

Large-Scale Circulation Patterns and Canadian Prairie Drought

Barrie Bonsal

Environment Canada
Saskatoon, SK



Environment
Canada

Environnement
Canada

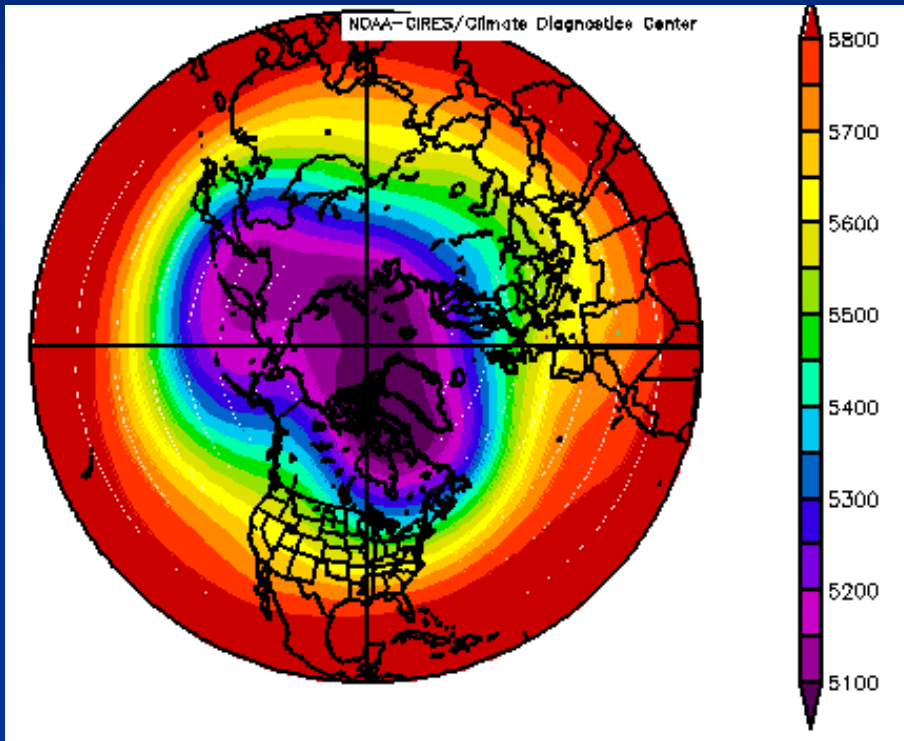
Outline

- Circulation patterns during extreme Prairie droughts
- Large-scale factors (teleconnections)
- Circulation comparisons of the 1999-2005 drought with other major droughts
- Teleconnection comparisons
- Theories
- Further research requirements

