GOVERNMENT OF CANADA PROGRAM FOR INTERNATIONAL POLAR YEAR (IPY)
2009/10 PROGRESS REPORT

[Reporting Period: January 1, 2009 to March 31, 2010]

Project Title: **TAWEPI** - Thorpex Arctic Weather and Environmental Prediction Initiative	
Government of Canada Project Number: 2006-SR1-CC-088	**IPY International Project Number(s):** **638**
Project Website (if available): http://collaboration.cmc.ec.gc.ca/science/rpn/tawepi/en/index.html	

Principal Investigator

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Key Project Statistics

Number of :		Number of:	
Subprojects*	6	Publications – 2009	1
Team Members*	16	Publications – 2010 to date	1
Students*	0	Presentations – 2009	10
New Researchers*	2	Presentations – 2010 to date	3
Northern students*	0	Metadata archived in Polar Data Catalogue?	not yet
Northern participants*	0	Fieldwork in 2010	no
International collaborators*	1	Anticipated Project Completion Date	Aug 2010

** over the duration of the IPY project*

Project Team

Please complete this information for each member of the project team. This may include co-applicants, collaborators and other key contributors such as Elders and students. Add additional rows as necessary.

Name	Affiliation	Role (i.e., Co-applicant, Collaborator, Other key contributor, e.g. graduate student, Elder, technician etc.)	Contact Information (include email)	Please check box as appropriate box	
				Northerner	Internationally-based
Greg Flato	CRD / EC	Co-applicant	greg.flato@ec.gc.ca		
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Paul Vaillancourt	MRD / EC	Co-applicant	paul.vaillancourt@ec.gc.ca		
Louis Garand	MRD / EC	Co-applicant	louis.garand@ec.gc.ca		
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Nadja Steiner	CRD / EC	Research assistant	nadja.steiner@ec.gc.ca		

Please fill out each section below. The information provided will be used for the review of the progress of this project and to provide information for IPY Program publications, website and ongoing Program evaluation.

Recommended maximum length of the written report (sections 1-12) is 20 pages with the emphasis to be placed on Section 5: Results and Discussion.

1. Plain Language Summary

Provide a plain language summary of the project, including essential background information, purpose of the project, a description of the progress to date, key activities and early results. This summary will be made available to the public and should be written at a level appropriate for a popular magazine or newspaper. (500 words maximum)

Weather and Environmental Prediction (WEP) constitutes one of the most important technological and societal successes of the last century. The positive impact of WEP on health, safety and economic competitiveness is recognized worldwide. The benefit of WEP applications in polar regions has been somewhat delayed due the higher priority of forecasting in the more densely populated southern regions. Concerns about an amplification of anthropogenic climate change at higher latitudes combined with an increasing interest of the federal Government in exerting Canadian sovereignty throughout the Arctic requires a better understanding of weather and climate processes in this region so as to improve our ability to make reliable, quantitative predictions. The International Polar Year provides the important international context for a Canadian-led initiative to improve WEP capabilities for the Arctic.

The primary objective of TAWEPI is to develop and validate a regional Numerical Weather Prediction (NWP) model over the Arctic during the IPY observational period. The proposed experimental model, called Polar-GEM, is a twin of the Environment Canada (EC) operational regional GEM (Global Environmental Multiscale) model, used for one- to two-day weather forecasts. This initiative includes modelling research and data assimilation studies that will help enhance our weather and environmental forecasting capabilities in Polar Regions and improve our understanding of the Arctic and its influence on world weather. These research activities and studies are taking place in various research divisions of EC, in collaboration with the Canadian Meteorological Centre (CMC), the Canadian Ice Service (CIS), the Department of Fisheries and Oceans (DFO), various Canadian universities and other IPY projects.

TAWEPI's research activities started in April 2007 and large progress has been made in the development of Polar-GEM since then. A new version of the CMC regional NWP model became operational in the spring of 2009, including a northward extension of its high-resolution domain, which now covers most of the Arctic and shares various features with Polar-GEM. A research version of the model is being used to study the representation of radiative and cloud processes in weather forecasts. A multi-layer snow model coupled to sea-ice and blowing-snow parametrizations, describing processes over the various types of surfaces of the Arctic environment, such as sea-ice, tundra, glaciers and ice caps, was tested and evaluated. A methodology to validate model forecasts of cloud and radiation using satellite hyperspectral radiances was developed. Using a stratospheric extension of the GEM model, analyses of the stratosphere were extended and now cover the entire IPY period of 2007/2009, including estimates of the ozone field.

2. Key Messages/Results

a) Please provide 3 to 5 (maximum) plain language key messages in bullet form that highlight the main findings and achievements of the overall project.

- The development of TAWEPI's Polar-GEM model is taking place in collaboration with the Canadian Meteorological Centre (CMC).

- A new version of the CMC regional NWP model became operational in the spring of 2009. The new model includes a northward extension of its high-resolution domain covering most of the Arctic,

shares various features with Polar-GEM and represents the ideal platform for a future technology transfer from TAWEPI to the CMC.

- TAWEPI is a component the international IPY-THORPEX initiative, a research and development program created in response to weather related challenges of the 21st century, and aiming to accelerate improvements in the accuracy of 1-day to 2-week high-impact weather forecasts, for the benefit of society, the economy and the environment.

b) If applicable, please also provide 1 to 2 plain language key messages / results for each sub-project.

- S1.1 – Snow processes: A blowing snow model, called PIEKTUK, was incorporated into a snow/sea ice coupled system of the CMC forecast model, significantly improving the simulation of snow depth, of temperature at the snow/ice interface, and of the onset of ice melt.

