COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Alliance Research Internship Program at Columbia University
Academic year 2016 - 2017

Created in 2002, the Alliance Program is an innovative joint-venture between Columbia University, the École Polytechnique, Sciences Po, and Paris Panthéon-Sorbonne University.

Internship Description

- Students work with a faculty member, who acts as an academic advisor and supervises their research project.
  Internships start in March 2017. The duration, objectives and tasks of the internship will be discussed with the supervisor at the host center or department.
- Internships are not paid. ***If compensated, it will be specified in the offer.***
- ***Students are responsible for finding housing.***
- ***All students are required to apply for a J1 Student Intern Visa to conduct an internship in the United States***.
  Please note that $500 fees are required by Columbia University for the process.
  If visa fees are sponsored by the host department, it will be indicated in the offer.

Applications requirements

- Applicants must include: a CV, a cover letter (1 page), and a letter of recommendation.
- Students should send their application to the Alliance Program to:
  alliance@columbia.edu

- For confidentiality matters, faculty members should send the letter of recommendation directly to:
  alliance@columbia.edu

- All materials must be submitted in English.

Deadline: December 18, 2016

Contact: For General Inquiry**:** alliance@columbia.edu

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SCHOOL OF ENGINEERING AND APPLIED SCIENCE - DEPARTMENT OF EARTH & ENVIRONMENTAL ENGINEERING

1. Faculty Sponsor:
Prof Pierre Gentine and Lorenzo Polvani

2. Number of interns: one (1)

3. Type of support available:

- ✓ Stipend
- ✓ Accommodation
- ✓ Access to campus services and facilities
- ✓ Immigration and visa assistance/sponsor

4. Internship Title: Ergodicity in the climate system

5. Description:
The intern will investigate using the recent climate model large ensemble experiments whether time averaging of climate observations match ensemble averages, in other words whether the climate system is ergodic. Implications for observations and future remote sensing missions will be highlighted.

6. Skills:
Physics, applied mathematics, ideally some nonlinear dynamics (attractors, bifurcation, Lyapunov exponents…)

SCHOOL OF ENGINEERING AND APPLIED SCIENCE - DEPARTMENT OF EARTH & ENVIRONMENTAL ENGINEERING

1. Faculty Sponsor:
   Pierre Gentine (associate professor) at Columbia University,
   Catherine Prigent (adjunct research scientist)
   Filipe Aires (adjunct research scientist).

2. Number of interns: 1

3. Type of support available:

   - ✓ Plane ticket to New York City
   - ✓ Immigration and Visa assistance
   - ✓ A stipend of 1500 USD / month
   - ✓ Access to Columbia University campus services and facilities

4. Internship Title: Analysis and monitoring vegetation biomass and water status with a synergy of multispectral satellite observations

5. Description:

Vegetation plays a key role in the Earth water and carbon cycle, and under a changing climate, monitoring its spatial and temporal evolution is crucial. This is essential to correctly predict the evolution of terrestrial carbon pools, land use impacts, and the interaction with the water cycle.

A good monitoring of vegetation characteristics is also essential for accurate satellite retrieval of other surface parameters, such as soil moisture or land surface temperature. Nevertheless, vegetation parameter retrieval has lagged behind other remote sensing products such as soil moisture or surface temperature.

A large range of satellite observations is now available, providing global and continuous monitoring of vegetation parameters.

(1) Visible and near infrared observations have been used for more than 30 years, to monitor the chlorophyll activity of the vegetation; with a spatial resolution from several km to 10 m. However, these observations can be highly contaminated by clouds and water vapor, and saturate for dense vegetation.

(2) Passive and active microwaves are sensitive to the presence of water in the vegetation (and in the soil) as well as to the density of biomass (leaves, branches, trunks) in the observations. Microwave measurements can provide information on the Earth surface, regardless of the cloud cover, but their spatial resolution is typically of the order of 10 to 20 km.

(3) More recently, satellites have measured the solar-induced fluorescence signal related to photosynthesis rates, when plants convert sunlight and the atmosphere carbon dioxide into energy, providing unprecedented information on plant health. Up to now, this information is available at a 50 km scale, on a monthly basis. The general idea for this study will be to combine all available satellite observations for a better characterization of vegetation biomass and water status and its dynamics, worldwide.

