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Comparison of Diurnal Tide, 2-day, and 5-day Waves between MERRA2, ERA-Interim, and JRA-55 Reanalyses for 2010

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Data Sets

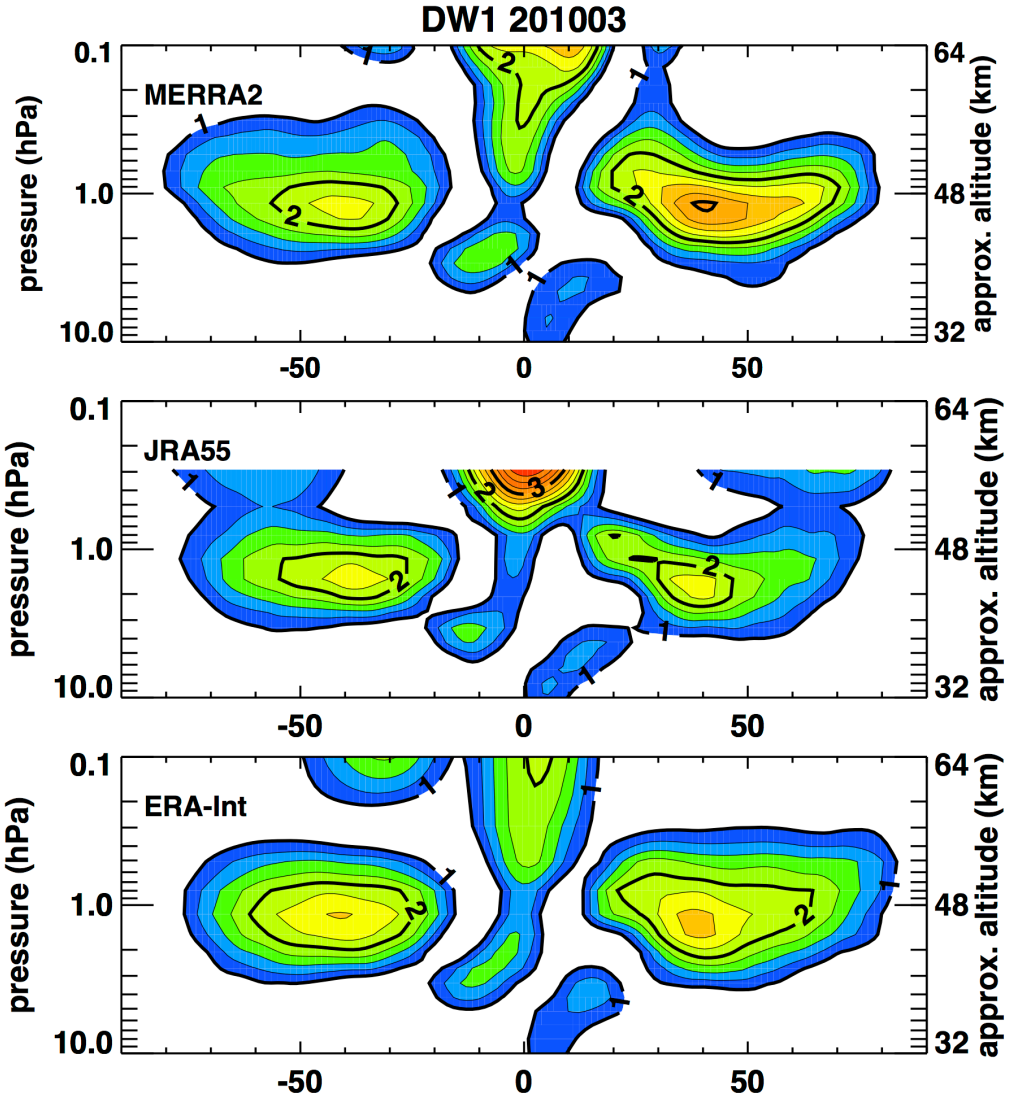
Analyzed temperatures on model levels from Jan 1 – Dec 31 2010:

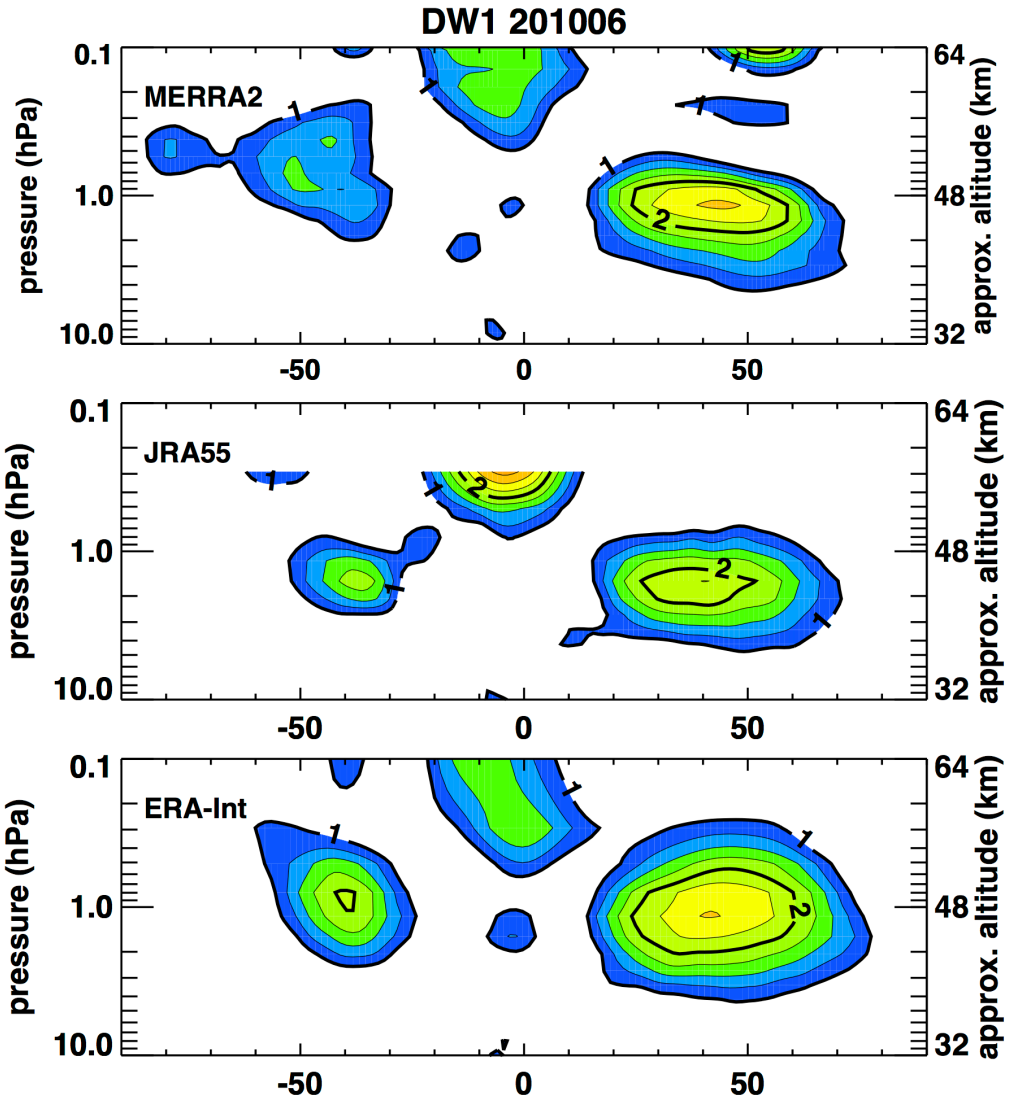
- **MERRA2**
  - **3-hourly, top level at 0.015 hPa (~80 km), 0.625^{o} lon x 0.5^{o}lat.**
  - Global Modeling and Assimilation Office (GMAO)(2015), MERRA-2 inst3_3d_asm_Nv: 3d,3-Hourly,Instantaneous,Model-Level,Assimilation,Assimilated Meteorological Fields V5.12.4, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), 10.5067/WWQSXQ8IVFW8
- **ERA-Interim**
  - **6-hourly, top level at 0.1 hPa (~65 km), 0.7^{o} lon x 0.7^{o} lat.**
  - European Centre for Medium-Range Weather Forecasts. 2009, updated monthly. *ERA-Interim Project*. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. https://doi.org/10.5065/D6CR5RD9
- **JRA-55**
  - **6-hourly, top level at 0.3 hPa (~60 km), 0.56^{o} lon x 0.56^{o} lat.**
  - Japan Meteorological Agency/Japan. 2013, updated monthly. *JRA-55: Japanese 55-year Reanalysis, Daily 3-Hourly and 6-Hourly Data*. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. https://doi.org/10.5065/D6HH6H41.

