IMPACTS OF CLIMATE CHANGE ON EXTREME PRECIPITATION AND DRY SPELLS IN NEW ZEALAND

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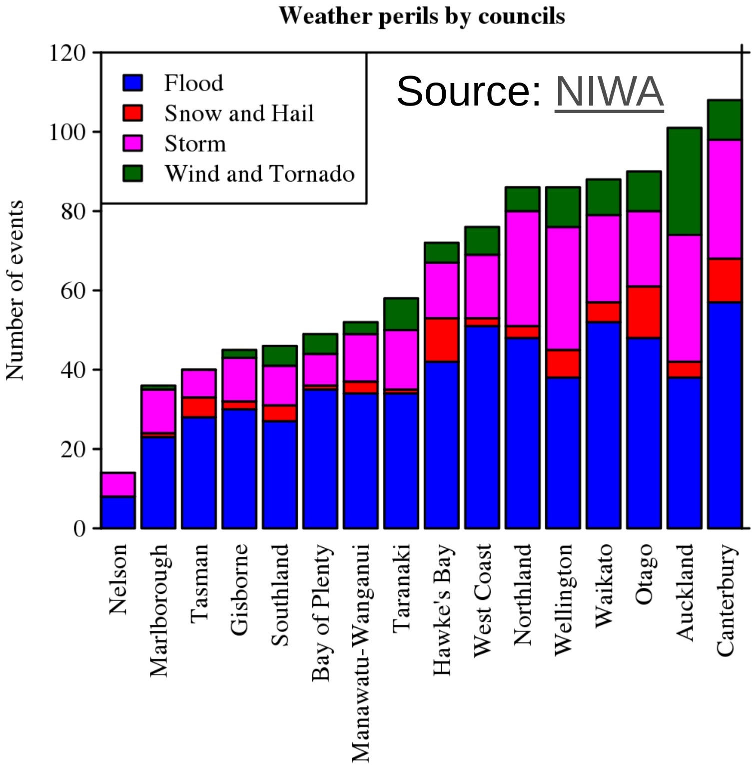
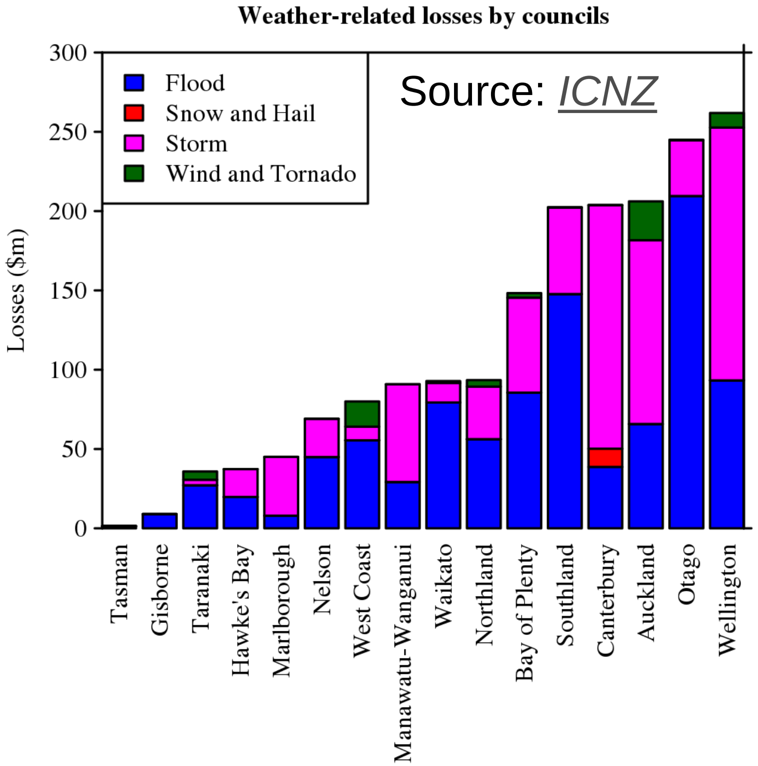
INTRODUCTION

- Flood is one of the most frequent and natural disasters in New Zealand and accounts for a large fraction of insurance losses
- Flood risk is likely to be affected by climate change
- Prediction of future flood risk is essential to implement effective mitigation and adaptation strategies





INTRODUCTION

- The potential impacts of a warming climate on precipitation in New Zealand are unclear, and historical rainfall data do not highlight clear temporal trends

- However, studies[1-5] have suggested that climate change is likely to increase the interannual variability of El Niño Southern Oscillation (ENSO). ENSO is one of the main controls on precipitation patterns in New Zealand.

