Variability of radiation properties for different cloud types observed by CERES

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8th CERES-II Science Team Meeting
Victoria, BC V8W 1W5, Canada
November 14-16, 2007

Introduction

- Cloud types:
  classification of clouds -- top pressure & thickness

- High and low cloud studies:
  - tropical deep convection: thermostat & iris effects
    satellite obs: GISS, LaRC, other institutes
  - temperature dependent
    ISCCP -- middle and low latitude clouds
    ARM -- similar results as those from satellite
    LaRC -- polar clouds

  all on environmental conditions

- This study -- variability, changes with time; indirectly related to environmental conditions

Introduction (conti.)

- Physical processes:
  - high clouds -- storms, deep convection
  - low clouds -- BL upwelling (q), shallow convection

- Cloud types and radiation:
  - high clouds -- anvils: SW (weak-strong); LW (cold)
  - low clouds -- straticu.: SW (strong); LW (warm)

- Observations:
  - BB radiation -- SW & LW
  - cloud detection -- MODIS, VIS & IR
  - physical properties – OD, LWP/IWP, CC, eff. size

Data Set & Method

- CERES Aqua SSF:
  Jan. 1, 2003 to Dec. 31, 2005
- TOA fluxes: direct measurements
- Surface fluxes: model B
- Cloud products:
  MODIS/CERES results

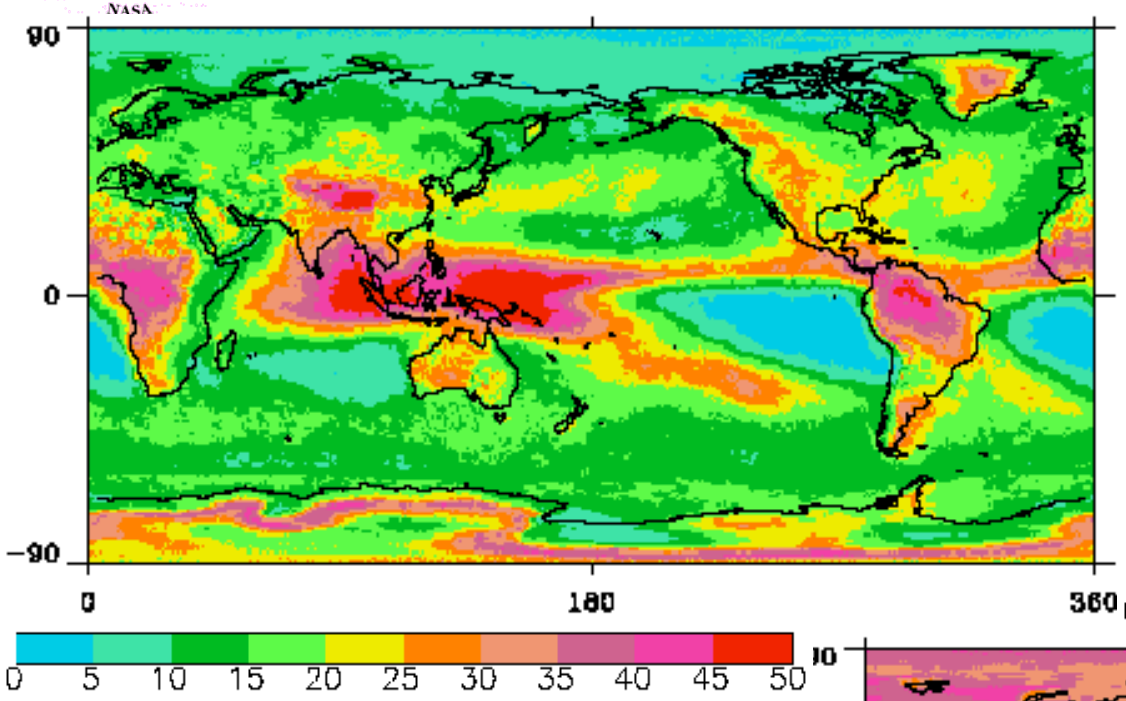
- Data selection:
  cloud types in typical areas -- annual mean

- Statistical analysis:
  means, histograms, and time series
  → variability

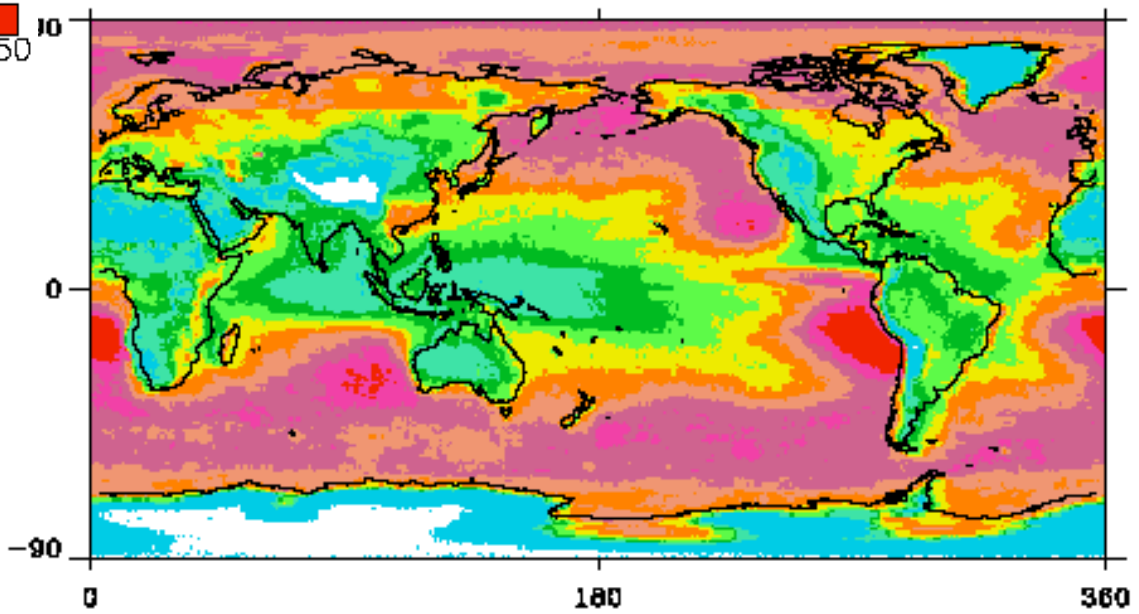
Global distribution (2005)