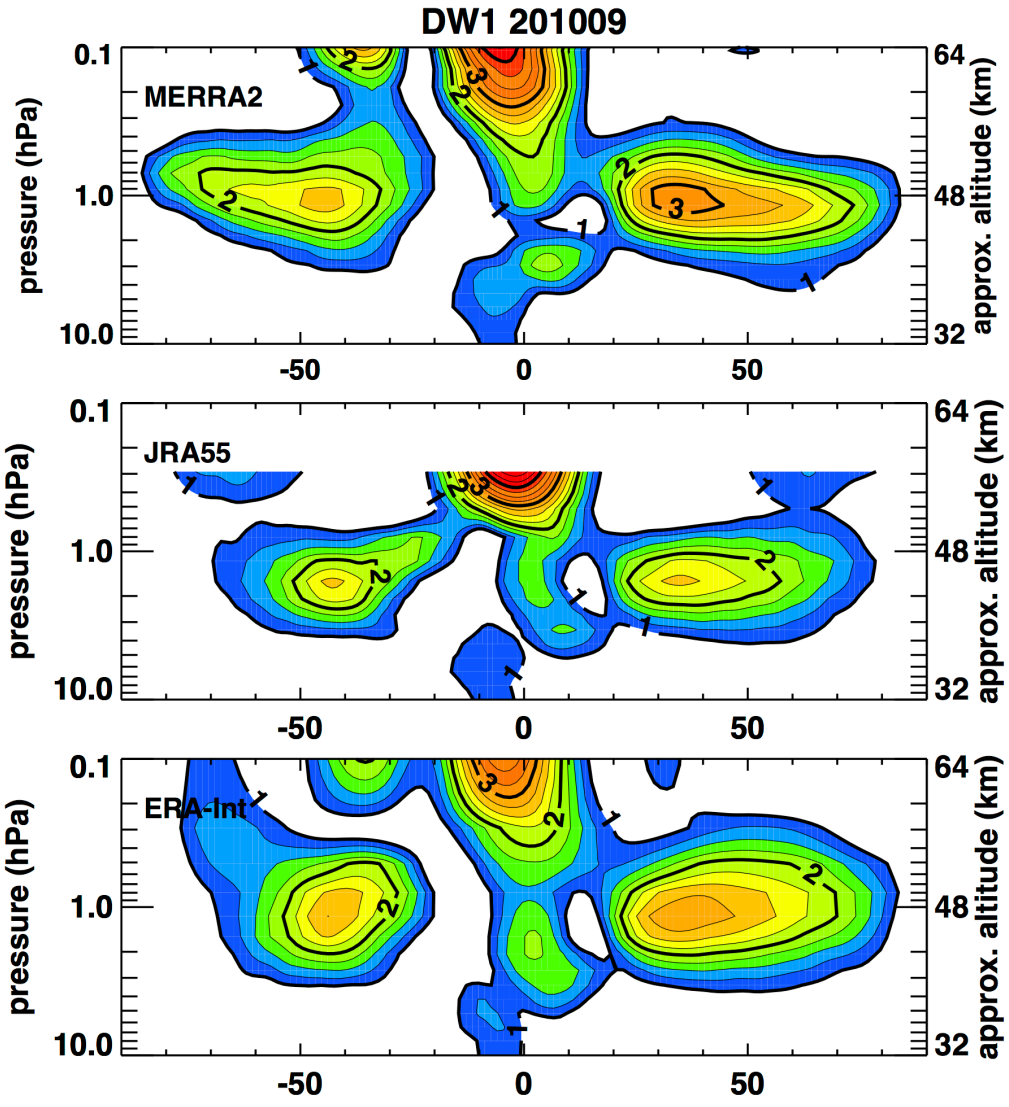
Method

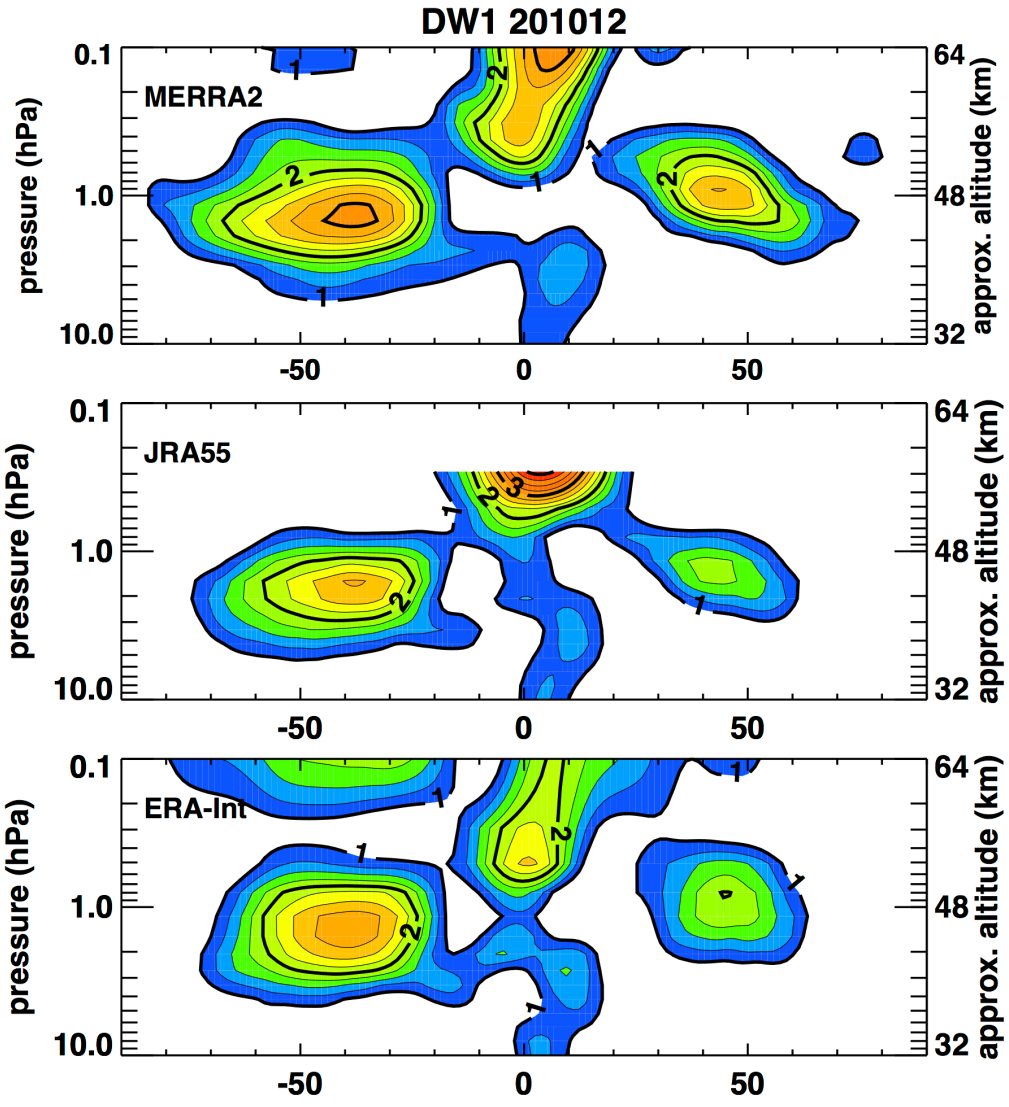
- Applied two-dimensional FFT (Hiyashi, 1971) to longitude-time sections of temperature from MERRA2 (3 hourly), ERA-Int (6 hourly), and JRA55 (6 hourly) for 2010.
- Details of method in McCormack et al. (JGR, 2009).
- Zonal and time mean subtracted from temperature fields prior to analysis. 2DFFT applied to each month so, e.g., MERRA Jan results based on 248 points (31 x 8), Feb results based on 224 points, etc.
- The results in the following plots can be considered the mean amplitude over the month-long analysis interval.
- Diurnal tide: bandpass filter applied to isolate westward zonal wavenumber 1 at frequencies from 0.9-1.1 cpd.
- Q2DW: bandpass for westward zonal wave 3 at 0.45-0.6cpd and zonal wave 4 at 0.45-0.6 cpd.
- 5-d wave: bandpass for westward wave 1 at 0.16-0.25 cpd.
- Bandpass values were chosen based on looking at FFT spectra at latitudes and altitudes where each tide/wave component was typically largest.

