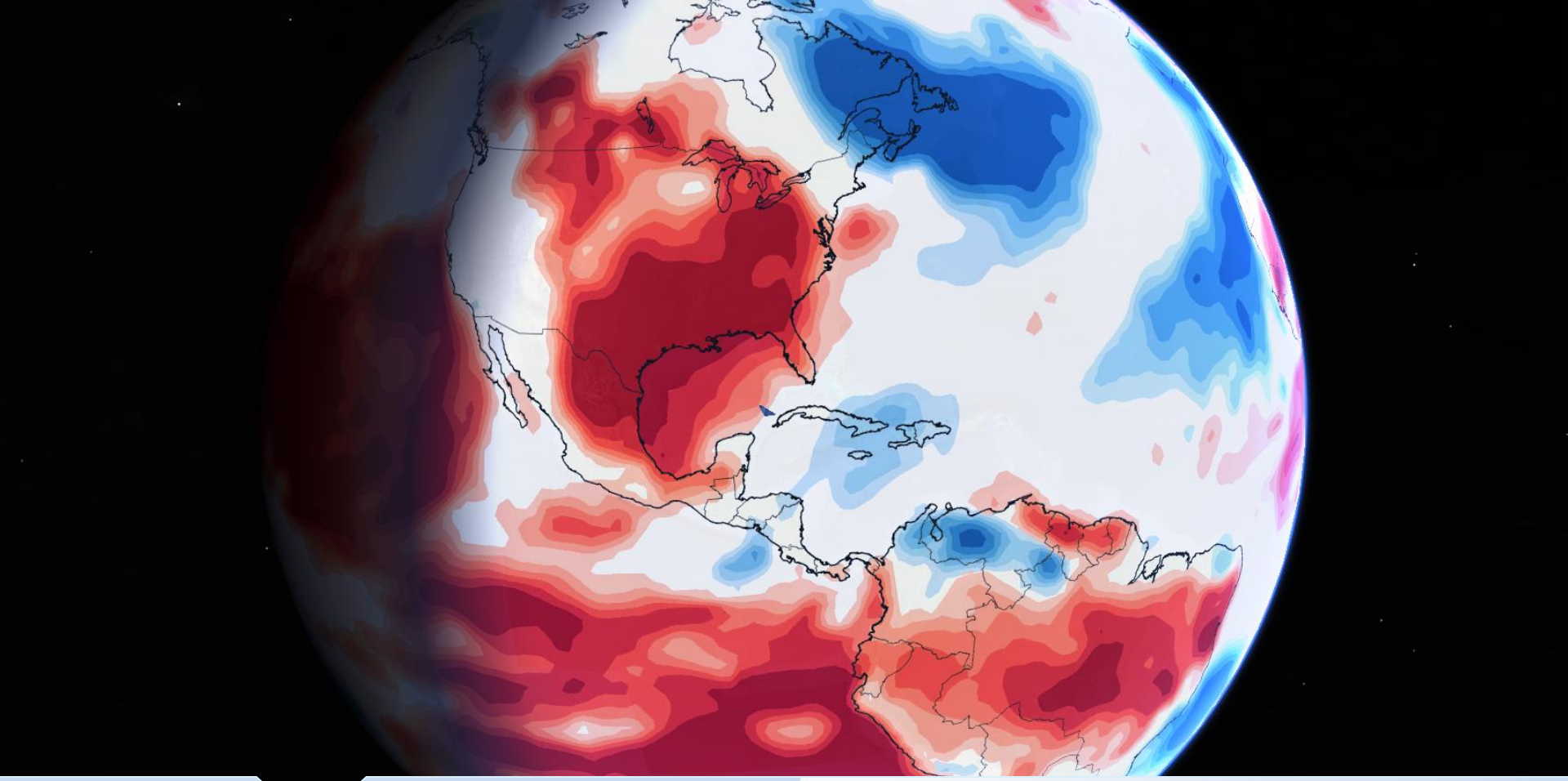


Real-time Refinement of ECMWF Subseasonal Forecast Confidence

June 2020

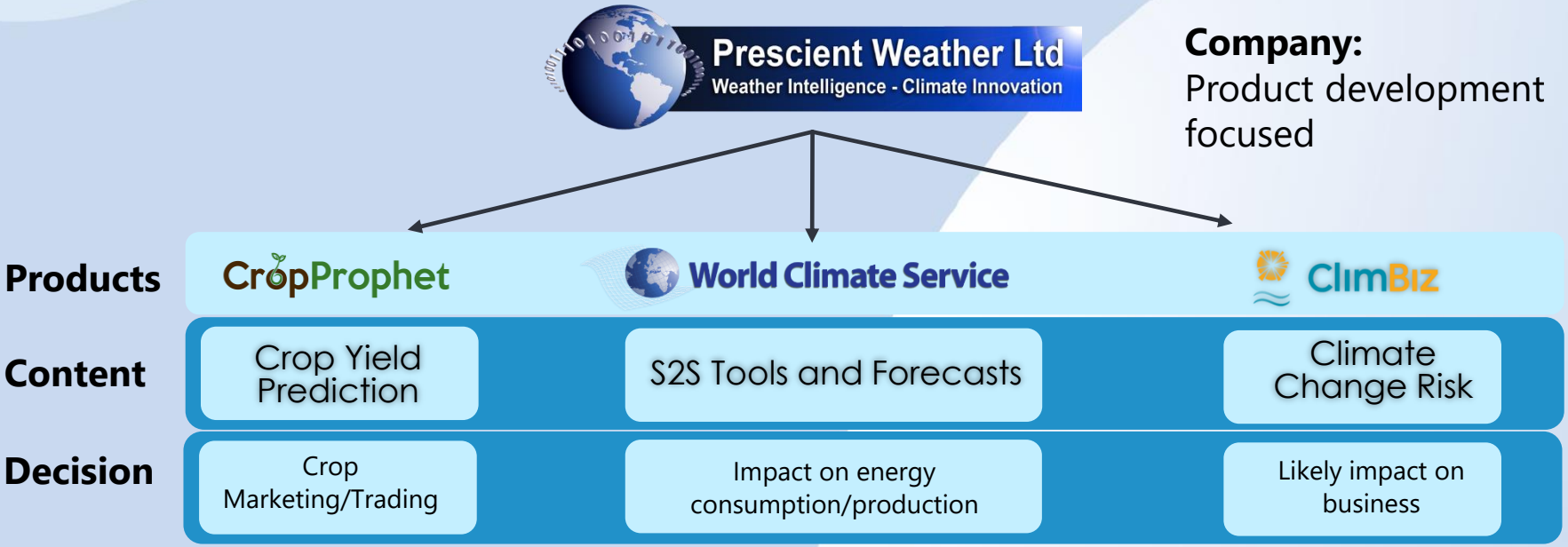
Dr. Jan F. Dutton, CEO
Prescient Weather

World Climate Service

If you knew then what we knew then ...

