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Global Search for High-Value Extended-Range Forecast Products

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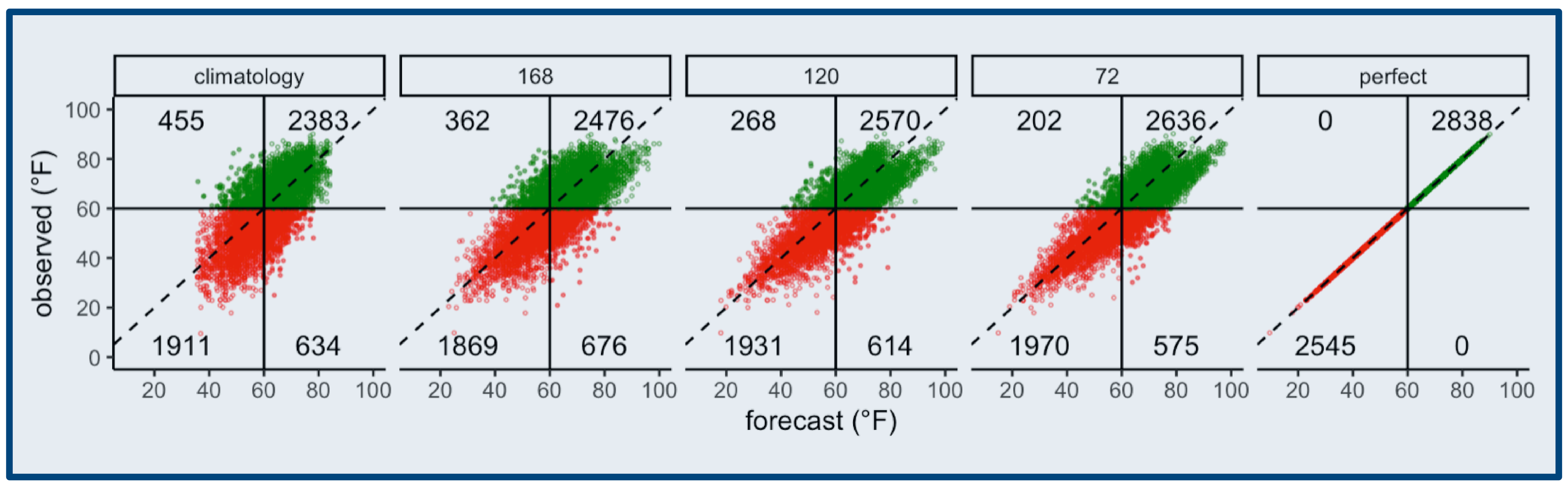
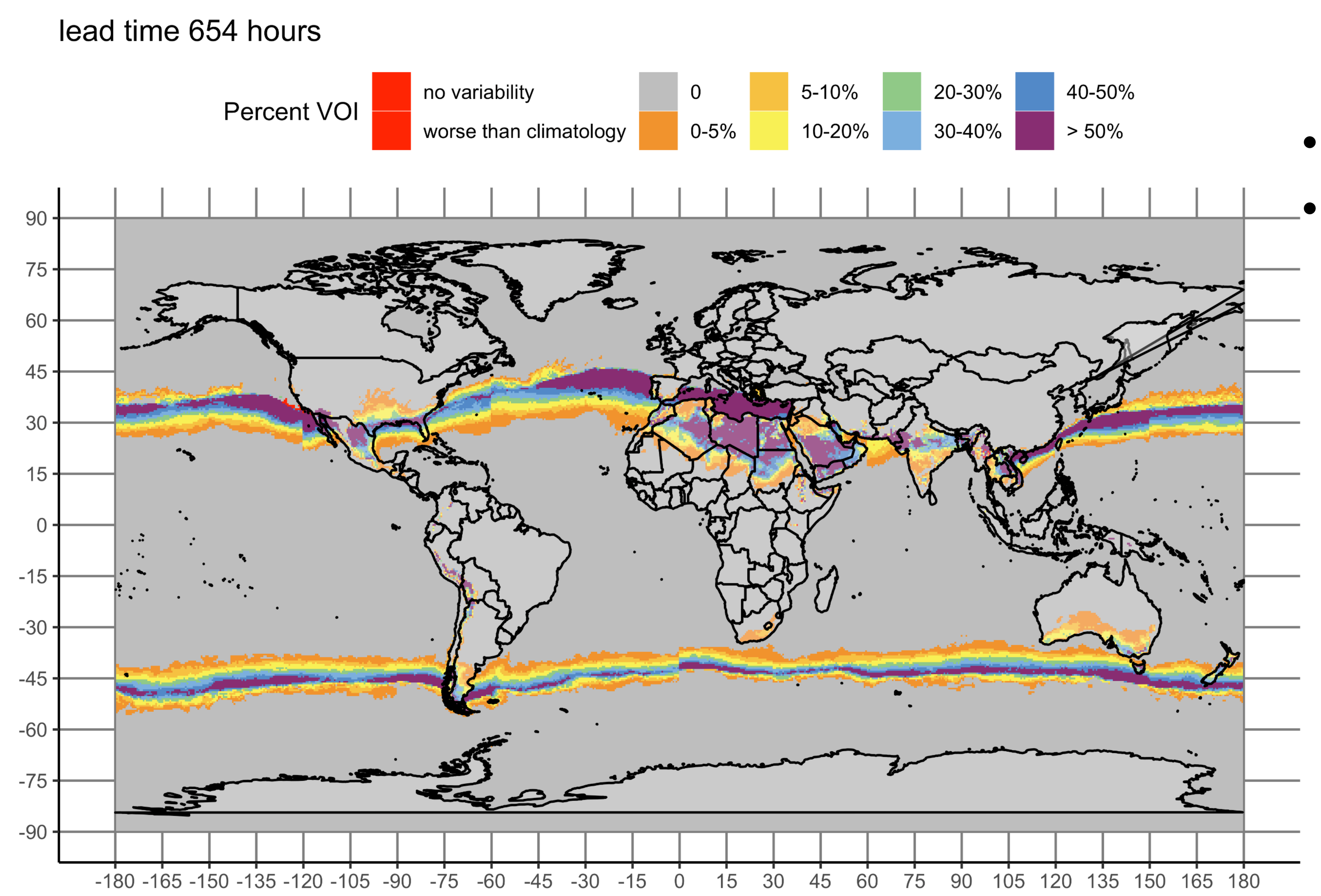
Project Summary:

