Job title	**Postdoctoral position in 3D modeling of forest canopies using digital photogrammetry and airborne laser scanning**

We are seeking a highly talented candidate to develop and improve advanced 3D methods during an18-month postdoctoral internship in France and Quebec (Canada). The candidate will improve on photogrammetric canopy height modelling algorithms to create methods that will eventually be used to operationally map France's forest resources.

The postdoctoral position is available at the French National Institute for Agricultural Research (INRA) in Nancy, France, as part of the project CHM-era, funded by LabEx Arbre (http://mycor.nancy.inra.fr/ARBRE/). The research will be conducted in close collaboration with the Laboratory of Forest Inventory (LIF) of the National Institute for Geographic and Forest Information (IGN), the Research Development and Innovation (RDI) department from the French National Forest Office (ONF), and the Department of Geography from UQAM in Montreal (Canada). The successful candidate **will be part time between Nancy (France) and Montreal (Canada)**. She/he will be supervised by pioneers of photogrammetric-lidar fusion methods (Cédric Véga and Benoît St-Onge), within the operational environment of French forest management and resources assessment experts.

The CHM-era project: (http://mycor.nancy.inra.fr/ARBRE/?page_id=9046&lang=en)

Context: Aerial photographs are widely used for land surveys and are regularly acquired within the framework of regularly updated country-wide coverages. With the combined development of both Lidar Digital Terrain Models (DTM) and digital photogrammetry, photogrammetric point clouds (PPC) have the potential to become a precise and efficient alternative data type for analyzing forest structure and their dynamics. However, some of their specific characteristics, such as their sensitivity to the sun-sensor-object geometry, or local occlusions due to view angle and shadowing effects, are challenging for image-matching algorithms. These current shortcomings have a direct impact on the sampling quality and distribution of data points. As a consequence, the development of optimized photogrammetric products for canopy height assessment for forest practitioners is required to develop, evaluate and optimize forest information processing chains.

Objectives: The aim of CHM-era is to test the capabilities of photogrammetric data to complement Lidar ones for assessing and mapping forest attributes over large areas. The main objective of the project are 1) to optimize the algorithmic production of 3D point clouds in a range of forest and image conditions; 2) to develop models of forest attributes prediction at both plot and tree level; 3) to test the potential of time series of 3D models of forest canopies to provide information on forest dynamics, productivity, and site quality.

Approach: To guaranty the coverage of a large range of forest and acquisition conditions, in view of the development and evaluation of standard products, the project will rely on 2 to 3 sites with i) existing aerial images from IGN and Quebec province surveys ii) existing Lidar data and associated field-plots measurement acquired in previous project and iii) additional field plot measurements on one application site. We will test the robustness of at least one commercial (Pix4DMapper) and one open source (MicMac) photogrammetric software to generate PPC in a range of forest and image acquisition conditions. Statistical approaches using allometric theories will be used to develop and validate predictive models of forest parameters at both plot and tree level. The resulting models will be applied to time-series of PPC to assess canopy dynamics in terms of growth and disturbances. Growth information will be further used to develop indices of site quality.

Expected results and impacts: the project will provide an evaluation of the potential of state of the art photogrammetric methods to extract forest parameters, as well as valuable approach to monitor forest dynamics and forest productivity. Not only will it make a scientific contribution, but it is designed to be very influential on France's approach to forest inventory.

Employer	French National Institute for Agricultural Research (INRA)
Department & Research Team	Biogeochemistry and forest ecosystems (BEF), INRA, France, in close cooperation with: - Department of Geography, UQAM, Canada - Laboratory of Forest Inventory (LIF), IGN, France - Research Development and Innovation (RDI), ONF, France
Place of work	Nancy (France) and Montréal (Canada) The successful candidate will be part time between Nancy (France) and Montreal (Canada) (9 months in Canada + 9 months in France, precise schedule to be defined according to the project organization), under the supervision of C. Véga (IGN, LIF) and Pr. St-Onge(Uquàm)
Duration	18 months
Salary & Working hours	Full time, Approximately 2,600 – 2,900 euros per month (gross salary) (*), according to experience. The successful candidate will be accompanied in applying for complementary AgreenSkills+ (France), FQRNT and NSERC postdoctoral fellowships (Canada) to augment her/his salary *(*) Candidates without a PhD may also be considered, as far as their skills and knowledge match the task description, the salary level being therefore reconsidered in accordance to the qualification level of the candidate.*
Application deadline	**June 24, 2016**
Job description	▪ *Context:* Aerial images offer a convenient way to acquire 3D information on canopy structure and to monitor canopy dynamics. Photogrammetric workflows need to be optimized with respect to the quality of outcomes. ▪ *Purpose :* Development of a processing chain for assessing forest parameters in a range of forest and image acquisition conditions, at both plot and tree level. Assessment of the capabilities of time series of forest outcomes to monitoring forest dynamics and quantifying forest productivity. ▪ *Duties and responsabilities:* The postdoctoral fellow will contribute to the development and validation of the photogrammetric/lidar processing chain. He/she will be involved in the overall tasks of the project. His / her main scientific input will deal with the optimization of algorithmic production of 3D point clouds, and its enrichment with radiometric information, as well as the definition of 3D metrics to be used in the modeling of forest attributes, which is the most crucial part of the project