Founded in 2009

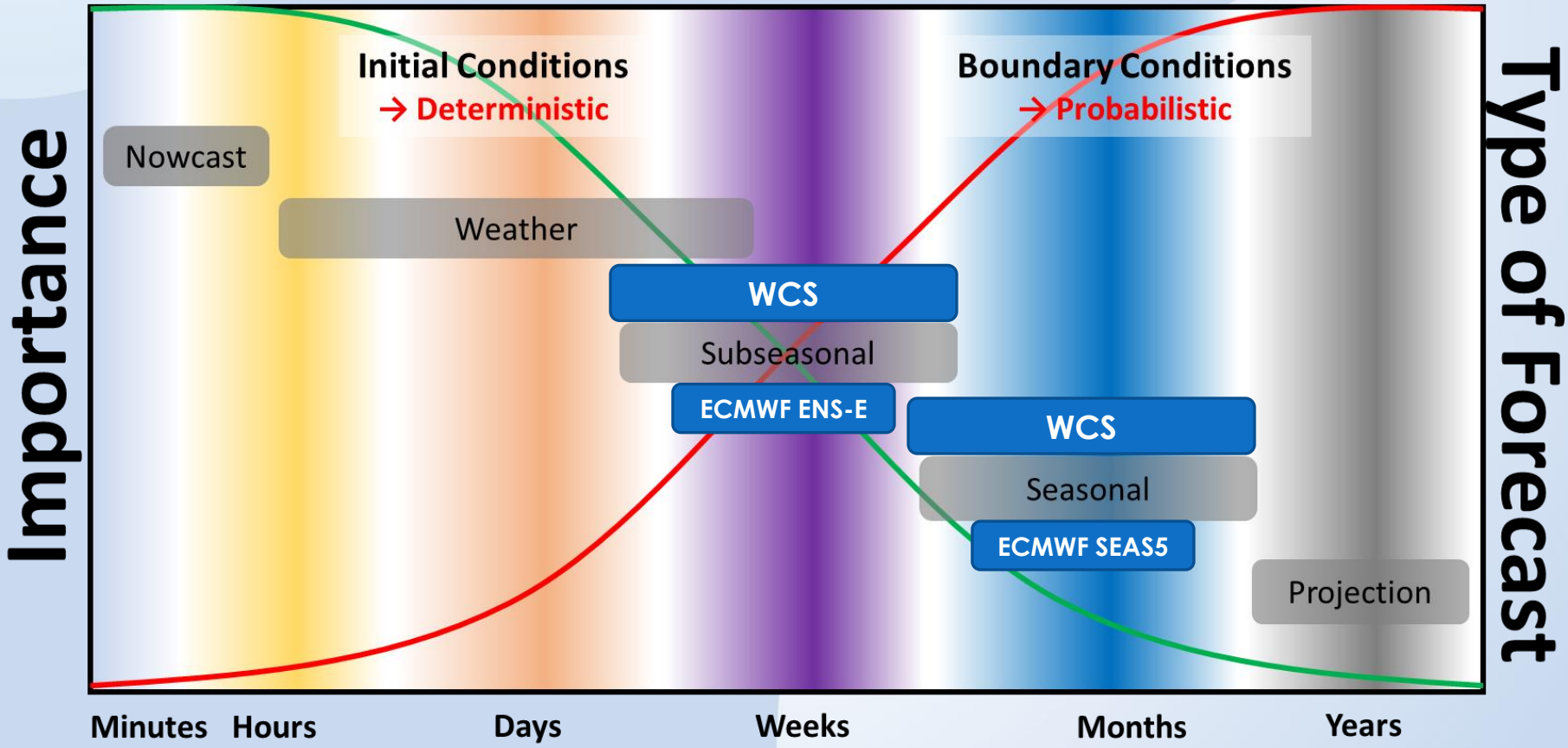
- 11-year history of CropProphet
- 16-year history of World Climate Service
- Significant R&D funding from U.S. government Small Business Innovation Research grants (SBIRs) focused on weather and climate risk



Objective: Create quantitative guidance for weather and climate related decisions based on the best science and information available.

Ethos: Conduct business with integrity, innovation, credibility, and transparency.

Weather/Climate Timescales



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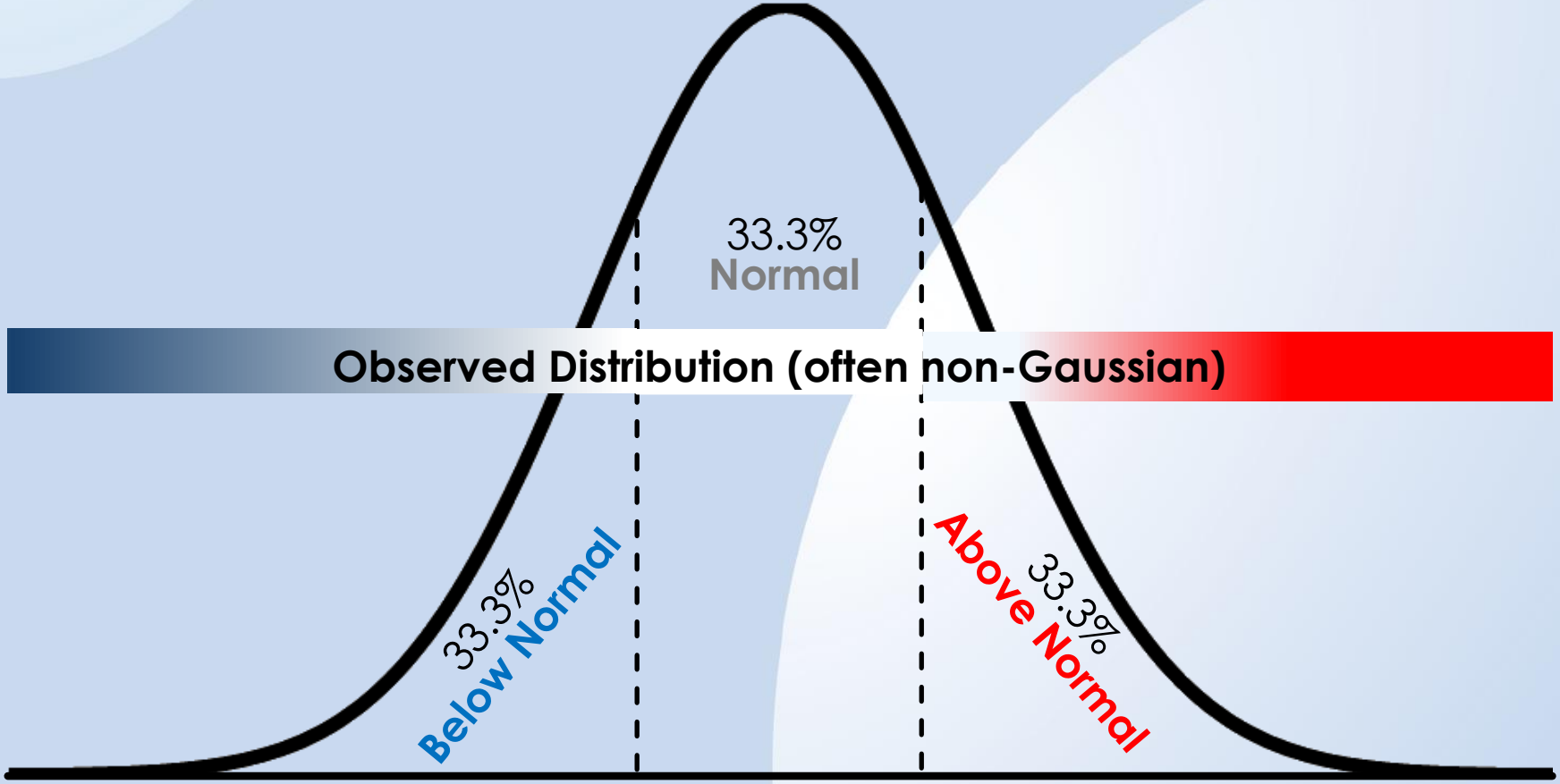
If you knew then what we knew then ...

