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Climate and Host Mapping of *Phytophthora ramorum,* Causal Agent of Sudden Oak Death

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Objectives

- Generate climate and host maps that identify areas at risk for *P. ramorum* infection
- Identify areas where the efficacy and economy of surveys for *P. ramorum* may be increased
- Identify areas where economic and environmental damage caused by *P. ramorum* may be mitigated
- Assist in the creation of scientifically sound and transparent regulatory decisions regarding *P. ramorum*

Methods

- NAPPFAST (www.nappfast.org) was used to model *P. ramorum* infection
- 10 year historical daily data was used
- GIS forest density and type data was acquired from the USFS and queried for deciduous and mixed forests
- Lethal cold soil temperature threshold was acquired from DEFRA, 2004
- Validation zip codes were acquired from the UC Berkeley California OakMapper (http://kellylab.berkeley.edu/OakMapper/viewer.htm)
- The preliminary relative risk map was based on the average of host density and climate match frequency

Model Parameters

- Tmin = 3°C; Topt = 20°C; Tmax = 28°C (Orlikowski and Szkuta, 2002; Werres *et al*., 2001, Tooley *et al.,* 2005)
- Minimum accumulated leaf wetness: 12 Hours (Huberli *et al*., 2003)
- ≥ 10 accumulated days during the month meeting these conditions (Jones pers. comm., 2004)
- Annual prediction map uses ≥ 60 or more accumulated days during the year meeting these conditions
- Areas where the soil temperature reached -25°C for at least 1 day during January were masked
- U.S. areas where no hardwood hosts occur were masked

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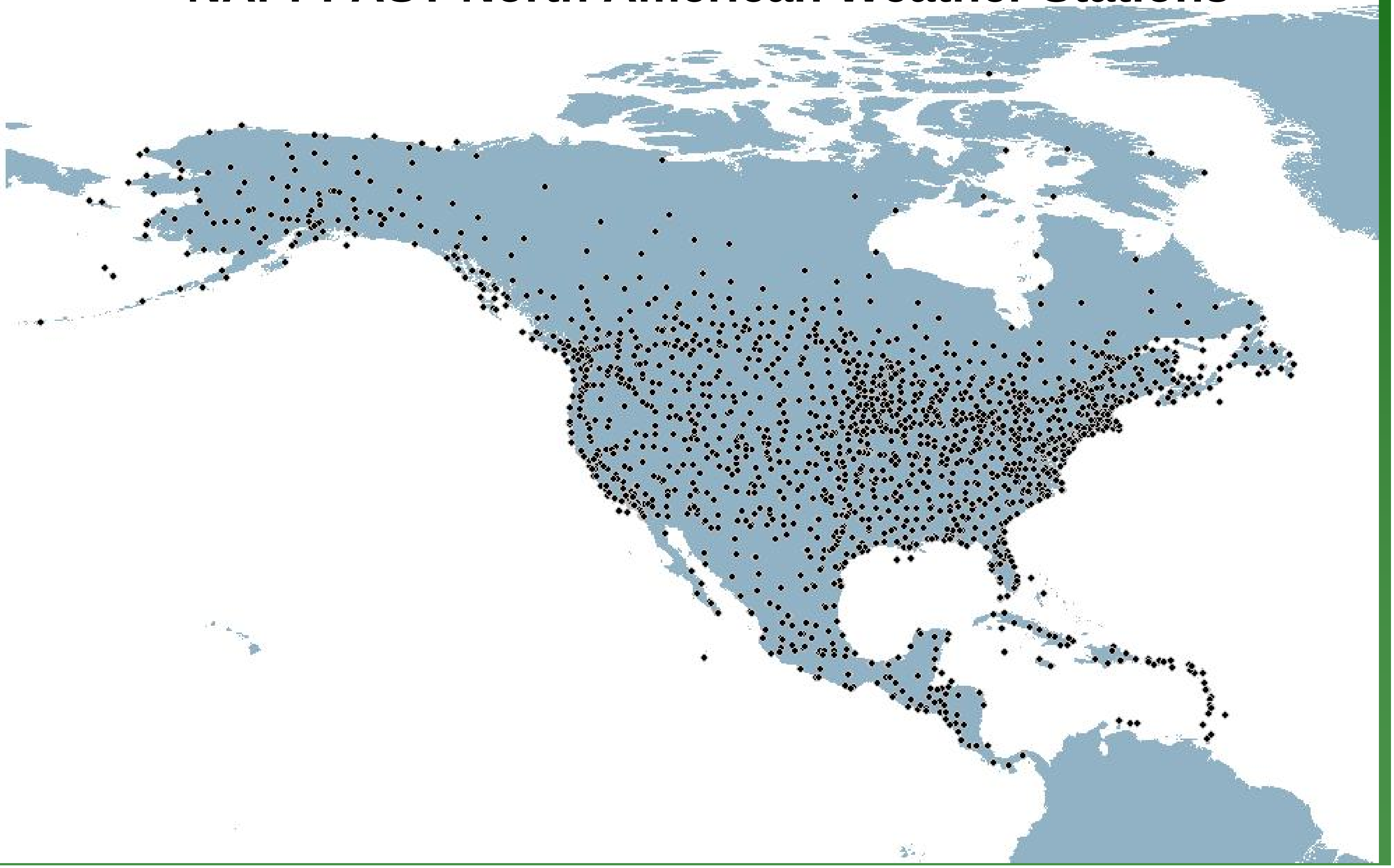
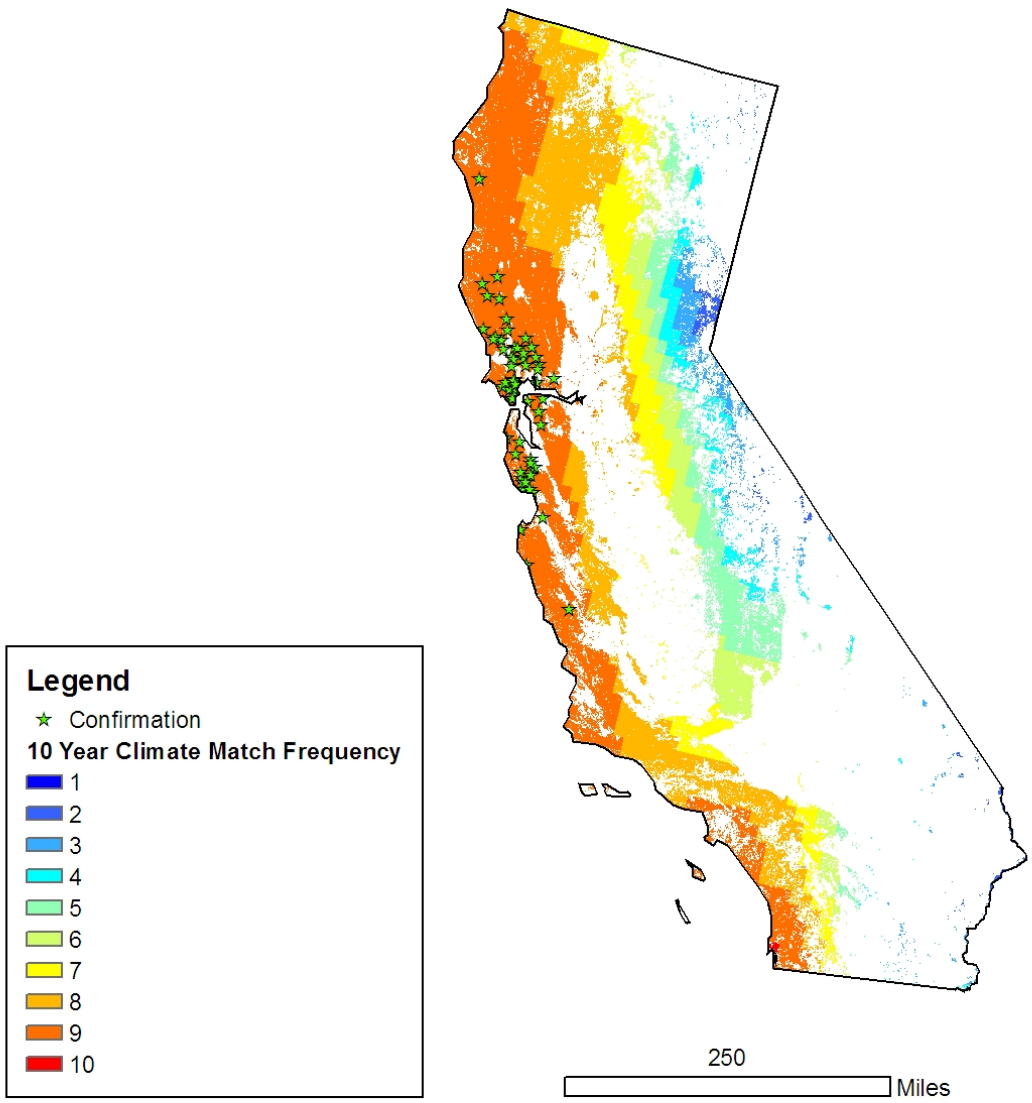
NAPPFAST North American Weather Stations



10 Year Climate Match Frequency and Model Validation



Sources: DEFRA, 2004; Huberli et al., 2003; NAPPFAST, 2005; Olikowski and Szkuta, 2002; USFS, 1991; Werres et al., 2001
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NAD83 Albers Equal Area Conic
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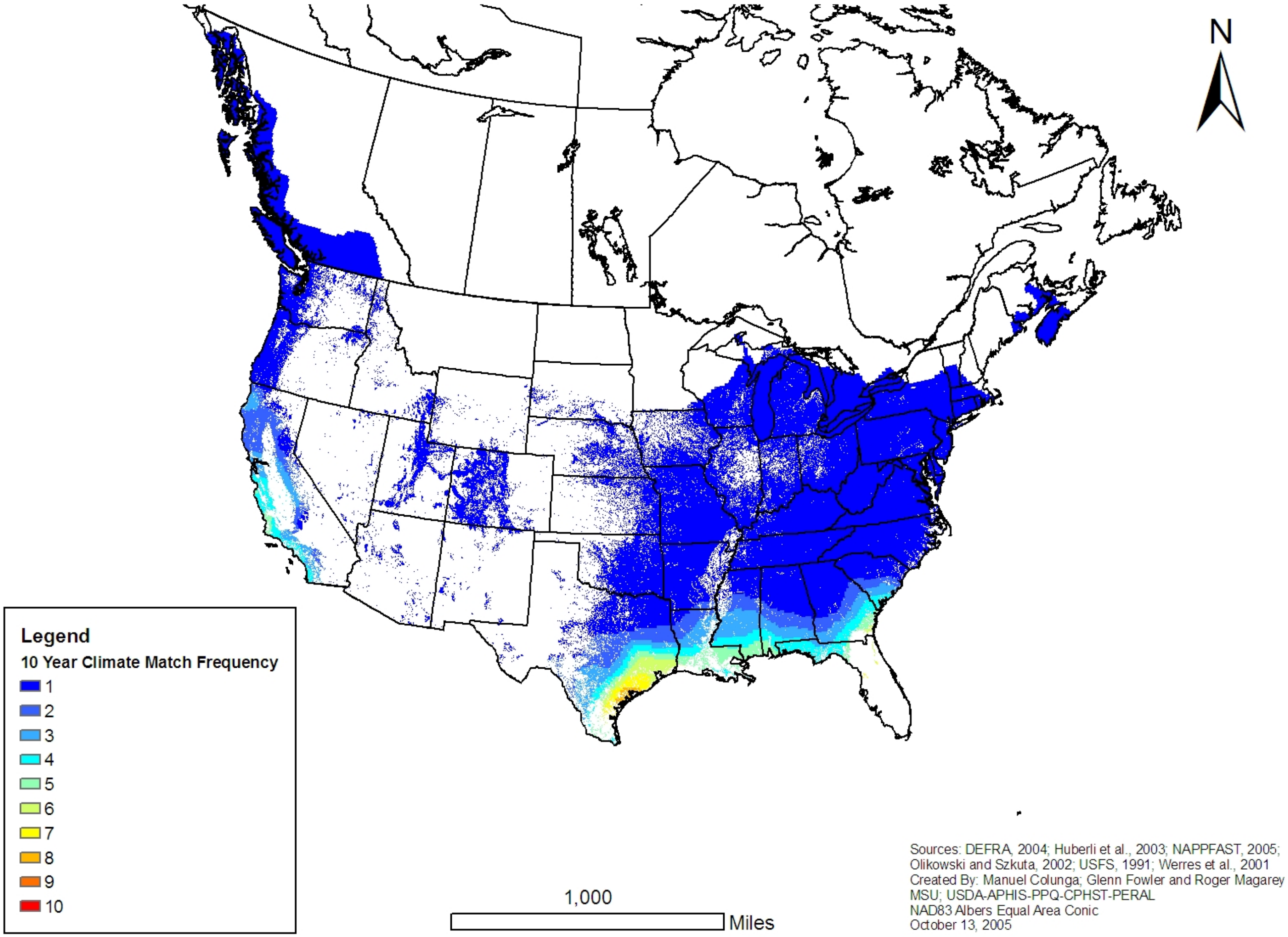
January



