

Using Ensemble Forecast Track Spread to Predict Deterministic Model Track Errors

Frank Colby

UMass Lowell

9th NOAA Ensemble Users Workshop

22-24 August 2023

Session 7A

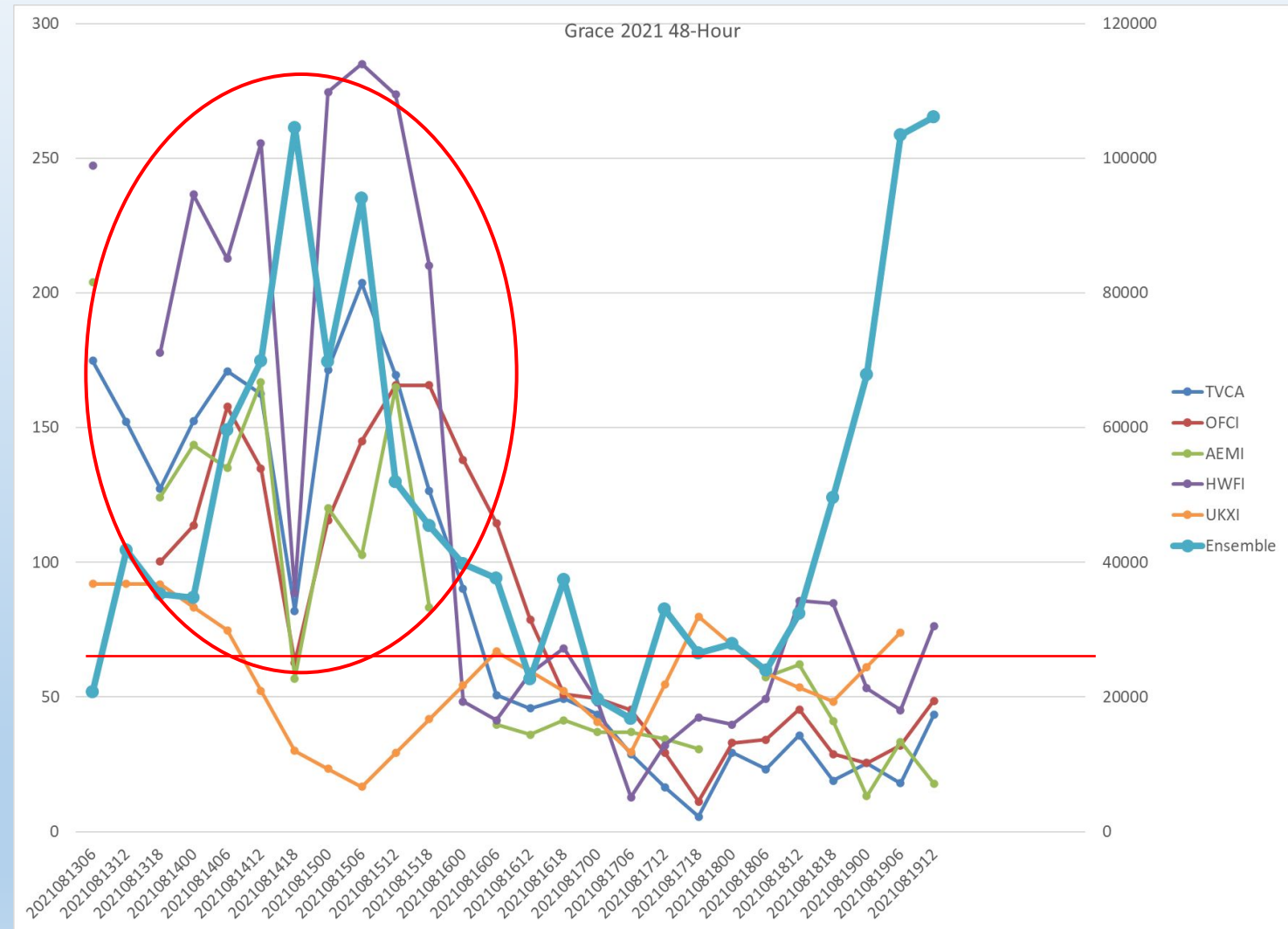


Acknowledgements

- Much appreciation to Andy Penny from the National Hurricane Center and Matt Barlow from UMass Lowell for insightful collaboration
- Vijay Tallapragada, Yuejian Zhu and Jiayi Peng from EMC for invaluable ensemble data

Introduction

- Periods of much-larger-than normal forecast track errors from GEFS v.12
- Multiple models, several consecutive forecast cycles and multiple lead times
- Example: Hurricane Grace (2021) 60-hour period
- 08-13 18z to 08-16 06z