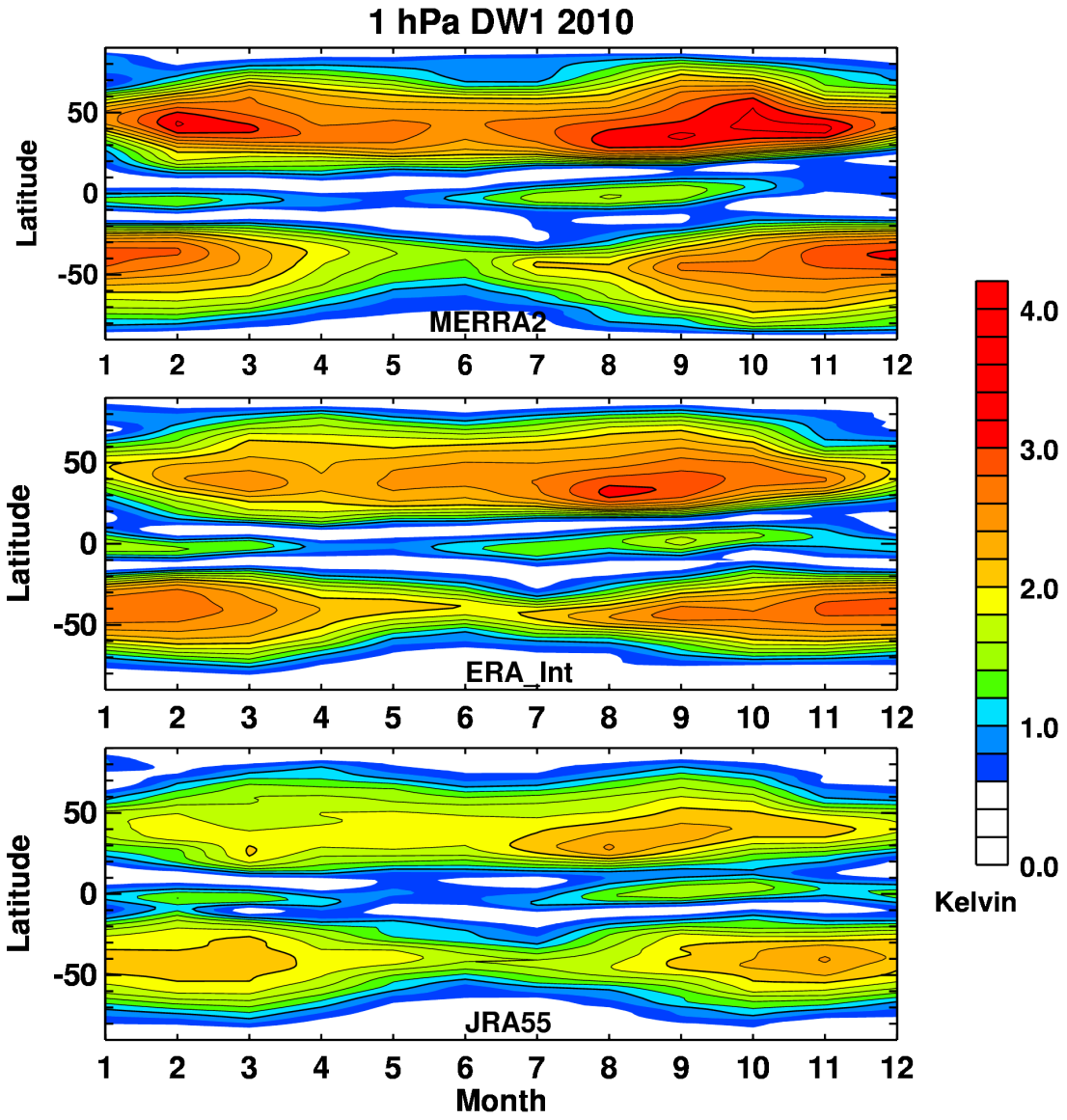
Diurnal Tide

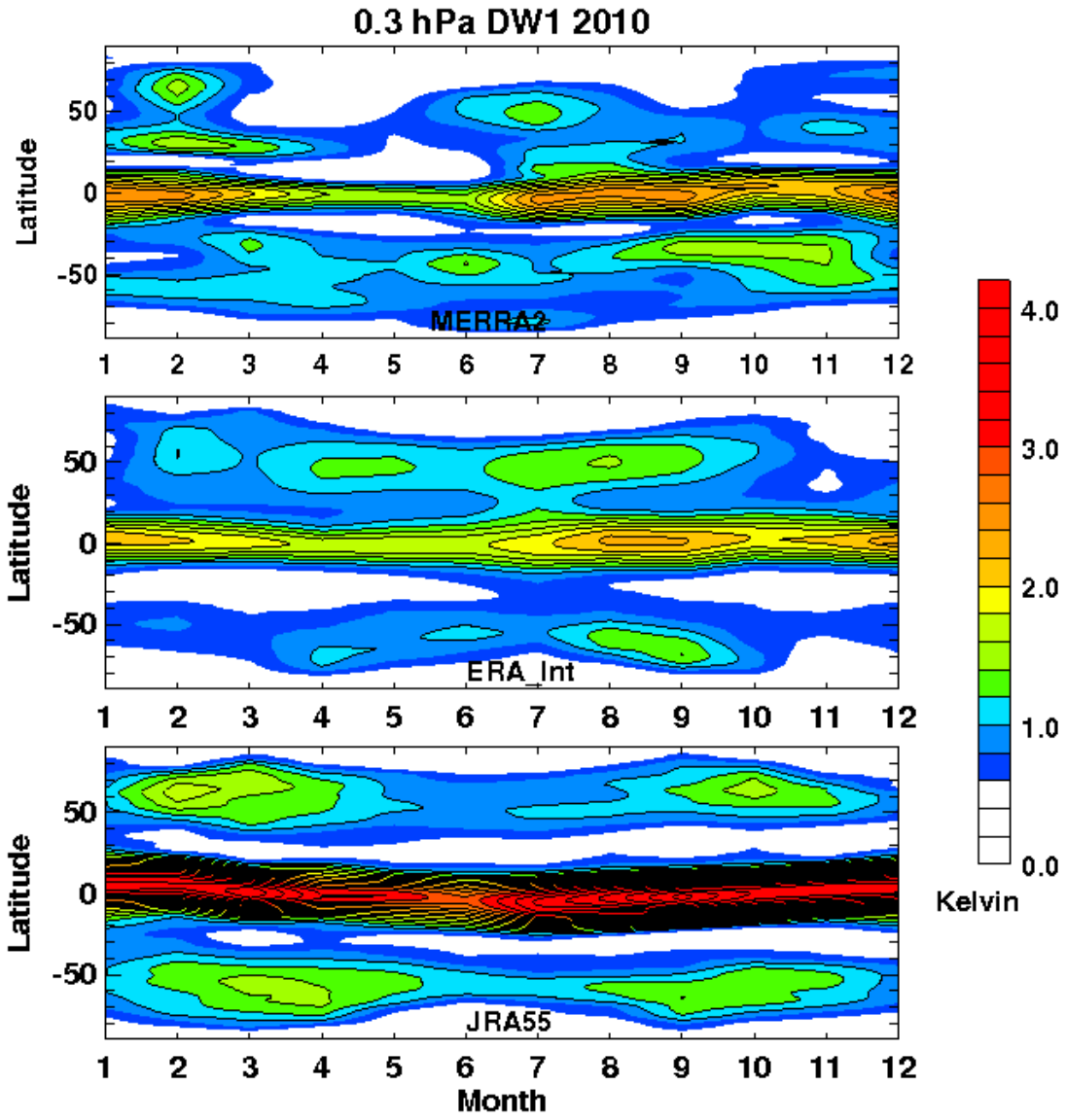

DW1 201003
MERRA2
JRA55
ERA-Int
pressure (hPa)
approx. altitude (km)
0.1
1.0
10.0
64
48
32
-50
0
50


DW1 201006
MERRA2
JRA55
