Introduction

This lesson, providing a general overview of the BehavePlus fire modeling system, is based on 'BehavePlus fire modeling system: past, present, and future' presented at the 7th Symposium on Fire and Forest Meteorological Society, October 2007. The paper is available on the BehavePlus Publications page of www.firemodels.org. It is appropriate to provide that paper as a handout.

Objectives

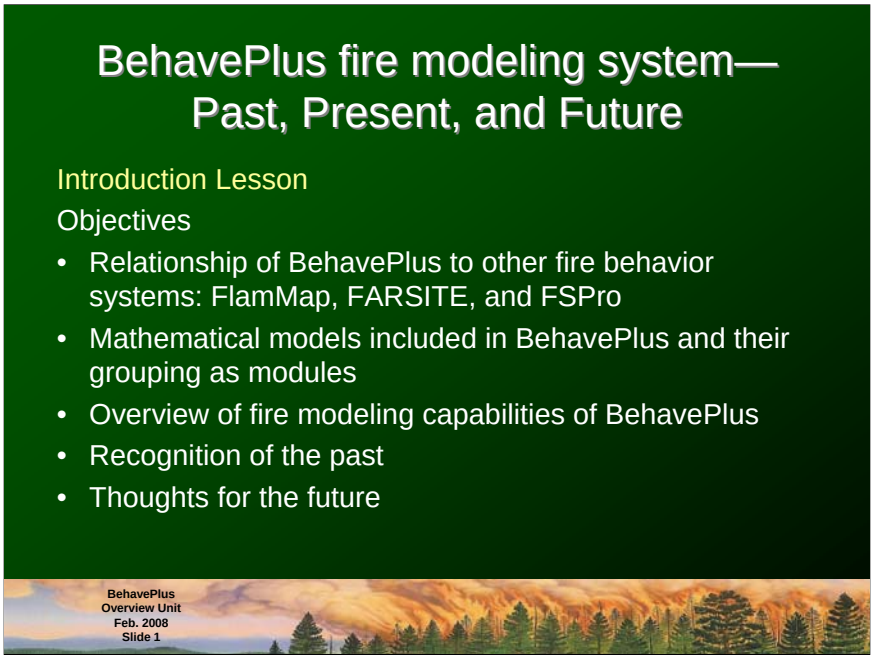
1. Understand the relationship of BehavePlus to other fire behavior systems: FlamMap, FARSITE, and FSPRo.
2. Understand the relationship of BEHAVE to BehavePlus.
3. See an overview of the fire modeling capabilities of BehavePlus
4. See ideas regarding the future of BehavePlus

Where This Lesson Fits In

This lesson is the first in the Overview Unit. It is a PowerPoint lesson. This is not a hands-on lesson; therefore the BehavePlus program is not run.

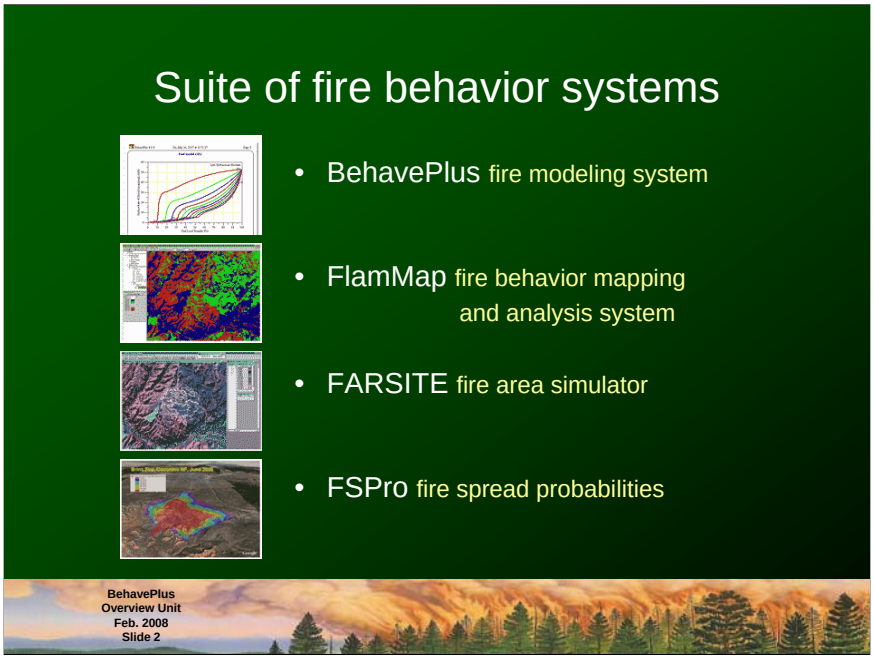
As a self-study, a person can view the PowerPoint slides in **Normal** mode to see the notes associated with each slide.

Following are the notes in a form that a presenter can use when showing the **Slide Show**.

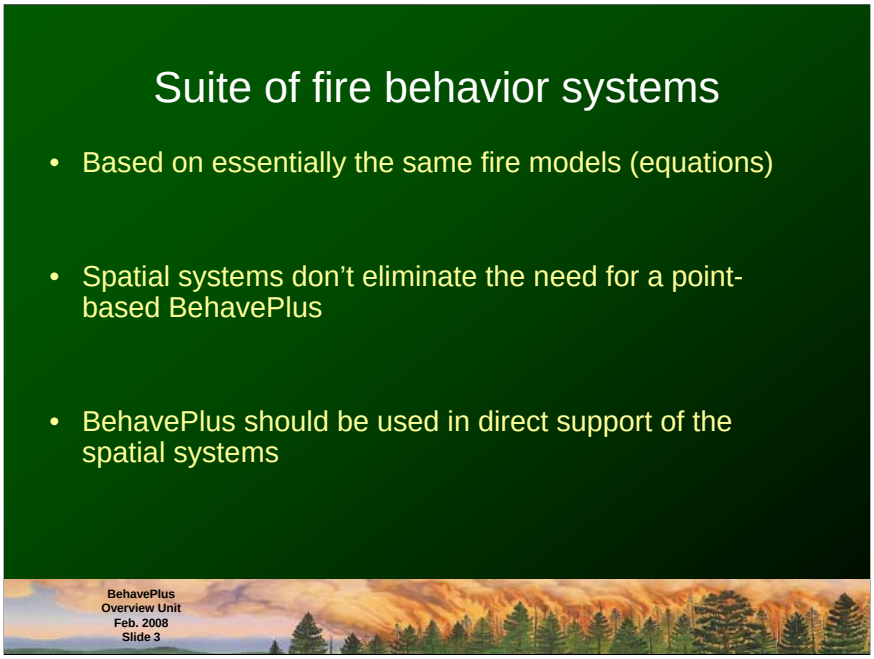


- This lesson is based on a presentation to the 7th Symposium on Fire and Forest Meteorological Society, October 2007.
- A paper related to this presentation is available on the BehavePlus publications page of www.firemodels.org

