Feasibility of Reanalysis before the Radiosonde Era (pre-1948)

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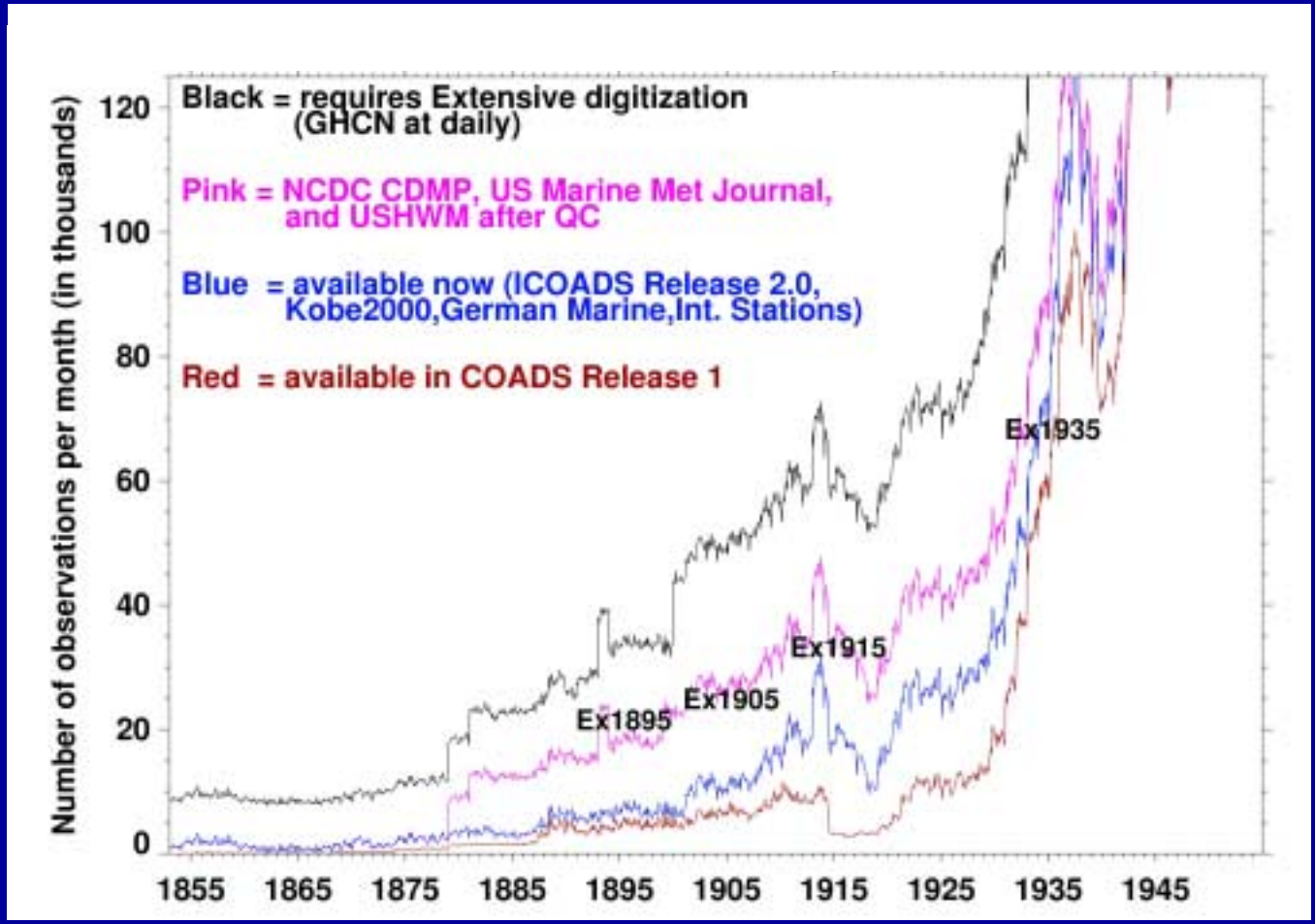
Motivation

1. Would like to determine storminess and blocking variations over last 100 years using gridded analyses. Currently available analyses are hand-drawn SLP maps, contain errors, and do not make use of all collected observations.
2. Modern data assimilation systems (DAS) have the potential to improve upon these analyses.
3. Prior to 1948, few radiosondes are available, but the many new surface pressure obs now “recovered” raise the possibility of generating useful “reanalyses” of at least the lower tropospheric circulation.

