

Experiments with increased analysis resolution and satellite radiance data volume in the GEM Global Deterministic Prediction System

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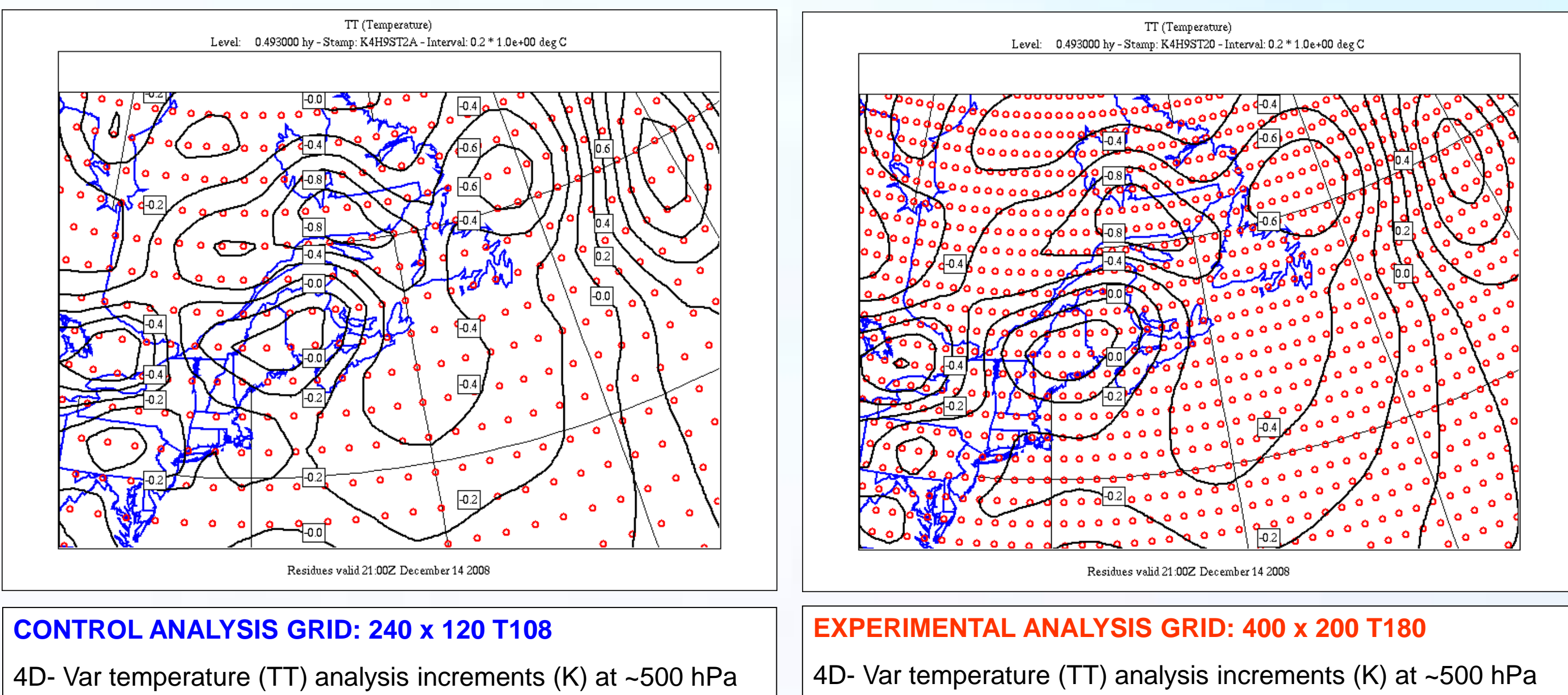
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A. Introduction

- Environment Canada is testing several upgrades to its analysis and forecast suite. The upgrades include an increased 4D-Var analysis increment resolution and a reduction in the thinning applied to satellite radiances prior to assimilation.
- Experiments were conducted to assess the impact of increased resolution of the analysis increments and reduced satellite radiance thinning on global 4D-Var analyses and 6 day Global Environmental Multiscale (GEM) model forecasts.
- Experiments were carried out for a 1 month period: 15 Dec 2008 to 15 Jan 2009 (63 cases). In the plots that follow, the control is always blue and the experiment red.

