NSF annual report: 5 May 2004 – 4 May 2005

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---------- personnel ----------

Grant provided a copy of his stationary model (spherical geometry) code. He has helped us by providing testing datasets, evaluating whether the updated model is working properly and coding issues. Grant has also been advising us as to developing a nonlinear iterative application of this model and a storm track model to sort out nonlinear forcing of the stationary wave error pattern.

Bruce has assisted us in identifying appropriate current model datasets. We needed data run at high resolution (T85) and using observed forcing in order to compare and contrast what model and atmosphere do differently. These 'AMIP' datasets were not publicized, but know to Bruce through his other work at NCAR. Bruce also gave some advice on how to read the data.

During the first year Joe has provided a valuable role of someone with whom the PI can discuss ideas and approaches.

Muhtar has been charged with a variety of tasks. He rapidly learned NCL and netcdf commands to develop and test some statistical analysis programs. The statistical programs do such tasks as: 1-point correlations (with significance tests), power spectra, Lanzcos filtering, and composite analysis (with significance). He needed much time to modernize and make portable on our computer system Branstator's stationary wave model. This last task proved more difficult than expected.

---------- Project Activities & Findings ----------

Research & Education activities

Monthly data had shown strong associations that we wanted to pursue with daily data (at leads and lags) to establish order of events, if not causality. We completed an initial sequence of observational studies with daily data. We added additional diaganostic tests as suggested by Brian Hoskins and by John (Mike) Wallace with whom the PI had extensive discussions at the 1st CLIVAR conference in Baltimore (June 04). Even the best of the raw daily observational results was inconclusive. We began to low-pass filter the data (using power spectra to guide our choice of cut-off frequency). This has begun to successfully reproduce our monthly associations whilst allowing some indication of the chain of events.
As promised, we have been able to implement locally a stationary wave model. In an effort to expedite that task, we started with a model developed by Grant Branstator many years ago. Unfortunately, the model was originally written in obsolete Fortran, relied on a NCAR-specific unsupported iftran preprocessor, relied on nearly obsolete NCAR library

routines, and used double precision in a way that would not work on our Linux system. These and other hurdles were not expected and required a huge effort on our part to resolve. While the process was more challenging than expected, it was likely still shorter than developing such a model from scratch. Happily, by the end of the grant year we had developed a FORTRAN 95 version this program working successfully at UC Davis.

Major Findings

It is too early to report what we might call major findings. Some minor, tentative results are these.
First, to see strong behaviors found in monthly mean data it was necessary to filter the data. Individual frontal cyclones dominate the variability and do not have significant correlation in raw data. However, the aggregate variability does have interannual variation that we propose (amongst several mechanisms) to impact the Arctic surface climate. (The model has significant problems with the aggregate cyclone activity.) A minimum period to cut-off the low pass filter turned out to be 10 days. This is small enough that a significant signal appears which shows remote midlatitude and tropical forcings that precede or follow SLP changes at various locations in the Arctic. One surprise was that stronger SLP in the Barents and GIN seas leads (not follows) a storm track shift into the Iberian peninsula. This work is being analyzed at the present time for presentation by the time of the next June 2005 CCSM workshop.
Second, discussions with attendees at the July 2004 CCSM workshop suggested that we cannot simply use a linear stationary wave model to diagnose the impacts of storm tracks errors upon the Arctic surface climate. This conclusion was based on a somewhat related linear calculation had just been done independently by Eric deWeaver. However, the observations show an association as some level, and Eric's work has spurred us to focus on developing a nonlinear iterative calculation.

---------- research and teaching skills ----------

Muhtar and the PI have developed understanding of the Lanzcos filtering method.
Muhtar has learned a variety of statistical techniques from the PI on this project.
Muhtar from the PI and others has learned about netcdf file structure and complex NCL coding sufficient to create statistical calculations of the data using NCL. We have also been creating netcdf output, such as daily anomaly files.
Muhtar has learned and applied new computer skills to modify the stationary wave model code to our linux system. This also required some new basic understanding of how such models are created mathematically (from parsing out wave-wave interactions to construct the matrix and do so in real-valued form).

---------- outreach activities ----------

Nothing yet for the general public. Of course, we have been informing those people most directly interested in the work via CCSM workshops.

---------- publications, etc. ----------

On type B cyclogenesis in a quasi-geostrophic model, QJRMS, 131, 2005, 109-124.

The QJRMS paper was listed because it acknowledges partial support from this NSF grant. The support consisted of using the new computer purchased by this grant to complete a research project started before this grant was funded. The paper is significant in ways that only indirectly relate to this project: through increased understanding of frontal cyclones. The paper's significance to dynamics is to clarify the 'type B' mechanism of cyclogenesis in a nonlinear framework using realistic initial conditions. In the process it also proposes a mechanism to explain observed propagating, but non-amplifying short waves. The ‘type B’ mechanism is richer than might be generally thought, for example, growth can be initiated when the low level feature inhibits a damping mechanism that had been causing the upper feature to be neutral.

---------- contributions to other disciplines ----------

nothing yet

---------- human resource development ----------

A variety of skills were learned by the PI and graduate student Muhtar that are listed above. (Perhaps they should have been here?)

---------- resources for research & education ----------

nothing yet

---------- beyond science and engineering ----------

nothing yet