

Seasonal and inter-annual variability in the atmospheric moisture transport across the Southern Ocean

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Antarctica overview

- ∅ Surface warming
- ∅ Ice sheet melt
- ∅ Sea ice increasing
- ∅ SAM intensifying

Precipitation ->

Moisture transport



ERA- Interim data

∅ 1989-2009, 4 times daily

∅ T255

∅ 80-km

∅ 37 vertical

∅ 4DVAR

∅ Improved moisture fields
over Southern Ocean /
Antarctica

Total meridional moisture flux

∅ Following Palmen and Vuorela, 1963 QJRMS

$$\mathbf{F} = -\frac{1}{g} \int_{p_s}^{p_0} \mathbf{q} * \mathbf{v} dp$$

∅ Units: kg m⁻¹ s⁻¹

Total meridional moisture flux

∅ERA-Interim vs earlier studies

Study	Time period	50° S	60°S	70°S	80° S
Howarth (1983)	1.09.1973 - 31.08.1978	- 10. 5	-6.7	-3.7	- 1.6
Bromwich et al. (1995)	1985-1992	-26	-17	-4	-1
Giovinetto et al. (1992 and 1997)	1956-1990	n/a	- 18. 6	-6.6	n/a
Slonaker and van Woert (1999)	1988	- 31. 8	- 15. 2	n/a	n/a
Tietavainen and Vihma (2008)	1958-2001	- 29. 1	- 16. 8	-5.5	- 0.9
	1979-2001	- 29.	- 18.	-6.2	- 1.1

Meridional moisture flux components

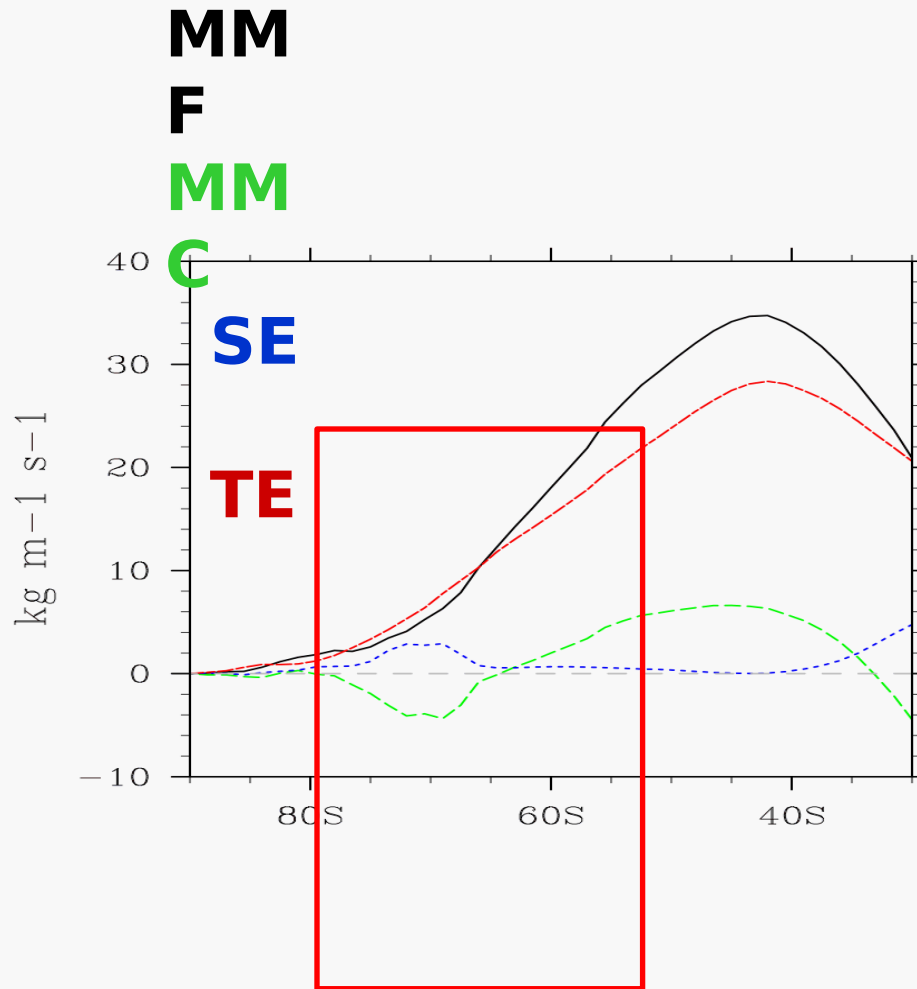
∅ Following Palmen and Vuorela, 1963 QJRMS