- Therefore, New Zealand climate is likely to be more dominated by ENSO-related interannual variability as the world continues to warm

- Here, we aim to investigate how extreme ENSO conditions affect precipitation, wet spells, and dry spells in New Zealand

References (click to open):

[1] Collins, M., An, S.I., Cai, W., Ganachaud, A., Guilyardi, E., Jin, F.F., Jochum, M., Lengaigne, M., Power, S., Timmermann, A. and Vecchi, G., 2010. The impact of global warming on the tropical Pacific Ocean and El Niño. *Nature Geoscience*, *3*(6), pp.391-397.

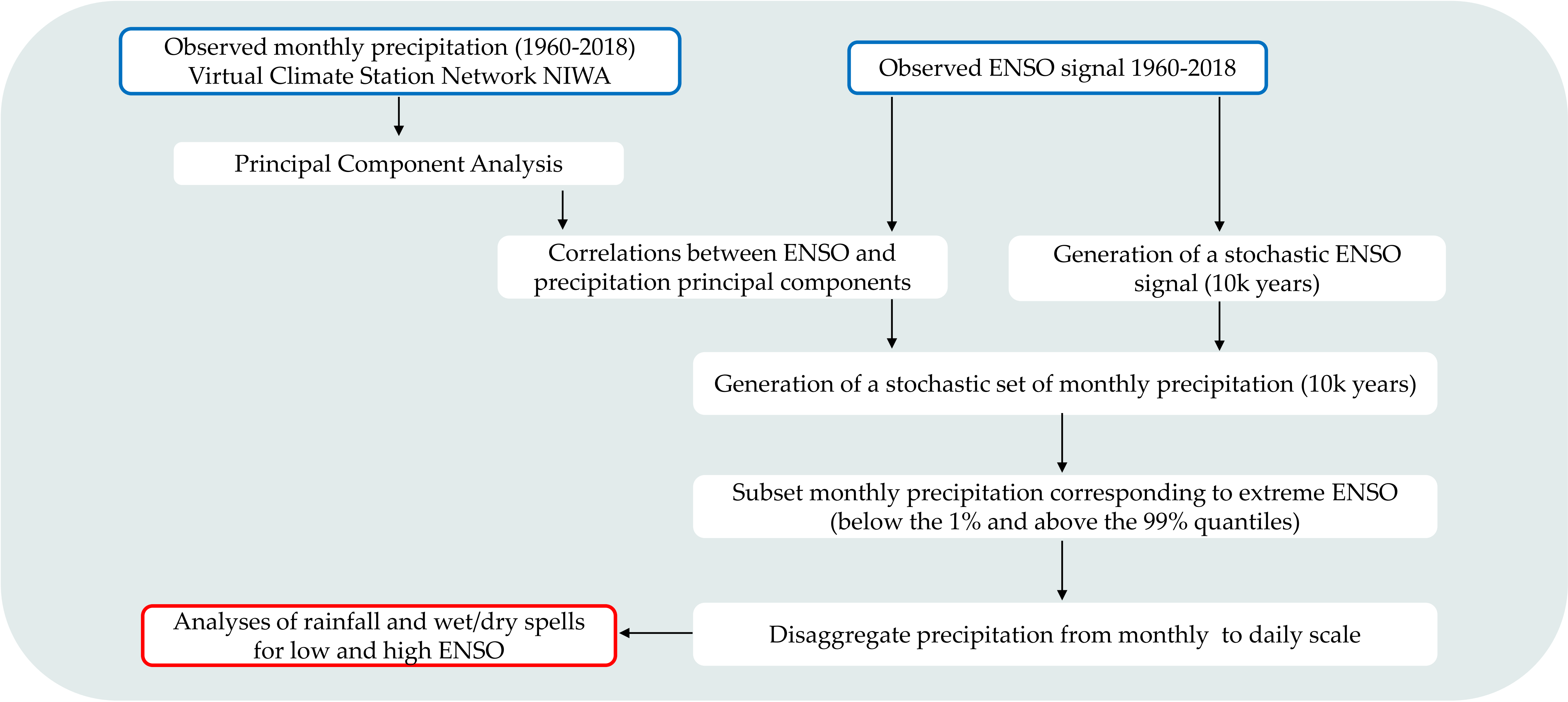
[2] Fowler, A.M., Boswijk, G., Lorrey, A.M., Gergis, J., Pirie, M., McCloskey, S.P., Palmer, J.G. and Wunder, J., 2012. Multi-centennial tree-ring record of ENSO-related activity in New Zealand. *Nature Climate Change*, *2*(3), pp.172-176.

