Are ocean reanalyses useful for Earth rotation research?

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Specific focus here:

- Testing oceanic angular momentum (OAM) estimates from ocean reanalyses
- Impact of data assimilation (DA) scheme?

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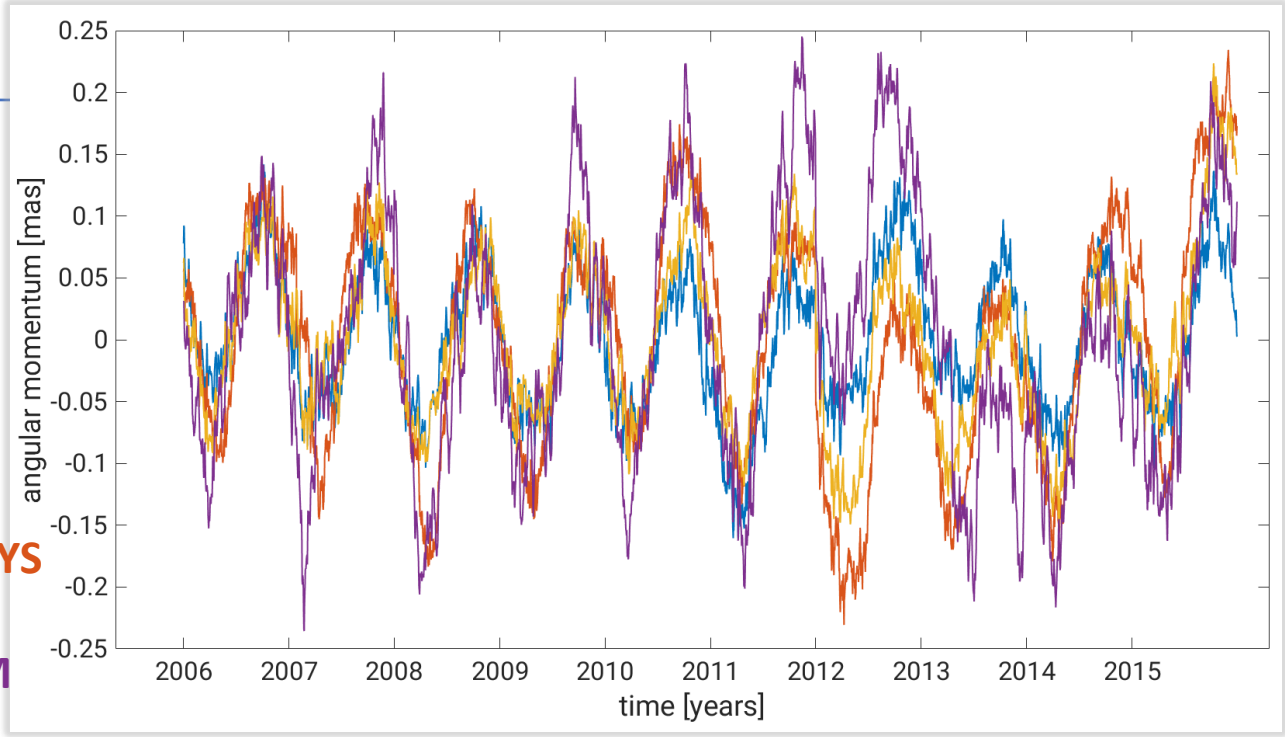
	GLORYS2v4 [3]	ORAS5 [5]	FOAM-GloSea5v13 [1]
Processing centre	Mercator Ocean	ECMWF	UK Met Office
Ocean model	NEMO3.1	NEMO3.4.1	NEMO3.4
DA scheme	SAM2 (SEEK)	NEMOVAR (3Dvar)	NEMOVAR (3Dvar)
Assimilation window length (days)	7	5	1

- Daily data from 01/2006 – 12/2015
- Discretization: $^1/_4\,°$ on 75 depth levels
- Provided at Copernicus Marine Environment Monitoring Service (CMEMS)[1]
- OAM from ECCOv4r3 [2] for comparison

χ_z mass component



[1] https://resources.marine.copernicus.eu/product-detail/GLOBAL_REANALYSIS_PHY_001_031/INFORMATION