∅ Mean meridional circulation

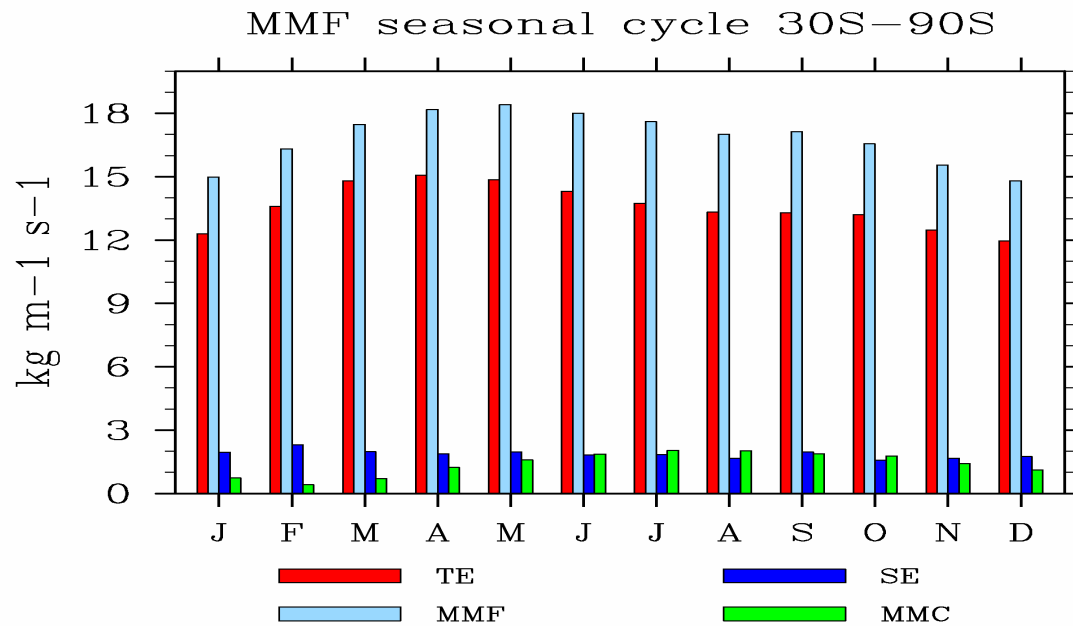
∅ Stationary eddies

∅ Transient eddies

Meridional moisture flux components

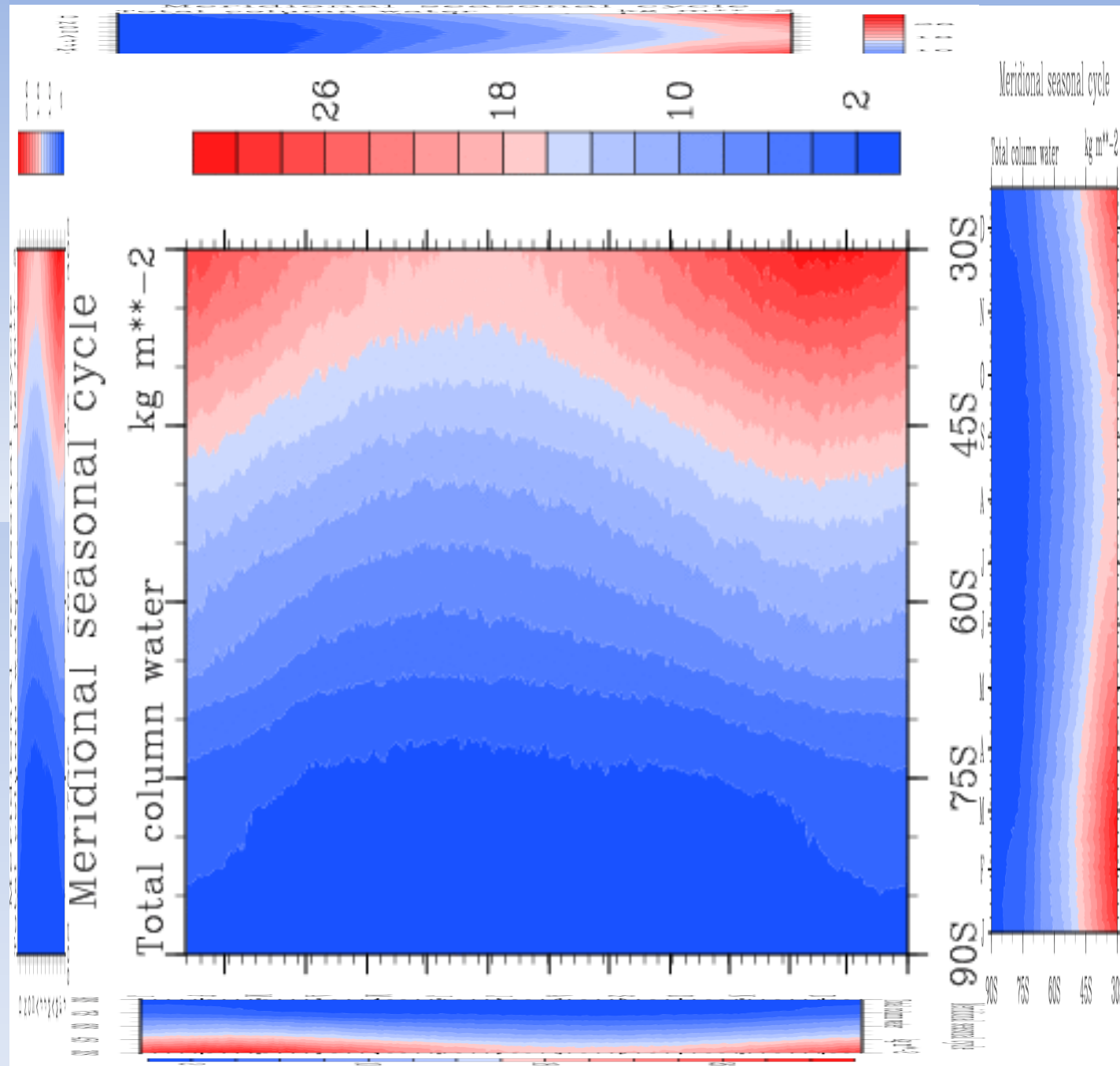


QV: Seasonal variability

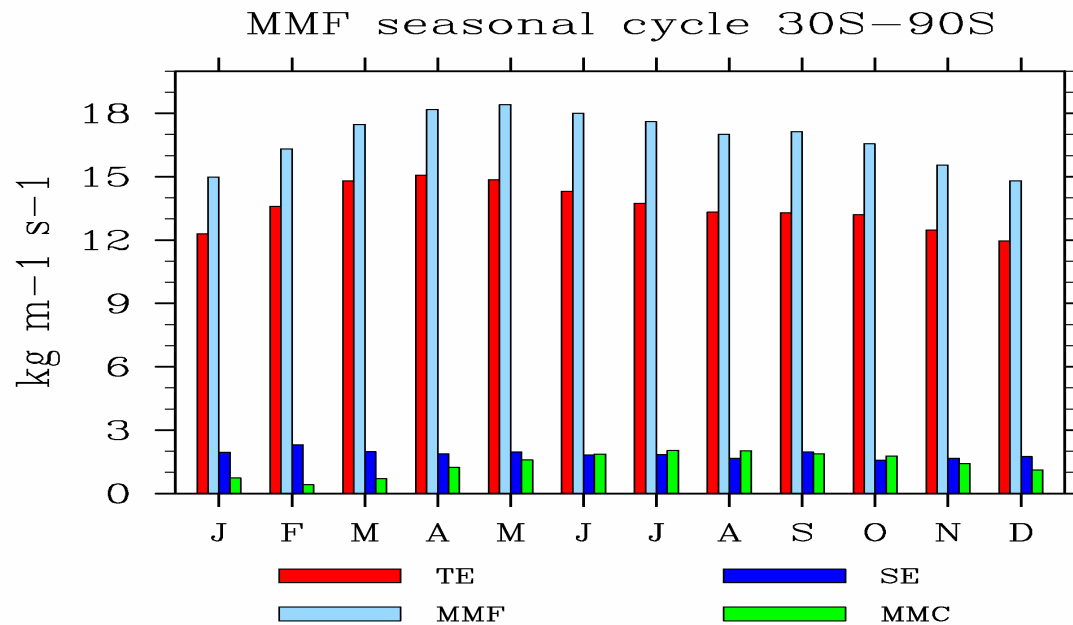


