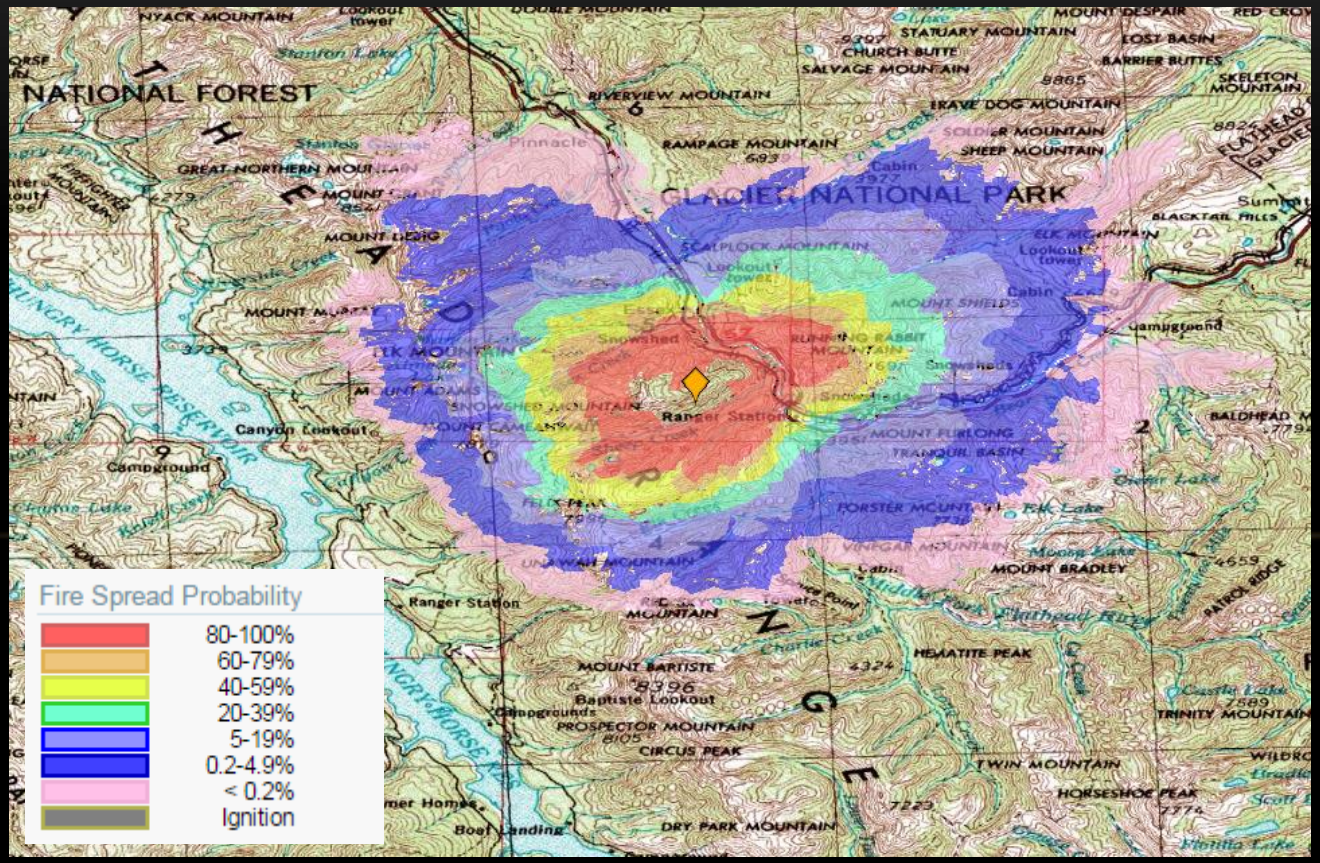
CHARACTERIZING UNCERTAINTY IN WILDLAND FIRE:
OCCURRENCE, DECISION MAKING, AND MANAGEMENT



A SPECIAL SESSION
AT THE 6TH INTERNATIONAL FIRE ECOLOGY CONGRESS OF THE ASSOCIATION FOR FIRE ECOLOGY
MODERATED BY KARIN RILEY,
FORESTRY SCIENCES LAB, US FOREST SERVICE, MISSOULA, MT

