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Subject: Implementation of the Regional Spectral Model Forecasts for Hawaii

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Abstract:

This Bulletin written by Hann-Ming Henry Juang, Kevin Kodama, Hua-Lu Pan and Ken Campana, describes the Environment Modeling Center of the National Center for Environmental Prediction's Regional Spectral Model (RSM) which has been running in a parallel mode over the Hawaiian Islands.

This Bulletin presents a short description of the RSM and some results over Hawaii from this new system, and makes comparison to the existing model guidance from the AVN.

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Implementation of the Regional Spectral Model Forecasts for Hawaii

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1. INTRODUCTION

The EMC/NCEP Regional Spectral Model (RSM) has been running in a parallel mode over Hawaii Island since November 1995 as a special support for Hawaii daily weather forecast. It has been internally implemented in operational runstream since mid-June 1997 for evaluating in real time. Since then, forecasters in Hawaii has been using it routinely.
This Bulletin presents a short description of the RSM and some results over Hawaii from this new system, and makes comparison to the existing model guidance from the AVN.

2. The model

A detailed description of RSM may be found in Juang and Kanamitsu (1994). It is a primitive equation, limited-area, atmospheric numerical model originally developed at EMC/NCEP. It has the same model structure, model dynamics and model physics as those in the AVN. The spectral computation with perturbation method is the major differences from the other regional models. The use of the AVN structure in the RSM makes it easier to maintain and manage the computer code. And It is easier to relocate horizontal grid to a new region, since it obtains lateral boundary values from the global model.

The model domain of the RSM for Hawaii, from 16.9 N to 23.6 N and 161.9 W to 152.8 W, is shown in Fig. 1. The raw terrain is obtained from 1 by 1 data set (Fig. 1a) and the model terrain is obtained after applying a spectral filter (Fig. 1b). The grid spacing is 10 km at 20 N in a Mercator projection. The model has 28 vertical layers (same as the AVN).

3. Forecaster's evaluation

The forecasters and staff at the Hawaii local office have been reviewing the performance of this 10 km RSM. The period of the subjective evaluation, October 1996 to April 1997, includes cold fronts, subtropical cyclones, and trade winds.

Of all the parameters evaluated, forecasters have the most confidence in the RSM's wind forecasts. One case (24 hr forecast valid on 0000 UTC 29 April 1997) is shown in Figs. 2, 3, 4 and 5. The wind from the AVN shows no influence of the Hawaiian Islands, but the RSM is more realistic (compared Figs. 4 and 5). The detailed circulation around the Hawaiian waters from the RSM has been useful to the marine forecasters.
Forecasters also note that the RSM has been quite successful at predicting the timing of cold front passage across islands with the 3-hourly boundary layers winds. Furthermore, forecasters have made use of the RSM wind forecasts for the 600 mb level, which is near the summits of volcanoes

on the island of Hawaii.

The forecasters place less faith in the RSM's predictions of rainfall in terms of quantity. However, the patterns of the rainfall and 850 mb relative humidity show good agreement with the satellite images as in Figs. 6, 7, 8, 9 and 10. It is an improvement over the guidance from the AVN (see Fig. 8). Another case, 15-16 May 1997, shows the forecast rainfall, observation and satellite image are well correlated (Figs. 11, 12 and 13).

4. Statistical verification

Grid point data were collected for both the AVN and the RSM during the period from 1 May to 25 May 1997. The surface observation used for verification come from NWS sites at Hilo(ITO), Kahului(OGG), Honolulu(HNL) and Lihue(LIH). The results of bias and rms errors are shown in Figs. 14a and 14b and 15a, and 15b respectively.

The RSM forecasts for 2 m temperature are superior to the AVN at all four sites, but larger cold bias. 10 m wind has better bias and rms error from the RSM than those from the AVN, especially for the station at the big Island.

5. Implementation details

The RSM needs the AVN as its source of initial and lateral boundary conditions. The initial field is interpolated from AVN, no data assimilation or initialization is performed before forecast. It runs immediately after the on-time AVN cycles. The forecast range is 48 hr with data output every 3 hours. The post processor produces all the GRIB formatted fields on pressure surface and flux fields as does the AVN.

6. Conclusions

Case results of both statistical and forecaster subjective evaluations, show that the RSM can provide more detailed and valuable information, than does the AVN, to daily weather forecasters for the Hawaii islands. The detailed orographic circulation and mesoscale thermodynamical patterns gives forecasters significantly improved guidance.

REFERENCE:

Juang, H.-M. H. and M. Kanamitsu, 1994: The NMC nested regional spectral model. Mon. Wea. Rev., 122, 3-26.

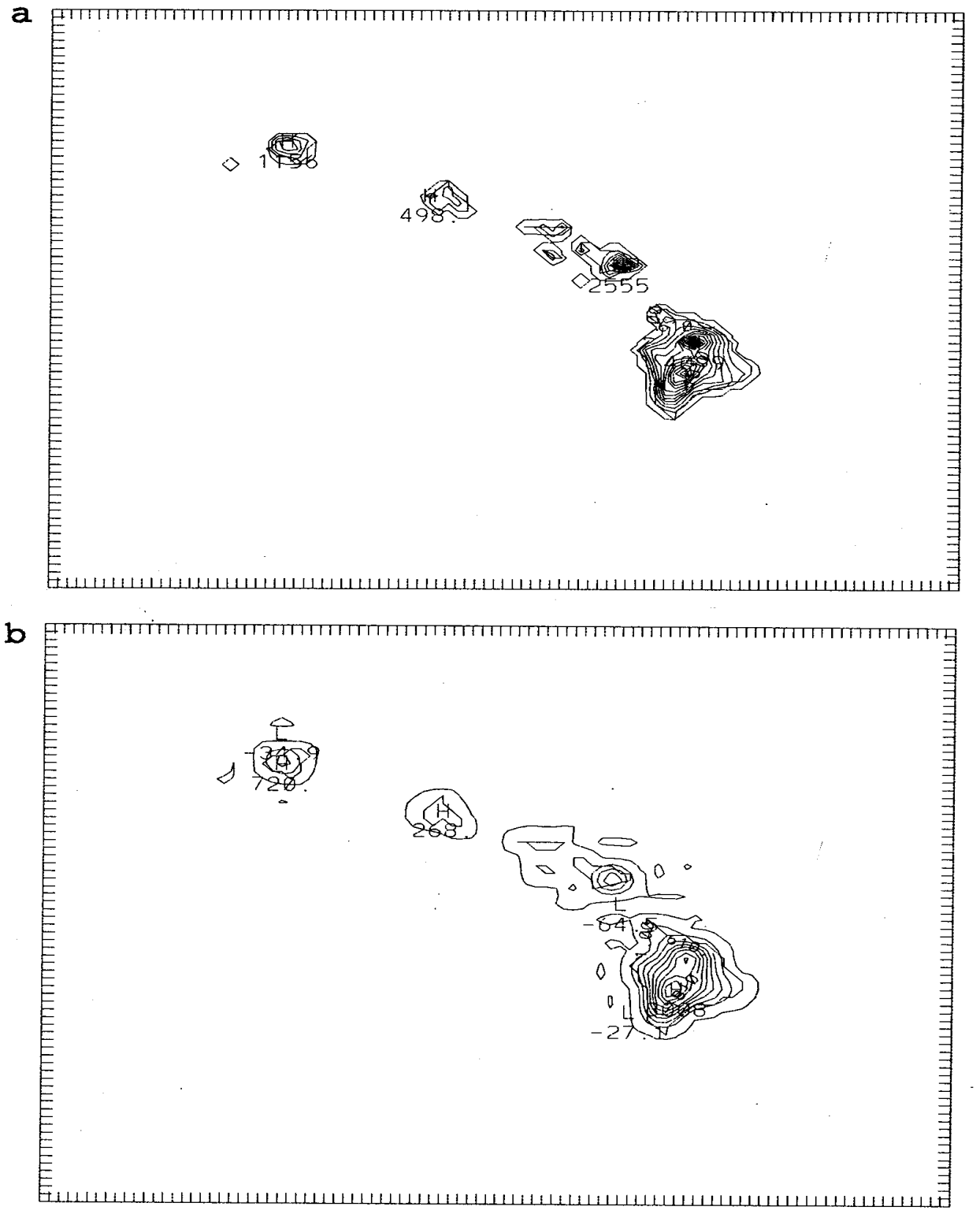

Fig. 1. (a) Terrain height (m) interpolated from 1 km by 1 km terrain data set. (b) Model terrain height (m) after spectral truncation.

