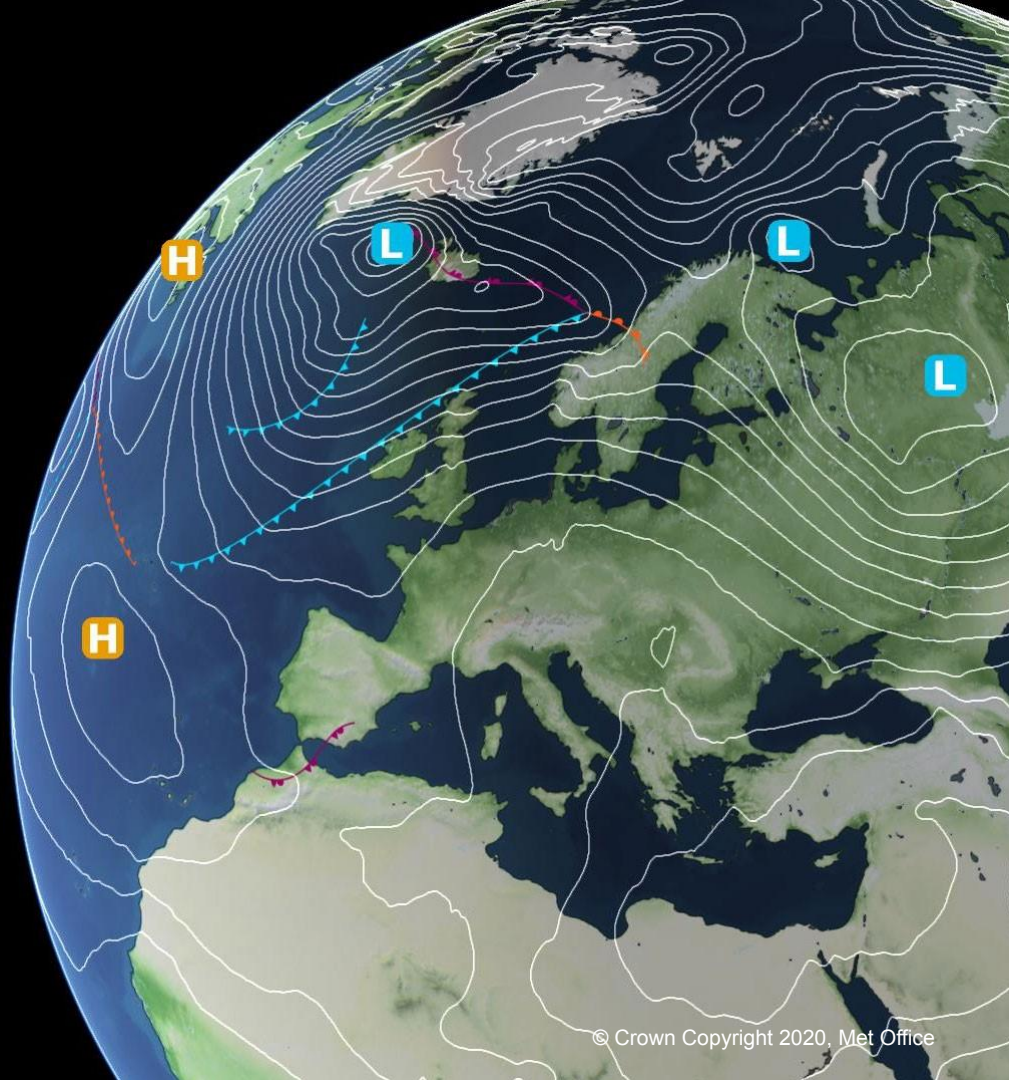