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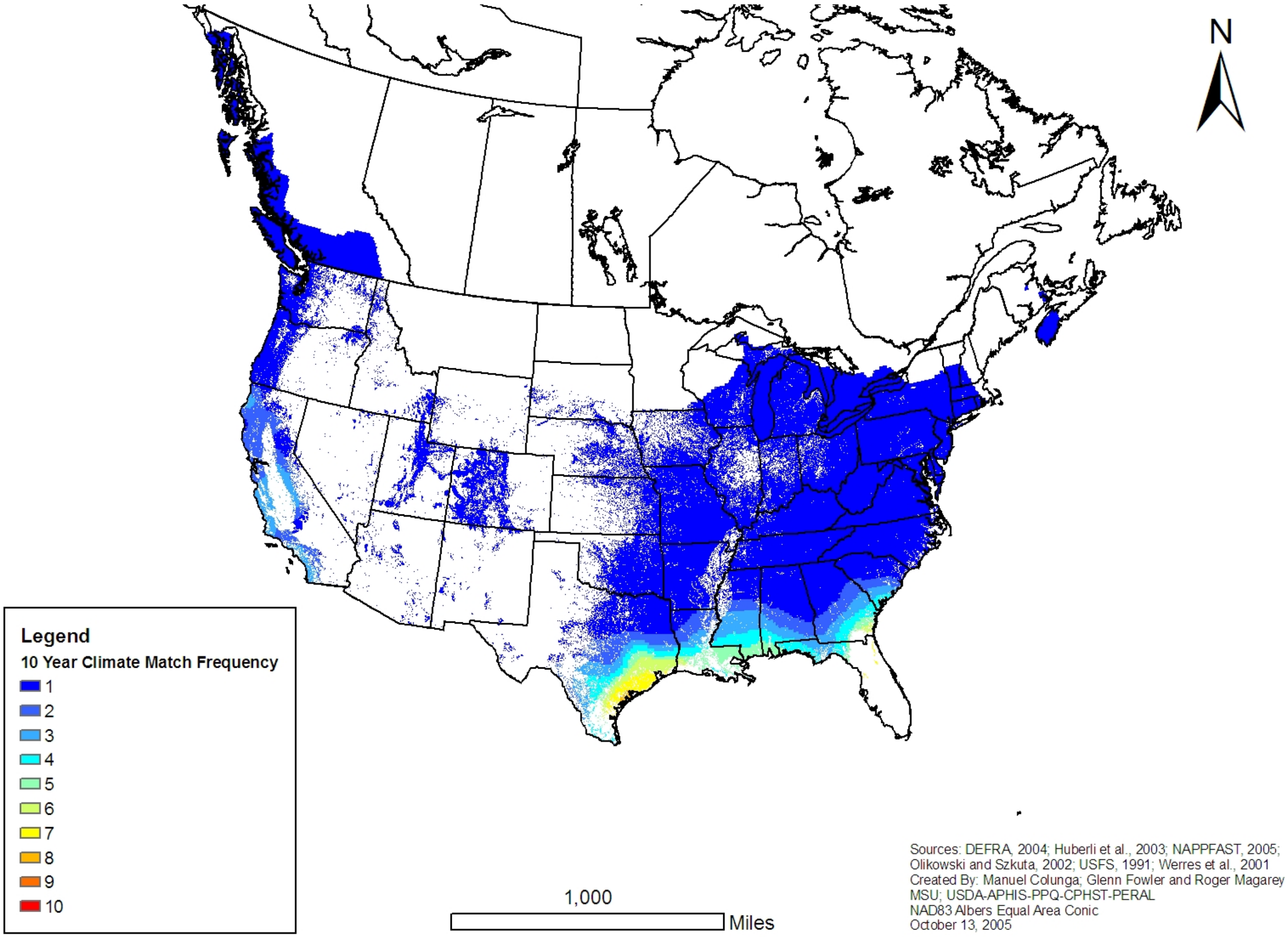
February



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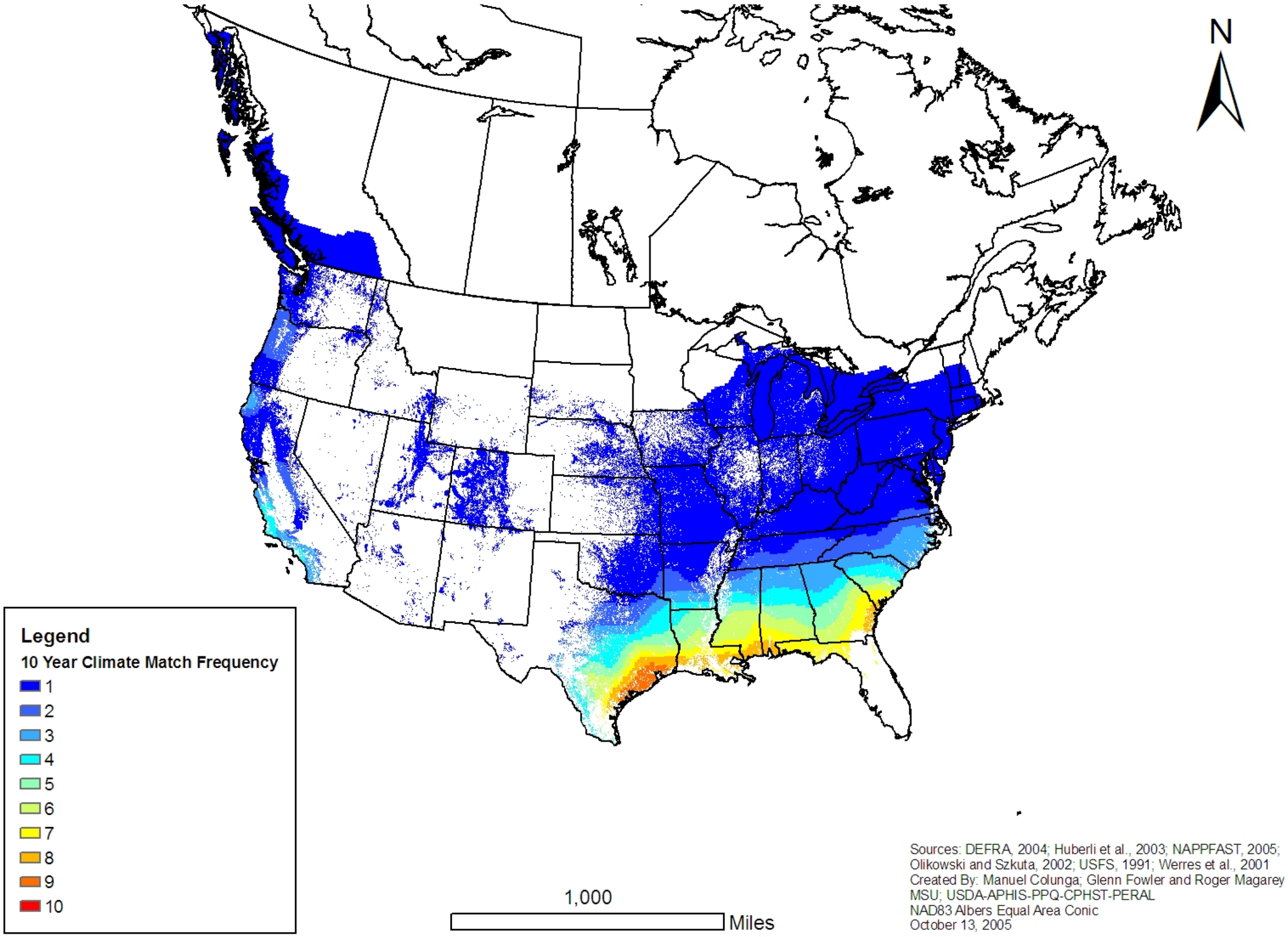
March



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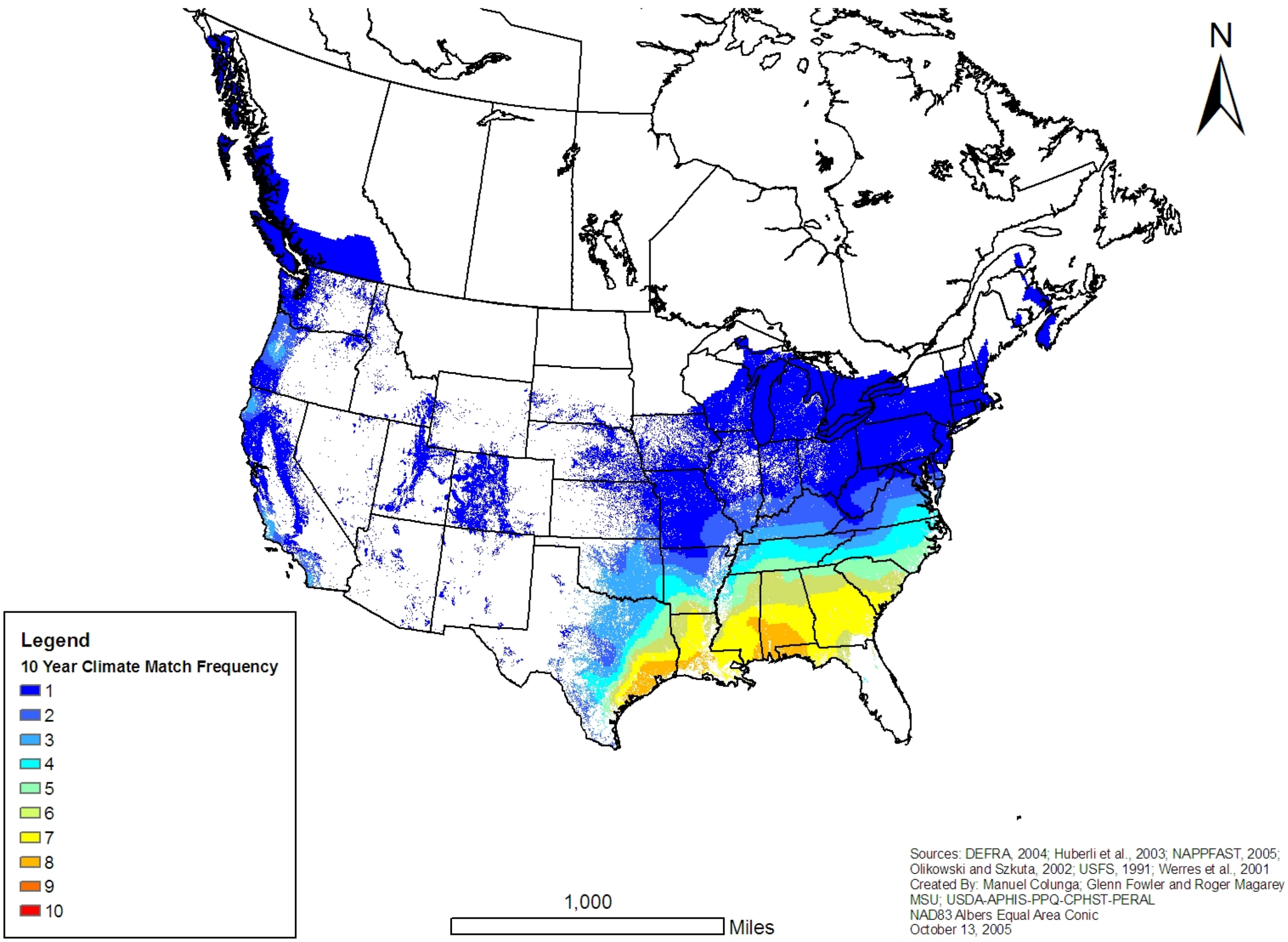
April



