

Skill assessment of the CSIRO multi-year Climate Analysis Forecast Ensemble (CAFE) system

CSIRO decadal climate forecasting project

Dougie Squire, James Risbey, Carly Tozer, Didier Monselesan, Thomas Moore, James Munroe

The CSIRO CLIMATE ANALYSIS FORECAST ENSEMBLE system

- New project to understand and improve predictability on multi-year time scales
- Use a variant of the GFDL CM2.1 ocean (MOM5) - atmosphere (AM2) - land (LM2) - sea ice (SIS) model
- Focus on internal variability

The CSIRO CLIMATE ANALYSIS FORECAST ENSEMBLE system

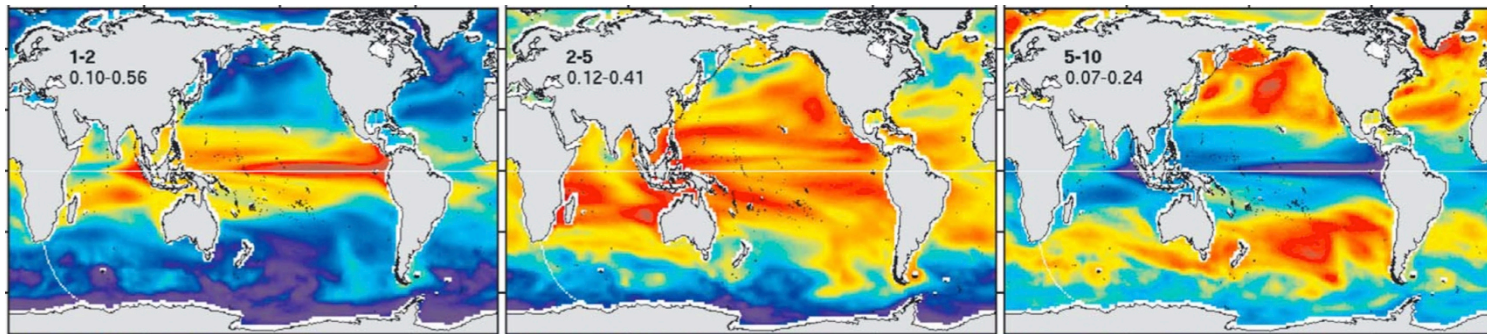
- New project to understand and improve predictability on multi-year time scales
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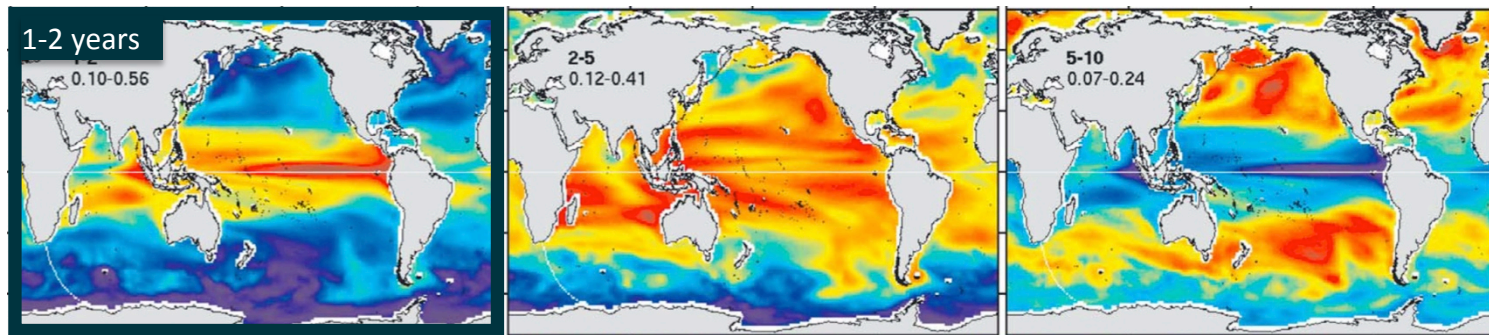


Fractional in-band variances of SLA

Monselesan et al. 2015 GRL

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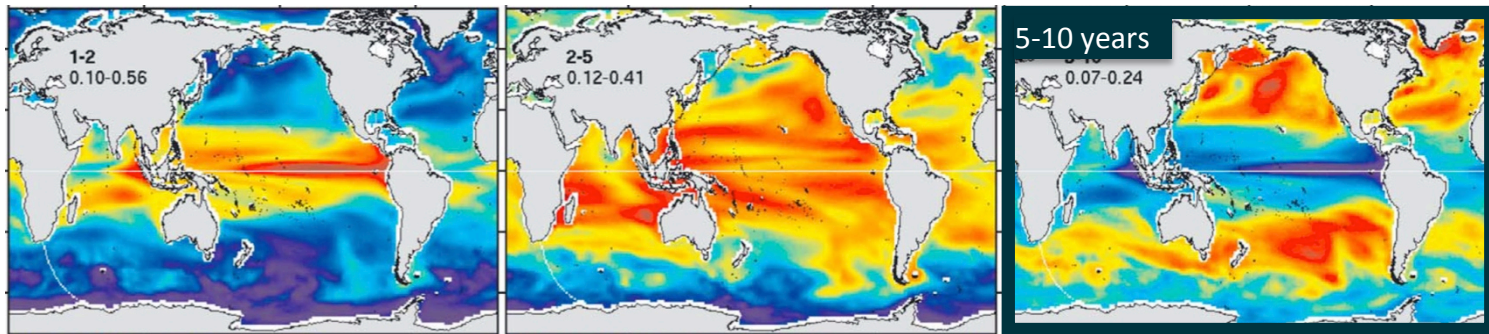


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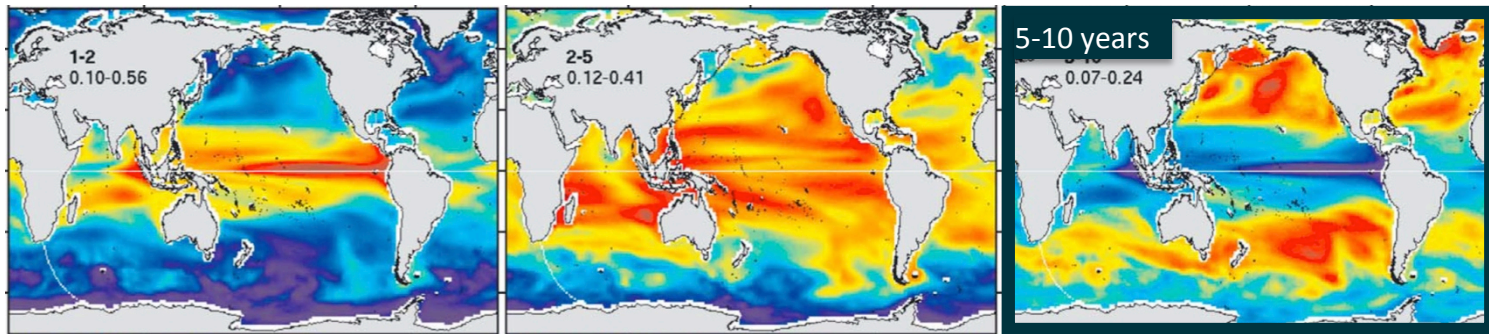


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- Use a variant of the GFDL CM2.1 ocean (MOM5) - atmosphere (AM2) - land (LM2) - sea ice (SIS) model
- Focus on internal variability, reflected in our approach to verification



Fractional in-band variances of SLA

Monselesan et al. 2015 GRL

doppyo diagnostics/verification software

- Leverage emerging efforts towards best practices in big data and reproducibility

