Don’t forget the ‘slow’ stuff.

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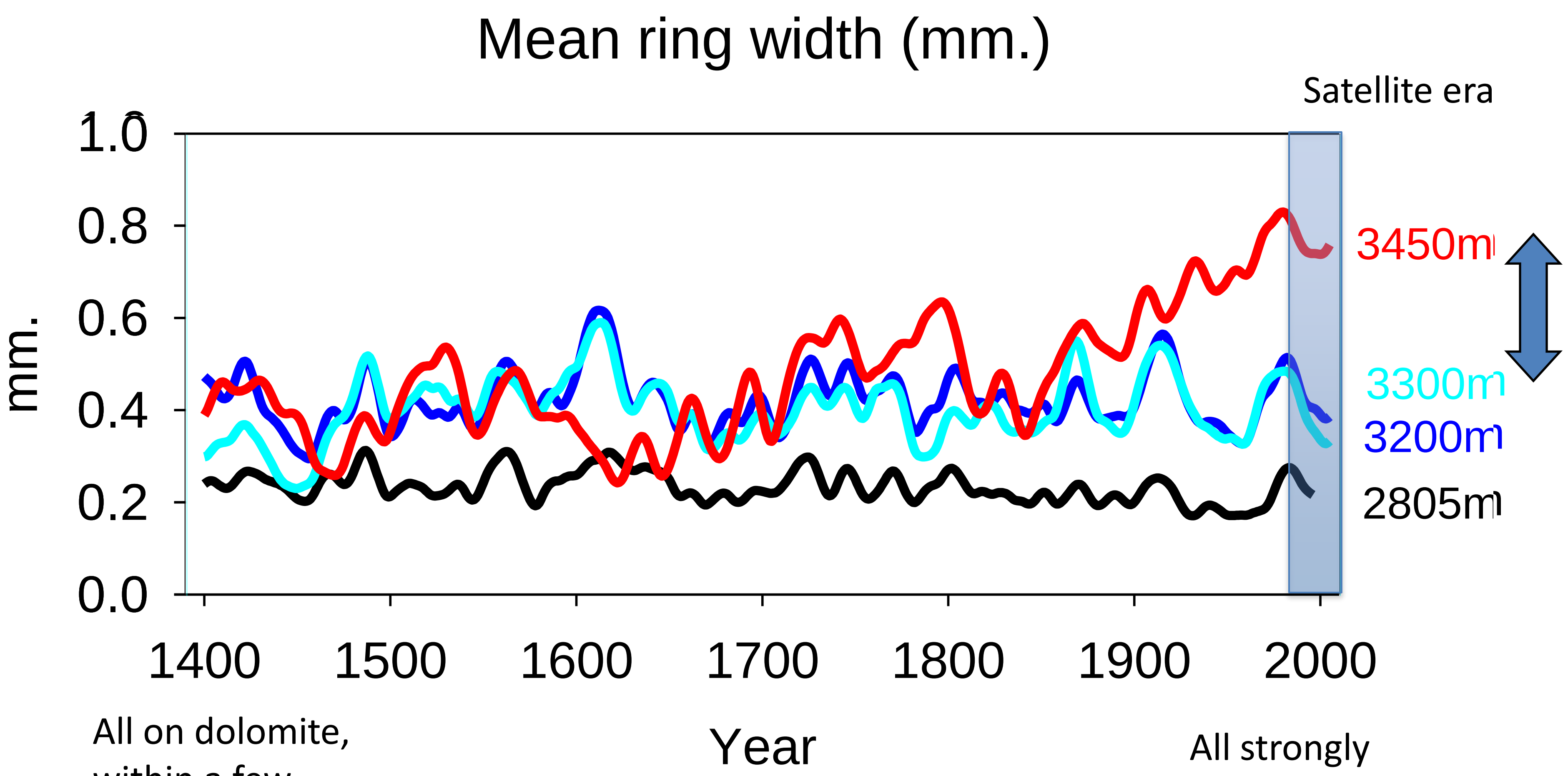
Laboratory of Tree-Ring Research
University of Arizona

Your slow stuff is my fast stuff…..

Bristlecone pine (*Pinus longaeva*) at ~3450 meters in the White Mountains, California.

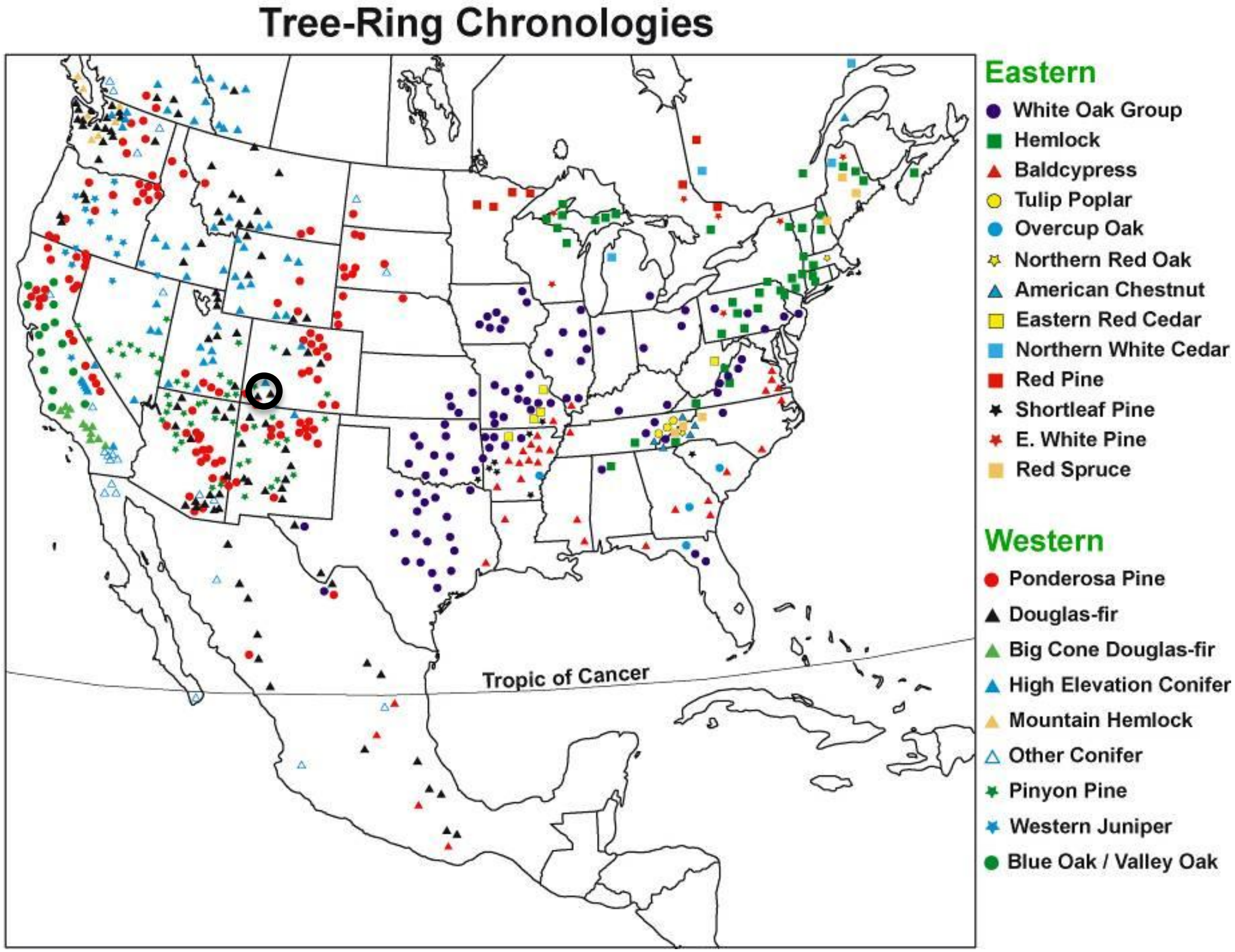
Elevational transect of *Pinus longaeva* tree ring width series in White Mountains, CA



