Multidecadal Regional Cloud and Radiation Changes

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Goals

- Document cloud and surface solar (SW) radiation flux variability during 1965-2005 by combining several datasets
- Assess trend credibility through dataset intercomparison
- Identify cloud and aerosol components of changes in surface SW radiation flux
- Examine Central Europe, Japan, Continental US, India, Mainland China, and Southern Africa

Datasets

- Monthly downward all-sky SW radiation flux from Global Energy Budget Archive (GEBA) stations for various time periods
- Monthly gridded total cloud amount from International Satellite Cloud Climatology Project (ISCCP) during 1983-2004
- Monthly gridded downward all-sky SW radiation flux at the surface from ISCCP Flux Dataset (FD) during 1983-2001
- Monthly total cloud cover from synoptic reports at World Meteorological Organization (WMO) stations during 1971-1996 (Hahn and Warren NDP026D)

SW Flux Estimated from Synoptic Reports

- Use synoptic cloud reports to bridge between satellite observations and pre-1983 GEBA measurements
- Cloud cover radiative forcing (CCRF) anomalies are defined as the component of radiation flux anomalies caused by changes in cloud cover (all else constant)

SW CCRF anomaly =

(mean SW CRF / mean cloud cover) ×

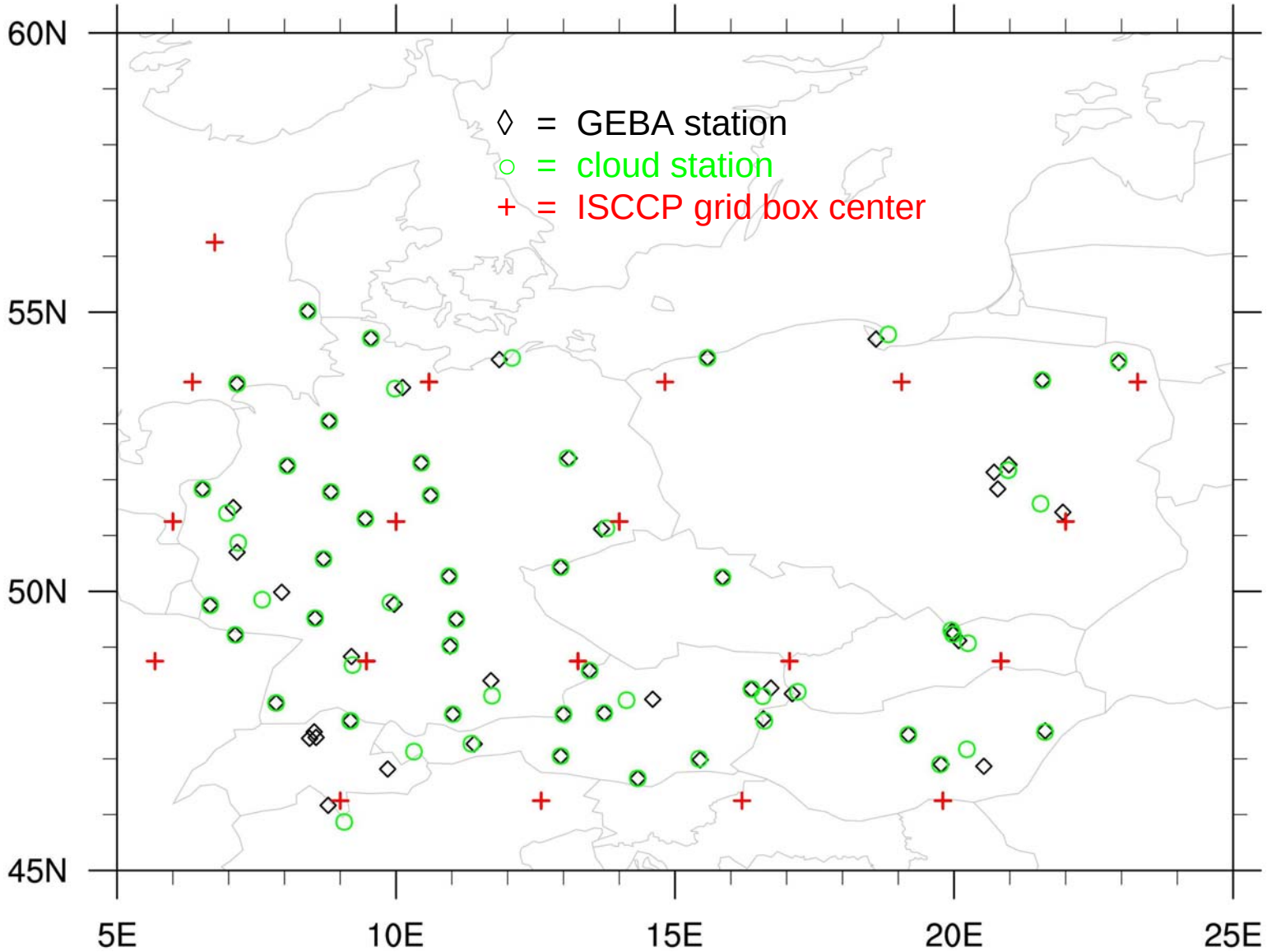
total cloud cover anomaly

- Assumes SW flux varies linearly with cloud cover and omits effects of other cloud and aerosol variability

Analysis Method

- Pair GEBA stations and ISCCP grid boxes with nearest WMO cloud station
- Calculate monthly anomalies for each station and align paired time series to common long-term mean
- Average all available station anomalies equally to obtain regional time series
- If fewer than 1/3 stations contribute, set to missing
- If fewer than 2/3 stations contribute, plot as dashed
- Apply 1-2-1 smoothing for readability
- Apply 5-year low-pass filter to emphasize multidecadal variations

Central Europe (64 stations)



