Seasonal & Subseasonal Forecasting Projects

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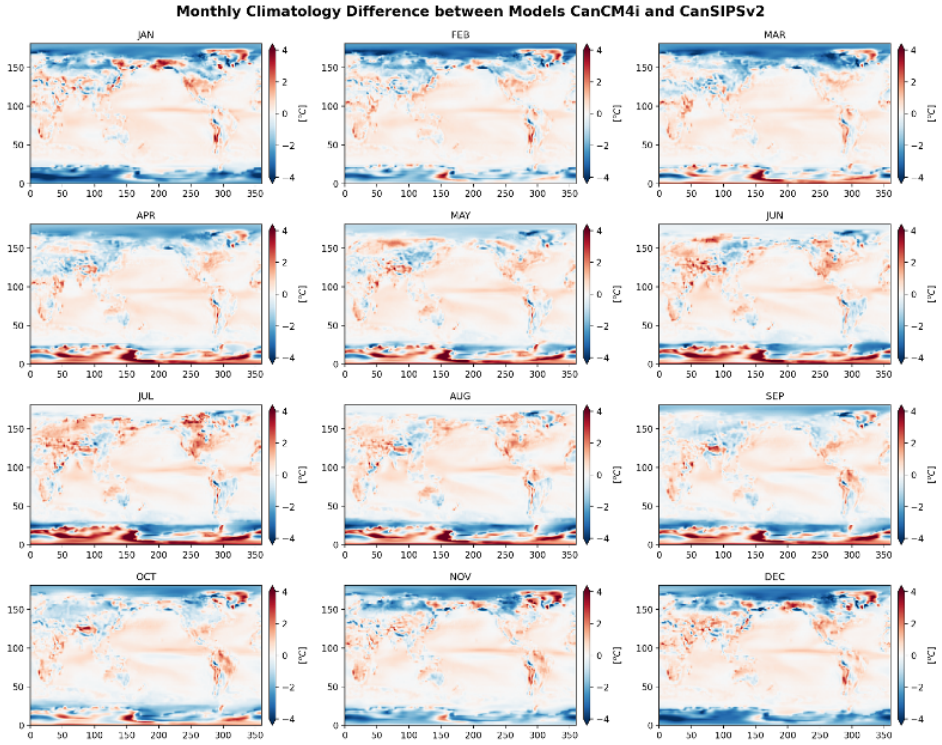
One of my first exercises with NMME datasets, xarray, and plotting:


Monthly Climatology Difference between Models CanCM4i and CanSIPSv2
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
[°C]

Outline

Seasonal Forecasts

- Overview
- Documentation

Subseasonal Forecasts

- Overview
- Documentation
- Next Steps

Seasonal Forecasts

Characterizing Uncertainty Analysis

Table 2. Summary of the dynamical models employed for our preliminary analyses. All the models have a spatial resolution of 1 degree (~100km), and have a common period of 1993-2010 for the hindcast period.

Source	Model	Hindcast Period	Forecast Period	Ensemble Size*
NMME	CanCM4i	1981-2018	2017-Present	10
NMME	CanSIPSv2	1981-2018	2019-Present	20
NMME	GEM-NEMO	1981-2018	2019-Present	10
NMME	GFDL-CM2.5-FLOR-B01	1980-Present		12
NMME	NCEP-CFSv2	1982-2010	2011-Present	24 (28)
NMME	NASA-GEOSS2S	1981-2017	2017-Present	4
ECMWF	SEAS5	1993-2016	2017-Present	25 (51)
*The value in the parenthesis shows the ensemble size for the forecast period				

Overview

Goal: Better understand seasonal forecast uncertainty from model, ensemble members, lead time, month/season, and region.

Importance: Understanding the differences among the models allows us to better comprehend the predictability in time and locations of interest.

ClimateAI's Use: Issue a probabilistic forecast as opposed to a deterministic forecast ("single value") on the product dashboard to help understand the forecast uncertainty.