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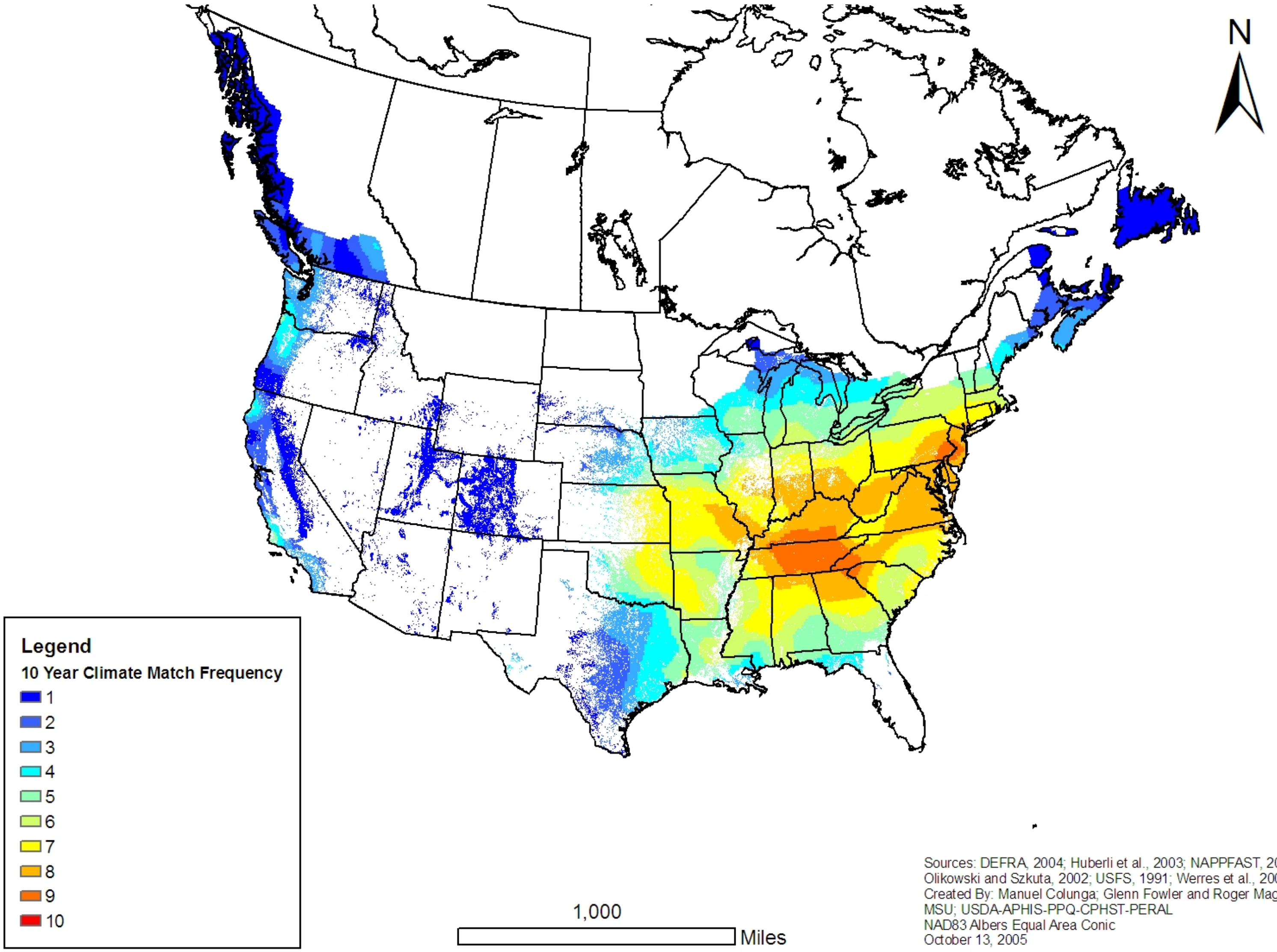
May



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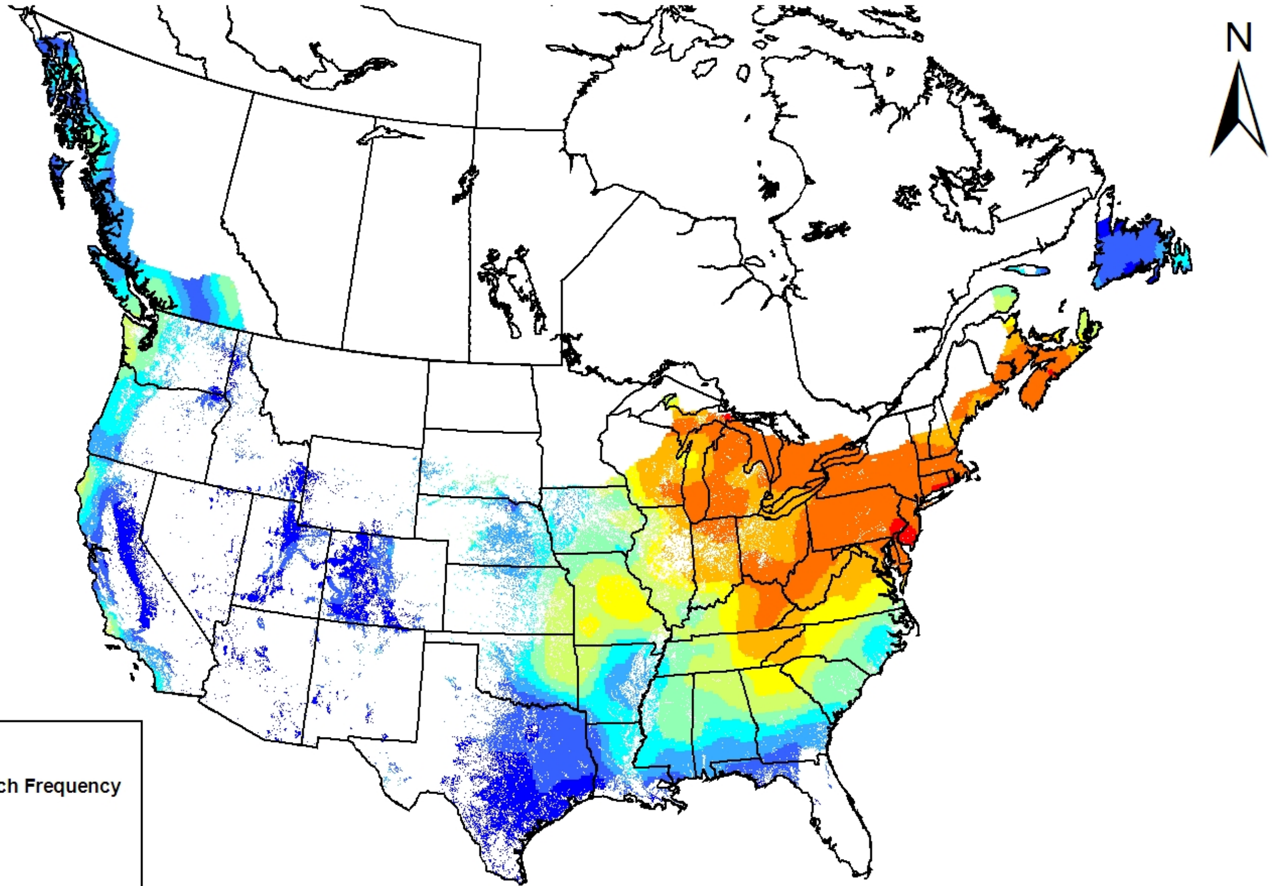
June



Legend

10 Year Climate Match Frequency

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

1,000 Miles

Sources: DEFRA, 2004; Huberli et al., 2003; NAPPFAST, 2005; Olikowski and Szkuta, 2002; USFS, 1991; Werres et al., 2001
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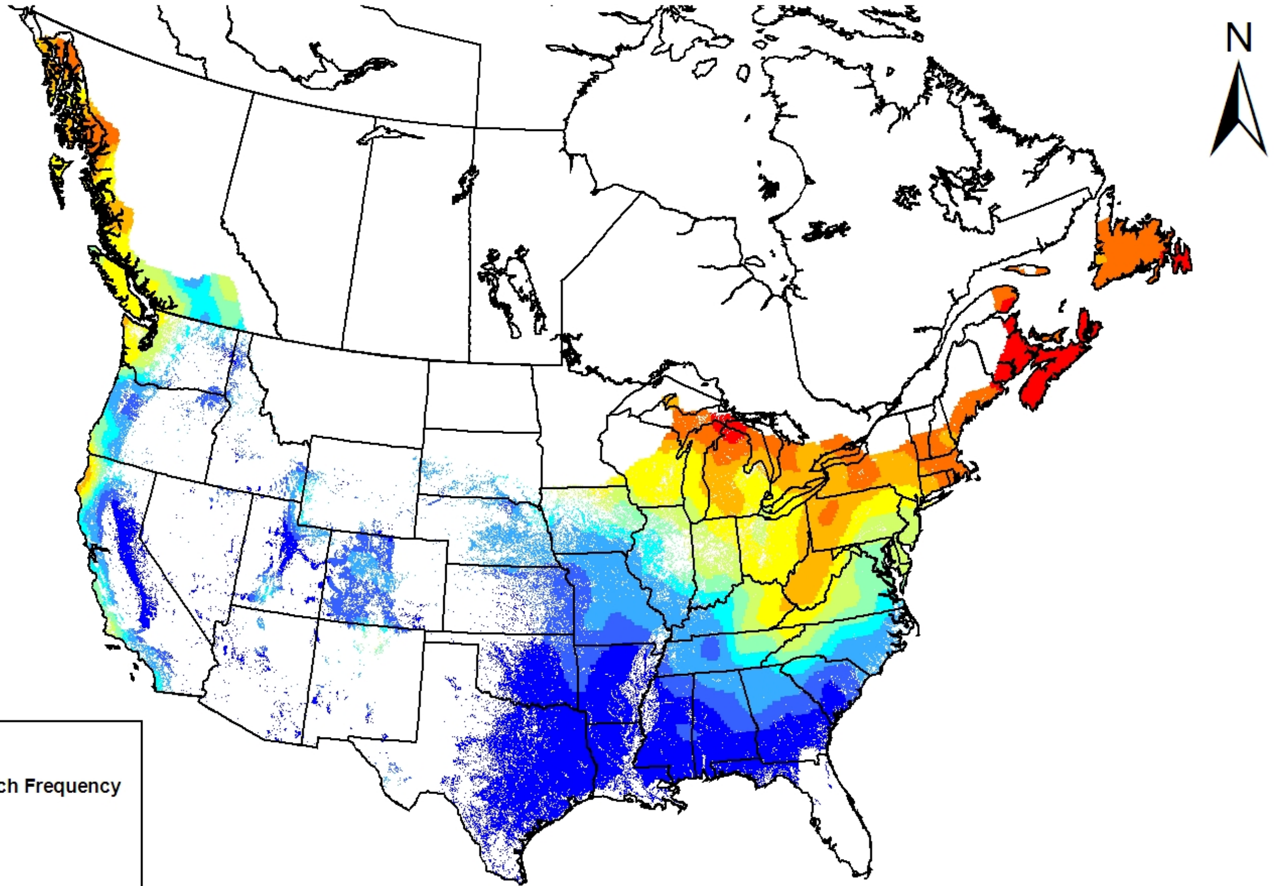
July



