forest · knowledge · know-how · well-being

METLA

Estimating Scots pine needle litterfall based on photosynthesis and stand structural development

Boris Ťupek, Liisa Kulmala, Mikko Peltoniemi, and Aleksi Lehtonen

Finnish Forest Research Institute, P.O. Box 18, FI-01301 Vantaa, Finland, boris.tupek@metla.fi

Introduction

A constant proportion of gross primary production (GPP) is often used in estimating leaf and foliar litterfall production which serve for a biomass and soil carbon modeling.

However, the annual litterfall production may be more dependent on GPP during an ontogenetic period of needles (e.g. Needle Growth, No Needle Growth) than on the annual GPP.

Furthermore, precise annual litterfall production might require GPP to be based not only on meteorological conditions (GPP*pot*), but also on the fraction of absorbed photosynthetically active radiation (*fAPAR*)(GPP*act*).

Motivation

We studied whether GPPact and GPPpot can be used to precisely estimate annual needle litterfall production, and cumulative GPP of what time span is the most influential?

Material and Methods

Needle litterfall and basic tree measurements were conducted between 1961 and 2012 on 17 Scots pine stands across Finland (Pukkala et al. 2010, Ukonmaanaho et al. 2008). The GPP was estimated with a semi-empirical ecosystem model calibrated to Finnish environment given meteorological conditions and/or fAPAR as inputs (Peltoniemi et al. 2012). Starting date of new needle elongation was estimated with a needle growth model (Schiestl-Aalto et al. 2013).

Summary and Conclusion

We found that the annual needle litterfall production can be explained best by cumulative GPPact outside of the needle growth period (autumn, winter and early spring); needle ontogenetic period which is associated with maturation, carbohydrate and nutrient resorption, and abscission.

References:

Peltoniemi et al.2012. User guide for PRELES, a simple model for the assessment of gross primary production and water balance of forests. Working Papers of the Finnish Forest Research Institute 247. 23 s. ISBN 978-951-40-2395-8 (PDF).

Pukkala et al. 2010:Prediction models for the annual seed crop of Norway spruce and Scots pine in Finland. Silva Fennica 44: 629-642.

Schiestl-Aalto et al. 2013. Physiological growth model CASSIA predicts carbon allocation and wood formation of Scots pine. In R. Sievänen et al (Eds.): Proceedings of the 7th Int.C.on Functional-Structural Plant Models, Saariselkä, Finland.

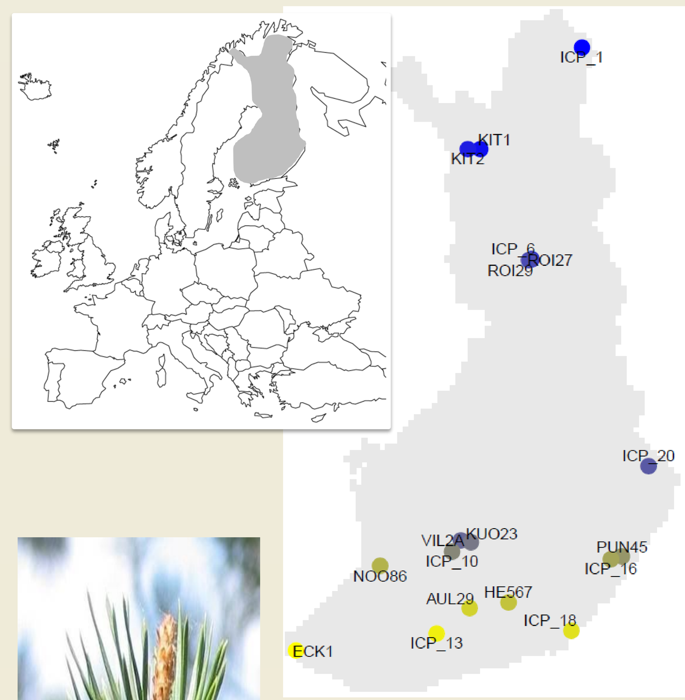
Ukonmaanaho et al.2008:Litterfall production and nutrient return to the forest floor in Scots pine and Norway spruce stands in Finland. Boreal Envir Res 13: 67-91.