ERA-Int
pressure (hPa)
approx. altitude (km)
0.1
1.0
10.0
64
48
32
-50
0
50
1
2

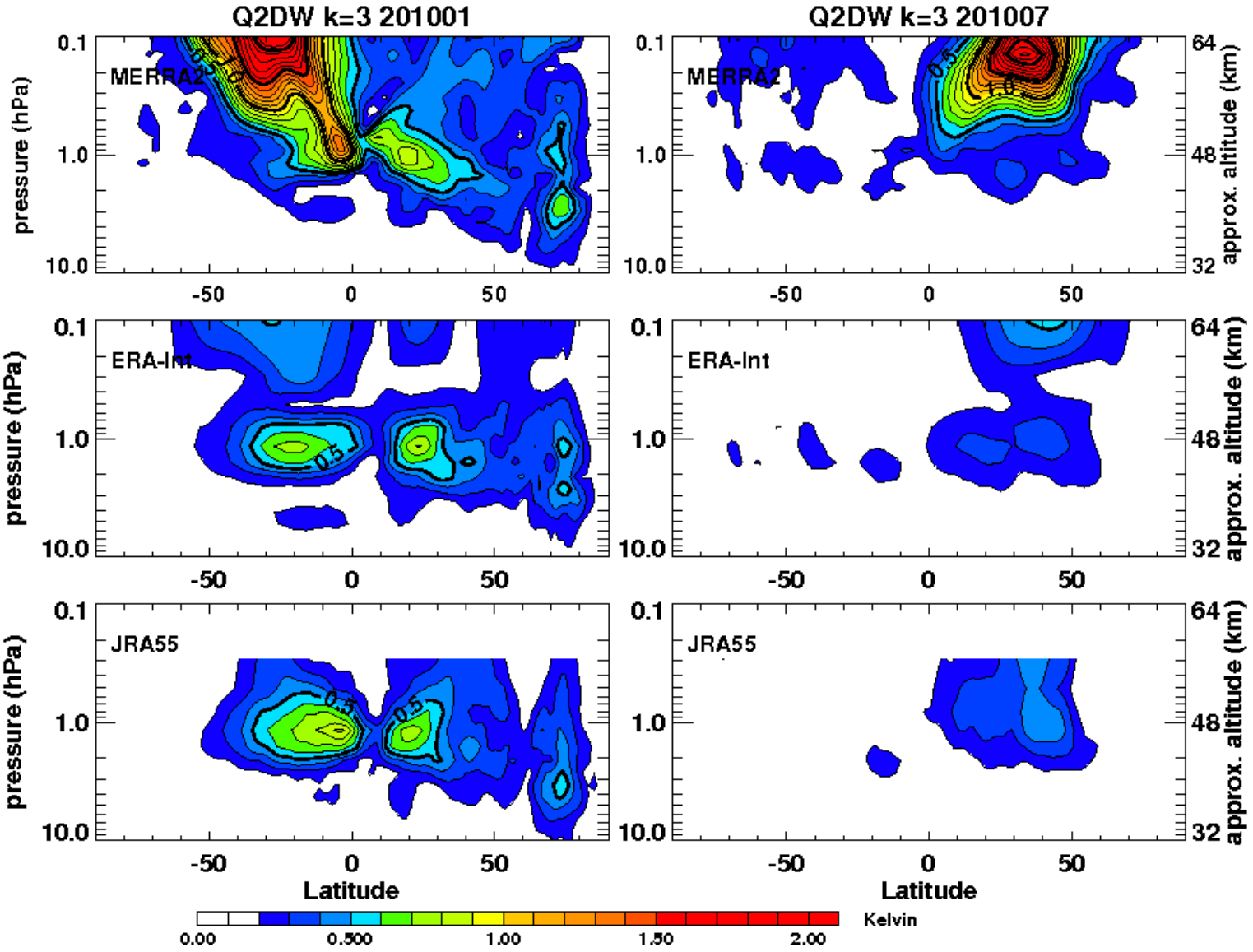

DW1 201009
MERRA2
JRA55
ERA-Int
pressure (hPa)
approx. altitude (km)
0.1
1.0
10.0
64
48
32
-50
0
50