WCS S2S Forecasting Philosophy

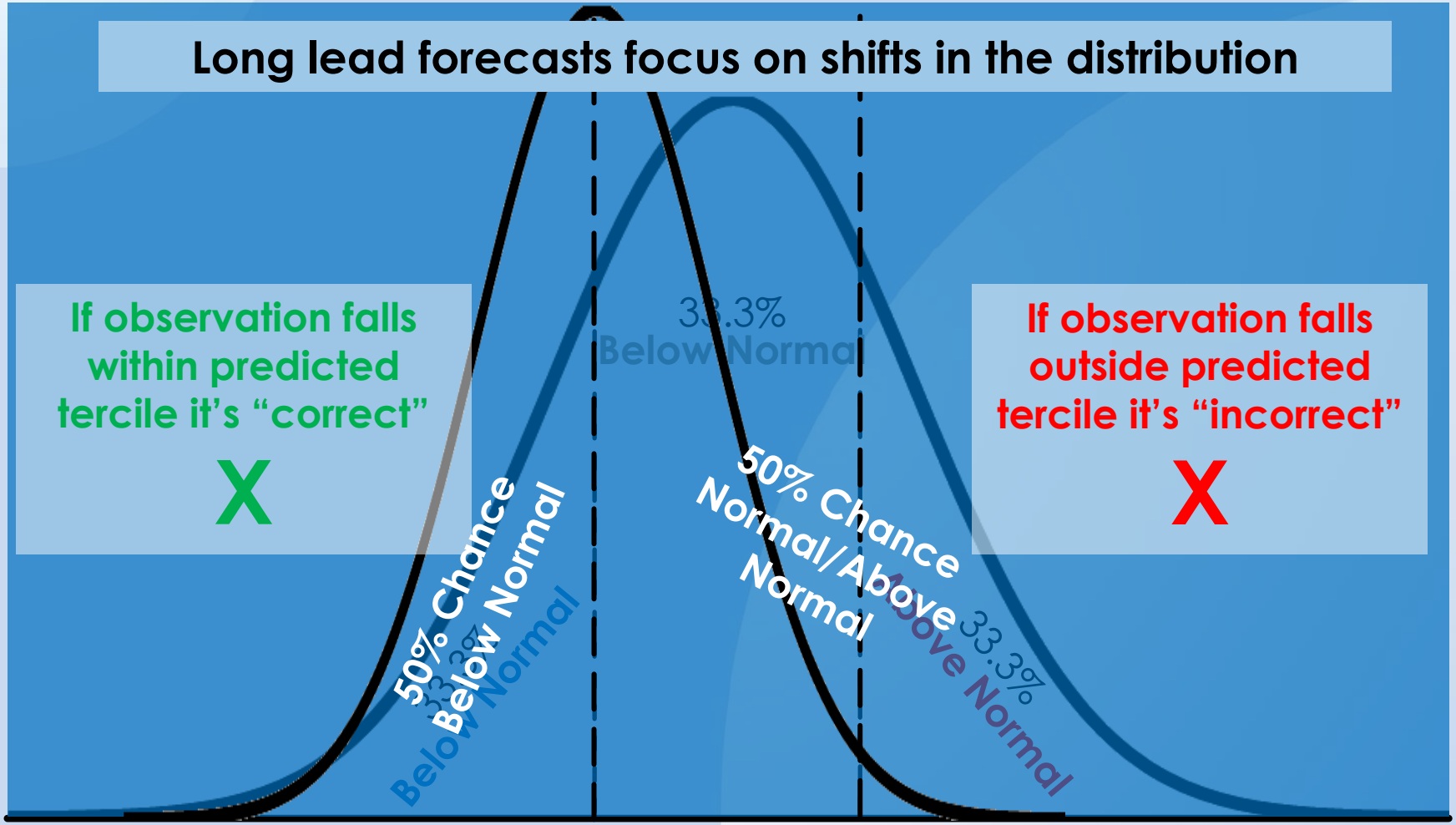
- A toolset to enable weekly, monthly, and seasonal forecast preparation and communication
- Enable risk analysis by providing **multiple independent prediction methods**
  - Calibrated dynamical ensemble model forecasts (including ECWMF ENS/SEAS5)
  - Statistical forecasts
  - Analog forecasts augmented by human insight/experience
- Emphasize **forecast confidence** and **probabilities**

