INTERACTIVE FORECAST PREPARATION POSITION PAPER 3

Overview of "Model-based Initialization":

Generating Initial Surface Forecast Values from NCEP Models

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SUMMARY

Numerical model output can be used to make initial values of all weather elements used by the IFP system. Values are made for all grid points in the grid used by each office's IFP. The model-based grids can be made anywhere inside each model's native grid, which is usually the entire AWIPS 211 or 212 grid, covering all the lower 48 U.S. states and adjacent waters and lands. Adjustments are made for terrain elevation so that derived elements are valid at all points. Tests against observations show that model-based initialization provides good guidance for coming weather.

Initialization is the provision of grids of initial surface weather elements, such as temperature, wind, cloud coverage, PoP, and so on, for the IFP editors.

Without initial grids of weather elements, a forecaster using the IFP system would be confronted with blank data display screens in the editors at the beginning of each forecast cycle. It is much easier for forecasters to modify a reasonable first guess of coming conditions than to create values from scratch with the editors. Initialization provides an automatic and reasonable set of future weather conditions which the forecaster modifies to represent the final best judgement of future conditions based on all information and experience.

IFP derives grids of initial surface weather values from many sources, including MOS, previous forecasts, and numerical atmosphere models. Future sources might include climatic averages and persistence. This position paper is an overview of generation of initial weather elements derived from numerical atmosphere models run at NCEP.

Numerical Weather Models used by Model-based Initialization

Presently we use the NCEP AVN, Eta, MesoEta, NGM and RUC models. We have used the FSL LAPS-RAMS combination running at FSL for the Colorado area, and plan to resume that service. Any good local model such as RAMS can be used for initial guidance.

Data Source used by Model-based Initialization

Initialization uses the same data files of model output as the WFO-Advanced (AWIPS) display system. The data is transmitted from NCEP via the Satellite Broadcast Network (SBN) and stored on WFO-Advanced as NetCDF files.

Some initialization development on RUC uses data not transmitted via the SBN to offices. RUC is in rapid development and we are testing the full capability of RUC, assuming that it will eventually be available in offices.

Weather Elements made by Model-based Initialization.

Presently model-based initialization of IFP makes the following weather elements at all grid points:

- Temperature
- Dewpoint
- Relative Humidity
- Wind Speed
- Wind Gust Speed
- Wind Direction
- Total Precipitation amount (liquid)
- Snow amount
- Precip rate

- Precip type (rain, frozen, freezing, mixed)
- Cloud coverage (5 layers)
- Total cloud coverage (percent or category) or sky condition
- Weather description (text such as Iso'd R -)
- Maximum temperature for the day
- Minimum temperature for the day
- Probability of Precipitation
- Probability of Showers
- Probability of Thunderstorms
- Probability of Severe Storms
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- Probability of Freezing Precip *
- Probability of Frozen Precip *
- Probability of Drizzle*
- Visibility, and obstructions to vision (fog, haze, blowing dust and snow)*
- Probability of Fog *
- Probability of Haze *
- Ceiling Height *
- Cloud base heights (5 layers) *

* These parameters are not well estimated by the current algorithms.

Time Periods covered by the Models, and Model Grid Resolution

Table 1 shows time periods covered by initialization from each kind of model, forecast time steps, and model grid resolution. IFP initialization nominally creates grids with 10 km resolution; that can be easily changed if needed.

Table 1: Model Time Coverage and Grid Resolution

Model	Time Coverage	Time Step	Model's Grid Resolution
AVN	0 - 72 hours	6 hours	80 km
Eta	0 - 48 hours	6 hours	48 km
MesoEta	0 - 33 hours	3 hours	29 km
NGM	0 - 48 hours	6 hours	80 km
RUC	0 - 12 hours	3 hours	60 km

Geographic Areas covered by the Model-based Initialization

Model-based initialization can be run anywhere inside the model output grids provided by NCEP to the offices via SBN. Usually this includes the lower 48 U.S. states and adjacent waters and lands. The new Eta model (late summer 1997) will also cover Hawaii and Alaska, and model-based initialization will be available over all of those areas.

Derivation of Surface Weather Elements from Model Output.

Techniques for derivation and creation of weather elements from model output are described in *IFP Position Paper 5*. The code in use at the moment uses algorithms for clouds, precip phase type, and visibility from Jim Ramer, and ideas for estimating probability of thunder and severe weather from Keith Brill and Ed Szoke. The remainder of the code was developed by Stuart Wier.

Derivation of surface weather elements from model output provides these enhancements over raw model output for IFP:

- Weather element values at the actual latitude and longitude of every IFP grid point, not model grid point locations. This involves interpolating from model grid positions to a denser grid.
- Weather element values are valid for the true surface elevation at every IFP grid point, not the model's surface elevation (if any). This involves mathematical and meteorological projections from data at other levels in model output.
- Creation of values for elements not present in the model's output, including daily maximum and minimum temperature, precip type, snow amount, cloud layer base heights, cloud coverage, visibility, obstructions to vision, ceiling, and the "probability" values.

Quality of Model-based Initialization

The values of many initial weather elements made from models are checked against observations at stations across the lower 48 states of the U.S. The quality of these initial forecasts is good. There are strong indications that IFP model-based initialization is ready for operational forecast tests.

Details of the tests and results are described in IFP Position Paper 4.

Advantages of Model-based Initialization

Model-based initialization takes full advantage of the high-quality models of the atmosphere now in use.

Model-based initialization instantly benefits from improvements made in the underlying models. Changes now happen rapidly in modeling, and IFP initialization benefits immediately from better model physics, spatial resolution, and time resolution, without re-coding or other delays.

Model-based initialization retains the full resolution of model output. The IFP system editors present the highly detailed model forecasts to the forecaster, and allow that high resolution detail to be preserved in forecast products.

Initialization on a high-resolution grid, based on a numerical model of the atmosphere, catches important weather developments in place, not only after they pass selected stations as is the case for station-based approaches. You can see the front coming *before* it reaches your location. You can see severe weather development *between* cities.

Having several models in initialization means that forecasters have a choice of which model to use.

Having several models in initialization means that the failure of a model or failure of arrival of some model data does not leave the forecaster empty-handed for 12 hours or more.

Graphical Displays of Model-based Initialization

The following displays are at the end of this paper:

Maximum Daily Temperature (47 K)
Surface Temperature (45 K).
QPF (22 K)
High Resolution Wind Forecast from RUC (16 K)
Chance of Thunderstorms, The Carolinas, offshore, with radar obs (17 K)
Hurricane Fran Wind Forecasts (27 K)
Hurricane Fran QPF Forecasts (36 K)
Hurricane Danny Cloud Cover (46 K)
Snow Accumulation (22 K)

Examples of today's initial forecast guidance from models are displayed by the AFPS Graphical Forecast Viewer (GFV) and Formatter available on the EFT home page. The GFV is in development and may not be available or have data at all times.

