RID: A reanalysis intercomparison dataset prepared for S-RIP

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A few words about S-RIP

SPARC Reanalysis Intercomparison Project https://s-rip.github.io/

- compare all (or some of the newer) reanalysis data sets for various key diagnostics
- understand the causes of differences among reanalyses
- provide guidance on the appropriate usage of various reanalysis products in scientific studies
- connect such activities with future improvements in the reanalysis products by establishing collaborative links between the reanalysis centres and the SPARC community

RID: A reanalysis intercomparison dataset

To facilitate the comparison of reanalyses, a dataset is prepared including the following core components:

- **Zonal :** zonal mean of temperature, wind, geopotential, eddy fluxes, Eulerian and Transformed Eulerian mean diagnostics (momentum & thermodynamic equations),
- **Surface:** 2-m temperature, surface pressure, mean sea level pressure
- **Single-level:** geopotential height at 10 and 500 hPa
- **Climate indices:** Northern annular mode (NAM), southern annular mode (SAM)

An extension to a first version (ZMD)

P. Martineau, J. S. Wright, N. Zhu, M. Fujiwara, Zonal-mean data set of global atmospheric reanalyses on pressure levels. Earth Syst. Sci. Data. 10, 1925–1941 (2018).

- ~18 citations as of December 2021,
- used extensively in S-RIP report

Some publications based on dataset (to be updated)

- P. Martineau, S.-W. Son, M. Taguchi, Dynamical Consistency of Reanalysis Datasets in the Extratropical Stratosphere. J. Clim. 29, 3057–3074 (2016).
- E. P. Gerber, P. Martineau, Quantifying the variability of the annular modes: reanalysis uncertainty vs. sampling uncertainty. Atmos. Chem. Phys. 18, 17099–17117 (2018)
- P. Martineau, S.-W. Son, M. Taguchi, A. H. Butler, A comparison of the momentum budget in reanalysis datasets during sudden stratospheric warming events. Atmos. Chem. Phys. 18, 7169–7187 (2018)
- Verification data and the skill of decadal predictions, George J. Boer, Reinel Sospedra-Alfonso, Patrick Martineau, Viatsheslav V. Kharin, *submitted*

Availability and technical details

Currently on-demand (Google Drive), first version (ZMD) available at CEDA

Provided as netcdf files

From ~35 TB of raw data, ~500 GB of diagnostic data

Dataset is regularly updated to include the latest data provided by reanalysis centers. Ongoing reanalyses: ERA5, MERRA-2, JRA-55, CFSv2

