# Predictability, forecastability, and observability

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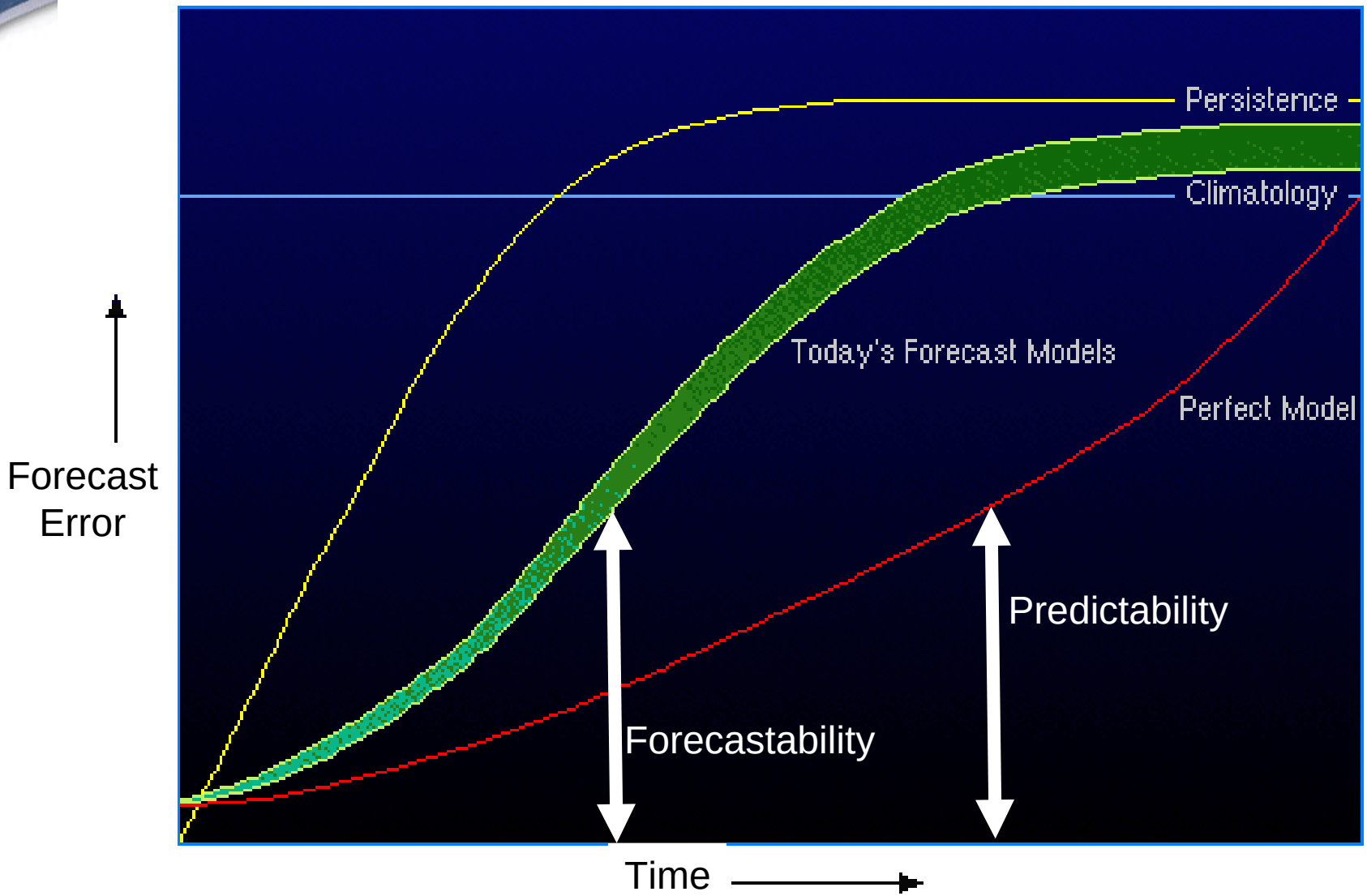
# Predictability

- The rate (or factor) of divergence of nearby trajectories (norm dependent)
- An intrinsic, yet unknowable, system property
- The aim is to learn about the system dynamics by asymptoting towards the system's intrinsic predictability.
- Ultimate aim is to attempt to increase forecast skill
- Inherently probabilistic

