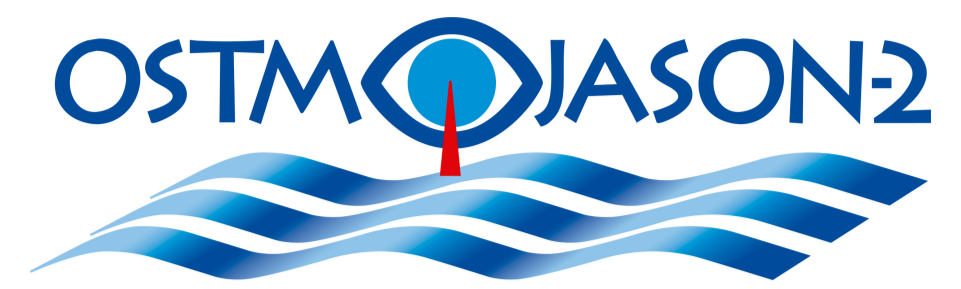


# THE IMPACT OF ECMWF MODEL EVOLUTIONS ON GEOPHYSICAL CORRECTIONS FOR ALTIMETRY



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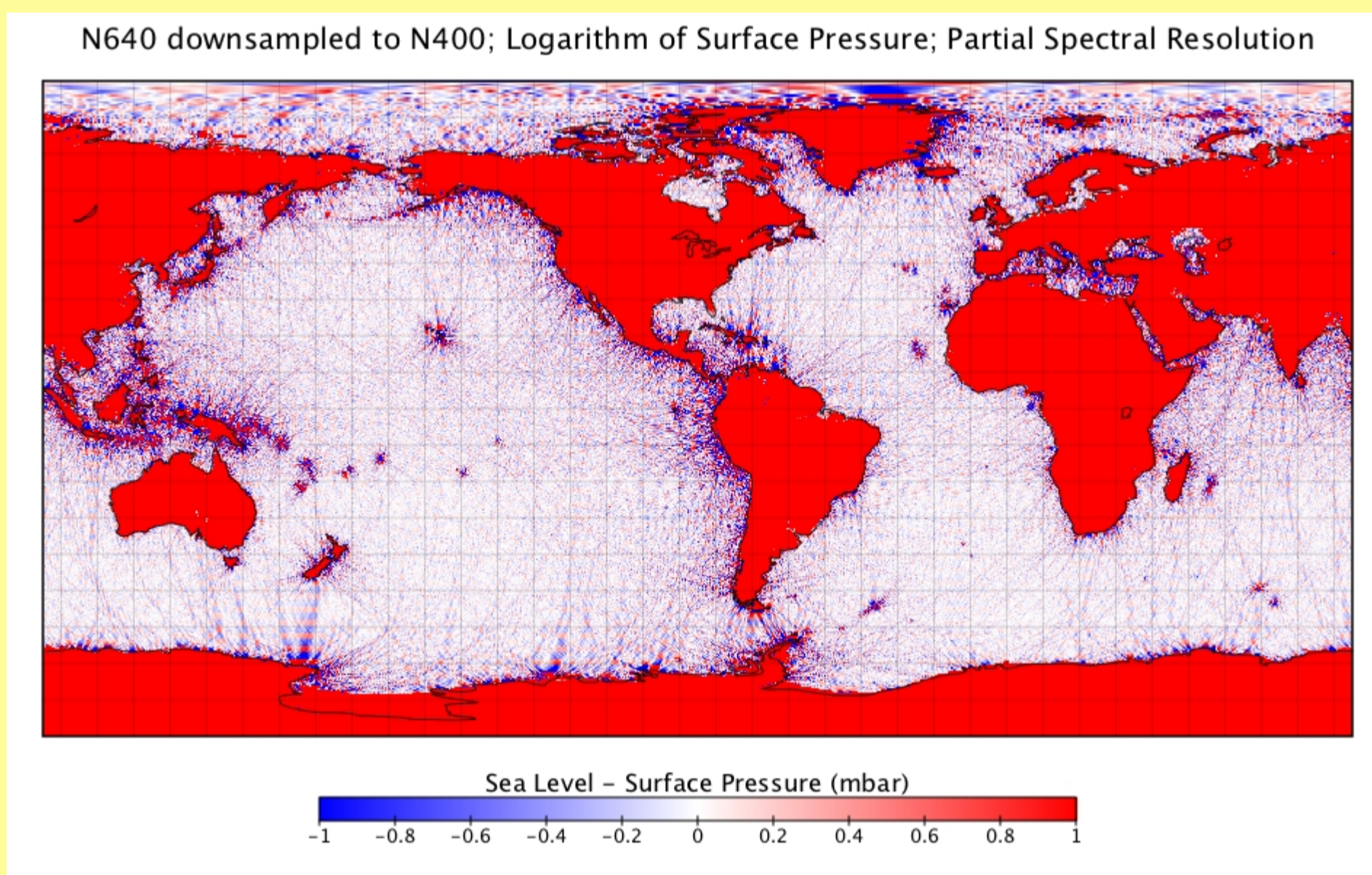