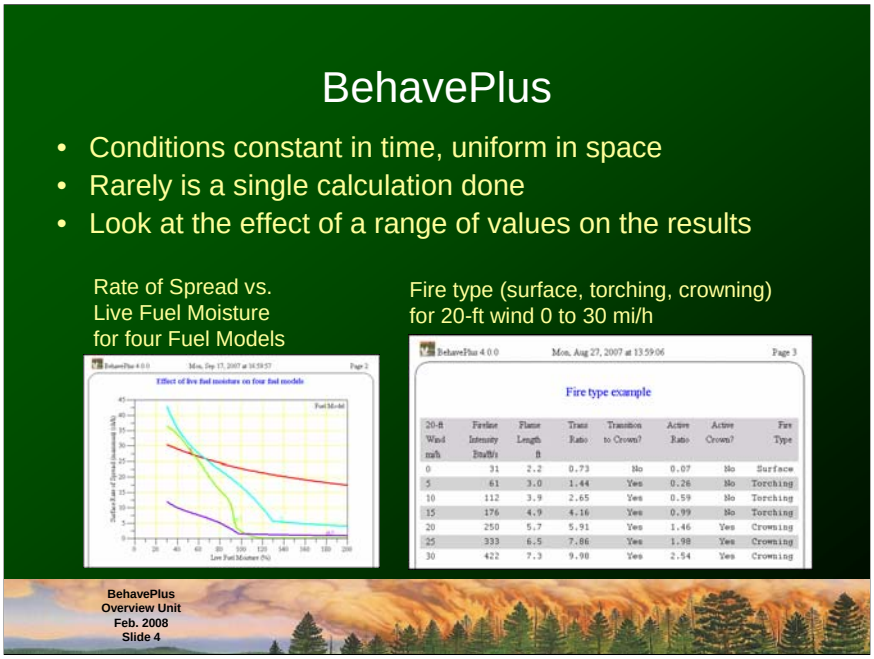
- We will start with a brief discussion of the relationship of BehavePlus to other fire behavior systems: FlamMap, FARSITE, and FSPro.
- We will then demonstrate how mathematical models are grouped together as modules in BehavePlus.
- A brief overview of the fire modeling capabilities of BehavePlus will be given.
- I will then say a few words about the history of BEHAVE, which is now BehavePlus.
- And we have some thoughts for the future of BehavePlus and other systems.



- We start with the question of whether BehavePlus even has a future given the availability of the more sophisticated spatial systems.
- The simple answer is ‘yes’.
- We will start with a brief overview of the relationship of BehavePlus to these other fire behavior systems, which we call a ‘suite of fire behavior systems’.



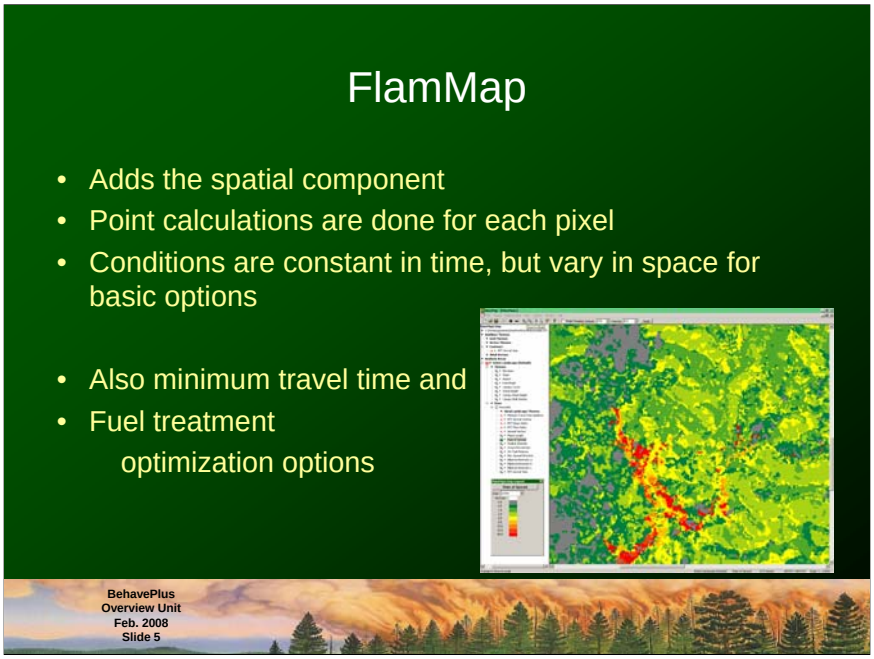
- We call this a 'suite of fire behavior systems' because they are all based on essentially the same mathematical fire models (the equations that form the basis of the systems).
- The spatial systems don't eliminate the need for the point-based BehavePlus fire modeling system.
- In fact, the value of BehavePlus might be increased because it should be used in direct support of the spatial fire behavior systems.
- A person should use the tables and graphs produced by BehavePlus to understand the models (e.g. crown fire, wind adjustment factor).
- Then the user can focus on spatial data and application of the spatial systems.



- While the fire models at the foundation of the systems are essentially the same, there are differences in temporal and spatial aspects of the systems.

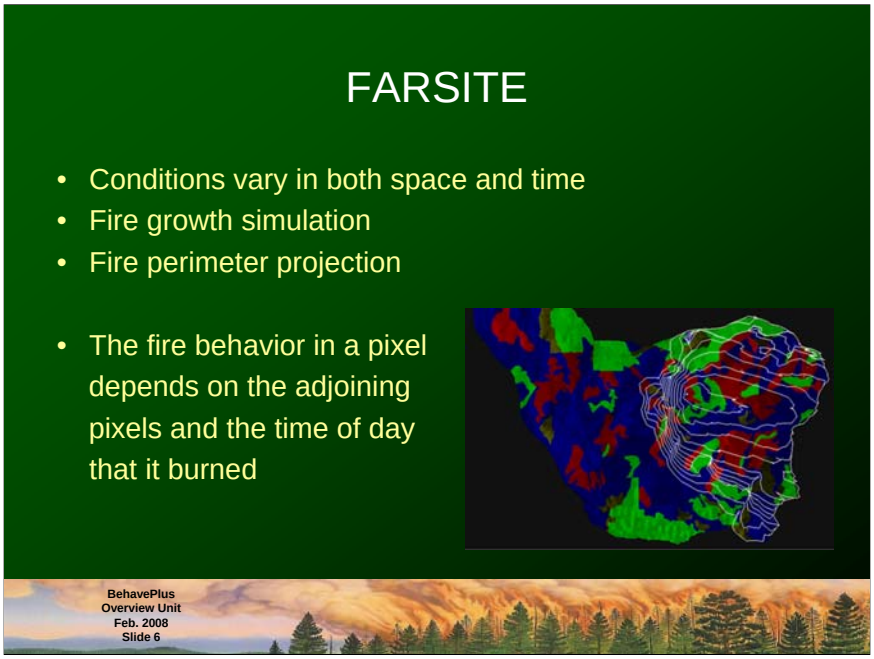
- Each calculation in BehavePlus is for conditions that are assumed to be constant in time and uniform in space.
- It is sometimes referred to as a 'point' system because these conditions are static for a given run.
- But rarely is a single calculation done.
- Tables and graphs are used to look at the effect of a range of values on the results.