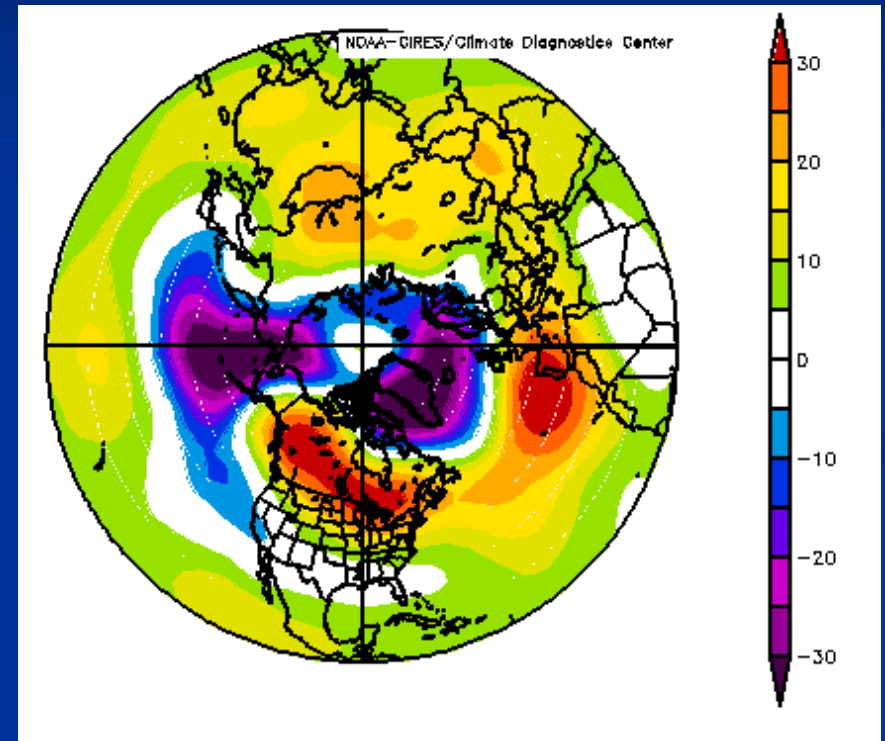


Warm, Dry Winters Over the Canadian Prairies

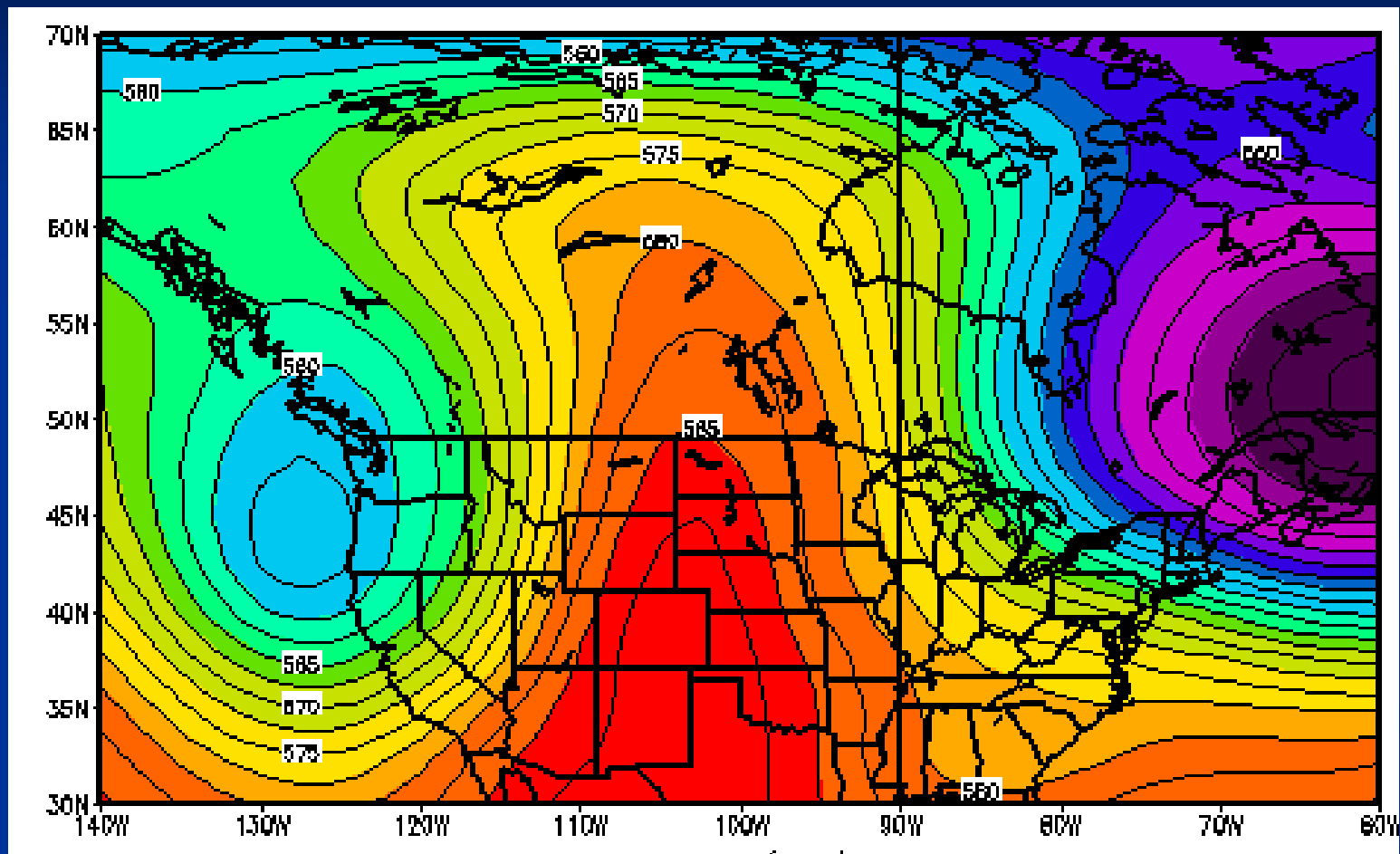
500mb Flow



500mb Anomalies



Hot, Dry Summers Over Western Canada



'Omega' Blocking

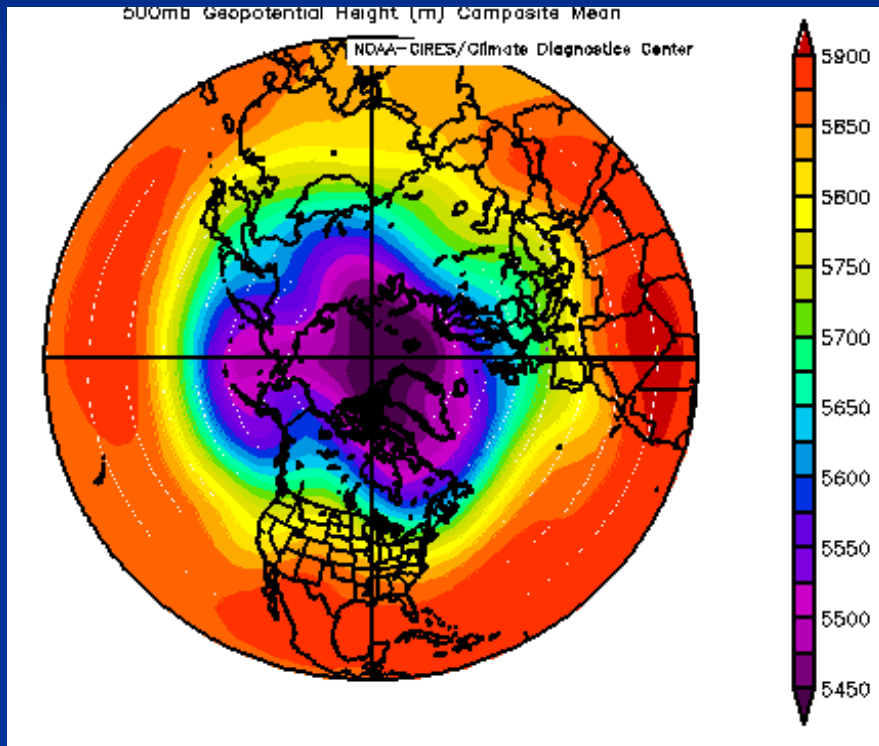


Environment
Canada

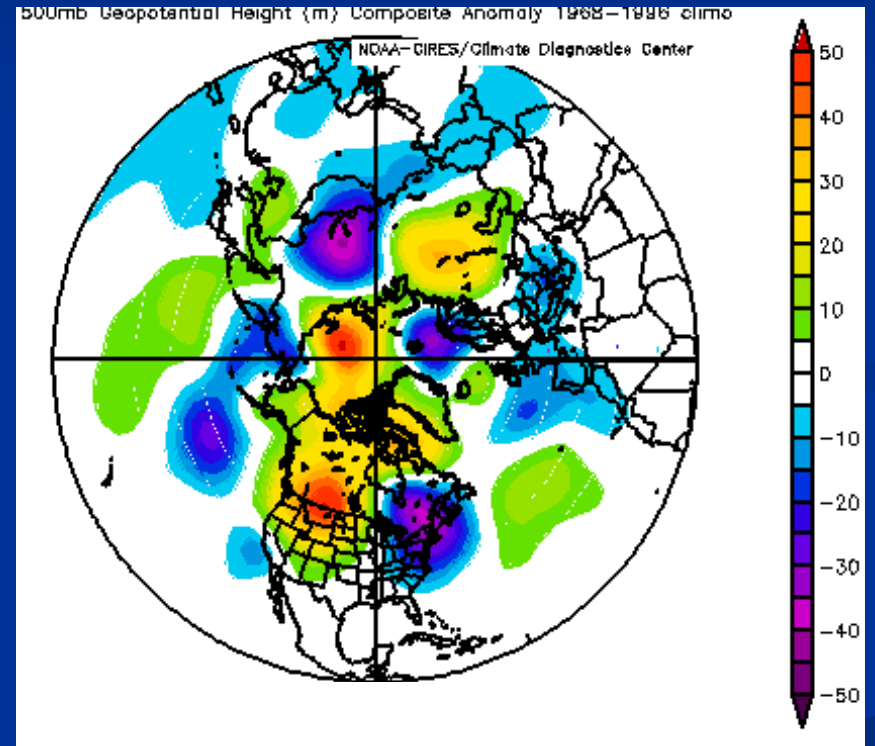
Environnement
Canada

Hot, Dry Summers Over Western Canada

