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# Version 5 Statistical Analysis

Thomas Hearty

# Outline

- Temperature, water vapor comparisons: V4, V5, and ECMWF.
- A little bit on clouds.
- Unrealistic Geophysical Conditions identified in Version 4.

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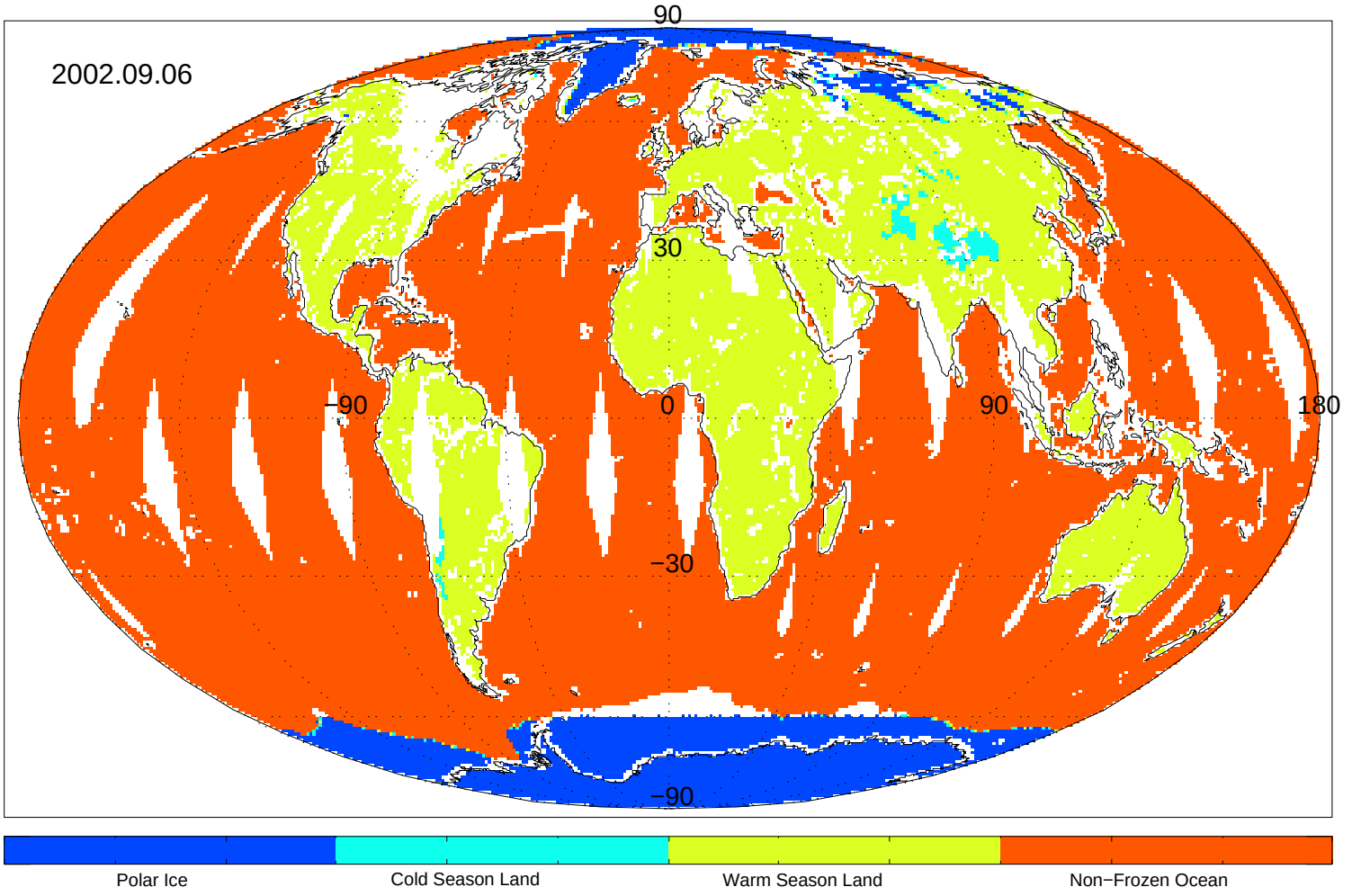
# Geographic Regions




Cryptic abbreviations

- NFO = Non-Frozen Ocean
- WSL = Warm Season Land

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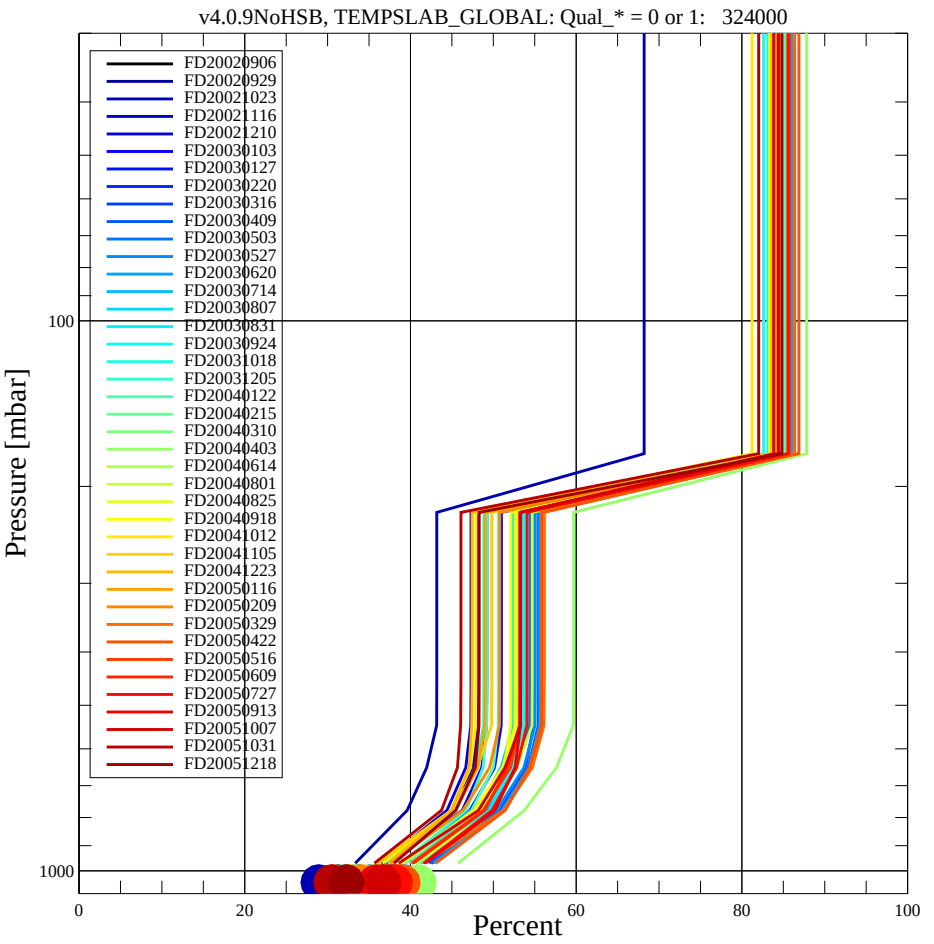
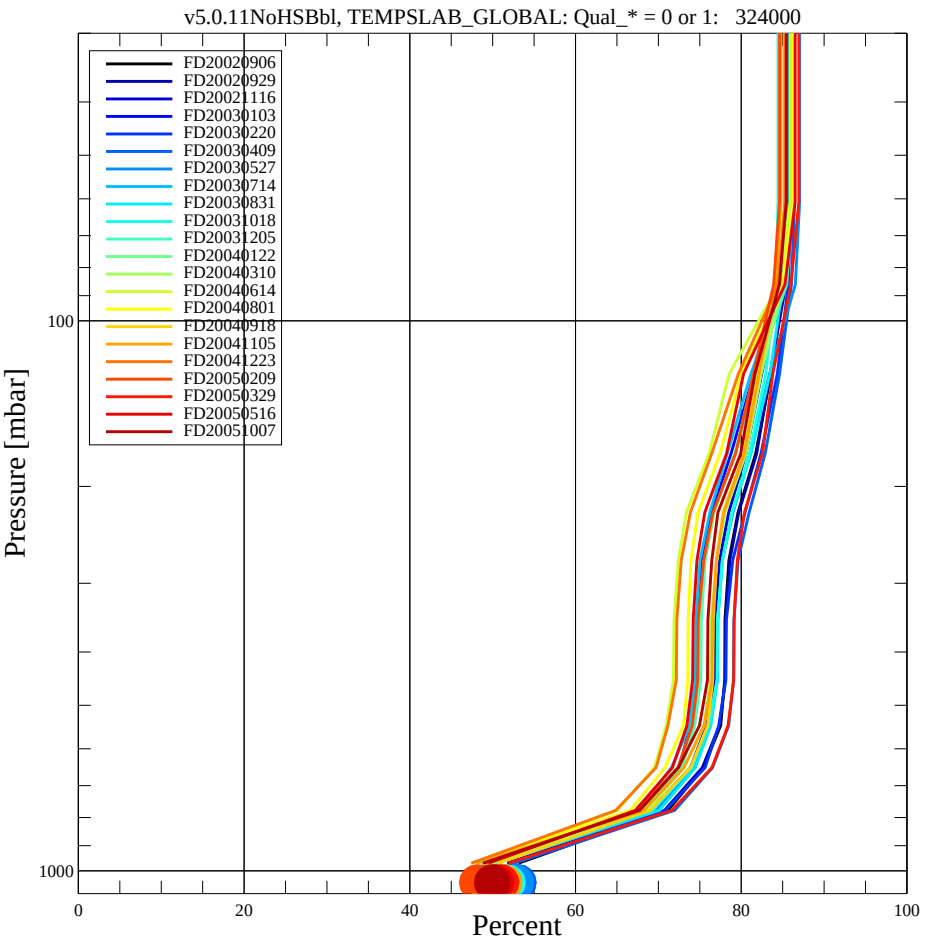
# Yield: Global Temperature




- The yield for temperature retrievals increased in most of the atmosphere.
- The yield for Surface Temperature retrievals increased (over land and ice).
- There may be a slight decreasing trend in the yield (over land).

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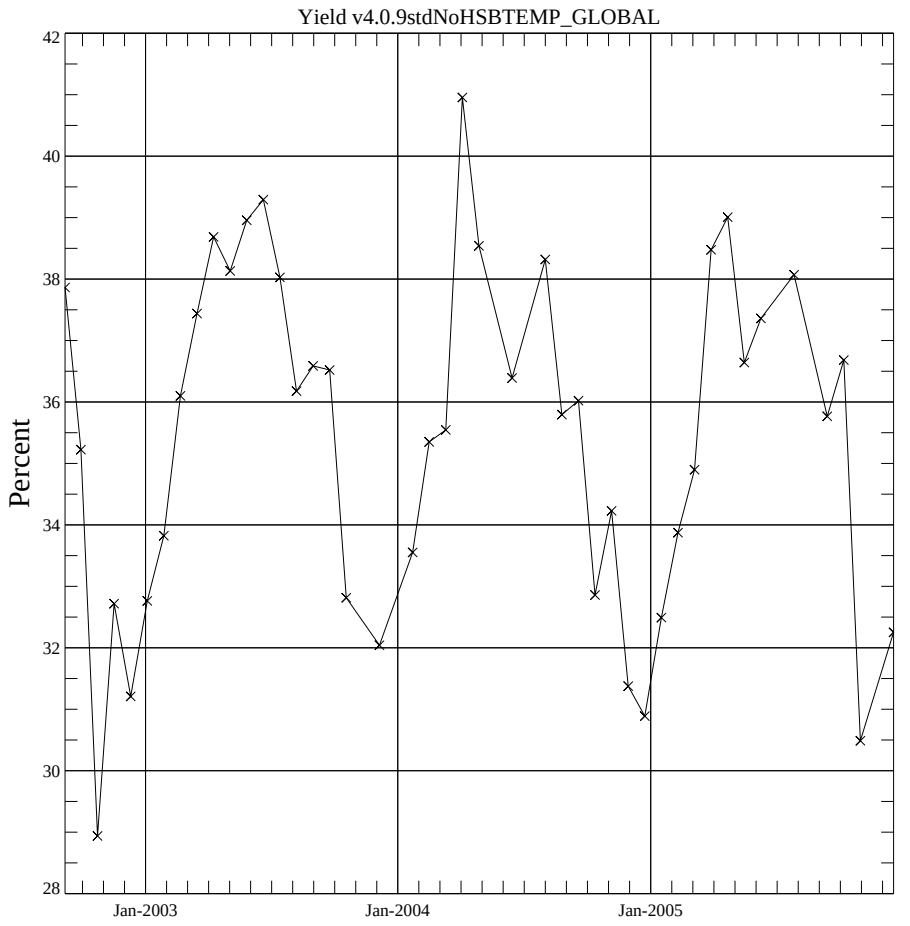
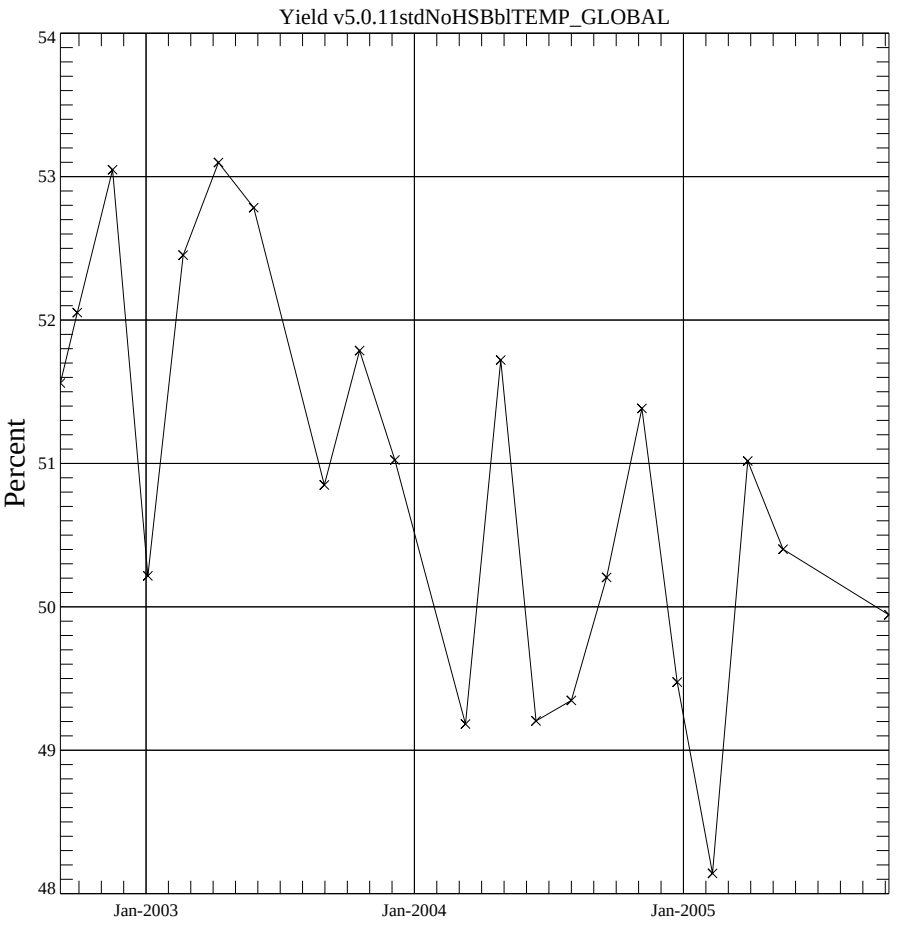
# Decreasing trend in the yield




- There is a decreasing trend in the temperature yield (mostly over land).
- But it is smaller than the seasonal variation from Version 4.