TCWV

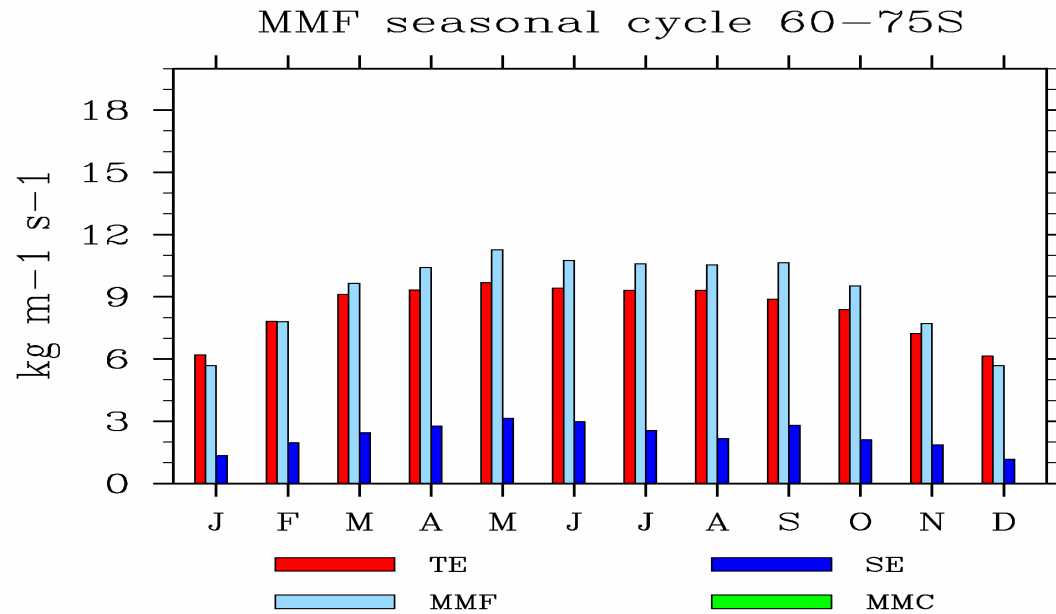
(q):
Seasonal
and
zonal
variability



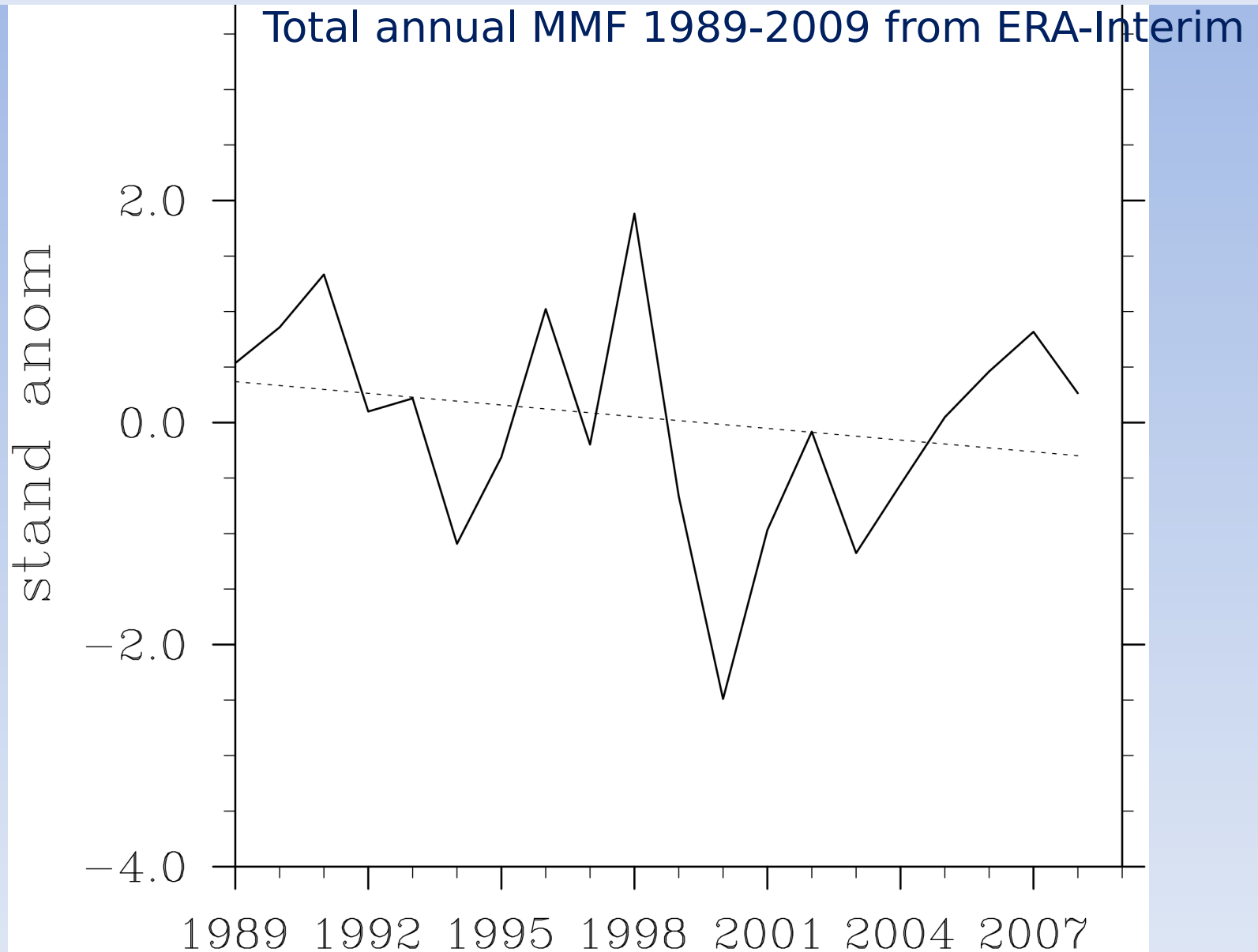
QV: Seasonal variability



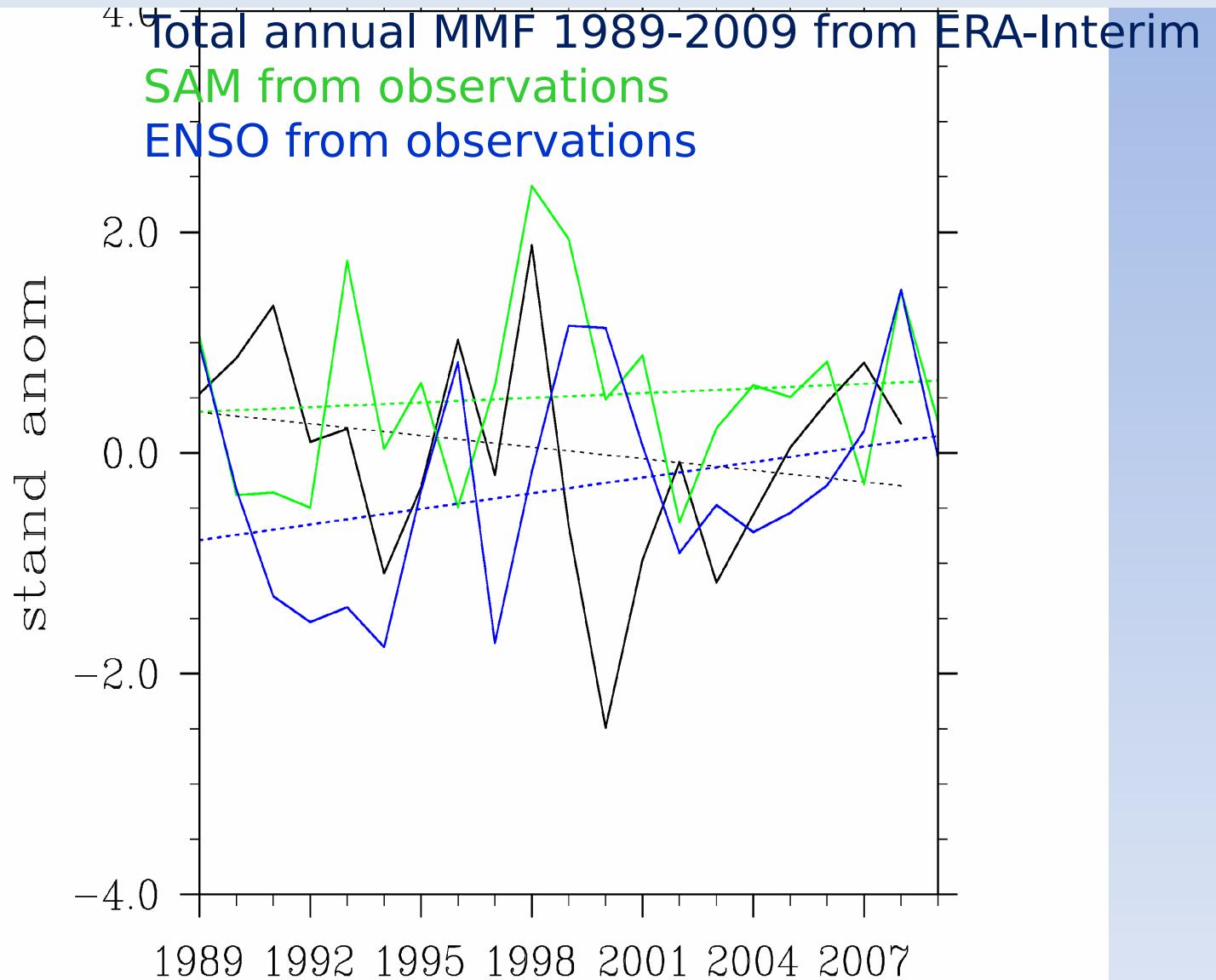
QV: Seasonal variability, coastal seas



