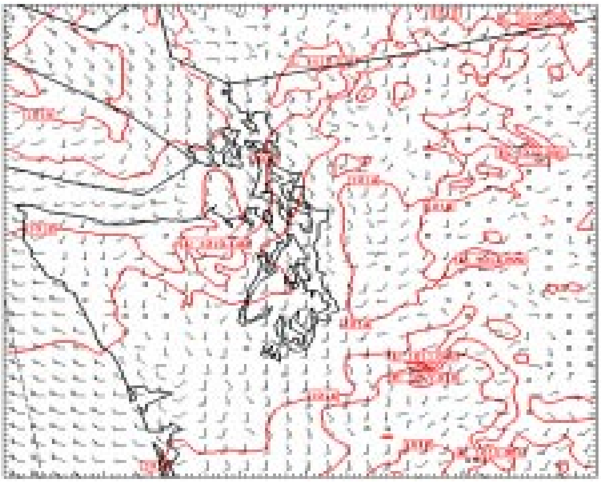

Figure 6. Expt2.d1d2d3: 24 hour forecast MSLP valid 00Z 26 October 1999.

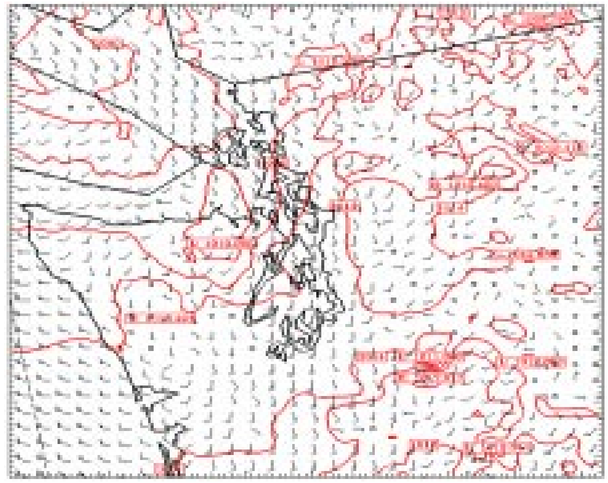

Figure 7. Expt2.d3.60: 24 hour forecast MSLP valid 00Z 26 October 1999.

propagate quickly and contaminate the forecast in the region of interest.

4. The 12 km nest already resolves both the terrain and meteorological features well enough to provide LBCs consistent with the inner (4 km) nest's simulation.

In this particular application, the dominant component of the meteorology appears to be the interaction of synoptic forcing with the strong and complex orography. A high resolution, multiply-nested NWP system designed for operational use under these conditions appears to be relatively insensitive to LBC effects, either as a result of LBC update frequency or domain size.

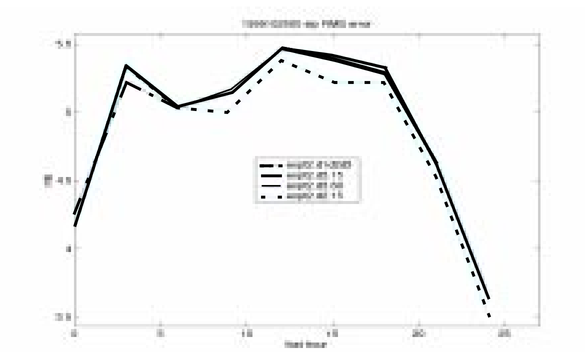

Figure 8. RMS sea level pressure error versus forecast hour for the case of 00Z 25 October 1999. Shown are errors for the simulations with varying LBC update frequency, also errors for the 12 km domain.

5. References

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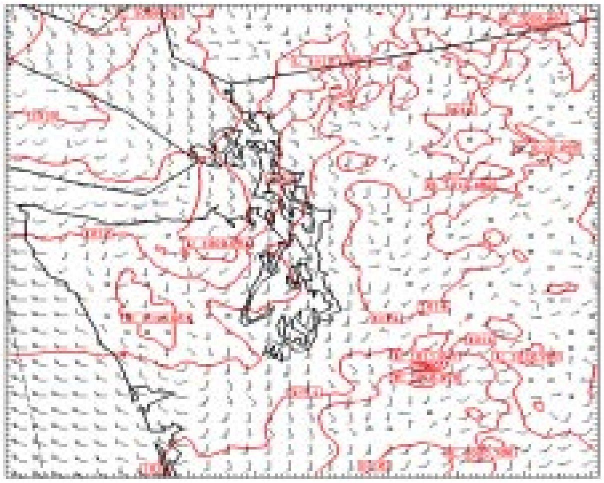

Figure 3. Expt1.d3.15: 24 hour forecast MSLP valid 00Z 26 October 1999.

