The use of COSMIC radio occultation data for the validation of the BPV Approach capable to retrieve atmosphere profiles in stand-alone mode

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Road Map

- Description of the BPV Approach
- Activity of Validation with COSMIC Data
- Discussion of Results
- Use of CIRA_Q model instead of Hopfield
- Some Preliminary Results
Description of the BPV Approach

• Proposed to “outflank” the problem of rank deficiency in RO: 2 eqs. (Smith-Weintraub, Archimedes law) 3 unknowns (P, T, Pw)

• Where Pw negligible RD is removed (i.e. for h where $T < 250^\circ$)

• The RO obs through the stratosphere layers are used to fit the dry model
A \quad \gamma(a) = \gamma_0(a) + \Delta \gamma(a)

F \quad n_j(a) = n_0(a) + \Delta n_j(a)

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<td>A</td>
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<td>C</td>
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A) \quad \gamma(a) = \gamma_0(a) + \Delta \gamma(a)

B) \quad \gamma(a,n(r)) = \gamma_0(a,n_0(r)) + \frac{\partial \gamma}{\partial n}|_{n_0}\Delta n_j(a) + \sigma(\Delta n)

F) \quad n_j(a) = n_0(a) + \Delta n_j(a)

G) \quad \epsilon_j = \frac{\sum_{i=1}^{k} [\gamma_{\omega_i}(a) - \gamma_j(a,n(r))]}{k}

H) \quad \{\epsilon_j - \epsilon_{j-1}\} \leq 5 \times 10^6, \quad \{i.e. \leq 1\text{milliarcsec}]}

I) \quad n_{net} = \sum_{i=1}^{k} \Delta n_i(r)

J) \quad \text{else } n_j(a) = n_0(a)

K) \quad \text{goto B}
**γ_0(a)** is computed fitting the stratosphere RO data with a dry refractivity model (Hf or CIQA86_Q. see C step)

<table>
<thead>
<tr>
<th>A</th>
<th>γ(a) = γ_0(a) + Δγ(a)</th>
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<tbody>
<tr>
<td>B</td>
<td>γ(a_i, n(r)) = γ_0(a_i, n_0(r)) + \frac{\partial γ}{\partial n_{\text{RO}}(r)} Δn_j(a_i) + o(Δn)</td>
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</tbody>
</table>
| C | If[j == 1] 
  n_1(r) = n_{str}(r, \tilde{P}, \tilde{T}) |
| D | \frac{\partial γ}{\partial n_{\text{RO}}(r)} = \frac{\partial r}{\partial n} \frac{\partial r}{\partial r} [γ(a_i, n_0(r))] |
| E | Δn_j(a_i) = \frac{\partial n_0}{\partial r} [γ(a_i) - γ_0(a_i)] |

| F | n_j(a_i) = n_0(a_i) + Δn_j(a_i); |
| G | \varepsilon_j = \left\| \sum_{i=1}^{k} (γ_{\text{obs}}(a_i) - γ_j(a_i, n_j(r))) \right\| |
| H | If (\varepsilon_j - ε_{j-1}) ≤ 5 \times 10^{-6}, (i.e. ≤ 1 \text{ milliarcsec}); |
| I | n_{\text{wet}}(r) = \sum_{k=1}^{j} Δn_k(r) |
| J | Else 
  n_0(a_i) = n_i(a_i) 
  GOTO B |
Background Dry Bending Angle Function

Cira86aQ

Fit RO data through the Stratosphere where T<250° (Humidity negligible)
Observed BA

Background BA function

\[ P_w = a_1 \frac{N_w T^2}{a_2 T + a_3} \]

\[ a_1 = 77.6; \]
\[ a_2 = 70.4; \]
\[ a_3 = 3.739 \times 10^5 \]
COSMIC Data used for Validation

~1000 Occ. (2009) with RAOB Obs dist<200 Km and time <1 h
COSMIC RESIDUALS - Refractivity
BPV RESIDUALS Water Vapour
BPV vs. COSMIC Water Vapour
BPV vs. COSMIC Water Vapour
CIRA86aQ Model

IMG/UoG Technical Report for ESA/ESTEC-No. 8/1999

ESA study:

End-to-end GNSS Occultation Performance Simulator Enhancement

[ESA/ESTEC contract no. 13327/98/NL/GD; Overview description of Term Object 8.70 of the EGOPS3 ADD/DDD (WP2.3)]

The CIRA86aQ_UoG model: An extension of the CIRA-86 monthly tables including humidity tables and a Fortran95 global moist air climatology model

by

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IMG/UoG, Graz, Austria
CIRA86aQ

- Surface P and T are replaced by the time (the months are transformed in DoY) and the Latitude, Lat. Just **DoY** and **Lat** are the parameters to compute in the fit.
- There is not a mathematical formulation but only tables…
- Thus we have used linear interpolation to built values of P and T for **DoY** and **Lat** not listed in the table.
- The DoY and Lat are very close to real epoch of RO (few Days and few degrees).