Decadal-to-Centennial Variability of the Pacific Equatorial Undercurrent Over the Next 400 Years Under RCP4.5 Greenhouse Gas Emissions

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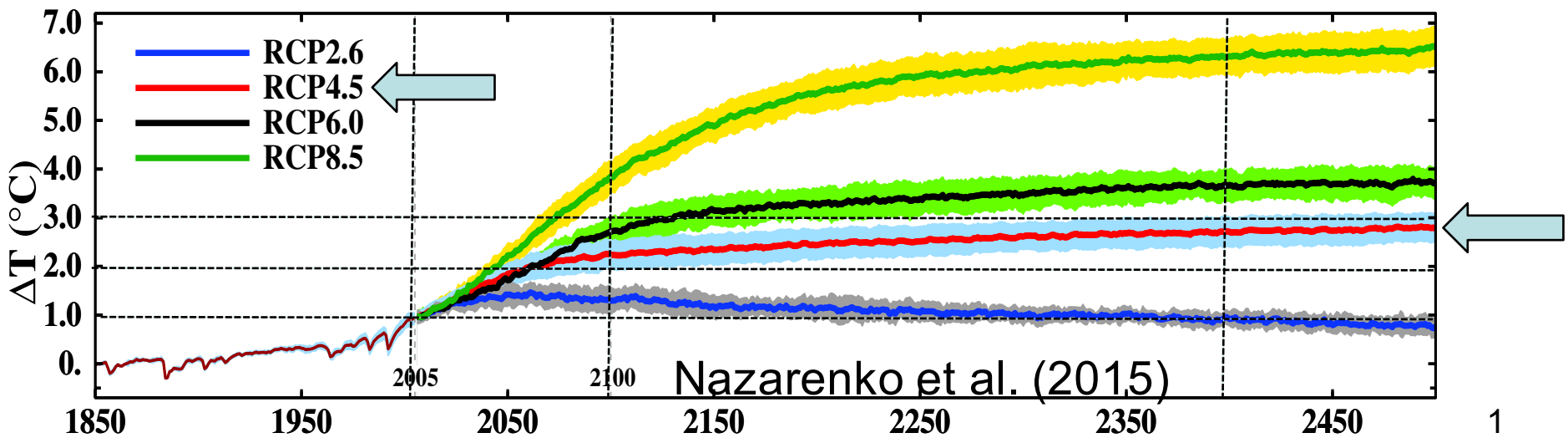

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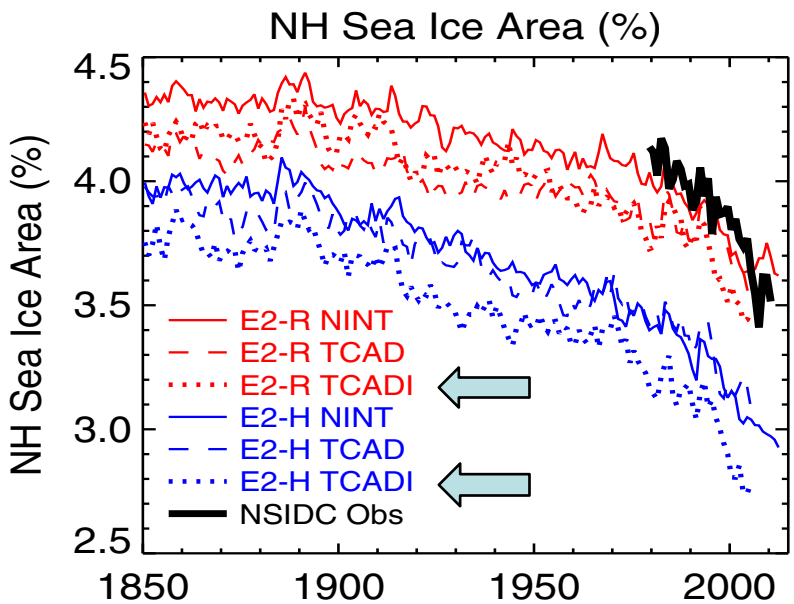
NASA GISS CMIP5/AR5 Model-E2