high clouds

from Aqua

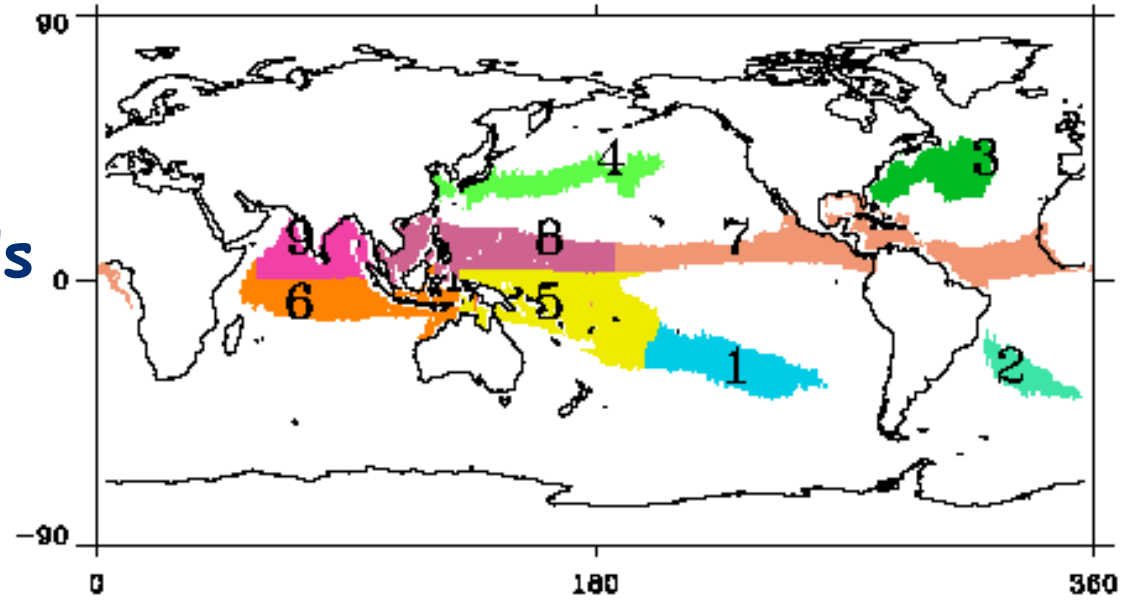


low clouds



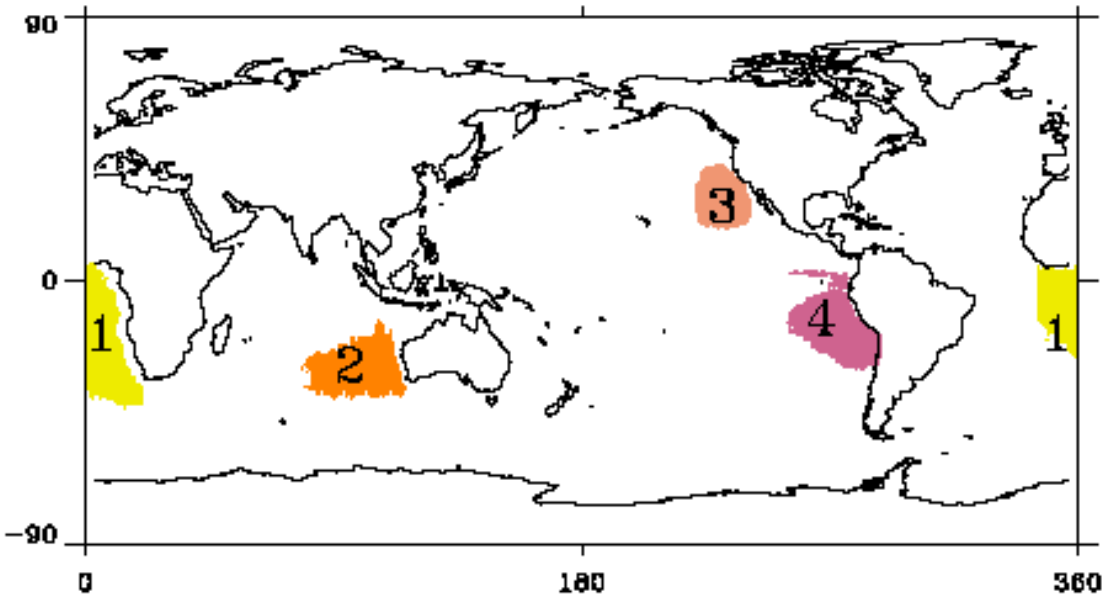
targeted regions

high clouds
>20%



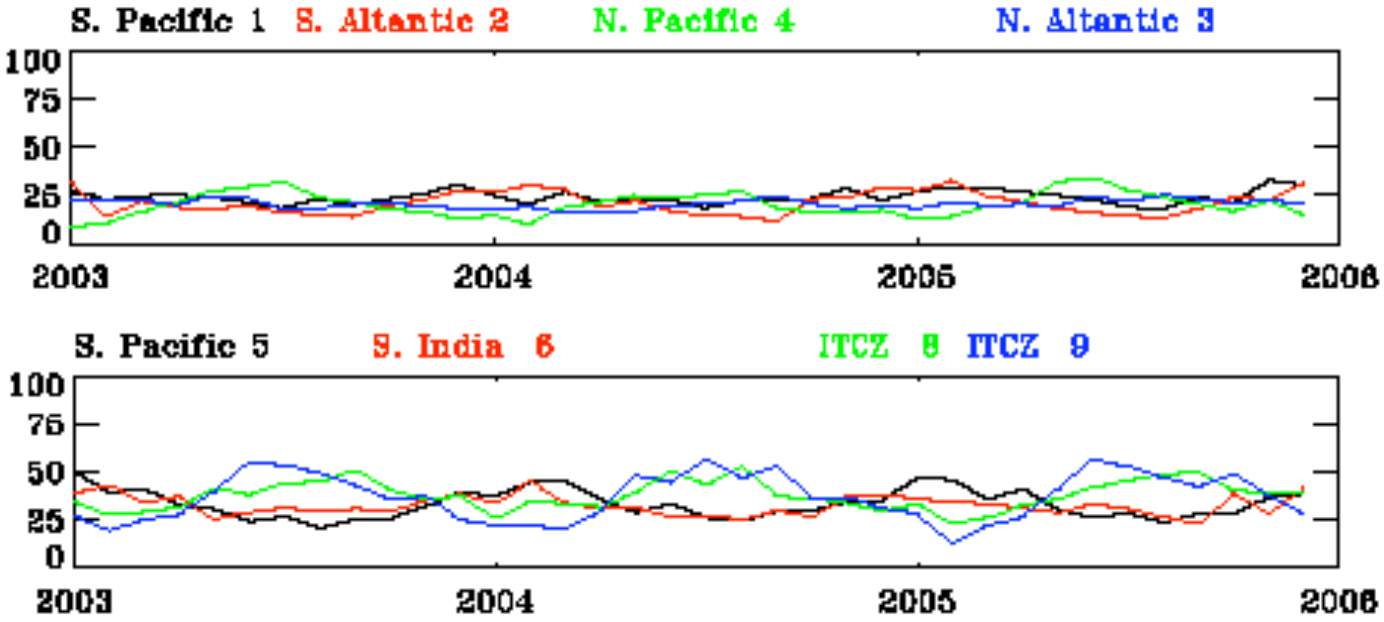
all clouds in the regions as long as in the type