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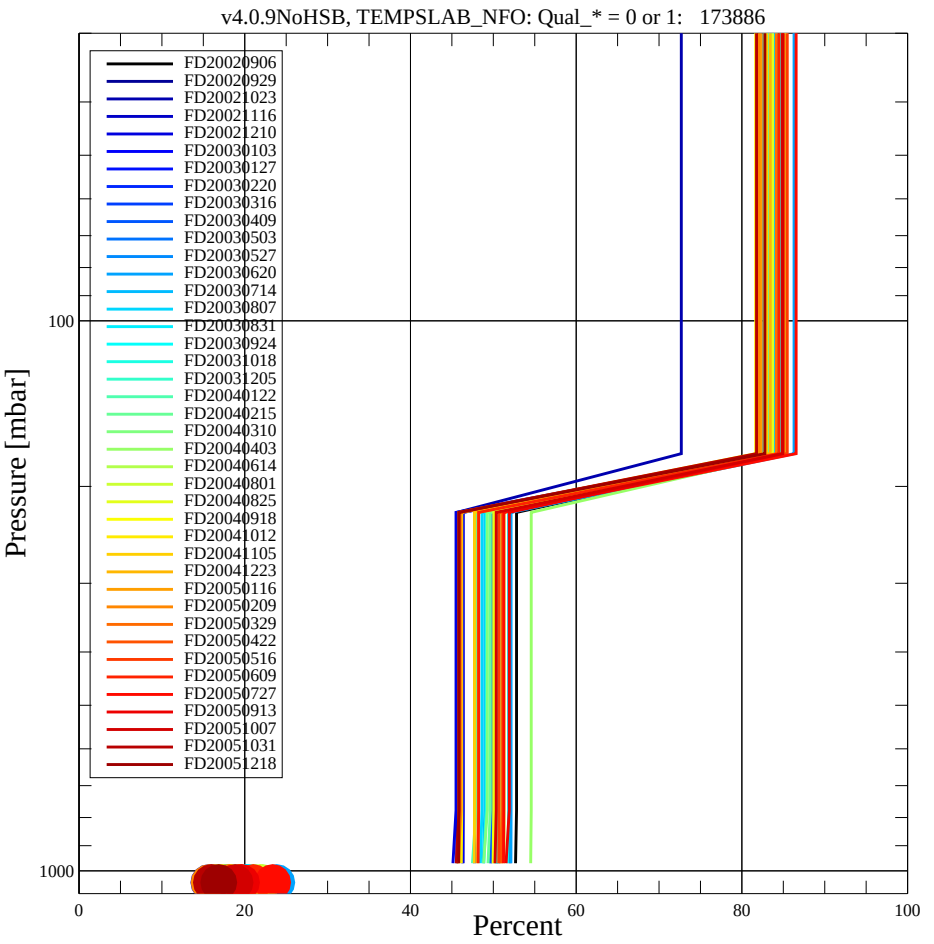
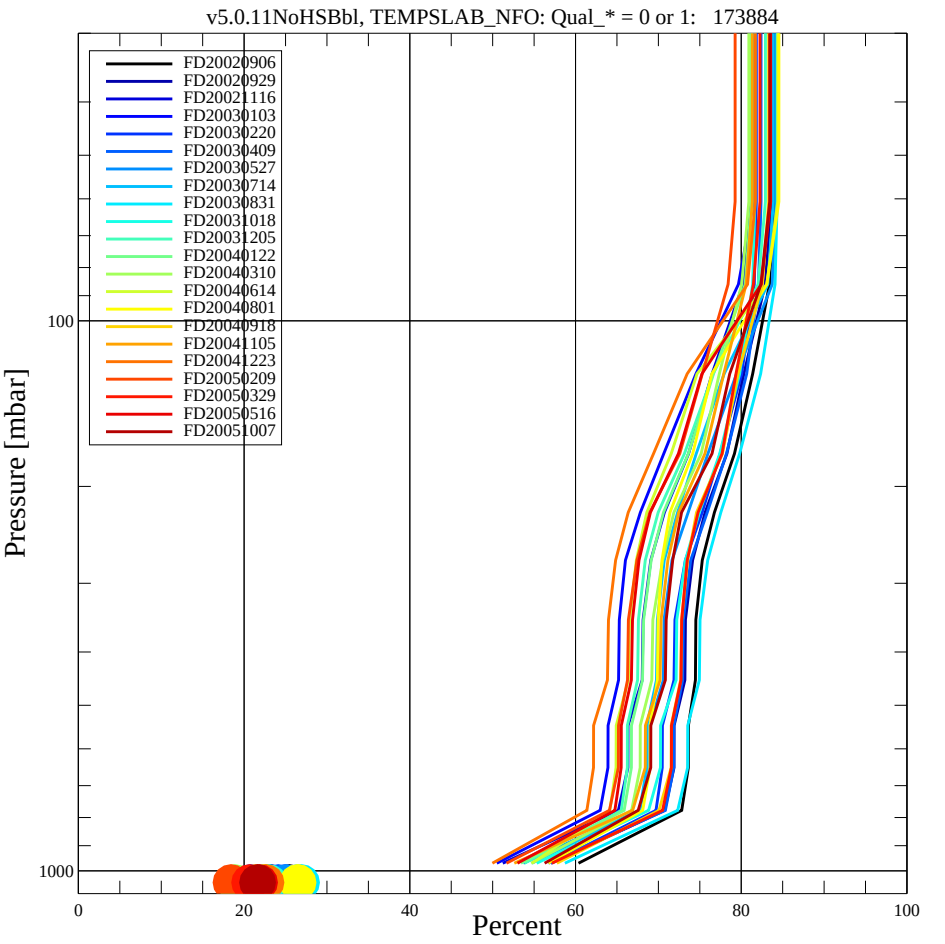
# Yield: NFO Temperature




- The yield increased in the troposphere.

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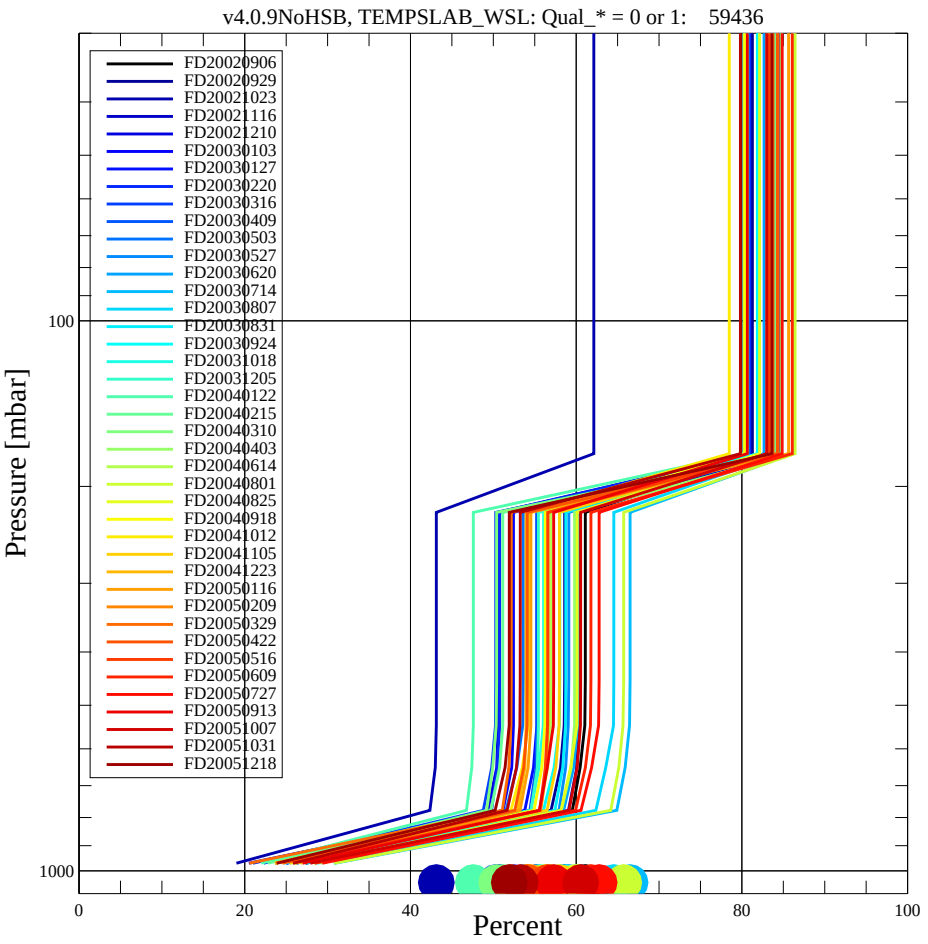
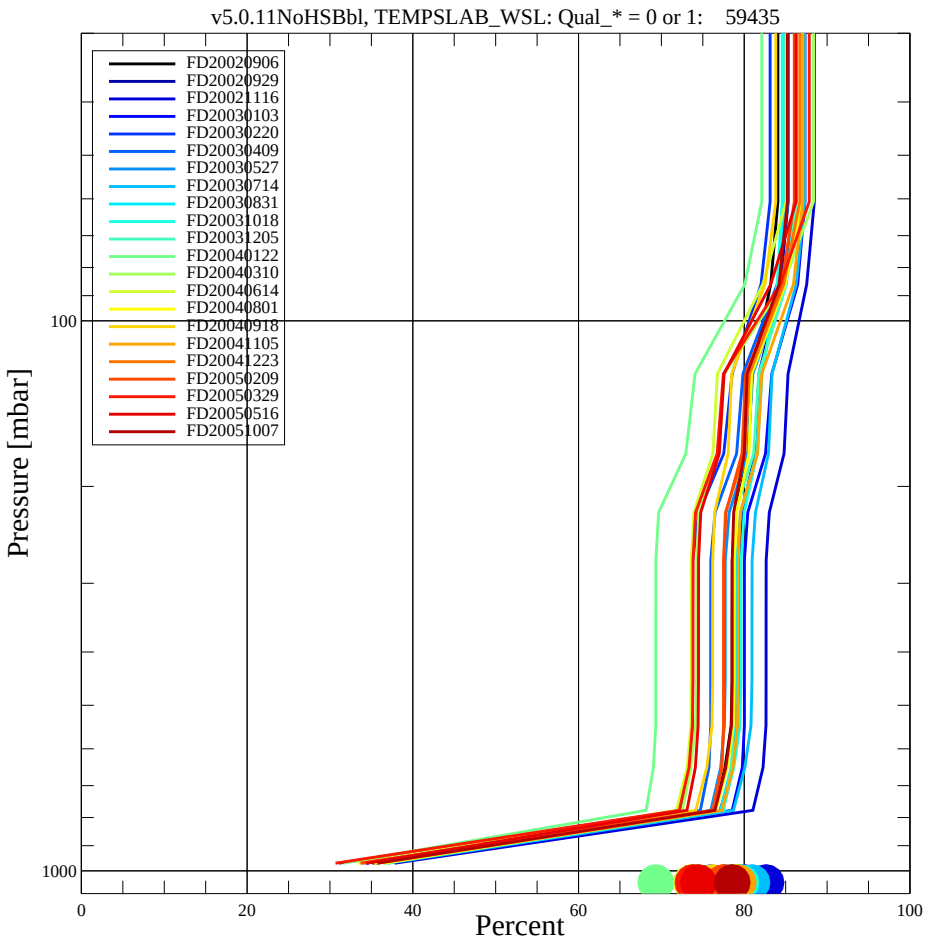
# Yield: WSL Air Temperature




- There were larger increases in the yield over land.
- There is a decreasing trend in the yield (but it is smaller than the seasonal variation in yield from Version 4).

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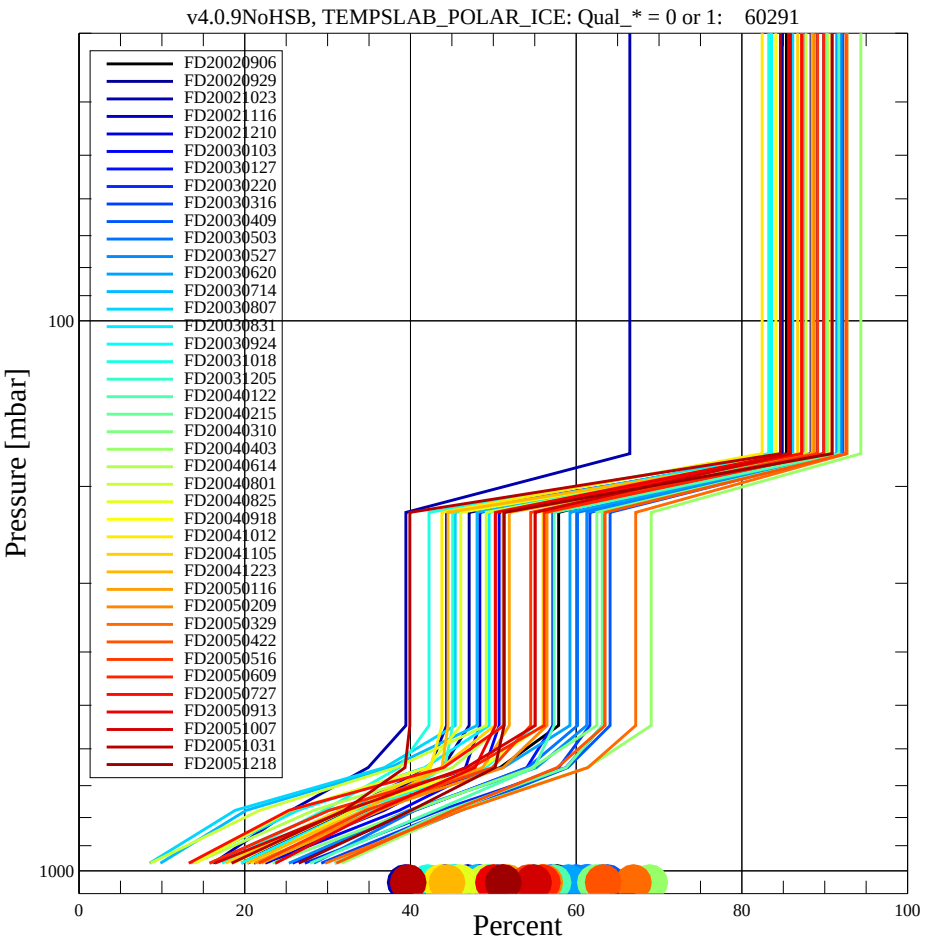
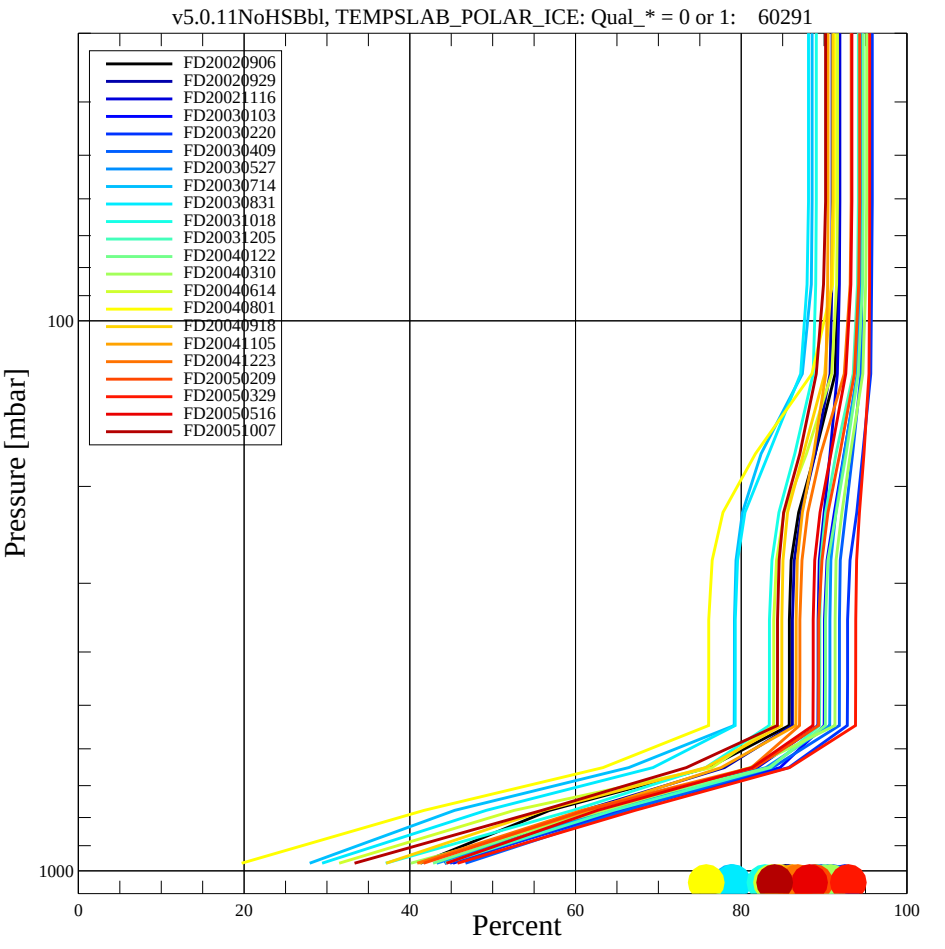
# Yield: Polar Ice Temperature




- The largest increase in yield was in polar regions.