[3] Cai, W., Borlace, S., Lengaigne, M., Van Rensch, P., Collins, M., Vecchi, G., Timmermann, A., Santoso, A., McPhaden, M.J., Wu, L. and England, M.H., 2014. Increasing frequency of extreme El Niño events due to greenhouse warming. *Nature climate Change*, 4(2), pp.111-116.

[4] Cai, W., Santoso, A., Wang, G., Yeh, S.W., An, S.I., Cobb, K.M., Collins, M., Guilyardi, E., Jin, F.F., Kug, J.S. and Lengaigne, M., 2015. ENSO and greenhouse warming. *Nature Climate Change*, *5*(9), pp.849-859.

[5] Yan, Z., Wu, B., Li, T., Collins, M., Clark, R., Zhou, T., Murphy, J. and Tan, G., 2020. Eastward shift and extension of ENSO-induced tropical precipitation anomalies under global warming. *Science Advances*, 6(2), p.eaax4177.

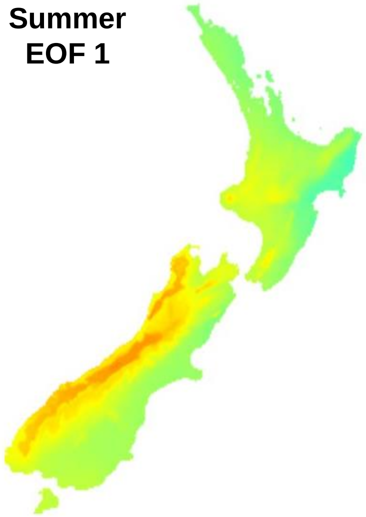
METHODOLOGY: OVERVIEW



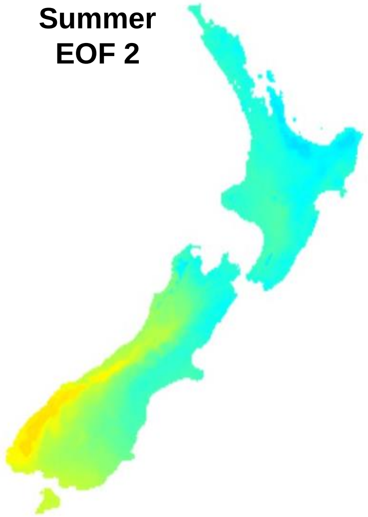
METHODOLOGY: STOCHASTIC MONTHLY RAINFALL