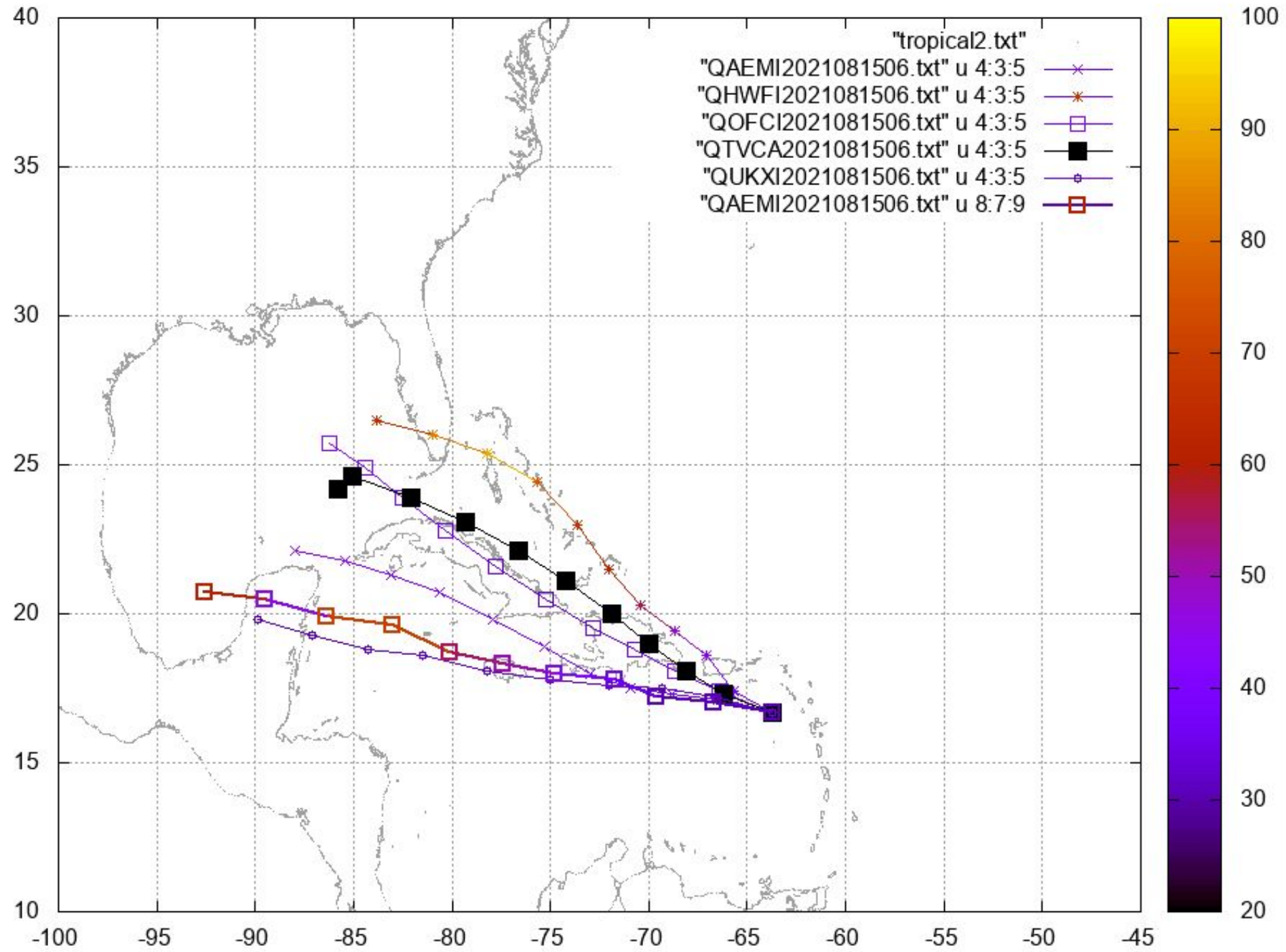


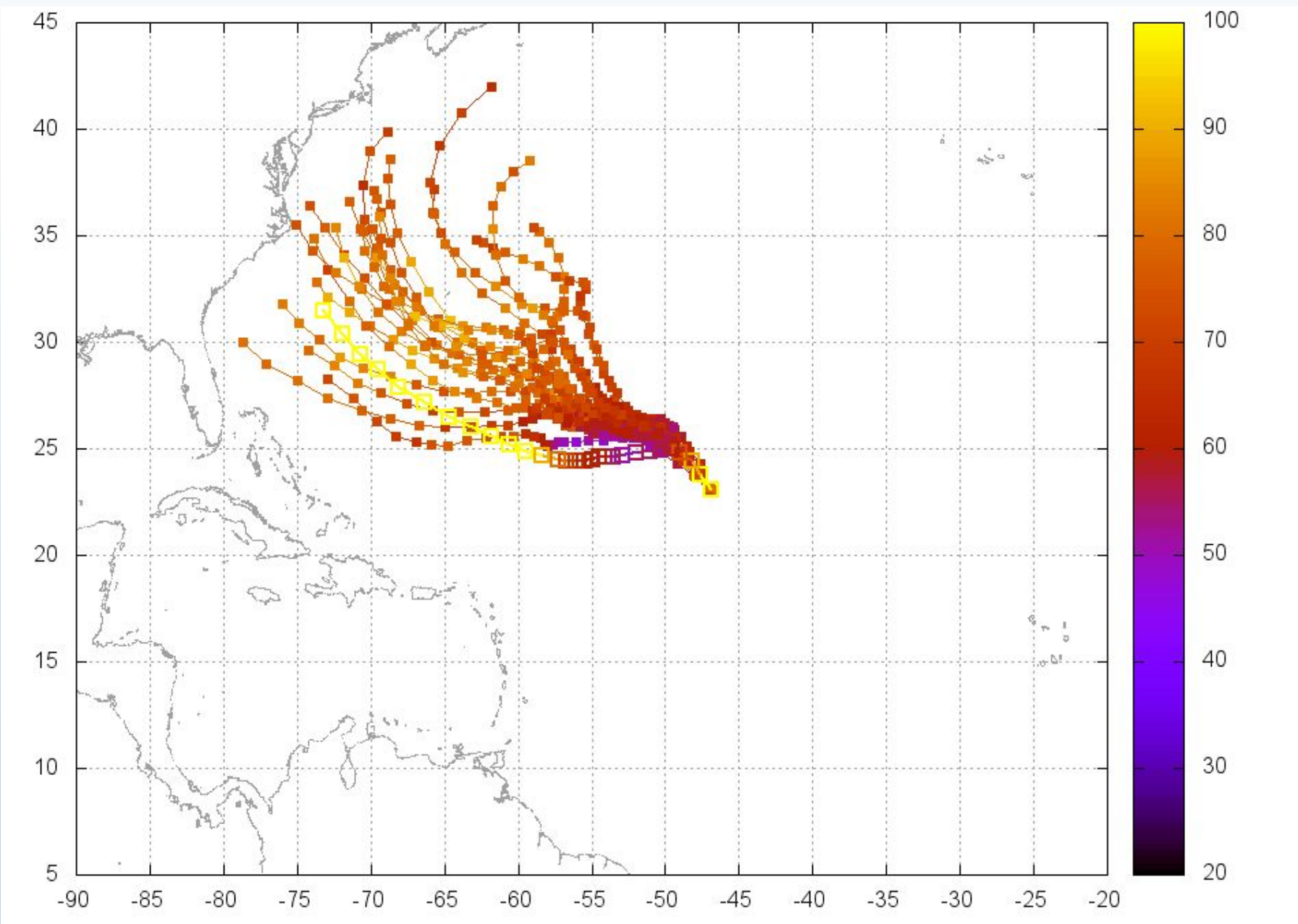
Outline

- Methods:
 - Measuring ensemble model track spread
 - Relationship to real-time forecast errors
- Overall Results
- Examples of Individual Storms
- Conclusions

Operational Forecast Tracks for Grace (2021)

Initialized
2021-08-15
06z





Forecast tracks for 20 members of GEFSv12 for Hurricane Florence. Large squares are NHC best track. Color coding for 10 m wind speed in knots. Forecast initialized 2018 September 6 at 0000 UTC.