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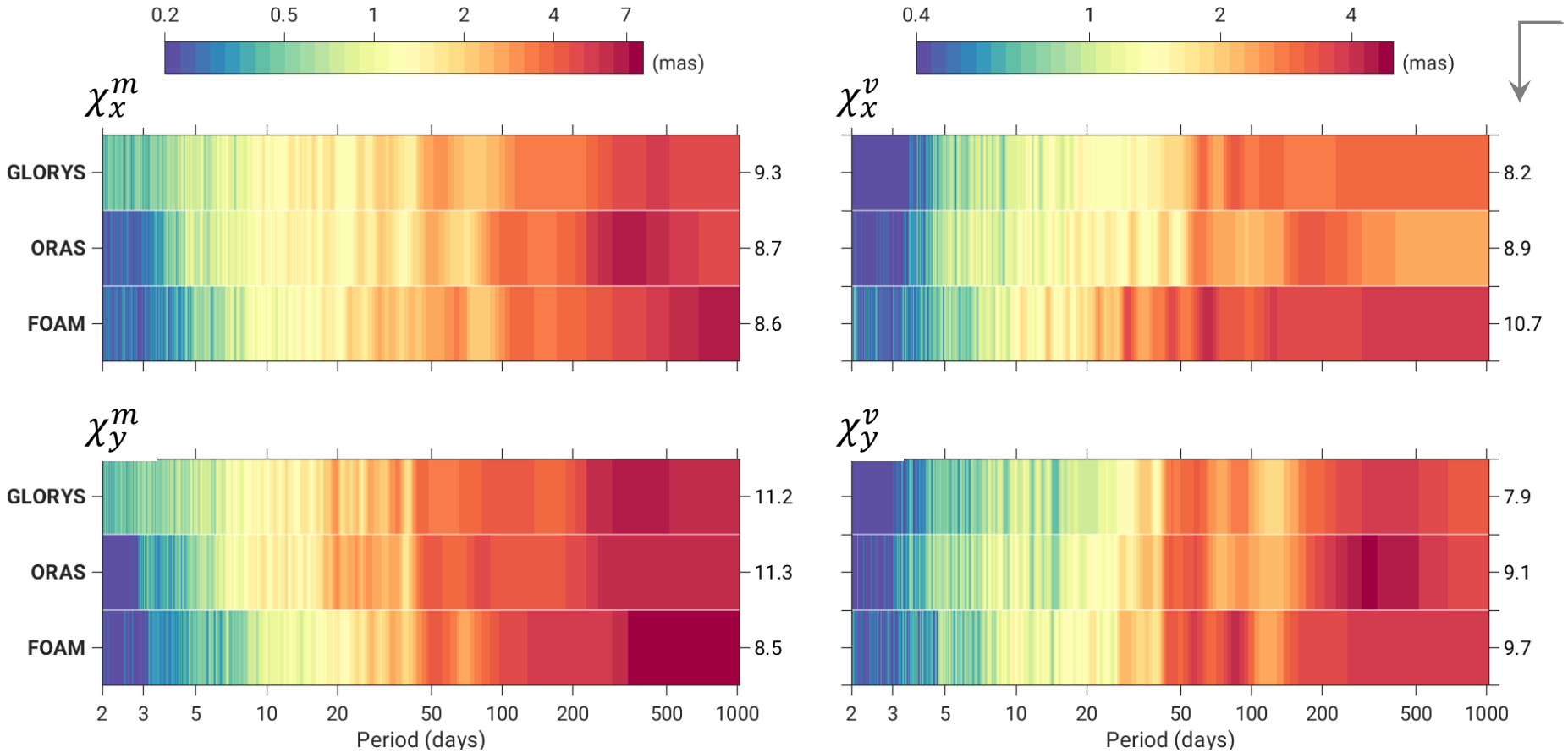
OAM ⟶ Amplitude spectra of OAM functions



- **GLORYS** has most variablity in **high-frequency** domain
- **FOAM** has highest power in **lower frequencies**
- Power of **ORAS distributed** over **entire frequency** band but **highest** in **lower frequencies**