low clouds
>36%

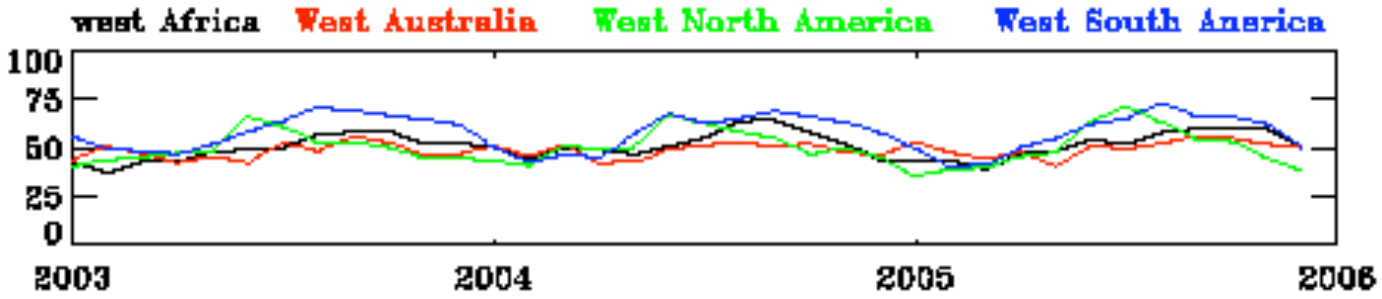


Cloud cover

high clouds

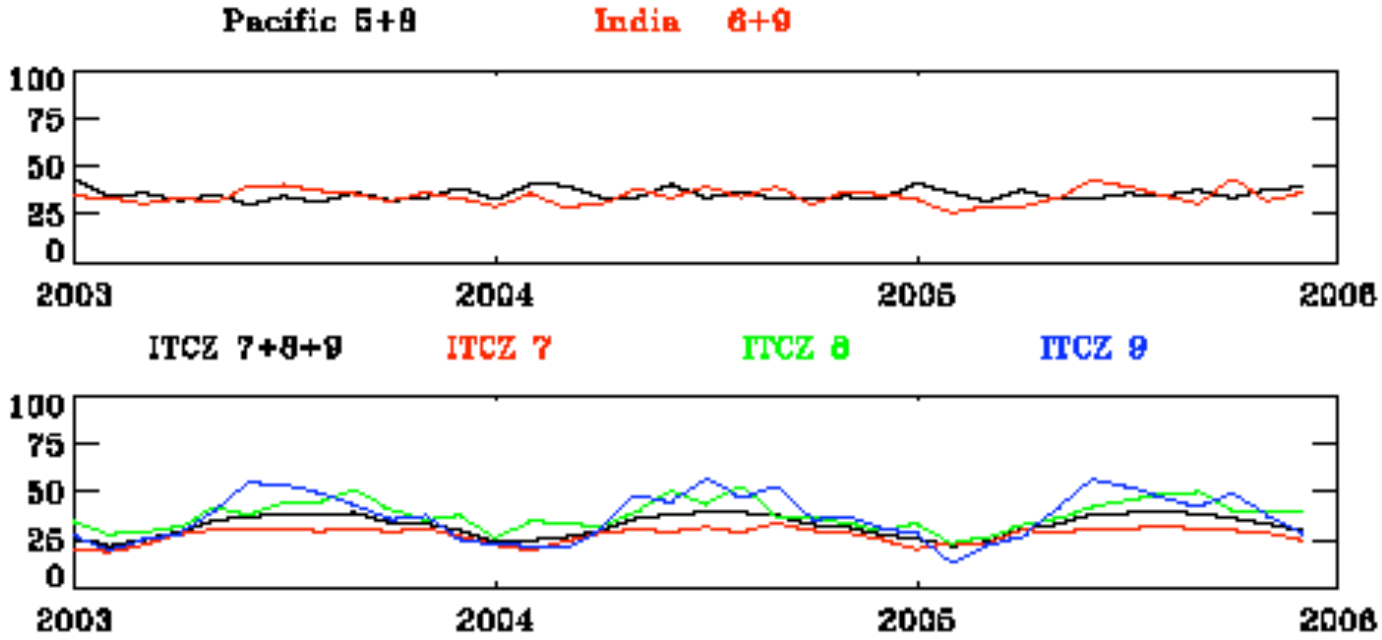


CC: pretty large differences



low clouds

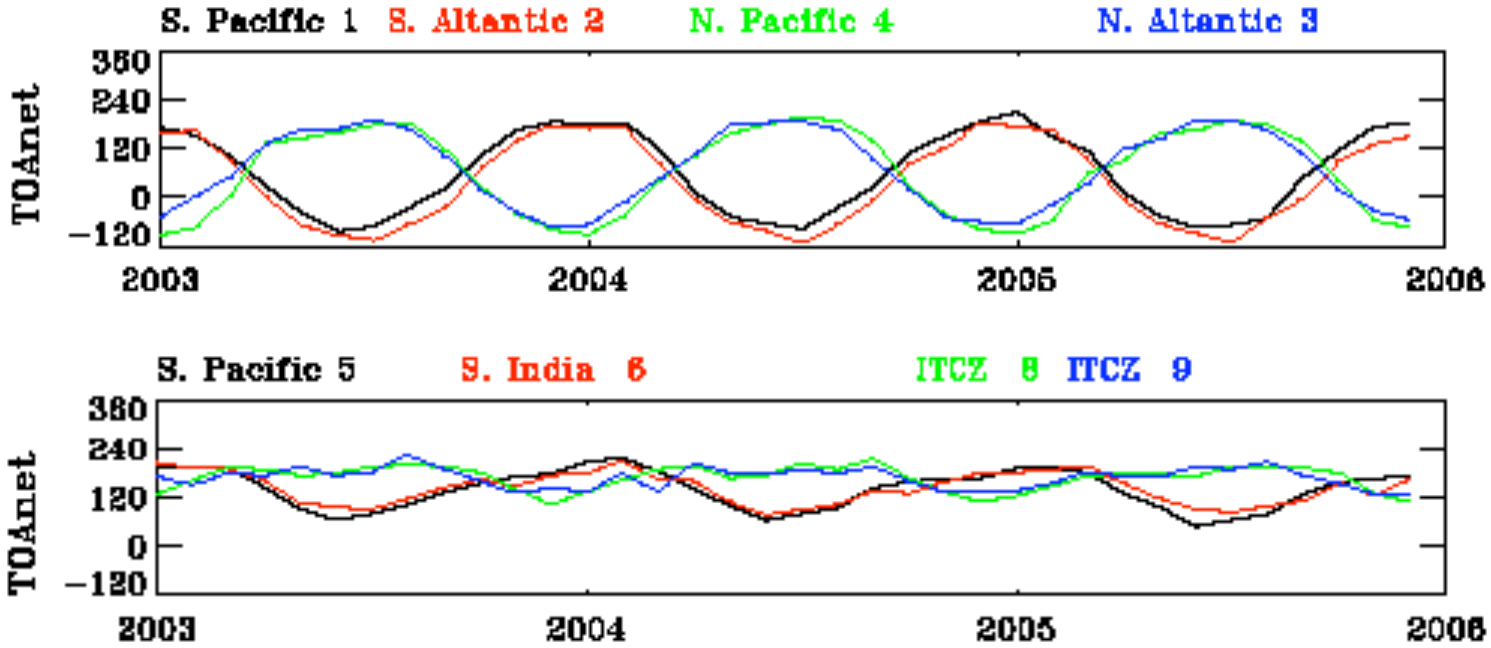
Cloud cover

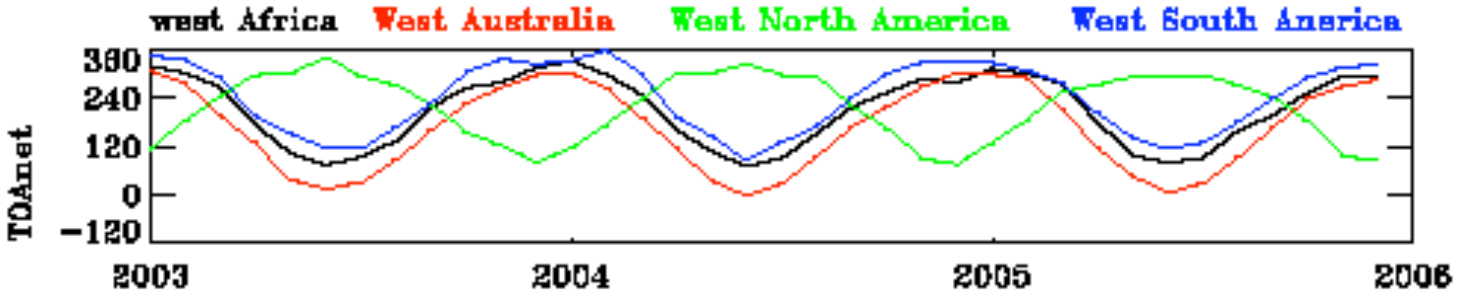


