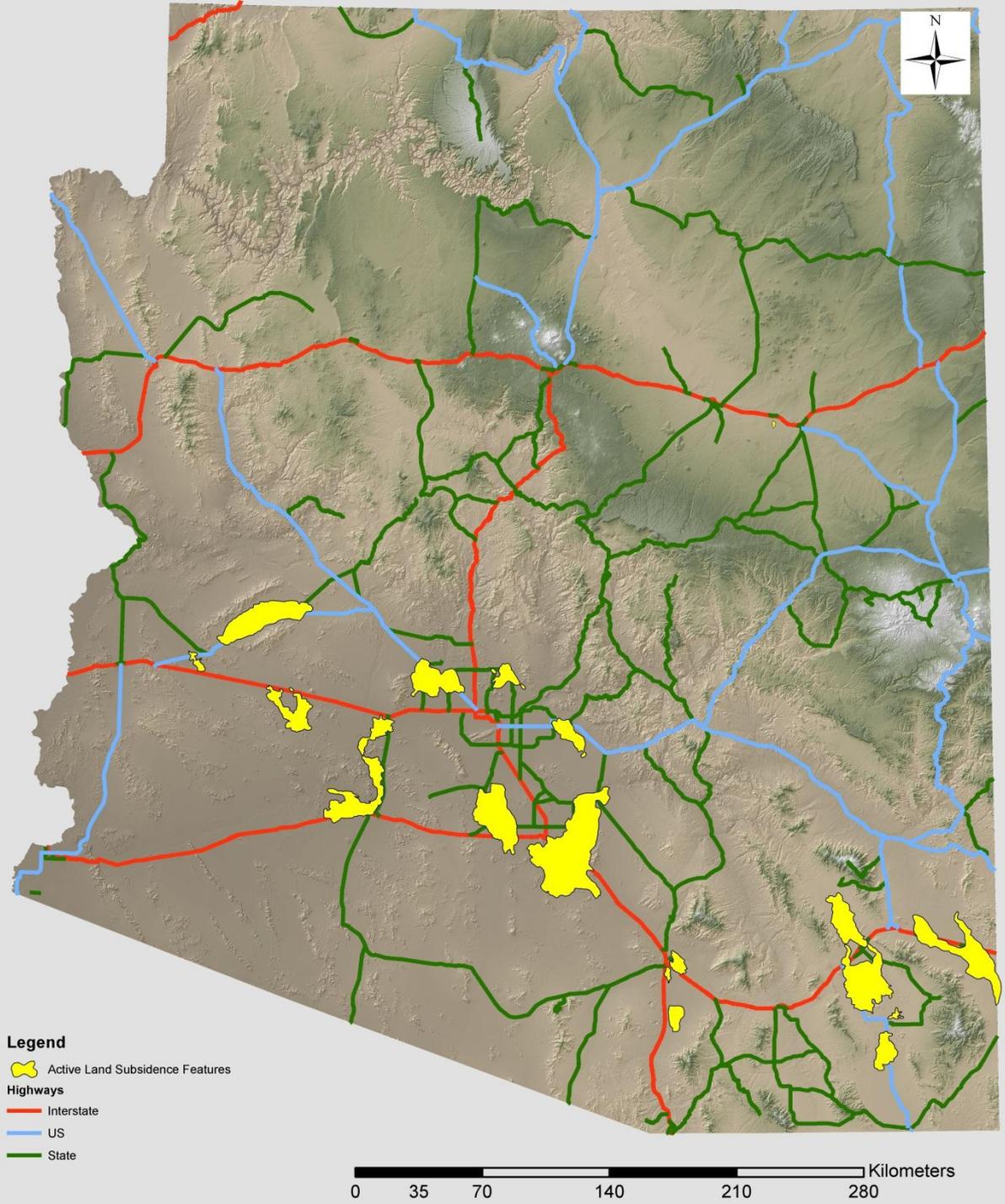
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- All SAR data frames collected by ADWR.



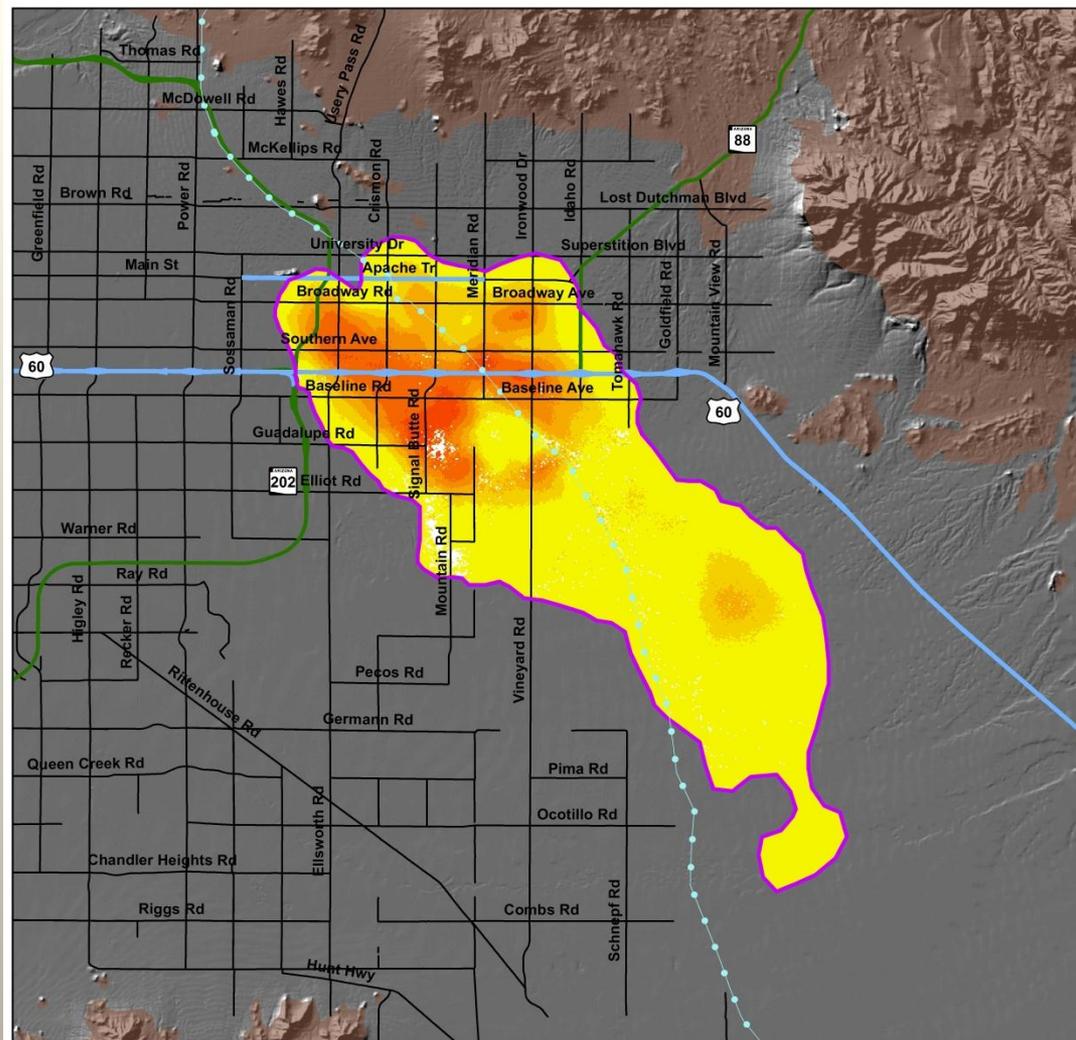
ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- By 2012 identified 25 land subsidence features, covering more than 3,600 square kilometers in mostly central and southern Arizona.
- InSAR program is fully funded through outside cooperation with other federal, state, county, and local government agencies and water providers.



ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Provide land subsidence products to the InSAR cooperators, the public, and to any group who requests the data.
- Land subsidence maps are updated annually and made available through ADWR's website.



