

Accuracy of short-term Sea Ice Drift Forecasts

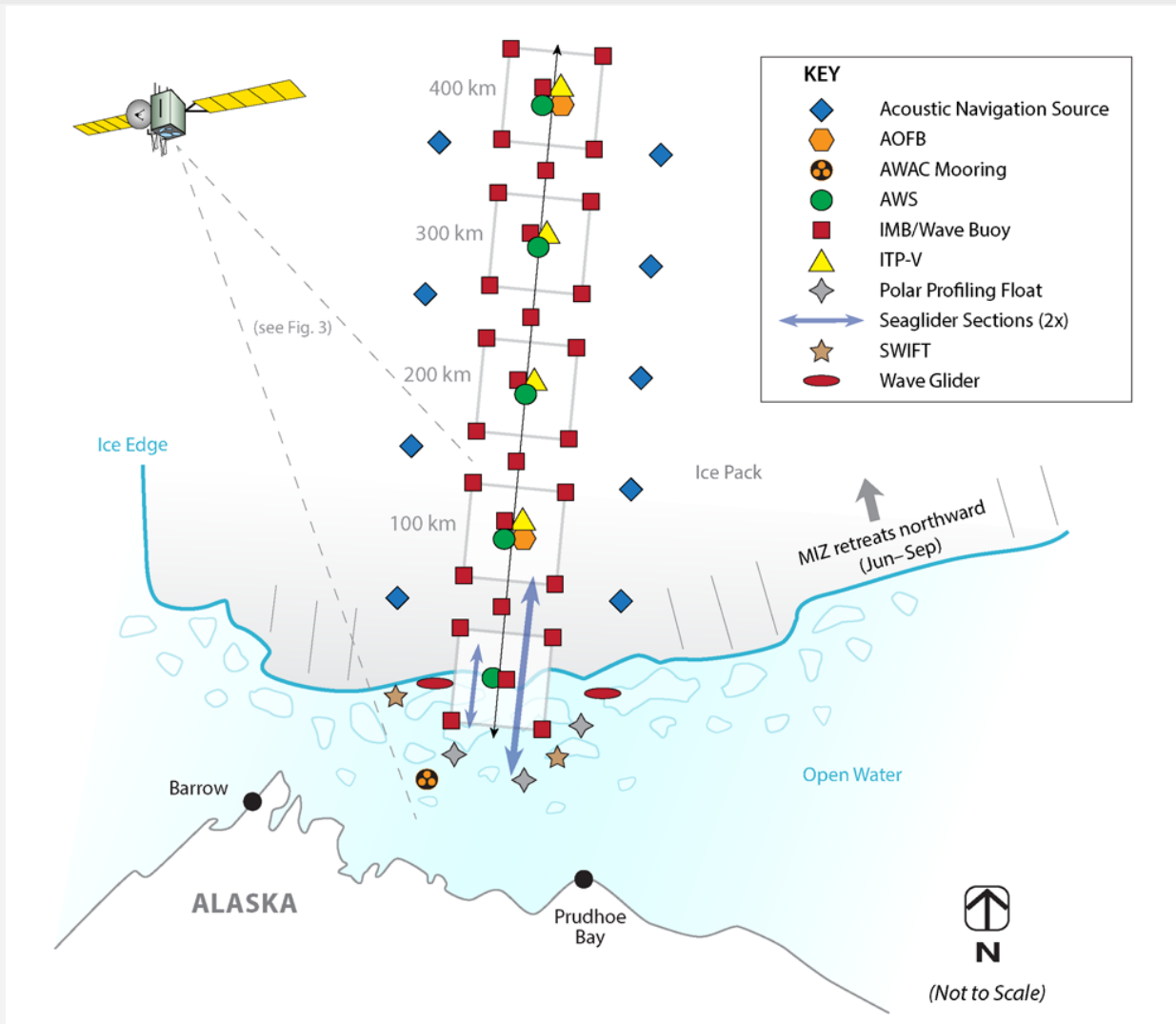
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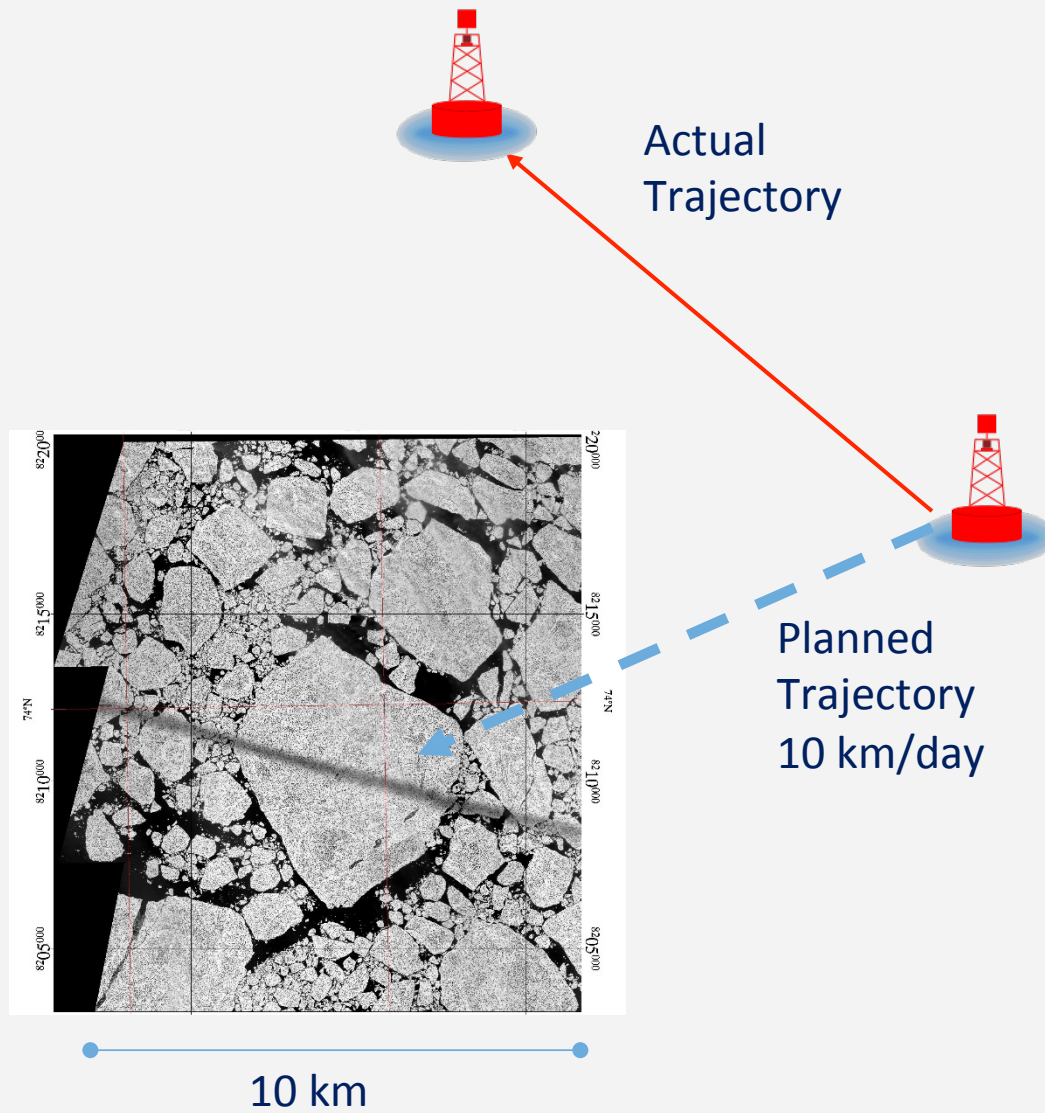
Schweiger and Zhang, JGR-Oceans, 2015



MIZ Experiment, 2014



Example Problem: Acquisition of high resolution Satellite Images Hit or Miss?