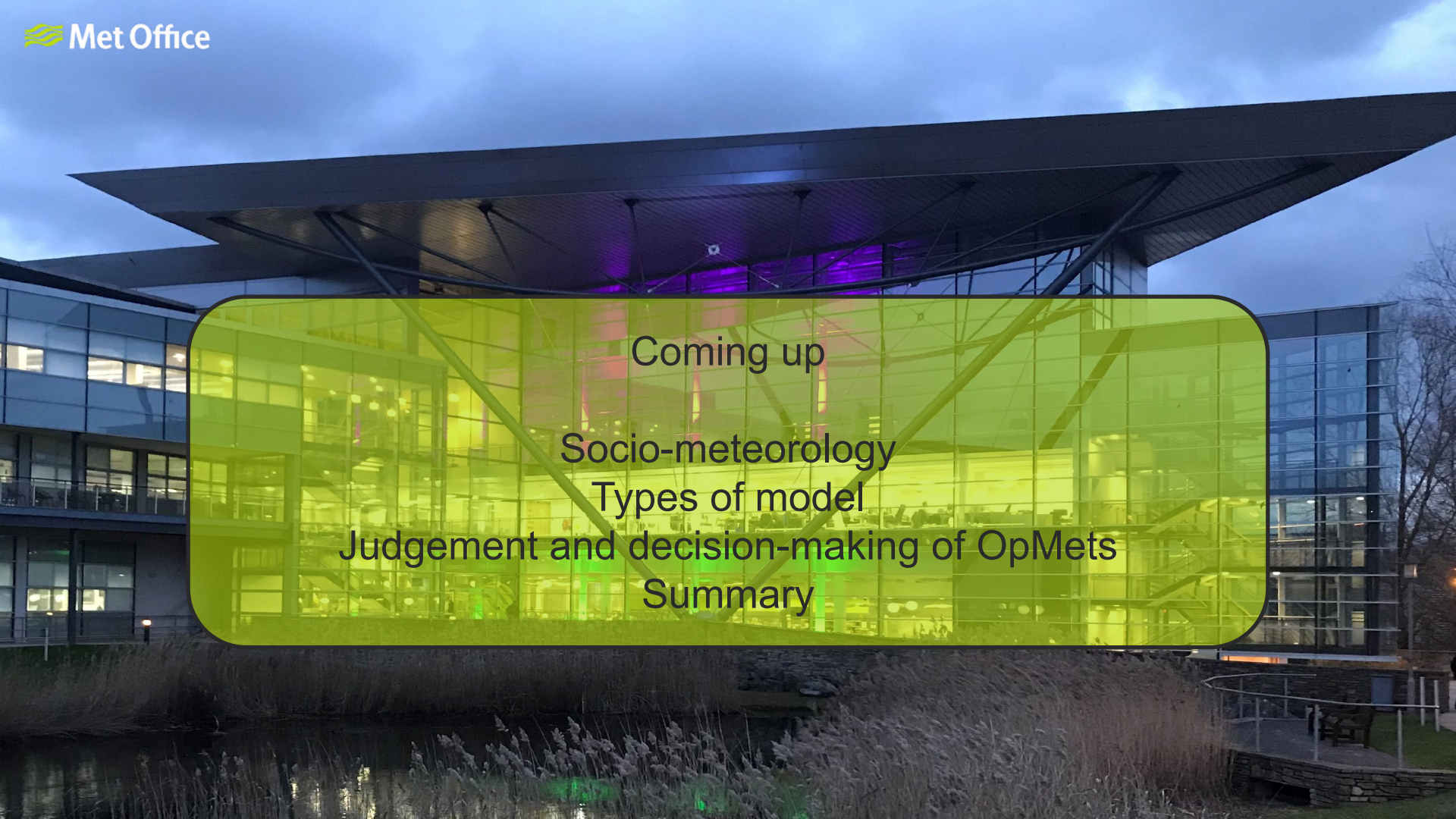
Data to Decisions