- Goals: to identify high-value products for the Navy's Earth Systems Prediction Capability (ESPC) system and mission planning contexts for these products.
- This NPS interdisciplinary collaboration is an initial step to identify higher-value forecasts in mission planning at longer lead times, identify high-value mission planning contexts, and illustrate the value for Navy end-users using Value-of-Information (VOI) and data farming. This flips the script on looking for users---characteristics of high-value missions, products, and end-users are identified first, then product design, and outreach to potential users can be better focused.



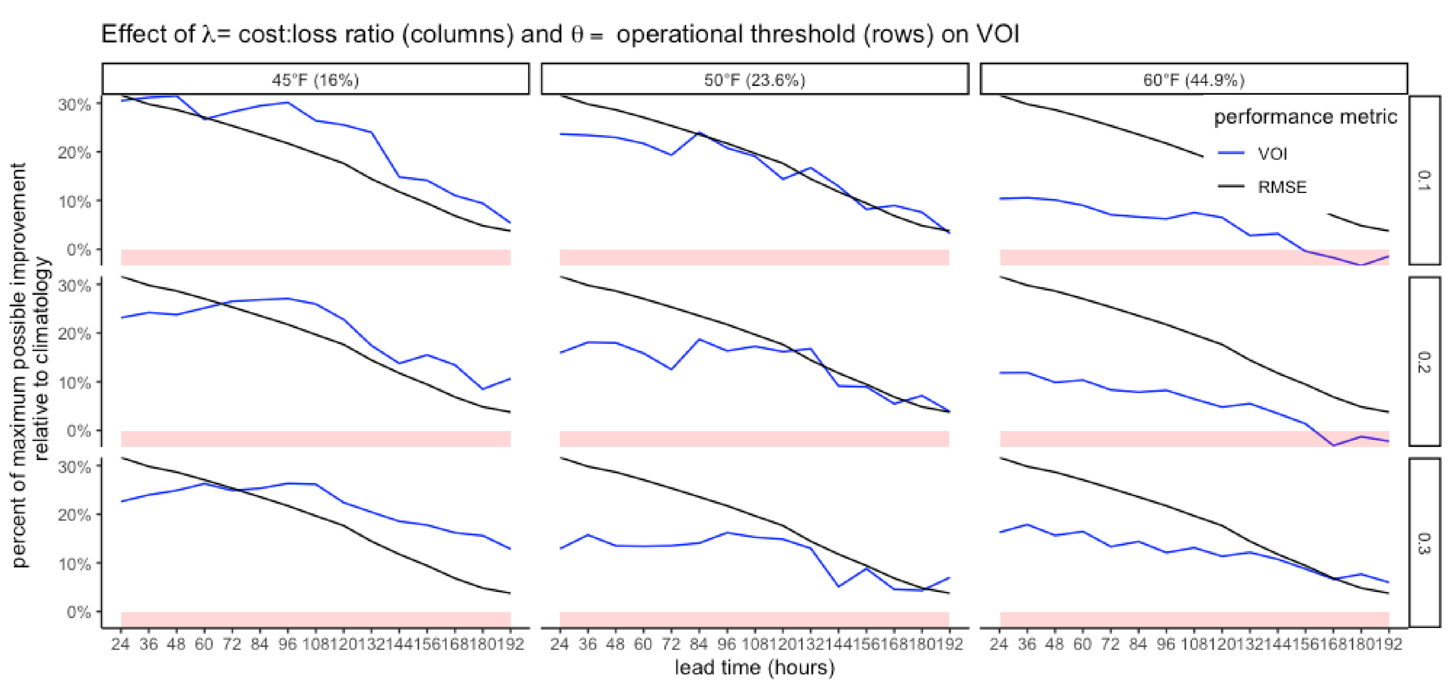
Forecasts produce better decisions - here, comparing decisions using climatology and shorter lead times (hours), and an operational limit of 60ºF.

The Global Search



VOI as percent of perfect information for ESPC temperature forecasts with 28-day lead time – positive VOI means better than climatology.

- Using ESPC reforecasts from the Subseasonal Experiment (SubX) experiment and verifications and climatology from the ECMWF ERA5 reanalysis,
- A single-stage cost:loss (atomic) decision model,
- Data farming to explore the interactions among parameters including operational limit(s), and consequences, for all seasons and regions, with lead times up to 1062 hours (45 days).



Unlike conventional performance measures such as RMSE, VOI depends on user parameters – and their interactions. Data farming explores these interactions.

Methods and Findings

- Using VOI and data farming, we conducted a global search for value in ESPC forecasts for 2m-temperature, sea surface temperature, 10-m winds, sea ice concentration, total cloud cover and spray icing prediction index.
- We processed data for use in VOI computations, coded the computation of the single-stage (atomic) and two-stage (extended and short-range) decisions.
- Using a data farming approach, conducted large-scale exploration of region, season, lead time and other parameters that characterize the operational context and forecast products.
- We identified clear benefits of ESPC extended-range forecasts as a function of METOC variable and user parameters.
- Through outreach to METOC users, we mapped mission and decision contexts to the variables and appropriate structure for the computational models

Mission / Decision Context	Variables	Structure
Shore installations, adverse METOC prep, e.g. TC-COR**	Winds, waves	Modified 1 x 1 x n Outcome depends on multiple valid times
Arctic operations**	Surface and air temperature and winds – combinations variables are very important	• Can use modified n variables x 1 x1 for spray ice; • Transit requires different model
UNREPS*	Winds, waves – combination	• 1 x 1 x 1 very appropriate for common UNREP locations • Some transit applications
Ship routing	Winds, waves	Transit – with applications elsewhere
Climate extremes*	Surface temperature	• 1 x 1 x 1 can work, with aggregated valid times and locations
ASW	Surface temperature, sonic layer depth	No one really knows

* Surprise favorites; ** unsurprising favorites

Future Research

- Develop tool for operational forecasters to identify high-value ESPC-derived products.
- Apply VOI to operational missions involving movement and selecting areas of operation such as optimal track ship routing, and underway replenishment.
- Use approach and code base to explore forecast product development questions such as choice of ensemble summary and combining forecast variables.

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