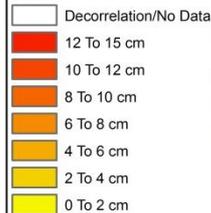
Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction
Based on ADWR Envisat InSAR Data

© ESA 2004 - 2010

Time Period of Analysis: 6.0 Years 10/20/2004 To 09/29/2010

10/20/2004 To 09/29/2010

Subsidence



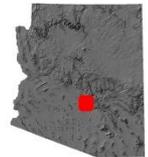
- Subsidence Feature
- Hardrock
- CAP Canal

Highways and Interstates

- Interstate
- US
- State
- Roads

Note! Colors assigned representing differing amounts of subsidence apply to this map only. Color codes may vary for other maps

1:178,556

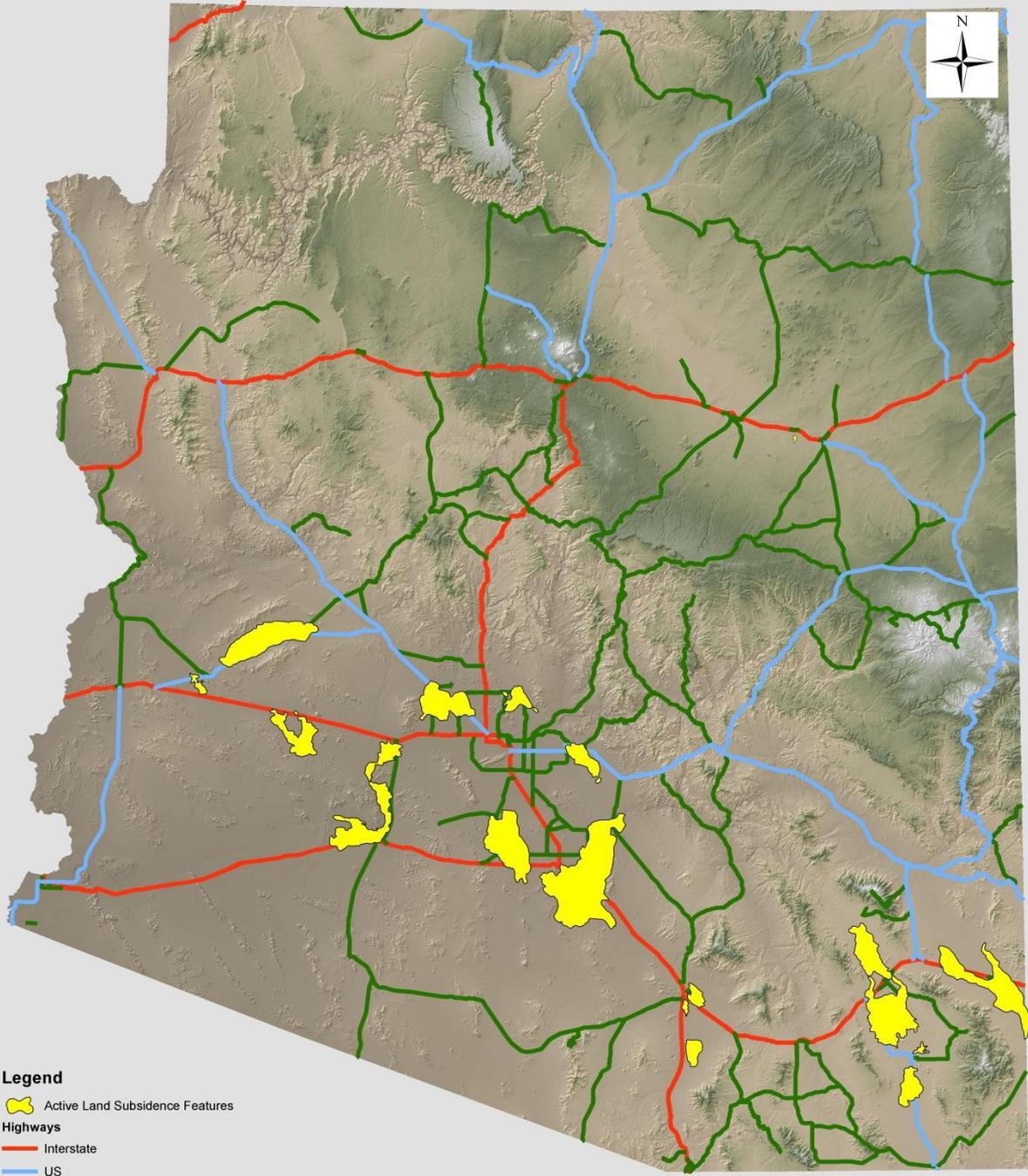


Decorrelation (white areas) are areas where the phase of the received satellite signal changed between satellite passes, causing the data to be unusable. This occurs in areas where the land surface has been disturbed (i.e. bodies of water, snow, agriculture areas, areas of development, etc).



Uses for ADWR's InSAR Data

- Land subsidence
- Seasonal deformation
- Recharge events
- Geological mapping
- Locating earth fissures
- Dam mitigation
- Infrastructure design
- Planning and development
- Surveying and control