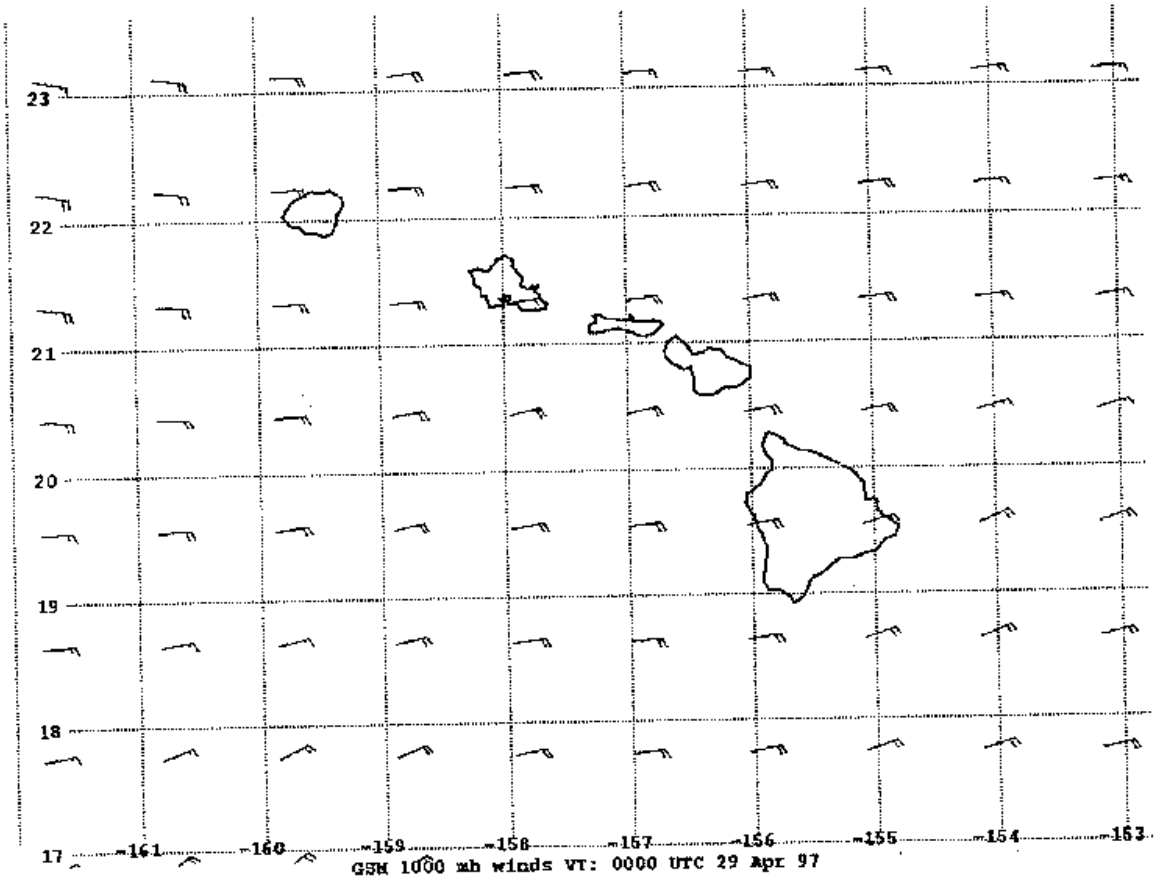

Fig. 2. GSM 24-h forecast of 1000 hPa winds, valid at 0000 UTC 29 April 1997. A full wind barb is 5 knots.

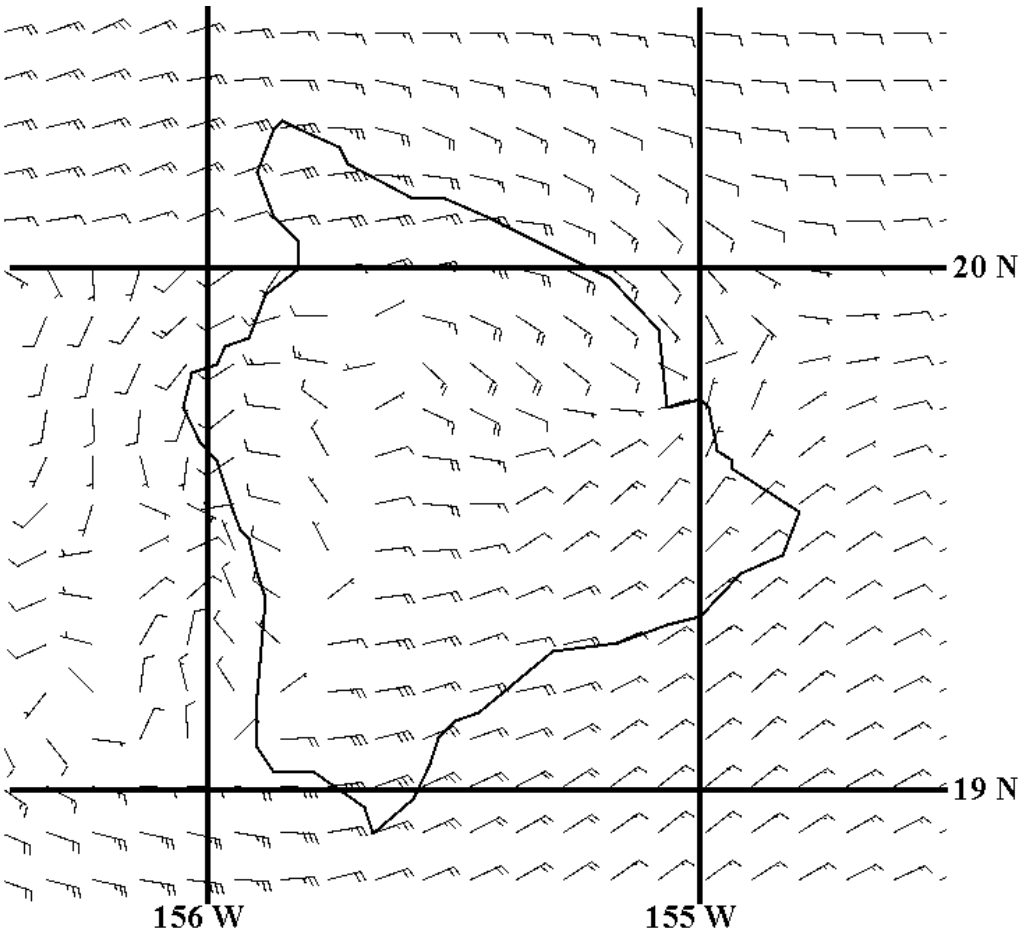

Fig. 3. 10 km RSM 24-h forecast of the lowest model layer, about 50 m, winds over full model domain, valid at 0000 UTC 29 April 1997. Every other model wind is plotted.

