Validation of IAU initialized reforecasts (2000-2018)

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Acknowledgments:
Scott Gregory, Jeff Whitaker and PSD staffs,
and Ensemble staffs,
Update: 2/28/2019

Update of reforecast 1989-1999

- Continue to run on DELL develop machine
- 750 nodes – “devmax” priority
- Years has been finished
  - 1994, 1995, 1996, 1997, 1998, 1999
  - Part of 1993
  - Validation is going on
- Machine is maintained today – not available

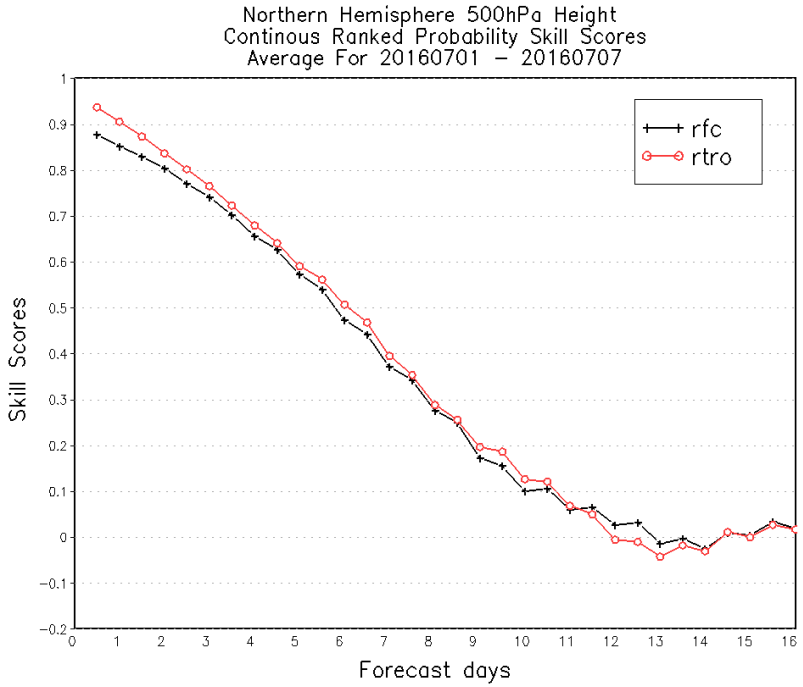
Purpose of this validation

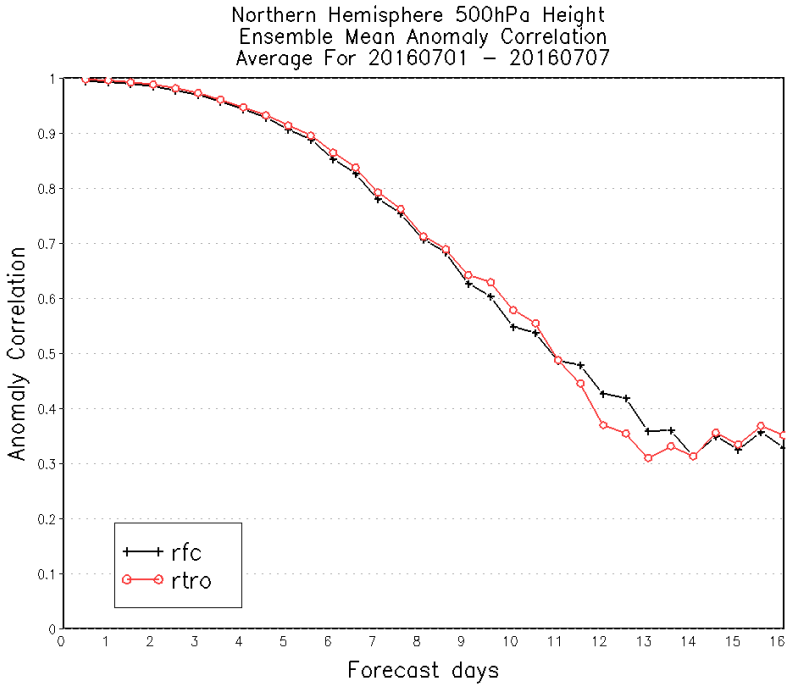
- Purpose of these 30-y reforecasts
  - Generate systematic error to calibrate real-time forecast
- Make sure all our processes (combined to PSD's process) are right for starting reforecast from using IAU (+3)
- To find out if there is any big difference compared to retrospective runs include analysis and forecast
  - It may indicate the difference to future operation, in particularly for systematic errors.
  - It may impact our application.
- We need to understand
  - There is no apple-to-apple comparison.

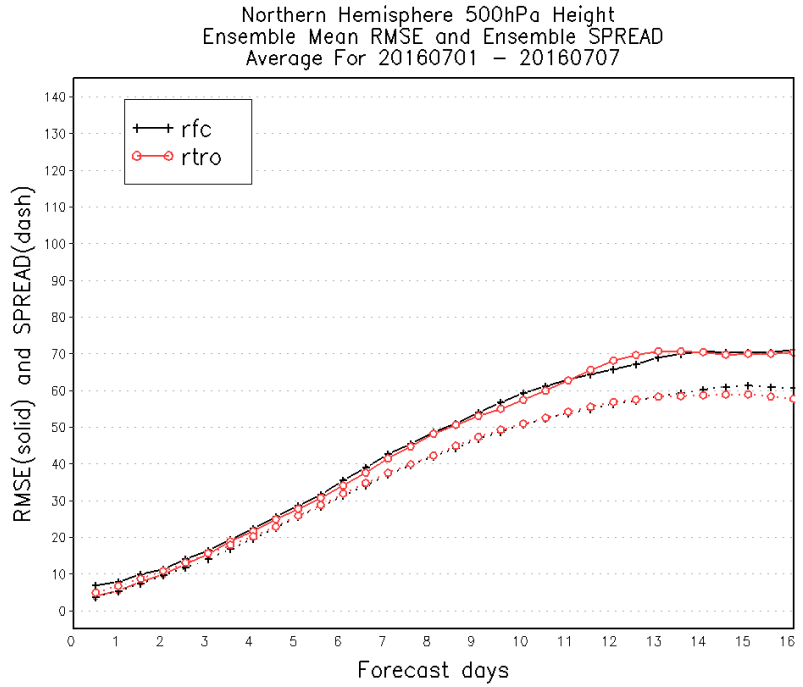
Experiments Setting

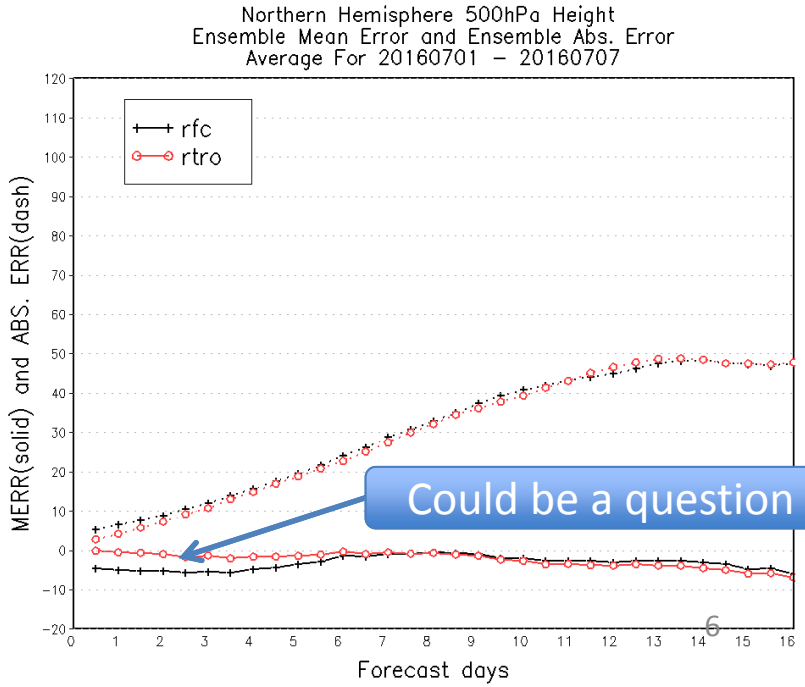
- Period:
  - One week for summer – 7/1 – 7/7/2016
    - 5 members per run out to 16 days
    - 11 members for 7/6/2016 (Wednesday)
  - One week for winter – 1/1 – 1/7/2016
    - 5 members per run out to 16 days
    - 11 members for 1/6/2016 (Wednesday)
- Model configuration
  - Frozen system (Dec. 21 2018)
    - Highlights – Hord=5; radiation bug fixed; SST adjustment; GFDL MP modification
  - Initial conditions (need to further confirm – both model version for cycling)
    - End of IAU (+3), and perturbations (EnKF analysis) with re-centerization.
    - Retrospective initials are using hybrid DA cycling (June 2018 version) and F06 of ENKF
- References:
  - Forecasts compare to retrospective experiments – only difference is a initial conditions
  - Verification reference – retrospective analysis which is more favor to retrospective experiments
- Stats
  - https://www.emc.ncep.noaa.gov/gmb/wd20hg/html/rfc_rtro_20160101_2lines.html
  - https://www.emc.ncep.noaa.gov/gmb/wd20hg/html/rfc_rtro_20160701_2lines.html

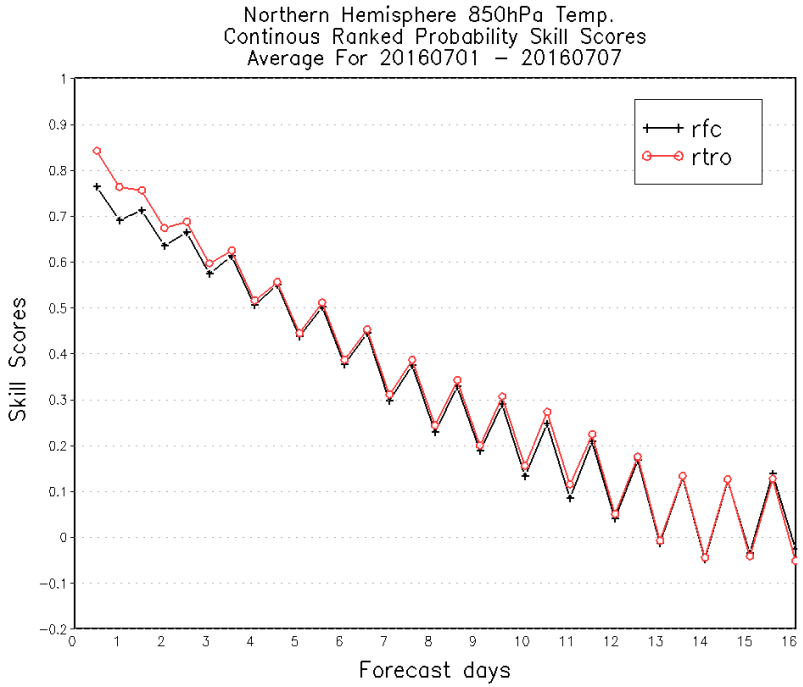
Summer


Northern Hemisphere 500hPa Height
Continous Ranked Probability Skill Scores
Average For 20160701 – 20160707
rfc
rtro
Skill Scores
Forecast days


Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20160701 – 20160707
rfc
rtro
Anomaly Correlation
Forecast days


Northern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20160701 – 20160707
rfc
rtro
RMSE(solid) and SPREAD(dash)
Forecast days


Northern Hemisphere 500hPa Height
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160701 – 20160707
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Forecast days
Could be a question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Continous Ranked Probability Skill Scores
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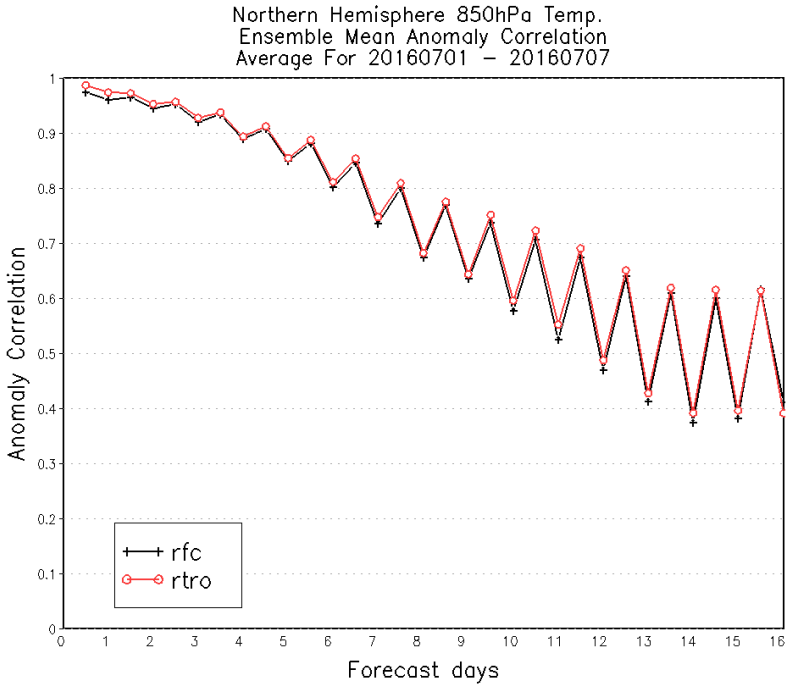
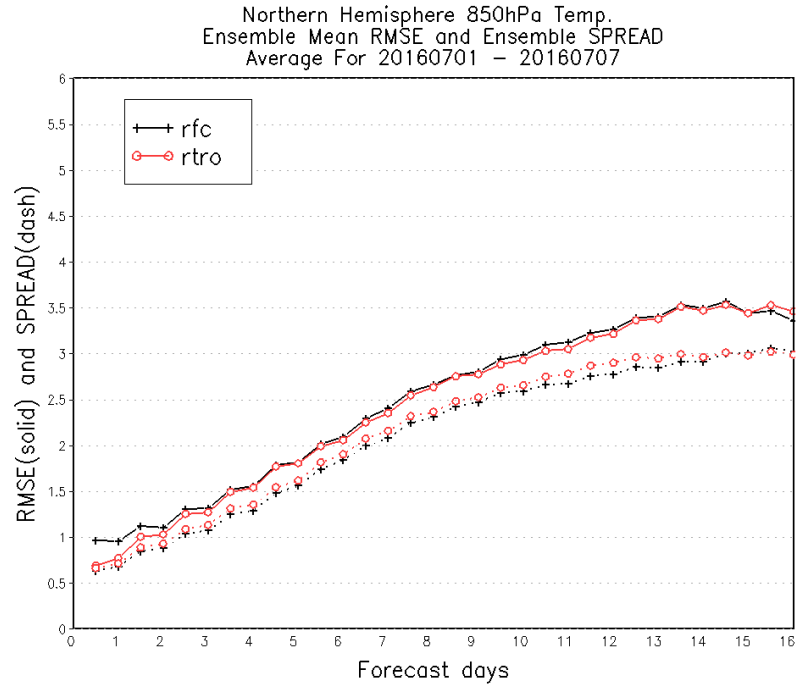
rfc
rtro
Skill Scores
Forecast days


Northern Hemisphere 850hPa Temp.
Ensemble Mean Anomaly Correlation
Average For 20160701 – 20160707
rfc
rtro
Anomaly Correlation
Forecast days


