INTRODUCTION

The Arctic is more profoundly affected by climate change than lower latitude regions. Warming has been more pronounced in the Arctic and this trend is expected to continue; vegetation in high latitude regions is also expected to respond to climate change more than other vegetation in the world. Tundra plants have had to adapt to the severity of the Arctic climate order to successfully colonize the region. Thus small changes in climate could have a large impact on the plant community. This study seeks to predict the response of plant species to climate change in association with the international Tundra Experiment (ITEX), by using experimental warming to simulate climate change at four study sites in northern Alaska.

The prevailing wisdom is that species that are predominantly distributed in low Arctic regions will respond faster to warming. These low Arctic species are expected to increase in cover and distribution, and as this happens, cover and distribution of species primarily found in the high Arctic will decrease. Present studies have found that when compared to the control treatment, the warming treatment results in increased absolute cover of vascular plants, an increase in relative cover of some individual species. When looking at each of the four sites individually, the overall warming trend is upheld at some sites but not at others. However, sites with a decrease or with no change in overall absolute cover still experienced changes in the community. We used a variety of grouping methods based on geography, morphology, and phenology of the plants to analyze how different groups of plants were responding to the warming treatment. Groupings were determined using both observations collected in the field and observations reported in the literature. The goal of this study is to determine which grouping schemes are best able to predict trends in changing Arctic vegetation communities.

METHODS

Seventeen grouping schemes were developed using both the literature about Arctic vegetation, and data collected from the field. These grouping schemes fall into two general groups: those relating to geographic distribution of the species (FIG 2), and those relating to morphology, development, and phenology (FIG 3). The species present were classified using each of these grouping schemes. Occasionally we had insufficient data to classify a species, such as when measurements were not taken or when an authority did not encounter a certain species, and in these cases we removed those species from the analysis of that grouping scheme. We used it as a tool to compare absolute cover of each group in each treatment through a two-way ANOVA.

RESULTS

Out of the seventeen grouping schemes used in this study, most were shown to be useful for at least one site (Table 1). We looked for a significant interaction between the grouping scheme and the warming treatment, because that indicated that the grouping scheme was a useful predictor of the plants’ response to warming. The interaction between the warming treatment and the grouping scheme was significant for ten of the classifications 

Of the remaining groups, the grouping scheme that was significant at the most sites was Greenland Distribution (FIG 2). That interaction was significant at all sites with High Arctic, Low Arctic, Alaskan Dry, and Alaskan Arctic sites, as well as overall for all sites combined. Two other sites, High Arctic/Low Arctic and Alaskan Distribution, also had significant interactions overall, and the group Biome Distribution showed a trend.

CONCLUSIONS

The grouping schemes used in this study were useful, though further study is needed to determine which grouping schemes are the most valuable for predicting plant response. Previous studies of these four sites have also shown that the sites respond differently to warming; a site that is more responsive will have the potential to show a stronger treatment effect in the interaction between warming and grouping. Grouping schemes related to geography and distribution were in general better predictors of species response to warming than grouping schemes related to morphology and development. The significant interactions for the four sites combined came all grouped from geographic grouping schemes. Of these, the Greenland Distribution scheme was the only one that showed a significant interaction with the warming treatment. At our sites, species present chiefly in the north of Greenland (label "N", see FIG 2) increased at a higher rate than other species in response to warming. This result agrees with the results of another of the groups that is significant for all sites combined, the High Arctic/Low Arctic grouping schemes, plants labeled "High Arctic" increased in cover, while plants labeled "Low Arctic" decreased in cover. Though we would expect an increase in cover from plants labeled "High Arctic", this increase is not in northern sites due to the way the plants are grouped. Our study sites exist within the boundaries of northern zones; the "N" label includes more southerly species than the "NN" label. This is seen in the "N" group as having a higher response than the "NN" group.

In some grouping schemes, one responsive group is dominated by one responsive species. The dry heath study sites were chosen because of the presence of the evergreen shrub Cassiope tetragona. C. tetragona is either the dominant species or the only species in the most responsive group in Wintering Stage of Buds scheme and the "NN" label includes more southerly species than the "NN" label. This is seen in the "N" group as having a higher response than the "NN" group. In some grouping schemes, one responsive group is dominated by one responsive species. The dry heath study sites were chosen because of the presence of the evergreen shrub Cassiope tetragona. C. tetragona is either the dominant species or the only species in the most responsive group in Wintering Stage of Buds scheme and the "NN" label includes more southerly species than the "NN" label. This is seen in the "N" group as having a higher response than the "NN" label.

Several of the geographic grouping schemes showed that groups with the largest range had the greatest increase in cover in response to warming. Thus those species that are already adapted to greater variations in habitat are successful under warmer conditions.