Legend

10 Year Climate Match Frequency

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

1,000 Miles

Sources: DEFRA, 2004; Huberli et al., 2003; NAPPFAST, 2005; Olikowski and Szkuta, 2002; USFS, 1991; Werres et al., 2001
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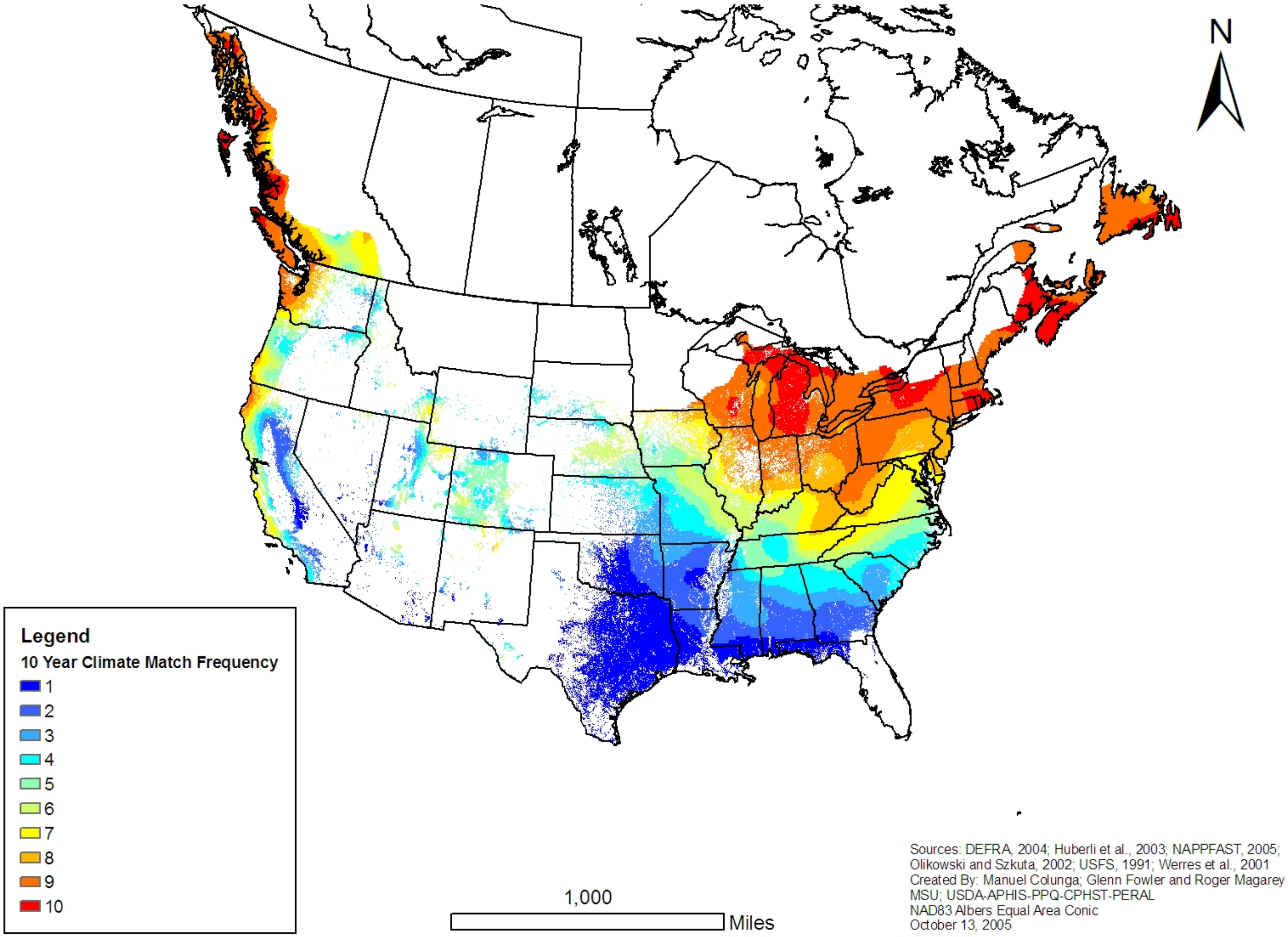
August



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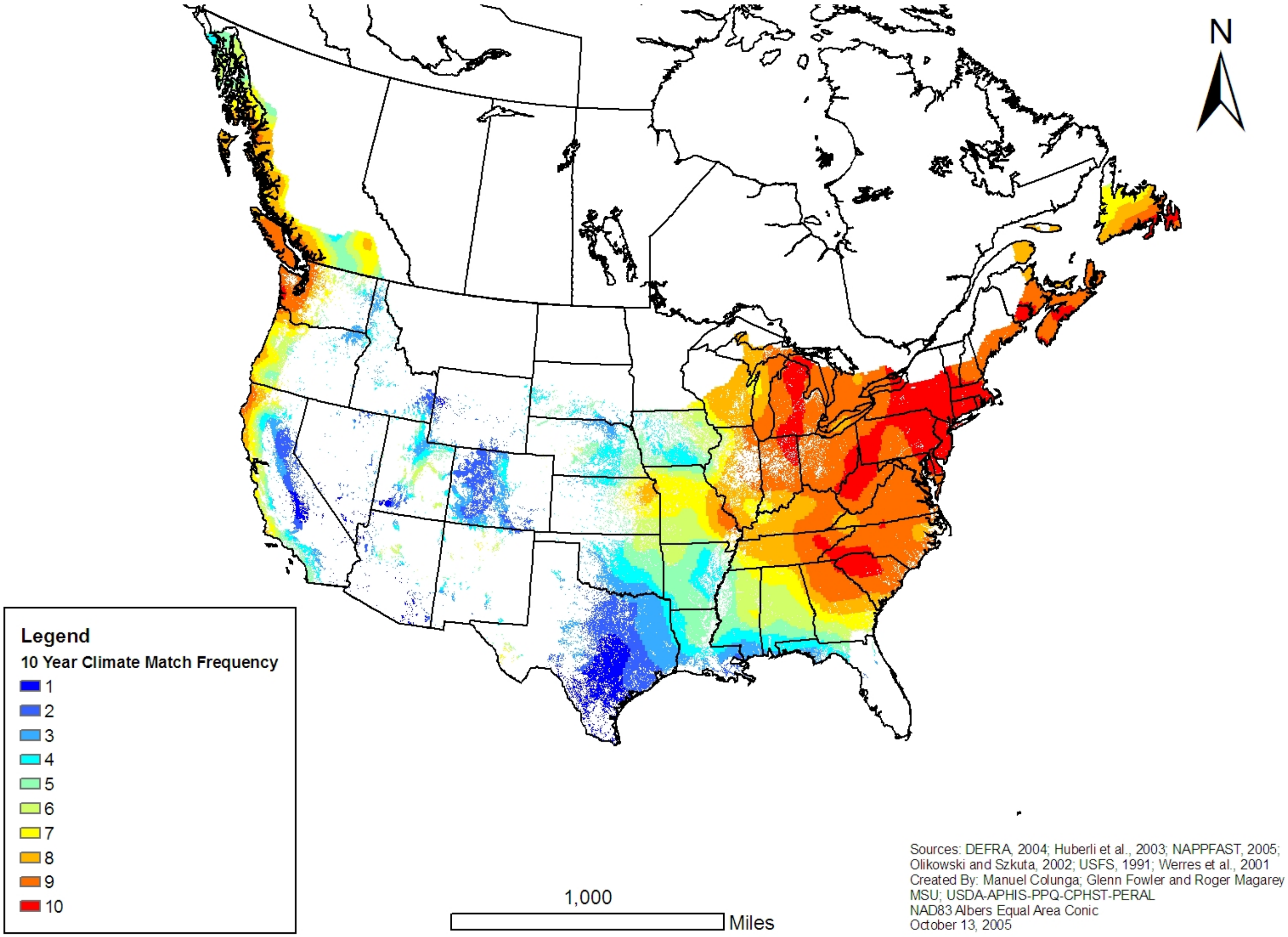
September