Climate Distribution

Seasonal forecasts have traditionally predicted tercile probabilities

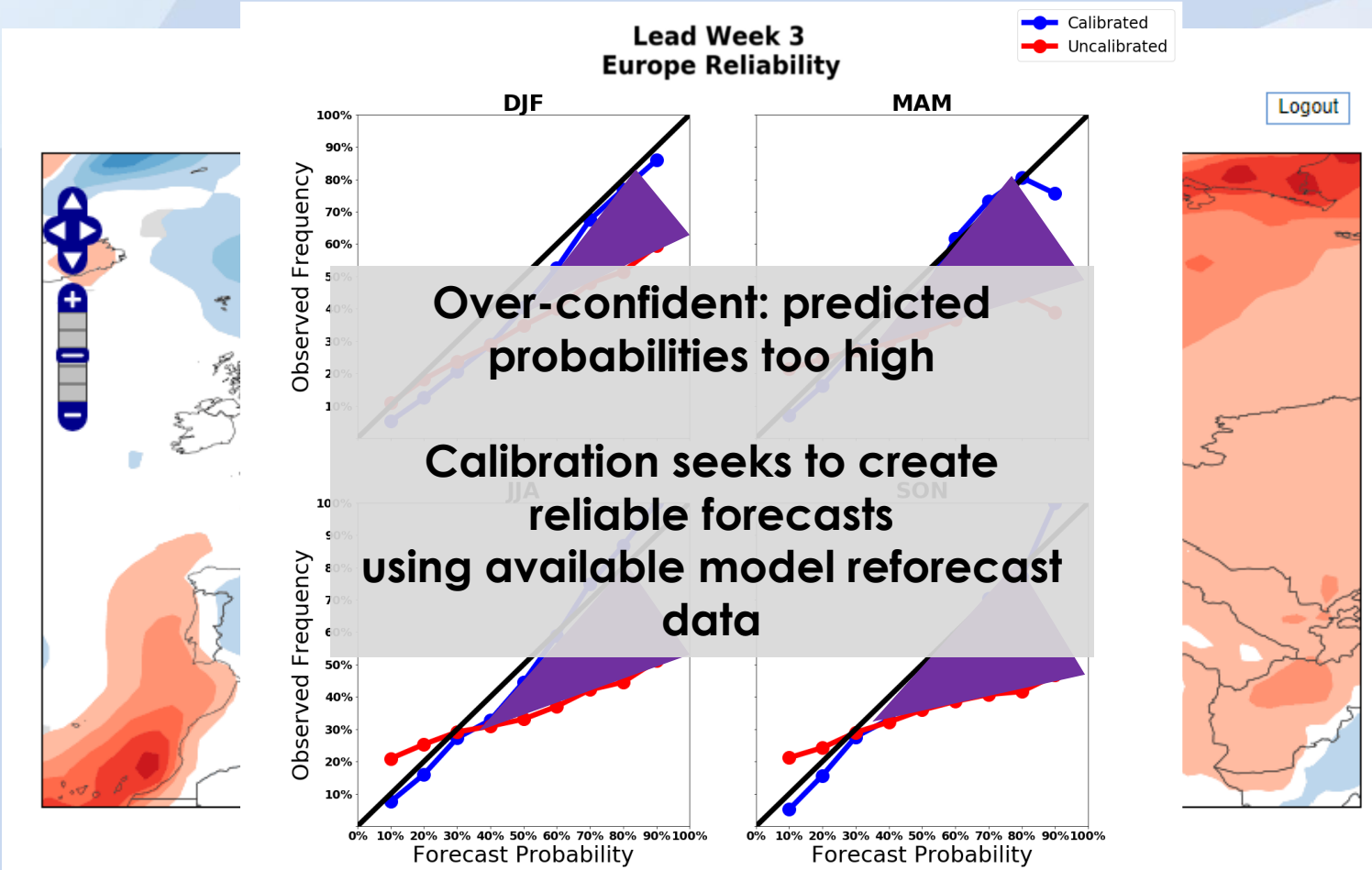


Forecast Application



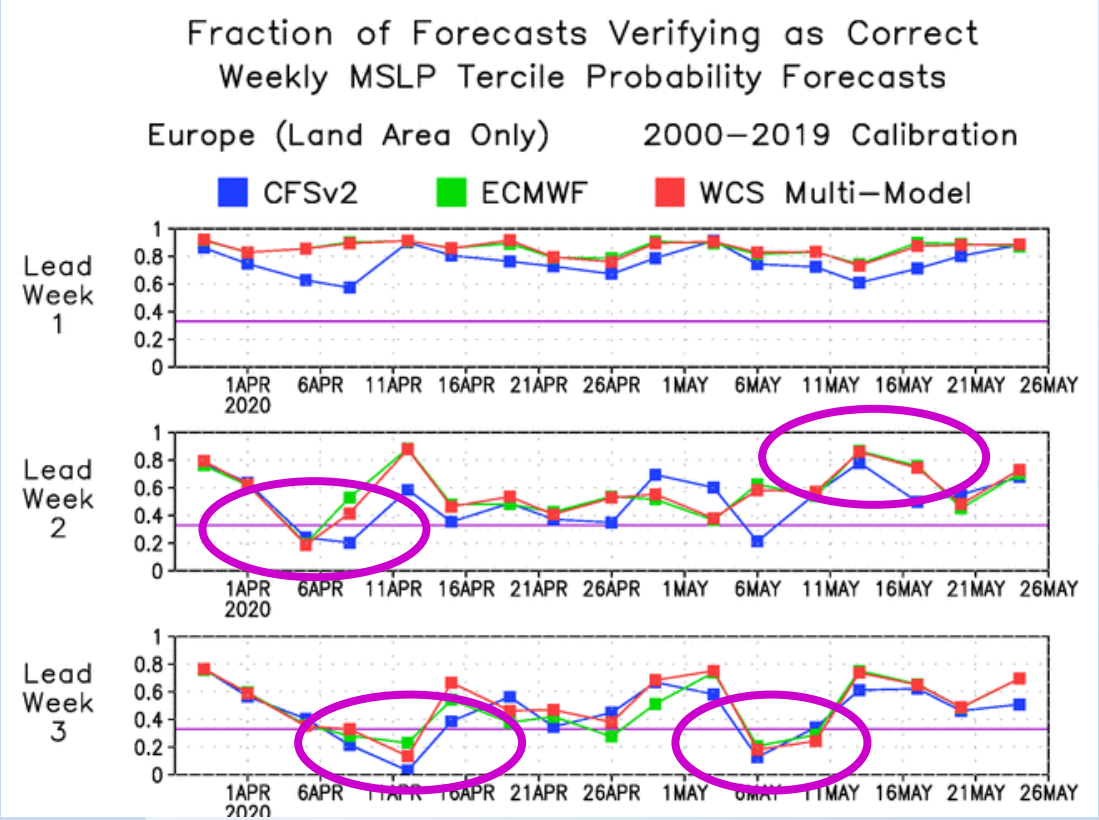
Example Forecast

Calibrated ECMWF “Week Three” Forecast



Forecaster Challenge

- Weekly predictability, on average, is low
- Time variant skill: windows of opportunity?
- When can the forecast be trusted?



Forecast Rodeo

- US Bureau of Reclamation
- Announced in 2017
- Western US Domain
- Provide week 3&4/week 5&6 temperature and precipitation anomaly forecasts
- Every week for 1 Year

Contest Results

- WCS/Prescient Weather (prxwx) submitted a simple calibrated ensemble forecast

Team	Week 3-4 Temp	Week 5-6 Temp	Week 3-4 Precip	Week 5-6 Precip	Average
prxwx	0.2265	0.2026	0.1711	0.1208	0.1803
bgzimmerman	0.2855	0.2357	-0.0221	0.0773	0.1441
StillLearning	0.2170	0.2044	0.0227	0.0941	0.1346
lupoa13	0.0895	0.1675	0.1246	0.0931	0.1187
CFSv2	0.1589	0.2192	0.0713	0.0227	0.1180
Salient	-0.1365	-0.0900	0.2144	0.2162	0.0510
asanteko2000	0.0909	0.0897	-0.0612	-0.0879	0.0079
DampedPersistence	0.1952	-0.0762	-0.1463	-0.1613	-0.0472

Results Detail

Click on a team's name to see the full stats about that particular team.

Weeks 3&4 Temperature

Team	Newest Score	Average Score
bgzimmerman	-0.0994	0.2855
prxwx	-0.1821	0.2265
StillLearning	0.029	0.217
DampedPersistence	**-0.0794**	**0.1952**
CFSv2	**-0.3997**	**0.1589**
asanteko2000	-0.1117	0.0909
lupoa13	-0.2187	0.0895
Salient	0.05	-0.1365

Weeks 5&6 Temperature

Team	Newest Score	Average Score
bgzimmerman	-0.4472	0.2357
CFSv2	**0.5267**	**0.2192**
StillLearning	0.1436	0.2044
prxwx	0.3105	0.2026
lupoa13	-0.5854	0.1675
asanteko2000	-0.1046	0.0897
DampedPersistence	**0.1084**	**-0.0762**
Salient	-0.8229	-0.09

Weeks 3&4 Precipitation

Team	Newest Score	Average Score
Salient	0.7758	0.2144
prxwx	0.0921	0.1711
lupoa13	-0.1367	0.1246
CFSv2	**0.1837**	**0.0713**
StillLearning	0.7987	0.0227
bgzimmerman	0.1087	-0.0221
asanteko2000	-0.7981	-0.0612
DampedPersistence	**-0.7996**	**-0.1463**

