ESSC (Environmental Systems Science Center)

University of Reading

Investigation of trends in the moisture budget of the tropical atmosphere

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Introduction

- Tropical atmospheric Circulation (TAC) important fragment of Global Water Cycle
- Different answers, whether TAC has intensified or weakened in the past[e.g.1,2,3]

Methods

- Data used: wind (U,V,Omega), specific humidity (Q), pressure (P) from ERA interim 1989-2008
- Regions of upward and downward vertical wind motion are identified (ascending (ASC) and descending (DESC) regions) each month (see Fig.1)

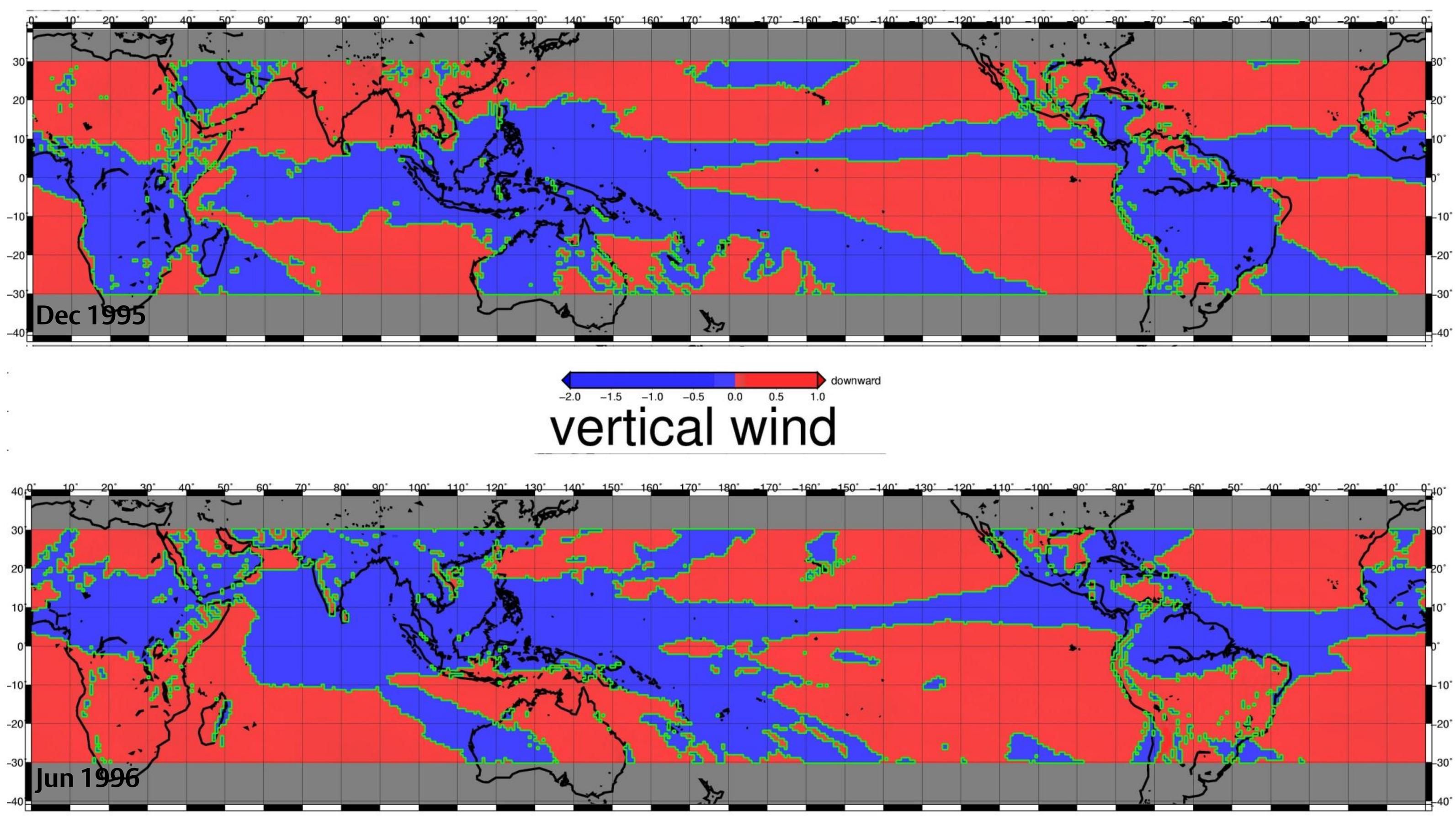

Fig 1: Regions with ascending (**blue**) and descendig (**red**) vertical motions in the tropics and boundary (**green**) separating both

- Precipitation (P) and evaporation (E) in ASC and cumulated moisture fluxes (MFs) are calulated along the boundary (green line) each month
- MFs are calculated based on monthly average values for Q and wind (MFmm) as well as on (6-hourly) instaneous values (MFhr)

Conclusions and outlook

- Generally positive trends for P-E and MFs are found
- Using mean values not adequate for calculating MFs
- Large offset between MF calculated based on monthly means and on instantaneous values
- Offset mainly due to different MF at upper levels

- Is trend in MF due to changes in wind or atmospheric moisture?
- Do observations/ satellite data confirm this?

