# 15 Jan 2019 ARRCU-I – Atmospheric Related Research in Canadian Universities: An "Industry" component

## **Background**

The ARRCU Working Group started as an ad hoc group of Canadian university faculty who undertake research in weather, climate, and air quality under the general framework of atmosphere-related research (ARR). It has now become a Special Interest Group within the Canadian Meteorological and Oceanographic Society, a CMOS-SIG. ARR considers the whole atmosphere, from the surface to space, and its interaction with land-surface, hydrologic, ocean, cryosphere, and space systems. Work in this area also connects atmospheric and related sciences to many other areas of environmental and social science.

We initiated a strategic planning process in Canadian ARR across the university, government, and industrial sectors. One aim is to help configure academic ARR to most benefit Canada in a time of rapid environmental and socio-economic change. We believe that this process will benefit ARR activities within and outside the wide range of University departments and research units where ARR takes place.

The initial focus has been on issues relating to collaboration with Federal Government agencies, primarily Environment and Climate Change Canada (ECCC) and the Department of Fisheries and Oceans (DFO), together with representatives from the Natural Sciences and Engineering Research Council (NSERC). A "White Paper" from June 2016 and other documents are available on the web site, http://www.arrcu.ca/documents-2/.

It has always been the intent to include "industry", meaning companies with interests in weather and climate analysis and prediction, including air quality, hydrology, and other atmospheric applications, in our planning and we have had some involvement. The present document has been slow to finalize and is focused on the industry sector. Collaboration with industry is important for the universities from several points of view including potential employment of our graduates in the atmospheric sciences, the design of curricula to serve the needs of this industry, as well as the Meteorological Service, and for investigating areas of potential collaborative research.

A small group of ARRCU Working Group members (Peter Taylor, Roland Stull and Pierre Gauthier) are involved in this activity. As one step in pursuing this we arranged a small workshop during the Canadian Meteorological and Oceanographic Society (CMOS) 2017 Congress in Toronto, June 4-8, 2017. Our goal was to produce a First Draft of a document by September 30, 2017 but we are running very late!

At least in part the delay was because of the postings in April and July 2018 that, for all areas of science and engineering, "NSERC is pleased to announce policy changes to its Collaborative Research and Development (CRD) and Industrial Research Chair (IRC) programs to broaden their impact and expand eligibility...... These changes will also provide faster and simpler delivery of funding to support research partnerships in Canada and to diversify the innovation ecosystem in Canadian universities. The policy changes will attract additional partners to university research in Canada and provide more opportunities for

multinational and foreign companies to partner with Canadian university researchers to conduct R&D here. Researchers will benefit with more opportunities to participate in collaborative projects with leading innovative companies." A later announcement noted that "Budget 2018 proposed that Engage Grants (including Engage Plus Grants), Industrial Research Chairs, Connect Grants, Strategic Partnership Grants for Networks and Projects, Experience Awards Grants, and existing Collaborative Research and Development Grants be consolidated into a single grant program." More details have been announced, see http://www.nserc-crsng.gc.ca/NSERC-CRSNG/RPR-RPR/framework-documentcadre\_eng.asp, but so far the changes have not come into effect and applications for Engage and CRD grants are still being accepted under the old rules.

A Key statement is, "The new Research Partnerships program will be more flexible and responsive to our community." Some details are; It will accommodate a broader range of partner organizations, including industry, government, and the non-profit sector.; The new program will comprise incentives for collaborations with small and medium-sized companies and for value-chain and multi-sectoral partnerships.; The new program will also offer an accelerated means for projects to scale-up and grow, based on their potential impact and the increased engagement of partners.; While the new program will include these many new features, participants familiar with NSERC's current partnerships grants will find that the new proposed program would support many of the same kinds of collaborations as the grants that it will replace.

NSERC is clearly trying to help industry take advantage of expertise in Canadian Universities and Colleges and we, both faculty and industry, should be seeking to make more use of these opportunities in ARR.

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## 1) Industry interests, activities and needs for ARR.

Many industries need information on weather and climate. Much of this information (weather forecasts, hourly, daily and seasonal, and archived and processed climate data) is provided by ECCC, NOAA/NWS and other federal and provincial government agencies. There are however needs for "value added" forecasts and analyses, for additional measurements, and for a variety of ways to process and provide information both to specific customers and to the public. A number of engineering and consulting companies, including some University groups, provide detailed weather and climate services. These include site specific road weather measurements and forecasts, specialized forecasts for aviation, hydrological information, wind and solar energy resource assessments, services to the agricultural sector and regional climate predictions. The Weather Network (Pelmorex Inc.) provide public forecasts through television, cellphone apps and web sites.