Future Work

Future work will include improvement in estimation of surface weather values from models, adaptation to new model features, and expansion into initial weather elements needed for aviation and marine forecasts, such as wave heights and superstructure icing.

One needed improvement is a good visibility algorithm. New output from Eta and RUC (cloud moisture amount, etc.) will allow trial of visibility algorithms based on actual optics an cloud physics. Good visibility will allow forecasting fog as well as visibility.

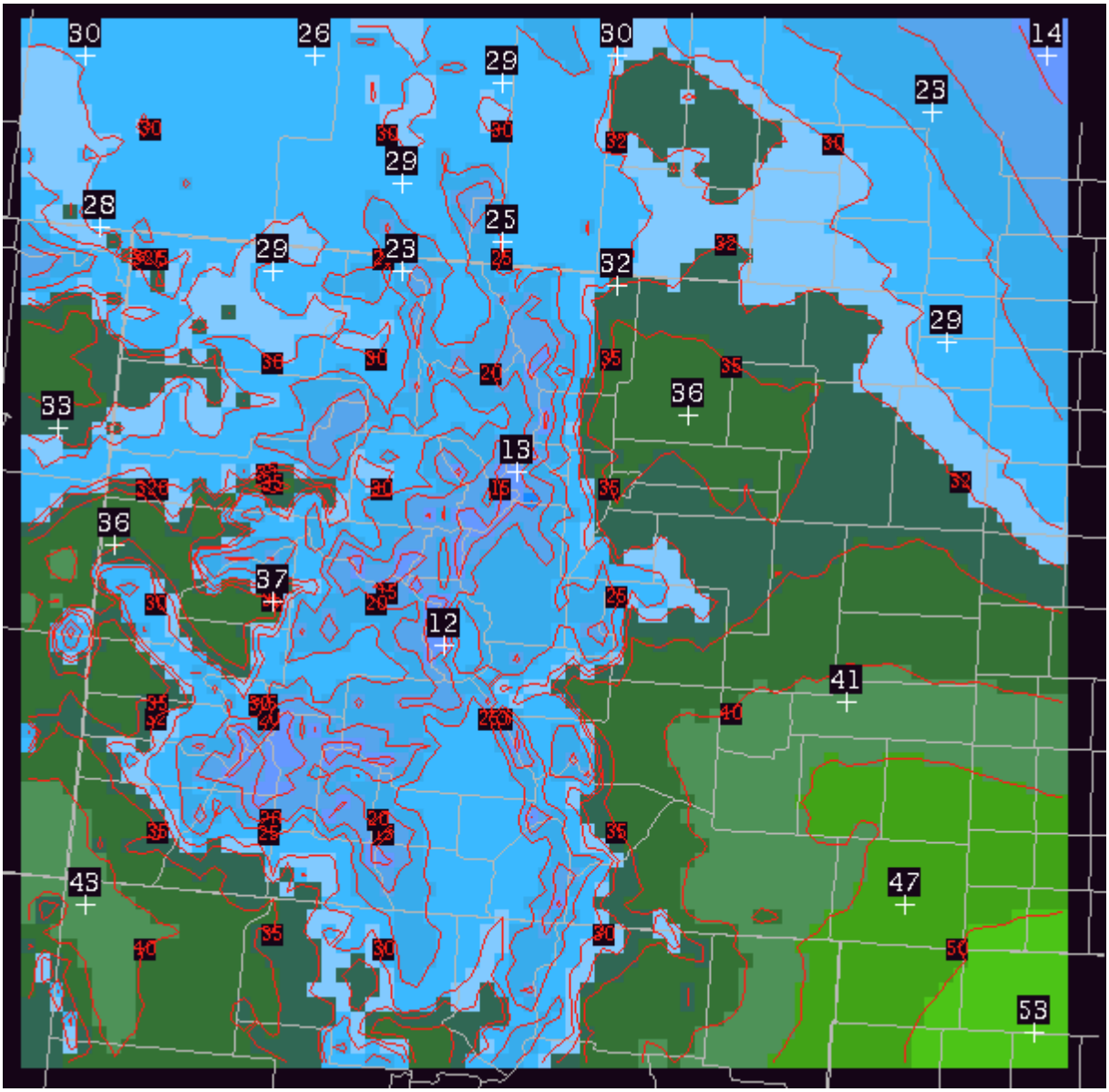
Another area of future work is orographic precip amounts, especially for snow amount. This is essential for good modeling of snow in the mountains. Since model-initialization already includes moisture, wind, and topography, no new data is required.

July 3, 1997; revised August 22, 1997.

Initial Eta-based initial forecast of Max temp, Dec 22 1996

Note the cold air mass to the Northeast.

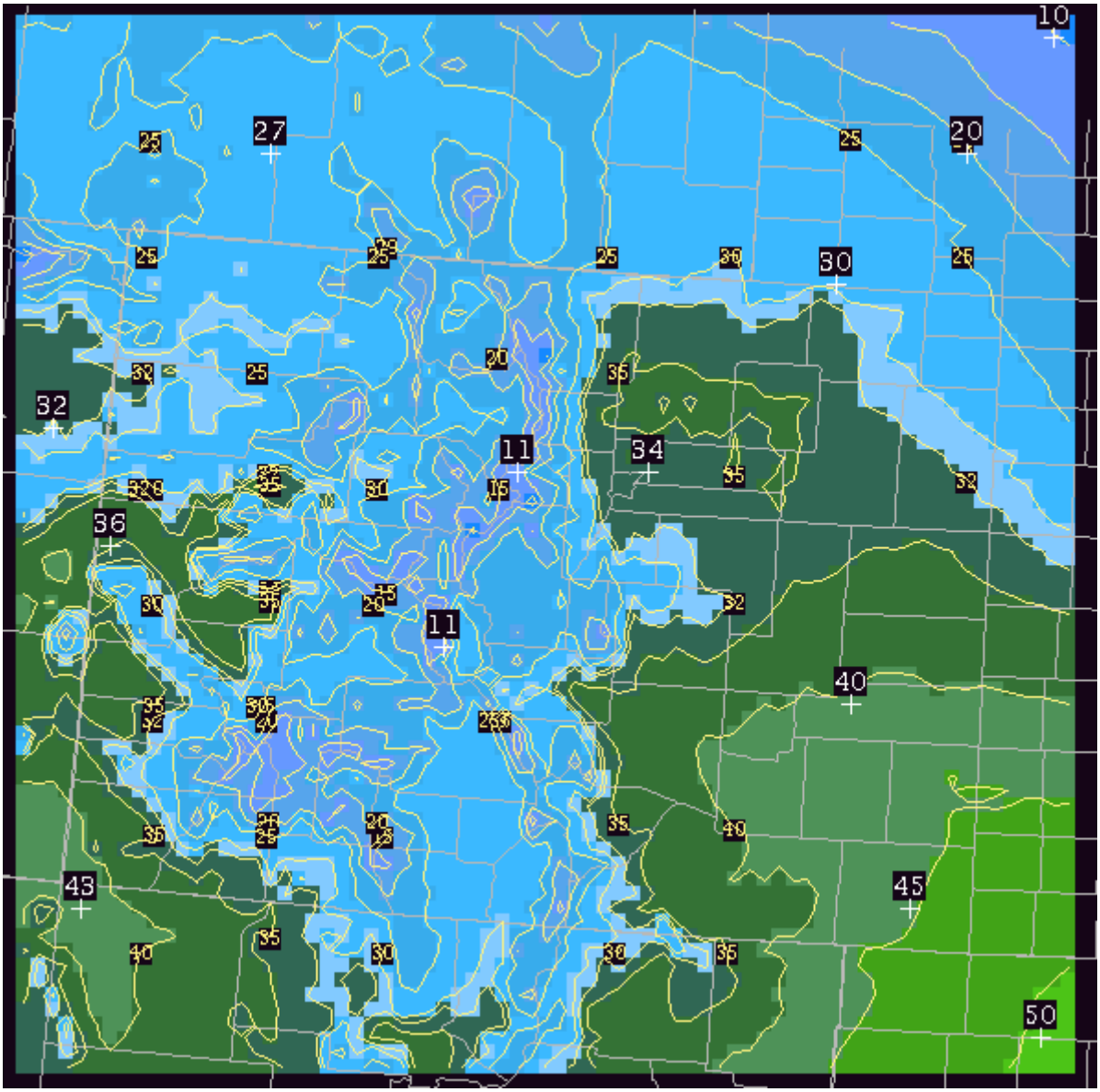
Background map: Colorado counties and surrounding states' counties.