Experiment

1. Reduce observational network to only surface pressure observations for Dec 2001 to Feb 2002 at densities typical of 1895, 1905, 1915, and 1935. Compare to surface pressure only for 2001 densities.
2. With the reduced network, make 6-hourly parallel assimilations for Dec 2001-Feb 2002 using:
   a) Optimal Interpolation (**OI**) with climatological mean as the first guess and anomaly covariances as the error statistics of that first guess.
   b) The NCEP-NCAR **CDAS** with ***fixed*** "first-guess" error statistics derived from the NCEP medium range forecast model (MRF).
   c) An Ensemble square root filter (**EnSRF**) with the mean of a 100 member ensemble from MRF as the first-guess and the ***time-varying*** ensemble covariance as the error in that first-guess
3. Compare with using only surface temperature, wind, and pressure together.

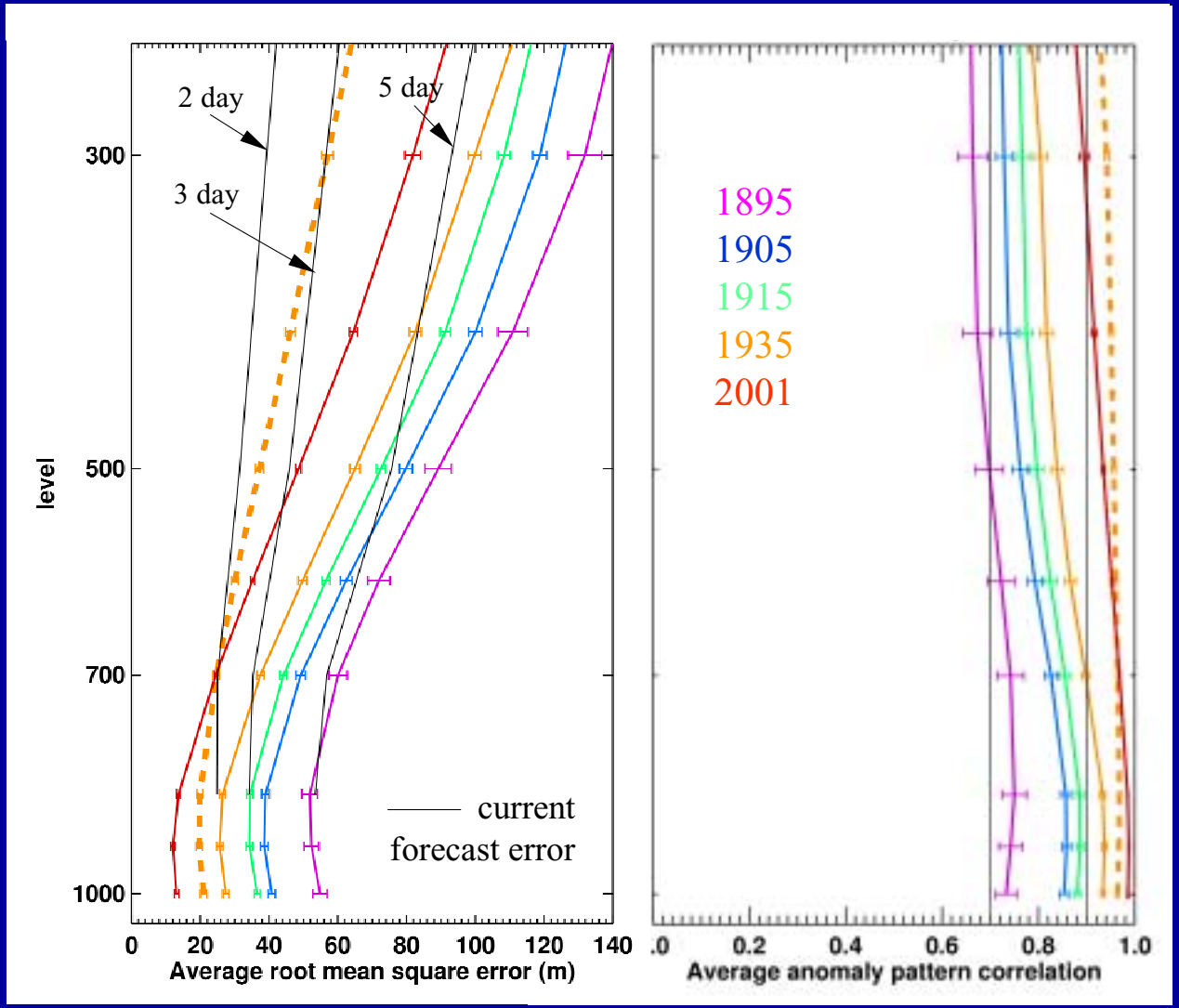
Historical surface pressure obs in each month poleward of 20N (1855-1954)