Seasonal Forecasts Documentation

Bias-Correction, Uncertainty Estimation, and Evaluation of Seasonal Forecasts

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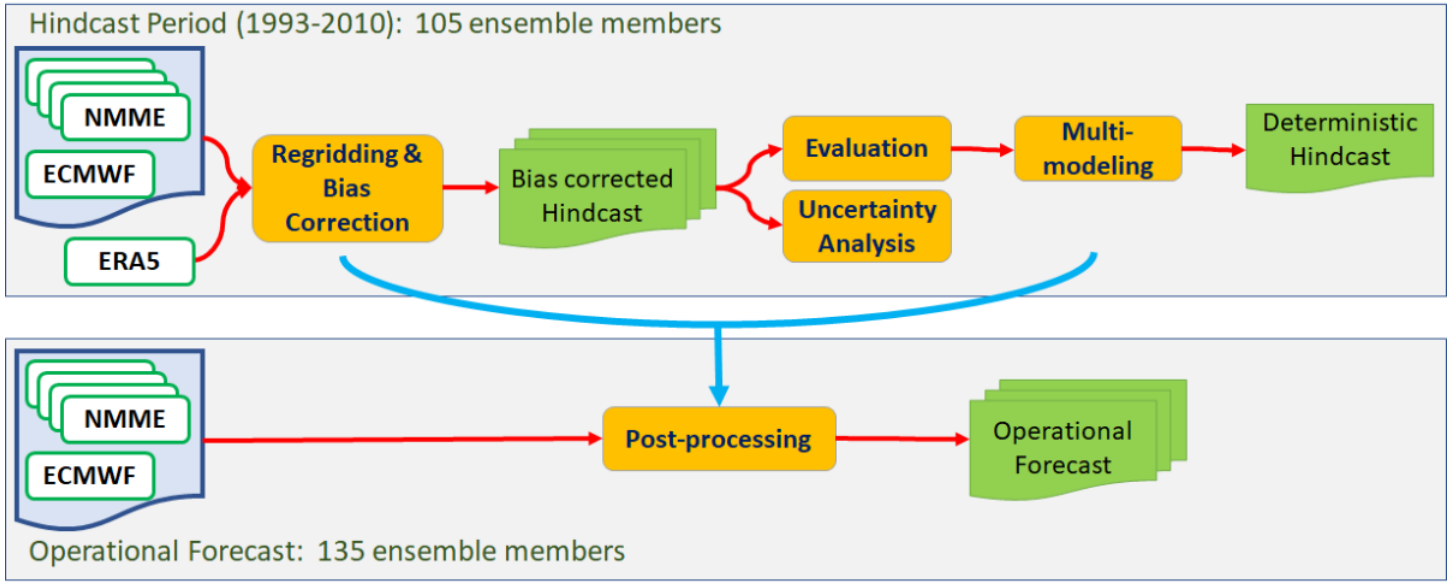
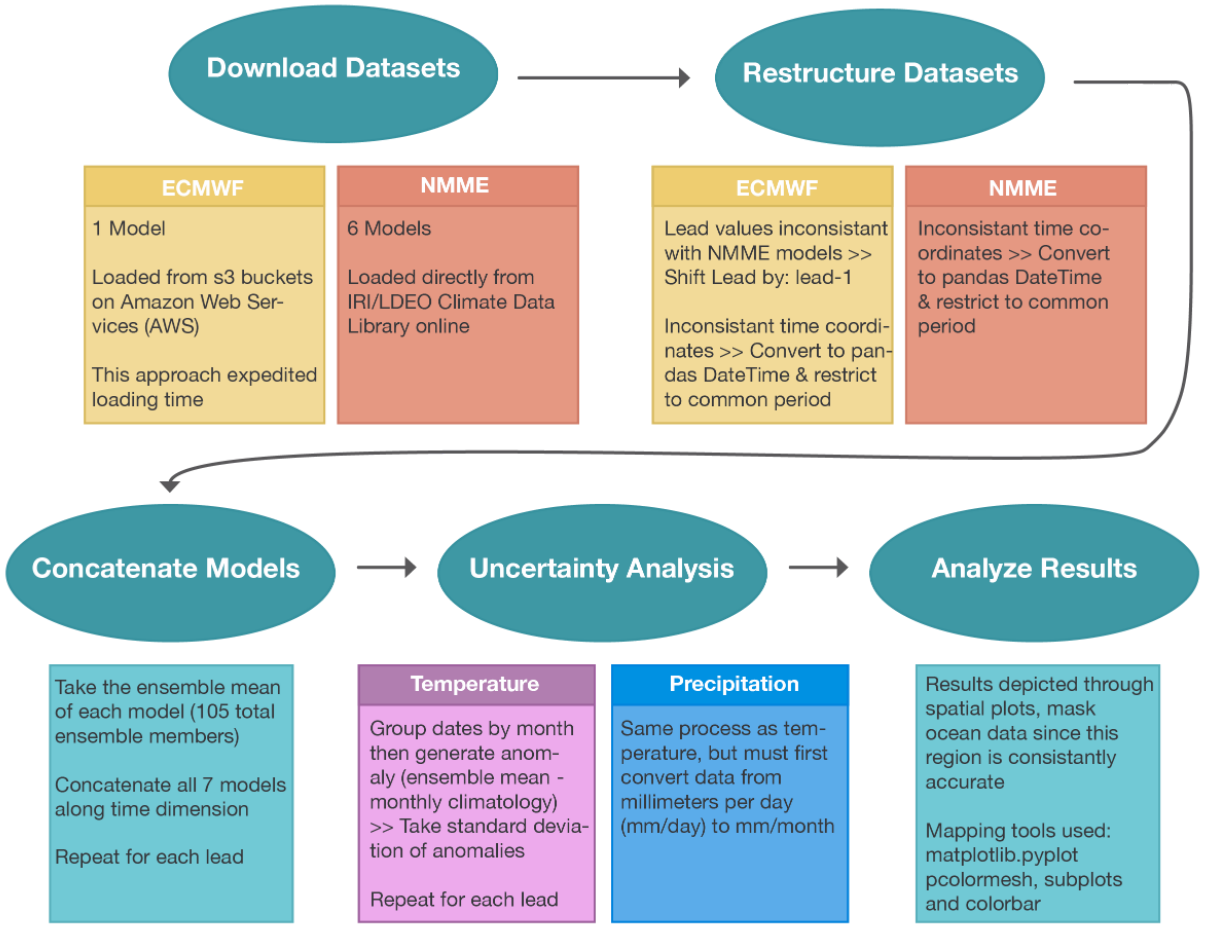
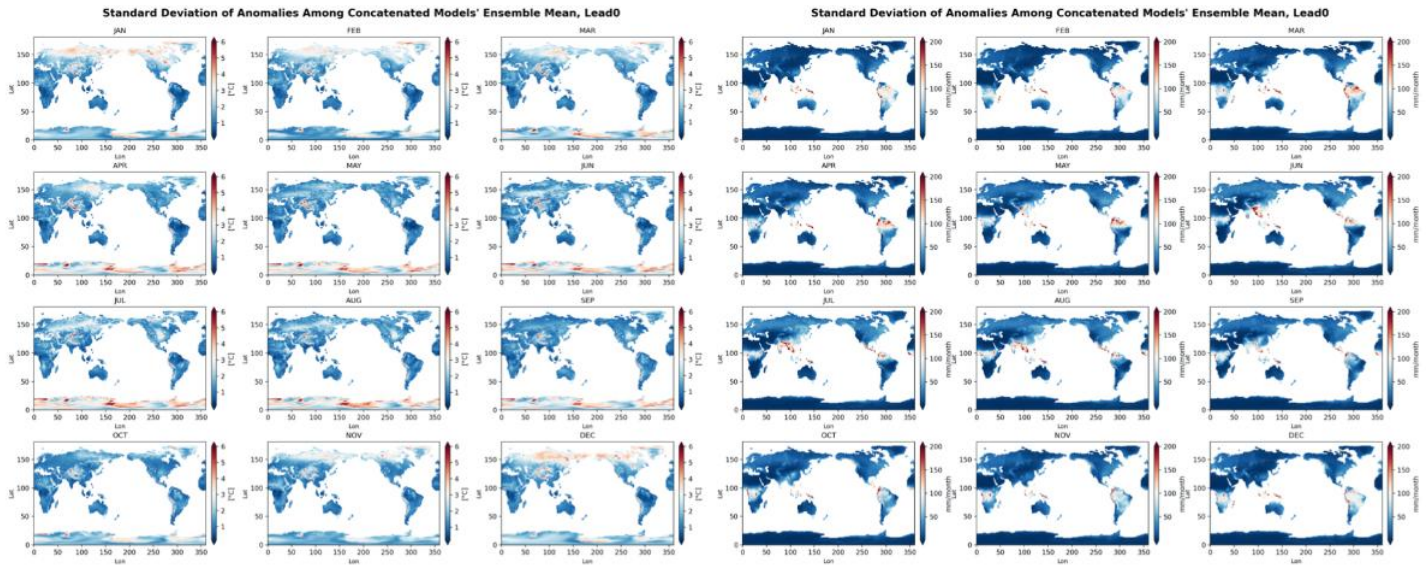
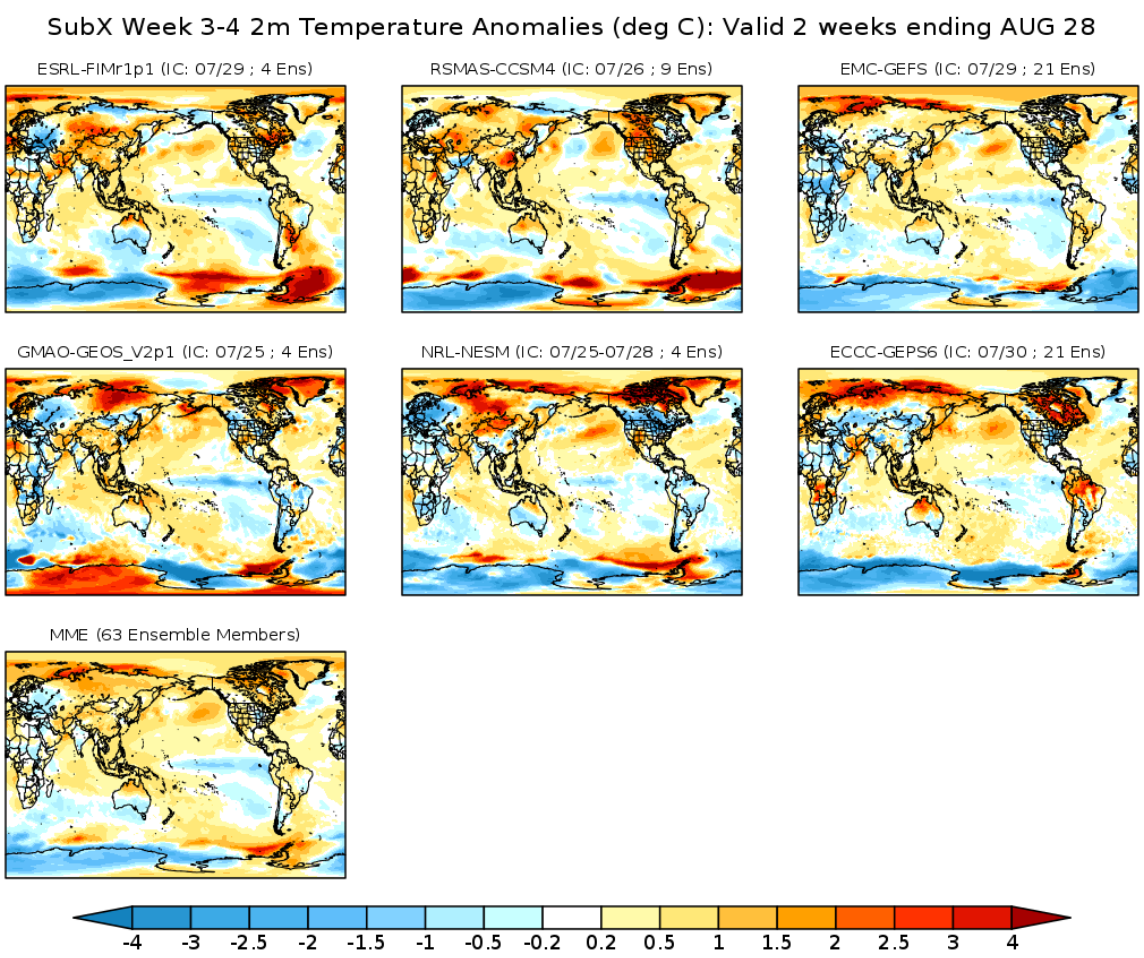