References

1. John, V.O.et al., (2009) 'How robust are observed and simulated precipitation responses to tropical ocean warming?', Geophysical Research Letters **36**
2. Vecchi et al., (2006) 'Weakening of tropical Pacific atmospheric circulation due to anthropogenic forcing', Nature **441**, pp. 73-76
3. B. J. Sohn and Seong-Chan Park, (2010) 'Strengthened tropical circulations in past three decades inferred from water vapor transport', JOURNAL OF GEOPHYSICAL RESEARCH **11**

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Results

Total yearly flux and yearly cycle

- Different values for yearly MFmm and MFhr
- Large offset between MFhr and MFmm
- MFhr is closer to P-E
- Yearly cycles between MFmm and MFhr/P-E differ
- Yearly trends are positive and read :
  - P-E : 0.27 km^3/d
  - MFhr : 0.24 km^3/d
  - MFmm: 0.51 km^3/d

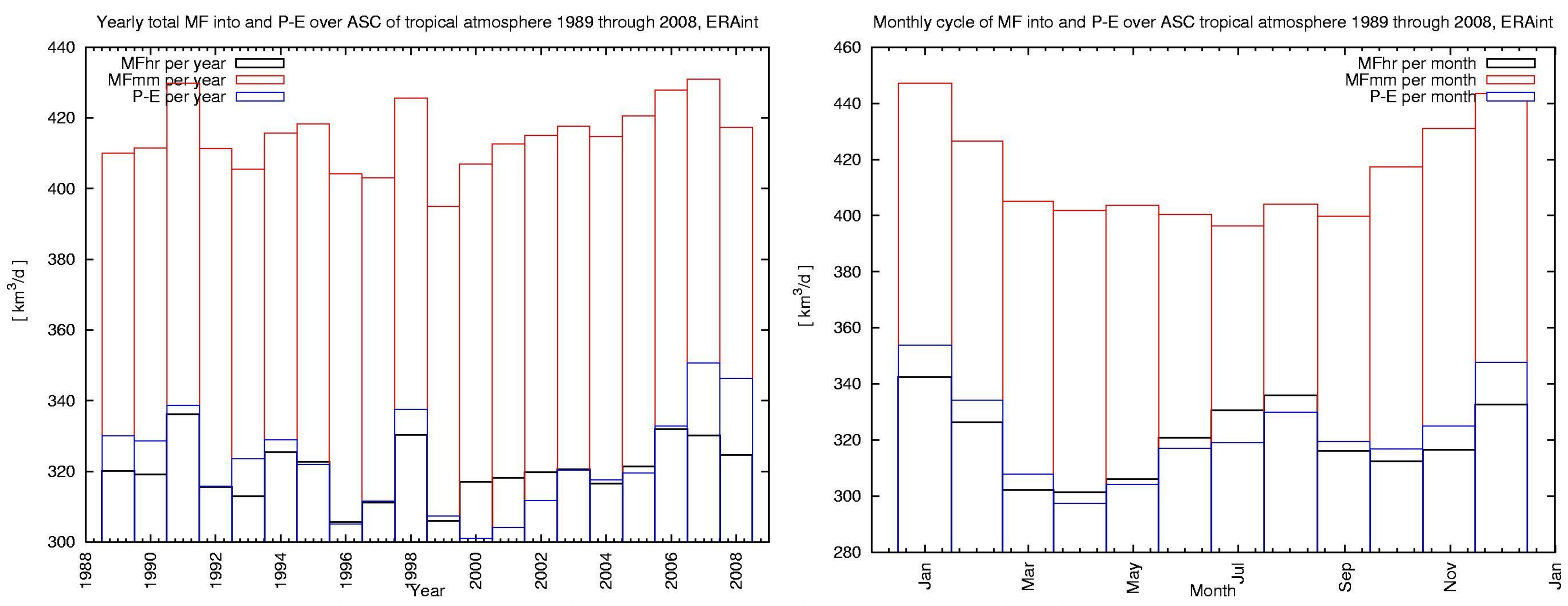

Fig 2: Yearly amount (left) and average monthly amount (right) of MFmm (**red**), MFhr (**black**) and P-E (**blue**)

Vertical profiles of MFhr and MFmm

- Total influxes on lower levels are similar
- Total outfluxes on upper level differ substantially
- Large outfluxes on upper levels seem to be averaged out in MFmm

