



Uncertainty in Atmospheric River Detection and Atmospheric River Induced Precipitation due to Reanalysis Selection

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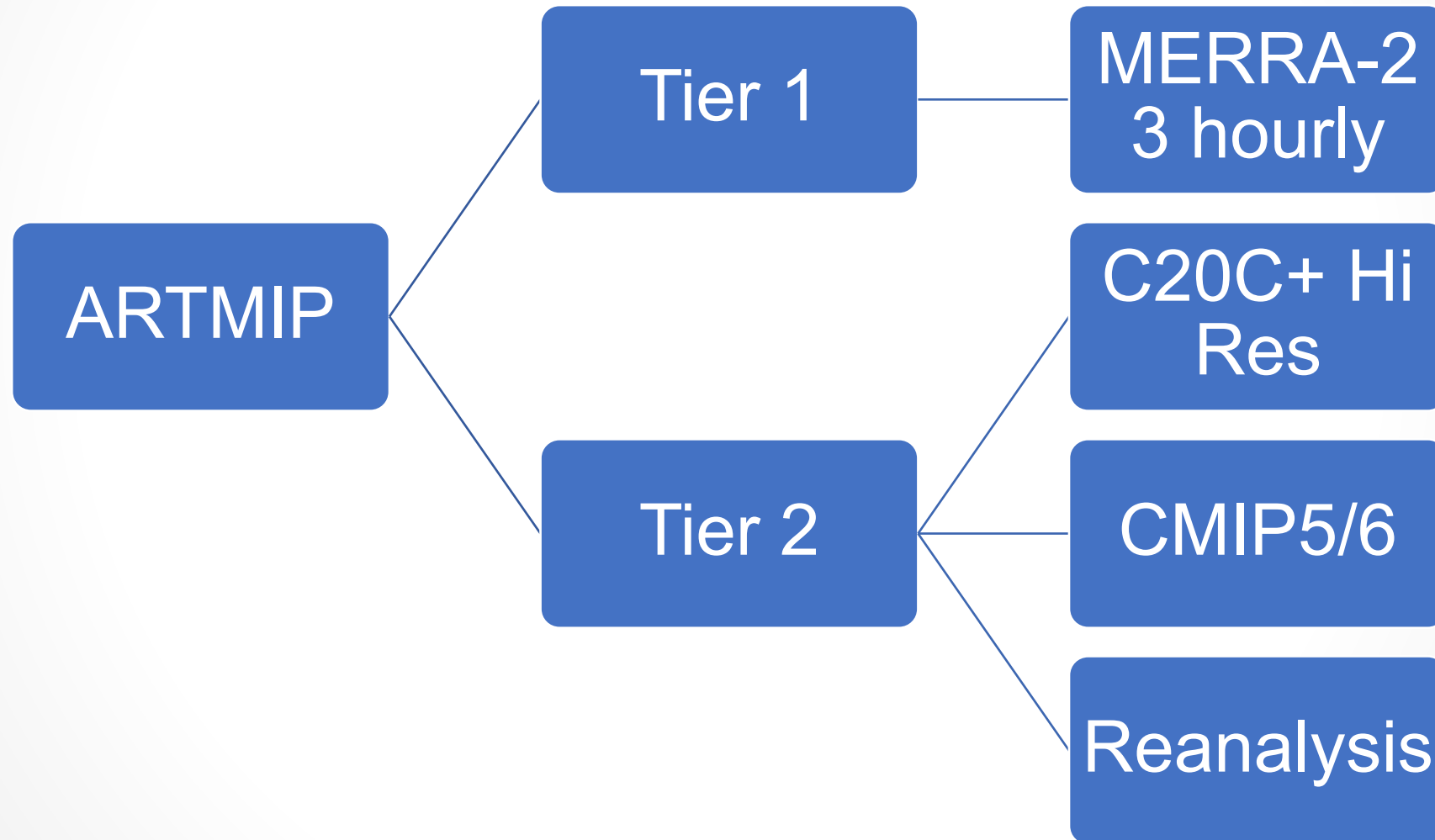
ARTMIP Committee: Christine Shields, Ruby Leung, Travis O'Brien, Ashley Payne, Marty Ralph, Jon Rutz, Michael Wehner, Paul Ullrich

Reanalysis Participants: Bin Guan, Sol Kim, Juan Lora, Kyle Nardi, Ashley Payne, Kim Reid, Eric Shearer, Christine Shields, Ricardo Tome, Jonathan Wille

Collow, A. B. M., Shields, C. A., Guan, B., Kim, S., Lora, J. M., McClenny, E. E., et al. (2022). An overview of ARTMIP's Tier 2 Reanalysis Intercomparison: Uncertainty in the detection of atmospheric rivers and their associated precipitation. *Journal of Geophysical Research: Atmospheres*, 127, e2021JD036155. <https://doi.org/10.1029/2021JD036155>

