Confidence in coastal forecasts

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October 30, 2012

Introduction

Fedor Baart

PhD thesis: Confidence in morpological forecasts

This research

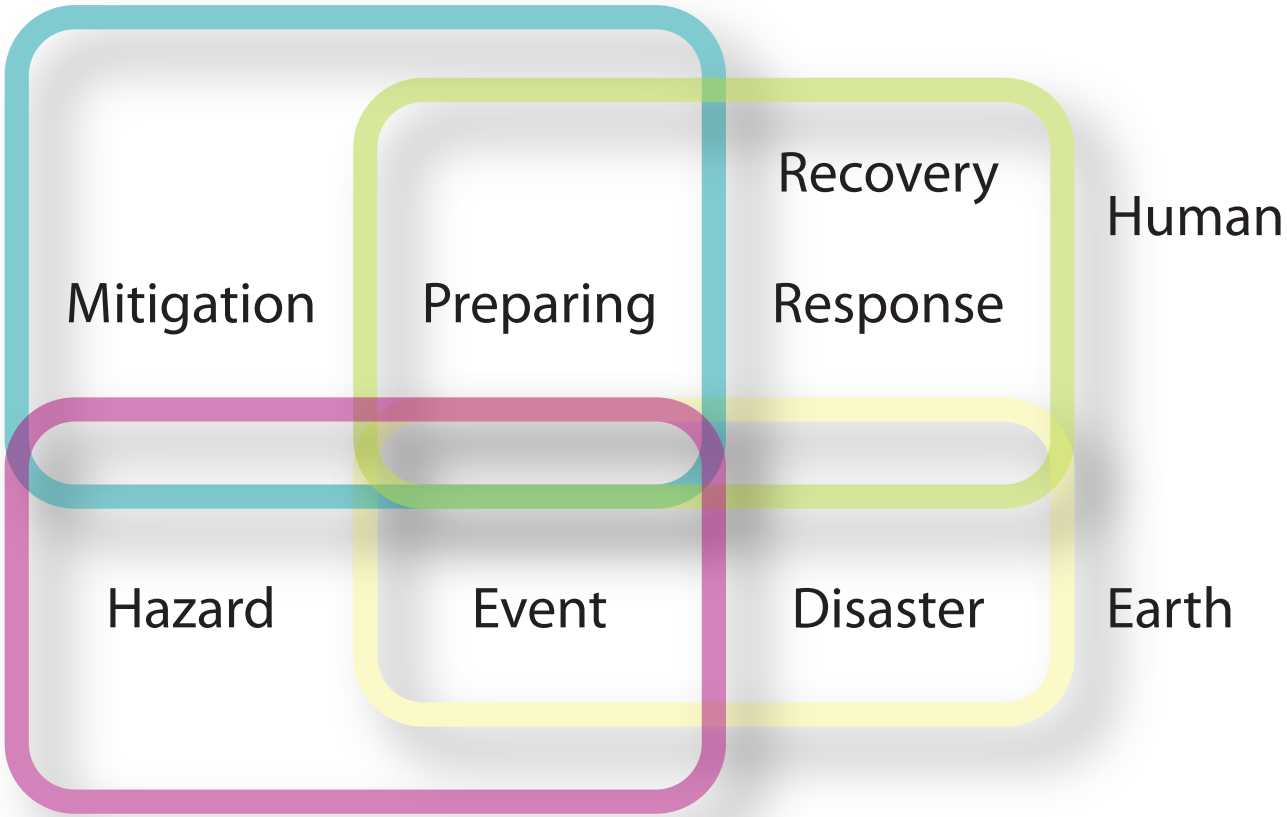
http://citg.tudelft.nl http://www.deltares.nl
http://www.openearth.nl http://www.micore.eu

This research has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement 202798 and the Cornelis Lely foundation.

Articles

JCR-2009	Real-time forecasting of morphological storm impacts: a case study in the Netherlands
JCR-2011	Confidence in real-time forecasting of morphological storm impacts (I)
NHESS-2011	Using 18th-century storm-surge data from the Dutch Coast to improve the confidence in flood-risk estimates
JCR-2012	The effect of the 18.6 year lunar nodal cycle on regional sea-level rise estimates
JCR-2012	Trends in sea-level trend analysis.
TGIS-2012	A comparison between WCS and OPeNDAP for making model results available through the internet.
-2013	Confidence in real-time forecasting of morphological storm impact (II)

Outline


Recovery
Human
Mitigation
Preparing
Response
Hazard
Event
Disaster
Earth

Relevant coastal forecasts

Mitigation

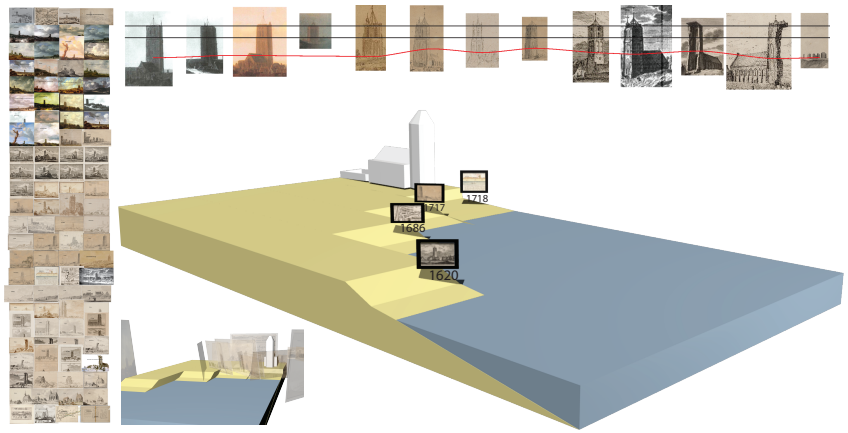
prevent hazards from developing into disasters (prevention, planning)

