Extreme Ranges of Groundwater Level

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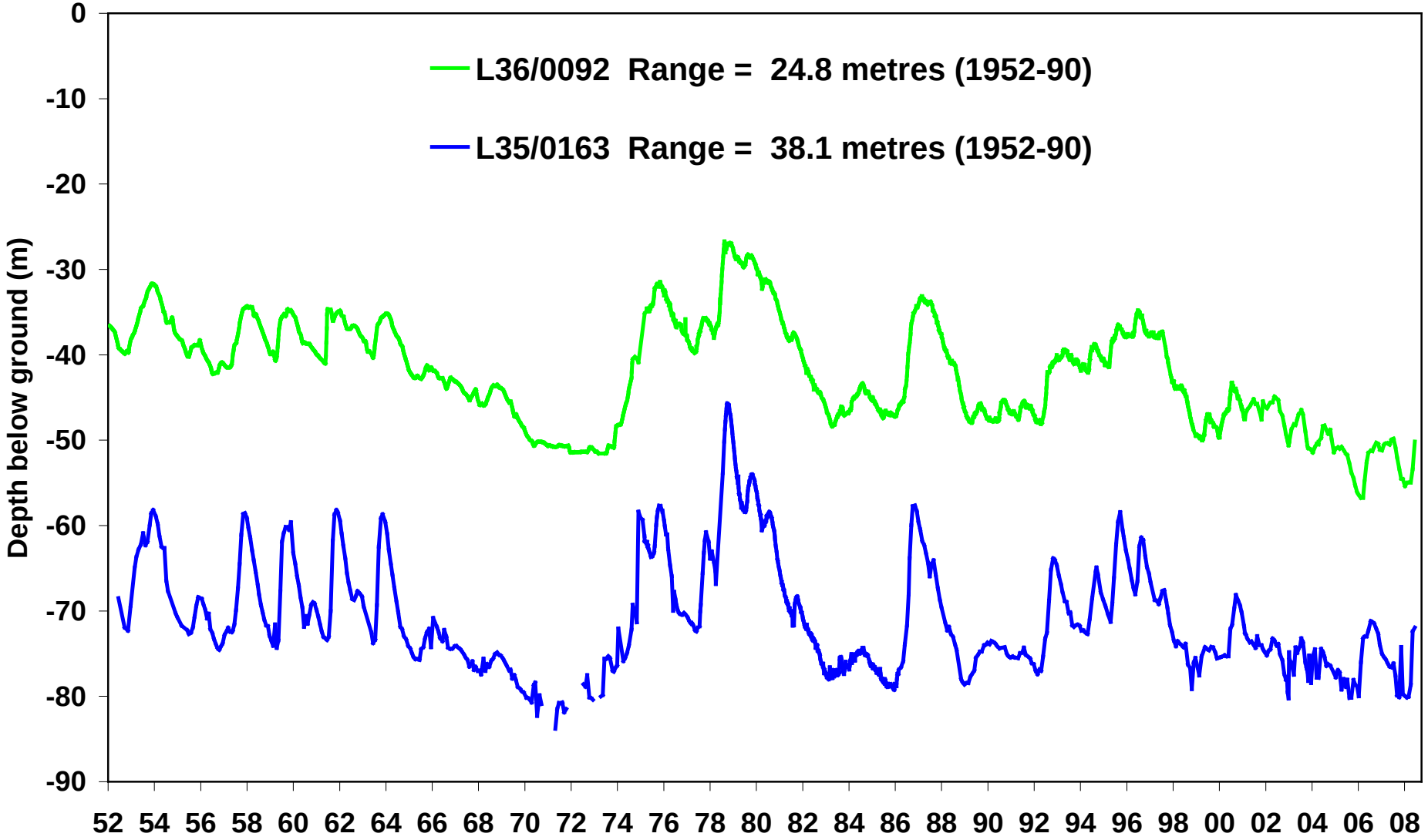
2008 NZHS & MSNZ Joint Annual Conference

Examples of groundwater level range
- observations (ECan database)