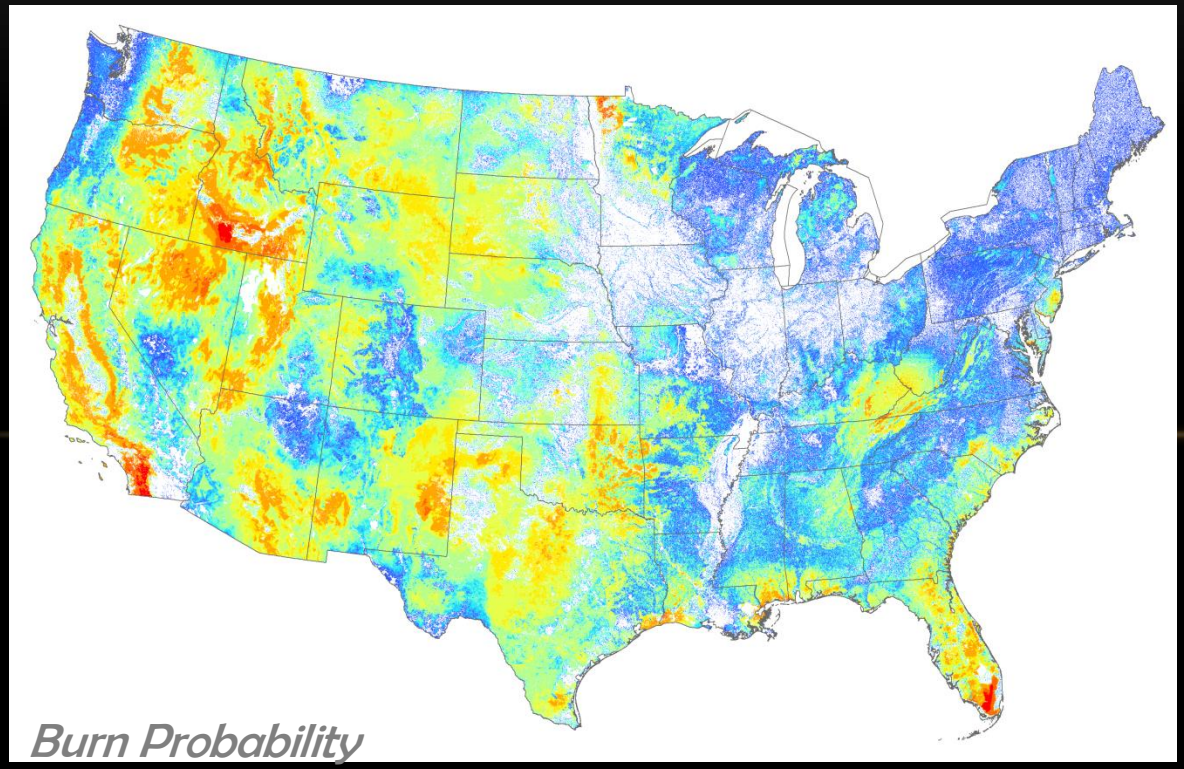
Natural Hazard Uncertainty Assessment

Modeling and Decision Support

Peter Webley, Karin Riley, and Matthew Thompson
Editors

AGU American Geophysical Union
WILEY

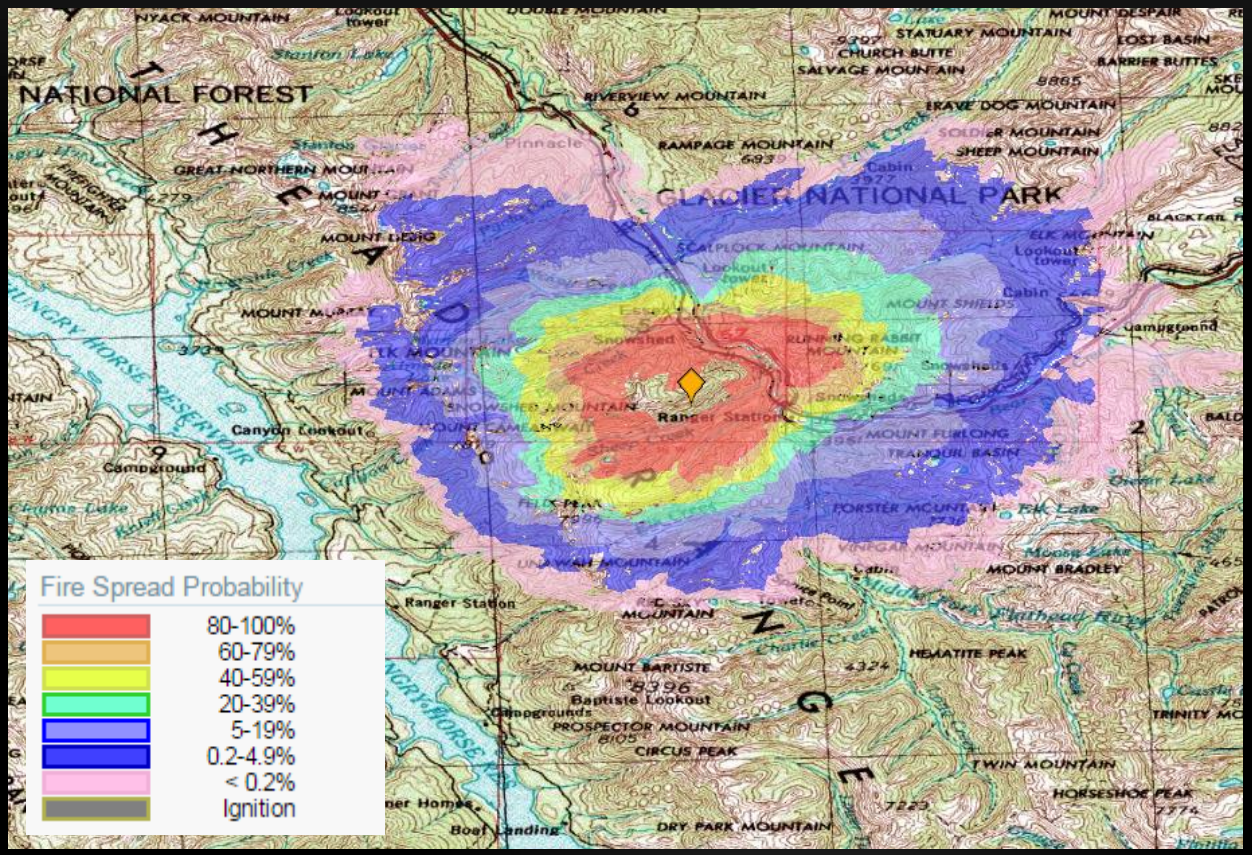
UNCERTAINTY ANALYSIS OF WILDFIRE MODELING