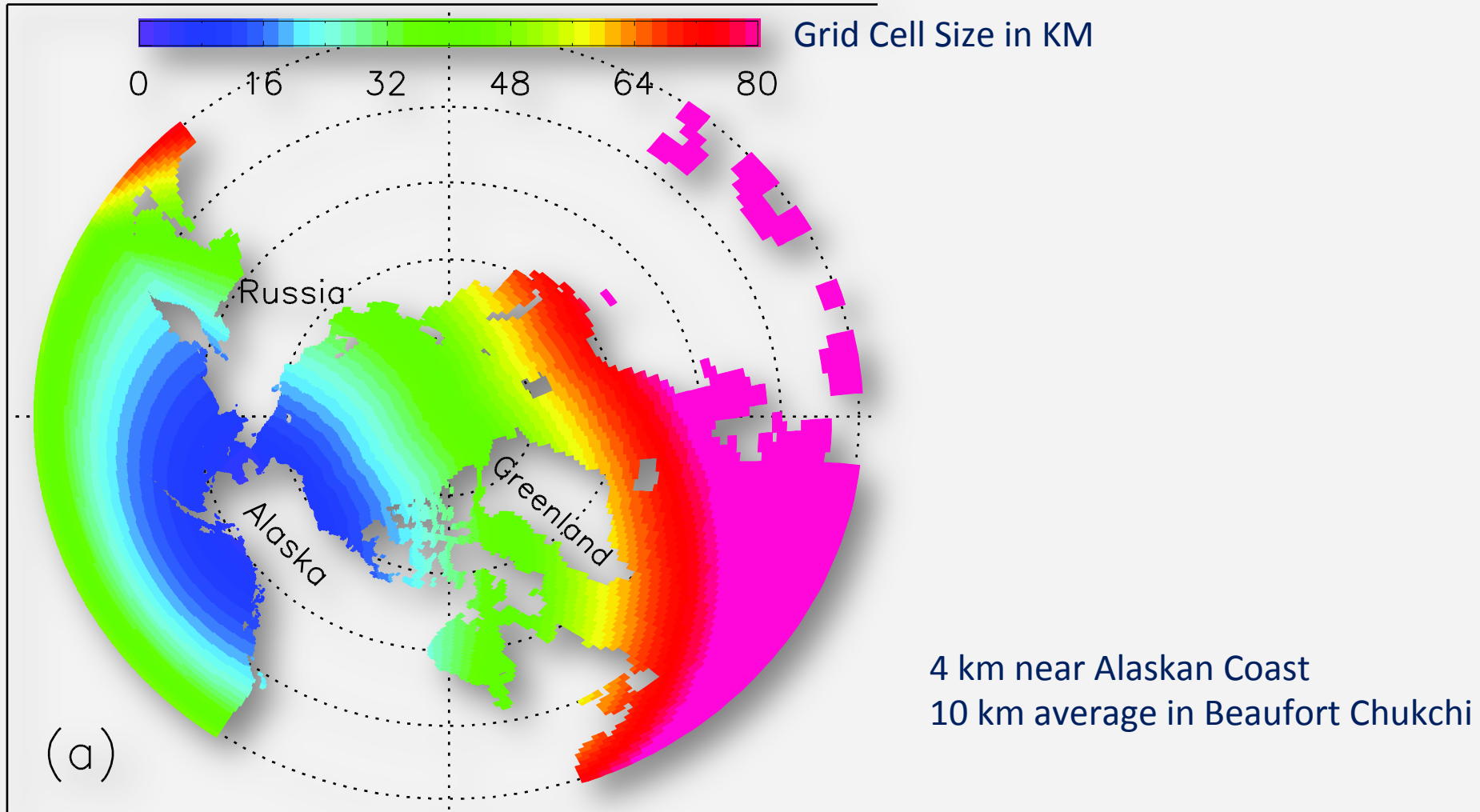
Questions

- How do you forecast future buoy positions?
- What is the accuracy and skill of the forecast at different lead times?
- What are the sources of errors?
- How can we improve the forecast?

MIZMAS Marginal Ice Zone Modeling and Assimilation System

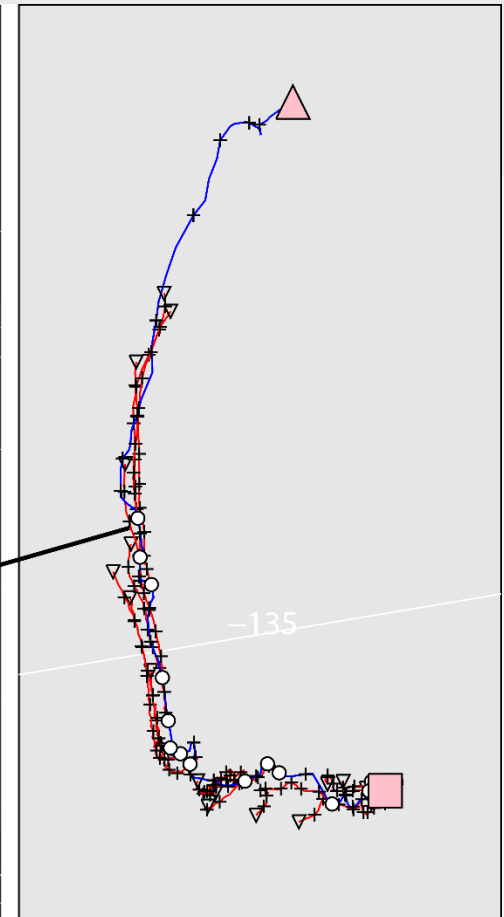
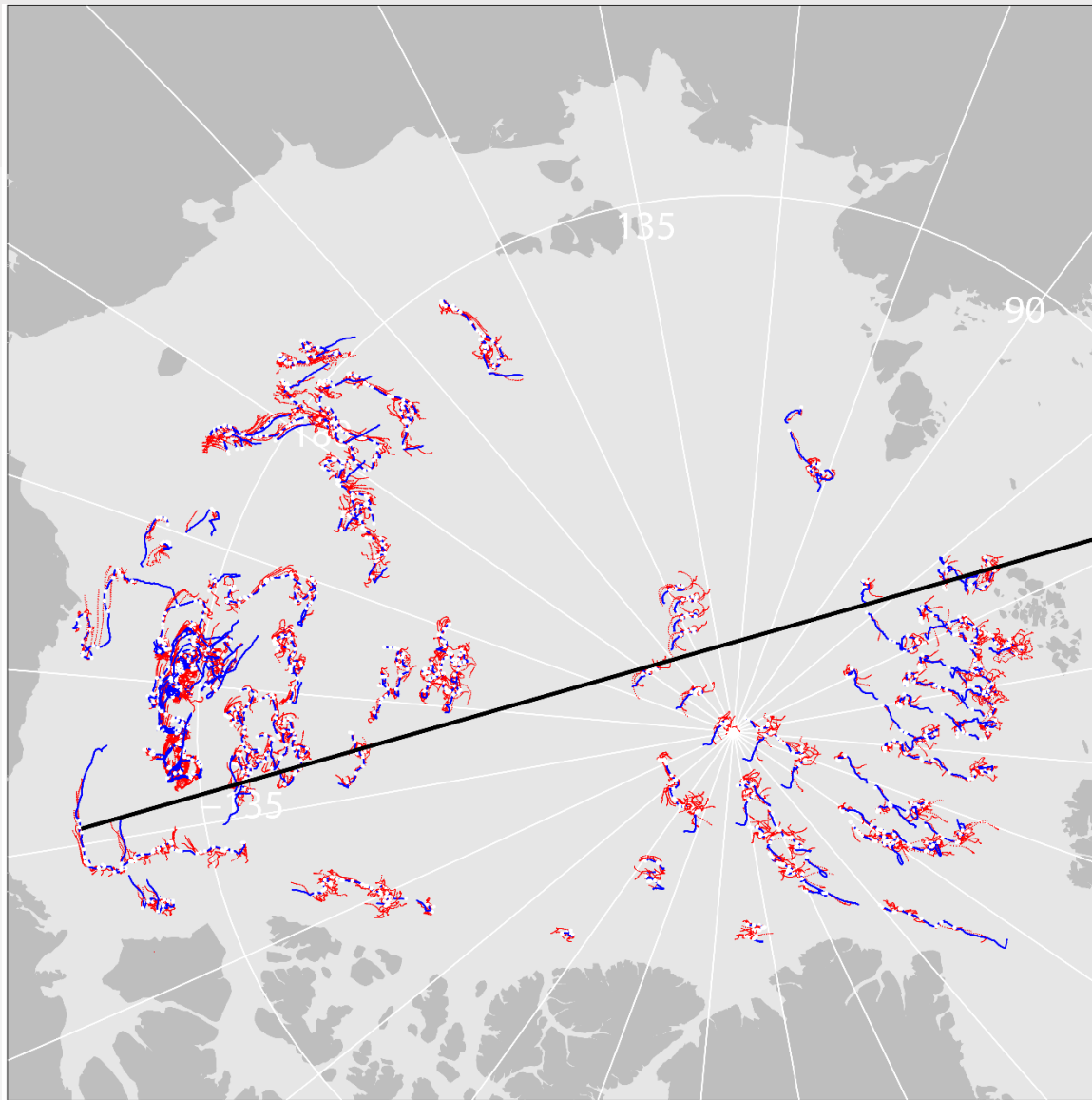
- Coupled parallel ocean and sea ice model (PIOMAS derivative)
- Multi-category thickness (12) and enthalpy distribution (TED) sea ice model
- Sea ice dynamics model with Teardrop-Plastic Rheology
- Ocean Model: POP (Parallel Ocean Program), generalized curvilinear,
- Nested (one-way) to a global ice-ocean model (GIOMAS)
- Incorporates tidal forcing (up to 8 components)
- Assimilates satellite sea ice concentration and SST
- Calibrated with all available in situ ice draft/thickness data over 1975–2009
- Calibrated with IABP buoy drift data over 1979–2010
- **Prognostic Floe Size Distribution (Zhang et al. 2015). Not used in this study**