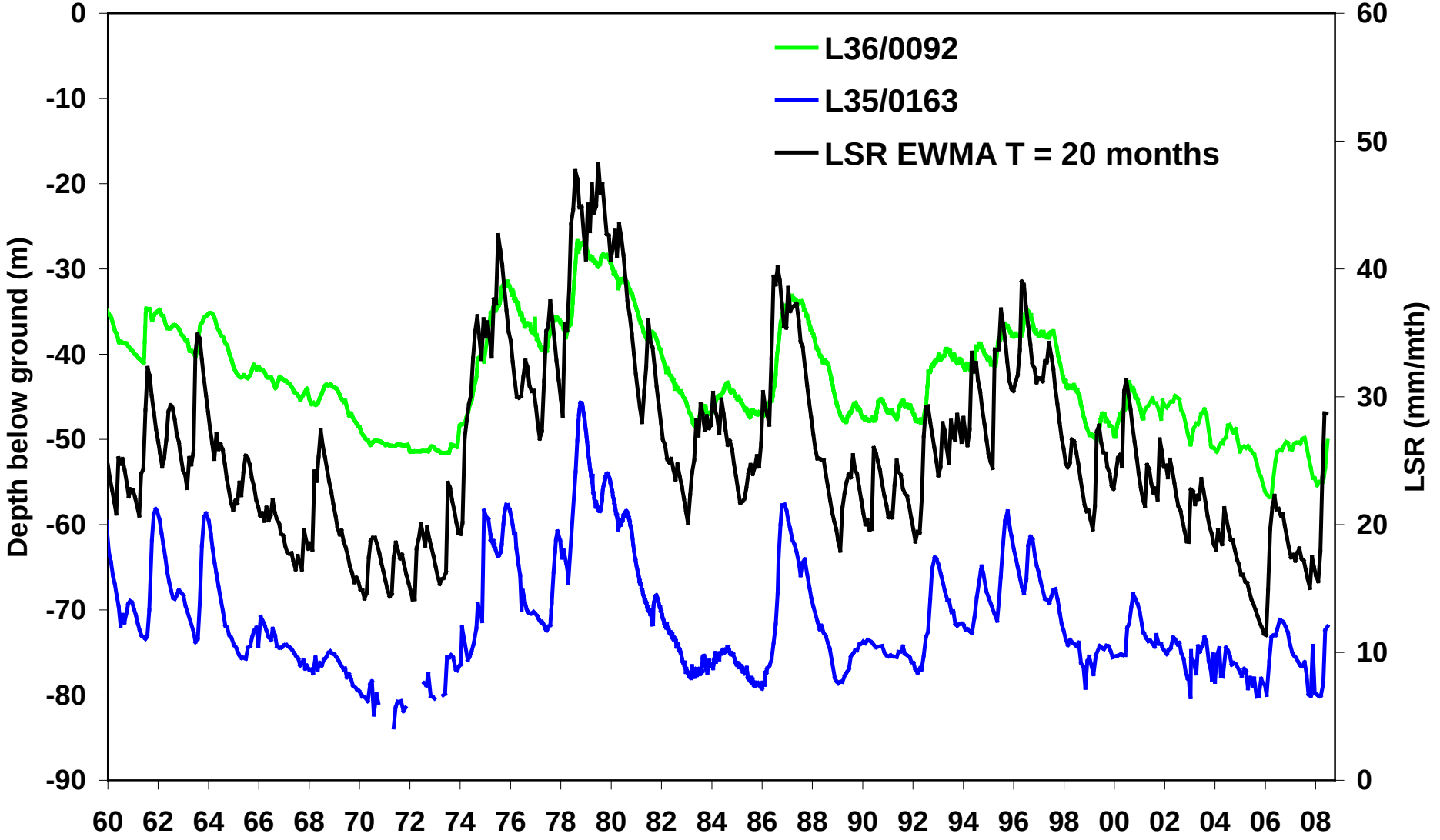


Examples of groundwater level range - locations

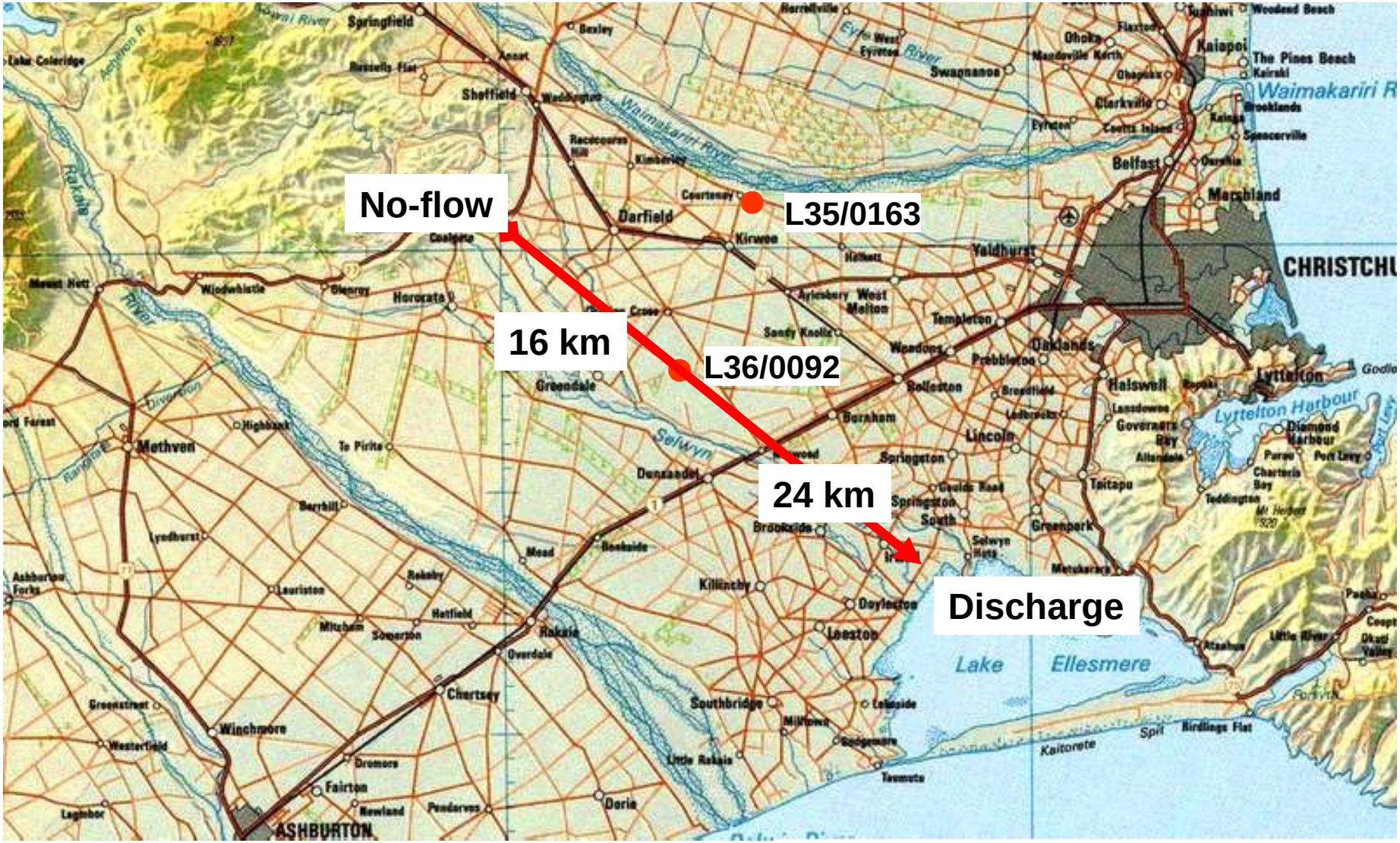
What causes natural groundwater level variation?

- Primarily caused by time variation of recharge from soil-water drainage (land surface recharge)
- Fluctuations in river recharge are damped to a relatively steady level within a few kilometres of the river
- Big rivers are from West Coast climate
- Recharge through the land surface (Canterbury Plains climate) causes most of the natural variation in groundwater level

Smoothed series of monthly land surface recharge
(data from D. Scott, ECan)



Layout of a 1D analytical groundwater model
(Eigenmodel)