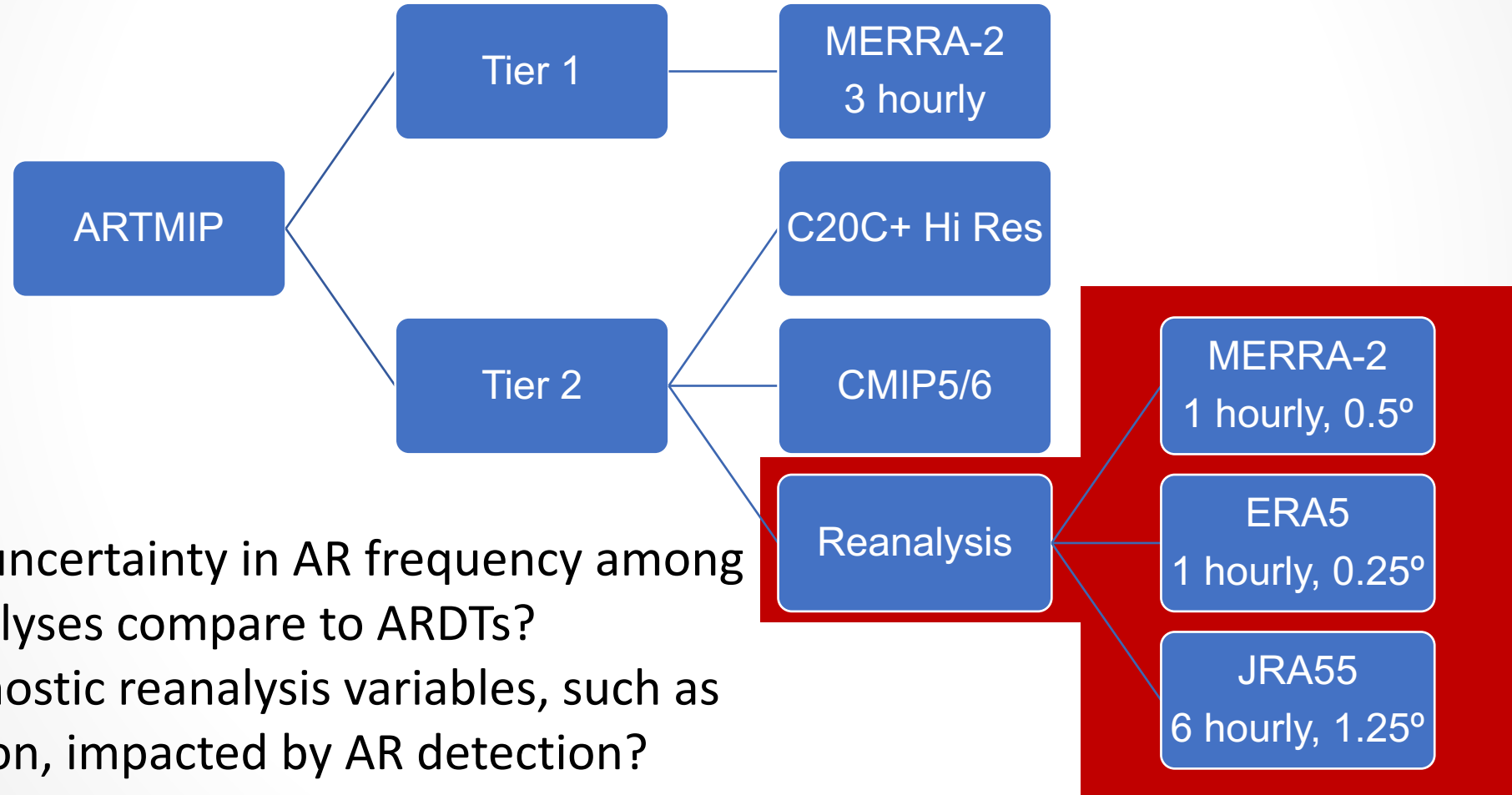
ARTMIP Experimental Design

- ARTMIP provides the framework necessary to compare different algorithms to allow independent researchers to understand what types of algorithms are best suited for specific science questions.
- Participants run atmospheric river detection tools (ARDTs) on common input data



