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Institutionen för skoglig resurshushållning

ANSÖKAN TILL KEMPESTIFTELSERNA
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Utveckling av metodik för satellitbaserad forskning och övervakning av kol- och vatten-cykeln i boreala skogsekosystem

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Syfte:
- att utveckla satellitbaserad radarfjärranalys för forskning och övervakning av boreal skog,
- att ytterligare förstärka Svartbergets skogliga försökspark, SLU, Vindeln, som internationell unik plattform för forskning om boreala skogars funktion och skötsel.

Sammanfattning:
Satellitbaserad fjärranalys är sedan länge centralt för forskning och övervakning av jordens biosfär. En av de viktigaste teknikerna utgörs av satellitbaserad radarfjärranalys, vilken idag är inne i ett intensivt skede av forskning och utveckling för skogliga tillämpningar. Satelliter med syntetisk aperturradar (SAR) har stor potential för registrering av skogliga variabler (t.ex. trädhöjd, volym, biomassa, arkitektur) såväl som vattentillgång i vegetation och mark. Det råder dock för närvarande begränsad kunskap om hur markfuktighet, nederbörd, solljus (fotosyntes), temperatur och vind påverkar mätningarna, speciellt för boreala skogar.

Projektet baseras på installation av en markbaserad radarstation, vilken kommer att användas för att i detalj studera hur radarsignalen kan användas för att beskriva olika egenskaper och processer i boreal skog. En avgörande komponent i projektet är samlokalisering av den nya radarstationen med forskningsinfrastrukturerna ICOS och SITES inom Svartbergets försökspark, SLU, Vindeln. Det sökta anslaget avses att användas för att installera och instrumentera ett 50 m högt radartorn på SLU:s försökspark i Vindeln. Samlokaliseringen med befintliga forskningsinfrastrukturer ICOS och SITES kommer att resultera i en internationell unik möjlighet att dels utveckla radarfjärranalys för boreala förhållanden och dels använda tekniken för studier av boreala skogars vattenutnyttjande. Medel från annan finansiär har inte sökts för detta projekt.

Sökt belopp: 3 932 288 SEK (varav 3 662 000 SEK för utrustning och 270 288 SEK för personal)

Umeå 2020-10-21 ..... Johan Fransson ..... Johan Fransson
Ort och datum — Sökandens underskrift — Namnförtydligande

Umeå 2020-10-21 ..... Hans Petersson
Ort och datum — Prefekt — Namnförtydligande

Bilagor: 1. Projektbeskrivning, 2. Utrustning, 3. CV, 4. Projektkalkyl

Projektbeskrivning av ”Utveckling av metodik för satellitbaserad forskning och övervakning av kol- och vatten-cykeln i boreala skogsekosystem”

Bakgrund

Under de senaste två decennierna har Europa, USA och Japan gjort stora investeringar för att bygga upp en infrastruktur i rymden med radarsatelliter för forskning och global övervakning av tillstånd och processer av jordens ekosystem. Dessa har företrädesvis varit optimerade för havs- (vind, vågor, strömmar, oljespill) och havsistillämpningar (iskoncentration, istjocklek, istyp). Under det senaste decenniet har tillämpningar relevanta för landekosystem successivt ökat i betydelse. Ett tydligt bevis på detta är att upplösningen i radarbilderna har blivit bättre (som bäst ca 0.5 m mot tidigare ca 10 m) och att tekniken med radarinterferometri har vidareutvecklats. Den senare tekniken innebär att flera radarmätningar med olika geometri nyttjas tillsammans för att åstadkomma 3D-mätningar av jordytan. 3D-mätningarna används sedan för att generera digitala höjdmodeller, men även för att producera högupplösta kartor av trädhöjd, som bl.a. två avhandlingar på SLU [1] respektive Chalmers [2] nyligen visat. Metoden kräver att en digital höjdmodell av marken finns tillgänglig, som kan fås t.ex. från flygburen laserskanning (ALS). Studier har visat att höjdmätningen från satellit-interferometri har mycket hög precision med ett fel på ca 5% (RMSE) på beståndsnivå, vilket är i klass med de bästa resultaten från ALS.

Satellitburen radar kan också användas för att kartera biomassa (torrmassa per ytenhet mätt i ton/ha), vilken har blivit en allt viktigare variabel att följa genom sin nära koppling till den globala kolomsättningen. Biomassa kan skattas med radarinterferometri på liknande sätt som trädhöjden, men kräver i detta fall träningsdata [1], [2]. Metoden bygger också på att en markmodell finns tillgänglig, vilket inte är fallet i de flesta länder. Ett alternativt sätt att kartera biomassa bygger istället på att nyttja radarvågor med längre våglängd som kan tränga igenom krontaket så att radarekot domineras av reflektioner från stammar och större grenar. Metoden liknar den som utvecklades i Sverige under 1990-talet med den internationellt uppmärksammade flygburna CARABAS-radarn, vilken använder våglängder i intervallet 3-15 m [3]. CARABAS-tekniken kan dock inte användas från satellit p.g.a. jonosfärens störande inverkan på radarvågen. Istället utvecklas nu metoden för våglängden 70 cm (P-band, se nedan), där jonosfärs-påverkan är mindre och kan korrigeras.

Utöver applikationer inriktade mot att skatta biomassa och kolförråd i skogsekosystem har data från satellitburen radar även börjat användas för att skatta fuktighet och även vattenytenivå i olika ekosystem [4]. Föreliggande projekt gör det möjligt att utveckla tekniken för att bestämma tillgång på vatten i mark och vegetation i boreala miljöer.

Värdet av att förstå de faktorer som påverkar radarmätningarna är störst när de tillämpas i stor skala där inga markmätningar finns tillgängliga. Därför kommer radarmätningarna från tornet att jämföras med motsvarande satellitdata från samma område.

Sedan 2006 har Japan skjutit upp två satelliter, ALOS och ALOS-2, vilka är utrustade med radar som har en relativt lång våglängd på ca 20 cm (L-band). En tredje japansk radarsatellit med L-band, ALOS-4, är planerad att skjutas upp 2022. Därutöver planeras också en amerikansk-indisk satellit, NISAR, att skjutas upp 2022 (även denna satellit kommer att vara utrustad med L-band). L-band har en bättre känslighet för biomassa

jämfört med att använda den vanligaste våglängden på ca 5 cm (C-band), vilken används av exempelvis Sentinel-1-satelliterna (europeiska rymdstyrelsen, ESA). Studier har dock visat att mer forskning behövs för att förbättra skattningen av biomassa, bl.a. genom att bättre förstå och modellera inverkan av fuktigheten i mark och träd.

ESA har nyligen beslutat att ta ytterligare ett steg och utveckla en satellitradar med våglängden 70 cm för global kartering av skogens biomassa. BIOMASS, som missionen heter, planeras för uppskjutning 2022 och kommer att bli den första satellitmissionen med denna våglängd, vars primära målsättning är kartering av skogens biomassa, höjd och dess förändringar [5]. Vad gäller boreal skog kommer BIOMASS att regelbundet avbilda hela Sibirien. Lars Ulander som är medsökande på föreliggande ansökan är en av de ursprungliga förslagsställarna och har varit medlem i ESA:s styrgrupp (Mission Advisory Group) för BIOMASS sedan den bildades 2006. Sverige (SLU och Chalmers) har haft en ledande roll under förstudierna för BIOMASS och ett antal radarexperiment med flygplan genomfördes under åren 2007-2010 [2], [5]. De flesta radarflygningarna genomfördes i Sverige över Krycklan vid Svartbergets försökspark i Vindeln (vilken tillhör SLU) och Remningstorps försöksområde utanför Skövde. Detta gjordes vid tre tillfällen våren 2007, ett tillfälle 2008 och ytterligare ett tillfälle 2010. Resultaten från studierna blev mycket goda [6], [7], [8], [9] och utgjorde ett viktigt underlag inför ESA:s beslut att finansiera BIOMASS, vilket togs våren 2013.

Radarflygningar genomfördes också över tropisk regnskog i Franska Guyana, vilka visade att radar med en våglängd på 70 cm kan tränga ned igenom krontaket till marken i tät och hög regnskog. Parallellt med radarflygningarna i Franska Guyana genomfördes också mätningar från ett 50 m högt torn över tropisk regnskog [10]. Mätningarna uppvisar dygns- och säsongsmässiga variationer, vilket bekräftade hypotesen att fuktigheten i mark och träd påverkar radarekot och måste kompenseras för.

För att kunna vidareutveckla tekniken och anpassa den till boreala förhållanden där väderfaktorer beaktas är det absolut nödvändigt med detaljerade markbaserade studier i den boreala regionen. I föreliggande projekt föreslår vi att radarinstrument som matchar satellitbaserade sensorer med våglängderna 5 cm (C-band, Sentinel-1), 20 cm (L-band, ALOS-2, ALOS-4, NISAR) respektive 70 cm (P-band, BIOMASS) installeras på ett 50 m högt torn, vilket placeras i anslutning till de befintliga forsknings-infrastrukturerna ICOS och SITES inom Svartbergets försökspark i Vindeln. Med denna utrustning kan radarmätningar utföras kontinuerligt (var 5:e minut) under lång tid för att registrera data under olika betingelser. Vårt projektförslag innebär att etablera ett torn med radarutrustning under 2021 för att först och främst genomföra mätningar fram till uppskjutningarna av BIOMASS (2022), ALOS-4 (2022) och NISAR (2022), och därefter kontinuerligt fortsätta mätserien fram till i först hand år 2026. Parallellt kommer meteorologiska och hydrologiska data att registreras, vilka är viktiga för framtagning av modeller i syfte att korrigera satellitmätningarna.

Metod

Tornet och mätutrustningen kommer att installeras enligt metoder som säkerställer att mätningar kan utföras kontinuerligt och som fångar både dygns- och säsongs-variationer. Data kommer att lagras lokalt med tidsstämpling och backup för att säkerställa dataintegritet. Data kommer sedan att föras över till SLU/Chalmers (Ljungbergslaboratoriet/Nationellt skogsdatalabb) via befintligt fibernät för vidare processering och analys samt arkivering.

Tornet utrustas med radarantenner i liknande geometri som aktuella radarsatelliter. Vidare utrustas tornet med en vektor-nätverks-analysator (Vector Network Analyser, VNA) med 20 portar som möjliggör koherenta mätningar av fyra polarisations-kombinationer, dvs. horisontell och vertikal polarisation för respektive sändning och mottagning. Övrig elektronik inklusive dator och datalagringsutrustning placeras i en liten byggnad eller container vid tornets fot. Lågförlustkablar förbinder elektroniken med antennerna i tornet. Åskskydd med gasurladdningsrör och jordkablar installeras. Nödvändig nätanslutning (230 V) dras fram från lämplig anslutningspunkt och värmereglering installeras för elektroniken. Tornet och byggnaden inhägnas så att obehöriga inte har tillträde. Radarantennerna kommer att vara utrustade för att samla in fullpolarimetriska data, dvs. både horisontell och vertikal polarisation med amplitud och fas. Radarutrustningen kommer att använda frekvensstegning för att åstadkomma stor bandbredd, vilket innebär att många oberoende sampel kan samlas in över mätområdet. Det senare kan användas antingen för att åstadkomma hög upplösning i radiell riktning eller medelvärdesbildning av mätsignalen, vilket är nödvändigt för den efterföljande analysen.

Uteffekten är låg (0,01 W toppeffekt), vilket gör att strålningsnivån är betryggande för personal. Signalbandbredden är flexibel och den utsända vågformen består av ett antal diskreta radiofrekvenser som stegas igenom samtidigt som den mottagna signalen med amplitud och fas registreras. Avståndsupplösning erhålls genom Fouriertransformering av mottagna signaler. Vertikal upplösning erhålls genom tomografisk bearbetning av data från de olika antennerna. Slutresultatet är en radarbild som avbildar skogen i ett vertikalt skikt (se vidare bilaga 2).

Statistiska metoder kommer att användas vid den efterföljande databehandlingen. Olika mått (glidande medelvärde, varians, fördelning etc.) beräknas från skiktbilderna och tidsserieanalys används för att modellera inverkan av miljöfaktorerna. Komplex signalrepresentation används för att beräkna Dopplersignaturer och koherens.

Data från befintliga och framtida aktuella satelliter kommer också att samlas in för att användas i analysen, bl.a. data från Sentinel-1 (C-band), ALOS-2, ALOS-4, NISAR (L-band) och BIOMASS (P-band). De sökande har tillgång till dessa data för forskningsändamål utan kostnad. Dessutom kommer meteorologiska (temperatur, luftfuktighet, vindstyrka etc.) och hydrologiska (markfuktighet) mätningar att göras. Likaså kommer omfattande skogsinventering att genomföras i området genom SLU:s försorg.

I dagsläget finns ett befintligt radartorn på Remningstorps försöksområde utanför Skövde, vilket byggdes 2016 av Chalmers (se vidare bilaga 2). Föreliggande projekt gör det möjligt för SLU att förutom vidareutveckling av satellitbaserad radarfjärranalys för forskning och övervakning av boreal skog, ytterligare förstärka Svartbergets försökspark i Vindeln som internationell unik plattform för forskning om boreala skogars funktion och skötsel. Detta möjliggörs genom att samlokalisera ett nytt radartorn med redan befintlig forskningsinfrastruktur (ICOS och SITES) där samtida mätningar från de olika infrastrukturerna kan analyseras tillsammans. Mätningarna från Remningstorp började 2017 och Chalmers har sedan dess erfarenhet av drift och analys av data från radartornet. Dessa erfarenheter kommer föreliggande projekt till stor nytta. Resultaten har nyligen publicerats i en doktorsavhandling vid Chalmers där Lars Ulander var huvudhandledare och Johan Fransson biträdande handledare [11]. Resultaten i avhandlingen pekar tydligt på vikten och nyttan av föreliggande projekt.

Forskningsmiljö
De sökandes grupper har ett långt och etablerat samarbete inom forskningsområdet sedan början av 1990-talet. Samarbetet har lett till ca 10 doktorsavhandlingar genom åren. SLU har stått för expertisen inom statistik, skogsvetenskap och fältmätningar och Chalmers har stått för expertisen inom radarteknik, elektromagnetisk vågutbredning och signalbehandling. Kombinationen av olika kunskaper och erfarenheter har varit till stor nytta för de genomförda forskningsprojekten.

De insamlade mätningarna kommer att utgöra en unik databas för den kommande generationen av doktorander och forskare inom området. Båda forskargrupperna kommer att nyttja databasen i sin forskning i olika projekt.

Vid SLU kommer forskargrupper i första hand vid Institutionerna för skoglig resurshushållning (SRH) samt Institutionen för skogens ekologi och skötsel (SES) att vara direkt involverade i att nyttja data som genereras av den nya forskningsinfrastrukturen. Forskargruppen vid SRH består för närvarande av elva disputerade forskare och fem doktorander varav minst fyra kommer att vara direkt inblandade i projektet. Vid SES kommer flera forskargrupper att vara direkt involverade, dels de som fokuserar på omsättning och utbyte av vatten och dels de som inriktar sig på skogens upptag och avgivning av CO_2. Totalt kommer minst fem personer vid SES att vara direkt involverade. Forskargruppen vid Chalmers består av åtta forskare varav fyra kommer att vara direkt inblandade i att nyttja data från den etablerade forskarinfrastrukturen.

Grupperna arbetar i en utpräglad internationell miljö, med bl.a. projekt finansierade av ESA och EU:s forskningsprogram, vilket garanterar en utmanande, kreativ och dynamisk miljö (se vidare bilaga 3).