Helen Roberts, Socio-Meteorologist

Seamless Global Modelling
June 2025




Met Office
Coming up
Socio-meteorology
Types of model
Judgement and decision-making of OpMets
Summary

BSc Enviromental Geoscience

22 years in weather - 17 years as an Operational Meteorologist:

military – transport – retail – sport – media

MSc Psychology, dissertation PTSD resulting from natural disasters

PhD (part time, started October 2023) – decision-making in the UK weather warnings process

Met Office

Socio-Meteorologist

'Meteorologist'

- an expert in or student of meteorology
- a weather forecaster

'Socio'

- relating to people and society

Met Office

Met Office incorporates a wealth of expertise and knowledge, particularly in terms of natural, physical and data sciences

Growing recognition that social science is equally as important

Everything we do is about predicting ‘the social consequences of the atmosphere’ (Phaedra Daipha, Masters of Uncertainty)

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Modelling

Escape from Model Land

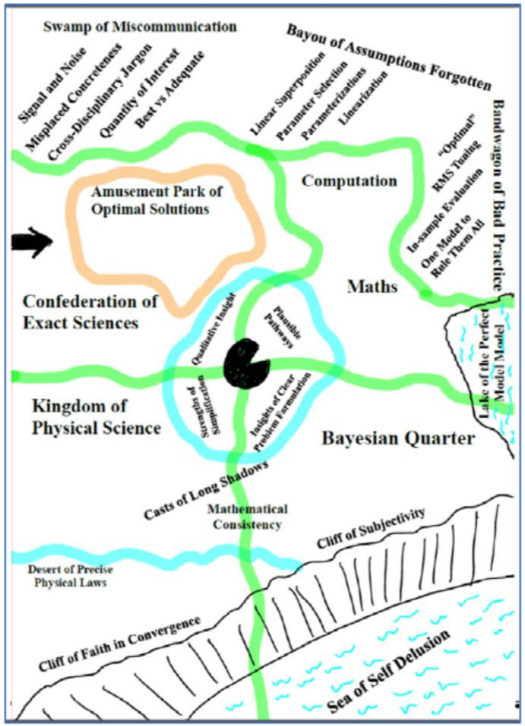
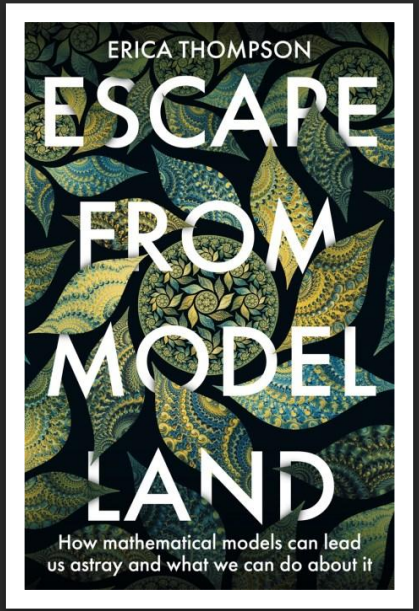


Figure 1: A map of Model-land. The black hole in the middle is a way out.

"'Model Lands', the hypothetical worlds we construct in order to explore the future, have no practical value until their analyses and predictions are applied in real life."

"The methods used to analyse models are as important as the models themselves, **we need expert judgement to make models**, which gets us into model land, and we also **need expert judgement to get out of model land**, through analysis and interpretation of model results."



Escape from Model Land

"Such naive Model Land realism can have catastrophic effects because it invariably results in an underestimation of uncertainties."

Goldman Sachs's chief financial officer blamed the global credit crunch on the occurrence of "twenty-five standard deviation events, several days in a row". If it couldn't happen in the model, it just wasn't meant to happen in real life.

Trust in Models

Vargas, Venezuela, 1999

Flash flood and destruction of towns

Model: 1 in 17.6 million years

Virtually impossible

Trust in model is part of calculation

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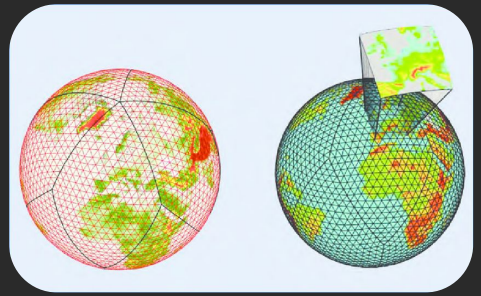
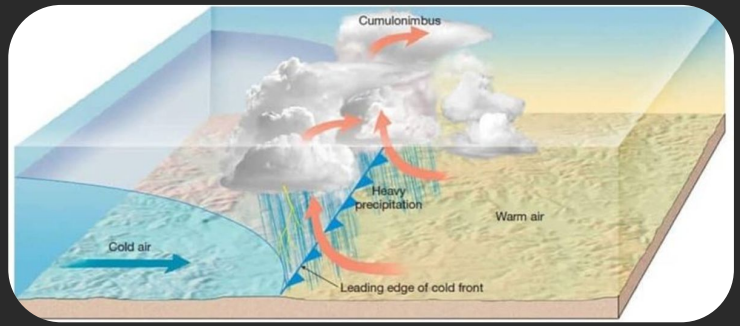
Operational Meteorologist (OpMet) Decisions

Different Types of Model

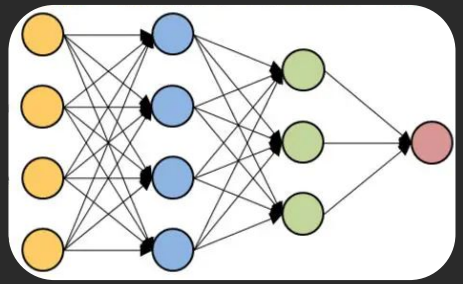
Computational Model



Conceptual Model (mental model)



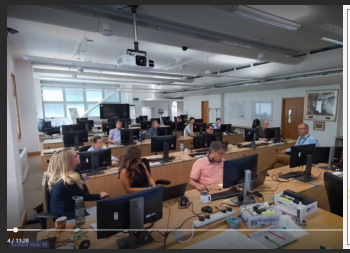
Reasoning model (decision model)