ARTMIP Experimental Design

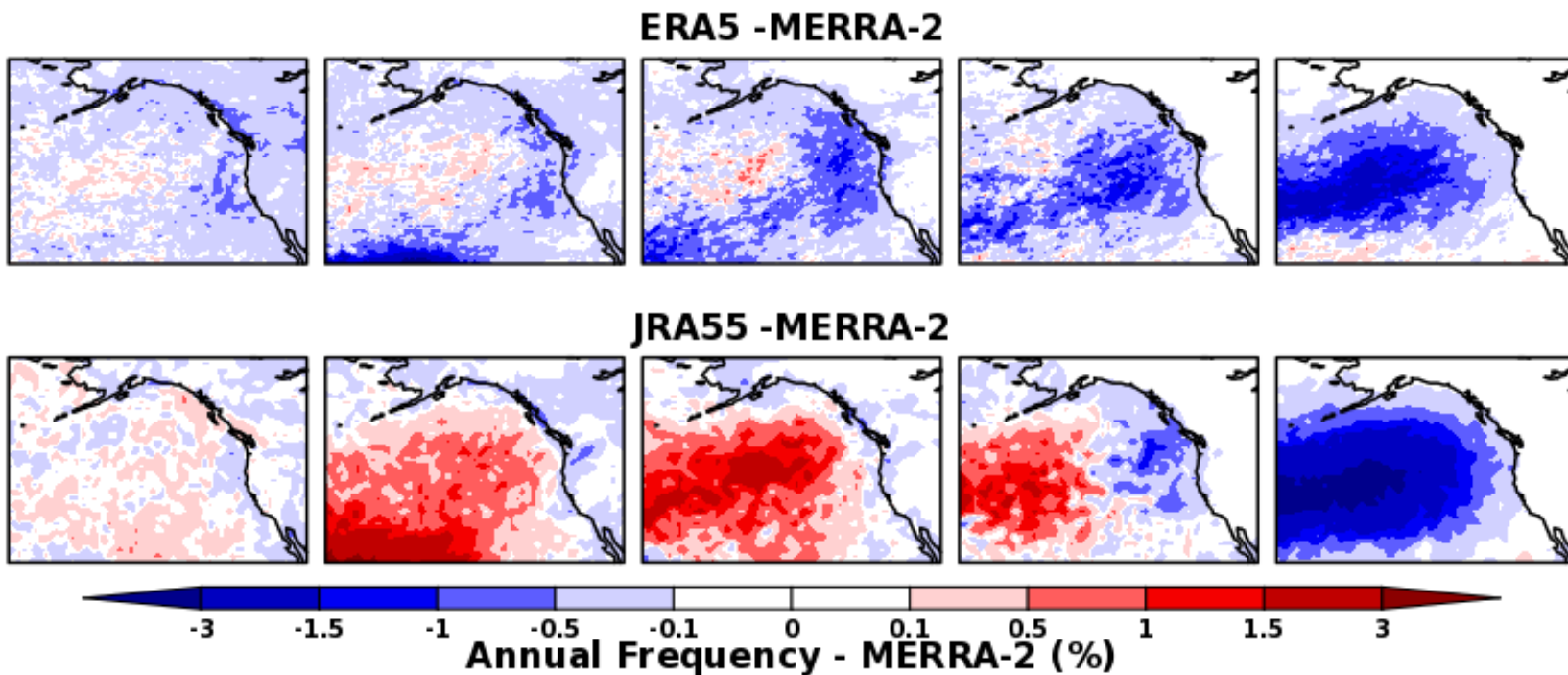
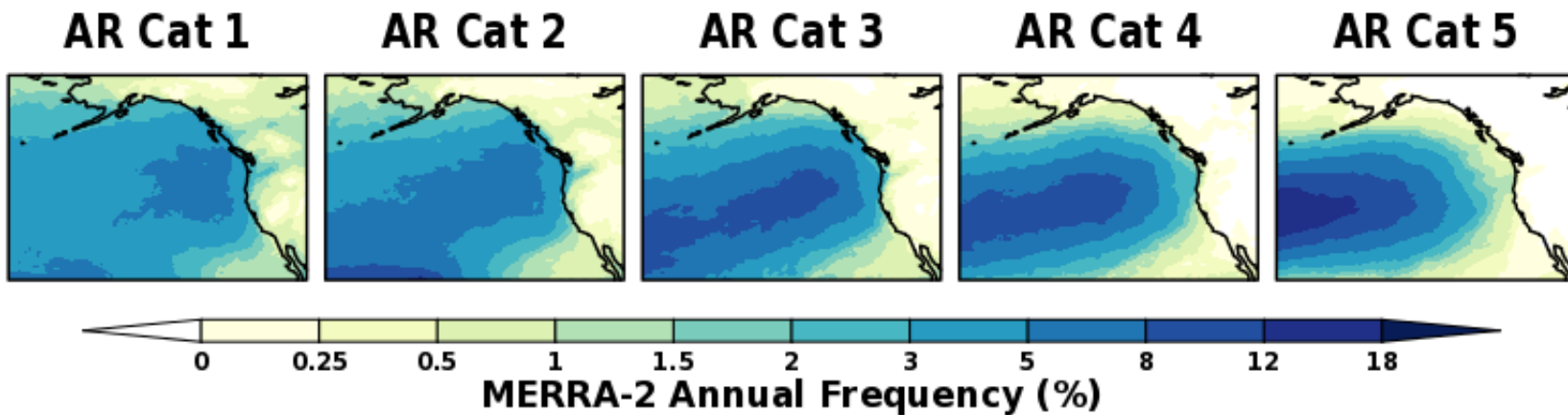
- ARTMIP provides the framework necessary to compare each of these different algorithms which will ultimately allow independent researchers to understand what types of algorithms are best for specific science questions.
- Participants run atmospheric river detection tools (ARDTs) on common input data



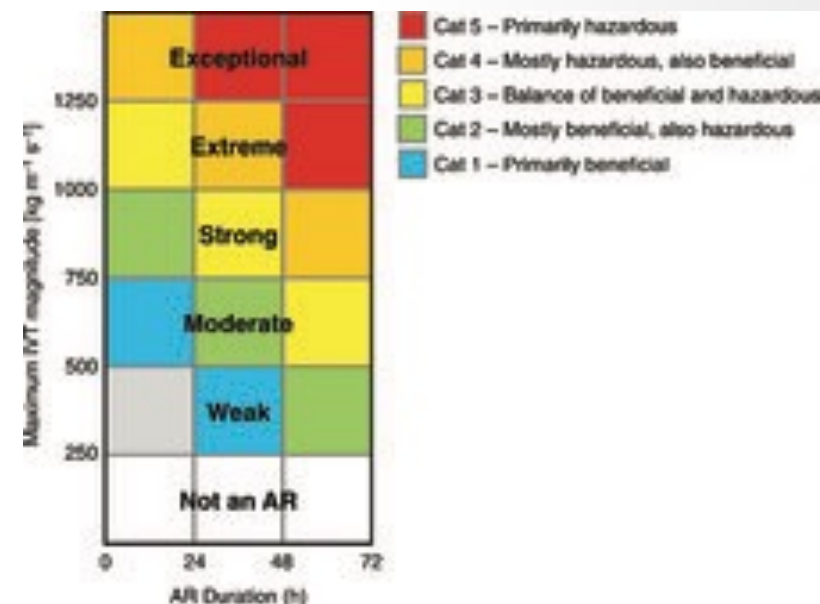
How does the uncertainty in AR frequency among reanalyses compare to ARDTs?

How are diagnostic reanalysis variables, such as precipitation, impacted by AR detection?