Northern Hemisphere 850hPa Temp.
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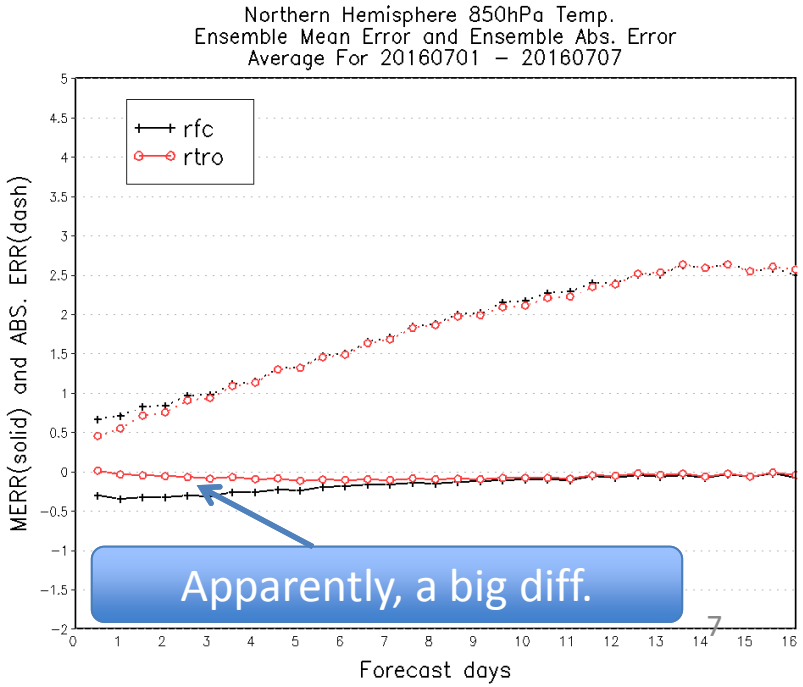
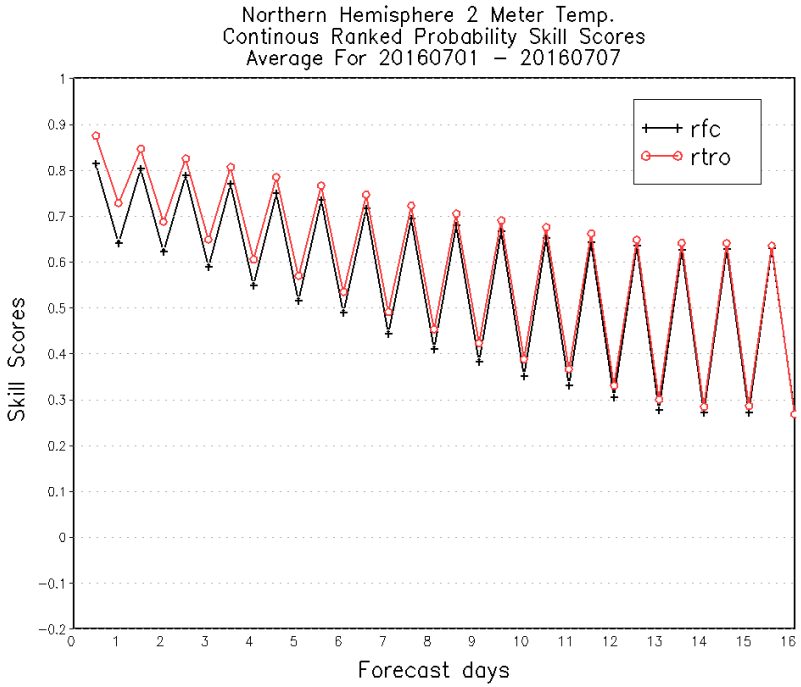
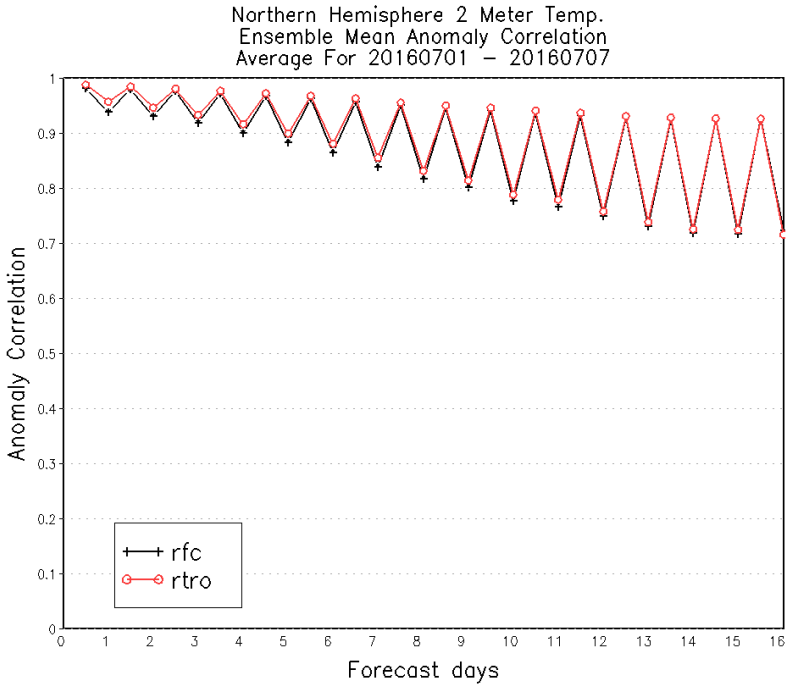
Forecast days


Northern Hemisphere 850hPa Temp.
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160701 – 20160707
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Apparently, a big diff.
Forecast days


Northern Hemisphere 2 Meter Temp.
Continous Ranked Probability Skill Scores
Average For 20160701 – 20160707
rfc
rtro
Skill Scores
Forecast days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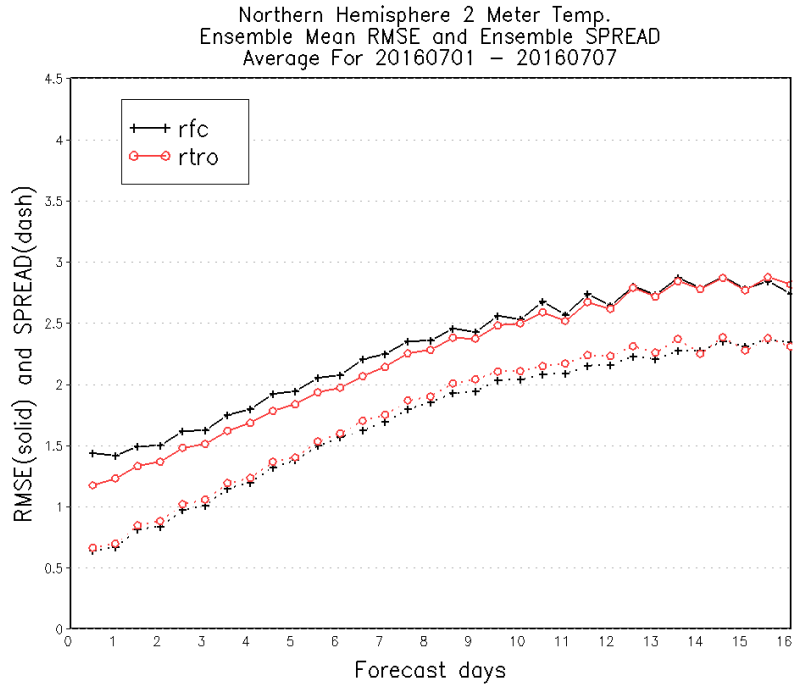
rfc
rtro
Anomaly Correlation
Forecast days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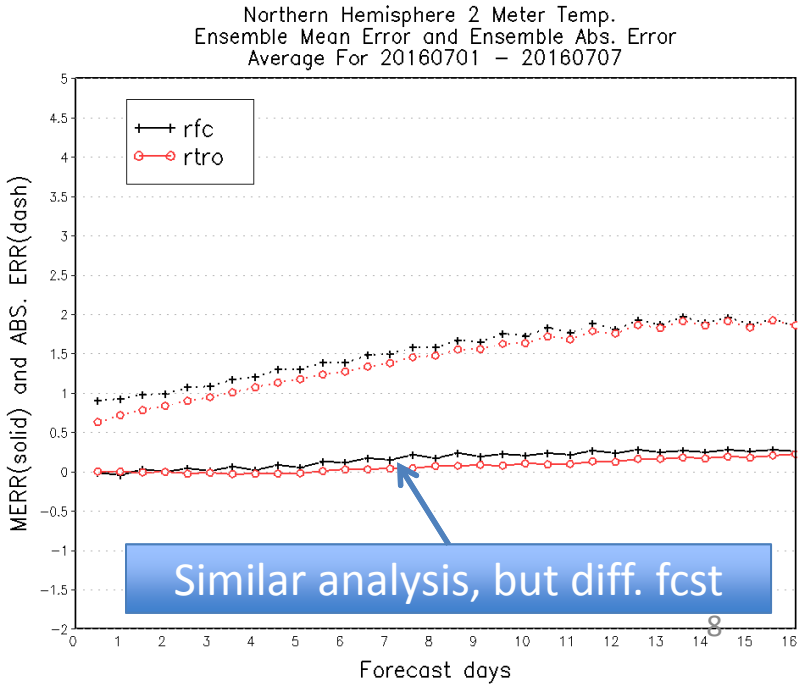
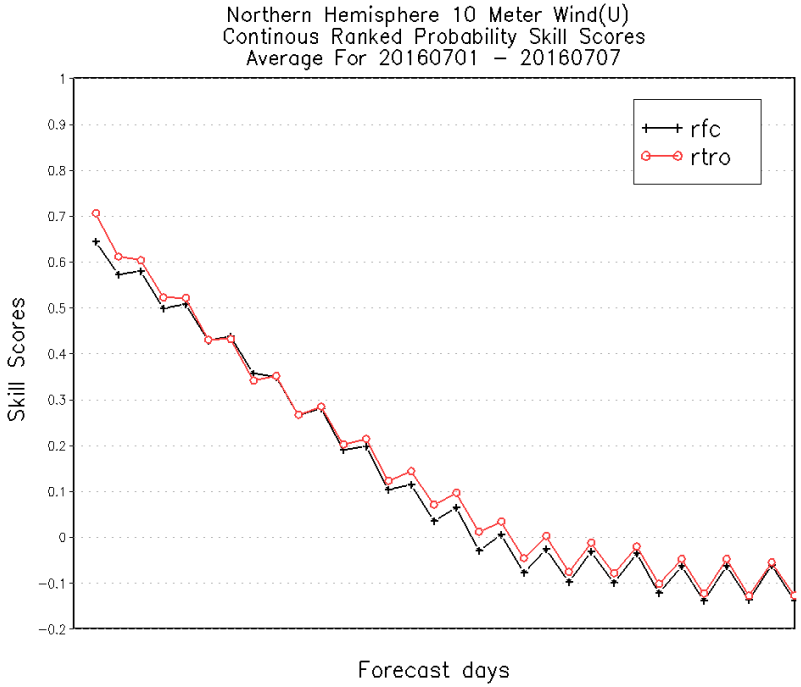
RMSE(solid) and SPREAD(dash)
Forecast days


Northern Hemisphere 2 Meter Temp.
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160701 – 20160707
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Similar analysis, but diff. fcst
Forecast days


Northern Hemisphere 10 Meter Wind(U)
Continous Ranked Probability Skill Scores
Average For 20160701 – 20160707
rfc
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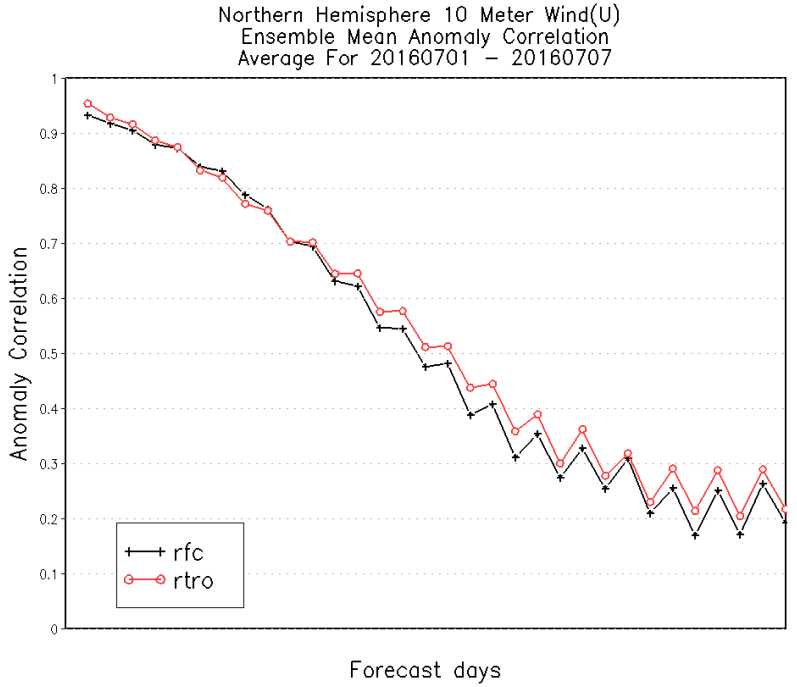
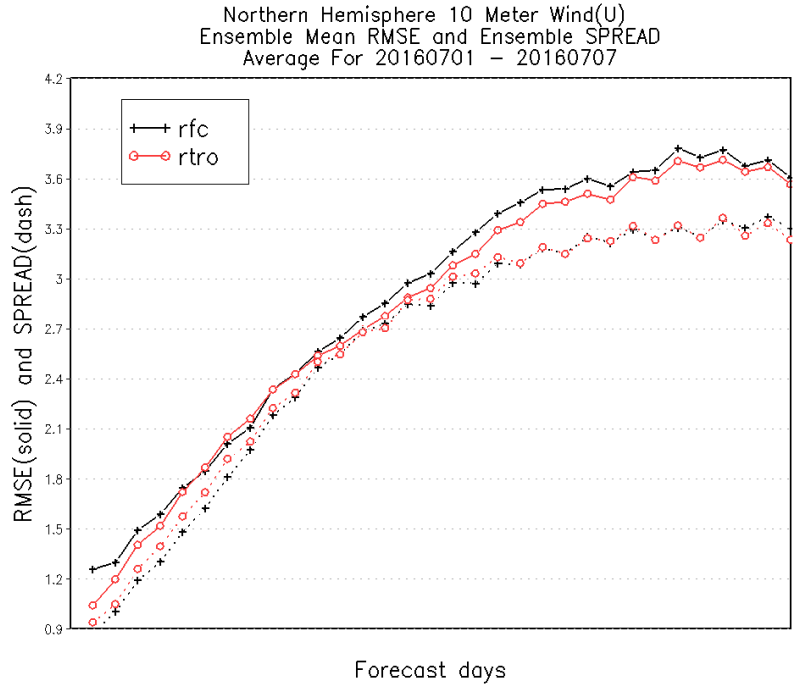
Skill Scores
Forecast days


Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean Anomaly Correlation
Average For 20160701 – 20160707
rfc
rtro
Anomaly Correlation
Forecast days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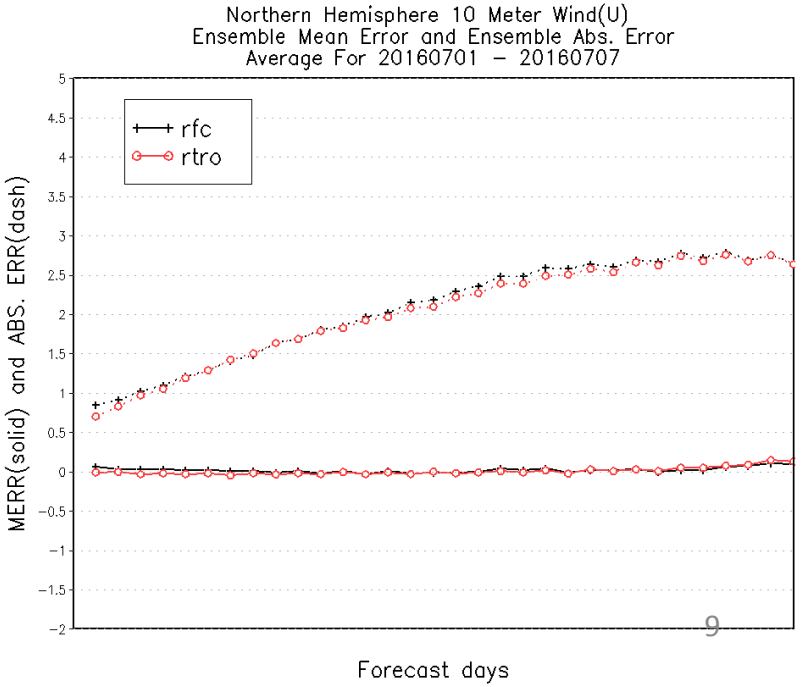
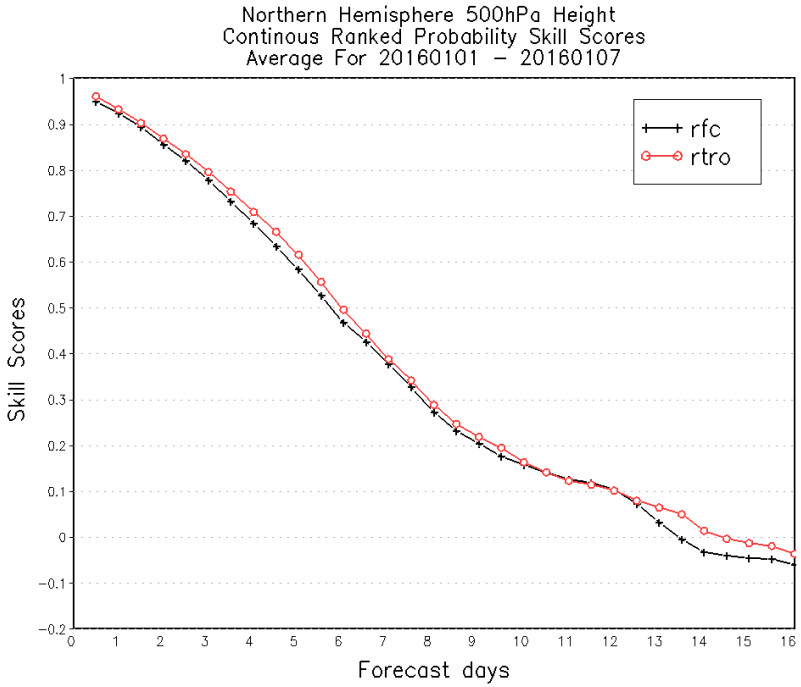
RMSE(solid) and SPREAD(dash)
Forecast days


Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160701 – 20160707
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Forecast days

Winter


Northern Hemisphere 500hPa Height
Continous Ranked Probability Skill Scores
Average For 20160101 – 20160107
rfc
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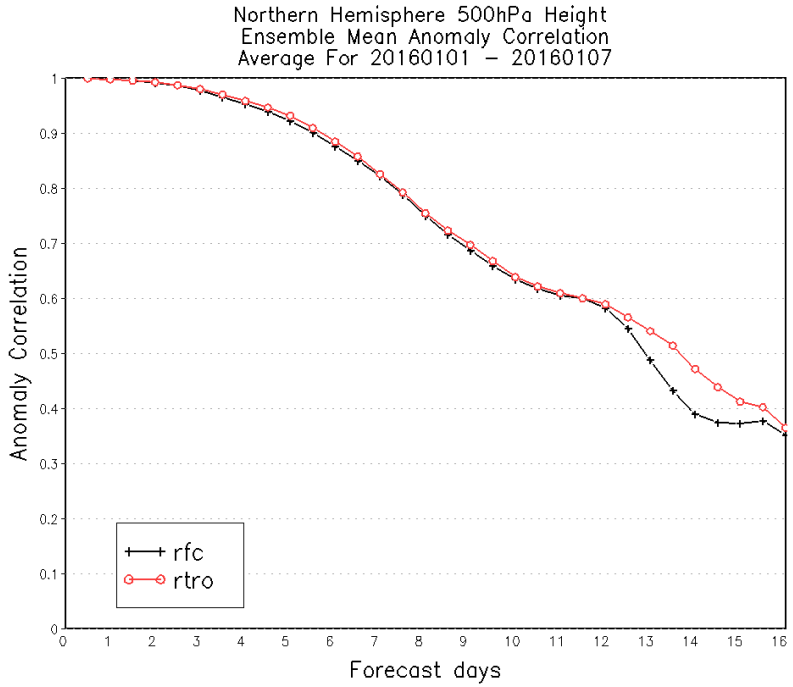
Skill Scores
Forecast days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Ensemble Mean Anomaly Correlation
Average For 20160101 – 20160107
rfc
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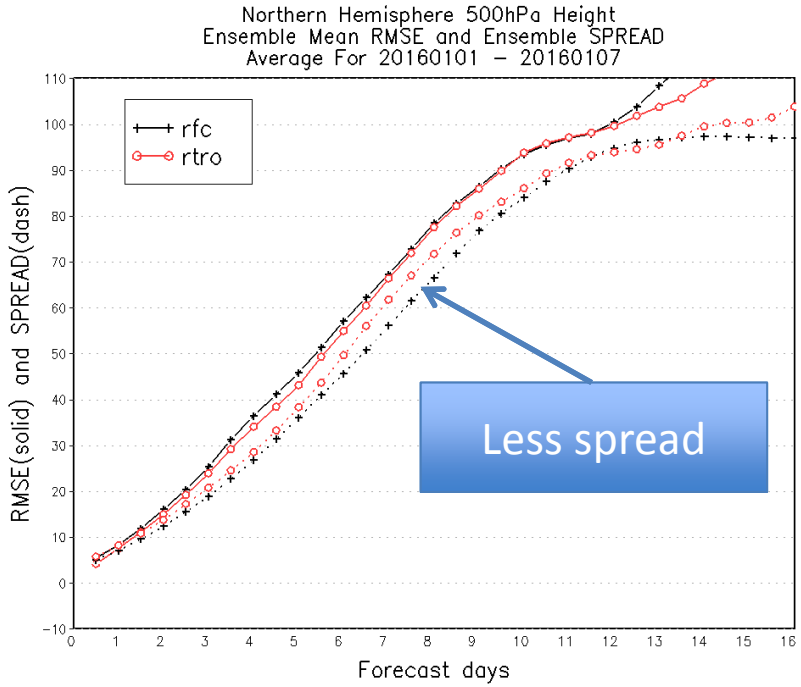
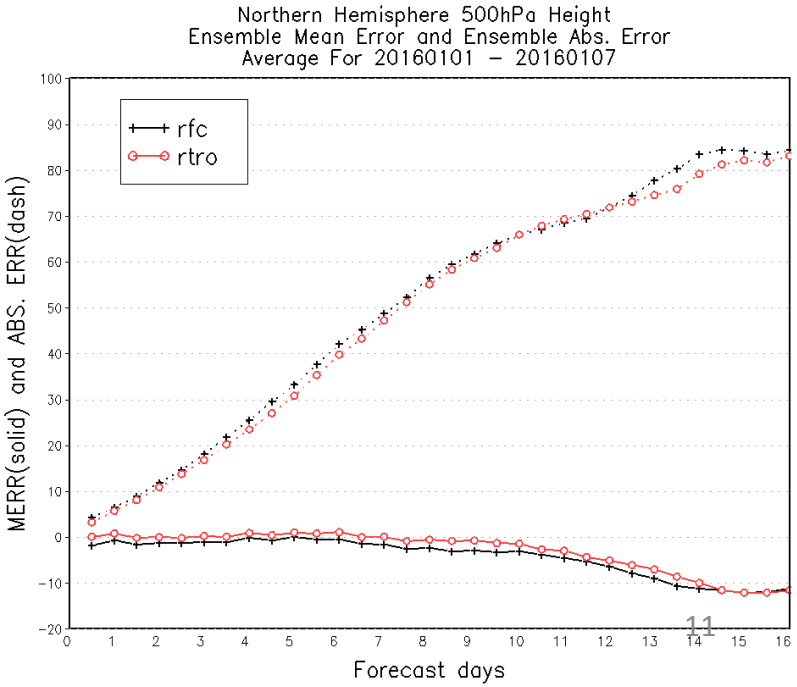

Northern Hemisphere 500hPa Height
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20160101 – 20160107
rfc
rtro
Less spread
RMSE(solid) and SPREAD(dash)
Forecast days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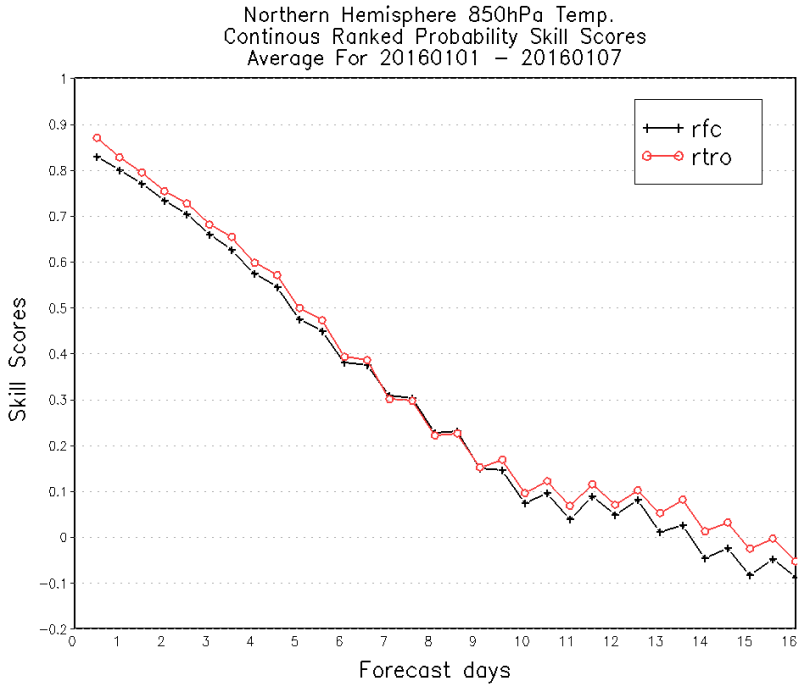
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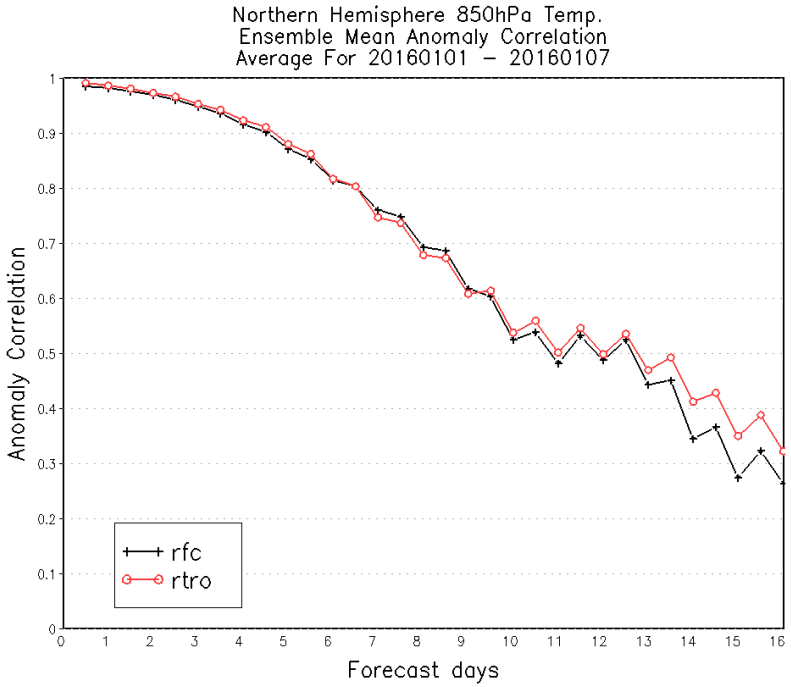
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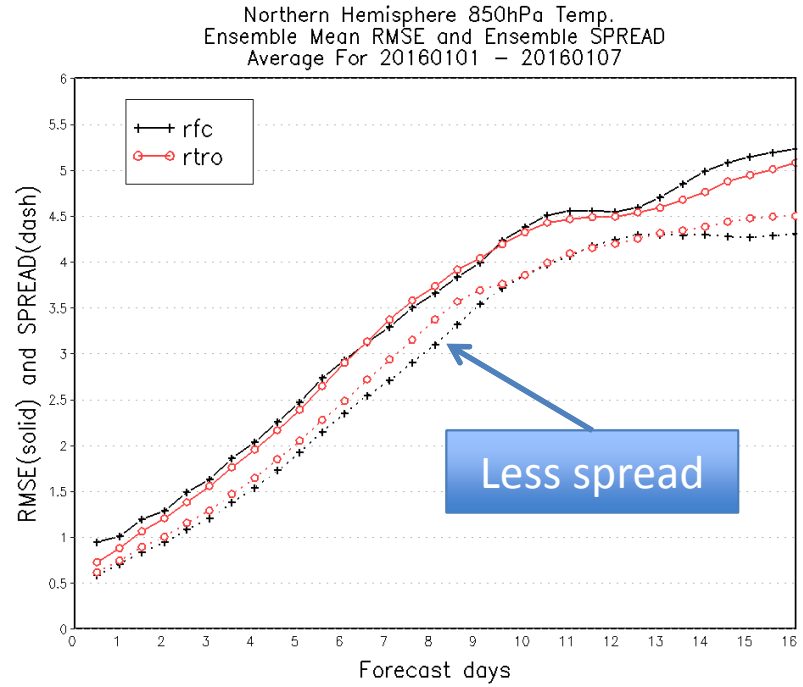
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Less spread
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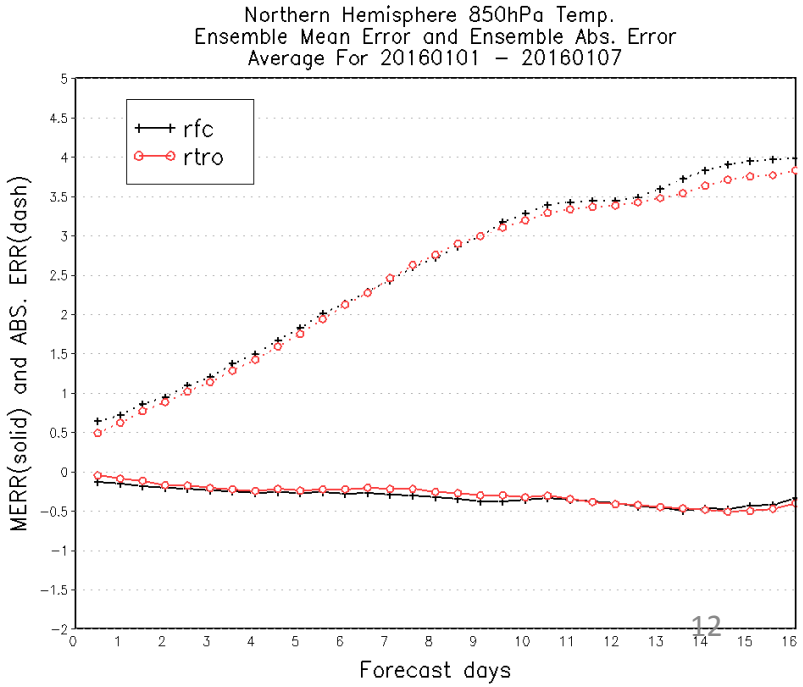
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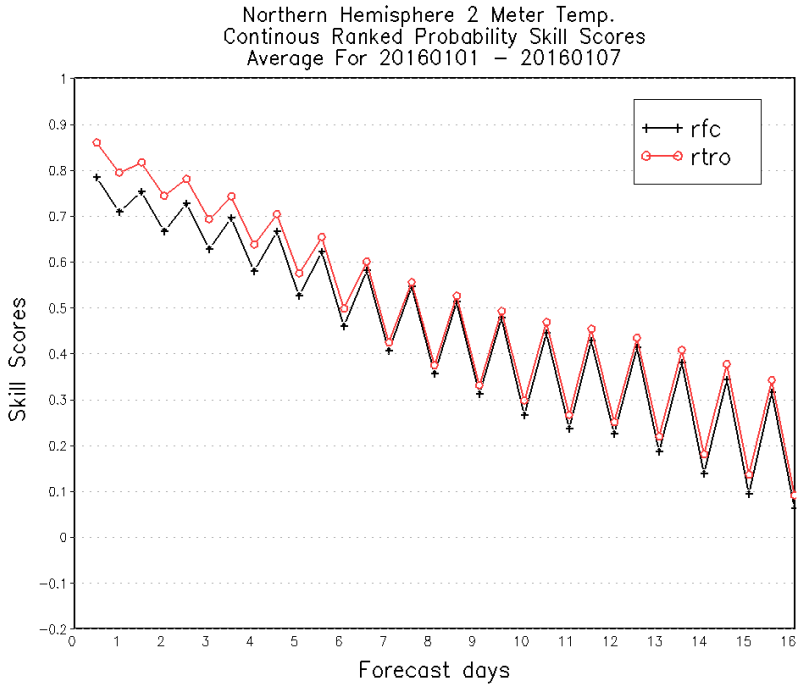
Northern Hemisphere 2 Meter Temp.
Continous Ranked Probability Skill Scores
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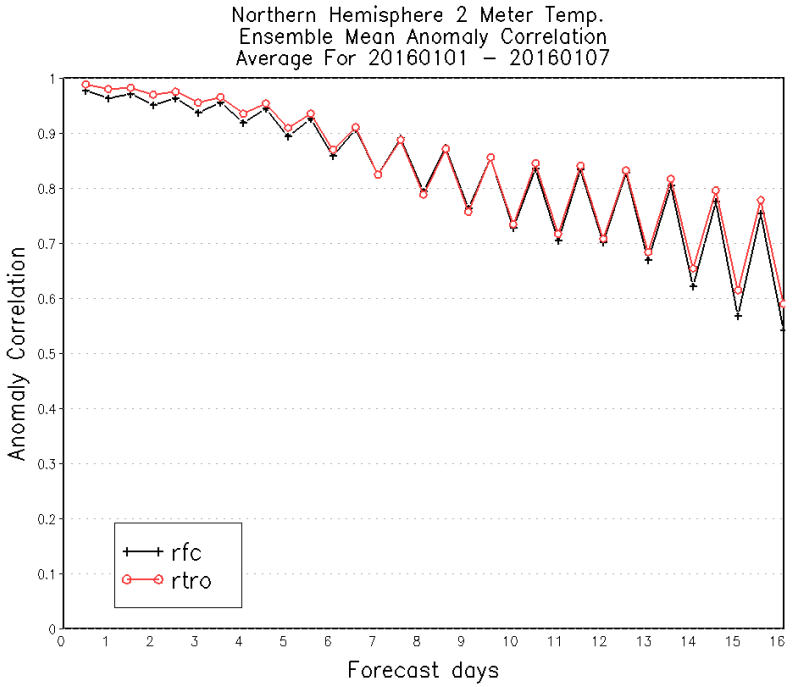
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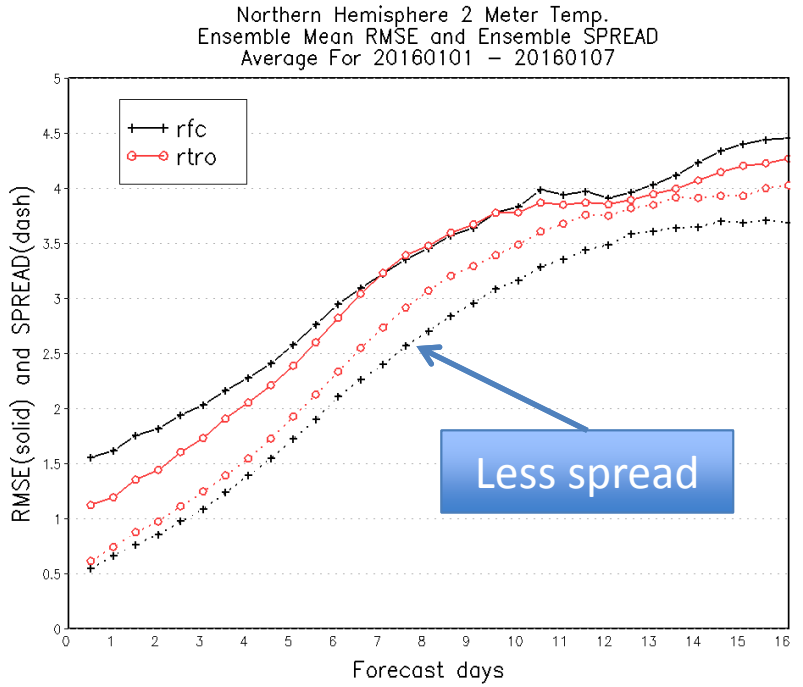
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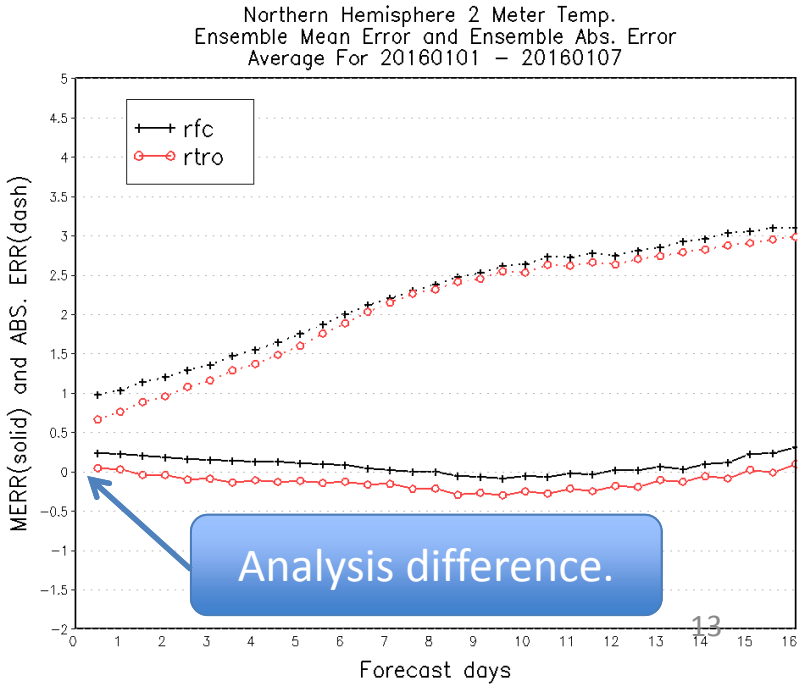
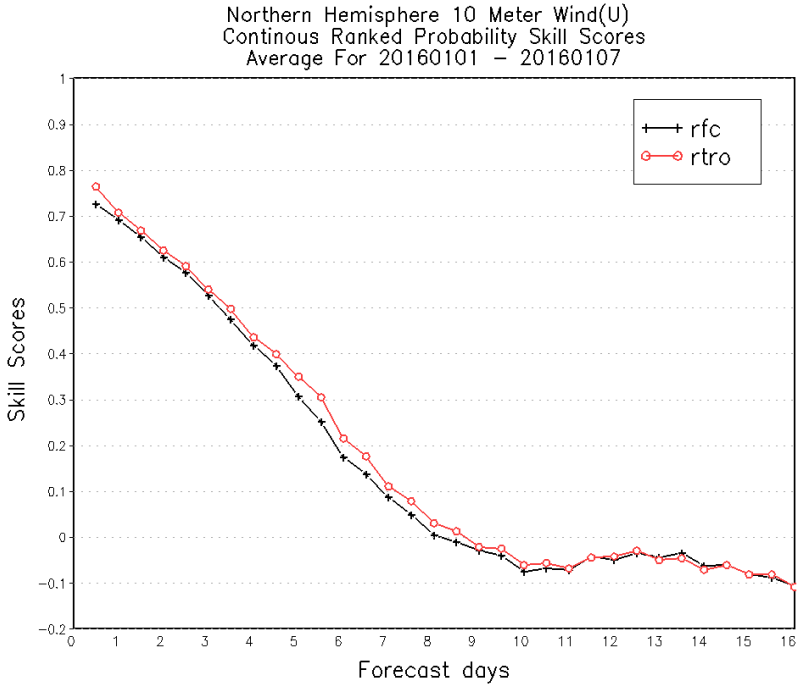
Less spread
Forecast days