Model Domain and Resolution



Forecast Experiment Setup

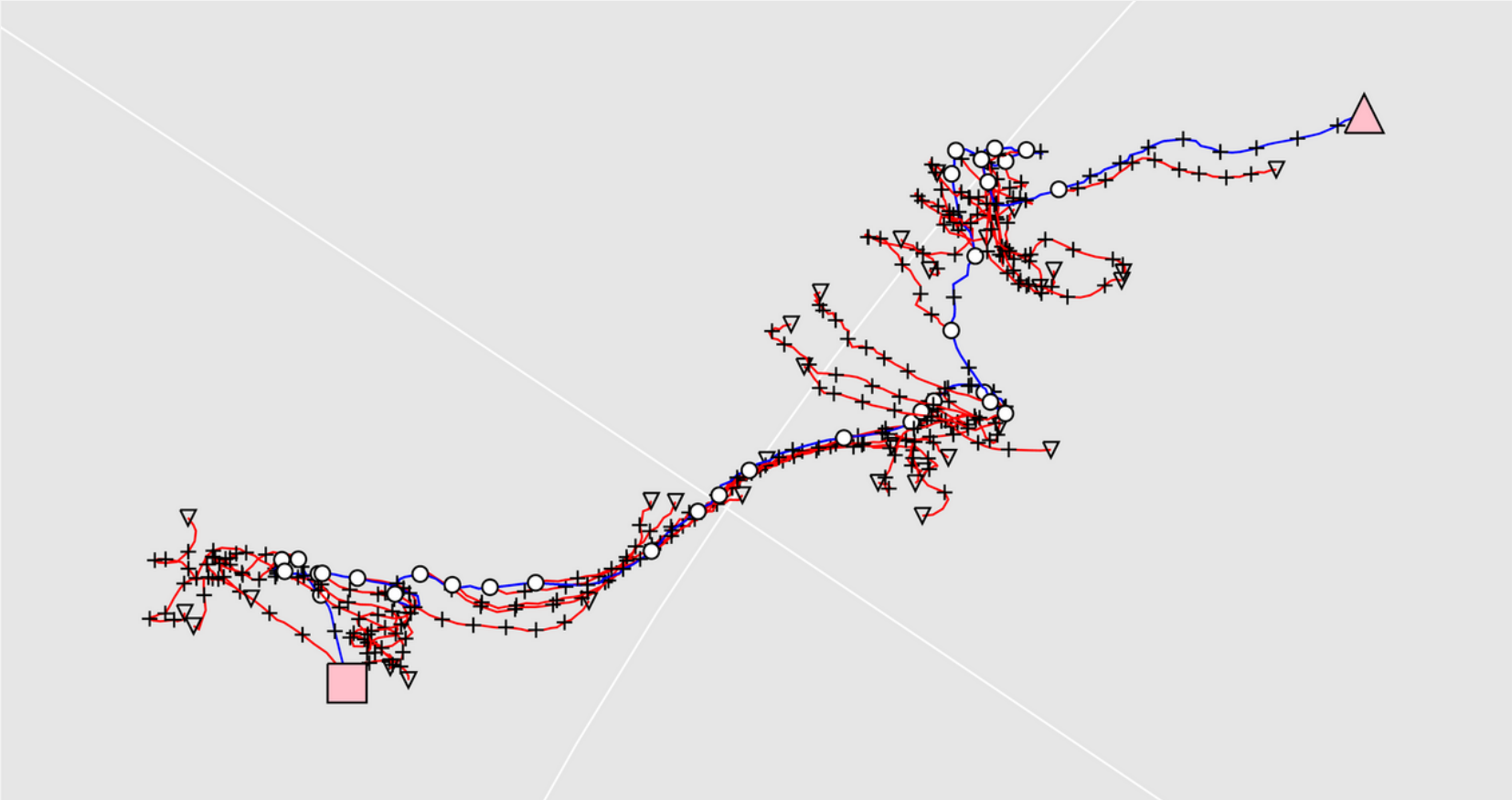
- Initialization:
 - July 17, 2014 – Sept. 17, 2014
 - MIZMAS is integrated up to the initial forecast time.
 - Ice concentration (NSIDC) and SST (Reynolds) assimilation
 - NCEP/NCAR Reanalysis atmospheric forcing
- Forecasts:
 - Daily for up to 9 days, 6 hour increments
 - NOAA CFSv2 forecast atmospheric forcings
 - Total 38, 9 day forecasts (some days missed)
- Validation:
 - Sea ice drift data from IABP buoys (128 observed tracks)
 - Comparison with virtual (modeled) buoy tracks
 - Ice covered areas only
- Reference:
 - Virtual tracks computed from climatology: 2003-2013 MIZMAS integration average



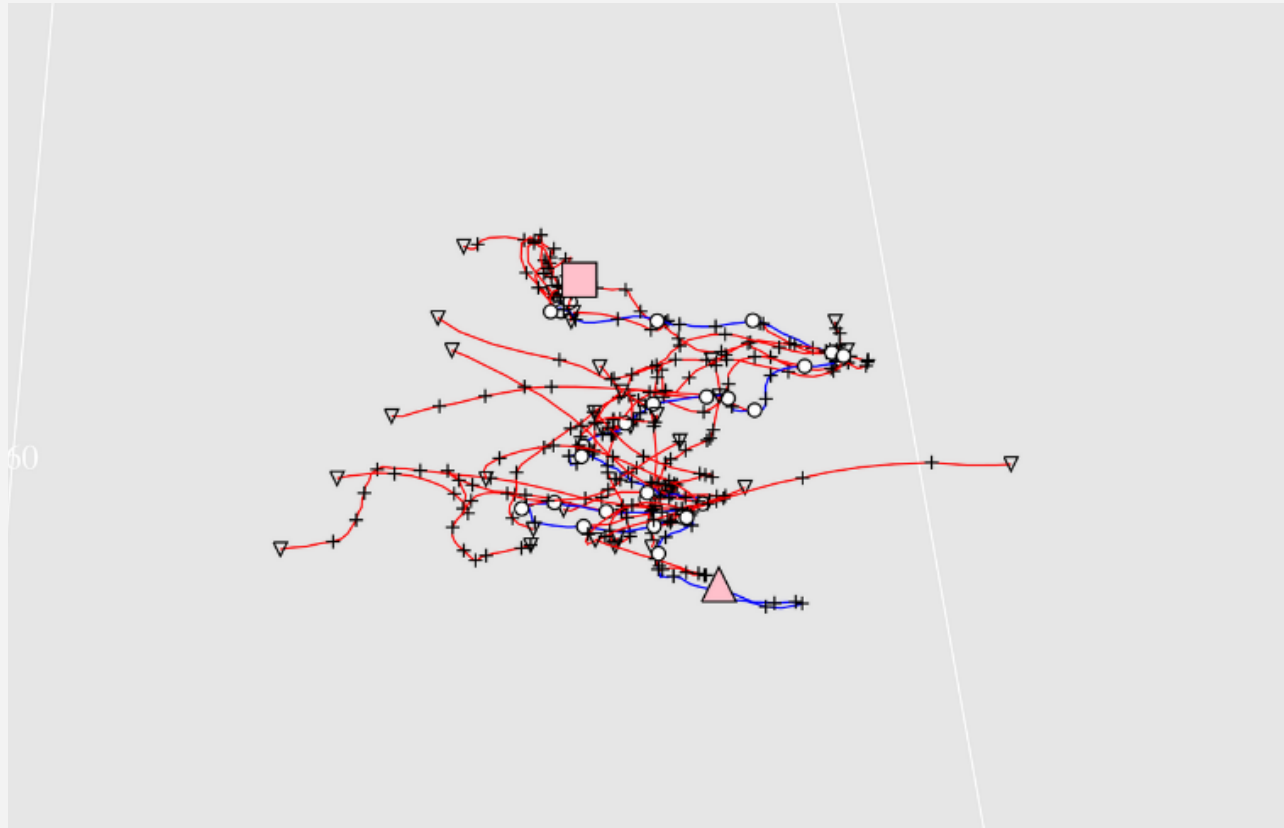
— Model Track
—○— Buoy Track

■ Start of Buoy Track
▲ End of Buoy Track
▼ End of Model Track
○ Model Initialization
+ Daily Increment