Groundwater model parameters

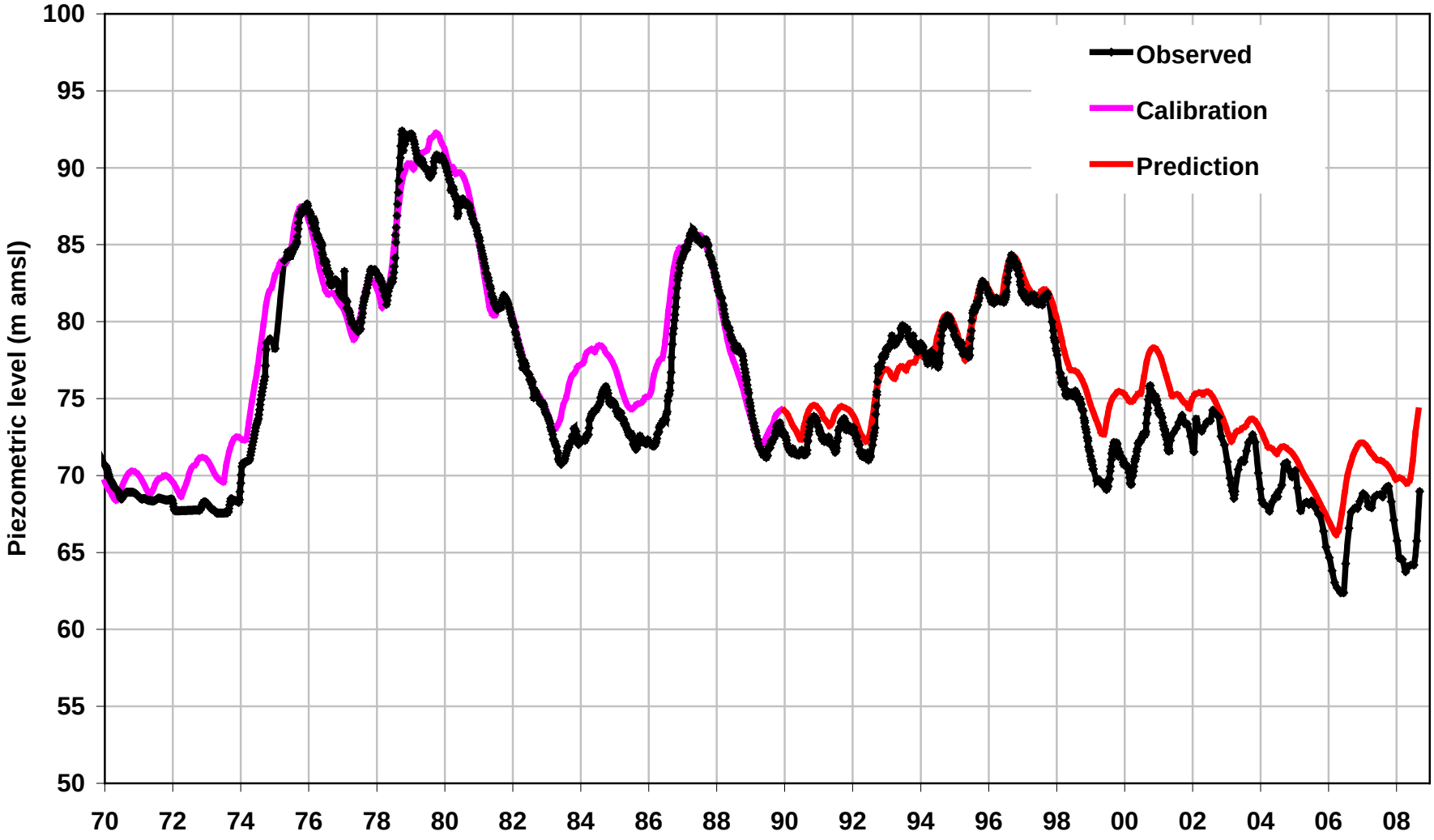
For calibration:

- Steady recharge contribution (from rivers) ***R***
- Bulk value of aquifer storativity ***S***
- Bulk value of aquifer transmissivity ***T***

Preset values

- Length of aquifer (landscape drainage scale) ***L*** = 40 km
- Location of well L36/0092 from upstream boundary ***x*** = 16 km
- Vadose zone transit time ***Tv*** = 5 mths

Calibration and prediction results



Calibrated parameter values

- Steady recharge, averages over length of the aquifer:

  R = 936 mm/y (distributed over length of aquifer)
  or
  R = 660 mm/y (at upstream boundary)

- Aquifer storativity:

  S = 0.022

- Aquifer transmissivity:

  T = 30,000 m^2/d

Limits on range of groundwater level

- At this site, ground level is at 119 m (amsl)
- Piezometric effect of river recharge is 58 m (amsl)
- Groundwater would have reached ground level if:

  Transmissivity ***T*** decreased by 25%
  Aquifer length ***L*** increased by 15%

  (Storativity ***S*** has much lower sensitivity)