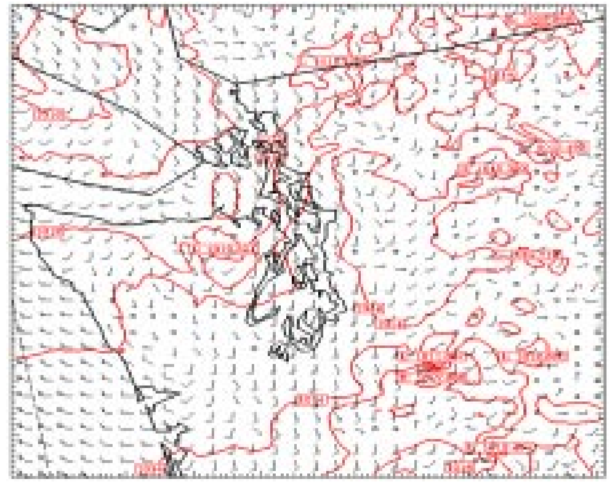

Figure 4. Expt3.d3.15: 24 hour forecast MSLP valid 00Z 26 October 1999.

24h forecast MSLP for the smallest 4 km domain configuration, and Figure 4 for the largest 4 km domain. The fields depicted in these figures demonstrate the nearly identical results produced by these two simulations. Another measure of the similarity between these two simulations can be seen in comparisons of objective verification of sea level pressure throughout the entire forecast period, shown in Figure 5.

Results from the simulations with varying LBC update frequency are shown in Figures 6 through 8. Figure 6 shows MSLP for the simulation employing continuous LBC updates, and Figure 7 for the simulation with one-hour LBC update frequency, both figures limited to the region of interest. Again, as in the varying domain sizes, nearly identical MSLP fields are produced by the simulations with different LBC update frequencies. Objective verification of MSLP for these simulations shows that the skill of these forecasts are nearly identical.

The results shown for this case illustrate the behavior observed in all the cases used in this experiment. In no cases were significant differences observed between either the simulations with different domain size or different LBC update frequency.

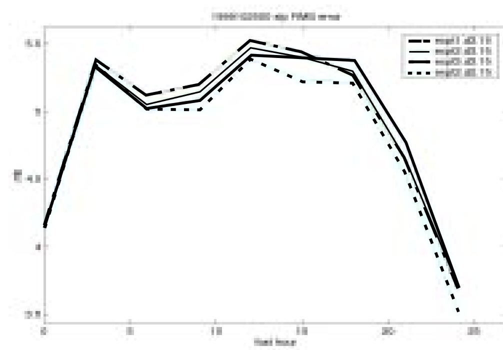

Figure 5. RMS sea level pressure error versus forecast hour for the case of 00Z 25 October 1999. Shown are errors for the simulations with varying domain sizes, also errors for the 12 km domain.

4. Discussion

Overall results suggest that LBC errors are relatively insignificant in this application of a LAM. Several possible reasons for these results include:

1. Since the MM5 is used as both the donor and recipient of LBCs, there are no significant differences in model physics or numerics.
2. Local orographic forcing dominates the model solution, overriding any LBC errors which may occur.
3. The LBC formulation in the MM5 sufficiently damps out inertia-gravity waves that could

Table 1:

Simulation	domain size	LBC freq. (s)
expt1.d3.15	94x94	900
expt2.d3.15	145x169	900
expt3.d3.15	217x217	900
expt2.d1d2d3	145x169	36
expt2.d3.60	145x169	3600

of simulations are performed using the MM5, with a region of interest defined which encompasses western Washington State.

2. Method

The MM5 version 2.7 is used throughout this experiment, in a triply-nested configuration. Shown in Figure 1, the outer domain covers the northeast Pacific Ocean and western North America, with grid spacing of 36 km; the intermediate domain covers the Pacific Northwest U.S. and southwest Canada with grid spacing of 12 km. The inner-most domain encompasses western Washington State (the region of meteorological interest) and a varying buffer zone extending outside this region, with grid spacing of 4 km. For all simulations, the outer and intermediate domains employ the Kain-Fritsch convective parameterization scheme (Kain and Fritsch, 1990) and the inner, 4 km domain uses only explicitly resolved precipitation physics. Initial conditions and LBCs for the outer-most domain are provided by forecasts from NCEP's Eta model.