Förväntade resultat
Det primära syftet med projektet är att etablera ett mättorn inom Svartbergets försökspark och installera radarinstrument som samlar in polarimetriska data för våglängderna 5 cm (C-band), 20 cm (L-band) respektive 70 cm (P-band). Mätningarna kommer att starta under hösten 2021 och fortgå fram till år 2026. Sannolikt finns det ett fortsatt behov av mätningar efter denna tidsperiod, vilket då gör det naturligt att fortsätta mätserien och permanenta torninstallationen. Databasen kommer att vara underlag för nästa generations forskare, bl.a. nya doktorander på SLU och Chalmers. Dessutom kommer ett antal forskare och doktorander på SLU och Chalmers att analysera data (se ovan). Resultaten kommer att publiceras fortlöpande i vetenskapliga tidskrifter och på konferenser.

Budget och tidsplan
Under 2021 kommer tornet och radarutrustningen att installeras på lämplig plats inom Svartbergets försökspark i Vindeln. Den största kostnadsposten utgörs av en vektornätverks-analysator (VNA) som är den del av systemet som sänder ut radio- och mikrovågor och mäter den reflekterade signalen med hög noggrannhet. Tillsammans med P- och L-bandsantennerna, kalibreringsslinga, omkopplingsnät och kablage uppgår denna kostnad till 1 962 000 SEK (observera att denna kostnad har ökat med 300 000 SEK jämfört med den kostnad som togs upp i den tidigare ansökan från januari 2020). Ytterligare en stor post utgörs av byggnationen av själva tornet (inklusive grundläggning, betongfundament och montage). Kostnaden för detta bedöms till 1 000 000 SEK efter kontakter med tänkbara leverantörer. Kostnader för C-bandsantenner, väderstation, stam- och markfuktighetssensorer, teknikbod och reflektor (för kalibrering) tillkommer med 300 000 SEK, 50 000 SEK, 150 000 SEK, 150 000 SEK

och 50 000 SEK (totalt: 700 000 SEK). För att täcka kostnaderna för ovan nämnda utrustning söker vi därmed ett belopp på 3 662 000 SEK. Vad gäller kostnaden för teknikbod ingår även markarbeten och kostnad för att dra fram 230 V nätspänning till mätutrustningen, vilket görs från den närbelägna ICOS-stationen.

Vi ansöker också för att finansiera en forskningsingenjör under 5 månader (1 månad per år under 2021-2025) för integration av radarutrustning och fortlöpande tekniskt arbete i samband med dataöverföring och datalagring. De totala personalkostnaderna bedöms uppgå till 270 288 SEK exklusive OH-kostnad.

Totalt söks 3 932 288 SEK från Kempestiftelserna (se vidare bilaga 4).

Arbetstid för forskare ingår inte i projektansökan utan kommer att sökas separat från exempelvis Formas, VR, Svenska Rymdstyrelsen, EU:s forskningsprogram och/eller ESA.

Projektet löper under perioden 2021-01-01 – 2025-12-31.

Chalmers (Lars Ulander huvudsökande) har tillsammans med SLU (SRH och SES medsökande) nyligen beviljats ett 4-årigt anslag från VR för ett projekt med titeln ”Kvantifiering och uppdelning av evapotranspiration i skog baserad på samlokaliserade radar- och fluxtornmätningar”. Detta projekt kommer att ha mycket stor nytta av den infrastruktur som vi söker för i föreliggande projekt.

Referenser

[1] H. Persson, Estimation of Forest Parameters Using 3D Satellite Data: Stereogrammetry, Radargrammetry and Interferometry, Ph.D. thesis, Swedish University of Agricultural Sciences, Umeå, 2014.

[2] M. Soja, Modelling and Retrieval of Forest Parameters from Synthetic Aperture Radar Data, Ph.D. thesis, Chalmers University of Technology, Göteborg, 2014.

[3] J. Fransson, Analysis of Synthetic Aperture Radar Images for Forestry Applications, Ph.D. thesis, Swedish University of Agricultural Sciences, Umeå, 1999.

[4] M. Bechtold, G.J.M. De Lannoy, R.D. Koster, R.H. Reichle, S. Mahanama, W. Bleuten, M.A. Bourgault, C. Brümmer, I. Burdun, A.R. Desai, K. Devito, T. Grünwald, M. Grygoruk, E.R. Humphreys, J. Klatt, J. Kurbatova, A. Lohila, T.M. Munir, M.B. Nilsson, J.S. Price, M. Röhl, A. Schneider, and B. Tiemeyer, PEAT-CLSM: A Specific Treatment of Peatland Hydrology in the NASA Catchment Land Surface Model, Journal of Advances in Modelling Earth Systems, vol. 11, no. 7, pp. 2130 – 2162, 2019.

[5] T. Le Toan, S. Quegan, M.W.J. Davidson, H. Balzter, P. Paillou, K. Papathanassiou, S. Plummer, F. Rocca, S. Saatchi, H. Shugart, and L. Ulander, The BIOMASS mission: Mapping Global Forest Biomass to Better Understand the Terrestrial Carbon Cycle, Remote Sensing of the Environment, vol. 115, no. 11, pp. 2850 – 2860, 2011.

[6] G. Sandberg, Estimation of Forest Biomass and Faraday Rotation using Ultra High Frequency Synthetic Aperture Radar, Ph.D. thesis, Chalmers University of Technology, Göteborg, 2013.

[7] G. Sandberg, L.M.H. Ulander, J. Holmgren, J.E.S. Fransson, and T. Le Toan, L- and P-Band Backscatter Intensity for Biomass Retrieval in Hemiboreal Forest, Remote Sensing of the Environment, vol. 115, no. 11, pp. 2874 – 2886, 2011.

[8] G. Sandberg, L.M.H. Ulander, J. Wallerman, and J.E.S. Fransson, Measurements of Forest Biomass Change Using P-Band SAR Backscatter, IEEE Transactions on Geoscience and Remote Sensing, vol. 52 , no. 10, pp. 6047 – 6061, 2014.

[9] M.J. Soja, G. Sandberg, G., and L.M.H. Ulander, Regression-Based Retrieval of Boreal Forest Biomass in Sloping Terrain Using P-band SAR Backscatter Intensity Data, IEEE Transactions on Geoscience and Remote Sensing, vol. 51, no. 5, pp. 2646 – 2665, 2013.

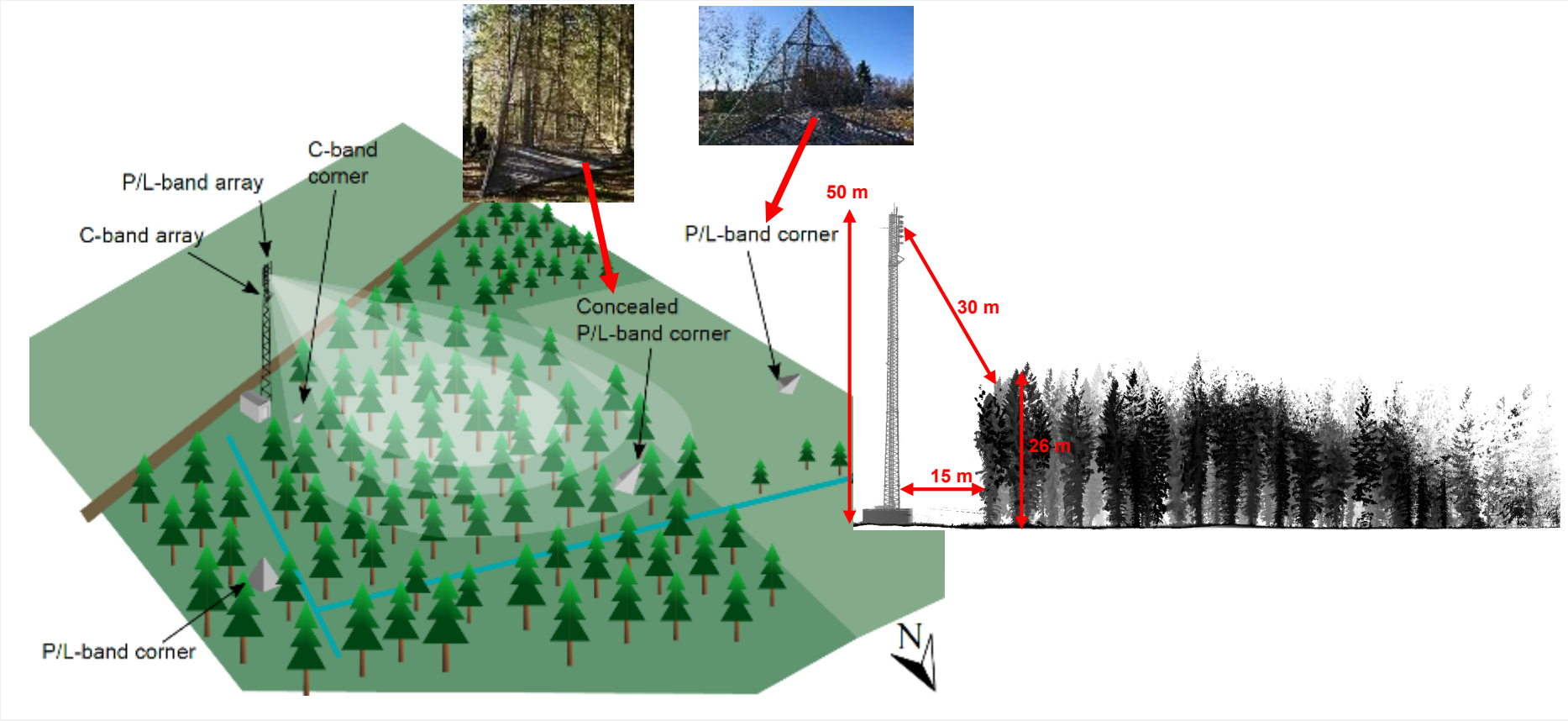
[10] D. Ho Tong Minh, S. Tebaldini, F. Rocca, T. Koleck, P. Borderies, C. Albinet, L. Villard, A. Hamadi, and T. Le Toan, Ground-Based Array for Tomographic Imaging of the Tropical Forest in P-Band, IEEE Transactions on Geoscience and Remote Sensing, vol. 51, no. 8, pp. 4460 – 4472, 2013.

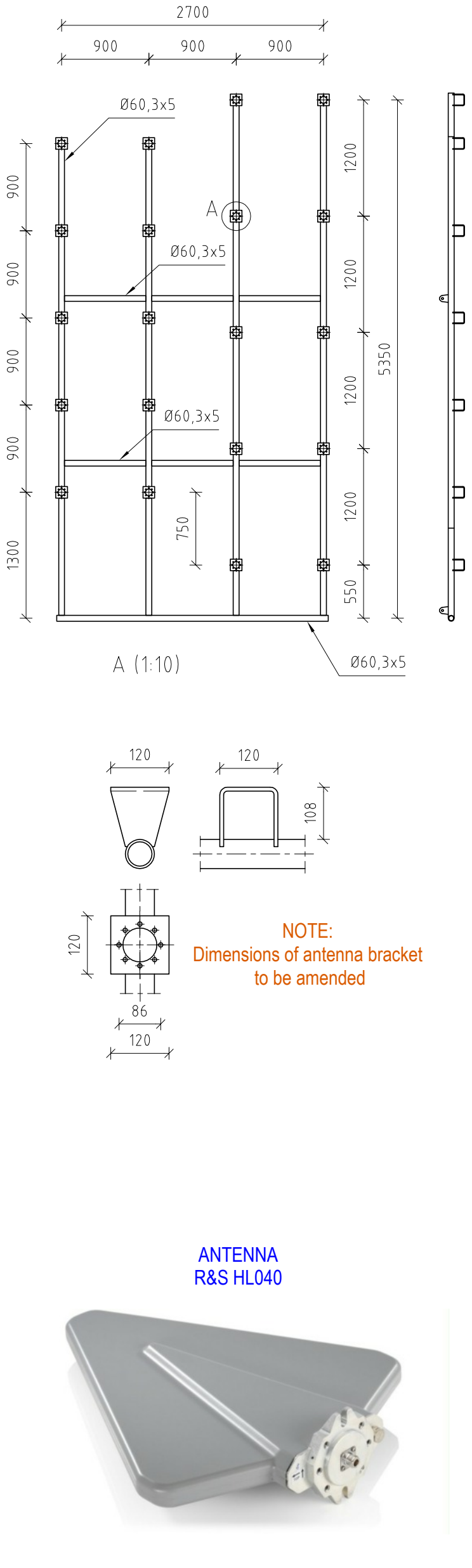
[11] A. Monteith, Temporal Characteristics of Boreal Forest Radar Measurements, Ph.D. thesis, Chalmers University of Technology, Göteborg, 2020.

Utrustning

Radartornet förses med toppmodern utrustning för att mäta tidsvariationer i radarreflektionen från skogen. Mätningar utförs för två olika polarisationstillstånd, både för sändning och mottagning, och tre olika frekvensband (P-band: 435 MHz, L-band: 1.3 GHz, C-band: 5.4 GHz). Frekvensbanden har valts för att vara desamma som aktuella radarsatelliter använder. Antennsystemet konstrueras som en virtuell digital gruppantenn för att generera radartomogram (skiktradarbilder) med både horisontell och vertikal upplösning. Totalt 20 antenner monteras nära tornets topp för att skapa en virtuell gruppantenn för P- och L-band, och ytterligare 10 dubbelpolariserade antenner för C-band. Placeringen av antennerna optimeras för att minimera gallerlober. Totalt 40 lågförlustkablar förbinder antennerna med en vektor-nätverks-analysator (VNA) som är den del av systemet som sänder ut mikrovågor och mäter den reflekterade signalen med hög noggrannhet. VNA:n sänder ut ett stort antal frekvenser inom varje band för att generera stor bandbredd och hög upplösning i avstånd. För att snabba upp det tomografiska mätförloppet används en VNA med 20 portar så att signalerna från 20 antenner kan tas emot samtidigt. En snabb mätning är helt avgörande för ett få bra resultat när träden rör sig i vinden. Tornet konstrueras för att inte röra sig mer än några cm i toppen när det blåser kraftigt (max 3 cm vid 17 m/s medelvind). Kablage jordas på flera ställen utefter tornet och i marken, och åskledare och gasurladdningsrör installeras som elektriskt skydd. VNA, tillsammans med styrdator, datadiskar, kalibreringsslinga och omkopplingsnät, placeras i en temperatur-kontrollerad teknikbod för att efterlikna laboratorieförhållanden och uppnå maximal noggrannhet. Data lagras lokalt med dubbel redundans för hög säkerhet och överförs via datornätverk (fiber eller radio) till en extern server för backup. Ytterligare sensorer installeras för att mäta fuktvariationer i skogen och marken nära tornet vilket används vid dataanalysen. Beprövade mätmetoder som dendrometrar och sap-flow kommer att användas. Även vindstyrka och riktning mäts med akustiska 3D-sensorer i tornet för användning vid dataanalysen.

