Role of Scatterometer Data in Tropical Meteorology

- MJO and Tropical Cyclone Studies –

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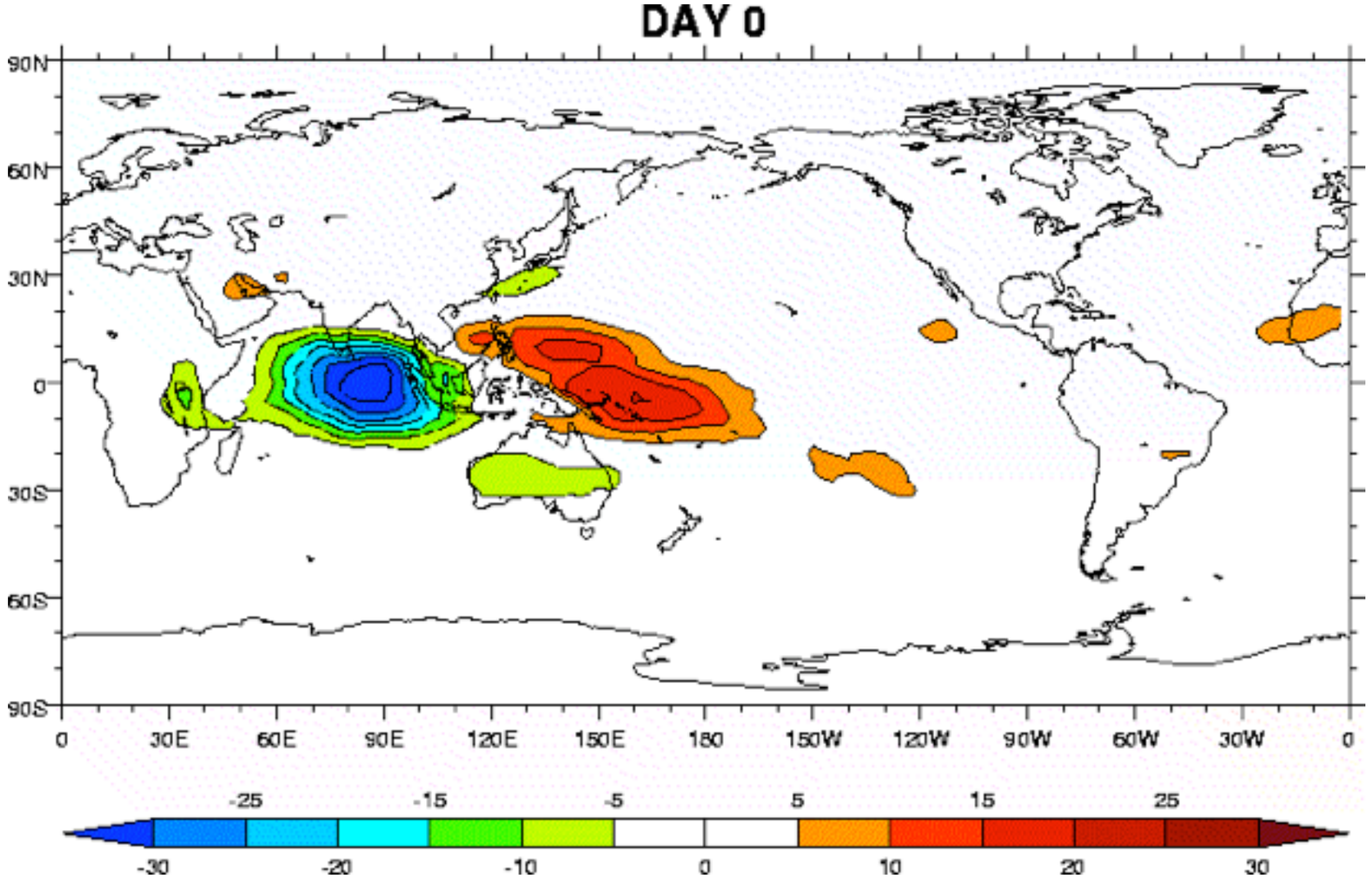
Meteorological Research Institute/JMA

MJO

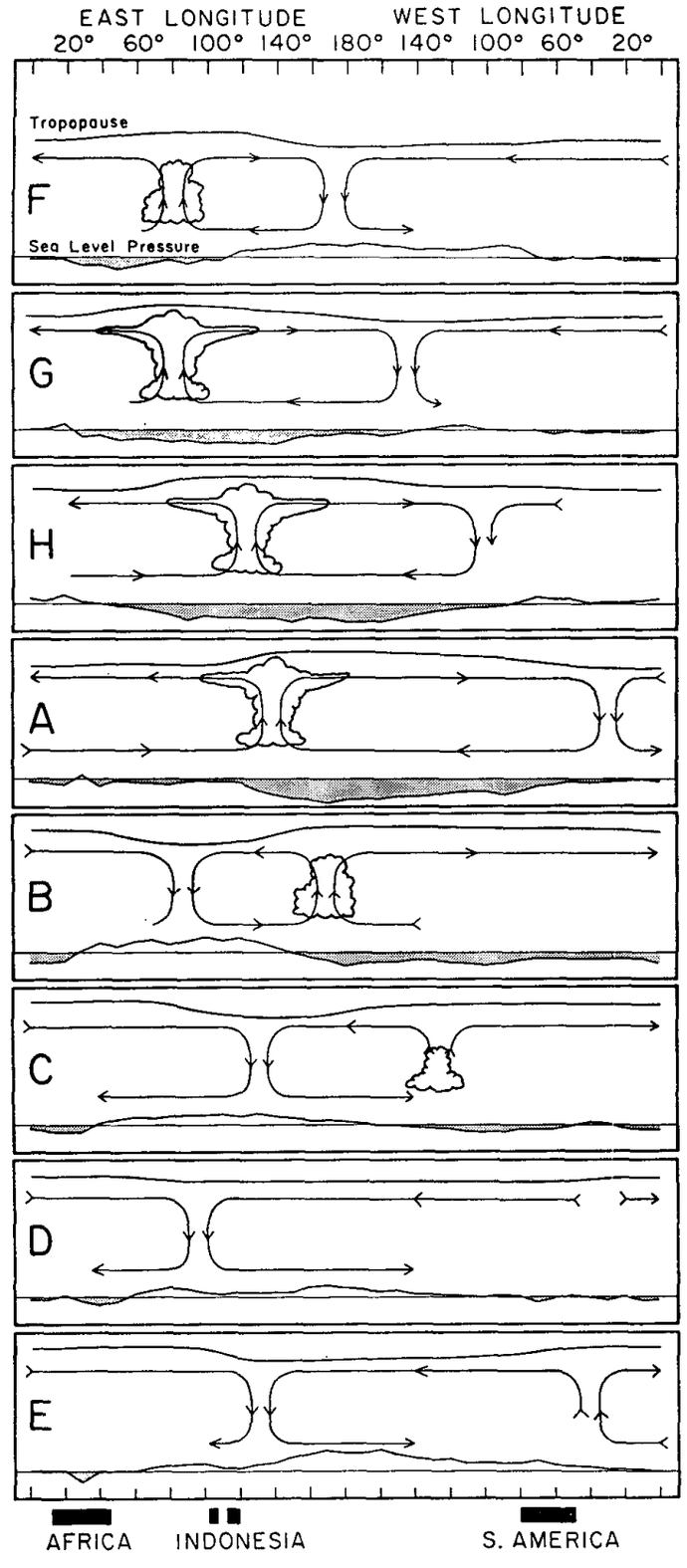
Tropical Intraseasonal Oscillation

Eastward-moving Active Convection from
Indian Ocean to Western Pacific



(Reference : http://envam1.env.uea.ac.uk/)

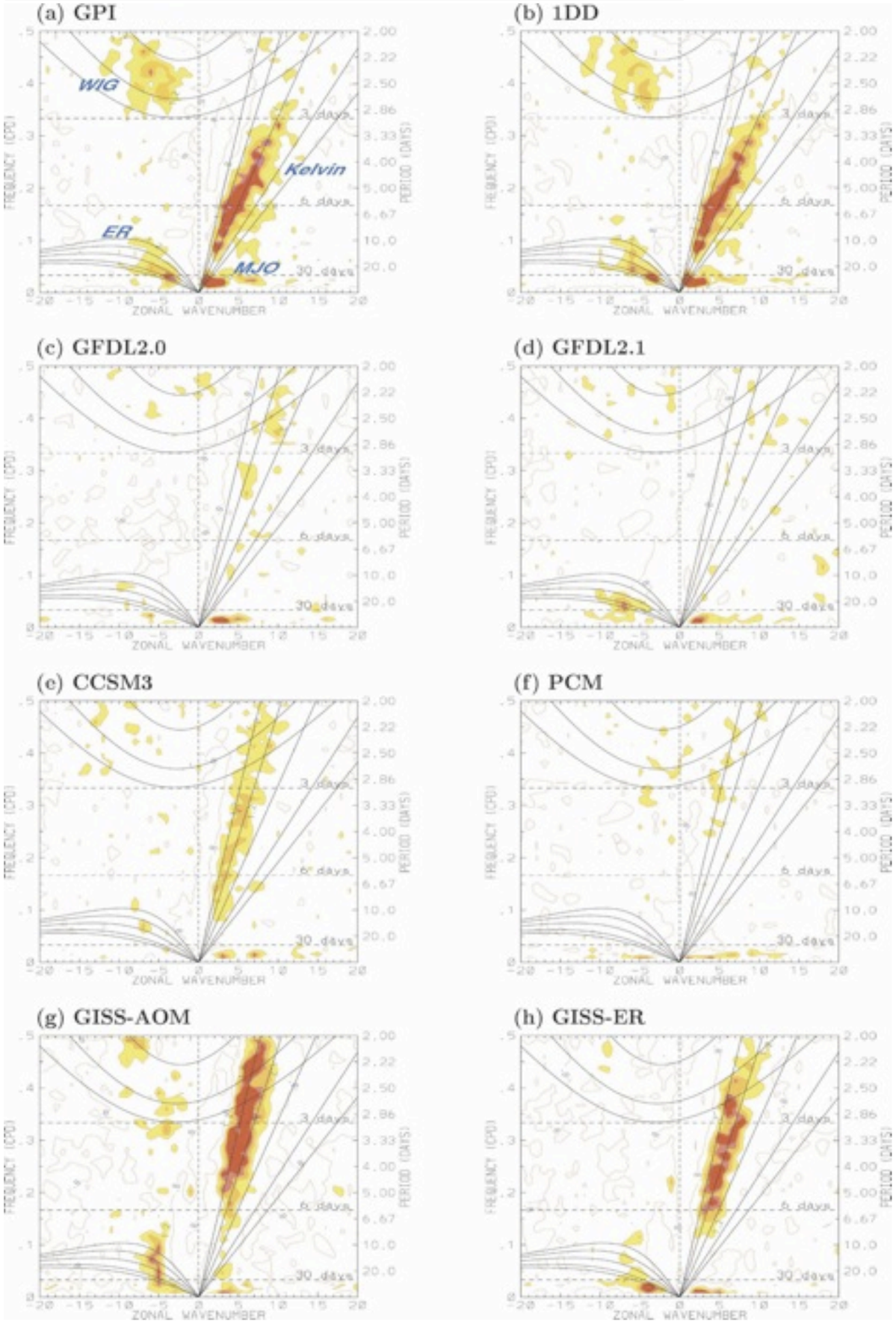
- Takes 1–2 month to move around the tropical globe
- Detected by Madden and Julian in 1971
- Called “Madden–Julian Oscillation” or “Tropical Intraseasonal Oscillation”
- Not well simulated in the model



(Madden and Julian, 1972)

Lin et al., 2006, J. Clim.

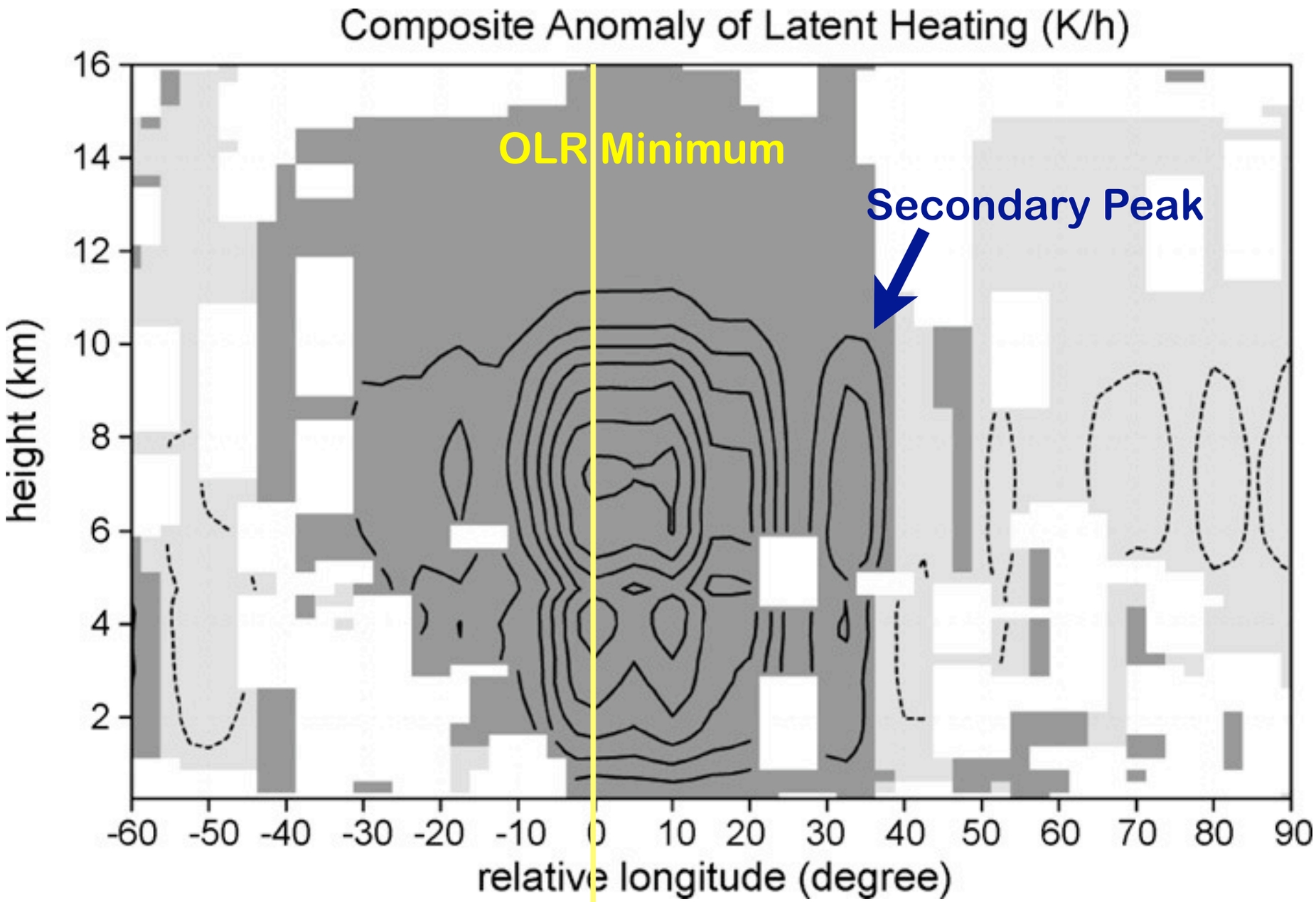
14 IPCC-4 Models for MJO



MYSTERY OF MJO

- MJO is a largest organized convection system (zonal wavenumber of 1 - 2) over the globe, but we do not know the organization mechanism into a planetary scale.
- It is really hard to draw the whole picture of it, due to its planetary scale. The data are usually band-pass filtered in time, to try to understand the behavior, but it does not help, because MJO is a mutli-scale phenomenon, composed by moist Kelvin waves.
- Most atmospheric GCMs can simulate moist Kelvin waves, but not MJO. Why?
- Pre-conditioning, or MJO-genesis is not well known.