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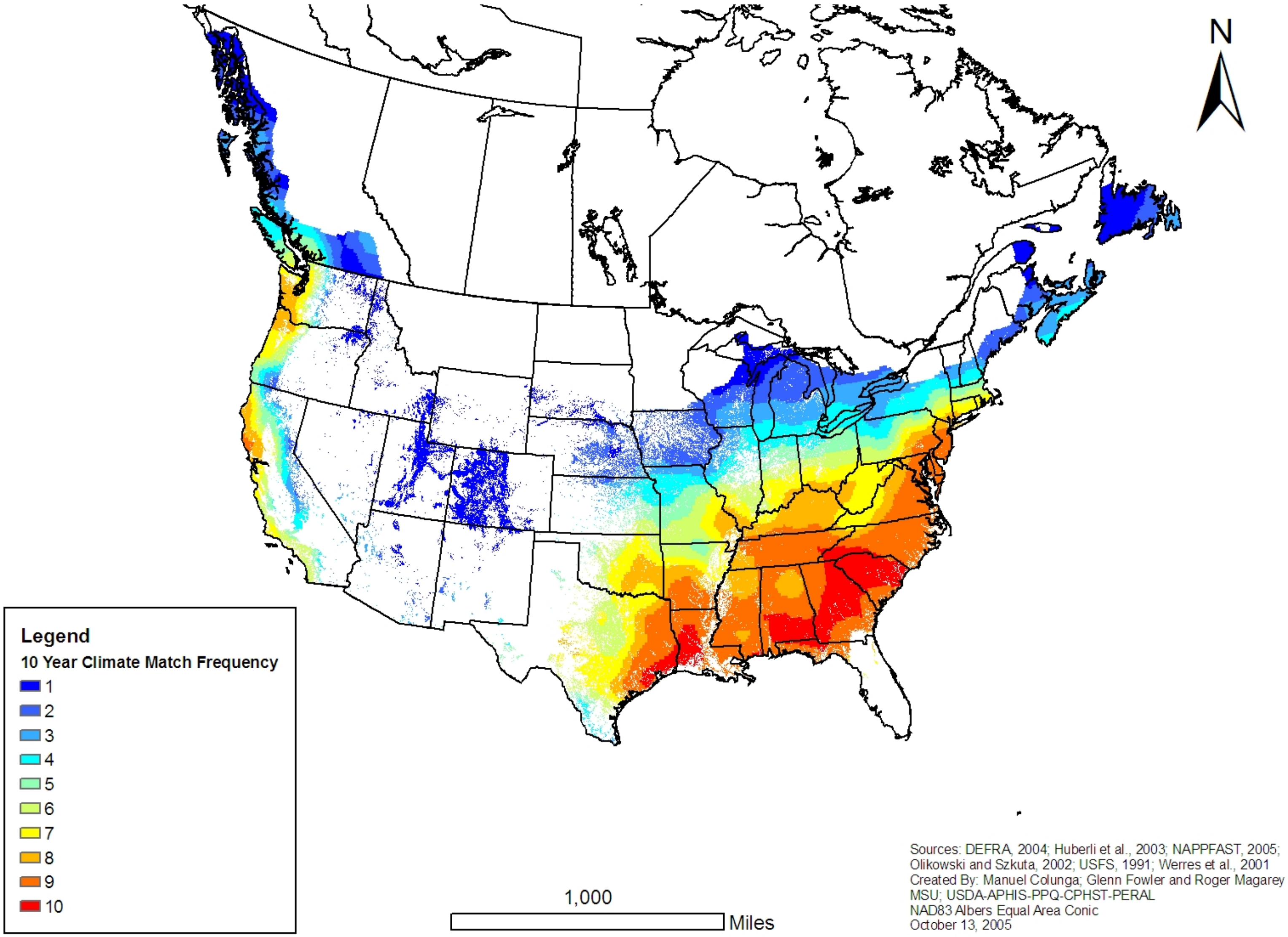
October



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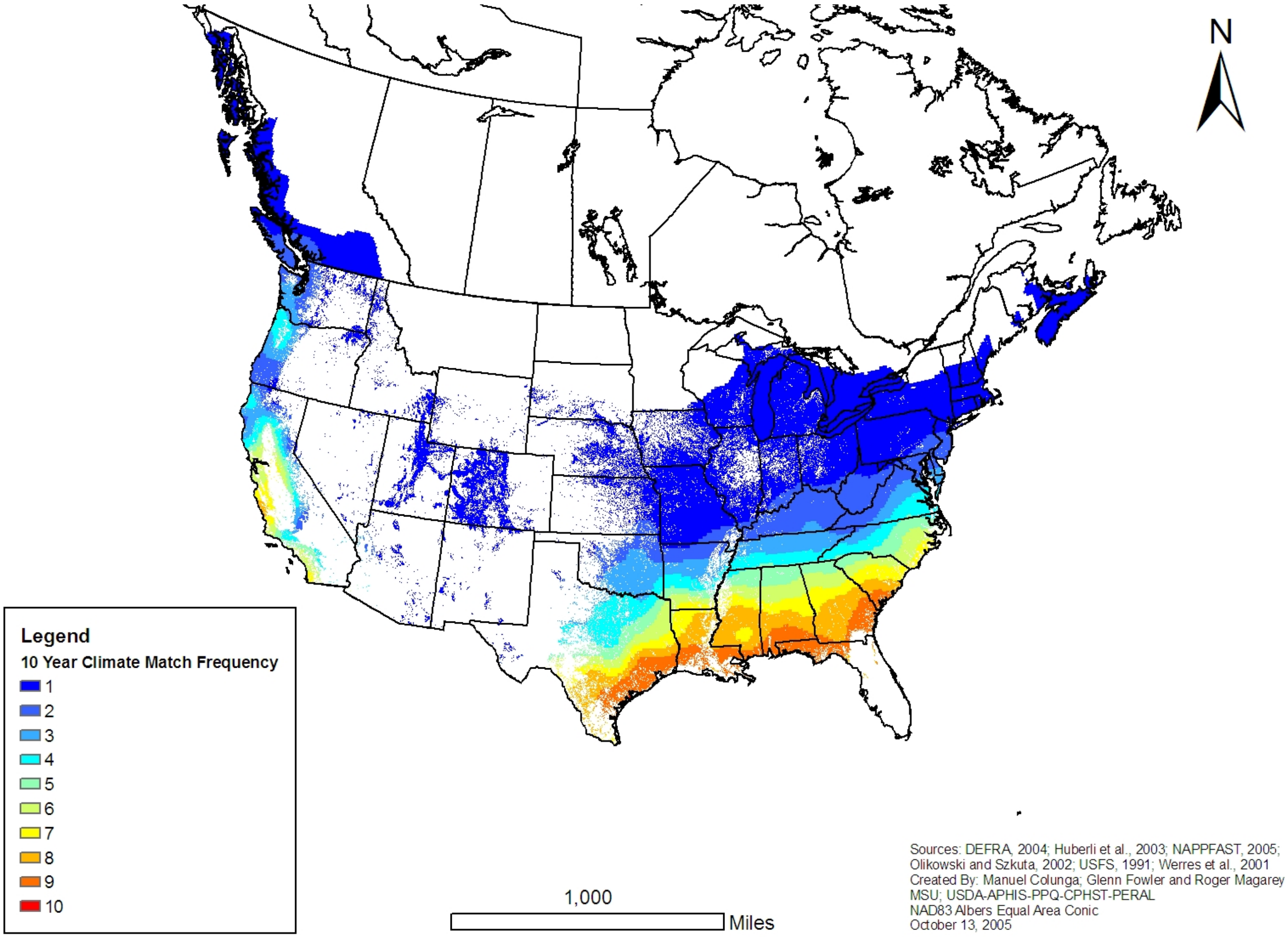
November



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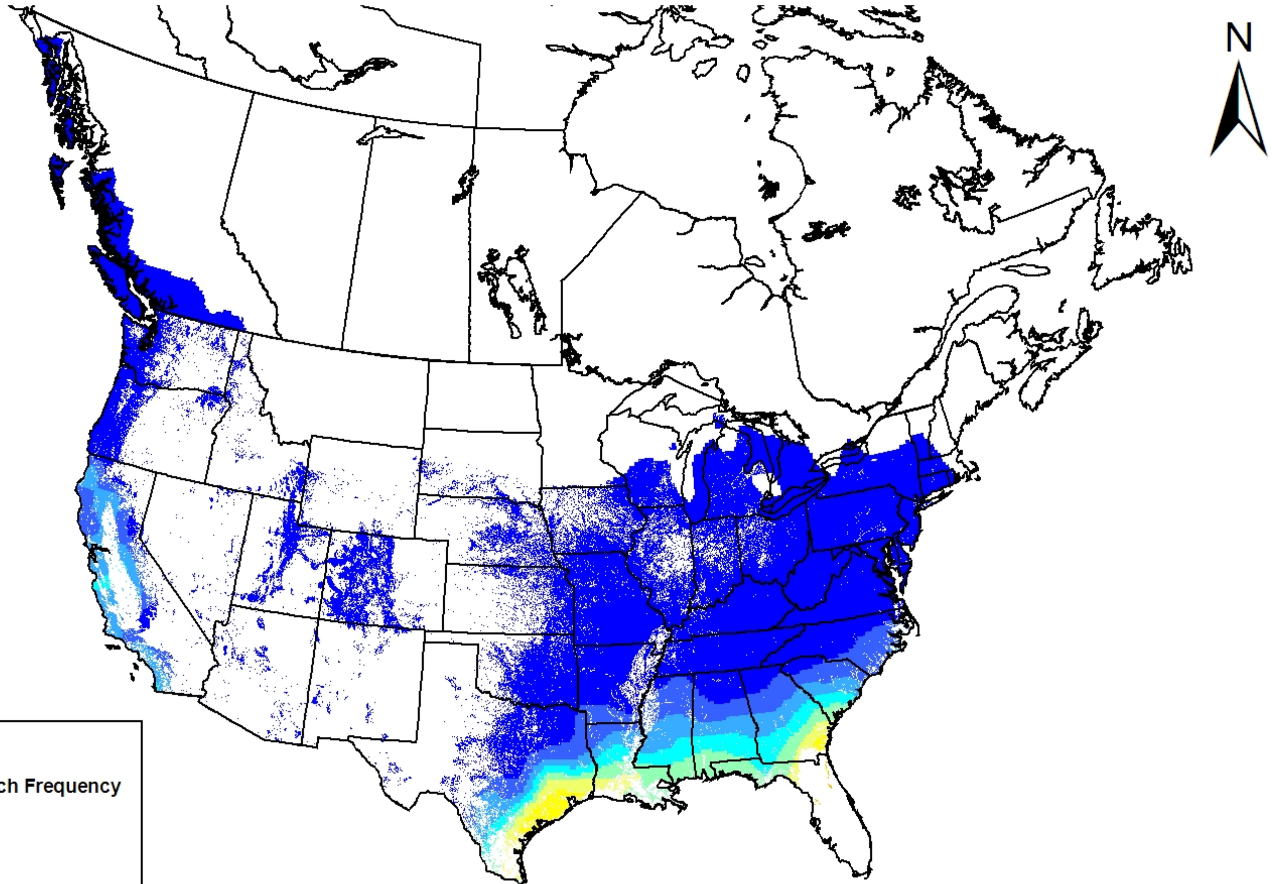
December