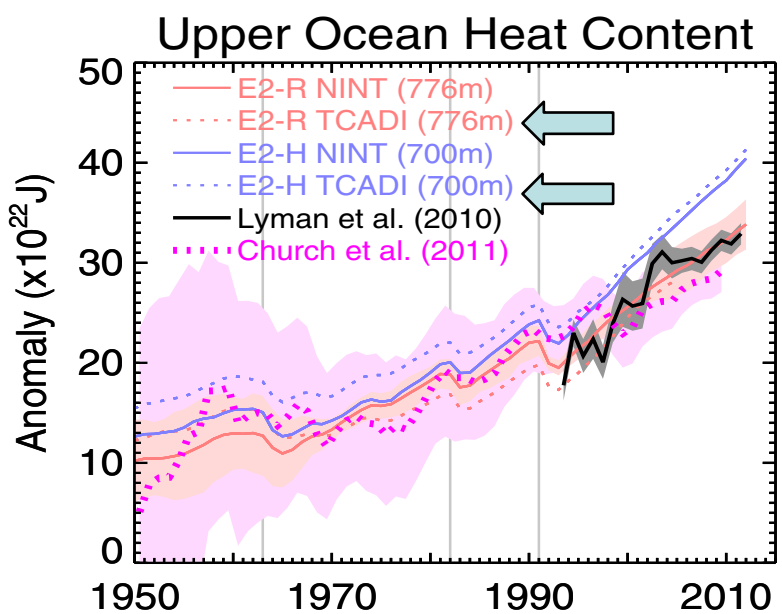
Miller et al. (2014), Schmidt et al. (2014), Nazarenko et al. (2015)

- Atmosphere Model
  - NINT, TCAD, **TCADI** [**t**racers of **c**hemistry, **a**erosols and their **d**irect radiative effect and the aerosol **i**ndirect effect by CCN]
    - 2° latitude x 2.5° longitude
    - 40 layers up 60-km height, with 200-m thick lowest layer
- Ocean Models
  - **R** = Russell
    - Russell et al. (1995)
    - 32 layers; bottom at 5 km
    - 1° lat x 1.25° long
    - Florida Current, 47 Sv {~33}
    - Kuroshio Current, 65 Sv {~57}
    - Large et al. KPP vertical mixing scheme
  - **H** = HYCOM
    - Sun and Bleck (2006)
    - 26 layers; bottom at 5 km
    - ⅓° lat at 0° x 1° long
    - Florida Current, 40 Sv
    - Kuroshio Current, 73 Sv
    - Kraus-Turner TKE vertical mixing scheme
- Land Cover
  - Same dataset for all GISS climate models