All on dolomite, within a few kilometers of one another.

All strongly replicated at least back to AD 1400

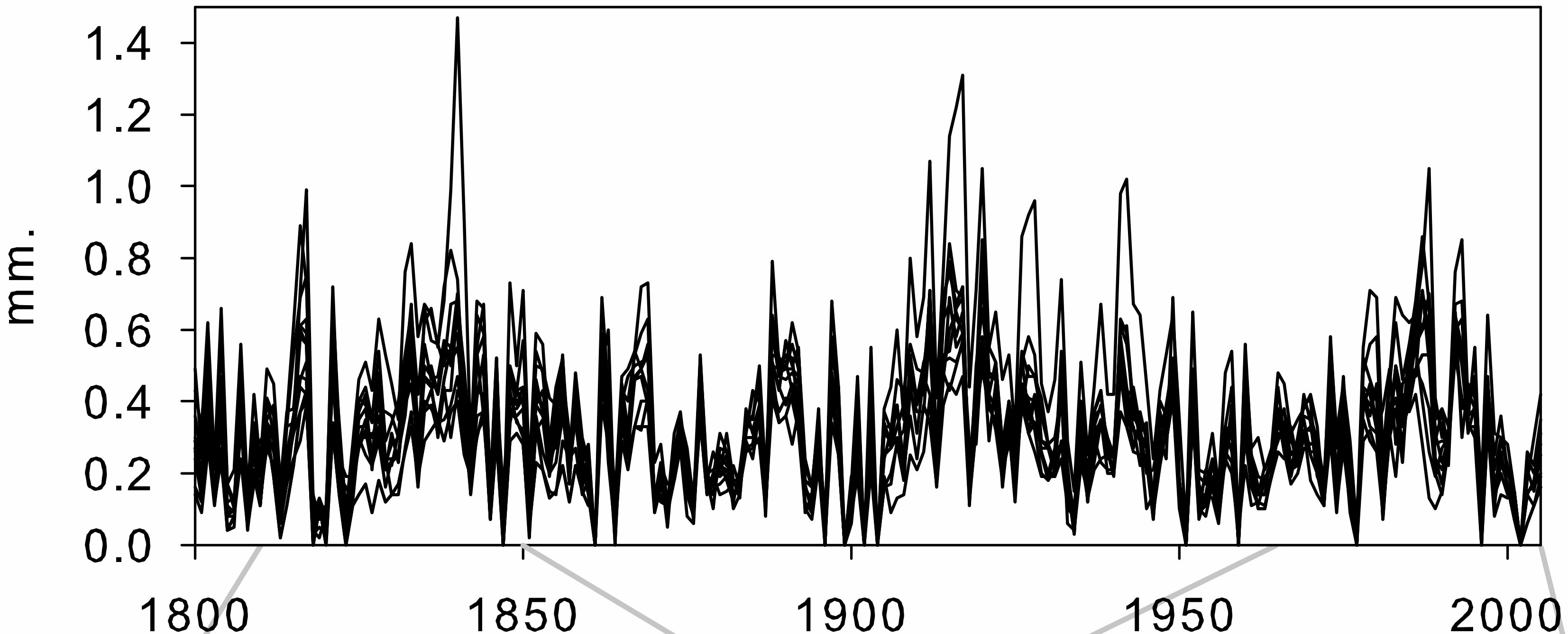
There are continental-scale networks…



Courtesy of David Stahle

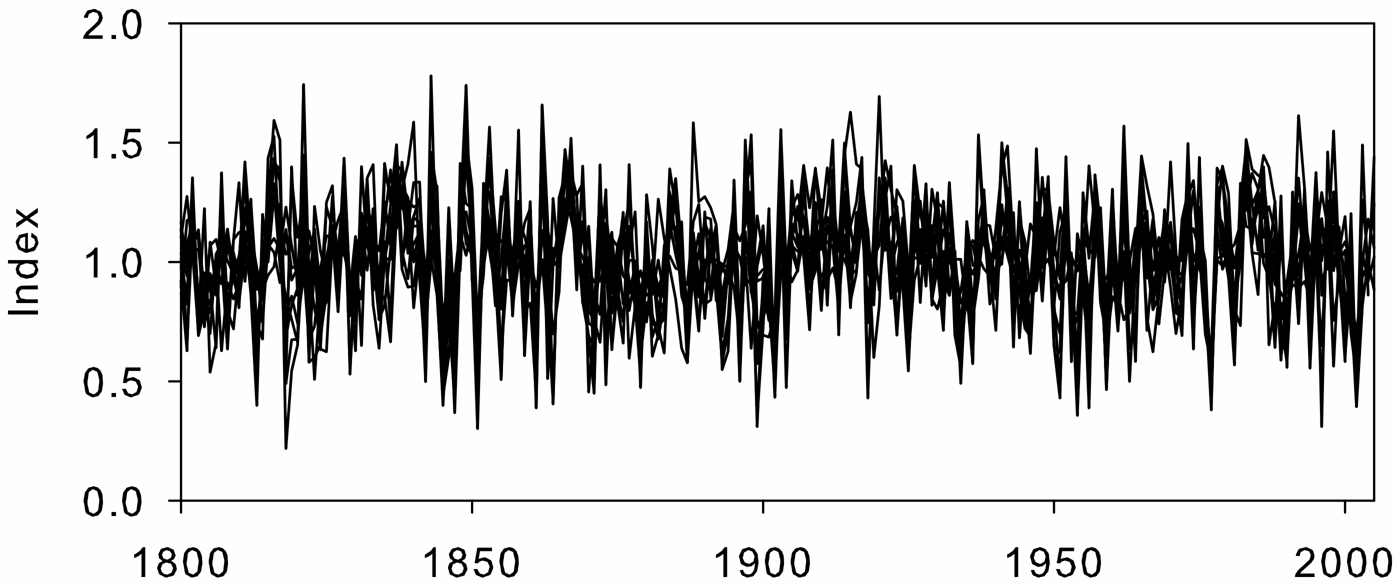
Semi-arid region on Colorado Plateau.