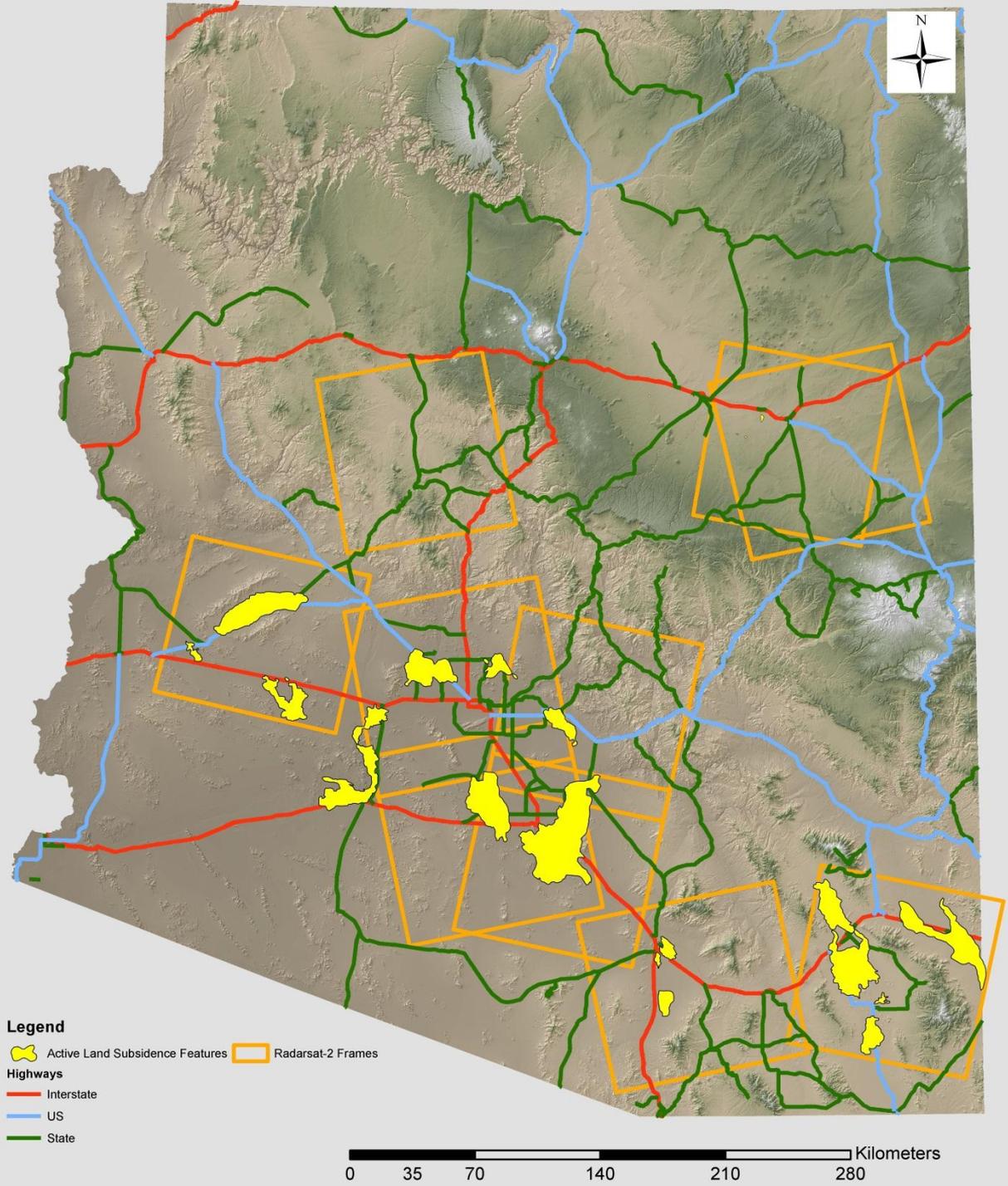
Legend

- Active Land Subsidence Features
- Highways**
 - Interstate
 - US
 - State

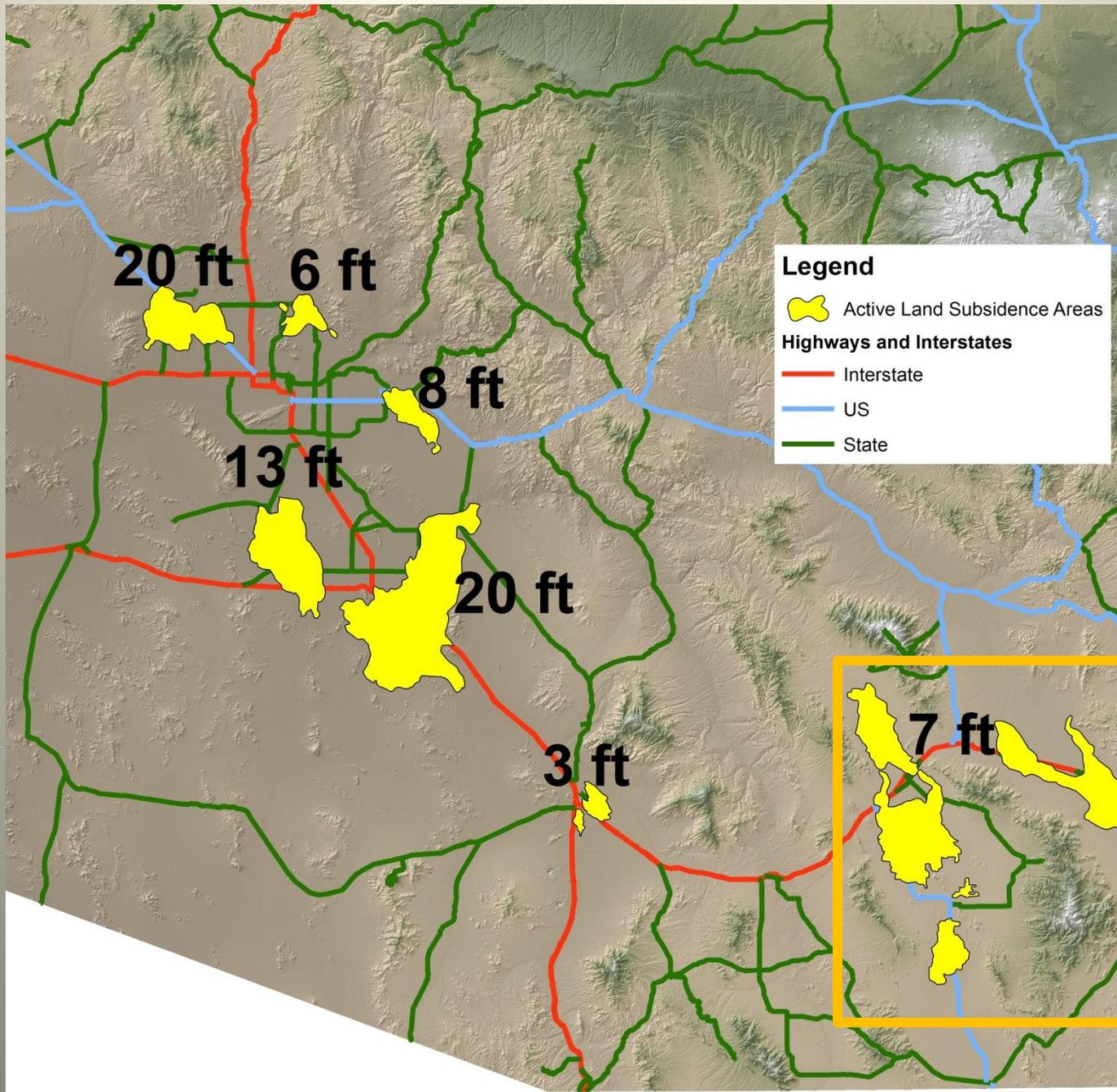


ADWR'S LAND SUBSIDENCE MONITORING PROGRAM

- Current InSAR monitoring program is collecting 6 Radarsat-2 passes each year for each frame covering different seasons and water-use demands.

