IAG Resolutions
adopted at the XXIIth General Assembly in Birmingham, 1999.

Resolution 1:

The International Association of Geodesy

recognizing

a. the vital interest to its national delegates of Global Navigation Satellite Systems (GNSS) such as GLONASS, GPS and GALILEO, for a tremendous range of future applications in all fields of geodesy and geophysics
b. the affordable support of GPS for sustainable infrastructure development, state-of-the-art transport navigation and guidance, and other industrial systems, and
c. the need to raise awareness of the global importance of GNSS and of critical issues affecting their use, since

a. for successful operation they require a dedicated radio frequency spectrum protected from incursions into the allocated bands,
b. this worldwide spectrum is supervised by the International Telecommunications Union (ITU) but decisions on band allocation are made by the World Radio Conference (WRC),
c. the next WRC in April/May 2000 will vote on proposals for the mobile satellite communications services (MSS) industry to share spectrum in the radio navigation band used by GLONASS, GPS and other satellite navigation services, so that
d. these proposals, if adopted, establish a dangerous precedent to undermine the capabilities, utility and future growth of GNSS,

considering

the extreme and critical importance of protecting existing radio frequency spectrum allocations to GNSS, and

recommends

1. the Association and its national delegates open active debate on spectrum issues to influence each country's position at ITU and the WRC-2000; specifically

a. in concert with related organisations they should promote international effort to change emphasis from purely telecommunication spectrum needs to include also those of existing and future satellite based positioning, navigation and timing systems, and
b. national delegates should approach their appropriate national institution or WRC delegate to register IAG's urgent concern for GNSS spectrum protection, while

1. the IAG secretary general be directed to send a letter, in consultation with GNSS radio frequency experts, to the appropriate official at ITU, advising them of the critical importance of this matter to IAG, in their scientific studies of the earth and in their practical applications of the results of this research; a copy of this letter to be posted on the IAG website.

Sponsored by Larry Hothem

Resolution 2:

The International Association of Geodesy

recognizing

1. the longstanding requirement for a precise and detailed determination of the Earth's gravity field and its fluctuation with time, documented in resolutions by IUGG, IAG and other organisations and resulting in development by NASA and ESA of the GRACE and GOCE missions, where

a. GRACE will be the first mission with satellite-to-satellite tracking between two low orbiters, and
b. GOCE will be the first with a gravity gradiometer, and

1. the urgent need for both types of mission,

a. a) GRACE concentrating on variations of earth gravity with time, and
b. b) GOCE on maximum spatial resolution,

so that the two types permit wide application of gravity research to solid earth physics, oceanography, glaciology, hydrology, geodesy and sea level determination

welcomes

such developments, and

urges

the space agencies to pursue these developments with vigour.

Sponsored by R. Rummel as President of Section II

Resolution 3

The International Association of Geodesy

recognizing

1. the accuracy of the instrumentation used for terrestrial electronic distance measurement and for measurements to satellites has improved greatly since IUGG adopted a resolution on the refractive index of air in 1963,
2. new absolute and relative measurements of the refractive index of air have been made since 1963,
3. more accurate refractive index formulae have been developed and older formulae have been found to be in error since 1963,
4. the international temperature scale was revised in 1990, and
5. a carbon dioxide content of air of 300 ppm is no longer appropriate

noting

the continuum dispersion formulae used by the recommendation below do not account for the effects of anomalous refractivity due to molecular resonances in the visible and near-infrared,

recommends

1. sub paragraphs (a) and (b) of Resolution No. 1 of the 13th General Assembly of IUGG (Berkeley 1963) be cancelled
2. the group refractive index in air for electronic distance measurement to better than one part per million (ppm) with visible and near infrared waves in the atmosphere be computed using the computer procedure published by Ciddor & Hill in Applied Optics (1999, Vol.38, No.9,1663-1667) and Ciddor in Applied Optics (1996, Vol. 35, No.9, 1566-1573),
3. the following closed formulae be adopted for the computation of the group refractive index in air for electronic distance measurement (EDM) to within 1 ppm with visible and near infrared waves in the atmosphere:

$$N_L = (n_L - 1)10^6 = \left(\frac{273.15}{1013.25} \cdot \frac{N_g p}{T}\right) - \frac{11.27 \cdot e}{T}$$

where N_L is the group refractivity of visible and near infrared waves in ambient moist air, T is the temperature in Kelvin (ITS-90), $T = 273.15 + t$, t is the temperature in degrees Celsius (ºC), p the total pressure in hectopascal (hPa) and e the partial water vapour pressure in hectopascal (hPa) and n_L is the corresponding group refractive index.