Common pattern of variability shared by trees at one location...

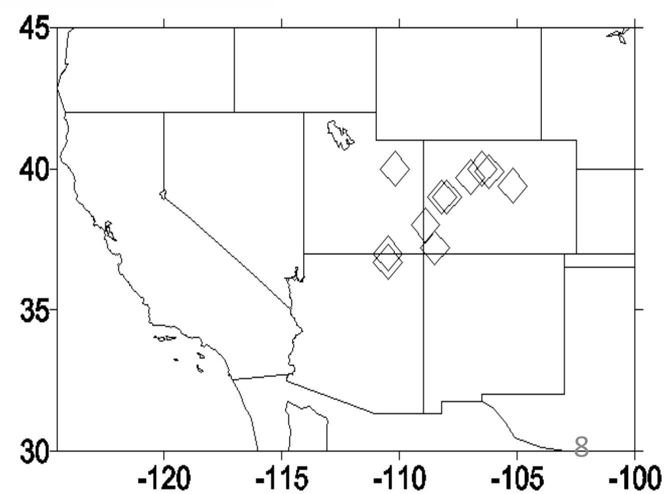


Raw, unmodified, ring widths (mm.) of 18 samples from douglas-fir in Navajo Canyon, Colorado, each shown by a single line. Note that although absolute growth rates differ in a few cases, the relative patterns of variability are very similar. Data provided by David M. Meko.

..and at many, over 100s of kilometers (in this case ~600 km).



Ring-width based site chronologies from 11 locations in the Upper Basin of the Colorado River, including that based on the samples from Navajo Canyon (previous slide). Each chronology is the mean of multiple detrended ring-width series. Data provided by David M. Meko, details of chronologies in Meko et al. 2007.



So, can tree rings be used to place observations from space in the context of interannual, decadal and century-scale growth variations observed on the ground?

Comparing NDVI and observed stem growth and wood density in forests of northern Eurasia

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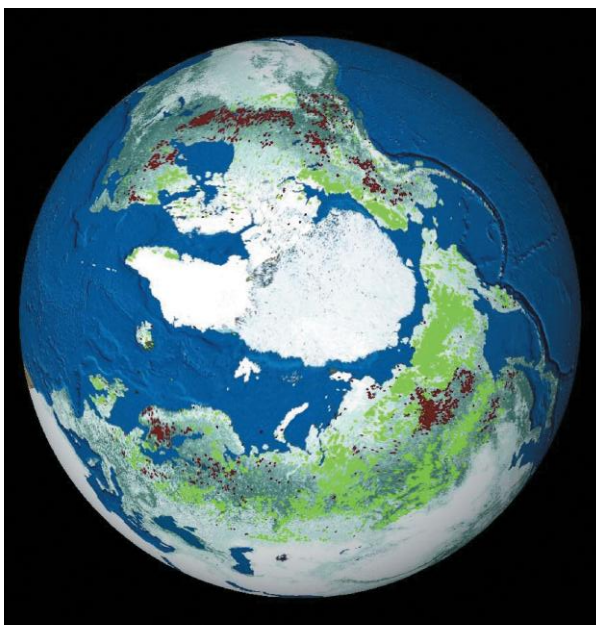
A contribution to: NEESPI

The question

- To what extent does NDVI (Normalized Difference Vegetation Index) observed from space co-vary with directly observed stem radial increment and maximum latewood density?



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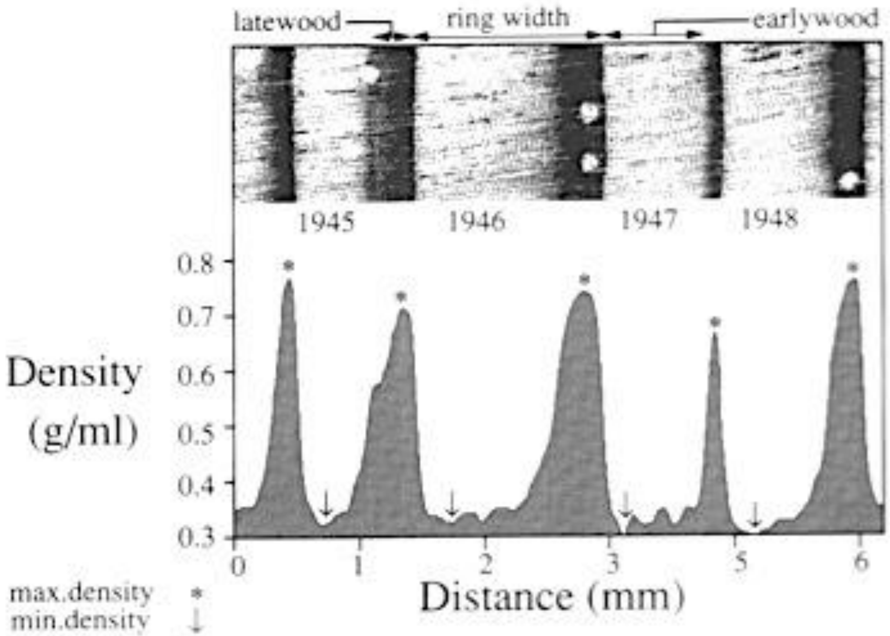
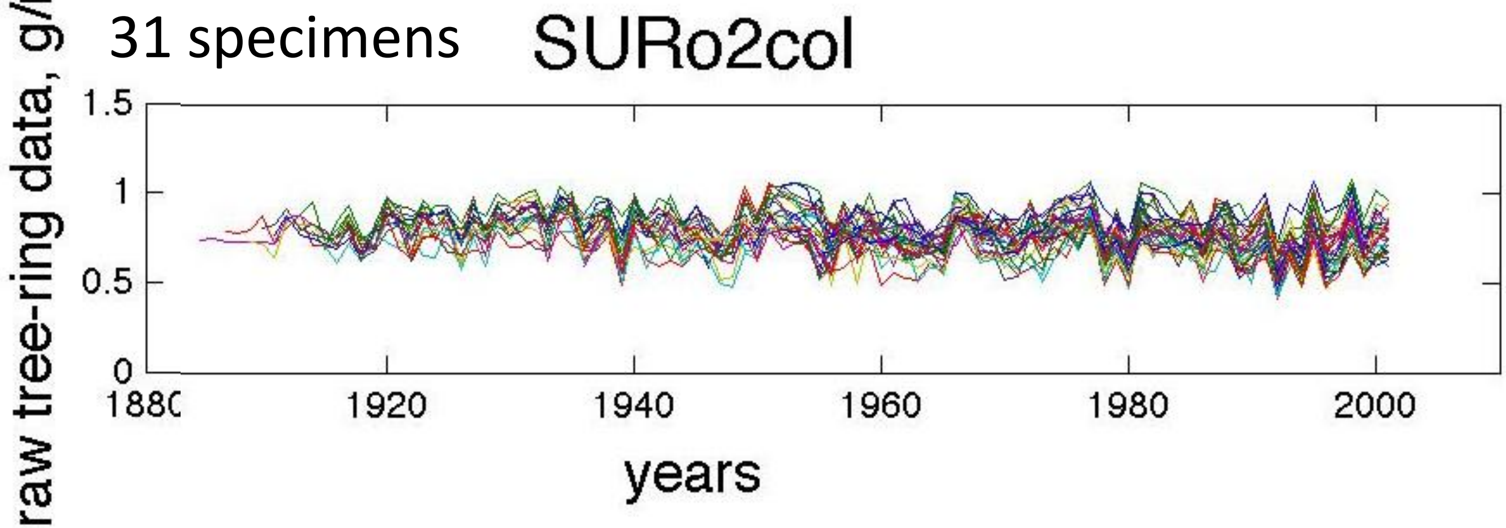