Hindcast Period (1993-2010): 105 ensemble members
NMME
ECMWF
ERA5
Regridding & Bias Correction
Bias corrected Hindcast
Evaluation
Uncertainty Analysis
Multi-modeling
Deterministic Hindcast
NMME
ECMWF
Post-processing
Operational Forecast
Operational Forecast: 135 ensemble members


Download Datasets
Restructure Datasets
ECMWF
1 Model
Loaded from s3 buckets on Amazon Web Services (AWS)
This approach expedited loading time
NMME
6 Models
Loaded directly from IRI/LDEO Climate Data Library online
ECMWF
Lead values inconsistant with NMME models >> Shift Lead by: lead-1
Inconsistant time coordinates >> Convert to pandas DateTime & restrict to common period
NMME
Inconsistant time coordinates >> Convert to pandas DateTime & restrict to common period
Concatenate Models
Uncertainty Analysis
Analyze Results
Take the ensemble mean of each model (105 total ensemble members)
Concatenate all 7 models along time dimension
Repeat for each lead
Temperature
Group dates by month then generate anomaly (ensemble mean - monthly climatology) >> Take standard deviation of anomalies
Repeat for each lead
Precipitation
Same process as temperature, but must first convert data from millimeters per day (mm/day) to mm/month
Results depicted through spatial plots, mask ocean data since this region is consistantly accurate
Mapping tools used: matplotlib.pyplot pcolormesh, subplots and colorbar



Subseasonal Forecasts

Analyzing SubX (Subseasonal Experiment) Models



Overview

Goal: Preliminary analysis and data extraction for future use of these novel datasets.

