

CME Arrival Time & Impact Working Team

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Team goals

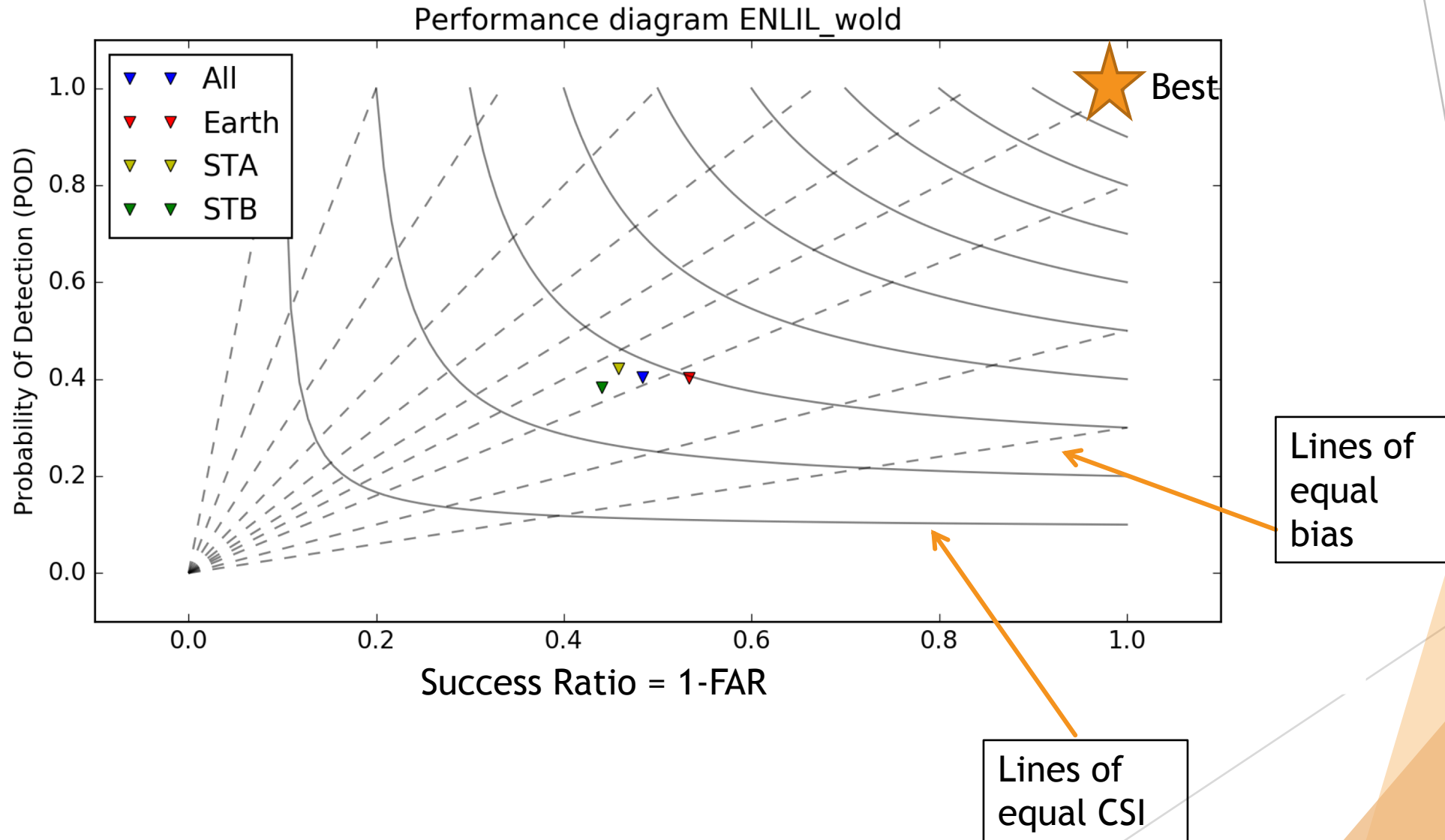
- ▶ Establish **community-agreed metrics and events** regarding CME arrival time and impact taking into account both **user and science needs**
- ▶ Provide a **benchmark** against which future models can be assessed
- ▶ Evaluate where we stand with **CME arrival time and impact prediction**
- ▶ Complimentary to CME Scoreboard

Community-agreed metrics for CME arrival time: Contingency table

	Observed Arrival	No Observed Arrival
Predicted Arrival	Hit (H)	False Alarm (FA)
No Predicted Arrival	Miss (M)	Correct Rejection (CR)

- ▶ What is a hit? - Different time intervals!
- ▶ Performance diagram

Contingency table: Performance diagram



Community-agreed metrics for CME arrival time: Basic metrics

- ▶ Mean Error
- ▶ Mean Absolute Error
- ▶ Root Mean Square Error
- ▶ Standard deviation
 - ▶ Each error reflects on a different aspect

CME impact: discussion

- ▶ Timelines versus mean/max/median/... values?
- ▶ Rolling average of data/simulation?
- ▶ Correlation coefficients? Regression? Scatter plots?