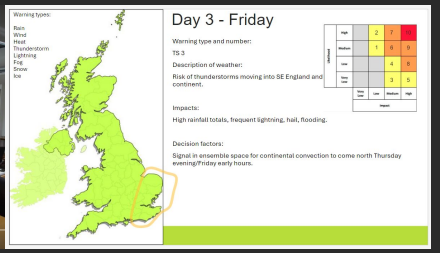


Decision-Making Research

Testbed experiments:

- Three groups working simultaneously
- Observation and recording of meteorologist decision-making
- Compare decision-making of each group





Interviews:

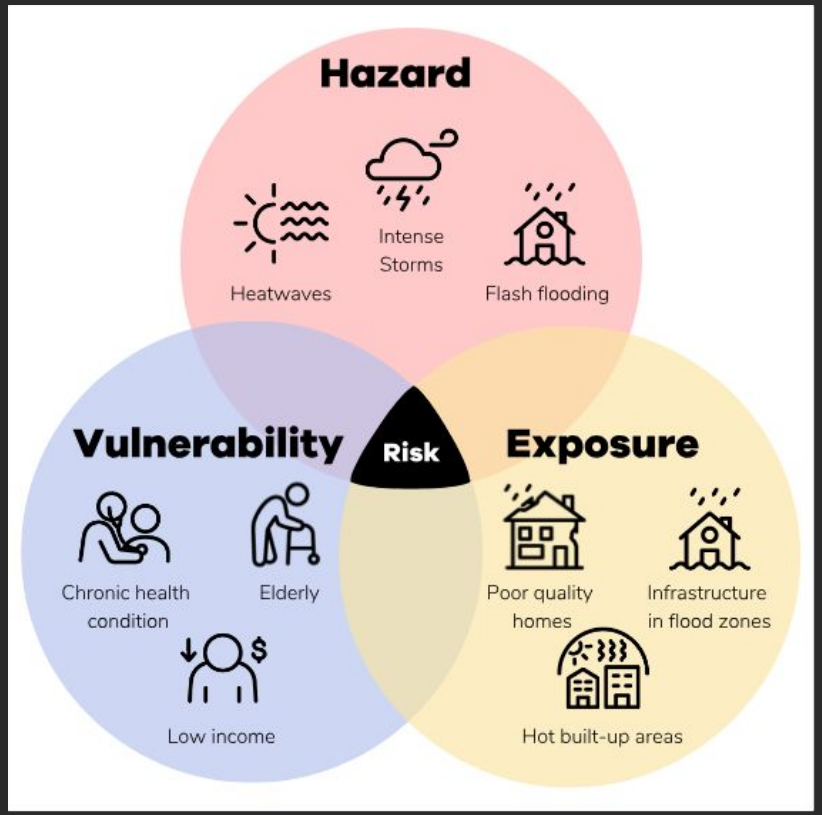
- Interviews with Principal and Expert Operational Meteorologists, as well as senior Hydrometeorologists and Civil Contingency Advisors

Observation / shadowing:

- Observation of Principal and Expert Operational Meteorologists while making decisions in real time

Risk

Impact based warnings factor in the (meteorological) hazard, and the vulnerability and exposure of people (which is dynamic) and of assets and infrastructure



Factors Considered for Impact Based Warnings

Factors	Considerations
NWP and observations	Situational awareness. Model performance and characteristics. Hazard and likelihood.
Population	Exposure and vulnerability including time of day/week/year, population density e.g. rural or urban, large (outdoor) events, tourism, school holidays, increased travel, socio-political context, societal resilience.
Impacts	On people, infrastructure and assets. Discussion with others, especially Civil Contingency Advisors and Hydrometeorologists. Any known factors, such as existing road/bridge closures.
Timings	Of impacts, and lead time of warning.
Position on matrix	Mainly for emergency responders. Factor in potential escalation / likely journey through matrix.
What could go wrong	Including verification of decision and warning.
Alignment	With others e.g. Flood Forecasting Centres (rain) and UK Health Security Agency (heat).
Overall messaging	Does this convey the right message? Does the warnings board look cluttered? Are there other considerations, e.g. socio-political – pandemic, election, unrest, unintended consequences.

Considerations

Model comparison / consensus

I mean this is really cool … **models are in amazing agreement**, so that's nice.

Data volumes

Whilst our models are better and we have a lot of decision aids, that doesn't mean to say making warnings is actually easier because **we have a huge amount of data to look at**.