Importance: Allows for risk reduction, disaster preparedness, and valuable routine planning and resource management.

ClimateAI's Use: Potential to provide customers with an expanded range of weather forecasts to help in their management/planning.

Figure is from the SubX Project site

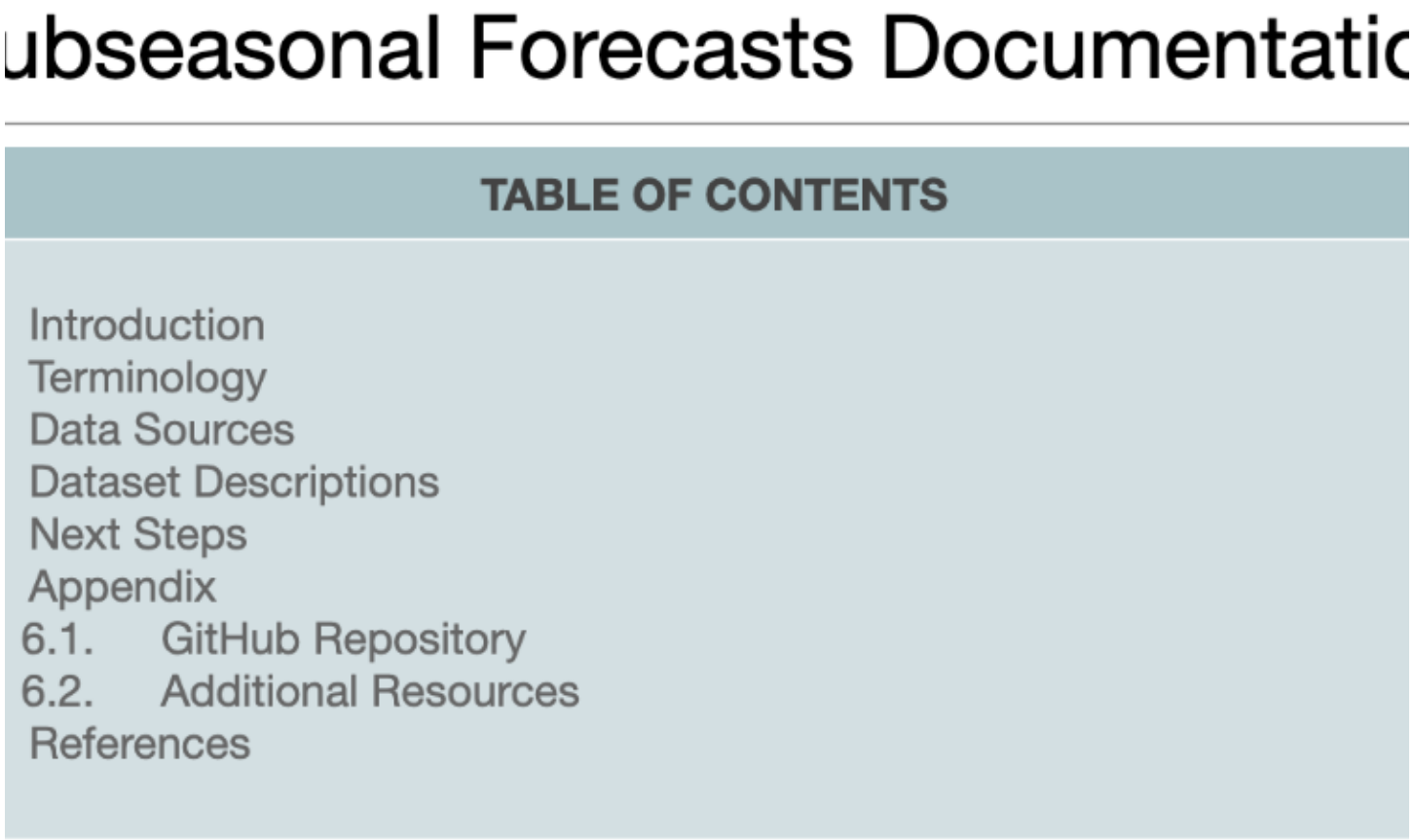
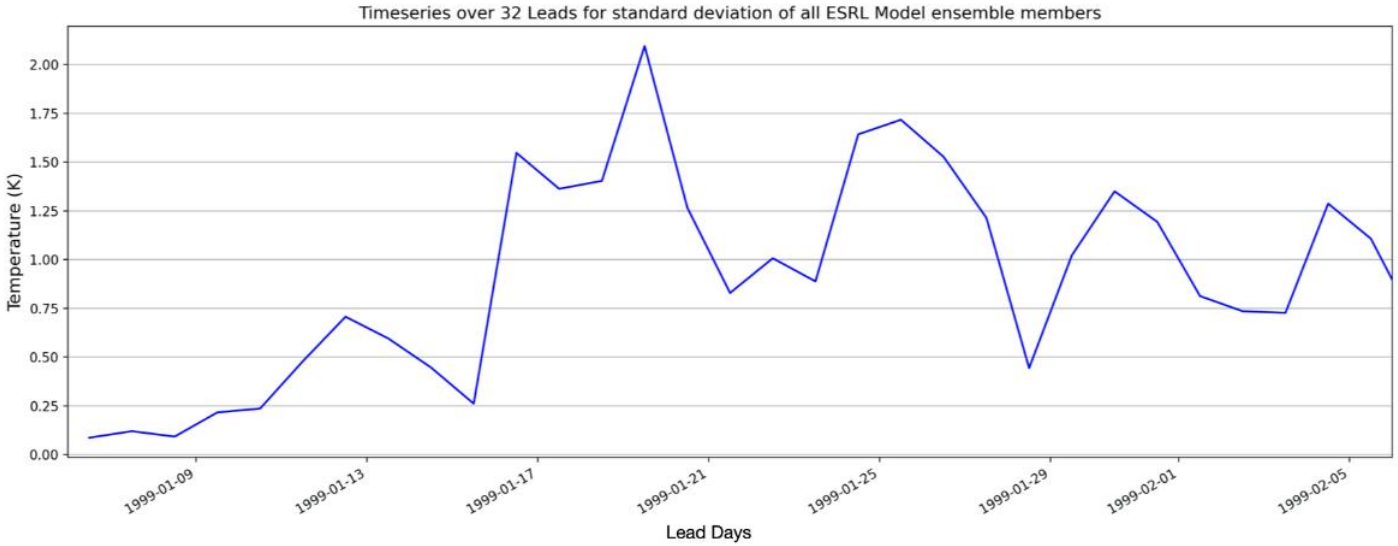
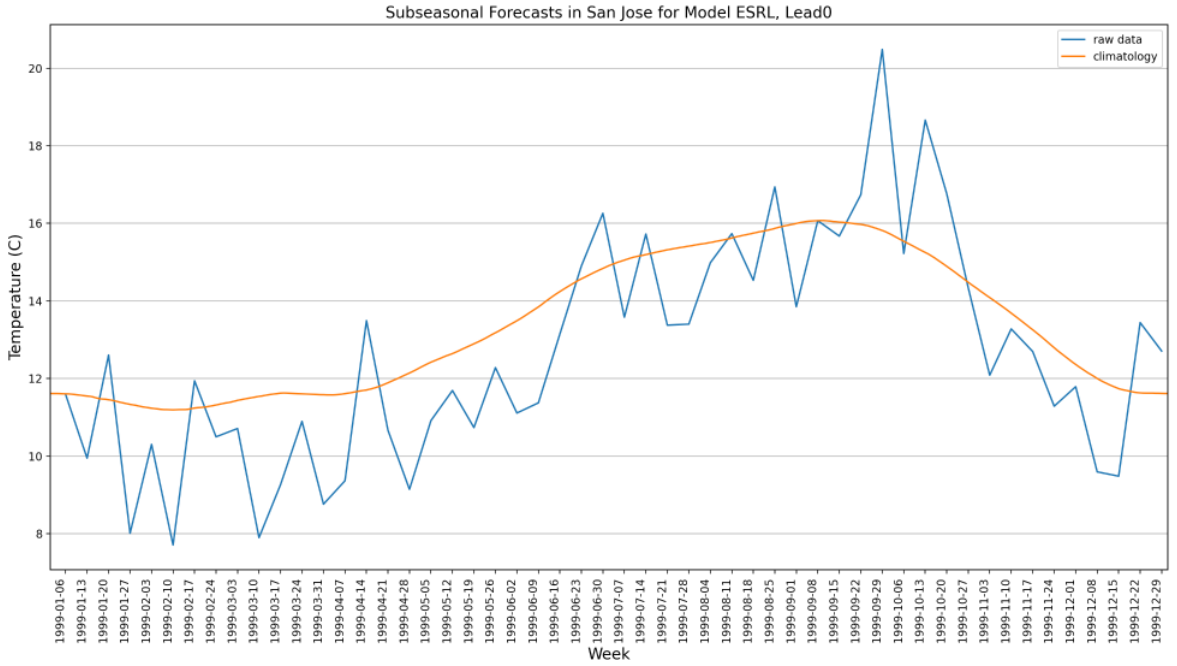
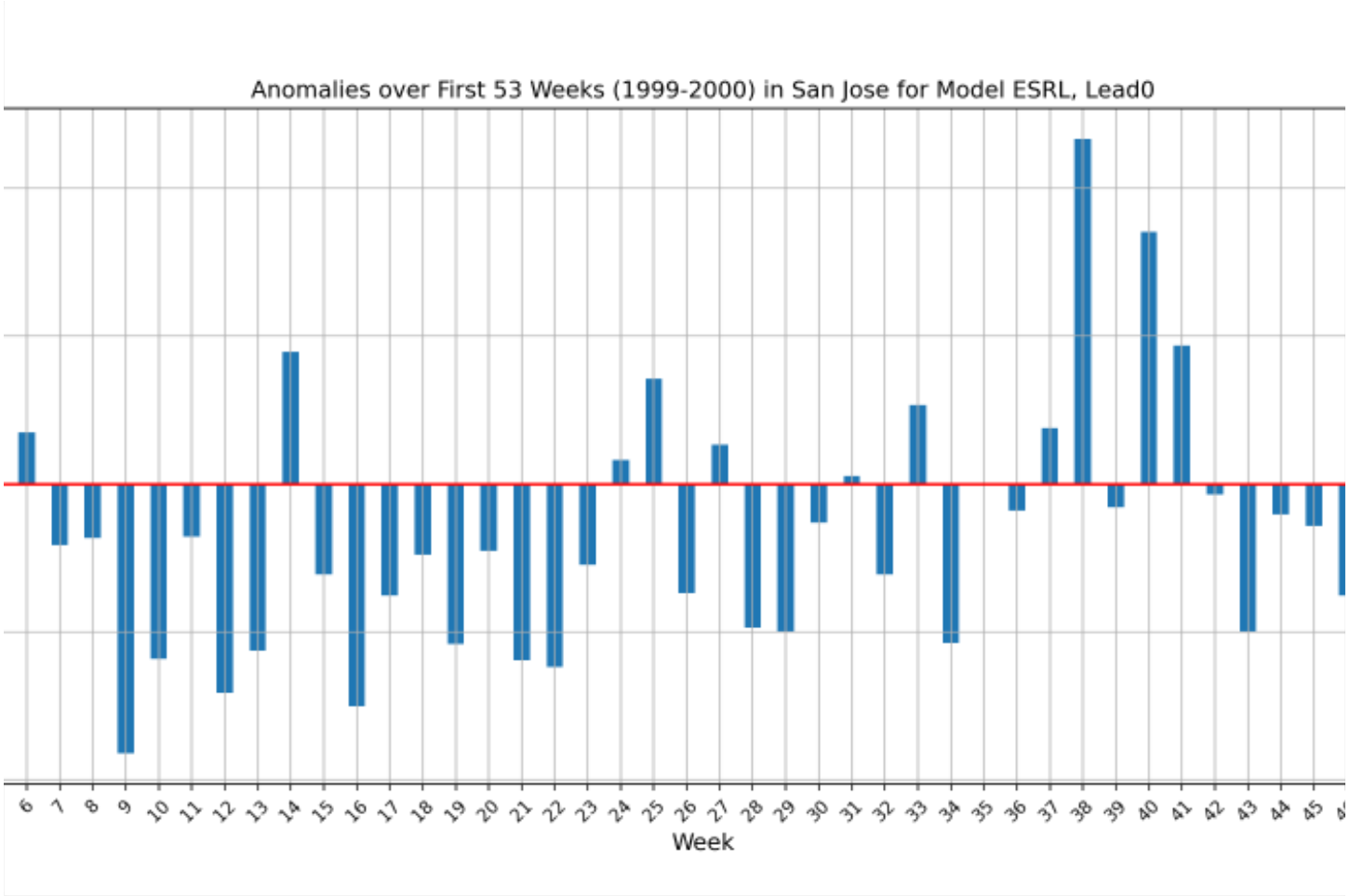


