Assimilation of CHAMP radio occultation profiles

John de Vries, KNMI, Po Box 201, 3730AE De Bilt, The Netherlands, jdevries@knmi.nl

Abstract

Assimilation and forecasting trials with CHAMP radio occultation (RO) data have been performed in HIRLAM. Initial experiments with refractivity profiles show a negative trend in the bias of surface and upper air parameters. RMS scores are only slightly affected.

1. Introduction

RO data can be assimilated in several ways (Eyre [1]). In this study refractivity profiles were selected for assimilation as a compromise between the complexity of forward modeling and the estimation of observation error characteristics. The selection can also be seen as a first step towards future assimilation of bending angle profiles.

2. CHAMP data

RO profiles have a high vertical resolution, ranging from 45m at 5km to 160m at 30km height.

Figure A shows a one-month spatial distribution of RO profiles and one day of profiles in red.

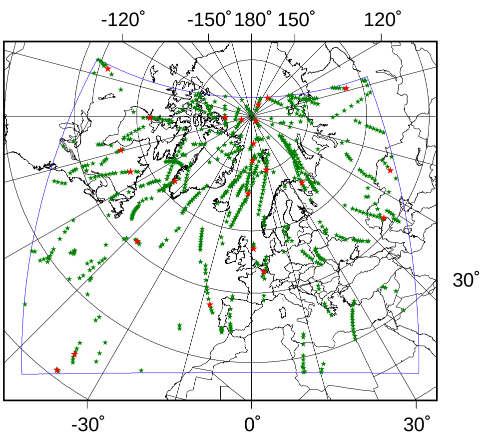


***Figure A**. RO profile distribution in the HIRLAM domain for May 2003.*

The penetration depth of RO profiles (figure B) with latitude is closely related to the distribution of atmospheric water vapor and the ability to retrieve good quality observations.

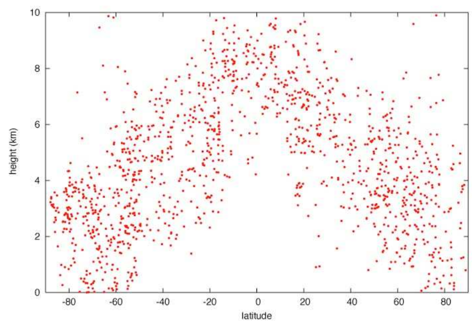


***Figure B**. The lowest perigee points in CHAMP profiles for May 2003.*

3.Results

3.1 Observation error study

Systematic and random error estimates were obtained in a comparison between CHAMP refractivity profiles and those computed from HIRLAM analysis fields (figure C). The systematic error estimate is used for bias correction and the random error is used as weight for the observations in the assimilation.

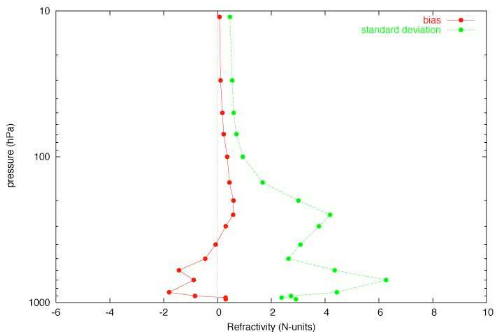


Figure C. *Refractivity bias and standard deviation relative to HIRLAM analyses*

3.2 Impact experiments

Three observation experiments were carried out with HIRLAM.A control run CTL with all conventional observations included. DNL, a model run equal to CTL but with radiosondes excluded. ROC, a run like CTL but with RO profiles included. In the experiments, HIRLAM version 6.3.7 was used at 22km resolution and with 40 layers in the vertical. Model run results were verified against SYNOP and radiosondes. Verification of surface parameters (figure D) shows that the bias in ROC gives a slight improvement for longer forecast ranges relative to CTL (red line), which in turn is much better than DNL, also in RMS. The impact in RMS of ROC is slightly positive in surface pressure but slightly negative in temperature compared to CTL. Changes in the magnitude of the RMS are small between CTL and ROC.

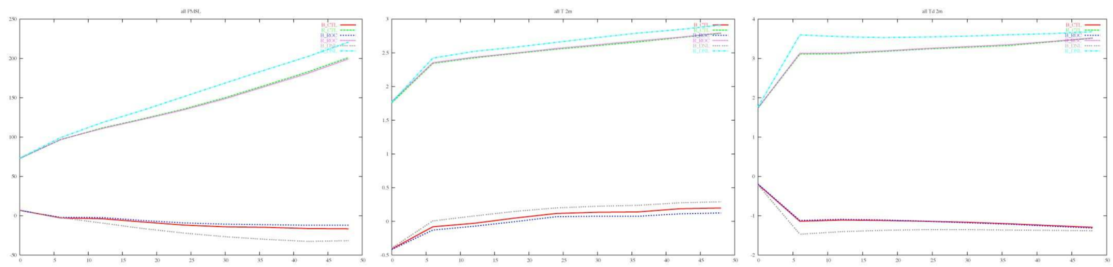


Figure D.*Verification for surface parameters.*

The upper-air bias (figure E) has a negative trend in ROC compared to CTL except for dew point temperature. The trend is beneficial for the warm temperature bias in the boundary layer. The negative bias in geopotential increases near the tropopause. Changes in the magnitude and structure of the RMS (figure F) are small between CTL and ROC.