- S1.2 – Arctic clouds: Various combinations of microphysical and radiative-transfer schemes were tested and compared in Polar-GEM simulations; their behaviour and benefit on the mean radiative and cloud properties were analysed.

- S2.2 – Validation and assimilation of satellite data from polar orbiting satellites: The revision and adaptation of the CO_2-slicing technique to get cloud parameters from AIRS (Atmospheric Infrared Sounder) was completed. This resulted in a slightly positive impact in data assimilation.

- S2.3 – Stratospheric analysis during IPY: Global atmospheric analyses of meteorological and physical variables as well as stratospheric chemical fields have been produced for Feb. 2007 – Feb. 2009 and uploaded to SPARC IPY public data base.

3. Introduction

This introduction to the project should briefly cover the rationale, overall project purpose and objectives, as well as linkages to other projects in Canada and internationally.

Background and Rationale:

In a significantly changing Arctic climate it will be more and more difficult to rely on traditional and climatological knowledge to predict day-to-day to seasonal environmental variability. Indeed, experienced elders and hunters who have been able to predict the weather for most of their lives are finding that recently their prediction skills no longer work and the weather changes they are witnessing are unprecedented. It will be essential to rely on science based forecasting technologies to reduce the impact of weather and related hazards on health, safety and the economy.

Objectives:

The primary objective of TAWEPI is to develop and validate a regional Numerical Weather Prediction (NWP) model over the Arctic during the IPY observational period. The proposed experimental model, called Polar-GEM, is a twin of the Environment Canada operational regional GEM (Global Environmental Multiscale) model, used for one- to two-day weather forecasts. This initiative includes modelling research and data assimilation studies that will help enhance our weather and environmental forecasting capabilities in Polar Regions and improve our understanding of the Arctic and its influence on world weather.

Linkages:

TAWEPI is a component the International IPY-THORPEX initiative. THORPEX is an international research and development program, created in response to weather related challenges of the 21st century, and aiming to accelerate improvements in the accuracy of 1-day to 2-week high-impact weather forecasts, for the benefit of society, the economy and the environment. THORPEX research topics include: global-to-regional influences on the evolution and predictability of weather systems; global observing system design and demonstration; targeting and assimilation of observations; societal, economic and environmental benefits of improved forecasts.

The development of the Polar-GEM model is taking place in collaboration with the Canadian Meteorological Centre (CMC). The development and coupling of the sea-ice model is being done through cooperation among EC, CIS and DFO. Various TAWEPI investigators are members or collaborators of other national and international IPY projects and programs, such as THORPEX-IPY, ArcticNet, the "Circumpolar Flaw Lead" (CFL) project, SPARC-IPY, STAR-IPY, and the project "Variability and Change in the Canadian Cryosphere".

4. Activities and Progress

Please identify the Northern regions in which the activities described below took place during the current reporting period:

☐ Yukon ☐ Nunavik
☐ Northwest Territories ☐ Nunatsiavut
☐ Nunavut ☒ Other: Quebec, Ontario, British Columbia

a) Please provide details about the project's progress towards meeting its goals during the current reporting period. Include information about where and when activities took place.

TAWEPI's research activities were planned as five PDF and one RA projects, taking place in three EC centres (in Dorval, Downsview and Victoria) dedicated to numerical weather prediction, data assimilation and climate modelling/diagnostics.

As described in previous reports, the research activities in some of TAWEPI's subprojects began later than the planned starting date (April 2007) – mostly due to delays in the approval of funds, in the selection process, and in visa related issues. Therefore, some of the 2-year subprojects, which were supposed to end in March 2009, continued for some more months – carry-forward funds have been managed internally (i.e. within EC). Details about the progress made so far are provided below, each of the remaining subprojects being discussed separately.

In the spring of 2009, the CMC implemented a new version of its operational regional NWP model (an initiative partly funded by LIEP-IPY). Among other changes, the new model includes a northward extension of its high-resolution domain thus covering most of the Arctic. It shares many features with TAWEPI's research model (Polar-GEM) and represents the ideal platform for a technology transfer from TAWEPI to the CMC.

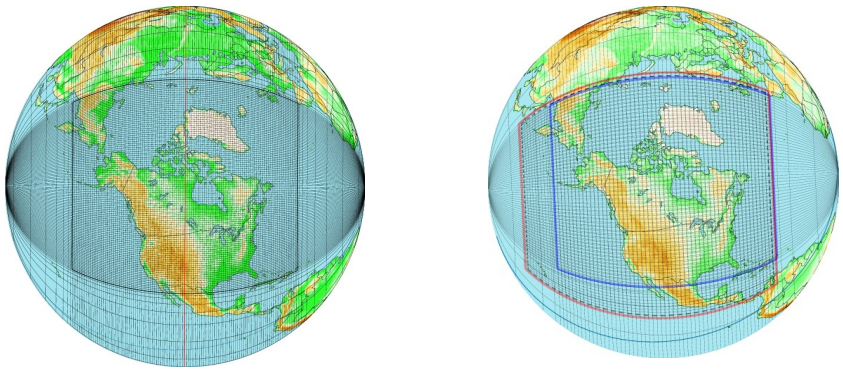

***Figure 1**: On the left: horizontal grid of the extended regional NWP model of the CMC, which become operational in the spring of 2009. On the right: the red line indicates the domain of the limited-area model that is expected to replace the CMC regional model, possibly in 2010.*

b) Describe how the IPY Northern Coordination Offices have assisted in the planning, coordination and/or delivery of any aspect of the project. Please identify the specific Northern Coordination Office(s) involved.

Not needed so far.

c) Discuss any issues and/or challenges encountered and how they have been addressed.