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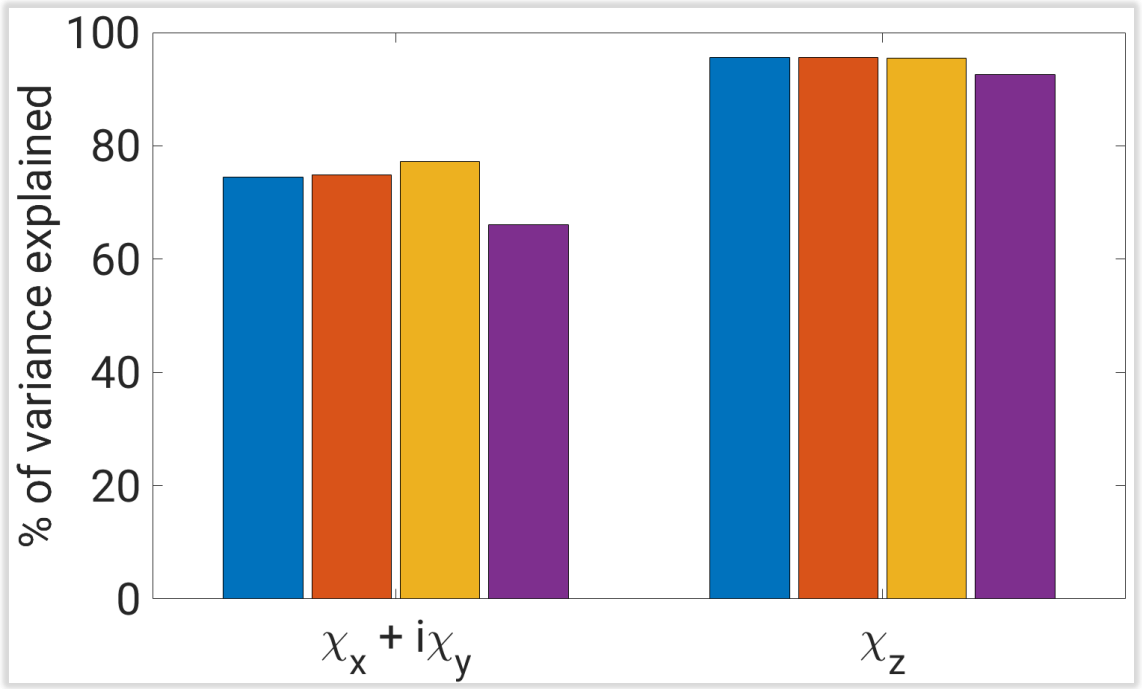
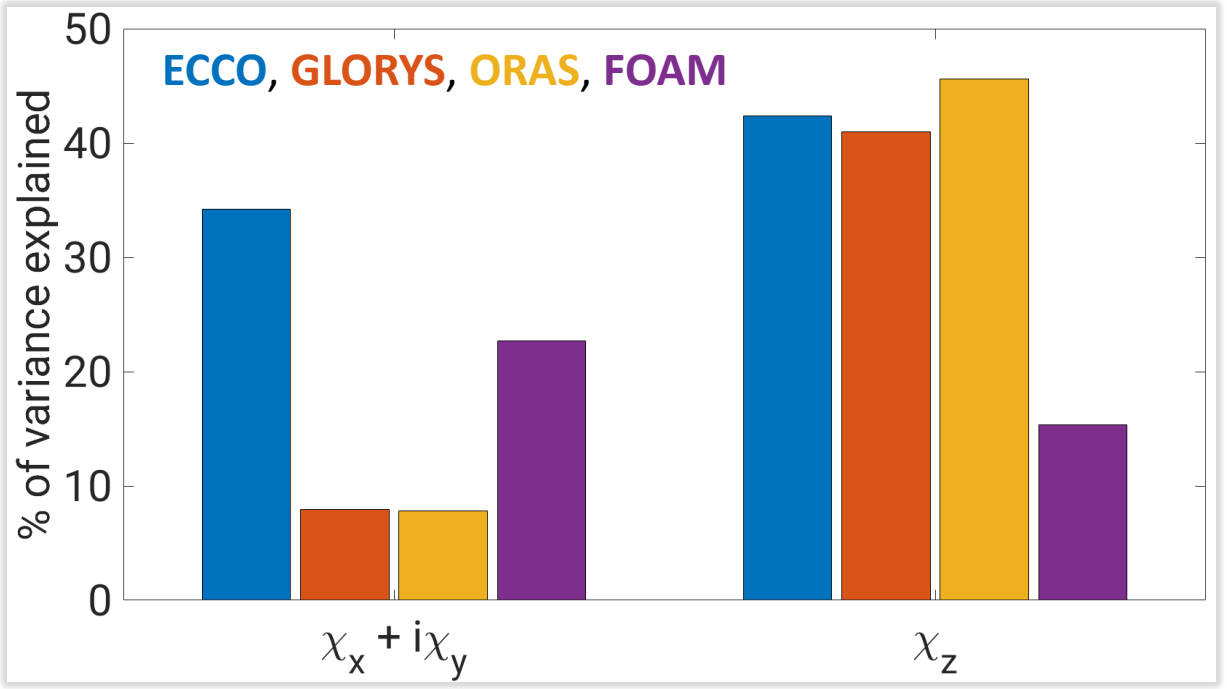
OAM ⟶ Excitation budget (geodetic - atmospheric vs. oceanic excitation)