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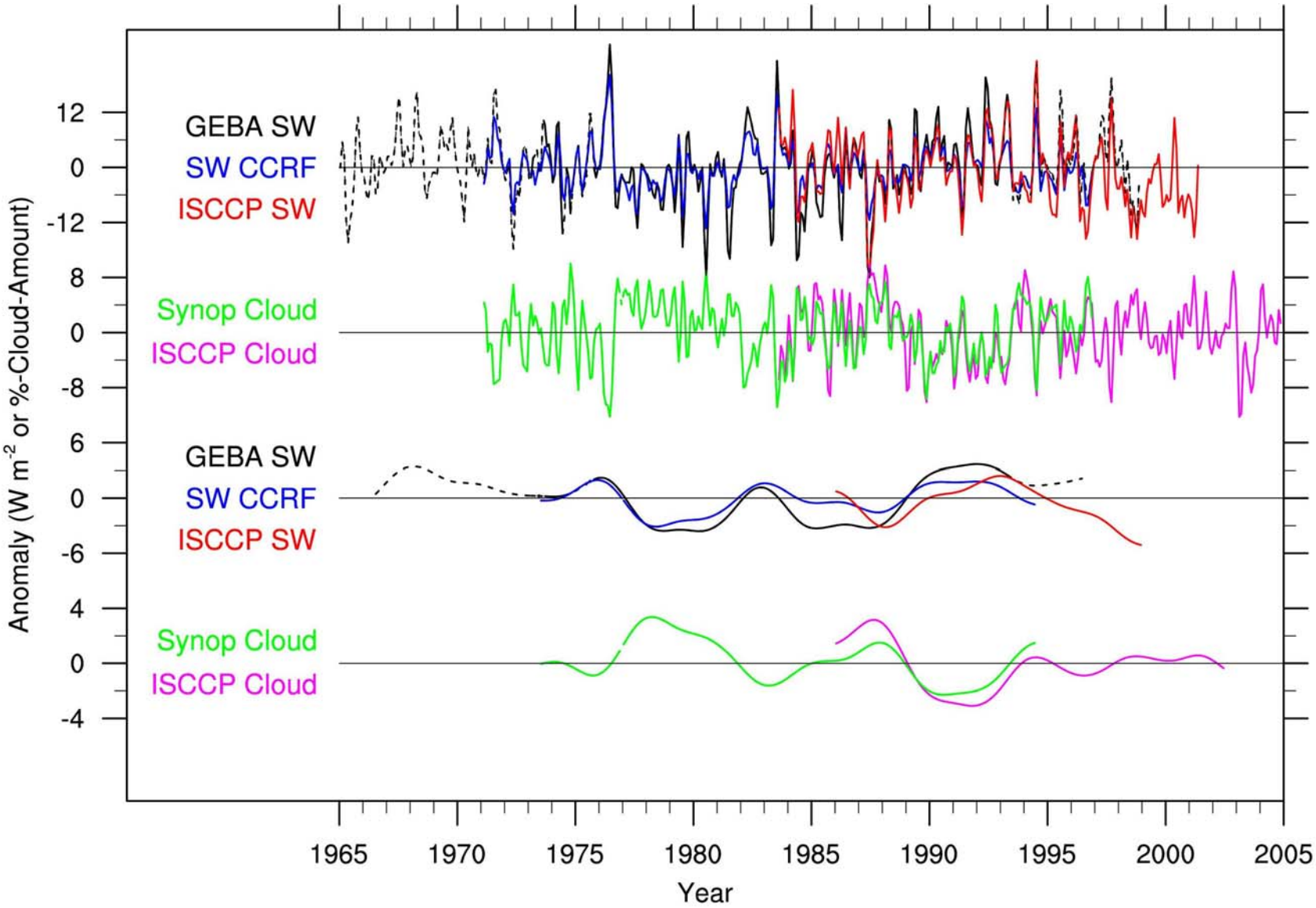
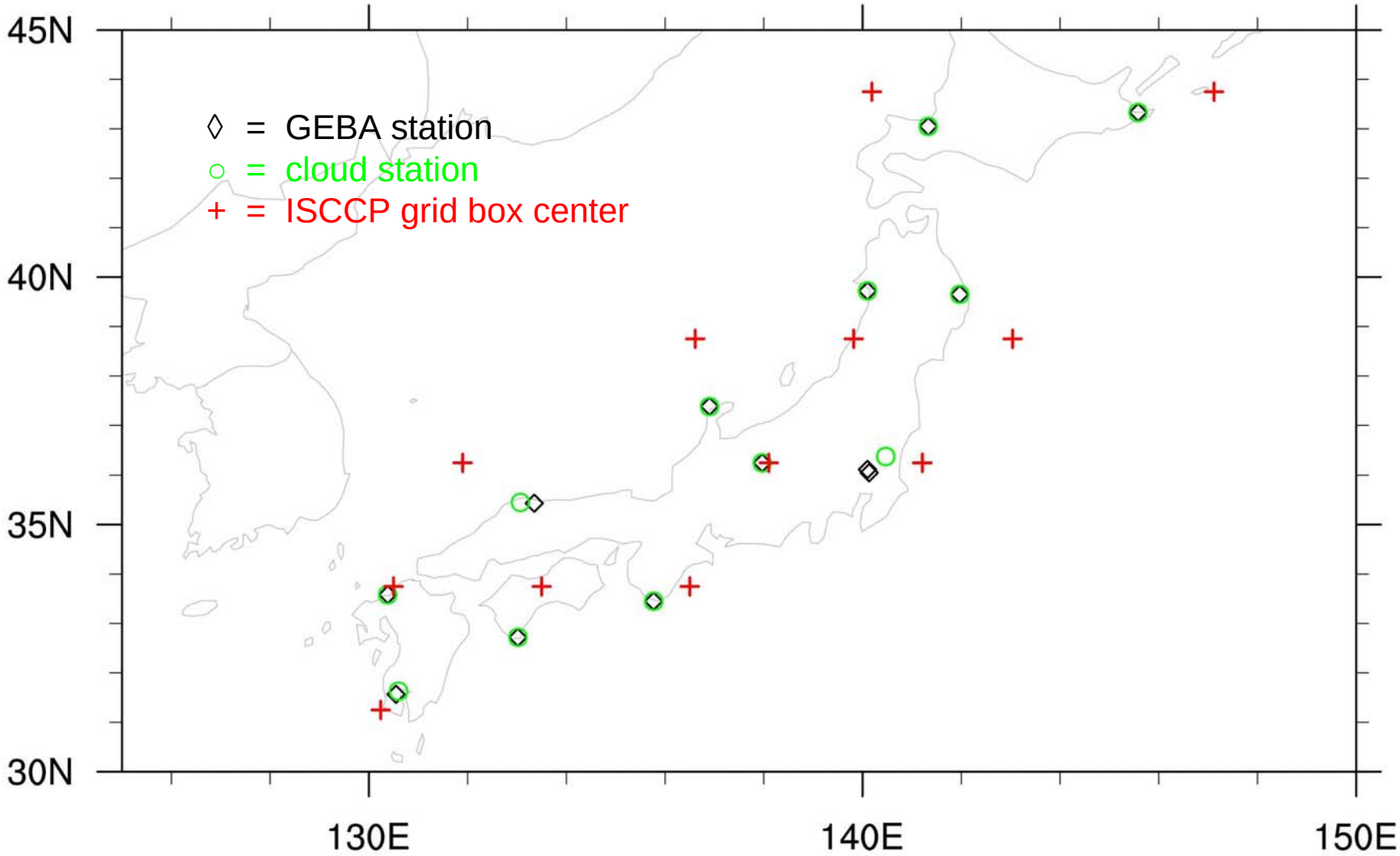