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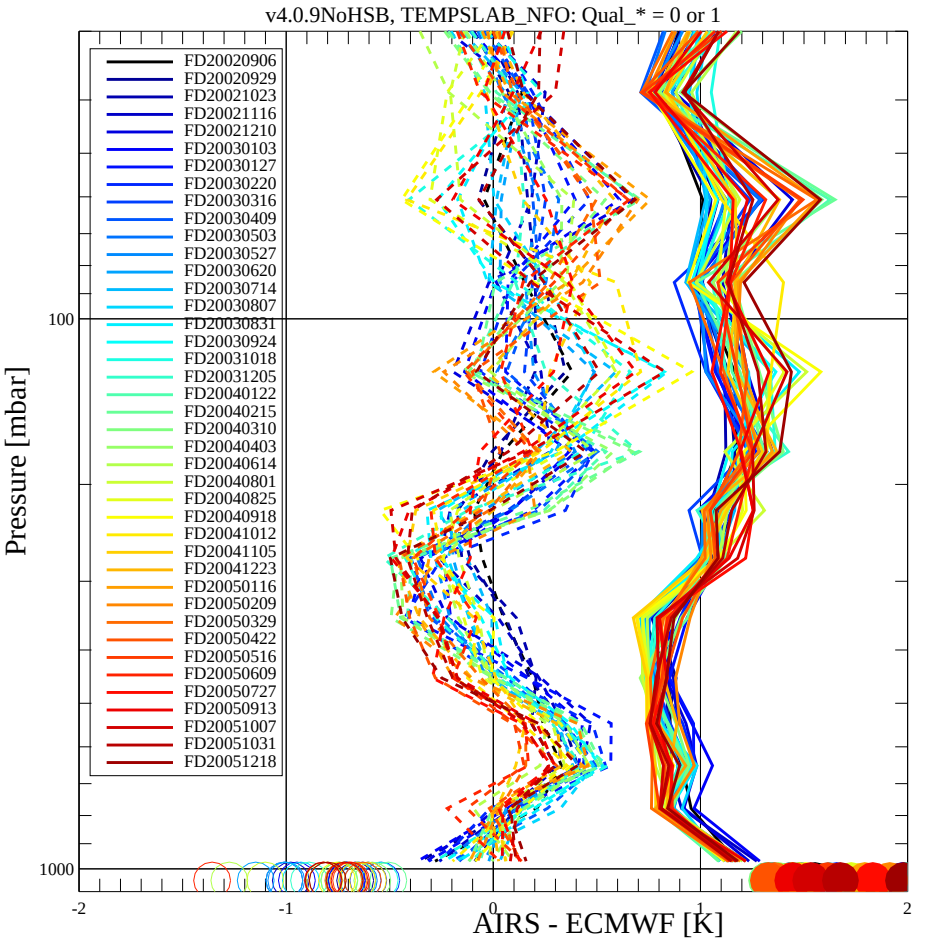
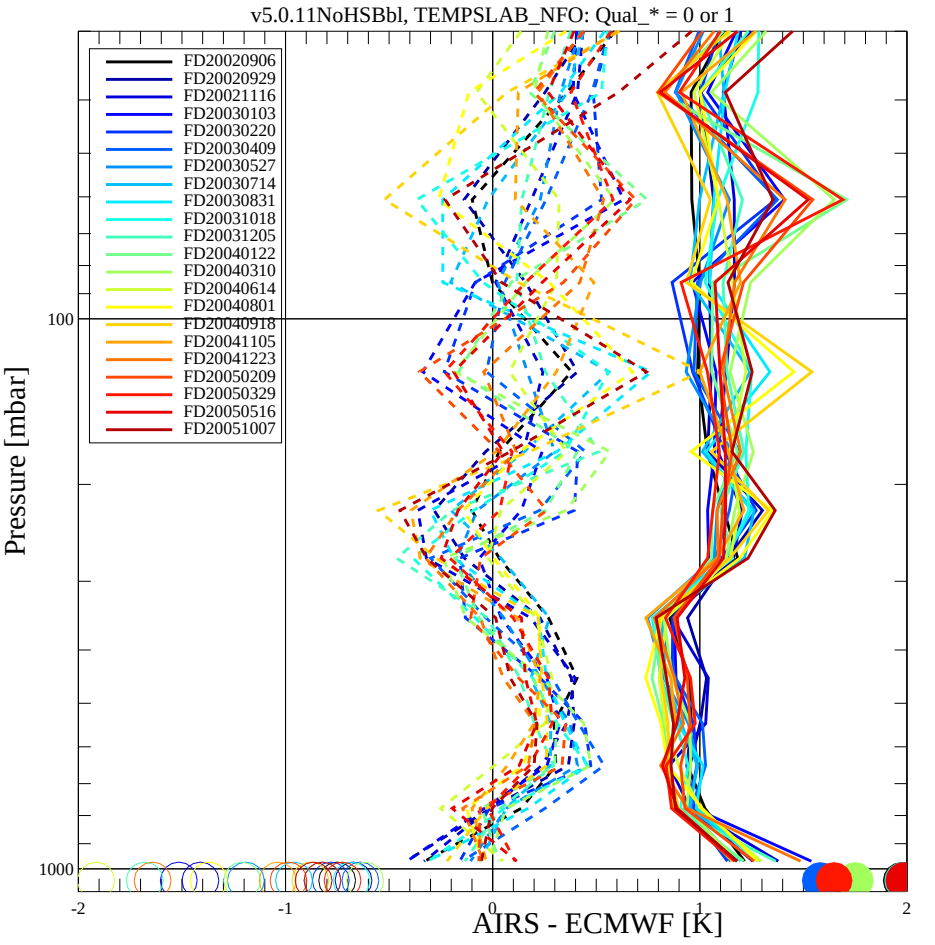
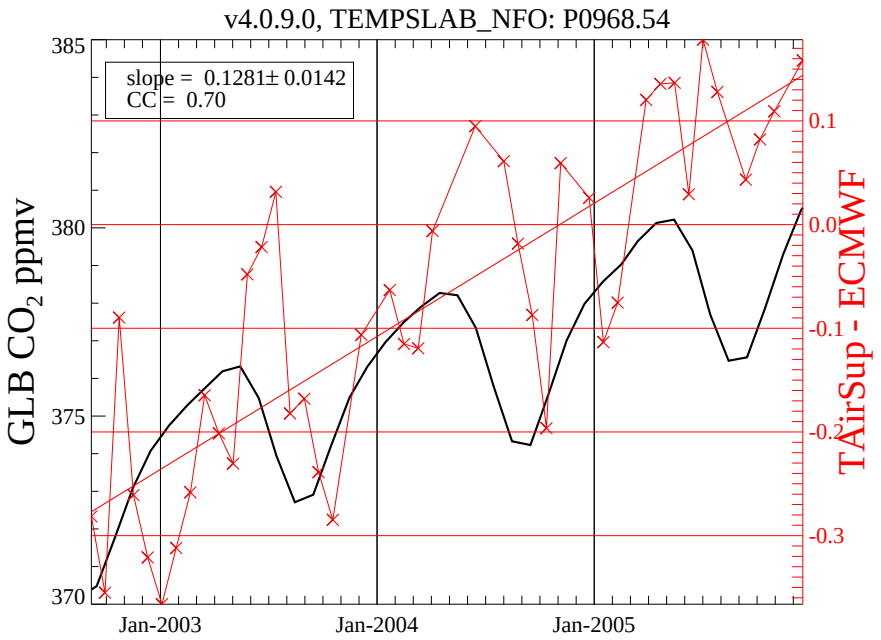
# NFO Air Temperature

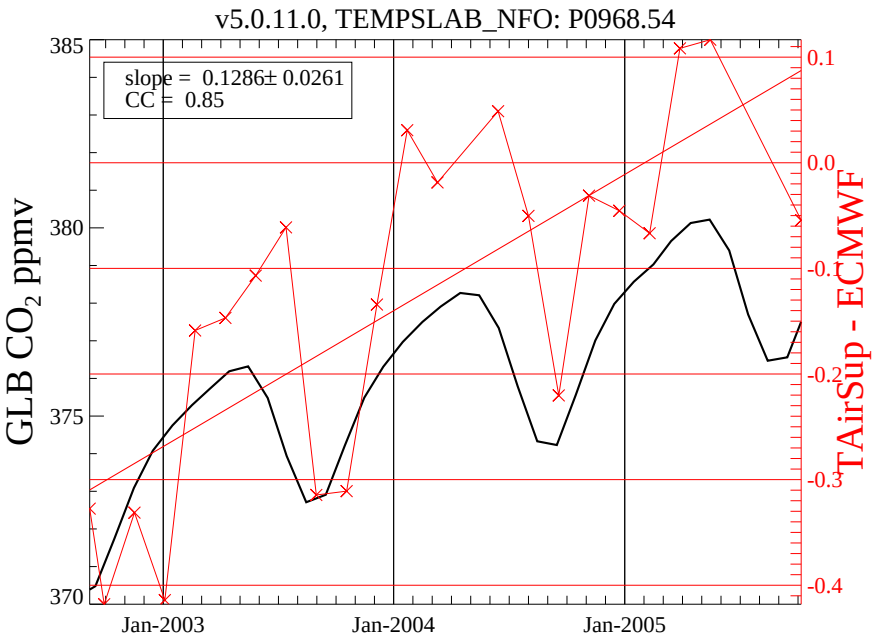



- The increasing trend in the temperature bias is still in Version 5.
- There is a decreasing trend $\sim$ 500 mbar.

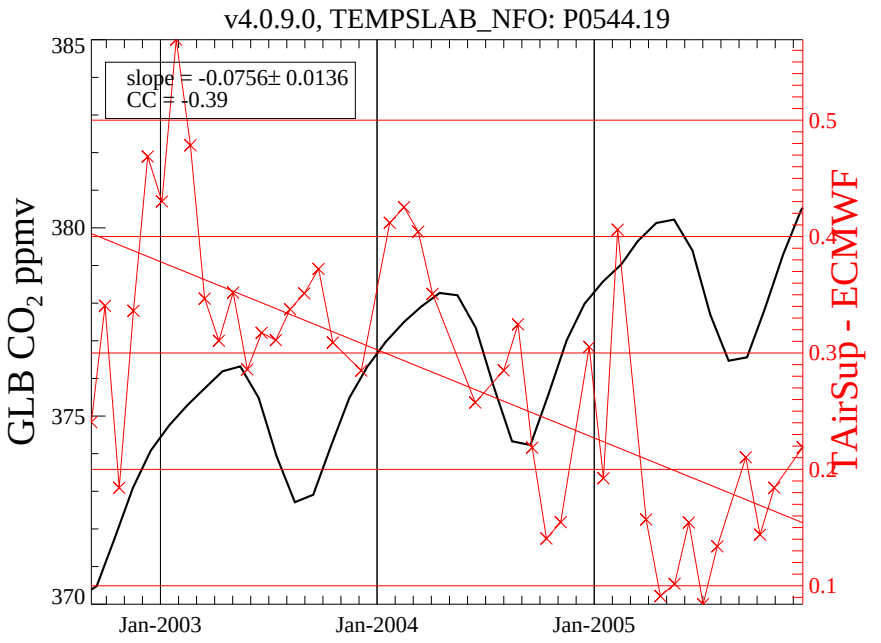
# NFO Air Temperature Trend

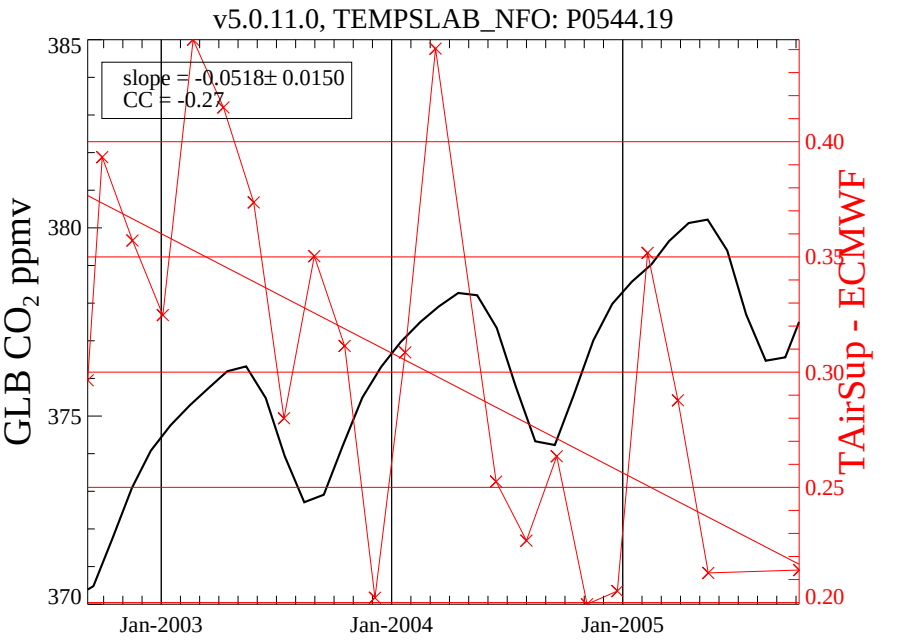



- Time Varying $CO_2$ did not remove this trend identified by Divakarla et al.
- Similar trends are seen in the Microwave Only and AIRS Only Retrievals.

# NFO Air Temperature Trend




- The opposite slopes are almost identical at $\sim$ 500 mbar.

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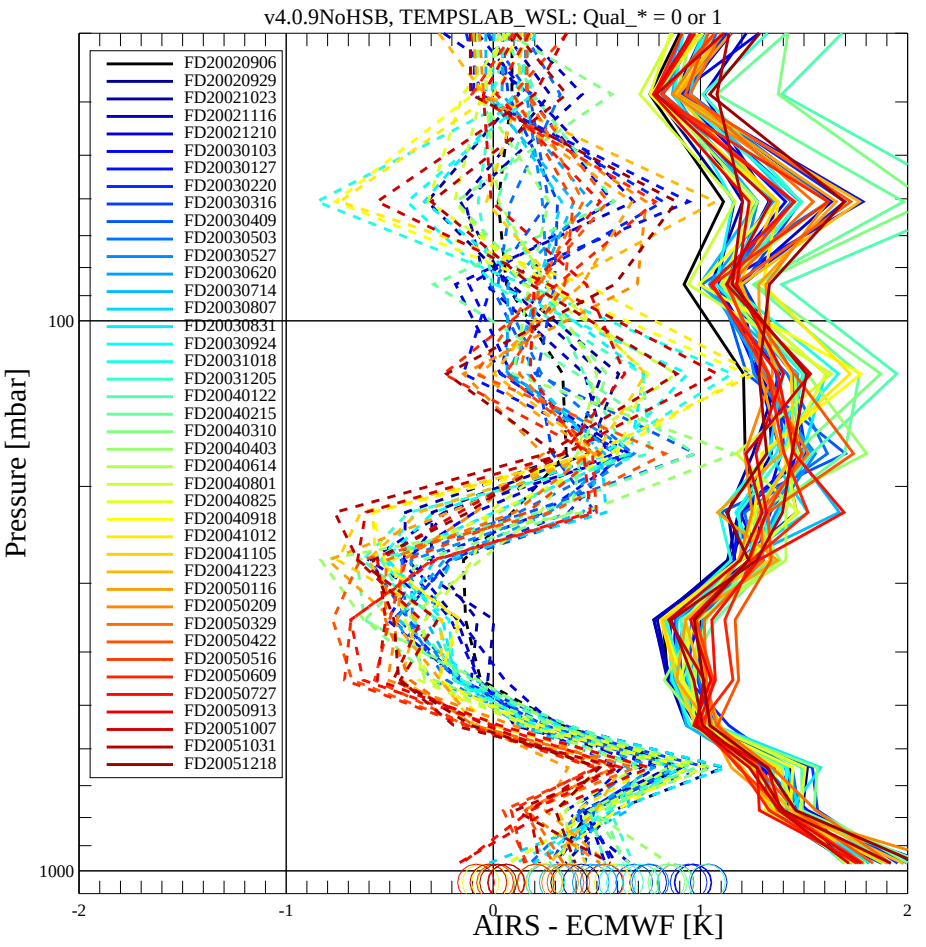
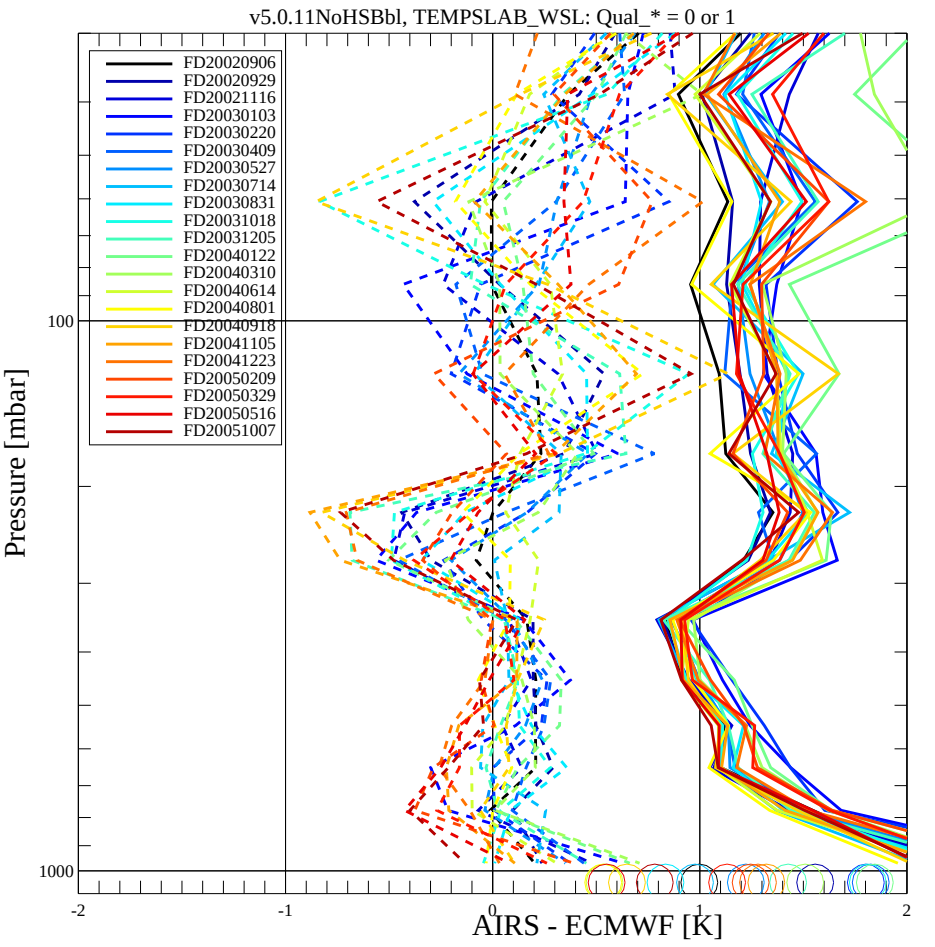
# WSL Air Temperature




- significantly less bias in the troposphere.
- There is still a decreasing trend in the temperature bias over land.
- Version 5 Land Surface Temperature is warmer than Version 4.

