Identifying Atmospheric Model Trends and Tendencies Using Observations and Analyses

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Overview

- Fleet Numerical Meteorology and Oceanography Center (FNMOC) provides high quality meteorological and oceanographic support to U.S. and coalition forces
- This support includes the dissemination of model data from the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS), as well as the Global Hybrid Coordinate Ocean Model (HYCOM), the Navy Global Environmental Model (NAVGEM), and other global and regional ocean, atmosphere, wave and ice models
- Verification metrics for model data within the last 30 days are also produced within FNMOC

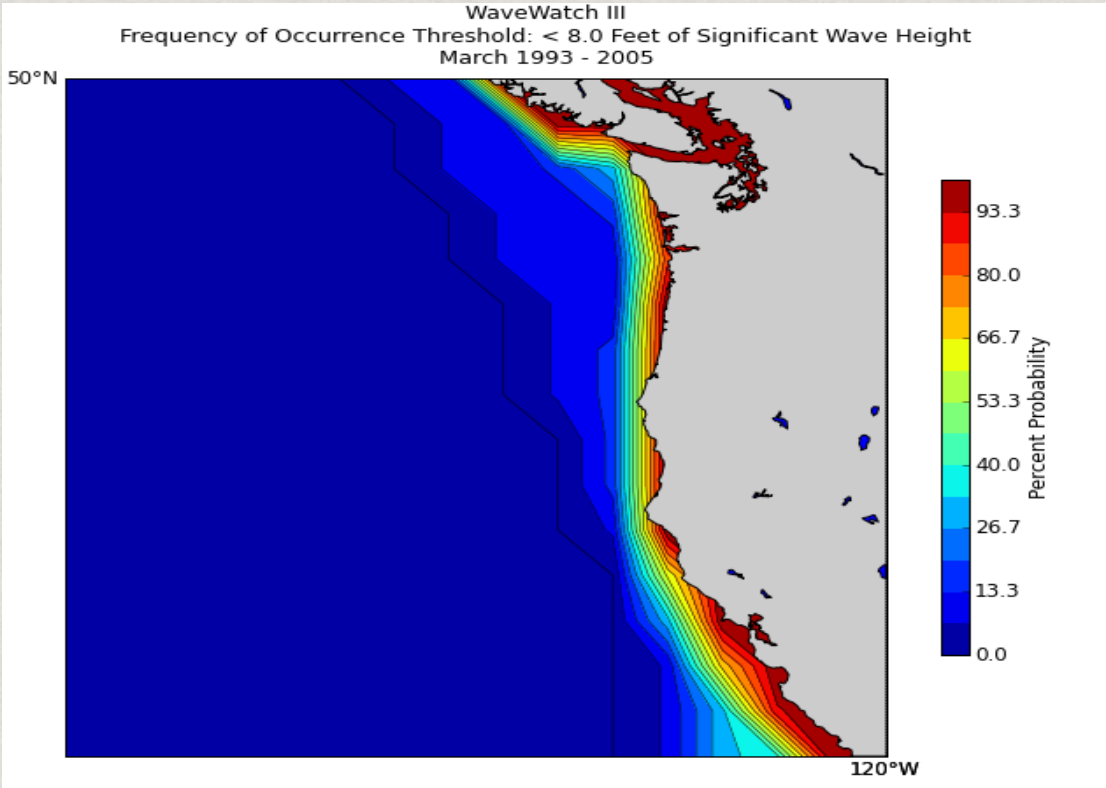
Overview (cont'd)