- The plot on the left shows calculated surface fire rate of spread for live fuel moisture from 30 to 300% for four fuel models.
- This graph shows the implications of choice of fuel model in spatial fuel model data layers.
- The table on the right shows fire type (surface, torching, crowning) for 20-ft wind speeds ranging from 0 to 30 mi/h.

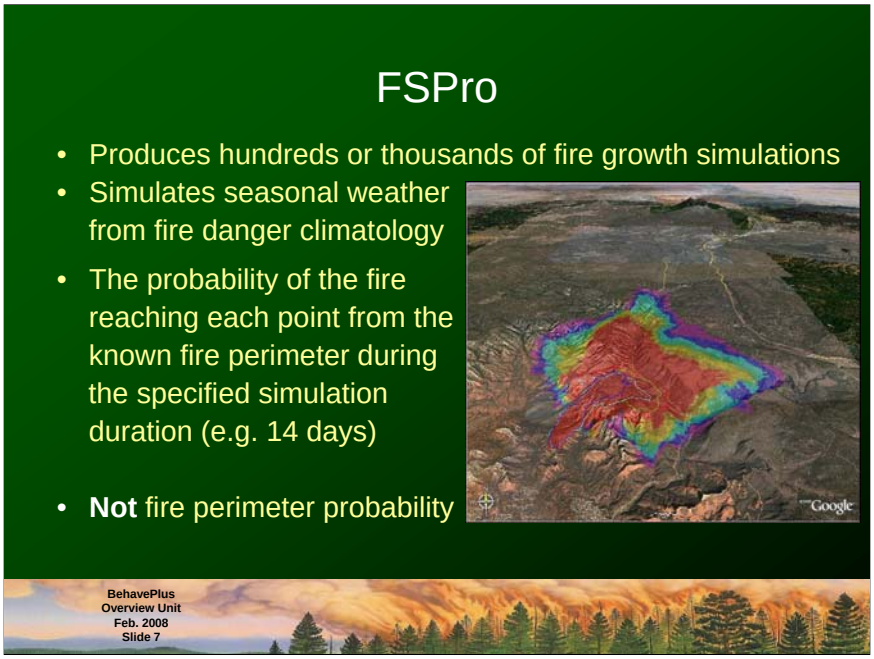


- FlamMap adds the spatial component.
- For the basic FlamMap products, point calculations are done for each pixel. It is as if an independent BehavePlus run is performed for each pixel.
- The calculations for a given point (cell or pixel) are independent of neighboring cells.
- Conditions (fuel, wind, and fuel moisture) are constant in time, but vary in space.

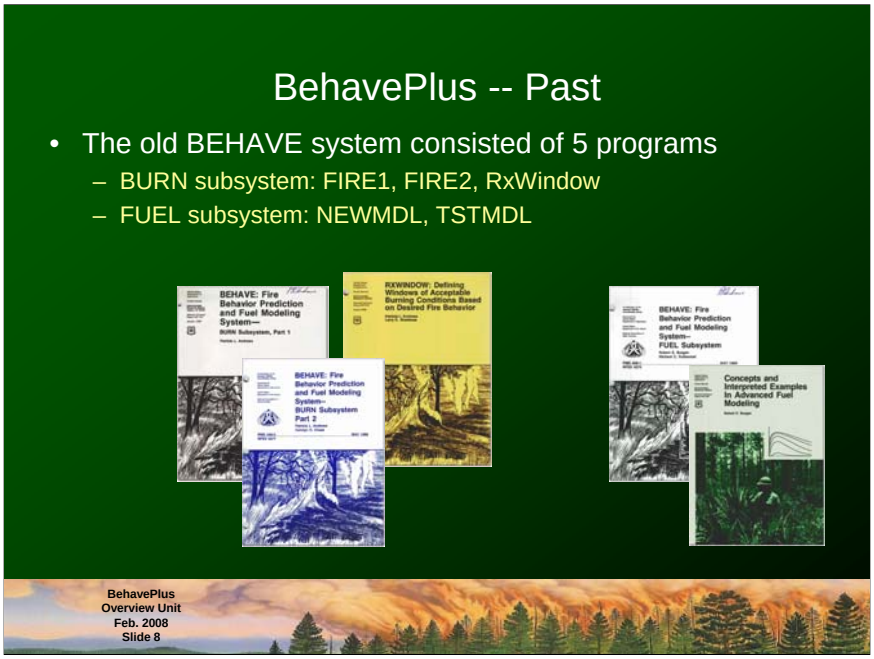
- FlamMap now offers features beyond the basic products just described.
- It includes calculation of minimum travel time and fuel treatment optimization options.



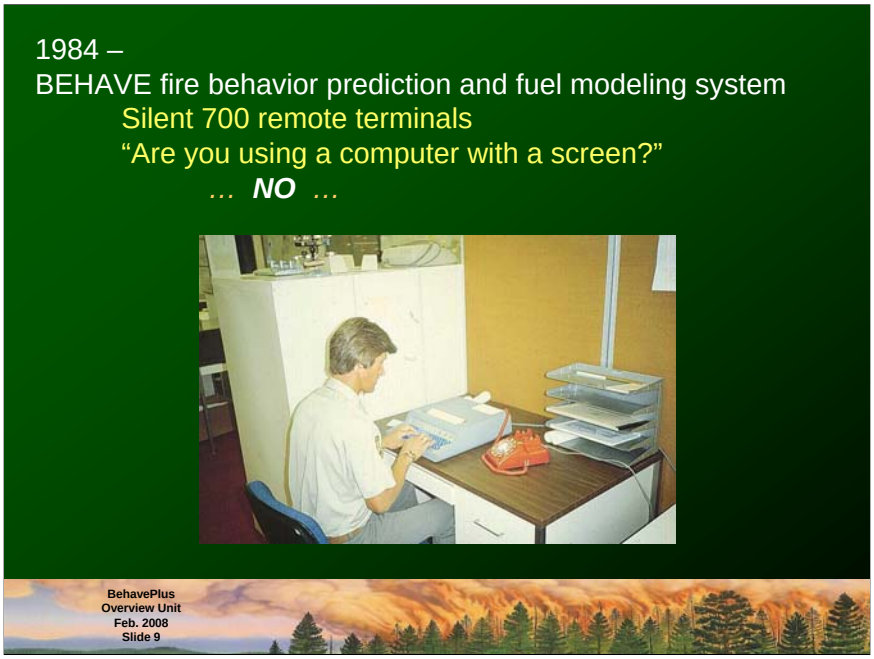
- FARSITE has the spatial features of FlamMap but adds an additional temporal component.
- Therefore, conditions vary in both space and time.
- The result is a fire growth simulation which gives fire perimeter projections.
- The fire behavior in a given pixel depends on where the fire came from, whether it is a backing or head fire, and the conditions under which it burned, which can vary by time of day.