Site SUR, *Picea obovata,* maximum latewood density, 31 specimens



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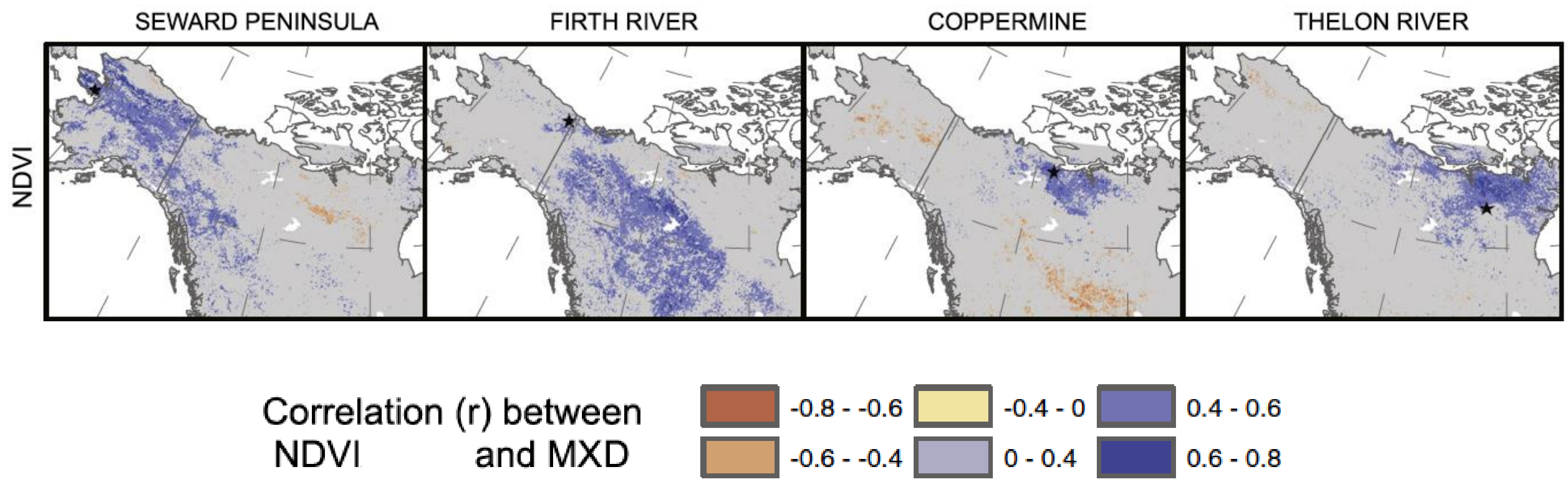
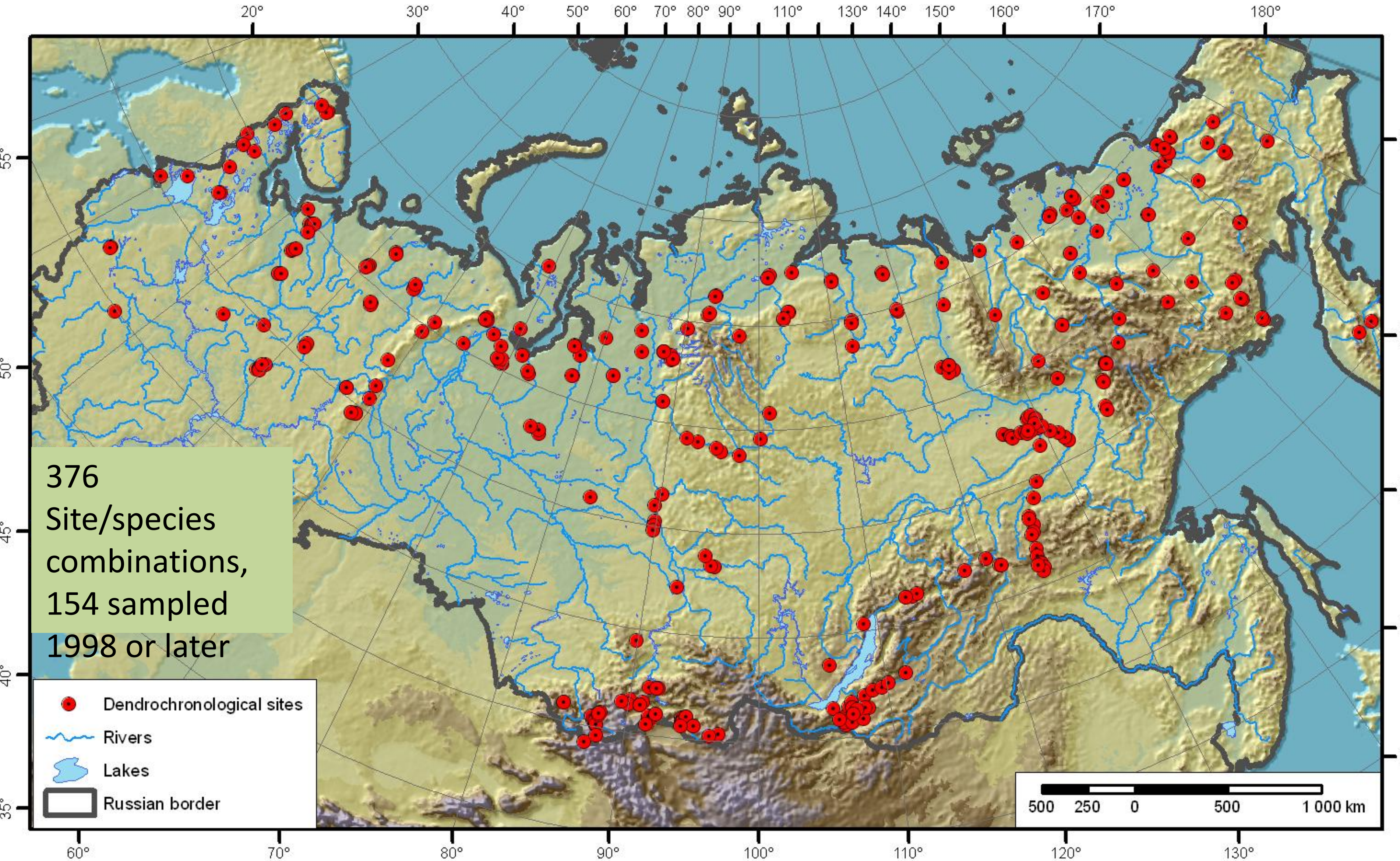
A large-scale coherent signal of canopy status in maximum latewood density of tree rings at arctic treeline in North America

