Comparison study of COSMIC dry air climatologies based on average profile inversion

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Average Profile Inversion

Individual Profile Processing (IPI)

$$\Delta\varphi(t) \rightarrow \alpha(z_a) \rightarrow N(z) \rightarrow \rho(z) \rightarrow p(z) \rightarrow T(z) \rightarrow q(z)$$

Problems from bending angle $\alpha(z_a)$ to refractivity $N(z)$:

- Bending angle profile limited in altitude
- Decreasing signal-to-noise ratio
- Abel integral up to infinity
- High altitude problem → need for a priori information, such as a statistical optimization (SO) step
- Source for structural uncertainties between climate data products from different processing centers (Ho et al. 2012, Steiner et al. 2013)

Average Profile Processing

Recently a new approach for the production of climate RO products has been introduced (Ao et al. 2012, Gleisner and Healy 2013). It suggests the processing of average bending angle profiles (API), instead of individual profiles through the Abel transform.

$$\bar{\alpha}(z_a) \rightarrow \bar{N}(z) \rightarrow \bar{\rho}(z) \rightarrow \bar{p}(z) \rightarrow \bar{T}(z) \rightarrow \bar{q}(z)$$

Advantage

- The averaging suppresses noise in the data
- Observed bending angle data can be used up to 80km
- Above 80 km a high altitude initialization is necessary
- Avoids complicated statistical optimization step
- Clean and easy computation

Tested succesfully on

- Monthly 5° zonal COSMIC data (Gleisner and Healy, 2013)
- Monthly 10° zonal CHAMP data (Danzer et al. 2014)

Goal

- Comparison study of API inversions between WEGC and DMI
- Plots show monthly 5° zonal COSMIC climatologies, Jan 2011
- DMI: Above 80 km extrapolation to infinity with fixed scale height
- WEGC: Initialization value at 80 km, using ECMWF analysis

References:
Ao et al. (2012), Geophys. Res. Lett., doi:10.1029/2012GL051720
Danzer al. (2014), Atmos. Meas. Tech., doi:10.5194/amt-7-4071-2014
Gleisner and Healy (2013), Atmos. Meas. Tech., doi:10.5194/amt-6-121-2013

Comparison WEGC and DMI

Comparison of Averaging Procedure

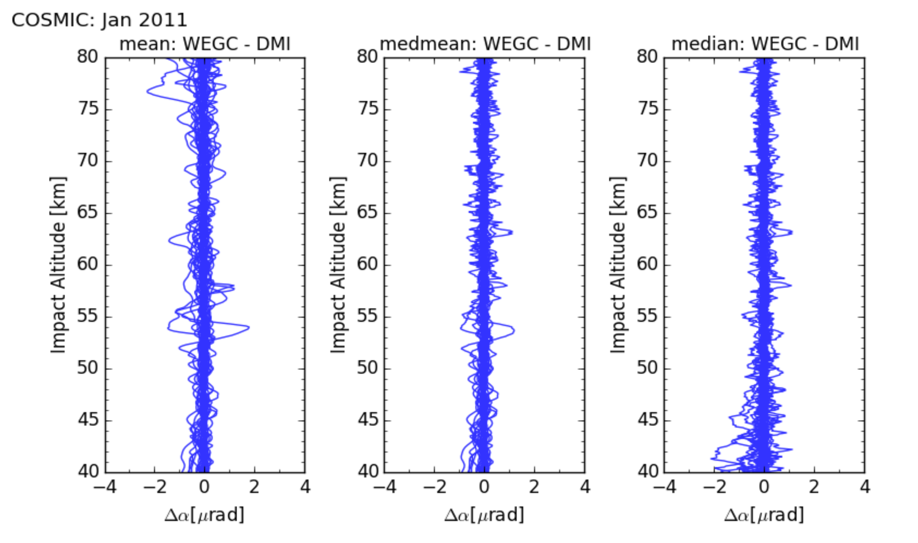

Fig.1: Difference between WEGC and DMI monthly mean, medmean, and median bending angle profiles (BA). Medmean uses mean values up to 50 km, median values above 60 km, and a linear combination inbetween.