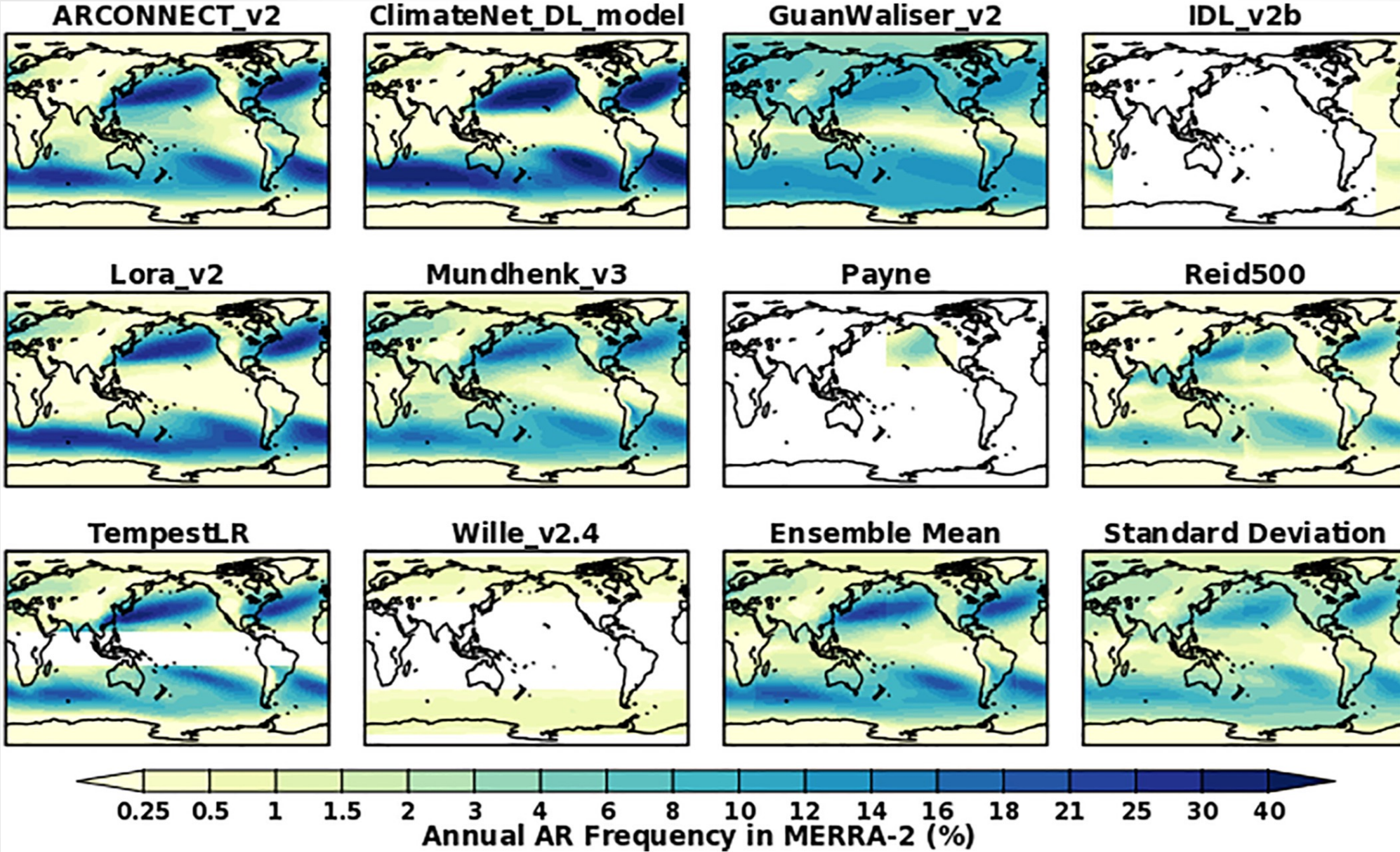
Ranking ARs by Intensity and Duration



- Categorical scale developed by Ralph et al. (2019) to convey benefits and hazards of an AR event
- Tuned to the US west coast
- Can be considered an ARDT in itself
- Demonstrates differences in the PDF of IVT among reanalyses
- MERRA-2 has more extreme ARs, JRA-55 has more moderate ARs