Pieter S.A. Beck [a,*], Laia Andreu-Hayles [b,c], Rosanne D'Arrigo [b], Kevin J. Anchukaitis [b,d], Compton J. Tucker [e], Jorge E. Pinzón [e], Scott J. Goetz [a]

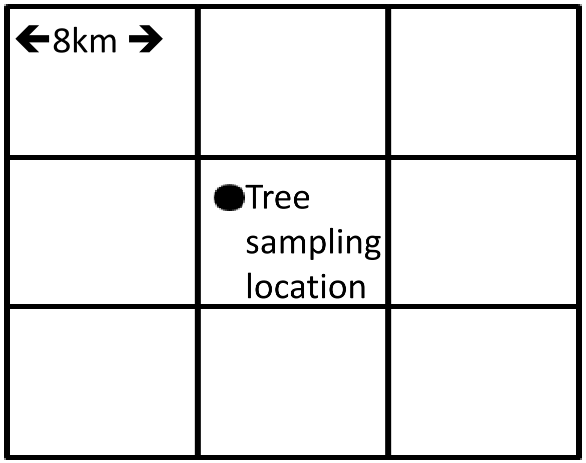
Picea glauca ring width – no consistent relationship with NDVI, but for maximum latewood density (MXD)……



“Site-level MXD records reflect early growing season canopy status of large regions” (Beck et al highlights)

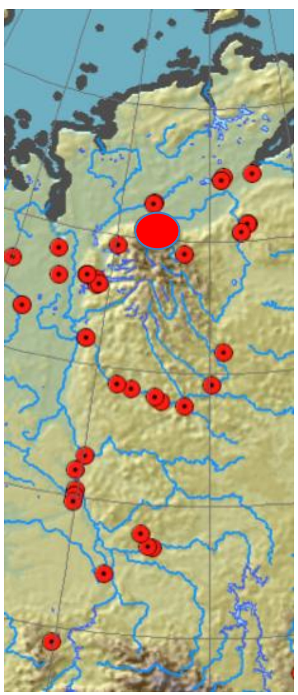


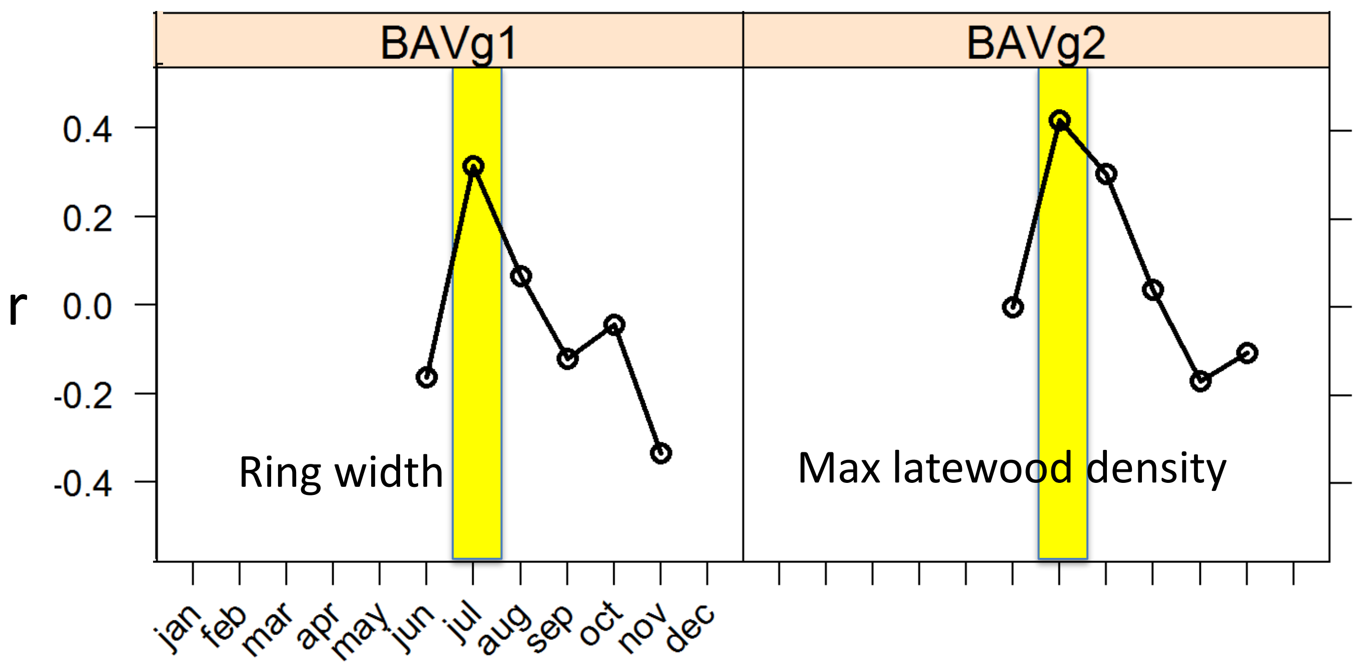
376
Site/species
combinations,
154 sampled
1998 or later
Dendrochronological sites
Rivers
Lakes
Russian border
500 250 0 500 1 000 km



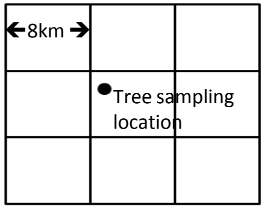
We examined correlations between NDVI* and a subset of the 154 local datasets (that end in 1998 or later). First we look at those with both maximum latewood density and ring width data. An example is shown here.

Correlation between NDVI (for ~24km box) and *Larix gmelinii* tree-ring series at the Bolshoi Avam (BAV) site on the Taimyr Peninsula (70.5 degrees North, 93.2 degrees East, 360 meters a.s.l.), 1982-2002.