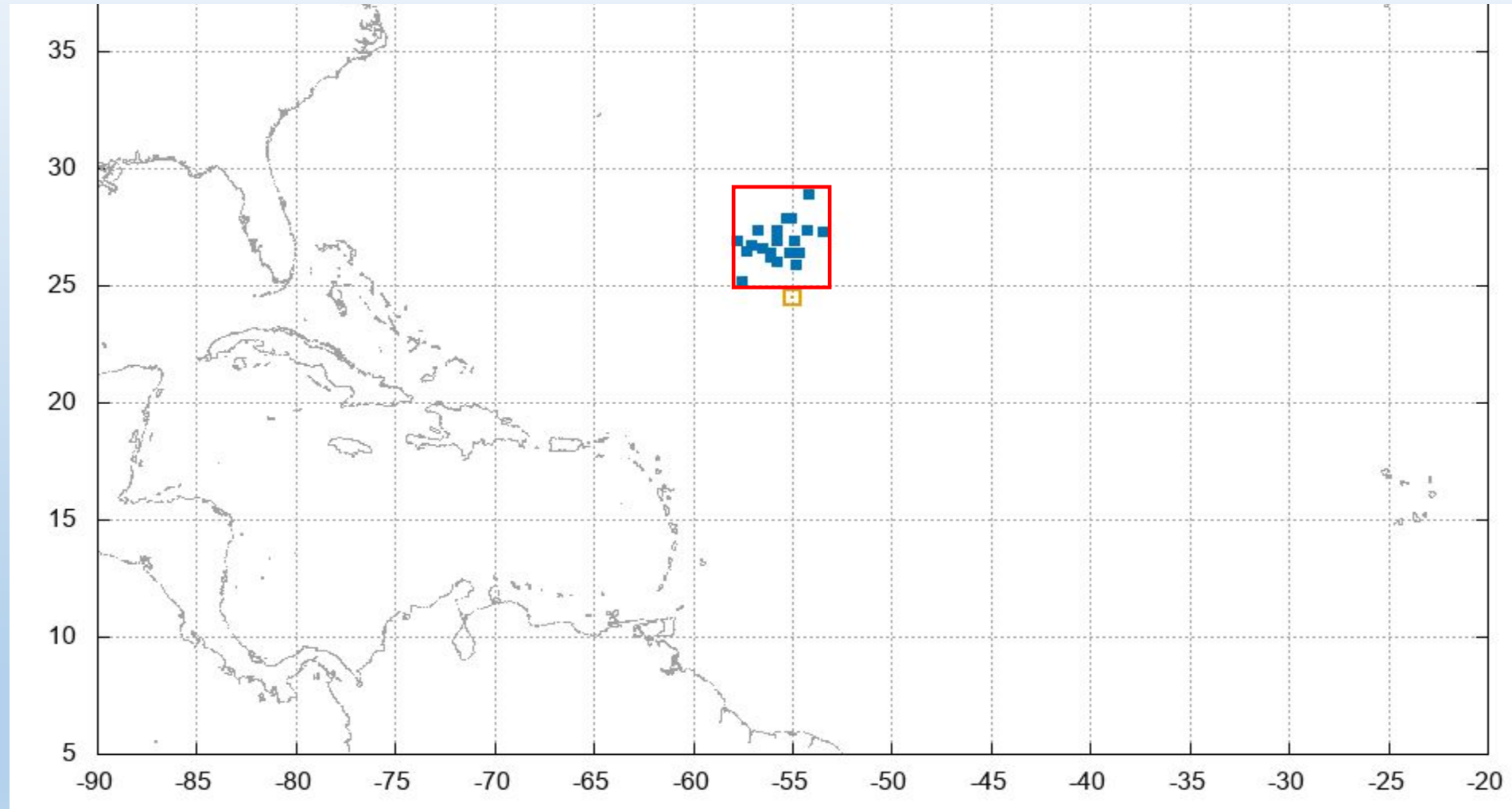
Methods: Measuring ensemble model track spread

Forecast Box:

a rectangle including all ensemble member locations for one forecast lead time

Spread:

Area of box



Blue squares are GEFS member locations. Best Track location is orange square.

Method: Relationship to Real-Time Forecast Errors

- GEFS v12.
 - FV3 core
 - 30 perturbed members
- Operational with 12 UTC cycle of September 22, 2020
- Compare ensemble spread to track forecast errors for 2021 and 2022 seasons

Overall Results

Linear correlations between ensemble spread and forecast errors are modest ~ 0.5 .

Strongest statistical signal is for 48-, 72-, and sometimes 96-hour forecasts.

48 hours: Spread greater than $\sim 50,000 \text{ nm}^2$.

72 hours: Spread greater than $\sim 100,000 \text{ nm}^2$.

96 hours: Spread greater than $\sim 200,000 \text{ nm}^2$.

Overall Results from 24 Storms*

Using these guidelines,

does the spread give a correct indication of coming forecast track errors?

**Results could be both correct for part of a storm's lifetime and miss periods for other parts.

* Storms of at least 4-days in length

Overall Results from 24 Storms*

Indications are either:

correct: Spread large and forecast errors are large* or spread small and forecast errors are small

miss: Spread not large but forecast errors are large

false alarm: Spread is large but the errors are not

*Large means larger than the previous 5-year average

Overall Results from 24 Storms*

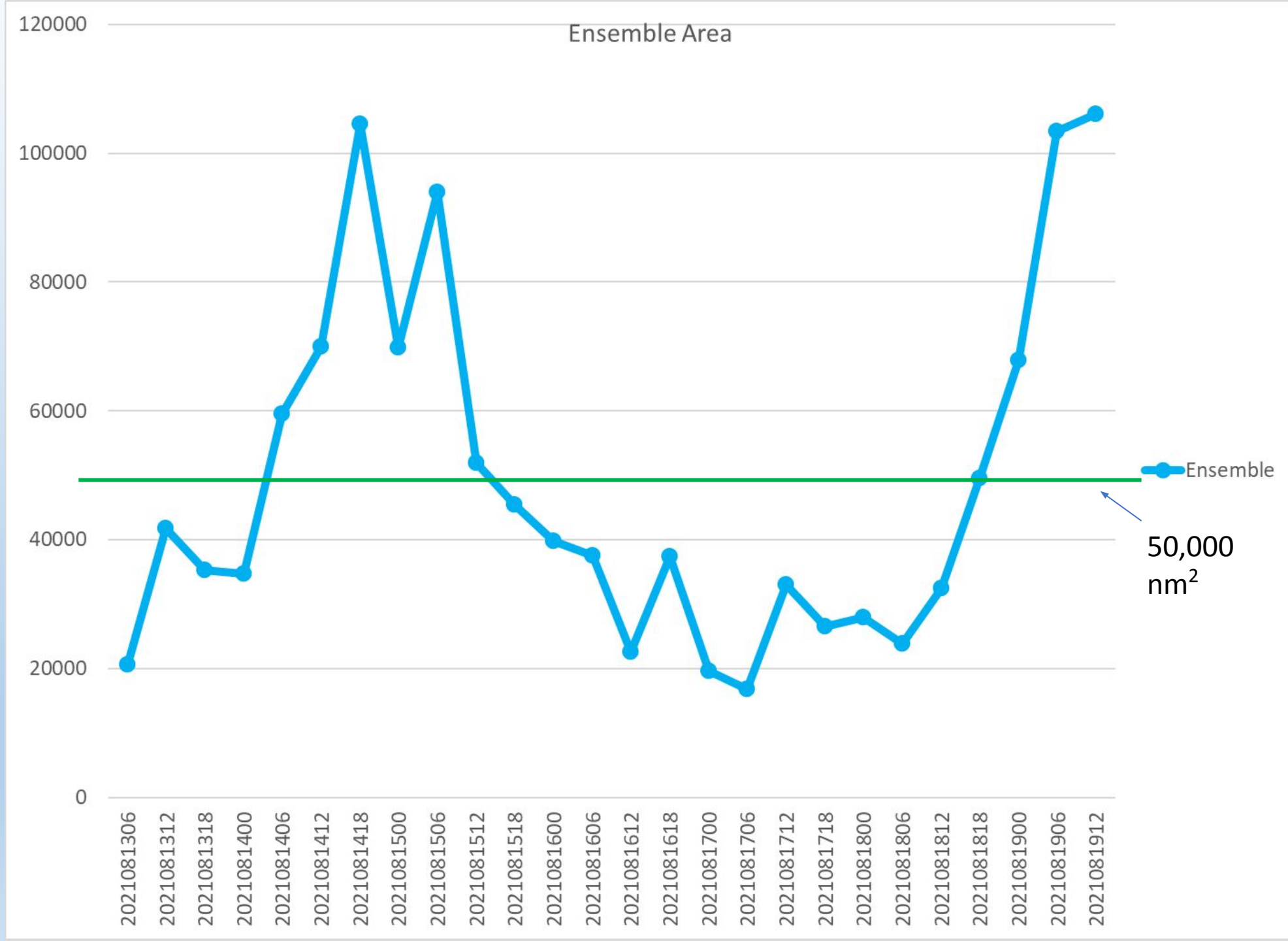
48 hours: 21 correct, 5 misses, 5 false alarms

