Abstract: In modern geodesy various effects of the neutral atmosphere have to be considered. The atmosphere delays radio signals emitted by satellites or by distant radio sources observed by VLBI. Atmosphere pressure loading causes deformation of the Earth's surface by more than one centimeter. A major part of the variations of Earth rotation is due to processes in the atmosphere and also to Earth gravity observations from dedicated satellites have to be reduced for the influence of atmospheric mass.

Thus, the atmosphere plays an important role for the Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) with its central theme 'Global deformation and mass exchange processes in the System Earth'. Within our project GGOS Atmosphere all four quantities

- Atmosphere Delay (AD)
- Atmosphere Pressure Loading (APL)
- Atmosphere Angular Momentum (AAM)
- Atmosphere Gravity Field Coefficients (AGC)

will be derived efficiently and consistently from a common data stream of the same underlying meteorological parameters based on the same weather models from the ECMWF (European Centre for Medium-Range Weather Forecasts) and the same geophysical models:

- Earth topography
- Earth model
- Earth gravity field
- Hydrostatic equilibrium
- Ocean models
- Atmosphere tides $S_1$ and $S_2$
- Reference frame and geocenter

In the analysis of space geodetic observations (including GNSS and VLBI) troposphere delays need to be modelled very accurately. This analysis is usually done by determining a priori hydrostatic delays (product of zenith hydrostatic delay and hydrostatic mapping function) and estimating the residual zenith (wet) delay with the wet mapping function as partial derivative.

All parameters of interest can be derived from data of numerical weather models with ray-tracing strategies.

Atmosphere Delay:

Tropospheric path delays

\[
N = k_1 \frac{R}{m_u} + k_2 \frac{e_{w}}{T_\text{w}} + k_3 \frac{e_{z}}{T_\text{z}}
\]

refractivity

\[
D_i = 10^{-6} \left[ \int N(s) ds \right]_{S-I} + \left[ S - G \right]
\]

Comparison of changes in length of day and the axial term $\chi_3$ calculated as sum of matter and motion terms ($\chi = \chi_1 X_1 + \chi_2 X_2 X_3$) for January 2006 – December 2008. The inverted Barometer-correction was applied to $\chi_3$. LOD taken from the IERS C04-record.

The goal of the AAM portion is to rigorously model the atmosphere contribution to changes in Earth rotation. Based on the assumption that the angular momentum of the whole Earth is conserved, short- and long-period atmosphere excitations of polar motion and LOD are estimated by using the so-called effective angular momentum (EAM) functions ($\chi_1 X_1 + \chi_2 X_2 X_3$).

Comparison to Earth rotation parameters will be carried out both in time and frequency domain, including state-of-the-art VLBI and GPS data.

Common wind-velocity & density of the atmosphere

Atmosphere Angular Momentum:

Atmosphere Pressure Loading:

Loading of the Earth’s crust due to the redistribution of global atmosphere masses can displace the positions of geodetic sites by more than one centimeter both vertically and horizontally. Thus, a rigorous computation of the displacements has to be carried out in order to correct the effects of the atmosphere pressure loading on geodetic sites.

The main objective of the APL part is to develop a procedure for accurate calculations of the displacements that would be suitable for routine analysis of space geodetic observations.

OUTLOOK: Within GGOS Atmosphere (FWF project number: P20902), based on identical data sets from the ECMWF and with the same underlying geophysical models, consistent time series for AD, APL, AAM and AGC will be obtained. For that the most accurate geophysical models with as few hypotheses and approximations as possible will be used.