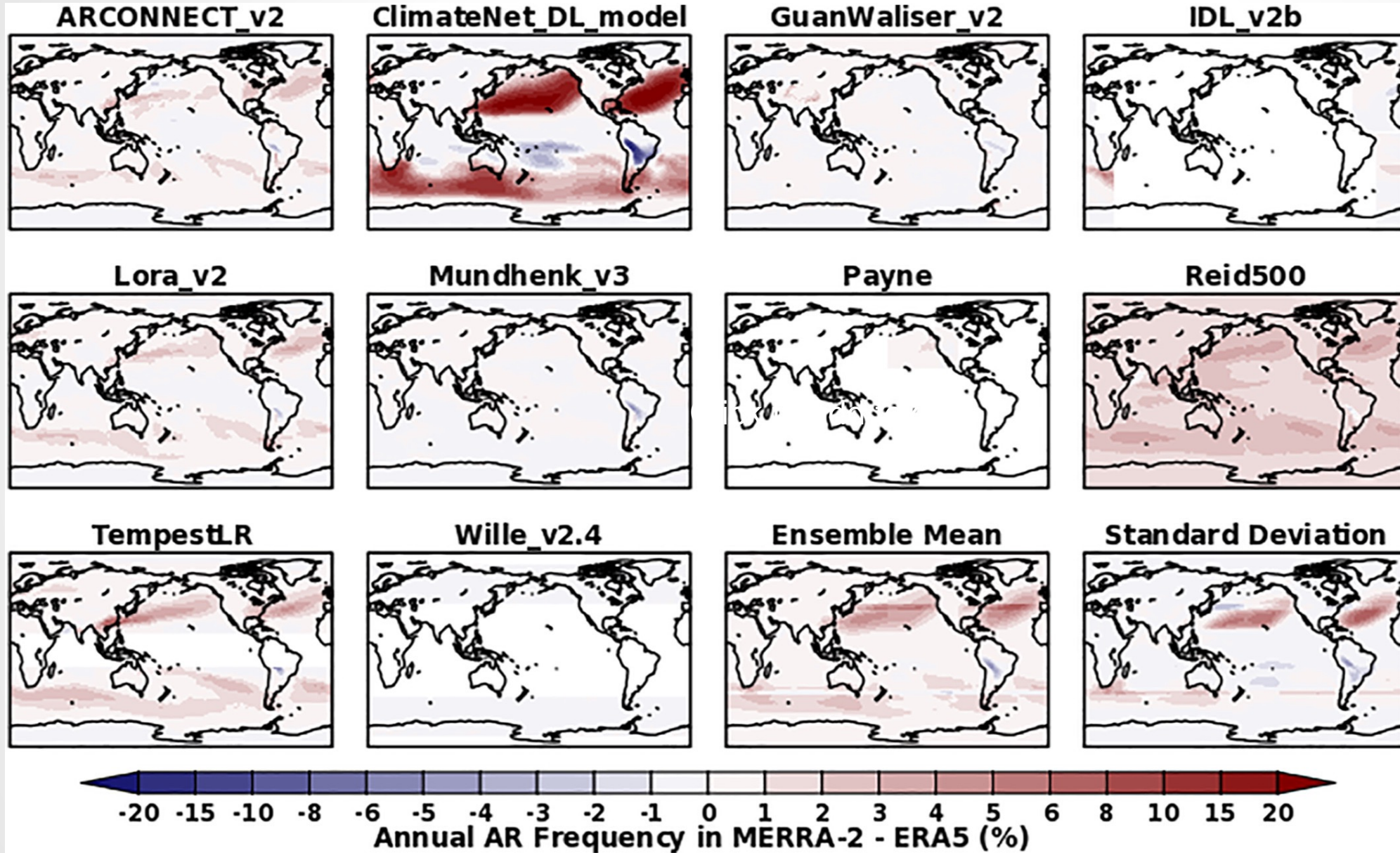


Atmospheric River Detection Tool (ARDT) Diversity



- 10 ARDTs with various methods for AR detection
- 5 "AR Tracks" are detected by all global ARDTs, though frequency varies
- GuanWaliser_v2 has a different character, with minimal gradient in equator to pole AR frequency (ARs are searched for incrementally using the 85th to 95th percentile of IVT)

ARs in MERRA-2 minus ERA5

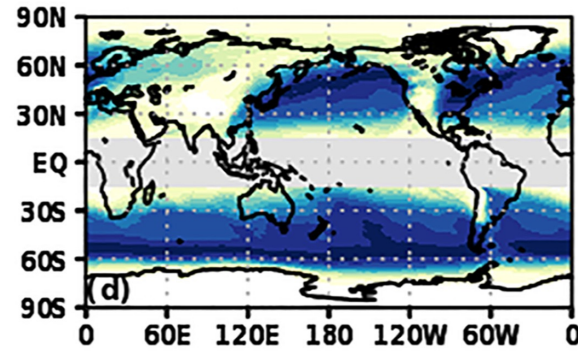
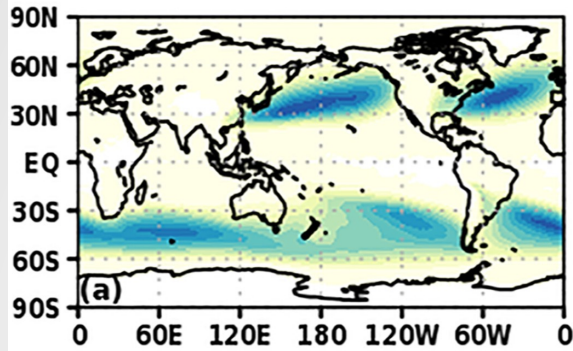


- MERRA-2 has a large- \rightarrow more ARs climatological IVT
- Differences are larger in ARDTs with absolute thresholds (e.g. Reid500) than relative thresholds (e.g. Mundhenk_v3)
- ClimateNet was trained using IWV, which is larger in MERRA-2
- ERA5 better represents the South American Low Level Jet
- Results are similar for JRA55

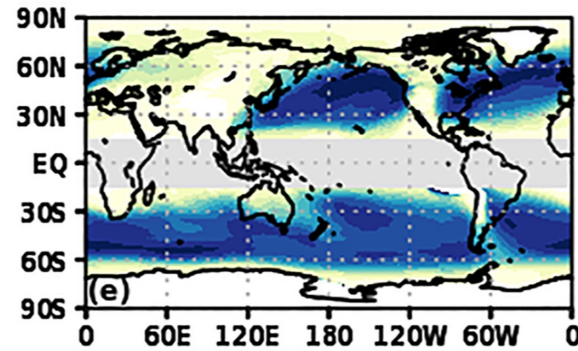
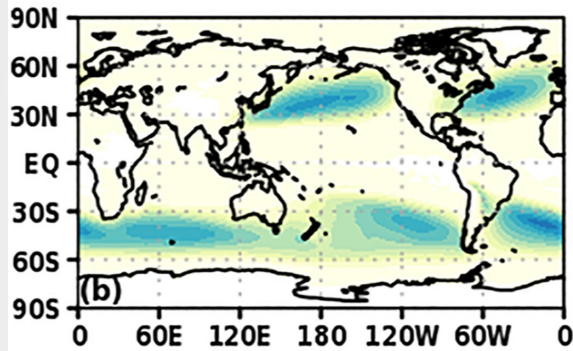
Consensus ARs

- At least half of the global ARDTs detect an AR at a given grid box and time step
- AR Consensus Frequency = percent occurrence of the "consensus AR"
- Percent AR Consensus = percentage of the ensemble mean AR frequency that is detected by the "consensus AR"
- ARDTs agree on the core AR object, but not the periphery