Karin Riley and Matt Thompson
Forestry Sciences Lab, US Forest Service, Missoula, Montana

6th International Fire Ecology Congress of the Association for Fire Ecology
November 19, 2015 * San Antonio, Texas

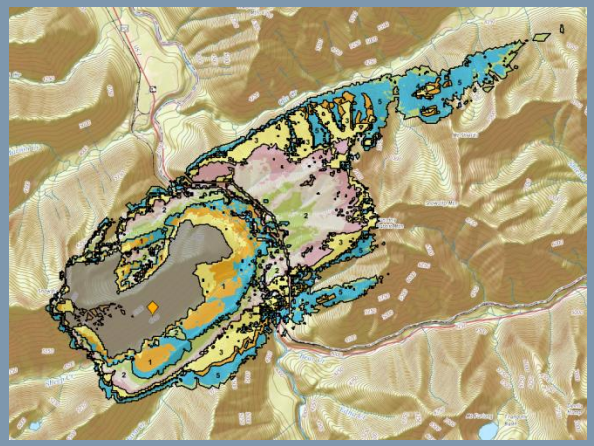
FIRE MODELING IS USED FOR RISK MANAGEMENT, DECISION SUPPORT, AND LAND MANAGEMENT PLANNING



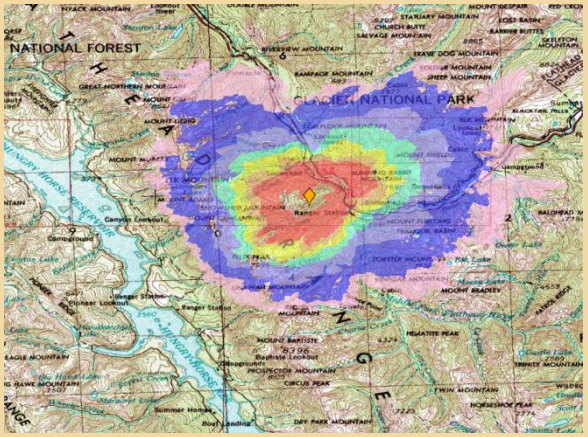
Sheep Fire, Montana, 2015

- Three planning horizons:
  - Incident (1-30 days)
  - Mid-term (1-10 years)
  - Long-term (10-50 years)

WHY ANALYZE SOURCES OF UNCERTAINTY?



- When not done:
  - Model accuracy can be undermined
  - Inappropriate data or modeling techniques may be chosen



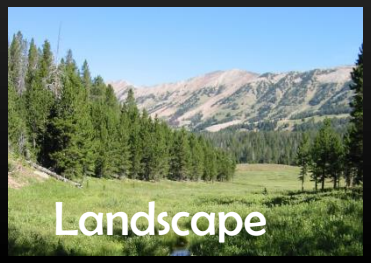
- When done:
  - Guides model calibration and validation
  - Increases managers' confidence in results
  - Guides future investments in data collection, research, or modeling
  - Facilitates communication of uncertainty