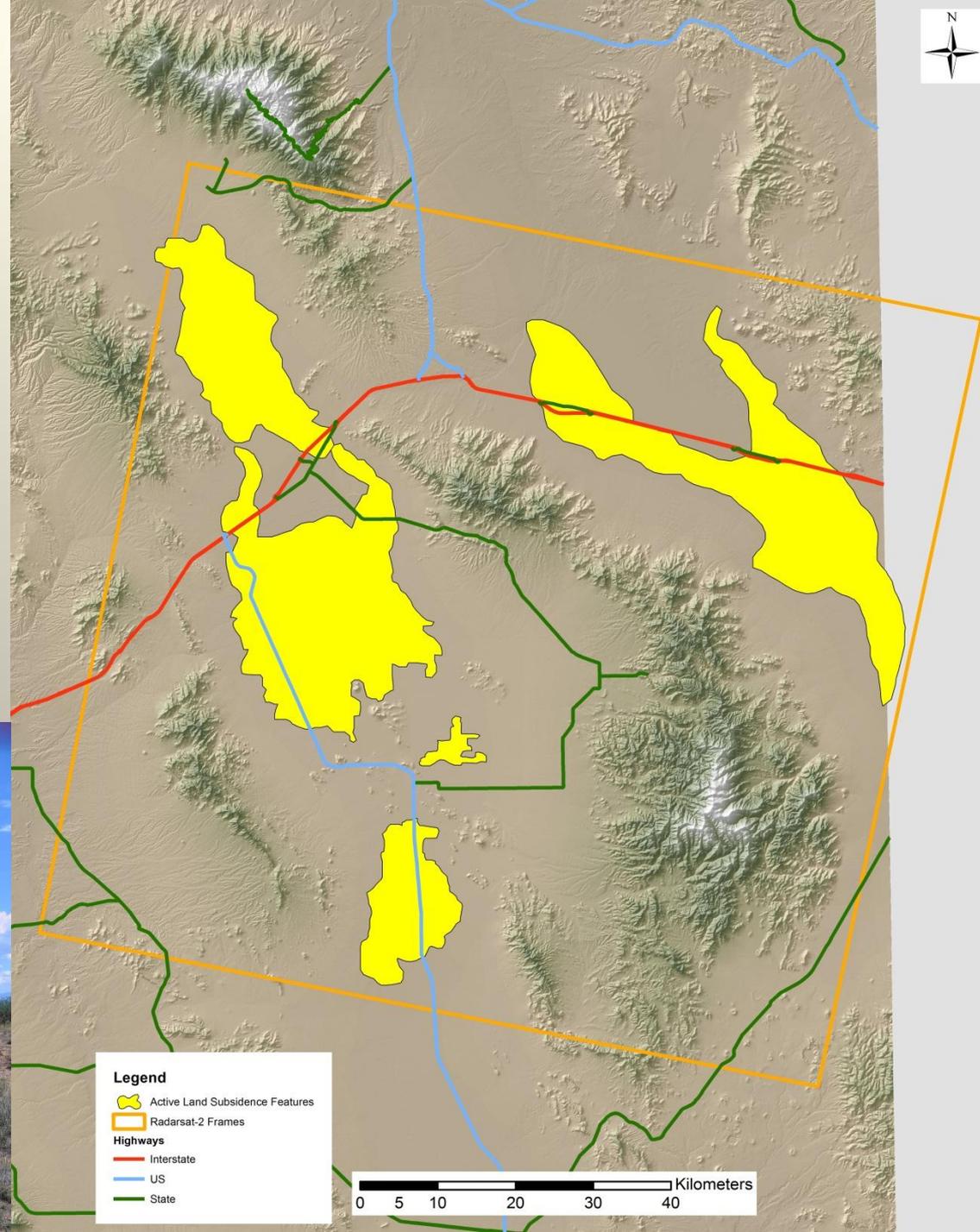


Historical Land Subsidence in Arizona



Cochise County Project in Southeastern Arizona

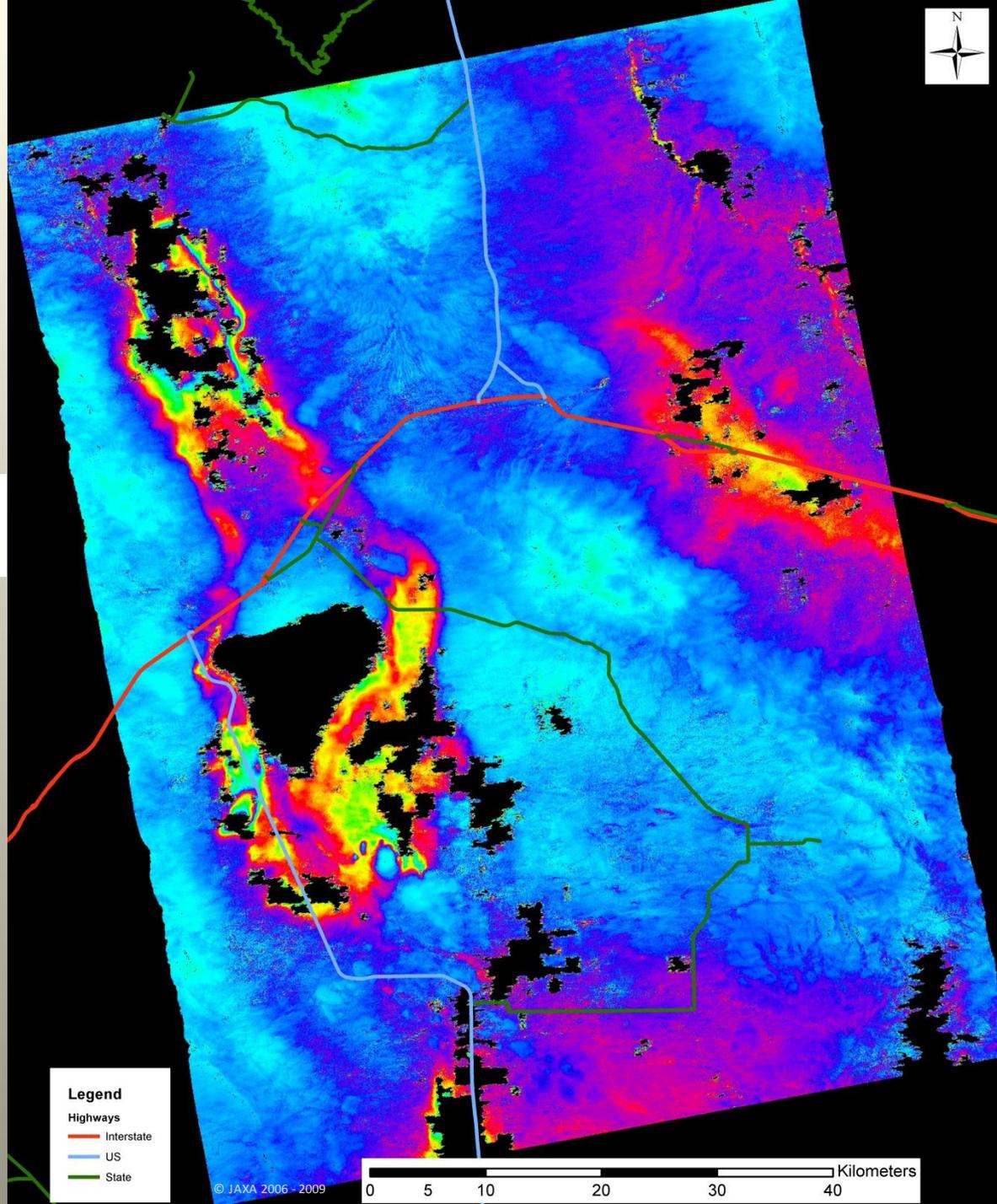
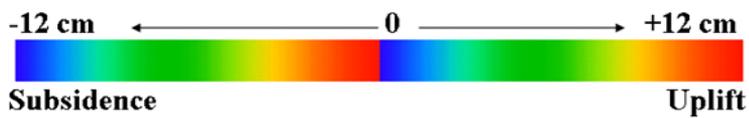
- Highest land subsidence rate in all of Arizona (15 cm/yr).
- Seasonal uplift and subsidence due to elastic aquifer conditions.



Cochise County Project in Southeastern Arizona



- 12/06/2006 to 12/14/2009
ALOS-1 single-pair interferogram



Legend

Highways

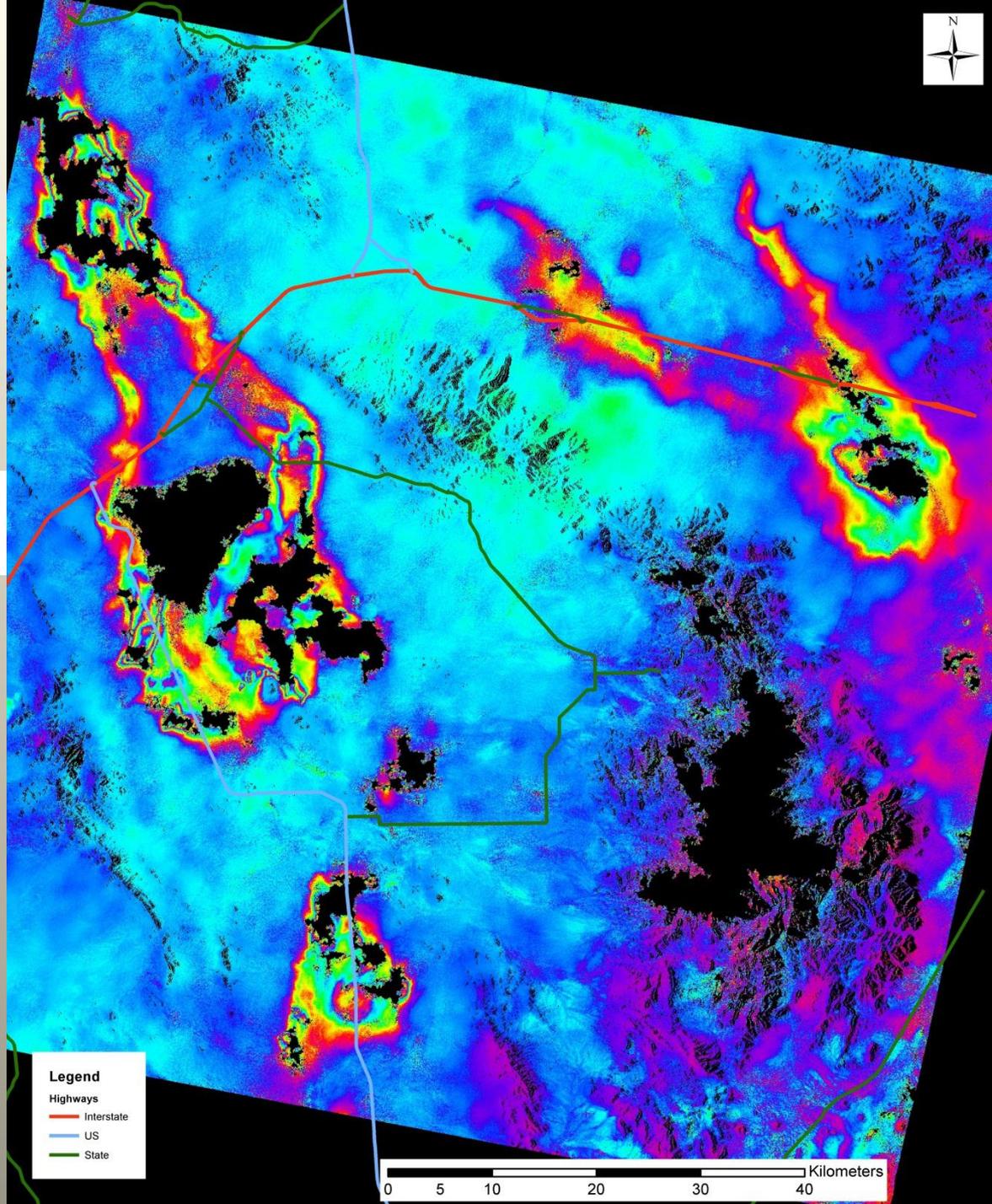
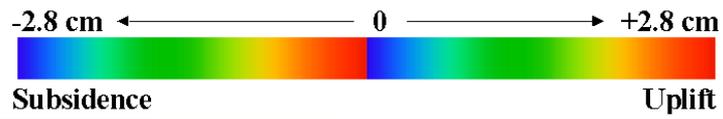
- Interstate
- US
- State