Data Access

Contact me pmartineau@jamstec.go.jp

Variables and availability

realm	file type	variable	latex_name	description	standard_name	units	20CRv2	20CRv2c	20CRv3	CFSR	CFSv2	ERA-20C	ERA-interim	ERA5	ERA5.1	JRA-25	JRA-55	JRA-55C	MERRA	MERRA-2	NCEP-DOE(R2)	NCEP-NCAR(R1)
single-level	moisture-fluxes_100-1000hPa	qtrop	q	Vertically-integrated specific humidity	specific_humidity	1	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-	-
		qflux_lat	qv	Vertically-integrated meridional moisture flux	product_of_northward_wind_and_specific_humidity	m s-1	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-	-
		qflux_lon	qu	Vertically-integrated zonal moisture flux	product of eastward_wind_and_specific_humidity	m s-1	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-	-
	z10hPa	z10	Z_g	Geopotential height at 10 hPa	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	z500hPa	z500	Z_g	Geopotential height at 500 hPa	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
climate-modes	annular-modes	z_65N_90N	Z_g	Geopotential height averaged from 65N to 90N	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		z_90S_65S	Z_g	Geopotential height averaged from 90S to 65S	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		z_global	Z_g	Geopotential height averaged from 90S to 90N	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
zonal	dt	t_dt	$\partial(\overline{T})/\partial(t)$	Time tendency of air temperature	tendency_of_air_temperature	K s-1	o	o	o	-	o	o	o	o	o	o	o	o	o	o	o	o
		u_dt	$\partial(\overline{u})/\partial(t)$	Time tendency of eastward wind	tendency_of_eastward_wind	m s-2	o	o	o	-	o	o	o	o	o	o	o	o	o	o	o	o
	moist	q	q	specific humidity	specific_humidity	1	-	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-
		vq	vq	specific humidity	product_of_northward_wind_and_specific_humidity	1	-	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-
		wq	wq	specific humidity	product_of_lagrandian_tendency_of_air_pressure_and_specific_humidity	1	-	-	-	-	o	-	-	o	-	-	o	-	-	-	-	-
	core	z	$\overline{Z_g}$	Geopotential height	geopotential_height	m	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		t	$\overline{T}$	Air temperature	air_temperature	K	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u	$\overline{u}$	Eastward wind	eastward_wind	m s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		v	$\overline{v}$	Northward wind	northward_wind	m s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		w	$\overline{\omega}$	Pressure velocity	lagrandian_tendency_of_air_pressure	Pa s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	fluxes	vt	$\overline{vT}$	Meridional heat flux	covariance_over_longitude_of_northward_wind_and_air_temperature	K m s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		wt	$\overline{\omega'T'}$	Vertical heat flux	product_of_lagrangian_tendency_of_air_pressure_and_air_temperature	K Pa s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		vu	$\overline{vu}$	Meridional zonal momentum flux	product_of_eastward_wind_and_northward_wind	m2 s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		wu	$\overline{\omega'u'}$	Vertical zonal momentum flux	product_of_eastward_wind_and_lagrangian_tendency_of_air_pressure	m Pa s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		zz	$\overline{Z_g^2}$	Square of geopotential height anomalies	N/A	m2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		tt	$\overline{T^2}$	Square of air temperature	square_of_air_temperaturee	K2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		uu	$\overline{u^2}$	Square of zonal wind anomalies	square_of_eastward_wind	m2 s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		vv	$\overline{v^2}$	Square of meridional wind anomalies	square_of_northward_wind	m2 s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	tem-qg	EPF_pre_qg	F^{qg}_{ω}	Upward component of QG Eliassen-Palm flux	upward_eliassen_palm_flux_in_air	m2 s-2 Pa	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPF_lat_qg	F^{qg}_{ϕ}	Northward component of QG Eliassen-Palm flux	northward_eliassen_palm_flux_in_air	m3 s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPFD_pre_qg	$-EPFD^{qg}_{\omega}$	Upward component of QG Eliassen-Palm flux convergence	tendency_of_eastward_wind_due_to_eliassen_palm_flux_divergence	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPFD_lat_qg	$-EPFD^{qg}_{\phi}$	Upward component of QG Eliassen-Palm flux convergence	tendency_of_eastward_wind_due_to_eliassen_palm_flux_divergence	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		coriolis_torque_tem	$F\overline{v}^*$	Coriolis torque by meridional residual circulation	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_adv_by_vres	$-\overline{v}^*/a\cos{\phi}{\partial}{\partial{\phi}}\overline{u}$	Momentum advection by meridional residual circulation	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_adv_by_wres	$-\overline{\omega}^*{\partial}{\partial{p}}\overline{u}$	Momentum advection by vertical residual circulation	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		wres	$\overline{\omega}^*$	Vertical component of residual circulation	N/A	Pa s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		vres	$\overline{v}^*$	Meridional component of residual circulation	N/A	m s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	tem-pr	EPF_pre_pr	F^{pr}_{ω}	Upward component of primitive Eliassen-Palm flux	upward_eliassen_palm_flux_in_air	m2 s-2 Pa	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPF_lat_pr	F^{pr}_{ϕ}	Northward component of primitive Eliassen-Palm flux	northward_eliassen_palm_flux_in_air	m3 s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPFD_pre_pr	$-EPFD^{pr}_{\omega}$	Upward component of primitive Eliassen-Palm flux convergence	tendency_of_eastward_wind_due_to_eliassen_palm_flux_divergence	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		EPFD_lat_pr	$-EPFD^{pr}_{\phi}$	Upward component of primitive Eliassen-Palm flux convergence	tendency_of_eastward_wind_due_to_eliassen_palm_flux_divergence	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	mom	coriolis_torque	$F\overline{v}$	Coriolis torque	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_adv_by_v	$-\overline{v}/a\cos{\phi}{\partial}{\partial{\phi}}\overline{u}$	Advection of zonal momentum by meridional wind	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_adv_by_w	$-\overline{\omega}\partial{\partial{p}}\overline{u}$	Advection of zonal momentum by pressure velocity	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_accel_by_wu_flux	$-\partial{\partial{\overline{\omega'u'}}}/\partial{a}$	Acceleration by vertical eddy momentum flux convergence	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		u_accel_by_vu_flux	$-1/a\cos{\phi}^2\partial{\partial{\overline{u'v'}\cos{\phi}^2}}/\partial{\phi}$	Acceleration by meridional eddy momentum flux convergence	N/A	m s-2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
	tem-thermo	theta_adv_by_vres	$-\overline{v}^*/a\partial{\partial{\overline{\theta}}}{\partial{\phi}}$	Advection of potential temperature by meridional component of residual circulation	N/A	K s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		theta_adv_by_wres	$-\overline{\omega}^*{\partial}{\partial{p}}\overline{\theta}$	Advection of potential temperature by vertical component of residual circulation	N/A	K s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
		flux_term	N/A	Flux term (see Middle Atmosphere Dynamics by Andrews, Holton, Leovy [1987])	N/A	K s-1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
surface	sp	sp	p_{sfc}	Surface pressure	surface_air_pressure	Pa	-	-	-	-	o	-	-	-	-	-	o	-	-	o	-	-
	precip	precip	TBD	Precipitation	TBD	TBD	o	o	-	-	-	o	o	o	o	-	o	-	-	-	o	o
	t2m	t2m	T_{sfc}	2-m temperature	air_temperature	K	-	-	-	o	o	o	o	o	-	-	o	-	-	o	-	-
	mslp	mslp	p_{msl}	Mean sea level pressure	air_pressure_at_mean_sea_level	Pa	-	-	-	-	-	o	o	o	-	-	o	-	-	o	-	-
intraseasonal	core	u	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		v	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		t	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		z	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		q	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		Q	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		w	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-momentum-10-60	uu10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		vv10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		uv10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-heat-10-60	tt10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		vt10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		ut10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		wt10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-moist-10-60	vq10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		uq10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	covariance-diab-10-60	Qt10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-momentum-0-10	uu0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		vv0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		uv0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-heat-0-10	tt0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		vt0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		ut0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		wt0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	covariance-diab-0-10	Qt0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	fluxes-moist-0-10	vq0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		uq0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
	filtered-vars	z0-10	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-
		z10-60	TBD	TBD	TBD	TBD	-	-	-	-	-	-	-	-	-	-	o	-	-	-	-	-