1. We identify the precipitation patterns (EOFs) that explain the largest fraction of precipitation anomaly variance

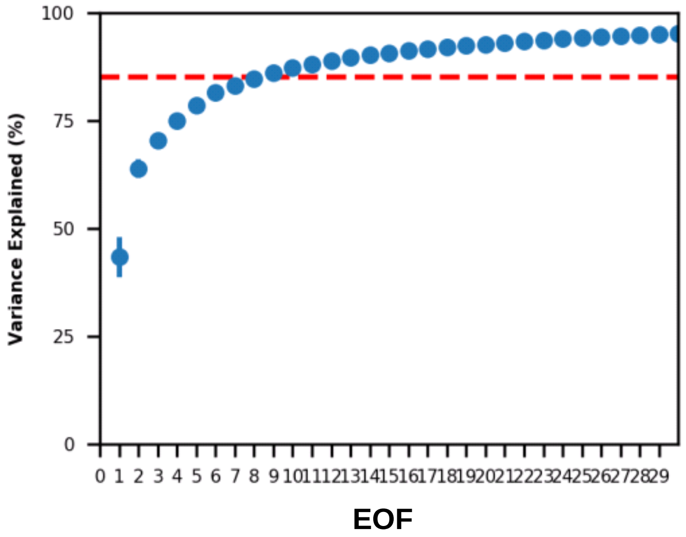
Summer
EOF 1



Summer
EOF 2



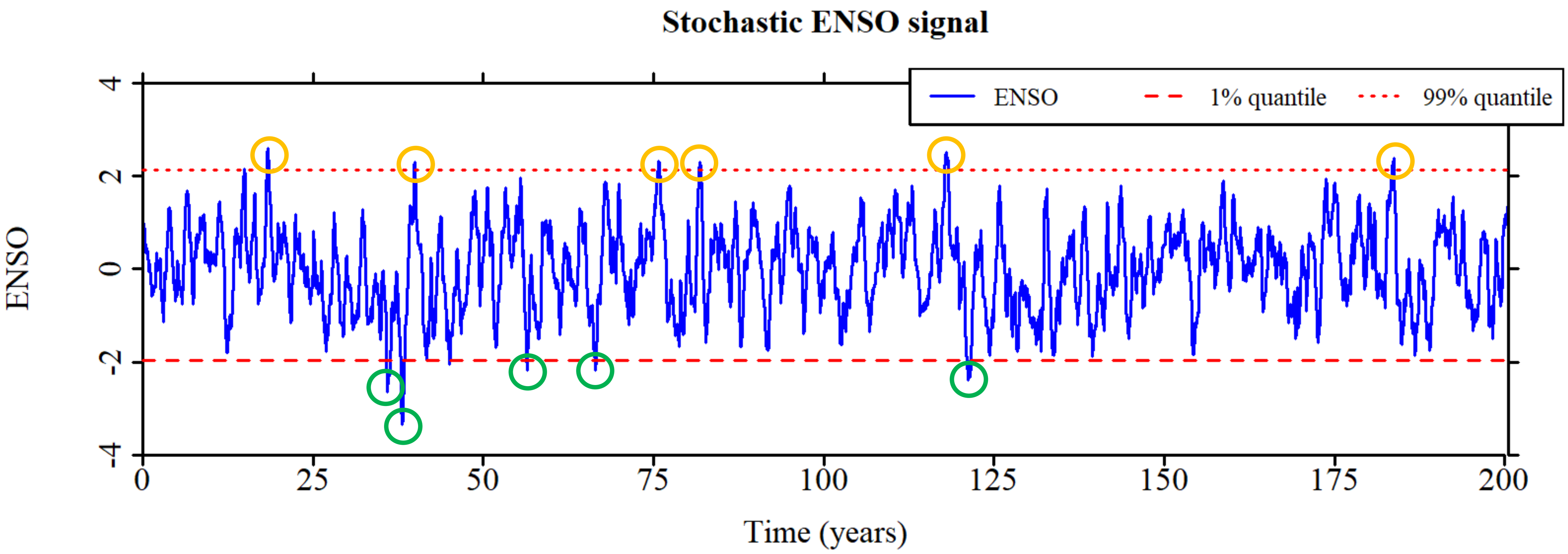
Summer
EOF 3



2. We calculate the correlation coefficients between the precipitation EOFs and ENSO from historical data

3. We generate stochastic monthly precipitation from a stochastic ENSO time series accounting for the observed correlations