Northern Hemisphere 2 Meter Temp.
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160101 – 20160107
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Analysis difference.
Forecast days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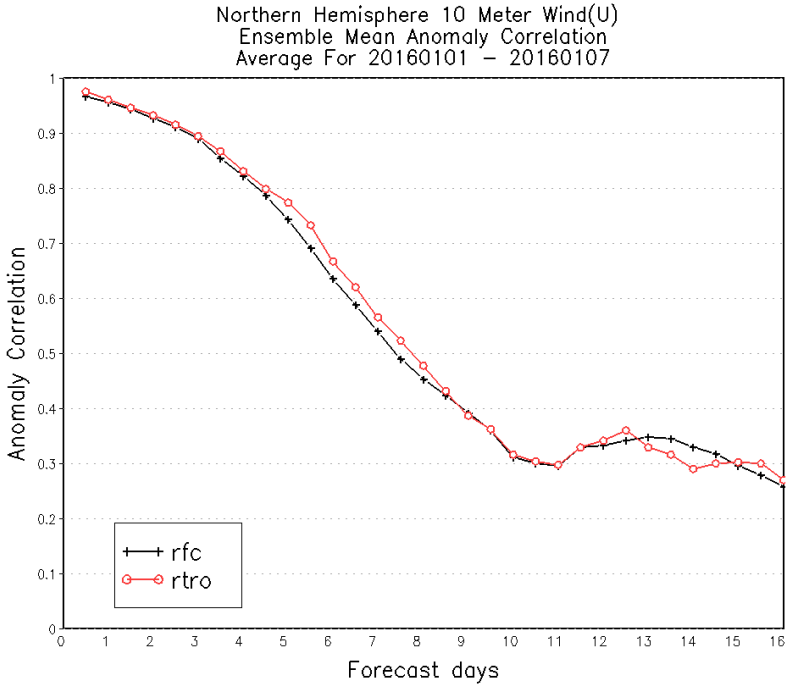
Skill Scores
Forecast days


Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean Anomaly Correlation
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rfc
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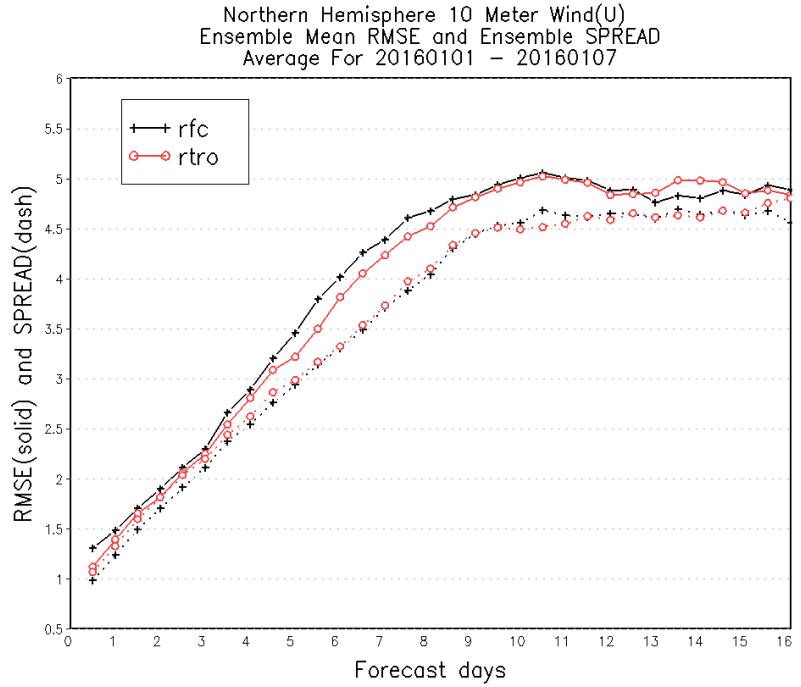
Forecast days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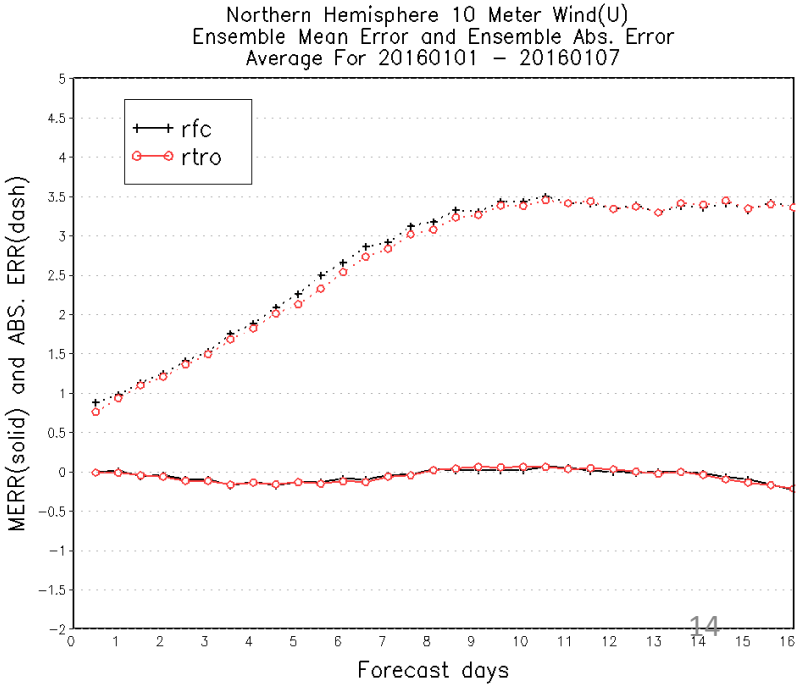
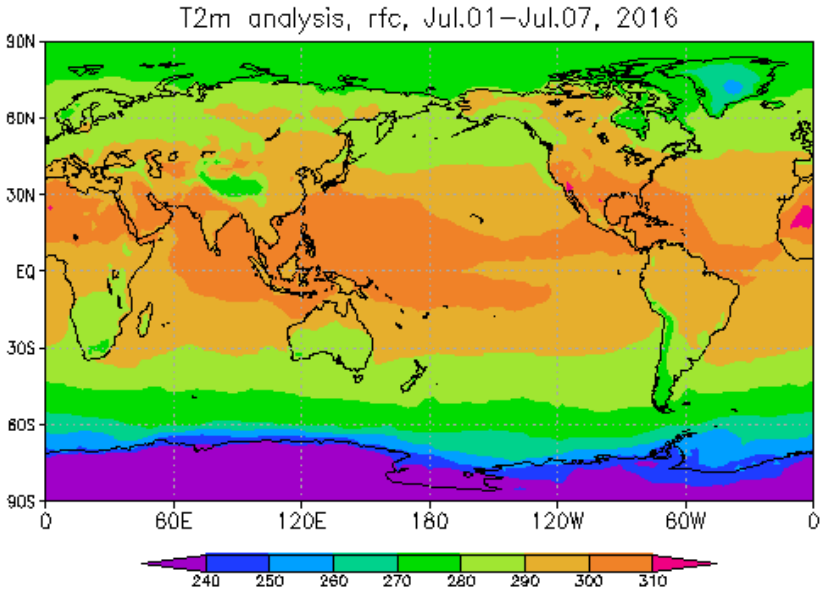

Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean Error and Ensemble Abs. Error
Average For 20160101 – 20160107
rfc
rtro
MERR(solid) and ABS. ERR(dash)
Forecast days