**ABSTRACT:** The deterministic weather prediction model run by the European Centre for Medium-Range Weather Forecasts provides 6-hourly fields of atmospheric surface pressure that are used to calculate two important geophysical variables for altimetry: the dry troposphere and inverse barometer corrections. On January 26, 2010, ECMWF increased the horizontal resolution of its Gaussian grids from N400 (~ 25 km) to N640 (~ 16 km, see [http://www.ecmwf.int/products/changes/horizontal\\_resolution\\_2009](http://www.ecmwf.int/products/changes/horizontal_resolution_2009)). However, the operational scripts running at EUMETSAT, which generate the altimetric corrections, continued to produce lower resolution N400 grids pending the full implementation of high resolution N640 processing. No significant impact to the altimetry data was expected from the model's resolution change. However, our initial validation work found unrealistic **static** variations, reaching several cm amplitude in coastal regions, due to the inverse barometer correction. The source of these artifacts was artificial oscillations in the surface pressure grids, found by differencing them with grids of mean sea level pressure from the same ECMWF model runs. In the final analysis, the surface pressure artifacts were completely eliminated by more carefully down sampling the N640 grids to N400 resolution in three ways:

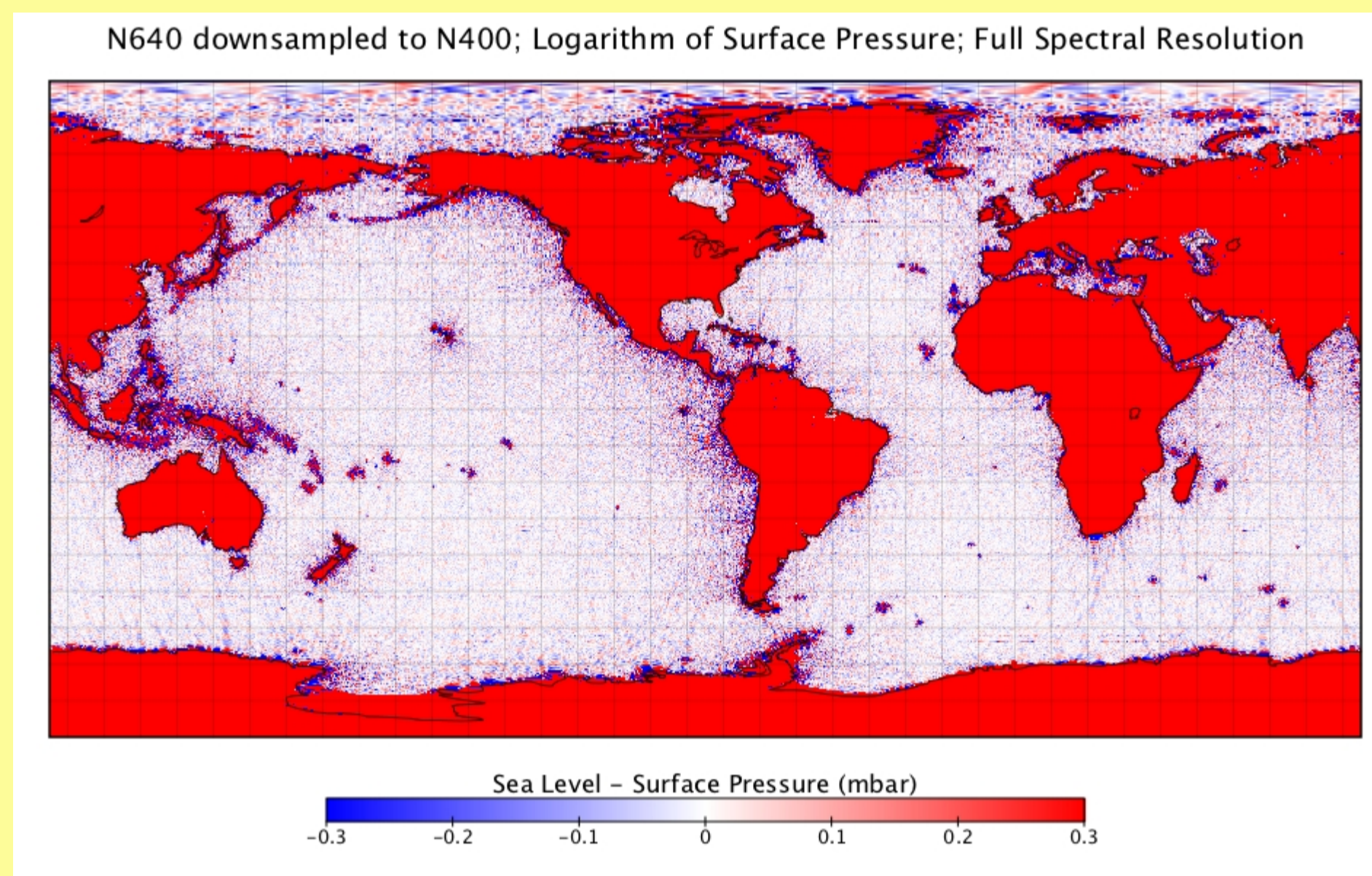
- 1) retain all spectral components when generating model data on the Gaussian (physical domain) grid.
- 2) make all computations using linear surface pressure grids vs. grids of the logarithm of surface pressure.
- 3) use a consistent down sampled geopotential grid for making an orographic correction to pressure.