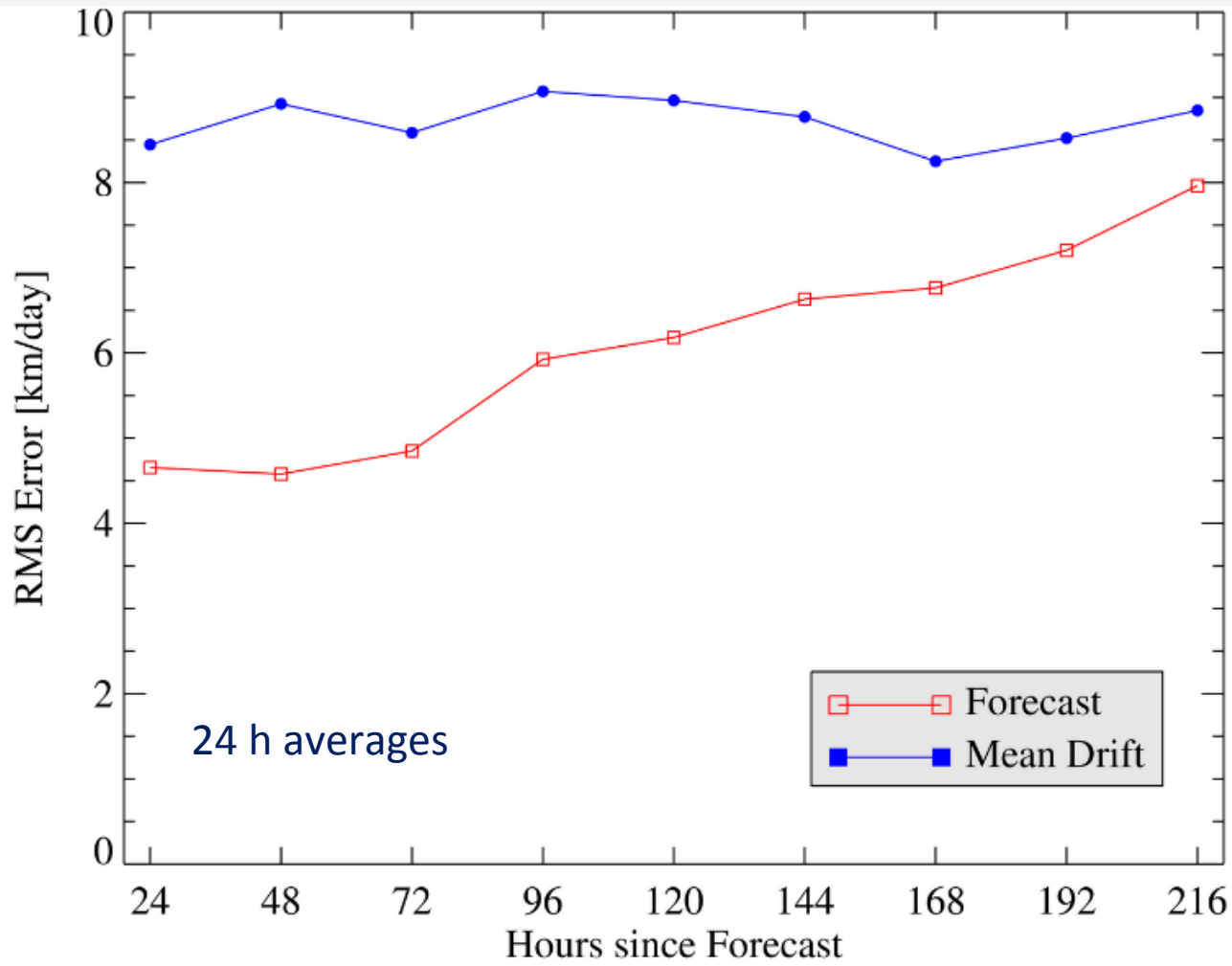
Observed and Modeled Trajectory



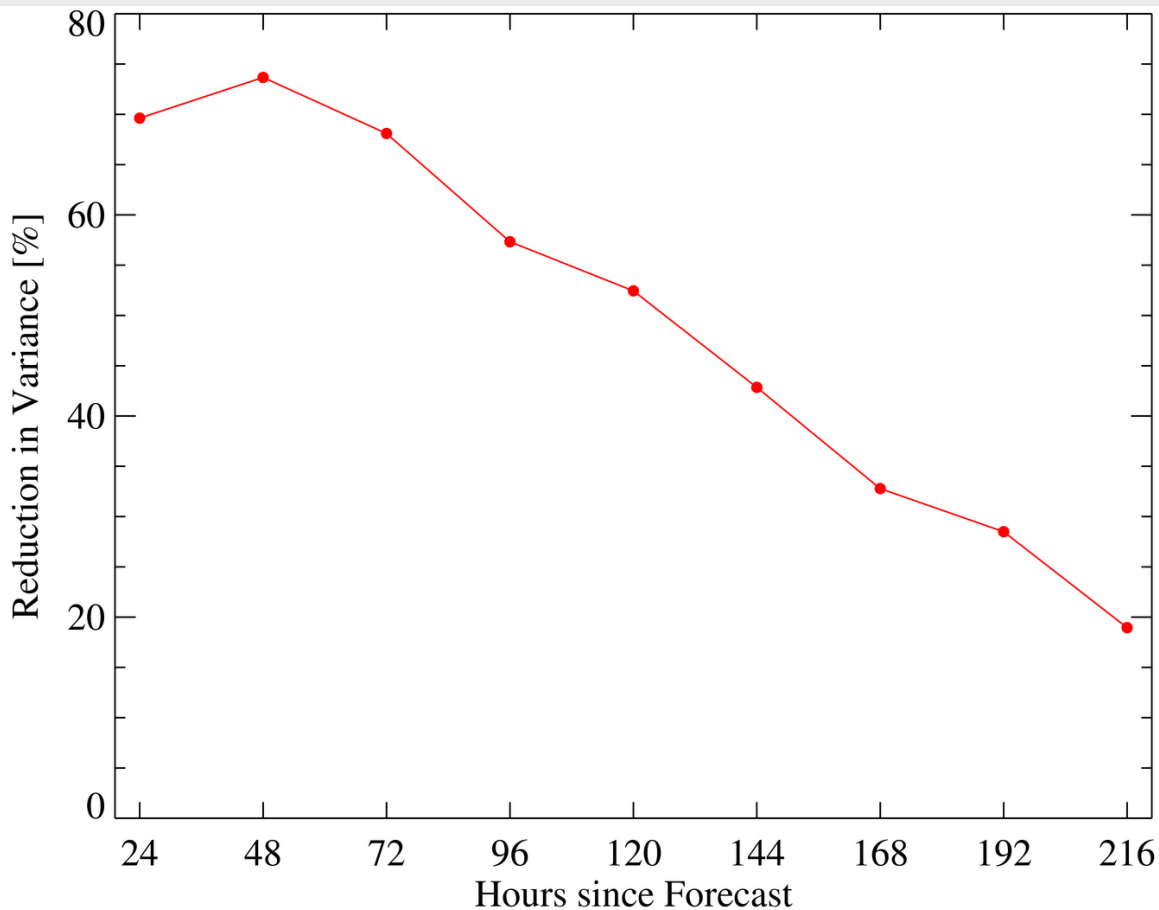
Observed and Modeled Trajectory



Speed Comparison