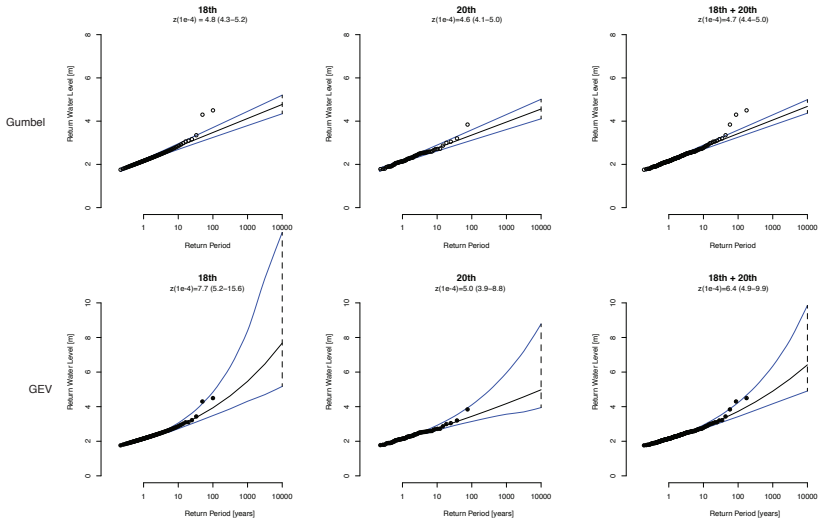
Preparation

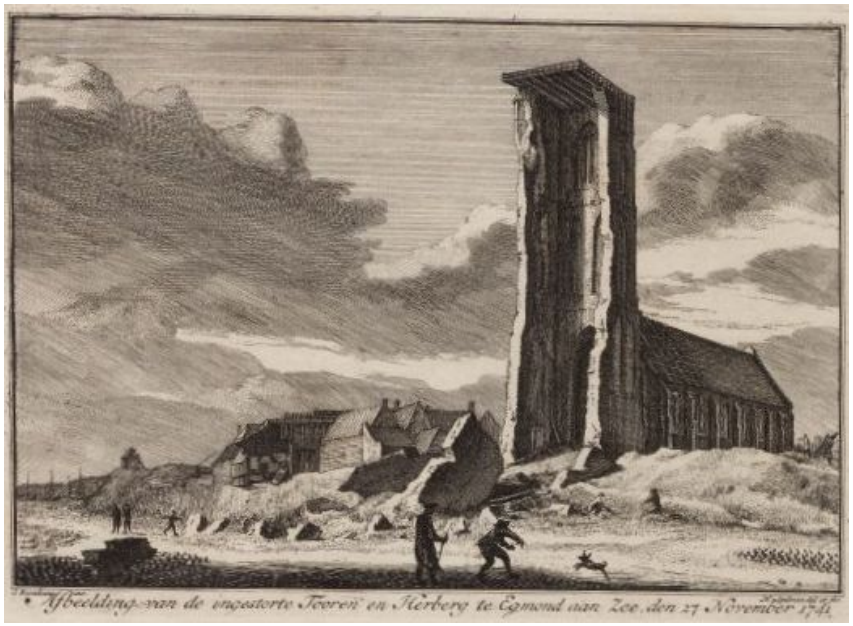
change behavior to limit the impact of disaster (emergency management)

http://www.youtube.com/watch?v=_f6s1TxXq3Y

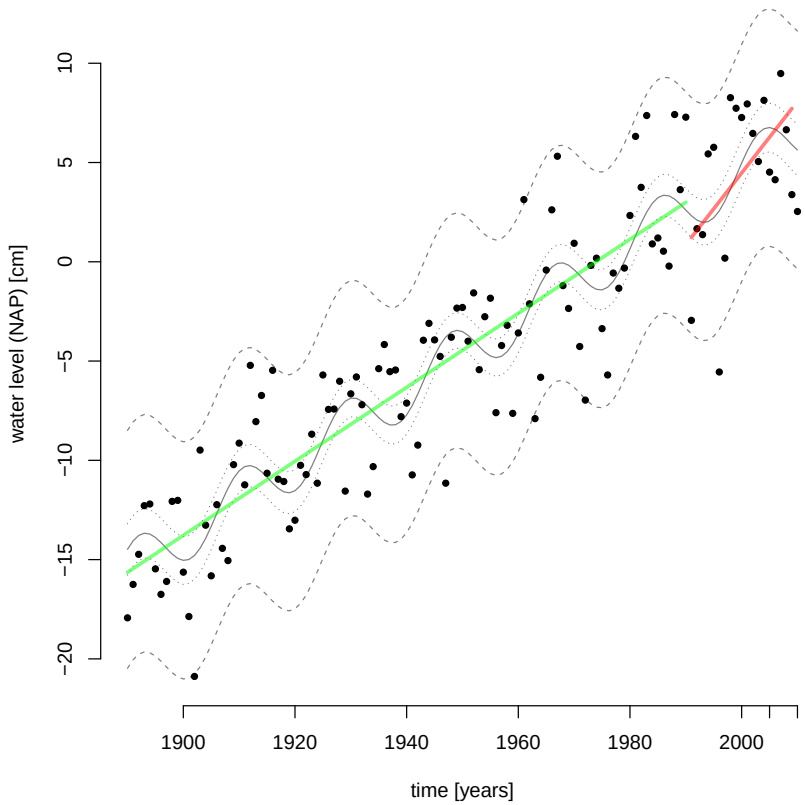
Mitigation forecast: the $^{1}/_{10000}$/year storm

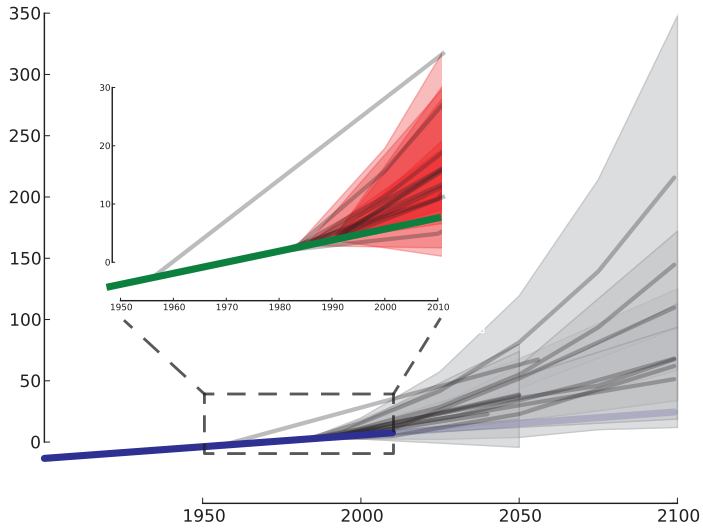




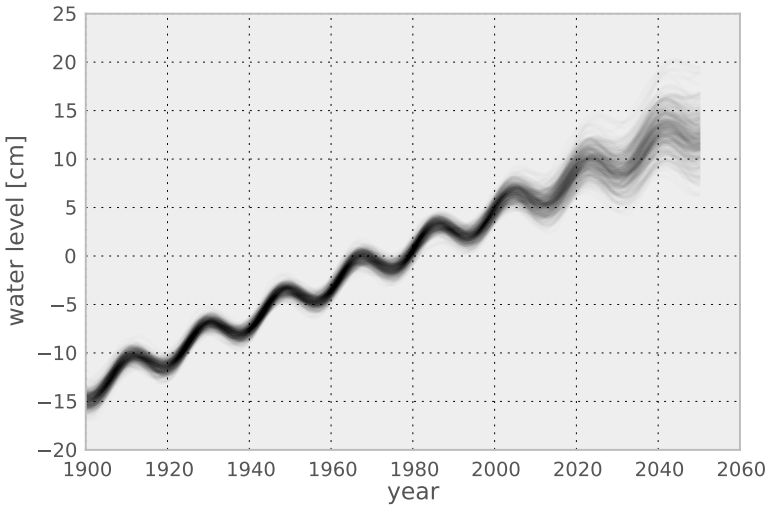

Afbeelding van de ingestorte Toren en Herberg te Egmond aan Zee den 27 November 1741