Two grids

Original grid: diagnostics provided at the resolution at which data was downloading for each reanalysis. *Not necessarily the highest resolution available.

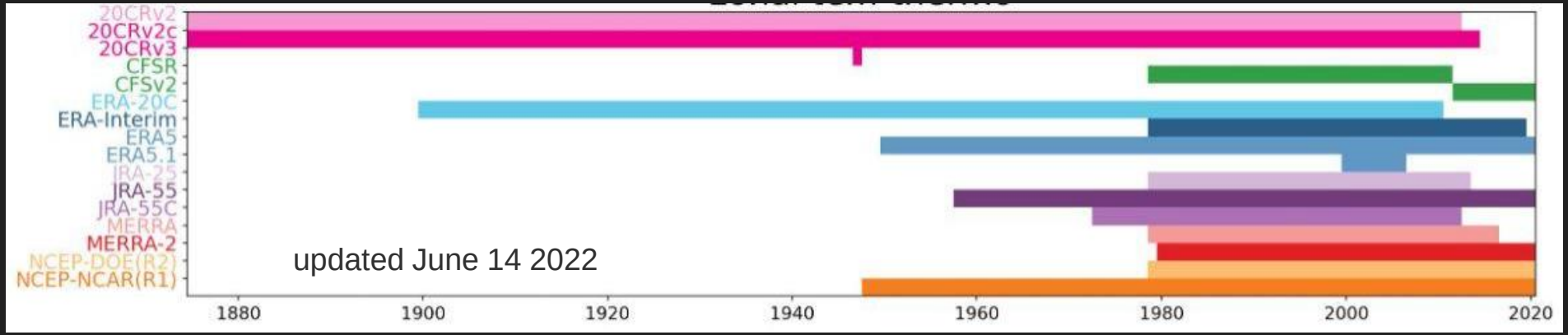
Common grid: All reanalyses are interpolated to a 2.5° by 2.5° horizontal grid and common pressure levels are subsampled before diagnostics are performed.

Two temporal resolutions

- Daily
- Monthly

*all diagnostics computed from 6-hourly data

Reanalyses



Standard Input: NCEP-NCAR, NCEP-DOE, CFSR/CFSv2, ERA-Interim, ERA5/5.1, JRA-25, JRA-55, MERRA, MERRA-2