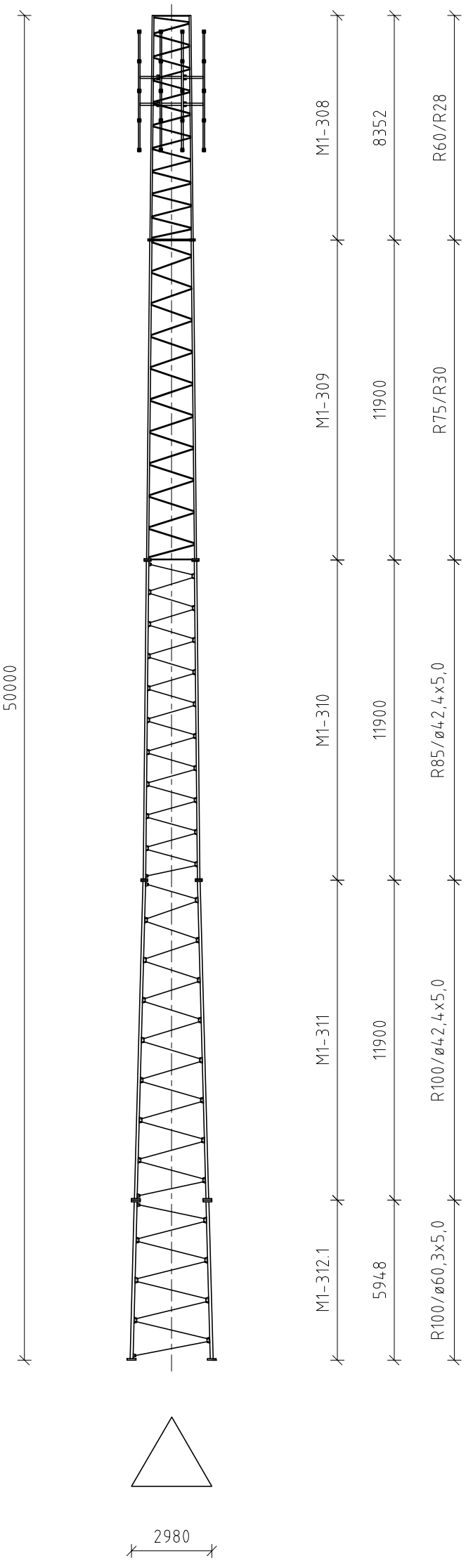
Skiss på radartorn med reflektorer





NOTE:
Dimensions of antenna bracket
to be amended

ANTENNA
R&S HL040



CE 0200

FORCE Certification
System Certification
DS/EN 1090-1
CE-Marking

FORCE Certification
System Certification
DS/EN ISO 9001
Quality

FORCE Certification
System Certification
DS/EN ISO 3834-2
Production

Rev.:	Int.:	Date:	Comment:

Carl C A/S

Customer: MTUH

Subject: 50m Radio Survey Tower Serie Met-M for Skövda Area, Sweden

Date: 14-04-2016	Production no.:	Scale: 1:200	Projektion: / Format: A3
Order no.:	Calculation:	Int.: ATJ	Tolerance: 0-1000 : ±1 mm 1001-5000 : ±2 mm 5001-~ : ±3 mm
Drawing no.: s8met-50m-3121-skövda		Note:	Holediameter : ±0,5 mm Node distance : ±10 mm

Carl C A/S Manufacturing Engineering Commerc Smedevej 2 DK-6900 Skjern Tel. +45 97351066 Fax +45 97351276

Curriculum Vitae for Johan E.S. Fransson

Name: Johan Erik Stefan Fransson

Date of birth: December 2, 1967

Place of birth: Karlshamn, Sweden

Professional preparation: 4-year Upper secondary school, Technical Sciences, Växjö, Sweden, Gymnasium engineer, June 1987
M.Sc. in Forestry, December 1992
Swedish University of Agricultural Sciences
SE-901 83 Umeå, SWEDEN

Language skills: English (Good), German (2nd foreign language)

Appointments: Associate Professor in Forest Remote Sensing, Nov. 2002
Assistant Professor in Forest Remote Sensing, May 2000
Ph.D. in Forest Remote Sensing, June 1999
Swedish University of Agricultural Sciences
Department of Forest Resource Management
Division of Forest Remote Sensing
SE-901 83 Umeå, SWEDEN

Ph.D. student courses: Library research (1 p)
Scientific communication (1 p)
Scientific publishing (2 p)
Electromagnetism, principles and applications (1 p)
ERS-1 and remote sensing by synthetic aperture radar (1 p)
Mathematics (40 p)
Sampling theory with resource assessment applications (5 p)
Sensors, atmosphere, and objects (3 p)
Forestry remote sensing and image interpretation (4 p)
International space university summer session 1995 (10 p)
Seminars, conferences, teaching, field inventory, etc. (10 p)
Total credits 78 p[1]

Pedagogic courses: Introduction course (4 p)
Docent course (4 p)
Total credits 8 p[1]

[1] one point (p) is equal to one week of studies

Leadership courses: SLU:s Hållbart ledarskap, 2008 (6 meetings)

Teaching responsibilities: *Undergraduate and Master's courses*
Computer Science, Forest Mathematics and Statistics, Forest Planning, Forest Remote Sensing, Aerial Photography, GIS

Ph.D. courses
Forest Inventory, Forest Remote Sensing, Basic Inventory Methodology

The total amount of teaching corresponds to about 130 weeks full time work, including about 25 weeks of teaching (Computer Science and Forest Mathematics and Statistics) carried out before finishing the M.Sc. degree in Forestry.

Main supervisor:

Jon Söderberg (started in June 2020)
Ivan Huuva (started in January 2016)
Jonas Bohlin (Ph.D. in December 2018)
Henrik Persson (Ph.D. in December 2014)
Andreas Pantze (finished in 2012)
Mattias Magnusson (Ph.D. in October 2006)
Swedish University of Agricultural Sciences
Department of Forest Resource Management
Division of Forest Remote Sensing
SE-901 83 Umeå, SWEDEN

Assistant supervisor:

Mozhgan Zahriban (started in 2018)
Gorgan University of Agriculture Sciences & Natural Resources, Gorgan, IRAN

Albert Monteith (Ph.D. in 2020)
Erik Blomberg (Licentiate in April 2017)
Maciej Soja (Ph.D. in November 2014)
Gustaf Sandberg (Ph.D. in November 2013)
Chalmers University of Technology
Department of Space, Earth and Environment
Radar Remote Sensing Group
SE-412 96 Göteborg, SWEDEN

Koffi Dodji Noumonvi (started in June 2020)
Johannes Larson (started in November 2018)
Swedish University of Agricultural Sciences
Department of Forest Ecology and Management
SE-901 83 Umeå, SWEDEN

Hampus Holmström (Ph.D. in September 2001)
Swedish University of Agricultural Sciences
Department of Forest Resource Management
Division of Forest Resource Analysis
SE-901 83 Umeå, SWEDEN

Dissertations:

Opponent – Osama Yousif, doctoral thesis, Royal Institute of Technology, 12 June, 2015
Opponent – Hongtao Hu, licentiate thesis, Royal Institute of Technology, 10 December, 2010
Pre-evaluator – Yrjö Rauste, doctoral thesis, Helsinki University of Technology, September, 2005
Opponent – Klas Folkesson, licentiate thesis, Chalmers University of Technology, 31 March, 2005
Member of the evaluation committee – Mats Erikson, doctoral thesis, Centre for Image Analysis, Swedish University of Agricultural Sciences, 26 November, 2004

Master thesis:

Examiner: Cornelia Roberge, 2007; Mattias Larsson, 2008; Olle Wiklund, 2009; Johan Djurberg, 2010; Roland Saitzkoff, 2010; Jennifer Martin, Canada, 2012; Christian Jensen, 2013; Johan

	Viklund, 2014; Linnéa Olofsson, 2015; Alberto Udali, 2019; Lina Selin, 2019 *Supervisor:* Anders Krantz, 2009
Chairman:	Session chairman at ForestSat conference, Borås, Sweden, 31 May-3 June, 2005 Session chairman at IGARSS 2019, Yokohama, Japan, 28 July-2 August, 2019 (two sessions)
Referee:	IEEE Transactions on Geoscience and Remote Sensing, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, IEEE International Geoscience and Remote Sensing Symposium, International Journal of Remote Sensing, Scandinavian Journal of Forest Research, Journal of Forest Economics, Remote Sensing of Environment
Invited speaker:	RIU-konferensen, Skinnskatteberg, Sweden, 13-14 November, 2019 Föreningen Skogen, Höstexkursionen 2017, Skövde, Sweden, 20-21 September 2017 Fjärranalysdagarna (Remote Sensing Days), Stockholm, Sweden, 21-22 October, 2015 Märgträffen – an industry and business day organized by Skogshögskolan's student union at the Swedish University of Agricultural Sciences in Umeå, Sweden, 20 November, 2013 Fjärranalysdagarna (Remote Sensing Days), Solna, Sweden, 9-10 April, 2013 Fjärranalysdagarna (Remote Sensing Days), Solna, Sweden, 14-15 March, 2011 International Workshop on Global measurements of forest biomass; needs, current capabilities and the BIOMASS mission (ESA, CNES, CTCD), Paris, France, 15-17 November, 2010 Kungliga Skytteanska Samfundet, Umeå, Sweden, 18 October, 2010 En dag om skogsresurser, teknologi och miljö, Umeå, Sweden, 14 March, 2007 KSLA, Skogen efter stormen?, Stockholm, Sweden, 14 March, 2005 Skogskonferensen, Uppsala, Sweden, 30 November - 1 December, 2004 Framtidens skogsbruk (a forest conference organised by Skogsvårdsstyrelsen Värmland-Örebro), Karlstad, Sweden, 28 September, 2000 Kartdagarna, Göteborg, Sweden, 29-31 March, 2000 RIU-konferensen, IT – åt skogen?, Skinnskatteberg, Sweden, 18-19 November, 1999 The 5th Alumni Conference of the International Space University, Vienna, Austria, 9-10 August, 1996
Invited lecturer:	Umeå University, Umeå, SWEDEN Royal Institute of Technology, Stockholm, SWEDEN
Media:	The research has been reported in national and local newspapers (about 50), television (SVT24, Sydnytt), and radio
Awards:	The award from "Kungliga Skytteanska Samfundet" to a younger researcher at the Swedish University of Agricultural Sciences, Umeå, April 2002

Responsibilities: Head of Department, Swedish University of Agricultural Sciences, Dept. of Forest Resource Management, January 2008 – June 2019
Deputy Head of Department, Swedish University of Agricultural Sciences, Dept. of Forest Resource Management, July 2019 –
Member of the Science Advisory Panel of the Kyoto & Carbon Initiative, July 2004 –
Senior Member of the Institute of Electrical and Electronics Engineers – Geoscience and Remote Sensing Society (IEEE-GRSS), March 2002 – April 2012 (Member), May 2012 –

Published articles in peer-reviewed international scientific journals (ten latest):

[1] Persson, H.J., Soja, M.J., **Fransson**, **J**.**E**.**S**., and Ulander, L.M.H. 2020. National forest biomass mapping using the two-level model. Accepted for publication as a Research Article in the IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

[2] Zahriban Hesari, M., Shataee, S., Maghsoudi, Y., Mohammadi, J., **Fransson**, **J**.**E**.**S**., and Persson, H.J. 2020. Forest variable estimations using TanDEM-X data in Hyrcanian forests. *Canadian Journal of Remote Sensing 46(2)*, 166-176.

[3] Chi, J., Nilsson, M.B., Kljun, N., Wallerman, J., **Fransson**, **J**.**E**.**S**., Laudon, H., Lundmark, T., and Peichl, M. 2019. The carbon balance of a managed boreal landscape measured from a tall tower in northern Sweden. *Agricultural and Forest Meteorology, 274*, 29-41.

[4] Rodríguez-Veiga, P., Quegan, S., Carreiras, J., Persson, H.J., **Fransson**, **J**.**E**.**S**, Hoscilo, A., Ziólkowski, D., Stereńczak, K., Lohberger, S., Stängel, M., Berninger, A., Siegert, F., Avitabile, V., Herold, H., Mermoz, S., Bouvet, A., Le Toan, T., Carvalhais, N., Santoro, M., Cartus, O., Yrjö, R., Mathieu, R., Asner, G.P., Thiel, C., Pathe, C., Schmullius, C., Seifert, F.M., Tansey, K., Balzter, H. 2019. Forest biomass retrieval approaches from Earth Observation in different biomes. *International Journal of Applied Earth Observations and Geoinformation 77*, 53-68.

[5] Chi, J., Nilsson, M.B., Kljun, N., Wallerman, J., **Fransson**, **J**.**E**.**S**., Laudon, H., Lundmark, T., and Peichl, M. 2019. The carbon balance of a managed boreal landscape measured from a tall tower in northern Sweden. *Agricultural and Forest Meteorology 274*, 29-41.

[6] Santoro, M., Cartus, O., **Fransson**, **J**.**E**.**S**., and Wegmüller, U. 2019. Complementarity of X-, C-, and L-band SAR backscatter observations to retrieve forest stem volume in boreal forest. *Remote Sensing 11(13)*, 1-25.

[7] Persson, H.J., Olsson, H., Soja, M.J., Ulander, L.M.H., and **Fransson**, **J**.**E**.**S**. 2017. Experiences from large-scale forest mapping of Sweden using TanDEM-X data. *Remote Sensing 9(12)*, 1-26.

[8] Lindgren, N., Persson, H.J., Nyström, M., Nyström, K., Grafström, A., Muszta, A., Willén, E., **Fransson**, **J**.**E**.**S**., Ståhl, G., and Olsson, H. 2017. Improved prediction of forest variables using data assimilation of interferometric synthetic aperture radar data. *Canadian Journal of Remote Sensing 43(4)*, 374-383.

[9] Persson, H.J. and **Fransson**, **J**.**E**.**S**. 2017. Comparison between TanDEM-X- and ALS-based estimation of aboveground biomass and tree height in boreal forests. *Scandinavian Journal of Forest Research 32(4)*, 306-319.

[10] Persson, H.J. and **Fransson**, **J**.**E**.**S**. 2016. Estimating site index from short-term TanDEM-X canopy height models. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 9(8)*, 3598-3606.

Publications (all):

In summary, I am the author or co-author of more than 230 professional publications including published / accepted articles / book chapters in peer-reviewed international scientific journals / books (46), doctoral thesis (1), articles in conference Proceedings / posters (133), working reports (21), articles in popular scientific journals / booklets (13), annual reports / newsletters to forest reference group (14) and goal and strategy documents (3). The publications have been written together with more than 100 co-authors. Database statistics: 91 (Web of Science), 97 (Scopus), 145 (Google Scholar); h-index: 22 (Web of Science), 22 (Scopus), 27 (Google Scholar); Citations: 1726 (Web of Science), 1891 (Scopus), 2963 (Google Scholar). Date: September 2020.

Curriculum Vitae for Mats B. Nilsson

Date of birth: February 29, 1956

1. B.Sc. in Biology (120 p), 1985, Umeå University.
2. Ph.D. in Soil Science, 1992-06-10, Thesis title “Fungi and bacteria in peat and peat-forming plant communities”. Supervisor, Professor Hilmar Holmen, Dept of Forest Ecology, SLU, Umeå.
3. **Postdoctoral positions** - none
4. Associate Professor (Docent) in Soil Science, 1998.
5. **Professor** in Forest Soil Science Biogeochemistry (Skoglig marklära med inriktning mot biogeokemi). 2007-05-30, permanent. Faculty financed research 30%, the rest on external grants.
6. **Senior lecturer** (30% salary granted by the department, the remaining fraction from teaching and external research funds) 1998-, Department of Forest Ecology, SLU, S-901 83 Umeå, Sweden

   Assistant Prof. (forskarassistent) (1996-1998) Department of Forest Ecology, SLU, S-901 83 Umeå, Sweden.

   Researcher (1992-1996) Department of Forest Ecology (Former Department of Forest Soil Site Research, SLU, S-901 83 Umeå).

