Initial Calculations of Geopotential Heights from HIRDLS Level-2 Temperatures and 50 mb Co-Located GMAO Geopotential Height

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Introduction

Initial Calculations of Geopotential Heights from HIRDLS Level-2 Temperatures and 50 mb Co-Located GMAO Geopotential Height with Comparisons to NCEP/NCAR, ECMWF, and GMAO Geopotential Heights.

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Abstract The High Resolution Dynamic Limb Sounder (HIRDLS) on board the Aura satellite has significant vertical resolution and the ability to sound the upper troposphere/lower stratosphere (UTLS). This enables computation of geopotential heights with significant vertical resolution. We utilize HIRDLS Level-2 temperatures and a 50 mb co-located GMAO geopotential height to complete initial calculations of HIRLDS Level-2 geopotential heights. We furthermore compare these HIRDLS Level 2 geopotential heights with NCEP/NCAR, ECWMF, and GMAO co-located geopotential heights.

Method

Calculate Geopotential Height via $Z_j - Z_i = (R_d/g_0)_{pj} \int^{pi} T\, dp/p$

where $Z_j - Z_i$ indicates GPH thickness between HIRDLS pressure layers, with the exception of the 50mb GMAO layer (see below) where we computed layers with it and HIRDLS pressures 51mb and 46mb.

Input

HIRDLS Level-2 Temperatures

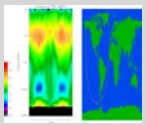

Figure 1: HIRDLS Temperature (K) vs. Latitude and Orbit for one sample orbit 2007d089 . Black indicates missing data.

50-mb co-located GMAO GPH where co-located means bi-linear interpolation from the lat/lon grid to the HIRDLS orbit path and linear interpolation to HIRDLS time steps.

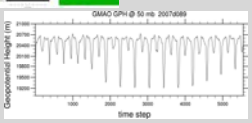

Figure 2: Co-located GMAO GPH @ 50 mb sample 2007d089

Compare to Existing GPH Data

NCEP/NCAR Reanalysis GPH and ECMWF GPH :

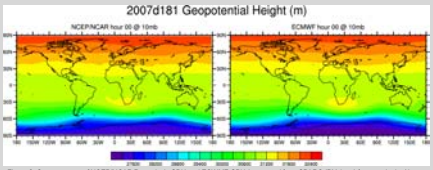

Figure 3: Contour maps of NCEP/NCAR Reanalysis GPH and ECMWF GPH (computed from SPARC-IPY data) for sample day/time 2007d181 hour 00. For comparisons, 2-d spatial dimension data was bilinearly interpolated to orbit paths, and time dimension was linearly interpolated to orbit time steps.

GMAO co-located GPH:

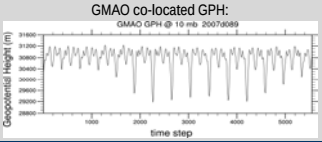

Figure 4: Co-located GMAO GPH @ 10mb sample 2007d089

Technique Refinement

Initial results showed some outliers. Why?

Look at HIRDLS Temperature Precision:

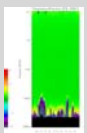

Figure 5: HIRDLS Temperature Precision (K) vs. Latitude for one sample orbit 2007d089

Outliers all had Temperature Precision < 0 K or Temperature Precision > 3 K

➔In GPH calc only use HIRDLS Temperatures with 0 K < Temperature Precision < 3 K

➔New HIRDLS GPH looks good: significant vertical resolution in the UTLS

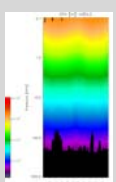

Figure 6: HIRDLS GPH (m) vs. Latitude for one sample orbit 2007d089

Results: Spring

March 30, 2007 HIRDLS GPH (m) @ 10mb and 100mb:

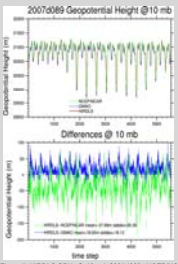

Figure 7: HIRDLS GPH @ 10 mb 2007d089 , NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