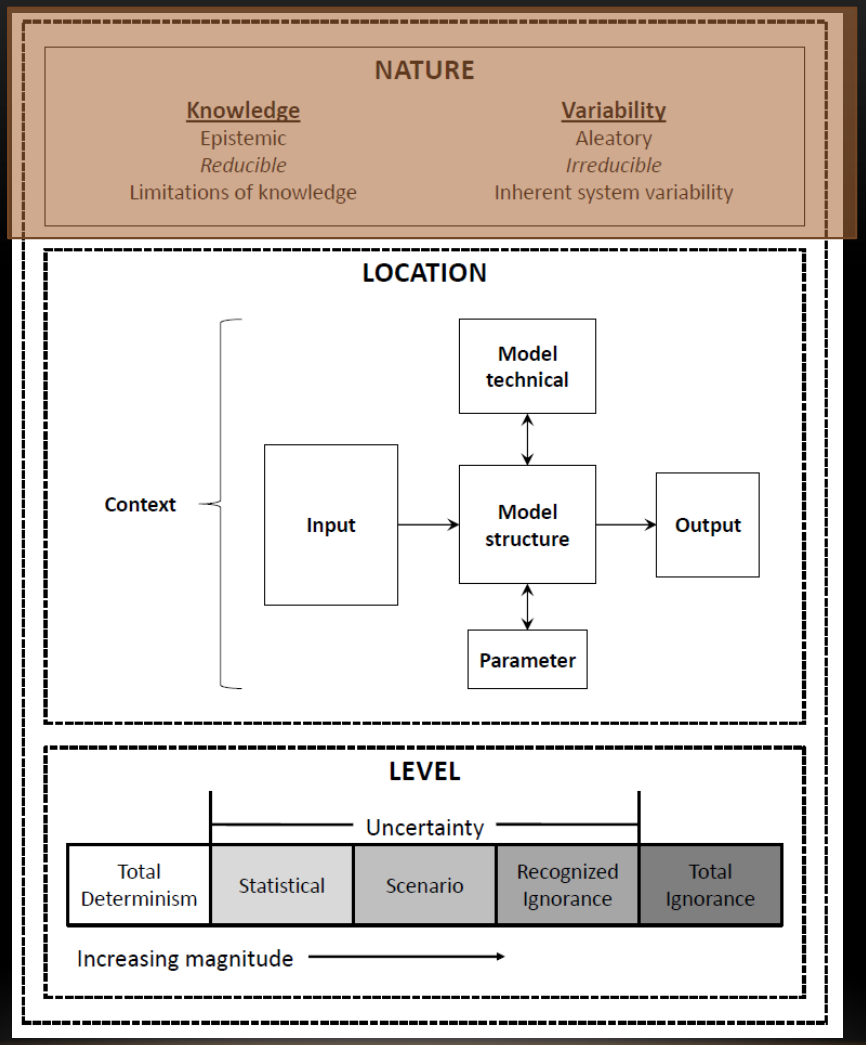
OBJECTIVE

- Present an uncertainty analysis framework

{ Systematic
Rigorous
Consistent

A FRAMEWORK FOR UNCERTAINTY ANALYSIS





- Based on Ascough II et al. [2008], Warmink et al. [2010], and Skinner et al. [2014], but tailored to the wildfire modeling context

A FRAMEWORK FOR UNCERTAINTY ANALYSIS

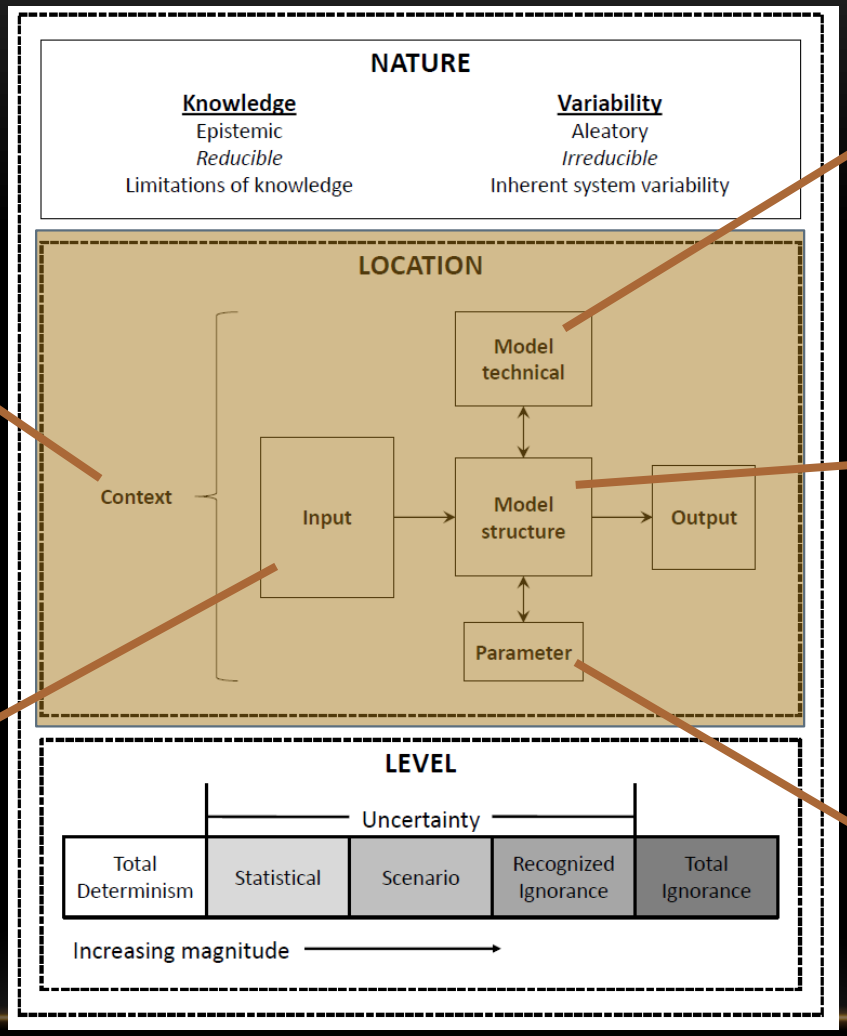
Landscape

Fire ignition, spread, and intensity

Climate

Which processes are inside model?