   Research assistent (1984-1992) Department of Forest Soil Site Research, SLU, Umeå.
7. **Interruption in research –** none
8. **DOCTORAL AND LICENTIATE RESEARCH SUPERVISION**

Main supervisor

1. **Koffi Dodij Noumonvi** (2020-2024) Methane emissions from high latitude peatlands, VR (2020-2024)
2. **Anna Larsson, Lic.,** (2009-2016) Boreal mire carbon dynamics – with focus on the various climatic controls on the land atmosphere exchange of CO_2 and CH_4 and the runoff C export, Formas
3. **Björn Erhagen, PhD,** (2008 – 2013) Temperature control of microbial turnover of organic carbon – effect off substrate quality and characteristics of catabolic and anabolic processes CMF, VR
4. **Tobias Eriksson, PhD,** (2004 – 2009) Nitrogen control on boreal mire carbon biogeochemistry. FORMAS
5. **Stina Harrysson, PhD,** (2005-2009) The control by temperature and water availability on soil microorganisms in frozen boreal soils CMF
6. **Jörgen Sagerfors, PhD,** (January 26th 2007) Climate sensitivity in boreal mire carbon dynamics – derived from full year micrometeorological CH_4 and CO_2 flux data. FORMAS
7. **Ylva Schnürer, PhD,** (January 19th 2007) Controls on degradation of chlorphenols in soils. MCN
8. **Malin Klarqvist, PhD,** 2001, Post-glacial impact of northern wetlands on the Atmospheric radiative forces. NFR
9. **Catharina Mikkelä, PhD,** 1998, *Methane Emission from Swedish mires – in relation to different spatial and temporal scales*. (SNV, STEM)
10. **Gunnar Granberg, PhD,** 1998, Umeå. *Environmental control of Methane emission from boreal mires – Experimental data and model simulations*. (SNV, STEM)
11. **Inger Bergman, PhD,** 1998 *Microbial carbon mineralisation in peat from a boreal mixed mire* (CMF)

Co-supervisor (incomplete list)

1. **Lukas Guth** (2020 – 2024) Partitioning boreal mire C fluxes into its component fluxes (VR) PI, Matthias Peichl, SLU, Umeå
2. **Jacob Smeds** (2020-2024) Are rewetted wetlands hotspots for methane emission and methyl mercury production? (SNV) PI, Mats Öquist, SLU, Umeå

3. **Aswin Thirunavukkarasu, (2019-2023)** The molecular chemical control on wood decomposition, PI, Mats Öquist, SLU, Umeå
4. **Cheuk Hei Marcus Tong** (2018-2022) The effect of drainage and forestry in peatlands on green house gas exchange
5. **Betty Ehnvall** (2017 – 2021) Using catchment characteristics derived from laserscanning (LiDar) to upscale CO2 and CH4 production, SLU, Umeå, Mats Öquist.
6. **Baolin Wang** (2016-2020) mercury biogeochemistry along a land uplift mire chronosequence
7. **Javier Segura** (2013 – 2018) Controls on organic matter biopolymer degradation at below zero temperatures in boreal forest soils, SLU, Umeå, Mats Öquist.
8. **Thomas Wieloch** (2013 – 2018) Using cellulose 13C isotopomers to trace physiological shifts in historical plant material. Umeå University, Jurgen Schleucher.
9. **Stefan Ostervalder,** (2013-2016) The Hg mass balance of a boreal mire, University of Basel, Cristine Allewell.
10. **Magali Marti Genero** (2012 – 2017) Effects of external perturbations on the microbial community in European peatlands, Linkoping university, Bo Svensson
11. **Sofi Jonsson,** (2011-2015) Global change effects on methylation and demethylation in estuarial ecosystems, Umeå University, Erik Björn
12. **Maria Gustafsson** (2003 – 2007) The impact of forest drainage of highly productive wetlands on fluxes of greenhouse gases. Göteborgs Universitet
13. **Alla Yurova** (2003 – 2007) Hydrological aspects of the carbon balance in a boreal catchment. Lund University.
14. **Jan Persson** (2005 – 2007) *Monitoring the impact of mining activities on boreal forest streams using near infra red spectroscopy (NIRS).* Main Supervisor, Ingemar Renberg, Umeå University. Licentiate degree seminar to be held June 1th 2007.
15. **Lars Lambertsson** (1999-2005), Methyl mercury dynamics and turnover in estuarine environments. Umeå Marine Research Center, Umeå University.
16. **Karin von Arnorld** (1999 –2005, 80%) The impact of forest drainage on fluxes of greenhouse gases. TEMA VATTEN Linköpings universitet.
17. **Eigil Dåbakk,** (1999) Department of Organic Chemistry, Umeå University, Umeå. *Near infrared spectrometry – a potential method for environmental monitoring of aquatic systems*.

Experience from operating infrastructure: Initiated (1995) and developed long-term measurements and experimental studies on boreal mire biogeochemistry at Degerö Stormyr**.** Currently one of the most studied and most heavily instrumented mires in the world; **Swedish ICOS VR research infrastructure 2010-2020,** co-applicant and PI of two ecosystem and one atmospheric measurement station; **SITES VR research infrastructure 2013-2018**,

Post-Doc Students: Joss Ratcliffe, 2019-2021, between mire variation in land atmosphere GHG and water exchange **Haijung Peng,** 2019-2020, Peatland Carbon Cycling; **Cecilie Skov Nielsen,** 2017-2019, *In situ* methane oxidation measurements in a boreal mire, Kempe Fundations; **Wei Zhu,** 2017-2018, Dynamics and biosphere-atmosphere exchange of mercury in oceans and forest ecosystems VR, SmaRef; **Stefan Ostervalder** 2016 -2017, Dynamics and biosphere-atmosphere exchange of mercury in oceans and forest ecosystems, VR, SmaRef; **Henrik Seark,** 2016-2018, Isotopomers - new tools to study soil organic matter turnover, Tryggers Fundation; **Jason Leach,** 2015-2017, Boreal landscape ecohydrology, Kempe Foundations; **Michal Gazovic,** 2014-2016, Boreal mire carbon biogeochemistry, Kempe Foundations; **Georg Jocher,** 2014-2016, Boreal forest biosphere-atmosphere exchange, Kempe Foundations; **Junbin Zhao,** 2013-2015, Boreal mire carbon biogeochemistry, Kempe Foundations; **Andy Siegenthaler**, 2011-2013. Boreal mire carbon biogeochemistry, Kempe Foundation; **Katie Fenn**, 2010-2012, Boreal mire carbon biogeochemistry, Kempe Foundation; **Staffan Åkerblom**, Mercury dynamics in boreal mires, 2008-2009, VR, Foma; **Mats Öquist**, 2001-2003, Low temperature processes in boreal environments, VR

Teaching

Teaching 5-10% of full time appointment. Teaching four to six courses annually at all levels. Deeply involved in supervision of PhD-students and Post-Docs.

Research grants – main applicant

VR, 2019-2022, Methane emissions from high latitude peatlands - bridging the abyss between environmental factors and ecosystem scale methane formation and emission, 3 380 ksek

Kempe Foundations, 2017, Instrumentation of an ecosystem scale whole mire nitrogen fertilisation research infrastructure, 1 500 ksek

FORMAS, 2017-2019 Using catchment characteristics derived from laser scanning (LiDAR) to upscale CO2 and CH4 production, 3 000 ksek

SLU, 2016-2020 Research infrastructure - Whole mire nitrogen fertilization experiment. 3 000 ksek.

Kempe Foundations 2016 Assessing methane oxidation at Degerö Stormyr – isotope instrument and Post-Doc stipend (2 years), 1 500 ksek in total

VR 2013-2016 Effect of nitrogen on temperature sensitivity of organic matter decomposition 4 x 800 kkr

Kempe Foundations 2013-2017 (contract # SMK 1211) Boreala ecosystems kolbalans – Post-Doc program for 5 st post-docs 2 500 ksek in total

Tryggers, 2013-2015, Post-Doc 2 years, soil organic matter turnover.

VR 2010 – 2012 Temperature sensitivity of degradation of organic material – intrinsic molecular controls and environmental feedbacks, 1 800 kkr for three years.

Kempe Foundations, 2008 Nordliga myrars kolbalans under ett varierande klimat. Grants for two post-docs, two year each, 1 100 kkr in total.

FORMAS, 2007 – 2010 Boreal mire carbon dynamics – with focus on the various climatic controls on the land atmosphere exchange of CO_2 and CH_4 and the runoff C export. 3 046 kkr during 3 years

CMF, 2006 – 2010 Temperature control of microbial turnover of organic carbon – effect off substrate quality and characteristics of catabolic and anabolic processes ca 450 kkr per year.

FORMAS, 2004 – 2006 Climate sensitivity in boreal mire carbon dynamics - The importance of winter soil frost development for the annual CH_4 and CO_2 exchange. 716 kkr, 621 kkr and 560 kkr

FORMAS, 2004 -2008 Increased nitrogen deposition perturbates the carbon cycle in boreal minerotrophic mires – decadal analysis of a long-term permanent field manipulations. 820 kkr, 810 kkr (year 1 & 2)

VR, 2002-2004, (Contract no: 621-2001-1911) Climate sensitivity in boreal mire carbon dynamics - the importance of different winter regimes on the exchange of CO_2 and CH_4, 450 kkr / year for salary, 50%, (lektorsfriköp) for MN.

Kempe Foundation 2002 Expansion of micrometeorological measurement system for continuous measurement of CH_4 flux. 10 00 kkr; Ion Chromatograph 6 00 kkr.

FORMAS, 2002- 2006 Climate sensitivity in boreal mire carbon dynamics – derived from micrometeorological CH_4 and CO_2 flux data 675 kkr / year.

Oscar och Lilly Lamms Stiftelse, 2002-2003 Betydelsen av varierande klimat för nordliga myrars kolomsättning – Hur påverkar olika vinterregimer utbytet av CO_2 och CH_4? 200 kkr.

Kempe Foundation 2000 Micrometeorological instrumentation for continuous CO_2 andCH_4 flux measurement (Tunable Diod Lasesr; Infra-red Gas Analyser; 3-D Sonic Anemometer) 1 500 kkr

NFR 1999-2001 Winter and spring emissions of methane 432 kkr, 397 kkr

NFR 1995-2001 Post-glacial impact of northern wetlands on the Atmospheric radiative forces 214 kkr, 109 kkr, 445 kkr, 303 kkr, 393 kkr, 193 kkr

PROTOWET, 1996-1999 Procedural Operationalisation of Techniques for Functional Analysis of European Wetland Ecosystems, European Comission, Framework Programme IV: Environment & Climate, 1.300.000 SKr (140.000 ECU) 36 month

NFR, 1997, 1998. Carbon dynamics in boreal wetlands. 245.000 Skr; 227.000 Skr

CMF, 1997, 1998. Koldynamik i nordliga våtmarker, 372.000 Skr

CMF, 1993 – 1998 Effect of differences in peat-forming environment for the anerobic decomposition of plant litter and production of methane. 75.000 SKr, 128.000 SKr, 210.000 SKr.

Research grants – co-applicant (incomplete)
VR 2010 -2020 ICOS Sweden - a research infrastructure for understanding and assessing the greenhouse gas exchanges at different temporal and spatial scales main applicant Anders Lindroth, Lund University: 2010-2014, 17.6 milj sek in total, 6.2 from SLU and 11.4 from VR; 2016-2020, 25,5 milj sek in total, ca 8 500 000 to SLU and 17 000 000 from co-funding by SLU
VR 2014-2018, Sino-Swedish Mercury Management Research Framework (SMaReF) main applicant Kevin Bishop, SLU, 24,4 milj sek in total; Nilsson, 2,8 milj sek
VR 2013 – 2016, New tools for studying soil organic matter turnover, (PI Jurgen Schleucher, UmU)
VR 2012-2014 Microbial activity and carbon mineralization in frozen soils (main applicant, Mats Öquist, SLU, Dept of Forest Ecol & Management; 2 400 kkr in total)
VR 2012-2014 Effects of nitrogen and sulfate deposition and temperature on the microbial community and functional groups in boreal minerotrophic mires - analysis of a long-term field manipulation experiment. (main applicant, Bo Svensson, LiU; 2 550 kkr in total)
VR 2010 -2014 ICOS Sweden - a research infrastructure for understanding and assessing the greenhouse gas exchanges at different temporal and spatial scales main applicant Anders Lindroth, Lund University, 75 milj sek in total, ca 20 000 000 to SLU
VR 2004 – 2006 Sulfur transformation in peat soil: effect of temperature, redox conditions, and different sulphur and nitrogen loads. Main applicant Reiner Giesler, Dept of Forest Ecology, 540 kkr, 540 kkr.
VR 2004 – 2006 Analysis of climate driven variation in soil carbon fluxes using ^{13}C technique and flux measurements. Main applicant Leif Klemetdsson, Botanical Institute, Göteborgs Universitet.
Nordiska Ministerrådet 2003 – 2007, Nordic Centre for Studies of Ecosystem Carbon Exchange and Its Interaction with the Climate System, main applicant Prof. Anders Lindroth, Dept of Physical Geography, Lunds University. 3, 500 000 Dkr/year. (The project includes 14 Departments and 26 flux sites in four Nordic countries)
VR 2002 – 2005 Field Testing a Critical Load Model for Mercury: The Influence of Sulfur Deposition and Wetland Extension on Bioaccumulation Main applicant Kevin Bishop, Department of Environmental Assessment 750 kkr in total.
STEM 2000 – 2002 – The Swedish Flux Consortium, main applicant Prof. Anders Lindroth, Dept of Physical Geography, Lunds University. Approximately 200,000 / year
NFR, 2000 –2002 Determination of fluxes and regulating factors for the nitrous oxide from cold and frozen soils, main applicant Dr. Leif Klemedtsson 199 kkr, 375 kkr, 375 kkr
MISTRA 1999, 2000 Methyl mercury production in boreal mires fertilised by sulfur deposition 430 kkr, 430 kkr
Monitoring environmental change by near infrared spectroskopy of lake sediment, SNV (main applicant Prof. Ingemar Renberg) 450,000 98; 450,000 99.
SNV Methane emissions from Swedish wetlands - total emission and the effects of climate change, drainage and peat harvesting, and increased deposition of nitrogen and sulphur, (main applicant Prof. Bo Svensson, Department of Water and Environmental Studies, University of Linköping), 750,000 93/94; 750,000 94/95; 750,000 95/96: 800,000 97; 425,000 98.

External examiner
1. Herbert Mbufong, 2015 1123, Aarhus University, Roskilde, Denmark
2. Fransisca Koebelsh, 2013 09 17, University of Rostock

3. Terhi Riutta, spring 2008, Department of Forest Ecology, University of Helsinki, Finland. Doctoral Thesis Title – “Fen ecosystem carbon gas dynamics in changing hydrological conditions”.
4. Sissel Ranneklev, 19/12 2001, Doctoral thesis dissertation. Department of Horticulture and Crop Sciences, Agricultural University of Norway

Member in PhD-degree evaluation committee’s (>>30 committeés)

1. PhD-thesis, 2017, Norbert Pirk, Lund University
2. PhD-thesis, January 25, 2012, Department of Geological Sciences, Stockholm University, Nguyen Thanh Duc, Abiotic and biotic methane dynamics in relation to the origin of life
3. PhD-thesis, May 21, 2010, Department of Ecology and Environmental Research, Umeå University.
4. PhD-thesis, Martin Wetterstedt, March 26, 2010, Department of Ecology, SLU, Uppsala
5. PhD-thesis, December 2009, Department of Ecology and Environmental Research, Umeå University.
6. PhD-thesis, June 4th, 2009, Department of Ecology and Environmental Research, Umeå University.
7. PhD-thesis, February 27th, 2009, Department of Ecology and Environmental Research, Umeå University.
8. PhD-thesis, October 31th, 2008, Department of Geology, University of Stockholm.
9. PhD-thesis, September 27th, 2008, Department of Chemistry, Umeå University.
10. PhD-thesis Henrik Svennerstam, September 19th 2008, Department of Forest Genetics & Plant Physiology, SLU, Umeå.
11. PhD-thesis Johanna Thelaus “The aquatic microbial food web and occurrence of predation resistant and potentially pathogenic bacteria, such as *Francisella tularensis*”. June 12th 2008, Department of Ecology and Environmental Research, Umeå University.
12. PhD-thesis Melakeselam Leuls "Biodiversity of hydrogenases in Frankia", December 8th 2007, Department of Plant Physiology, Umeå University.
13. PhD-thesis Pernilla Christensens "The long-term decline of the grey-sided vole (*Clethrionomys rufocanus*) in boreal Sweden: importance of focal forest patch and matrix" October 20th 2006, Department of Ecology and Environmental Science, Umeå University.
14. PhD-thesis Tomas Östberg, Degradation of long-chain petroleum compounds 13 Oktober 2006, Mittuniversitet, Sundsvall
15. PhD-thesis Jonas Dahlgren Interactions between gray-sided voles (*Chletrionomys rufocanus*) and vegetation in the Fennoscandian tundra. Umeå University, June 1, 2006.
16. PhD-thesis Johnny Berglund, “Ecology and diversity of eukaryotic microorganisms in the northern Baltic Sea”, Dept of Ecology and Environmental Sciences, Umeå University, November 26th 2005.
17. PhD-thesis Grete Algesten, “Regulation of Carbon dioxide emission from Swedish boreal lakes and the Gulf of Bothnia” Dept of Ecology and Environmental Sciences, Umeå University, 11 March 2005.
18. PhD-thesis Gudrun Sjöberg, Lignin Degradation, Long-term effects of nitrogen addition on decomposition of forest soil organic matter. Department of soil science, SLU, Uppsala. 24 October 2003.
19. PhD-thesis Lena Dahlman, Resource acquisition and allocation in lichens. Dept of Ecology and Environmental Science, Umeå University, 17 October, 2003
20. PhD-thesis K. Samuelsson, Mechanism structuring the pelagic microbial food web - importance of resource and predation. Dept of Ecology and Environmental Science, Umeå University.12 June 2003.
21. PhD-thesis S. Sjögersten Soil organic matter dynamics and methane fluxes at the forest tundra ecotone in Fennoscandia Dept of Geography, Uppsala, 25 April 2003

