NEW ZEALAND WAVE CLIMATE VARIABILITY BASED ON WEATHER PATTERNS

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NEW ZEALAND

1st International Workshop on Waves, Storm Surges and Coastal Hazards, Liverpool, Sept. 2017

MOTIVATION

"*Climate change impacts on weather-related coastal hazards*" project funded by MBIE*

How do they change over time?

Waves
Storm surges

Would it be possible to perform a robust statistical relationship between waves and storm surge with atmospheric variables at a national scale?

*Ministry of Business, Innovation and Employment

PREVIOUS WORKS

GOALS:

- To find a regional atmospheric predictor of waves and storm surges reaching NZ coasts.
- To analyze wave climate variability at daily, weekly, seasonal and interannual scales.
- To develop a framework for climate change projections.

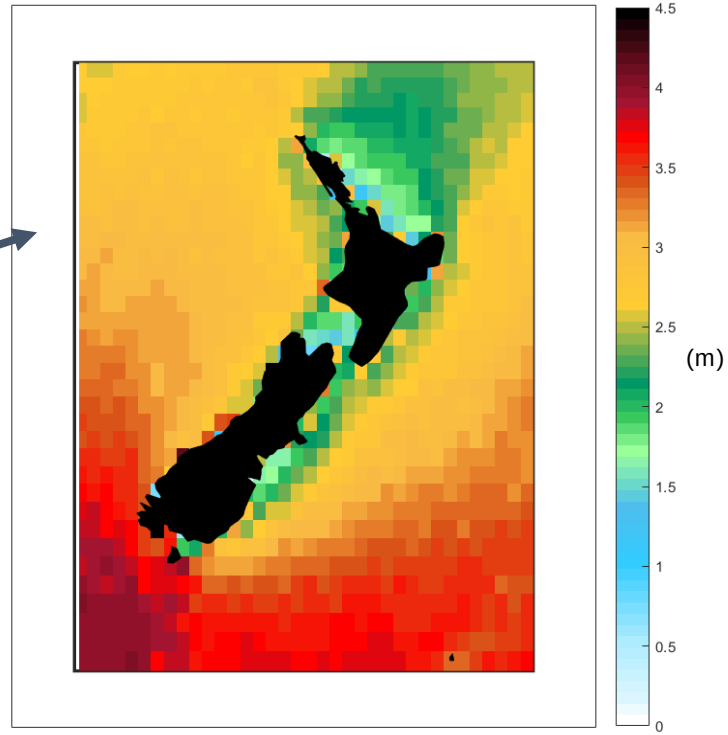
www.swellmap.co.nz/forecast-maps

NEW ZEALAND WAVE CLIMATE ANALYSIS

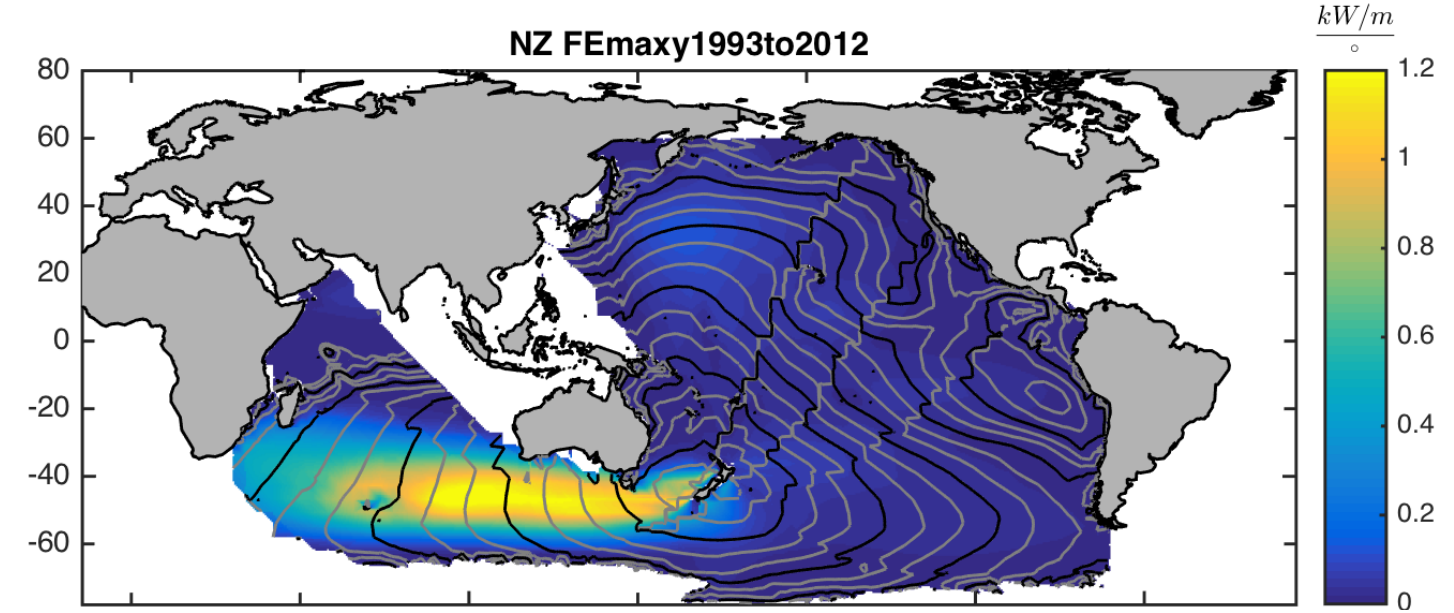
Pickrill and Mitchell (1979) – 17 years obs.
Laing (1993) – 5 months wave hindcast
Laing (2000) – 13 y. from radar altimeter
Gorman et al.(2003a,b) – 20 y. wave hindcast
Godoi et al. (2015) - 45y. Wave hindcast
Coggins et al. (2016) – 29y. Wave hindcast

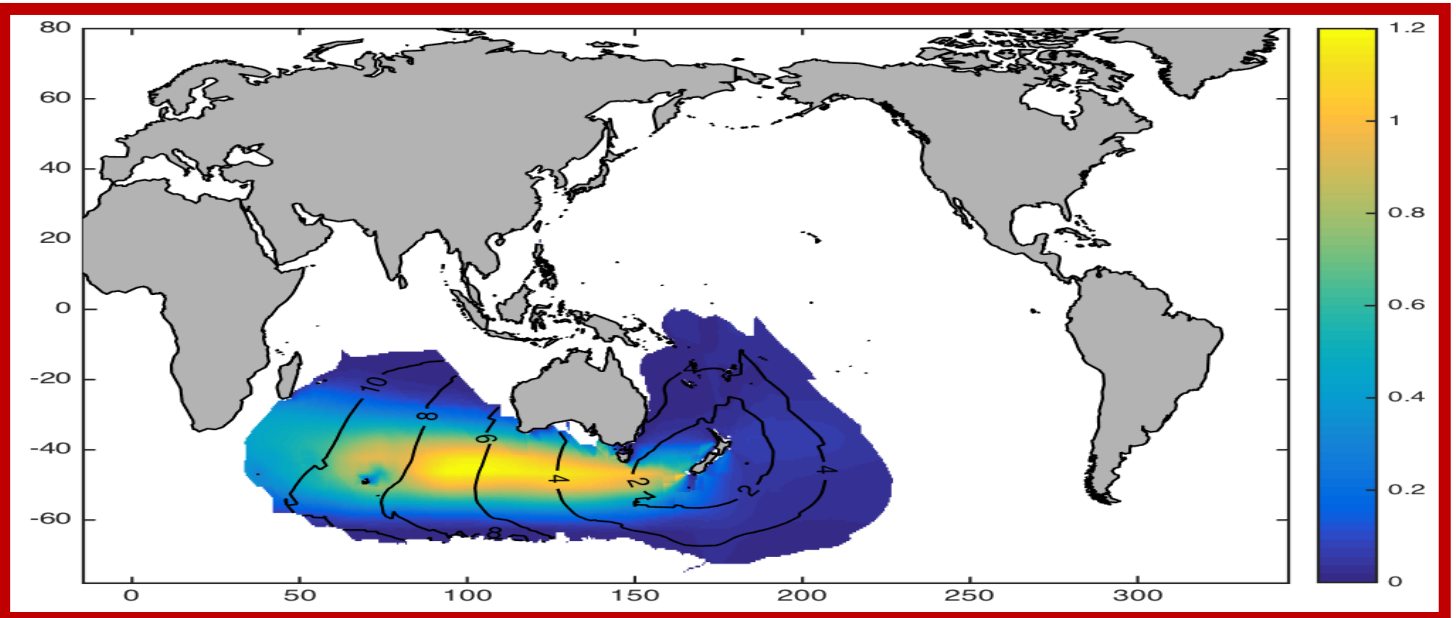
MEAN Hs

Correlations with Climate Modes



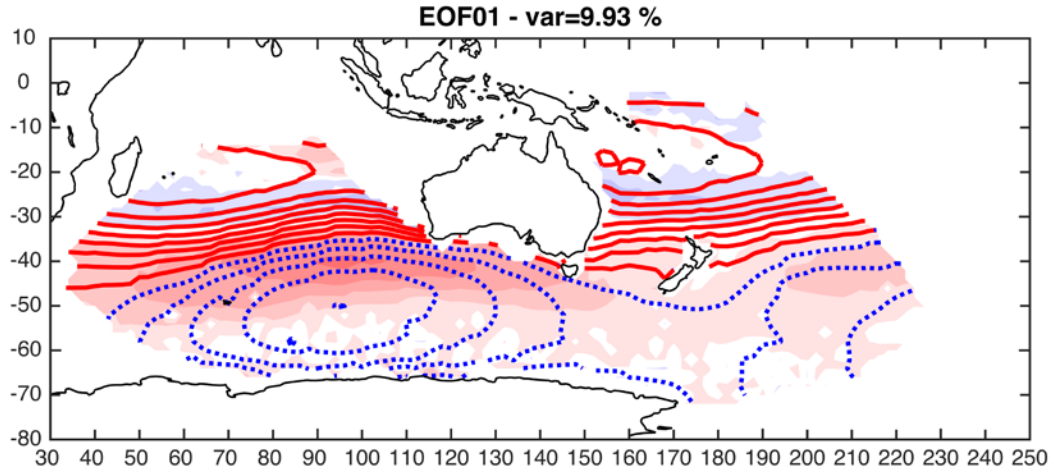
TAILOR-MADE INDICES





ESTELA: a method for evaluating the source and travel time of the wave energy reaching a local area. (Perez et al. 2014a)