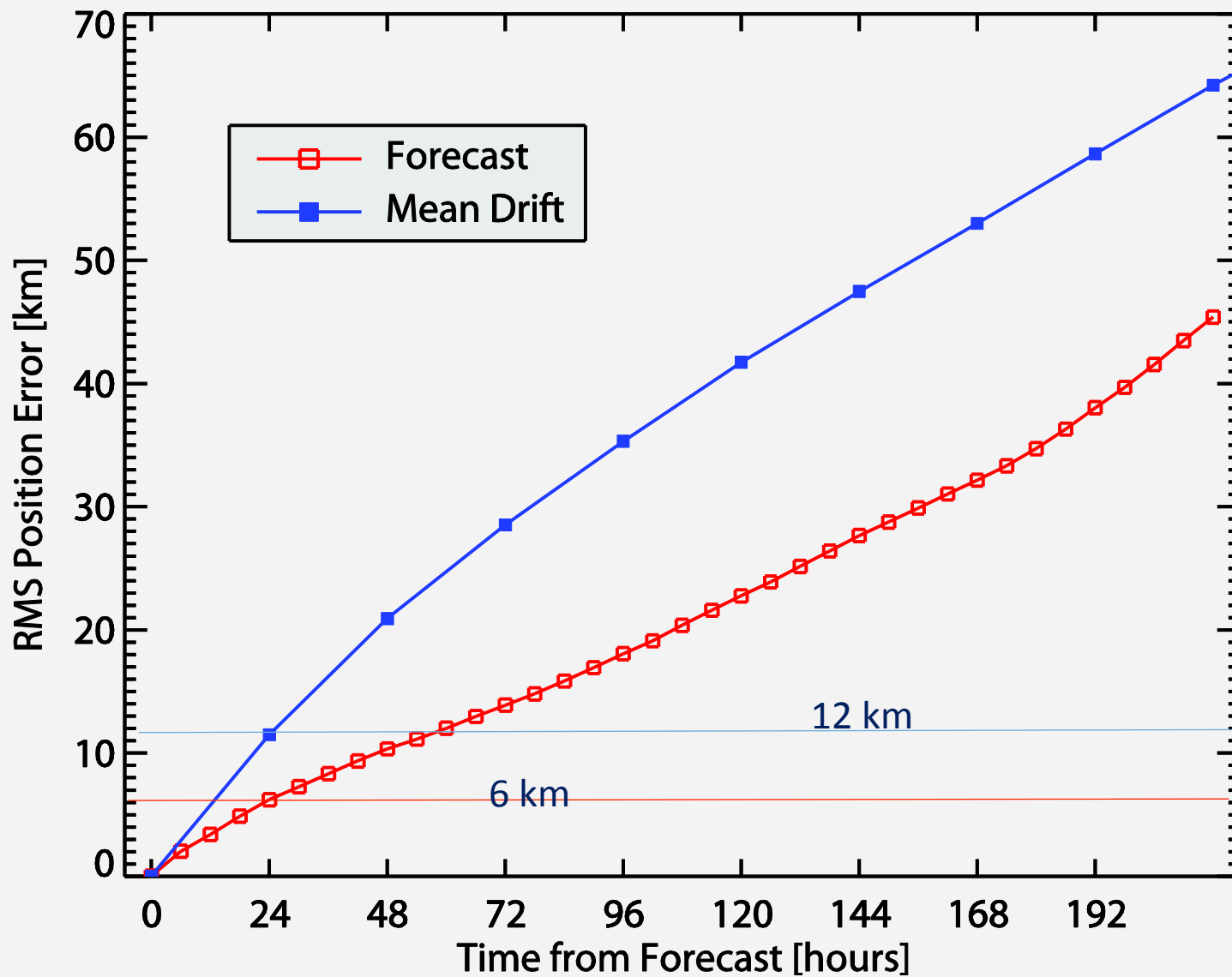
Skill Score for Speed



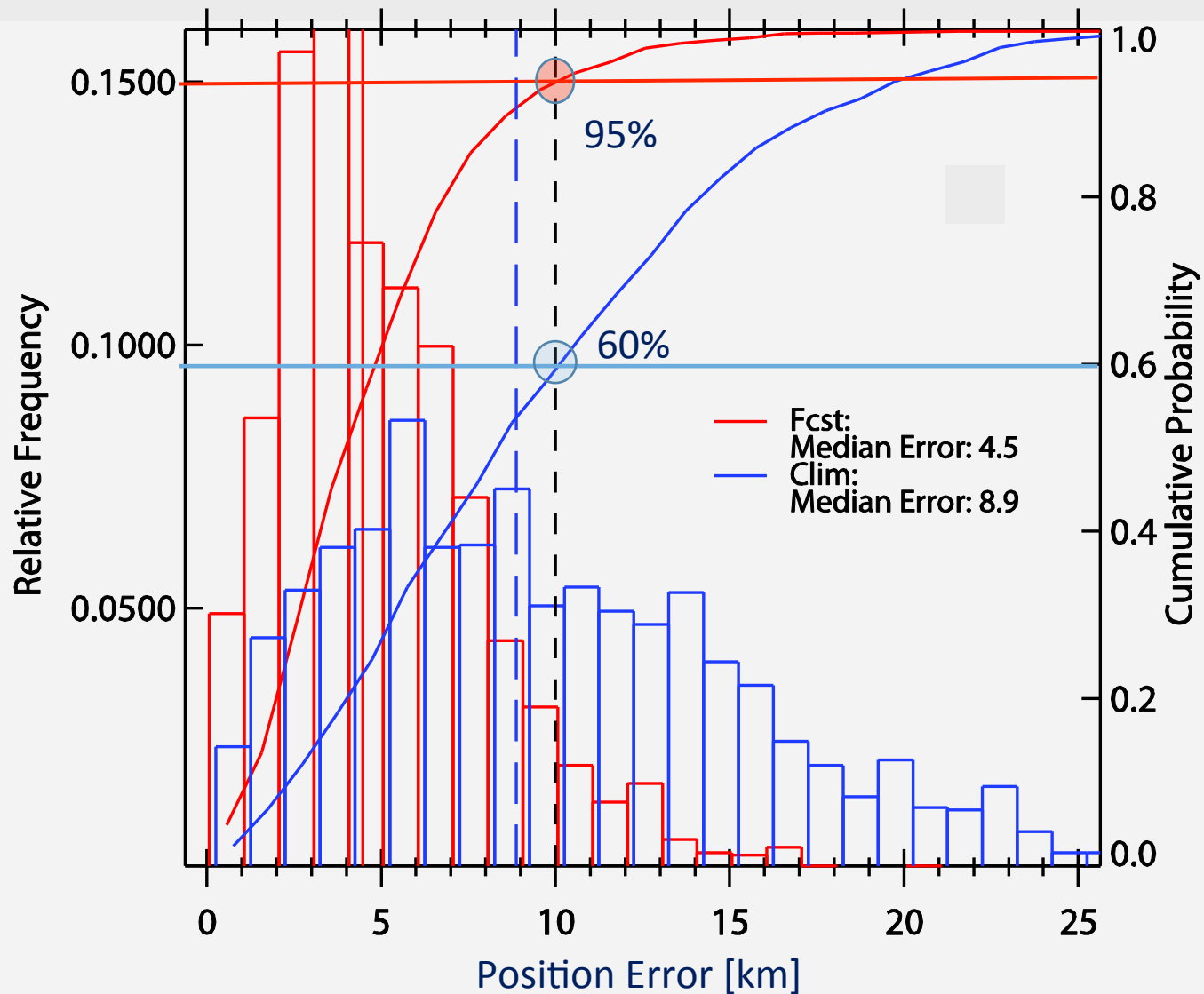
$$SS = 1 - \frac{MSE_{forecast}}{MSE_{Mean}}$$