Initial Eta-based initial forecast of surface temperature, 00Z Dec 23 1996

Note the cold air mass to the Northeast, the tail end of the major cold outbreak of the preceding week in the central U.S.

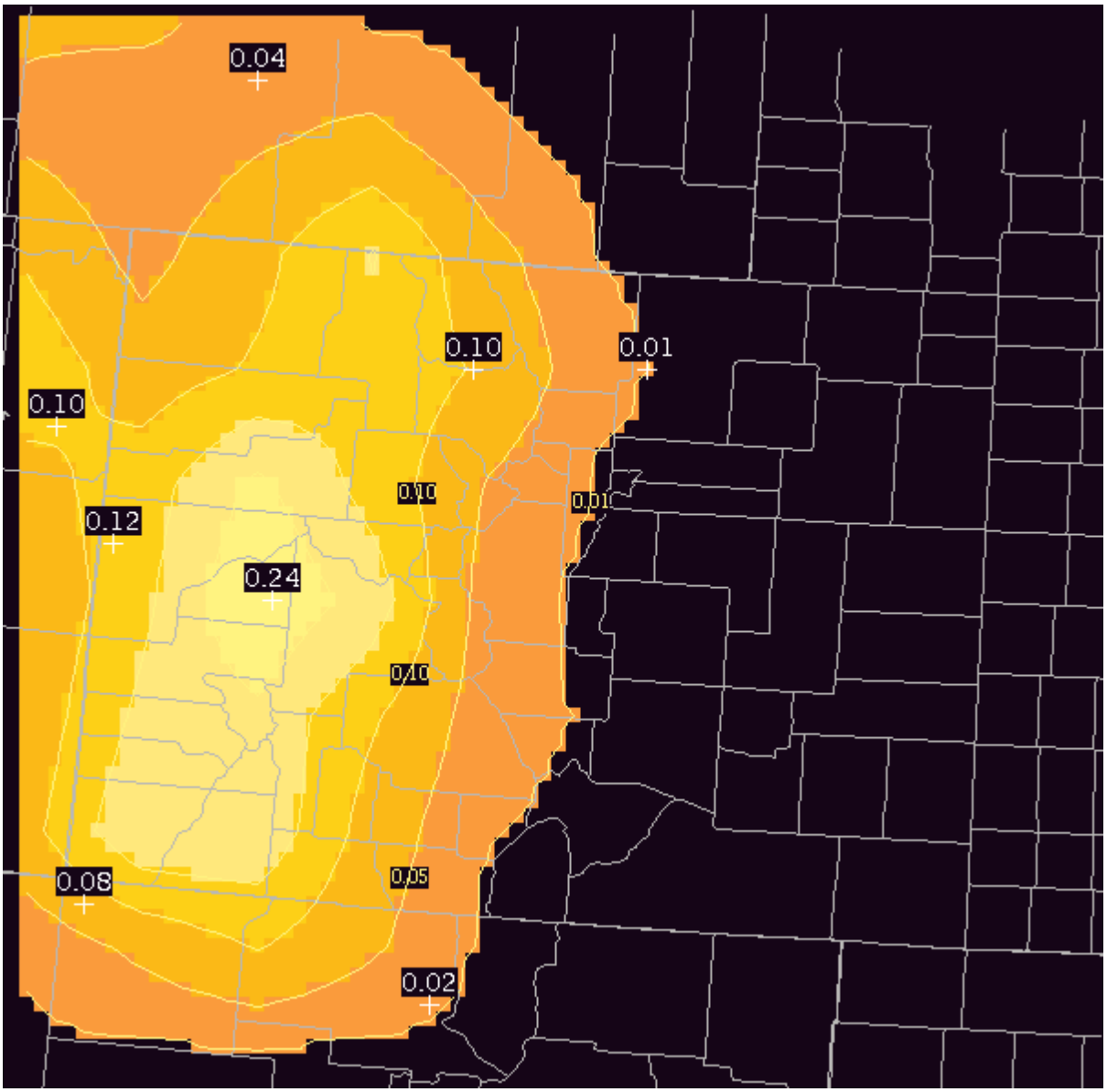
Background map: Colorado counties and surrounding states' counties.



Colorado is an excellent place to test weather forecasting techniques. Sometimes there is more variation in weather across one county in Colorado than across one state in the eastern U.S. Notice the details provided by model-based forecasts displayed on the AFPS 10-km grid.

Initial Eta forecast of QPF, 12Z - 18Z Dec 22 1996

Background map: Colorado counties and surrounding states' counties.