Some of the commercial organizations involved in atmospheric related activities (ARA) conduct some ARR in house and/or support ARR in Universities or other organizations. We would like to see more!

#### 2) Opportunities for collaborative research

There are a number of ways in which collaborative ARR can be helped by government funding. These include NSERC Engage, CRD and Strategic, MITACS and provincial support

Search Criteria			_	_		_	
Fiscal Year From:	2016-2017						
Fiscal Year To:	2016-2017						
Area of Application:	Earth sciences Alternative energy resources Climate and atmosphere Environment						
Reasearch Subject:	Atmospheric chemistry (including air pollution) Atmospheric science Biometeorology Boundary layer Climatology Dynamic meteorology						
By Institutions:	All						
Add or Modify Criteria	New Search						
Program		Number		Amount		Average Award (\$)	
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DISCOVERY RESEARCH							
Climate Change and Atmospheric Research		4	4.76%	3,461,545	49.58%	865,386	
Discovery Grants Program - Individual		61	72.62%	2,343,766	33.57%	38,422	
Discovery Grants Program - Northern Research Supplement		4	4.76%	70,000	1.00%	17,500	
Research Tools and Instruments		6	7.14%	683,736	9.79%	113,956	
	Subtotal:	75	89.29%	6,559,047	93.95%	87,454	
RESEARCH PARTNERSHI	PS						
Applied Research and Development Grants - Level 1		1	1.19%	24,210	0.35%	24,210	
Collaborative Research and Development Grants		1	1.19%	66,000	0.95%	66,000	
Engage Grants Program		5	5.95%	125,000	1.79%	25,000	
Industrial Research Chai	Industrial Research Chairs		1.19%	150,000	2.15%	150,000	
Strategic Projects - Grou	p	1	1.19%	57,000	0.82%	57,000	
	Subtotal:	9	10.71%	422,210	6.05%	46,912	
Total		84	100 00%	6 081 257	100 00%	83 110	

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Search Criteria						
Fiscal Year From:	2017-2018					
Fiscal Year To:	2017-2018					
Area of Application:	Earth sciences Alternative energy resources Climate and atmosphere Environment					
Reasearch Subject:	Atmospheric chemistry (including air pollu Atmospheric science Biometeorology Boundary layer Climatology Dynamic meteorology	tion)				
By Institutions:	All					
Add or Modify Criteria	New Search					
Program		Number		Amount		Average Award (\$)
		N	%	\$	%	5
DISCOVERY RESEARCH						
Climate Change and Atmospheric Research		4	6.56%	1,876,509	45.38%	469,127
Discovery Grants Program - Accelerator Supplements		2	3.28%	77,501	1.87%	38,751
Discovery Grants Program - Individual		47	77.05%	1,984,454	47.99%	42,222
Discovery Grants Program - Northern Research Supplement		5	8.20%	87,170	2.11%	17,434
	Subtotal:	58	95.08%	4,025,634	97.36%	69,407
RESEARCH PARTNERSHIPS						
Collaborative Research and Development Grants						
Collaborative Research and	Development Grants	1	1.64%	66,000	1.60%	66,000
Collaborative Research and Engage Grants Program	Development Grants	1	1.64% 3.28%	66,000 43,357	1.60% 1.05%	66,000 21,679
Collaborative Research and Engage Grants Program	Development Grants Subtotal:	1 2 3	1.64% 3.28% <b>4.92%</b>	66,000 43,357 <b>109,357</b>	1.60% 1.05% <b>2.64%</b>	66,000 21,679 <b>36,452</b>

Table 1: Sample results 2016-2017 and 2017-2018, from the NSERC awards database (http://www.nserc-crsng.gc.ca/ase-oro/index\_eng.asp) used for finding the details of federal government support.

programs. Information on some of these awards are at the web sites <u>http://www.nserc-crsng.gc.ca/Innovate-Innover/index\_eng.asp</u> <u>https://www.mitacs.ca/en/programs</u>

From Table 1 we can see that for 2016-2017 and using appropriate search criteria in atmospheric science, 9 Research Partnerships awards were made in that year, 5 of which were 6-month Engage grants. Other grants are mainly the annual contribution to multi-year grants (CRD, Industrial Research Chairs). The site can also provide details of individual awards. In addition to the NSERC contribution there will be industrial contributions, in cash and in kind, supporting all of these research projects. There were also 61 recipients of Individual Discovery Grants (\$2,343,766) for programs in Atmospheric Science in the same fiscal year, with an average of \$38,422.