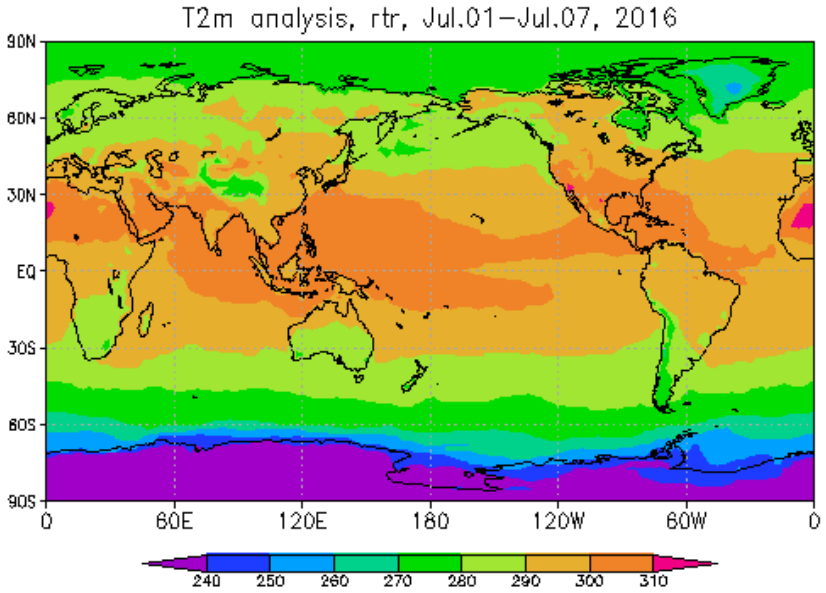
Summary

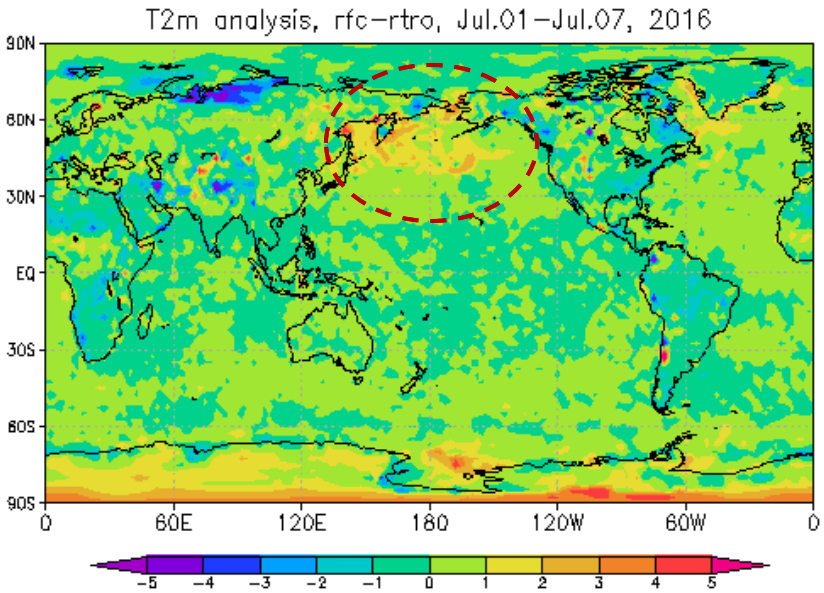
- Overall, retrospective runs has better scores
- Summer
  - NH 500hPa height, 850hPa temp show in-consistent analysis
  - NH 2-m temp shows similar analysis, but forecast has difference
- Winter
  - NH 2-m temp shows difference analysis
  - NH 500hPa height, 850hPa temp and 2-m temp have less spread

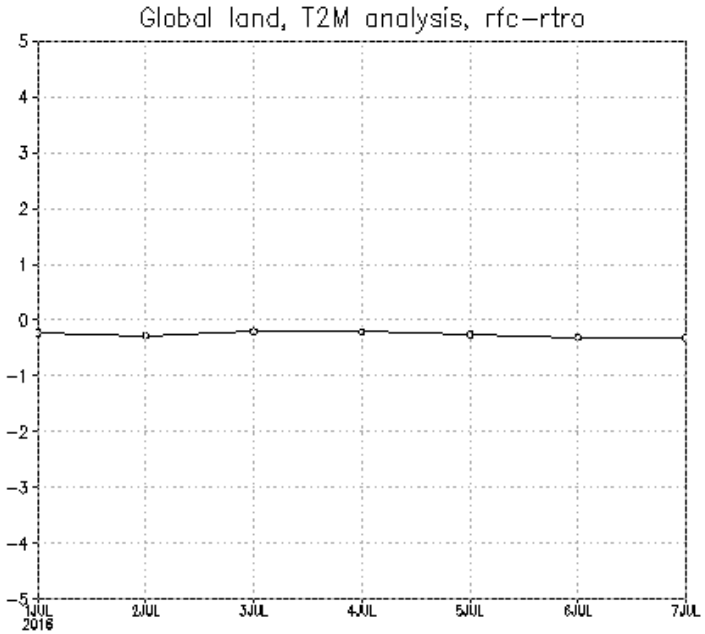
More comparison!!!

- We focus on 2-meter temperature
- One week average of summer and winter
- A couple of question and concerns:
  - Which FV3 model version (PSD) is used for reanalysis?
  - What are the differences of reanalysis and retrospective analysis?
    - Retrospective analysis was from early version (June 2018 with HORD=5)
    - Note that retrospective analysis has been upgraded as well since it handled to NCO in June 2018
      - Radiation bug fixed, SST changes (9/16/2018)
  - We have evaluated OISST and NSST for 2-tier SST approach for September 2018
    - Used later (not latest) version, and differences are smaller.
    - Kate Zhou presented on November 6 2018

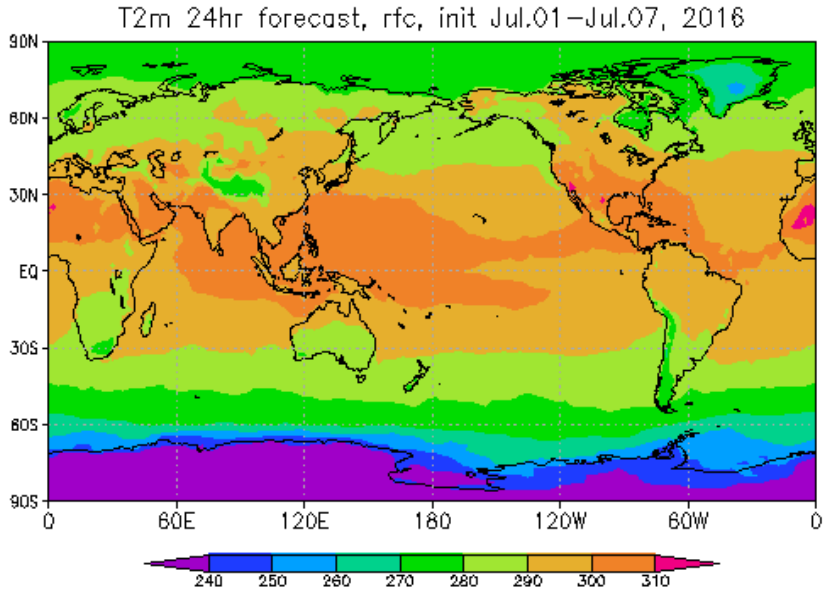


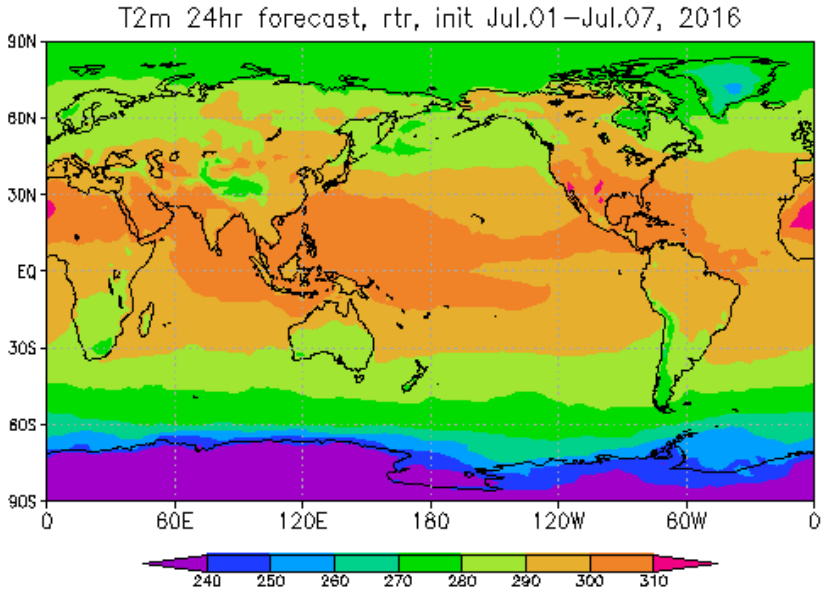






Analysis Summer


T2m 24hr forecast, rfc, init Jul.01–Jul.07, 2016
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
240 250 260 270 280 290 300 310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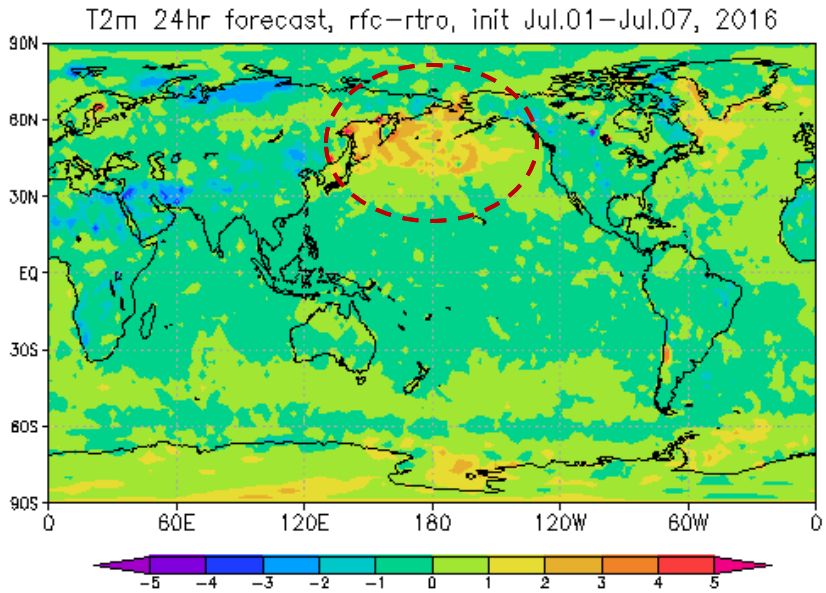
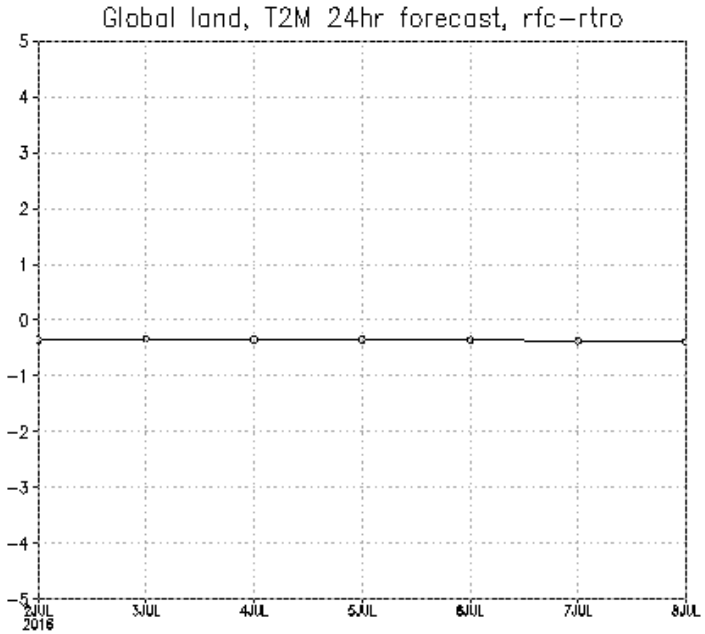
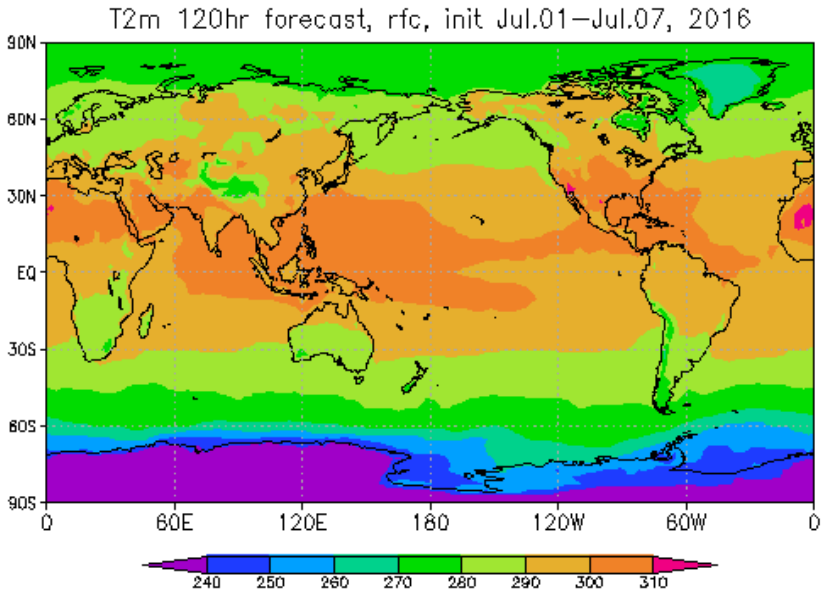
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
240 250 260 270 280 290 300 310


T2m 24hr forecast, rfc–rtro, init Jul.01–Jul.07, 2016
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−5 −4 −3 −2 −1 0 1 2 3 4 5


Global land, T2M 24hr forecast, rfc–rtro
5
4
3
2
1
0
−1
−2
−3
−4
−5
2JUL
2016
3JUL
4JUL
5JUL
6JUL
7JUL
8JUL