large differences for different ITCZ areas

TOA radiation

high clouds similarity: diff. areas

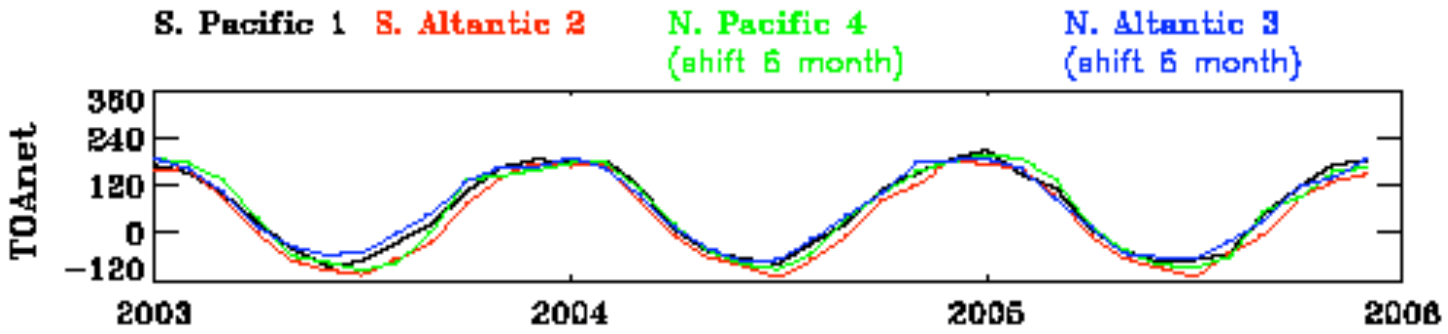




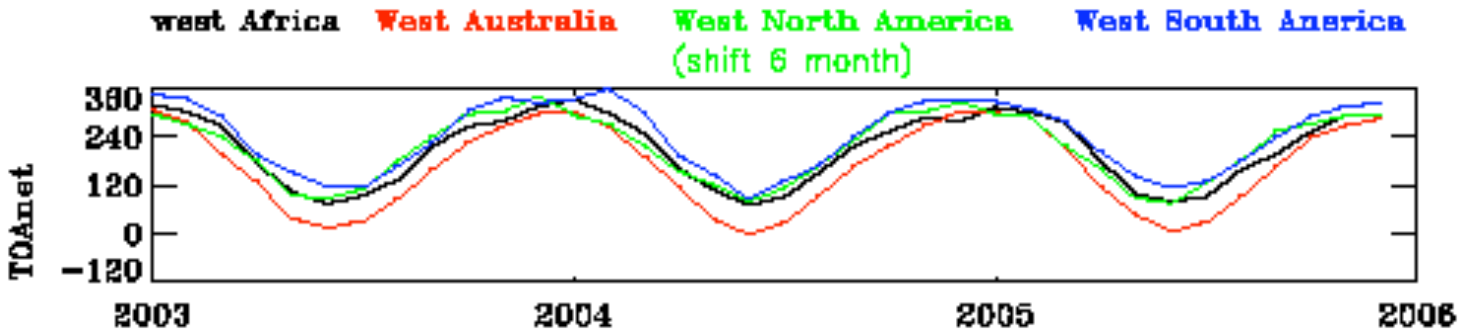
low clouds

TOA boreal radiation

high clouds

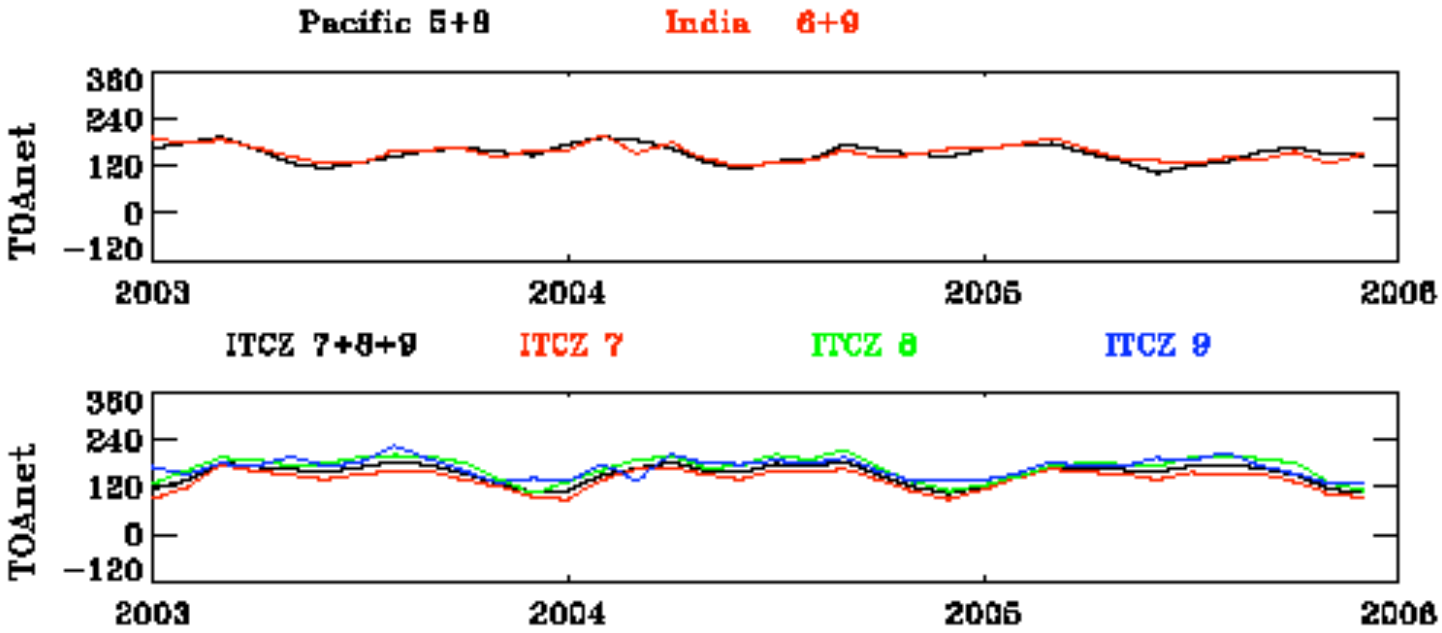


6-months-shifted data: N.P. & N.A.