$$MSE = \frac{\sum^N (U_{Predicted} - U_{Buoy})^2}{N}$$

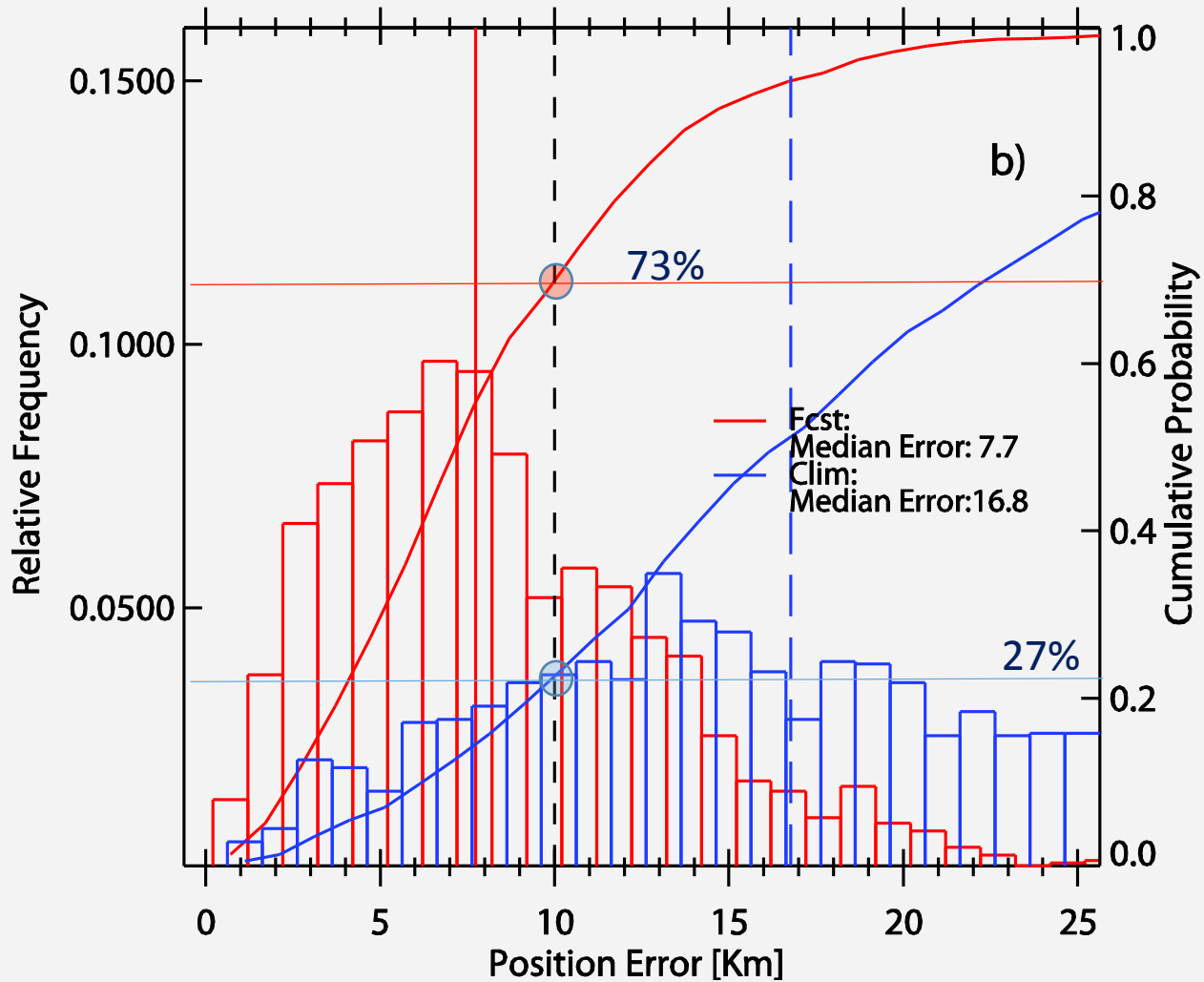
Position Errors



Likelihood of Imaging Target with a 10 km image after 24 h

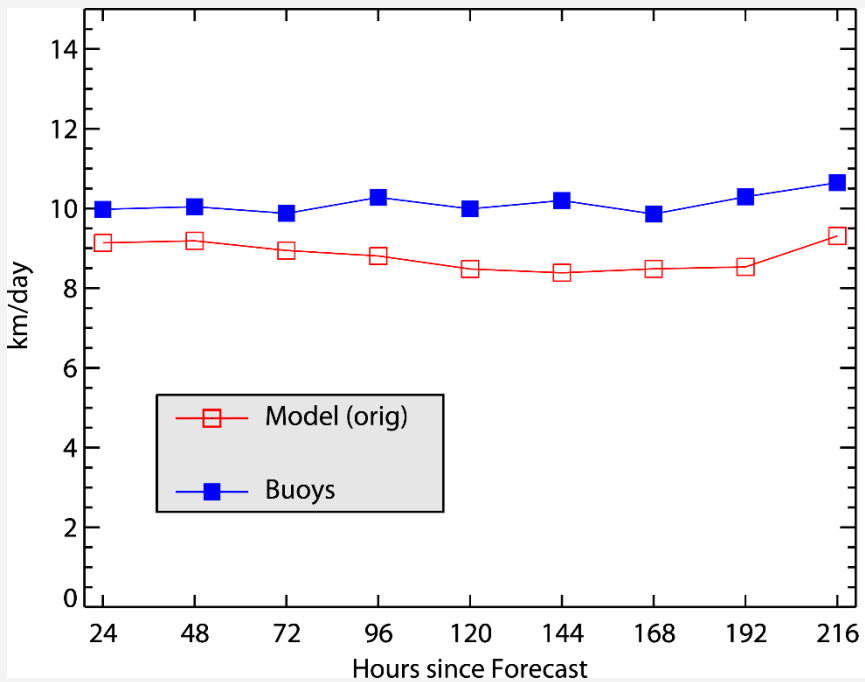


Likelihood after 48 hours

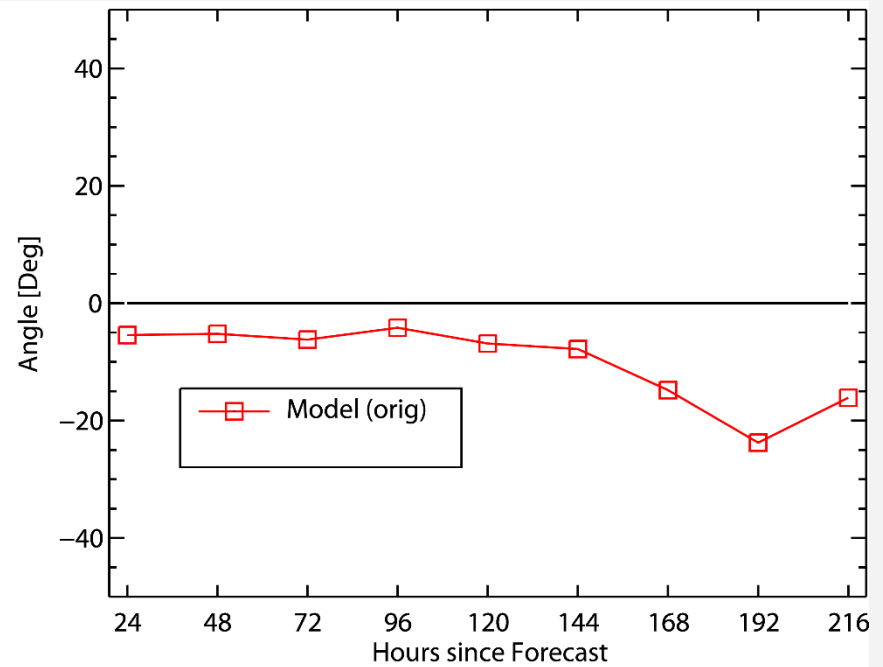


Speed and Angle Bias

Speed

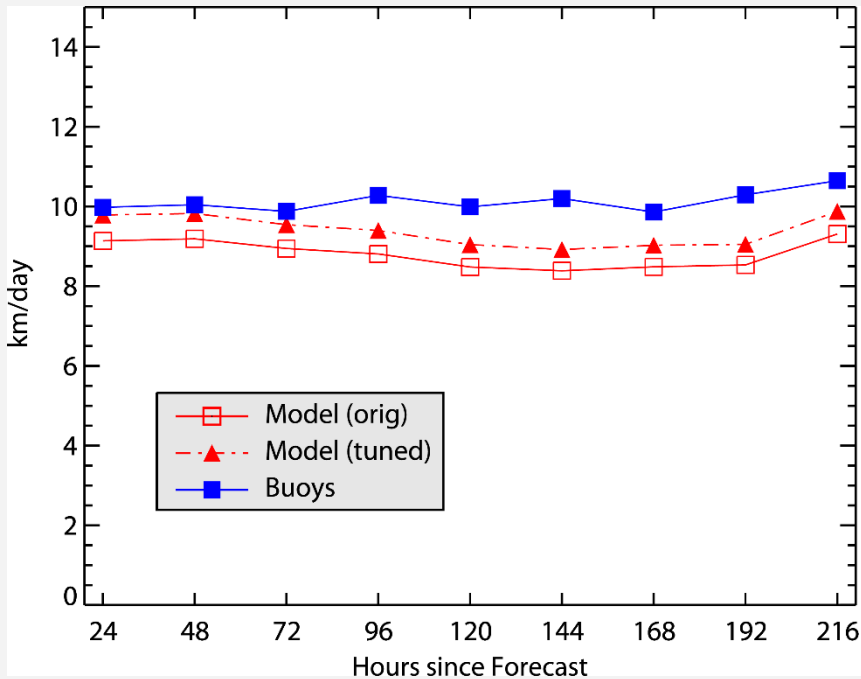