72 hours: 18 correct, 7 misses, 4 false alarms

96 hours: 3 correct, 3 misses, 3 false alarm

Examples of Individual Storms

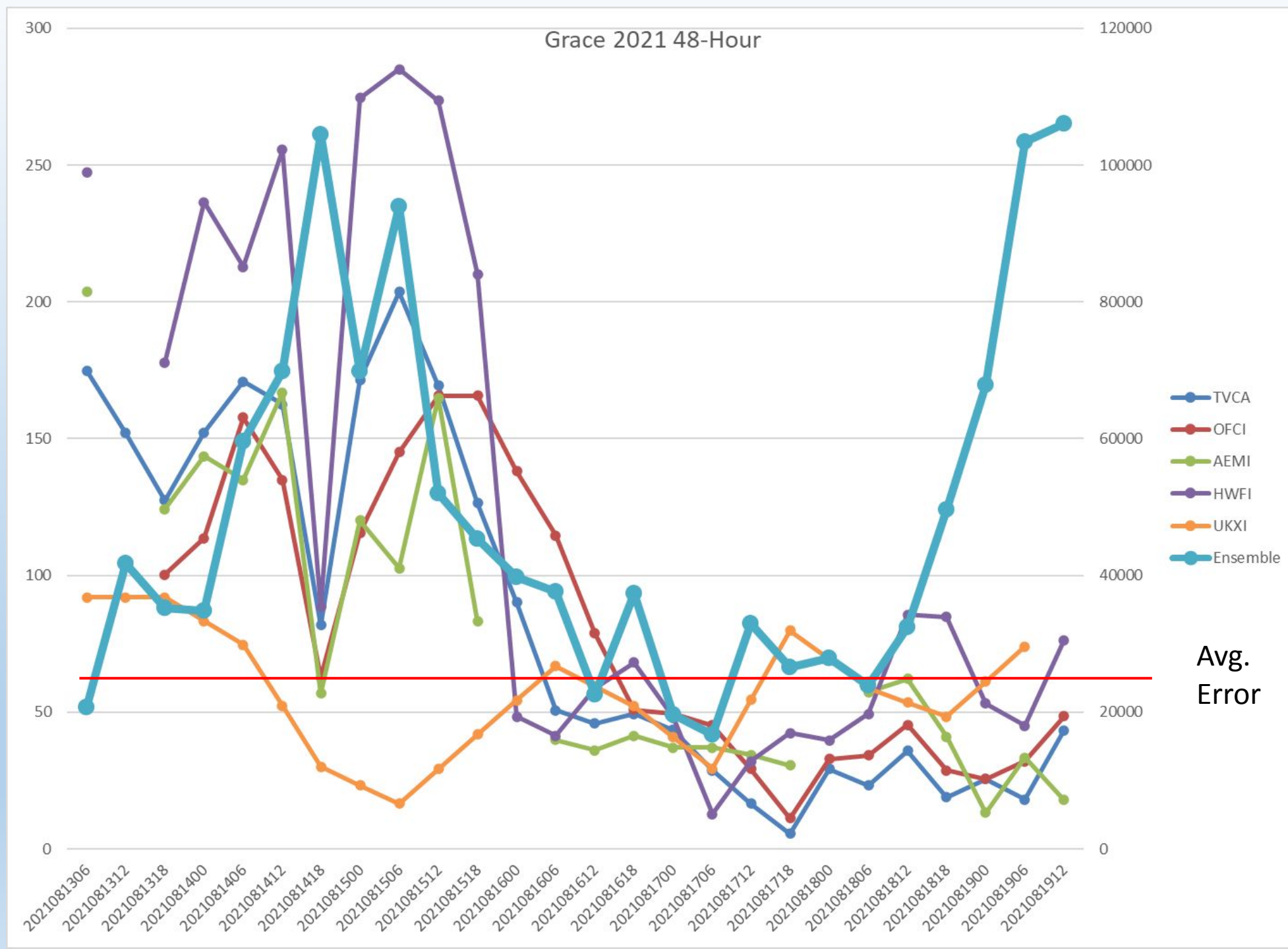
Grace (2021) 48-hour forecasts



Examples of Individual Storms

Grace (2021) 48-hour forecasts

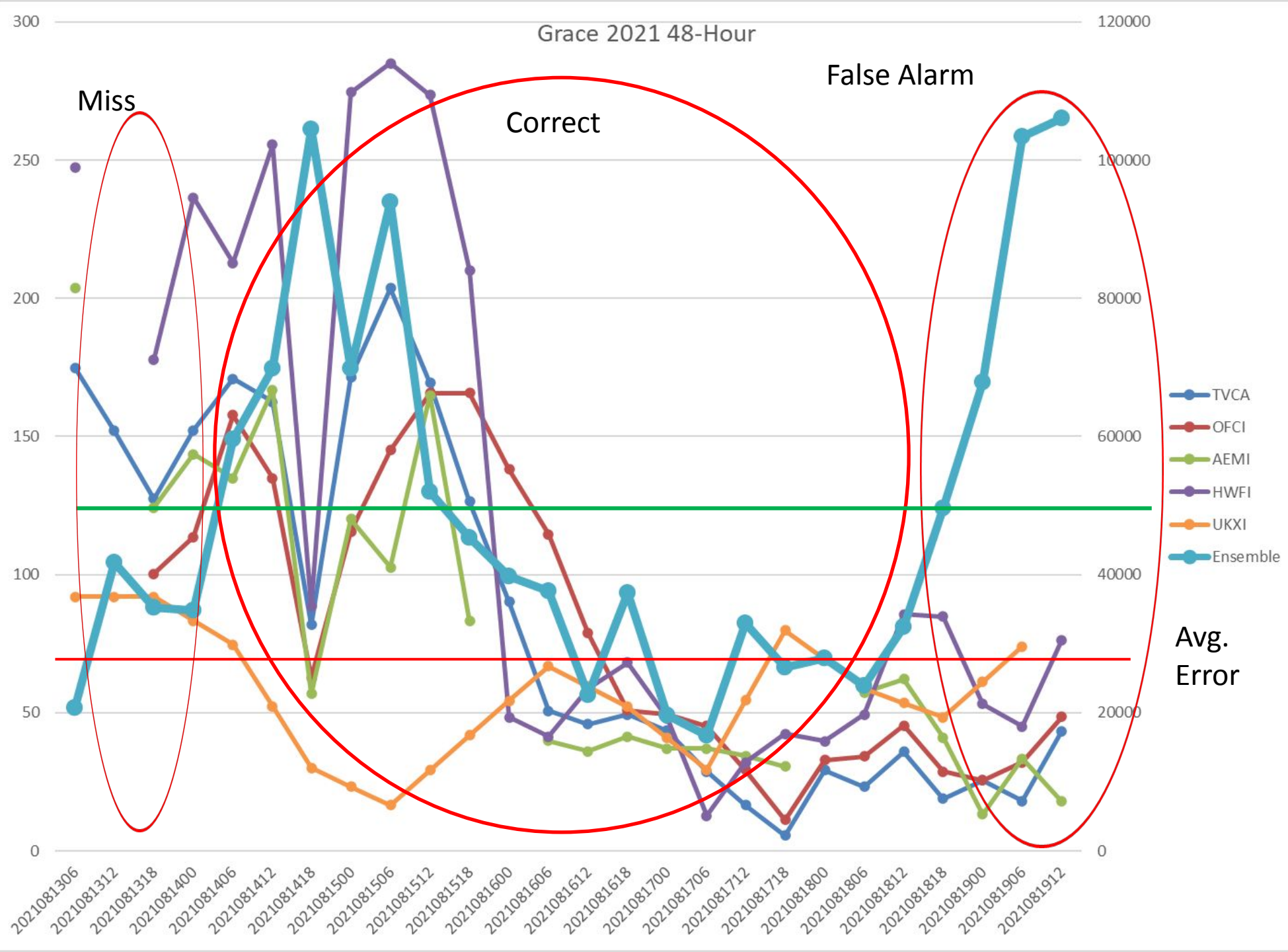
Avg. Error over past 5 seasons



