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Seismological and volcanological investigations of the Villarrica-Valdivia region, South-Central Chile

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Understanding the processes behind subduction-related hazards is an important responsibility and major challenge for Earth scientists. South-central Chile is known to experience both very large earthquakes (e.g., the 1960 Mw 9.5 Valdivia earthquake, and the 2010 Maule earthquake) and intense volcanism, hosting two of South America's most active volcanoes, Villarrica and Llaima.

In the framework of the collaborative research centre SFB 574, the south-central Chilean subduction zone is investigated by a seismological subproject conducted by Chilean, Argentinian and German partners. Two temporary seismic networks have been operated by the SFB 574 in this region:

1. The Villarrica Network, a local network of 55 stations between 39° and 40°S, covering the area from the coast to the back-arc in Argentina. The network, deployed in November 2008 and active for one full year, consisted of 40 short-period seismometers and 15 broad-band stations.

2. A volcano-seismicity network consisting of 10 seismometers installed around the volcanoes Villarrica and Llaima (with 5 stations each), which has been operating from November 2009 on.

Our aims are to characterise the larger subduction zone structure and seismicity in this region, which has long been considered a seismic gap due to the scarcity of local earthquakes registered in this region both by international networks (IRIS-NEIC) and the Chilean National Seismological Service (SSN). The two small volcano networks are used to investigate the volcano seismic activity and to determine the fore-, and aftershocks of the 2010 Maule earthquake, which were observed by the volcano networks.

The registered local seismicity is significantly higher than expected, with more than 1000 observed events out of which about 300 were localized in the area covered by the network. The completeness magnitude of the network is 2.2. The plate interface where the 1960 slip occurred is free of seismicity. At greater depths, the Wadati-Benioff-Zone can be clearly observed down to depths of about 160 km with a dip angle of about 30°; some indication for a double Benioff-zone at shallower depths (ca. 60 km) is also found. In the continental crust, seismicity is observed related to local fault structures and the active volcanoes. Some clusters of seismicity are located offshore, possibly delineating fault structures in the incoming oceanic plate. In the vicinity of the trench, a large number of events is recorded, and focal mechanisms will be presented, along with the first results from local earthquake tomography and a surface wave dispersion analysis. Ongoing work includes the characterisation of the aftershock distribution of the Maule earthquake and the identification of volcano-seismic signals, which will be correlated with the degassing activity measured by DOAS stations in the future.