 **PANGEO** + James Munroe

- Towards a community effort
- Dataset/filetype agnostic

doppyo diagnostics/verification software

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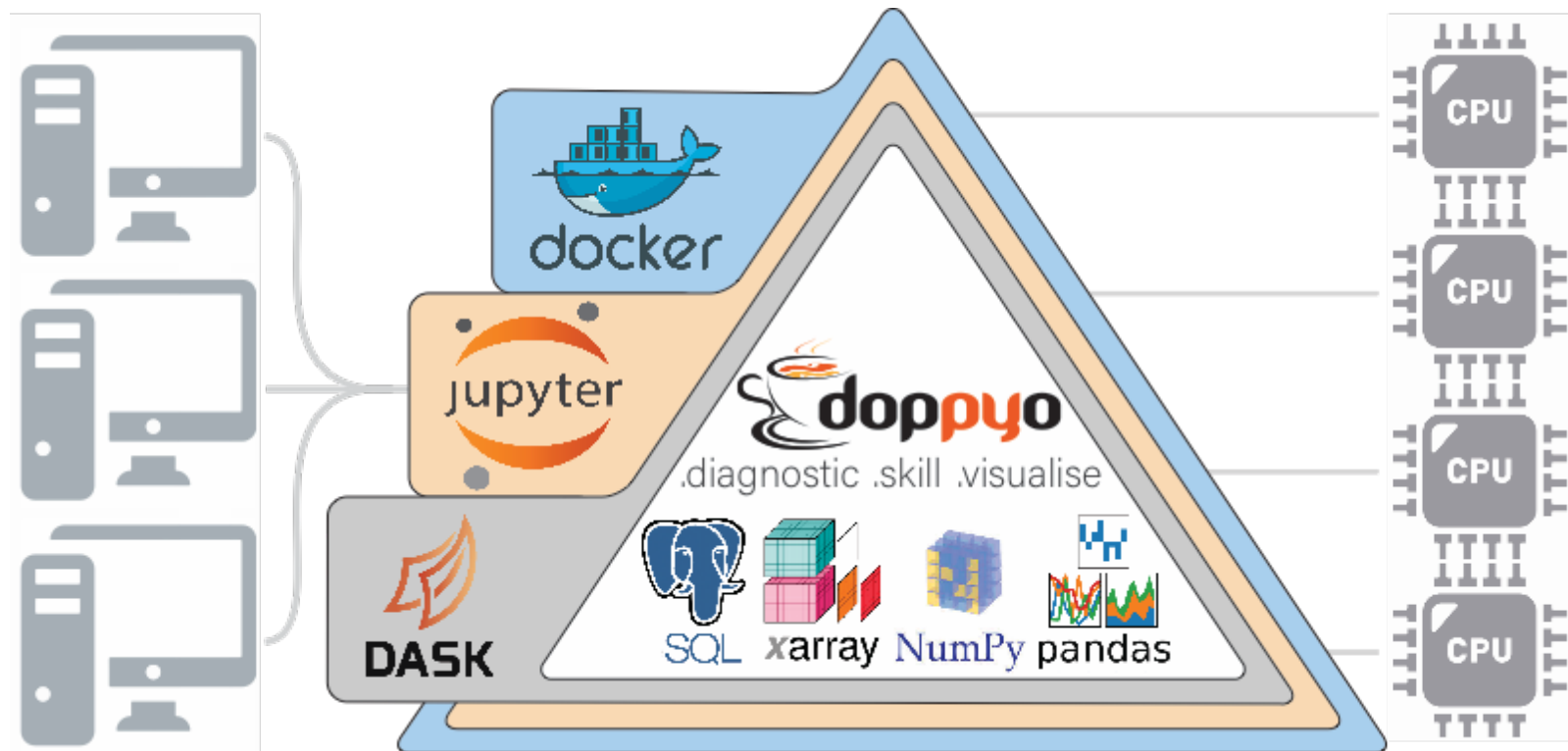
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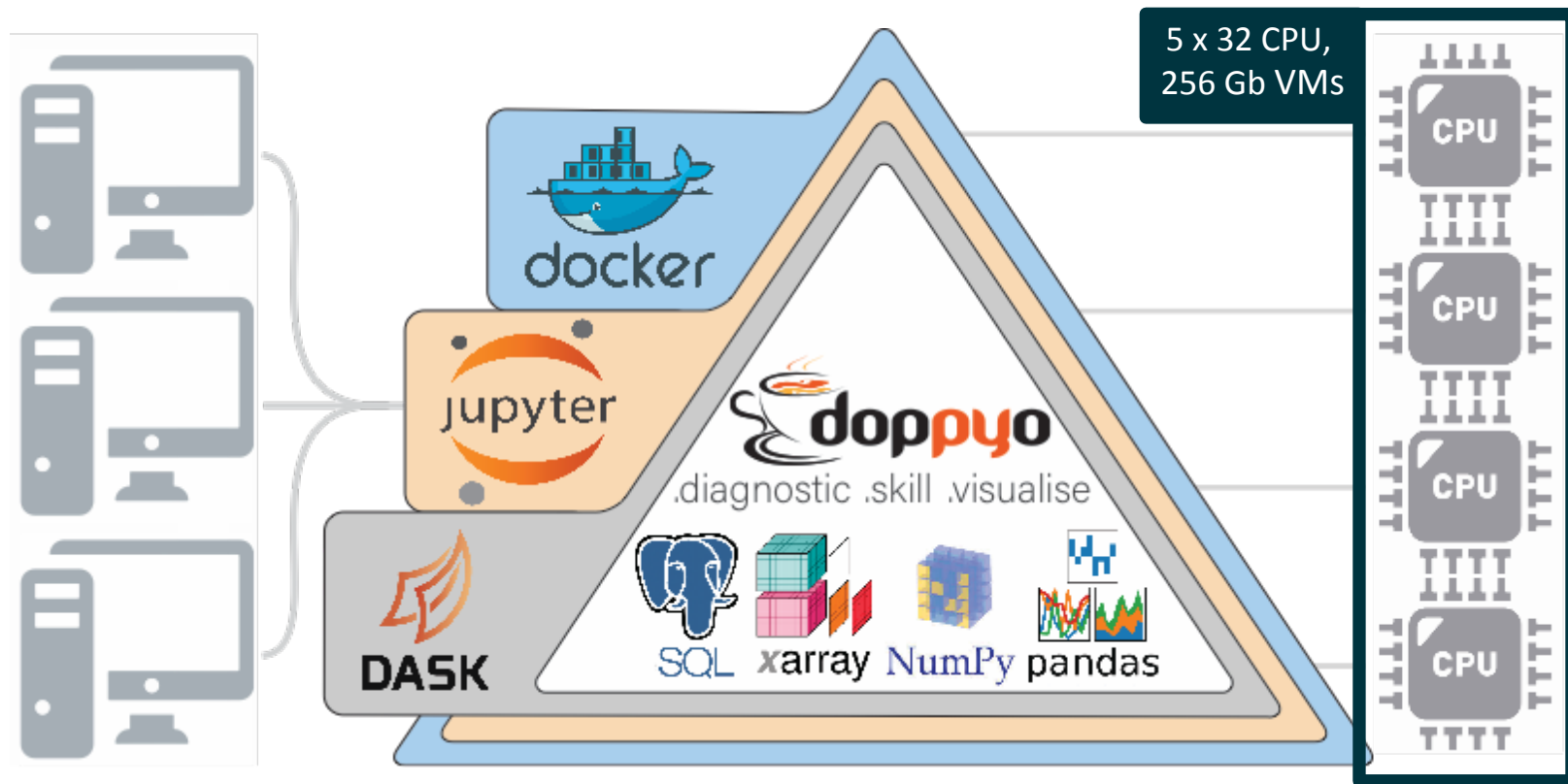
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- Towards a community effort
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doppyo diagnostics/verification software



diagnostics/verification software



oa-32-cdc.it.csiro.au

File Edit View Run Kernel Tabs Settings Help

Python [default]

Import required packages

```
In [ ]: import dopypy
import dask
import distributed
import xarray as xr
import numpy as np
```

Initialise dask client

```
In [ ]: client = distributed.Client('tcp://oa-32-cdc.nexus.csiro.au:8786')
client
```

Query database for JRA55 files and load them lazily

```
In [ ]: %%time
gh, temp, u, v, omega = dopypy.utils.load_ncfiles(dataset='jra55', variables=['gh','temp','u','v','w'])
```

Lazily compute the total eddy available potential energy

```
In [ ]: %%time
energetics = dopypy.diagnostic.compute_atmos_energy_cycle(temp, u, v, omega, gh, terms='Pe')
```

Compute seasonal means of total eddy available potential energy

```
In [ ]: %%time
```

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Dask: Status

CAFE-f1 hindcasts (today's data)

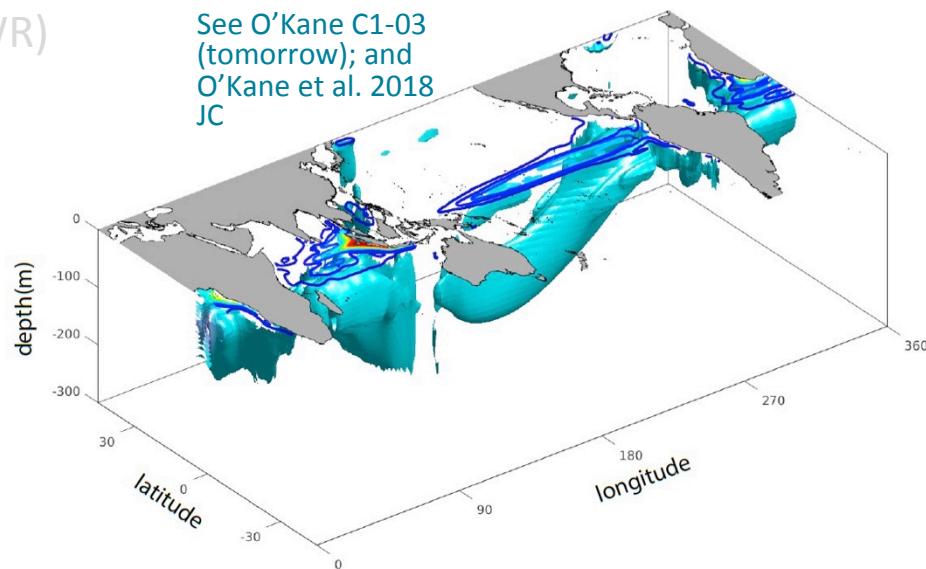
- 2-year, 11-member hindcasts started monthly over 2002-2016
- Only ocean observations assimilated
- Bred-vector-initialised on sub-surface ocean temperature isosurface corresponding to high in-band variance on 1-2 month time scales
- Mean bias corrected (Stockdale 1997 MWR)