By the end of 2010, the EUMETSAT scripts will be transitioned to full N640 resolution. A change in the ECMWF model's vertical resolution is planned for early 2011. This will be accompanied by a required change from GRIB to GRIB-2 format for 3-D fields extracted from the model. Our experience serves as a cautionary tale for preparations and testing, prior to these upcoming model evolutions.

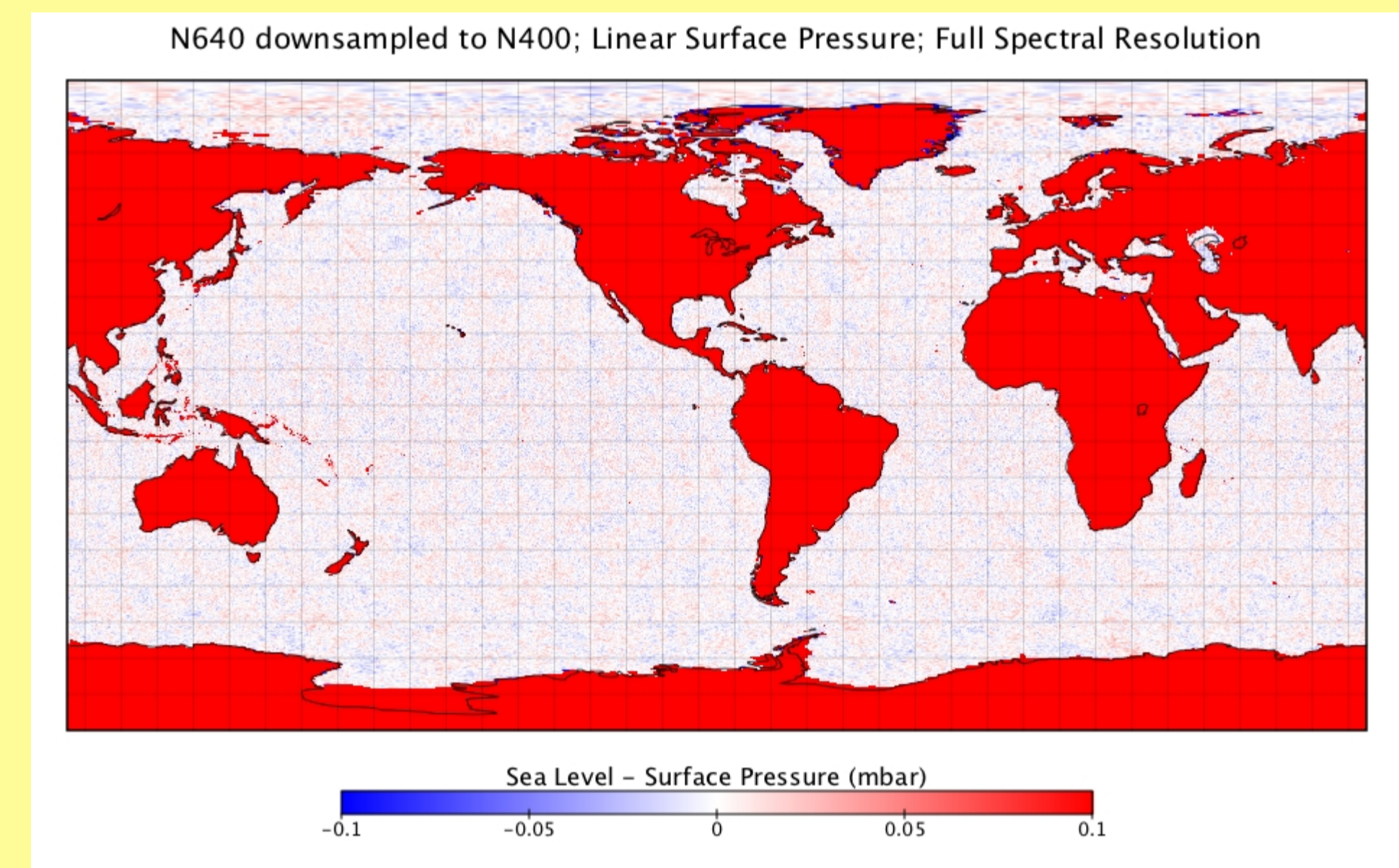
## Horizontal Resolution Increase: 26-Jan-2010