© JAXA 2006 - 2009



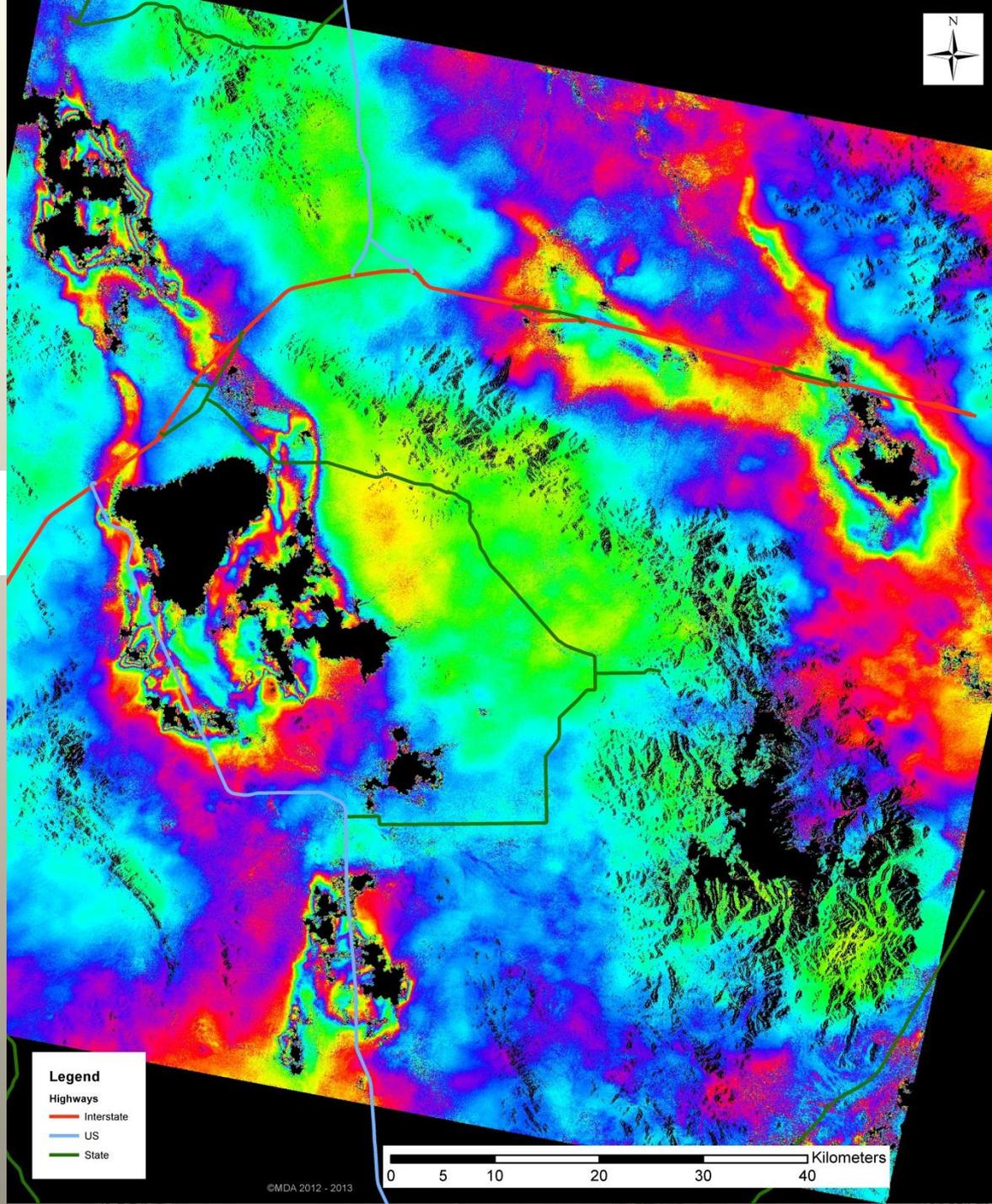
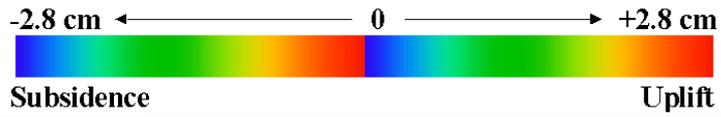
Cochise County Project in Southeastern Arizona