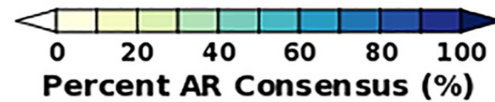
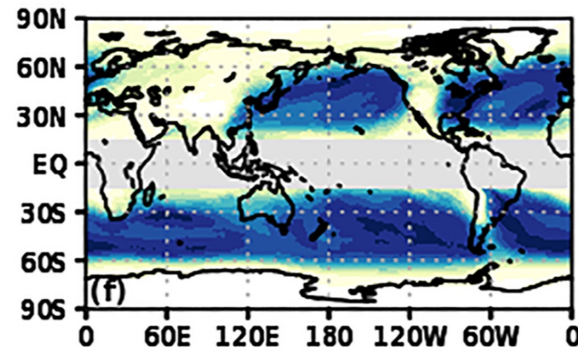
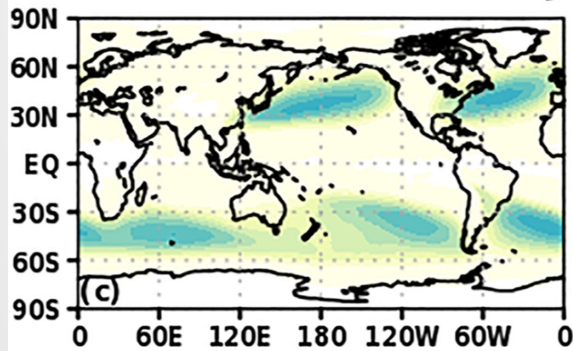
MERRA-2



ERA5



JRA-55



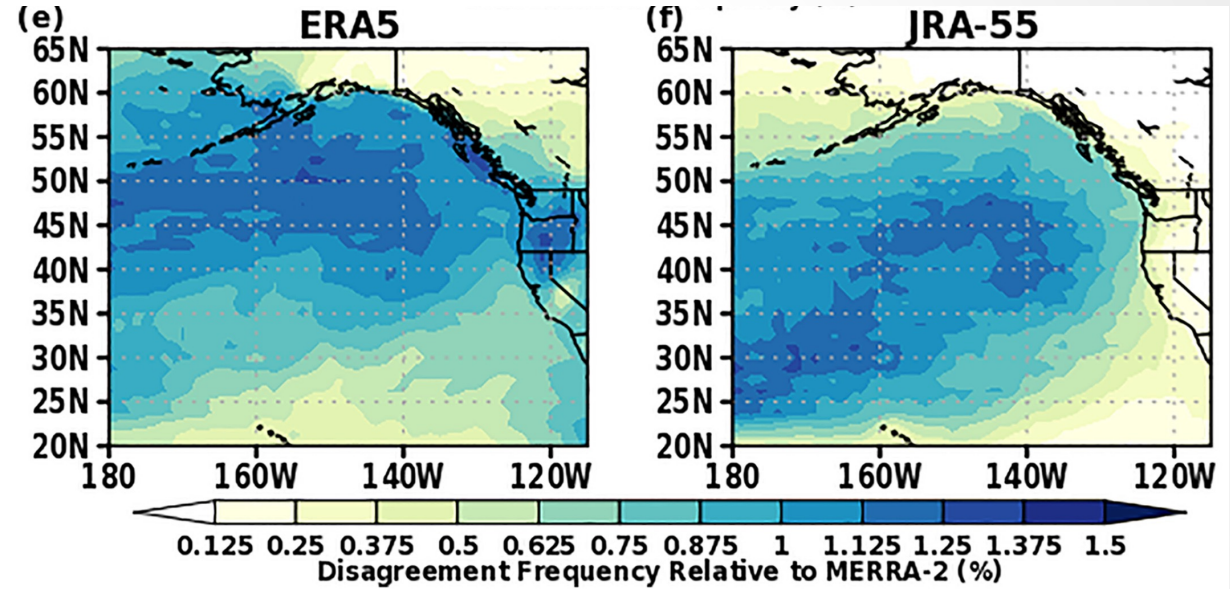
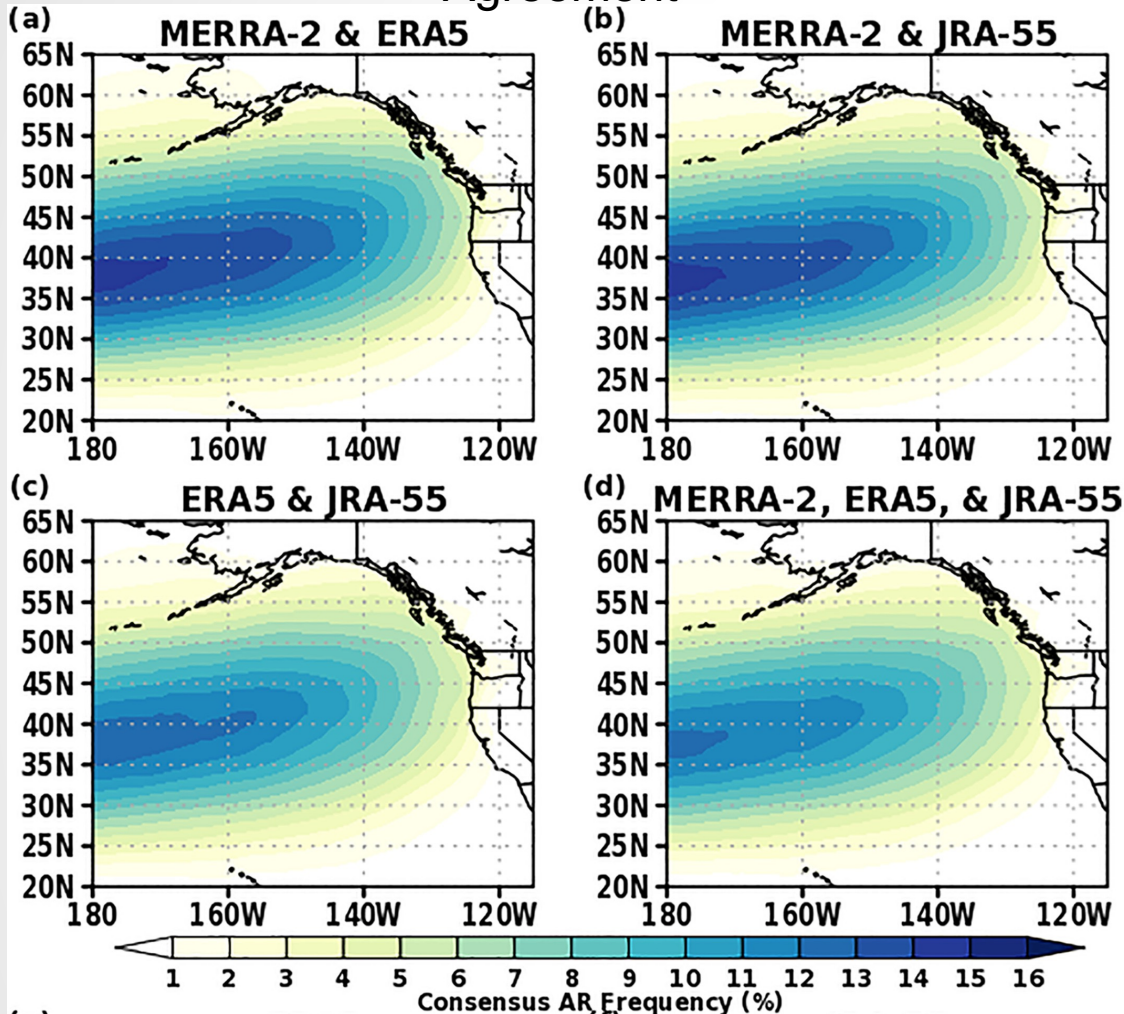
Collow et al., 2022