DAILY PREDICTOR AND PCA



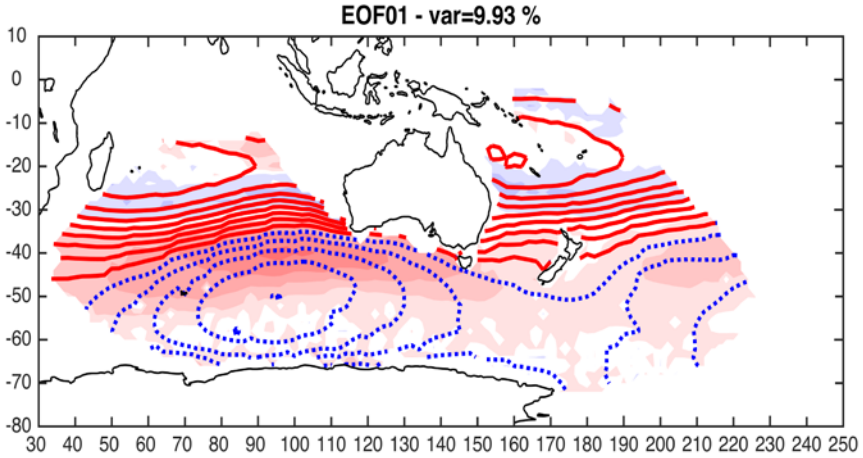
Following (Hegermiller et al. 2016)
With CFSR SLP fields of 2º resolution from 1993 to 2012

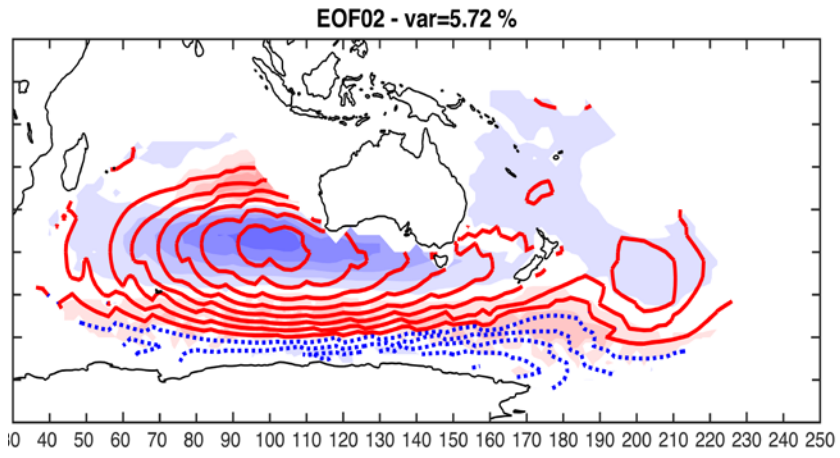
TAILOR-MADE INDICES

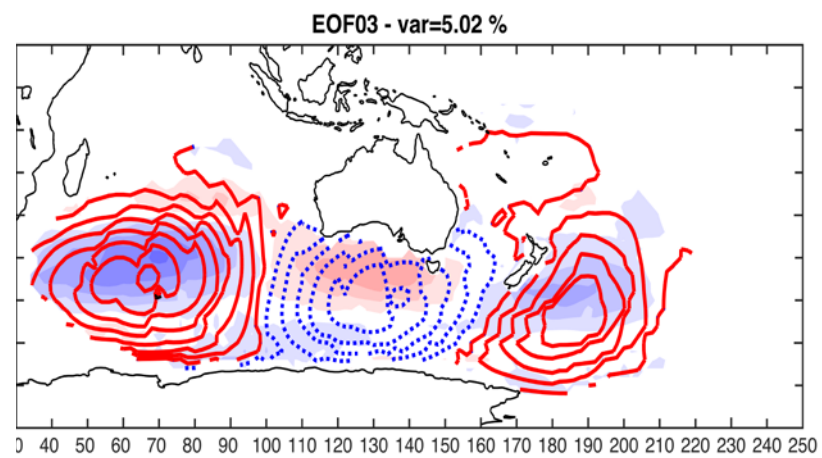
PCA correlation

WAVE DATA

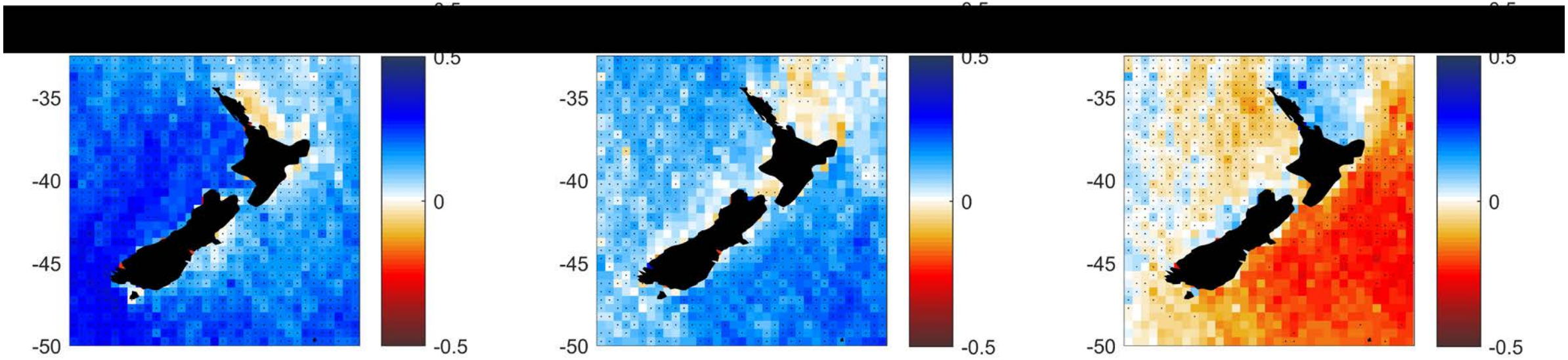
- **GlobWave database**
- Ifremer wave reanalysis