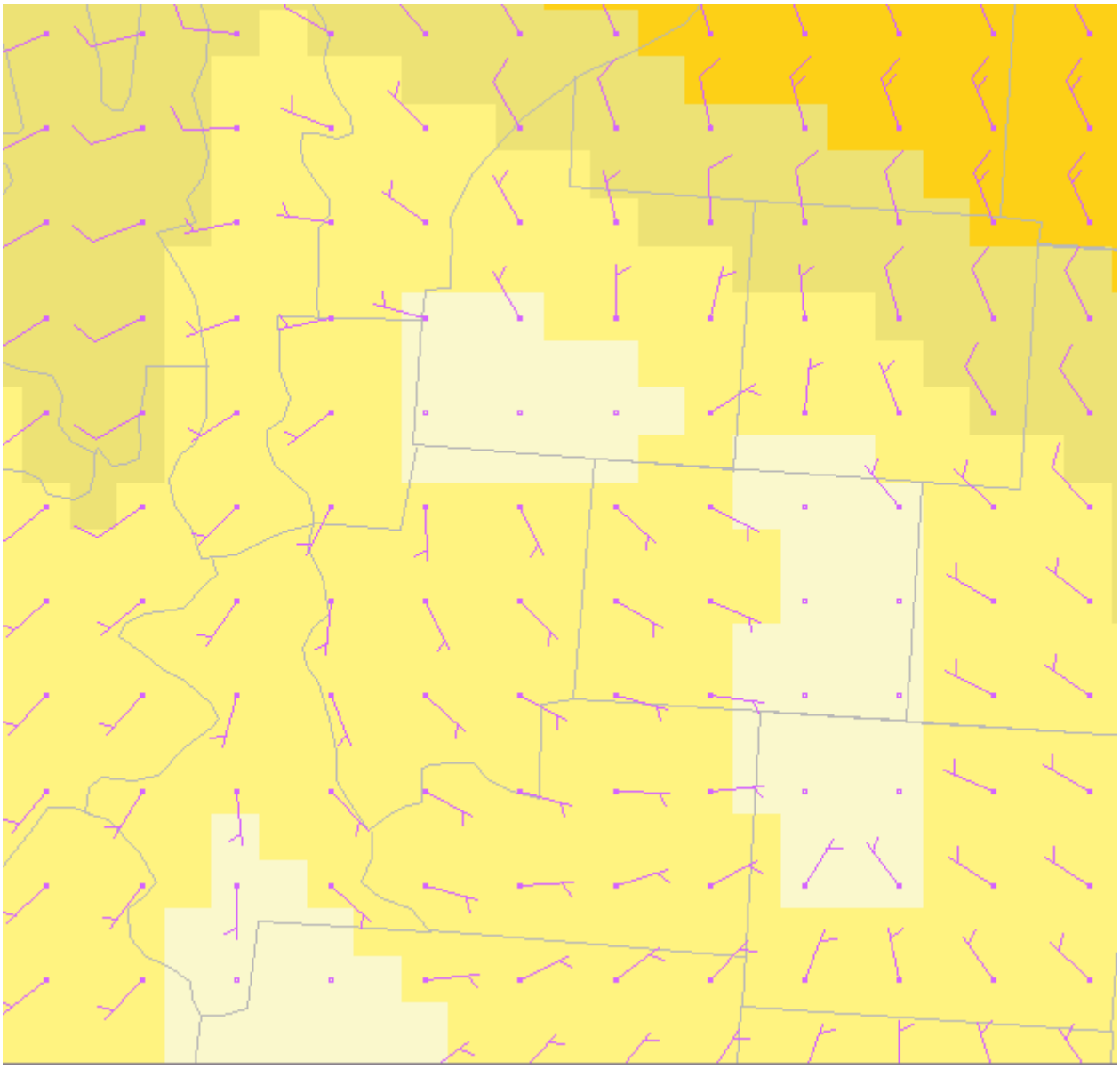
Initial RUC-based forecast of surface winds 03Z Jan 16, 1997

Centered on Denver International Airport

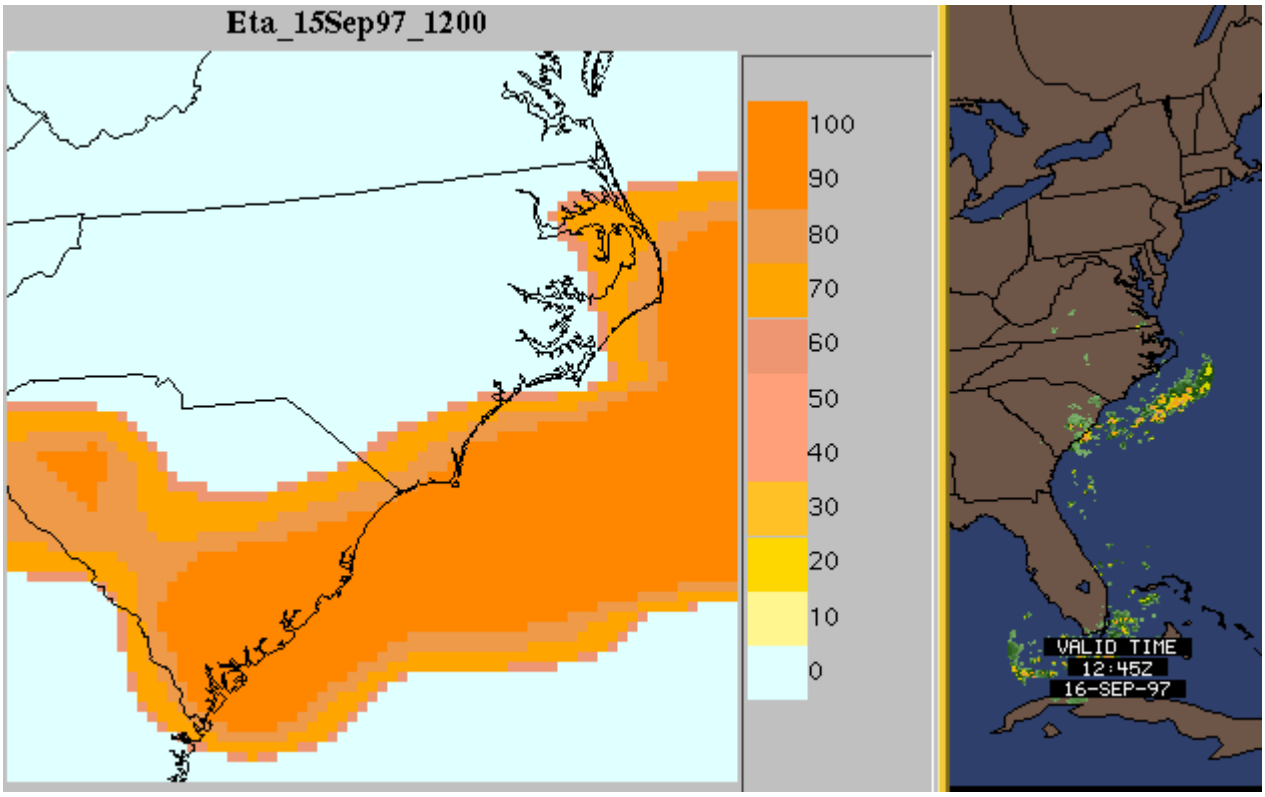
Spacing between wind barbs shown is 20 km;

Spacing between grid cells is 10 km.

Background map is NWS forecast Zones.



Initial Eta-based Chance of Thunderstorms, the Carolinas area, for 12Z September 16, 1997, with radar obs at the same time. Eta model run of 12Z Sept 15.



