V. CONCLUSIONS AND RECOMMENDATIONS

The randomness inherent in atmospheric turbulence imposes a natural limit on flow predictability, which provides an upper bound on model accuracy as a function of available data. Nonetheless, recent analysis suggests that some degree of stratification may be obtained in flows strongly influenced by local boundary shapes, strong wind fields, or the diurnal cycle.

Given the desire to use the "best available" science and numerical models in the forest spray program limited by the desire to use "off-the-shelf" codes, a selection among the models reviewed can be made. Computational models most suitable for adoption wind energy-meteorology are:

TAPAS (NUATMOS) - This model is attractive because it is a) oriented toward forest and land-management personnel, b) contains attractive input and output modules, and c) can operate quickly on mini or micro computers.

The model should predict flow over undulating or rolling terrain in situations where drainage movements are small, ridge separation does not occur, and winds are moderate or high.

FLOWSTAR -

MS3DJH/3R - These models are also attractive because they are a) fully documented, b) input and output modules could be modified to fit siting needs, and c) they can operate on mini or micro computers.

The type model can provide almost infinite resolution over undulating or rolling terrain in situations where drainage movements are absent, ridge separation does not occur, and winds are moderate or high.

SUMMARY OF ADVANTAGES AND DISADVANTAGES OF VARIOUS MODEL CLASSIFICATIONS:

Phenomenological Models:

Advantages

1. Models are designed to reproduce specifically the dominant features of the identified flow system,
2. Models like VALMET can inherently handle complicated temporal variations of valley flows, and
3. Recent versions of the model can operate on mini size computers.

Disadvantages

1. Models are limited to terrain geometries for which they were created (e.g. VALMET is limited to narrow valleys of simple planform),
2. Models usually can not handle flow systems beyond their design range (e.g. cross-valley flows, tributary flows, sudden change in terrain shape or direction), and
3. Models will require extensive development to make them flexible.

Mass Consistent Objective Analysis Models:

Advantages

1. Models can be terrain specific and provide for terrain steering of winds,
2. Models can handle wind shear,
3. Versions of these models can handle stratification, surface roughness and lee wave behavior, and.
4. Recent versions of the model can operate on mini or micro computers.

Disadvantages

1. Requires substantial input data to yield accurate results (results are possible with minimal input, but accuracy degrades),
2. Turbulent diffusion parameters such as sigmas must be determined separately,
3. Models can not handle flow separation or strong drainage flows, and
4. Does not provide any estimate of variance from predicted values.

Depth Integrated Models:

Advantages

1. Grid reduction by depth integration increases substantially the computer space available for horizontal domain size or horizontal resolution; hence, large domains can be examined on mini or micro size computers, and

2. Models have been extensively validated against oceanographic and atmospheric flows as well as heavy gas spills.

Disadvantages

1. Models can not handle flow separation, strong vertical shear, or recirculation situations, and
2. Models are effectively limited to situations where inversions or other boundaries cap the layer being examined.

Linear or Perturbation Models:

Advantages

1. Models can be terrain specific and provide for terrain steering of winds,
2. Models can provide almost infinite resolution over the domain chosen,
3. Models can adjust for atmospheric stratification, wind shear, and inhomogeneities in surface roughness, and
4. Models can operate on mini or micro computers.

Disadvantages

1. Requires substantial input data to yield accurate results (results are possible with minimal input, but accuracy degrades),
2. Turbulent diffusion parameters such as sigmas must be determined separately,
3. Models can not handle flow separation or strong drainage flows, and
4. Models do not provide any estimate of variance from predicted values.

Primitive Equation Models:

Advantages

1. Models can provide simulations of almost all meteorological variables,
2. Models contain all the necessary physics to predict wind shear, flow separation, secondary flows, etc., and
3. Models can be structured to take advantage of almost all of available data in providing a best-guess simulation.

Disadvantages

1. Models require very large computing resources,
2. Further development work will be required to reduce response time and make input and output modules user friendly,
3. Boundary condition data may often be difficult to obtain,
4. Some tests suggest many models contain large numerical pseudo-viscosity which distorts the predictions, and
5. Many of these models are still not very well validated.

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