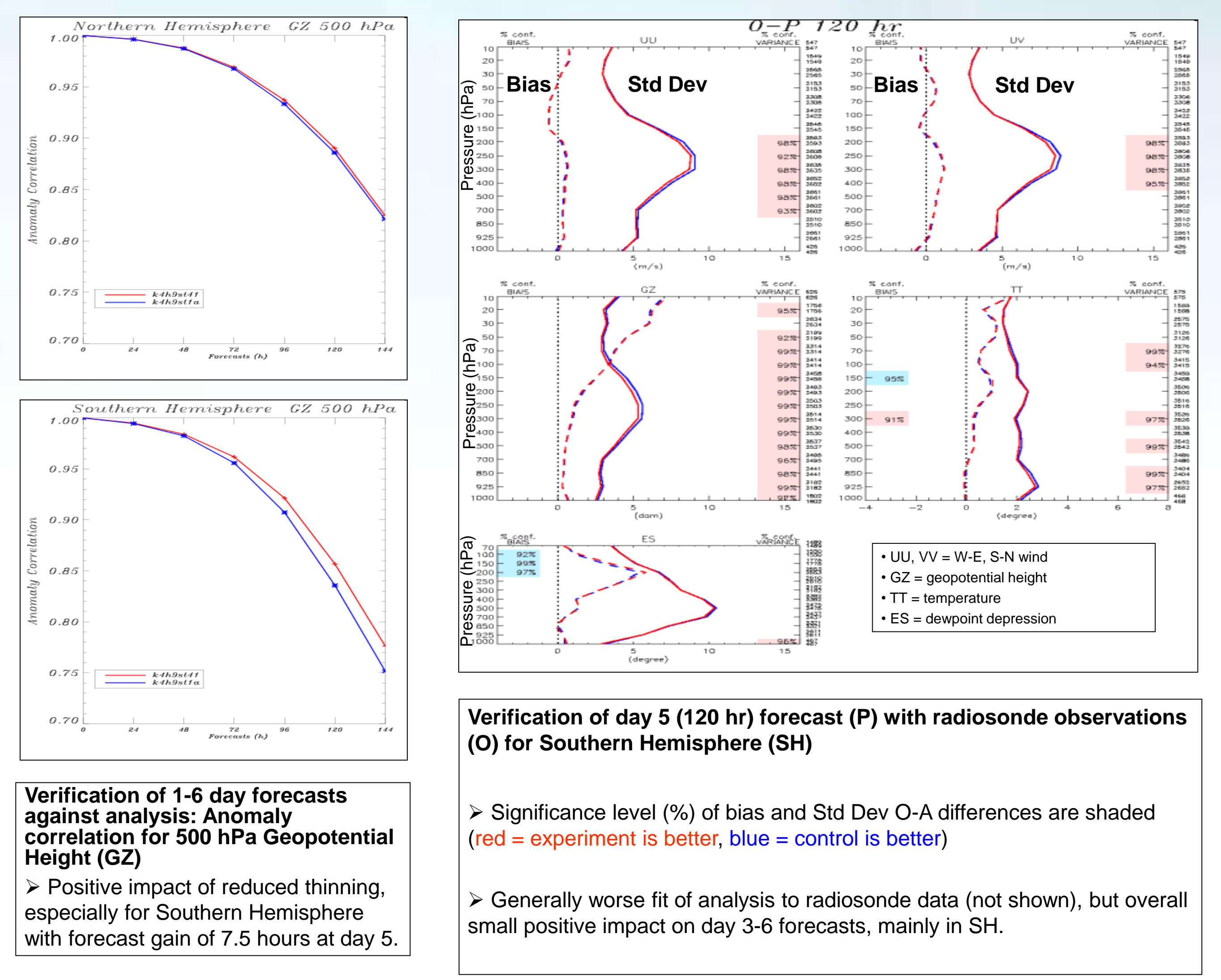