22. Licentiate thesis, Jin Quang, Department of Foresst Ecology, SLU, Umeå.
23. PhD-thesis Jan Karlsson, 07 December 2001, Dept of Ecology and Environmental Science, Umeå University.
24. PhD-thesis Anna Joabsson, 18 October 2001, Dept of Ecology, Lund University.
25. PhD-thesis, Eva Ring, Inst. för Markvetenskap, SLU, Uppsala, 18 maj 2001.
26. PhD-thesis, Michael Sjöberg, The Swedish Univ. of Agric.Sciences Dept. of Ecology and Environmental Research, Section for Soil Ecology, 29 September 2000,
27. PhD-thesis, Ann-Kristin Bergström, 17 March 2000, Department of physical Geography, Umeå University.
28. PhD-thesis, Anna Ek, Dept of Ecology and Environmental Science, Umeå University.15 December 2000.
29. PhD-thesis, Johan Nordback, 24 September 1999, Department of Chemistry, Umeå University

SERVICES IN EVALUATION and ASSESSMENT FOR ACADEMIC POSITIONS

1. Carleton University, Faculty of Arts and Social Sciences, Canada, Elyn Humphreys, promotion to Full Professor, 2018; **2**) City University of New York, (CUNY), Chuixiang Yi, promotion to Professor, 2018; **3**) Chinese University of Honkong, Yuk Fo Lai, promotion to Associate Professor, 2107; **4**) Linköping University, Tema Vatten, Magnus Gålfalk, promotion to Senior Lecturer, 2017; **5**) Montreal University, Faculty of Arts and Sciences, Julie Talbot, Tenure track promotion to Associate Professor, 2017; **6**) Faculty of Natural Sciences, Lund University, Per Bengtsson, Associate Professor, (Docent), 2017; **7**) University of Eastern Finland, Forest Meteorology and Hydrology, Samuli Launiaianen, Promotion to Associated Professor (Docent), 2013; **8**) Lund University, Almut Arneth, promotion to Professor, 2010; **9**) Department of Physical Geography, Lund University, Senior lecturer position, (oavlönad docent) Lena Ström; **10**) Department of Physical Geography, Lund University, Senior lecturer position, (oavlönad docent) Torben Christensen; **11**) Department of Ecology, Microbial Ecology, Lund University, Assistant Professor Position; **12**) Finnish Forest Research Institute, Helsingfors, Professor position in Peatland Forestry

SERVICES IN GRANT BOARDS, AWARD BOARDS, EDITORIAL BOARDS e.t.c.

17) Expert Scientist for Swedish Environmental Protection Board evaluating potential actions for mitigating atmospheric GHG from Swedish organic soils; **16)** Grant application evaluation for Estonian Research Council Dept of Research Funding ;**15)** Evaluation of PhD research proposals, Environmental Research Program, Lund University, January 2013; **14)** Chair of Standing Committee on Peatlands and Climate Change, International Peat Society, 2011-; **13)** Steering committee member of the VR National Research Infrastructure, Swedish ICOS; **12)** Research application evaluation, Hartley et al, York University, Sustainable Peatland Ecosystems in the UplandsBiodiversity for Ecosystem Service Sustainability (BESS) consortiums, Natural Environment Research Council (NERC) November 2011; **11)** Member of Site Visiting committee for NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL of Canada (NSERC) for evaluation of Price et al Cooperative Research and Development Grant (CRD) *Evaluating the success of fen creation in the post oil sands landscape* November 17-18, 2011; **10)** Editorial board member of Boreal Environmental Research; **9)** Member of the national steering committee of Long Term Ecological Research (LTER), 2011 - ; **8)** Member of Vice chancellors committee for harmonizing criteria for promotion to associate professor or professor at SLU, 2010; **7)** Member of the Faculty Board, Forestry Faculty, SLU, Umeå 2007 –2012; **6)** Member of the committee on Environmental Monitoring at Forestry Faculty, SLU, Umeå 2006 – 2008; **5)** VR, member of the grant evaluation committee for grant applications on biodiversity, 2005; **4)** FORMAS, member of the evaluation committee for grant applications on processes in soil, air and water. 2002 – 2004; **3)** Kempe doctoral student award board, SLU, Umeå. 2002 – 2004; **2)** Centre of Environmental Research (CMF), local grant board to facilitate research co-operation between research organisations in Umeå. evaluation committee

member 2001 – 2004; **1)** Member of the Election committee for the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning 2003.

Awards and special commissions

Top 5% of research groups at SLU evaluation of Quality and Impact (KoN 2009); ICOS Sweden (VR 2010-2014) steering committee; **The WMO Norbert Gerbier-MUMM International Award for 2012; WMO 2012 Norbert Gerbier-MUMM International Award Ceremony, Geneva, Switzerland, 2 July 201**2

Bibliography, ISI, WoS, October 2020, 157 peer-reviewed publications, 5200 citations, H-index 43

Peer-reviewed journals * - with graduated students

1. **Nilsson, M**., Mikkelä, C., Granberg, G., Sundh, I., Svensson B. and B. Ranneby (2001) Methane emission from Swedish mires: National and regional budgets and dependence on mire vegetation, *Journal of Geophysical Research*, 106 (D18):20847-20860.
2. **Nilsson, M**., Sagerfors, J., Buffam, I., Laudon, H., Eriksson, T., Grelle, A., Klemedtsson, L., Weslien, P. and A. Lindroth (2008) Contemporary carbon accumulation in a boreal oligotrophic minerogenic mire – a significant sink after accounting for all C-fluxes *Global Change Biology* 14, 1–16, doi: 10.1111/j.1365-2486.2008.01654.x
3. Schubert, P., L. Eklundh, M. Lund and **M. Nilsson** (2010) Estimating northern peatland CO_2 exchange from MODIS time series data, *Remote Sensing of Environment*, doi:10.1016/j.rse.2010.01.005
4. *Lund, M., Roulet, N.T., Lindroth, A., Lafleur, P.M., Christensen, T.R. Aurela, M., Chojnicki, B.H., Flanagan, L.B., Humphreys, E.R., Laurila, T., Oechel, W.C., Olejnik, J., Rinne, J., Schubert, P. and **Nilsson, M.B.** (2010) Variability in exchange of CO2 across 12 northern peatland and tundra sites *Global Change Biology* doi: 10.1111/j.1365-2486.2009.02104.x
5. Chuixiang Yi, Daniel Ricciuto, Runze Li, John Wolbeck, Xiyan Xu, **Mats Nilsson**, *et al* (2010) Climate control of terrestrial carbon exchange across biomes and continents. *Environmental Research Letters*. **5** 034007 (10pp) doi:10.1088/1748-9326/5/3/034007
6. Wu, J., Roulet, N.T., **Nilsson, M.B.,** Lafleur, P. and Humphreys, E., (2012) Simulating the Carbon Cycling of Northern Peatlands Using a Land Surface Scheme Coupled to a Wetland Carbon Model (CLASS3W-MWM) *Journal of Geophysical Research Atmosphere-Ocean* DOI:10.1080/07055900.2012.730980
7. Qiu, C., ….. **Nilsson, M. B**., ……. et. Al., (2018) ORCHIDEE-PEAT (revision 4596), a model for northern peatland CO_2, water, and energy fluxes on daily to annual scales, ***Geoscientific Model Development,*** 11:497-519, https://doi.org/10.5194/gmd-11-497-2018
8. Franz, D., …… **M. Nilsson**, ……. et. al,. **2018**, Towards long-term standardised carbon and greenhouse gas observations for monitoring Europe´s terrestrial ecosystems: a review**,** *International Agrophysics. 32, 4, 439-455, doi.* 10.1515/intag-2017-0039
9. Jinshu Chi; **Mats B Nilsson**; Natascha Kljun; Jörgen Wallerman; Johan Fransson; Hjalmar Laudon; Tomas Lundmark; Matthias Peichl, **2019**, The carbon balance of a managed boreal landscape measured from a tall tower in northern Sweden, *Agriculture and Forest Meteorology*
10. M. Bechtold1,2, G. J. M. De Lannoy1, R. D. Koster3, R. H. Reichle3, S. Mahanama3, W. Bleuten4, M.A. Bourgault5, C. Brümmer6, I. Burdun7, A. R. Desai8, K. Devito9, T. Grünwald10, M. Grygoruk11, E. R. Humphreys12, J. Klatt13, J. Kurbatova14, A. Lohila15,16, T. M. Munir17, **M.B. Nilsson18**, J. S. Price19, M. Röhl20, A. Schneider21, and B. Tiemeyer6 (**2019**) PEAT-CLSM: A Specific Treatment of Peatland Hydrology in the NASA Catchment Land Surface Model, *Journal of Advances in Modelling Earth Systems,* doi.org/10.1029/2018MS001574

Curriculum Vitae for Hjalmar Laudon

Personal

Name:	Erik Hjalmar Laudon
Personal number:	660127-5552
Research ID:	J-3074-2013
E-mail:	Hjalmar.Laudon@slu.se
Web site:	www.slu.se/Krycklan

***In short** – My research is focused on hydrological and biogeochemical processes in the boreal landscape, with an agenda especially directed towards using basic research approaches to improve the management of the forest landscape in a changing climate. I have led several large research programs focused on process-based understanding of natural and human-induced changes in boreal ecosystems, including the strong-research program* ForWater *(2012-2016) and* Soils & Water *in Future Forest (2009-2016). Within my national and international network, I have over 50 ongoing collaborative projects across the world. Since 2002, I have been the scientific director for Krycklan Catchment Study (www.slu.se/Krycklan).*

University degrees

MSc University of British Columbia, 1995
PhD, Swedish University of Agricultural Sciences, Uppsala, Sweden, 2000

Current position

Professor (chair), Forest Landscape Biogeochemistry, Department of Forest Ecology and Management, SLU, Umeå since 2008-
Head of department (prefekt), Department of Forest Ecology and Management, SLU, Umeå since 2016-

Previous employments and leaves of absence

Parental leave (16 months in total 1998-2003, with three children)
Post-Doc 2001-2002, MIT (Massachusetts Institute of Technology, Boston).
Assistant Professor. 2003-2005, Swedish University of Agricultural Sciences, Umeå, Sweden
Associate Professor. 2006-2007, Dept. Ecology and Environmental Sci. Umeå Univ.

Awards and special commissions

SLU Excellence award, 2018-2022
Nominated by the Minister of Environment to Water Framework Delegation, 2016-2018
Award for best SLU post-graduate course 2015
Top 5% of research groups at SLU evaluation of Quality and Impact (KoN, 2009)
Young Research Award at Umeå University, 2008

Commission of trust (selected recent activities)

PhD opponent for seven PhD defenses in Sweden, Norway, Finland and the UK.
External examiner for PhD graduation for >10 PhD theses
European member of the USGS lead and NSF funded Powell Centre DOC, 2012-2016
Head of department of Forest Ecology and Management (2016-
Evaluation panel for ERC advanced grants (2016, 2018)
Board member for national research Infrastructures (RFI) at the Scientific Council, 2014-2019
Vice-chair, evaluation panel on research infrastructures for Earth processes, VR, 2014-2017
Chair for SLU call for new vice-Chancellor 2014-2015

Ongoing research funding

KAW Branch-Point 2016-2020 (PI T Näsholm), co-PI
KAW Future Silviculture 2019-2028 (PI T Lundmark), co-PI
VR 2017-2020, Extreme weather and DOC export, PI H. Laudon
FORMAS, Extreme weather and hydrology, PI H. Laudon
JPI-Waters, Wetland restoration, PI H. Laudon
SKB, ~1000 tSEK/yr Natural Radionuclides in heterogenous catchments. PI H. Laudon
Kempe Foundation, 2019, 3 000 tSEK (Field research infrastructure). PI H. Laudon.

Outreach

Over 150 End-user and stake holder presentations in last 10 years
10 interviews in national radio since 2014, three last on the 2018 extreme drought
3 interviews on national TV since 2014, the last one on soil carbon degradation 2018
~20 national newspaper interviews since 2014, the last one on riparian buffer zones

Supervisor of MSc thesis

Main advisor for >25 completed MSc thesis on hydrology and biogeochemistry of the boreal landscape since 2008. Of the supervised MSc students 10 has gone on to PhD programs, most others work within the forest industry, environmental consulting or authorities.

Main supervisor of Ph.D thesis (ongoing)

Stefan Ploum; Optimizing the design of riparian buffer zones
Elin Jutebring Sterte; Hydrological landscape modelling in changing climate
Johannes Larson; Landscape regulation over tree/soil/water interaction
Shirin Karimi; Wetland restoration effects on hydrological storage
Vicky Mosquera; Ditch cleaning effects on greenhouse gas production
Co-supervisor of another 10 ongoing Ph.D students

Supervisor of Ph.D thesis (finished)

Main advisor for 8 completed PhDs: Ishi Buffam (2007), Mahsa Haei, (2011); Martin Bergvall, (2011). Jakob Schelker (2013); Fredrik Lidman (2013); Andres Peralta-Tapia (2015); Tobias Lindborg (2017); Meredith Blackburn (2018).

Co-adviser (15 in total): Neil Cory, SLU (2006), Zlatko Petrin, UmU (2007), Anneli Ågren UmU (2007); Louise Björkvald, SU (2008); Martin Erlandsson, SLU (2008); Rasmus Sörensen, SLU (2009); Martin Berggren, UmU (2010); Marcus Wallin SLU (2011); Karin Eklöf SLU (2012); Mattias Winterdahl, SLU (2013), Lenka Kuglerova, UmU (2015), Tejshree Tiwari, SLU (2015), Reinert Karlsen, UU (2016), Aida Bargues Tobella, SLU (2016), Bala Selvam, LU (2017), Svetlana Serikova, UmU (2019).

Post doctoral students

Heli Miettinen; Landscape control of carbon flux regulation (Kempe 2019-)
Tejshree Tiwari; Role of episodes for quality and quantity of DOC (VR 2018-)
Natalia Kozii; Separation of evapotranspiration into its components (KAW 2017-)

Finished: Eliza Hasselquist (2017-2019) Univ. of Helsinki; Anna Lupon (2016-18) *Center for Advanced Studies of Blanes, Spain*; Fredrik Lidman (2014-2017), *Ass Professor SLU*, Jason Leach (2015-2016) *Senior scientist Canadian Forest Service*; Lovisa Lind (2016-2017) *Ass professor Univ of Karlstad*; Stephen Oni (2014-16) *Private consultant, Toronto*; Lenka Kuglerova (2015) *Ass professor SLU*; Johan Rydberg (2012-13), *Ass professor Umeå Univ*. Åsa Bengtsson (2009-11) *Faculty director Umeå Univ;* Anneli Ågren (2009-11), *Assoc. professor SLU*; Per-Erik Mellander (2004-06) *Researcher officer at Teagasc, Irland*; Kevin Petrone (2005-06), *Researcher Alaska Division of Geological & Geophysical Surveys*.