A set of meteorological cases representing the range of synoptic conditions expected during the course of the year were selected for use in this experiment, to determine the applicability of results to an operational model. For each case, a sensitivity test is performed, involving five simulations in which the size of the inner-most domain is varied and the frequency that

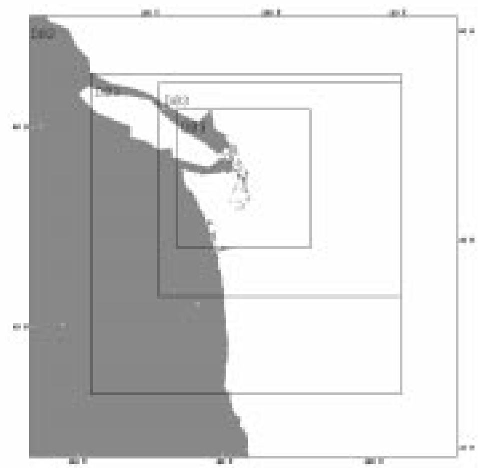

Figure 2. Within this plot of the intermediate, 12 km domain are the outlines of the 4 km domain sizes for (from largest to smallest) expt3.d3.15, expt2.d3.15, and expt1.d3.15.

the LBCs are passed from the intermediate to the inner-most domain is changed. These experiments are summarized in Table 1.

In the series of simulations which test sensitivity to domain size, the area covered by the 4 km nest is varied between 80x80 and 217x217 grid points (Figure 2). The simulations testing sensitivity to LBC update frequency vary this frequency from continuous (inner domain integrated simultaneously with the outer two domains) to one hour, each using the same 4 km domain size.

3. Results

Results from the case of 00Z 25 October 1999 are shown here to illustrate the behavior seen in a case of strong synoptic forcing and cross-boundary flow. Initially, a developing cyclone is poised several hundred miles off the pacific northwest U.S. coast. A westerly jet aloft is driving this system onshore during the simulation period, with a cold front making landfall mid-way through the forecast.

For the simulations with varying domain size, plots of mean sea level pressure are shown for the region of interest. Figure 3 shows the

The Effects of Domain Size and Lateral Boundary Condition Update Frequency on High Resolution NWP

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1. Introduction

With advances in computing power, the operational use of limited area numerical weather prediction models has become widespread in recent years (Mass and Kuo, 1998). With this proliferation comes the need for users to consider issues of model configuration which they have control over, and which may affect model performance and accuracy. One of these important issues is the treatment of lateral boundary conditions (LBCs) (Warner et al., 1997).

A limited area model (LAM) such as the PSU/NCAR MM5 (Grell et al., 1994) receives LBC information derived from the forecast of a source model (or a set of analyses) which cover a larger area than the LAM domain. LBC related model errors result from two basic factors: 1) differences between the source model (or analyses) and the LAM, such as temporal or spatial resolution, or physical parameterizations, 2) the numerical way in which LBCs are treated by the LAM.

As reviewed by Warner et al. (1997), significant errors associated with LBCs have been found for LAMs with relatively coarse horizontal resolution (grid increments of 40 km and larger). These errors seem to be exacerbated when the source of the LBCs (either an analysis or model) differs from the LAM. It remains an open question, however, whether the same sources of LBC errors necessarily contribute significantly to inner domain errors in a multiply-nested model configuration.

In the context of a triply-nested LAM, the relationship between the inner-most domain and the intermediate domain is similar to the one between the outer-most domain and its LBC source, with some important differences.

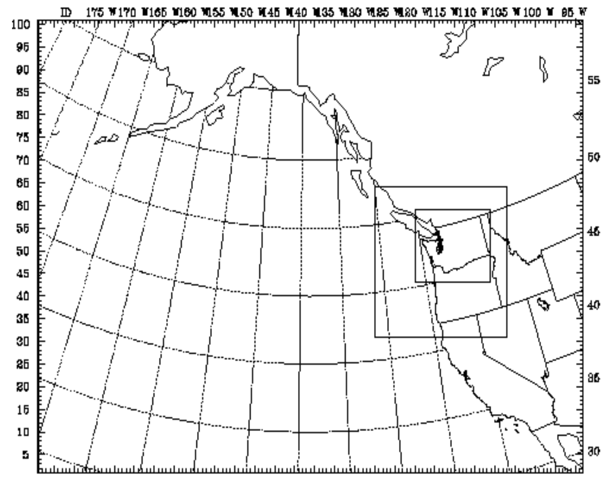

Figure 1. Model domain configuration.

The inner-most domain receives its LBCs from the intermediate domain. In this relationship, unlike the one between the coarse domain and its LBC source, differences between LBC donor (intermediate domain) and recipient (inner-most domain) are minimized since they are both of the same model. Physical parameterizations can be identical, and differences in the spatial and temporal resolution of these nests can be accounted for in the numerical treatment of LBCs. Nevertheless, results from the inner-most domain may still be subject to LBC effects due to basic domain configuration choices.

One of these choices is the size of the inner nest, and how much larger than the region of meteorological interest it is. Another is the temporal resolution of the LBCs which are passed from the intermediate to the inner nest. In each unique application of a LAM, sensitivity to these relationships must be examined, especially in the design of an operational modeling system. To investigate these issues, a short series