Subproject S2.2 – Validation and assimilation of satellite data from polar orbiting satellites

Post doctoral fellow (O. Pancrati) involved in this work had to terminate on January 31, 2010, having accepted a position elsewhere. However, all key results were already obtained.

Subproject S1.2 – Arctic clouds

Some challenges were faced during the adaptation of successive (new) versions of GEM's dynamics and physics packages to the POLAR-GEM environment. Numerical (computer time) cost of the numerous simulations over such a large domain and time period also posed some limitations.

5. Results and Discussion

a) Describe any results to date and their significance/impact with respect to the science for climate change impacts and adaptation and/or the health and well being of northern communities. Please include figures, graphs and tables. Should this project have produced any innovations in methods and/or technology, please describe those as well.

Results from each of the active subprojects are presented separately. They summarize the main modelling and data assimilation contributions from TAWEPI to the development of the Polar-GEM system and to Arctic-related research at the Meteorological Research Division of EC.

S1.1 - Snow processes

The NEW-RPN model, a coupled system including a multi-layer snow model (SNTHERM) and the sea-ice model currently used in MSC's operational forecasting system, was evaluated in a one-dimensional mode using meteorological observations from SHEBA's Pittsburgh site in the Arctic Ocean collected during 1997–98. Numerical results show that NEW-RPN exhibits better agreement in the timing of snow depletion, ice thickness and the temperature transition at the snow/ice interface in spring. The profiles of snow thermal

conductivity in NEW-RPN show considerable variability across the layers but the mean value (0.39 W m^{-1} K^{-1}) is within the range of reported observations for SHEBA and larger than the value of 0.31 W m^{-1} K^{-1} commonly used in single-layer snow models. Besides, the strong stratification of temperature in the snowpack estimated by NEW-RPN indicates that a multi-layer snow model is needed in the SHEBA scenario. A sensitivity analysis indicates that snow compaction is also a crucial process for a realistic representation of the snowpack with the snow/sea-ice system. Based on observations, it was hypothesized that the overestimation of snow depth by NEW-RPN could be related to other processes not included in the study, such as small-scale variability of snow depth and snow erosion due to wind blowing snow.

To pursue this last point, a one dimensional (1D) blowing snow model, called PIEKTUK, has been incorporated into a snow/sea ice coupled system. Intercomparison of simulations performed with and without this effect using the SHEBA observational dataset shows that including blowing snow for this particular numerical experiment significantly improves the simulation of snow depth, of temperature at the snow/ice interface, and of the onset of ice melt. Several sensitivity analyses have demonstrated that a threshold wind speed for blowing snow sublimation of 9 m s^{-1} better fits the SHEBA data for snow depth, ice thickness, and temperature at snow/ice interface. It also appears that drift particles range between 0 µm and 40 µm and extend to heights between 400 m (April to September) to beyond 1000 m (November to March). Accumulated blowing snow sublimation is found to be as large as 56 mm of snow water equivalent and leads to a decrease (9 cm in average) in snow depth. All this results in a shortening of the duration of snow cover above sea ice by approximately 4 days, with an earlier ice melt by approximately 6 days, a slight increase of 4 cm in average in ice thickness, and a temperature at snow/ice interface decrease of 0.4 K. The effect of blowing snow on internal characteristics of the snowpack such as grain size and density is found to be small.

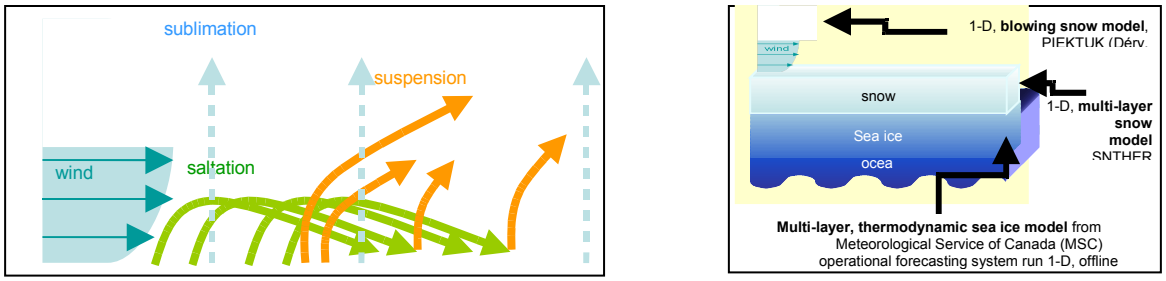

***Figure 2**: On the left: schematics of the various snow processes related to blowing snow. On the right: schematics of the three components of the NEW-RPN coupled sea ice / snow / blowing snow model.*

S1.2 – Arctic clouds

This subproject is dedicated to the development of the cloud and radiative transfer schemes and their interactions within the Polar-GEM modelling system. This system takes data from a global model – the numerical weather prediction model used operationally by Environment Canada – to provide lateral boundary conditions to the limited-area model called Polar-GEM, which covers the Arctic basin and includes northern parts of Canada, with a constant grid resolution of 15km approximately. Polar-GEM allows various options of microphysical schemes, such as the classical Sundqvist-like (Sundqvist, 1989) single moment microphysical scheme; and the Milbrandt and Yau (2005, hereafter M&Y) microphysical scheme, which can be used in its single, double or triple moment versions. Also available are two radiative transfer schemes, the one that was operational until 2009 and the recently implemented scheme based on a k-correlation method (Li and Barker, 2005). The M&Y scheme is of particular interest, as it provides much more detailed description of microphysical and precipitation processes than the previous one, using six hydrometeor classes and explicit representation of their number concentration, improving the realism of cloud processes.