Data for specific run



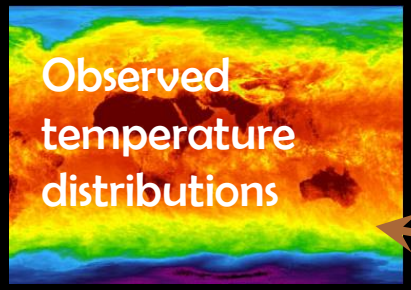
Algorithmic & software implementation

Relationship between variables & system

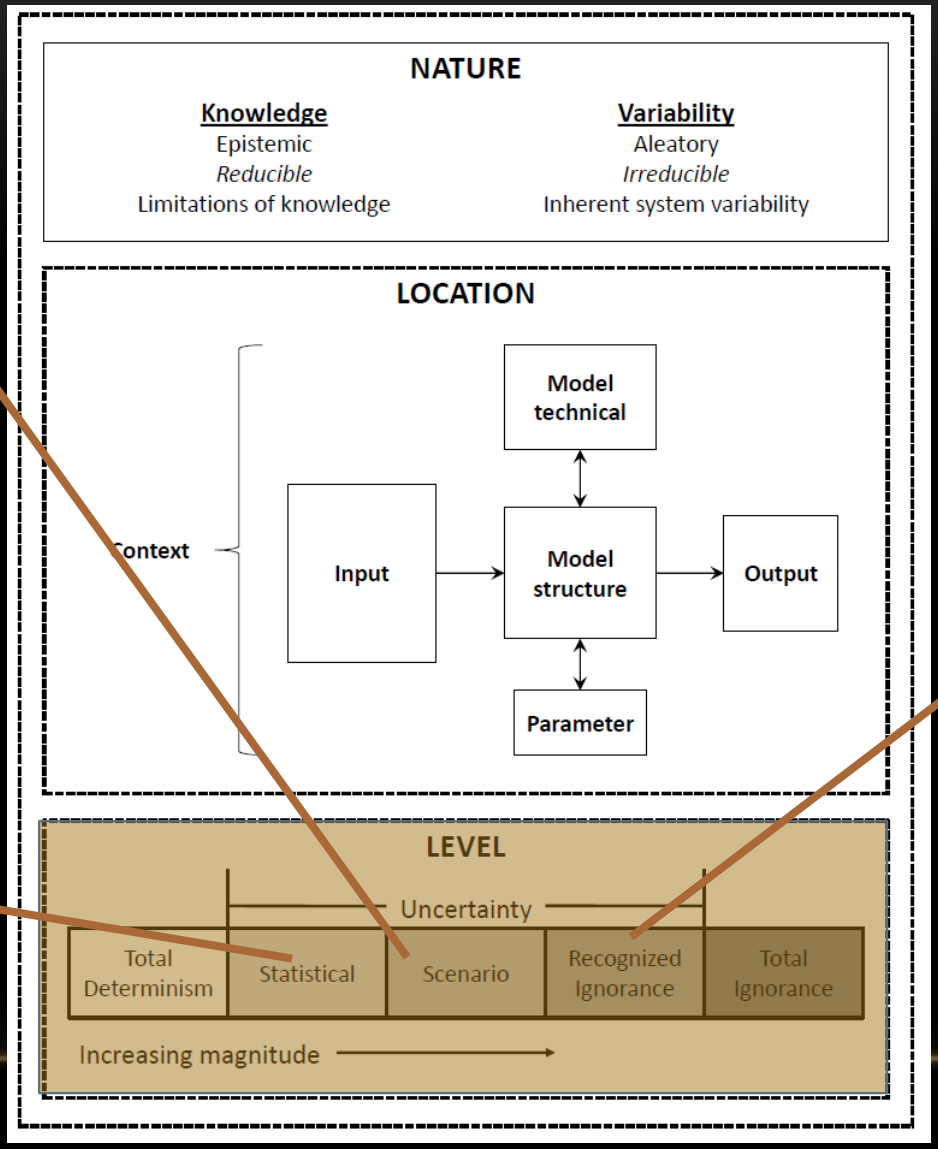
Values invariant in model

A FRAMEWORK FOR UNCERTAINTY ANALYSIS

Don't know probability



Know probability