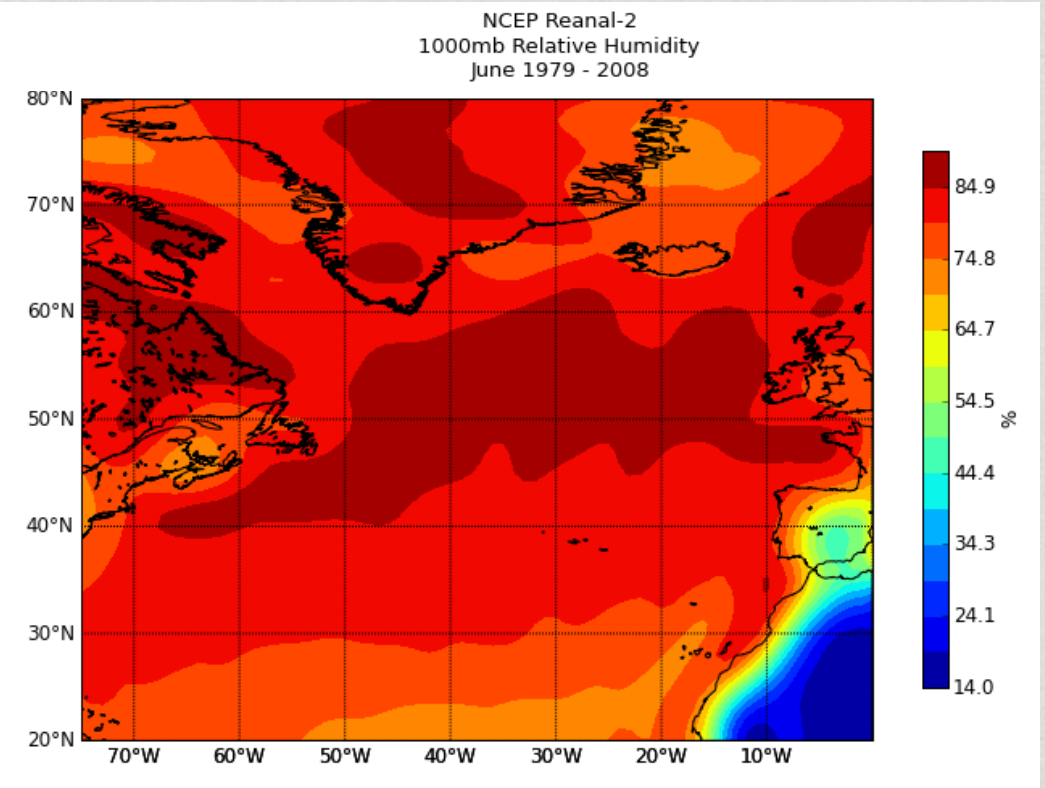
- Divisions of FNMOC include modeling, climatology, IT services, and more
- Modeling teams focus on modeling both the atmosphere and ocean, including tropical cyclones, as well as model verification
- Climatology division provides products for tactical planning and decision support and maintains data archives

- FNMOC often focuses on:
  - Marine and littoral areas, especially overseas
  - Indirect applications of weather, such as atmospheric attenuation due to humidity
  - Tactical and long-range planning involving climatological data using observations, reanalyses, and other products
- Coding and development must be done using a set of approved software packages due to information assurance and related regulations

Climatology Division

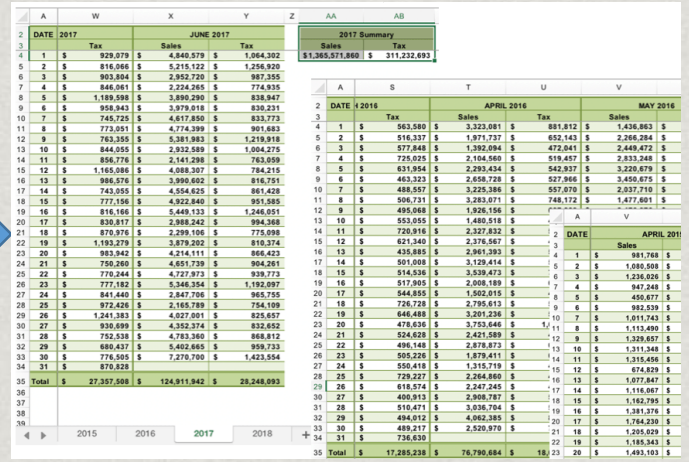
- The Climatology Division at FNMOC provides various products for decision support and long-range planning
- Atmospheric and wave climatology support is largely based on data from civilian sources, such as NCEP and NCEI (formerly NCDC)
- Data is often obtained from reanalyses, but observational and model data are also used in some cases