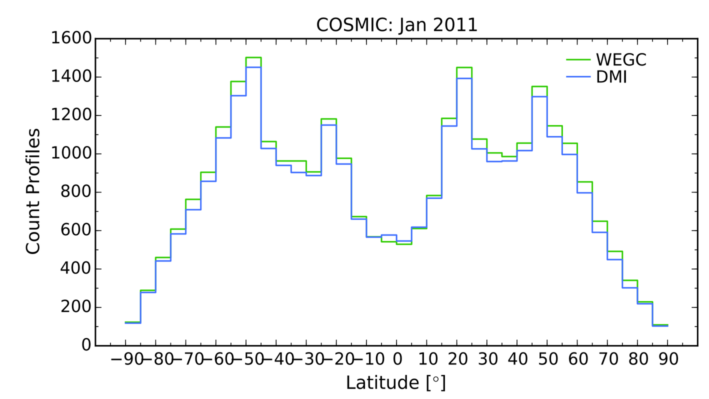

Fig.2: WEGC and DMI number of profiles statistic. Differences enter due to different quality control.

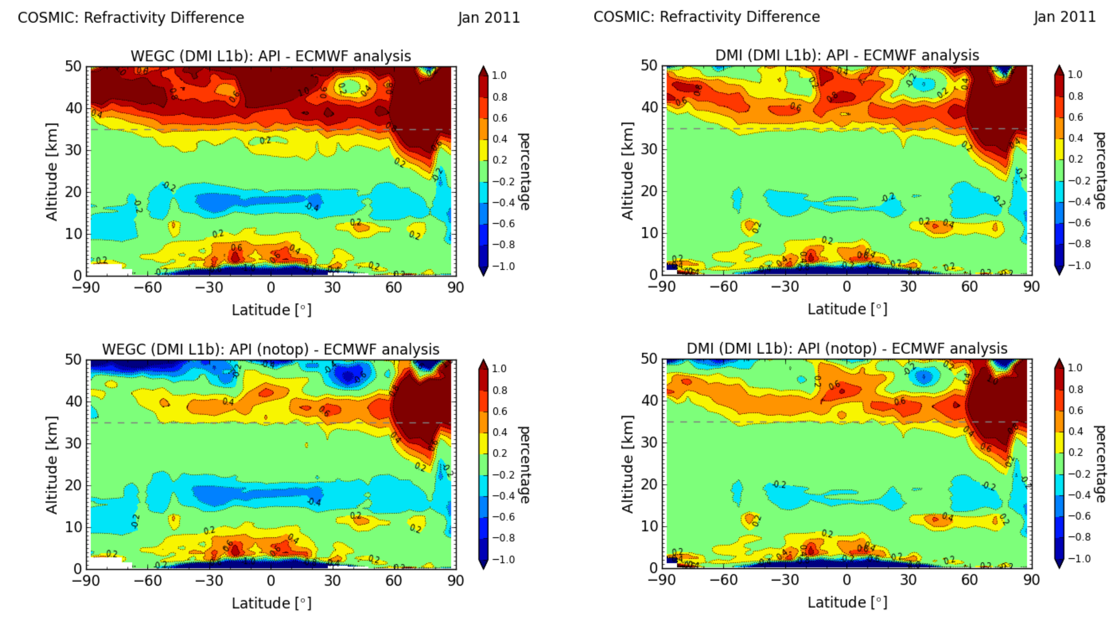

Fig.5: l.h.s. Refractivity difference between WEGC API and ECMWF analysis. Top: Uses a high altitude initialization in the retrieval of the refractivity climatologies. Bottom: Applies no high altitude initialization (notop) in the retrieval. r.h.s. Studies the same, using the DMI API processing.

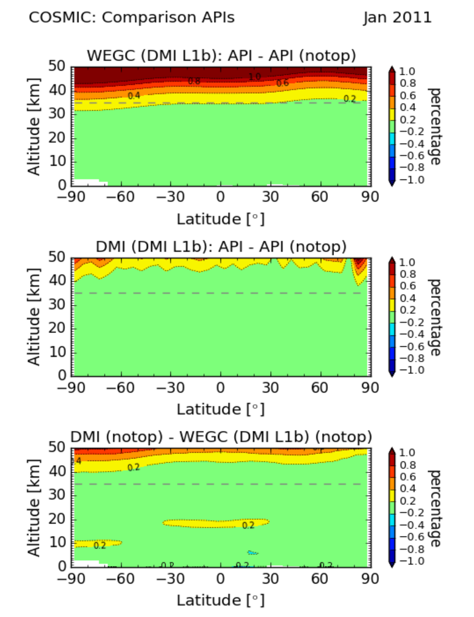

Fig.6: Refractivity difference between WEGC API and DMI API, comparing no high altitude initialization (notop) to high altitude initialization.