# A spectrum of -abilities

- Predictability
  - How trajectories of the true system diverge
- Model predictability
  - How trajectories of a given model diverge
- Forecastability
  - How a model trajectory diverges from a true system trajectory


Persistence
Climatology
Today's Forecast Models
Perfect Model
Predictability
Forecastability
Forecast Error
Time

# Back story

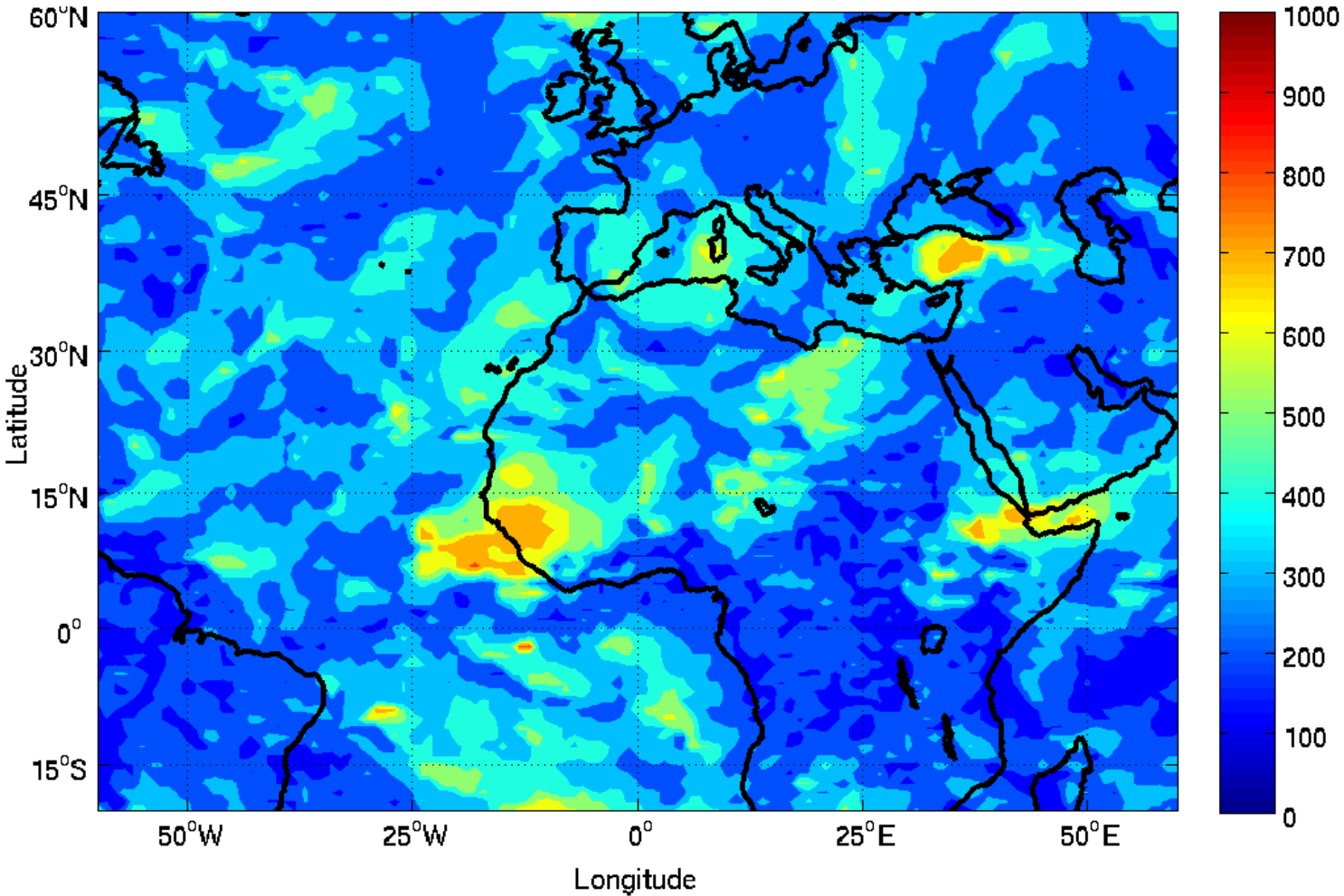
- Aerosols are an important parameter for Navy operations.
- Aerosol estimation and prediction is a hard problem fraught with uncertainties.
- The NRL Probabilistic-prediction Research Office aims to advance the estimation, communication, and use of METOC uncertainty for improved science and improved decision making.
- Got to talking with Jeff and Doug about predictability and uncertainty, but quickly learned that there are extreme observational challenges as well.