Consensus and Disagreement among Reanalyses



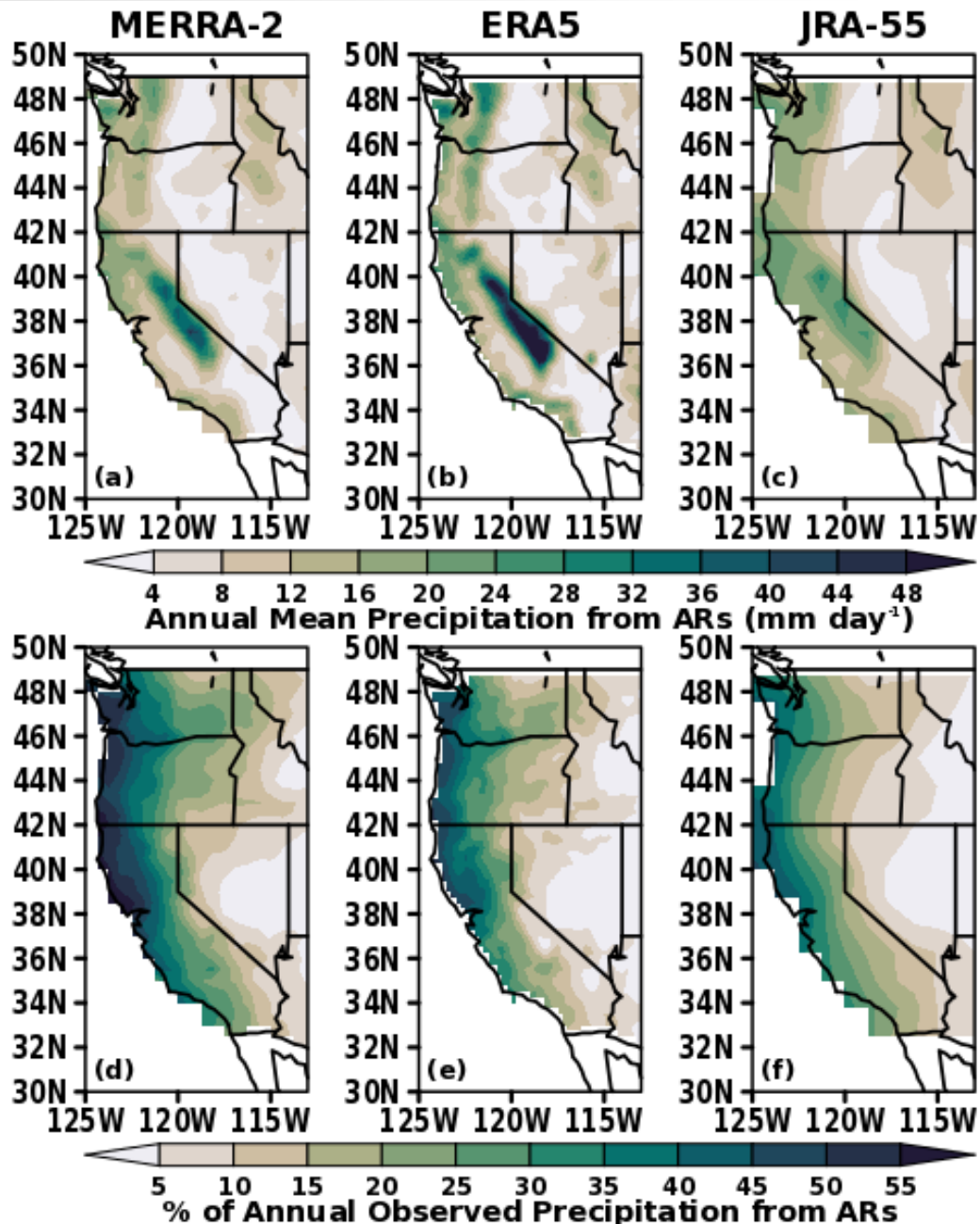
Agreement

Disagreement



- How often does the consensus AR in one reanalysis agree with a different reanalysis?
- During disagreements to MERRA-2:
 - ERA5 indicates a higher frequency to the north of the AR track and allows for inland penetration of ARs
 - JRA55 has a shift in the "core" – could be related to temporal resolution or propagation speed