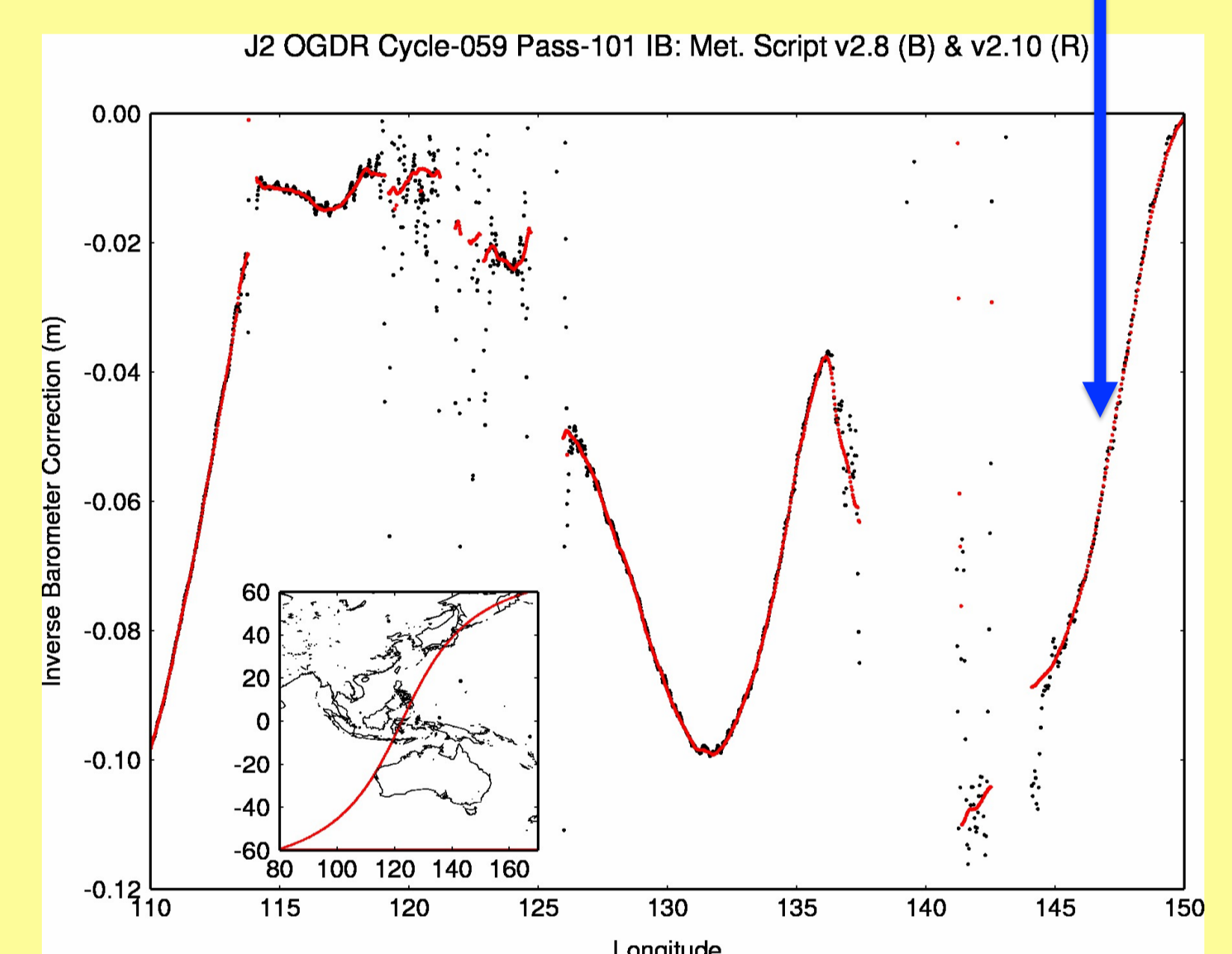
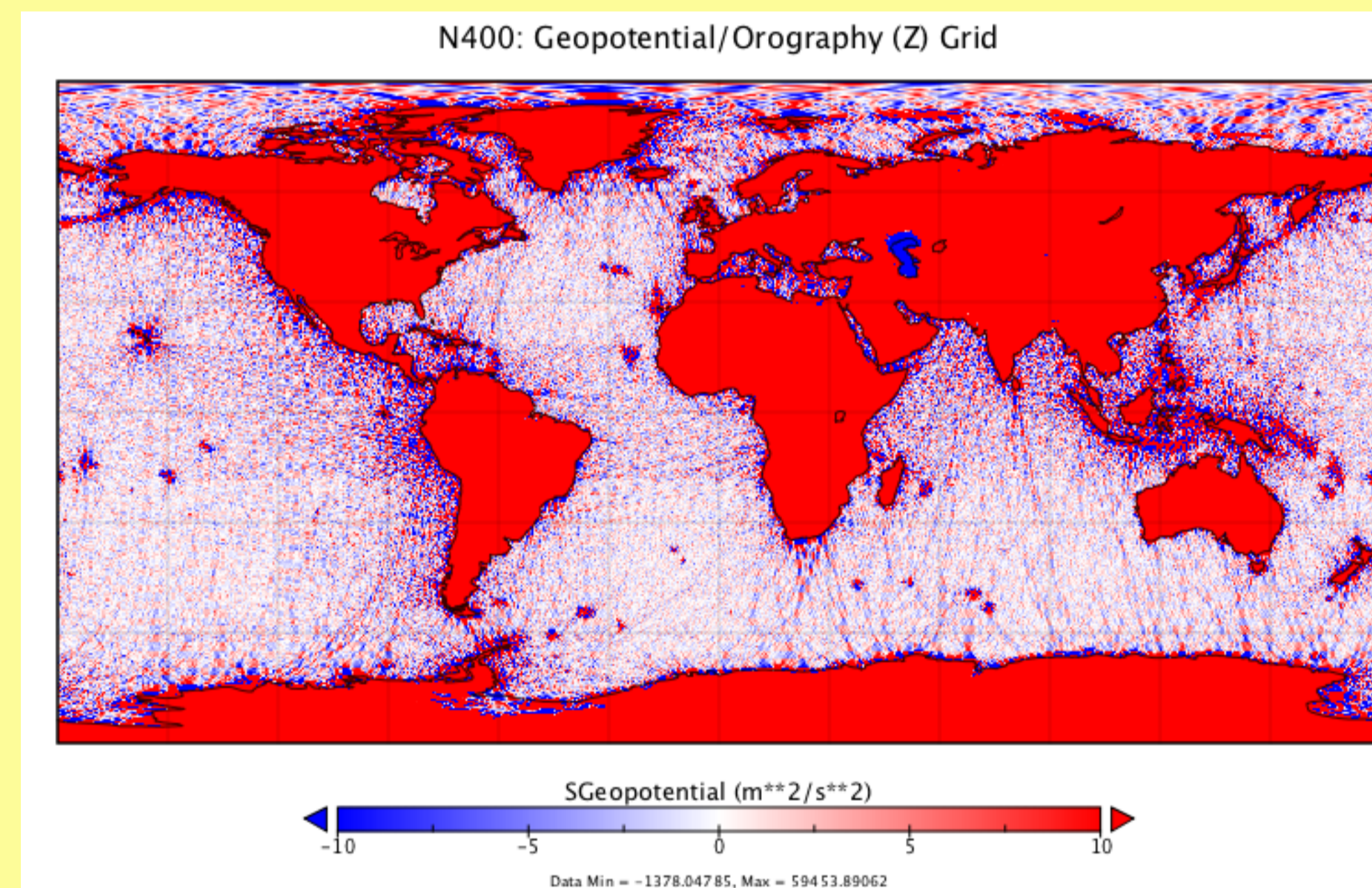
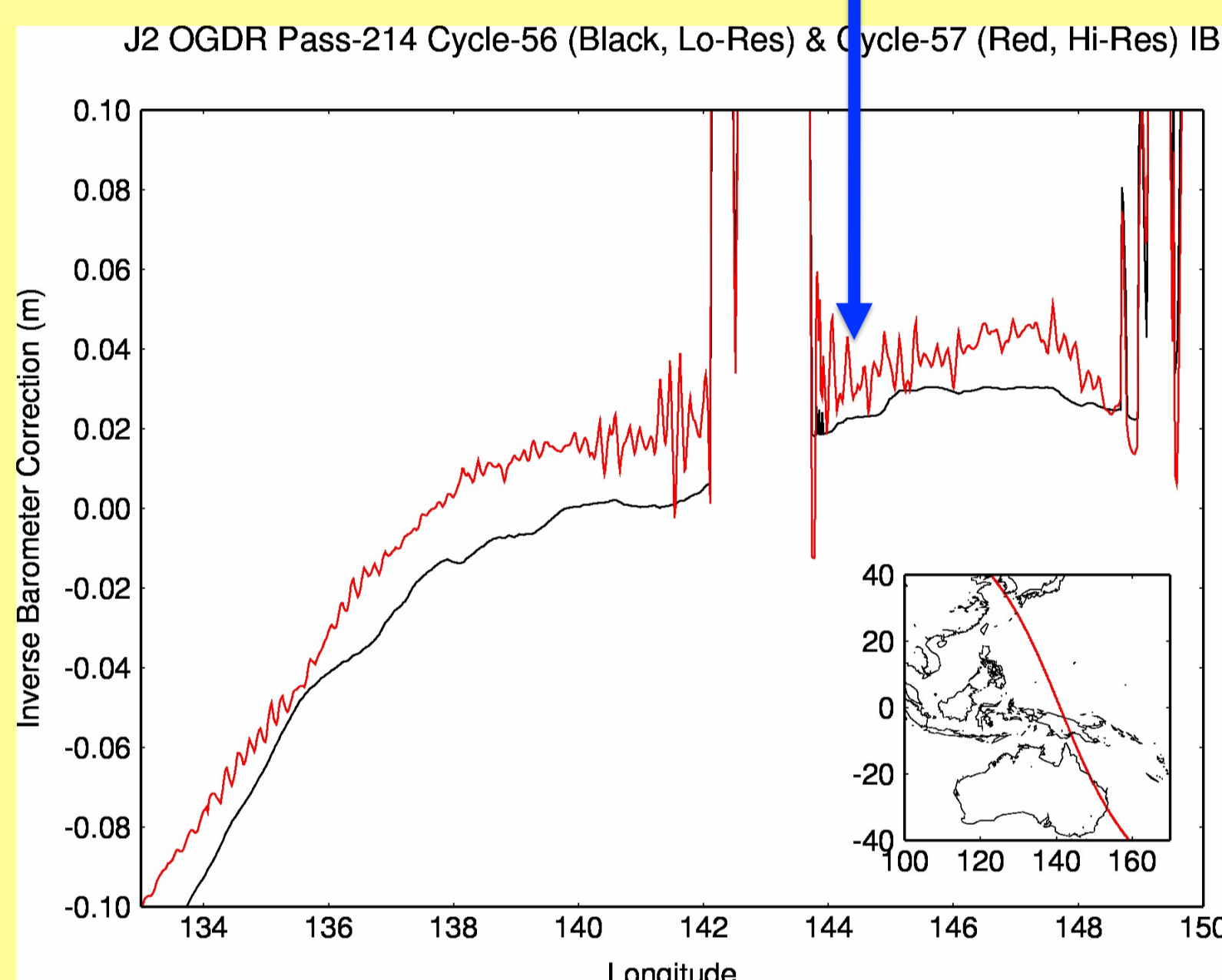
**Original "Met Script" configuration:**  
 Static variations > 1mbar  
 Enhanced noise in coastal regions  
 Leads to cm-level IB errors in SSH