- 03/13/2011 to 03/31/2012 RS-2
single-pair interferogram



Cochise County Project in Southeastern Arizona

- 03/07/2012 to 03/26/2013 RS-2
single-pair interferogram



Legend

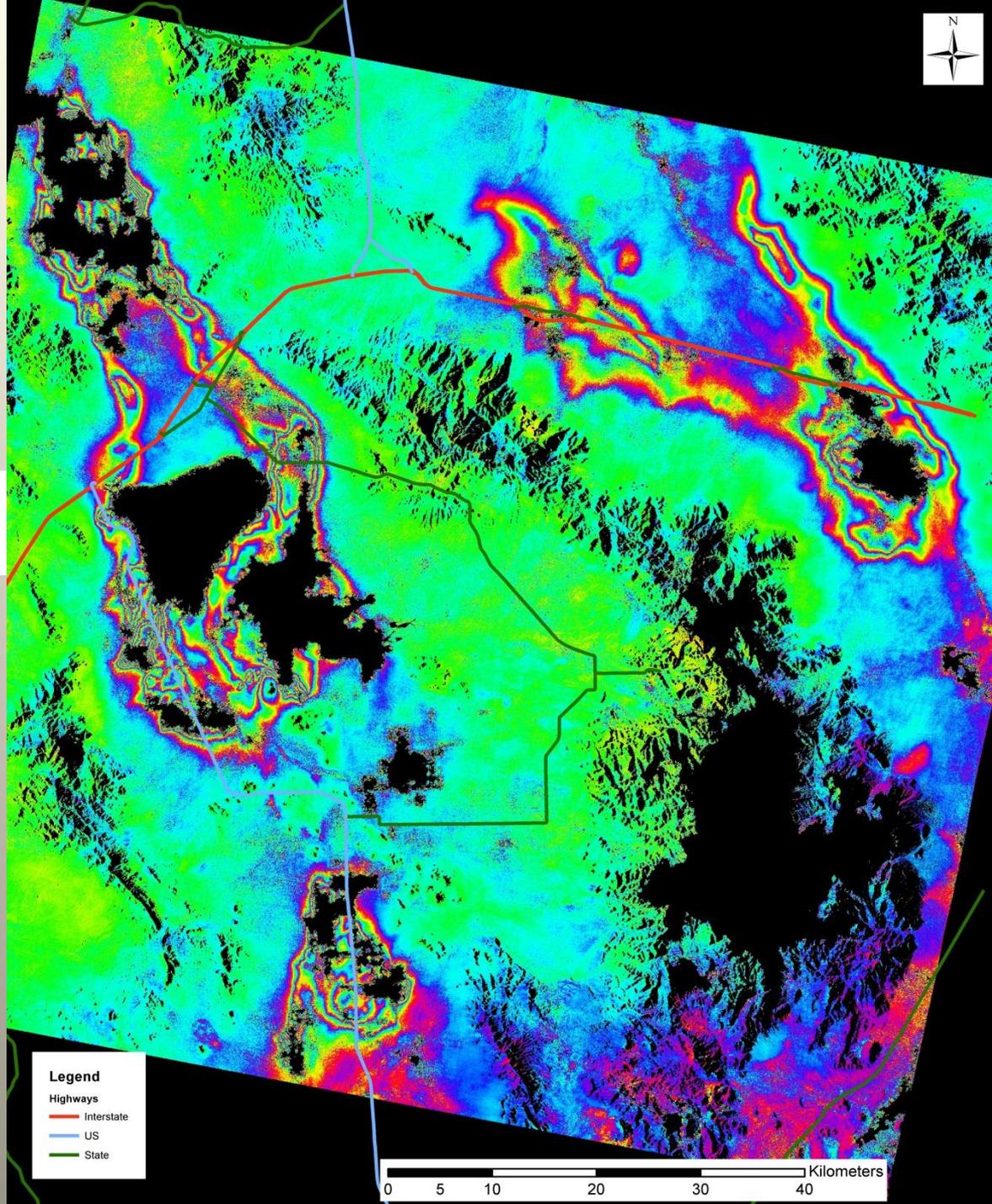
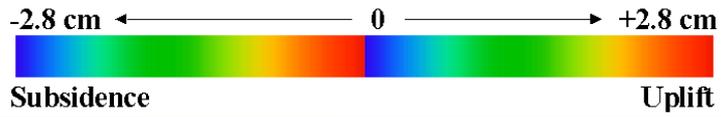
Highways

- Interstate
- US
- State

0 5 10 20 30 40 Kilometers

Cochise County Project in Southeastern Arizona

- 05/05/2010 to 03/26/2013 RS-2 stacked interferogram



Legend

Highways

- Interstate
- US
- State



Cochise County Project in Southeastern Arizona

- 2010 NAIP Imagery
- Large agricultural areas with center pivot irrigation



Cochise County Project in Southeastern Arizona

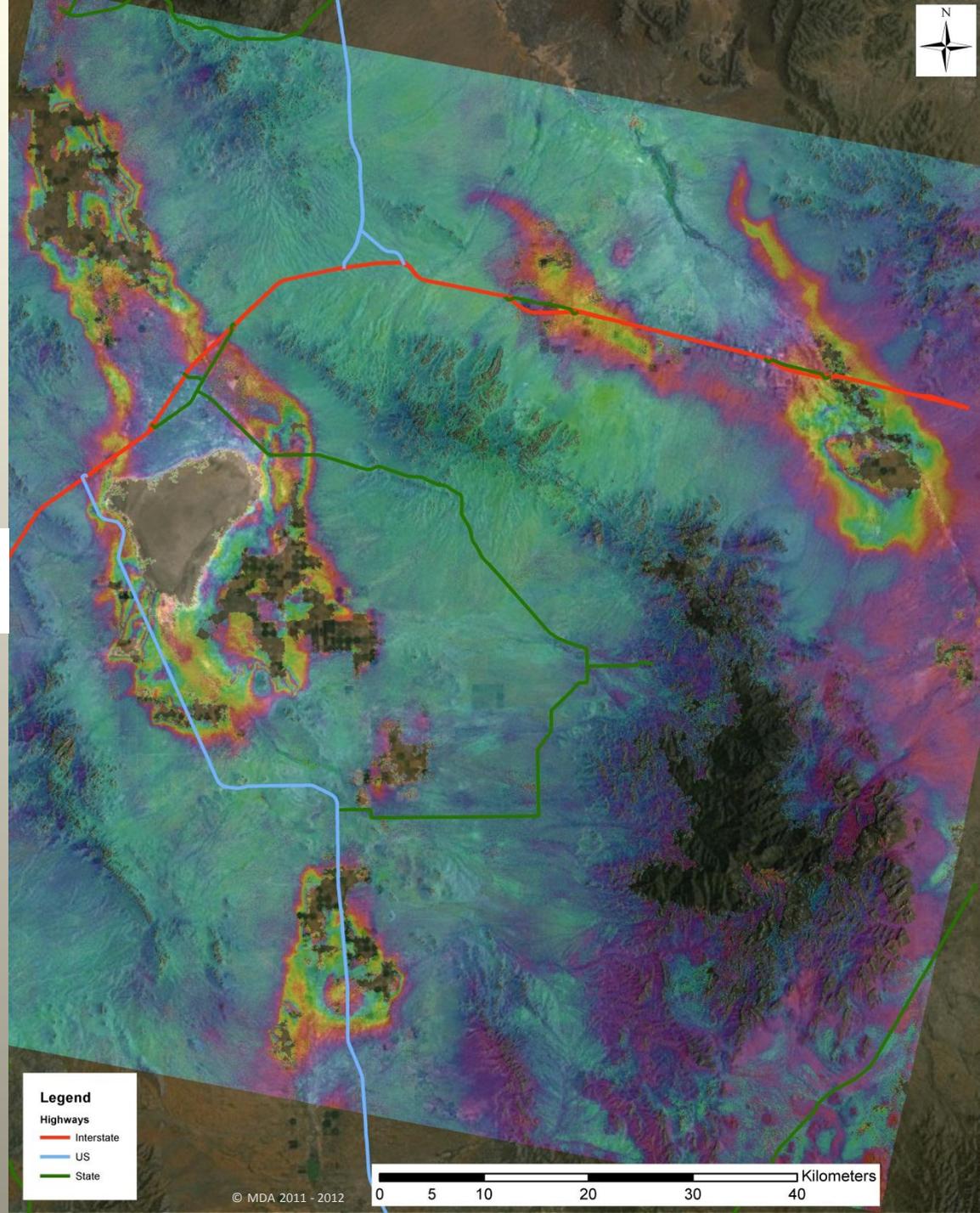
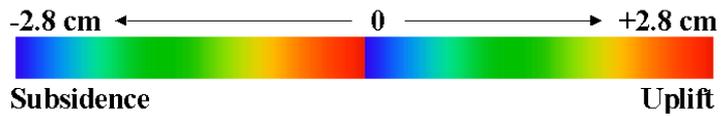
- 2010 NAIP Imagery
- Large agricultural areas with center pivot irrigation