low clouds

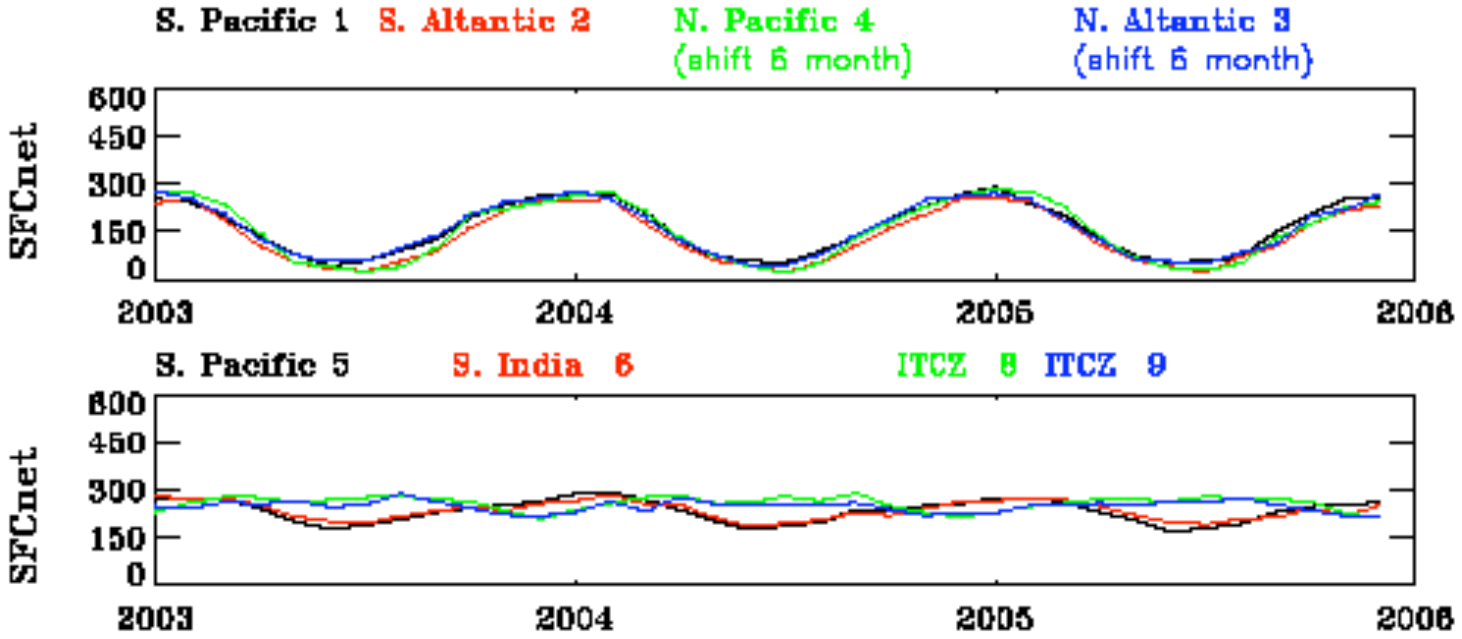
TOA radiation



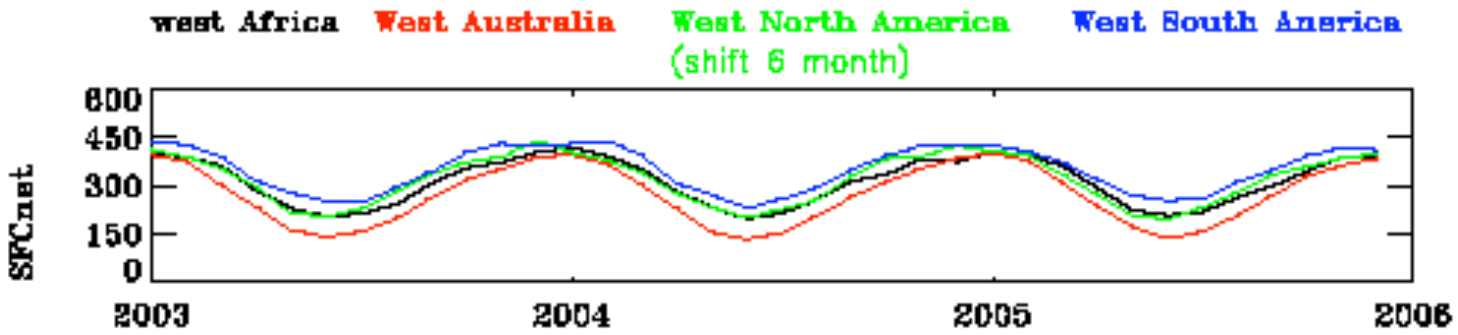
high similarity between western Pacific and India Ocean and among ITCZ areas

SFC radiation

high clouds

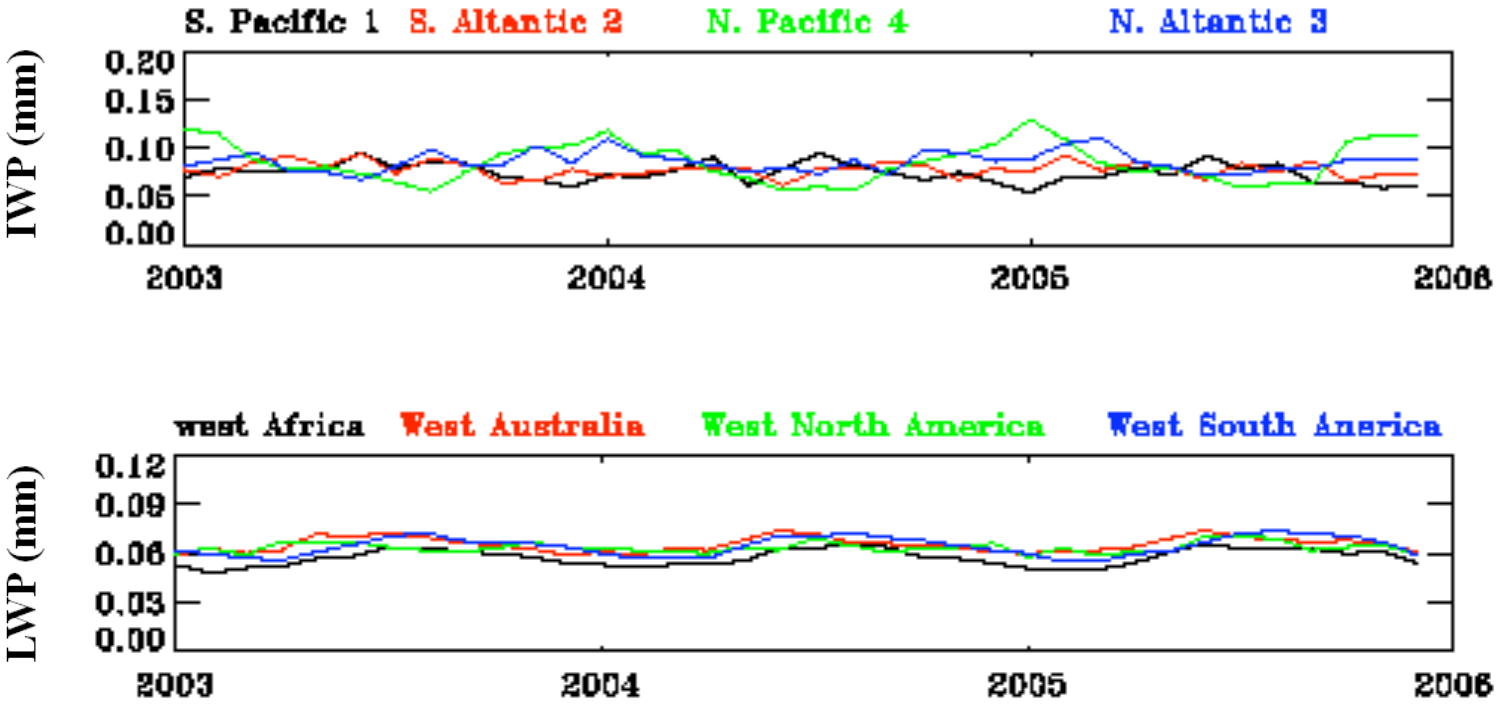


6 months shifted data: N.P. & N.A.