Angle Bias

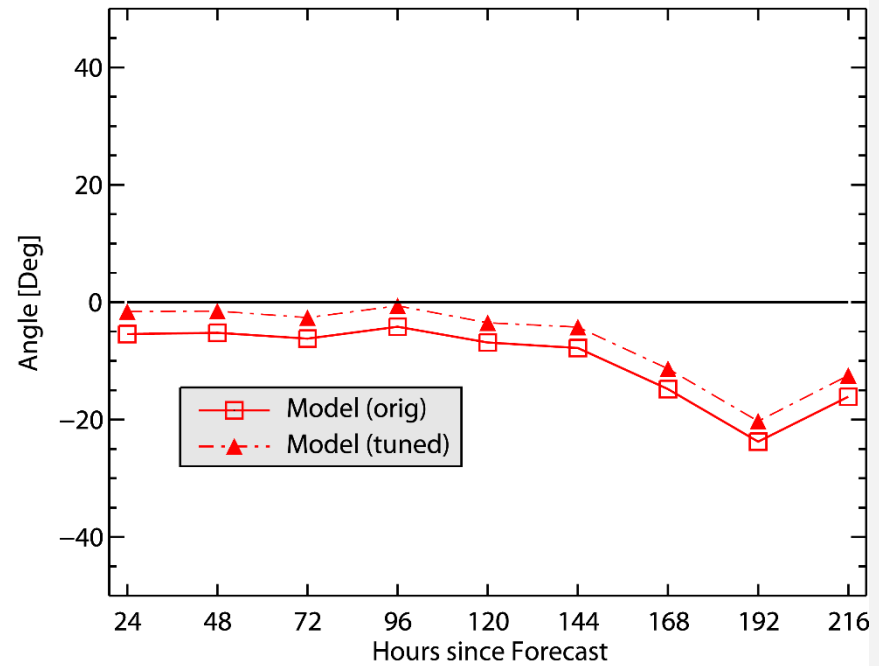


Speed and Angle Bias

Speed



Angle Bias

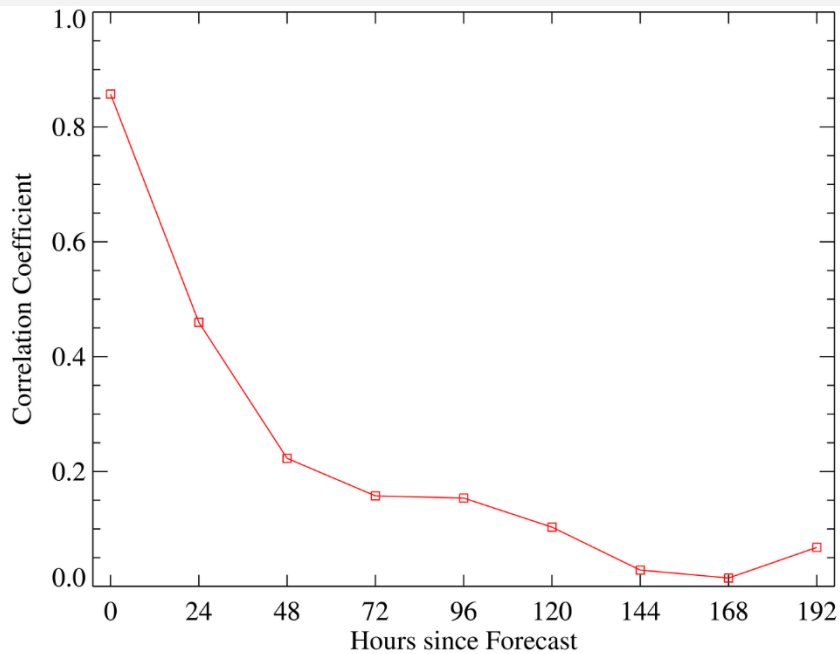


Tuning:

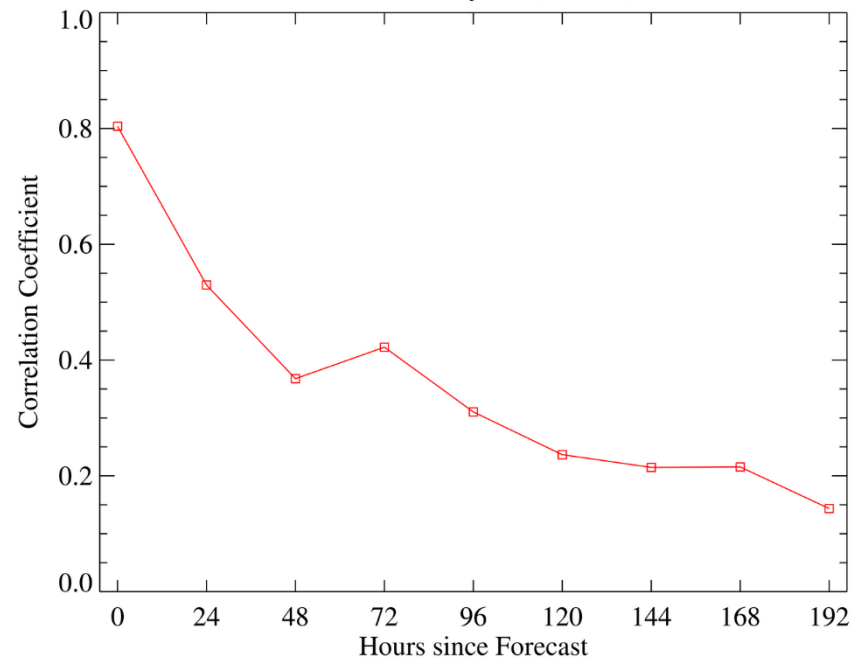
Change in angle between geostrophic current and ice ($25^\circ \rightarrow 30^\circ$)

Atmospheric Drag Coefficient ($0.0033 \rightarrow 0.0036$)