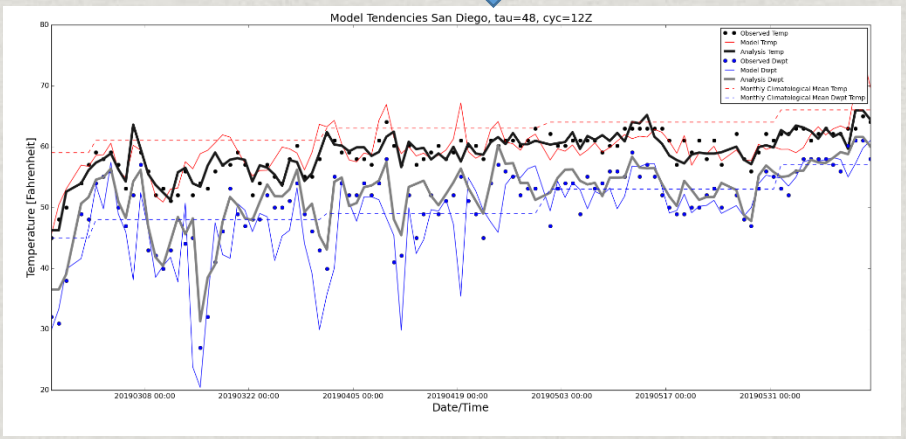




Trends and Tendencies (TnT)

- Recently, a need has been identified for documenting trends in model data observed over long periods of time by Navy forecasters in order to:
  - Understand the dependence of model performance on season and weather patterns
  - Explore the relationship, if any, between climate variations and model bias
- These trends can be identified and stored in a database for future reference, and analysis of large amounts of data can be performed to further support these claims
- This presentation will focus mostly on the work that has been done with Python to allow us to perform this type of analysis on large data sets





Python and TnT

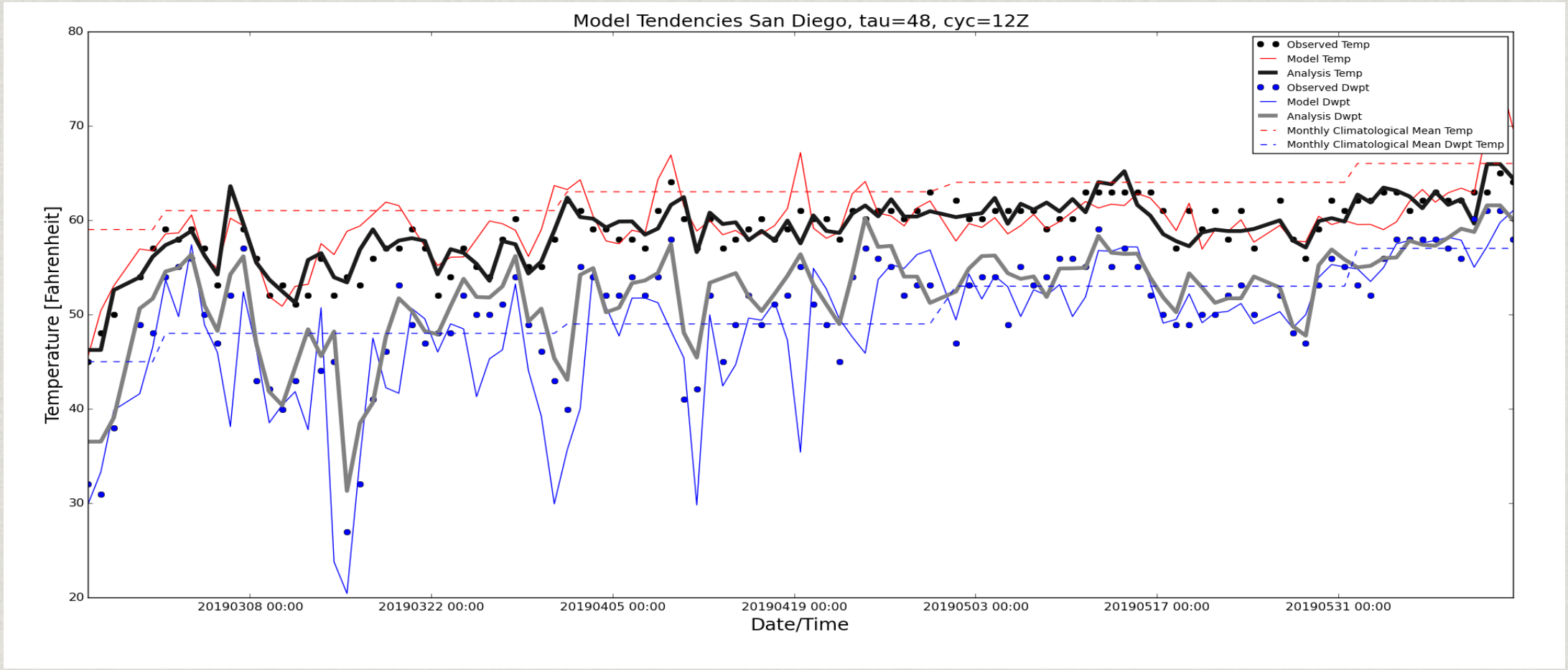
- Version: Python 2.7
- The codes that have been developed are relatively simple and make use of some Python libraries such as:

  - NumPy
  - Matplotlib
  - Other features such as the datetime module

Methodology

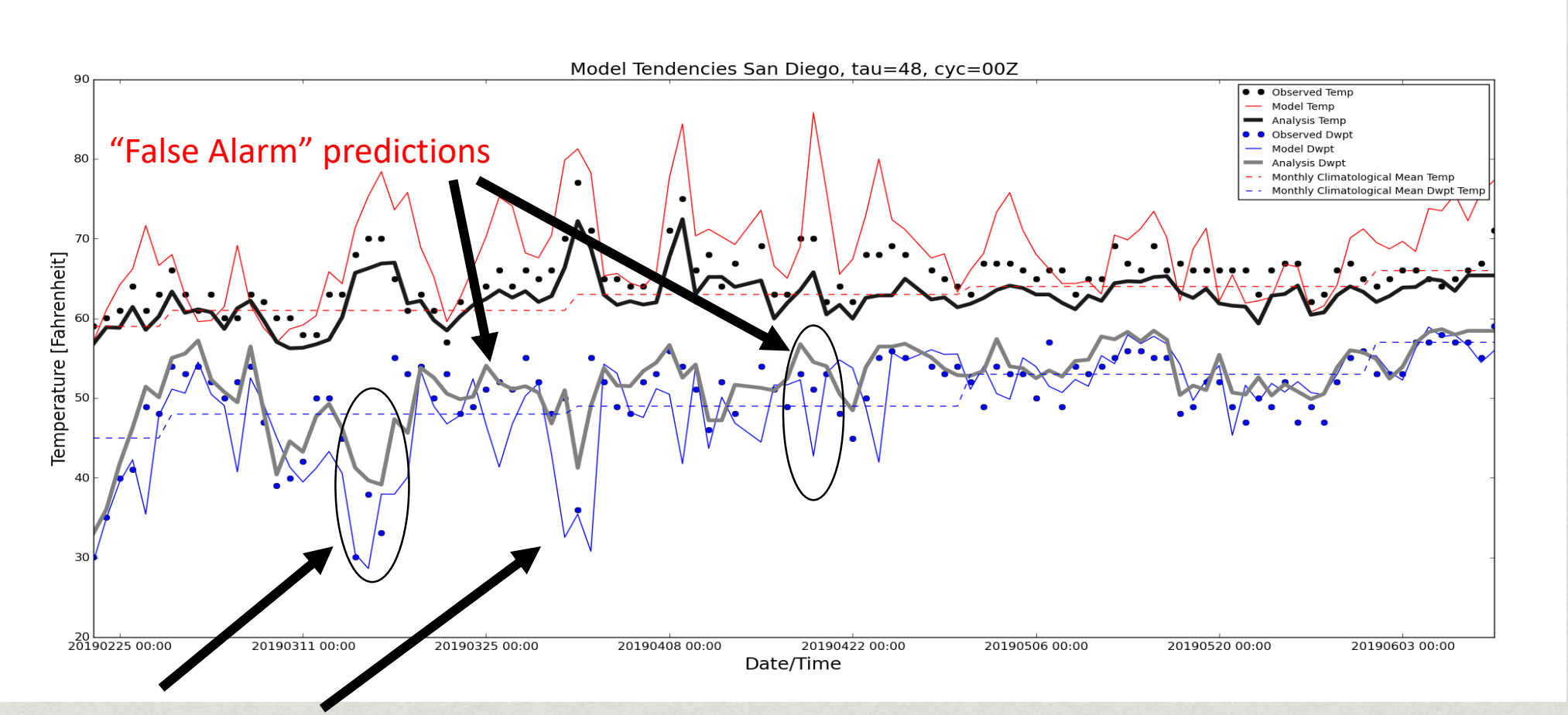
- The current goal: analyze the model data against available observational data to better understand trends in model performance over the desired time period and the dependence of such performance on climatological patterns
- Inputs: model, tau, cycle, date range, and weather element
- Methods
  - Create an archive of organized matchup files containing data from various models and grid boxes and for several different weather elements – this archive for the past 30 days is currently built by our modeling team
  - Build a larger archive containing data beyond just the last 30 days for a select number of stations around the globe
  - Using Python scripts, create a simplified process of sifting through these archives in order to analyze model performance for the specified inputs
- The following images use data from the SOCAL grid box of the COAMPS model