4. Conclusion

This implementation for RO profiles trades a partly beneficial negative trend in the bias for a slight reduction in skill. Future work will include extending quality control procedures, tuning of observation error statistics and verification of results for the stratosphere

References

[1]Eyre,J.R., Assimilation of radio occultation measurements into a numerical weather prediction system, ECMF Tech. Memo., 1994

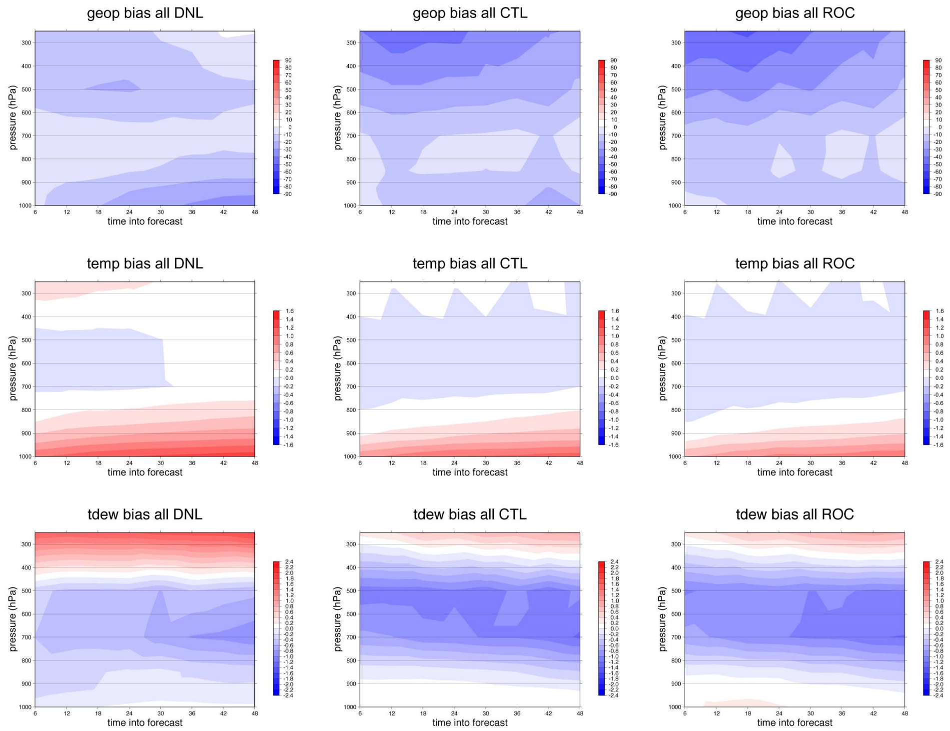
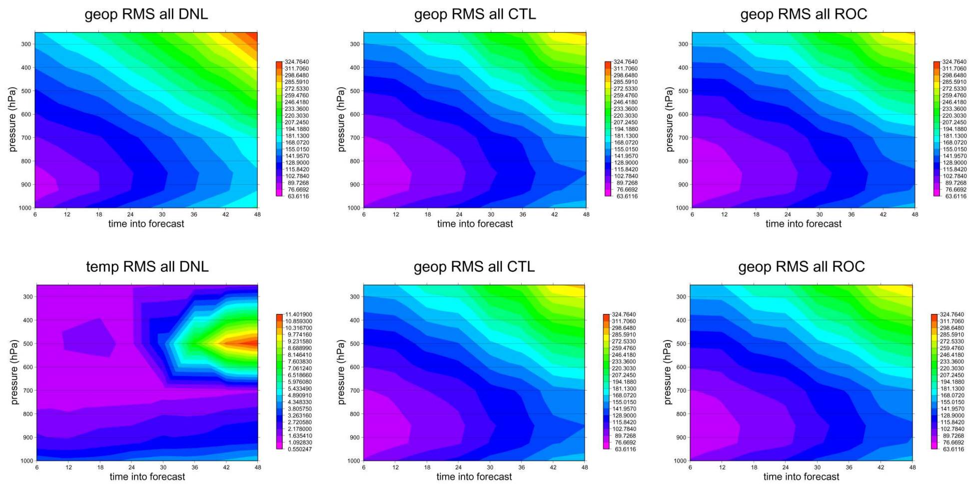


Figure E. *Upper air biases*



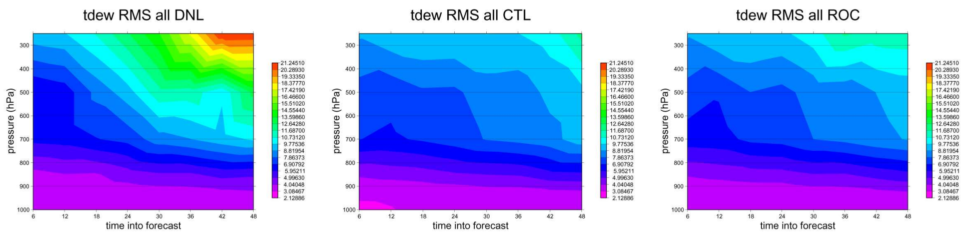


Figure F. *Upper air RMS*