# Observability

- The ability to estimate the system state through indirect observations
  - Predictability studies can tell us how close our initial conditions need to be to the “true” state in order to produce useful forecasts
  - **Observability** speaks to constraining the initial state to the necessary level
    - what we need to observe
    - with what accuracy
    - with what spatial distribution
    - with what frequency

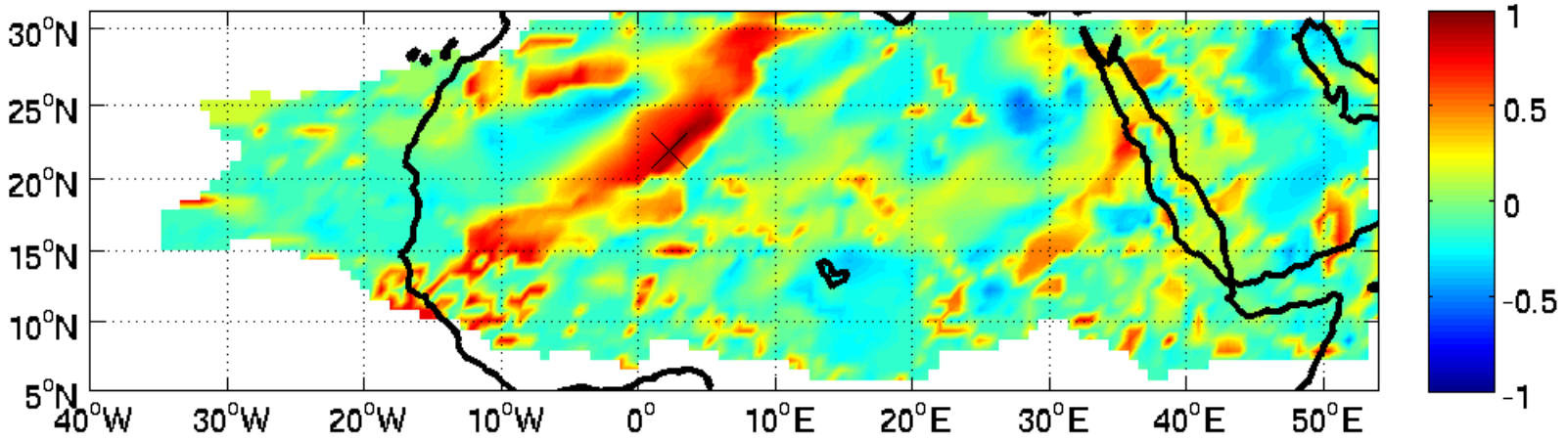
# Indirect: sparse observations

Average AOD correlation length scales (km) for a single 12hr forecast



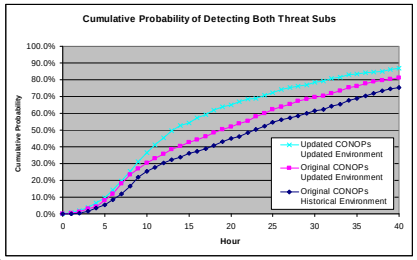