Japan (13 stations)



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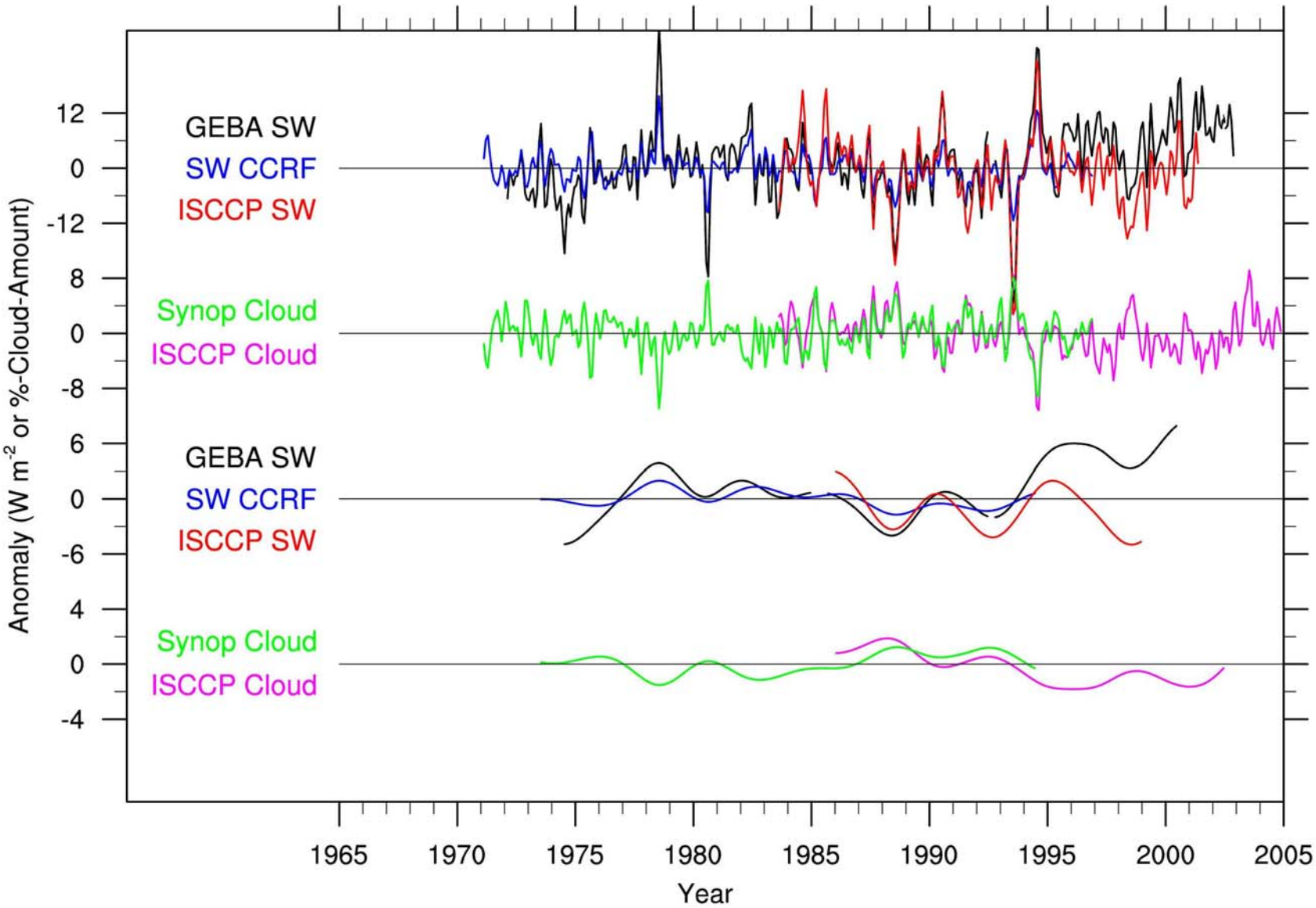
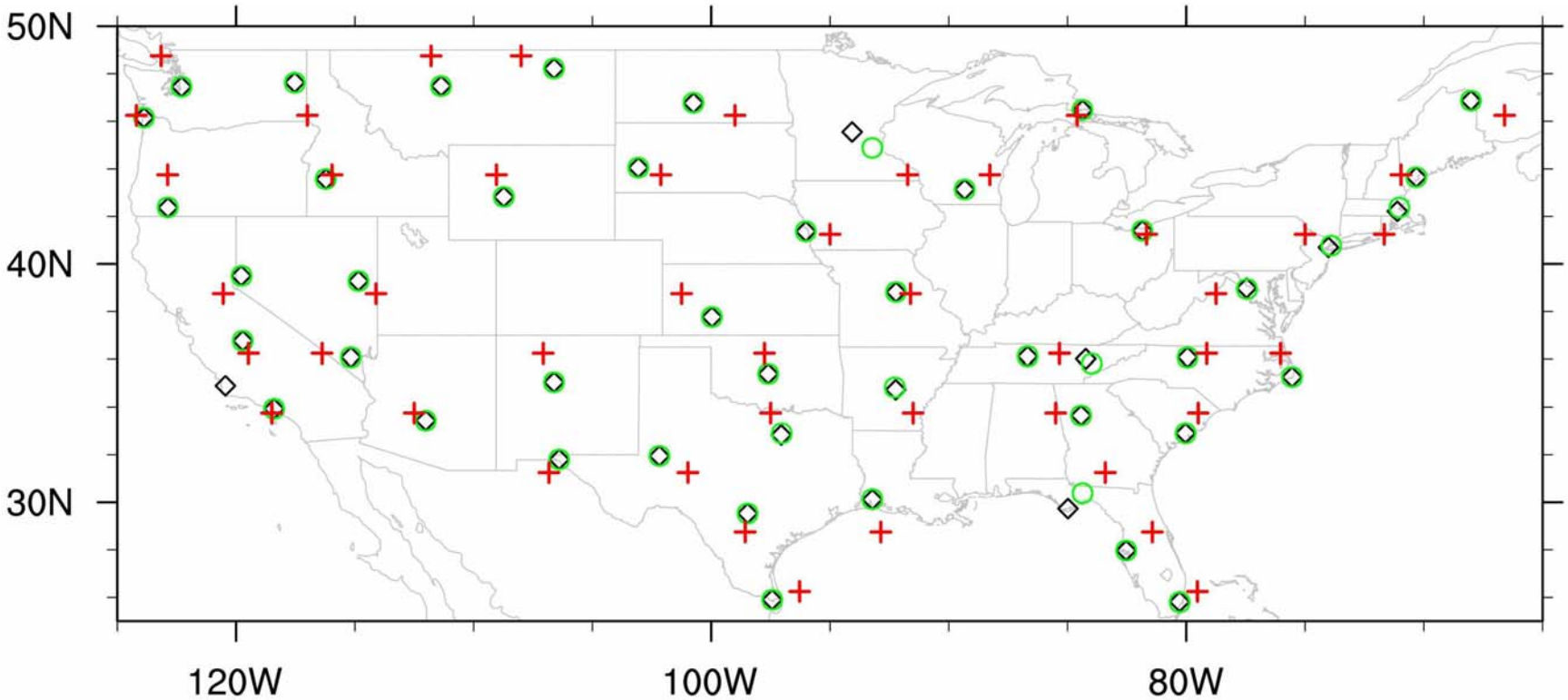