F24 Summer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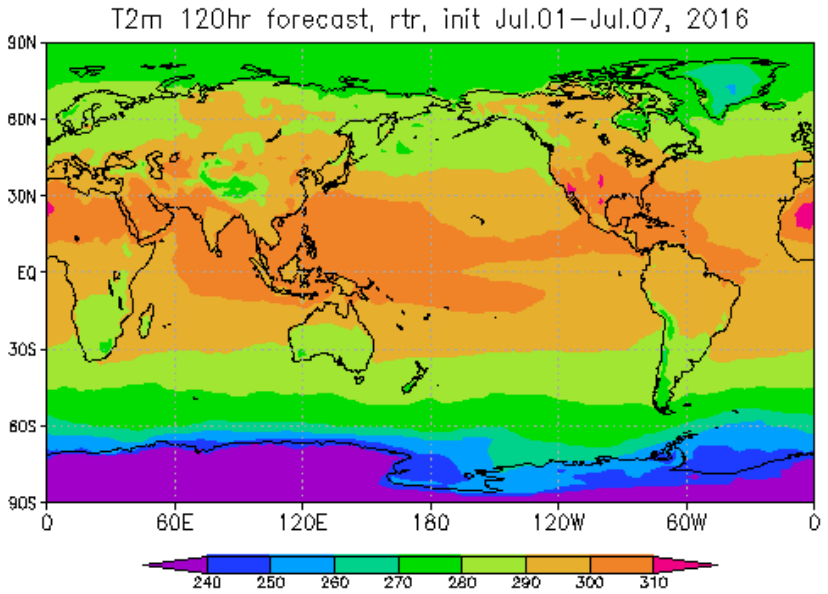
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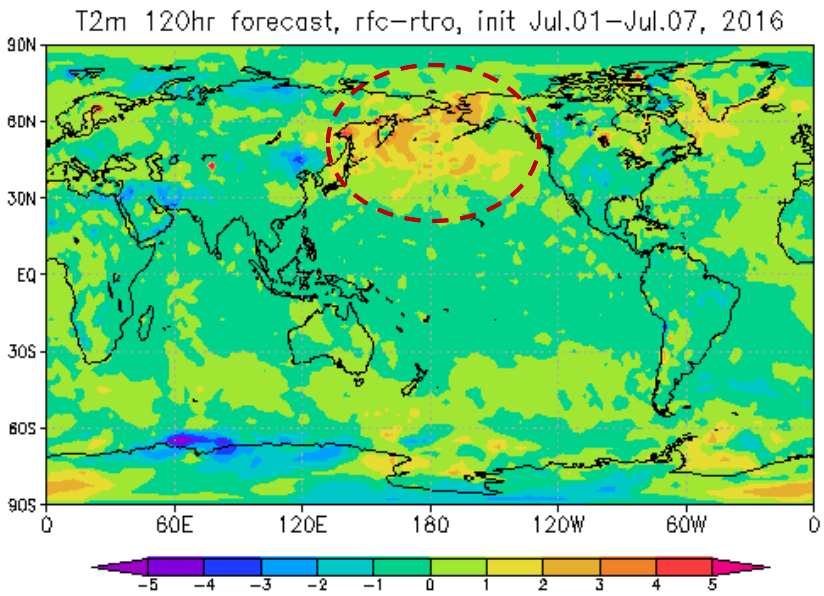
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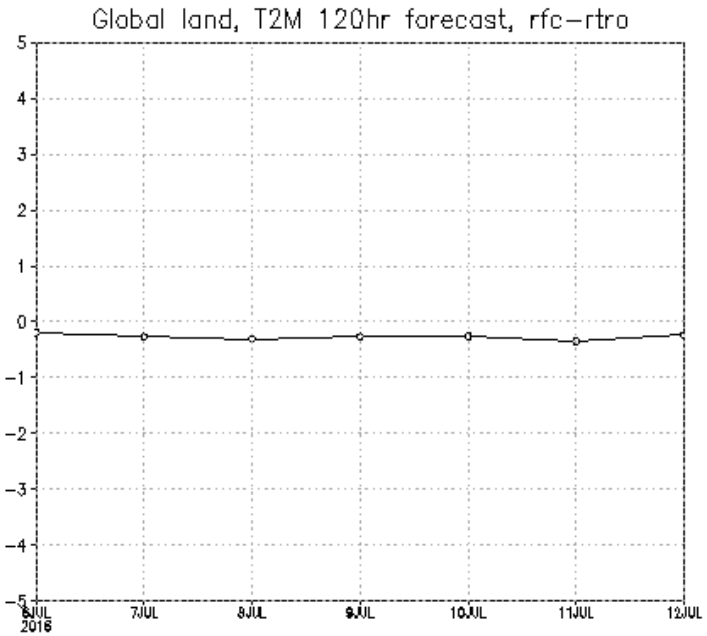
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2016
7JUL
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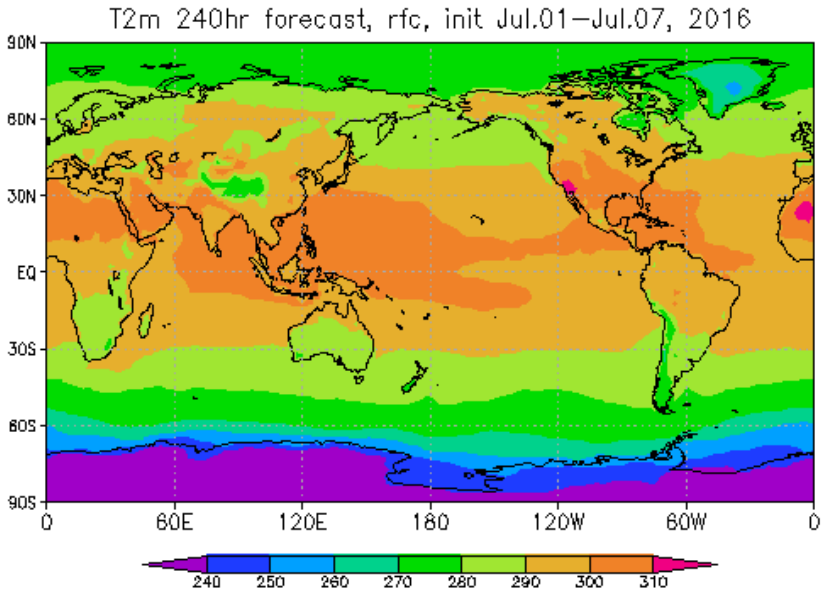
9JUL
10JUL
11JUL
12JUL

F120 Summer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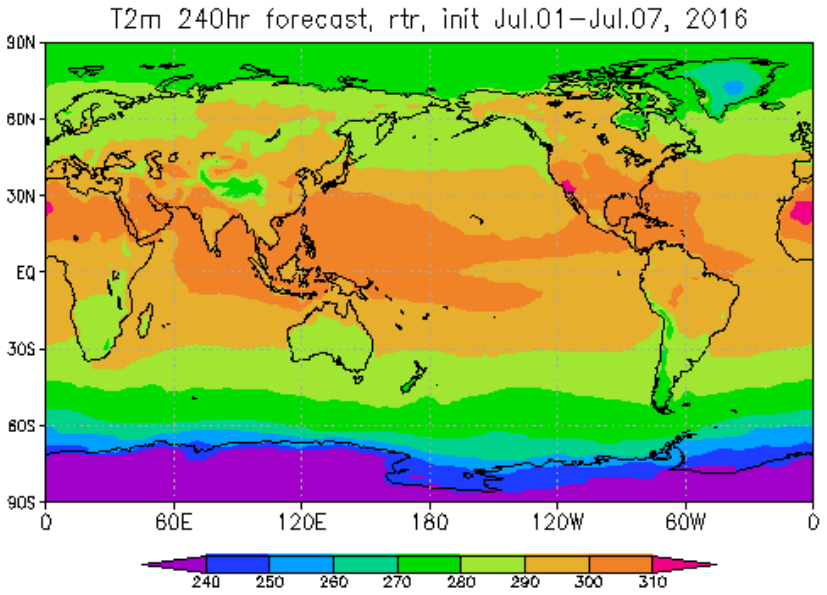
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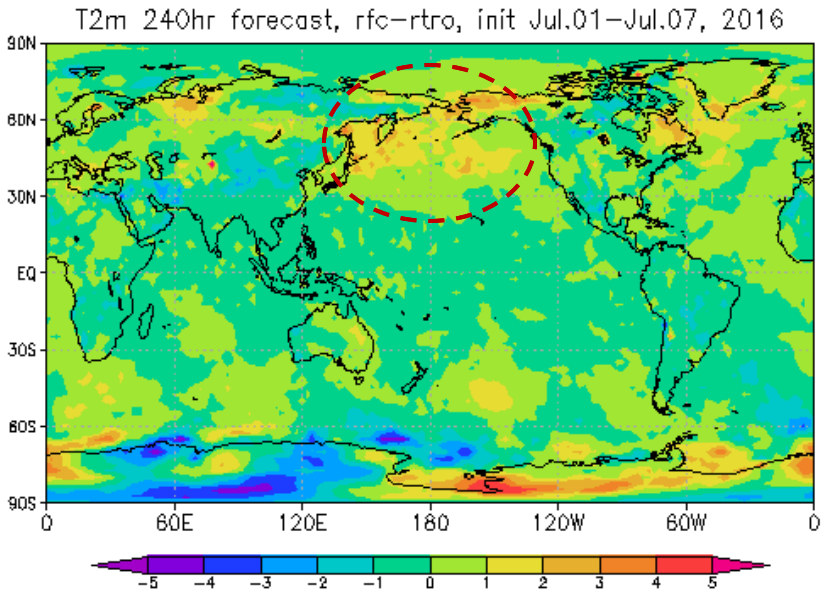
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60W
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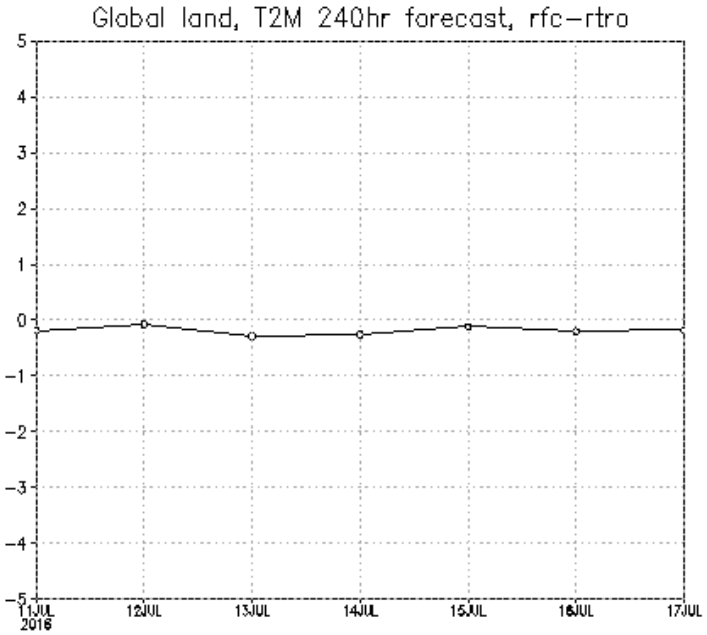
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11JUL
2016
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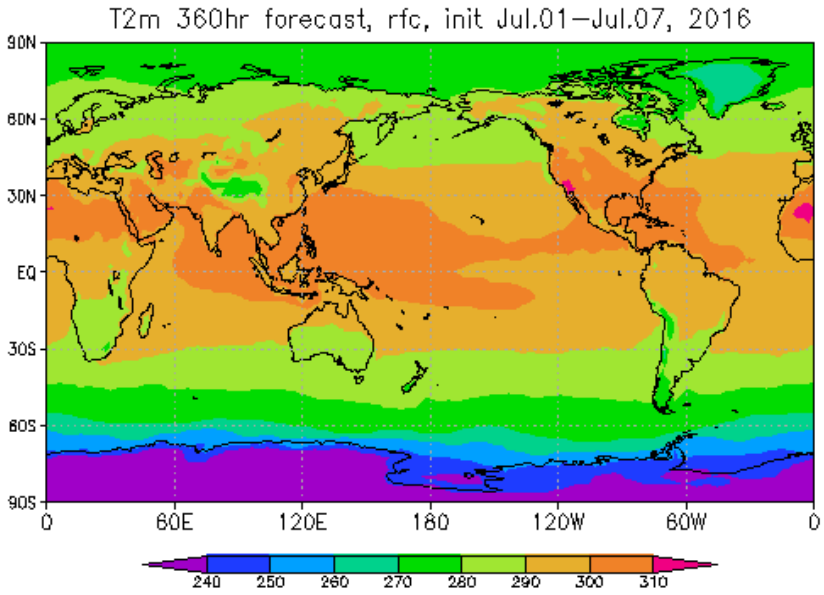
15JUL
16JUL
17JUL

F240 Summer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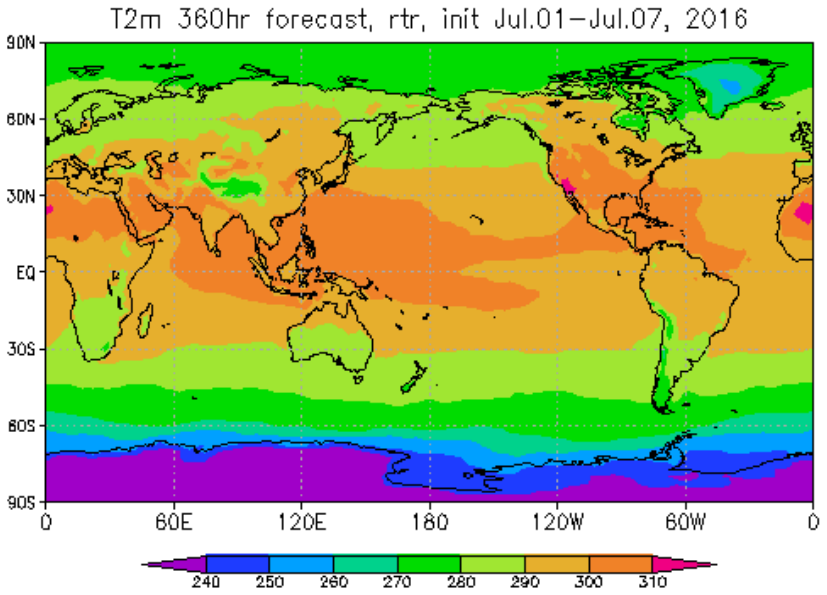
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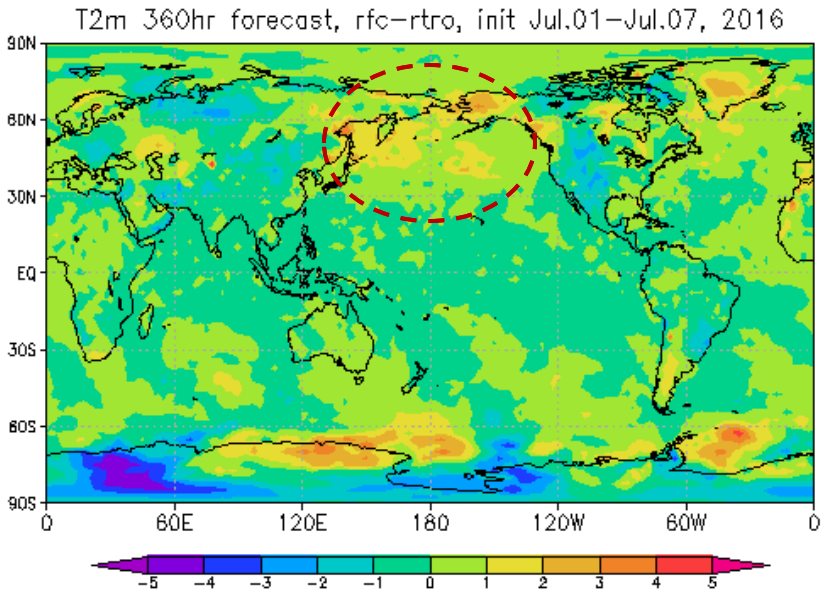
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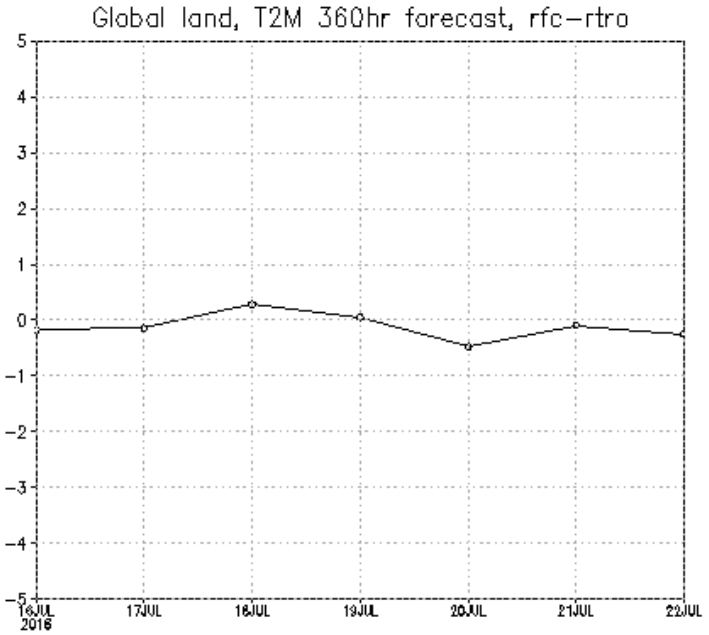
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16JUL
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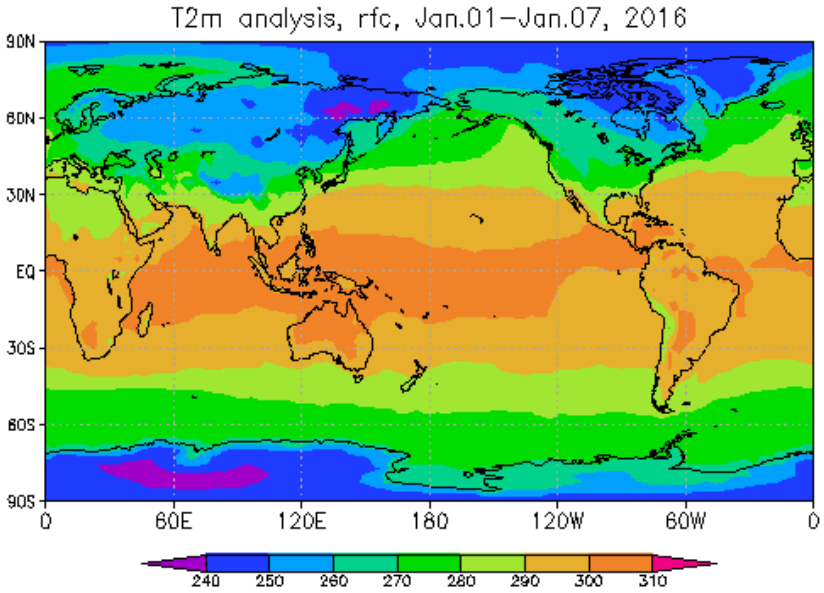
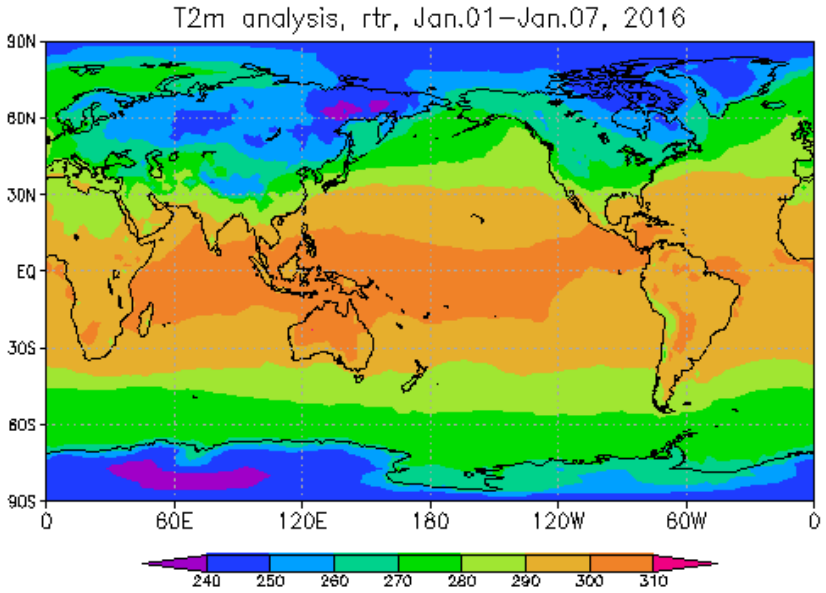
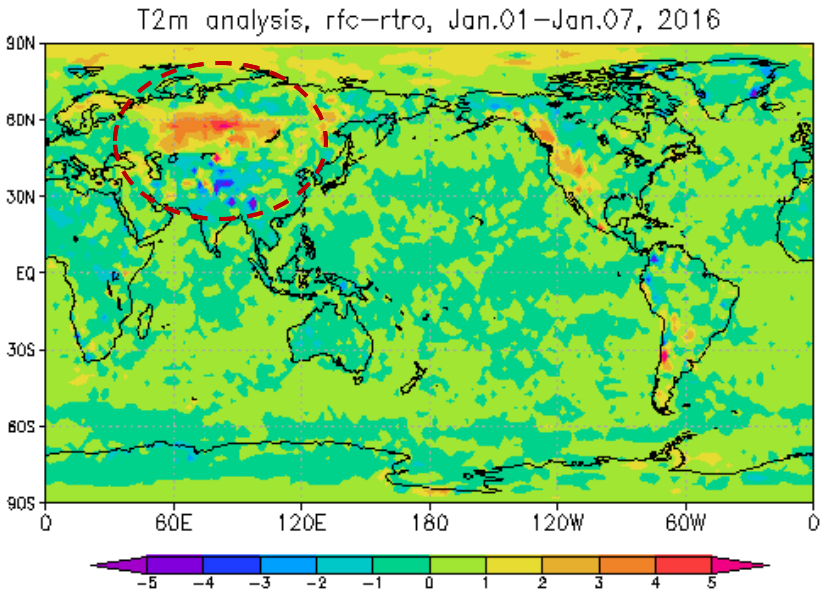
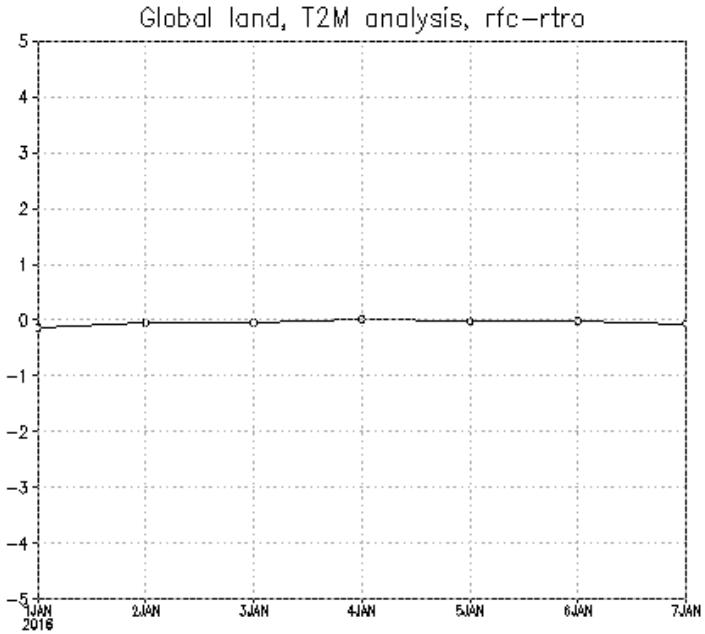
22JUL