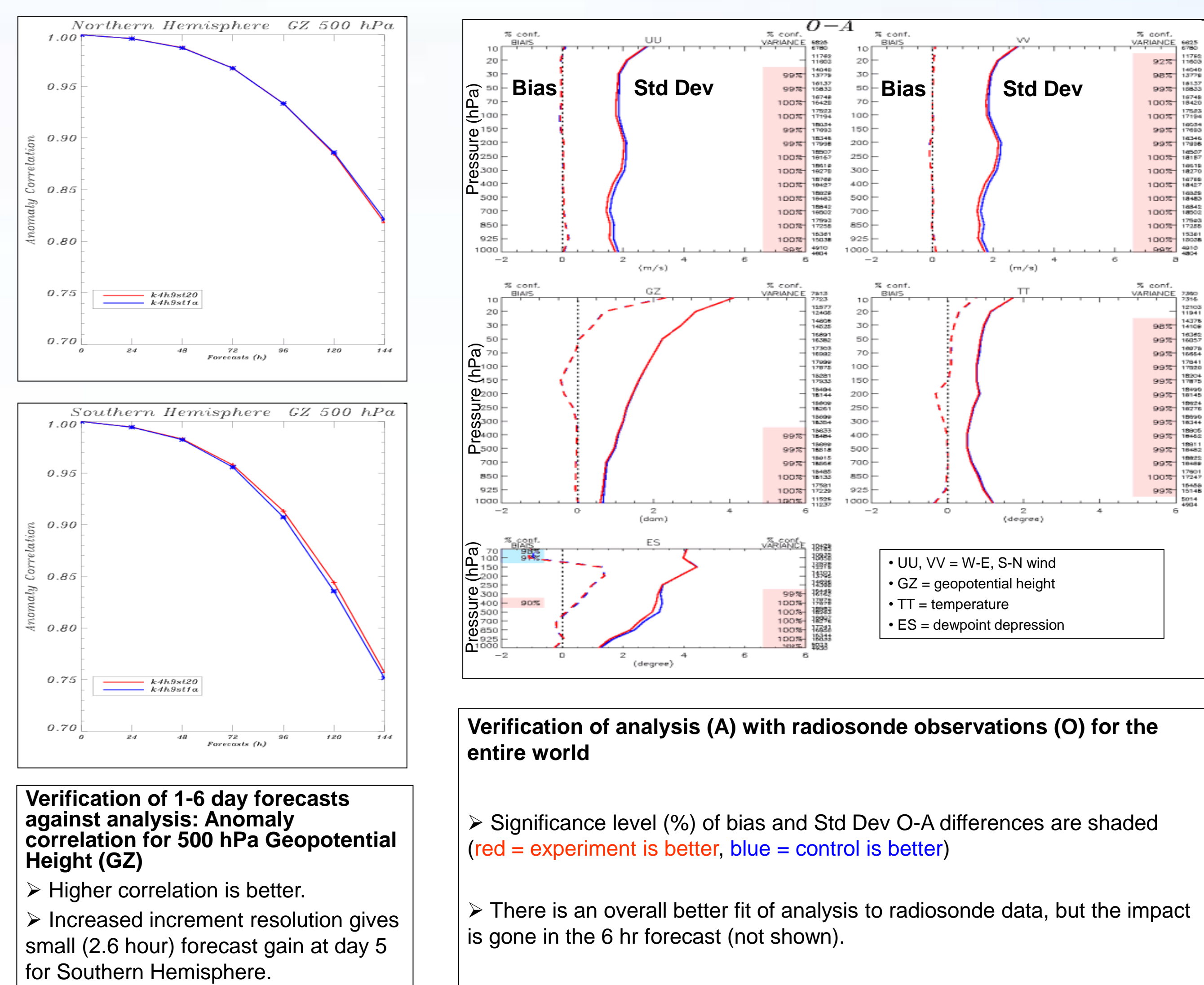
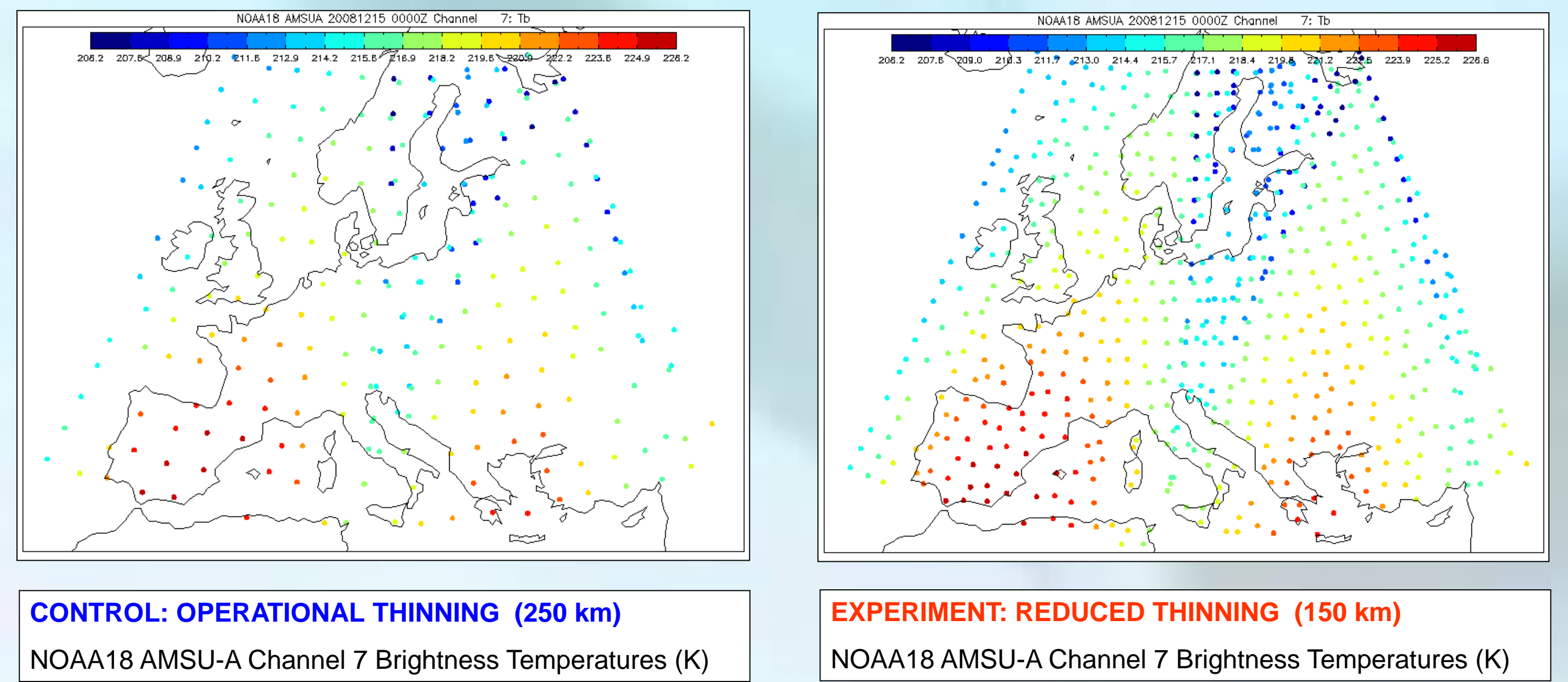
B. Increasing the Analysis Resolution