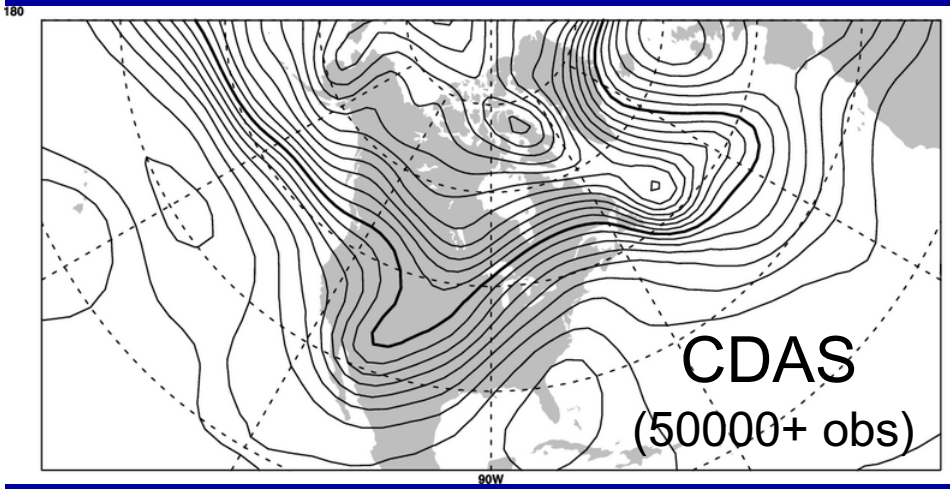
RMS and AC Skill of 6-hourly geopotential height analyses
CDAS (solid) and EnSRF (dashed)
Using Surface Pressure Obs Only

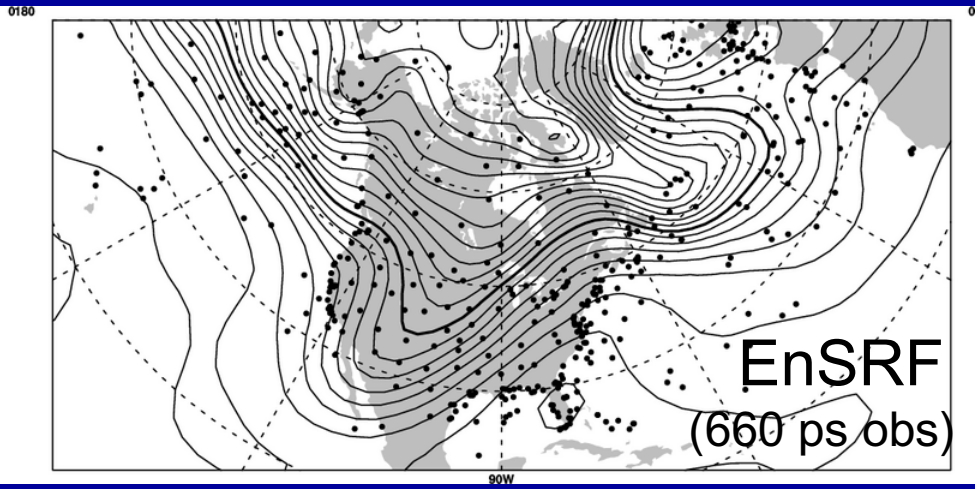
Surface pressure obs alone produce a good 6-hourly analysis even at 1895 densities.