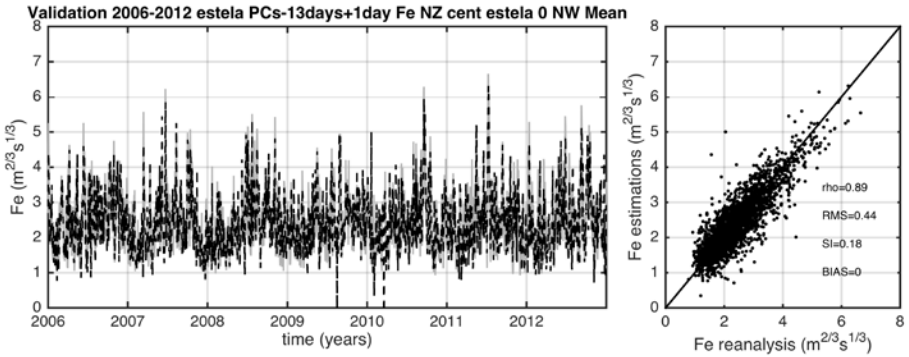


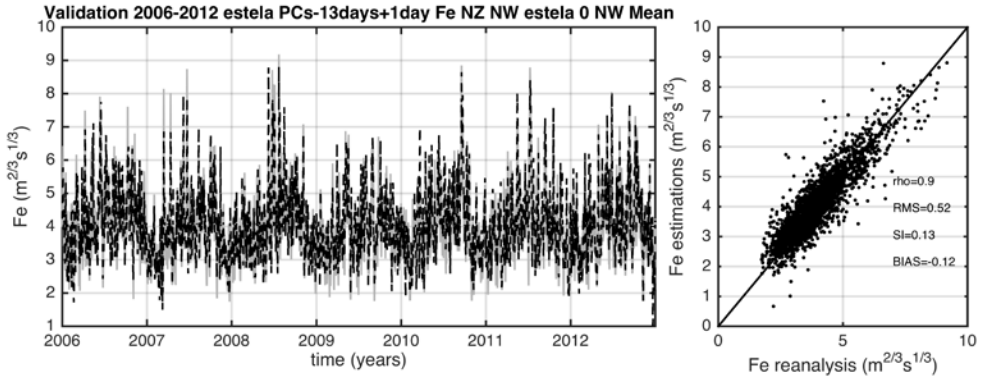


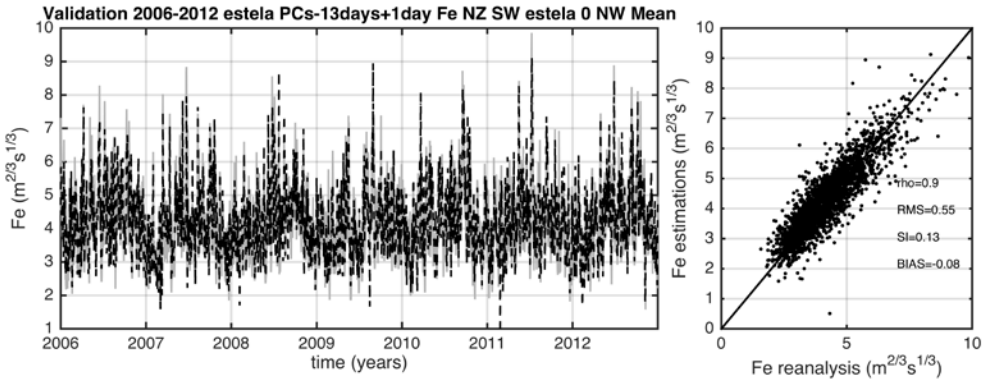
p_{HS}

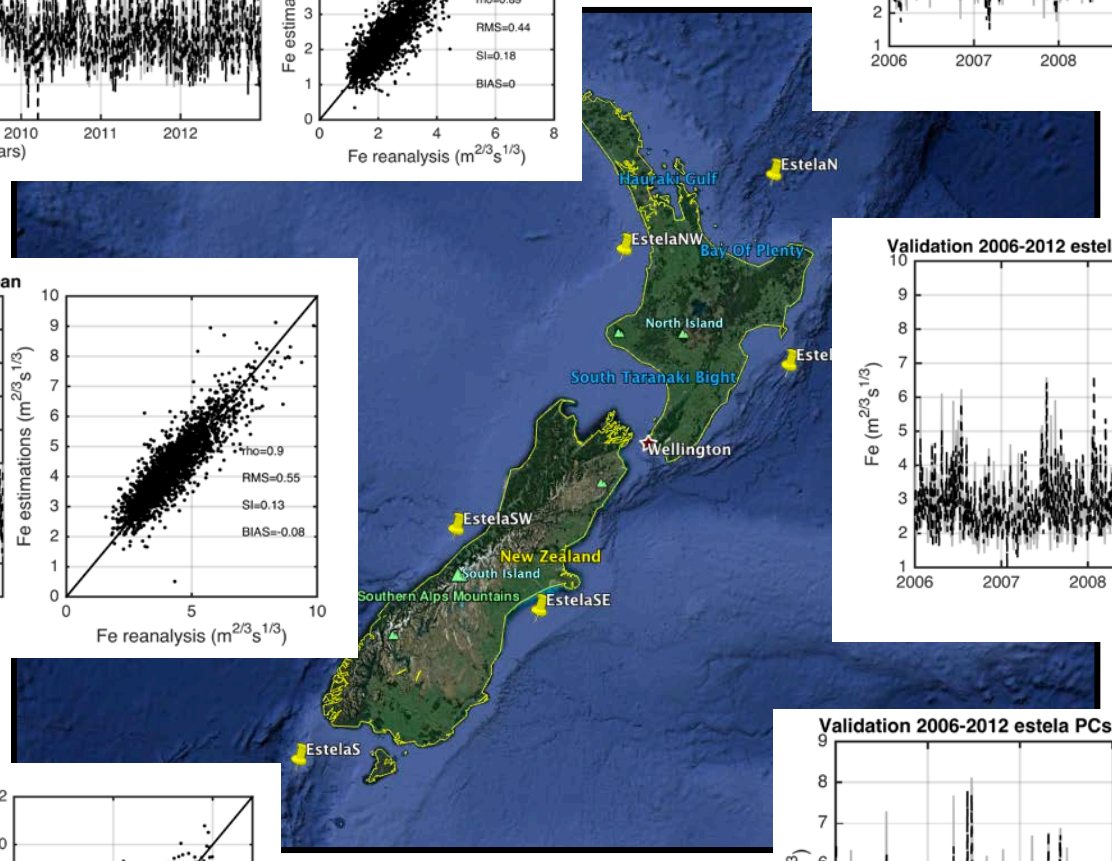


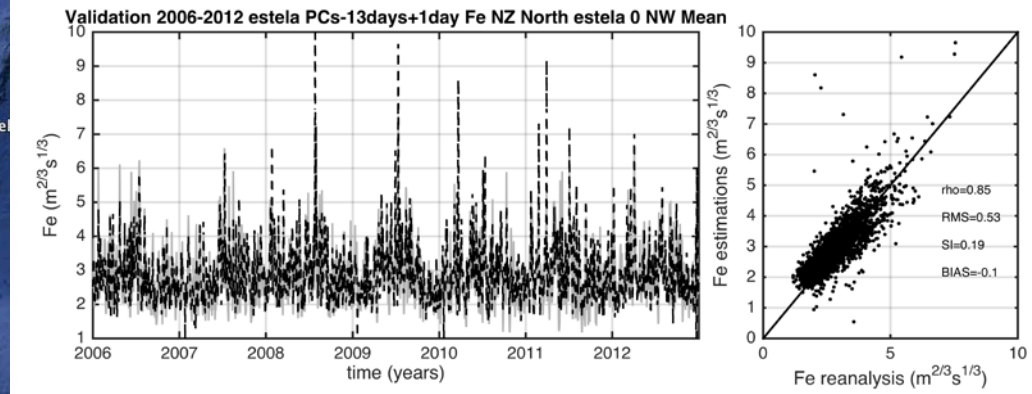
LINEAR REGRESSION: VALIDATION PERIOD

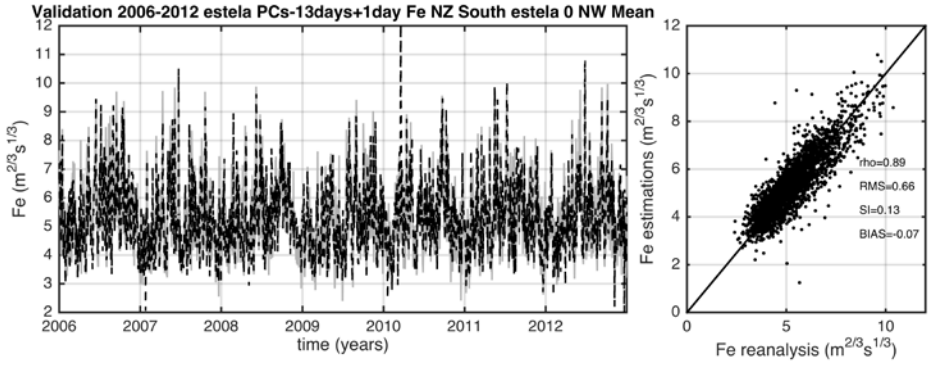


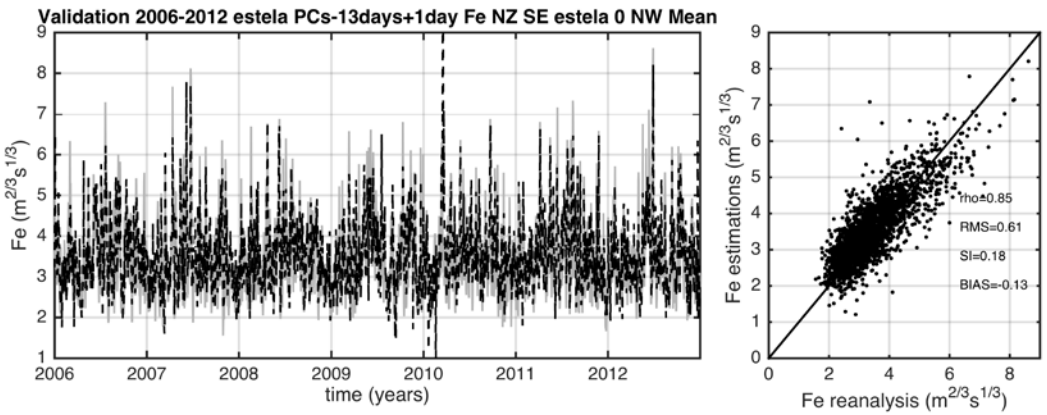






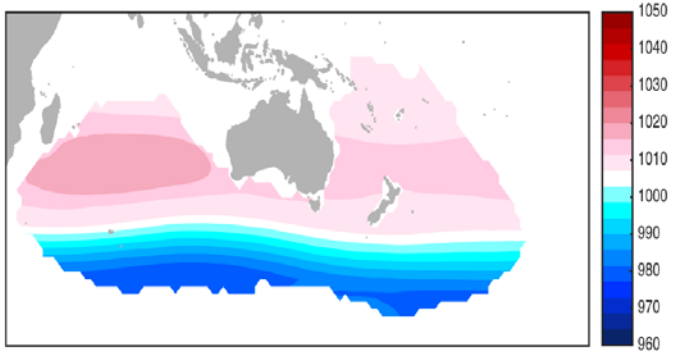




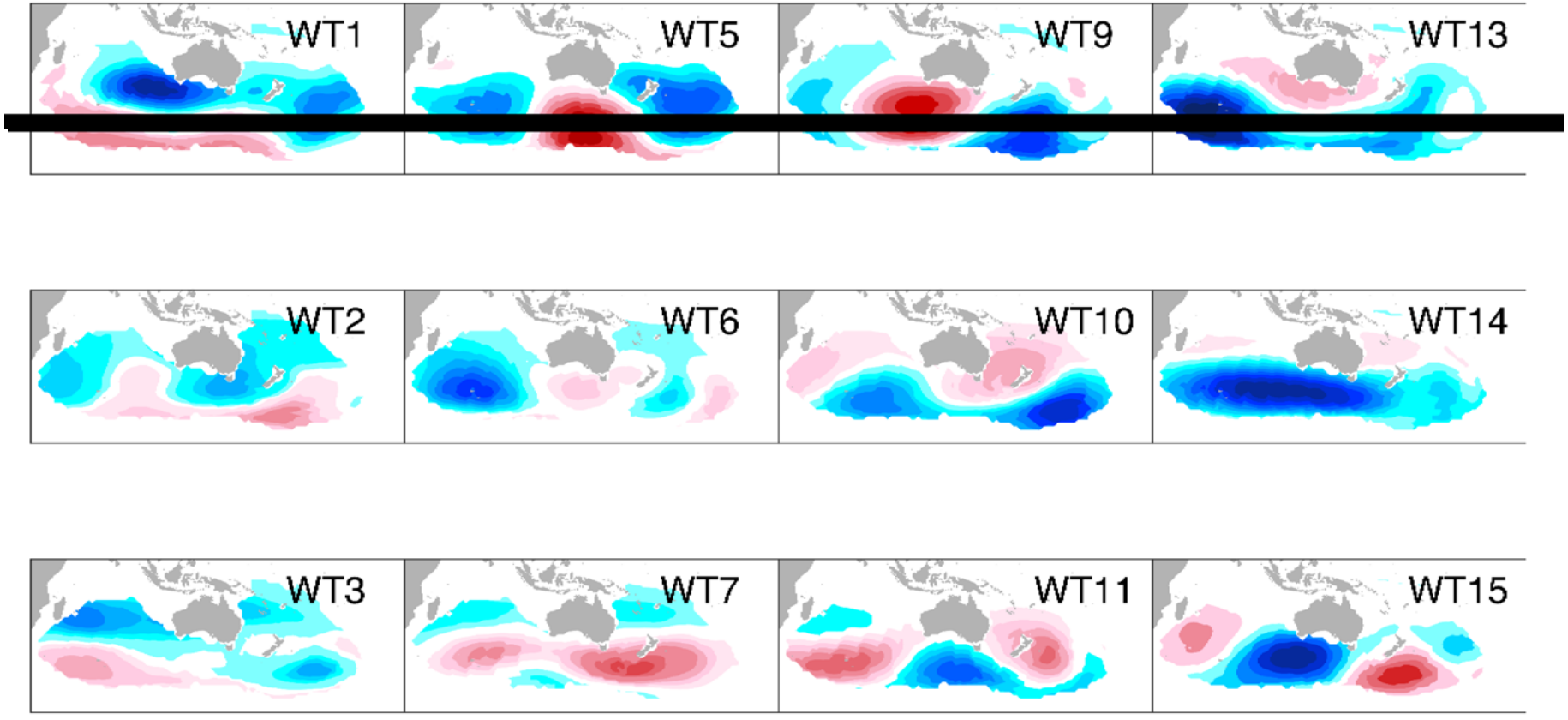


WEATHER PATTERNS

MEAN SLP



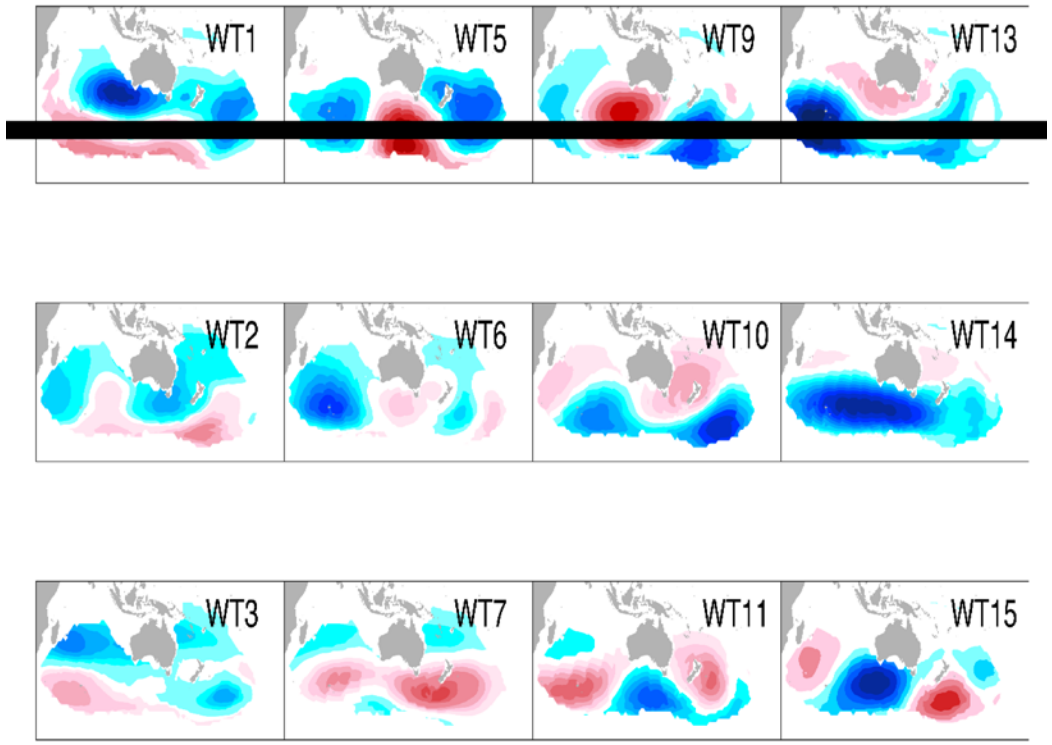
CFSR reanalysis 1993-2012



K-MEANS

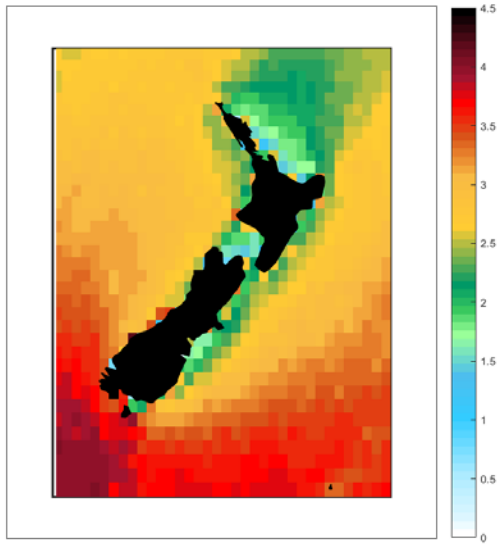
WEATHER PATTERNS – WAVES

[redacted]