Continental U.S. (47 stations)



◊ = GEBA station
○ = cloud station
\+ = ISCCP grid box center

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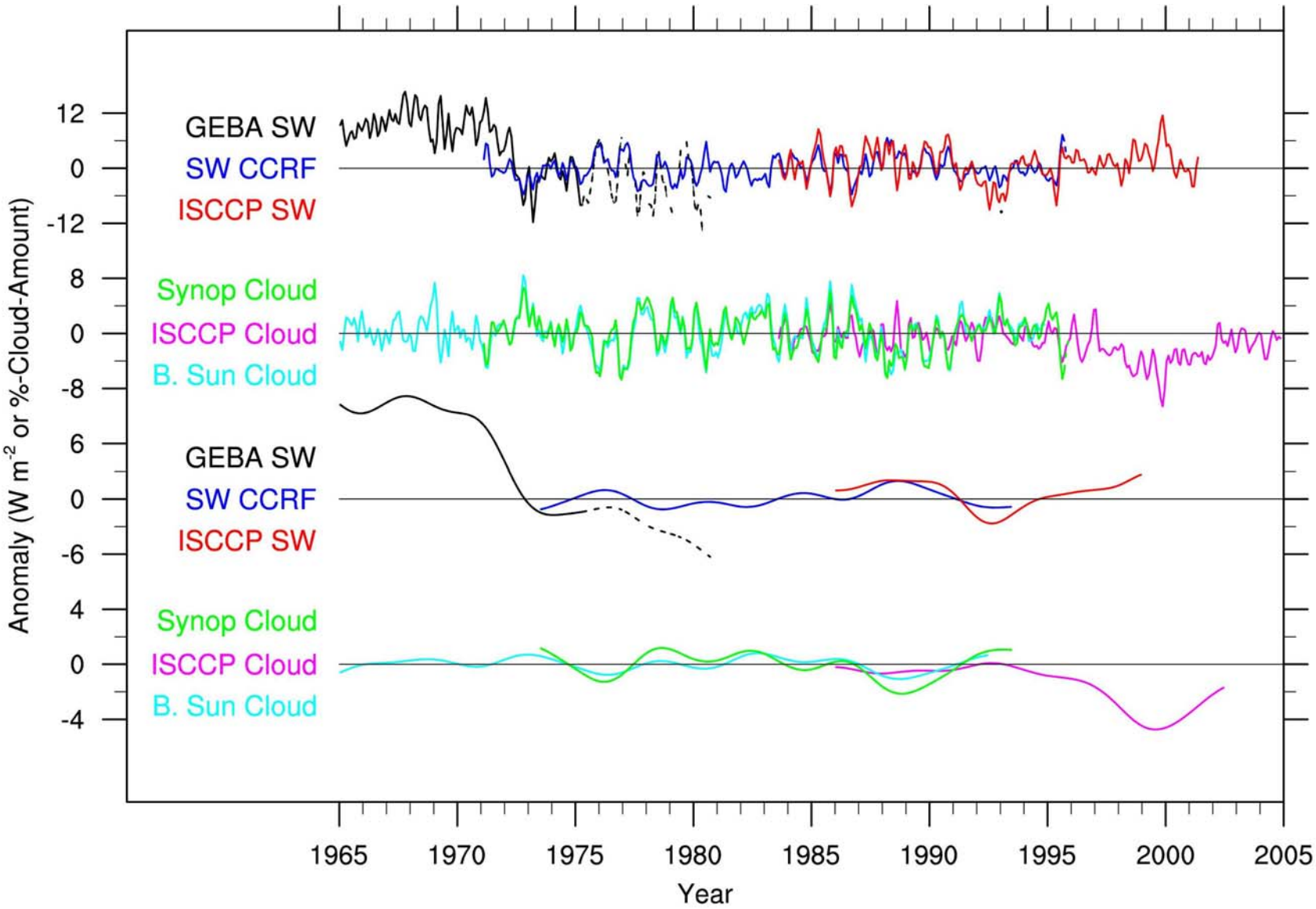
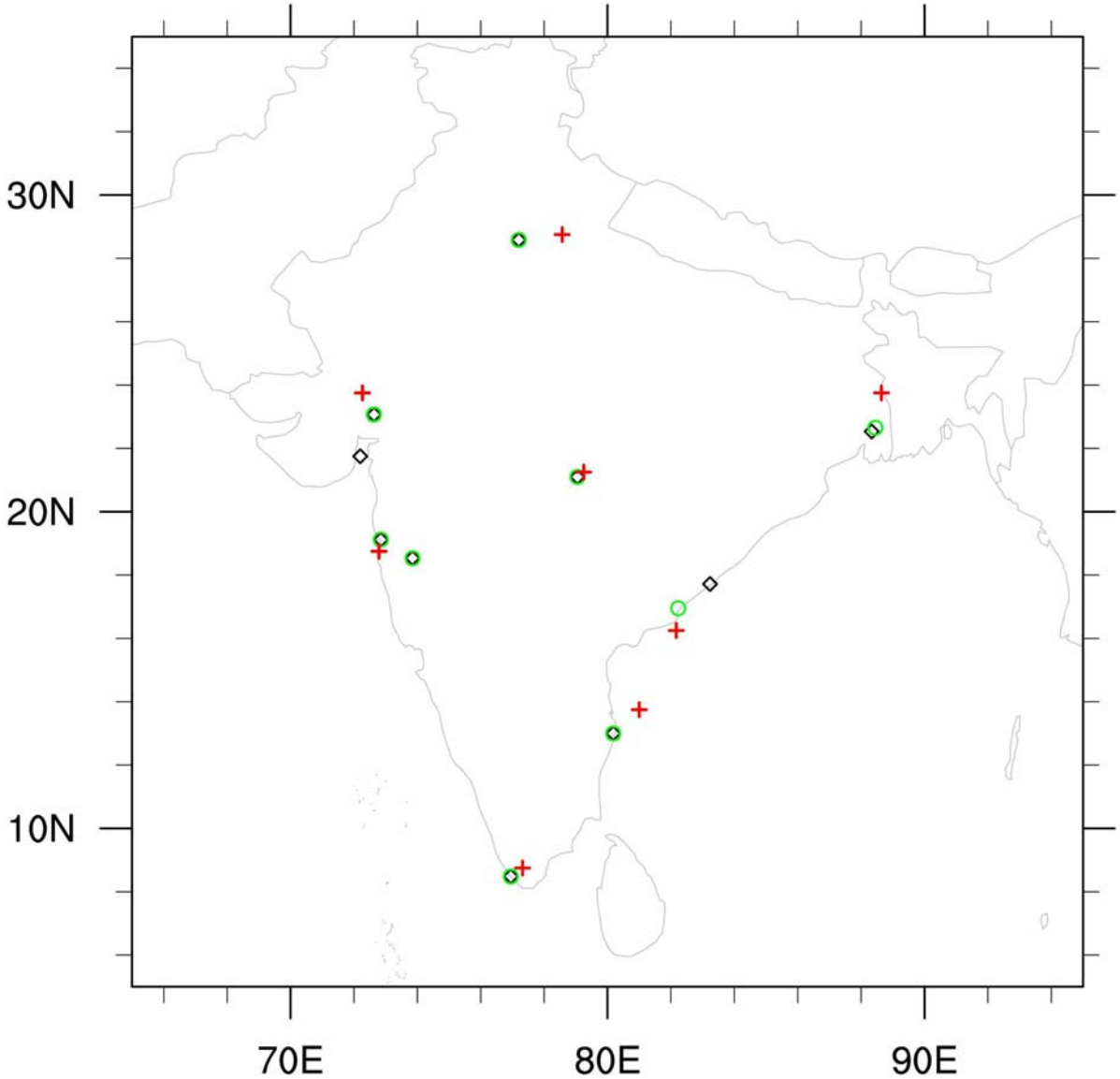


India (10 stations)