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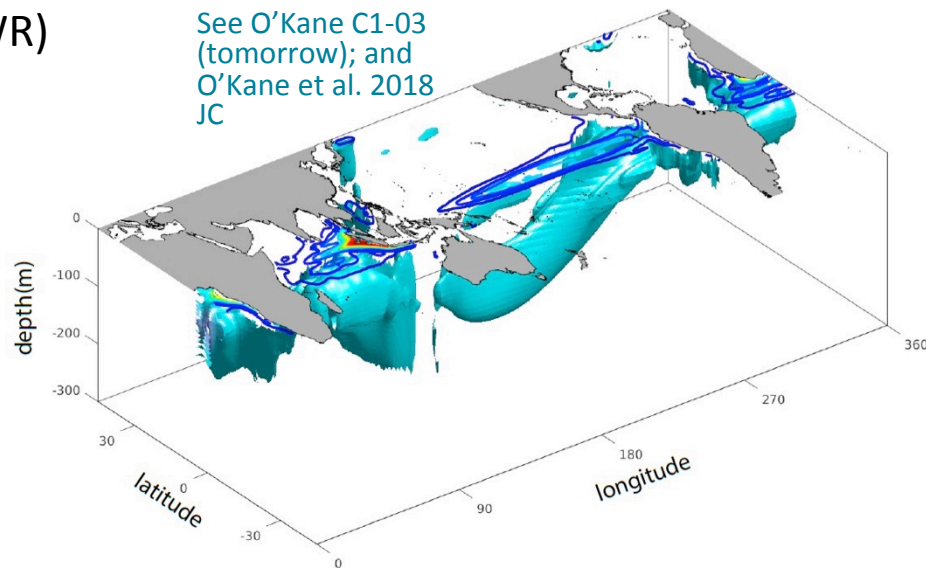
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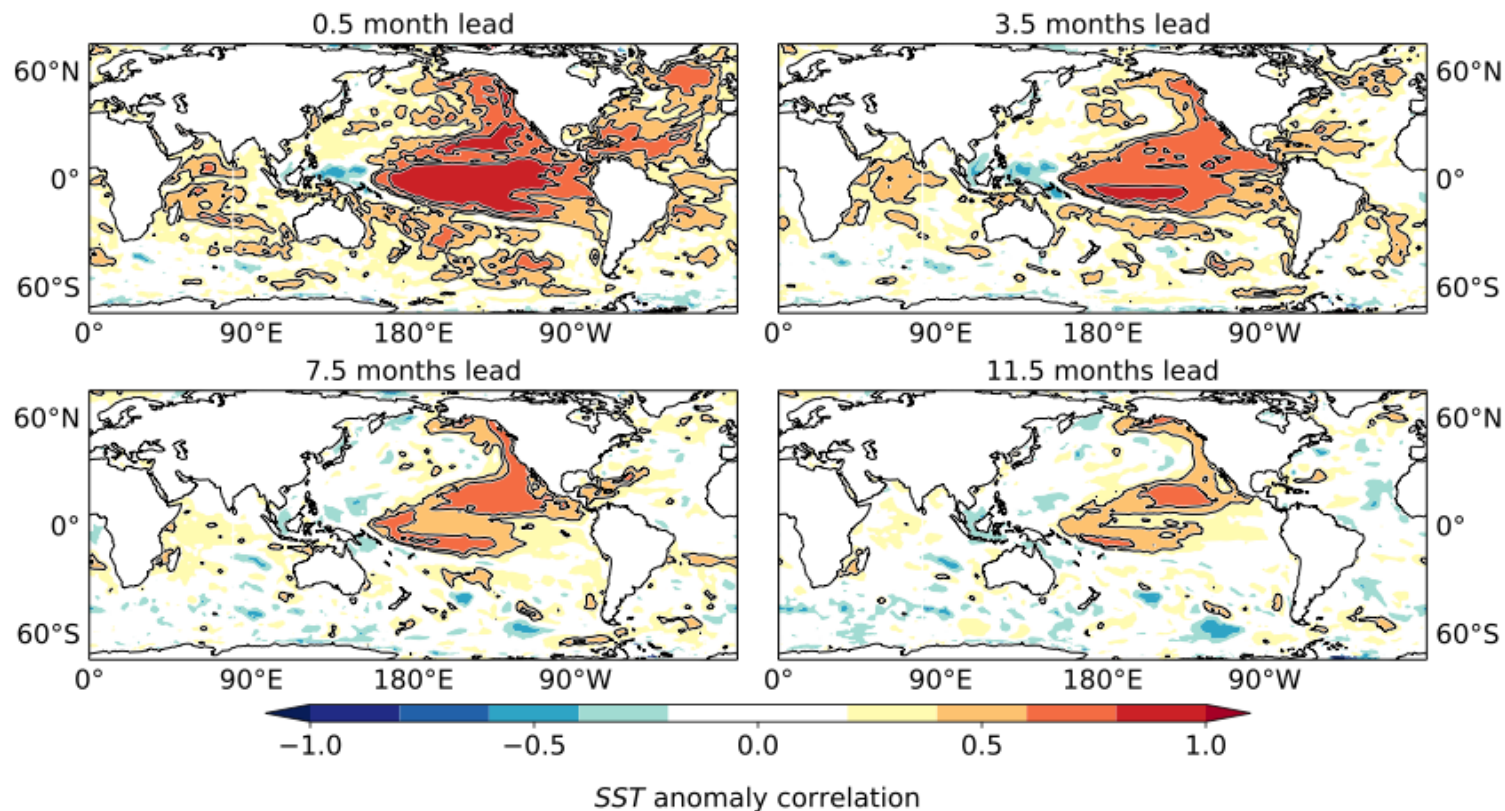


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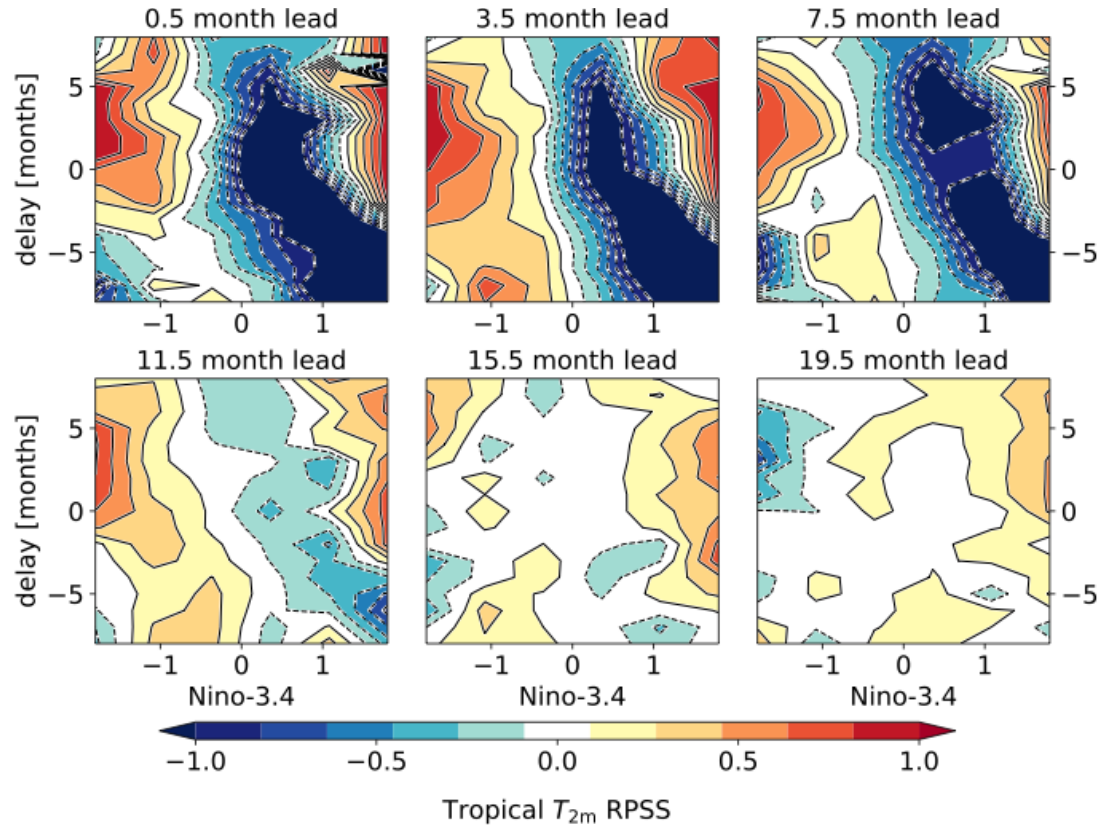
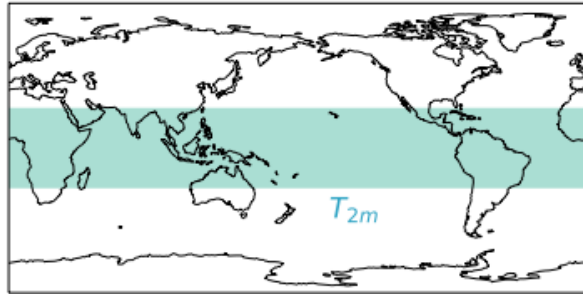
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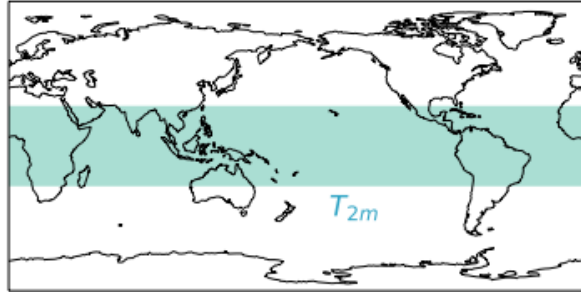
Temporal anomaly correlations of monthly SST