During this period covered by this report, the following tasks were completed:

- Various simulations of high resolution (10km) over an extended domain (down to 45°N lat.) of cloud and radiative properties centred on the North Pole for the evaluation and validation of a new retrieval scheme (in cooperation with L. Garand and O. Pancrati). These simulations will also be

used within a demonstration for the Canadian double satellite Polar Communications & Weather (PCW) / PolarSat mission (http://www.asc-csa.gc.ca/fra/satellites/pcw/default.asp).

- Implementation of a comprehensive and coherent link between cloud microphysics, especially in the double moment version of the M&Y scheme and the optical properties of cloud used in the CCCMARAD radiative transfer scheme. This link takes into account the mixing ratios, number concentrations, probability distribution functions, typical shapes and phase of each hydrometeor class provided (or not) by the microphysical scheme. Significant impact on radiative fluxes, radiative budget and heating rates are expected. Analyis of simulations results still in progress.
- Correction of the calculation of the radiative properties of cloud ice and snow particles in CCMARAD based on the Fu (1996) and Fu and Liu (1993) parameterization for both visible and infrared spectrum. Noticeable differences were found between the coefficients describing the radiative parameters in the GEM code and the original papers. The corrections can be significant in some parts of the visible and far-infrared part of the spectrum, but have little impact on broad-band flux calculation at surface and top of atmosphere.
- Demonstration of the high impact of small ice particles sedimentation with M&Y microphysical scheme on cloud amounts, cloud fraction and surface precipitations. Although thought to be negligible, small ice particle sedimentation is a key factor controlling the cirrus-like cloud behaviour. When not taken into account, this prevents size sorting of particles and growth of ice particles, significantly decreasing precipitations, and leads to an unrealistic large amounts of overcast cirrus clouds through the major part of the POLAR-GEM domain.
- In M&Y schemes, it has been found that the parameterization of water vapour diffusion on ice particles, based on the “capacity” approach is a key parameter controlling the solid/liquid and mixed phase partition of polar clouds. A corrective capacitance factor of 0.5 taking account of complex ice particle shape appears to be suitable.
- Impact of time step duration: All three microphysical schemes appear to be highly sensitive to the time step duration in terms of precipitations and, in a lesser extent, of cloud liquid condensate amounts. Essentially, the surface precipitation increases as the time step duration decreases. Comparisons with available observations from the Global Precipitation Climatology Project (GPCP, http://precip.gsfc.nasa.gov/) show a good agreement with SUNDQVIST results using typical 450s time step, and very good agreement with M&Y double moment scheme using 60s time step.
- Presentation of TAWEPI subproject 2 results as a demonstration of potential fallout for the kick-off of the Polar Precipitation Mission / Earth Explorer 8, Feb 8-10 2010, together with Jason Milbrandt, EC/RPN.

References:

Fu, Q., 1996: *An accurate parameterization of the solar radiative properties of cirrus clouds for climate models*. J. Climate, **9**, 2058–2082

Fu, Q. and K. N. Liou, 1993: *Parameterization of the radiative properties of cirrus clouds*. J. Atmos. Sci., **50**, 2008–2025.

Milbrandt, J. and P. Yau, 2005: *A Multimoment Bulk microphysical Parameterization. Part I: Analysis of the role of the Spectral Shape Parameter*, J. of Atmos. Sci., vol.**62**, pp.3051-3064.

Li, J. and H.W. Barker, 2005: *A radiation algorithm with correlated k-distribution. Part I: local thermam equilibrium*. J. Atmosp. Sciences, **62**, 286-309.

Sundqvist, H.E. and J.E. Kristjansson, 1989: *Condensation and cloud parameterization studies within a mesoscale numerical weather prediction model*. Mon. Wea. Rev. **117**, 1641-1657.

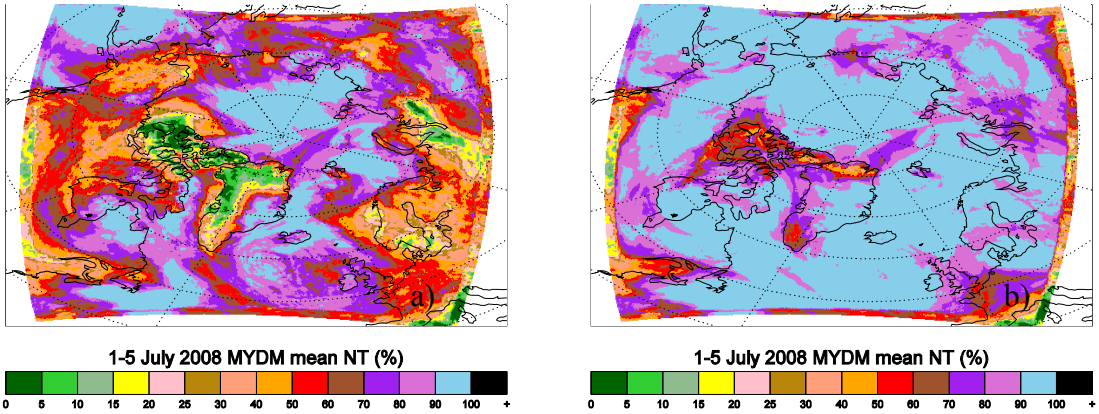

***Figure 3**: Five-day averaged cloud cover (in %) with (left) and without (right) small ice particle sedimentation using M&Y double moment microphysical scheme over the POLAR-GEM domain*