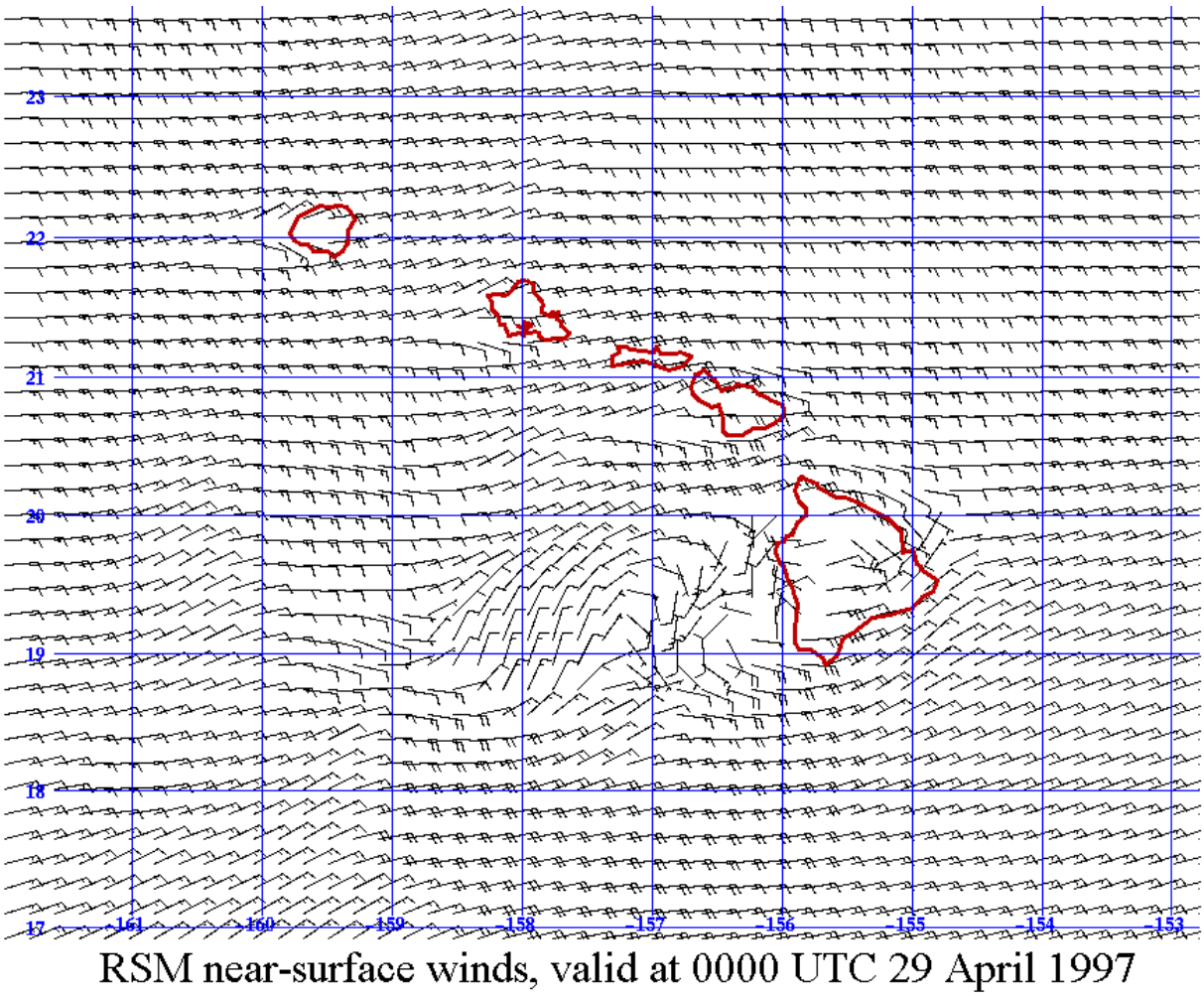

Fig. 4. Same as Fig. 3, but zoomed-in on the island of Hawaii with all wind barbs plotted.

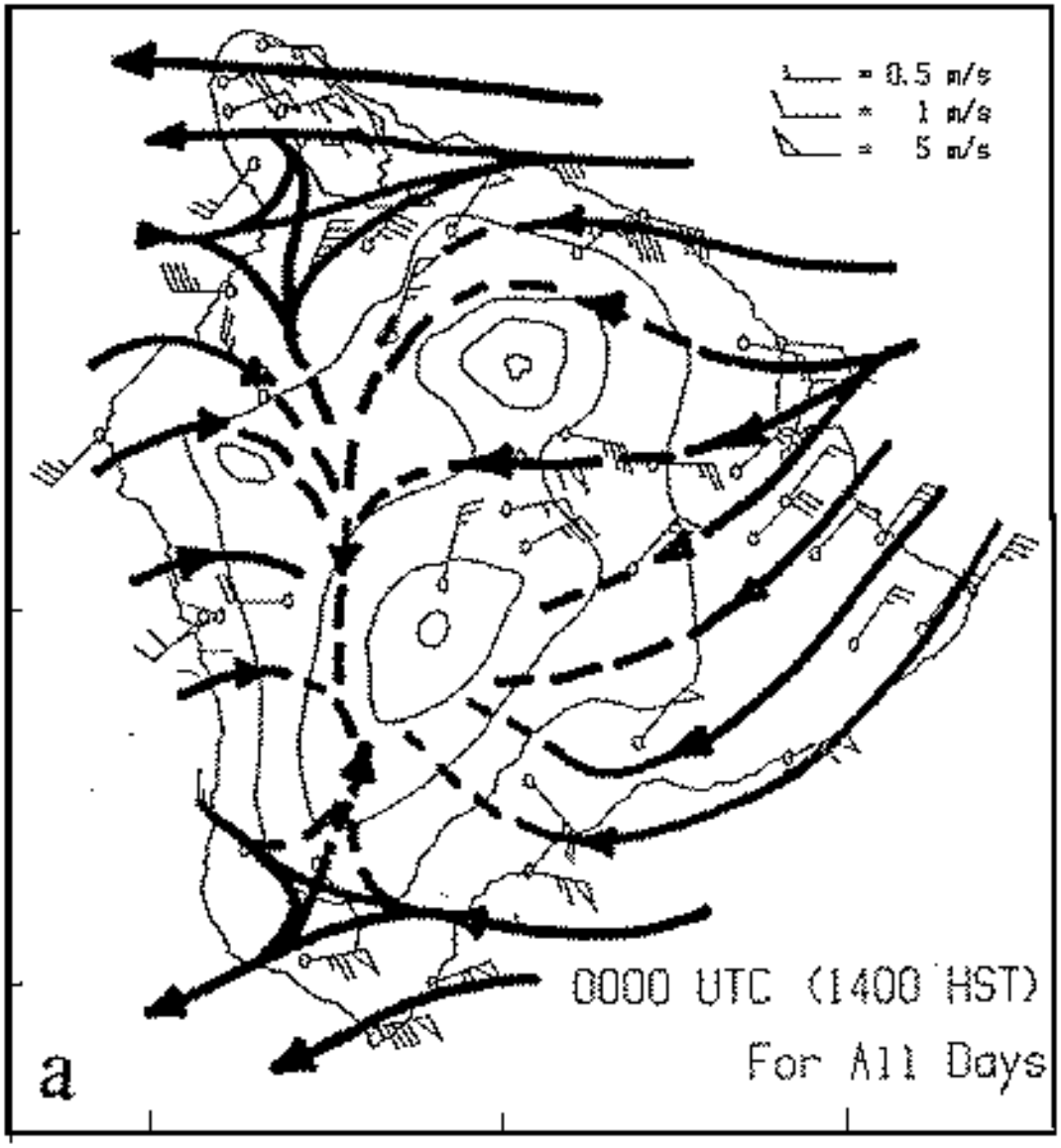

Fig. 5. Composite of 0000 UTC winds from the Hawaiian Rainband Project (HaRP) (11 July-24 August 1990). Observations are from 50 Portable Automated Mesonet (PAM) stations. Note that the wind barb plotting convention differs from the previous figures, with pennants=5 m/s, full barbs = 1 m/s, and half barbs = 0.5 m/s. From Chen and Nash (1994).

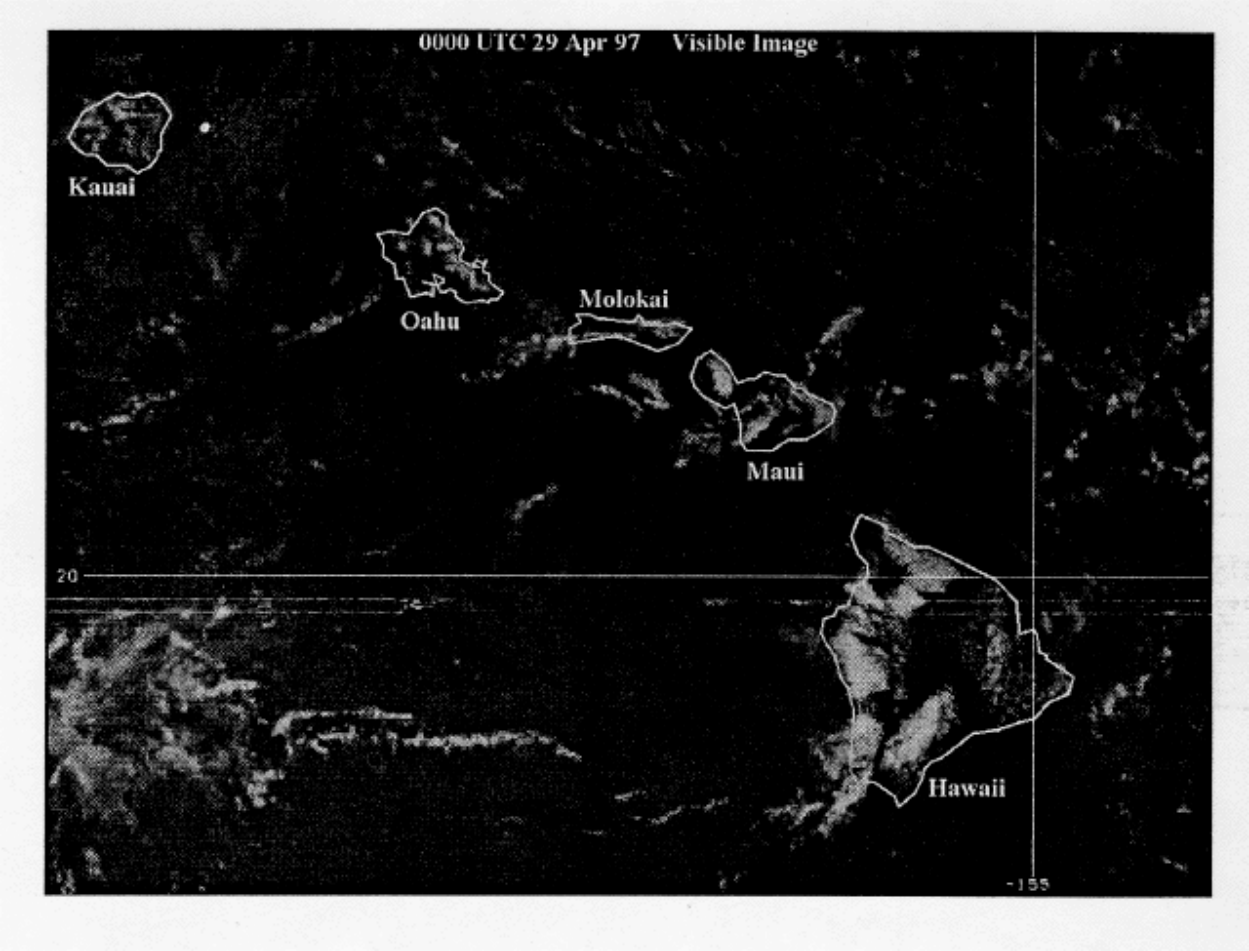

Fig. 6. GOES-9 visible wavelength image for 0000 UTC 29 April 1997.