Refractivity Climatologies

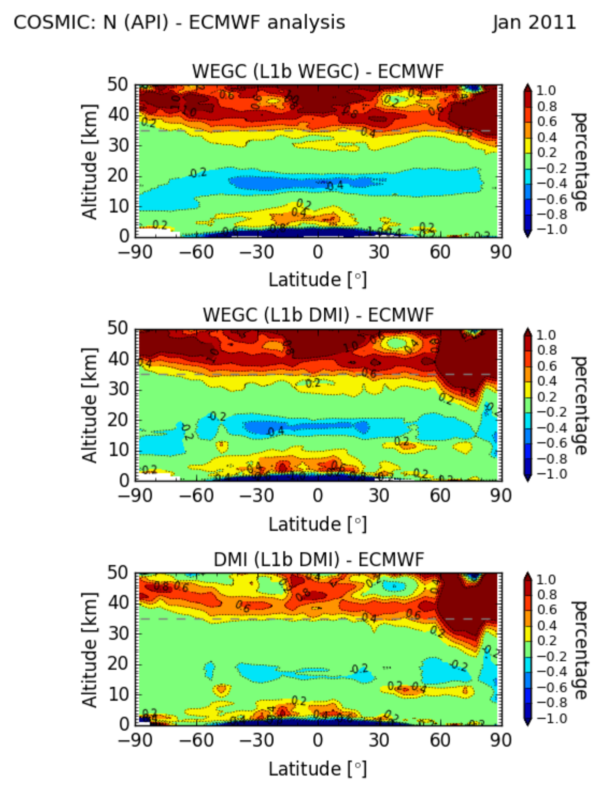

Fig.3: Refractivity difference of API inversions relative to ECMWF analysis. Top: WEGC API using WEGC BA as input (L1b WEGC). Middle: WEGC API using DMI BA (L1b DMI) as input. Bottom: DMI API using DMI L1b as input for the Abel inversion. WEGC API shows larger differences relative to ECMWF, above 35 km.

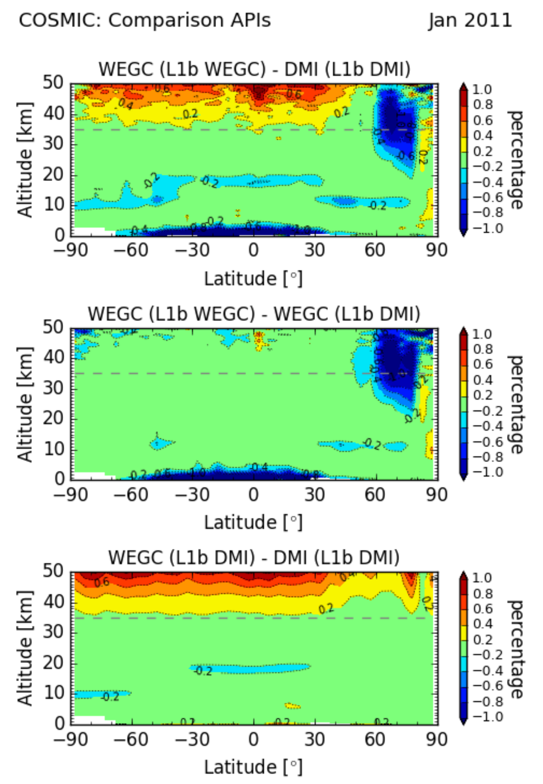

Fig.4: Refractivity difference between WEGC and DMI API inversions, using WEGC and DMI L1b BA climatologies in the Abel inversion. Different API implementations (bottom) lead to differences increasing with height above 35 km.