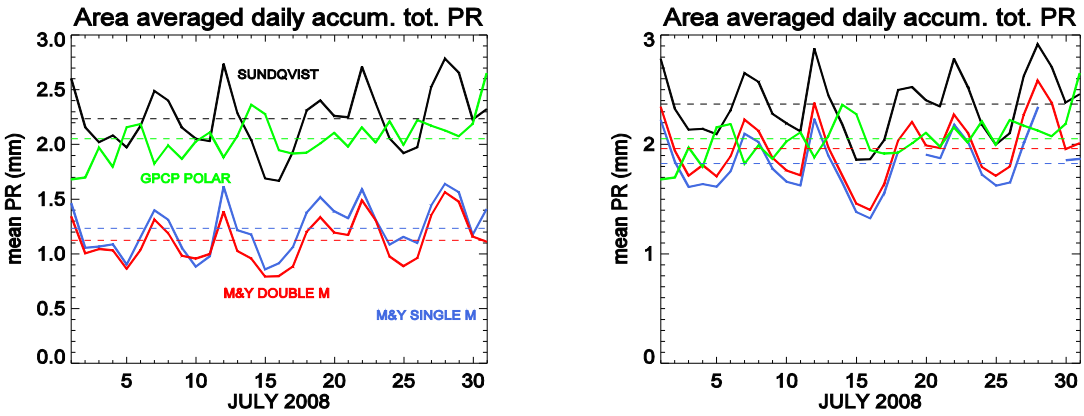

***Figure 4:** Comparison of daily total precipitations averaged over POLAR-GEM domain using SUNDQVIST (black), M&Y simple (blue) and double moment (red) with available observations (GPCP, green), with a time step of 450s (left) and 60s (right).*

S2.2 – Validation and assimilation of satellite data from polar orbiting satellites

The revision and adaptation of the CO_2-slicing technique to get cloud parameters from AIRS (Atmospheric Infrared Sounder) was completed. This resulted in a slight positive impact in data assimilation. A bias correction to the height retrievals was implemented, based on both simulated retrievals and real ones compared to lidar observations from CALIPSO. Then the validation methodology was applied to the whole month of July 2008 for 6-h and 12-h global forecasts launched every 6-h (124 forecasts for the month). That methodology is based on comparing cloud height and amount distributions from both real and simulated radiances using the CO_2-slicing technique, as well as directly from model output. Results vary by region, but in general the model tends to have too many low-level clouds at the expense of middle-level clouds. This suggests either modifying cloud optical properties or cloud parameterizations. Monthly maps were produced from the 124 forecasts. Comparisons were made between observed and forecast cloud parameters. Independent retrievals from MODIS and the AIRS science team at JPL (Jet Propulsion Laboratory) were also studied. While patterns are in good agreement, significant differences are found, which can be explained by the differing retrieval approaches. Deficiencies of the model were clearly identified, notably in polar areas and for extended stratocumulus regions west of continents. Differences between 6-h and 12-h forecasts were not significant, which is indicative that the model does not suffer from a significant spin-up problem. These and more findings will be described in an upcoming paper. Overall, a sound model

validation methodology was developed, which can be easily adapted to various infrared sounders, notably IASI. It was demonstrated that cloudy radiative transfer computations are sufficiently realistic to be used for the evaluation of retrieval techniques from simulated radiances.

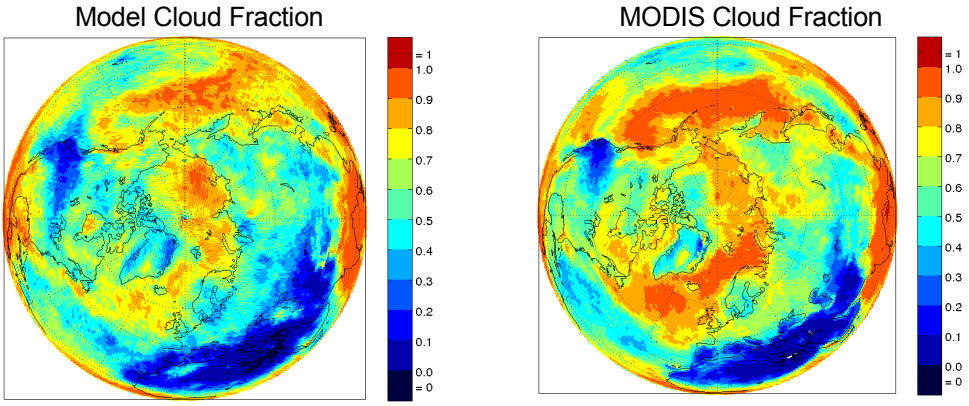

***Figure 5**: Comparison between could fraction fields over the Arctic averaged over July 2008: (left) generated by the CO2-slicing method, and (right) data from the MODIS satellite science team.*

S2.3 - Stratospheric analysis during IPY

Complete global atmospheric analyses of meteorological and physical variables as well as stratospheric chemical fields have been produced for the entire IPY period, Feb. 1, 2007 – Feb. 29 2009. A comparison study involving ground-based trace gas measurements demonstrated the high quality of the analysed chemistry distributions and variability (collaboration with University of Toronto).

b) Beyond the scientific research community, describe how the results of this research:
   i) are currently being used by others such as government programs, policy makers, communities, etc.
   ii) are going to be used by others such as government programs, policy makers, communities, etc., and/or
   iii) could be used by others such as governmental programs, policy makers, communities, etc.

To develop the Polar-GEM model TAWEPI investigators worked closely with the Canadian Meteorological Centre (CMC), Environment Canada. This collaboration has been one of the most important aspects of TAWEPI. In 2009, a new version of the CMC's regional model became operational. This is the model that generates short-term forecasts (up to 48 hours) for the entire country. One of the main changes in this model was a northward extension of its central domain (the higher-resolution area indicated in Figure 1), which now covers most of the Arctic basin. This provides an ideal platform for future transfer of research findings and improvements proposed by TAWEPI researchers.