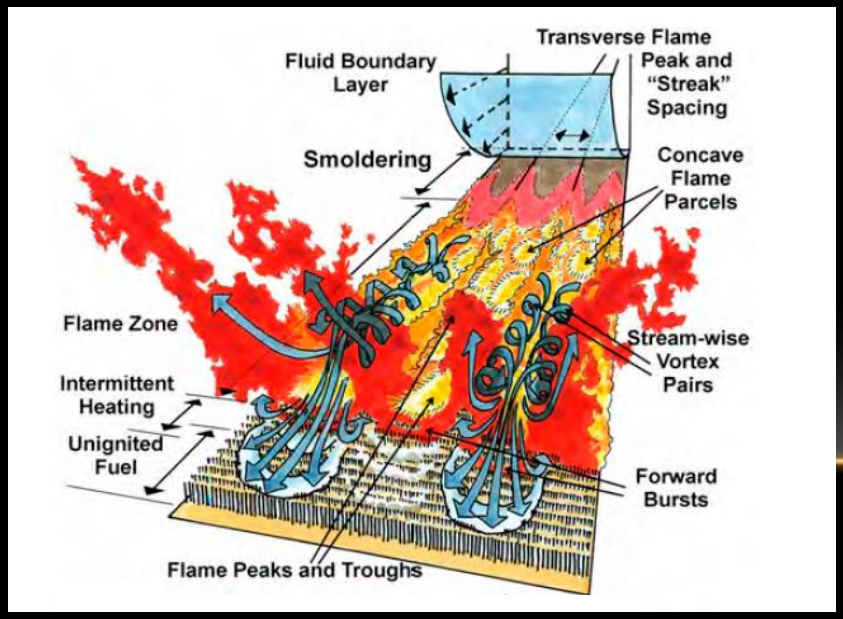


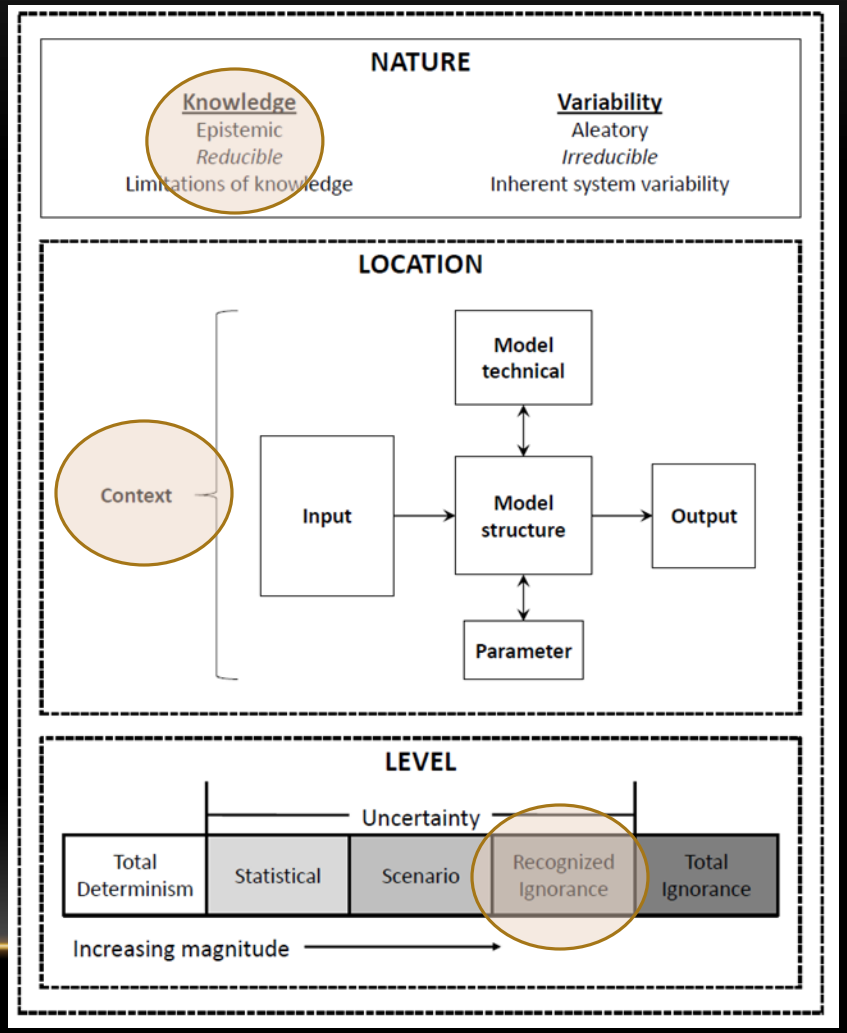
Can't quantify

UNCERTAINTIES COMMON ACROSS PLANNING HORIZONS:

FIRE BEHAVIOR

- Mechanisms producing fire spread not yet known
  - Direct flame contact produced by buoyancy-driven instabilities=likely mechanism, but not yet modeled (Finney et al 2015)

