# Towards the Application of Decadal Climate Predictions in Water Management

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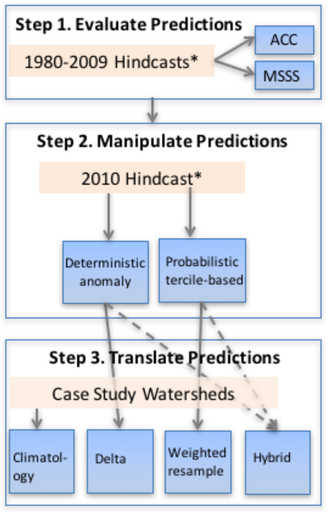
## The Big Idea

Decadal climate prediction fills the gap between seasonal climate forecasts and multi-decadal to century climate change projections.

Though experimental, real-time decadal climate predictions are available[1], creating a research opportunity to understand their potential role for users and impact modelers.

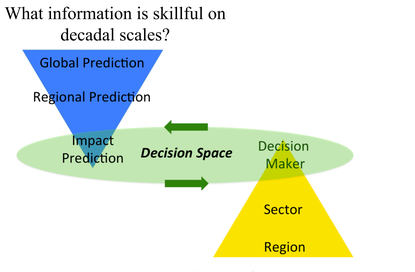
To explore how the decadal temperature predictions could be applied by potential users, we develop a **three-step framework[2]**:




**The Upshot:**

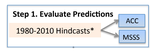
- Decadal predictions are still experimental, but framework provides water managers with **systematic alternatives** to using climatology
- Approaches have **distinct pros and cons** and can be **selected based on user needs**.

This research is part of an ongoing NSF-funded project, **Understanding Decision-Climate Interactions on Decadal Scales (UDECIDE)**, that aims to understand the role of decadal climate information for water management decisions.



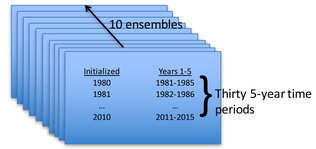

## The Three-Step Framework

### Step 1. Evaluate Predictions

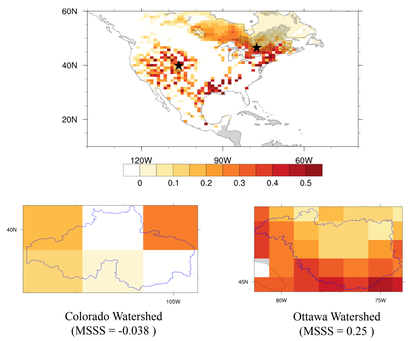



Data:

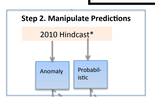
- NCAR CCSM4 **temperature** hindcasts
  - Initialized every year 1980-2010
  - Examine years 1-5
  - 10 ensembles




Mean squared skill score (MSSS) is positive where hindcast is more skillful than climatology.

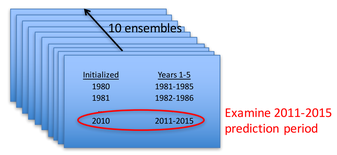



### Step 2. Manipulate Predictions

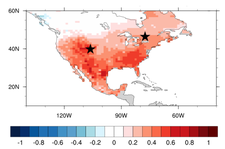



Data:

- NCAR CCSM4 **temperature** hindcasts



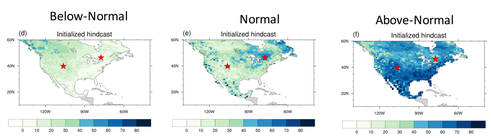

**Anomaly:** Decadal temperature predictions can be presented like climate change projections (i.e., a delta)




Discrete temperature anomalies (deltas) for 2011-2015 (relative to 1981-2010) shows warming across the US.

| | Delta | |
|---|---|---|
| | Colorado | Ottawa |
| Anomaly (C) | **0.9** | **0.2** |

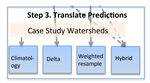
**Probabilistic:** Decadal temperature predictions can be presented like seasonal climate forecasts (i.e., probabilistic)




Probabilistic temperature predictions for 2011-2015 tilt towards "Above-normal" category

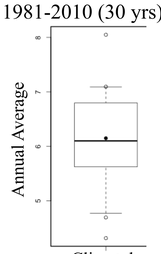
| | | Colorado | Ottawa |
|---|---|---|---|
| Probability (%) | Below-Normal | **0** | **27** |
| | Normal | **27** | **30** |
| | Above-Normal | **73** | **43** |

### Step 3. Translate Predictions




Only look at **Colorado watershed results…**

**Climatology** is observed average temperatures over watershed from 1981-2010 (30 yrs).




The **Delta** adds the average temperature **anomaly**

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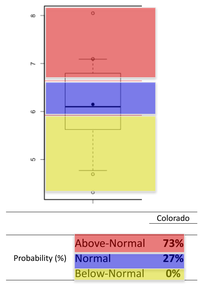
Delta (0.9C)

The **Weighted Resample** resamples average temps over the watershed to reflect the **probabilistic hindcast**




The **Hybrid** re-centers the weighted resample over climatology, then adds the delta.

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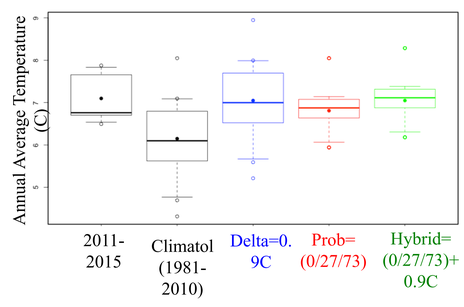
$(Resamp_{Avg} - Clim_{Avg})$

\+

Delta (0.9C)

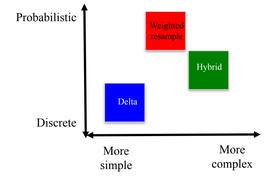
There is a distinct increase in average temperature from 1981-2010 to 2011-2015. Delta adds 0.9C to climatology & distribution shape stays the same. Weighted resample samples 0% from below-normal, 27% from normal, and 73% from above-normal climatology distribution; distribution shape changes. Hybrid re-centers weighted resample to climatological average, then adds the delta.




All three translation methods do better than climatology.

| | | Avg Abs % Error |
|---|---|---|
| Colorado | Clim | 18% |
| | Delta | 4% |
| | Weighted | 5% |
| | Hybrid | 4% |

Translations have pros/cons & depend on user needs




- Weighted resample: Most conservative
- Delta: Most straightforward
- Hybrid: Tailored for decadal predictions

**Next step:** Use hydrologic model to make predictions more relevant to water managers.

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**References:**

[1] Smith DM et al (2013) Real-time multi-model decadal climate predictions. *Clim Dyn*, 41(11–12), 2875–2888.

[2] Towler E et al (2018) Towards the Application of Decadal Climate Predictions. *Journal of Applied Meteorology and Climatology* (in review).

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