Acknowledgements:

This work was part of the project 'Improving soil carbon estimation of GHG inventory' funded by Finnish Ministry of the Environment and Ministry of Agriculture and Forestry. We acknowledge projects which made this work possible: Climforisk (LIFE09 ENV/FI/000571), EU/ICP forest (Regulation 3528/86), EU/Forest Focus Programme (Regulation (EC) No 2152/2003), FutMon programme (LIFE07/ LIFE07 ENV/DE/000218), Long term monitoring of forest ecosystem (Metla project 3511, 3153). We thank Dr. Liisa Ukonmaanaho and Mr. Tatu Hokkanen for providing valuable data.

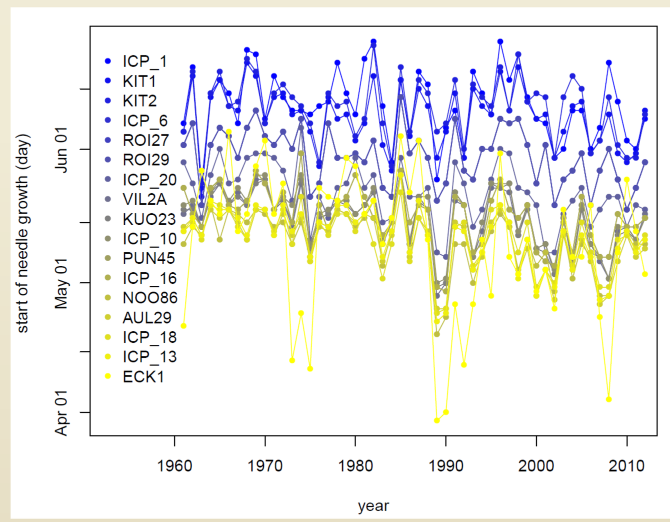
Results

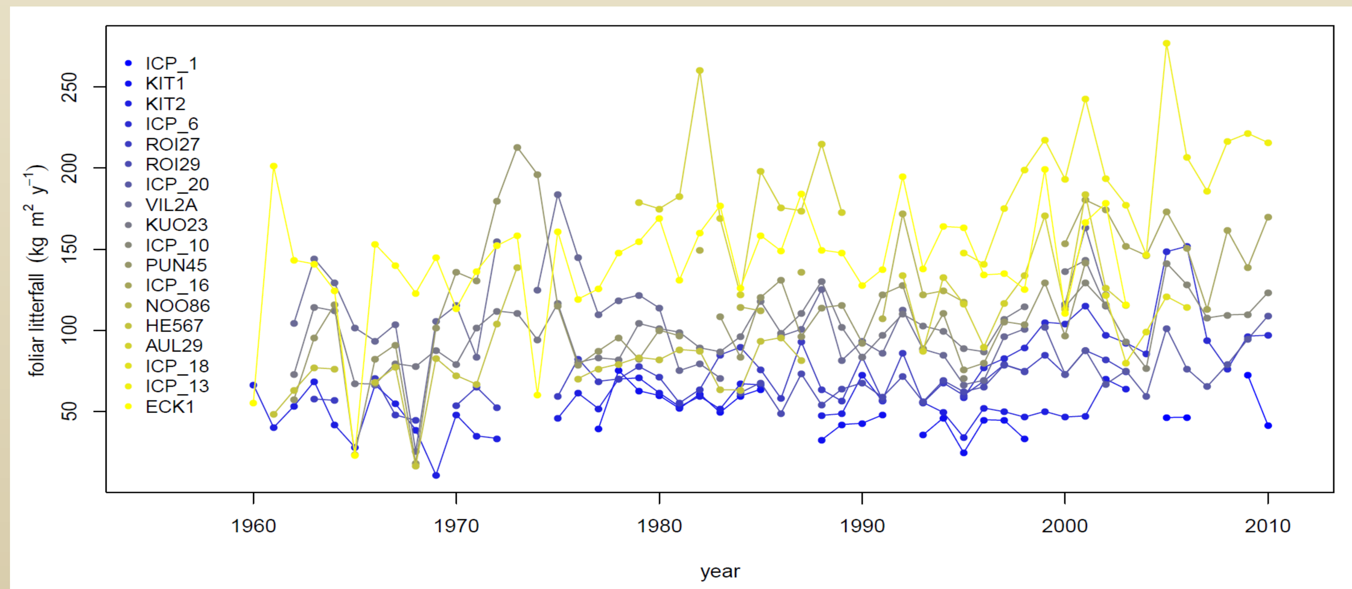
Sites

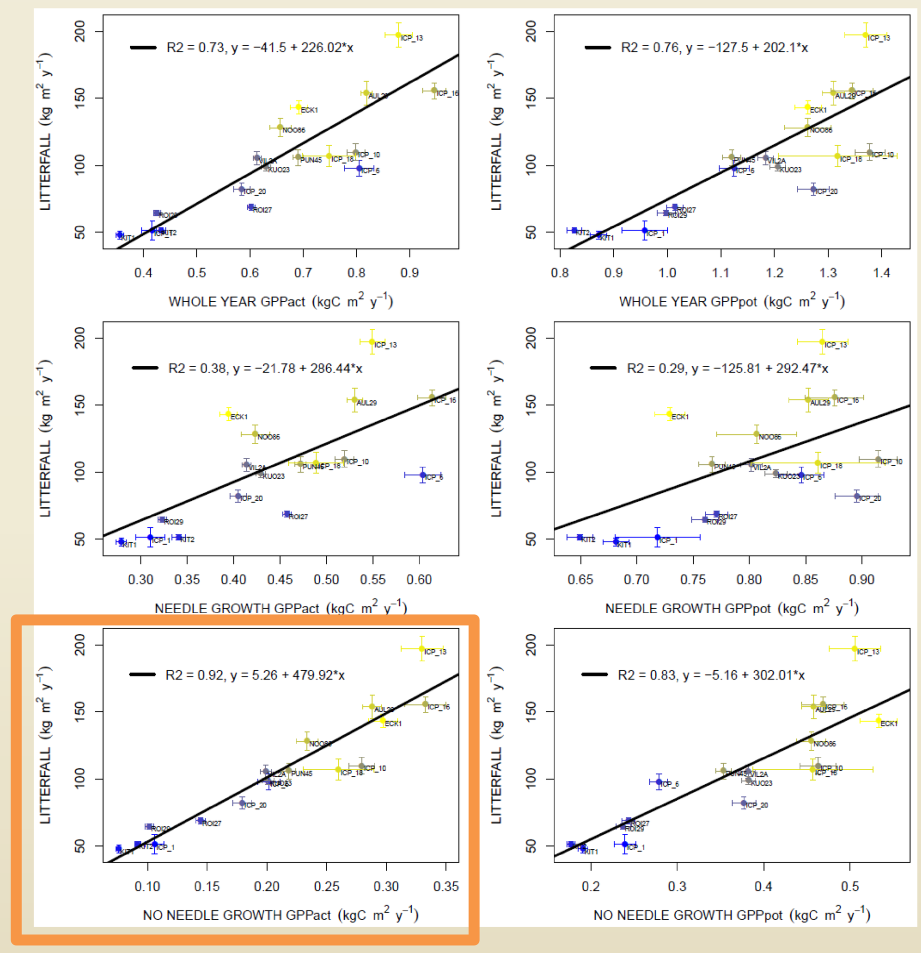


Needle Growth

=Start+3months







Welch Two Sample t-test	
WHOLE YEAR GPPact : WHOLE YEAR GPPpot	t31.9 = 8.6, p < 0.001
NO NEEDLE GROWTH GPPact : NO NEEDLE GROWTH GPPpot	t29.1 = 4.6, p < 0.001
WHOLE YEAR GPPact : NO NEEDLE GROWTH GPPact	t23.1 = 9.6, p < 0.001
WHOLE YEAR GPPpot : NO NEEDLE GROWTH GPPpot	t27.7 = 15.7, p < 0.001