Weeks 5&6 Precipitation

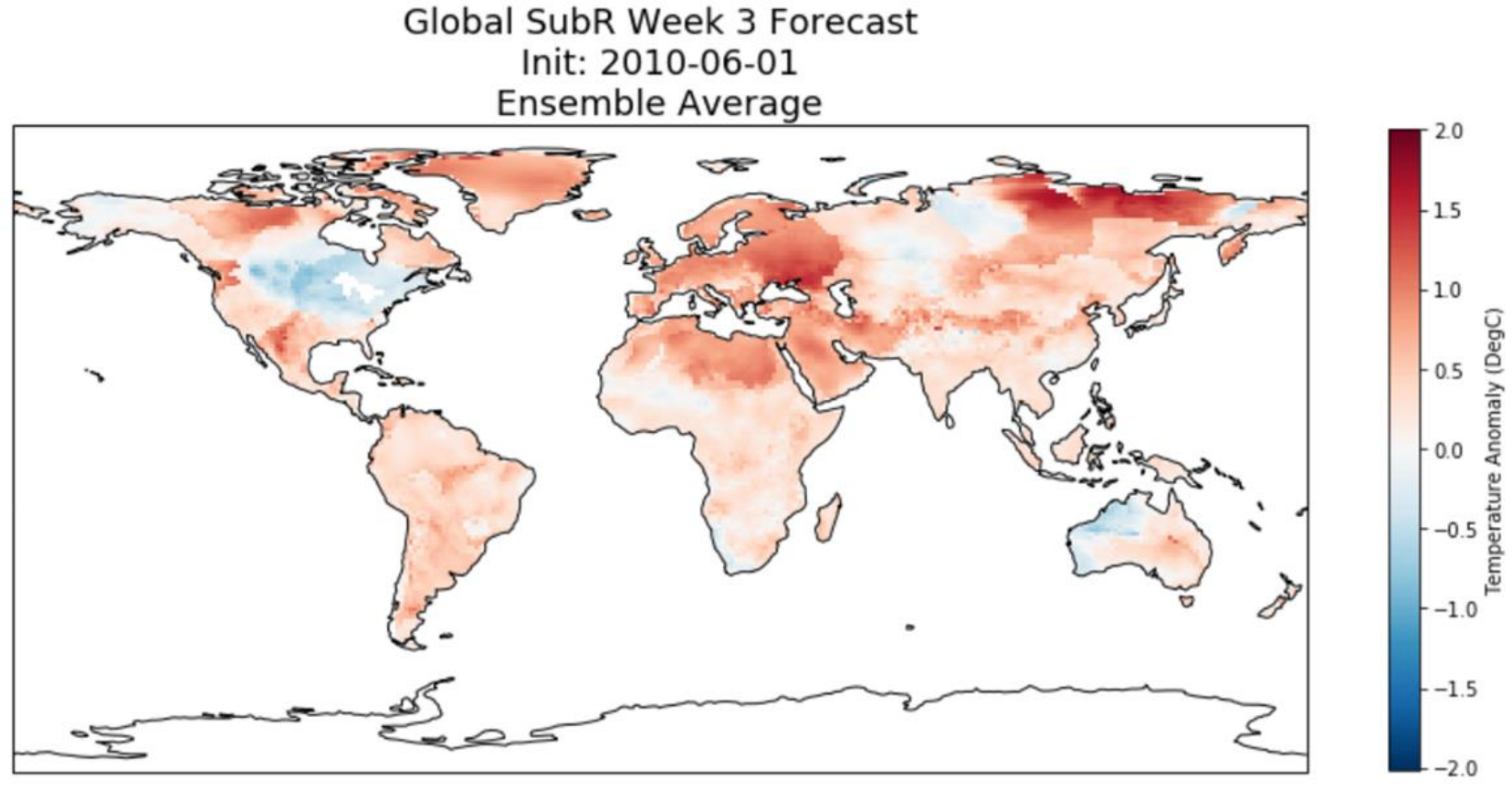
Team	Newest Score	Average Score
Salient	0.5897	0.2162
prxwx	0.0995	0.1208
StillLearning	0.5816	0.0941
lupoa13	0.0916	0.0931
bgzimmerman	0.303	0.0773
CFSv2	**0.0692**	**0.0227**
asanteko2000	-0.5561	-0.0879
DampedPersistence	**-0.4375**	**-0.1613**

Who is “bgzimmerman?”

Sub-R Statistical Model Methodology

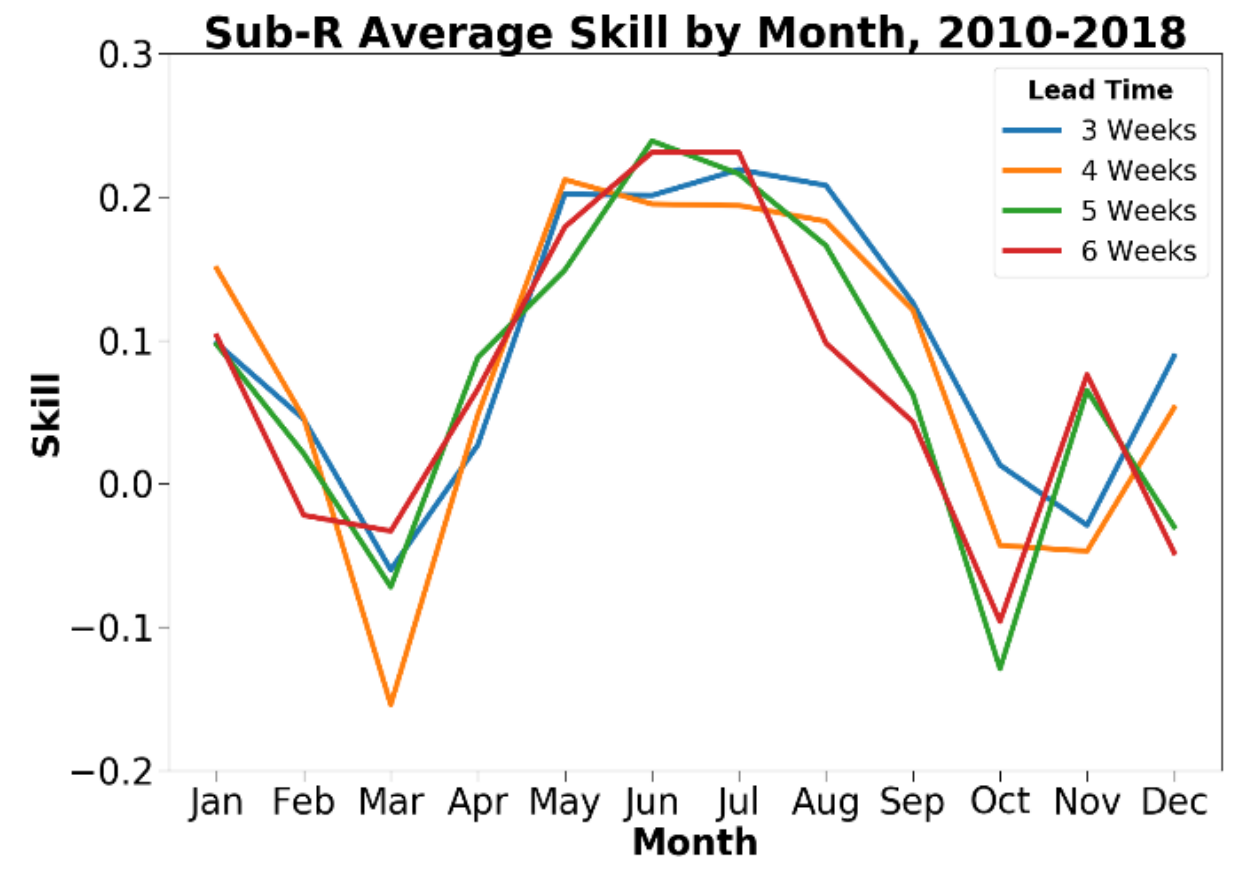
- Cluster the predictand (i.e. T2M) to reduce dimensionality and capture regional variability on the weekly timescale.
- Optimize out-of-sample accuracy by searching through a variety of antecedent global variables (SST, SLP, H500, T2M) from one week to two months prior.
- Condition on climate indices such as ENSO to enhance predictability.