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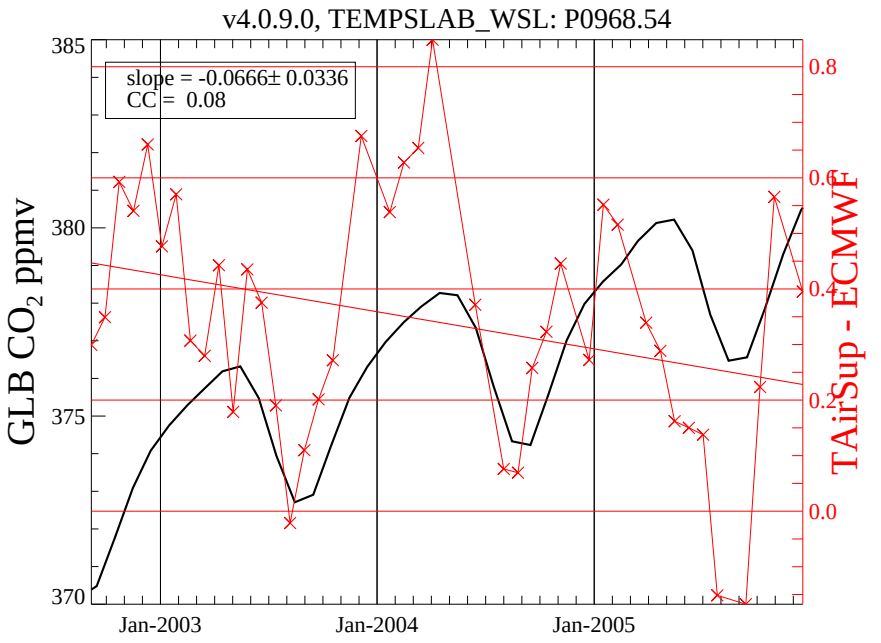
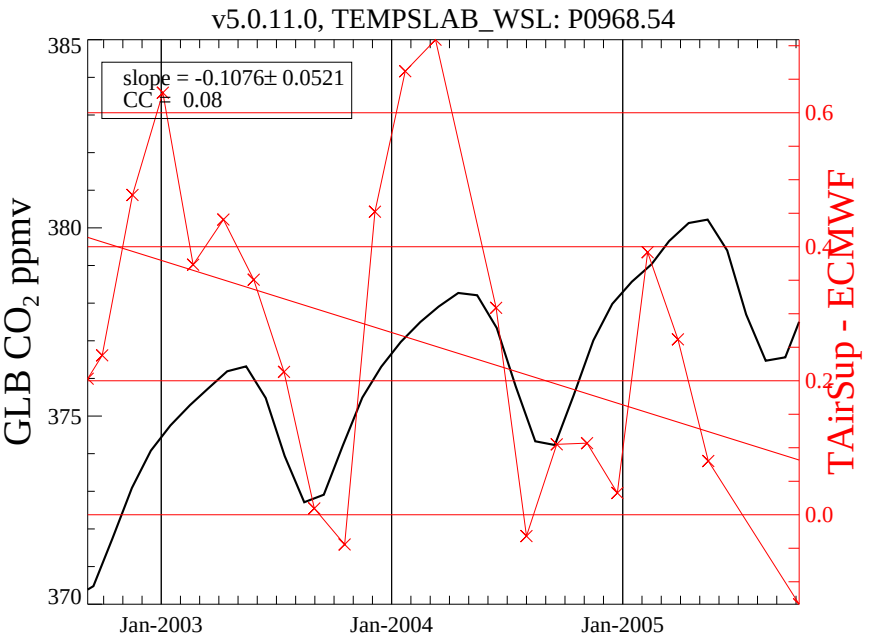
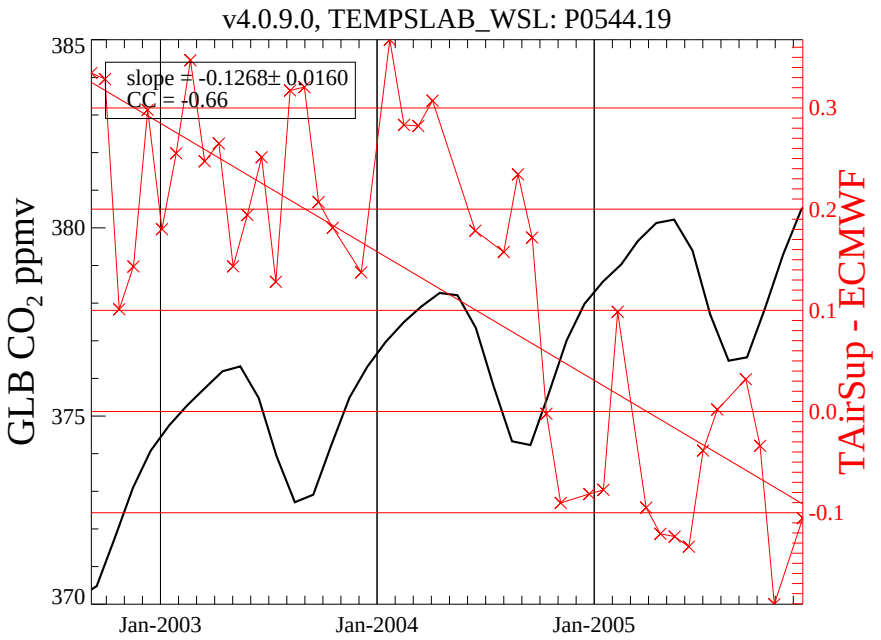
# WSL Air Temperature Trend

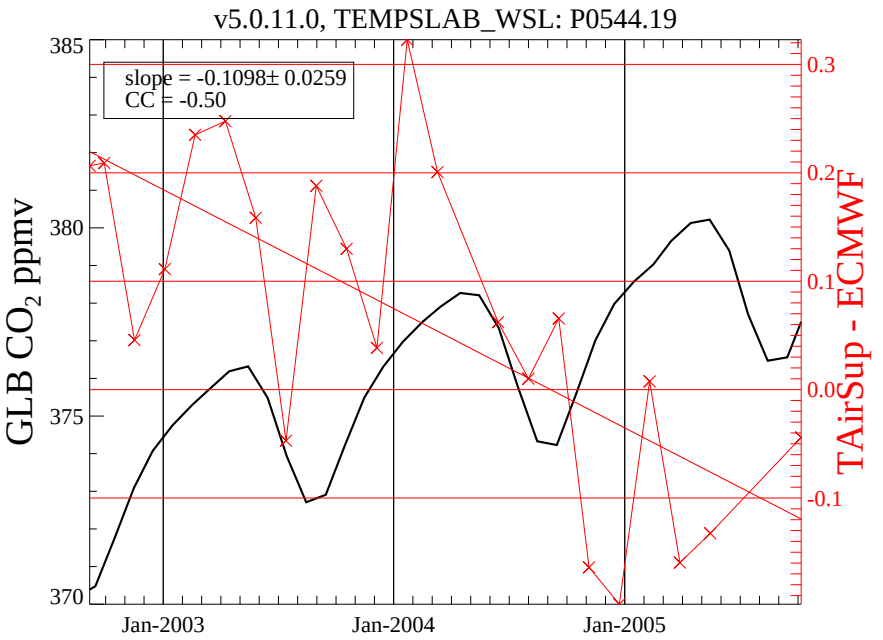



- The trend temperature bias trend over land has a negative slope?!

# WSL Air Temperature Trend 544 mbar




- Same slope as seen over water.

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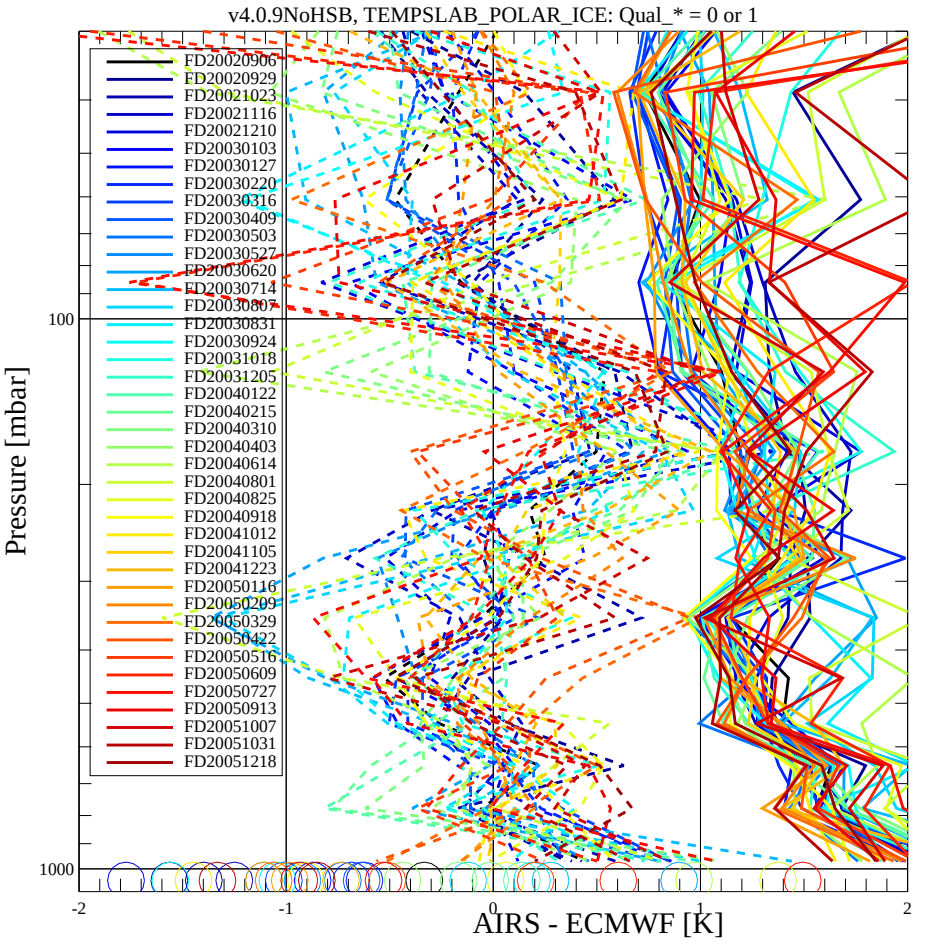
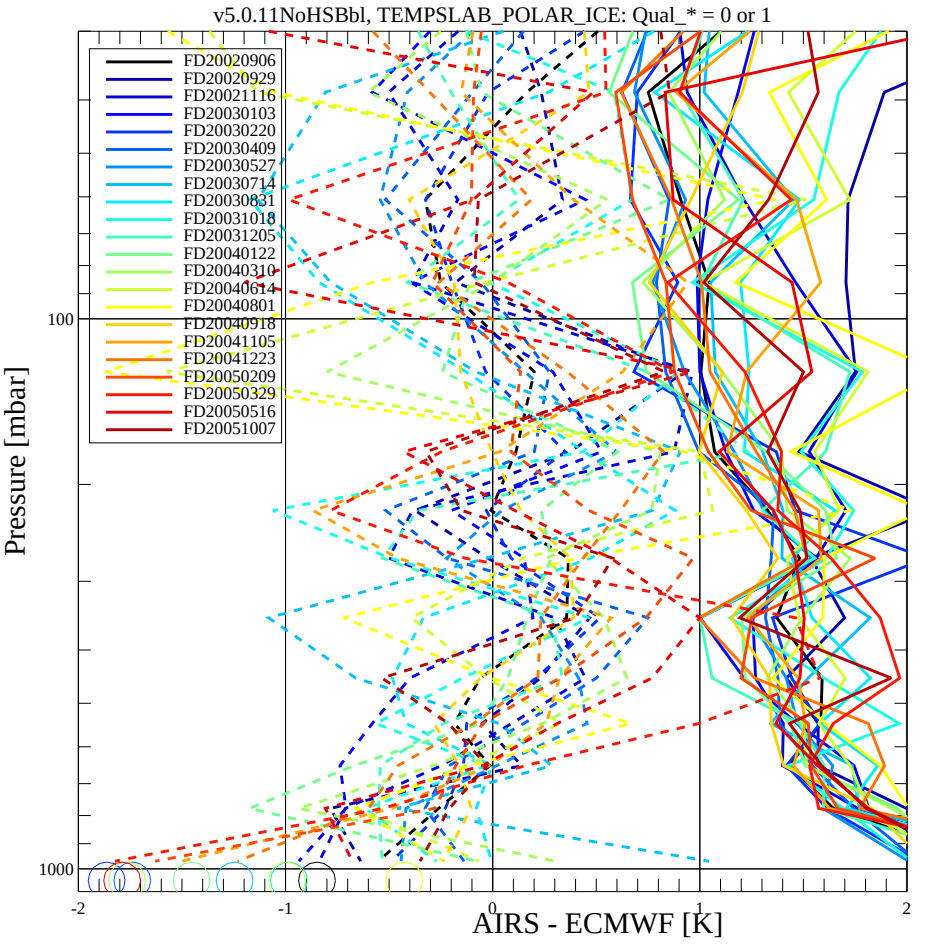
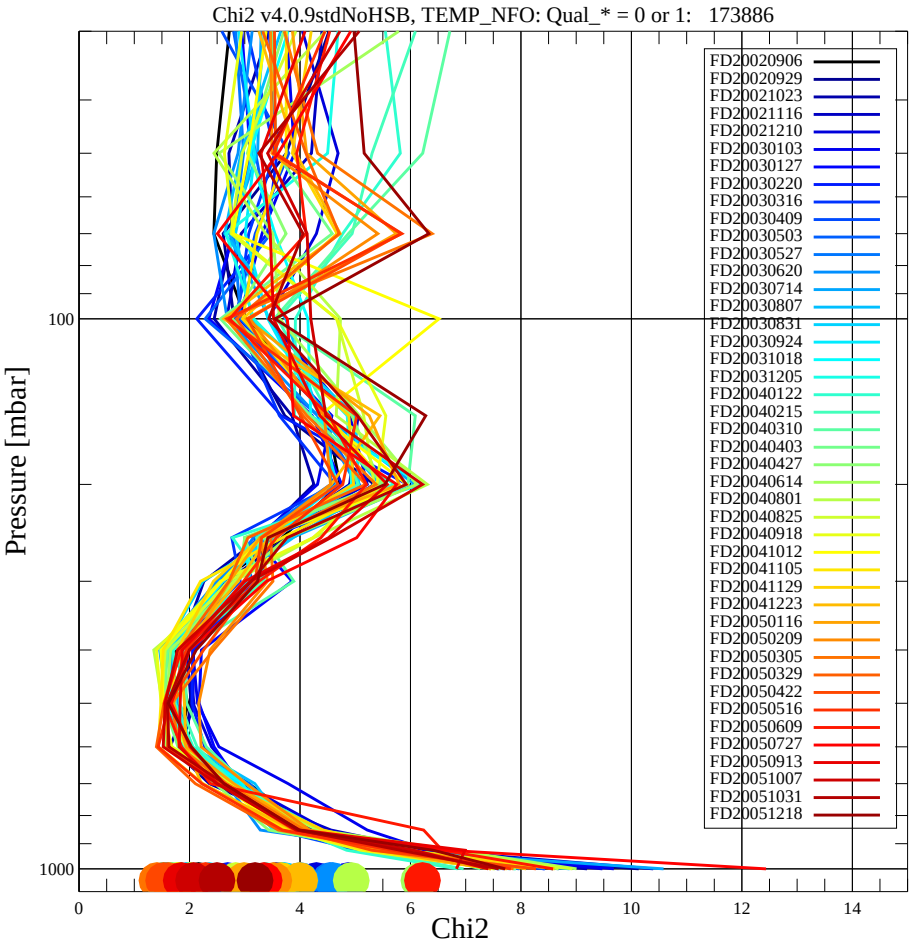
# Polar Ice Temperature

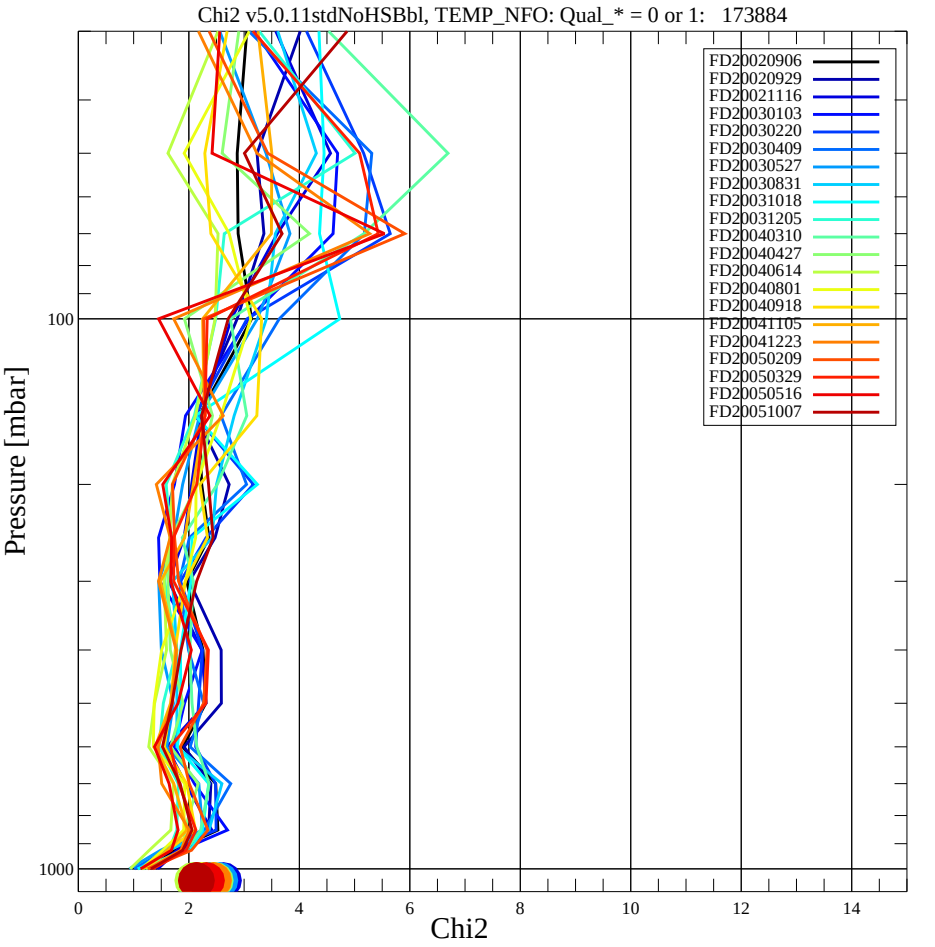



- Version 5 has a larger bias and RMS over the pole (but the yield is $\sim$ 90%)

# Air Temperature Error Estimates




- The Version 4 error estimates are significantly better than those in version 4.
- The errors are evaluated by calculating the reduced $\chi^2$ where, $\chi^2 = \Sigma(\frac{T_{AIRS} - T_{ECMWF}}{T_{err}})^2$.