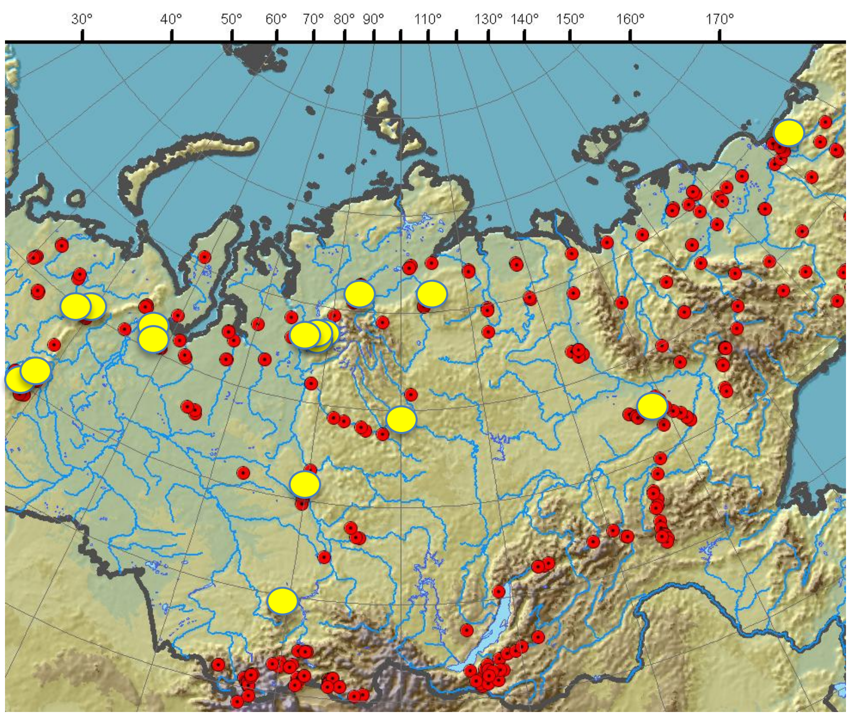




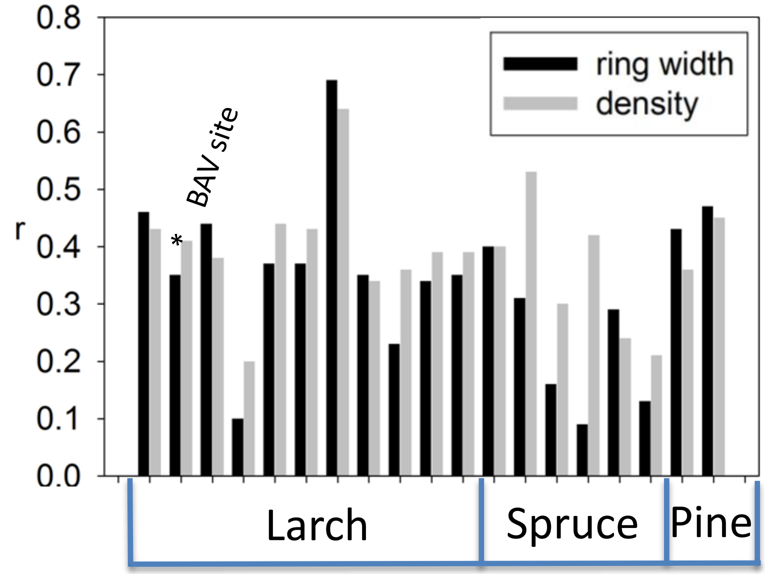
* GIMMs NDVI data computed monthly.



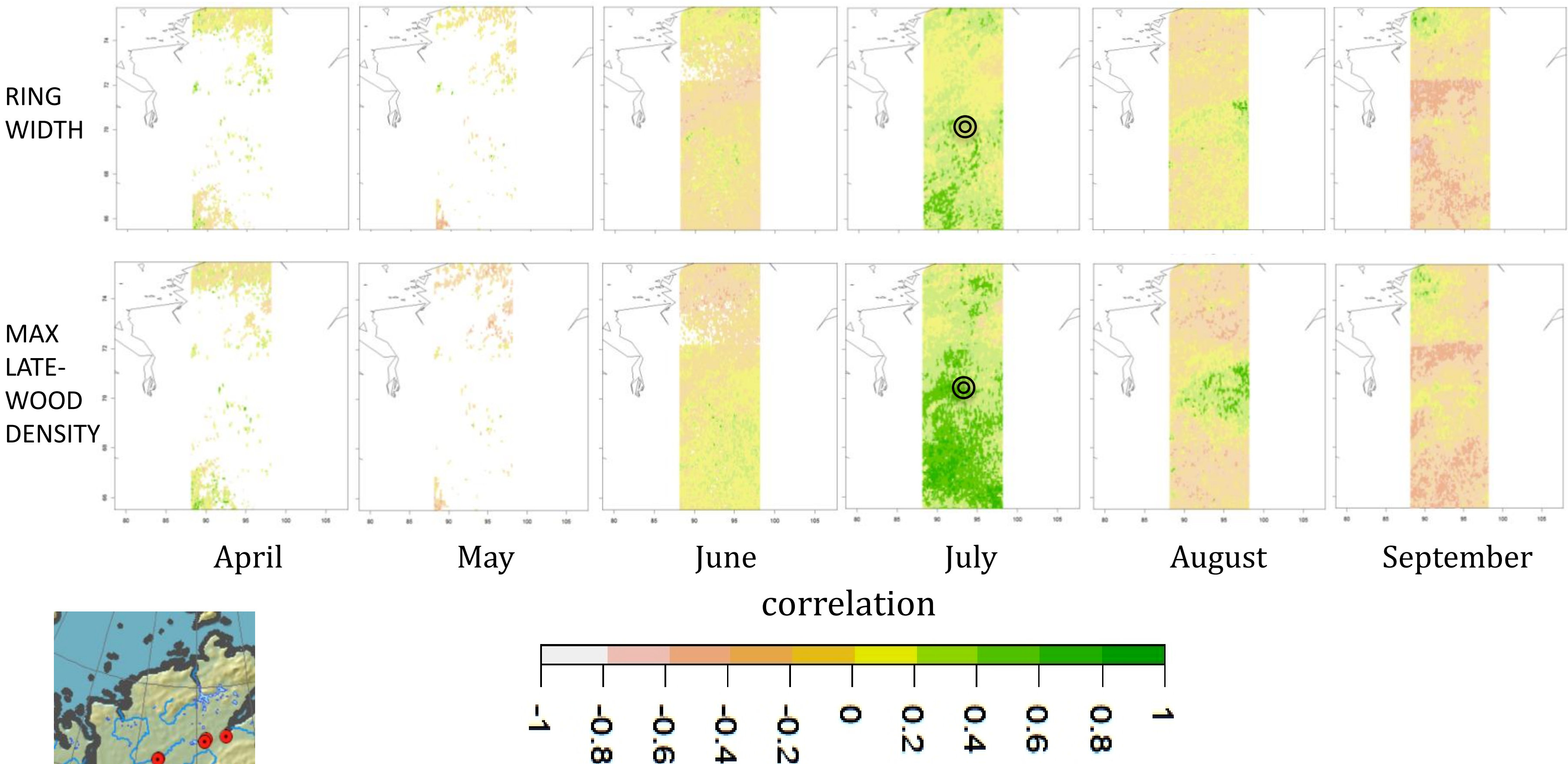
Some locations with ring width and maximum latewood density series ending in 1998 or later.