Requirements	▪ *Knowledge:* Knowledge of digital photogrammetry, Lidar, image processing, computer vision. Experience in forest inventory, forestry, statistical modeling will also be taken into consideration ▪ *Skills:* strong organizational skills, to work with different partners, to organize his/her work in different phases between France and Canada; and to manage large databases from different test sites ▪ *Abilities :* use of different photogrammetric and image processing software (as well as GIS), quality of oral and written expression ▪ *Behaviors:* team work, adaptability to different working environment (France, Québec), communication ability
Working language(s)	Proficiency in either French or English is required. For candidates whose native language is not French, basic French would be useful to work in a French/bilingual environment and to use French field databases.
Application	▪ *How to apply and required documents* Please send (by email) your CV, a cover letter describing your interests/experience and two letters of recommendation to : Dr. Cédric Vega email: cedric.vega@ign.fr cc: st-onge.benoit@uqam.ca, anne.jolly@onf.fr, standre@cirad.fr ** Please note that the applicant's PhD thesis must have been defended prior to the beginning of the contract.
Contact	▪ Name: Dr. Cédric VEGA ▪ Address: IGN / LIF - 11 rue de l'Ile de Corse- F-54000 Nancy – France ▪ Email : cedric.vega@ign.fr
Research Team Publication	Bellemarre-Racine, E., N.C. Coops, B. St-Onge, and J. Bégin, 2014. Estimating Forest Stand Age from Lidar-Derived Predictors and Nearest Neighbor Imputation. Forest Science 60: 128-136. Durrieu, S., C. Véga, M. Bouvier, F. Gosselin, J.-P. Renaud, and L. St-André. 2015. "Optical Remote Sensing of Tree and Stand Heights." In Remote Sensing Handbook, Volume II. Vol. II. Taylor & Francis Group\CRC Press. Henry, M., Bombelli, A.,Trotta, C., Alessandrini, A., Birigazzi, L., Sola, G., Vieilledent, G., Santenoise, P., Longuetaud, F.,Valentini, R., Picard, N. Saint-Andre, L. 2013. GlobAllomeTree: international platform for tree allometric equations to support volume, biomass and carbon assessment. IFOREST-BIOGEOSCIENCES AND FORESTRY, 6: E1-E5

Longuetaud, F.; Santenoise, Ph.; Mothe, F.; Kiesse, TS. ; Rivoire, M. ; Saint-Andre, L.; Ognouabi, N.; Deleuze, C. 2013.Modeling volume expansion factors for temperate tree species in France. Forest Ecology and Management, 292:111-121.

St-Onge, B., Audet, F.-A. and Begin, J. (2015) Characterizing the height structure and composition of a boreal forest using an individual tree crown approach applied to photogrammetric point clouds. Forests, 6(11):3899-3922.

St-Onge, B., Y. Hu and C. Vega, 2008. Mapping the height and above-ground biomass of a mixed forest using lidar and stereo Ikonos images, International Journal of Remote Sensing, 29: 1277-1294.

St-Onge, B., C. Vega, R. A. Fournier and Y. Hu, 2008. Mapping canopy height using a combination of digital stereophotogrammetry and lidar, International Journal of Remote Sensing, 29: 3343-3364.

St-Onge, B., Jumelet J., Cobello M., and Véga, C., 2004. Measuring individual tree height using a combination of stereophotogrammetry and lidar. Canadian Journal of Forest Research, 34:2122-2130.

Vega, C., Hamrouni, A., Mokhtari, S. El, Morel, J., Bock, J., Renaud, J.-P., Bouvier, M. Durrieu, S. (2014). PTrees: A point-based approach to forest tree extraction from lidar data. International Journal of Applied Earth Observation and Geoinformation, 33, 98–108.

Véga, C., & St-Onge, B. (2009). Mapping stand site index and age combining times-series of canopy height models with growth model. Forest Ecology and Management, 257, 951–959.

Véga, C., & St-Onge, B. (2008). Height Growth Reconstruction of a Boreal Forest Canopy Over a Period of 58 Years Using a Combination of Photogrammetric and Lidar Models. Remote Sensing of Environment, 112, 1784–1794.