Examples of Individual Storms

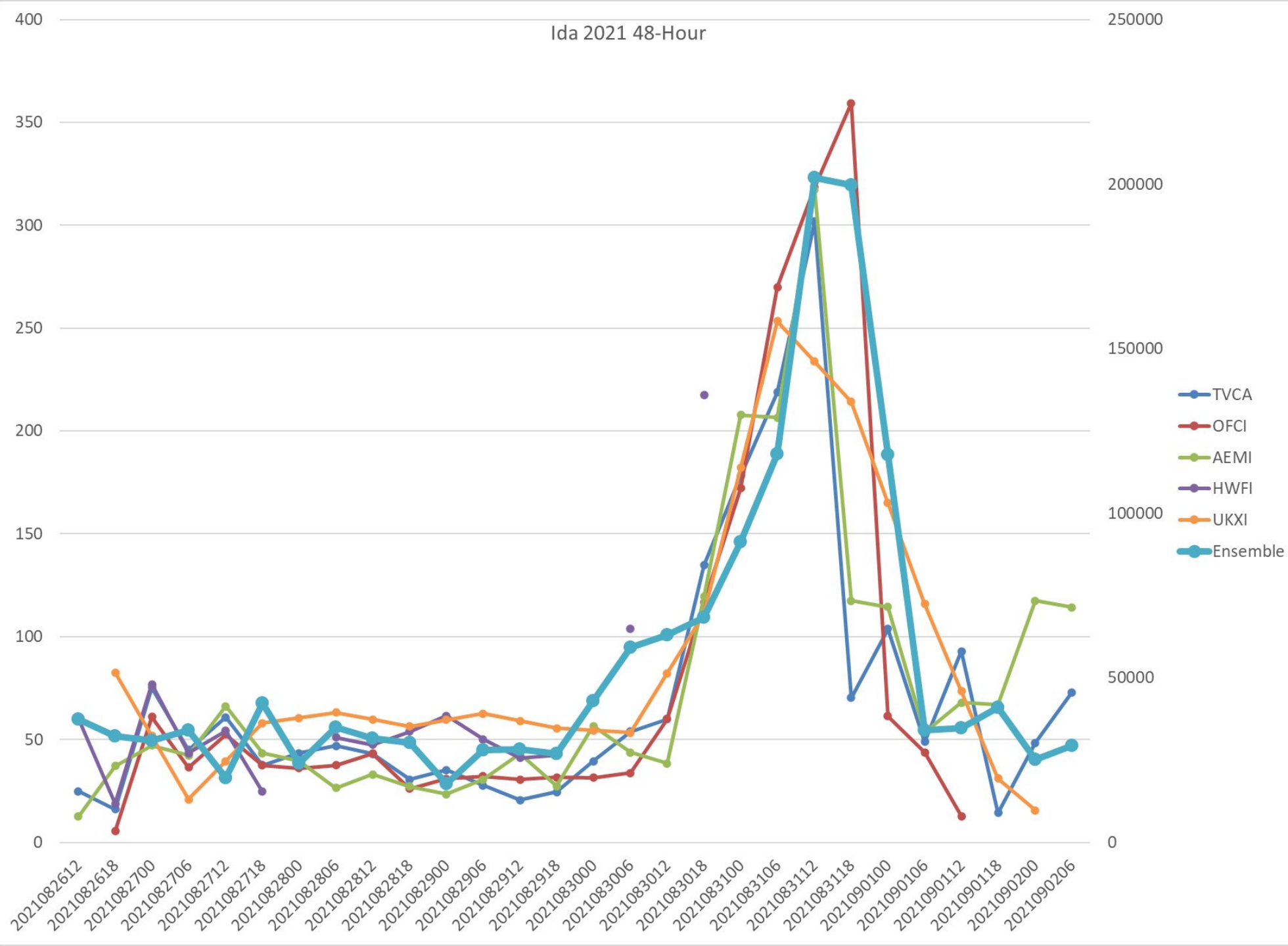
Grace (2021) 48-hour forecasts

Correct, Miss and False Alarm



Examples of Individual Storms

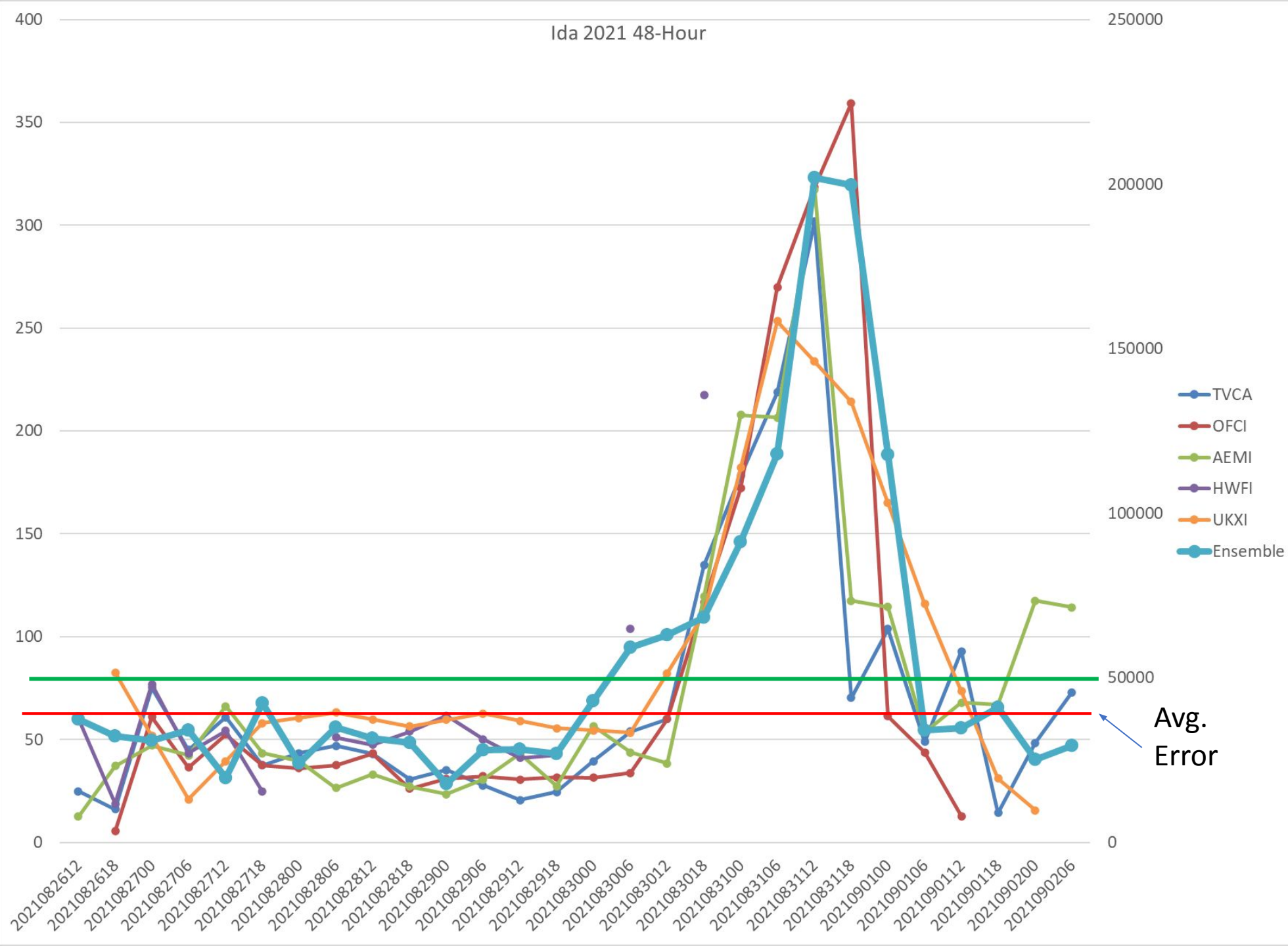
Ida (2021) 48-hour forecasts



Examples of Individual Storms

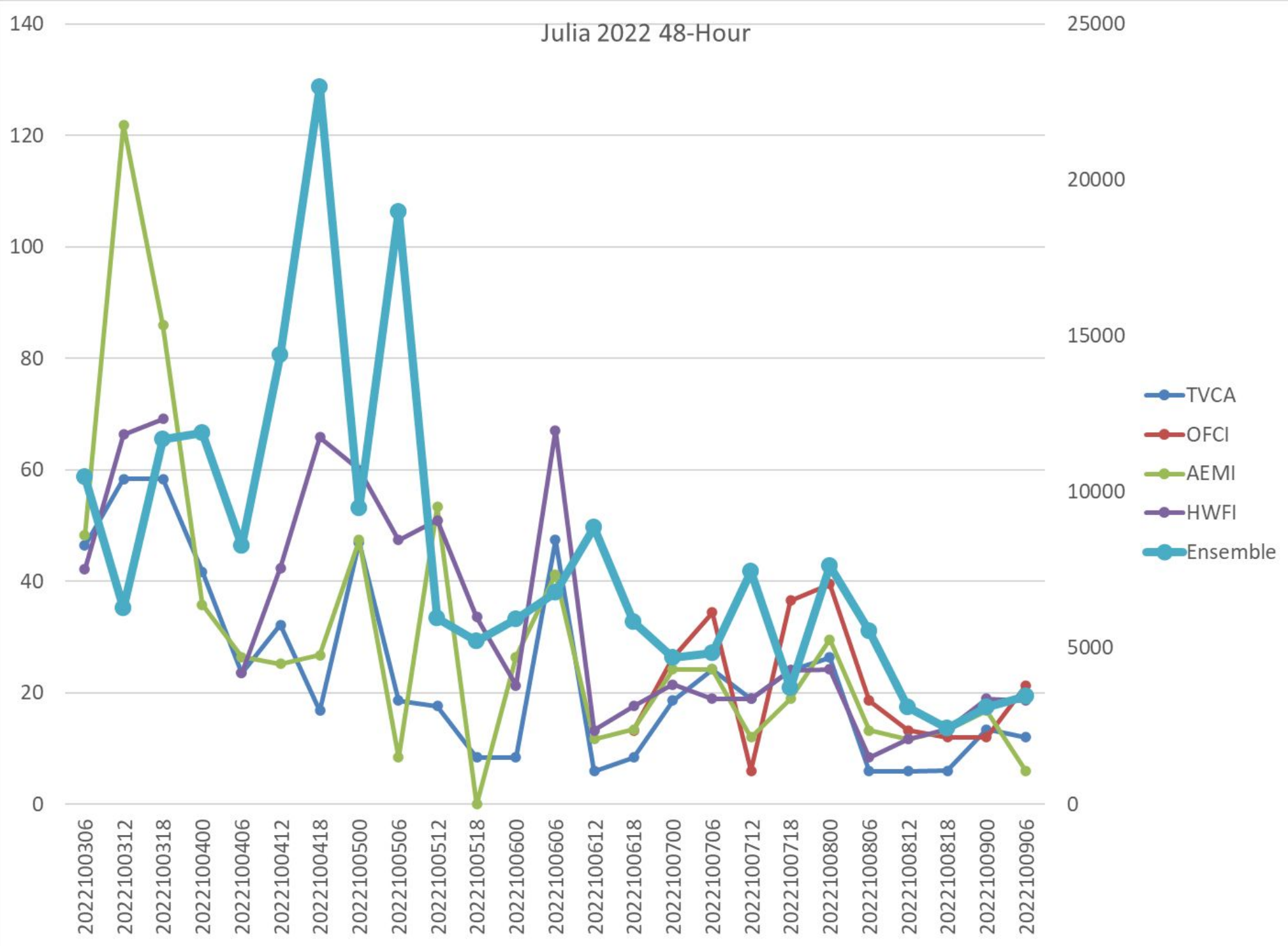