- FSPro has the temporal and spatial features of FARSITE, but adds an additional probability component.
- Results are based on hundreds or thousands of fire growth simulations.
- Each simulation is driven by simulated seasonal weather which is derived from fire danger climatology.
- This is a means of projecting beyond available weather forecasts.
- The result is **not** a fire perimeter probability. It is rather the probability of the fire reaching each point from the known perimeter during the simulated time.



- We have just two slides on the 'past' of BehavePlus. There is much more information in the paper.
- The BehavePlus system replaces the 5 programs that made up the old BEHAVE fire behavior prediction and fuel modeling system.
- BEHAVE was first available for field application in 1984, when computer technology made it possible.



- The BEHAVE programs had the question “Are you using a computer with a screen?”
- Can you imagine answering ‘No’? (I’m sure that some of you can.)
- The answer of ‘No’ put the program into the ‘terse’ mode where fewer words were typed on the paper.

- Fire Models are grouped into Modules
  - SURFACE – Surface fire spread
  - CROWN – Crown fire
  - SAFETY – Safety zone size
  - SIZE – Size of a point source fire
  - CONTAIN – Fire containment
  - SPOT – Spotting distance
  - SCORCH – Crown scorch
  - MORTALITY – Tree mortality
  - IGNITE – Probability of ignition

- 'BEHAVE' is not equal to 'Rothermel's fire model'

BehavePlus
Overview Unit
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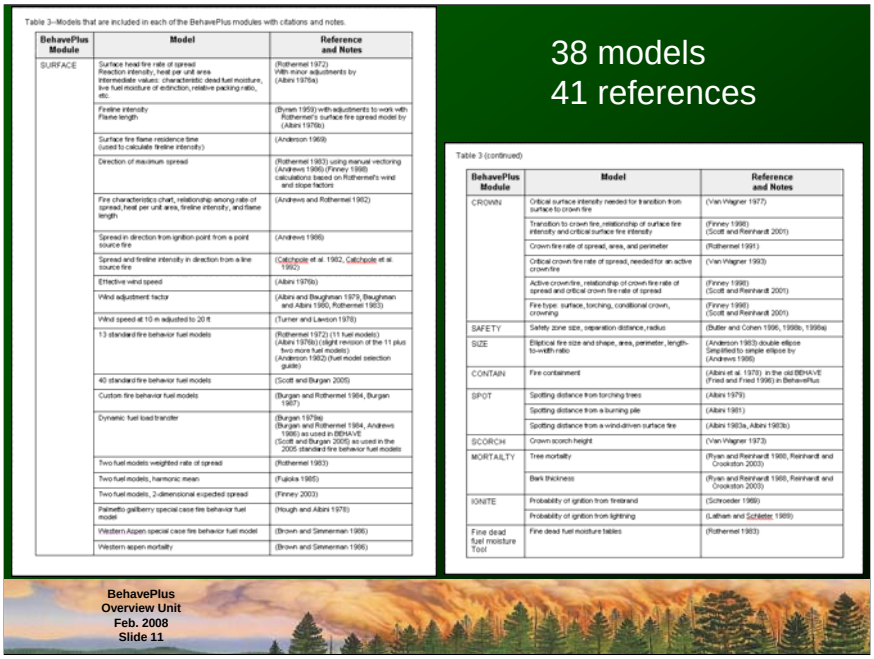
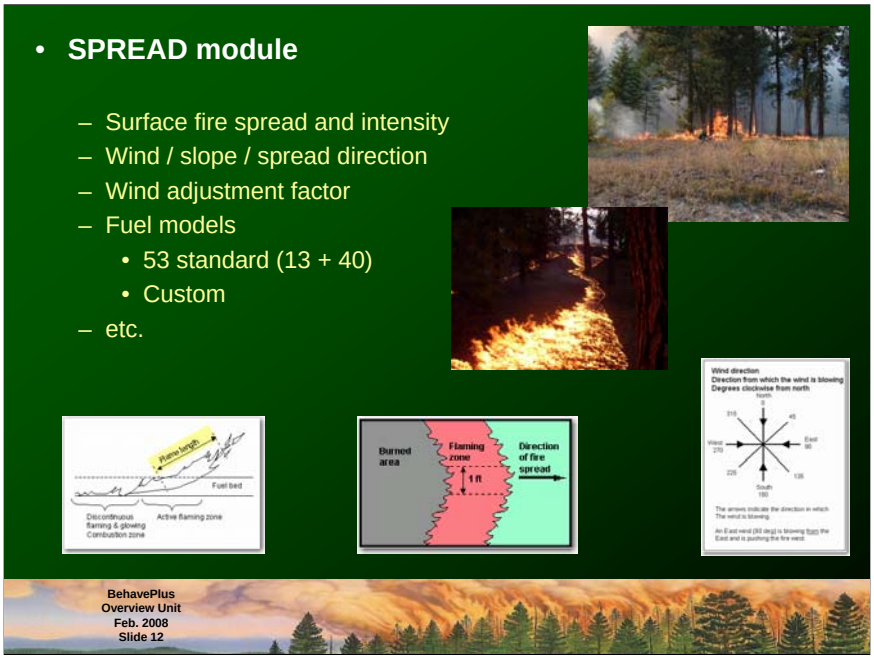
- And now, back to the 'present'.
- A number of things have changed since 1984.
- The many fire models in BehavePlus are grouped according to modules.
- BEHAVE or BehavePlus is sometimes incorrectly used as a synonym for Rothermel's surface fire spread model.
- However, that is only one of the models in BehavePlus (although a very important one).