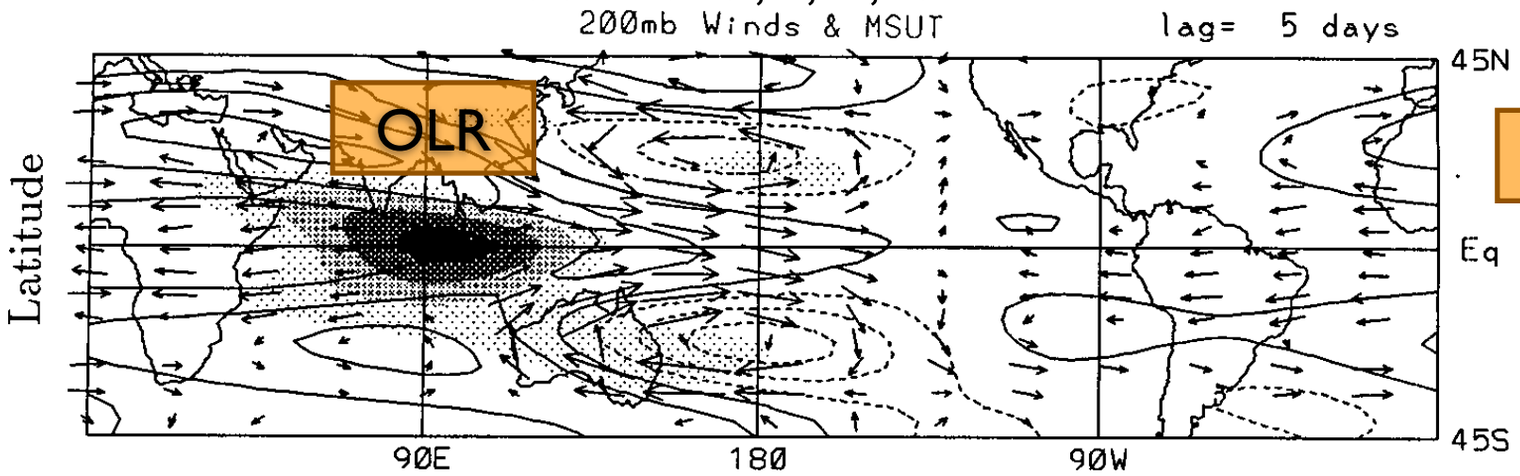
Latent Heating Characteristics of MJO



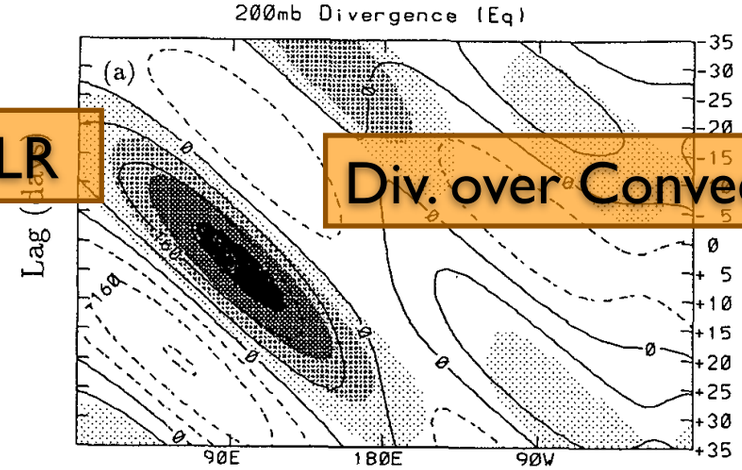
Morita et al. (2006)