Results obtained using EnSRF (yellow dashed) are significantly better than the traditional CDAS.

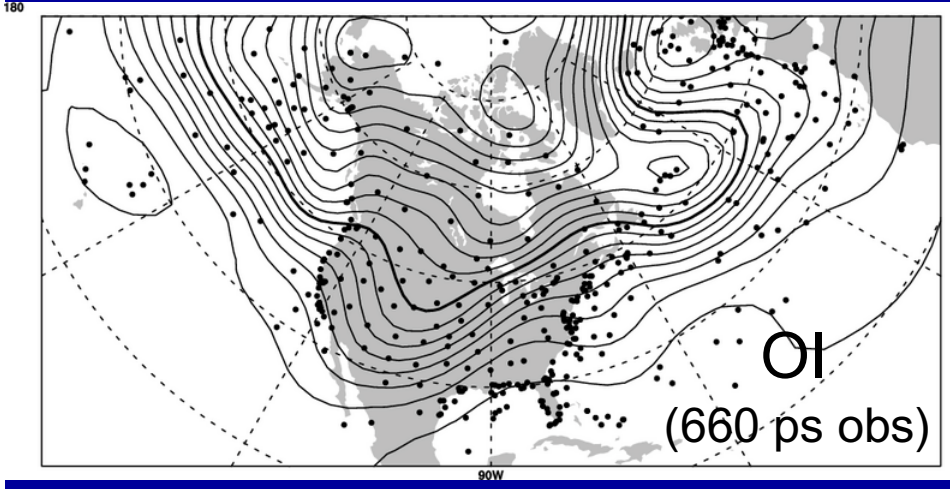


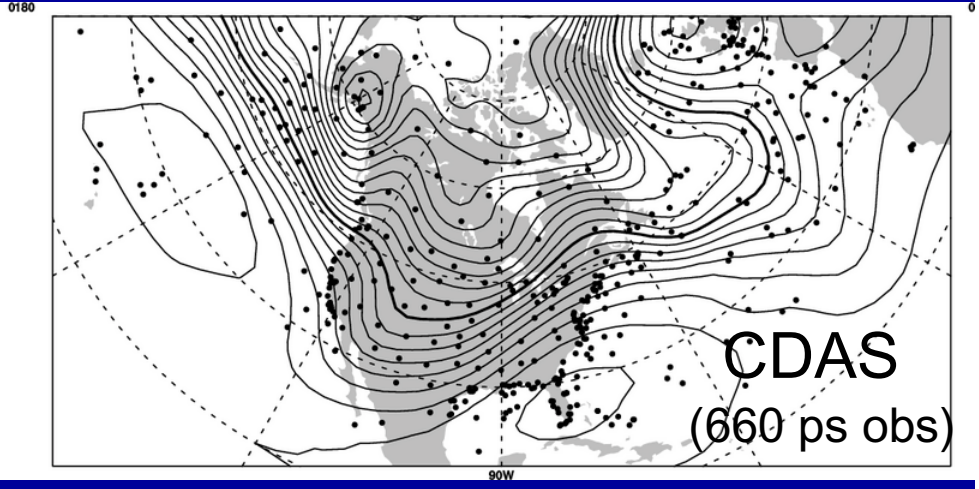
Z500 Analyses for 0Z 13 Dec 2001