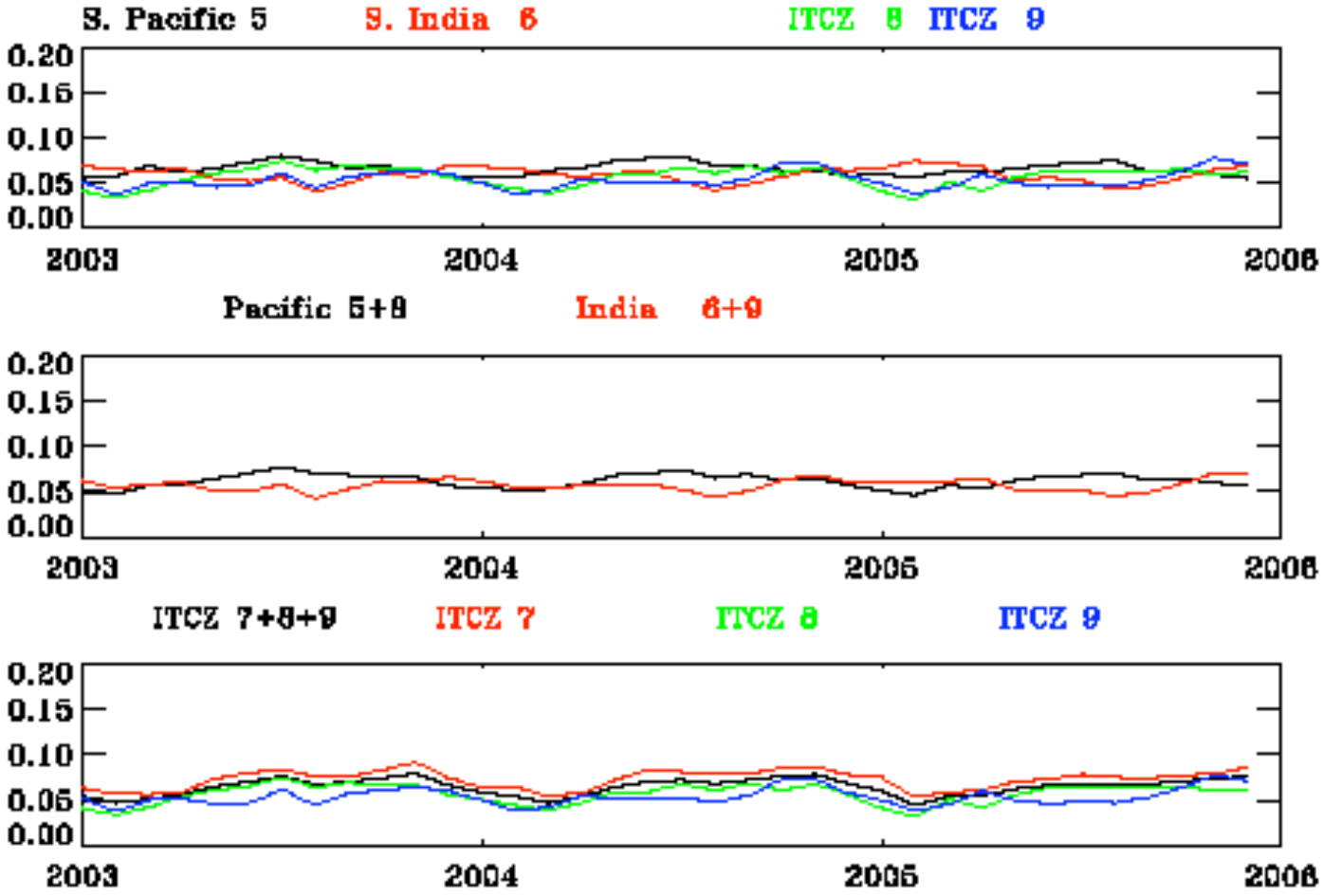


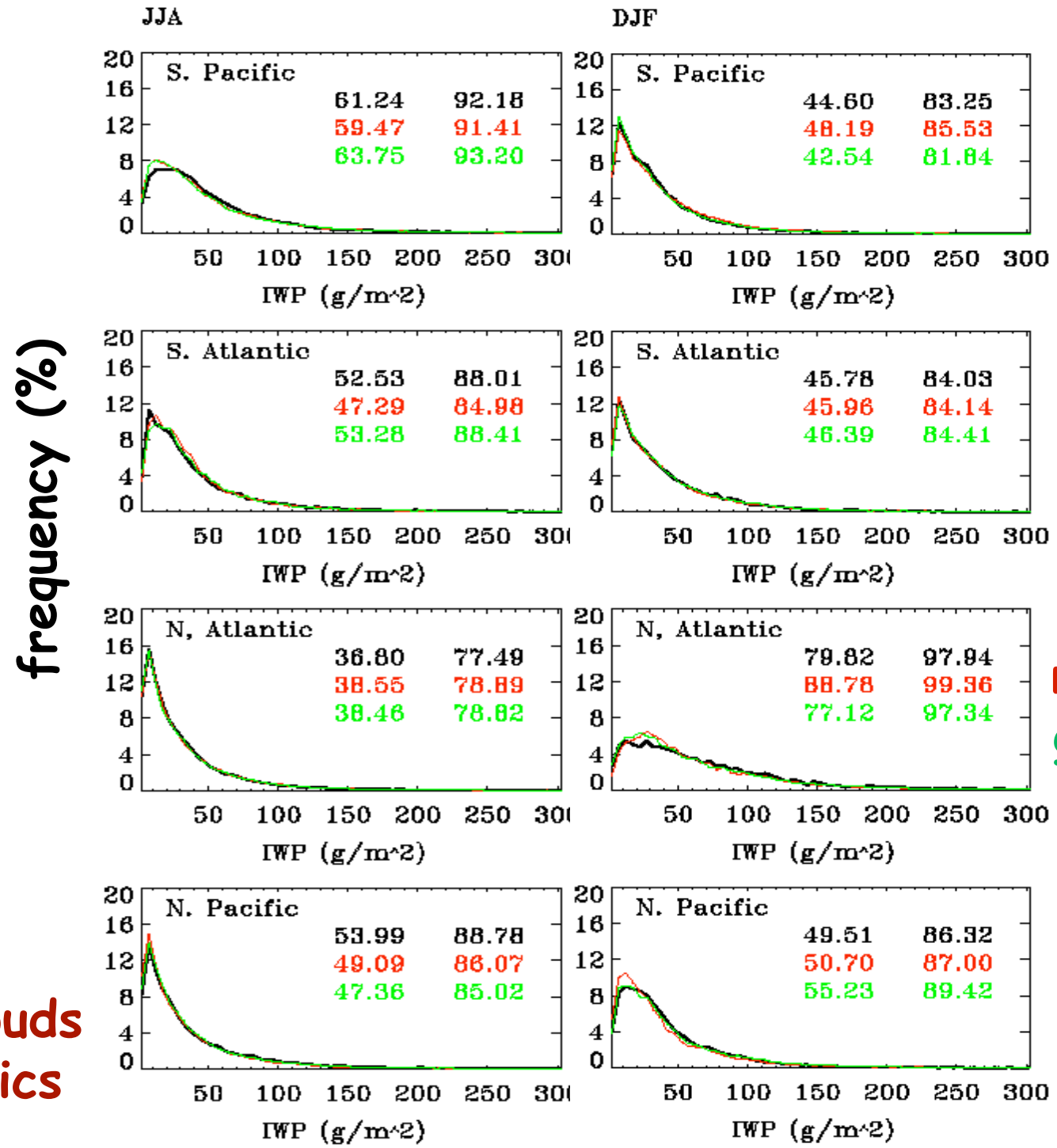
low clouds

IWP & LWP


S. Pacific 1
S. Altantic 2
N. Pacific 4
N. Altantic 3
IWP (mm)
0.20
0.15
0.10
0.05
0.00
2003
2004
2005
2006
west Africa
West Australia
West North America