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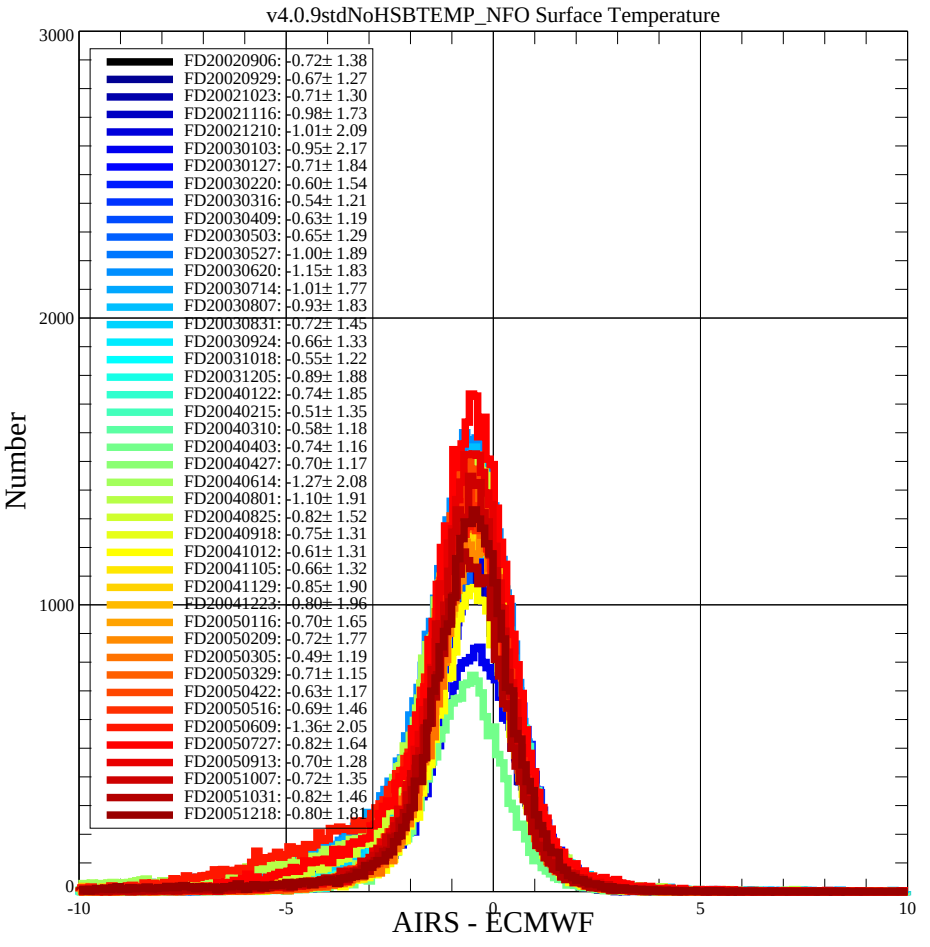
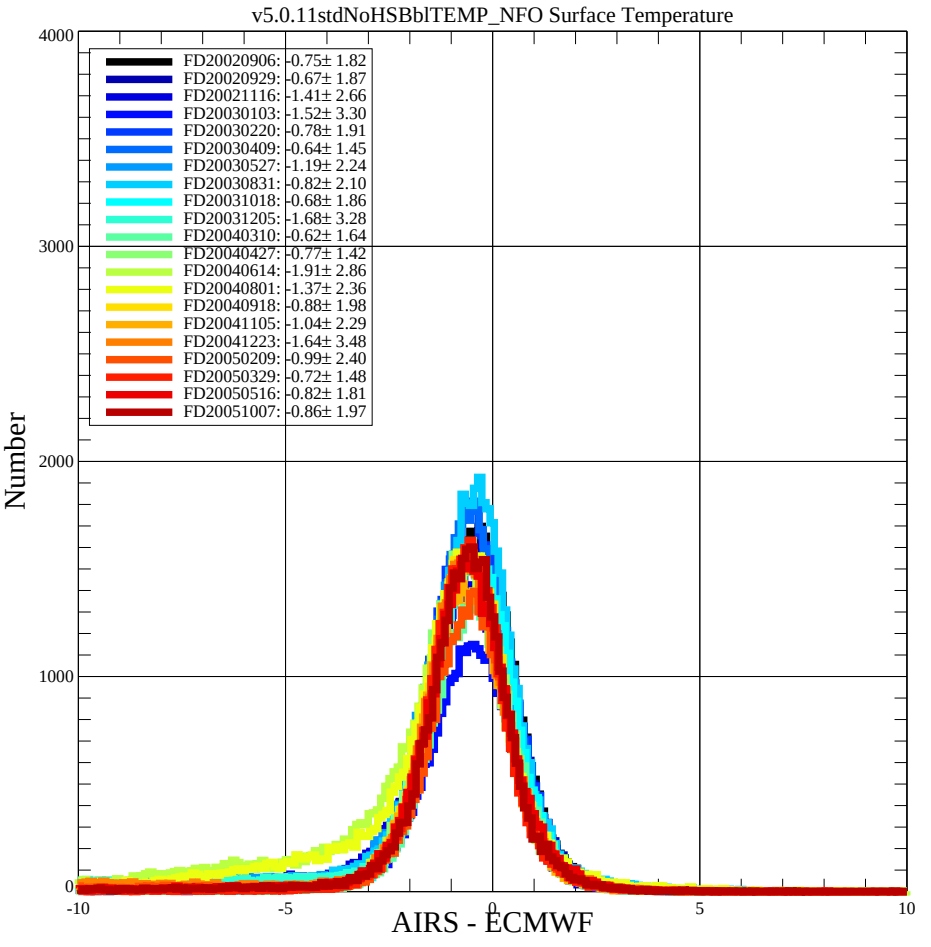
# Surface Temperature biases




- Version 5 SST is colder than Version 4.

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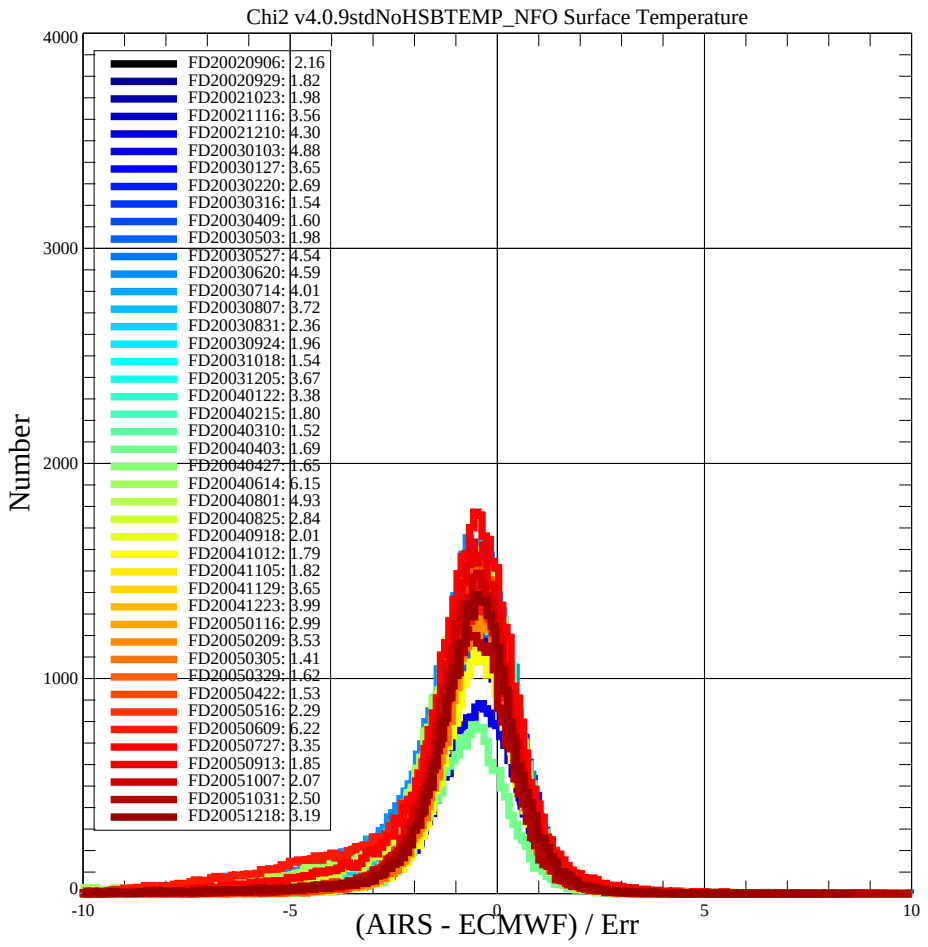
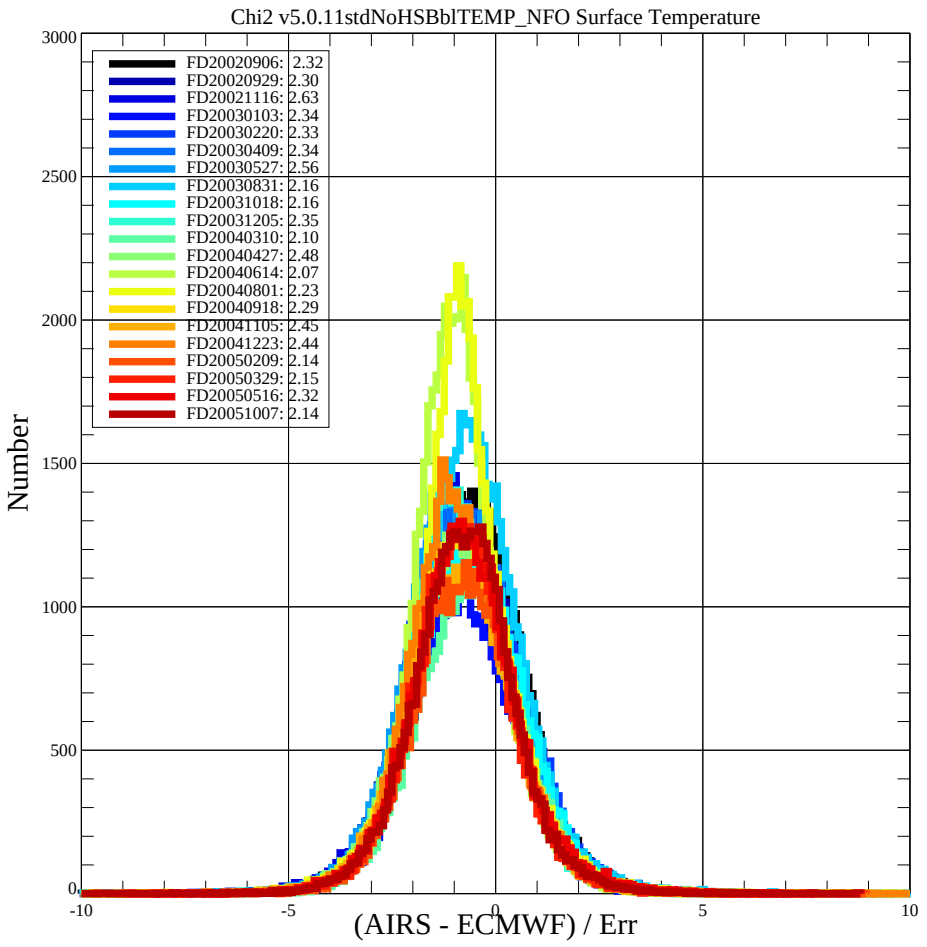
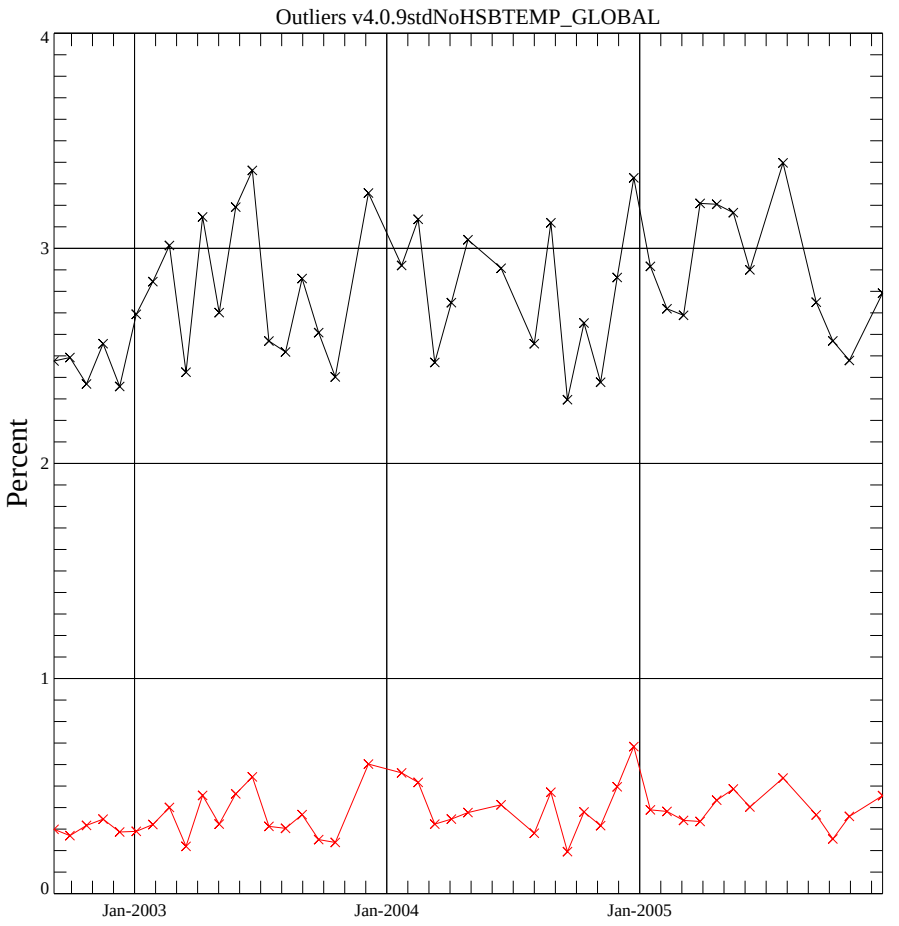
# Error Estimates for Sea Surface Temp

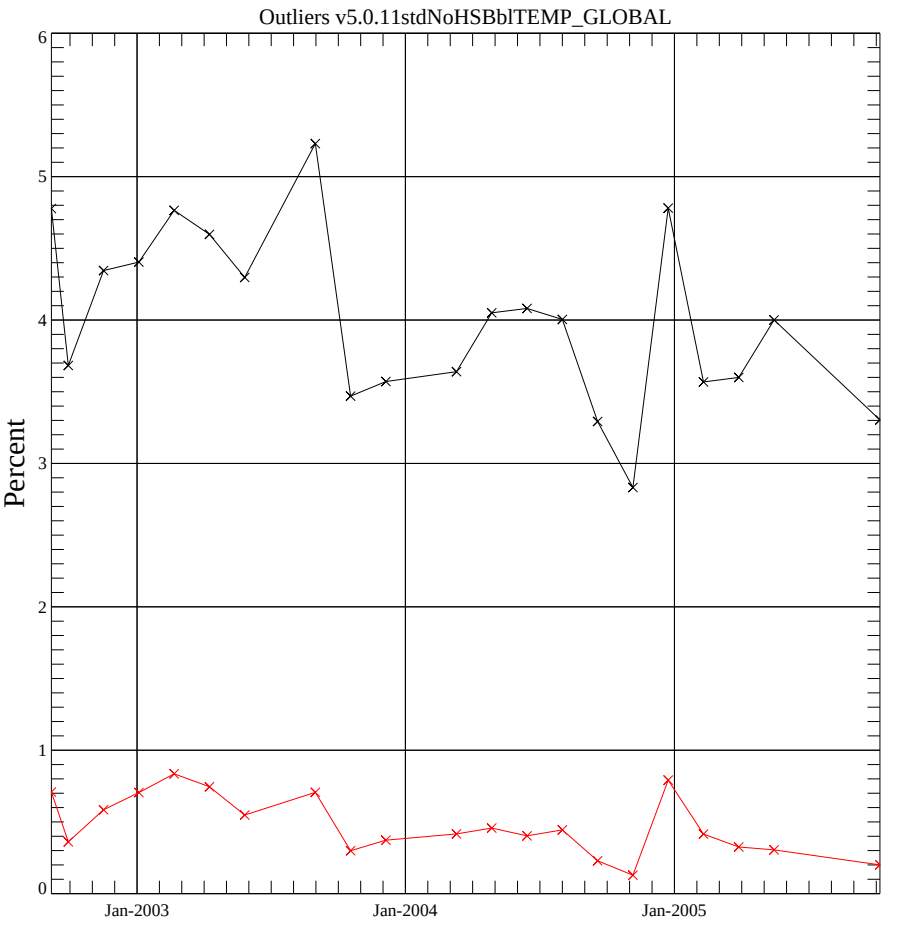



- The outliers got correspondingly larger error estimates.