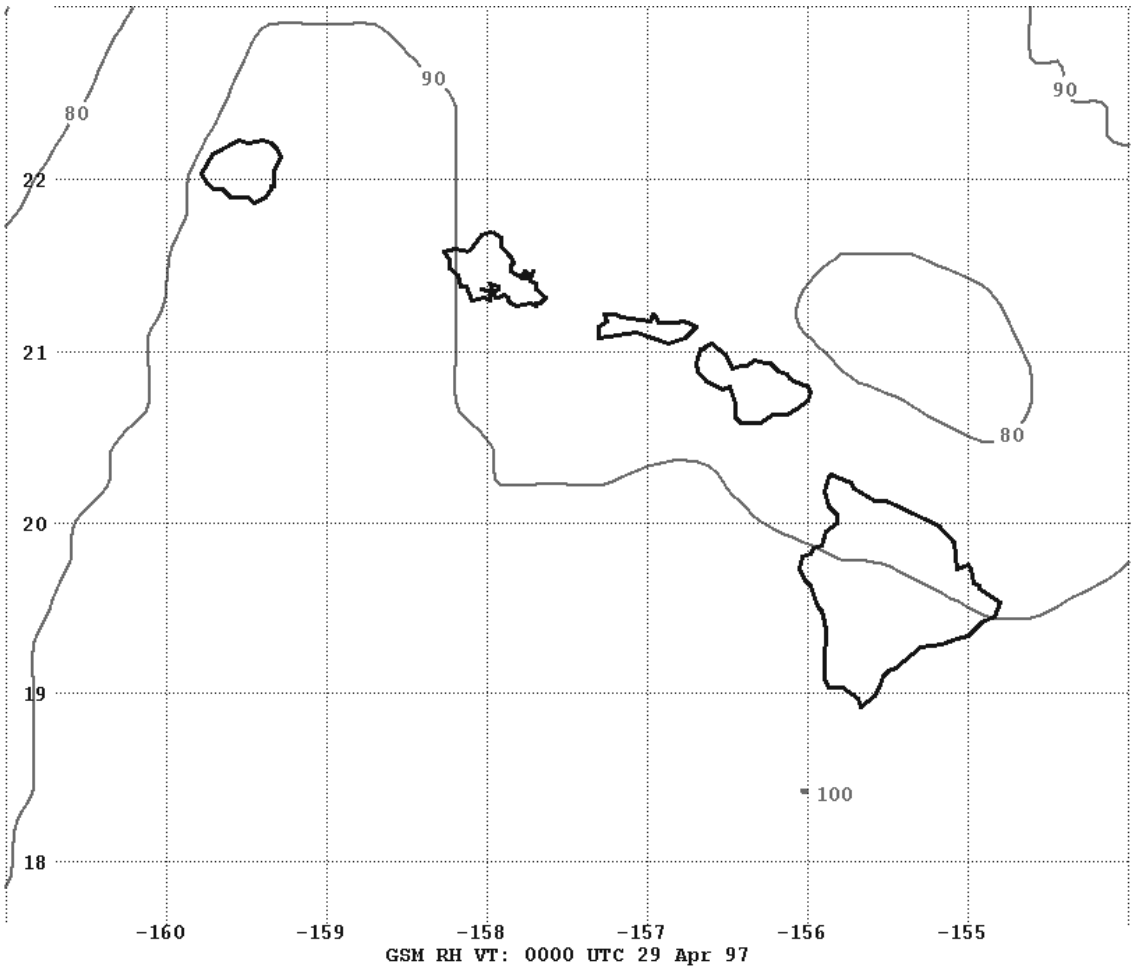

Fig. 7. 10 km RSM 24-h forecast of 850 hPa relative humidity, valid at 0000 UTC 29 April 1997, with contour interval of 10 percent.

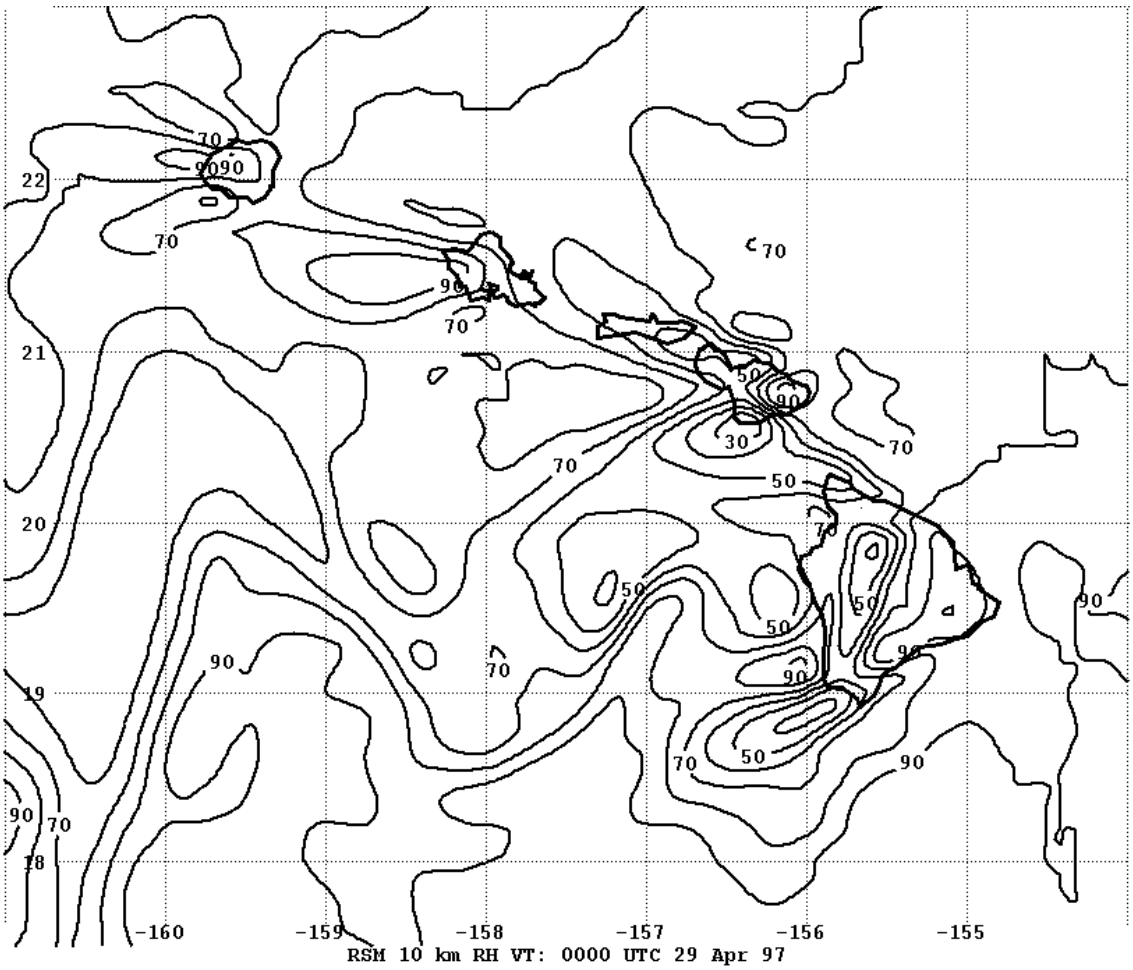

Fig. 8. Same as Fig. 7, but from the GSM.