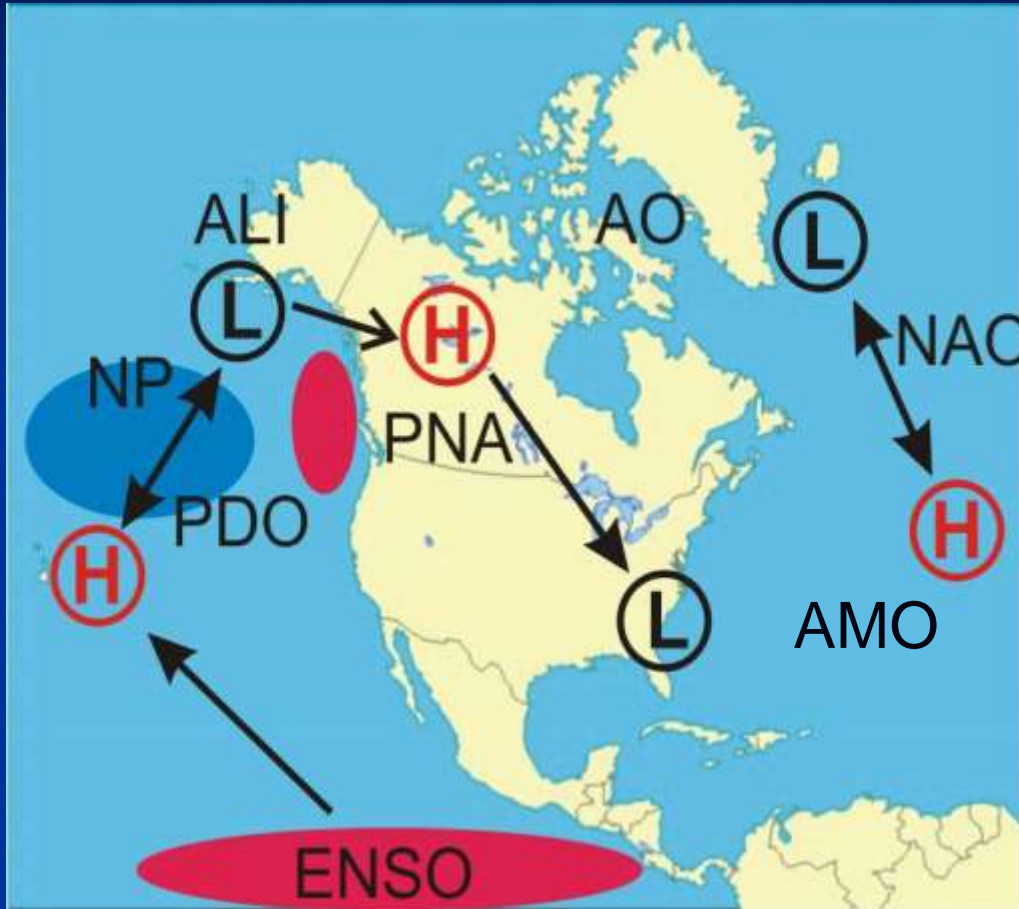
500mb Flow



500mb Anomalies



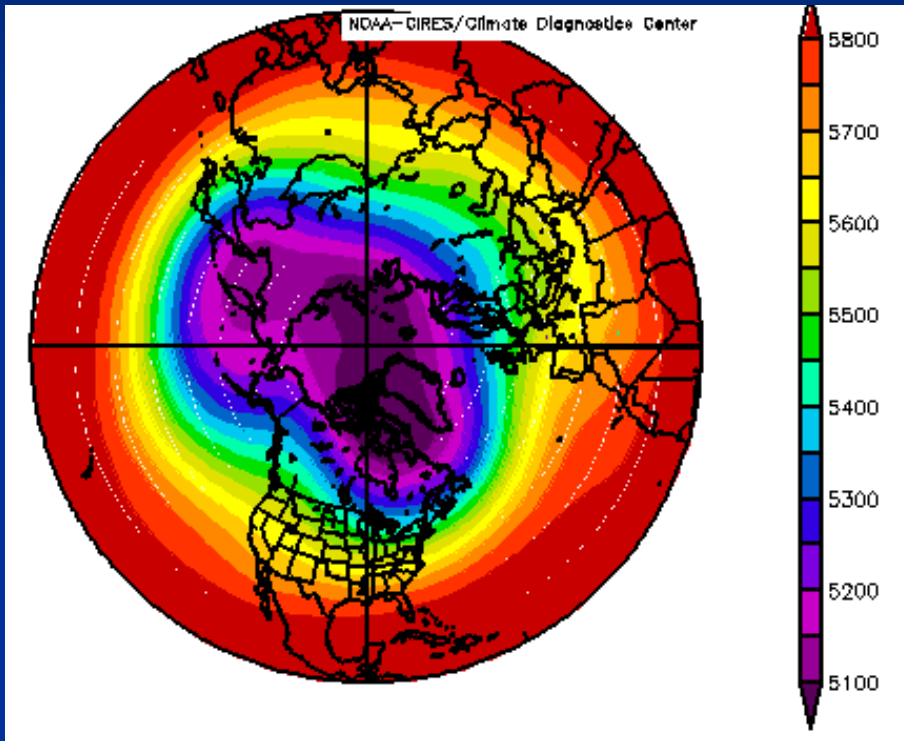
Hemispheric to Global-Scale Teleconnections



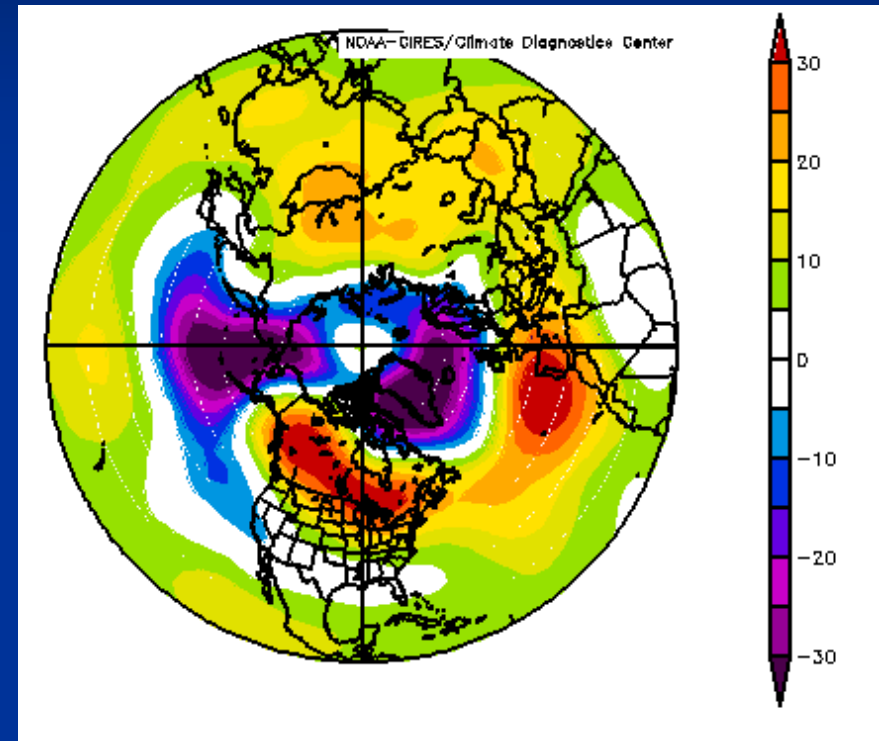
- Significant relationships between hemispheric to global-scale teleconnections and climate anomalies over Canada and the Prairies
- ENSO, PDO, PNA are most prevalent
- Strongest during cold season