Titre du poste	**Assistant de recherche (post-doctorat) - modélisation 3D de canopée forestière à partir de photogrammétrie numérique et de lidar aéroporté**
Organisme Employeur	Institut National de la Recherche Agronomique (INRA)
Département & Equipe de recherche	INRA – BEF (Biogéochimie des écosystèmes forestiers), en coopération étroite avec : - le département de Géographie de l'UQAM (Canada) - le laboratoire de recherche sur les inventaires forestiers de l'institut de l'institut national de l'information géographique et forestière (IGN-LIF) - le département recherche, développement et innovation de l'Office National des Forêts (ONF-RDI)
Lieu de travail	Nancy (France) et Montréal (Canada) Le contrat sera réparti entre Nancy et Montréal (9 mois Nancy, 9 moins à Montréal, la répartition précise étant à définir en fonction de l'organisation du projet), sous l'encadrement de C.Vega (PhD, LIF) et du Pr. Benoît St-Onge (UQAM)
Durée du contrat	18 mois
Salaire & Temps de travail	Travail à temps plein Salaire brut environ 2 600 à 2 900 € (*) / mois, selon l'expérience du candidat retenu. Le candidat sera soutenu pour effectuer des demandes de financements complémentaires auprès des programmes Agreenskills+ (France), et FQRNT ou NSERC au Canada. *(*) Les candidatures de postulant(e)s non titulaires d'un doctorat pourront également être étudiées, sous réserve qu'elles répondent aux critères de connaissances et de compétences nécessaires au poste. Le salaire sera alors adapté en fonction des qualifications du / de la candidat(e).*
Date limite des candidatures	**24 juin 206**
Description du poste	▪ *Contexte :* Les images aériennes constituent un moyen efficace pour obtenir des informations 3D sur la structure de la canopée forestière et pour en suivre la dynamique. Cependant, les chaines de traitements photogrammétriques nécessitent une optimisation spécifique pour les couverts forestiers. ▪ *Objectifs* L'objectif est (i) de développer une chaine de traitement permettant d'évaluer des paramètres forestiers à l'échelle de l'arbre et du peuplement à partir de modèles numériques de canopée issus de photogrammétrie, dans des contextes variés d'acquisition d'images et de types de forêts et (ii) d'évaluer la possibilité productivité forestière à partir de de séries temporelles. ▪ *Fonctions et responsabilités* Le / la post-doctorant(e) contribuera au développement et à la validation de la chaine de traitement photogrammétrie + lidar. Il/elle sera impliquée dans toutes les étapes du projet. Son apport scientifique portera principalement sur l'optimisation des algorithmes de production des nuages de points photogrammétriques et leur enrichissement radiométrique, ainsi que sur la définition des métriques 3D pour la modélisation des attributs forestiers.

Pré-requis	▪ *Connaissances :* connaissances et expérience en photogrammétrie, lidar aérien, traitement d'images, vision par ordinateur. Une expérience en inventaire forestier, modélisation statistique est également souhaitée ▪ *Compétences :* bonnes capacités d'organisation (travail avec différents partenaires, organisation du travail en différentes phases entre la France et le Canada, gestion de larges bases de données concernant des sites différents) ▪ *Aptitudes :* utilisation des différents logiciels de photogrammétrie et de traitement d'images (ainsi que de SIG), qualité d'expression écrite et orale ▪ *Comportement* : facilité et goût pour le travail en équipe, capacité d'adaptation à différents contextes professionnels (en France et au Canada), facilité de communication
Langue(s) de travail	Maîtrise du français ou de l'anglais indispensable Pour les candidats non francophones, des bases en français sont souhaitables pour travailler dans l'environnement bilingue français-anglais du projet et pour utiliser les bases de données de terrain françaises
Candidature	▪ *Comment postuler et documents requis* Transmettre par email un CV, une lettre de motivation décrivant votre intérêt pour le projet et votre expérience, ainsi que deux lettres de recommandation à : Cédric Vega email: cedric.vega@ign.fr cc: st-onge.benoit@uqam.ca, anne.jolly@onf.fr, standre@cirad.fr ** Nota : pour les post-doctorant(e)s, la thèse doit avoir été soutenue avant la date de démarrage du contrat.
Contact	▪ Nom: Cédric VEGA ▪ Adresse: IGN / LIF - 11 rue de l'Ile de Corse- F-54000 Nancy – France ▪ Courriel: cedric.vega@ign
Publications de l'équipe	Bellemarre-Racine, E., N.C. Coops, B. St-Onge, and J. Bégin, 2014. Estimating Forest Stand Age from Lidar-Derived Predictors and Nearest Neighbor Imputation. Forest Science 60: 128-136. Durrieu, S., C. Véga, M. Bouvier, F. Gosselin, J.-P. Renaud, and L. St-André. 2015. "Optical Remote Sensing of Tree and Stand Heights." In Remote Sensing Handbook, Volume II. Vol. II. Taylor & Francis Group\CRC Press. Henry, M., Bombelli, A.,Trotta, C., Alessandrini, A., Birigazzi, L., Sola, G., Vieilledent, G., Santenoise, P., Longuetaud, F.,Valentini, R., Picard, N. Saint-Andre, L. 2013. GlobAllomeTree: international platform for tree allometric equations to support volume, biomass and carbon assessment. IFOREST-BIOGEOSCIENCES AND FORESTRY, 6: E1-E5 Longuetaud, F.; Santenoise, Ph.; Mothe, F.; Kiesse, TS. ; Rivoire, M. ; Saint-Andre, L.; Ognouabi, N.; Deleuze, C. 2013.Modeling volume expansion factors for temperate tree species in France. Forest Ecology and Management, 292:111-121. St-Onge, B., Audet, F.-A. and Begin, J. (2015) Characterizing the height structure and composition of a boreal forest using an individual tree crown approach applied to

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