Total meridional moisture flux

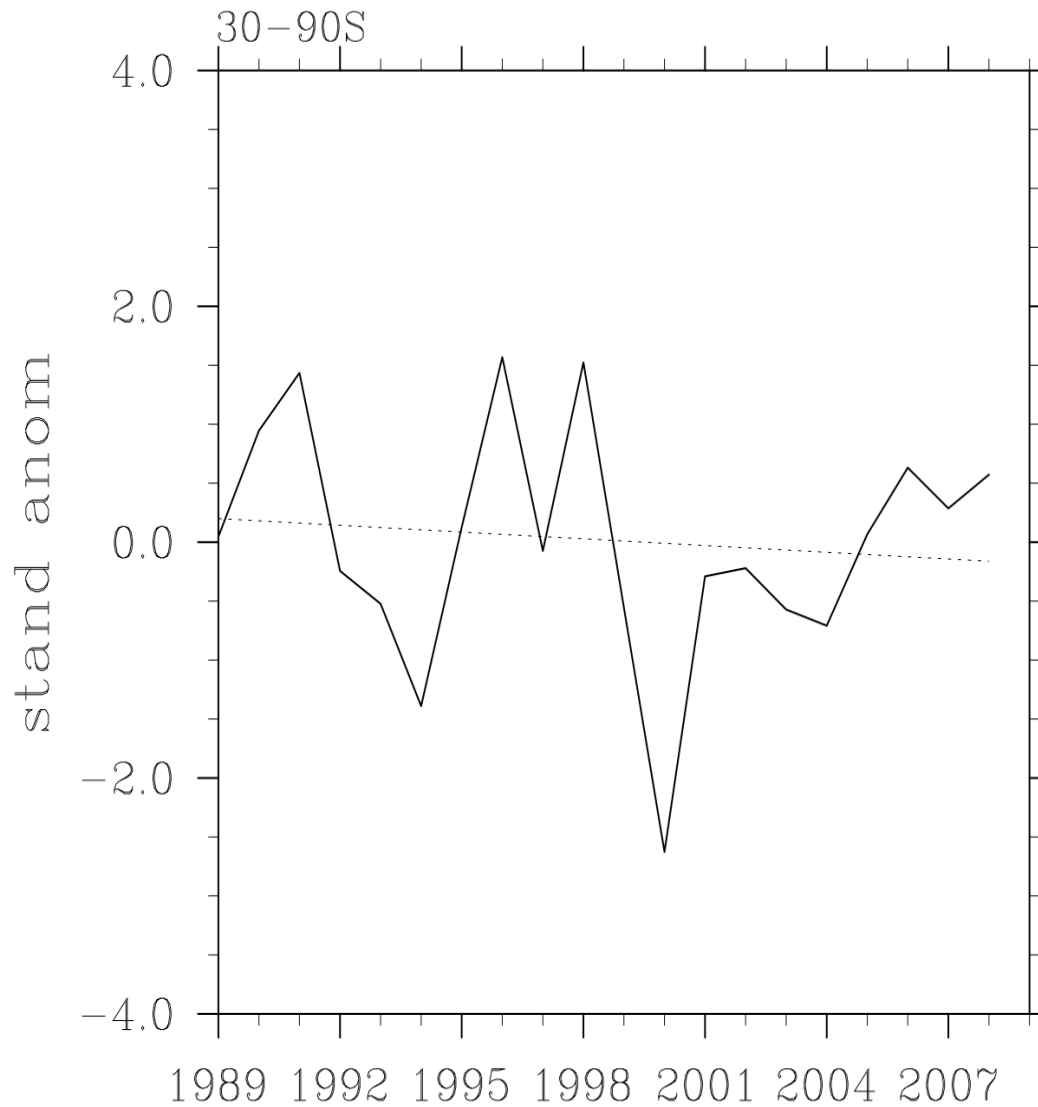


Total meridional moisture flux



Transient eddy flux

erim



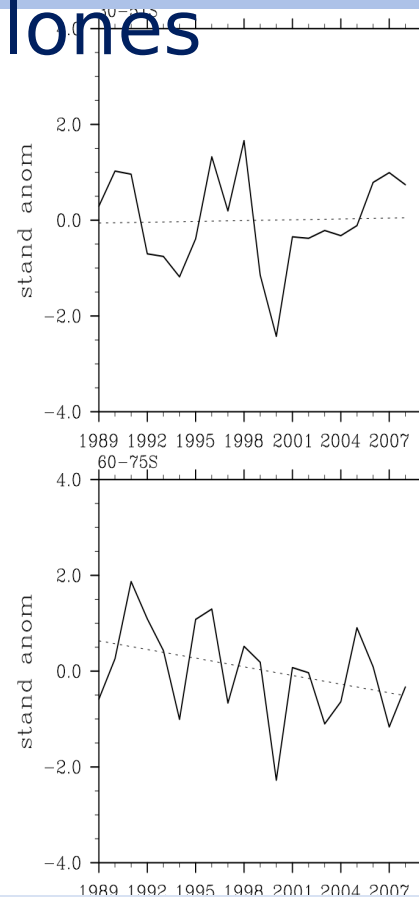
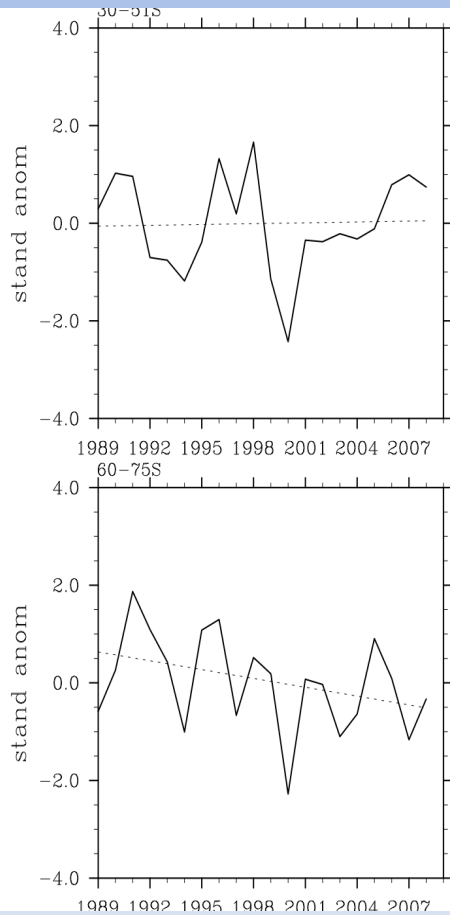
Transient eddy flux