Legend

10 Year Climate Match Frequency

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

1,000 Miles

Sources: DEFRA, 2004; Huberli et al., 2003; NAPPFAST, 2005; Olikowski and Szkuta, 2002; USFS, 1991; Werres et al., 2001
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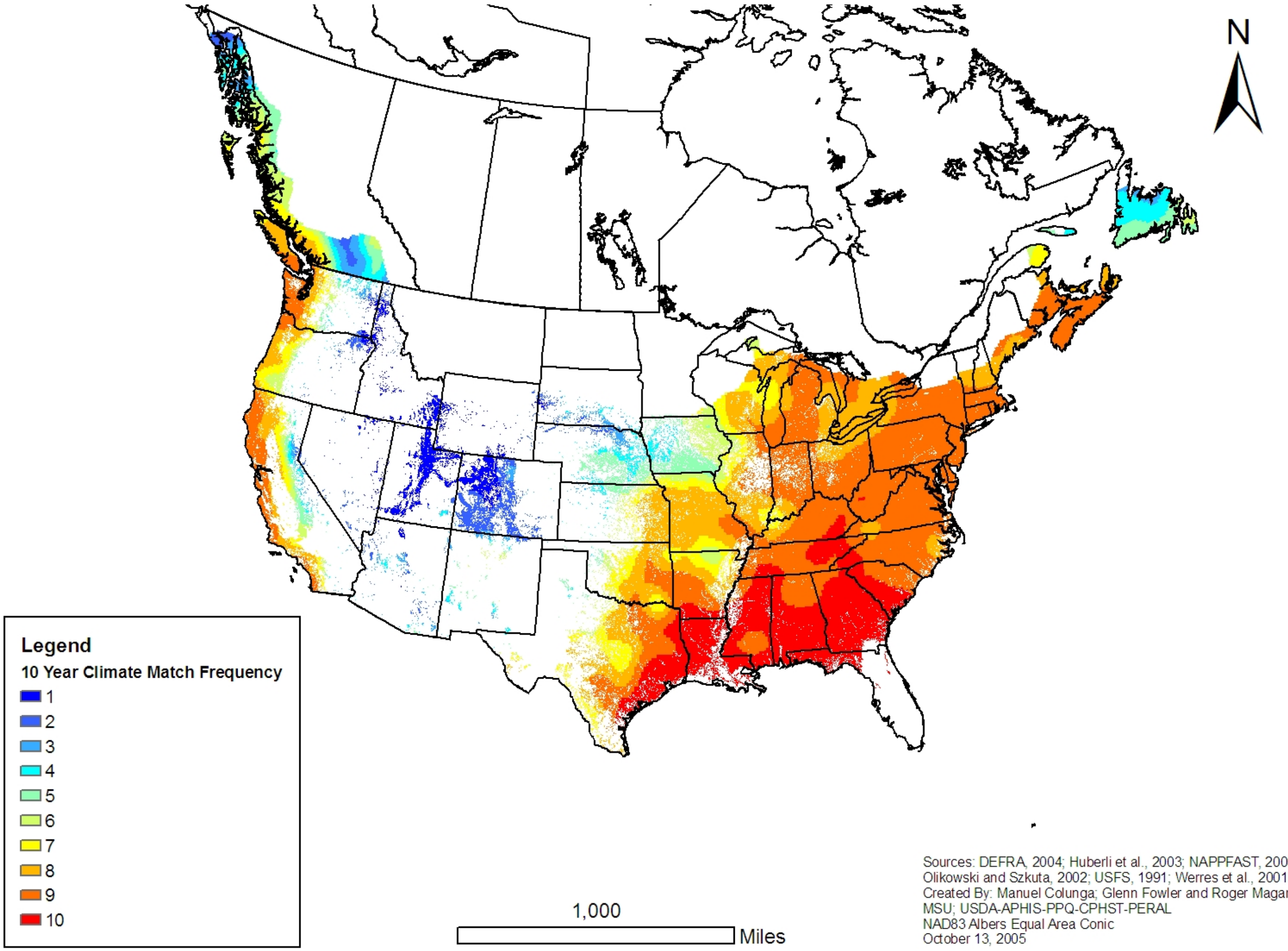
Annual



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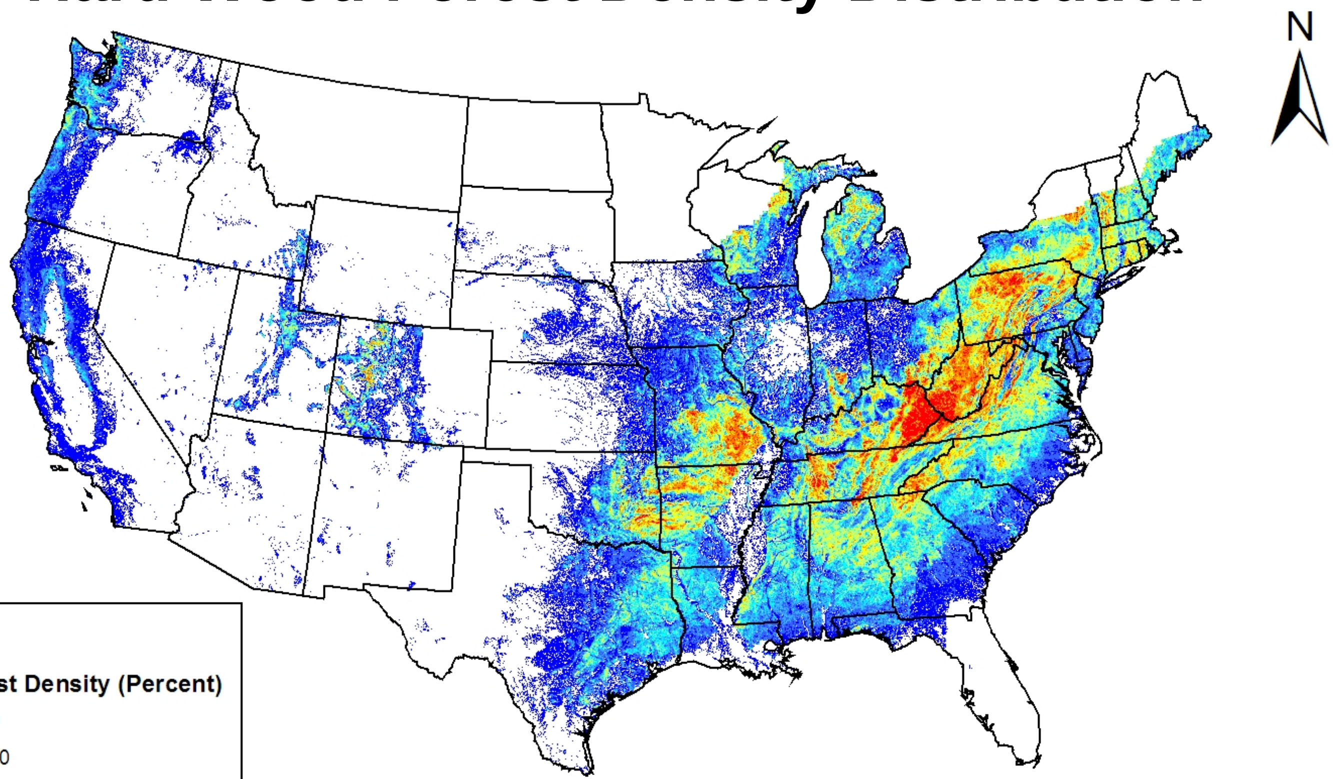
Hard Wood Forest Density Distribution



Legend

Host Forest Density (Percent)

- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

1,000 Miles

Sources: DEFRA, 2004; Huberli et al., 2003; NAPPFAST, 2005; Olikowski and Szkuta, 2002; USFS, 1991; Werres et al., 2001
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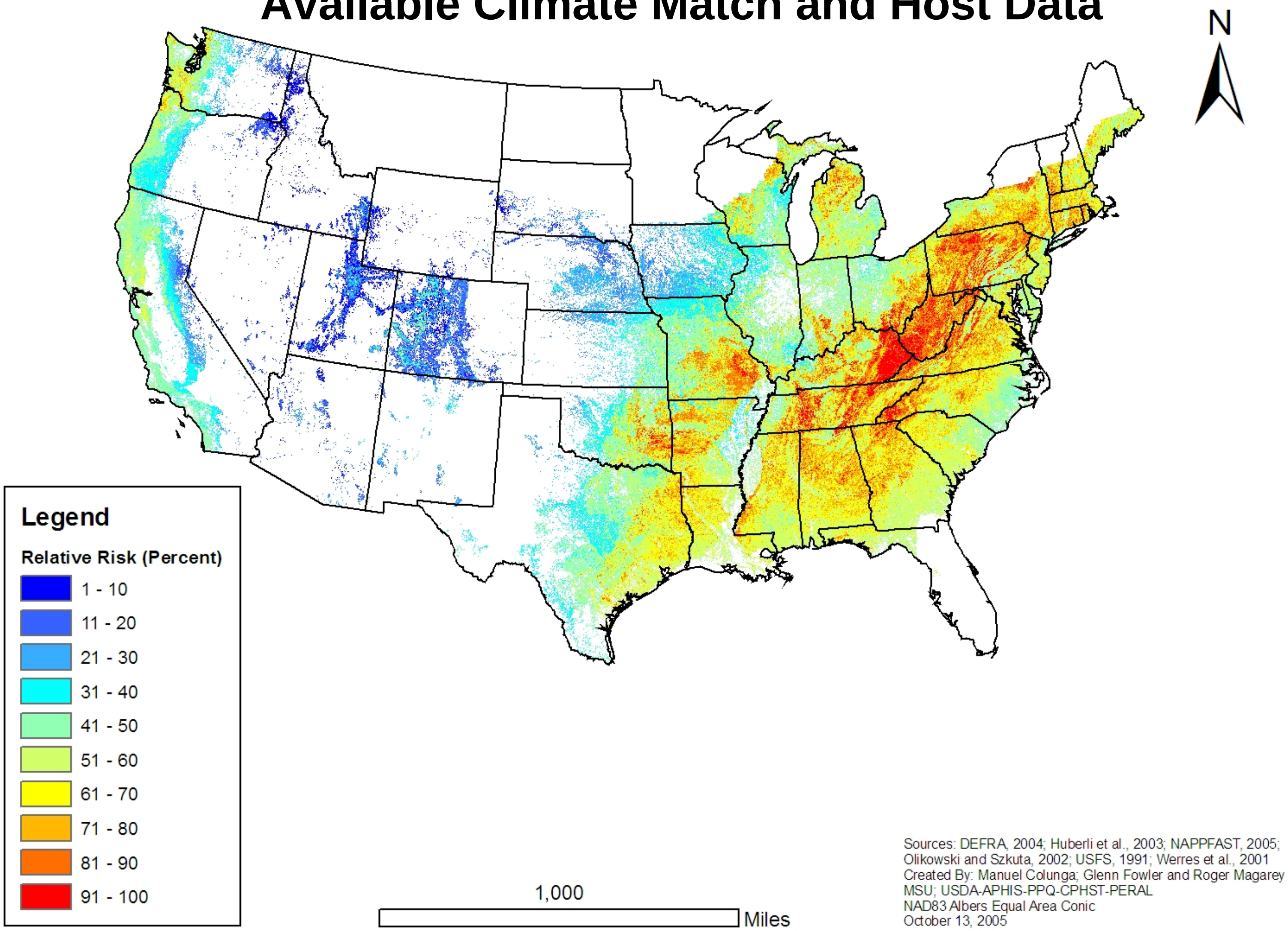
Potential Risk for Occurrence of *P. ramorum*, Based on Available Climate Match and Host Data



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Conclusions

- The predictive climate maps demonstrated a good correlation with *P. ramorum* confirmations
- The climate host maps indicate that parts of the eastern United States could be at significant risk for *P. ramorum* infection

Status

- The climate maps have been used in the 2004 and 2005 National Survey Manuals for *P. ramorum*
- The climate maps have been presented at numerous conferences including the *P. ramorum* Science Panel, the *P. ramorum* Program review and the 2nd Sudden Oak Death Science Symposium
- More sophisticated models incorporating climate match and host density are being developed
- Global predictive mapping capability has been developed
- Global spatial and temporal modeling resolution will be increased in future iterations

International Model

- **Purpose: Help identify *P. ramorum* 1) origin and 2) at risk countries**
- **Data set:** International Panel on Climate Change (IPCC) data set with monthly 55 km spatial resolution
- **Infection Model:** Monthly minimum air temperature greater than 3^{o}C and monthly maximum air temperature less than 28^{o}C
- At least 10 days during each month with precipitation
- Visualized areas where at least 2 months of the year met these conditions
- **Survival:** Areas where the monthly average minimum air temperature was less than -10^{o}C were used as a surrogate for a daily average soil temperature of -25^{o}C or less

