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Inter-annual absolute gravity variations observed in western North America: Regional or global origin?

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Absolute gravity (FG5) measurements have been made at ten sites in western North America over the period 1995 to the present for the purpose of subduction-zone and postglacial rebound studies. Sites on the west coast of Canada (235-236 deg. East) were measured at approximately 3-month intervals, whereas sites in the mid-continent (260- 270 deg. East) were measured annually at the same time each year. West coast sites are influenced by annual variations of soil moisture, whereas most of the mid-continent sites are relatively free of such effects, being located on low-porosity rocks of the Canadian Shield. In spite of the large range in hydrological environments covered by these sites (annual precipitation ranges from 40 cm/yr on Hudson Bay to 340 cm/yr on the west coast of Vancouver Island), similar and correlated, inter-annual variations in gravity are observed with a “period” of about 7 years. At the mid-continent sites gravity is high in 1995, low in 1998 and high again in 2002 with a range of about 6 microGal. The gravity variation on the west coast has a smaller range and is delayed by about 6 months.

Several possible causes of the inter-annual gravity variations have been investigated, including elastic loading and direct attraction by groundwater and sea level, as well as motions of the axis of the inner core. Both inter-annual variations of sea-level in the eastern Pacific and variations in water-table storage on Vancouver Island are generally high in 1997 and low in early 2001, out of phase with the gravity. Similarly, water-table storage variations around the mid-continent sites explain only part of the gravity signal at sites that have been investigated. A combined analysis of GPS vertical data at four of the mid-continent sites also appears to rule out regional, elastic loading by groundwater as the primary cause of the gravity signal in the mid-continent. A model of retrograde motion of the axis of the inner core fits the data. However, the amplitude of the required inner core motion would be such as to produce trends of the order of 3

x 10^(-10) per year in the degree-2 GRACE coefficients over the period 2002 to 2004. To our knowledge, such large trends have not been reported.