30°S - 51°S

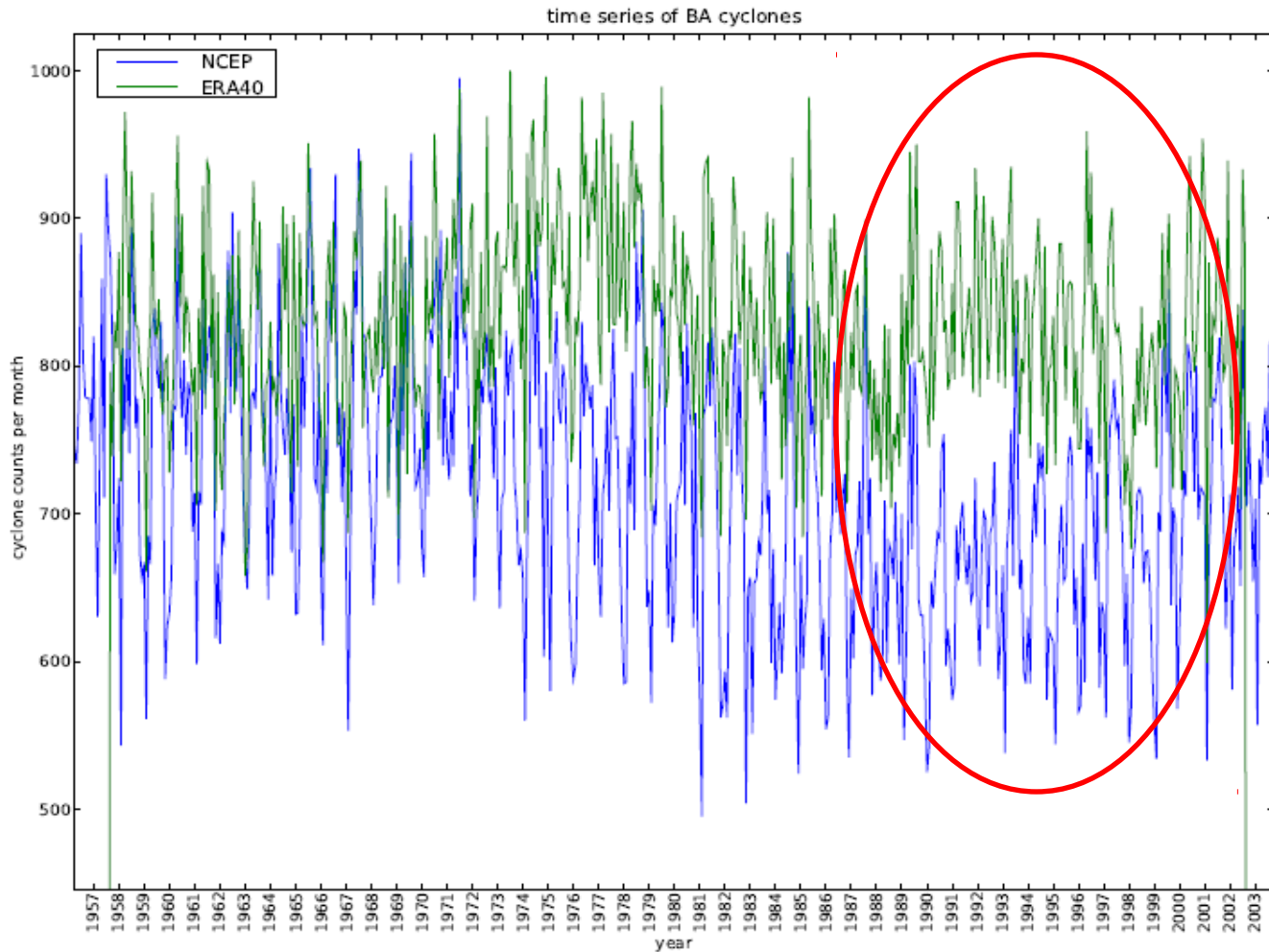
Major storm track

60°S - 75°S

Antarctic coastal cyclones



Synoptic activity in coastal seas



1957-2002

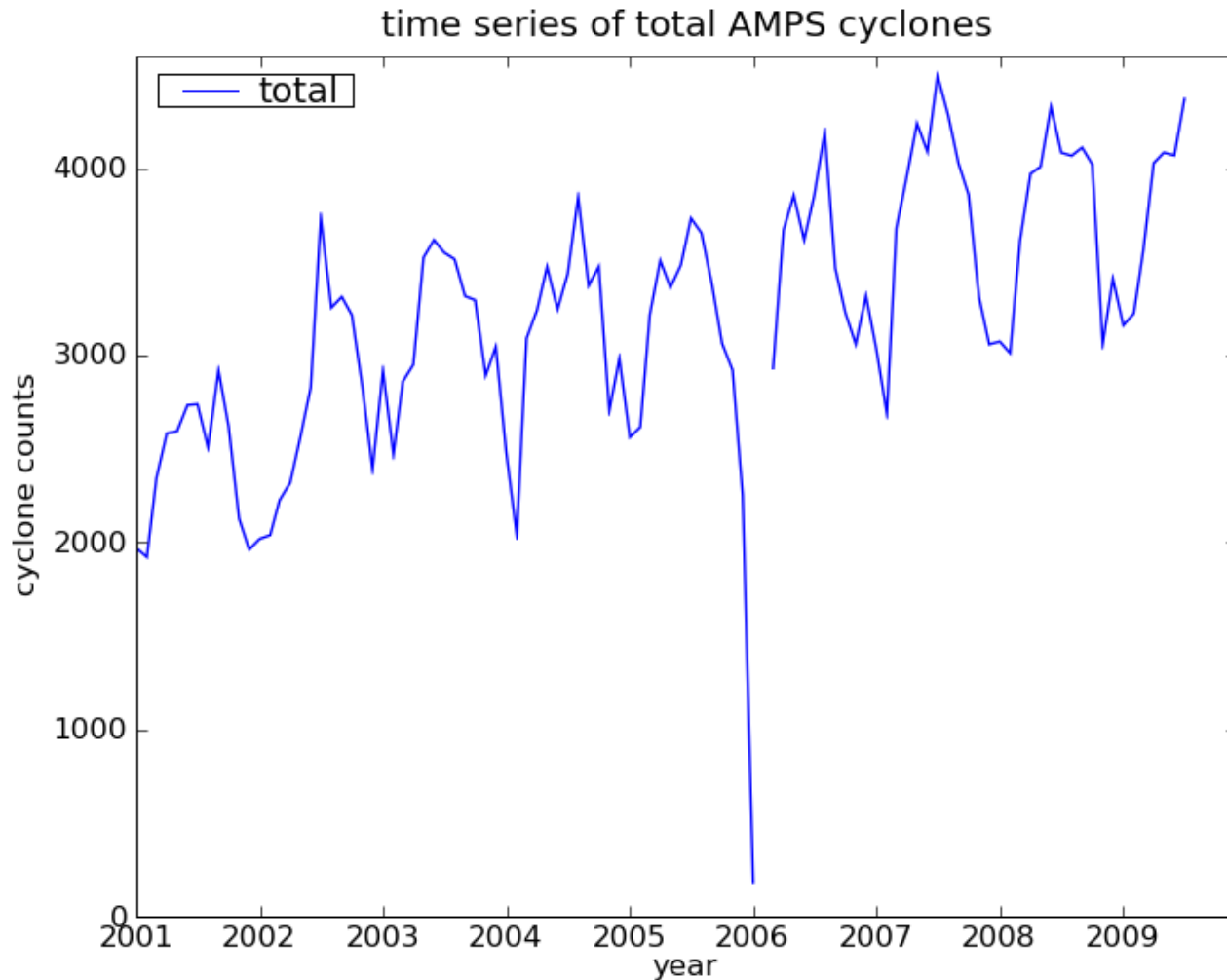
NCEP

ERA-40

Amundsen &
Bellingshaus
en Seas:
60°W to
140°W
30°S to 90°S