E2-H and E2-R Sensitivities to Model Formulation

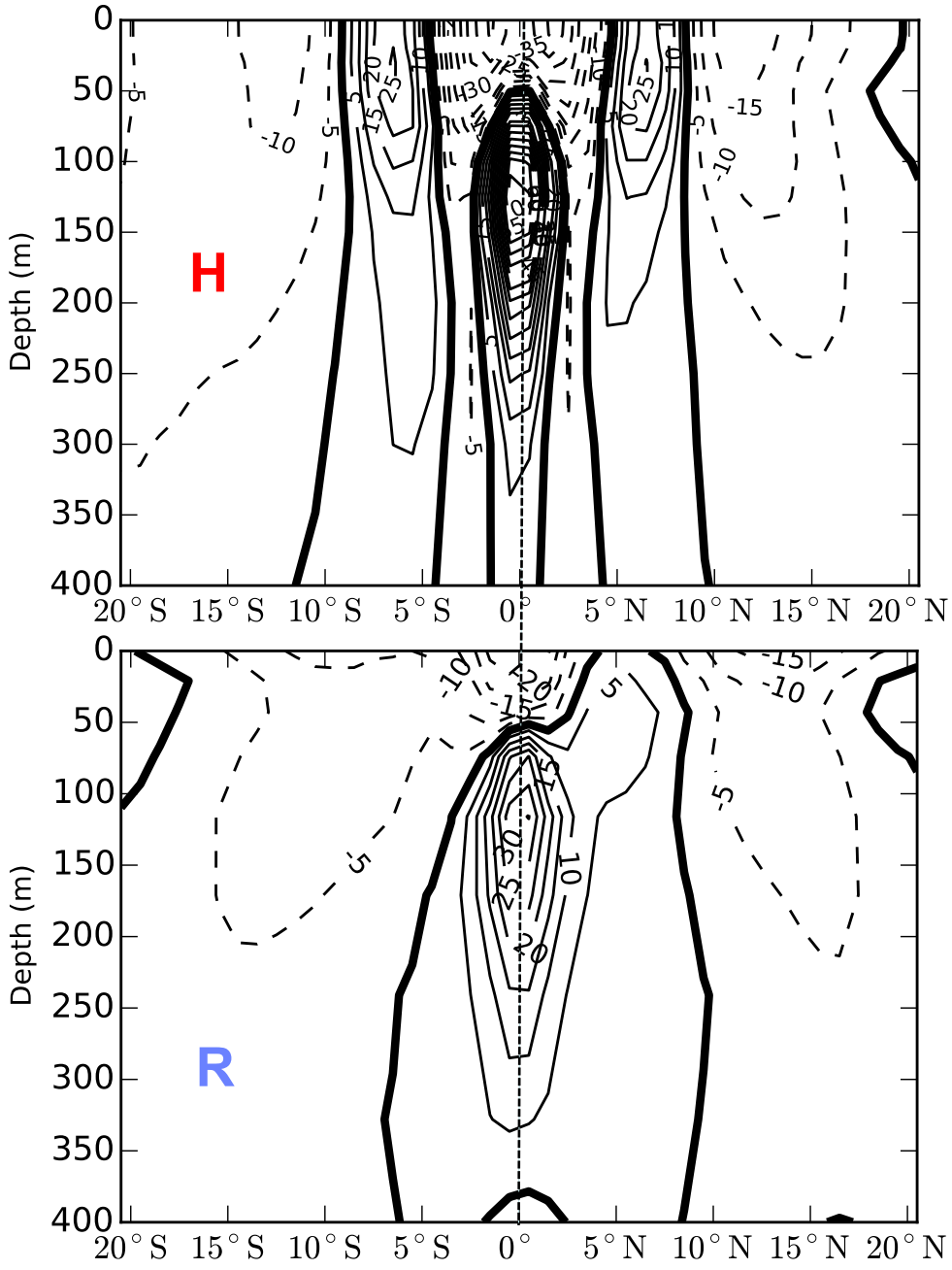
Miller et al. (2014)





E2-R was more representative of global and regional ocean observations than E2-H.

GISS Model-E2 Control Run With H and R Oceans
23-Decade Mean EUC and NECC at 140°W