# Sea Surface Temperature Outliers




- Version 5 has more mild outliers (black line).
- Both version have about the same amount of extreme outliers (red line).

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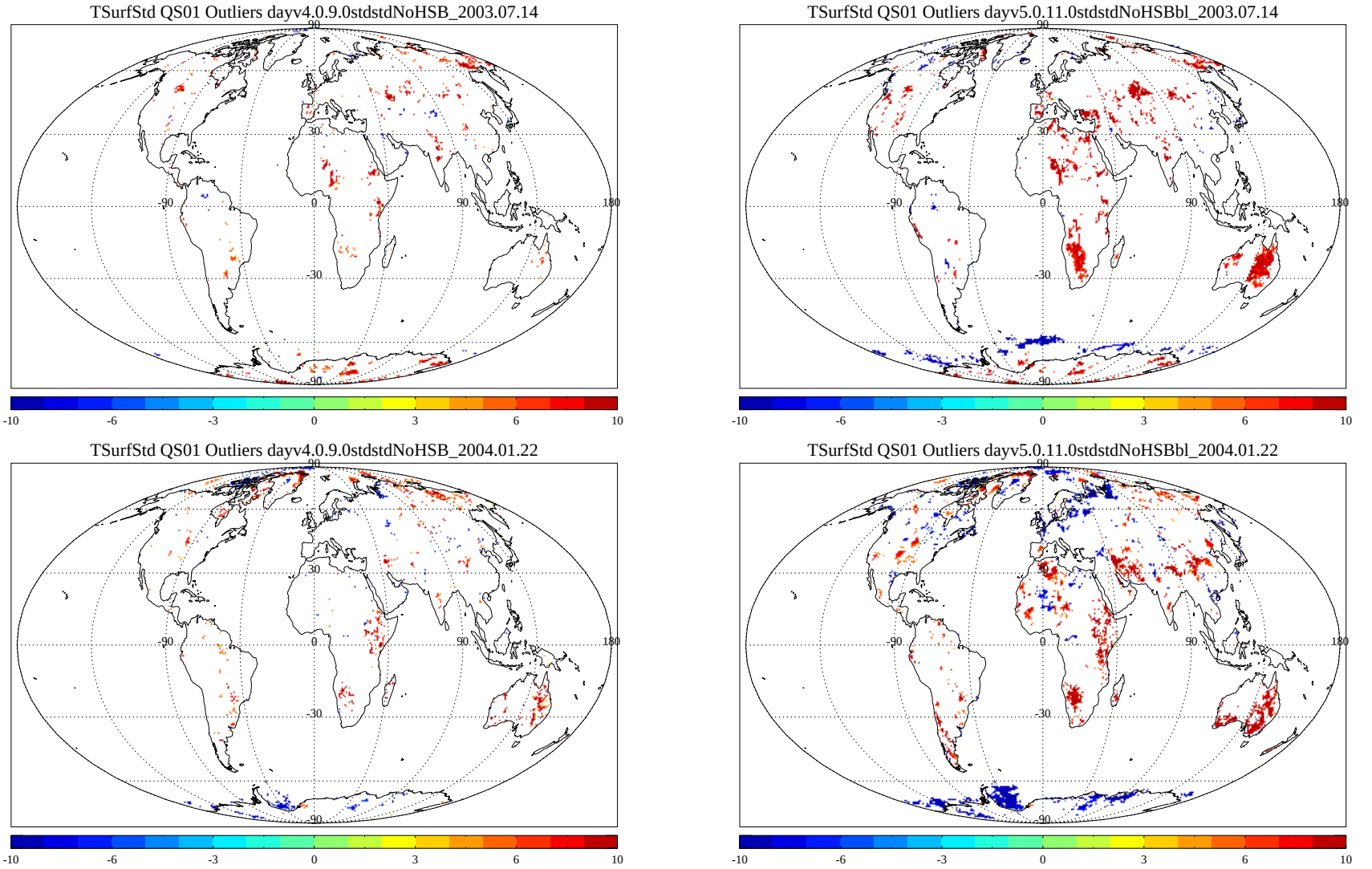
# Outlier Spatial Distribution




- The outliers over land tend to be warm.
- The outliers over ocean tend to be cold.

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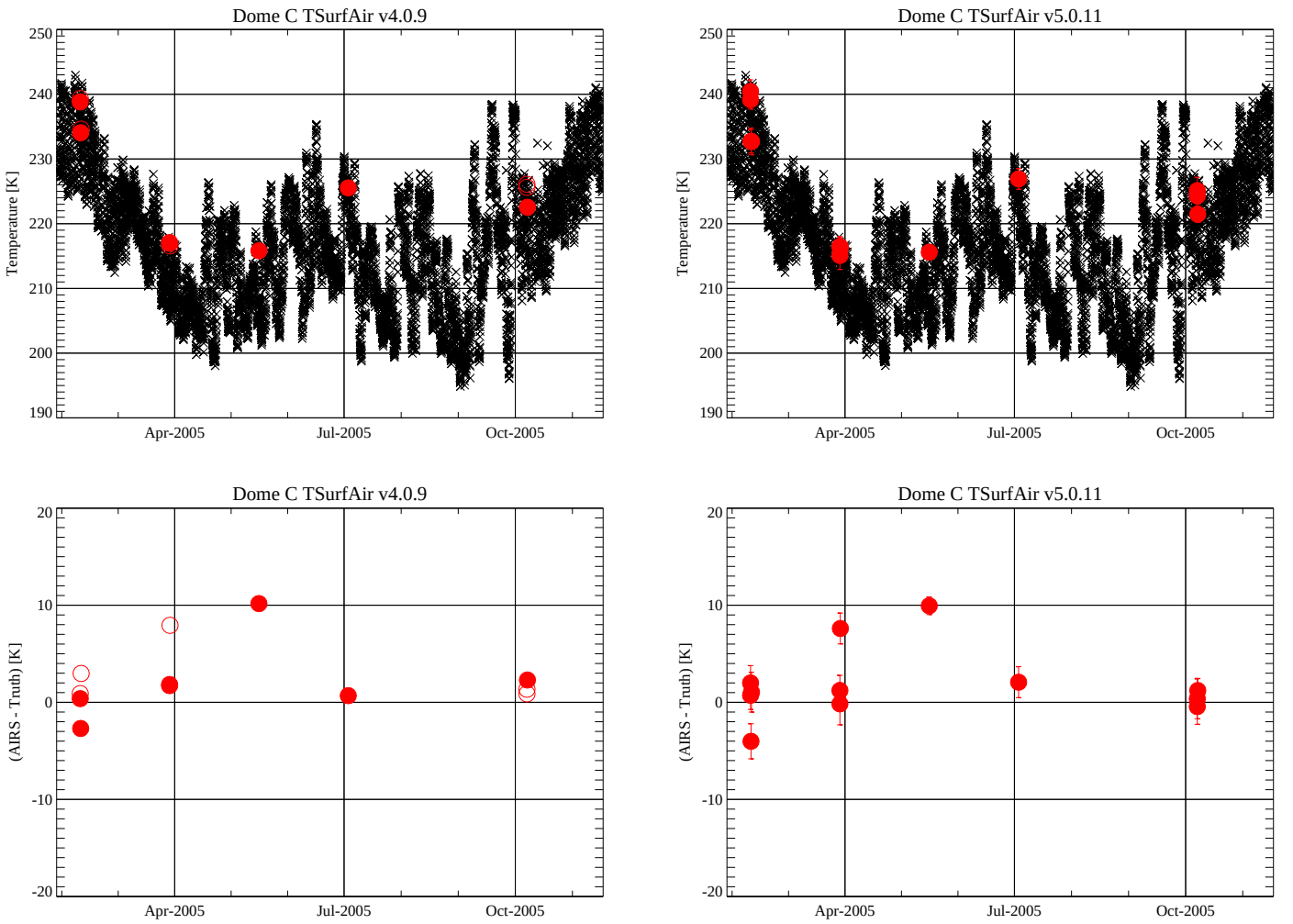
# TSurfAir at the poles




- Black symbols are the 3 meter high temperature at Dome C.
- Filled red circles are TSurfAir with Qual_Surf = 0 or 1.
- Open circles are TSurfAir with Qual_Surf = 2.

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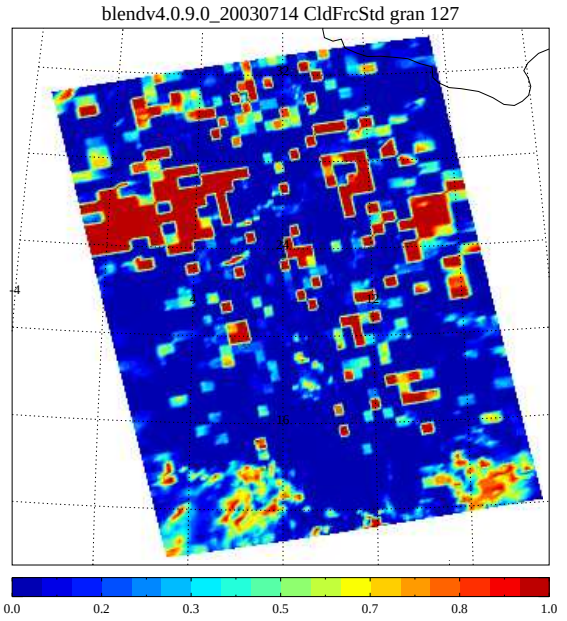
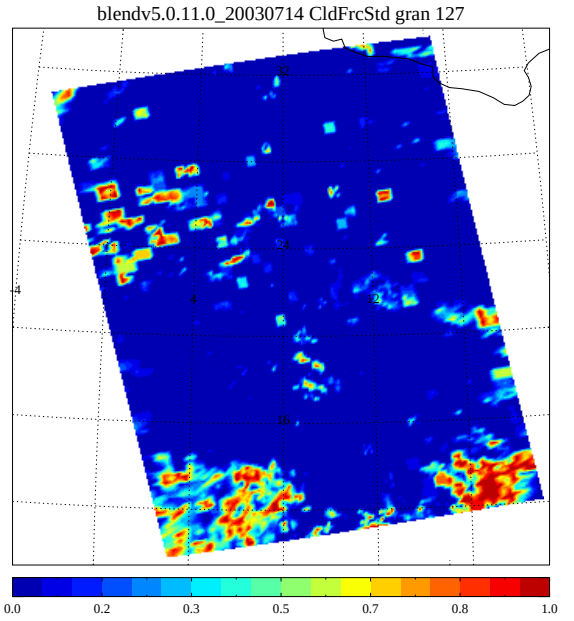
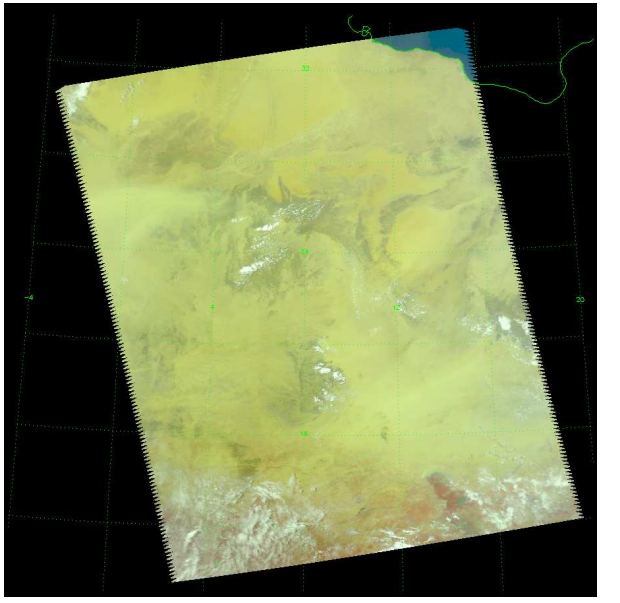
# Spurious Clouds Over Desert



- Fewer spurious clouds over the desert.
- Could the spurious clouds be dust storms?

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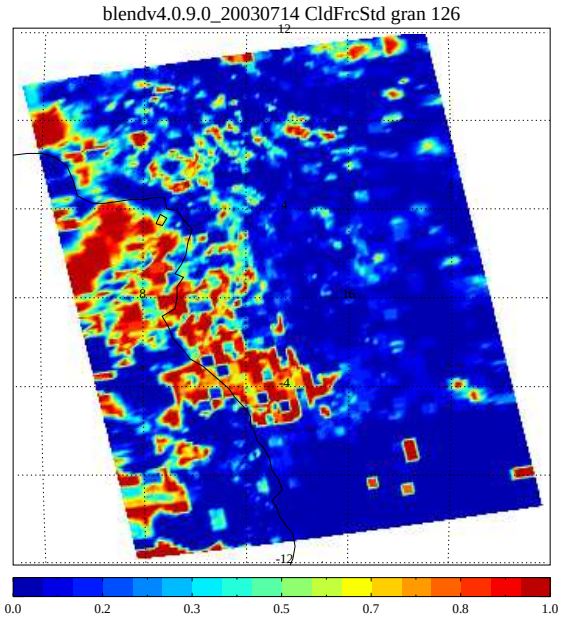
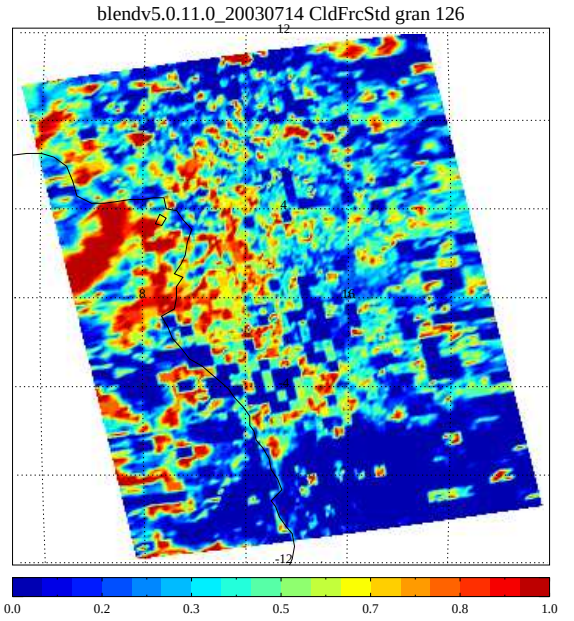
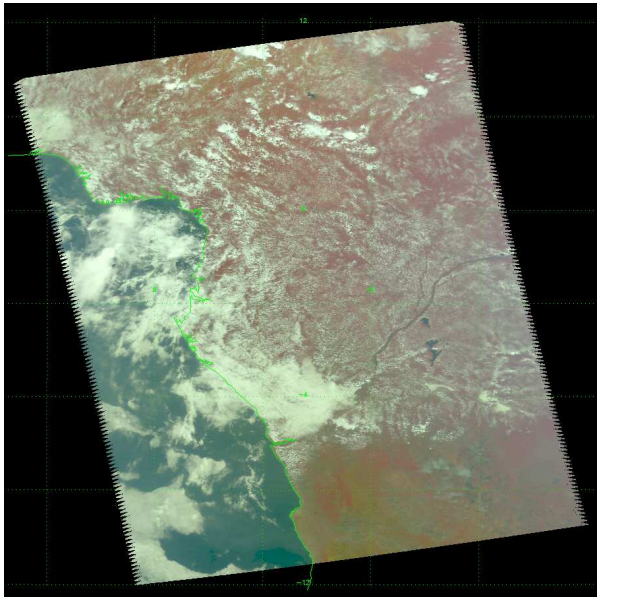
# Angola



- We are detecting more thin clouds over vegetated areas.
- But fewer thick low clouds over ocean.

