
July 2, 2004
MEMO TO: Franz-Josef Luebken
Colleagues of the Atmospheric
Coupling Processes “Theme”
FROM: Alan Manson (3.1 Dynamical Coupling, WG)
TOPIC: Research Focus
Plans and Ideas

Phenomena

- I suggest that a focus upon the radiationally unexpected phenomena in the atmosphere 0-110km (lower and middle atmosphere, MA) has enormous advantages. These events are so unique that they require extreme combinations of dynamics, chemistry and radiation to bring them into existence: stratospheric sudden warmings (or in their hemispheric absence, instabilities of the winter polar vortex) and their full atmospheric implications; the cold summer mesopause of extra-tropical latitudes; mesospheric thermal inversions; equinoctial middle atmospheric transitions and their asymmetry about the summer solstice; global couplings associated with El Nino and the Arctic Oscillation; global ozone morphology, including meridional wave-driven circulation patterns; QBO and solar modulations/influences upon all of the above (cf. Ted Shepherd, JASTP, p1587, 2000).
- The hemispheric differences in all of the above must be considered; we are fortunate to live on 'two-planets'.
- The studies must also be inclusive of all latitudes of the planet earth: the equatorial regions have dominant effects upon all of the above, directly or indirectly through dynamical processes.
- The influences of the above phenomena upon Climate Change processes must be strongly in our thinking and strategies. Campaigns can be formed around these phenomena.

Causalities

- These phenomena have zeroth level explanations in terms of essential dynamical processes and the interactions of tides, PW and GW–turbulence with each other and the background flow.
- These explanations have now expanded from enlightened arm-waving (STEP), through 2-, 3-d models to complex GCM models, with coupled dynamics-chemistry (PSMOS, EPIC). There have been recent papers of outstanding quality (Sassi et. al. JGR D19, 2002; Liu & Roble JGR D23, 2002; Randel et. al. JAS, p2141, 2002; Liu & Roble, JASTP, p769, 2004) based on beautiful GCMs, which are richly diagnostic and shed light on wave-processes inherent in similar (but modelled) phenomena.
- However, insofar as these models, while increasingly ‘realistic’, do not yet produce middle atmosphere/MLT wave spectra and climatologies convincingly close to observations (radars, lidars, space-based ‘opticals’; e.g. Manson et al JASTP, p65, 2002), improvements in observational campaigns and in coupled-experiments carried out with those models are required during CAWSES.
- Solar influences (storms, 27-d and 11-yr) upon the dynamics, through changes in the tidal forcing (ozone) and possible sun-weather influences upon PW & GW activity should be assessed (cf. “Solar Influences on Climate” theme): this includes changes in atmospheric electricity and MLT electro-dynamic forcing.

Observations

◊Data are required from the lower atmosphere and throughout the middle atmosphere to provide the next level of quantitative understanding. Up to 50 km or so the 'UKMO' (daily mean) products (and other competitive data assimilation products) are invaluable. However the ECMWF 'data' (and its kin), with higher temporal resolution, which allows resolution of higher frequency waves (including tidal information), is required to be more readily available and to 50 km. Increasingly, (other) GCMs e.g. TIME-GCM, CMAM, are being coupled to the real troposphere, to enable calendar-year comparisons with observations in the MA (Models, below).

◊ Radars (MFR, MWR), giving MA winds/ temperatures are increasingly better spaced in latitude and longitude (CUJO at NH mid-latitudes, DATAR at circa 70°N, Antarctica and equatorial systems). However there are serious longitudinal gaps that lead to aliasing problems in wave-number analyses of PW and tides: NH systems are required at Mediterranean and Chinese/Mongolian locations. The longitudinal variability in wave characteristics, associated with PW and non-migrating tides (e.g. Manson et al., Ann Geo p347, 2004; Ann Geo p1529 2004; Sassi et al JGR D19, 2002) are inherent and essential in all of the Phenomena listed above.

◊Wherever possible, optical systems should be co-located with the radars, for dynamical-thermal-chemical studies and analyses. Indeed, their presence at some locations of all latitudes is required to determine the onset of thermally important phenomena/events.

◊***GW observations/climatologies are essential (below, Models)****.)*. Full advantage should be taken of SPARC activity before and during CAWSES.

Satellite missions

◊Their time scales are (normally) too long for development within the life of CAWSES. However, insofar as ILWS is coexisting with us, and is a ‘space agencies’ dominated activity, encouragement to fly some existing ‘systems’ within (or before the end of) CAWSES should be provided to some agencies.

◊ In Canada, GWIM (GW), SWIFT and WaMI (dynamics, waves, chemistry) systems exist; but flight opportunities are required.

◊ Existing missions e.g. TIMED, Odin-OSIRIS can provide important assistance; examples being improved O3 distributions for tidal forcing, and for GCM comparisons.

Models

◊The most sophisticated GCMs (or wave-specific models) must be run for experiments (with 'realistic' tropospheres) that match observational campaigns designed to explore the above phenomena.

◊ Improved GW parameterizations (or comparative experiments with competing schemes (Alexander & Rosenlof, JGR D19, 2003; Manson et. al. JASP p65, 2002) are required to better match observed wave climatologies and therefore realistic wave processes during the observed phenomena.

◊Data assimilation into the MA is a challenging but important activity for GCMs associated with CAWSES.

Conclusion

◊The above would provide opportunities to significantly improve our understanding of **Atmospheric Coupling Processes** (0-100 km).

◊Collaborations with the other CAWSES themes, **"Solar Influence on Climate", Space Weather" and Space Climatology",** are also required to make full benefit of the CAWSES program.

Alan Manson July 2, 2004