Transport

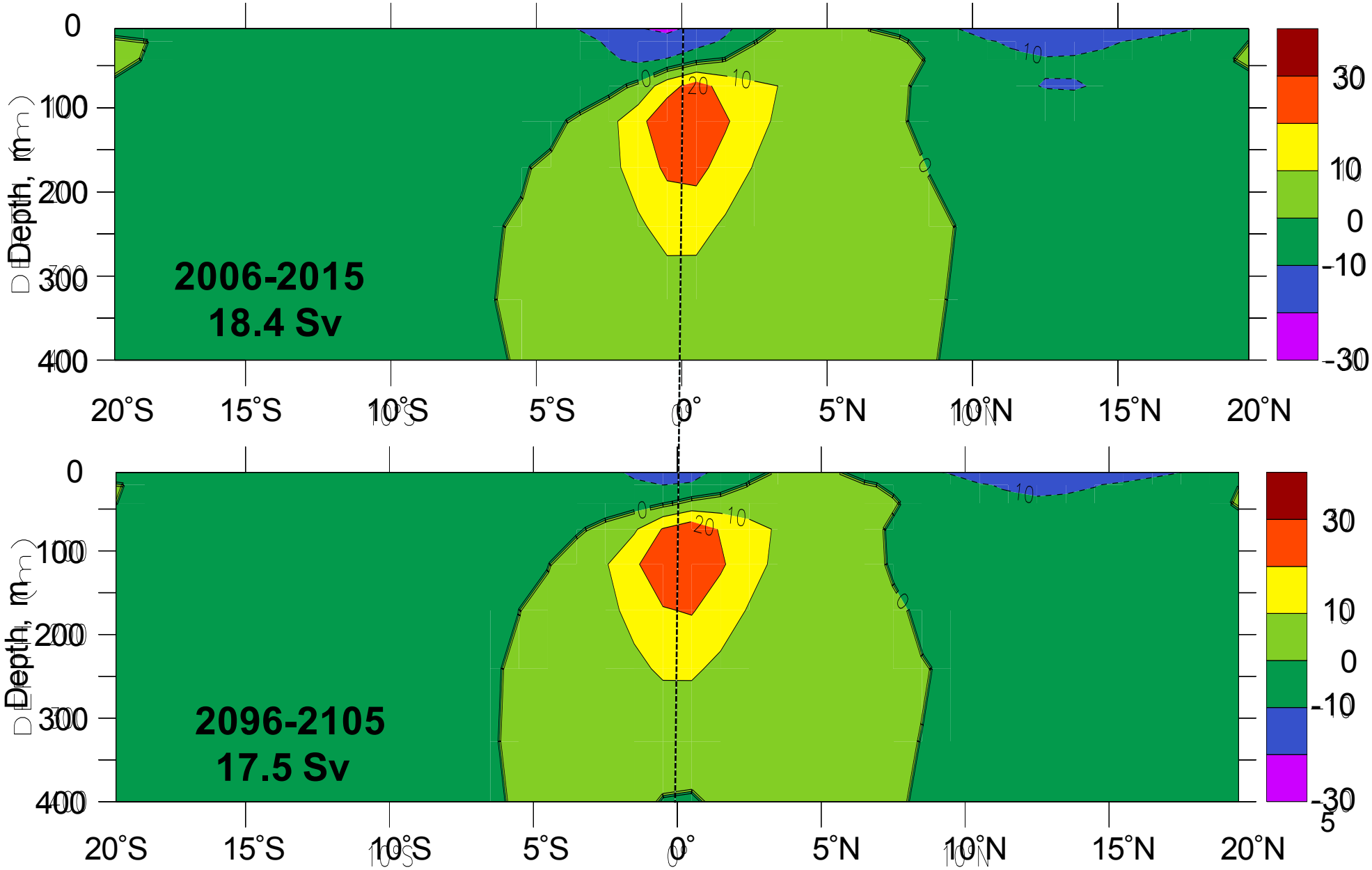
EUC		**NECC**
U > 0		U > 0
1.5°S – 1.5°N		4°N – 9°N
0 – 400 m		0 – 400 m
24.3 Sv	12.2 Sv	11.8 Sv
[23.2-25.5Sv]		[10.5-13.0 Sv]
{0.5 Sv}		{0.6 Sv}
16.5 Sv	18.4 Sv	6.1 Sv
[15.4-17.1 Sv]		[5.5-7.1Sv]
{0.4 Sv}		{0.4 Sv}

[ ] = Range of 23 Decadal Means
{ } = Std Dev of 23 Decadal Means

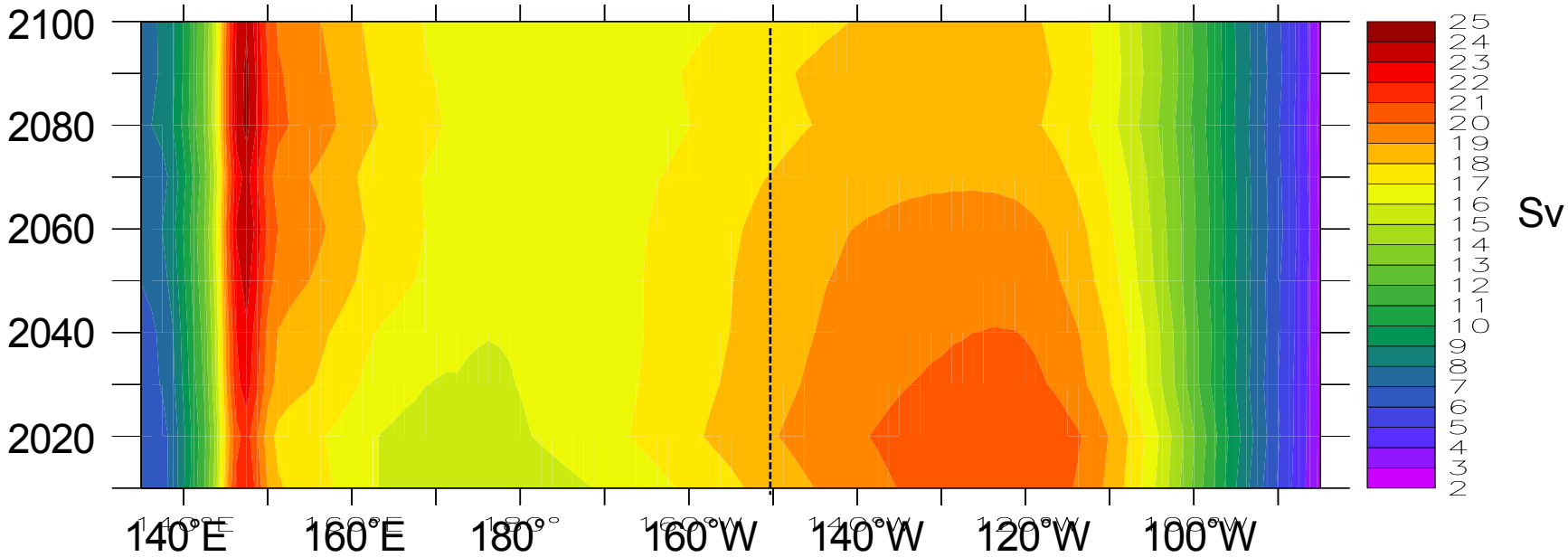
1991-1999 Observations
(Johnson et al., 2001)