RMSD = 30m AC=0.97





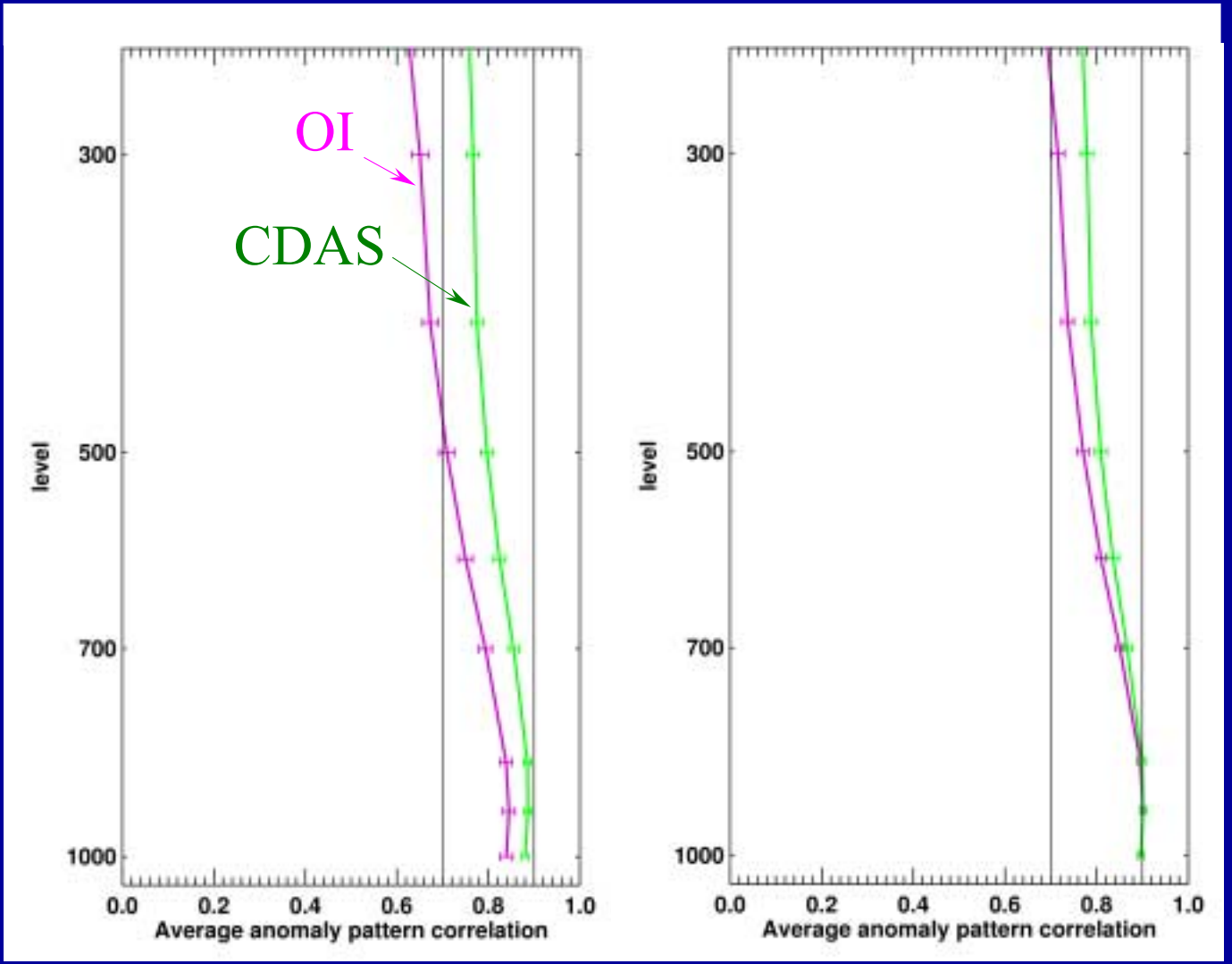
RMSD = 67m AC=0.82

RMSD = 65m AC=0.86

AC Skill of geopotential height analyses
CDAS (green) and OI (purple)
Using Surface Pressure Obs at 1915 Densities