Warm, Dry Winters Over the Canadian Prairies

500mb Flow



500mb Anomalies

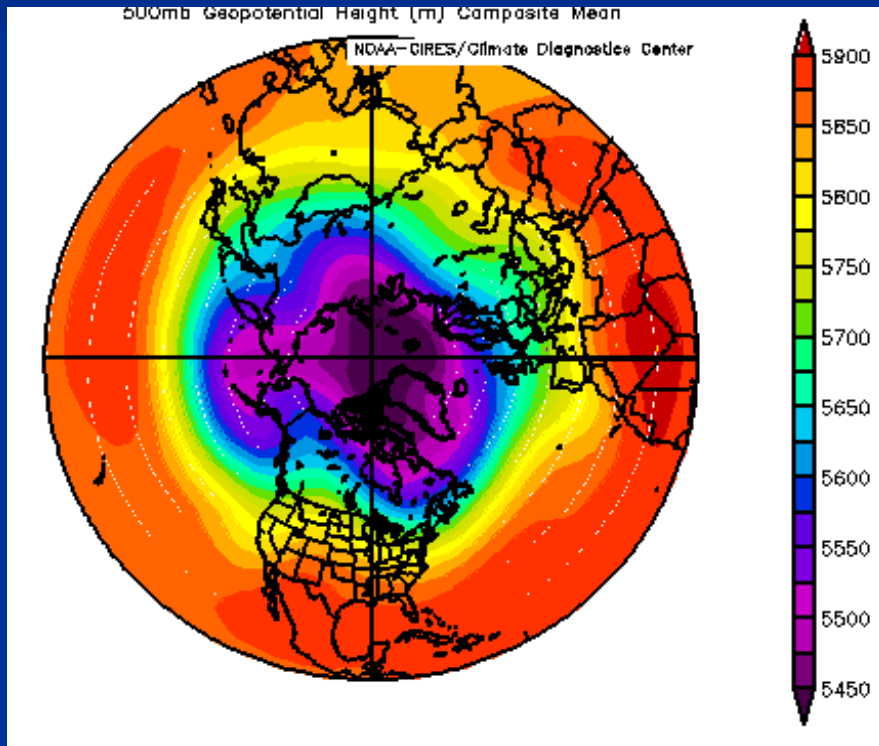


- El Niño, +PNA, +PDO, Deep Aleutian Low

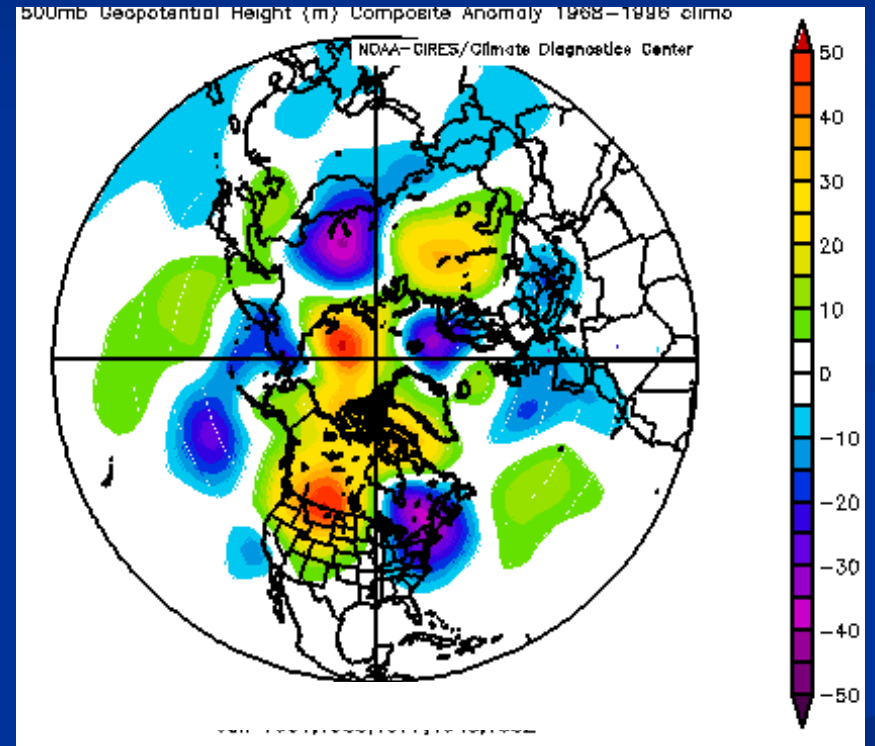


Hot, Dry Summers Over Western Canada

500mb Flow



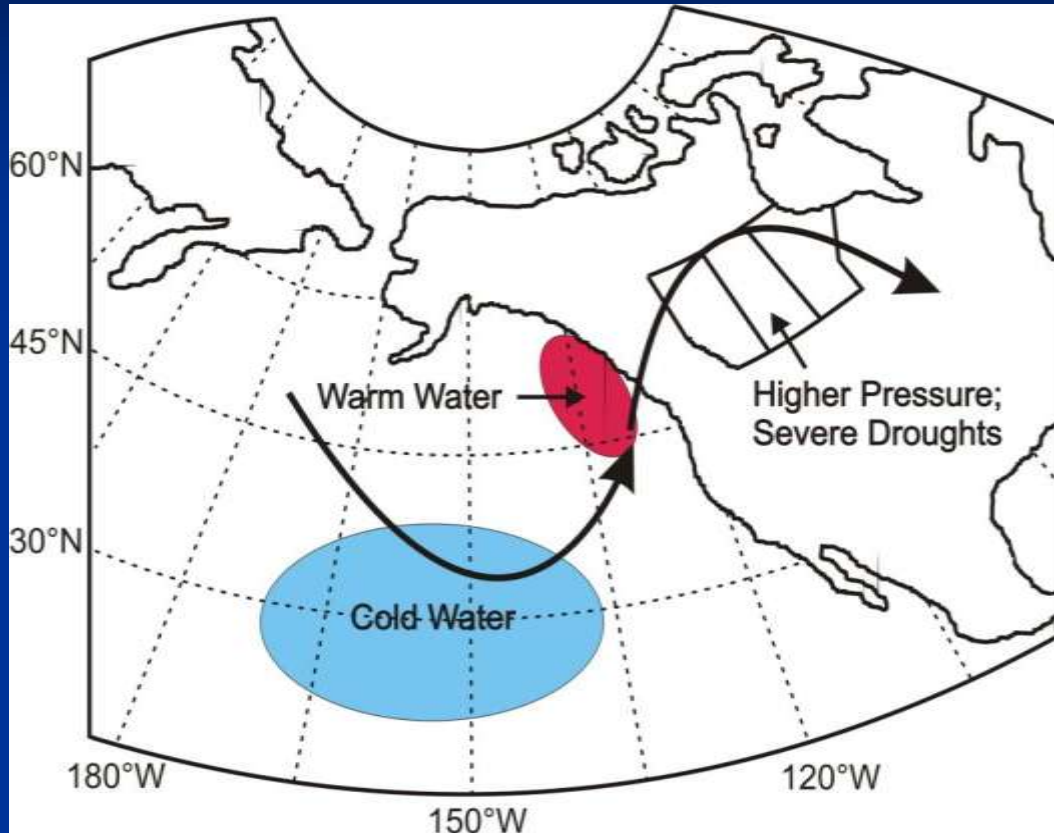
500mb Anomalies



- +PNA, Meridional Flow, +PDO?