Dry Temperature Climatologies

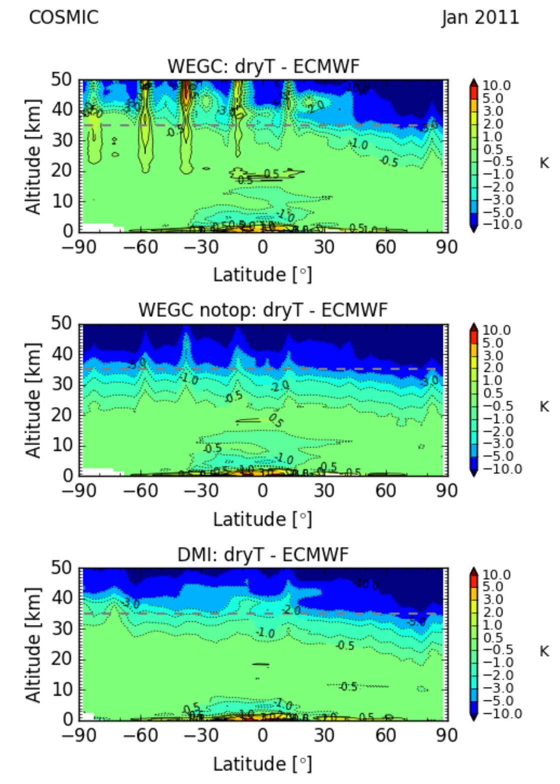

Fig.7: Dry temperature difference relative to ECMWF analysis. From top to bottom we analyze WEGC API, WEGC API (notop), and DMI API, using the DMI L1b BA climatology as input for the Abel inversions.

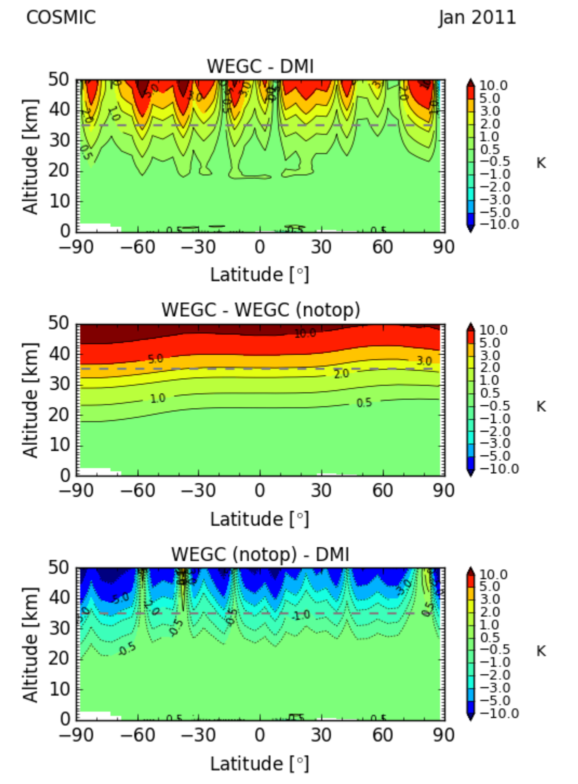

Fig.8: Dry temperature difference between WEGC and DMI API, using the DMI L1b BA climatology as input for the Abel inversions.

Differences in High Altitude Initialization and Abel Inversion

- Use same DMI bending angle input climatology (DMI L1b)
- Use input climatology up to 80 km
- Test no high altitude initialization (notop)
- WEGC and DMI API inversions differ only in their Abel inversions

Conclusions

→ Different Abel inversions have little impact on the resulting refractivity climatologies
→ Largest impact above 35 km results from different high altitude initializations
→ The choice of the high altitude initialization affects the dry temperature climatologies at 30 km about 1 K

Ho et al. (2012), J. Geophys. Res., doi:10.1029/2012JD017665
Steiner et al. (2013), Atmos. Chem. Phys., doi:10.5194/acp-13-1469-2013

Acknowledgments: This work was funded by the Austrian Science Fund (FWF) under grant T 757-N29 (NEWCLIM). Furthermore we thank UCAR/CDACC for providing excess phase data and the ECMWF for providing analysis data.

FWF Der Wissenschaftsfonds.