- The global 4D-Var analysis increment resolution was increased from 240x120 T108 (~180 km) used in operations to 400x200 T180 (~100 km), with a corresponding increase in resolution for the GEM tangent-linear (TL) and adjoint (AD) models
- The operational background state, analysis, and GEM (non-linear) model resolution is 800x600 (~33 km) and was not changed in the experiments.



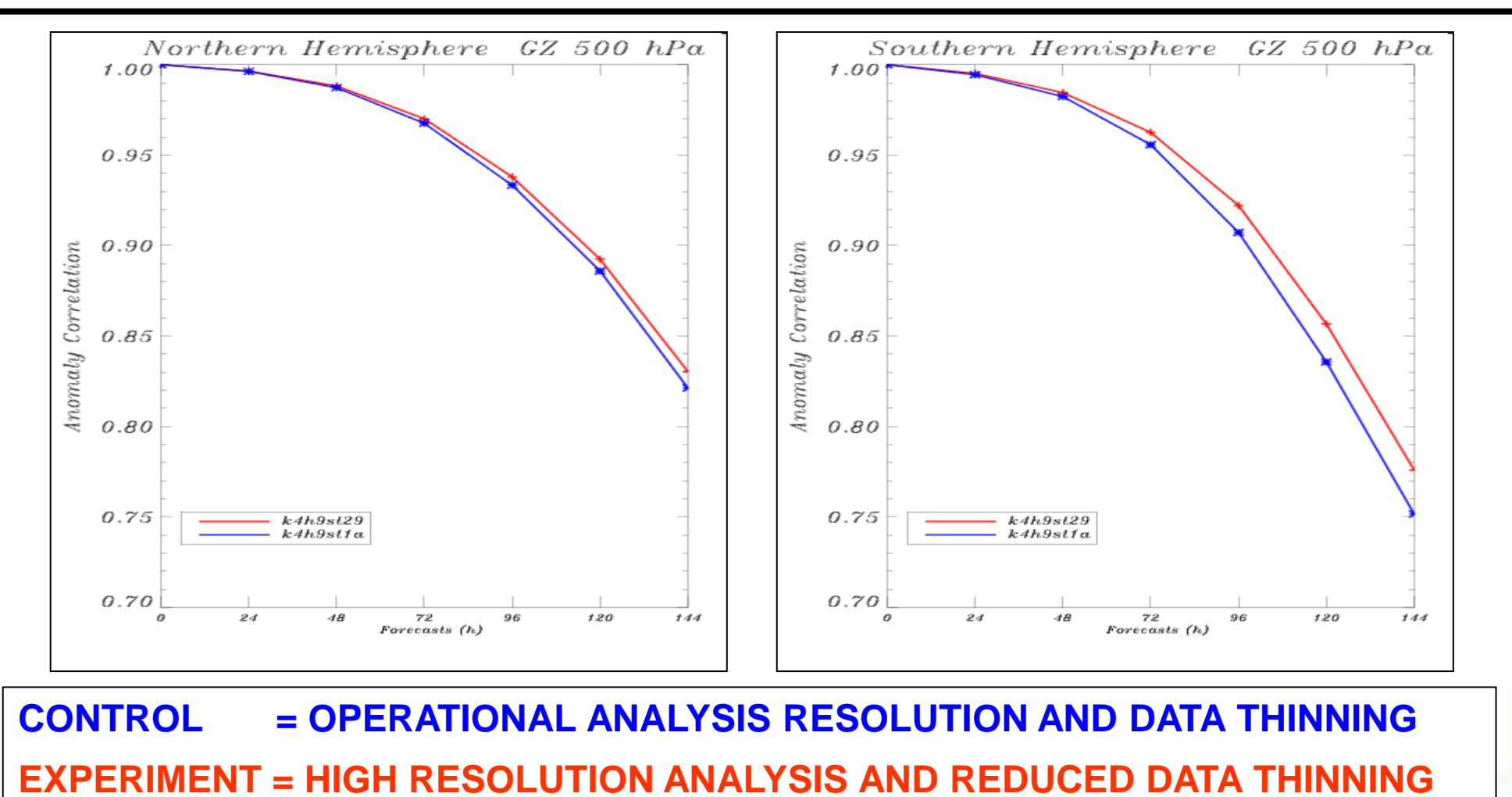
C. Reducing Satellite Radiance Thinning

- Satellite radiances from the following instruments are assimilated: AMSU-A, AMSU-B/MHS, SSM/I, GOES and AIRS.
- In the operational system, satellite radiance data are thinned to 250 km, except for SSM/I and GOES where data are thinned to 200 km.
- In the experiment, all radiances are thinned to 150 km resulting in a 175% increase in radiance data volume (60% for SSM/I and GOES).



D. High Resolution Analysis Plus Reduced Satellite Radiance Thinning

- Reduced thinning of satellite radiances combined with increased analysis increment resolution produces very similar results to reduced thinning alone (Section C) with
 - slightly more positive impact on forecasts for Northern Hemisphere as seen in anomaly correlation (small increase in forecast gain after day 3) and verification against radiosondes (not shown).
 - slight degradation in forecast accuracy for Southern Hemisphere as seen in anomaly correlation (drop of ~0.5hr in day 5 forecast gain) and verification against radiosondes (e.g. the improvements noted in Section C for O-P120h for Southern Hemisphere are absent).
- Verification of forecast 24h precipitation accumulations against precipitation gauge measurements over North America was also done (not shown). Compared to control, impact is neutral to slightly positive in terms of bias and threat scores.



E. Concluding remarks

- Tests show that increasing analysis increment resolution and reducing thinning of satellite radiance data has a positive impact on the analyses and forecasts of the EC global 4D-Var analysis and forecast system, especially in the Southern Hemisphere.
- Most of the improvement stems from increasing satellite data volume through reduced thinning.
- Increasing analysis increment resolution significantly increases the time needed to complete a 4D-Var global analysis and is currently too expensive for operational implementation.
- Reduced thinning is part of a proposed analysis and forecast system upgrade (currently being tested) that includes an updated forecast model (GEM Strato 2), data from additional satellite platforms (IASI, SSMIS, MeteoSat, MT-Sat) and a new unified satellite radiance bias correction scheme.