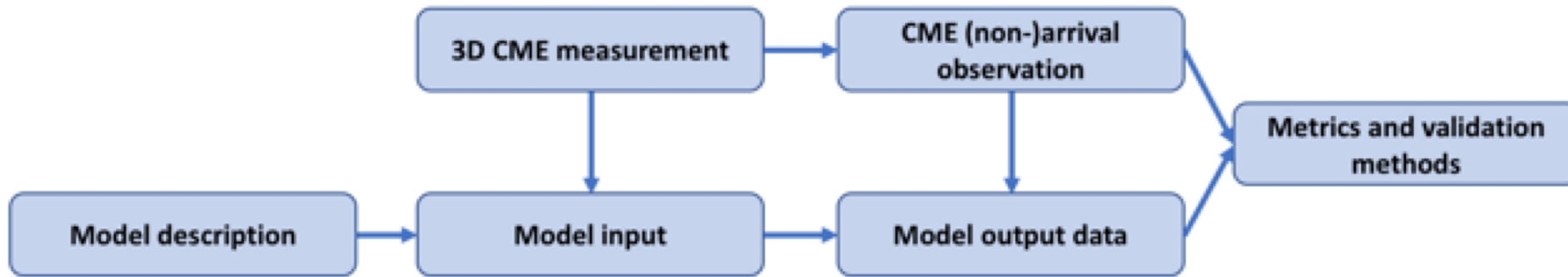
Solar background wind: discussion

- ▶ How do we **disentangle** wrong arrival due to wrong solar wind or due to wrong CME inputs/model limitations?
- ▶ Still under discussion: different options
 - ▶ Tag and model single CME events and their solar wind conditions
 - ▶ Do parametric model runs

Provide benchmark

- ▶ Database of events
- ▶ Metadata collection
- ▶ Agree on observations/inputs/outputs

Metadata



Provide benchmark: Database of events

- ▶ Model entire period, not selected set of events
 - ▶ 2011-2012: 475 CMEs
 - ▶ 2015: 173 CMEs
 - ▶ 97 total arrivals at Earth (R&C catalog)
 - ▶ Contingency table: accurate representation
- ▶ Core set as training events; other training events must be disclosed and excluded from validation set
- ▶ Optional: 33 hit events with operational parameters from NOAA

Provide benchmarks: Metadata & Inputs/Observations/Outputs

- ▶ CME input parameters from observations?
 - ▶ Catalog will be provided
 - ▶ Data can be modified in a consistent way
 - ▶ Can models use their own CME input parameters?
 - ▶ YES but: Must run the provided data set as well
 - ▶ Add their measurements to the database

Skill Score	Equation	Perfect Score	Comments
Hit Rate (POD)	$\frac{H}{H+M}$	1	Fraction of observed arrivals that were predicted.
Success Ratio (SR)	$\frac{H}{H+FA}$	1	Fraction of correct predicted arrivals. False Alarm Ratio = 1–SR
Bias Score	$\frac{H+FA}{H+M}$	1	Ratio of predicted arrivals to observed arrivals, < 1 = underforecast; > 1 = overforecast
Critical Success Index (CSI)	$\frac{H}{H+M+FA}$	1	Fraction of correct observed arrivals.
Accuracy	$\frac{H+CR}{Total}$	1	Fraction of correct forecasts.
False Alarm Rate (POFD)	$\frac{FA}{CR+FA}$	0	Fraction of incorrect observed non-arrivals
Hanssen & Kuipers discriminant	$HK=POD-POFD$	1	Forecast ability to discriminate between observed event occurrence from non-occurrence

Table 4
CME arrival time error validation results.

Simulation	ME (hrs)	MAE (hrs)	RMSE (hrs)
SWPC operational†	-0.7	4.5	5.6
(a) Benchmark	-0.2 ± 1.9	5.1 ± 1.0	$6.0^{+0.9}_{-1.0}$
(b) Time-dependent	$+0.6^{+2.2}_{-2.1}$	5.8 ± 1.2	$6.9^{+1.2}_{-1.1}$

† Metrics computed using the SWPC provided simulated arrival times from their operational runs.