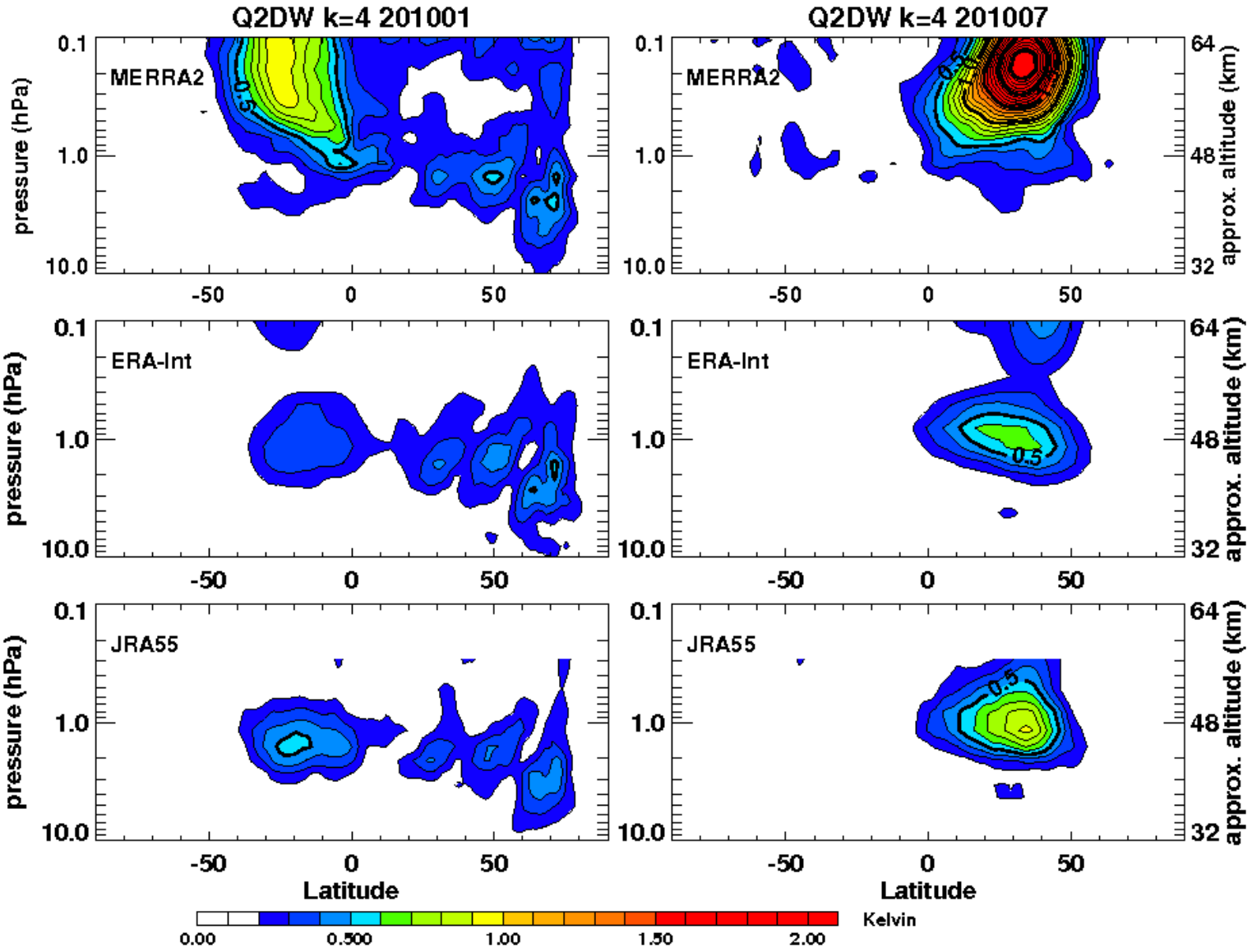

DW1 201012
MERRA2
JRA55
ERA-Int
pressure (hPa)
approx. altitude (km)
0.1
1.0
10.0
64
48
32
-50
0
50

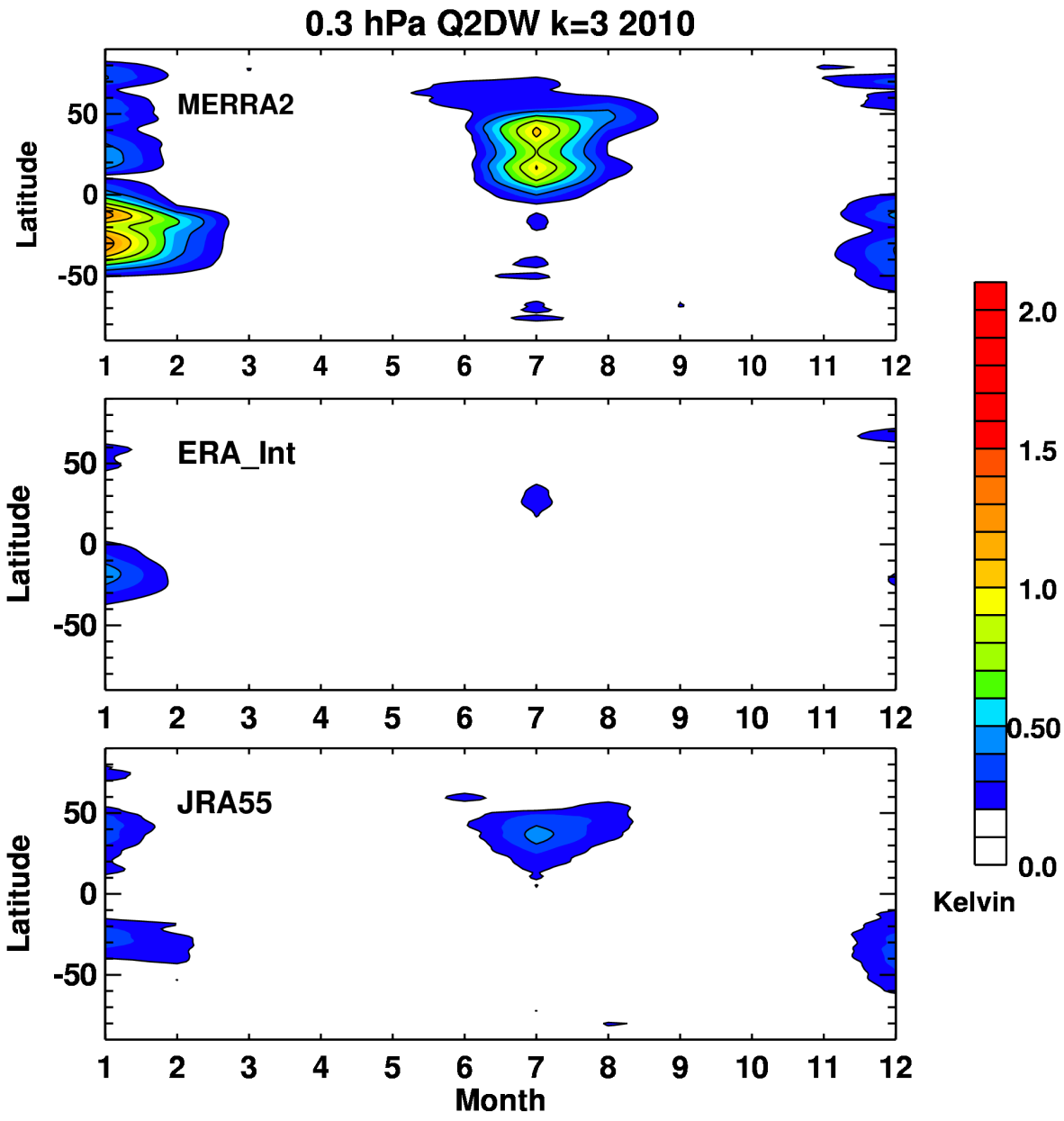

1 hPa DW1 2010
Latitude
50
0
-50
MERRA2
ERA_Int
JRA55
1
2
3
4
5
6
7
8
9
10
11
12
Month
4.0
3.0
2.0
1.0
0.0
Kelvin