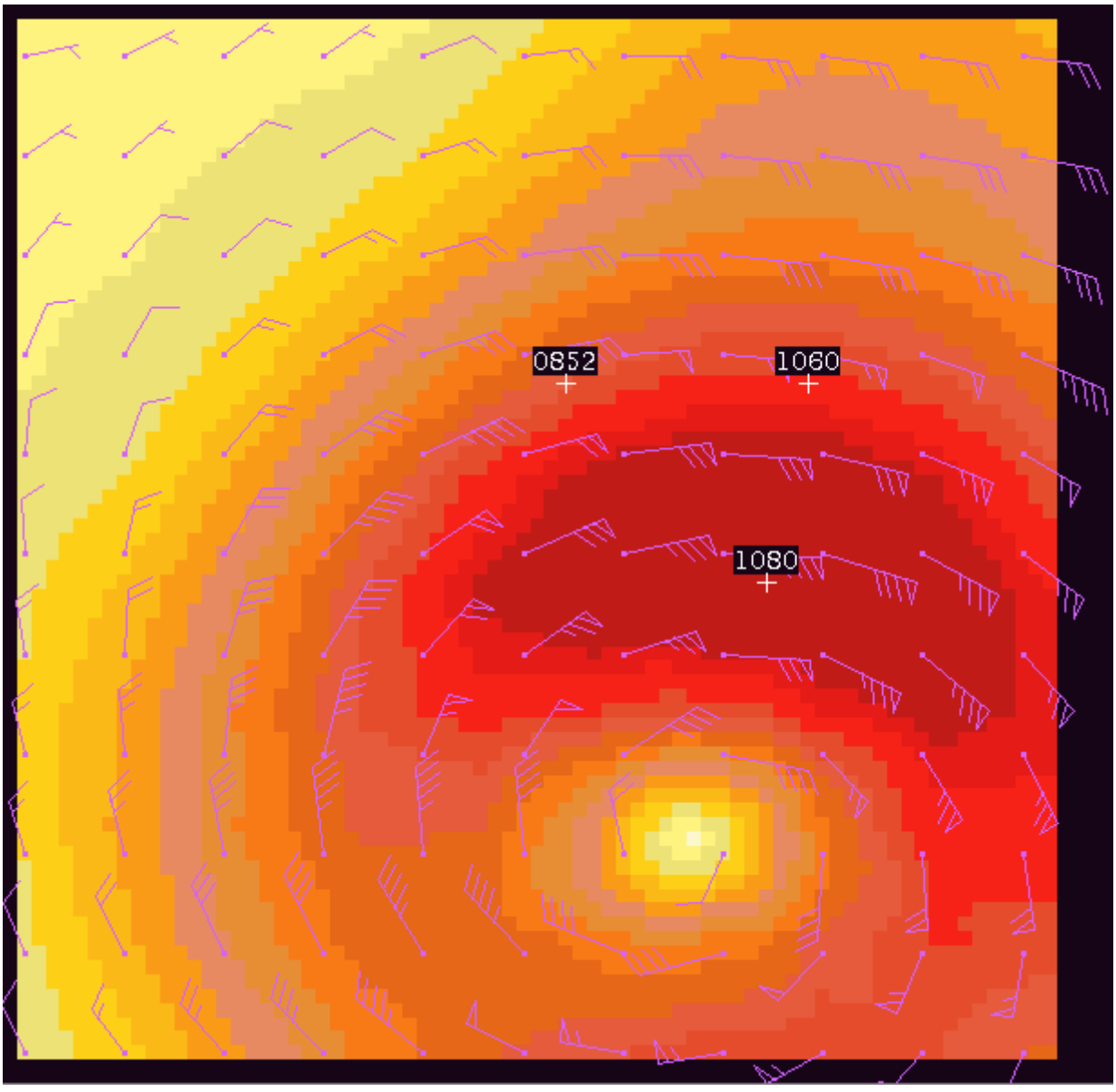
Initial Eta-based forecast of surface winds from Hurricane Fran.

12Z, 5 Sept 1996

South Carolina - North Carolina border runs across upper left corner.

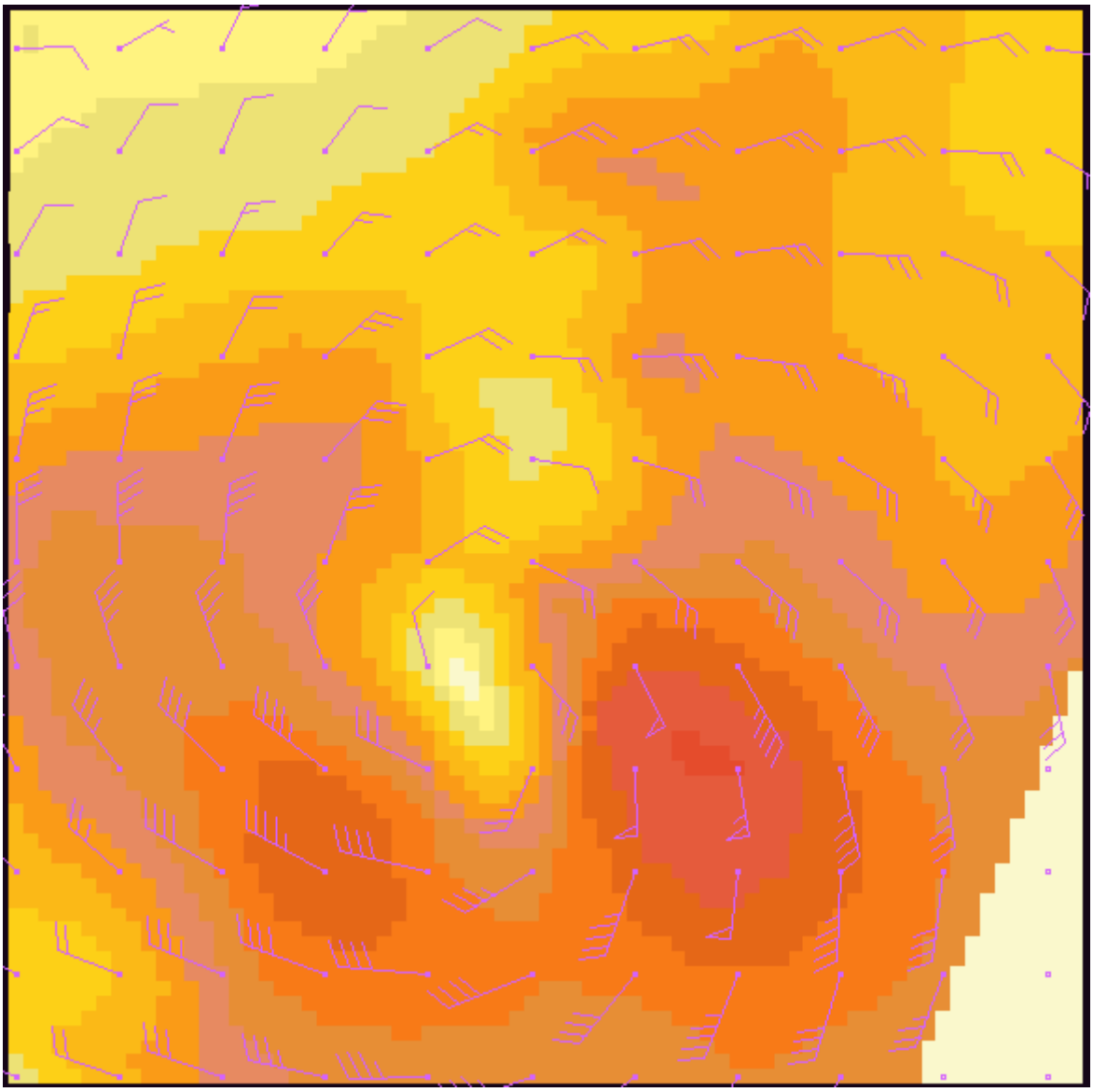
10 km grid cell size. Each 7th grid cell has a wind barb.