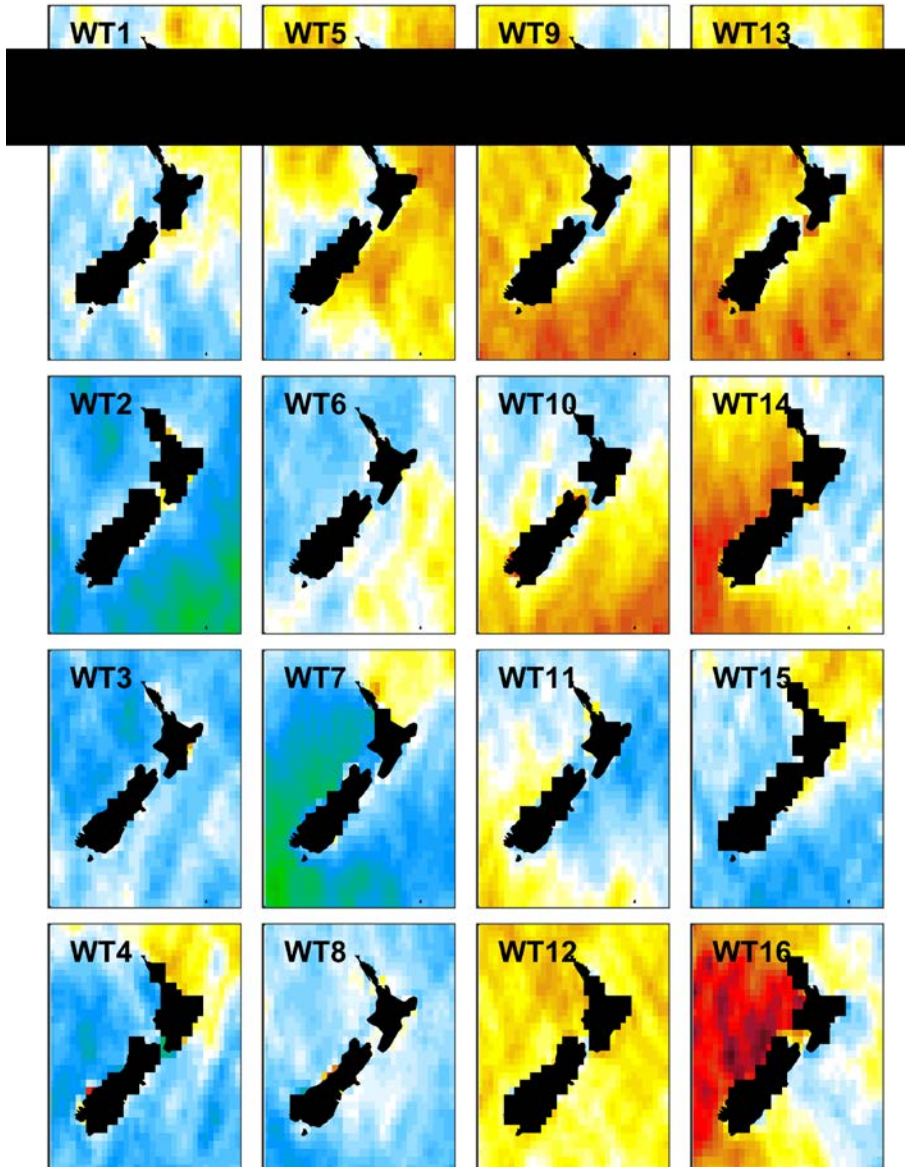


[redacted]