- Resulting range about 35 m, compared with observed 25 m

Discussion about geomorphology

- Groundwater “sapping” is an erosive factor in the formation of landscapes

- Occurrence of groundwater at the land surface (for erosion) is determined by a combination of:

  climatically-driven recharge

  aquifer properties ***T, S***

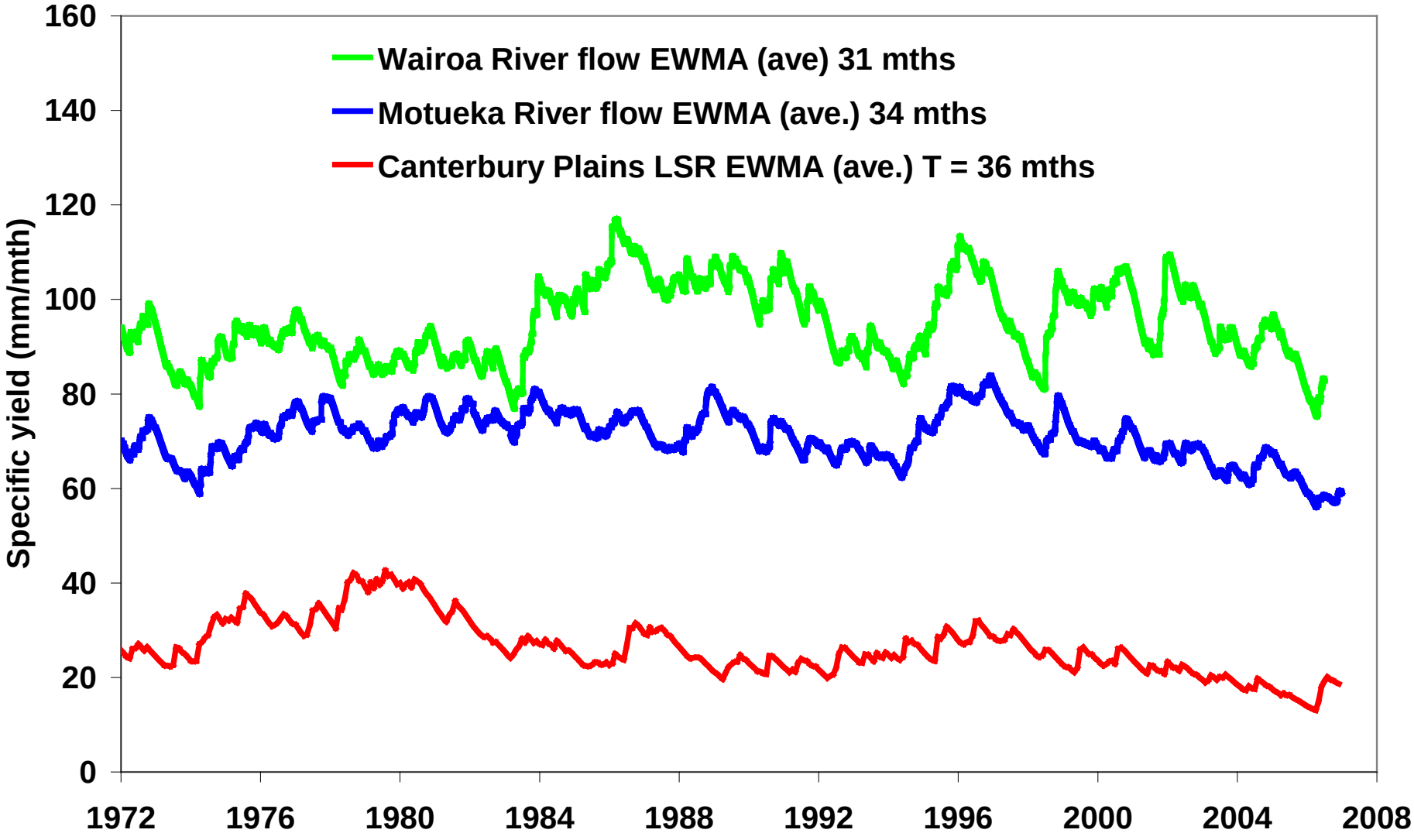
  landscape drainage scale ***L***

- Landscape drainage scale ***L*** varies with sea level changes and development of new drainage patterns