Courtesy of Petteri Uotila and Michelle D'Amico

Synoptic activity in coastal seas



AMPS:

30°S -
90°S
2001-
2009

Cyclone
counts
increase
with
increasing
resolution

Courtesy of Petteri Uotila

Synoptic activity in coastal seas

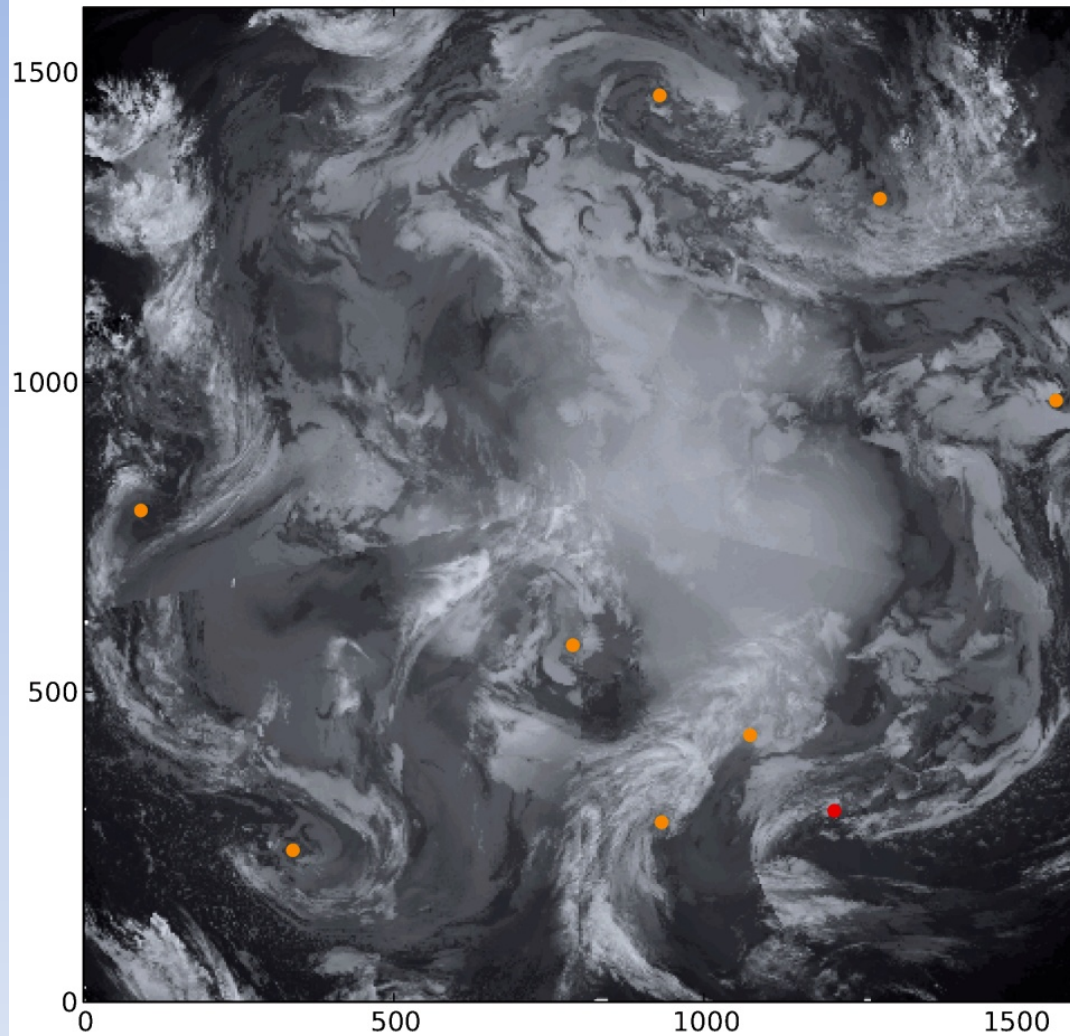
Manual tracking:

AVHRR
Polar Pathfinder:
5 km Ease Grid
twice daily
Jan 1994 - Jun
2005

Cloud signature

5 Jan 2001 14:00
UTC

a14_s005_2001005_1400_chn4.v3



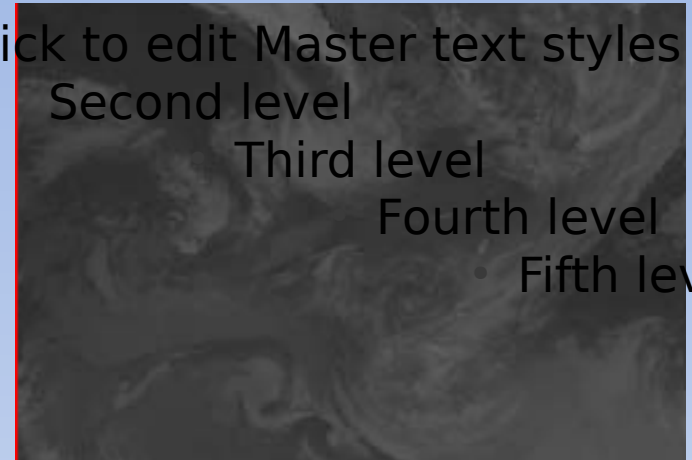
Courtesy of Michelle D'Amico

Cloud signatures

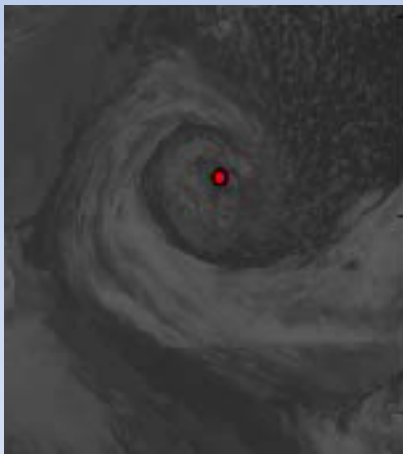
There are different cloud signatures / types of mesoscale cyclones

- The comma cloud
- The spiraliform signature
- Merry-go-round signature

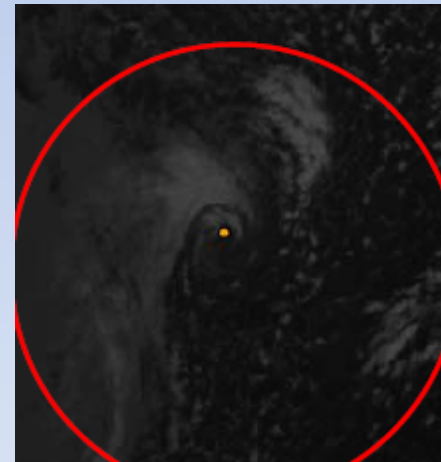
Click to edit Master text styles
Second level
Third level
Fourth level
• Fifth level



Merry-go-round



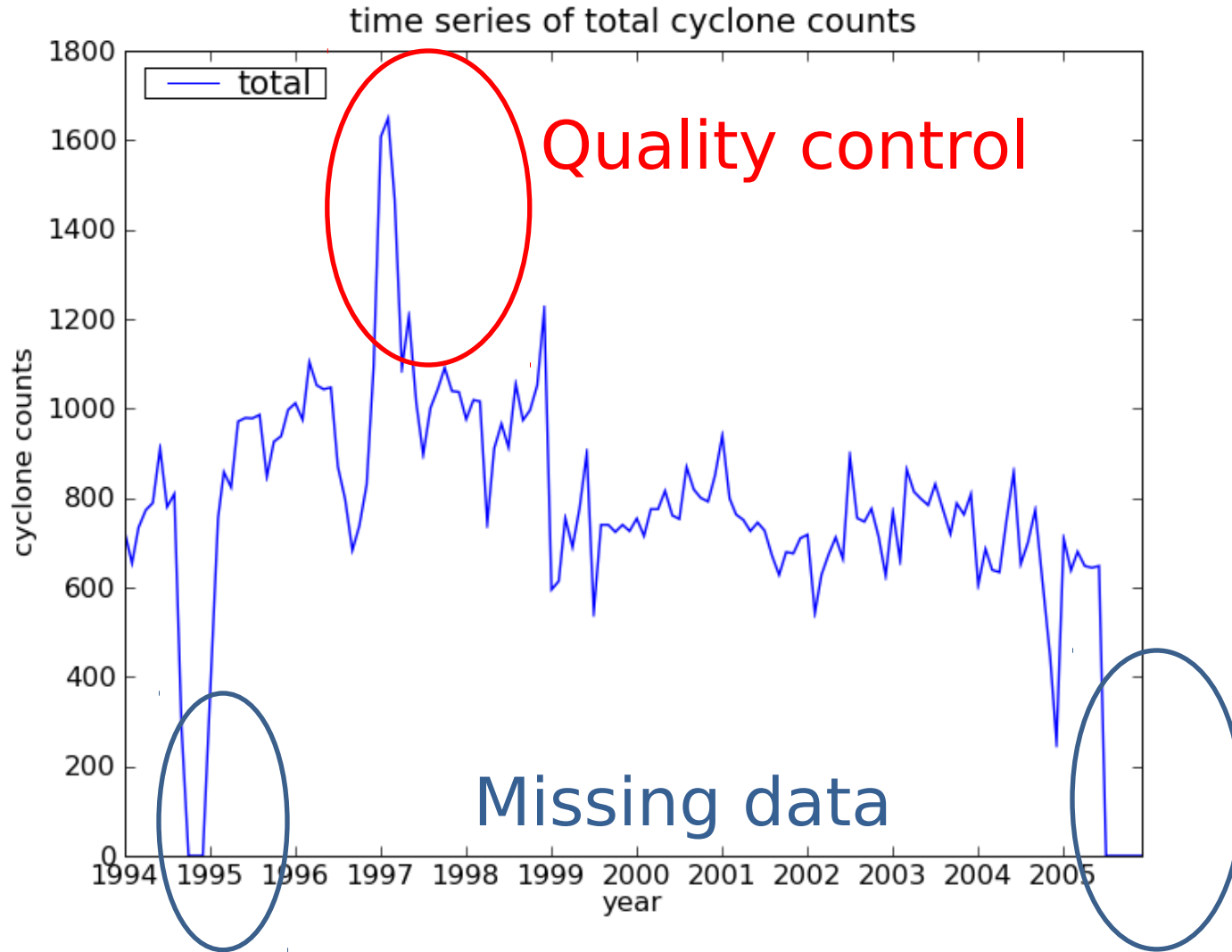
Spiraliform



Comma cloud

Courtesy of Michelle D'Amico

Synoptic activity in coastal seas



Preliminary result from manual tracking:

30°S -
90°S
1994-
2005

Courtesy of Michelle D'Amico

Conclusions/Further directions

- ∅ Moisture transport is dominated by TE
- ∅ Seasonal cycle is shifted?
- ∅ TE decreases over $60^{\circ}\text{S} - 75^{\circ}\text{S}$ for 1989-2009
 - ∅ What drives this decrease?
- ∅ Cyclone behavior is key
 - ∅ Automated satellite cyclone identification
 - ∅ Seasonal and regional differences
 - ∅ Cryosphere feedbacks

A large, jagged iceberg with a prominent peak, floating in clear blue water. The iceberg has a textured, crystalline appearance. The text "Thank you!" is overlaid in white, bold, sans-serif font in the center of the image. The sky is a deep, clear blue.