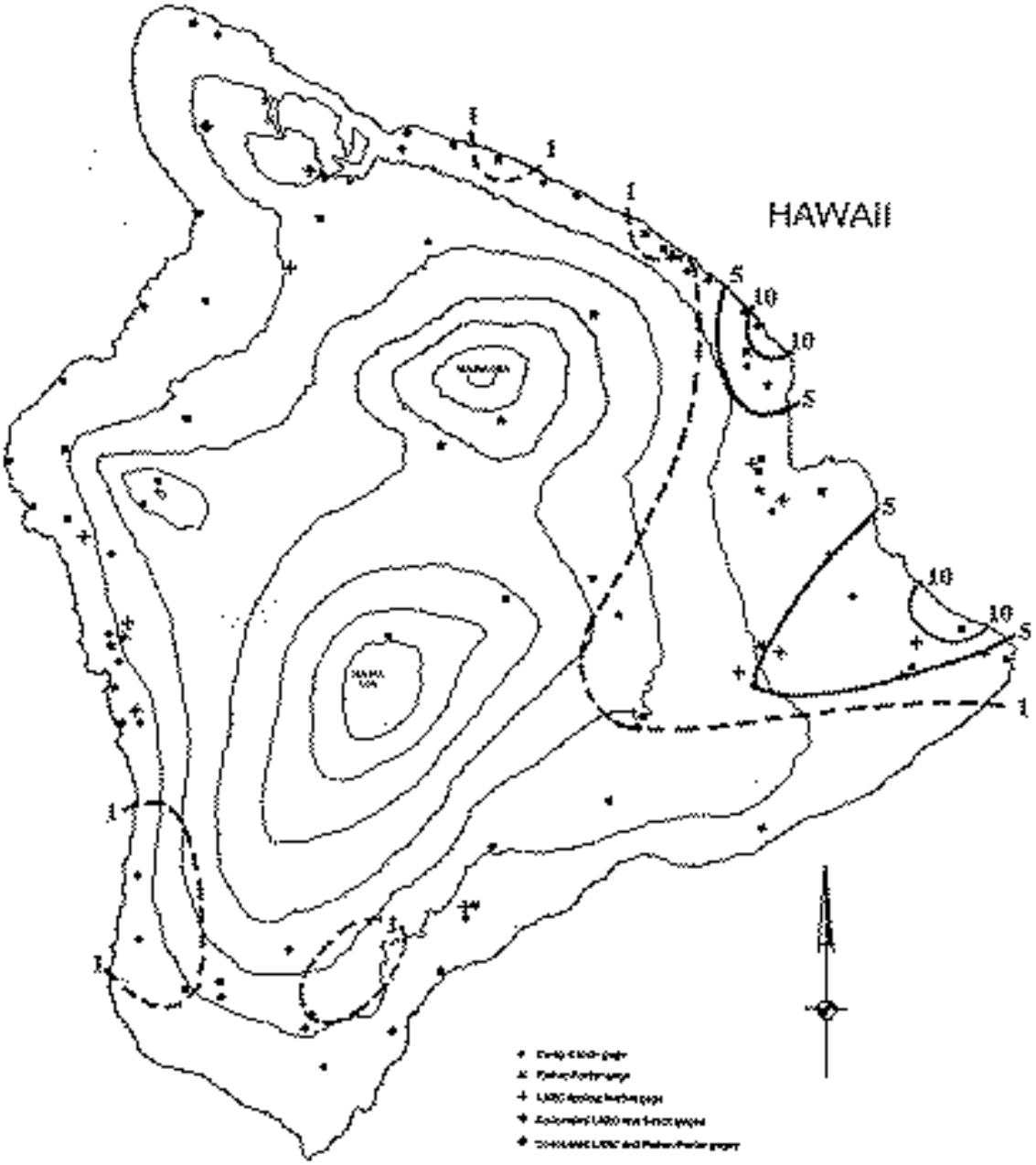

Fig. 9. Rainfall analysis for the island of Hawaii covering the period from 1700 UTC 28 April 1997 to 1700 UTC 29 April 1997. Observations are from the co-operative observer network and are taken once per day. Isopleths are in mm.

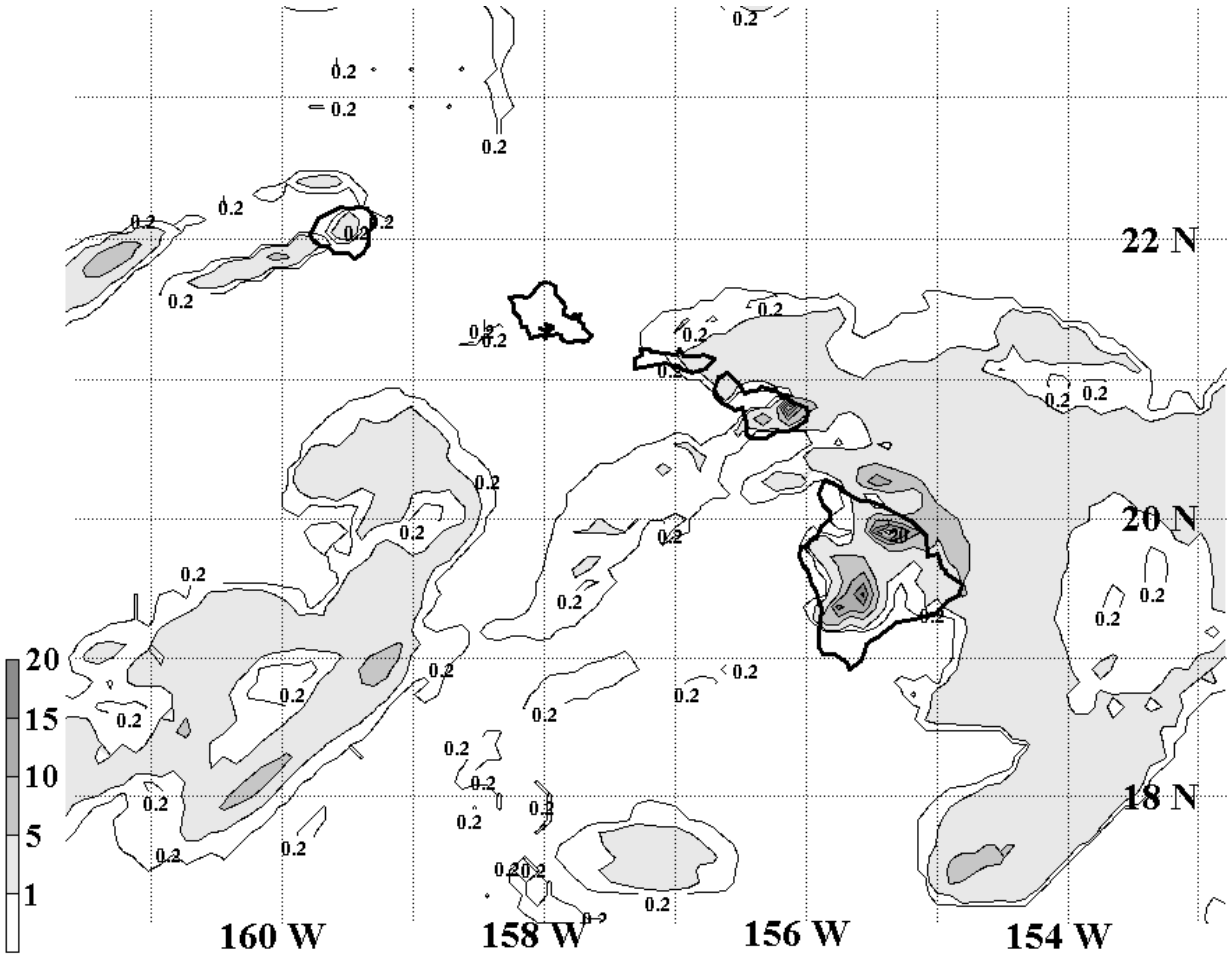

Fig. 10. 10 km RSM 24-h accumulated rainfall over the period from 1800 UTC 28 April 1997 to 1800 UTC 29 April 1997. Contour are in mm.