# Indirect: correlated variables

COAMPS: Correlation between AOD at a point and 10m dust concentration

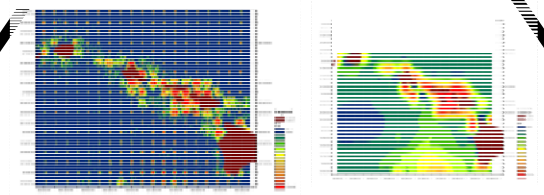


# Battlespace on Demand

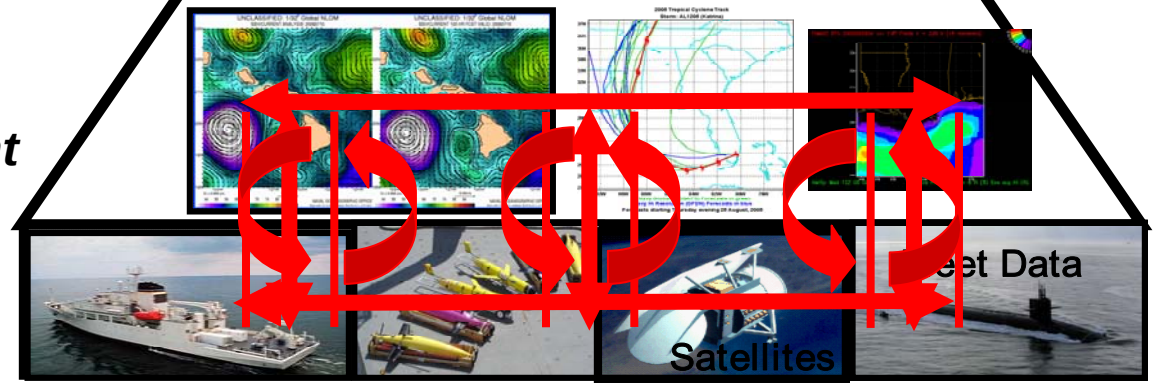
***Tier 3 – the Decision Layer***
- ***Options / Courses of Action***
- ***Quantify Risk***
- ***Asset Allocation / Timing***


***Tier 2 – the Performance Layer***



***Tier 1 – the (forecast) Environment Layer***



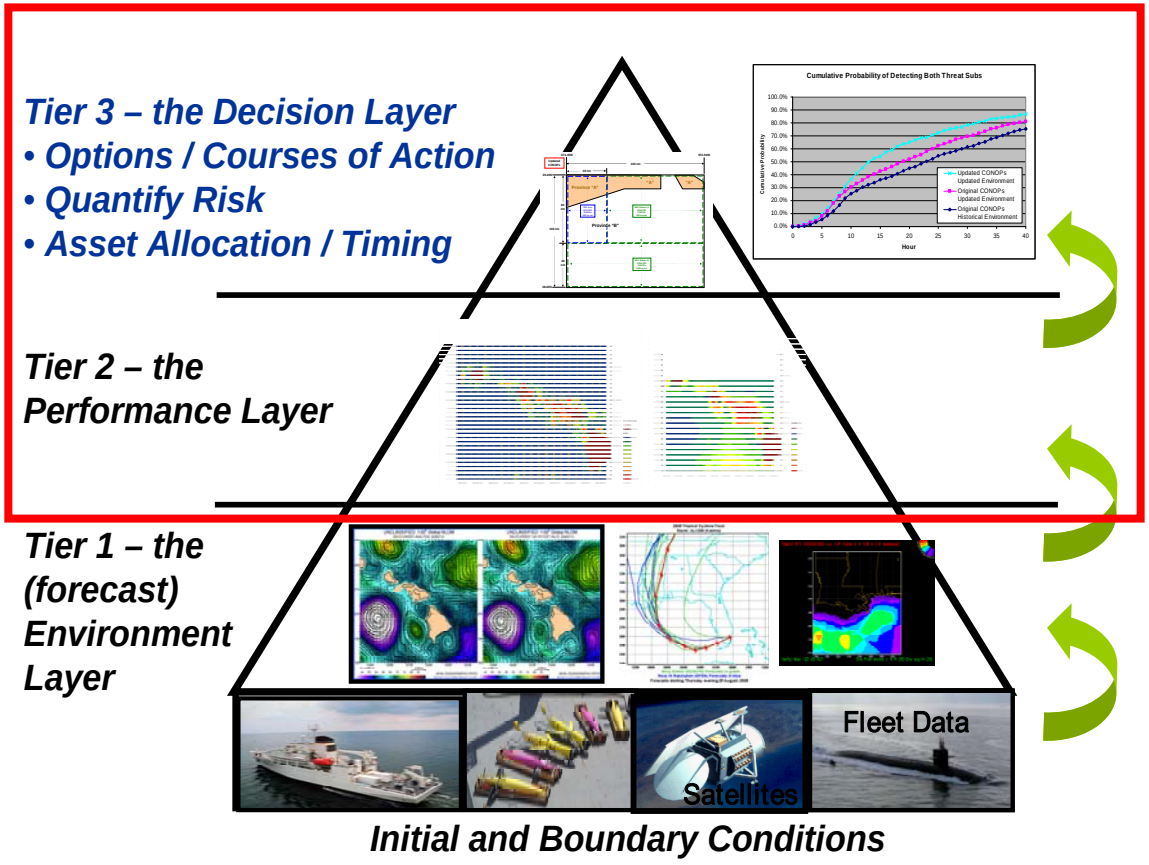

***Initial and Boundary Conditions***

# Opportunities

- What about T2 and T3 in the context of civilian aerosols?