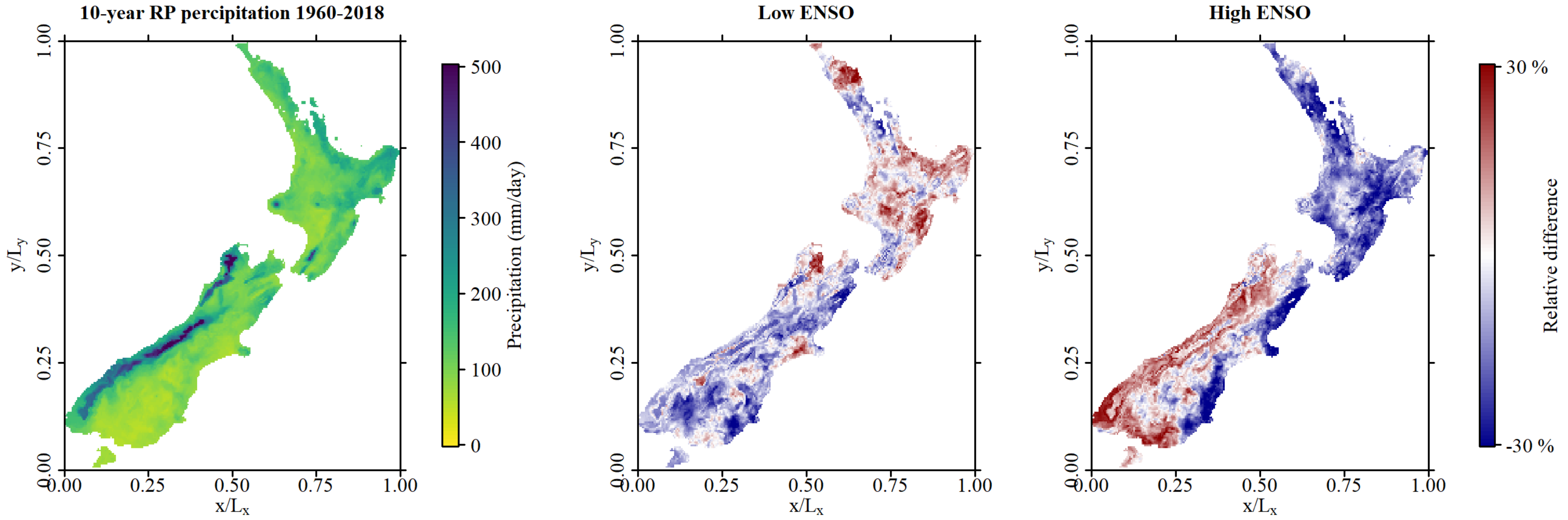
METHODOLOGY: ENSO SUBSET AND DISAGGREGATION



4. We subset the rainfall maps corresponding to the smaller and higher ENSO values

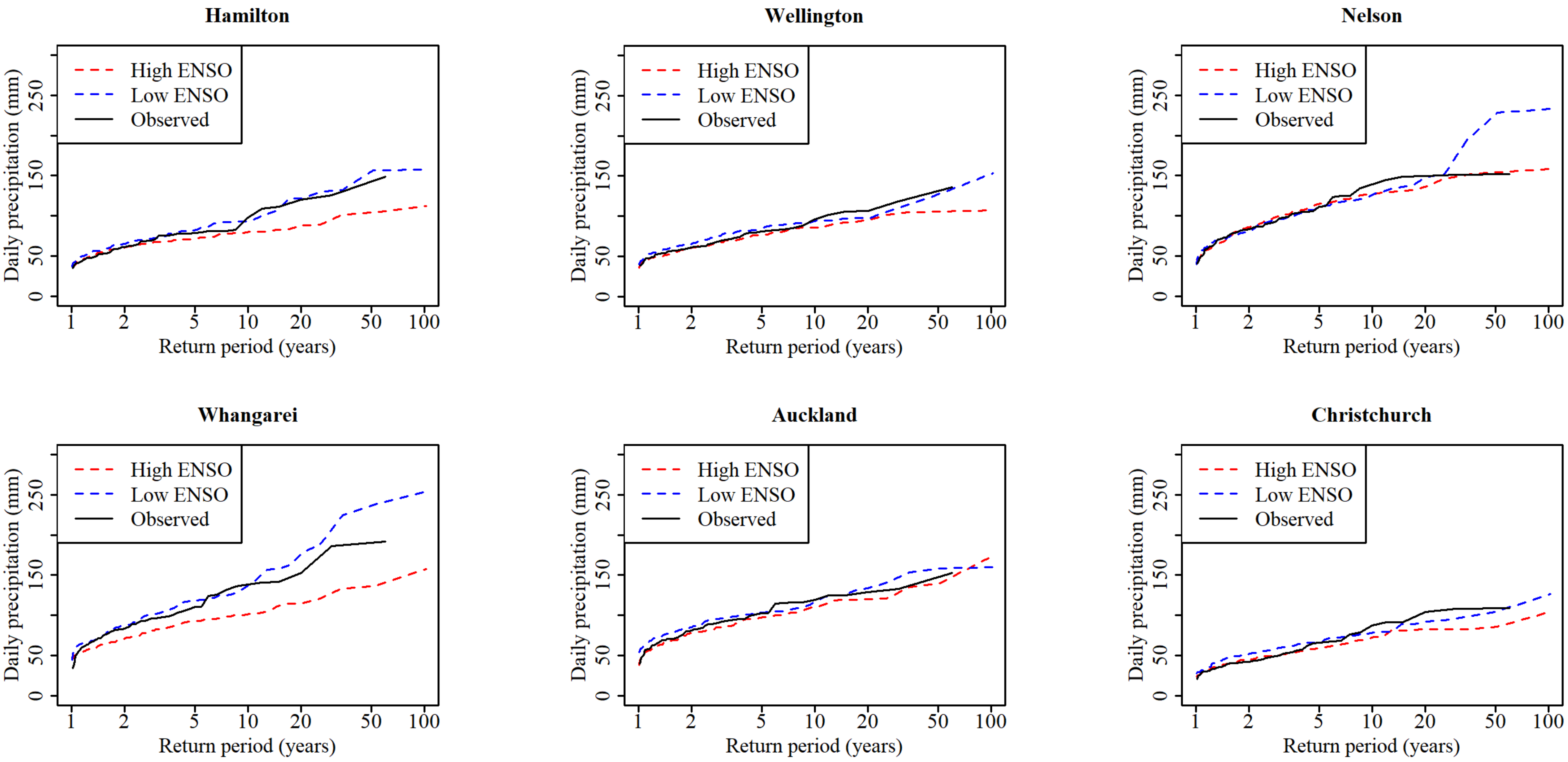
5. We compare the small- and high-ENSO precipitation scenarios to historical data (1960 – 2018)