West South America
LWP (mm)
0.12
0.09
0.06
0.03
0.00
2003
2004
2005
2006

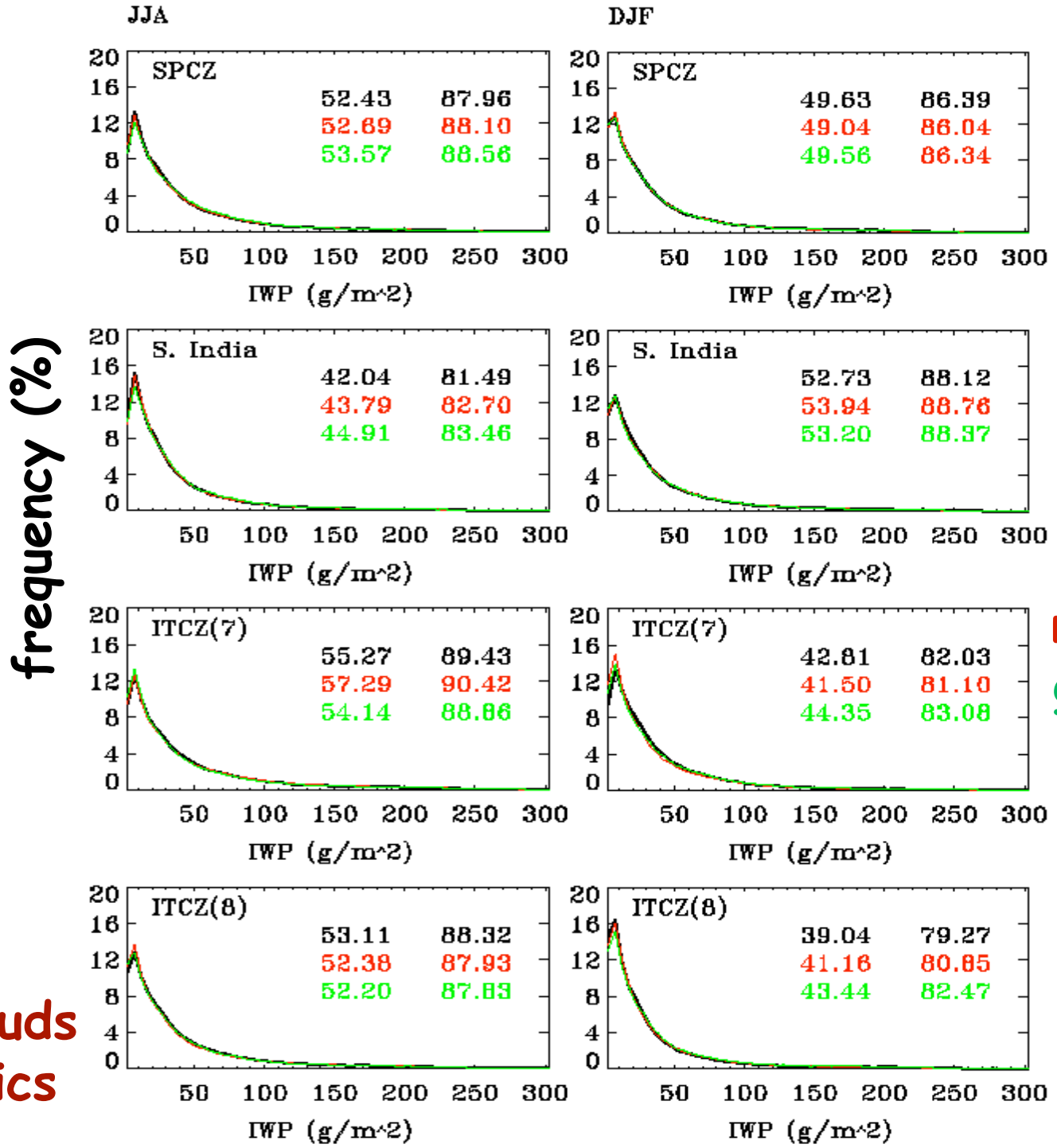
IWP (mm)


S. Pacific 5
S. India 6
ITCZ 8
ITCZ 9
0.20
0.15
0.10
0.05
0.00
2003
2004
2005
2006
Pacific 5+8
India 6+9
ITCZ 7+8+9
ITCZ 7
ITCZ 8
ITCZ 9



