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Discussions

Interactive comment on "What are the main climate drivers for shrub growth in Northeastern Siberian tundra?" *by* D. Blok et al.

Anonymous Referee #2

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This manuscript investigates annual ring widths for two widespread deciduous shrub species of contrasting growth form in a region of the Arctic (NE Siberia) that has not yet been reported in the literature. As such, it makes a potentially important contribution of the growing body of literature documenting the relationship between summer temperatures and increasing shrub abundance in the Far North. The field sampling regime and lab analyses look solid. Out of 50 shrubs sampled using serial sectioning from two stem locations 19 individuals were accurately crossdated and deemed suitable for the final chronologies, and that is a pretty good yield, especially for such a remote site. The text is overall well written and argued, with the appropriate literature cited, and few typos or grammatical errors.

Among the interesting findings are that Salix pulchra showed a positive relationship

with peak growing season NDVI despite the small percentage cover of S. pulchra shrubs in the research area (<5%), whereas Betula nana did not correspond significantly with summer NDVI. This is useful information in helping to partition the NDVI signal. It indicates that even small amounts of erect deciduous shrubs within a given landscape really drive NDVI, as was indicated from previous work in W Siberia, albeit with greater coverage of Salix (≈20%). Also, the lack of a response to winter precipitation underscores the need for a broader synthesis of circumpolar shrubs. Evidence from W Siberian Salix lanata indicated no winter precipitation response (Forbes et al. 2010), but previous studies with other species have found such a response. Finally, the finding that climate zones were defined by elevational and latitudinal boundaries, rather than simply distance between different climate-growth reconstructions, suggests the way forward for future modeling efforts aimed at projecting regional scale responses to warming.

Specific comments appear below.

L35-38 ". . .land-use changes such as intensive caribou and muskoxen grazing . . . may restrict future shrub expansion rates. . ." I would be careful with this one. My feeling is that the jury is still out and that a blanket explanation is not possible. The best evidence on the 'restricted growth' hypothesis comes from studies in low shrub tundra in Fennoscandia and Greenland (Post & Pedersen 2008; Kitti et al. 2009; Olofsson et al. 2009). However such evidence needs to be carefully considered in light of the shrub canopy height relative to the grazing/browsing capacity of the herbivores, be they ungulates or otherwise. In the case of Fennoscandia and Greenland, the shrubs investigated were of low stature. In contrast, in W Siberia, the erect shrubs studied were already well above the browse line (Forbes et al. 2010). This indicates that future deciduous forest development in situ (sensu Edwards et al. 2005) may be an option.

L93-94 "Samples of B. nana and S. pulchra shrubs (50 individuals per species) were collected. . ." For the erect shrubs,

L230-231 “. . .for the period 1948-2006 showed a slight positive trend (trend line slope = 231 0.014°C yr-1, Fig. 2). . .” In Fig. 2 it would be good to show also the actual trend line from e.g. RES.

L272-274 “Shrub growth in our research site in NE-Siberia was found to be highly sensitive to early summer temperatures, as also observed for boreal tree growth in our research region.” This raises a question about whether eastern Siberia exhibits divergent trends of temperature and tree growth in its coniferous forests as has been reported from many places, presumably caused by drought stress (Briffa et al. 1998; D’Arrigo et al. 2008).

L317-319 “An alternative explanation for the lack of growth response to a thicker snow-pack includes that shrubs may not be metabolically active yet and thus unable to take up resources (Edwards & Jefferies, 2010).” The paper referred to here (Edwards & Jefferies 2010) actually treats an aquatic sedge (Carex aquatilis), so I was unclear why this is cited to illustrate the nutrient uptake capacity of the shrubs Salix pulchra and Betula nana.

Literature cited

Briffa, K.R. et al. 1998. Reduced sensitivity of recent tree-growth to temperature at high northern latitudes. Nature 391: 678–682.

D’Arrigo, R. et al. 2008. On the ‘divergence problem’ in northern forests: a review of the tree-ring evidence and possible causes. Global Planetary Change 60: 289–305.

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Edwards K, A., Jefferies R, L. 2010. Nitrogen uptake by Carex aquatilis during the winter- spring transition in a low arctic wet meadow. Journal of Ecology 98: 737-744.

Forbes, B.C. et al. 2010. Russian Arctic warming and ‘greening’ are closely tracked by tundra shrub willows. Global Change Biology 16: 1542–1554.

Olofsson J, et al. 2009. Herbivores inhibit climate-driven shrub expansion on the tundra. Global Change Biology 15: 2681-2693.

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Post E, Pedersen C. 2008. Opposing plant community responses to warming with and without herbivores. PNAS 105: 12353-12358.

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