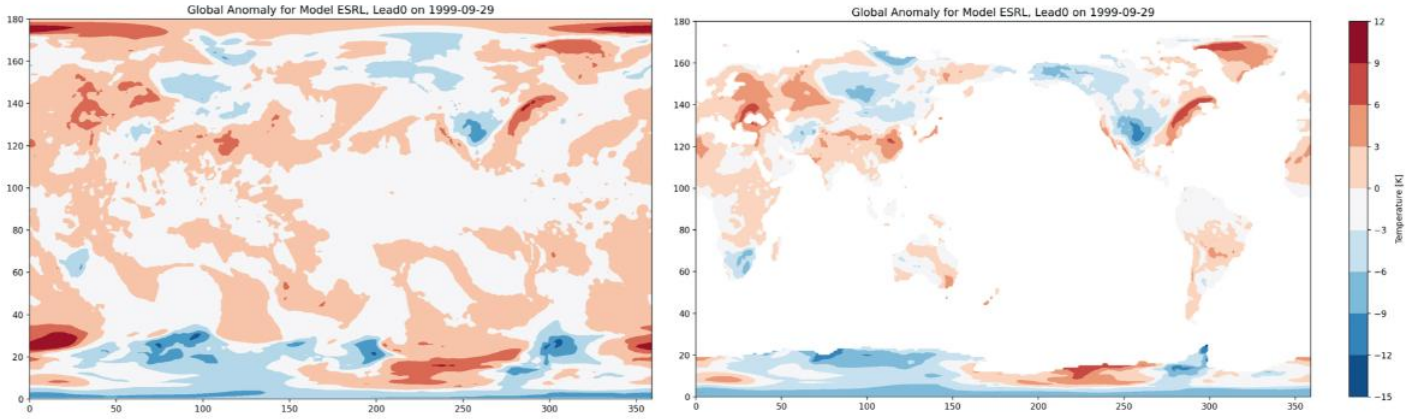
Table 3. Summary of SubX model data for the common hindcast period 1999-2014.