Peak wind speed 81 knots.



AFPS RUC-based forecast of winds from Hurricane Fran, 03Z 6 Sept 1996

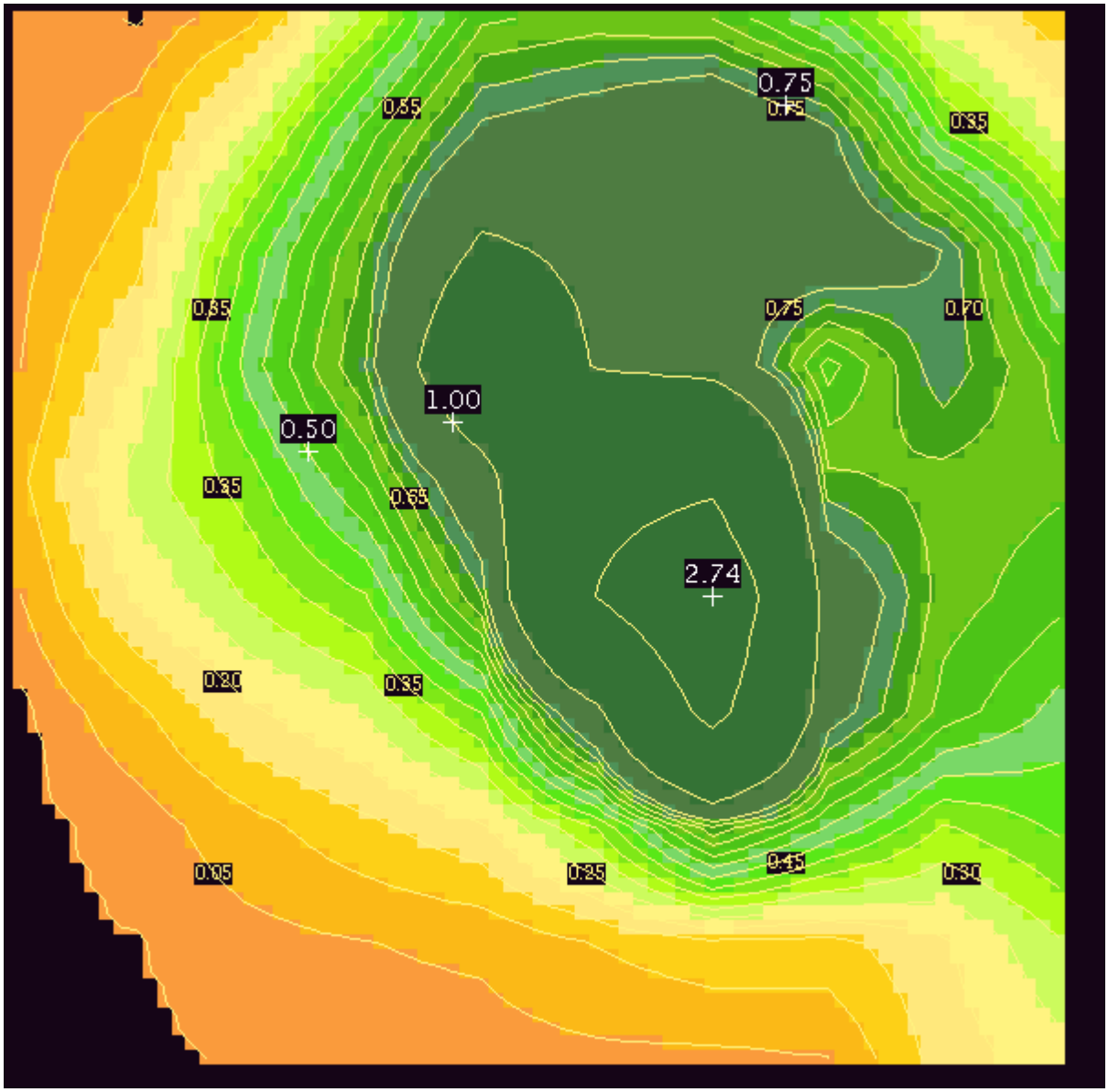
North and South Carolina coast runs from lower left to upper right.



Initial Eta 6 hour QPF from Hurricane Fran, 12 to 18 Z, 5 Sept 1996

Peak value is 2.75 inches.