Results: Model vs. Observations and Analysis



Data from COAMPS SOCAL

Results: Model vs. Observations and Analysis

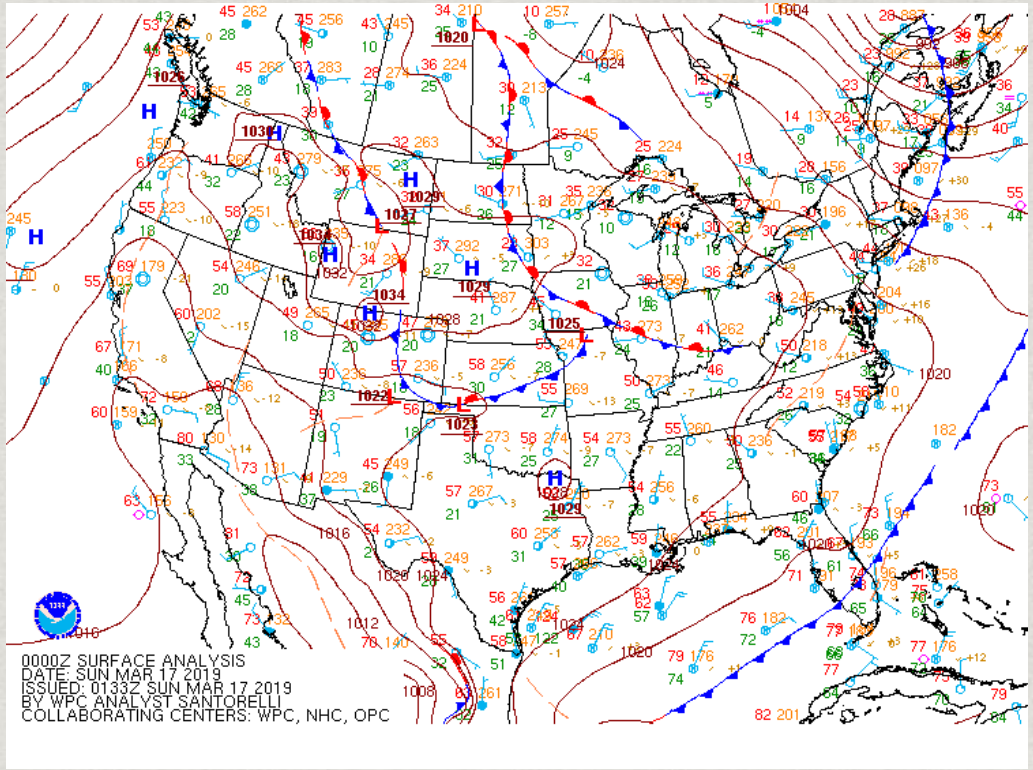


Accurate representations by model

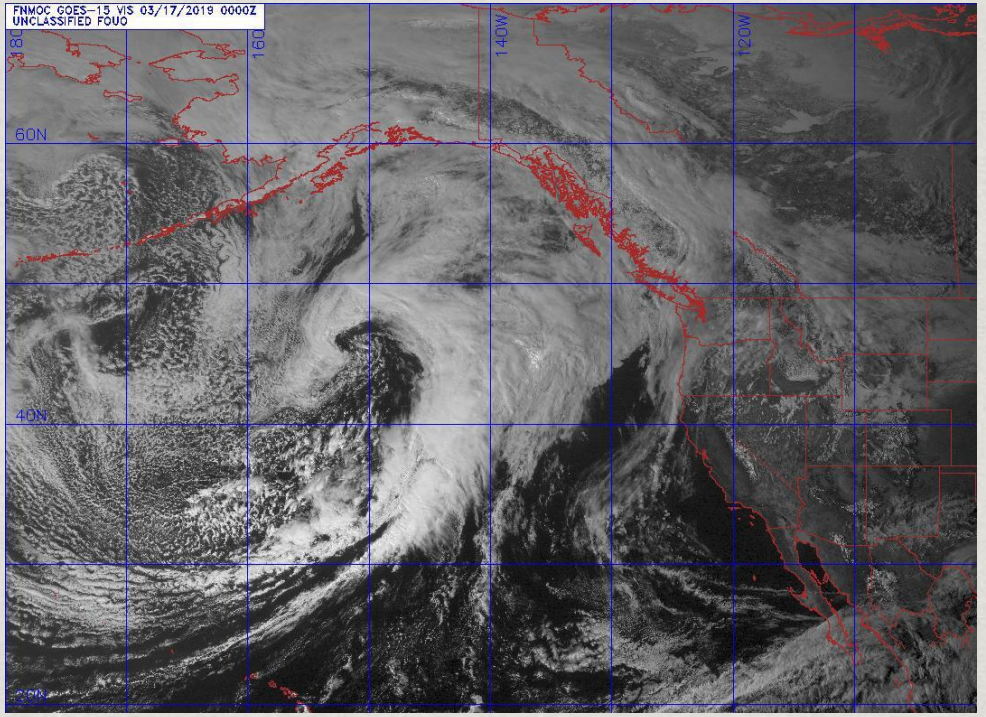
Data from COAMPS SOCAL

Santa Ana Wind Event: March 17, 2019

Surface analysis from the Weather Prediction Center
03/17/2019 0000Z



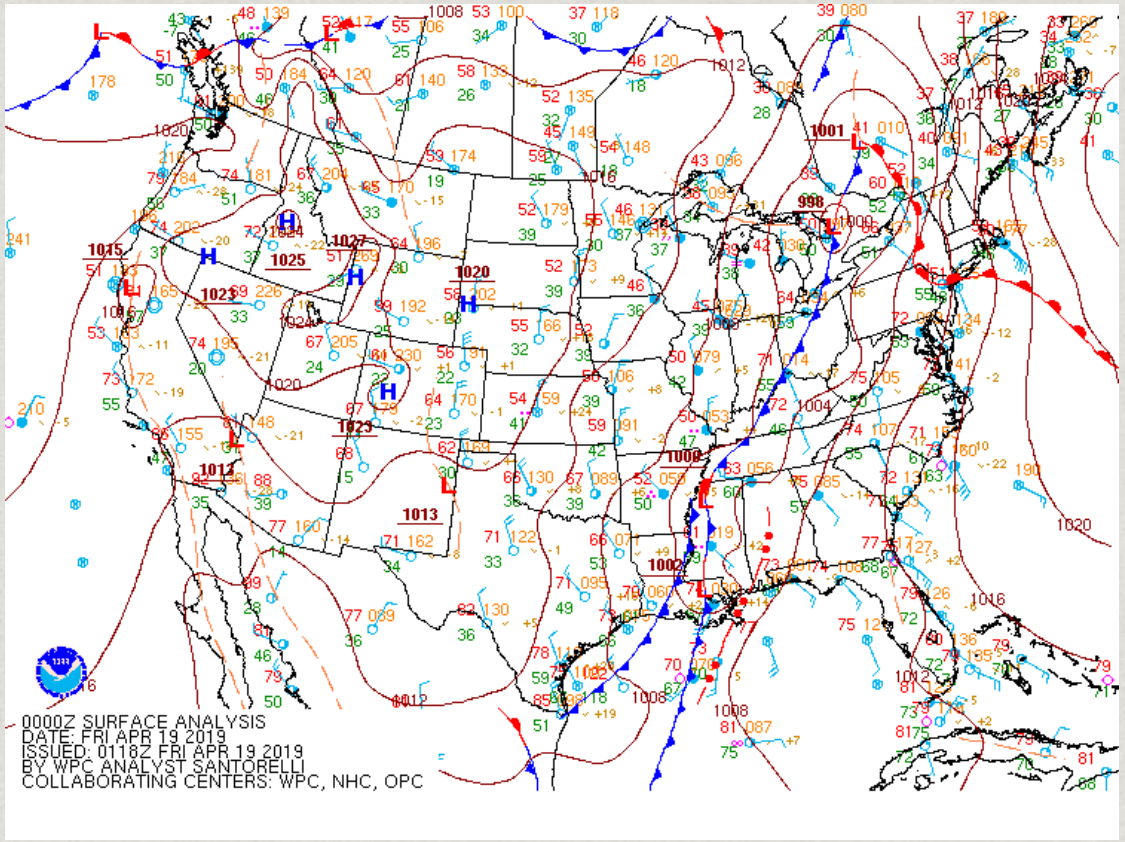
GOES-15 Visible Satellite Image, 03/17/2019 0000Z



Easterly winds, ridging, and dry air – typical Santa Ana patterns – were observed for this particular case

False Alarm : April 19, 2019

Surface analysis from the Weather Prediction Center
04/19/2019 0000Z



The typical Santa Ana signature was not observed during this date, although the model predicted it would occur

Forecaster Importance

- It is important to note that one of the main goals of the TnT project is to harness the knowledge and experience of the forecasters and to see what model trends they are observing out in the field