**Thank
you!**

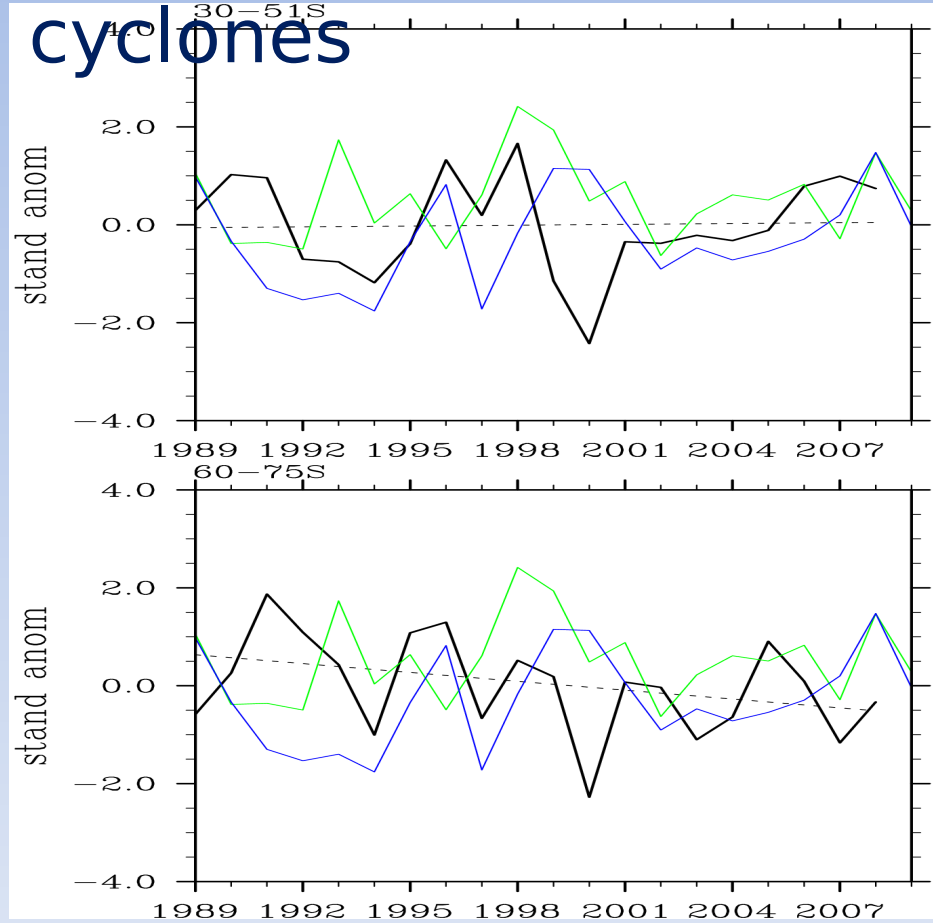
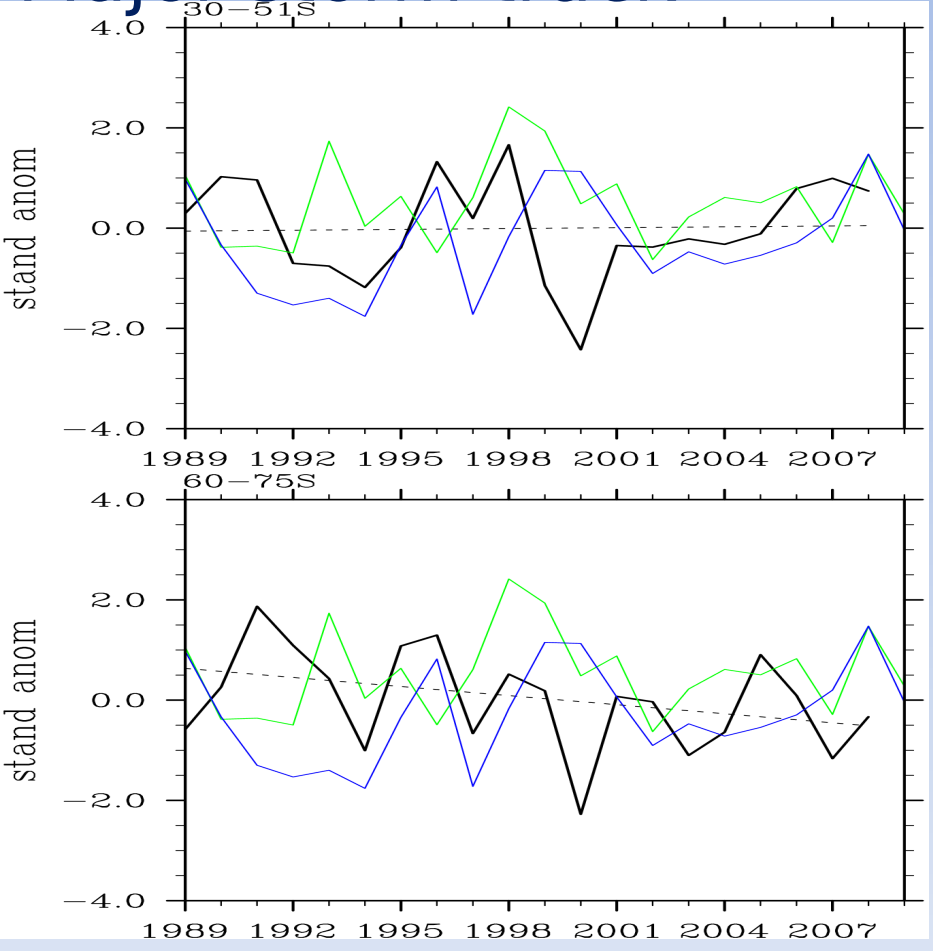
Transient eddy flux

30°S - 51°S

Major storm track

60°S - 75°S

Antarctic coastal cyclones



Annual TE flux 1989-2009 from ERA-Interim, SAM, ENSO

Meridional seasonal cycle