Invited conference presentations (selected out of >45 the last 10 yrs)

Invited "Searching for mechanistic understanding: The advantage of combining long-term monitoring with process-based research". AGU, San Francisco, USA, 2019.

Invited "A landscape perspective on the role of connectivity, interfaces and scaling on stream biogeochemistry", Gordon Research Conference, Maine, USA, 2017.

Keynote "Fifty shades browner - On the need to combine long-term monitoring with process-based research" Ecohydro, Birmingham, 2017.

Invited "Water quality in a landscape perspective: From natural variability to land use and climate change effects". Oikos annual meeting, Umeå, Sweden, 2016.

Invited "Three decades of research on water & carbon", ICOS annual meet, 2015.

Invited "Linking the terrestrial and aquatic system across scales". Water Alliance meeting Berlin, Germany, 2015.

Invited "Fifty shades of brown: From hotspots and episodes to an integrated perspective of DOC". Berkley catchment science symposium, USA, 2014.

Invited "The quality and quantity of DOC: Ecological and biogeochemical significance in a nested boreal stream network". AGU, San Francisco, USA, 2014.

Invited "Understanding ecosystem response to perturbation: The need to combine long-term monitoring with process-based research across spatial and temporal scales". American Geophysical Union. USA.

Keynote "Dissolved organic carbon in the boreal landscape". BIOGEOMON 8th International symposium on ecosystem behavior, University of Bayreuth, 13-17 juli. Bayreuth, Tyskland, 2014.

Invited "Linking the terrestrial and aquatic system across scales. EGU, Annual assembly, Vienna, Austria, 2014.

Main conference and workshop organizer

Krycklan symposium – Organized every year since 2005 with up to 120 scientist, stake-holders and end-users.

Royal Academy of Forest and Agricultural seminar – Soils & Water in Future Forests, 2016. >60 participants.

Forest waters – Focus on science based management – 2013, >130 scientist, stake-holders and end-users.

International weathering workshop, >90 participants, Stockholm 2012

Teaching

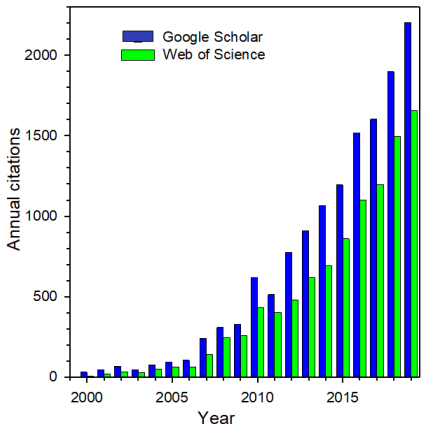
Approximately 10% of my time is used for lectures, labs and field excursions on hydrology water quality to forestry students, PhD students and stake-holders. I have developed and executed several water related course, of which 'Ecology and Biogeochemistry of Boreal Aquatic Systems' attracts 30 international PhD students every other years and has been awarded prize for best graduate course at SLU.

Citation highlights

294 peer-reviewed publications in total,

Web of Science *>11,100 citations in total*
H-index 57
Search: Laudon, H (author); Ume or Can* (address)*

Google Scholar *>15,800 citations in total*
H-index 69
Search: Hjalmar Laudon



Ten selected peer-reviewed papers

1. Gomez-Gener, L., A. Lupon, H. Laudon, and R.A. Sponseller (2020). Drought-induced biogeochemical shifts in high latitude streams. Nature Communications, DOI: https://doi.org/10.1038/s41467-020-15496-2
2. Fork, M., Sponseller, RA and **Laudon, H.** (2020). Changing source-transport dynamics drive differential browning trends in a boreal stream network. *Water Resources Research*, 10.1029/2019WR026336.
3. Tiwari, T. Sponseller, RA, **Laudon, H.** (2019). Contrasting responses in dissolved organic carbon to extreme climate events from adjacent boreal landscapes in Northern Sweden, *Environmental Research Letters*, 14. 084007. doi:/10.1088/1748-9326/ab23d4.
4. Leach, JA and **Laudon, H**. (2019). Headwater lakes and their influence on downstream discharge. *Limnology and Oceanography Letters* 4, 105–112, doi: 10.1002/lol2.10110.
5. Campeau, A., Bishop, K., Amvrosiadi, N., Billett, MF., Garnett, MH., **Laudon, H**., Öquist, MG. and Wallin, MB (2019). Current forest carbon fixation fuels stream CO2 emissions. *Nature communications* 10 (1), 1876.
6. Tiwari, T, Buffam, I, Sponseller, RA and **Laudon, H.** (2018) Inferring scale-dependent processes influencing stream water chemistry from headwater to Sea, *Limnology and Oceanography*, 10.1002/lno.10738.
7. **Laudon, H.,** Spence, C., Buttle, J., Carey, S.K., McDonnell, J.J., McNamara, J.P., Soulsby, C., and Tetzlaff, D. (2017). Save northern high-latitude catchments, *Nature Geoscience*, 10, 324–325, doi:10.1038/ngeo2947.
8. **Laudon, H**., I. Taberman, A. Ågren, Futter, M., Ottosson-Löfvenius M., Bishop, K., (2013), The Krycklan Catchment Study—A flagship infrastructure for hydrology, biogeochemistry, and climate research in the boreal landscape, *Water Resources Research*, 49, doi:10.1002/wrcr.20520.
9. **Laudon, H**., Buttle, J., Carey, S., McDonnell, J., and McGuire, K., Seibert, J., Shanley, J., Soulsby, C, and Tetzlaff, D, (2012). Cross-regional prediction of long-term trajectory of stream water DOC response to climate change. *Geophysical Research Letters*. 39, L18404, DOI: 10.1029/2012GL053033.
10. **Laudon, H**., Berggren, M., Ågren, A., Buffam, I., Bishop, K., Grabs, T., Jansson, M. Köhler, S (2011). Patterns and Dynamics of Dissolved Organic Carbon (DOC) in Boreal Streams: The Role of Processes, Connectivity, and Scaling, *Ecosystems*, 14, 880-893. DOI: 10.1007/s10021-011-9452-8).

Curriculum Vitae for Tomas Lundmark

Personal

Name: Per, Axel, Tomas Lundmark
Date of Birth: 10 October 1955
Research ID: O 0003-2271-3469
E-mail: Tomas.Lunmdark@slu.se

In short **–** My background is in silviculture and forest ecophysiology and my early research focused on photosynthesis, temperature stress, photoinhibition and Scots pine seedlings. For me, still photosynthesis is a process and phenomenon among the most interesting in the forest. My current research is about carbon sequestration and carbon balance of managed boreal forests, even-aged vs. uneven-aged management and forest fertilization. I have experience of practical forestry, as for more than 20 years I have been responsible for the practical forestry of 5500 ha of forestland. I have far reaching experiences in research leadership and I am well recognized in in the Swedish forest sector and regularly engaged in commissions of trust both by governmental agencies and by the forestry business sector in Sweden as well as internationally.

University degrees

MSc in Forestry, Swedish University of Agricultural Sciences, Sweden, 1982
PhD, Swedish University of Agricultural Sciences, Sweden, 1996

Current position

Professor (chair) of Silviculture, Forest Ecology and Management, SLU, Umeå since 2009
Director of the Unit for Field-based Forest Research, SLU, since 2004

Previous employments

Director of the Vindeln Experimental Forests, SLU. 1987-2004
Research assistant at the Department of Silviculture, SLU. 1983-1987

Special commissions

Member of the Royal Swedish Academy of Forestry and Agriculture since 2011, Chair of the Forestry section 2014-2017.

Commission of trust (selected recent activities)

Dean at the Faculty of Forest Sciences, SLU 2010 - 2012.
Prodean at the Faculty of Forest Sciences, SLU 2007 - 2009.
PhD opponent for two PhD defense in Finland.
Member of the Marcus Wallenberg price committee 2012-2014.
Member of the review panel for applications to Academy of Finland in 2017-2018.
Member of the advisory board of the Swedish National Forest Programme since 2015.
Member of the advisory board of the Forest Agency since 2009.
Member of the steering committee for the working group “Continuous cover forestry” at the Swedish Forest Agency since 2006.

Supervisor of Ph.D. thesis (finished)

Main advisor for 2 completed PhDs: Marlene Lidén (2009) and Kristina Ulvcrona (2016).

Co-adviser (4 in total): Per-Erik Mellander (2003), Charlotta Erefur (2010), Bishnu Poudel (2014) and Fredrik From (2016).

Main supervisor of Ph.D. thesis (ongoing)

Gustav Stål; Carbon balance of managed boreal forests
Felicia Dahlman; Identifying microsites suitable for natural regeneration of birch
Jenny Dahl; Carbon balance of unmanaged and managed forest

Post doctoral students

Linda Gruffman 2013-2014
Bishnu Poudel 2015
Petter Axelsson 2015-2016
Robert Blasko 2017-
Hyungwoo Lim 2018-2019
Reimo Lutter 2019-2020

On-going research grants

KAW Science for enhanced forest productivity to meet the demands of a bio-based society 2019-2029 Director and PI.

SLU Future Forests 2017 – 2020, co-PI.

SLU Trees and Crops for the Future 2017 – 2020, co-PI.

List of Publications (October 2020)

Total peer-review publications:	85
Total citations:	3446
H-index:	32

Google Scholar

Ten selected peer-reviewed papers

1. **Lundmark, T**., Bergh, J., Hofer, P., Lundström, A., Nordin, A., Poudel, B. C., ... & Werner, F. (2014). Potential roles of Swedish forestry in the context of climate change mitigation. *Forests*, *5*(4), 557-578.
2. **Lundmark, T**., Bergh, J., Nordin, A., Fahlvik, N., & Poudel, B. C. (2016). Comparison of carbon balances between continuous-cover and clear-cut forestry in Sweden. *Ambio*, *45*(2), 203-213.
3. Nordström, E. M., Forsell, N., Lundström, A., Korosuo, A., Bergh, J., Havlík, P., **Lundmark, T**., ... & Nordin, A. (2016). Impacts of global climate change mitigation scenarios on forests and harvesting in Sweden 1. *Canadian Journal of Forest Research*, *46*(999), 1427-1438.
4. Lim, H., Oren, R., Linder, S., From, F., Nordin, A., Fahlvik, N., **Lundmark, T**. ... & Näsholm, T. (2017). Annual climate variation modifies nitrogen induced carbon accumulation of Pinus sylvestris forests. *Ecological Applications*.
5. Felton, A., Ranius, T., Roberge, J. M., Öhman, K., Lämås, T., Hynynen, J., **Lundmark, T.** ... & Nordin, A. (2017). Projecting biodiversity and wood production in future forest landscapes: 15 key modeling considerations. *Journal of Environmental Management*, *197*, 404-414.
6. Holmström, E., Goude, M., Nilsson, O., Nordin, A., **Lundmark, T**., & Nilsson, U. (2018). Productivity of Scots pine and Norway spruce in central Sweden and competitive release in mixtures of the two species. *Forest Ecology and Management*, *429*, 287-293.
7. **Lundmark, T**., Poudel, B. C., Stål, G., Nordin, A., & Sonesson, J. (2018). Carbon balance in production forestry in relation to rotation length. *Canadian Journal of Forest Research*, *48*(6), 672-678.
8. Lim, H., Oren, R., Näsholm, T., Strömgren, M., **Lundmark, T**., Grip, H., & Linder, S. (2019). Boreal forest biomass accumulation is not increased by two decades of soil warming. *Nature climate change*, *9*(1), 49-52.
9. Blaško, R., Forsmark, B., Gundale, M. J., **Lundmark, T**., & Nordin, A. (2020). Impacts of tree species identity and species mixing on ecosystem carbon and nitrogen stocks in a boreal forest. *Forest Ecology and Management*, *458*, 117783.
10. Kauppi, P. E., Ciais, P., Högberg, P., Nordin, A., Lappi, J., **Lundmark, T**., & Wernick, I. K. (2020). Carbon benefits from Forest Transitions promoting biomass expansions and thickening. *Global Change Biology*, *26*(10), 5365-5370.

Curriculum Vitae for Matthias Peichl

Date of Birth: 1st November 1976
Telephone (work): +46 (0)90-786 8463
E-mail: matthias.peichl@slu.se
Department of Forest Ecology & Management, SLU, SE-901 83 Umeå

1. **University degree**
   BSc (Diplom) Alberts-Ludwigs University, Freiburg, Germany, 2003 in Forestry Sciences

   MSc School of Geography and Earth Sciences, McMaster University, Hamilton, ON, Canada, 2005 in Physical Geography.

2. **PhD exam**
   a) July 21, 2009 in Physical Geography
   b) Thesis title: *Carbon dynamics and greenhouse gas exchange in an age-sequence of temperate pine forests.* School of Geography and Earth Sciences, McMaster University, Hamilton, ON, Canada (Advisor: M. Altaf Arain).

3. **Post doctoral studies**
   2009-09 to 2011-03 at the Center for Hydrology, Micrometeorology & Climate Change, Department of Civil and Environmental Engineering, University College Cork, Ireland

4. **Docent/Associate Professor**
   June 12, 2015

5. **Current position**
   Senior Lecturer in the Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, since 2016, 100% research

6. **Previous employments**
   a) Researcher in the Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, 2015-2016, 100% research
   b) Assistant Professor in the Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, 2011-2015, 100% research
   c) Research Assistant (2003-2004); Department for Silviculture, University of Freiburg

7. **Deductible time**
   Parental leave: 2019-01 to 2019-03 and 2019-05 to 2019-06

8a. Supervision of Ph.D./Licentiate thesis
Ongoing:
Cheuk Hei Tong, 2018-2022 (Main supervisor); Lukas Guth, 2020-2024 (Main supervisor); Arnis Jurevic, 2013-2020 (Co-supervisor); Johannes Larsson, 2019-2022 (Co-supervisor); Koffi Dodji Noumonvi 2020-2024 (Co-supervisor)

Completed: Anna Larsson, 2016, Licentiate, (Co-supervisor)

8b. Supervision of postdocs

Ongoing:
Jinshu Chi, 2019-2021 (Main supervisor); Eduardo Martínez García 2018-2020 (Main supervisor); Anne Klosterhalfen, 2019-2021 (Main supervisor); Anusha Sathyanadh, 2019-2021 (Main supervisor); Joss Ratcliffe, 2019-2021 (Main supervisor); Peng Zhao, 2019-2021 (Main supervisor)

Completed:
Simon Drollinger, 2018-2019 (Main supervisor); Jinshu Chi, 2016-2018 (Main supervisor); Franziska Koebsch, 2017-2019 (Main supervisor);
Järvi Järveoja, 2016-2018 (Co-supervisor); Cecilie Skov Nielsen, 2017-2019 (Co-supervisor); David Hadden, 2017-2019 (Co-supervisor); Junbin Zhao, 2013-2015 (Co-supervisor); Michal Gazovic, 2014-2016 (Co-supervisor); Georg Jocher, 2014-2017 (Co-supervisor)

9. Research grants

Main applicant

- Advancing the modelling of the peatland carbon balance through assimilation of high-resolution component flux and phenology data' Swedish Research Council VR, 2020-2023; 3,682 kSEK
- 'Ansökan om medel för att bestämma betydelsen av det boreala landskapet för upptag och avgivning av kol och växthusgaser – från småskaliga processer till regionala flöden', Five Postdoc Scholarships from the Kempe Foundations, 2018-2020; 2,700 kSEK
- **'**How do nature restoration and forestry affect the greenhouse gas emissions from drained peat soils?' Stiftelsen Oscar och Lili Lamms Minne, 2018-2021; 2,000 kSEK
- **'**How does drainage and ditch maintenance affect the greenhouse gas balance of forested peatlands in the Swedish boreal landscape?' FORMAS, 2017-2019; 2,982 kSEK
- **'**Does sustained yield of forest biomass result in a carbon sink at the forest landscape scale?' FORMAS, 2016-2018; 6,572 kSEK
- 'Betydelsen av växternas fenologi för reglering av växthusgaser och kolackumulering i nordliga myrar', Kempe Foundations Postdoc Stipendium, 2016-2017; 540 kSEK
- 'A novel approach to separate vegetation and abiotic controls on the peatland carbon cycle', Carl Trygger Stiftelse Postdoc Stipendium, 2016; 381 kSEK