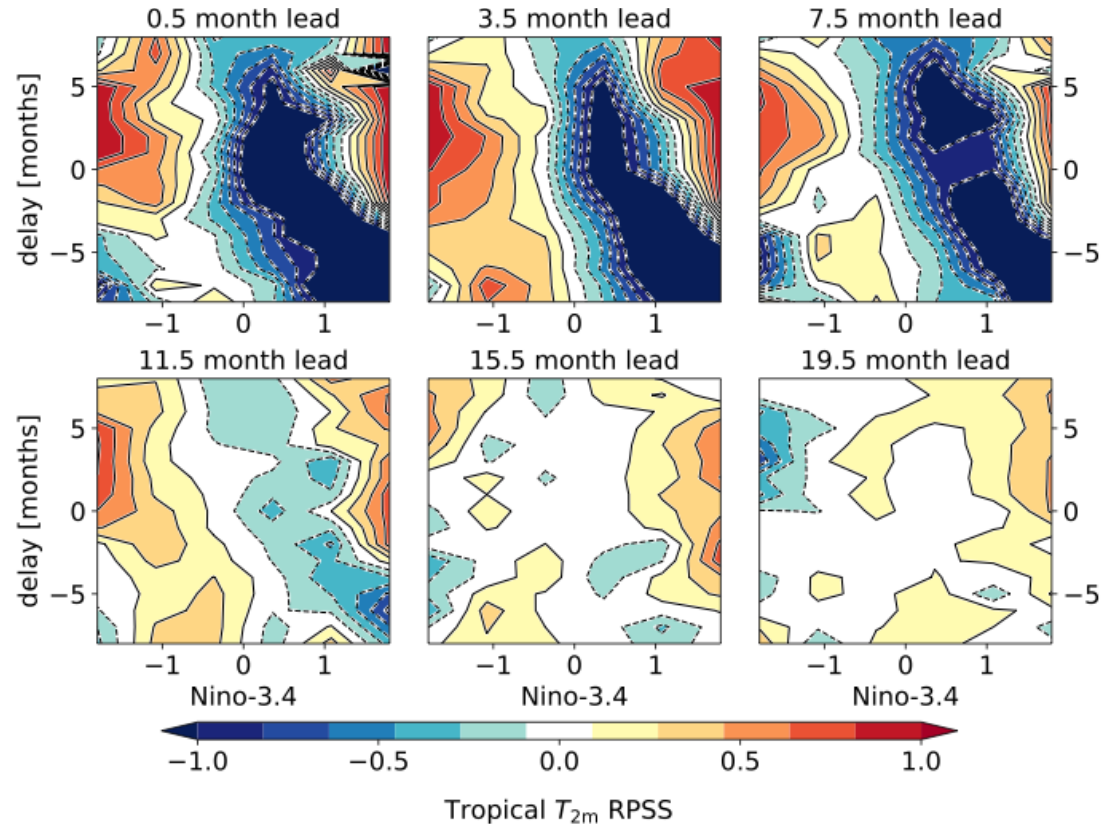
Ranked probability skill score of tropical T_{2m}



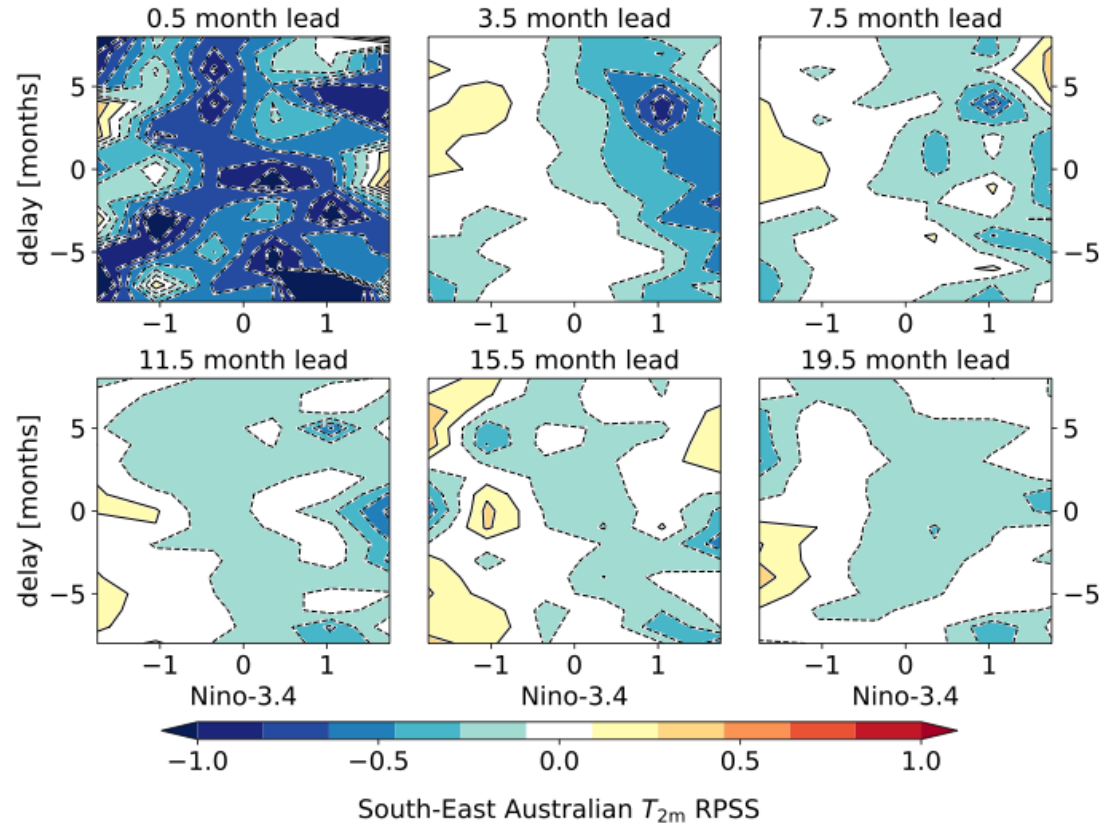
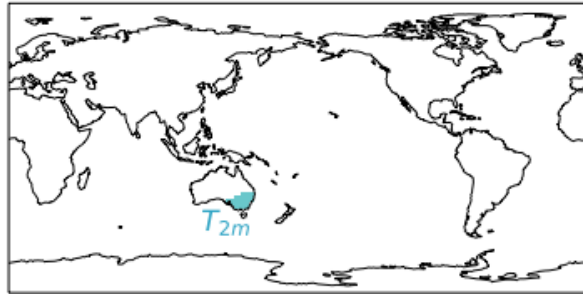
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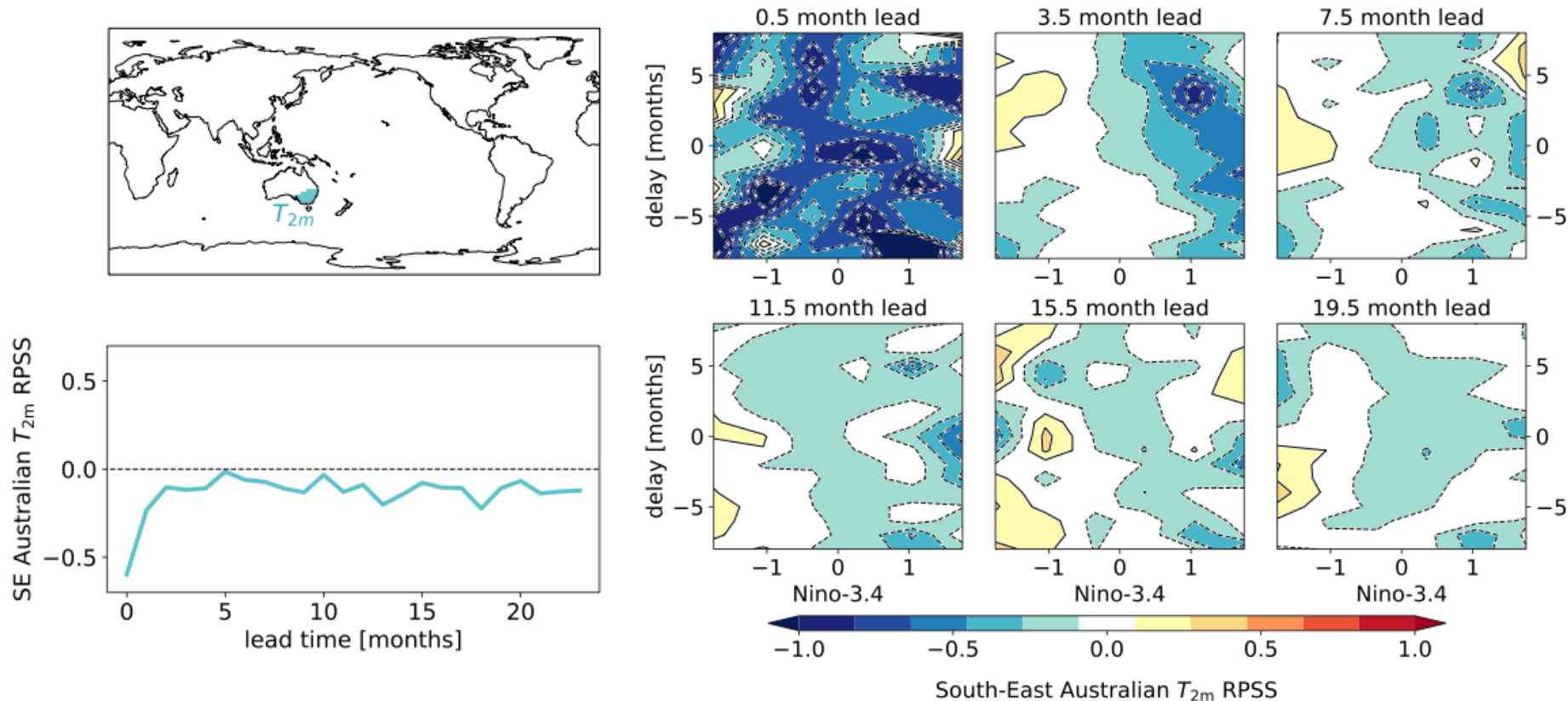
➤ Forecast skill is strongly related to ENSO variability