Sub-seasonal band, periods < 120 days



Interannual band, periods > 365 days



- **Good** perfomance in **sub-seasonal** band
- Reanalyses **vary** on **interannual** band

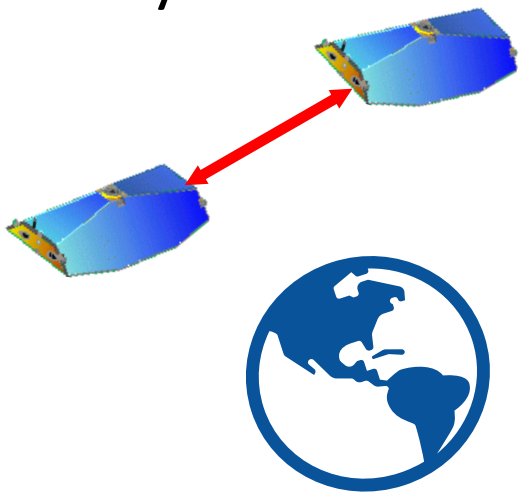
Are ocean reanalyses useful for Earth rotation research?

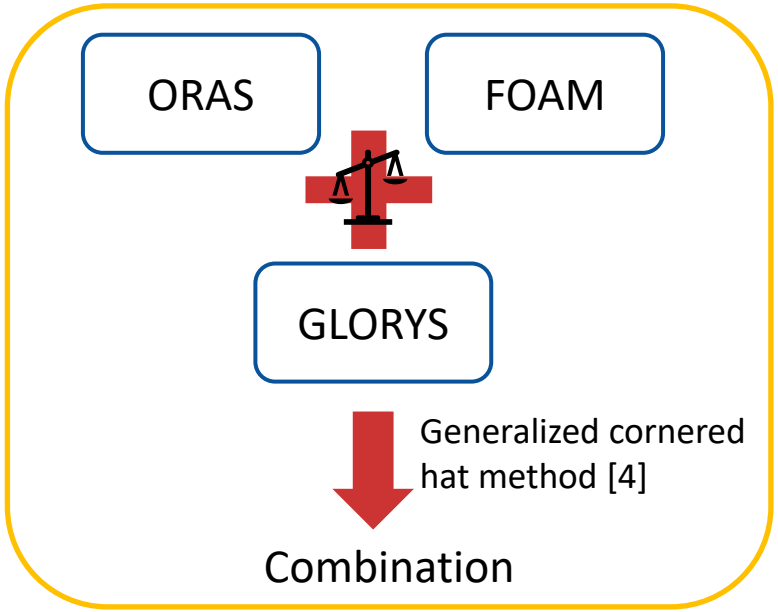
→ **Yes**, but **with reservation**

- Differences in spectral domain
- Good performance on excitation budget
- Varying results in interannual band

→ **Impact** of **data assimilation scheme**

Further analysis:





References & Acknowledgements

[1] Blockley, E. W., Martin, M. J., McLaren, A. J., Ryan, A. G., Waters, J., Lea, D. J., Mirouze, I., Peterson, K. A., Sellar, A., & Storkey, D., 2014. Recent development of the Met Office operational ocean forecasting system: An overview and assessment of the new Global FOAM forecasts, *Geoscientific Model Development*, **7**(6), 2613–2638.