Co-applicant

- ICOS - ansökningar om nationella forskningsinfrastrukturer, VR-The Swedish Research Council, 2021-24; 40 000 kSEK
- 'Bridging the abyss of environmental factors between methane formation and emission at high latitude peatlands', VR-The Swedish Research Council, 2019-2022; 3 380 kSEK
- 'Physiological branch-points with ecosystem consequences: carbon and water in boreal forests', The Knut and Alice Wallenberg Foundation, 2016-2020; 39,450 kSEK
- 'Developing SITES spectral sampling capability using sensors in towers and on UAVs for process studies and remote sensing validation', SITES, 2015-2017; 3,649 kSEK
- 'Replicated ecosystem scale mire nitrogen fertilization experiment', SLU Infrastructure Grant, 2016-2019; 3,000 kSEK

- Ansökan om medel för att utveckla ny metodik för att kvantifiera oxidation av metan ”in situ” i en boreal myr, Kempe Foundations, 2016-2018; 1,500 kSEK
- Ansökan om medel för etablering av en fältforskningsinfrastruktur för långsiktiga studier av ökad kvävedeposition på boreala myrar, Kempe Foundations, 2017; 1,500 kSEK
- Fysiologiska noder styr skogens tillväxt: Isotopbaserade mätningar och beräkningar för att länka samman flöden av kol, vatten och energi i boreala skogar, Kempe Foundations, 2017; 2,160 kSEK

10. Awards and special commissions

- Appointment as Adjunct Assistant Professor at the School of Geography and Earth Sciences, McMaster University, Hamilton, ON, Canada, July 1, 2014
- Kungl. Skytteanska Samfundets prize for young researchers at SLU, Umeå, 30 kSEK, 2014
- Swedish Representative in the Management Committee at the European COST Action CA17134 Optical synergies for spatiotemporal SENsing of Scalable ECOphysiological traits (SENSECO); 2018-2022
- Swedish Representative in the Management Committee at the European COST Action ES1309 Innovative Optical Tools For Proximal Sensing Of Ecophysiological Processes (OPTIMISE); 2014-2018
- PhD thesis nominated for the Governor General Academic Medal by the School of Geography & Earth Sciences, McMaster University, 2009
- Awarded the prestigious Ontario Graduate Scholarship (OGS; 15,000 Can$), 2008
- Member of the Evaluation Committee for PhD defense:
  Elin Sundqvist, Lund University, Lund, Sweden, 2014
  Eduardo Martínez García, University of Castilla-La Mancha, Spain, 2018
  Laura Matkala, University of Helsinki, Finland, 2020
- Evaluation of MSc thesis: Cormac O’Doherty, 2012-2013, North Carolina State University, USA; Ilse Vermeij, 2013-2014, Wageningen University and Research Centre, The Netherlands; Eefje de Goede, 2014-2015, Radboud University Nijmegen, The Netherlands; Quan Zhou, 2017-2018, Wageningen University and Research Centre, The Netherlands; Itziar Aguinaga Gil, 2017-2018, Wageningen University and Research Centre, The Netherlands; Thalisa Slier, 2018-2019, Wageningen University and Research Centre, The Netherlands; Hanna Glöd, 2018, Swedish University of Agricultural Sciences, Sweden; Jenny Dahl, 2018, Swedish University of Agricultural Sciences, Sweden; Jelle Visser, 2020-2021, Wageningen University and Research Centre
- Principle Investigator (PI) of the ICOS-Svartberget ecosystem station
- Co-PI of the ICOS-Degerö ecosystem station
- Co-PI of SITES-Spectral
- Guest Editor for Special Issue on ‘Wetland Ecology and Biogeochemistry Under Natural and Human Disturbance’ in the Journal *Frontiers*
- Editor for the Journal *Forests*

11. Referee for international journals

Active as reviewer for several journals including: Global Change Biology, Environmental Research Letters, Agricultural & Forest Meteorology, Biogeosciences, JGR–Biogeosciences, Plant and Soil, Canadian Journal of Forest Research, Environmental Science & Technology, Science of the Total Environment, Biogeochemistry, Forest Ecology & Management

12. Conference presentations

21 first-author oral presentations and 14 first-author poster presentations from 2007-2020 at international conferences including the Fall Meeting of the American Geophysical Union (AGU), the European Geosciences Union (EGU) General Assembly, the General Meeting of the Canadian Climate Program, the International Peat Society and the ICOS-Europe/Sweden Annual Meetings.

Invited talks

1. Peichl, M., GHG fluxes in drained and restored boreal peatlands: Mätningar i Västerbotten. Workshop Dikad Torvmark: Hur kan vi omvandla dikad torvmark från utsläppskälla till sänka? Gothenburg University, February 3, 2020
2. Peichl, M., The carbon balance of a managed boreal forest landscape. School of Geography, Earth & Environmental Sci., University of Birmingham, Birmingham, UK, April 18, 2018
3. Peichl, M., Integrating terrestrial and aquatic fluxes of CO2, CH4 and H2O: the GHG balance and water-use efficiency of a forest landscape. Krycklan Symposium at the Swedish University of Agricultural Sciences, Umeå, Sweden, September 20, 2017
4. Peichl, M., The carbon balance of a managed boreal forest landscape - combining tall tower EC measurements with a bottom-up approach. Keynote talk at the First Nordic ICOS Symposium, DTU, Copenhagen, Denmark, August 30, 2017
5. Peichl, M., Is the boreal forest landscape a carbon sink? Future Forest Seminar at the Swedish University of Agricultural Sciences, Umeå, Sweden, March 22, 2017
6. Peichl, M., The terrestrial biosphere-atmosphere exchanges of carbon and greenhouse gases and their feedbacks with climate, vegetation and management. Docent lecture at the Swedish University of Agricultural Sciences, Umeå, Sweden, June 8, 2015
7. Peichl, M., The carbon balance of the boreal landscape: Integrating terrestrial and aquatic fluxes to complete carbon budgets. Invited talk at the 11th Annual Krycklan Symposium at the Swedish University of Agricultural Sciences, Umeå, Sweden, October 1, 2014
8. Peichl, M., The biosphere-atmosphere exchange of CO2 and energy in grassland ecosystems. Laboratory of Arid and Grassland Ecology, Lanzhou University, China, July 2, 2014
9. Peichl, M., Challenges of deriving a complete biosphere greenhouse gas balance through integration of terrestrial and aquatic ecosystems. Keynote talk for Session BG1.6 at the European Geosciences Union (EGU) General Assembly, Vienna, Austria, April 7-12, 2013
10. Peichl, M. Exploring the terrestrial biosphere-atmosphere exchange of carbon dioxide - three short stories. Seminar at the Dept. of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden, September 14, 2011
11. Peichl, M. Carbon and GHG dynamics in a chronosequence of pine forests. Colloquium at the Biodiversity and Climate Research Center (BiK-F) in Frankfurt, Germany, October 12, 2009
12. Peichl, M. The role of forest ecosystems in climate change. Leading and Learning Workshop at McMaster University, SGES, Hamilton, ON, Canada, June 27, 2007

Selected peer-reviewed publications

Bibliometric summary: a total of 79 peer-reviewed papers with >2400 citations since 2006, 16 first-author papers, H-index = 24 (Google Scholar)

1. Järveoja, J., M.B. Nilsson, P.M. Crill and **M. Peichl**. 2020. Bimodal diel pattern in peatland ecosystem respiration rebuts uniform temperature response. *Nature Communications* 11:4255
2. Helbig, M. et al. 2020. Increasing contribution of peatlands to boreal evapotranspiration in a warming climate. *Nature Climate Change* 10:555–560
3. Chi, J., M.B. Nilsson, H. Laudon, A. Lindroth, J. Wallerman, J. Fransson, N. Kljun, T. Lundmark, M. Ottosson Löfvenius, and **M. Peichl**, 2020. The Net Landscape Carbon Balance – integrating terrestrial and aquatic carbon fluxes in a managed boreal forest landscape in Sweden. *Global Change Biology*, 26: 2353-2367
4. Kozii, N., K. Haahti, P. Tor-ngern, J. Chi, E. Maher Hasselquist, H. Laudon, S. Launiainen, R. Oren, **M. Peichl**, J. Wallerman, N. J. Hasselquist, 2020. Partitioning the forest water balance within a boreal catchment using sapflux, eddy covariance and process-based model. Hydrol. Earth Syst. Sci. 24, 2999–3014
5. Wandera, L., K. Mallick, G. Kiely, O. Roupsard, **M. Peichl**, and V. Magliulo, 2017. Upscaling instantaneous to daily evapotranspiration using modelled daily shortwave radiation for remote sensing applications: an Artificial Neural Network approach. *Hydrology and Earth System Sciences* 21: 197–215
6. Skubel, R., M.A. Arain, **M. Peichl**, J.J. Brodeur, M. Khomik, R. Thorne, J. Trant and M. Kula, 2015. Age effects on the water use efficiency and water use dynamics of temperate pine plantation Forests. *Hydrological Processes* 29: 4100-4113
7. **Peichl, M.,** J. Sagerfors, A. Lindroth, I. Buffam, A. Grelle, L. Klemedtsson, H. Laudon and M.B. Nilsson, 2013. Energy exchange and water budget partitioning in a boreal minerogenic mire. *JGR – Biogeosciences*, doi:10.1029/2012JG002073
8. MacKay, S., M.A. Arain, M. Khomik, J.J. Brodeur, J. Schumacher, H. Hartmann and **M. Peichl**, 2012. The impact of induced drought on transpiration and growth in a temperate pine plantation forest. *Hydrological Processes* 26: 1779-1791
9. **Peichl, M**., Brodeur, J.J., Khomik, M., and M.A. Arain, 2010. Biometric and eddy-covariance based estimates of ecosystem carbon exchange in an age-sequence of temperate pine forests. *Agricultural and Forest Meteorology* 150: 952-965
10. McLaren, J.D., M.A. Arain, M. Khomik, **M. Peichl**, and J.J. Brodeur, 2008. Water flux components and soil water-atmospheric controls in a temperate pine forest growing in a well drained sandy soil. *JGR - Biogeosciences,* 113, G04031

Curriculum Vitae for Henrik J. Persson

1. PERSONAL BACKGROUND

1.1 Personal Data

Birth Place: Örnsköldsvik, Sweden
Birth Date: May 13th, 1983

1.2 Affiliation

Researcher in Forest Remote Sensing
Department of Forest Resource Management
Swedish University of Agricultural Sciences (SLU)
SE-901 83 Umeå, Sweden
Phone: +46-(0)90-7868105
E-mail: henrik.persson@slu.se

1.3 Education

Assoc. Prof., Technology, Swedish University of Agricultural Sciences, 2019
Ph.D., Forest Remote Sensing, Swedish University of Agricultural Sciences, 2014, Thesis Title: "Estimation of Forest Parameters Using 3D Satellite Data"
M.Sc., Engineering Physics, Luleå University of Technology, 2009, Thesis Title: "Selection and analysis of the mounting position for a sensor cluster"

1.4 Professional Expertise

Dr. Persson's professional expertise includes radar remote sensing, synthetic-aperture radar (SAR), stereogrammetry, radargammetry, interferometry, photogrammetry, SAR, ALS, image processing, and radar applications. His experience includes lecturing, supervision, and project management. His research on 3D based remote sensing is internationally recognized.

1.5 Scientific Work and Experience

2019 Associate Professor, SLU, Sweden
2015 Post-Doc at TU Wien, Austria
2014-present Researcher at Swedish University of Agricultural Sciences
2013 Visiting researcher at Gamma Remote Sensing, Switzerland
2011-2014 Ph.D. student in Forest Remote Sensing.
2009-2011 Programmer and IT specialist at ETH Zürich, Switzerland.
2008 Master thesis at Robert Bosch, Germany
2006-2007 Exchange student at Colorado School of Mines, Denver, USA.
2004-2009 M.Sc. student at Luleå University of Technology

1.6 Contributions, Scientific Honors

Scientific reviewer:

- International Journal of Remote Sensing
- Remote Sensing
- Canadian Journal of Forest Research
- Canadian Journal of Remote Sensing
- Croatian Science Foundation

- German Research Foundation
- Forestry: An International Journal of Forest Research
- IEEE Transactions on Geoscience and Remote Sensing
- Scientific Committee of IGARSS 2017-2019
- Scientific Committee of SilviLaser 2017

1.7 Supervision of Graduate Students

Main Supervisor and/or Examiner: André Wästlund, M.Sc., 2016, Edward Sjödin, M.Sc., 2016. Lina Selin, M.Sc. 2019, Alberto Udali, M.Sc. 2019, Robert Holmgren, M.Sc. 2020.
Assistant supervisor: Marcus Wiklander, M.Sc. 2020, Daniel Bertilsson, M.Sc., 2016, Nils Lindgren, Ivan Huuva, and Mozhgan Zahriban, current Ph.D. students, Langning Huo, Post-Doc 2020.

1.8 Lecture activities (SLU)

Year	*Course name*	*Role*
12-19	Forest Remote Sensing	Selected lectures
17-18	Statistics and forest inventory	Examiner for certain elements

2. PUBLICATIONS

2.1 Publication statistics

Dr. Persson is the author or co-author of more than 60 professional peer-reviewed publications.

	Total Number of publications
Peer-reviewed articles	**25**
Peer-reviewed conference papers	**38**
Review articles, book chapters, books	
Patents	
Self-developed, generally available computer programs	
Popular scientific articles or presentation	**1**

2.2 Selected papers
(the most recent publications available on https://www.slu.se/cv/henrik-persson)

[1] **Persson, H**. and Fransson, J.E.S. 2014.
Forest Variable Estimation Using Radargrammetric Processing of TerraSAR-X Images in Boreal Forests. Remote Sensing, 6, No. 3, pp. 2084-2107, 2014.

[2] Soja, M., **Persson, H.**, and Ulander, L.M.H., 2015. Estimation of Forest Height and Canopy Density from a Single InSAR Correlation Coefficient. IEEE Geoscience and Remote Sensing Letters, vol 12, No 3, pp 646-650, 2015.

[3] Soja, M., **Persson, H.**, and Ulander, L.M.H., 2015. Estimation of Forest Biomass from Two-Level Model Inversion of Single-Pass InSAR Data. IEEE Transactions on Geoscience and Remote Sensing, vol 53, No 9, pp 5083-5099, 2015.

[4] **Persson, H.J.** 2016. Estimation of boreal forest attributes from very high resolution Pléiades data. Published in Remote Sensing.vol 8, No 9:736, 2016.

[5] **Persson, H.J.**, Olsson, H., Soja, M.J., Ulander L.M.H., Fransson, J.E.S., 2017.
Large-scale forest mapping of Sweden using TanDEM-X data. Remote Sensing Vol. 9, No 12, 2017.

[6] Askne, J.I.H., **Persson, H.J.**, Ulander L.M.H., 2018.
Biomass growth from multi-temporal TanDEM-X interferometric synthetic aperture radar observations of a boreal forest site. Remote Sensing Vol. 10, No 4, 2018.

[7] Soja, M.J., **Persson, H.J.**, and Ulander, L.M.H., 2018. Modeling and Detection of Deforestation and Forest Growth in Multi-Temporal TanDEM-X Data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol 11, No 10, 2018.

[8] Askne, J.I.H., **Persson, H.J.**, Ulander L.M.H., 2019.
On the Sensitivity of TanDEM-X-Observations to Boreal Forest Structure. Remote Sensing Vol. 11, No 14, 2019.

[9] **Persson, H.J.**, Ståhl, G. Characterizing Uncertainty in Forest Remote Sensing Studies. Remote Sensing Vol. 12, No 3, 2020.