Cochise County Project in Southeastern Arizona

- 03/13/2011 to 03/31/2012 RS-2 single-pair interferogram with 2010 NAIP Imagery



Legend

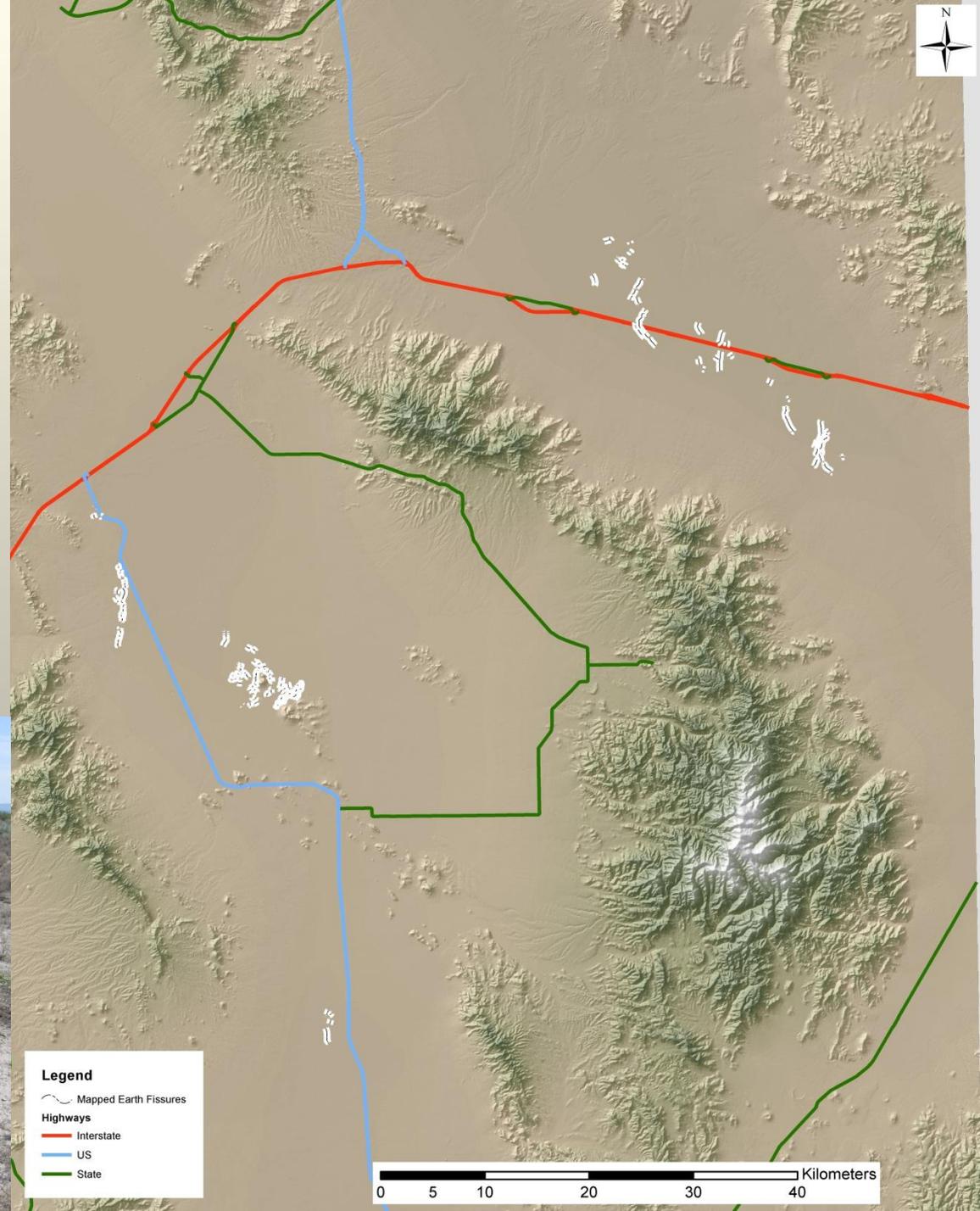
Highways

- Interstate
- US
- State



Cochise County Project in Southeastern Arizona

- Mapped earth fissures by the Arizona Geological Survey.
- More than 150 miles of mapped earth fissures in all of Arizona.



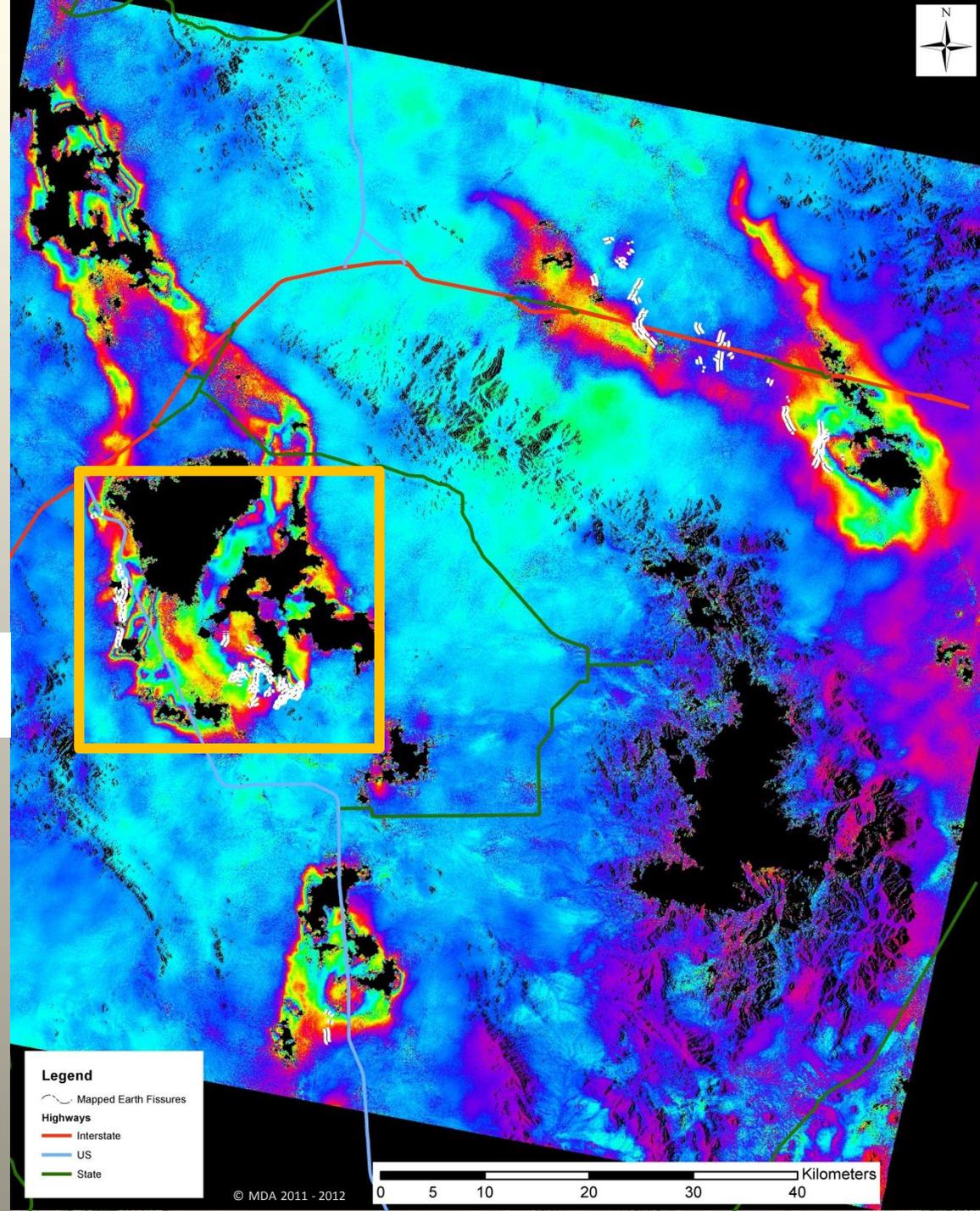
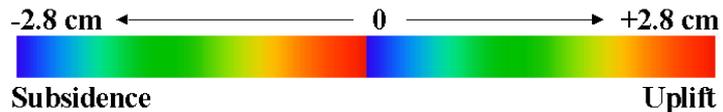
Cochise County Project in Southeastern Arizona