TAWEPI investigators expect that all of the modelling projects and data assimilation studies of TAWEPI will further the development of the Polar-GEM system. They expect to transfer results from this experimental system to the CMC. This process of WEP research and development should provide improved day-to-day forecasting with a much improved representation of Arctic weather and environmental trends.

The TAWEPI project responded to a clear need for improved weather and environmental forecast capabilities for the Arctic. This was a known but accepted limitation; forecasting in more densely populated

southern regions had been the priority. Through TAWEPI funding, the IPY provided an opportunity to measure and better understand the deficiencies and propose improvements.

c) Please list any NEW publications and posters/presentations given at conferences that are directly related to this project. "New" is defined as anything published or presented since the last IPY Annual Progress Report. Publications should include peer-reviewed articles, but can also include articles published in popular magazines/literature, and grey literature reports (technical and non-technical).

Peer Reviewed Publications:

Chung, Y.-C., S. Bélair, and J. Mailhot (2009): *Simulation of Snow on Arctic Sea Ice Using A Coupled Snow/Ice Model. Journal of Hydrometeorology*. Journal of Hydrometeorology, **11**, 199-210.

Deacu, D., A. Zadra and J. Hanesiak (2009): *Simulating wind channeling over Frobisher bay and its interaction with downslope winds during the 7-8 November 2006 wind event*. Atmosphere-Ocean, in press.

Other Publications:

Buehner, M. and A. Mahidjiba (2009): *Sensitivity of global ensemble forecasts to the initial ensemble mean and perturbations: Comparison of EnKF, Singular Vector and 4D-Var approaches*. Submitted to Monthly Weather Review.

Garand, L., O. Pancrati, and S. Heilliette (2010): *Validation of forecast cloud parameters from multi-spectral AIRS radiances.* In preparation.

Environment Canada's International Polar Year 2010 Achievements Report: a report based on material from five IPY projects led by Environment Canada's scientists, including TAWEPI.

Presentations:

2009 Pancrati, O., L. Garand and S. Heilliette
Hyperspectral model validation in cloudy radiance space from AIRS
16th Conference on Satellite Meteorology and Oceanography
5th Annual Symposium on Future Operational Environmental Satellite Systems – NPOESS and GOES-R, Pheonix (AZ), Jan 2009
Poster presentation by O. Pancrati

2009 Nordeng, T. E. et al.
IPY-THORPEX Cluster
3rd Thorpex Science Symposium, Monterey (CA), USA, May 2009
Oral presentation by T. E. Nordeng.
Including contribution on TAWEPI (slides prepared by A. Zadra)

2009 Zadra, A.
TAWEPI: an overview of modelling and data assimilation activities
Canada-Finland Workshop, Montreal (QC), May 2009
Oral presentation by A. Zadra

2009 Zadra, A.

TAWEPI: and update on modeling and data assimilation activities
2009 CMOS Congress, Halifax (NS), June 2009
Oral presentation by A. Zadra

2009 Deacu, D., A. Zadra and J. Hanesiak
Simulating wind channeling over Frobisher Bay and its interaction with downslope winds during the 7-8 November 2006 wind event
2009 CMOS Congress, Halifax (NS), June 2009
Poster presented by A. Zadra

2009 Pancrati, O., L. Garand and S. Heilliette
Model validation of cloud and radiation from the Atmospheric Infrared Radiance Sounder (AIRS)
2009 CMOS Congress, Halifax (NS), June 2009
Poster presented by O. Pancrati

2009 Zadra, A.
TAWEPI: a summary of modeling and data assimilation activities
MOCA-09 Joint Assembly, Montreal (QC), July 2009
Oral presentation by A. Zadra

2009 Chung, Y.-C., S. Belair, J. Mailhot and A. Zadra
The impact of blowing snow on Arctic sea ice and snow: results from an improved sea-ice / snow / blowing snow coupled system
MOCA-09 Joint Assembly, Montreal (QC), July 2009
Poster presentation by Y.-C. Chung

2009 Liu, Z., J. Hanesiak, R. Martin, R. Goodson, R. Steward, D. Deacu and A. Zadra
Case study of GEM-LAM over Southern Baffin Island
MOCA-09 Joint Assembly, Montreal (QC), July 2009
Poster presentation by Z. Liu

2009 Y.-C. Chung
Snow evolution over mid-latitudes and Arctic regions
Department of Hydraulic Engineering, Civil Engineering, National Taiwan University, Taipei, Taiwan

2010 F. Chosson, P. Vaillancourt and J. Milbrandt
Modelling polar clouds
Oral presentation for the kick-off of the Polar Precipitation Mission/Earth Explorer 8
McGill University, Montreal (QC)

2010 O. Pancrati, L. Garand and S. Heilliette
Validation of forecast cloud parameters from multispectral AIRS radiances
Internal Seminar, Canadian Meteorology Centre, Dorval (QC)
Oral presentation by O. Pancrati

2010 A. Zadra

Overview of recent NWP projects at RPN/Environment Canada: forecast of tropical cyclones, modelling of boundary layer, sensitivity studies in the Arctic
UK Meteorology Office, Exeter, UK, March 2010
Oral presentation by A. Zadra

d) Please describe your activities (past, current, and planned) to integrate/synthesize results of this project, including activities within different project components, with other projects (IPY or other), both on a national and international scale.

In the summary of results in section 5a above, one can find examples of integration among the various components of TAWEPI; in particular, between subprojects S1.2 (modelling of polar clouds) and S2.2 (data assimilation of polar orbiting satellite data).