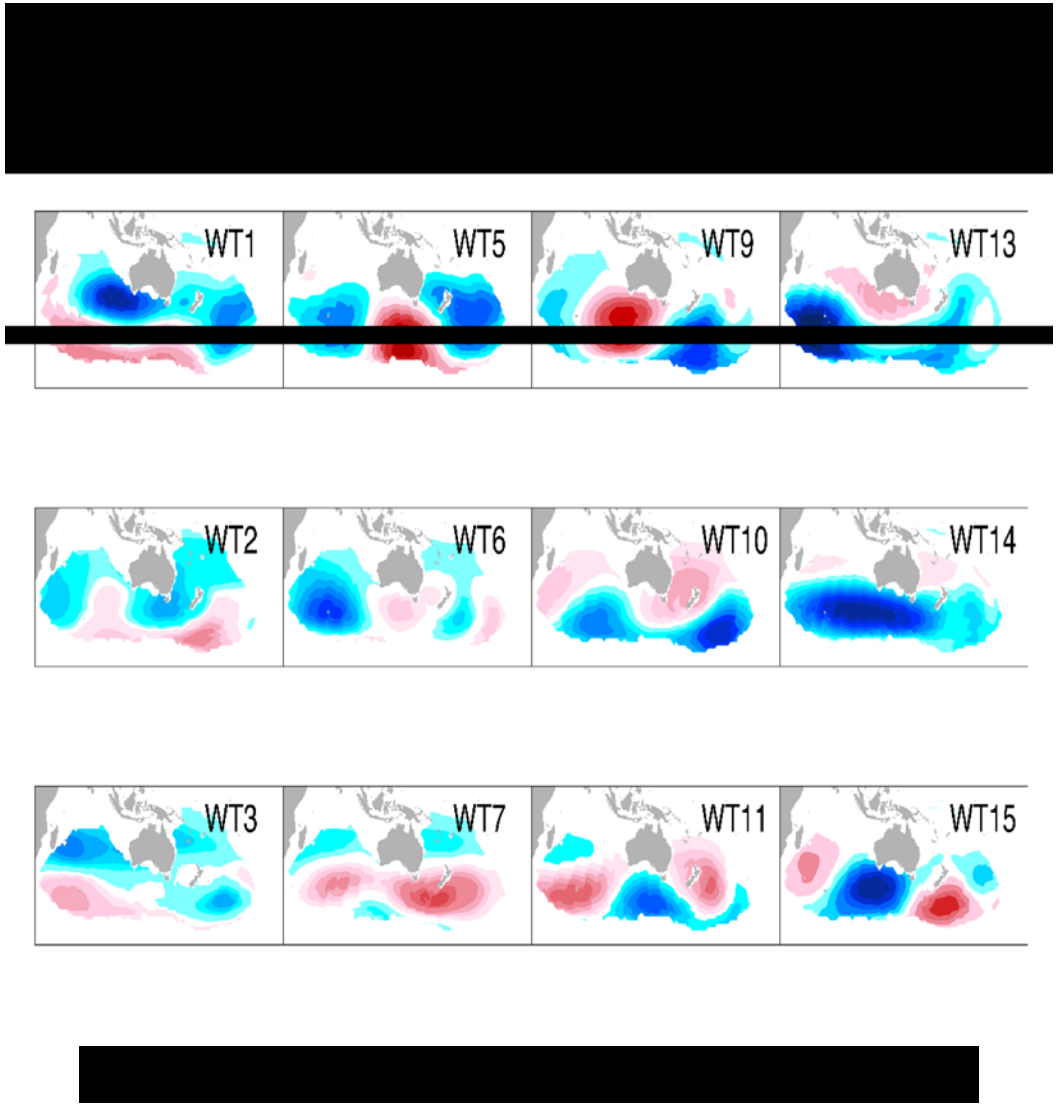
MEAN Hs



MEAN ANOMALY

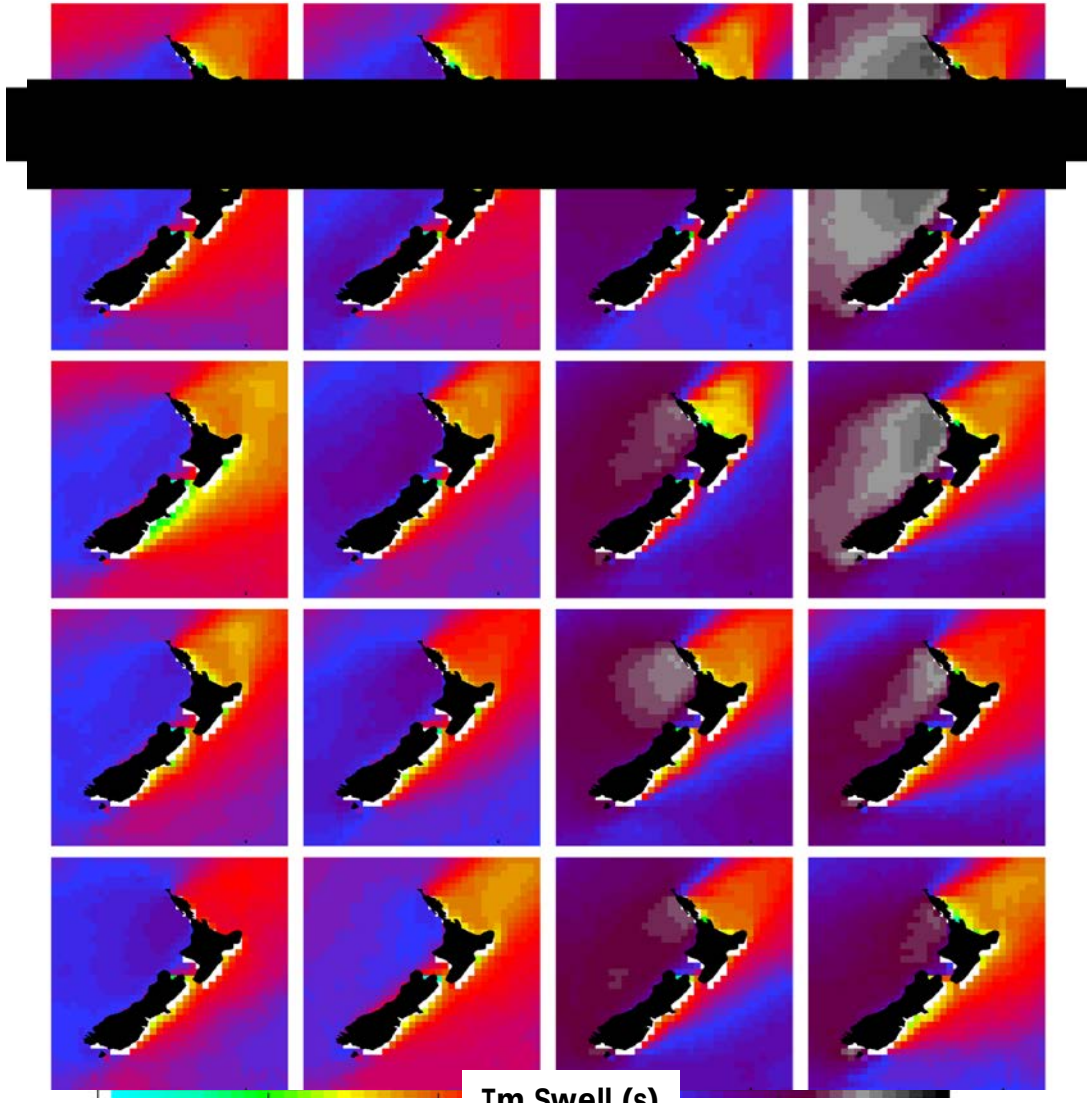


WEATHER PATTERNS – WAVES

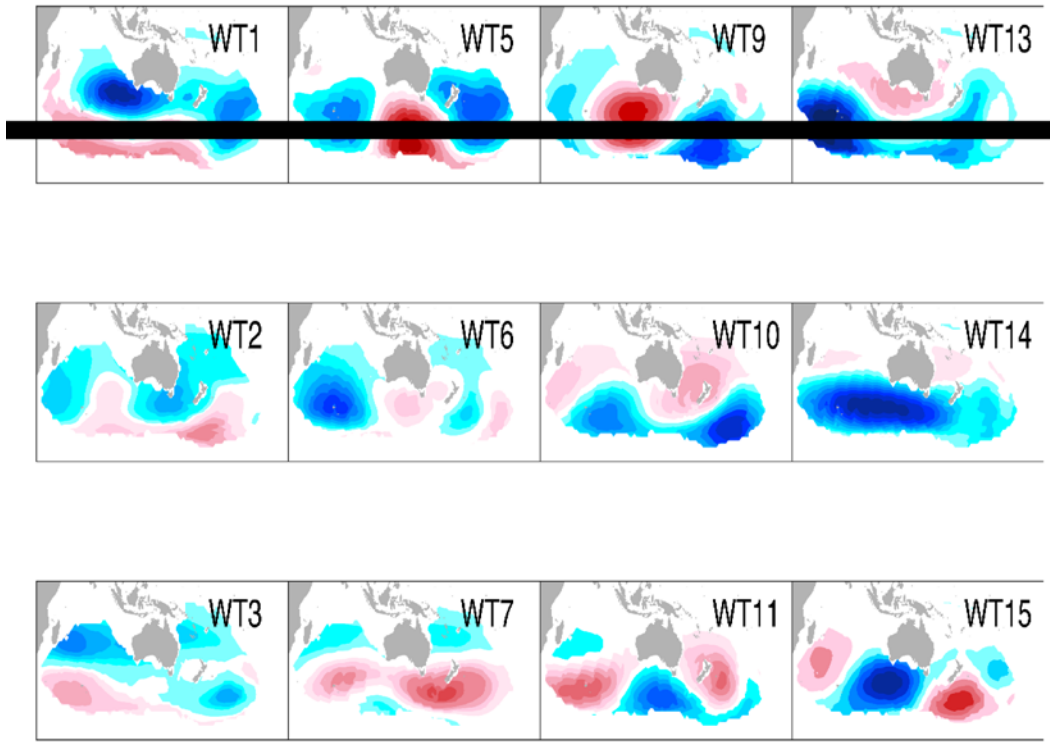


WAVE DATA

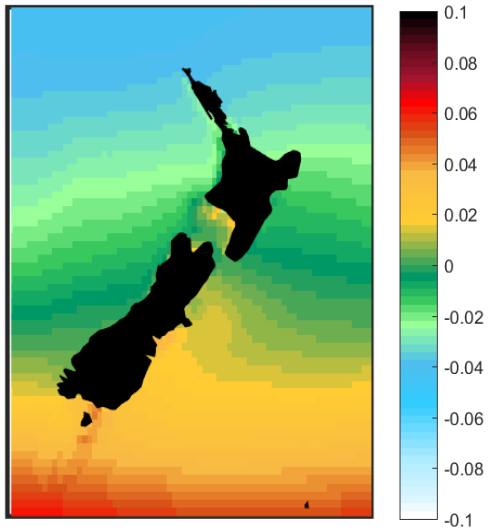
- GlobWave database
- **Ifremer wave reanalysis**