10-YEAR RETURN PERIOD PRECIPITATION

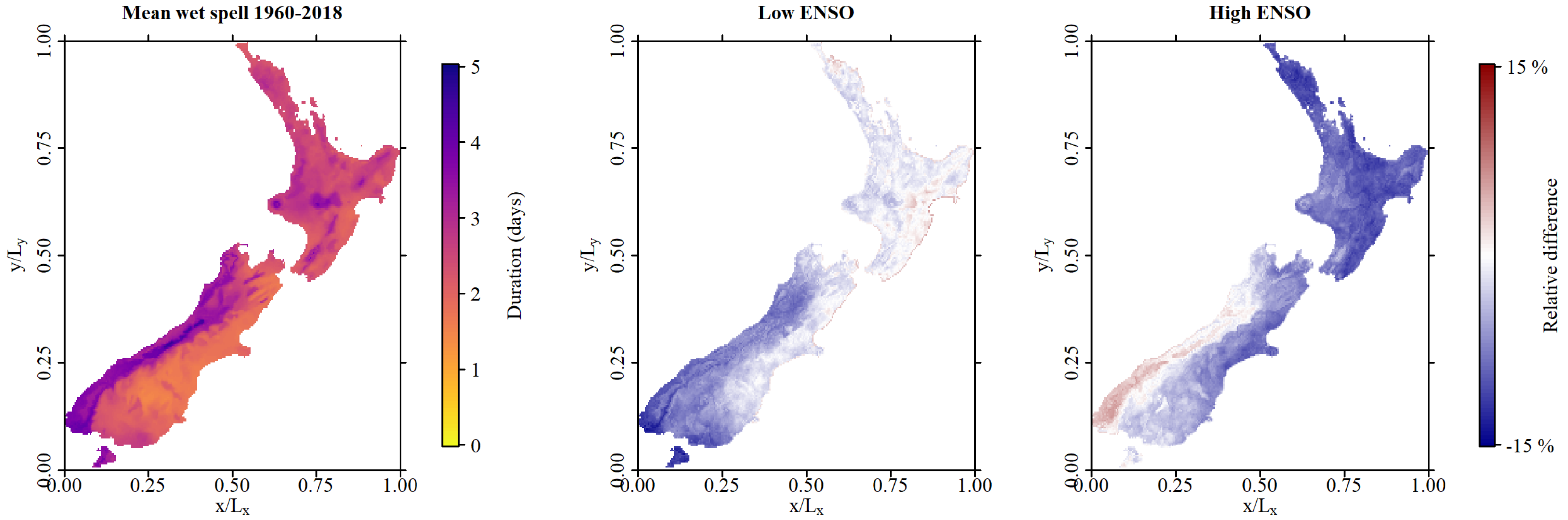


- ❑ Low ENSO: Overall higher extreme rainfall in the North Island
- ❑ High ENSO: Higher extreme rainfall in West Coast and Southland