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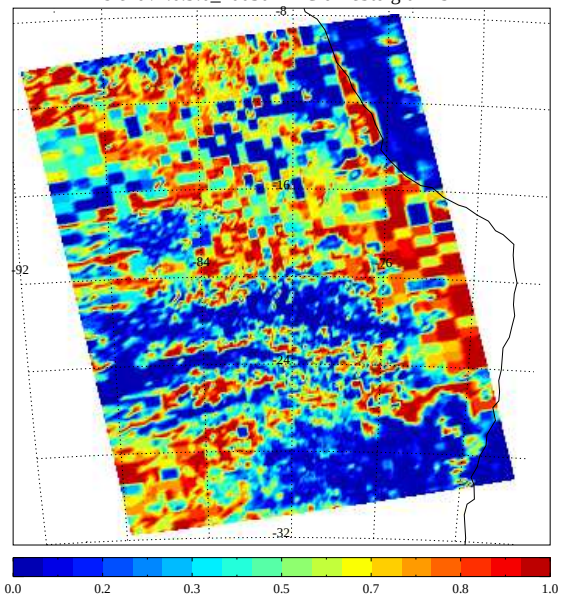
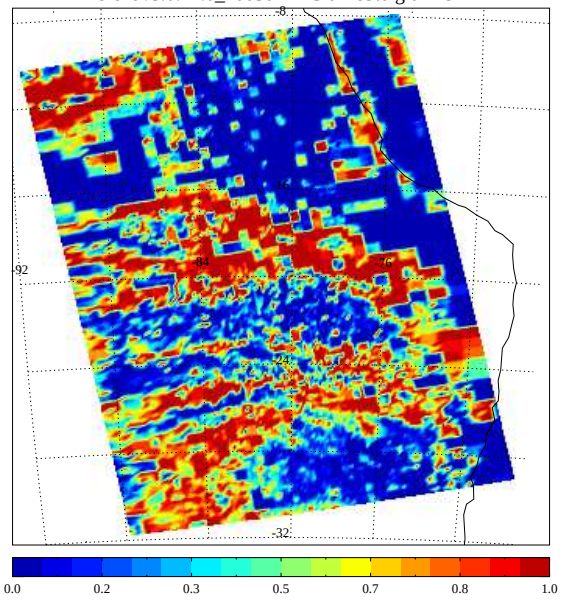
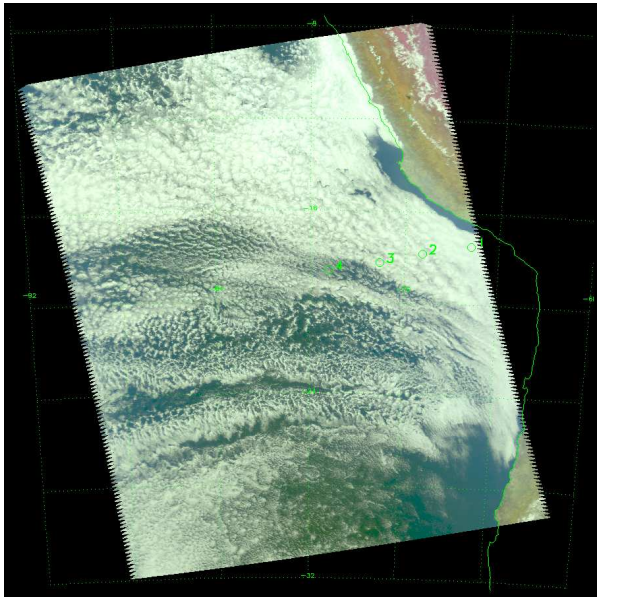
# Low Clouds over the Ocean

blendv4.0.9.0_20030714 CldFrcStd gran 191

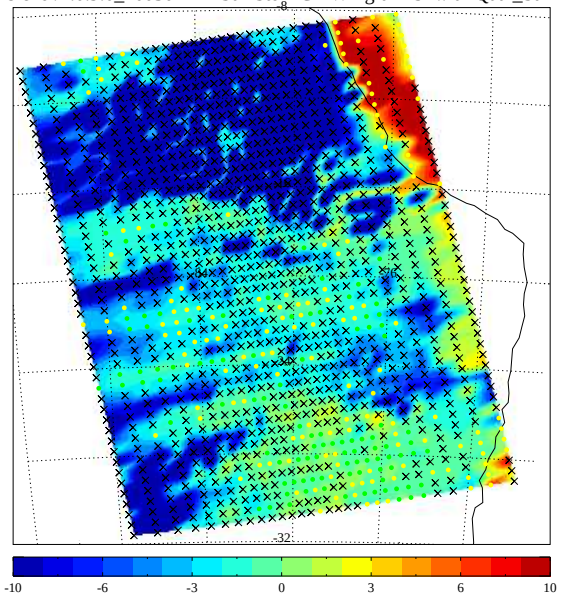



blendv5.0.11.0_20030714 CldFrcStd gran 191

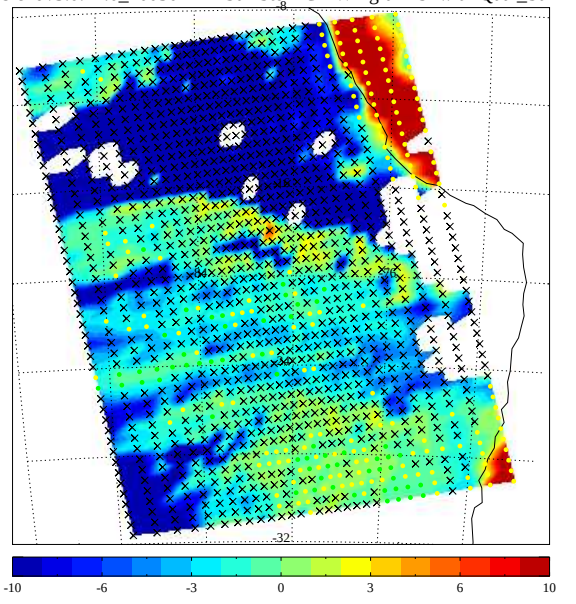


blendv4.0.9.0_20030714 TSurfStd-ECMWF gran 191with Qual_Surf




blendv5.0.11.0_20030714 TSurfStd-ECMWF gran 191with Qual_Surf

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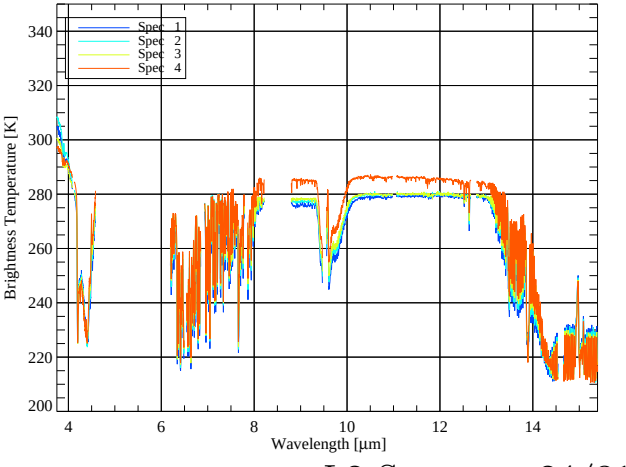

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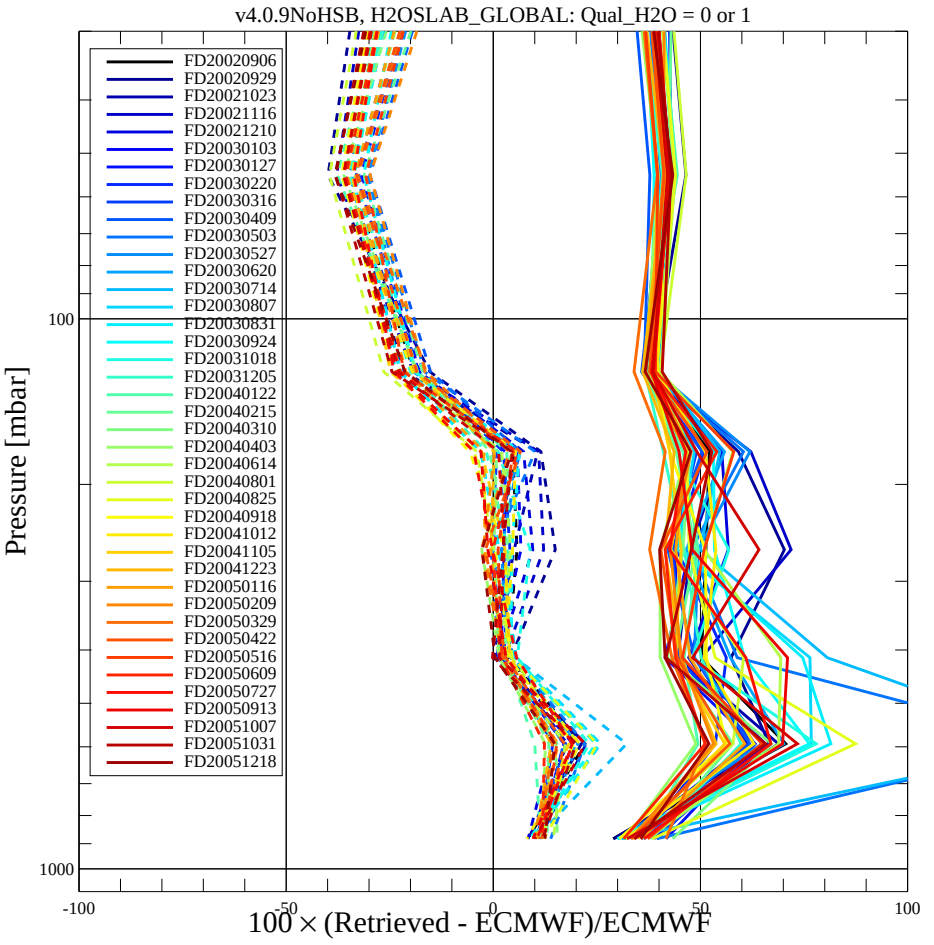
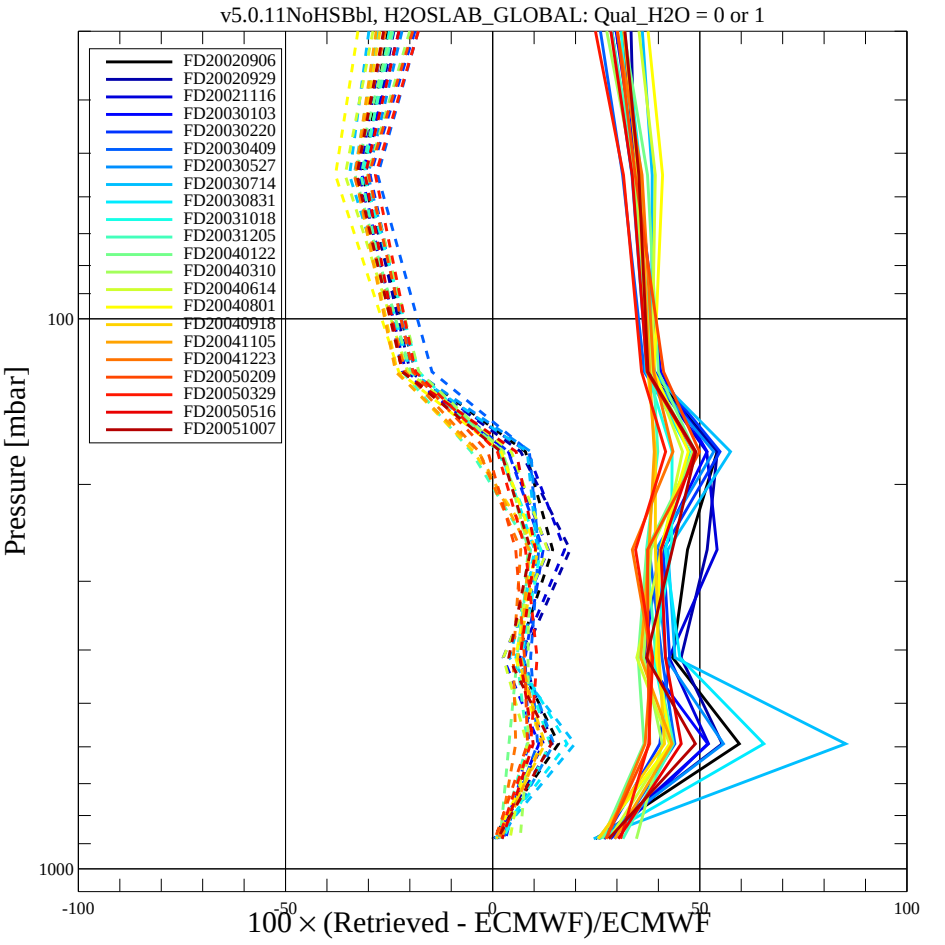
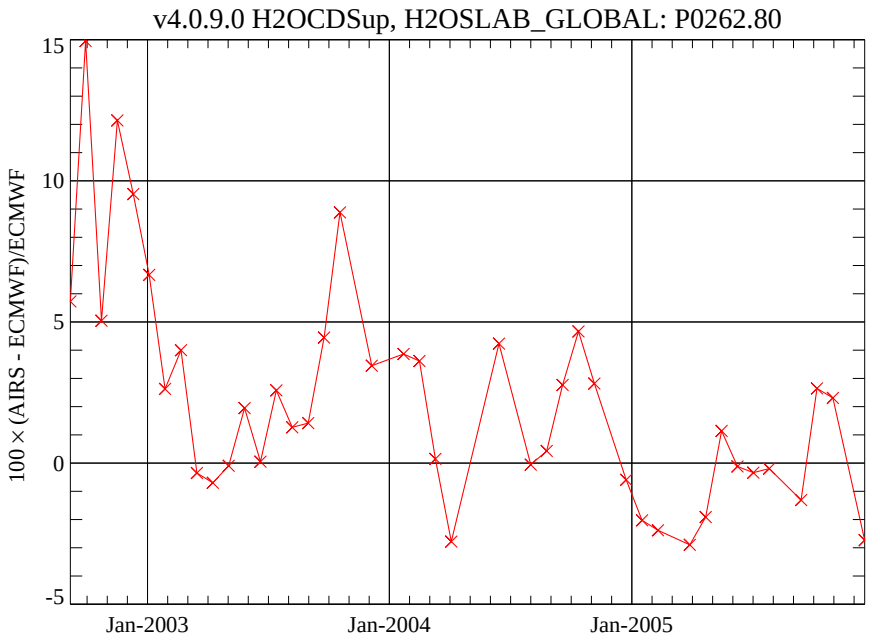
# Global Qual_H2O = 0 or 1

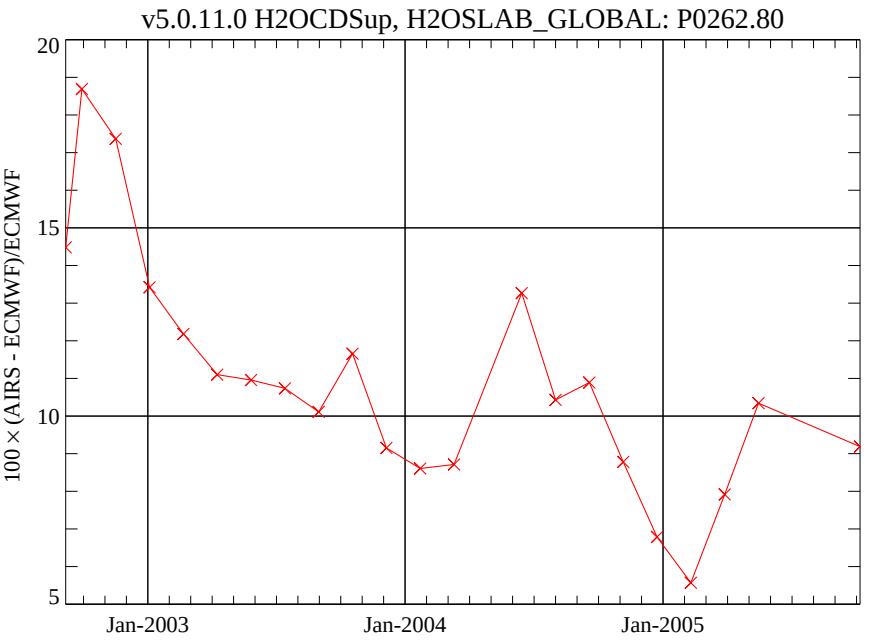



- Yield for Qual_H2O in version 5 reduced from $\sim 82\% \rightarrow \sim 78\%$
- Upper tropospheric dry bias improved
- lower tropospheric wet bias improved.

