



Canadian Foundation for Climate  
and Atmospheric Sciences (CFCAS)  
Fondation canadienne pour les sciences  
du climat et de l'atmosphère (FCSCA)

## 2007 DRI Progress Report

**Project Title:** Quantifying Agricultural Drought in Western Canada

**Investigator:** Paul Bullock

### 1.0 Progress (beginning January 2007 to end December 2007)

1.1 Describe progress towards meeting the project objectives for those theme areas where you have received funding for 2006-2007. How are the original milestones being met (be specific)? List the key objectives and results achieved to date as well as any relevant application(s) of the results.

#### 1.1.1 Objectives

The overall objective of the Drought Network Initiative (DRI) is *to better understand the physical characteristics of and processes influencing Canadian Prairie droughts, and to contribute to their better prediction, through a focus on the recent severe drought that began in 1999.*

To address this overall objective, the Network is focussed on complementary and cross-cutting research objectives that correspond to the following themes:

#### 1. Theme 1: Quantify the physical features of this recent drought:

- a) spatial and temporal features,
- b) flows of atmospheric and terrestrial water and energy into and through the region, and their storage and redistribution within the region.

- A MSc student, Mark Gervais, started a two-year project in January 2007 that will focus on improving the accuracy of the 2<sup>nd</sup> Generation Prairie Agrometeorological Model (PAM2nd). The project will help improve model estimates of potential and actual evapotranspiration over agricultural surfaces.
- Assimilation of data generated from a NSERC Strategic project has been completed.
- Baseline model results have been generated in preparation for testing.
- Various strategies for model improvement have been identified.

#### 2. Theme 2: Improve the understanding of the processes and feedbacks governing the formation, evolution, cessation and structure of the drought.

NA

#### 3. Theme 3: Assess and reduce uncertainties in the prediction of drought and its structure.

NA

## 1.2 Describe your plans for research during the coming year and the following year and outline how the expected results will support the deliverables and goals of DRI.

### i) PAM2nd Model testing and improvement

A series of potential modifications for the PAM2nd model will be tested against field observations from a previously-collected dataset of soil moisture and wheat crop phenological observations (NSERC Strategic project). The ultimate goal is to improve the modeled soil water and actual evapotranspiration output and lower the RMSE based on the observed values to improve confidence in the model results and its use for drought monitoring.

### ii) Agricultural drought characterization, 1999-2004

The PAM2nd model outputs have been shown to be well correlated to crop performance, specifically yield and quality of spring wheat. Another phase of the research can utilize these relationships to characterize the spatial extent and intensity of agricultural drought over the period of interest using weather data from the drought period as model input. In addition, the meteorologically-based drought characterization can be combined with a satellite-based characterization to exploit the strengths of full spatial coverage. The first need for this initiative is identifying an appropriate graduate student or HQP to carry out the research.

## 2.0 Impact

### 2.1 Describe the significance / impact of the results achieved to date and how this new knowledge has influenced research policy, enhanced research collaboration or competitiveness, or helped attract or train skilled personnel.

Address the following items, as appropriate:

- **The impact of the project on government policy development (federal, provincial or municipal);**
- **How the project has expanded contacts in partner organizations, or increased cross-disciplinary cooperation;**
- As a result of the work on this model, the Canadian Wheat Board has expressed an interest in utilizing it as a tool to generate soil moisture estimates for the prairies using their real-time weather network for input.
- MAFRI has expressed an interest in using the model to generate soil moisture estimates in potato fields as well as input for a disease risk estimate of sclerotinia in canola.
- **Whether and how it has improved the reliability of predictive methods;**
- Precipitation-based indices (e.g. % of normal rainfall, standardized precipitation index) are not strongly correlated to spring wheat yield or quality. However, moisture demand (i.e. potential evapotranspiration) is strongly related to wheat yield and quality. Therefore, testing and improvement of the PAM2nd model is useful and valuable for improving the accuracy of agricultural drought characterization.
- **The impact of the project on your own institution;**
- **Whether and how the project has helped increase funding from other agencies, or led to new partnerships;**
- Currently, a new proposal is being evaluated by the Canadian Grain Commission and the Canola Council of Canada, to do an assessment of weather impacts on canola

quality. The proposal is based on work already completed showing the relationships between growing season weather and wheat quality.

- **Any current (or potential) commercial or social applications, which the results may have;**
- Drought monitoring is normally performed using drought indices to provide decision makers with information on drought severity. In some cases, drought indices can be used to trigger drought contingency plans and financial support programs, if they are available. More accurate characterizations of agricultural drought will help improve the response to drought by various provincial and federal agencies by providing more accurate information on drought extent and intensity in terms of its agricultural impacts. This will facilitate a more appropriate level of response to drought and help to ensure that program payments are targeted most effectively to assist those most in need.
- **Links with international initiatives and the potential impact of these;**
- **Anticipated benefits of the work for Canadians.**

### 3.0 **Dissemination**

#### 3.1 **Provide information on dissemination of the research results (publications, including journal names and whether refereed), conference contributions, seminars, workshops or videos, websites or other methods of transferring the results.**

##### Written

Finlay, G.J., Bullock, P.R., Sapirstein, H.D., Naeem, H.A., Hussain, A., Angadi, S.V and DePauw, R.M. 2007. Genotypic and environmental variation in grain, flour, dough and bread making characteristics of western Canadian spring wheat. *Canadian Journal of Plant Science* 87: 679-690.

Saiyed, I., Bullock, P.R., Sapirstein, H.D., Finlay, G.J., and Jarvis, C.K. Heat unit models for estimating wheat phenological development and weather-based relationships to wheat quality. *Canadian Journal of Plant Science* (submitted 29 June 2007).

Bullock, P.R., Finlay, G.J. and Sapirstein, H.D. A preliminary assessment of evaporation as an agricultural drought index for spring wheat yield and breadmaking quality in western Canada. *Canadian Water Resources Journal* (submitted 23 November 2007).

##### Presentations

Gervais, M., Bullock, P.R. and Raddatz, R. A soil water budget approach to improving evapotranspiration estimates from the 2nd generation prairie agrometeorological model. *Drought Research Initiative Evaporation Workshop*, Saskatoon, Saskatchewan, May 2007.

Bullock, P.R. Agricultural drought indices. *Drought Research Initiative Evaporation Workshop*, Saskatoon, Saskatchewan, May 2007.

Bullock, P.R., Finlay, G.J., Jarvis, C.K., Sapirstein, H.D., Naeem, H. and Saiyed, I. Quantifying Agricultural Drought: An assessment using western Canadian spring wheat. *2<sup>nd</sup> Annual Drought Research Initiative Workshop*, Winnipeg, Manitoba, January 2007.