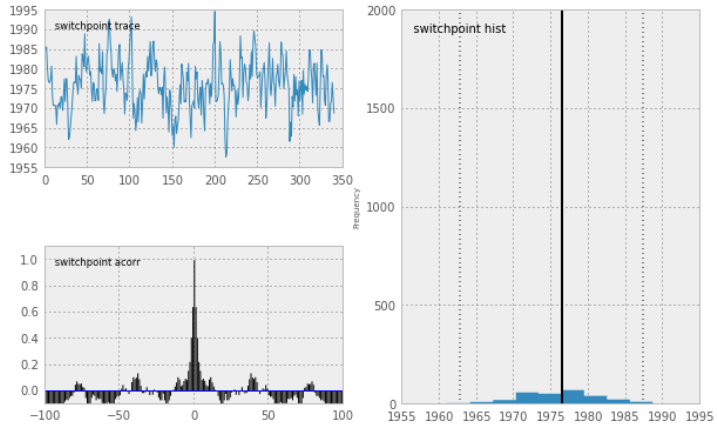
Mitigation forecast: sea level rise



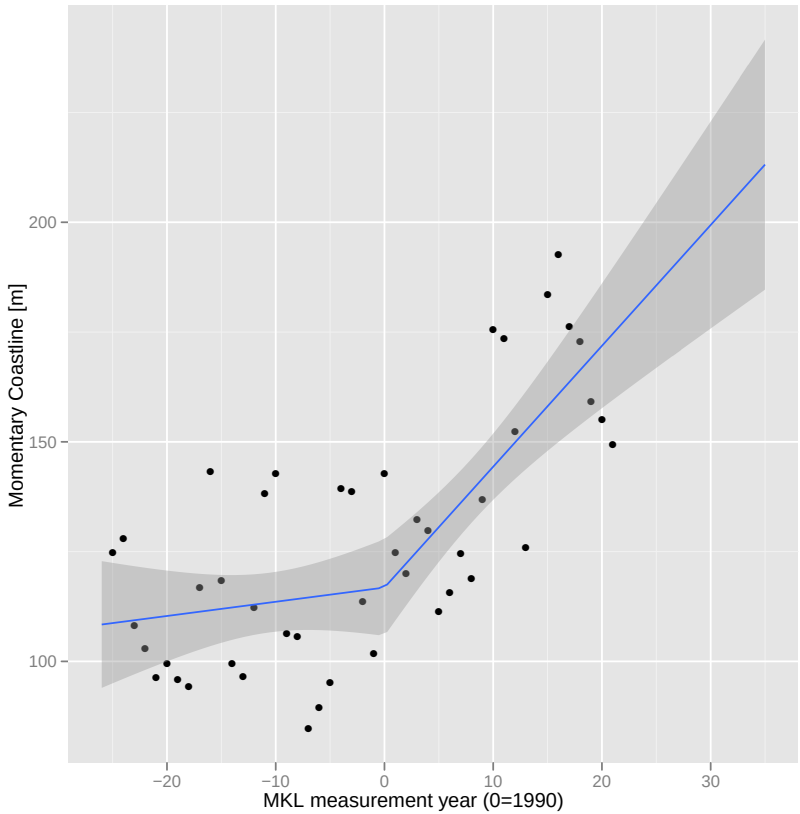


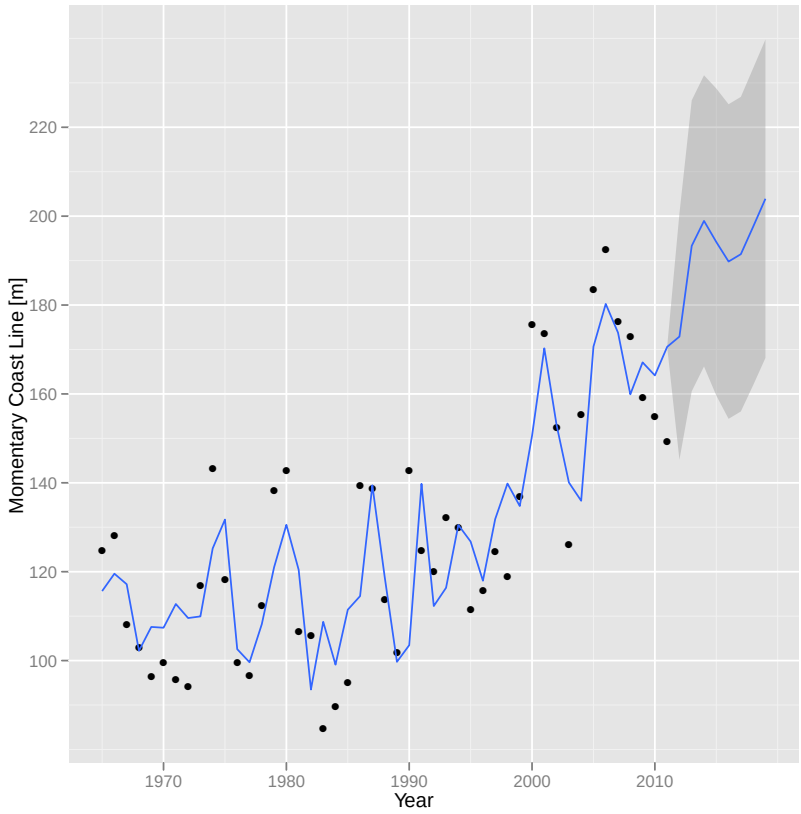
Mitigation forecast: sea level rise