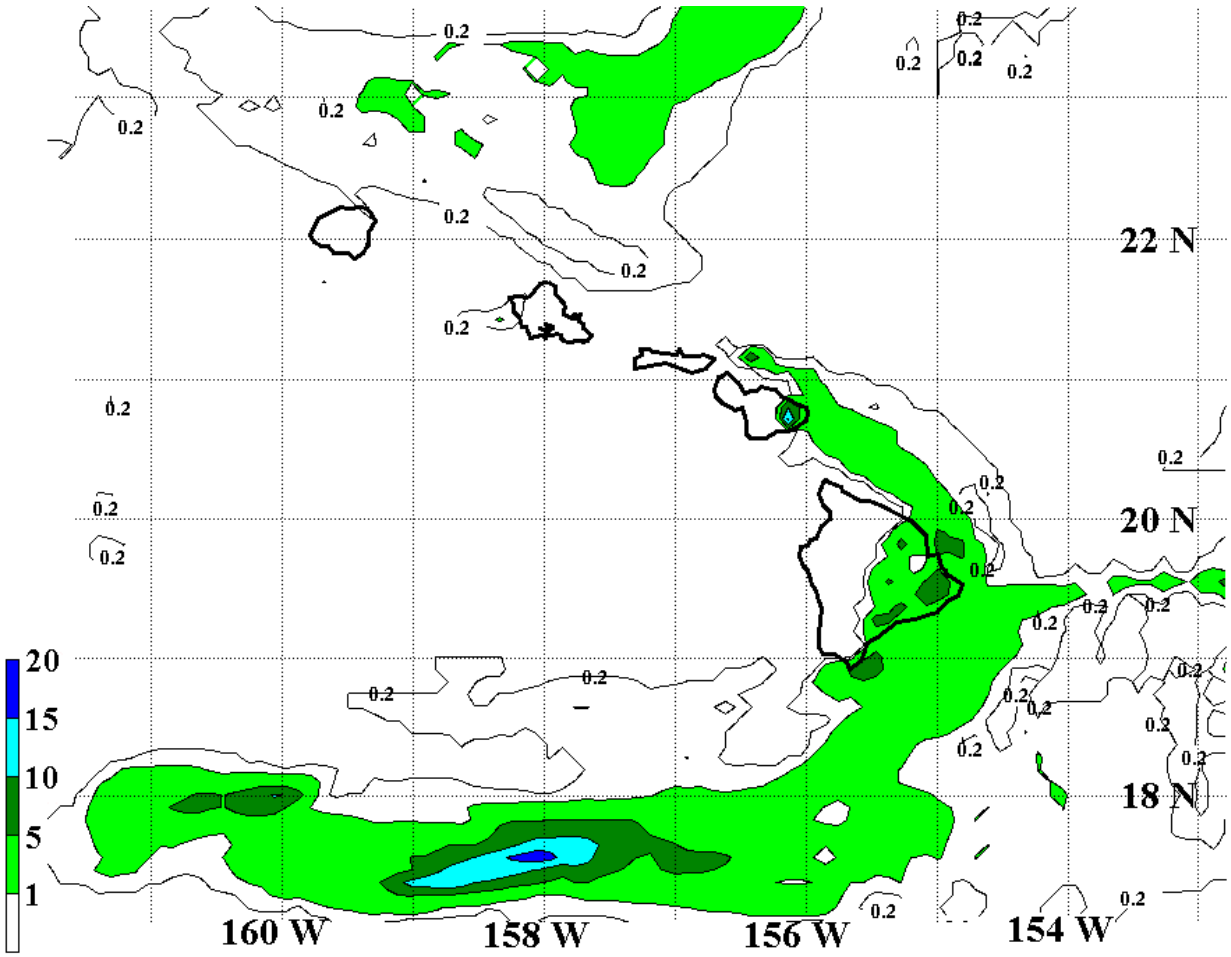

Fig. 11. 10 km RSM 6-h accumulated rainfall for the period from 1800 UTC 15 May 1997 to 0000 UTC 16 May 1997. Contours are in mm.

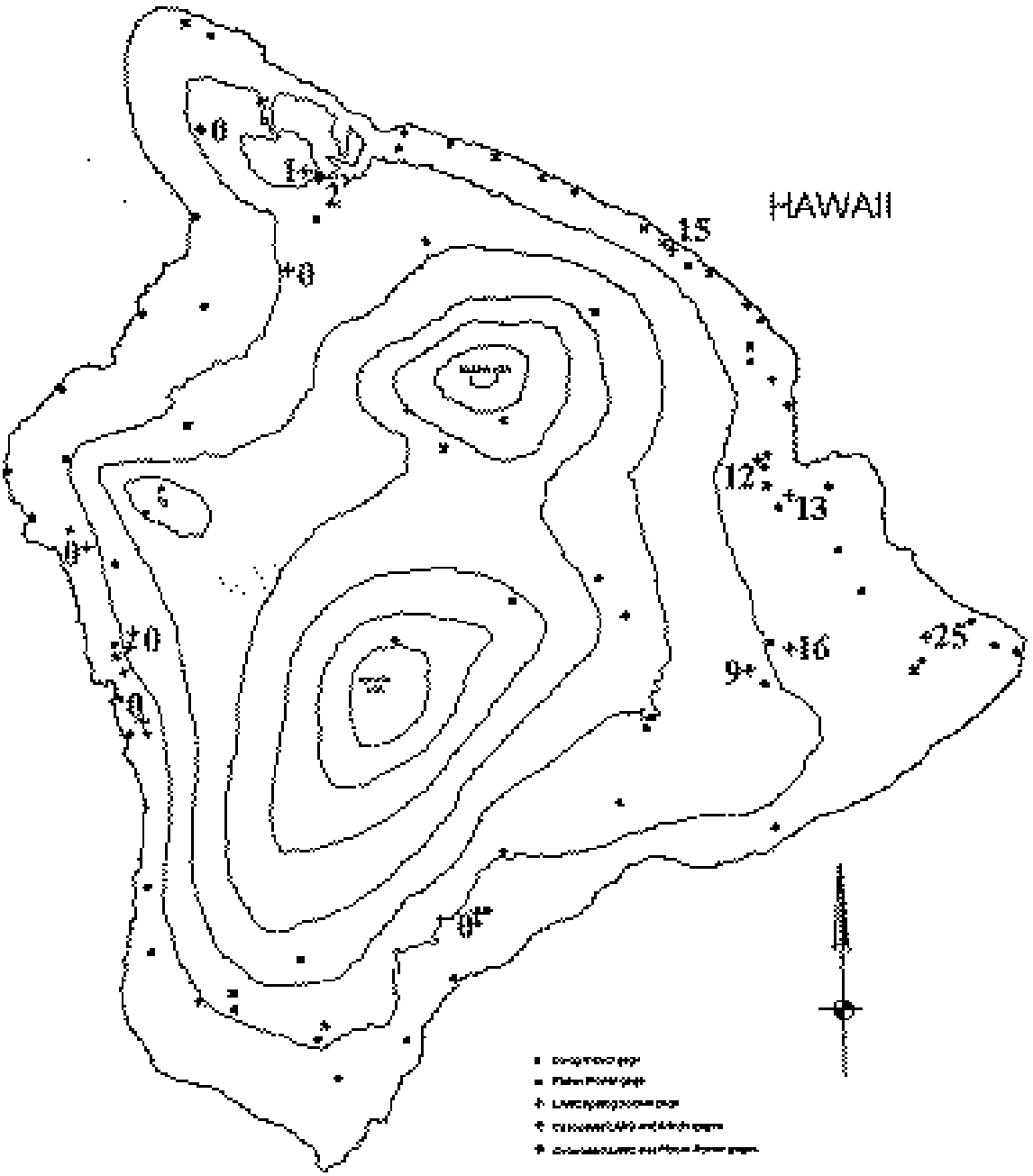

Fig. 12. 6-h accumulated rainfall (mm) for the same period as Fig. 11. Observations are from telemetered NWS rain gages. Due to limited number of observations, isopleths were not drawn for this figure.