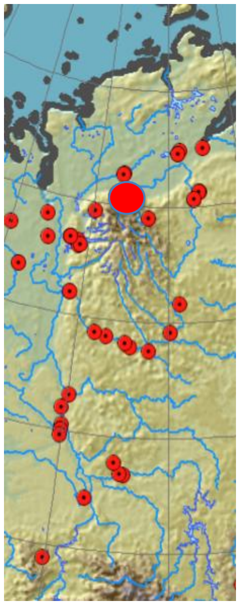


Maximum monthly correlation with local NDVI at 19 locations



Moderate correlations at most locations for both ring width <u>and</u> maximum latewood density, often significant at $p<0.05$ after taking account of autocorrelation. This differs from the Beck et al finding (earlier slide).

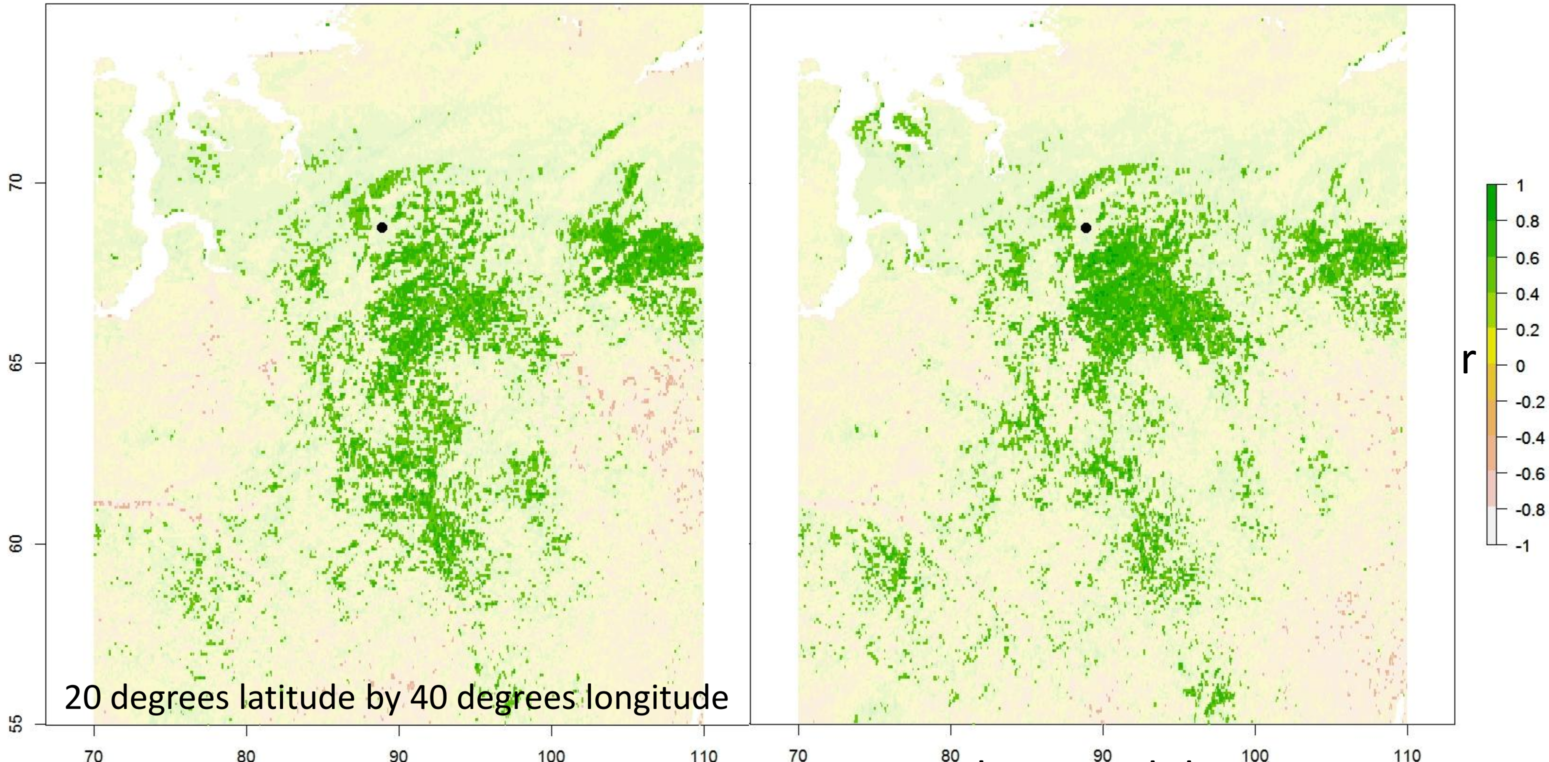




Same tree-ring data, larger area for NDVI: Correlation between NDVI (<u>5 by 5 degree box</u>) and *Larix gmelinii* tree-ring series at the Bolshoi Avam (BAV) site on the Taimyr Peninsula (70.5 degrees North, 93.2 degrees East, 360 meters a.s.l.), 1982-2002.

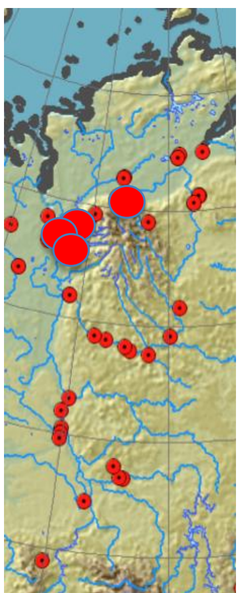
Even bigger region: Correlation July NDVI vs 1st PC of tree-ring data from multiple sites, including BAV, 1982- 1998, p<=0.05

- Centroid of tree-ring site locations



Ring width

Max latewood density



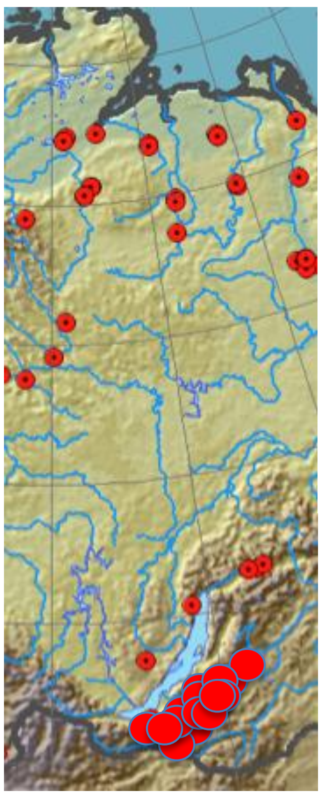
Site- and regional-level maximum density AND ring width reflect canopy conditions of large regions. <u>Why the difference with Beck et al, North America?</u>