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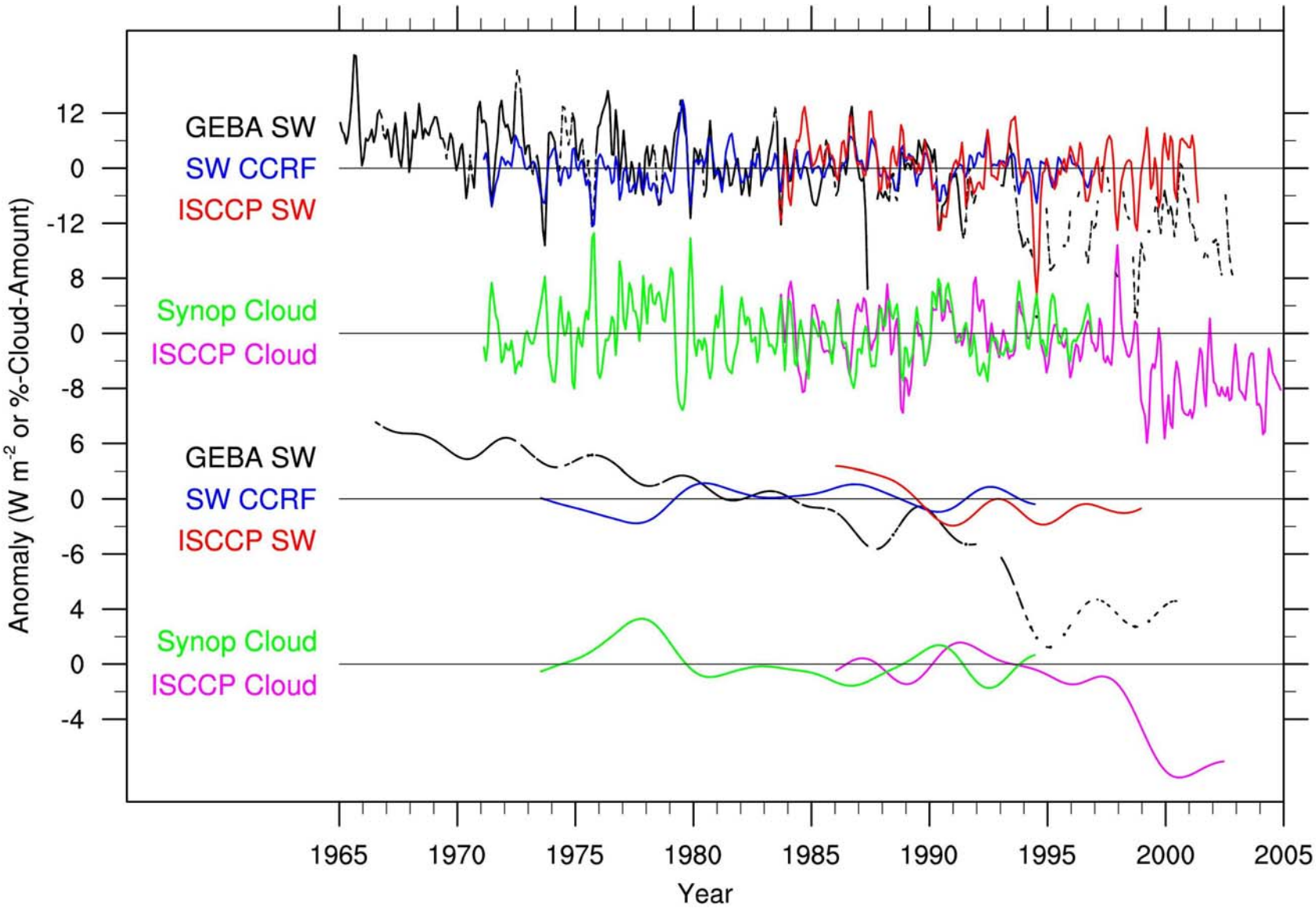
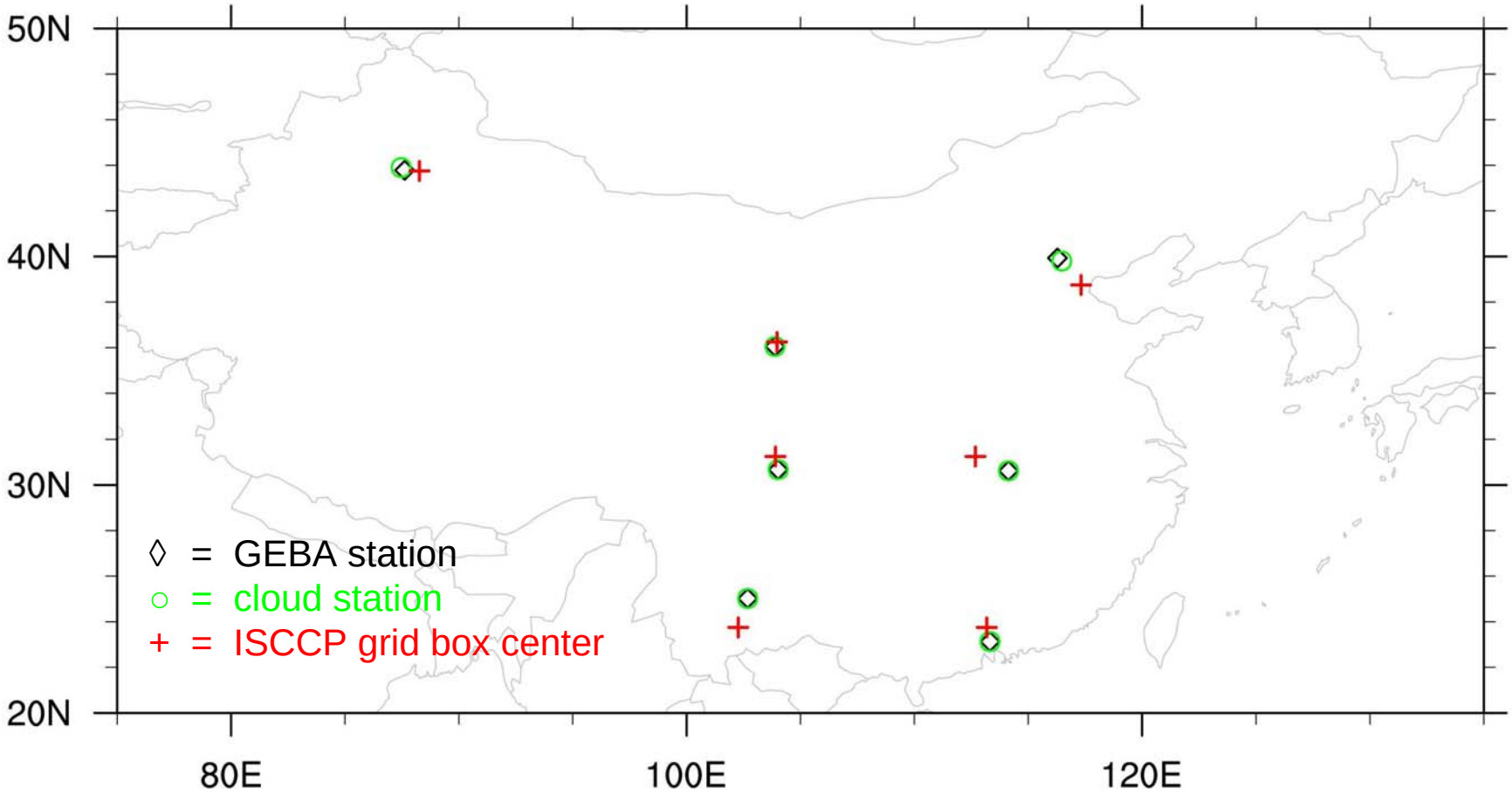


Mainland China (7 stations)