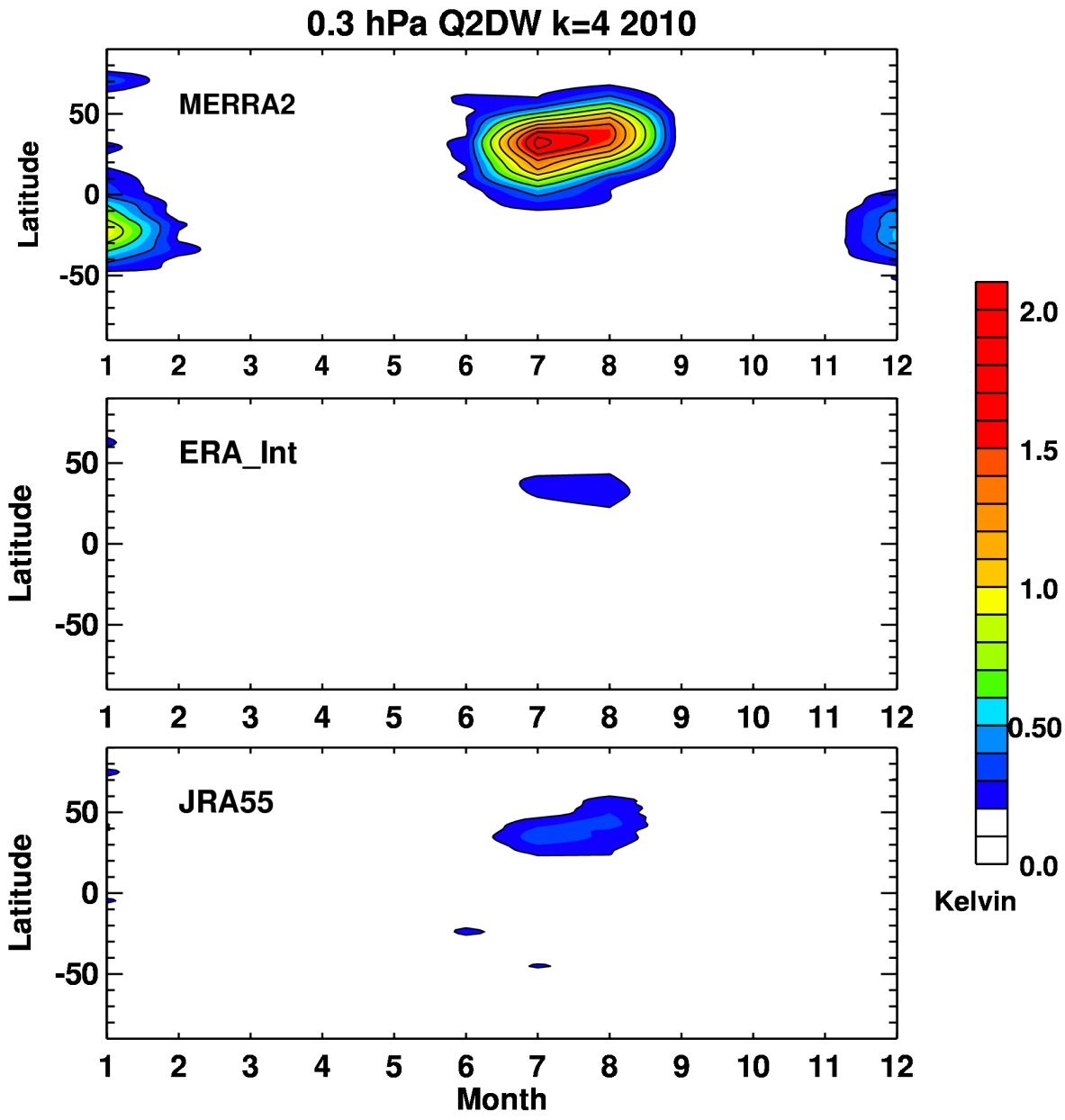

0.3 hPa DW1 2010
Latitude
50
0
-50
MERRA2
ERA_Int
JRA55
1
2
3
4
5
6
7
8
9
10
11
12
Month
4.0
3.0
2.0
1.0
0.0
Kelvin

Quasi-Two Day Wave

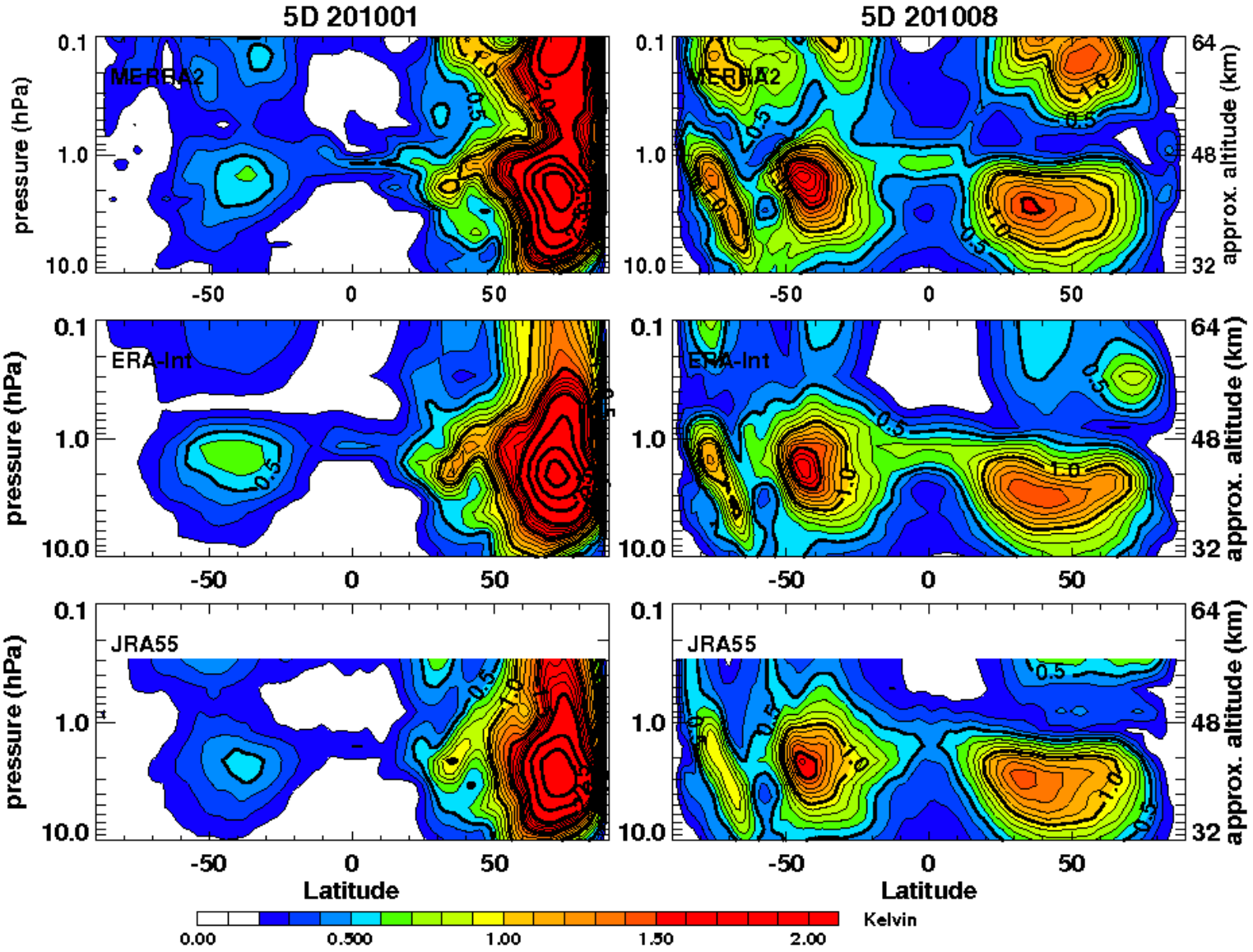

Q2DW k=3 201001
Q2DW k=3 201007
MERRA2
ERA-Int
JRA55
pressure (hPa)
approx. altitude (km)
0.1
1.0
10.0
64
48
32
-50
0
50
Latitude
0.5
1.0
0.00
0.500
1.00
1.50
2.00
Kelvin