WEATHER PATTERNS – STORM SURGE

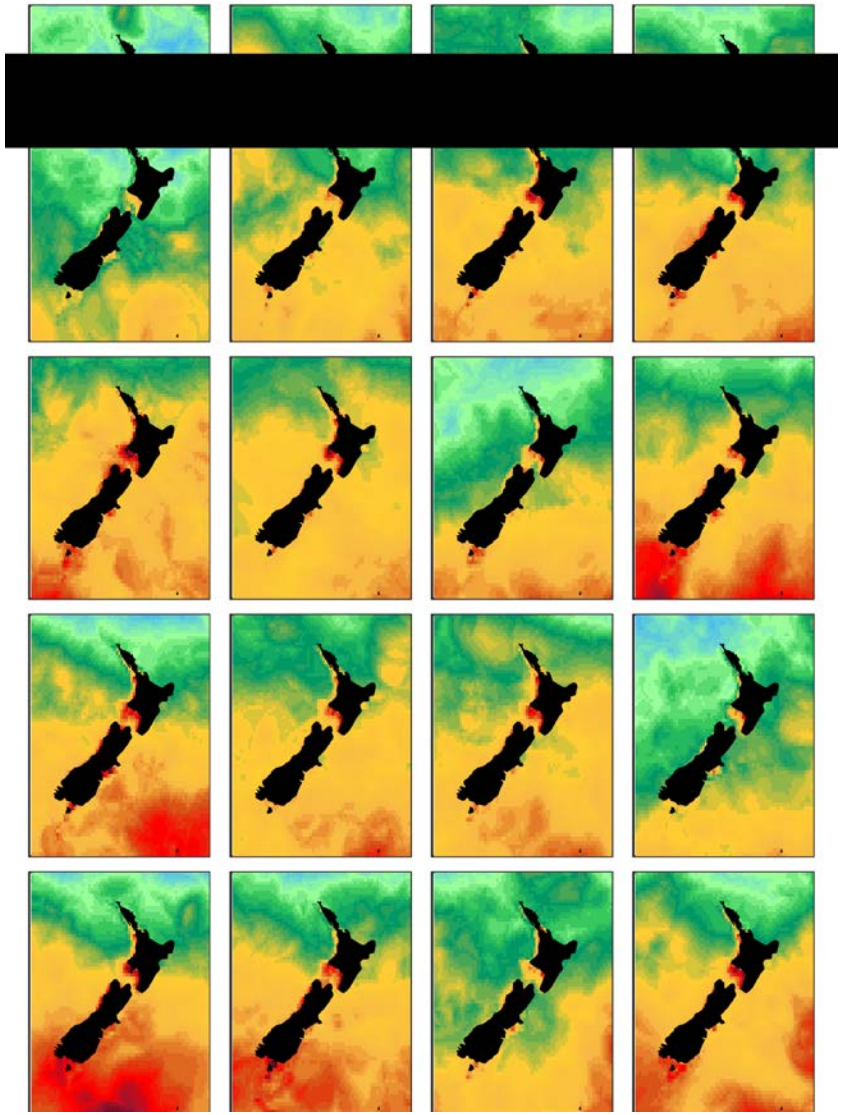


MEAN SS

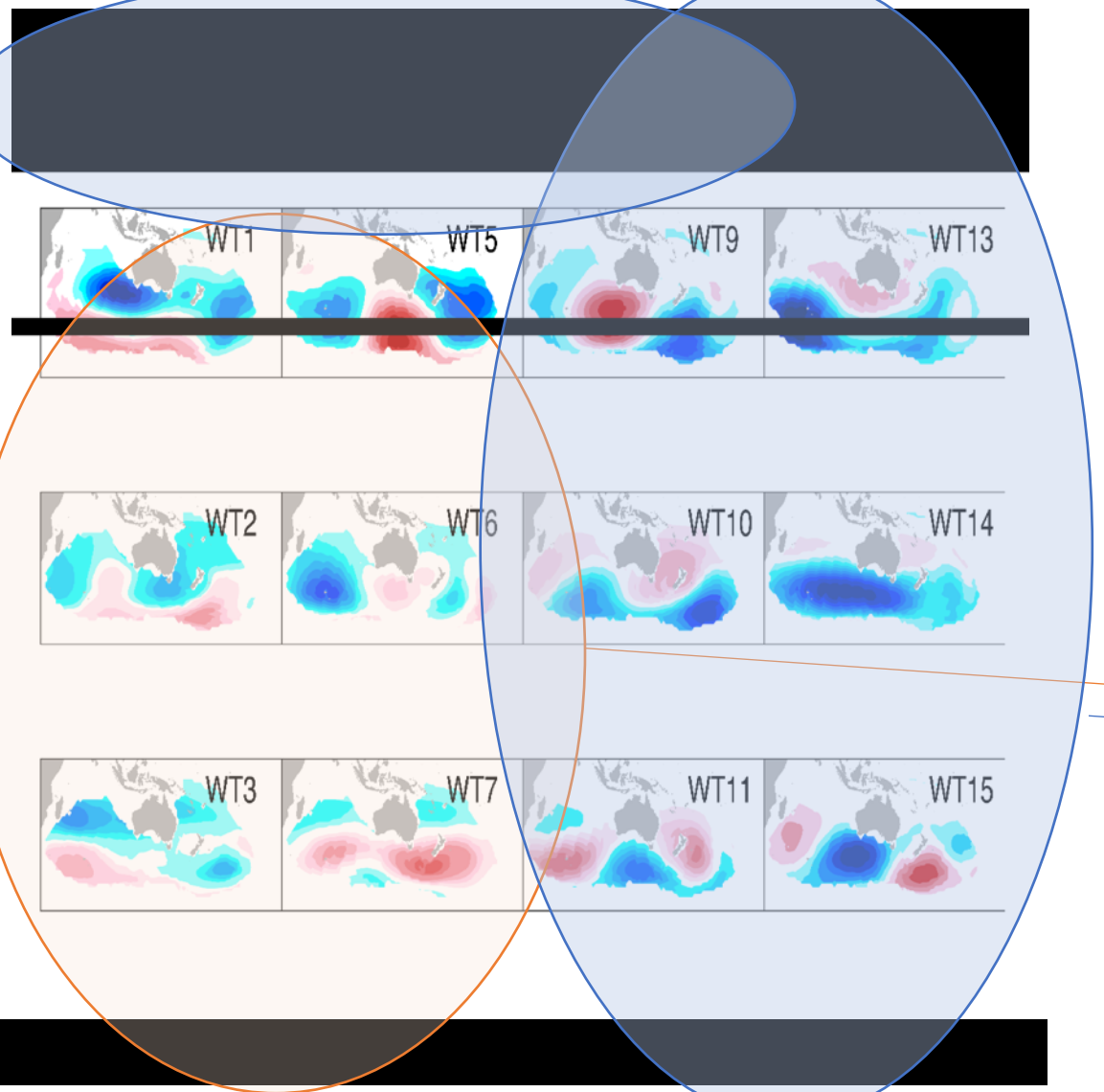


SURGE DATA: DAC Reanalysis

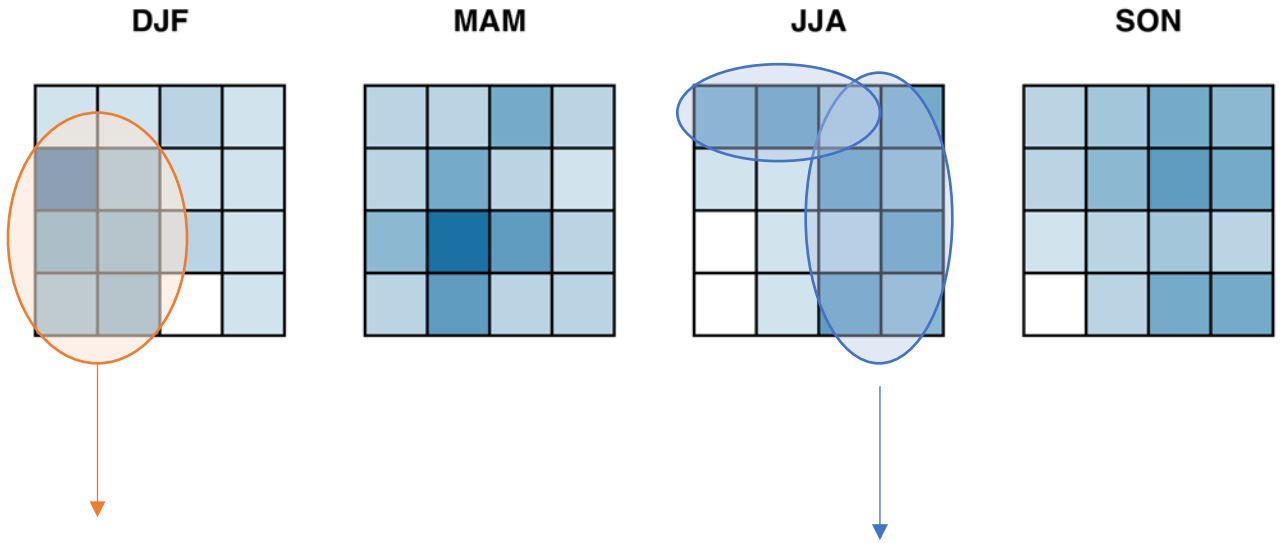
ANOMALY 99%



TIME-SCALES OF VARIABILITY



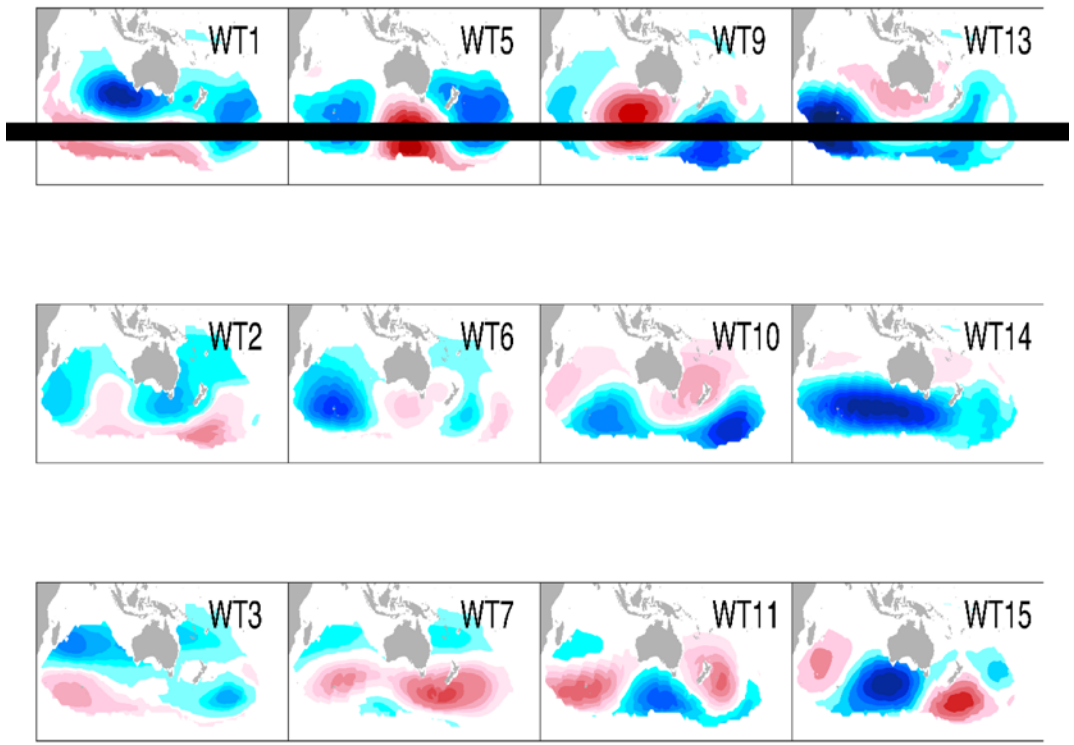
- **SEASONALITY**



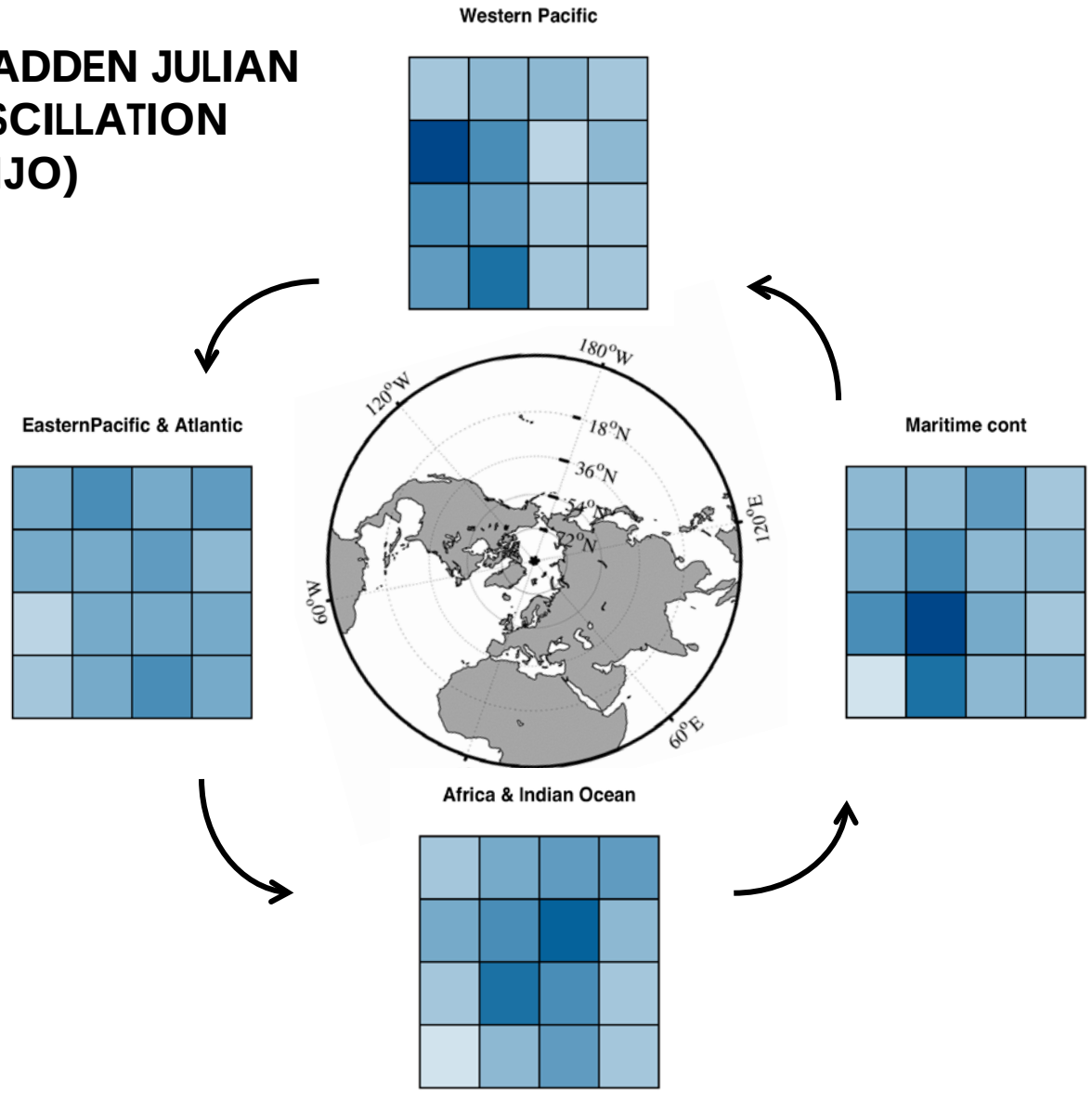
AUSTRAL SUMMER CONDITIONS

AUSTRAL WINTER CONDITIONS

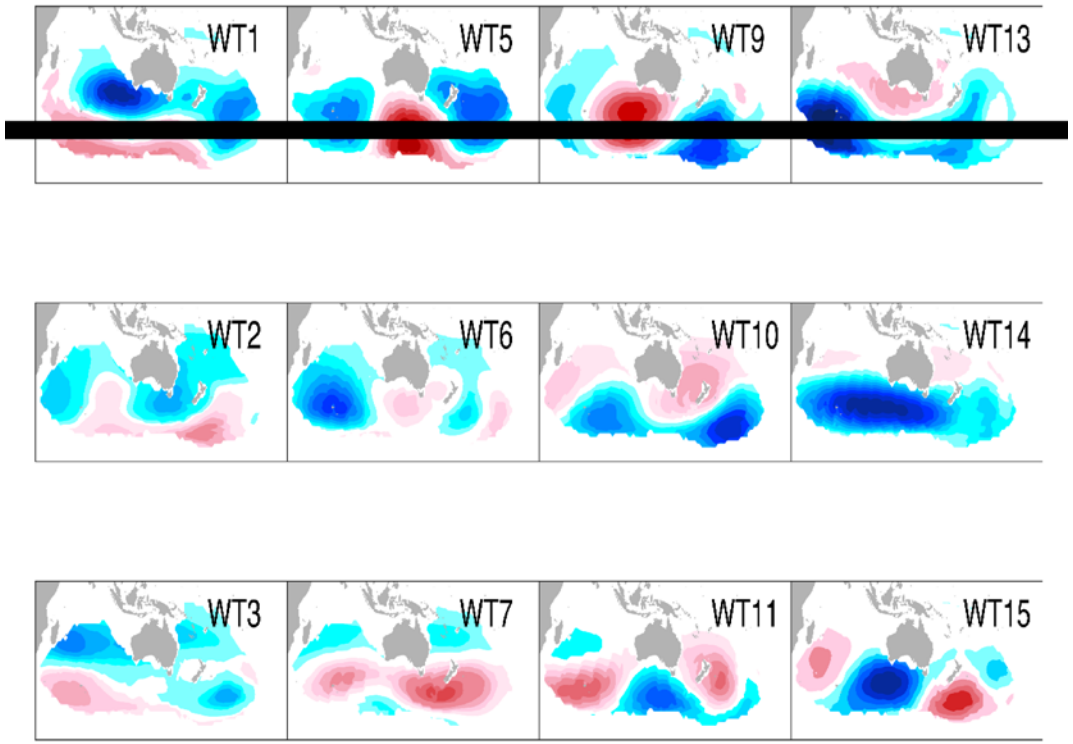
TIME-SCALES OF VARIABILITY



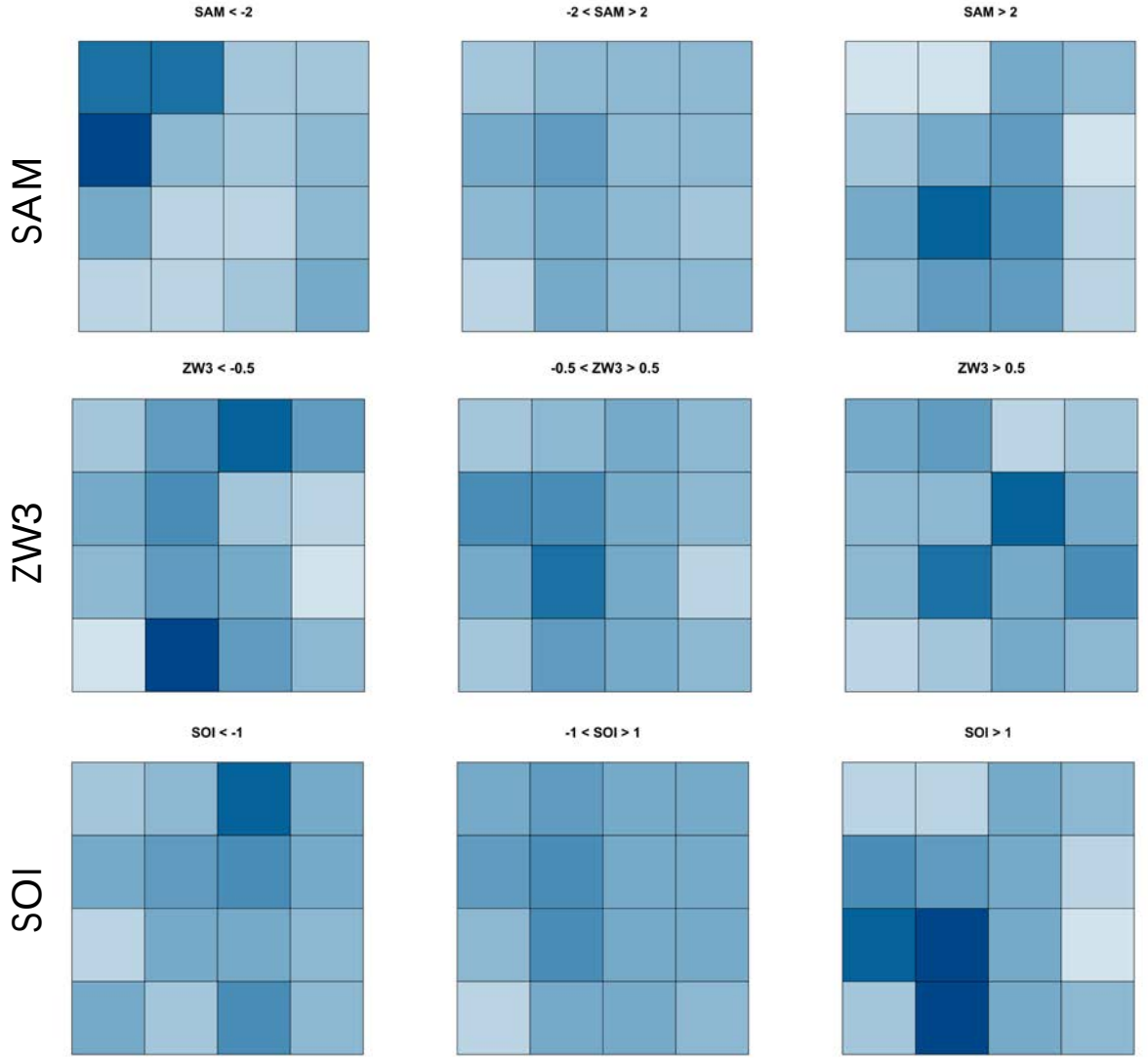
- **MADDEN JULIAN OSCILLATION (MJO)**



TIME-SCALES OF VARIABILITY

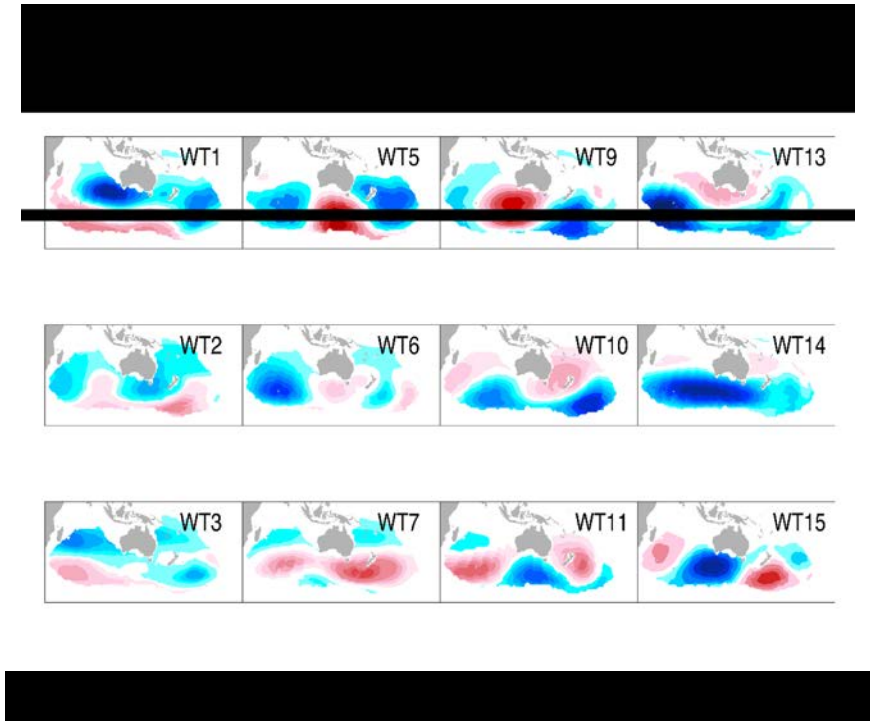