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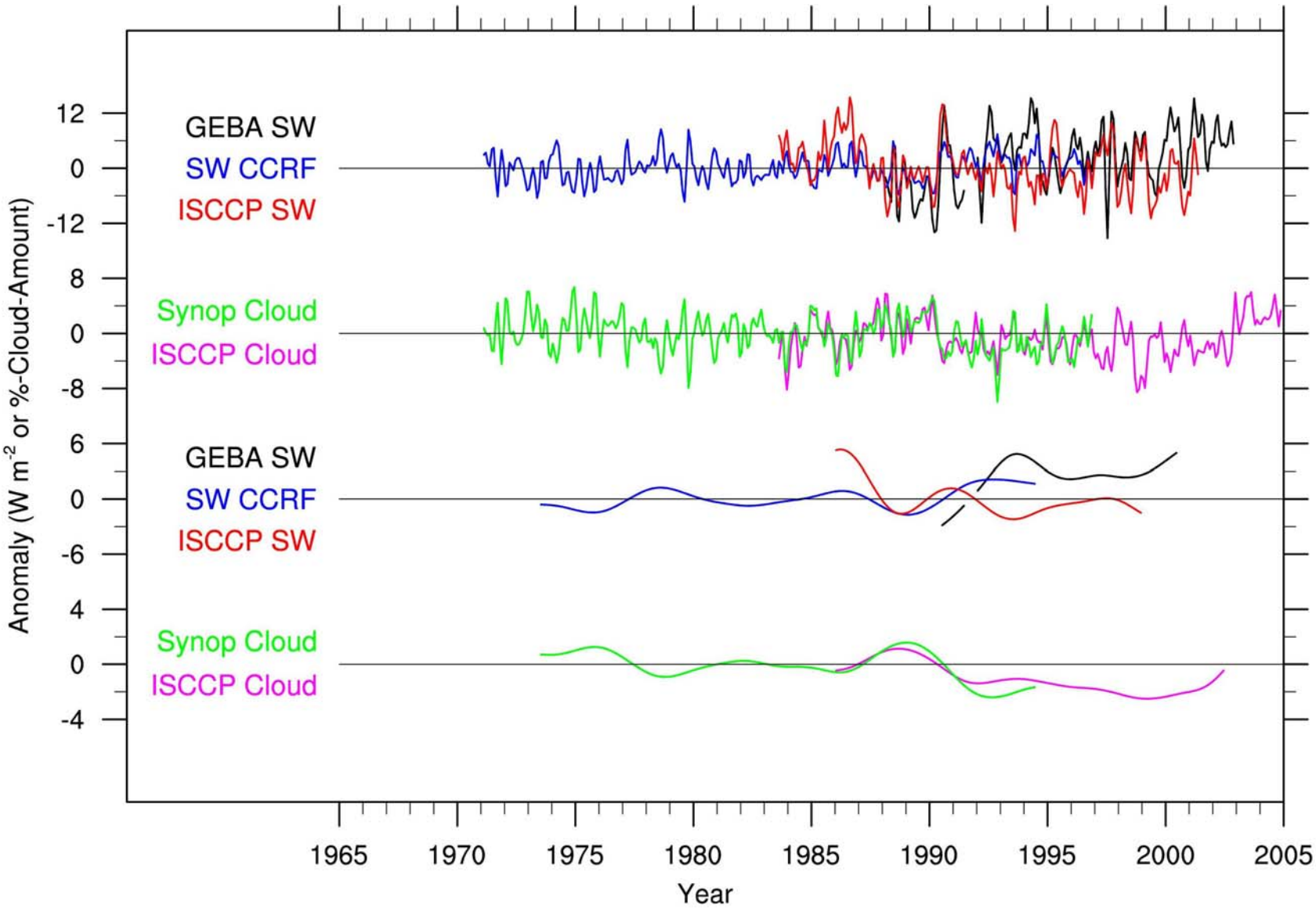
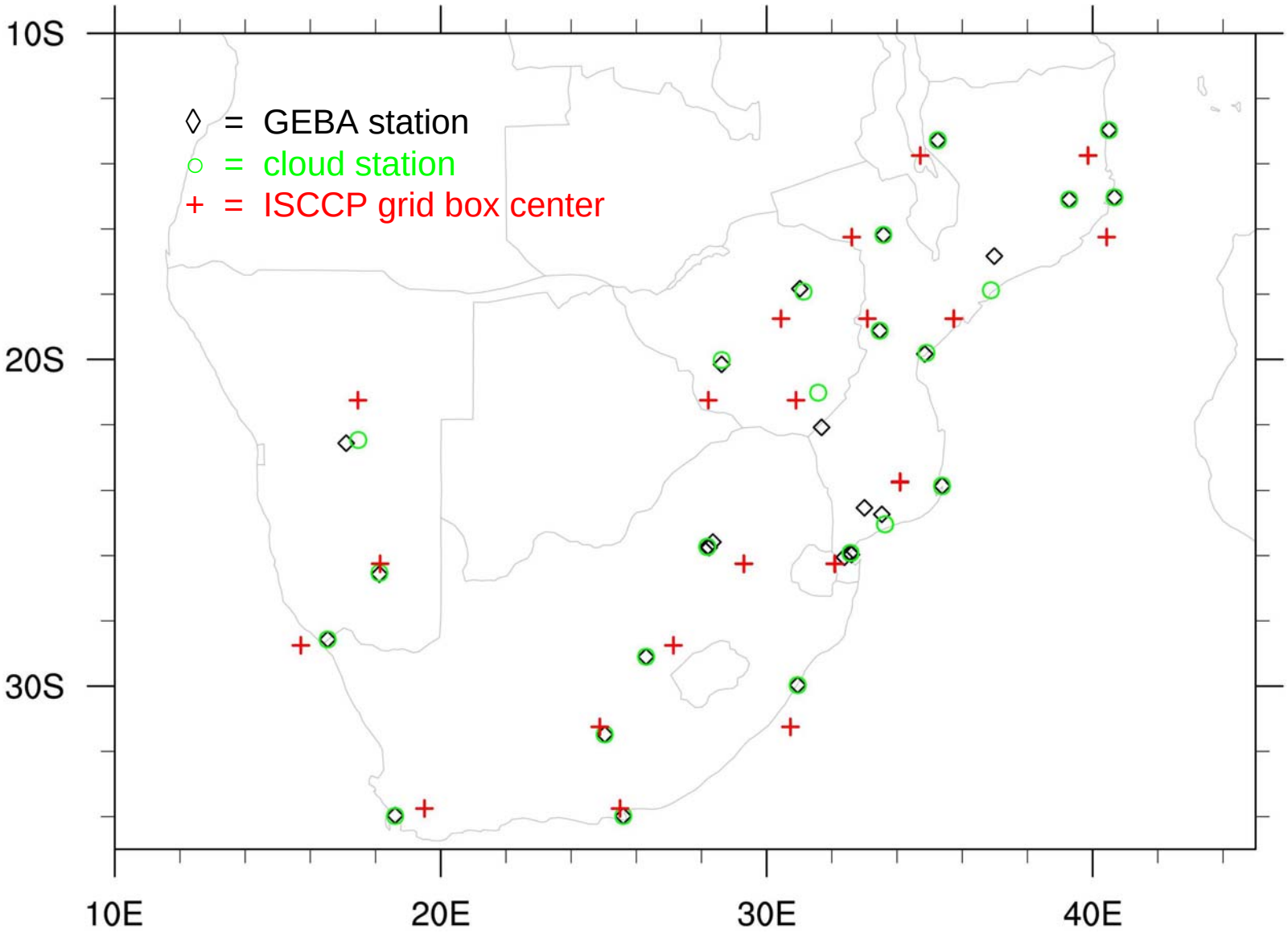