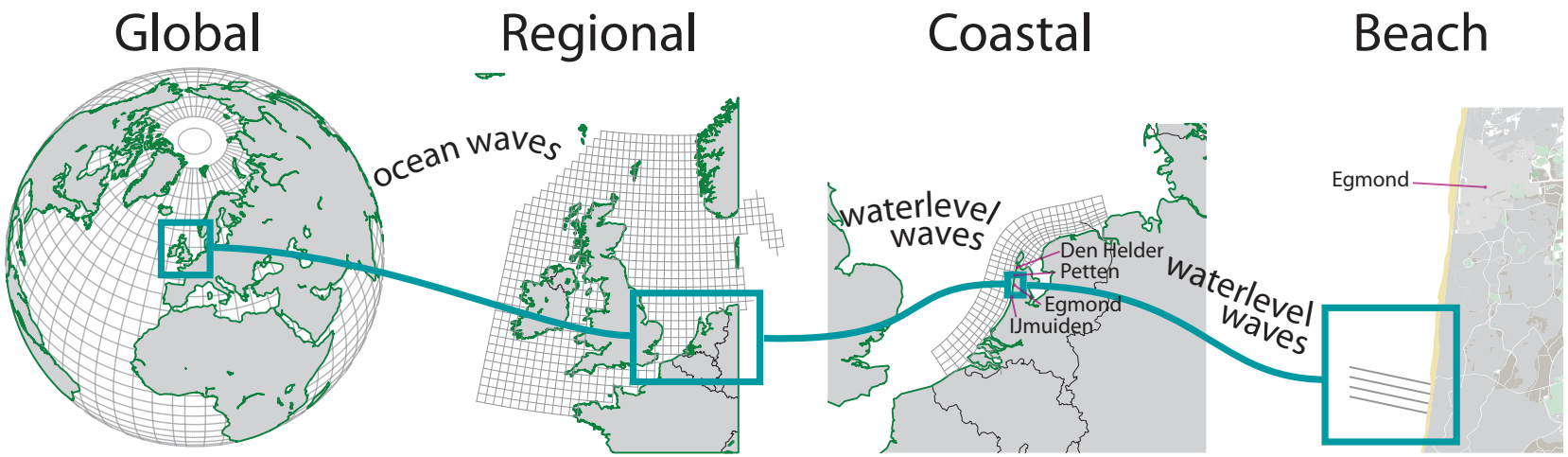


Mitigation forecasts: dune volume change

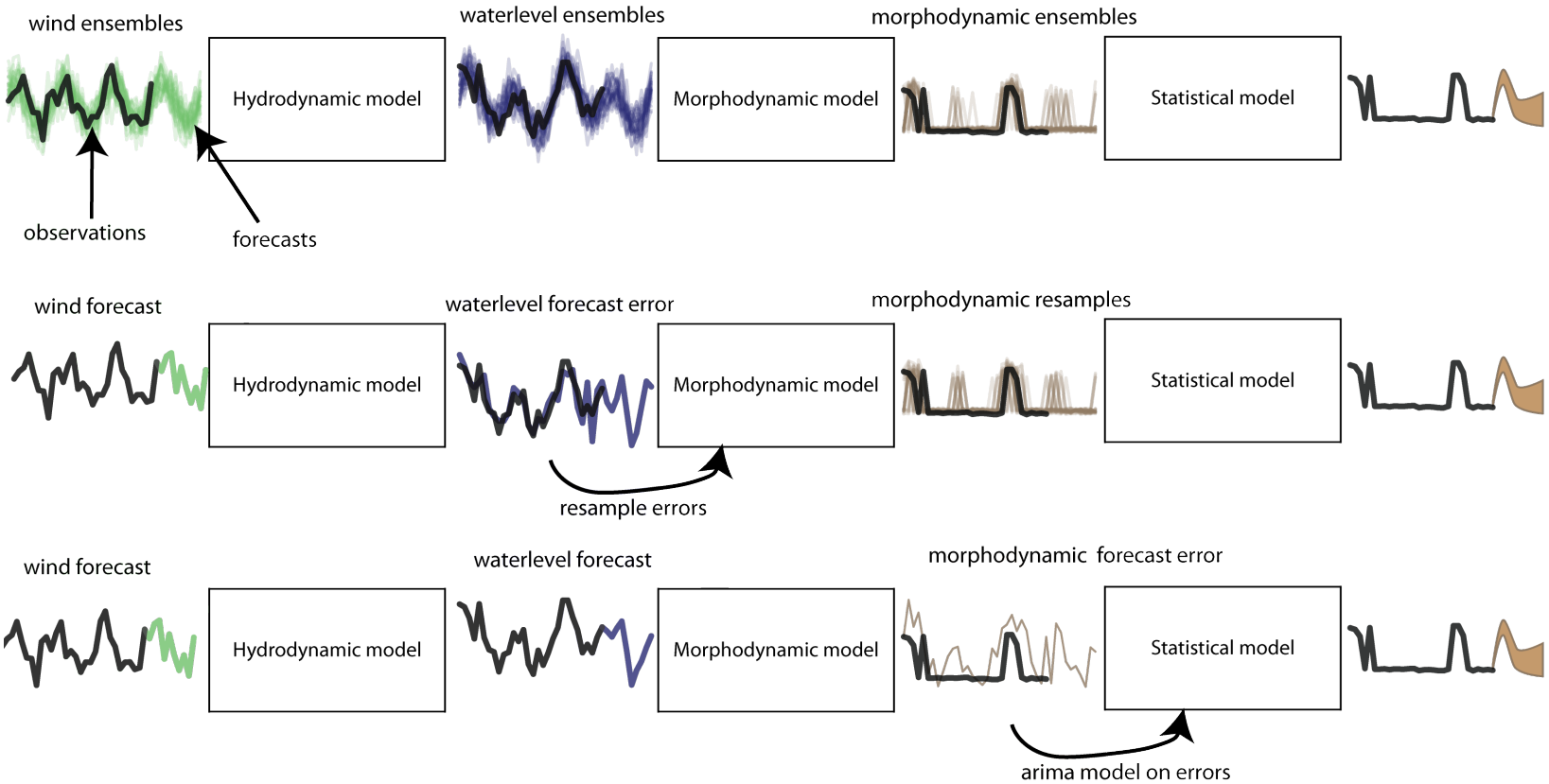




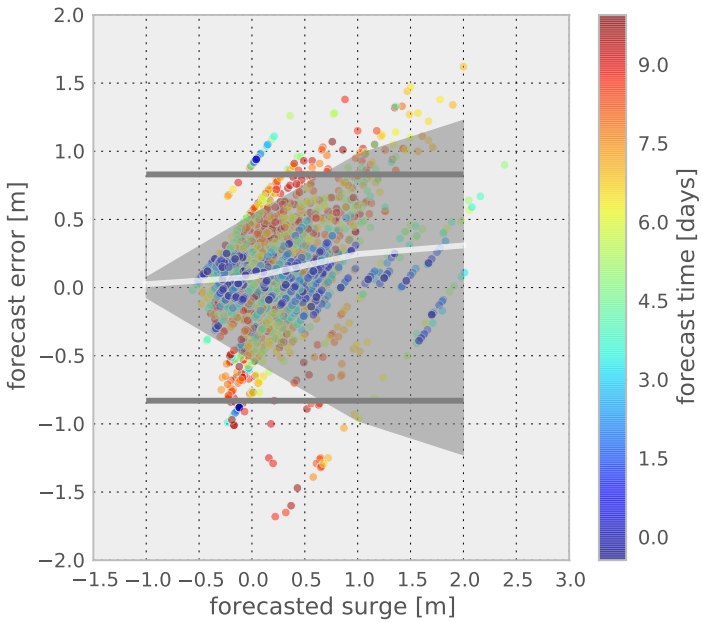
Preparation forecasts: hydrodynamic & morphodynamic a few days ahead