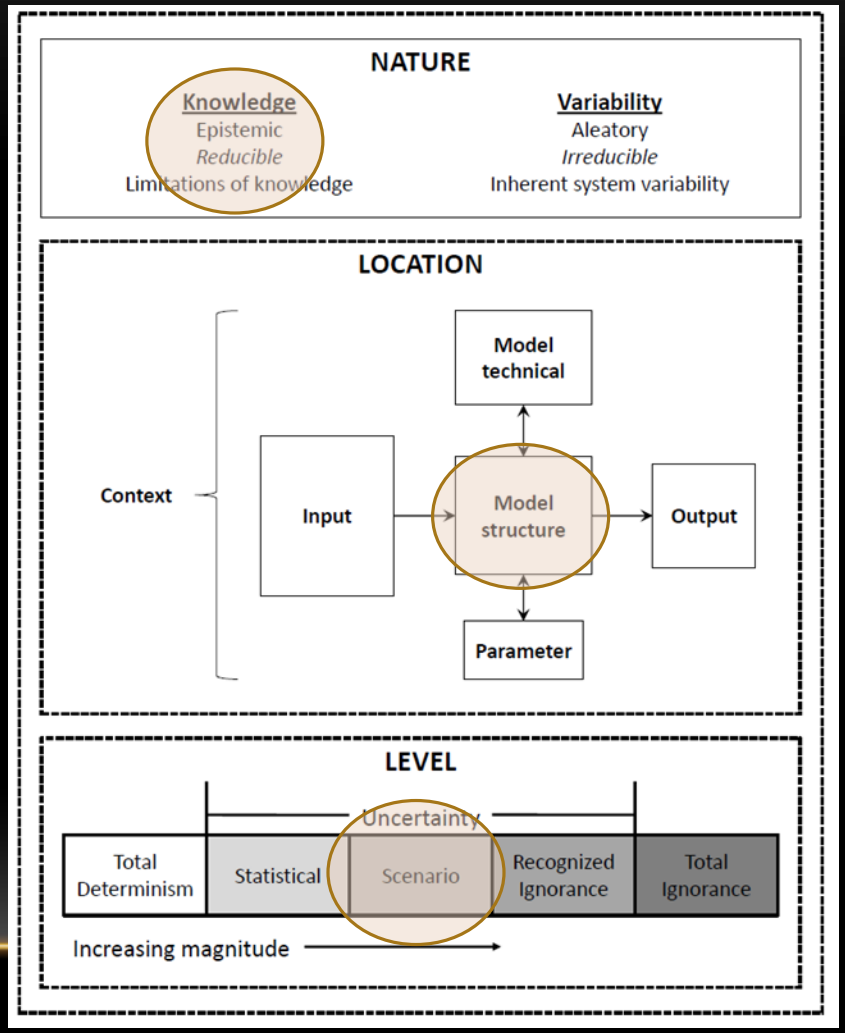




UNCERTAINTIES COMMON ACROSS PLANNING HORIZONS:

FIRE BEHAVIOR (AS IMPLEMENTED)

- Current empirical models of fire spread (e.g. Rothermel 1972) provide estimates of spread considered accurate within a factor of 2-3

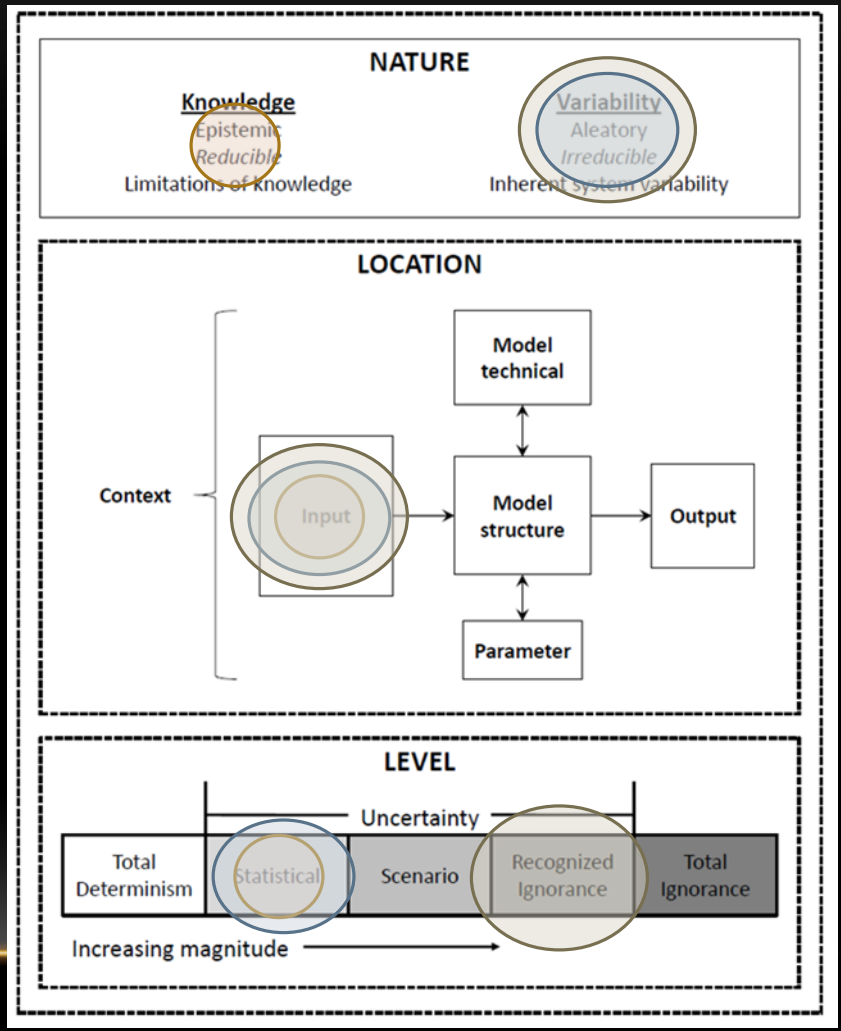


UNCERTAINTY IN IGNITIONS ACROSS PLANNING HORIZONS

Increasing spatial & temporal scale

Increasing uncertainty

Planning Horizon	Ignitions
Wildfire Incident Response	Observed
Mid-term (1-10 years)	Historical patterns
Long-term (10-50 years)	Scenarios for changes in patterns due to climate change and land use change