Hendon & Salby, 1994, JAS

200hPa U,V, T, OLR



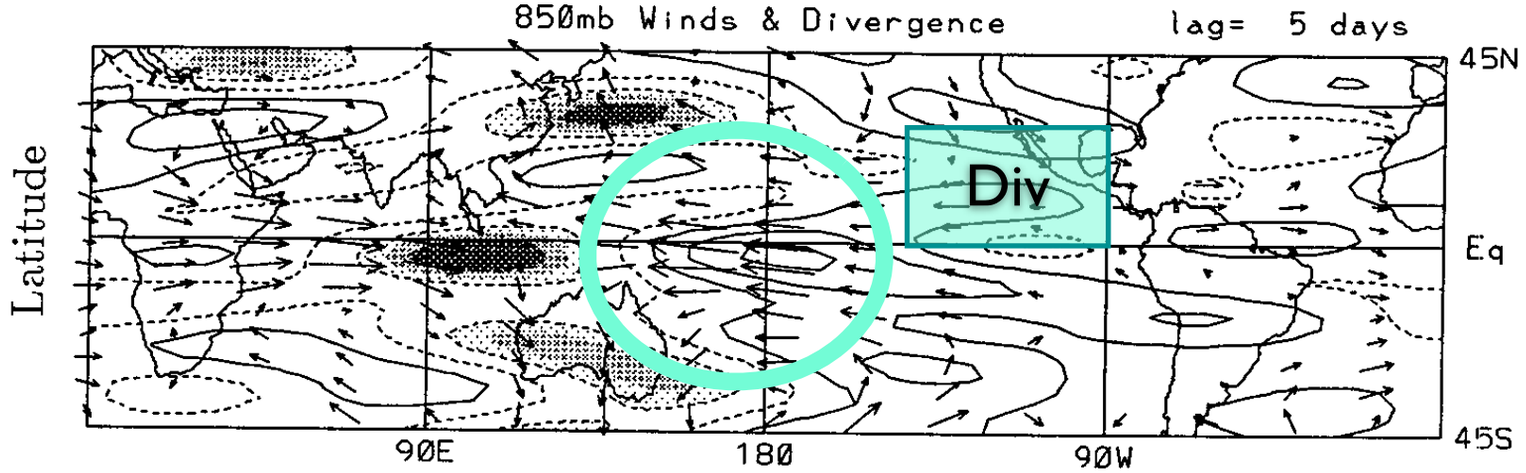
200hPa Div



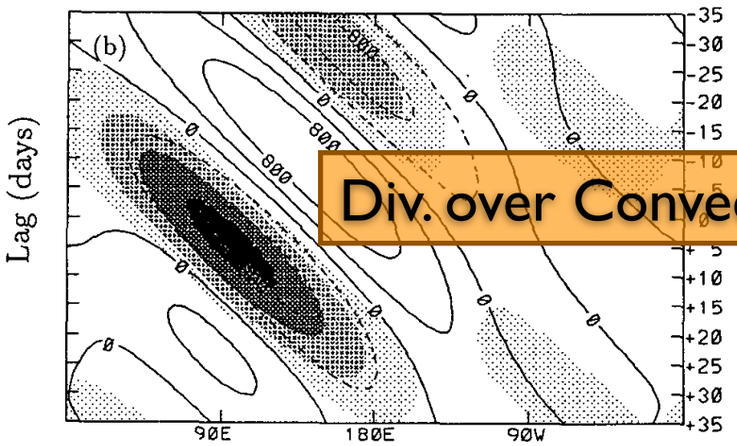
OLR

Div. over Convection

850hPa U,V, Div, OLR

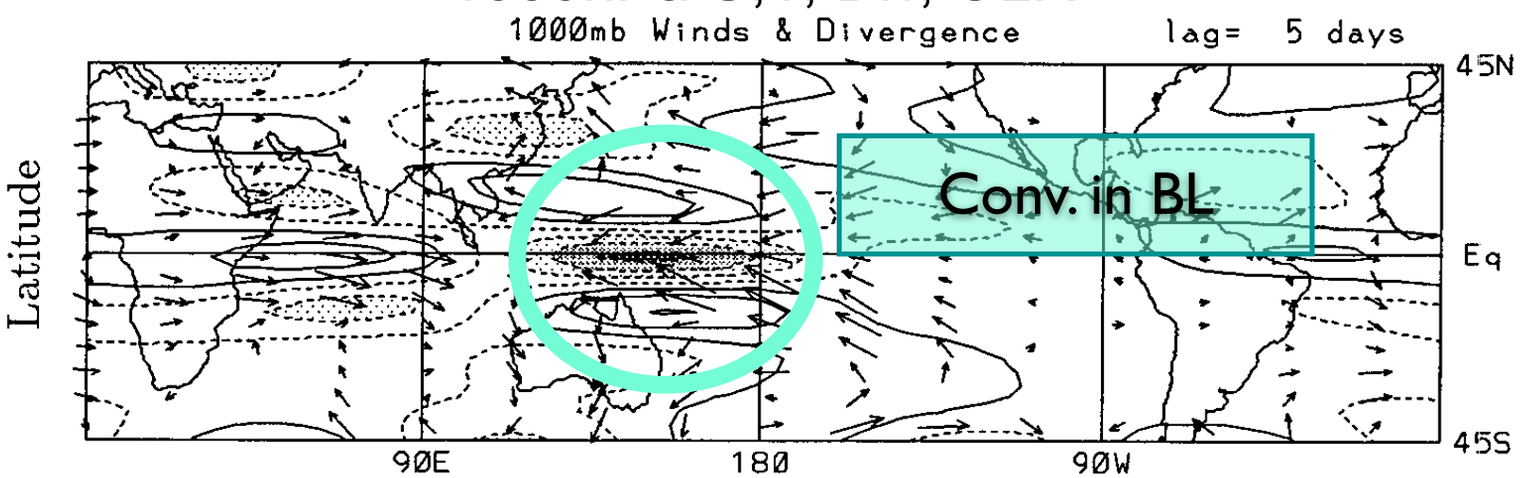


850hPa Div

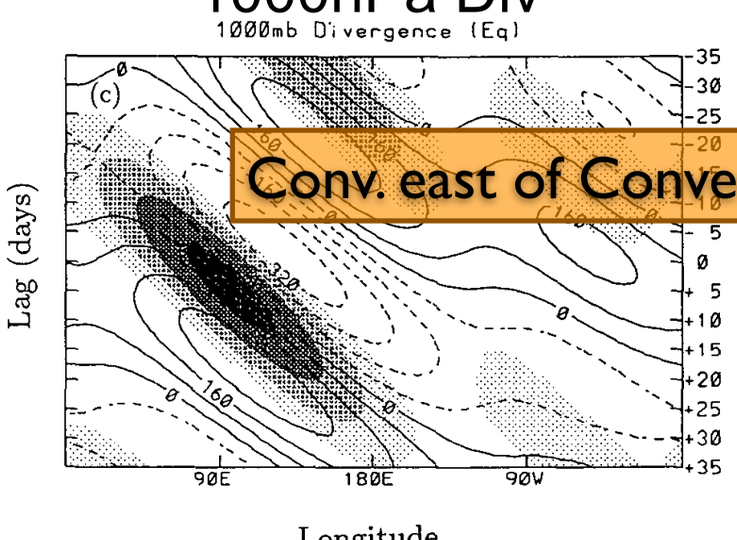


Div. over Convection

1000hPa U,V, Div, OLR

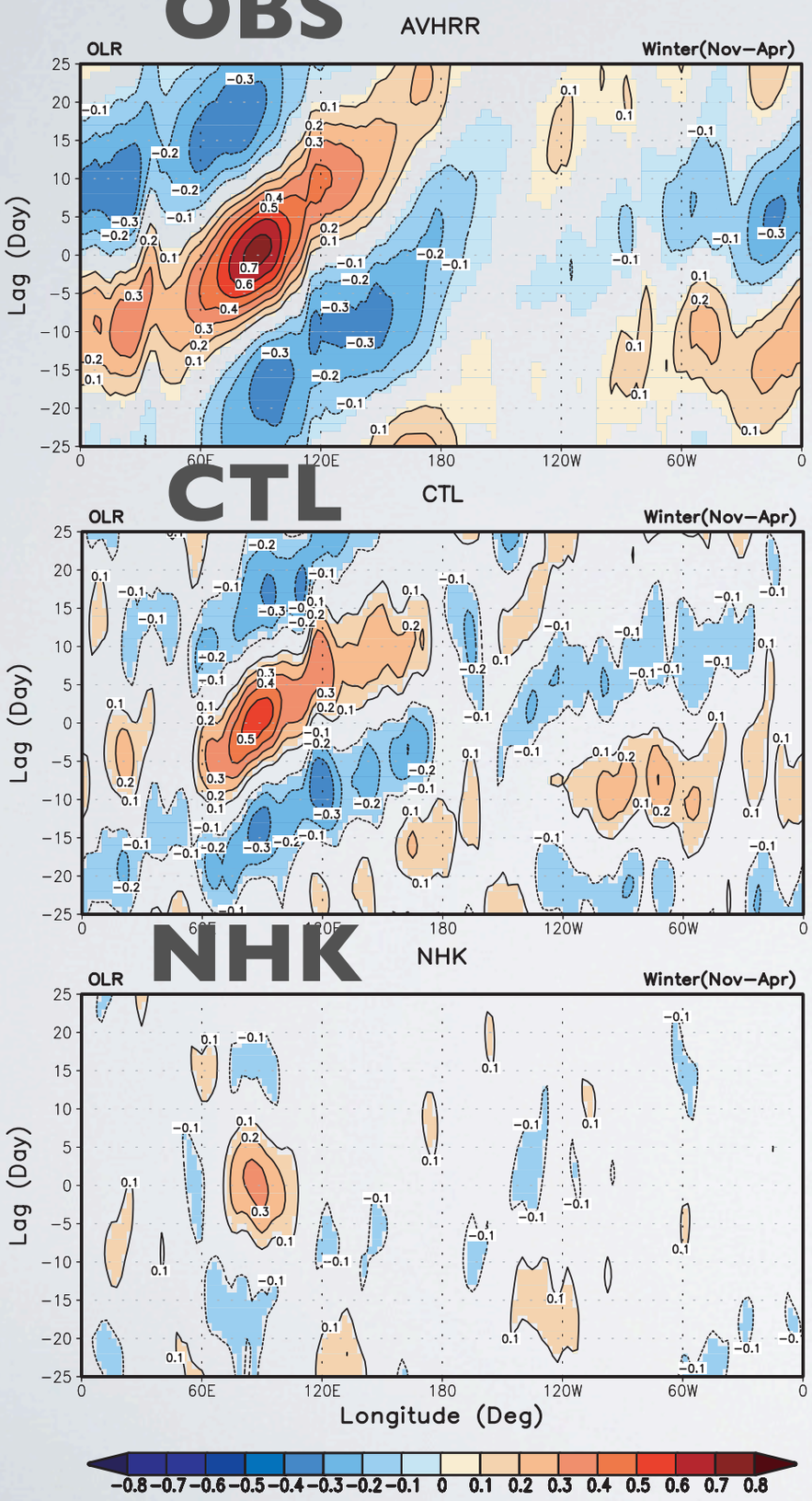


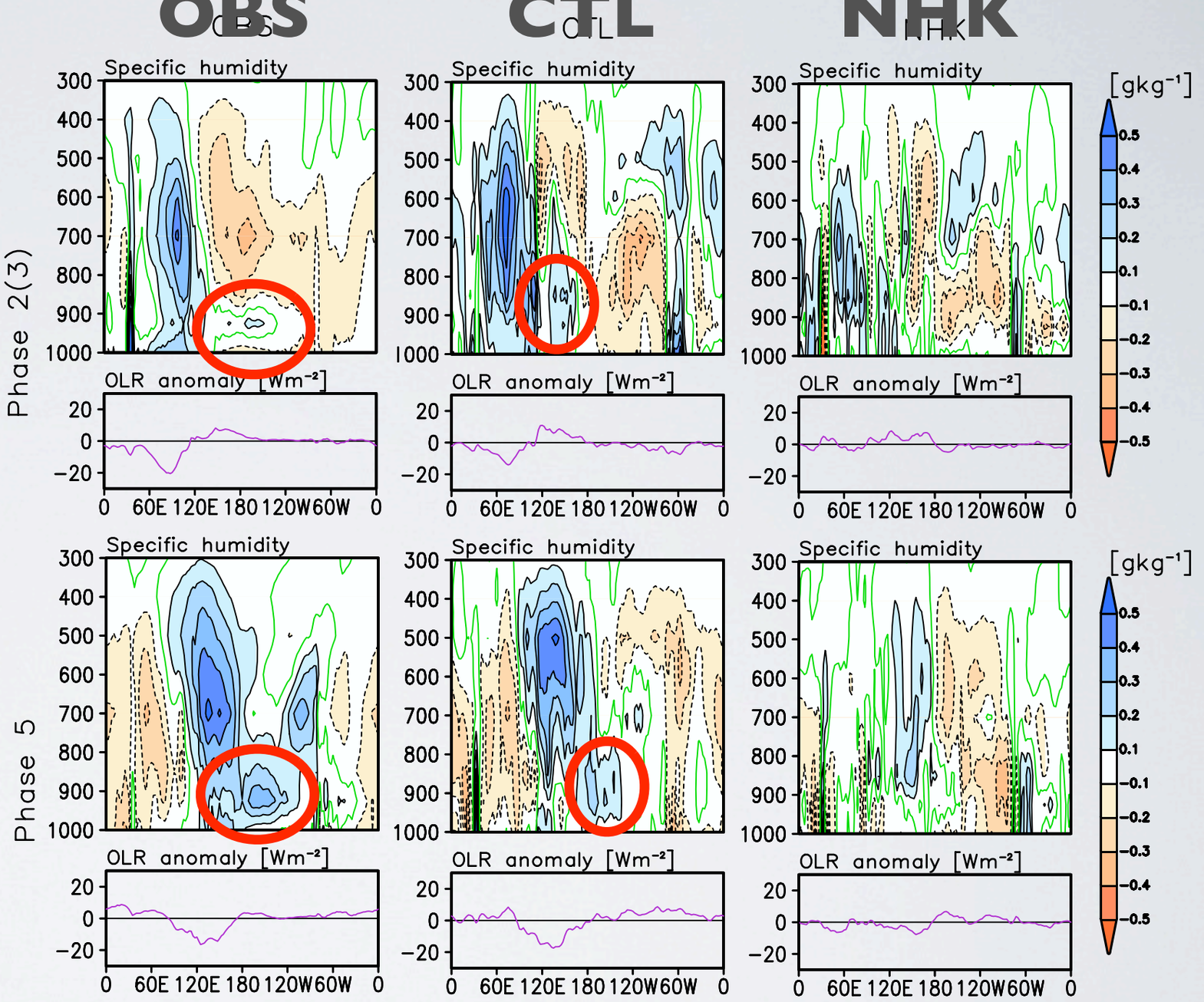
1000hPa Div



Conv. east of Convection

ZHANG AND SONG, 2009 GRL

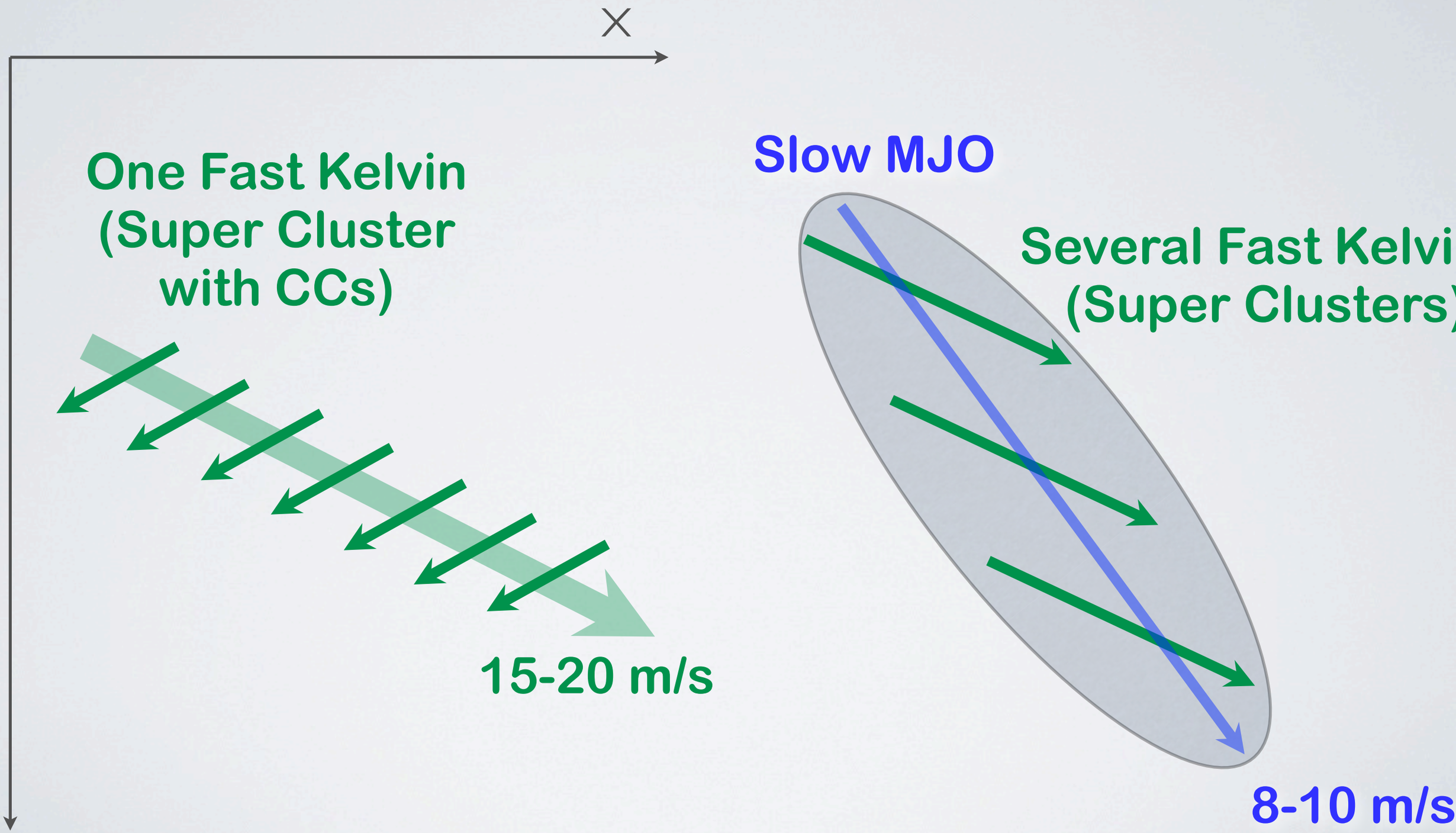




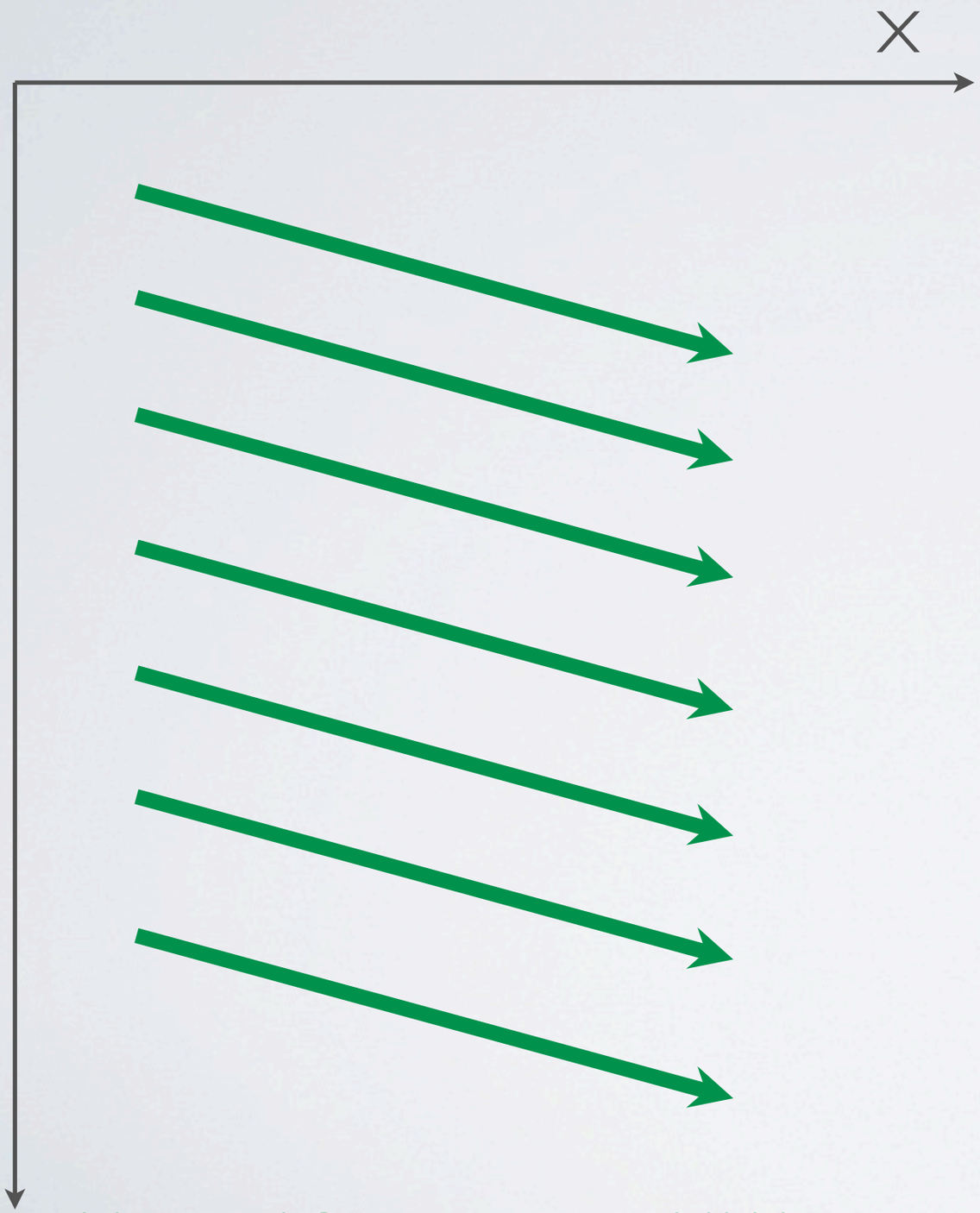
CTL: Deep Convection Scheme by Zhang & Mu(2005) + Shallow Convection Scheme by Hack(1994)

NHK: No Shallow Convection Scheme by Hack(1994)

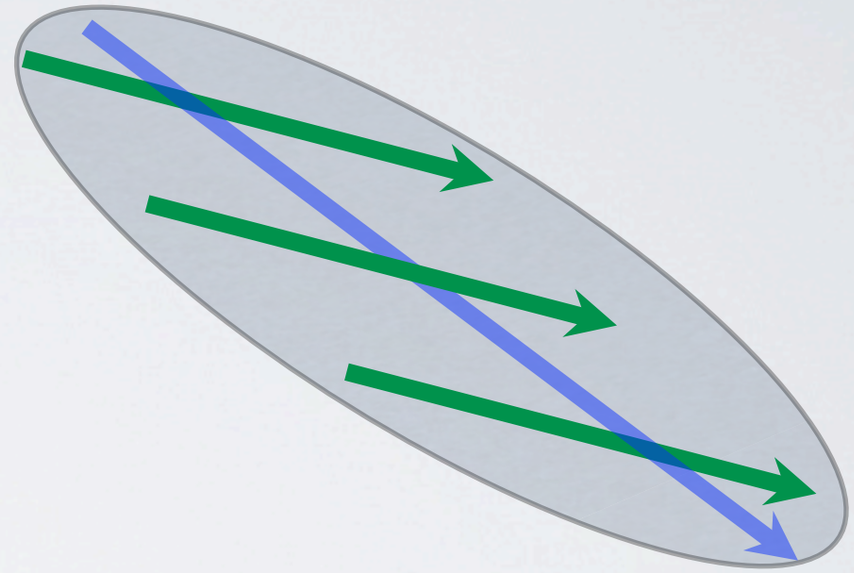
WIDE PERIODICITY OF MJO

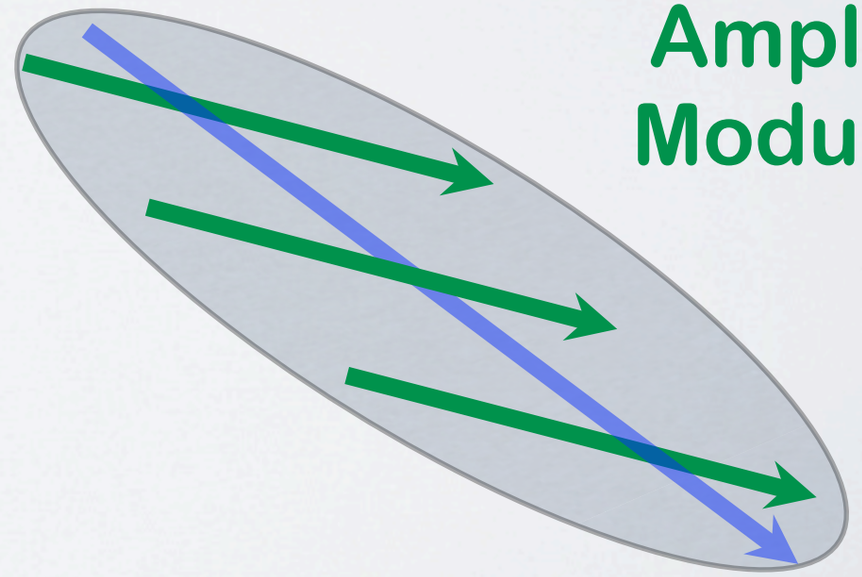


CLUSTERING OF KELVIN WAVES



No MJO, many MKWs



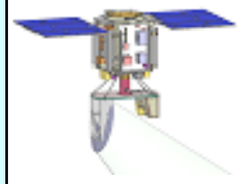


Amplitude Modulation

MJO with MKW Clustering

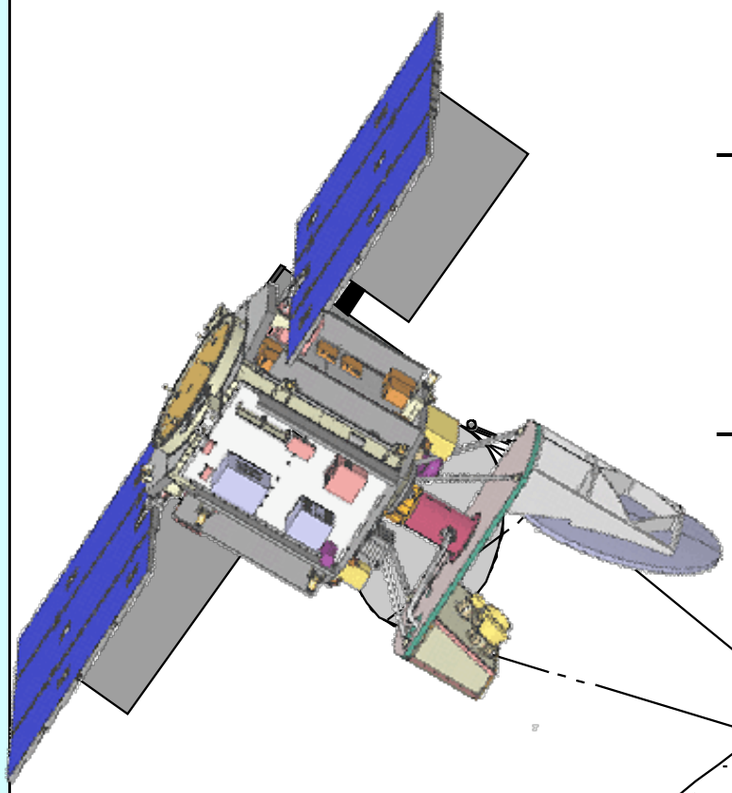
MJO BY SCATTEROMETERS

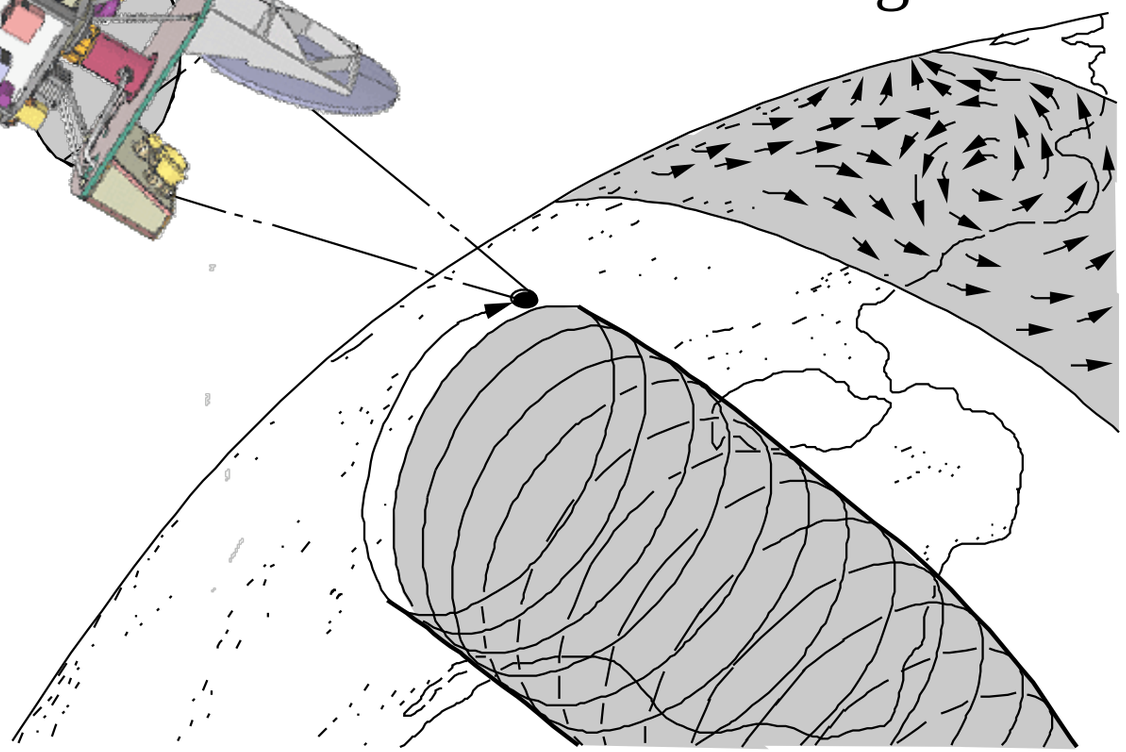
- Pre-conditioning over the Indian Ocean would be a key?
  - Indian Ocean: Genesis Region
- Coupling of moist Kelvin waves with convection
  - Kelvin-wave westerlies west of MJO
  - Trade wind easterlies east of MJO
- Detailed Circulation Analysis by Scatterometers