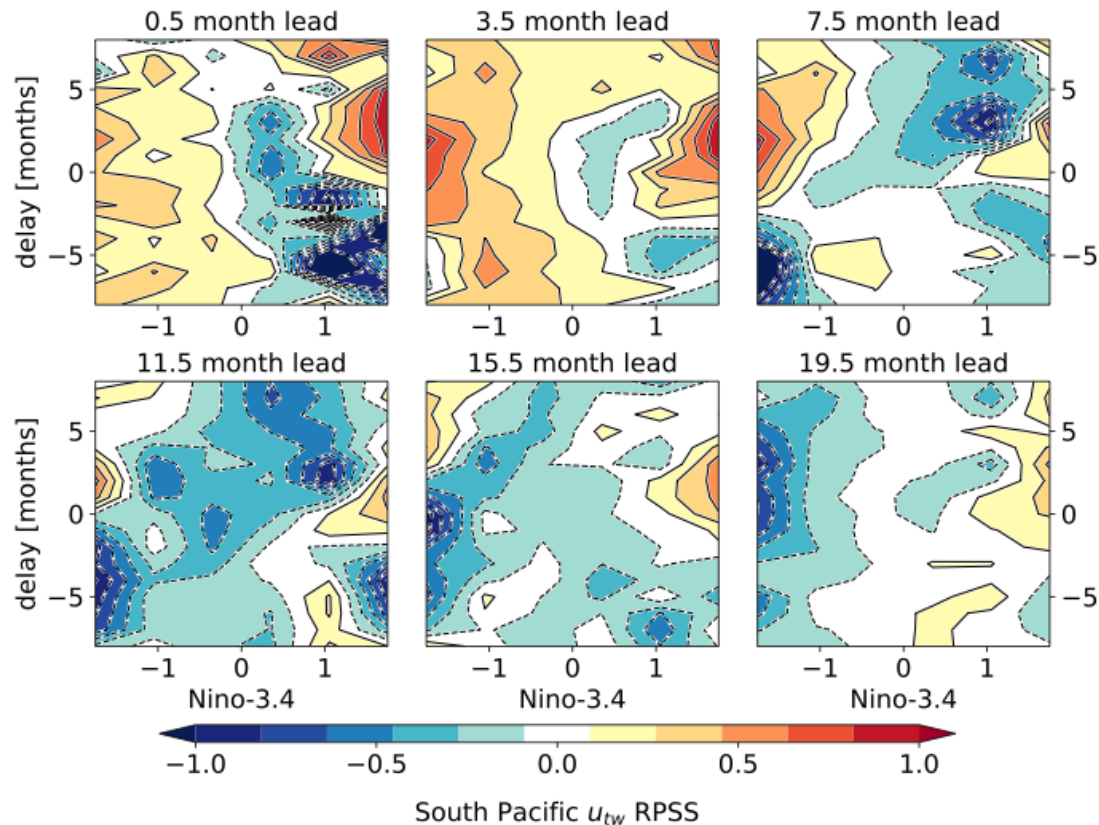
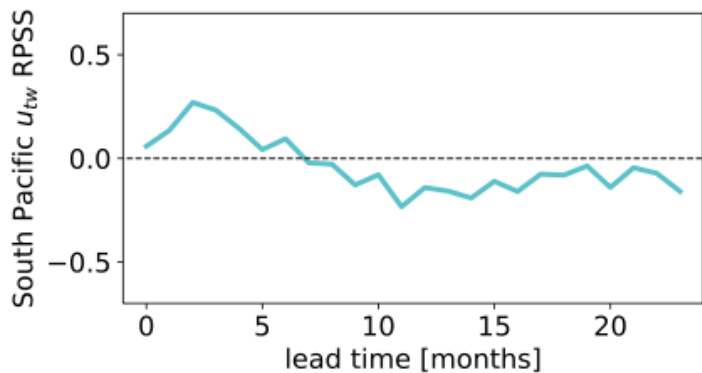
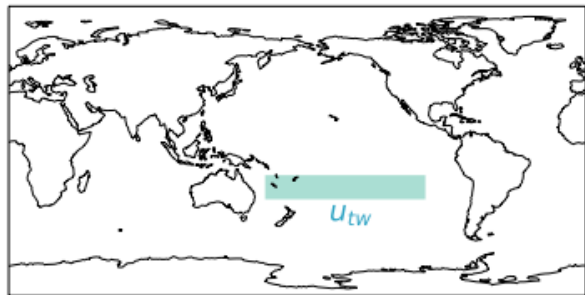
Ranked probability skill score of SE Australian T_{2m}



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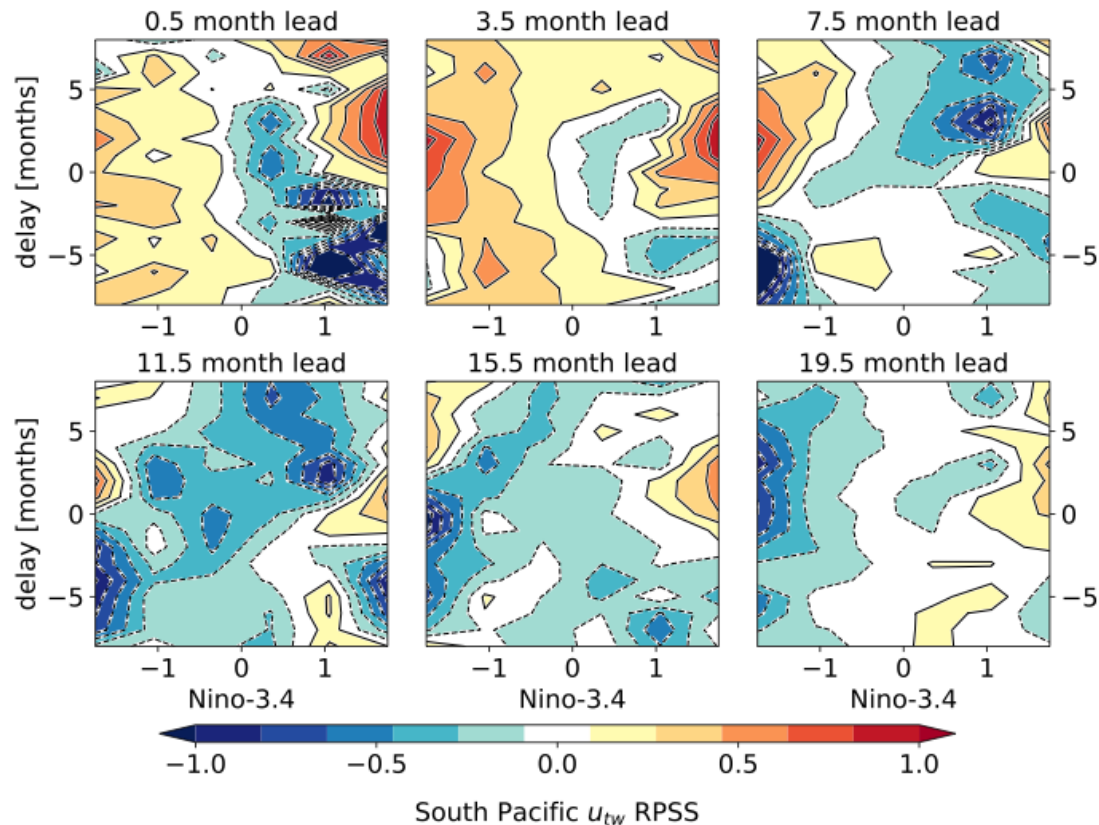
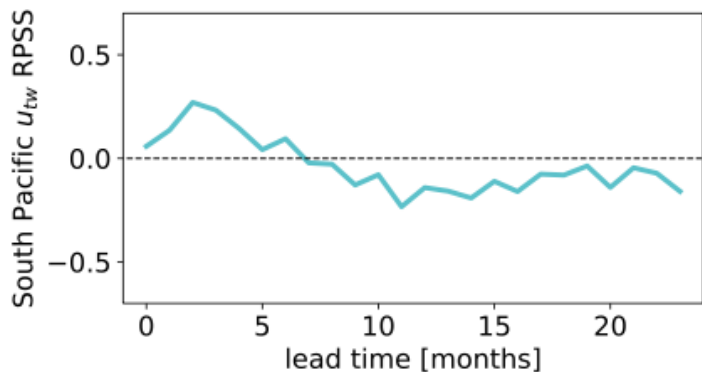
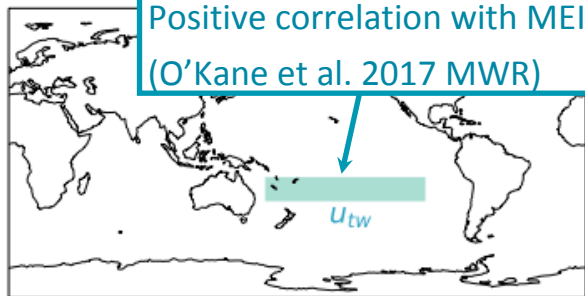