[2] ECCO Consortium, Fukumori, I., Wang, O., Fenty, I., Forget, G., Heimbach, P., & Ponte, R. M., 2017. ECCO Version 4 Release 3, Technical, Jet Propulsion Laboratory.

[3] Lellouche, J.-M., Le Galloudec, O., Drévillon, M., Régnier, C., Greiner, E., Garric, G., Ferry, N., Desportes, C., Testut, C.-E., Bricaud, C., Bourdallé-Badie, R., Tranchant, B., Benkiran, M., Drillet, Y., Daudin, A., & De Nicola, C., 2013. Evaluation of global monitoring and forecasting systems at Mercator Océan, *Ocean Science*, **9**(1), 57–81.

[4] Tavella, P. & Premoli, A., 1994. Estimating the Instabilities of N Clocks by Measuring Differences of their Readings, *Metrologia*, **30**(5), 479–486

[5] Zuo, H., Balmaseda, M. A., & Mogensen, K., 2017. The new eddy-permitting ORAP5 ocean reanalysis: Description, evaluation and uncertainties in climate signals, *Climate Dynamics*, **49**(3), 791–811.

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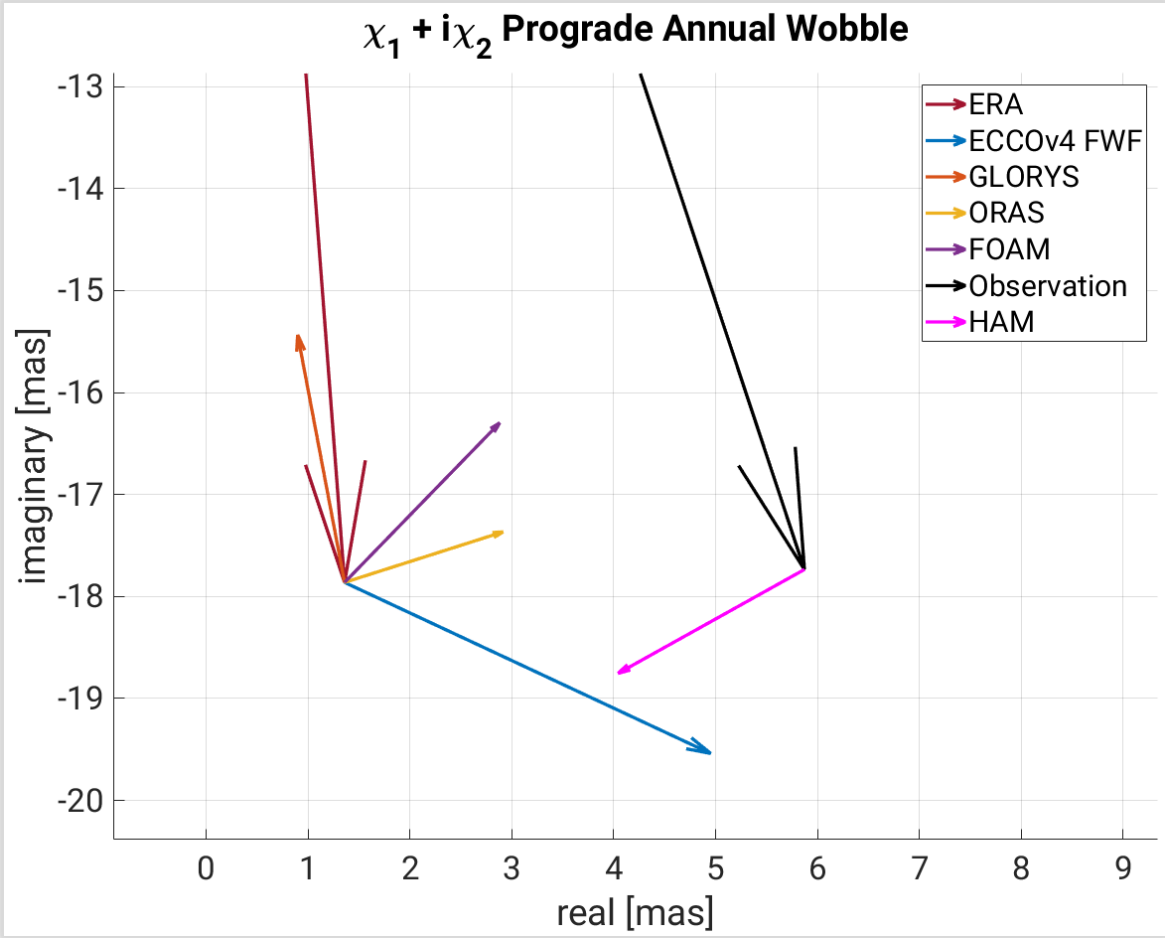
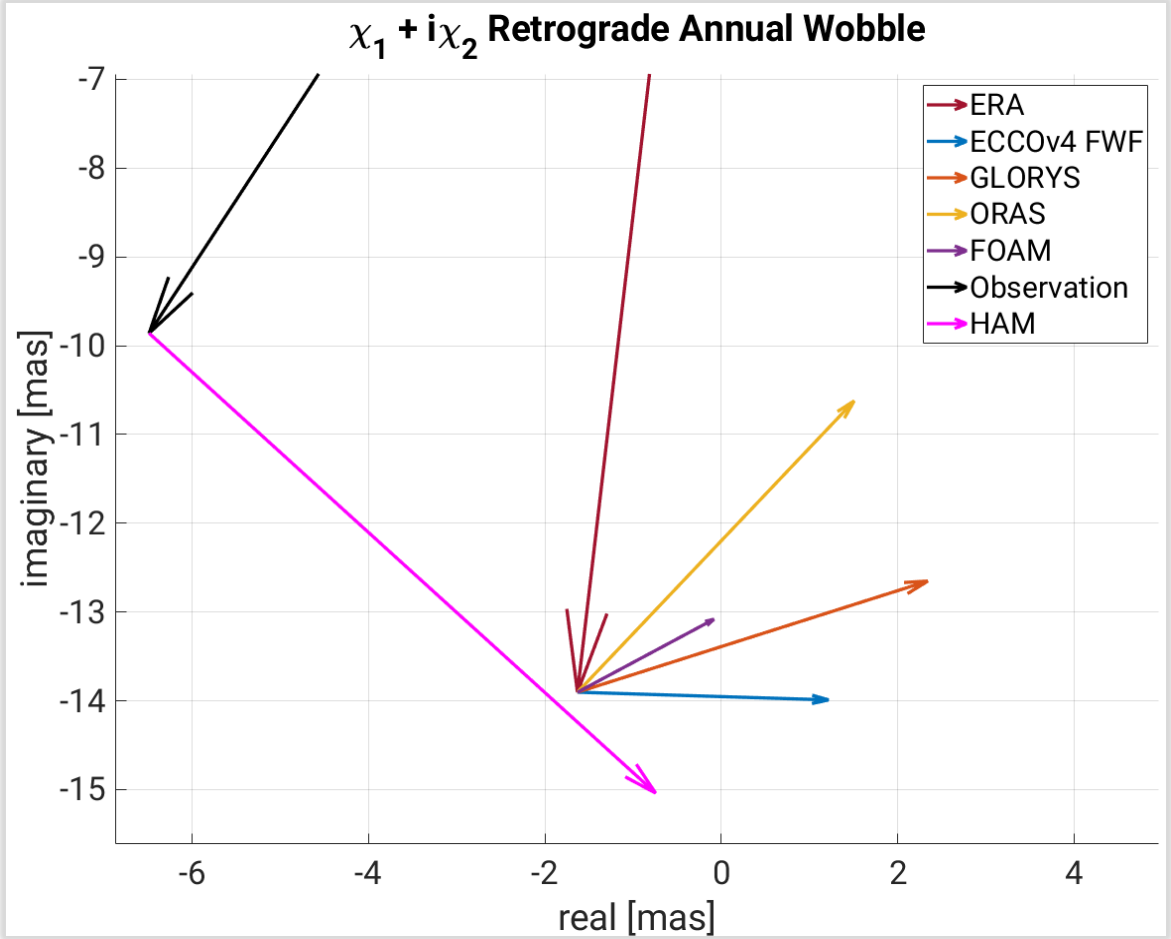
Additional Material