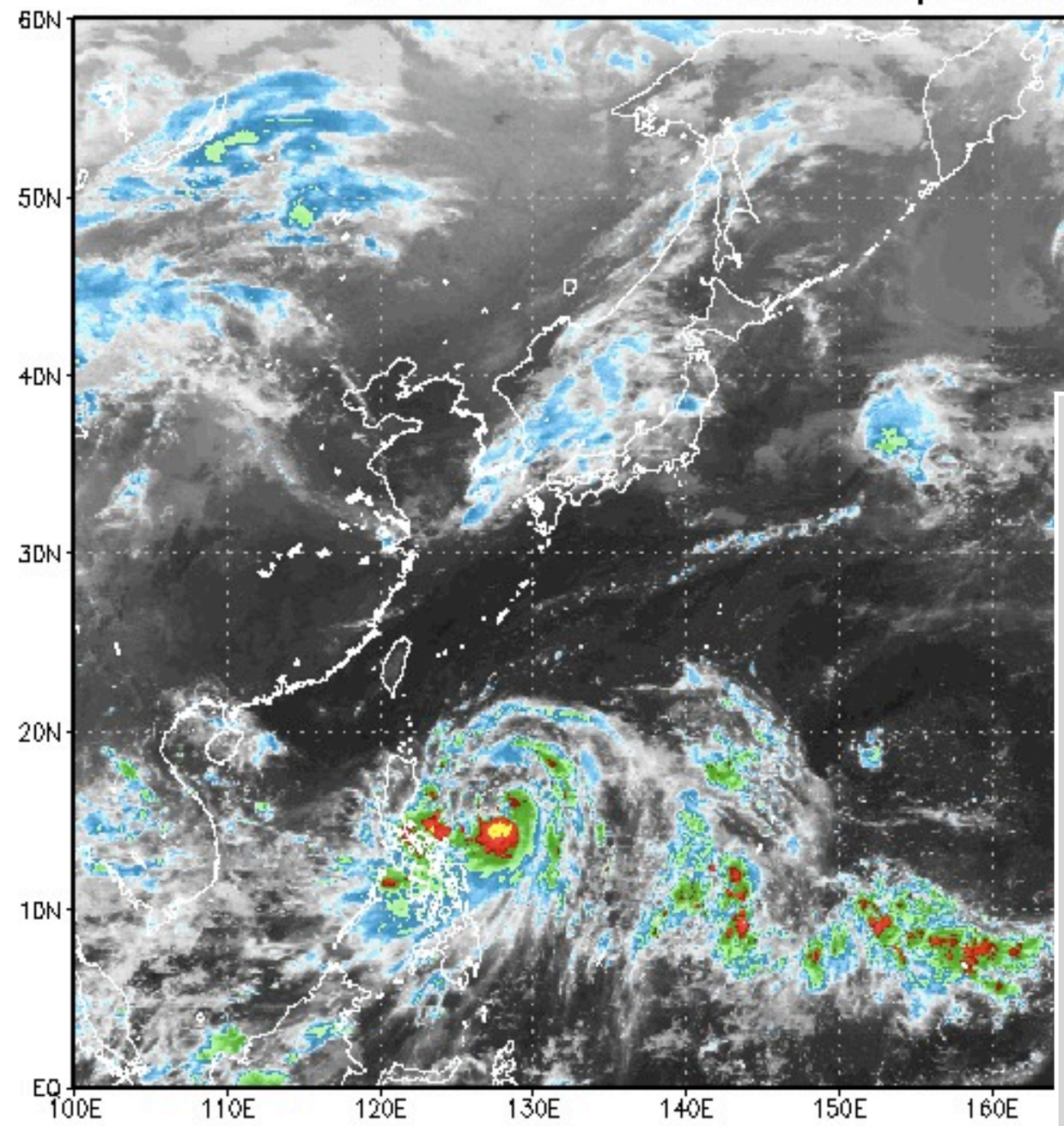
TropSat Observatory Concept

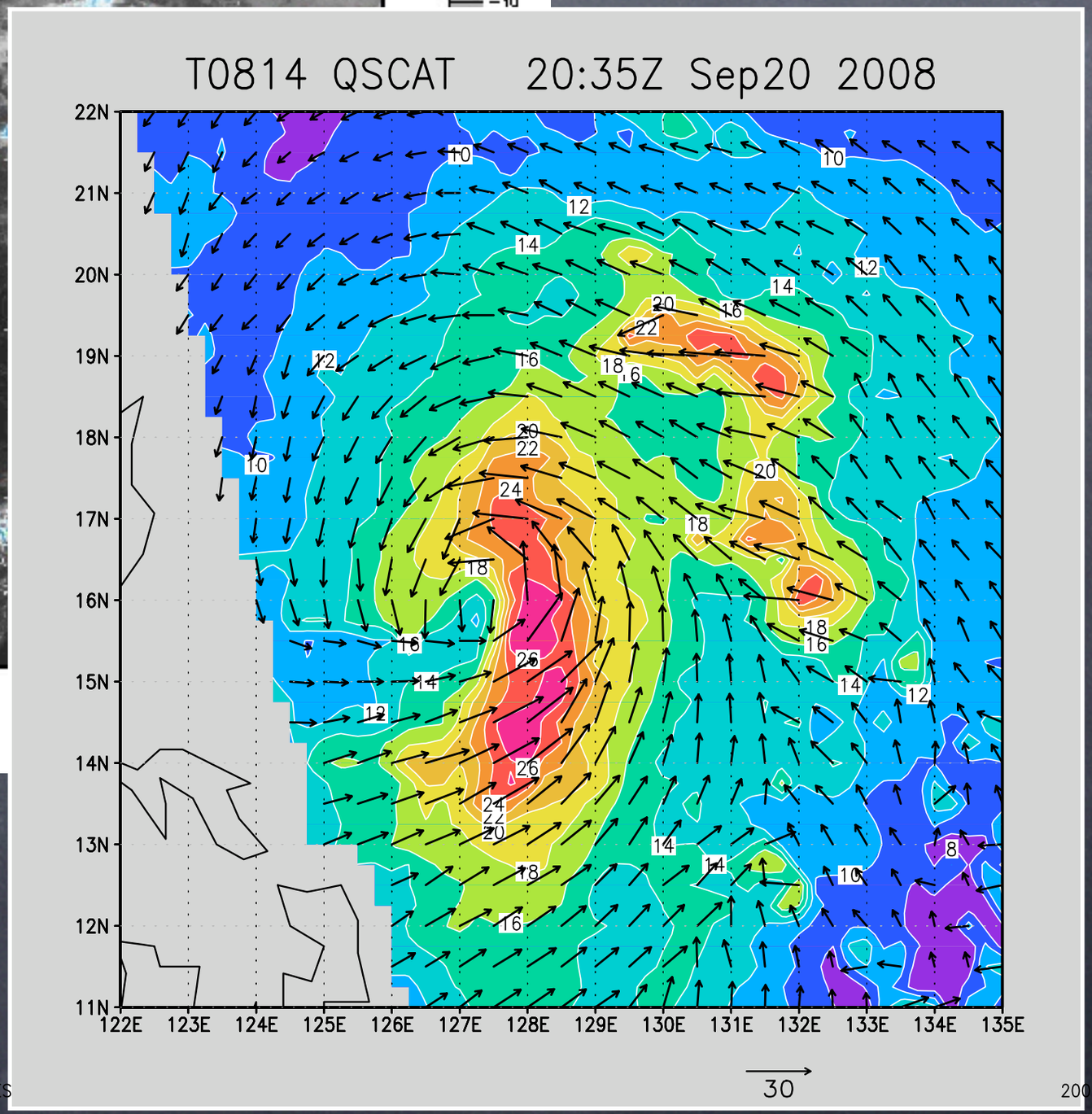
- Scanning scatterometer/radiometer
  - Measure near-surface winds, rain, atmospheric water vapor at ~ 10 km spatial resolution
    - Dual band scatterometer: wind & rain
    - Multichannel radiometer: water vapor & rain
  - 100 min sampling, 6-9 contiguous samples of equatorial band
    - *Low inclination angle orbit*, wide swath
  - Low technological risk