We propose here to compare the information provided by these different satellite sensors, at a global scale, and across seasons. The temporal and spatial structures of the different information will be analysed in order to identify the complex spectral signatures of vegetation. We will first concentrate on the large spatial and temporal scales (typically 20 km and monthly), but then local analysis will be performed, for potential comparisons with in situ experiments.

Unsupervised clustering techniques (such as Kohonen maps) will be used to first determine vegetation classes with different characteristics and dynamics. This classification of vegetation will then be exploited to develop a retrieval scheme (from machine learning theory) to estimate vegetation density and water content from the satellite observations. For that, we will consider either an independent retrieval for each vegetation class or a mixture of experts system. This work should conduct to a global, long-term dataset of vegetation properties and this dataset will be extremely useful for the climate and ecology communities.

This study will imply collaborating with several groups: satellite remote sensing experts to understand the physics of the interaction of the radiation with the vegetation, statisticians to derive state-of-the-art methodologies to analyze the data and built retrieval algorithms, ecology and climate scientists to interpret the results versus in situ data.

6. Skills:

Physical intuition;
Computer programming (Matlab or Python)
Some machine learning/statistics

7. Additional Information:

Time: Starting in March, for 6 months
Location: Columbia University / New York / USA, with an initial period of 2 months at LERMA/Observatoire de Paris, France.

8. Contacts:

Catherine Prigent (Catherine.prigent@obspm.fr)
Filipe Aires (fa131@columbia.edu)
Pierre Gentine (pg2328@columbia.edu)

DEPARTMENT OF NEUROSCIENCE

1. Faculty Sponsor:
Rudy Behnia, assistant professor of neuroscience http://behnialab.neuroscience.columbia.edu/

2. Number of interns: One (1)

3. Type of support available:

- ✓ Stipend
- ✓ Access to campus services and facilities
- ✓ Immigration and visa assistance/sponsor
  Will assist in finding accommodation

4. Internship Title: Analyzing neural responses to visual color stimuli in *Drosophila* using electrophysiology and 2-photon calcium imaging.

5. Description:
How are colors encoded in the brain? Despite decades of research, this question remains unanswered. My lab is interested in deciphering the neural computations underlying color vision by exploiting the genetic toolkit of *Drosophila* to ask how spectral information from photoreceptors in the eye is combined to encode colors in the brain. We combine electrophysiological recordings and 2-photon activity imaging in live animals in response to visual stimuli to characterize the response of specific neurons. The intern will be involved in the process of setting up an advanced visual stimulus system for color vision and a workflow for data acquisition and analysis.

6. Skills:
Coding skills (Matlab), optical engineering/neuroscience/image analysis background encouraged but not necessary.

7. Additional Information:
We will be moving to the new Zuckerman Mind Brain and Behavior Institute early 2017.

CENTER FOR INTERNATIONAL EARTH SCIENCE INFORMATION NETWORK (CIESIN)

1. Faculty Sponsor:

Supervisor: Xiaoshi XING, Information Scientist, CIESIN, Earth Institute, Columbia University, New York, USA

2. Number of interns: One (1)

3. Type of support available:

- ✓ Access to campus services and facilities
- ✓ Immigration and visa assistance/sponsor (Columbia administration fee)

4. Internship Title: Geospatial Analysis and Visualization in Environmental and/or Climate Change Studies, with Alternative Concentrations on:

a) Energy Production and Emissions from Power Plants.
b) Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) Observed Climate Change Impacts.

5. Description:

a) Energy production data and emissions inventories are basic information for climate research, environmental and human health impact assessment, mitigation policy, and even international negotiations. The student will participate in a synthetic assessment of Carbon Monitoring for Action (CARMA) data source containing information over 60,000 power plants and 20,000 power companies worldwide. The Student will work with CIESIN scientist and external partners on geospatial data mining and collection of energy production parameters of power plants. She/he will be involved in construction of database, computation of emissions using Multivariate Adaptive Regression Splines (MARS) model, and analysis of impacts. The student will also contribute to global, regional and/or country-level maps with training from CIESIN GIS specialist, and conduct visualization of the results on the maps.

b) The student will work with CIESIN scientist/staff on geospatial data mining and collection related to IPCC AR5 observed climate change impacts. She/he will also get involved in construction of the database, creating global, regional and/or country-level maps with training from CIESIN GIS specialist, and visualization of the observed impacts on the maps.

6. Skills:

Basic GIS knowledge, preferable in ArcGIS but not required (Student will be trained in the internship). Some programming skills, preferable in VB, R, or Matlab.

