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

DROUGHT RESEARCH INITIATIVE
RÉSEAU DE RECHERCHE SUR LA SÉCHERESSE

Final DRI Progress Report

Project Title: SURFACE-ATMOSPHERE COUPLING DURING DROUGHT AND CONVECTIVE EVENTS

Investigator: JOHN HANESIAK

1.0 Progress (beginning January 2010 to end December 2010)

1.1 **Describe progress towards meeting the project objectives for those theme areas where you have received funding for 2010. 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:

My overall project objective has not changed over the past year.

Project Objective:
(1) examine the linkages between surface characteristics and other atmospheric forcing on deep convective activity (initiation and rainfall) during the drought period.

The methods to address objective 1 fall under Themes 1-3 (via characterizing the drought, improve process understandings and modeling experiments). The modeling work has already been completed in other years, hence, I am reporting on work done with regards to Themes 1 and 2.

Theme 1 & 2 *(Drought Characterization and Synthesis)***:**

I continue to lead the Theme 1 drought characterization and synthesis article that will appear in the DRI special issue. The original plan was to have a dedicated article to characterization only, however, the DRI leads and others have agreed that one article to address characterization and synthesis will be achievable. Much of the work in the past year has been successful by gathering a significant amount of material from DRI investigators and collaborators and beginning to synthesize what we have learned. This article is still in preparation, however, it should be submitted early in the new year (2011).

Theme 1 & 2 *(Drought Characterization and Improved Process Understanding)***:**

(related to Hanesiak Objective 1):

- We have completed an annual and monthly lighting analysis over the entire Prairies between 1999-2008 as part of the synthesis article. Lightning activity over both eco-zones (boreal forest and cropland) is seen to decrease as the drought evolves from the beginning to the mature stages and reaches a minimum during the transition stage between 2002 and 2004. Furthermore, as the drought enters the dissipating stage, lightning activity increases. These observations suggest that fewer severe storms might have occurred during the drought. This is consistent with hail and tornado occurrences/reports during the drought that were below normal. The maximum number of extreme events occurred at the beginning and dissipating stages of the drought, while a minimum number of extreme events characterized the mature and transitional stages of the drought. Consequently, these episodes are significant as the associated convection is usually accompanied by rainfall. This work was a collaboration between myself and Bob Kotchtubajda.
- Work is ongoing to examine in more detail convective activity in association with wet/dry areas. We have found that less lightning generally occurs over very dry areas but wet areas does not necessarily result in greater lightning. This result supports other findings that sufficient moisture is a necessary but not sufficient condition for deep convection to occur, however, this work explicitly shows the surface's role in the moisture supply. It also proves, for the first time on the Prairie region, that drought perpetuates drought with respect to deep convection. The work has also shown that the degree of vegetation stress (as determined from NDVI images) and the spatial extent of the dry area is critical for the surface to have sufficient impact on the atmosphere and deep convection. This work has been accepted for publication in Earth Interactions. This work is being done by my Ph.D. student Brimelow.

1.6 **Describe the participation of government (federal, provincial or municipal), university, industry, foreign or private sector researchers (and/or other staff) involved in the project.**

- Lightning data was acquired through Bob Kochtubajda and Bill Burrows from HAL in which a users agreement was required. Direct collaboration with Bob took place for the lightning analysis for the Theme 1 article, described above and Julian Brimelow's recent work is in collaboration with Bill. Bill has done extensive programming to assist Julian's analysis.
- Snow water equivalent (SWE) data from SSM/I has been acquired from Anne Walker and Chris Derksen from Climate Research Branch, Environment Canada. Gratitude is extended to Chris for his metadata explanation and cooperation.
- The following DRI collaborators have contributed to the Theme 1 article thus far: A.G. Barr, T.A. Black, R. Brown, C. Derksen, L.B. Flanagan, T. Hogg, B. Kochtubajda, Y. Luo , J.H. McCaughey, A. Shabbar, A. Trishchenko, S. Wang, C. Wielki, Y. Yang, and T. Zha

2.0 <u>Impact</u>

2.1 What short and medium term objectives have been achieved, or are anticipated;

- We have published one more journal article (Brimelow CFCAS funded) focusing on linkages between soil moisture, NDVI and lightning.
- We have produced more analysis toward the drought characterization/synthesis and have continued to work on this important article.

4.0 Dissemination of results

4.1 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.

Refereed Articles:

Brimelow, J.C., J.M. Hanesiak, and W. Burrows, 2010: On the surface-convection feedback during drought periods on the Canadian Prairies. (accepted) Earth Interactions.

Conferences:

- (oral) Hanesiak et al., The role of storms on Arctic water availability, CFCAS-Environment Canada Symposium on Water Security, Ottawa, ON, May 27-28, 2010.
- (oral) Hanesiak et al., Drought Research Initiative Theme 1 Characterization: Applications to Drought Monitoring, DRI-GEO workshop, Inn at the Forks, Winnipeg, MB, May 10-11, 2010.
- (oral, co-author) Brimelow & Hanesiak, Relationship between root-zone plant available moisture and Normalized Difference Vegetation Index on the Canadian prairie under drought and pluvial conditions, 44th Annual CMOS congress, Ottawa, ON, May 31 - Jun. 4, 2010
- (oral, co-author) Brimelow et al., The surface-convection feedback during drought periods on the Canadian prairie, 44th Annual CMOS congress, Ottawa, ON, May 31 - Jun. 4, 2010
-

4.4 What data sets have been used by and generated by your research. Please provide a list or table with the Name of the Dataset and the Source for both the data sets you have used and those you have generated/developed.

- Cangrid data (EC)
- Lightning data (EC)
- AB Ag datasets (AB Agriculture)
- Crop model input/output (Brimelow/Hanesiak)
- NDVI data (CCRS)
- PASPC severe weather database (PASPC, Winnipeg)

5.0 Training

5.1 Quantify student and postdoctoral involvement in the project, indicating the number of: undergraduate, masters, doctoral or PDF's. Also summarize their roles in the project.

Julian Brimelow (PhD), working on linkages of surface characteristics to deep convection during drought.