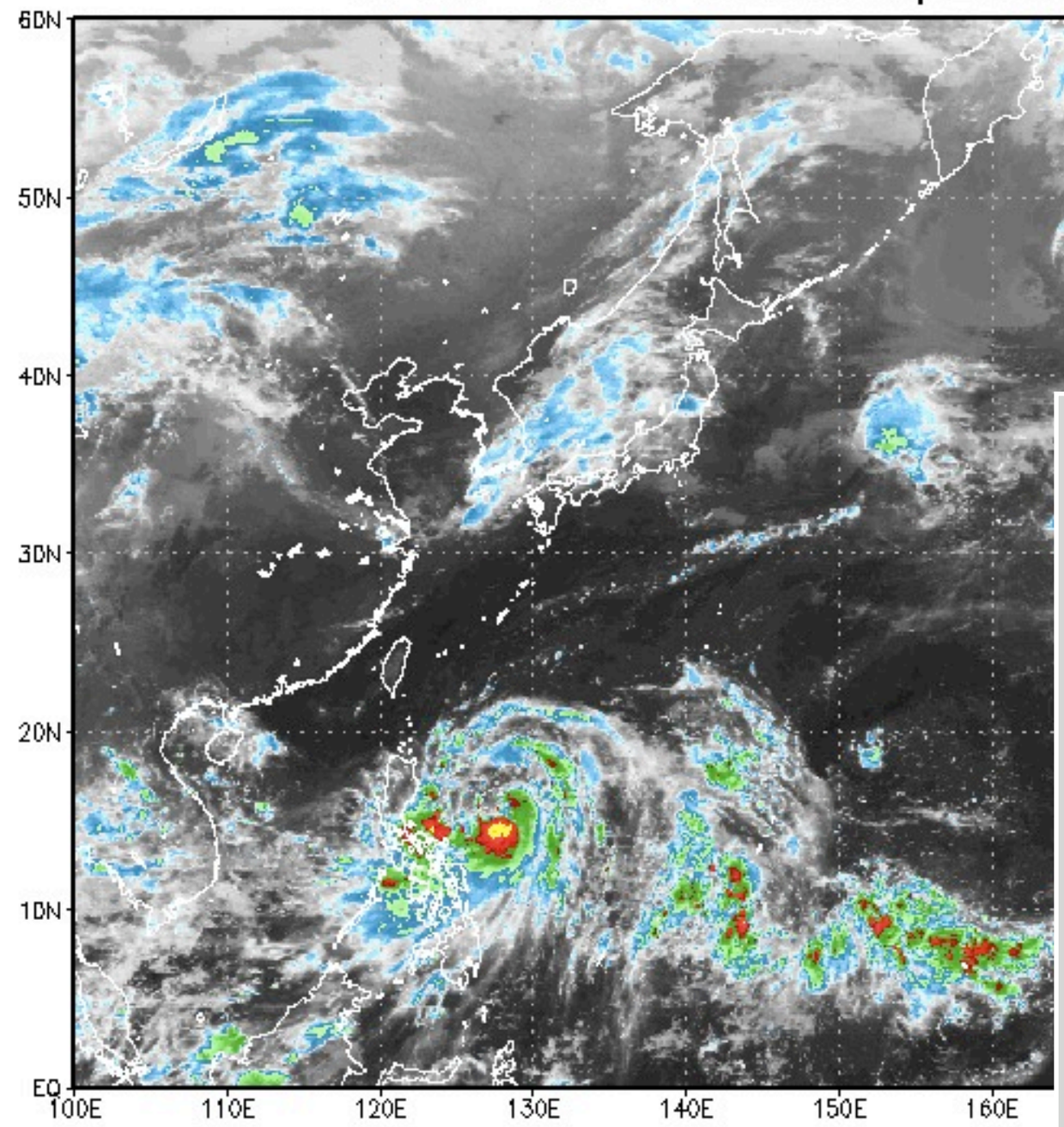
Tropical Cyclones

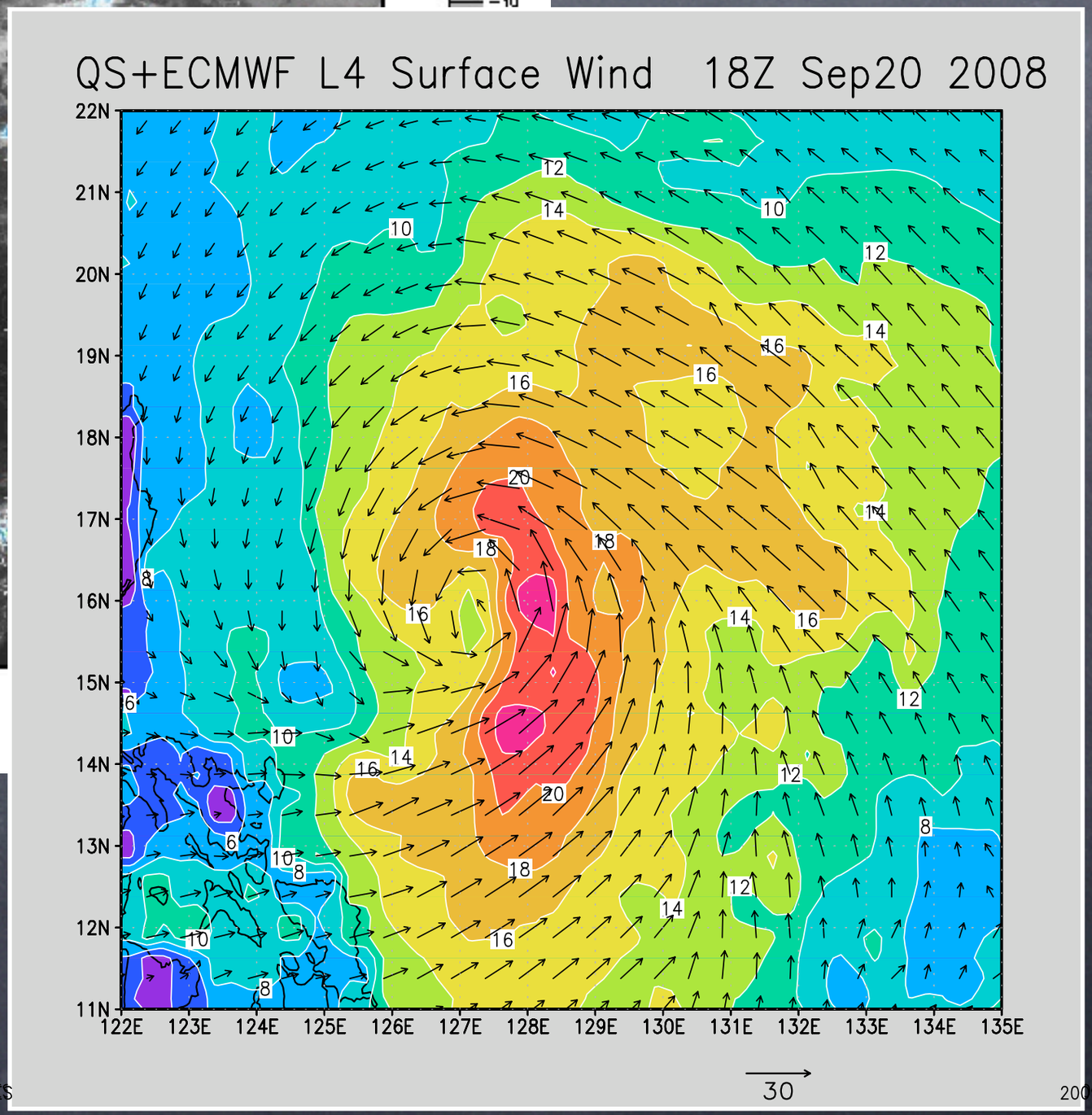




GrADS: COLA/IGES

2009





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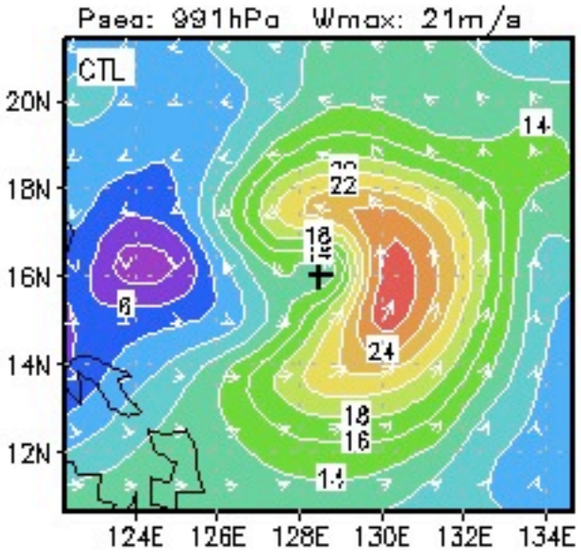

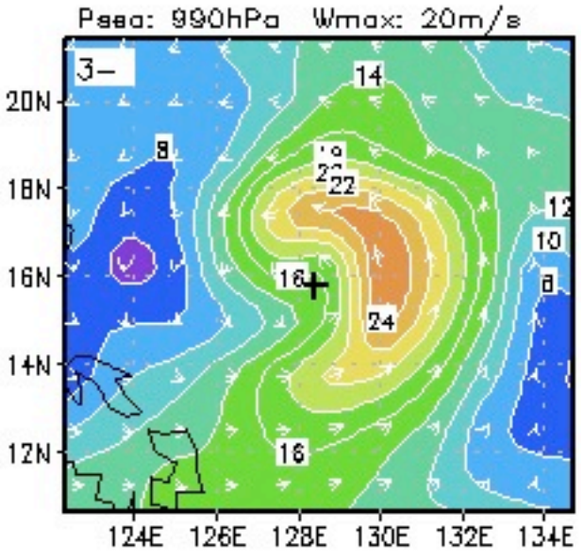

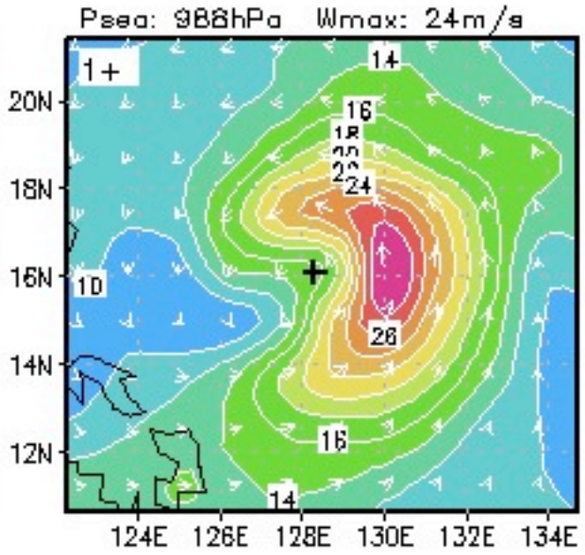

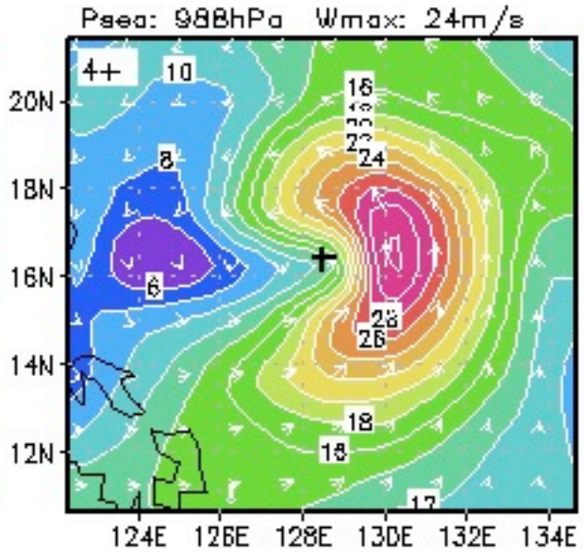

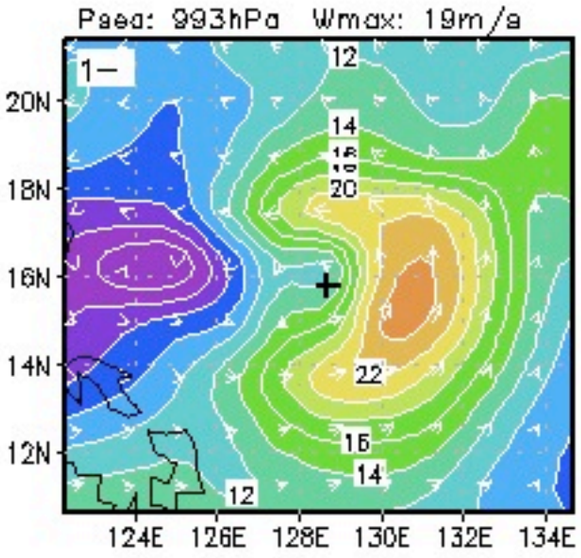

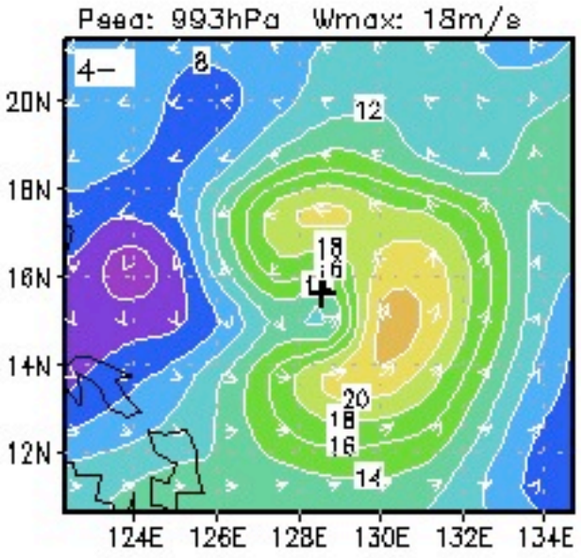

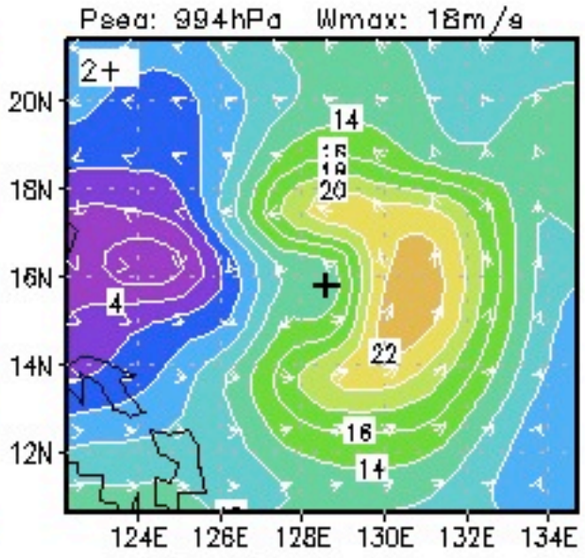

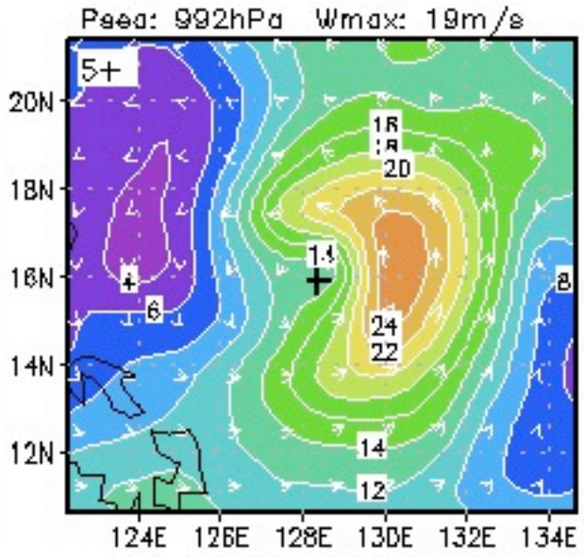

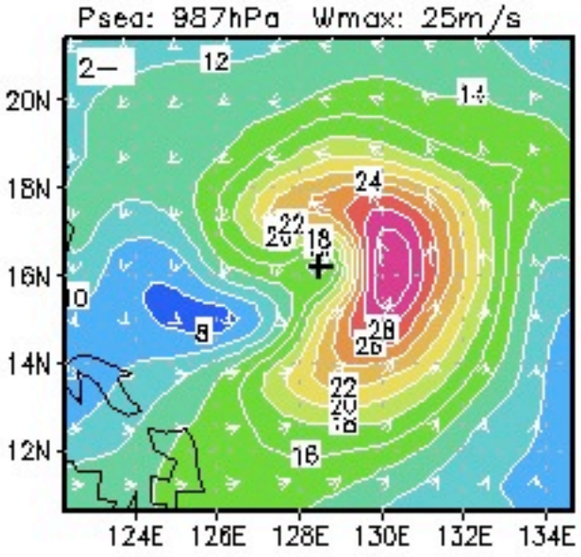

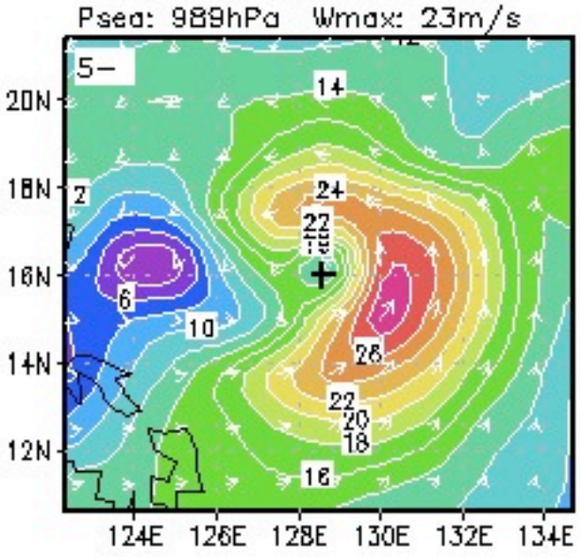

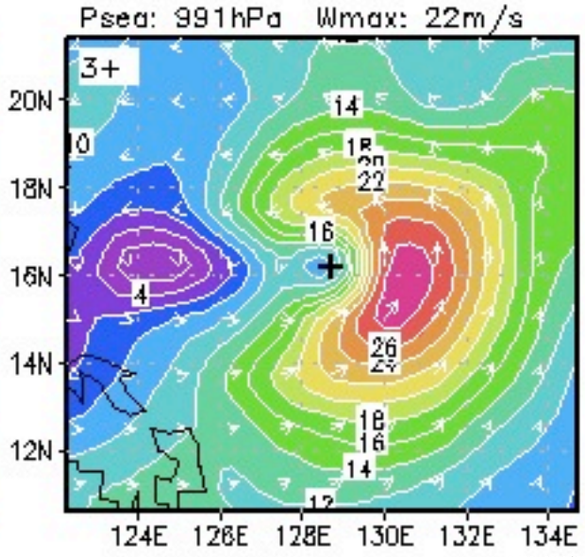

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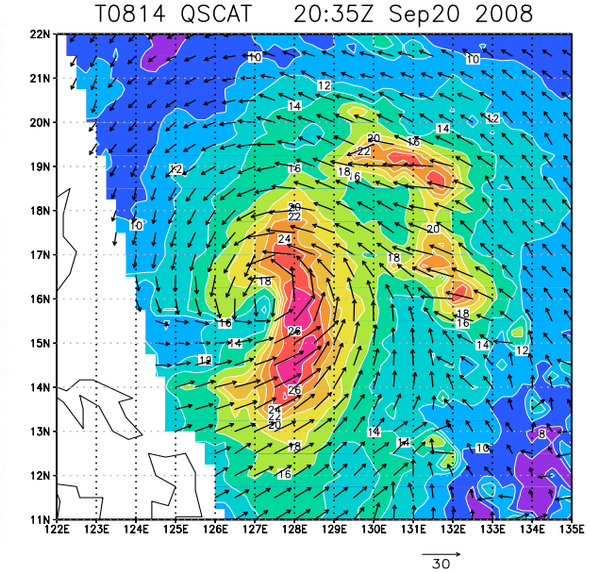