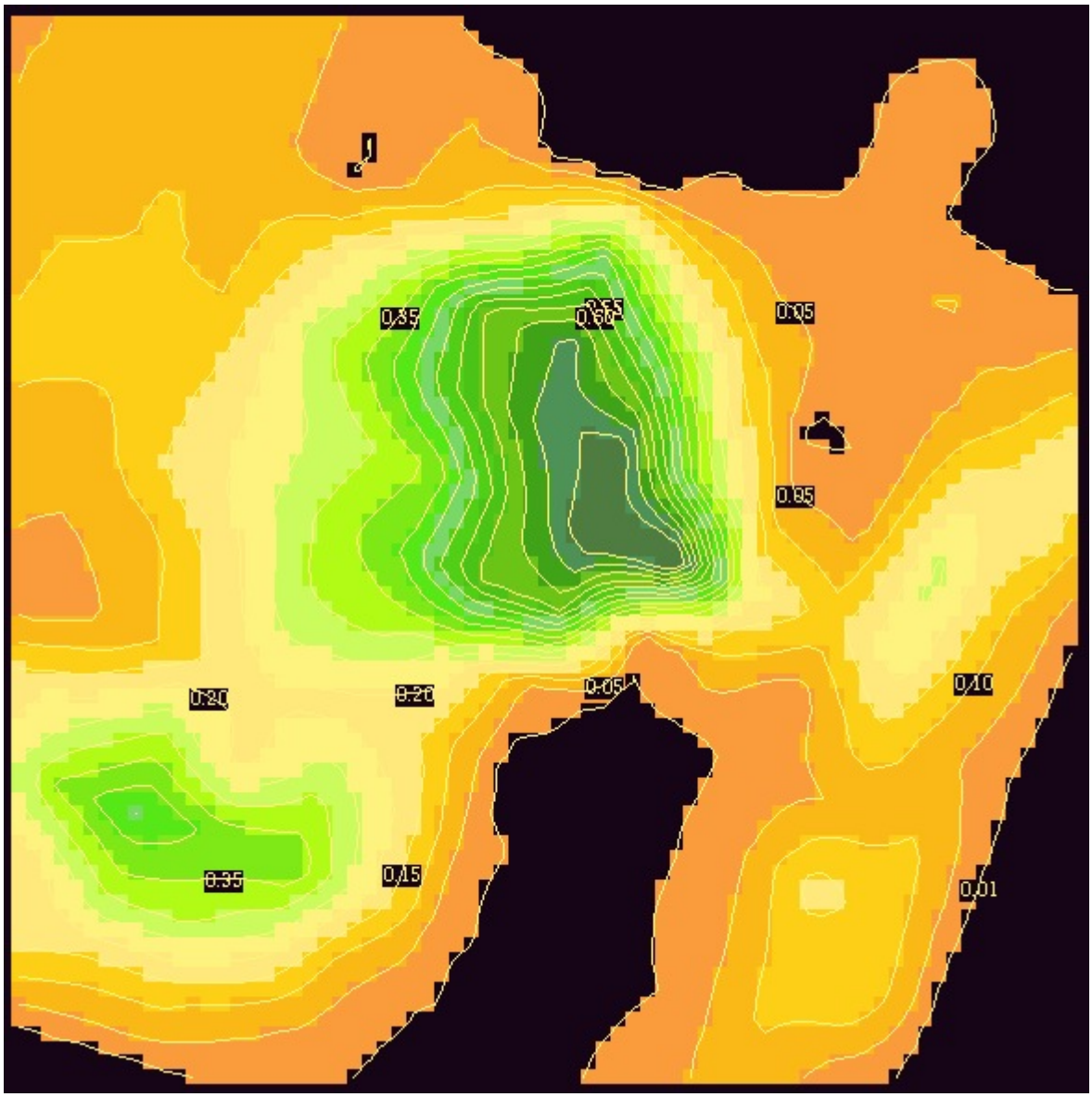
Grid cell size is 10 km.



Initial RUC 6 hour QPF from Hurricane Fran, 3 to 9 Z, 6 Sept 1996

Peak value is about 0.85 inches.

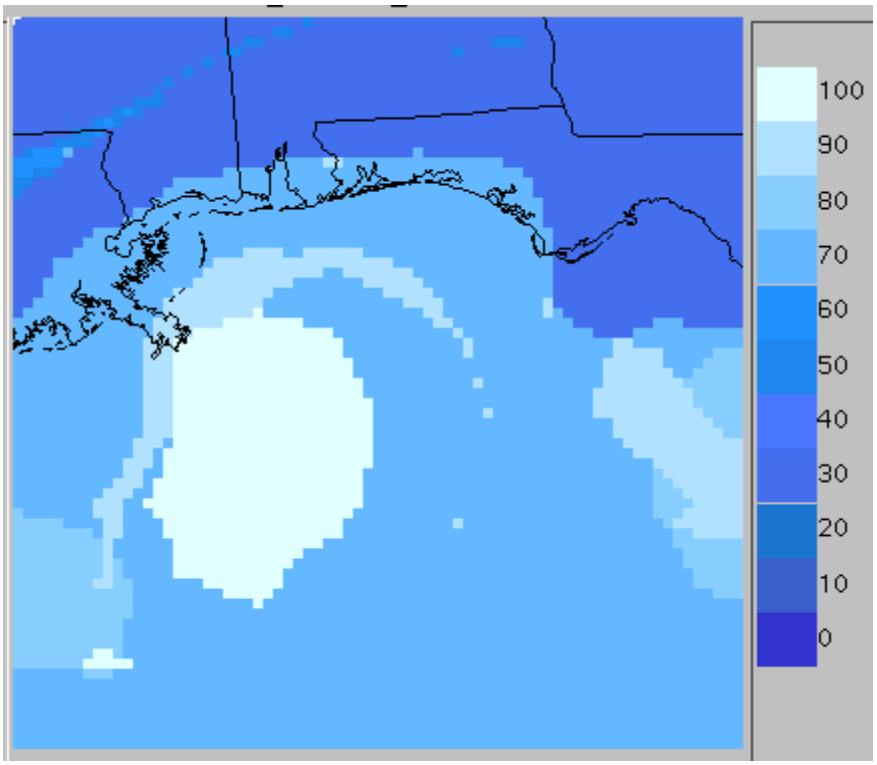
Grid cell size is 10 km.



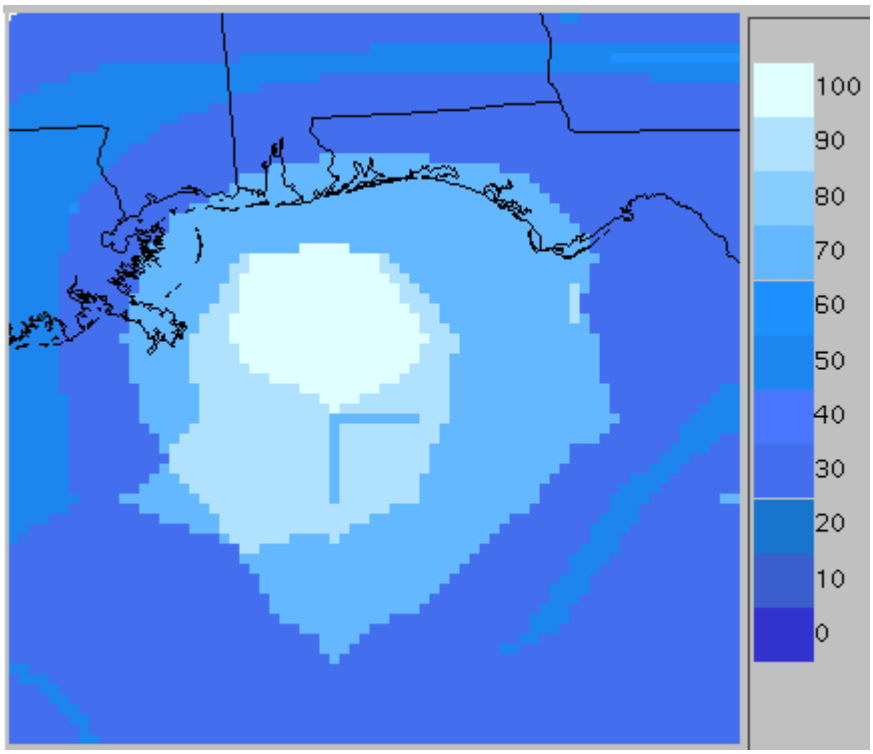
Eta-based forecasts of cloud coverage (percent) for Hurricane Danny, July 18 and 19, 1997

Background map: state boundaries.