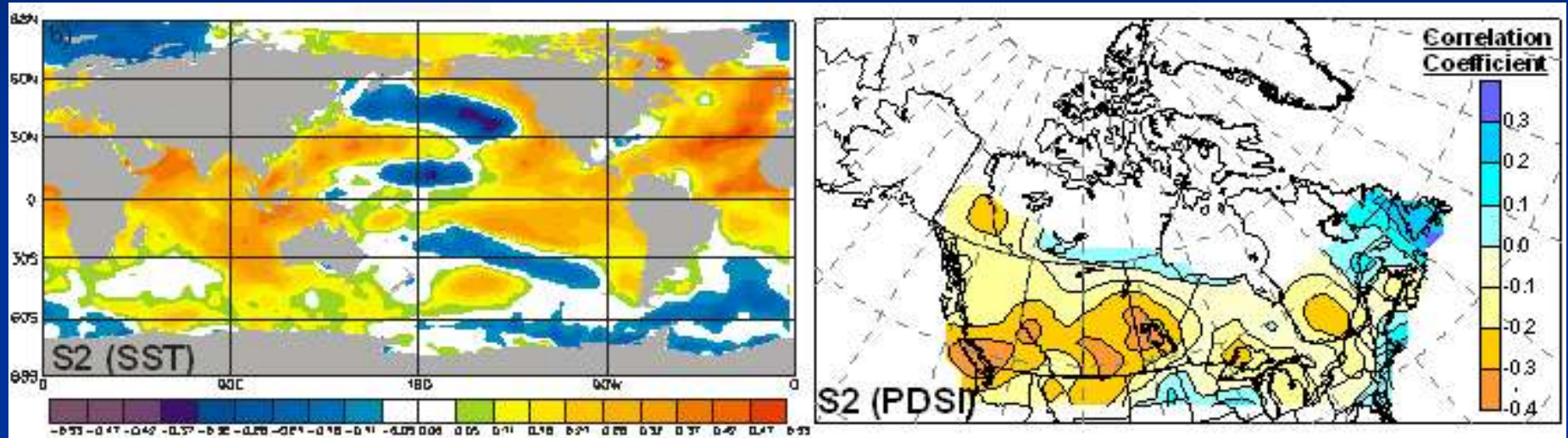


North Pacific SSTs



- *Bonsal et al. (1993):* Associations between persistent North Pacific SSTs and major droughts on the Prairies
- These include 1961, 1988, & the mid 1930s
- Similar to a +PDO pattern

Coupled SVD pattern between Global Winter SSTs and Summer PDSI



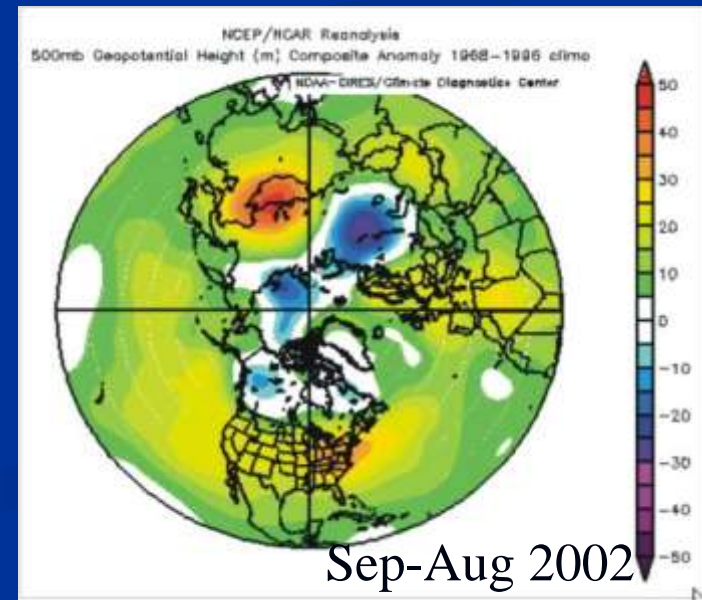
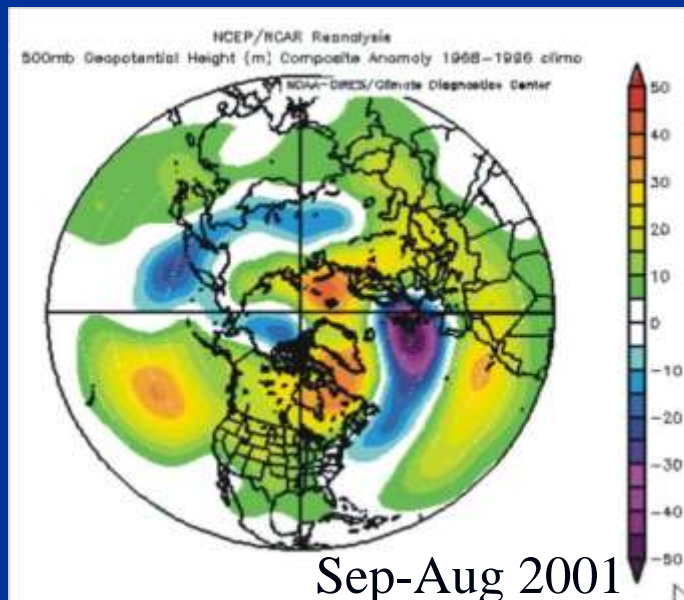
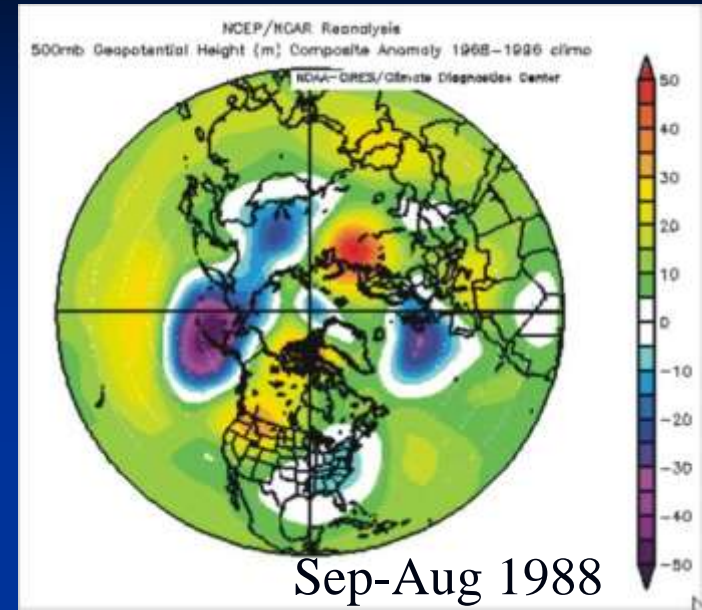
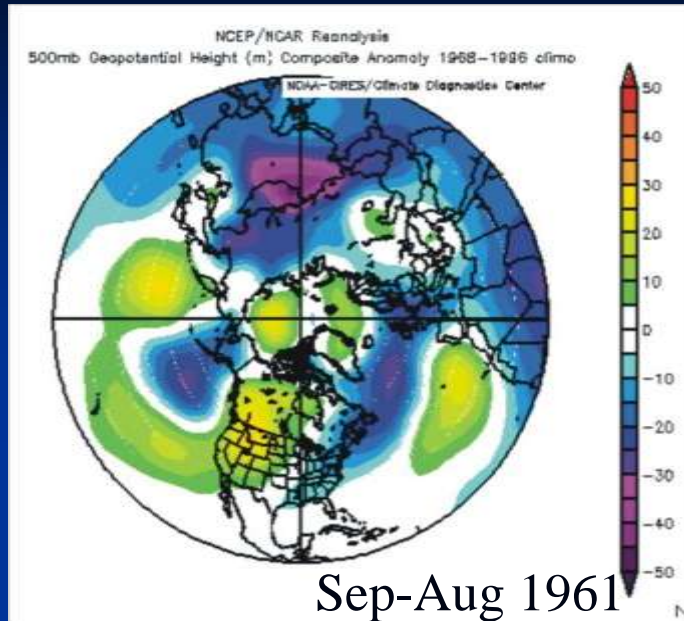
Winter Interannual and interdecadal ENSO-like pattern is associated with dry summer conditions in western and central Canada. Squared Covariance Fraction = 28%, Correlation between time expansion = 0.5 (Shabbar and Skinner, 2004)

