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大区域似大地水准面模型的建立方法研究

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摘　要:在充分研究现有几何方法确定局域似大地水准面的基础上,根据独立网内点间高程异常差的不变性和独立网间大地高起算基准面与 WGS84 椭球面的平行性,提出通过两步处理,获得大区域连续似大地水准面的思想和方法,即首先统一相邻两个独立 GPS 网大地高起算基准面,然后再利用几何方法确定大区域似大地水准面。该方法在长江口北岸得到了很好的验证,并取得了比较理想的精度。

关键词:高程异常;似大地水准面;大地高;正常高
中图法分类号:P223.0; P228.42

在地形起伏相对平坦、高程异常变化不大的情况下,利用独立 GPS 网中分布均匀且具有一定密度的 GPS/水准点资料,采用几何方法,可建立局域似大地水准面,从而替代四等甚至三等水准测量[1,2]。需要说明的是,这些 GPS/水准点的大地高并不是非常准确,是以网中观测时间较长的测点资料作为起算数据,通过无约束平差获得的[3]。由于不同独立网中起算点观测时间、条件等因素的不统一,起算点大地高的精度也存在着很大的差异。根据大地高的定义,若认为各网的大地高准确,则这种差异可认为是由不同网内大地高起算基准面的不一致引起的,简称为大地高起算基准面不一致。这种不一致在单一的网内无法体现,可利用几何法获得独立网内的似大地水准面;而在网间却表现得非常明显,即在相邻两个网公共区域内的公共 GPS/水准点上存在着两个截然不同的高程异常,其差异甚至达到几米,并导致利用这些不同期的 GPS/水准数据难以在大区域内建立一个实用的大地水准面模型。

1　基于网间大地高基准面统一的似大地水准面的确定

根据 GPS 网三维无约束平差思想,GPS 网中各点是根据起算点坐标推算得到的,起算点大地高的不准确,会使网中各点的大地高与以 WGS84 椭球面为起算基准的精确的大地高间存在一个常偏差。与此类似,相邻 GPS 网中也存在着相同的情况。若忽略起算点精度的影响,认为无约束平差结果中各点的大地高准确,则根据大地高的定义,可以认为无约束平差计算所得各点大地高的基准面相对 WGS84 椭球面平行且存在常差值,若能寻找出相邻两个 GPS 网大地高起算面相对 WGS84 椭球面在法线方向的差值 dh,即可以实现两个网大地高起算基准面的统一,从而可以利用多个 GPS 网中的 GPS/水准数据,建立大区域似大地水准面模型。其基本思想如图 1 所示。

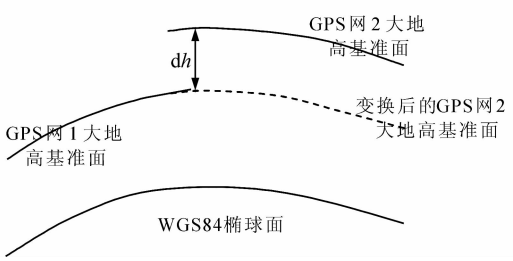

图 1　GPS 网间垂直基准的统一

Fig. 1　Consistency of Vertical Datum Between Adjacent GPS Nets

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Determination of a Quasi-geoid in Large Region with Datum of Continuous GPS Networks

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Abstract: Due to the inconsistency of geodetic-height datum between two adjacent GPS networks, there exists a height-anomaly difference in same GPS point lied the common area of the two networks. The difference results in unable building a quasi-geoid in large-region with these historic GPS-net data. In order to solve the problem, two methods are studied in detail. One is unifying vertical datum; the other is building height-anomaly difference model. For the first, according to the theory of 3-dimension unconstrained adjustment, the two height anomalies of a GPS/leveling point in adjacent GPS networks and the geoid models established respectively in different GPS networks, a geoid model in large-region is constructed finally. For the second, using the way to unify vertical datum in adjacent GPS network, integrating the stability of height-anomaly difference between two points, firstly the height-anomaly difference of each point relevant to the height anomaly of a given GPS/leveling point is calculated. Then, build a model of height-anomaly difference with a polynomial function is built. In virtue of the polynomial function and the given GPS/leveling point, the height anomaly of any GPS point in the GPS network can be calculated. The two methods are tested with 3 historic GPS-net data in north shore of Changjiang estuary, and ±4 cm of root of mean square is acquired.

Key words: height anomaly; quasi-geoid; normal height; geodetic height

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the basis of GGIS is put forward. This multi-level grid framework is based on a uniform 3D Earth reference system and rely on Earth ellipsoid model. A lot of academic and technical problems exist and need to be resolved in sides such as multi-resources and multi-levels global spatial data integration, data expression on 3D ellipsoid surface, multi-levels grid coding and index technologies. Further analysis on the difficulties of these problems, and some reference solutions are also given.

Key words: global GIS; GIS; global grid; uniform 3D earth reference system

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