The collaboration with the Canadian Meteorological Centre also illustrates the integration of results: the eventual transfer of TAWEPI's findings to operational weather forecast systems remains one of our main objectives. For example, one of the data assimilation techniques (C02-slicing for assimilation of satellite data) revised and adapted through subproject S2.2 is expected to become operational in the Canadian global weather forecast system in 2010.

Within the various Canadian IPY projects, TAWEPI's lead applicant (A. Zadra) is an active collaborator of:

- CFL-IPY: subproject on modelling of Arctic boundary layer and its interaction with sea-ice; contact/lead J. Hanesiak (Univ. Manitoba); ongoing project
- STAR: subproject on high-resolution modelling of storms in the Arctic; contact/lead J. Hanesiak (Univ. Manitoba); ongoing project
- OASIS: validation of model data against Arctic boundary layer observational data; contact Ralf Staebler; planned project

At the international level, the integration of TAWEPI's research is coordinated by THORPEX-IPY (http://www.ipy-thorpex.no/en/the-research) and includes contributions to other THORPEX-related initiatives such as NA-THORPEX (http://www.ucar.edu/na-thorpex).

e) How is this project integrating Traditional Knowledge?

Not applicable so far.

6. Data Management

a) Briefly list and describe, including size (ie. mb, Gb), the data set(s) collected, generated and/or used during the current reporting period.

In TAWEPI, most of the data generated correspond to weather data produced by computer models. A typical 48-h forecast of the Polar-GEM model may have up to 10 Gb of data. Considering the various experiments and simulations conducted by the various subprojects of TAWEPI, the total amount of data might be of the order of a several Tera-bytes.

b) List all metadata records that have been submitted to the Polar Data Catalogue. Include title of metadata record and submitter's name. Please indicate whether this list reflects all metadata to be submitted by this project or whether more metadata should be expected to be submitted in the future.

Not yet submitted.

c) To which data centre(s) has and/or will this project's data be sent?

Most data and metadata generated by TAWEPI modelling activities will be archived at the CMC, as described in the original proposal.

Regarding subproject S2.3 (Stratospheric analysis during IPY): A copy of the stratospheric analyses has been provided to the SPARC-IPY database.

d) Identify the project team member(s) responsible for managing the data for this project.

Jocelyn Mailhot (RPN/EC) is responsible for the development of the Polar-GEM model.

Louis Garand (ARMA/EC) is responsible for the data assimilation projects in TAWEPI.

e) Describe the process used or to be used in making these data available to other IPY researchers, policymakers and/or the public.

As mentioned above, data generated by TAWEPI modelling activities consist in numerical forecast output data, which are archived at the CMC, and are available upon request – as described in TAWEPI's original proposal.

For subproject S2.3 (Stratospheric analysis during IPY) in particular, a complete copy of the stratospheric analyses has been provided to the SPARC-IPY database. Access may be obtained by contacting the SPARC Data Center, at the following URL:
http://www.sparc.sunysb.edu/html/user_ipy.html

f) If applicable, please list any requests for data or information that have been received. If possible, note from whom the request came, their affiliation and the type of data requested.

No requests so far.

7. Training and Capacity-Building

a) Describe the education and training opportunities, both formal and informal, provided through this project during the current reporting period. Please describe any unique initiatives and/or events that occurred. Also, please include the extent to which Northerners and Aboriginal people have benefited from these opportunities. Please indicate how many individuals were involved in each activity and the type of training provided.

Thanks to the training opportunity provided by TAWEPI, yet another one of our post-docs, namely Dr. Ovidiu Pancrati, has recently been offered a position elsewhere.

b) Students and New Researchers

Please provide information about the students and new researchers[1] who have participated in this project during the current reporting period using the table below.

Note: Students and new researchers listed below may also be listed as project team members on page 1 of this report. Any students and new researchers listed as project team members on page 1 MUST also be listed below.

This information will be used by the IPY Federal Program Office to determine the level of involvement of students and new researchers in IPY projects and, at the completion of IPY, to assess whether these students continue in Northern research or other science fields beyond IPY. The data collected in this table will only be used by the IPY Federal Program Office and the Science Review Boards. No information that identifies an individual or which could be used to deduce the identity of an individual will be released to the public. Any statistical data derived from this information will only be released to the public in aggregate form. Provision of information marked with an asterisk (*) is voluntary. Under the *Privacy Act*, the individual to whom the information pertains has rights of access to, and protection of, the personal information provided.

Add additional rows as necessary.

Name*	**Affiliation and contact information***	**Student**	**Northern student[2]**	**New Researcher**	**If Student: Education Level currently being sought**	**If New Researcher: Highest Education Level Achieved**	**Nature of Involvement** (Indicate the type of activity each individual undertook)	**Time** (indicate approx. time devoted to IPY project activities during current reporting period)
Yi-Ching Chung	MRD / EC yi-ching.chung@ec.gc.ca			x		PDF	full-time investigator	since Aug 2007
Frederick Chosson	MRD / EC frederick.chosson@ec.gc.ca			x		PDF	full-time investigator	since Apr 2008

New researchers are individuals who are younger than 30 **OR** who have less than 10 years northern research experience. A new researcher is not a student

Northern students are individuals who originate from the North or whose permanent residence is in the North and who are enrolled in a formal education or training program. For the purposes of the IPY Program, the North is

1.
2

defined as the three Territories as well as the northern parts of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Newfoundland and Labrador.

8. Northern Community Engagement

Describe how this project has engaged Northerners, northern communities and Aboriginal organizations (e.g., consultation, partnerships, membership on project team, outreach activities, etc.). In addition, please fill out the tables below.

Not applicable so far.