- **INTERANNUAL VARIABILITY**

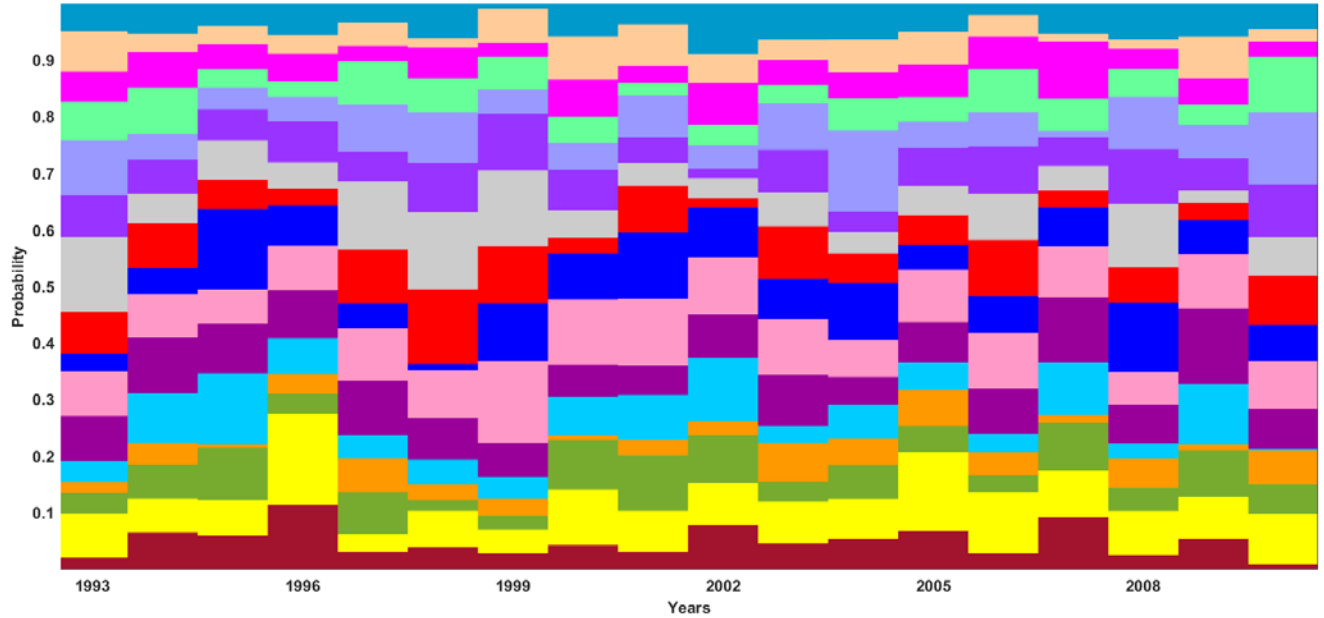


TIME-SCALES OF VARIABILITY

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16



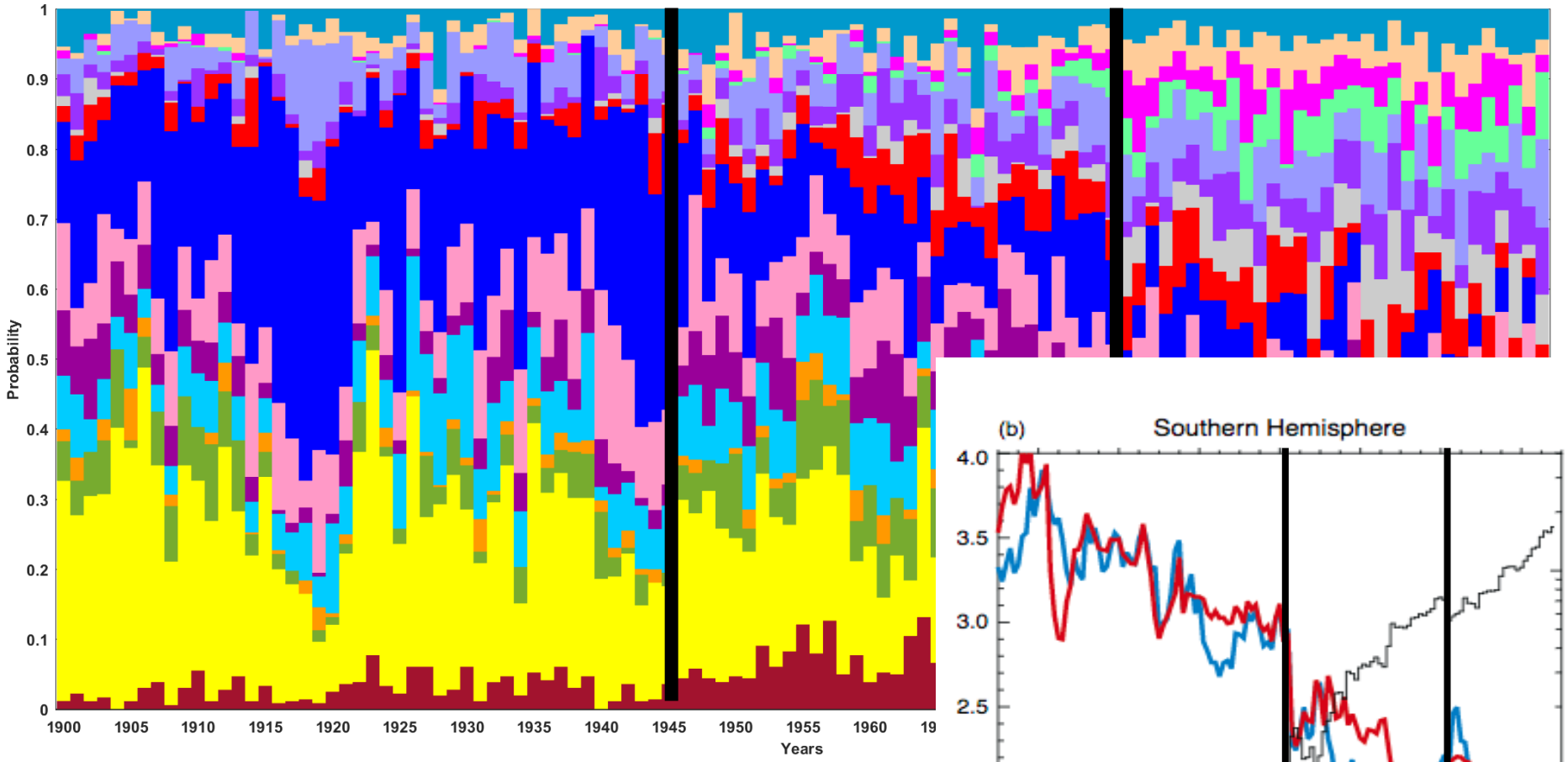
CFSR



20CR

TIME-SCALES OF VARIABILITY

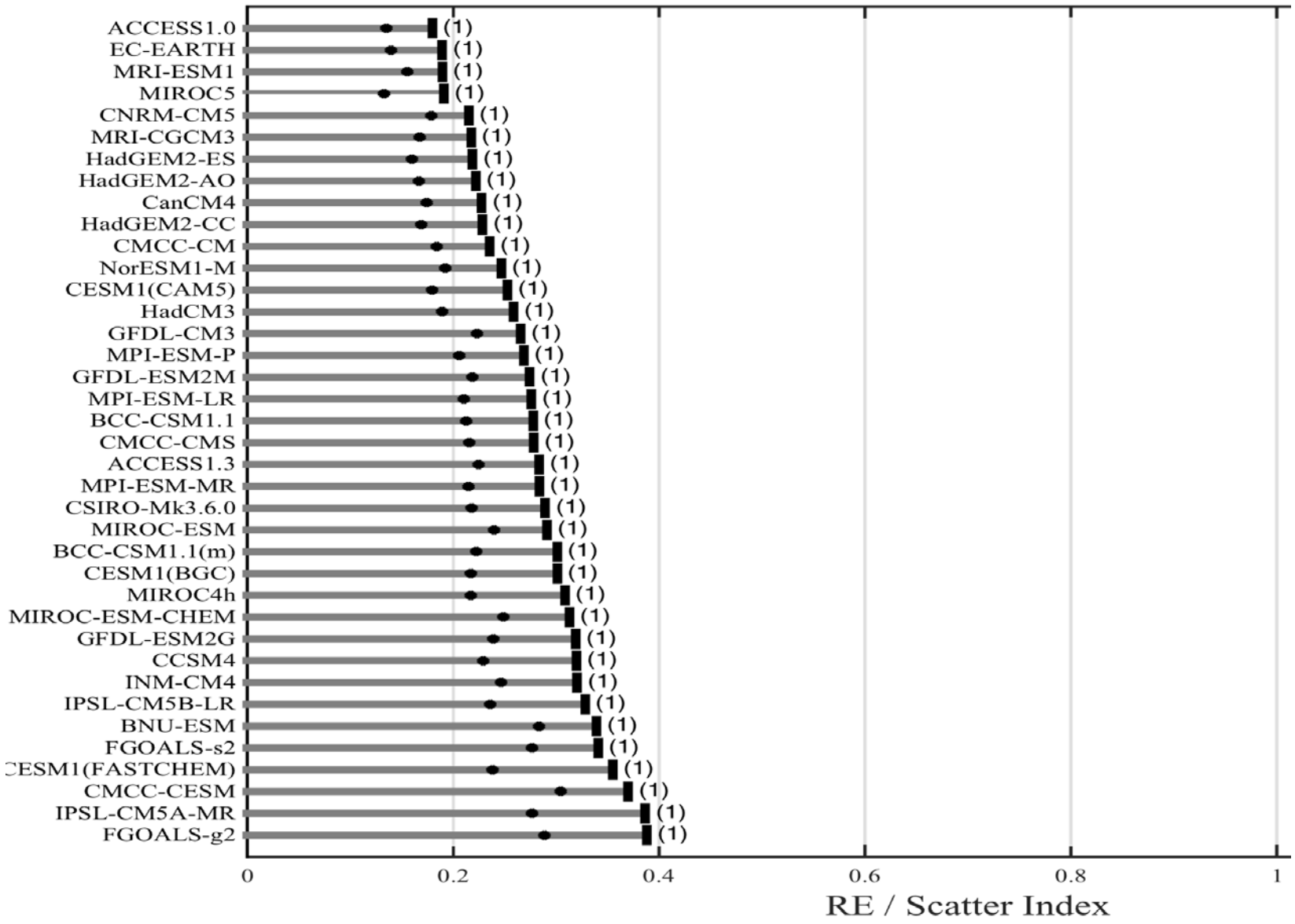
20CR



1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

Compo et al. 2011

GCMs' skills (on-going work)



SORTED OUT BY PERFORMANCE TO MODEL SYNOPTIC SITUATIONS based on Perez et al. (2014b)

SUMMARY

- We have defined a regional daily atmospheric predictor for waves and storm surges along NZ coasts.
