CLIMATE CONTROLS OF TROPICAL-EXTRATROPICAL CLOUD BANDS OVER SOUTHERN AFRICA

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Overarching Research Question:

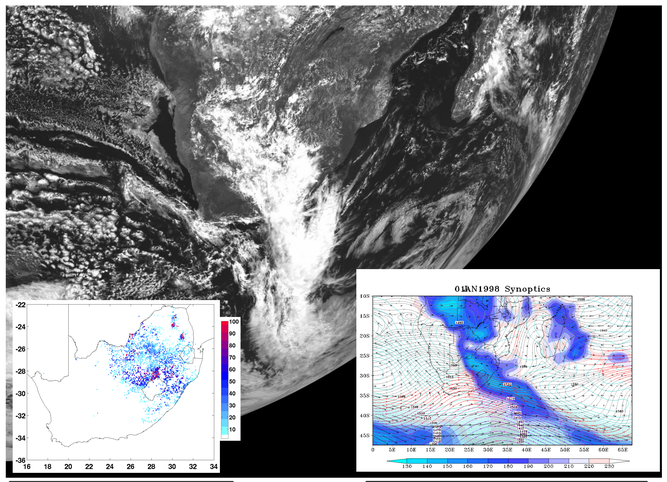
How does ENSO project into daily rainfall over southern Africa during austral summer?

Specific Research Question:

How does El-Nino impact cloud band seasonal frequency?

BACKGROUND

WHAT CLOUD BANDS?



Station rainfall 01-Jan-98

Daily OLR, 250mb Streamlines, 850mb gph & winds

- Know regionally as Tropical Temperate Troughs (TTTs)
- Subtropical S. Afr. Supplied moisture by NE winds, deep convection triggered by approach of mid-latitude upper-level trough ↦ substantial summer season rain (eg. Hart et al 2011)
- Produce over 50% total season rainfall during some summers (Harrison, 1984)

ENSO HAS A REGIONAL INFLUENCE?

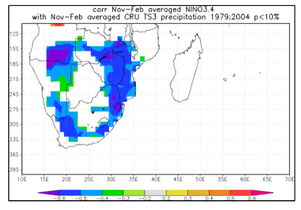
KNOW:

Nino3.4 strongly related to summer rainfall total

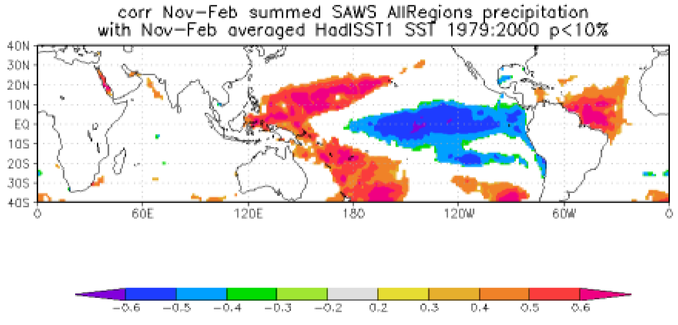
DON"T KNOW:

How ENSO modulates seasonal cycle?

Why strong El-Nino events (97/98, 09/10) didn't produce drying suggested by correlation?



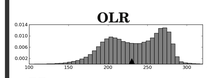
NDJF Rain corr to Nino3.4

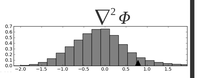


HOW CAN WE CHARACTERIZE EACH SEASON BY ITS SYNOPTIC EVENTS?

METHODOLOGY

Use Computer Vision





Humans identify and synthesise features from many different atmospheric variables

How we approximate that ability: *(Hart et al in prep)*

1 - Raw OLR, other variables use ∇^2 to highlight depressions/jet zones

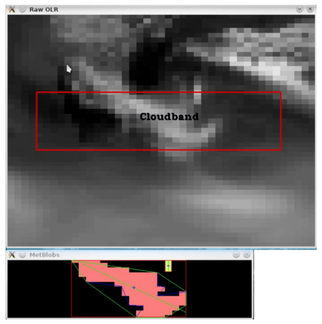
2 - Threshold data, see above histograms, and plot

3 - Apply connected component labeler to "blob" contiguous data

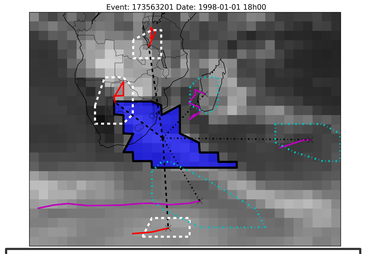
4 - Build tracks of blobs in each variable

5 - Associate tracks to OLR blob tracks that met cloudband criteria at least once