**Initial "Met Script" modification:**  
 Retain **full spectral resolution**  
 Static variations reduced 50%  
 Leads to mm-level IB errors in SSH

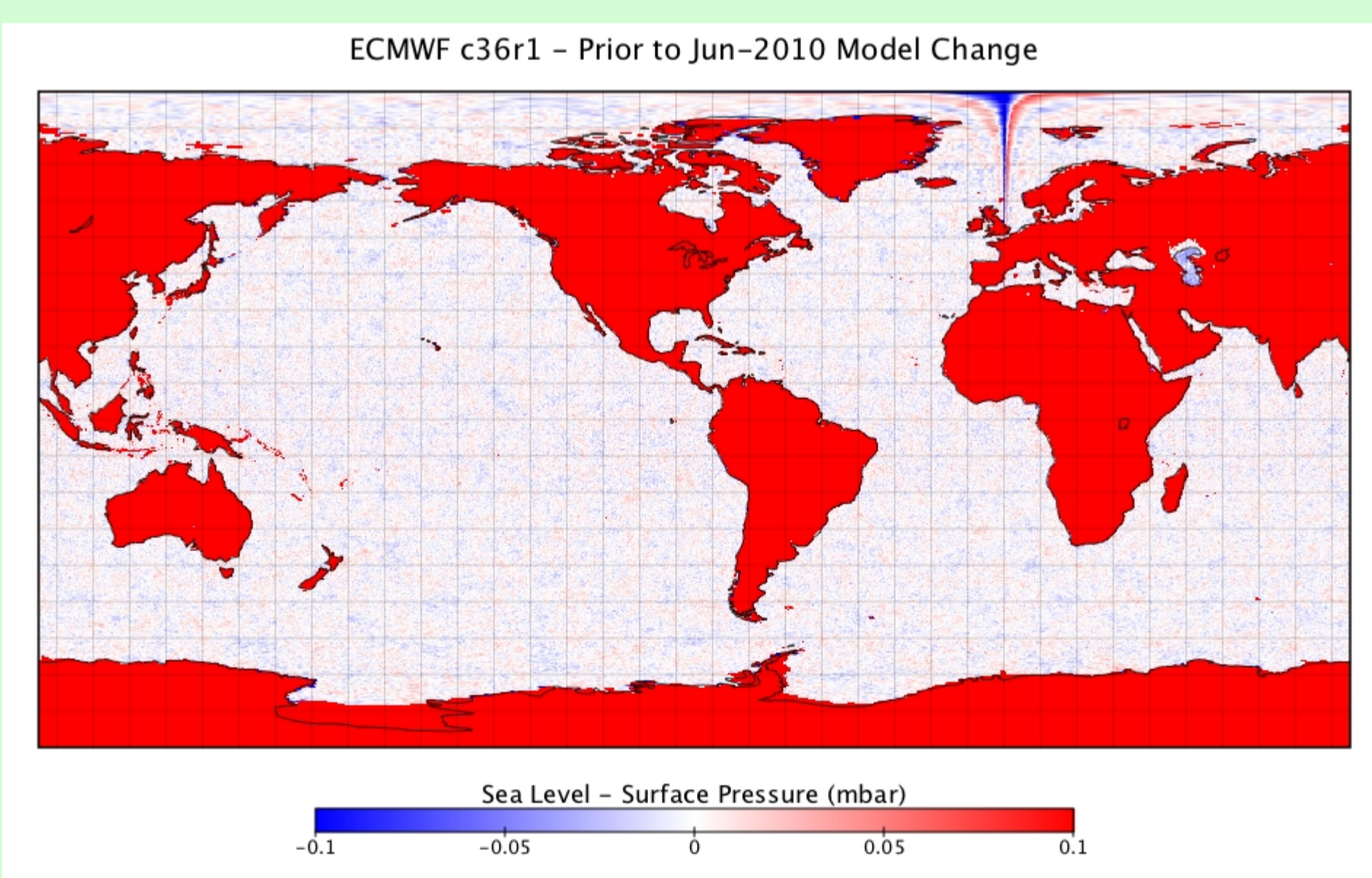


**Final "Met Script" modifications:**  
 Utilize **linear surface pressure vs. logarithm**  
 Include **consistent orographic correction**  
 Static variations eliminated: sub-mm errors