6-hourly daily averages

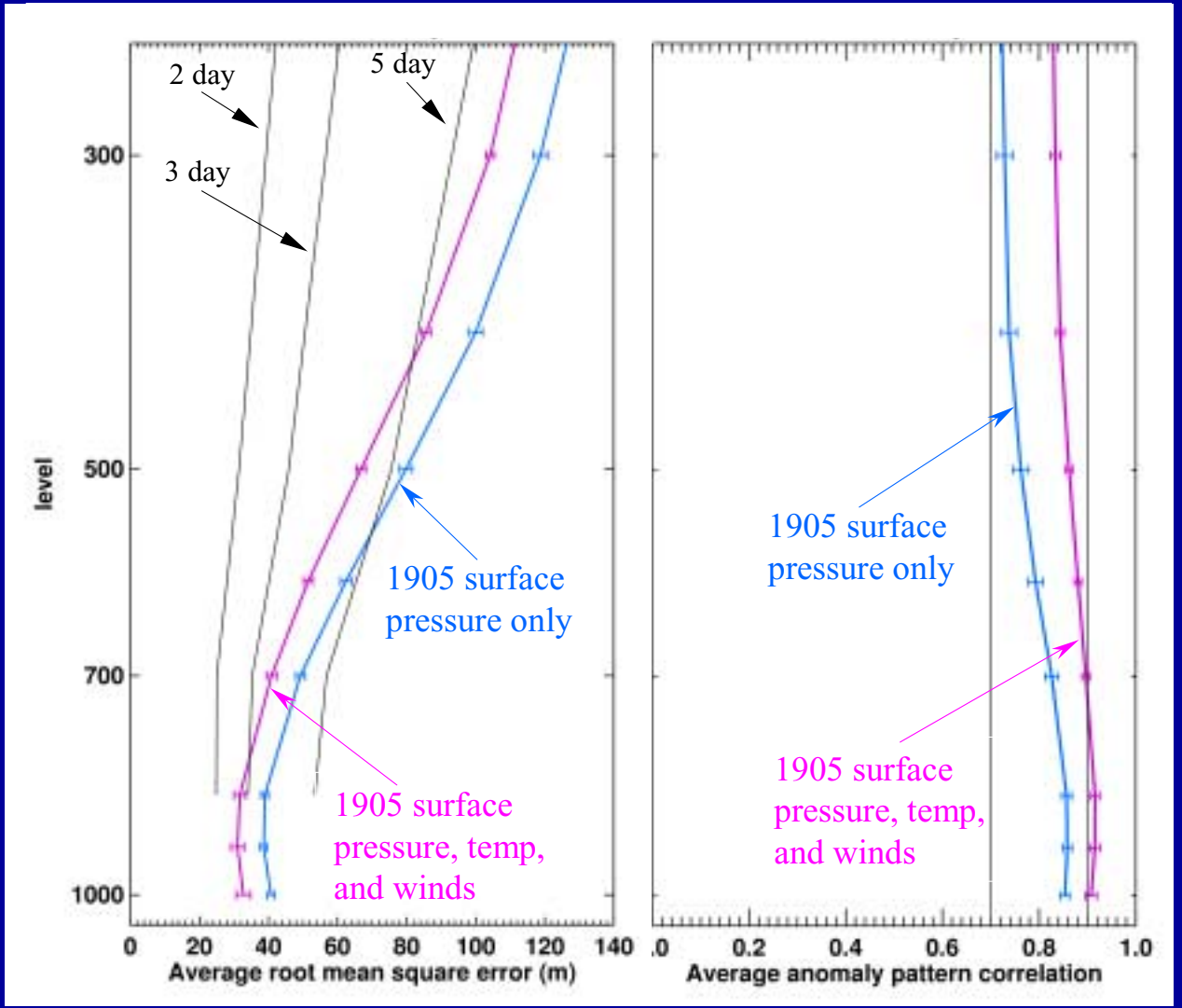
OI {using ***climatology*** as first guess!} is competitive with CDAS for daily averages.



RMS and AC Skill of 6-hourly geopotential height analyses with CDAS using surface pressure, temperature, and wind observations at 1905 densities

Surface pressure, temperature, and wind obs together improve analysis at all levels.