Expanded to Global Forecasting



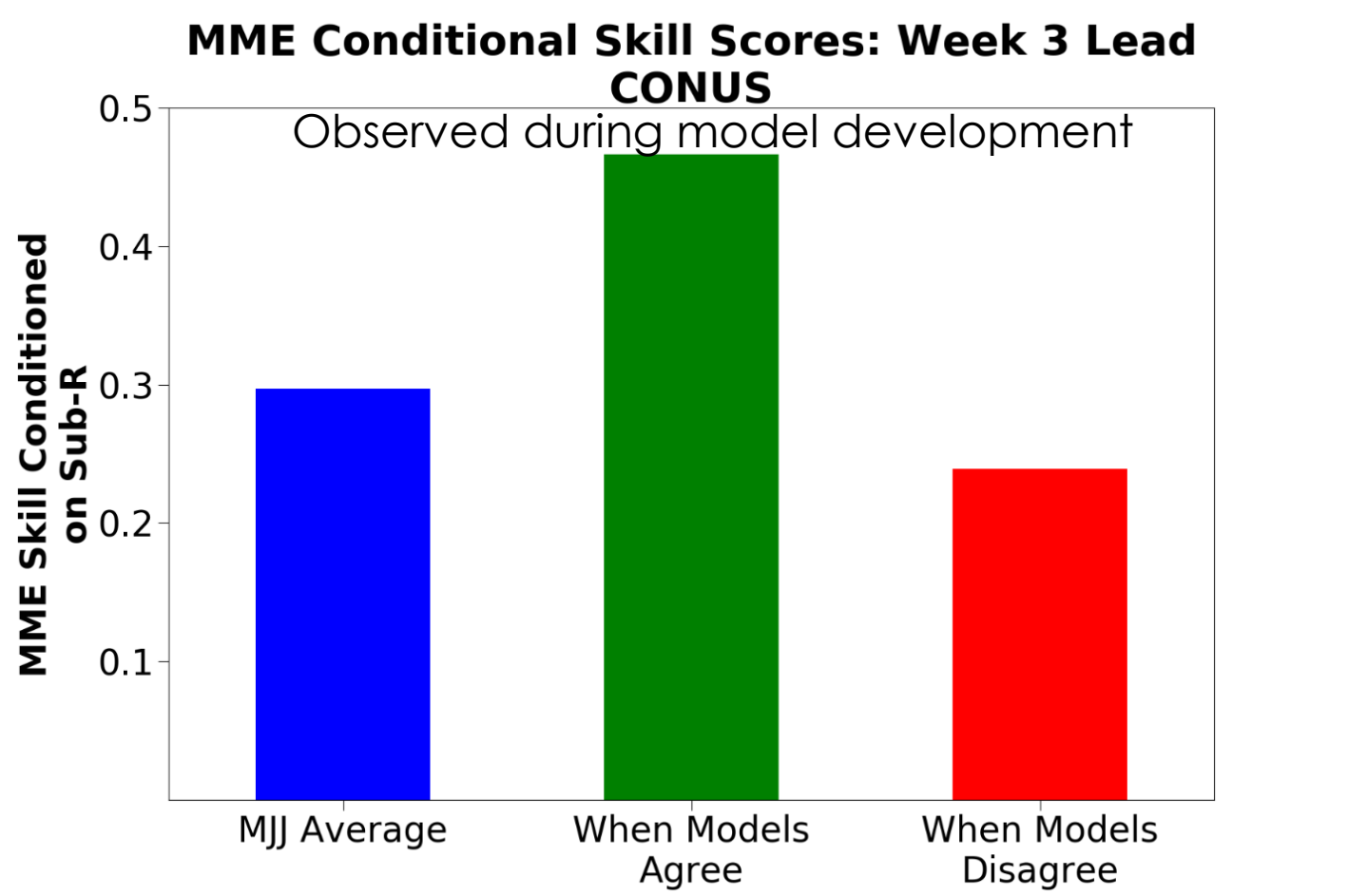
Sub-R Performance

9-year Hindcast – Out of Sample Results for Temperature



Anomaly Correlations between forecasts and observations

During Model Development

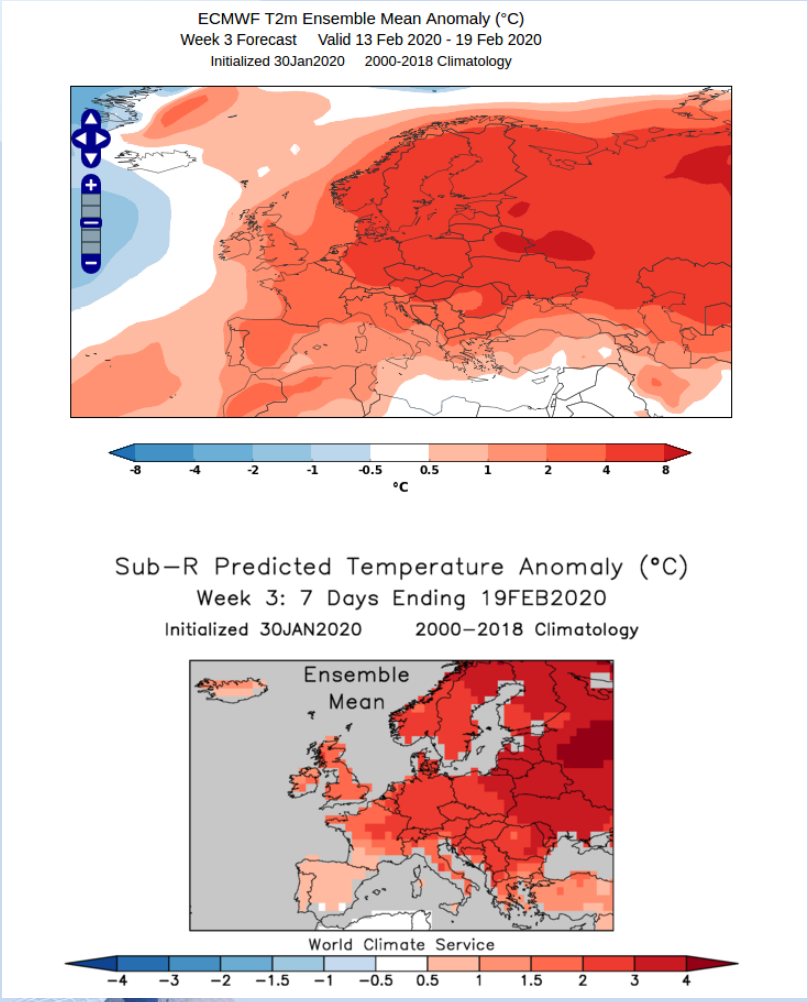


Agreement measured using land-only anomaly correlation of forecasted anomaly from both statistical & dynamical models

