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28 February 11
GEOL 495
Homework 1

Problem 1: **Define geodesy as a science and describe concisely the three pillars of modern geodesy.**

Geodesy is a science that measures the Earth's geometry and motion over time with a high level of precision by imposing a coordinate system onto the Earth. The three pillars of geodesy are the Earth's shape, gravity field, and rotation; data that allows monitoring of temporal changes in these parameters is being integrated in as it becomes available, and atmospheric remote sensing is emerging as a fourth pillar.

Problem 2: **What is a geodetic "reference system" and what a "reference frame"?**

A geodetic reference system is a 3-diminsional coordinate system that is imposed onto the Earth's ellipsoid from which measurements are observed, a reference frame is how and where objects or points are located within that coordinate system.

Problem 3: **What are the two fundamental global geodetic reference systems and what physical quantity links these two systems together?**

The two fundamental systems are the Celestial and Terrestrial Reference Systems (ICRS and ITRS) they are connected through the Earth's rotation.

What are the two conventional systems accepted by IAG and IAU, and what are the corresponding most accurate reference frames?

The ICRS and ITRS are accessed through the International Celestial, and Terrestrial Reference Frames (ICRF and ITRF).

What organization maintains the systems and frames, and where are the conventions published?

All of the Reference Systems, and Frames are maintained by the International Earth Rotation and Reference Systems Service (IERS), the same service responsible for publishing the conventions.

Problem 4: **For the International Terrestrial Reference Frame (ITRF):**

1.How is the ITRF given and published?

The IERS determines and publishes ITRF.

2.How do reference coordinates for ITRF reference points change over time?

ITRF reference points are determined by the precise locations of known and monitored objects on the Earth's surface, which move as the Earth deforms over time.

3.What is the general mathematical relationship between two versions of the ITRF?

The Helmert transformation is used to convert coordinates between ITRF versions.

4.How can the coordinates of a point in the two systems be compared?

By using the Helmert transformation.

Problem 5: **What are the mathematical shapes of the solid Earth that are related to the main phases in the development of geodesy since its beginning and what are the main parameters of these shapes that were the focus of research/observations in these phases?**

In the first phase, the earth was believed to be a sphere, and as such the radius would be the pertinent parameter. The model changed to a rotational ellipsoid in the second phase, where the equatorial radius and rotational axial length were the main observable parameters. For the third phase, the model evolved into a surface of gravitational equipotential overlaid onto an ellipsoid, where the gravity field, along with former parameters became the focus of study. The current phase of geodesy looks at the Earth as a dynamic model with a shape and gravity field that change over time, the parameters from the previous field remain, but temporal variance is now also considered.

Problem 6: **How is the geodetic reference ellipsoid for the Earth defined and what are the key parameters?**

The geodetic reference ellipsoid is an idealized shape whose surface closely follows the Earth's topography, but is determined mathematically using the equatorial radius and polar flattening. The currently accepted ellipsoid is the GRS80.

Problem 7: **What are the main endogenic and exogenic processes impacting the shape of the Earth from periods of sub-seconds to millions of years?**

Seismic Free Oscillations, co-seismic displacement, plate tectonics, and magma transport are Earth's main endogenic processes. Tides, rotational perturbations, and surface loading are Earth's main exogenic processes.