F360 Summer

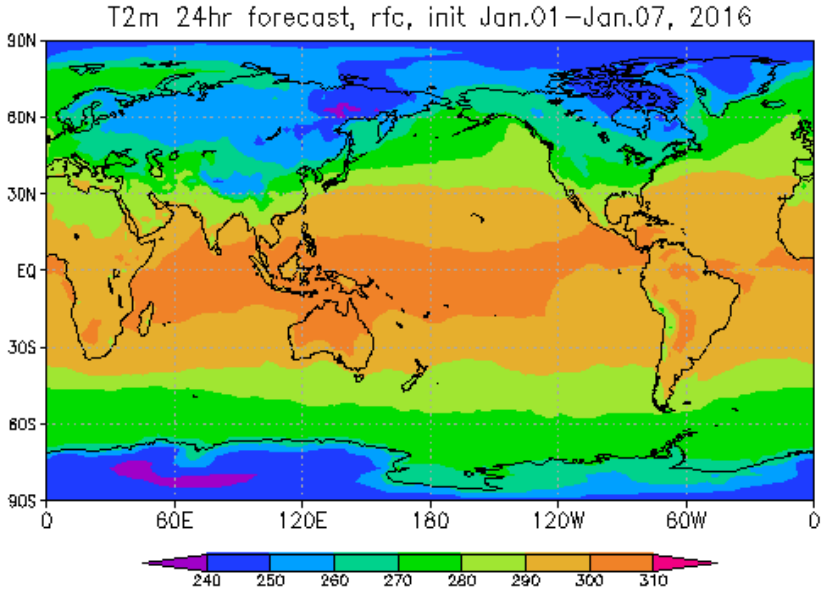








Analysis Winter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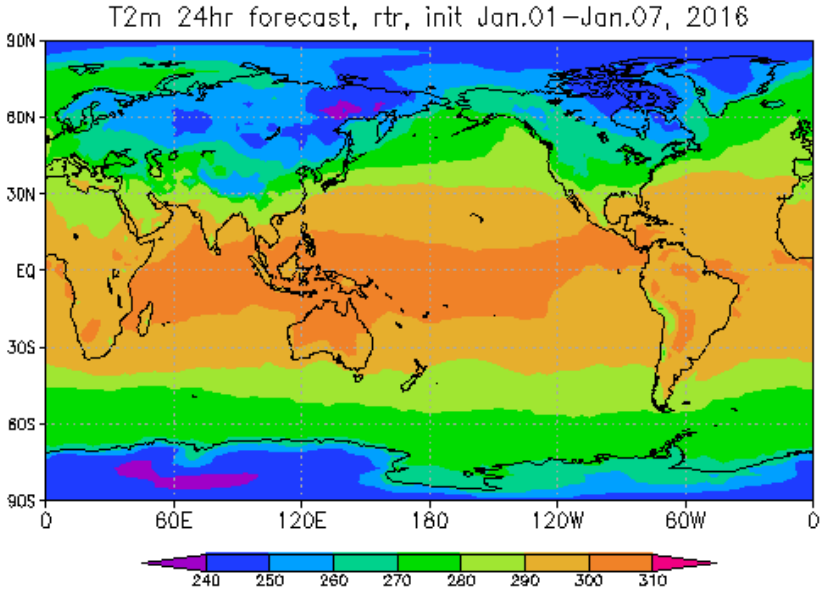
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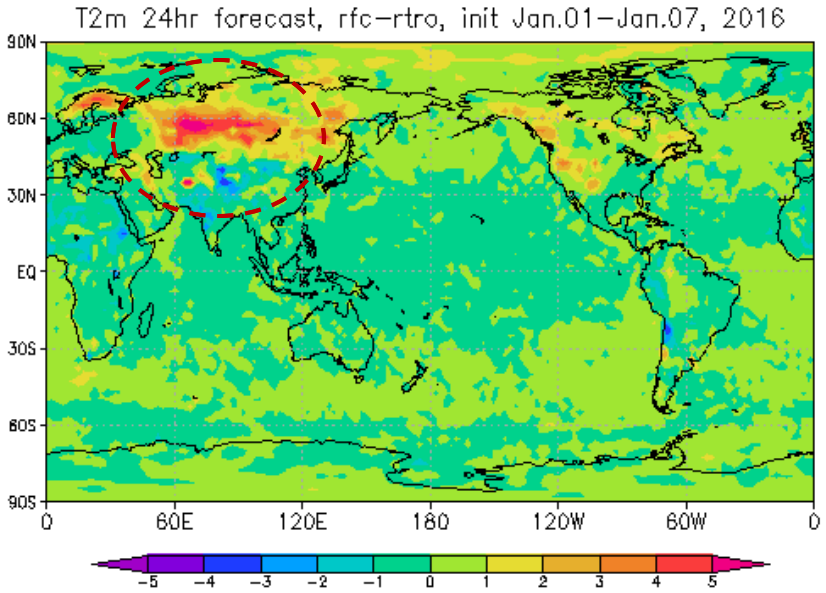
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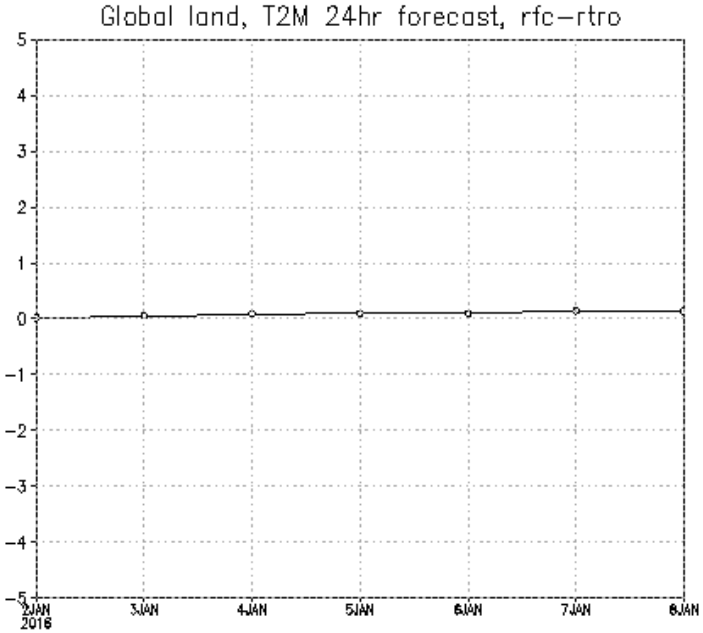
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5
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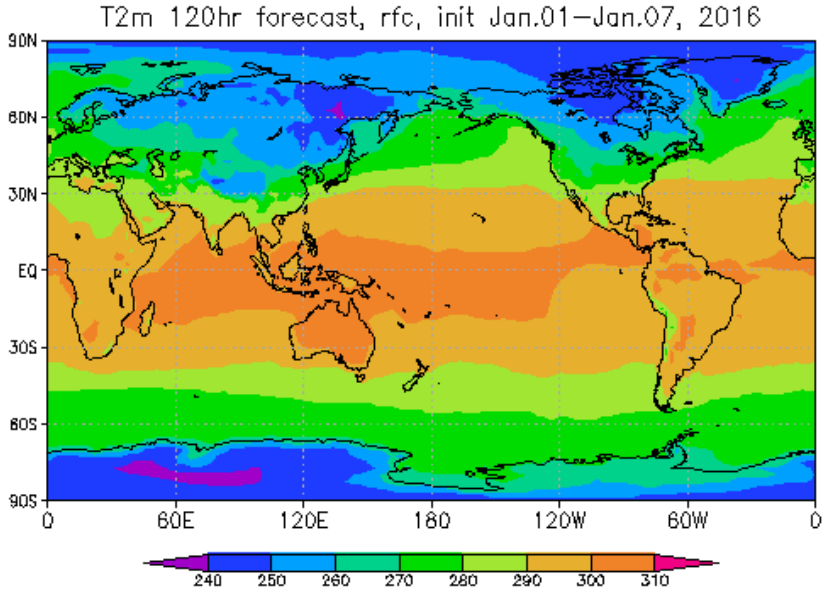
2JAN
2016
3JAN
4JAN
5JAN
6JAN
7JAN
8JAN

