DETERMINING WIND SPEED DISCREPANCIES IN CLIMATE REANALYSIS MODELS FOR NEWFOUNDLAND AND LABRADOR

What is Climate Reanalysis?

- A simulation or model used to reconstruct historical climate
- Consists of modern forecast models massaged with observational records
- Recent releases have resolution as high as 32km

Why is it important?

- A way to map the trajectory of climate over a region or the globe through time
- Beneficial for areas without long-term, reliable observation data
- Used for climate change forecasting & wind farm site suitability

How is it relevant to Newfoundland and Labrador?

- Few weather stations with long-term historical observation records – majority in coastal regions
- Experience the highest mean wind speeds in Canada
- Recognizing areas with intensifying trends & forecasting potential impacts
- Areas close to sea level especially at risk where flooding due to coastal erosion has occurred in recent past (Bonavista, 2014)

Project Objective

- By comparing against observation readings at 17 weather stations across Newfoundland and Labrador from 1984-2013, measure the accuracy of two climate reanalysis models:
  1. **North American Regional Reanalysis (NARR)** – by National Centers for Environment Protection (NCEP)
  2. **ERA5** – by European Centre for Medium-Range Weather Forecasts (ECMWF)
- Measure performance of both reanalysis models compared to observations through the following metrics:
  - **Analysis of Variance (ANOVA)**
  - **Descriptive Statistics** (Mean, Median, Range, Mean Absolute Deviation)
  - **Comparative Statistics** (Root Mean Square Error, Mean Square Error, Mean Absolute Error)
  - **Extremes Analysis** (Mean/Median/Max Days per Month a Threshold Value is Passed)

Methodology

- A top-down approach to analysis, reviewing small time slices and increasing gradually in granularity

Daily Means ⟶ Seasonal Means ⟶ Seasonal Means, Grouped by Location

Data Manipulation and Analysis Tools

- Reanalysis datasets available in netCDF format
- Observations provided in CSV format via weathercan package in R
- Reanalysis resampled and cropped using xarray package
- Converted to pandas dataframe to perform statistical computations using functions in scikit-learn and pandas packages
- Data presented using seaborn and matplotlib packages

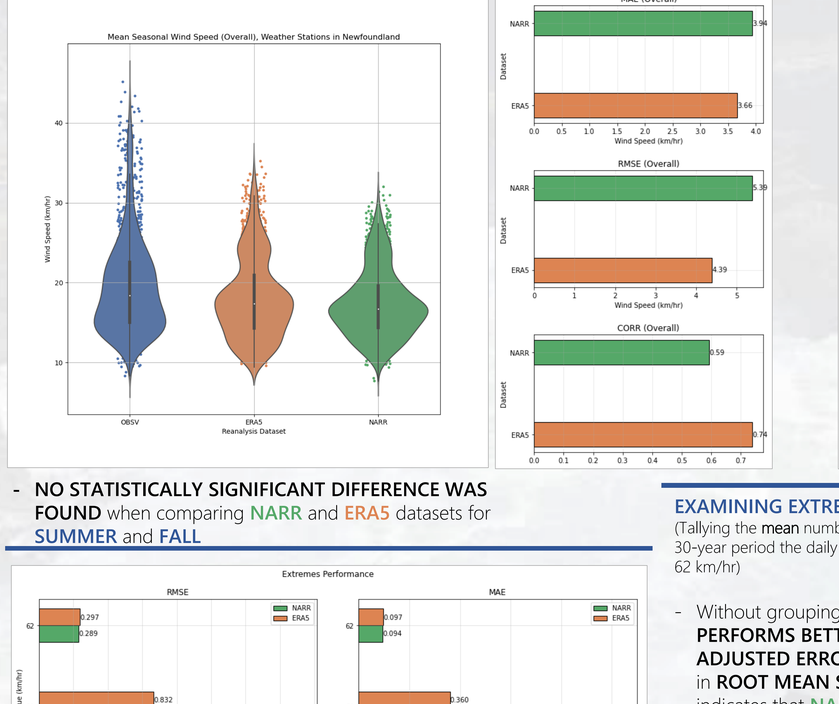


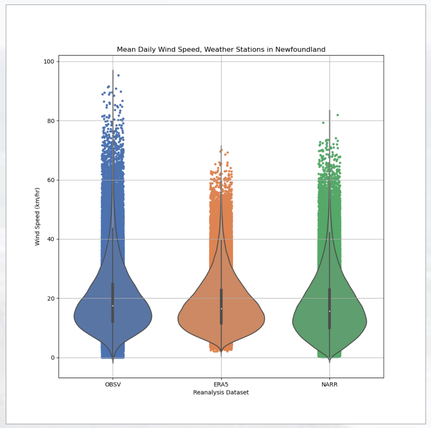
Image: Reanalysis Data Points for each Weather Station - NL

