Model-based analysis of tree-ring growth phenology in *Picea glehnii* forests on Hokkaido Island, Japan

*Dai Koide[1], Akihiko Ito[1]

1.National Institute for Environmental Studies

Recent global change is predicted to broaden uncertainty of ecosystems especially in terrestrial area. To reduce such uncertainties, tree-ring data is recently paid attention. Tree-rings have high potential to examine terrestrial carbon fluxes since tree-rings intrinsically correlate with forest carbon gains and stocks. A long observation time-span (decades to centuries) of tree-rings also increases its potential, extending observation period beyond fundamental flux-tower carbon observation (two or three decades). However, annual tree-rings are not simply in proportion to the annual sum of forest production. Annual tree-rings are made in a short time-span (e.g. two to three months) and such growing season's production is important for tree-rings though such growing season is still not clearly determined in ecosystem models for many tree species. This insufficient tree-ring growth phenology scheme has prohibited ecosystem modelers to use tree-ring data for validation though it has high potential to reveal spatiotemporal carbon stocks. Therefore, this research aims at revealing tree-ring growth phenology in conifer-hardwood mixed forests on Hokkaido Island, Japan.

Seven tree-ring site data of Sakhalin spruce (*Picea glehnii*) on Hokkaido Island were obtained from the International Tree-Ring Data Bank. At each site, mean chronology was calculated in BAI (basal area increment). Long-term climate data were obtained from the ERA20C reanalysis data (1900–2010) with downscaling and bias correction using random forest modeling and Automated Meteorological Data Acquisition System (AMeDAS) data on Hokkaido Island. Eight climatic parameters were used to construct the Vegetation Integrated SImulator for Trace gasses (VISIT) model. Flux data in Teshio flux tower site was used to modify the VISIT model. Net primary production (NPP) in each tree-ring site was predicted using the modified VISIT model and the downscaled ERA20C data. Predicted daily NPP were summed up for various periods (from a month to seven months at two weeks intervals) and in various temporal timings (at two weeks intervals). To analyze the most effective NPP period for BAI explanation, correlations between BAIs and the sum of each NPP period were calculated with random factor of sites and years and the best generalized linear mixed model was selected using the Akaike's information criterion (AIC).

Model selection revealed that a model using the sum of NPP from day of year 43 to 183 was the best model. This period contains tree-ring growing season (June) for *Picea glehnii* and other top models whose AIC differences from the best model were less than two also contained this season, suggesting importance of production in the tree-ring growing season. However, onset of the effective NPP period varied from January to May among these top models.

This research revealed that NPP in the tree-ring growing season is an important factor for tree-ring width variations. Although this analysis aimed at clarifying mean growth phenology among seven sites, differences in growth phenology among sites is expected to be a potential source of wide variance in the timing of onset. Although tree-ring growth phenology is difficult to observe, this research suggests that the growth phenology can be estimated from statistical analysis between tree-ring and NPP, which connects to a next step toward tree-ring-based validation of ecosystem models to reduce terrestrial ecosystem uncertainties.

Keywords: Process-based ecosystem model, VISIT, Phenology, Conifer-hardwood mixed forest, Allocation