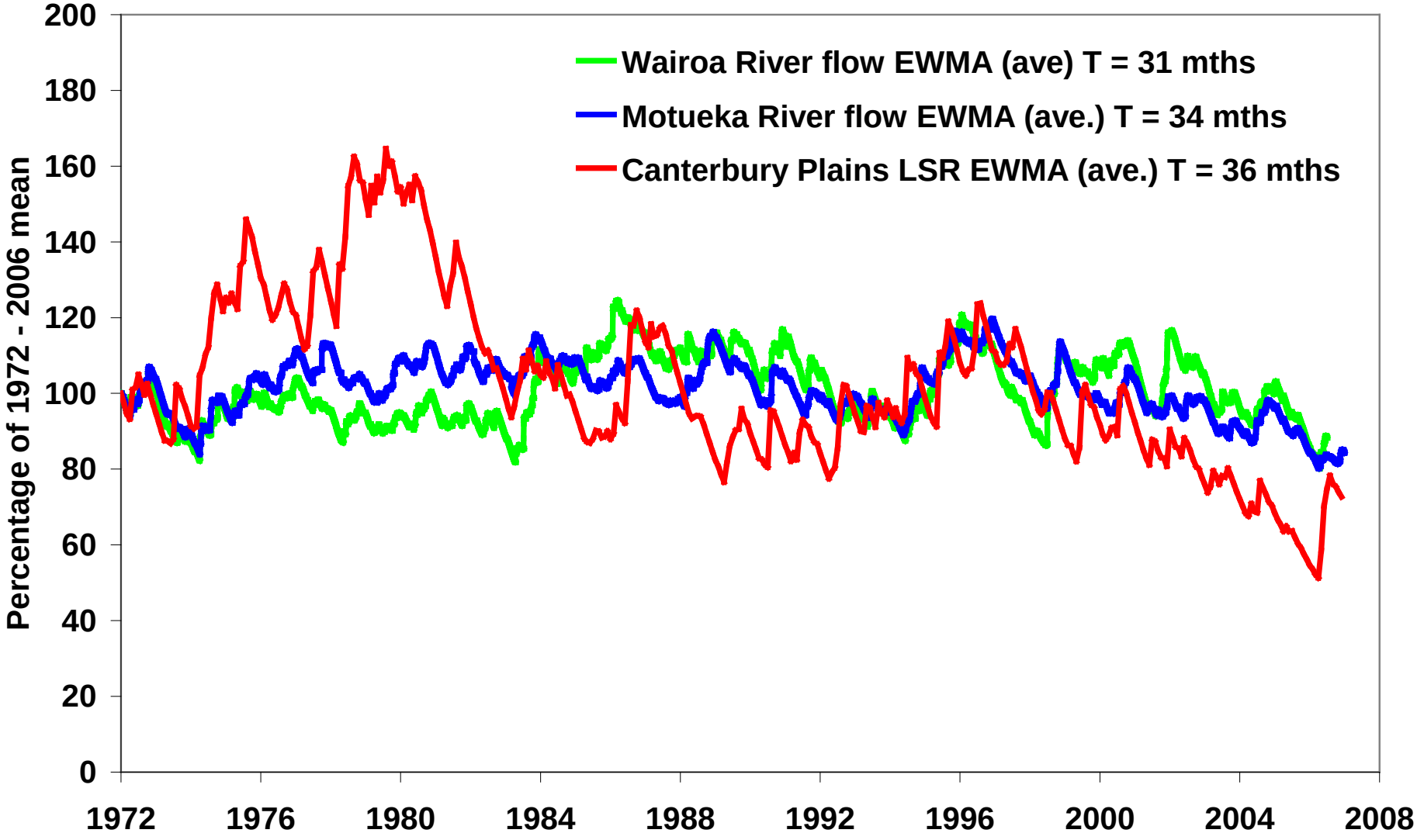
The role of climate in range of groundwater levels

- Geomorphological processes limit the possible extreme maximum and minimum groundwater levels
- Recharge from soil-water drainage is the dominant cause of natural variability in groundwater level
- The actual range of groundwater levels depends on the variability of the hydrological climate that generates soil-water drainage
- Does Central Canterbury have a particularly variable hydrological climate?

Comparison of climatic variation: specific yield EWMA (1972-2006 ave.) T = 36 mths



Comparison of climatic variation: percent of mean EWMA (1972-2006 ave.) T = 36 mths



Conclusions

- Groundwater is an agent in the formation of landscapes
- Extremes of groundwater level depend on the interaction between landscape and aquifer properties
- Observed range of groundwater levels, within these extremes, depends on the variability of the hydrological climate
- The hydrological climate of Central Canterbury is more variable in comparison with other more humid climates in NZ
- The particular combination of climate, landscape, and aquifer properties in Central Canterbury causes unusually large variations in groundwater levels