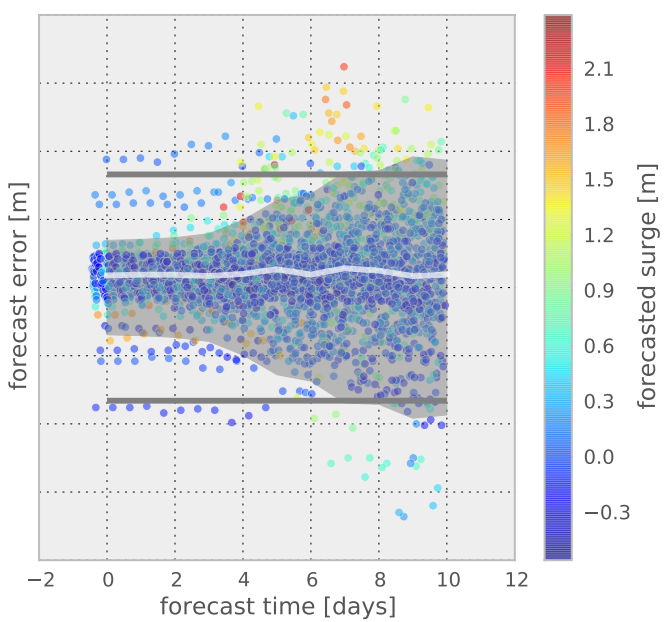


Including confidence intervals



Preparation forecasts: hydrodynamic a few days ahead





Preparation forecasts: morphodynamic a few days ahead

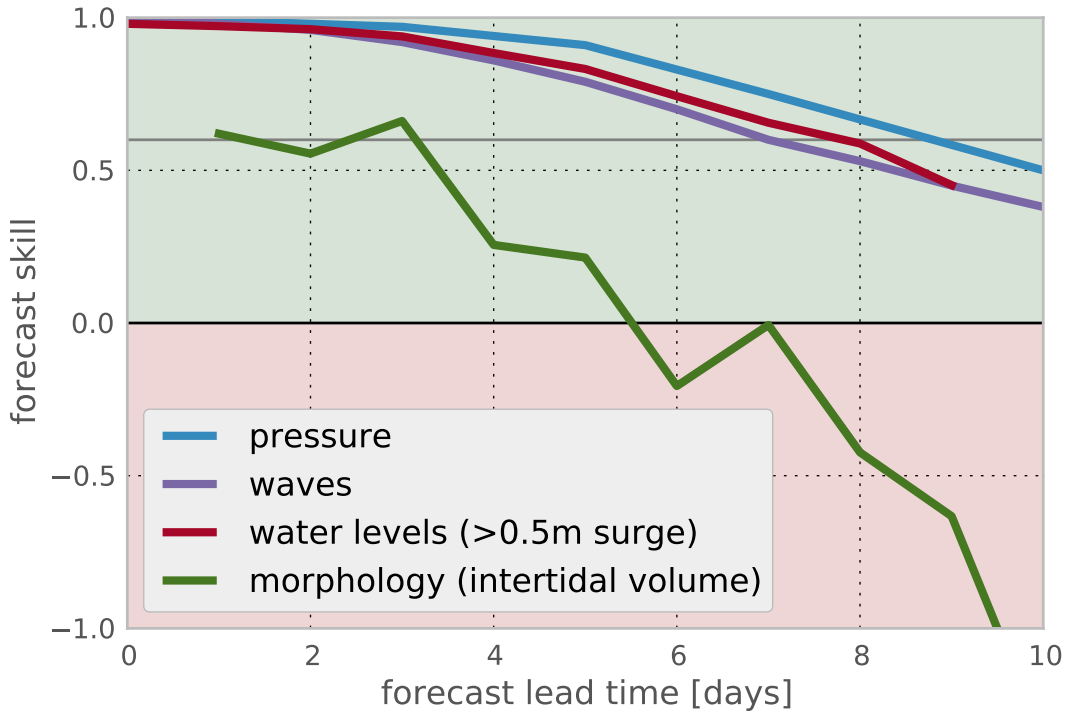


Figure : Skill as a function of forecast lead time

Outline

Types of forecasts

Numerical

- Generalizable to where assumptions hold
- Increase to improve

Statistical

- Applies to samples from the same population
- Reduce to improve

Reducing confidence intervals

increase n

include confounders

stronger assumptions

Qualitative versus Quantitative research

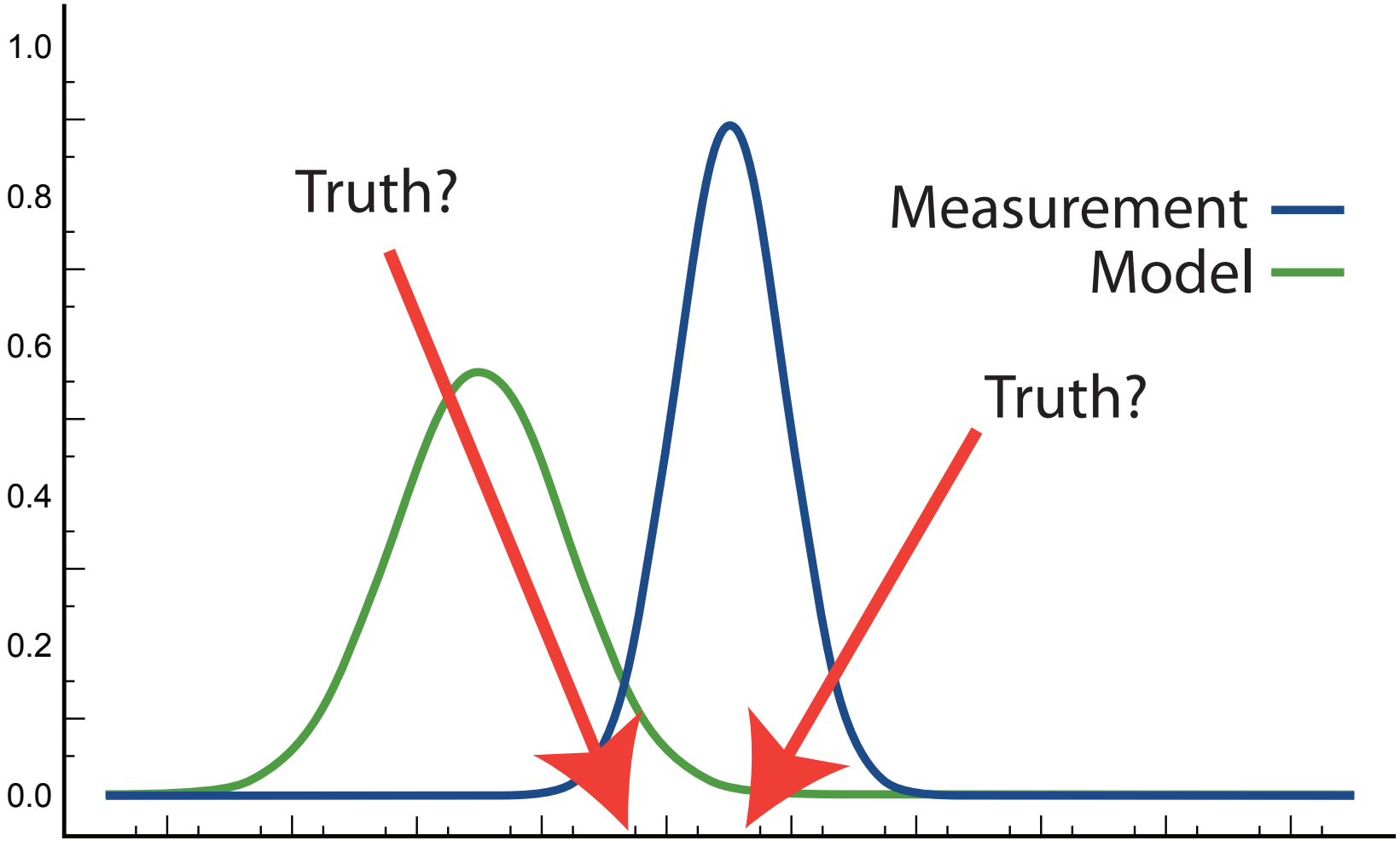
Quantitative

Verify hypothesis

Qualitative

Gain insight

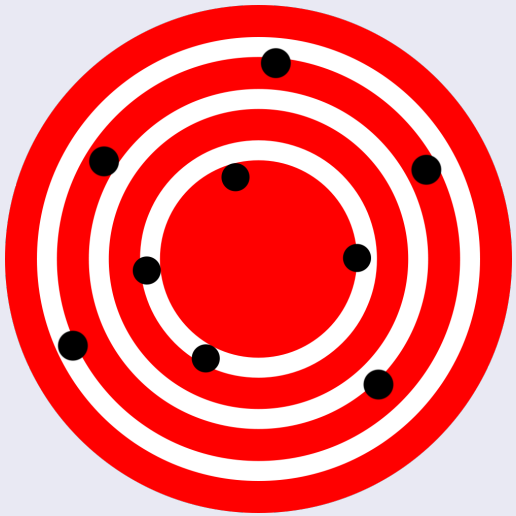
Measurements versus truth



Terminology

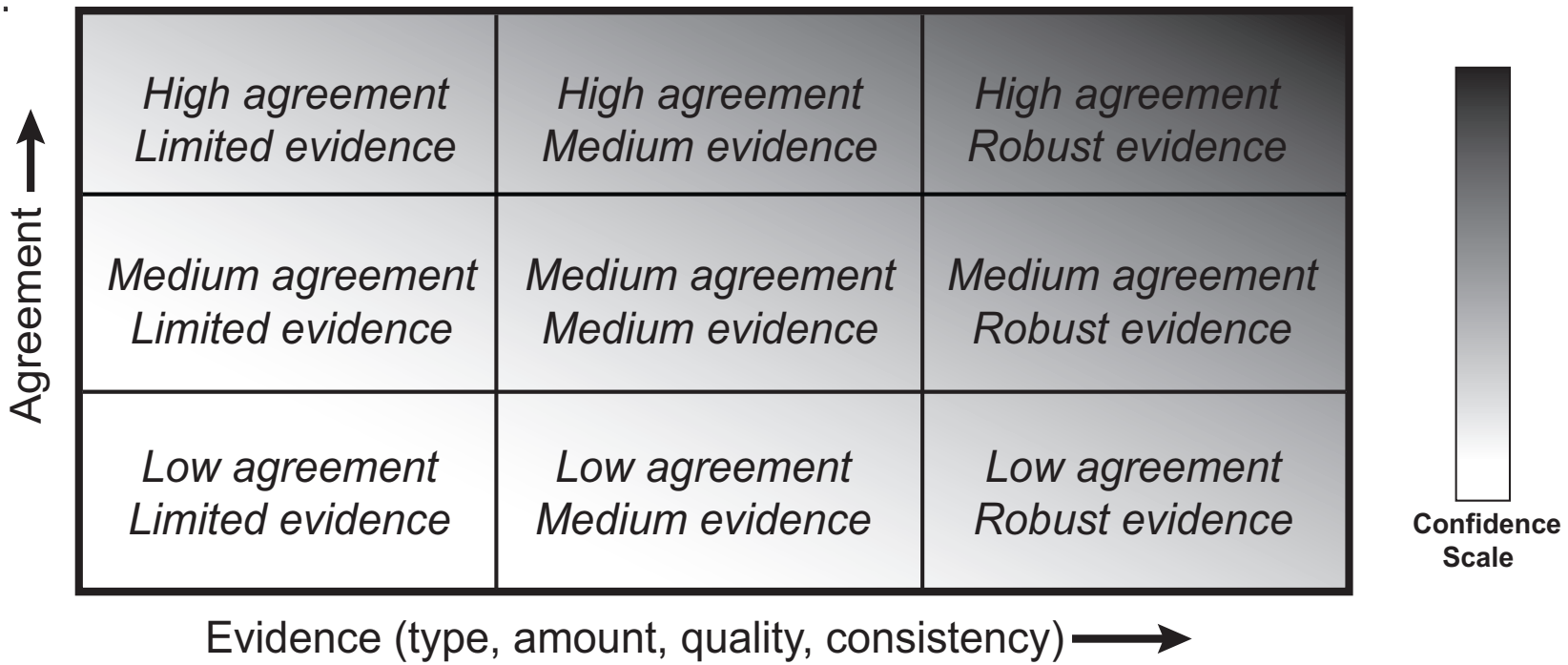
reliability-
validity+

accuracy+
precision-



accuracy+
bias-

Confidence...


High agreement Limited evidence
High agreement Medium evidence
High agreement Robust evidence
Medium agreement Limited evidence
Medium agreement Medium evidence
Medium agreement Robust evidence
Low agreement Limited evidence
Low agreement Medium evidence
Low agreement Robust evidence