# Global Qual_H2O = 0 or 1




- There is a decreasing trend in the $H_2O$ bias.
- Needs more investigation.

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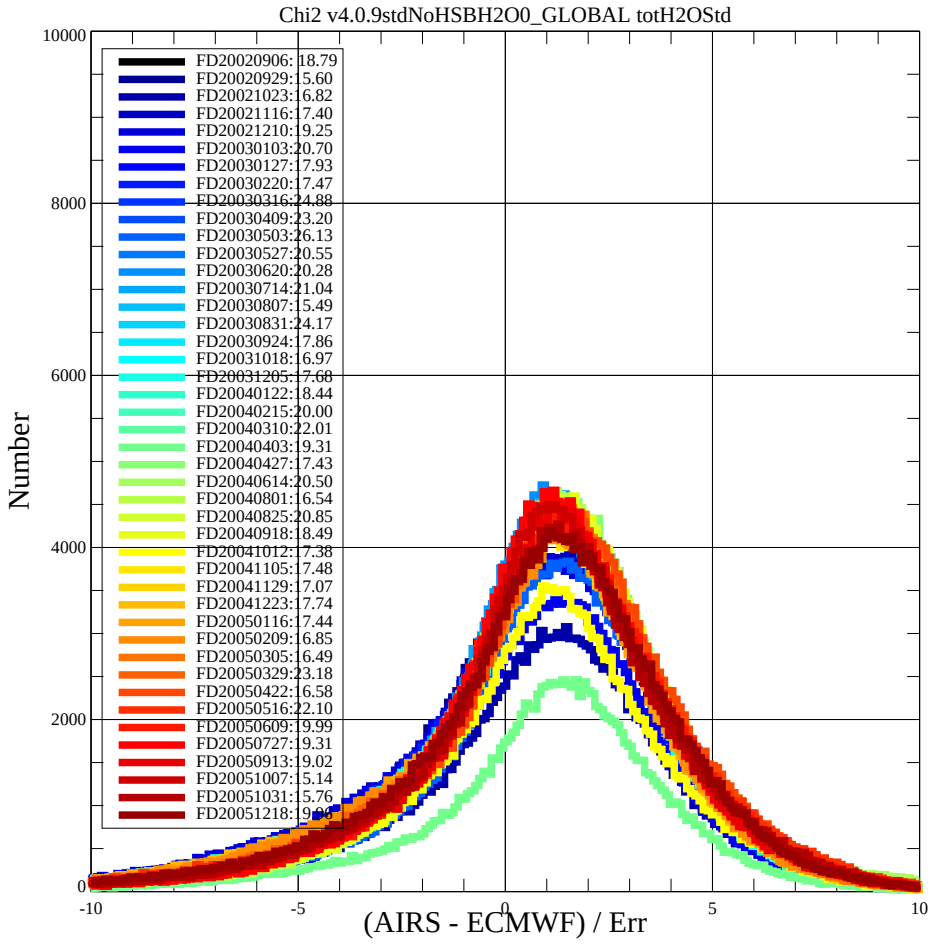
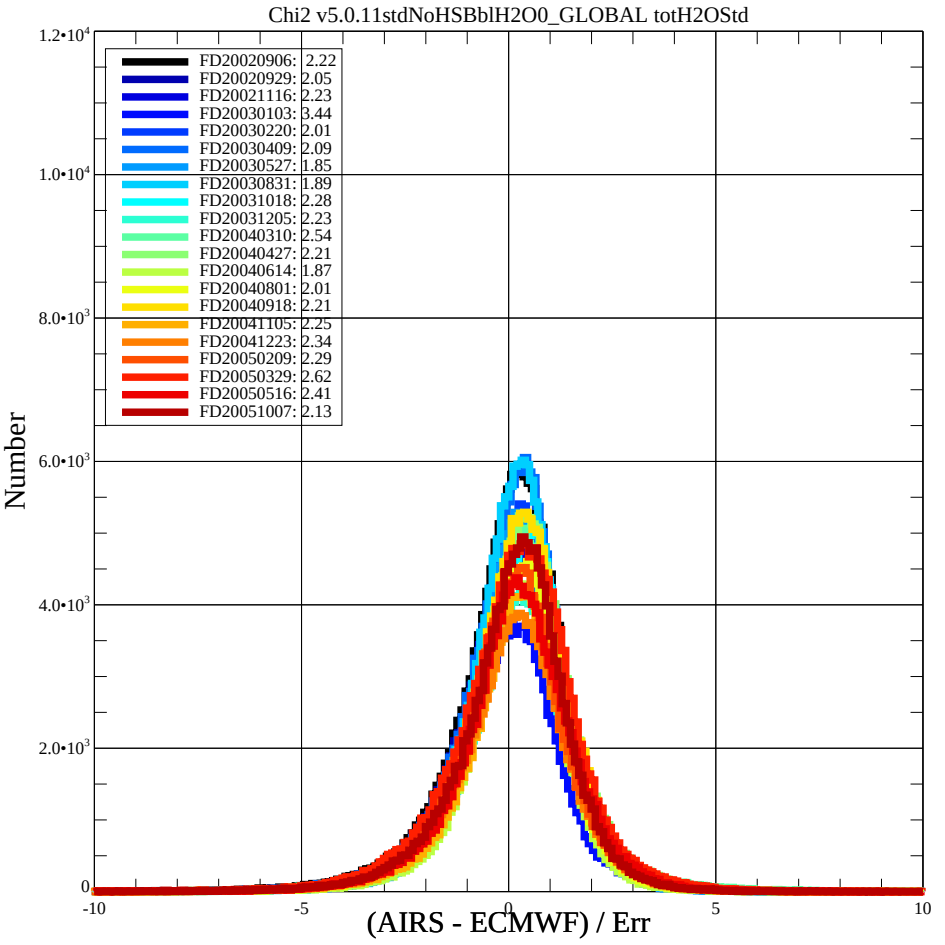
# $H_2O$ Error Estimates




- The improved $\chi$ distribution suggests improved error estimates.

# Conclusions

- The Version 5 yield increased over land and ice covered surfaces.
- Temperature and Water Vapor Error estimates are better than in Version 4.
- Spurious clouds and high water vapor over warm surfaces is fixed.
- There is a slight decreasing trend in the yield.
- Version 5 detects fewer low clouds over ocean.
- Sometimes we retrieve a surface temperature but there is not an error estimate.
- V5 has more -9999s.

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# Extra Slides

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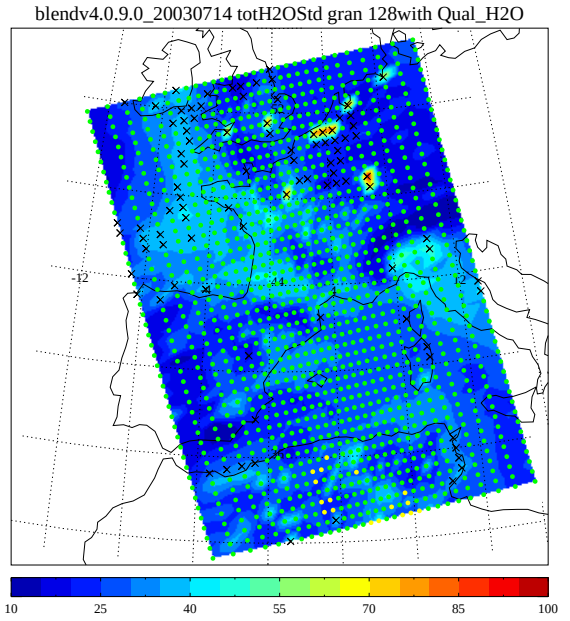
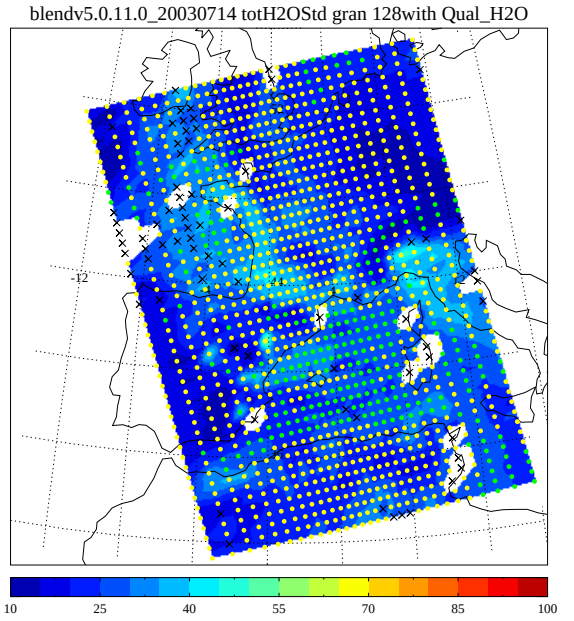
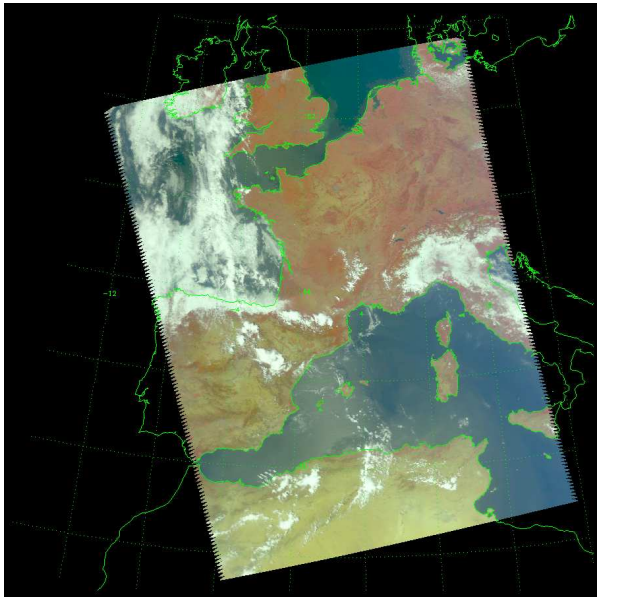
# High Water Vapor



- Fewer high $H_2O$ retrievals over warm scenes.

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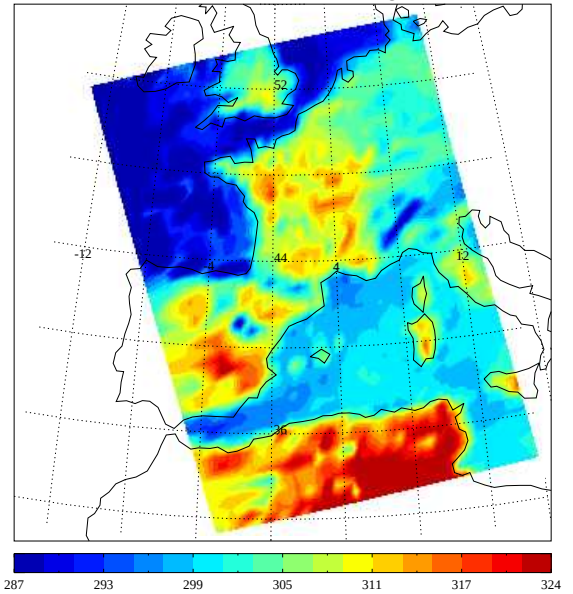
# Land Surface Temperature

blendv4.0.9.0_20030714 TSurfStd gran 128

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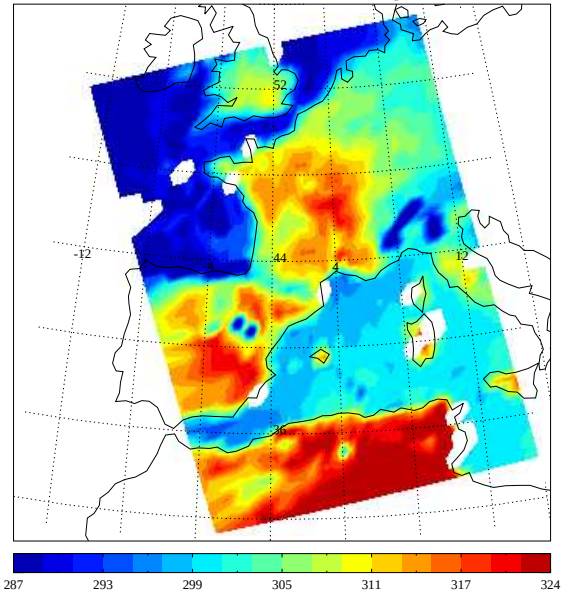


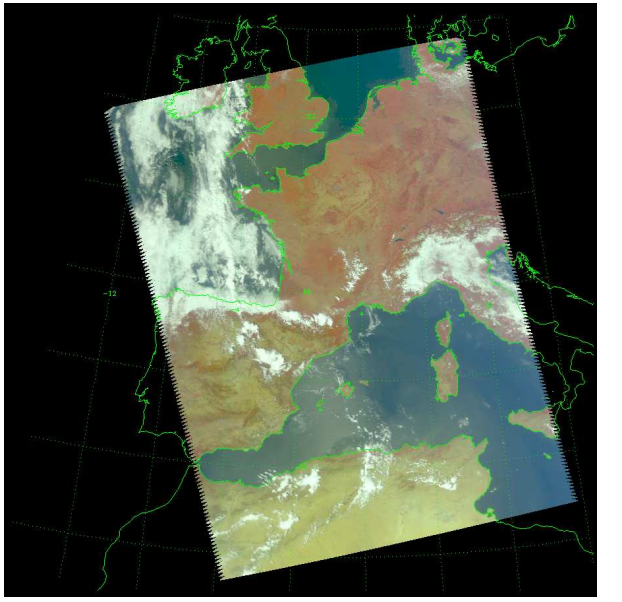


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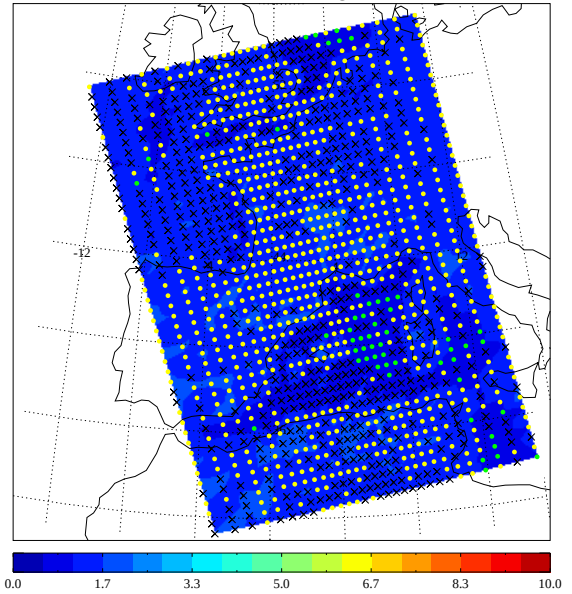


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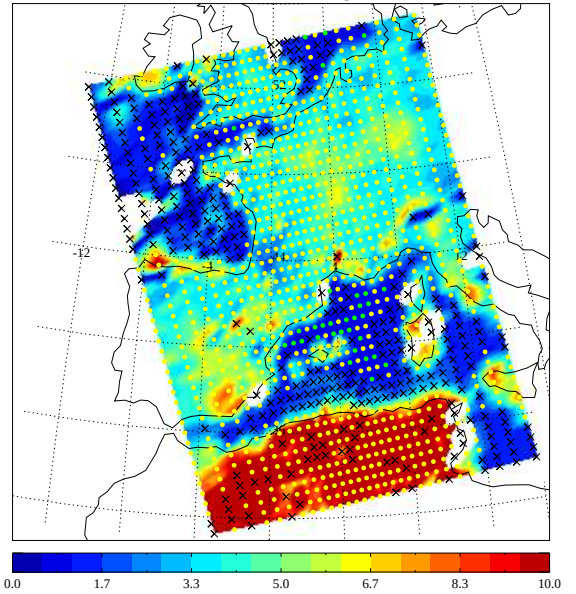

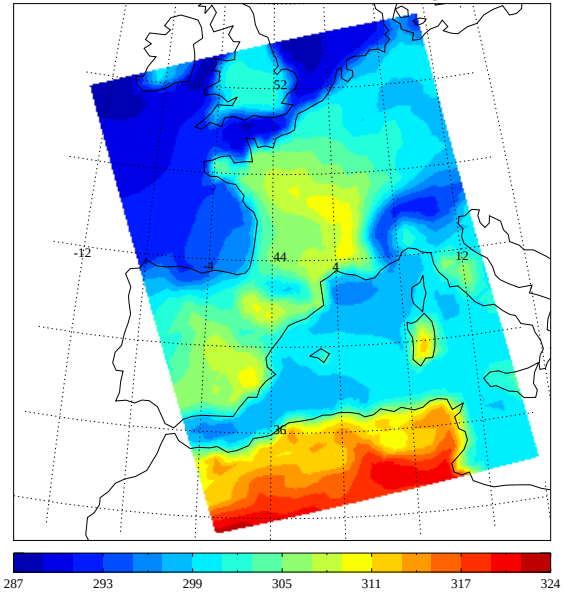
blendv5.0.11.0_20030714 TSurfStd ECMWF gran 128