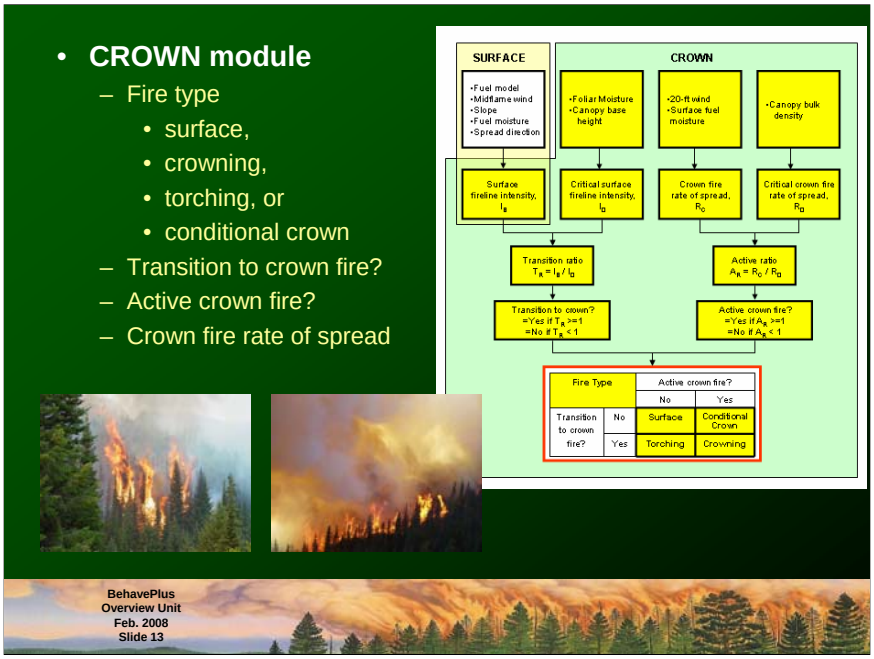
- The paper includes a table of the 38 mathematical models included in BehavePlus.
- It is not important that you can't read the words in this slide.
- The number of models depends on how you count.
- The 53 standard fuel models were counted as one model.
- Rothermel's surface fire spread model also counts as one model, although the model has may possible outputs.
- The main point of this discussion is that BehavePlus is much more than Rothermel's model.

- These *models* are grouped as *modules* for ease of application.

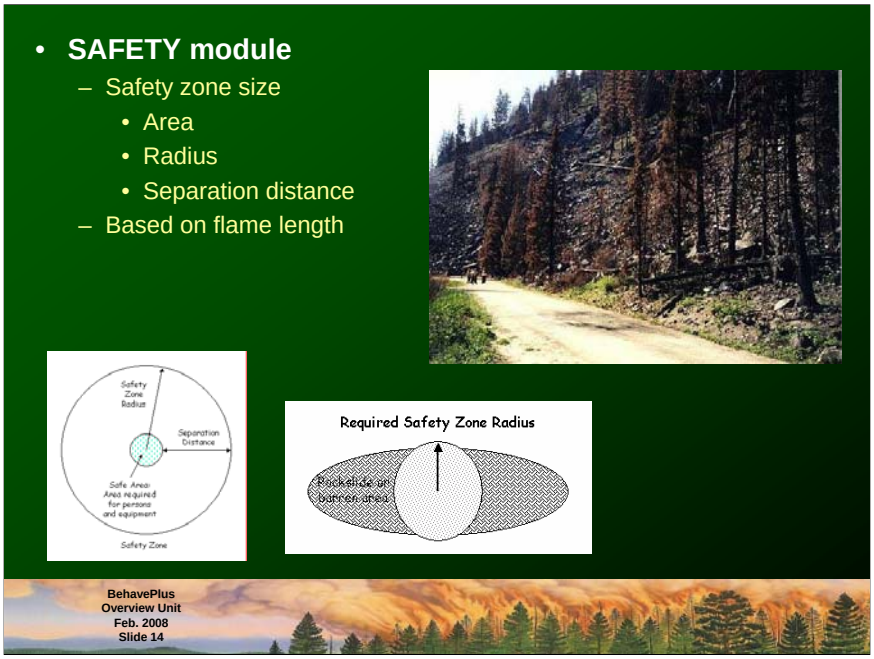


- Following is a quick overview of the fire modeling capabilities in each of the modules:

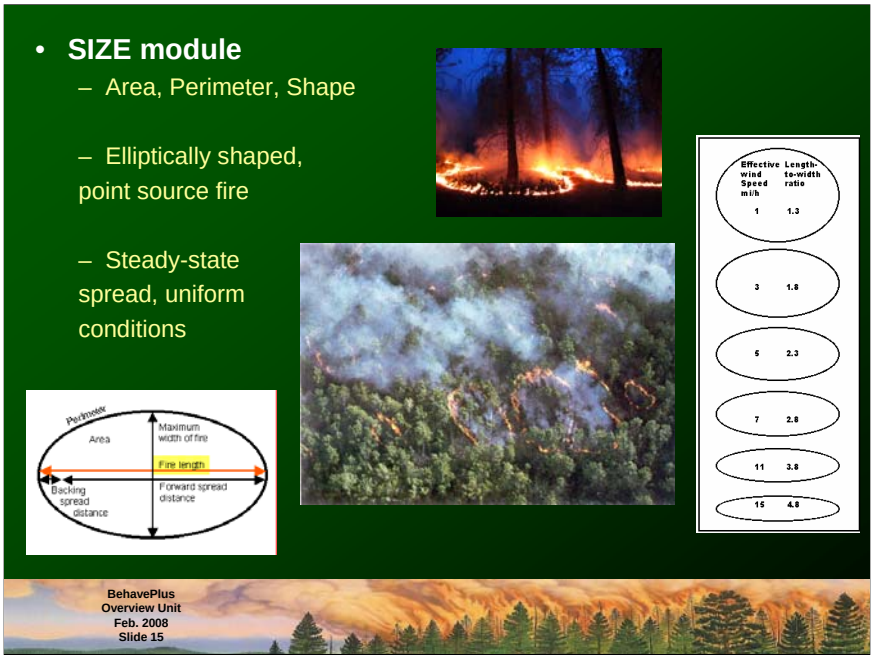
- The SPREAD module is used to calculate surface fire spread and intensity.
- It includes many models and offers many options. It is the core of the BehavePlus fire modeling system.
- There are options for wind, slope, and fire spread directions.
- The wind adjustment factor (which reduces 20-ft wind to midflame wind) can be calculated.
- The 53 standard fuel models are available.
- Custom fuel models can be developed and saved.
- And more…