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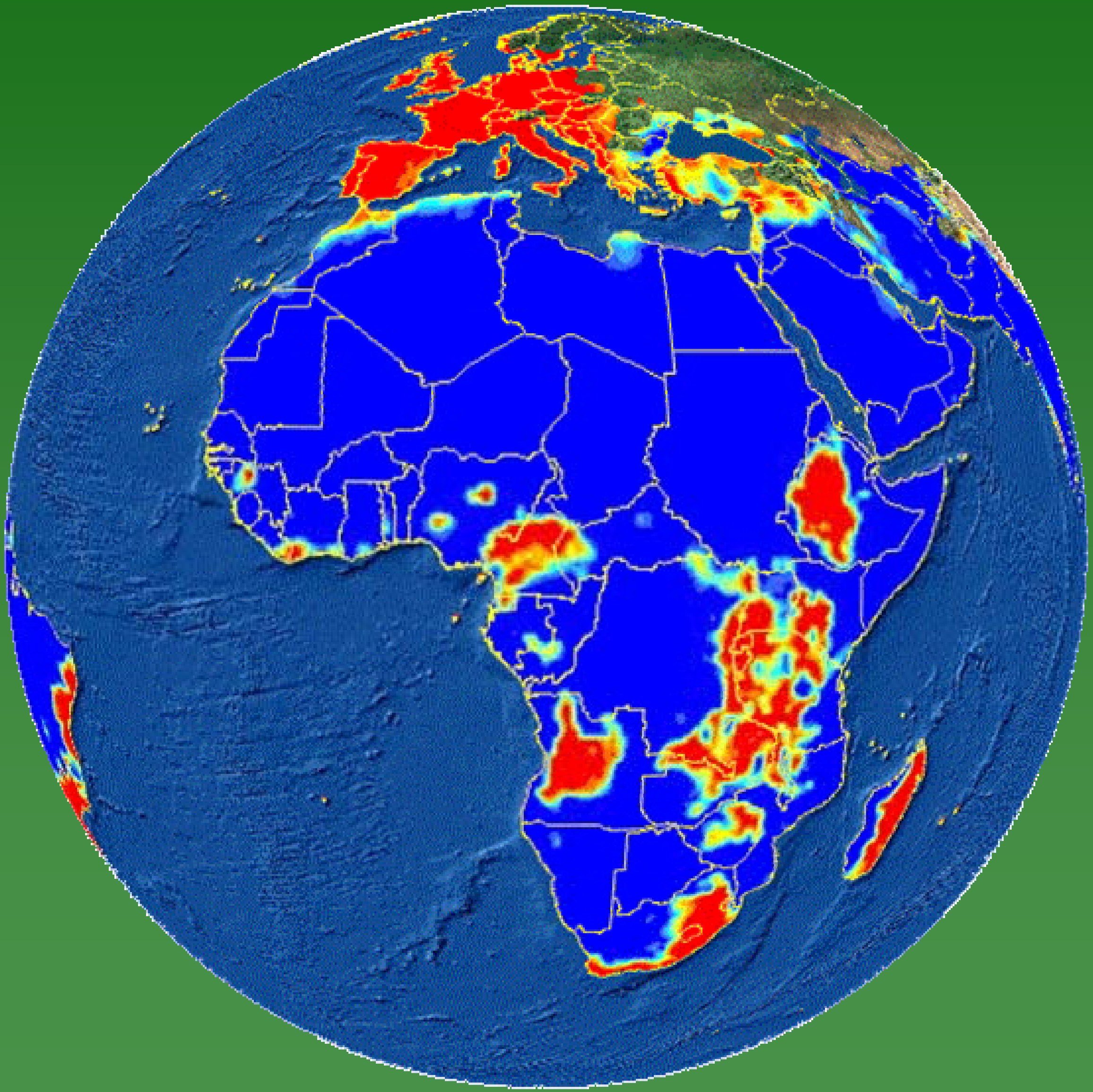
Africa



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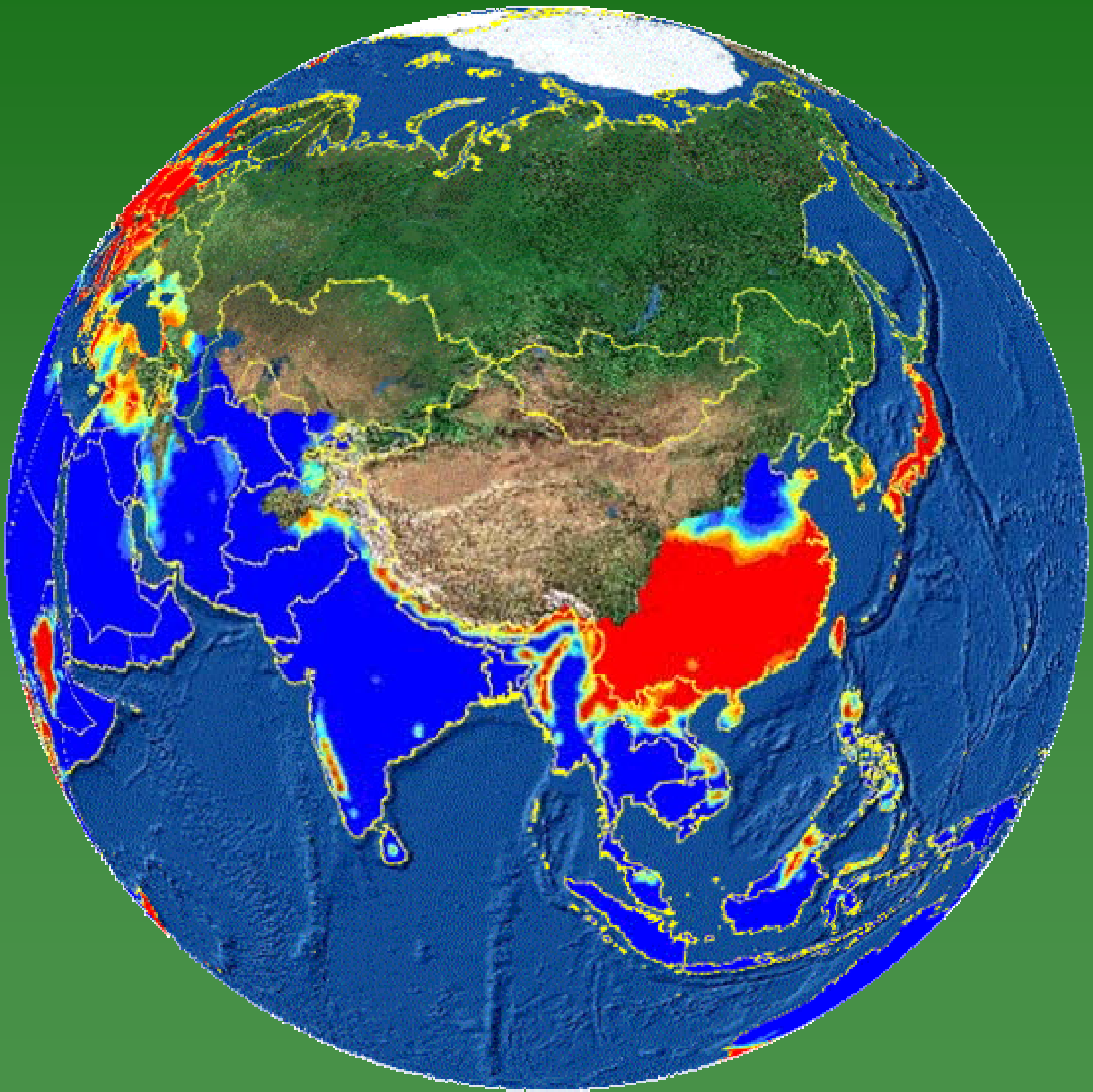
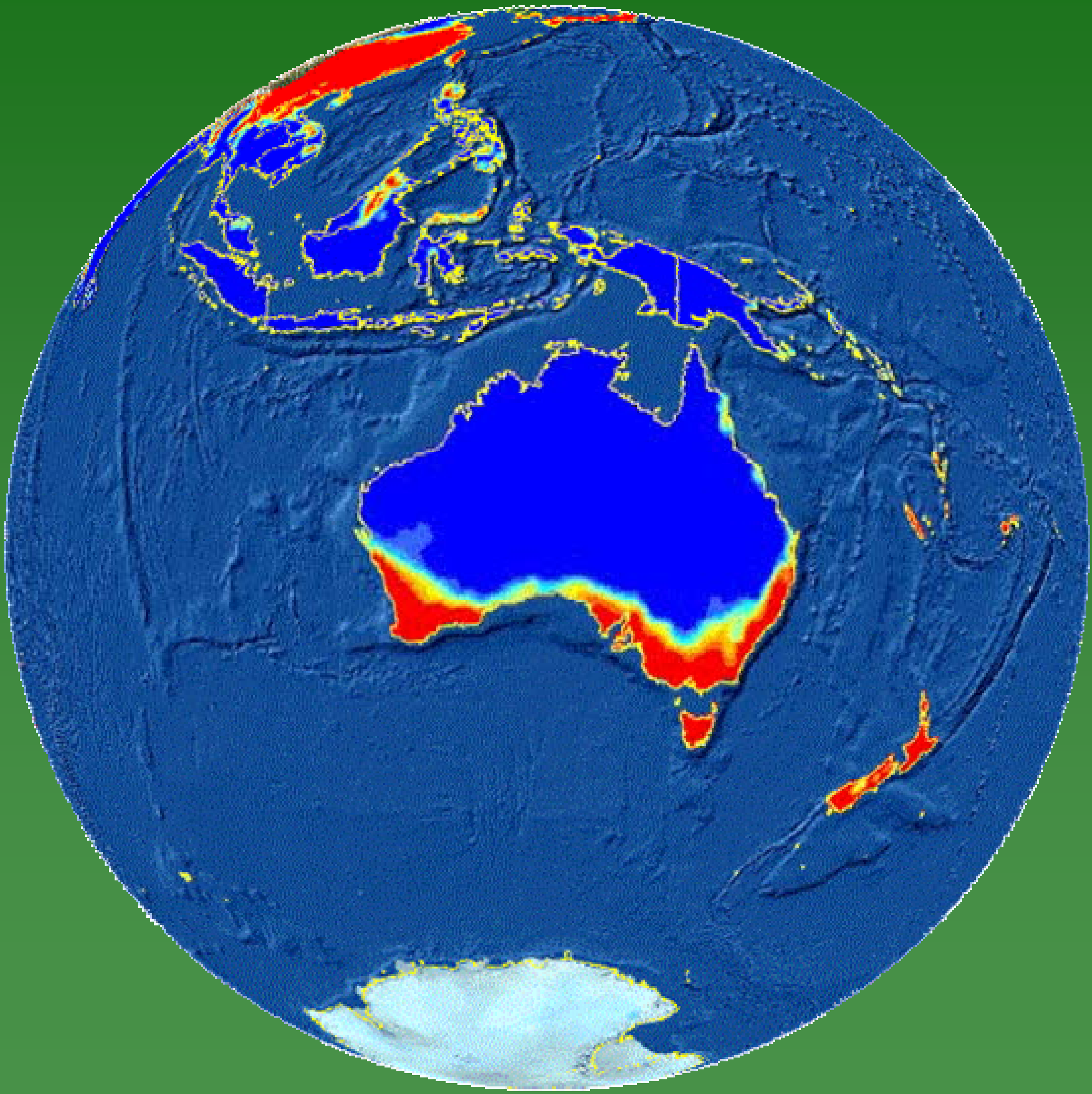
Asia