Ida (2021) 48-hour forecasts

Correct for whole lifetime



Examples of Individual Storms

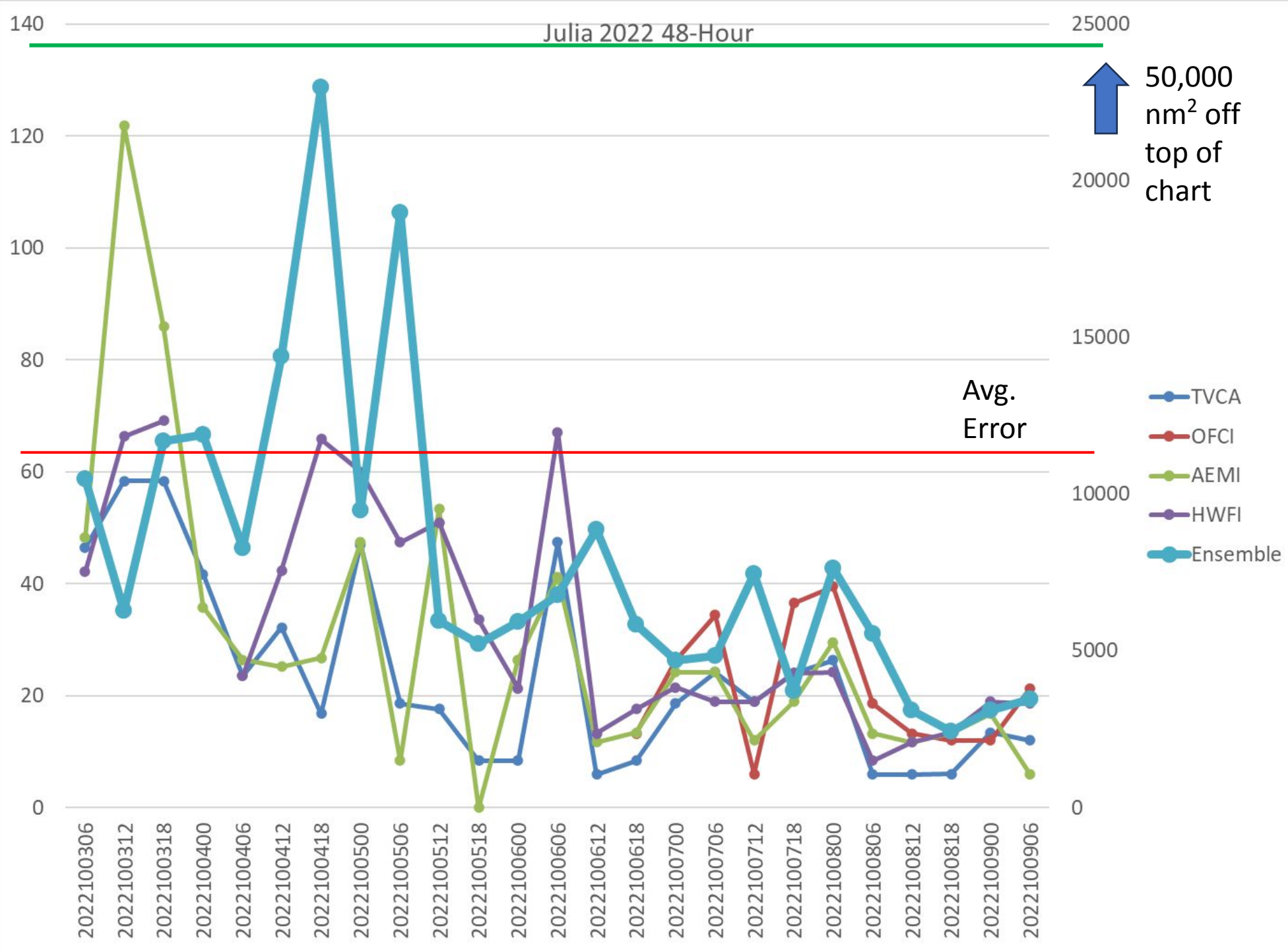
Julia (2022) 48-hour forecasts



Examples of Individual Storms

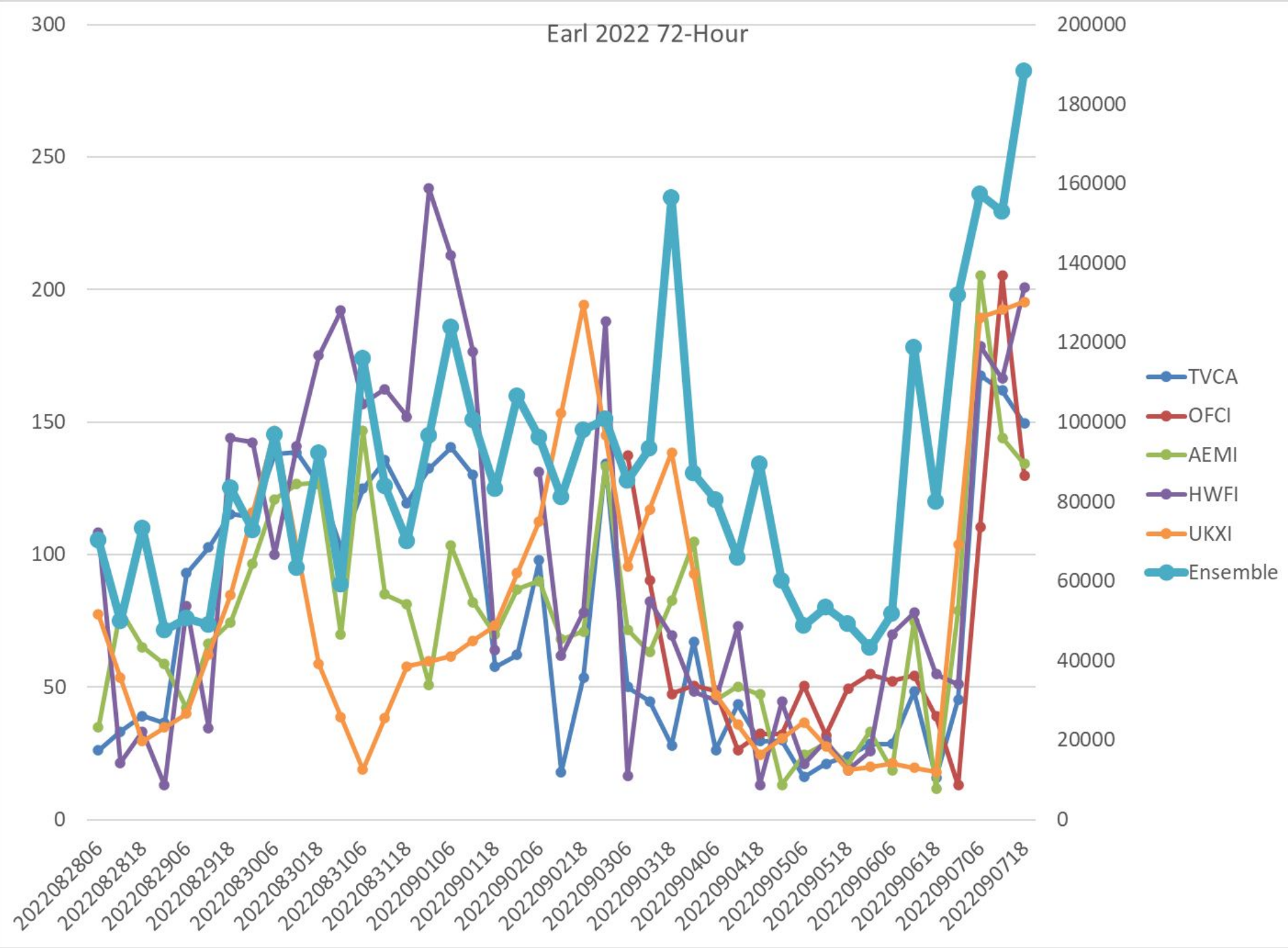
Julia 2022 48-hour forecasts

Correct Indication – all errors at or below avg.