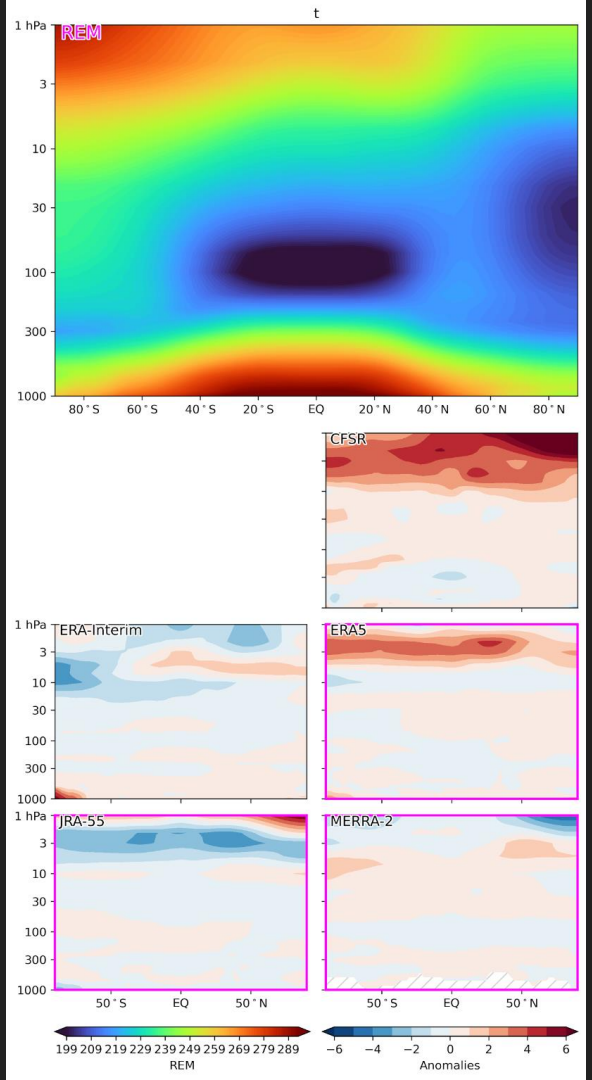
Surface Input: ERA-20C, 20CRv2, 20CRv2c, 20CRv3

*currently processing 20CRv3 (June 14 2022)

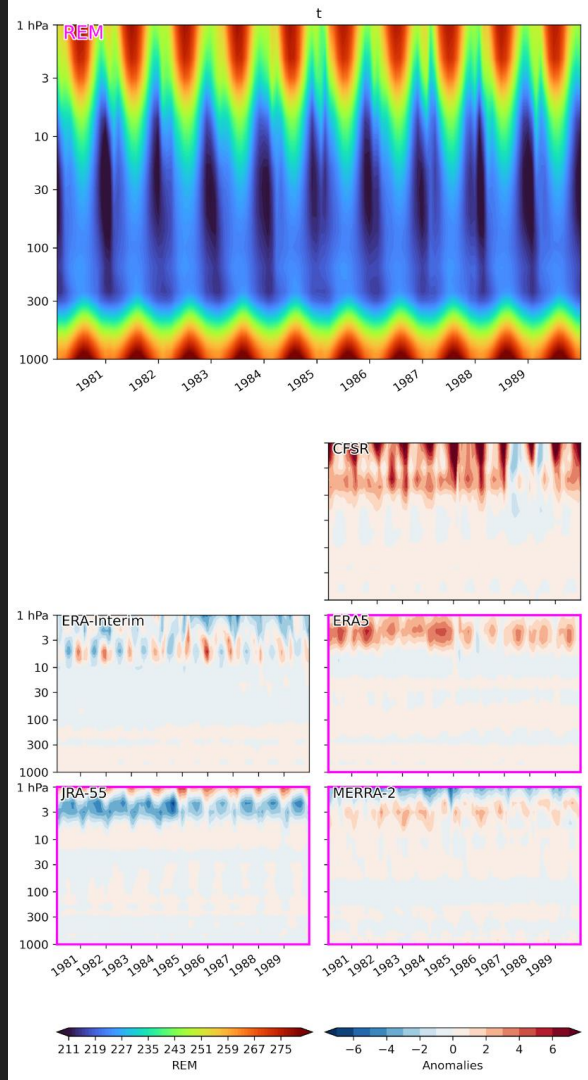
Difference between RID and ZMD (old dataset)

- Inclusion of ERA-5, 20CRv3 (ongoing / June 14 2022)
- Addition of surface, single-level, and climate-modes data types
- New scheme for vertical derivatives (link)
  - Works for unevenly-spaced grids
  - Data provided at uppermost pressure levels by using 1-sided differences
- 6-hourly data not provided, daily data is provided instead
- For flux terms, contribution of wavenumber 1 and 2 is provided (3 not archived anymore)

Sample diagnostics: Zonal-mean DJF temperature averaged from 1980-1990



Sample diagnostics: Zonal-mean temperature averaged from 45N-90N



Future work

Include newer reanalyses: MERRA-3, JRA-3Q, etc.

Find hosting solution for the dataset (Google Drive is practical but there are some limitations)

Identify and prepare useful diagnostics in consultation with the S-RIP phase II community

Suggestions are welcome!

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