Individual responsibility and decision process

It's where you **feel comfortable**, 'cause ultimately it's kind of got **your name attached** to it. And I think as long as you can **justify your decision** based on the information you have at the time, there isn't necessarily a right or wrong.

Lead time

There is a danger by going very early for a warning that you're just talking about it endlessly. And … is that is that useful or not? And also, you know you can put out a warning that's over a large area and a relatively low likelihood because it's necessary because it's uncertain. But then that means that **people are taking actions that they actually don't need to take**. There's … an **optimum point between size of area and likelihood of warning and lead time**.

Intuition and expertise

To be honest with you, it feels like when I do this, **it feels like I'm relying on some sort of innate inbuilt sense borne out by years and years of experience**, which to be perfectly honest with you, is, is actually a very unsatisfactory way of doing it. It shouldn't, you know, I shouldn't be making warnings just based on, on forecaster experience. There should be a lot more going into it than that.

Tacit knowledge

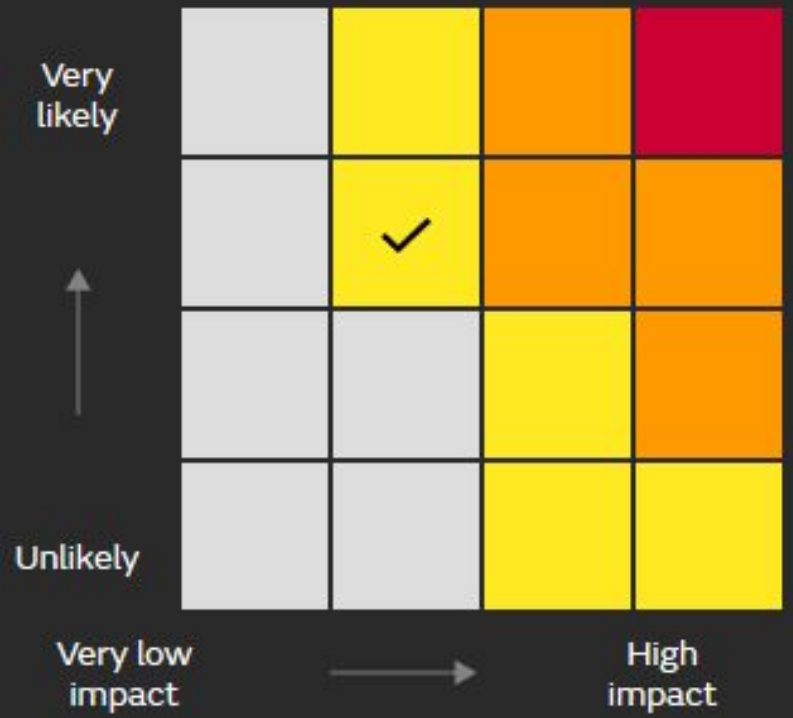
Decreased thresholds in summer take account of the increase **risk of disruption caused by trees in leaf** and things like that.

Model characteristics

As a forecaster you learn your model … and **you get used to the model characteristics**.

Probability

Met Office Warning Impact Matrix



"Probability is a qualitative subject"
(Nassim Teleb, Lebanese-American essayist, mathematical statistician, former option trader, risk analyst, and aphorist)

When making forecasts about the future, the mathematical probabilities we come up with, depend on expert judgements.

Findings and Training

The decision process when considering NSWWS is complex and multifaceted. It requires:

(a) the integration of multiple factors (which are not always meteorological, objective, or easily quantifiable)

(b) the incorporation of input from multiple sources (which are not always digitised or readily available)

As a result, the decision process is difficult to formalise, and consistency can be challenging.

By increasing our understanding of the science behind human judgment and decision-making, we can ensure that the decision process is optimal and robust, while fully utilising the value of human expertise.

Summary

To achieve our Met Office purpose, human judgement and decision-making must be better understood

"We cannot avoid uncertainty. So we need to embrace it, be humbled by it, and even try to enjoy it." (David Spiegelhalter, The Art of Uncertainty)

Any questions?