EXTREME PRECIPITATION BY CITY

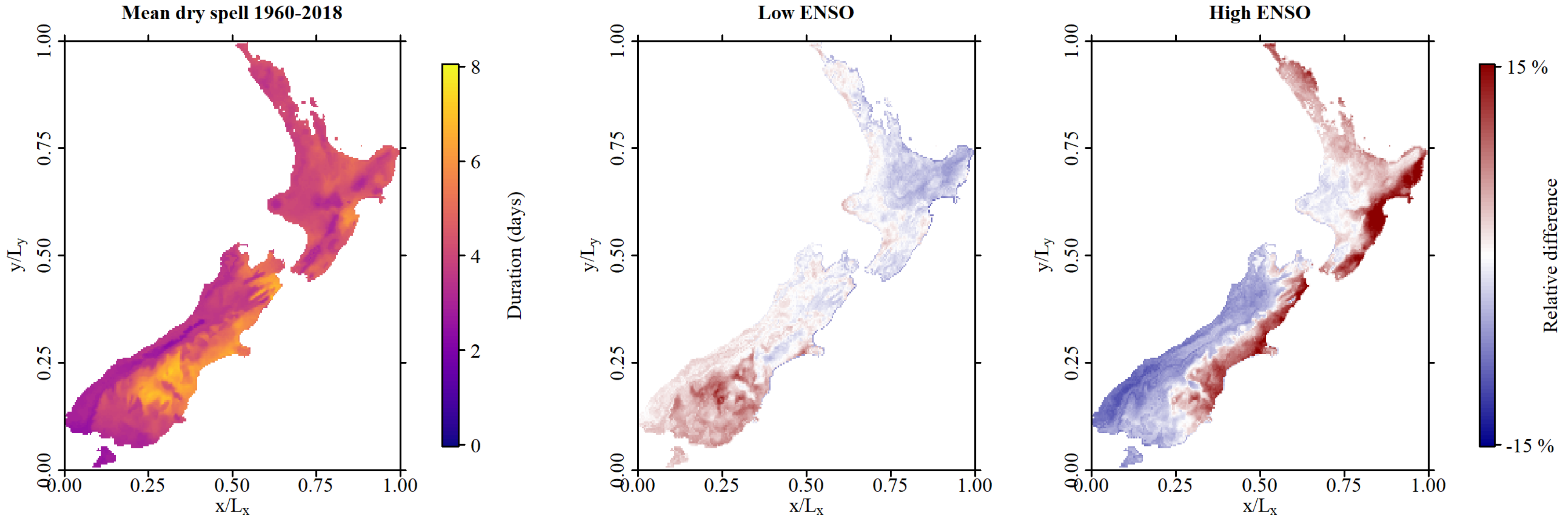


MEAN WET SPELL DURATION



- ❑ Low ENSO: Shorter wet spells in West Coast and Southland
- ❑ High ENSO: Shorter wet spells across the Country, except for West Coast

MEAN DRY SPELL DURATION



- ❑ Low ENSO: Longer dry spells in Southland and Otago
- ❑ High ENSO: Longer dry spells in Otago, Canterbury, Marlborough, Wellington, Hawkes Bay, and Gisborne

SUMMARY AND CONCLUSIONS

- We compared precipitation scenarios under low and high ENSO conditions against current climate conditions
- Changes in ENSO may lead to significant differences in extreme rainfall events (up to 30%) as well as dry/wet spell durations (up to 20%)
- Wet spells may be shorter across NZ and extreme precipitation may increase in the North Island during negative ENSO phases and in the South Island for positive ENSO phases.
- Dry spells are likely to become longer in Southland and Otago during negative ENSO phases, and the east coast of NZ during positive ENSO phases.
- Such changes may significantly impact the risk of flooding and droughts across New Zealand. These results may provide useful guidelines to implement adaptation and mitigation strategies