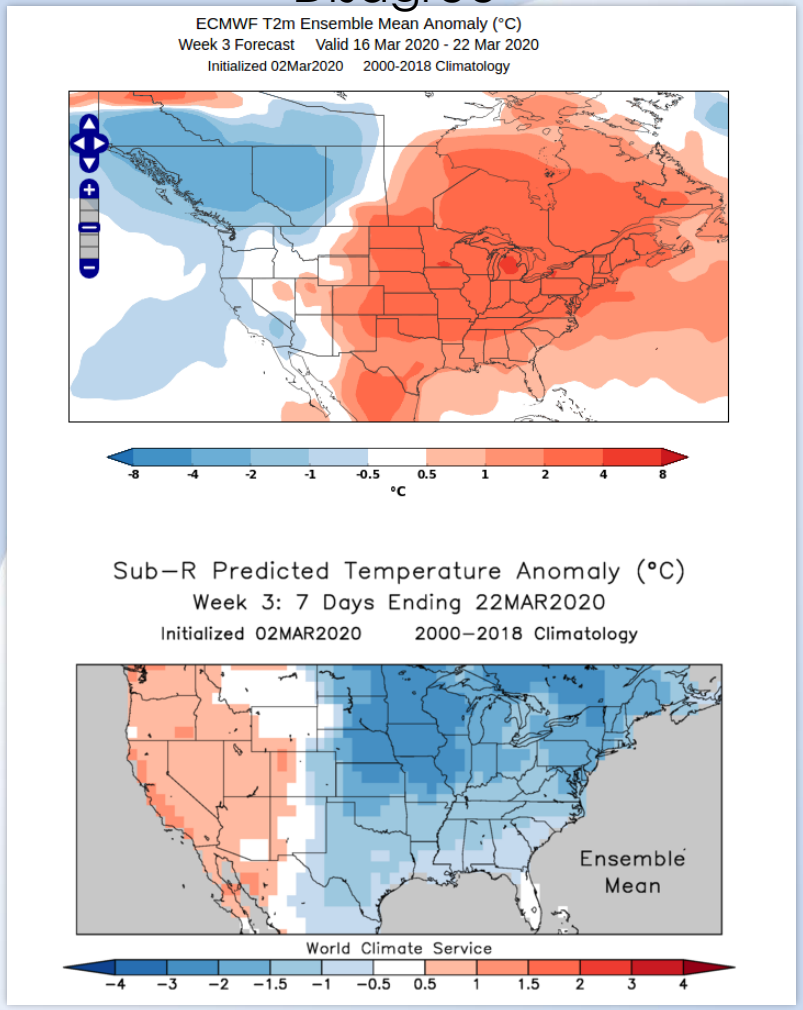
Forecast Agreement

Anomaly Correlation

Agree



Disagree



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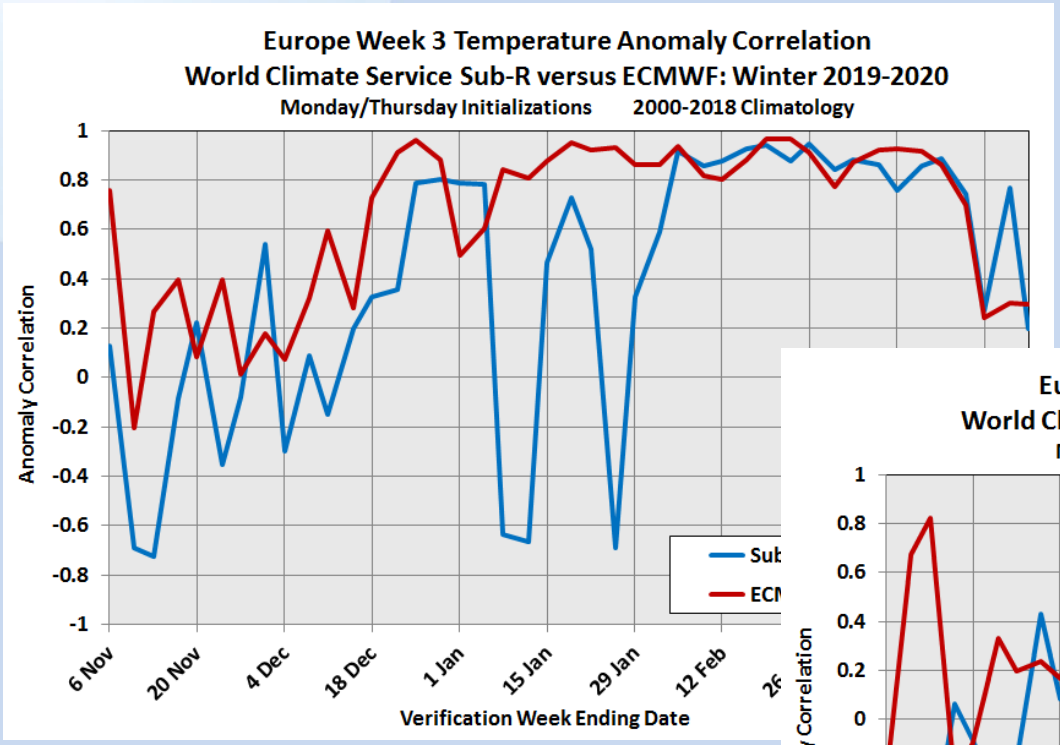
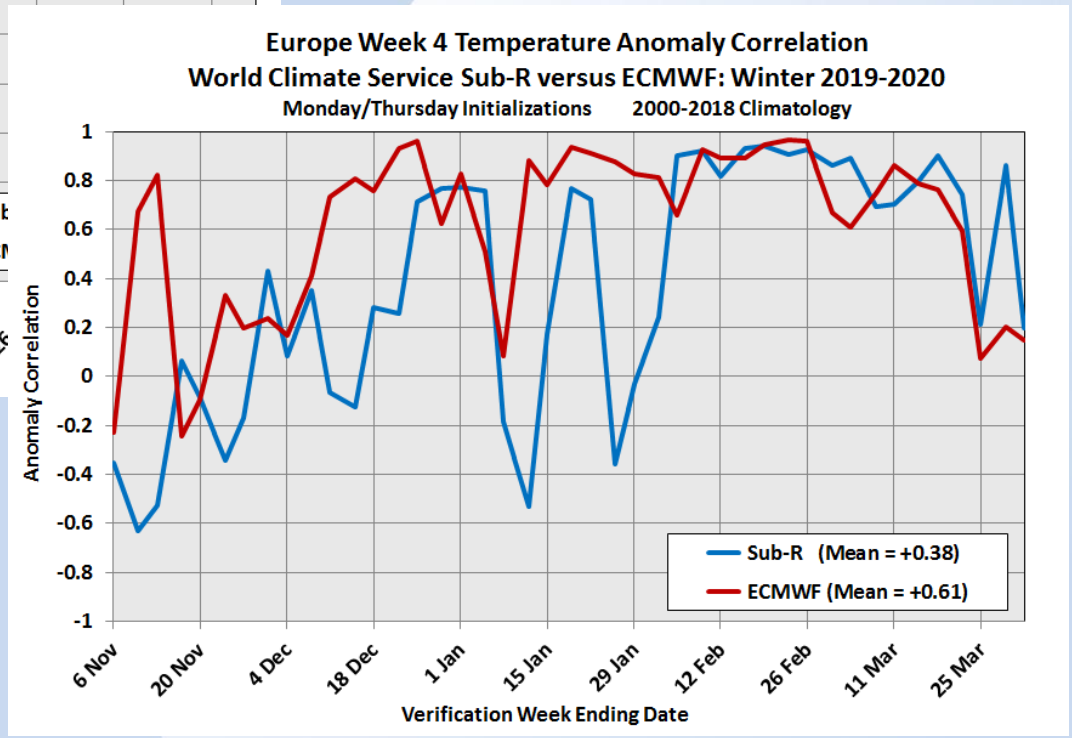
If you knew then what we knew then ...