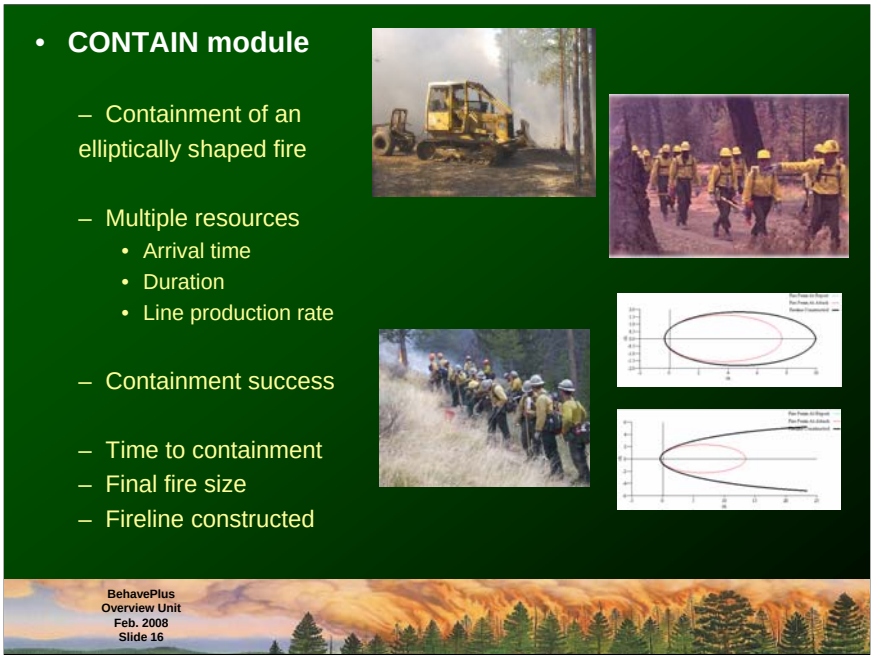
- The CROWN module calculates fire type: surface, torching, conditional crown, or crown.
- Conditions indicate whether a fire will transition from surface to crown fire and whether an active crown fire is possible.
- Crown fire rate of spread can be estimated.



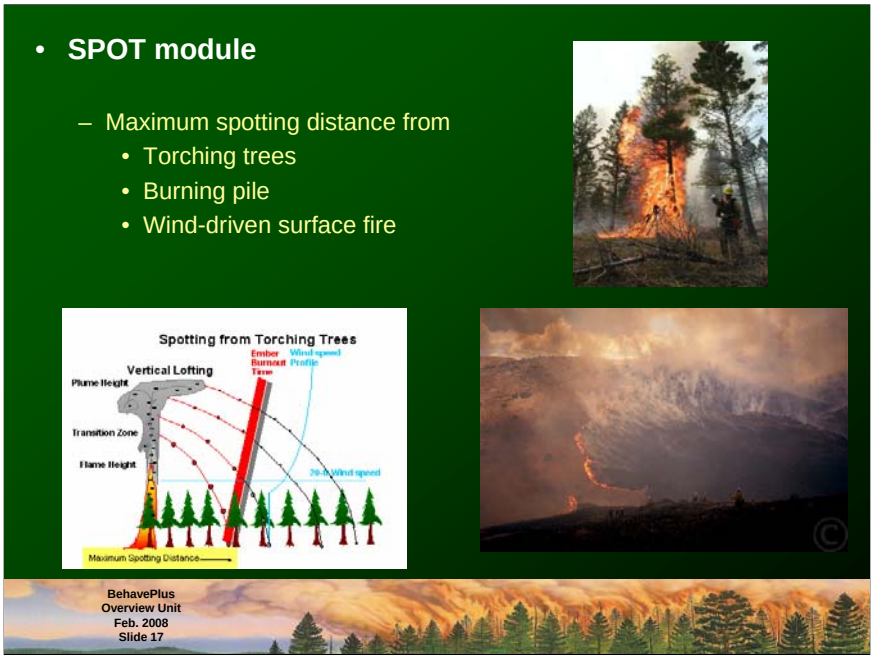
- The SAFETY module is used to calculate safety zone size, which is estimated from flame length.



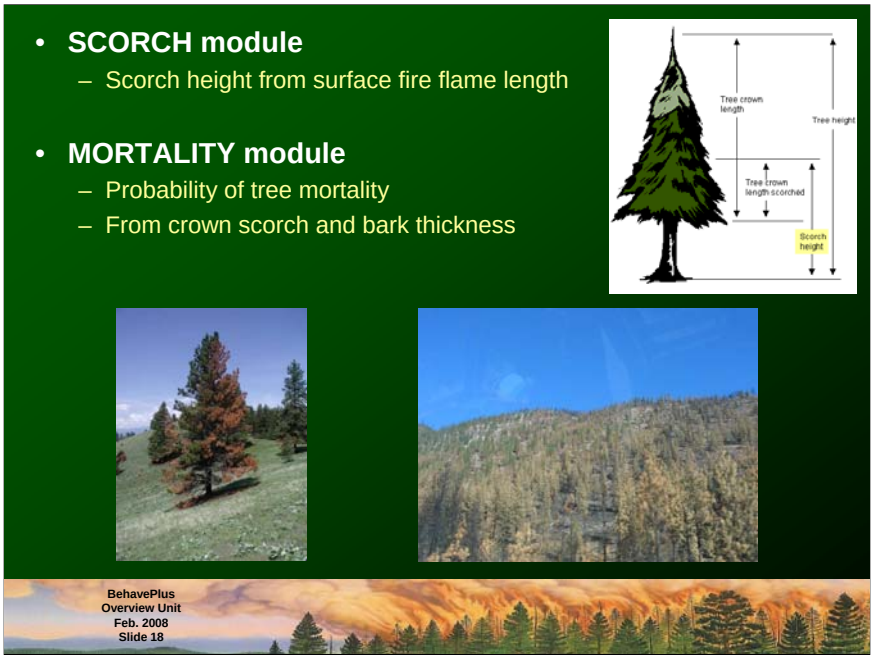
- The SIZE module calculates fire size and shape for a point source, elliptically shaped fire.
- The modeling is applicable only when conditions are close to uniform in both space and time.



- The CONTAIN module is especially useful for contingency planning for prescribed fire.
- The success of containment is modeled for given fire behavior and resource availability.
- There are options on number of resources, arrival time, line production rate, and so on.

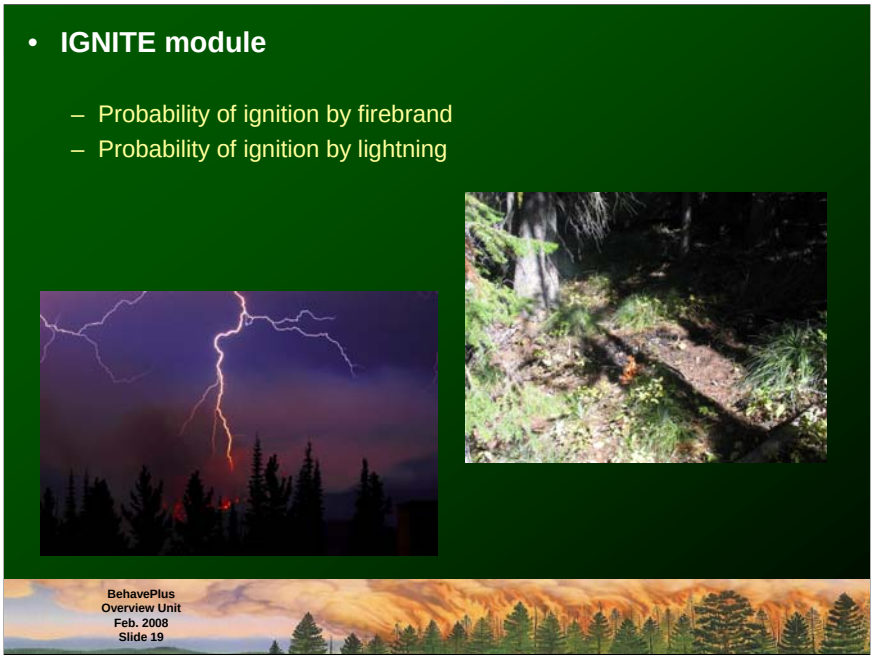


- The SPOT module calculates maximum spotting distance from torching trees, from a burning pile, or from a wind-driven surface fire.