FACTORS INFLUENCING FIRE OCCURRENCE ACROSS PLANNING HORIZONS

Increasing spatial & temporal scale

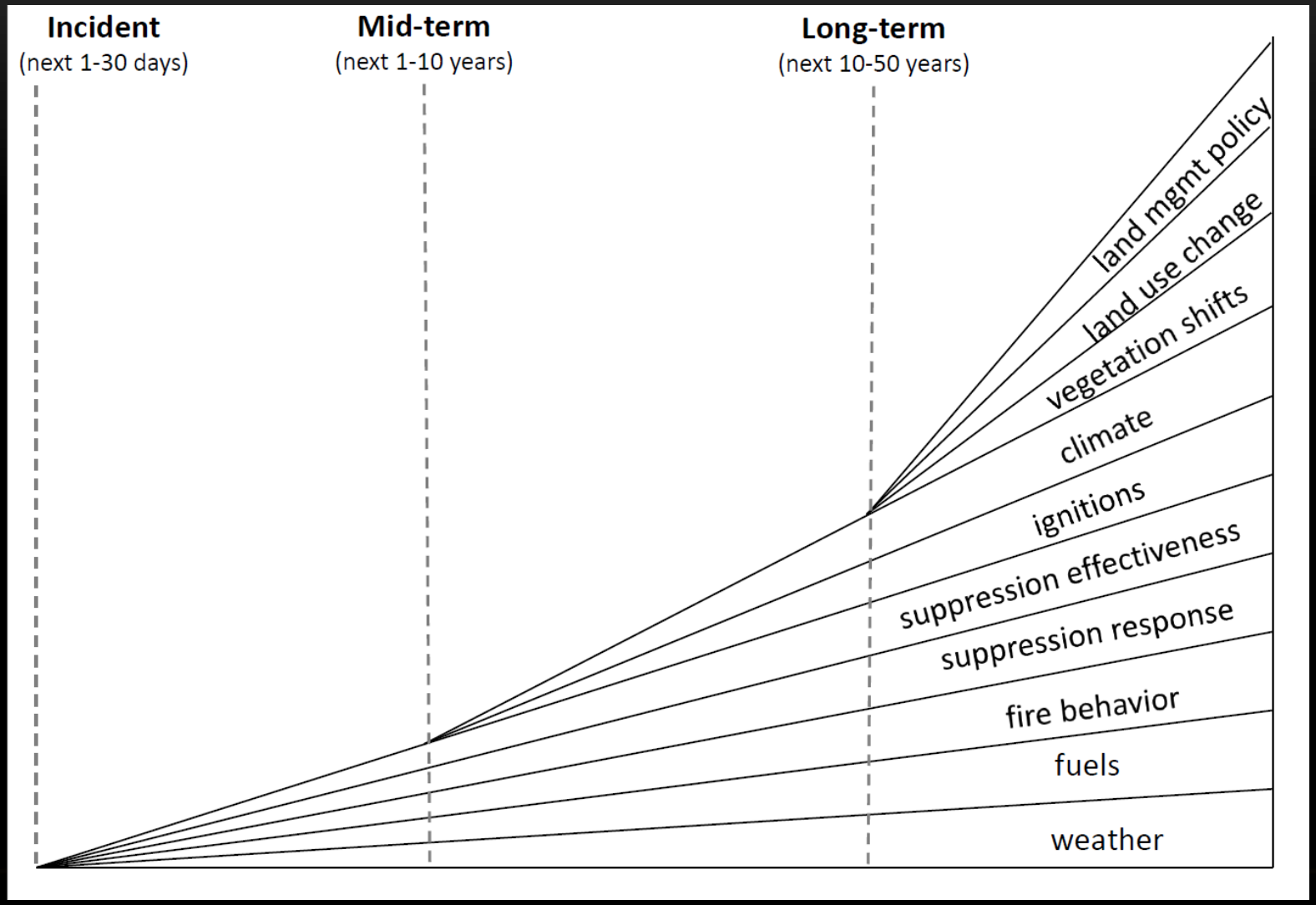
Increasing uncertainty

Planning Horizon	Ignitions	Weather	Landscape	Management
Wildfire Incident Response	Observed	Forecasts and historical patterns	Static landscape	Suppression tactics provided by incident commander
Mid-term (1-10 years)	Historical patterns	Historical patterns	Static landscape	Historical patterns of effectiveness; policy scenarios for suppression and fuel management provided by land manager
Long-term (10-50 years)	Scenarios for changes in patterns due to climate change and land use change	Climate scenarios	Scenarios for biome migration, land use change, management, and disturbance (including no-analog fuel conditions)	Scenarios for policy change in suppression, fuel management, and land use

UNCERTAINTY MATRIX

			Nature			Location				Level		
Planning horizon	Uncertainty domain	Uncertainty source	Knowledge	Variability	Context	Input	Model structure	Model technical	Parameter	Statistical	Scenario	Recognized ignorance
Incident	Weather	Wind speed & direction forecast		x		x				x		
		Temp & RH forecast		x		x				x		
	Landscape	Vegetation type & configuration	x			x					x	
		Surface & canopy fuel model	x			x					x	
		Fuel moisture	x			x					x	
		Landscape representation	x			x					x	

COMPOUNDING UNCERTAINTY



CONCLUSIONS

- Systematic identification and classification of uncertainty faced in wildfire modeling
- Some sources of uncertainty are common across incident, mid-term, and long-term planning horizons → fire behavior
- At broader spatial and temporal scales, more sources of uncertainty appear while others grow in magnitude → compounding uncertainty
  - Are modeling approaches used in one planning horizon appropriate in others?

CONCLUSIONS

- Positive aspects of identifying and analyzing uncertainty:
  - Can increase confidence in model predictions
  - Can improve the modeling process
  - Can improve study design
  - Can enhance communication across modelers, analysts, decision makers, and stakeholders
- We present a framework for future analyses

QUESTIONS?

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"UNCERTAINTY IS AN UNCOMFORTABLE POSITION. BUT CERTAINTY IS AN ABSURD ONE." --VOLTAIRE