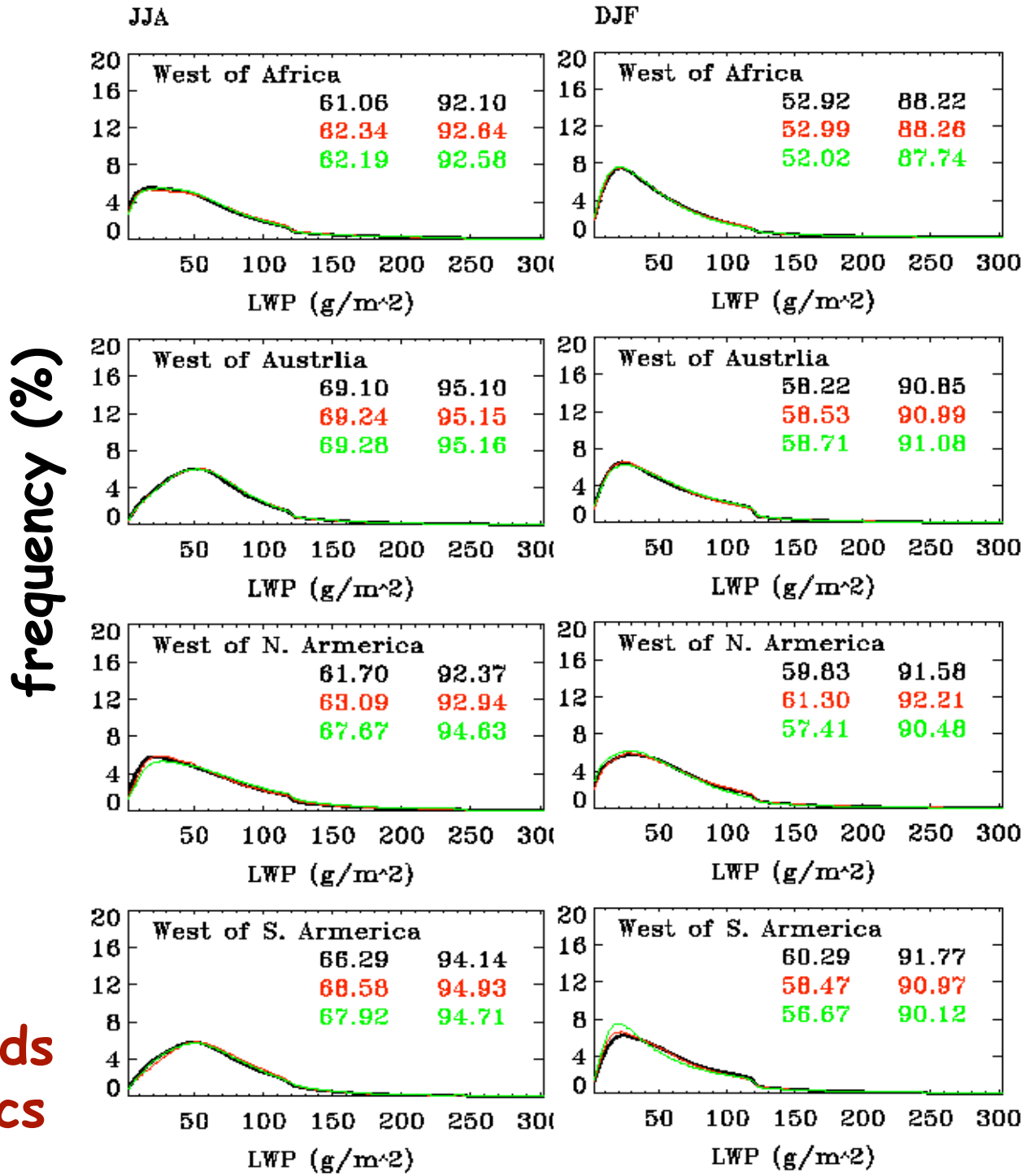
blk: 2003
red: 2004
grn: 2005

high clouds statistics



blk: 2003
red: 2004
grn: 2005

high clouds statistics



blk: 2003
red: 2004
grn: 2005

low clouds statistics

Summary

- For major cloud types, such as marine high and low clouds, they persistently occur in certain areas due to local meteorological conditions.

- The same types of clouds from different preferred areas generally have different radiative fluxes due mainly to the differences in solar insulation and local temperature.

- When the same types of clouds are analyzed in the same boreal seasons, although there are large differences in cloud covers, the differences in radiation fluxes of these clouds are remarkably reduced: both in time series and histograms.

Summary (conti.)

- The inter-annual variations in the mean LWP and IWP estimates for marine straticumulus and anvil clouds, respectively, are very small, at least for these normal climate years.

- Generally, area-to-area variability is as large as seasonal variability. Anvils in North Atlantic storm track may have the largest seasonal variability, while clouds off the coast of California has minimal variation.

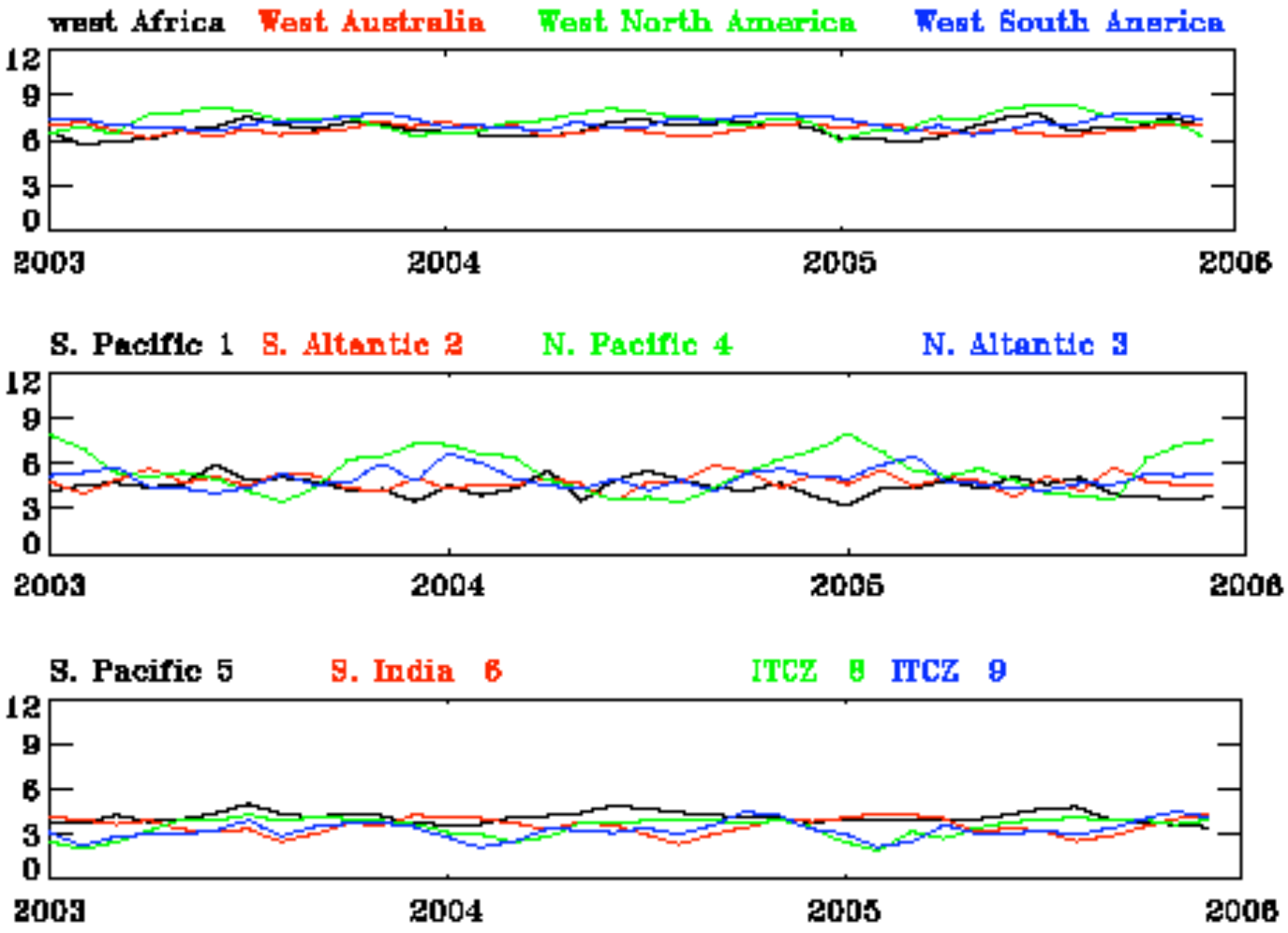
- The cloud climate feedbacks for the clouds in the targeted areas could be obtained through monitoring physical properties (CC, LWP, IWP, and OD) or the basic meteorological conditions in the areas. The former may be more suitable for satellite observations.

Acknowledgement

Discussions with D. Young, G. Gibson, W. Sun, and Y. Hu of LaRC, and others are very helpful for this study.

This research was supported by NASA CERES Mission and NEWS Projects.

OD


west Africa
West Australia
West North America
West South America
12
9
6
3
0
2003
2004
2005
2006
S. Pacific 1
S. Atlantic 2
N. Pacific 4
N. Atlantic 3
12
9
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3
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2005
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S. Pacific 5
S. India 6
ITCZ 8
ITCZ 9
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