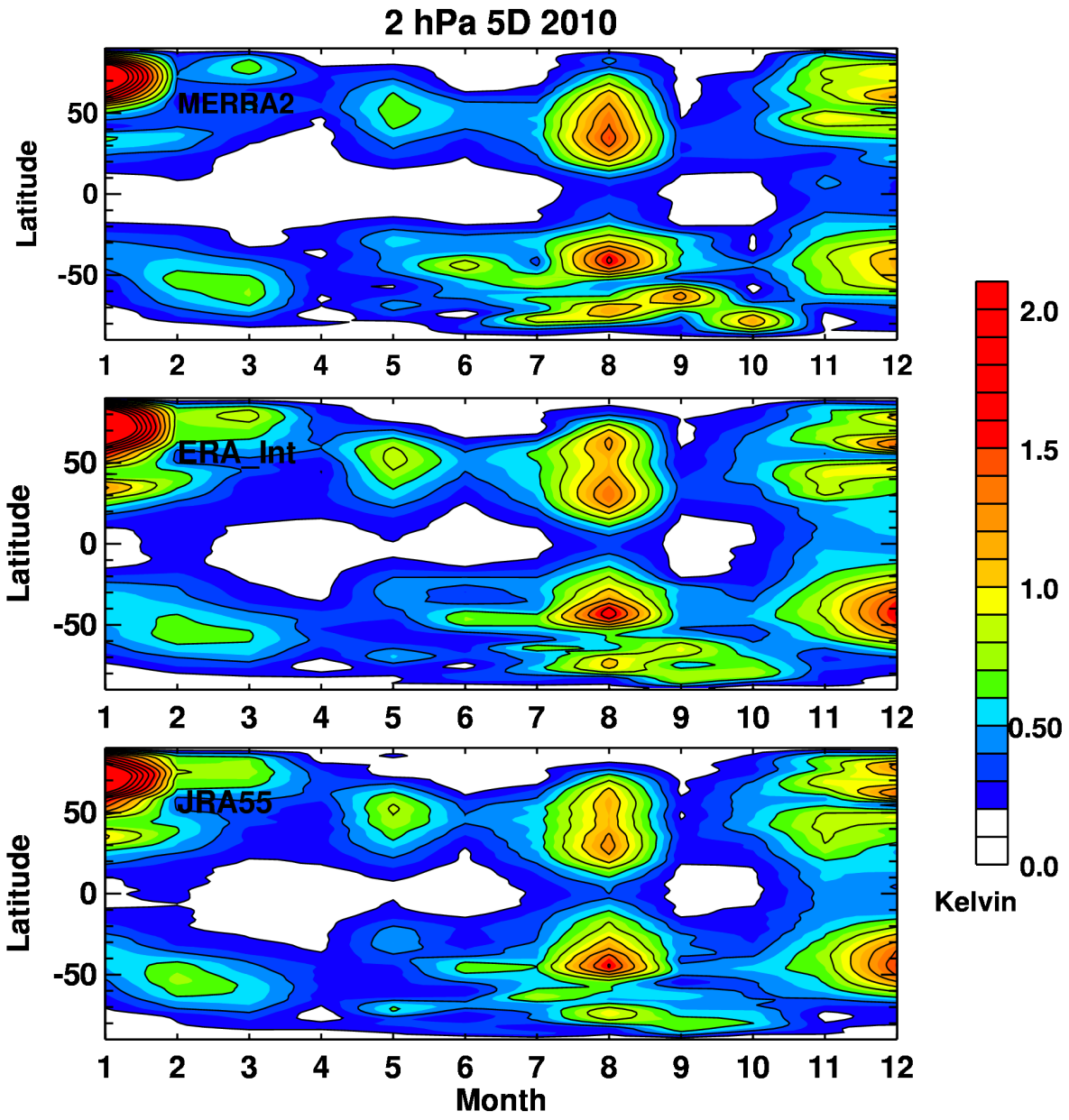

Q2DW k=4 201001
Q2DW k=4 201007
MERRA2
ERA-Int
JRA55
pressure (hPa)
approx. altitude (km)
Latitude
0.1
1.0
10.0
64
48
32
-50
0
50
0.5
0.00
0.500
1.00
1.50
2.00
Kelvin


0.3 hPa Q2DW k=3 2010
MERRA2
ERA_Int
JRA55
Latitude
Month
50
0
-50
1
2
3
4
5
6
7
8
9
10
11
12
2.0
1.5
1.0
0.50
0.0
Kelvin

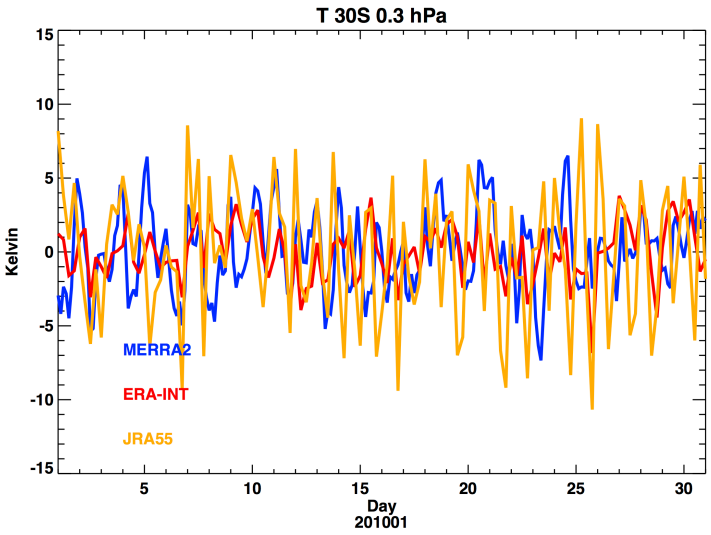

0.3 hPa Q2DW k=4 2010
MERRA2
ERA_Int
JRA55
Latitude
Month
50
0
-50
1
2
3
4
5
6
7
8
9
10
11
12
2.0
1.5
1.0
0.50
0.0
Kelvin