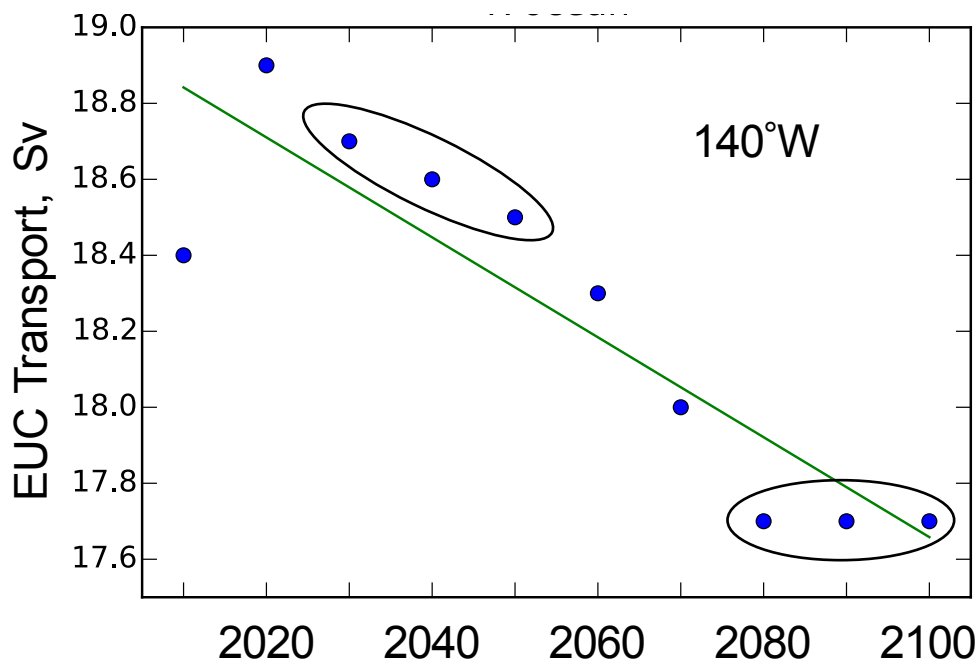
28 Sv 14 Sv

R EUC Responses at 150°W to RCP4.5 GHG (t_0 = 1850) 2010 and 2100



R EUC Transport Decadal Variations, 2010-2100





Causes of strong EUC transports at 145°-150°E and 130°-120°W are unknown.