[10] **Persson, H.J.**, Soja, M.J., Fransson, J.E.S., Ulander L.M.H. National biomass mapping using the Two-Level model. In press IEEE JSTARS 2020.

Curriculum Vitae for Lars M.H. Ulander

Personal Data
Birth date: Dec 5th, 1962
Birth place: Växjö, Sweden
Gender: Male

Affiliation
Professor in Radar Remote Sensing
Department Space, Earth and Environment
Chalmers University of Technology
SE-412 96 Göteborg, Sweden
Phone: +46-(0)31-7721843
e-mail: lars.ulander@chalmers.se

Education
Docent (Dr-habil.), Radio and Space Science, Chalmers University of Technology, 1996
Ph.D., Electrical and Computer Engineering, Chalmers University of Technology, 1991, Thesis Title: "Radar Remote Sensing of Sea Ice: Measurements and Theory"
Lic.Eng., Electrical and Computer Engineering, Chalmers University of Technology, 1987, Thesis Title: "Active Microwave Remote Sensing for Sea Ice Parameters"
M.Sc., Engineering Physics, Chalmers University of Technology, 1985, Thesis Title: "Airborne Radar Altimetry over the Greenland Ice Sheet"

Scientific Work and Experience

2014-present	Professor at Chalmers University of Technology
2001-present	Director of Research at Swedish Defence Research Agency (FOI).
1999-2014	Adjunct Professor at Chalmers University of Technology
1995-2000	Senior Scientist at FOI; Assistant Professor at Chalmers
1991-1992	Research Associate at Chalmers.
1989-1990	Visiting Fellow, Canada Centre for Remote Sensing (CCRS)
1985-1991	Ph.D. student in Radar Remote Sensing.
1984-1985	M.Sc. student at Imperial College and University College London.

Contributions, Scientific Honors and Awards
Scientific reviewer for journals:
- Regularly (since 1989) for IEEE Transactions on Geoscience and Remote Sensing, IEEE Geoscience and Remote Sensing Letters, IEEE Transactions Aerospace and Electronic Systems, IET Radar, Sonar and Navigation
- Occasionally for Int. J. Remote Sensing, Electronics Letters, Journal of Geophysical Research, EARSeL Advances in Remote Sensing, Canadian Journal of Remote Sensing, IEEE Trans. Signal Processing, Journal of Electromagnetic Wave Propagation and Applications, Pattern Recognition

Committees:
- Member of ESA's BIOMASS Mission Advisory Group through phase 0/A/B
- Member of the board of "Sveriges Rymdforskares Samarbetsgrupp" (SRS)
- Member of numerous conference technical committees and special sessions organizer
- Adjunct Member of SNRV-F (Swedish Chapter of URSI Commission F)

- Past member of ESA's expert panel for SAOCOM Companion Satellite
- Past member of Swedish Remote Sensing Committee (2002-2011)
- Past member of CEOS SAR Calibration group, ESA Fringe group, ESA Calibration group

Member of PhD thesis evaluation committees:
- Chalmers University of Technology (I. Moradi 2015-03-06, M. Ström, 2015-03-20 suppl., J. Nohlert, 2018-03-22)
- Ecole Polytechnique (E. Everaere, 2015-05-06)
- Halmstad University (A. Åhlander, 2007-05-29)
- Linköping University (Z. Sjanic, 2013-10-18)
- Royal Institute of Technology (Xin Niu, 2012-11-23; Wei Wang, 2017-12-11)
- Swedish Institute of Space Physics (A. Westman, 1997-11)
- Swedish University of Agricultural Sciences (E. Lindberg, 2012-06-08)
- Technical University of Denmark (U. Nielsen, 2015-05-28)
- ETH Zurich (O. Ponce Madrigal, 2016-12-21)

Scientific evaluation board:
- Department of Electromagnetism and Radar, ONERA, France (2008)
- DTU Space, Technical University of Denmark, Denmark (2011, 2016)

Honors, awards and prizes:
- IEEE Fellow 2017, Senior Member, 2004
- Outstanding Technical Paper (together with H. Hellsten), IEEE Radar Conference, Waltham, MA, 1999
- Best Oral Presentation (together with G. Smith), 2nd International Workshop on Retrieval of Bio- and Geo-physical parameters from SAR Data for Land Applications, Noordwijk, the Netherlands, 1998
- Best Paper of Session (together with B. Larsson et al.), 3rd International Airborne Remote Sensing Conference and Exhibition, Copenhagen, Denmark, 1997
- Best Paper of Session (together with B. Larsson et al.), 2nd International Airborne Remote Sensing Conference and Exhibition, San Francisco, CA, 1996
- Canadian Governmental Laboratory Fellowship, NSERC, Ottawa, Canada, 1989
- Saab Scania's Sensor Award, Linköping, Sweden, 1989
- Dr. Marcus Wallenberg's Scholarship, Stockholm, Sweden, 1985
- Honorary prize (individual), International Physics Olympiad, Moscow, Russia, 1979
- Swedish Physics Competition, 1979; Sixth prize (individual), First prize (school team)

Invited plenary talks at international conferences:
- SIAM Conference on Image Science 2008, San Diego, CA
- European Electromagnetics Symposium (EUROEM) 2000, Edinburgh, Scotland, UK

Patents:
- Holder of five patents in the area of Synthetic Aperture Radar (SAR)

Supervision of Graduate Students

Examiner and main supervisor of Ph.D and Lic. Eng. Students at Chalmers:
- P.-O. Frölind, Lic.Eng. 1998, Ph.D. 2005
- B. Hallberg, Lic.Eng. 2004, Ph.D. 2007
- K. Folkesson, Lic.Eng. 2004, Ph.D. 2008

- A. Wyholt, Lic.Eng. 2008
- G. Sandberg, Lic.Eng. 2009, Ph.D. 2013
- G. K. Carvajal, Lic.Eng. 2011, Ph.D. 2013
- A. Berg, Lic.Eng. 2011
- M. Soja, Lic.Eng. 2012, Ph.D. 2014
- J. Torgrimsson, Lic.Eng. 2013, Ph.D. 2015
- E. Blomberg, Lic.Eng. 2017
- A. Monteith, Lic.Eng 2018, Ph.D. 2020

Examiner and assistant supervisor of Ph.D and Lic. Eng. students at Chalmers:

- A. Carlström, Lic.Eng. 1992, Ph.D. 1995
- J. Hagberg, Lic.Eng. 1994
- M. Pettersson, Lic.Eng. 1995, Ph.D. 2000
- P. Dammert, Lic.Eng. 1996, Ph.D. 1999
- G. Smith-Jonforsen, Lic.Eng. 1998, Ph.D. 2000
- A. Berg, Ph.D. 2014
- W. Aldenhoff, Lic.Eng. 2017
- A. Elyouncha, Lic.Eng 2018, Ph.D. planned 5 Nov 2020

Assistant supervisor of Ph.D students at SLU:

- H. Persson, Ph.D., 2014
- Ivan Huuva

Educational responsibilities (Chalmers):

2017- Director of Master's Programme Wireless, Photonics and Space Engineering

Educational work (Chalmers)

Year	*Course name*	*Role*
08-present	Radar Systems and Applications (M.Sc. level)	Examinor, 80-100% lectures
05, 13	Radar polarimetry (Ph.D.-level)	Examinor, Selected lectures
98, 06, 12, 17	Spotlight SAR processing (Ph.D.-level)	Examinor, Selected lectures
02	Understanding SAR images (Ph.D.-level)	Examinor, Selected lectures
94-95	Microwave Systems (M.Sc.-level)	Examinor, Lectures
93-94	Microwave Systems (M.Sc.-level)	ca. 30 % of lectures
93-94	ERS-1 and Remote Sensing by SAR	Selected lectures
93-94	Tutorials for first-year students	Tutor for one group
92-93	Radar System Techniques (Ph.D.-level)	Examinor, Selected lectures
92-93	Microwave Systems (M.Sc.-level)	ca. 30 % of lectures
92-93	ERS-1 and Remote Sensing by SAR (M.Sc.-level)	Selected lectures
91-92	ERS-1 and Remote Sensing by SAR (M.Sc.-level)	Selected lectures
90-91	Introduction to Space Techniques (M.Sc.-level)	Selected lectures
88-89	Synthetic Aperture Radar Techniques (Ph.D.-level)	Selected lectures
87-88	Wave Propagation incl. Remote Sensing (M.Sc.-level)	Exercises

Other lectures (not Chalmers)

99, 12	Synthetic-Aperture Radar (Ph.D.-level)	One lecture, KTH
97, 04	Synthetic-Aperture Radar (Ph.D.-level)	One lecture, Uppsala U
97	Low-Frequency SAR (short course at International Airborne Remote Sensing Conference and Exhibition, Copenhagen, Denmark)	Selected lectures
16, 17	Grundläggande radar (2-day course on Radar Principles)	Four lectures, FMV

Publication statistics

Prof. Ulander is the author or co-author of more than 300 professional publications.
h-index: 29 (Web of knowledge), 35 (Scopus), 43 (Google Scholar).
Citations: 3609 (Web of knowledge), 4575 (Scopus), 7041 (Google Scholar).

Publication type	Total number of publications	Open access papers
Peer-reviewed articles	**80**	**7**
Peer-reviewed conference papers	**266**	**0**
Review articles, book chapters, books	**3**	**0**
Patents (97-06-18, 99-02-26, 98-12-18, 03-02-11, 06-12-11)	**5**	
Self-developed, generally available computer programmes	**0**	**0**
Popular scientific articles or presentation	**3**	**0**

For a publication list, see
https://research.chalmers.se/en/organization/?tab=publications&query=lars+ulander
or https://scholar.google.se/citations?user=mVldAZ4AAAAJ&hl=sv&oi=ao

10 SELECTED PUBLICATIONS

[1] L.M.H. **Ulander**, A.R. Monteith, M.J. Soja, L.E.B. Eriksson, Multiport vector network analyzer radar for tomographic forest scattering measurements, IEEE Geoscience and Remote Sensing Letters, vol. 15, no. 12, pp. 1897 – 1901, 2018

[2] M.J. Soja, H. Persson, L.M.H. **Ulander**, Modeling and Detection of Deforestation and Forest Growth in Multi-Temporal TanDEM-X Data, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 11, no. 10, pp. 3548 - 3563, 2018

[3] A.R. Monteith, L.M.H. **Ulander**, Temporal survey of P- and L-band polarimetric backscatter in boreal forests, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 11, no. 10, pp. 3564 – 3577, 2018

[4] E. Blomberg, L. Ferro-Famil, M.J. Soja, L.M.H. **Ulander**, S. Tebaldini, Forest biomass retrieval from L-band SAR using tomographic ground backscatter removal, IEEE Geoscience and Remote Sensing Letters, vol. 15, no. 7, pp. 1030 - 1034, 2018

[5] H.J. Persson H. Olsson, M.J. Soja, L.M.H. **Ulander**, J. E.S. Fransson, Experiences from Large-Scale Forest Mapping of Sweden Using TanDEM-X Data, Remote Sensing, vol. 9, no. 12, 1253, 26 pp., 2017

[6] G. Sandberg, L.M.H. **Ulander**, J. Wallerman, J.E.S. Fransson, Measurements of Forest Biomass Change Using P-band SAR Backscatter, IEEE Transactions on Geoscience and Remote Sensing, vol. 52 , no. 10, pp. 6047 – 6061, 2014

[7] M.J. Soja, G. Sandberg, G., and L.M.H. **Ulander**, Regression-based Retrieval of Boreal Forest Biomass in Sloping Terrain using P-band SAR Backscatter Intensity Data, IEEE Transactions on Geoscience and Remote Sensing, vol. 51, no. 5, pp. 2646-2665, 2013

[8] T. Le Toan, S. Quegan, M.W.J. Davidson, H. Balzter, P. Paillou, K. Papathanassiou, S. Plummer, F. Rocca, S. Saatchi, H. Shugart, L. **Ulander**, "The BIOMASS mission: Mapping global forest biomass to better understand the terrestrial carbon cycle," Remote Sensing of the Environment, vol. 115, pp. 2850-2860, November 2011

[9] G. Sandberg, L.M.H. **Ulander**, J. Holmgren, J.E.S. Fransson, and T. Le Toan, "L- and P-band backscatter intensity for biomass retrieval in hemiboreal forest," Remote Sensing of the Environment, vol. 115, pp. 2874-2886, November 2011

[10] L.M.H. **Ulander**, H. Hellsten, and G. Stenström, "Synthetic-Aperture Radar Processing using Fast Factorised Back-Projection," IEEE Trans. Aerospace and Electronic Systems, vol. 39, pp. 760-776, July 2003

SLU

Projektkalkyl med koppling till 0

SLU id:

Projekt: Utv. av metodik för satellitbaserad forskn. och övervakn. av kol- och vatten-cykeln i boreala skogsekosystem
Huvudsökande forskare: Johan Fransson
Huvudsökande institution: Skoglig resurshushållning
Finansiär: Kempestiftelserna
Fullkostnadsfinansiär: NEJ
Finansiering av indirekta och lokaler (% på av finansiär accepterad kostnadsbas): 0%

Valuta/penningvärde: **SEK**
Projektstart: 2021-01-01
Projektslut: 2025-12-31

Kalkylkommentar:
SRH (Johan Fransson) huvudsökande, Chalmers (Lars Ulander) och Inst. för ekologi och skötsel medsökande. Jonas Bohlin har muntligen lovat att finansiera OH-kostnader ej täckta av Kempestiftelserna. Principen är annars att de tre institutionerna tar 1/3 av kostnaderna vardera.

Projektkostnader

Kostnader förväntade att täckas av finansiär	**2021**	**2022**	**2023**	**2024**	**2025**						***Total***
Löner inklusive LKP	54 058	54 058	54 058	54 058	54 058	0	0	0	0	0	*270 288*
Driftskostnader och övriga personalkostnader	3 662 000	0	0	0	0	0	0	0	0	0	*3 662 000*
Utrustning - avskrivningar	0	0	0	0	0	0	0	0	0	0	*0*
Lokalkostnader accepterade som direkta av finansiär	0	0	0	0	0	0	0	0	0	0	*0*
Indirekta och lokaler accepterade som OH av finansiär	0	0	0	0	0	0	0	0	0	0	*0*
Total kostnad i ansökan till finansiär	*3 716 058*	*54 058*	*54 058*	*54 058*	*54 058*	*0*	*0*	*0*	*0*	*0*	*3 932 288*
Varav utanför SLU	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Kostnader förväntade att medfinansieras											
Indirekta och lokaler inte accepterade som OH av finansiär*	25 948	25 948	25 948	25 948	25 948	0	0	0	0	0	*129 738*
	0	0	0	0	0	0	0	0	0	0	*0*
	0	0	0	0	0	0	0	0	0	0	*0*
	0	0	0	0	0	0	0	0	0	0	*0*
	0	0	0	0	0	0	0	0	0	0	*0*
	0	0	0	0	0	0	0	0	0	0	*0*
	0	0	0	0	0	0	0	0	0	0	*0*
Total kostnad i medfinansiering av ansökan till finansiär	*25 948*	*25 948*	*25 948*	*25 948*	*25 948*	*0*	*0*	*0*	*0*	*0*	*129 738*
Varav utanför SLU	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total projektkostnad	**3 742 005**	**80 005**	**80 005**	**80 005**	**80 005**	**0**	**0**	**0**	**0**	**0**	**4 062 026**
Medfinansieringsandel	**1%**	**32%**	**32%**	**32%**	**32%**						**3%**

* Finansieringskälla: **Institutionen för skoglig resurshushållning**

	Huvudsökande SLU-forskare	*Prefekt huvudsökande SLU-institution*	*Ekonom huvudsökande SLU-institution*
Namnteckning:	Johan Fransson	Hans Petersson	Pär Andersson
Namn:	Johan Fransson	Hans Petersson	Pär Andersson
Datum (ÅÅÅÅ-MM-DD):	2020-10-21	2020-10-21	2020-10-21