Ranked probability skill score of thermal wind




Ranked probability skill score of thermal wind

Positive correlation with MEI
(O’Kane et al. 2017 MWR)



Conclusions

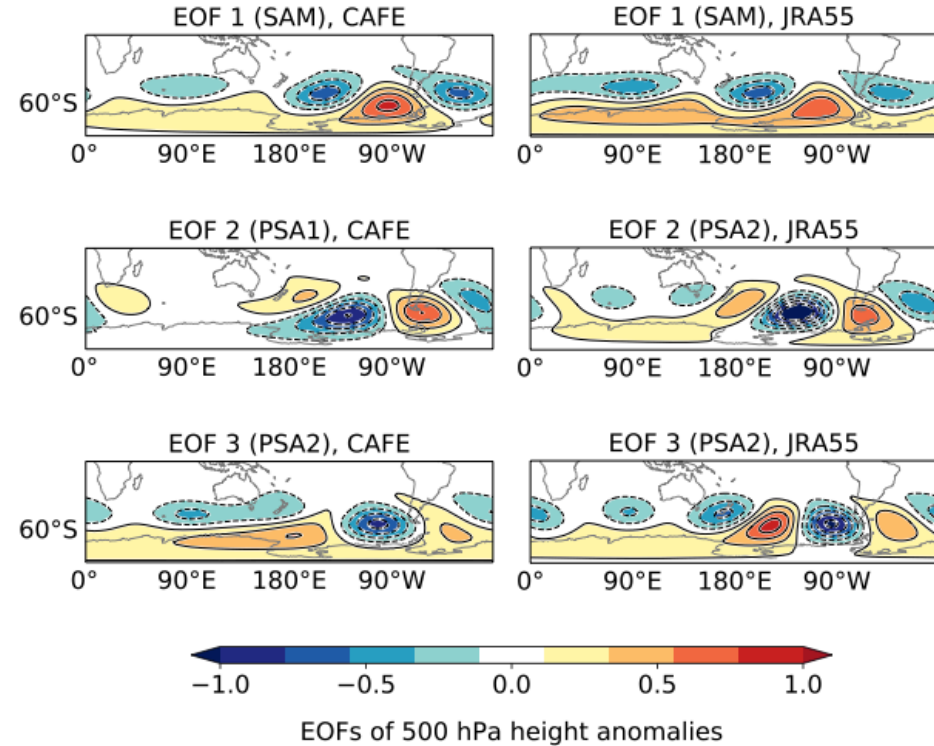
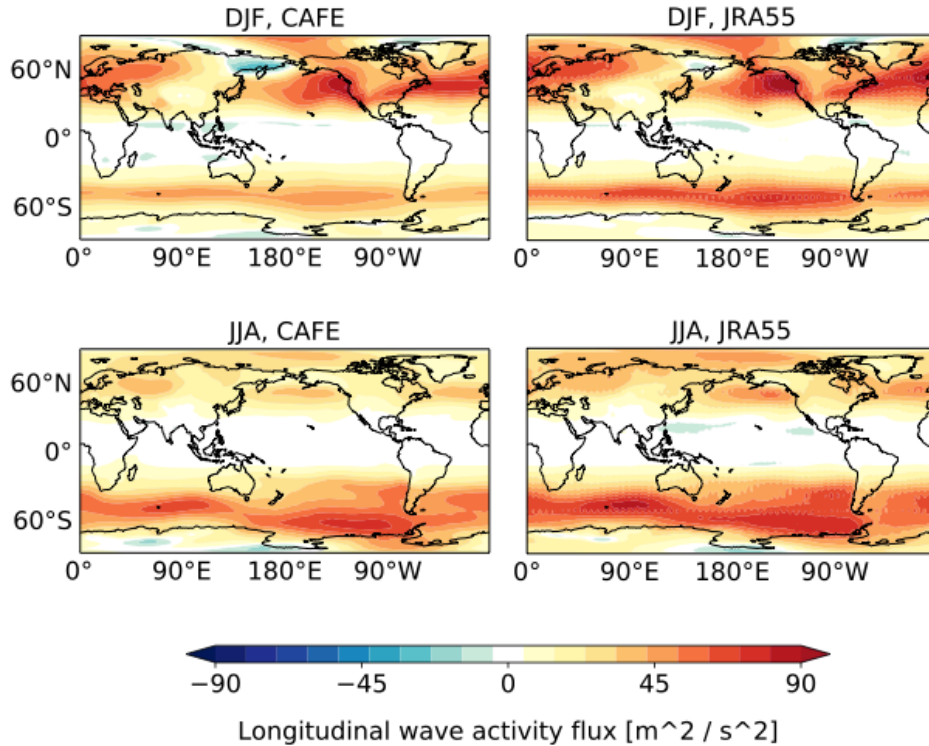
-  is a diagnostics/verification software package that we are building to leverage best practices in scalable and reproducible science.
- Early CAFE system hindcasts indicate comparable skill to other systems.
- Internal predictability in the CAFE system is largely derived from the tropical ocean. Skill in Southern Hemisphere extratropical continental regions is generally only present during positive and negative phases of ENSO.
- Extratropical skill improvements may be realised through better simulation of ENSO and relevant teleconnection processes.

Contact: Dougie.Squire@csiro.au

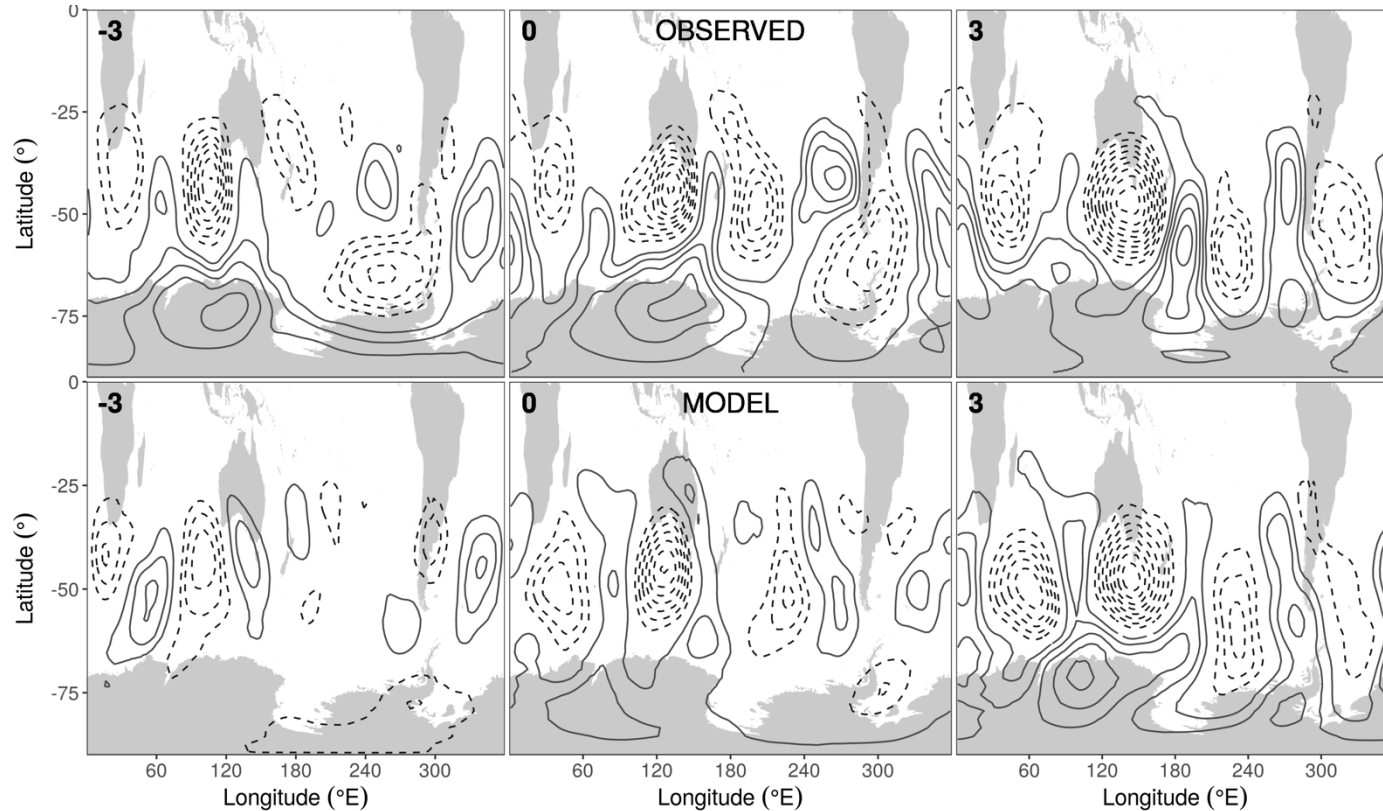
Free-running model diagnostics

Longitudinal wave activity flux at 500hPa

H500 EOFs

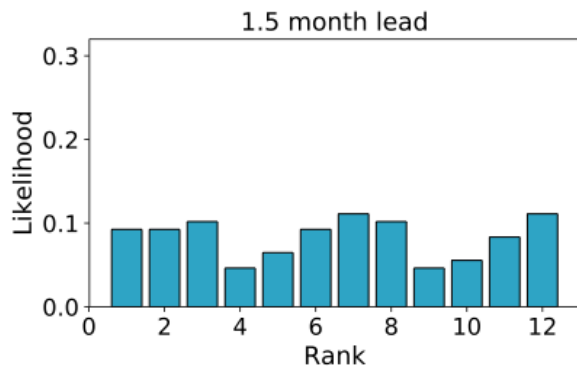
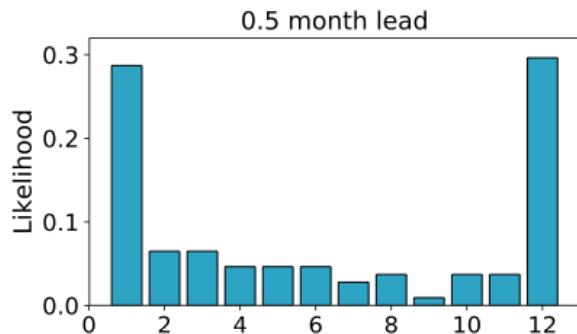