This information will be used by the IPY Federal Program Office to determine the level of involvement of Northerners in IPY research projects. The data collected in these two tables will only be used by the IPY Federal Program Office and viewed by peer-reviewers. No information that identifies an individual or which could be used to deduce the identity of an individual will be released to the public. Any statistical data derived from this information will only be released to the public in aggregate form. Provision of information marked with an asterisk (*) is voluntary. Under the *Privacy Act*, the individual to whom the information pertains has rights of access to, and protection of, the personal information provided.
Add additional rows as necessary. These tables must include all northerners listed on page 1 under Project Team.

INDIVIDUALS:

Name* (if applicable)	**Community, Institution or Affiliation**	**Nature of Involvement** (indicate the type of activity)	**Time** (indicate duration)

GROUPS:

Group Name* (if applicable)	**Approx. Group Size**	**Community, Institution or Affiliation**	**Nature of Involvement** (indicate the type of activity)	**Time** (indicate duration)

9. Communication and Outreach

a) Describe any communication and outreach activities and products developed to date, for example community consultations, presentations, websites, posters etc. Please provide copies of any communications materials developed to the IPY Federal Program Office, if possible.

TAWEPI has a bilingual website:
http://collaboration.cmc.ec.gc.ca/science/tawepi/en/index.html
http://collaboration.cmc.ec.gc.ca/science/tawepi/fr/index.html
where the main objectives and structure of the project are described.

In May 2009 Dr. Gilbert Brunet was interviewed by Global TV, which was preparing a short movie/vignette about Arctic weather and numerical weather forecasts.

b) From your perspective, what are/have been some of the successes and/or challenges associated with your project's communication and outreach activities?

An important human concern in today's world is the knowledge to allow Canadians, and especially northern residents, to adapt to climate change. As a whole, the IPY research is advancing the knowledge required for adaptation. But in particular, the environmental forecasting and monitoring projects will provide the needed day-to-day information. Results of the TAWEPI project should improve our weather forecasting capabilities in the north.

Due to the nature of TAWEPI's activities – complex scientific projects involving computer simulations and numerical forecasts, conducted in Environment Canada's centres where supercomputers are available – communication and outreach has so far been limited to presentations to the scientific community.

The transfer of findings from a research project (such as TAWEPI) to Environment Canada operational systems, such as the operational forecast model of the Canadian Meteorological Centre, often takes time (3 years or more) to be completed. Therefore TAWEPI's legacy, i.e. improvements to our weather forecast capacity in Arctic regions, may become visible only a few years from now.

c) How might the IPY Federal Program Office / IPY Northern Coordination Offices be able to assist in communicating the progress and results of this project to northern communities and beyond?

Given the nature of their work, TAWEPI's scientists don't have the opportunity nor the training needed to communicate directly with the northern communities. The IPY Federal Programme Office might suggest suitable ways to communicate our results.

10. Upcoming Activities

Describe the work that will be carried out in the next fiscal year (April 1, 2010 to March 31, 2011) and any expected changes that will be made to the project as compared to the originally approved project proposal and any financial implications of these changes.

Due to the late arrival of some PDFs, two projects are slightly behind schedule, and their work will be extended for a few months. Otherwise, there are no major deviations from the original plans and all projects should be completed by August 2010.

11. Revenue and Expenditures

a) Please complete the *2009/10 Statement of Revenue and Expenditures* using the template and worksheets that have been provided. The template and worksheets cover actual expenditures from April 1, 2009 to March 31, 2010. In the space provided below, please outline any unspent funds from 2009/10.

Please note:

1. If the funding for this project flows through a Contribution Funding Agreement with Indian and Northern Affairs Canada, completing this section and the accompanying worksheets DOES NOT FULFILL the financial reporting requirements as laid out in Part E of the associated Contribution Funding Agreement, which indicates that a fiscal year-end Financial Report confirming total expenditures is required by July 29, 2010.

2. Any requests to carry-forward funds must be sent directly to the IPY Federal Program Office through a separate and detailed email/letter and should also be noted in this progress report. The ability to carry-forward funds depends on the funding mechanism under which a project is being funded and is not always possible.

Please see worksheets (to be submitted by April 30, 2010) for details.

b) Explain any deviations from the previously approved budget and how they will be addressed.

In the approved budget of TAWEPI, the IPY funds received for the third and last year (April 2009 to March 2010), that is $116,000 correspond to the salary and travel expenses of two PDFs ($56,000 for salary and $2,000 for travel, per PDF).

For fiscal year 2009/2010, the approved IPY funds ($116,000) were received by EC, according to a provisional allocation among two co-applicants: Ayrton Zadra and Pierre Gauthier. Please notice that Pierre Gauthier was replaced by Louis Garand, as stated in previous reports. Also the amount corresponding approximately to one year of salary was carried forward into the 2009/2010 fiscal year, to pay for the salary of the PDF Frederick Chosson who started his project 12 months behind schedule. Following recommendations given at the IPY Workshop in Gatineau in Oct 2007, funds have been re-profiled and managed internally (i.e. within EC) when needed.

c) Describe all additional cash contributions in support of this project, their sources and amounts.

Some cash contributions are different from those in the original proposal, to accommodate carry-forward funds from the previous fiscal year.

Please note: The overhead / administrative amounts listed in the original budget are contributions from MRD/EC, and correspond to the standard administrative costs associated with PDFs at EC. No IPY funds are used for this.

d) Describe any in-kind contributions made in support of the project, their sources and estimated values.

In-kind contributions are those described in the original proposal, there were no additional contributions.

e) Please estimate the project expenditures spent in each of the following regions during the current reporting period (if applicable):

Yukon: $_____ Nunavik: $_____
Northwest Territories: $_____ Nunatsiavut: $_____
Nunavut: $_____ Other (Quebec, Ontario, B. Columbia):
$ 167,000 .