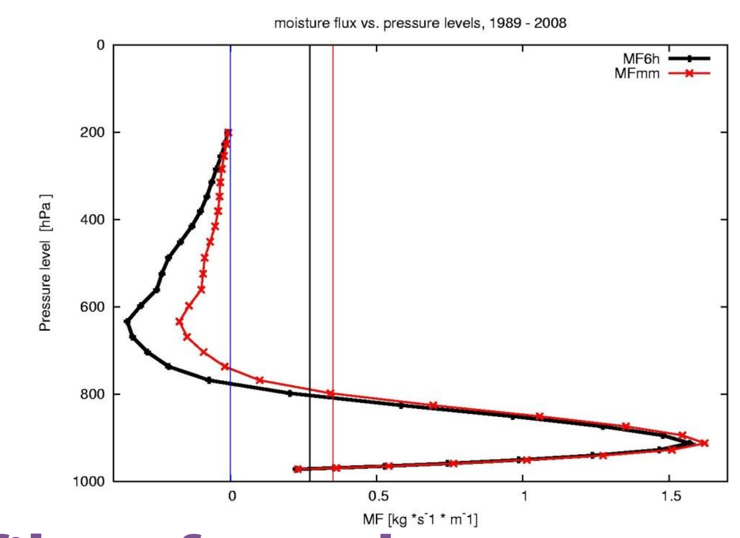

Fig 3: Vertical profile of moisture fluxes from MFmm (**red**) and MFhr (**black**)

Vertical profiles of trends

- Trends on different levels are generally similar
- Increase in outflow on the upper levels weaker in MFmm

	MF monthly avg, [kg/(s*m)]/month		MF yearly avgs, [kg/(s*m)]/year	
level	trend 6h	trend mm	trend 6h	trend mm
1	**-0.535E-05**	**-0.530E-05**	-0.664E-04	**-0.655E-04**
2	**-0.201E-04**	**-0.178E-04**	**-0.247E-03**	**-0.218E-03**
3	**-0.342E-04**	**-0.284E-04**	**-0.421E-03**	**-0.348E-03**
4	**-0.317E-04**	**-0.206E-04**	**-0.393E-03**	-0.256E-03
5	-0.127E-04	0.666E-05	-0.161E-03	0.757E-04
6	0.272E-05	**0.321E-04**	0.238E-04	0.381E-03
7	-0.532E-05	**0.365E-04**	-0.822E-04	0.426E-03
8	-0.516E-04	0.186E-05	-0.652E-03	-0.214E-05
9	**-0.123E-03**	**-0.604E-04**	**-0.151E-02**	-0.748E-03
10	**-0.209E-03**	**-0.138E-03**	**-0.252E-02**	**-0.166E-02**
11	**-0.276E-03**	**-0.200E-03**	**-0.329E-02**	**-0.237E-02**
12	**-0.272E-03**	**-0.185E-03**	**-0.324E-02**	**-0.220E-02**
13	**-0.210E-03**	**-0.112E-03**	**-0.250E-02**	-0.132E-02
14	**-0.177E-03**	-0.679E-04	**-0.208E-02**	-0.777E-03
15	**-0.241E-03**	**-0.122E-03**	**-0.281E-02**	-0.138E-02
16	**-0.315E-03**	**-0.196E-03**	**-0.363E-02**	-0.220E-02
17	**-0.291E-03**	**-0.189E-03**	-0.331E-02	-0.207E-02
18	-0.625E-04	0.107E-04	-0.561E-03	0.338E-03
19	**0.235E-03**	**0.284E-03**	0.298E-02	0.358E-02
20	**0.457E-03**	**0.477E-03**	**0.558E-02**	**0.583E-02**
21	**0.580E-03**	**0.577E-03**	**0.698E-02**	**0.695E-02**
22	**0.593E-03**	**0.578E-03**	**0.707E-02**	**0.690E-02**
23	**0.527E-03**	**0.509E-03**	0.625E-02	0.605E-02
24	**0.428E-03**	**0.413E-03**	0.508E-02	0.489E-02
25	0.363E-03	0.352E-03	0.430E-02	0.417E-02
26	**0.325E-03**	0.316E-03	0.383E-02	0.373E-02
27	**0.269E-03**	**0.262E-03**	0.318E-02	0.310E-02
28	**0.205E-03**	**0.200E-03**	0.243E-02	0.237E-02
29	**0.144E-03**	0.141E-03	0.171E-02	0.167E-02
30	**0.951E-04**	0.934E-04	0.113E-02	0.111E-02
31	0.598E-04	0.590E-04	0.709E-03	0.698E-03

Table 1: trends of MF at different vertical levels, trends in bold are significantly .ne. 0 at 99.50000 % level