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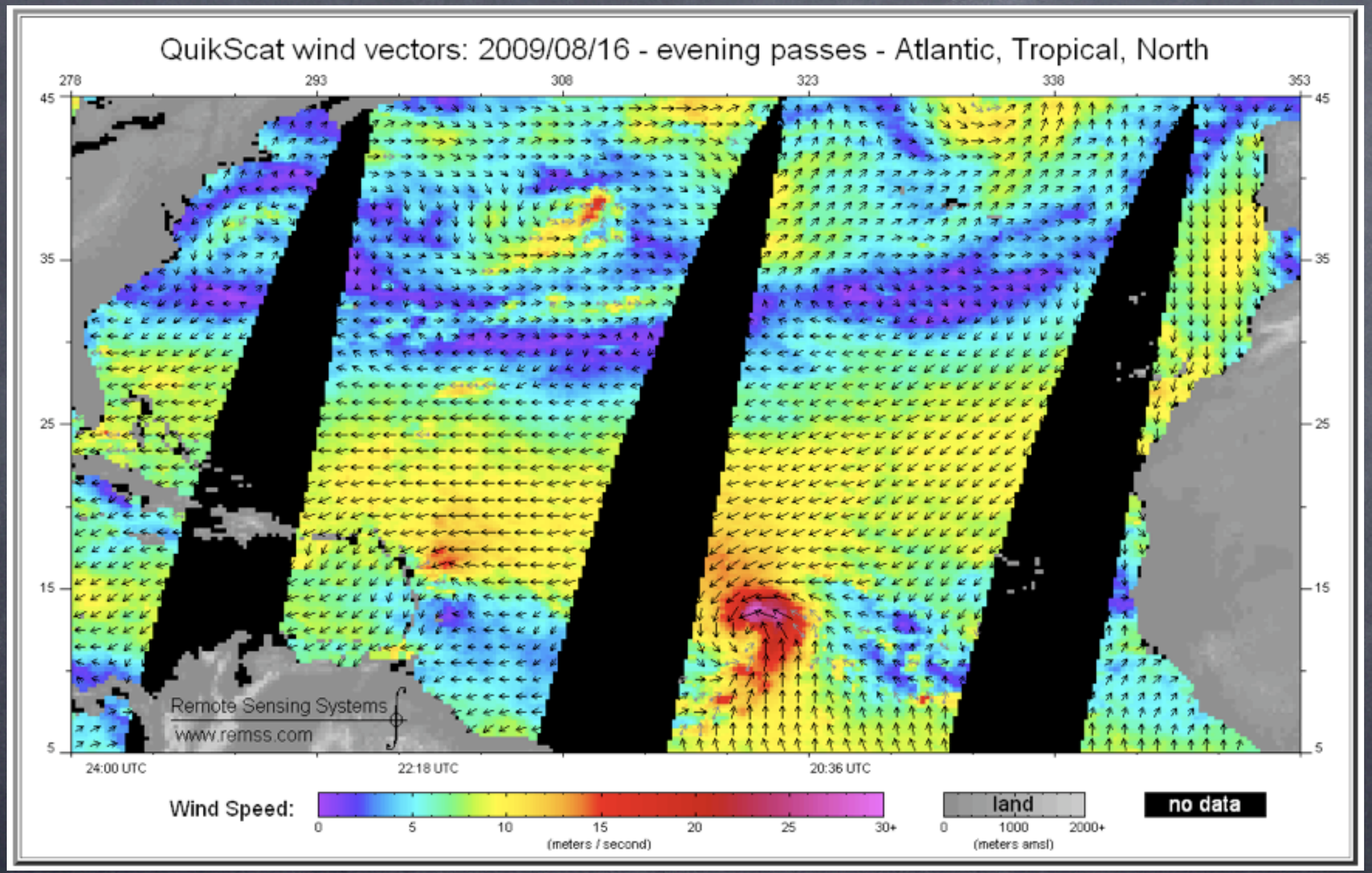
QuikScat wind vectors: 2009/08/16 - evening passes - Atlantic, Tropical, North
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Remote Sensing Systems
www.remss.com
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20:36 UTC
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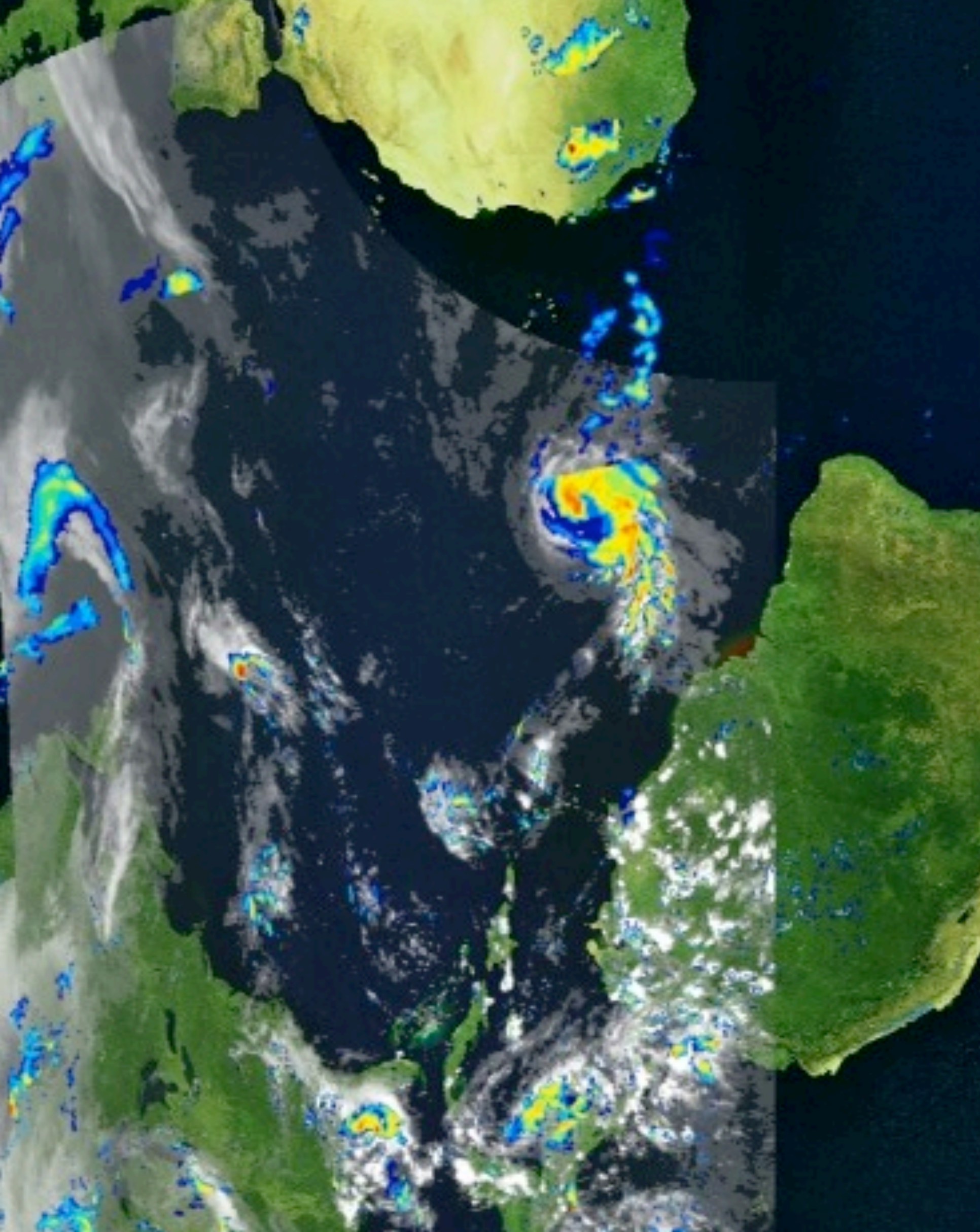

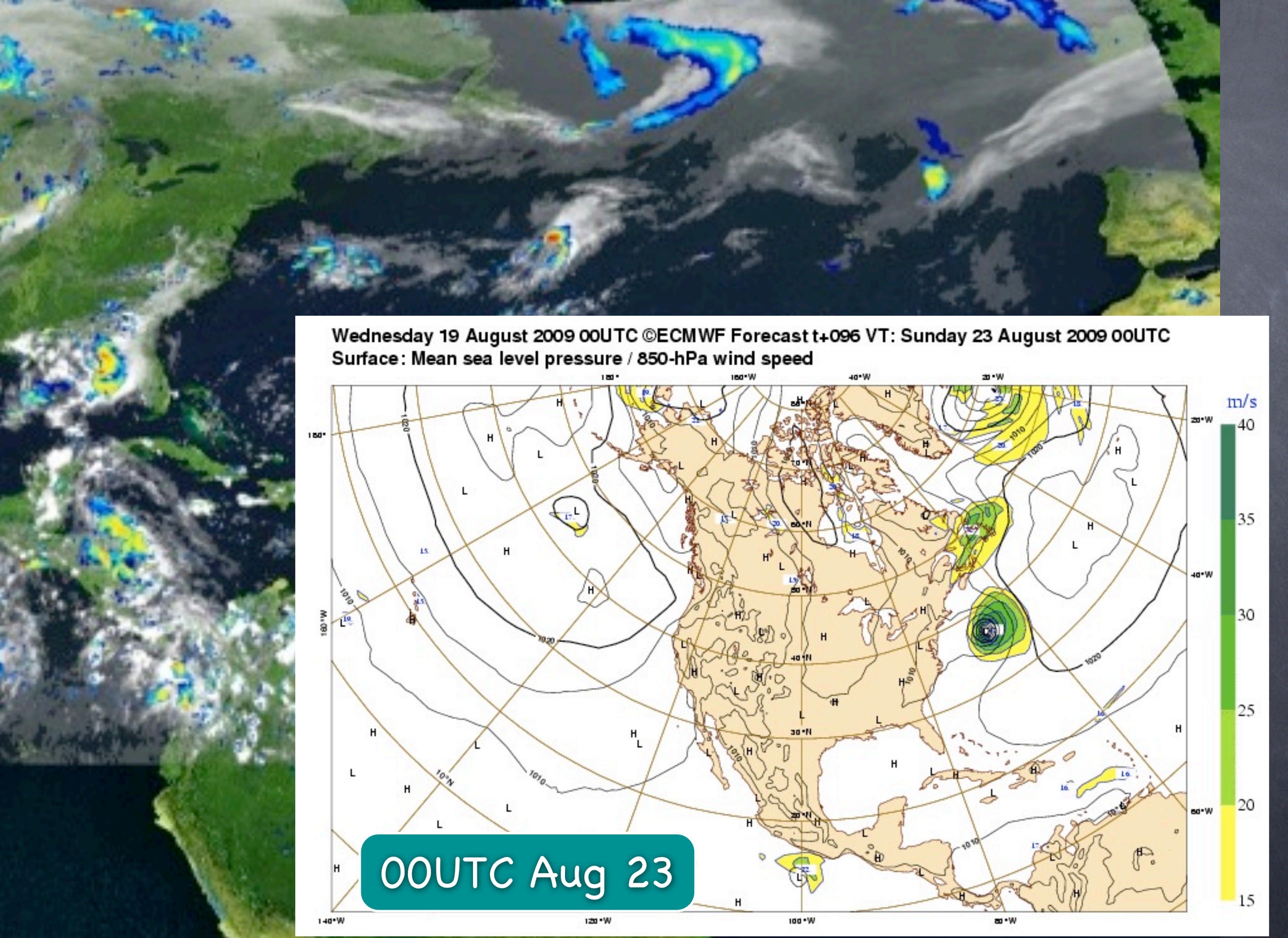
Wednesday 19 August 2009 00UTC ©ECMWF Forecast t+096 VT: Sunday 23 August 2009 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
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Global Rainfall Map in Near Real Time

JAXA/EORC

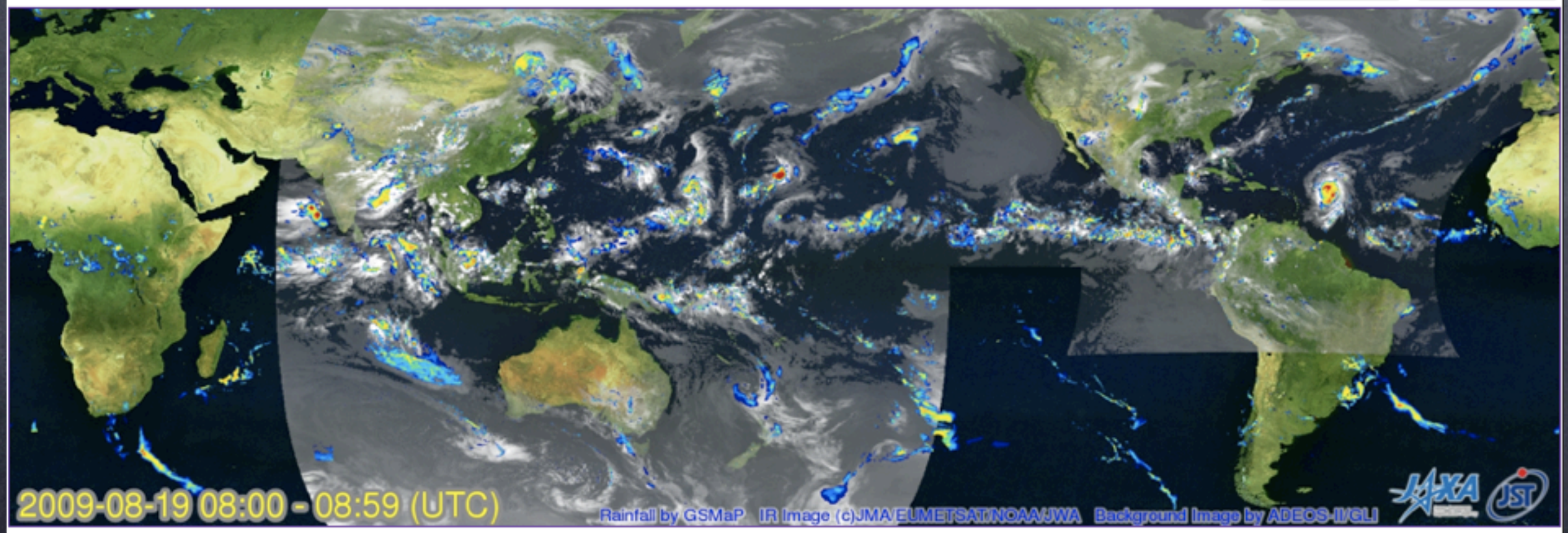
>> Members Page
>> Japanese

Last up date: 2009/Aug/19 13:50:07 UTC

Hourly Rainfall

Date: 2009 / Aug / 19 08:00-08:59 UTC Submit

Latest 10 hours | 24h Movie | Pre << | Latest | >> Next | MWR Coverage | Google Earth



Rain 0.1 0.5 1.0 2.0 3.0 5.0 10.0 15.0 20.0 25.0 30.0 [mm/hr]

http://sharaku.eorc.jaxa.jp/GSMaP/index.htm

More Frequent Stronger TCs are Coming?

- Questions
  - Best Track Intensity Data, based on Dvorak Method, are reliable?
    - Same Intensity for Same Typhoon in JTWC and JMA over WP?
- Longer Series of Scatterometer Data are Important!