Recent Drought Comparison to Other Droughts

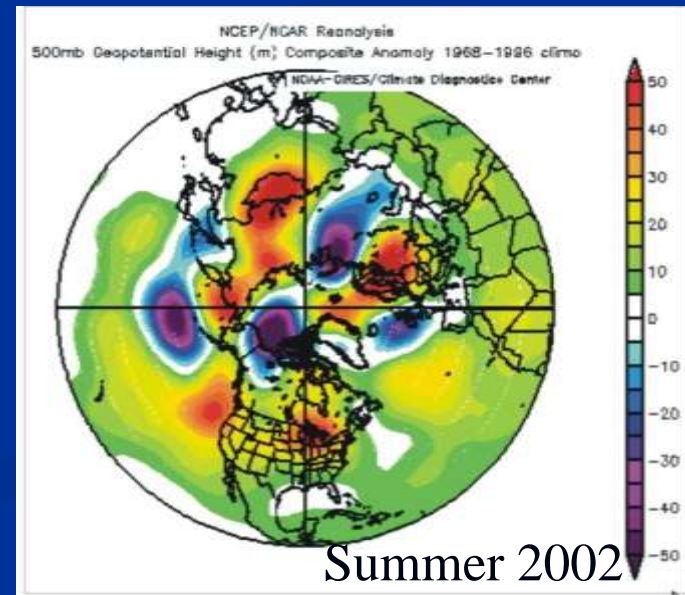
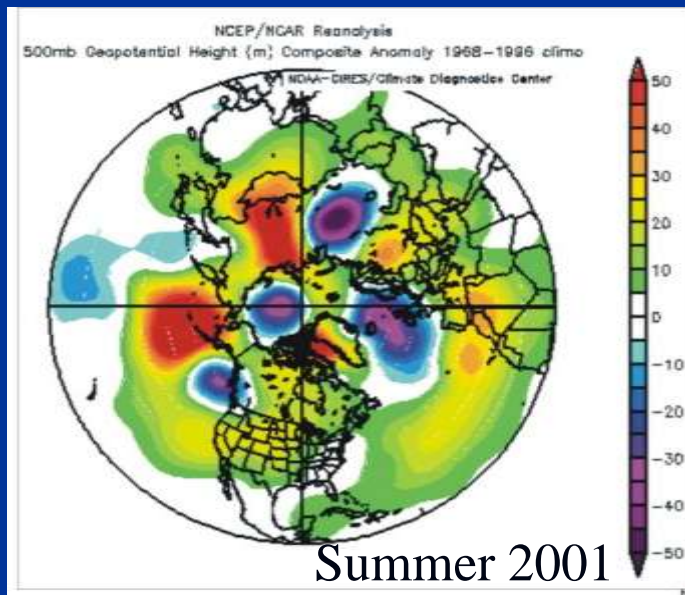
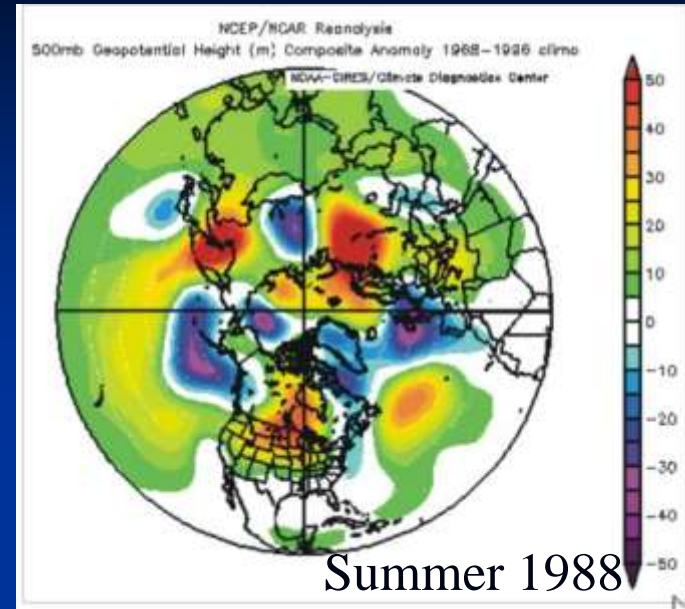
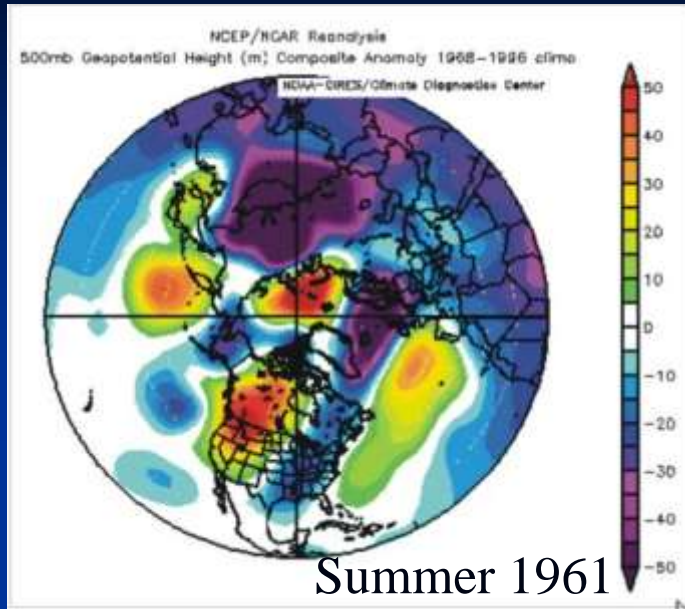


- Canadian Prairies
- 1930s, 1980s, 1961
- 1961 & 1988:
- Multi-season
- Data availability
- Widespread over western Canada
- Severe impacts