Agreement
Evidence (type, amount, quality, consistency)
Confidence Scale

Certainty...

Table 1. Likelihood Scale	
Term*	**Likelihood of the Outcome**
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

Forecast quality checklist

Reliability degree to which the forecast is consistent.

- **Reproducible** does the forecast change when it is recreated?
- **Sensitive** does the forecast depend on perturbations of input variables or parameters?
- **Stability** does the forecast magnify numerical approximation errors?

Validity degree to which the forecast corresponds to the real world and is well founded.

- **Predictive** does the forecast correlate with measurements?
- **Sharpness** does the forecast predict uncommon events?
- **Concurrent** does the forecast predict the event at the correct time?
- **Spatial** does the forecast predict the event at the correct location?
- **Discriminant** does the forecast produce different outcomes when the measurements are different.
- **Construct** does the forecast predict the intended quantity?

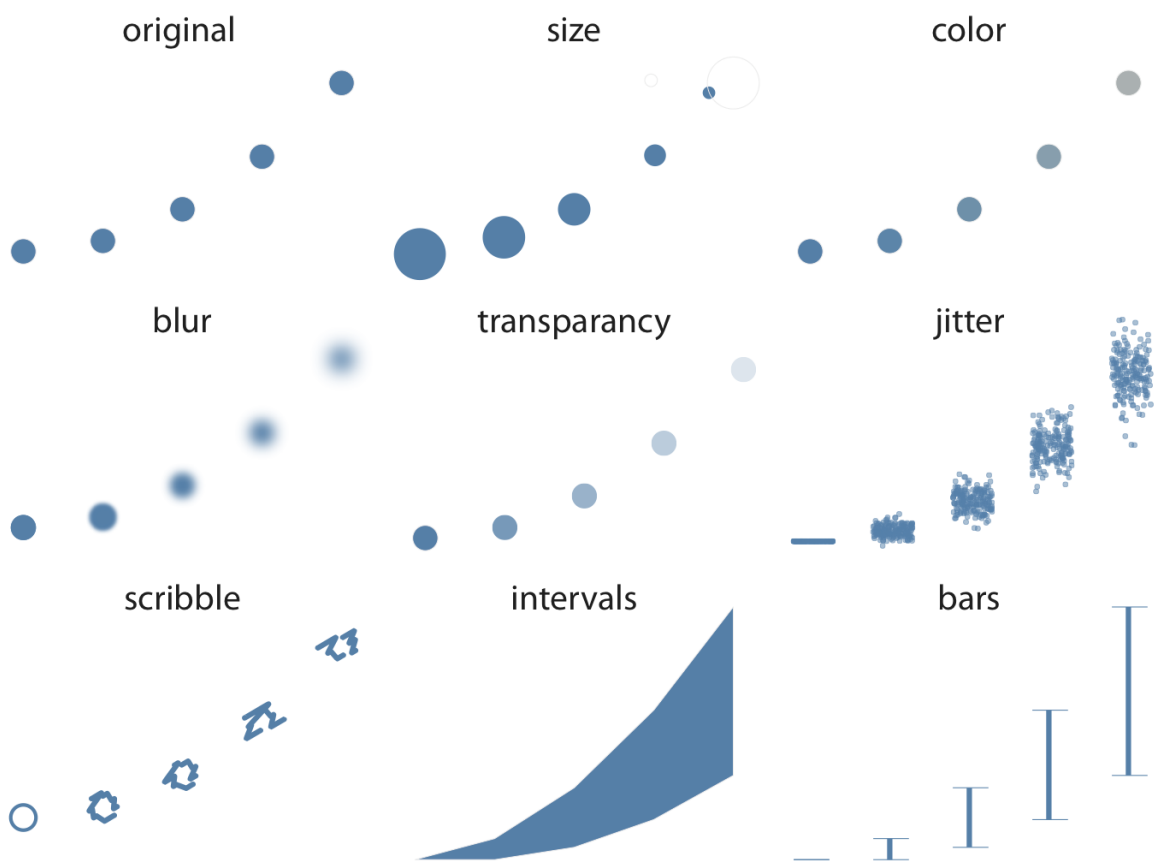
Validity degree to which the forecast corresponds to the real world and is well founded.

