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If we purposely make small changes to the initial data that we use to generate our numerical (computer model) forecasts, or make very small changes in the equations we use, and observe the range of results, we can get a sense of how chaotic the system is and also know how confident we can be about the forecast. Look at the three temperature diagrams. Do the lines look like spaghetti? We meteorologists do call them spaghetti diagrams. Now you see where my weird title came from. These diagrams show the location of a temperature of about 60° about 1 mile high in the atmosphere. The initial location (Figure 1) of 60° is varied, because different computer models are used to begin the creation of a variety of computer solutions for this weather variable.

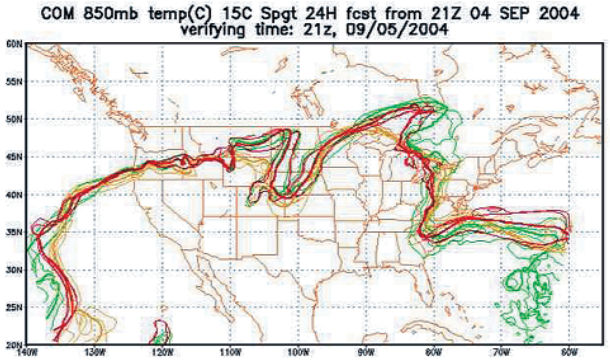

Fig. 2 1 Day Forecast

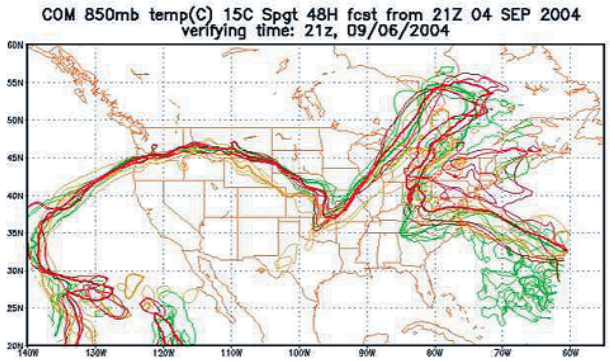

Fig. 3 2 Day Forecast

If you look closely, you can count 15 different 60° temperature lines or 15 separate pieces of spaghetti. There are 15 members of this "ensemble." Look how the range of solutions changes with time, out to 2 days. Would you have more confidence in the location of this 60° temperature at 2 days near Portland, Oregon, or near Portland, Maine? Why the great differences? The Pacific Ocean's water temperature doesn't change dramatically from day to day; the air temperatures above the ocean are also rather stable compared to the great day-to-day, and day-to-night variation over the land. And because our weather and air generally move from west to east, those big predicted differences show up much more above Portland, Maine than above Portland, Oregon.

These ensemble models are becoming a more powerful tool for forecasters. In addition to providing us information about the "spread" or uncertainty of weather variables, the mean or average of the ensemble gives us useful information to compare with single deterministic models. Ensembles are now used in hurricane track forecasts, winter precipitation type forecasts, as well as day-to-day and long-range forecasts. In the future, ensemble forecasts will help us better forecast very short-term weather such as summer thunderstorm squall lines and even help us give probability estimates of different events because of global changes. The statistical and probabilistic information we can derive from ensemble models is also helpful to anyone who has to make weather-related decisions, from power company managers to drivers, who hope their vehicles continue to operate in a linear manner.

Spaghetti: fun to eat, and great fun to have as a weather forecasting tool.