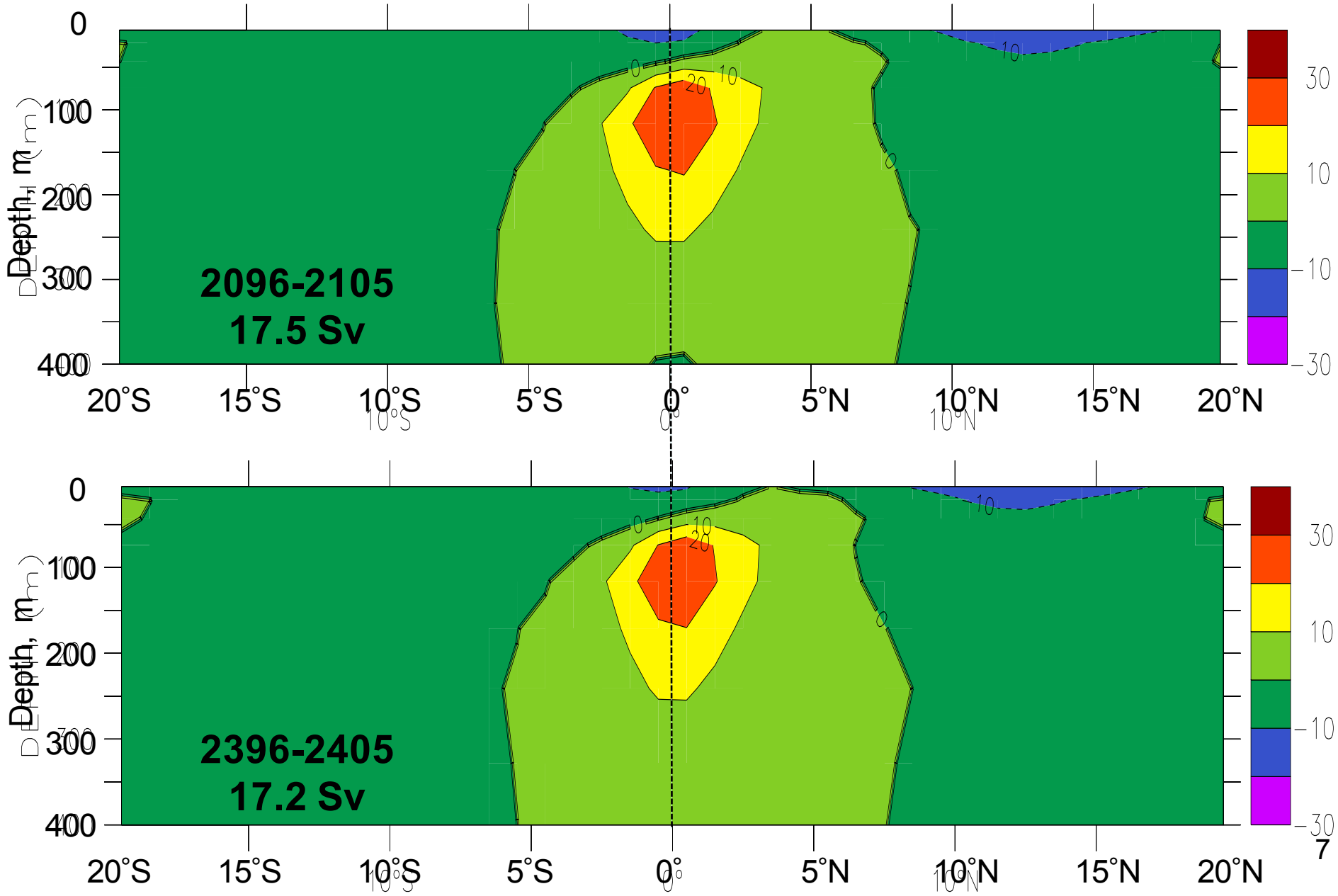
EUC Transport (Sv)