- T2 examples
  - Air quality
  - Volcanic ash impacts
- T3 examples
  - Advisories
  - Policy

## Battlespace on Demand

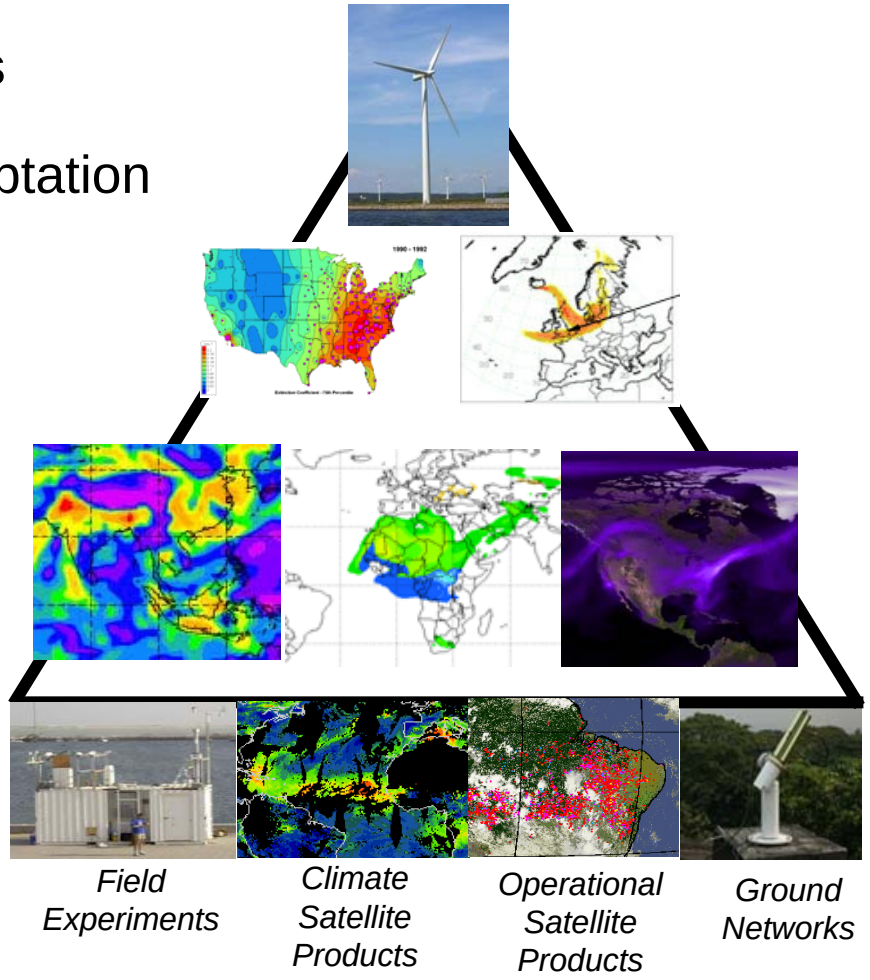


# Global Aerosol Community?

Tier 3:
Safety of navigation/operations
Air quality mitigation/permitting
Climate change mitigation/adaptation

Tier 2:
PM2.5/PM10
Plume locations
Radiative forcing

Tier 3:
Operational forecasts models
Long term re-analyses
Climate model predictions




*Same as DoD construct: many data providers, models, required performance metrics. Ultimately, need to aid many customers*

# Questions

- Science
  - What types of observing systems or networks should be put in place to best advance the science and/or forecast products?
  - What are the relevant prediction problems and norms?
- Culture
  - Does the aerosol community really care about “broader impacts”, or are the basic science questions motivation enough?
- Strategy
  - How far should the aerosol community move in the T2/T3 direction?  Is throwing your product over the fence good enough, or do you need stronger T2/T3 links to justify and motivate your T0/T1 efforts?