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Decision Process

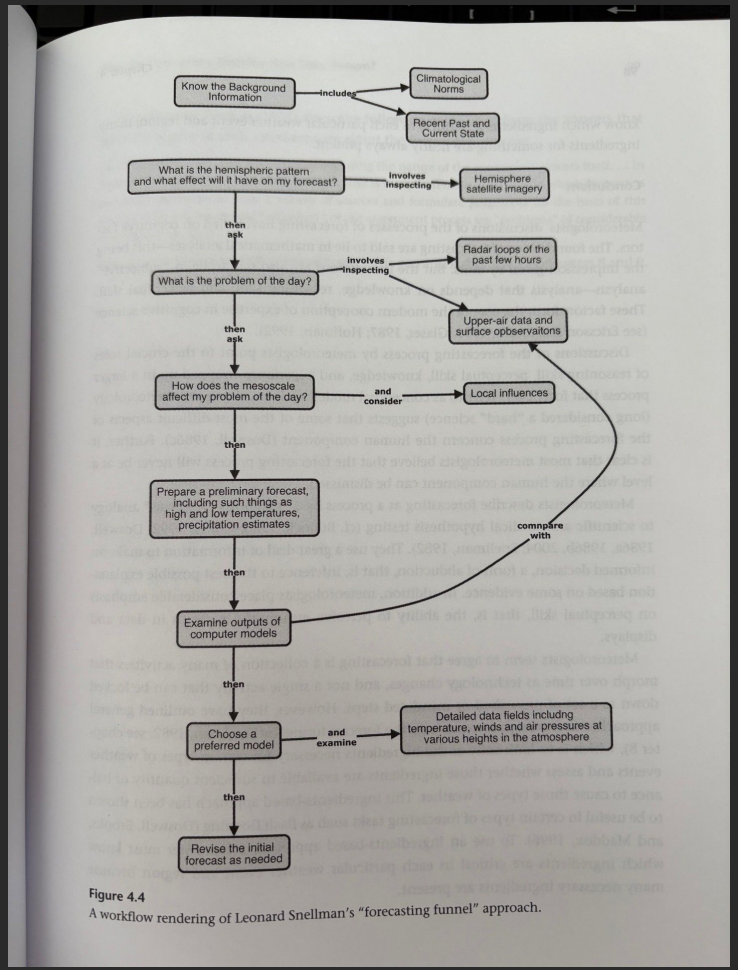

Figure 4.4
A workflow rendering of Leonard Snellman's "forecasting funnel" approach.

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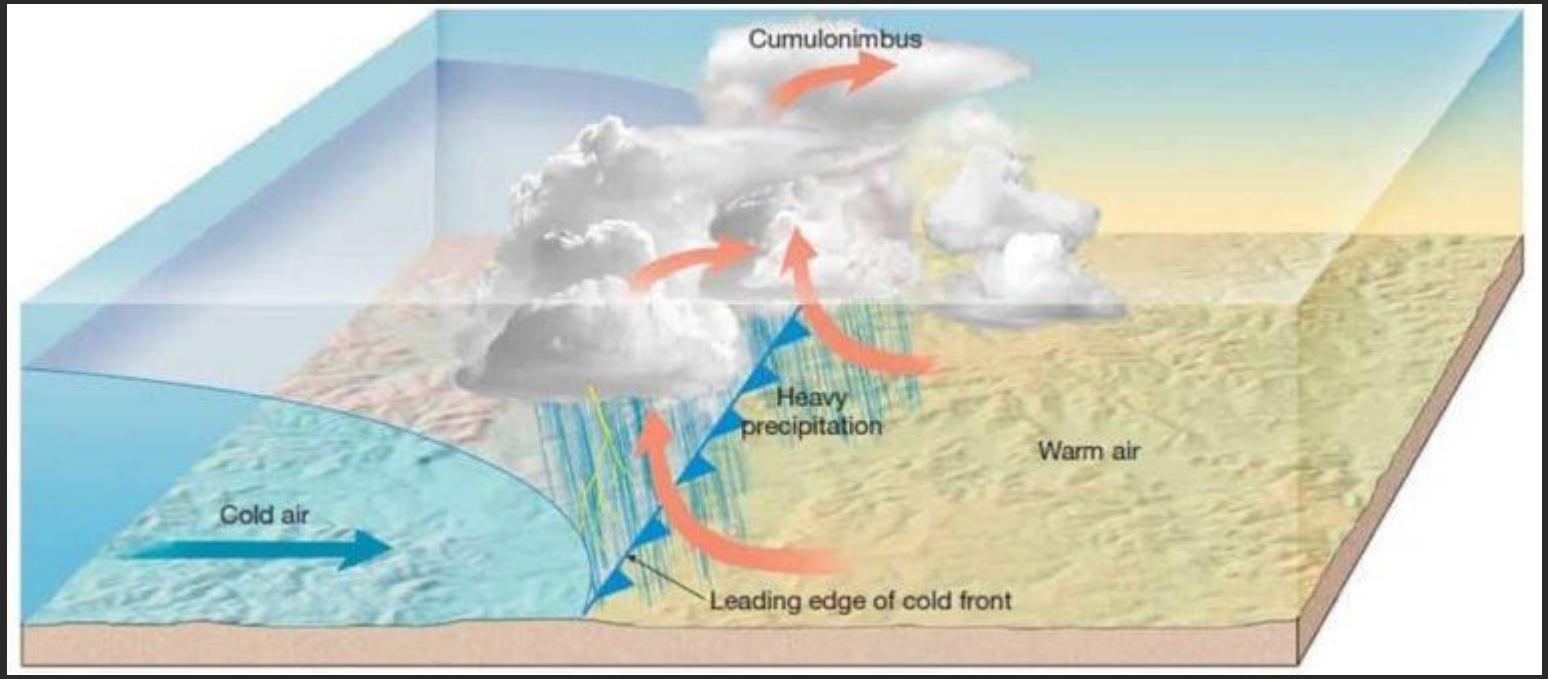
Different Types of Model