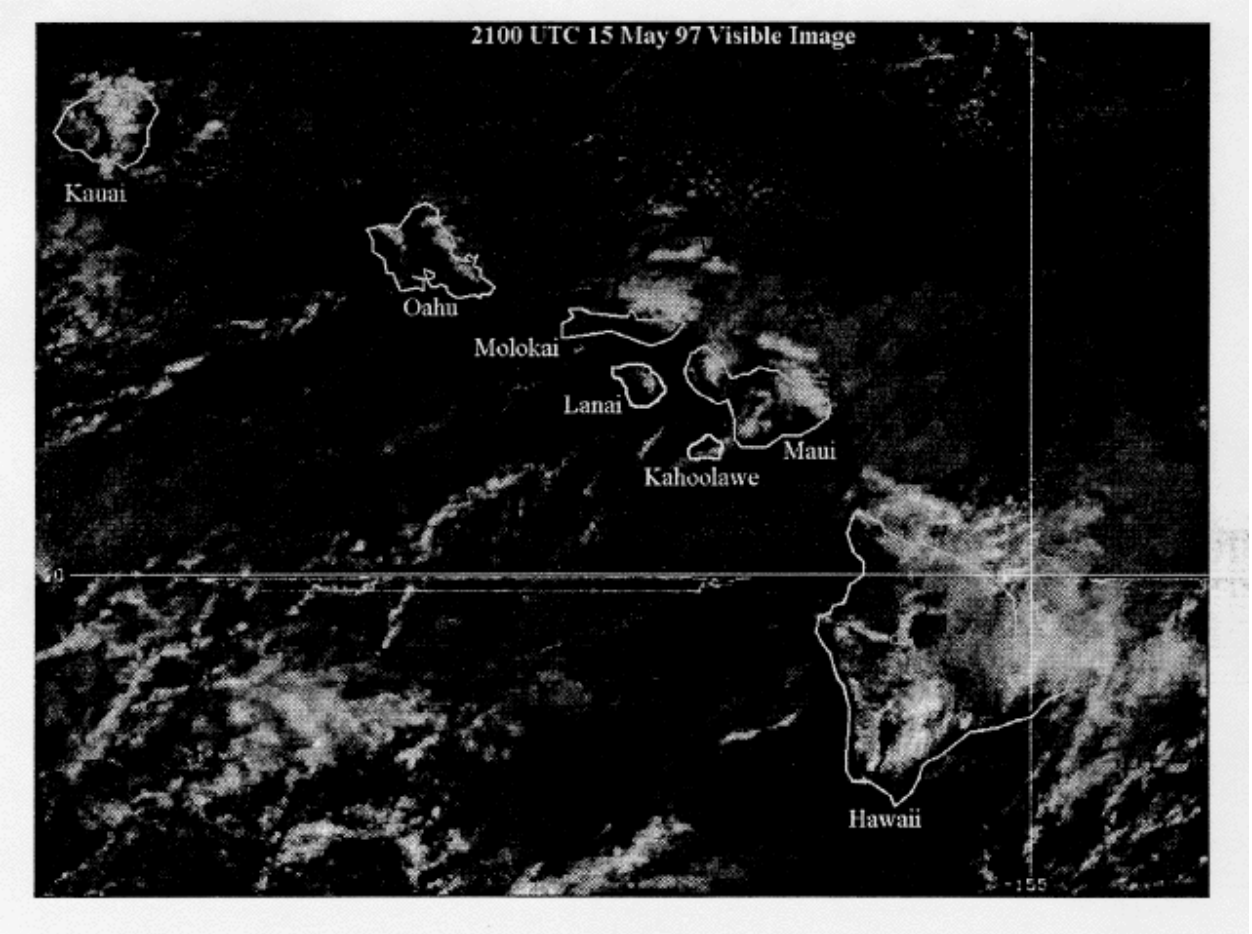

Fig. 13. GOES-9 visible wavelength image for 2100 UTC 15 May 1997.

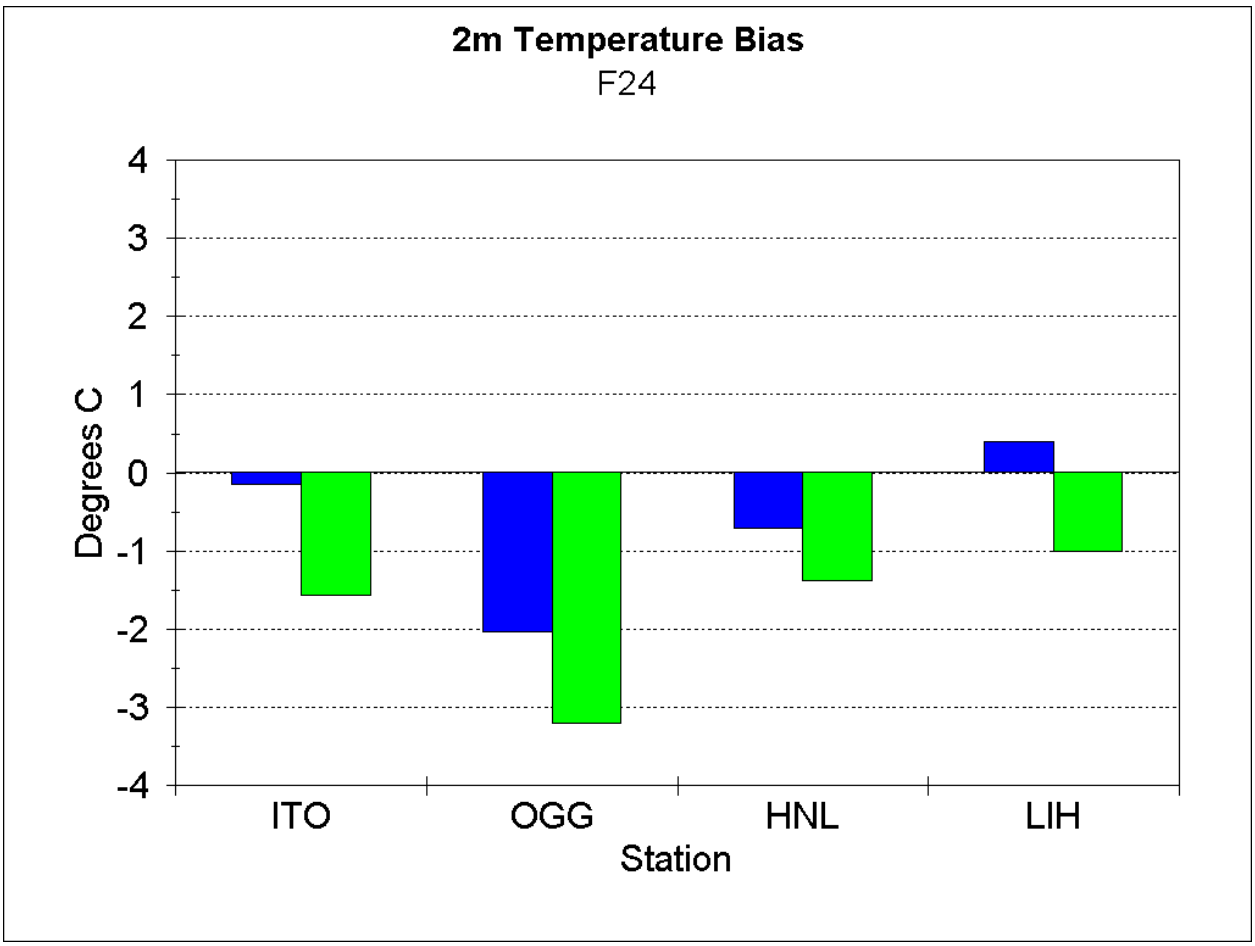

Fig. 14a. Bias of the 24-h forecast for 2 m temperature. The left bar is for AVN results, the right bar is for the RSM. Stations included are Hilo(ITO), Kahului(OGG), Honolulu(HNL) and Lihue(LIH).

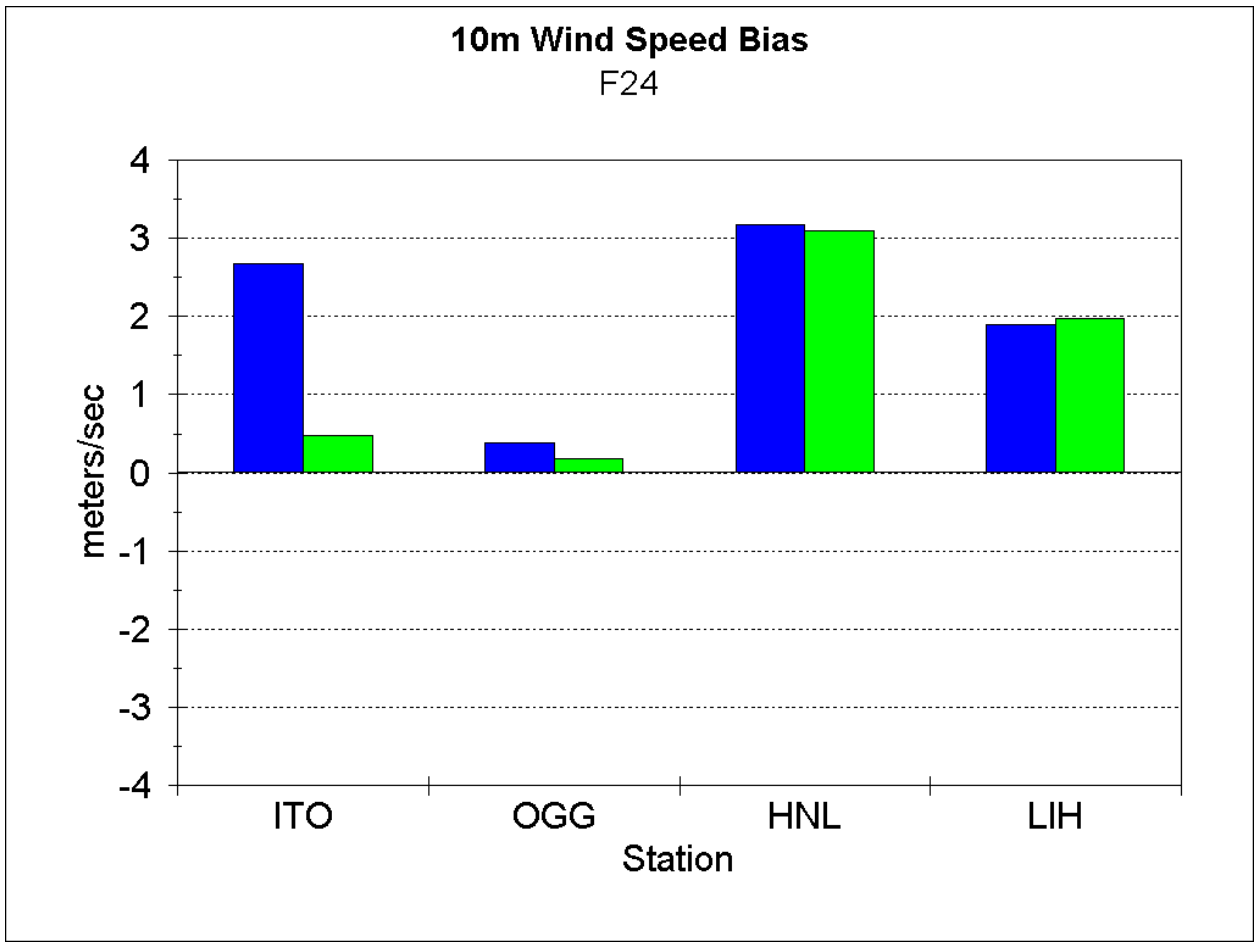

Fig. 14b. Bias of the 24-h forecast for 10 m wind speed. The left bar is for AVN results, the right bar is for the RSM. Stations included are Hilo(ITO), Kahului(OGG), Honolulu(HNL) and Lihue(LIH)