  - Forecaster input has been collected in the recent past through surveys

- Then by analyzing large amounts of data, we can further support their claims and communicate them to the rest of the community

- We need to provide information for safety of flight and navigation, and the Trends and Tendencies Project helps us achieve this goal through data mining (lots of model, analysis and observational data)

Conclusion

- Although the TnT project prototypes focus mainly on FNMOC models (e.g., COAMPS), the intention is to perform comprehensive analyses on all models used by Navy forecasters
- The procedure used in the TnT project can be replicated at other modeling and forecasting centers around the world, not just at Navy centers

Future Work

- Future work will include development of a webpage that forecasters can access on-demand and provide input on model performance for specific locations, models, weather elements, etc.
- This data will be routed into a database that FNMOC will manage
- FNMOC can then perform TnT data analysis regularly and confirm or reject trends
- Quarterly updates can be provided back to the forecasters, detailing the TnT analyses performed in that quarter

Acknowledgements & References

Thank you to the FNMOC Modeling team for providing key data for use in the development of TnT Project prototypes and for helping to identify recurring trends in model performance. Also, thank you to Naval Research Laboratory for their assistance and recommendations on these prototypes.

Image References

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New in Tableau Prep: Preparing spreadsheet data for analysis gets easier. https://www.tableau.com/about/blog/2018/6/preparing-spreadsheet-data-analysis-gets-easier-new-tableau-prep-201812-89557

Ocean World: Earth Globe Toss Game. https://www.jpl.nasa.gov/edu/teach/activity/ocean-world-earth-globe-toss-game/

Surface weather analysis maps obtained from National Weather Service's webpage

Thank You!

Questions?

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