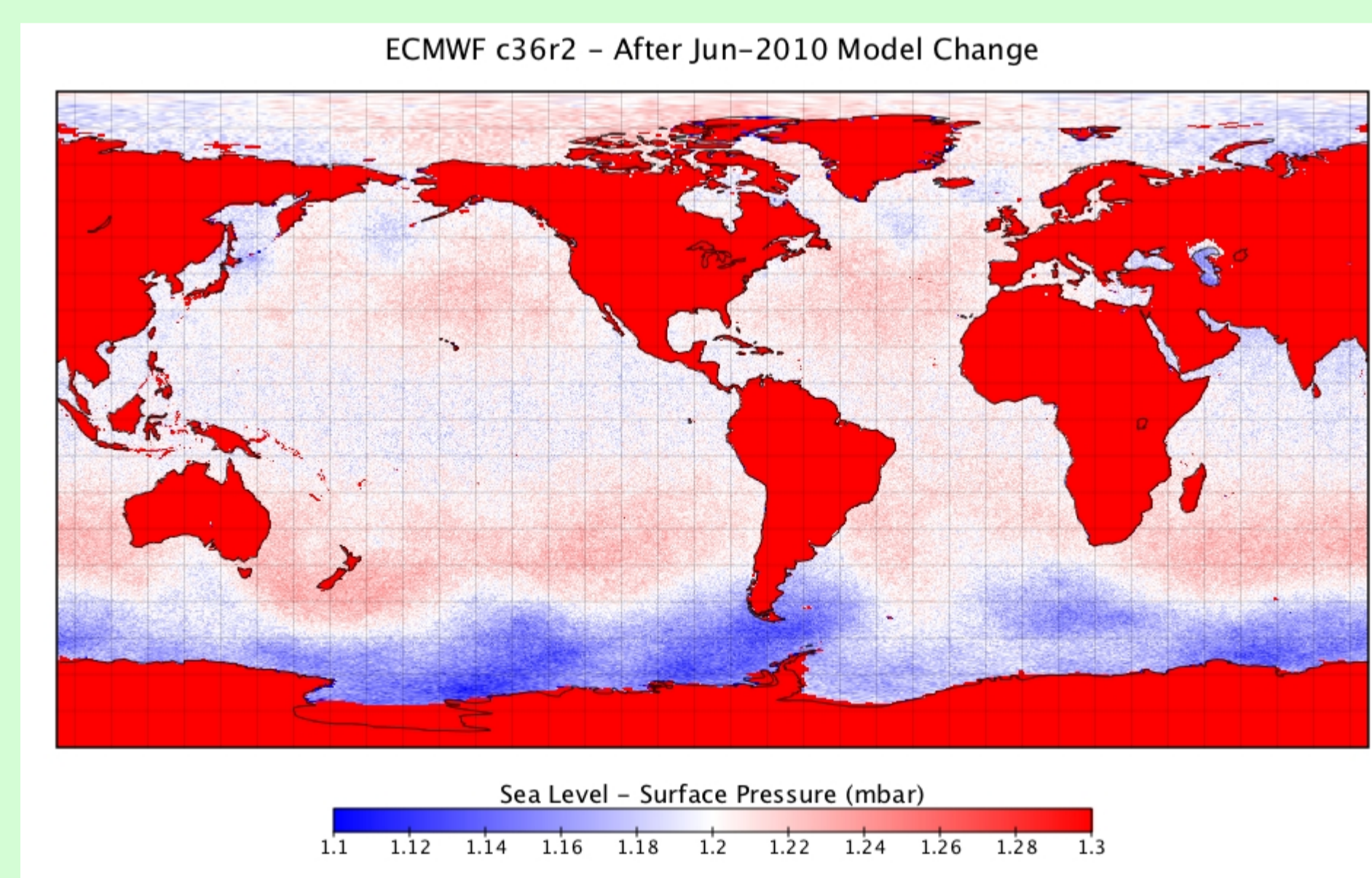


**The orographic correction is crucial in eliminating open ocean Gibbs effects in Surface Pressure**

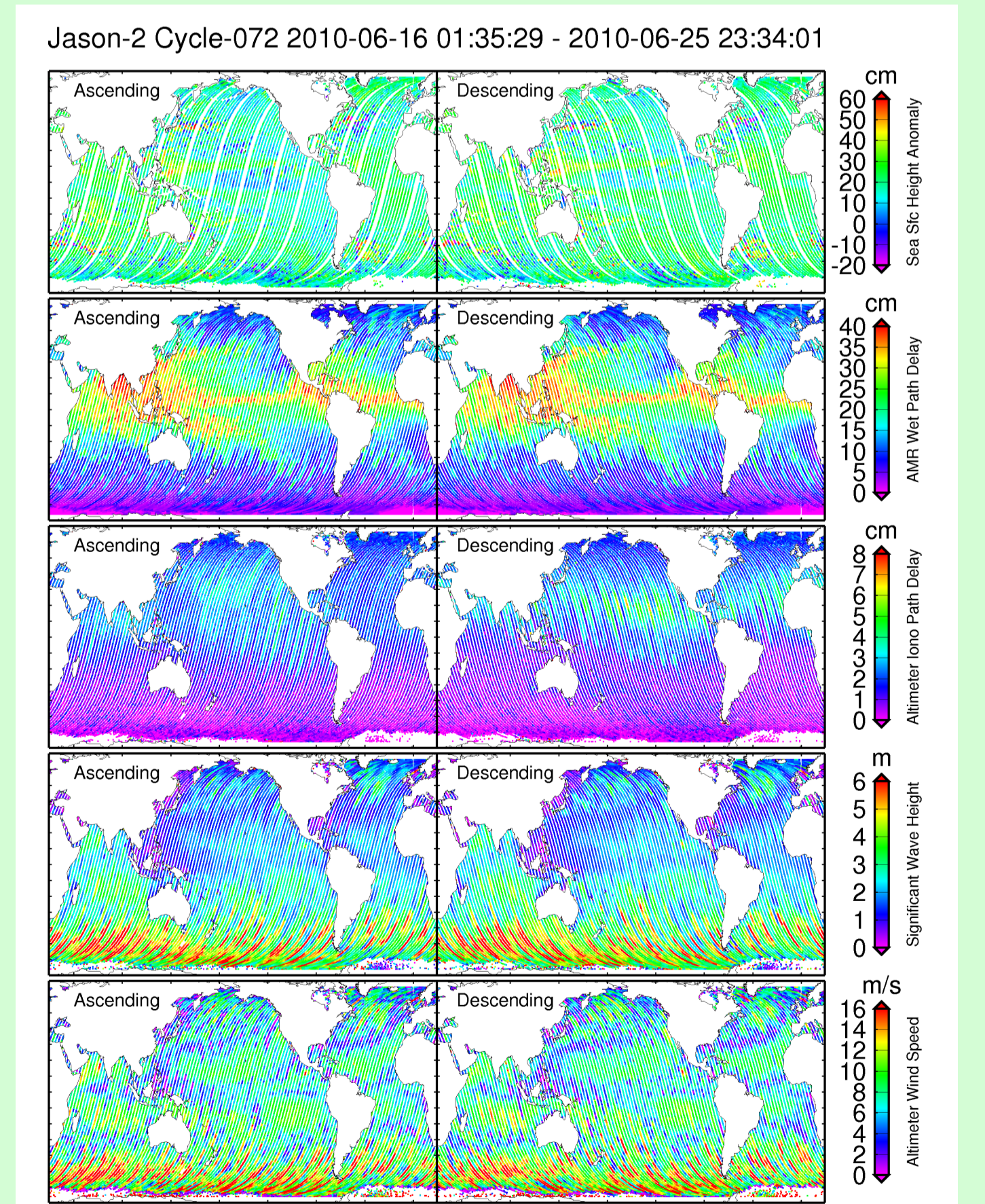
## Implementation of GRIB API (c36r2): 22-Jun-2010