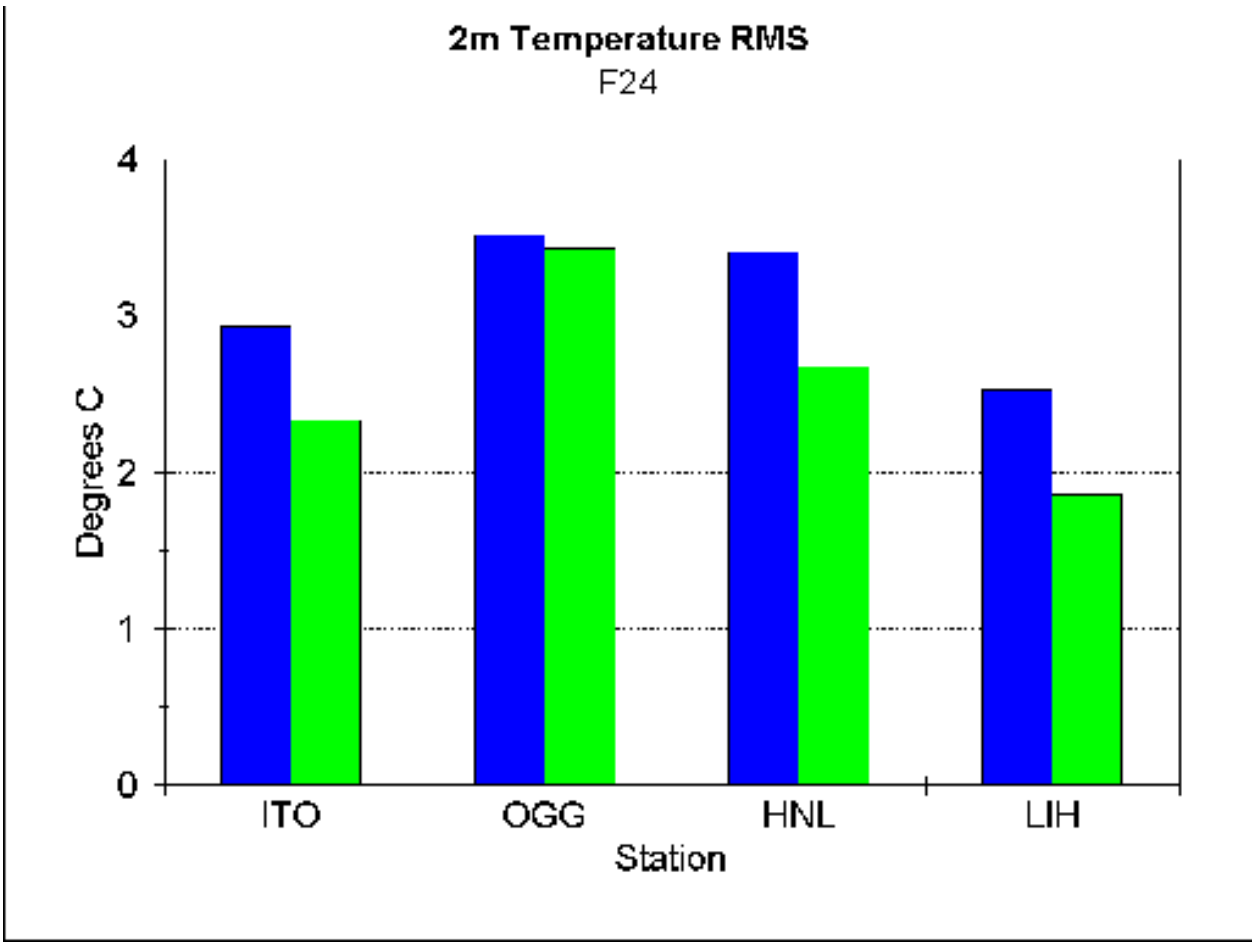

Fig. 15a. Same as fig. 14a, but for root-mean-square error.

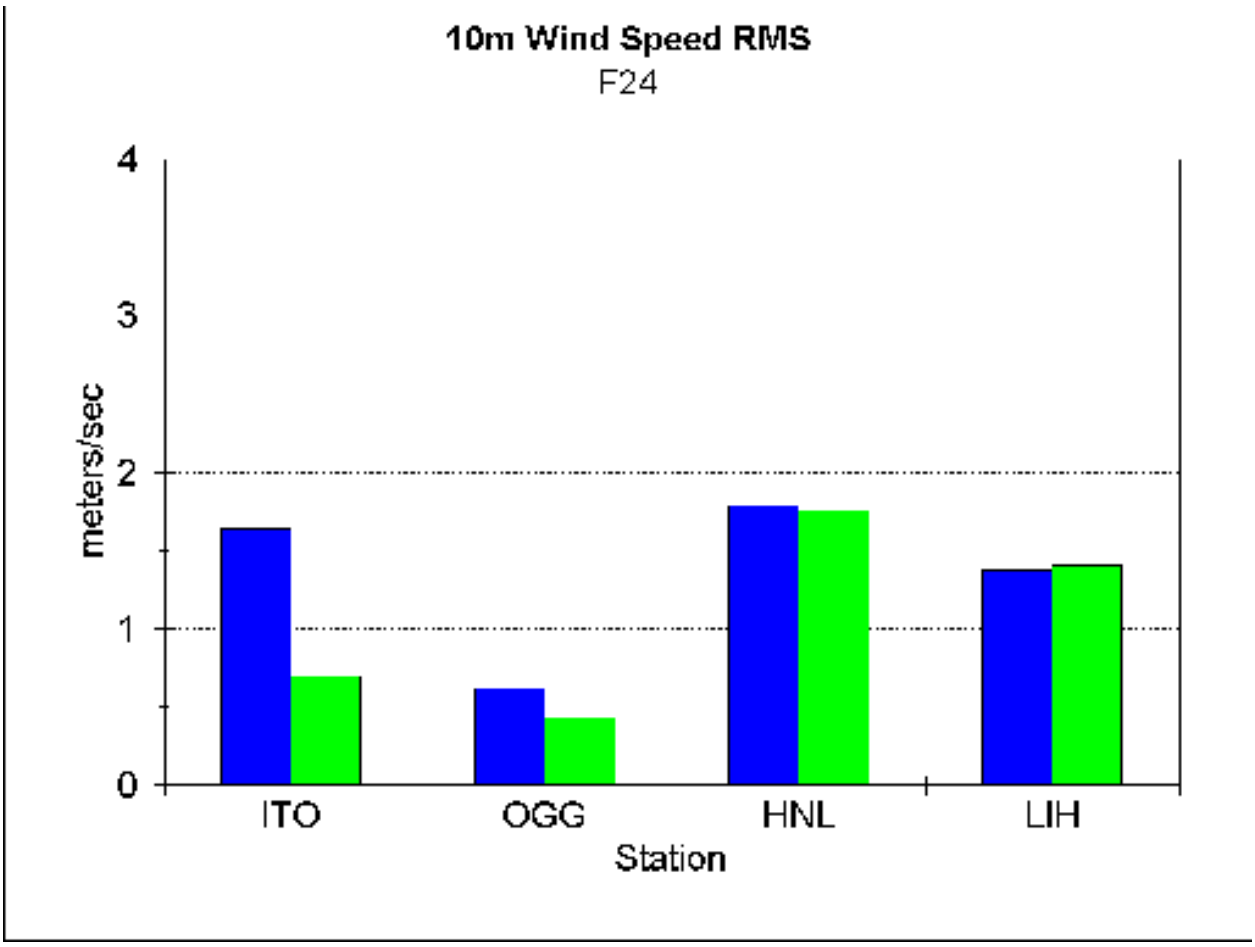

Fig. 15b. Same as fig. 14b, but for root-mean-square error.