- Mapped earth fissures by the Arizona Geological Survey with the NAIP Imagery



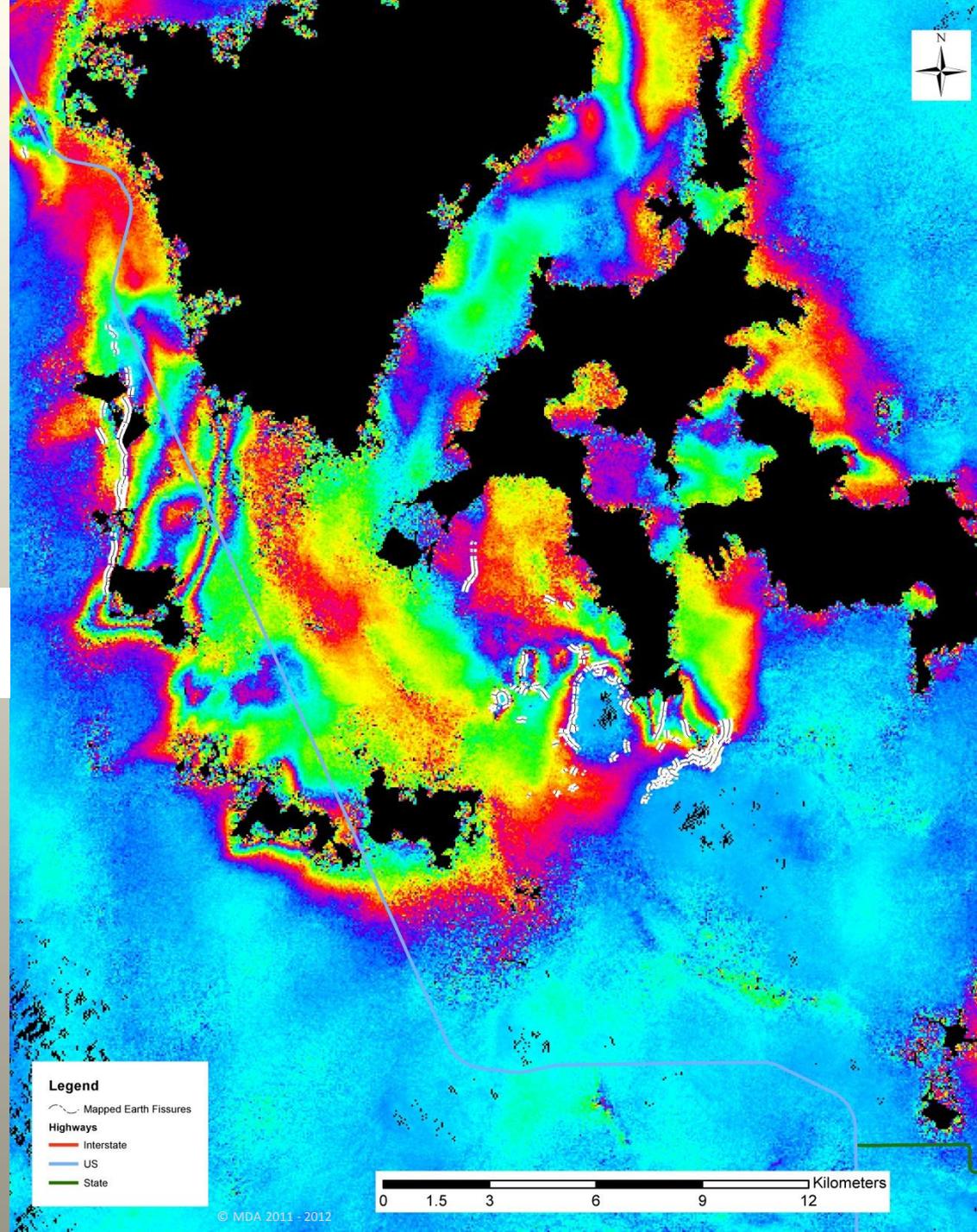
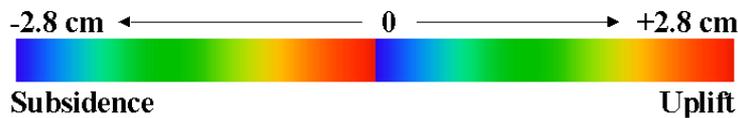
Cochise County Project in Southeastern Arizona

- Mapped earth fissures by the Arizona Geological Survey with the NAIP Imagery and the 03/13/2011 to 03/31/2012 RS-2 single-pair interferogram



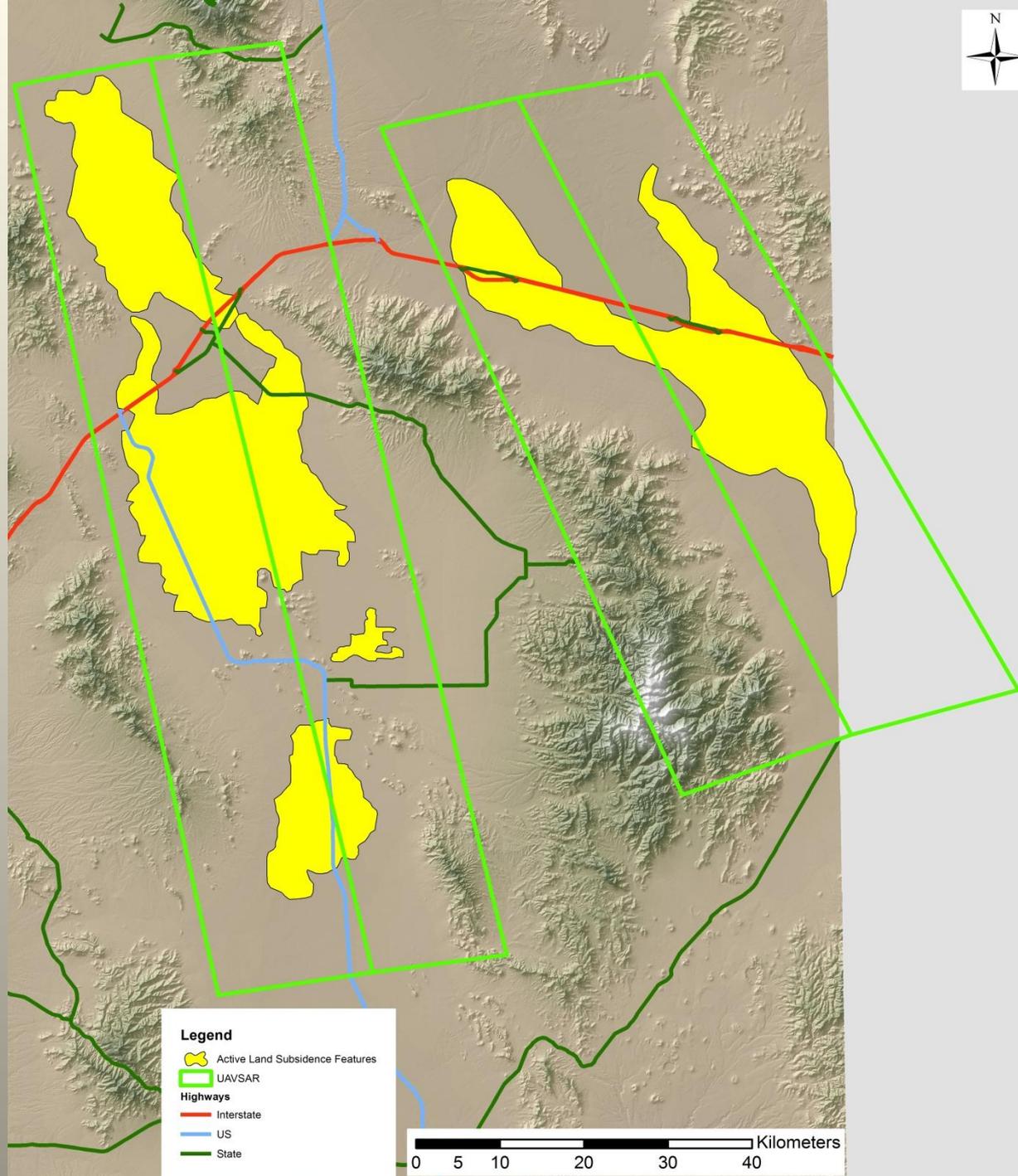
Cochise County Project in Southeastern Arizona

- Mapped earth fissures by the Arizona Geological Survey with the 03/13/2011 to 03/31/2012 RS-2 single-pair interferogram



Cochise County Project in Southeastern Arizona

- UAVSAR data will be collected twice a year (late fall and early spring) to ensure seasonal uplift and subsidence are captured.
- First collect was 10/23/2012 and the second collect is scheduled for 04/04/2013.
- UAVSAR L-band data will hopefully improve decorrelation problems seen with the C-band data.



Questions?



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