- **Calibrated** was the forecast calibrated?
- **Content** does the forecast predict a representative sample of the domain of interest?
- **Resolution** does the forecast predict at a high enough resolution to describe the features of interest?
- **Internal** does the forecast depend on causality?
- **Integrity** is the quality of the forecast system guaranteed?
- **External** does the forecast system predict in new situations?

Validity degree to which the forecast corresponds to the real world and is well founded.

- **Criterion** does the forecast correlate with related quantities?
- **Convergent** does the forecast correlate with other forecasts made by other models?
- **Skill** does the forecast do better than a reference forecast?
- **Persistence** does the forecast do better than a persistent forecast?
- **Face** does the forecast appear to predict what it should?

Visualization methods

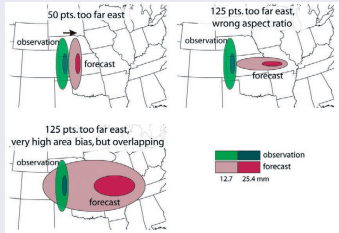


Outline

Formalizing eyeballing

Rorschach card 9

Spatial mismatch



Error as transformation function

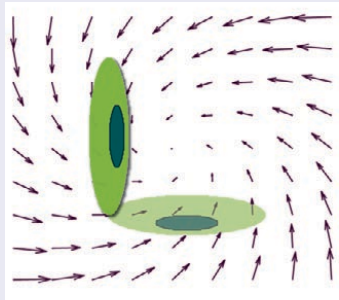
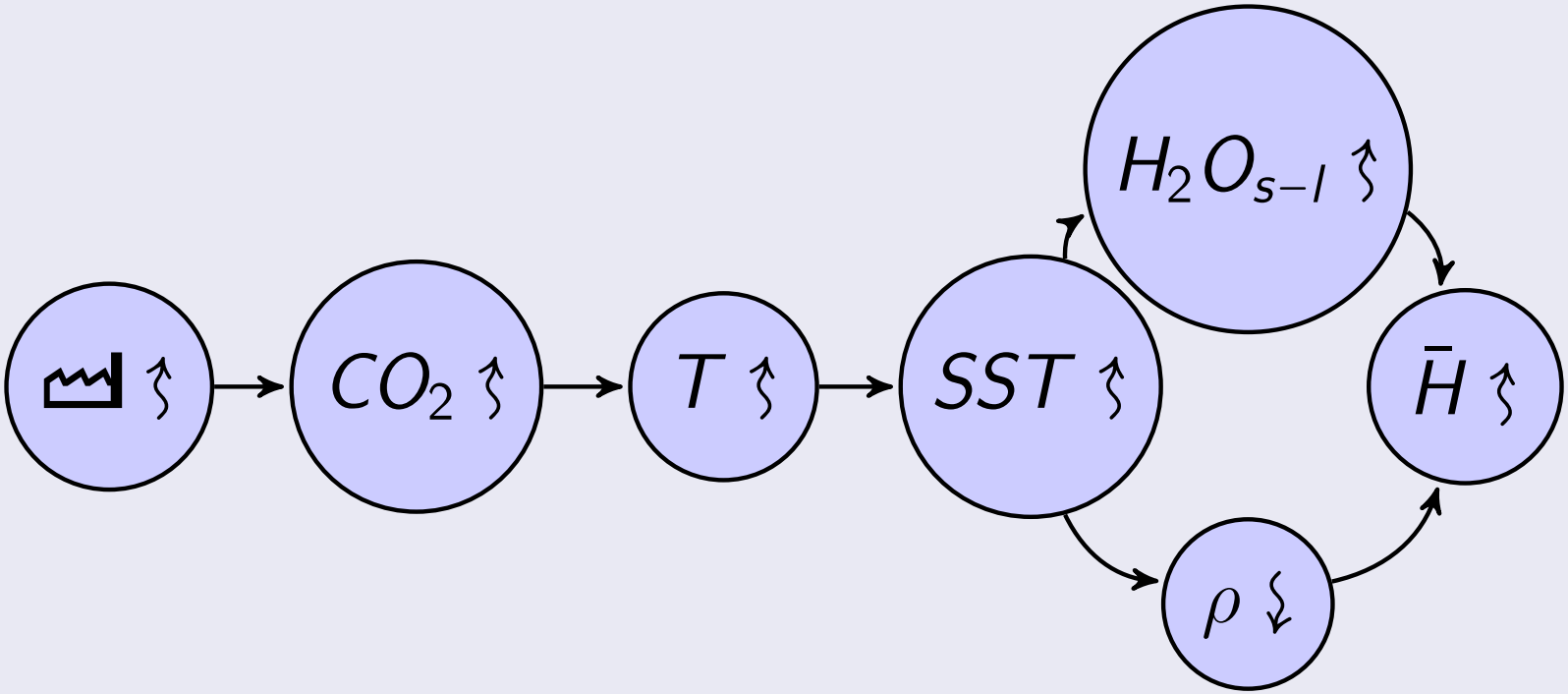
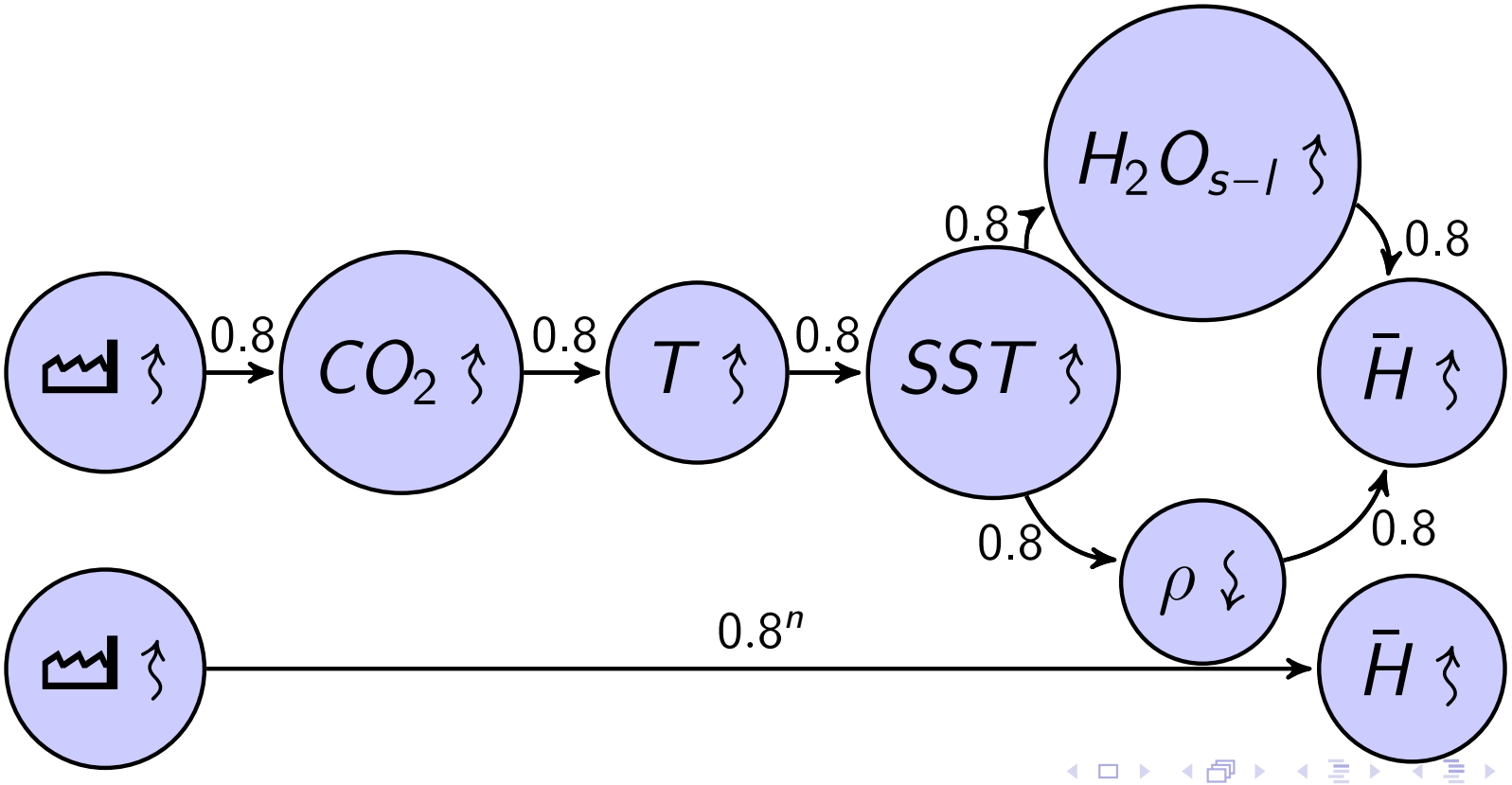