The group refractivity N_g of standard air with 0.0375% CO_2 content at $T = 273.15$ K (0ºC), $p = 1013.25$ hPa, $e = 0.0$ hPa is as follows

$$N_g = (n_g - 1)10^6 = 287.6155 + \frac{4.88660}{\lambda^2} + \frac{0.06800}{\lambda^4}$$

where λ is the carrier wavelength of the EDM signal (in micrometre, μ m) and n_g the corresponding group refractive index.

These closed formulae deviate less than 0.25 ppm from the accurate formulae (see (2) above) between -30ºC and +45ºC, at 1000 hPa pressure, 100% relative humidity (without condensation) and for wavelengths of 650 nm and 850 nm, for example. The 1 ppm stated before makes some allowance for anomalous refractivity and the uncertainty in the determination of the atmospheric parameters.

Where required, the phase refractivity N_{ph} of standard air with 0.0375% CO_2 content at T = 273.15 K (0ºC), p = 1013.25 hPa, e = 0.0 hPa may be calculated as follows

$$N_{ph} = (n_{ph} - 1)\,10^6 = 287.6155 + \frac{1.62887}{\lambda^2} + \frac{0.01360}{\lambda^4}$$

where λ is the carrier wavelength of the signal (in micrometre, μ m) and n_{ph} the corresponding phase refractive index.

Sponsored by the Ad-Hoc Working Group on *Refractive Indices of Light, Infrared and Radio Waves in the Atmosphere* (convener: J. M. Rüeger) of the IAG Special Commission SC3 on Fundamental Constants (SCFC).

Resolution 4

The International Association of Geodesy

recognizing

1. the ultimate limit set by anomalous refractivity, due to absorption lines, to the accuracy of any continuous visible and near infrared refractive index formula, particularly the group refractive index,
2. the scarcity, particularly in the near infrared, of the absolute refractivity measurements of dry air and moist air, on which present dispersion formulae are based, and
3. the scarcity of direct measurements of the group refractive index, and

noting

the preliminary work done towards computing the magnitude of anomalous phase and group refractivity in the visible and near infrared,

recommends

1. further work on the effect of absorption lines on the phase and group refractive indices of air so as to compute the magnitude of anomalous refractivity for specific instruments and, ideally, provide software to correct for such effects, and
2. new absolute measurements of the refractivity of the constituent gases of the atmosphere (including water vapour) under non-laboratory conditions, with special emphasis on near infrared wavelengths.

Sponsored by the Ad-Hoc Working Group on *Refractive Indices of Light, Infrared and Radio Waves in the Atmosphere* (convener: J. M. Rüeger) of the IAG Special Commission SC3 on Fundamental Constants (SCFC).

Resolution 5

The International Association of Geodesy

recognizing

1. the need for terrestrial and airborne gravity measurements due to the lack of gravity coverage over the polar caps by the planned satellite missions, and
2. the need for improved geoid models in the polar regions,

recommends

a concerted international effort to compile existing available gravity data and to encourage new gravity surveys in the polar regions.

Sponsored by René Forsberg as President of Section III.

Resolution 6

The International Association of Geodesy

recognizing

1. the increasing role played by space techniques in all branches of geodesy,
2. the support by the IAG-related services for a broad range of geoscience activities outside the IAG, and
3. the need to further strengthen the contribution of IAG to the other geosciences,

recommends

1. a process, to be set in motion to define long-term goals for IAG research and effective ways of directing IAG activities towards these goals,
2. a proposal resulting from this process, to be presented to a Council meeting at the Scientific Assembly in 2001, for implementation at the General Assembly in 2003, and
3. a Steering Committee, to be formed during the Birmingham meeting to initiate and organize the above process.

Sponsored by K.P.Schwarz as President of IAG

Resolution 7

The International Association of Geodesy expresses its thanks to the local organising committee and to the University of Birmingham and their staff, not forgetting the contribution of the Guild of Students, for all that they have done to make this last IAG Assembly of the old Millenium a memorable one.