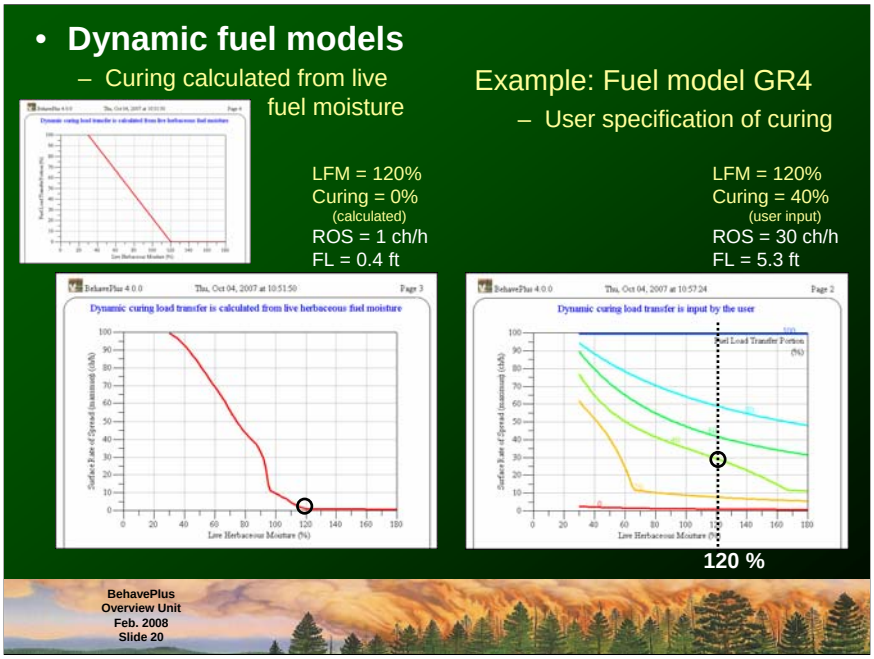


- The SCORCH module calculates scorch height from surface fire flame length and from wind speed (as it affects flame tilt).

- The MORTALITY module calculates the probability of tree mortality from crown scorch height and bark thickness.



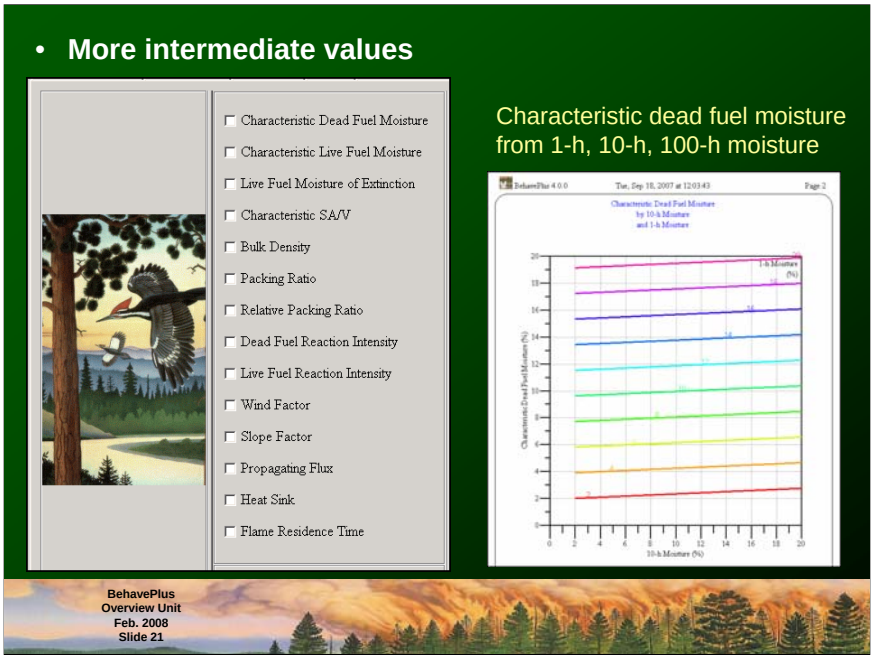
- The IGNITE module calculates probability of ignition from either a firebrand or from a lightning strike.



- One of the options added to version 4 is related to the dynamic fuel models. Some of the newer 40 fuel models include a transfer of load from the live to the dead class as a function of live fuel moisture as shown by the plot in the upper left graph.
- This can have a significant effect on fire behavior. The second plot shows calculated surface rate of spread for the grass fuel model GR4 for live herbaceous moisture from 30 to 180%.
- The black circle indicates the point where live fuel moisture (LFM) is 120%. According to the fuel load transfer function, curing is calculated to be 0%. No fuel is transferred to the dead category.
- In this case, rate of spread is 1 ch/h and flame length is less than ½ foot.

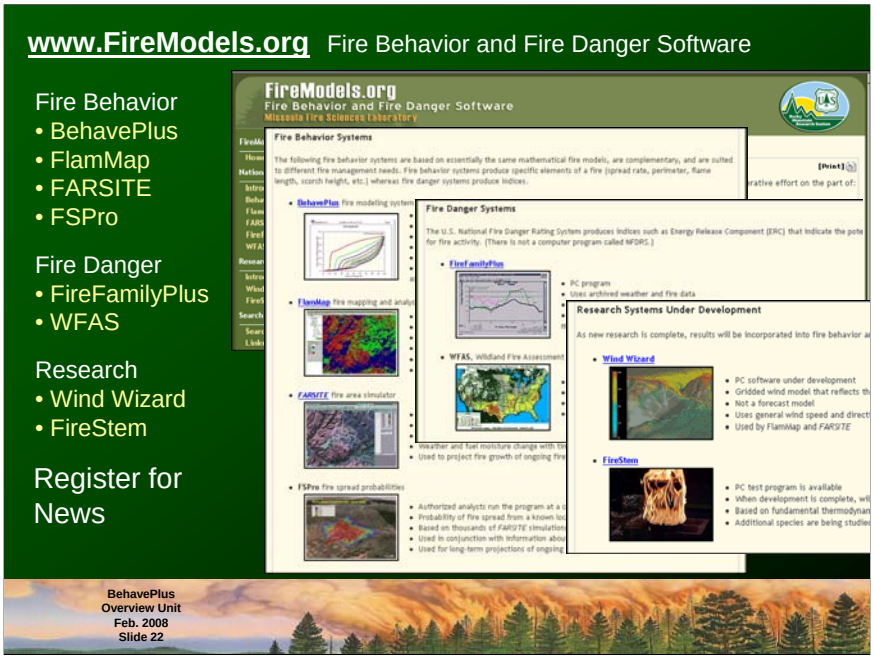
- You now have the option of entering a value for curing if you know it, rather than using the load transfer function.
- The graph on the right shows a curve for six values of curing: 0, 20, 40, 60, 80, and 100%.
- The circle indicates the point where live fuel moisture is 120% (as before) but with the user specification that curing is 40%.
- In this case, rate of spread is 30 ch/h and flame length is 5.3 ft.