**ECMWF Cycle-c36r1:**  
 Pressure differences < 0.1 mbar  
 Northern Hemisphere "Greenwich Anomaly"  
 • only impacts analyzed grids  
 • to be repaired in next model upgrade



**ECMWF Cycle-c36r2:**  
 Surface Pressure bias of 1.2 mbar  
 Large-scale dynamic pressure differences > 0.1 mbar  
 Due to bug in ECMWF archiving prior to Met. Script:  
 "GRIB parameter 134, surface pressure (SP), is in cycle 36r2 generated directly by the IFS, instead of a separate post-processing application."

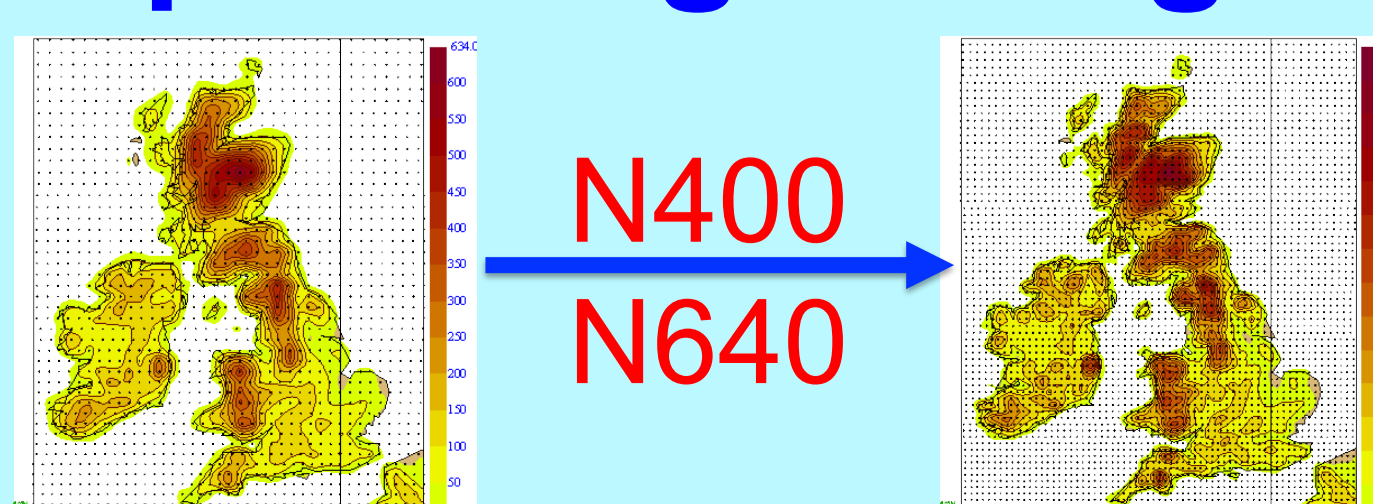


**Processing Impact:**  
 ECMWF grids blocked on 23 June  
 OGDRs missing SSHA data for 24 hours:  
 Grids not extrapolated by TM-NRT  
 Largest data gap in 2010 QA Report

## Upcoming Changes

**Complete Met. Script migration to full N640 high resolution**

- Initial analyses show minimal interpolation differences
- Downsampling issues (above) no longer a concern
- Scheduled for completion by end of 2010



**ECMWF migration to GRIB-2 format**

- Associated with increase in model vertical resolution
- Implementing GRIB-1/GRIB-2 API in advance
- ECMWF model change anticipated in mid-2011