Conceptual Model



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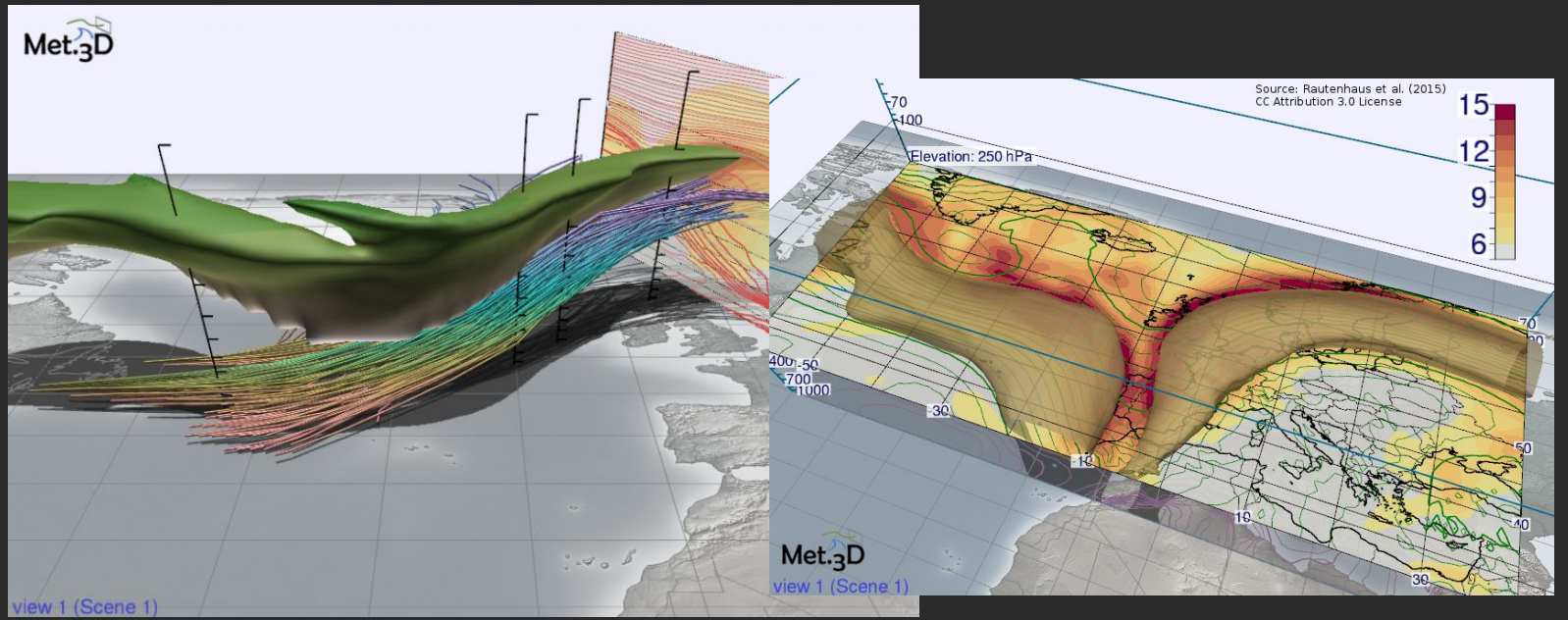