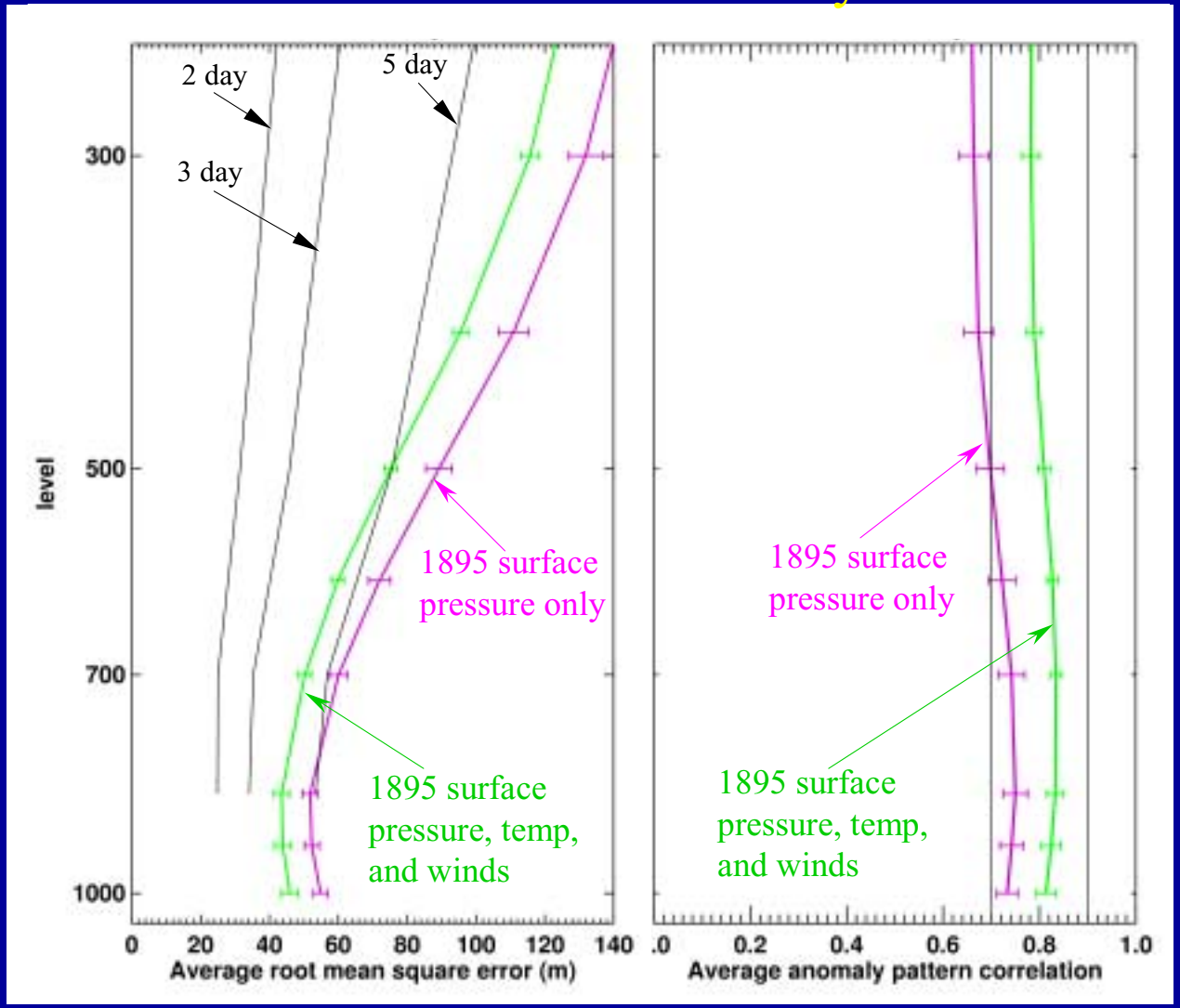
The effect is smaller on more dense networks.



RMS and Anomaly Correlation Skill of analyzing 6-hourly geopotential height with CDAS using surface pressure, temperature, and wind observations at 1895 densities

Surface pressure, temperature, and wind obs together improve analysis at all levels.

The improvement decreases as observation density increases.



Conclusions

1. Reanalyzing the pre-1948 lower-tropospheric circulation is feasible ***using just the available surface observations***.

2. OI would be adequate for analyzing daily averages.

3. More advanced data assimilation methods will produce even better results, especially in the ***upper*** troposphere.