Southern Africa (28 stations)



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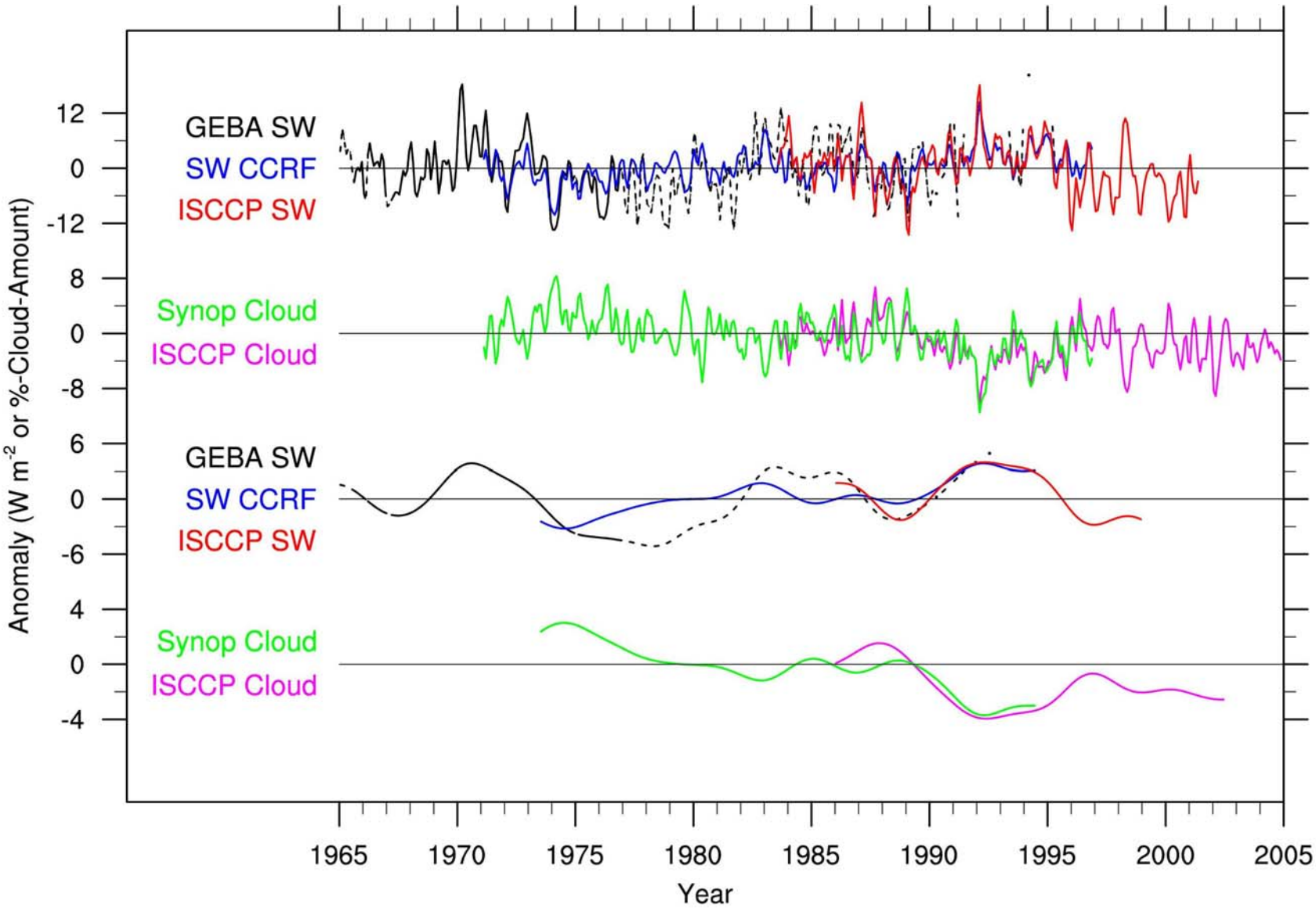

Conclusions

- Interannual anomalies in GEBA SW, ISCCP SW, and estimated SW CCRF generally exhibit good agreement
- Central European decrease in surface SW radiaation prior to 1985 followed by an increase appears to be partially due to cloud cover changes
- An abrupt decrease in GEBA SW flux in the early 1970s over the U.S. appears unrealistic

Conclusions

- A gradual decrease in GEBA SW flux over India with no increase in cloud cover change suggests the occurrence of increasing aerosol radiative forcing
- Decreasing cloud cover over China may explain why GEBA SW flux is increasing despite a presumed increase in anthropogenic aerosol concentration
- Southern Africa has experienced a substantial decrease in cloud cover since 1971 along with a corresponding increase in GEBA SW flux