P. J. Webster et al., Science 309, 1844 -1846 (2005)

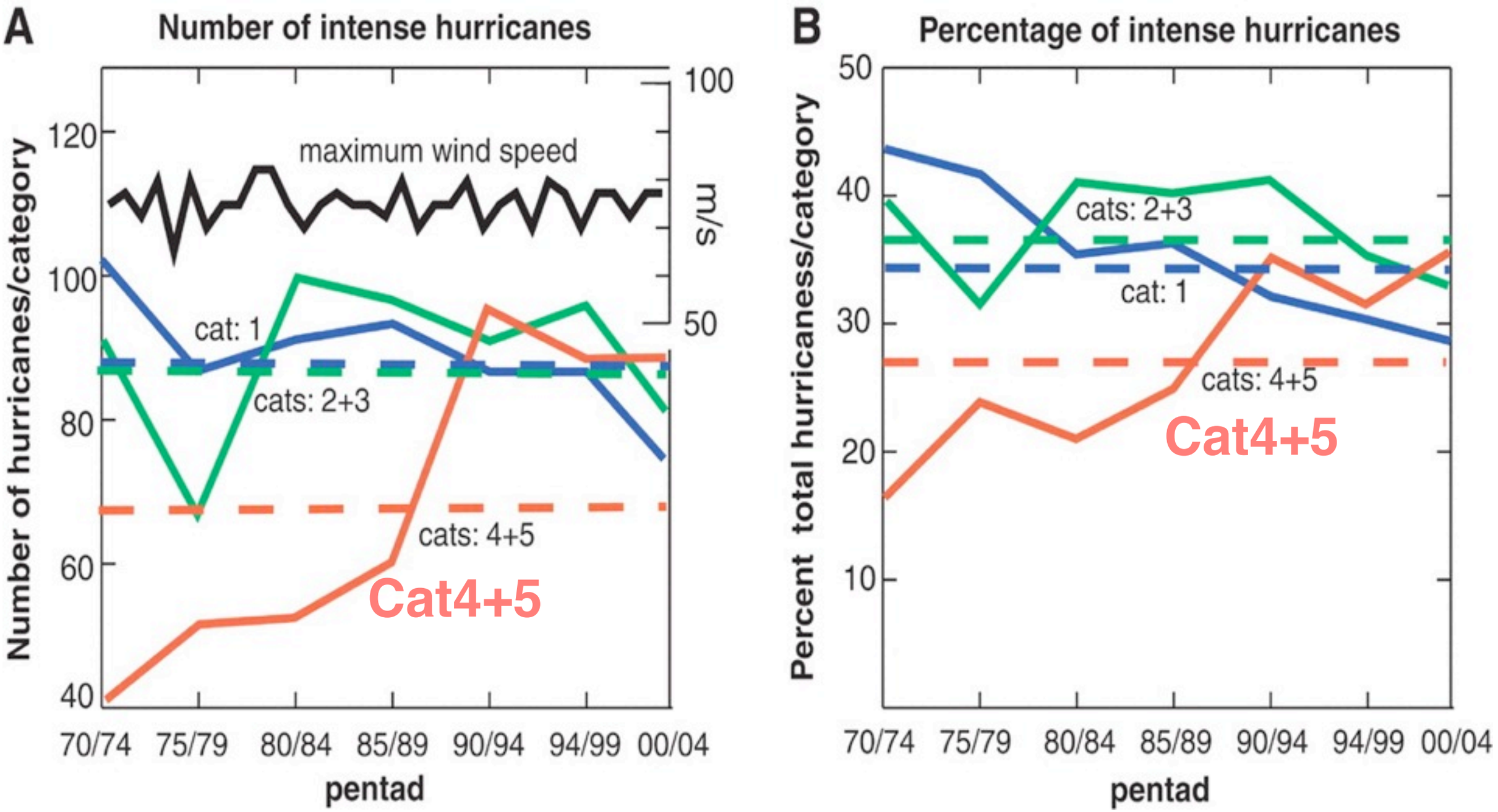
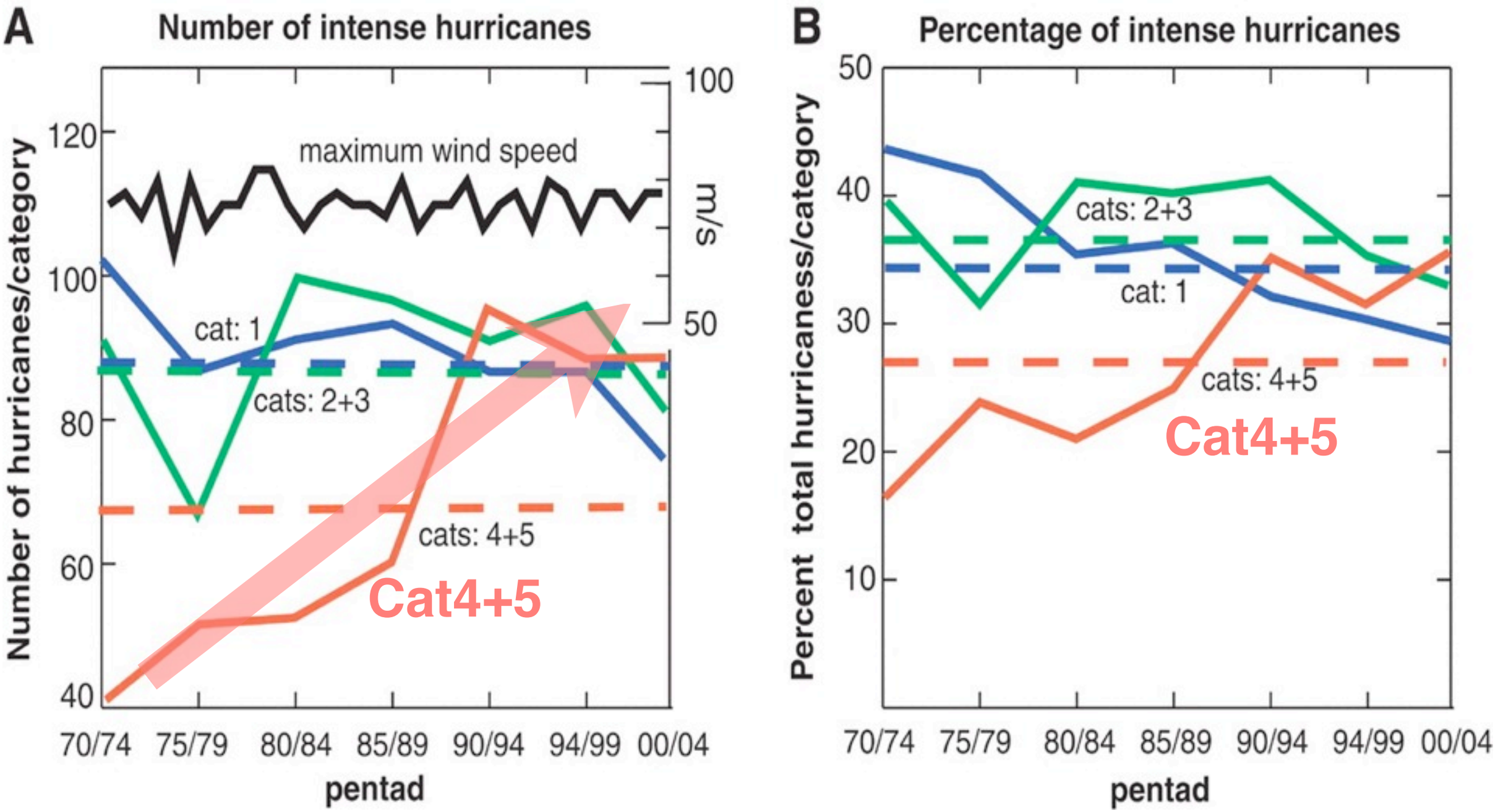


Fig. 4. Intensity of hurricanes according to the Saffir-Simpson scale (categories 1 to 5)

P. J. Webster et al., Science 309, 1844 -1846 (2005)



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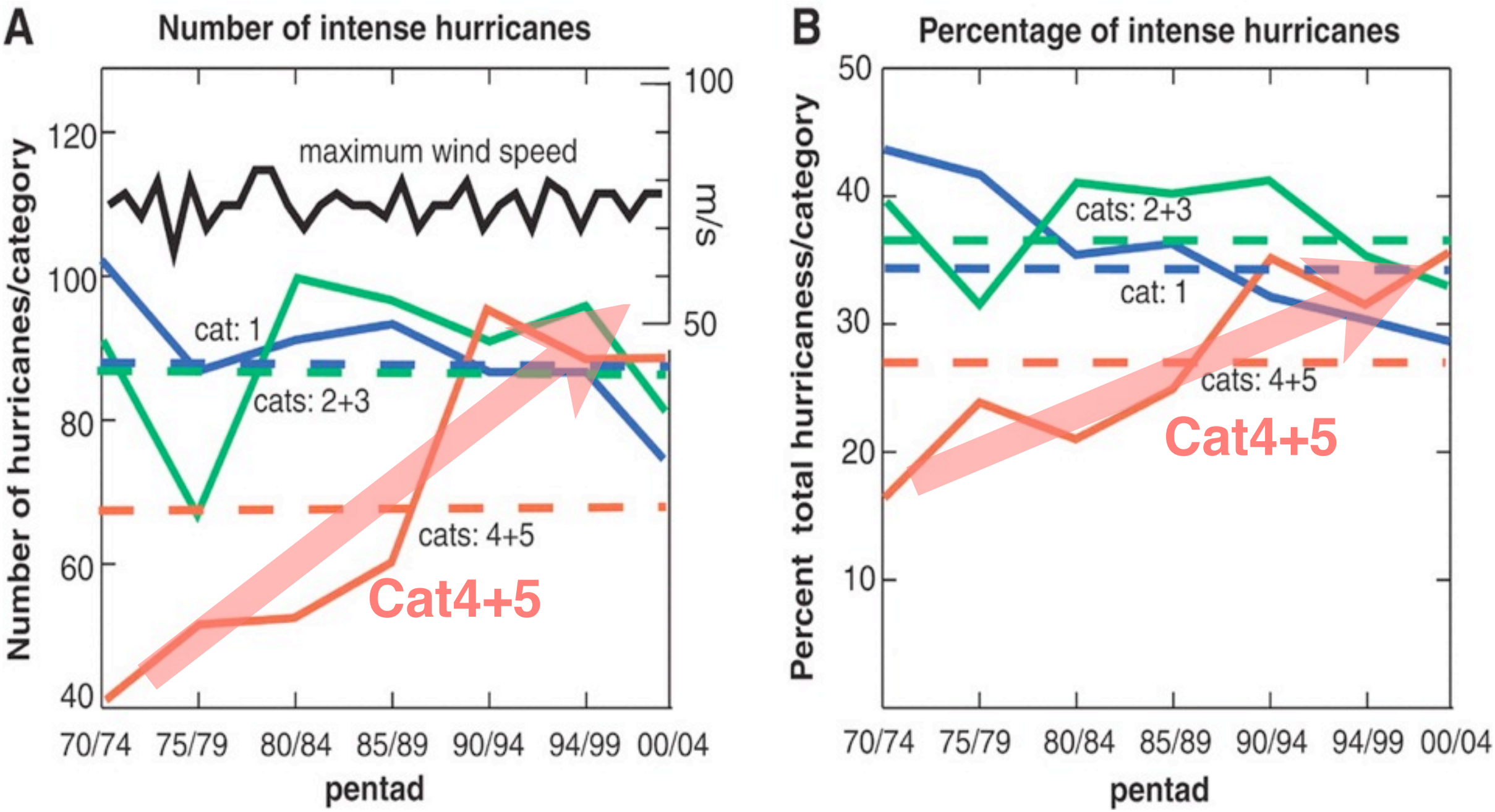

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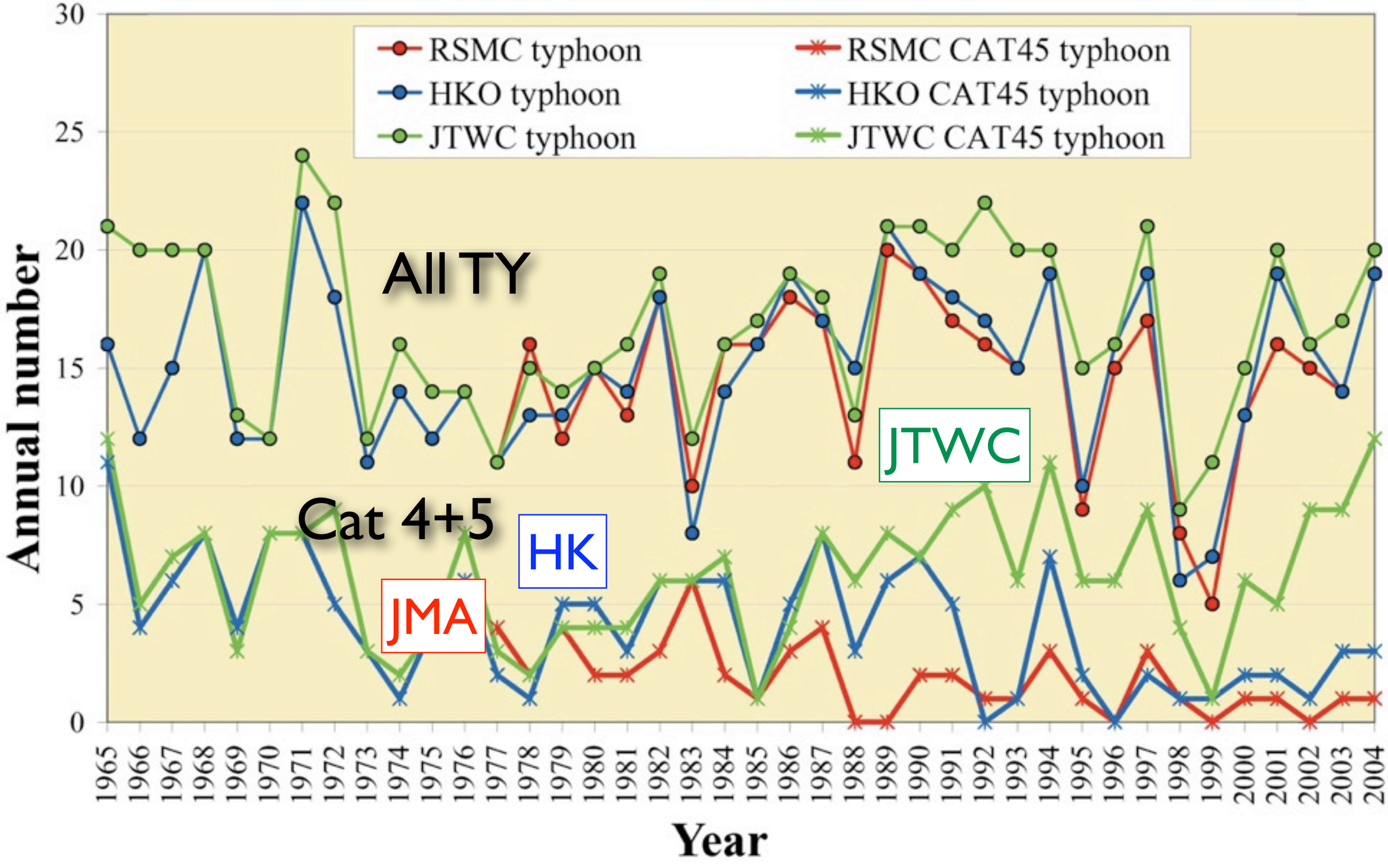
Wu et al.(2006)


RSMC typhoon
HKO typhoon
JTWC typhoon
RSMC CAT45 typhoon
HKO CAT45 typhoon
JTWC CAT45 typhoon
All TY
Cat 4+5
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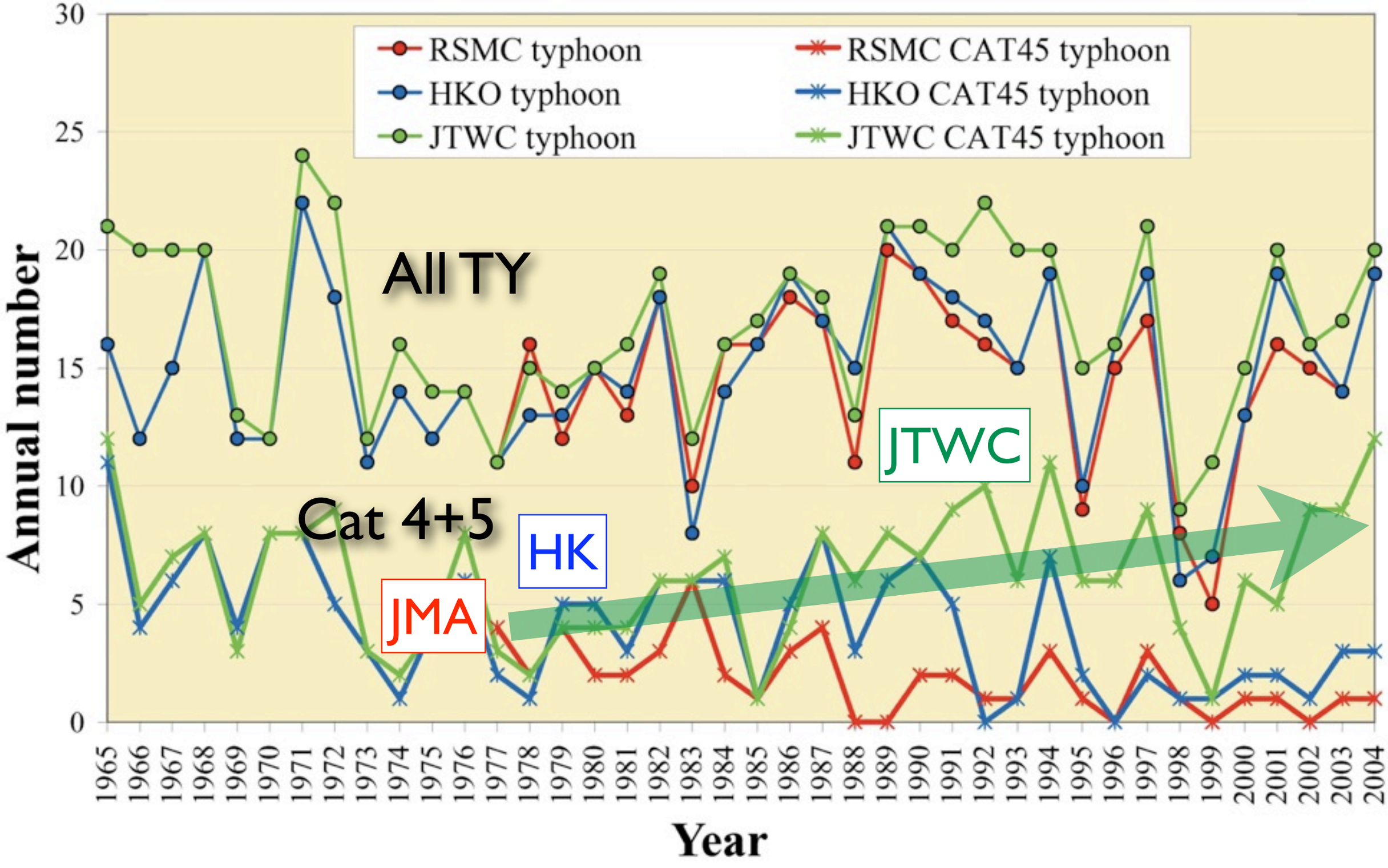
Wu et al.(2006)