F24 Winter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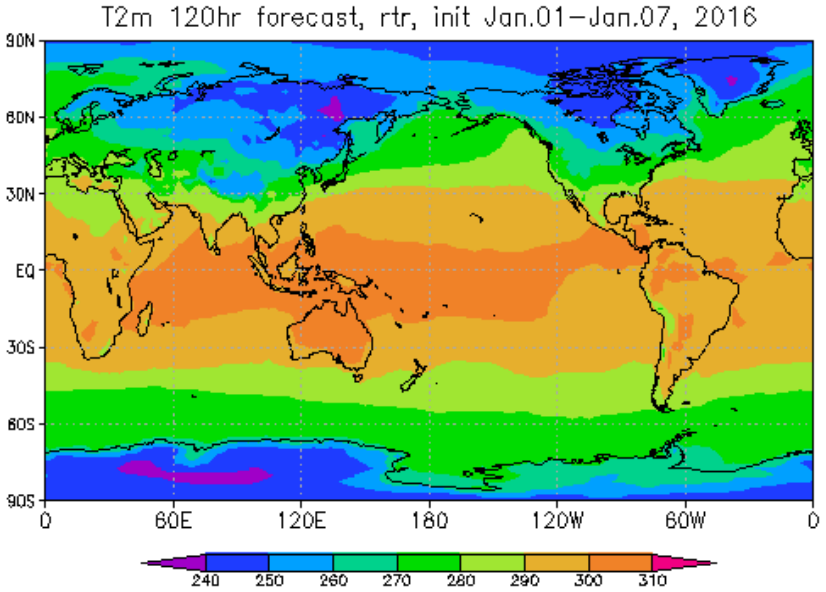
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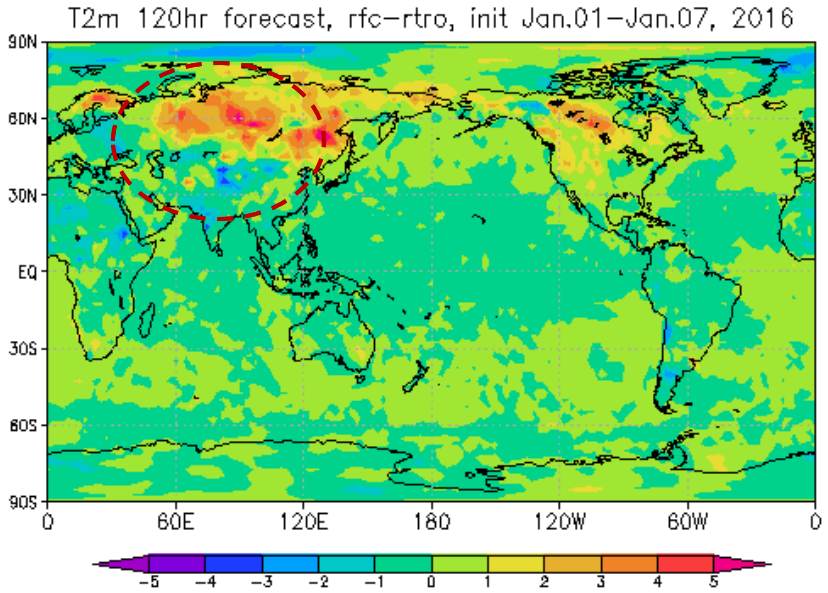
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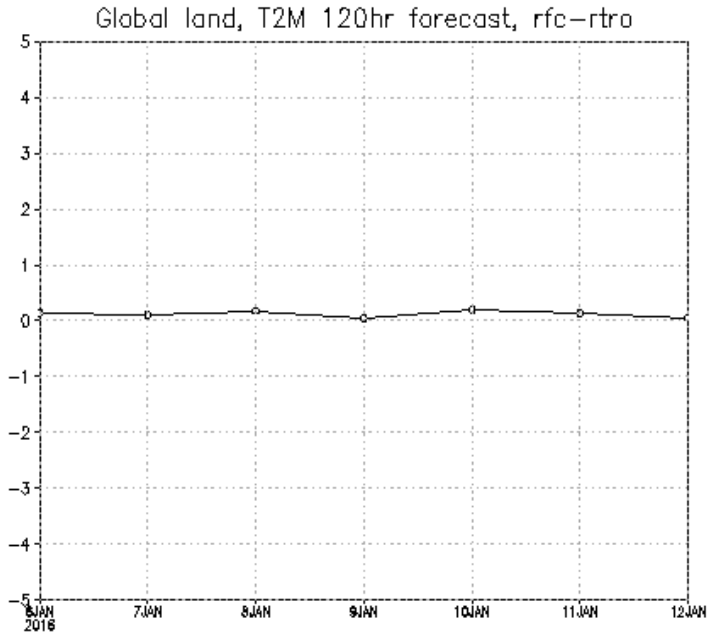
Global land, T2M 120hr forecast, rfc–rtro
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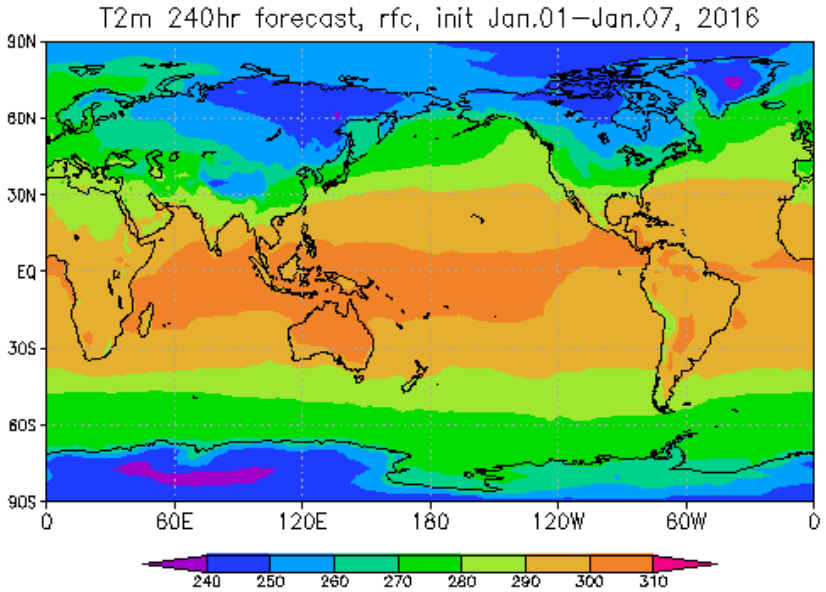
6JAN
2016
7JAN
8JAN
9JAN
10JAN
11JAN
12JAN

F120 Winter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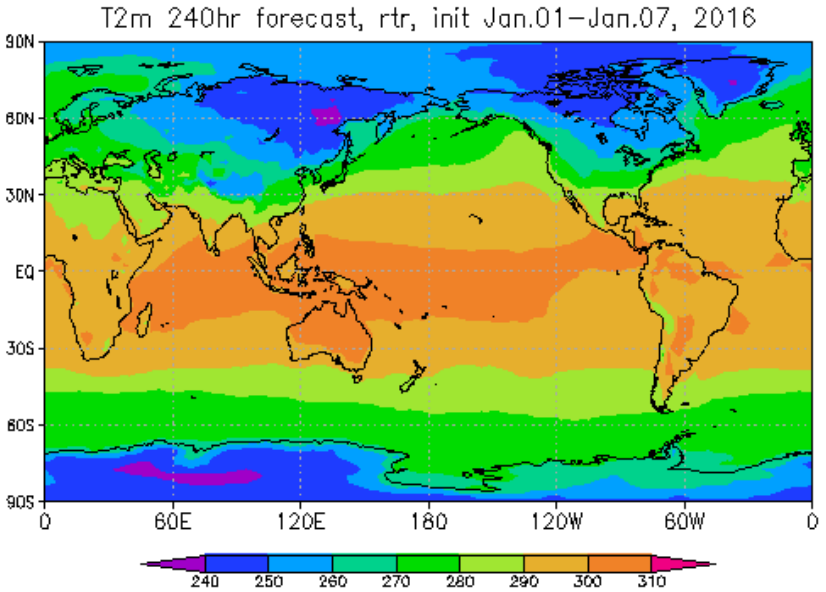
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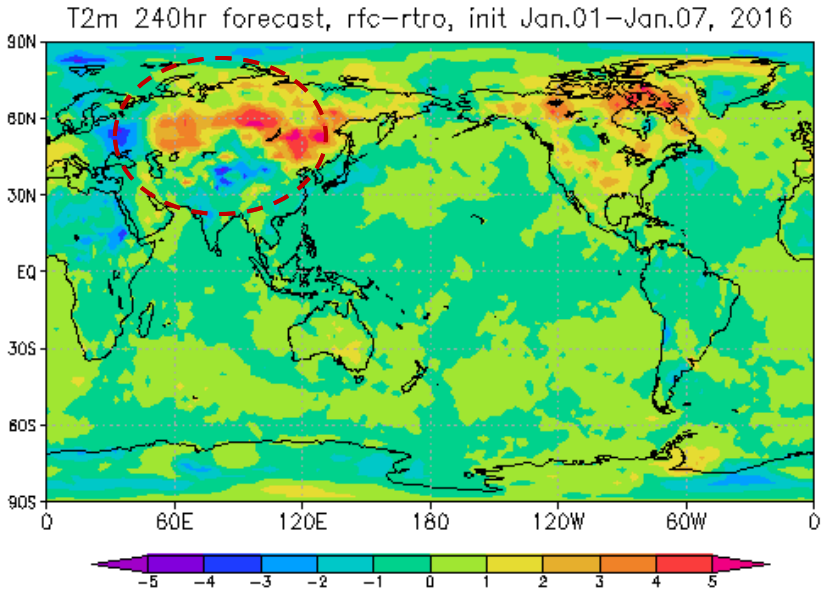
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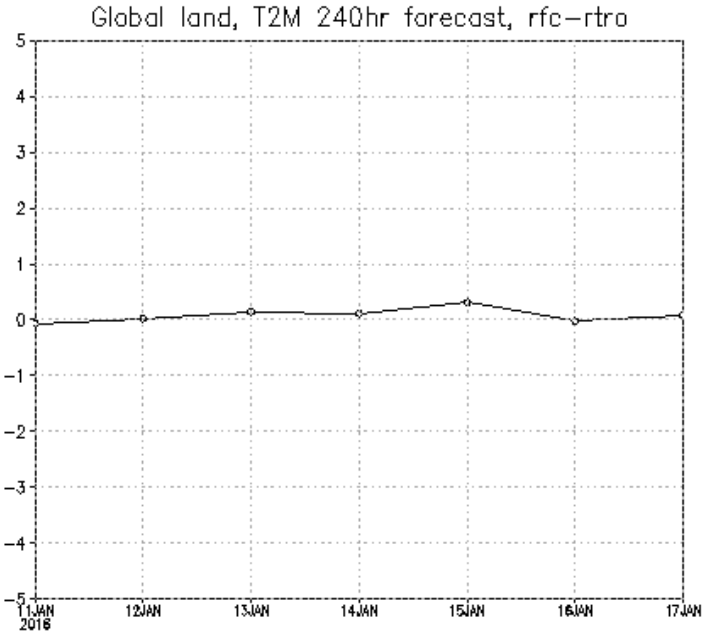
Global land, T2M 240hr forecast, rfc–rtro
5
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11JAN
2016
12JAN
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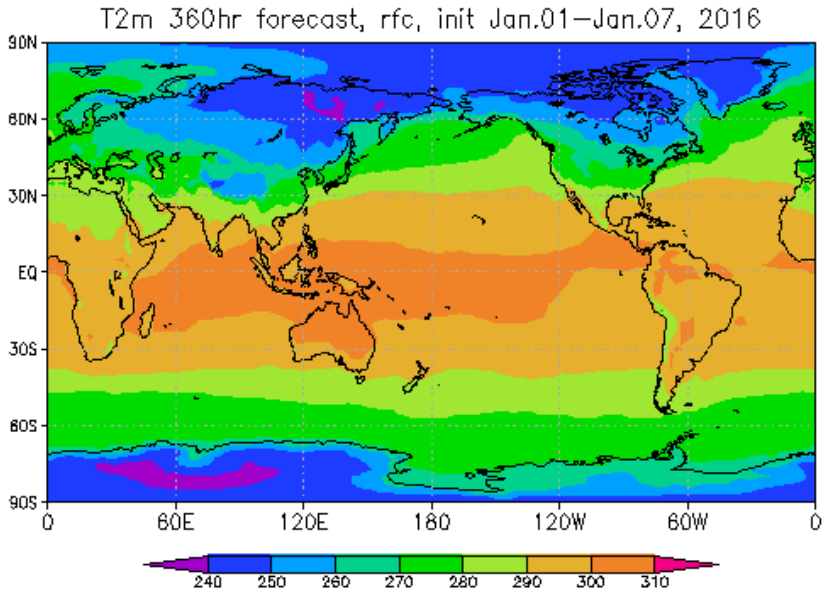
16JAN
17JAN

F240 Winter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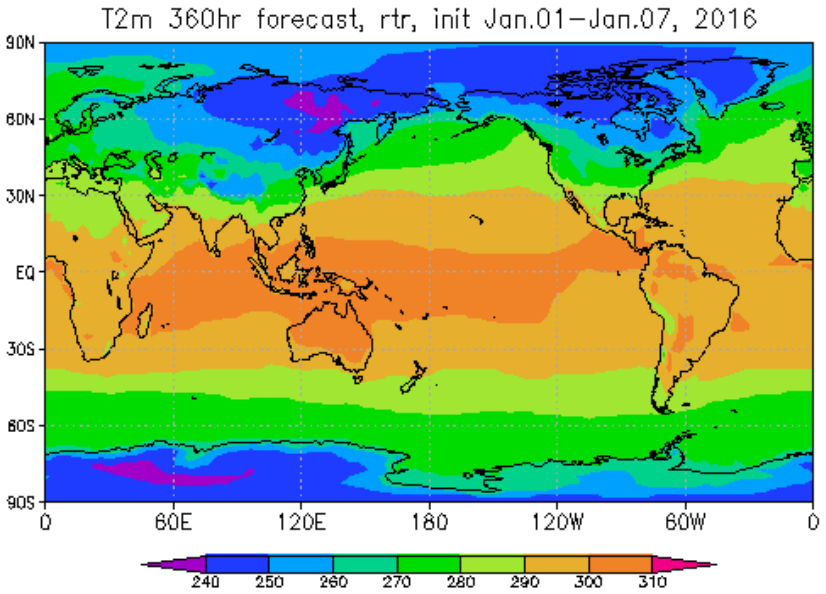
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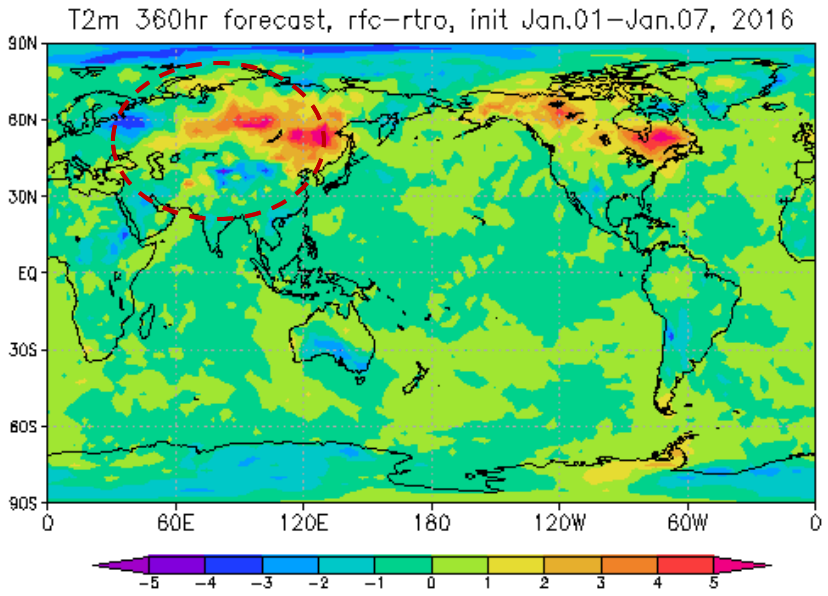
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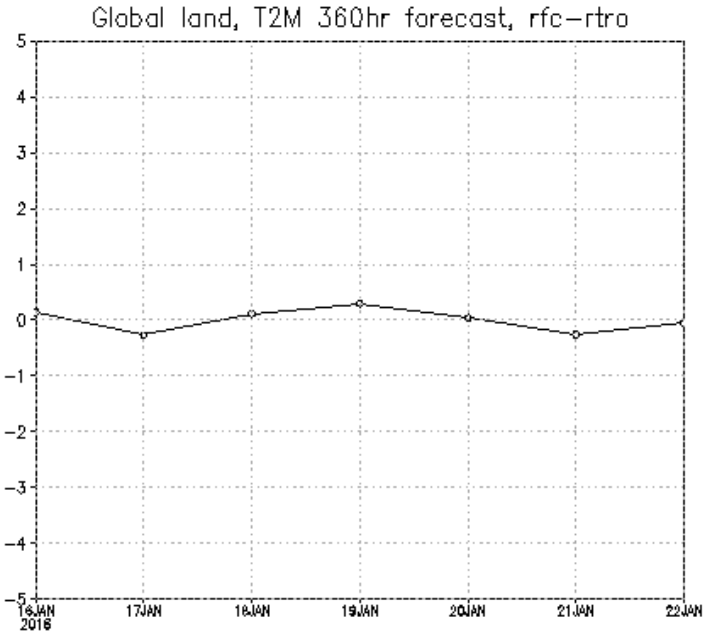
Global land, T2M 360hr forecast, rfc–rtro
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16JAN
2016
17JAN
18JAN
19JAN
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21JAN
22JAN

F360 Winter

Final Summary for surface T

- Summer:
  - Reforecast shows warmer in **Northern Pacific Ocean**
  - Difference is persistent (no moving) from analysis to forecast
  - Not sure where does this difference come from?
- Winter:
  - Reforecast shows much warmer in the NH land, particular in the **center of Asia-Europe and North American** from analysis to forecast
  - The different is moving slowly to northeast.
  - We have a difficulty to figure out why there are large land temperature differences from two analyses?
    - We assume both analyses used similar model!!!
- Questions:
  - Is the difference acceptable?
  - Do we need more diagnostics and comparison of longer period?
- What is our decision?
  - Can we start 19 years (2000-2018) reforecast?