Figure : src: Glleland 2010

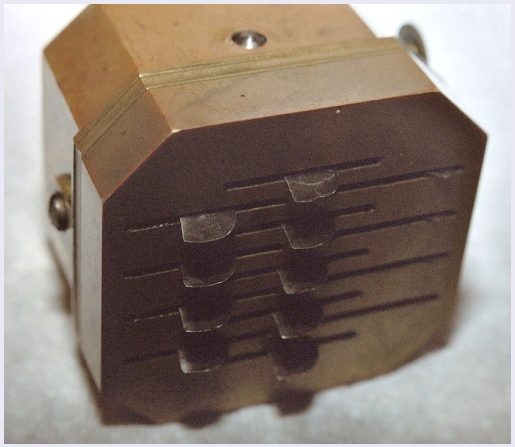
Chain of evidence

Model chain used for sea level rise forecasts



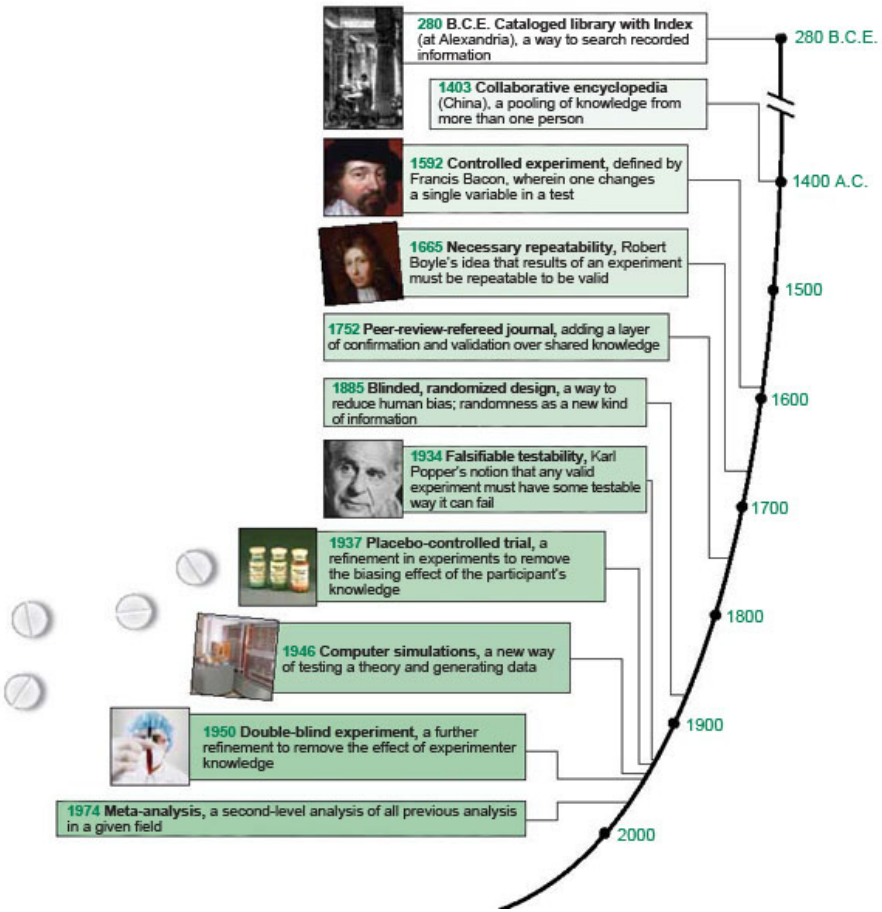

0.8
0.8
0.8
0.8
0.8
0.8
0.8
0.8
CO_2
T
SST
H_2O_{s-l}
ρ
$\bar{H}$
$\bar{H}$
0.8^n

bloodletting



waterletting

Developments in the scientific method



1926 Randomized design

1934 Falsifiability

1937 Placebo

1946 *Computer simulation*

1950 Double blind

1962 Meta analysis

1964 Strong inference

Outline

Evidence Based Practice

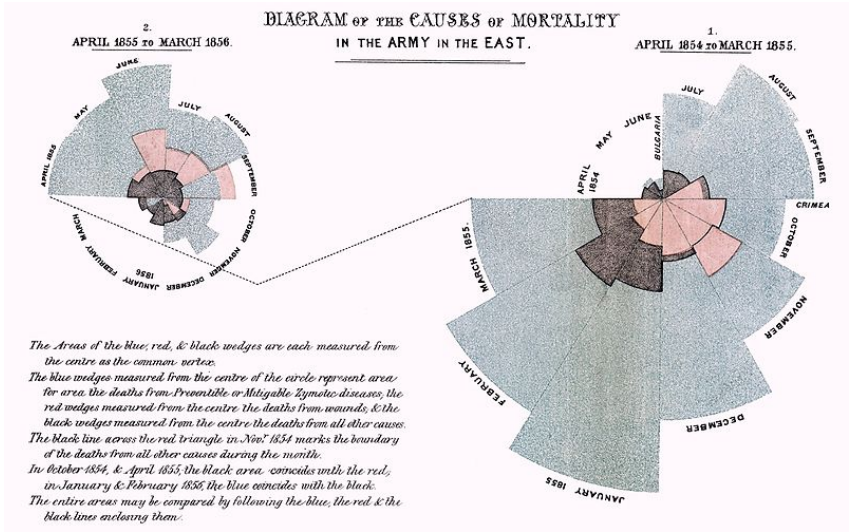


Figure : Florence Nightingale

Evidence Based Coastal Management

- Coastal interventions should be based on effect studies.
- Effect studies are selected based on norms (disregard theoretical and qualitative studies).
- Effect studies are combined using meta analysis, resulting in the current evidence.