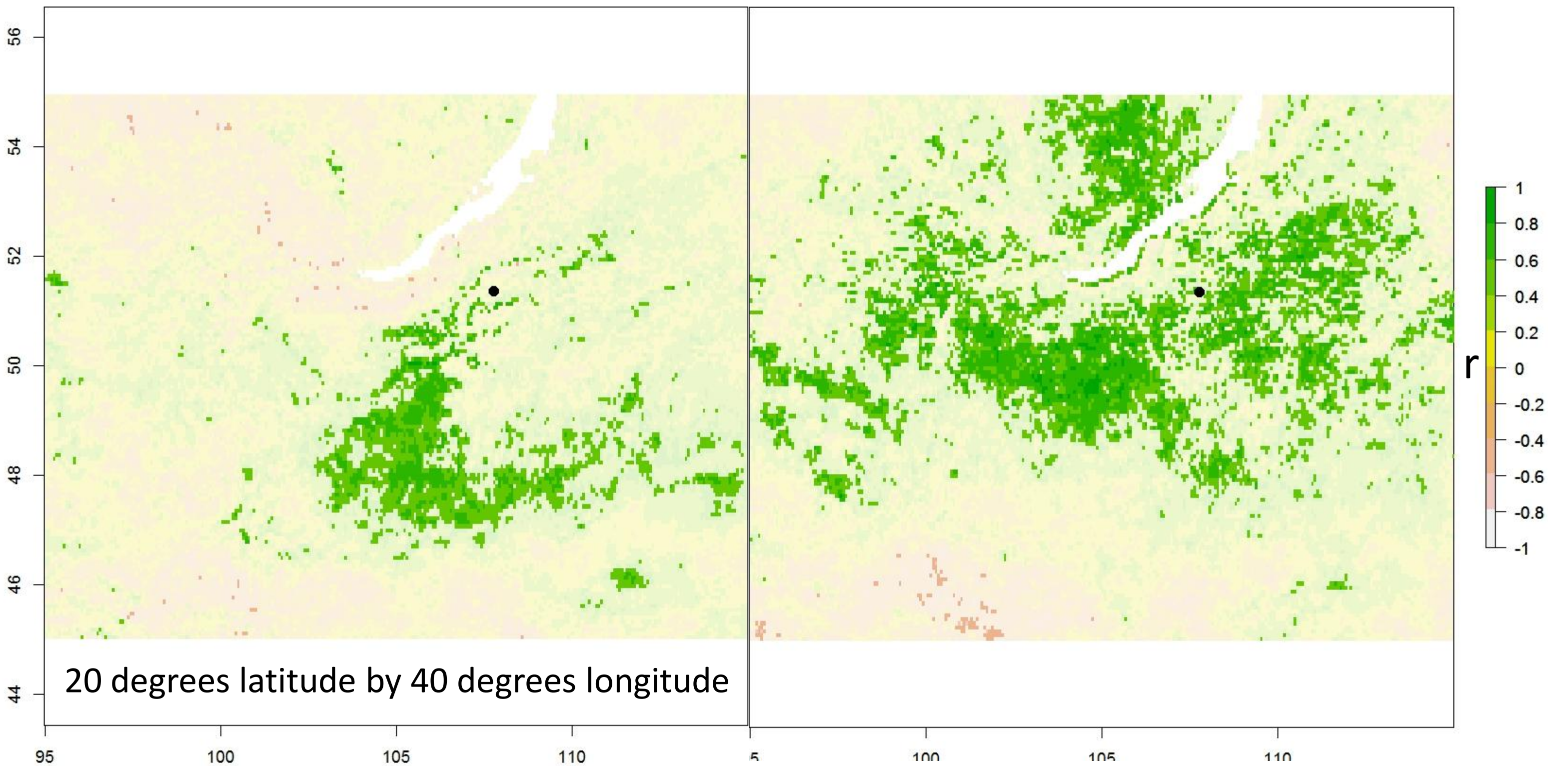
a) Ring width and maximum latewood density remain strongly intercorrelated in Siberia (maybe a result of small rings), unlike Beck et al examples.

b) Spruce in Siberia behave as other conifers there, not as in N. America reported by Beck et al.

Correlation of NDVI vs 1st PC of tree-ring width data*, 1982- 1998, p<=0.05

- Centroid of tree-ring site locations





June ring width

July ring width

*21 site collections of *Pinus sylvestris* south of Lake Baikal.

Site- and regional-level <u>ring width</u> reflects canopy conditions of a large semi-arid region 20 degrees south of the forest tundra.

The question

- To what extent does NDVI (Normalized Difference Vegetation Index) observed from space co-vary with directly observed stem radial increment and maximum latewood density?

This week's answer

- At local (24x24km), and regional levels (5x5 degrees) in Siberia, NDVI (usually July) covaries moderately but significantly well with <u>both</u> ring width (stem radial increment) and maximum latewood density from single locations.
- Regional tree-ring width and density data sets (as the first principal component of each region's set of tree-ring data) covary significantly and coherently with NDVI over large regions (20 latitude by 40 longitude).

The next question

Given these results, what is needed so that tree rings could be used to place observations from space in the context of interannual, decadal and century-scale growth variations observed on the ground?

Correlations in previous studies

- Malmström et al 1997
  - Alaska, one area, many trees 1982-1990, NDVI//TRW
    - Mixed spruce/birch 0.86
- D'Arrigo et al 2000
  - Siberia (1 site), Alaska (2 sites) 1982-1990, NPP from CASA/FASIR//MXD
    - *Larix gmelinii* 0.79; *Picea glauca* -0.19-0.79
- Lopatin et al 2006
  - Komi Rep., many trees 1982-2001, NDVI//TRW
    - *Pinus sylvestris* 0.27-0.57; *Picea obovata* 0.06-0.59
- Berner et al 2011
  - Siberia (12 sites), Canada (10 sites) 1982-2007/8, NDVI//TRW
    - *Larix gmelinii* 0.08-0.57; *Picea (abies, glauca/mariana)* 0.16-0.75; *Pinus banksiana* -0.58-0.15; *Pinus sylvestris* 0.36-0.82
- Beck et al 2013
  - Alaska/Canada (4 locations, very many trees) 1982-2001/4, NDVI//TRW/MXD
    - *Picea glauca* TRW – no consistent relationship; MXD – see slide 4.