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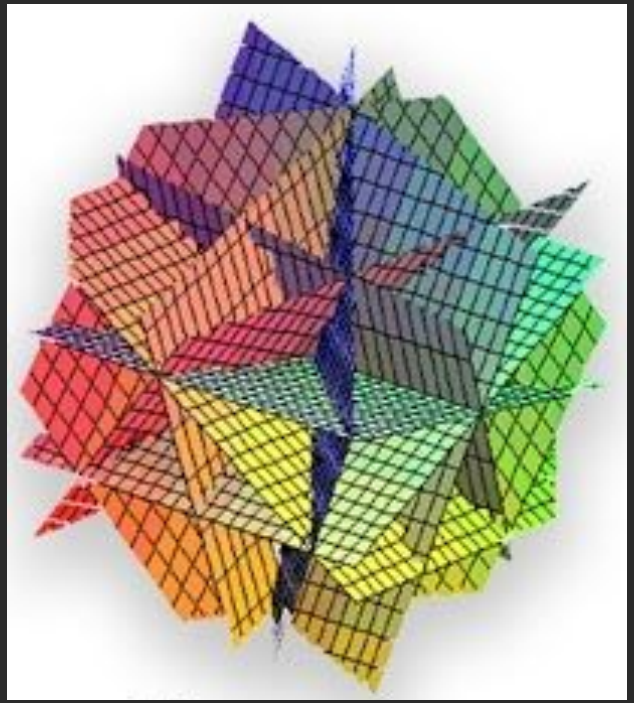
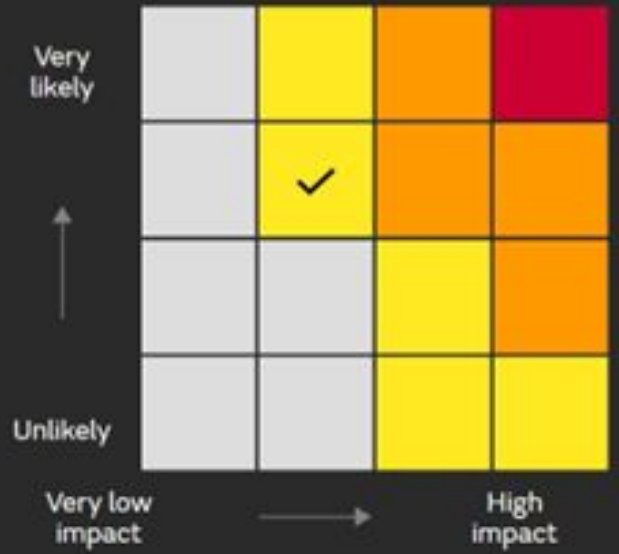
Multidimensional



Impact-Based Warnings

Met Office Warnings Matrix



Decision-making under uncertainty

Risk = Hazard × Exposure × Vulnerability

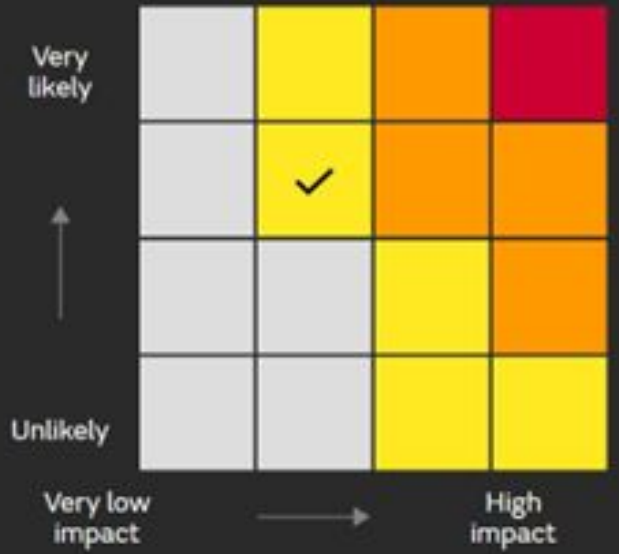
Hazard:
wind, rain, snow, ice, fog, thunderstorm, lightning, heat

Impact depends on all the above
Subjective
Not all data is available or digitised
Likelihood is also subjective

Bayesian

Impact-Based Warnings

Met Office Warnings Matrix



Statistical and judgemental uncertainty
Semi-quantified analysis

Factors to consider include:
Time of day/week/year
Antecedent conditions
Outdoor events
Tourism
Trees in leaf
Societal resilience

Forecasting

Three characteristics of a good forecaster:

Aggregation
Use multiple sources open to new knowledge, work in teams

Meta-cognition

Insight into their own thinking and biases

Humility

Willingness to acknowledge uncertainty, admit errors and change mind
Acknowledging both the known unknowns and the unknown unknowns

Dan Gardner, Future Babble: Why Expert Predictions Fail and Why We Believe them