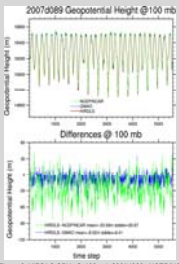

Figure 8: HIRDLS GPH @ 100 mb 2007d089 , NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

Results: Summer

June 30, 2007 HIRDLS GPH @ 10mb and 100mb:

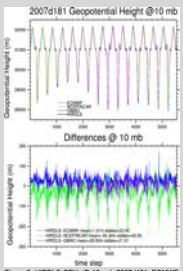

Figure 9: HIRDLS GPH @ 10 mb 2007d181, ECMWF GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

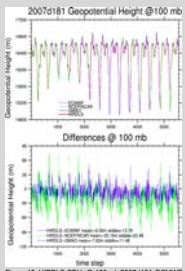

Figure 10: HIRDLS GPH @ 100 mb 2007d181, ECMWF GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

Results: Fall

September 30, 2007 HIRDLS GPH @ 10mb and 100mb:

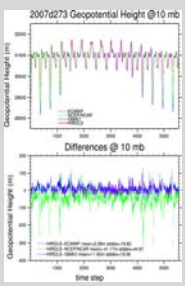

Figure 11: HIRDLS GPH @ 10 mb 2007d273, ECMWF GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

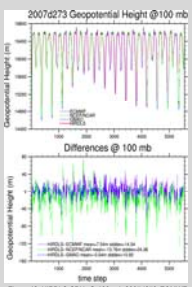

Figure 12: HIRDLS GPH @ 100 mb 2007d273, ECMWFs, GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

Results: Winter

December 30, 2007 HIRDLS GPH @ 10mb and 100mb:

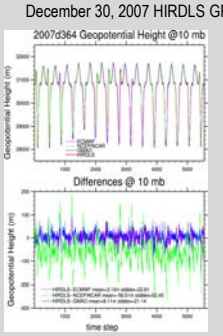

Figure 13: HIRDLS GPH @ 10 mb 2007d364, ECWMF GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

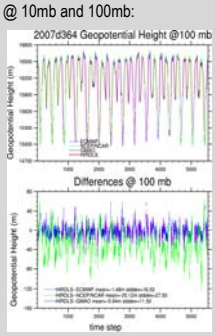

Figure 14: HIRDLS GPH @ 100 mb 2007d364, ECMWF GPHs, NCEP/NCAR GPHs , co-located GMAO GPHs, and their differences

Conclusions:

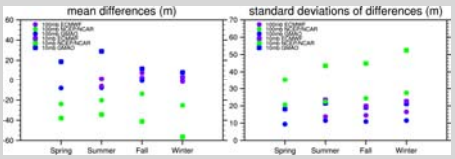

Figure 15: Mean differences of HIRDLS GPHs and other data and standard deviations of differences, by season.

HIRDLS GPHs are compatible with other GPH data at multiple levels for all seasons. This high vertical resolution HIRDLS GPH data should be very useful for various scientific studies.

Further Improvements?

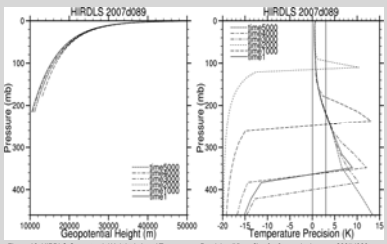

Figure 16: HIRDLS Geopotential Height (m) and Temperature Precision (K) profiles for 6 sample times on 2007d089

We can reduce the number of missing data HIRDLS GPH values if we modify our preliminary Temperature Precision test or improve the HIRDLS Temperature Precisions.

Future Work

- Eliminate High Precision values (see above)
- Check other levels, e.g. 1 mb (see right).

September 30, 2007 HIRDLS GPH @ 1 mb:

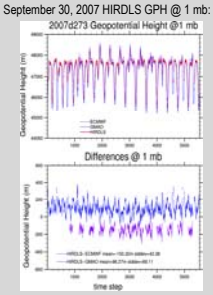

Figure 17: Preliminary HIRDLS GPH @ 1 mb 2007d273 , ECMWF GPHs , co-located GMAO GPHs, and their differences

Acknowledgements

We'd like to thank the whole HIRDLS team for their efforts.

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