Different periods for reanalysis

Laura C. Slivinski^{1,2}, Gilbert P. Compo^{1,2}

¹Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO ²Physical Sciences Laboratory, NOAA, Boulder, CO

SYNOPTIC WEATHER MAP NORTHERN HEMISPHERE SEA LEVEL 1300 GMT AUG 16 1915

1%

ふえみ できまっ

1



The 20th Century Reanalysis (20CR) provides a global, 200-year history of sub-daily weather

by assimilating only surface pressure observations into a modern weather model

NOAA-CIRES-DOE 20CRv3, 13 Mar 1888 (0Z) (b) Ens. mean Z500 and confidence





confidence

(c) Ens mean. 2m air temperature



0 14

deg C

-28 -14

-0.8-0.6-0.4-0.2 0.0 0.2 0.4 0.6 0.8 confidence (d) Ens. mean precip (6h accum.) 21

20th Century Reanalysis Version 3

- Ensemble Kalman Filter with 80 ensemble members to quantify uncertainty
- Prescribed sea surface temperature (quasiweakly coupled; Giese et. al., 2016), sea ice concentration, and radiative forcing
- Estimates temperature, wind, precipitation, pressure, humidity, & other variables, from the ground to the top of the atmosphere
- Global, 75km grid
- 3-hourly resolution
- Spans 1836-2015 [1806-1835 experimental]
- Publicly available! https://go.usa.gov/XTd

5-year averaged global **2m air temperature** anomalies from paleo reconstructions, reanalyses, and climate model projections



Reanalyses provide an instrument-based link between paleo reconstructions and climate model projections

Uses of the 20th Century Reanalysis

- Paleoclimate validation and calibration
- Droughts, floods, blizzards, wind storms, typhoons
- 1815 eruption of Mt. Tambora and the following "Year Without a Summer"
- Irish potato famine of 1845
- "The Long Winter" of 1880-1881 described in Laura Ingalls Wilder's books
- Weather and ocean conditions during the sinking of the Titanic
- Economic impacts of diseases spread by the TseTse fly in sub-Saharan Africa
- US Dust Bowl of the 1930s

- Arctic warming in the 1920s-1930s
- Probability of wind-assisted, cross-Atlantic bird species migration
- Studying Greenland ice sheet melting
- Discovering previously unknown hurricanes
- Coastal defense planning against sealevel rise and storm surges
- Wind and solar droughts for renewable energy planning
- Risk assessment of extreme events for insurance and reinsurance
- Historical risks of wildfires
- Variations in forest productivity

• Full-input

Conventional-only/upper-air

• Sparse-input (e.g. 20CR)

Paleo

• Full-input

- 1979-present
- Can run at high(er) spatial/temporal resolution
- Accurate
- E.g., ERA5
- Conventional-only/upper-air
- Sparse-input
- Paleo

• Full-input

Conventional-only/upper-air

- Mid-20th century present (from S. Brönnimann: upper-air back to 1939, maybe earlier)
- No assimilation of satellite data
- Illuminate artifacts due to satellite observing system changes
- E.g., CORe (JRA-55, ERA5 BE)
- Sparse-input
- Paleo

• Full-input

- Conventional-only/upper-air
- Sparse-input
 - Centennial-length
 - Only assimilate surface observations (surface pressure, marine winds)
 - E.g., 20CR, CERA-20C, ERA-20C
- Paleo

• Full-input

- Conventional-only/upper-air
- Sparse-input
- Paleo
 - Extend 1000+ years back
 - Proxy data instead of instrument-based observations
 - Generally coarse temporal resolution (monthly)

- Can a case be made for a suite of reanalyses (sparse/conventional-only/full-input)?
 - Benefits of using same system: illuminate ob biases, model errors by assimilating different observing networks
 - Sparse-input system can be used as a testbed for new DA methods
 - Conversely, "optimal" DA configuration likely depends on observing network
- How can paleo reanalyses be incorporated? Is it possible to blend paleo & sparse-input to extend further back in time?



More information:

- Compo, G.P., et. al. (2011) The Twentieth Century Reanalysis Project. Q.J.R. Meteorol. Soc., 137: 1-28. https://doi.org/10.1002/qj.776
- Slivinski, L.C., et. al. (2019) Towards a more reliable historical reanalysis: Improvements for version 3 of the Twentieth Century Reanalysis system. *Q.J.R. Meteorol. Soc.*, 145: 2876–2908. <u>https://doi.org/10.1002/qj.3598</u>
- Slivinski, L.C., et. al. (2021) An Evaluation of the Performance of the Twentieth Century Reanalysis Version 3. J. Clim., 34(4): 1417-1438. <u>https://doi.org/10.1175/JCLI-D-20-0505.1</u>

For data access, visualization tools, and references, please visit <u>https://go.usa.gov/XTd</u>



THORN CHARTEN OF COMMENT

Laura.Slivinski@noaa.gov