Flag Cloud Bands

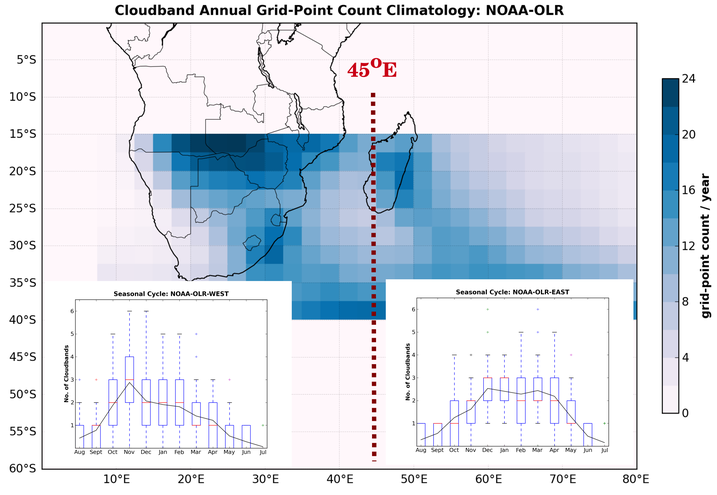


Synthesize Meteorology



Tracks and Blobs associate with event:
- Red/White ↦ 850mb depressions
- Purple/Cyan ↦ 250mb troughs

SEASONAL CYCLE



THIS WORK WAS MADE POSSIBLE WITH:

Data

- Outgoing longwave radiation (Liebmann & Smith 1996)
- NCEP-DOE II 6-hourly variables (Kanamitsu 2002)
- Water Research Commision daily station rainfall (Lynch 2003)

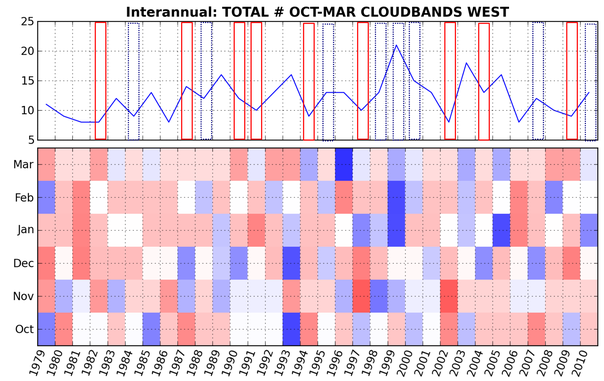
Software

- Python 2.7: matplotlib, Basemap, NumPy, SciPy, PIL, PyClimate
- Python wrappers into C++ Libraries: OpenCV, cvblob

HOW DOES ENSO MODULATE SEASONAL CYCLE?

RESULTS

INTERANNUAL VARIABILITY



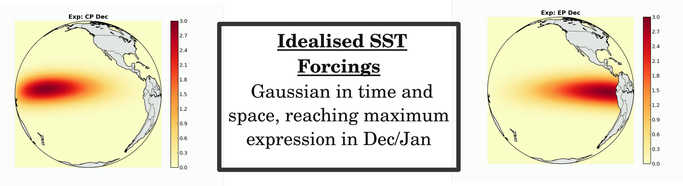
(1) Generally El-Nino corresponds with reduced # cloud bands (vis versa for La-Nina) for season

(2) Few cloud bands during severe droughts in 82/83 and 02/03

(3) No clear intraseasonal characteristic identifiable for El-Nino or La-Nina years

EL-NINO FLAVOURS

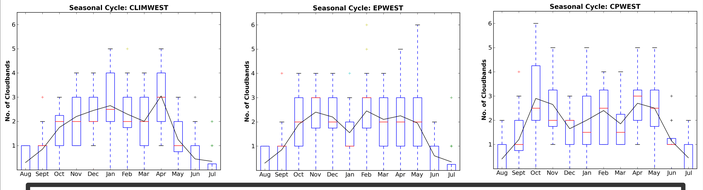
Is region sensitive to longitude of maximal El-Nino warming?



Idealised SST Forcings

Gaussian in time and space, reaching maximum expression in Dec/Jan

- Used HadAM3P seasonal forecast set-up at Climate Systems Analysis Group, UCT by Mark Tadross
- 20 ensemble members realised with climatology SST's, Eastern Pacfic (EP) and Central Pacfic (CP) idealised warming



- Model climatology lacks Nov cloud band peak, produces ~1 p/m more than observations and has spurious April peak
- EP exp suggests moderate suppression of seasonal cycle
- CP exp displays early season increase in cloud band likelihood
- CP exp suggests more robust (see box-plots) mid-season suppression of cloud band occurrence