

**PARALLEL IMPLEMENTATION  
OF TWO LEVEL BAROTROPIC MODELS  
APPLIED TO THE WEATHER PREDICTION PROBLEM**

**By**

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**Thesis Submitted to the School of Graduates Studies, Universiti Putra Malaysia,  
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of the requirements for the degree of Doctor of Philosophy

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**Chairman : Associate Professor Fudziah Ismail, Ph.D.**

**Faculty : Science**

Forecasting model for short range weather prediction that is used here is the two level Barotropic models. This model is used because it can give approximation of air conditions covering higher isobar levels. By using finite difference approximation, quasigeostrophic vorticity equations and thermodynamic equations are used to develop forecasting equations for each level. The forecasting equation for determining the geopotential heights can be solved by using suitable lateral conditions. In relation to the conformal map, the quasigeostrophic equations are modified by using a formula. These equations are then transformed into finite difference equation. This can be achieved by using grids chosen from the mesh scale. Then, the system of equations is solved using Gauss Seidel method.

To process the data collected from British Atmospheric Data Centre (BADC), the sequential programs in row and columnwise fashions are developed and implemented. Then the parallel algorithms are constructed and run using the Beowulf Cluster machine. The numerical results based on the sequential and parallel

algorithms for both row and columnwise fashions are presented and compared to determine their performance.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENGIMPLEMENTASIAN SELARI MODEL BAROTROFIK  
DUA ARAS KEATAS MASALAH RAMALAN CUACA**

Oleh

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Model ramalan cuaca jangka pendek yang digunakan adalah model barotrofik dua aras. Model ini digunakan kerana ianya dapat memberikan penghampiran bagi keadaan udara pada beberapa aras isobar yang lebih tinggi. Dengan menggunakan penghampiran beza terhingga, persamaan kuasigeostrofik dan persamaan termodinamik yang membentuk persamaan ramalan bagi setiap aras tersebut, dapat ditentukan. Persamaan ramalan bagi mendapatkan ketinggian geopotensial, boleh diselesaikan dengan menggunakan syarat sempadan yang sesuai. Dalam hubungan dengan peta konformal, persamaan kuasigeostrofik dijemakan dengan menggunakan rumus, seterusnya ia dijemakan menjadi persamaan beza terhingga. Ini diperolehi dengan menggunakan grid yang dipilih menggunakan suatu skala mesh. Kemudian sistem persamaan tersebut diselesaikan menggunakan kaedah Gauss Seidel.

Bagi memproses data yang diperolehi dari British Atmospheric Data Center, pengaturcaraan jujukan dalam baris dan lajur dibentuk dan dilaksanakan. Kemudian algoritma selarinya dibina dan dilarikan menggunakan mesin Cluster Beowulf.

Keputusan berangka berdasarkan algoritma jujukan dan selari bagi pelaksanaan iaitu kedua-dua bentuk baris dan lajur dipersembahkan dan dibandingkan untuk menentukan prestasinya.

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**The Most Beneficent, The Merciful**

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I certify that an Examination Committee met 7<sup>th</sup> May 2004 to conduct the final examination of Susila Bahri on her Doctor of Philosophy thesis entitled “Parallel Implementation of Two Level Barotropic Models Applied to The Weather Prediction Problem” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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Date: 29 October 2004

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