RSMC typhoon
HKO typhoon
JTWC typhoon
RSMC CAT45 typhoon
HKO CAT45 typhoon
JTWC CAT45 typhoon
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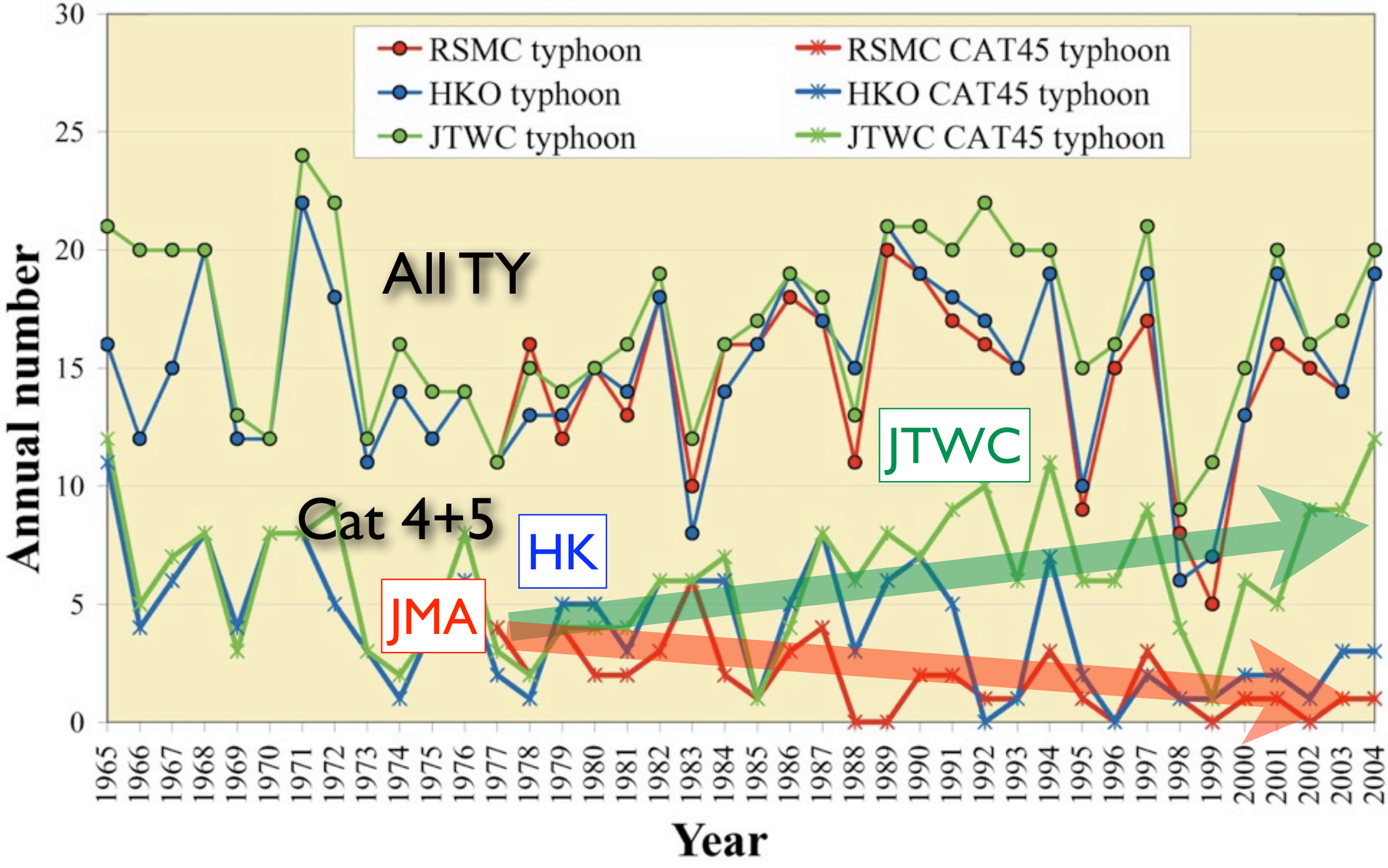
Wu et al.(2006)


RSMC typhoon
HKO typhoon
JTWC typhoon
RSMC CAT45 typhoon
HKO CAT45 typhoon
JTWC CAT45 typhoon
All TY
Cat 4+5
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JMA
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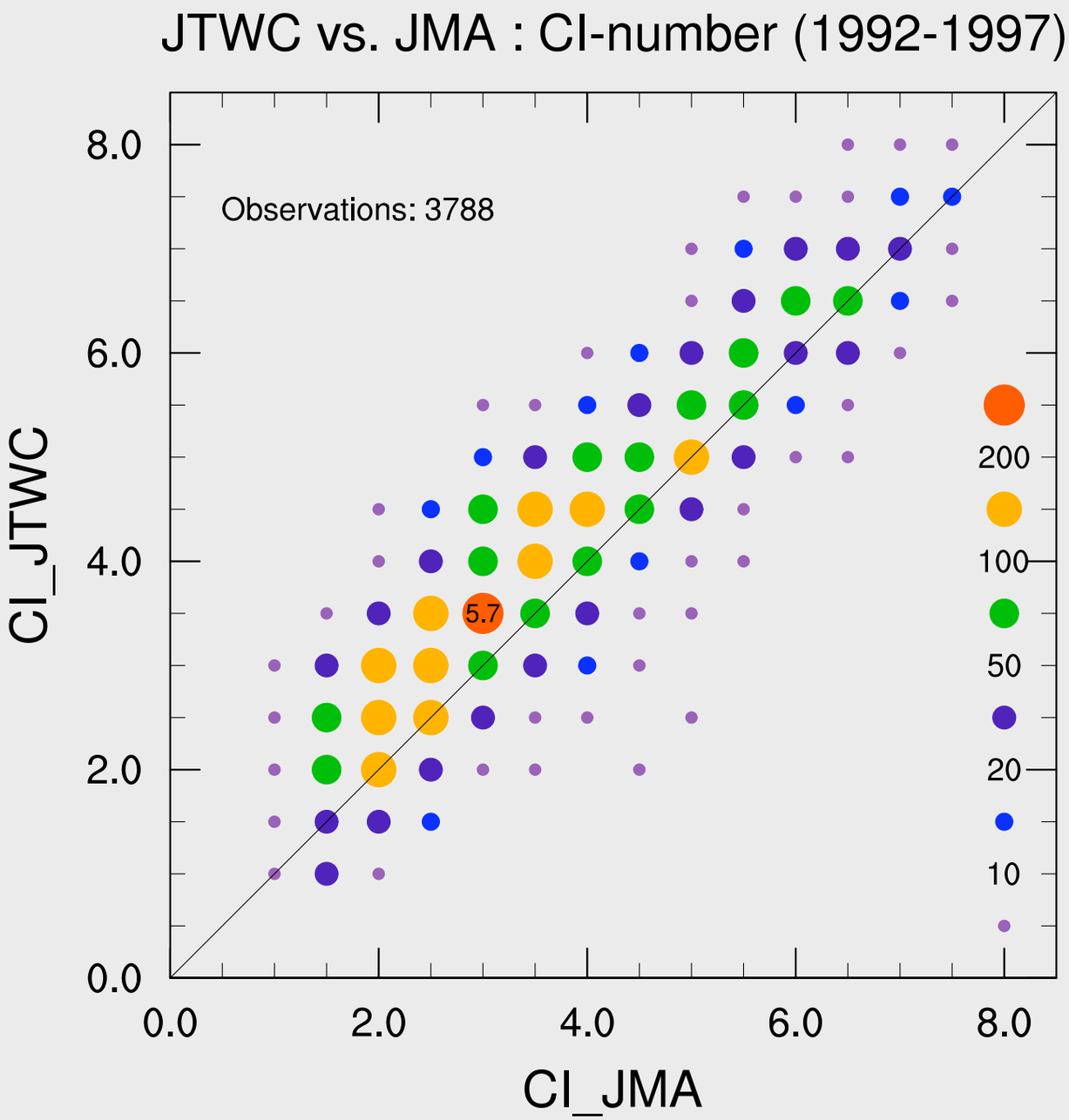
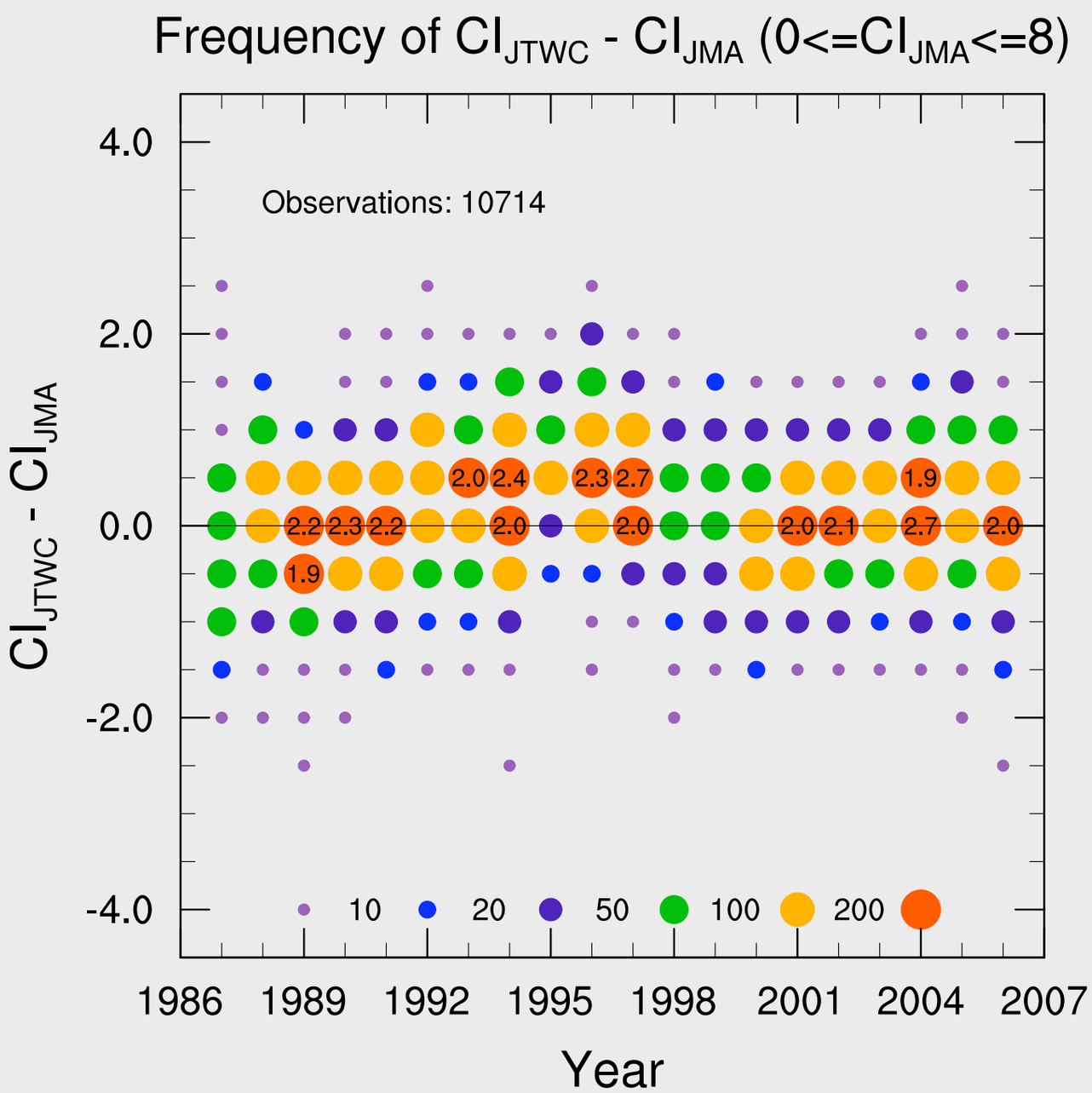
Differences in Dvorak CIs

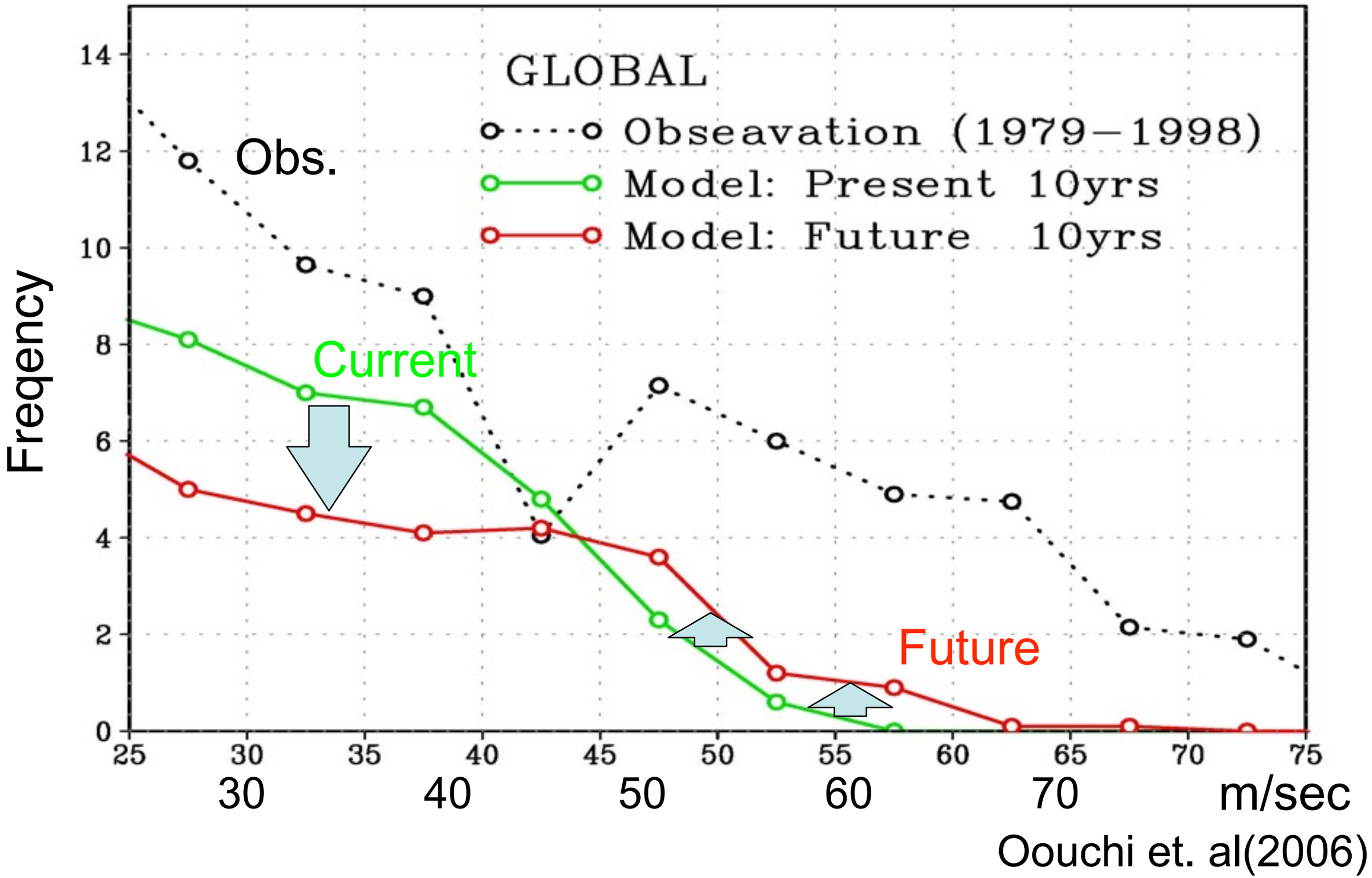
Nakazawa and Hoshino (2009)





http://www.jstage.jst.go.jp/article/sola/5/0/33/_pdf

More Severe TCs in late 21st Centuries



Oouchi et. al(2006)

TC BY SCATTEROMETERS

- Better Performance in Higher Winds is a KEY!
  - Operational Use
    - Data Assimilation
      - Representations of TCs are getting better
      - Sometimes the data are rejected... Why?
  - Research Use
    - Long-term Trend Analysis on TC Intensity Changes
    - Structural Changes of TC Wind Distributions
    - TC Genesis under Weak Wind Conditions