- This is a huge difference (an understatement).
- This is an example of the importance of a person understanding the implication of choices and of the influence of various factors on results.
- BehavePlus will help you understand the models and influence of input values on results.



- Version 4 also adds more intermediate output variables.
- This is especially useful for someone who wants to better understand Rothermel's surface fire spread model.

- One of the intermediate values is characteristic dead fuel moisture, which is a weighted value of 1-h, 10-h, and 100-h moisture values.
- It can be used to assess the relative influence of 1-h and 10-h moisture.
- [A tip on this topic is available on www.firemodels.org]

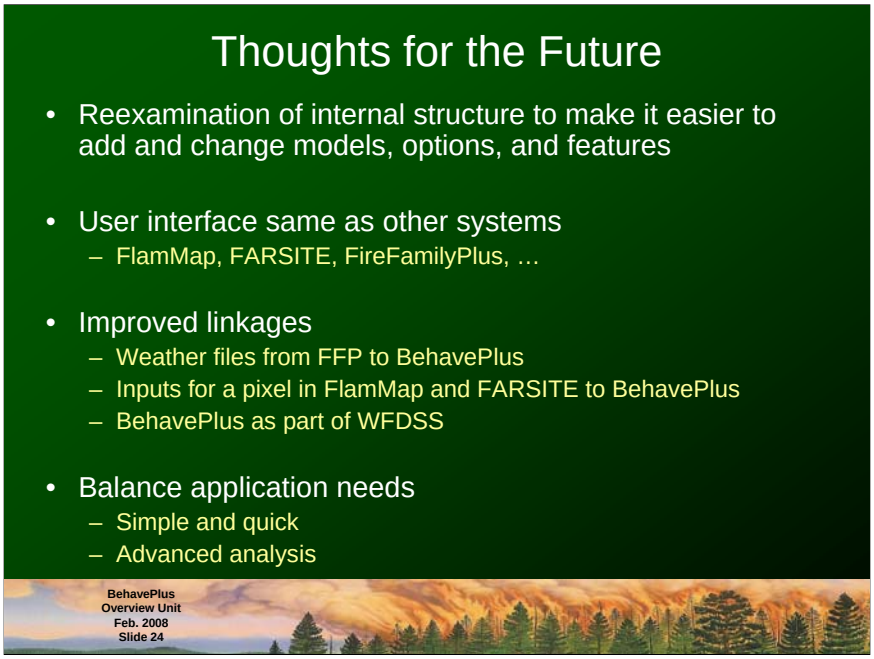


- The latest information on BehavePlus and other fire behavior and fire danger systems is available on www.firemodels.org.
- You can register for news on the systems you are interested in.

- We hope to have a stable, well-documented version 4.0 for field application while options for future systems are examined.

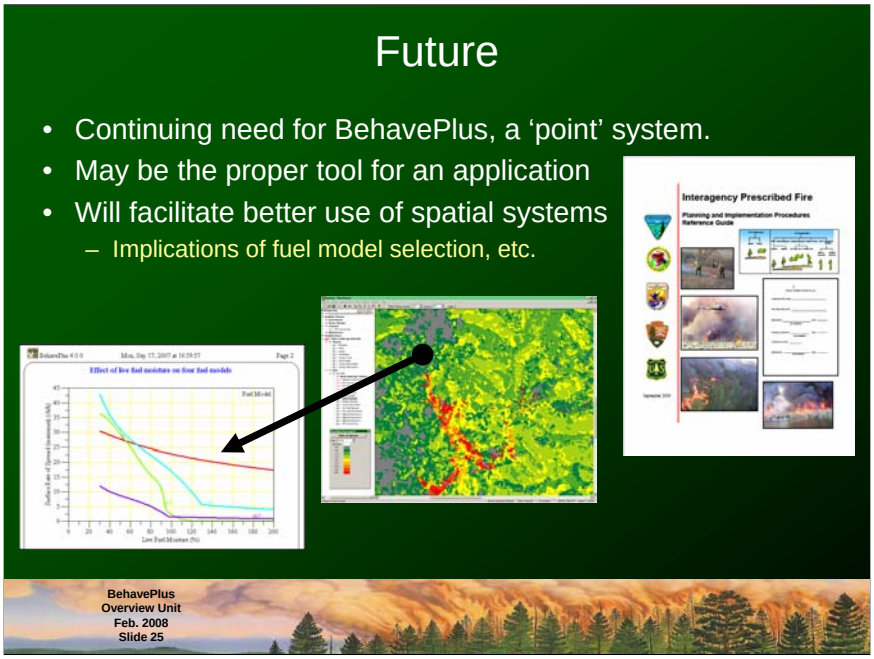
- A series of lessons are being developed. This lesson is in the Overview Unit.
- The Introduction Unit includes 4 lessons which cover basic operation of the program.
- Other aspects of operation are covered in the Operation Unit (e.g., Table Shading, Units and Decimals).
- Various modeling capabilities are covered in the Modeling Unit.
- Specific applications are given in the Application Unit.

- Lessons can be completed as self-study or can be presented in a classroom.



- In thinking about the future, there is a lot to think about.
- In the future, we may need to reexamine the internal structure of the model so that it is easier to make changes.
- Having a consistent user interface across the various fire behavior systems would make it easier for the user to move from one system to the next.
- It would also be helpful if input information from the various systems could be extracted in such a way that it could be used in a different system (e.g., extract inputs for a given FlamMap pixel for use in BehavePlus).

- There is always the challenge of satisfying people who want a program that is quick and easy to use as well as those who have need for more advanced analysis.



- In addition to using BehavePlus to understand the models in the spatial systems, specific direct linkages between the models might be developed.
- For example, a click on a pixel could provide the input to BehavePlus for further analysis – assigning values for fuel model, fuel moisture, slope, etc.
- This example shows the implication of other fuel models and live fuel moisture on calculated fire behavior.

- Prescribed fire planning includes the need for fire modeling.
- The graphs, tables, and table shading options in BehavePlus are well-suited to this application.


BehavePlus fire modeling system—
Past, Present, and Future
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