7. Additional Information:

The purpose of this internship is for student to get involved in a real-world project and to gain hands-on experience in research related to energy production and emissions in environmental studies and/or climate change. The student should gain experience in literature search and review, data mining and collection, analysis and assessment, conclusion drawing, and suggestions and recommendations. Through this internship the student should also gain/improve technical skills in spatial analysis, database creation/management, computing and programming.

CENTER FOR INTERNATIONAL EARTH SCIENCE INFORMATION NETWORK (CIESIN)

1. Faculty Sponsor:
Supervisor: Alex de Sherbinin, PhD, Associate Director for Science Applications, CIESIN, Earth Institute, Columbia University, New York, USA

2. Number of interns: One (1)

3. Type of support available:

- ✓ Access to campus services and facilities
- ✓ Immigration and visa assistance/sponsor (Columbia administration fee)

4. Internship Title: Development of Indicators for the U.S. National Climate Assessment

5. Description:
The U.S. National Climate Assessment (NCA) has developed a series of indicators that track observed climate change impacts. Most of these indicators represent trends in physical parameters such as temperature, heating/cooling degree days, the length of the frost-free season, or ocean chlorophyll concentrations (see http://www.globalchange.gov/browse/indicators). The purpose of this project is to develop one or more indicators of exposure to climate-related hazards. Examples may include annual population exposed to drought (combining the US Drought Monitor data set with CIESIN's US Census grids), or changes in the elderly/vulnerable population over time that is exposed to extreme heat (combining climatic data with US Census grids). The goal will be to develop a proof of concept that can be presented to the NCA as an operational indicator of climate change impacts on human populations.

6. Skills:
The work will entail geospatial processing, and experience with ArcGIS, R, and/or Matlab are desirable but not required. The student will receive some training

7. Additional Information:

The purpose of this internship is for student to get involved in a real-world project and to gain hands-on experience in research related to indicator development. The student will gain experience in literature search and review, data collection, analysis and assessment, and policy applications. Through this internship the student will also gain/improve technical skills in spatial analysis, database creation/management, computing and programming.

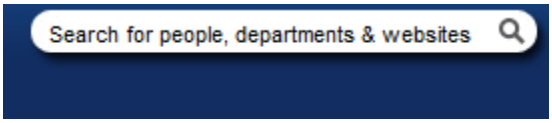
COLUMBIA UNIVERSITY RESEARCH GROUPS

Please find below a list of some Columbia University Research Groups.

- ***Please note this list is not exhaustive and only includes some Departments that you might be interested in.***

- If you need to find the address email of a faculty/contact at Columbia University, please go to **http://www.columbia.edu/content/university-news.html**

On the top of the page, please type the name of the person and you will access his exact department and contact information



FU FOUNDATION SCHOOL OF ENGINEERING AND APPLIED SCIENCE	**Research Involvement Program**
APPLIED PHYSICS AND APPLIED MATHEMATICS	
Applied Physics	Research Groups
Applied Mathematics	Research Groups & Centers
Materials Science and Engineering	Research Groups
Cross-Cutting Research	
Biomathematics & Biophysics	Contacts
Computational Science	Contacts
Earth & Climate	Contacts
Electron Conduction on the Nanoscale	Contacts
Grain Structures in Films	Contacts
Inverse Problems	Contacts
Nanomaterials	Contacts
Optical Physics	Contacts
Plasma Physics	Contacts
X-Ray & Neutron Scattering	Contacts
BIOMEDICAL ENGINEERING	
Cell and Tissue	Research Groups
Biosignals and Biomedical Imaging	Research Groups
Biomechanics	Research Groups
CHEMICAL ENGINEERING	
Molecular Design and Modification of Material Surfaces	Research Group
Biophysics and Soft Matter Physics	Research Group
Genomics Engineering	Contact
Interfacial Engineering and Electrochemistry	Contact
Protein and Metabolic Engineering	Contact
CIVIL ENGINEERING AND ENGINEERING MECHANICS	
Research Groups	Research Groups
COMPUTER ENGINEERING	
Computer Science	Research Groups
Electrical Engineering	Research Areas

EARTH AND ENVIRONMRNTAL ENGINEERING	
Environmental Health Engineering Sustainable Waste Management (SWM) Water Resources and Climate Risks	Research Groups Research Groups Research Groups
BIOLOGY	
Dept. of Biology	Research Groups
CHEMISTRY	
Dept. of Chemistry	Research Groups