Winter 2020 Forecasts



Europe



Summary Skill Score Peformance

Europe

Lead	Sub-R	ECWMF
Week 3	0.39	0.65
Week 4	0.38	0.61

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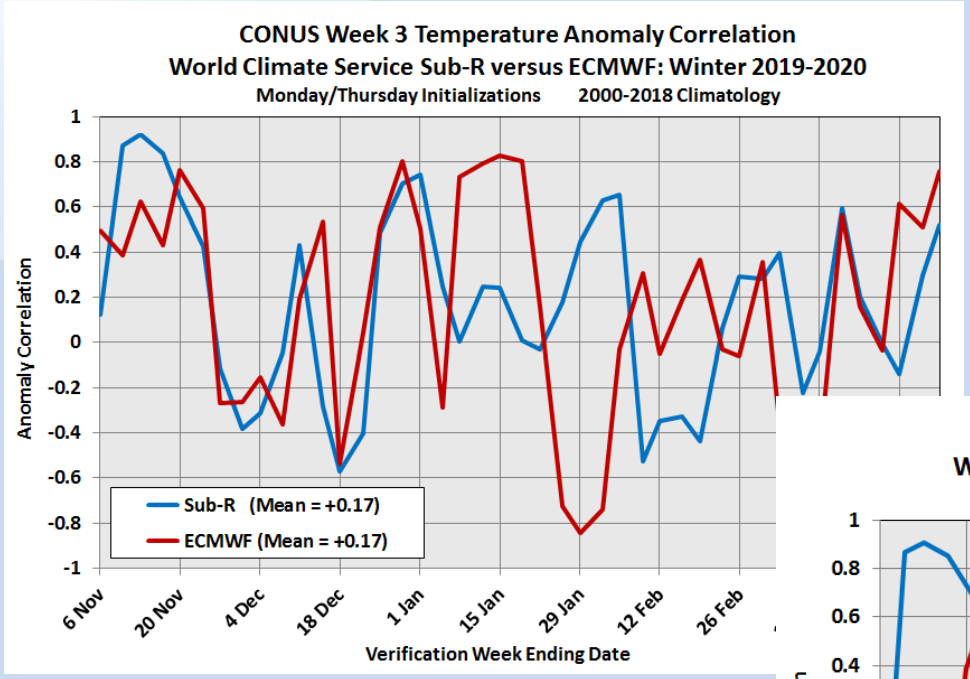
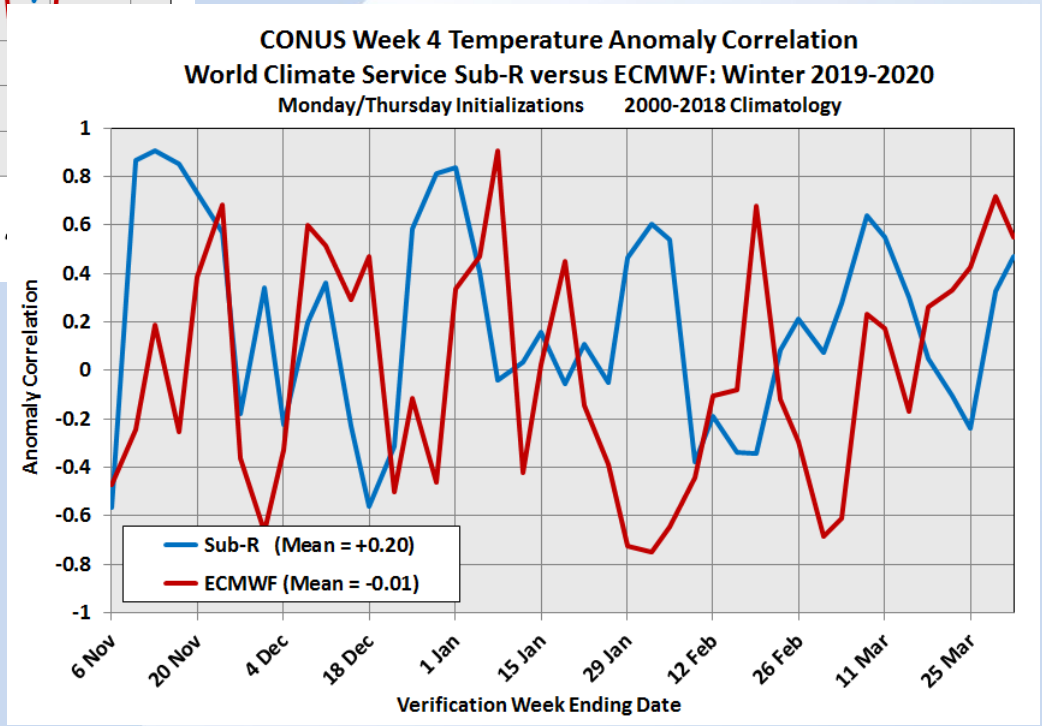
Winter 2020 Forecasts



United States



Summary Skill Score Performance

CONUS

Lead	Sub-R	ECWMF
Week 3	0.17	0.17
Week 4	0.20	-0.01

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If you knew then what we knew then ...

Winter '19/'20

2m Temperature Anomaly Correlation
Forecasts Verifying in Nov 2019 - Mar 2020

CONUS Week 3

	Sub-R	ECMWF
All Forecasts	0.17	0.17
Agree	0.24	0.26
Disagree	0.10	0.08

Europe Week 3

	Sub-R	ECMWF
All Forecasts	0.39	0.65
Agree	0.73	0.77
Disagree	0.02	0.51

East Asia Week 3

	Sub-R	ECMWF
All Forecasts	0.30	0.55
Agree	0.54	0.64
Disagree	0.05	0.45

2m Temperature Anomaly Correlation
Forecasts Verifying in Nov 2019 - Mar 2020

CONUS Week 4

	Sub-R	ECMWF
All Forecasts	0.20	-0.01
Agree	0.22	0.18
Disagree	0.16	-0.21

Europe Week 4

	Sub-R	ECMWF
All Forecasts	0.38	0.61
Agree	0.68	0.70
Disagree	0.09	0.55

East Asia Week 4

	Sub-R	ECMWF
All Forecasts	0.28	0.43
Agree	0.49	0.58
Disagree	0.09	0.29

Summary

- Subseasonal forecasts have a low skill baseline, but skill variations over time are large.
- A major forecasting challenge is trying to identify windows of predictability.
- Winter '19/'20 ECMWF mid-latitude forecast skill was higher when forecasts agreed with an independent statistical model.
- World Climate Service users now have a tool to refine confidence in dynamical model subseasonal forecasts.

Thank You!

https://www.worldclimateservice.com

info@worldclimateservice.com