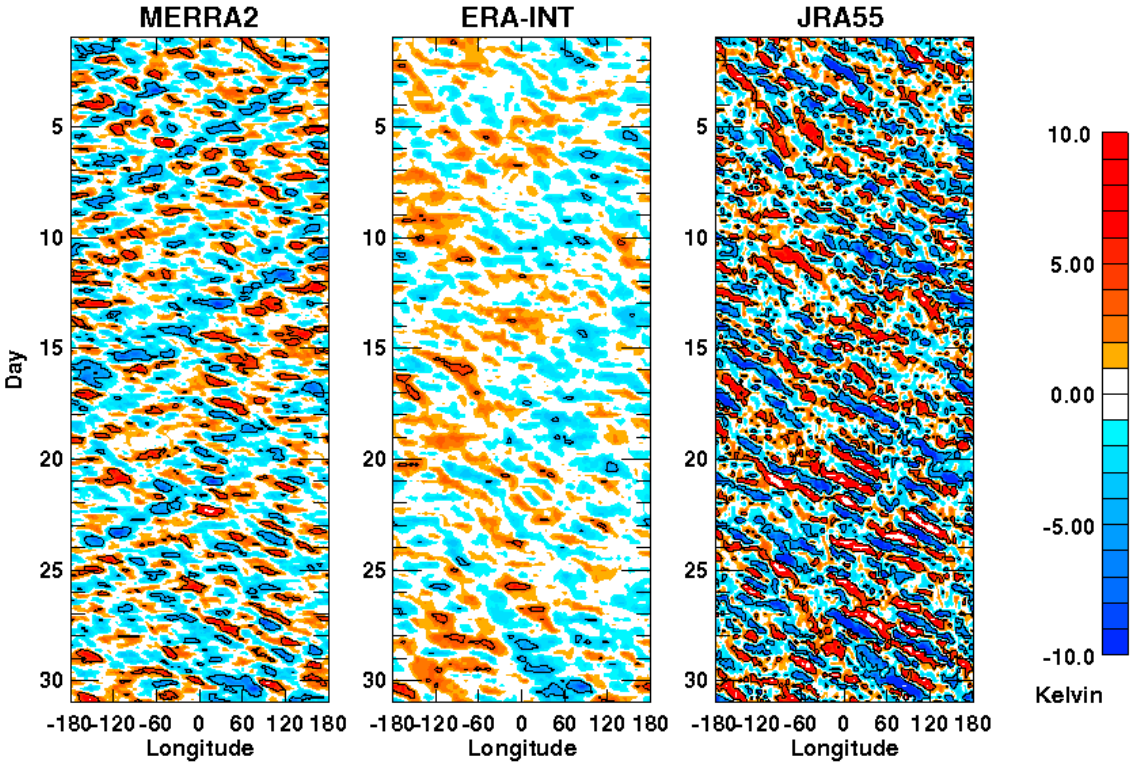
5-day Wave


5D 201001
5D 201008
MERRA2
ERA-Int
JRA55
pressure (hPa)
approx. altitude (km)
Latitude
Kelvin
0.00
0.500
1.00
1.50
2.00

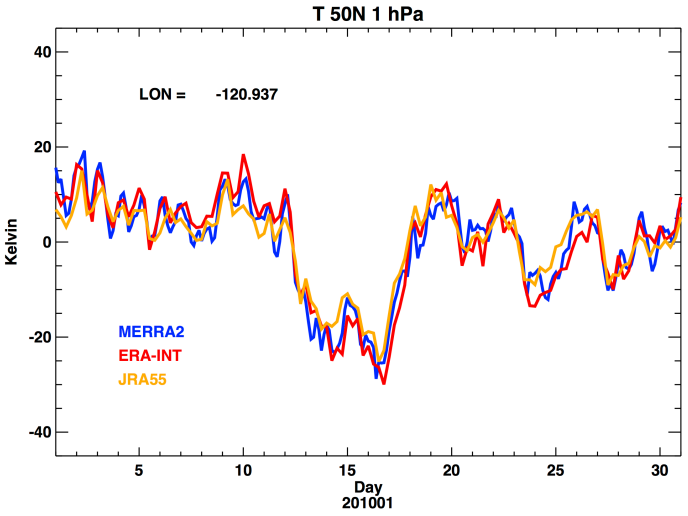

2 hPa 5D 2010
MERRA2
ERA_Int
JRA55
Latitude
50
0
-50
1
2
3
4
5
6
7
8
9
10
11
12
Month
2.0
1.5
1.0
0.50
0.0
Kelvin

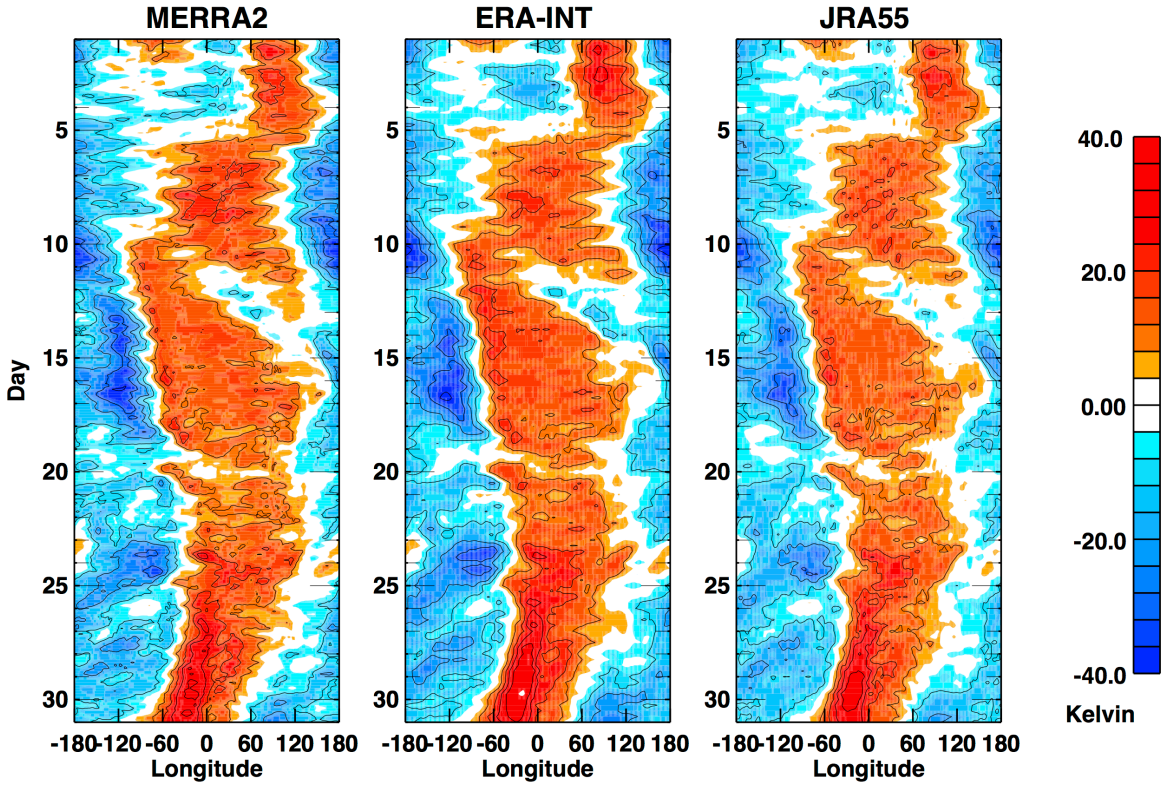
30°S 0.3 hPa Temperature Anomalies Jan 2010





50°N 1 hPa Temperature Anomalies Jan 2010





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Summary

- Latitude and seasonal variations in diurnal tide show good agreement between the 3 data sets
- Only MERRA-2 captures mesospheric 2-day wave
- Strong 5-day wave present in all 3 data sets in stratosphere
- Caution must be used when using temperatures at/near top level

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Acknowledgments

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Some references

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- McCormack, J. P., L. Coy, and K. W. Hoppel (2009), Evolution of the quasi-2 day wave during January 2006, *J. Geophys. Res.*, *114*, D20115, doi:10.1029/2009JD012239.
- McCormack, J. P., L. Coy, and W. Singer (2014), Intraseasonal and interannual variability of the quasi 2 day wave in the northern hemisphere summer mesosphere, *J. Geophys. Res. Atmos.*, *119*, 2928-2946, doi:10.1002/2013JD020199.
- Tunbridge, V. M., D. J. Sandford, and N. J. Mitchell (2011), Zonal wave numbers of the summertime 2 day planetary wave observed in the mesosphere by EOS Aura Microwave Limb Sounder, J. Geophys. Res., 116, D11103, doi:10.1029/2010JD014567.