h500 anomaly composites for heavy Tasmanian rainfall

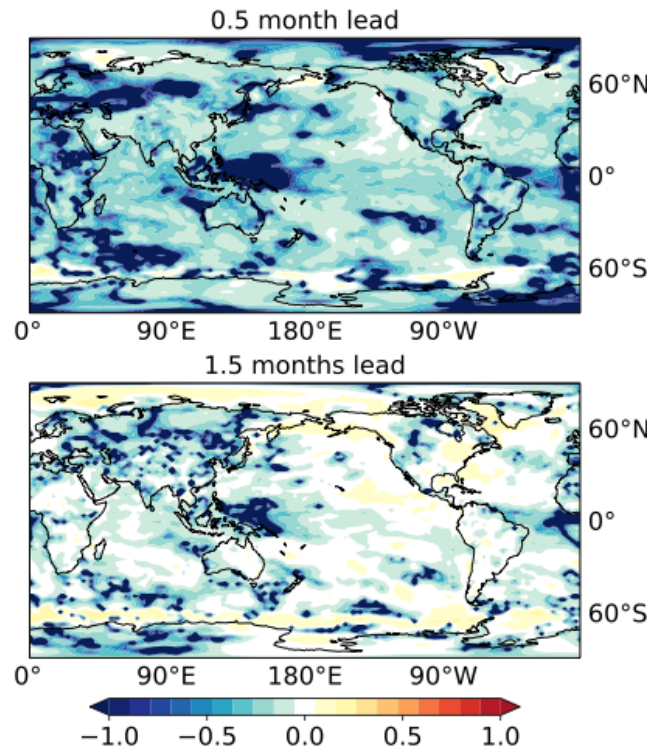


Ensemble spread metrics

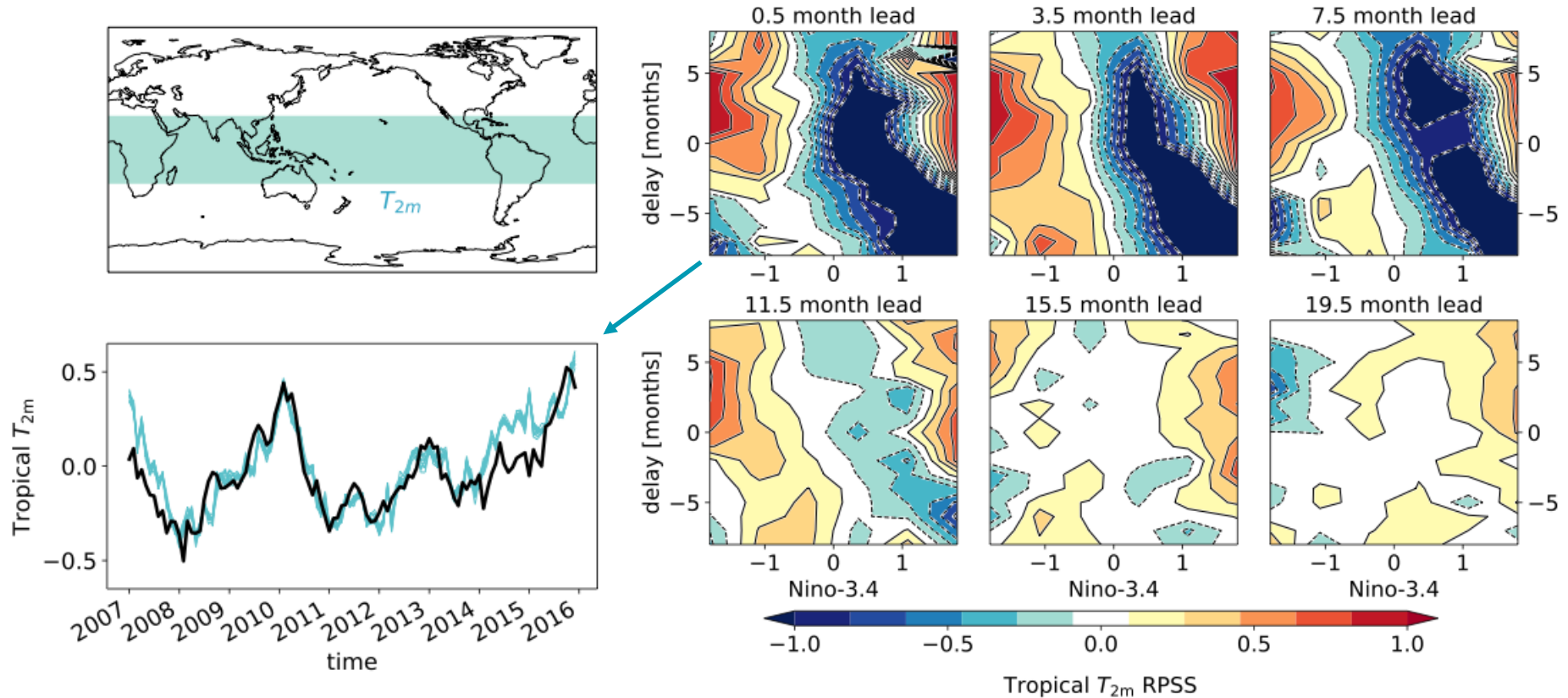
Talagrand of SE Australian T_{2m}



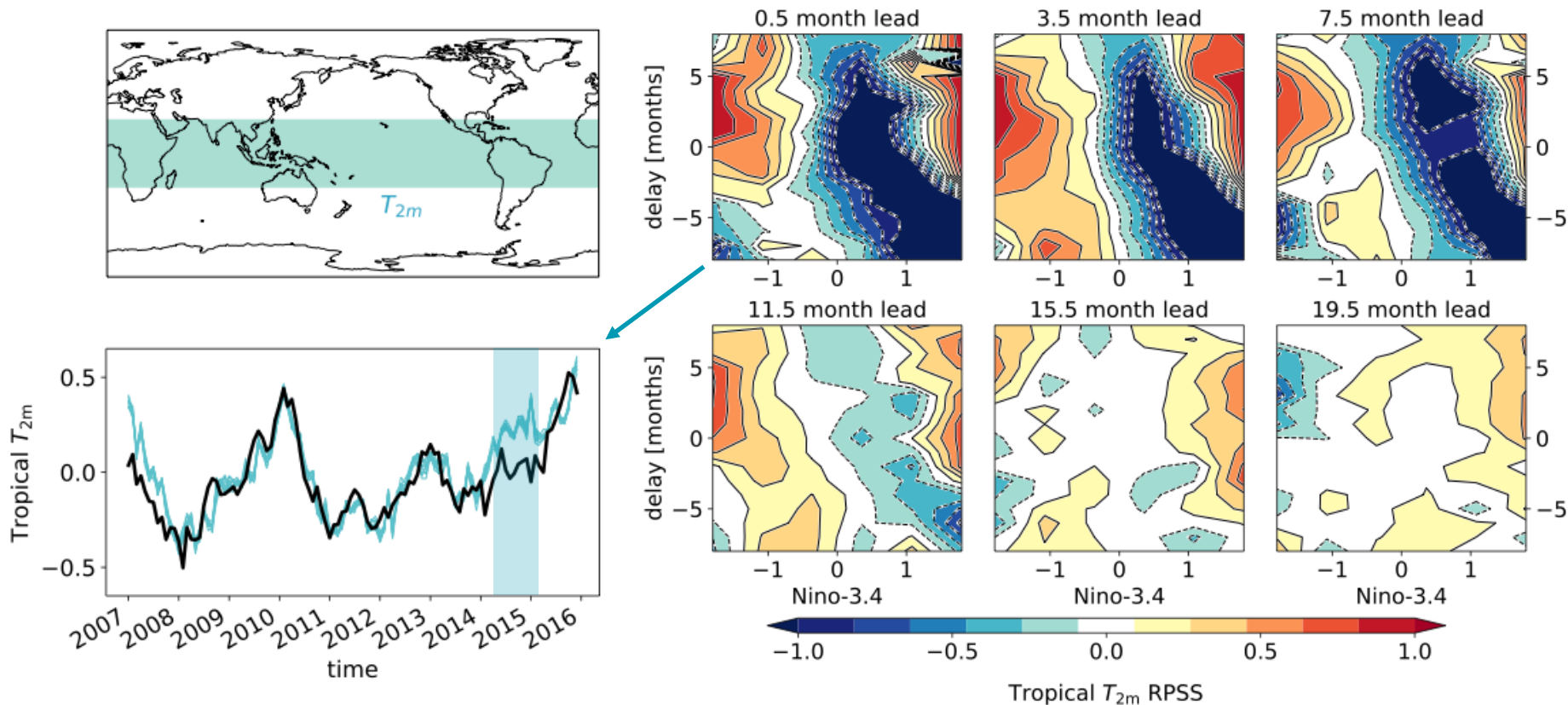
Goddard et al. ensemble spread metric, T_{2m}