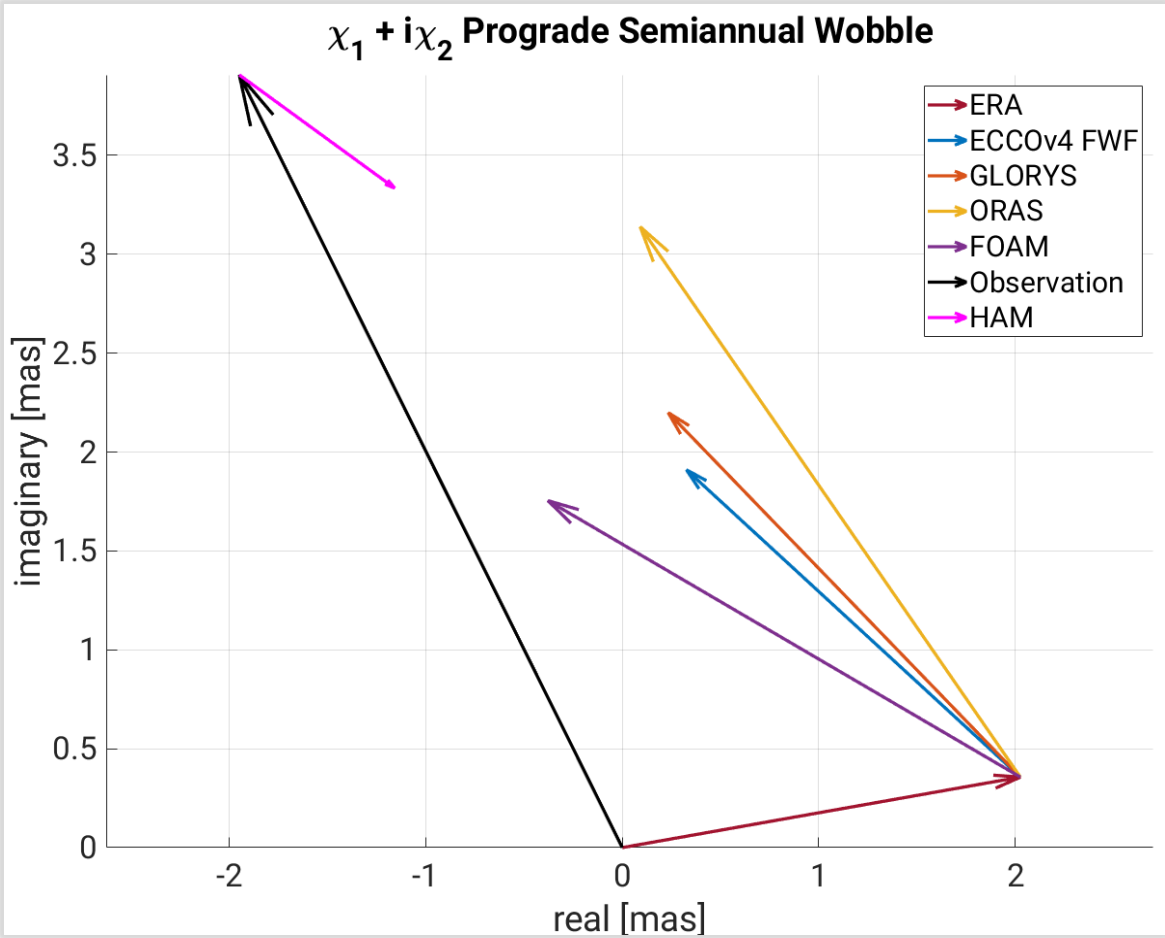
OAM ⟶ Seasonal variability

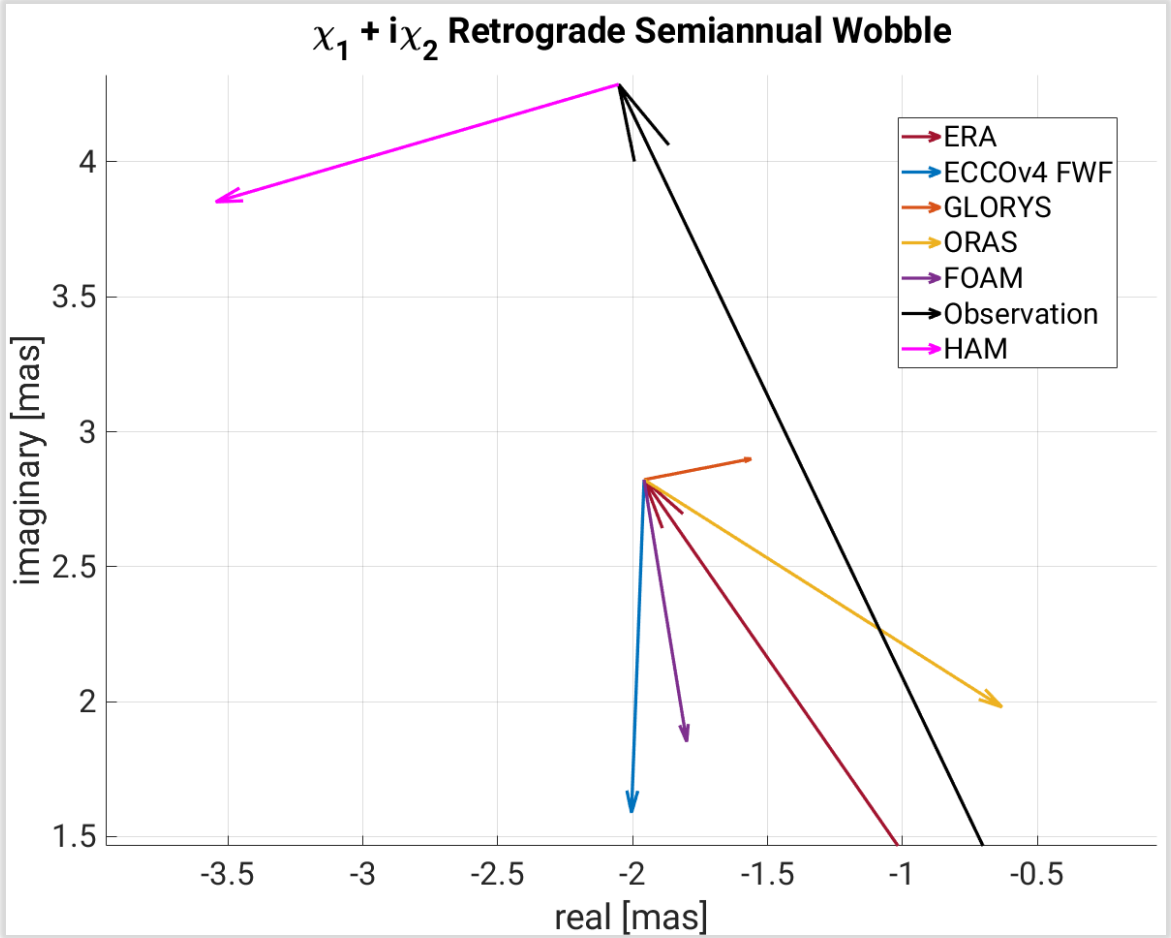
- Atmosphere from ERA-Interim
- Observation from SPACE2018 series
- HAM from ESMGFZ





OAM ⟶ Seasonal variability





OAM ⟶ Seasonal variability