Examples of Individual Storms

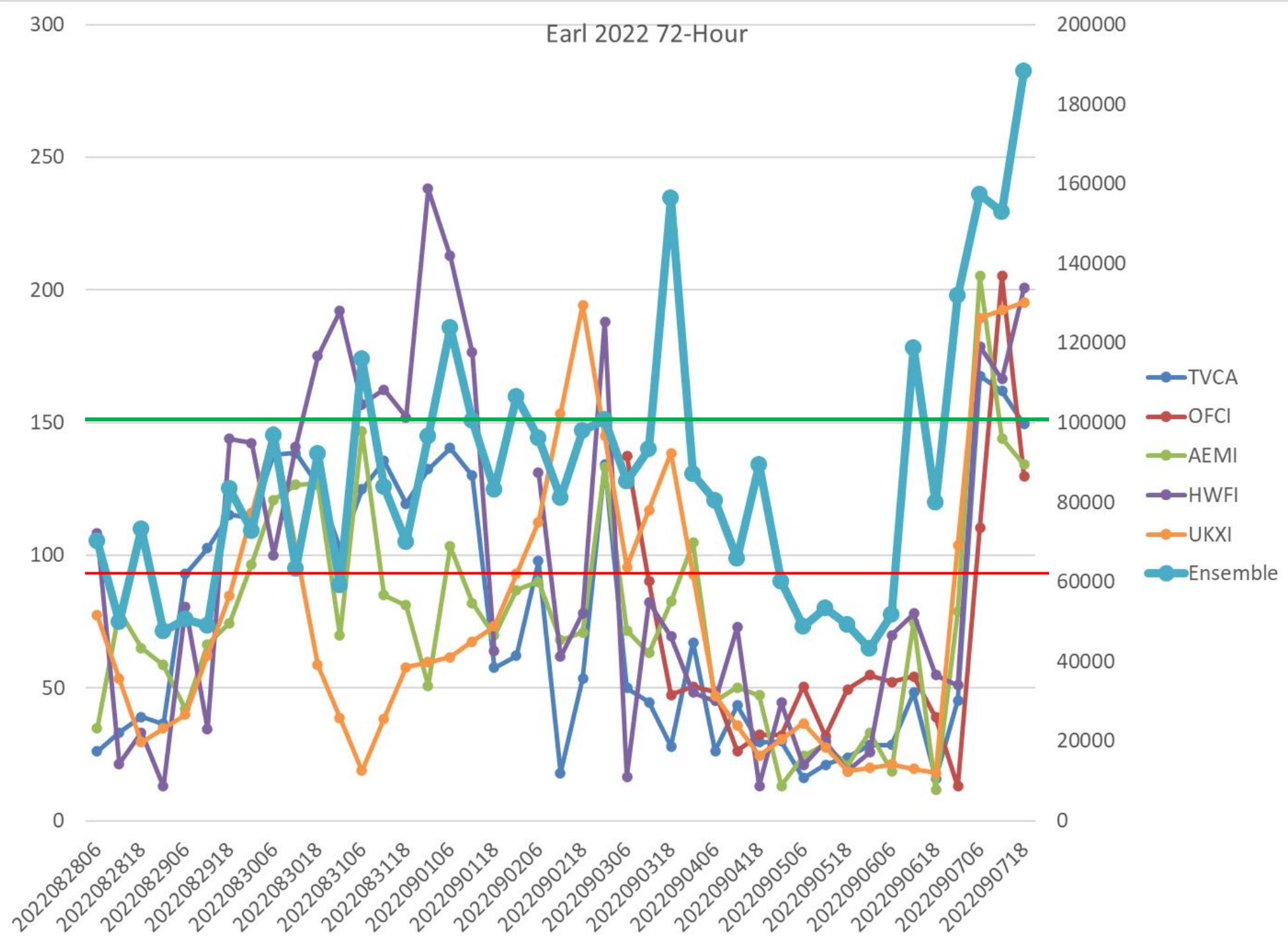
Earl (2022) 72-hour forecasts



Examples of Individual Storms

Earl (2022) 72-hour forecasts

Correct Indications



Conclusions

- The spread of the members of the GEFS is related to track forecast errors of the deterministic models
- Large spread can forecast coming periods of larger than average forecast track errors

Future Work

- Linear regression to gain more precision in spread – track error relationship
- Use along-track and cross-track statistics to compare with spread patterns
- Examine ECMWF ensemble members for similar relationship

Thank you!

Questions?