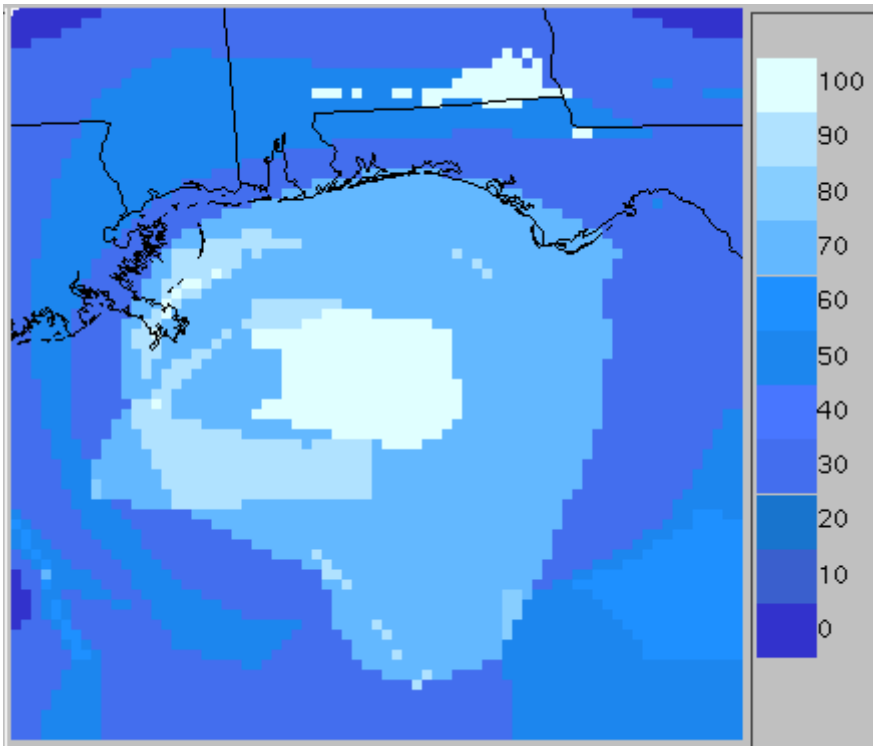
1 PM CDT July 18 1997



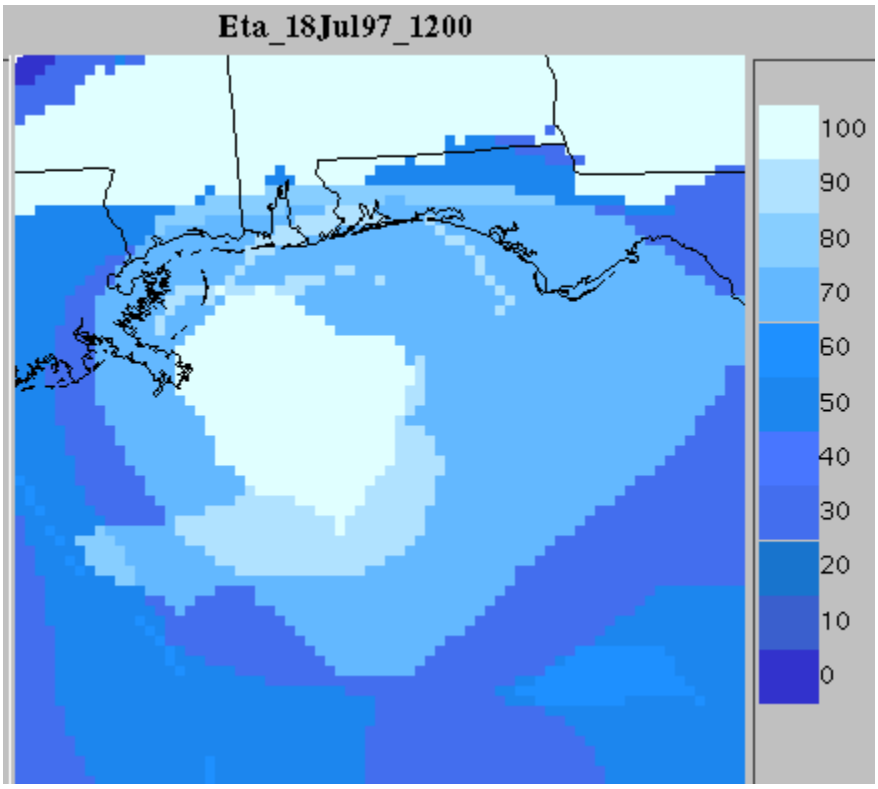
7 PM CDT July 18 1997



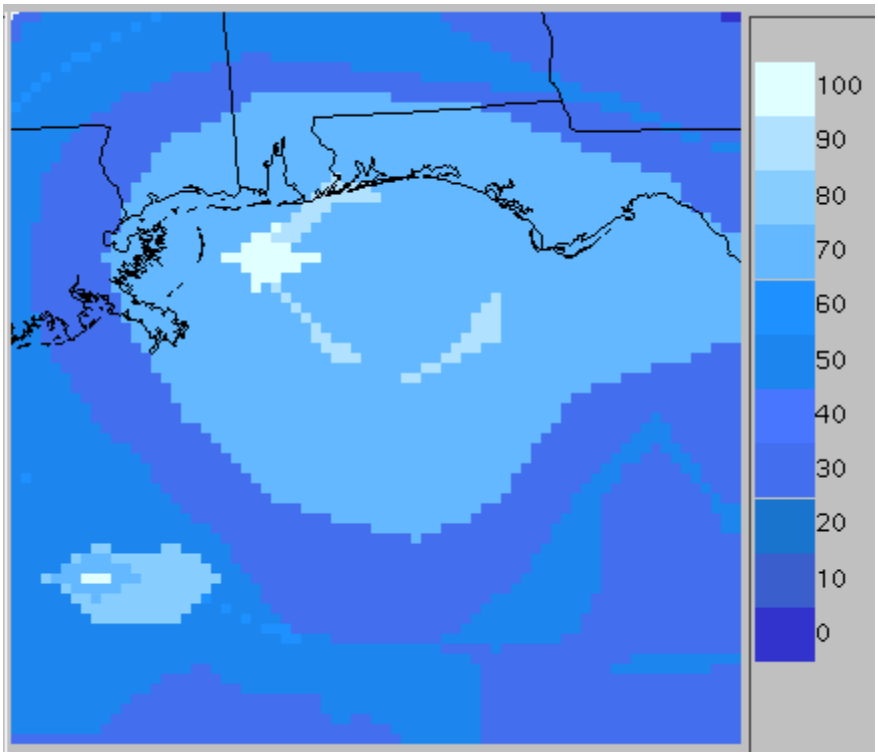
1 AM CDT July 19 1997



7 AM CDT July 19 1997



1 PM CDT July 19 1997



Initial Eta-based initial forecast of snow amount, 12Z-18Z Dec 22 1996 (6 hrs)

A major snowstorm occured in the Colorado Rockies during this period.

Background map: Colorado counties and surrounding states' counties.