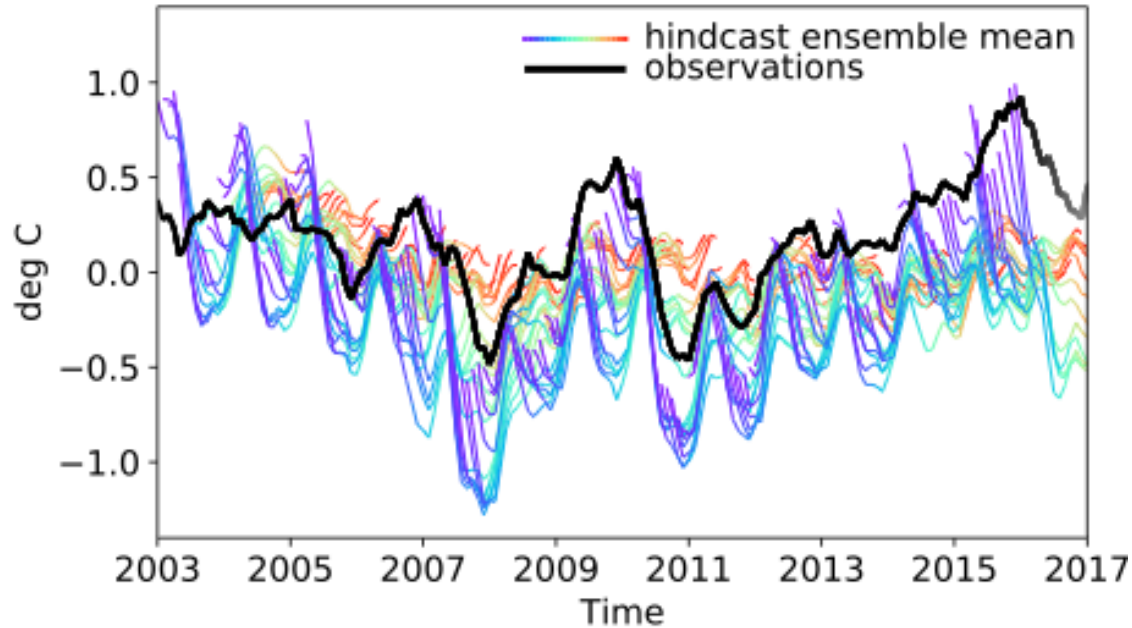
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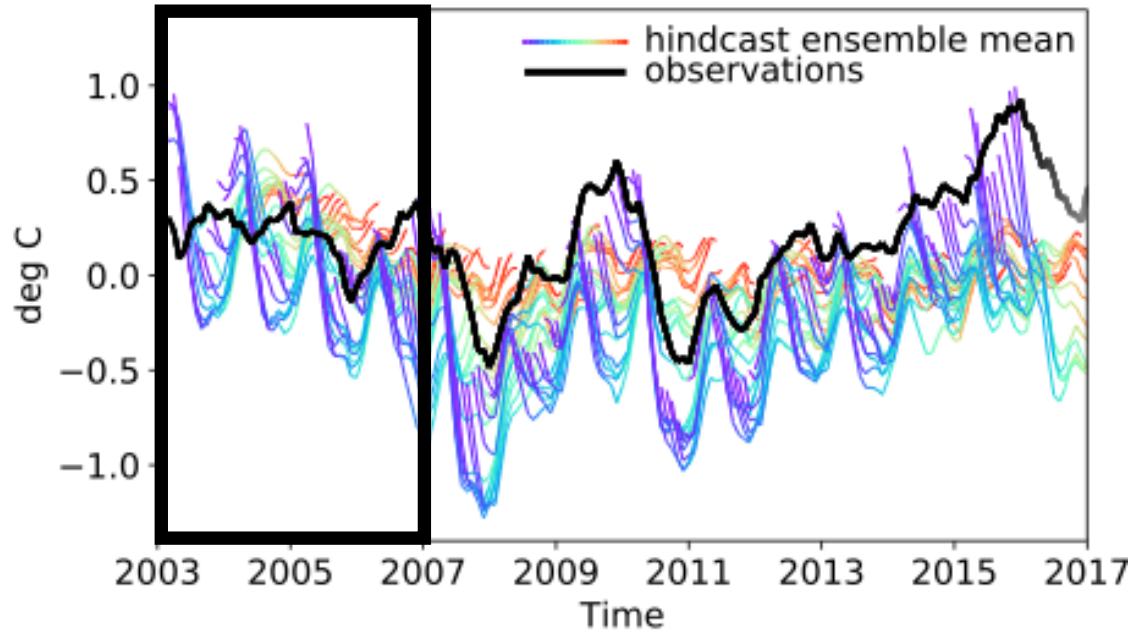
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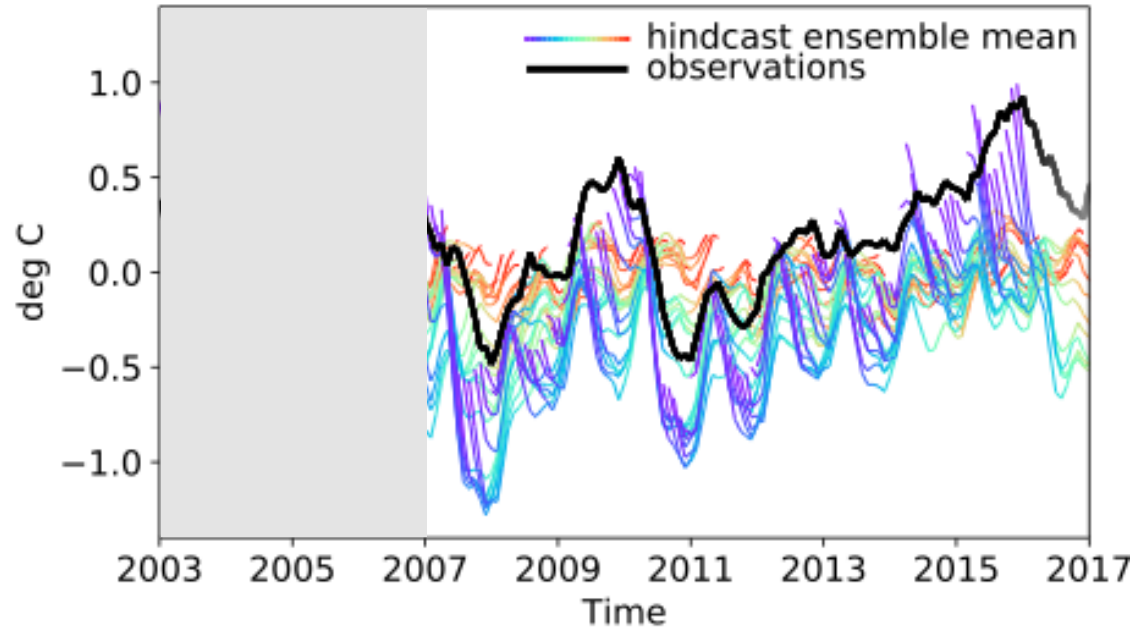
Uncorrected tropical Pacific SST



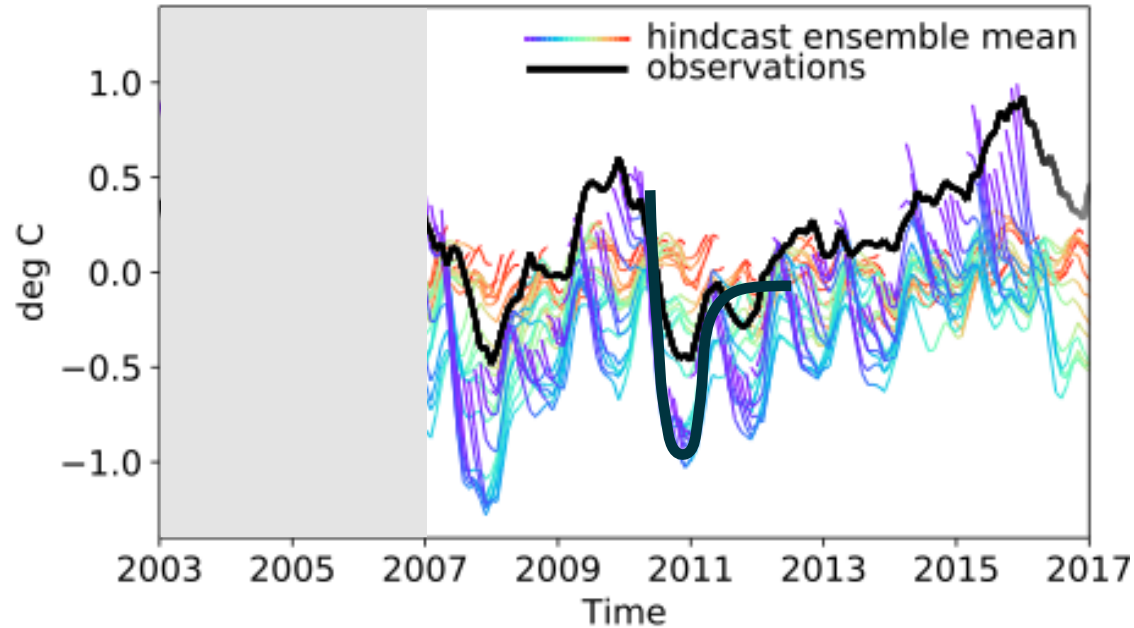
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