- This regional predictor is able to explain wave climate variability at daily, intramonthly, seasonal and interannual time-scales.
- The use of clustering techniques simplifies the analysis of multivariate problems such as coastal flooding and erosion.
- The statistical-relationship established between waves and storm surge with slp fields, allows its application for climate change projections.
- The skill of GCMs should be analyzed carefully!!

THANK YOU FOR YOUR ATTENDANCE!

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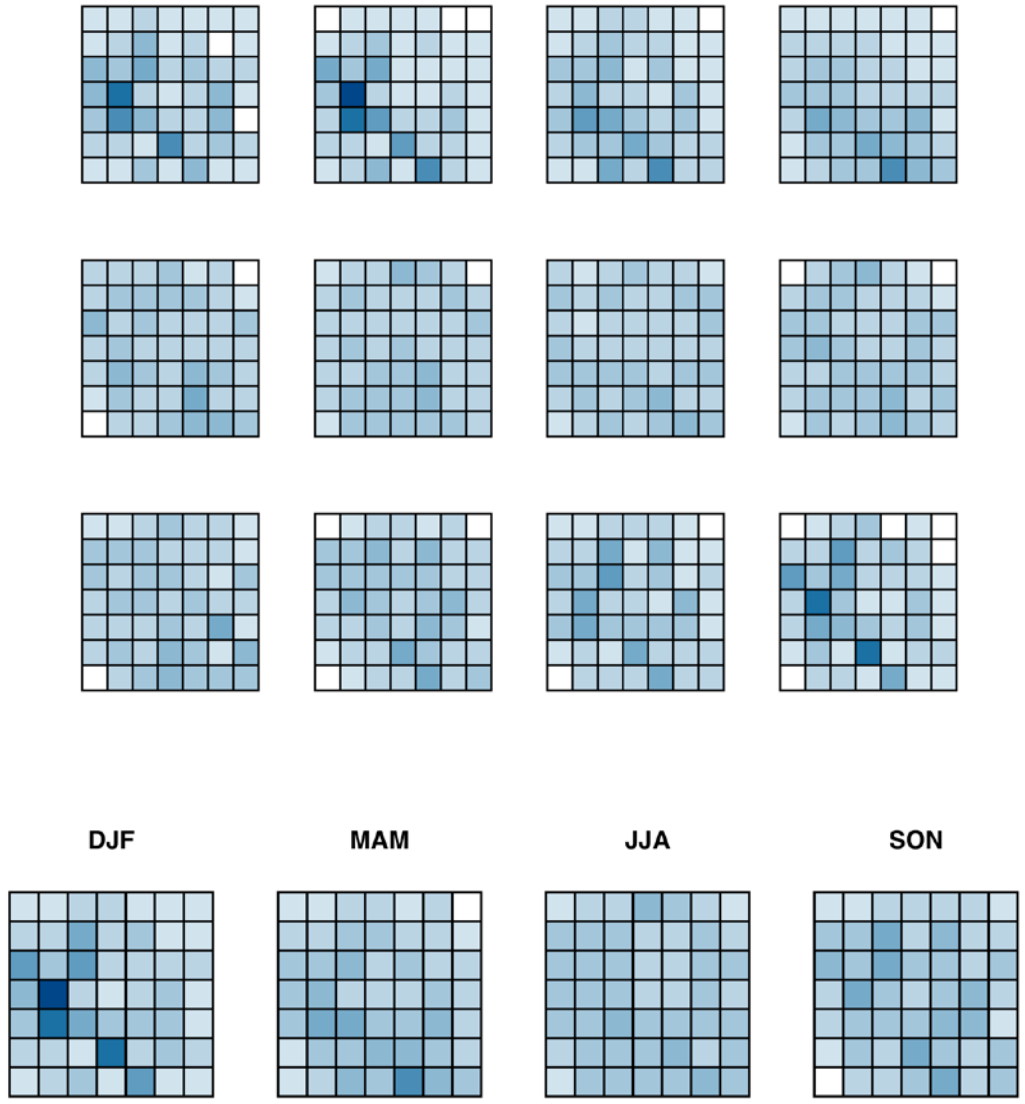
WEATHER TYPES



HISTORICAL PROBABILITIES 1979-2009