Results for 2017-2018 using the same search criteria show only 3 Research Partnership awards (1 CRD and 2 Engage) and 47 individual Discovery Grants. It is disappointing to see these numbers going down. In 2015-2016 there had been 9 Research Partnership awards and 61 individual Discovery Grants, the same as 2016-2017, and at similar funding levels.

Over all fields of research supported by NSERC in 2016-2017 the average of 9,725 Discovery Grants was \$33,740 while for 2671 Industry related awards the average was \$59,259. The ARR ratio of Industrial/Discovery is slightly lower (0.23) than average (0.27). ARR was also supported in 2016/2017 and 2017/2018 by ECCC through the CCAR program. (7 awards at an average of \$778,923). These were mostly research networks rather than individuals.

Internships, adjunct professorships, use of university facilities/labs and data also provide opportunities for collaboration and should be encouraged.

## 3) Needs of industry for atmospheric science graduates, at BSc/BEng, MSc and PhD levels.

Despite public concerns over climate change and the apparent increase in intensity of severe weather events, the numbers of students applying for Atmospheric Science programs in Canadian Universities remains low, somewhat variable, and a concern to Deans and those who worry about University finances. In the past many graduates from these programs have been hired by ECCC as weather forecasters but ECCC recruitment has declined as numerical weather prediction models take over many of the routine forecasting duties. Human forecasters are still essential for short range severe weather analyses and forecasts but with the increased use of machine learning and artificial intelligence the need for traditional ECCC weather forecasters may decline even further. The MSC "Path Forward from 2018 to 2023" planning document however indicates new activities for forecasters in a positive way and we believe that ECCC will still need a strong base of well-trained atmospheric scientists. There should however be increased demands in industry as more and more weather and climate data become available through, for example, the new GOES East and West satellites incorporating the Advanced Baseline Imager, with 16 wavelengths and higher spatial and temporal resolution. A new weather radar network is being installed, higher resolution models are being run and data volumes are exploding. While computers can do most of the calculations, atmospheric scientists are needed to program the machines and, until everything is taken over by AI, to interpret the output,

### 4) Research Support

In Canada most ARRCU (Atmospheric Related Research in Canadian Universities) is supported by governments, Federal and Provincial. Some is industry related but much of that is supported in part by NSERC and MITACS. There is some ARR done in industry in Canada but many industrial activities that are dependent on weather, climate and related issues who should be more active in ARR.

While Government support, federal or provincial, is not a prerequisite for University-Industry collaboration it certainly helps and many of us have taken advantage of the opportunities created under this partnership scheme. With some exceptions such as software development and meteorological instrument development (in situ or remote) ARR in Canadian universities is mostly a mix of measurement and observation, running numerical models, with or without code modifications, and analyzing model output and measurements. This is generally done in order to better understand the way that the atmosphere, and its relationships with the oceans, lakes, rivers, plants and animals, "work" and to be able to better predict their behavior on a very broad range of time and space scales. The "industrial" or private sector component of ARR in the Canadian context is limited but there are opportunities and some very interesting areas where new applied research can be developed.

In order to increase the degree of industrial collaboration, university scientists involved in ARR need to look around and see how their interests can tie in with the needs of the industrial sector. From the other end, the "industry" needs to take a closer look at the research going on in universities and envisage how they could benefit from collaboration. Certainly some Canadian Industry partners have done this. The Canadian Meteorological and Oceanographic Society (CMOS) and its annual CMOS congress (in Halifax last year and in Montreal in July 2019, together with the Canadian Geophysical Union and the IUGG) provide an excellent opportunity for making these contacts. ARRCU is now a CMOS Special Interest Group and will play a role in expanding areas of collaboration, with both Industry and Government partners wherever it can. Weather and Climate will always be important factors in Canadian life and we need to make sure that Canadian universities and Canadian industry (and Canadian branches of multi-national companies) play their full part in ARR.

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