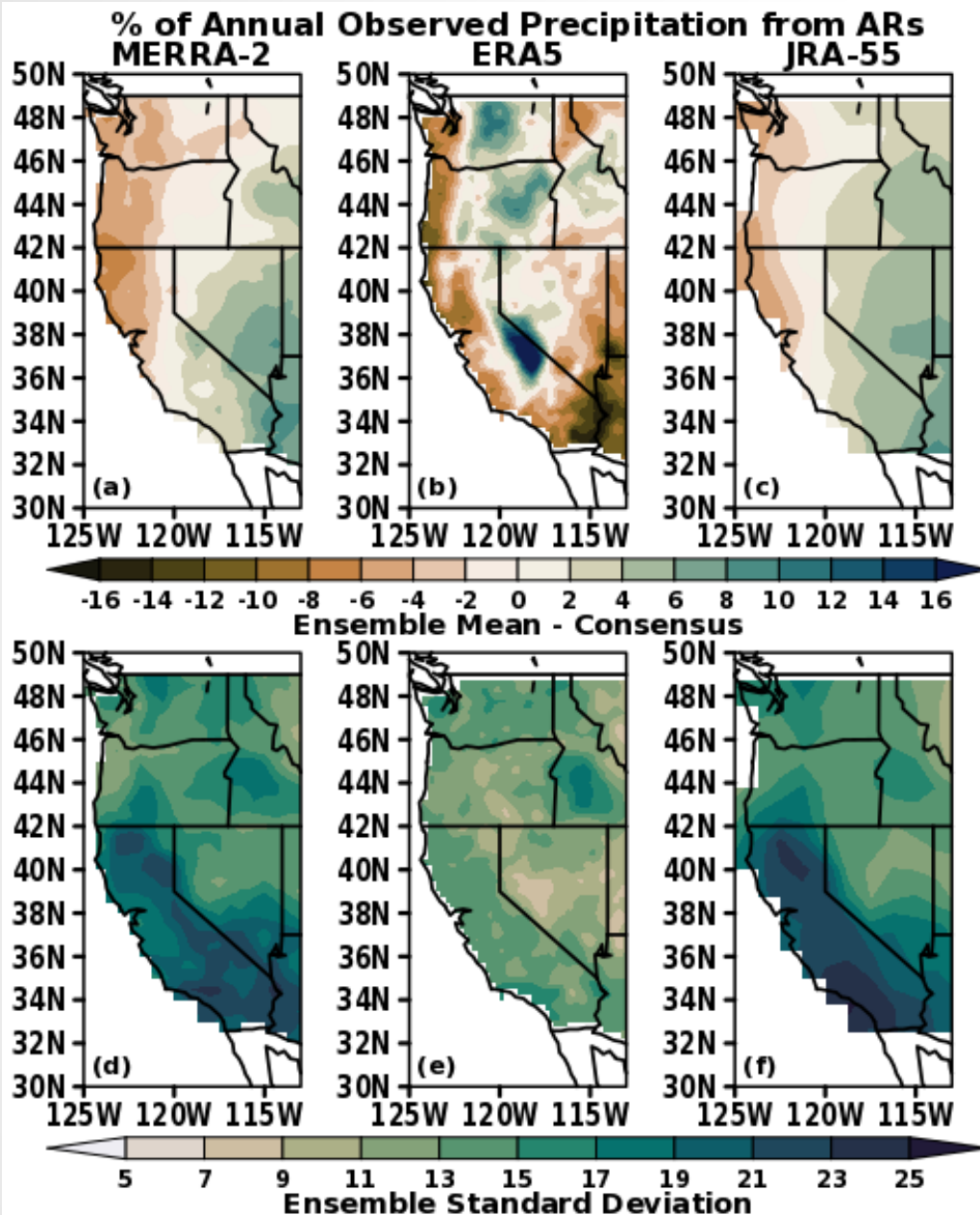
Collow et al., 2022



AR-Related US West Coast Precipitation

- Independent precipitation from CPCU Daily 0.25° gridded obs
- Using a “consensus AR”
- Spatial pattern of annual mean AR precipitation dictated by topography, % of precipitation from ARs dictated by AR frequency
- More precip with each AR in ERA5 → less, but more intense ARs are getting detected than MERRA-2
- JRA55 AR precip is smoothed out
- Spread in % of precip from ARs is on par with the spread associated with different ARDTs and methodologies shown earlier

Collow et al., 2022



Consensus vs Ensemble Approach

- Consensus = an AR that at least half the ARDTs agree upon
- Ensemble = Precip is composited for each ARDT and then averaged
- The consensus AR is associated with a larger percentage of precipitation along the coast and less in land relative to an ensemble mean
- Highlights the disagreement with inland penetration in AR detection
- Ensemble standard deviation is lowest in ERA5, but the spatial pattern is the same in the reanalyses

Collow et al., 2022



Summary and Conclusions

- Lessons learned for AR detection in reanalyses:
 - Use the reanalysis and ARDT that best suits your needs
 - JRA55 is sufficient for global studies, ERA5 is difficult to work with but best resolves finer scale features, more ARs are detected in MERRA-2 due to higher climatological TPW
 - Regional ARDTs are ideal for regional studies
 - Uncertainty in AR frequency is larger due to ARDT than the choice in reanalysis
 - Absolute/fixed thresholds result in larger differences in AR frequency between reanalyses than varying/relative thresholds
 - Peer review process has shifted toward requiring an ensemble of ARDTs
 - Over 2 dozen ARDTs have provided AR tags in MERRA-2
(<https://www.earthsystemgrid.org/dataset/ucar.cgd.artmip.html>)
 - Different answers arise if using a consensus AR compared to an ensemble mean