The Tropospheric Humidity Trends of NCEP/NCAR Reanalysis before the Satellite Era

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Acknowledgement: Roger Lin, Shuntai Zhou, Mel Gilman, etc.
NCEP/NCAR REANALYSIS
lwcf 4901-7812 12-month running mean
$LWCF = CS\text{OLR}-\text{OLR}$
NCEP/NCAR REANALYSIS
500mb RH Anomaly 4901~9712 12-month running mean

![Graph showing 500mb RH Anomaly 4901~9712 12-month running mean with different regions labeled: Tropics, SH mid lat, NH mid lat.](image-url)
### The Attributes of Reanalysis GDAS and the Model used for AMIP runs

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reanalysis</th>
<th>AMIP-ensemble10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convection Scheme</td>
<td>SAS</td>
<td>RAS</td>
</tr>
<tr>
<td>Boundary Layer</td>
<td>Local Diff</td>
<td>Non-Local</td>
</tr>
<tr>
<td>Orography</td>
<td>Mean</td>
<td>Smooth Enhanced</td>
</tr>
<tr>
<td>Resolution</td>
<td>T62L28</td>
<td>T42L24</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>w/ nudging</td>
<td>interactive</td>
</tr>
<tr>
<td>Snow</td>
<td>Obs (fixed on ‘72)</td>
<td>Climatology</td>
</tr>
<tr>
<td>Radiation Resolution</td>
<td>124 (3-hr)</td>
<td>128 (3-hr)</td>
</tr>
</tbody>
</table>
30 Stations Suggested by J. Christy
Red – 300 hPa
Yellow – 500 hPa
Green – 700 hPa
Black – 850 hPa
T Profiles from 36-month means
T-dif Profiles from 36-month means
RH Profiles from 36-month means

Green – 76~78
Black – 49~51
Hygristor Time constants

- Carbon hygristor: 1~2 sec at sfc
- Thin Film: 1~2 sec at sfc
- Goldbeater, Hair: >10 sec at sfc, 5min 300 hPa
Hygrometer simulator

an educational toy

\[ \lambda (T) = 3 + 5(15-T), \ T \leq 15 \ C \]

Time-lag constant of a hygristor is a function of temperature. Based on Nash and Schmidlin, 1987, we determine that the rate of increase to be 5 sec/°K, so that the time-lag constant can reach 5 minutes at 300 hPa, where the temperature is lower than -40°C. Balloons ascend at 15 f/s.

\[ RH(i) = RHe + (RH \ (i-1) - RHe ) \ exp \ (-t/ \ \lambda (T)) \]
Conclusion

• The trend of upper air humidity within NCEP/NCAR Reanalysis appears to be an artifact, caused by long time-lag constant in the older hygrometers, and other factors.

• Implies that similar problems, in general, in the time-series radiosonde time-series before the satellite era.

• Significant implication on the earth energy balance and cloud fields of the Reanalysis.

• No humidity climatology yet!

• **Suggestions: future** Reanalyses includes a special fixed observation system sub-analysis using only the limited well-known, high quality, well calibrated, fixed number stations for GDAS, such that a baseline reference analysis for the full analysis can be established.
An AMIP simulation Using the Current NCEP Operational Global Forecast Model

S-K Yang
Alvin J. Miller
28th CERES Science Team Meeting
5/6-8/03, Norfolk, VA
Attributes of GFS AMIP Model
1949~2001

AMIP

• Convection Scheme SAS
• SW Radiation Chou et al (1992, 96)
• Boundary Layer Non-Local
• Orography Mean
• Resolution T62L64
• Soil Moisture Climatology
• Snow Climatology
• Radiation Resolution as dynamics 194 Gaussian Grid (3-hr)
Comparison of 1985~1989 4-year global means to ERBE/LaRC-Surface Radiation Budget Dataset, \(W/\text{m}^2\)

<table>
<thead>
<tr>
<th></th>
<th>TOA OLR</th>
<th>TOA RSW</th>
<th>Sfc dn Lw</th>
<th>Sfc Dn SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDAS R-1</td>
<td>237.3</td>
<td>115.6</td>
<td>333.2</td>
<td>207.0</td>
</tr>
<tr>
<td>AMIP</td>
<td>245.5</td>
<td>87.4</td>
<td>325.5</td>
<td>211.2</td>
</tr>
<tr>
<td>ERBE/ LaRC sfc</td>
<td>235.3</td>
<td>102.7</td>
<td>348.3</td>
<td>184.3</td>
</tr>
<tr>
<td>Diff</td>
<td>10.2</td>
<td>-15.3</td>
<td>-22.8</td>
<td>26.8</td>
</tr>
</tbody>
</table>
OLR - White; Tsfc*(-10.)-Red; RH(sigma 1-0.33)*(-1.)-Green
Global Tropical (20S-20N) Monthly Means

OLR- White; Tsfc-Red; RH(sigma 0.33-0.44)*(-10)-Green
Global Tropical (20S-20N) 12-month Running Means

OLR- White; Tsfc*10-Red; RH(sigma 0.33-0.44)*(-100)-Green
Standardized Outgoing Longwave Radiation (OLR) Anomalies

Year

National Climatic Data Center / NESDIS / NOAA
Why we care about small calibration drifts:

1% = 2.5W/m² LW flux
5 current climate models all miss this decadal variation in the tropics: apparent strengthening of Hadley and Walker Circulation in the Tropics (20S-20N) from the 1980s to the 1990s. 1% to 3% signals, but as large or larger than century scale greenhouse gas forcing: climate may not change smoothly. (Science, Feb, 2002)
summary

• NCEP GFS AMIP is a Darker and Warmer Planet at TOA; Brighter and Colder at the surface.
• In the Nino 3.4 (120~170W, 5S~5N)
  OLR $\uparrow$ –TsfC; OLR $\downarrow$ –Rhcol
• In the global tropics (20S-20N),
  OLR $\downarrow$ TsfC; OLR $\downarrow$ out of phase with UTH
• Judging from the sensitivity to SST, the Model can’t simulate ERBE/ScaRab/CERES observations