= 18.88 – 0.013 (t – 2010),

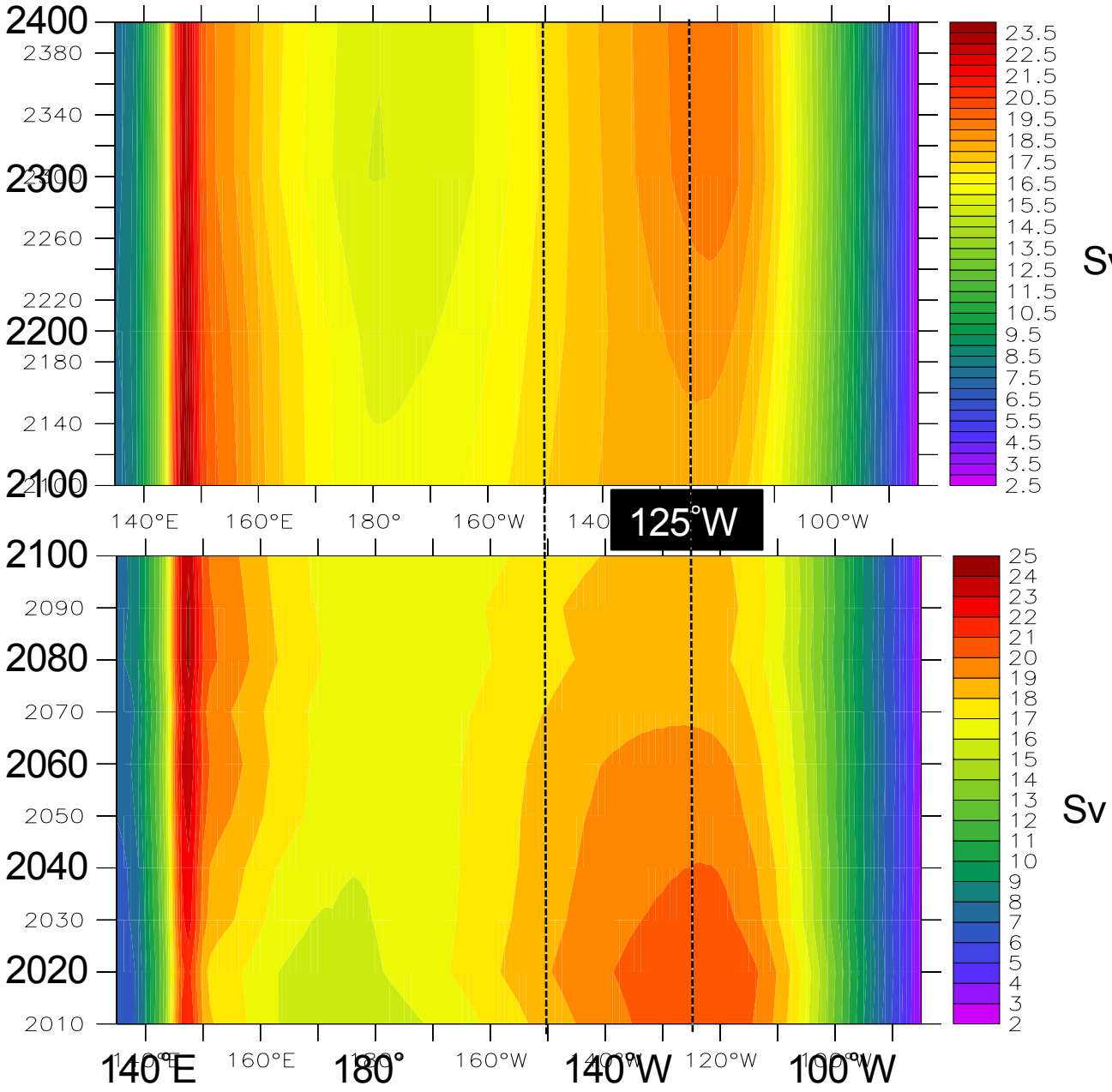
where t = time in years beyond 2010.

95% (68%) statistically significant difference would be ± 0.8 (0.4) Sv.

R EUC Responses at 150°W to RCP4.5 GHG (t_0 = 1850) 2100 and 2400



Decadal Variations of R EUC Transports, 2010-2100
Centennial Variations of R EUC Transports, 2100-2400



At 0°, 125°W EUC transport is **increasing.**

At 0°, 125°W EUC transport is **decreasing.**

Summary

- NASA GISS CMIP5 Climate Models E2: 3 atmospheres, 2 oceans, 1 land
  - Chose TCADI atmosphere + **R** ocean
- EUC Transport
  - Control run at 140˚W was stable, with standard deviation of 23 decades equal to about 10% of "measured" uncertainty of 5.5 Sv
  - RCP4.5 produced 1.9 Sv increase from 1850 to 2010 at 150˚W-140˚W
  - RCP4.5 produced 1.7 Sv decrease from 2010 to 2100 at 140˚W
  - RCP4.5 produced 0.3 Sv decreased from 2100 to 2400 at 140˚W
  - Longitude of maximum time variations was 125˚W
    - EUC transport displayed an approximate 400-year fluctuations
  - Decadal and centennial variations were smaller than measurement capability
- Next Step
  - Analyze CMIP6 **H** and **R** ocean models

Thank you

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