Australia



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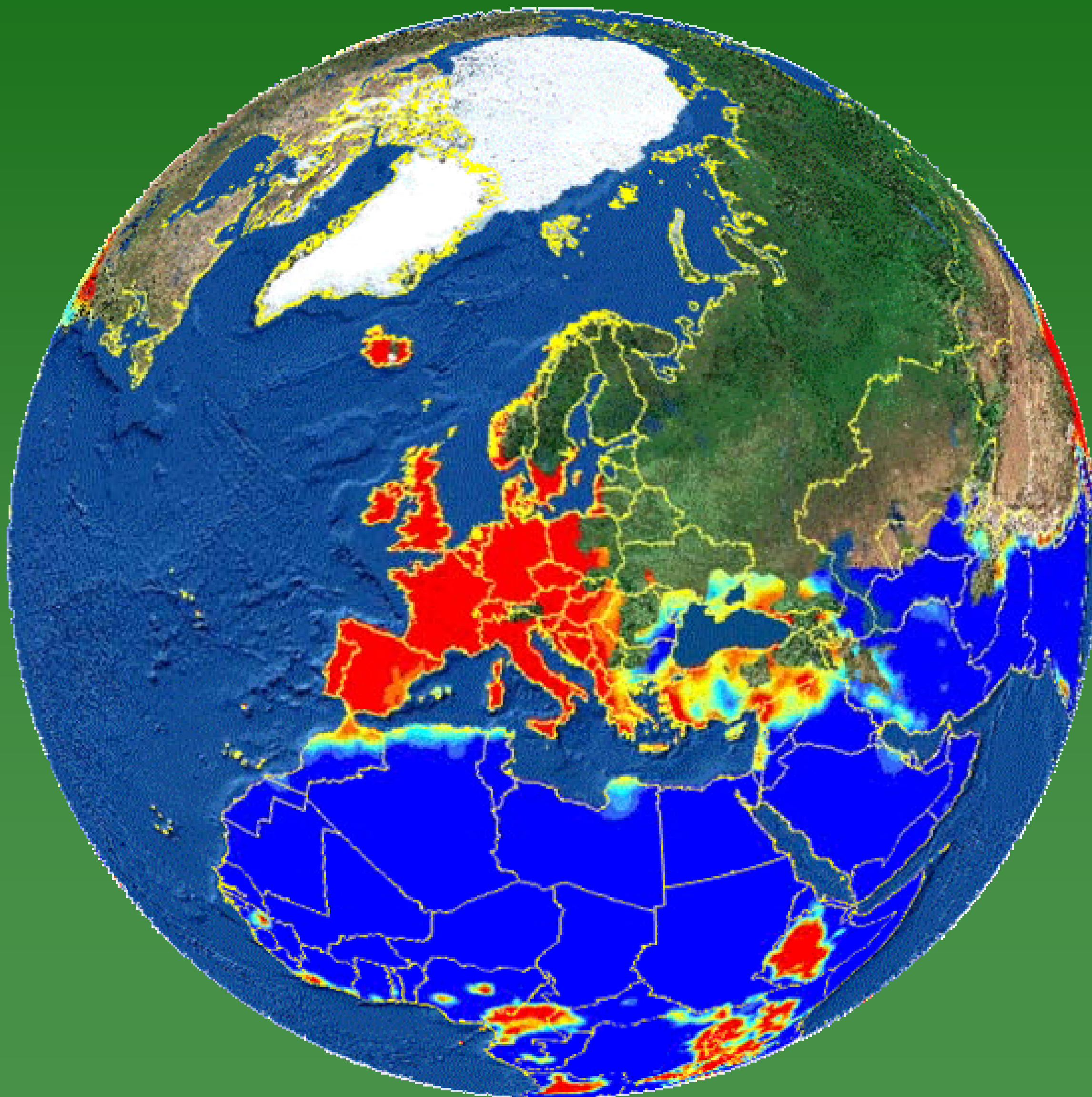
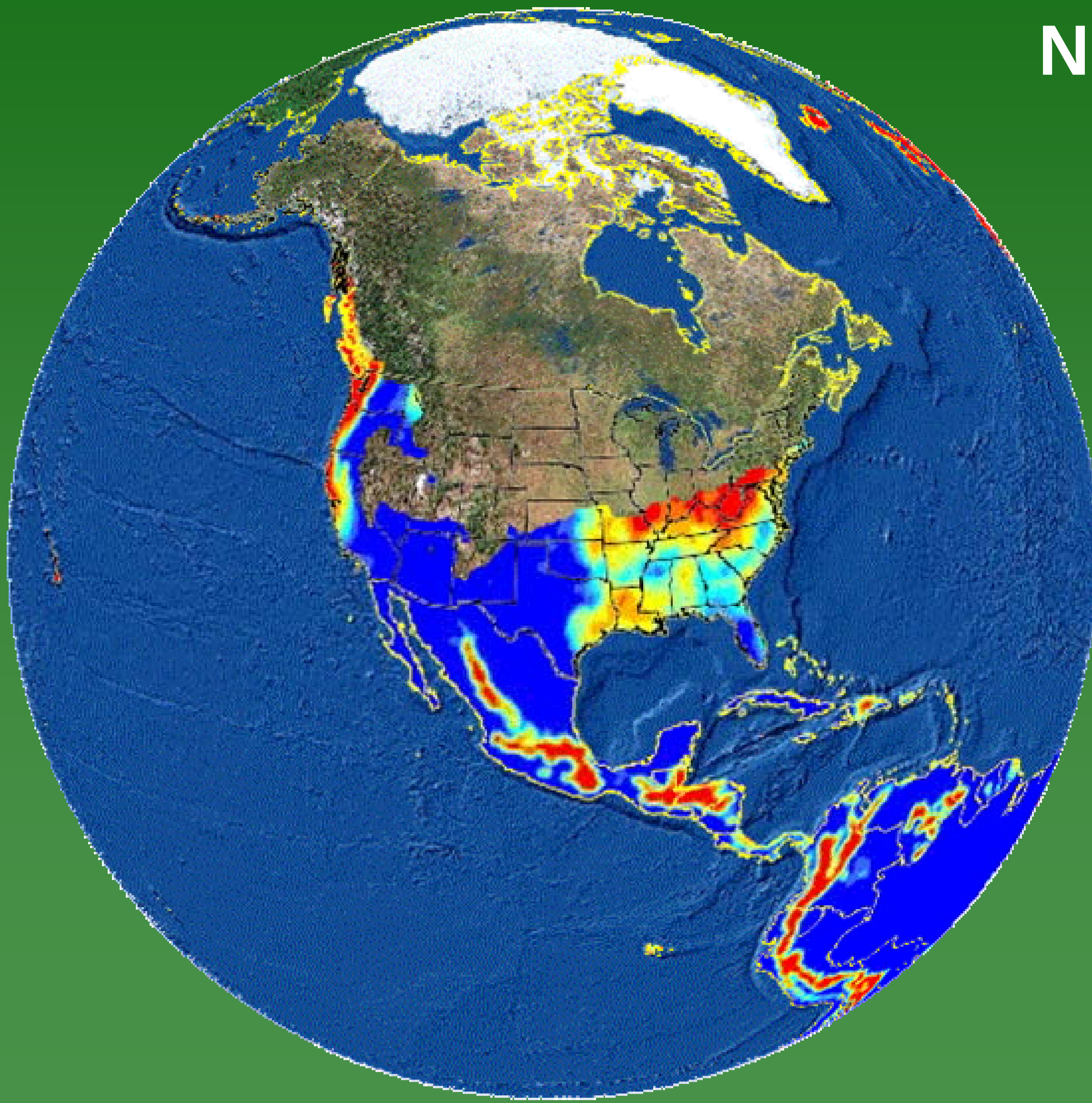
Europe



North America



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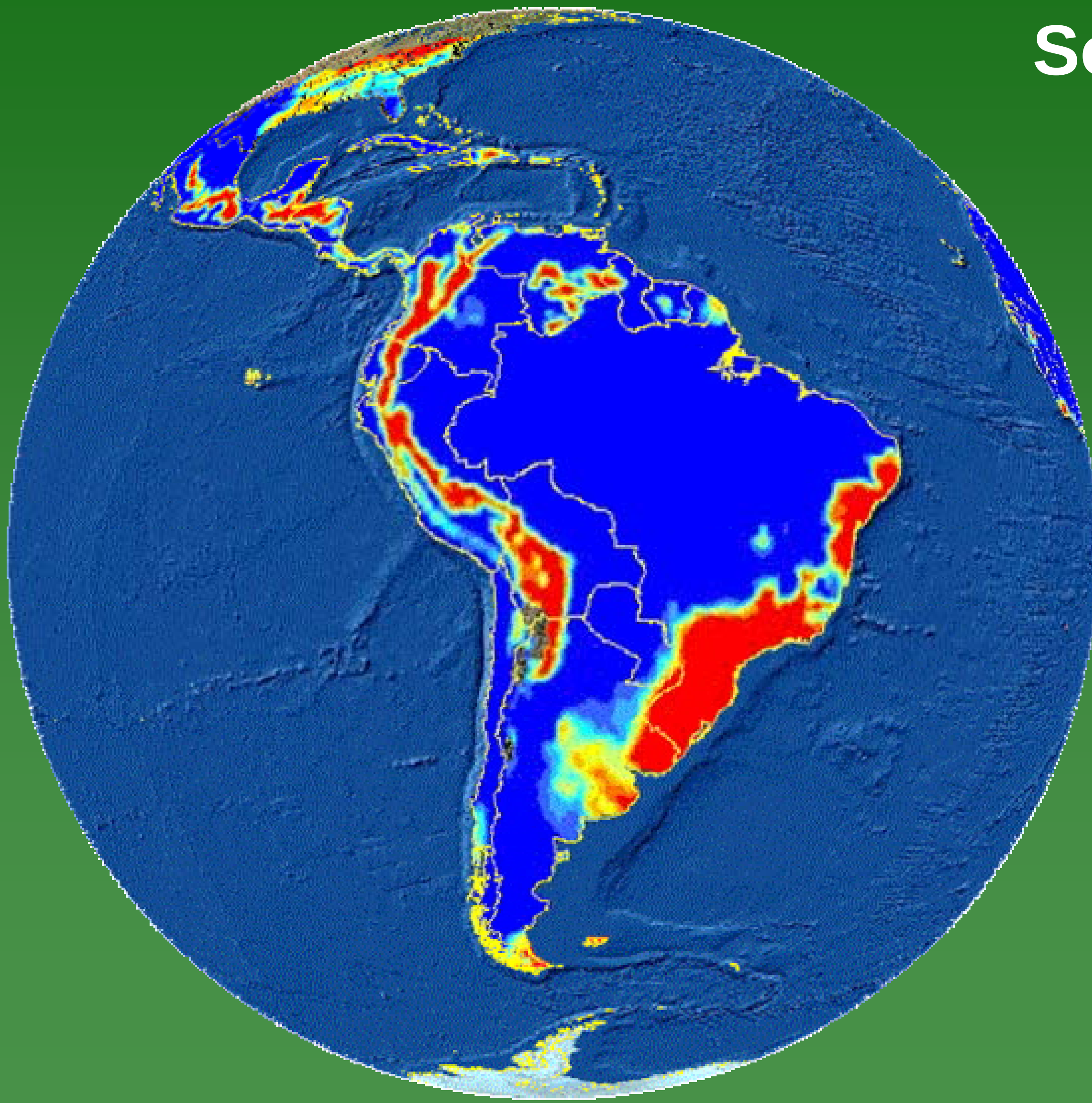
South America



Acknowledgements

- William Smith. USFS. Raleigh, North Carolina