Comparisons with Other Droughts

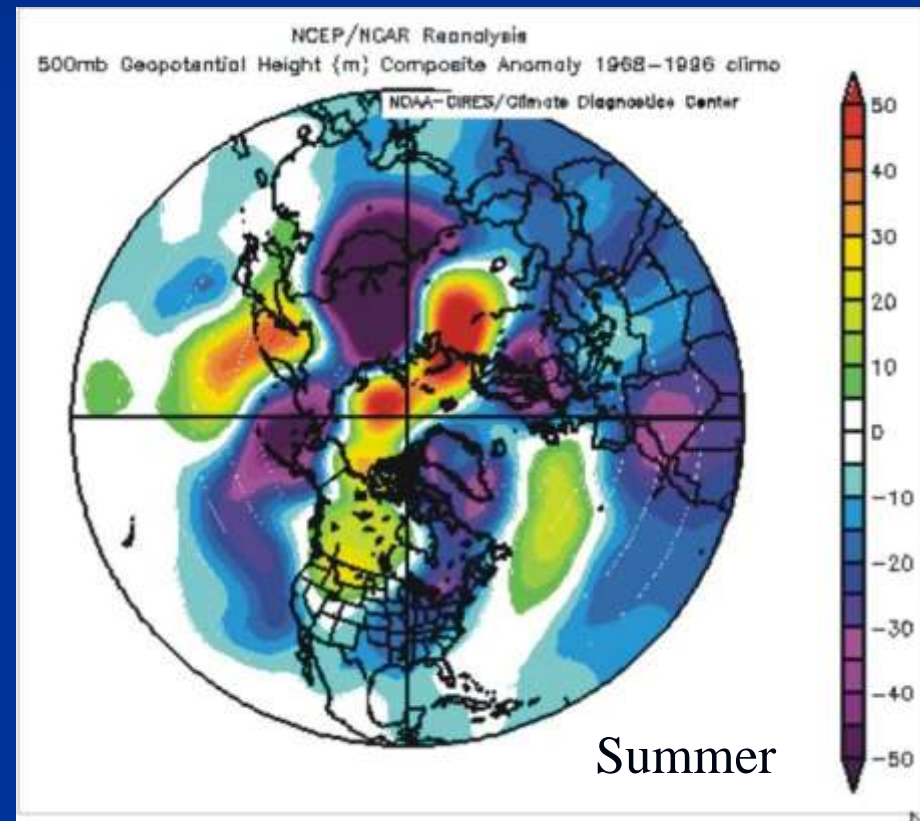
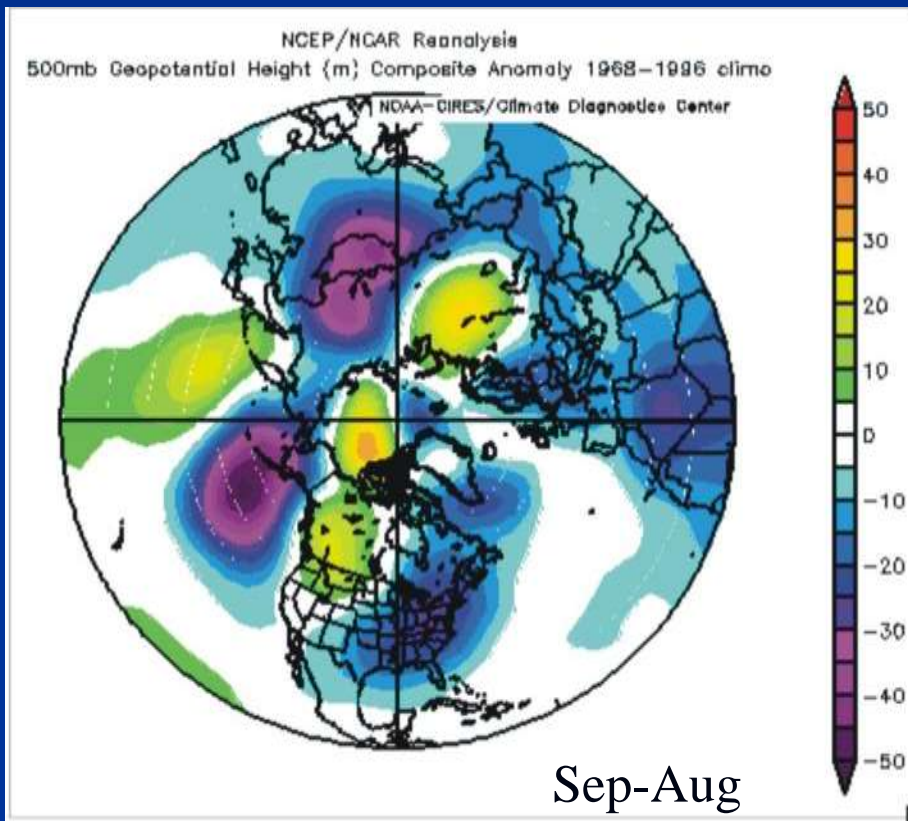


