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Supplement of

Influence of wood density in tree-ring-based annual productivity assessments and its errors in Norway spruce

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Supplement S1. Sampling plot location, stand and tree characteristics

	Plot ID	Plot area	Altitude	Stand age	N trees Total plot	N trees sampled	dbh range sampled trees	height range sampled trees
Units		m²	m a.s.l.	years			cm	m
WD dataset								
	4	625	733	10	132	3	2.1 – 6.2	2.3 – 5.0
	9	625	759	15	144	3	7.3 – 13.4	6.0 – 9.6
	33	625	727	35	39	3	16.9 – 35.3	17.6 – 20.5
	67	2500	784	75	127	3	19.7 – 46.0	18.0 – 24.7
	114	2500	738	115	66	3	27.7 – 59.5	23.7 – 31.8
Stem analysis								
	4	625	733	10	132	5	2.1 – 6.2	2.3 – 5.0
	9	625	759	15	144	5	7.3 – 13.4	6.0 – 9.6
	33	625	727	35	39	5	16.9 – 35.3	16.9 – 20.9
	67	2500	784	75	127	7	19.7 – 46.0	18.0 – 24.7
	114	2500	738	115	66	5	27.7 – 59.5	23.7 – 31.8
Application set								
	IP2	707	773	55	36	36	19.1 – 48.9	NA

	IP4	707	785	50	55	55	11.8 – 34.3	NA
	IP7	707	766	50	62	62	11.9 – 35.8	NA
	P11	707	777	75	37	37	12.4 – 44.5	NA
	P15	707	775	55	35	35	17.1 – 43.8	NA
	P16	707	764	45	39	39	13.5 – 38.9	NA
	P3	707	778	55	38	38	11.5 – 38.0	NA
	P4	707	763	40	37	37	14.2 – 41.1	NA
	P6	707	771	60	53	53	10.2 – 42.7	NA
	P7	707	778	50	40	40	12.4 – 44.5	NA
	P8	707	774	60	31	31	8.1 – 43.3	NA
	W57	707	785	75	35	35	22.0 – 42.7	NA
	W60	2500	733	75	53	53	19.6 – 50.7	NA

Supplement S2. WinBUGS code

```
# Level 2: wood density as a function of ring width and size
for(i in 1:Ndata1){
  wd[i] ~ dnorm(mu.wd[i], tau.wd)
  mu.wd[i] <- a[1] +u[1,tree1[i]]
              + (a[2]+u[2,tree1[i]])*pow(rw1[i], 0.5)
              + (a[3]+u[3,tree1[i]])/pow(diam1[i],0.5) }

# Random terms, centered by a1-a3
for (j in 1:Ntree1){ u[1,j]~dnorm(0, tau.u[1])
                    u[2,j]~dnorm(0, tau.u[2])
                    u[3,j]~dnorm(0, tau.u[3]) }

# Prior
tau.wd <- 1/(sd.wd*sd.wd) # Residual variance
sd.wd ~ dunif(0,100)
a[1] ~ dnorm(500,0.001)
for(i in 2:3){ a[i] ~ dnorm(0,0.001) } # Fixed coefficients
for(i in 1:3){ tau.u[i] <- 1/(sd.u[i]*sd.u[i]) # Random effects
               sd.u[i] ~ dunif(0,1000)
               }

# Level 2: volume increment as a function of ring width and size
for(i in 1:Ndata2){
  dv[i] ~ dnorm(mu.dv[i], tau.dv[i]) # Likelihood model for volume increment (dv)
  mu.dv[i] <- b[1]+b[2]*(pow((2*diam2[i]), b[3]))*pow(rw2[i], b[4]+v[tree2[i]]) # dv
  process model
  tau.dv[i] <- 1/(sd.dv[i]*sd.dv[i]) # conversion of sd to tau
  sd.dv[i] <- b[5]+b[6]*2*diam2[i] # predictive equation for sd as a function of the
  diameter
  }

for (i in 1:Ntree2){ v[i]~dnorm(0, tau.v) } # Random term for b4
for (i in 1:6){ b[i]~dnorm(0,0.001) } #Priors
tau.v <- 1/(sd.v*sd.v)
sd.v ~ dunif(0,100)

#Prediction at the stand-level using the application dataset
for(i in 1:Nplot3){
  for(j in 1:Ntree3[i]){
```

```

# Sample random effects first at the tree level
u1.new[i,j]~dnorm(0,tau.u[1])
u2.new[i,j]~dnorm(0,tau.u[2])
u3.new[i,j]~dnorm(0,tau.u[3])
v.new[i,j]~dnorm(0,tau.v)

for(k in 1:Nyear3){
  wd.new.nor[i,j,k]<- a[1] + a[2]*pow(RWnew[i,j,k],0.5) +
    (a[3]/pow(Dnew[i,j,k],0.5))
  dv.new.nor[i,j,k]<- b[1] + b[2]*pow(Dnew[i,j,k], b[3])*pow(RWnew[i,j,k], b[4])

  # Realise prediction by inserting new predictors and u.new
  wd.new.par[i,j,k]<- (a[1]+u1.new[i,j]) + (a[2]+u2.new[i,j])*pow(RWnew[i,j,k],0.5)
+ (a[3]+u3.new[i,j])/pow(Dnew[i,j,k],0.5)
  dv.new.par[i,j,k] <- b[1]+b[2]*pow(Dnew[i,j,k], b[3])*pow(RWnew[i,j,k],
b[4]+v.new[i,j])

  # Sample from residual distribution
  wd.new[i,j,k]~dnorm(wd.new.par[i,j,k], tau.wd)
  # Calculate new tau.dv (residual variance is modeled, not fixed)
  tau.dv.new[i,j,k] <- pow(b[5]+b[6]*Dnew[i,j,k],-2)
  dv.new[i,j,k] ~ dnorm(dv.new.par[i,j,k], tau.dv.new[i,j,k])

  # Multiplication to of WD and deltaV to obtain the biomass increments
  sc0[i,j,k] <- 475*dv.new.nor[i,j,k]
  sc1[i,j,k] <- 400*dv.new.nor[i,j,k]
  sc2[i,j,k] <- 400*dv.new[i,j,k]
  sc3[i,j,k] <- wd.new.nor[i,j,k]*dv.new.nor[i,j,k]
  sc4[i,j,k] <- wd.new[i,j,k]*dv.new[i,j,k]
}}

#aggregated estimates at stand level
for(i in 1:Nplot3){
  for(k in 1:Nyear3){
    ssc0[i,k]<-sum(sc0[i,1:Ntree3[i],k])/areaplot[i]
    ssc1[i,k]<-sum(sc1[i,1:Ntree3[i],k])/areaplot[i]
    ssc2[i,k]<-sum(sc2[i,1:Ntree3[i],k])/areaplot[i]
    ssc3[i,k]<-sum(sc3[i,1:Ntree3[i],k])/areaplot[i]
    ssc4[i,k]<-sum(sc4[i,1:Ntree3[i],k])/areaplot[i]
  }
}

```