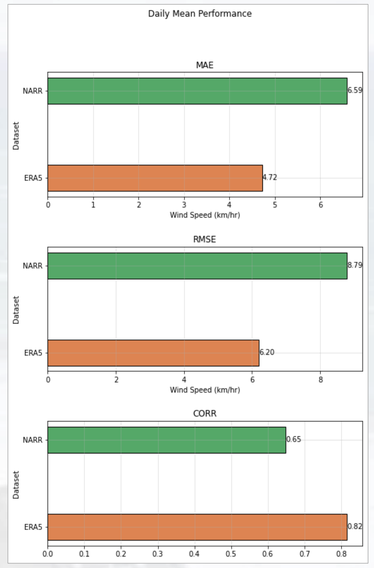
Image: North American Regional Reanalysis (NARR)

Results

USING DAILY MEANS:

– ERA5 PERFORMS BETTER than NARR in MEAN ADJUSTED ERROR (MAE), ROOT MEAN SQUARE ERROR (RMSE), AND CORRELATION (CORR)





	pvalue-hs	reject-hs
NARR-ERA5	0.0	True
OBSV-ERA5	0.0	True
OBSV-NARR	0.0	True

Results (cont.)

USING SEASONAL MEANS (BELOW):

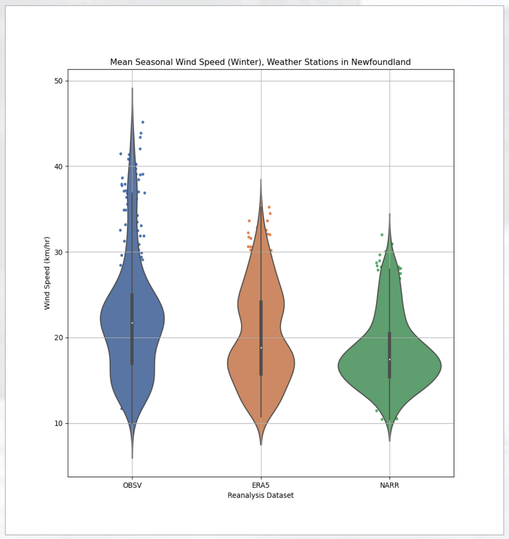
- ERA5 PERFORMS BETTER than NARR in MEAN ADJUSTED ERROR (MAE), ROOT MEAN SQUARE ERROR (RMSE), AND CORRELATION (CORR) when looking across ALL SEASONS COMBINED.

	pvalue-hs	reject-hs
NARR-ERA5	0.000041	True
OBSV-ERA5	0.000000	True
OBSV-NARR	0.000000	True

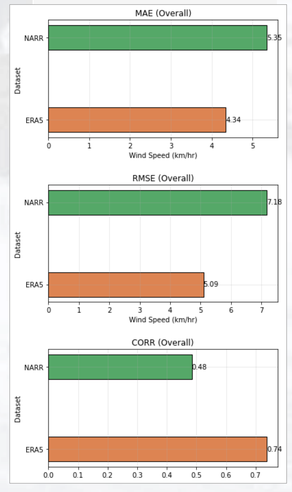
- NO STATISTICALLY SIGNIFICANT DIFFERENCE WAS FOUND when comparing NARR and ERA5 datasets for SUMMER and FALL

USING SEASONAL MEANS (BELOW):

- ERA5 PERFORMS BETTER than NARR in MEAN ADJUSTED ERROR (MAE), ROOT MEAN SQUARE ERROR (RMSE), AND CORRELATION (CORR) for WINTER, the season with the highest mean wind speed in NL



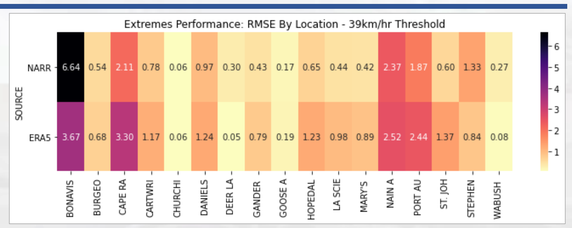
	pvalue-hs	reject-hs
NARR-ERA5	2.705062e-06	True
OBSV-ERA5	9.240739e-08	True
OBSV-NARR	0.000000e+00	True



EXAMINING EXTREMES ANALYSIS:

(Tallying the **mean** number of days per calendar month over the 30-year period the daily mean wind speed surpasses 39, 50, and 62 km/hr)

- Without grouping by location (left), the NARR PERFORMS BETTER than ERA5 in MEAN ADJUSTED ERROR (MAE), but is narrowly inferior in ROOT MEAN SQUARE ERROR (RMSE). This indicates that NARR may be being penalized by one or more large errors.
- The **RMSE** heatmap for 39 km/hr (right) indicates that for the majority of locations NARR OUTPERFORMS ERA5



David St. George
GIS Post-Diploma Program
Intersession 2021