Model	Hindcast Period	Frequency	Initialization Day	Common Period (as seen in dataset)
ECCC-GEM	1/4/1995 - 12/28/2014	Every 7 days	Mon	1/1/1999 - 12/28/2014
ECCC-GEPS5	1/3/1998 - 12/27/2017	Every 7 days	Sun	1/1/1999 - 12/31/2014
ECCC-GEPS6	1/3/1998 - 12/27/2017	Every 7 days	Sat	1/1/1999 - 12/31/2014
EMC-GEFS	1/6/1999 - 12/28/2016	Every 7 days	Wed	1/6/1999 - 12/31/2014
ESRL-FIMr1p1	1/6/1999 - 6/28/2017	Every 7 days	Wed	1/6/1999 - 12/31/2014
GMAO-GEOS_V2p1	1/1/1999 - 12/27/2016	Every 5 days	Varies (first day in our DS is Fri)	1/1/1999 - 12/31/2014
NCEP-CFSv2	1/1/1999 - 9/30/2017	Every day 4x a day	Daily (times: 00,06,12,18)	1/1/1999 - 12/31/2014
NRL-NESM	1/2/1999 - 12/31/2016	4 days every 7 days	Sat-Tues	1/2/1999 - 12/30/2014
RSMAS-CCSM4	1/7/1999 -12/31/2016	Every 7 days	Wed and Thurs (first date in dataset starts on Thurs)	1/7/1999 - 12/31/2014


Timeseries over 32 Leads for standard deviation of all ESRL Model ensemble members
Temperature (K)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1999-01-09
1999-01-13
1999-01-17
1999-01-21
1999-01-25
1999-01-29
1999-02-01
1999-02-05
Lead Days


Subseasonal Forecasts in San Jose for Model ESRL, Lead0
raw data
climatology
Temperature (C)
Week


Anomalies over First 53 Weeks (1999-2000) in San Jose for Model ESRL, Lead0
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Week



Next Steps

Continue working with the SubX models to determine if they are useful for ClimateAI.

Immediate action: Complete data preprocessing

Down the road: Apply a post-processing technique for bias correcting, evaluate the forecasts, and characterize the anomaly

forecasts' uncertainty

Special thanks to the AI-team who also worked on these projects

Ali Ahmadalipour, Ankur Mahesh, Edgar Rojas, Lorenzo Brown, Maximilian Evans, Ron Domingo