Comparisons with Other Droughts

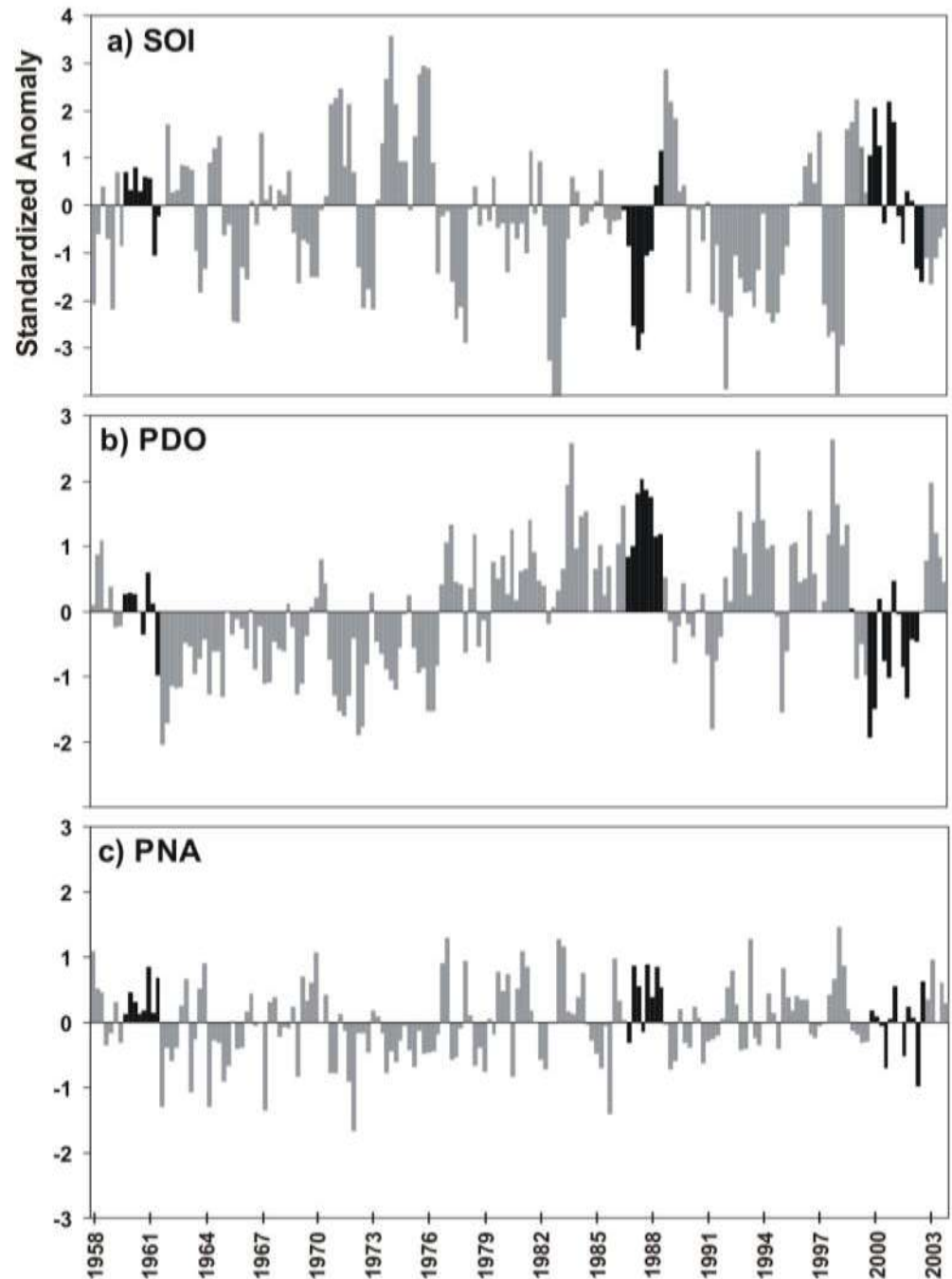


Circulation Differences

1961 & 1988 minus 2001 & 2002

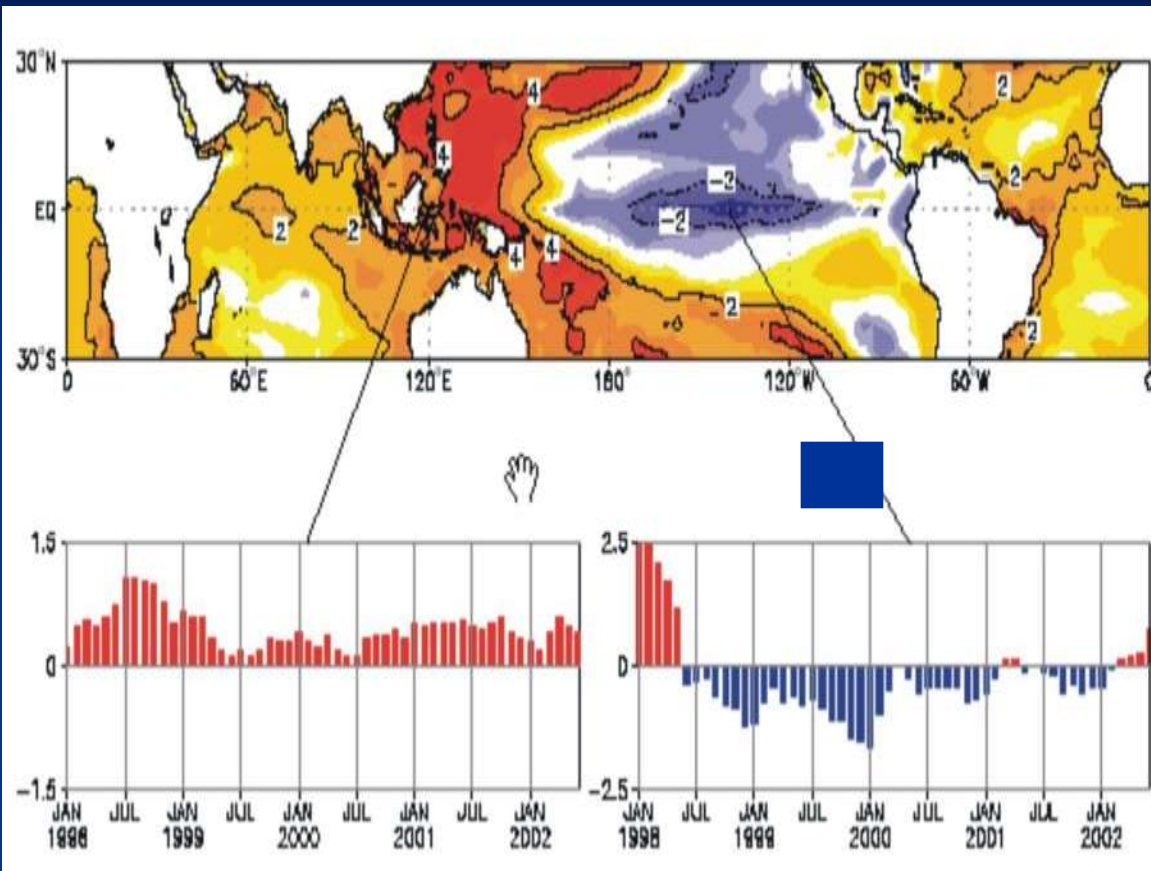


Teleconnection Comparisons



Hoerling and Kumar (Science, 2003)

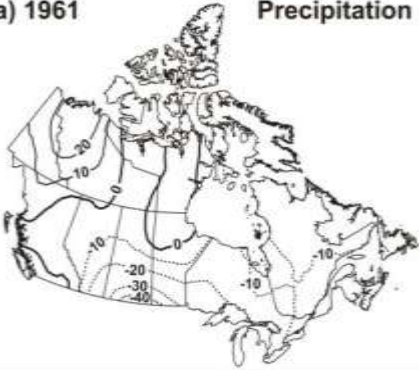
- Examined US severe drought that persisted from June 1998 to May 2002
- Attributed in part to persistent SST pattern in tropical Pacific – cold in central, unprecedented warm in west
- representative of La Nina



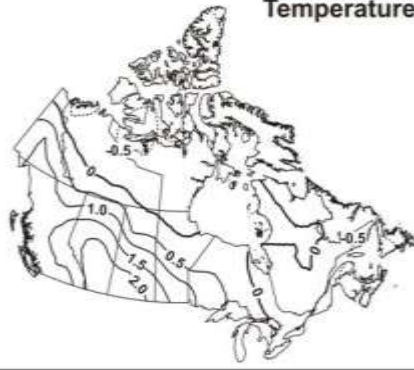
Average SST Anomalies – June 1998 to May 2002

Cold versus Warm Droughts?

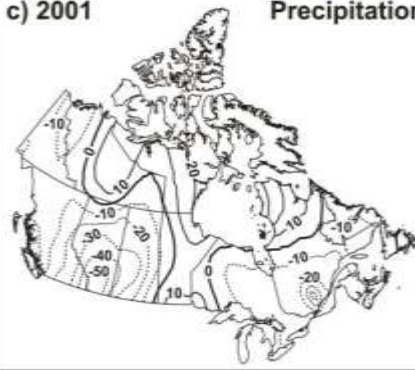
a) 1961 Precipitation



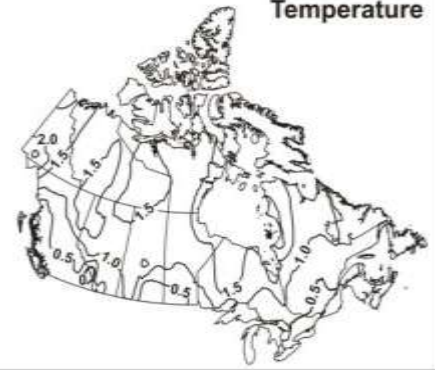
Temperature



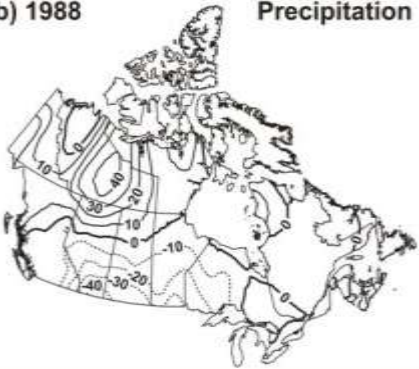
c) 2001 Precipitation



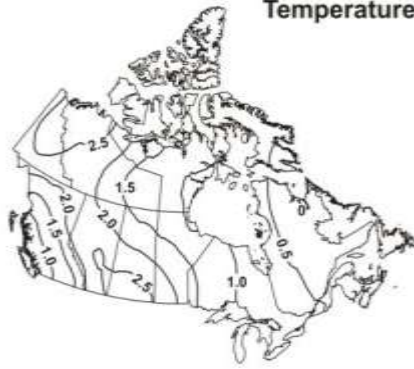
Temperature



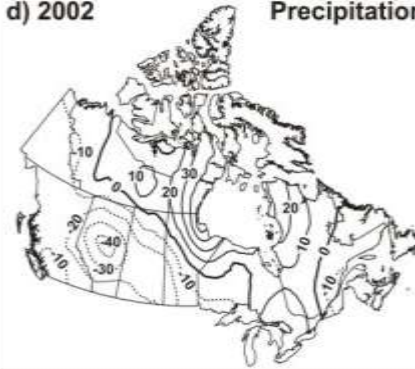
b) 1988 Precipitation



Temperature



d) 2002 Precipitation



Temperature



Future Research Directions

- Considerable differences in circulation compared to past Prairie droughts; No consistency with major teleconnection indices
- Due to a cold versus warm drought?
- Identify other “cold” droughts in the instrumental record
- Determine if atmospheric circulation and teleconnections are consistent with 1999-2005 episode
- Keep pluggin away