Decay of Wind Speed Correlation Reanalysis vs. Forecast



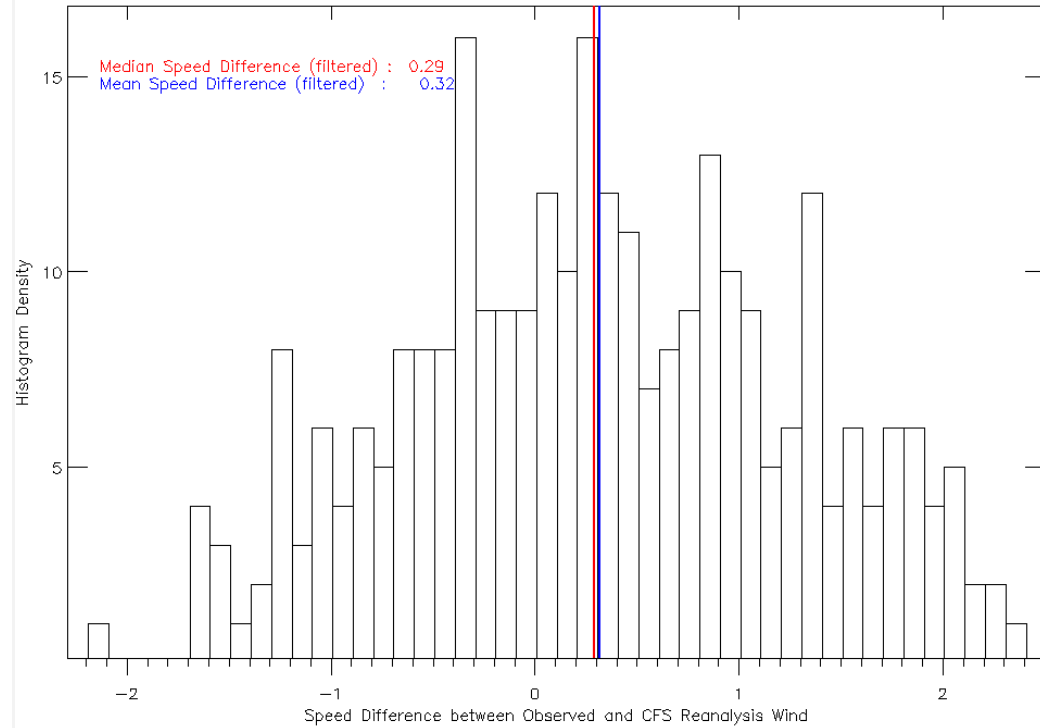
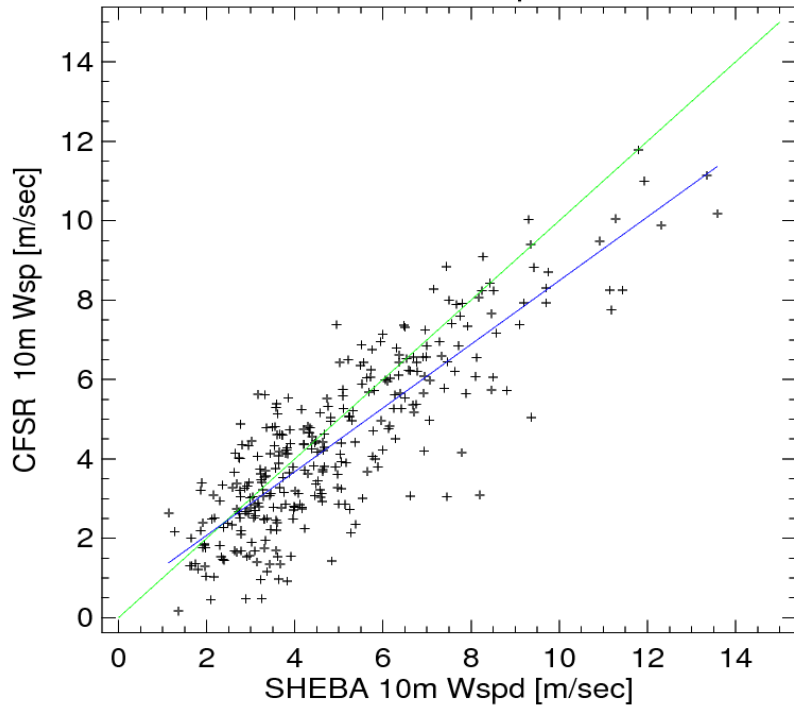
MIZMAS Domain



Near Barrow, AK

Wind Speed Comparison

SHEBA: 10m Windspeed: CFSR



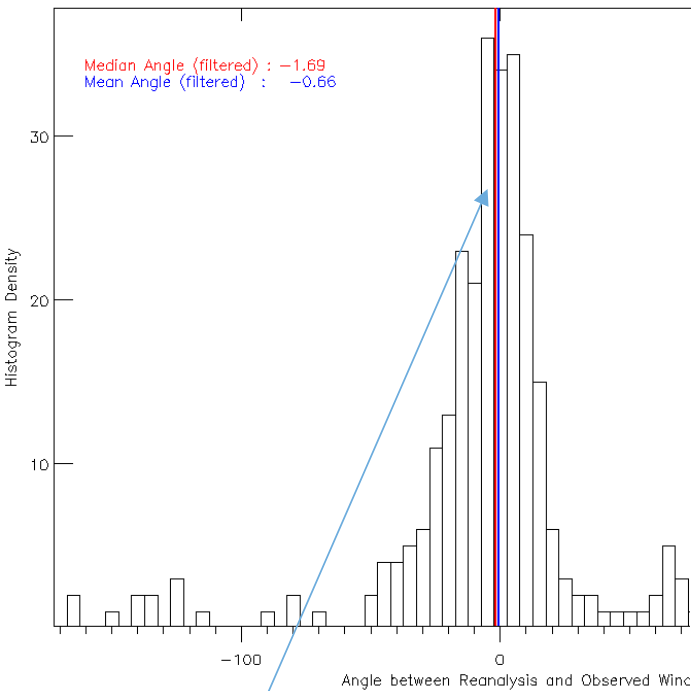
CFSR (Reanalysis) vs. SHEBA (OBS), daily (ETL tower)

Correlation: 0.84

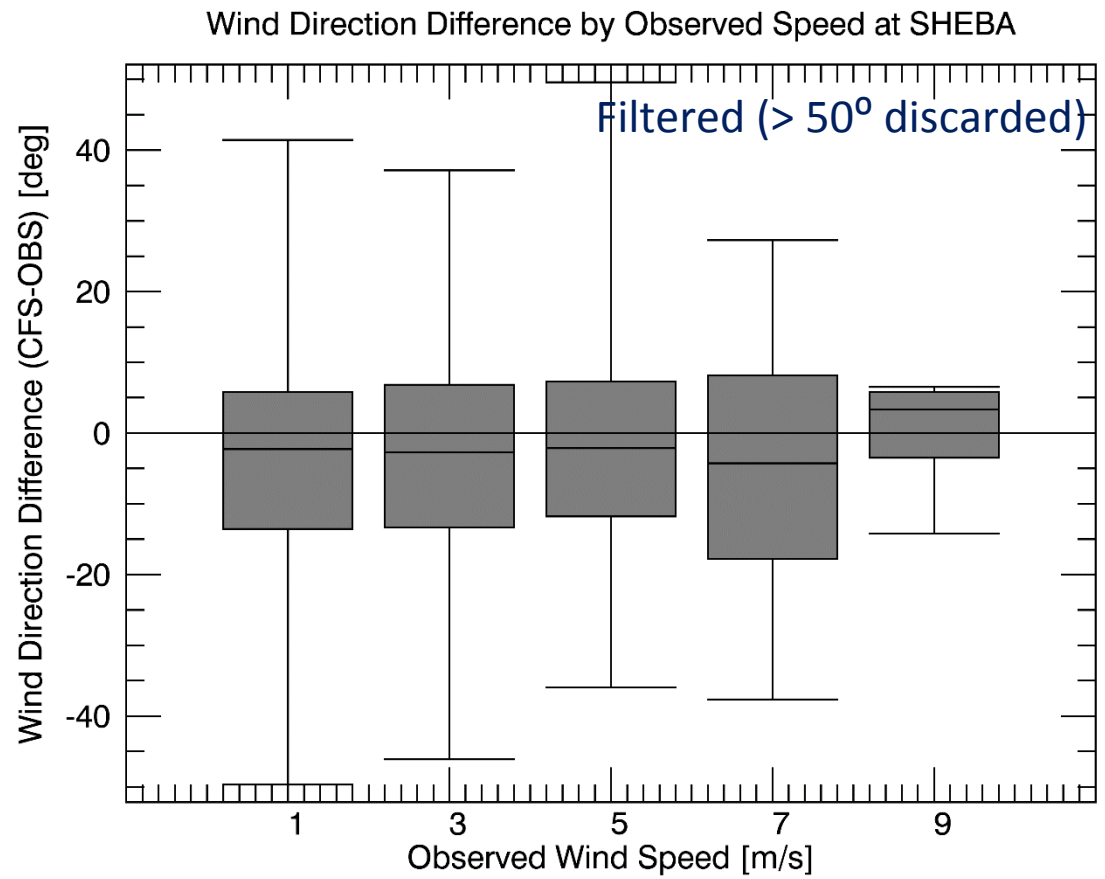
Small Bias 0.25 m/sec

PDF of wind speed differences
[m/sec]

Wind Direction Errors CFSR Reanalysis vs. SHEBA



Small wind angle bias,
but substantial scatter



Bias and variation seem independent of speed



Conclusions

- Speed Errors: 4.5 km/day for 24h forecast rising to 9 km/day
- Speed Forecasts skillful relative to climatology at 70% level for 3-days
- Forecast RMS Position errors: 6km after 24 hours, 45 km after 9 days.
- Errors are not small relative to average drift speeds (10km/day)!
- However: Using forecast dramatically improves chances of finding target (60->95%, 24h),(15->57%, 72h) compared to climatology
- Examination of wind forecasts highest priority
 - boundary layer representation (See Thursday talk, Zheng Liu)
 - More high quality measurements would be helpful